List of Community White Papers
and
Additional Contributions Abstracts

OceanObs'09

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Community White Papers

Full drafts of all Community White Papers, as well as draft Plenary Papers/Talks, are available to download from the web site at: http://www.oceanobs09.net/

Community White Papers contribute to multiple Plenary Sessions and Talks, but were given a classification by Plenary Session reflected below by the organizers to group them thematically for viewing as posters during the conference

Day 2: Scientific results and potential based on global observations

Session 2A: Large-scale ocean properties: science, observations and impacts

CWP-2A-01 An Integrated International Approach to Arctic Ocean Observations for Society (A Legacy of the International Polar Year)

Calder, J.; Proshutinsky, A.; Carmack, E.; Ashik, I.; Loeng, H.; Key, J.; McCammon, M.; Melling, H.; Perovich, D.; Eicken, H.; Johnson, M.; Rigor, I.

CWP-2A-02 A Global Ocean Acoustic Observing Network

Dushaw, B.; Au, W.; Beszczynska-Möller, A.; Brainard, R.; Cornuelle, B.; Duda, T.; Dzieciuch, M.; Fahrbach, E.; Forbes, A.; Freitag, L.; Gascard, J.-C.; Gavrilov, A.; Gould, J.; Howe, B.; Jayne, S.; Johannessen, O.M.; Lynch, J.; Martin, D.; Menemenlis, D.; Mikhalevsky, P.; Miller, J.H.; Munk, W.H.; Nystuen, J.; Odom, R.; Orcutt, J.; Rossby, T.; Sagen, H.; Sandven, S.; Simmen, J.; Skarsoulis, E.; Stephen, R.; Vinogradov, S.; Wong, K.B.; Worcester, P. F.; Wunsch, C.

CWP-2A-03 Argo - A Decade of Progress

Freeland, H; Roemmich, D; Garzoli, S; LeTraon, P; Ravichandran, M; Riser, S; Thierry, V; Wijffels, S; Belbeoch, M; Gould, J; Grant, F; Ignazewski, M; King, B; Klein, Birgit; Mork, K; Owens, B; Pouliquen, S; Sterl, A; Suga, T; Suk, M; Sutton, P; Troisi, A; Velez-Belchi , P; Xu, J

CWP-2A-04 Progressing towards global sustained deep ocean observations

Garzoli Silvia, L.; Boebel, Olaf; Bryden, Harry; Fine , Rana A.; Fukasawa, M.; Gladyshev, S.; Johnson, Greg; Johnson, Mike; MacDonald, Alexander; Meinen, Christopher; Mercier, Herle; Orsi, Alejandro; Piola, Alberto; Rintoul , Steve; Speich, Sabrina; Visbeck, Martin; Wanninkhof , Rik

CWP-2A-05 The Ship Of Opportunity Program

Goni, G.; Roemmich, Dean; Molinari, Robert; Meyers, Gary; Rossby, Thomas; Sun, Charles; Boyer, Tim; Baringer, Molly; Garzoli, Silvia; Vissa, Gopalakrishna; Swart, Sebastiaan; Keeley, Robert; Maes, Christophe

CWP-2A-06 Interocean Exchange of thermocline water: Indonesian Throughflow; “Tassie” Leakage; Agulhas Leakage

Gordon A.; Wijffels S.; Sprintall J.; Susanto D.; Molcard R.; Van Aken H.; Ffield A.; De Ruijter W.; Lutjeharms J.; Speich S.; Beal L.

CWP-2A-07 Problems and Prospects in Large-Scale Ocean Circulation Models

Griffies, S.; Adcroft, A.; Gnanadesikan, A.; Hallberg, R.; Harrison, M.; Legg, S.; Little, C.; Nikurashin, M.; Pirani, A.; Samuels, B.; Toggweiler, J.; Vallis, G.; White, L.

CWP-2A-08 The ICES Working Group on Oceanic Hydrography: building on over 100 years of North Atlantic observations

Holliday, N.P.; Hughes, S.L.; Nolan, G.; Østerhus, S.; Trofimof, A.; Valdimarsson, H.

CWP-2A-09 Ship-based Repeat Hydrography: A Strategy for a Sustained Global Program.

Hood, M.; Fukasawa, M; Gruber, N.; Johnson, G.; Sabine, C.; Sloyan, B.; Stansfield, K.; Tanhua, T.

CWP-2A-10 The Global Tropical Moored Buoy Array

M. J. McPhaden, K. Ando, B. Bourles, H. P. Freitag, R. Lumpkin, Y. Masumoto, V. S. N. Murty, P. Nobre, M. Ravichandran, J. Vialard, D. Vousden, W. Yu

CWP-2A-11 Observing Systems in the Indian Ocean

Masumoto, Y.; Yu, W.; Meyers, G.

CWP-2A-12 The Global Sea Level Observing System (GLOSS)

Merrifield, M.; Aarup, T.; Aman, A.; Mitchum, G.; Rickards, L.; Schöne, T.; Woodworth, P.; Woppelmann, G.

CWP-2A-13 Observations of Sea Level Change: What have we learned and what are the remaining challenges?

Nerem, R.; Chambers, D.; Leuliette, E.; Mitchum, G.; Merrifield, M.; Willis, J.

CWP-2A-14 Future observations for monitoring global ocean heat content

Palmer, M.; Haines, K.; Antonov, J.; Barker, P.; Bindoff, N.; Boyer, T; Carson, M.; Domingues, C.; Gille, S.; Gleckler, P.; Gouretski, V.; Guinehut, S.; Harrison, D.E.; Ishii, M.; Johnson, G.; Levitus, S.; Lozier, S.; Lyman, J.; Meijers, A.; Smith, D.; Wijffels, S.; Willis, J.

CWP-2A-15 Evaluating climate variability and change from modern and historical SST observations

Rayner, N. A.; Kaplan, A.; Kent, E.C.; Reynolds, R.W.; Brohan, P.; Casey, K.S.; Kennedy, J.J.; Woodruff, S.D.; Smith, T.M.; Donlon, C; Breivik, L.A.; Eastwood, S.; Ishii, M.; Brandon, T.

CWP-2A-16 Geodetic Observations of Ocean Surface Topography, Ocean Currents, Ocean Mass, and Ocean Volume Changes

Shum, C. K.; Emery, William; Cazenave, Anny; Chamber, Don; Gouretski, Viktor; Gross, Richard; Huges, Chris; Ishii, Masayoshi; Jayne, Steven; Kuo, Chungyen; Leuliette, Eric; Maximenko, Nikolai; Morison, James; Plag, Hans-Peter; Levitus, Sydney; Rothacher, Markus; Rummel, Reiner; Schroter, Jens; Sideris, Michael; Song, Y. Tong; Shibuya, Kazuo; Willis, Josh; Woodworth, Philip; Zlotnicki, Victor

CWP-2A-17 Ocean Variability evaluated from an Ensemble of Ocean Syntheses

Stammer, Detlef; Köhl, Armin; Awaji, T.; Balmaseda, M.; Behringer, D.; Carton, J.; Ferry, N.; Fischer, A.; Fukumori, I.; Gise, B.; Haines, K.; Harrison, D.E.; Heimbach, P.; Kamachi, M.; Keppenne, C.; Lee, T.; Masina, S.; Menemenlis, D.; Ponte, R.; Remy, E.; Rienecker, M.; Rosati, A., Schröter, J.; Smith, D.; Weaver, A.; Wunsch, C.; Xue, Y.

CWP-2A-18 Data buoy observations: the status quo and anticipated developments over the next decade

Meldrum, D; Wallace, A.; Rolland, J; Burnett, W.; Lumpkin, R.; Niller, P.; Viola, H.; Charpentier, E.; Fedak, M.

Day 2: Scientific results and potential based on global observations

Session 2B: Large-scale ocean circulation and fluxes

CWP-2B-01 Monitoring ocean - atmosphere interactions in western boundary current extensions

Cronin, M. F.; Bond, N.; Booth, J.; Ichikawa, H.; Joyce, T.; Kelly, K.; Kubota, M.; Qiu, B.; Reason, C.; Sabine, C.; Saino, T.; Suga, T.; Talley, L. D.; Thompson, L.; Weller, R. A.

CWP-2B-02 The present and future system for measuring the Atlantic meridional overturning circulation and heat transport

Cunningham, S.; Baringer, M.; Toole, J.; Osterhaus, S.; Fisher, J.; Piola, A.; McDonagah, E.; Lozier, S.; Send, U.; Kanzow, T.; Marotzke, J.; Rhein, M.; Garzoli, S.; Rintoul, S.; Speich, S.; Wijffels, S.; Talley, L.; Baehr, J.; Meinen, C.; Treguier, A-M.; Lherminier, P.

CWP-2B-03 Observations to Quantify Air-Sea Fluxes and Their Role in Climate Variability and Predictability

Fairall, C.; Barnier, B; Berry, B.; Bourassa, M.; Bradley, F.; Clayson, C.; de Leeuw, G.; Drennan, W.; Gille, S.; Gulev, S.; Kent, E.; McGillis, W.; Ryabinin, V.; Smith, S.; Weller, R.; Yelland, M.; Zhang, H.-M.

CWP-2B-04 Using global arrays to investigate internal-waves and mixing

Jennifer MacKinnon, Matthew Alford, Pascale Bouruet-Aubertot, Nathan Bindoff, Shane Elipot, Sarah Gille, James Girton, Mike Gregg, Eric Kunze, Alberto Naveira Garabato, Helen Phillips, Rob Pinkel, Kurt Polzin,Tom Sanford, Harper Simmons, Kevin Speer

CWP-2B-05 Combining satellite altimetry, time-variable gravity, and bottom pressure observations to understand the Arctic Ocean

Kwok, R.; Farrell, S.; McAdoo, D.; Farrell, S.; Laxon, S.; Morison, J.; Steele, M.; Peralta-Ferriz, C.; Proshutinsky, A.; Forsberg, R.; Padman, L.

CWP-2B-06 Measuring the global ocean surface circulation with satellite and in situ observations

Lagerloef, G; Dohan, K.; Bonjean, F.; Centurioni, L.; Cronin, M.; Lee, D.; Lumpkin, R.; Maximenko, N; Uchida, H

CWP-2B-07 Southern Ocean Observing System (SOOS): Rationale and strategy for sustained observations of the Southern Ocean

Rintoul, S., Kevin Speer, Eileen Hofmann, Mike Sparrow, Mike Meredith, Eberhard Fahrbach, Anthony Worby, Matthew England, Richard Bellerby, Taco de Bruin, Alberto Naveira Garabato, Graham Hosie, Keith Alverson, Sabrina Speich, Dan Costa, Julie Hall, Mark Hindell, Hyoung Chul Shin, Vladimir Ryabinin, Sergei Gladyshev, Kate Stansfield

CWP-2B-08 A global boundary current circulation observing network

Send, U.; Davis, R.; Fischer, J.; Imawaki, S.; Kessler, W.; Meinen, C.; Owens, B.; Roemmich, D.; Rossby, T.; Rudnick, D.; Toole, J.; Wijffles, S.; Beal, L.

CWP-2B-09 OceanSITES

Send, U.; Weller, R.; Wallace, D.; Chavez, F.; Lampitt, R.; Dickey, T.; Honda, M.; Nittis, K.; Lukas, R.; McPhaden, M.; Feely, R.

Day 2: Scientific results and potential based on global observations

Session 2C: Biochemistry and ecosystems

CWP-2C-01 A global sea surface carbon observing system: inorganic and organic carbon dynamics in coastal oceans

Borges, A.V.; Alin, S.R.; Chavez, F.P.; Vlahos, P.; Johnson, K.S.; Holt, J.T.

CWP-2C-02 Sensors and Systems for Observations of Marine CO2 System Variables

Byrne, R.; DeGrandpre, M.; Short, T.; Martz, T.; McNeil, C.; Sayles, F.

CWP-2C-03 New insights into Southern Ocean physical and biological processes revealed by instrumented elephant seals.

Charrassin, J.-B.; Roquet, F.; Park, Y.-H.; Bailleul, F.; Guinet, C.; Meredith, M.; Nicholls, K; Thorpe, S.; McDonald, B.; Tremblay, I.; Costa, D.P.; Goebel, M.; Muelbert, M.; Bester, M.N.; Plötz , J.; Bornemann, H.; Timmermann , R.; Hindell, M.; Meijers, A.; Coleman, R.C.; Field, I.C.; McMahon, C.M.; Rintoul, S.R.; Sokolov, S.; Boehme, L.; Lovell, P.; Fedak, M.A.; Biuw, M.; Nost, O.A.; Lydersen, C.; Kovacs, K.M.

CWP-2C-04 An International Observational Network for Ocean Acidification

Feely, R.A.; Fabry, V.; Dickson, A.; Gattuso, J.-P; Bijma, J.; Riebesell, U.; Doney, S.; Turley, C.; Saino, T.; Lee, K.; Anthony, K.; Kleypas, J.

CWP-2C-05 Toward a global ocean ecosystem Mid-trophic Automatic Acoustic Sampler (MAAS)

Handegard, N.O.; Demer, David; Kloser, Rudy; Lehodey, Patrick; Maury, Olivier; Simard, Yvan

CWP-2C-06 Benthic biology time-series in the deep sea: Indicators of change

Larkin, K; Ruhl, H A

CWP-2C-06 Observational Needs of Dynamic Green Ocean Models

Le Quere, C; Sathyendranath, S; Bopp, L; Buitenhuis, E.T.; Doney, S; Dutkiewicz, S; Geider, R; Harrison, S; Klaas, C; Legendre, L; Pesant, S; Platt, T; Prentice, I.C.; Rivkin, R; Vogt, M; Wolf-Gladrow, D; Yamanaka, Y

CWP-2C-07 Building a Global System of Systems for the Coastal Ocean

Malone, T.; DiGiacomo, P.; Muelbert, J.; Parslow, J.; Sweijd, N.; Yanagi, T.; Yap, H.; Blanke, B.

CWP-2C-08 A global sea surface carbon observing system: assessment of changing sea surface CO2 and air-sea CO2 fluxes

Monteiro, P.M.S.; Schuster, U.; Lenton, A.; Tilbrook, B.; Sabine, C.L.; Wanninkhof, R.; Takahashi, T.; Hood, M.; Olsen, A.; Bender, M.; Yoder, J.; Rogers, K.; Watson, A.J.

CWP-2C-09 Adding oxygen to Argo: Developing a global in-situ observatory for ocean deoxygenation and biogeochemistry

"Nicolas Gruber, Scott C. Doney, Steven R. Emerson, Denis Gilbert, Taiyo Kobayashi, Arne Körtzinger, Gregory C. Johnson, Kenneth S. Johnson, Stephen C. Riser, and Osvaldo Ulloa"

CWP-2C-10 Technology Legacy of the Census of Marine Life

Rogers, A.; Urban, E.; Best, M.; Farmer, D.; Fedak, M.; German, C.; Gunn, J.; Halpin, P.; Lewis, M.; Vanden Berghe, E.

CWP-2C-11 TOPP: Using Electronic tags to monitor the movements, behaviour and habitats of marine vertebrates

Costa, D.P.; Block, B.A.; Bograd, S

Day 3: Delivering services to society

Session 3A: Information and Assessment

CWP-3A-01 Observations as Assets in Decision Support

Beegle-Krause, C.; Allen, A.; Bub, F.; Christensen, J; Howlett, E.; Glenn, S.; Kohut, S.; Schofield, O.; Terrill, E.; Thomas, J.; Tintore, J.

CWP-3A-02 An International Network of Coral Reef Ecosystem Observing Systems (I-CREOS)

Brainard, R.E.; Bainbridge, S.; Brinkman, R.; Eakin, M.; Field, M.; Gattuso, J-P; Gledhill, D.; Gramer, L.; Hendee, J.; Hoeke, R.; Holbrook, S.; Hoegh-Guldberg, O.; Lammers, M.; Manzello, D.; McManus, M.; Moffitt, R.; Monaco, M.; Morgan, J.; Obura, D.; Planes, S.; Schmitt, R.; Steinberg, C.; Sweatman, H.; Vetter, O.; Wong, K.

CWP-3A-03 Societal Applications in Fisheries and Aquaculture using Remotely-Sensed Imagery – The SAFARI project

Forget, M.-H.; Platt, T.; Stuart, V.; Sathyendranath, S.

CWP-3A-04 GODAE OCEANVIEW: From an experiment towards a long-term International program for ocean analysis and forecasting

Le Traon, P.Y.; Bell, Mike; Dombrowsky, Eric; Schiller, Andreas; Wilmer Becker, Kirsten

CWP-3A-05 Development of delivery of services from ocean observing systems – an opportunity to promote common approaches

Seim, H.; Dahlin, H.; Meyers, G.; Shuford, R.; Proctor, R.

Day 3: Delivering services to society

Session 3B: Forecasting

CWP-3B-01 Initialization for Seasonal and Decadal Forecasts

Balmaseda, M.; Aves, O.; Awaji, T.; Behringer, D.; Ferry, N.; Fujii, Y.; Lee, T.; Rienecker, M.8; Rosati, T.; Stammer, D.; Smith, D.; Molteni, F.

CWP-3B-02 Requirements of numerical weather prediction for observations of the oceans

Eyre, J; Andersson, E; Charpentier, E; Ferranti, L; Lafeuille, J; Ondras, M; Pailleux, J; Rabier, F; Riishojgaard, L P

CWP-3B-03 Decadal Climate Prediction: Opportunities and Challenges

Hurrell, J.; Delworth, T.; Danabasoglu, G.; Drange, H.; Griffies, S.; Holbrook, N.; Kirtman, B.; Keenlyside, N.; Latif, M.; Marotzke, J.; Meehl, G.; Palmer, T.; Pohlmann, H.; Rosati, T.; Seager, R.; Smith, D.; Sutton, R.; Timmermann, A.; Trenberth, K.; Tribbia, J.

CWP-3B-04 Dynamics of Decadal Climate Variability and Implications for its Prediction

Latif, M.; Delworrth, T.; Dommenget, D.; Drange, H.; Hazeleger, W.; Hurrell, J.; Keenlyside, N.; Meehl, G.; Sutton, R.

CWP-3B-05 Ocean Observing System Evaluation

Oke, P; Balmaseda, M; Benkiran, M; Cummings, J; Dombrowsky, E; Fujii, Y; Guinehut, S; Larnicol, G; Le Traon, P-Y; Martin, M

CWP-3B-06 Ocean State Estimation for Global Ocean Monitoring: ENSO and beyond ENSO

Xue, Y.; McPhaden, M.; Lee, T.; Balmaseda, M.; Alves, O.; Ishikawa, I.

Day 3: Delivering services to society

Session 3C: Hazards, Impacts and Management

CWP-3C-01 The ocean observing system for tropical cyclone intensification forecasts and studies

Goni, G.; DeMaria, M.; Knaff, J.; Sampson, C.; Price, J.; Mehra, A.; Ginis, I.; Lin, I-I.; Sandery, Paul; Ramos-Buarque, S.; Ali, M.M.; Kang, K.R.; Lumpkin, R.; Halliwell, G.; Lauer, C.; Bringas, F.; Mavume, A.

CWP-3C-02 The California Cooperative Oceanic Fisheries Investigations (CalCOFI): the continuing evolution and contributions of a 60-year ocean observation program

J. Anthony Koslow, Ralf Goericke Sam McClatchie, Russ Vetter and Laura Rogers-Bennett

CWP-3C-03 Observations as decision support for coastal management in response to local sea level changes

Plag, H.-P.; Adegoke, J.; Bruno, M.; Christian, R.; Digiacomo, P.; McManus, L.; Nicholls, R.; van de Wal, R.

CWP-3C-04 Storm Surge

Swail, V.; Lee, B.; Soares, A.; Resio, D.; Horsburgh, K.; Murty, T.; Dube, S.; Entel, M.; Flowerdew, J.

CWP-3C-05 Wave measurements, needs and developments for the next decade

Swail, V; Jensen, R; Lee, B; Meldrum, D; Turton, J; Gulev, S; Yelland, M; Thomas, J; Etala, P; Warren, G; Birkemeier, W; Burnett, W

Day 4: Developing technology and infrastructure

Session 4A: In situ

CWP-4A-01 In situ nutrient sensors for ocean observing systems

Adornato, L.; Cardenas-Valencia, A.; Kaltenbacher, E.; Byrne, R.H.; Daly, K.; Larkin, K.; Hartman, S.; Mowlem, M.; Prien, R.D.

CWP-4A-02 Biologging in the Global Ocean Observing System

Boehme, L.; Kovacs, K.; Lydersen, C.; Nøst, O.A.; Biuw, M.; Charrassin, J.-B.; Roquet, F.; Guinet, C.; Meredith, M.; Nicholls, K.; Thorpe, S.; Costa, D.; Block, B.; Hammill, M.; Stenson, G.; Muelbert, M.; Bester, M.; Plötz, J.; Bornemann, H.; Hindell, M.; Rintoul, S.; Fedak, M.; Lovell, P.

CWP-4A-03 Sensor Needs and Readiness Levels for Ocean Observing: An Example from the Ocean Observatories Initiative (OOI)

Brasseur, L; Tamburri, M

CWP-4A-04 Bio-optical profiling floats as new observational tools for biogeochemical and ecosystem studies

Claustre, Herve; Bishop, J.; Boss, E; Stewart, B; Berthon, J.-F.; Coatanoan, C; Jonhson, K; Lotiker, A; Ulloa, O; Perry, M.-J.; Dortenzio, F; Hembise Fanton D'Andon, O; Uitz, J

CWP-4A-05 Seafloor Observatory Science

Favali, P.; Person, R.; Barnes, C.; Kaneda, Y.; Delaney, J.R.; Hsu, S.

CWP-4A-06 The Way Forward in Developing and Integrating Ferrybox Technologies

Hydes, D.J.; Colijn, F.; Petersen, W.; Schroeder, F.; Mills, D.K.; Durand, D.; Wehde, H.; Sørensen, K.; Morrison, G.

CWP-4A-07 The Voluntary Observing Ship Scheme

Kent, E.; Ball, Graeme; Berry, David; Fletcher, Julie; North, Sarah; Woodruff, Scott

CWP-4A-08 Autonomous Platforms in the Arctic Observing Network

Lee, C. M.; Melling, H.; Eicken, H.; Schlosser, P.; Gascard, J. C.; Proshutinsky, A.; Fahrbach, E.; Mauritzen, C.; Morison, J.; Polykov, I.

CWP-4A-09 The Ocean Tracking Network

O'Dor, R.; Stokesbury, M.; Smith, P.; Jonsen, I.; Whoriskey, F.; Payne, J.

CWP-4A-10 Optical plankton imaging and analysis systems for ocean observation

Sieracki, ME; Benfield, M; Hanson, A; Davis, C; Pilskaln, CH; Checkley, D; Sosik, HM; Ashjian, C; Culverhouse, P; Cowen, R; Lopes, R; Balch, W; Irigoien, X

CWP-4A-11 Automated Underway Oceanic and Atmospheric Measurements from Ships

Smith, S.; Bourassa, M.; Bradley, F.; Kent, E.; Fairall, C.; Goni, G.; Gunn, J.; Hood, M.; Jackson, D.; Lagerloef, G.; Petit de la Villeon, L.; McGillivary, P.; Pinker, R.; Sprintall, J.; Stammer, D.; Weill, A.; Wick, G.; Yelland, M.; Schulz, E.; Cosca, C.

CWP-4A-12 Gliders as a component of future observing systems

Testor, P.; Meyers, G.; Pattiaratchi, C.; Bachmayer, R.; Hayes, D.; Pouliquen, S.; Petit de la Villeon, L.; Carval, T.; Ganachaud, A.; Gourdeau, L.; Mortier, L.; Claustre, H.; Taillandier, V.; Lherminier, P.; Terre, T.; Visbeck, M.; Krahman, G.; Karstensen, J.; Alvarez, A.; Rixen, M.; Poulain, P.M.; Osterhus, S.; Tintore, J.; Ruiz, S.; Garau, B.; Smeed, D.; Griffiths, G.; Merckelbach, L.; Sherwin, T.; Schmid, C.; Barth, J.A.; Schofield, O.; Glenn, S.; Kohut, J.; Perry, M.J.; Eriksen, C.; Send, U.; Davis, R.; Rudnick, D.; Sherman, J.; Jones, C.; Webb, D.; Lee, C.; Owens, B.; Fratantoni, D.

Day 4: Developing technology and infrastructure

Session 4B: Satellite

CWP-4B-01 Remotely sensed winds and wind stresses for marine forecasting and ocean modeling

Bourassa, M; Bonekamp, H; Chang, P; Chelton, D; Edson, R; Fraklin, J; He, Y; Hersbach, H; Hilburn, K; Lee, T; Liu, W; Long, D; Kelly, K; Knabb, R; Lehner, S; Perrie, W; Portabella, M; Powell, M; Rodriguez, E; Smith, D; Stoffelen, A; Swail, V; Wentz, F; Courtney, J

CWP-4B-02 Integrating satellite altimetry and key observations: what we've learned, and what's possible with new technologies

Bourassa, Mark; Chelton, Dudley; Cipollini, Paolo; Ferrari, Raffaele; Fu, Lee-Lueng; Galperin, Boris; Gille, Sarah; Huang, Huei-Ping; Klein, Patrice; Maximenko, Nikolai; Morrow, Rosemary; Qiu, Bo; Rodriguez, Ernesto; Scott, R.; Stammer, Detlef; Tailleux, Remi; Wunsch, Carl

CWP-4B-03 Remote Sensing of Sea Ice

Breivik, L.A.; Eastwood, S.; Girard-Ardhuin, F.; Karvonen, J.; Kwok, R.4; Meier, W.; Mäkynen, M.; Pedersen, L.T.; Similä, M.; Tonboe, R.6; Carrieres, T.; Fleming, A.

CWP-4B-04 The Role of Altimetry in Coastal Observing Systems

Cipollini, P.; Benveniste, J.; Bouffard, J.; Emery, W.; Gommenginger, C.; Griffin, D.; Høyer, J.; Madsen, K.; Mercier, F.; Miller, L.; Pascual, A.; Ravichandran, M.; Shillington, F.; Snaith, H.; Strub, T.; Vandemark, D.; Vignudelli, S.; Wilkin, J.; Woodworth, P.; Zavala-Garay, J.

CWP-4B-05 Successes and Challenges for the Modern Sea Surface Temperature Observing System

Donlon, C; Casey, K; Gentemann, C; LeBorgne, P; Robinson, I; Reynolds, R; Merchant, C; Llewellyn-Jones, D; Minnett, P; Piolle, J; Cornillon, P; Rayner, N; Brandon, T; Vazquez, J; Armstrong, E; Beggs, H; Barton, I; Wick, G; Castro, S; Hoeyer, J; May, D; Arino, O; Poulter, D; Evans, R; Mutlow, C; Bingham, A; Harris, A

CWP-4B-06 The SWOT (Surface Water Ocean Topography) Mission

Fu, L.L.; Alsdorf, D.; Rodriguez, E.; Morrow, R.; Mognard, N.; Lambin, J.; Vaze, P.; Lafon, T.

CWP-4B-07 ChloroGIN: Use of satellite and in situ data in support of ecosystem-based management of marine resources

Hardman-Mountford, N; Ahanhanzo, J; Bernard, S; Byfield, V; Dowell, M; Field, John; Groom, S; Hoepffner, N; Jacobs, T; Kampel, M; Kumar, S; Lutz, V; Platt, T

CWP-4B-08 Resolving the global surface salinity field and variations by blending satellite and in situ observations

Lagerloef, G.; Boutin, J.; Carton, J.; Chao, Y.; Delcroix, T.; Font, J.; Lilly, J.; Reul, N.; Schmitt, R.; Wentz, F.

CWP-4B-09 Ocean Surface Topography Constellation: The Next 15 Years in Satellite Altimetry

Wilson, S.; Parisot, F.; Escudier, P.; Fellous, J.L.; Benveniste, J.; Bonekamp, H.; Drinkwater, M.; Fu, L.; Jacobs, G.; Lin, M.; Lindstrom, E.; Miller, L.; Sharma, R.; Thouvenot, E.

CWP-4B-10 The Ocean Colour Radiance Virtual Constellation (OCR-VC)

Yoder, J.; Dowell, M.; Hoepffner, N.; Murakami, H.; Stuart, V.; Yoder, J.; Dowell, M; Hoepffner, N.; Murakami, H; Stuart, V

Day 4: Developing technology and infrastructure

Session 4C: Information Synthesis and Delivery

CWP-4C-01 The JCOMM in situ Observing Platform Support Centre: A decade of progress and remaining challenges

Belbeoch, M; Viola, H; Clark, C; Fellous, J.L.; Dexter, P; Charpentier, E; Alverson, K; Freeland, H; Meldrum, D

CWP-4C-02 Ocean and Coastal Data Management

de La Beaujardiere, J; Beegle-Krause, C. J.; Bermudez, L; Hankin, S; Hazard, L; Howlett, E; Le, S; Proctor, R; Signell, R. P.; Snowden, D; Thomas, J.

CWP-4C-03 Evolution in data and product management for serving operational oceanography, a GODAE feedback

F. Blanc, V. Baralle, J.D. Blower, E; Bronner, R. Clancy, P. Cornillon, J. deLaBeaujardiere, C. Donlon, A. Gemmel, P. Hacker, K. Haines, S.C. Hankin, R. Keeley, O. Lauret, T. Loubrieu, S. Pouliquen, M. Price, T. Pugh, A. Srinavasan

CWP-4C-04 Integrating QA/QC into Open GeoSpatial Consortion Sensor Web Enablement

Fredericks, J.; Botts, M.; Bermudez, L.; Bosch, J.; Bogden, P.; Bridger, E.; Cook, T.; Graybeal, J.; Haines, S.; Rueda, C.; Waldmann, C.

CWP-4C-05 Ocean Data Portal: a standards approach to data access and dissemination

Greg, Reed; Keeley , Robert; Belov, Sergey; Mikhailov, Nikolay

CWP-4C-06 NetCDF-CF-OPeNDAP: Standards for Ocean Data Interoperability and Object Lessons for Community Data Standards Processes

Hankin, S., Jon D. Blower, Theirry Carval, Kenneth S. Casey, Craig Donlon, Olivier Lauret, Thomas Loubrieu, Loic Petit de la Villeon, A. Srinivasan, Joaquin Trinanes, Øystein Godøy, Roy Mendelssohn, Rich Signell, Jeff de La Beaujardiere, Peter Cornillon, Frederique Blanc, Russ Rew

CWP-4C-07 Observational requirements for global-scale ocean climate analysis: lessons learnt from ocean state estimation

Heimbach, Patrick; Forget, G.; Ponte, R.M.; Wunsch, C.; Balmaseda, M.; Stammer, D.; Awaji, T.; Behringer, D.; Carton, J.; Ferry, N.; Fischer, A.; Fukumori, I.; Giese, B.; Haines, K.; Harrison, Ed.; Hernandez, F.; Kamachi, M.; Keppenne, C.; Koehl, A.; Lee, T.; Menemenlis, D.; Oke, P.; Remy, E.; Rienecker, M.; Rosati, A.; Smith, D.; Speer, K.; Weaver, A.; Baehr, J.

CWP-4C-08 Data Management System for Surface Drifters

Keeley, R; Pazos, M; Bradshaw, B

CWP-4C-09 Ocean State Estimation for Climate Research

Lee, T.; Stammer, D.; Awaji, T.; Balmaseda, M; Behringer, D; Carton, J; Ferry, N.; Fischer, A.; Fukumori, I.; Giese, B.; Haines, K.; Harrison, E.; Heimbach, P.; Kamachi, M.; Keppenne, C.; Köhl, A.; Masina, S.; Menemenlis, D.; Ponte, R.; Remy, E.; Rienecker, M.; Rosati, A.; Schroeter, J.; Smith, D.; Weaver, A.; Wunsch, C.; Xue, Y.

CWP-4C-10 Ocean and Coastal Data Stewardship

Margarita Conkright Gregg,; Newlin, M; Casey, K; Levitus, S; Boyer, T; Tielking, T; Allegra, A; Roby, E; Beard, R; Bosch, J; LeDuc, S; Ji, M; Keeley, R; Pissierssens, P

CWP-4C-11 Argo Data Management

Pouliquen, S; Wong , A; Schmid, C; Guinehut, S; Belbeoch, M

CWP-4C-12 The Data Management System for the Shipboard Automated Meteorological and Oceanographic System (SAMOS) Initiative

Smith, S.; Bourassa, M.; Rettig, J.; Rolph, J.; Kent, E.; Schulz, E.; Verein, R.; Rutz, S.; Paver, C.

CWP-4C-13 Metadata Management in Global Distributed Ocean Observation Networks

Snowden, D.; Belbeoch, M; Burnett, B; Carval, T; Graybeal, J; Habermann, T; Snaith, H; Viola, H; Woodruff, S

CWP-4C-14 The Data Management System for the Global Temperature and Salinity Profile Programme

Sun, C; Baldoni, A; Carval, T; Chinn, P; Cowen, L; Goni, G; Gopalakrishna, V; Guerrero, R; Hall, N; Hamilton, M; Ji, F; Kanno, Yoshiaki; Keeley, R; Klein, B; Lin, S; Manzella, G; Nagaya, Y; Reseghetti, F; Rickards, L; Tran, A; Thresher, A.

CWP-4C-15 Atmospheric reanalyses: a major resource for ocean product development and modeling

Trenberth, K; Dole, R; Xue, Y; Onogi, K; Dee, D; Balmaseda, M; Schubert, S; Large, W.

CWP-4C-16 Integrating biological data into ocean observing systems: the future role of OBIS

Vanden Berghe, E.; Halpin, P.; Lang da Silveira, F.; Stocks, K.; Grassle, J.F.

CWP-4C-17 Quality Assurance of Real-Time Ocean Data (QARTOD)

William Burnett, W; Richard Crout, R; Mark Bushnell, M; Julie Thomas, J; Janet Fredricks, J; Julie Bosch, J; Christoph Waldmann, C

CWP-4C-18 Surface In situ Datasets for Marine Climatological Applications

Woodruff, S.D.; Scott, N.; Berry, D.I.; Bourassa, M.A.; Gulev, S.; Haar, H.; Kent, E.C.; Reynolds, R.W.; Rosenhagen, G.; Rutherford, M.; Swail, V.; Worley, S.J.; Zhang, H-M.; Zollner, R.

CWP-4C-19 The Role of ICOADS in the Sustained Ocean Observing System

Worley, S.J.; Woodruff, S.D.; Lubker, S.J.; Ji, Z.; Freeman, J.E.; Kent, E.C.; Brohan, P.; Berry, D.I.; Smith, S.R.; Wilkinson, C.; Reynolds, R.W.

Additional Contributions

Day 2: Scientific results and potential based on global observations

Session 2A: Large-scale ocean properties: science, observations and impacts

AC-2A-01: Error Estimation of the Regional Mean Sea Level Trends From Altimetry Data

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1CLS, FRANCE;
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The global mean sea level (MSL) provided by satellite altimetry (TOPEX/Poseidon and Jason-1) is used as the reference to calculate the ocean elevation. From these data updated with the best geophysical corrections and the best altimeter data, a global rate of 3.4 mm is obtained over the 15 year period from 1993 to 2009 applying the post glacial rebound (MSL aviso website http://www.jason.oceanobs.com/msl). Besides, the regional sea level trends bring out an inhomogeneous repartition of the ocean elevation with local MSL slopes ranging from +/- 10 mm/year.
In this study, we have analyzed and estimated the different errors which can impact the regional MSL trends. The potential drifts detected in the orbit models and in the geophysical corrections as the wet troposphere and atmospheric corrections are the main sources of error impacting the MSL trends. The use of different orbit solutions provided by JPL, CNES and GSFC allowed to estimate the MSL slope uncertainty, highlighting a north/south hemispheric effect on the regional MSL slope close to +/- 2 mm/year. Concerning the geophysical corrections, a similar method is applied using different meteorological models (NCEP, ECMWF, ERA40) bringing out regional MSL slope error close to +/- 1 mm/year. Other sources of regional slope discrepancies have been registered and estimated as the error due to the sea surface height (SSH) bias to connect the different MSL time series provided by Jason-1 and TOPEX, but also by TOPEX using altimeter-A and altimeter-B. The SSH bias is indeed associated with an error leading directly to an error on the MSL trend calculation. Finally, the combination of each error provides an error estimation of the regional MSL trends. Using a statistical approach from an inverse method (Bretherton et al;, 1976) allows us to calculate a map of these realistic errors with a confidence interval.

AC-2A-02: Current and Future of Tropical Ocean Climate Study (TOCS) and Triangle Trans-Ocean Buoy Network (TRITON) Buoy Array

Ando, Kentaro[1]; Ishihara, Yasuhisa[2]; Mizuno, Keisuke[1]; Masumoto, Yukio[1]; Baba, Shoichiro[2]; Hase, Hideaki[1]; Hasegawa, Takuya[1]; Horii, Takanori[1]; Iskandar, Iskhaq[1]; Kashino, Yuji[1]; Takahashi, Naoko[2]; Takahashi, Yukio[2]; Ueki, Iwao[1]; Yamaguchi, Masayuki[2]
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This paper describes the past, current and future activities of both scientific TOCS project and technical and operational TRITON buoy project in JAMSTEC. These two projects have been linked each other for the purpose to promote the understanding ocean climate variations and ocean circulations in the Indo-Pacific regions, and to contribute to monitor El Nino/Southern Oscillation (ENSO) phenomena with the TAO array in the Pacific Ocean.

The scientific TOCS project started in 1993 aimed originally to understand surface ocean circulation in the western Pacific by using sub-surface ADCP moorings in the western boundary and on the equator. In this project, we have also joined international efforts to maintain the TAO array, and routinely serviced the TAO array along 165E, 156E, 147E and 138E lines in 1993-1999. In 1998, the replacement of TAO-ATLAS buoy to TRITON buoys along 156E, 147E, 138E has started. After the data comparison between TRITON buoys and ATLAS buoys along 156E in 1999, TRITON buoy array became part of the present TAO/TRTION buoy array starting 2000. In the Indian Ocean, we have been deploying one subsurface ADCP mooring at 0-90E since 2000 in the TOCS project. Two TRITON buoys at 1.5S-90E and 5S-95E have also been deployed since 2001. The dataset of surface current profile by ADCP has been accumulated for last 8 years, the longest time series in the Indian Ocean.

In more than 15 years activity, many scientific results regarding to the variations in the western Pacific Ocean and the eastern Indian Ocean could be obtained mainly from above mentioned moored buoy data and ship observation data, and these scientific results have been contributed to better understanding of the ocean climate variations such as the El Nino/Southern Oscillation phenomena and the Indian Ocean Dipole mode. For example, the datasets of ADCP current profiles and subsurface temperature and salinity data of TRITON buoys in the eastern Indian ocean could capture the ocean variability associated with three Indian Ocean Dipole modes occurred in 2006, 2007, and 2008.

The TRITON buoy project is the corporative project with the TOCS project in terms of buoy operations and developments of buoy technology. In 1998, original TRITON buoy was developed and tested by a Japanese heavy industry company. However, due to several disadvantages such as difficulties to deploy and recover by smaller vessel etc., we have developed a new smaller and lower cost surface buoy with flexibility in modifying electric system, named m-TRITON buoy system. This buoy is currently used in the Indian Ocean RAMA array at 1.5S-90E and 5S-95E, and will be used for the new site at 8S-95E in 2009.

In future, in cooperation with CLIVAR/GOOS/IOP activity in the Indian Ocean, we will expand our RAMA sites with m-TRITON buoys in the south-eastern Indian Ocean, and will contribute to complete the RAMA array. In the western Pacific, we will continue maintenance of the current TRITON sites, and also stimulate participations of other institutions to the TAO/TRITON array by providing buoys and/or ship-time as in a framework of international efforts. Two programs will contribute to better understanding of tropical warm pool climate variations, which may play important role in overarching from the Indian Ocean to Pacific Ocean.

AC-2A-03: The HOAPS-3 satellite climatology of global freshwater flux

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The proper knowledge of the global water cycle is crucial for successful climate system understanding and modeling in order to answer questions like "What is the temporal and spatial variability of essential water cycle components ?" or "How does the global water cycle develop in a warming world ?" With the ability to derive ocean latent heat flux and precipitation from satellite data with acceptable accuracy and frequent global coverage, a climatological assessment of the crucial processes has become possible. The HOAPS-3 climatology (Hamburg Ocean Atmosphere Parameters and Fluxes from Satellite Data) contains fields of precipitation, surface fluxes and related atmospheric parameters over the global ice-free ocean between 1987 and 2005. Except for the AVHRR Pathfinder SST, all basic state variables needed for the derivation of the fluxes are calculated from SSM/I passive microwave radiometer measurements. A sophisticated processing chain, including multi-satellite averages, inter-sensor calibration, an efficient sea ice detection procedure, and well validated retrieval algorithms make HOAPS a suitable data set for climatological applications as well as for case studies. Gridded 0.5 degree monthly, pentad and twice daily data products are freely available from

www.hoaps.org. On a global scale, HOAPS-3 shows, that the average evaporation since 1987 exceeds rain rate over the ocean systematically with almost negligible yearly cycle and small monthly variations. The globally averaged evaporation shows a continuous increase during the study period, especially in the subtropics. Precipitation does not exhibit any significant global trend. Regionally some reduction in the subtropics and a substantial increase in the ITCZ and over the southern mid latitude oceans can be seen, but no significant change over the northern oceans. Comparison with similar satellite and reanalysis fields of the same period exhibit remarkable similarities and differences in the temporal developments of global evaporation and precipitation with a substantial range of results for the E-P balance over global oceans.

AC-2A-04: Observing System for Turkish Straits System

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Exchange flows through straits play important role on the evolution of the water masses in the basins connected by straits. Observations of the water exchange in the straits provide information about the evolution of the water mass properties in the basin as well as providing information on the water properties in the straits. An efficient observing system must take into account the wide variety of dynamical processes which occur over the multiplicity of time and space scales. Observations of flow and water mass properties in the straits require resolving important spatial and temporal time scales in the processes occurring in and near straits. In this paper, observing system designed for Turkish Straits System (TSS) shown as an example for using different platforms and sensor as a part of integrated observing system. The Turkish Straits System provides an opportunity to observe dynamical processes over a wide variety of time and space scales known to occur in many straits of the world. Complex non-linear processes of two-way exchange flows, hydraulic controls, dense water overflows and jets, turbulent mixing and entrainment, locally and remotely driven motions reflecting ocean-atmosphere interactions in adjacent basins as well as locally, occur in this region of a relatively small size. The Turkish Straits System is an excellent and challenging area to observe all these processes above issues, while its manageable size provides excellent opportunities for conducting at-sea experiments. Observing System which consists of in-situ and satellite platforms, covering different scales of motion from the Black Sea to the Aegean Sea in the TSS are used to monitor the physical and bio-optical properties of the waters during September 2008 and February 2009 by NATO Undersea Research Center (NURC). Large scale hydrographic surveys carried out by the R/V Alliance provide a complete synoptic view of the hydro-physical variables in the Black Sea, Marmara Sea and the Aegean Sea. Sub-mesoscale and turbulence (microstructure) measurements were carried out in the Istanbul and Canakkale Straits and their outflows to adjacent seas where these scales are important to resolve the dynamical details of the flow. In order to resolve sub-mesoscale features, towed systems, CTD chains mobilized and used to make measurements at strategic locations to observe flow details. Currents, sea-level, temperature and salinity measurements obtained from fixed moorings to quantify mechanisms of two-way transports through the TSS, to study their variability over different time scales (from hourly to seasonal), and to estimate mean, seasonal, and synoptic exchange rates in the Istanbul and Canakkale Straits. Concurrent time-series of satellite data obtained during the experiment used to support in-situ measurements and identify transport and plankton activity patterns. Knowledge gained from these exercises could offer the opportunity to understand the strait dynamical processes in other parts of the world ocean and develop predictive capabilities for these processes. The enclosed geometry of the Marmara Sea, connected to the adjacent basins through two narrow, highly restrictive straits with hydraulically-controlled flows offers a unique opportunity in terms of experimental control. On the other hand, the complexity of the flow and mixing processes in the region are also in many ways unique: some essential details are either experimentally difficult to capture or not adequately handled by existing ocean models which are often geared for open ocean or relatively simpler coastal areas. The processes are often not sufficiently understood to design experiments or develop models that will address all the problems in unison.

AC-2A-05: Monitoring deep convection combining altimetry and modelling: Application to the Labrador and Mediterranean Sea.

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The center of the Labrador Sea and the North Western Mediterranean (NWM) are characterized by weak stratification and, in winter exposed to intense buoyancy loss due to atmospheric forcing generating open-sea convections. The Deep Convections (DC) is a key-process of the oceanic circulation, costly to monitor in situ and under the influence of climate change. Our study is a first step toward monitoring DC combining remote-sensing and models. In this respect, oceanic simulations of the Mediterranean and Labrador circulation were performed respectively for the 1999–2007 and 1960-2001 period. DC are realistically modelled, and the Sea Surface Elevation (SSE) is in agreement with altimetric data. Numerical results show a strong correlation (>0.9) between the annual DC characteristics and the winter SSE. From that, we propose a simple method to monitor DC long term evolution using only altimetry. Our method, applied to the longest available altimetric time-series, represents correctly the variability of DC both in the NWM and Labrador Sea between 1994 and 2008

AC-2A-06: Variability of the equatorial Atlantic cold tongue

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Climate fluctuations in the tropical Atlantic sector are dominated by two distinct patterns of coupled ocean/atmosphere variability. These modes of variability, collectively referred to as tropical Atlantic variability (TAV), are tightly phase locked to the pronounced Atlantic seasonal cycle and vary on interannual to decadal timescales. During boreal spring, when the equatorial Atlantic is uniformly warm, conditions are favorable for the development of an interhemispheric gradient of sea surface temperature (SST) anomalies often referred to as the meridional mode. The so-called zonal mode is frequently viewed as the Atlantic counterpart of the Pacific El Nino Southern Oscillation (ENSO) and is most pronounced during boreal summer coinciding with the seasonal development of the eastern equatorial cold tongue. The interannual variability of SST in the cold tongue during boreal summer is closely linked to rainfall variability in the countries surrounding the Gulf of Guinea and in the northeast region ("Nordeste") of Brazil. Cold tongue SST is controlled by different oceanic and atmospheric processes, among them are surface heat fluxes, vertical mixing, mean and eddy advection. A multinational observational program is at place in the frame of the Tropical Atlantic Climate Experiment (TACE) including shipboard and moored measurements as well as measurements from autonomous floats, drifters and gliders. Within this program the year-to-year variability of the central and eastern equatorial upper ocean heat budget and SST will be quantitatively linked to the different oceanic and atmospheric processes at work.

AC-2A-07: CLIVAR Global Ocean Observation and Synthesis Activities

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The overall mission of CLIVAR, the Climate Variability and Predictability Project of the World Climate Research Programme (WCRP) is to observe, simulate and predict the Earth's climate system, with a focus on ocean-atmosphere interactions. CLIVAR has established its Global Synthesis and Observations Panel (GSOP) to develop, promote and seek to implement strategies for global ocean synthesis efforts, building on previous experiences and developments, eventually leading to a fully coupled reanalysis with atmosphere, ocean. land and cryosphere models. The panel is also responsible for the definition and (in collaboration with relevant bodies) fulfillment of CLIVAR's global needs for sustained observations. To do this it works closely with CLIVAR's regional ocean basin panels on the one hand and international bodies such as Global Ocean Observing System, the Ocean Observations Panel for Climate and the Joint WMO-IOC Technical Commission on Oceanography and Marine Meteorology on the other.

One of the main contributions of GSOP to CLIVAR science is its evaluation of the current generation of ocean synthesis/reanalysis products providing guidance on their use for study of the global ocean circulation. This evaluation has led to several improvements in the products. Notably it has led to several papers comparing different ocean synthesis products and thus to first specifications of uncertainties in ocean syntheses. An "Ocean Synthesis Directory" provides community links to global ocean synthesis data.

GSOP is engaging through its ocean synthesis project in decadal forecast experiments. One key element is for ocean synthesis groups to provide updated datasets to be used for the decadal prediction experiments. GSOP is also currently in the process of providing all available ocean syntheses as initial conditions for decadal prediction experiments. First such experiments are ongoing and show some success. Possibilities of coupled data assimilation are also being explored. These efforts are currently only just spinning up and will grow over the coming years.

The panel co-sponsors (with the International ocean carbon Coordination project and the International Geosphere-Biosphere Programme's Surface-Ocean / Lower Atmosphere Study- Integrated Marine Biogeochemistry and Ecosystem Research Carbon Coordination Group) the Global Ocean Ship-based Hydrographic Investigations Panel (GO_SHIP). GO_SHIP brings together interests from physical hydrography, carbon, biogeochemistry, Argo, OceanSITES, and other users and collectors of hydrographic data to develop a strategy for ship-based repeat hydrographic observations post CLIVAR. This activity includes the review and an update of the WOCE hydrographic manual. More widely, GSOP is also seeking to organize the production of an update to the 2002 WOCE Global Data Set v3 to include observations made between the WOCE era and the end of 2010.

This poster will provide illustrations of the work of GSOP including the outputs from ocean synthesis intercomparisons, CLIVAR links to ocean carbon activities and GSOP's role, with others, in promoting the sustained global ocean observation network.

AC-2A-08: Deep ocean observing system over middle and long time scale: the E2M3A site in the Southern Adriatic

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The open-ocean convection has been considered the engine of the global conveyor belt. It is a mechanism forming new dense and oxygenated waters, and it riggers the solubility and the biological pump. Among the few zones in the world interested by the open-ocean convection, the South Adriatic is a small but key area for the intermediate and deep thermohaline cell of the Eastern Mediterranean. There, the Adriatic Dense Water ADW formed prevailing by the open-ocean vertical convection , becomes the main component of the Eastern Mediterranean Deep Water (EMDW). This process takes place in the South Adriatic Pit (SAP) in the centre of the cyclonic gyre. The extension of the vertical mixing, varies on the interannual and decadal time-scales in function of the air-sea heat fluxes and the pre-conditioning vertical density structure.

The high spatio-temporal variability of the deep convection and its interaction with other processes makes difficult it study. Oceanographic cruises provide a good spatial coverage but lack in temporal resolution. The need of high temporal sampling to resolve events and rapid processes and the long sustained measurement of multiple interrelated variables from sea surface to seafloor can be solve by the use of moorings located in specific areas as the Southern Adriatic Pit.

In the framework of the Italian VECTOR project a deep-sea mooring (41°29.7N, 17°42.1E) containing CT sensors at five depths, an upward looking 150 kHz ADCP and an Aanderaa current meter RCM11 was located in the vertical convection area. Moreover, two sediment traps were positioned at 168 m and 1174 m on the mooring line. This mooring configuration permits to individuate water mass formation, measuring simultaneously physical and chemical parameters. The mooring is still in the water and new upgrades will be done in the framework of the European project EuroSITES during 2009. The deployment of pCO2 sensor together with a pH sensor within the mixed layer will allow to estimate the Carbon system at the site. The deployment of a surface buoy will allow the real data transfer from the platform to the land station.

Here, data recorded in the period between end-November 2006 and October 2008 covering two consecutive year with pre-conditioning and deep convection periods will be presented . Surface chlorophyll a obtained from the SeaWiFS data is a good indicator of the vertical mixing patch as demonstrated earlier, and here it has been used in determining the patch position with respect to the mooring location and its geometry.

AC-2A-09: WCRP CLIVAR and ocean observations

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The overall mission of CLIVAR, the Climate Variability and Predictability Project of the World Climate Research Programme (WCRP) is to observe, simulate and predict the Earth's climate system, with a focus on ocean-atmosphere interactions. CLIVAR is a long-term, 15 year, programme which began its implementation phase in 1998. Its role is to provide international coordination in areas of science that progress our understanding of climate variability and change and climate prediction. Implementation of CLIVAR is carried out through the activities of its regional panels (one for each of the ocean basins, and one each for the American and Asian-Australian monsoon and African climate systems) and through its global modelling, observational and synthesis groups. Modelling activities within CLIVAR are focussed on coupled numerical model experiments on seasonal, decadal and centennial timescales, including prediction of the response to both natural and anthropogenic forcing. Special attention is given to assessing and improving predictions and facilitating their applications to society. A key question is how anthropogenic climate change will both be influenced by and modulate climate variability and what are the implications for prediction out to decades and longer.

CLIVAR has overall responsibility for the role of the oceans in climate within WCRP. Sustained ocean observations (as well

as ocean process studies) provide key inputs to CLIVAR activities and CLIVAR seeks to stimulate the continued development of the Ocean Observing System in collaboration with the Global Ocean Observing System, the Ocean Observations Panel for Climate and the Scientific Committee on Antarctic Research. It does this through the activities of its Atlantic, Pacific, Indian and Southern Ocean Basin Panels and its Global Synthesis and Observation Panel (GSOP). CLIVAR was an early co-sponsor (with the Global Ocean Data Assimilation Experiment) of Argo and is, for example, co-sponsor of OceanSITES, the PIRATA array and the developing Indian Ocean sustained ocean observing network.

Ocean modelling is an integral part of the work of CLIVAR's coupled modelling and seasonal prediction working groups for which ocean observations are needed both for model initialization and validation. A key activity within CLIVAR, carried out by GSOP is the coordinated application of data assimilation systems to provide and intercompare integrated ocean syntheses. These have the potential to provide initial conditions for climate predictions on seasonal to decadal timescales (coordinated by CLIVAR's seasonal and coupled modelling working groups) and for validation and comparison of coordinated ocean-ice reference experiments by CLIVAR's group on ocean model development. Ocean observations also have a role in CLIVAR's wider activities in monsoon and African climate prediction.
This poster will summarize the key ocean-related activities of CLIVAR from the perspective of the role of sustained ocean observations in research on climate variability and change. It will provide a backdrop to posters describing the ocean-observation-related work of CLIVAR's ocean basin panels and GSOP in more detail.

AC-2A-10: Observed Freshening and Warming of the Western Pacific Warm Pool

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Trends in observed sea surface salinity (SSS) and temperature are analyzed for the tropical Pacific during 1955–2003. Since 1955, the western Pacific Warm Pool has significantly warmed and freshened, whereas SSS has been increasing in the western Coral Sea and part of the subtropical ocean. Waters warmer than 28.5°C warmed on average by 0.29°C, and freshened by 0.34 pss per 50 years. Our study also indicates a significant horizontal extension of the warm and fresh surface waters, an expansion of the warm waters volume, and a notable eastward extension of the SSS fronts located on the equator and under the South Pacific Convergence Zone. Mixed layer depth changes examined along 137°E and 165°E are complex but suggest an increase in the equatorial barrier layer thickness. Our study also reveals consistency between observed SSS trends and a mean hydrological cycle increase inferred from Clausius-Clapeyron scaling, as predicted under global warming scenarios. Possible implications of these changes for ocean-atmosphere interactions and El Niño events are discussed.

AC-2A-11: Developing global long-term altimeter datasets and climatologies of ocean wave measurements

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The prime objective of this work is to build long-term climatologies of ocean significant wave height and wave period based on multi-mission satellite altimeter datasets. The development of such global climatologies is driven by the need to validate present day operational wave forecasting systems as well as improve our understanding of the role of waves in atmosphere-ocean dynamics, ocean surface transport and mixing, and facilitate the detection and measurement of global climate change as revealed in ocean wave parameters. Typical applications also include better estimation of ocean-based renewable energy resources and improved estimation of extreme sea states.
The basic methodology is first to calibrate altimeter-derived significant wave height (SWH) and wave period estimates against a network of in situ buoy measurements. In this study, we use primarily buoy data extracted from the National Data Buoy Center (NDBC) database, made available freely online by the US National Oceanic and Atmospheric Administration (http://www.ndbc.noaa.gov).
Altimeter SWH and radar backscatter, sigma-0, are extracted for the whole duration of the TOPEX, ENVISAT and JASON-1 altimeter missions, thus spanning a period of over 15 years. Collocation of altimeter and buoy data is performed here using a maximum time separation of 30 minutes (buoy data are collected hourly) and a range of maximum spatial separations of (a) 50 km; (b) 100 km; and (c) closest collocation up to a maximum of 500 km. The altimeter data are all obtained via the Radar Altimeter Database System (RADS) hosted at Delft University of Technology (http://rads.tudelft.nl/rads/rads.shtml). The SWH is measured directly by the altimeters while the wave period is calculated using the algorithm of Mackay et al. (2008). An important consideration when dealing with long-term datasets is the development of a robust technique to perform the calibration in time: how do the best-fit parameters change in time, and what is the dependence on both the specified collocation distance and the duration of the collocated dataset for the ODR results? Our initial investigations suggest that 10 days of data provide too few measurements for a reliable calibration. Conversely, although performing the calibration over a year (or longer) typically provides tens of thousands of altimeter-buoy data pairs, leading to a high-precision calibration, it may smooth over potentially significant intra-annual variability. Next, the calibration is applied to each dataset of along-track altimeter measurements, yielding along-track global estimates of SWH and wave period for each altimeter mission. These along-track data are then gridded using optimal interpolation to a regular temporal and spatial grid (typically monthly and 2x2 deg, respectively) over the global ocean (within the latitude range covered by each satellite altimeter).
Continuation of the work will include the investigation of other collocation techniques, such as the triple collocation between three independent datasets, which leads to estimate of errors on all data sources (Caires & Sterl, 2003). Additional altimeter datasets, from past and emerging missions, will also be incorporated in the study, including data from ERS-2, GFO, JASON-2 and Cryosat-2.

AC-2A-12: COriolis Re-Analysis (CORA) : a new comprehensive and qualified ocean in-situ dataset from 1990 to 2008

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Coriolis is a french programme basically aimed to contribute to the ocean in situ measurements part of the french operationnal system. It has been especially involved in gathering all global ocean in-situ observation data in real time, and developing continuous, automatic, and permanent observation networks. Coriolis data center now produces by the end of 2009 a comprehensive ocean in-situ dataset of temperature/salinity profiles on the global scale and ranging from year 1990 to 2008. This dataset is meant to be used for general oceanographic research purposes, for ocean model validation, and also for initialisation or assimilation of ocean models. Here we first present the observations types and distribution used to build this dataset (argo, gts data, vos ships, nodc historical data...). Then we will review the processing and quality controls that have been applied to the data (e.g. objective analysis to remove outliers and/or some visual checks). In a last part, we

show some basic characteristics of the temperature and salinity fields constructed from this dataset.

AC-2A-13: Spatial and temporal variability of water masses in the 4 AR/IPCC models

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The development and sophistication of numerical models in recent years has allowed to perform many climate system's simulations. Such simulations aim to reproduce the dynamics and variability of the climate and consequently predict future climate and possible climate changes. Oceanic processes such as formation and distribution of water masses have an important role in understanding the oceans as a reservoir of salt, dissolved gases and heat. Considering that changes in such processes may have great impact in global and regional climate this work aims to describe spatial and temporal variability of water masses in the South Atlantic Ocean and Southern Ocean. Data from the numerical simulations used for the preparation of the Intergovernmental Panel on Climate Change Fourth Assessment Report (4AR/IPCC) were used. Four climate models were chosen: ECHAM5/MPI-OM, IPSL-CM4-V1, MIROC3.2, NOAA / GFDL CM2.1. Results from the Climate of the 20th Century (20c3m) and the 1% per year CO2 increase (to doubling) experiment (1pctto2x) were analyzed. All models show a positive trend of temperature and a freshening trend of the Antartic Intemediate Water (AAIW), Circumpolar Deep Water (CDW) and the Antartic Deep Water (AADW). Densities of these water masses become significantly lighter in the 20c3m scenario. In the 1pctto2x scenario in the AAIW and CDW moved to upper layers. Also in this scenario there is a cooling of the AADW, moving this water mass to deeper layers.

AC-2A-14: Visual Wind Wave Data From VOS: A Substantial Component of Wind Wave Observing System

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Visual wave observations (assimilated in ICOADS) are available effectively from the mid 19th century and represent the longest records of wind wave information worldwide taken with a unique observational practice. Visual wave data are characterized by quite strong systematic and random errors. Maximum random observational errors in wins sea height amount to 1 meter with maximum random observational errors in swell height being up to 1.6 meters. Significant uncertainties (both random and systematic) in wind wave periods estimates of up to 2-3 seconds may result from the deviation of the actual observational practices from the guidelines. VOS-based climatological estimates of wave characteristics also suffer from spatially and temporally inhomogeneous sampling with the largest sampling errors (up to 1.5-2 meters in wave height) identified in the poorly observed regions of the Southern Ocean and subpolar Northern Hemisphere. We will present 60-yr climatology of wind waves based on visual observations. It includes estimates of heights and periods of wind sea and swell as well as derived SWH and dominant period along with error estimates. Climatology allows for the analysis of linear trends and patterns of interannual variability in wind wave characteristics worldwide. Analysis of the earlier 20th century records of visual wave data for selected ship routes demonstrated centennial increase of SWH (of 8-10 cm/decade) in the North Pacific, with no significant centennial trends in the Atlantic. Visual VOS data also allow for estimates of extreme wind waves for the last several decades, if only in well sampled North Atlantic and North Pacific mid latitudes. Further prospects for the improvement of the accuracy of visual wind wave data will be discussed. These include installation onboard of selected VOS rolling sensors and recording of ship radar scans for providing alternative data for the validation of visual wave estimates.

AC-2A-15: Recent Change in Global Sea Surface Layer Salinity Detected by Argo Float Array

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We investigated surface layer salinity distributions and characteristics of those spatial and temporal variations in the global ice-free ocean. Surface layer salinity is one of the most important measures indicating the accumulated fresh water flux in the ocean. The fresh water flux change, mainly caused by the flux from atmosphere, links strongly to a change of strength in the global hydrological cycle. The deployment of the Argo float is increasing and the Argo float array has allowed us to document changes in global salinity. In the climatology calculated using historical data in 1960-1989, the surface layer salinity is generally lower in the subpolar and tropical regions and higher in the subtropics. We compared the annual averaged surface layer salinity distribution in 2003-2007 with the climatology and found a general enhancement of lower and higher surface layer salinity, except in the North Atlantic Ocean. Since direct observational estimation of evaporation and precipitation (E-P flux) is difficult at the sea surface, estimating the E-P flux from oceanic salinity is an effective alternative. We estimated the changes of basin-scale E-P flux associated with the strength of the global hydrological cycle from the averaged surface layer salinity in 2003-2007. The results show a high probability of increasing the global hydrological cycle in the past 30 years, showing that surface layer salinity change is a useful proxy to detect long-time climate change or trend, such as global warming. We suggest that sustaining Argo float array allow us to detect detailed variation of global surface layer salinity, and blending satellite (SMOS and Aquarius/SAC-D) and in situ observation by the Argo floats makes it possible to understand changes of the global hydrological cycle in detail.

AC-2A-16: Deep Water Warming and Steric Height Change in the Pacific Ocean

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Changes in the heat content in the Pacific Ocean were studied using data from ship-based basin-scale repeat hydrographic surveys. The comparison between results from recent surveys mainly conducted in the 2000s in CLIVAR/IOCCP and previous surveys conducted in World Ocean Circulation Experiment reveals that the heat content in the deep layer has increased in the almost entire Pacific Ocean. In particular, the contribution from the deep ocean below 2000 dbar is estimated as 5% of the total.
The steric height change below 2000 dbar averaged over the Pacific Ocean was calculated to be 0.1 mm/year, small but not insignificant contribution to the global steric height increase of 1.9 +/- 0.2 mm/year as estimated from the satellite altimeters and the Gravity Recovery and Climate Experiment (GRACE) space mission. The contribution of thermal expansion was 0.16 mm/year and that of saline contraction was -0.07 mm/year. The steric height below 2000 dbar increased in the western Pacific and decreased in the eastern Pacific. The largest increase was seen in the Southern Oceans and as well as the western boundary region off the coast of Japan.

AC-2A-17: Long-term variations of Subantarctic Mode Water at 32°S in the Indian Ocean

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Long-term variations of Subantarctic Mode Water (SAMW) at 32°S in the Indian Ocean are examined for 1950-2008 using a time-series mapped objectively from historical hydrographic and Argo data. In the upper part of SAMW (<26.7 sigma-theta), saltier water distributed widely around 1960 is replaced with fresher water in the late 1980s after large-amplitude (over 0.1 in salinity) oscillations with 5-10-year time scales. After 2000 the saltier SAMW occupies the area again. A freshening trend in the density range is difficult to conclusively identify now because of the large variations. Meanwhile, the lower part of SAMW (>26.8 sigma-theta) shows a clear freshening trend; its salinity decreases by over 0.1 since the 1960s. A thick pycnostad of SAMW in the 1960s disappeared in the 1980s. Recently, the thick core recovered and became less dense. These features seem consistent with recent model results showing that SAMW is freshened with large, quick fluctuations due to global warming and natural variation.

AC-2A-18: A decade of physical and biogeochemical measurements in the northern Indian Ocean

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The northern Indian Ocean consists of two tropical basins (Arabian Sea and Bay of Bengal) and the equatorial region, which comes under the influence of strong monsoonal wind reversal. In response to this forcing, the upper ocean circulation and hydrography show strong seasonality. It was the International Indian Ocean Expedition (IIOE) during 1959 to 1965 that provided the first description of the physical, chemical and biological characteristics of this region. Since then there have been several observational campaigns, both by individual nations as well as through international collaborative efforts, which contributed towards furthering our understanding. The availability of satellite remote sensing data further enhanced our understanding of the basin-wide structure and its variability. In this paper we present the results from 3 national programmes that India under took to address the seasonal variability of physical and biogeochemical parameters since 1992 – (1) the Joint Global Ocean Flux Studies (JGOFS) during 1992-1997 in the Arabian Sea, (2) the Bay of Bengal Process Study (BOBPS) during 2001-2006 and (3) the Equatorial Indian Ocean Process Study (EIOPS) which started in 2005 and will continue until 2012. In the above programmes, measurements were and are being carried out following the JGOFS protocol including in situ incubation for primary productivity measurements. The results showed that the Arabian Sea was the most productive region in the northern Indian Ocean followed by the Bay of Bengal and the equatorial Indian Ocean. The Arabian Sea showed strongest seasonal cycle with blooms occurring during summer (June-September) and winter (November-February). The summer blooms in the Arabian Sea are driven by the upwelling and upward nutrient pumping while winter blooms are by convective mixing that supply nutrients to the euphotic zone. In the Bay of Bengal though the surface chlorophyll biomass showed a weak seasonality, the mesoscale eddies played important role in enhancing the biological productivity through upward-pumping of nutrients. In the EIO, the data collected so far suggest very low chlorophyll biomass and productivity. Though the above observational programmes greatly enhanced our understanding of the coupling between the physical and biogeochemical fields in the northern Indian Ocean over the seasonal time scale, our understanding of the inter-annual variability still remains to be rudimentary. Efforts are needed to develop a sustained regional observational network through international collaboration which would include repeat sections, moored arrays as well as drifters. We discuss the urgency of such an initiative and its benefit to climate change study.

AC-2A-19: Detection of Natural and Anthropogenic signals in the ocean climate record using the Met Office EN3 data set

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We present a method to quantify ocean warming that filters out the natural internal variability from both observations and climate simulations and better isolates externally forced air-sea heat flux changes. As a result, we gain a much clearer picture of the drivers of oceanic temperature changes and are able to detect, for the first time, the effects of both anthropogenic and volcanic influences simultaneously in the observed record. Our analyses are based upon Met Office climate models and the EN3 quality controlled subsurface ocean observations, which include XBT bias corrections and cover the period 1950 to present. We present an overview of the EN3 data sources, quality control procedures and data products. The EN3 dataset is freely available to download and use for research purposes from www.metoffice.gov.uk/hadobs.

AC-2A-20: Glider measurements around the Vercelli Seamount (Tyrrhenian Sea) in May 2009

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Many international projects focus on sea mountains because of their importance on the ecology of the marine environment and of their high level of vulnerability to the global change. Hence the Italian Ministry of University and Research (MUR), sensible to this topic, financed the Tyrrhenian Seamounts Ecosystem Project (TySEc) polarizing the attention on the Vercelli Seamount located in the Northern Tyrrhenian Sea, (41°05'00 N / 10°53'00 E), whose summit reaches 55 m below the sea surface. As part of this integrated study, the Istituto Nazionale di Oceanografia e Geofisica Sperimentale (OGS) operated a Slocum shallow battery-powered glider around the Vercelli seamount from the 23rd to the 30th of May 2009 to sample the physical and bio-chemical characteristics of the water column in its vicinity. The glider "Trieste-1" was programmed to cover an area of roughly 750 km2, above the seamount. It was configured to provide oceanographic data during the ascending phase of the saw tooth path, every 0.75 km. During the entire campaign 300 profiles between 4 and 200 m depth were acquired providing temperature, salinity, oxygen, fluorescence, and turbidity data. Preliminary results derived from the glider data are presented. In addition to the expected thermal stratification and the sub-surface salinity maximum characteristic of the Levantine Intermediate Water, a layer with minimum in salinity and maximum in oxygen concentration is evident near 20 m depth. A sub-surface maximum in chlorophyll concentration and turbidity is also seen between 60 and 80m, just below the surface highly oxygenated layer.

AC-2A-21: Operational Oceanography at the Naval Oceanographic Office: Real-Time Oceanographic Measurements

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The Naval Oceanographic Office (NAVOCEANO) currently collects data from a variety of real-time satellite and in situ sensors that are processed into tailored fleet products within hours. Satellite sea surface temperature (SST) data are generated from a variety of polar-orbiting and geostationary satellites including NOAA-18/19, METOP, GOES, and MSG. These data are directly assimilated into operational ocean models in near-real-time and are also used to generate regional fleet support products. Satellite altimeter data are received from Jason-1, Jason-2, and ENVISAT altimeters to maintain continuous sea surface height observations that are assimilated into operational ocean models. Significant wave height and marine wind speed products are also generated to support

operational maritime activities. Satellite ocean color data are received from sensors aboard two polar-orbiting satellites, SeaWiFS and MODIS. These data are processed into visibility, chlorophyll, and K532 products for a broad range of fleet support. Each data set described here is routinely checked for accuracy, coverage, and timeliness requirements. In addition, NAVOCEANO deploys profiling floats, drifting buoys, and ocean gliders throughout the world to measure surface and subsurface oceanographic parameters such as temperature, salinity, currents, and optics. These tools enable NAVOCEANO to persistently sample areas of naval interest and, coupled with performance models, provide characterization of the operational environment.

AC-2A-22: Seasonal Variability of Chl a (SeaWiFS) and SST (MODIS Aqua) off Magdalena State, Colombian Caribbean, 1997-2006

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The productive characteristics of the waters off the Magdalena State, Colombia Caribbean, have not been fully described because of a lack of complete studies performed to evaluate its biological, chemical and physical dynamics over time. Even though remote sensing is a sampling technique that allows data in a long temporal and spatial scale to be obtained, it has not been widely used in the study of ecosystems in the Colombian Caribbean. Therefore, the present study applied this method to compare the potential production of events such as continental water inputs and upwelling, which occur during wet and dry seasons, by obtaining, processing and interpreting 16 km^2 monthly average satellite data and images of the sea surface temperature (SST) and chlorophyll *a* (Chl *a*) concentration in a total area of 12,553.8602 km^2, throughout a time period comprised between 1997 and 2002 and 1997 and 2006 and measured using the MODIS Aqua and SeaWiFS remote sensors, respectively. The study area was divided in three oceanic and three coastal sectors, given the differences in the oceanographic, topographic and continental runoff characteristics of the waters. The analysis of the average air atmospheric temperature, wind speed, precipitation levels and Ekman´s depth, concluded that the duration of the seasons was highly variable, contrary to what was generally thought. A temporal thermal and a Chl *a* concentration stability was found, which allowed to conclude that although events such as El Niño Southern Oscillation took place within the study time, the capability of the waters to enhance the phytoplanktonic development, remained unaffected over time. With regards to the spatial variability, no thermal differences were found between sectors, while the higher Chl *a* concentrations found in the further southwestern coastal waters defined them as mesotrophic, which was different to the oligotrophic waters of the coastal northeastern sector and the three oceanic sectors. Continental runoffs were defined as the more powerful event that controls the phytoplanktonic development, especially in the west part of the study area during wet seasons. On the other hand, upwelling events play a comparatively more important role in the water fertilization only far in the eastern extreme, during periods of time in which the continental discharges were low.

Key Words: SST, Chlorophyll *a*, SeaWiFS, MODIS Aqua, Upwelling, Continental Runoff.

AC-2A-23: Upper ocean variability of the equatorial Indian Ocean and its relation to chlorophyll pigment concentration

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Equatorial Indian Ocean (EIO) is characteristically different from the rest of the equatorial regions of the world ocean due to (1) the semi-annual reversal in the winds as well as currents and (2) lack of upwelling. The satellite derived chlorophyll pigment concentration shows that EIO is biologically less productive region in the northern Indian Ocean. The reason for this was explored using the monthly mean climatology of the atmospheric and oceanic parameters in the domain 5oN-5oS and 40o-100oE. The oceanic temperature and salinity data were extracted from 3 sources. Hydro-cast and CTD data from the World Ocean Data base 2005 during the period 1919-2004, Responsible National Oceanographic Data base during 1972-2006 and Argo data during 2002-2008. Meterorological data were extracted from National Oceanographic Centre, UK. In addition to the above data, the in situ nutrient and chlorophyll data were also analyzed. The sea surface temperature (SST) showed a strong semi-annual signal in the western EIO (3.5oC) with peak warming in April and cooling in July-August. This warming was due to the high positive net heat flux whereas the cooling was driven by the upwelling along the western boundary. The central and eastern EIO showed a weak annual signal of amplitude 1oC. The sea surface salinity (SSS) showed a weak annual signal in the western EIO (0.3 psu) with high in winter and low in summer. Towards the central and eastern EIO there was no perceptible seasonality. Both mixed layer depth (MLD) and barrier layer thickness (BLT) also showed a weak annual signal. The MLD was deep during boreal summer (June-August) and shallow during boreal winter. The deep MLD during summer was due to the combined effect of strong winds and low net heat flux. The shallow MLD in winter was driven by weak winds and negative E-P. The net heat flux in summer (May-August) was higher than that of winter. The BLT was thickest in the eastern EIO compared to both central and western EIO, which was closely linked to the presence of low salinity water. The satellite derived chlorophyll concentration was highest along the western EIO and showed a semi-annual cycle of amplitude 0.4 mg/m3. The chlorophyll showed a strong correlation with SST. In the central and eastern EIO chlorophyll values were extremely low and did not show any strong seasonality. The correlation of chlorophyll with SST in these regions was also poor. Thus, the study indicated that the lack of strong seasonality in the chlorophyll pigment concentration and extremely low biomass away from the western boundary arises from lack of nutrient supply from subsurface. Lack of physical processes such as upwelling, eddies or strong wind-driven mixing were unable to break the strong stratification, both thermal as well as haline, in the EIO which inhabited supply of sub-surface nutrients as the nutracline was deep.

AC-2A-24: Station M in the Norwegisn Sea

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Having performed daily oceanographic measurements in the deep Norwegian Sea since 1 October 1948, Ocean Weather Ship Station (OWS) M, at 66N,02E, can present the longest existing homogeneous time series from the deep ocean. Station M is operating above the eastern margin of the Norwegian Sea deep basin where a branch of the Atlantic current is entering the area. The location proved to be strategic both for studying the Atlantic inflow and the Norwegian Sea Deep Water. The OWS M is operated by The Norwegian Meteorological Institute (met.no) and the hydrographic programme is carried out by Geophysical Institute, University of Bergen.

AC-2A-25: Sustainable monitoring system for ice shelves and polar oceans

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Monitoring of the flow of dense water from its formation area towards the abyss of the world oceans is a key issue for climate research. In the Weddell Sea, Antarctica, formation of high salinity shelf water (HSSW) takes place on the Ronne shelf. Underneath the floating Filchner-Ronne ice shelf the HSSW is transformed to Ice Shelf Water (ISW, t<-1.9). The ISW cascade towards the deep Weddell Sea, and its fate in connexion with

the formation of the WSBW, and finally AABW, are key issues. In the IPY project the Bipolar Atlantic Thermohaline Circulation (BIAC) we have defined and operate an ocean observing system for the Ice Shelf Water in the southern Weddell Sea. The stations (moorings) are constructed so that they only need to be serviced at ~5 year intervals, and the data are planned to be extracted by ships of opportunity, acoustic communication and via satellites. The running costs will therefore be low, and these climate stations should be operative for several decades.

AC-2A-26: Monitoring the Tropical Ocean: The Importance of Small Vertical Scale Velocity Features

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The tropical oceans are our best monitored regions of the World's Oceans. The observing arrays have been designed to capture the basin--wide variations in the velocity and tracer fields. Here we present recent measurements of the velocity field in the Pacific Ocean. We argue that the present observing system misses a sizable fraction of the structure of the velocity field which potentially contributes significantly to ocean mixing. Figure 1 (upper panel) shows the zonal component of velocity along 156E measured using a high (600kHz) lowered ADCP. A striking aspect of the flow shown is the numerous small vertical scale features superimposed on the major currents. The strength of the small vertical scale features is such that the cores of the EUC and NECC are split into multiple maxima. Figure 1 (lower panel) shows the data after a high--pass filter has been applied in the vertical and then plotted on constant potential density surfaces at the mean depth of the individual surfaces. Numerous small vertical scale features (SVSs) are present across the width of the section. A number of these features are seen to stretch over more than one sampling location with some being in excess of 100km. Shear spectra averaged over a number of latitudes are shown in Figure 2. Distinct peaks in the shear spectra are seen at vertical wavenumbers ranging from 15-50m. For comparison the spectrum from a moored 150kHz ADCP is also shown. The lower frequency ADCP does not capture the smaller scale features. Potential causes of the SVSs include instability of the current system through inertial and parametric subharmonic instabilities and direct forcing by the wind.
The amplitude of the SVSs is such as to suggest they contribute significantly to both lateral and vertical mixing. The implication is that mixing is controlled by factors other than the shear of the larger scale currents. Little is known, however, of the temporal and spatial variations of the properties of these small scale features and their potential contribution to scale-interactions linking mixing scales to basin-scale dynamics. We propose a series of process studies focussed on elucidating the properties and impact of SVSs combined with a larger scale monitoring. Because of its ease of operation, a lowered high frequency ADCP could be made a part of routine measurements that are at present made in conjunction with maintenance of the tropical arrays.

AC-2A-27: Decadal Scale Sea-level Validation of the ENSEMBLES Ensemble of Ocean Reanalyses

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A new set of global, low-resolution ocean reanalyses over the ERA40 period (1960-2006) has been produced for sake of seasonal to decadal climate prediction within the EC-FP6 ENSEMBLES project. These reanalyses all use ERA40 winds and fluxes as forcing, the EN3 quality-controlled temperature and salinity profiles data base built at the UK Met-Office, and are strongly constrained by the observed Sea Surface Temperature. From those reanalyses produced by several groups (including ECMWF, INGV, UK Metoffice, and CERFACS), a common set of variables (temperature, salinity, velocity, upper ocean heat content, sea level height, mixed layer depth and depth of the 20°C isotherm) have been stored with a common Netcdf format, interpolated on a common 1°x1° resolution, 33 vertical levels grid, and made publicly available at http://ensembles.ecmwf.int/thredds/catalog/ocean/catalog.html. This poster presents a comparative validation of those reanalyses against a set of quality-controled multi-decadal tide gauge sea level measurements. Comparison with each reanalysis ensemble is stratified with respect to the location of the tide gauges. Results classically show that the quality of the reanalyses is better at low latitudes, but that a significant amount of variance of the low frequency signals at mid-latitudes is well reproduced. The north Atlantic is shown as the poorest constrained region, though the observational coverage is relatively important. Differences between reanalyses are also characterised and discussed in the light of the differences of the systems used.

AC-2A-28: Investigating changes in the Atlantic Waters characteristics along the Egyptian Mediterranean Coast.

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The paper investigates the changes in characteristics of the Atlantic Waters (AW) as they move eastwards along the Egyptian coast in the South-eastern Mediterranean. The study analyzed a long series of temperature, salinity and ót data, collected by several expeditions that were carried out by research vessels of different nationalities, including Egypt, during the period 1959-2008, averaged for the winter and summer seasons. The paper also examined the long-term (50 years) changes that occurred in the characteristics of the water masses off the Egyptian coast as a result of damming the Nile River in 1965 and the subsequent cessation of its discharge into the Mediterranean. These changes were considered in terms of their possible contribution to the observed changes in the characteristics of the AW along the Egyptian coast. The results show that the sea surface temperature of the southeastern Mediterranean waters off the Egyptian coast varied between 16.6-18.5oC in winter, and between 22-28oC in summer. Furthermore, the salinity of the coastal waters off the Egyptian coast has, on average, increased from 26.675 in 1964 before the erection of Aswan Dam, to around 38 in the 1970s and reached more than 39 in 2008. Vertically, only one water mass could be observed in winter in the upper 200 m layer, whereas in summer, three distinct water masses could be observed. The subsurface water mass, which is of Atlantic origin, occupying the 50-150 m layer and characterized by low salinities ranging from < 38.60 to 38.80, runs throughout the study area from west to east and spreads over the range of density between 27.5-28.5 ót. Temperature and salinity anomalies indicated increasing trends for both temperature and salinity that reached 0.62oC/dec and 0.067/dec, respectively for the Mediterranean surface waters. For the Atlantic water, the trends were 0.56oC/dec for temperature and 0.035/dec for salinity. These results confirm that the increase of temperature and salinity of AW with time are attributed to both anthropogenic modifications, especially the Nile damming, and the local climatic changes, which need further investigation.

AC-2A-29: Observing Deep-Water Changes in the Northern North Atlantic

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In 1997-2009, full-depth transatlantic hydrographic section along 60°N between Cape Farewell (Greenland) and the Scottish shelf was repeatedly occupied on board the Russian research vessels. Since 2002 onwards, the section has been repeated annually. The comprehensive dataset thus collected has contributed to the research of the recent and long-term deep-water changes in the region. Our presentation

summarizes the main published and work-in-progress results of this research including analyses of decadal hydrographic variability, local water mass formation and regional circulation changes.

AC-2A-30: New hydrographic scenarios in the Western Mediterranean: a possible monitoring strategy

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Introduction
Recent studies have evidenced that significant changes in the climate conditions are not always related to centenary or millenary time scales, but may also happen in much shorter periods. This is particularly true for the Mediterranean, where space/time scales are one order of magnitude less than in the ocean and where, starting from the 80s, a rapid and extended change in the thermohaline circulation of the eastern Mediterranean (EMED) has been observed. An important task is to define a realistic survey strategy, focalized on a continuous monitoring of key regions, and to capitalize the existing time series, to understand the time scales of variability and to provide elements of comparison and verification to models.

Recent changes
The long-term monitoring of the hydrographic and dynamic properties of water masses in the Sicily Channel and in other key positions of the western Mediterranean (WMED) during the last 20 years permitted to follow the interannual variability of the E-W exchanges, considering the propagation of the Eastern Mediterranean Transient (EMT) signature toward the WMED. The changes produced by this event in the deep thermohaline circulation of the EMED modified the properties of the Sicily Channel outflow and deeply influenced the hydrographic structure of the WMED water. More specifically, an acceleration of the increasing T and S trends in the deep and intermediate layers has been produced.
During recent years, those changes were able to play a key role in modifying the WMED deep water production. The abrupt increase of the heat and salt contents in the deep layer of the basin can be largely attributed to an increased heat and salt lateral advection.

Approaches
A continuous monitoring of the Mediterranean circulation is necessary to detect possible changes when they happen and to understand their time scales. Straits and channels form an important network inside the basin. Their monitoring permits to determine, at a basin scale, the evolution of the water mass characteristics and the transport variability. Therefore an adequate survey strategy would consist in (Fig. 1):
1. Long-term monitoring of Mediterranean straits, to define the main inter-basin exchanges, and some few regions characterized by relevant processes (moorings in the Straits of Sicily and Corsica since 25 years)
2. Repeated observations in sites of special interest, to maintain a deep-basin monitoring with repeated CTD casts at fixed stations in deep basins (Ionian and Tyrrhenian since more than 20 years, 1-2 casts per year)
3. Large-scale monitoring, through basin wide hydrographic surveys, a necessary tool for budget calculation, e.g. by means of box models (Fig. 2), to initialize and validate general circulation models, and to be assimilated in models to improve their forecast capability.
Recently, wide-ranging dedicated field experiments have been carried out to get a quasi-synoptic view of the circulation in the WMED (Fig. 2b). A first comprehensive estimate of water fluxes in the WMED was obtained by means of a physically robust approach, aimed to an inter-comparison of differently achieved results. Three approaches have been adopted to describe the WMED circulation and velocity field, resolving different spatial–temporal scales and components of the motion, in order to evaluate their degree of accordance: a geostrophic approach, a direct approach and a modeling approach. The results confirm the qualitative overall circulation pattern, providing a solid quantitative basis to be used for budget estimates of different chemical/biological properties.

Conclusion
The interannual variability of the hydrographic conditions evidences how the influence of the EMT in the Mediterranean is far to be concluded. Recent observations (since 2006) in the Sicily Channel suggest the arrival of new dense waters from the EMED. The experience of the propagation of the EMT demonstrates that straits and channels are suitable points to provide early warning of anomaly propagation.
The long-term monitoring of the straits of Sicily and Corsica permitted to detect important changes in the circulation and hydrography at basin-scale, giving important information concerning the investigation strategy for the basin interior. This is done by providing time-series of repeated CTD casts in the deep layers of both the western (Tyrrhenian) and the eastern (Ionian) Mediterranean, as well as performing basin-wide surveys, that provide quasi-synoptic views of the hydrographic and dynamic features.
New available technologies are able to significantly improve the present monitoring in term of space/time resolution and extending the coverage to biogeochemical parameters. The important task of data transmission needs to be evaluated to permit a real time monitoring and the consequent possibility to make the acquired data available for forecasting purposes.

AC-2A-31: Biophysical Couplings in South Australian Shelves Waters Under Conditions of Summer Upwelling and Winter Downwelling

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The Southern Australia Integrated Marine Observing System, or SAIMOS, is one of five nodes operating as part of the Australia-wide Integrated Marine Observing System (IMOS). This is a collaborative program designed to observe Australia's oceans, both coastal and blue-water. Since February 2008 Physical Data has been collected for SAIMOS in both summer and winter months during 8 surveys. The data collected during summer are used to characterise the nature and dynamics of the Kangaroo Island-Eyre Peninsula upwelling system during a record upwelling event in February 2008. During this event a plume of very cool water was observed along the bottom from South of Kangaroo Island to the Eyre Peninsula. This plume dissipated rapidly after the end of upwelling favourable winds and by March 2008 had disappeared entirely from the observations.
The data are also used to study the dense high salinity outflow from Spencer Gulf observed during the winter months. The dense plume result from surface cooling of high salinity waters at the head of Spencer Gulf. One striking result of these observations is that the outflow occurs during a series of strong pulses with a period of approximately 2 weeks and duration of 1-3 days. During these pulses bottom velocities at 100 m can exceed 1 m/s.
The abundance and composition of viral, bacterial and pico- and nanoplankton communities have concurrently been investigated. In summer, the space-time dynamic of viral, bacterial and pico- and nanoplankton communities is generally driven by the plume of upwelled, cool and nutrient rich water that flows across the continental shelf, and is locally heavily influenced by the level of vertical stability of the water column. In winter, the qualitative and quantitative nature of the plankton community is related to the local physical properties of the water column, which include the presence of a dense plume of bottom waters outflowing from the Spencer Gulf, the vertical stability of the water column and the presence of a deep chlorophyll maximum (DCM).

AC-2A-32: Sustained Observations in the Atlantic and Southern Oceans

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The marine environment is large in scale, highly dynamic and relatively inaccessible. It requires sustained observations to obtain meaningful information on environmental changes and their causes. To this end, the National Oceanography Centre, Southampton, through the UK Natural Environment Research Council's Ocean 2025 programme, supports a number of marine time-series and monitoring studies in the Atlantic and Southern Oceans. Some of these are in conjunction with other UK marine laboratories. The primary aims are to provide data and knowledge on a wide range of ecosystem processes, from ocean circulation to biodiversity. They have been developed not just to provide long-term data sets but also to capture extreme or episodic events and play a key role in the initialisation and validation of models. • The Atlantic Meridional Transect (AMT) aims to understand ocean plankton communities and improve our ability to predict the role of the open ocean in the global carbon cycle. • The Porcupine Abyssal Plain Ocean Observatory focuses on ecosystem behaviour and involves high frequency measurements both in the water column and on the sea floor. • Two arrays of instruments, one at 26°N and one across the Canadian-US continental slope, have been positioned to monitor the Meridional Overturning Circulation (MOC) which is a key component in the way the Atlantic Ocean will respond to climate change. • The extended Ellett Line, a hydrographic section from Scotland to Iceland, crosses important components of the North Atlantic MOC and provides additional knowledge of the North Atlantic's response to climate change. • The international Argo programme aims to populate the world's oceans with autonomous profiling floats, contributing to long-range weather forecasts and climate change research. • Antarctic Circumpolar Current monitoring in the Drake Passage provides measurements from a choke point in the global ocean circulation which impacts on the North Atlantic and the MOC. • The integration of increasing sources of historical and operational environmental data provides information on air-sea fluxes and how they are changing on multi-decadal scales, which is critical for monitoring and assessing climate change and improving models. The information from these activities has been integrated into the UK Marine Monitoring Assessment Strategy and has contributed to the UK DEFRA Charting Progress II initiative. The observations also contribute to International GOOS and GMES Acronyms DEFRA Department for Environment, Food and Rural Affairs GOOS – Global Ocean Observing System GMES Global Monitoring for the Environment and Security

AC-2A-33: Determining the Response of the Tropical Pacific to Global Warming

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There is a long-standing debate in the climate community as to how the tropical Pacific will respond to increased greenhouse gases: Will the structure of the time-mean changes in the ocean surface temperature more closely resemble an El Niño or a La Niña? This distinction is of profound significance because conditions in the tropical Pacific affect a range of weather phenomena including tropical cyclone activity, global patterns of drought and flood, agricultural productivity, and oceanic biological activity. There is substantial modeling and observational literature advocating both sides of the debate, and these opposing points of view remain to be reconciled [see Vecchi et al., EOS, 2008: Examining the tropical Pacific's response to global warming, EOS, 89, 81-83 for a summary]. Historical reconstructions of SST trends over the past century are currently unable to resolve this dispute. One reconstruction – HadISST [Rayner et al. 2003] – shows a 'La Niña-like' pattern, with an increase in the zonal SST gradient. However, the NOAA extended reconstruction of SST (ERSST) [Smith and Reynolds 2004] exhibits an 'El Niño-like' pattern, and is consistent with recent analyses of sea level pressure data indicating a weakening of the Walker circulation. Closer inspection of the contrasting SST reconstructions indicates that the differing behavior between the products arises primarily during two periods around the 1930s and 1980s. These periods are roughly coincident with, respectively, the period of greatest change in "bucket-to-intake" corrections of SST measurements (a correction that differs between the products) and the beginning of satellite infrared SST retrievals (satellite data is used in HadISST, but not in ERSST). We propose that a focused effort be placed towards identifying the specific sources of this discrepancy and the appropriate corrections. Another way forward would be through reconstructions of local temperature and salinity using coral skeletons from the tropical Pacific over the historical record. Currently, there are only a handful of published data sets that can address this issue with conflicting interpretations. A more complete picture of the evolution of tropical Pacific climate of the 20th Century would emerge if additional records from various locations were incorporated using a multi-proxy, synthesized approach [Evans et al., 2002: Paleoceanography, 17, 1006]. Because the discrepancies in the reconstructions of pacific SST arise primarily in two discrete periods, proxy observations spanning these periods could prove particularly useful in helping to reconcile the current observational interpretations.

AC-2A-34: CLIVAR's regional basin panels and ocean observations.

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The overall mission of CLIVAR, the Climate Variability and Predictability Project of the World Climate Research Programme (WCRP) is to observe, simulate and predict the Earth's climate system, with a focus on ocean-atmosphere interactions. Within WCRP, CLIVAR carries overall responsibility for coordinating it's activities on the role of the oceans in climate. Sustained ocean observations (as well as ocean process studies) provide key inputs to CLIVAR activities and CLIVAR is active, in stimulating the continued development of the Ocean Observing System in collaboration with the Global Ocean Observing System (GOOS), the Ocean Observations Panel for Climate and the Scientific Committee on Antarctic Research (SCAR). It does this through the activities of its Atlantic, Pacific, Indian and Southern Ocean Basin Panels and its Global Synthesis and Observation Panel (GSOP).
This poster will outline the role of CLIVAR's ocean basin panels in the regional implementation of ocean observation activities. In particular it will illustrate:
 CLIVAR's Atlantic Panel coordination of measurements of the Atlantic Meridional Overturning Circulation, efforts to stimulate the observing system of the South Atlantic and, through PIRATA and the Tropical Atlantic Climate experiment, the observing system of the tropical Atlantic.
 In collaboration with IOC GOOS, the progress with coordination of the implementation of a sustained ocean observing system for the Indian Ocean, including the implementation of the Research moored Array for African-Asian-Australian Monsoon Analysis and prediction which will complete the distributed moored tropical buoy network around the globe.
 The CLIVAR Pacific Panel's needs for ocean observations for ENSO prediction; also its coordination of the interactions between key Pacific process studies that will leave a legacy of sustained observations and/or improved understanding of climate processes, such as the Northwest Pacific Ocean Circulation Experiment, the Southwest Pacific Ocean Circulation and Climate Experiment and the CLIVAR VAMOS (Variability of the American Monsoon Experiment) Ocean-Cloud-Atmosphere-Land Study.
 The regional implementation plan for a Southern Ocean Observing System (SOOS) which the CLIVAR/CliC/SCAR

Southern Ocean Panel is contributing to in collaboration with SCAR and others.

AC-2A-35: Geochemical and physical instrumentation development for characterizing a subglacial aquatic environment in Antarctica

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We are developing a number of instrumentation enabling the study of subglacial environment in Antarctica through narrow kilometer long boreholes. Instrumentation includes: i) slim line Sub-Ice ROV (SIR), ii) Geochemical Instrumentation Package for Sub Ice Environments (GIPSIE) to study geochemical fluxes in water and across the sediment water interface with real-time telemetry for targeted sampling, iii) long term energy-balance mooring system, iv) active source slide hammer sediment corer, and v) integration of a current sensor into the ITP profiler. The instrumentation presented here is likely of interest for a wider science community. Of specific interest for the Ocean Obs community are likely the GIPSIE and the active source sediment corer.
The GIPSIE is a geochemical instrumentation package to study geochemical fluxes across the sediment water interface and with the flux of water inside of a water mass. The GIPSIE includes a number of geochemical sensors (CO_2, CH_4, dO, NH_4, NO_3, Si, PO_4, pH, redox, T, H_2, HS, O_2, N_2O, CTD, particle size, turbidity, color camera, current meter and automated water sampler). A real-time telemetry system allows user controlled targeted sampling of water for chemical and biological work based on actual measurements and not an automated program. The porewater profiler (pH, redox, T, H_2, HS, O_2, N_2O) can penetrate the upper 50 cm of sediment. A thermal probe extension allowing geothermal flux measurements of the upper 1 to 2m is under consideration as is an in situ porewater sampler.
The sediment corer is an active source slide hammer corer, allowing penetration of stiffer sediment. The design concept increases the impact force of the slide hammer with penetration to overcome greater sediment strength with depth.
Further information on the technology developments and our sub ice work can be found at http://jove.geol.niu.edu/faculty/svogel/Technology/Technology-index.html

AC-2A-36: Inventory of anthropogenic carbon in the Atlantic

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The Atlantic is an important sink for anthropogenic carbon (Cant). High concentrations of Cant are found not only in surface and central waters, but also in the newly formed North Atlantic Deep Water (NADW). The Cant concentrations are calculated by means of the Transit Time Distribution (TTD) method. The TTD parameters are inferred from CFC data from the WOCE period and the CARINA data set, a collection of carbon relevant parameters measured in the Atlantic within international and national programs. The repeated observations in the North Atlantic clearly indicate a decrease of the carbon uptake of Labrador Sea Water during the last decade. This is only partially compensated by enhanced storage of anthropogenic carbon in the newly formed, lighter Upper Labrador Sea Water. The deeper NADW layers, however, show the expected Cant increase due to the rising atmospheric CO2 concentrations.

AC-2A-37: Coherent signals between the RAPID array and satellite altimetry

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The RAPID array monitors the vertical density structure at a few locations across the North Atlantic. By contrast, satellite altimetry has much better horizontal resolution but is limited to the surface signal. The first step for combining the advantages of each array, for better resolution of Atlantic circulation, is to investigate the shared or coherent signals in each. The consistency among the arrays indicates not only their accuracy, but also a quantitative assessment of the range of motions to which each responds. We consider three data sets: moored density or geopotential anomalies (GPA) from the RAPID temperature and salinity moorings spanning the Atlantic at 26.5 N, sea surface height (SSH) from satellite altimetry, and bottom pressure (BP) measured at the base of the RAPID moorings, The vertical structure of correlation between GPA and SSH or BP at fixed depth levels describes how the dominant variance is inter-related, while a method for fitting vertical dynamic modes to density anomalies provides a physical mechanism to describe the correlations. Directly at the western boundary, correlation between SSH and GPA is small in magnitude and is slightly surface intensified. In stations to the east - at 500 km from the western boundary and on the western flank of the Mid-Atlantic Ridge - the correlation increases near the surface (to 0.85) and at water depths of 1000-3000 m (0.3-0.5). From the western boundary to the Mid-Atlantic Ridge, the correlation between SSH and both the barotropic and first baroclinic modes also increases by a similar amount. This structure of correlation is mostly explained by an increase in the absolute and relative variance of the first baroclinic mode across the same distance. Away from the boundaries, satellite SSH correlates more strongly with a reconstructed SSH calculated from only the barotropic and first baroclinic modes, compared with a reconstruction from all modes. The relative variance contained in baroclinic modes higher than mode 1 is largest at both boundaries, indicating more complex dynamics at these locations that are poorly resolved by surface measurements. A spectral analysis shows that the SSH and GPA signals are coherent at periods of 10 days and 30-100 days when considered in the vertical, and at periods of 30-100 days for the barotropic and two lowest baroclinic modes when considered against mode number. In contrast to SSH, correlation of GPA with BP is largest at the boundaries and is vertically uniform, but is weak (<0.5) in general. Except at the Mid-Atlantic Ridge, the surface expressions of the barotropic and first baroclinic modes are in phase with BP but have correlations less than 0.5. A spectral analysis between GPA and BP against depth shows coherent periods of 10 days and 30-100 days, while the same analysis against mode number shows coherent periods of 30-100 days for low modes (second baroclinic mode and lower). Signals coherent throughout the full water column also occur at periods of 2-5 days.

AC-2A-38: Impact of Sea Ice Variability on the Ross Sea Water Masses

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It has been known for a long time that the ocean plays the most important role on Earth's heat budget, what turns it into a major component of the global climate system. Therefore, many studies have been made to assess whether features climate processes are changing and how may climate itself be affected by these changes. Considering that sea ice is rapidly affected by climate changes and is directly linked to the oceanic overturning circulation, which is responsible for the heat exchange and storage, this work aims to look at the impact of changes in sea ice on deep water masses formation in the Southern Ocean. Results from the 20th century and A1b CCSM3/NCAR simulation (1870 to 2100) were analyzed. Using the Optimum Multiparameter Analysis (OMP) to separate water masses, we have focused on the Ross Sea Ice Shelf Water (ISW) spacial variation along the whole simulation period. Much closely to what have been seen on previous sea ice

observational data, model results have shown an important ice coverage increasing trend on the Ross Sea along the late 20th century and the entire 21st century. Simulation results have also shown that the ISW gets shallower during the 20th century and then, due to an important sea ice increase during the 21st century, it gets each time deeper and occupies the deepest layer by 2100 while it flows towards higher latitudes. These results show how observational data assimilation is important to properly simulate the future and understand what we may expect.

AC-2A-39: Ligurian Sea Observing System; A Multi-platform Approach for Model Development and Validation.

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Because of the close proximity of NURC to the Ligurian Sea, which provides easy access by research vessels and AUVs, NURC has selected this area to develop and test physical and bio-optical models as well as remote sensing/glider data fusion techniques and adaptive sampling strategies for improved model predictions. The Ligurian Sea is ideal for setting up a regional observing system for model validation and testing as it has some complexity in offshore and near shore areas, river discharge in the eastern region and seasonal variability in current speed and direction and bio-optical variability (Mar-Apr phytoplankton blooms and Sep-Oct oligotrophic conditions, Figures 2a and b). NURC's fleet of gliders are supported by a Command and Control and 3-D Visualization Centre and for 2010 there are plans to deploy several gliders to spatial map the physical and bio-optical variability of coastal and offshore areas on a continuous basis. Using this multi-platform approach of remote sensing, shipboard measurements and AUVs, a bio-optical model that is coupled to an atmospheric/oceanic model will be developed. The beginning of this effort will start with a modeling workshop in the fall 2009 that describes the framework for such an effort. Other modeling efforts such as NRL-Stennis BIOSPACE (Bio-Optical Studies of Predictability and Assimilation for the Coastal Environment) model (Shulman et al., 2008; AGU Fall Mtg, #OS43C-1303), which is being developed and validated in Monterey Bay, USA, can be tested as to the robust nature and portability using NURC Ligurian Sea regional database.

AC-2A-40: Mediterranean Sea Level Variations from Altimetry Data and Ocean Circulation Models

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A complete study of the Mediterranean Sea level Variations (SLV) for the last 16 years is presented. We use mainly multimission altimetry data and simulations from the ECCO Ocean Circulation Model. The seasonal and trend components are analyzed, while the residual variability is explained by means of physical fenomena. The different components of the total SLV are also estimated for the period of study.

AC-2A-41: Changes in Subduction in the South Atlantic Ocean During the 21st Century in the CCSM3

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Water mass formation in the South Atlantic is an important component of ocean ventilation in the southern hemisphere. For example, a large component of Antarctic Intermediate Water (AAIW) is formed in this basin, and much of the Antarctic Bottom Water (AABW) is formed in the Weddell Sea. In this paper, the South Atlantic is defined as the region between the equator and the Antarctic continent. This region is important because it takes up a lot of heat and carbon dioxide from the atmosphere. Therefore, a very important question is how water mass formation will change over the 21st century, especially if formation rates weaken, and the South Atlantic can't take up as much heat and CO2 as it does at present? The Community Climate System Model version 3 (CCSM3) is used to analyze changes in water mass formation rates in the South Atlantic over the 21st century. The model results are first compared to observations over 1950--2000, and shown to be rather good. A major reason to address this question with the CCSM3 is that AAIW and AABW are simulated much better in the generation of climate models used in the fourth report of the International Panel on Climate Change than those used in the third report. The formation rates do not change significantly over the 21st century, but the densities at which water masses form become significantly lighter. This suggests small changes to the rate at which the Southern Ocean takes up heat and carbon dioxide over the 21st century

AC-2A-42: The Global Ocean Mixing Community - A Progress Update

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Mixing in the ocean controls the transport of heat, freshwater, dissolved gasses, and pollutants and is linked directly to processes responsible for climate variability and predictability. Turbulent mixing is also of crucial importance for ocean biology, from determining the flow field for the smallest plankton to setting large-scale gradients of nutrient availability. In coastal regions the distribution of nutrients and pollution controls the health of our fisheries as well as the broader coastal ecosystem. Technological improvements over the last five decades have led to several direct and indirect observational methods for the study of mixing in the coastal, arctic and abyssal oceans, as well as in lakes. Recent work suggests that there is considerable spatial and temporal non-homogeneity in deep-ocean mixing. Therefore, an improved understanding of the distribution of deep-ocean mixing intensity, and the physics that drives that distribution, is central to understanding the energetics of the ocean and reducing the uncertainties in global circulation and climate models. The community of ocean mixing scientists is organized through the SCOR affiliated Ocean Mixing Group, which has the mandate to foster and contribute to the development and coordination of international research programs related to ocean mixing. This poster presentation provides an overview of the state of work in the ocean mixing community, the observational challenges, and future efforts to study linkages between ocean mixing and climate variability and coastal ecology.

AC-2A-43: A Decade of Acoustic Thermometry in the North Pacific

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The Acoustic Thermometry of Ocean Climate (ATOC) and North Pacific Acoustic Laboratory (NPAL) projects have demonstrated the sustainable utility of long term measurements of temperature by long range acoustic transmissions. Over the decade 1996-2006, acoustic sources located off central California (1996-1999) and north of Kauai (1996-1999, 2002-2006) transmitted to receivers distributed throughout the northeast and north central Pacific. By traversing O(4-5 Mm) ranges, the acoustic travel times are inherently spatially integrating, which suppresses mesoscale variability and provides a precise measure of ray-path-averaged temperature . The acoustic data provide excellent signal-to-noise ratio measurements of large-scale temperature variability with high temporal resolution. This data type offers information about the large-scale, subsurface temperatures of ocean basins that complements that provided by in situ hydrographic profiles and satellite altimetry. Altimetry, hydrography and acoustic remote sensing offer three largely independent measurements of the ocean in the context of ocean state estimation through data assimilation.
The measured travel times were compared with equivalent travel times derived from four independent estimates of the North Pacific: (i) climatology, as represented by the World Ocean Atlas 2005 (WOA05), (ii) objective analysis of the upper ocean temperature field derived from satellite altimetry and in situ profiles, (iii) an analysis provided by the "Estimating the Circulation and Climate of the Ocean" project as implemented at the Jet Propulsion Laboratory (JPL-ECCO), and (iv) simulation results from a high-resolution configuration of the Parallel Ocean Program (POP) model. The comparisons of time series provide a stringent test of the large-scale temperature variability in the models. The measured and calculated travel times are similar, but they also show significant differences. The differences between the measured and computed acoustic travel times, which are comparable in size to the observed signals, indicate that the acoustic data can provide significant additional constraints for numerical ocean models, as suggested long ago by Munk and Wunsch.
The next logical step from these comparisons is to use acoustic travel times, together with other data, to constrain numerical ocean models. Data assimilation allows rigorous assessment of the contributions the various data types make to constraining model behavior. There are no technical impediments, either observationally or computationally, to the simultaneous use of altimetry, hydrography and acoustic remote sensing in operational ocean state estimation.

AC-2A-44: Upper Ocean Heat Content Simulated by NCEP GODAS

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Upper ocean heat content (UOHC) is one of the key indicators of climate variability on many time-scales extending from interannual to long-term anthropogenic trends. Since UOHC variability is also associated with SST variability, a better understanding and monitoring of UOHC variability can help us understand, monitor, and forecast, other SST modes such as Indian Ocean Dipole (IOD), Pacific Decadal Oscillation (PDO), Tropical Atlantic Variability (TAV) and Atlantic Multidecadal Oscillation (AMO). An accurate ocean initialization of UOHC variability in coupled climate models will also play a crucial role in emerging decadal climate prediction efforts. The NCEP operational global ocean data assimilation system (GODAS) provides a historical ocean reanalysis from 1979 onward, and maintains a continuous update in near real time (1 day delay). The operational GODAS is based on the GFDL Modular Ocean Model version 3 (MOM.v3) forced by the NCEP Reanalysis 2 (R2) surface fluxes, and a three-dimensional variational scheme that assimilates observed temperature, synthetic salinity and Altimetry sea level. Temperature observations include data from XBTs, TAO/TRITON/PIRATA and Argo profiling floats. Estimations of UOHC variability can be affected by many factors including analysis and assimilation produces, and changes in the input data. For example, the coverage of in situ temperature data was poor at the beginning of the reanalysis, but gradually increased with time and reached a near global coverage since 2005. To quantify uncertainty in the UOHC estimates, a comparison of UOHC in the top 300m and 700m using multiple ocean reanalysis products, which include the operational GODAS (GODAS3), its control simulation (CTL), the experimental GODAS that is identical to the operational GODAS except MOM.v4 was used (GODAS4), and the NODC objective ocean reanalysis based on in situ observations only (NODC), was made. We compared the basin average of the top 300m heat content from the four ocean reanalysis products. In the tropical Pacific, GODAS3 and GODAS4 were close to NODC except during 1979-1985 when the initial adjustment was still taking place, and during 1998-1999 when the discharge of heat content following the 1997/98 El Nino was underestimated. In the tropical Indian Ocean, GODAS3 and GODAS4 agreed well with NODC except during 1979-1984 and 1996-2001. In the tropical Atlantic, GODAS3 and GODAS4 were somewhat warmer than NODC before 2002, but became close to NODC afterwards. In the North Pacific, both GODAS3 and GODAS4 agreed very well with NODC prior to 2005, but started to have cold biases afterwards. In the North Atlantic, GODAS4 agreed with NODC much better than GODAS3 did, suggesting that including the Arctic Ocean in the ocean model is important for realistically simulating the North Atlantic heat content. Once the climatological mean differences were removed, the agreement among the ocean reanalysis products was significantly improved. The data assimilation products (GODAS3 and GODAS4) were superior to CTL in the tropical oceans, particularly in the tropical Indian and Atlantic Ocean. Note that the anomalous UOHC in the North Pacific and North Atlantic was very well simulated by CTL. However, it is puzzling that all the NCEP products started to deviate from NODC significantly since 2005 in the North Pacific where observations were generally plentiful. In the Southern Oceans, there was generally a poor agreement among the NCEP products and NODC. However, the agreement was slightly improved when the MOM.v4 was used. Another way to quantify the uncertainty of UOHC variability is to compare the dominant EOF patterns and their time series in the ocean reanalysis products. Separate EOF analysis will be done in each ocean basin in order to isolate mode of variability associated with the PDO, IOD, TAV and AMO. A consistency among the dominant EOF patterns and time series would be an indication of their robustness in representing the climate signal.

AC-2A-45: Origin and Variability of the Deep and Abyssal Waters of the Northwest Atlantic

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The two dense water overflows that cross the Greenland–Scotland Ridge via the Denmark Strait and Faroe–Shetland Channel form the Denmark Strait Overflow Water and Northeast Atlantic Deep Water, respectively, filling the deep and abyssal reservoirs of the subpolar North Atlantic. Changes at depths greater than the limits of open-ocean deep convection (2300 m or so) are primarily controlled by the processes involved in the formation and subsequent modification of these waters, starting with the overflows themselves. Each of the constituent water masses that form the original overflows will carry with them the imprint of time-varying climatic forcing in their source regions and of modifications en route. Their properties will also be subject to alteration by the processes of horizontal and vertical exchange from their spillways to the Labrador Basin and further downstream. The purpose of this presentation is to identify from the hydrographic record those

locations that are of primary importance for the transfer of ocean climate 'signals' into and between the two spreading overflow plumes, and if possible to trace the influence of these changes downstream to the Newfoundland Basin and beyond in the Deep Western Boundary Current.

AC-2A-46: Causes, Variability and Consequences of Deep Convection in the Labrador Sea in Recent Years

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The causes, strength and consequences of the deep convection that produces Labrador Sea Water (LSW) are analyzed by interpreting hydrographic, moored, profiling float and satellite measurements. Significant changes in the winter atmospheric forcing over the Labrador Sea explain most of the observed variability in the properties and volumes of the newly-formed year classes of LSW. The evolution of this water mass along its exit pathways and the associated signal transfer/transit rates will be described. Combining data from two consecutive occupations of the repeat hydrographic section AR7W conducted in May by Bedford Institute of Oceanography and August by University of Bremen in 2008 and 2009, we estimate the export rates of LSW and examine changes in overall stratification associated with input of salt and heat from the Atlantic sources and freshwater from the Greenland melt and Arctic.

Day 2: Scientific results and potential based on global observations

Session 2B: Large-scale ocean circulation and fluxes

AC-2B-01: Agulhas Current Time-series (ACT): Towards a multi-decadal index of Agulhas Current transport

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ACT is a US-led, NSF-funded project with the goal of building a multi-decadal time series of Agulhas Current volume transport as a contribution to the Global Ocean Observing System. The Agulhas is an important component of the global thermohaline circulation and changes in its interocean flux have been linked to the end of the last ice age. Knowledge of the seasonal and interannual variability of Agulhas transport, its sensitivities and feedbacks, will help us understand its role in our current changing climate. The first phase of ACT requires deployment of an array of instruments across the Agulhas Current and along an altimeter ground track, to obtain a three-year time series (2010-2013) of transports via in situ measurements. The second phase will be to correlate the along-track altimeter data with these measured transports to produce a proxy for Agulhas Current transport, which can be extended forwards and backwards in time. Ultimately,a twenty-year proxy of Agulhas Current transport will provide an important climate index for the Indian and global oceans, which can be compared to other climate indices, such as the Indian Ocean Dipole and the Atlantic Meridional Overturning, as well as to other western boundary currents, such as the Florida Current and Kuroshio time series.

AC-2B-02: Determination of Surface Wind Vector and Stress Fields Using METOP/ASCAT and QuikSCAT/SeaWinds Retrievals

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Since March 2007 two scatterometers onboard MetOp-A and QuikSCAT satellites provide routinely and continuously 10-m surface wind speed and direction with high spatial resolution. Due to the scatterometer sampling scheme, the use of the retrievals for operational oceanic forcing is rather limited and especially at global scale. Indeed, most of the oceanic models require gridded wind fields. A number of efforts have been made to produce regular in space and time wind fields from scatterometer off-line wind observations. However, in order to minimize the "trackiness" effect related to the scatterometer sampling over a swath, the method, used to estimate the gridded wind fields, averages at each grid point observations occurring within specified space and time windows. The mapping methods tend to smooth some instrumental and/or geophysical events such as measurement errors, and rapid spatial or temporal wind variability. Another limitation of scatterometer wind observations is related to the nearshore use. Due to land contamination scatterometer wind retrievals are generally not available in these areas. To overcome these limitations especially associated with operational use, new surface wind fields, estimated from the remotely sensed wind data are calculated over global ocean with a spatial resolution of 0.25° in longitude and latitude, and temporal resolution of 12 hours. Their quality is investigated through various comparisons with surface wind vectors from buoys moored in various oceanic basins. The comparisons show that speeds and directions compare well to in-situ data. The root-mean-squared differences of the wind speed and direction are similar to those estimated for buoy hourly measurement and scatterometer retrieval comparisons.

AC-2B-03: Terra Nova Bay POLYNYA: A Small Coastal Area Affecting Basin Scale Oceanic Conditions

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It is widely recognize the crucial role of the brine release during the sea ice formation processes for the formation of the Antarctic Bottom Water (AABW). Modification of thermohaline properties have been recently detected in the abyssal basins close to the Ross Sea pointing out its key role. Actually the Ross Sea is known to be an important area for the formation dense shelf water, the two most important shelf waters have peculiar characteristics in salinity (High Salinity Shelf Water - HSSW, S > 34.8 and temperature close to the freezing surface value) and in temperature (Ice Shelf Water - ISW, pot. temp. < 2.1 °C and S ≈ 34.6). Recent studies showed a relative short residence times of the Ross Sea shelf waters, the 3-4 years seems a reasonable period representative of the time interval between their formation and their ventilation of the deep ocean at the shelf break. The Italian CLIMA project started in 1995 a monitoring program of the polynya collecting both oceanographic and meteorological data in order to study at different time scales the atmospheric forcing (heat fluxes), HSSW formation rates, and the thermohaline characteristics of the water column. SSM/I remote sensed data of the last 15 years allowed us to discriminate two different behaviour of the polynya during the summer and winter conditions. The former is peculiar of the period between December-March and the polynya is often completely ice free, while the latter is between April-November when the polynya shows an average dimension of about 1500 km^2 with a maximum extension of about 5000 km^2. The TNB polynya is controlled by the katabatic wind regimes which is responsible for both the formation of the sea ice and for its continuous removal keeping the sea surface ice-free despite a continuous production. The analysis of the meteorological data collected by the Italian meteorological AWS network (www.climantartide.it) stressed the importance of the persistency of the katabatic regime (mainly the offshore component of the wind) which plays a major role for the maintaining the polynya opened. Analyzing the katabtic events we observed that they concentrated during the May-October with a significant interannual variability. The maximum in the offshore wind speed was regularly detected in June/July, few months later, in September/October, a salinity maximum appears in the surface layer (120 m depth approx.); while the former is related with a maximum in the sea-ice production in TNB polynya the latter marks the ending phase of the polynya. During this stage the polynya may still be open by the presence of relatively intense offshore winds but the production of sea-ice (and the associate release of brine) is not allowed by the shortness or by the infrequency of the katabatic wind regime. Along the water column the salinity freshen between March and June while it shows a sharp increase between July and October. A relatively surface warm layer 150 m deep appears in November producing a thermocline between 150 - 500 m which persists during the austral summer (December - February) and rapidly disappears at the beginning of the winter conditions (March) cause the increase of vertical turbulent mixing provided by the katabatic events. The estimated yearly averaged surface heat budget remarks a large variability in the last two decades showing higher values between 2001 to 2006 (maximum in 2003 with an average heat loss of -313 Wm^2); the minimum heat loss (-58 Wm^2) occurred in 1996 and the mean value for the entire period was -140 Wm^2. The estimated HSSW mean yearly production span in the same period between 0.7 to 2.0 Sv with an estimated average value of 1.2 Sv. In the deeper layers of the water column a general freshening was detected from 1995 up today (ΔS = -0.06 at 900 m deep) with a short positive anomaly measured in correspondence of the period 2002-03 associated to the maximum of the heat loss at the surface (i.e. maxim in the HSSW estimated formation). A remarkable role in the controlling the thermohaline condition of the TNB water column may be played also by the heat and salt carried by the modified Circumpolar Deep Water which flows along the Ross Sea slope and periodically may reaches the polynya area. Recent works analyzed at the shelf break of the Ross Sea the variability of the shelf waters involved in the ventilation processes and in the AABW formation showing an significant correlation with the TNB thermohaline variability.

Therefore the Terra Nova Bay polynya represents, not only for the logistic facilities due the proximity of the Italian scientific station, a unique polar environment to realize a relative cost-effective multi-disciplinary observing system that will provide the long-term measurements needed to improve understanding of climate change and variability, biogeochemical cycles and the coupling between climate and marine ecosystems in polar environments.

AC-2B-04: Dissolved Chlorofluorocarbons as Transient Tracers in the CLIVAR Repeat Hydrography Program

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As part of the CLIVAR Repeat Hydrography Program, a number of key hydrographic sections sampled in the 1990s as part of the World Ocean Circulation Experiment (WOCE) are being re-occupied at approximately decadal intervals. Measurements of a suite of physical and chemical properties are being made at full depth, closely spaced (nominally 30 nautical mile) CTD/rosette stations, with water samples collected at between 24 and 36 depths per station. Key goals of the chlorofluorocarbon (CFC) studies in this program are to document the invasion of these compounds into the ocean interior and apply the data to:

1) Determine the rates and pathways of ocean circulation and mixing processes. 2) Quantify water mass formation rates, and document decadal changes therein. 3) Quantify biogeochemical cycling rates in the ocean interior. 4) Determine rates and patterns of uptake and storage of anthropogenic CO2 in the oceans.5) Evaluate global ocean model simulations, and highlight the models' fidelity to oceanic uptake of anthropogenic compounds.

Significant differences in CFC concentrations (and CFC-derived water mass ages) have been observed during CLIVAR reoccupations of WOCE sections. Transient tracer combinations including Sulfur Hexafluoride (SF6) measured on the same samples have been used to constrain transit time distributions in the ocean interior to help separate tracer age changes due to decadal changes in ventilation along the sections from artifacts due to the impact of mixing on tracer ages. The multiple tracer technique can also be used to correct mixing biases' effects on anthropogenic CO2 estimates that rely on CFC ages. The addition of SF6 to our sampling plans also affords an unambiguous age tracer in the upper 400m of the water column during this and coming decades.

Recent studies using CLIVAR repeat hydrography data have revealed wide-spread changes in the temperature and salinity of abyssal waters during the past several decades. In many cases these changes are strongly correlated with regions of significant CFC invasion along the sections. CFCs thus provide sensitive indicators of regions of the deep ocean where surface-derived climate change signals propagate into the ocean interior on decadal time scales.

AC-2B-05: Bias in the bathythermograph records and its impact on ocean climate analysis

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This paper examines the impact of correcting time-dependent temperature bias in bathythermograph observations on a global data assimilation–based reanalysis of ocean circulation. Three different estimates of temperature bias are considered: that of Hanawa et al. (1995), Levitus et al. (2009), and Wijffels et al. (2008). Examine of 36-year analysis experiments repeated with each show that the latter two bias correction algorithms reduce the observed warm bias in global heat content significantly, notably in the decade and a half beginning in the early 1970s, and again in the early 1990s. The results indicate that the bias correction of Wijffels et al. overcompensates after 1995, leading to a slight cool bias in the resulting analysis. Examination of the mean temperature structure from the experiments shows that generally the impact of the bias correction on the analysis is what one might expect – at the depths where the correction is largest the analysis is modified proportionately. Since the Wijffels et al. (2008) correction is larger than the Levitus et al. its impact on the analysis is larger. The exception to this result occurs in the equatorial thermocline where the cooling of the observations associated with the Wijffels et al. correction actually results in a warming of the analysis in excess of 0.3oC (the impact of the Levitus et al. correction is less than half of that). To understand the cause of this large and counterintuitive result the impact of the bias correction on the time-dependent circulation is examined. Interestingly, the Levitus et al. correction causes a larger impact on El Nino than on the mean state, including a reduction of the magnitude of the temperature anomalies associated with ENSO by 10-20% and a strengthening of the currents in the eastern equatorial Pacific by up to 50%.

AC-2B-06: Eddy-balanced buoyancy gradients on eastern boundaries and their role in the Meridional Overturning Circulation

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It is demonstrated that eddy fluxes of buoyancy at the eastern and western boundaries maintain alongshore buoyancy gradients along the coast. Eddy-fluxes arise near the eastern and western boundaries because on both coasts buoyancy gradients normal to the boundary are strong. The eddy fluxes are accompanied by mean vertical flows that take place in narrow boundary layers next to the coast where the geostrophic constraint is broken. These ageostrophic cells have a velocity component normal to the coast that balances the geostrophic mean velocity. It is shown that the dynamics in these thin ageostrophic boundary layers can be replaced by effective boundary conditions for the interior flow, relating the eddy flux of buoyancy at the seaward edge of the boundary layers to the buoyancy gradient along the coast. These effective boundary conditions are applied to a model of the thermocline linearized around a mean stratification and a state of rest. The linear model parametrizes the eddy fluxes of buoyancy as isopycnal diffusion. The linear model produces horizontal gradients of buoyancy along the eastern coast on a vertical scale that depends on both the vertical diffusivity and the eddy diffusivity. The buoyancy field of the linear model agrees very well with the mean state of an eddy-resolving computation. Because the East-West difference in buoyancy is related to the zonally integrated meridional velocity, the linear model successfully predicts the meridional overturning circulation.

AC-2B-07: Water flux and Phosphorus transport in the mixed layer of the northern Red Sea and Gulf of Suez

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The study presents an attempt to calculate water flux and phosphorus transportation in the upper 50m layer (mixed layer) of the northern Red Sea and Gulf of Suez using data collected during the joint Russian-Egyptian expedition onboard the

Russian R/V "Professor Bogorov" which took place during March 1990. The hydrographic structure of the study area indicated the existence of an inflow of low salinity (40.10), warm (>22°C) and <28.3 surface water from the Red Sea into the Gulf of Suez and an outflow of a more saline (>40.40), colder (<22°C) and relatively high density (>28.3) subsurface water in the opposite direction. This water is forming in the entrance area of the Gulf, sinking as indicated by the down-sloping of the isotherms, isohalines and isopleths and entering the Red Sea as a mid-deep water. Vertical profiles of temperature, salinity and at some stations indicated that, the water temperature in the upper layer down to about 200 m depth shows a great uniformity in temperature. Below that depth, the water temperature decreases with increasing depth to reach 21.60°C at 500 m depth. Salinity and values at these stations show also great variations in the upper 200 m layer. Below this layer, the salinity and increase with depth to reach 40.46 and 28.5 at 500 m depth respectively. The distribution of phosphate in the investigated area showed that all the surface waters are nearly depleted in the phosphate and lie near 0.1 mole PO4-P/l. An apparent first peak lies nearly between 50 and 100m depth. All the stations showed gradual increase of the phosphate with depth till 500m. Phosphorus transported to the area from the west accounts for 316.05 tons/day, while 1.34 tons/day are transported from the east. Phosphorus flux from the south plays the most important role; it reaches 1212.67 tons/day. From Gulf of Aqaba, 2.25 tons/day enters the area. Cumulatively about 1530 tons phosphorus/day enters the upper 50m layer, of which only 117.63 tons/day enters the Gulf of Suez. The rest may be exhausted in plant growth or through sinking to the lower layers.

AC-2B-08: Observing System Simulation Experiments for the Atlantic Meridional Overturning Circulation.

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We report on initial efforts associated with a new project supported by NOAA and the National Oceanographic Partnership Program to quantitatively evaluate observing system strategies for the purpose of monitoring the Atlantic Meridional Overturning Circulation. The primary strategy is to use Observing System Simulation Experiments (OSSEs) to evaluate the impact of new and planned observing systems, and also to use Observing System Experiments (OSEs) to evaluate the impact of existing observing systems. The procedure for evaluating a proposed observing system using an OSSE is straightforward: (1) the proposed observations are sampled from an ocean model simulation known as the "nature run" that is assumed to represent the true ocean; (2) noise is added to make the observations more representative of what might actually be observed with actual instruments; (3) the observations are assimilated into a different ocean model, known as the operational model, to correct it with respect to the nature run; (4) an ocean forecast initialized with the corrected fields of the operational model is performed; and then (5) the quality of the forecast is evaluated against the nature run. We summarize our plans for developing and validating an ocean OSSE capability at NOAA/AOML and the University of Miami over the next 1-2 years. During this development period, our initial effort toward monitoring the AMOC is focused on evaluation of a multi-model ensemble to quantify the significant errors in the representation of the AMOC that exist in present-day ocean models, and also on identifying the best choice for use as a nature run. Error covariances determined from this analysis are then used to perform "virtual" OSSEs, which enable evaluation of the potential impact of observations without actually having to actually sample the observations from a nature run and assimilate these into the operational model.

AC-2B-09: Surface drifter measurements in the Mediterranean and Black Seas

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Surface currents in Marginal seas, such as the Mediterranean and Black Seas, can be measured efficiently from the drifts of Lagrangian instruments tracked by, and transmitting data to, satellite systems (Argos, Iridium). These surface drifting buoys (called drifters) are low-cost, expandable systems that measure sea surface temperature (SST) and currents through their displacements between satellite fixes. Drifters are actually quasi-Lagrangian since they do not perfectly follow the surface water because of the effects of the winds and waves acting on them. However, over the past two decades, drifters, such as the CODE and SVP designs, have been developed to reduce these effects. In the Mediterranean and Black Seas, satellite-tracked drifters were operated starting in 1986 and 1999, respectively, as part of national and international scientific projects and in support of military operations. They have been deployed from research vessels and from ships of opportunity (ferries, small boats, etc.). The data of most drifters operated in the Mediterranean and Black Seas between 1986 and 2009 have been assembled in a common database in which all the data have been processed and quality controlled uniformly. This database and corresponding graphical products are available online whereas partial databases have also been released on CD-ROMs. The data of more than 1000 drifters (mostly corresponding to CODE and SVP designs) have been included in the database. Among all the studies in which drifter data can be utilized, it is important to mention their use in concert with satellite maps of SST or surface chlorophyll concentration. The combination of Lagrangian data and satellite maps provides a remarkable description of the often complex spatio-temporal variability, at sub-basin and meso-scales, of the surface circulation and its connection with the SST and chlorophyll fields. From a more statistical point of view, drifter data are also used to compute pseudo-Eulerian maps of mean circulation and sub-grid/temporal (also called eddy) variability. Kinetic energy levels of the surface currents can also be mapped. In addition, using the Lagrangian nature of the drifters, Lagrangian statistics (time-lagged auto-covariance, diffusivity, etc.) can be calculated to investigate the absolution and relative dispersion of water parcels. International collaboration is crucial to obtain a useful drifter dataset even at the scales of the Mediterranean and Black Seas. The combination of data from drifters with similar properties (same depth of drogue, same effects of wind and waves) in a marginal sea is needed to provide a better description of the complex spatial and temporal variations of the surface currents. Colleagues from the USA, Spain, France, Italy, Tunisia, Ukraine and Russia have contributed to the Mediterranean and Black Sea drifter database between 1986 and 2009. Starting in late 2006, the Mediterranean Surface Velocity Program (MedSVP) has been formed to coordinate the use of surface drifters in the Mediterranean and Black Seas and to make their data available in near-real time (daily) for several end-user applications, including their assimilation into operational numerical forecasting models. Hence, through MedSVP, drifter data are now readily available and represent an important component of the Mediterranean Operational Oceanography Network (MOON). Recent examples of Mediterranean and Black Sea drifter programs are presented, including the EGYPT-EGITTO experiment in the southeastern Mediterranean, and the TSS experiment with main focus on the Marmara Sea.

AC-2B-10: Surface Fluxes in High Latitude Regions

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Improving knowledge of air-sea exchanges of heat, momentum, fresh water, and CO2 is critical to understanding climate, and this is particularly true in high latitude regions, where anthropogenic climate change is predicted to be exceptionally rapid. However, observations of these fluxes are extremely scarce in the Arctic, the Southern Ocean, and the Antarctic marginal seas. High winds, high sea state, extreme cold temperatures, seasonal sea ice, and the remoteness of the regions all conspire to make observations difficult to obtain. Existing gridded flux products can differ substantially, by 50 W m-2 or more in the case of heat fluxes, and in many cases there is no clear consensus about which flux products are most reliable. Gains would be achieved with improvements in the accuracy of scatterometer winds at high wind speed and with improvements in heat fluxes to achieve 0.01Nm-2 and 10 W m-2 accuracy (averaged over several days) with 25 km grid spacing. Progress in this regard will require a combination of efforts, including a concerted plan to make better use of ships of opportunity to collect meteorological data, targeted effort to deploy a few flux moorings in high wind regions, and improved satellite retrievals of flux related variables. A sustained flux observing system might eventually rely extensively on satellite data, but it will require in situ monitoring from ships of opportunity and buoys as ground truth and to support continuing algorithm improvements.

AC-2B-11: Observations of Atmosphere-Ocean Freshwater Input With In Situ and Satellite Measurements of Surface Salinity and Rain

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Two new satellite missions in 2009 and 2010 will attempt for the first time to measure ocean surface salinity remotely from space. The European Space Agency (ESA) mission for Soil Moisture and Ocean Salinity (SMOS) and the US/Argentina mission Aquarius both aim to deliver regularly updated global maps of sea surface salinity (SSS). These will eventually produce the first global view of the variability over oceanic basins and seasonal to inter-annual scales of this hitherto poorly known field. Together with sea surface temperature (SST), SSS determines surface water densities and has important implications for air-sea exchanges of freshwater, heat and carbon. In the North Atlantic, sinking of dense waters associated with the Meridional Overturning Circulation leads to the heat transport, which gives Northern Europe its relatively mild climate compared to other regions at the same latitude.

Given the technical and scientific innovation of flying an L-band interferometric radiometry in space, there are many challenging aspects linked with the calibration and validation of SMOS SSS. For example, while L-band (1.4 GHz ≈ 20cm wavelength) is the frequency with highest sensitivity to salinity, that sensitivity remains weak and is dominated instead by surface roughness effects. Those effects are poorly known, primarily because few observations sites provide surface water salinity and temperature measurements together with full descriptions of wind and sea conditions. In the case of SMOS, the absence of an ancillary surface roughness measuring payload only compounds the problem of retrieving salinity, by introducing uncertainties linked to possible biases and sampling errors in the operational wind and wave fields used for salinity retrieval.

One key aspect of measuring salinity from space is that significant spatio-temporal averaging over several satellite overpasses is necessary to achieve sufficient accuracy for meaningful comparisons with in situ data. Conventional validation methods, based on instantaneous comparisons with collocated in situ measurements, are thus of limited use. Both SMOS and Aquarius aim to produce composite salinity maps with 0.1psu accuracy averaged over 10-30 days and 1-2 degree resolution grid. To compare these against accurate but sparse in time and space in situ observations of near-surface salinity measurements will call for new methodologies to combine related information from different sources, each with different error and sampling characteristics.

In this paper, we begin by focusing on the North Atlantic area, examining the variability of key oceanic and atmospheric parameters like sea surface salinity, sea surface temperature and ocean roughness, using earlier studies in the literature and currently available observations and climatologies. Surface salinity observations are available from a multitude of sources (see e.g. Figure 1), from moored buoys and platforms (e.g. PIRATA, Station Mike), underway temperature and salinity (e.g. Voluntary Observing Ships, Ferrybox, research cruises), XBTs and of course Argo. Argo provides the most extensive and uniformly distributed dataset of salinity measurements but its shallowest measurements are rarely closer than 10 meters to the surface. In many places where the surface is well mixed, the salinity at 10 meters depth will differ little from the salinity measured by satellite in the top centimeter. But this will not be the case in areas of intense precipitation. Thus, precipitation satellites may also yield information relevant to assessing the validity of new satellite salinity data. In the end, combining satellite and in situ measurements may lead to important insight about atmospheric freshwater fluxes into the ocean as well as the degree of near-surface ocean mixing.

AC-2B-12: Long term ocean variability and effects on regional ocean dynamics

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Ocean variablity during the last fourteen years (1993-2007) is analyzed using different sets of satellite observations and products. Results show that trends in sea surface temperature are mostly positive in the northern hemisphere and negative in the southern hemisphere. Linear trends in the Southern Hemisphere show basin wide changes in the Pacific Ocean with positive values in the west and negative values in the east. In regional scales the variability of the sea height may be due to changes in the location and intensity of western boundary currents. Results are presented jointly with trends in wind field to investigate their possible link to an atmospheric response. Changes in the intensity and location of main currents are inferred from the variability in the eddy kinetic energy field. Results of the analysis indicate that several boundary currents show an increase in eddy and meandering activity. Among them, it is observed a change in the main location of the Gulf Stream and a southward shift of the Brazil/Malvinas Confluence in the South Atlantic. The variability of the Brazil-Malvinas frontal region is presented in terms of two parameters: the separation of the Brazil Current from the continental shelf break and the southernmost location of the Brazil Current Front.

During the study period, these parameters exhibit a shift to the south of approximately 1.5 and 0.8 degrees, respectively. Simultaneously, the interior of the South Atlantic subtropical gyre exhibits an expansion with mean increase of 2 cm of dynamic height per decade. Statistically significant changes are not observed in the geostrophic transport of the Brazil and Malvinas currents, which theory and models have shown to govern the separation of the BC, thus suggesting that a different mechanism governing the low-frequency changes of the Brazil Current front. The shift of the Brazil Current front is hypothesized here to be associated to this concurrent expansion of the South Atlantic subtropical gyre. This shift is consistent with the trend in the latitude of the maximum basin-averaged wind stress curl, suggesting that the migration is driven by Sverdrup dynamics and that longer term estimates of the frontal location can be derived from wind fields. This proxy for the Confluence location is derived from the NCEP/NCAR reanalysis v.2 fields for the period 1979—2007, with results suggesting that the front was at an anomalously northward position in the early part of the modern altimetry period. Correlation of this decadal record with SST anomaly suggests that the wind changes may have been driven by warming along the Agulhas-Benguela pathway. Comprehensive numerical experiments will ultimately be needed to determine the origin of these changes.

AC-2B-13: Seven Years of measuring the Makassar Strait throughflow, the primary component of the Indonesian Throughflow

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The transfer of tropical Pacific water into the Indian Ocean through the Indonesian seas, the Indonesian Throughflow (ITF), is a significant part of the ocean system of interocean fluxes, ocean-scale heat and freshwater budgets and sea-air fluxes, providing an oceanic interactive link with the ENSO and Asian monsoon climate features. The ITF to a large extent governs the overall oceanographic stratification, circulation and ecosystems within the Indonesian Seas. Makassar Strait is primary inflow pathway of the ITF, carrying >80% of the total ITF. The Makassar throughflow has been observed within the 45 km wide Labani constriction near 3°S for a 1.5 year period in 1997/98 as part of the Arlindo program, and for three years, 2004-2006, as part of the INSTANT program. The observed transport in the Makassar Strait, from January 2004 through November 2006 is ~11.6 x106 m3/sec, 27% larger than observed during 1997 when a strong El Niño suppressed the flow. As the ITF transport varies with ENSO, and likely other climate indices (e.g. Indian Ocean Dipole) a multi-year record is needed to fully appreciate its characteristics and links to the regional and larger scale climate system. Directly after the recovery of the NSF funded INSTANT western Makassar mooring in November 2006, a NOAA funded mooring was deployed at the same site (2°51' S; 118°28' E; 2147 m) on 22 November 2006. The NOAA-Mak was recovered on 31 May 2009, and re-deployed for another 2 years to continue to build the time series. We now have a 5.5-year continuous time series of Makassar throughflow; with the Arlindo data we have a full 7 years of Makassar throughflow recorded. During the INSTANT periods ENSO was in a weak El Niño state, with a brief La Niña phase occurring in early 2006. The NOAA mooring period spans a time of an overall weak La Niña phase. Except for the Arlindo period, there is no clear correlation of the Makassar throughflow to ENSO, but it is noted that neither the INSTANT or NOAA time series recorded during strong ENSO episodes. The December 2006 through May 2009 record displays many of the same attributes as revealed by the INSTANT data: a clear seasonal behavior with maximum flow in August, with minimum flow in November. The particularly weak flow of November 2007 may be a consequence of a strong Kelvin Wave derived from the Indian Ocean. The mean flow within the thermocline and deeper as measured by the NOAA-MAK mooring is strikingly similar (less than 10% difference) to that measured during the INSTANT period. However the flow at 40 meters is notably weaker in the NOAA record, with an average southward speed of 0.3 m/sec versus 0.4 m/sec in the INSTANT 2004-2006 record.

AC-2B-14: The Solomon Sea observed by glider and altimetry

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The Solomon Sea with intense western boundary currents like the New Guinea Coastal Current is a key region for the tropical/subtropical connexion and for the feeding of the Equatorial Under current with possible effect on ENSO modulation. The sharp Papua-New Guinea coastline and the Solomon Sea with its narrow straits to the north impose strong topographic constraints on the flow that is little documented so far. Long-term observations in the region are sparse, and so far the Argo floats array does not sample this enclosed area well. Climatologies are hampered by the sparse data coverage. Gliders are autonomous underwater platforms that are moved over the water column by modifying their buoyancy and "glide" using wings that confer a horizontal velocity associated with their vertical displacements. Gliders are expected to be an important contribution to monitor boundary current, especially in regions of difficult accessibility. An experimental glider monitoring of the LLWBC within the Solomon Sea is currently tested to understand how the inflow distributes within the Solomon Sea. Five glider missions have been operated from August 2007 to January 2009 showing the huge variability of the transports in relation with ENSO conditions and eddy activities. Another information on this variability comes from altimetry where the Solomon Sea exhibits the highest levels of sea level variability of the whole South Equatorial Pacific Ocean. Surface geostrophic current, as eddy kinetic energy level, deduced from altimetry reflect most of the transport variability in the Solomon Sea. The satellite data are useful to replace the data along the glider track in a synoptic context whereas the glider data are useful to test how the surface information from altimetry is representative of the dynamics at depth. The complementary of both datasets: gliders and altimetry, motivates this study.

AC-2B-15: International Research in Nares Strait

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The Poster will give a brief overview of activities undertaken through a number of years in Lincoln Sea and Nares Strait as a contribution to the International Polar Year. Highlights of results obtained will be presented.

Nares Strait is the 500-km seaway between Lincoln Sea and Baffin Bay bordering Ellesmere Island (Canada) in west and Greenland in east. Every winter it carries a great volume of ice

southwards subject to the prevailing south-going ocean current and dominant northern winds.

The research activities include the disciplines of oceanography, meteorology and ice drift monitoring, the latter complemented by a series of buoys with positions monitored at short time intervals.

The ocean studies include a long-term flux-measuring array crossing Kennedy Channel, the middle part of Nares Strait, as well as ship-borne measurements carried out during cruises in late summer months, lately in August 2007.

Meteorological investigations comprise atmospheric modelling at a grid size of 6 km that takes the special orography of the region into account. It presents hourly data at six points along the strait having been operated since 2003. In May 2008 an automatic weather station (AWS) was installed on Hans Island positioned in the centre of Kennedy Channel. It delivers standard met data on a half-hour basis via the Iridium communication system. Both set of met data show good correlation between wind speed and ice movements determined from satellite observations.

Ice movements are determined from consecutive satellite observations of the strait at time intervals determined by satellite mission planning. Based on these data the flux of ice into Nares Strait has been monitored since 1996 and ice movements in the strait correlated with wind data – recently with measured data from the AWS on Hans Island. GPS-monitored buoys deployed in spring 2006 and 2008 show the strong influence of the large tides that are present in the region.

AC-2B-16: Minimization of the Impact of Sampling Errors in VOS-based Global Air-Sea Flux Fields

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Sampling uncertainties in the voluntary observing ship (VOS)-based global ocean-atmosphere flux fields were estimated by sub-sampling of reanalyses and operational forecasts. In poorly sampled regions sampling errors amount to 2.5°-3°C for air temperature, 3 m s-1 for the wind speed, 2-2.5 g kg-1 for specific humidity, and 15%-20% of the total cloud cover. The highest sampling errors in surface fluxes range from 30 to 80 Wm-2. In poorly sampled subpolar latitudes of the Northern Hemisphere and throughout much of the Southern Ocean the total sampling uncertainty in the net heat flux can amount to 80-100 W m-2. The largest uncertainties in linear trend estimates are found in relatively poorly sampled regions like the high-latitude North Atlantic and North Pacific as well as the Southern Ocean, where trends can locally show opposite signs when computed from the regularly sampled and undersampled data. Spatial patterns of shorter-period interannual variability can be also affected by sampling uncertainties, especially in the Labrador Sea and northwest Pacific as well as the Southern Ocean, where trends can locally change sign due to sampling uncertainty. In order to minimize sampling errors in surface air-sea flux fields we suggest an approach based on estimation of probability distributions for surface fluxes. We apply the modified Fisher-Tippett (MFT) distribution providing accurate estimation of all statistical moments and estimation of surface turbulent fluxes of rare occurrences. Application of MFT allows for abating sampling uncertainties by 3 to 10 times. We will also demonstrate the application of this approach for the reconstruction of surface ocean-atmosphere heat fluxes over the North Atlantic for the last 127 years (1880-2006). Reconstructed fluxes reveal long-term trends, implying, for example, about 4 W/m2 per decade growing sensible heat fluxes in the Labrador Sea and about 2 W/m2 per decade secular increase in the Central subpolar gyre in the Atlantic.

AC-2B-17: MORE: Five Years of Radiative Air-Sea Flux Measurements in the Atlantic Ocean

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The Meridional Oceanic Radiative Experiment (MORE) is a joint initiative of the P.P. Shirshov Institute of Oceanology (IORAS) and the Leibniz Institute of Marine Sciences at the University of Kiel (IFM-GEOMAR) MORE is set up to conduct long-term, high quality measurements of surface parameters and fl uxes in the Atlantic Ocean with a particular emphasis on short wave (SW) and long-wave (LW) radiation fluxes. These are needed for proper quantification of the global ocean heat balance. Since 2004 under MORE there has been carried 8 cruises with direct measurements of short-wave and long-wave radiation fluxes along with the observation of basic meteorological variables and cloud sky imaging taken with approximately similar sampling in different latitudes in the belt from 60N to 60S at the Atlantic meridional section. Thus, these data account for most potential cloud conditions at sea. In the poster we will demonstrate the pilot MORE results, first of all the potential of using MORE data for the development of new parameterizations of radiative fluxes at sea. For instance we will demonstrate that new parameterizations demonstrate statistically significant improvement of the accuracy compared to the other schemes based exclusively on the total cloud cover, being especially effective under high cloud cover and conditions close to complete overcast. Finally the poster will discuss the perspectives of the improvement of observations of clouds and radiative fluxes for achieving better accuracy of global and regional air-sea interaction estimates.

AC-2B-18: Atlantic Meridional Overturning Circulation Simulated by NCEP GODAS

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The Atlantic meridional overturning circulation (AMOC) was estimated using the NCEP operational Global Ocean Data Assimilation System (GODAS), which assimilates observed temperature and synthetic salinity profiles down to 750m. The averaged (1982-2004) AMOC is 17 Sv at 37N (Fig. 1), consistent with other observed analyses and model simulations.

The AMOC was also estimated from two experimental GODAS runs, one that is identical to the GODAS except assimilating observations down to 2200m (GODAS_deep) and the other assimilating observed temperature and Argo salinity profiles down to 750m from 2001 to 2006 (GODAS_Argo). The GODAS_deep AMOC drifted upward for about 5 years from its initialization in 1979 provided by GODAS, and then became stationary until the Argo data became available in 2000 when the upward drift started again. The averaged (1982-2004) AMOC in the GODAS_deep is 26 Sv, about 9 Sv stronger than that of GODAS. However, the strength of the GODAS_Argo AMOC is similar to that of the GODAS. The results suggested that the strength of AMOC can be reasonably assimilated by a shallow data assimilation scheme, and the quality of AMOC simulation was not necessarily improved by using a deep data assimilation scheme. The impacts of Argo salinity on the AMOC simulation will also be analyzed.

An EOF analysis of the AMOC simulated by the operational GODAS indicates that the AMOC variation has a large spatial structure with maximum variability located at 45N and 1500m

(Fig. 2a). The first EOF pattern represents 50% variance, and its principle component indicates an increasing trend from 1982 to 1994, and a decreasing trend from 1995 to present (Fig. 2b), in a good agreement with the AMOC variability estimated at 40N.

Since AMOC is density-driven, it is critical to analyze the features of temperature and salinity variability, and their contributions, to density variability. We analyzed the features of temperature and salinity variability in the GODAS and compared them with observations. It is found that the AMOC variability in GODAS is largely driven by temperature variability since salinity variability was severely underestimated by synthetic salinity. However, since upper ocean heat content can be used as the AMOC fingerprint, the AMOC variability in GODAS appears reasonable, and has a potential to be used in monitoring and assessing the current conditions of AMOC.

AC-2B-19: Objectively Derived In-Situ Turbulent Flux Climatology: Application to Tropical Atlantic Variability

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In order to better understand both regional and global climate variability accurate estimates of the surface turbulent fluxes (momentum, latent and sensible heat) between the ocean and atmosphere on multiple spatiotemporal scales is essential. Observationally, the near ocean surface properties are primarily measured by ships, moored and drifting buoys, and satellites. Direct measurements of the fluxes between the ocean and atmosphere are sparse in both space and time and thus woefully inadequate to capture variability on basin-wide to global scales. Consequently, the turbulent fluxes need to be estimated using surface meteorological data obtained from said oceanic sources, numerical weather prediction (NWP) models, or a combination thereof. This study highlights the third generation Florida Statue University (FSU3) monthly mean 1°x1° gridded wind and surface flux product and its application to tropical Atlantic sea surface temperature (SST) variability. The FSU3 product is constructed from in situ ship and buoy observations via a variational technique and includes: wind stress, latent heat flux, sensible heat flux, pseudostress, scalar wind speed, specific humidity, and air temperature. The resulting fields are available for the Atlantic, Pacific, and Indian oceans from 1978 through 2004.

Previous studies (Carton et al. 1996, Xie and Tanimoto 1998, Seager et al. 2001, Czaja et al. 2002, Foltz and McPhaden 2006) have shown that SST variability in the tropical North and South Atlantic is driven primarily by wind-induced changes in the latent heat flux. Analysis of the FSU3 product for the time period 1978-2004 shows that the latent heat flux anomalies explain approximately 10% (25%) of the change in SST variability in the tropical North (South) Atlantic. The inclusion of the FSU3 sensible heat flux along with the ISCCP-FD shortwave and longwave fluxes had a minimal impact on the correlation between the surface fluxes and change in SST over the tropical Atlantic. The analysis did not consider the depth of the mixed layer or other sub-surface oceanic process (e.g., horizontal advection). The preliminary results suggest that the ocean plays an active role in regulating the tropical Atlantic SST variability. In agreement with Foltz and McPhaden (2006), it appears that sub-surface observations are vital to the understanding of tropical Atlantic SST variability and air-sea interactions.

AC-2B-20: Annual Signal Modulation of the Kuroshio Through-flow Volume Transport South of Japan Leading West Pacific Pattern

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The present study shows the possible societal benefit of eMonitoring ocean-atmosphere interactions in western boundary current extensions in the North Pacific.

As the Western Boundary Current of the North Pacific Subtropical Gyre, the Kuroshio south of Japan is considered to play an important role in a global climate system through transporting a large amount of heat which is released to the atmosphere in the Kuroshio Extension region. However, the relation between the Kuroshio and the global climate has not been clarified yet mainly because the inter-annual variation of the Kuroshio transport south of Japan is not clear due to large fluctuations of volume transport caused by recirculation eddy to the south of Shikoku and meso-scale eddies from the east.

For getting the data necessary for estimating the net volume and heat transports of the Kuroshio through-flow south of Japan by reducing the dominant recirculation and eddy components, we conducted the moored array observation from July 2004 to October 2006 using 9 current meters at 9 sites and 11 pressure-gauge-equipped inverted echo sounders (PIES) along the ASUKA (Affiliated Surveys of the Kuroshio off Cape Ashizuri) -line north of 30°N, and the 30°N line from 135°E to 142°E.

By combined use of these moored observation data and satellite altimeter data, we have estimated a 16-year long time series from 1993 of the volume transport of the Kuroshio through-flow (KTVT) across the ASUKA-line as shown in Fig.1. It is obvious in this figure that annual signal is much more dominant than any other components in KTVT, and its amplitude changes year by year while it has the maximum every winter. Focusing on this dominant inter-annual amplitude modulation in the KTVT annual signal, we have examined the relation of KTVT with the climate indices such as Multivariate ENSO Index (MEI), Arctic Oscillation (AO) Index, Pacific Decadal Oscillation (PDO) Index, West Pacific Pattern (WP) Index and others, not by wavelet analysis but by correlation analysis due to lack of available data duration length of KTVT time series.

The cross correlation function, R, between annual signals in KTVT and WP is found to have statistically significant maxima of -0.73 at lag (L) = -19-month (WP leads KTVT) and -0.72 at L = 65-month (WP delays KTVT) while other indices have not so large correlation maxima as WP. This result indicates that, while KTVT is affected more directly by WP before 19 months, it has some feedback process affecting the annual signal of WP after 65 months, and that we can predict well the 65-month later temperature and precipitation over the North Pacific associated with WP using present KTVT.

For improving the prediction accuracy of temperature and precipitation over the North Pacific by better understanding of various ocean-atmosphere interaction processes connecting WP with KTVT, we must keep continuing the monitoring of KTVT and surface heat flux in the Kuroshio and Kuroshio Extension region.

AC-2B-21: Volume Transport Variability in the Northwestern Weddell Sea Seen in a Global Ocean Model (OCCAM)

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The Synoptic Antarctic Shelf-Slope Interactions Study (SASSI) project has conducted multidisciplinary studies on the continental shelf and slope at Antarctic margins during the International Polar Year (IPY-2007/09). In summary, during the IPY several countries contributed to SASSI project with short synoptic transects that were undertaken circumpolarly and radiated outwards across the Antarctic continental shelf and slope. One of those is the high sampled WOCE SR4 hydrographic section starting near the tip of the Antarctic Peninsula across the Weddell Sea, which is one of the main areas of Antarctic Bottom Water (AABW) export to the global oceans. As part of the SASSI project and because of the high spatial-temporal resolution available, we have chosen to analyze the 1/12° simulation obtained with the Ocean Circulation and Climate Advanced Modelling (OCCAM) model to investigate the temporal variability of AABW (i.e. Weddell Sea varieties) volume transport in the northwestern Weddell Sea. Here, we focus in the volume transport variability. The mean total full depth cumulative volume transport obtained was respectively 28.6 ± 8 Sv (1 Sv = 106 m3s-1) and 28.7 ± 10 for section 1 (i.e. the western part of the WOCE SR4 section) and section 2, this is somewhat lower than the transport (i.e. 46 ± 8 Sv) obtained during the summer 2007 cruise of the Antarctic Drift Experiment Link to Isobaths and Ecosystems (ADELIE) project [Thompson & Heywood 2008]. On the other hand, this is the mean volume transport considering all the simulated years (i.e. 1988-2004). It is not unexpected that the bottom layer volume transport is also underestimated by the model (i.e. 11.6 ± 4 Sv – section 1 and 10.7 ± 4 Sv – section 2. This could be probably associated with the weaker current velocity representation by OCCAM model in the Weddell Gyre [Renner et al. 2009]. The monthly variability of the total volume transport, considering both the entire section and only the neutral density layers >28.26 kg.m-3, shows the maximum (minimum) transport occurring in June (January). Comparing with the results from Fahrbach et al. [1995], there is a delay of one month in the model. However, the monthly variability of the total volume transport in the model is in phase with sea ice fraction monthly average in the Antarctic Peninsula sector. The annual variability of the total volume transport of section 1 is not in phase with the sea ice parameters. In contrast, the annual average of the bottom volume transport is ~2 years lagged with both the sea ice fraction and the sea ice thickness variability. Other parameters (as the wind patterns) are under investigation to try to explain these findings.

AC-2B-22: Formation rates of Labrador Sea Water inferred from repeated tracer sections

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Since more than three decades oceanic measurements of anthropogenic tracers such as chlorofluorocarbons (CFCs) have served as valuable tools to investigate the spreading and the formation of deep water components in wide-spread regions of the Atlantic Ocean. Labrador Sea Water (LSW) is the shallowest components contributing to the cold and deep branch of the Meridional Overturing Circulation. Evidence from the past two decades have shown that the formation history of LSW in the Labrador Sea succumbs to substantial interannual and decadal variability. Repeated tracer sections on basin-wide scales have yielded valuable information on LSW formation changes. Since 1997 the spatial data coverage in the subpolar North Atlantic is sufficient to determine the CFC-12 inventories of Labrador Sea Water (LSW) on biennial time scales. Temporal changes in the CFC-inventories are therefore used to infer LSW formation rates and associated uncertainties. In contrast to oceanic convection peak times in the early 1990s producing a dense, deep mode of LSW, the convection activity of the late 1990s resulted in a shallow and lighter mode, called upper LSW. The results indicate a weakening of the total LSW formation in the years 1997-2005 which corresponds to a decrease of the baroclinic mass transport of the upper 2000m between Bermuda and the central Labrador Sea which is thought as an index of the strength of the subpolar North Atlantic gyre. The fact that the atmospheric signal of CFC-12 does not further increase, may hamper in future the detection of an oceanic CFC-12 increase due to water mass formation processes and will lead to greater uncertainties when considering changes in CFC-12 inventories. Therefore, we present first results from basin-wide measurements of sulphur hexafluoride (SF6) in the subpolar North Atlantic in conjunction with CFC-12 measurements and investigate the potential of using the transient signal of SF6 to estimate LSW formation rates.

AC-2B-23: Introduction of Japanese Ocean Flux data sets with Use of Remote sensing Observations (J-OFURO) Version 2

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We have constructed ocean surface flux data sets mainly using mainly satellite data. The data set named Japanese Ocean Flux data sets with Use of Remote sensing Observations (J-OFURO) has been provided to scientists since 2002 (Kubota et al., 2002) and has been used in many research studies. Recently, new surface heat flux data sets have been constructed in J-OFURO, thereby upgrading it to version 2 (J-OFURO2). Version 2 has many improvements over version 1 for the estimation of momentum turbulent heat fluxes. For example, multisatellite data are used in J-OFURO2, while data from only one DMSP-SSM/I sensor has been used for the estimation of turbulent heat fluxes in J-OFURO1. We are going to introduce J-OFURO2 products with evaluation results.

AC-2B-24: U.S. AMOC Program

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U.S. ATLANTIC MERIDIONAL OVERTURNING PROGRAM: PROGRESS, GAPS AND PLANS The U.S. Atlantic Meridional Overturning Circulation (AMOC) program is a near-term priority of the U.S. Ocean Research Priorities Plan issued in January of 2007. A panel of U.S. scientists developed a five-year implementation plan, released in October of 2007, that laid the groundwork for an inter-agency program that will develop the initial components of an AMOC monitoring system and AMOC prediction capability. The overall objective of this research program is to investigate the physical variability of the AMOC such that researchers will be able to understand and predict the impact of AMOC variability on regional and global climate, ocean ecosystems, sea level, sea ice and the global carbon budget. Specifically, the three principal objectives of this program are: Objective 1: The design and implementation of an expanded AMOC monitoring system Objective 2: An assessment of AMOC's role in the global climate Objective 3: An assessment of AMOC predictability The goal of this short paper is to summarize progress on the three main objectives of the program, identify gaps in the programmatic needs and make recommendations on how to fill those gaps. Progress on and identifiable gaps in the three main program objectives can be summarized as: 1. The design and implementation of an AMOC monitoring system At present, AMOC monitoring in the U.S. is accomplished by a collection of field programs that were largely in place at the creation of the program. Several nationally and internationally-funded global-scale programs are presently returning data that contribute to AMOC monitoring but do not constitute an adequate monitoring system for the Atlantic basin. These include Argo, JASON, the Global Drifter Array and the collection of satellites returning ocean surface and meteorological information. Several research efforts are presently utilizing these data to study and make estimates of the time-varying AMOC. There are several research programs conducted by European investigators (in addition to Argo, the Surface Drifter program and satellite missions) that are either

directly associated with AMOC projects or contribute indirectly. Chief among these is the U.K. RAPID/RAPID_WATCH program. While each of the activities described above is focused on identifiable goals of the US AMOC program or UK RAPIDWATCH program, collectively they are clearly insufficient to constitute an AMOC observing "system". Furthermore, there is no such system in place nor are there currently any international plans for such a system. 2. An assessment of AMOC's role in the global climate Although overall progress on this program objective remains in its initial stages, several modeling efforts are now underway. The NOPP Program has chosen three modeling projects: a study of optimal observing systems, an analysis of ocean state estimates for AMOC from US and European assimilation projects and an analysis of MIT-ECCO-GODAE results to design observing systems and understand the sensitivity of AMOC estimates to observing systems. Additionally, efforts to reconstruct AMOC variability using data from existing global observing systems are ongoing. Despite these efforts and others, substantial work remains to adequately assess the AMOC's role in the global climate system. Specifically, no comprehensive measurement systems currently exist or are planned that are capable of providing broadscale measurements of the ocean below 2000 m, thus preventing direct assessments of the volumetric heat and freshwater content of the deep ocean. This gap makes it difficult to assess the AMOC's role in absorbing the excess heat caused by anthropogenic climate forcing. 3. An assessment of AMOC predictability Assessments of what might potentially be predictable, to what degree, and via which physical mechanisms are currently under discussion in both the climate modeling and observing communities. Approaches including initial condition constraints and transient boundary forcing to investigate both natural and anthropogenically-induced variations are being pursued, as are investigations of natural internal variability. NCAR and GFDL, as well as international modeling centers, are in the process of generating output useful for addressing AMOC predictability in the next few years. Despite recent research efforts, we still lack an understanding of 1) the physical mechanisms governing low-frequency variability of the MOC, the 2) relationship between SST variability and MOC variability, 3) the teleconnection mechanisms linking changes in high latitudes of the North Atlantic to changes in low latitudes and other ocean basins, 4) predictable dynamics and predictability limits and 5) data assimilation methods for decadal climate prediction. To fill programmatic gaps the U.S. AMOC Science Team recommends that: 1. The design and implementation of a monitoring system for the time varying strength of the AMOC in the subpolar North Atlantic and subtropical South Atlantic be comprehensively planned this year and then realized in the next several years. It is crucial that resources be provided and coordinated internationally so that these quantities are well measured for a sufficiently long time to provide useful indices of various part of the AMOC system in their own right, and to provide the benchmarks needed to validate ocean state estimation models. A vital first step in this process is to conduct, with our international partners, an objective assessment of how effective existing observational efforts are in achieving these objectives, what resources might be added to enhance the accuracy and/or comprehensiveness of existing measurement systems, and to develop plans for continuous maintenance of these observations. 2. Model-based and data analyses continue with a strong focus on the establishment of a link between AMOC variability and SST changes. This linkage is crucial to our understanding of how AMOC changes impact the climate system. Additionally, studies are needed that explicitly address the impacts of changes in the AMOC on climate-relevant variables such as sea ice, marine ecosystems, sea level, and carbon uptake 3. Assimilation and non-assimilation modeling efforts be focused on reaching a consensus on the past state of the AMOC and on advancing our nascent mechanistic understanding of the AMOC so that such models can be reliably used to guide the optimization of a long-term monitoring system. 4. In conjunction with the U.S. Climate Change Science Program (CCSP), a coordinated effort focus on the assessment of the potential predictability of the climate system on decadal time scales and the AMOC's role in that predictability. Given the scope of this program, on both the observational and modeling front, the US AMOC Science Team is interested in partnering with international collaborators to meet many of the stated goals. Progress and future plans for each of these US AMOC program objectives will be presented at Ocean Obs 09.

AC-2B-25: Multi-year Observations of the Brazil Current Baroclinic Transport Variability Near 22oS

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Despite of the recognized importance of the western boundary currents (WBC) to the oceanic and climate systems from regional to basin-wide scales, the Brazil Current (BC) remains one of the least studied and understood of all WBCs, especially in terms of its associated variability. Several aspects of BC low-latitude variability remain unexplained mostly due to the lack of reliable observations and consistent time series. As the BC mean flow is relatively weak, eddy features can impose a large variability to the current, leading to uncertainties in the baroclinic transports estimates from hydrographic snapshots. In this sense, we have set up a partnership joining Brazilian institutions and NOAA to fund and run a long-term high-density XBT line in the southwestern Atlantic in order to improve our understanding about the region and particularly the BC variability. The project has been labeled MOVAR (Monitoring the upper ocean transport variability in the western South Atlantic) and the line has been designated in the NOAA/AOML high-density program as AX98. The line was set up using a ship of opportunity scheme between Rio de Janeiro and the Brazilian navy oceanographic post at Tridade Island (POIT, 30oW 20oS). The Brazilian navy visits the POIT regularly (≈ every 3 months) to take supplies and exchange personnel. Thus, since August 2004, the same transect has been repeated eighteen times using the same sampling scheme providing valuable novel data in the study area. For example, the zonally integrated baroclinic transport (relative to 700 dbar) has proven to be much variable both temporally (4 Sv ± 3 Sv) and spatially (zonal fluctuations of the BC axis of more than 150nm). Those fluctuations are further related to the presence/absence fo the Vitoria Eddy, a transient feature already described for the region.

AC-2B-26: Ocean striations

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Accumulation of large, high-quality satellite and in situ data led to significant improvements in the description of the mean dynamic ocean topography (MDOT) [Maximenko et al., 2009]. The new models of MDOT, with the resolution improved to 50-100 km, have not only revealed important details in the complex mesoscale structure of circulation systems such as the Gulf Stream, Kuroshio Extension, and Antarctic Circumpolar Current, but also led to the discovery of new anisotropic jet-like features in ocean circulation referred to as "striations" [Maximenko and Niiler, 2005; Maximenko et al., 2005; Maximenko et al., 2008].

While somewhat similar features -- alternating zonal jets, are predicted by a number of theories inspired by the banded cloud patterns in the atmospheres of Jupiter and Saturn [Galperin et al. 2004], preliminary analysis of satellite and high-resolution ocean models reveal that striations (at least at the sea surface) are inconsistent with the two-dimensional, geophysical turbulence, which produces jets through the combination of processes commonly known as the "Rhines mechanism"

[Rhines, 1975]. Equally unlikely is the role of the PV staircases that could be formed by breaking Rossby waves [Baldwin, 2007]. The uniqueness of the ocean dynamics comes from the existence of the continents and culminates in the generation of large gyres associated with essentially meridional flows. To remain time-invariant in such a flow, striations behave as waves rather than as inertial jets. Once detected, the striations, both stationary and periodic in time, are found to be common throughout the ocean, although their properties varying to different degrees both geographically and interannually.

This paper outlines the main challenges of the striation study, both observational and theoretical. It discusses hypotheses of the forcing and dynamics of these features, interaction between striations and mesoscale eddies, and presents evidence that striations play an important role in regularizing the otherwise random eddy field. The striations are shown to be not just an artifact of misinterpreted moving eddies, but a structure retaining its coherence on spatiotemporal scales significantly exceeding the eddy scales (in some reported cases, up to thousands of kilometers and 15 years). Also discussed is the impact of striations on the climate system, both through the ocean dynamics and air-sea interaction, and possible differences between the circulation regimes in the upper and intermediate-depth ocean. It is also noted that techniques currently employed to map the sea level anomaly, derived from the along-track satellite altimetry, may tend to convert the signal from striations into the one from a train of eddies. We demonstrate the importance of the combined use of data of satellite and in situ observations, and realistic high-resolution global ocean general circulation model along with theoretical analysis and numerical experimenting with the regional ocean model system.

AC-2B-27: Mediterranean subsurface circulation and thermohaline properties from ARGO data

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In order to examine subsurface currents and thermohaline properties of the Mediterranean Sea, we used profiling floats deployed as a part of the International Argo program, since 2003. These floats are programmed to execute 5-day cycles drifting at a neutral parking depth of 350 m and CTD profiles from either 700 or 2000 m up to the surface. The Argos positions are used to estimate the circulation at the parking depth. This study involves a sophisticated determination of the surface and sub-surface displacements. From these, the subsurface velocities at the 350 m parking depth are estimated. Finally, the estimated subsurface velocities are used to compute pseudo-Eulerian circulation statistics, including maps of mean circulation and eddy variability in the Mediterranean Sea. We also used 5 years of Argo data (2004-2009) to study the spatial structures and the temporal variability of temperature and salinity in the Mediterranean Sea at surface, at 700 and 2000 m and at the depth of the salinity maximum. The dataset allows us to reconstruct the main spatial structures of salinity and temperature in the entire Mediterranean on a 2 degrees squared boxes. The analysis of the temporal variability in selected sub-basins of the Mediterranean reveals a positive trend of salinity at the depth of the salinity maximum in the Levantine basin.

AC-2B-28: 28 00:00 THOR: long term observations of MOC variability in the North Atlantic

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The variability of the ocean circulation in the North Atlantic has direct implications for the European climate, and for the global climate through its effects on the meridional overturning circulation (MOC). The new EU-funded THOR project ("Thermohaline Overturning: at Risk?") aims to quantify the range and probability of changes associated with MOC variability using palaeoclimate studies, long term observations and numerical models of ocean circulation. We present the observation system currently available for THOR, as well as plans for developing and enabling near real-time data transfer capabilities from deep sea moorings. This observation system, consisting of arrays of self contained instruments as well as ship- and space-borne measurements, will provide accurate time series of mass, heat and salt fluxes at key locations, allowing for the first time to assess the strength of the Atlantic Overturning Circulation.

AC-2B-29: Seasonal and Interannual Variation of North Pacific Subtropical Mode Water in 2003−2006

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Temperature and salinity data from 2003 through 2006 from Argo profiling floats have been analyzed to examine the formation and circulation of the North Pacific Subtropical Mode Water (STMW) and the interannual variation of its properties over the entire distribution region. STMW is formed in late winter in the zonally-elongated recirculation gyre south of the Kuroshio and its extension, which extends north of ≈28°N, from 135°E to near the date line. The recirculation gyre consists of several anticyclonic circulations, in each of which thick STMW with a characteristic temperature is formed. After spring, the thick STMW tends to be continually trapped in the respective circulations, remaining in the formation region. From this stagnant pool of thick STMW, some portion seeps little by little into the southern region, where southwestward subsurface currents advect relatively thin STMW as far as 20°N to the south and just east of Taiwan to the west. The STMW formed in the recirculation gyre becomes colder, less saline, and denser to the east, with an abrupt change of properties across 140°E and a gradual change east of 140°E. The STMW formed east of 140°E exhibits coherent interannual variations, increasing its temperature by ≈1°C from 2003 through 2006 and also increasing its salinity by ≈0.05 from 2003 through 2005. These property changes are clearly detected in the southern region as far downstream as just east of Taiwan, with reasonable time lags.

AC-2B-30: Chile Ocean Observing System

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We describe the present state of the Chile Ocean Observing System and present main results from mooring and ship based time series. The first long- term observational program to study ocean circulation off Chile considered the deployment of two currentmeter moorings near 30ºS in November 1991. Those moorings have been maintained for several years and, except for relatively short periods, long time series for these sites are presently available. After this initial effort, further initiatives have been accomplished to extend observations to northern (~21°S in 1998) and southern (~37°S in 2003) locations. Presently, six subsurface moorings, conforms the base of a regional ocean observing system. The observing system includes 3 deep ocean moorings (deployed at about 150-200 km from the coast in a water depth of ~ 4400 m near 21°S, 30°S and 37°S), 2 slope moorings (deployed over a depth of ~900 m at 30°S and 21°S) and one continental shelf mooring (deployed near 37ºS). The deep-ocean moorings are equipped with traditional current meter and sediment traps, and during some period we have

included in all the line 300 kHz or 75 kHz ADCPs. Additionally, several monitoring cruises are maintained for different programs. Off northern Chile seasonal oceanographic cruises have been carried out since the beginning of the 80's supported by the Chilean government and the fishery industry, while near 37°S an oceanographic station over the continental shelf is monthly visited since 2002. There a complete set of biological and biogeochemical data is being collected by the University of Concepcion. These efforts, although modest to cover the large lack of information in the zone, have revealed novel dynamical features underlying low frequency variability. The alongshore current over the slope near Iquique (21ºS) and Coquimbo (30ºS) shows impressive intraseasonal fluctuations (oscillations with periods between 30 and 90 days). Such oscillations are forced by equatorial Kelvin waves that, after hitting the South American coast, generate coastally trapped waves. These oscillations decay rapidly offshore and are not present in the oceanic current records. In contrast, the oceanic time series near 30ºS show large variability at lower frequencies related to mesoscale eddies and meanders of the alongshore flow. On the other hand, the seasonal cycle of the current is related to both, the annual variation of the alongshore wind stress near the surface and annual and semiannual equatorial disturbances. At lower frequencies, interannual oscillations of the flow are closely related to the El Niño-La Niña cycles. Both seasonal and interannual disturbances can leave the coast and propagate offshore modulating the flow and thermocline depth several hundred of kilometers offshore in the region. Progress of the Chile ocean observing system has been possible thanks to various research projects, leaded by researcher from different international and national institutions. Particularly, the ocean moorings are maintained in a collaborative effort between the Catholic University of Valparaiso, the University of Copenhagen, and the University of Concepcion. Contributions from the Hydrographic and Oceanographic Service of the Chilean Navy (SHOA) and from the Fisheries Development Institute (IFOP) have been also essentials to maintain the moored lines.

AC-2B-31: The RAPID-MOC/MOCHA Mooring Array at 26ºN in the Atlantic

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The Atlantic Meridional Overturning Circulation (AMOC) at 26.5°N carries a northward heat flux of 1.3 PW. Northward of 26.5°N, over the Gulf Stream and its extension much of this heat is transferred to the atmosphere and is responsible for maintaining UK climate about 5°C warmer than the zonal average at this latitude. However, previous sparse observations did not resolve the temporal variability of the AMOC and so it is unknown whether it is slowing in response to global warming as suggested by recent model results. In 2004 NERC, NSF and NOAA funded a system of observations in the Atlantic at 26.5°N to observe on a daily basis the strength and structure of the AMOC. Two papers (Cunningham, et al., 2007 & Kanzow, et al., 2007) demonstrated that not only does the system of observations achieve a mass balance for the AMOC, it reveals dramatic and unexpected richness of variability (fig. 1): the AMOC mean strength and variability is 18.5±4.9 Sv. From estimates of the degrees-of-freedom the year-long mean AMOC is defined with a resolution of around 1.5 Sv so abrupt changes would be readily identified and long-term changes will be measured relative to the 2004-2005 average. The NERC contribution to the first four years of continuous AMOC observations was funded under the directed programme RAPID Climate Change. Following an international review of the system NERC will continue funding to 2014 under the programme RAPID-WATCH. The NSF and NOAA have also continued funding and commitments so that the system can continue operating at the same level of activity as during the period 2004-2008. The objectives of RAPID-WATCH are: To deliver a decade-long time series of calibrated and quality-controlled measurements of the Atlantic MOC from the RAPID-WATCH arrays and; To exploit the data from the RAPID-WATCH arrays and elsewhere to determine and interpret recent changes in the Atlantic MOC, assess the risk of rapid climate change, and investigate the potential for predictions of the MOC and its impacts on climate. The 26.5°N Atlantic section is separated into two regions: a western boundary region, where the Gulf Stream flows through the narrow (80km), shallow (800m) Florida Straits between Florida and the Bahamas, and a transatlantic mid-ocean region, extending from the Bahamas at about 77°W to Africa at about 15°W (fig. 2). Variability in Gulf Stream flow is derived from cable voltage measurements across the Florida Straits, and variability in wind-driven surface-layer Ekman transport across 26.5°N is derived from QuikScat satellite-based observations. To monitor the mid-ocean flow we deployed an array of moored instruments along the 26.5°N section. The basic principle of the array is to estimate the zonally integrated geostrophic profile of northward velocity on a daily basis from time-series measurements of temperature and salinity throughout the water column at the eastern and western boundaries. Inshore of the most westerly measurement of temperature and salinity, the transports of the Antilles current and deep western boundary current are monitored by direct velocity measurements. The array as deployed in 2008-2009 consists of a total of twenty-one moorings and twelve landers in three sub-arrays (fig. 2). The principal moorings measure the density profile at the eastern and western boundaries through use of CTDs. In the west the continental shelf forms a "wall" whereas in the east a series shorter moorings step up the slope reducing the influence of bottom triangles. Each sub-array also includes four bottom pressure landers that are serviced in alternate years so that each recovery provides a two-year record with a year's overlap with the previous lander to remove instrument drift. The Mid-Atlantic Ridge moorings provide full depth density profiles either side of the ridge to allow separation of the eastern and western basin MOC contributions. The western boundary sub-array includes current meters to directly measure the currents in the western boundary wedge. The contribution of the Antarctic Bottom Water is captured through an offshore mooring in the western boundary combined with a mooring on the western flank of the mid-Atlantic ridge. In addition to the moorings listed above, the western boundary sub-array also contains three full depth moorings and four landers from the University of Miami that act as a backup to the density profile moorings and also provide the thermal-wind shear and measured velocities of the deep western boundary current (Johns, et al., 2008). Cunningham, S. A., et al. (2007), Temporal variability of the Atlantic Meridional Overturning Circulation at 26.5°N, Science, 317, 935-938. Johns, W. E., et al. (2008), Variability of shallow and deep western boundary currents off the Bahamas during 2004-2005: First results from the 26°N RAPID-MOC array, J. Phys. Oceanog., 38, 605-623. Kanzow, T., et al. (2007), Flow compensation associated with the MOC at 26.5°N in the Atlantic, Science, 317, 938-941.

AC-2B-32: Time series of transport variability and spreading paths of the North Atlantic subpolar gyre

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The subpolar gyre of the North Atlantic Ocean is one of the key regions for the earth´s climate system. Warm and saline waters of the North Atlantic Current (NAC) are transferred into the subpolar and polar regions, and subsequently returned as the deep and cold limb of the Atlantic Meridional Overturning Circulation (AMOC). Model simulations hint to a relation between deep water fomration, the strength of the subpolar gyre and the intensity of the AMOC. To measure the variability

of the NAC and thus the strength of the subpolar gyre, an array of 4 inverted echo sounders with bottom pressure sensors (PIES) was deployed along the Mid Atlantic Ridge between 47 and 52°N in August 2006. The location of the PIES allows the separation of the main NAC spreading paths through the fracture zones. The data were retrieved by acoustic telemetry in August 2008 and 2009, while the array remained at the seafloor to complete its scheduled 5-year deployment period. The travel time measurements of the PIES are combined with hydrographic data from profiling Argo floats, and ship measurements to calculate time series of hydrographic properties and the baroclinic transport variability. The horizontal bottom pressure differences are used to estimate the barotropic contribution.

AC-2B-33: Long term direct observations on currents and volume transport in the Mozambique Channel

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Since 2003, a team of Dutch physical oceanographers maintains a mooring array with current meters and T-S sensors across the narrowest part of the Mozambique Channel in the South West Indian Ocean. The goal is to study the time variability of the currents and volume transport in this branch of the global ocean circulation. The observations form part of OceanSites. An analysis of the volume transport through the channel, including the variability on interannual and seasonal time scales is presented for the period 2003-2008. The mean volume transport over the entire observational period is about 15 Sv poleward. Seasonal variations have a magnitude of some 5 Sv and can be explained from the variability in the wind field over the western part of the Indian Ocean. Interannual variability has a magnitude of about 10 Sv and is only slightly smaller than the mean. This time scale of variability is related to variability in the Indian Ocean Dipole, showing that it forms part of the variability in the ocean-climate system of the entire Indian Ocean. The relatively strong inter annual variability stresses the importance of these long term direct observations.

AC-2B-34: A New Mean Dynamic Topography Computed Over the Global Ocean Ffrom GRACE Data, Altimetry and In-situ Measurements

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Accurate knowledge of the ocean Mean Dynamic Topography at all spatial scales is mandatory for the full exploitation of altimetric data including their assimilation into operational ocean forecasting systems.

In the framework of the French SLOOP project, whose objective is to improve the processing of altimetric data for the open ocean, a new Mean Dynamic Topography has been computed, with improved data and methodology compared to the previous RIO05 MDT field.

The estimation is based on two steps. First, a large scale Mean Dynamic Topography was computed from the CLS01 altimetric Mean Sea Surface and the latest geoid model computed at GRGS from 5 years of GRACE data. For the first time, the geoid covariance error matrix is used for a more accurate estimation of the large scale MDT and associated error.

The second step of the estimation consists in combining altimetric sea level anomalies and in-situ measurements to compute synthetic estimates of the MDT and the corresponding mean currents. While the RIO05 MDT was based on 9 years of in-situ data (dynamic heights and drifting buoy velocities), the new field benefits from an enlarged dataset of in-situ measurements covering 15 years from 1993 to 2008 and including the latest ARGO reanalysis from the Coriolis center. Moreover the processing of the in-situ data has been improved: A new Ekman model was computed to extract the geostrophic velocity component from the drifting buoy measurements. The handling of hydrologic measurements has also been improved so as to allow for the inclusion of T,S profiles referenced to different pressure levels in the computation of the synthetic heights, resulting in a better sampling of the ocean, mainly in coastal areas.

The resulting new Mean Dynamic Topography is then validated comparing it to other existing solutions, based on observations or models.

AC-2B-35: Mapping the Ocean Interior's Currents From Altimetry, SST and In-Situ Measurements

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Monthly maps of the ocean currents from the surface to 1500m have been computed for the 1993-2008 period combining altimetry to temperature and salinity data through the thermal wind equation. The 3D monthly current field compares well to the Mera-11 and Glorys reanalyses from the Mercator operational ocean forecasting system. Also, the regression coefficients computed between the new field and in-situ subsurface velocities measured by RAFOS and P-ALACE floats reach 0.66 and 0.65 for the zonal and meridional components respectively. The analysis of these new 3D observed currents shows that the NAO-related modifications of the North Atlantic subpolar gyre already observed at the surface extends down to 1500m. Finally, the estimated currents are used to monitor the strength of the North Atlantic Meridional Overturning Circulation (MOC) over the 1993-2008 period. Results are compared to previous studies as well as to estimates based on the RAPID-MOC array measurements.

AC-2B-36: Energetics From Drifting Buoys in the Southwestern Atlantic Ocean

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The Southwestern Atlantic mean surface circulation, its associated variability and energetics are studied through the analysis of 16 years (1993-2008) of surface drifter data from the NOAA (SVP) velocity data binned onto a 0.5° x 0.5° grid. Special attention is given to three main regional features of the domain: the Brazil Current (BC), the Malvinas Current (MC) and the Brazil-Malvinas Confluence (BMC).

The overall result shows that the current NOAA drifter database is robust enough to significantly increase the resolution of the circulation features in the area, when compared with previous studies. Moreover, that fact led to a notable improvement in the estimates of several variables and parameters of the surface circulation and motivated us to pursue a robust analysis of the region's energetics. Furthermore, from the analysis of the data it was possible to calculate the barotropic energy conversion

term. The results unveil that the barotropic conversion fluxes are present in the Brazil Current (BC), Malvinas Current (MC) and the Brazil-Malvinas Confluence (BMC).

The highest Mean Kinetic Energy (MKE) values are found along the path of the Western Boundary Currents in the area (WBCs), particularly in the MC north of 45°S, where values approaching 2500 cm2 s-2 where computed. The Eddy Kinetic Energy (EKE) field is normally associated with mesoscale activity. The highest EKE was found in the vicinity of the BMC, where values approach 3000 cm2 s-2. High EKE in the BMC has been attributed to the frequent observation of mesoscale eddies and meanders. When compared to the BC, the MC current displays lower values of EKE (<265 cm2 s-2) indicating that the eddy activity is lower in the latter. Indeed, when comparing the EKE with the MKE, the MC displays a clear dominance of the mean flow over the eddy variability. The conversion of MKE to EKE is given by the BT term and can be used as an indicator for barotropic instability. Wherever this term is positive, MKE is being converted to EKE through the work of the Reynolds stresses on the mean shear. However, there is a dynamic distinction between those currents, which was identified by the barotropic conversio term (BT). On the Brazil Current, the BT conversion goes from MKE to eddy kinetic energy. Conversely, on the Malvinas Current the term BT in the most of the path is negative, i.e., conversion of the EKE to MKE.

The term Production of Mean Kinetic Energy (PKE) by the eddies indicates that they are producing mean kinetic energy in the most of the path of MC. However, with BC the scenario is the opposite. The net exchange between mean and eddy kinetic energy is characterized by the term BT – PKE, so the mean flow loses kinetic energy to the eddies in the Brazil Current, but the situation is again opposite with Malvinas Current. The anticyclonic branch of the BC includes the region of its recirculation cell. In the most of this region the eddies lose kinetic energy to the mean flow (e.g. Ivchenko et al. [1997]) but the reverse energy flow is also possible. On the cyclonic branch of the MC the mean flow loses energy to the eddies. These results supporting old investigations [Webster, 1961; Schmitz e Niiler, 1969; Brooks e Niiler, 1977] which suggest that different energetic systems can exist in the cyclonic and anticyclonic branches of the western boundary currents.

AC-2B-37: Water flux and Phosphorus transport in the mixed layer of the northern Red Sea and Gulf of Suez

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ABSTRACT The study presents an attempt to calculate water flux and phosphorus transportation in the upper 50m layer (mixed layer) of the northern Red Sea and Gulf of Suez using data collected during the joint Russian-Egyptian expedition onboard the Russian R/V "Professor Bogorov" which took place during March 1990. The hydrographic structure of the study area indicated the existence of an inflow of low salinity (40.10), warm (>22°C) and <28.3 surface water from the Red Sea into the Gulf of Suez and an outflow of a more saline (>40.40), colder (<22°C) and relatively high density (>28.3) subsurface water in the opposite direction. This water is forming in the entrance area of the Gulf, sinking as indicated by the down-sloping of the isotherms, isohalines and isopleths and entering the Red Sea as a mid-deep water. The distribution of phosphate in the investigated area showed that all the surface waters are nearly depleted in the phosphate and lie near 0.1 mole PO4-P/l. An apparent first peak lies nearly between 50 and 100m depth. All the stations showed gradual increase of the phosphate with depth till 500m. Phosphorus transported to the area from the west accounts for 316.05 tons/day, while 1.34 tons/day are transported from the east. Phosphorus flux from the south plays the most important role, it reaches 1212.67 tons/day. From Gulf of Aqaba, 2.25 tons/day enters the area. Cumulatively about 1530 tons phosphorus/day enters the upper 50m layer, of which only 117.63 tons/day enters the Gulf of Suez. The rest may be exhausted in plant growth or through sinking to the lower layers. The calculated downward phosphorus transport amounts to 872.79 tons/day.

AC-2B-38: A revisit of the reason why the properties of the Central Mode Water in the North Pacific changed in regime shifts

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The Central Mode Water (CMW) is known as a water mass in the lower part of the ventilated pycnocline in the North Pacific subtropical gyre. It was reported that CMW got warmer, saltier and lighter remarkably just after the regime shift at the end of 1980s (Suga et al., 2003). This change was considered to result from the decrease of heat and freshwater losses at the sea surface in the CMW formation region accompanied by weaker westerly wind. However, it was recently found using atmospheric reanalysis data that the change of these factors was not large enough to explain the change of CMW properties. Rather, a high-resolution OGCM indicated that the increase of the sea surface temperature and salinity in the CMW formation region might be due to northward movement of the Kuroshio Extension and acceleration of the upstream Kuroshio Extension jet. Therefore, we hypothesize that the dynamical change of the Kuroshio Extension affects a northward supply of high temperature and salinity water to the northern margin of the subtropical gyre and makes the CMW properties change. To inspect this hypothesis, we analyzed Argo data from 2000. The Kuroshio Extension moved southward rapidly at the beginning of 2006, although the shift was small compared to that at the end of 1980s. Associated with this shift, sea surface temperature and salinity in the area north of the Kuroshio Extension decrease from January to March in 2006. Temperature and salinity at the core of CMW observed from May to September in 2006 also decreased compared to those in 2005 by 1°C and 0.1, respectively. Although heat and freshwater losses in the CMW formation region increased in winter of 2006, the change of these factors was not large enough to explain that of CMW properties. Thus, the change of CMW properties in 2006 supports our hypothesis.

AC-2B-39: Verification of Numerical Weather Prediction Marine Meteorology using Moorings: An OceanSITES Application

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There has been an increased emphasis on coupled ocean-atmosphere modelling at the Australian Bureau of Meteorology with the development of routine seasonal forecasting and ocean modelling capabilities. The model forcing via fluxes at the air-sea interface is critical to the forecasting skill of the models. Verification of numerical weather prediction marine meteorology against moored buoy observations is undertaken routinely to establish the uncertainty in modelled fluxes. The OceanSITES program provides an overarching structure to moored arrays of long-term deepwater reference stations that span the global oceans. One of the benefits of OceanSITES is the provision of common data formats and metadata that enable ingestion of numerous data-streams into analysis activities. The real-time, daily mean marine meteorology observations from 17 high quality "flux reference stations",

spanning all the oceans (excluding the Southern Ocean), from 66O North to 20O South are used to validate forecasts (0 out to 10 days) for two numerical prediction models (GASP and the newly implemented ACCESS-G). The current observational array is concentrated in a band along the tropics, and expansion into the extra-tropics is essential if the array is to be considered truly global.

AC-2B-40: A monitoring system for the South Atlantic as a component of the MOC

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We will report on the two SAMOC workshops (san Ceferino, Argentina in 2007 and Paris, France in 2009) that gathered scientists from Argentina, Brazil, France, Germany, Italy, Russia, Spain, South Africa, Uruguay, United Kingdom, and the United States to foster collaborations and to discuss the design and implementation of an observational system to monitor the South Atlantic's branch of the Meridional Overturning Circulation (SAMOC). The workshops were financially supported by the NOAA Climate Program Office and US CLIVAR. After reviewing and discussing existing modeling and observational efforts in the South Atlantic Ocean we came to the conclusion they are yet inadequate to monitor the MOC. Discussions were focused on the design of an observational array that was adequate for this purpose and that has started to be implemented more consistently since 2008. Plans have been established to coordinate modeling efforts, and the implementation of such longterm observing network in the Drake Passage, in the region between South Africa and Antarctica, and on a zonal transect nominally across 30°S.

AC-2B-41: The Great Barrier Reef Ocean Observing System Moorings array: Monitoring Coral Sea Impacts on the Great Barrier Reef

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Since 1987 Great Barrier Reef weather and water temperature observations have been transmitted in near real time using HF radio from pontoons or towers on coral reefs by AIMS. In contrast oceanographic measurements have however been restricted to loggers serviced at quarterly to half yearly downloads. The Great Barrier Reef Ocean Observing System (GBROOS) is a regional node of the Integrated Marine Observing System (IMOS). IMOS is an Australian Government initiative established under the National Collaborative Research Infrastructure Strategy and has been supported by Queensland Government since 2006. GBROOS comprises real time observations from weather stations, oceanographic moorings, underway ship observations, ocean surface radar, satellite image reception and reef based sensor networks. This paper focuses on an array of in-line moorings that have been deployed along the outer Great Barrier Reef in order to monitor the Western Boundary currents of the Coral Sea. The Westward flowing Southern Equatorial Current bifurcates into the poleward flowing East Australian Current and the equatorward North Queensland Current. The 4 mooring pairs consist of a continental slope mooring, nominally in 200m of water and one on the outer continental shelf within the GBR matrix in depths of 30 to 70m. The array is designed to detect any changes in circulation, temperature response, mixed layer depth and ocean-shelf interactions. A review of likely impacts of climate change on the physical oceanography of the GBR is providing a basis upon which to explore what processes may be affected by climate change. Sample data and results from the initial year of observations will be presented.

AC-2B-42: Formation and Export Rates of North Atlantic Deep Water

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The concept from Bolin and Rhode (1973) of transit time distributions (TTDs) for reservoirs is applied to North Atlantic Deep Water (NADW) in the subpolar North Atlantic. The 'reservoirs' are the different density classes of NADW, i.e. Upper Labrador Sea Water (ULSW), Labrador Sea Water (LSW), Gibbs Fracture Zone Water (GFZW) and Denmark Strait Overflow Water (DSOW). The TTDs for these reservoirs are computed as volume integral of pointwise TTDs, which are inferred from CFC data collected between 1997 and 2005. It will be discussed, in how far these TTDs and their temporal derivatives can be used to infer ventilation, formation, and export rates for NADW. These results will be compared with direct observational data, e.g. the export of NADW from the subpolar North Atlantic in the deep western boundary current as reported in Schott et al. (2006). Bolin, B., and H. Rohde, A note on the concepts of age distribution and transit time in natural reservoirs, Tellus XXV, 1, 1973. Schott, F. A., J. Fischer, M. Dengler, and R. Zantopp,Variability of the Deep Western Boundary Current east of the Grand Banks, Geophys. Res. Lett., 33, L21S07, doi:10.1029/2006GL026563, 2006.

AC-2B-43: Upper Layer Variability of Indonesian Throughflow

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Indonesian throughflow (ITF), the transfer water mass and heat flux of tropical/subtropical Pacific water into the Indian Ocean through the Indonesian seas plays significant part of the global ocean system of interocean fluxes, ocean-scale heat and freshwater budgets, sea-air fluxes and biogeochemical exchange. The ITF is believed to play interactive link with Asia-Australian monsoon, ENSO and Indian Ocean Dipole, and to the large extent governs the overall oceanographic stratification, circulation, and ecosystems within the Indonesian Seas. Although the ITF measurements have been conducted for more than two decades including a simultaneous measurement at various straits during INSTANT program in 2003-2006, and Makassar ITF in 2006-2009, they failed quantify upper layer variability and freshwater fluxes which is important for the mixing and sea-air interaction within the region. The ITF branches through the South China Sea-Karimata Strait, and Tores Strait have always been ignored and have received little observational attention. There have been no field measurements to quantify the total transport and its associate heat-freshwater fluxes, even though trajectories of sea surface drifters of the Global Drifter Program from August 1988 to June 2007 have indicated that the Karimata Strait is another important channel for the Throughflow from the SCS to the Indonesian Seas. Since December 2007, South China Sea - Indonesia Seas Transport/Exchange (SITE) has been measured using trawl resistant bottom mounted ADCP deployed in the Karimata Straits, an international collaboration between Lamont Doherty Earth Observatory (LDEO) of Columbia University-USA, Agency for Marine and Fisheries Research (BRKP)-Indonesia, and First Institute of Oceanography-China. Preliminary analysis indicated that the annual mean may be small ~1-1.5Sv, however, the seasonal volume transport associated with monsoon can reach as large as 4.4Sv. In addition, two bottom mounted ADCP have been deployed in the Sunda Strait in November 2008 to measure the water mass and fresh water fluxes between Java Sea and eastern Indian Ocean which is the center of Indian Ocean Dipole. For future observation, we should have an integrated

observation of Indonesian throughflow and biogeochemical properties, to fill the gap of the map of global climatological mean of pCO2 and net sea-air flux of CO2.

AC-2B-44: Analysis of a 44 - Year Hindcast for the Mediterranean Sea : Comparison with altimetry and in situ observations

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 We use the global ocean general circulation model simulation (ORCA R025-G70) to perform a model assessment in the Mediterranean Sea by using altimetry and in situ data.
 Comparison of temperature and salinity from ORCA R025-G70 and from the MEDAR (temperature and salinity) hydrographic database show that the temperature interannual variability in the suface layer (0-150m) over the 1965-1998 period is very accurately represented, demonstrating an accurate heat flux exchange between the atmosphere and the ocean. However, the sea surface salinity from ORCA R025-G70 lacks most of the interannual variability. This is due to a surface salinity restoring term (a correction of the model data towards the MEDAR climatology in the form of either rainfall or evaporation) which is applied in order to correct a salinity drift in the model.
Intermediate (150-600m) and deep (600m - bottom) layers show a clear positive temperature trend, with almost no variability in the deep layers, probably caused by the atmospheric forcing which has too low a resolution as to allow for deep water formation in the Mediterranean Sea.
Mean surface salinity for the entire Mediterranean basin is significantly lower in ORCA R025-G70 than in MEDAR (~0.3 psu), and could mean that the surface salinity restoring might be too weak, without su cient evaporation to compensate for a weak atmospheric forcing (ERA40) water loss flux. The mean temperature of the Mediterranean Sea is also slightly higher than the observations (linked to the ERA40 underestimation of winter heat loss), which in combination to the lower salinities, leads to a less dense water mass.
 Comparison of Sea Surface Height (SSH) and Steric Height (SH) from the model and the sea level anomalies (SLA) obtained from altimetry over the 1993-2004 period shows that the interannual variability and the annual cycle are well reproduced, with good correlations, especially at the basin scale. The diagnostic SSH shows a clear positive trend, possibly due to an imbalance in the fresh water budget of the model (E-P-R). The SH on the other hand, shows a similar trend to the altimetry data. It appears that the most likely cause of the trends is an inaccurate atmospheric forcing (ERA40), with too coarse a resolution (0.2° x0.2°) to resolve the typical scales in the Mediterranean Sea. Improving the atmospheric forcing could greatly improve the trends displayed by the model.
 Transport through the Gibraltar Strait shows adequate values when compared to observations with an inflow of about 1.07Sv and an outflow of about 1.01 Sv (0.067 Sv net inflow).
 Besides the mesoscale and sea level trends, it is surprising how well this global ocean model behaves in the Mediterranean Sea, taking into account its relatively low resolution for the dynamic features of this semi-enclosed sea. With a few key issues (such as surface salinity restoring and atmospheric forcing) that, once identified, can be improved, the ORCA R025-G70 ocean model can provide a very promising tool for the study of the Mediterranean seasonal cycle and interannual variability characteristics.

AC-2B-45: Discrepancies between observed and OGCM-simulated anomalies in recent SSTs of the tropical Indian Ocean

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We investigated the discrepancy between observed and ocean general circulation model (OGCM)-simulated anomalies in recent sea surface temperatures (SSTs) of the tropical Indian Ocean. Observed SSTs show a warming beginning in the late 1990s, whereas simulated SSTs show a cooling over the same period. Examination of surface heat fluxes in the OGCM showed that the simulated SST cooling was caused primarily by a decreasing trend in the reanalyzed solar radiation used as the surface boundary condition. In the atmospheric reanalysis, the decrease in solar radiation was attributed to an increase in cloud cover, deduced from precipitation data, and in part responding to observed local warming of the Indian Ocean SSTs prescribed as the lower boundary condition. Observation-based estimates of precipitation, however, show no significant increasing trend, so no increase in cloud cover is indicated. Caution is needed when atmospheric reanalysis data are used for surface boundary conditions for OGCMs.

AC-2B-46: Direct velocity measurements of deep circulation southwest of the Shatsky Rise in the western North Pacific

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The Lower Circumpolar Deep Water (LCDW) transported by the global deep circulation from the Southern Ocean is known to spread to the basins in the North Pacific after passing the Central Pacific Basin (e.g., Mantyla and Reid, 1983). Though the western North Pacific has so complex bottom topography that observational studies on the deep circulation has been made difficult, Johnson and Toole (1993) and Kawabe et al. (2003) found an eastern branch of the deep circulation flowing northward through Wake Island Passage and a western branch flowing through the East Mariana Basin at low latitudes (Fig. 1). Yanagimoto and Kawabe (2007) indicated the both branches have northwestward flows between the Shatsky Rise and the Ogasawara Plateau, which is an eastward bulge of the Izu-Ogasawara Ridge.
We conducted hydrographic and mooring observations along a line located southwest of the Shatsky Rise. Kawabe et al. (2009) analyzed the hydrographic data in 2004 and 2005 and concluded volume transport of the eastern and western branches of the deep circulation to be a little less than 4 Sv (1 Sv = 10^6 m^3 s^{-1}) and a little more than 2 Sv, respectively. In their results, the location and volume transport of the branch currents are different between the observations in 2004 and 2005. This suggests that the variability of the deep currents is significant. We analyze current velocity data for approximately 14 months, September 2004 to November/December 2005, from nine moorings with 50 currents meters on the aligning line from M1 at 25°42'N, 149°16'E to M9 at 31°13'N, 156°33'E (Fig.1). Current meters were installed near the bottom and at depths of approximately 5500, 5000, 4500, 4000 and 3500 m.

The western branch of the deep-circulation current flowing northwestward (270°-10°T) is detected almost exclusively at M2 (26°15'N), east of the Ogasawara Plateau, indicating a width less than the 190 km distance between M1 (25°42'N) and M3 (26°48'N) (Fig. 2). The mean current speed near the bottom at M2 is 3.6 ± 1.3 cm s^{-1}.

The eastern branch of the deep-circulation current is located at the southwestern slope of the Shatsky Rise, flowing northwestward mainly at M8 (30°48'N) on the lower part of the slope of the Shatsky Rise with a mean near-bottom speed of 5.3 ± 1.4 cm s^{-1}. The eastern branch often expands to M7 (30°19'N) at the foot of the rise with a mean near-bottom speed of 2.8 ± 0.7 cm s^{-1} and to M9 (31°13'N) on the middle of the slope of the rise with a speed of 2.5 ± 0.7 cm s^{-1} (nearly 4000 m

depth); it infrequently expands furthermore to M6 (29°33'N). The width of the eastern branch is 201 ± 70 km on average, exceeding that of the western branch.

Temporal variations of the volume transports of the western and eastern branches consist of dominant variations with periods of 3 months and 1 month, varying between almost zero and significant amount, and are correlated to each other with a phase lag of several months for the western branch. The almost zero volume transport occurs at intervals of 2-4 months. It is similar with variations of the current and volume transport at the Wake Island Passage (Kawabe et al., 2005). In the eastern branch, volume transport and current width are highly correlated, and, in other words, volume transport increases with current width.

Because the current meters were too widely spaced to enable accurate estimates of volume transport, mean volume transport is overestimated by a factor of nearly two, yielding values of 4.1 ± 1.2 and 9.8 ± 1.8 Sv for the western and eastern branches, respectively. Sparsely distributed single-point measurements may yield large volume transports in wide basins in which current axes move over time, such as the strait in this study. In contrast, realistic volume transports are estimated in narrow straits such as the Samoan Passage (6.0 ± 1.5 Sv; Rudnick, 1997) and the Wake Island Passage (3.6 ± 1.3 Sv; Kawabe et al., 2005).

AC-2B-47: Continuous Observations From the Weather Ship Polarfront at Station Mike

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This poster will describe the various observations made from the world's last remaining weather ship "Polarfront" which operates year-round at Station mike (66 N, 2 E). Station Mike has been occupied by a weather ship continually for 60 years. Data presented will include the high resolution, 60 year, full depth hydrographic observations, the 30 year atmospheric gas sampling data, and the 30 year wave measurements. Also presented will be the results of more recently installed systems, such as the continuous surface water sampling and direct measurements of the air-sea fluxes of momentum, heat and CO2.

Day 2: Scientific results and potential based on global observations

Session 2C: Biochemistry and ecosystems

AC-2C-01: A Joint ICES-IOC Study Group on Nutrient Standards

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The comparability and traceability of nutrients data in the world's oceans are one of primary importance to Marine Science, and to the studies of Global Change. The IOC-ICES joint Study Group on Nutrient Standards, SGONS, is established in 2009. The work of the SGONS would enable better comparability between data sets measured at different times, and by different laboratories, so it would be possible to investigate, reliably, the change of nutrients distributions in the ocean, and the tight coupling between the nitrogen and phosphorus cycles in the ocean with that of carbon.

AC-2C-01b: An expanding observatory to monitor hypoxia in the Northern California Current System

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Near-bottom waters over the inner shelf (< 50 m water depth) off central Oregon, U. S. A., have been increasingly hypoxic (dissolved oxygen < 1.4 ml/l) over the last 8 years, including the appearance of anoxia in summer 2006. The appearance of near-bottom, inner-shelf hypoxia is driven by upwelling of low-oxygen and nutrient-rich sourcewater onto the continental shelf, followed by the decay of organic matter raining down from surface phytoplankton blooms. Through a combination of ship sampling, moorings and autonomous underwater vehicle gliders, we have been measuring dissolved oxygen with increasing temporal and spatial coverage. For longer term context, we use historical observations along the Newport Hydrographic Line sampled since the 1960s. The mooring array spans the inner shelf (15 m isobath) along 60 km of Oregon coastline and includes two mid-shelf (70-80 m isobath) moorings. Two of these moorings return near-bottom dissolved oxygen, as well as temperature and salinity, in near real-time. Since April 2006, we have occupied the Newport Hydrographic Line nearly continuously using two Webb Research Corporation 200-m Slocum electric gliders and a 1000-m Seaglider. In total, gliders have been at sea for 1,253 days (3.4 years), sampled over 400 cross-shelf sections, collected in excess of 110,000 vertical profiles and traveled over 28,000 km. We analyze data from this observatory to show how the severity of inner-shelf hypoxia varies year-to-year due to changes in upwelling sourcewater properties and the characteristics of wind-driven upwelling.

AC-2C-02: High Frequency Monitoring of pCO2 using a CARIOCA sensor in a Temperate coastal ecosystem (2003-2009)

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Long-term monitoring of the marine carbon chemical species is necessary to assess the chemical and biological modifications occurring in the coastal ocean in a high CO2 World. Coastal marine ecosystems are directly impacted by human activities and are crossing a threshold of changing from their pre-industrial state, during which ocean margins are widely viewed as heterotrophic and a CO2 source, to a current or future state as a CO2 sink. The CARbon Interface Ocean Atmosphere (CARIOCA) sensor allows for both long term and high frequency measurements of the partial pressure of CO2 (pCO2). The CARIOCA sensor is therefore an excellent tool for investigating the high variability and the evolution of pCO2 in coastal environments. Here we present high-frequency pCO2 data recorded for 6 years during the first deployment of a CARIOCA sensor on a MAREL buoy in the surface waters of a temperate coastal ecosystem, the Bay of Brest, which is impacted by both coastal and oceanic variability. High frequency measurements allowed for the quantification of the diurnal, tidal and seasonal variability in the assessment of the annual CO2 air-sea fluxes. The preliminary results indicate that biological activity is the main process controlling the pCO2 variability in surface waters on a seasonal time-scale. On a shorter scale, the tidal and diurnal cycle are shown to be responsible for high pCO2 variability. The 6 years of investigation revealed that the surface waters of the Bay were near equilibrium with the atmosphere and that the inter-annual variability was small.

AC-2C-03: The MOOSE network: a tool to observe the long-term carbon change in the NW Mediterranean Sea

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In the Mediterranean Sea, the global warming and of the anthropogenic activities have been identified as the main forcings on the marine environment. However, their impact towards the biogenic elements cycle as carbon is not well understood. In the next decade, the reduction of the dense water formation in the Mediterranean Sea will induce a higher stratification of surface waters, lower ventilation and consequently a decrease of nutrient supply conducting to a decrease of new production and carbon export. However, this process should counteract the predicted increase in new production and in carbon export due to the raising of nutrient terrestrial discharge. In the deep water, the consumption of O2 for the remineralisation could be reduced due to the decrease in carbon export but concomitantly the supply of O2 to the deep water could also be reduced. The net effect on the O2 level in the deep water is difficult to predict. Acidification is climbing fast since increased seawater temperatures due to global warming enhance the capture of carbon dioxide by the world ocean, leading to a gradual increase in acidity in recent year. This process may induce significant changes on structure community of the Mediterranean ecosystems. While rates of change in marine acidity are still unclear, scientists stress the need to promote ocean acidification and global warming-related studies in the Mediterranean region in order to better

understand these processes and predict consequences. Towards this Mediterranean evolution, only few time series have been performed over long term to explore the real effects of the massive anthropogenic activities and climate change on the oceanic carbon cycle. In this context, a Mediterranean Ocean Observing System on Environment project (MOOSE) is in progress to set up as an interactive, distributed and integrated observatory system of the NW Mediterranean Sea to detect and identify long-term environmental anomalies. It will be based on a multi-sites system of continental-shelf and deep-sea fixed stations as well as Lagrangian platform network to observe the spatio-temporal variability of physical and biogeochemical processes as carbon sequestration and acidification. Such observation network offers also an ideal platform to study specific processes with high temporal resolution on seasonal scale (INSU Mediterranean Program in progress).

AC-2C-04: Carbon Dioxide Variability in the Northern Adriatic Sea

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Coastal marine regions such as the Northern Adriatic Sea are strongly influenced by changes in climate and may play an important role in biological productivity and the global air-sea CO_2 flux. These regions serve as a link between carbon cycling on land and the ocean interior and because the carbon dynamics are not studied in many coastal regions, their role in the global carbon cycle is highly uncertain. To date, in-depth studies of carbon cycling in coastal waters have been mostly limited to coastal transects that provide interesting snapshots of carbon dynamics. No CO_2 flux data are currently available in the Northern Adriatic.

The Northern Adriatic, being one of the most productive regions in the Mediterranean and affected by freshwater input, eutrophication and large changes of air-sea exchange during Bora high wind events, makes this region an excellent study site for investigations of air-sea interaction and changes in biology and carbon chemistry.

Here we present the first measurements of air and water CO_2 flux in the Northern Adriatic. The aqueous CO_2 was measured at the coastal oceanographic buoy VIDA, Slovenia using the SAMI-CO_2 sensor during four deployments in spring and summer/fall 2007, and spring/summer and fall of 2008. CO_2 measurements were combined with hydrological and biological observations to evaluate the processes that control carbon cycling in the region. The results indicate that the GOT was a net sink for atmospheric CO_2. Although some of the interannual and seasonal variability in aqueous CO_2 can be explained with changes in SST, our data also suggest a significant influence by fresh water input from rivers, biological production associated with high nutrient input, and gas exchange during high wind events.

AC-2C-05: Sampling frequencies necessary for coastal ocean observatories

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As part of the Northwest Association of Networked Ocean Observing Systems (NANOOS), a mooring is maintained in coastal waters of Washington State. The mooring takes full depth water-column profiles for temperature, salinity, oxygen, fluorescence, nitrate and currents every two hours. Additionally, 10-minute averages of the meteorological data atmospheric temperature, wind velocity, wind direction, relative humidity, and solar radiation are also collected. All data is telemetered back to a shore-based laboratory computer in real time. Analysis of data obtained from the mooring for the150 day growing season in 2006 are used to determine the frequency of sampling at this site necessary to characterize various parameters. High frequency variability is characteristic of the study site and the variability is caused by a combination of tidal advection of horizontal patchiness as well wind induced destabilization of the mixed layer. The analysis suggest that the following sampling frequencies necessary to resolve; (1) the mean air-water gas exchange - ~ every 4 hours, (2) the mean the mean diurnal oxygen change - a diurnal oxygen cycle every other day, (3) and the annual chlorophyll cycle, (a chlorophyll profile once a week).

AC-2C-06: Time-series observation for biogeochemistry in the Western Pacific Subarctic Gyre

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Based on the time-series observation for the biogeochemistry at station KNOT (44N/155E)□@between 1998 and 2001, which was Japanese national project under an umbrella of Joint Global Ocean Flux Study (JGOFS), it was verified that the North Pacific Western Subarctic Gyre (WSG) has large seasonal variability in nutrients, pCO_2, primary productivity and particulate organic carbon flux, and time-series observation is very important in order to quantify carbon cycle in the ocean and air-sea exchange of CO_2 by, especially, the biological activity (biological pump). Since 2001, time-series observation has been conducted at station K2 (47N/160E) by using the new mooring systems and research vessel. Our mooring system consists of various automatic sensor or samplers such as an optical sensor package (BLOOMS), a water sampler (RAS) and sediment traps deployed at multiple layers. Time-series observation of optical field and nutrients at □` 35 m by BLOOMS and RAS, respectively, revealed that phytoplankton increases and nutrients, especially silicate, decreases largely between late June and early July. During this time, increase of fluxes of particulate organic carbon and biogenic opal at □` 150 m was observed by sediment trap. It is indicative of that primary produced or assimilated organic carbon is transported quickly to the ocean interior. Multiple sediment traps from 150 m to 5000 m revealed that 1) biogenic materials are transported vertically without significant lateral transport, 2) sinking velocity of particles increases with depth, and 3) biogenic opal plays an important role in organic carbon transport. Seasonal observation of primary productivity, nutrients and natural radionuclide (thorium 234) by research vessel has also revealed that new production, export flux and export ratio are higher than those in other oceans, indicating that the biological pump at station K2 is very efficient for uptake of atmospheric CO_2. On the other hand, long-term increase of dissolved inorganic carbon following increase of atmospheric CO_2 has been observed at station K2. It is noted that increase rate of atmospheric pCO_2 ($pCO_{2(air)}$) in winter was higher than that of sea surface pCO_2 ($pCO_{2(sea)}$) in winter. Though $pCO_{2(sea)}$ in winter has been higher than $pCO_{2(air)}$ in winter until now, it is predicted that $pCO_{2(sea)}$ will be higher than $pCO_{2(air)}$ all year round after the middle 21 century. It is indicative of possibility that the ocean acidification will be accelerated after that period and ocean ecosystem will change in the WSG. In order to predict change in the biological pump and its feedback to the global environment, time-series observation should be continued with a new mooring system (optical sensor package including FRRF supported by underwater winch) at not only station K2, but also a new station located in the Western Pacific Subtropical Gyre as a counterpart of station K2.

AC-2C-07: SIBER: Sustained Indian Ocean Biogeochemical and Ecological Research

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Historically the Indian Ocean has received relatively little attention from the oceanographic community and therefore remains substantially under-sampled compared to the Atlantic and Pacific Oceans. This situation is compounded by the Indian Ocean being a dynamically complex and highly variable system under monsoonal influence, which causes circulation features that are unusual in many respects. Comprehension of how biogeochemical and ecological processes respond to this dynamic physical environment has only partially been achieved and is fundamentally hampered by our current sampling deficiencies. Specific questions and hypotheses have emerged from recent studies that have yet to be tested, such as the potential role of zooplankton grazing versus iron limitation in controlling phytoplankton production in the Arabian Sea. Furthermore, the Indian Ocean is a globally important denitrification zone and it also appears to be a region where N2 fixation rates are significant. However, there are still large uncertainties in the rate estimates for both dentrification and N2 fixation so the role of the Indian Ocean in the global nitrogen budget has not yet been determined. The Indian Ocean is also warming rapidly, but the impacts of this warming on the biota, carbon uptake, and nitrogen cycling are unquantified. The increasing population density and rapid economic growth of the countries surrounding the Bay of Bengal and eastern Arabian Sea make these regions' coastal environments particularly vulnerable to both this warming trend and to other anthropogenic influences. These anthropogenic effects might also impact the huge myctophid stocks in the Arabian Sea, but the time-space variability and the biogeochemical and ecological role of these fish are poorly quantified, as are the linkages between climate fluctuations and equatorial tuna migrations. The potential influences of climate variability and change on fisheries resources and their socio-economic ramifications need to be explored. Deployment of coastal and open-ocean observing systems in the Indian Ocean have created new opportunities for carrying out biogeochemical and ecological research. International research efforts should be motivated to exploit these opportunities for addressing these (and many other) pressing research questions.

AC-2C-08: Long-term observation of deep-sea benthic activities in Sagami Bay, central Japan

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Sagami Bay locates at the central Japan facing to the Pacific Ocean. Deep trough, called Sagami Trough, that show more than 1500 m deep lines at the central part of the Bay. Sagami Trough is convergent plate boundary between North American Plate and Philippine Sea Plate. Epicenter of huge earthquakes and active submarine volcanoes are located at the western part of the Bay. A lot of cold seepages with Calyptogena-clam colonies are distributed in the bay. JAMSTEC has long been monitoring crustal movement at the deep-sea floor. There is a long-term deep-sea observatory at the Off Hatsushima Island site at the western part of the bay. Since 1993, JAMSTEC continuously monitor benthic activities at the permanent observatory. We could pile up time-series video records and environmental dataset. Through these dataset we can trace environmental changes at continental slope regions and also watch how deep-sea benthic organisms actively dwell at deep-sea floor in relation to environmental changes. We also keep permanent deep-sea station at central Sagami Bay for monitoring long-term changes in population ecology of deep-sea meiofauna since 1991. Using these dataset, we can evaluate deep-sea environmental changes and responses of deep-sea organisms against environmental changes. We believe that human impact has already started to affect even at deep-sea floor. We propose to continue monitoring of deep-sea environments and organisms in Sagami Bay with several innovative approaches. Continual environmental monitoring through cable network at deep-sea observatory of the Off Hatsushima Island site, frequent ROV and AUV observational dives are strong tools for getting deep-sea data in Sagami Bay.

AC-2C-09: Long-term Biogeochemical Time-Series from the Porcupine Abyssal Plain Deep Ocean Observatory, North East Atlantic

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We present a suite of multidisciplinary biogeochemical data measured in situ at the Porcupine Abyssal Plain (PAP) fixed point observatory in the North East Atlantic (49°N, 16.5°W) over the past 20 years. The observations cover the entire water column and the seafloor beneath (4800 m). Data include autonomous measurements of temperature and salinity (to 1000 m), biogeochemical data at 30 m (including nitrate, chlorophyll and CO2) and deep ocean studies from benthic time-lapse photography and deep sediment traps. Future developments of the PAP site will be presented in a European and international context including contributions to EuroSITES, an EU FP7 project to integrate European deep ocean observatories and OceanSITES a worldwide system of deep water reference stations.

AC-2C-10: Monitoring pH of Seawater in the Adriatic Sea. Results From a Regional Observing Effort.

Luchetta, Anna[1]; Cantoni, Carolina[1]; Catalano, Giulio[1]; Civitarese, Giuseppe[2]; Celio, Massimo[3]
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The Mediterranean Sea is an area climatically complex with deficient hydrological balance and high anthropogenic pressure (Milliman J.D.,1992), so this basin is expected to have a rapid response to the climate variability (Marty J.C., 2002). On global scale, it can be regarded as a key site very sensitive to the climate change (as the polar regions are), this can be particularly true for acidification. In this frame, the Adriatic Sea can play a very crucial role for the entire Eastern Mediterranean Sea, since has already shown modifications (volume of the dense water formed, i.e.) as response to the climate change. The Adriatic Sea has considered the dominant source region of dense waters for the Eastern Med, before the Eastern Mediterranean Transient occurrence (Roether et. al. 1996). The North Adriatic in particular is site of dense water formation (North Adriatic Deep Waters), the densest of the Mediterranean, being shallow and exposed to cold dry winds during winter (Artegiani et al.,1989). Moreover it receives high river runoff and nutrient loads sustaining high primary production and an active biological pump. The two mechanisms, involving solubility and biological pump for CO2, can have a relevant role for pH of deep and bottom waters. NADW flows southward and accumulates at the bottom of the Southern Adriatic pit (1250 m), which is dominated by quasi-permanent cyclonic circulation and winter deep convection events. Oceanographic dynamics of the area control the outflow of NADW (and of deep waters formed locally) through the Otranto Strait sill (750 m), thus controlling the export to Ionian and Eastern Mediterannean Seas (Civitarese et al.2001). Despite the increasing numbers of studies on ocean acidification there's still lack of good quality pH data over the Adriatic region,central and southern basins in

particular (Medar group 2002-MEDATLAS/2002 database), necessary to asses and monitor the process. We present pH data gathered over the whole Adriatic Sea during two cruises (february and october 2008) and new preliminary results of two time series (just started in 2008) from two key areas of the basin: the former in the Gulf of Trieste (the northermost of Med area, on monthly sampling), the latter in the Southern Adriatic pit (on seasonal sampling).

All of the values have been measured by means of the spectrophotometric determination, described by Dickson (in: DOE, 2007. According to the international quality protocols) and are expressed on the total H+scale (pHT), at 25 C, with a precision of ± 0.001. To our knowledge the dataset is the first collected with such a precision over the whole basin.

During February 2008 the Adriatic Sea was characterized by winter conditions: the water column was cold, quite homogeneus, well mixed and ventilated (Apparent Oxygen Utilization ≈ 0 µM) pHT values ranged from 7.847 to 8.099, with the highest values recorded by a few coastal stations. In general the pHT spatial distribution varies, at large scale, with latitude and longitude The whole northern basin was involved in dense water formation process (ot >29.3). Data collected during this cruise in the North Adriatic basin were compared with an old data set collected in 1983 over the same area. From a very careful comparison we have obtained robust indications of an acidification of at least 0.063 pHT units, occurred in the last 25 years (Luchetta A. et al., submitted).

First results from the monthly time series, carried out since January 2008, in the middle of the Gulf of Trieste (25 m deep) points out a seasonal variability of surface pHT, with minimum values during winter (7.870, in December) and maximum value in late spring and summer (8.120, in June). The dynamics of pHT in the lower part of the water column were strongly influenced by regeneration processes; in particular pHT dropped down to 7.648 in August 2008 because of the release of CO2 during remineralisation of biomass (A.O.U.= 142.9 µM). In the southern Adriatic pit, five seasonal datasets of pH have been gathered for assessing vertical distributions (0-1200 m) of pH and the seasonal variations. pHT varied between 7.931 and 8.068 in surface waters (0-100 m), with a clear seasonal pattern: the lowest values observed in winter and highest in spring through late summer, primarily due to biological processes occurring there because of the vertical injection of nutrients in the euphotic zone after winter deep convection events (Gacic M. et al., 2002). Below 100 m the pHT decreased and varied between 7.946 and 7.845, with the minimum generally located between 300 and 500 m (in the Levantine Intermediate Water core) and increasing again with depth up to values ranging between 7.920-7.940 in the bottom waters.

AC-2C-11: Dissolved Carbon Dioxide, Nutrients and Oxygen in the Adriatic Sea. A Regional Observing Effort.

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Increasing knowledge of the biogeochemistry of the Mediterranean Sea has been reputed important on global scale, since this "semi-enclosed" sea can be considered as a model for many open-ocean processes, including carbon cycling (Marty J.C., 2002). In particular, dissolved carbon dioxide content of seawater over an area, where anthropogenic influence is high due to proximity of industrialized zones, is expected to give rapid response to the climate change. Mediterranean basin can be therefore regarded as a key region very sensitive to the climate variability. In this frame the Adriatic Sea can play a quite relevant role for entire Eastern Mediterranean area, being site of dense water formation in winter and being able to sustain the most relevant primary production of entire region. This can provide further information about the sequestration of atmospheric CO2 through the Continental Shelf Pump mechanism, as proposed by Tsunogai (1999). The North Adriatic basin, in particular, is supposed to act a major role within the mechanism.

Despite of the increasing numbers of studies, there's still lack of good quality datasets regarding the inorganic carbon system in seawater over the region (Medar group 2002-MEDATLAS/2002 database), necessary to asses and monitor it . We present here data concerning the in situ fCO2, inorganic nutrients and dissolved oxygen collected over the whole Adriatic Sea during one cruise (February 2008) and new preliminary results of two time series (just started in 2008) from two key areas of the basin: the former in the Gulf of Trieste (the northermost of Med area, on monthly sampling), the latter in the Southern Adriatic pit (on seasonal sampling).

In situ fCO2 values have been calculated, according to Lewis & Wallace (1998), from experimental determinations of the pH (spectrophotometric method, as reported by Dickson in: DOE, 2007) and of the total alkalinity (potentiometric titration, precision of ± 1.0 µm/kgsw) For what concerns the wide shallow shelf region of northern Adriatic basin, fCO2 values provide an interesting winter snapshot of the CO2 dissolved in seawater. T/S data indicate February 2008 was characterized by the formation of very dense water (ot>29.3 kg/m3) at mesoscale; the water column was cold, homogeneous, well mixed and ventilated (AOU < 0) down to bottom, it was still rich of DIN (1.00-7.00 µM) and SiO2 (1.20-5.33 µM) while primary production had not yet started, except than in a very shallow coastal station. Our surface values (228.7<fco2< 338.5 µatm) mean (320.2 µ atm), much lower than equilibrium value with atmospheric co2 (398 µatm, avg. measurements conducted on board) whole area, clearly indicate region act as sink co2. dataset confirms, for time, that solubility was able to work and first gear of the continental shelf pump mechanism could be active in wintertime over such a wide area.></fco2<>

First results from the monthly time series carried out since July 2008 in the middle of the Gulf of Trieste (25 m depth), evidenced a seasonal variability of surface fCO2 controlled by both physical and biological parameters. In August 2008, even if production processes dominated the surface layer (Apparent Oxygen Utilization = -41.2 µ M), the high water temperature (26.5°C) decreased CO2 solubility (fCO2 428 µ atm) and the system acted as a CO2 source (Δ pCO2 = 63 µatm). During fall remineralization processes prevailed and surface fCO2 reached the higest value (462 µ atm, September 2008). Only in Janury 2009, the weak biologial activity (AOU≈ 0) and the temperature decrease, lead the gulf to act as a CO2 sink (fCO2 ≈ 320 µatm, Δ pCO2 = -45 µatm).

Also in the southern Adriatic pit data have been collected in seasonal time series (September 2007-october 2008). In situ fCO2 have been calculated, for assessing vertical distributions (0-1200 m) and the seasonal variations. In surface waters (0-100 m) variations were wider (360–420 µ atm) than in deeper layers. They depended clearly on the season and were controlled either by physical or biological processes: the highest values (≈ 400 µatm) were observed in winter (because of mixing with deeper layer, allowed by deep convection), the lowest (<320 µatm) in late spring through late summer (when biological activity was high).

AC-2C-12: Dissolved Carbon Dioxide, Nutrients and Oxygen in the Adriatic Sea. A Regional Observing Effort.

Luchetta, Anna[1]; Cantoni, Carolina[2]; Cozzi, Stefano[2]; Catalano, Giulio[2]; Civitarese, Giuseppe[3]
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Increasing knowledge of the biogeochemistry of the Mediterranean Sea has been reputed important on global scale since this 'semi-enclosed' sea can be considered as a model for many open-ocean processes, including carbon cycling (Marty J.C., 2002). In particular, dissolved carbon dioxide content of seawater over an area, where anthropogenic influence is high due to proximity of industrialized zones, is expected to give rapid response to the climate change. Mediterranean basin can be therefore regarded as a key region very sensitive to the climate variability. In this frame the Adriatic Sea can play quite relevant role for entire eastern Mediterranean area, being site of dense water formation in winter and being able to sustain the most relevant primary production of entire region. This can provide further information about the sequestration of atmospheric CO2 through the Continental Shelf Pump mechanism, as proposed by Tsunogai (1999). The North Adriatic basin, in particular, is supposed to act a major role on it.

Despite the increasing numbers of studies, there is still lack of good quality datasets regarding the inorganic carbon system in seawater over the region (Medar group 2002-MEDATLAS/2002 database), necessary to asses and monitor it . We present here data concerning the in situ fCO2, inorganic nutrients and dissolved oxygen collected over the whole Adriatic Sea during one cruise (February 2008) and new preliminary results of two time series (just started in 2008) from two key areas of the basin: the former in the Gulf of Trieste (the northermost of Med area, on monthly sampling), the latter in the Southern Adriatic pit (on seasonal sampling).

In situ fCO2 values have been calculated, according to Lewis & Wallace (1998), from experimental determinations of the pH (spectrophotometric method, as reported by Dickson in: DOE, 2007) and of the total alkalinity (potentiometric titration, precision of ± 1.0 µm/kgsw)

For what concerns the wide shallow shelf region of northern Adriatic basin, fCO2 values provide a winter snapshot of the CO2 dissolved in seawater. T/S data indicate February 2008 was characterized by the formation of very dense water (ot>29.3 kg/m3) at mesoscale; the water column was cold, homogeneous, well mixed and ventilated (AOU < 0) down to bottom, it was still rich of DIN (1.00-7.00 µM) and SiO2 (1.20-5.33 µM) while primary production had not yet started, except than in a very shallow coastal station. Our surface values (228.7<fco2< 338.5 mean (320.2 µatm) much lower than equilibrium value with atmospheric co2 (398µatm, avg. measurements conducted on board), whole area, clearly indicate region act as sink co2. dataset confirms, for time,that solubility was able to work and first gear of the continental shelf pump mechanism could be active in wintertime over such a wide area.> </fco2<>

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Also in the southern Adriatic pit data have been collected in seasonal time series (September 2007-october 2008). In situ fCO2 have been calculated, for assessing vertical distributions (0-1200 m) and the seasonal variations. In surface waters (0-100 m) variations were wider (360≈420 µ atm) than in deeper layers. They depended clearly on the season and were controlled either by physical or biological processes: the highest values (≈ 400 µatm) were observed in winter (because of mixing with deeper layer, allowed by deep convection), the lowest (<320 µatm) in late spring through late summer (when biological activity was high).

NOAA Coral Reef Ecosystem Integrated Observing System (CREIOS): A Collaborative Ecosystem-Based Observing System
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The U.S. National Oceanic and Atmospheric Administration (NOAA) Coral Reef Conservation Program (CRCP) Coral Reef Ecosystem Integrated Observing System (CREIOS) conducts mapping and monitoring of coral reefs, their biota, and their environments in U.S. coral jurisdictions, uninhabited U.S. flag islands, and the Freely Associated States. CREIOS is a multi-agency effort by NOAA scientists in partnership with, on a jurisdictional-to-regional basis, Federal, State, Territory, Commonwealth, and local coastal management agencies, universities, non-governmental organizations, and international entities. CREIOS provides an ecosystem-based component to U.S. regional coastal ocean observing systems. The partnership approach is developing a CREIOS structure that will creatively and adaptively address managers' needs for scientifically-sound data, information products, and decision support tools that are both consistent and customized, allowing for regional-to-global analyses while also meeting local agencies' requirements. The CREIOS goal is to understand the condition of coral reef ecosystems in order to assist stakeholders in making ecosystem-based management decisions to conserve coral reef resources. Reef mapping and benthic habitat characterization provide a detailed picture of the physical and biological structure of coral reef communities, while periodic biological, physical, and chemical monitoring provide direct field observations of the condition of critical reef ecosystems, and continuous automated monitoring (in situ instrumentation and satellite-based) provides key environmental factors affecting reef condition. Mapping and monitoring activities are integrated to accurately document the status and changes in the habitats, depth ranges, geomorphologic zones, and reef types present in coral reef environments. All of the integrated mapping and monitoring studies are conducted in consultation with local natural resource management institutions and also through CRCP's coral reef ecosystem monitoring grants to State, Territory, and Commonwealth partners. CREIOS data and integrated information products provide support for a variety of management actions, including Marine Protected Area design and evaluation, and assessing the impacts of overfishing, land-based sources of pollution, and climate change. CREIOS products are accessible through the NOAA Coral Reef Information System (CoRIS).

AC-2C-13: Evaluation of MODIS bio-optical algorithms in the Arctic waters

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A data set containing chlorophyll-a (Chl-a), absorption coefficients of colored dissolved organic matter (aCDOM) and phytoplankton (aph) and remote sensing reflectances collected from field measurements in coincidence with MODIS observations during summer 2007 and 2008 was used to evaluate the performance of several standard bio-optical algorithms in the Artic Sea, where the Chl-a concentration varied from 0.01 to 5.0 mg m-3, aCDOM at 400 nm from 0.01 to

1 m-1, and aph at 400 nm from 0.005 to 5 m-1. Comparison of MODIS-observed remote sensing reflectances with in situ measurements showed good correlation at regional level, but with significant overestimation at 412nm and 443nm and underestimation at 551nm and 667nm wave bands. It was traced that higher MODIS remote sensing reflectances were likely caused by sub-pixel/adjacent effects of the ice cover in the region and improbable negative remote sensing reflectances in the blue bands by sub-pixel cloud contamination and known atmospheric correction failure in high latitude waters. All the MODIS pigment algorithms examined showed a systematic and significant overestimation particularly in low chlorophyll regimes, whereas MODIS_CZCS_Chl and MODIS_DAAC-v4_Chl algorithms yielded lower mean bias (MNB) and RMS errors than other algorithms. The performance of MODIS_OC3_Chl, MODIS_DC_Chl (Default case), and MODIS_DC_case-2_Chl (Default case) were however found relatively satisfactory than that of MODIS_case2_Chl and MODIS_case-1_Chl algorithms in these waters. The algorithms for estimating the absorption coefficients of CDOM and phytoplankton showed the worst performance among all the algorithms examined, with MNB and RMS error of 10.5% and 55.66% for aCDOM and 130% and 638% for aph. This suggests the apparent problems of the standard bio-optical algorithms and that new approaches for ocean colour algorithms are required in the high latitude Arctic Sea. The analysis also reveals that the atmospheric correction currently in use for MODIS usually fails to retrieve upwelling radiances emerging from the Arctic Sea and the cloud detection algorithm neglects to mask the contaminated pixels by clouds.

AC-2C-14: A Comparative Analysis of Climatic Variability and its impact on the ABROLHOS REGION (BA, BRASIL) Coral Bleaching

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The Abrolhos bank region shelters one of the biggest and more complex biologic systems of the South Atlantic. Yet, this region of great ecologic, economic and social value hasn't been suficiently studied and it´s physical and biologic aspects hasn´t been described and interpreted in detail. There are few studies about the climatological variability of the Abrolhos bank despite the growing attention with respect to global warming impacts.This work, using meteorologic and oceanographic data aims to better understand this region with respect to climate parameters and establish, when possible, connections to the coral bleaching events. This will contribute to the evaluation and management of antropogenic impacts of the Abrolhos bank.

AC-2C-15: Phytoplankton Community and Trace Gas Studies from the Pride of Bilbao

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Primary production by plants and algae forms the base of all ecosystem processes. In addition, the oceans and their margins are home to a wide range of micro and macroalgae that are known to produce halogenated trace gases through their metabolic processes. Once in the atmosphere, these gases provide mechanisms by which chlorine, bromine and iodine compounds reach the stratosphere and are involved in the catalytic destruction of ozone. Many of these gases also have the ability to contribute to global warming, while some appear to instigate the production of cloud condensation nuclei that may help mitigate it. Studies have shown that biological gas release is not solely related to one species or taxa. It is more likely to be controlled by community structure and/or environmental conditions. Therefore, to understand and manage marine ecosystems and further our knowledge of trace gas release it is vital to monitor changes in phytoplankton community structure seasonally, inter-annually and on decadal timescales. In turn this will help us better understand how phytoplankton released gases might force or mitigate climate change. To this end, we have developed automated systems for the collection of biological samples and the analysis of halogenated trace gases for deployment on the Pride of Bilbao ferry. The biological sampler is a robotic system collecting samples for plant pigment analysis and taxonomic counting by microscopy and flow cytometry. The trace gas instrument is a membrane-inlet purge and trap system coupled to a GC-MS. Both systems take samples from the ship's seawater intake. The systems work alongside a standard "Ferrybox system' which logs temperature, salinity fluorescence and oxygen and sometimes includes a CO2 measuring system. The novelty of this work is the long time series of integrated, simultaneous measurements. The community structure work will form part of the new EU programme PROTOOL and the concept will be taken forward within the SCOR/IAPSO* working group Ocean Scope. * Scientific Committee on Ocean Research/International Association for the Physical Sciences of the Ocean.

AC-2C-16: Biophysical Moorings on the Eastern Bering Sea Shelf: 15 Years of Observations

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The southeastern Bering Sea shelf is one of the world's most productive shelf regions . This high subarctic sea is characterized by high biological productivity and the seasonal presence of sea ice. In the last decade, global temperatures have reached some of the highest levels recorded in recent history and projections of future temperature suggest that the greatest rates of change will be at high latitudes. A series of biophysical moorings have been deployed on the broad eastern Bering shelf at four sites . The southern most mooring is at ≈56.9°N and the northern site is at 62°N. At each site, ocean temperature, salinity, nitrate, oxygen, chlorophyll fluorescence and currents are measured. In addition, listening devices for marine mammals are also deployed at each site. At the southern site, instruments that measure zooplankton biovolume provide important information on temporal variability of zooplankton. These biophysical moorings, coupled with shipboard measurements, are used to understand how this ecosystem is changing under the influence climate variability.

AC-2C-17: Semi-automated classification of zooplankton by the ZooScan system: a network approach.

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Using zooplankton data for ecological or modelling studies in global analysis requires homogeneous datasets. The ZooScan (www.zooscan.com) is a laboratory instrument that, in conjunction with free ZooProcess and Plankton Identifier software, forms an integrated analysis system for acquisition and classification of digital zooplankton images from preserved zooplankton samples. Digitized objects are detected, enumerated, measured, and classified. A semi-automatic approach is presented here where automated classification of images is followed by manual validation, which allows rapid and accurate classification of zooplankton and abiotic objects. The

ZooScan system also provides an efficient mean to reconstruct plankton size spectra from taxonomically well-characterized zooplankton samples. In addition, it permits digital archiving of images in databases accessible to the scientific community and standardization of images from different ZooScans, allowing the construction of combined Learning sets and implementation of comparative studies. The analysis is non-destructive so the samples can be used for other purposes. Laboratory operation with aqueous samples is safe. Cooperative, networked activities over broad geographic scales can be enhanced by database management using, for example, the PANGAEA® data warehouse. The classification method proposed here allows a relatively detailed taxonomic characterization of zooplankton samples and provides a practical compromise between the fully automatic but less accurate and the accurate but time consuming manual classification of zooplankton for ecologically oriented studies or monitoring programs at regional and global scales through networks of users.

AC-2C-18: Physical-Biogeochemical Study Using a Profiling Float: Subsurface Primary Production in the Subtropical North Pacific

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[4]University of Tokyo, JAPAN

Profiling floats equipped with biogeochemical sensors present a unique opportunity to break new ground in exploring biogeochemical processes in conjunction with associated physical processes, which will contribute to a new generation of global ocean observing systems not only for physical fields but also biogeochemical fields and ecosystem. We present a recent result from physical-biogeochemical study using a profiling float equipped with biogeochemical sensors, which demonstrate its usefulness and potential.

Based on the extensive profiling float observation carried out as part of the Kuroshio Extension System Study (KESS), Qiu et al. (2006) reported large vertical eddy diffusivity (2 - 5 x10-4 m2s-1) near the upper boundary of Subtropical Mode Water (STMW). This large diffusivity possibly have an impact on subsurface redistribution of heat, nutrients and dissolved gas components, etc., in the subtropical ocean. On the other hand, recent measurement of turbulent kinetic energy dissipation rate by Mori et al. (2008) indicates much smaller vertical eddy diffusivity (10-7 - 10-5 m2s-1) over the whole depth range of STMW. However, the direct comparison between the estimation by Qiu et al. and that by Mori et al. is possibly inappropriate because the former is based on the PV change over a couple of months and the latter on the instantaneous turbulent measurements.

We carried out physical and biogeochemical observation to examine the vertical diffusivity near the top of STMW using a profiling float. The profiling float, which was equipped with a fluorometer and a dissolved oxygen sensor along with temperature and salinity sensors, was deployed in the STMW formation region and acquired quasi-Lagrangian, 5-day-interval time-series records from March to July in 2006. The time-series distribution of chl.a showed a sustained and sizable deep chlorophyll maximum just above the upper boundary of the STMW throughout early summer. Vertically integrated chlorophyll in this period was consistently ranging from 15-30 mgm-2, indicating sustained primary production and a continuous supply of nutrients ranging from 10-30 mgNm-2day-1. The time-series data indicate no appreciable sporadic events to supply nutrients and instead support, along with vertical profiles of nitrate obtained by ship-board measurements near the float, the large vertical diffusivity reported by Qiu et al. Since our estimation of vertical diffusivity is based on temporal evolution of primary production over several weeks, it is fairly consistent with their estimation.

AC-2C-19: An ocean monitoring program around Japan: a sensor for climate/environment variation of the western North Pacific

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The western North Pacific region in the vicinity of Japan Islands is the formation region of two large-scale water masses, North Pacific Intermediate Water (NPIW) and North Pacific Subtropical Mode Water (NPSTMW). These water masses play a key roll in the North Pacific shallow overturn system, and hence have strong relation to subdecadal-scale variation of oceanic environment observed in this basin (such as PDO). Japan Islands also face several marginal seas such as East China Sea and Japan Sea: Each of them has own long-term variation patterns independent to open western North Pacific, under the influence of large river systems and/or other coastal processes. These oceanic regions are also known as one of the most productive area in the world oceans, having definite importance in biogeochemical cycles and oceanic ecosystems including fisheries. Furthermore, now they are believed to be subject of ongoing changes caused by the global warming. To monitor these existing variations and predict future changes in the around-Japan oceanic regions, and to estimate their influence to biogeochemical and /or ecological processes including fisheries, Fisheries Research Agency had started a new set of hydrographic monitoring lines covering these oceanic regions from 2002. Shipboard surveys are operated basically seasonally on four lines in the around-Japan oceanic regions, and monitoring for hydrographic, biogeochemical and lower-trophic biological properties are observed in each line. A part of these monitoring lines have precedently established in 1988 and already have ~20 years time length, and retrospective studies using the pre-existing public dataset enable us to analyze more longer-term changes in these oceanic regions. So far, we have detected several long-term variations in these regions such as: 1)enhancement of surface stratification in subarctic Western North Pacific regions 2)subdecadal-scale reduction of winter surface nutrient concentrationsconcurrent with the surface stratification; and as the consequent, slight reduction of spring phytoplankton bloom in these regions. 3)High possibility for the advanced establishment of spring phytoplankton bloom after 1990s. Zooplankton biomass had both decreasing/increasing trend depending on oceanic regions and/or species, receiving combined affect of size-decreasing and advanced timing of spring blooms. 4)Surface stratification also occurs in East China Sea after 1960s to 1990s, owing to the enhanced load of Yangtze River concurrent to the changes of Chinese rainfall pattern.

AC-2C-20: Summer-Time CO2 Fluxes and Carbonate System Behavior in the Mississippi River and Orinoco River Plumes

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High-resolution simultaneous spectrophotometric measurements of surface water pH, CO2 fugacity (fCO2), and total dissolved inorganic carbon (DIC) were obtained in July 2005 and September 2006 in the Mississippi River Plume

(MRP) and the Orinoco River Plume (MRP) using a recently developed underway system, Multi-parameter Inorganic Carbon Analyzer (MICA). Traditional Niskin bottle samples of DIC and pH at depth were also collected and analyzed using the MICA system. The resulting data were analyzed to compare and contrast the CO2 fluxes and carbonate system behavior of the two river plumes under summer conditions. The surface water within the MRP shows a strong atmospheric CO2 sink (-4.9 ~ -7.7 mmol C m-2 d-1), while oligotrophic waters of the Gulf of Mexico were a CO2 source (1.3 ~ 2.9 mmol C m-2 d-1). The CO2 sink of the ORP is much less significant (-0.7 ~ -1.1 mmol C m-2 d-1), and the adjacent surface water of the Caribbean Sea was approximately in equilibrium with the atmosphere. The carbonate system inside the MRP exhibits patchiness (strong temporal and spatial variation). Such behavior is much less significant for the ORP, where both DIC and TAlk show strong conservative mixing. This study confirms that the two large river plums constitute carbon sinks under summer conditions. However, the strength of the sinks in these two coastal systems differs significantly due to both natural and anthropogenic influences.

AC-2C-21: JMA New Ship-based Observation for Climate/Carbon in the Western North Pacific

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The Japan Meteorological Agency (JMA) has been conducting ship-based hydrographic observation along repeat sections for over 40 years in the western North Pacific, including the meridional section of 137E, to monitor interannual and decadal variability of the ocean circulation and water mass property. Since 1990s, the carbon observation such as total dissolved inorganic carbon (DIC) and a partial pressure of CO2 in near-surface seawater has been also conducted.

CLIVAR/Carbon and JMA results in the Pacific indicate that the various components of Pacific shallow meridional overturning circulation are subjected to climate change, and playing an important role in transporting the anthropogenic CO2 from the surface into the intermediate depths of the Pacific Ocean. However, to reduce the uncertainty in the anthropogenic CO2 uptake, it is needed to monitor the distribution of DIC and related biogeochemical parameters with higher spatial/vertical resolution. Furthermore, high frequency sampling could be effective to reduce the biases in high latitudes where property concentrations/inventories are affected by short-term climate variations through water mass formation, and in the western boundary region where the basin-scale dynamic response signals are accumulated.

JMA is planning a new ship-based observation which consists of the WHP-spec observation and routine observation to reinforce the international cooperation for monitoring and research on the oceanic CO2 uptake. The WHP-spec observation provides data with high-quality and high spatial and vertical resolution covering over the full water column every 4-5 years. It contains revisits of the WOCE P09 and P13. The semiannual/seasonal routine observation is conducted along meridional and zonal lines in the western North Pacific and seas adjacent to Japan. The routine observation would contribute to calibration of Argo sensor as well. JMA will start to implement the new plan in 2010.

AC-2C-22: The VECTOR Project: A Challenge for the Italian Marine Science Community

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V.E.C.T.O.R. (Vulnerability of the Italian coastal area and marine Ecosystems to Climate changes and Their rOlein the Mediterranean caRboncycles) is an overarching project which is seeing the joint effort of a very large portion of the Italian research community involved in coastal and marine sciences.

The project studies the most significant impacts of climate change on the Mediterranean marine environment and the role of this basin on the planetary CO2 cycle.

Its overall objectives are the assessment of the mechanisms related to the CO2 sequestration in the Italian seas, the evaluation of the role of the Mediterranean Sea on the planetary CO2 cycle, the assessment of the vulnerability of costal areas and of the effects of climate change on biodiversity.

Its main scientific sub-objectives can be summarized as follows: defining the role of the Mediterranean ecosystem in establishing sources and sinks of CO2; improving the understanding of the biogeochemical and carbon cycles; defining the sensitivity of the Mediterranean ecosystem to global change; predicting the ocean behavior in the CO2 cycle for the next 200 years; providing data on the effectiveness of the Italian seas in carbon sequestration, to be used in the international negotiations.

The project is in its third year of activity; so far, 21 cruises have been carried out in the framework of VECTOR, for a total of more than 150 days at sea. In this poster, we briefly report on the devised methodologies and discuss a choice of preliminary results obtained within the different workpackages, which have been characterized by a very strong interaction among different groups and institutions, as well as among different disciplines, with a special focus on dynamical and sedimentary processes, biogeochemical cycles and biodiversity, in different key areas of the Italian seas and of the Mediterranean basin.

AC-2C-23: Application of liquid waveguide to shipboard underway and in situ low-level nutrient measurements in seawater

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Colorimetry is the conventional method for measuring nutrients in seawater. Recent applications of liquid waveguide long-path capillary flow cells to the colorimetric analysis have enhanced the sensitivity of nutrient detection by orders of magnitude. A nanomolar level of nitrate, nitrite, ammonium, phosphate, silicate and iron can be detected in oligotrophic waters. Such enhancement of sensitivity has been achieved by incorporation of liquid waveguide with a variety of automated analytical systems, including the gas-segmented continuous flow analysis(a method used in the nutrient autoanalyzers), flow injection analysis(FIA), and sequential injection analysis(SIA). Recent advances in application of liquid waveguide technology to nutrient analysis will be summarized and its potential for shipboard underway and in situ low-level nutrient measurements in seawater will be discussed.

Day 3: Delivering services to society

Session 3A: Information and Assessment

AC-3A-01: Ocean Data Stewardship

Conkright Gregg, Margarita[1]; Sun, Charles[2]; Casey, Kenneth[2]; Ji, Ming[3]; Fox, Christopher[4]; Beard, Russ[5]; May, Nelson[6]; Schwing, Frank[7]; LeDuc, Sharon[8]; Pavia, Robert[9]; Levitus, Sydney[2]
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[4]National Geophysical Data Center, UNITED STATES;
[5]National Coastal Data Development Center, UNITED STATES;
[6]Southeast Fisheries Science Center, UNITED STATES;
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As the ocean community looks to the next decade of ocean observations, end to end data management must be considered as an integral part of the design. This paper outlines the increasingly critical role played by ocean data stewardship in ensuring that coastal and ocean observations and information deliver maximum service to society. Ocean data stewardship means more than mere mechanical or electronic acts of data archiving and transfer. It consists of an integrated suite of functions to preserve and realize the full value of environmental data. These functions must be successfully implemented to ensure optimal use of oceanographic data and information, both in current and in future, often unpredictable applications. This topic cuts across all themes of this conference, particularly Theme 3 which will focus on the benefits of ocean information for services, forecasts, and impacts/management. This topic incorporates areas such as data systems and their elements, data providers, ocean reanalysis, and operational oceanography/services.

This paper addresses the following topics:

1) Why ocean data stewardship?

Data are unique, irreplaceable, and collected at great cost and therefore must be preserved. The acquisition, processing, preservation, quality control, and dissemination of coastal and ocean data by national and international data centers has greatly contributed to studies of the role of the ocean as part of Earth's climate system, weather forecasting and hindcasting experiments, and marine ecosystem studies. This section will provide examples of societal benefits achieved by coordinated ocean data stewardship efforts. It will also illustrate how the end to end management of data facilitates the ability to integrate data from multiple sources and sensors (i.e. satellites, in situ, and model data).

2) How do we ensure proper stewardship of observations?

To achieve this goal, a truly end to end design and management system is needed along with adoption of the latest standards and technologies. This section will describe tools, which if incorporated as part of the ocean observing system infrastructure, provide the capability for real time sensor to archive data management of coastal and ocean observations. For example, the addition of a data acquisition service that manages data along side collection-level metadata provides an opportunity to automate and manage elements of the process at strategic points. Another example is implementing QA/QC standards for in situ ocean sensors using OGC-Sensor Web Enablement.

3) What are the challenges for today and the future?

New science questions demand new data. Forecasting sea level rise, understanding the impact of climate on coastal ecosystems, forecasting the "weather of the ocean", loss of sea ice, changes in ocean circulation, all require a data integration framework that accommodates multiple data types, formats, and user needs. For example, Integrated Ecosystem Assessments (IEA) incorporate regional physical, biological, and social data in order to improve management of coastal and marine ecosystems.

These and other large scale issues require large scale partnerships. This section will explore the need for coastal and ocean communities partnerships to ensure stewardship of all new data, develop the capability to provide increasingly complex data in a form that is usable for multiple purposes, and engage the user community to generate products that meet their needs.

AC-3A-02: Integration of Marine Environmental Data in support of the Stewardship of Living Marine Resources

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There is an increasing emphasis on the employment of ecosystem-based management towards the stewardship of living marine resources. This inherently includes a requirement for the accessibility of timely descriptions of the aspects of marine environment that are relevant to a given ecosystem. In the past decade there has been a proliferation of publicly available oceanographic data sets derived from a variety of platforms and sensors. National, Provincial, and Municipal researchers and managers who are not necessarily expert in the production and distribution of oceanographic satellite data often face a bewildering, and seemingly contradictory, array of options when choosing data for use in their applications. The standards and data products stemming from the international components of the Global Earth Observing System of Systems (GEOSS) provide a mechanism that may serve to increase the accessibility of such products while improving their quality. We offer examples in which highly-derived products and dissemination systems are being employed on the North American Pacific Coast to support management of both fisheries and protected species.

AC-3A-03: Performance Assessment of ERS-2 and Envisat Ocean Altimetry Time Series

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Almost 14 years after its launch, ERS-2 is still flying and providing altimetric measurements. Due to the loss of the on-board register in 2003, the data coverage is now partial. Its successor, Envisat, launched in 2002, does not only ensure the continuity of the observations provided by ERS-2, it also significantly improves the data quality, allowing Envisat to reach the same high level of accuracy as other precise missions such as T/P and Jason-1. Data from these 2 missions are used by a various range of oceanic applications, from real time mesoscale modelling to fine climatology analysis.

The quality assessment of these data is routinely performed at the CLS Space Oceanography Division. This paper presents the main results in terms of ERS-2 and Envisat data quality and performance: verification of data availability and validity, monitoring of the most relevant altimeter and radiometer parameters, assessment of the altimeter systems performances.

This work includes a cross-calibration analysis of data with other flying precise altimetric missions. This step is essential to assess data quality and performances, and to allow combination of altimeter datasets as required by applications

and operational oceanography. Envisat is also an important third point of comparison between the Jason-1 and -2. Finally, altimetry data are compared to a tide gauge data network. Comparisons with an independent data set are indeed of great interest to detect drifts and biases.

AC-3A-04: Mean Sea Level Trend Estimated From Envisat Altimetry Mission: Comparison with Jason-1 and In Situ Data

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The global Mean Sea Level (MSL) derived from altimetry data, TOPEX/Poseidon and Jason-1 dataset in particular, are today used as the reference for climate studies (MSL aviso website http://www.jason.oceanobs.com/msl). Envisat altimeter system (RA2/MWR/DORIS) has the technical capacity of reaching the high accuracy needed for MSL studies. Extensive work has been done on the Envisat MSL which allows to identify the potential causes of the differences with the other satellites. The recent Envisat MSL studies henceforth show a certain confidence in the MSL evolution provided by Envisat after removing the first years.

First, a status on the current MSL seen by Envisat altimeter will be given and a cross comparison with Jason-1 will be performed. Notably, the impact of recent updates and sensitivity studies will be detailed. A list of all the possible causes of errors in the MSL Envisat computation will then be analysed: geophysical, instrumental and orbital potential sources will be listed. Secondly, the Ra-2 time series will be compared to in situ data a global tide gauge network and Temperature and Salinity (T/S) in-situ measurements. These two kinds of in situ measurements are complementary: TG in-situ data have a very good temporal sampling (1 hour) but a poor spatial repartition (only on coastal areas), while T/S profilers are very well spread out over the whole open ocean but with a temporal sampling close to 10 days. The objective of this comparison is on the one hand to detect jumps or drifts in the altimeter MSL, and on the other hand to estimate the performances of new standards in the altimeter products. This shall give to the users a quantification of the confidence that can be given to Envisat altimetric mission as a complementary source of data in climate studies.

AC-3A-05: Observation Requirements for Scientific Assessment of Operational Ocean Forecasting System, as Performed in GODAE

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In the framework of GODAE, but also European funded project like MERSEA, several countries around the world have been developing an operational capacity for short term ocean dynamics prediction. Ocean forecasting systems rely on observations to provide more realistic hindcasts and forecasts, through assimilation procedures. Moreover, most of these operational groups have implemented Cal/Val procedures, based on scientific assessment of the system and products. These procedures aimed first to verify the realism of ocean estimates, and monitor the forecasting system in operation. Second, used in delayed mode, they provide a validation of numerical simulations as performed classically by the ocean modelling community.

This scientific assessment is based on standardized diagnostics - or metrics - that allow quantifying the error level of ocean products. They usually rely on observations, in-situ or from space. The diagnostic can be "independent" if the set of observation has not been previously used in the assimilation. Satellite observations of sea level (altimetry), sea surface temperature (radiometry), ocean colour (imagery) are frequently used to verify mesoscale and large scale signal of the upper ocean. At depth, one relies on in situ data for assessment of currents (e.g. from moored currentmeters, vessel mounted ADCP, drifters) or assessment of water masses (temperature or salinity from moored array, drifters or profiling floats, XBTs, CTDs, thermosalinograph...). Forcing fields errors are also verified in some cases, and other combined products are also used. An overview of observations used in GODAE-like assessment procedures is given, as well as some requirements in term of observing network for future implementations.

AC-3A-06: World Ocean Database and World Ocean Atlas

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The World Ocean Database (WOD) is the largest collection of quality-controlled ocean profile data available without restriction. WOD is constructed and maintained by the U.S. National Oceanographic Data Center. The WOD contains data for 25 different variables including temperature, salinity, oxygen, nutrients, and tracers among others. These data have been measured with several different types of instrument systems including water bottle samplers, reversing thermometers, CTDs, XBTs, MBTs, profiling floats, gliders, moored buoys, and drifting buoys among others. The data in WOD and products based on WOD such as the World Ocean Atlas (WOA) climatologies have proven to be of great value to the oceanographic, climate, and geodetic communities. These products are used in ocean climate diagnostic studies, as boundary conditions in ocean circulation models, for ocean data assimilation studies, and as "sea-truth" for satellite altimetry studies among others. The effect of WOD and WOA can be quantified by a count of citations in the peer-reviewed scientific literature of the WOD and WOA atlases and their predecessor "Climatological Atlas of the World Ocean". Figure 1 shows that since 1982 these products have been cited more than 5,900 times. It is clear that global compilations of oceanographic data and analyses of these compilations are of great value to the science community. The scientific community is advising governments about global climate variability and global climate change. Thus the community needs to have access to the most comprehensive ocean profile databases possible. All data from ocean observing systems need to be permanently archived with appropriate metadata.

AC-3A-07: Observing Systems in Italian Waters

Manzella, G.[1]; Griffa, A.[2]; Santoleri, R.[3]; Zambianchi, E.[4]; Spezie, G.C.[4]; Marullo, S.[5]; Cervino, R.[6]; DeMarte, M.[6]; Masina, S.[7]; Vichi, M.[7]; Tunesi, L.[8]; Mosetti, R.[9]; Crise, A.[9]; Zincone, A.[10]; Ribera D'Alcalà, M.[10]; Corsini, S.[8]
[1]ENEA, ITALY;
[2]CNR ISMAR, ITALY;
[3]CNR ISAC, ITALY;
[4]CONISMA, ITALY;
[5]ENEA ACS, ITALY;
[6]IIM, ITALY;
[7]INGV, ITALY;
[8]ISPRA, ITALY;
[9]IN OGS, ITALY;
[10]Stazione Zoologica, ITALY

In January 2009 it was established the Italian Oceanographic Commission (COI), having the role of a coordination body foreseen in IOC-Unesco statutory regulations. The commission is composed by representatives of the main Italian institutions working in the marine sciences: Consiglio Nazionale delle Ricerche, Consorzio Nazionale Interuniversitario per le Scienze del Mare, Ente per le Nuove tecnologie l'Energia e l'Ambiente, Istituto Idrografico della Marina, Istituto Nazionale di Geofisica e Vulcanologia, Istituto Superiore per la Protezione e la Ricerca Ambientale, Istituto Nazionale di Oceanografia e Geofisica Sperimentale, Stazione Zoologica Anton Dorhn.

The commission has to address those issues that make more effective the participation to IOC activities.

COI collaborate with the Italian operational systems (GNOO) to consolidate and expand the concerted monitoring and forecasting systems. It aims to encourage national scientific research on monitoring, assessment activities and advances in scientific understanding of the Mediterranean Sea. The institutions represented in COI are managing observing networks on: sea level, waves, temperature and salinity profiles with ships of opportunity and research vessels, physical, chemical and biological parameters with buoys, currents and physical parameters with moorings. Also satellite data are operationally collected in order to provide sea surface temperatures, colour data, altimetric data, scatterometer data.

The COI institutions are actively participating to the following IOC programmes: Global Sea Level Observing System, Global Ocean Observing System, International Oceanographic Data Exchange, Joint IOC/WMO Commission on Marine Meteorology, Marine Environment, Tsunami, World Climate Research Programme.

AC-3A-08: Potential improvement to the standard technique for calculating expandable bathythermographs fall-rate equation

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The presence of biases in Expandable Bathythermograph (XBT) is an unresolved issue which has implications on the estimation precision of the global ocean heat content, particularly in the instance of using historical XBT records for determining its change rate. Hanawa et al (1994) published a temperature-error-free method for calculating fall rate equation adopted by UNESCO as technical method for marine sciences. This study is based on a comparative analysis of a collection of collocated XBT/CTD using the Hanawa method and reports on the results of testing potential improvement to this standard technique. The accuracy of the Hanawa technique is proven to be particularly effective in regions of the water column characterised by varying temperature gradients. However, the accuracy of the method for detecting depth-differences significantly decreases in situations where the temperature gradient is constant or where the XBT temperature profile has features not matched by the collocated CTD profile (Hanawa et al 1994). These situations may represent a large proportion in operational conditions. In order to overcome these shortcomings, a method based on correlation and pattern recognition has been tested and has produced promising results. The technique used an approach which takes into consideration the whole of a profile, instead of sections of defined length for determining depth-differences. This enabled to preserve the continuity of the equation over gaps of low temperature gradient change. The analysis used a series of collocated XBT and CTD data in comparative analysis and examined a number of cases where the standard technique failed to produce reliable results. The new technique was then applied to these series and produced significantly greater accuracies. Figure 1 shows an example of depth estimation errors between a collocated XBT and CTD pair along 25-meters depth-sections with the associated correlation coefficient values. The left plot shows the depth-errors produced by simple area minimization (Hanawa) and the right plot shows the depth-errors obtained by applying the new technique. Visual examination of the paired data confirmed that the technique represented more accurately the matching state in the real profiles. Figure 1. The enhanced matching obtained by the new method (right-hand figure) is confirmed by the visual inspection of the real pair. Conclusion. This technique minimises the effects of biasing or over-weighing due to low signal to noise ratios and offers potential improvement to the standard Hanawa technique for calculating expandable bathythermographs fall-rate equation. It could also be used for achieving greater precision in "batch calibration" for future XBT deployments. Reference Hanawa, K., Rual, P., Bailey, R., Sy, A., Szabados, M. (1994). Calculation of New Depth Equations for Expandable Bathythermographs Using a Temperature-Error Free Method. Unesco Technical Paper – Marine Science, 67.

AC-3A-09: "El Nino" Influences Fish Capture in La Paz Bay, Gulf of California: Eight years of Monitoring.

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From 1998 to 2005, artisanal fish captures were analyzed from records provided by official sources. Monthly surface temperature of La Paz bay was obtained from satellite data. The fishing effort was estimated for 552 fishing boats of 20-foot length in the whole bay and the surrounding Gulf of California. From 1998 to 2000 the small annual variability of temperature showed "El Nino" influence. Starting 2001 this condition disappears and larger temperature variability was evident. During "El Nino" influence captures of Spotted rose snapper (Lutjanus guttatus), ocean whitefish (Caulolatilus princeps), flathead mullet (Mugil cephalus), and the yellow fin mojarra (Eucinostomus sp), were lower. After 2001 without "El Nino" influence, the captures of these species increased. The opposite trend was observed for tuna (Thunnus albacares), and no influence was evident for Pacific red snapper (Lutjanus peru), Leopard grouper (Mycteroperca sp.), and Crevalle Jack (Caranx sp.).

AC-3A-10: OceanBIT: an International Coastal Ocean Observing and Forecasting System based in the Balearic Islands

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OceanBIT (BIT for Balearic Islands Technologies) is a multi-platform distributed and integrated facility that will provide streams of oceanographic data and modelling services in support to operational oceanography in the Balearic Islands in a European and international frame, therefore also contributing to the needs of marine and coastal research in a global change context. Operational Oceanography is here understood in a wide sense, including both the systematic, long-term routine measurements of the seas and their interpretation and dissemination and also the sustained supply of multidisciplinary data to cover the needs of a wide range of scientific research priorities.

OceanBIT activities will be mostly (but not only) centred in the western Mediterranean, with focus in the Balearic Islands and adjacent sub-basins (specifically Algerian and Alboran/Gibraltar) and covering from the nearshore to the open ocean. Basic principles are: scientific and technological excellence through peer review; science, technology and society driven objectives; support to R&D activities in the Balearic Islands (existing and new ones); integration, coordinated multiplatform, multidisciplinary and sustained

(systematic, long term and different scales) monitoring, partnership between institutions; free, open and quality controlled data streams; baseline data in adherence to community standards.

OceanBIT objectives are driven by state of the art international scientific and technological priorities but also, by specific interests from the Spanish and Balearic Islands society. The general objective is twofold: (1) to address and respond to international scientific, technological and strategic challenges for operational oceanography in the coastal ocean and (2) to vertebrate the coastal ocean operational oceanography research being carried out in the Balearic Islands, contributing to the consolidation of a well structured centre of excellence. Five specific objectives have been also identified: Scientific, Technological, Strategic (response to society needs), Transfer of Knowledge (including Outreach and Education) and Training and Mobility.

On a long term, our vision is to advance on the understanding of physical and multidisciplinary processes and their non linear interactions, to detect and quantify changes in coastal systems, to understand the mechanism that regulate them and to forecast their evolution and or adaptation under, for example, different IPCC scenarios. Ocean_BIT will specifically address the preservation and restoration of the coastal zone and its biodiversity, the analysis of its vulnerability under global change and consider new approaches, such as connectivity studies and Marine Protected Areas optimal design to advance and progressively establish a more science based and sustainable management of the coastal area (ICZN).

OceanBIT will be composed of three major subsystems: (1) an observing sub-system, (2) a forecasting and data assimilation sub-system and (3) a data management, visualization and dissemination sub-system. OceanBIT components will be constituted by a sustained, spatially distributed, heterogeneous, potentially relocatable and dynamically adaptive observing network that will be integrated through data management and numerical methodologies to exploit the synergies between both the observational network (moorings network, surface velocity drifters, ARGO profilers, HF radar, gliders, AUV's, R/V's, VOS, etc.) per se and between the observational network and the numerical models (physical-waves and currents at different scales- and biogeochemical coupling) and assimilation tools, with the aim to provide a complete and integrated description of the physical and biogeochemical properties of the marine environment.

OceanBIT will have both static and relocatable facilities (the facilities make the observations that are specified by the nodes that provide the objectives, in line with IMOS in Australia). The first ones will be mostly sustained in permanent locations (in response to operational and scientific needs) and will be open and internationally access free. The second, relocatable dynamic facilities will have adaptive capability in space and time to respond to specific scientific requests that will be allocated after an international peer reviewed process in response to open annual international calls.

OceanBIT is part of the Spanish Large Scale Infrastructure Facilities (ICTS). An international scientific advisory committee will be responsible for the implementation of a peer review evaluation process following the highest quality standards. It is no formally a new Consortium with legal entity, with approved funding, up to 36 million Euros, including 14 million Euro for scientific equipment and facilities, and 2 million Euros/year for running costs during 11 years (2011-2021). Activities planned for 2009 specifically include preparation of the implementation plan.

AC-3A-11: An ocean monitoring system for fisheries in waters around Japan

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The waters around Japan are known as a densely observed area in the world. Fisheries institutes in Japan are playing an important role in the continuation of the ocean monitoring from the 1910□fs. The monitoring system operated by fisheries institutes has definite purpose to provide oceanographic information to fisheries communities. The work was done by using the handwriting systems and real mail system in the past. Numerical modeling systems are necessary for integration of various sorts of observation data in the present time. An ocean forecast model, FRA-JCOPE, was developed under the cooperation of JAMSTEC and is operated by Fisheries Research Agency for the monitoring system. The monitoring system has advantages that can use oceanographic data obtained by fisheries institutes for data assimilation. While ARGO data and satellite SSH data are very important in the model, the data are less available in the coastal region which is quite important for fisheries. This insufficiency is expected to be compensated by the oceanographic data obtained by fisheries institutes in the monitoring system. Requests for improvement of the accuracy of oceanographic products in the coastal region occupy main position of the subject list of the monitoring system. The three-dimensional data produced by the monitoring system are provided to member institutes for diagnosing the oceanographic conditions and for providing fisheries information to their tax payer. The data are also applied to the fisheries researches. For example, the drift of Giant Jellyfishes in the East China Sea is calculated by using the forecasted surface currents. Transport experiment of bluefin tuna larvae near the continental shelves is performed in order to investigate the mechanisms of the recruitment of young bluefin tuna.

AC-3A-12: Towards a Long Term Monitoring of Water Discharge in Coastal Arid Climates: Changes by Natural and Human Influences

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Water sources in arid climates assure human settlements and productive activities, from subsistence to intensive agricultural practices. In southern Baja California a number of water sources (mainly oases) are characteristically spread out and funnel their water resources to a short watercourse eventually discharging to a central lagoon, surrounded typically by fresh water vegetation. The lagoons are typically nourished by a larger waterway, and the surface water is eventually lost by evaporation, by filtration, or sea discharge.

The chemical composition of the emerged water, its watercourse, and fate (whether oceanic, atmospheric or reincorporation to the ground) show variability driven by natural influences (type of soils, density of vegetation, insolation, and rain amount) or by human uses (agriculture, waste water discharges). Nitrogen and phosphorus enrichment is expected as a result of agriculture or urban activity. Along the waterway, salinity can be modified by the type of soil, evaporation or by its proximity to a marine inlet. The waterways are also a source of oceanic nitrogen, phosphorus and silicate discharges and affect the marine biota and, by consequence, the extent of variability of the flow discharge can promotes changes in the site marine primary productivity.

Those scenarios are important for arid zones such as Baja California, where a number of small and larger towns depend on the underground water. This research describes the water quality at the source, along the waterway, and at its discharge on the sea. This work (2004-2008) is part of a long term monitoring program reports of chemical data of some of the known oases in Baja California Sur. These sites are

recommended for insertion into the new international net of Marine Observatories (Mexican-French agreement), starting in 2009. The purpose of which is to observe changes driven by increased human activity, and for developing indicators of change for French coasts, the Gulf of Mexico coast, the Caribbean Coast, and the Baja California coasts.

Day 3: Delivering services to society

Session 3B: Forecasting

AC-3B-01: Benefits of Altimeter Ocean Wave Data Assimilation

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Unlike atmospheric data assimilation, which started in the 1960's, wind-wave data assimilation emerged only in the 1980's. Satellite wave data are assimilated to produce the analysis and to improve the forecast of the wave model. This has proven to be of great value to compensate for the possible model errors due to the modelling limitations (e.g. numerics and parametrisations) and the errors in the driving forces (mainly wind speed). The more severe those errors are, the more impact altimeter wave data assimilation would have. The more data available for assimilation in NRT, the more impact would be resulted.

At the European Centre for Medium-Range Weather Forecasts (ECMWF) we have gained over the past 20 years a considerable experience with the use of altimeter (onboard ERS-1, ERS-2, ENVISAT, Jason-1 and Jason-2) wind and wave data products. Since the launch of ERS-1 in 1991, the availability of the altimeter significant wave height data in near-real time (NRT) has enabled the operational assimilation of the wave height data in the ocean wave model that runs operationally at ECMWF from 15 August 1993 onwards. This had a significant impact on the wave model analysis and forecast. Assimilation of altimeter wave height data at ECMWF continued with data from ERS-2 (1995-2003), ENVISAT (since 2003), Jason-1 (since 2006) and Jason-2 (since 2009). It is worthwhile mentioning that the ECMWF wave model assimilates Synthetic Aperture Radar (SAR) wave spectra from ENVISAT as well.

The assimilation of ocean wave products was found to have positive impact not only on wave model products but also on the atmospheric products as well. This is only only possible through the two-way interaction between the atmospheric and the wave components of the model.

The ECMWF forecasting system will be briefly introduced and the benefits of ocean wave data assimilation will be presented.

AC-3B-02: Assimilation of Altimetric and SST Observations in a Coastal Model: An Exploratory Study with an Ensemble Kalman Filter

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We aim to constrain a coastal OGCM with sea surface height (SSH) and temperature (SST) satellite data. The objective is to provide a more realistic ocean state estimation at monthly time scales, with specific focus on the surface layers and heat content variability. Modelling and assimilation in coastal areas present specific challenges because of the numerous physical processes that need to be taken into account as well as the wide range of their associated spatial and temporal scales. In particular, high frequency atmospheric forcing on the shelf, tides, coastal waves, mesoscale eddies and instabilities of slope currents are critical mechanisms for the dynamics and hydrology on the shelf as well as on the slope. In such a context, data assimilation can effectively constrain the model if the method is able to take into account the complexity of the model error space that is due to the richness of the processes at work and to the specificity of the studied region. For this reason, we are working on an Ensemble Kalman Filter (EnKF) method where the full multivariate forecast error covariances are used. The SYMPHONIE OGCM is used in a realistic configuration of the Bay of Biscay (North East Atlantic). The model has 43 generalized sigma levels and 3 km horizontal resolution. It is forced with the Meteo-France ALADIN 3 hourly atmospheric fields and with MERCATOR products at the open boundaries. The ensembles are generated by randomly perturbing the wind stress forcing. We use the SEQUOIA data assimilation software that includes a code for the EnKF. SSH data are processed through a tool dedicated to coastal altimetry (XTRACK). SST fields are high resolution products, derived from satellite measurements. Before attempting to assimilate the altimetric and SST datasets we need to answer the following questions: which processes are the altimetric and SST signals representing? Is the model able to simulate these processes? To what extent does the signature of such processes compare in the simulations and in the observations? These issues are addressed through a study of a slope current in the southern part of the basin: we investigate the observability of the Iberian Poleward Current in the satellite datasets and compare the observed signals with the SYMPHONIE simulations. The model is also used to interpret the observations. Then, as a first step towards the assimilation with real data, we set up twin experiments that allow a straightforward evaluation of the assimilation impact. The influence of both kind of observations (SSH and SST) is studied through the analysis of the assimilation results and of the space-time structure of the representers. Our objective is to estimate and characterize the impact of the data on the Iberian Poleward Current, as well as on the mixed-layer properties and on vertical mixing.

This work is part of a group effort at POC (Pole d'Oceanographie Cotiere, Toulouse, France) to develop tools for coastal areas (XTRACK, SYMPHONIE, SEQUOIA, TUGO) and use them within research projects that combine observational and modelling studies.

AC-3B-03: Impact of the Number Space Altimetry Observing Systems on the Altimeter Data Assimilation in the Mercator-Ocean System

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The impact of the number of space altimeter satellites and the data number SLA observations available for assimilations is assessed using one eddy resolving experimental data assimilation system PSY2V2. And twin experiments performed in delayed-time conditions when 4 datasets are available. The assimilation system is based on the Reduced-Order Optimal Interpolation algorithm and uses 1D vertical multivariate EOFs to extract statistically-coherent information from the observations. In first step, we analyse here their respective impact on the analysis. We led several simulations in parallel that we compare with a simulation that we shall call after reference simulation Sref. In the reference simulation Sref, we assimilate the altimeter data (J1, En and Gfo). For all the simulations presented, we leave the same restart. We made these simulations over six months. First of all, we shall show that it is important to use the altimetry data stemming from various satellites, in particular when their spatial resolutions are different (J1, En, Gfo and Tp). In a second step, we compare the performance of fast delivery products with respect to delayed time data. The validation with independent in-situ data (tide gauge and drifter data) demonstrates a clear degradation of real time in relation to delayed time. To obtain the same quality we need: 1 altimeter for hindcast, 2 altimeters for nowcast and 4 altimeters for forecast. This is essentially due to the fact that to compute the real time only observations of the past are accessible.

AC-3B-04: Qualification of the MyOcean Global Ocean Analysis and Forecast System: Skill Estimation for Various Applications.

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The operational oceanography European project MyOcean is part of the Global Monitoring for Environment and Security GMES program. During the next 3 years, 61 European partners in 29 different countries will work to build a pan European ocean monitoring and forecasting capacity. The "marine core service" will be produced by ocean forecast centers and data centers working together. MyOcean is particularly attentive with the setting of quality control, including the scientific validation of the products.

The computation of various forecast scores and the inter-comparison of these scores between the various systems is done with an ensemble of metrics defined in the context of MERSEA and GODAE. Based on these metrics and on various data comparisons, this contribution will give an overview of the quality of the product of the state-of-the-art analysis and forecast system.

We will look at the global Ocean system which is run at Mercator-Ocean and is based on the ocean and sea ice modelling system NEMO and on an assimilation system based on Kalman filter/SEEK. It is declined in eddy permitting and eddy resolving configurations: The current version of the global system has a 1/4° horizontal resolution, with a North Atlantic (including the tropics) and Mediterranean zoom at 1/12° , and a global 1/12° system is under development which will be the reference global system at the end of MyOcean.

One of the aims of this quality report (which will probably be updated on a quarterly basis) is to interact with the scientific community and other users so that one can derive the level of confidence (or the correction one can make) for the use of the products in one's own application. We will show that measuring the quality of the systems points out the importance of the real time observation network. In order to monitor the ocean we need a perpetual relatively high resolution spatial and temporal coverage, as an input for ocean analysis and forecast systems as well as for a validation purpose. We also need reliable references like long ocean reanalyses in order to validate these systems but also to provide useful information such as interannual or decadal anomalies (for instance for users who whish to initialize seasonal forecast, decadal forecast).

AC-3B-05: Observing System Evaluations Using the Ocean Data Assimilation and Prediction System, MOVE/MRI.COM

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Some activities to evaluate impacts of observing systems are conducted in JMA/MRI using an ocean data assimilation and prediction system, MOVE/MRI.COM. From the activities, we here introduce two major results, the singular vector analysis of the Kuroshio large meander and the evaluation of the impacts of TAO/TRITON array and Argo floats on ENSO forecasting.

Singular Vector (SV) analysis is a way to identify the most unstable perturbations that grow up rapidly in a certain period and affect following phenomena effectively. We applied SV analysis to the formation process of the Kuroshio large meander reproduced in the western North Pacific version of MOVE/MRI.COM. The analysis result shows that an anticyclonic perturbation contacting the Kuroshio path in the southeast of Kyushu grows rapidly and affects the large meander path two month later. This implies that observations in that region are likely to benefit the forecast of the variability of the Kuroshio Current south of Japan.

Effects of assimilating TAO/TRITON array and Argo float data in the global version of MOVE/MRI.COM and its impact on the JMA seasonal forecasting system has been evaluated by an Ocean System Experiment (OSE). The impact of TAO/TRITON array on 1-7 month SST forecasts is remarkable in a most part of the central and eastern tropical Pacific, showing the importance of TAO/TRITON array for ENSO forecasting. In contrast, the homogeneity of data from Argo floats causes an impact on SST forecasts in a broader area.

AC-3B-06: Climate Change, Prediction and Return Precipitation in Morocco

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The atmospheric conditions prevailing since September 2007 to put the global space geoclimatic of the Western Mediterranean to cool conditions, characterized by moderate air temperatures, abnormal negative pressure, positive temperature anomalies of surface water "SST" of the Atlantic Ocean and the Western Mediterranean, and the return of precipitation in North Africa and in South-West Europe. These rains have already caused flooding and damage in fall 2007 in Spain, Algeria and Tunisia. Morocco was spared compared to its neighbours, despite the spring rains have left some minor damage, and dispersed. The same conditions will strengthen and continue to the present, and should continue until August 2009, they are manifested by early rains and violent storms across Morocco, and should continue during the autumn season. The first flood have already left huge damage. In the year 2006, an event "El Niño" appears to the Pacific and was expected to drought in Morocco for winter 2007. Indeed, there has been no rain in winter 2007, although the "SST" off the country were surplus to the normal, and precipitation were not made until spring 2007. Events 2006-2007 that was not seen for at least 20 years, the period during which the ocean and the atmosphere are systematically monitored by satellites, such as Seasat, Topex-Poseidon, Jason and Envisat. It turned out that the phenomenon "El Niño 2006-2007: an event upset" as was stated in a press release from the IRD in March 2007, has not performed as usual scenarios. Indeed, instead of "El Niño" reaches its peak in December 2006, a turnaround was achieved by the return to normal. In the year 2007, the phenomenon has continued its progress towards the other extreme negative "La Niña", which continues to persist until now. This was manifested by storms and floods in our region in autumn 2007, first in Iberia and North Africa (Algeria and Tunisia). Morocco and was protected by a dorsal air did not allow the fall of precipitation occur during this period. It was not until the spring for the rain returned to Morocco, and was brutal in some places. This year 2008, we noticed a lack of heat waves during the summer, or even a drink, but the average temperature in September is still high, During this time of year, and under these conditions, there is the installation of a system of atmospheric circulation called "transition" between summer and winter. This system is characterized by the appearance of depression centers in the Western Mediterranean and Northeast Atlantic, and the rocking of the circulation from West to the South in the form of a meridional circulation. This swing takes the form which creates wave of South-West North-East and North West South East, which swept North Africa and South-West Europe, thus leaving

achieve a energy conversion often in the form of rain, which could cause dangerous floods, such events of the fall 2007 in Algeria and Tunisia, and end in September 2008 in Morocco. These conditions should persist throughout the autumn season and continue in winter, which should give us a wet year at the national level. Oceanic conditions of the regional climate system is characterized by the appearance of surface ocean "SST" with a warm anomaly, which facilitates the exchange positive vertical heat between the ocean and atmosphere, and allows it to convey a tremendous amount of moisture, which turns into a torrential rain in the event of rain, which become more common in these conditions. These weather events are now known to scientists, and can be tracked and predicted using space technology and know-how and should serve as an aid to decision makers for our country, with a view to planning effective against the risks of environmental and social security for sustainable development.

AC-3B-08: Roles of dense in-situ observation network around Japan in the eddy-resolving ocean reanalysis

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We have produced high-resolution reanalysis data in Japanese coastal ocean by using the JCOPE2 ocean forecast system as a part of a cooperative study between FRA and JAMSTEC. We found that incorporation of the in-situ temperature and salinity data obtained by Japanese local fishery research agencies into JCOPE2 reanalysis data significantly improved biases for temperature south of the Japanese coast.

AC-3B-09: Quantifying the Role of Ocean Initial Conditions in Decadal Prediction

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The forecast skill of decadal climate predictions is investigated using two different initialization strategies. First we apply an assimilation of ocean synthesis data provided by the GECCO project (Koehl and Stammer 2008) as initial conditions for the coupled model ECHAM5/MPI-OM. The results show promising skill up to decadal time scales particularly over the North Atlantic (Pohlmann et al. 2009). However, mismatches between the ocean climates of GECCO and the MPI-OM model may lead to inconsistencies in the representation of water masses. Therefore, we pursue an alternative approach to the representation of the observed North Atlantic climate for the period 1948-2007. Using the same MPI-OM ocean model as in the coupled system, we perform an ensemble of four NCEP integrations. The ensemble mean temperature and salinity anomalies are then nudged into the coupled model, followed by hindcast/forecast experiments. The model gives dynamically consistent three-dimensional temperature and salinity fields, thereby avoiding the problems of model drift that were encountered when the assimilation experiment was only driven by reconstructed SSTs (Keenlyside et al. 2008, Pohlmann et al. 2009). Differences between the two assimilation approaches are discussed by comparing them with the observational data in key regions and processes, such as North Atlantic and Tropical Pacific climate, MOC variability, Subpolar Gyre variability.

AC-3B-10: Empirical Parameterization for the SAR Polarization Ratio

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In recent years, efforts have tried to derive wind vectors from SAR images. The wind direction can be estimated by measuring the orientation of the wind-induced streaks visible in most SAR images. Vachon and Dobson (1996) used the absolute radiometric calibration of the radar images, in conjunction with a wind retrieval model function that relates the ocean wind speed to the normalized radar cross section, the relative wind direction, and the local incidence angle. This model function was developed for C band VV polarization ocean wind scatterometry. For C band VV polarization radars such as the ERS SARs, there are several well-developed Geophysical Model Functions (GMFs), for example, CMOD-4 and CMOD-IFR2. But for the C band HH polarization RADARSAT-1 SAR, similarly well developed and validated wind retrieval models do not exist. Horstmann et al. (2000) derived a polarization ratio relationship, deduced from a comparison between the NRCS obtained from C-band HH polarization ScanSAR images of RADARSAT-1, and observations of the C- band ERS-2 scatterometer in VV polarization, collocated in space and time. Vachon and Dobson et al. (2000) compared observed values of NRSC in HH polarization from RADARSAT-1 with values of NRCS in VV polarization estimated from in situ wind measurements and the empirical CMOD2-IFR3 model from IFREMER. They concluded that the parameter in the empirical polarization ratio mode proposed by Thompson et al. (1998) should be 1.0 rather than 0.6, and they showed that leads to an overestimate in wind speeds (e.g. for high winds). Additional efforts have been made in recent years to estimate by Elfouhaily et al. (1996) and Mouch et al. (2005). In this presentation we present an empirical parameterization based on RADARSAT-2 data.

AC-3B-11: The Mediterranean Operational Oceanography Network

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An operational ocean forecasting system has been developed and demonstrated for the entire Mediterranean Sea and its coastal areas. From observations to modeling, the system operationally demonstrates the quality and feasibility of short term ocean forecasts together with end-user applications. The Mediterranean Operational Oceanography Network (MOON) designed and implemented the basic operational oceanographic service for the Mediterranean area. In this talk we overview the status of development of the MOON products and services after ten years of development. The basin scale system, both for the observing and modeling components, were implemented in three sequential EU-funded projects. The MOON components are now:

a) the Real Time-RT satellite and in situ Observing system; b) the forecasting system at basin scale and with downscaling in sub-regional and shelf areas, connected to Numerical Weather Prediction (NWP) forecasting and ecosystem numerical models; c) an information management system for observations/analyses/forecasts production/dissemination/exploitation, also called the Core Service; d) end-users applications or Downstream Services.

MOON coordinates the RT system and the numerical modeling and data assimilation components and it foster the improvements of most of its parts. The regional approach and the sharing of responsibilities makes the effort sustainable and effective. Several applications of the generic forecasting products will be shown.

AC-3B-12: COSYNA: Improving regional forecasting capabilities for the German Bight

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The presented studies are part of the COSYNA (Coastal Observation System for Northern and Arctic Seas) project. The objective of COSYNA is to enable a long-term observational network for the southern North Sea and Arctic coastal waters, which will be linked to pre-operational models for scientific and management purposes.

The presented poster gives an overview of COSYNA related activities at the GKSS Research Centre with a focus on data analysis and numerical modeling. Investigations are carried out concerning surface waves, suspended sediment, sea surface temperature (SST), sea surface salinity (SSS), and water level. Numerical circulation models and ocean wave models are used in combination with optical satellite data to estimate suspended particulate matter (SPM) concentrations in the North Sea. A detailed study on the impact of currents and waves on sediment transport processes is carried out for the East-Frisian Wadden Sea using a nested model approach. A new method to re-construct SST and SSS fields from data acquired by ferry ships (FerryBox) is described. The approach is based on EOF decompositions of both the 2-D parameter fields and the corresponding 1-D measurements provided by ships. A special technique is applied to interpolate discontinuous FerryBox observations.

Some key results obtained in a study on the assessment of observational networks are presented in the context of water level measurements with tide gauges and satellite altimeters in the German Bight. The method takes into account measurement errors as well as the background covariance structure and can also be applied for the optimisation of observing networks.

Furthermore, first steps towards the assimilation of water level data into the circulation model GETM using a Singular Evolutive Interpolated Kalman filter (SEIK) are presented. A twin experiment is set up to assess the performance of the method based on simulated observations.

The next steps of the COSYNA project are summarised. Of particular importance is the systematic merging of numerical models and observations using assimilation techniques, which are suitable for operational use.

AC-3B-13: The GNOO-INGV Mediterranean and Adriatic Forecasting Systems

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The Mediterranean Forecasting System (MFS) is operationally working since year 2000 and it is continuously improved in the frame of international projects. The system is part of the Mediterranean Operational Oceanography Network-MOON and MFS is coordinated and operated by the Italian Group of Operational Oceanography (GNOO) at the National Institute of Geophysics and Vulcanology (INGV).

The latest upgrades and integration to MFS has been undertaken in the EU-MERSEA, BOSS4GMES and MyOcean Projects. Since October 2005 ten days forecasts are produced daily as well as 15 days of analyses once a week. The daily forecast and weekly analysis data are available in real time to the users through a dedicated ftp service and every day a web bulletin is published on the web site (http://gnoo.bo.ingv.it/mfs). A continuous evaluation in near real time of the forecasts and analyses produced by MFS has been developed in order to continuously verify the system and to provide useful information to the users. The MFS forecast system production is done using an OGCM implemented on the Mediterranean Sea and an assimilation scheme able to assimilate all the available in situ and satellite data. At present two different systems, SYS3a2 and SYS4 are running in parallel every day. SYS3a2 is the official one while SYS4 is under evaluation. SYS3a2 is composed by the numerical code of OPA8.2 implemented on the Mediterranean sea (Tonani et al., 2008) and 3DVAR assimilation scheme (Dobricic et al. 2008). SYS4 uses NEMO as numerical model and 3DVAR as well for the assimilation. The major differences between the two systems are the boundary in the Atlantic ocean which are closed in SYS3a2 while are nested into GLOBAL - MERCATOR in SYS4.

The Adriatic Forecasting System (AFS) is nested into the Mediterranean Forecasting System - MFS (Pinardi et al, 2003; Tonani et al., 2008) - as well managed in Bologna by the Operational Oceanogaphy Group. AFS has been implemented within the framework of the ADRICOSM Partnership (ADRIatic sea integrated Costal areas and river basin Management system). This system provides the forecast of the main physical fields of the sea, such as temperature, salinity, currents, air-sea fluxes, sea surface elevation, and disseminates the data for reaserch and commercial purposes via ftp and via web, and publishes a daily bullettin on the web (http://gnoo.bo.ingv.it/afs/) in image format.

The numerical forecasting model used (AREG, Adriatic REGional model) is based on the Princeton Ocean Model. Its implementation covers the entire Adriatic Sea and extends into the Ionian Sea and a detailed description of the model implementation is described in Oddo et al., 2005. The tides have been introduced into the model, since December 2008, following the formulation of Flather (1976) on the barothropic velocities. The tidal signal has then been introduced in the model through the lateral open boundary condition, where the Adriatic Forecasting System nests into the Mediterranean Forecasting System, at 39° North. The open boundary conditions are taken from the daily simulations and forecasts of the Mediterranean Forecasting System, while the atmospheric forcings come from the ECMWF data at 0.25° degrees of resolution, with a frequency of 6 hours, provided to INGV by the italian Air Force.The precipitations used in both forecasts and simulations come from the climatological dataset by Legates and Willmott (1990), while all the rivers flows, except for the Po river, come from the climatological dataset by Raicich (1994), to which some corrections have been applied, especially along the eastern coast. For what concerns the Po River, daily means at the section of Pontelagoscuro are considered for the simulations, while the last available datum is persisted for all the daily forecasts.

AC-3B-14: Monitoring the Global Ocean Mesoscale with a Global Ocean Forecasting System at 1/12°

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The new global ocean forecasting system developed at Mercator Ocean will be the reference at the end of the

European MyOcean project. A global ocean and sea ice high resolution model with a horizontal resolution of 1/12° and 50 vertical levels based on the NEMO OGCM and a data assimilation scheme named SAM2v1 (based on the SEEK filter) are the two main components of the global ocean forecasting system. The third important component is the observation data set routinely used both by the data assimilation scheme and by the validation procedures. This multivariate data assimilation system is able to assimilate in real time both in situ and remotely sensed data (SLA, SST) in order to provide the initial conditions required for numerical ocean prediction. Thus, this new global ocean forecasting system offers a new perspective on the global ocean mesoscale monitoring. First results of different simulations will be shown.

AC-3B-15: E-SURFMAR – The EUMETNET Surface Marine Observation Programme

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[5]Puertos del Estado, SPAIN

The Surface Marine observation programme (E-SURFMAR) of the EUMETNET (Conference of European National Meteorological Services) Composite Observing System (EUCOS) started in April 2003. It is an optional programme supported by 17 countries and is managed by Météo-France. The main aim of EUCOS is to improve the quality of numerical weather prediction (NWP) and general forecasts over Europe, for which the most important parameter is surface air pressure over the North Atlantic, the adjacent Arctic Ocean and the European regional seas, which cannot be measured from space. The programme delivers marine observations from Voluntary Observing Ships (VOS) operated by EUMETNET members, drifting and moored buoys. As the priority for E-SURFMAR is to increase the density of in situ air pressure observations, the focus of E-SURFMAR has been on the introduction of Automatic Weather Stations (AWS) on ships alongside a significant increase in the number of drifting buoys deployed. Key issues for the programme are to improve the quality and timeliness of the observations, whilst reducing operating costs, e.g. through the use of Iridium for communications

AC-3B-16: Development of a variational data-assimilative system for the Mid Atlantic Bight

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This poster describes the development of an operational analysis and dynamical/statistical forecast system for mesoscale and sub-mesoscale variability in a coastal transition zone: the Mid Atlantic Bight. The analysis system uses adjoint-based data assimilation techniques to integrate a high-resolution 3-dimensional coastal model (ROMS; the Regional Ocean Modeling System) with data from a coastal observing system comprised of surface current radar (CODAR) installations, autonomous gliders, satellite imagery, moorings, and XBT/CTD acquired during the ONRs Shallow Water Acoustics 2006 (SW06) field program. Comparison with not-assimilated temperature and salinity observations suggest that the regional model has an skill superior to other data-assimilative global models. We attribute the added skill to a bias reduction due to assimilation of climatological information and to the correct projection of the satellite information by the adjoint model.

AC-3B-17: MATROOS, a web-based information system for forecasting services

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Deltares, NETHERLANDS

The Netherlands has started a number of activities to work towards a new generation of web-based information and data systems connected to integrated forecasting systems. The MATROOS system compiles, stores and distributes real-time data for forecasting of various parameters, such as wind, waves and storm surges. It also stores all the model forecasts and provides tools for analysis of previously made forecasts. Within the NOOS network, MATROOS is used for model comparison tasks. The MATROOS architecture is flexible to data providers and the data formats confirm to international standards. On the user side, all data are directly addressable via web-based interfaces and protocols. In the future, MATROOS will form part of the backbone of Dutch forecasting systems, also including water quality and ecological forecasting. As a data achieve system, it will become very valuable for research on ocean properties.

Day 3: Delivering services to society

Session 3C: Hazards, Impacts and Management

AC-3C-01: Assessment of anthropogenic influence on quality of marine environment for the borders seas of Russia

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In order to assess marine environment ecological safety level in the boundary seas of Russia, following characteristics for nature - community system are required: 1. significance of ecological risk for people and biota; 2. scales of ecological damage; 3. expenses of preventive and compensatory measures to achieve permissible ecological risk level. We understand significance of ecological risk (SER) as biological systems mortality (biota and people population). We used an expression permitting to calculate probability of single mortality for population components for SER variability assessment for marine ecosystems in the Okhotsk Sea. It was found that considerable part of aquatorium of the Okhotsk Sea was framed by isoline corresponding to SER, equal to n*10-3 case/year, which exceeds permissible ecological level for population of hydrobionts. Results forecasting negative consequences of oil exploitation for ecosystem of the Okhotsk Sea received experimental confirmation after 10 years, when volumes of fish catch decreased in 2 times. Techno-economical calculations demonstrated that in conditions of the Sakhalin Island mean additional ecological expenses formed of 11% from direct financing on building and exploitation of oil complex. It is necessary for sustainable development of the Sakhalin Island community that such surplus must exceed damage from different phases of projects realization. However calculations demonstrated that significance of damage in 2 times exceeds expected in 2010 year values. Comparison of afore mentioned mean significance for scales of true inner saving (indicator of accumulation speed minus expenses of exhaustion of natural resources and pollution of environment) with GDP for Russia in 2000 year was equal 0,67. Problem for dangerous assimilation from sinking chemical weapon in the Baltic Sea has not solved today due to 2 reasons: 1. modern data on battle poisons in marine environment are absent, but we have indirect indication of its presence; 2. geopolitical factors predominate over scientific knowledge in connection with building underwater tube for gas transportation. We have examined different mechanisms of influence on premature mortality to forecast possible negative consequences of battle poison for human organism. Individual cancerogenic risk of joint influence of all factors after passing cyclone is equal to 1,1*10-2 men/men*year, that is in 104 times more than permissible risk for people population according to EU rules. However our estimations demonstrated that ecological risk from yperite and lewisite discharge was equal to value made up by the Baltic Sea "background" ingredients, like pesticides and heavy metals for example. It is necessary to assure financing of battle poison pollution problem in two times more than EU countries spend on environment protection. Pollution of sulphur and heavy metals of the Barents Sea is determined by mine industrial complexes on the Kolski peninsula increasing concentrations of heavy metals by 2-5 times. Calculation of SER has been made for human population using the information that presence of heavy metals in marine environment is a reason of increase of SER in 10-100 times more than from long-term radioactive elements In 1986 superposition of two accidental discharges of artificial radionuclids to the atmosphere from Chernobyl reactor and from nuclear submarine in Chagma Bay caused rise of individual ecological risk for people in Primorski Krai more than in 60 times in comparison with permissible level influenced by seafood consumption. Hence, we observed that an internal irradiation of local residents was less than two-multiple increase of an external irradiation one in two times.

AC-3C-02: Adaptation of Coastal Communities in the Philippines to Climate Change

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More than half a million small fishers in the Philippines have been availing of loans from Quedancor, the credit arm of the Department of Agriculture. The financing scheme has been quite successful with repayment rate at 95%. However, climate change has brought about more frequent typhoons as well as pests and diseases which have affected the productivity of fisheries, thus, hindering fishers from paying and renewing their loans. Failure to access credit could disable them to continue venturing on fishing activities and could eventually jeopardize the welfare of their entire household. The inability of creditors to pay their loans and meet their obligations also impair, to a large extent, the financial operation and viability of the lending institutions. This study analyzes the adaptation practices of these fishers. It recommends mitigation mechanisms to minimize the impact of climate change. Moreover, it suggests a bridge financing scheme that can be an effective and efficient instrument to enable fishers to carry on their livelihood activities and support their families' basic needs and slowly recover from their losses.

AC-3C-03: Combination of chemical measurements and remote sensing in coastal water monitoring. The case of Eastern Mediterranean

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Coastal zones are important and sensitive ecological systems. They are also significant from an economic point of view as they are used for tourism, fishing, aquaculture and recreation. Unfortunately many times their significance is ignored and they are over exploited or subjected to intense environmental pressures. Large loads of land-based pollutants from industrial, urban and agricultural activities are disposed to coastal areas. Physical, chemical, biological or thermal pollution can cause adverse effects to the marine environment, ecological damages and can even pose dangers for public health.

Remote Sensing techniques have been utilised with various types of sensors and applications in environmental purposes. Their main advantage is the large-scale monitoring of entire basins, which allows taking into account the highly dynamical nature of marine processes. However, only few chemical pollutants are detectable in the marine environment by Remote Sensing techniques and only in high concentrations (usually a short time after their disposal, e.g. in the case of oil spills).

Remote sensing techniques have been used mainly for the measurement of physicochemical parameters that have a direct effect on the optical properties of the examined water body. Therefore phytoplankton pigments, particularly chlorophyll-a, and suspended particulate matter have been measured and thus eutrophication phenomena and river plumes have been monitored from above. Surface seawater temperature is also another parameter widely measured with such techniques over large scale marine areas. In the case of marine pollution remote sensing has only been appropriate and applicable for oil spills. Optical and multispectral sensors using advanced algorithms optimise target reflectance and support quantitative measurements of the above mentioned parameters with relatively coarse resolution and wide fields of view. Hyperspectral data (collected in many and narrow ranges of the visible and infrared wavelengths) allow for greater precision in characterizing target spectral signatures.

However these applications have not been able to lessen the efforts undertaken by marine scientists during in situ monitoring campaigns, because the measured parameters are only a small fraction of those that have to be studied in the marine environment and because the results of Remote Sensing techniques are less accurate than the results of in situ and laboratory measurements. In addition Remote Sensing techniques are limited to surface waters and have possible atmospheric interference and poor spatial resolution for certain applications.

Our focus area, for this review, the eastern Mediterranean is oligotrophic with occurring eutrophication phenomena, there is increased transportation of oil products and accident occurrence, there are river discharges and coastal hot spot areas and there is also the influence from the Black Sea outlet through the Dardanelles and from the Western Mediterranean through the Straits of Sicily. This results in a west to east gradient of decreasing surface chlorophyll-a, that is readily seen from space, with the Eastern Mediterranean Levantine waters exhibiting highly oligotrophic conditions.

The coastal marine environment of the East Mediterranean is affected by economic development, population increase and changing in land use patterns. The existing Remote Sensing results in the area are rather limited. Most remote sensing work has concentrated on pollution from point sources as it is much less problematic and it often contrasts sharply with the surrounding water.

A marine pollution monitoring project that would combine remote sensing techniques with chemical analytical measurements can be an effective tool for the environmental protection and sustainable management in this ecologically sensitive area.

AC-3C-04: Remote sensing and coastal zone management in the EU's less-developed areas: The role of the EFMS

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Coastal zones are vulnerable systems of great environmental and ecological importance. In addition, they play a significant role in the economic development of a region, as they are exploited through tourism, fishing, aquaculture and recreation. The necessity for sustainable development of such areas is fully acknowledged by the European Union and described in environmental strategies; a lot of EU directives now incorporate the necessary legal commitments of member states in relation to the protection of the coastal zone.

Nevertheless, many coastal areas, especially in the EU's less-developed areas are usually inadequately managed and subjected to various anthropogenic pressures through agricultural, urban and industrial activities. Huge amounts of land-based pollutants are disposed in and around coastal areas, both directly and indirectly affecting the marine environment and leading to ecosystem disruption and public health concerns. These problems are further enhanced in many cases by a communication gap between environmental scientists, decision-makers and local communities, causing a considerable impediment in any environmental management.

In the past few years, there has been an increase in research related to ocean observing systems, resulting in considerable advances in Operational Oceanography. There has also been an increase in all disciplines of coastal marine research. The establishment and use of oceanographic databases of various kinds is an important asset in the amalgamation of remote sensing and "on the spot" marine research, leading to the development of effective management schemes.

However, the use and support of these scientific tools, techniques and processes is insufficient in many EU coastal regions. If the incentive for local communities and the training of new scientists is provided, this can effectively contribute to the sustainable management of the coast.

In the effort to promote this course of action, the role of scientific organisations is absolutely essential. The EFMS (European Federation of Marine Science and Technology Societies) is already engaged in an attempt towards this objective, aiming to make the most of new scientists and effectively encourage all interested parties towards sustainable coastal zone management. The EFMS consists of 14 non-governmental associations from 10 different countries that specialize in research and education pertaining to the marine environment. Its objectives are to contribute to the advancement of and disseminate information regarding research and education in marine science and technology in Europe. Members of the federation have carried out various European programmes and participated in numerous conferences, workshops and EU policy consultations related to the coastal zone. It is also currently involved in the identification of the State of Marine Research in Europe through a questionnaire on its website (www.efmsts.org). The existing priorities of the EFMS lie with the Mediterranean and especially the Eastern Mediterranean, as it is one of the EU's less-developed areas yet environmentally significant.

AC-3C-05: Sediment transport on the Palos Verdes shelf, California

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Sediment transport and the potential for erosion or deposition have been investigated on the southern California shelf using a one-dimensional (vertical) model of hydrodynamics and suspended-sediment transport, to help assess the fate of an effluent-affected deposit contaminated with DDT and PCBs. Bottom boundary layer measurements at one site were used to calibrate a model of local, steady-state flow and suspended-sediment transport (Wiberg et al., 1994, Continental Shelf Research 14:1191-1219). The model was run with waves estimated from a nearby buoy and currents from up to six years of measurements made on the Palos Verdes (PV) and San Pedro (SP) shelves by the Los Angeles County Sanitation District. Sediment characteristics were based on gentle wet-sieve analysis and erodibility on erosion-chamber measurements. Modeled flow and sediment transport were mostly alongshelf toward the northwest on the PV shelf with a small off-shelf component. Bottom shear stresses at 65 m were greatest (95th percentile was 0.09 Pa) at the northwest and southeast ends of the PV shelf and smallest (0.07 Pa) in the middle of the shelf near the Whites Point sewage outfalls where the effluent-affected deposit is thickest. Transport rates increased from 1.7 T m^{-1} yr^{-1} at the southeast end of the PV shelf to 15.9 T m^{-1} yr^{-1} at the northwest end because of increases in sediment erodibility and stronger mean flow. Decreases in particle emissions from the Whites Point outfalls and stabilization of the Portuguese Bend landslide, which contributes sediment to the nearby nearshore region, have reduced the supply of sediments to the effluent-affected deposit. The alongshore gradients in modeled transport rates suggest that, in the absence of a supply of sediment from these sources, the effluent-affected deposit would slowly erode at rates ranging from 0.2 to 1.3 mm yr^{-1}. Profiles of DDT taken every two years indicate that the regions northwest of the outfalls have been depositional for the last decade, which suggests that the supply of sediment from the outfalls and the PV coast has more than offset modeled gradients in alongshelf transport. However, model results indicate that erosion is most likely to occur on the southwest margin of the effluent-affected deposit as input from these sediment sources decreases.

AC-3C-06: Coupling 3-D models of ocean physics and biogeochemistry to fish population dynamics for operational monitoring of marine living resources

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Marine ecosystems presently suffer from the combined effects of climate change and direct anthropogenic pressure (fisheries, pollution). Understanding, modelling, and ultimately predicting how populations of marine animals respond to these perturbations is crucial for the development of sound management strategies for marine ecosystems.

If models of ocean physics and biogeochemistry are now well developed and widely used, this is still far for being the case with models of the mid- and upper-trophic levels of marine ecosystems. In this poster we will present the bases for such models and their coupling with 3-D ocean models. We will show some important achievements but also highlight limitations. Examples of the interest of such models for the management of heavily-fished tuna populations will be presented.

We will finally demonstrate that progress in this field is presently seriously slowed down by the lack of important data. This calls for the development of a large-scale observation system for mid-trophic levels, improved real time monitoring of fishing fleets and further development of electronic tagging of individuals to support habitat studies and behaviour modelling.

AC-3C-07: A U.S. Integrated Ocean Observing System (IOOS): Operational Directional Wave Observation System

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The deployment of a worldwide Ocean Observing System is one goal within the three central science and technology elements of the Ocean Research Priority Plan issued by the Joint Subcommittee on Ocean and Science and Technology in January 2007. Since the U.S. Integrated Ocean Observing System (IOOS®) identified ocean surface waves as one of the most important ocean variables to be observed in real-time, this document presents a U.S. national operational plan for observing wind-generated surface gravity waves.

Surface gravity waves (whose wave frequencies range from 1.0 to 0.033 Hz) entering and crossing the nation's waters, have a profound impact on navigation, offshore operations, recreation, safety, and the economic vitality of the nation's maritime and coastal communities. Although waves are a critical oceanographic variable and measurement assets exist, there are roughly 200 observation sites (about one-half estimate directional waves) around the U.S. leaving significant gaps in coverage. Existing locations were determined based on local weather forecast office requirements, resulting in a useful, but ad hoc wave network with limited integration of the observations into user products. The proposed system will increase the wave observation spatial coverage along and across the US coasts to about 300 sites (upgrading approximately 130 existing platforms to directional capabilities); and will serve a large and increasing user community. The design will complement existing and future remote sensing programs (land and satellite based systems). This effort will also coordinate with and leverage related international efforts, such as the Global Earth Observing System of Systems (GEOSS).

The overriding goal of this National Wave Measurement Plan is to provide the US with a seamless coverage along and offshore system of consistent directional wave measurements comprised by a level of accuracy that will serve the requirements of the broadest range of IOOS® wave information users. To achieve this goal requires that the observations satisfy a First-5 standard. Setting the standard to a First-5 level will directly lead to improved estimates in height, period, direction, and provide better information to all users of wave information. First-5 refers to 5 Fourier coefficients defining variables at the entire range of energy carrying frequencies. The first variable is the wave energy, related to the wave height, and the other four are the first four coefficients of the Fourier series that defines the directional distribution of that energy.

The plan identifies existing wave observation assets, presents a comprehensive system design and then makes specific recommendations to (1) upgrade existing sensors; (2) add additional observations in critical "gap" locations; (3) implement a continuous technology testing and evaluation program; (4) support the Quality Assurance / Quality Control (QA/QC) and data integration of wave observations from a large number of IOOS operators; (5) support the operation and maintenance requirements of the system; (6) include the training and education of IOOS wave operators; and (7) promote the development of new sensors and measurement techniques.

The design of the network is based on establishing four along-coast observational subnets. These include:

- Offshore Subnet: deep ocean outpost stations that observe approaching waves, prior to their passage into coastal boundary currents;
- Outer-Shelf Subnet: an array of stations along the deepwater edge of the continental shelf-break where waves begin to transition from deep to shallow water behavior;
- Inner-Shelf Subnet: on wide continental shelves (notably the Atlantic and Gulf of Mexico coasts), an array of shallow water stations to monitor cross-shelf bottom dissipation and wind generation of waves;
- Coastal Subnet: shallow coastal wave observations, which provide local, site-specific information.

This national waves plan is presented to the OceanObs'09 audience to demonstrate that the ideas and techniques discussed in the plan can be broadened to an international observation surface gravity wave network.

AC-3C-08: Marine invasive species and their potential impacts

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The introduction of invasive marine species into new environments by ships' ballast water, ships' hulls and other means has been identified as one of the four greatest threats to the biodiversity of the world's oceans. The other three are land-based sources of marine pollution, over-exploitation of living marine resources and physical alteration/destruction of marine habitat. In this study, an attempt was made to analyze the present status of problems of invasive marine species in Kuwait waters and to relate this to global context. Most countries are being affected by the adverse impact of the invasive marine species. Developed countries are most affected and are responding to this crisis by introducing national legislations, adopting new technologies and researching into the subject. International organizations are responsibly playing their part by planning to impose effective legislation to prevent international spread of invasive marine species. Numerous research projects are underway to identify the alien species in particular areas, to determine their potential impacts, and to discover effective ballast water treatment technologies. Studies reveal that so far no detailed research has been done in Kuwait to ascertain or

understand the status of alien species in its waters. Officially only, nine invasive species were found according to the Global Invasive species Database two are aquatic species Oreochromis aureus (fish) and Acanthophora spicifera (algae). There is currently, no regulation on the discharge of ballast water or to prevent the introduction of alien species into ¡Kuwaiti waters. There is thus a need to establish some regulations to prevent the introduction of alien marine species. However, local baseline information on the native marine species is inadequate and extensive research work is required. To further evaluate the impacts of alien marine species, more appropriate research is necessary

AC-3C-09: Testing a Coastal GPS Network for a Global Tsunami Warning System

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Instantaneous GPS receivers can measure ground motions in real time as often as once every few seconds. Recently, we have found that coastal GPS stations are able to detect continental slope displacements of faulting due to large earthquakes and the GPS-detected displacements are able to estimate the disturbed oceanic energy and tsunami scales within a few minutes after the quake [Song, 2007, GRL]. This innovative method has successfully replicated several historical tsunamis - caused by the 2004 Sumatra earthquake, the 2005 Nias Islands earthquake, and the 1964 Alaska earthquake. These preliminary results suggest that a global tsunami warning system can be established based on a coastal GPS network for saving lives and reducing false alarms. This project has the following objectives:

1. To demonstrate the prototype of a coastal GPS network for a global tsunami warning system;

2. To test GPS capabilities for replicating historical earthquake tsunamis and feasibility for detecting tsunami scales with required accuracy;

3. To improve the robustness a coupled earthquake-tsunami prediction system with using the GPS displacement measurements.

This presentation will report the current progress and future activities

AC-3C-10: Developing the Hawaii and Pacific Islands Ocean Observing Systems

Ostrander, Chris E.; Taylor, B.; Au, W.; Brooks, B.; DeCarlo, E.; Flament, P.; Fletcher, C.; Grabowski, M.; Haws, M.; Holland, K.; Lukas, R.; Luther, D.; Okimoto, D.; Pawlak, G.; Potemra, J.; Powell, B.; Shor, A.; Steward, G.
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The Hawaii Ocean Observing System (HiOOS)

HiOOS is a coordinated effort among numerous researchers at the University of Hawaii School of Ocean and Earth Science and Technology (SOEST) as well as other federal, state, and county agencies, non-profit organizations, and private companies to develop capabilities for collecting and serving oceanographic data from the Hawaiian coastal waters. Instrument development, deployment, and data collection are initially focused on the southern shore of O‘ahu and center on four main catalyst projects—areas of focus identified through workshops, conferences, and scoping meetings as high-priority to the large group of ocean information stakeholders. These projects, which support one another to enhance community capabilities and are prototypes of future regional development plans, consist of: (1) coastal ocean-state measurements and forecasting; (2) coastal hazards mitigation; (3) automated water quality sensing; and (4) marine ecosystem stewardship and monitoring. Each of the focus areas to the HiOOS depends upon a wide array of technology to produce very distinct product suites.

Coastal Ocean-State Measurements and Forecasting

Investigators are utilizing an array of high frequency Doppler radios along with AUVs and gliders, current meters, drifters, wave buoys, and coastal cameras. The HiOOS group integrates data from these sources into atmospheric (WRF, MM5), wave (WWIII, SWAN), and ocean circulation (HYCOM) models. Once coupled, the aggregate data can be used to monitor, model, and predict channel and nearshore circulation, waves, coastal run-up, and water levels. Efforts are underway to allow observations and model output to feed into a dynamic, web-based coastal ocean atlas providing interpretive products such as most efficient inter-island shipping lanes, hazardous conditions at beaches and in harbors, pollutant dispersion, and high water levels in vulnerable communities.

Assessment and Imaging of Coastal Hazards

The coastal hazards component of the observing system uses imaging technologies to track changes in coastal elevation and shape, and document the effects of incoming swell and high water levels on coastal beaches. By coupling LiDAR, digital still and video images, GPS, coastal erosion history, and digital elevation models (DEM) the investigators are able to determine the rates of change and shapes of shorelines, identify areas of frequent high-water level inundation, and provide more accurate predictions of the frequency and extent of coastal inundation and the potential effects of sea-level rise on the Hawaiian Islands.

Coastal Water Quality Sensing

Through an array of moorings, cabled observing assets, shipboard surveys, and autonomous underwater vehicle (AUV) surveys, the coastal water quality component of HiOOS actively monitors parameters related to coastal water quality including: currents, temperature, salinity, chlorophyll a, dissolved oxygen, carbon dioxide, turbidity, and fluorescence. These data are used to provide early warning of potentially polluted runoff and/or sewage spills in real-time. These data will be coupled with coastal circulation models to predict which coastal areas are most likely affected by poor water quality. Additionally, water quality instrumentation is being deployed through the Pacific in collaboration with PacIOOS member states in an effort to build capacity throughout the region and address coastal environmental management concerns.

Monitoring of the Marine Ecosystem

The movement patterns of cetaceans and top predators are being tracked by a network of autonomous acoustic receivers and recorders deployed in the coastal and offshore waters around O‘ahu. Tuna, marlin, sharks, and other animals that have been tagged with active acoustic transmitters can be located and identified as they pass receivers, while ecological acoustic recorders record the sound of marine life (whales and dolphins, snapping shrimp, fishes) and vessel traffic. These acoustic arrays allow researchers to better link animal behavior within the ecosystem to physical and biogeochemical processes as well as monitor the activity of marine animals and humans in protected areas of the ocean.

Data Management

Crucial to the success of HiOOS is effective management of the data generated by the extensive suite of instrumentation. The integration of diverse and unique datasets collected throughout the state is accomplished through a unique data architecture that responds to the requests of the user and seamlessly marries relevant data streams to produce both conjoined datasets as well as user-defined products. Full data system development is currently in progress and is expected to be completed within the coming year---allowing the Hawai‘i Ocean Observing System to begin operational delivery of timely and relevant data, information, and products to the residents of Hawai‘i and the broader Pacific Islands region.

Pacific Islands Ocean Observing System (PacIOOS)

The efforts of the HiOOS program also serve as the pilot project for the larger PacIOOS program currently being developed by researchers at SOEST, the University of Hawaii at Hilo, and institutions through the insular Pacific region. PacIOOS is one of 11 regional associations (RAs) comprising the United States Integrated Ocean Observing System (IOOS) initiative and is focused on the US interests in the insular Pacific region, namely the State of Hawaii, the Territories of Guam and American Samoa, the Commonwealth of the Northern Mariana Islands, and the freely-associated states of Micronesia, the Marshall Islands, and Palau.

With funding from the National Oceanic and Atmospheric Administration of the United States (NOAA), SOEST and its partners are in the process of conducting initial PacIOOS development activities focused on the following objectives:

- Identify and engage stakeholders at federal, state, and local levels throughout all islands in the region to evaluate the need for and design of ocean observing information products and services;
- Establish a governance structure and business plan with appropriate program oversight, coordination, and implementation mechanisms for the Hawai‘i sub-region of PacIOOS in conjunction with the PacIOOS pilot project (HiOOS);
- Demonstrate the value and viability of sustained ocean observations in the Pacific Islands region through the creation of a complete observing system off the southern shore of O‘ahu, Hawai‘i (HiOOS).
- Build ocean observing capacity throughout the region by deploying instrumentation, providing training, and disseminating data and products to relevant resource managers and other stakeholder groups.

Day 4: Developing technology and infrastructure

Session 4A: In situ

AC-4A-01: Quality Assessment of In-situ and Altimeter Measurements Through SSH Comparisons

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Altimetry missions provide accurate measurements of sea surface height (SSH) from 1992 onwards with TOPEX/Poseidon (T/P), and until now thanks to Jason-1, Envisat and more recently Jason-2. A global assessment of these data is systematically performed in order to detect potential anomalies and estimate system performances. In addition, cross-calibration between each altimeter mission is carried out to thoroughly analyse SSH bias, and potential drifts or jumps in the global Mean Sea Level (MSL). In order to complete this assessment, in-situ measurements are also used as independent sources of comparison. In this way, tide gauge networks (GLOSS/CLIVAR, SONEL, BODC and OPPE) as well as Dynamic Height Anomalies from T/S profiles (provided by ARGO) have been compared to altimeter data. In this study, we present the main results obtained from these comparisons (for T/P, Jason-1, Jason-2 and Envisat) through the 3 following objectives linked together. The first one consists in detecting drifts or jumps in altimeter SSH by comparison with in-situ measurements. The second goal is the analysis of the SSH consistency improvement between altimeter and in-situ data using new altimeter standards (orbit, geophysical corrections, ground processing...). The last objective is the detection of anomalies on in-situ time series thanks to the cross-comparison with all available altimeter data. In-situ measurements can thus be corrected or even removed in order to further improve the SSH comparison with altimeters.

AC-4A-02: An application to integrate bathymetric and other dataset to study gas hydrates reservoir.

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We show an application of geographical information system for integrating bathymetric and other dataset to study gas hydrates reservoir along the South Shetland Margin (Antarctic Peninsula). The main goal of this project was to map the regional distribution of gas hydrates reservoir. In this area, an integrated approach has pointed out the presence of gas hydrates reservoir. The available geophysical information are the following: Multibeam data, seismic images, 2D and 3D velocity and porosity models, 2D and 3D gas phase concentrations, pore pressure information, chirp images, gravity core analysis and CTD data. The first step consisted in collecting and homogenizing the data, which has been organized in a specific database, in order to connect all scientific information acquired in the area. This integrated approach has allowed us to obtained regional information, such as geothermal gradient, by correlating all available data and obtaining 3D information distribution.

AC-4A-03: Operational Observatory of the Catalan Sea (OOCS)

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1. Presentation.

The Operational Observatory of the Catalan Sea (OOCS) is maintained by the Group on Operational Marine Sciences and Sustainability (CMOS) taking advantage of the facilities available at the CEAB with regard to the capacity for observing the marine and coastal environment in the Catalan Sea and beyond, assessing and modelling the hydrodynamic and biogeochemical processes of the region. The observatory started in January 2009 as a Spanish National Project (OAMMS) and is expected to be fully operational in 2011. Much of the work that should integrate the observatory is already done in the framework of research projects (ENVIST CAL/VAL). A Quality Control Program will be developed and implemented.

2. Components.

Multiparametric oceanographic buoy. The buoy system is being tested at CEAB's facilities. Pre-deployment on a shallow nearshore mooring site is planned to take place in April 2009 and final deployment is expected for September 2009. Data are collected continuously and averaged over 30 minute periods before they are transmitted to the base in the CEAB. The buoy system was operated in a pilot study for three months back in 2005 with relatively satisfactory results. Much of the instrumentation is available and a factory calibration is in progress.

Complementary sampling and infrastructure maintenance. Fortnightly CTD/Niskin casts started in March 2009 on board the CEAB's vessel DOLORES. The vessel will be equipped with an autonomous rosette water sampler control and data acquisition. Six-monthly visits from the R/V GARCIA DEL CID will be performed at the mooring site and at a grid covering parts of the Catalan Sea. On-deck inspection and maintenance of the instrumentation will be carried out.

Real-time modelling and forecast. Two models available and implemented by Group members, 1DV Model and 3D coupled hydrodynamic-biogeochemical model for NW Mediterranean Sea, will be adjusted to assimilate data obtained from the observing system as well as from remote sensing to produce real time operational forecast.

Historical data. Oceanographic cruises performed by the team in last decades in the study area providing historical information of hydrographical and biogeochemical conditions in the area will be accessible on-line.

3. Outreach and potential contribution to the global system.

The observatory, through its web page, will disseminate results and data sets and will also advertise the willingness of the scientists in the CEAB to lecture in colleges, high schools and other communities which might be interested in knowing first hand the experiences of the day-to-day work.

Once the system will be consolidated it is expected to become an observatory providing services for local and regional meteo-marine climate change projections. The OOCS is currently a part of the consortium MOON: Mediterranean Operational Oceanography Network. The success in contributing to the global system will much depend on setting a solid system providing high-quality data and predictions and on funds available after 2011.

AC-4A-04: In Situ Mass Spectrometry for Chemical Measurements in the Water Column and on the Sea Floor

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Among the techniques used in modern elemental and molecular analysis, none surpasses mass spectrometry (MS) in analytical access to elements, isotopes (stable and radioactive), and complex molecules (including natural and anthropogenic organics). Interest in the development of MS as an in situ analytical technique is a consequence of the demonstrated versatility, sensitivity, and reliability of MS characterizations. As an in situ technique, MS provides a means of simultaneously monitoring many types of chemicals with high temporal and spatial resolution.

SRI International and the University of South Florida have developed underwater membrane introduction mass spectrometry (MIMS) systems capable of in situ detection and quantification of dissolved gases and volatile organic compounds (VOCs). The instruments are based on a 200 amu (atomic mass unit) linear quadrupole mass analyzer with a closed ion source (Transpector CPM-200 Residual Gas Analyzer, Inficon, Inc., Syracuse, New York). Introduction of analytes into the mass spectrometer occurs through a high-pressure polydimethlyl siloxane membrane introduction system that has been tested at pressures equivalent to oceanic depths of ¡Ü 2000 meters. The membrane interface used in these systems provides parts-per-billion level detection of many VOCs and sub parts-per-million detection limits for many dissolved light stable gases.

The underwater MIMS systems have been deployed on a wide variety of platforms for a number of applications in coastal oceanographic, estuarine, and freshwater research. Types of deployments include shallow-water monitoring for pollutants (VOCs) in tethered/moored scenarios, as well as onboard autonomous and remotely controlled unmanned vehicles. By recording the position of the vehicle/MS system using global positioning system or ultra-short baseline navigation technology, and time matching to concurrent MS data, we have demonstrated that chemical maps can be created to show spatial chemical concentration variations with unprecedented resolution. The underwater MIMS systems have also been used in vertical profile studies of dissolved gases to approximately 900 m depths. Methods to calibrate for effects of hydrostatic pressure at depth have been devised to provide in situ dissolved gas concentrations.

More recently, a sediment probe and syringe pump system has been developed to provide additional in situ analytical capability. The syringe pump system provides a very constant sample flow rate over a wide range of sampling speeds, and allows the introduction of reagents to convert non-volatile analytes to volatile species that can be detected by the underwater MIMS system. For example, dissolved inorganic carbon can be converted to gaseous carbon dioxide in order to quantify total carbon in aqueous environments. The sediment probe can be programmed to sample pore water at various depths in the sediment to measure vertical gradients of dissolved gases. Future goals include development of an in situ mass spectrometer capable of long-duration deployment, further miniaturization of MS systems, and development of new sampling interfaces. Several innovations and improvements relative to current underwater MS technology are required to meet these goals. Providing the capability to make stable measurements over periods of weeks to many months (with in situ recalibration or minimal drift from calibration) will immensely expand the utility of in situ mass spectrometry technology for ocean observing applications.

AC-4A-05: Deep ocean observing system over middle and long time scale: the E2M3A site in the Southern Adriatic

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The open-ocean convection has been considered the engine of the global conveyor belt. It is a mechanism forming new dense and oxygenated waters, and it riggers the solubility and the biological pump. Among the few zones in the world interested by the open-ocean convection, the South Adriatic is a small but key area for the intermediate and deep thermohaline cell of the Eastern Mediterranean. There, the Adriatic Dense Water ADW formed prevailing by the open-ocean vertical convection , becomes the main component of the Eastern Mediterranean Deep Water (EMDW). This process takes place in the South Adriatic Pit (SAP) in the centre of the cyclonic gyre. The extension of the vertical mixing, varies on the interannual and decadal time-scales in function of the air-sea heat fluxes and the pre-conditioning vertical density structure.

The high spatio-temporal variability of the deep convection and its interaction with other processes makes difficult it study. Oceanographic cruises provide a good spatial coverage but lack in temporal resolution. The need of high temporal sampling to resolve events and rapid processes and the long sustained measurement of multiple interrelated variables from sea surface to seafloor can be solve by the use of moorings located in specific areas as the Southern Adriatic Pit.

In the framework of the Italian VECTOR project a deep-sea mooring (41°29.7'N, 17°42.1'E) containing CT sensors at five depths, an upward looking 150 kHz ADCP and an Aanderaa current meter RCM11 was located in the vertical convection area. Moreover, two sediment traps were positioned at 168 m and 1174 m on the mooring line. This mooring configuration permits to individuate water mass formation, measuring simultaneously physical and chemical parameters. The mooring is still in the water and new upgrades will be done in the framework of the European project EuroSITES during 2009. The deployment of pCO2 sensor together with a pH sensor within the mixed layer will allow to estimate the Carbon system at the site. The deployment of a surface buoy will allow the real data transfer from the platform to the land station.

Here, data recorded in the period between end-November 2006 and October 2008 covering two consecutive year with pre-conditioning and deep convection periods will be presented . Surface chlorophyll a obtained from the SeaWiFS data is a good indicator of the vertical mixing patch as demonstrated earlier, and here it has been used in determining the patch position with respect to the mooring location and its geometry.

AC-4A-06: An operational In Situ Ichthyoplankton Imaging System (ISIIS)

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One driving factor improving the resolution of oceanographic sampling has been the observation of fine structure in the ocean. As oceanographers improve their sample resolution, the finer patterns that are discovered lead to a better understanding (and new questions) about dynamic processes in the ocean. To date, current technologies available for the study of many zooplankters remain limited in comparison to the spatial-temporal resolution and data acquisition rate available for physical oceanographic measurements, especially for the relatively rare meso-zooplankton. To overcome these challenges, we have built a towed, very high resolution digital imaging system capable of sampling water volumes sufficient for accurate quantification of meso-zooplankton *in situ*. The images are high quality, enabling clear identification of meso-zooplankters (e.g. larvaceans, gelatinous zooplankters, chaetognaths, larval fish), often to family or genus level. However, the efforts directed toward high speed and high-resolution imaging have the potential to create a bottleneck in data analysis. To address this problem we also have developed efficient algorithms detect multiple regions (organisms) of

interest (ROI) automatically, while filtering out noise and out-of-focus organisms, and simultaneously classify the detected organisms into pre-defined categories using shape and texture information. Here we demonstrate the current design, image quality, image analysis approach and example data analyses as an overview of the system capabilities.

AC-4A-07: Monitoring Sea Surface Salinity in the Global Ocean from Ships of Opportunity: The French SSS Observation Service

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Sea Surface Salinity (SSS) observations are needed to improve our understanding of the earth's water cycle and climate variability. SSS has proven to be valuable for describing and understanding climate variability at seasonal to decadal time scales, improving estimates of long-term trends in the context of climate change, testing physical processes, assessing numerical model performances, quantifying the relative role of salinity on sea level change, improving El Nino prediction lead time, etc.. The importance of SSS in the climate system has further motivated the development by European and USA/Argentina space agencies of dedicated satellite missions (SMOS and Aquarius) which will enhance global observations.

As an additional contribution to Community White Papers dealing with in situ and/or future satellite-derived SSS measurements, this poster aims at presenting the French SSS Observation Service (http://www.legos.obs-mip.fr/observations/sss/). This Observation Service is a nationally certified 'Observatory for Research in Environment' since 2002, and it represents the main contribution to the international Global Ocean Surface Underway Data (GOSUD; http://www.gosud.org) program. It aims at collecting, validating, archiving and distributing in situ SSS measurements derived from thermosalinographs installed on Voluntary Observing Ships, for climate research and operational ocenanography. Details will be given about technical issues, instruments and softwares used, management of real time data transmission, validation processes for both real time and delayed mode data, with a special focus on derived products, climatic indices and recent scientific results.

AC-4A-08: Autonomous Platforms for Studies in the Coastal Zone

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Global climate-change programs have been driven by the need to understand the nature and variability of open ocean processes and the role they play in climate change. Blue water research has benefited from the emergence of low power sensors, advances in electronics and software techniques, high speed RF, and satellite communications all of which have spawned well proven technological tools – Argo profiling floats, moored and drifting buoys, ship based profiling instrument packages, and of more recent vintage ; gliders, AUVS, and ASVS. However, use of this technology comes with a price as it is expensive and only a few developed countries can afford it with the resources at their disposal. The coastal zone is prone to a diverse array of natural hazards caused by storm surges, sea level rise from global warming, floods and anthropogenic effects of pollution from sewage and waste disposal, sand& gravel extraction, river run-off, and hypoxic zones cause by eutrophication. The scientific challenges here are in separating out man made effects from natural variability of coastal processes. There has been a growing interest from both developed and developing countries in monitoring and understanding the coastal environment. However, the technological tools of blue water research are designed for deep water operations – for example , it would be difficult to use profiling floats or gliders in typical shallow depths of 50m to 100m. Ocean Colour satellites generate large scale images of the open ocean, but produce unreliable data in near shore areas and estuaries due to uncertainties in atmospheric corrections and geo-location coordinates. Thus, there is a lack of appropriate low cost technology tools that could be used to monitor and understand coastal processes.

In this poster, we present the development of an Autonomous Vertical Profiler (AVP) as an example of an automated platform that is being used to obtain high resolution vertical structure of shallow coastal zone waters. It belongs to the class of propelled robot vehicles that traverse the water column rapidly while sensing and storing the vertical structure of water column properties. The concept of a thruster driven profiler was first described in US Patent 6,786,087 (2005). The AVP can be programmed to descend at variable speeds to a given depth set by the user. It ramps down the motor thrust, reaching zero velocity at a desired depth layer above the sea bed. Being lightly buoyant for safety purposes, it ascends relatively slowly to the sea surface without power. In order to locate the profiler after it breaks surface, the AVP transmits its GPS (Global Positioning System) coordinates via RF or through a satellite modem. Low frequency acoustic pingers are additional safety devices that can strapped on the hull.

What are the principal advantages of the AVP ?

1. The motion of the AVP is decoupled from the ship/ boat from which it is launched so that external perturbations of the platform are nullified. A thin fishing line with near zero drag attached to the AVP hull is used as safety precaution in case of any problem.

2. The AVP accommodates sensors of Chlorophyll, backscattering, Dissolved Oxygen, and CTD in its nose cone. These sensors are sampled concurrently at a high rate.

3. Data profiles are transmitted via high speed RF link to the GUI of the shore/ship user after it resurfaces.

4. The AVP software uses an echo-sounder and pressure sensor mounted on its nose cone to ensure a vey low probability of crashing into the seabed.

5. Repetitive dives offer adequate statistics on the profile shape variability, if any, with error bars on each measured variable.

6. In a worst case scenario, the profiler can do 24 dives/day to a depth of 100m. More dives/day are possible at shallower coastal depths e.g 36 dives to 50m, 60 dives to 30m, 90 dives to 15m.

7. The control system on the AVP invests it with the capability of hovering at any set depth so that time series of a feature can be studied in detail. In addition, time series of vertical profiles every 5 mins for 8 hours has been possible.

8. The AVP can morph into an autonomous profiling drifter in the coastal and open ocean waters by reporting its coordinates periodically via an Iridium satellite modem.

Another example of an autonomous platform for coastal monitoring is the Autonomous Surface Vehicle (ASV) which provides spatial data of surface coastal waters. The incorporation of a simple heading controller and smart path following navigational algorithms makes it possible to execute lawn mower missions in coastal areas. The data from these platforms can be processed to generate 2D surface maps of chlorophyll and temperature which if combined with AVP profiles provides the means to understand coastal processes in more detail. Our aim here is to propose and recommend appropriate technology that would benefit the world wide community of marine scientists in developing countries who may need to build capacity in learning about their own near shore areas.

AC-4A-09: Optimization of a Membrane Based NDIR-sensor for Dissolved CO2

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The autonomous measurement of dissolved carbon dioxide (CO2) is without doubt of great and still increasing scientific importance. As one of the parameters of the marine CO2 system its long-term measurement is crucial for the understanding and monitoring of many biogeochemical processes in the ocean. Due to the rising atmospheric CO2 concentrations with its impact on world's climate and the resulting ocean acidification the measurement of aqueous CO2 extends its importance towards social and by the issue of sequestration even to economical aspects. There is thus a need for reliable, fast and easy-to-use instrumentation to measure the partial pressure of dissolved CO2 (pCO2) in situ. However, there are only few autonomous underwater sensors available.

The poster presents the measuring principle as well as the latest development state of a commercial sensor (HydroC™/CO2, CONTROS Systems & Solutions GmbH, Kiel), which is optimized in a collaboration of the IFM-GEOMAR together with the manufacturer. The sensor's design and size lend itself to autonomous long-term measurements on e.g. floats, which mark one of the development goals. A hydrophobic membrane acts as a gas permeable phase boundary between the water and the inner gas circuit of the sensor. The circulating air inside the instrument is continuously passing through a non-dispersive infrared detector (NDIR-detector), in which the CO2 concentration is determined on the principle absorption spectrometry.

Along with a description of the optimization methodology comprising membrane investigations and optimization of the optical unit as well as the internal overall design, the poster shows results of laboratory experiments carried out with the latest sensor model. It features a total of 6 additional sensors for the measurement of temperature, humidity and pressure at different positions within the gas circuit and an extra temperature probe for sea water. These sensors are both, essential for proper pCO2 measurements and necessary to understand the processes happening in the instrument during the time of long deployment. An adjustable zero-point calibration allows for in situ performance tests of the sensor. Data of a first intercomparison exercise with participation of a predecessor model are presented as well.

AC-4A-10: Ubatuba Long-term of Plankton and Biooptical Time Series-UPBITS

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Historically, people have depended on access to coastal waters for trade and transport and access to fresh water for their living requirements; this has resulted in the establishment of major population centers along the shores of estuaries and coastal seas. In the Brazil today, over two-thirds of the population lives within 50 km of the coasts. This population, with its necessary energy generating facilities, industries and waste-treatment plants has created a significant burden on coastal zones.

Ubatuba inner shelf is under the influence of a cyclonic meandering at a region of diverging bathymetry, which promotes a crosscurrent transfer of Slope Water throughout the continental shelf. Indeed, this region is under a strong influence of South Atlantic Central Water (SACW) remotely forced from the Cabo Frio upwelling core or under a mild intrusion of SACW revealed by locally upwelled water during summer. A colder, less saline and relatively nutrient rich surface water, to the south of Brazil, is observed during winter advecting northward along the continental shelf. The horizontal spreading and mixing of this water with the Brazilian Current (BC), is another mechanism determining mesoscale patchness of phytoplanton biomass and primary production.

UPBITS - main goal is to distinguish variance due to natural variability from variance due to eventual external perturbations (anthropogenic effects). Since December 2004 we have been sampling monthly CTD, particulate matter, chlorophyll a, CDOM, primary production, dissolved oxygen, upwelling radiance, downwelling radiance, fluorescence, PAR light field, phytoplankton, zooplankton, secondary production, sediment chlorophyll, sediment bacteria, sediment lipids,benthic macrofauna (IOUSP). Also a satellite data base has been processed (INPE) which can be used to validate and improve the algorithms used to retrieve oceanographic information by remote sensing, such as; VSR - Visible Spectral Reflectance - (or ocean color), developing algorithms for remote sensing of Case II waters and identifying residuals problems, SST - Sea Surface Temperature, and wind field. UPBITS is part of the ANTARES network (www.antares.ws) which program involves the integration of continental-scale images with knowledge gained from both in situ time series and global-scale studies. Statistical Analysis in order to test seasonal differences between years, cross correlations, periodicities and power spectra has been started in a exploratory way taking into account the low degree of freedom available (n=52).

AC-4A-11: Electrochemical methods for autonomous chemical monitoring in marine environments

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Monitoring the biogeochemical response of oceanic systems to environmental change is a key issue in understanding the vulnerability and resilience of marine ecosystems. Long time series of observations are particularly needed to address the links between biological and chemical processes in anthropogenically-disturbed environments and to study feedback mechanisms linked to climate change. Observations are also crucially needed in poorly explored deep sea environments (hydrothermal vents, cold seeps) to document the extreme natural chemical instabilities and improve our understanding of these amazing systems. The oceans play a crucial role in the sustainable future of humankind. They provide essential natural resources such as food, minerals, offshore energy and a route for global transport of goods and resources. However, the immensity of the oceans remains largely undersampled in both space and time. The oceans are opaque to electromagnetic radiation, which precludes the use of remote sensing beyond the surface. Water sampling is sparse, costly (~15-40 keuros ship/day), and prone to contamination. In situ sensors are the only solutions to this

chronic undersampling. Physical sensors are now reaching a mature stage in development and use, due to many decades of research and testing. In contrast, biogeochemical sensors are in their infancy and are dominated by large macro, expensive, one-off devices requiring expert operation and maintenance. New strategies involve deployment of autonomous observatories. Thus this long term monitoring in marine environments requires an in situ miniaturized autonomous instrumentation able to achieve excellent figures of merit: lifetime, high precision, low detection limit, fast response time, good reproducibility, robustness, reliability, resistance to biofouling and high pressure, able of stable long-term operation, and low energy consumption. Real time transmission of collected data should be integrated and optimized. Sensors and analysers based on wet chemistry and electrochemistry techniques exist for a limited number of key-parameters of marine environments (e.g. NO3- , PO43-, Fe, Mn, Si, CO2, O2, pH). Prototypes of these systems have been widely used in situ for short-term deployments in various marine systems. At LEGOS, an Autonomous Nutrients Analyser In Situ (ANAIS) has been developed. Nitrate, phosphate, silicate are measured between 0 and 1000 m of depth when ANAIS is adapted on an eulerian YOYO profiling subsurface vehicle (Provost and Du Chaffaut, 1996). The ensemble YOYO-ANAIS nitrates was first deployed in the Western Mediterranean Sea offshore of the Blanes canyon over a two weeks period with an acquisition of two vertical profiles of nitrates concentrations per day between 200 and 1100 m (Thouron et al., 2003). Within the CLIVAR/Confluence project, the same ensemble was then deployed from the Argentinean R/V Puerto Deseado and operated during several weeks in the Southwest Atlantic ocean in the Malvinas current (41°S, 55°W). 28 vertical profiles of nitrates concentrations were obtained between March 28 and April 19, 2003. Autonomous sampling occurred at 800, 700, 600, 400, 300, 200, 100 and 80m (Figure 1) and two in situ calibration were performed per profile at the rest depth (800 m) and at the shallowest depth, 80 m. Data were recorded on Flash cards inside the YOYO body vehicle. ANAIS nitrates alone was also deployed at a coastal site (Western Mediterranean Sea offshore the bay of Banyuls sur Mer) at 23m depth on the SOLA mooring location between 2003 and 2005 within the framework of the SOMLIT (Service d'Observation en Milieu Littoral) network. Four measurements per day were acquired in order to obtain high frequency data (as compared to the regular field acquisition on site every other week). Episodic events such as the Rhone river high flooding discharge or sediments resuspension due to strong swell caused by intense southeasterly winds could be observed in the data record. Comparison with classical nitrates determination was excellent especially in the low concentration range between 0.1 and 0.8 µM. However, submersible colorimetric analyzers for dissolved nutrients need significant energy and reagents, and their main drawbacks are their lack of autonomy, size and weight. Electrochemistry provides promising reagentless methods to go further in miniaturization, decrease in response time and energy requirements. Sulfide has been determined in sea water by different electrochemical methods (Lacombe et al., 2007a). First we developed potentiometric sulfide electrodes (based on an Ag/Ag2S electrode) that have been implemented from a submersible at 2300 and 3600 meters depth for short term measurements in a hydrothermal environment. Second we performed laboratory studies to set up a protocol with cyclic voltammetry (using Ag electrode) that could be more suitable for precise sulfide measurement in long term deployments. The voltammetric methods developed exhibited satisfying sensitivities for the broad range of concentration encountered in deep-sea chemosynthetic environments (from 5 µM to 10 mM). Silicate has been determined in sea water by different electrochemical methods based on the detection of the silicomolybdic complex formed in acidic media by the reaction between silicate and molybdenum salts. Cyclic voltammograms present two reduction and two oxidation peaks giving four values of the concentration and therefore increasing the precision. Then, chronoamperometry is performed on an electrode held at a constant potential. A complete reagentless method with a precision of 2.6 % is described based on the simultaneous formation of the molybdenum salt and protons in a divided electrochemical cell. Voltammetric detection of silicates was shown to be feasible within the range of concentration found in the ocean (between 0.3 and 160 µM) in about 6 minutes (Figure 2). The detection limit is 1 µM. The comparison of the voltammetric detection with the classical colorimetric analysis on seawater samples collected from the Drake Passage in the southern ocean yielded an excellent comparison. This latter method is very useful for developing a reagentless sensor suitable for long term in situ deployments on oceanic biogeochemical observatories (Lacombe et al., 2007b, Lacombe et al., 2008). This effort will be performed within the ongoing RTRA (Réseau Thématique de Recherche Avancée) Midi Pyrénées within the framework of the STAE (Sciences and Technologies for Aeronautics and Space) Foundation. Indeed the MAISOE (Microlaboratoires d'analyses in situ pour des observatoires environnementaux) aims to develop and test in situ microsensors in order to measure concentrations of elements (which may be present at trace levels) and to analyse their speciation. These studied elements may either act as nutrients (silicate, and nitrate here) in phytoplankton growth (marine systems and hydrothermal fluids) or be toxic such as mercury (continental systems). Since these natural systems are very complex and hostile due to their heterogeneity and extreme conditions, it is necessary to develop anticorrosion and antifouling protection in order to obtain relevant and accurate data over time, even in remote locations. The expected products from MAISOE will be prototypes of microsensors designed to quantitative detection of the selected components, in a first step at the laboratory scale with reference materials and in a second step in natural systems. These new instruments will be inexpensive, micro-designed and robust after implementation of the different functionalities. The voltammetric method developed for silicate measurements will be adapted to determine phosphate concentrations over the concentration range found in the open and coastal oceans. Silicon and polymer-based microtechnologies will be used to integrate electrochemical principles of phosphate detection in liquid phase. A phosphate microsensor will be developed within the framework of the ongoing Initial Training Network Marie Curie SENSEnet, led by Dr Connelly from NOCS, UK. This 4-years long European combined effort will develop techniques for high performance in situ measurements of key biogeochemical parameters (e.g. phosphate and nitrate), pH, oxygen, carbon dioxide and reduced sulfur species. The technologies to be developed should be of course readily modified for use in a wide range of freshwater systems (cryosphere, lakes, rivers, groundwaters).

References Lacombe M., Builport J.P., Garçon V., Comtat M., and Le Bris N., 2007a, Sulfide in situ measurements in deep-sea environments: actual and future tools, Geophysical Research Abstracts, Vol 9, 11310. Lacombe M., Garçon V., Comtat M., Oriol L., Sudre J., Thouron D., Le Bris N., and Provost C., 2007b, Silicate determination in sea water : toward a reagentless electrochemical method, Marine Chemistry, 106, 489-497. Lacombe M., Garçon V., Thouron D., Le Bris N. and Comtat M., 2008, A new electrochemical reagentless method for silicate measurement in seawater, Talanta, 77, 744-750. Provost, C., and Du Chaffaut, M., 1996, YOYO profiler : an autonomous multisensor, Sea Technology, 37(10), 39-45. Thouron D., R. Vuillemin, X. Philippon, A. Lourenço, C. Provost, A. Cruzado, and Garçon V., 2003, An Autonomous Nutrient Analyzer for Oceanic Long-Term In Situ Biogeochemical Monitoring, Analytical Chemistry, 75, 11, 2601-2609.

AC-4A-12: OOCMur - Coastal Ocean Observing System of Murcia Region (SE Spain, South-Western Mediterranean)

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OOCMur (Spanish acronym for Coastal Ocean Observatory of Murcia) is a Singular Scientific and Technological Infrastructures (ICTS) to be implemented in Spain co-financed

by the Spanish Ministry of Science and Innovation and the Regional Government of Murcia. It will be located in Cartagena (Murcia) 10 miles from the Mar Menor coastal lagoon – the largest in the Iberian peninsula and of the largest in the Mediterranean -, 18 miles from the Cape Palos marine protected area (15 years working up to date) and 8 miles from Cape Tiñoso new marine protected area to be established in 2010. The Cape of Palos is a biogeographical boundary and a transitional area between the Atlantic and the Mediterranean. OOCMur is devoted to study the influence of climate change on marine ecological processes at regional scales driving marine biodiversity changes. It is a large facility open to the international research community under international peer review selection process. Land facilities include: 1) Mechanical and electronic workshops and laboratories for maintaining and development of ocean instrumentation, particularly buoys, TUVs, ROVs, AUVs and gliders, 2) Computational facilities for data assimilation and high resolution numerical modeling for operational oceanography including forecast of currents, waves, sea level, temperature, salinity and chlorophyll in a first phase and other water quality and ecosystem modeling parameters in a second phase, 3) Chemical and biological laboratories including genetic analyses of species and populations as a tool to study biodiversity and connectivity between marine populations. Sea facilities include: 1) 4 coastal buoys equipped with met stations, temperature, salinity, turbidity, chlorophyll, OD, CDOM, nitrate and ADCPs; 2) 6 deep water buoys; 3) Several underwater autonomous vehicles, 4) two cabled observatories, one from Cape Palos to its marine protected area, another in the Mar Menor Coastal lagoon. OOCMur will be integrated in European and other international networks of coastal ocean observatories.

AC-4A-13: Long-term temperature trends in the Bay of Bengal

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Indian Ocean SST has been linked to rainfall patterns in Southern Africa (Reason, 2001) and in India (Clark et al., 2000. Longterm changes in Indian Ocean SST may have an effect on East African rainfall patterns Trsaska et al., 2002). In the Bay of Bengal, warming SSTs have been linked to decreased storm activity (Jodhav and Munot, 2007). Despite a significant increase in Bay of Bengal SST since 1960 (Jodhav and Munot, 2008) and overall in the North Indian Ocean (Rajaveen et al. 2000), the heat content for the Northern Indian Ocean as a whole shows no significant increase in the top 700 meters (Levitus et al., 2005. It is important to understand the subsurface heat content and understand the connection with SST. Is the subsurface North Indian Ocean affecting and possibly ameliorating the increased SST? Or are the two significant basins in the North Indian Ocean, the Arabian Sea and the Bay of Bengal exhibiting opposing behavior with respects to ocean heat content, with one cooling and the other warming, resulting in no obvious trend in ocean heat content? With the XBT lines in the Bay of Bengal, we have a convenient time series (1989-present) with multiple samplings in most years, with which to investigate surface and subsurface temperature changes to answer the questions posed above, which have significant societal impact, and to continue to monitor changes in the future. Argo floats can assist in this monitoring, but add the complication of a completely different monitoring system with irregular sampling in the area along the time series XBT lines. The consistent 20 year monitoring provided by the XBT lines should continue into the future. Some results of preliminary work looking at long term change in the Bay of Bengal are presented. The XBT time series provided by NIO-India shown in the red box were binned by year after statistical removal of the XBT bias and subtraction of the climatological monthly mean temperature as per Levitus et al. (submitted. Figure 2 shows temperature anomaly at the sea surface (black), and temperature anomaly at 600 meters depth (red). Both exhibit a trend of increasing temperature. Figure 3 shows the temperature anomaly at the surface (black) again along with temperature anomaly at 100 meters depth. The temperature anomaly at 100 meters depth exhibits strong year to year variability (note the larger intervals on the temperature axis) and no long term trend. This is near the depth of the thermocline in this area. It may be that, while the surface and 600 meters show significantly increasing temperatures, depths inbetween do not exhibit the increase, and are at times, opposite in sign to the upper and lower depths. This type of study, which is preliminary, can only be performed using the long-time series provided by the XBT lines in the Bay of Bengal. Maintaining the lines will extend this work into the future and provide crucial information on climate change in the North Indian Ocean.

AC-4A-14: The Peruvian climate observing system: A Synthesis, Capitalizing opportunities and Perspectives

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The coastal ocean of the North Humboldt Current System (NHCS) presents remarkable features. Firstly, it is the most productive region of the world oceans in terms of fisheries, producing close to an order of magnitude more fish per unit area than any other region in the world. This extremely rich fisheries is due to a permanent coastal upwelling which brings into the euphotic zone, cold and nutrient-rich deep water allowing the increase of biological productivity. Secondly, the NHCS exhibits a relatively complex circulation and encompasses distinct water masses from both equatorial and subantarctic origins. Mesoscale and submesoscale features, principally generated near the coast and propagating offshore, allow the transfer of physical and biogeochemical properties toward the open ocean. Thirdly, it encompasses the most pronounced and extended subsurface oxygen minimum zone (OMZ) playing an important role on the resource distribution and on climate by regulating the exchange of greenhouse gases -CO2 and N2O- with the atmosphere. Finally, superimposed to these oceanic features, the NHCS is also characterized by the largest and most poorly-observed subtropical stratocumulus deck on Earth having important repercussions on the radiative energy budget and hence on climate. Based on these statements, and knowing that all the compartments of the NHCS ecosystem, from the physics to biogeochemistry and upper layer trophic chain, are strongly modulated by the equatorial dynamics at different timescales, this region appears as a key site to study the impacts of climate variability and climate change and its global consequences.

This study presents the observational strategies routinely performed by the Peruvian Marine Research Institute (IMARPE) and the National Service of Meteorology and Hidrography (SENAMHI) since 1960 to investigate and follow-up the state of the NHCS fisheries and the associated environment. The resultant dataset is analyzed in order to provide analytical environmental pieces of information and to understand the modes of variability of the NHCS and prevent their societal and economic impacts. This is a priority task for the Peruvian Government, due to the vulnerability of this country to extreme El Nino Southern Oscillation events and climate change.

We also present the recent observational efforts which consisted to extend the routinely observational networks by deploying relatively new available technologies such as Argo floats, SVP drifters and autonomous underwater vehicles (glider). Cooperative, sinergistic multidisciplinary projects have been recently undertaken to generate comprehensive

meteorological, physical, biogeochemical, paleooceanography and fishery datasets. For example, two-high-resolution mesoscale surveys were realized in February and October 2008. The first, "Filamentos", was dedicated to the study of a near-coastal filament in northern Peru. The second, the "VOCALS Peru cruise" (Figure 1), in the frame of the international VOCALS (VAMOS Ocean Cloud Atmosphere Land Study) Regional experiment, aimed at understanding air-sea interactions in the active upwelling region off Pisco (14°S) and San Juan (15°30´S) and their impacts on the local ecosystem. These new survey programs considerably improve sampling strategies and allow resolving mesoscale and submesoscale oceanic structures leading to a better understanding of the oceanic-biogeochemical coupling and cross-shore exchanges.

However, the NHCS still suffers for a lack of continuous and sustained observations. It is thus actually planned to enhance the existing hydrographic and the associated meteorological databases with new observations and capabilities. The proposed system considers long-term deep moorings at key sites with the aim at resolving the alongshore propagation of upper oceanic signals and wave dynamics in the NHCS. Repetitive glider experiments are expected to document permanently the cross-shore transport at meso and submesoscale scale from coastal regions to the offshore ocean off Pisco. The proposed observations are expected to contribute improving the forecasting skills of coupled ocean-atmosphere models by assimilating 3D ocean in-situ observations towards predicting the intra-seasonal and interannual variability, as well as the impacts of climate change.

AC-4A-15: On the use of satellite altimeter data in Argo quality control

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A new method has been developed to check the quality of each Argo profiling floats time series. It compares collocated Sea Level Anomalies (SLA) from altimeter measurements and Dynamic Height Anomalies (DHA) calculated from the Argo temperature (T) and salinity (S) profiles. By exploiting the correlation that exists between the two data sets along with mean representative statistical differences between the two, the altimeter measurements are used to extract random or systematic errors in the Argo float time series. Different kinds of anomalies (sensor drift, bias, spikes, etc) have been identified on some real-time but also delayed-mode Argo floats. This method is actually deployed in near real-time in order to separate rapidly suspicious floats for more careful examination.

AC-4A-16: The Voluntary Observing Ship Climate Project (VOSClim)

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Abstract
This poster describes the Voluntary Observing Ship (VOS) Climate Project (VOSClim), its current status and recommendations for the future. The background to VOSClim is described along with current data management and monitoring procedures. The role of VOSClim in providing high quality data is outlined and examples shown of the use of VOSClim data. Finally the advantages of extending VOSClim practices to all VOS are discussed.

Description
VOSClim is currently a project within the Joint WMO-IOC Technical Commission for Oceanography and Marine Meteorology (JCOMM) VOS Scheme that provides a high-quality subset of marine meteorological data, with extensive associated metadata, made available in delayed mode to support global climate studies. All VOSClim ships are also VOS (Kent et al. Community White Paper (CWP)) and are selected based on their past observing performance and specific instrumentation with the goal to provide the highest quality observations. A need for higher quality marine meteorological data has been identified by, inter alia, the Ocean Observing System Development Panel (OOSDP,1995), the Ocean Observations Panel for Climate (OOPC, 1998), and the JSC/SCOR Working Group on Air Sea Fluxes (WGASF, 2000). The observations made by all VOS and VOSClim ships are needed for marine climatological applications (Woodruff/Scott et al. CWP, Worley et al. CWP, Rayner et al. CWP) and for air-sea interaction datasets (Fairall et al. CWP).

Normal delayed-mode VOS reports (Woodruff/Scott et al. CWP) are augmented with several parameters (relative wind speed and direction and information on ship speed, course and loading) that allow better characterization and adjustment of regularly reported elements such as wind direction and speed, sea level pressure, sea surface temperature, air temperature and humidity. For those primary variables, the Real-Time Monitoring Centre (RTMC) at the UK Met Office appends forecast model parameters to the real-time ship report.

The RTMC produces monthly monitoring information on VOSClim ships based on observation differences from the UK Met Office short range forecasts. Poorer quality observations of the primary variables are considered to be 'suspect'. The criteria for labeling VOSClim ships as suspect are stricter than those used for non-VOSClim ships. However, the percentages of suspect ships are very similar for both VOSClim and non-VOSClim (e.g. 2.1% for pressure), which reflects the higher quality data obtained from VOSClim ships. Suspect lists are circulated to VOSClim focal points each month, enabling action to be taken to correct any problems.

Since July 2002, all project data and information have been assembled at the project's Data Assembly Centre (DAC) at NOAA's National Climatic Data Center (NCDC). The high-quality data from the project will be used to provide a reference for possible adjustment of observations from the entire VOS fleet and for a range of applications including validation of satellite observations and model output

It is proposed to transition the project to an operational component of the VOS Scheme and to progressively apply VOSClim enhanced practice standards to the regular VOS. Improved links of VOS and VOSClim data management with climate datasets such as ICOADS (Worley et al. CWP) will facilitate the use of VOSClim data more widely by the scientific community.

AC-4A-17: EuroSITES: The Cental Irminger Sea (CIS) Observatory

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Deep water formation is a key process for the global overturning circulation. The Irminger Sea is one of the few deep

water formation areas in the North Atlantic. In the Irminger Sea deep water formation has found to intermittent depending on the local and large scale oceanic and atmospheric state. The CIS observatory was established in 2002 and designed to study the variability of and the interaction between physical and biogeochemical processes in a deep water formation area. The backbone of the observatory is a steel wire mooring with a number of autonomous recording instruments attached to it. A telemetry buoy allows real-time data access for most of the instruments. Public access of the data is achieved via the DAC at NOC and the GDAC Coriolis. Selected research highlights of the CIS observatory will be presented as well as future plans for this observatory.

AC-4A-18: Quality Control of Argo Surface Trajectory Data Considering Position Errors Fixed by ARGOS System

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To estimate global surface and subsurface velocities is another goal of Argo, the array of numerous profiling floats. Here, we introduce an automatic quality control (QC) method of Argo float position data. The method identifies suspicious float positions based on float's speed estimated from the surface trajectory as follows. Considering a segment composed by two temporal-continuous positions, one position, at least, is identified suspicious if float speed on the segment is estimated at 3 m/sec or faster. A position with less accurate ARGOS flag of the segment is determined suspicious. If both are fixed with the same accuracy by ARGOS system, the suspicious one is determined by relation among the segment and the temporally back/forth positions of the float trajectory. In case that the distance between the positions is less than the error range determined by ARGOS position errors of them, both positions are considered to be acceptable. The method gives us fairly reasonable QC results which are comparable with those by visual inspection of experts. Several percents of position data are identified suspicious in average.

This method seems appropriate as a standard QC method of Argo trajectory data. It is better that the QC method works as a preliminary QC and that it is succeeded by a more sophisticated inter- and extrapolating scheme (i.e., 'delayed-mode QC') to estimate actual float movements and locations where a float arrives at and departs from sea surface.

AC-4A-19: The Italian Operational Observing System: Distributed Data Collection and Information Systems

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In September 1999, a operational observing system was launched in the Mediterranean as part of the Mediterranean Forecasting System project. Initially the observing systems was composed by Ships Of Opportunity, deep sea buoys. This constituted the observational component of the Mediterranean Forecasting System - Pilot Project. Successively also gliders and lagrangian profiling floats were added, as part of the Mediterranean Forecasting System - Toward Environmental Protection. A coastal observing network has been added in the framewotk of sub/regional projects such as Adricoms. In these frameworks, innovative real-time data management system were developed. Purposes and role of an operational sampling system were defined in the period 1999 - 2000, mainly for new methodologies in data transmission and quality control. The Italian Group of Operational Oceanography is continuing the data collection in Italian Seas and the Mediterranean providing data to regional, sub/regional and coastal forecasting systems. Data are transmitted in full resolution (except for profiling floats) to Data Assembling Centres and the near real time quality control procedures included all the steps defined for delayed mode data. The observational system is composed by four main elements: Data collection (including sampling design); Implementation of quality control (QC) methodologies and protocols; Implementation of technologies for data collection and transmission; Near real time (NRT) data management, information system and services. Although the limitation in number of parameters collected (XBT temperature profiles for the large scale monitoring system and CTD+O2 for the coastal areas, meteo parameters for deep sea and coasta areas), the data allows the description of interactions between shelf and deep-sea waters. This multidisciplinary - multiplatform data provision is only one component of the Italian operational system. It is complemented by assimilation, optimal estimation of parameters field, and prediction of the marine environmental state variables. The different blocks are interconnected in order to assure an efficient flow of high quality data/products. This is done through the information management systems residing in all components. The mission of the information system is to facilitate the access to data, products and information through a distributed system of portals. This is done with a technical and management plan that is supporting the evolving information management needs:

- Guidelines for data originators (laboratories and institutes participating to the operational data collection);
- Requirements and priorities of data users (operational systems, research, public authorities, students and general public);
- How data and products are available to users (services for selection, viewing and access);
- Functional and system requirements (assure some interoperable elements in order to be part of a larger network).

The mission charter must also define the 'basic services' to be provided to all users, and the 'specific services' to be provided to specialised users. Basic services are: Data discovery - the possibility to find data through a catalogue by means of a user-friendly interface. Data view - the possibility to have a quick look to data, in order to establish if data are useful to user. A specific service is the data access (free or under restricted conditions) on the base of the business rule. A central portal is providing links to the data assembling centres portals, where different services are offered, and in particular: discovery, view, selection, downloading. All data are normally accessible within 24 hours from data collection.

AC-4A-20: Real Time Marine Data Acquisition: A Proposal for a New Joint Coastal Oceanographic Observatory Network in Adriatic Sea

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Currently, several operational marine centres issue routine seasonal forecasts produced with coupled ocean-atmosphere models. For good result they require also real-time knowledge of the state of marine area as regard as oceanographic and atmospheric parameters. Effectiveness of marine climate knowledge and predictability resides in fast, reliable, scattered and numerous information on the initial marine and atmospheric conditions. The aim of this work is to present a review of the

existing real time stations in the Adriatic sea and a critic state of the art with the aim to propose a new single and standardized coastal oceanographic observatory network based on previous existing oceanographic buoys set up by different projects and institutions and with various features. The network ISMAR could be based on various oceanographic buoys located along the Adriatic Sea coastal waters transmitting real time data, accessible, after a data quality control and sensor/instrument field calibration validation, on internet by a web site. In this way it will possible to have a single system of real time oceanographic and meteorological standardized data available for regional stakeholders, policy makers, economic operators, environmental safety and tourists. Data will also useful to improve forecast systems active for the Adriatic Sea; finally it will greatly improve the knowledge of the main hydrological and meteorological forcing factors in a LTER (Long Term Ecological Research) study area where decadal time series on ecological studies are collected in a collaborative joint effort to depict trends in the trophic status and biogeochemical proprieties of the basin. The principal projects involved are: Adricosm, Vector, Emma-Life, Interreg, PITAGEM, PRISMA.

AC-4A-21: Low-cost, Robust and Easy-to-Deploy Surface Moorings for Tsunami and Climate Observations

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Over the past 45 years, surface moorings have yielded valuable data for improved understanding of the world's oceans. However, today's deep-ocean mooring technology has changed very little over these 45 years and requires expensive infrastructure costs including, 1) large and expensive buoys, 2) dedicated ships and highly specialized crew, 3) complex deck operations that are potential dangerous and, 4) limited real-time subsurface capabilities. To meet future needs in making global ocean observations at affordable costs, a next generation surface mooring technology is being developed at NOAA's Pacific Marine Environmental Lab in Seattle, Washington. For tsunami monitoring a DART-ETD (Deep Ocean Assessment and Reporting of Tsunamis-Easy to Deploy) is in the advanced prototype stage and for climate monitoring a PICO (Platform and Instrumentation for Continuous Observations) has had encouraging results in preliminary field trials.

The next generation mooring technology has several desirable features for making sustained global observations, including: 1)Safe and dramatically simplified deployments, 2) 'Factory-built' pre-palletized design, 3)Vandal resistant features, 4) Deep water, high latitude capable, 5)Significantly lower cost of operations. Further development and testing is required, but year long deployments in high and low-latitudes have been very encouraging and have proven that the mooring concept is viable for tsunami warning and climate observations.

AC-4A-22: High Resolution Current Velocity Profiling Argo Floats: Preliminary Results From Subantarctic Waters.

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The EM-APEX (ElectroMagnetic-Autonomous Profiling EXplorer) is a recent addition to the Argo float fleet, capable of making very precise measurements of ocean velocities over a wide spatial and temporal range. These floats not only have the standard CTD package, but also carry an electromagnetic subsystem, which measures the motionally induced electric fields generated by the ocean currents moving through the vertical component of the Earth's magnetic field.

Within the framework of the SOFINE (Southern Ocean Finestructure project) experiment, eight EM-APEX floats were deployed along the Subantarctic Front at the Northern Edge of the Kerguelen Plateau in November 2008. Over a two month period, these floats collected four vertical profiles a day with a resolution of 2 dbar for temperature and salinity and 5 dbar for horizontal velocity within the region of interest (65-75°E, 41-48°S).

The rapid profiling combined with the high resolution of these floats provides a clear picture of the physical properties in the top 1600 m of the water column, with over 1300 profiles of temperature, salinity and horizontal velocity processed. The dense coverage of the temperature and salinity field shows strong along-track watermass property variations in time and space. When investigating vertical mixing, patterns of unstable turbulent patches in Thorpe scales track the evolution of internal waves and other dynamic features.

AC-4A-23: In situ chemical pCO2 sensor with autonomous drifting buoy system

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To assess the spatial and temporal variations of surface pCO_2 in the global ocean, new automated pCO_2 sensor which can be used in platform systems such as buoys or moorings is strongly desired. We have been developing the small drifting buoy system (diameter 250-340 mm, length 470 mm, weight 15 kg) for pCO_2 measurement. The measurement principle for the pCO_2 sensor is based on spectrophotometry. The pCO_2 is calculated from the optical absorbance of the pH indicator solution equilibrated with CO_2 in seawater through a gas permeable membrane. The measured data were transmitted to the laboratory by satellite communication (Argos system). One of the challenges we faced was developing an anti-biofouling paint for the buoy and pCO_2 sensor. Minimizing toxicity is important for the buoy system. In order to reduce the effects of biofouling on the sensors, we tried the antifouling tests with some paints in our port side (Aomori, Japan) for 18.5 months. Following tests, the silicon type paint was adapted as an anti-biofouling paint for drifting buoy. To test the long-term durability and effect of anti-biofouling, the buoy systems were moored with TRITON buoy in the western tropical Pacific Ocean (2N, 156E) and with K-TRITON buoy in the western North Pacific Ocean (38N, 146.5E). Our first deployment of drifting buoy system was made in the east Labrador Sea in May 2008, with the support of the Bedford Institute of Oceanography. The buoy system is measuring sea-surface pCO_2 four times a day and every six days intervals. We succeeded in obtaining the data for six months. Moreover, we deployed the two drifting buoys in Antarctic Ocean and Western North Pacific in January and March 2009, respectively. The planned lifetime of buoy systems, is about 1 year.

AC-4A-24: Australian ocean observing systems, and bio-optical and biogeochemical observations of the East Australian current

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The East Australian Current (EAC) is a major oceanographic feature along the Australian coast and has an important impact on biogeochemical and biological dynamics of this region. The meso-scale warm- and cold-core eddies and coastal upwelling associated with the EAC make it a particularly complex system where the coupling between physical and biogeochemical processes is poorly understood. Autonomous ocean gliders equipped with miniature bio-optical sensors (WETLabs ECO-Puck) were deployed off the coast of New South Wales during November 2008 (anticyclonic eddy) and March 2009 (cyclonic eddy) for a better understanding of the role of entrainment and source water on eddy significance, regional productivities and larvae recruitment/fisheries. The ECO-Puck optical measurements provide proxies for some key biogeochemical quantities such as chlorophyll a and coloured dissolved organic matter content (from fluorescence measurements) as well as particle load and particulate organic carbon for open ocean waters (from backscattering coefficient measurements). These routine in situ glider observations will be complemented by in situ high frequency bio-optical measurements/biogeochemical determinations during research cruises and synoptic remote sensing observations of physical parameters (eg, SST) and biogeochemical quantities (eg, chlorophyll, total suspended matter, coloured dissolved organic matter). This multi-disciplinary/multi-tools approach will provide a better understanding of the factors driving phytoplankton, particulate and dissolved organic matter dynamics, and the associated organic carbon fluxes, in the EAC. This study is part of the Australian Integrated Marine Observing System (IMOS), a nation-wide collaborative program designed to observe/monitor the coastal and open oceans around Australia. As part of this program, bio-optical observations are conducted from a large range of platforms such as gliders, moorings, AUVs, ships of opportunity and Argo floats. This large 'arsenal' of bio-optical/biogeochemical observing systems deployed around Australia will allow a better understanding of the factors driving the biogeochemical dynamics in different ecosystems, and the impact of climate change on coastal and open oceans.

AC-4A-25: Oceanographic Observations of the Australian Continental Shelf and Slope Waters Using Autonomous Ocean Gliders

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Ocean gliders are autonomous vehicles designed to operate in water depths up to 1000 m. By changing its buoyancy, the glider is able to descend and ascend. This momentum is converted to forward motion by its wings. Pitch adjustments are made by moving an internal mass (battery pack) and steering is done using a rudder and/or battery packs. Moving at an average horizontal velocity of 25 - 40 cm s-1 the glider navigates its way to a series of pre-programmed waypoints using GPS, internal dead reckoning and altimeter measurements. The gliders are programmed to provide data through satellite communication when it is at the surface and it is also possible to control the path of the glider during its mission. Depending on the type of glider and the number of vertical 'dives', the endurance of a glider ranges between 1 and 6 months. The Australian National Facility for Ocean Gliders (ANFOG) has been established as part of the Integrated Marine Observation System (IMOS) for Australia. ANFOG will develop a fleet of 9 gliders using two different types of gliders. The Slocum glider is designed to operate to a maximum depth of 200m and a maximum endurance of 30 days, whilst the Seaglider is able to operate to a maximum depth of 1000m and a maximum endurance time of up to 6 months. Both gliders have the same suite of sensors to measure conductivity (for salinity), temperature, dissolved oxygen, fluorescence, turbidity and CDOM (dissolved organic matter) with depth. In this presentation, operation of the ocean gliders will be highlighted using deployments from the entrance to Spencer Gulf; shelf waters off Sydney (NSW) and Fremantle (WA) and, shelf and slope waters off Tasmania.

Spencer Gulf is a reverse estuary located along the south coast of Australia (Figure 1a). High evaporation in the upper reaches of the estuary results in the formation of a high salinity water mass which exists the Gulf as a gravity current which is modulated by the spring/neap tidal cycle. Ocean glider data obtained at the entrance to the Bay in January 2009 did not indicate a constant near bed outflow of water: higher salinity water was present at mid-depth and was modulated by the tidal cycle.

The shelf waters of Sydney are influenced by the East Australian current - the western boundary current of the south Pacific. The current is strong and eddies and meanders are common features of the current. A Slocum glider was used to monitor the physical and biological processes within an eddy and revealed strong physical/biological interaction (Figure 2a).

The continental shelf waters off Fremantle are influences by the southward flowing warmer, lower salinity Leeuwin current generally located along the 200m isobath and during the summer months the Capes current, a colder wind driven current generally located inshore of the 50m isobath. The Capes current, has a higher productivity due to upwelling. Slocum missions have monitored the both these current systems with cross-shore transects undertaken weekly to fortnightly. The glider data clearly identified the interaction between these two current systems (Figure 2b).

The Seaglider deployments off eastern Tasmania monitored the East Australian current in this region - the glider was entrained into an eddy and revealed very strong currents within the region (Figure 1d).

AC-4A-26: In-Situ Delayed Mode at Coriolis Data Center

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End of 2007, the Coriolis Data Center has set up a new product dedicated to operational oceanographic centers that want to perform re-analysis on a delayed mode basis. The release 2007 covers the period 2002-2006, and the release 2008 is extended to 1990-2007. In addition to the near real time validation done on a daily and weekly basis for the forecasting needs, it has been decided to create a reference dataset updated on a yearly basis. The new procedure has involved an objective analysis method (statistical tests) with a visual quality control (QC) on the suspicious profiles, and has been developed to improve the database content and to fit the level required by the physical ocean re-analysis activities. The quality control process uses two runs of objective analysis, corresponding to two different time windows, with an additional visual control in between. The first run is done on a three weeks window to capture the most doubtful profiles which are visually checked by an operator to decide whether or not they are bad data or real oceanic phenomena. Whereas the second run is operated on a weekly basis for the modeling needs. The reprocessing of both releases is global and annual delayed analysis of the content of the database and an additional validation of the dataset collected in real time and delayed mode during this 17 years period. Each release provides T and S weekly gridded fields and individual profiles both on their original levels and interpolated levels. These Coriolis products are available on different servers using different technologies (ftp, OPeNDAP and web).
http://www.coriolis.eu.org/cdc/global_dataset_release_2007.htm
http://www.coriolis.eu.org/cdc/global_dataset_release_2008.htm

AC-4A-27: The POSEIDON reference time-series stations of the Eastern Mediterranean Sea

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Monitoring the marine environment apart from being a challenge for the scientific community has been acknowledged as a top most priority to support policy making and environmental management. In a dynamic and continuously changing marine system, important issues such as eutrophication, overfishing, climatic change and natural hazards require the long term tracking of key variables. The Mediterranean Sea although has long been considered as a single functional climatic, ecological, economic and social system, in reality it displays a great variability. The Greek seas are characterized by a complex morphology as a result of the geologic history of the eastern Mediterranean and the recent geodynamic processes. This complex morphology together with the narrow shelf and the particularly deep basins create a unique ecosystem characterized as an important area of dense water formation (following the Adriatic Sea), while abrupt changes in its hydrology and dynamics have affected the entire eastern Mediterranean.
Responding to the need of marine observations the Hellenic Centre for Marine Research (HCMR) has established a Monitoring, Forecasting and Information System for the Greek Seas named POSEIDON (http://www.poseidon.hcmr.gr). Considering both the variability of the system and the need for high frequency information a mixture of platforms was chosen, ranging from coastal buoys equipped with few basic met-ocean sensors to open sea stations with an extensive list of sensors targeted to both physical and biochemical process and their coupling at various time scales. Two multi-parametric deep water observatories currently operate: the Poseidon E1-M3A mooring operating in the Cretan Sea since 2000, and the recently (February 2007) deployed Poseidon Pylos mooring site that operates in the SE Ionian Sea. These two systems recently became parts of an integrated network of deep European observatories developed in the framework of EuroSITES (http://www.eurosites.info/) project (EU-FP7) that will coordinate the European contribution to OceanSITES.
The E1-M3A observatory of the Cretan Sea is oriented towards air-sea interaction studies, biochemical processes in the euphotic zone and variability of intermediate and deep water mass characteristics. Its payload (see table) includes a) an extended set of meteorological sensors including those for relative humidity and precipitation, b) a series of radiometers including multispectral sensors for radiance and irradiance, c) optical and biochemical sensors (chl-a, turbidity, PAR, DO) in the upper 100m and d) sensors for physical parameters (T, S) in the upper 1000m. The antifouling methods that have been used for the recently upgraded E1-M3A observatory under the POSEIDON-II project, were based on the experience of the early deployments of the system and have significantly improved the quality of the data.
The Pylos observatory of the Ionian Sea is equipped with standard meteorological sensors hosted by the surface buoy and CTs for the upper 1000m of the water column. An autonomous seabed platform transmitting data to the surface buoy through hydro-acoustic modems is also tested for the first time in the Mediterranean Sea. The platform has been originally developed for Tsunami detection based on the design of the DART system but has been expanded to host a SBE16 for salinity and temperature measurements.
The planed upgrades of the system include the introduction of pCO2 and pH sensors to support climate variability related studies. The first pCO2 sensor was introduced in the E1-M3A observatory (1m depth) in July 2009 delivering for the first time such a time-series in the Aegean Sea and allowing a pre-operational assessment of these systems. An ongoing upgrade of the Pylos site aims to extend the capabilities of the seabed platform. A new platform with increased energy autonomy and an expandable central processing system able to host new sensors including DO, turbidity, CO2 and pH will be developed during the next 2 years under the POSEIDON-III project.

AC-4A-28: Providing an Ocean in Situ Data Service for the Needs of Operational Oceanography

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Seven French research agencies involved in ocean research and ocean predictions are together developping a strong capability in operational oceanography based on three components including altimetry (Jason), digital modelling with assimilation (Mercator) and in situ data service (Coriolis). The Coriolis data centre aims to collect, quality control and distribute ocean data worldwide in both near real-time and delayed formats for assimilation and validation purposes. Furthermore, the Coriolis data centre is able to deliver products such as T & S fields and reference datasets. To be able to deliver such a global dataset, the Coriolis data centre plays an important role in three major JCOMM projects: - The Argo project, where the Coriolis data centre acts as one of the two global data centres. The comprehensive Argo dataset is available via the Coriolis server. This dataset holds the data from 3039 active profiling floats (July 1st 2009). - The GOSUD project, which aims to process and distribute sea surface data collected by both research vessels and merchant ships when they are at sea. For the moment, only SST & SSS surface data are taken into account but the objective is to extend the project to include other parameters such as oxygen, fluorescence or PCO^2. The Coriolis data centre is one of two GOSUD global data centres. Since the beginning of 2008, forty ships have sent surface data to the Coriolis data centre - The OCEANSITES project which collects and processes data from deep open ocean time series sites. Data from 60 different platforms deep sea moorings are available at the Coriolis data centre which acts as one of the two global data centres In order to complement this dataset collected within the projects mentionned above, connections to the GTS –the WMO network for data exchanges- have been implemented to retrieve any of the ocean data which were not part of the three projects Argo, Gosud and OceanSites. All the datasets described above are freely distributed on a daily or regular basis via different servers using different technologies (ftp, OPENDAP, Thredds and web). From this complete dataset, value added products are produced and delivered regularly. The reprocessing of the 1990-2007 period produced a global data set better validated that provides three products: T & S gridded fields, individual quality controlled profiles both at original and interpolated levels.

AC-4A-29: GOSUD : Global Ocean Surface Underway data Pilot Project

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Introduction The Global Ocean Surface Underway Data (GOSUD) Project is a project from IODE –Intergovernmental Ocean Data and information Exchange Committee of UNESCO. It is designed as an end to end system for surface data collected by ships at sea. Objectives The main objective of GOSUD is to collect, process, archive and disseminate in real-time and delayed mode, sea surface salinity and other variables collected underway, by research and volunteer ships. The data reach the GOSUD database either by extraction from the Global Telecommunications Systems (GTS), the world wide data exchange network of the national meteorological agencies, or by direct submission from the ship operators. The data that are centralized in the GOSUD database are distributed for scientific studies and are also used for validation of ocean models. In the very near future, sea surface salinity data that are gathered in GOSUD will be a major contribution to validate

the surface salinity data that will be collected by the SMOS (European Space Agency) and AQUARIUS (USA) satellites. They will be respectively launched during autumn 2009 and 2010. Progress accomplished during the 10 last years Development of the GOSUD Project began in 2000 with expressions of interest at the IODE meeting in Lisbon, Portugal. A preliminary meeting was held in Brest, France, in November, 2001 at which a strategy to develop a project plan was agreed. The Sea Surface Salinity data that have been acquired during the WOCE period has been integrated in the GOSUD dataset as the source of historical data. Since then, efforts have been done to gather data either by direct submission or by extraction from the GTS. In 2009, 65 ships are reporting data on a regular basis with a maximum of 70 ships in April 2009. The major data set that is directly provided to GOSUD is related to the IRD network of merchant ships (ORE Sea Surface Salinity). An important contribution to the project comes from the data collected on voluntary ships of the SeaKeepers Society Use of the data - Scientific studies - Sea Surface Salinity variability and trends in the tropical Pacific - Elaborating a Sea Surface temperature and Salinity climatology - Vertical and Horizontal Structure of the Sea Surface Salinity - Global Sea Surface Salinity variability - Validation purposes - Study of the vertical variability of surface salinity. - Best understanding the vertical differences of the 10 first meters of the ocean in order to link the vertical profiles measurements to the surface data. - Validation of the SMOS & Aquarius satellites data Next steps - Enlarge the network. The project is still seeking for new data providers especially for data collected at high latitudes - Elaborate a delayed mode dataset using calibration coefficients and water samples. This is a requirement for accurate scientific studies - Increase the effort to collect accurate meta-data - Implement the new format that has been defined to hold both meta-data, near real-time data and delayed mode data - Extend to more parameters (O2 , fluorescence) in cooperation with FerryBox

AC-4A-30: Underwater Vision Profiler- a sensor for detailed assessment of particles (> 100 µm) and large plankton distribution

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The Underwater Vision Profiler (UVP) records simultaneously the abundances and size distributions of particles >100 µm and mesozooplankton in the water column (0-3000 m) at a rate of 5 Hz (i.e. one image every 20 cm with a lowering speed of 1 ms-1). The images are treated and analyzed in real time, and when the UVP is interfaced with a CTD, the distribution of particles can be displayed in real time together with the CTD data. The UVP is a compact (weighs 30 kg in air) and self-powered system that can be mounted within a CTD-Rosette frame. It can also be adapted to other vectors, and be used on moorings for long-term monitoring. The main watertight cylinder contains the following components: optics, intelligent camera, pressure and angle sensors, acquisition and piloting board, internet switch, hard drive and dedicated electronic power boards. Collimated light is delivered by red light-emitting diodes of 625 nm wavelength housed in two independent glass cylinders, illuminating a field of view of 4x20 cm that corresponds to a volume per image of 1.02 L. At each deployment of the rosette, the UVP acquires the size distribution of particles and different attributes of each object >100 µm, and it simultaneously extracts vignettes of objects >600 µm (mostly large marine snow and mesozooplankton). The publicly available Zooprocess and Plankton Identifier softwares developed at the Laboratoire d'Océanographie de Villefranche, France, provide tools to sort and cluster vignettes into categories. The numerous deployments of the UVP on different cruises have demonstrated its ability to characterize the vertical and horizontal variability of particles size distributions and mesozooplankton including their diel vertical migrations. Considering the transmission in real time of particle size distribution data, the acquisition of zooplankton data and its simple CTD connectivity, the UVP is an ideal instrument for investigating the 'twilight' and deep-ocean zones, from meso- to global scales.

AC-4A-31: COSYNA, a German Initiative of an Integrated Coastal Observating System

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The development of an integrated coastal observing system for the German Bight is one of the focal issues of German marine research in the next decade. A major challenge of the "Coastal Observation System for Northern and Arctic Seas" (COSYNA) is to tightly combine data from a dense observational network with modeling via data assimilation. The integrated system will focus on daily-to-weekly processes providing objective measures of uncertainty in the state estimates and forecasts. In the longer run it will also cover seasonal and inter-annual time scales and could contribute to identifying changes in the North Sea ecosystem, including climate-induced and anthropogenic cause-and-effect chains and development of future scenarios with increased confidence. In this way, COSYNA represents the German contribution to an anticipated North Sea wide coastal observatory.

COSYNA will link partially existing systems for the Wadden Sea to the North Sea scale. Physical and biogeochemical key parameters including fluxes will be measured vertically from the sediment-water to the water-atmosphere interface. Transects from intertidal zones to offshore locations will allow the representation of horizontal, cross-coastal gradients, for example with respect to wave fields or water quality, including turbidity.

The German Helmholtz Research Centre GKSS will coordinate the implementation of COSYNA from 2007 to 2012 as a central part of its national mission in close cooperation with members of the German Marine Research Consortium (KDM). In the first phase (2007-2009), a pre-operational observing subsystem is installed and tested by GKSS alone. It is based on already existing near-coast in-situ components comprising X-Band and HF-Radar, wave-rider buoys and multi-parameter Wadden Sea poles. On the North Sea scale FerryBox-systems operating on ships of opportunity and satellite remote sensing images are included. Three-monthly cruises with profilers and an undulating towed scan fish complement information in the vertical dimension.

In the main phase (2010-2012), novel technological solutions will be applied by GKSS and the KDM-Partners to extend the in-situ systems deeper into the German Bight and to probe the sediment water and atmosphere water interfaces systematically. High-resolution time-series will be recorded by multi-sensor underwater systems mounted on research platforms and wind turbines in the German Bight. Cruising autonomous underwater vehicles and ships of opportunity will fill up the spatial gaps between these reference stations throughout the water body. In this way a better understanding of the significance of internal and external forcing in the German Bight and more reliable estimations of bio-geochemical budgets of a North-Sea subsystem is aimed for.

The poster presents the general observing and modeling concepts of COSYNA on the basis of already existing observational and modeling examples, shows the consistency and complementarity of different data sets from observations and modeling and exemplify the integration of data into coupled models resolving meso-scale structures.

AC-4A-32: On the validation of hydrographic data collected by instrumented elephant seals

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To study the foraging ecology of elephant seals in relation to oceanographic conditions, Satellite-Relayed Data Loggers (SRDL) with an integrated Conductivity-Temperature-Depth (CTD) have been developped by the Sea Mammal Research Unit (University of St Andrews), which autonomously collect and transmit hydrographic profiles (temperature/salinity) in near-real time via Argos satellites. These devices have the potential to provide detailed oceanographic information in logistically difficult areas at comparatively low cost, being therefore highly interesting for the oceanographic community as well. Large efforts for calibrating and validating the huge amount of collected hydrographic data have been constantly made since the first deployments in 2004, as a necessary step to produce data useful for oceanography. When possible, at-sea experiments were performed on ships of opportunity before deployments on seals, consisting in comparing hydrographic profiles from SRDLs with reference profiles obtained simultaneously with a standard CTD. These experiments brought to light a satisfying repeatability of SRDL sensors but also the presence of systematic biases, especially for salinity, which should be corrected. In 2007 and 2008, more than 6000 valid temperature/salinity (T/S) profiles were collected by 17 SRDLs around the Kerguelen Islands in the Southern Indian Ocean. We present several delayed-mode methods of estimation and reduction of systematic biases, applied to this peculiar seal dataset. These methods are based on comparisons of T/S profiles from SRDLs with available historical profiles (mainly CTD and ARGO profiles) or with each other (cross-comparisons). Based on this two-fold procedure, we show here the important technical and methodological improvements made since 2004 to produce hydrographic data suitable for oceanographic studies.

AC-4A-33: The underwater glider Spray: Observations around the world

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Underwater gliders are autonomous vehicles that profile vertically by changing buoyancy and move horizontally on wings. The Spray glider was developed at Scripps Institution of Oceanography, and has been used at many locations around the world in several international projects. During a typical deployment, Spray dives from the surface to 500-1000 m depth and back, taking 3-6 h to complete the cycle while traveling a horizontal distance of 3-6 km. Spray's speed through the water is thus about 0.25 m/s in the horizontal, and 0.1 m/s in the vertical. Endurance depends on the sensors carried, stratification, dive depth, and speed; deployments are usually planned for 3-4 months. Observed variables include pressure, temperature, salinity, velocity, chlorophyll fluorescence, and acoustic backscatter. To date, Spray gliders have completed over 40,000 dives, covering over 120,000 km. Some notable results are excerpted in this poster. A continuous Spray presence has been established for over three years in the California Current where climate impacts on the productive ecosystem is the focus. Over two years of continuous observations have been made along a 1300 km line northward from Hawaii. Spray observations are ongoing in the Philippine Sea where the North Equatorial Current feeds the Kuroshio. Sprays in the Solomon Sea are monitoring the low latitude western boundary current in the southern hemisphere. Programs in the Gulf of Mexico and in the Gulf Stream have Sprays navigating energetic mesoscale flows. Spray's success to date makes it a good candidate for comprehensive observational systems.

AC-4A-34: Vertical velocities in the upper ocean from glider and altimetry data

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This study represents a first attempt to combine new glider technology data with altimetry measurements to diagnose vertical velocities in a frontal region. In July 2008, just two weeks after Jason-2 altimeter was launched, a glider mission took place along a satellite track in the Eastern Alboran Sea (Western Mediterranean). The mission was designed to be almost simultaneous with the satellite passage. Direct estimations of dynamic height from glider profiles reveal a sharp gradient (~15 cm) and correspond very well with the absolute dynamic topography obtained from Jason-1 & Jason-2 tandem mission ($r > 0.97$, rms differences < 1.6 cm). Our method blends both data sets (glider and altimetry) to provide a consistent and reliable 3D dynamic height field. Using quasi-geostrophic dynamics, we find vertical motion (~1 m/day) which may provide a local mechanism for subduction processes, such as the chlorophyll tongue (down to 180 m) observed by the glider.

AC-4A-35: A global current meter archive with matlab interface

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We present a Curret Meter Archive (CMA) created by combining the Deep Water Archive of Oregon State University (OSU) Buoy Group, 1901 current meter records collected by Carl Wunsch, and other sources. The current meter records were between Sept. 1973 and Feb. 2005. The OSU dataset contains over 5000 current meter records (including acoustic and mechanical devices, on surface and subsurface moorings) from many investigators and includes the WOCE archive. Most records are in deep water and typically have at least 6-month duration. Each record was visually inspected and quality controlled by the OSU Buoy Group as described on their website http://kepler.oce.orst.edu/. The archive provided by Carl Wunsch contained 1901 records on 525 moorings, of which over 100 moorings were visually inspected (Wunsch, pers. com. 2009). Literature citations to the first published work on the various moorings were tabulated by Wunsch (1997). The records were further quality controlled by visual inspections and comparing with records that also appeared in the OSU dataset. We also obtained over a hundred current meter records from several experiments in the online archive maintained by the Upper Ocean Processes Group at Woods Hole Oceanographic Institution, http://uop.whoi.edu/index.html. Working with large volumes of data requires a convenient software interface. We've developed a matlab interface that works with a standard set of metadata, making extraction of thousands of records possible in a few lines of matlab.

AC-4A-36: Development of Compact Electrochemical In-situ pH-pCO2 Sensor for Oceanographic Applications

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In recent years, in-situ measurement using pH and pCO2 sensors has attracted attention in relation to global warming issues. The high precision electrochemical in-situ pH-pCO2 sensor was developed for measurement of these parameters in

seawater. A new pH sensor was used an ion sensitive field effect transistor for the pH electrode and a chlorine ion selective electrode for the reference electrode. For a new pCO2 sensor, the pH sensor was sealed with a gas permeable membrane filled with inner solution. The pH sensor can detect pCO2 change as the inner solution pH changes which is caused by penetration of carbon dioxide through the membrane. Several sea tests using this sensor was carried out in various locations of the ocean. High accuracy, quick response, and long-term stability have been achieved. In the field, response speed of the pH sensor is 1 second or less, and measurement accuracy is ±0.005 pH. In-situ response time of the pCO2 sensor was less than 60 seconds.

In-situ monitoring of pH and pCO2 changes in the ocean is important because these parameters related to the global warming issues, such as oceanic carbon cycles and ocean acidification. The existing pH sensor based on the glass electrode/reference electrode pair is not satisfying about accuracy, response time and resolution for the chemical oceanography. In order to solve these problems, Shitashima and Kyo (1998) applied an ion sensitive field effect transistor (ISFET) as the pH electrode to oceanographic in-situ pH sensor for the first time. In this study, new ISFET-pH electrode specialized for oceanographic use was developed and a reference electrode was examined for more accurate and stable measurement. Furthermore, the pCO2 sensor was devised by incorporating the pH sensor to measure in-situ pCO2 in seawater.

A chloride ion selective electrode (Cl-ISE) is a pellet made of several chlorides having a response to the chloride ion, a major element in seawater. The electric potential of the Cl-ISE is stable in the seawater, since it has no inner electrolyte solution. The pH amplifier, data logger and battery are also housed in a pressure vessel. Several sea trials for in-situ response time of the pH-pCO2 sensor were performed at the deep-sea hydrothermal area and open ocean. When the in-situ pH-pCO2 sensor was brought close to the low pH and high CO2 concentration seawater derived from the hydrothermal fluid by using a ROV (Remotely Operated Vehicle), pH and pCO2 responded rapidly at two different sites (depth and temperature were different). These results are indicating that this in-situ pH-pCO2 sensor is a very effective tool for high precision long-term monitoring of pH change in the ocean.

AC-4A-37: The development, current state and future of Cefas SmartBuoys

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The SmartBuoy system developed at Cefas is an operational network of 6 databuoys deployed since 1999 in UK coastal waters and since 2006 at one site in Netherlands coastal waters.. The system was designed to improve monitoring of anthropogenic eutrophication. It is comprised of a solid state logger and system controller (ESM2), built at Cefas, interfaced with a wide range of proprietary sensors.. Data is generally logged twice (2 bursts of 10 minutes at 1 Hz) per hour and "burst means" sent back to Cefas via Orbcomm satellite telemetry and published on the web (www.cefas.co.uk/monitoring). The core parameters measured are salinity, temperature, oxygen, chlorophyll fluorescence, optical back scatter and downwelling (PAR) irradiance. An in-situ nitrate analyser (NAS-2E) is deployed at four sites and an automated water sampler (WMS-2) collects up to daily samples for nutrients (nitrate, silicate, phosphate) and phytoplankton species composition from all seven sites. The concentration of SPM can also be determined by gravimetric analysis of WMS-2 collected water samples. SmartBuoy measurements are typically made between 1-2 m depth in relatively shallow tidally mixed waters but are supplemented with sub-surface measurements using the same payload in deeper summer stratified waters. SmartBuoys are serviced approximately monthly and all burst mean data is subsequently loaded onto the operational database (networked and accessible online via Citrix). Initial automated quality assurance takes place during the unpacking of the data to check it is within a specified range. This is followed by a comprehensive manual quality assurance procedure which includes the application of sensor-specific calibrations derived from the results of discrete samples. The database also holds the service and calibration details for every sensor and instrument and is used for creating deployment records and programming the logger. This approach provides an audit trail from individual sensor readings to calibrated results. The SmartBuoy system is proven and fully operational with data returns in excess of 90%. The quality assured data are being used to strengthen the evidence base for assessments of eutrophication required by international treaties (e.g. OSPAR) and EU directives. The SmartBuoy network is now key part of the UK marine monitoring strategy that is part of an integrated system that makes use of ships and satellites. SmartBuoy also provide crucial data for ground-truth data for remote sensing of ocean colour. The high-frequency multi-variable data sets are also important for calibration and validation of hydrodynamic and ecosystem models.

AC-4A-38: Underway Air-Sea Measurements from the R/V Laurence M. Gould in Drake Passage.

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In the Southern Ocean, upper-ocean processes and air-sea fluxes play a critical role in transforming water at the ocean surface by changing its density and thus shaping the characteristic properties of many globally important water masses. These processes control the meridional overturning circulation, and lead to the formation of Intermediate and Mode Waters that carry with them evidence of their contact with the atmosphere that may indicate changes in forcing on time scales of relevance to climate.

Drake Passage has long provided a convenient chokepoint to observe and study these processes in the Southern Ocean. Over the past decade or so, underway in situ measurements within Drake Passage from XBT, XCTD and ADCP instrumentation, along with concurrent shipboard meteorological and pCO2 sampling, have been relatively routinely acquired aboard the U.S. Antarctic Supply and Research Vessel, the R/V Laurence M. Gould (LMG). The LMG is the principal supply ship for the U.S. base of Palmer Station, Antarctica, and crosses Drake Passage on average twice a month, thus providing concurrent air-sea along-track measurements at high temporal and spatial resolution on a near year-round basis.

Our poster will highlight the results from some recent analyses of the in situ underway shipboard observations from the near-repeat LMG transects in Drake Passage. Our motivation is to demonstrate the significant benefits and synergy of air-sea observations when they are measured at similar time and space scales from the same platform. The multi-year high-resolution measurements have been used to examine seasonal and spatial variability in upper ocean diapycnal eddy diffusivities, eddy heat and momentum fluxes, mixed layer depth and Polar Front location. Long-term trends in Drake Passage upper ocean temperature, CO2 concentration, winds and shifts in the Polar Front are related to large-scale climate modes of variability. The simultaneous, comprehensive suite of air-sea LMG shipboard data have enabled one of the few data-based evaluations of the air-sea heat fluxes in the Southern Ocean, as estimated from satellites, National Weather

Prediction models and the reanalysis flux products. At present the existing flux products are not accurate enough to fully explain the observed seasonal to interannual variations in the upper ocean heat budget of the Southern Ocean: the available air-sea flux products differ substantially, often by 50 Wm-2 or more, with the largest imbalances occurring in winter when there are few in situ measurements available. Improving our estimates of air-sea fluxes by validation with shipboard meteorological data should improve our physical understanding of the climate-scale processes that occur in the Southern Ocean.

To date, the high sea state and winds have deterred deployment of large surface meteorological buoys in Southern Ocean and merchant ship traffic is comparatively infrequent. Automated underway observations on research vessels and supply ships thus provide a cost-effective method for obtaining high-quality data at the air-sea interface that has benefits for a broad range of climate-related research questions. At present, the LMG provides some of the only year-round air-sea measurements in the Southern Ocean. Encouraging the routine collection of underway concurrently measured air-sea data from vessels operating in the Southern Ocean is critical, and future observation systems would benefit from expanding vessel recruitment in this region of importance to global climate.

AC-4A-39: Implementation of Geospatial Web Services for COMPS in-situ observations

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The University of South Florida (USF) College of Marine Science (CMS), St. Petersburg, Florida, US established a near real-time web-based Coastal Ocean Monitoring and Prediction System (COMPS) for the West Florida Shelf in 1997. COMPS collects and disseminates near real-time marine observations to researchers, educators, students, local, state and federal emergency management agencies, and the public via Internet. COMPS is a sub-regional coastal ocean observing system in the Southeast Atlantic Coastal Ocean Observing Regional Association (SECOORA), the Gulf of Mexico Coastal Ocean Observing System (GCOOS) Regional Association, and the Florida Coastal Ocean Observing System Consortium (FLCOOS), all regional components of the US Integrated Ocean Observing System (IOOS). The COMPS program consists of an array of coastal and offshore buoy stations located along the West Florida Shelf from the Florida Panhandle to the Dry Tortugas. COMPS offshore buoys are mounted with Air-Sea Interaction Meteorological sensors, a bridle mounted Acoustic Doppler Current Profiler (ADCP), and temperature/conductivity sensors attached to the mooring cable. Data from all the sensors are acquired by a data logger built by the USF Center for Ocean Technology and transmitted via GOES satellite once every hour. COMPS coastal stations consist of meteorological sensors, acoustic tide gauges, and conductivity/temperature sensors. The data are acquired by a Campbell Scientific Data Logger and transmitted via GOES satellite as well as by line-of-site radio. Sensors and data telemetry deployed on both types of platforms vary with location, and we also have mounted water quality sensors on some of our coastal and offshore stations. We maintain a state-of-the-art Tempest Local Readout Ground Station (LRGS) satellite receiving system, which allows us to receive and archive raw data transmitted from our stations via the GOES satellite. The raw data received from the platforms via LRGS are then parsed or decoded and quality controlled using a suite of software written in PHP, Perl and C. The data are then stored in a PostgreSQL relational database and made available on our web site. Once an hour, the parsed data from all our COMPS platforms are disseminated to the SECOORA and GCOOS Regional Associations and are aggregated with other sub regional coastal ocean observing systems located within the southeast US and Gulf of Mexico. The aggregated data are displayed and disseminated via SECOORA and GCOOS RA web sites. We also push our data once an hour in XML format to the NOAA's National Data Buoy Center (NDBC), where they are further quality controlled and distributed worldwide via the Global Telecommunication System (GTS). NDBC also makes our data available on their web site. NDBC has implemented the IOOS Data Integration Framework version of Sensor Observation Service and COMPS data will be available on their web site via established web services. Realizing the importance to increase data accessibility, enhance data integration, and enable interoperability between sub-regional, regional and federal and international coastal ocean observing systems, we have made significant improvements within COMPS data management. With active participation in the IOOS Data Management and Communications (DMAC) related initiatives and projects within the regional associations as well in state and national level within US, we have implemented community developed open source DMAC technologies to advance the COMPS system towards interoperability. As one of the largest sub-regional coastal ocean observing systems maintained by an academic institution in the southeast US and Gulf of Mexico coastal ocean regions, we have participated in the NOAA-Coastal Services Center Data Transport Laboratory projects in deploying and evaluating data transport technologies and in the OpenIOOS interoperability experiment. Implemented web services technologies include: OpeNDAP, an Open-source Project for a Network Data Access Protocol, Geographic Markup Language (GML), Web Feature Service (WFS), and Open Geospatial Consortium (OGC) Sensor Observation Service. In addition to the above web services offerings, we have implemented a Google Maps Interface on our web site and provide our observations packaged using Keyhole Markup Language (KML). KML, an OGC standard, is a very popular data sharing method and is used widely among the public and earth science communities. Users can also download archived data for a station of interest according to a chosen set of criteria from the PostgreSQL server. In conclusion, COMPS will continue to engage in US IOOS DMAC related initiatives via the Regional Associations and implement DMAC technologies that will facilitate seamless delivery of data and data products to end users within US and around the world.

AC-4A-40: The Ocean Observatories Initiative

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The U.S. National Science Foundation's Ocean Observatories Initiative will provide and maintain new ocean observing infrastructure that will be maintained for 25-30 years. The Consortium for Ocean Leadership is the prime contractor. Two Marine Implementing Organizations (IOs) will design, build, install, and maintain observing infrastructure. The Regional Scale Nodes (RSN) IO, based at the University of Washington, will provide cabled seafloor and water column observing capabilities on the Juan de Fuca plate off the Pacific Northwest coast of the U.S. The Coastal and Global Scale Nodes (IO), led by the Woods Hole Oceanographic Institution and including Scripps Institution of Oceanography and Oregon State University. CGSN will provide observing capabilities at two coastal arrays and at four high latitude global sites. Across the marine IO infrastructure there are goals of providing increased levels of real time connectivity, power to host diverse instruments, and deployment and maintenance of a core set of sensors that are multidisciplinary. The Cyberinfrastructure or CI IO will provide the marine network command and control and near-real-time data delivery to users ashore via high-speed 10Gbps networks.

The RSN will consist of seven Primary Nodes offshore in the North East Pacific, and complements a similar system being constructed by the Canadians using cable support. Each RSN Primary Node is provisioned with an initial 10gb/s of bandwidth and capable of delivering up to 8 Kilowatts of power. At present

the configuration approved by NSF involves two Primary Nodes close to the Juan de Fuca Spreading Center near Axial Sea Mount, two Primary Nodes, one at the base of the continental slope, and one midway up the slope on the so-called "Hydrate Ridge, an actively venting methane hydrate system. There are two nodes associated with the coastal research being conducted offshore from Newport, Oregon. And finally, there is a Primary Node near the middle of the Juan de Fuca Plate, to the west of Newport. A potential early addition to the approved design would involve implementing a complementary offshore HF Radar at or near the RSN Primary Node site close to the mid-Plate Node.

The CGSN coastal sites will include the Endurance Array with a line of moorings off Newport, Oregon, a line of moorings off Grays Harbor Washington, and gliders; and the Pioneer Array spanning the shelf break in the mid-Atlantic Bight, with moorings, gliders, and AUVs. The subsurface moorings of the Endurance Array's Newport line will be connected to the RSN cable. CGSN will also provide observing capabilities at four global sites: the Irminger Sea (60°N, 39°W), the Gulf of Alaska (46°N, 127°W), the Argentine Basin (42°S, 42°W), and off the southwestern coast of Chile in the Southern Ocean (55°S, 90°W). Each global site will comprises a triangular moored array, with a surface mooring and hybrid profiler mooring at one corner and taut subsurface moorings at the other two corners, and three gliders.

The OOI data will be provided to users by the CI IO and are fully open. The data will be used for analysis, event detection and assimilation into models to interpolate the sparse marine data and add data from divers observatories to predict future states of Earth. The derived knowledge will be used to plan and schedule command and control of the network including the fleet of gliders. The CI IO is located at UCSD while components of the CI are developed and maintained at Woods Hole, Rutgers, University of Chicago, North Carolina State University, NASA/JPL, MIT, USC, National Center for Supercomputer Applications, MBARI, and the University of North Carolina.

AC-4A-41: An Autonomous Mobile Platform for Underway Surface Carbon Measurements in Open-Ocean and Coastal Waters

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Understanding the role of anthropogenic carbon as a forcing factor in global climate change is an important scientific goal that has far reaching implications for government policy formulation with associated impacts upon social and economic activities and infrastructures. The presence of excess green-house gases in the atmosphere is fundamentally tied to the uptake of carbon by the world's oceans. The ocean stores carbon primarily in the form of dissolved inorganic carbon, which is increasing with time due to the absorption of CO2 gas from the atmosphere. Greater understanding of the global ocean's ultimate capacity as a sink of anthropogenic carbon is much needed. The NOAA Pacific Marine Environmental Laboratory and Liquid Robotics, Inc., are collaborating to address the need for long-term observation of carbon parameters over broad swathes of the global coastal and open ocean by integrating a suite of state-of-the-art pCO2, pH, CTD, CDOM, chlorophyll, and turbidity sensors onto a Wave Glider wave-powered autonomous marine vehicle (AMV). The resulting Bio-geochemical/Bio-Optical Wave Glider platform will be capable both of acting as a long-duration (up to 1 year) "virtual mooring" to augment the existing sparse collection of moored carbon science sensors and of conducting autonomous, basin-scale ocean transits to provide new insight into the spatial variability or carbon uptake (or release) and associated parameters. The Bio-geochemical/Bio-Optical Wave Glider's primary payload sensor is the MAPCO2 sensor being adapted by PMEL. The MAPCO2 sensor is designed for extended autonomous operation (up to 400 days) and has previously been deployed on several NOAA Ocean Climate Observatory buoys. Figure1 shows a preliminary design for the integration of MAPCO2, pH, and optical water properties sensors into the float portion of a Wave Glider platform. The autonomy, mobility, and endurance capabilities of the platform, married with its relative low-cost in comparison to ship-based sampling programs, has generated significant interest in the platform from within the National Oceanic and Atmospheric Administration (NOAA) and the greater academic community. This poster will discuss the development of the Biogeochemical/Bio-Optical Wave Glider platform and payload suite and the planned use of the platform for ocean carbon science observation. The integrated package will be tested in both open ocean environments in the North Pacific Subtropical Gyre and in coastal regions along the west coast of the US. The Biogeochemical/Bio-Optical Wave Glider data will be validated against buoy- and ship-borne sensors.

AC-4A-42: Australia's Integrated Marine Observing System Autonomous Underwater Vehicle Facility

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This paper will describe the current status of Australia's Integrated Marine Observing System (IMOS) Autonomous Underwater Vehicle (AUV) Facility. IMOS is an initiative designed to provide critical infrastructure to support marine science in Australia. The University of Sydney's Australian Centre for Field Robotics operates an ocean going Autonomous Underwater Vehicle (AUV) called Sirius capable of undertaking high resolution, seabed survey work. This platform is a modified version of a mid-size robotic vehicle called Seabed built at the Woods Hole Oceanographic Institution. The submersible is equipped with a full suite of oceanographic instruments, including a high-resolution stereo camera pair and strobes, a multibeam sonar, depth and conductivity/temperature sensors, Doppler Velocity Log (DVL) including a compass with integrated roll and pitch sensors, Ultra Short Baseline Acoustic Positioning System (USBL) and forward looking obstacle avoidance sonar. As part of the establishment of the AUV Facility, IMOS is supporting deployment of the AUV, which is made available to scientists on a competitive basis in order to assist marine projects in Australia.

The AUV has been operated on cruises around the country, providing high-resolution seabed surveys of selected sites in support of marine studies. Trials have included deployments with scientists from the Australian Institute of Marine Science (AIMS) assessing benthic habitats off the Ningaloo Reef, Western Australia; a research cruise aboard the R/V Southern Surveyor documenting drowned shelf edge reefs at multiple sites along the Great Barrier Reef; surveying of proposed Marine Parks and cuttlefish spawning grounds in South Australia; and documenting sites along the Tasman Peninsula and in the Huon MPA in Tasmania. Highlights from these deployments will be presented, illustrating the role of the AUV in the context of cruise objectives and demonstrating how the high-resolution, stereoscopic seafloor models are being used to better understand benthic habitats at depth.

AC-4A-43: Using Ocean Gliders to Measure Turbulent Mixing

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Turbulence measurements are typically carried out from tethered free-fall profilers because they provide a nearly

vibration-free platform to measure the turbulent velocity shear. While these profilers provide relatively fast repetition of the measurement and real-time data display, their operation is labor intensive and requires dedicated ship operations and skilled personnel. This mode of sampling, therefore, is not well suited to the severe spatial and temporal inhomogeneities of ocean mixing.

Here we present the results from a recent deployment of turbulence shear probes on an autonomous Slocum ocean glider. This is the first reported deployment of these sensors on a glider and the data show that the shear probes were able to resolve dissipation rates, ε, as low as 5×10^{-11} W kg^{-1}. This detection level is comparable to tethered free-fall profilers, making it possible to study turbulent mixing over large geographic areas without a proportional increase in cost and labor.

Tests flights were performed in a small lake near Cape Cod, Massachusetts. On the day of the test winds were light and the water column showed an active mixing layer with a thermocline at 7 m depth. Below the thermocline conditions were quiescent with very low turbulence levels, providing an ideal test environment. The data from the turbulence package indicate that vehicle vibrations are small. The accelerometer spectra show vibration peaks at 25, 60, 80 Hz, caused by vibrations of the glider's tail fin assembly. These vibrations are excited by the action of the glider's buoyancy pump and rudder. The vibration peaks have a small magnitude and narrow bandwidth and only the 80 Hz peak enters the shear probe spectrum in some instances. The shear probes resolved dissipation rates between in the quiescent layer below the thermocline and in the mixing layer. All measured shear spectra fit well with the Nasmyth Empirical Spectrum.

AC-4A-44: Sustained Ocean Observations for 30 Years Using Argos

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Since the late 1970's oceanographers, meteorologists and climatologists have used the satellite-based Argos system to report in-situ observations collected by a wide-range of buoys, fixed stations and profiling floats. These data have made significant contributions to our ability to describe, understand and predict global climate and weather on all space and time scales. These global in-situ data collection platforms represent essential core elements of the international Global Climate Observing System (GCOS) and the Global Ocean Observing System (GOOS). These platforms, reporting their data via Argos, have formed the backbone of international weather and climate programs for almost 30 years and through GCOS and GOOS in particular, will play a substantial role in the implementation of the Global Earth Observing System of Systems (GEOSS). This poster will illustrate the significant role Argos has played in the evolution of ocean observing systems during the last few decades, as well as how the new generations of Argos systems are positioned well to serve the satellite-based data collection needs of GEOSS interdisciplinary science.

Day 4: Developing technology and infrastructure

Session 4B: Satellite

AC-4B-01: Sentinel-3 Surface Topography Mission System Performance Simulator and Ground Prototype Processor and Expertise

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Sentinel-3 is an Earth Observation Mission in the frame of GMES which launch is expected for the end of 2012. Its payload includes the following instruments:

- A Ocean and Land Colour (OLCI) instrument,
- A Sea and Land Surface Temperature (SLSTR) instrument,
- A SAR Radar Altimeter (SRAL) instrument,
- A Microwave Radiometer (MWR) instrument,
- A Global Navigation Satellite System (GNSS) receiver.

The set of the 3 instruments, SRAL, MWR and GNSS constitute the so-called Surface Topography payload.

In the frame of the development of the first Sentinel-3 satellite, System Performance Simulator (SPS) and Ground Processors Prototype (GPP) are to be built for each instrument of the topography mission. This activity is performed by CLS under Thales Alenia Space contract for ESA (end customer). The objectives of these simulators/processors are the following:

- Support the development and the validation of the operational level 0, level 1b processor;
- Support the development of the instruments.
- Evaluate along the development program the end-to-end mission performances
- Support during the In Orbit Commissioning phase To reach these objectives, the two simulators/processors are identified as follows:
- The Ground Prototype Processors (GPP) which will include the level 0, level 1b processing and will help satisfying the above first objective
- The System Performance Simulators (SPS) which include the GPP as well as other modules. It will help satisfying the last two objectives by generating geophysical representative Mission data products. It will require a simplified level 2 processing.

The usage of the STM SPS and GPP will evolve in time. At the beginning of their life, they will be used to establish the performances baseline. Then along the development of the instruments they will be used to check the instruments conformance to the expected products performances. In parallel they will be used to support the ground processing development. Once the instruments integrated to the platform, they will be used to check the correctness of the integration. Finally once the satellite in orbit, they will be used as a support for the performance assessment.

The SPS aims at simulating the end to end Surface Topography Mission , from scene simulation, through satellite and instruments behavior , and up to the ground processing system. It will be used for checking the Satellite or Instrument parameters (monitoring the instrument design and effect of characterisation data), and for analysing the overall Satellite and Sentinel-3 Surface Topography Mission Instruments compliance to the products performance requirements, at L1b level and simplified Level 2 processors.

AC-4B-02: Sentinel-3 Surface Topography Mission Products and Algorithms Definition

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GMES is an ambitious program developed by ESA and European Union which will allow Europe to get autonomous and independent access to geo-spatial information services.

It will be composed of satellites and in situ measurement facilities, core services and downstream services. In this framework the Sentinel-3 mission is devoted to provide ocean information products.

For that, the payload has been designed to fulfill three objectives:

- the topography mission through combination of altimeter, radiometer and POD measurement,
- the ocean color and land cover mission,
- the sea surface temperature mission.

This payload takes benefit from the heritage of past and on-going ESA missions, namely ERS1-2 and ENVISAT. As far as the topography mission is concerned it will also take benefit from the CRYOSAT development allowing to enhance the altimeter performances through use of delay Doppler technique. The payload will also benefit from new features, a GPS POD receiver will be used, the POD system will be coupled to the altimeter to get a better tracking of all surfaces and the radiometer will also include new developments.

The purpose of the project presented here is to define and develop the mission level 2 products and associated processing algorithms for the Topography Mission. Thanks to the orbit selection and topography payload design the Sentinel-3 mission will provide valuable information over multiple areas:

- Open and coastal ocean,
- Sea ice and glaciers,
- Inland waters.

This will give to these measurements a key role to fulfill various GMES objectives. Three types of products will be processed and distributed to meet the requirements all users operational requirements:

- The Near Real Time product will be mainly dedicated to meteorological analysis and forecast centers needs.
- The Slow Time Critical product will be mainly dedicated to ocean analysis and forecast centers needs.
- The Non Time Critical product will be mainly dedicated to off line analysis and climatology.

These products will meet specifications defining error budget, latency, etc. and CalVal processes will monitor their quality.

The main tasks that are performed in the framework of the project are:

- Level 2 products design to fulfill users needs.

 Algorithms design necessary to process these products from level 1b products, satisfying error budgets.
 Reference processor development that will implement these algorithms and will be used to verify the performances and provide TDS, this processor will also be used to support the ground system development.

To realize this work our consortium gathers key actors, CLS, MSSL, ACS and CNES having recognized experience in this area and which cover all the expertise needed. More precisely:

 CLS provides its expertise in altimetry processing over open ocean, coastal zone and hydrology and its expertise in CalVal and level 3/4 processing.
 MSSL provides its expertise in altimetry processing over ice, sea ice, its expertise in SAR altimeter processing and CalVal.
 ACS provides its experience in the development of CRYOSAT processing and its knowledge of GAMME environment.
 CNES provides its global experience in altimetry and its expertise in POD processing using multiple techniques, DORIS, GPS, laser through its involvement in TOPEX/POSEIDON, ENVISAT, Jason among other missions.

AC-4B-03: The Lucinda Jetty Coastal Observatory's Role in Ocean Colour Calibration and Validation for Coastal Waters

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As part of the Australian National Mooring Network 9ANMN) of the Integrated Marine Observing System (IMOS), the Facility "Satellite Ocean Colour calibration and validation" aims to provide valuable data in coastal waters to unravel the inaccuracies in remotely-sensed satellite ocean colour products due to the optical complexity in coastal waters and the overlying atmosphere. The Lucinda Jetty Coastal Observatory (LJCO) is the first of the site of the "Satellite Ocean Colour calibration and validation" IMOS-ANMN Facility. LJCO aims to become a major source of measurements in the Great Barrier Reef for the validation of coastal-ocean colour radiometric products by increasing the number of satellite vs. in situ match-ups assessment of normalized water-leaving radiances, water inherent optical properties and aerosol optical properties. LJCO will merge two different data streams: above water measurements of the water radiance and in water measurement of the optical properties. An autonomous above-water radiometer (CIMEL-SeaPRISM) will perform marine radiometric measurements for determining water leaving radiance in addition to the regular atmospheric data for retrieving aerosol optical properties. An in situ instrument package representing the state-of the art of underwater optical instruments will be deployed to characterize the optical properties of these complex coastal waters. The instruments will be commissioned in May – June 2009. Preliminary results for LJCO will be presented.

AC-4B-04: The Wavemill Concept for Direct Measurement of 2D Ocean Surface Currents

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Wavemill is a variation on the Wide-Swath Ocean Altimetry concept. As such, tt uses pairs of antennas separated in the across-track direction to form interferogrammes and hence derive the sea-surface topography to both the left and right of the sub-satellite track. However, there the similarity with WSOA ends since the beams of Wavemill are squinted fore and aft by up to 45 degrees, the incidence angle is around 20-30 degrees and in addition to the across-track baseline, there is also an along-track baseline between the antennas. In this way it is possible to measure directly, by means of along-track interferometry, the current velocities on the surface of the ocean in orthogonal directions (line-of-sight of the antenna beams) so that a 2D map of these currents can be formed. Furthermore, the Wavemill concept includes the capability for self-calibration with respect to attitude and baseline errors which in the past have been seen as a major obstacle to the conventional WSOA-type instrument.

This paper looks at the properties and possibilities of the Wavemill concept and reports on on-going work to determine its performance in terms of accuracy - resolution, height, current velocity and current direction. It also looks at the possible applications such as separating surface from geostrophic currents and its suitability for monitoring coastal waters.

AC-4B-05: CTOH Regional Altimety Products: Examples of Applications

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The Centre for Topographic studies of the Oceans and Hydrosphere (CTOH) is a French Observation Service dedicated to satellite altimetry studies. Its objectives are to 1) maintain and distribute homogeneous altimetric databases for applications over the oceans, the hydrosphere and cryosphere, 2) help scientific users develop new altimetry derived products and 3) contribute to the development and validation of new processing approaches of the altimetric data in emerging research domains. For some years, a dedicated data processing system has been developed by the MAP (Margins Altimetry Project) community to recover information from altimetry over marginal seas: the X-Track software. Starting from classical Geophysical Data Records (GDR) products, it incorporates the latest corrections available in the CTOH database, the editing strategy has been re-defined to recover a maximum of useful information, a variable sampling rate processing is available (1Hz to 20 Hz), inversion algorithms have then been added for estimating a high resolution mean sea surface directly from the improved altimeter data and the post processing step is based on user defined criteria. When available, regional high-frequency models of tides and atmospheric loading are also applied. The result is a processing tool which can be easily tuned to respond to particular applications. After a validation stage in different experimental regions, the X-Track software is now routinely operated by the CTOH for coastal applications. 1Hz or higher frequency along-track data from different altimetric missions are reprocessed on a regional basis. Once they are validated, these data are made freely available through the CTOH website: http://www.legos.obs-mip.fr/en/observations/ctoh/. They have already been used for various scientific applications (eg coastal and shelf ocean dynamics, model validation, data assimilation, regional variations of long term trend, ...) in different areas: in the Mediterranean Sea, the southwest and southeast Pacific, northern Indian Ocean, Gulf of Biscay, Great Australian Bight. Besides technical difficulties in recovering the oceanic signal near the coasts, the question of how to interpret sea level anomalies observations in terms of coastal processes is still open. Here, we start to address this issue through examples of different applications.

AC-4B-06: Performance Estimation of Recent Tide Models Using Altimetry

and Tide Gauges Measurements

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Thanks to its current accuracy and maturity, altimetry is considered as a fully operational observing system dedicated to various applications such as climate studies. Altimeter measurements are corrected from several geophysical parameters in order to isolate the oceanic variability and the tide correction is one of the most important.

Global tide models GOT00v2 and FES 2004 are commonly used as a reference for tide correction in the altimetry products (GDR). GOT00v2 is an empirical model based on altimeter data, while FES 2004 is a finite elements hydrodynamic model which assimilates altimeter and in situ data. The accuracy of both models in open ocean is centimetric but significant errors remains in shallow waters and in polar regions, due to the omission of compound tides and to sea ice effects on data respectively.

New global models are now available (GOT4.7, EOT08a). We use multi-mission (Topex-Poseidon, Jason-1 and EnviSat) altimetric analysis of Sea Surface Height (SSH) differences at crossovers, sea level anomalies (SLA) and in-situ measurements (tide gauges from several databases) to determine and compare their performances. First analysis shows that GOT4.7 improves GOT00v2 in polar and coastal areas but is worse in Hudson Bay and Bering Strait due to seasonal ice coverage. Tide gauge time series constitute local references and comparison to altimetric SSH reveals a decrease of the SSH variance of 4 cm2 when using GOT4.7 model instead of GOT00v2. EOT08a model also allows reducing the variability in shallow water regions if compared to the reference model, even though some problems due to aliasing of S2 signal are detected in deep ocean. In the future, assimilation of data is essential to maintain good performances of models in open ocean and still improve the transition to coastal zones. In these areas, more observations are needed to improve the modelling of non linear tides and secondary waves which are characterised by respectively short wavelengths and weak amplitudes, and are thus not well resolved by actual altimetric systems. A better bathymetry is also essential to refine local modelling of tides. Moreover, the performances of global models will be improved in coastal areas thanks to the coupling with high resolution local models: nested models are being developed by several international research groups (Laboratoire d'Etudes en Geophysique et Oceanographie Spatiales, Bedford Institute of Oceanography).

AC-4B-07: Experimental Coastal Altimetry Data From the Coastal Project

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Satellite altimetry over the open ocean is a mature discipline, and data are routinely assimilated for operational applications. In contrast, global altimetry data collected over the coastal ocean remain largely unexploited in the data archives, simply because intrinsic difficulties in the corrections (especially the wet tropospheric component, the high-frequency atmospheric signal and the tides) and issues of land contamination in the footprint have so far resulted in systematic flagging and rejection of these data. In the last couple of years, significant research has been carried out into overcoming these problems and extending the capabilities of current and future altimeters to the coastal zone, with the aim to integrate the altimeter-derived measurements of sea level, wind speed and significant wave height into coastal ocean observing systems. At the same time the major Space Agencies have recognized the importance of the topic and are sustaining coastal altimetry research through projects such as COASTALT (ESA), PISTACH (CNES) and some OSTST (NASA/CNES) initiatives. A number of crucial improvements to the processing of the altimetric waveforms in the coastal zone and to the correction of the measurements for path delay and geophysical effects (tides and atmospheric) are being implemented and tested. The first custom-processed coastal altimetry data are now available, and many more data from Jason-1, Jason-2 and Envisat will become available during 2009. This new "coastal altimetry" community, inherently interdisciplinary, has already had two well-attended international workshops (see http://www.coastalt.eu/pisaworkshop08/) and the third one is scheduled for the week before OceanObs'09 (http://www.congrex.nl/09C32/)

In the poster we will illustrate the new experimental Envisat radar altimeter products in the coastal zone generated within the COASTALT Project, funded by the European Space Agency. COASTALT aims at defining, developing and testing a prototype software processor over a few pilot areas surrounding Europe, including the Northwestern Mediterranean, the West Britain coast and the West Coast of the Iberian Peninsula. Ultimately, the plans are for ESA to routinely generate and distribute these new Envisat coastal altimetry products globally, also in preparation for exploitation of data from the future altimetry missions, CryoSat and Sentinel-3. These missions will have inherently improved coastal zone capabilities by virtue of the adoption of a Delay-Doppler instrument.

First we will show the architectural design and operation of the COASTALT prototype software retracker, i.e. the software processor that generates the improved coastal altimetry data. This consists of two functional units, which are both run as stand-alone applications:

- the baseline COASTALT Processor. The processing options of the baseline processor are controlled by the user at run-time through an editable Configuration file. The baseline processor components, interfaces and data flow are shown in Figure 1. The basic functions of all the significant blocks are described below in more detail.
- the User-defined Coastal Geophysical Corrections (UCGC) module. The UCGC module is an optional add-on for users interested in ingesting their own user-defined geophysical corrections into the COASTALT product

Then we will briefly describe the COASTALT Envisat product generated for the coastal domain by the above processor. The product will be based on the data from the Envisat level 2 Sensor data record, as defined in the Envisat product handbook and product specification documents. Not all records from the Envisat SDR data are included in the COASTALT product – instead only those data considered necessary for processing of the output data, or useful for direct comparison with the new fields, are included. The COASTALT data product uses the NetCDF (network Common Data Form) data format. The format was chosen as it is extremely flexible, self describing, platform independent and has been adopted as a de-facto standard for many operational oceanography systems. Although the latest version of NetCDF (v 4) has advantages in terms of data compression, COASTALT data will be produced in NetCDF v 3 format, to retain maximum compatibility with existing software and for simplicity of installation, as it does not require the additional HDF 5 and compression libraries.

Finally, we will briefly recall some possible applications of the new product – which are covered in a more extensive way in a OceanObs'09 Community White Paper on Coastal Altimetry.

AC-4B-08: Ephemeral mesoscale niches of phytoplankton taxa in the global oceans

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The biogeochemical role of phytoplankton organisms strongly varies from one taxon to another. The type and depth of web chain sustained by phytoplankton, the efficiency in stocking CO2 at the ocean interior, and the response to acidification are in large part determined by which dominant group is present in a community. In situ observations find dominant groups often associated to specific physical and chemical water properties. However, the mechanisms and spatiotemporal scales by which these dominant groups are organized are largely not known. Here we show how the structure of phytoplankton communities can be observed at the global scale, by combining multisatellite data, notably high resolution ocean color maps of dominant groups and altimetry-derived Lagrangian properties of the surface transport. We find that the landscape of dominant phytoplankton taxa is organized by mesoscale (10-100 km) dynamical niches with lifetimes comparable with the timescale of a bloom. These niches are maintained by the mesoscale turbulence, that stirs water masses of different origin from the ocean basin scale up to filamentary patterns few km wide. We find no evidence of invasion fronts driven by purely ecological dynamics at this scale. Through this stirring mechanism, fluid dynamics affects key ecological and evolutionary features, such as the localization of the bloom, the scales of dispersal and of competition. This mechanism may suggest how to exploit available observational and model data of surface transport properties for more efficient in situ sampling strategy and for incorporating the biotic component in models for global climate change.

AC-4B-09: Comparing And Combining Argo Data With Altimeter And SST Data To Reconstruct 3D Thermohaline Fields

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Studying the ocean's vertical structure greatly depends upon the availability of ocean observations. On one hand, temperature (T) and salinity (S) profile measurements from Argo profiling floats provide sparse in-situ data, but give precise estimations of the ocean's steric vertical structure every 10 days and for large part of the world ocean. On the other hand, satellite altimetry (Sea Level Anomaly, SLA) and sea surface temperature (SST) measurements provide steric and non-steric synoptic observations of the sea level every 7 days, all over the world. Both types of data are needed for climate and operational oceanography and it is necessary to distinguish steric and non-steric components in order to merge correctly altimeter and in-situ data through data assimilation techniques. The aim of the study is to merge these three dataset in order to reconstruct global instantaneous 3D thermohaline fields (ARMOR-3D) from the surface, down to a depth of 1500-m according to the method develop by Guinehut et al. (2004). The first step consists in using a linear regression method to reconstruct temperature and salinity fields from satellite altimeter and SST measurements. The accuracy of the merging is highly sensitive to the extraction of the steric component from the altimetry signal, to the climatology data used as the first guess, to the resolution of the SST and of course to the estimated errors covariances between different signals. In the second step, these reconstructed fields are combined with in-situ data using an optimal interpolation method.

Compared to previous estimates, this study shows large improvements thanks to the Argo data set and the use of high resolution SST fields. In particular, the mesoscale structures and the deep fields are much better constrained. Relative impact of the three observing systems (SLA, SST, T/S profiles) has been quantified at global scale and shows their complementarities. ARMOR-3D fields have been used to analyse the ocean variability over the past 16 years, and keep being improved.

AC-4B-10: Global maps of altimetry-derived submesoscale fronts and filaments from Lyapunov exponent calculation

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The calculation of the Lyapunov exponent is a robust diagnostic that can be applied to altimetry-derived geostrophic currents, in order to extract the position and strength of sub-mesoscale fronts and filaments for the global oceans. The information obtained from Lyapunov exponents is useful to explain the impact of lateral stirring on the spatiotemporal variability and redistribution of biogeochemical tracers such as chlorophyll, surface salinity, sea surface temperature. In particular, this diagnostic has been shown to reproduce the filamentation induced in advected tracer fields by mesoscale eddies and to estimate the position and timescale of filament formation up to sub-mesoscale resolution (a few km). In this way, high-resolution sea surface temperature and chlorophyll satellite images can be combined with mesoscale-resolution altimetry-derived structures. Applications include climatological analysis of stirring and mixing, front and filament detection for in-situ research campaign studies, and as an independent validation for models. The calculation of the Lyapunov exponent however is more demanding than traditional diagnostics, requiring the construction of particle trajectories by interpolating and integrating the surface currents. In a joint collaboration between the CTOH-LEGOS in Toulouse, and LOCEAN-IPSL and the Institute of Complex Systems (ISC) in Paris, we are constructing maps of Lyapunov exponents from satellite based surface velocity fields, producing filament-resolving, daily maps. These have been obtained using the delayed-time and near-real-time AVISO altimetry-derived geostrophic velocities, and using the CTOH geostrophic and Ekman near-surface currents. The fine-resolution Lyapunov maps will be distributed to scientific users via the CTOH and LOCEAN web sites under a joint license.

AC-4B-11: Investigating Bay of Biscay mesoscale and coastal ocean dynamics from a combination of satellite and in-situ observations

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The dynamics of the Bay of Biscay have been intensively investigated, from both hydrographic data and numerical studies. In parallel, satellite data also give very important informations about the ocean dynamics. Optical and infrared sensors provide high spatial and temporal resolution data,but their use is significantly limited by the atmospheric conditions prevailing in the Bay of Biscay. On the other hand, satellite altimetry, which is substantially less affected by meteorological conditions, has been relatively scarcely used within the Bay of

Biscay compared to other oceanic regions. One of the reasons is the aliasing of unresolved high-frequency tidal and wind induced signals corrupting measurements over shallow waters parts of the basin. Recent studies have shown that the use of state-of-the-art dealiasing models significantly improve the quality of the data in these highly dynamic regions and enable access to their dynamics.

In this study we analyze the potential of altimetry (from both standard gridded altimetric data, and a regional altimetric product including the latest available dealiasing corrections and a specific coastal oriented processing) in conjunction with other data sets (in-situ and remote sensing data) to investigate the dynamics of the Bay of Biscay. We will focus on the ability of these different data (used in combination or separately) to detect mesoscale processes and to document their main characteristics. We will also examine closely the associated year-to-year modulation and its possible relationships with coastal dynamics and climatic conditions.

AC-4B-12: Exploitation of GlobColour dataset: global characterisation of Chlorophyll, aCDM and bbp uncertainties at pixel level

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The GlobColour project has been initiated and funded by the ESA Data User Element Programme to develop a satellite based ocean colour data service to support global carbon-cycle research and operational oceanography. It aims to satisfy the scientific requirement for a long (10+ year) time-series of consistently calibrated global ocean colour information with the best possible spatial coverage. In order to cover the long time span necessary for climate monitoring purposes, the required ocean colour data set can only be built by merging together observations made with different satellite systems. To that purpose, MERIS products are merged with MODIS and SeaWiFS and a Full Data Set (FPS) covering more than 10 years of observation has been built and made available to the scientific community (www.globcolour.info) and in particular to the key users of the project: IOCCP, IOCCG and UKMO. The GlobColour service distributes global daily, 8-day and monthly data sets at 4.6 km resolution for, chlorophyll-a concentration, normalised water-leaving radiances (412, 443, 490, 510, 531, 555 and 620 nm, 670, 681 and 709 nm), diffuse attenuation coefficient, coloured dissolved and detrital organic materials, total suspended matter or particulate backscattering coefficient, turbidity index, cloud fraction and quality indicators. New demonstration products are available online too: Photosynthetic Available Radiation, Depth of the Heated Layer, Secchi Disk Depth. Error statistics from the initial sensor characterisation are used as an input to the merging methods and propagate through the merging process to provide error estimates on the output merged products. These error estimates are a key component of GlobColour as they are invaluable to the users; particularly the modellers who need them in order to assimilate the ocean colour data into ocean simulations. The NRT service was started mid-2008, with a global daily delivery of merged MERIS and MODIS ocean colour data to primarily support operational oceanography. The GlobColour service has begun to feed in the European Community funded Marine Core Service, MyOcean, which starts to provide, in 2009, a suite of services to support Europe's decision makers. GlobColour's merged ocean colour dataset are provided by the Global Ocean Colour Thematic Assembly Centre (http://www.myocean.eu.org/repository/full_catalogue_v0.pdf) whose main objective is to bridge the gap between space agencies providing ocean colour data and Global Monitoring for Environment and Safety (GMES) marine applications. The exploitation of the GlobColour dataset gives access to the spatial and temporal variability of the Chlorophyll, aCDM and bbp uncertainties at global and regional scales. Results of this characterisation will be presented and discussed.

AC-4B-13: The SLOOP Project: Preparing the Next Generation of Altimetry Products for Open Ocean

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Since the launch of the first altimeters the accuracy of the altimetry data has continuously increased thanks to the improvement of both the technology of the instruments and the on-ground processing. These improvements allowed the apparition of various applications. About a thousand teams (in 2007) now use the altimetry products around the world for geodesy, oceanic circulation, model, wind/waves applications...

The SLOOP project, initiated by CNES in 2008, intends to prepare the next generation of altimetry products for open ocean. This project consists in two phases. The first phase is the analysis of the users needs and the subsequent redefinition of the product content in terms of resolution way of data distribution to the final user. Secondly all the potential improvements of the altimetry processing chains will be analysed. This includes the development of new retracking algorithms, the update of geophysical corrections based on recent models and algorithms, and the computation of new reference surfaces (Mean Sea Surface, Mean Dynamic topography). A specific study will also be dedicated on the quantification of the errors of altimetry measurements.

Improving the altimetry products requires several fields of expertise. A consortium gathering experts in most of these fields will be in charge of this project on behalf of CNES. This project is a good opportunity to have a consistent approach for the general improvement of the current altimetry processing. It is also a good opportunity to reinforce the collaboration between the altimetry product development teams and the final users, which is essential to have optimal products, suitable for all kind of applications.

AC-4B-14: CP34: A Spanish Infrastructure to Provide Global Salinity and Soil Moisture Maps From SMOS Satellite Observations

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The European Space Agency's Water Mission, the Soil Moisture and Ocean Salinity mission (SMOS) was selected in 1999 as the second Earth Explorer opportunity mission to be implemented and is expected for launch in July 2009. SMOS single payload, an interferometric microwave (L-band) radiometer, shall provide for the first time global observations of soil moisture and ocean salinity to improve our understanding of the Earth's hydrological cycle.

The SMOS Data Processing Ground Segment (DPGS) is organised to generate reconstructed images of brightness temperature from the multiple (69 elements) antenna correlations measured on board and transmitted to the ESA ground stations (primarily ESAC, near Madrid, Spain). Then these snapshot brightness temperatures are accumulated along an orbit, and the multi-angular measurements used to retrieve

both geophysical variables, through an iterative adjustment based on modelling the L-band emissivity of the observed surfaces with the knowledge of auxiliary information on the environmental characteristics of both soil and ocean. The result will be strips, approximately 1000 km wide, of the spatial distribution at a resolution of 30-50 km of moisture over the continents and surface salinity over the oceans with an expected accuracy of 4% and 1 psu respectively.

The ESA mandate is to compute and distribute these level 2 products. However, many users interested in performing large scale and climate studies are expecting global gridded maps at an improved geophysical resolution. This can be achieved by temporal and spatial averaging of the SMOS L2 products to reduce noise, and that in the case of ocean salinity can result e.g. in monthly maps at 1º spatial resolution and accuracy of the order of 0.1 psu.

The Spanish Delegation to ESA and the National Program on Space decided to fund and implement a specific facility, the SMOS Level 3 and Level 4 Processing Centre (CP34), to offer these high level products to the international research community. CP34 has been designed and developed since 2004 and will be ready for operation at the SMOS launch. It is formed by a Production and Distribution Centre, located at ESAC close to the SMOS DPGS, and an Expert Centre in charge of the definition, algorithm development and testing, and further validation of the CP34 products. The latter is part of the SMOS Barcelona Expert Centre on Radiometric Calibration and Ocean Salinity (SMOS-BEC) installed at the Institute of Marine Sciences (Spanish Research Council, Barcelona) in cooperation with the Universitat Politècnica de Catalunya.

This presentation is describing the different products that will be generated and openly distributed by CP34, as well as providing an overview of the SMOS-BEC activities in support of several aspects of the SMOS mission.

AC-4B-15: The Aquarius Salinity Satellite/ In-situ Data Comparison Processing System – A Demonstration

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The Aquarius/SAC-D satellite mission, scheduled to launch in 2010, will utilize various types of near-real time in situ data to validate the satellite remote sensing sea surface salinity (SSS) measurements. The validation data will include SSS data from Argo floats, moored buoys, ship thermosalinographs, CTD's and surface drifting buoys. Each data type will require data-specific processing to optimize the comparison with the surface-focused satellite measurement. The objectives of the Aquarius Validation Data System (AVDS) are to collect appropriate in situ surface salinity data for comparison with Aquarius/SAC-D satellite surface salinity measurements and to make this data available to the user community at large. The AVDS data will be matched up with associated satellite data by the Aquarius Data Processing System at Goddard Space Flight Center which will be incorporated back into the AVDS for processing and evaluation. An operational model of the Aquarius/SAC-D data exchange will be running during the year prior to launch to resolve conflicts and to fine-tune the data exchange process before real-time satellite data are available. As part of the AVDS, a web-based data base management system will allow the user community to review and evaluate the data and validation processing utilizing user selectable parameters. We will present an overview of the AVDS system as well as provide an example of the prototype web database access with simulated satellite data and in situ data.

AC-4B-16: Physical Oceanographic Data Sets Available at PO.DAAC

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What is PO.DAACPO.DAAC (Physical Oceanographic Distributed Active Archive Center) is the archive for NASA's physical oceanographic data and related information. It manages and distributes satellite data for Ocean Surface Topography (OST), Ocean Vector Winds (OVW), Sea Surface Temperature (SST), Ocean Circulation & Currents, and Gravity.

Operational Products
PO.DAAC has several data products that are available within 6-hours or less from time of data collection. These products are ideal for meteorological use, plotting courses for shipping routes and fisheries management.

OST
OST includes sea surface height (SSH), sea surface height anomalies (SSHA), and significant wave height (SWH). Jason-1 OSDR's are available within a 3-5 hour time lag and contain significant wave height and wind speed. PO.DAAC also has a GPS orbit derived SSHA product from OSTM/Jason-2. It is available within a 5-7 hour time lag and includes all the same parameters as the OSTM/Jason-2 OGDR plus a highly accurate GPS orbit and derived SSHA.

OVW
OVW products provide ocean surface wind speed, direction, and individual wind components referenced at the 10 meter height level. QuikSCAT data are available within a 2 hour time latency and has 25 km spatial resolution.

GHRSST
PO.DAAC, in conjunction with NOAA NODC, is also distributing the complete catalog of sea surface temperature products from the Group for High Resolution SST (GHRSST) Project. This is an international effort to produce SST products in common file and metadata formats for nearly every SST measuring instrument in space. They provide real time data from microwave instruments such as AMSRE and TMI, and from IR instruments such as MODIS, AATSR, GOES, SEVIRI and AHVRR. Resolutions vary from 25 km to 1 km.

Science Quality Products
PO.DAAC's primary mission is to provide Level-2, 3 and 4 data products that can be used for ocean and climate research. These products have typically undergone rigorous calibration and validation processes to ensure the highest quality product possible. Moreover, as algorithms improve these products are often superseded with more accurate ones.

OST
OST data can be used for analysis and/or prediction of sea level rise, hydrology and geostrophic currents. PO.DAAC archives the entire suite of products for TOPEX/Poseidon and Jason-1, which together span16 years of data collection. In collaboration with Ray et al, PO.DAAC will soon distribute a consistent 16+ years climate data record. This will be followed by a gridded level 3 version of this product from Leben et al. This year PO.DAAC will also distribute a coastal SSH and near surface alongshore current product available for the USA's west coast from Strub et al.

GRACE measures the Earth's gravity field and can be used for sea level variations, ice mass variations and changes in ocean bottom pressure. It was launched in 2002. It has a spatial resolution of 500 km to 1 degree.

OVW
PO.DAAC's OVW data holdings collectively account for nearly 28 years of data starting in July of 1978 and discontinuously extend until present day. These products are primarily acquired through satellite-based scatterometer instruments such as: SeaWinds on QuikSCAT, SeaWinds on ADEOS-II, NSCAT,

and Seasat SASS. Satellite radiometer ocean surface wind speeds are also available from SSM/I, TMI, AMSR-E, and Nimbus-7.

The Cross-Calibrated Multi-Platform (CCMP) multi-instrument ocean surface wind velocity product is an analysis of satellite, in situ, and NWP-derived quantities. It offers a consistent gap-free climate data record at a grid resolution of 25 km with temporal sampling every six hours extending from January 1, 1987 until June 30, 2008.

SST
SST is useful for detecting currents, ocean circulation, predicting locations of sea life and for helping determine long-term climate change. PO.DAAC provides over a dozen SST data sets including the Pathfinder Version 5 dating back to 1985. The primary instruments used in detecting SST are the Advanced Very High Resolution Radiometer (AVHRR), the MODerate Resolution Imaging Spectroradiometer (MODIS) and the Imager used on the Geostationary Operational Environmental Satellites (GOES).

PO.DAAC will be producing sea surface temperature frontal probabilities (fig. 1) and average SST gradient fields derived from the 1985-2008 version 5 AVHRR Pathfinder SST time series. These products will be produced in 10 day and monthly intervals for the entire Pathfinder record as a retrospective product. These products are useful for identifying persistent regions of high mesoscale SST variability and gradients due to upwelling, eddies, and strong western boundary currents and current shear. Many of these ocean dynamics have been linked to phytoplankton growth, food web dependencies, and fisheries and marine mammal management. These products will become available summer 2009.

AC-4B-17: Operational Wind Field Retrieval from Synthetic Aperture Radar

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Satellite borne synthetic aperture radar (SAR) instruments enable image the ocean surface at a very high resolution, typically below 100 m. Since the launch of the European remote sensing satellites ERS-I, ERS-2 and ENVISAT, as well as the Canadian satellites RADARSAT-1 and RADARSAT-2, SAR images have been acquired on a continuous basis over the oceans for the last 18 years. Their high resolution and large spatial coverage make them a valuable tool for measuring ocean surface winds. The above mentioned SARs operate at C-band and at moderate incidence angles. For this electromagnetic wavelength and range of incidence angles the backscatter of the ocean surface is primarily caused by the small scale surface roughness, which is strongly influenced by the local wind field and therefore allows the backscatter to be empirically related to the wind.

In this paper, we introduce WiSAR a methodology that enables retrieval of high resolution ocean surface wind fields from C-band SAR data on a fully automated and operational basis. Wind directions are extracted from wind-induced phenomena that are aligned in the wind direction. The orientations of these features are derived by determining local gradients of the normalized radar cross section (NRCS) from the SAR data. In this approach, a SAR image is sequentially smoothed and reduced to resolutions of 100, 200, and 400 m. From each of these images, local directions defined by the normal to the local gradient (to within a 180° ambiguity) are computed. Pixels associated with land, surface slicks, and sea ice, are masked and excluded from the analysis by considering land masks and several parameters retrieved from the SAR data. From all of the retrieved directions, only the most frequent directions in a predefined grid cell are selected. For better results this process can be assisted by consideration of results of an atmospheric numerical forecast model. The 180° directional ambiguity is removed by considering external a priori information, e.g., weather charts, atmospheric models or in situ measurements. Wind speeds are retrieved utilizing a geophysical model function (GMF) that describes the dependency of the NRCS on the local near-surface wind and imaging geometry. For C-band, VV-polarization, there are a number of popular model functions. The most commonly used is Cmod5. Each of these GMFs is directly applicable for wind speed retrieval from C-band VV polarized SAR images. For wind speed retrieval from C-band SAR images acquired at HH-polarization, no similar well-developed GMF exists. To meet this deficiency a hybrid model function is used that consists of one of the prior mentioned GMF and a C-band polarization ratio (PR).

WiSAR is validated on a data set consisting of over 600 ENVISAT ASAR images acquired in European waters and co-located to in situ wind measurements from buoys. For the validation WiSAR was run with and without assistance of the numerical atmospheric model NOGAP. The comparison to buoy winds also includes the comparison of the C-band models Cmod_Ifr2, Cmod4, and Cmod5.

Within a demonstration project, WiSAR has been running since September 2005 at the GKSS Research Center on an operational basis. In this project wind field maps of the North and Baltic Sea are generated on a daily basis and made available via the internet. Therefore, WiSAR was setup to process ENVISAT ASAR data of the North and Baltic Sea into ocean surface wind fields fully automated and in near real time.

AC-4B-18: Multi-Satellite Blended Ocean Surface Wind Product

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The ocean, covering roughly 71% of the Earth's surface, plays a major role in driving both regional and global climate variability via the exchange of heat, moisture, momentum, gases, and particulate matter across the air-sea interface. The fluxes of energy and matter exhibit variability on multiple spatiotemporal scales, thus in order to better understand the coupled climate system the ocean surface variables need to be observed on a range of scales. In order to investigate variability on synoptic and smaller scales, data from numerical weather prediction (NWP) models and/or satellites must be utilized. Observationally, information from multiple orbiting satellites is required to accurately represent phenomena on synoptic/sub-synoptic scales due to the discrete nature of the sampling. The ultimate goal of this work is to objectively construct a global high resolution multi-satellite blended ocean surface wind (speed and direction) product using data obtained from the Remote Sensing Systems (RSS). A direct minimization approach is utilized with the University of Washington Planetary Boundary Layer (UWPBL) model acting as a physical constraint. The objective technique applies several constraints to maximize similarity to observations and minimize nongeophysical features (e.g., satellite tracks) in the spatial derivatives with a minimal amount of smoothing. The achievable temporal resolution of the product remains uncertain due to the inhomogeneous distribution of observations in time. Regions of large natural variability (e.g., mid-latitude storm tracks) require frequent observations to accurately capture the evolving environment. The accuracy of the product, especially in highly variable conditions, is greatly depended on the number of overpasses, amount of rain flagged data, and redundant observations throughout the averaging period.

AC-4B-19: Use of satellite measurements to reconstruct the three-dimensional dynamics of the oceanic upper layers

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We examine the emerging potential offered by satellite microwave measurements to derive the three-dimensional dynamics of the upper ocean. The proposed approach exploits the properties of a theoretical framework based on Surface Quasi-Geostrophic (SQG) equations. Within this framework, Sea Surface Heights (SSH) and Sea Surface Temperatures (SST) are closely related. This provides a way to combine SSH and SST measurements and allows to recover surface currents from a single SST image. On the other side, this framework allows to reconstruct subsurface fields, such as horizontal velocities and density anomaly, in the upper 500m of the ocean from SSH and/or SST measurements. Furthermore, within this framework vertical velocities can also be diagnosed from a single SST and/or SSH snapshot. To demonstrate the feasibility of this approach, first, we have explored the ability to reconstruct the three-dimensional dynamics of the oceanic upper layers using numerical simulation. Then, these results have been applied to existing altimetric measurements and microwave SST data from AMSR-E instrument. Our results confirm the validity of this framework and unveil some limitations in the existing microwave measurements that should be improved in future missions.

AC-4B-20: Ocean Modelling using GOCE geoid products

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With the availability of satellite altimeter data since the mid eighties, both globally andover longer periods of time a huge effort were made in the scientific communities to process those global data sets in joint analyses of geoid and ocean dynamic topography. The quality of the available data was not sufficient to recover the details of the general ocean circulation. However, the very large scales (>5000 km) of the dynamic topography could be recovered and compared with the early oceanographic results obtained from hydrographic data. Already at this time the importance of consistency between the reference ellipsoids as well as the role of the permanent tidal correction were identified. The release of satellite gravity data from the GRACE mission and the launch of the ESA GOCE satellite on 16 March 2009 are starting to provide a more accurate and higher resolution global picture of the Earths gravity field than ever before. The basic definition of the ocean dynamic topography is simply the difference between the sea surface height and the geopotential reference surface called the geoid. Hence, the topography is a geometrically surface that describes the shape of the Earth. Simultaneously the dynamic topography may be considered as a reference surface for the ocean circulation at the ocean surface. The key application of oceanography will benefit because the sea level slopes relative to the geopotential surface allow calculation of surface ocean currents on a global scale. Oceanographers have become familiar with the uses of satellite altimeter data over the last 15 years, but are less familiar with the geodetic information, that gravity satellite will provide. The EU FP5 project GOCINA brought together a small consortium of geodesists and oceanographers in order to develop a common understanding of the geodetic and oceanographic needs, in order to prepare to maximize the information available with the new satellite data from GOCE. One of the most interesting opportunities with the GOCE mission is that it will pprovide error covariance information on the gravity field down to spatial scales of 100 km for the first time. The purpose of this white paper is to further advance mutual understanding between the geodesy and oceanography communities and to identify issues related to methods for producing a mean dynamic topography from the gravity and altimeter data. It will furthermore identify issues on how the geoid or the mean dynamic topography (MDT) will be used by the oceanography community and how the errors in the MDT can be estimated and used.. The purpose is to fill a gap by describing the final uses of satellite gravity data within oceanography, and should inform the geodesy community about the subtleties encountered for ocean circulation studies. The experiences from the EU GOCINA and GOCINO projects and the ESA GOCE User Toolbox (GUT) consortium seeks to highlight the major use cases that have been developed over the last few years in preparation for the GOCE mission. Further cross-disciplinary research in geodesy and oceanography is needed to meet and trigger the interests in the oceanographic community to contribute to the challenging task of validation of the GOCE derived geoid and MDT, both on global and regional scales.

AC-4B-21: COASTAL HIGH RESOLUTION ALTIMETRIC DATA : Application of the Regional CTOH product in South-West Australia

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The coastal zone is an actual important challenge. In term of ocean forecasts, shelf modelling is necessary if we want to extend the predictability of the global operational systems towards coastal and regional sub-systems. And on another hand, climatic shelf reanalysis are also crucial to understand the actual global climatic change because the exchanges at the shelf breaks are important source terms which need to be taken into account at a global scale. Satellite altimetry data have been distributed to the scientific community since 1992 and are routinely assimilated for operational forecasting system. Altimetry data over the coastal ocean remain largely unexploited because of difficulties of corrections and land contamination problems. Using the X-TRACK processing tool and the post-processing technique adapted specifically for coastal regions, the Centre de Topographie des Océans et de l'Hydrosphère (CTOH) (LEGOS, FRANCE) provides along track Sea Surface Height regional products, with a resolution of 300m (http://www.legos.obs-mip.fr/soa/altimetrie/ctoh/COTIER/). In this poster, the regional high resolution CTOH product is analyzed and compared with the AVISO along track product (6km of resolution, http://www.aviso.oceanobs.com/) along the South-Western Australian coast. The main oceanographic feature in this area is the Leeuwin Current (LC) an eastern boundary current flowing towards the South Pole. As the LC is a warm and narrow current with a lower density than the Indian Ocean waters, SSH map allows us to follow the LC along the Australian coastline. Moreover, the LC exhibits a high mesoscale activity, which can be tracked with altimetry products. After smoothing, the CTOH product exhibits a usable resolution of 2 km with a better coverage near the coast (up to 10km close to the coast). Compared to AVISO, we obtain a

better representation of the LC on the shelf. Even offshore, the high resolution product highlights mesoscale details unrevealed by AVISO. A comparison with the Bluelink Ocean ReAnalysis (BRAN) (a global short-range operational forecasting system (http://www.bom.gov.au/oceanography/projects/BLUElink/index.html)) lets us expect an improvement of the eddy resolving simulation, in case of assimilation of the high resolution CTOH product.

AC-4B-22: The EUMETSAT Ocean & Sea Ice SAF (OSI SAF): Overview of the Project and its Products

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The two previous phases of the OSI SAF, the Development phase (1997-2002) and the IOP (initial Operations Phase, 2002-2007) met the main target which was to develop, validate and then produce operationally quality controlled satellite-derived products related to four key parameters (Sea Surface Temperature, Radiative Fluxes, Sea Ice, Wind) over various geographical coverage from regional to global.

These products are currently available in near real time both through EUMETCAST and local FTP servers, and off line from local archive. Archiving at EUMETSAT central Archive (UMARF) is being implemented.

The current phase of the OSI SAF, the CDOP (Continuous Development and Operations Phase) has taken into account new requirement sources, in particular from GODAE, GHRSST and GCOS at international level, and GMES (through MyOcean) at European level, with a strong need for increasing the temporal and geographical resolution of the products and for extending the coverage range from coastal to global.

In terms of access to the products a new approach has been defined that can be summarized as following:

The products are (or will be soon) accessible both:

 via EUMETCAST and UMARF, in particular at the intention of meteorological institutional users, in GRIB (ed 2) or BUFR, over predefined areas and projections,
 via INTERNET FTP servers, in particular at the intention of the oceanographic community, with increasing use of NETCDF, at full resolution and satellite projection, and with specific interface allowing geographical extraction, re-projection and re-gridding, etc.
The objective of the poster is to offer an overview on the OSI SAF project and its current and future production in the time frame of the CDOP.

AC-4B-23: Validation of the Updated Envisat ASAR Ocean Surface Wave Spectra with Buoy and Altimeter Data

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Ocean surface wave forecasting is an important tool for aiding various marine activities and coastal defence decision making. The state of art wave forecast is based on an ocean surface wave spectral model, which plays an increasingly important role in a coupled atmospheric and ocean system. Developing and validating wave spectral models result in a direct demand for global ocean surface wave spectral observation. Traditional buoy observations cannot not meet this demand alone because of a limited space coverage and restriction on direction information. Remote sensing instruments, like altimeter and synthetic aperture radar onboard satellites, have greatly enhanced the possibility to achieve global monitoring of the ocean surface wave condition. The advanced synthetic aperture radar (ASAR) on board the Envisat satellite (launched in March 2002) is a good example of global ocean surface wave spectral observation (ESA 2002). However, assessment of this valuable data set is not straightforward, due to a lack of other independent ocean wave spectral observations. The radar altimeter (RA2) on board the same satellite measures ocean wave height at the same time as the ASAR but at a different location about 200 km distant.

A small number of moored buoys produce 1-D ocean wave spectra operationally but few ASAR spectra fall on the buoy positions in a given time period. An indirect comparison method by pairing the three independent observations with a common media (an ocean wave model output) is proposed by Li and Holt (2009) to bridge the spatial and temporary gaps among these observations and gain an objective validation of the ASAR wave spectra. This study over the period from July 2004 to February 2006 revealed that the Envisat ASAR ocean surface wave spectra are generally in good agreement with the other two observations though some spurious long waves are present in the ASAR spectra. The Envisat ASAR fast delivery ocean surface wave spectral data have undergone an important upgrade in late October 2007 (Johnsen and Collard 2006) and preliminary study has showed that the updated spectra are better than those before the upgrade. This paper presents the result of a validation study of the updated Envisat ASAR ocean surface wave spectra using the above indirect comparison technique over a 14-month period from November 2007 to December 2008. One conclusion is that the update has removed the spurious long waves in the old ASAR spectra, leading to enhanced agreement of the ASAR and spectral buoy data in the long wave range. In addition, the updated ASAR spectra have tidied up noise beyond the azimuthal cutoff, resulting in improvement in the short wave range. A parameter equivalent to the widely used significant wave height (SWH) but integrated over a finite spectral sub-range, and hence called sub-range wave height (SRWH), is used to show the spectral performance of these observations. The SRWH provides a practical solution to tackle the varied spectral resolutions among the different observations and wave models. It is also an efficient alternative for ocean model spectral output as most model 2-D wave spectra are too large (typical 600 elements for each grid point) to be saved for full grid. A proposed set of sub-ranges (>16 s, 16-10 s, 10-5 s, and < 5 s in periods) is used for this study and is recommended for other weather centres to facilitate cross-model comparison in the future. References: ESA, 2002: ASAR

Product Handbook. ESA web page: http://envisat.esa.int/dataproducts/, 539 pp. Johnsen, H., and F. Collard, 2006: ASAR wave mode - validation of reprocessing upgrade. Report IT, 26pp. Li, J. G. and M. Holt, 2009: Comparison of ENVISAT ASAR ocean wave spectra with buoys and altimeter data via a wave model. J. Atmos. Oceanic Techno., 26, 593-614.

AC-4B-24: The PARIS Ocean Altimeter In-orbit Demonstrator

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Mesoscale ocean altimetry remains a challenge in satellite remote sensing. Conventional nadir looking radar altimeters can make observations only along the satellite ground track and many of them are needed to sample the sea surface at the required spatial and temporal resolutions. The Passive Reflectometry and Interferometry System (PARIS) using GNSS reflected signals was proposed as a means to perform ocean altimetry along several tracks simultaneously over a very wide swath. The bandwidth limitation of the GNSS signals and the large ionospheric delay at L-band are however issues which deserve careful attention in the design and performance of a PARIS ocean altimeter. This presentation describes such an instrument specially conceived to fully exploit the GNSS signals and to provide multi-frequency observations to correct for the

ionospheric delay. Furthermore an in-orbit demonstration mission is proposed that would prove the expected altimetric accuracy suited for mesoscale ocean science.

AC-4B-25: SMOS Payload In-Orbit Performance

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SMOS is ESA's second Earth Explorer mission with the objective of producing global maps of Soil Moisture and Ocean Salinity over the Earth. It will fly a single payload, MIRAS, the first-ever spaceborne L-band Microwave Imaging Radiometer with Aperture Synthesis in two dimensions. The performance requirements of MIRAS are demanding in terms of spatial resolution, accuracy, stability and precision, all critical to fulfil its scientific objectives.

During the ground test campaigns both at payload and satellite levels the performance of the instrument was checked against the original system requirements. The verification of the requirements, written in terms of brightness temperatures (Level-1 data), included some image processing of the raw correlations (Level-0 data) acquired inside an empty anechoic chamber. All requirements are satisfied with some margin. The launch of SMOS has been recently confirmed for July 2009. If this calendar is fulfilled, we should have the first in-orbit data available by the time of the OceansObs-09 conference. In such a case, this presentation will include, in addition to the pre-launch performance of SMOS, a description of the Level-1 mission requirements, the in-orbit measurement configurations used to verify them, and the preliminary results of the processing of the first flight data. An extrapolation of this in-orbit learning into the case of a possible SMOSops follow-on mission will also be included.

AC-4B-26: A Multi-Sensor Approach Towards Coastal Ocean Processes Monitoring

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The coastal ocean is of crucial societal importance. A quantitative understanding of the physical processes impacting the coastal region is necessary to determine how the sea level and current variability will affect coastal systems. Dynamics along the continental slopes are difficult to observe given the wide spectrum of temporal and spatial variability of physical processes which occur. Thus, studying such complex dynamics requires the development of synergic approaches through the combined use of modeling and observing systems at several spatial/temporal sampling level requirements. The objective of this work is to develop coastal operational oceanography on the basis of adequate observing systems which can be integrated into coastal circulation models. Specifically, it is intended: (1) to process, validate and intercalibrate multi-sensor datasets dedicated to coastal ocean studies. In this context, we will implement the technological existent advances in satellite altimetry in the coastal area, that up to now it has not been possible to be used for coastal applications due to relatively poor sampling and inaccuracy of corrections. An ongoing work consists in applying improved altimeter corrections (tidal model, mean profile, MOG2D HR, troposphere correction), high frequency sampling data and reviewing the data recovery near coast. In the meantime the so far unexploited possibilities from the merging of existing in situ data sources with remote sensing data to monitor coastal dynamics will be investigated. The developed system will be implemented initially in the coastal area of the Balearic Islands where the scientific knowledge and the necessary data exist. A second (2) objective consists in scientific applications i.e. to exploit multi-sensor data (in situ and remote sensing) in the context of regional hydrodynamic modelling of shelves and coastal circulation, with focus in the North Western Mediterranean (NWMED). These activities are in line with the new OceanBIT Coastal Observing and Forecasting System, a new facility that will address scientific and technological coastal ocean international priorities. The System will be based in the Balearic Islands but will have a more general Mediterranean / Global Ocean interest (the Mediterranean as an ideal, small scale ocean).

AC-4B-27: SSALTO/DUACS: Three-Satellite Quality Level Restored in Near Real Time

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Near Real Time (NRT): Daily Operational Products

DUACS-NRT provides GODAE, climate forecasting centers, the MyOcean EU FP7 project, and real time oceanographic research (e.g.: in-situ campaigns) with directly usable, high quality near real time altimeter data. Regional products (European Shelves, Mediterranean Sea, and Black Sea) are delivered to operational projects. Commercial applications are also developed for the fishery and offshore drilling industries. All DUACS near real time products are generated and distributed on a daily basis to reduce the NRT delay, and to smooth the operational procedures of NRT users.

DUACS features a systematic quality control of the input data, the system itself, and its products with detailed reports put online twice per week. The system also carries out on-the-fly editing and reprocessing of erroneous datasets, as well as a long term monitoring of NRT data it has used, to quickly detect anomalies, drifts and discontinuities in incoming altimeter data.

Delayed Time (DT): A consistent data set from built upon all altimeters

The second generation of DUACS-DT products is composed of global data sets of along track and gridded Sea Level Anomaly, Absolute Dynamic Topography, and geostrophic currents, but also of regional-specific products (higher resolution, optimized parameters). DUACS reprocessed all past altimeter data: Jason-1, T/P, ENVISAT, GFO, ERS1/2 and GEOSAT. These delayed time products are regularly updated when new Level2 data are released and fully validated. The system operationally integrates the state-of-the-art corrections, models and references recommended by the altimeter community, as well as the best Cal/Val and cross-calibration and merging algorithms.
To that extent, the standards of the ongoing GDR-C reprocessing (Jason1, Envisat) and the standards recommended for the upcoming Topex/Poseidon reprocessing will be taken into account for an update of the DUACS DT data set that should be available by late 2009.

Ongoing Improvements to secure multi-mission products

The DUACS system was significantly modified to integrate Jason-2. After a successful experimental phase done during the

temporary absence of Jason-1 in August 2008, Jason-2 definitively became the reference mission of the system since January 21, 2009, few days before Jason-1 has been moved on its new orbit. Data from the latter have been reintegrated in the DUACS since Mars 2009. The performances of the multi-satellite system were greatly improved with the tandem Jason-2/Jason-1. The tandem thus allowed a reduction of the formal mapping error from 20 to 60% of the variance of the signal and assuring an improved restitution of mesoscale structures especially in high energetic areas. Thanks to the excellent consistency of the Jason tandem data, this upgrade was made operational only 10 days after Jason-1 reached its interleaved orbit. \In compliancy with the objectives of the SL-TAC from EU project MyOcean, the Black Sea regional product already available in Delayed Time has been added to the NRT product generation in March 2009.
More DUACS upgrades are also being worked on: Cryosat is scheduled for launch in November 2009. Initially aimed at ice observation, the mission may provide opportunity data on ocean as well. System and algorithm upgrades are being worked on to use this additional dataset in the multi-satellite system by mid-2010 (pending green light from the CalVal phase). Lastly, in order to minimize the impact of an anomaly on the reference mission used in DUACS (especially in NRT), a new orbit error reduction scheme based on multiple reference missions (e.g.: Jason-2 and Jason1, or Jason-2 and AltiKa/Saral) is being developed.

AC-4B-28: Intercomparisons among Global Daily SST Analyses

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Six global daily SST analyses were compared. These analyses were the Remote Sensing System (RSS) analysis on a ~1/11° degree grid, the NCEP Real Time Global High Definition (RTG-HD) analysis on a 1/12° grid, the UK Met Office 1/20° Operational SST and Sea Ice Analysis (OSTIA) analysis on a 1/20° gird, the NCDC Daily OI analyses using AMSR+AVHRR and AVHRR-only on a 1/4° grid and the Fleet Numerical Meteorology and Oceanography Center (FNMOC) analysis on a 1/9° grid on the equator. Qualitative comparisons of maps of SST from the various products show areas with large differences (exceeding several °C) over the time period. The regions of the large differences tend to occur near the coast, in strong gradient regions such as western boundary currents and in the far north and south where SST measurements (both in situ and satellite) tend to be sparse and simulated SSTs from sea-ice concentrations may have a large impact if used. To try and quantify these results, comparisons were carried out with moored buoys. Average differences were computed between the analyses and the buoys. In general differences were higher with respect to the RSS and RTG-HR analyses than with respect to the others. Spectra and cospectra (with respect to the buoys) were computed at each buoy location from the buoy data and from each analysis interpolated to the buoy locations. The results show that FNMOC and to a lesser extent OSTIA were strongly tuned locally to the buoy data. SST wavenumber spectra were computed for several regions which show that RSS is noisy, RTG_HR has lower resolution than the others analyses and FNMOC appears to have the highest resolution.

AC-4B-29: Basic Radar Altimetry Toolbox & Tutorial

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The Basic Radar Altimetry Toolbox is an "all-altimeter" collection of tools, tutorials and documents designed to facilitate the use of radar altimetry data. Such an integrated approach and view is vital not only for assessing the current status of what altimeter products offers, but also to show the system and consistency with the past.

It has been available (http://www.altimetry.info) from April 2007, and had been demonstrated since about six months before that, including during training courses and scientific meetings. Quite a large number of people downloaded it. Users' feedbacks, developments in altimetry, and practice, show that some new interesting features could be added.

It is able - to read most distributed radar altimetry data, from ERS-1 & 2, Topex/Poseidon, Geosat Follow-on, Jason-1, Envisat, Jason- 2, and the future Cryosat mission, - to perform some processing, data editing and statistic, - and to visualize the results.

Version 2 has just been developed, with, among other things, improved easiness-of-use of the graphical user interface, pre-selection of data files before computation (to speed it), additional visualization features such as waveform viewing or geo-localized output images. A release for MacOS is also made.

As part of the Toolbox, a Radar Altimetry Tutorial gives general information about altimetry, the technique involved and its applications, as well as an overview of pas present and future missions, including information on how to access data and additional software and documentation. It also presents a series of data use cases, covering all uses of altimetry over ocean, cryosphere and land, showing the basic methods for some of the most frequent manners of using altimetry data.

BRAT is developed under contract with ESA and CNES. It is available at http://www.altimetry.info

AC-4B-30: New models for deriving and partitioning absorption coefficients of colored dissolved organic matter in the global ocean

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Colored dissolved organic matter (CDOM) is a strong absorber of ultraviolet and blue light and a key factor in the light-induced biogeochemical cycling of many components in surface waters. Despite the importance of CDOM to such upper ocean processes and optics, our current understanding of its spatial and temporal distributions and the factors controlling these distributions is very limited. This eventually prevents our understanding of its relationship to the pool of dissolved organic carbon in coastal and open oceans. Here we present a new model for deriving absorption coefficients of CDOM (aCDOM) and portioning its terrestrial and marine pools in the global waters. The robustness of this new model was evaluated on the in-situ bio-optical data sets collected in a variety of waters and also tested on the SeaWiFS images acquired over the Northwest Pacific and global ocean waters. The accuracy of the estimates of absorption coefficients of CDOM is generally excellent, although it deviates from the detrital absorption coefficients generally observed in many coastal waters. Applying the model to SeaWiFS images reveals the highest surface abundances of CDOM within the subpolar gyres and along the continental shelves dominated by terrestrial inputs of colored dissolved materials and the lowest surface abundances of CDOM in the central subtropical gyres and the open waters presumably regulated by photobleaching phenomenon, biological activity and local oceanic processes. Large interseasonal changes in CDOM absorption/distribution are also apparently consistent with recent satellite-based assessments at global scale and significant interannual seasonal changes in (terrestrially-derived) CDOM distribution closely correspond with increase of the global mean runoff and river discharge induced by climate change/warming scenarios.

AC-4B-31: Annual sea surface height variation and dynamic topography on the Caspian Sea from Jason-1 altimetry data

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The recent unseasonably overflow of the Caspian Sea and onrushing to the coastal region is the predominant motivation of this study on the sea surface height anomaly in order to find the climatic and environmental changes impact on the last decade. For this propose the data gathered by Jet Propulsion Library (JPL) from Jason-1 (2002 to present) and Topex/ Poseidon (1995-2002) have been utilized. In addition to the altimetry data, the sea level observation data by Caspian Water Research Institute (CWRI) in Iran has been also used to compare the results. Due to non-stationary habit of sea surface dynamic topography (SSDT) time series in this region, SSDT can be divided into the periodical part and fluctuation around the mean. This fluctuation shows the trend of sea level changes clearly. Since the fluctuations inherit the very low frequency constituents of sea level, the satellite orbit errors came into concentration and the optimal interpolation method has been employed to reduce the orbit errors. The results confirm that the SSDT derived from altimetry data can be used as a forecast module to detect the monthly trends precisely, in order to determine the source of environmental changes before long.

AC-4B-32: Combined AATSR/MERIS Algorithm for Aerosol Optical Depth Retrieval Over Ocean

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The combined AATSR/MERIS algorithm for aerosol optical depth (AOD) retrieval over ocean has been developed at the Finnish Meteorological Institute and tested for more accurate retrieval of the aerosol properties and surface correction. The AOD retrieval algorithm, which is applied to cloud-free pixels over ocean, is based on the comparison of the measured and modeled reflectance at the top of the atmosphere (TOA). The algorithm uses look-up-tables (LUTs) to compute the modeled TOA reflectance. For LUTs generation the SCIATRAN radiative transfer module developed at the University of Bremen has been used. LUTs are generated for different aerosol types as derived for MODIS.

For AOD retrieval, the atmospheric aerosol is assumed to be an external mixture of fine and coarse mode particles. The two aerosol types are mixed such that the spectral behavior of the reflectance due to aerosol best fits the measurements. The algorithm consists of three parts. The first part of the algorithm includes the AOD retrieval over ocean using AATSR top of the atmosphere reflectance measurements for 555nm, 685nm, 875nm and 1600nm, and chlorophyll concentration data base. The TOA reflectance is the contribution of a path reflectance due to scattering in the atmosphere by aerosols and molecules and reflection by the ocean surface. Contribution of ocean white caps and sun glint are accounted for.

In the second part of the algorithm, we use LUTs and the aerosol mixture which is chosen in the first part of the algorithm, for determining the reflectance at the TOA for MERIS wavelengths (412-900nm). Using this result for the atmospheric correction, the actual chlorophyll concentration is determined using the MERIS radiance data. In the third part of the algorithm, the MERIS chlorophyll concentration is used in the AATSR algorithm instead of the database. The use of real chlorophyll concentration results in more accurate aerosol optical depth retrieval.

The combined AATSR/MERIS algorithm has been tested by the comparison with AERONET and MAN ground-based measurements of the retrieved AOD for about 100 collocations of AATSR and MERIS. The work is done in the framework of the ESA sponsored AMARSI project

AC-4B-33: CLS as Expert Support Laboratory for the Envisat Altimetry Mission

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CLS, as Expert Support Laboratory (ESL), was in charge of the development of the EnviSat RA2/MWR prototype for the level2 processing chain, which became the reference processor for the L2 IPF (Near real time processing). Since 2007, CLS was also designed by ESA to become the MWR ESL which is responsible of the L1B MWR reference processor CLS is not only responsible of the definition, the specification, the development and the maintenance of the ground processing chain, but is also responsible of long term monitoring and validation of the MWR data and of the comparisons of altimeter data against tide gauge measurements. One of the ESA strength requests is that CLS should propose the up to date algorithms, models, corrections ... in order to have the best EnviSat RA2/MWR data product. The main evolutions since the EnviSat Launch will be described as well as some major studies results (MWR Drift, Ice and Rain Flags..).

AC-4B-34: Directional wave spectrum estimation by SWIM instrument on CFOSAT

Tison, C.[1]; Hauser, D.[2]; Enjolras, V.[3]; Rey, L.[3]; Lambin, J.[1]; Castillan, P.[1]; Amiot, T.[1]
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C. Tison(1), T. Amiot (1), D. Hauser(2), V. Enjolras (3), L. Rey (3), J. Lambin, P. Castillan (1) (1): CNES, 18 avenue Edouard Belin, 31400 Toulouse, France (2): LATMOS/CNRS, 10-12 avenue de l'Europe, 78140 Vélizy, France (3) : Thales Alenia Space, 26 avenue Jean-François Champollion – BP 33787, 31037 Toulouse Cedex 1, France Oceanography greatly benefits from remote sensing satellites for global monitoring and forecast of the sea surface. The CFOSAT (China France Oceanography SATellite) mission, whose launch is planned for 2013, should embark two radar payloads to monitor both wind and waves over the ocean. One of this two radar instruments is called SWIM (Surface Waves Investigation and Monitoring). It is a Ku-band scatterometer designed to measure ocean waves. Actually, this SWIM concept is based on the Jackson et al. proposals [1,2,3], which describe the design and processing of a scatterometer dedicated to the wave field estimation. SWIM is currently in Phase B (concept and design phase). In [6,7], the preliminary design and associated performance analysis have been published taking into account the end of Phase A design. This poster is focused on the performance assessment of the SWIM instrument based on the new developments which occur during Phase B. We aim here at up-dating the first results obtained during Phase A by taking into account the last developments of the instrument. In addition, major reviews have been carried out on the performance analysis. [1] Jackson, F. (1981). An analysis of short pulse and dual frequency radar techniques for measuring ocean wave spectra from satellites. Radio Science, 16(6) :1385–1400. [2] Jackson F. C., Walton W.T., and Peng C.Y.. A comparison of in situ and airborne radar observations of ocean wave directionality, J. Geophys.

Res. , 90 (C1), 1005-1018, ,1985 [3] Jackson F. C., and Walton T.W., Baker P. L., Aircraft and satellite measurement of ocean wave directional spectra using scanning-beam microwave radars, J. Geophys. Res., 90, (C1), 987-1004, 1985 [4] Soussi, E. (1997). Contribution à la spécification et à l'analyse des performances du système VAGSAT pour la mesure spatiale des vagues à partir d'un radar à ouverture réelle. PhD thesis, Université de Paris VI. [5] Hauser, D., Soussi, E., Thouvenot, E., et Rey, L. (2001). SWIMSAT : a real aperture radar to measure directional spectra of ocean waves from space - main characteristics and performance simulation. AMS, 18. [6] C. Tison, D. Hauser, G. Carayon, J. Lambin, P. Castillan, A spaceborne radar for directional wave spectrum estimation: first performance simulations, IGARSS'08, July 2008 [7] Enjolras V., Caubet E., Richard J., Lorenzo J., Carayon G., Castillan P., SWIM: a multi-incidence beams Ku-band real aperture radar for the observation of the ocean wave field spectra, IGARSS'08, July 2008.

AC-4B-35: High Resolution SST fields: the Medspiration project, analysis of 3 years of data

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In 2002, GODAE (Global Ocean Data Assimilation Experiment) initiated the GODAE High Resolution SST Pilot Project, GHRSST-PP to address an emerging need for accurate high resolution sea surface temperature (SST) products (1). SST is required by operational ocean and atmospheric forecasting systems to constrain the modeled upper ocean circulation thermal structure and for exchange of energy between the ocean and atmosphere. The goal is to combine all the available SST data from across the globe to form a high resolution, high accuracy and high availability SST product. It is organized as a partnership between regional groups responsible for generating SST products, to a common specification, within a limited geographical area. The primary task of the Regional Data Assembly Centers is to collate all level 2 satellite SST measurements within their region, perform quality assessment and reissue the data in a common format (GHRSST L2P data) including a measure of the quality of every measurement. Some centers also use the L2P data to produce global or regional analyzed SST products (called GHRSST L4 data), using well defined procedures. Medspiration has been created by ESA in 2004 to serve as a European DAC for GHRSST-PP, generating L2P and MDB products for the Atlantic Ocean and its adjoining seas (2). Medspiration has also the task of producing an ultra-high resolution (2 km) analyzed SST product for the Mediterranean Sea. The Medspiration system is operational for the European Seas since 2005 and after a test period the processing chain has been stabilized beginning of 2006. Two years of data (2006-2007) have been produced with only minors processing changes. This archive provides a good opportunity to evaluate and to analyzed the interest of ultra high resolution analyzed SST fields.

AC-4B-36: Monitoring the South West Indian Ocean marine environment: the AMESD program

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The need for timely access to accurate and reliable satellite based information was stressed as one of the top priorities of the World Summit on Sustainable Development (WSSD) held in Johannesburg in August 2002.

As a response to this urgency, the Africa Union and European Union launched the "African Monitoring of the Environment for a Sustainable Development" program (AMESD). This continental-wide project is financed by the European Development Fund (21 M€) and allocated to the Regional Economic Communities, namely ECOWAS, IGAD, IOC, CEMAC and SADC. The project is implemented by the African Union which is supported by a Project Management Unit with a Technical Assistance.

AMESD is regarded as the continuation of the PUMA program which allowed the creation of a meteorological network of fifty-three Africa countries equipped with satellite data receiving technology. The project is expected, during its four year of existence, to achieve the following results:

- improved access by African users to existing basic Earth Observation data.
- development of regional information services to improve decision making process by African institutions
- strengthening of political and policy development frameworks, such as Global Earth Observation (GEO) or Global Monitoring Environment and Security (GMES)- Africa
- development of human resources via i. a. training sessions, staff exchange, fellowship programs, etc...

The Mauritius Oceanography Institute (MOI) was mandated to implement the South West Indian Ocean (SWIO) component of this project. The latter has as overall objectives to help Indian Ocean Commission countries (i.e. Mauritius, Seychelles, Comoros, Madagascar, Reunion) and riparian countries of the Mozambique canal (Kenya, Tanzania, Mozambique) to better take into account satellite Ocean Observation data for the monitoring of their marine resources and the definition of their marine policies.

Two kind of operational services, using satellite ocean observation data, will be particularly developed with the strong support of our European partner EUMETSAT:

- one service to help for the control of fishing activities and for the management of fish resources (mainly Tuna)
- one services to provide regional dataset in physical oceanography and marine climatology

To operate the service several EumetCast satellite receiving stations will be installed in the SWIO region.

All these regional project activities will be undertaken by the Mauritius Oceanography Institute (MOI) in collaboration with several regional partners : Fisheries Monitoring Centers, oceanography and fisheries research institutes, ministries of fisheries…

Session 4C: Information Synthesis and Delivery

AC-4C-01: Data Tools and Services at Physical Oceanography DAAC

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PO.DAAC Overview

The Physical Oceanographic Distributed Active Archive Center (PO.DAAC) archives and distributes NASA's satellite data and associated information pertaining to the state of Earth's oceans.

PO.DAAC supports a diverse community of over 12,000 users that includes ocean and climate researchers, operational agencies, ocean resource managers, educators and the general public. PO.DAAC has developed a set of tools and services for searching and acquiring data from its holdings, which exceeds 50 TB. Moreover, these tools and services are continually evolving to stay apace with technological advancements, especially as they relate to web services.

Existing Tools & Services

POET (http://poet.jpl.nasa.gov)

The PO.DAAC Ocean ESIP Tool (POET) provides interactive, on-line subsetting and visualization for many of PO.DAAC's gridded (Level-3) data products. Viewing options include latitude-longitude maps, animations, time series plots, and space-time profiles. In addition, this tool can handle WMS/WCS requests.

SCCOOS Portal (http://sccoos.jpl.nasa.gov)

As part of the Southern California Coastal Ocean Observing System, this portal serves out high-resolution, near real-time images and data that support several coastal resource management applications.

FTP/HEFT (ftp://podaac.jpl.nasa.gov)

All PO.DAAC data are freely available via the PO.DAAC FTP site. The site is laid out in a standardized and logical directory structure, which helps users to quickly navigate to the data of interest. Coupled with each data set is a README file, links to documentation and sample software to read the data. The High Efficiency File Transfer (HEFT) requires users to download a client to achieve downloads on the order of 1000x standard FTP.

Datacasting (http://podaac.jpl.nasa.gov/datacasting)

Uses RSS feeds to create a notification when a new data granule (data file) is made available. With the Datacasting Feed Reader, users are able to subscribe to feeds and download granules immediately to their computer. Moreover, they can create filters based on metadata tags in the feed to limit what files get downloaded. For example, only download granules that pass through a specified region or contain data related to a specific event.

Hurricane/Typhoon Tracker (http://podaac.jpl.nasa.gov/hurricanes)

This tool tracks the location of historical and on-going hurricanes and provides overlays of ultra high-resolution wind images (from QuikSCAT) and optimally interpolated 5 km sea surface temperature.

Tools and Service under Development

Granule-based Searches

Using the OpenSearch protocol, this search feature will provide a free-text or machine-machine query interface to quickly identify granules based on the full set of metadata maintained in the PO.DAAC inventory.

Level-2 (Swath-based) Subsetter

This capability will give users the ability to subset swath-based data granules by (time, space and parameter) and output the data in a standardized NetCDF file format, as well as other common image formats ands standards, such as GeoTIFF and KML.

Cutting Edge Technologies

PO.DAAC is partnering with several research and development teams funded under the NASA ACCESS program to infuse cutting-edge technologies into an operational setting. The Virtual Oceanographic Data Center (Mattmann et al.) will utilize modern search technologies from Apache's software foundation including Lucene and Solr to create web services and a common portal allowing free-text and facet-based searching of oceans data and metadata from NASA ocean missions (OSTM, GHRSST), NOAA, and the National Virtual Ocean Data System (NVODS). The Web-Based Altimetry Service (Callahan et al.) uses the SciFlow technology to give users the capability to select different altimeter processing algorithms and create altimeter products tailor to a localized region.

AC-4C-02: Web-based Altimeter Service

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Jet Propulsion Laboratory, UNITED STATES

We are developing a web-based system to allow updating and subsetting of altimeter data. This is crucial to the expanded use and improvement of altimeter data. The service aspect is necessary for altimetry because the result of most interest (sea surface height anomaly, SSHA) is composed of several components which are updated individually and irregularly by specialized experts. This makes it difficult for projects to provide the most up-to-date products. Some components are the subject of ongoing research, so the ability for investigators to make products for comparison or sharing is important. The service will allow investigators/producers to get their component models or processing into widespread use much more quickly. For coastal altimetry, the ability to subset the data to the area of interest and insert specialized models or data processing results is crucial.

A key part of the Altimeter Service is having data producers provide updated or local models and data. In order for this to succeed, producers need to register their products with the Altimeter Service and agree to provide the product either on demand or in a way that can be integrated into the basic altimeter data record structure.

We will describe the basic structure of the web service and the steps toward implementation. We will integrate the web and Grid workflow features of SciFlo with algorithms developed for the Ocean Surface Topography Science Team work to produce improved Geophysical Data Records (GDRs) with retracking (RGDRs) and other improved data elements. TOPEX RGDRs in a netCDF format that has been coordinated with Jason data will be the initial basis of the service. The goal is to allow individual users to produce their own GDRs and/or SSHA data sets using data components that they select from known sources or supply themselves. In particular, we will enable for the first time customized and easily repeatable regional studies by allowing users to "swap in" accurate, high-resolution, local

models (tides and other corrections) and update the SSH and SSHA for regions of interest. In addition to time and space subsetting, we will provide the ability to select variables of interest as the data will be in netCDF, allowing straightforward extraction of data elements.

The research described here was carried out at the Jet Propulsion Laboratory, California Institute of Technology, under a contract with the National Aeronautics and Space Administration.

AC-4C-03: Operational Quality Control Monitoring of Envisat RA-2 Data

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Operational quality control monitoring of data streams from all ESA's space-borne Earth Observation instruments is carried under the IDEAS contract. IDEAS started its operation on August 1st 2008, supporting the ESA Sensor Performance Products and Algorithms (SPPA) team and replacing the previous DPQC (Data Processing and Quality Control) activity.

IDEAS provides the following services:

- Handling of user requests
- Operational Quality Control of ESA and 3 Party Mission products
- Support to CAL/VAL teams where appropriate
- Maintenance of consortium QC / analysis tools
- Provision of adequate hardware and servers for service access

At present, IDEAS activities are managed in four instrument "families":

- Atmospheric Chemistry (SCIAMACHY, GOMOS, MIPAS, GOME)
- Optical (MERIS, AATSR, LANDSAT, Prism, AVNIR)
- Altimetry (RA, RA-2, CRYOSAT)
- SAR (SAR, ASAR, SCAT, PALSAR)

In this presentation we focus on data from the ENVISAT RA-2 instrument, and highlight key issues that have been identified in the past year through this important monitoring activity. This includes a study into the possible impacts of the new IF filters acquired by a revised procedure put in place after cycle 66, to address the problems caused by anomalous IF masks that were acquired up until this time.

We also summarise data handling recommendations, provide information on how users can access Quality Reports, and invite users to comment on the usefulness of the information that is made available.

AC-4C-04: Argo and Synthesis Products Being Developed and Served at the Asia-Pacific Data-Research Center

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The Asia-Pacific Data-Research Center (APDRC) within the International Pacific Research Center (IPRC) at the University of Hawaii offers a web-based, data and product server system, which provides access to a range of in situ, model-based and satellite-based products. Initiated in 2001, a primary motivation has been to provide easy access for the broad user community to the wide range of climate data and products, often underutilized due to lack of easy access. Working closely with our NOAA/PMEL partners, the center has implemented a data server system using OPeNDAP protocol in order to provide web-based access to atmospheric, oceanic, and air/sea flux products, which can be directly accessed via client-based software such as GrADS, Matlab, Ferret, and FORTRAN code. The system uses a range of servers including LAS and OPeNDAP (THREDDS and GDS) for gridded products, and DAPPER/DChart and TSANA for in situ data.

Recently and into the future, the APDRC is shifting focus from data server infrastructure to the production of value-added products using the new observing system data sets such as Argo and satellite-based products. Global Argo products under development and available on our servers include: surface and deep velocities from float trajectories; profile data interpolated on standard depth levels and isopycnals; mixed layer, isothermal layer and barrier layer depths; and statistics, climatologies, and monthly and annual averages. Map products include information on data coverage, and are available as both gridded/interpolated products and spatial bin-averaged products. Synthesis products under development include absolute dynamic topography computed from Argo floats, drifters, satellite wind and altimetry data. Mean surface dynamic topography is computed from drifter, wind and altimetry data. Instantaneous surface dynamic topography is obtained from Mean Dynamic Ocean Topography (MDOT). Absolute dynamic topography at depth is calculated from Argo T/S profiles by integrating surface topography downward. The horizontal gradient of absolute dynamic topography at Argo float parking-depths is assessed from float velocities and geostrophy. At the present time, these products are updated monthly.

Future collaborative activities follow. Since a variety of Argo products are currently being produced by several centers and by individual researchers, we propose hosting an 'open work space' on our website for product demonstration, evaluation and intercomparison, and for comments and discussion. The goal would be to increase product quality and utility.

Future product development at the APDRC will include the combined use of Aquarius sea surface salinity data with Argo data to provide global products on the space/time variability of oceanic salinity fields and regional salinity fronts.

In order to provide increasing utility in the future to the broad user community including applications, management, and the general public (in addition to the traditional research communities), we plan to make products available via Google Earth, Goggle Map and Geospatial Information System (GIS) formats.

The IPRC/APDRC server address is: http://apdrc.soest.hawaii.edu with Argo products available at http://apdrc.soest.hawaii.edu/projects/argo/.

AC-4C-05: The GENESI-DR infrastructure: an opportunity for the ocean science community

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Ground European Network for Earth Science Interoperations - Digital Repositories (GENESI-DR) (http://www.genesi-dr.eu/) is an ESA-led, European Commission funded two-year project, aimed at providing reliable, easy, long-term access to historical

and recently aquired Earth science data from space, airborne and in-situ sensors archived in large distributed repositories. The specific strength of GENESI-DR lies in the concept of offering a single access point to the petabytes of heterogeneous data located at a variety of individual data repositories. Here we will show how the already deployed infrastructure, which currently involves 9 different digital repositories (from ESA, CNES, DLR, KSAT, ASI, NILU, Infoterra, JRC, ENEA), allows the scientists to easily discover, access, and even process heterogeneous and scattered data from a single access point. We will discuss how the GENESI-DR e-Infrastructure can inter-operate with other infrastructures (SeaDataNet) and how it is being validated against an ocean-related application (ENEA and CNR ISAC subset of SeaDataNET distributed data bases). As an example, we will demonstrate the following data: (a) daily generated sea surface temperature (SST) maps archived at the Italian National Council of Research; (b) vertical profiles of sea temperature measured by Volunteer Opportunity Ships (VOS) and archived at ENEA; (c) SST and chlorophyll maps, generated on-the-fly from satellite data stored at ESA using computational resources federated to GENESI-DR, and based on the parameters set by the user. Finally, we will provide training for scientists interested in using GENESI-DR for data access and processing. Training will also be available to data repository holders who would like to "genesi-fy" their data, i.e., to link their own data (or data repositories) to GENESI-DR.

AC-4C-06: Design of Future Altimeter Missions: The End-to-End Thematic Simulator

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In the current frame of debates on future altimetry constellation design, the need for a decision-making tool has been highlighted by CNES and realised through the development of an end-to-end altimeter thematic simulator. This simple, flexible and evolutive tool aims at examining the merits of various observing configurations and discriminate among them.

The present study describes the first prototype of this end-to-end mission simulator for altimetry. Based on a simplified version of the recently published Ensemble Twin Experiments methodology (Mourre et al., 2006), the simulator aims at quantifying the potential of an altimetry observing system by estimating its ability to reduce the statistical error of a storm surge model of the Bay of Biscay. Relative performance score helps discriminate the various observing scenarios (number of satellites, orbits, instrument type,...).

Some validation and application case results are presented.

AC-4C-07: Integrating ncWMS into the THREDDS Data Server

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TDS is a framework for serving and cataloguing heterogeneous data types through common protocols over HTTP. It is a middleware that simplifies the publication of and access to scientific data (Caron, John, Davis, E. R., Ho, Y. and Kambic, R. P., 2006). It has a significant global user base with many ocean, climate and modelling communities using this to share data. The main advantage of the TDS server (and also of other OPeNDAP servers) is its use of the Data Access Protocol (DAP) to harmonise the delivery across the internet of a whole suite of self-describing file formats (currently 20 types) commonly used in the these communities. Interoperability is enhanced with the use of NetCDF Markup Language (ncML) (Nativi, Stefano, Caron, J., Davis, E., Domenico, B., 2005), where metadata views can be added to conform to a naming convention, while the underlying files remains unchanged. Additionally, ncML offers aggregation of datasets, where large datasets spanning multiple files can be seen as a logical volume. These capabilities give TDS an enormous amount of flexibility to deliver heterogeneous files from legacy data sets and from diverse applications and sources to across the internet through a uniform interface with simple client applications.

However, sharing data across discipline, such as the GIS community has been difficult, as the underlying protocol, DAP does not allow data to be referenced in geospatial coordinates. This protocol depends on the structure of the underlying objects and uses exclusively indexes for referencing elements and thus can be used for almost any indexed data (James Gallagher, N. Potter, T.Sgouros, S. Hankin, G. Flierl, 2007). The gap in protocols for geo-referenced data sets is being filled by the specification of a suite of web services from the Open Geospatial Consortium (OGC). This suite includes data access - most commonly Web Feature Service (WFS) and Web Coverage Service (WCS) and visualisation - Web Map Service (WMS). WCS has already been integrated into the TDS framework (Nativi, S. and Domenico, B. and Caron, J. and Davis, E. and Bigagli, L, 2006). Adding WMS is a logical progression of features for TDS. Instead of implementing from scratch another WMS server, an existing server, ncWMS was chosen to integrate into TDS. The ncWMS server was developed by the Reading eScience Centre (ReSC) as part of the UK e-Science initiative to enable commonly developed meteorological and oceanographic data sets that were available in the NetCDF file type to be delivered to the geographical information systems community using internationally recognised standards, such as WMS. This application allowed the visualisation of the NetCDF data into this standard protocol, thus creating a bridging from NetCDF data types to the WMS standard.

The TDS server (Version 3.17) has the capacity to deliver data in the WCS and OPeNDAP protocol across the internet. The server is built on top of the core NetCDF-Java library - an implementation of Unidata's Common Data Model (CDM). CDM creates an abstraction layer over file formats and metadata convention, such that, it is possible to access data using temporal-spatial referencing systems through a single interface. ncWMS is a visualisation server that is also using the same NetCDF-Java library. It contains a user interface, Godiva2 that allows users to select and view configured layers. As TDS and ncWMS share many common libraries, integration could proceed without major changes to the code. Datasets are typically served through OPeNDAP using TDS with additional servers installed and configured to enable visualisation. It requires managing multiple servers and essentially doubling the amount of administration workload. The tight integration of ncWMS allows the visualisation service to be toggled like any other services in TDS. It also means that only a single server has to be administrated.

The work is now included as part of the TDS 4.0 stable release and is expected to form part of the infrastructure for the MyOcean project (http://www.myocean.eu.org). It is also used by the eMarine Information Infrastructure (eMII) to serve Integrated Marine Information System (IMOS) datasets (http://www.imos.org.au/).

This project is made possible through the support of the NERC Knowledge Exchange Funding Scheme, Unidata, the Australian

Research Collaboration Services (ARCS) and Australian National Data Services (ANDS).

AC-4C-08: Unified Access to Distributed Data Sets: SeaDataNet - Pan-European Infrastructure for Marine and Ocean Data Management

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Multidisciplinary oceanographic and marine data are collected by more than a thousand research institutes, governmental organizations and private companies in the countries bordering the European seas using various heterogeneous observing sensors installed on research vessels, submarines, aircraft, moorings drifting buoys and satellites. The various sensors measure physical parameters (temperature, salinity current, sea level, optical properties, magnetic field, gravity), chemistry, biology, seabed characteristics, seabed depth etc. The data are collected at a very considerable cost and are of prime value because they are the reference for any study and, if lost, cannot be remade.

This data and information is very important for research, but also for monitoring, predicting and managing the marine environment, assessing fish stocks and biodiversity, offshore engineering, controlling any hazard or disaster, and the tourist industry. They support the execution of international protocols, conventions and agreements, which have been signed by coastal states for protection of the seas, such as OSPAR, HELCOM and the Bucharest and Barcelona conventions. They are essential for implementation of Europe's environmental policy concerning Integrated Coastal Zone Management (ICZM), the Water Framework Directive, and the new Marine Strategy Directive. Overall there are many thousands of users, based in the research sector, government and industry.

SeaDataNet is an Integrated Research Infrastructure Initiative (I3) in EU FP6 to provide the Pan-European data management system adapted both to the fragmented observation system and the users need for an integrated access to data, meta-data, products and services. The SeaDataNet project started in 2006, but builds upon earlier data management infrastructure projects, undertaken over a period of 20 years by an expanding network of oceanographic data centres from the countries around all European seas. Its predecessor project Sea-Search had a strict focus on metadata. SeaDataNet maintains significant interest in the further development of the metadata infrastructure, but its primary objective is the provision of easy data access and generic data products.

The SeaDataNet project has the following objectives:

 To set up and operate an efficient Pan-European distributed infrastructure for managing marine and ocean data by connecting 40 National Oceanographic Data Centres (NODC's), national oceanographic focal points, and ocean satellite data centres, in Europe. These Data Centres are mostly divisions of major national marine research institutes and based in 35 countries, surrounding the European seas.
 To ensure consistent dataset quality and to provide on-line trans-national access to marine metadata, data, products and services through a unique portal, while the base data and information are stored and managed at the distributed data centres.
 To secure the long term archiving of the large number of multidisciplinary data.
 To develop added value regional data products like gridded climatologies and trends, in partnership with scientific research laboratories.

AC-4C-08b: Utilization of Ocean Reanalysis Data for Climate Variability Analysis of the North Pacific Intermediate Water

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Recently, the number of ocean observations has been denser in time and space. Historical observation data is, however, not sufficient from the climate analysis point of view. Numerical ocean models have also improved. They are necessarily affected by defects of parameterization schemes of sub-grid scale phenomena and sea surface fluxes. On the other hand, ocean reanalysis gives a more realistic and 4 dimensional gridded historical data by synthesis of the information from the observation and the model. Therefore, ocean reanalysis data sets are beneficial to climate variability analyses of the historical ocean.

We conducted ocean analysis/reanalysis experiments for global ocean and the North Pacific. The MRI Multivariate Ocean Variational Estimation (MOVE) System was applied for these experiments. The system adopts a multivariate 3DVAR scheme, in which adopted are a coupled temperature-salinity empirical orthogonal function decomposition in the vertical and horizontal Gaussian structure for background error covariance matrix. Periods of the analyses/reanalyses are 1948-2007 for global ocean and 1955-2005 for the North Pacific. Resolutions in the global and North Pacific are 1 degree (0.3 degree for meridional direction at tropical region) and 0.5 degree, respectively. Sea surface boundary condition for these analyses is an atmospheric reanalysis data, NCEP-R1. Assimilated observation data are in situ observations of temperature and salinity profile (World Ocean Database 2001, Global Temperature and Salinity Profile Project) and satellite altimetry sea surface height anomaly data (AVISO).

We have been investigated ocean climate variability (e.g., subsurface ocean heat content) and water mass variability (e.g., the North Pacific Tropical Water and Intermediate Water) by using these analysis/reanalysis datasets. In this paper, we report a climate change of the North Pacific Intermediate Water (NPIW). Freshening of NPIW for recent several decades has been shown by observation based analyses. We obtained 3 dimensional distribution of freshening trend of North Pacific for the last 40 years from ocean reanalysis data (MOVE_G_RA_2007). The trend is consistent with the observation based analyses. The trend is large at the western sub-tropical region and the upstream of NPIW, i.e., confluence zone of the western boundary currents of sub-polar and sub-tropical gyres. The freshening at the upstream is caused by increasing of a sub-polar water ratio of the mixed water and not able to explain by changes of the characteristics of the sub-polar and the sub-tropical waters themselves.

AC-4C-09: Global Ocean and Sea Ice State Estimation in the Presence of Eddies

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The Estimating the Circulation and Climate of the Ocean, Phase II (ECCO2) project, aims to produce a best-possible, global, time-evolving synthesis of most available ocean and sea-ice data at a resolution that admits ocean eddies. A first ECCO2 synthesis for the period 1992-2002 has been obtained using a Green's Function approach to estimate initial temperature and salinity conditions, surface boundary conditions, and several empirical ocean and sea ice model parameters. Data constraints include altimetry, gravity, drifter, hydrography, and observations of sea-ice. Although the control space is small (~80 parameters have been adjusted), this first global-ocean and sea ice data synthesis substantially reduces large-scale biases and drifts of the model relative to observations and to the baseline integration. A second ECCO2 synthesis is being obtained during the ARGO-rich period (2004-present) using the adjoint method (Lagrange multipliers), which permits a much larger number of control parameters to be estimated. This paper compares and contrasts the two estimation methodologies, with emphasis on the particular challenges caused by ocean eddies and by sea ice processes, it evaluates the Green's-function-based solution relative to a wide range of satellite and in-situ observations, and it presents early results from the adjoint-method-based solution.

AC-4C-10: Towards an operational ecosystem approach - European Marine Ecosystem Observatory

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European policies on the sea, such as the new Marine Strategy Framework Directive, require a wide range of marine scientific data and information to support the ecosystem-based approach to the management of human activities. The evidence required will be within 'regions' which cross national boundaries and will be based on observations from physics to fish over wide time and space scales. Also additional information is necessary to understand the causal relations between natural and human pressures and environmental status. A European Marine Ecosystem Observatory (EMECO) has been developed that initially focuses on observations in the North Sea. The aim of EMECO is to facilitate networking between European research and monitoring communities with complementary interests focussed on innovative monitoring methods and strategies, that integrate modelling and data-model integration (e.g. field measurements and remote sensing). EMECO builds on existing international cooperation including on-going research and monitoring projects as well as current networks (e.g. EuroGOOS, NOOS, ECOOP, MyOcean, GMES). Many of the component platforms such as Ferrybox and SmartBuoy are mature technologies funded by the EU or its member states which have been delivering in situ data for nearly a decade. Methods for integrating and interpreting spatial and temporal multinational data sets from satellite and models are under development and a prototype application using web based tools including Google Earth has been implemented allowing users to manipulate and visualise integrated data products. EMECO has started dialogues with marine policy makers at European and national level, and is addressing an urgent need for integrated international initiatives that are essential in supporting sustainable development of the coastal seas at regional scales.

AC-4C-11: GODAE Ocean Data Quality Control Intercomparison Project

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A workshop was organized prior to the Biarritz GODAE symposium to discuss the potential and priorities for the exchange of information and collaboration on the quality control of ocean observations. The workshop was the initial step in a process that has evolved into a comprehensive ocean data quality control intercomparison project. Currently, outcomes of profile data quality control procedures from 5 oceanographic centers are available on the US GODAE server: http://www.usgodae.org/ftp/outgoing/godae_qc. The contributing centers include: (1) U.S. Navy Fleet Numerical Meteorology and Oceanography Center (FNMOC); (2) U.K. Met Office (UKMO); (3) Marine Environmental Data Service of Canada (MEDS); (4) Australian Bureau of Meteorology (BMRC); and (5) French Coriolis Data Center (Coriolis). Daily inputs of profile QC data from the centers are matched and used to create NetCDF formatted WMO call sign data files. A WMO call sign file contains the entire time history of the reporting platform and all of the QC information used by the center to determine profile data quality. WMO call sign data files exist for the time period 2004 to the present and are updated daily as new profile data QC information is received from the centers.

The WMO-based call sign files have a vareirty of applications. First, the call sign files allow GOOS data providers access to information about the fate of their data in GODAE analysis/forecast systems. Oceanographic centers are in the best position to operate ocean data quality control systems and the call sign data files provide a way to facilitate the relay of real-time QC information back to program managers and operators regarding utilization of their buoy, XBT, and profiling float observing networks. Second, the WMO call sign files provide a way for the oceanographic centers to compare their ocean data quality control systems. The quality control procedures being used at the centers are expected to substantially vary depending upon the type of data being considered and whether extensive use is made of ocean model first guess fields or whether more specific tools (e.g., instrumentation error checks), manual checks, and comparisons with climatology are used at the center. Finally, the time history aspect of the call sign files provide a natural way to look at systematic problems (biases) in the reporting platform, such as sensor drift or calibration errors.

In this paper we review the development and future of the GODAE Ocean Data Quality Control Intercomparison Project. We describe the design and process of generating the WMO call sign data files using daily outputs of profile data quality control information from the oceanographic centers. The WMO call sign data files represent the starting point of all follow-on analysis and intercomparison of ocean data QC outcomes. The project is initially focusing on the ocean profile data, but the system can easily be expanded to include additional ocean data types, QC variables, and analysis/application tools.

AC-4C-12: Cyberinfrastructure for the U.S. NSF Ocean Observatories Initiative: A Modern Virtual Observatory

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The Ocean Observatories Initiative (OOI) is an environmental observatory covering a diversity of oceanic environments, ranging from the coastal to the deep ocean. Construction will begin in summer 2009 with deployment phased over five years. A comprehensive cyberinfrastructure is the key integrating element of the OOI and is based on a design utilizing loosely coupled, distributed services with components throughout the observatories, from seafloor instruments to deep sea moorings to shore facilities to computing and archiving infrastructure. The OOI cyberinfrastructure itself can be viewed as an example (instantiation) of a grid or cloud of sensors, networks and other resources. At the same time, the multi-institutional organization can be thought of as a Virtual Organization; in fact, the cyberinfrastructure and organization can both be viewed as Virtual Organizations in which there is flexible, secure, coordinated resource sharing among dynamic collections of individuals, institutions and resources. An earlier realization of such a Virtual Organization on an equally large scale is the Large Hadron Collider (LHC) at CERN, which is connected to more than 750 physicists at 130 sites. The OOI design includes fifty different instrument types with more than a thousand sensors, actuators and autonomous vehicles. While the LHC has been delayed by hardware startup problems, the delivery of data to analysis sites throughout the world relies upon many of the same technologies that are being incorporated into the OOI cyberinfrastructure as well as new approaches, which expand technologies beyond grids to distributed computing and storage clouds, both academic and commercial. Developments in information technology, message passing and social networking, as examples, advance so rapidly that the Virtual Organization must be able to adapt to these changes through evolution of the system architecture even during construction. To meet this need, we have adopted a spiral development strategy and a modular design that can be adapted during both the construction and operations and maintenance phases. In order to meet NSF requirements and provide a basis for integrated planning, the OOI as a whole has relied heavily on systems engineering including user and system design requirements derived through small, intense elicitation workshops bringing together experts in information technology and domain science, and formal testing, verification and validation procedures. In addition, work breakdown structures, program execution plans, risk assessment and mitigation tools and other formal planning methods have been adopted. In developing the OOI cyberinfrastructure, years of planning including conceptual, preliminary and final designs have been necessary requiring the use not only of person-person meetings throughout the US and abroad, but electronic means supporting teleconferencing, videoconferencing, wikis, e-mail, web sites and social networking have been essential. We will review each of the approaches in use to build a viable Virtual Organization and offer an evaluation of the relative importance of each. Plans and existing activities for integration of the OOI with other environmental sensing networks globally will be discussed.

AC-4C-13: Information Infrastructure for the Australian Integrated Marine Observing System

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Marine data and information are the main products of the Integrated Marine Observing System (IMOS, www.imos.org.au) and data management is therefore a central element to the project's success. The eMarine Information Infrastructure (eMII) provides a single integrative framework for data and information management that will allow discovery and access of the data by scientists, managers and the public. The initial strategy has focussed on defining specific data streams and developing end-to-end protocols, standards and systems to join the related observing systems into a unified data storage and access framework.

IMOS data streams can be categorized in four ways: 1) gridded data from satellites and HF radar systems 2) timeseries data from moorings, argo floats, gliders and ships of opportunity 3) image data from Autonomous Underwater Vehicles 4) biological data from continuous plankton recorders and acoustic tagging

1) and 2) provide real-time and delayed-mode data sets whereas 3) and 4) are delayed mode delivery only.

The IMOS data management infrastructure employs Open Geospatial Consortium (OGC) standards wherever possible. The main components of the system are:

- OpeNDAP /THREDDS servers hosting CF-compliant netCDF, HDF or Geotiff data
- The opensource GeoNetwork (http://geonetwork-opensource.org/) Metadata Entry and Search Tool (MEST) for metadata cataloguing. Much of the development work for this tool was carried out by the BlueNet project (www.bluenet.org.au).
- SensorML, which provides standard models and an XML encoding for describing sensors and measurement processes
- the opensource DataTurbine (www.dataturbine.org), data streaming middleware providing the foundation for reliable data acquisition and instrument management services
- A web portal using the opensource ZK Ajax framework (www.zkoss.org) and the OpenLayers geospatial framework (http://openlayers.org/) incorporates access to Web Services.

Additional storage formats and database protocols (e.g. WOCE exchange format, oracle) accommodate the data sets not readily converted to netCDF.

A distributed network of OPeNDAP/THREDDS servers around Australia forms the primary data storage. This complements the regional nodal structure of IMOS and allows rapid access to data by the local research community. Each local server also supports the GeoNetwork catalog with, wherever possible, automatic harvesting of metadata from the OPeNDAP/THREDDS system. An IMOS netCDF standard ensures that all necessary metadata to comply with ISO 19115 can be automatically extracted from the netCDF files. Automation of metadata creation from non-netCDF datasets is also being investigated. A master GeoNetwork catalog at the University of Tasmania routinely harvests new metadata records from the regional catalogs to maintain a central registry.

The IMOS Facility for Automated Intelligent Monitoring of Marine Systems (FAIMMS) uses DataTurbine streaming middleware to deliver real-time data from a sensor network across the Great Barrier Reef. However, the software is also being used provide a real-time view (through the portal) of all IMOS timeseries data collected within the preceding month or two.

The portal acts as a 'shop-window' to view IMOS data and as a data search engine utilising the GeoNetwork catalog tool. At

present three 'views' of IMOS data are being developed: the real-time view through DataTurbine; a 'Facilities' view whereby all data from an IMOS facility, e.g. gliders, can be explored; and a 'Node' view whereby all data within an IMOS regional node, e.g. Southern Australia, can be explored. Through the GeoNetwork MEST the search engine can allow simple and complex data searches, both of IMOS data and other national and international datasets. Accompanying the different views of IMOS data will be a 'software toolbox'. All IMOS data is freely available without constraints and is obtainable through a simple self registration process.

Data storage and retrieval in IMOS is designed to be interoperable with other national and international programs. Thus, it will be possible to integrate data from sources outside IMOS into IMOS data products, and IMOS data will also be exported to international programs such as Argo, Oceansites. Also, most of the real-time physical parameters data will be exported to the World Meteorological Organisation's Global Telecommunications System (GTS).

As the IMOS program gains momentum the concept of data sharing and its value is spreading across Australia.. The long-term view of the data management infrastructure developed for IMOS is that it will become the infrastructure of the Australian Oceans Data Network.

AC-4C-14: Multi-altimeter Sea Level Assimilation in MFS Model : Impact on Mesoscale Structures

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The impact of multi-satellite altimeter observations assimilation in a high-resolution Mediterranean model was analysed. Four different altimeter missions (Jason-1, Envisat, Topex/Poseidon interleaved and Geosat Follow-On) were used over a 7-month period [September 2004, March 2005] to study the impact of the assimilation of one to four satellites on the analyses quality. The study highlighted three important results. First, it showed the positive impact of the altimeter data on the analyses. The corrected fields capture missing structures of the circulation and eddies are modified in shape, position and intensity with respect to the model simulation. Secondly, the study demonstrated the improvement in the analyses induced by each satellite. The impact of the addition of a second satellite is almost equivalent to the improvement given by the introduction of the first satellite: the second satellite data brings a 12% reduction of the root mean square error (rmse) for the Sea Level Anomaly (SLA). The third and fourth satellite also significantly improve the rmse, with more than 3% reduction for each of them. Finally, it was shown that Envisat and Geosat Follow-On additions to J1 impact the analyses more than the addition of Topex/Poseidon suggesting that the across track spatial resolution is still one of the important aspects of a multi-mission satellite observing system. This result could support the concept of multi-mission altimetric monitoring done by complementary horizontal resolution satellite orbits.

Comparison of the model analyses with independent temperature and salinity profiles confirmed these results showing a positive impact of the sea level assimilation on the subsurface salinity and temperature estimates.

AC-4C-15: Arctic Regional Ocean Observing System: Arctic ROOS

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An Arctic Regional Ocean Observing System (Arctic ROOS) has been established by a group of 14 institutions from nine European countries working actively with ocean observation and modelling systems in Arctic and sub-Arctic seas. The background for Arctic ROOS is the growing demand for operational monitoring and forecasting services in Arctic and sub-Arctic seas as a consequence of climate change and increasing human activities in these areas. The Arctic regions offer vast areas of hydrocarbon resources that have just started to be exploited. The Arctic Ocean is surrounded by continental shelves, where in particular the huge Siberian shelf covering the eastern hemisphere, extending from the Barents Sea to the Chukchi Sea. There is growing political interest for the Arctic Ocean and several countries have started investigations of the continental shelves. Sea ice is a major obstacle to accessing the Arctic shelf areas where large potential petroleum resources are located. Operations in sea ice require specialized vessels and constructions designed to withstand the forcing from ice pressure. The observed and predicted sea ice reduction has stimulated the interest for oil and gas exploration in Arctic areas that previously were considered to be inaccessible due to sea ice. Polar waters represent a significantly higher degree of risk to shipping and offshore operations than most other waters, due to the presence of ice fields, wind and waves, icing of vessels and darkness in the winter. The risk of oil spills and other pollution in Arctic waters is a serious issue because of potential damage to the environment. The presence of sea ice makes cleanup techniques normally employed in more temperate climates useless in ice-covered areas. The safety and efficiency of sea transportation, off-shore operations, fisheries and other marine activities have been the motivation to establish operational sea ice monitoring and forecasting services in many countries in addition to the weather services. These services are usually limited to national areas of interest and leaves large parts of the Arctic without daily monitoring and forecasting services. With support from the Global Monitoring for Environment and Security programme (GMES) and other international programmes, satellite observations and modelling systems covering the whole Arctic and sub-Arctic regions are being developed, and several operational services are presently delivering information on sea ice and ocean variables The main components of Arctic ROOS are (1) satellite observations from polar orbiting satellites using active and passive microwave, optical and infrared instruments, (2) numerical modelling including data assimilation, nowcasting, short term forecasting, model comparison and validation, and (3) In situ observation systems based on ship-borne instruments, moored instruments, ice buoys, floats and drifters. Satellite observations of seas ice, wind, waves, oil spills and ocean colour parameters have been developed extensively in recent years with support from GMES projects funded by ESA and EU as well as national programmes. Modelling and forecasting systems have been developed through several EU-funded projects, in particular MERSEA IP, which is completed in 2008 (http://www.mersea.eu.org/). The in situ component of the Arctic ocean observing system is the least developed. In a few places, such as the Fram Strait, moorings have been deployed for more that ten years, measuring ocean and sea ice parameters. Hydrographical surveys from ships have been performed in ice-free waters for many years, but large parts of the interior of the ocean are not observed by any in situ system at all. During IPY 2007 – 2009 there are, however, several research projects developing new observing systems for ice-covered areas (Dickson, 2007). A key project is DAMOCLES IP, funded by FP6, where testing of new instruments and platforms for under-ice operations is a main activity (http://www.damocles-eu.org/). More information about Arctic ROOS is found at http://arctic-roos.org

AC-4C-16: GlobWave: Providing Global Harmonized Wave Data

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The primary objective of the GlobWave project is to improve the uptake of satellite-derived wind-wave and swell data by the scientific, operational and commercial user community. The project is a 3 year initiative funded by the European Space Agency, which aims to develop, operate and maintain an integrated set of information services based on satellite wave data.

Wave data are available from in-situ measurements, satellite altimeter and SAR instruments and are generated by an increasing number of wave models used in forecasting wave conditions. However, the use of wave data in a commercial, scientific and operational environment has been hampered the lack of harmonized and integrated wave data; users are often confused by what wave data are available, the data quality and a lack of data standardization. Merging and analysis of complementary satellite and in-situ measurements can deliver wave products with enhanced accuracy, spatial and temporal coverage, together with new types of higher-level products. This requires the development of methodologies for complementary use of wave data from these different sources.

This concept has been pioneered in the GHRSST initiative (including its ESA component Medspiration), which has clearly shown the benefits of a user-centric scientific approach. The GlobWave project proposes to transfer this successful approach into the wave domain, and build on it with new achievements.

- Standardized wave data products and formats to provide a uniform, harmonized set of satellite wave data and ancillary information, in a common format.
- Reliable wave data based on multiple sensors and sources, which has been quality controlled, calibrated and validated with consistent characterization of errors and biases.
- Easy access to wave data products via a web portal, regularly updated including processed near-real-time data, and based on an integrated set of information services that are continuously updated and improved based on user feedback and ongoing process improvement.
- Improved uptake of satellite-derived wind-wave and swell data by the scientific, operational and commercial user community.
- A sustainable service that users can rely upon to meet their needs in the long term, not just for the duration of the ESA-funded project.

The project will build on the knowledge and contacts of the consortium members, lead by Logica UK, with support from CLS, IFREMER, SatOC and NOCS, to increase the value provided to GlobWave by existing projects. The project User and Steering Groups will provide direction and focus for the project, ensuring the widest range of activities are included and ensuring that user expectations are met.

AC-4C-17: A High-Quality Global Historic Hydrographic Data Set

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There is a general need in the oceanographic community for a historic hydrographic data product, providing quality-controlled temperature and salinity information as long backwards in time as possible. In a cooperative effort between the KlimaCamus of the University of Hamburg, the German Oceanographic Data Centre (DOD, Hamburg), the PANGEA Publishing Network for Geoscientific & Environmental Data and the Alfred Wegener Institut für Polarforschung (AWI), we combine all available global historic hydrographic data into a new quality-controlled product in support of ocean state estimation which provides an estimate of the time-varying ocean circulation by combining all available ocean data with ocean models. Such a data set will provide a description of the two most important characteristics of sea water and applications will include water mass analysis, ocean modeling, besides ocean syntheses. In a first step we create an up to date hydrographic profile data set, which includes temperature and salinity measurements, obtained by means of the old Nansen hydrographic casts and by the modern Conductivity/Temperature/Depth (CTD) instruments. These two kinds of data are by far the most accurate compared to other instrument types. Efforts are spend to include many German data sets not included in the historic data archives before, as well as other data obtained in the past over the global ocean. We extend the quality-control procedure of the World Ocean Database 2005 in several ways. The T and S quality checks will be conducted in the T/S-space and inter-cruise offsets will be calculated wherever possible. As shown by Johnson et al. (2001) and by Gouretski and Jancke (2001), systematic offsets exist between quality-controlled data from different cruises (e.g. WOCE data set). Such inter-cruise offsets will be determined and documented on a cruise by cruise basis. The metadata, most important for the quality assessment of the temperature and salinity data, will be also provided (if available) along with profile data on a cruise by cruise basis. Data processing methods developed during the initial stage of the project will be used for the analysis of other types of hydrographic subsurface data, such as those from mechanical and expendable bathythermographs and profiling floats. The hydrographic cast data will be used as a reference for the quality assessment of data from other instruments. Data will be world-wide available on the data server of the KlimaCampus of the University of Hamburg (www.klimacampus.de).

AC-4C-18: The CLIVAR and Carbon Hydrographic Data Office

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The CCHDO's primary mission is to be a distribution center - to data users - of CTD and hydrographic data sets of the highest possible quality. These data are a product of WOCE, CLIVAR, IOCCP and other oceanographic research programs -- past, present and to come. Whenever possible the CCHDO provides these data in three widely-used formats: WHP-Exchange, which is recommended for data submissions to the CCHDO, and WOCE and netCDF. The CCHDO acquires data through contacts with scientists, data teams, and national data centers. All files are checked for consistency and formats and headers adjusted as needed. The CCHDO also merges bottle data parameters from multiple data originators. The CCHDO produces data files which are up-to-date, properly attributed, well-documented, and with a data history that is available to users. Files are posted on a public web site along with extensive documentation. The CCHDO stands ready to assist the oceanographic community with distribution of the next generation of CTD, hydrographic, ocean carbon, and tracer data.

AC-4C-19: Enhancements to a Digital Library Web Portal for Ocean and Climate Data.

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The Tasmanian Partnership for Advanced Computing (TPAC) currently hosts a digital library web portal providing the marine and climate scientific communities with ready access to a wide variety of ocean and climate datasets. The portal uses the OPeNDAP framework for delivery of files and deals with a large number of heterogeneous and geographically distributed datasets, some huge in scale. It employs an associated data harvester that regularly checks specified locations for updated or modified datasets, and updates the portal with the current state of each dataset. The harvester is also capable of discovering new datasets and automatically adding them to the portal. A significant problem hampering data discovery by the harvester is the non-compliance of the datasets to a common standard and the lack of comprehensive metadata to accompany each dataset. The strategy in developing the TPAC Digital Library has been to accept all datasets and collect whatever metadata is associated with each one. This strategy has enabled the Digital Library to expand quickly to become a useful facility, but, as it expands further, a lack of critical metadata, particularly information on the geospatial extent of each dataset, is limiting its capacity to guide researchers to the datasets they require. To address this problem, the database employed by the portal has been restructured to accommodate spatial data, and the harvester modified to retrieve geospatial extents using the OGC Web Coverage Service standard. This enables users to perform spatial searches on some datasets within the Digital Library. Further modifications are currently being made to the harvester to allow spatial searches on almost all of the datasets within the library. Another problem has been the fact that, although the harvester is capable of handling datasets with tens of thousands of files, in some cases datasets include over a million files and it takes a very long time to harvest the required metadata. In order to improve its performance on datasets with very large numbers of files, strategies have been identified and implemented to improve the speed of the harvester. The strategies implemented so far have achieved a three-fold increase in the speed of the harvester in the test environment. This poster outlines the facilities that the TPAC Digital Library portal currently offers, and discusses recent enhancements (including the two described above) that increase the portal's usefulness for the marine and climate scientific communities.

Day 5: The way forward

Session 5A: Delivering societal benefits from the ocean observing system

AC-5A-01: DELOS:- 25 year monitoring of the benthic animal community in the vicinity of offshore hydrocarbon operations.

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The deep-sea environment into which oil company operations are gradually extending is generally poorly understood with surveys regularly discovering new habitats and communities of animals previously unknown to science. By establishing long term monitoring of the deep sea physical environment and biological activity in that environment it should be possible to compensate to a large degree for previous lack of knowledge. The DELOS system comprises two environmental monitoring platforms situated in the Atlantic Ocean at 1400m depth in block 18 off Angola: - one in the far field (16km form sea floor infrastructure); and one in the near field (within 50metres of a sea floor well). Each platform comprises two parts: - the sea floor docking station that is deployed on the sea floor at the start of the monitoring program and remains for the 25 year project duration; and a number of observatory modules that are designed to perform specific environmental monitoring functions. One of each observatory module will be available to each platform. Once deployed each observatory module will have enough battery and storage capacity for autonomous operation for at least 6 months. Towards the end of the 6 month deployment period each platform will require ROV intervention to recover observatory modules to the surface for service, calibration and data offload. During this service period no monitoring will be possible at the sea floor however, long periods of monitoring will be possible (months), interrupted by short service periods (days). The DELOS represents a stepping stone towards a long term cabled observatory. Returning instrumentation to the surface each 6 months overcomes the problems of instrument calibration, bio fouling, and failure. The DELOS was installed off west Africa in January 2009.

AC-5A-02: Long term monitoring of oceans around Southern Africa

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The South African Environmental Observation Network (SAEON) aims to provide a comprehensive, sustained, co-ordinated and responsive South African Earth observation network that delivers long-term reliable data for scientific research and informs decision making for a knowledge society and improved quality of life. SAEON addresses the environmental observation and information needs of future generations, reaching far and wide, nationally, regionally and globally, and its success as a platform for environmental observations depends on delivery of reliable environmental data and products for science, policy and management. Education-Outreach, based on environmental sciences, has a specific focus on science educators, learners and research students. The marine offshore node of SAEON aims to fill the gaps in long-term ocean monitoring, helping to understand the impact of climate change on oceans and their resources surrounding South Africa, as well as improving our knowledge of the oceans' influence on climate change. It is vital that we better understand these oceans as they have been shown to play a major role in the weather and climate patterns over southern Africa. Thus the impact of climate change through factors such as increases in temperature and sea level rise, which are already evident, are likely to have devastating effects on the lives of millions of impoverished people.

AC-5A-03: Observational Needs for Regional Earth System Prediction

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As the impacts of global change become manifest in every component of the Earth System, the need for producing personalized, pre-emptive, and predictive environmental information for Joe, the plumber, is upon us. A regional Earth System model is the only realistic way to combine climate predictions and climate change projections to generate end-to-end Earth System predictions for water, energy, food, human health, transportation, and so on including decision support tools and policy inputs. Such a regoinal Earth System model has been developed as a prototype for the Chesapeake Bay by downscaling seasonal to interannual predictions and IPCC projections to generate routine forecasts of temperature, winds, pollutants, pathogens, currents, watershed, fisheries, harmful algal blooms, including the impact of land use change scenarios on the health of the Bay for an integrated assessment. A decision support tool allows the users to change crop types, smart growth options, urban development, etc. to assess the consequences in terms of nutrient and sediment loadings, streamflow changes, deadzones, fisheries, HABs, waterquality, etc. The challenge is to validate, provide uncertainties, optimize model parameters, and compute skills of these forecasts and this can only be accomplished by a continuous feedback to observational networks via coupled and interdisciplinary observational system simulation experiments. SOme preliminary experiments with a localized ensemble transform Kalman filter are discussed in the context of physical-biogeochemical data assimilation for the Bay. The importance of designing and optimizing observational networks for Earth System prediction can not be overstated.

AC-5A-04: Development of a Regional Coastal Ocean Observing System for Societal Benefit through US IOOS: NANOOS.

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The United States Integrated Ocean Observing System (US IOOS) is designed to fill global, national, and regional scale needs for ocean data to serve societal benefit in seven areas: public health risk, living marine resources, ecosystem health, coastal hazards, climate change, maritime operations, and national security. Notably, most of these issues vary geographically on a regional basis, in terms of issues and risks as well as in forcing functions. As part of the coastal effort, IOOS has adopted the use of Regional Associations, based on large geographic units. The US is divided into 11 Regional Associations (RAs). Each RA is responsible for connecting with regional stakeholder groups, designing a process to assess user needs, and then crafting a Regional Coastal Ocean Observing System (RCOOS) that is responsive to those needs. A strong component of the RCOOS is the integration of observing assets, data management and communication, modeling and products, and education/outreach. The Northwest Association of Networked Ocean Observing Systems (NANOOS) is the US IOOS RA for the states of Washington, Oregon, and N. California. Established since 2003, this RA has developed a governance system, an assessment of regional needs, and a coalition to build the RCOOS and deliver its products. Focusing on fisheries, maritime operations, coastal hazards, and ecosystem impacts including hypoxia and HABs, NANOOS has developed ocean data products to inform specific user groups, as diverse as tuna fisherman, recreational boaters, state resource managers, and public health officials.

An important part in the process is communication and focus on high quality data and science in order to deliver accurate products of use. I will present some case examples and factors for success.

AC-5A-05: Long-term Monitoring and Early Warning Mechanisms for predicting ecosystem variability and managing climate change

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Marine ecosystem interactions are critical to climatic variability (both in terms of their climatic driving functions, as well as their being impacted by variability in climate). Yet research is lacking in many areas linking marine ecosystems and climate change. Monitoring is fragmented and unsustainable thereby preventing scientists and policy-makers from making informed decisions on ecosystem-based management and on adaptive reaction to climate change. Various discussion documents related to the IPPC reports focus heavily on the need for adaptation to climate change, on developing a framework for action, particularly at the national level, and on matching financial and technical support (primarily focusing on technologies for adaptation). Little attention, however, has been given to the need for monitoring and measurement mechanisms at the regional and local level that can A. provide accurate indications of specific changes related to climate change at the ecosystem level whilst B. identifying the scale and distribution of expected impacts, and C. translating these into reliable predictions and policy guidelines which countries can act upon so as to adapt and mitigate/avert the negative impacts. There is a strong general agreement on the necessity for assistance to be targeted at the more vulnerable countries to take appropriate adaptation measures, but there is a missing link in terms of how to identify, at the regional and national level, what such measures would need to address and at what scale, in relation to the predicted and actual measurable inputs. Yet this must have inevitable and significant implications in terms of prioritisation of actions and targeting of available funding. Although there is much discussion about mitigation and adaptation, there has been little focus on continuous and sustainable monitoring of changes in many of the world's more vulnerable areas, the data and information from which are essential in justifying management and governance actions, and to provide credibility for policy decisions. The conclusion of this scenario is an urgent need to develop focused early warning and continuous long-term monitoring networks, particularly in relation to critically vulnerable ecosystems and communities. These need to be sustainable and sufficiently credible in their data and information outputs to be able to drive reliable predictive mechanisms for adaptive management and governance. The Large Marine Ecosystems of the world are seen to be directly related to major global physical phenomena with a particularly close linkage to climate in terms of ocean-atmosphere interactions Specific indicators need to be selected that will act as early warnings of ecosystem variability and climate change at a global, regional and local level.

AC-5A-06: Quantitative analysis for ocean observations using hyper/multspectral data provided from a multi-sensor system package

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The maritime zone is a highly dynamic region where hydrodynamic and morphodynamic processes may change on a wide range of spatial and temporal scales. Information regarding the variations of the littoral environment is critical for a large range of military and civilian missions. Standard in situ surveying can provide this information but are typically very challenging because they require people and extended periods of time. Moreover, they may not be possible in denied areas. For these reasons, remote sensing of the shore is highly desirable. Satellites are an attractive solution but, for the nearshore-zone they typically have problems related to limited resolution, a complete lack of temporal sampling on dynamical time scales and access limitations. Motivated by this fact, our idea consists in the utilization of alternative platforms (aircraft). The data presented here have been acquired during a cruise conducted by NURC and collaborating institutions. This experiment (BP09 – Battlespace Preparation 2009) address specific problems associated with remote sensing (RS) of denied areas, specifically to improve the quality of the optical properties derived from RS in marine coastal environments. The main objective is to assist in the calibration and validation of large-scale ocean color sensors (MODIS, 1 km), medium scale sensors (MERIS, 300m), and small scale sensors (GeoEye and hyperspectral aircraft over-flights, 1-2 m). During this trial aerial and in situ sensors were used and integrated to provide combined measurements allowing the characterization of the nearshore both in spatial and spectral dimensions (see the attached fig with the aircraft, satellite and in situ stations). In particular, we present a feasibility study which examined the application of a distributed sensor system package to perform ocean observations for maritime missions. The system incorporates several platforms: aerial vehicle, satellites as well as in situ sensors. To analyze the platform integration and their data reliability for oceanographic purposes, a field exercise were performed to build sensor integration, performance evaluation and process refinement. Once these technical aspects were assessed and errors minimized, image geo-rectification and processing were performed. To integrate the satellite measurements, the aircraft images were rectified and geo-referenced to within 1-2 m accuracy generating images that surpass spatial and spectral resolution available from the satellites. To prove the system utilization for oceanographic scope the available optical in situ measurements were integrated with the remote sensing images. The main goal of the project was the development of a novel technique for creating high spatial/spectral resolution surf zone imagery from the available data (satellite, airplane and in situ). In particular, the project objectives were: _to test the logistics and operational use of the OGS aircraft and hyperspectral sensor (Imaging Spectrometer -Aisa EAGLE); _to review the aircraft geolocation capabilities based on internal metadata and to refine the metadata using an high-spatial resolution RS (GeoEye satellite, 0.55 m in the panchromatic channel); _to provide methodologies to perform the atmospheric corrections and provide performance evaluation matrices using the available coincident in situ optical measurements. _to compare variability between instrument calibrations and measurement protocols to compute uncertainties in retrieving in situ radiometric values and how these uncertainties are propagated in RS imagery, thus affecting geophysical parameter derived products. _to determine the intra/inter-pixel variability in optical and physical properties and how this affects the merging of low/medium/high spatial and spectral resolution of RS data for improving spectral and spatial resolution. During our project several methodologies and algorithms have been developed and implemented. In these pages we would like to emphasis the aircraft data that provided an innovation contribution to the development of optical information and assessments as well as coastal forecasting. Aircraft data were radiometrically and georectified using an inertial navigation system mounted onboard the aircraft, final aircraft to satellite (GeoEye) image co-registration has been also applied. After georectification, the atmospheric correction was performed using standard methodologies also with the help of the high-resolution satellite

acquisition and the in situ available coincident data. In particular the Research System Incorporated (RSI) ENVI software package was used to perform dark subtraction, thermal infrared correction and to integrate the aerosol characterization information available from the in situ sensors (using FLAASH). Once the path atmosphere and noise were removed, the resultant imagery was converted from radiance values to reflectance and was compared with the in situ coincident available measurements.

Day 5: The way forward

Session 5B: Towards an integrated observing system (expanding and enhancing the system)

AC-5B-01: New International Climate Research Center in Maritime Continents, and Contributions to Global Moored Buoy Arrays

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Based on the long-term collaborations of more than 12 years between JAMSTEC/Japan and BPPT/Indonesia, the proposal on the development of Indonesia Maritime Continent (IMC) climate research laboratory on enhancement of atmospheric and oceanic study for societal benefits in Indonesia was just accepted by JICA-JST matching funds of the Japanese Government. In this project, BPPT and JAMSTEC plan to develop collaboratively a) science research center (Research Center) to study the climatic variability and change phenomena in the IMC both land and sea, b) observational technology center (Technology Center) to develop Indonesian land-atmosphere-ocean observing system for monitoring climate variability, and c) observation information center (Information Center) for the societal benefits and scientific research in Indonesia by using data from the TAO/TRITON buoy array, HARIMAU atmospheric radar-profiler network, RAMA buoy array, current NEONET information, and other available data in public.

The laboratory will be initially managed and operated by scientists from the two countries; however, we welcome participations and contribution from other institutes in other countries. As one of activities currently planned, the transfer of surface buoy technology by JAMSTEC to BPPT is listed. The final goal of the technology transfer is set as the replacement of TRITON buoy operation in the Indonesian EEZ in the western Pacific (Eq.-138E and 2N-130E) by Indonesian original surface buoys. This means that the present TAO/TRITON buoy array will not be maintained only by the US and Japan if this project will success.

Our presentation includes the historical story of JAMSTEC-BPPT collaborations, current status of ocean and atmospheric observations in and around IMC, draft plans of the laboratory in near future. We welcome any comments on the roles of the planned new laboratory to global ocean observations, especially to the Global Tropical Moored Array (http://www.pmel.noaa.gov/tao/global/global.html), the TAO/TRITON array, and the RAMA array.

AC-5B-02: Application of Wireless Sensor Networks to Coastal Observing Systems - An Example From the Great Barrier Reef

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The Great Barrier Reef Ocean Observing System (GBROOS) is an observation system that seeks to understand the impact of the Coral Sea, in particular cool and warm water intrusions, on the Great Barrier Reef (GBR) of north eastern Australia. GBROOS is a regional node of the Australian Integrated Marine Observing System (IMOS, 2009). One component of GBROOS is the deployment of wireless sensor networks at seven reefs along the GBR.

Sensor networks have the potential to provide large amounts of cost effective real-time data from a range of sensors but most applications have focused on small scale terrestrial deployments. GBROOS looks to apply these new technologies to remote marine systems to better understand the thermal events that lead to coral bleaching and how the exchange of water from outside the reef impacts local conditions within the reef.

Seven reefs along the GBR will be instrumented; current deployments include Heron and One Tree Islands in the southern GBR and Davies Reef in the central GBR. The other reefs will be completed by 2010. At each site a base station is installed using existing towers or platforms. A high speed IP based data link is installed back to the mainland using 3G phone networks, line of sight microwave or surface ducted microwave (Palazzi et al, 2005). Around the reef lagoon six metre steel relay-poles are placed to create the wireless network with one of the poles also housing a weather station (Vaisala WXT520). Into the wireless network are deployed moored buoys onto which the main sensors are attached using a mix of inductive modem technology and simple cables.

An example deployment from One Tree Island is shown in Figure One. The main lagoon has a number of circular coral micro-atolls, a relay pole is installed in the centre of the micro-atoll and a sensor string run from the pole across to the edge of the atoll, up and over the rim and down into the main lagoon. This gives a vertical profile down the atoll wall as well as measurements within the atoll and the main lagoon.

The design uses a cheaper thermistor string coupled with more expensive oceanographic grade instruments with a SeaBird SBE39 located within the atoll and an SBE37 deeper in the lagoon (Fig. One). The SeaBird instruments act as a reference for the cheaper thermistors. The instruments are monitored by an intelligent controller that controls the sampling rates, coordinates the collection of data and monitors the battery life. Data are collected every ten minutes and sent, via the base station, back to the main data centre.

Automated quality control is done to identify bad data using the IODE (UNESCO/IOC/IODE, 1993) quality control flags. This produces a 'Level-1' product that is available in near-real time. Every month the data is manually reviewed and corrected to produce a Level-2 product, higher level summary products are also produced.

The data shows the dynamics of these lagoonal reefs including the impact of oceanic processes. A good example is tropical cyclone Hamish which went past One Tree Island on the 9th of March 2009. The real-time data (Fig. Two) shows a pressure drop as the cyclone moves by with a corresponding increase in wind. There was a marked mixing of the lagoonal waters; the profile shown in the bottom of Figure Two shows a stratified pattern before the cyclone and a well mixed one after.

Sensor networks offer a new set of capabilities for observing systems including real-time data, the ability to monitor and manage sensors and instruments remotely and the ability to do adaptive sampling to better capture events of interest. Most sensor networks have been in terrestrial environments using 'cheap and cheerful' sensors; the GBROOS project is one of the first to mix smart controllers with real-time communications and oceanographic grade instruments. This design returns data that has the required scientific robustness along with the many benefits of the new smart sensors such as rules based and adaptive sampling, central control and monitoring and support for a wide range of sensors.

Quality control of real-time data is problematic as the need to make data available quickly means that only limited automated checks can be applied. The project has adopted the idea of 'levels' of data where the lowest levels are raw data with more processing and correction being applied for higher level data (Bainbridge and Rehbein, 2008). The other issue is the lack of standards for the access and discovery of sensor data. The project is adopting the Open GIS Consortium (OGC) set of Sensor Web Enablement (SWE) standards (OGC, 2009),

although some of these standards are not fully developed and there is currently little supporting software.

The GBROOS project shows a practical demonstration of the value of sensor networks, when combined with oceanographic grade instruments, to provide real time adaptive sampling of a range of ocean phenomena and the processes that drive them.

AC-5B-03: GBROOS - An Ocean Observing System for the Great Barrier Reef

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The Great Barrier Reef Ocean Observing System (GBROOS) is an observation system that seeks to understand the impact of the Coral Sea on the Great Barrier Reef (GBR) of north eastern Australia. GBROOS is a node of the Australian Integrated Marine Observing System (IMOS) project.

Coral reefs are under threat. A recent survey (Wilkinson 2008) shows that 20% of reefs globally are already lost; 15% are under immediate threat and 20% are under longer term threat. Corals are sensitive to climate change and the sustainability of coral reefs globally may be under threat (IPCC AR4 2007). GBROOS looks to provide the real-time data required to understand climate change and the sustainability of the GBR.

The experimental design looks to provide complementary data at a range of scales and to link processes occurring at the tens of kilometres down to the environment around an individual coral head. The location of equipment deployed under GBROOS is shown in Figure One.

At the largest scale is remote sensing data from an X and L band receiving station located near Townsville in north-east Australia. The data includes NOAA AVHRR data used for Sea Surface Temperature and MODIS data used for ocean colour and productivity. Validation data are collected from a ferry mounted radiometer, an optical reference station for ocean colour validation and underway systems on selected research vessels.

At the next scale is an ocean HF radar installation in the southern part of the GBR that provides real-time information on surface waves and currents. The installation covers around 150 kilometres square at a resolution of four kilometre cells with data collected every ten minutes. The data is retrieved in real-time and processed into vector plots showing surface currents and waves.

Reference moorings have been deployed around Australia as part of the IMOS project. GBROOS maintains moorings off Townsville in the central GBR and off Darwin in northern Australia. The moorings have a surface weather station, bottom acoustic Doppler current profiler (currents and waves) and a series of SeaBird SBE39's and WetLabs WQM instruments to give a profile of temperature, salinity, turbidity, chlorophyll and dissolved oxygen. Each month water samples are manually collected and analysed for zooplankton, pigments, alkalinity and water chemistry.

The heart of GBROOS is an array of moorings along the Great Barrier Reef designed to monitor the flow of oceanic water along and into the reef matrix. The moorings are set up as pairs with one offshore deeper slope mooring and one inshore shelf mooring. Pairs of moorings are located in the northern, central and southern parts of the GBR (Fig. One). In the very southern area the design is more complex in order to capture the eddy systems that occur in this region. The design of the moorings is similar to the reference moorings.

The finest scale data comes from wireless sensor networks located on seven reefs (Fig. One). Sensor networks allow for intensive sampling of environments in shallow locations giving real-time information about water flows around individual corals as well as flows within the reef. Using smart controllers and two-way IP communication the systems can be controlled and monitored in real time. This allows for adaptive sampling where the sampling can be changed in response to events. The deployments mix oceanographic grade instruments with smart controllers to give intelligent systems returning quality environmental measurements.

The deployments are targeted at understanding particular geographic issues. In the south the issue is monitoring the variability in the current flows and understanding the impact of these on the local climate and downstream as they form into the East Australian Current. This is an area of complex re-circulation, the variability of which has an impact on downstream oceanography and climate.

In the central GBR the issue is the inflow of oceanic water into the reef matrix and the impact this has on thermal events such as summer warming and risks of coral bleaching. Intrusions have been detected across the slope, understanding what forces these events will lead to a better understanding of how oceanic changes are reflected into on-shore communities. In the north the systems are designed to collect comparative information on climate links to spawning events (such as coral mass spawning).

GBROOS is an observing system that looks to measure the connectivity between the oceanic systems that drive shelf and coastal water flows and the biological systems that use the services provided by these flows. The impact of long term changes in the oceans on coastal systems needs to be understood if the long term sustainability of coral reefs is to be assured. Systems such as GBROOS are a fundamental part of understanding these systems and in developing appropriate responses.

AC-5B-04: Post-EPS Altimeter Mission Orbit Determination, Considering Tide Aliasing Criteria and Applications Requirements

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The aim of the study is to suggest optimal orbit candidates for a new Post-EPS (EUMETSAT Polar System) altimeter mission planned around 2020 and onward. After more than 15 years of continuous and accurate space altimetry, it is worth questioning old strategies, and trying to define the best choices for future missions, based on the experience of previous missions and on the requirements from data users.

Optimising future altimeter missions is indeed a complex problem. Many conflicting requirements, constraints and issues must be taken into account: the diversity of user requirements (ocean applications and climate, ice and land applications of altimetry), the need to optimise the altimeter system error budget (mission payload), adequacy between the signals of interest and the altimeter system capacity (aliasing of high frequency signals like tides, atmospheric forcing, continuity between successive missions for climate change estimation), the incentive to minimize mission costs (technology, orbit, missions' lifespan...), the need to consider the multi-mission, multi-agency context.

The orbit geometry determines the geographical coverage, the space/time sampling by the altimeter measurements and the type of applications that can be addressed. While defining a

new altimeter mission, it is thus of highest importance to optimise the orbit parameter. Particularly the aliasing of tides is a crucial issue: it was one of the drivers of the choice of the Topex/Poseidon-Jason's orbit. Nowadays tidal signals are well known in deep ocean. However some issues remain in coastal areas and internal tides are not determined accurately. Aliasing of tides by altimeter sampling remains important as it may pollute other signal estimations, particularly in the aliasing band of 40-90 days and the semi-annual/annual band.

Some orbit candidates for Post-EPS altimeter mission have been selected and investigated within this context, when accepting or relaxing the tidal aliasing criteria which can be very restrictive. Only non sun-synchronous orbits are considered, because there is no possible aliasing of daily signals in such orbits.

Each post-EPS candidate is assessed in term of sampling capability (temporal and spatial), and the direct sampling effect of the orbit is investigated for the most important applications of altimetry (mesoscale variability of the ocean, high frequency phenomena...) thanks to OSSE experiments in a mapping context. As Sentinel-3 is the mission which will most likely fly around the same period, only 2-satellites constellations with Sentinel-3 are considered in the study and they are then compared to the well-known altimetric constellations (Jason-1/Envisat, Jason-1/TP).

AC-5B-05: The West Australian Integrated Marine Observation System (WAIMOS)

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The main area of interest of for the West Australian Integrated Marine Observation System (WAIMOS) is the continental shelf and slope regions offshore Fremantle extending northwards to Guilderton. Within this region there important topographic features such as the Rottnest Island and Perth Canyon and the circulation is dominated by the southward flowing Leeuwin Current (LC) with the northward flowing Leeuwin Undercurrent (LU) beneath the (LC) and the wind driven Capes Current (CC) located on the shelf, particularly during the summer months. The IMOS infrastructure located in this region includes HF Radar (CODAR and WERA systems) for surface current measurements at 2 different scales (Figure 1); Ocean gliders (Slocum and Seagliders) for subsurface water properties (Figure 2); continental shelf moorings (ADCP, thermistor and water quality loggers) (Figure 2); passive acoustic sensors for whale monitoring (Figure 2); and, remotely sensed data products (SST and ocean colour). Example data collected from these instruments will be presented in relation to the understanding of different processes operating in the region. These include: (1) Interaction between the LC and CC. Here, the warmer, lower salinity southward flowing Leeuwin Current interacts with the cooler, higher saline northward flowing Capes Current creating region of high horizontal shear and thus intense mixing; (2) Winter cascade of dense water along the continental shelf. The region experiences a Mediterranean climate with hot summers and cold winters. During the summer months the inner continental shelf waters increases in salinity due to evaporation. In winter as this higher salinity waters cool its density is higher than offshore waters and a gravitational circulation is set-up where the inner shelf water are transported as higher salinity plumes into deeper waters.

AC-5B-06: A system for predicting, adapting and mitigating global change off western South America

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Developing countries have a significant proportion of the coastal zone making them key to managing this area along with their own growth. The coastal zone is changing and increasingly threatened in new ways, driven by the oceans' natural rhythms and a growing human population and developed society. Managers struggle to understand how fast and by how much the climate will become warmer, what to do about the problem and how the ocean will be impacted. The accelerating rates of climate change raise concerns about the stability of ocean ecosystems: will tipping points be reached beyond which they cannot recover? While eventually these concerns will be integrated into a unified earth management system, there are presently no concrete development plans for an integrated coastal zone management module to adapt and mitigate climate change Here we propose a systems approach to develop a management module for developing countries and to use western South America as a "pilot project". Why western South America? The region is the most variable in the world ocean. It harbors the largest single species fishery in the world producing an order of magnitude more fish than any other region per unit area. The economies of the region are heavily dependent on the ocean. It is a region of great scientific importance with very low in oxygen and pH. There is an entity, The Permanent Commission for the South Pacific (CPPS in Spanish), that coordinates ocean policies and activities for Colombia, Ecuador, Peru and Chile. The system would leverage ongoing efforts and serve as the overall coordination and management module. At the heart of the system are an information collection, management and modeling system that can rapidly inform policy makers, elected officials and the business community about imminent threats (Figures 1 and 2). Today's scientific/management strategy iterates between observations, basic ecosystem rules and single-purpose models or management practices. This process often takes years and has a short time horizon. Decisions are reached for yesterday's problem rather than todays and tomorrows. In the proposed new system (Figure 2) there is tight integration between components and broad participation by all sectors. The system is composed of the following elements: 1) Observations; 2) Data and Information Management; 3) Modeling; 4) Products; 5) Decision Making; and 6) The Integrated System with Feedbacks. Broader-purpose models, using novel techniques and increased available data, are used to make predictions that lead to: 1) no action; 2) a change in behavior (reducing emissions, fishing, pollution, educating the public, etc.) and 3) an active response to mitigate. New observations lead to modifications of the plan of action and improvement in the model. The system allows decisions to be evaluated against each other. The proposed system integrates and therefore increases efficiency. The proposed development starts from the top of Figure 2 with observations and moves down vertically. The development team includes leading academic scientists and engineers with experience in ocean observations and forecasts, government entities responsible for ocean resource and environmental management, private companies, and local and international NGOs. The system allows interested parties to become involved as needed. The observation system consists of sub-components. The first is a sparse but continuous in water component complemented with observations made from space. This sub-component is the backbone and includes gliders, floats, moorings and ship surveys (Figure 1). The second component is a rapid and controlled response unit. The target of this unit are crisis (anoxia, oil spills) and studies for understanding the temporal and spatial variability of important processes for which the models need parameters. It includes gliders and AUVs. New long-range AUVs presently under development are ideally suited for this application. The third component is a country/local system geared to specific issues of a sub-region. The needs of tropical Ecuador and Colombia are different from

upwelling-dominated Peru and Chile. Required as part of the integrated backbone are basin-scale to regional atmospheric and oceanic models that can be used for product generation, hindcasting and forecasting. These models would assimilate information from the backbone and the rapid response units. The data and information management system would link the observations and models and provide easy access for those parts dealing with product generation and decision support. These elements would then feedback to the top (Figure 2). The intent of this presentation is to provide the overall vision and to receive input from the participants in OceanObs09.

AC-5B-07: Improving Altimetry Products Over Coastal Ocean: PISTACH, a Recent CNES Initiative

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Since the launch of Topex-Poseidon in 1992, satellite altimetry has become the major component of the Earth's observing system. Thanks to its global view of the ocean state, numerous improvements in the environment understanding have been done and global monitoring of changes has now become possible.

More and more needs are nowadays expressed for similar coverage near the coastlines where human activities are concentrated. In these peculiar oceanic regions, satellite altimeter techniques are unfortunately limited by the emerged lands leading to a growth of the error budget of the altimeter products. To fulfil the need of coastal studies, the French Spatial Agency CNES set up in November 2007 its PISTACH initiative for improving Jason-2 altimeter products over coastal areas and also inland waters.

In the first months of the project, a study of the user needs and the definition of the products were conducted. A second phase dealt with analysis, selection and development of the new fields to be implemented in these new altimeter products (retracking of the waveforms, radiometer and model wet troposphere correction, local model for correction of tides and atmospheric forcing, sea state bias, data editing). The third and last phase has consisted in the prototype implementation, validation and operations during Jason-2 CalVal phases and after. These operations should end up in September 2009.

Since November 2008, the PISTACH prototype have been generating coastal dedicated Level 2 (I)GDR altimeter products freely provided to users trough an anonymous FTP website: ftp://ftpsedr.cls.fr/pub/oceano/pistach/. The evaluation of the actual improvements and data quality reached near the coasts with this new dataset is still under investigation by users. This contribution will present the main results of the PISTACH project about user needs. It will also define all the new algorithms developed and implemented into the prototype and exhibit some early results of comparison with standard products.

Towards Long-term Sustainable Observations of Ocean Wind and Waves with GNSS Signals of Opportunity

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The scientific usefulness of Global Navigation Satellite Systems (GNSS) signals for Earth Observation is already well established for atmospheric sounding, where GPS signals can help recover tropospheric temperature, pressure and humidity and provide near real-time ionosphere total electron content data. More recently, GNSS signals proved their worth for Earth Surface Reflectometry as well, thanks to a pioneering experiment on-board the UK-Disaster Monitoring Constellation Satellite in 2003 by Surrey Satellite Technology Ltd (SSTL). In that experiment, GPS signals reflected off the Earth surface were successfully recovered from a dedicated receiver on a low-Earth-orbiting satellite and subsequently analysed to yield geophysical information about the scattering properties of the ocean, ice and land surfaces (Gleason et al., 2005, 2006).

Over the ocean, GNSS-Reflectometry equates to bi-static altimetry, and, as in conventional ocean altimetry, the reflected GNSS signals contain information about the sea surface height (altimetry) and the ocean roughness (sea state and scatterometry). The retrieval of sea surface height and ocean roughness with GNSS-R has now been demonstrated to a satisfactory level of accuracy for scientific applications despite the suboptimal GNSS signal characteristics for altimetry, although GNSS-R for altimetry has yet to be demonstrated from space. The capabilities of GNSS-R for ocean wind and waves monitoring was demonstrated in 2005 when useful surface roughness information (in the form of the mean square slope variance) was retrieved from the UK-DMC data and validated again in situ buoy measurements. A recent re-analysis of the UK-DMC data proposed a new methodology whereby it is now also possible to retrieve directional information about sea state by exploiting Delay-Doppler Maps of the reflected GPS signals (Clarizia et al., 2009).

GNSS navigation signals are ubiquitous and could help dramatically improve the monitoring of ocean wind and waves. High-density global measurements of directional mean square slope variance are essential for scientific and operational uses which need proper characterisation of the ocean/atmosphere interface. Air-sea exchanges of gases, for example, are controlled by surface mean square slope, so that better sampling would have a direct impact on our understanding of the magnitude and distribution of atmospheric CO2 uptake by the ocean. Equally, mean square slope variance is relevant to operational weather and ocean forecasting, with important applications in the prediction of high winds, dangerous sea states, risk of flooding and storm surges. Finally, ocean roughness plays a supporting role for important climate-relevant Earth Observation techniques, for example IR SST where wind history is used to quantify the degree of vertical stratification in micro layer, or surface salinity retrieval with SMOS to remove the effect of ocean roughness on L-band brightness temperature.

The GPS-R receiver onboard UK-DMC was a small, low-power, low-cost instrument ideally suited for deployment on small satellites. The method therefore offers improved sampling of ocean wind and waves by means of a very modest instrument that could easily be fitted on more satellites. Work is now underway to optimise the instrument design and build the next generation of GNSS-R receivers to improve performance while maintaining its low-cost, low power and lightweight advantages.

References

Clarizia, M. P., Gommenginger , C., Gleason, S., Srokosz, M., Galdi, C., and Di Bisceglie, M., 2009: Analysis of GNSS-R Delay-Doppler maps from the UK-DMC satellite over the ocean, Geophysical Research Letters, doi:10.1029/2008GL036292.
Gleason S, Hodgart S, Sun Y, Gommenginger C, Mackin S, Adjrad M & Unwin M, 2005: Detection and Processing Bistatically Reflected GPS Signals from Low Earth Orbit for the Purposes of Ocean Remove Sensing, IEEE Trans. Geosci. Remote Sens., Vol 43, No. 6, pp.1229-1241.
Gleason S, 2006: Remote Sensing of Ocean, Ice and Land Surfaces Using Bistatically Scattered GNSS Signals from Low Earth Orbit, PhD Thesis, University of Surrey, December 2006.

AC-5B-08: Multi-year and very high frequency measurements of nutrients in an operational data buoy network

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The supply of energy to higher trophic levels in open marine ecosystems is dependant on primary production of phytoplankton. Primary production is limited by the time varying supply of light and nutrients. Until relatively recently nutrient measurements were only possible using low-frequency ship-based monitoring techniques with samples analysed on board using traditional chemical methods such as continuous flow analysis or stored prior to analysis in the laboratory. The Cefas SmartBuoy measures nutrients using two different approaches. High frequency measurements (typically 2 hourly) of TOxN (nitrate + nitrite) are made using an Envirotech NAS-3X in-situ nutrient analyser. This instrument uses the traditional chemical method within a robust submersible casing. Instruments are checked for linearity prior to deployment and calibration is achieved in-situ by use of an on board standard. The second method relies upon an automated waters sampler (AquaMonitor) where water samples (up to 150 ml) are collected and stored in blood transfusion bags pre-loaded with mercuric chloride. On return to the laboratory samples are analysed using standard techniques. The concentrations of nitrate, phosphate (if only negligible suspended particulate matter present) and silicate can be determined using this approach. The use of different methods allows comparison of datasets and also builds in redundancy in case of instrument failure. In-situ data are also compared to the results of discrete water samples which are collected by ship alongside the buoy by a rosette sampler lowered into the water during mooring service cruises. Measurements made since 2001 on the SmartBuoy network (www.cefas.co.uk/monitoring) reveal variability at a wide range of temporal and spatial scales. Results will be presented that show nearly an order of magnitude variability in TOxN over tidal cycles in nutrient enriched coastal sites. Strong interannual variability is also evident as well as episodic events associated with increased rainfall. The rapid draw down of nutrients during the spring bloom is a recurrent feature of the time-series as is the build up of nutrients during the winter period. Lesson learnt from nearly 10 years of continuous observations will be discussed and future plans for the monitoring network will be described.

AC-5B-09: PLOCAN: an off-shore multidisciplinary platform and testbed for deep sea systems and operations

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PLOCAN - Canary Islands Oceanic Platform, SPAIN

The Canary Islands Oceanic Platform (PLOCAN) is a public infrastructure for research, development and innovation in the fields of ocean science and technology at increasing depths. Located East of Gran Canaria Island (Canary Islands, Spain), PLOCAN will provide rapid access to great depths at short distance from the shore, accelerating research and the generation of water column and deep-ocean knowledge. Specifically, PLOCAN will host a permanent deep-sea observatory, be a test-bed for innovative technologies, form specialists and provide training in the field and be a national base of manned and unmanned submersibles. PLOCANâ€™s vision is focused on generation and exchange of science and innovations between the academic and the socio-economic spheres. PLOCAN will be a fully instrumented gate to the deep ocean, an efficient and cost-effective solution to test products and processes, and cluster private and public partnerships to face undersea challenges. PLOCAN also anticipates the diversity of technological and scientific opportunities that will result from the multiplication of ocean observatory initiatives. Beyond the realm of ocean observing systems PLOCANâ€™s vision is to be an accelerator for marine and deep-sea research and development at large, to provide optimal working conditions in a controlled environment with the necessary environmental guarantees

AC-5B-10: The Australian Integrated Marine Observing System

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There are ongoing concerns about adequate marine research-infrastructure in Australia to service Australia's requirements and responsibilities, which are significant because Australia has one of the largest marine jurisdictions of any nation on earth. At over 14 million km2 Australia's Exclusive Economic Zone (EEZ) is nearly twice the surface area of the Australian continent. It extends from the tropics to high latitudes in Antarctic waters and much of it is unexplored.

The surrounding Pacific and Indian Oceans strongly affect the continental climate-system at all time scales, from seasons to decades. Boundary currents such as East Australian Current and the Leeuwin Current affect regional climatic conditions and help sustain the marine ecosystems. There is evidence that these currents are changing on decadal time scales and have already impacted marine ecosystems, but the data is sparse and neither the currents nor ecosystems have been monitored in a systematic way.

The Integrated Marine Observing System (IMOS) was established as part of the Australian Government's National Collaborative Research Infrastructure Strategy (NCRIS) with $A50M and more than equal co-investments from Universities and government agencies. It is a nationally managed and distributed set of equipment providing streams of in situ oceanographic data and satellite data products.

IMOS provides essential data streams to understand and model the role of the oceans in climate change, and data to initialize seasonal climate prediction models. If sustained in the long term, it will permit identification and management of climate change in the coastal marine environment. It will provide an observational nexus to better understand and predict the fundamental connections between coastal biological processes and regional/oceanic phenomena that influence biodiversity.

The IMOS strategic research-goal is to assemble and provide free, open and timely access to streams of data that support research on the role of the oceans in the climate system and the impact of major boundary currents on continental shelf environments, ecosystems and biodiversity.

Given the extent and challenge of addressing the broad range of marine issues in the Australian EEZ, IMOS is considered only the beginning of the observing system that Australia needs. The cost of an adequate observing system will be high due to the great length of coastline and the relatively small population and economy. Never-the-less, staged enhancements are being planned. The return from investing in ocean observations around Australia estimated in 2006 concluded that the cost:benefit to the Australian economy of investing in ocean observations was better than 1:20.

Governance of IMOS is controlled by an Advisory Board with an independent Chair. The Board members are appointed for outstanding abilities to guide the program and are senior leaders able to take a broad, national perspective on IMOS development. The IMOS Office established at the University of Tasmania coordinates and manages all of the investments as a national system. The IMOS Office also receives advice from a Scientific Steering Committee made up of the leaders of regional Nodes.

The scientific rationale for IMOS is set by five regional Nodes covering the Great Barrier Reef, New South Wales, Southern Australia, Western Australia and the Bluewater and Climate Node (fig 1). Each Node has 50 to 100 members. Nine national Facilities make the observations specified by the Nodes using different components of infrastructure and instruments. The

observing facilities include three for bluewater and climate observations (Argo Australia, Enhanced Measurements from Ships of Opportunity and Southern Ocean Time Series), three facilities for coastal currents and water properties (Moorings, Ocean Gliders and HF Radar) and three for coastal ecosystems (Acoustic Tagging and Tracking, Autonomous Underwater Vehicle and a biophysical sensor network on the Great Barrier Reef). The operators of the facilities are the major players in marine research in Australia. A satellite remote sensing facility assembles data for the region and the electronic Marine Information Infrastructure (eMII) provides access to all IMOS data, enhanced data products, and web services in a searchable and interoperable framework.

Implementation of IMOS facilities began in 2007, and over 90% of the planned infrastructure has now been deployed. All data streams are now available in near real time through the IMOS website. Over the next two years, focus will shift from infrastructure deployment, to the development of user communities within the Nodes. Looking to the future, uptake of data from a broad user community is critical as focus turns to justify funding sustained ocean observations in Australia for a further 5 years.

AC-5B-11: Euro-Argo : towards a sustained European contribution to Argo

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1. The Euro-Argo research infrastructure

Maintaining the array's size and global coverage in the coming decades is the next challenge for Argo. Euro-Argo will develop and progressively consolidate the European component of the global network. Specific European interests also require increased sampling in some regional seas. Overall, the Euro-Argo infrastructure should comprise 800 floats in operation at any given time. The maintenance of such an array would require Europe to deploy about 250 floats per year. Euro-Argo must be considered in its entirety: not only the instruments, but also the logistics necessary for their preparation and deployment, field operations, the associated data streams and data centres. Maintenance, evolution and sustainability of European contributions to Argo require high level of cooperation between European partners.

2. The Euro-Argo preparatory phase (January 2008-June 2010)

As a new European research infrastructure, Euro-Argo (www.euro-argo.eu) started a preparatory phase funded through the EU 7th Framework Research Programme. Euro-Argo preparatory phase includes all European Member States (France, United Kingdom, Germany, Ireland, Italy, Spain, Netherlands, Norway) involved in Argo and several potential new actors (Greece, Portugal, Poland and Bulgaria). The main objective of the Euro-Argo preparatory phase is to undertake the work needed to ensure that by 2010 Europe will be able to provide, deploy and operate an array of 800 floats and to provide a world-class service to the research (climate) and environment monitoring (e.g. GMES) communities. The specific objectives of the Euro-Argo preparatory phase are as follows:

- The consolidation and strengthening of existing national contributions to the infrastructure.
- The development of a direct EC-wide contribution through GMES.
- The development of legal and governance arrangements for the Euro-Argo infrastructure.
- Evaluation and improvement of the European contribution to the Argo data management and delivery system.
- Enhancing European float technological capabilities and working towards using Argo to study aspects of ocean biogeochemistry
- The development of a vigorous European Argo user community.
- Exploiting the open access to Argo data as an educational "window" on the oceans and their role in climate.
- Developing new partnerships between European Argo nations, new European countries and nations outside Europe.
- Integrating the European observing array into the international system.
- Developing a ten year implementation plan.

3. Towards a long term research infrastructure

One of the main objectives of the preparatory phase is to define and agree on a long term funding and organization (i.e. governance and legal issues) for Euro-Argo. Funding issues are analyzed at national and European Commission (EC) levels. The future long-term structure for Euro-Argo is currently being defined and will be agreed by the end of 2009. It should allow us:

- To supervise operation of the infrastructure and ensure that it evolves in accordance with the requirements set forth by the research and operational communities.
- To coordinate and supervise float deployment to ensure that Argo and Euro-Argo objectives are fulfilled (e.g. contribution to Argo global array, filling gaps, improve regional coverage, open data access, etc).
- To decide on the evolution of the Euro-Argo infrastructure (e.g. data system, products, technology and new sensors, number or floats deployed per year).
- To share expertise on all scientific/technological developments and use of Argo.
- To monitor the operation of the infrastructure (e.g. array performance monitoring) and to maintain the links with research and operational (GMES) user communities.
- To organize float procurement at European level (e.g. in case of direct EC funding and for small participating countries).
- To link with the international Argo structure.

The structure should include a central facility (Central RI) and distributed national facilities. The central RI should have a legal structure receive EC and national (member states) funding, to procure floats (includes logistics and test facilities) and to provide funding to the international structure. A governance model for the structure has been defined (council, board, scientific and technical advisory group) and its main characteristics have been agreed by all partners.

AC-5B-12: The Australian National Mooring Network

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The Australian National Mooring Network (ANMN) is a series of National Reference Stations (NRS) and various mooring arrays which monitor oceanographic phenomena in Australian coastal waters. The network is a facility of the Integrated Marine Observing System (IMOS) and managed on a regional basis within 7 sub-facilities. These are: NRS – Coordination & Analysis, Queensland and Northern Australia, New South Wales, South Australia, Western Australia, Acoustic Observatories, and Satellite Ocean Colour – Calibration & Verification.

The NRS consist of nine sites, eight with moored sensors and all with water and plankton sampling, on the Australian continental shelf (Figure 1). Though nationally co-ordinated they are managed regionally by the relevant sub-facility. Multi-disciplinary data sets of physical, chemical and biological parameters are collected at each NRS. Building on three existing sites where a simple set of water quality data have been regularly collected since the 1940s the NRS forms the backbone of the ANMN, providing context to other studies and a time series of datasets to monitor climate change.

The Queensland and Northern Australia sub-facility consisting of four pairs of moorings located north to south along the Great Barrier Reef (GBR) and two NRS sites (Figure 2). Each pair has an outer mooring on the continental slope in water greater than 200m and an on-shelf mooring sitting on the continental shelf in shallower water around 30-70m deep. Like other ANMN moorings, the array deploys a range of instrumentation including Acoustic Doppler Current Profilers and WetLabs Water Quality Meters (WQM) that measure current velocities, dissolved oxygen, fluorescence, turbidity, conductivity, temperature, and depth. Three of the four shelf moorings will also have surface buoys to measure meteorological and radiation observations in real-time. The sub facilities objective is to observe the cross-shelf exchange of water between the Coral Sea and the GBR. Water moving along and onto the GBR will be measured by monitoring the southward flowing East Australian Current (EAC) and the northward Hiri western boundary current. Moorings in the southern GBR monitor the strength of currents related to upwelling events detectable on the Capricorn-Bunker Shelf, which supply deep, nutrient-rich water to the reef.

The New South Wales sub-facility is establishing a national reference transect of moorings and measurements off Sydney, which includes all parameters measured by other NRS. The facility also plans to deploy two moorings in the northern, and two moorings in southern NSW waters. The transect consists of three moorings and five water sampling stations in an area just downstream of typical EAC separation from the coast which is often influenced by EAC eddies. Data collection will support research on the marine ecosystems associated with these eddies. As this is the most densely populated area of Australia, issues such as water quality, waste disposal, shipping hazards, harmful algal blooms and recreation are of particular research interest. The moorings to the north and south will enhance the ANMN coverage along the coast of south-eastern Australia and also provide long term monitoring of the continental shelf region both upstream and downstream of the EAC separation point.

The South Australian sub-facility is deploying six moorings to monitor the large seasonal coastal upwelling of water that occurs along the continental shelf during summer. The mooring will include a slope mooring at the 600m isobath to measure the Flinders Current. An outer shelf mooring also examines outflows of saline rich water from coastal gulfs during Austral winter as well as enhanced upwelling from the du Couedic canyon. Three shelf moorings will be located in the path of both upwelling and downwelling exchange to allow measurement of the alongshore currents and exchange, and the alongshore evolution of the planktonic systems as it evolves towards the Gulfs and Eyre Peninsula. A NRS mooring is located at a convergence point of isobaths and will be able to monitor upwelling/outflow events as well as long-term variations in the strength of the coastal current.

The Western Australia sub facility will deploy an array of moorings around Perth will assit local researchers investigate the variability in the Leeuwin Current and continental shelf currents both in-terms of alongshore and cross-shore variability as well as processes within the Perth canyon. The array will consist of five moorings along the 'Two Rocks' transect from the 50m to the 500m isobath. One biophysical mooring with WQMs is to be deployed near the head of Perth canyon in 200m depth and two thermistor chains to a depth of 500m. The sub-facility will also support three NRS located at Ningaloo, Esperance and Rottnest.

The Acoustic Observatories sub-facility is deploying.passive acoustic listening station arrays in the Perth Canyon and Portland in South Australia. The stations will provide baseline data on ambient oceanic noise, detection of fish and mammal vocalizations linked to ocean productivity, whale migration patterns and detection of underwater events. Through an analysis of these signals, it is possible to both identify different species and assess the number of animals present within the range of acoustic observation. Big animals can also be located by a horizontal array of sea noise loggers constituting a passive acoustic observatory.

The Satellite Ocean Colour Calibration and Validation sub-facility is located on the Lucinda Jetty Coastal Observatory in Northern Queensland. The observatory aims to provide ground-truth data in tropical Queensland coastal waters to unravel the inaccuracies in remotely-sensed satellite ocean colour products due to the optical complexity of these waters and the overlying atmosphere. The observatory will become the preeminent source of measurements for the validation of coastal-ocean colour radiometric products applied to biogeochemistry and climate studies in Australia. It will merge two different data streams: the above water measurements of the water radiance and the in water measurement of the optical properties. Two reference sites will also be used to provide satellite operators and data users with access to reliable calibration and validation data for the coastal and ocean colour satellite mission data sets.

AC-5B-13: An Adjoint Sensitivity Analysis for an Optimal Observing System in the Subarctic North Pacific

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An optimal design of the ocean observing systems has been yearned to provide. In this paper, we demonstrate the effectiveness of an adjoint sensitivity analysis on the development of an optimal observing system for basin-scale processes. The estimate of the adjoint solution enables us to detect the sensitivity to fluctuations of model variables, which can facilitate the identification and characterization of the origins and pathways of specific water masses. The obtained information should contribute to the development of the strategic plan for the spatial and temporal deployment of measurement instruments (e.g., moored buoy), hydrographic survey, and others. Here, we performed observing system simulation experiment (OSSE) to evaluate the impact of the observing system data, assumed by an adjoint sensitivity analysis, on ocean state estimate.

We focus on typical subarctic North Pacific water which is indicative of the mesothermal water, and then applied an adjoint sensitivity analysis to the mesothermal water to detect the origins. The results show that the origin of this water lies mostly in the Kuroshio Extension region and a minor proportion comes from the Gulf of Alaska. Based on this analytical result, two different data assimilation runs were executed with/without the simulated observations in the source regions. The error value for the water temperature representative for the mesothermal water in the case with the simulated observations is reduced to approximately 1/2 of the value in the case without them. This fact shows that observation data input in the detected source regions can effectively achieve better reproduction of the mesothermal water in the reanalysis field. These results imply that our strategy for the development of an optimal observing system using an adjoint sensitivity analysis is promising.

AC-5B-14: Automationa in Microbial Observatories and Their Contribution for Ocean Observing Systems

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The Microbial Observatory of Rio de Janeiro (MORio) was stablished 13 years ago and since then has been a structure for regular sample collection. It is represented by an estuarine monitoring site, and the sampling began in 1997 with water quality measurements. Bacterioplankton analyses by flow cytometry were included in 1998, and more recently microbial diversity has been also studied. Even in the beginning of the study period, the values were already higher than shown in previous reports. This was attributed to the restriction of the water circulation in the bay, and the consequent reduction of water renewal and dilution of effluents. In the last years, it has been observed an increase in sewage discharges in Guanabara Bay. Based on this scenario and the data presented here, it could be predicted a continuous decreasing trend in water quality for the next years. We are now moving towards the automation on data acquisition, analyses, quality control, data handling and storage, following data distribution and availability.Well stablished technologies will be used, as e.g. the "ferry-box" concept. Microbial and general ecosystems observation projects depends more and more on good field instrumentation and smart data acquisition techniques, for precise and reliable studies. Field sensors are becoming much more complex and "inteligent", requiring software skills not always easy to be learned by the aplication-focused professionals. Also, the cost related to these activities are high, when compared to the main research areas. The eLua (Embedded Lua) project aims to take care and hide the low-level software complexities and offer the simplicity and power of the Lua language, so that no specialized embedded software programmer is needed in the team. eLua also offers a degree of portability never seen on the embedded development world before. It allows the hardware platforms to be treated as "comodities", evolving to faster and newer hardware without the need to rewrite the aplication programs. Our approach is a proof of concept and a test field for the development of new environmental monitoring technologies applied to the Global Ocean Observing Systems.

AC-5B-15: Using High Resolution Altimetry to Observe Mesoscale and Sub-mesoscale Signals

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During the last 15 years, multi-satellite altimetry data was largely shown to be able to observe a significant fraction of sea surface height variability. Past altimeter constellations ranged from one to four satellites. It allowed to better assess the performances of the global altimetry observing system (multi-mission merged maps), and it underlined the limits of spatial and temporal sampling for observing smaller scales and high frequency signals.

In order to better observe sea surface variability, new technologies and new altimeter constellations are considered, and their sampling capability is assessed and compared to historical scenarios. The focus is on high resolution altimetry: large swath altimetry (SWOT) or large altimeter constellations (20+ altimeters). In this study, an OSSE baseline was used to underline the observing capability of old and new altimetric systems to better sample mesoscale and sub-mesoscale signal in a mapping (objective analysis) context.

AC-5B-16: A Ship of Opportunity Observation Network for the Oceans Around Australia

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Aims

We present results from a major new ship of opportunity (SOOP) program observing the ocean waters around Australia. The SOOP Facility encompasses both the open ocean and coastal waters, in support of short time-scales associated with ocean prediction and the longer term scales of climate research. The aim of the SOOP Facility is to implement an integrated observing system in Australian regional seas that link physical, chemical and biological oceanography. Our ships of opportunity include both commercial vessels on regular routes and research vessels covering more varied routes. The SOOP Facility forms part of the Integrated Marine Observing System (IMOS) which is a new science infrastructure initiative funded by the Australian Government.

The target regions are the boundary current systems off Eastern and Western Australia, the Southern Ocean, the shelf seas across northern Australia, and the Great Barrier Reef. This is achieved by the following specific goals:

1. Implement vessels on suitable routes with an integrated system of measurements including physical and biogeochemical parameters . Monitor the major boundary currents systems around Australia
b. Monitor both local processes and the interactions of the boundary currents on the continental shelf

2. Provide in situ input and/or validation to model and data analyses covering the waters around Australia (SST, Air-Sea flux, BLUElink, POAMA etc).

Monitoring Platforms

High-density XBT Sections - Five major (HRX) high-resolution XBT lines provide boundary to boundary profiling, closely spaced sampling to resolve mesoscale eddies, fronts and boundary currents. The lines are repeated 4 times per year with an on-board technician. The routes sample each major boundary current system using available commercial vessel traffic. All of the transects transmit data in real-time.

Biogeochemical Program - uses the RV Southern Surveyor and the I' Astrolabe which sample the critical regions of the Southern Ocean and Australian waters, which have a major impact on CO2 uptake by the ocean and are regions where biogeochemical cycling is predicted to be sensitive to changing climate. Southern Surveyor has a wide spatial coverage and each year covers tropical to sub-polar waters.

The Astrolabe line, is one of the most significant repeat sampling lines for the ocean and samples all major Southern Ocean water masses. Observations of carbon, nutrients, pigments, phytoplankton species and bio-optical properties of organic matter cover the spring through late summer period when the region is most active biologically.

AusCPR - To monitor plankton we use the Continuous Plankton Recorder (CPR), the only platform that can assess plankton

species and be towed behind ships of opportunity. Species-level data are vital to examine mesoscale productivity, biodiversity, and climate impacts on marine ecosystems. Two seasonal routes are operated, in the Southern Ocean, and the East Australian Current Sensors on Tropical Research Vessels – Fixed sensor sets maintained on the 2 tropical research vessels (RV Cape Ferguson and RV Solander). The instruments obtain underway observations of temperature, salinity, chlorophyll, fluorescence, light absorption, and irradiance. Data are collected in both the Great Barrier Reef waters, the western Coral Sea, and Arafura Sea within repeated transects and individual voyage tracks. The actual location of data collected depends on the operational schedules of both vessels.

SST Sensors - Implemented on Australian Volunteer Observing Fleet (AVOF) vessels and several passenger ferries. Hull-mounted sensors supply high-quality bulk SST data fed into existing data management systems and broadcast via satellite back to Australia every one to three hours. Radiometers on ferries supply high-quality skin SST data in near real-time.

Research Vessel Real-time Air-Sea Fluxes - Research vessels have been equipped with "climate quality" met. systems, providing high quality air-sea flux measurements and delivered in near real-time. A full set of air-sea fluxes essential for climate studies requires: wind, air and sea temp., humidity, pressure, precip., long- and short-wave radiation. Data are broadcast via satellite back to Australia daily.

All of the data are freely and as far as possible, immediately available to all Australian and international researchers. Research in climate science, physical oceanography, ocean forecasting, coastal ocean dynamics and ecosystem and fisheries benefit from these regular, high-quality, timely observations of the ocean state. Results from each of the components will be presented.

AC-5B-17: SCOR/IAPSO 'OceanScope' Working Group

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The 'OceanScope' concept envisions a new paradigm for the systematic and sustained observation of the ocean water column. It proposes to develop a partnership between the ocean observing community and merchant marine industry so that a number of synergies can be realized which to date have not been possible, notwithstanding a very high level of cooperation between individual ship operators and scientists. These include 1) an enhanced ability identify routes and operators in all oceans, 2) new instruments and technologies developed and optimized for automated operation on commercial vessels, and 3) real time data streams, automated data processing and distribution to the user community. One option for implementation of this concept would be through the establishment of an international agency, something like an ESA or a CERN, which have long-term mandates appropriate to the tasks they are charged with. To develop these ideas SCOR and IAPSO have teamed up to sponsor a Working Group called OceanScope (SCOR WG #133). Marine vessels impose special challenges but also provide enormous possibilities for global coverage of the oceans. To address these in a systematic indeed holistic way, the Working Group will bring together experts from the shipping industry, the ocean observing community and instrumentation companies. The product of the Working Group will be an Implementation Plan for OceanScope. The Working Group's first meeting will take place this summer July 17-19 just prior to the IAPSO meeting in Montreal. The activities of this Working Group should be of interest to OceanObs09, and we propose therefore to present a progress report when OceanObs09 meets in September.

AC-5B-18: NSW-IMOS An Integrated Marine Observing System for South Eastern Australia

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The Integrated Marine Observing System, (IMOS), is a centrally co-ordinated nationally distributed set of equipment and data-information services which collectively contribute to meeting the needs of marine research in Australia. The observing system provides data in the open oceans around Australia as well as the coastal waters. The in situ data when combined with satellite data, enables the modeling required to explain the role of the oceans in seasonal prediction and climate change. Sustaining the project will allow identification and management of climate change in the coastal marine environment. It will also provide an observational nexus to better understand and predict the fundamental connections between coastal biological processes and regional/oceanic phenomena that influence biodiversity. In this paper we introduce the New South Wales node of the Integrated Marine Observing System (NSW-IMOS), one of 5 regional nodes. The oceans play a key role in the variability of the Australian climate, the global heat and carbon budgets and variability of marine ecosystems. The East Australian Current flows poleward along the coast of NSW from the Coral Sea to the Tasman Sea. It impacts the coastal ocean along its path, particularly along the coast of southeastern Australia where the EAC and its eddy field dominates the shelf circulation. The primary goals of NSW-IMOS are to: 1) Quantify the seasonal and annual variation in EAC along the coast of southeastern Australia and to identify key continental shelf processes; 2) Make sustained observations of the coastal separation of the EAC and the resulting eddy dynamics and biological consequences; 3) Determine the biological response to oceanographic and climate effects (eddies, upwelling, rainfall, dust storms), from fish movements, to phytoplankton communities, to benthic habitats. We will achieve these goals through an integrated monitoring program along the NSW continental shelf (Figure 1) which includes: 1) Establishing a national reference transect of 8 oceanographic moorings, supported by a high frequency coastal radar; 2) Monthly biogechemical sampling near the oceanographic moorings supported by autonomous ocean gliders 3) Deploying two cross-shelf transects of acoustic receivers ("listening posts") from the shore to the shelf break off Sydney and off Coffs Harbour, and using an Autonomous Underwater Vehicle (AUV); The data is being made available freely and in a timely fashion through the IMOS data portal eMII (http://imos.aodn.org.au/webportal/). The expected outputs from NSW-IMOS will be knowledge of the latitudinal gradient in EAC effects and climate impacts; the availability of near-real-time in situ observations that could be used to evaluate or initialise ocean models, such as Bluelink; evidence-based prediction of the biophysical response to climate impacts on beaches and coastal lowlands; contributing to evidence-based planning for marine parks; estimates of larval connectivity along the coast of southeastern Australia, amongst estuaries (and ports) as well as among marine parks; predictions of fish landings based on rainfall and oceanographic variation. Of course the benefit to the general public cannot be overlooked, for example, through an extension of NSW-IMOS data products to high schools, the public and the media (especially over the internet) of products such as temperature and velocity fields, shark tracks and glider paths. Other outputs are the post-graduate research theses and associated publications resulting from IMOS activities.

AC-5B-19: Acoustic technologies for observing the interior of the Arctic Ocean

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The demand for operational monitoring and forecasting systems in Arctic Ocean is growing as a consequence of climate change and increasing human activities in the area, but there is a severe lack of systematic observations of the deep Arctic Ocean. The GMES project MyOcean (2009-2011) develops and implements operational monitoring and forecasting system for global and regional oceans, including the Arctic. MyOcean combines observations from different satellite remote sensing techniques and in-situ open ocean measurements (mainly Argo floats and moorings) with ocean circulation models through advanced assimilation techniques. Satellites can sufficiently monitor changes in surface properties of the polar oceans, such as formation and retreat of sea ice, while the interior of the ocean is poorly observed and remains largely unknown both in ice-covered and ice-free areas, since the water mass is opaque to electromagnetic waves. Furthermore, the system of Argo floats, which is an important component of the global open ocean observing (GOOS) system, cannot be implemented in polar ice-covered waters. Correspondingly, the internal of the Arctic Ocean is not monitored on a systematic basis, and this represents a significant gap in the Global Ocean Observing System. Several new observing technologies based on acoustics such as Acoustic Ice Tethered Platforms (AITP), acoustic navigation systems for float and glider operations under the ice and acoustic tomography/thermometry are developed in the EU projects DAMOCLES IP (2005-2010) (http://www.damocles.eu.org) and ACOBAR (2008-2012) (http://acobar.nersc.no). Acoustic tomography provides measurements of acoustic travel times between acoustic sources and receivers. Through inversion techniques, internal ocean temperature can be retrieved at an accuracy of 0.01°C over a 200 km distance. In the same way, precise measurements of average current velocities can be determined from the difference between reciprocal travel times produced by simultaneous transmission of acoustic pulses in opposite directions along an acoustic path. OceanObs'99 identified high-latitude regions and the Arctic Ocean as key areas where ocean acoustic tomography should be applied. Stand-alone acoustic tomography systems in Arctic regions have been developed and successfully tested in ice covered regions, such as in the 1-year-long Greenland-Sea Experiment, the 7-year-long experiment in the Labrador Sea, the Trans-Arctic Acoustic Propagation (TAP) Experiment, and the 14-month long ACOUS experiment in the central Arctic Ocean. It is recommended to establish an integrated observation and modeling system for the Arctic combining acoustic tomography, oceanographic fields from gliders, floats and fixed profiling moorings, satellite remote sensing data and coupled ice-ocean models. The observed data will be assimilated into the ice-ocean models in order to provide monitoring and forecasting of the sea ice and ocean conditions. It is recommended to design and implement a cost-efficient, multi-purpose infra-structure for tomography, navigation/positioning of gliders and floats under ice, and standard oceanographical moorings. Furthermore, the acoustic system can be used for monitoring of ambient noise and marine mammals in the polar regions. The anticipated increase of human activities in the Arctic will lead to higher noise levels, e.g. from fishing vessels, oil and gas installations, seismic exploration and ship transportation. The observing system can therefore be used to assess the impact of increasing ambient noise levels on marine mammals. The implementation of multi-purpose observing system will build on experience from the previous acoustic tomography experiments in the central Arctic Ocean and the regional acoustic system currently under implementation in the Fram Strait within DAMOCLES and ACOBAR projects.

AC-5B-20: Adding Animal Movement Data to Ocean Observing Systems

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Acoustic telemetry provides the means to track movements and gather other data from fish as small as 10 centimetres. However, in the cases of fish that undergo large migrations, the amount of information available is limited by the extent of receiver networks that can be installed. In recent years, collaborative initiatives like the Pacific Ocean Shelf Tracking Project (POST), the Australian acoustic Tracking and Monitoring Systems (AATAMS, the Ocean Tracking Network (OTN) and others have started to address this issue by installing extensive arrays of receivers in various high interest areas. For example, the POST infrastructure includes a number of acoustic curtains extending from California to Alaska with the initial intent of determining what was happening to salmon smolt when they leave the rivers and enter the ocean. In addition, the arrays have provided valuable data on the migration of a number of other species. These collaborative initiatives have been the catalyst for many new and valuable projects as researchers can often take advantage of existing receiving infrastructure with significant savings in time and effort over project-specific installations.

The objective of this poster is to stimulate discussion with a view to adding a relatively small amount of information of high economic value about animal movements to existing and future ocean observation systems. The technology can be as simple as a small, low power module that would easily integrate into the platform; such modules are readily available today. This alone, by greatly expanding areas of coverage, would dramatically impact the applicability of acoustic telemetry and the value of data obtained. Future technology could be more closely integrated allowing for communication between satellite and acoustic technologies increasing the amount and timeliness of data collected.

The wide use of ocean observatories provides an opportunity to exploit emerging Integrated Tag technology to obtain far more information of fish movements and behaviour than is currently the case. For the large majority of species too small to carry an electronic tag incorporating a satellite transmitter, tags fall into two classes:

Data storage Tags which store sensor values in memory with data recovered when and if the fish is recaptured
Acoustic Telemetry Tags which transmit sensor data in real time.
Each approach, of course, has a serious drawback. With Data Storage Tags, no data is recovered if the fish is not recaptured while, with Telemetry Tags, no data is available for the time that the tag is not near a receiver (most of the time in the case of migrating fish). The Integrated Tag concept combines the features of both approaches and adds a small acoustic modem which uploads stored sensor data (e.g. Temperature, Depth, Geolocation Data, ID of other fish encountered, etc.) when in the presence of a compatible receiver. The power of this

approach depends on the likelihood of tagged fish encountering receivers and, therefore, an initiative to install receivers in as many ocean observatories as possible could be critical to the success of this approach.

AC-5B-21: Ocean Observations From the IRIDIUM NEXT Constellation of 66 Sattelites

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Iridium Satellite LLC is offering the unique opportunity to fly EO payloads on the NEXT constellation of 66 LEO satellites, due for launch from 2013 through 2016.

The proposition of this public-private partnership has been actively pursued since Jan 2007, federated by the Group on Earth Observation. Now more than 10 missions are under consideration, some more advanced than others, but there is truly international involvement.

Monitoring and mitigating Global Climate Change is the underlying theme, with ocean observations at the forefront.

Constellations of 24 Ku Altimeters and 9 Ocean Imagers are planned and under full evaluation. Such constellations will provide unprecedented temporal and spatial coverage.

These and other missions will be discussed and progress reported.

AC-5B-22: Observing High Latitudes: extending the core Argo array

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Over the past decade, Argo floats have provided an unprecedented number of profiles of the global oceans (to 2000 m depth), far surpassing the number collected historically from ship-based hydrography. The original design of the Argo mission specified nominal 3 x 3 degree spacing, with 10 day sampling interval, of the oceans between 60 °N and 60 °S, excluding the high latitudes and marginal seas. The exclusion of the high latitudes was due to the inability of early floats to sample under sea-ice. Technological advances in float design in recent years now give us this capability. Advancements have come through re-design of hardware (*i.e.* armoured ice floats), software (ice-avoidance algorithm and open-water test) and communications (Iridium), allowing the transmission of stored winter profiles. Observing circulation in seasonally ice-covered seas is challenging. To date, most observations have been made during ice-free summer periods and consequently the winter circulation beneath the sea-ice is not well understood. Despite this, Argo has already made a significant contribution to high latitude research with successful deployments of floats in the polar oceans of both hemispheres. As of December 2008, over 100 floats had been deployed above 60 °N and over 200 below 60 °S. Approximately 60% of these floats are still active (the failure rate of early floats was high as the ice-capable technology was being developed and tested). Mortality rates of newer ice floats are now equivalent to those deployed in less demanding conditions. In fact, a number of floats deployed in the Weddell Sea have survived for 7 years (surpassing 225 profiles) equal to some of the longest-lived floats deployed globally. The high latitudes are important deep water mass formation regions. The Southern Ocean connects the global ocean basins and regulates the meridional overturning circulation. The exposed Arctic Ocean will have important consequences for ocean and atmospheric circulation, moisture and heat fluxes. Therefore, both polar regions play a critical role in setting the rate and nature of global climate variability through their moderation of the earth's heat, freshwater and carbon budgets. Recent studies have shown that certain regions at high latitudes are warming more rapidly than the global average. Some of the most important climate change signals are seen near ice shelves and within the sea ice zone. In the Arctic, reductions in sea-ice extent and changes in freshwater fluxes, deep water mass properties and convection have been observed. Similarly strong reductions in sea-ice coverage are occurring near the Antarctic Peninsula while small increases appear in the Ross Sea. At the same time decreasing salinity on the Ross Sea shelf is thought to be linked to increased glacial melt. The Argo network has been crucial for documenting the recent changes in the open ocean; robust and large-scale freshening of the Southern Ocean has been observed from Argo and historical hydrographic data. But sampling at these higher latitudes is less systematic than for the rest of the globe. Therefore, observations of high latitude oceans in both hemispheres should be a top priority. In considering sampling strategies for the high latitudes we recommend extending the Argo network beyond 60 °S and 60 °N through the deployment of ice-capable floats at the nominal density (3 x 3 degrees). In addition, regional arrays of acoustically-tracked floats will provide a more focused effort on basin scales. An established array of sound-sources (RAFOS) and acoustically-tracked floats in the Weddell Sea is already yielding valuable information on ocean circulation and structure beneath the sea-ice. A similar array should be established to sample the Ross Sea gyre. In the Arctic, an array of low frequency (< 100 Hz) sound sources would be required to provide basin-wide geo-location for profiling floats. Now that we have come to review the past decade of progress within Argo, we find there is considerable support and justification for the official extension of the Argo array into the seasonally ice-covered seas. Sustained, comprehensive observation of the polar oceans is required to adequately monitor global climate change signals. This can only be achieved in a broad-scale and cost-effective way by using autonomous platforms like Argo profiling floats. It is thus imperative that a commitment is made to enhance and maintain a profiling float array in the high latitudes. The extension of the core Argo array beyond 60 degrees in both hemispheres will ensure that it remains one of the most important and truly global components of the ocean observing system.

AC-5B-23: The Ocean Observatories Initiative: Establishing A Sustained And Adaptive Telepresence In The Ocean

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Sponsored by the U.S. National Science Foundation, the Ocean Observatories Initiative (OOI) has the potential to help revolutionize ocean science. Its 24/7 telepresence will capture climate, carbon, ecosystem, and geodynamic changes on the time scales on which they occur, rather than when research vessels are able to be in the area. Data streams from the air-sea interface through the water column to the seafloor will be openly available to educators and researchers in any discipline, making oceanography available to citizens and scholars who might never go to sea.

The unique, sustained, time-series data sets provided by the OOI will enable researchers to study complex, interlinked physical, chemical, biological, and geological processes operating throughout the global ocean. The science drivers motivating the OOI include the ocean carbon cycle and its response to global change, ocean acidification, the impact of climate variability on ocean circulation, coastal ocean dynamics and ecosystem response, and the impact of tectonically driven fluid flow on the carbon cycle, deep ocean ecosystems and earthquakes. The magnitude and mechanisms of air-sea exchange, the fundamental processes that control turbulent ocean mixing on all scales and the biophysical consequences thereof, and the impact of plate tectonics on the sea floor and society underpin these topics.

The vision underpinning the OOI was to provide a state-of-the-art observational infrastructure that would open new paths for observation and experimentation over the next 20-30 years. The design goals for the OOI include: (1) continuous observations at time scales of seconds to decades; (2) spatial measurements from millimeter to kilometers; (3) the ability to collect data during storms and other severe conditions; (4) two-way data transmission and remote instrument control; (5) power delivery to sensors between the sea surface and the seafloor; (6) standard sensor interfaces, (7) autonomous underwater vehicles (AUV) docks for data download and battery recharge; (8) access to facilities to deploy, maintain, and calibrate sensors; (9) an effective data management system that provides open access to all; and (10) an engaging and effective education and outreach program that increases ocean literacy.

These design goals form the foundation of the current OOI design, a network that will provide a continuous presence in critical regions in the world's ocean. Four high-latitude ocean arrays will be built near Greenland, in the Gulf of Alaska, in the Argentine Basin, and in the poorly known Southern Ocean. A coastal Pioneer Array on the continental shelfbreak off New England, where south-flowing cool waters of the Labrador western boundary countercurrent interact with warm Gulf Stream waters flowing northward, will tie finescale observations of ecosystem health to the large-scale circulation and transport observations made at the Greenland station. The coastal Endurance Array off the U.S. Pacific Northwest will observe a narrower shelf with a wind-driven eastern boundary current, referenced back to high-latitude observations from the Gulf of Alaska. This array is connected to regional electro-optical cabled nodes at sites where extensive methane venting creates gas hydrates and/or sustains chemosynthetic vent communities off the Pacific Northwest coast, and which provide a window into seismic processes and hazards.

The observations from these multidisciplinary, adaptive platforms will be wired together and eventually networked into a multi-agency and international observing grid through a powerful cyberinfrastructure (CI). The CI provides a powerful lens to combine hundreds of thousands of individual observations into customizable views that can be "focused" on a particular science question akin to the fine-tuning control on a telescope. The fully OOI integrated network will quantitatively measure the interaction of major and minor global ocean components and processes and determine their interdependence for the first time.

The OOI is envisioned as a research-based counterpart to the U.S. Integrated Ocean Observing System (IOOS), which will be oriented towards applications and a component of the US contribution to the Global Earth Observing System of Systems (GEOSS). The science drivers motivating the OOI represent not only national ocean research questions, but questions that have global interest and impact. The ability to address science oriented around geodynamics engendered the interest of our Canadian neighbors, such that they are leading the way in instrumenting the northern portion of the Juan de Fuca plate (Neptune Canada). The selection of the OOI global mooring locations represent the cumulative and coordinated interest of U.S. scientists and those from two dozen nations involved in OceanSITEs, an effort dedicated to providing long-term measurements to address questions involving climate change, ecosystem dynamics, carbon cycling, and tsunamis.