OceanObs'09

Ocean information for society: sustaining the benefits, realizing the potential

Session 3A : Delivering services to society information and assessment

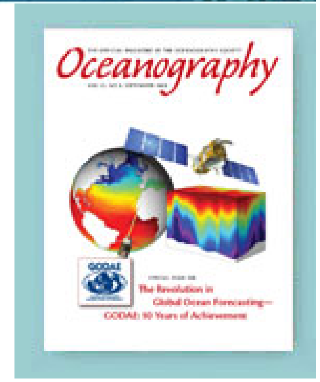
Physical hindcasts and nowcasts

Pierre-Yves Le Traon
and the GODAE / GODAE Ocean View science teams

21-25 September 2009 | Venice, Italy

www.oceanobs09.net

Acknowledgments



Most of the work presented here is based on presentations / proceedings from the GODAE final symposium (Nice, Nov. 2008) and GODAE Oceanography Magazine special issue (Sept. 2009)

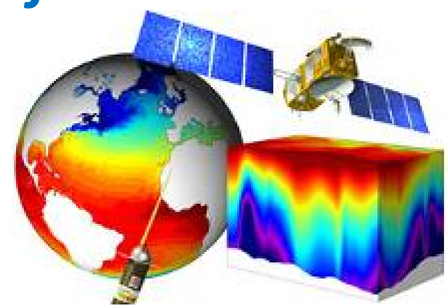
see www.godae.org

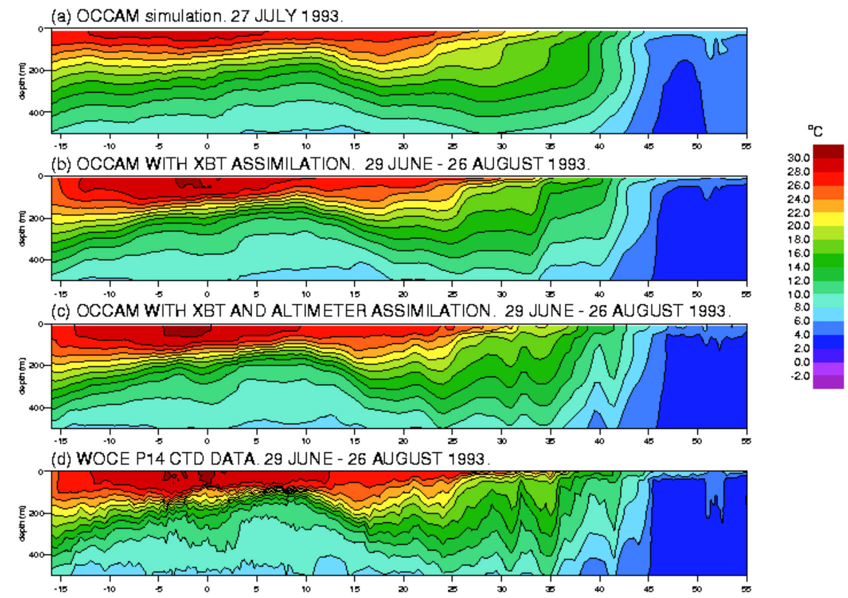
Content

- Operational oceanography and the integrated approach. Applications.
- Progress made during the last decade in real time global and regional modelling and data assimilation (GODAE).
- The global ocean observing system and operational oceanography.
- Examples of applications and contributions from operational oceanography systems. Other examples by G. Brassington (next session). Seasonal and climate covered elsewhere.
- Lessons learnt for the future and conclusions.

An integrated approach: combining data and model dynamics to provide an "integrated" description of the ocean state

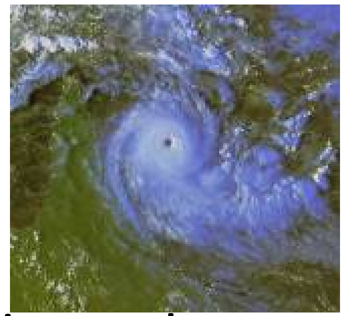
- **Use remote sensing data, in-situ data and models for an improved description and forecast of the ocean state. See Rienecker at al.**
- **Required for operational oceanography applications and to develop an improved understanding of the oceans.**
- **Importance of links/feedbacks with applications and end-users.**
- **GODAE (1998-2008) : develop the capabilities and demonstrate the feasibilty/utility.**



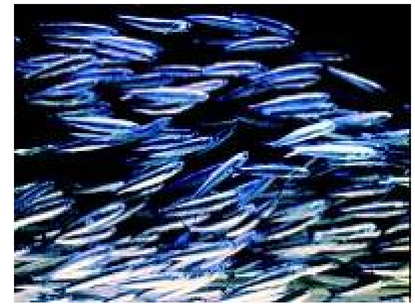


Operational Oceanography applications





Global warming, climate and seasonal forecasting, weather



Fisheries and fishery management

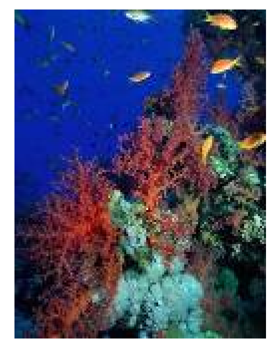
Offshore Industry
Ship routing

Maritime security
Marine Safety

Navies

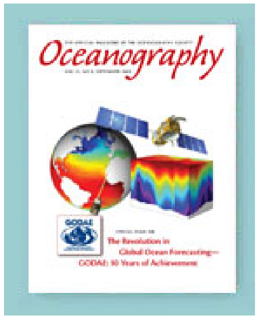
Coastal applications and environmental monitoring

Ocean and ecosystem research



others…

GODAE Achievements and Successes



Implementation of observing and data processing systems

- **Argo and GHRSST-PP (pilot projects), altimetry, in-situ**

Implementation of global modelling and data assimilation capabilities

- **high resolution and climate**

Implementation of data/product serving capabilities - standardization

Intercomparison / validation, metrics and standardization

Demonstrations of feasibility and utility

- **Mesoscale nowcasting and forecasting, ocean climate and research, marine pollution and safety, weather forecasting, marine resources, etc**

Scientific advances

- **Modelling, data assimilation, scientific validation**

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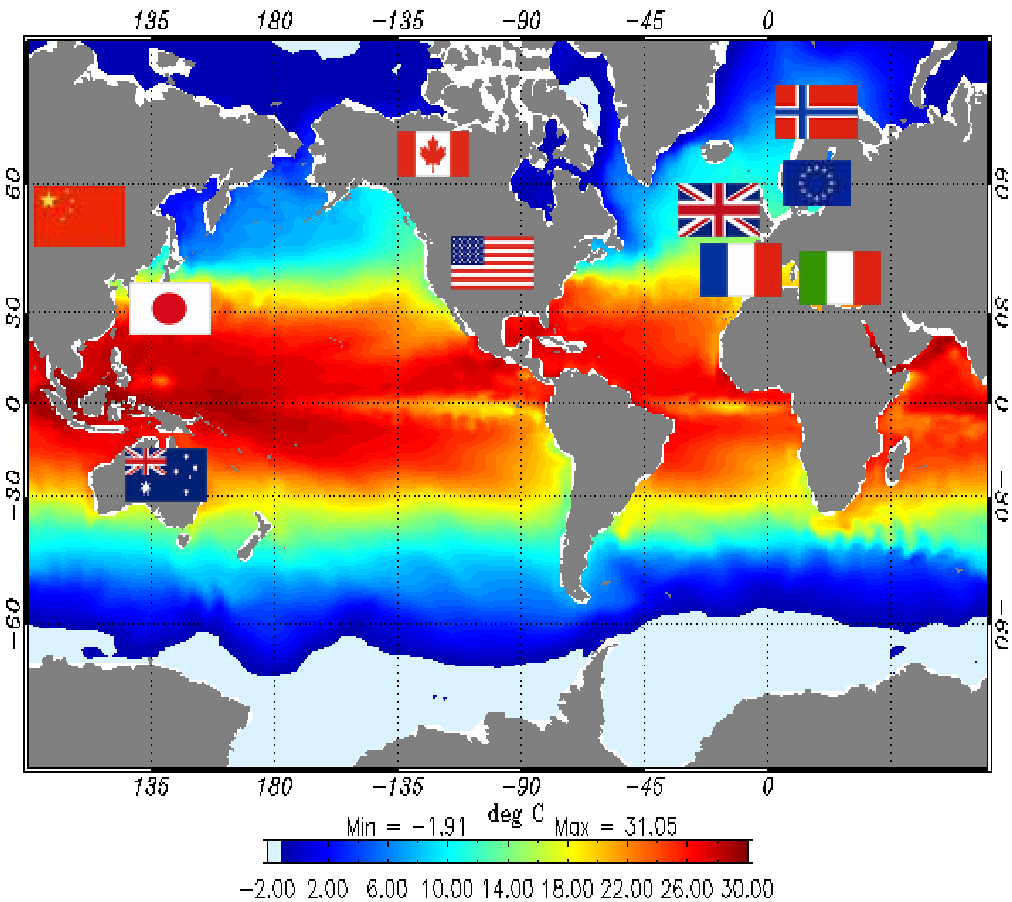
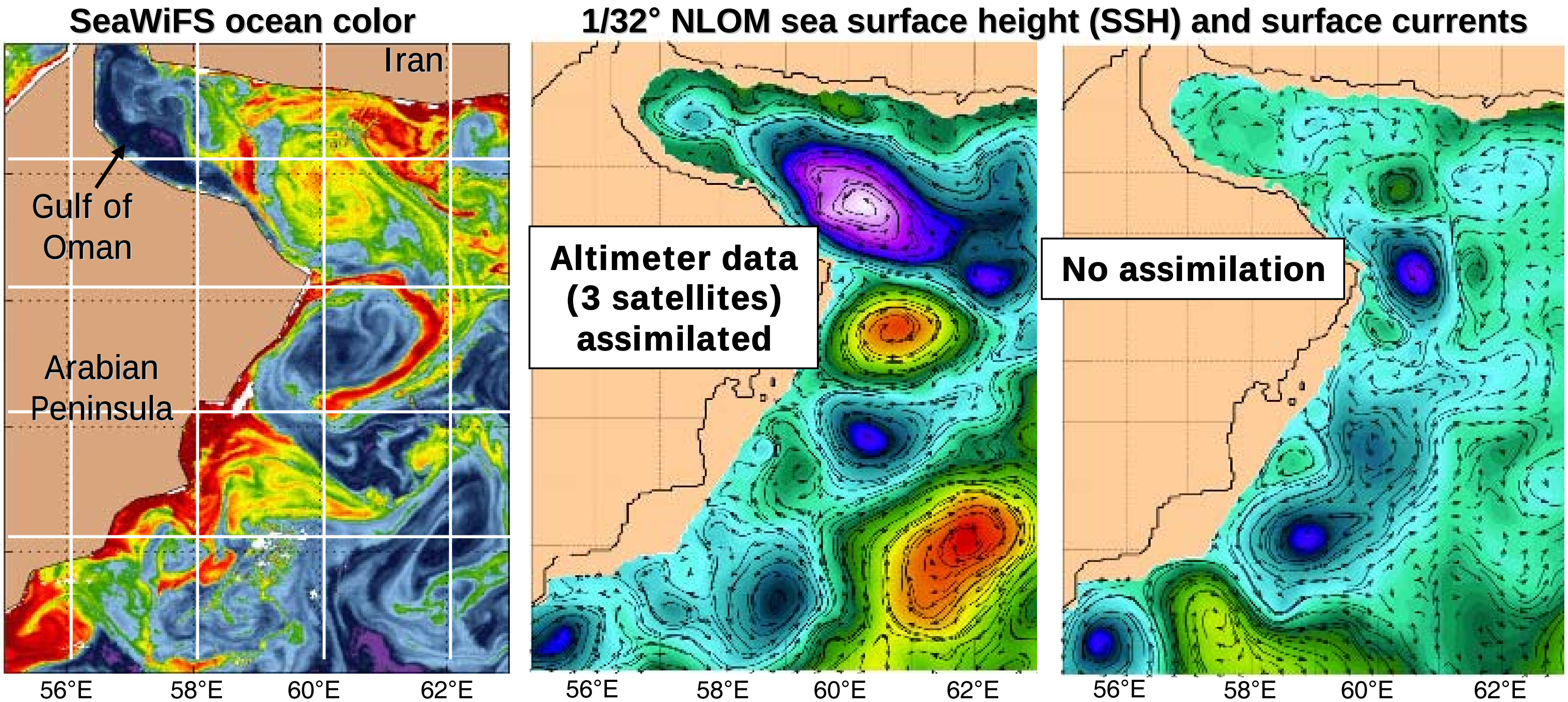
GODAE Modelling/Forecasting systems



- National systems involving research & operational institutes
  - BlueLink – Australia
  - Canadian consortium
  - NLOM and NCOM - USA
  - HYCOM consortium – USA
  - ECCO - USA
  - Move & COMPASS-K –Japan
  - China
  - MERCATOR – France
  - MFS - Italy
  - NCOF (FOAM) – UK
  - TOPAZ - Norway
- European coordination
  - MERSEA, GMES



Feasibility Nowcasting/Forecasting of ocean mesoscale using altimeter data

Need at least 3 altimeters with one reference system (Jason series)

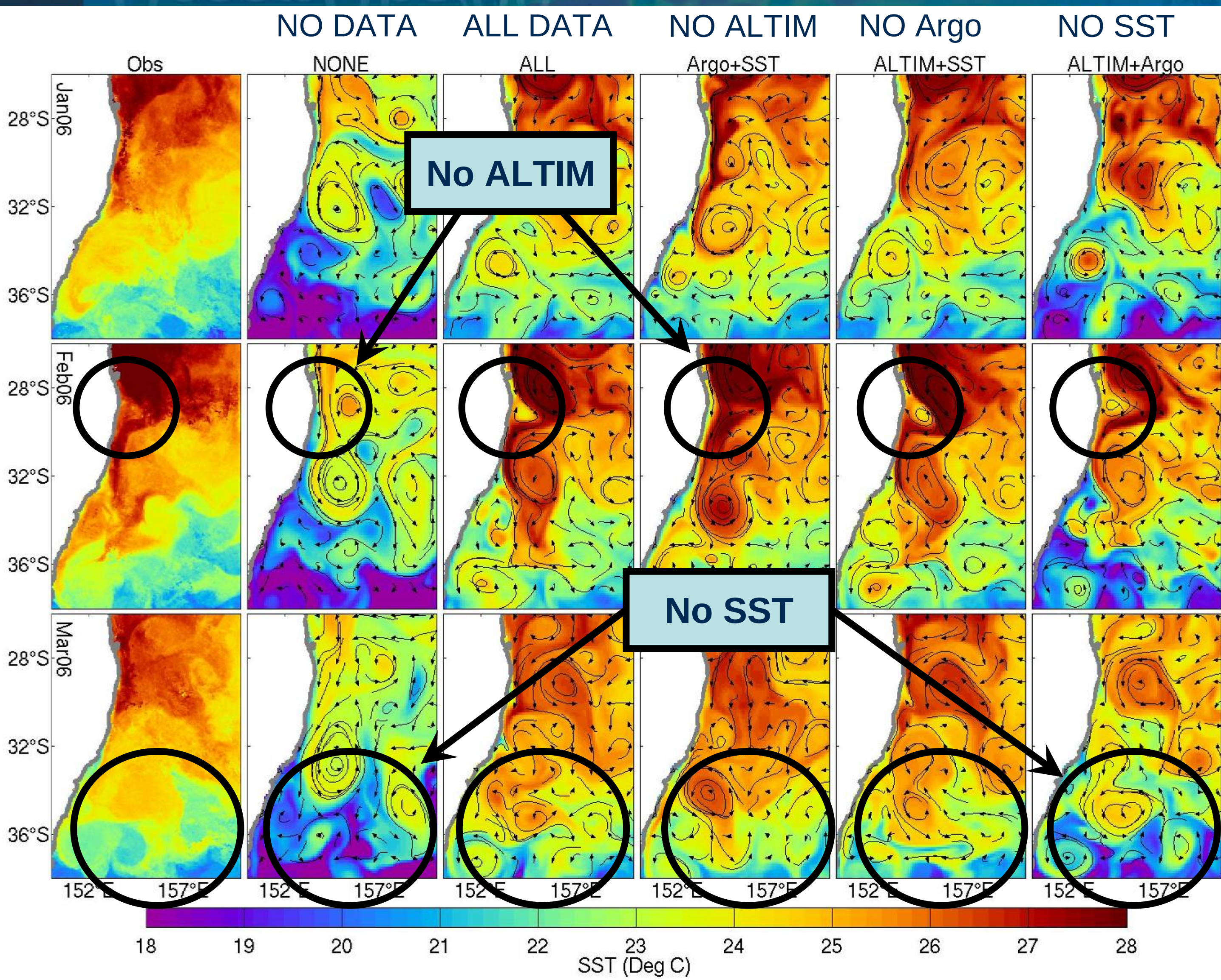
Eddies in Ocean Model Nowcasts vs SeaWiFS Ocean Color in the Northwestern Arabian Sea and Gulf of Oman on 6 Oct. 2002

Prediction System Resolution at 20°N	1/16° NLOM 8 km	1/32° NLOM 4 km	1/8° NCOM 18 km	1/12° HYCOM 8km	1/32° NLOMn No Assim
	% of Eddies Present in the Model				
All eddies	70	90	55	80	35
Large eddies, 1-10	80	100	80	90	20
Small eddies, 11-20	60	80	30	70	50
	Median Eddy Center Position Error, km				
All eddies	35.5	29	48	50	42
Large eddies	42.5	37	57	68	38
Small eddies	32.5	22.5	47	44	42

Adapted from Hurlburt et al. (2008; AGU Monograph 177)

Operational oceanography and the global ocean observing system

- Observations are essential
- In 1998, good prospects for altimetry but the in-situ observing system was clearly inadequate => Argo a joint GODAE/CLIVAR project.
- Same backbone system for climate and operational oceanography (GOOS, GCOS, JCOMM) (St Raphael, 1999).
- High resolution needed for most of OO applications (altimetry, SST).
- Complimentary nature of observations - examples

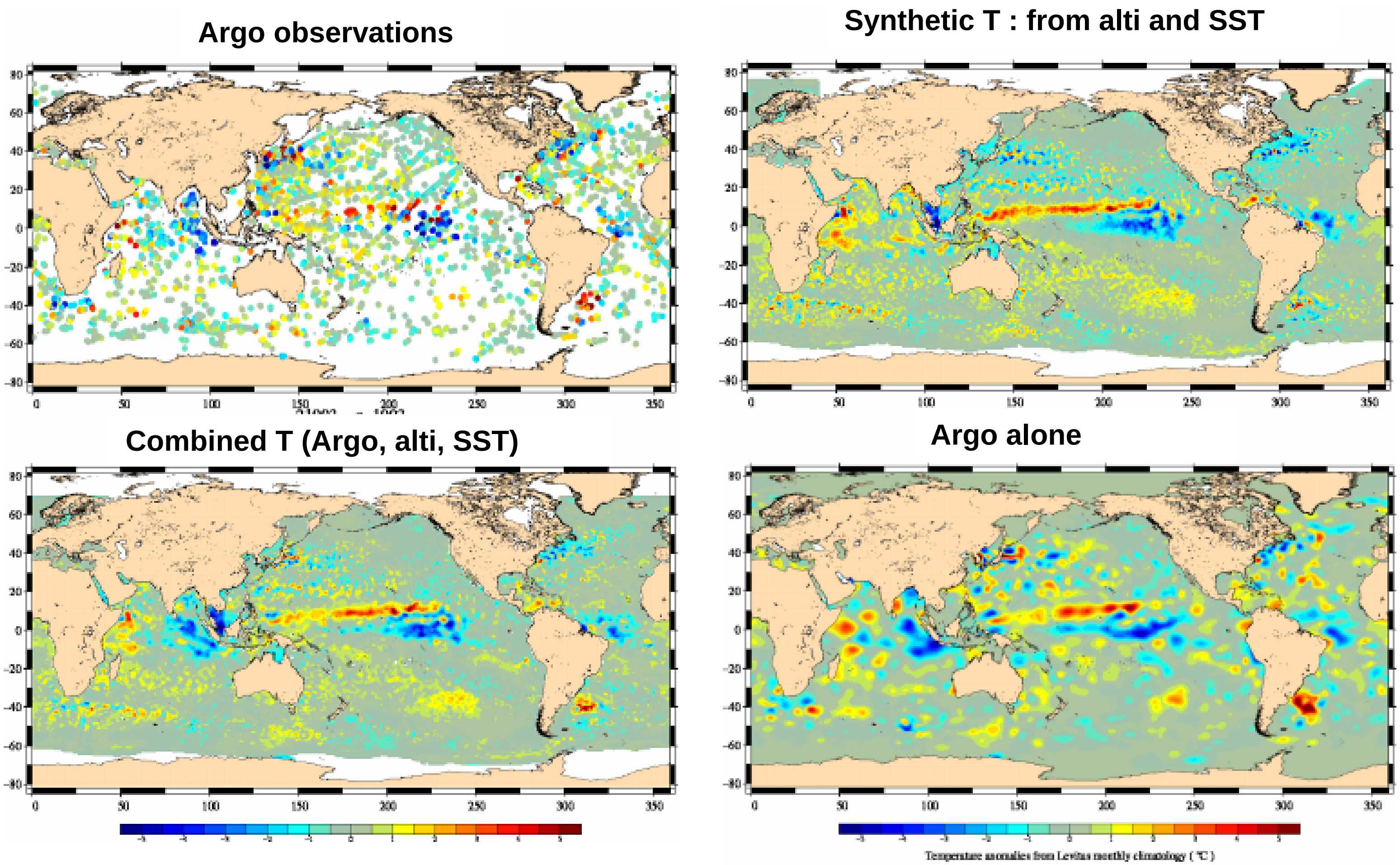


Complimentary data types: mesoscale

- 1/10° Bluelink system
- 6-month long OSEs starting December 2005
- Oke, P. R., and A. Schiller (2007): Impact of Argo, SST and altimeter data on an eddy-resolving ocean reanalysis (GRL).

CSIRO

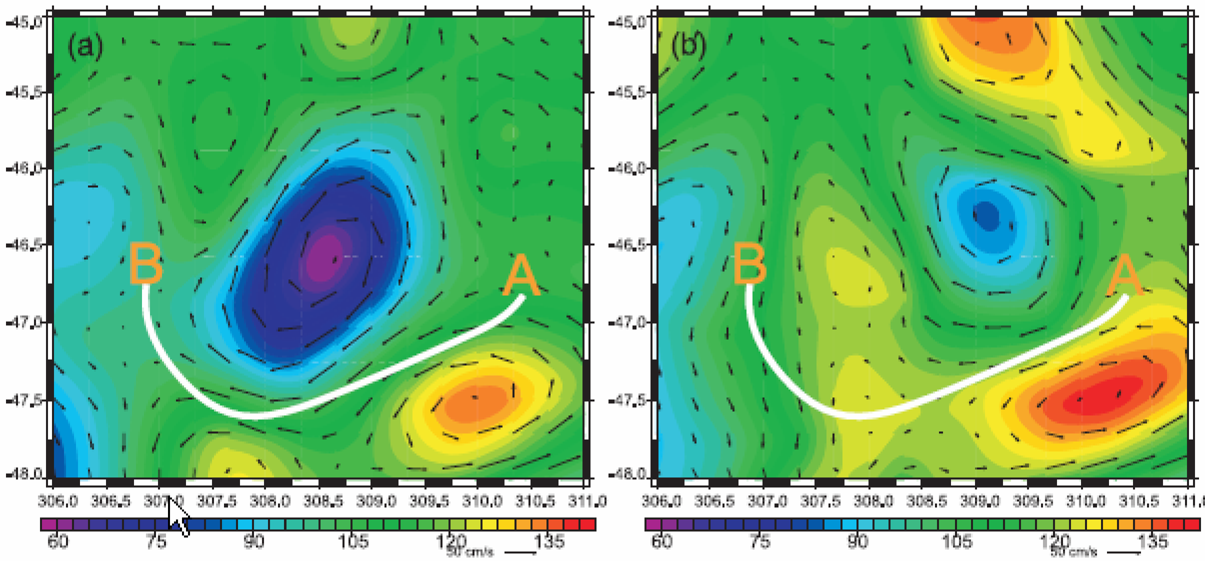
Use of Alt, SST and Argo to reconstruct 3D mesoscale temperature fields



Improvements Argo+Alt+SST vs Alt+SST = 20 to 30% of the signal variance. Alt+SST alone = 40 to 50% (Guinehut et al., 2009)

Observing system requirements : for a given precision, requirements for forecasting > nowcasting > hindcasting (but hindcasting applications generally require higher accuracy)

Two altimeters in delayed mode (left) and in real time (right) (Pascual et al., 2009)



4 altimeters in real time (nowcasting) are needed to achieve a similar accuracy as 2 altimeters in delayed mode (hindcasting) (Pascual et al., 2009). Benkiran et al (2009) : **7-day forecasting with two altimeters = nowcasting with one altimeter**.

Applications

- No clear separation between nowcasting and short term forecasting applications. Both are generally used together. Nowcasting - impact of observations.

- Hindcasting required for ocean and environmental state estimation, design studies, coastal zone management, etc

- A few examples (progresses made, issues) : marine pollution, marine safety, offshore industry, coastal applications and links with ecosystem monitoring. Others in G. Brassington talk this afternoon.

The marine pollution problem – OO contribution

B. Hackett et al., 2009

- A wide range of pollutants in the marine environment. Main impacts are:
  - harm to life, property and commerce
  - environmental degradation

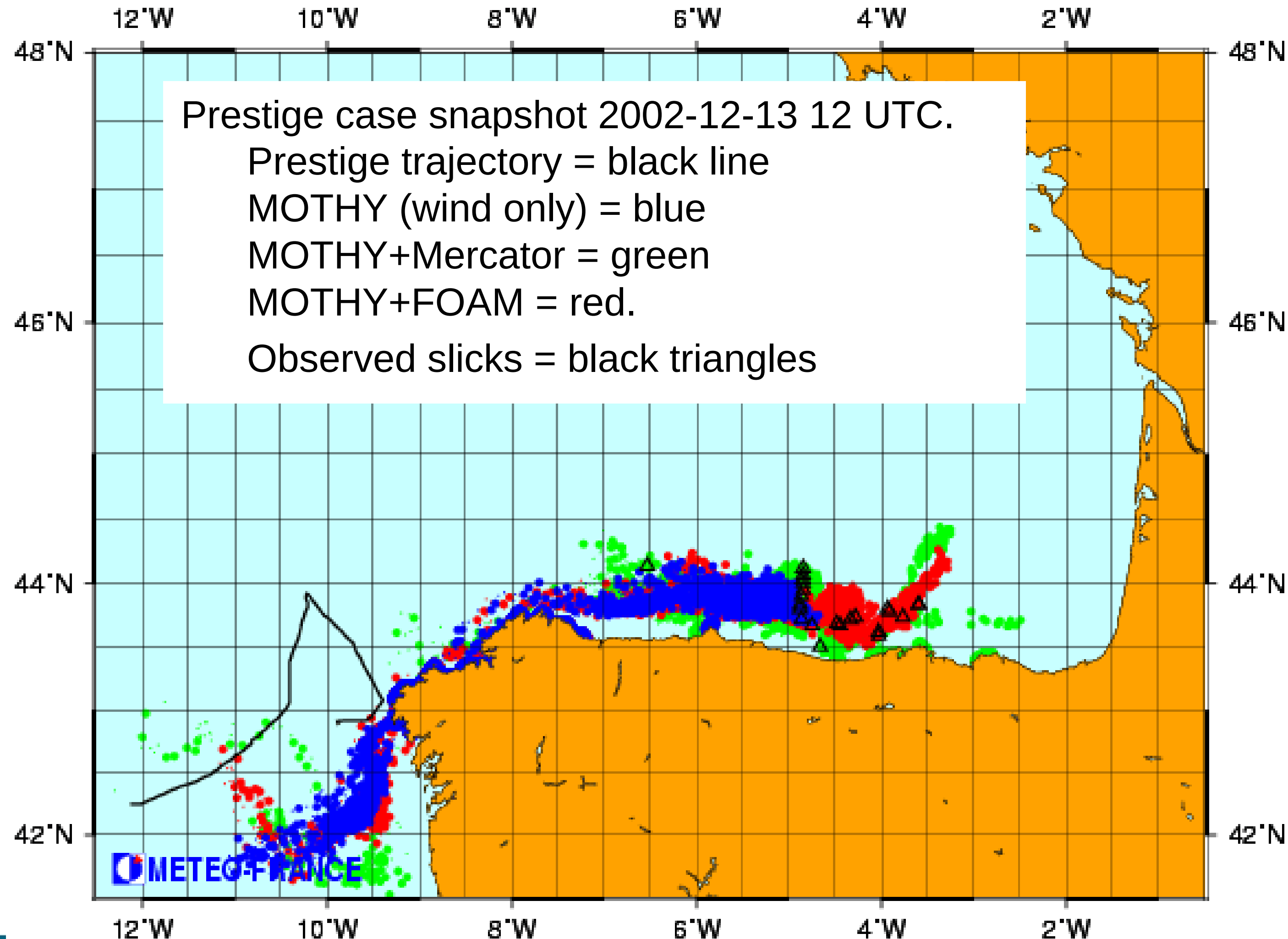
- We need monitoring and prediction for:
  1. emergency response to spill events
  2. impact assessment, both for specific events and for scenarios

- Both need a good description of the metocean conditions
  - Weather, sea-state, ocean circulation
  - Observations, hindcast, nowcast and forecast

GODAE and oil spill forecasting – Europe

Positive impact of adding GODAE current data (Mercator and FOAM) in waters where the large-scale circulation has a significant impact.

However, there are large differences between the current data sets (Mercator and FOAM).



GODAE & oil spill applications : summary and perspectives

- **Access to ocean data**
  - Immensely improved during GODAE lifetime!
  - Demonstrated in projects and by individual middle users
  - … still need to improve standards for access and products
- **Accuracy of ocean data**
  - Still the main source of oil spill forecast error.
  - GODAE assimilation systems continue to improve nowcast/forecast accuracy but still gross errors in some eddy-rich areas (expertise required).
  - Need also more detailed currents in coastal and shelf seas
    - Higher resolution models, Nesting
    - Improved forcing from atmosphere (high-resolution, high freq data)
    - Assimilation of current data (HF radar, drifters)

Search and rescue

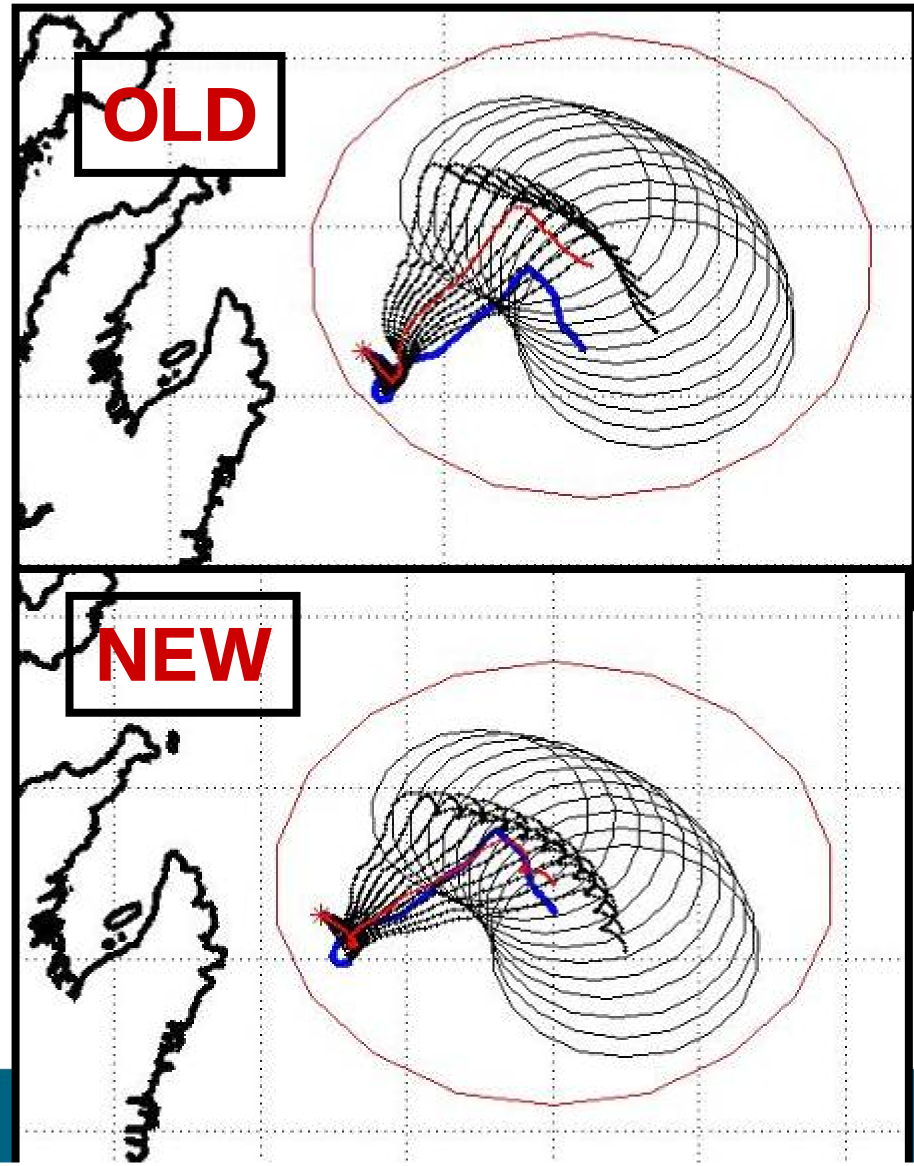
Impact of GODAE products on Canadian Coast Gards system

Observation **Model**

4 person life raft

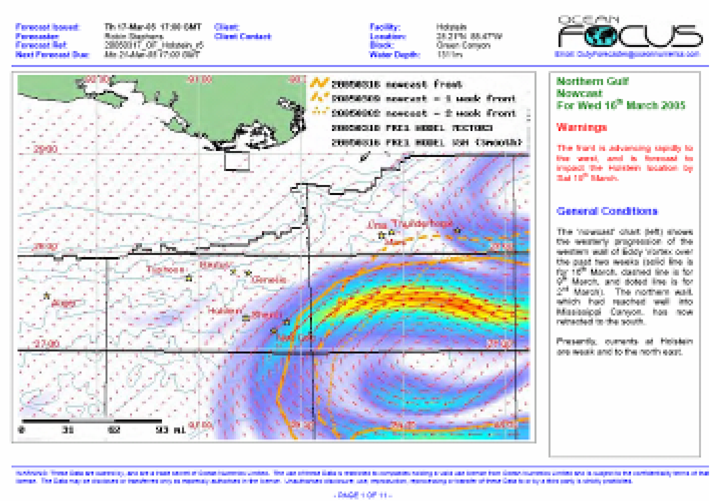
72 hrs

Davidson et al., 2009



Offshore industry needs (Rayner et al., 2009)

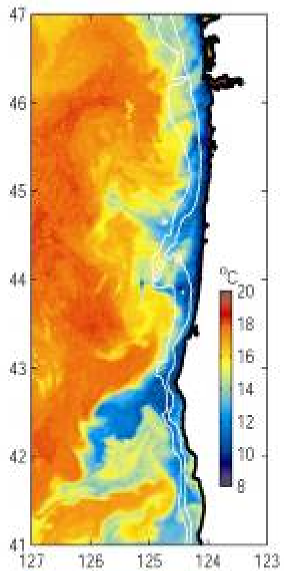
- **For winds, seastate and water column structure**
  - Hindcasts : for use in design and pre-planning
  - Nowcasts : good quality nowcasts of important features (mainly based on observations)
  - Forecasts : to support operational planning



Observation, modelling and data assimilation challenges : quality and resolution (km)

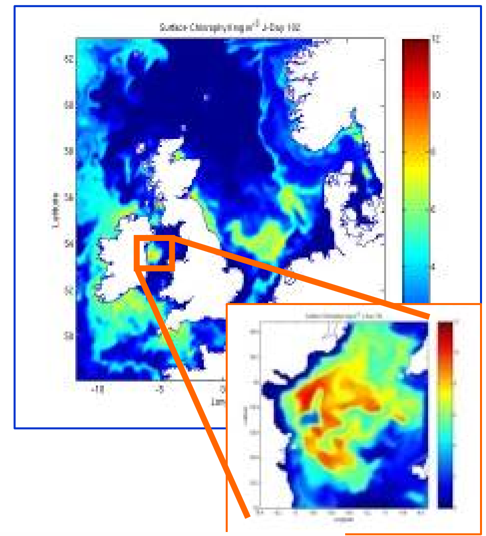
Links with coastal systems and applications

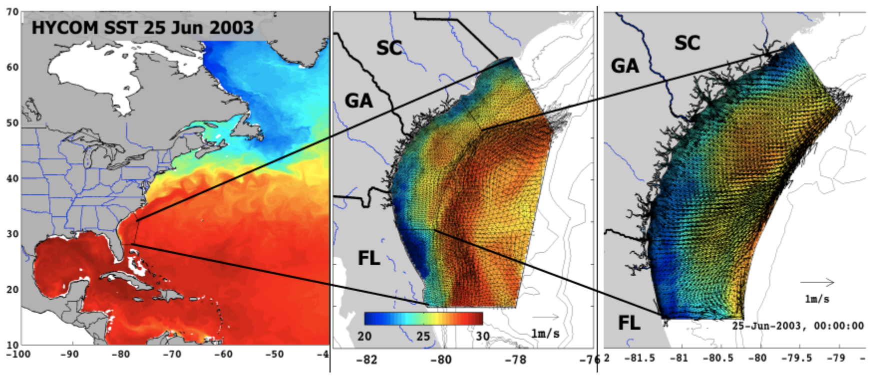
(de Mey et al., 2009; Malone et al., 2009)

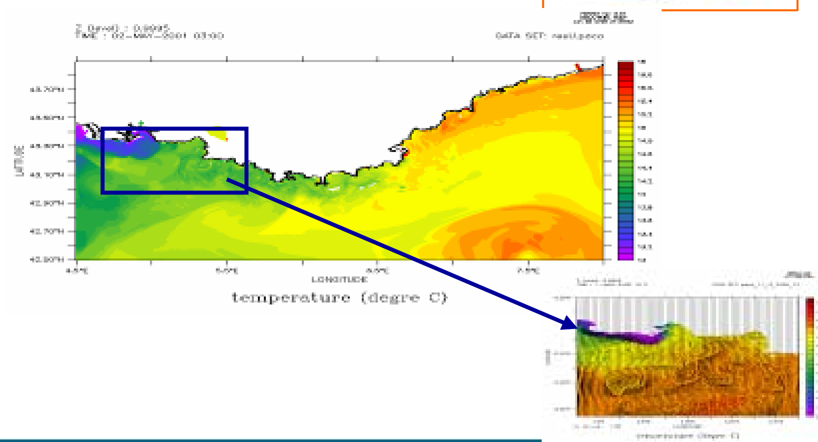


Coastal-ocean and open-ocean problems are intertwined. Influence of coastal ocean processes felt far beyond shelf break, overlaps & interacts with open ocean dynamics

Downscaling, one-way/two-way nesting

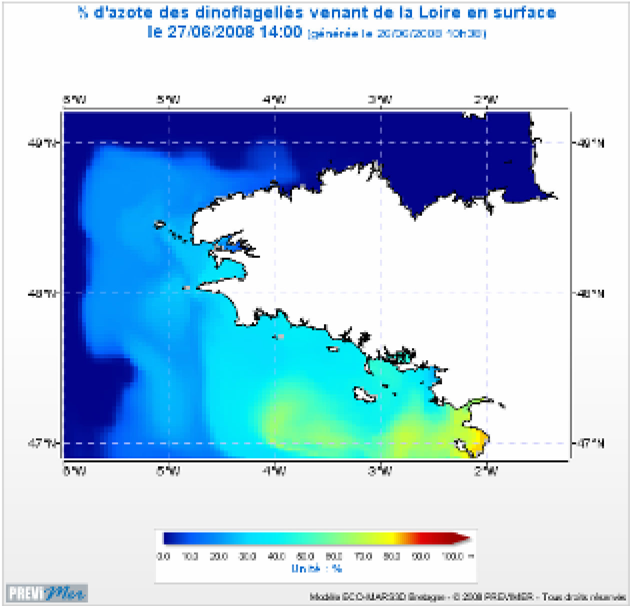


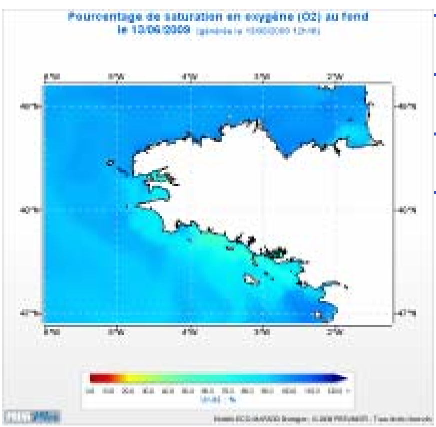




Coastal operational oceanography system and environmental monitoring : PREVIMER example

- **Physical and ecosystem modeling**
- **Context and objectives**
  - Eutrophisation of the Brittany coastal environment
  - Real time modelling of river nitrate and phosphate evolution at sea
  - Proliferation of green seaweed
  - Disolved Oxygen saturation
  - ASP contamination risks estimation
  - Microbiology (impact of physics)





Hindcasting & nowcasting (e.g. environmental status, finding the origin of a pollutant, measuring the impact of mitigation measures)

www.previmer.org

Operational oceanography and the global ocean observing system

What was right in the St Raphael vision ?

- Need for an integrated approach
- Sharing of data, knowledge and experience
- Commonalities climate, research and operational oceanography.
- Role of altimetry and Argo

What did we learn ?

- More specific requirements (e.g. high resolution altimetry, surface currents, salinity from Argo, high resolution SST).
- Specific requirements for nowcasting and forecasting vs hindcasting
- Time needed to "best use" a given observing system (we are not yet using the full potential of the global ocean observing system).
- Impact of observations : from a qualitative to a quantitative approach. OSEs/OSSEs, adjoint techniques and sensitivity analyses (Oke et al., 2009).

Lessons learnt for the future and conclusions (1)

- Major progresses over the past 10 years to develop operational oceanography capabilities and to link with applications and services.

- Integrated approach, international cooperation, sharing of data, knowledge and experience were key elements to success. Need a common "good" vision shared and engagement of a broad community (St Raphael, 1999).

- Main issue and priority for the global ocean observing system: complete and sustain the initial St Raphael design (in particular altimetry and Argo). Pre-requisite for applications and services.

Lessons learnt for the future and conclusions (2)

- Operational oceanography systems require and will require continuous improvements (observations, models, data assimilation) to better serve applications.
- New requirements, new drivers (e.g. environmental policies, climate change, weather forecasting) => evolution of modelling and data assimilation systems (e.g. coastal and shelves, ecosystems, ocean/wave/atmosphere coupling) and new requirements for observing systems.
- International coordination and cooperation on observing system design and evaluation is a very high priority.