WCRP
World Climate Research Programme

Celebrating a Decade of Progress and Preparing for the Future:

Ocean Information for Research and Applications

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Chairman, Joint Scientific Committee, WCRP

WCRP
World Climate Research Programme

Mission & Objectives

World Climate Research Programme supports climate-related decision making and planning adaptation to climate change by developing science required to improve

(1) climate predictions and

(2) our understanding of human influence on climate

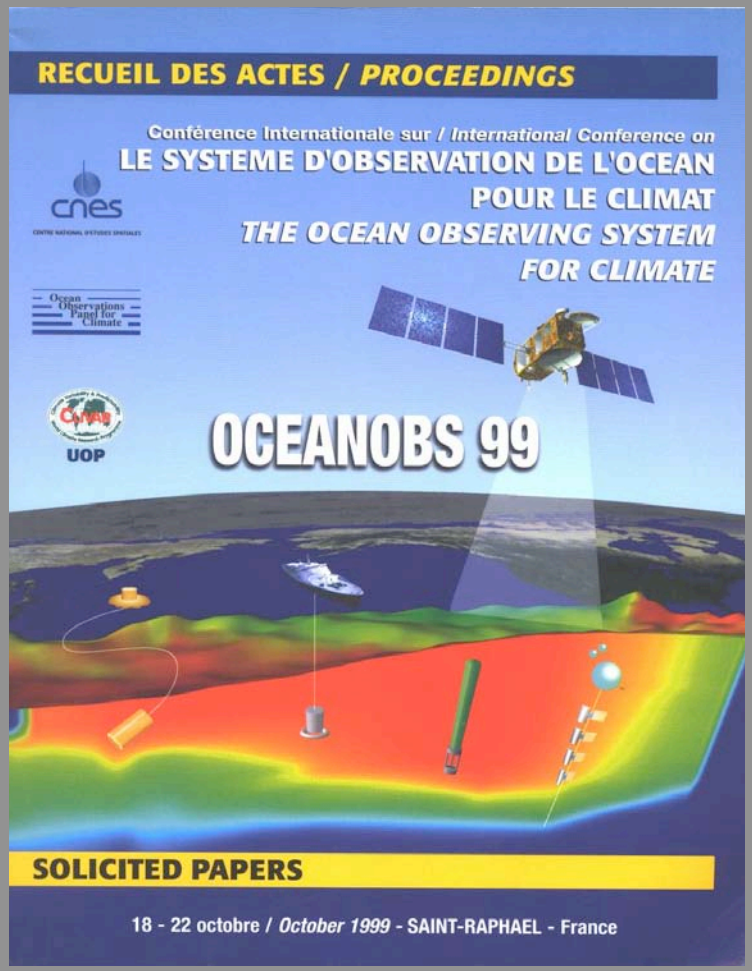
"for use in an increasing range of practical applications of direct relevance, benefit and value to society" (WCRP Strategic Framework 2005-2015).

Conference Objective

"Ocean Information for society:

sustaining the benefits, realizing the potential"

Strengthen and enhance the international framework under GCOS, GOOS, WCRP, IGBP and supporting regional and national frameworks for sustained world ocean observing and information systems supporting the needs of society about ocean weather, climate, ecosystems, carbon and chemistry


RECUEIL DES ACTES / PROCEEDINGS
Conférence Internationale sur / International Conference on
LE SYSTEME D'OBSERVATION DE L'OCEAN POUR LE CLIMAT
THE OCEAN OBSERVING SYSTEM FOR CLIMATE
cnes
Ocean Observations Panel for Climate
UOP
OCEANOBS 99
SOLICITED PAPERS
18 - 22 octobre / October 1999 - SAINT-RAPHAEL - France

OceanObs '99

Objective of OceanObs '99 was to review

- **scientific climate program priorities, and existing and planned operational efforts that address the priorities of GOOS and GCOS. Specifically, to:**

(i) Build consensus on the blend of methods and their uses and value;

(ii) Build an appreciation for how each component contributes and how the system considered as a single entity works;

(iii) Document the techniques, the investment in particular elements, and the way data are used for research and routine applications; and

(iv) Build the foundations for a new era in oceanography, one where research and operational systems are mutually supportive and beneficial, and one where the rapid and wide distribution of information (data, methods and products) is accepted as the preferred *modus operandi*.

- **A new paradigm for oceanography.**

World Climate Conference-3

Better Climate Information for a Better Future

A Global Framework for Climate Services

WCC · 3

World Meteorological Organization
Weather • Climate • Water

Geneva, Switzerland

31 August–4 September 2009

UN SYSTEM
DELIVERING AS ONE ON
CLIMATE KNOWLEDGE

WCC-3 Statement

Called for *major strengthening* of the essential elements of a global framework for climate services:

- The **Global Climate Observing System** and all its components and associated activities; and provision of free and unrestricted exchange and access to climate data;
- The **World Climate Research Programme**, underpinned by adequate computing resources and increased interaction with other global climate relevant research initiatives.
- **Climate services information systems** taking advantage of enhanced existing national and international climate service arrangements in the delivery of products, including sector-oriented information to support adaptation activities;
- **Climate user interface mechanisms** focussed on building linkages and integrating information, at all levels, between the providers and users of climate services; and
- Efficient and enduring **capacity building** through education, training, and strengthened outreach and communication.

DRAFT Conference Declaration

VISION

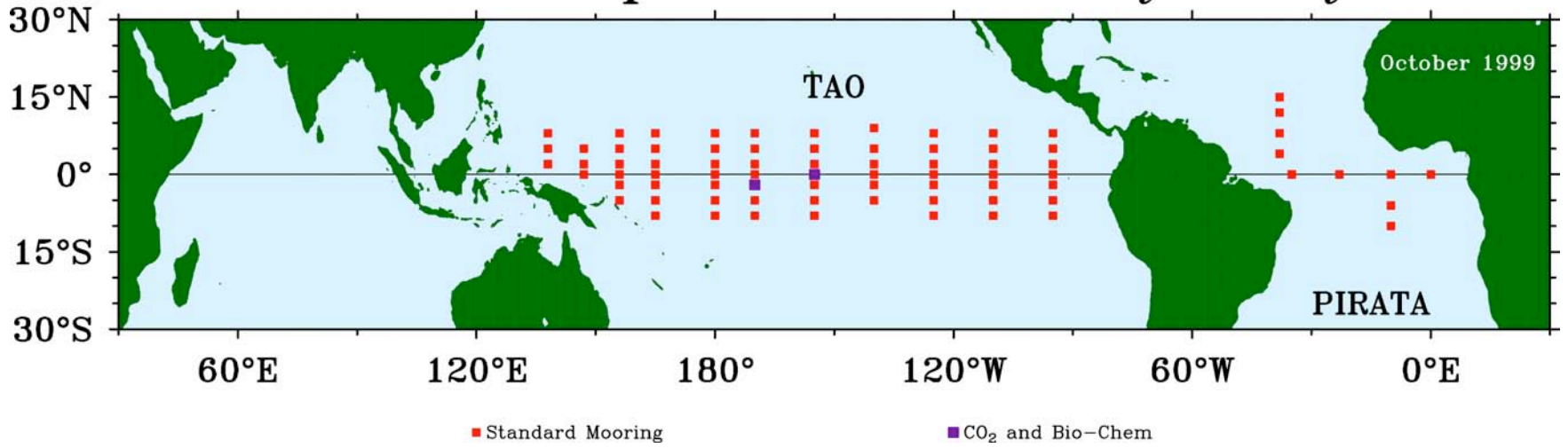
- Routine and sustained provision of global information regarding the marine environment sufficient to meet society's decision-making needs for useful forecasts of marine variability (including physical, biogeochemical, ecosystems and living marine resources), of seasonal to decadal climate variability, sustainable management of living marine resources, and for assessment of longer term trends

- Global Perspective
- Seasonal to Decadal Climate Prediction
- Forecasting of Marine Variability
- Sustainable Management
- Longer Term Trends

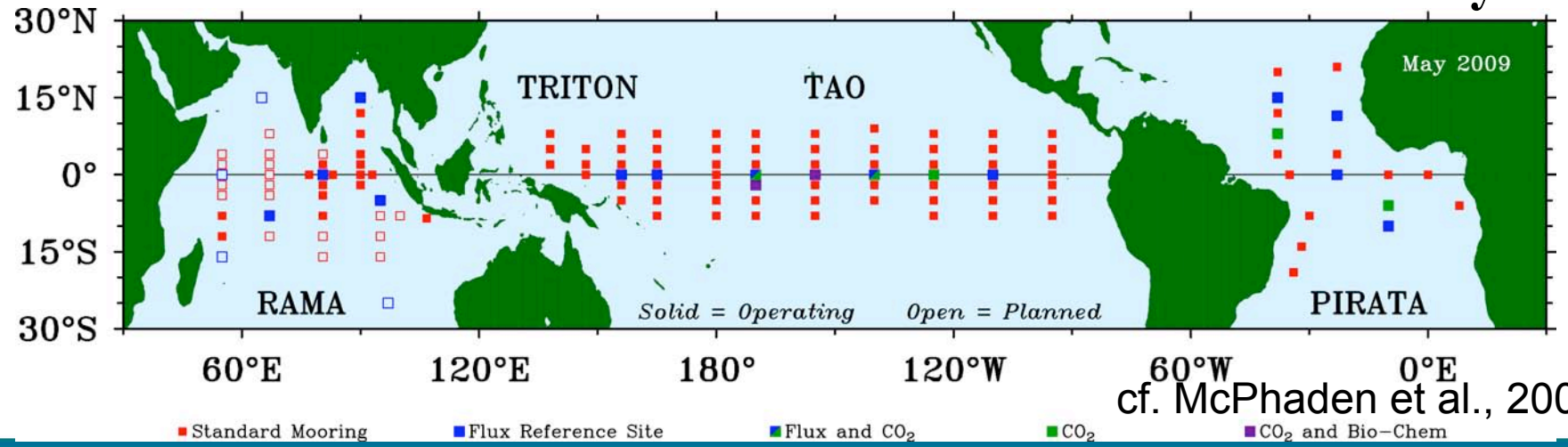
Global Perspective

Global Tropical Moored Buoy Array

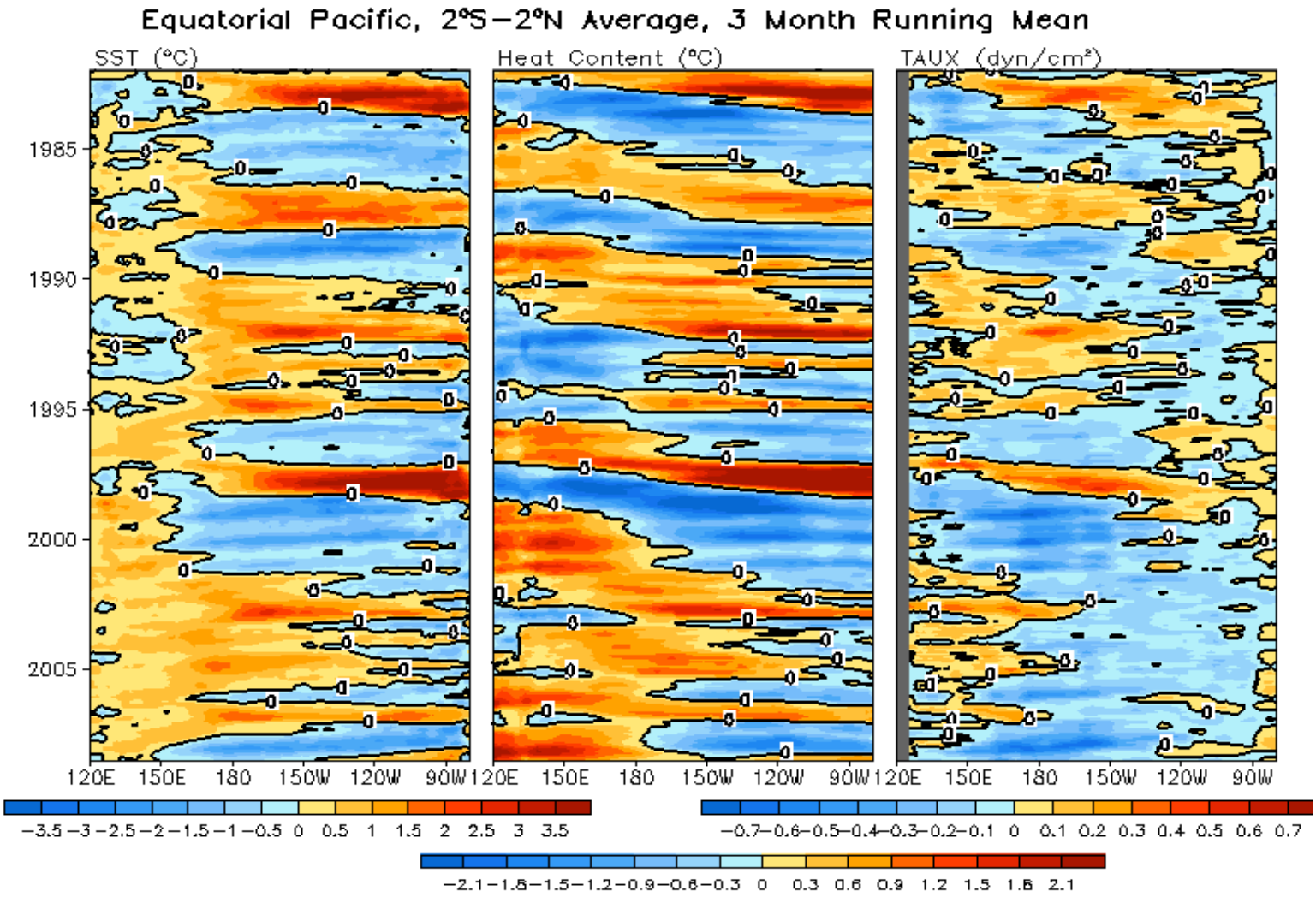
Oct 1999



May 2008



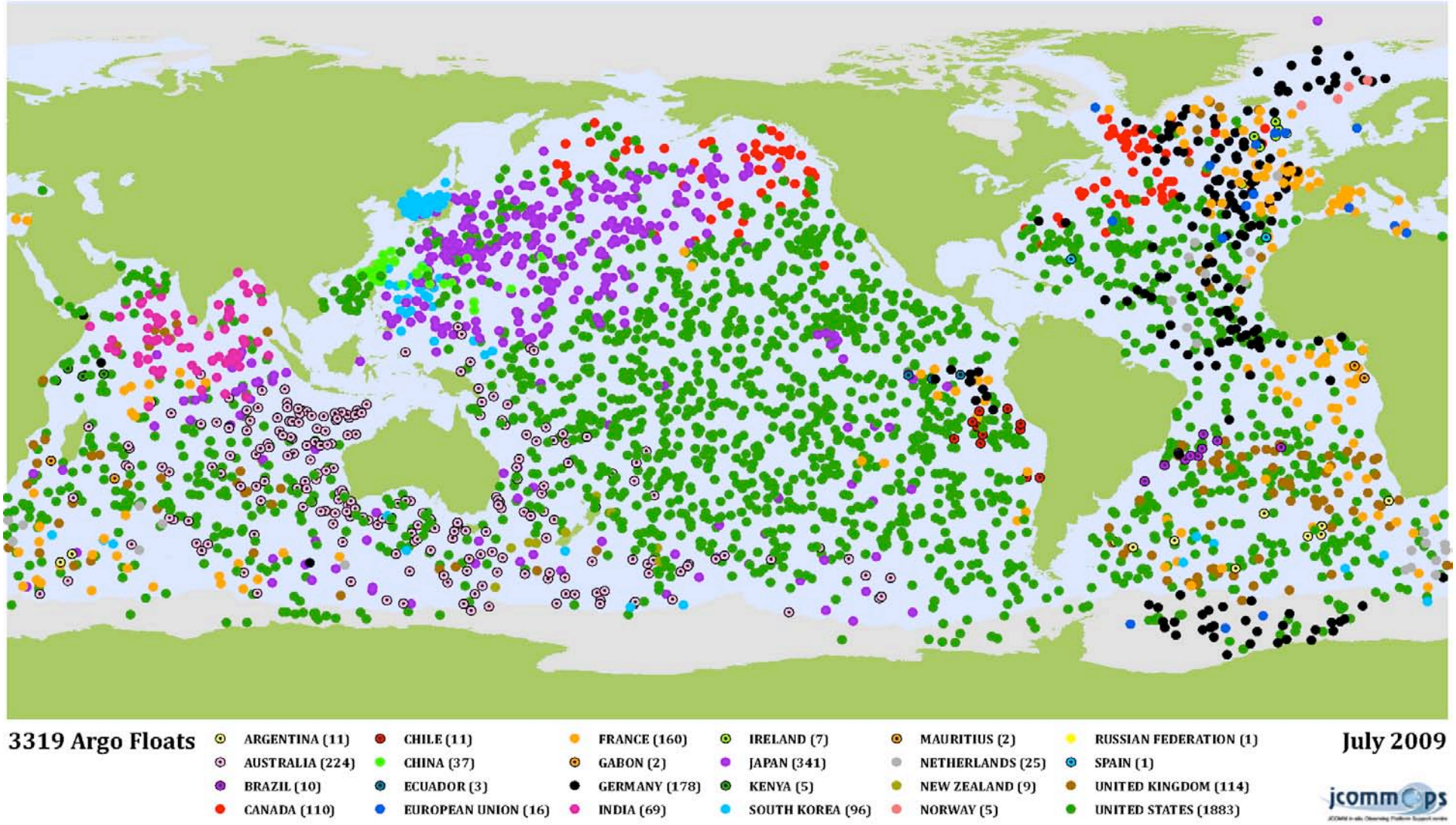
cf. McPhaden et al., 2009



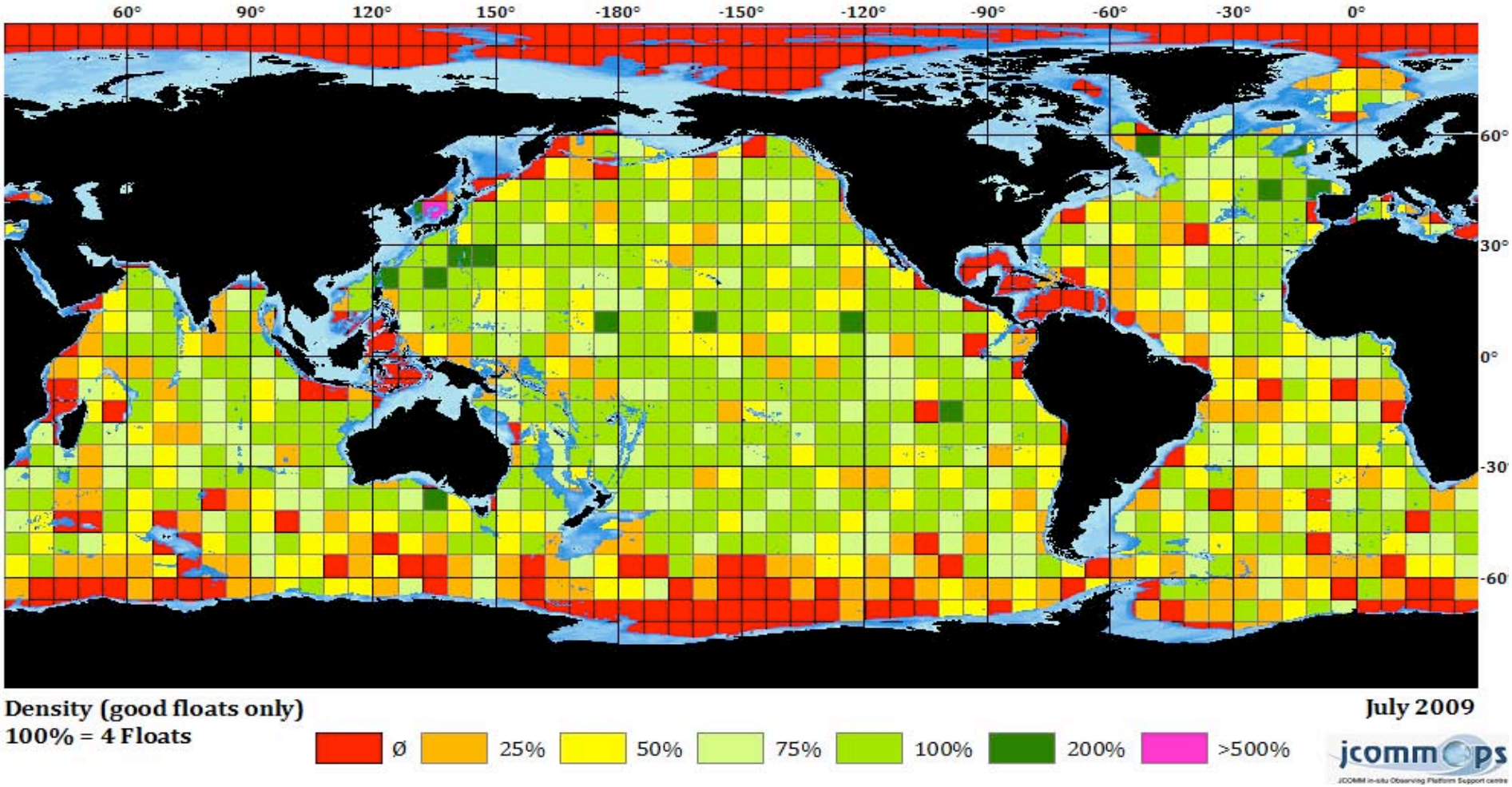
cf Xue et al., 2009

OceanObs'09

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



cf Freeland et al., 2009


60°
90°
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-180°
-150°
-120°
-90°
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-30°
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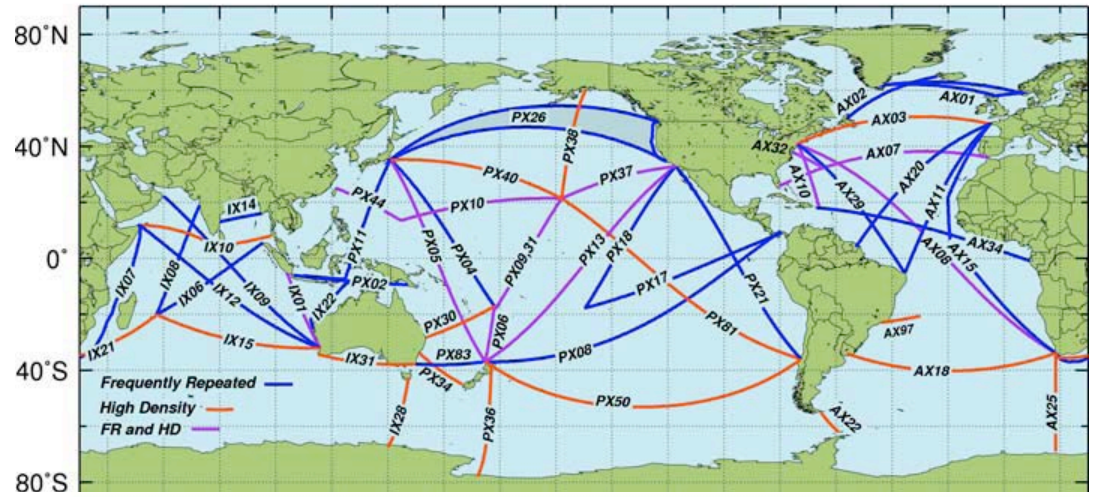
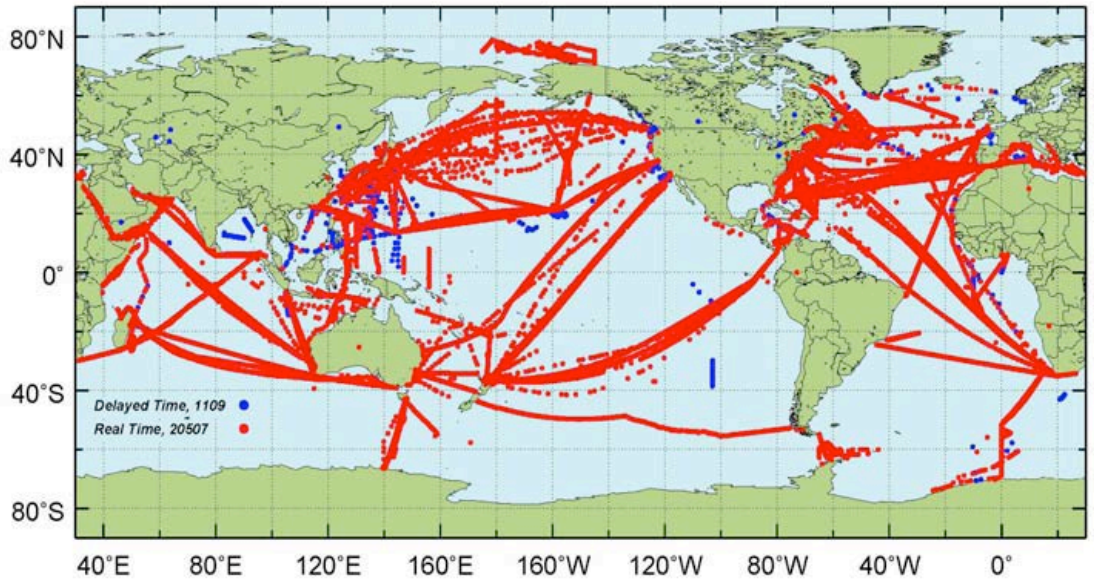
-30
-60
Density (good floats only)
100% = 4 Floats
Ø
25%
50%
75%
100%
200%
>500%
July 2009
jcommops

Global XBT Network, OceanObs09 Recommendations

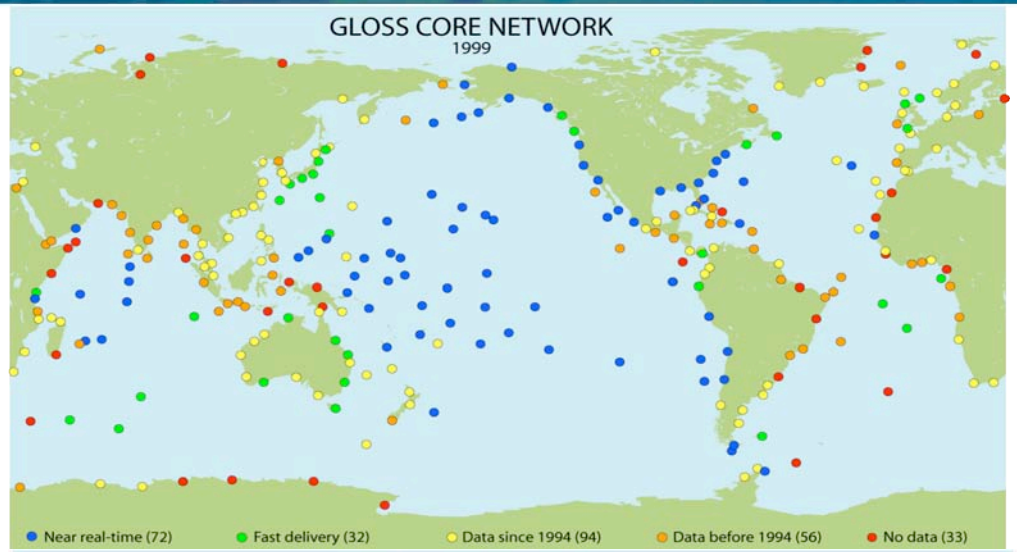
Proposed XBTs at Ocean Obs'99

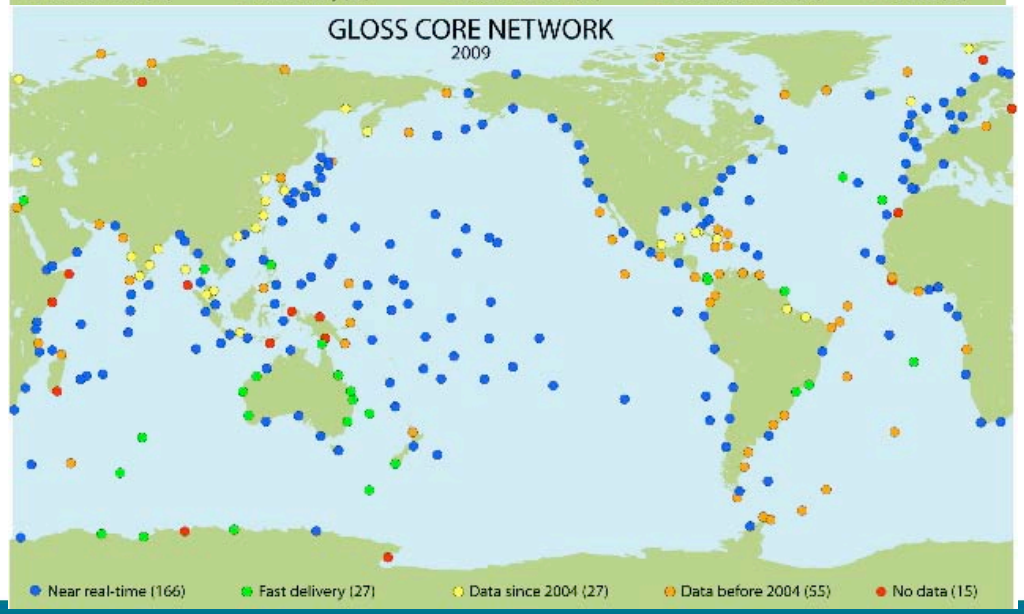




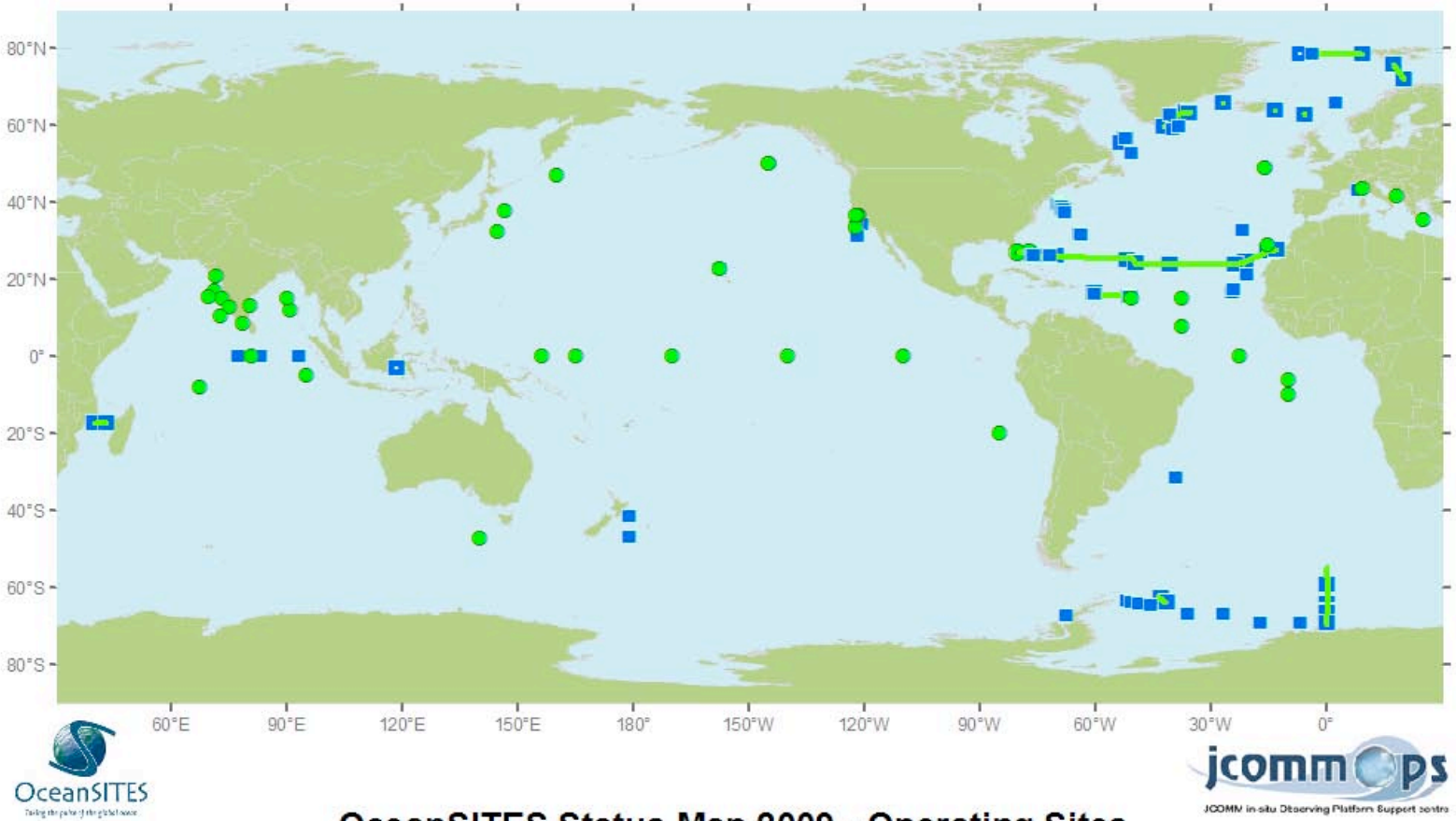
XBTs transmitted in 2008

cf Goni et al., 2009





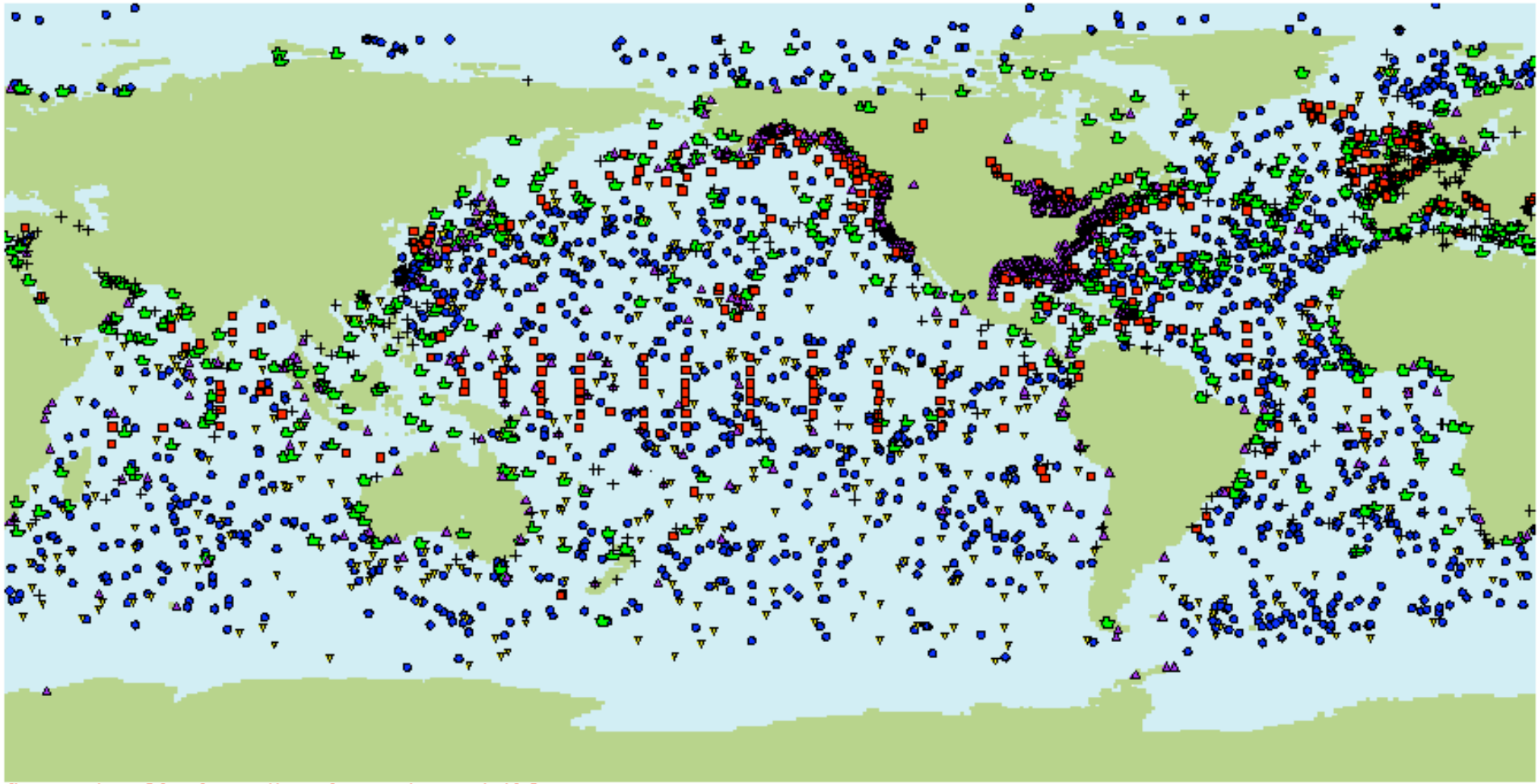
cf Merrifield et al., 2009



cf Send et al., 2009

Date: 10-Sep-2009 00:00:00 to 11-Sep-2009 23:59:59

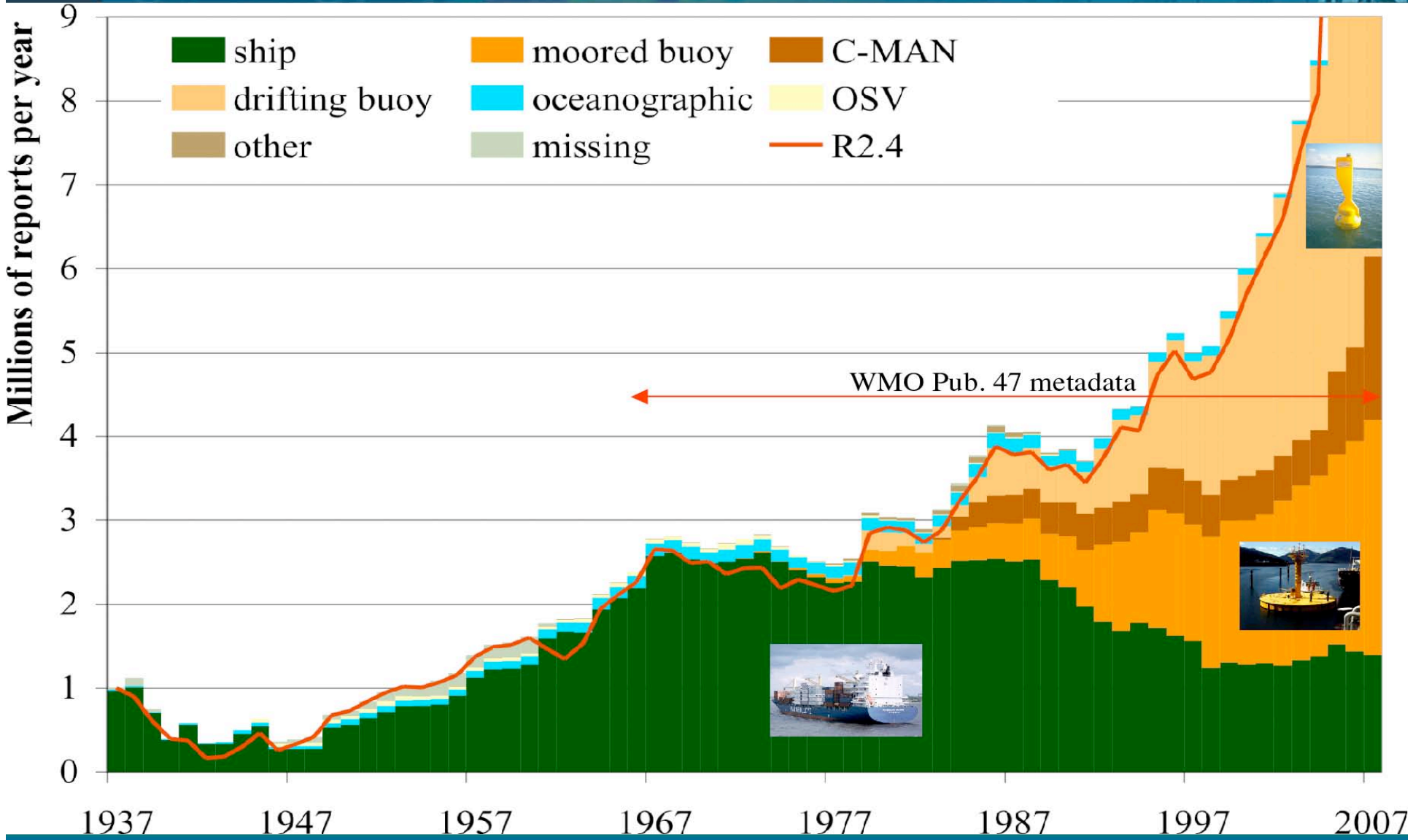
Platforms Reporting: 4300



Suppressing ship observations for most recent 48 hours

OceanObs'09

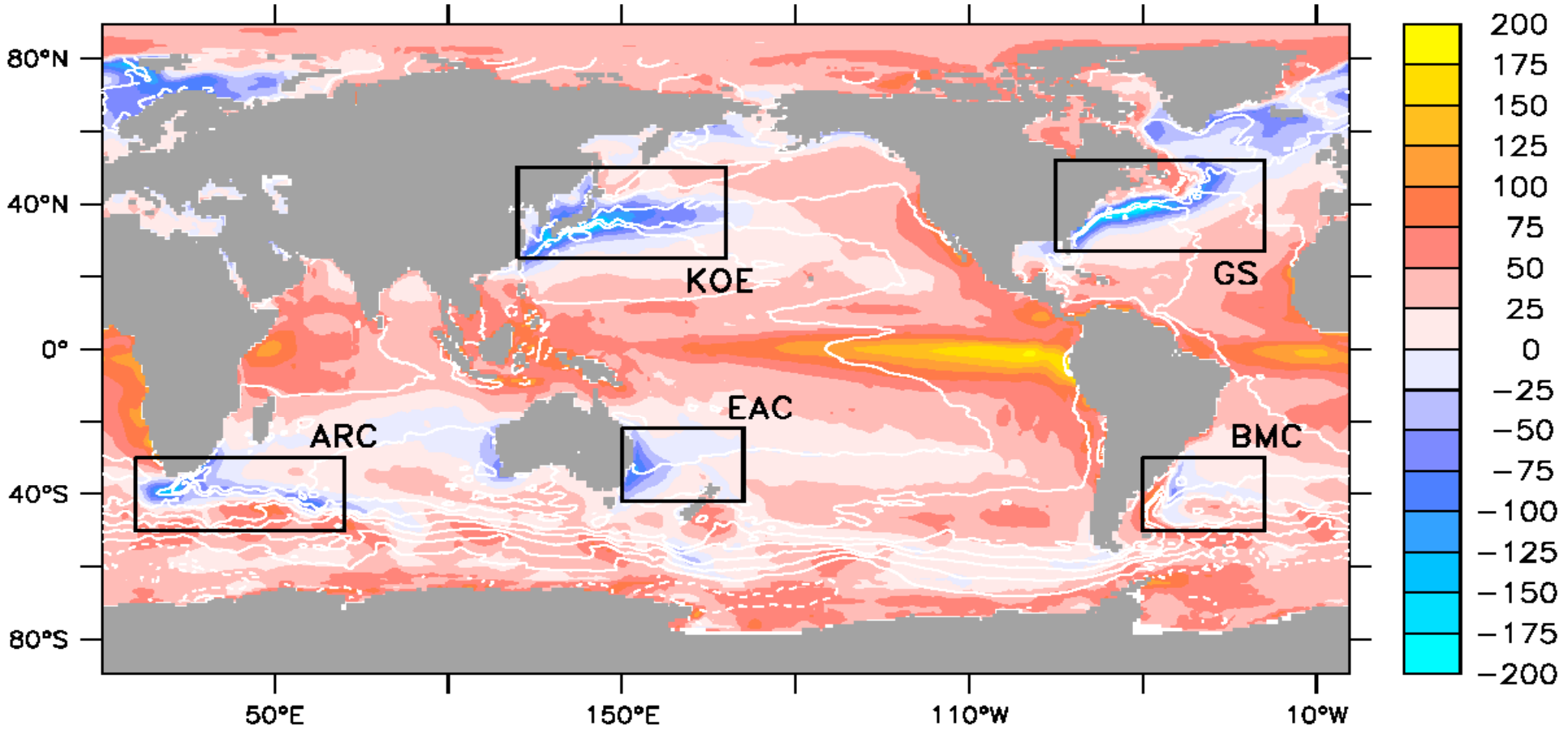
Ocean information for society: sustaining the benefits, realizing the potential



21-25 September 2009 | Venice, Italy

cf Worley et al., Snowden et al., 2009

www.oceanobs09.net

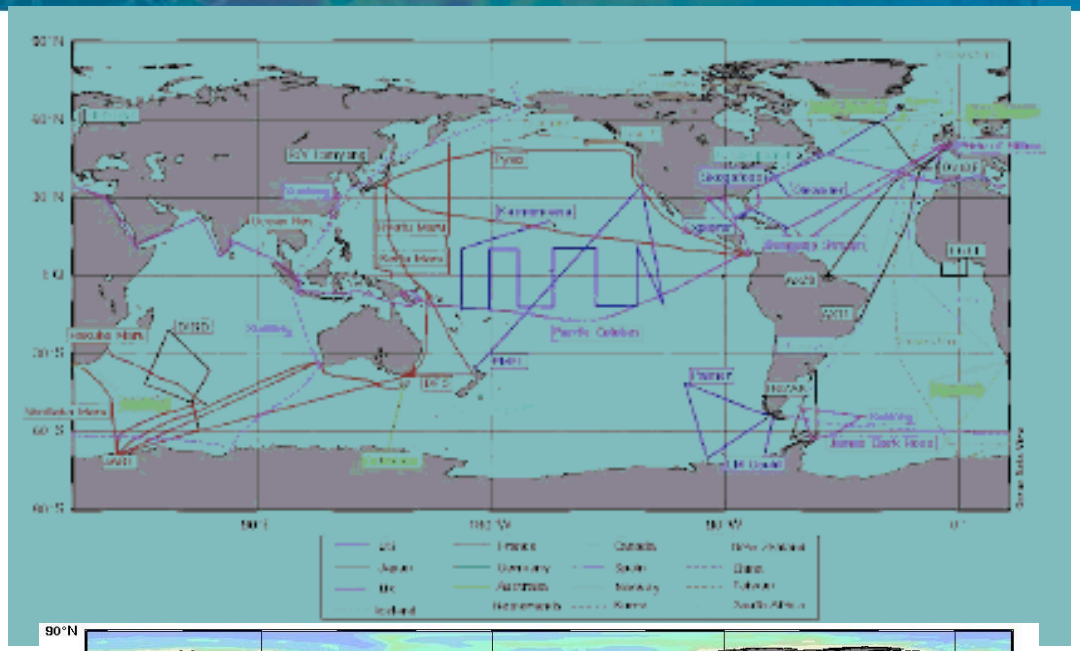


Mean Net Surface Heat Flux (Wm^{-2})

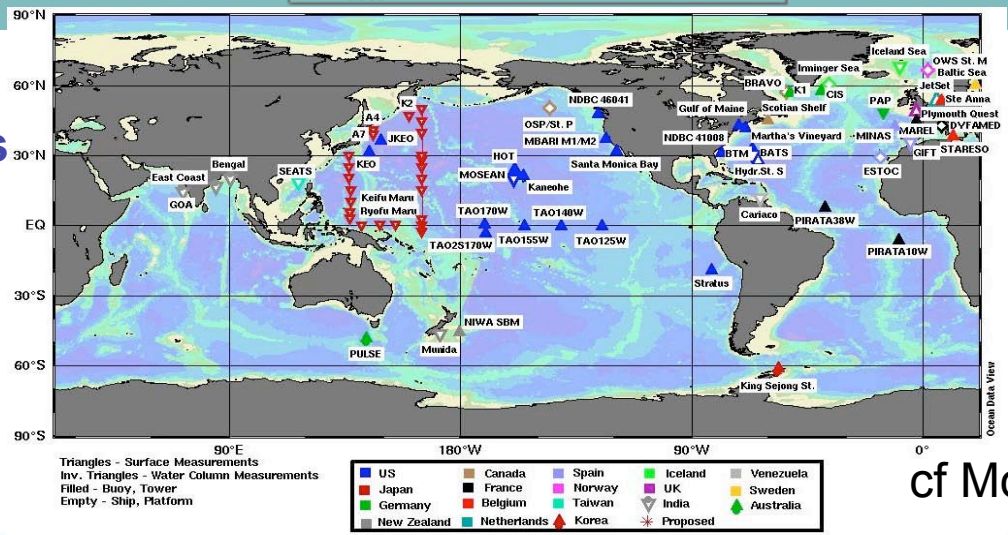
Yu and Weller, 2007

cf Cronin et al, 2009

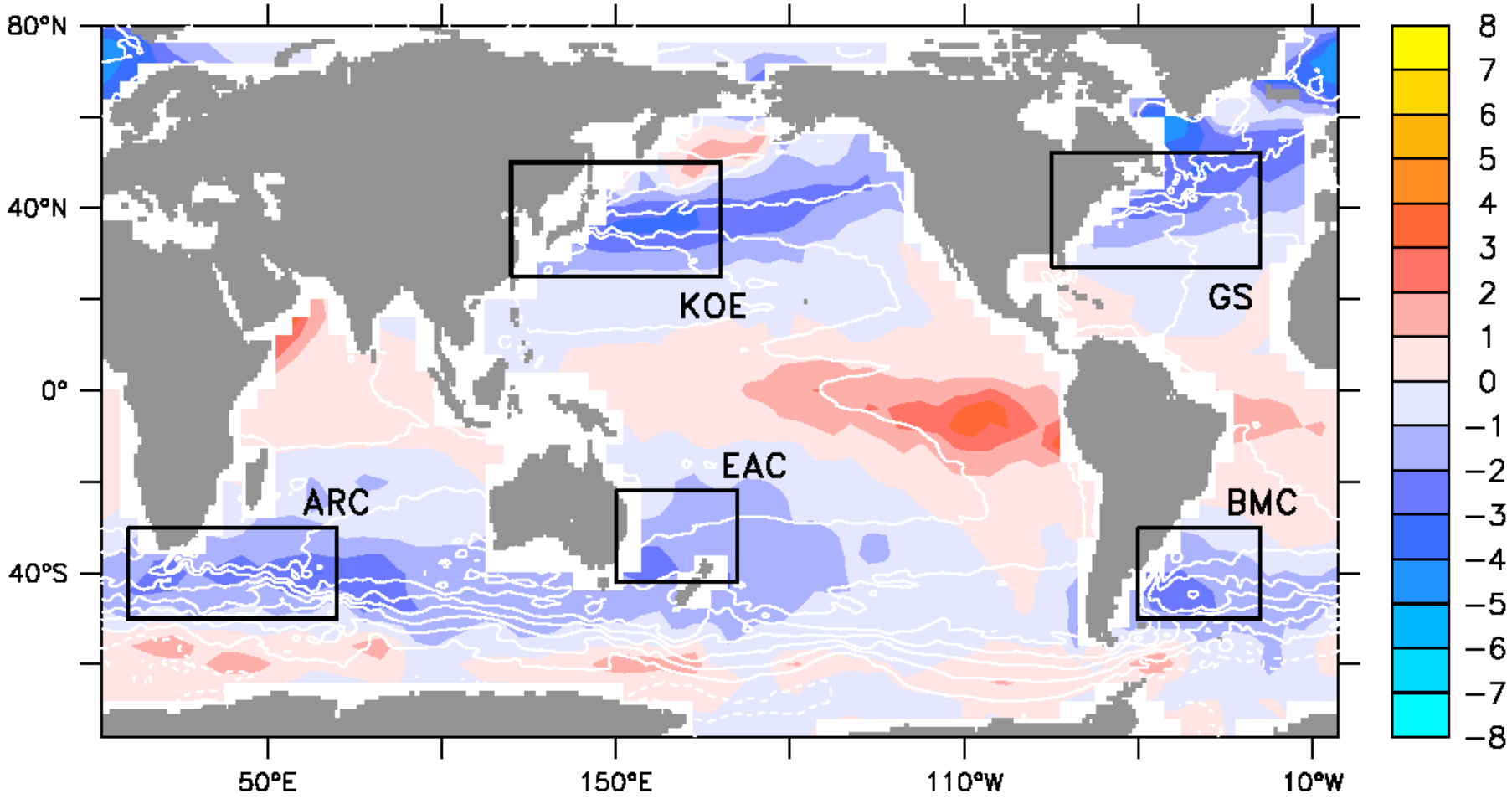
Surface Carbon Observation: Shipboard



Time Series Stations



cf Monteiro et al., 2009

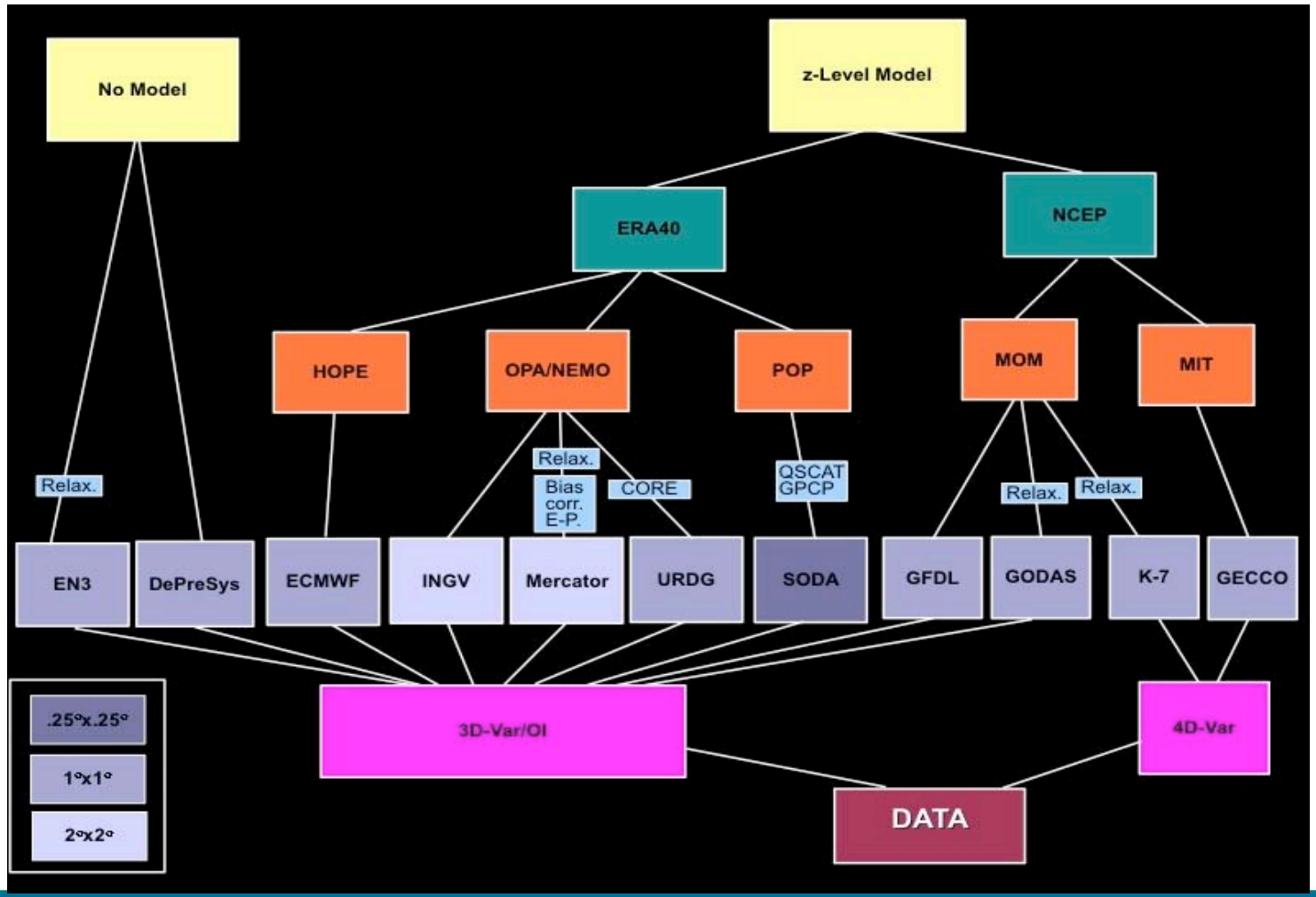


Mean CO_2 flux (moles m^{-2} yr^{-1})

Takahashi et al., 2009

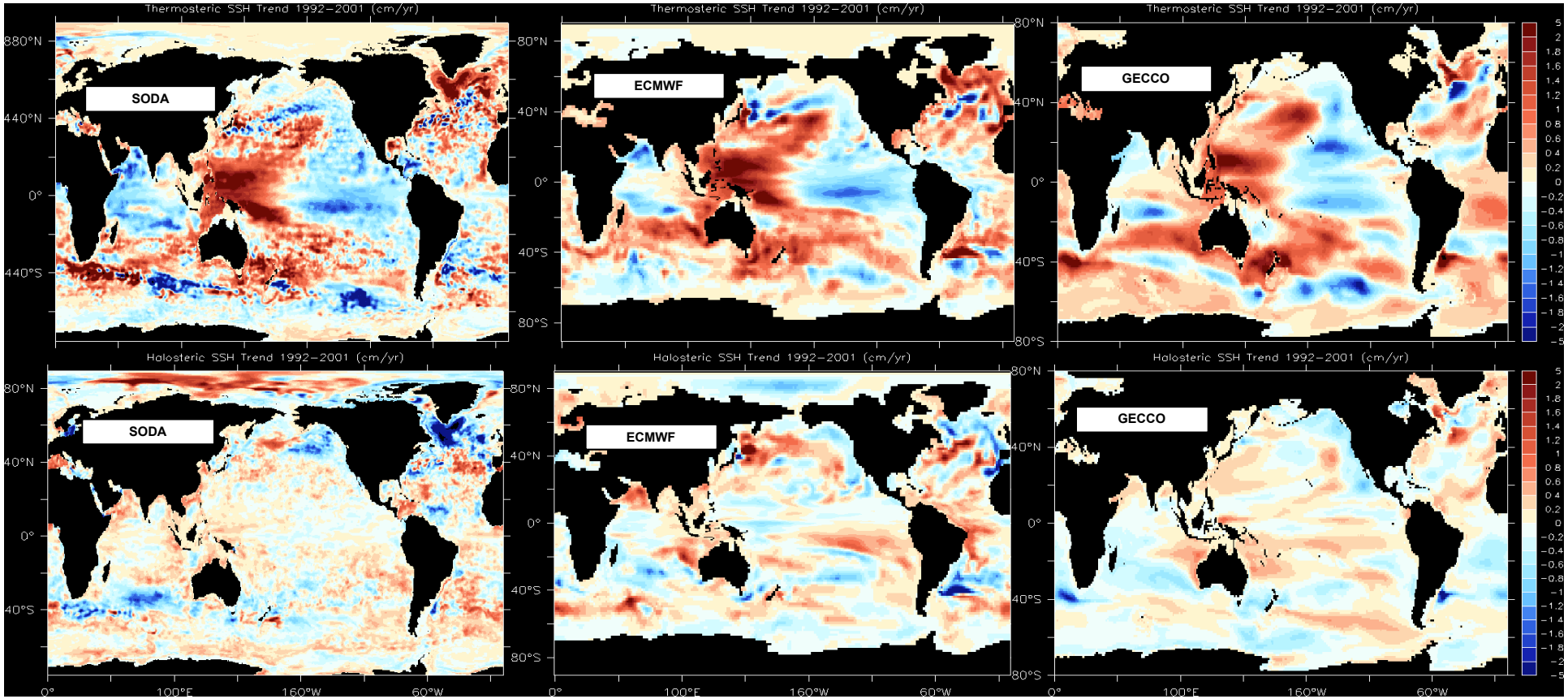
cf Cronin et al., 2009

Ocean Analyses

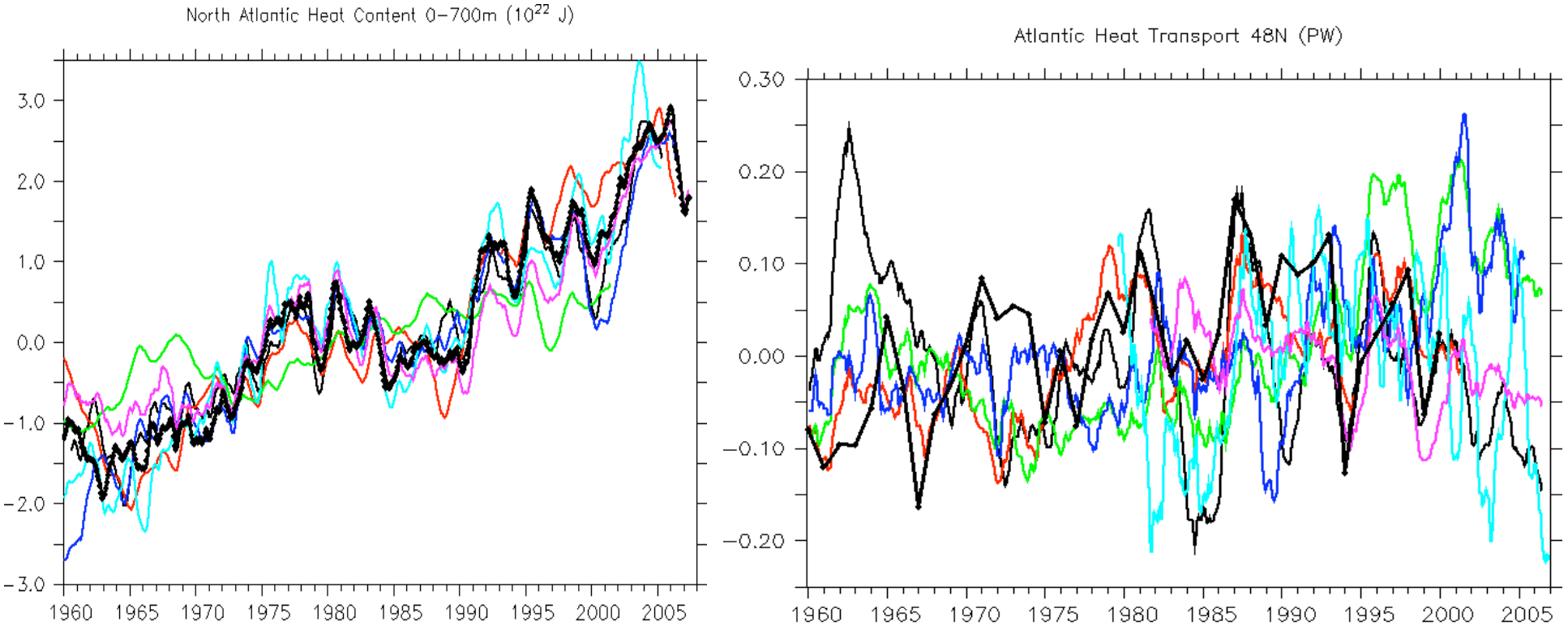


cf Stammer et al., 2009

Estimates of local thermosteric (top) and halosteric (bottom) SSH trends 1992-2001

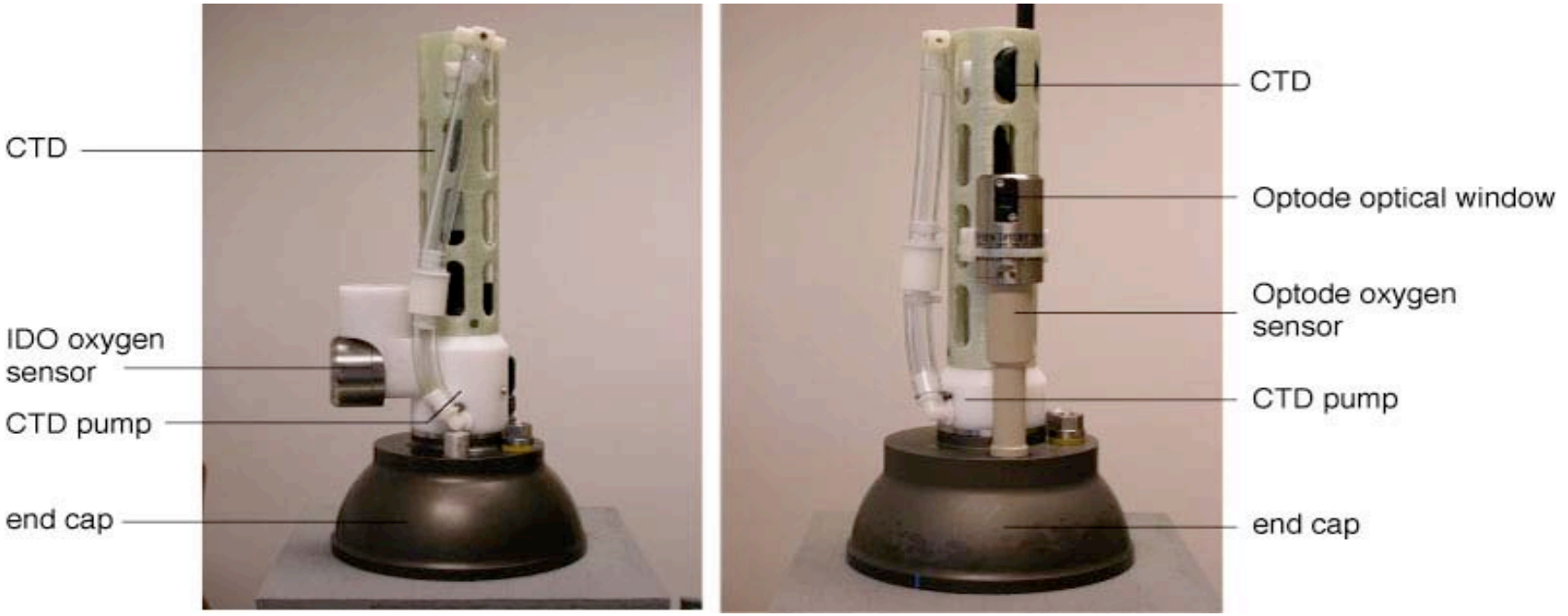


cf Stammer et al., 2009

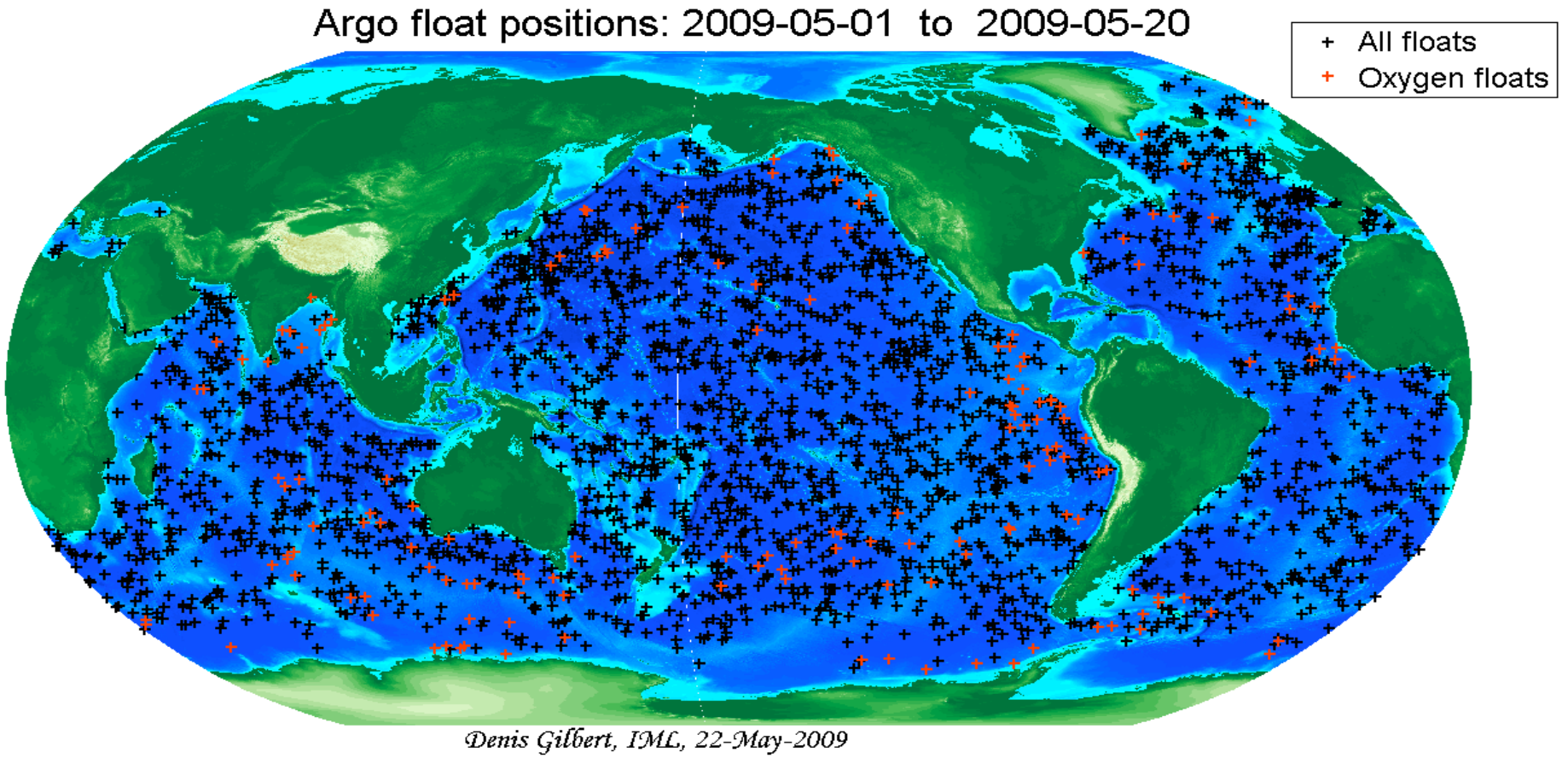


cf Stammer et al., 2009

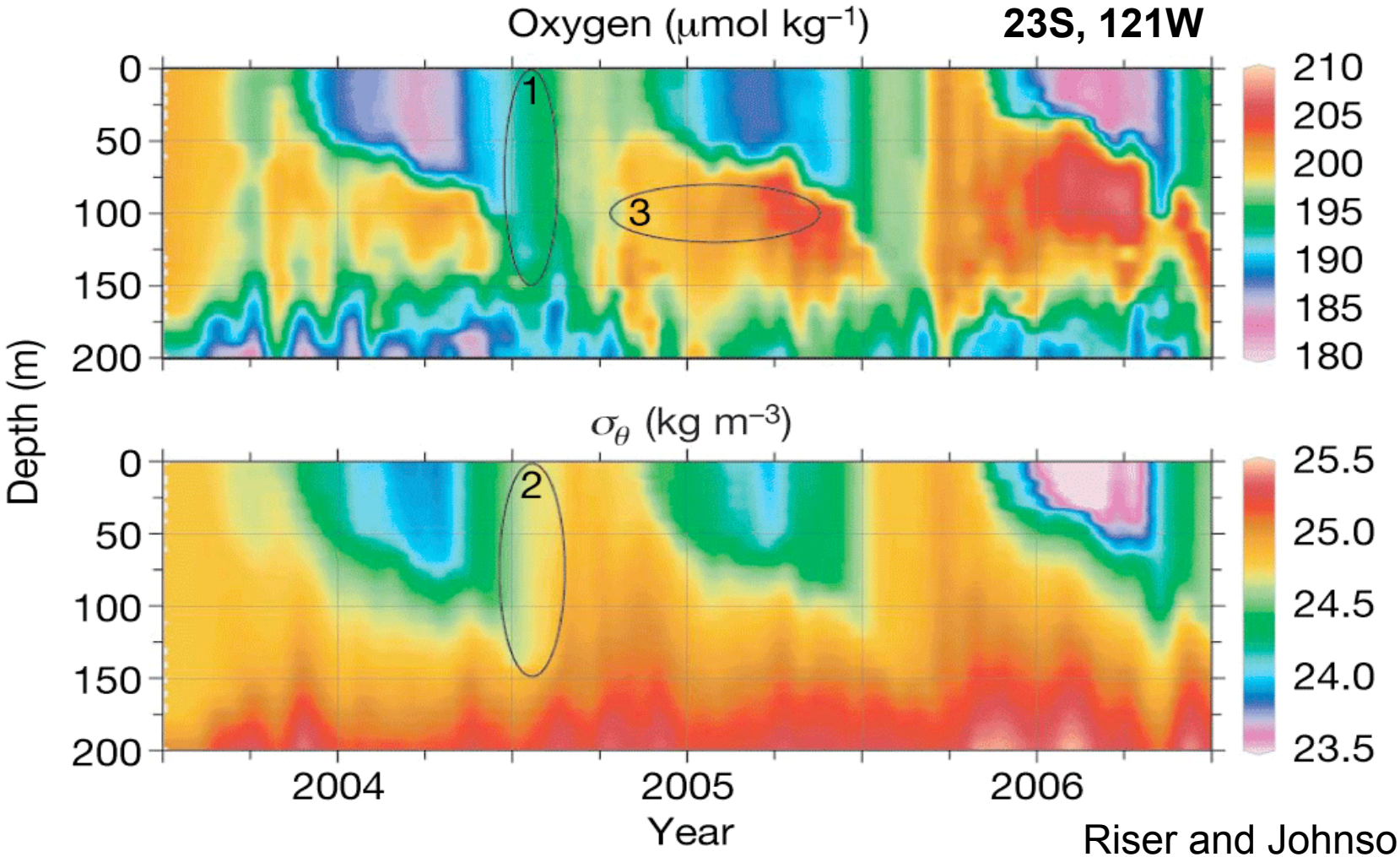
ARGO O_2



cf Gruber et al., 2009



cf Gruber et al., 2009



Riser and Johnson, 2008
cf Gruber et al., 2009

Particulate Organic Carbon and Particle Flux from Carbon Explorer Floats

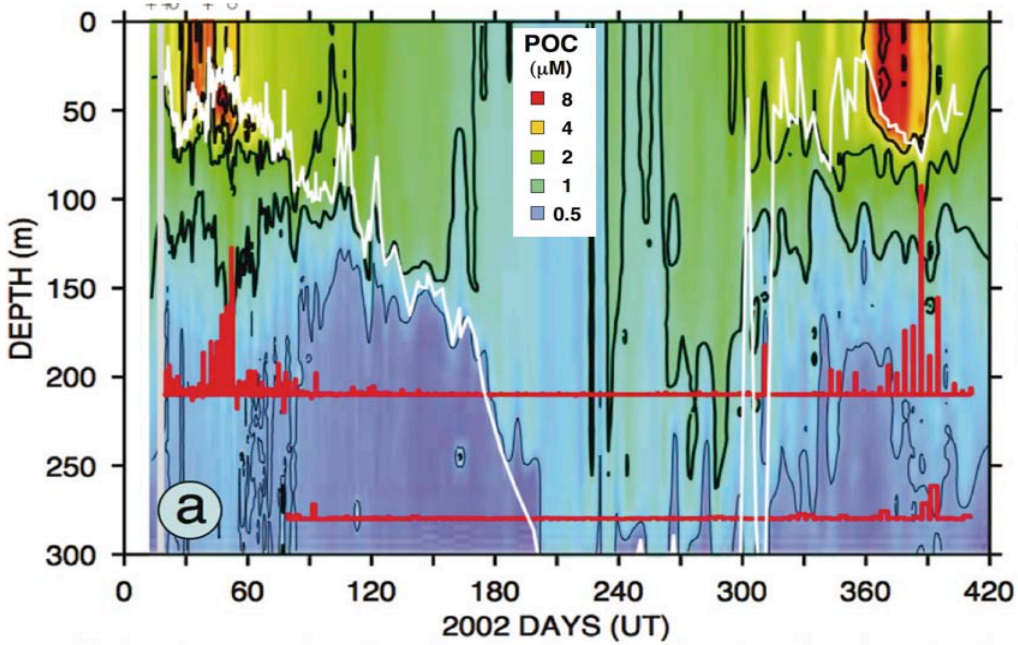
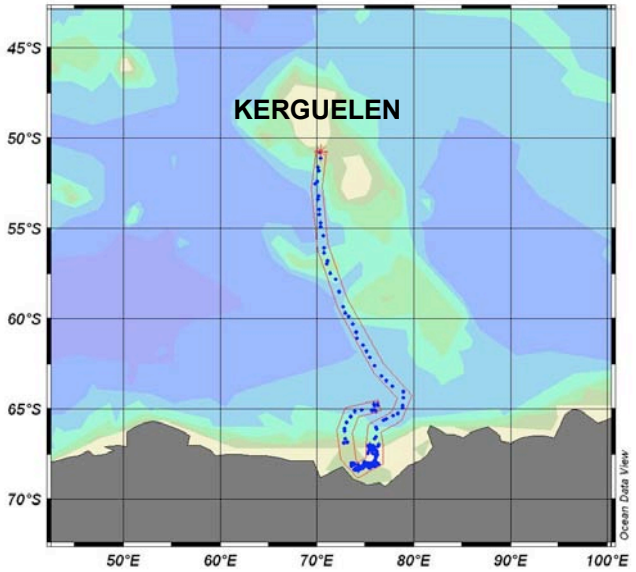
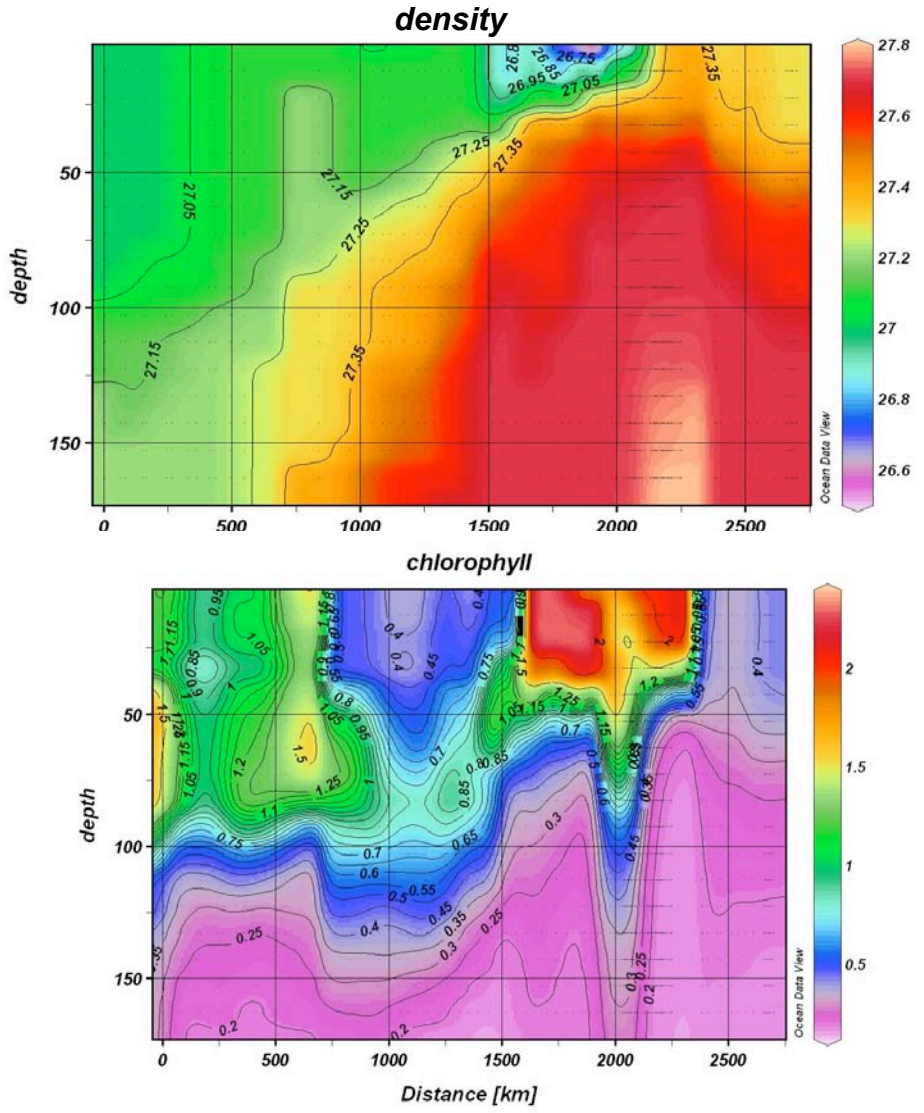


Figure 3. Time series of particulate organic concentration (color plot) and particle flux (red bars, in relative units) in the Southern ocean (around 55°S, 170°W). The data were acquired by the Carbon Explorer float which associates a Solo float to a suite of optical sensors. The reduction of the mixed layer (white line) in spring allows the increase in POC resulting from the development of the phytoplankton bloom, and the subsequent increase of particulate material export of at depth. From Bishop and Wood (2009)

cf Claustre et al., 2009



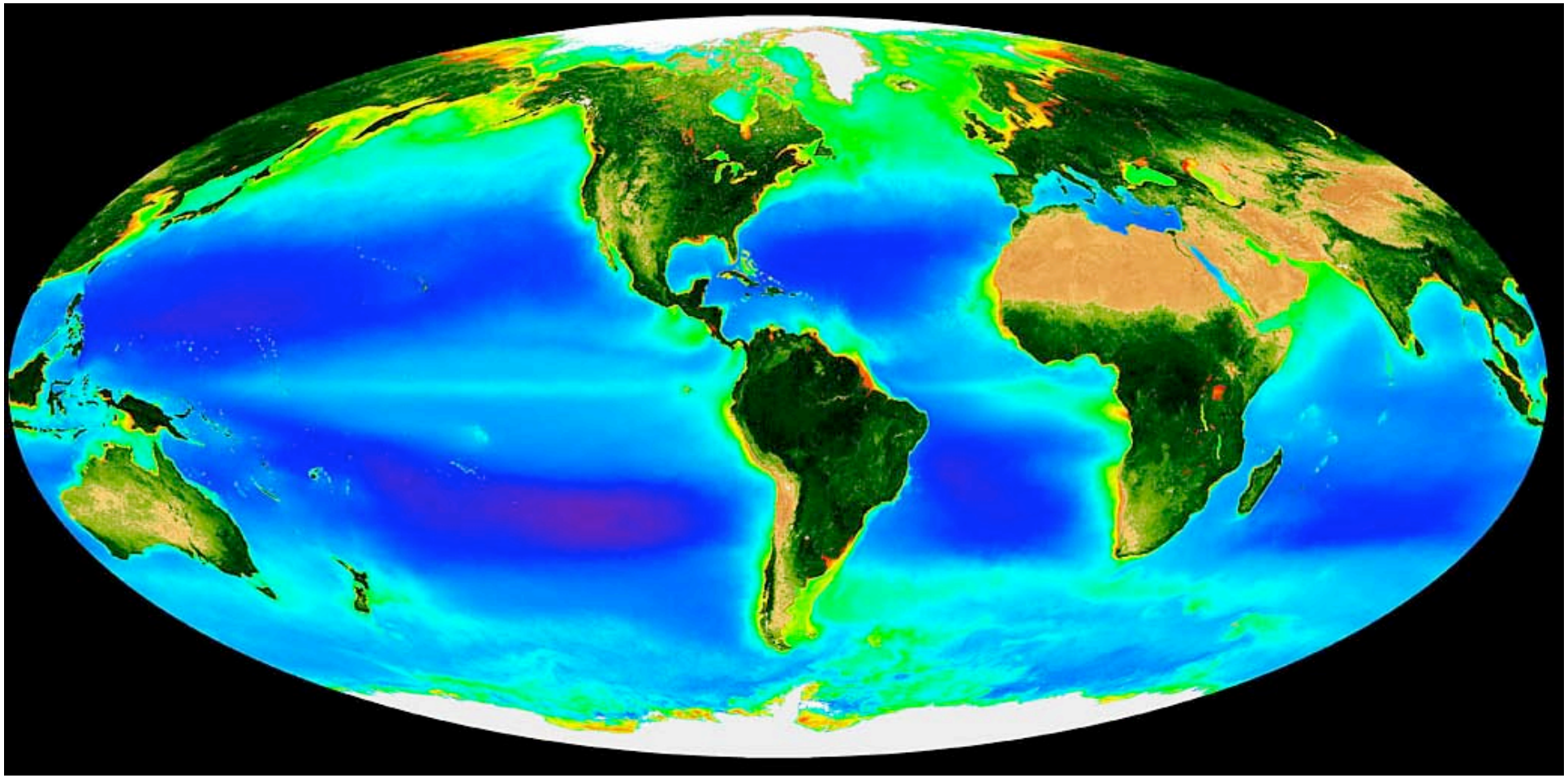


Elephant seal profiles with a CTD-Fluorescence sensor between Kerguelen Island to Antarctica in January 2009

cf Charrassin et al., 2009

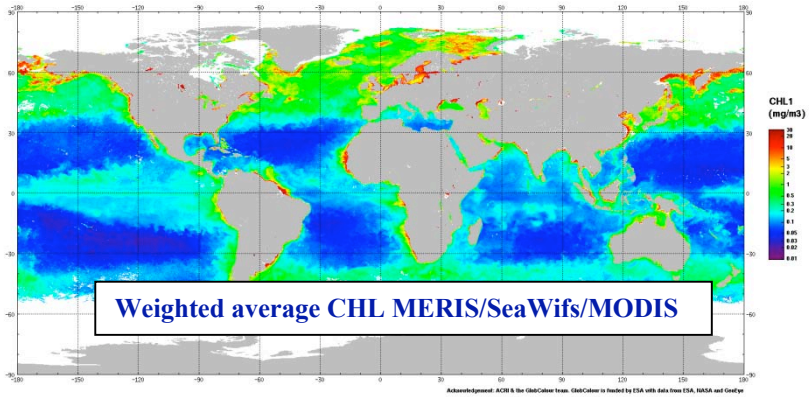
OceanObs'09

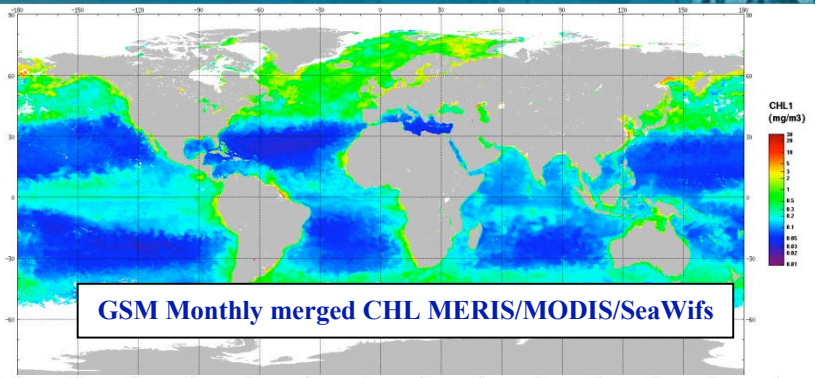
Ocean information for society: sustaining the benefits, realizing the potential

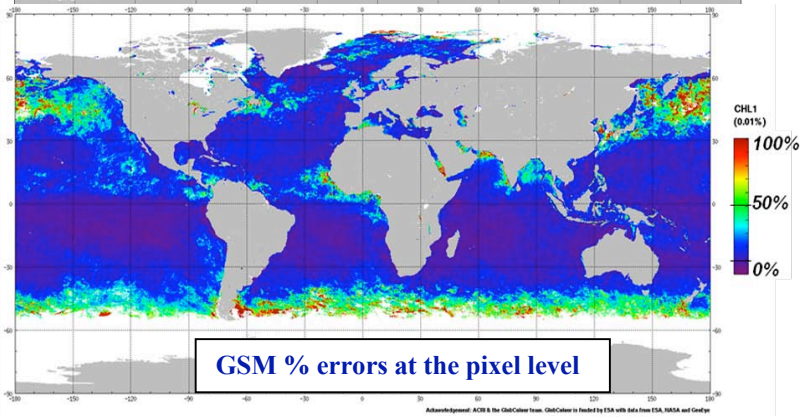


21-25 September 2009 | Venice, Italy

www.oceanobs09.net



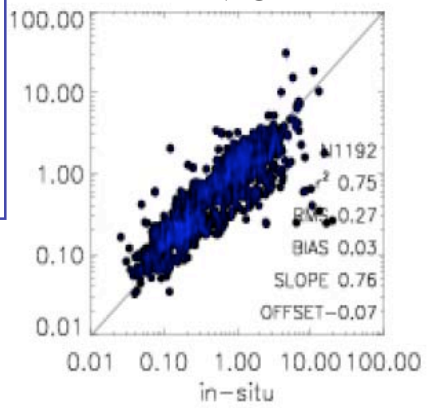




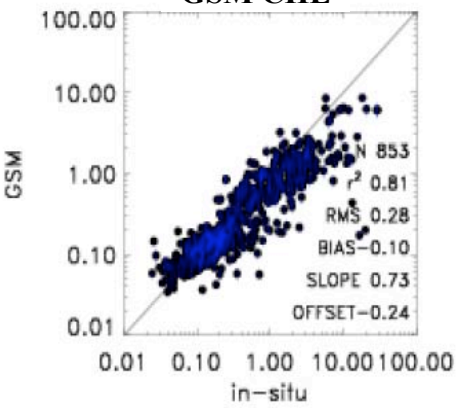
Match-up analyses (OBPG/NOMAD/BOUSSOLE) & product inter-comparison show:

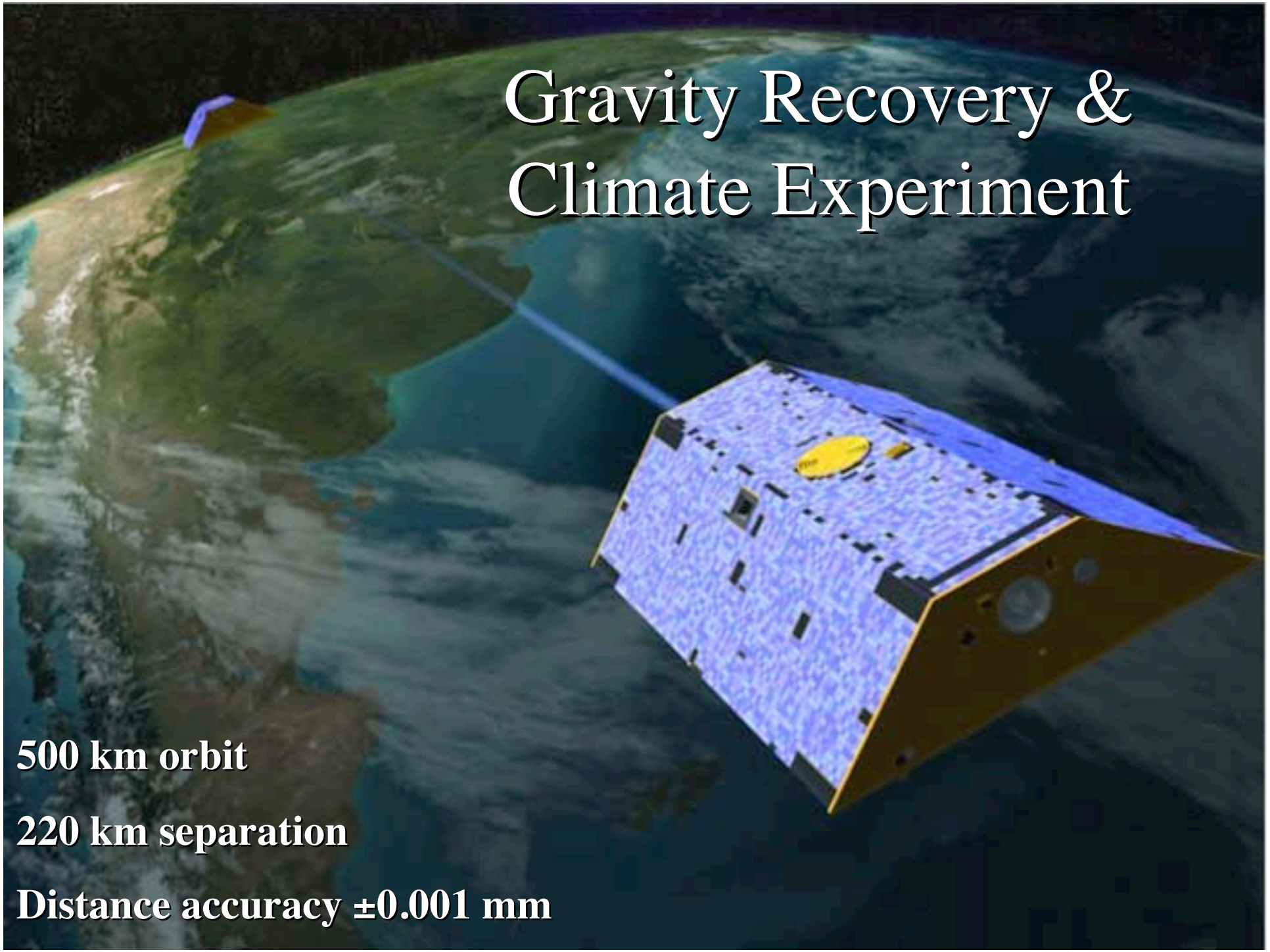
- Error statistics of the merged data are in general better than data from the tree individual sensors
- The normalized water-leaving radiance at 490 nm is by far the most homogeneous product among the 3 sensors
- GlobColour GSM01 merging algorithm shows to be quite robust over coastal waters

AV CHL



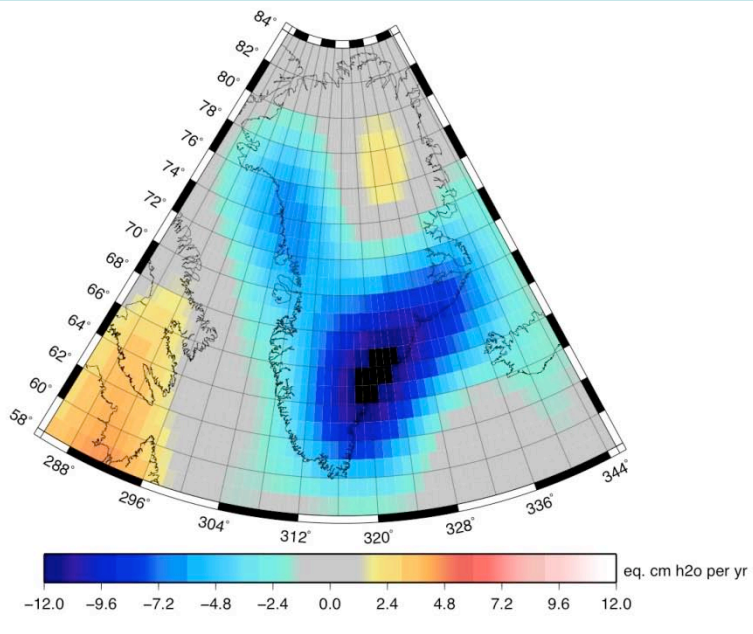
GSM CHL

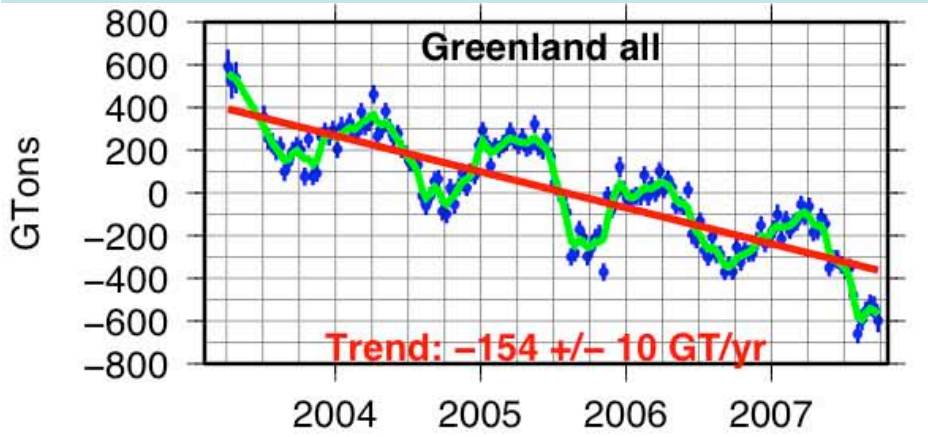



Gravity Recovery &
Climate Experiment
500 km orbit
220 km separation
Distance accuracy ±0.001 mm

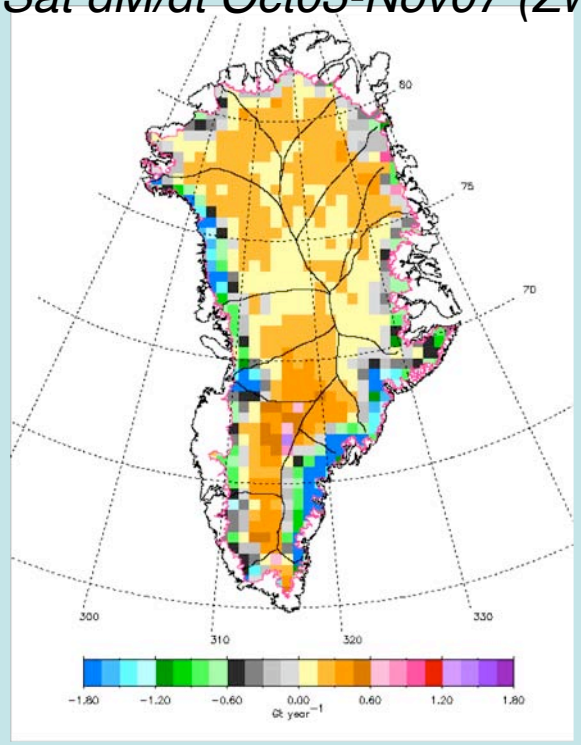
Greenland Mass Change from GRACE and ICESat

GRACE dM/dt Apr03-Apr07





ICESat dM/dt Oct03-Nov07 (Zwally et al.)

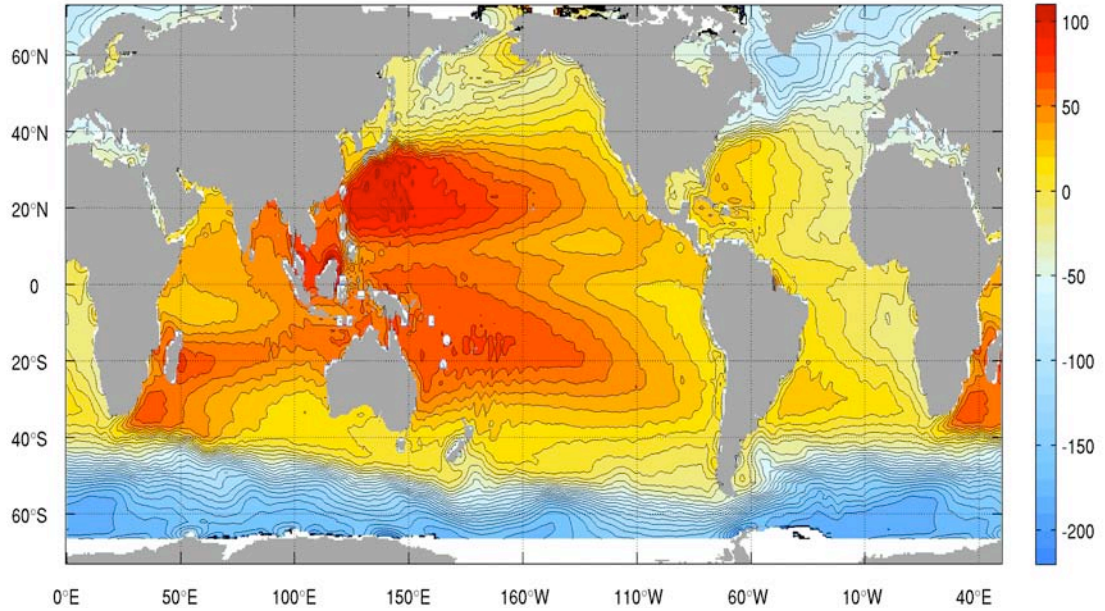


ICESat Trend:
Oct03-Nov07: -137 Gt/yr

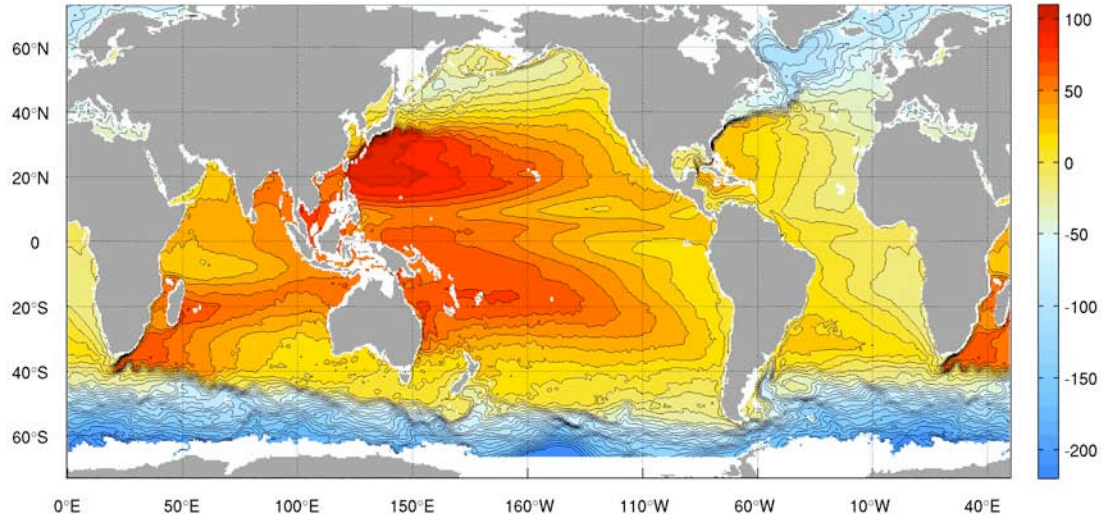
GRACE mascon Trend:
Sep03-Oct07: -161±10 Gt/yr

Mean Dynamic Topography:

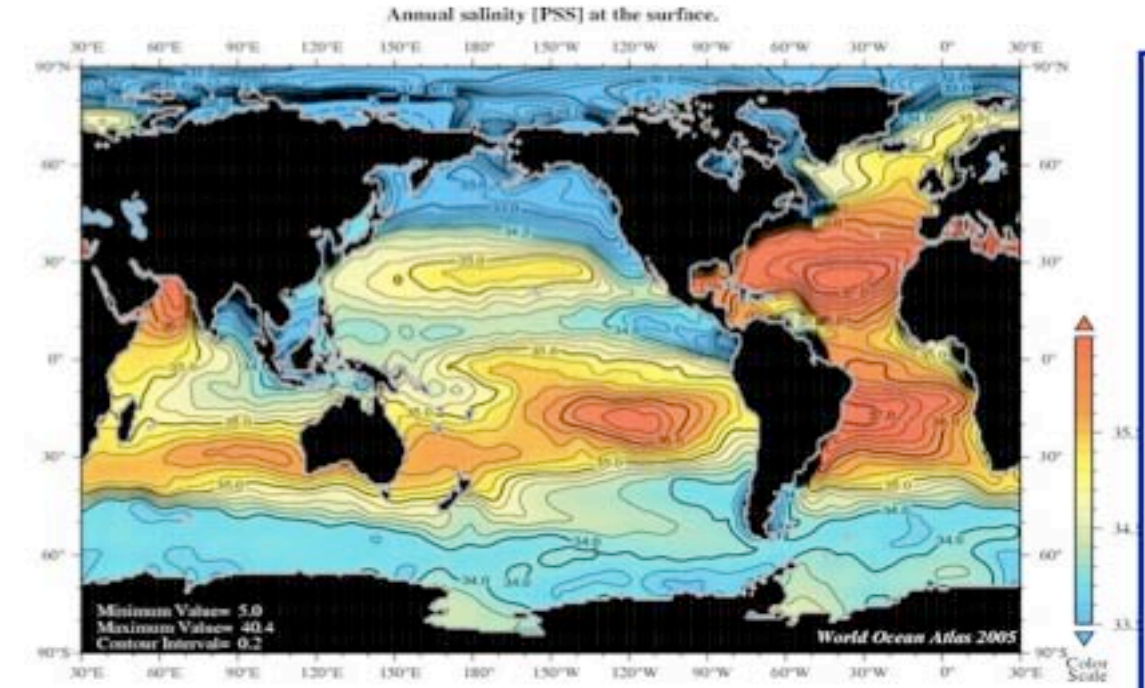
GRACE gravity plus Altimetry

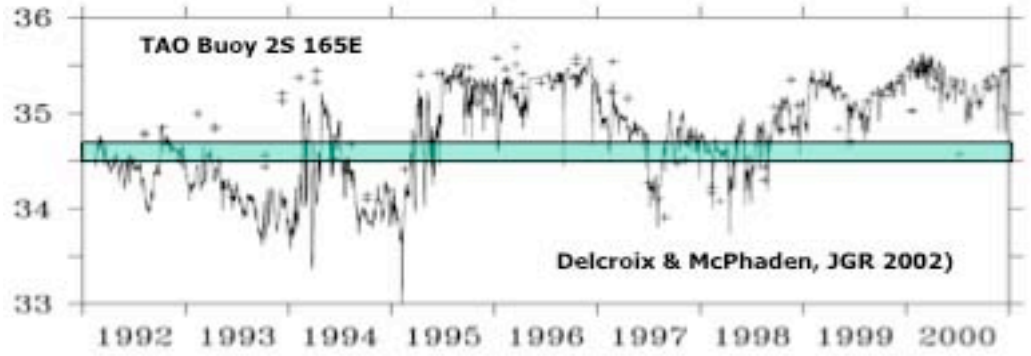


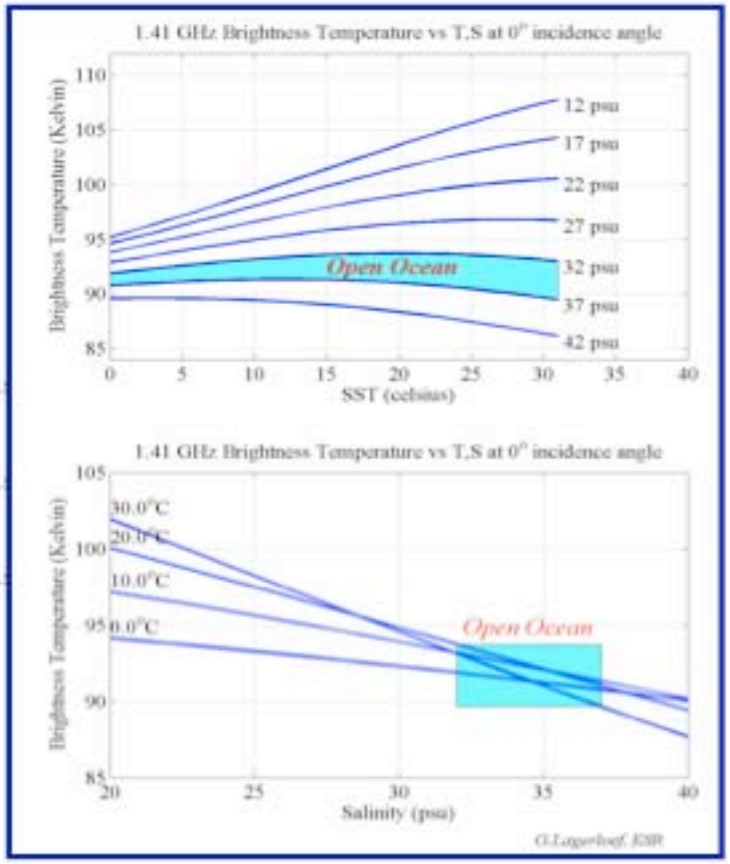
Drifter based technique of Maximenko et al,.2009



CF Shum et al., 2009



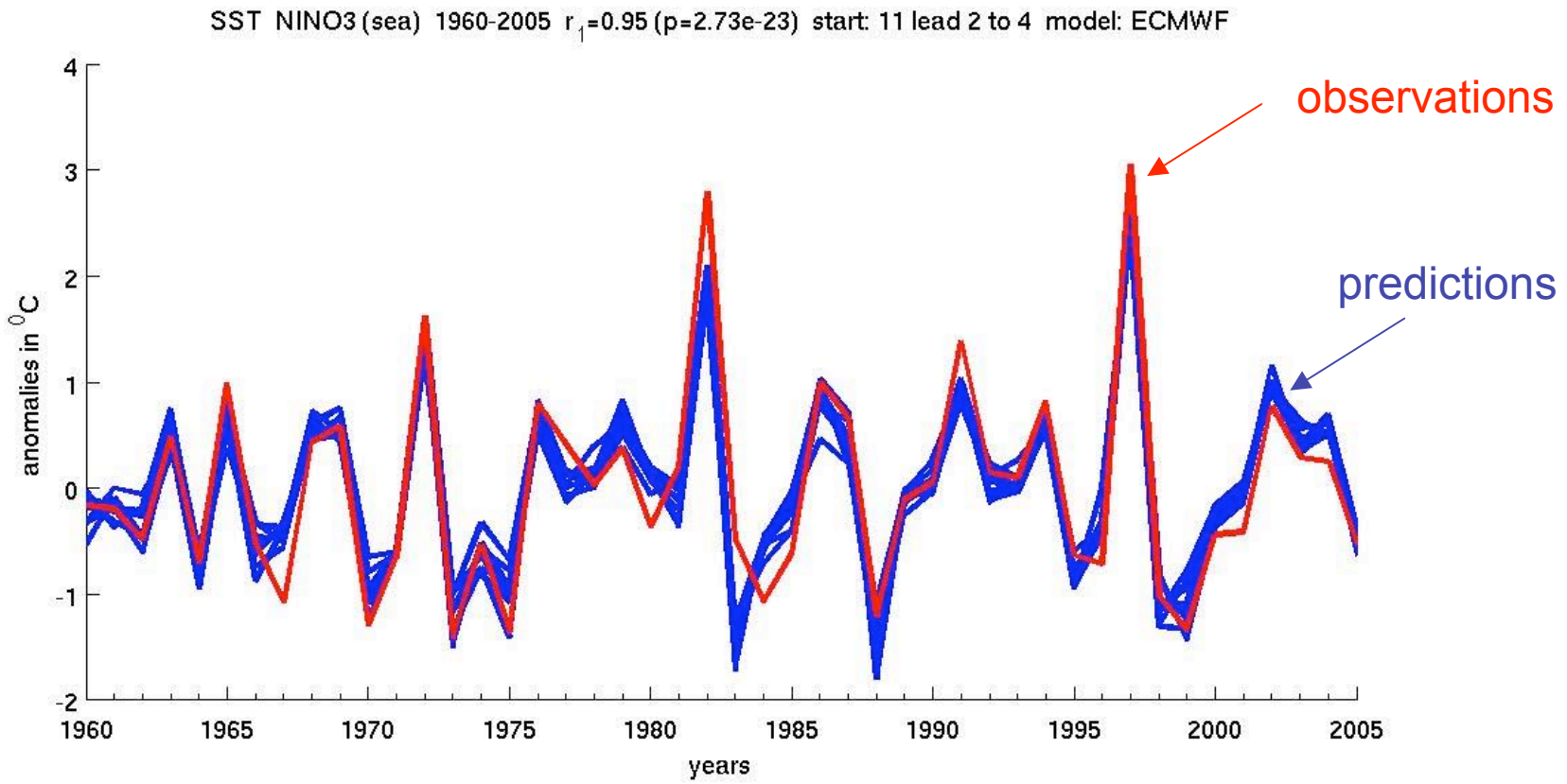




cf Lagerloef et al., 2009

Seasonal to Decadal Climate Prediction

Seasonal Reforecasts (months 2-4) of El Niño with a comprehensive coupled model

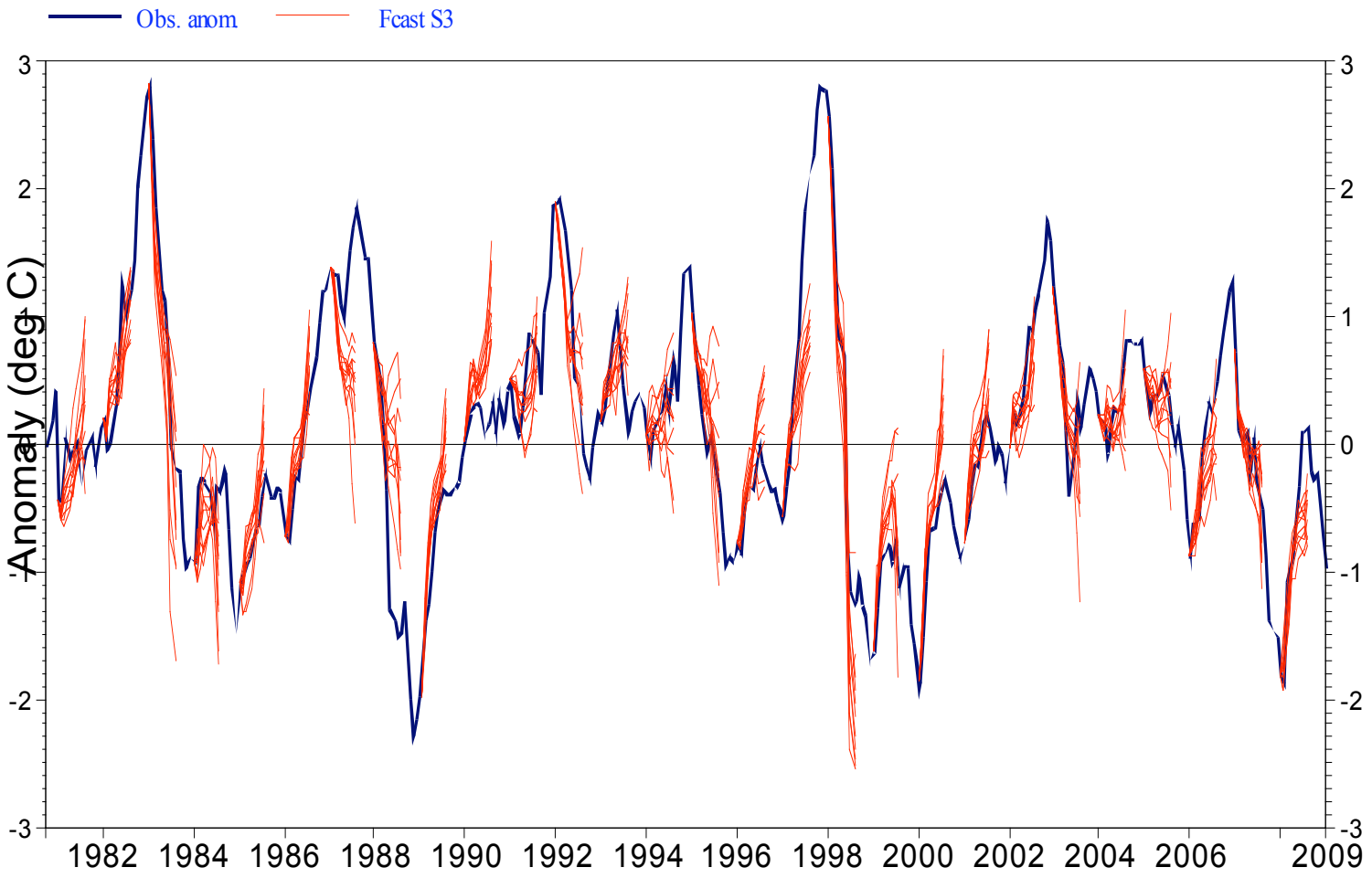


Palmer, 2009

NINO3.4 SST forecast anomalies

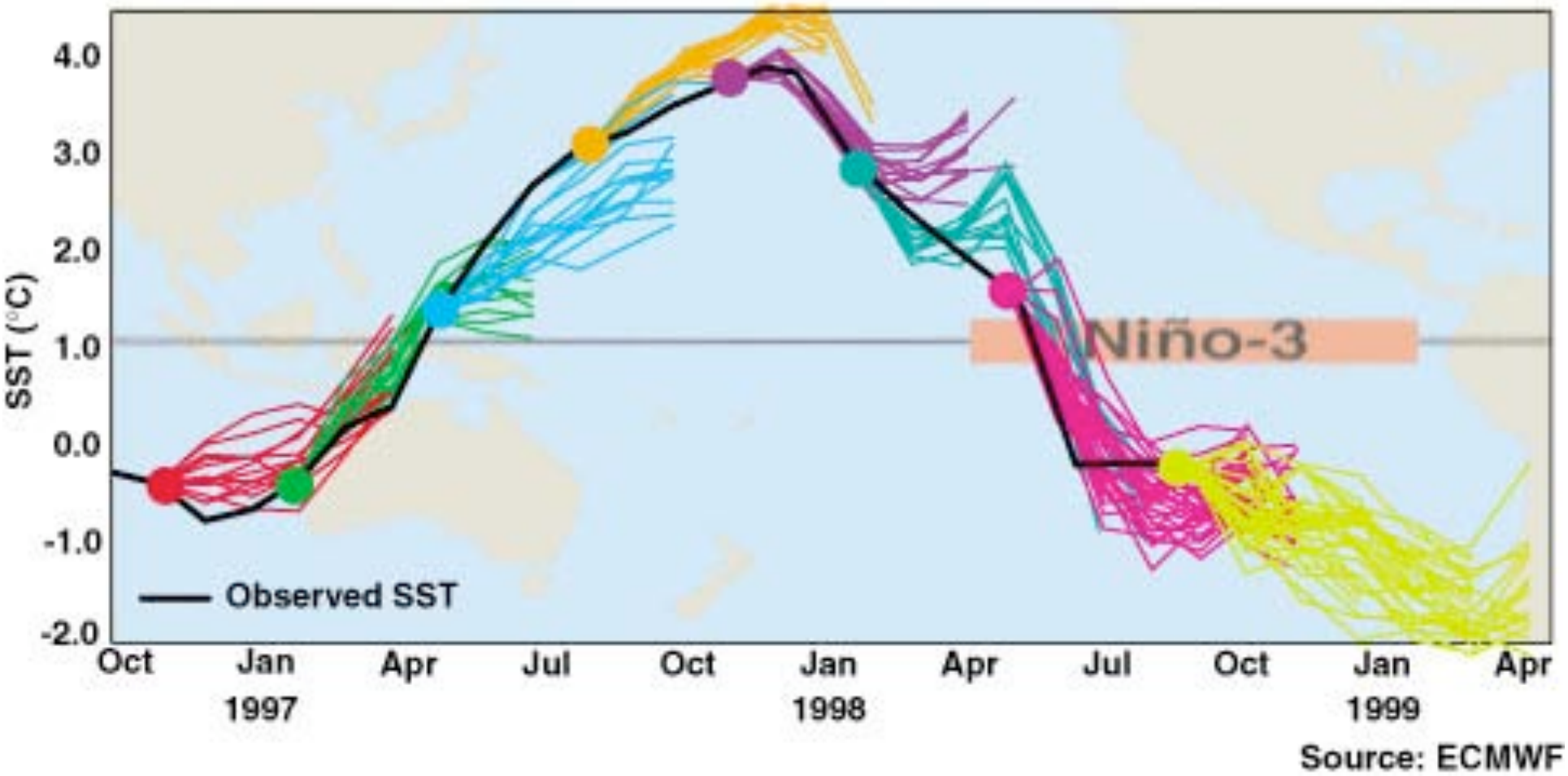
ECMWF forecasts at month 7

Ensemble size is 11 SST obs: HadISST1/OIv2



Stockdale et al., 2009

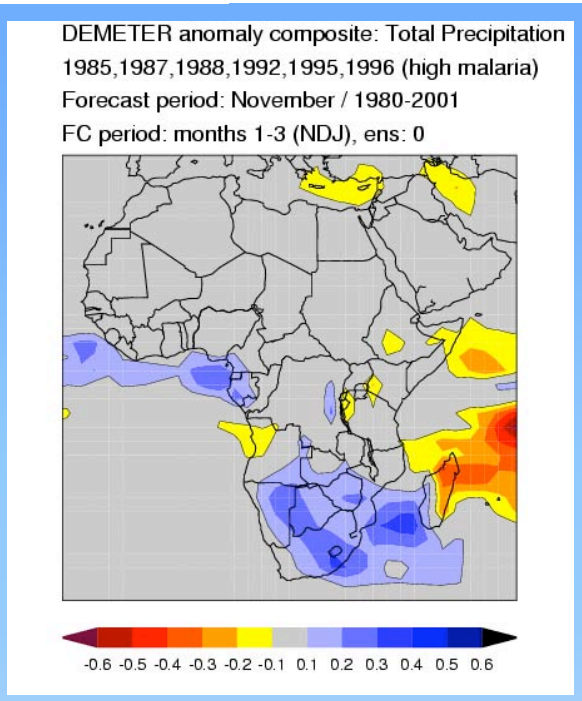
El Niño 1997/98
Seasonal Predictions

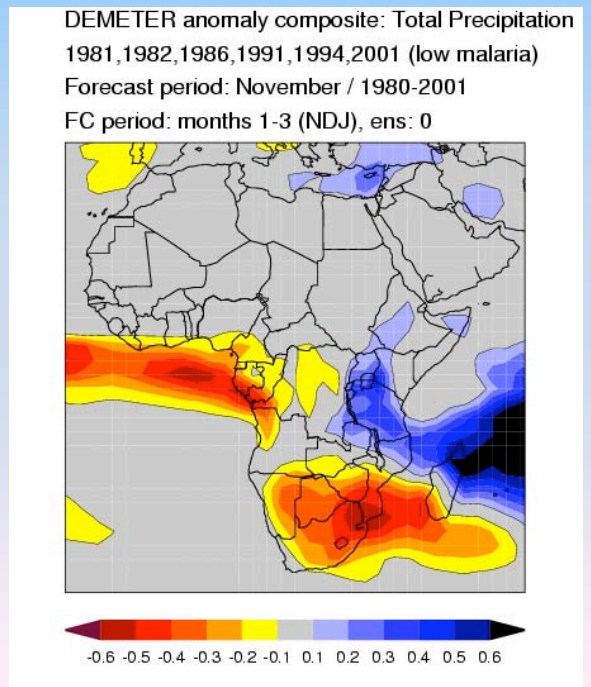


Source: ECMWF

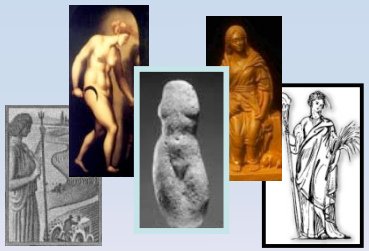
Seasonal prediction of epidemic malaria in Southern Africa

(Thomson et al, Nature, 2005)



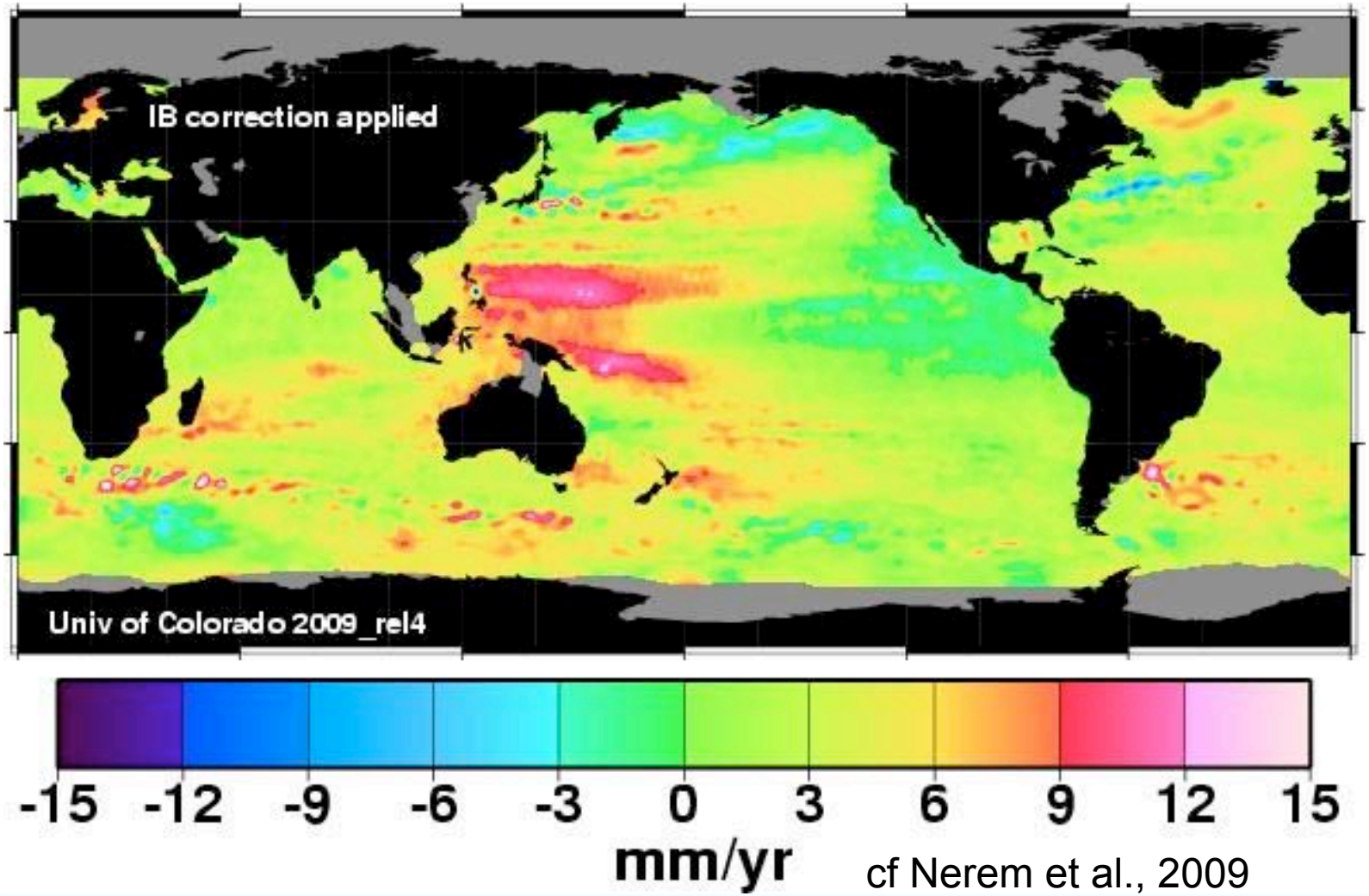


Dhmhthr

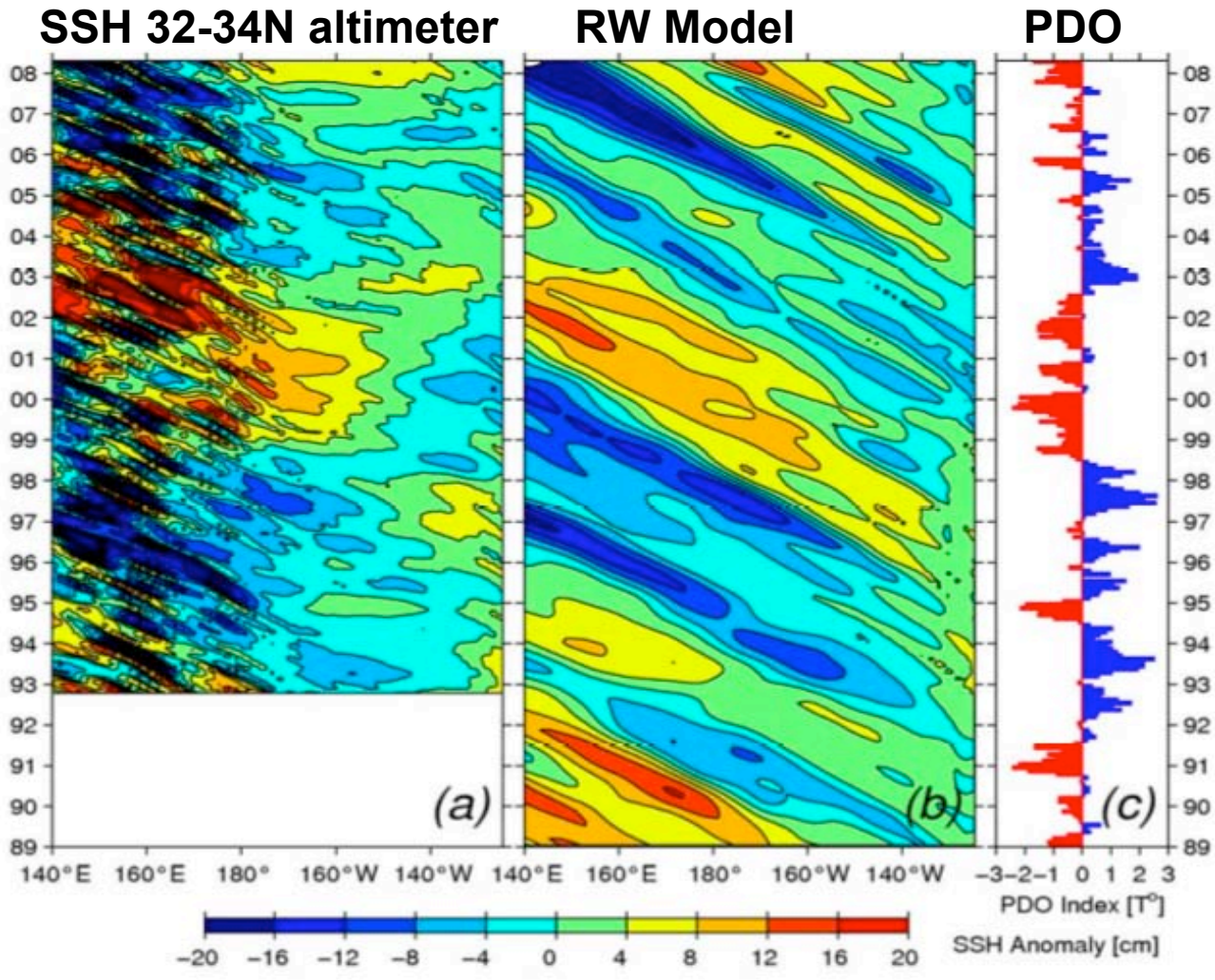


Palmer, 2009

14-Year Sea Level Trends

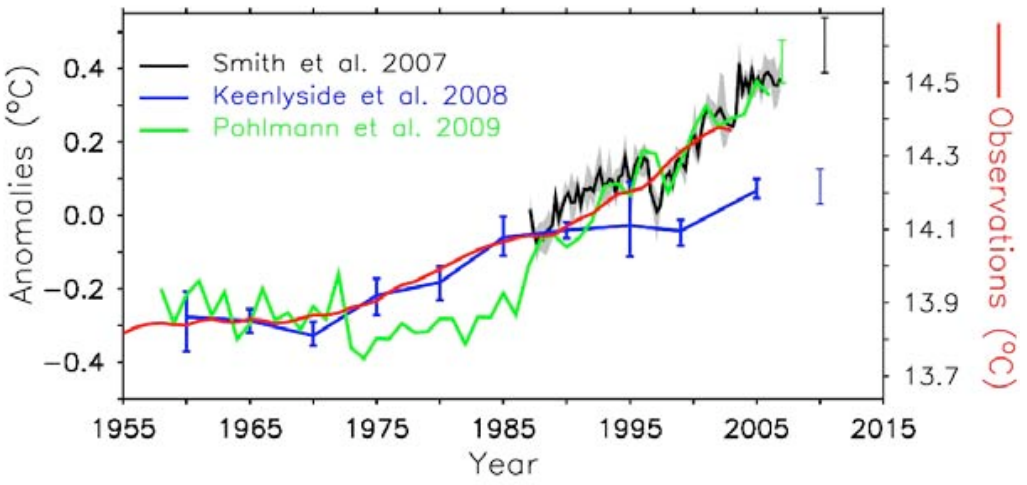


cf Nerem et al., 2009

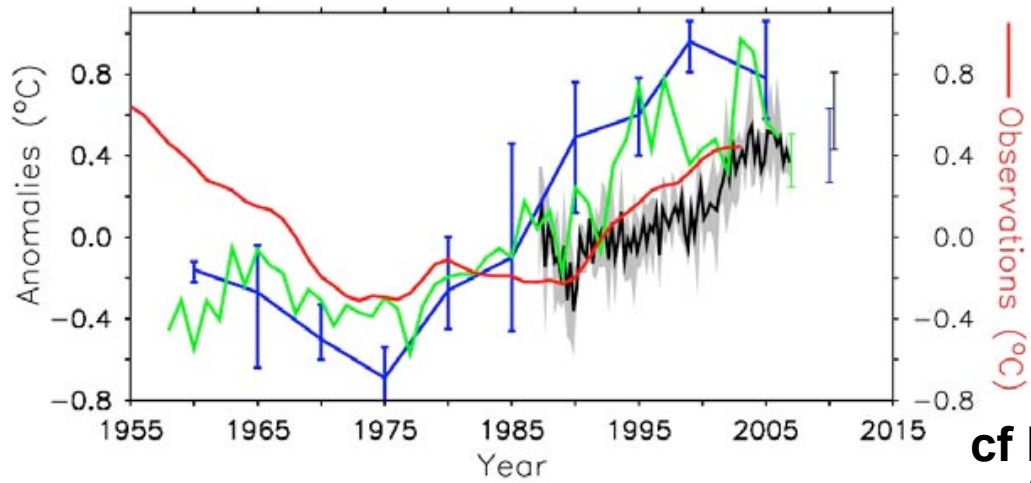


cf Scott et al, 2009

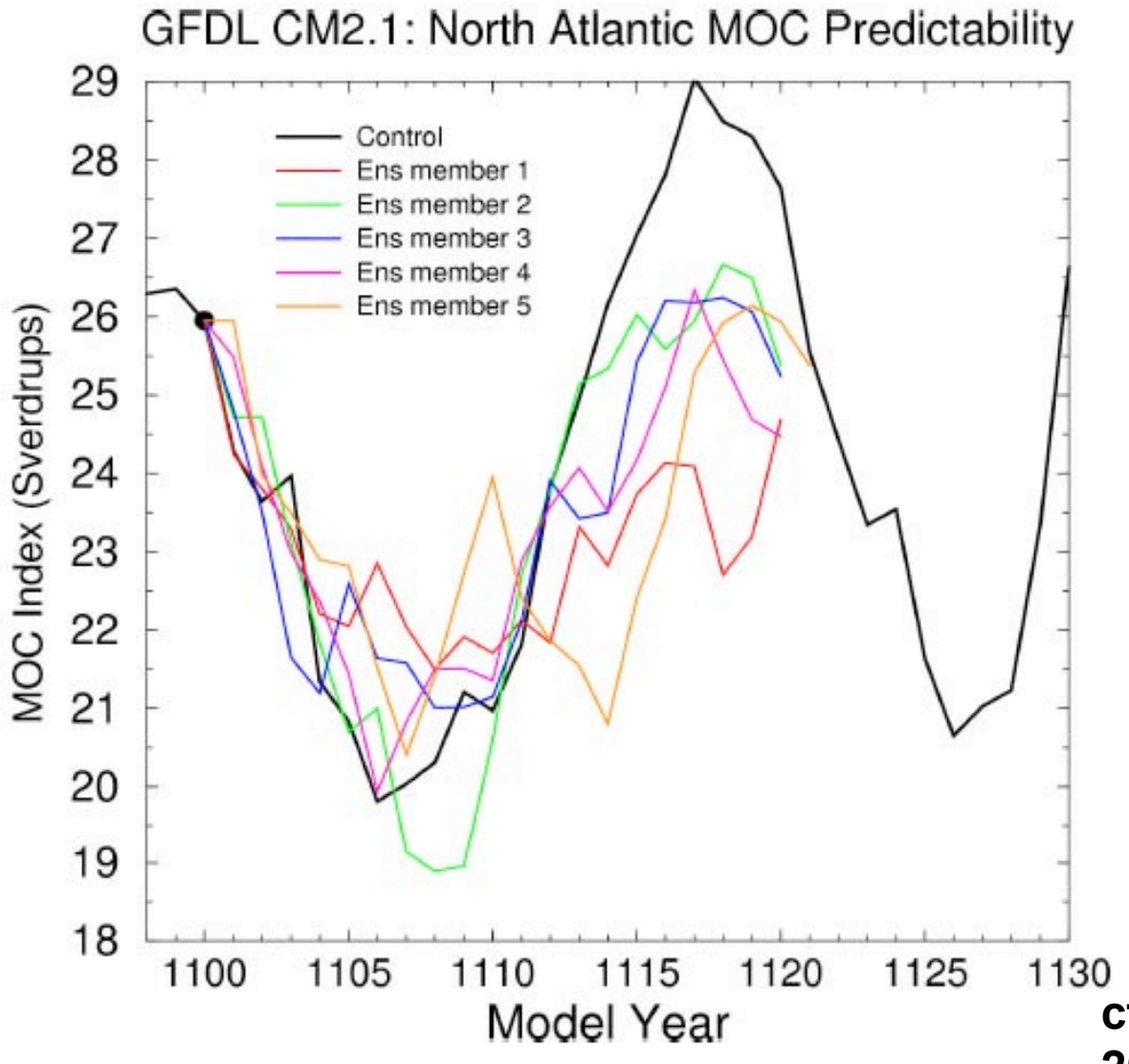
(A) Global average surface temperature



(B) Atlantic SST dipole index **(60-10W, 40-60N) - (30W-10E, 10-40S)**

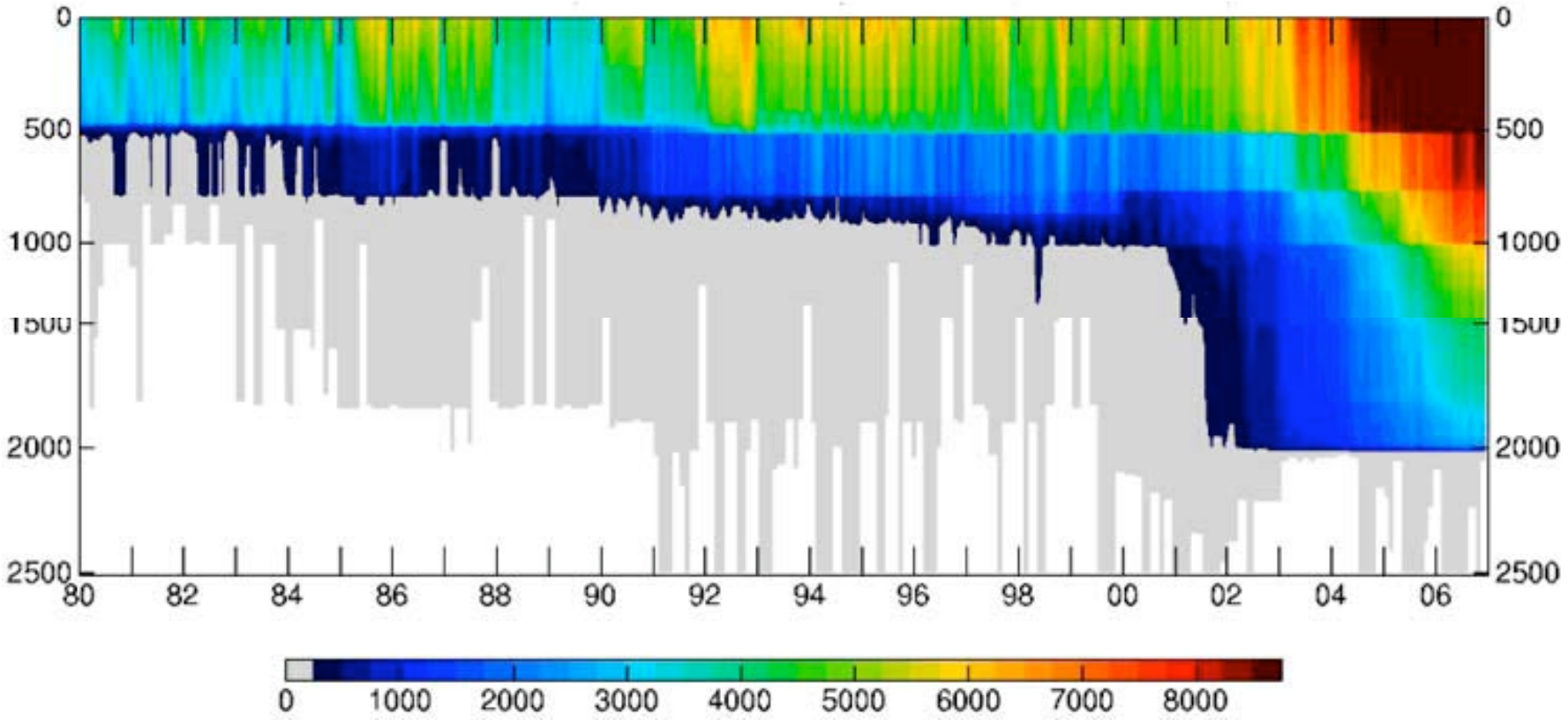


cf Hurrell et al, 2009



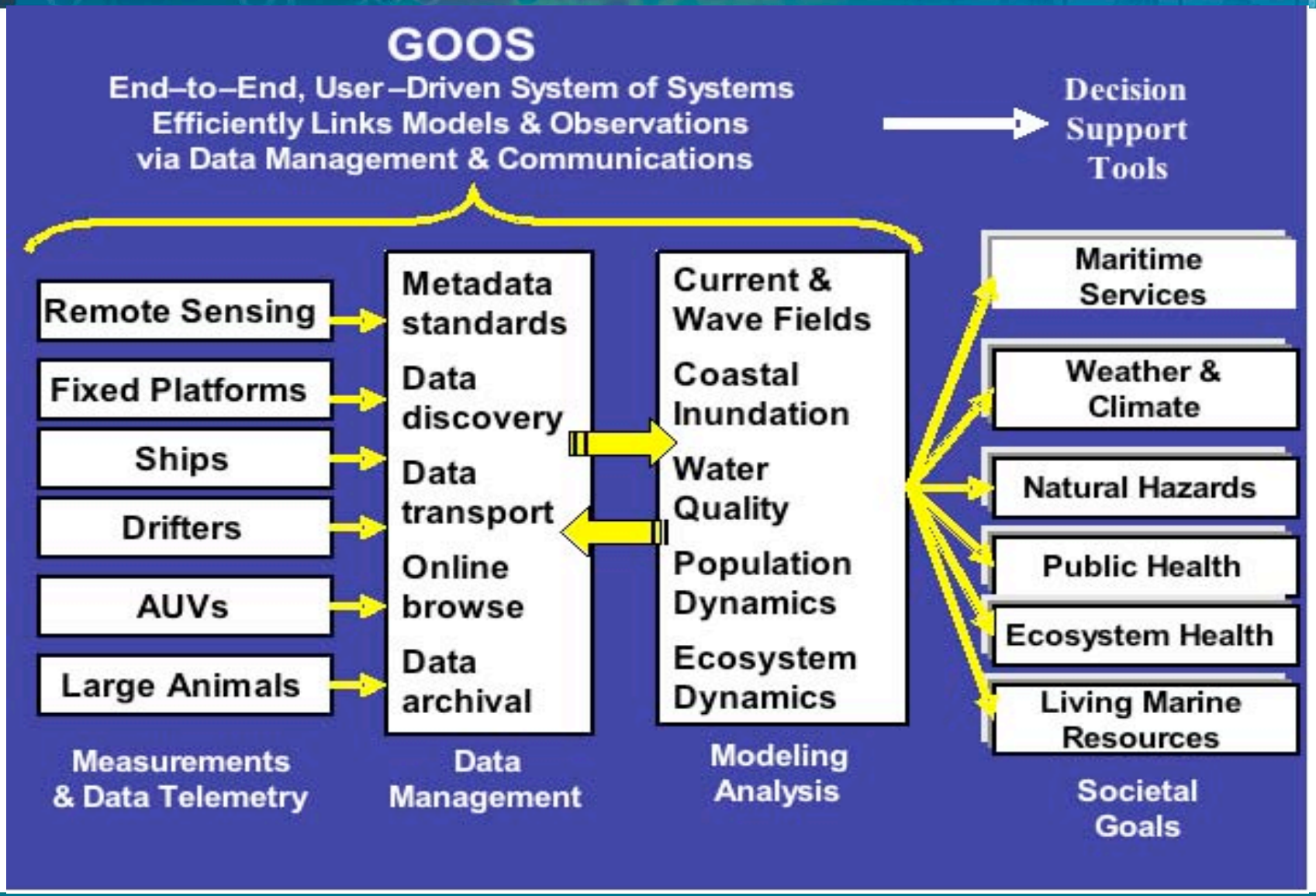
cf Hurrell et al, 2009

Global Number of Temperature Observations per Month as a Function of Depth



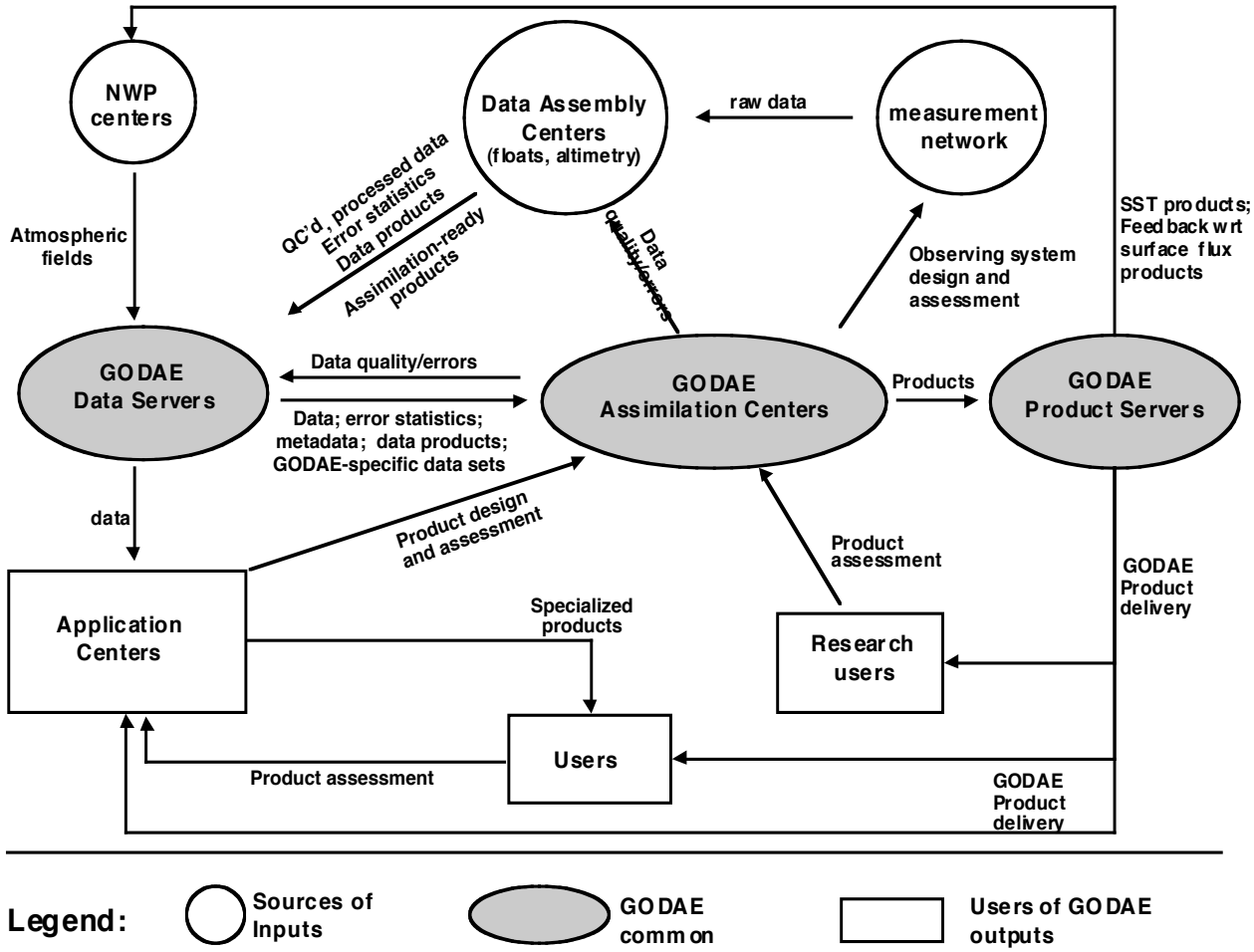
cf Hurrell et al, 2009

Forecasting of Marine Variability



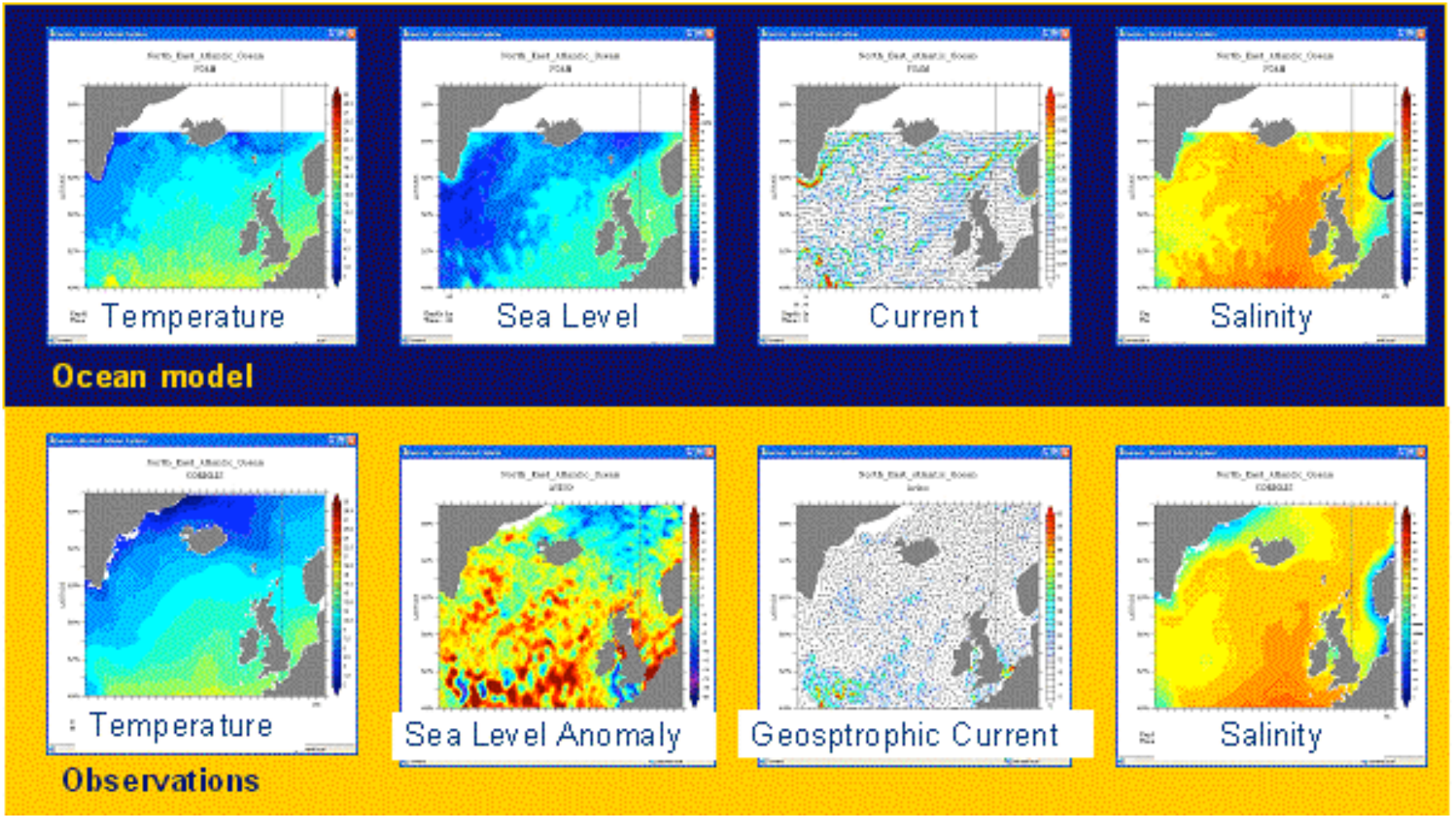
cf Malone et al., 2009

Functional Components of GODAE



cf Le Traon et al., 2009

GODAE Products



cf Blanc et al., 2009

stem,

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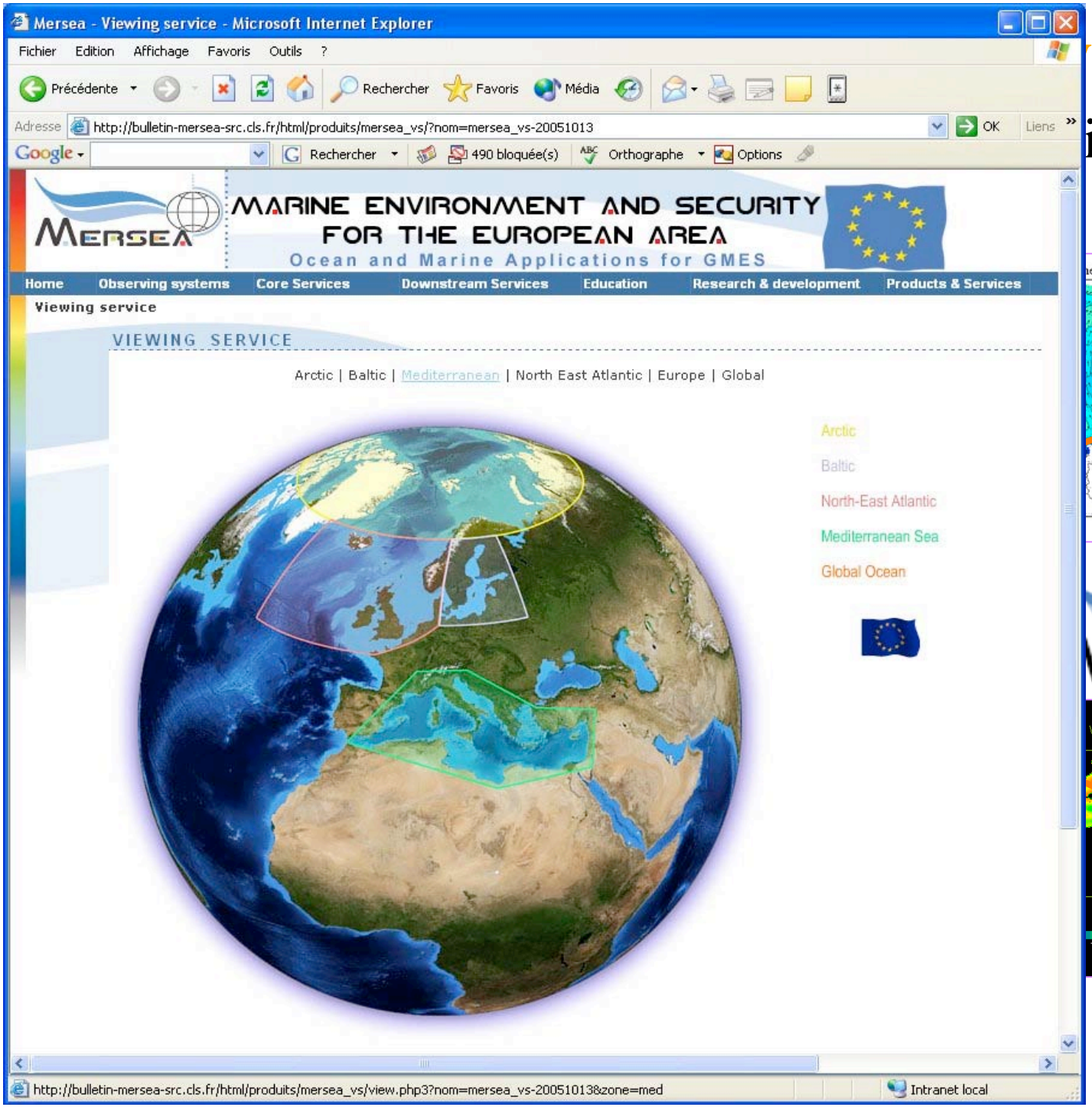
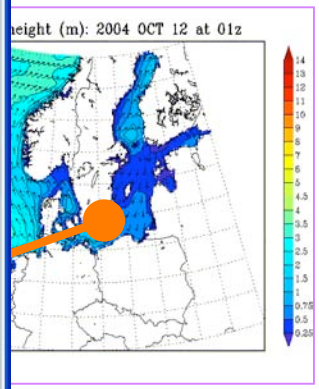
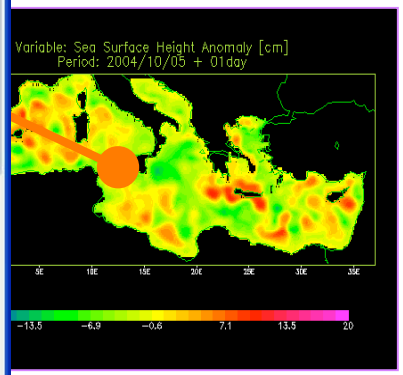
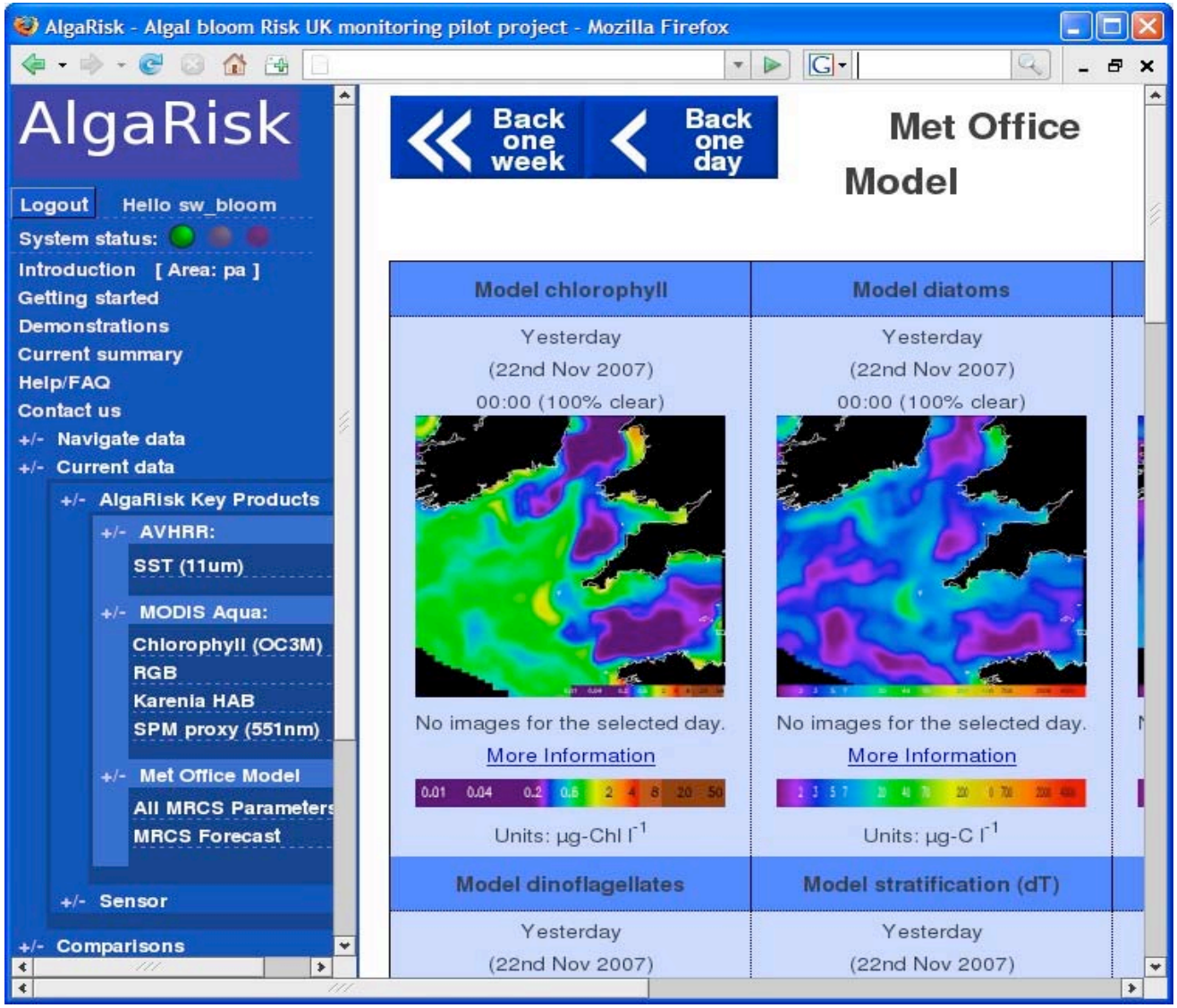




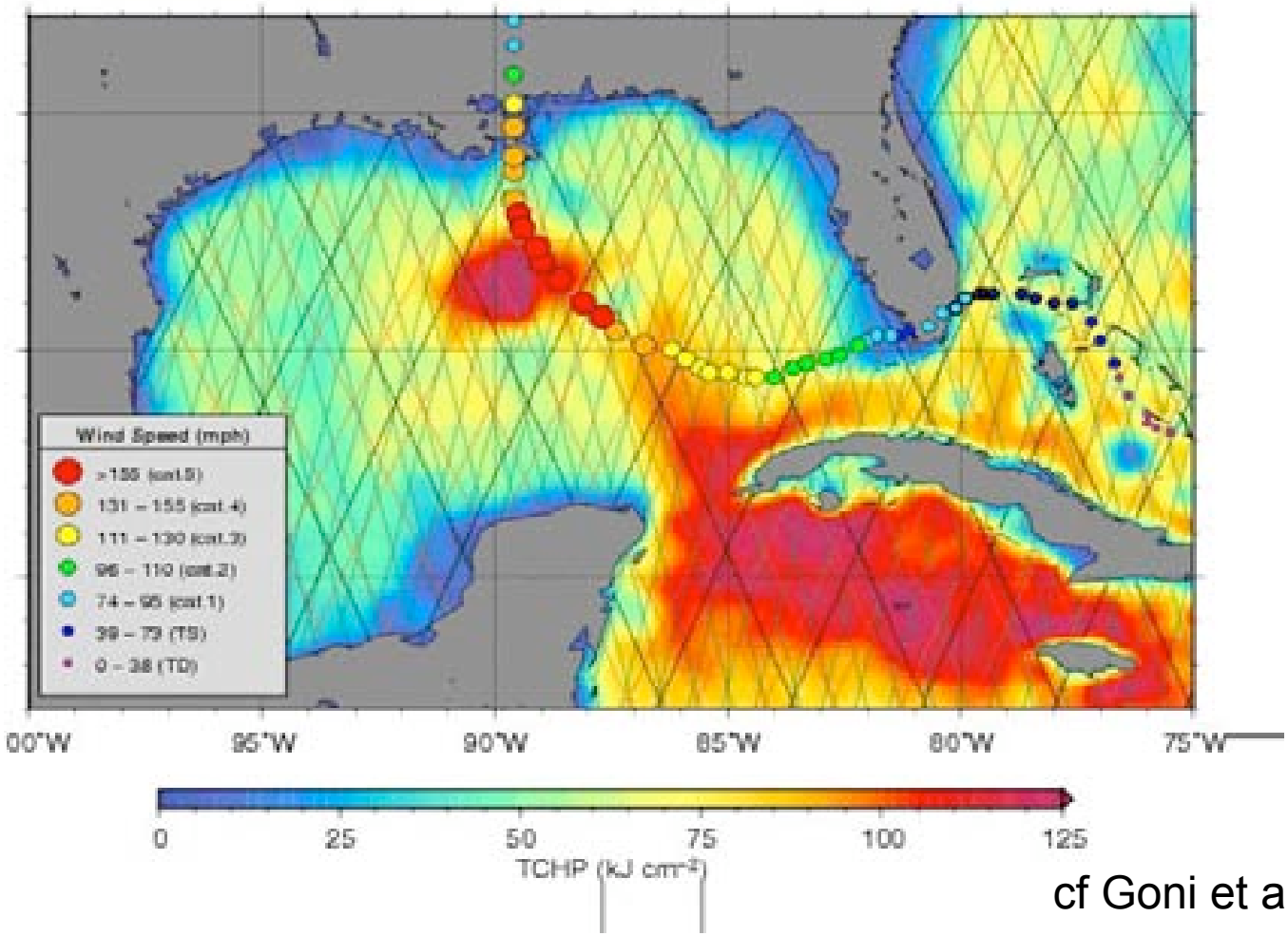
MERSEA





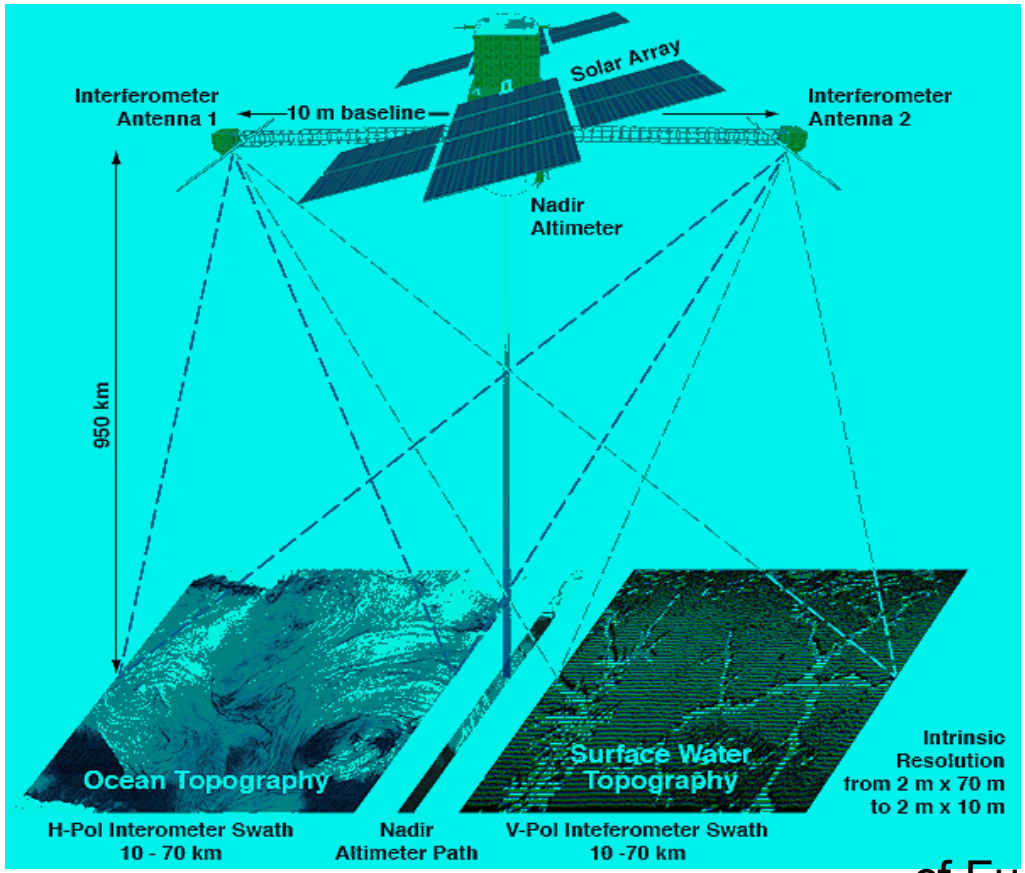
Blanc et al., 2009

Hurricane Katrina: TCHP



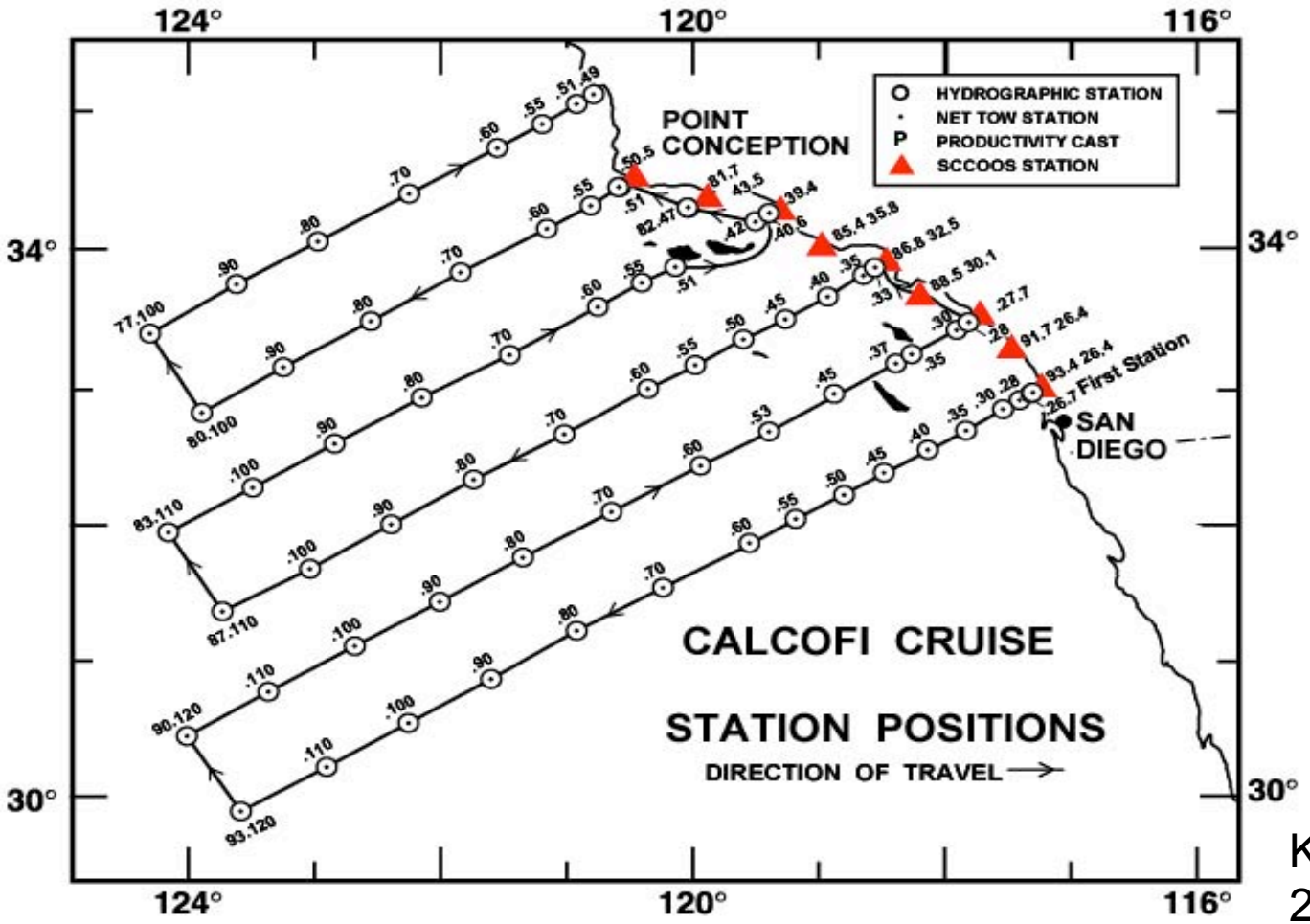
cf Goni et al., 2009

Surface Water Ocean Topography Mission

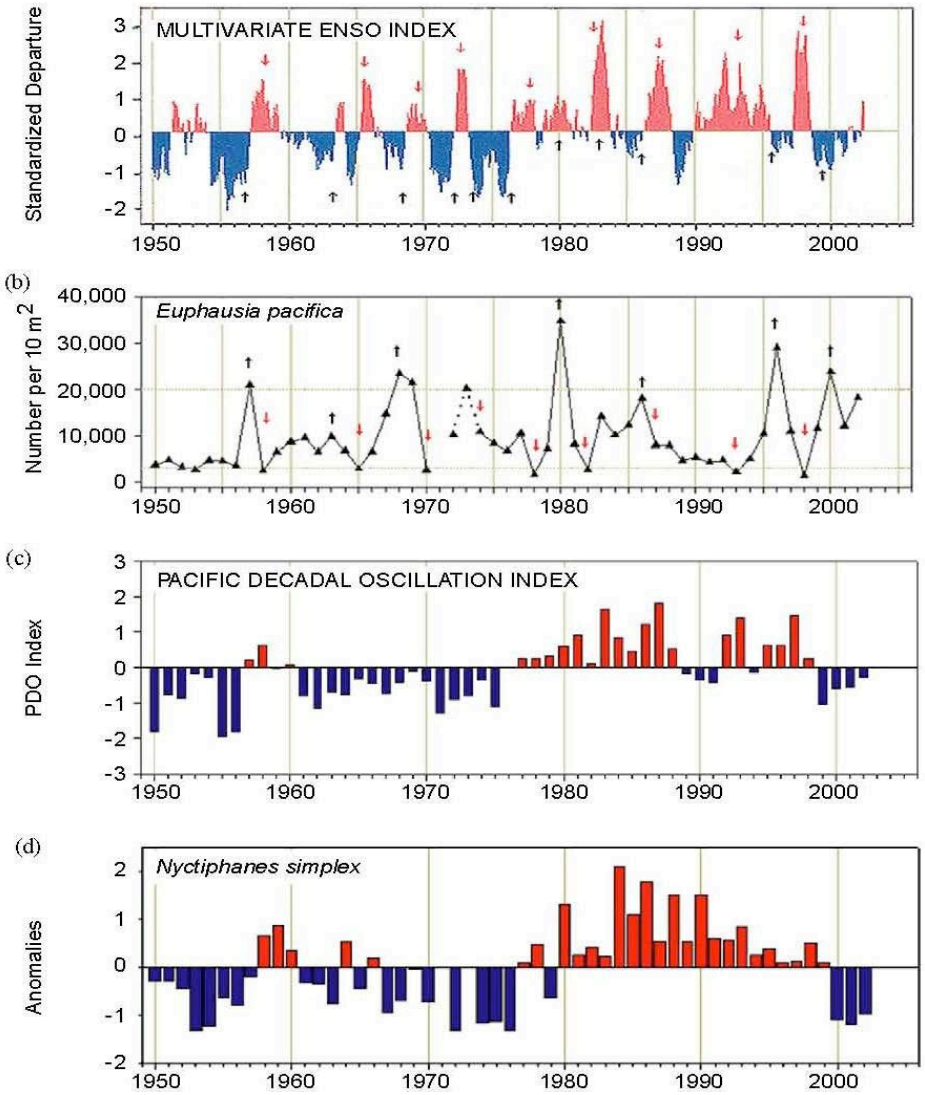


cf Fu et al., 2009

CALCOFI Station Plan



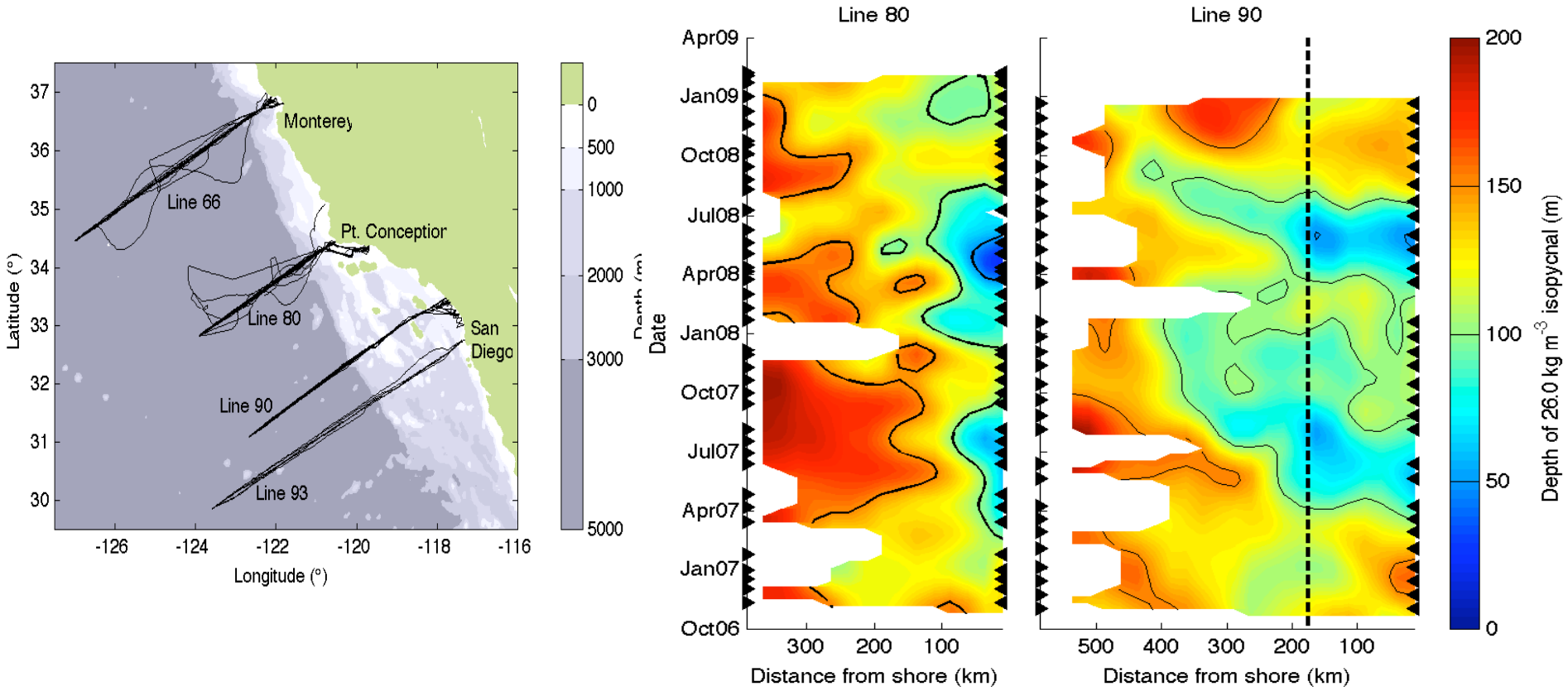
Koslow et al., 2009



Brinton and Townsend2003

cf Koslow et al., 2009

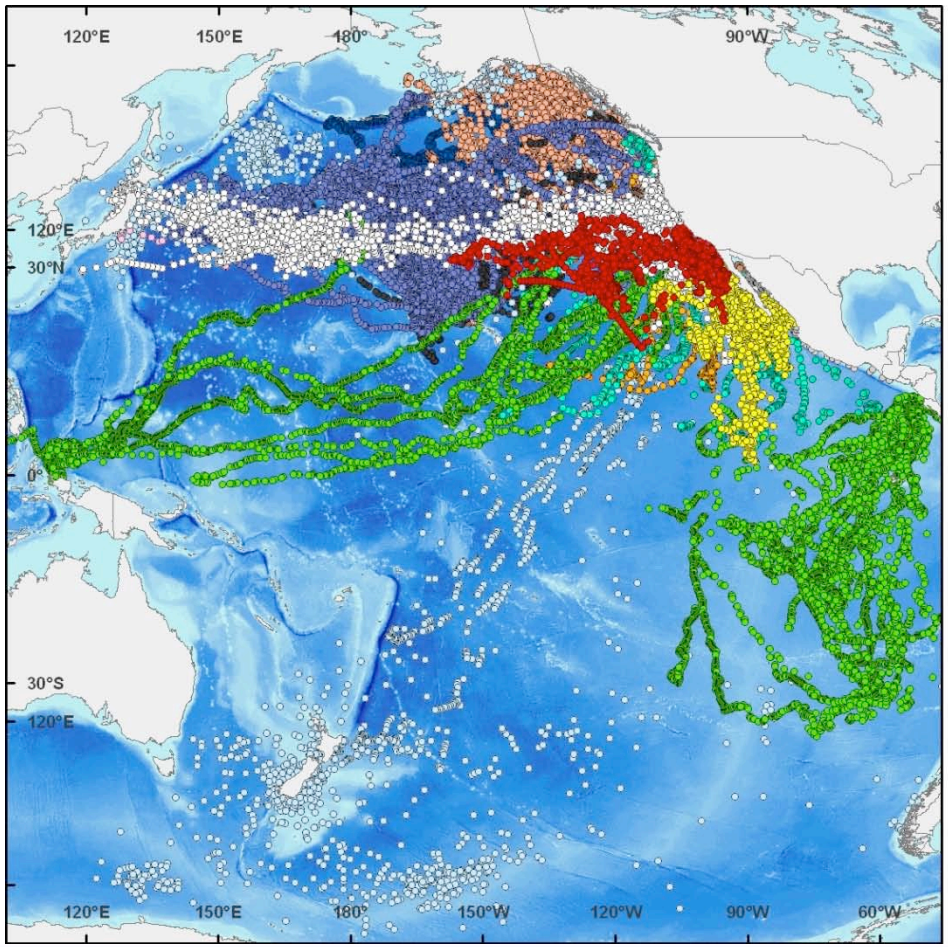
Glider Transects (0-1000m) 9/05-4/09



cf Testor et al., 2009

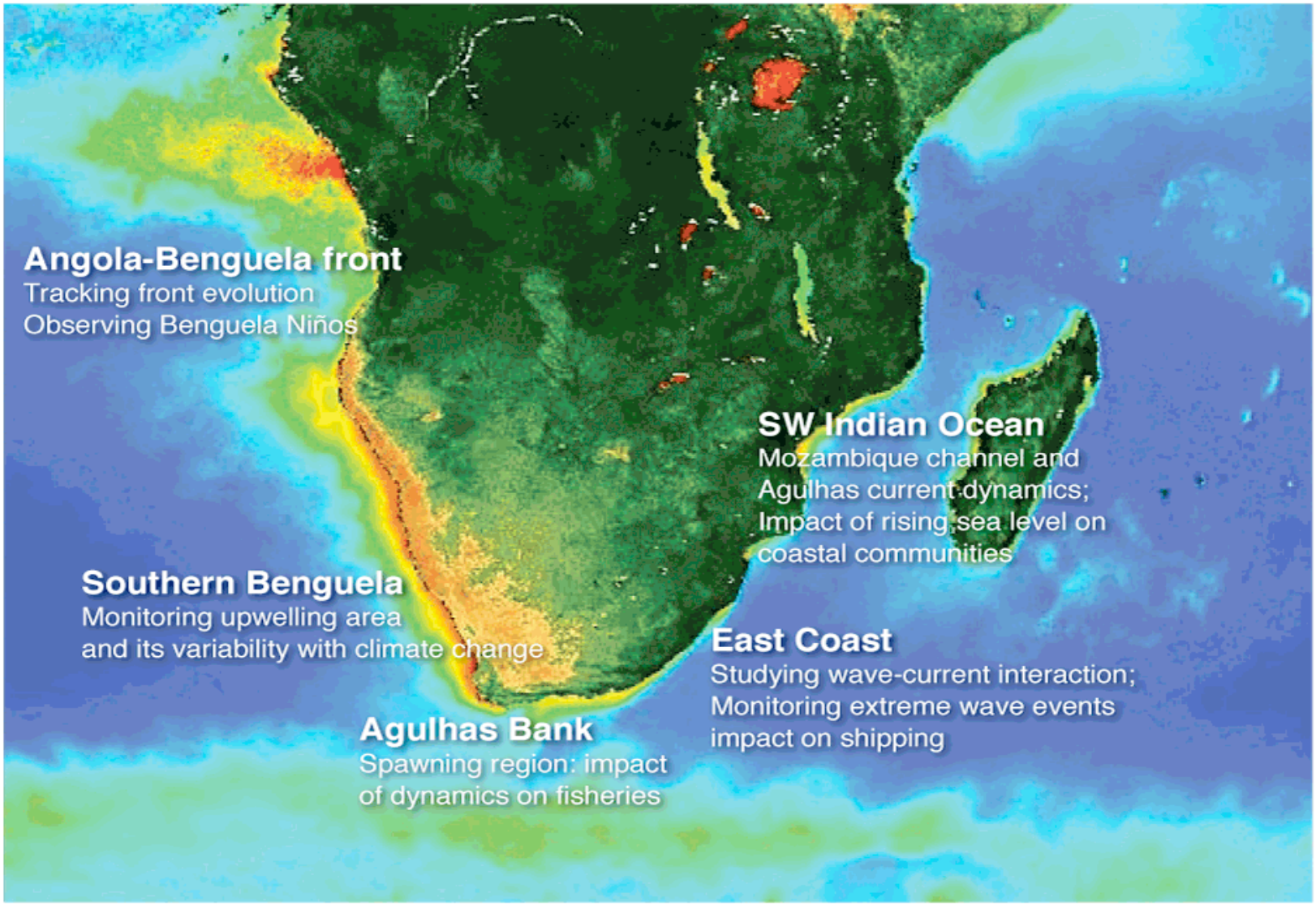
Sustainable Management

Tagging of Pacific Pelagic (TOPP) a field program of the Census of Marine Life



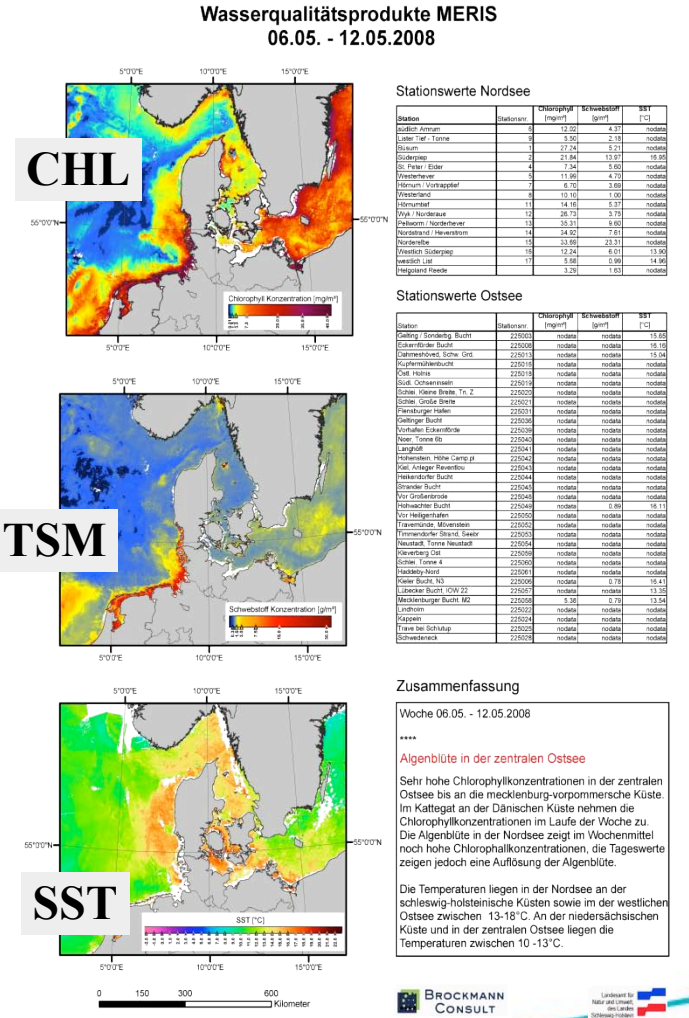
- Black-footed Albatross
- Blue Whale
- California Sea Lion
- Humpback Whale
- Laysan Albatross
- Northern Elephant Seal
- Sooty Shearwater
- Albacore
- Blue Shark
- Humboldt Squid
- Leatherback Turtle
- Loggerhead Turtle
- Mako Shark
- Mola
- Pacific Bluefin
- Salmon Shark
- Thresher Shark
- White Shark
- Yellowfin Tuna

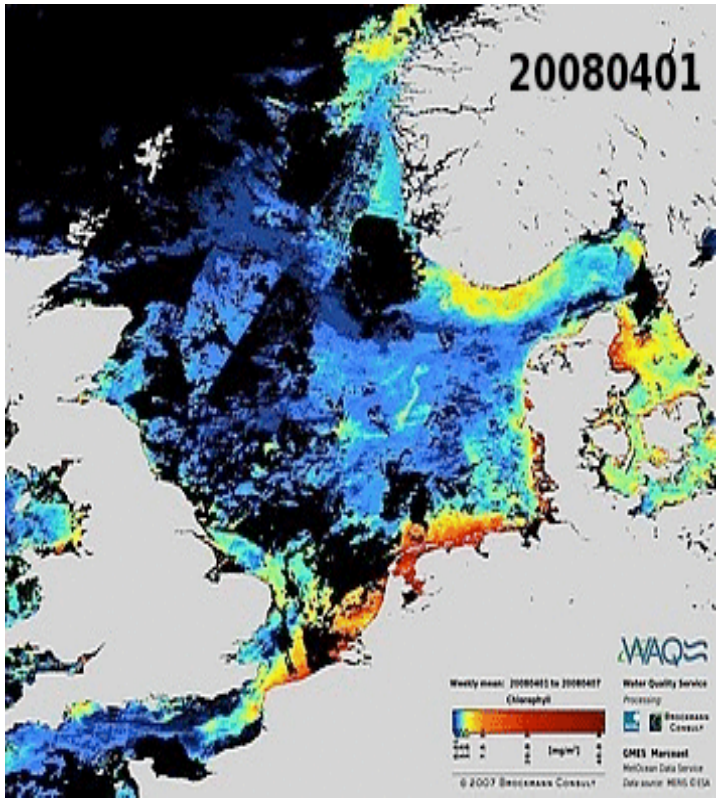
cf Costa et al., 2009



Cipollini et al., 2009

Water Quality Products to local monitoring authorities in Germany



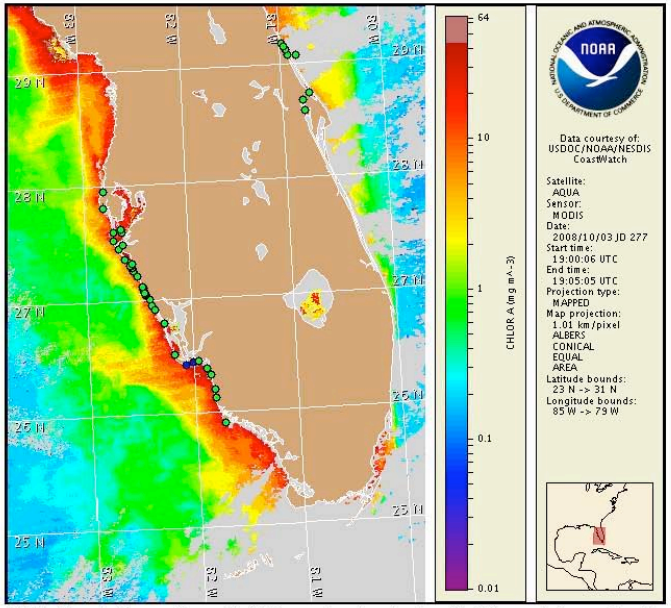


Algal bloom in the North Sea

MarCoast
a GMES Services Network

Gulf of Mexico Harmful Algal Bloom Bulletin

Region: South Florida
6 October 2008
NOAA Ocean Service
NOAA Satellites and Information Service
NOAA National Weather Service
Last bulletin: October 2, 2008



Satellite chlorophyll image with possible HAB areas shown by red polygon(s). Cell concentration sampling data from September 26 to October 1 shown as red (high), orange (medium), yellow (low b), brown (low a), blue(very low b), purple (very low a), pink (present), and green (not present). For a list of cell count data providers and a key to the cell concentration categories, please see the HABFS bulletin guide:

http://tidesandcurrents.noaa.gov/hab/habfs_bulletin_guide.pdf

Please note the following restrictions on all SeaWiFS imagery derived from CoastWatch.

1. Data are restricted to civil marine applications only; i.e. federal, state, and local government use/distribution is permitted.
2. Image products may be published in newspapers. Any other publishing arrangements must receive GeoEye approval via the CoastWatch Program.

Conditions Report

A harmful algal bloom has been identified in southern Lee County. Patchy very low impacts are possible in the eastern Sanibel Island region Monday night and Tuesday night through Thursday. No other impacts are expected alongshore southwest Florida today through Thursday, October 9.

Analysis

A harmful algal bloom has been confirmed in southern Lee County. 'Very Low b' concentrations of *Karenia brevis* were identified onshore Sanibel Island, Lee County (Tarpon Beach and Lighthouse Beach) on 10/1 (FWRI). Background concentrations were also reported onshore near New Pass in Sarasota County on 9/29 (MML). No additional *K. brevis* was identified alongshore southwest Florida from Pinellas to Collier Counties, or offshore southwest Florida from Manatee to Lee Counties, in the past week (SCHD, FWRI, MML; 9/29-10/3).

Recent MODIS imagery indicates that chlorophyll levels significantly intensified offshore southern Lee and northern Collier Counties (up to ~12 miles) between 10/1 and 10/3. High chlorophyll levels (>10μg/L) are visible near Sanibel Island (from 26°25'25"N 82°2'54"W eastward to 26°25'14"N 81°58'39"W and northeast to 26°26'49"N 81°57'21"W); and additionally alongshore southern Lee to northern Collier County (south to 26°12'19"N 81°50'52"W). A larger elevated to high (greater than 3μg/L) chlorophyll feature is visible up to ~114 miles west and southwest of Sanibel Island. High chlorophyll levels (>10μg/L) are also visible alongshore Gasparilla Island and Cayo Costa in northern Lee County. Sampling is highly recommended in each of these locations.

Conditions were favorable over the weekend for further intensification of the existing bloom in the Sanibel Island region and for bloom formation elsewhere along southwest Florida. Further intensification of the bloom is possible through Thursday. Slight southerly transport is possible today through Wednesday.

Bulletins will now be issued twice weekly on Monday and Thursday while harmful bloom conditions remain.

Please note that due to technical difficulties, SeaWiFS imagery is temporarily unavailable for display in this bulletin; MODIS imagery is shown on pages 1 and 3 of this bulletin.

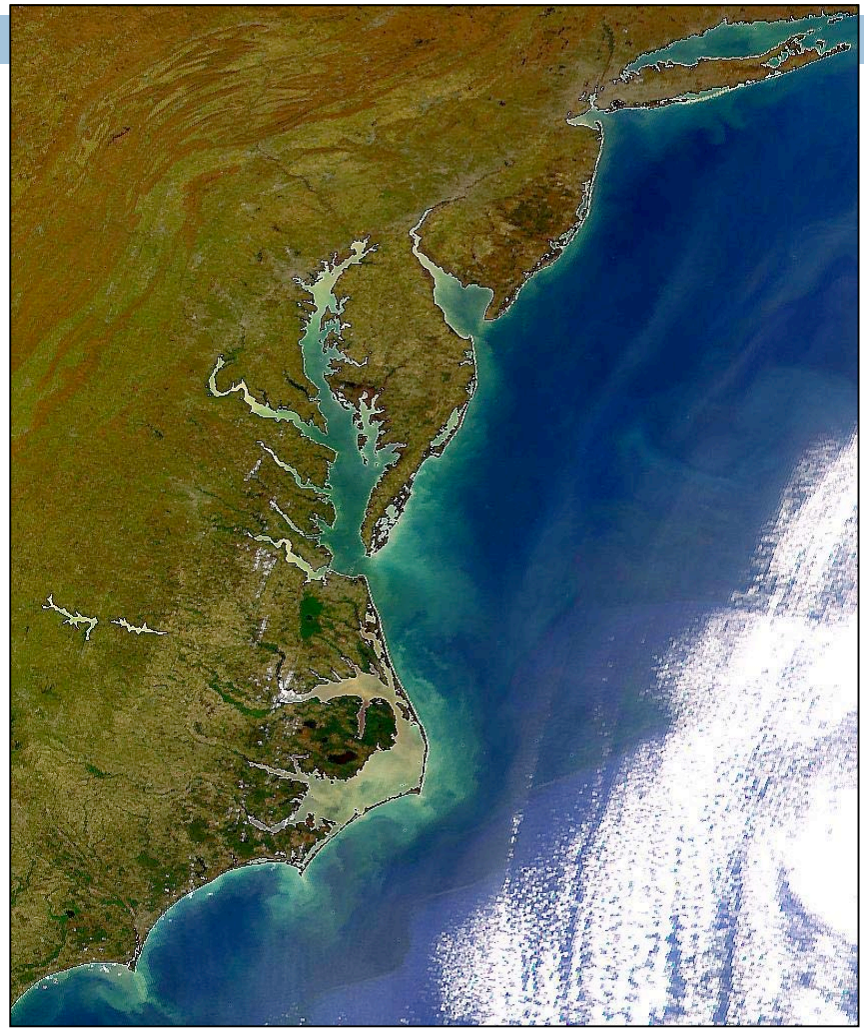
~Fisher, Fenstermacher, Gan

Beegle-Krause et al., 2009

Conkright et al., 2009

Chesapeake Bay Forecast System: A Regional Earth System Model

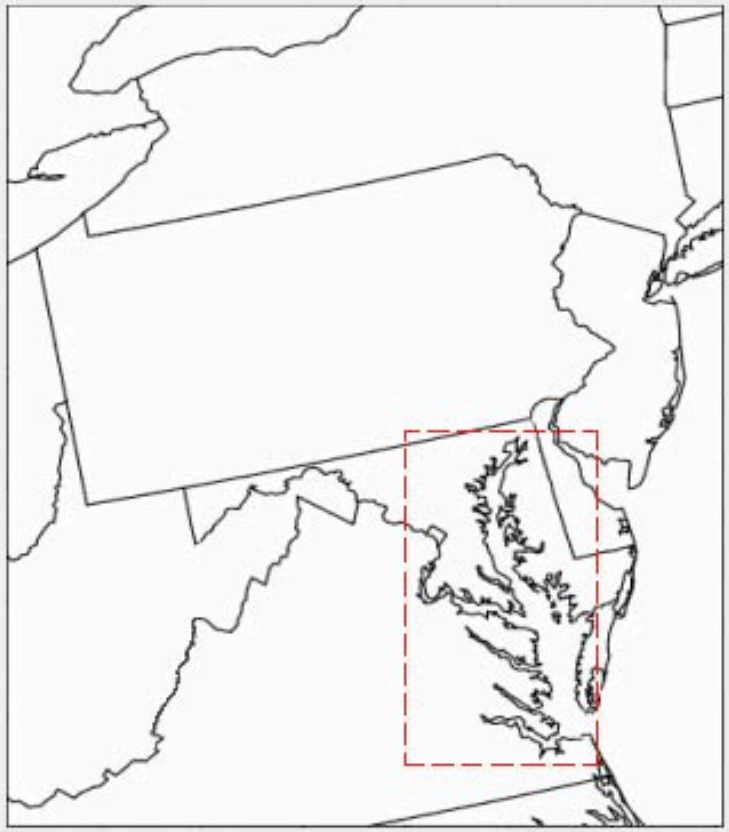
- **Objective:** Develop a fully integrated model of the Chesapeake Bay and its air and watershed
- **Purpose:**
  - Near-Real Time Applications: Nowcasting and forecasting of the Bay circulation, ecosystem, pathogens, harmful algal blooms, waves and inundation.
  - Climate Projections: Estimating effect of climate change, between now and 2050, on the health of the Bay and its watershed.
  - Provide a decision making tool for users



Murtugudde, 2009

Chesapeake Bay Forecast Tool Main Window

Chesapeake Bay Forecast Tool



Set the region

Time Scale

0 months

20 years

Compute

Output Variables

- [ ] Sealevel
- [ ] Storm surge
- [ ] Land coverage
- [ ] Fish / Crabs
- [ ] Air quality
- [ ] Winds
- [ ] Precipitation
- [x] Phosphorus
- [x] Oxygen
- [x] Nitrogen
- [ ] Temperature
- [ ] Salinity
- [x] Algae bloom
- [x] Sea nettles

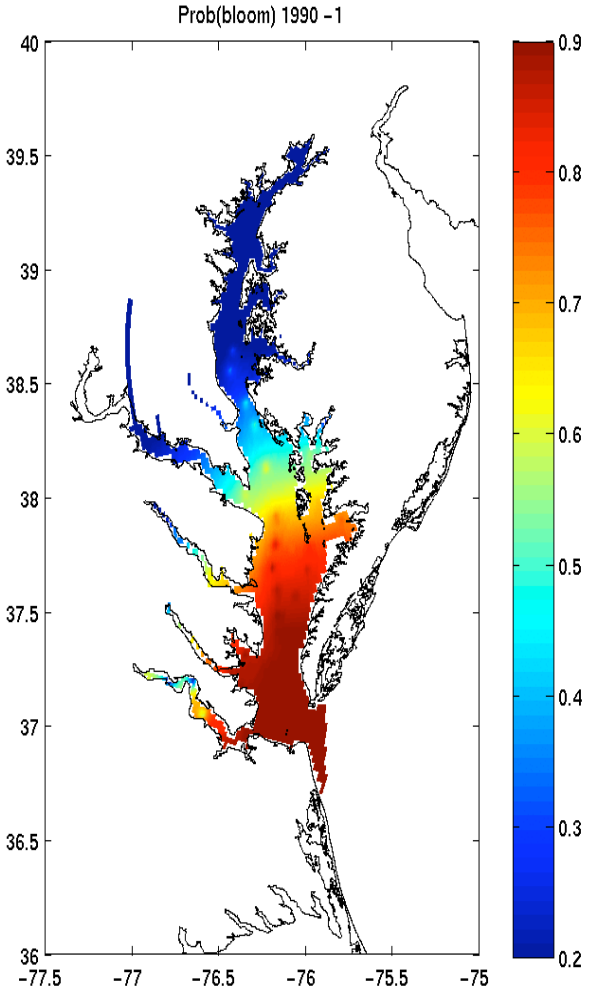
Input Variables

- ( ) Population density
- ( ) CO2 pollution
- ( ) Hi/low prognosis
- (•) Land use
- ( ) Stream runoff
- ( ) Agricultural mix

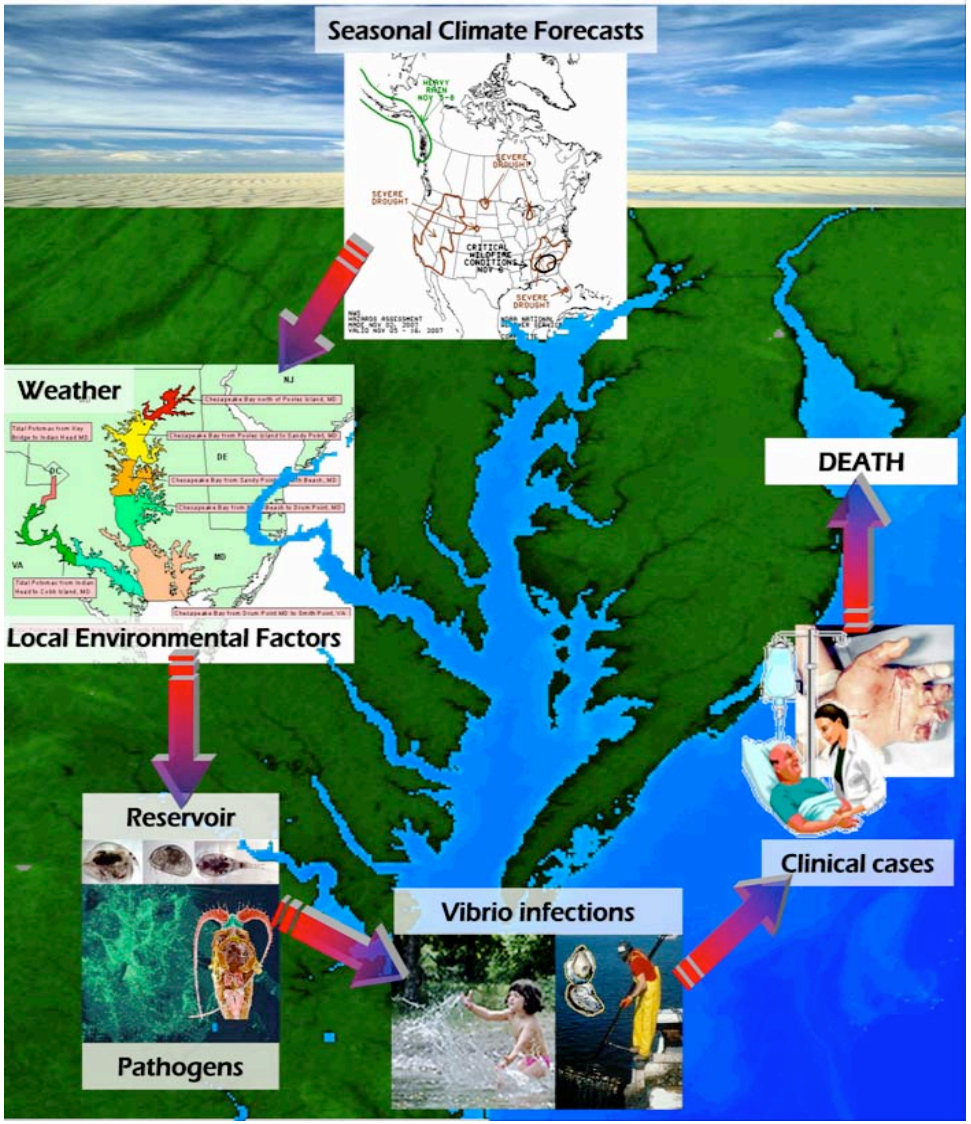
Working with the users

- **“Pilot Applications of the Chesapeake Bay Forecast System: Forecasting Future Drinking Water in an Urbanizing Warmer World”**
  - Opportunity to forecast how changes in climate can influence the transport of nutrients, metals and Pathogens, and serve as a resource for water quality managers and decision makers
- **A habitat suitability forecasting model for Chesapeake Bay’s striped bass population**
  - Produce and validate a forecast model of striped bass recruitment using output from the CBFS
- **Pilot User Collaboration for Harmful Algae Forecasts in MD Chesapeake Bay**
  - The objectives of this study are to assess the skill of the Chesapeake Bay Forecast system, CBFS, model in regards to harmful algae blooms, HABs, and to refine the habitat suitability model for *Karlodinium* associated with cryptophyte abundance.
- **Chesapeake Community Modeling Program proposal for CBFS applications**
  - The CCMP proposes to work in coordination with various Chesapeake Bay watershed groups and River Keepers to determine how they can best benefit from output from the CBFS and similar environmental models. We feel that organizations such as these could be major users of modeled data.

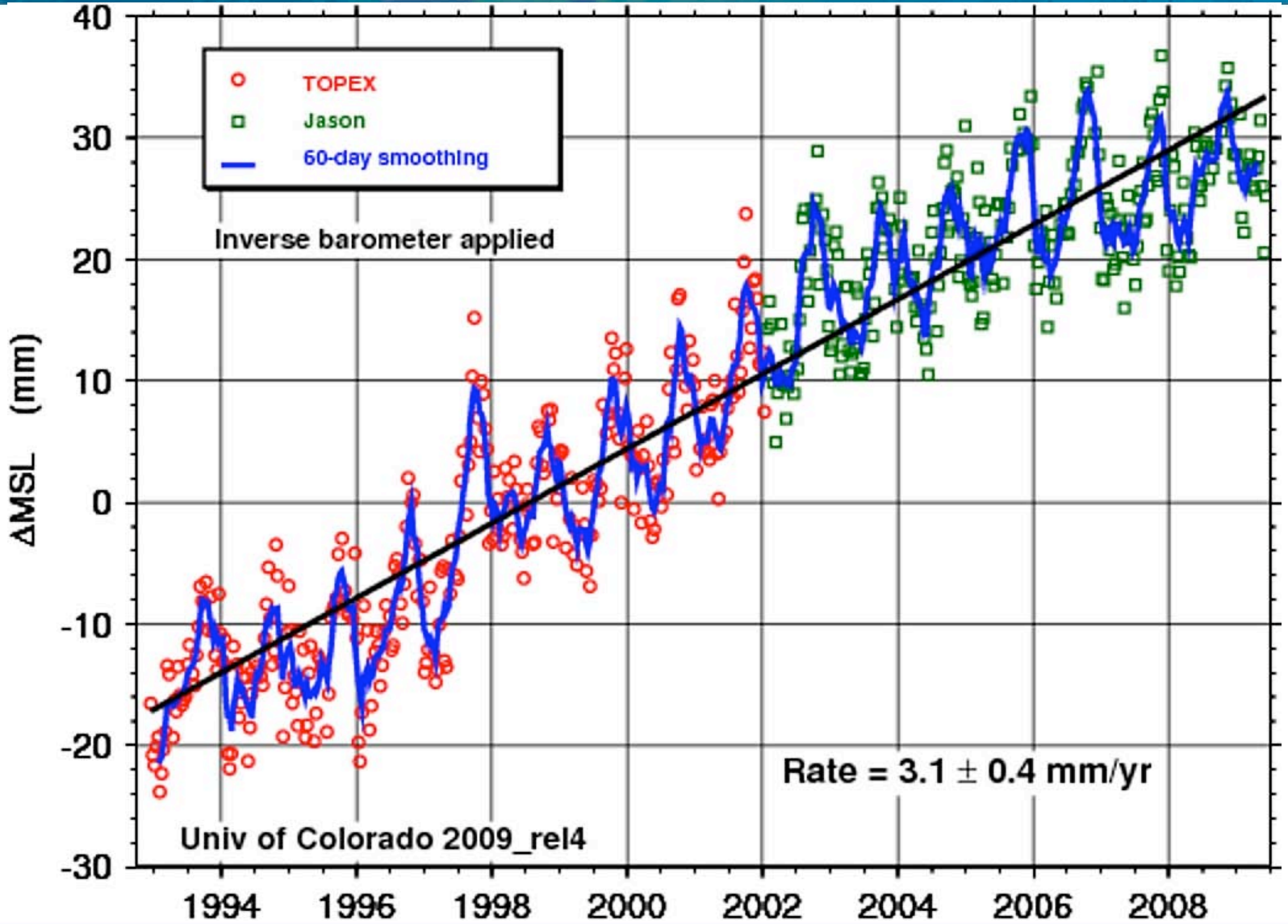
An End-to-End Early Warning System: Can we provide reliable early warning? Some need just two week advanced warning to save lives.



Murtugudde, 2009

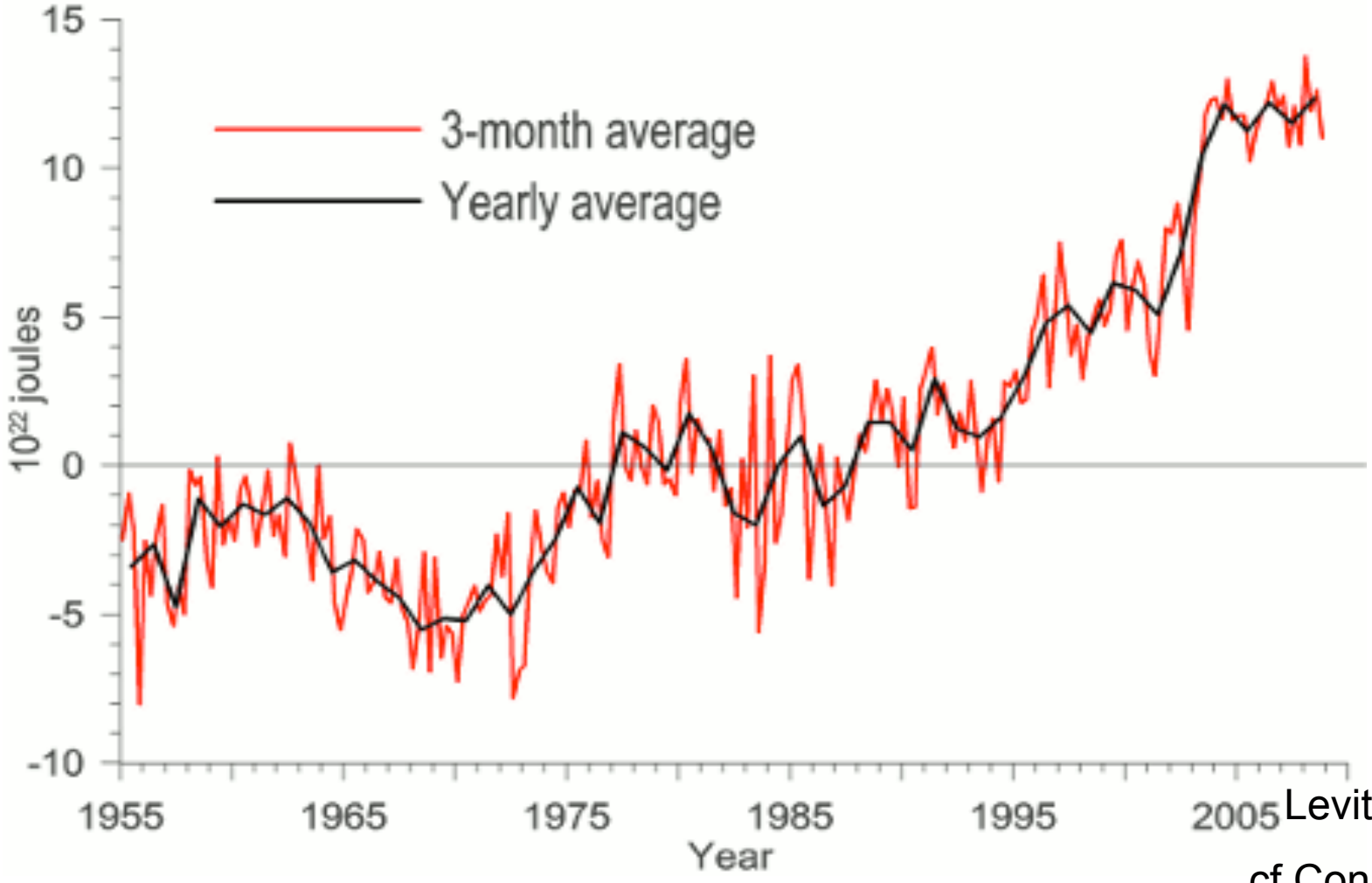


Longer Term Trends



cf Nerem et al, 2009

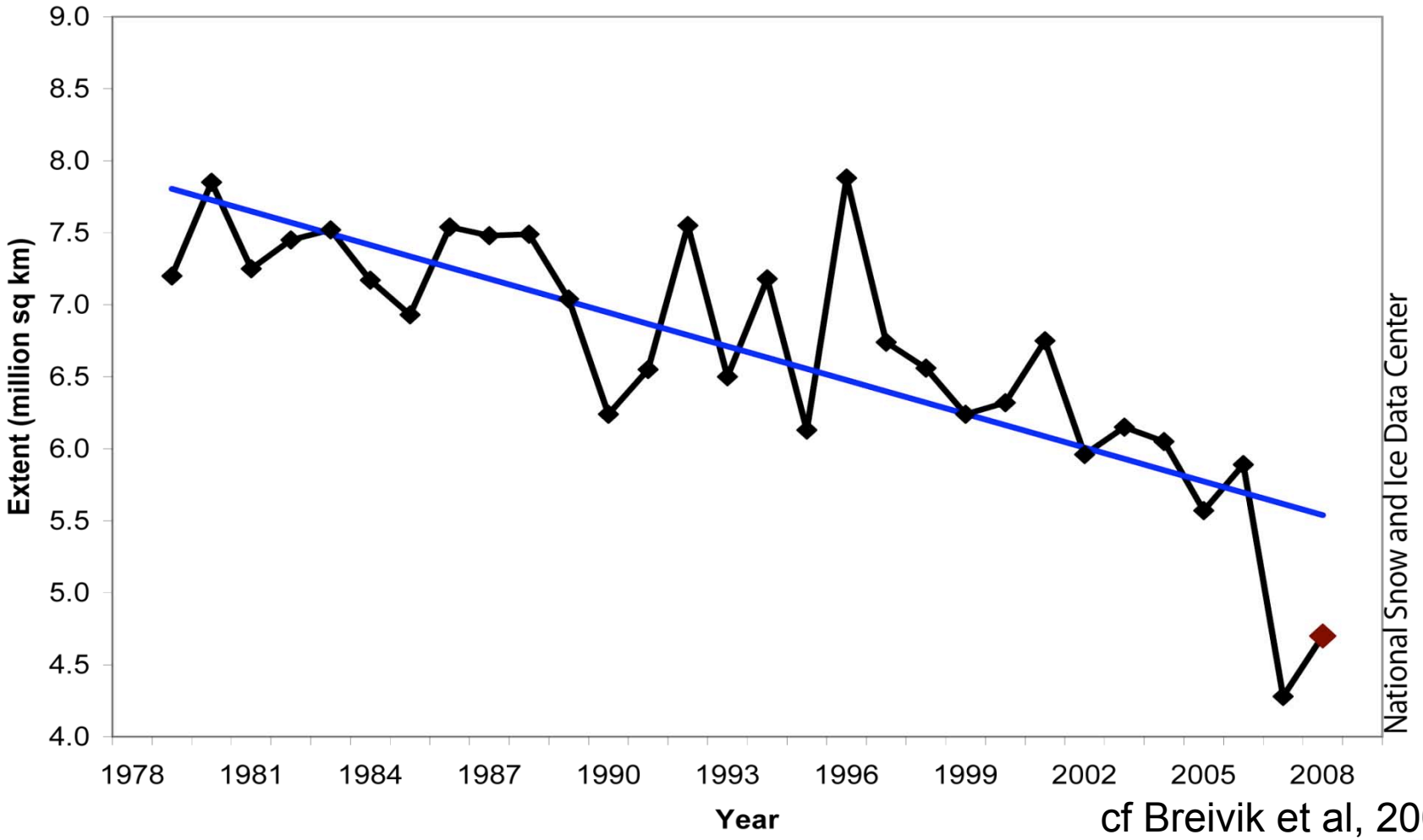
Global Ocean Heat Content



Levitus et al., 2009

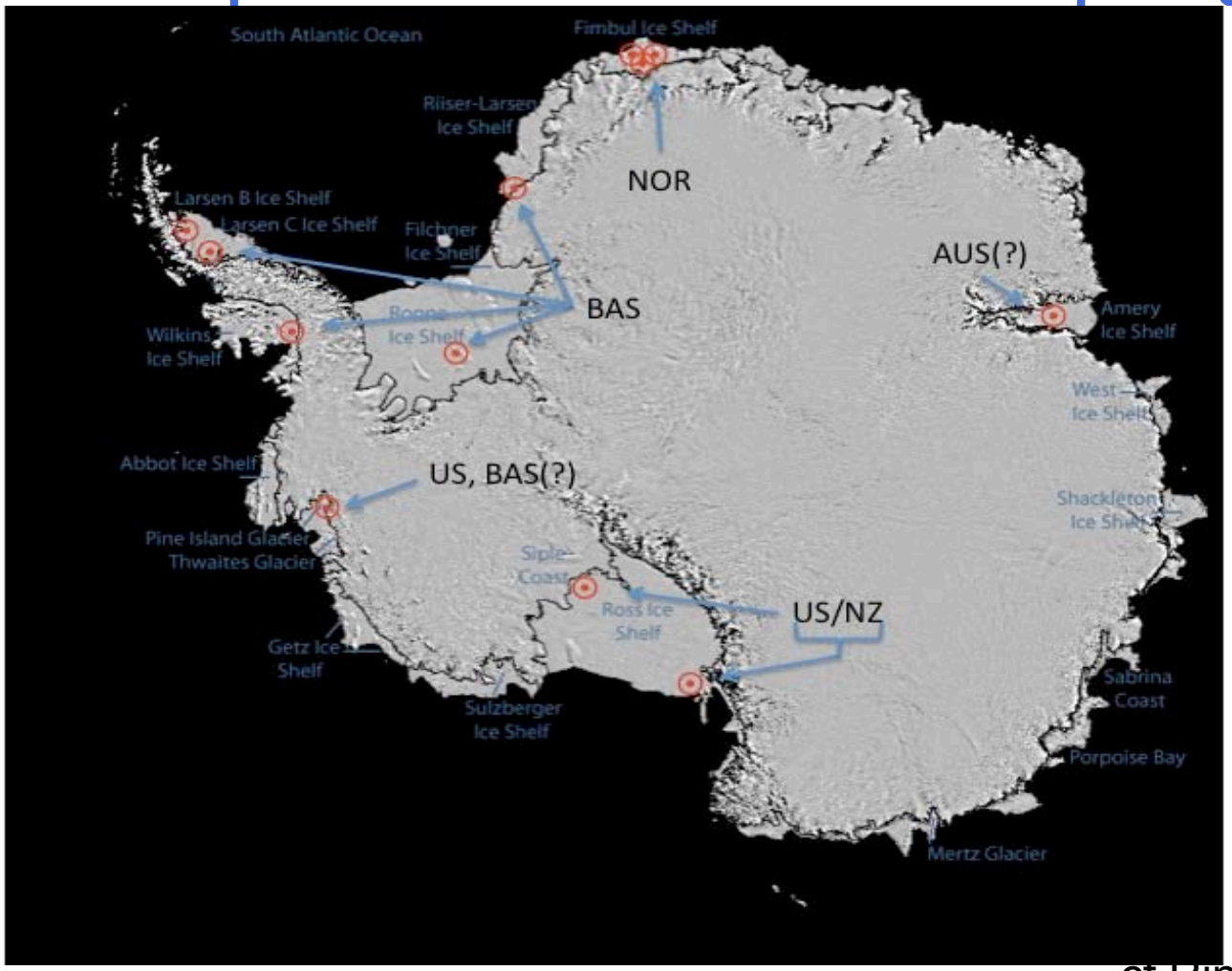
cf Conkright et al., 2009

Arctic Sea Ice Extent



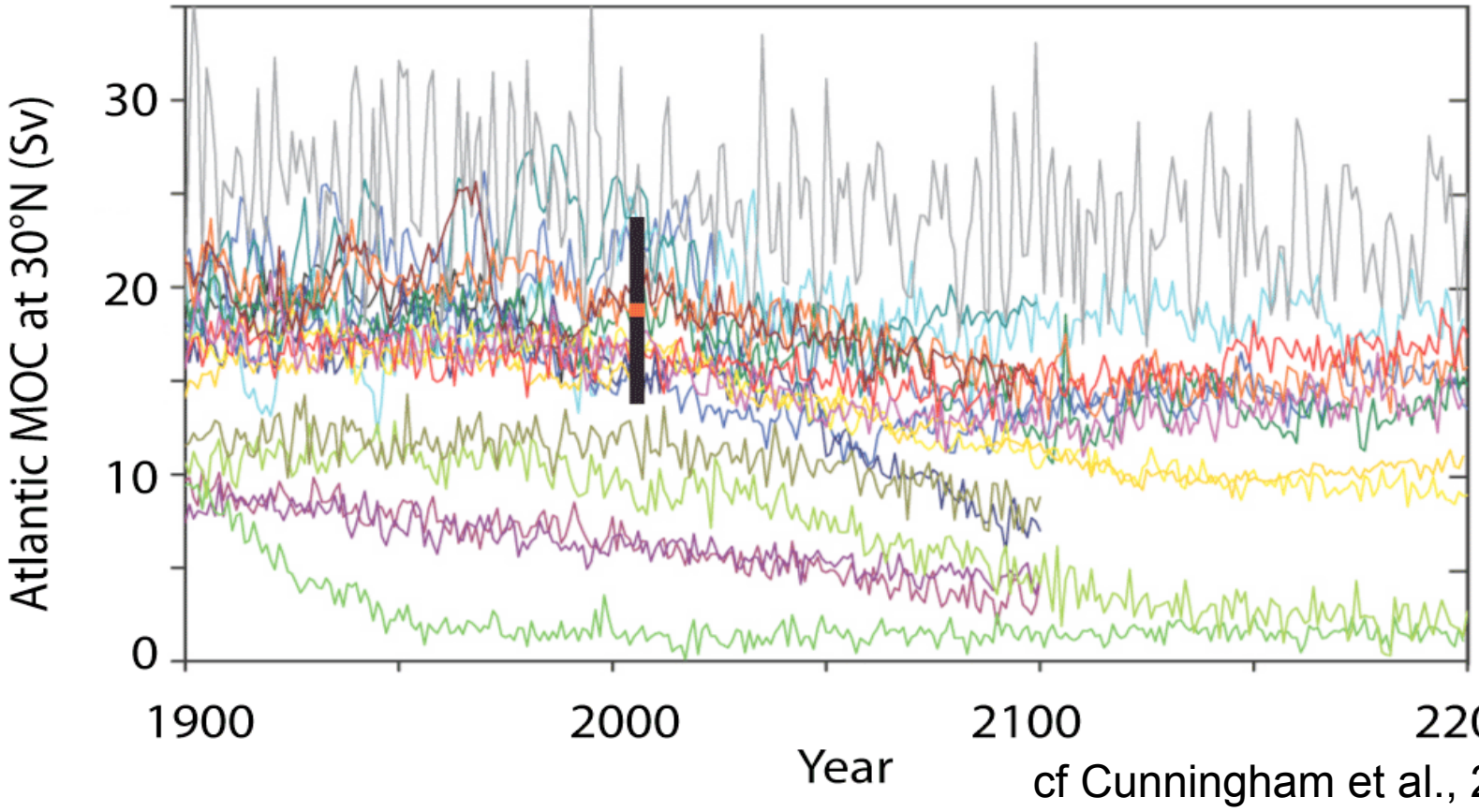
cf Breivik et al, 2009

Proposed Ice Shelf Sampling



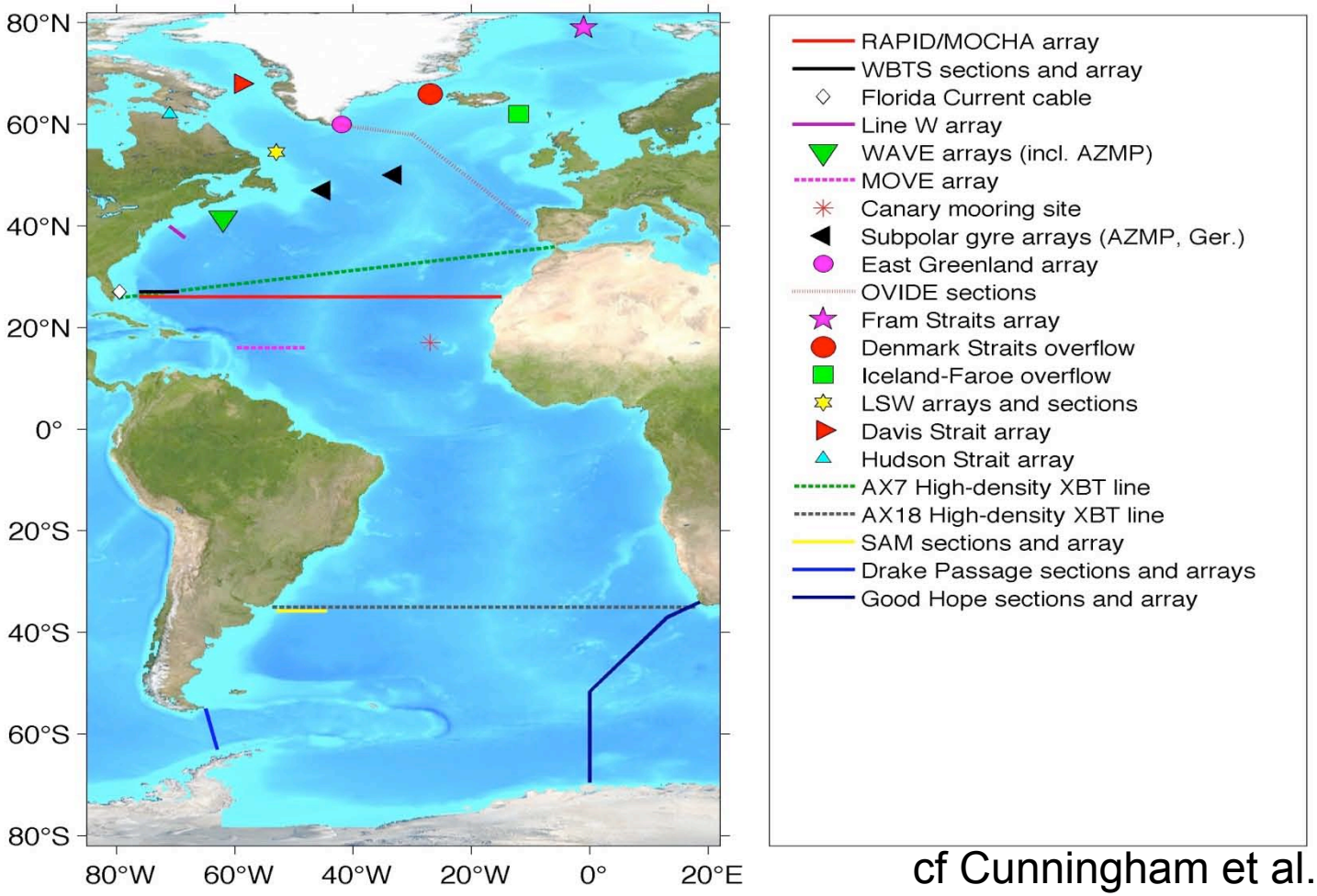
cf Rintoul et al., 2009

Evolution of the Atlantic meridional overturning circulation (AMOC) at 30°N



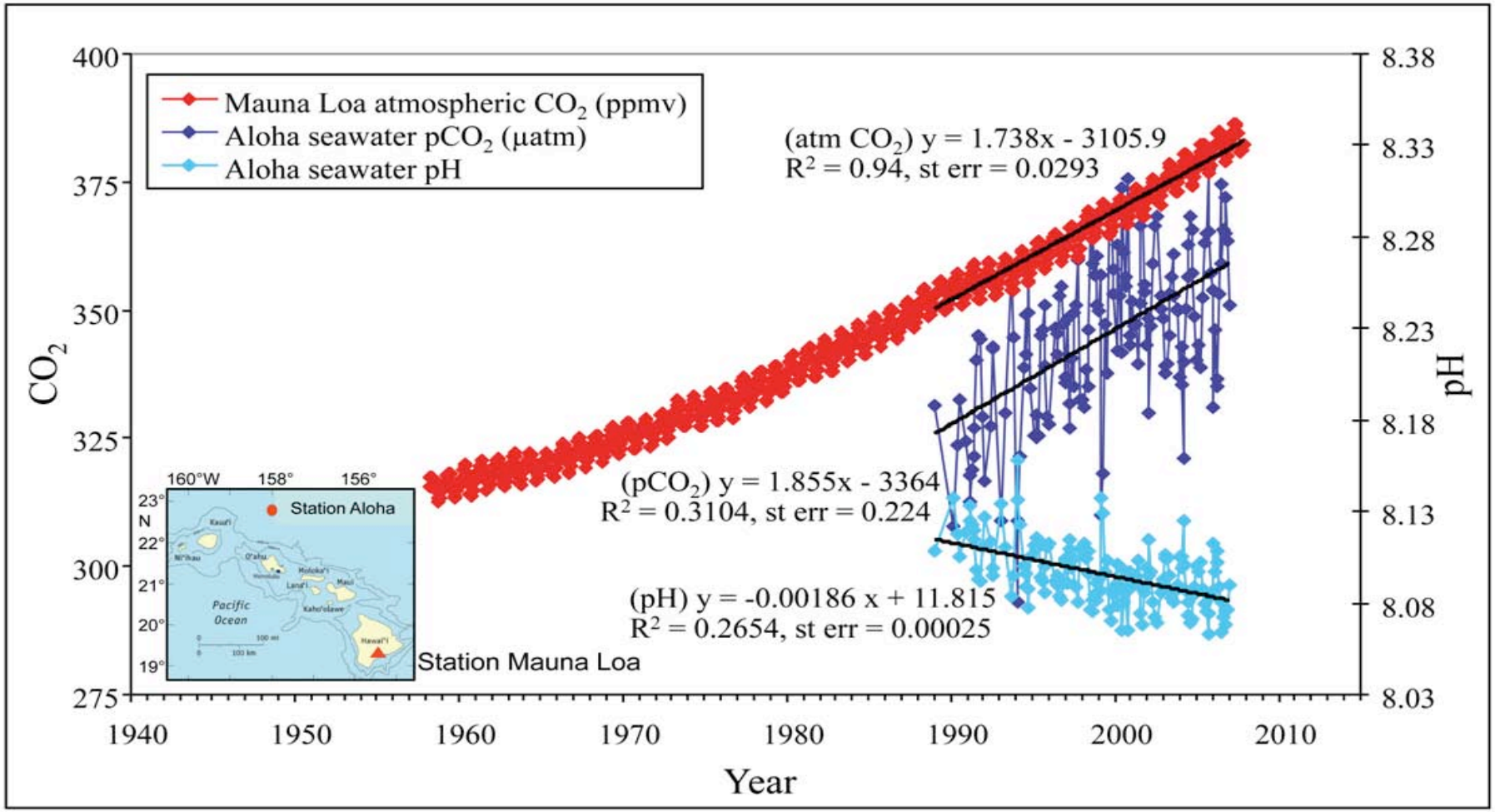
cf Cunningham et al., 2009

AMOC Measurement Programs



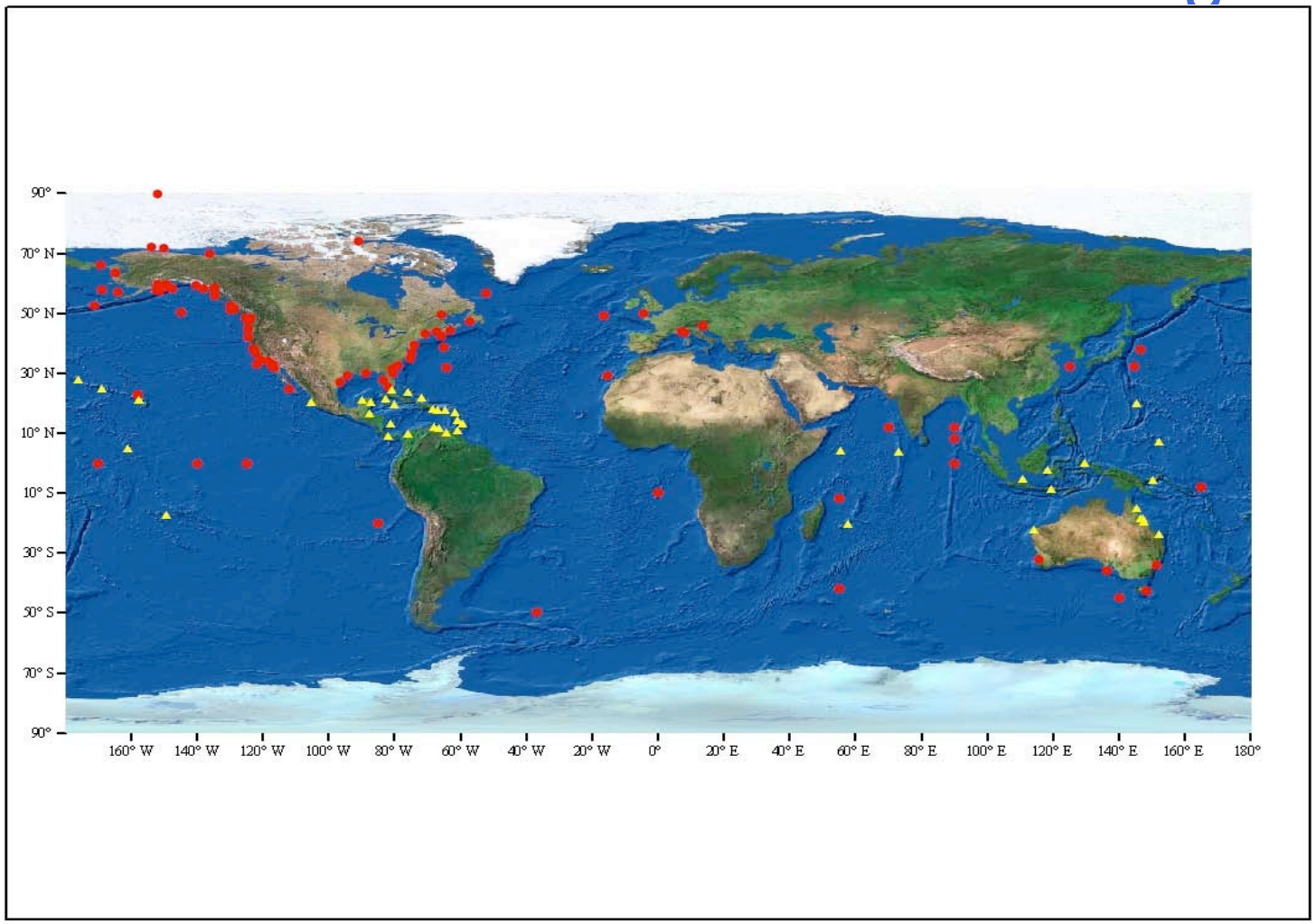
cf Cunningham et al., 2009

CO_2 Time Series in the North Pacific Ocean



cf Feely et al, 2009

Potential ocean acidification monitoring sites



Feely et al., 2009

Summary

- Much of the vision of OceanObs '99 has been realized
- Real-time global ocean coverage, cultural shift
- Enabled nascent marine core service activities
- Initial broadening in scope of observing system
- Deficiencies of our understanding at high latitudes
- Long way to go for Marine Forecasting - Sustainable Management in the larger sense

Challenges

- Sustaining today's global observations
- Initiating marine core services, ocean component of climate services
- Linking/bridging blue+brown water
  - SLR example
- Expanding the observational suite up from and beyond phys ocn with biogeochemistry
- Ocean carbon cycle, impact of acidification on marine life
- Increased emphasis of ocean obs in climate prediction
  - Decadal prediction
- Greater engagement with end users

Grazie a tutti