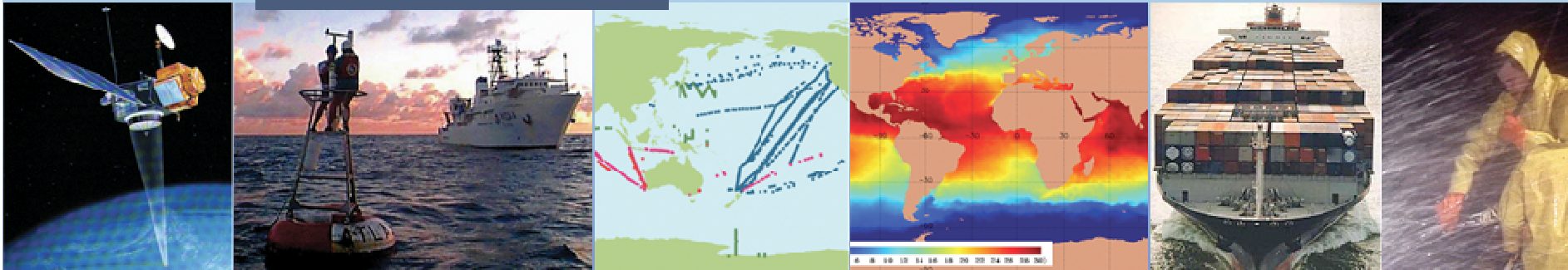


GOOS

IODE

jcomm

OCEANOGRAPHY & MARINE METEOROLOGY



Keith Alverson

Ocean Observations and Services

Intergovernmental Oceanographic Commission of UNESCO

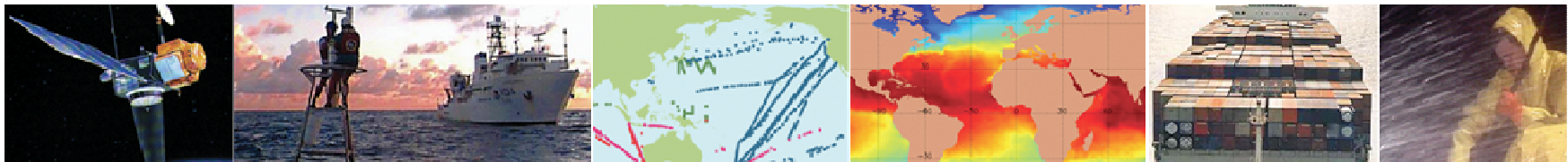




Major Accomplishments 2005-2010: Global Ocean Climate Observations

- The ocean observing system for climate is 60% complete.
- Reporting to UNFCCC ensures high visibility and national engagement.
- Understanding of global climate change – particularly detection and attribution - has been substantially enhanced.
- Development of a Global Framework for Climate Services is being enabled.

EUROPE: is **directly** affected by regional impacts of global climate variability and change and **indirectly** affected through socio-economic impacts such as human migration, calls for adaptation funding, etc.

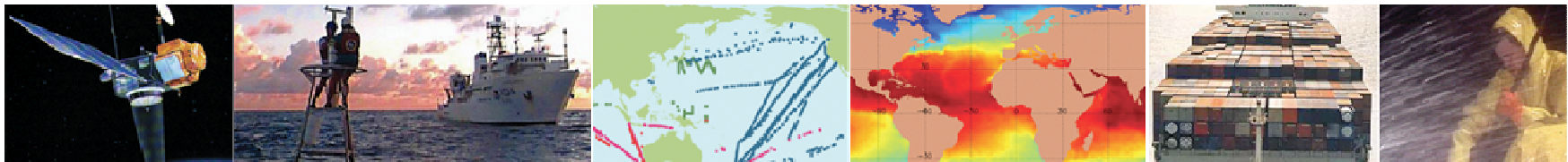


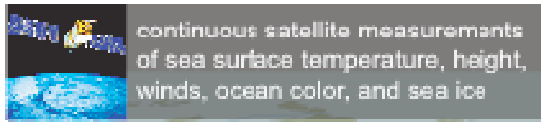


Major Accomplishments 2005-2010: Regional Observations for Societal Benefit

- Relevant regional components of the GOOS are increasingly available in real time, enabling coastal hazard warnings and mitigation (eg. oil spills, storm surges, tsunami, cholera ...).
- Seasonal products derived from ocean observations are also starting to become possible (eg ENSO, Monsoon, drought, flooding and fire regime forecasts).
- Quotidian services are being delivered (eg. Shipping and Port traffic optimization, offshore wind and drilling operations supported ...)

EUROPE: provides a stellar example of a strong and effective GOOS regional alliance (I-OOS in the US and IMOS in Australia are single-nation systems).

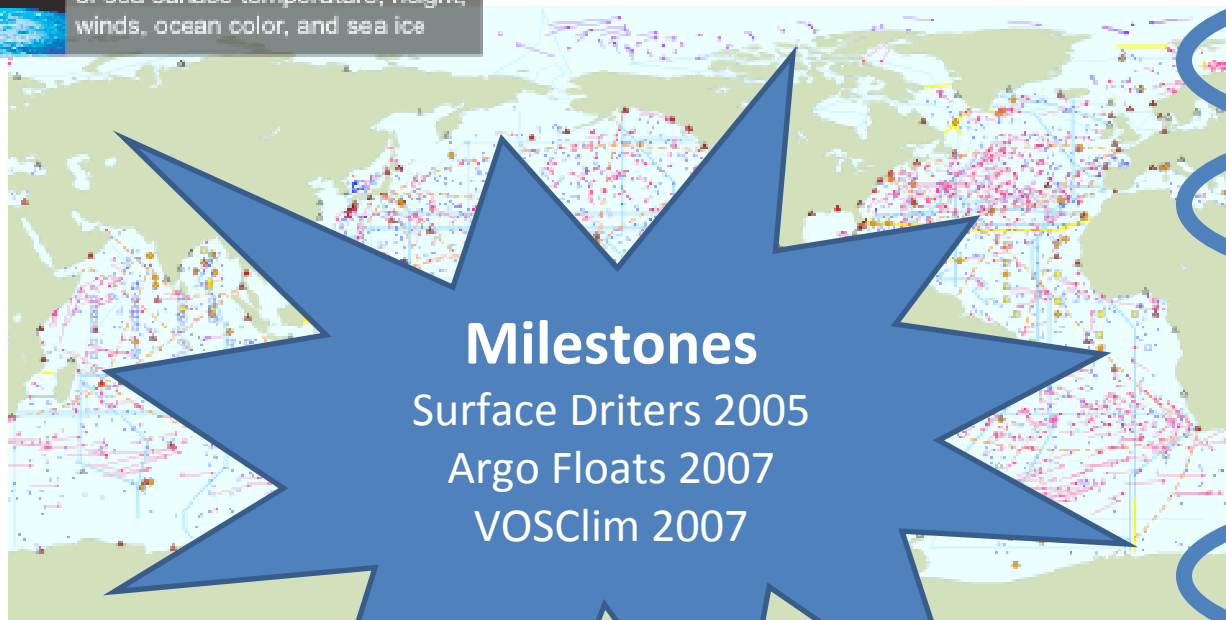




lots of *in situ* networks

62%

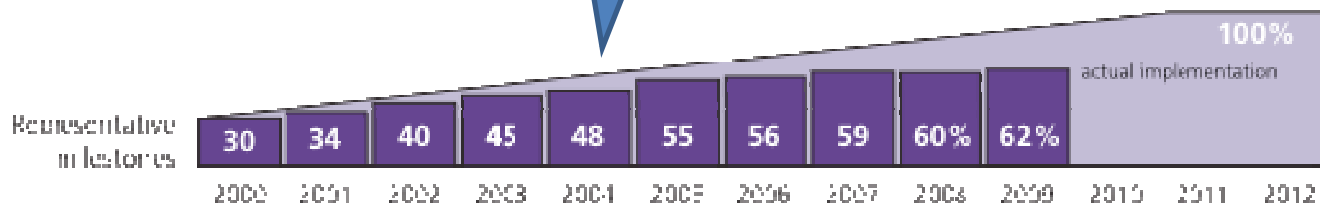
January 2010



Milestones
 Surface Drifters 2005
 Argo Floats 2007
 VOSclim 2007

- 100% Surface measurements from volunteer ships (VOS)
 - 250 ships in VOSclim pilot project
- 100% Global drifting surface buoy array
 - 3000 buoys array, 1000 floats
 - floats range around 1000 km subset of GLOSS core network
- 59% Tropical moored buoy network
 - 170 moored buoys in tropical oceans
- 80% XBT sub-surface temperature section network
 - 5000 XBTs deployed
- 100% Argo profiling float network
 - 3000 floats in global array, 3000 floats
- 62% Global hydrography and carbon inventory
 - Full-term survey in 10 years

Transport monitoring 34%
 29%
 40%
 73% tropical moored buoy network
 113 moorings planned

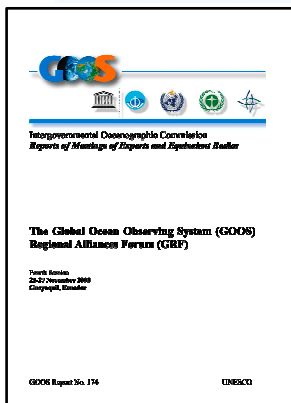
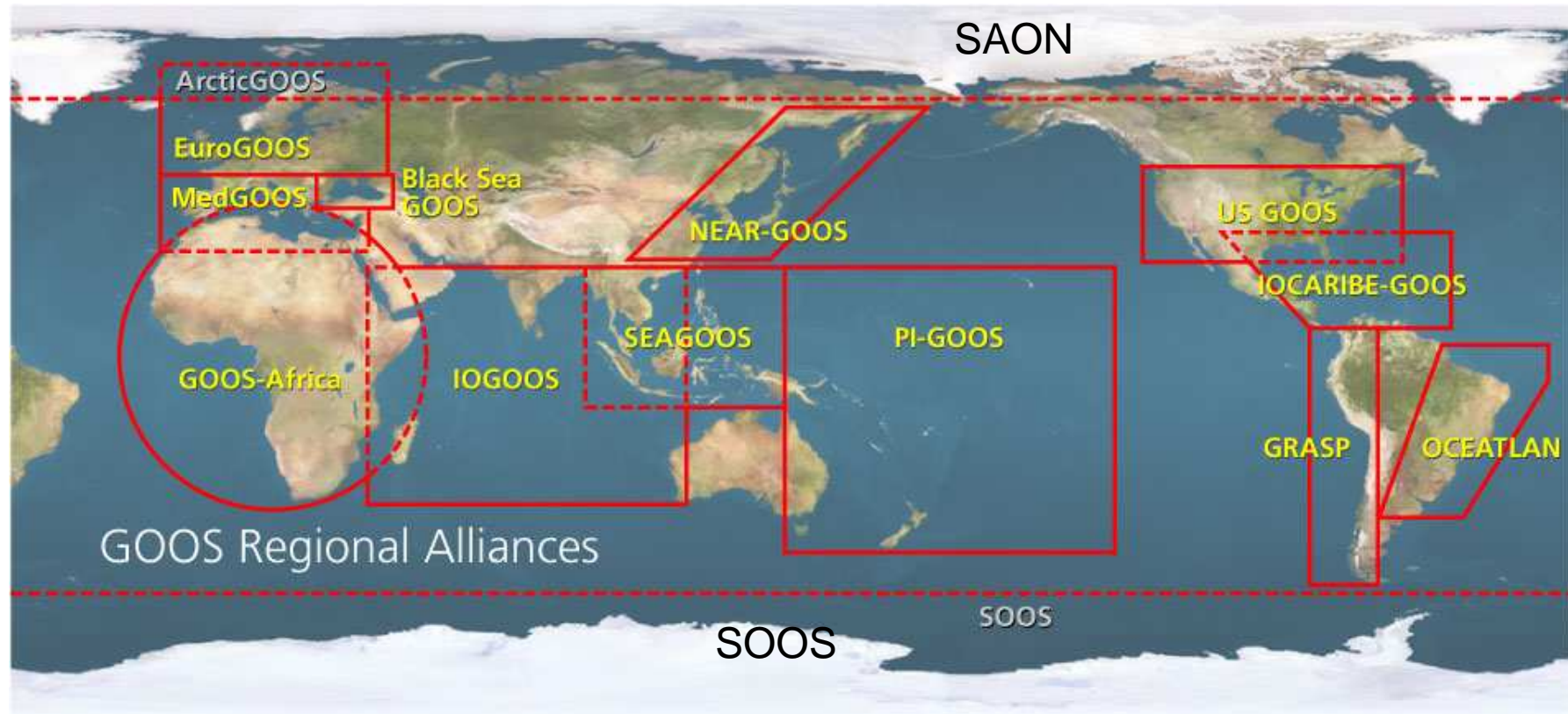


of annual... to full implementation by 2012

System % of initial goals



Implementing Coastal and Regional GOOS



1st GOOS Regional Forum, Athens, Greece, 2002

2nd GRA Forum, Nadi, Fiji, 2004

3rd GRA Forum, Cape Town, S. Africa, 2006

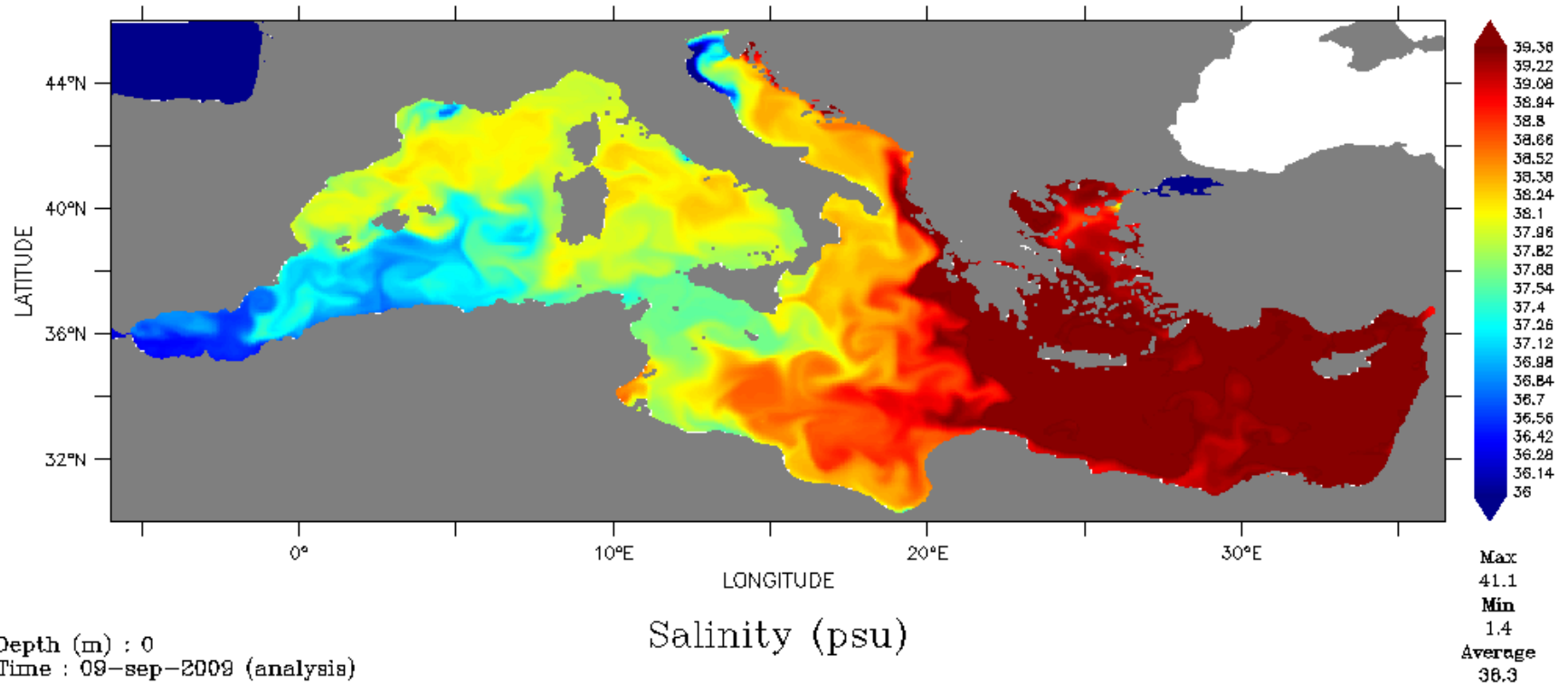
4th GRA Forum, Guayaquil, Ecuador, 2008

5th GRA Forum and 1st Regional Council, Sopot,



Regional Products

Mercator_Ocean_PSY2V3 1/12 deg
Mediterranean_Sea



Near real time ocean conditions (t, s, and currents) are now freely available on the web, and widely used. These products depend on data streams from the observing system (eg. www.mercator-ocean.fr)





An Example of a National System: The Australian Integrated Marine Observing System (www.imos.org.au)

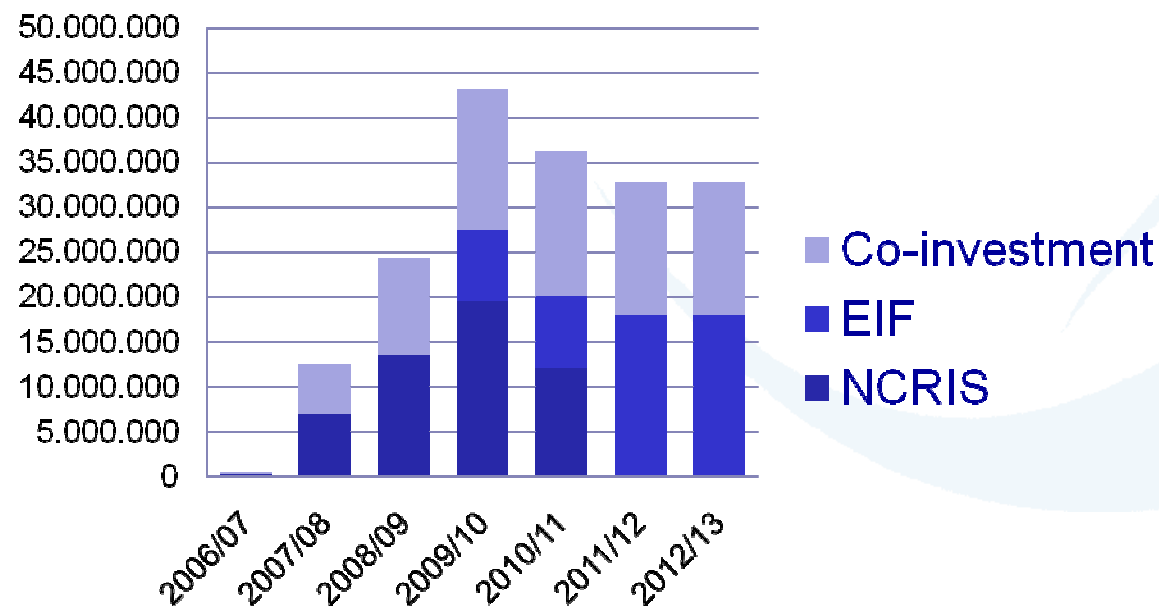
Thanks:

Nick D'Adamo, Director, IOC Perth Regional Office (N.D'Adamo@bom.gov.au)

Katy Hill, IMOS Scientific Officer (Katy.Hill@imos.org.au)

The bottom line

- Core funding from the Australian Government
 - \$102M over ~six years (\$50M 'NCRIS' and \$52M 'EIF')
- Co-investment by Partners
 - Operators, other Australian Govt. Programs, State Govt's
 - ~\$78M cash and in-kind (40+%)
- Ramp up to 2009-10, then levelling out at ~\$35M pa



IMOS Facilities (there are 11)

1. Argo Floats

- autonomous profiling floats

2. Ships of Opportunity

- repeat underway observing on volunteer ships
- physical, chemical and biological observations

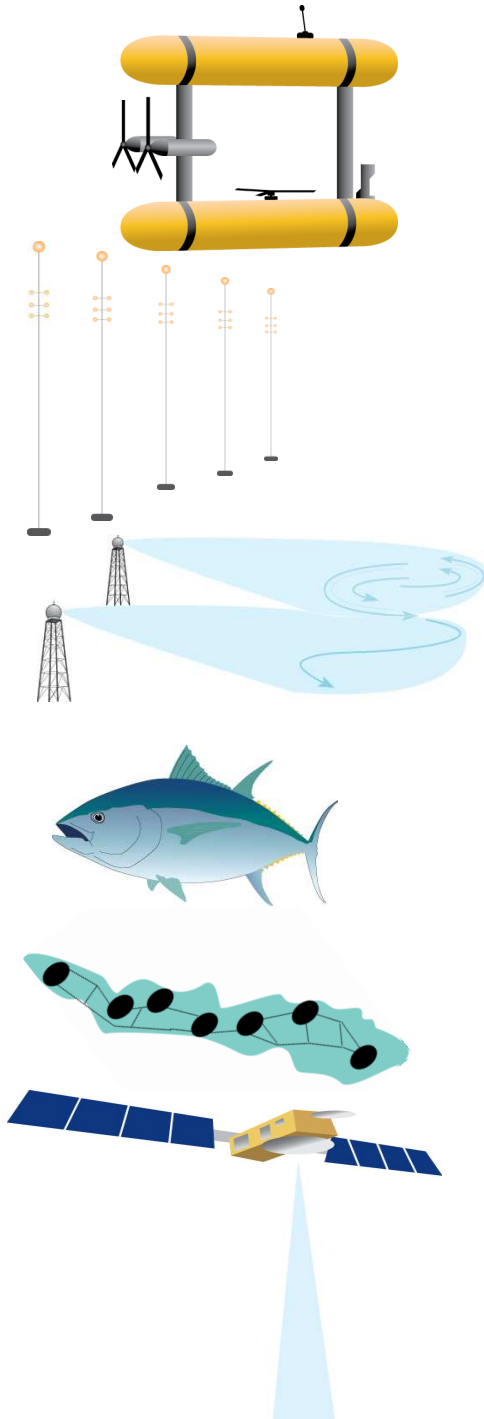
3. Deepwater Moorings

- existing: Southern Ocean Time Series (47°S)
- planned: Antarctic Coast (Adelie), Indonesian Through Flow, East Australian Current (26°S)

4. Ocean Gliders

- coastal and open ocean





5. Autonomous Underwater Vehicle

- benthic surveys

6. National Moorings Network

- National Reference Stations (nine)
- shelf moorings and arrays

7. Coastal Radar Network

- phased array and direction finding

8. Tagging Marine Creatures

- Acoustic curtains and satellite tags

9. Sensor Networks

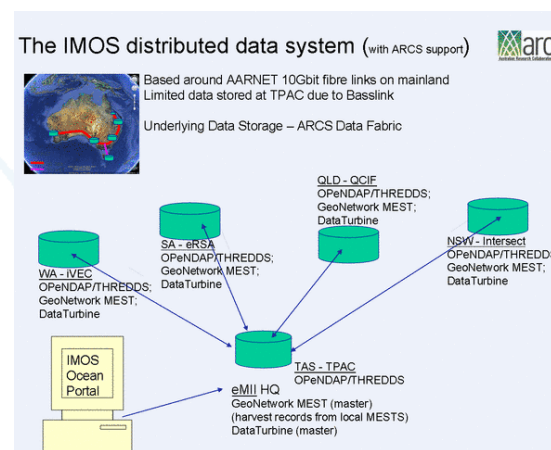
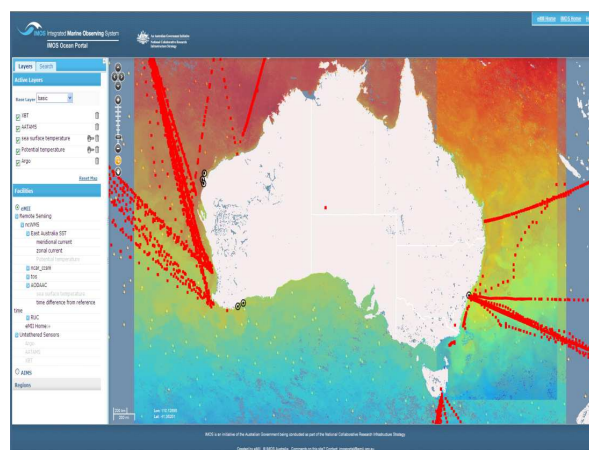
- southern Great Barrier Reef

10. Satellite Remote Sensing

- SST, altimetry (planned), and ocean colour

11. electronic Marine Information Infrastructure (eMII)

- Facility responsible for creating and developing the information infrastructure
 - to make all data discoverable and accessible
 - via the IMOS Ocean Portal <http://imos.aodn.org.au/webportal/>
- ~10% of core funding invested in this activity
- Opportunity to use this infrastructure to create a larger Australian Ocean Data Network (AODN)
 - providing access to IMOS and non-IMOS data
 - *'publicly-funded data, publicly available'*



Six IMOS Nodes

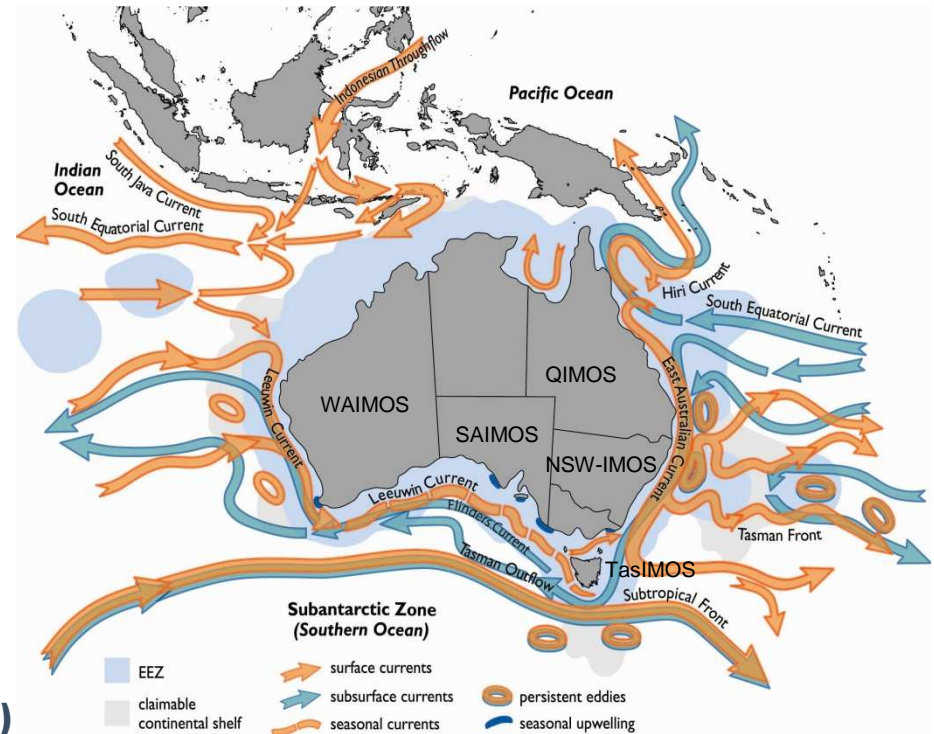
- **Bluewater and Climate Node**

- open ocean focus

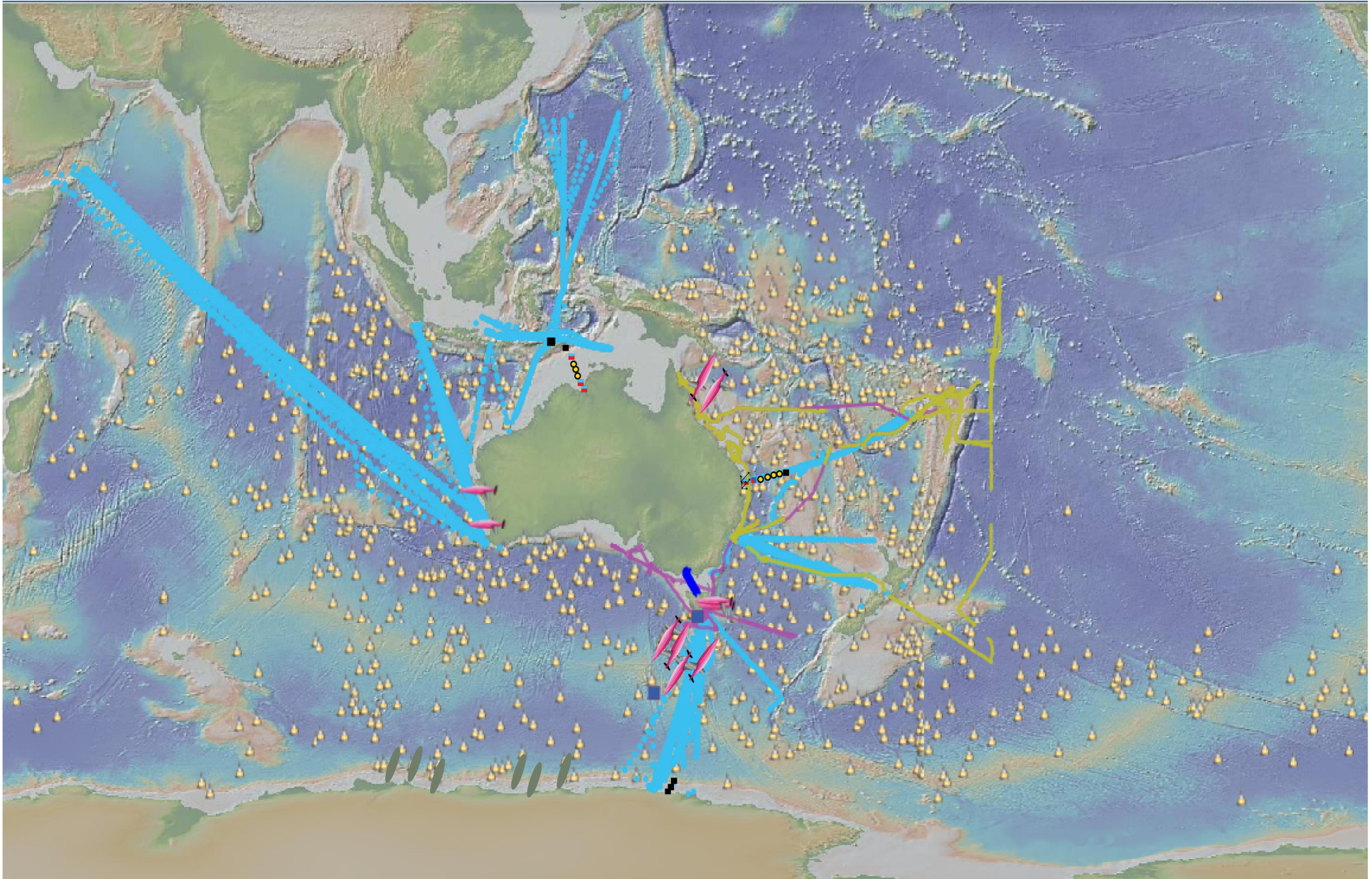
- **Five Regional Nodes**

- continental shelf and coastal focus

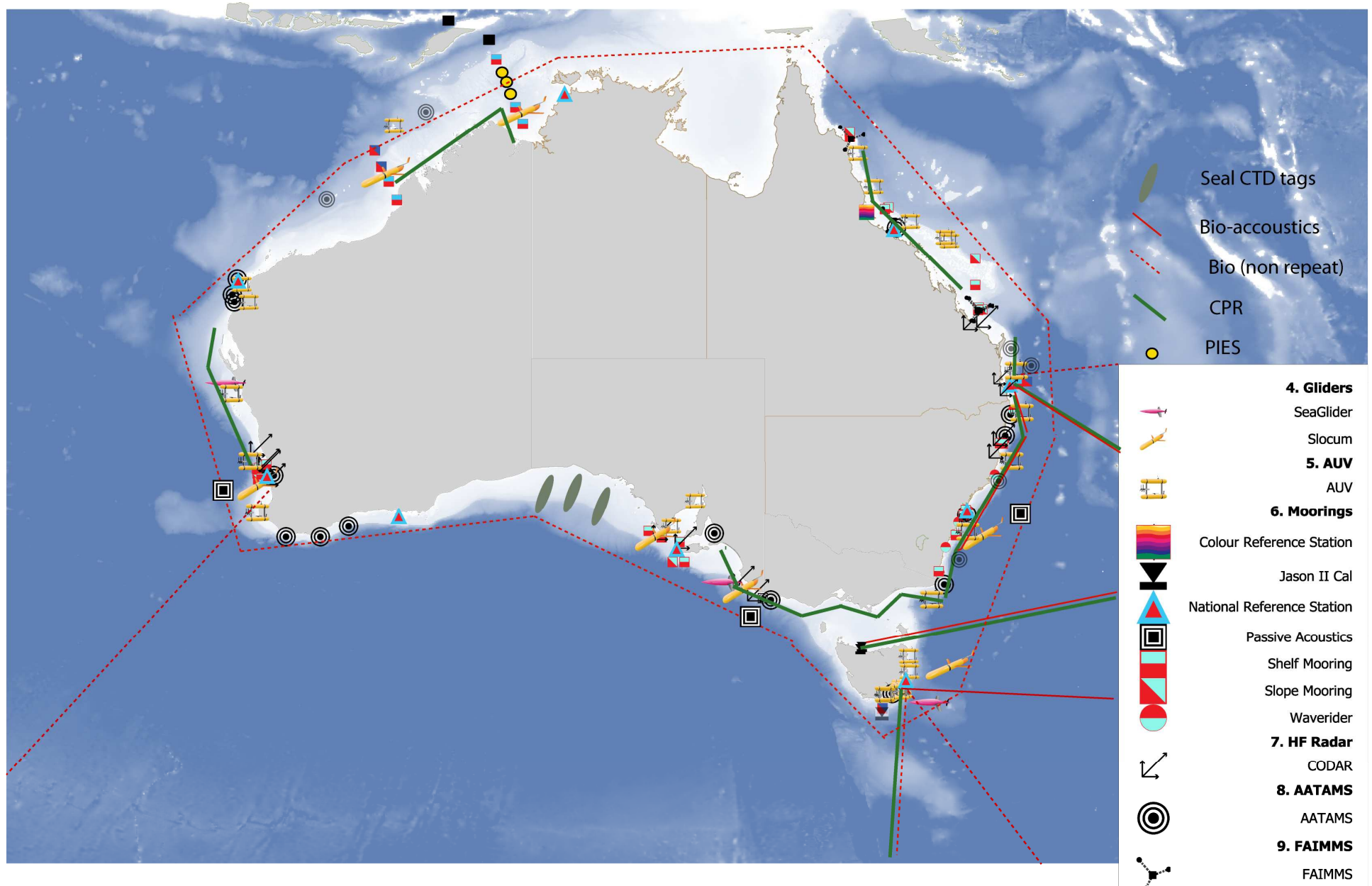
- **Western Australia**
 - **Queensland**
 - **New South Wales**
 - **Southern Australia**
 - **Tasmania (planned)**



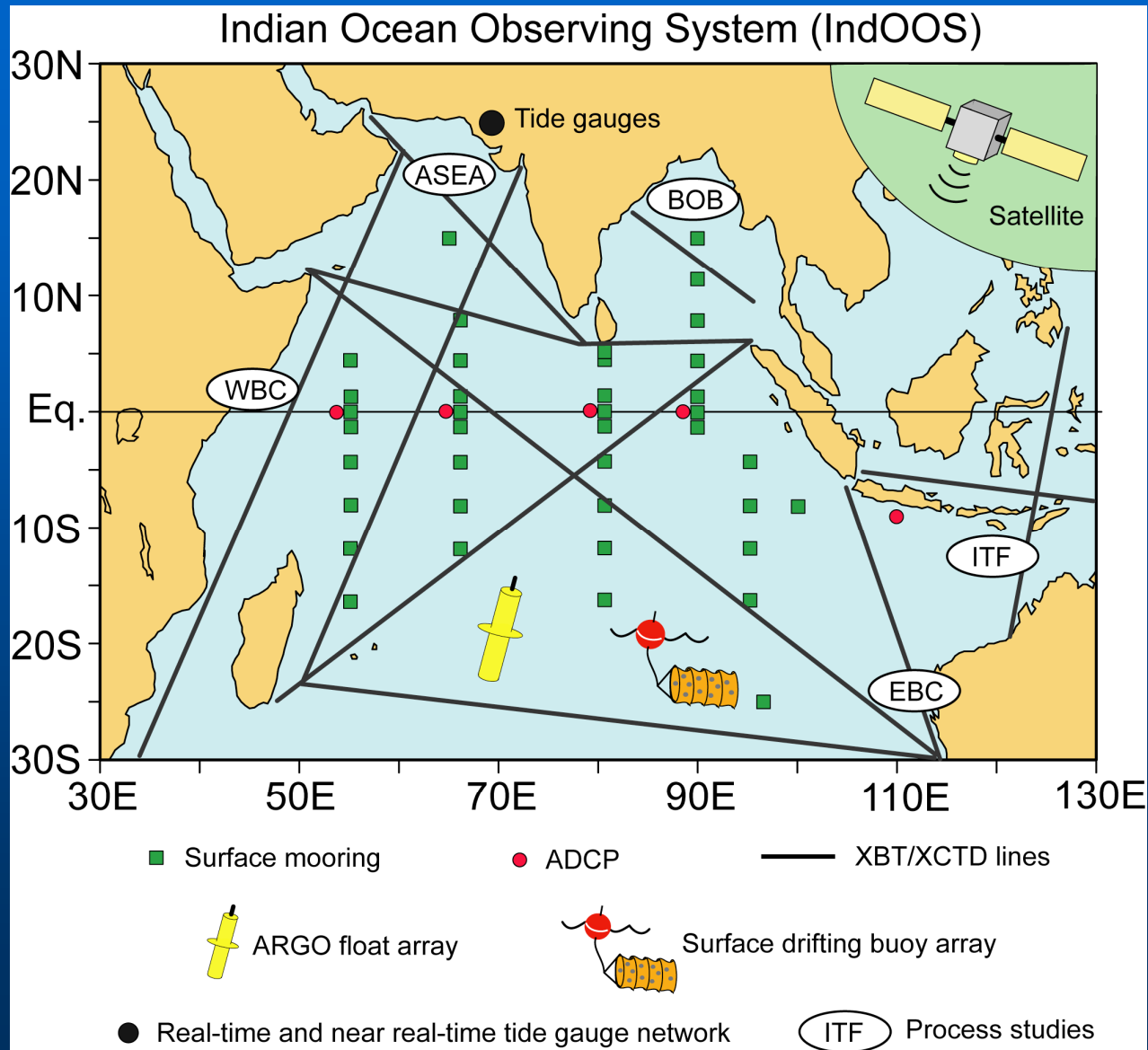
IMOS – Bluewater Observations



IMOS – Shelf Observations



IMOS contributes to regional systems such as the Indian Ocean Observing System (IndOOS)



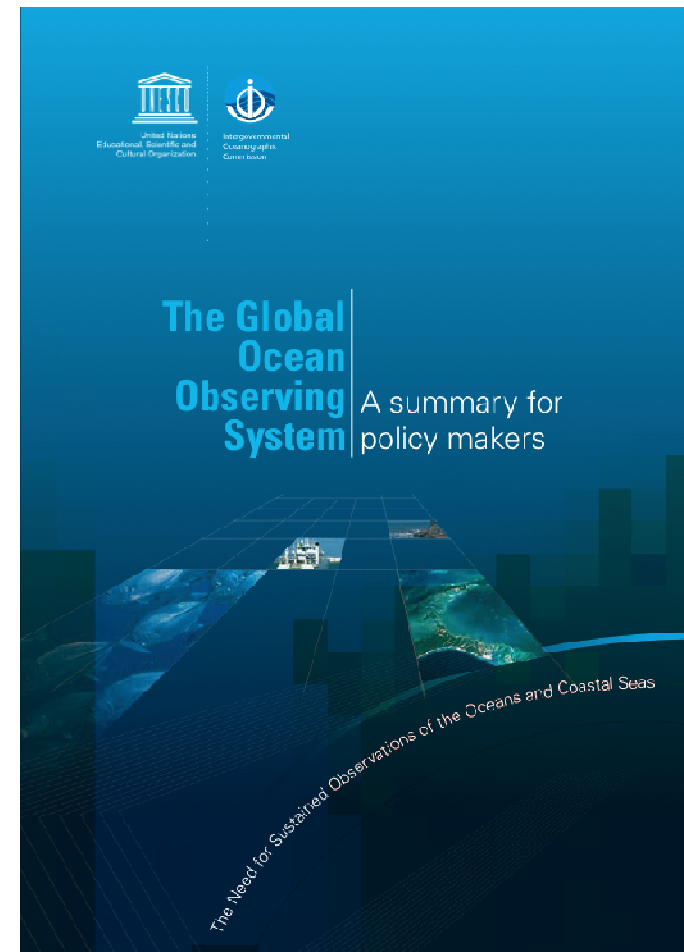
Sustaining the GOOS

The Marine Economic Sector comprises approximately 5% of Global GDP (2.7 Trillion Dollars).

At present, investment in the observing system underpinning this economic sector is approximately \$1 billion/year, of which about \$500,000/year is for global coordination.

The estimated required investment for adequately sustaining the system, as designed, is \$2 billion/year of which \$2 million/year is for global coordination

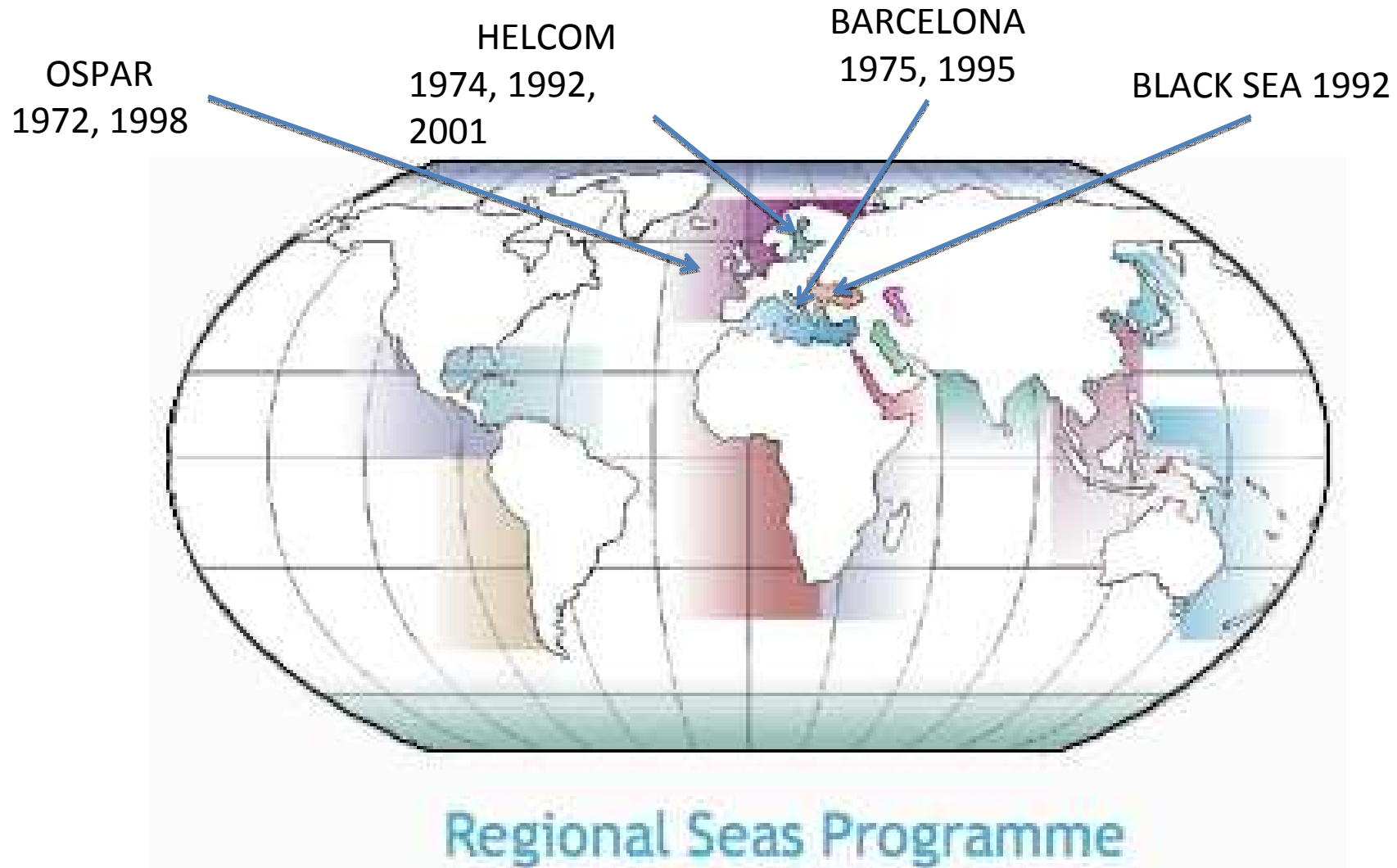
The glass is about ½ full...



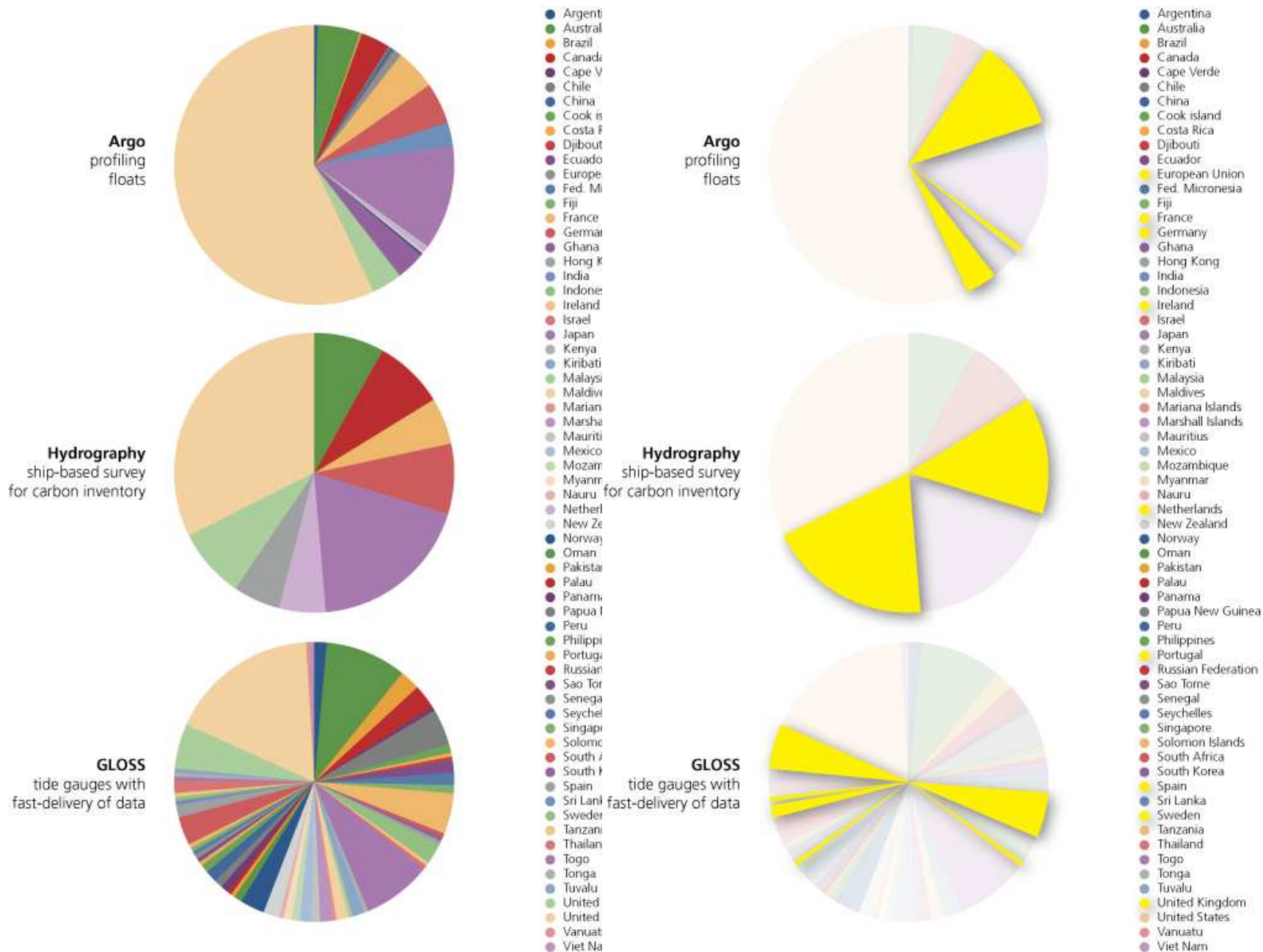
GOOS Summary for Policy Makers, "Cost and Benefits of coordinated ocean observations" 10-12, 2009

Regional Seas Conventions

Can they play an analogous role for *regional GOOS* to the one that the UNFCCC has played in developing the global climate module of GOOS?



European Contributions to the Global System

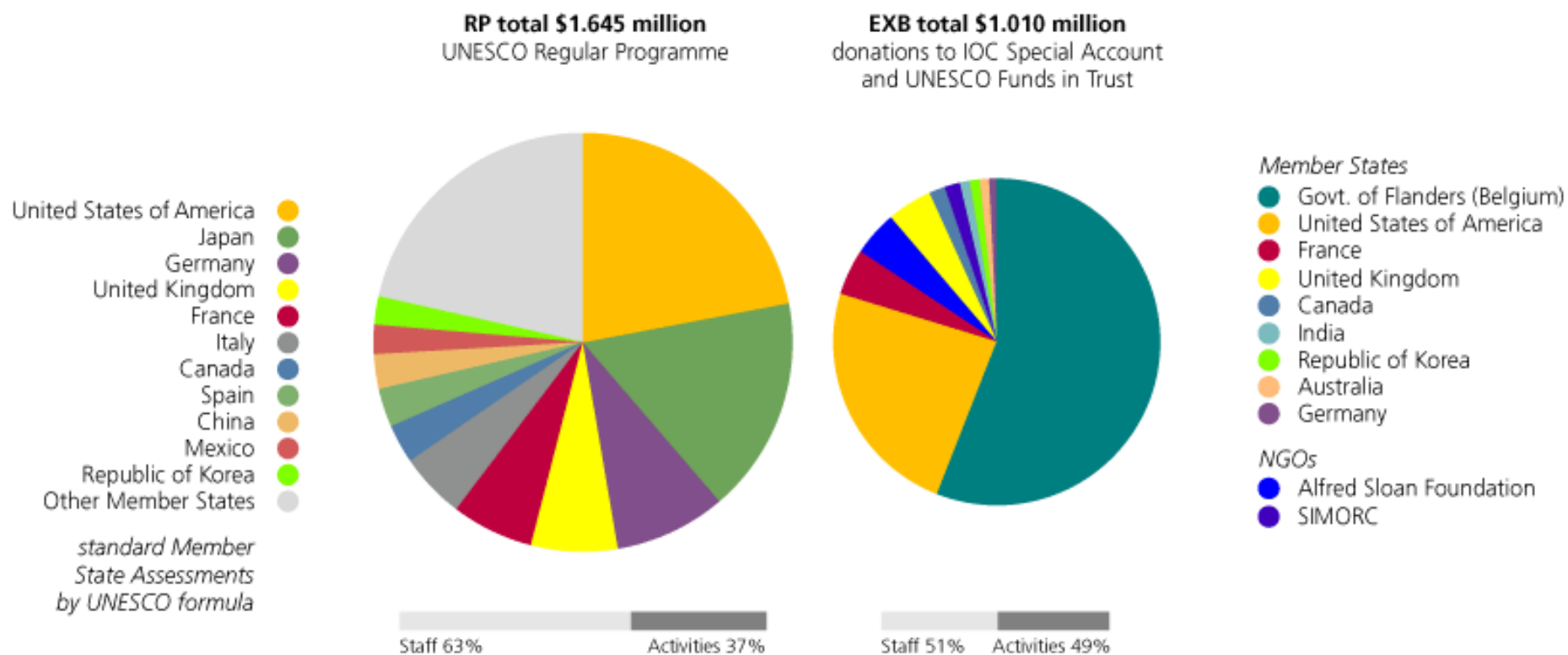


European Contributions to Global Coordination

Funds available for international coordination of the Global Ocean Observing System through IOC/UNESCO in 2008

includes funds for GOOS, JCOMM, JCOMMOPS, IODE, ocean carbon

includes staff and programme costs



RP + EXB total \$2.655 million

Calendar year 2008

GOOS Summary for Policy Makers, "Cost and Benefits of coordinated ocean observations"12, 2009



Sustaining the system

Governmental engagement and willingness to commit resources for both implementation and coordination remains weak.

Demonstrating clear societal benefits to catalyze 'user pull' requires better **advocacy**

The observing system – especially the coastal module – needs redesigning to serve adaptation needs.

EDITORIAL



Keith Alverson is director of the Global Ocean Observing System and head of Ocean Observations and Services at the IOC of UNESCO, 1 rue Miollis, 75732 Paris, Cedex 15, France. E-mail: kalverson@unesco.org.

Taking the Pulse of the Oceans

UNDERSTANDING HUMAN IMPACT ON THE GLOBAL ENVIRONMENT REQUIRES ACCURATE and integrated observations of all of its interconnected systems. Increasingly complex models, running on ever more powerful computers, are being used to elucidate dynamic links among the atmosphere, ocean, earth, cryosphere, and biosphere. But the real requirement for integrated Earth system science is a systematic, sustained record of observations, starting from as early as we can get quantitative information and extending reliably into the future. In particular, the ocean is critically undersampled both in space and time, and national and intergovernmental observational commitments are essential for progress.

Ocean basins cover most of the planet and are filled with circulating turbulent fluid whose behavior can be modeled only by approximation. For instance, we talk of a "conveyor belt," but this is an unrealistic cartoon of actual turbulent circulation, which by transporting heat and fresh water affects the planet's climate. Knowledge about the true variability of the circulation remains elusive because long-term systematic observations are lacking.

Any seafarer knows that although one can look up from the deck of a ship and see the Moon clearly through 100 km of atmosphere, one cannot look down and see farther than 1 m. Because the ocean is opaque to all wavelengths of electromagnetic radiation, Earth-observing satellites can't see below the surface either. Thus, much of the ocean must be observed from a patchwork of drifting and moored buoys, neutrally buoyant floats, coastal installations, and ship-based measurements.

Great recent progress has been made with each of these individual observing-system components. The launch of the 1250th drifting surface buoy in Halifax Harbor last year completed a network that is vital for tropical storm track prediction. The rapidly expanding international network of Argo floats has rewritten our knowledge of the temperature and salinity of the upper oceans. Moored buoy arrays in the tropics have made seasonal climate and El Niño prediction a real possibility. With tide gauges reporting in real time, not only can we predict coastal inundation hazards, but we can also disentangle the myriad processes involved in changing global sea level. Although observing the ocean is challenging, in particular cases it can be done well.

For 15 years, a global ocean-observing system under the auspices of the Intergovernmental Oceanographic Commission (IOC) of the United Nations' Educational, Scientific, and Cultural Organization (UNESCO) has been meeting important needs of global society. However, surprisingly little progress has been made toward a truly global system with long-term funding commitments. Lacking such a system and commitments, critical scientific hypotheses will remain untested.

The IOC is now working with the Global Earth Observation System of Systems (GEOSS) to identify national focal points for ocean observation efforts and to integrate these efforts into a truly global system. Unfortunately, there is still no plan for sustaining individual measurement programs, for integrating them into a coherent observing system, or for supporting them with stable funding. With a few notable exceptions, substantial multilateral government support for coordination and integration remains elusive.

To address this flaw, we propose the development of a UNESCO convention that commits nations to sustaining an integrated ocean-observing system that will lead to better understanding of the ocean and at the same time enable the provision of hazard warnings, monitoring of climate change, and management of marine and coastal resources. UNESCO's IOC stands ready to broker the development of such a convention. Preliminary discussions, including completion of the initial GEOSS tasks in ocean observation, begin at the next meeting of the Intergovernmental Committee for the Global Ocean Observing System in June 2007 in Paris. Will your nation be at the table?

—Keith Alverson and D. James Baker

10.1126/science.1135358



D. James Baker is a former undersecretary for Oceans and Atmosphere and administrator of the National Oceanic and Atmospheric Administration and is currently a consultant at the IOC of UNESCO. E-mail: djamesbaker@comcast.net.



Downloaded from www.sciencemag.org on December 28, 2006

CHRISTOPHER ARNDT/ISTOCK

A multi-user, multi purpose system delivering societal benefits beyond climate

commentary



Will we be ready for the next one? Storm-surge waves, such as this one from Hurricane I



Watching over the w

A quick technological fix is not the best response to the December tsunami.

Keith Alverson

In the mid-nineteenth century, the HMS Beagle docked in Concepcion, Chile, giving

years is likely to be falling apart by the time it is called to use.

This is not a wholly pessimistic view —

the same rapidity as tsunamis, but occur much more frequently. For unprepared and unwarned populations, they can be equally

Alverson, *Nature*, 2005

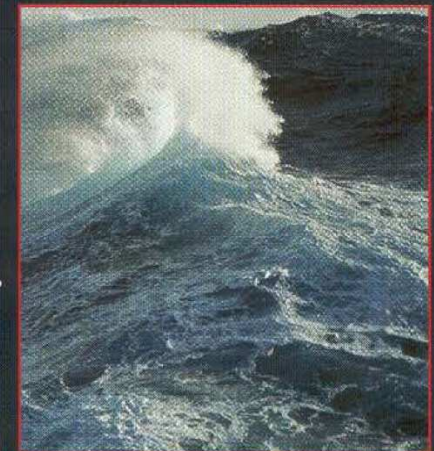
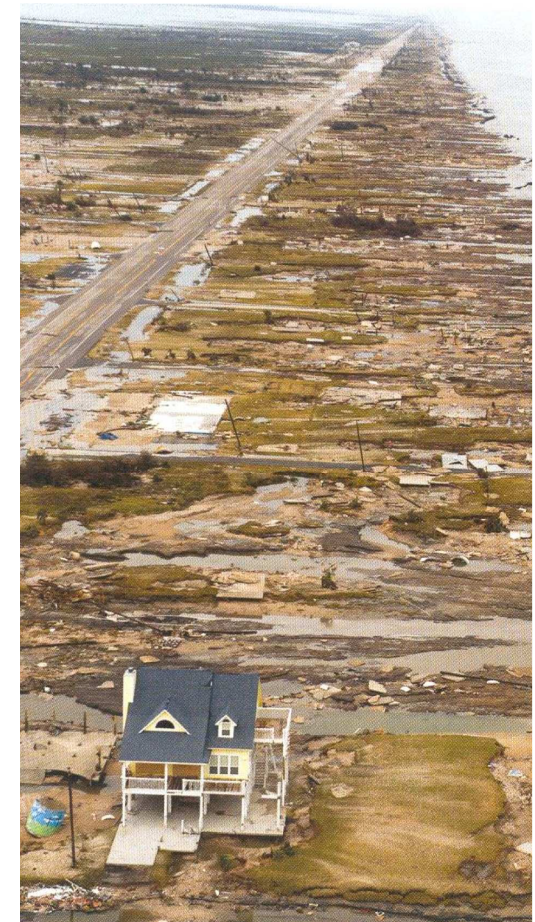
The Economist, May 21, 2009



Advocacy and Outreach depends on high profile public interest stories

- 2004 Indian Ocean Tsunami
- Storm Surges (Katrina 2005 in New Orleans, Nargis 2008 in Myanmar...)
- Global Climate (Sealevel, ENSO, etc)
- Toxic Algal Blooms
- Pacific Garbage Gyres
- Ocean Acidification
- Fisheries Collapses – (Tunafish 2010)
- Opening of the Arctic to development

not to mention ...



The Economist

Acid waters, dying corals, melting ice caps, rising slime, a plague of plastic and a dearth of fish...

A 16-PAGE SPECIAL REPORT ON THE SEA



IOC
UNESCO



JANUARY 3RD-9TH 2009

www.economist.com





Bridge the research-operational divide

“A comprehensive ocean observing system simply cannot exist without the full engagement of the oceanographic research community”

- improve deployment opportunities for autonomous platforms (eg. Argo, drifters)
- facilitate data availability, archiving
- Ensure high quality ‘research’ data contributes to the sustained data flow of GOOS



Alverson, IOC Annual Report, 38-39, 2005

operational observing systems Overview

By Keith Alverson, Head of Section

On 2 August 2005 the U.S. National Weather Service called for a ‘95 percent to 100 percent chance of an above normal 2005 Atlantic hurricane season.’ This was the highest confidence they had ever expressed in predicting an above normal season. True to the prediction, the season was indeed far above normal, with a record four Category 5 storms (Emily, Katrina, Rita and Wilma) including the most intense hurricane ever recorded in the Atlantic (Wilma, 882 millibars). The season also included the largest total number of tropical storms on record (27) and the latest ever dissipation of the final tropical storm of the season (Zeta, 6 January 2006). Given the veracity of these predictions, there can be no doubt that climate related hazard predictions based on operational ocean observations are providing substantial and tangible societal benefits.

The reported slowdown of the Atlantic meridional overturning makes an interesting counterpoint. This report was based on five transatlantic hydrographic sections at 25°N carried out by research cruises over the period 1957 to 2004 (figure 2), which appear to show a slowing, by about 30 percent. Along with widespread publicity in the mainstream press, this study drew further critical comments from some scientists for its dramatic conclusions about a system that is poorly understood, based on five data points, at a single location, spread over five decades. The short and easy answer to such criticisms is no doubt to acknowledge their validity, but also assert that these are the best data at our disposal and thus our best guess as to what is going on.

A soon forward looking answer would be to ensure that the ocean observing system we are building will monitor large-scale ocean changes occurring on decadal timescales. Realistically, the scientific research community is, and for many years will continue to be, both the primary provider and primary user of climate related ocean data. Thus, incorporating the research community products in the observing system, and simultaneously designing the system to help address research community hypotheses, will be absolutely critical in ensuring that we can monitor climate change in the oceans. A case in point is the Bryden et al. study. These five hydrographic sections were brought together by a small research team to address a specific hypothesis. This kind of research would surely be a lot easier, and the conclusions substantially more robust, if research vessel tracks and data were seamlessly included in the observing system. The observing system would be a lot richer as well. Research vessels travel far from traditional ship-of-opportunity routes and take a large number of the highest quality temperature and salinity data available from any source (figure 3). They provide the

Fig. 1 Hurricane Epsilon in the Atlantic Ocean (centered around the International Space Station)

Fig. 2 Station positions for transatlantic hydrographic sections along 25°N from 1957 to 2004. The 1957 and 1992 sections each went roughly along 24.58N from the African coast to the Bahamas Islands. Because of diaphanous clearance issues, the 1991, 1998 and 2004 sections angled southward from the African coast at about 23.8N to join the 24.58N section at about 23°W. The 1998 and 2004 sections angled southward at about 23.8N to finish the section along 25.58 N. Reproduced with permission from Bryden, Bryden, et al., 2005, *Effect of the Atlantic meridional overturning circulation on 20°N*. *Marine Research*, No. 438, pp. 455-467.

Fig. 3 Number of marine reports from 24 research vessels in the International Comprehensive Ocean-Atmosphere Data Set in one degree bins during 1997. Reproduced by permission of the American Geophysical Union, *The Oceanographic Literature Review*, Washington, DC: Research Institute International Association for Climate Observation, 100, No. 65, No. 2, 2004 (2004).

Fig. 4 1997 ICADS Meteorological Reports Research Vessels by Call Sign.

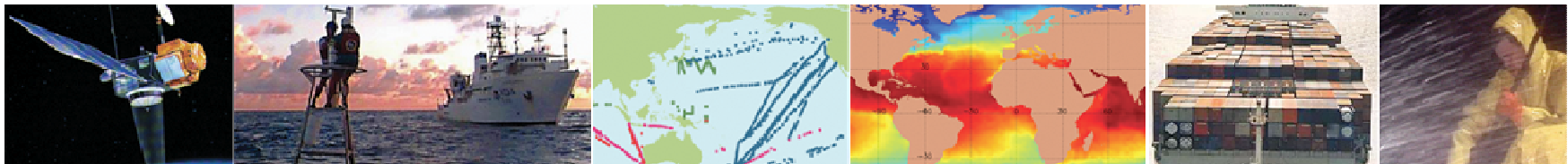
INTERNATIONAL OCEANOGRAPHIC COMMISSION • Annual Report 2005 39



Major Challenges 2010-2015: **Global Ocean Climate Module**

Europe and its Member States have built strong national and regional infrastructures and services. But, just as oceans and climate change know no political boundaries, Europe must also play a leading role at the international level by actively supporting global efforts.

- European Member States, and the European Commission, should support increase their support for the global ocean climate observing system.
- The European Commission has strongly supported satellite observations (eg through GMES). Because the oceans are opaque satellite data can only scratch the surface of the ocean. Engagement by the commission in sustaining the in-situ oceanographic observing system for climate is a top priority.

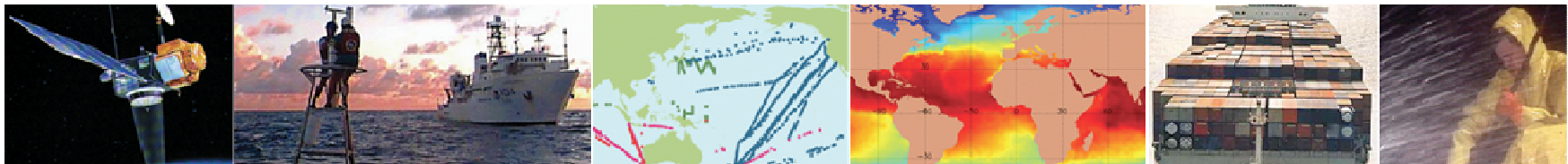


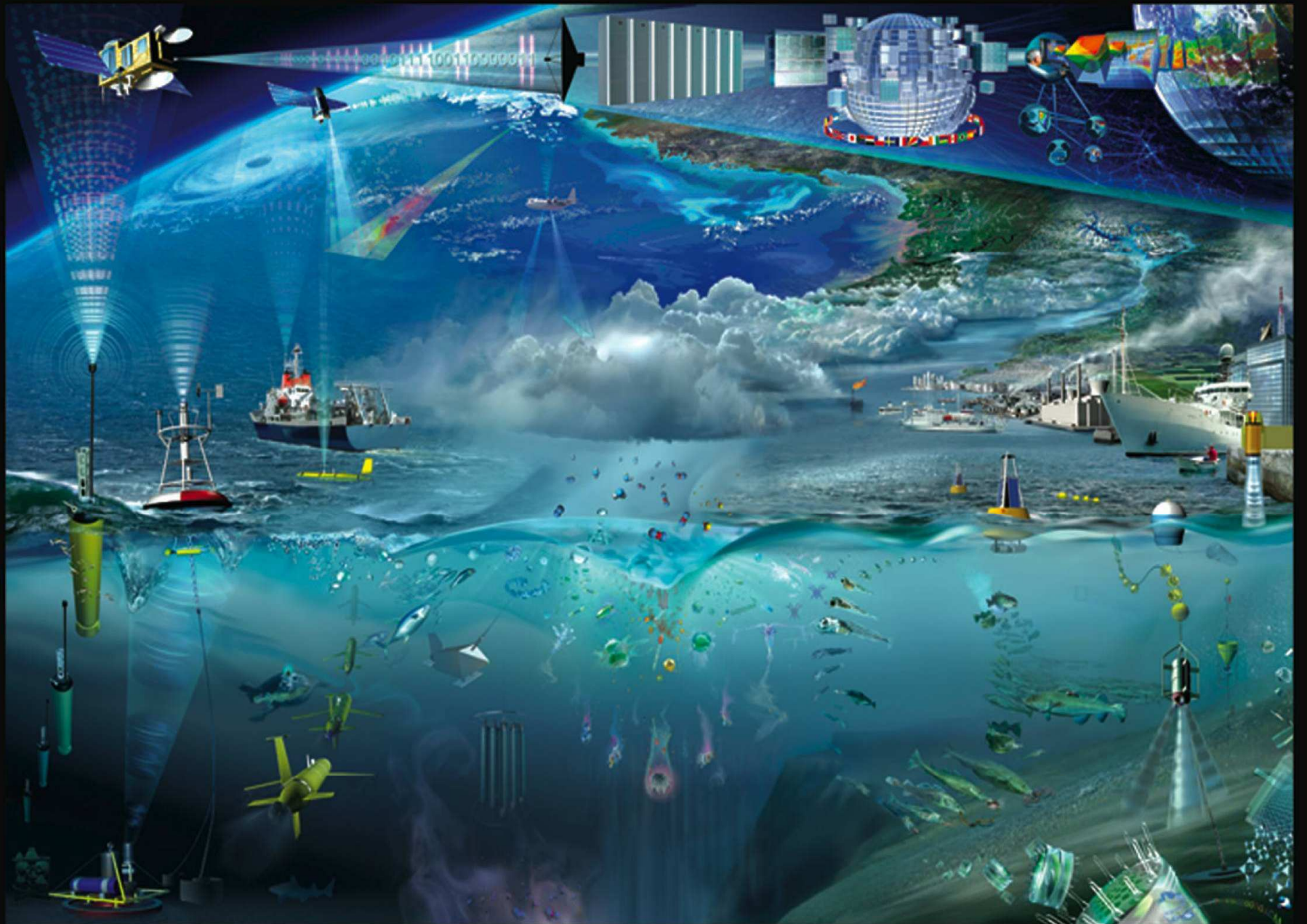


Major Challenges 2010-2015: European Regional Observing System

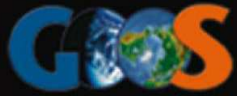
GOOS' contribution, through its global climate module, to detection and attribution of anthropogenic impacts on global climate has been a substantial assistance to governments. A major challenge for the future comes with recognizing that adaptation to climate change occurs on a regional level and requires regional observing systems. There is an urgent imperative to ensure that GOOS can provide relevant, timely and useful data that will be required to underpin the development of the global framework for climate services that is being developed in the context of adaptation and mitigation.

- Europe lead by example. Show a regional alliance can work.
- Europe must provide leadership to the global council of regional alliances, thereby facilitating sharing of best practices, adoption of common standards, etc...





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GLOBAL OCEAN OBSERVING SYSTEM

www.ioc-goos.org

The oceans are the basis of the life support system. GOOS measures ocean warming and provides an opportunity for the human system to respond.