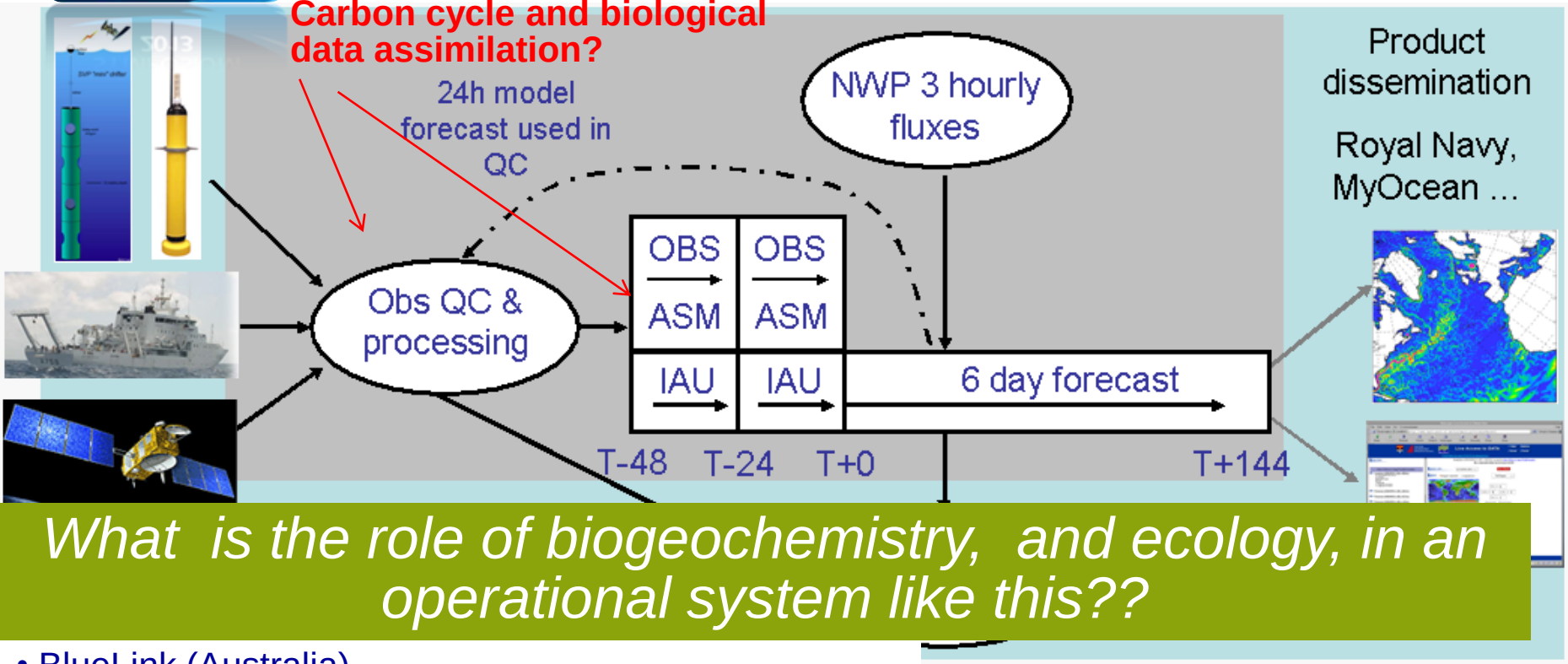
Generic schematic of a marine operational system

GODAE OceanView SYMPOSIUM 2013

Biogeochemistry models , Carbon cycle and biological data assimilation?



What is the role of biogeochemistry, and ecology, in an operational system like this??

- BlueLink (Australia)
- ECCO/HY
- Mercator (France)

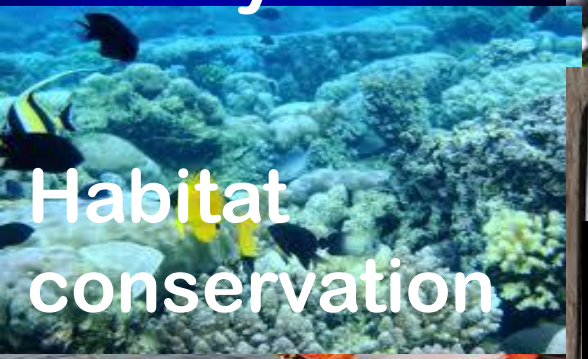
What are the drivers?

(Canada)

- INDOFOS (India)

Can this system meet the requirements of the environmental user?

What is the role of BGC/ecology in operational oceanography?

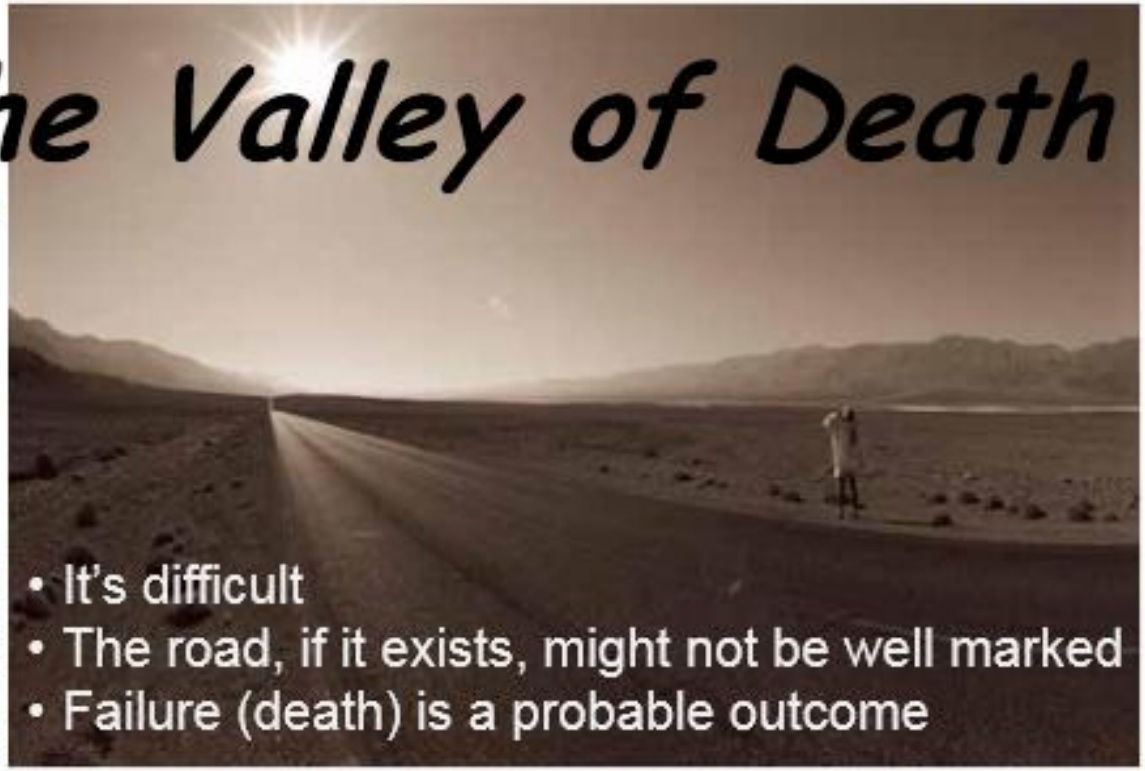


- Monitoring
- Environmental Assessment
- Marine management (food security)
- Decision support
- Informing policy and the public
- Scientific process understanding

HOT CAKES
SOLD OUT

Research to Operations (R2O)

Crossing the Valley of Death



Bring lots of water!

Species composition of CA landings

Environmental Influences?

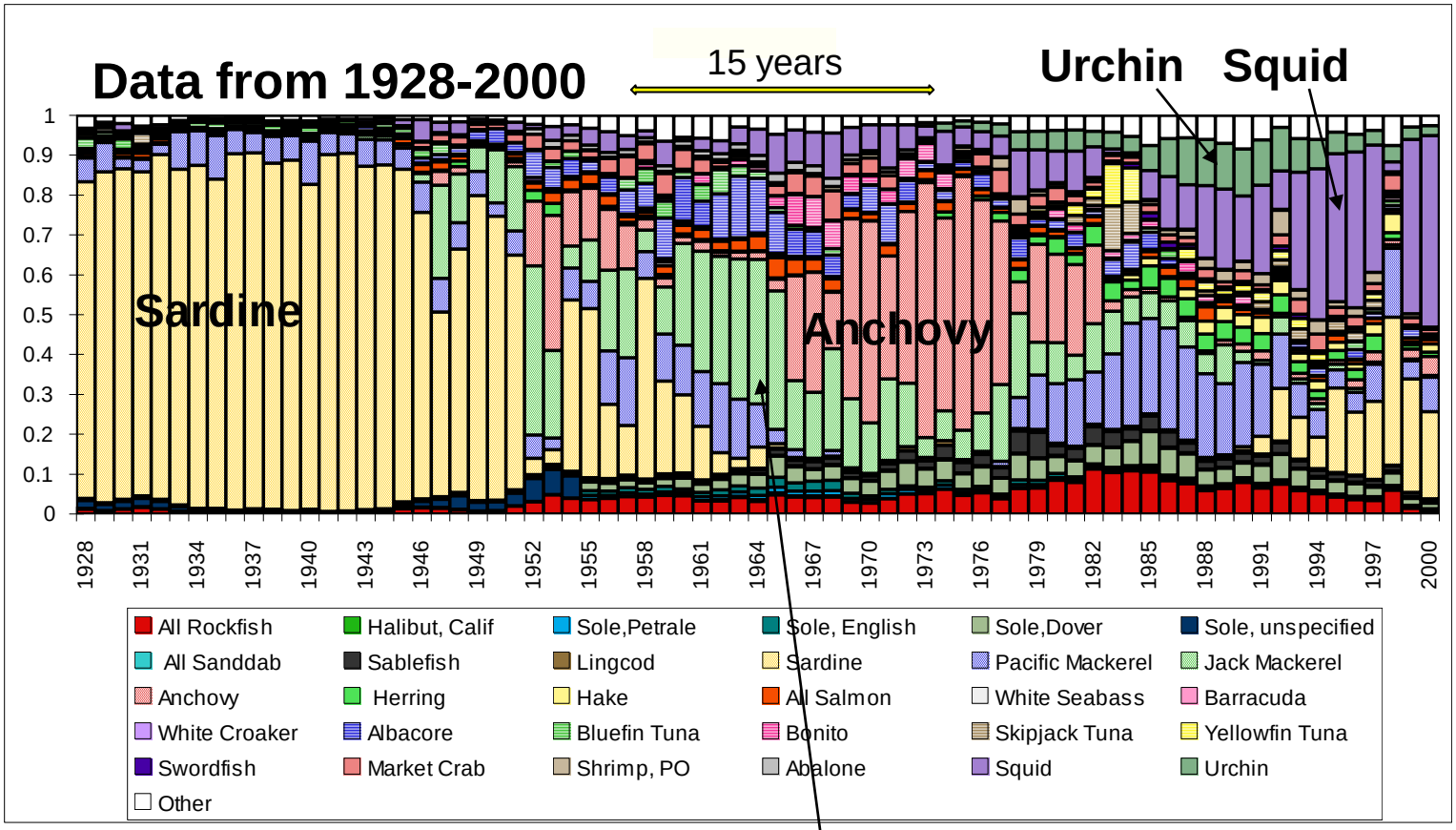


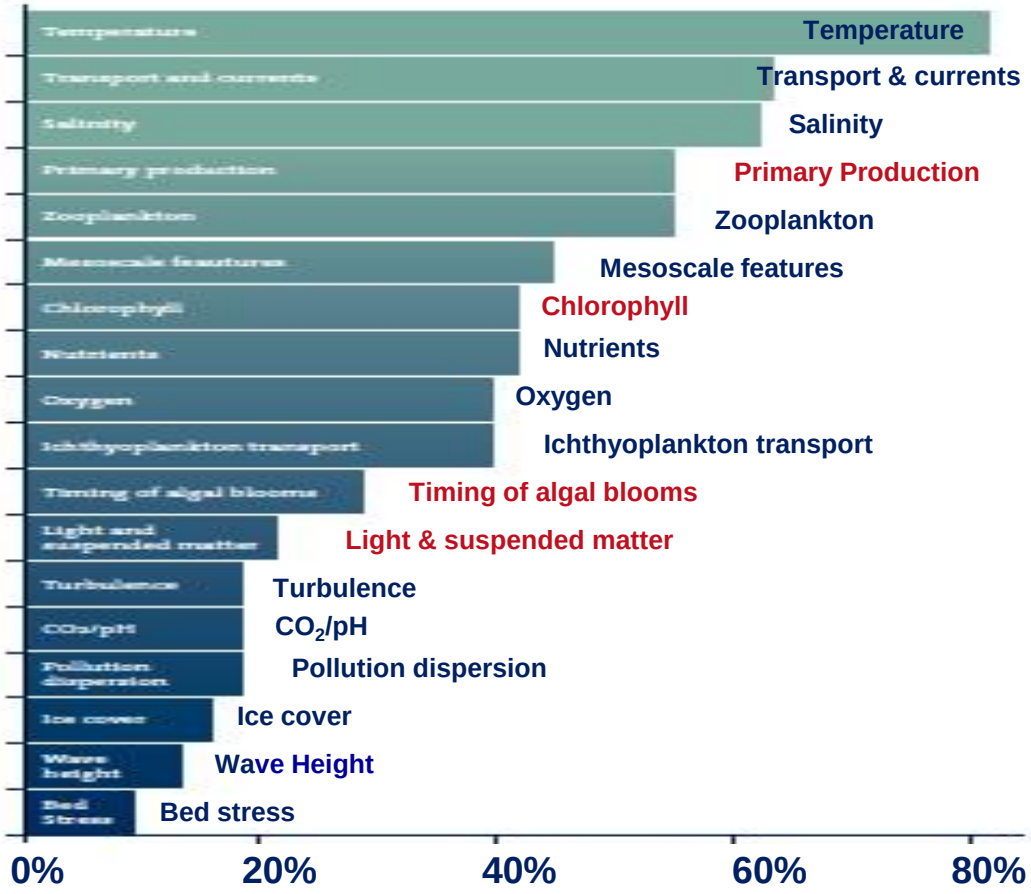
Figure courtesy of Jan Mason, NOAA/NMFS/SWFSC/ERD

Responses from EU fisheries managers (commercially exploited species and ecosystems)

ICES Working Group on Operational Oceanographic Products for Fisheries and the Environment.

ICES Insight Sept 2010.

Oceanographic data products requested by the ICES community of marine researchers, in order of importance.



Percentage of users requesting oceanographic products

Delivery of data products

- **Data access.** Data should be free and operationally available to all. Registration prior to data access should be avoided. — **Free & No Registration**
- **Time scale.** Two-thirds of users highlighted monthly average data as important. All other time-scales were requested by less than 50% of users. — **Monthly averages**
- **Data type.** More than 90% of ICES users requested access to historical data. This forms a stark contrast to the move in operational oceanography to develop forecast, nowcast, and real-time systems. — **> 90% historical data**
- **Data updates. Regular on an annual basis;** quarterly and monthly updates were also requested by a large proportion of users. — **Annual updates**
- **Data format.** An overwhelming majority requested that **data values** be available for download in **ASCII format.** Graphical outputs were seen as a good way to characterize the data, but the users wanted access to data that they could manipulate. — **ASCII**
- **Meta data.** Users want a **description of the methodology** accompanying the data. — **Methodology**

Berx *et al.*(2010) **Regional/Coastal focus**

http://groupsites.ices.dk/sites/wgoofe

Paper submitted to ICES SCICOM

(M. Dickey-Collas, R. Barciela, R. Berx, S. Dye, K. A. Mork and G. Nolan)

- **"Supply of Operational Oceanographic Products and Services to facilitate Integrated Ecosystem Advice from ICES"**

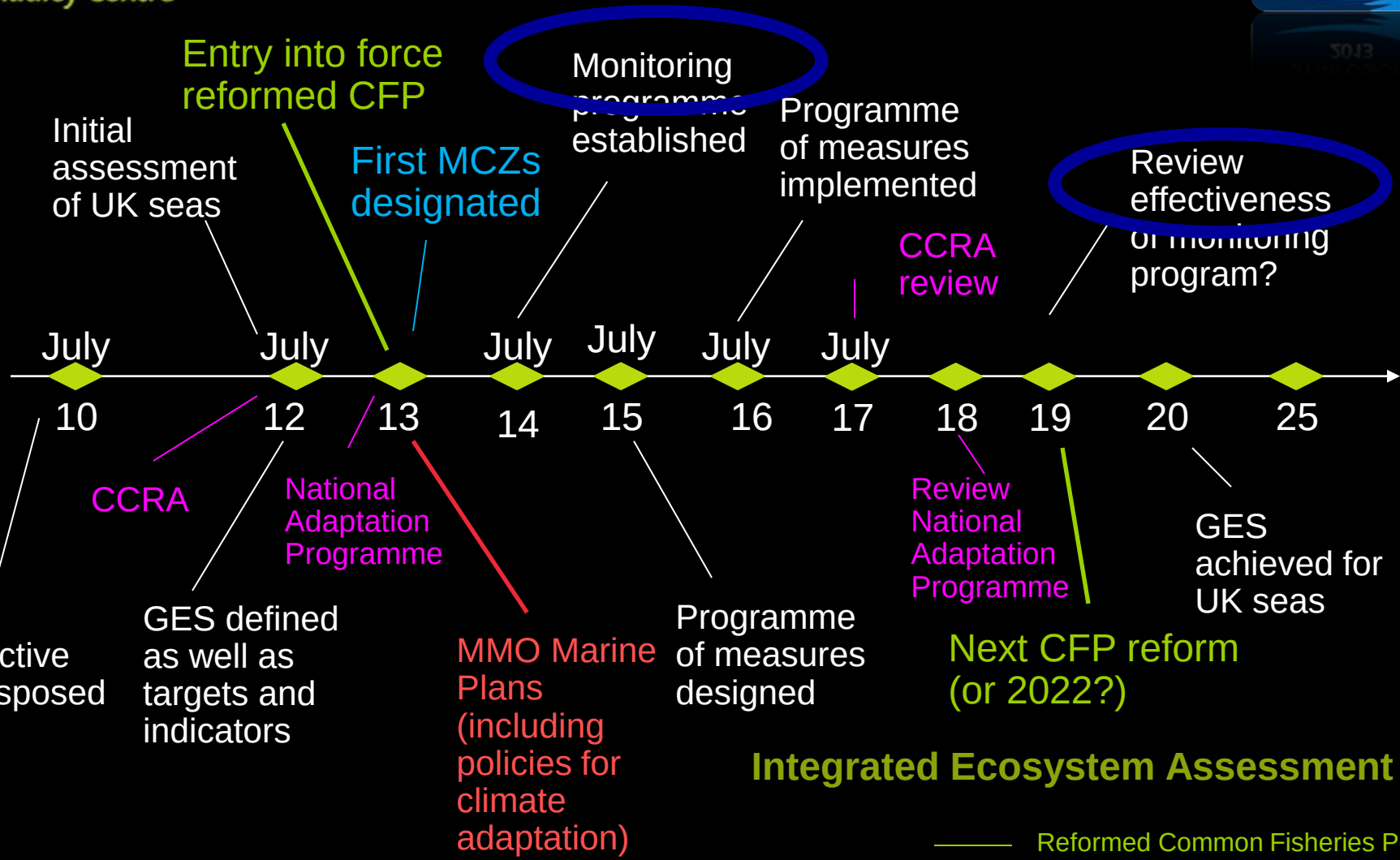
- Aims:

- To exploit the existing wealth of operational products in order to underpin ICES regional integrated ecosystem advice.
- Expressions of interest will be sought in 2014.

Drivers:
International Water Quality

- Australia: National Water Quality Management Strategy
- United States:
  - All water bodies are protected by the Clean Water Act (CWA, 1988)
  - National Coastal Assessment
  - National Aquatic Resource Assessment
- Europe:
  - Water Framework Directive
  - Marine Strategy Framework Directive
- Oslo-Paris (OSPAR) Commission Common Procedure
- Helsinki Commission (HELCOM) Eutrophication Assessment Tool (HEAT)

International Marine Policy Drivers – the details!



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Key Points
Messages to take home

- Many common requirements:
  - Monitoring, data exploitation, knowledge, research
- Time scales of interest
  - **Seasonal**: 2/3 months ahead (for licensing and planning)
  - **inter-annual**: 5/6 years
  - **Decadal** (10 to 20 years in order to inform future CFP reforms)
- Management **measures** and **monitoring** programmes
  - Understanding the past
  - Natural variability vs. climate change vs. non-climatic drivers
  - Future-proof
- **Coastal** and **regional** waters as opposed to deep sea (LBCs as constraints for coastal models is an opportunity)

- An exception, rather than the norm

- Perception

- High level statements: *what do these really mean?*

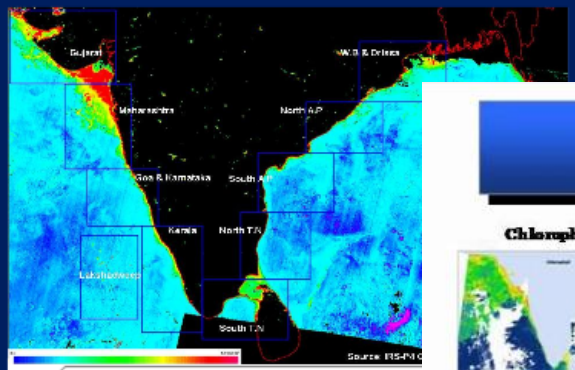
Marine Ecosystems- NE Arabian Sea

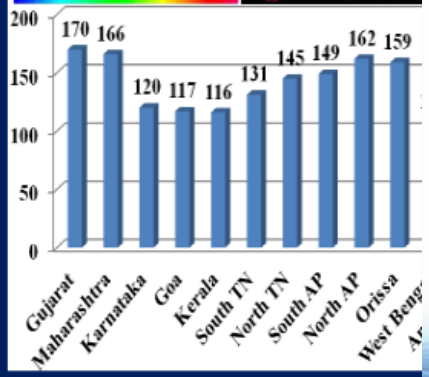
Monitoring & Surveillance of Harmful Algal Blooms

- Regular monitoring of Noctiluca Bloom in the NEAS and the Trichodesmium bloom in the SEAS to understand the impact of bloom on biogeochemistry of the region.
- Blooms alter the absorption &
- backscattering properties leading to changes
- in surface albedo and

- Developed conce NEAS bloom dynam
- ✓ Bloom areas detec AQUA and OCM
- ✓ Validation on-boa *Sampada*.
- Requirement: Algor species-specific alg
- (*Noctiluca*, *Trich diatoms*)

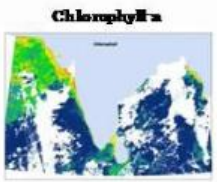
Potential Fishery Zone

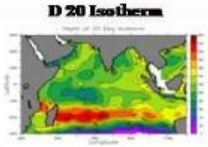


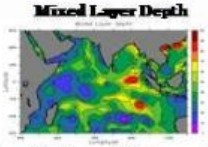


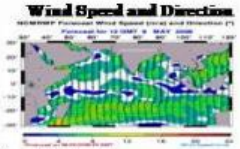
- Potential Fishing zone advisories issued daily. Model

Tuna Fishery Advisories

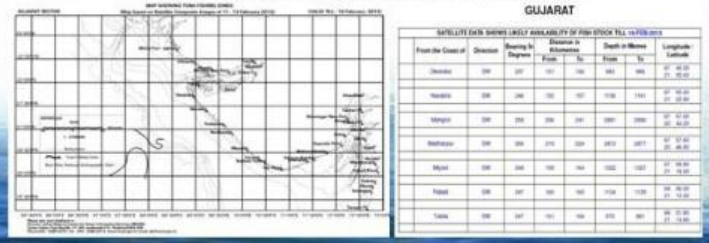








Tuna Fishery Advisories Map & Text



- Tuna Potential of the Indian EEZ: 2,78,000 MT
- Annual Catch: 40,000 MT
- Advisories started with RS and in-situ data on experimental basis
- Developed methodology based on Hind-cast Experiments (503 catch details from 12 vessels)
- Advisories based on Satellite derived Chlorophyll-a, Sea Surface Temperature and Water Clarity Index
- Advisories in similar lines to PFZ
  - Forecast to Long-line vessels weekly thrice on every Tuesday, Thursday and Saturday through e-mails.

- Operationalised from November 2010 onwards
- Dedicated web pages for dissemination of the advisories (Feb 2011)

Limited Accuracies due to lack of geo-referenced data

Slides Courtesy of Shailesh Nayak (Earth System Science Organisation, India)

- An exception, rather than the norm.

- Perception

- High level statements: *what do these really mean?*

Perception

- Environmental data required:
  - do not exist.
  - quality is regarded as poor (models and ocean colour observations have a bad name!).
- For applications, inter-annual and decadal timescales are more relevant than operational, NRT 24/7.
- It is often assumed that “operational” means any quality of data will suffice.

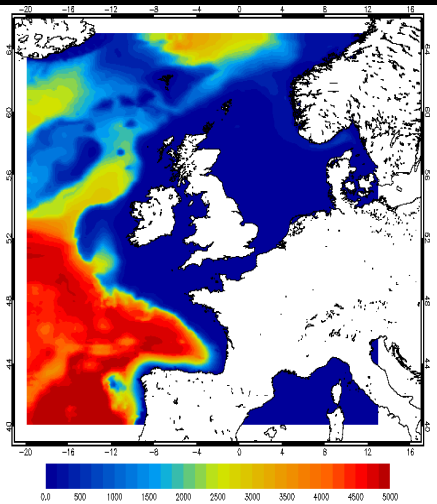
- An exception, rather than the norm.
- Perception

- High level statements: *what do these really mean?*

Future Opportunities: Effective and efficient monitoring

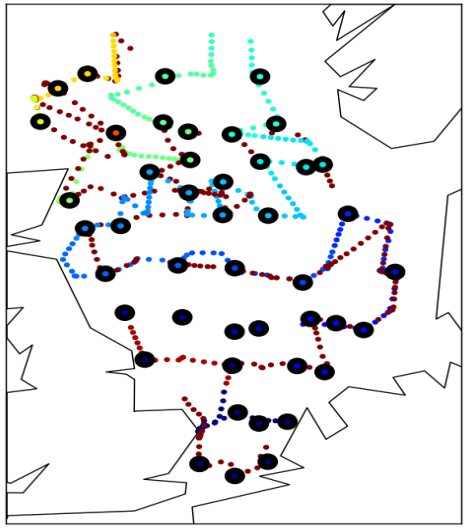
Objectives

- To extract the maximum information from observations using advanced modelling and data assimilation



GODAE Activities:

- **OSE/OSSEs**
- **Reanalyses**



(e.g. sampling density)

- How can we best use legacy data to increase the value of current monitoring?

Future opportunities
2. Understanding what's driving changes in marine indicators

Applying existing "attribution" techniques in order to:

• examine the likely cause of detected changes from amongst a set of specific drivers.

• recognise the impact of climate change on, for example, indicators of GES

GODAE Activities: Reanalyses

• and the impact, individual or cumulative, of other man-made factors (e.g. fishing, noise, pollution).

• identify any early warning signs of future changes, such as tipping points, and inform adaptive management measures.

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Future opportunities
3. Understanding the future direction of change of statutory indicators

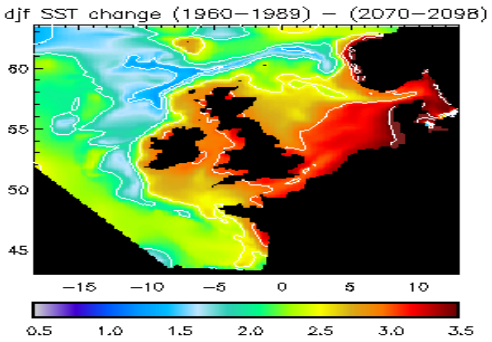
What are the benefits?

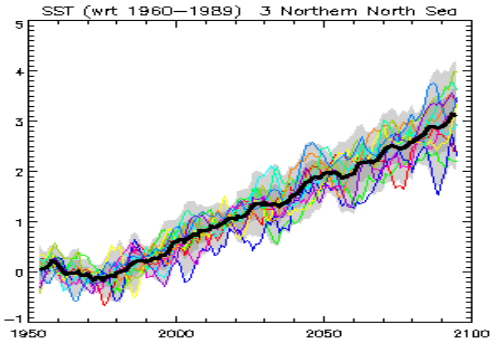
- The prediction of consequences of non-controllable factors (e.g. climate change) *versus* controllable ones (e.g. management actions).

- Assessment of how robust statutory targets are.

- Identification of any early warning signs of future changes, such as tipping points, and inform adaptive management measures.

ESM model downscaling - Projecting the future





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Can this system meet the requirements of the environmental user?

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Requirements that keep coming back

- Consistently provide realistic uncertainty information.

  Concern over accuracy and error estimates. Less concern regarding the error with standard *in situ measurements.*
- Communicate differences and complementarities of different types of data.
- Rescue, curate and make available valuable data that are presently inaccessible.
- Meaningful, widely accepted metrics.
- Long-term, sustainability and data continuity.
- Mission continuity (e.g. ocean colour) relevant to investment.
- Ability to browse data before downloading and to create spatial and temporal sub-set data.
- Easy and efficient distribution and access are critical.

“ The first step towards getting somewhere is to decide that you are not going to stay where you are”

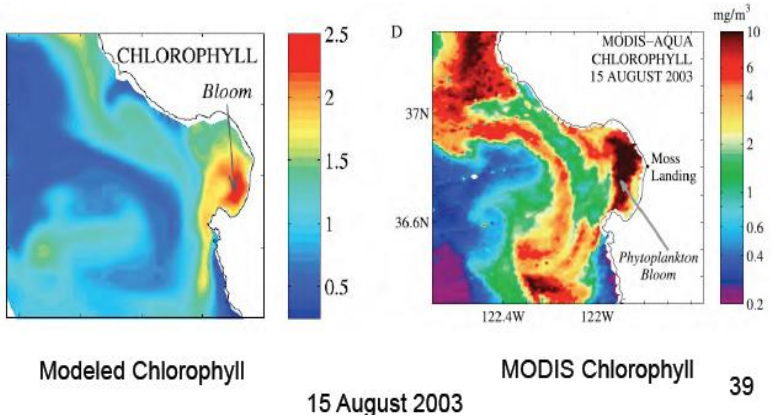
Chauncey Depew, 1928

Research Push vs. User Pull (daily, seasonal, decadal)

Observed and modeled bio-optical, bioluminescent, and physical properties during a coastal upwelling event in Monterey Bay, California

Igor Shulman,[1] Mark A. Moline,[2] Bradley Penta,[1] Stephanie Anderson,[1] Matthew Oliver,[3] and Steven H. D. Haddock[4]

JGR, VOL.116, 2011



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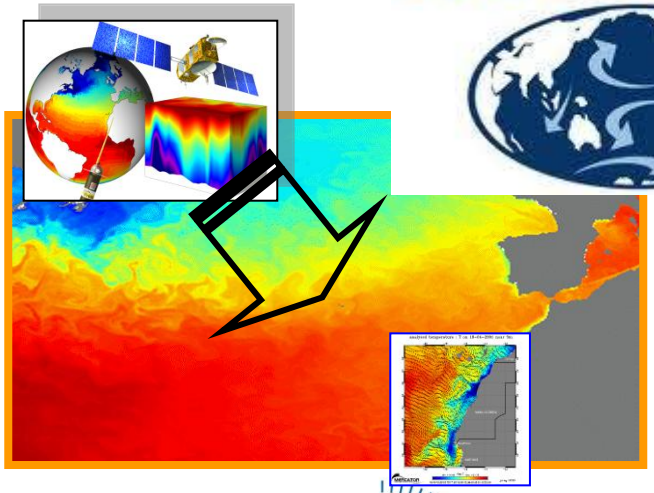
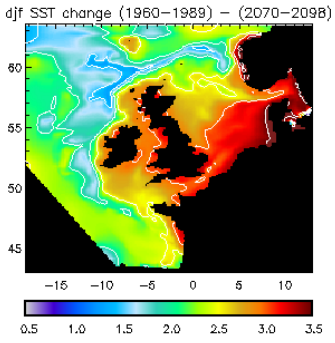
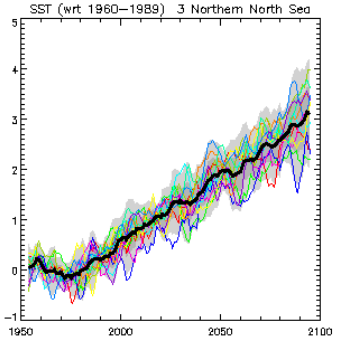
Observing System Evaluation

GODAE OceanView



ESM models - Projecting the future





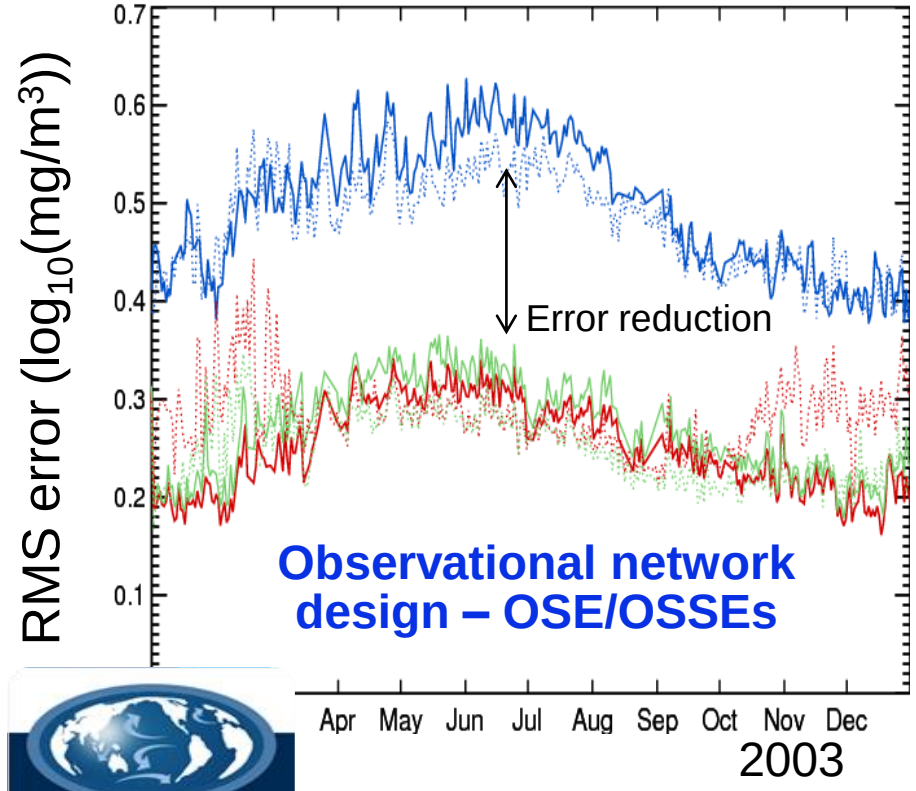
European GMES Marine Core Service

www.myocean.eu.org

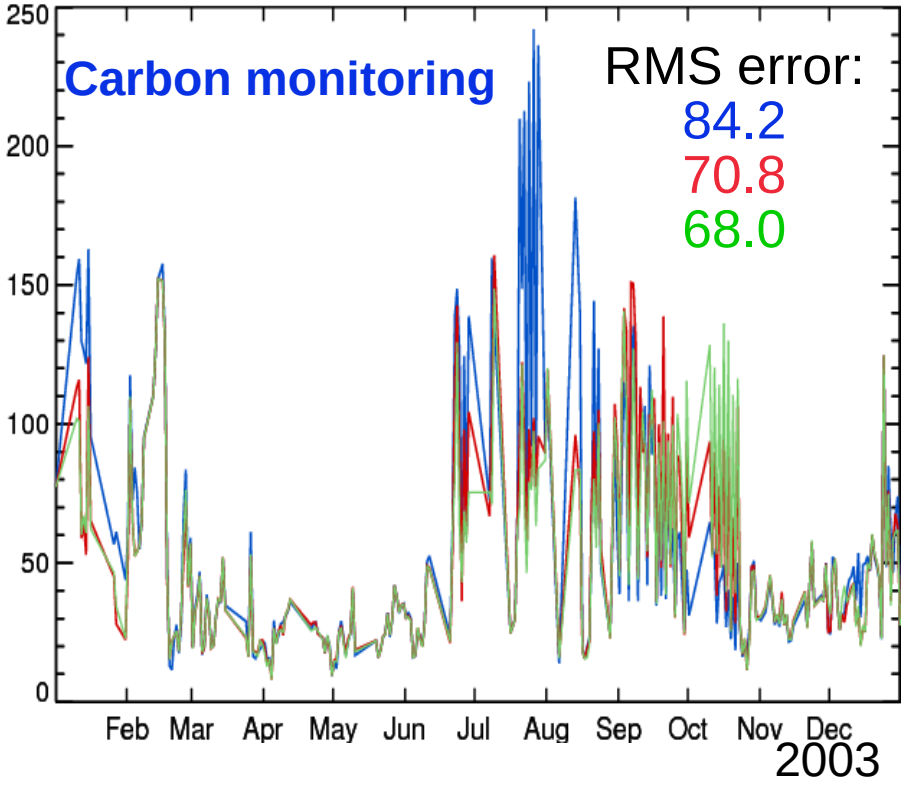
- Underpinning science coordination
- Vision
- Clear owners

Carbon monitoring - impact of ocean colour data assimilation

log_{10}(chlorophyll) error North Atlantic



Global pCO_2 RMS error *versus in situ* obs



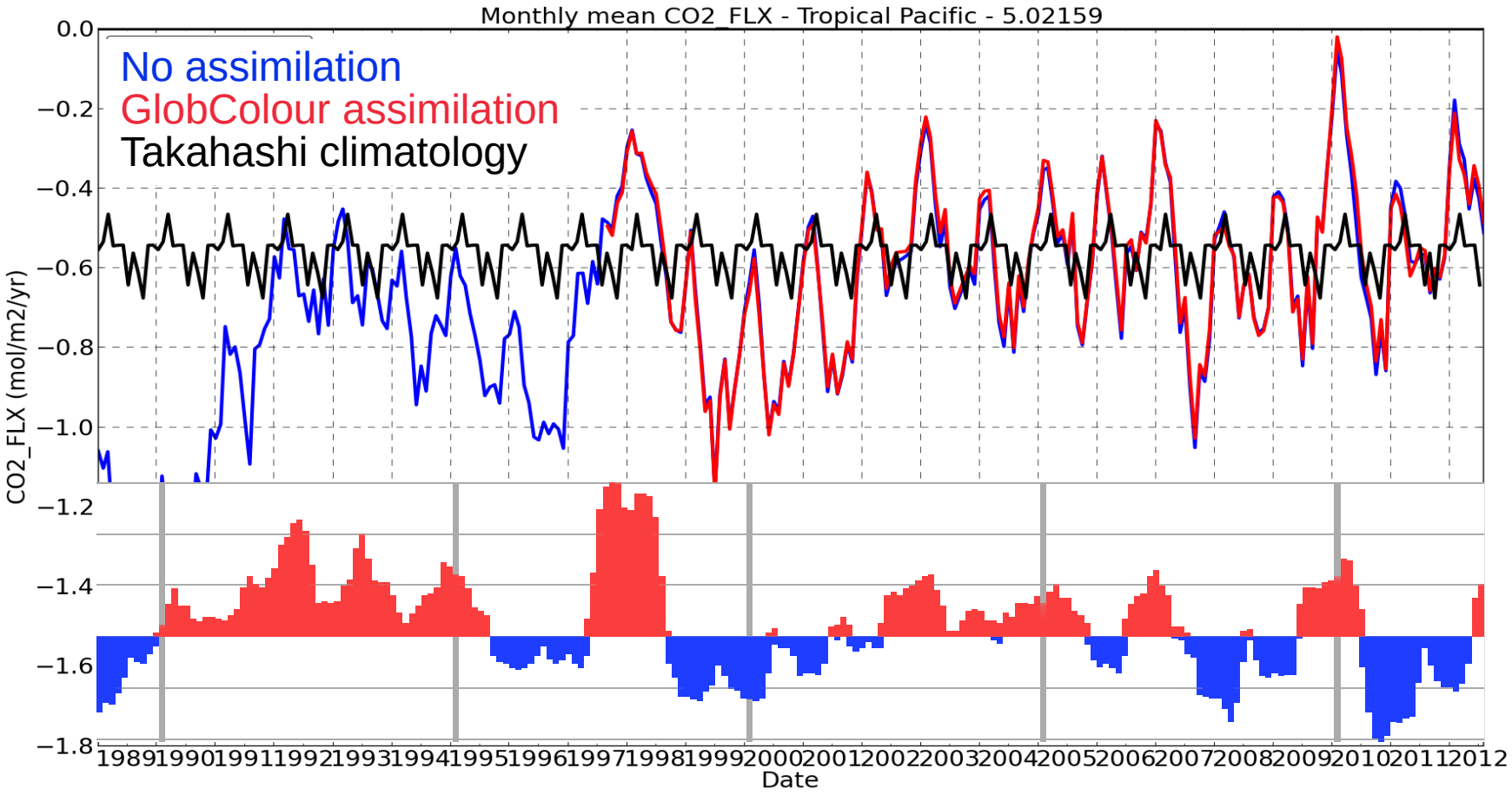
GODAE OceanView SYMPOSIUM

Control GlobColour assim CCI assim

Air-sea CO_2 flux

(delayed mode assimilation of ocean colour)

Tropical Pacific mean



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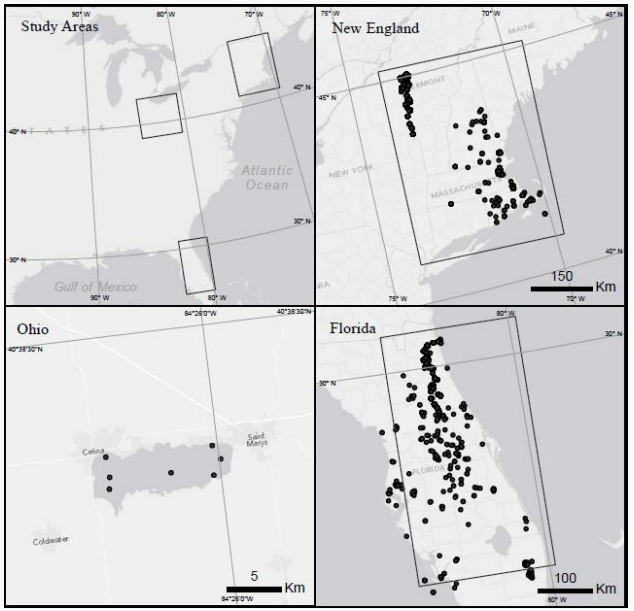
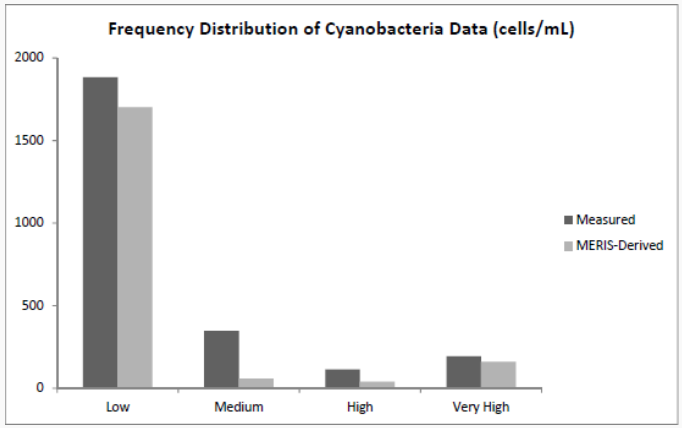
Multivariate ENSO index sourced from: http://www.esrl.noaa.gov/psd/enso/mei/

Cyanobacteria Assessment Network (CyAN)

- Correspondence % (+/- 7 day match-up)
  - Low = 90%
  - Medium = 17%
  - High = 35%
  - Very High = 83%
- Dissemination
  - EPA EnviroAtlas
  - Web-based mapping tool
  - Community decision makers need to make strategic choices about development and environmental policy

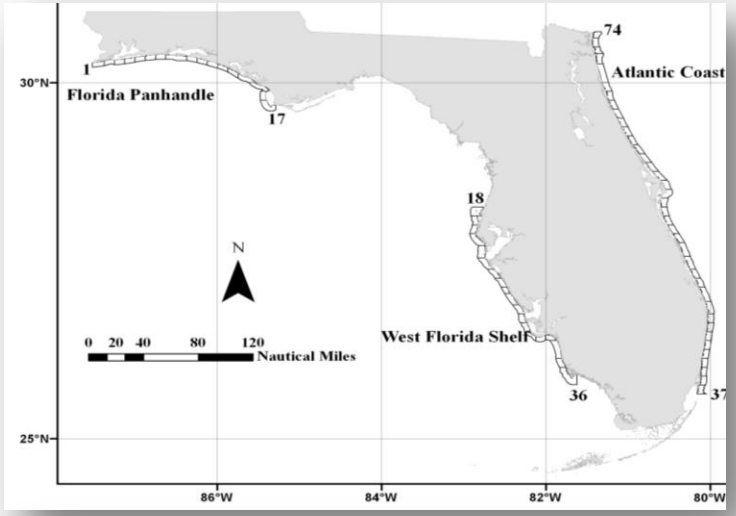


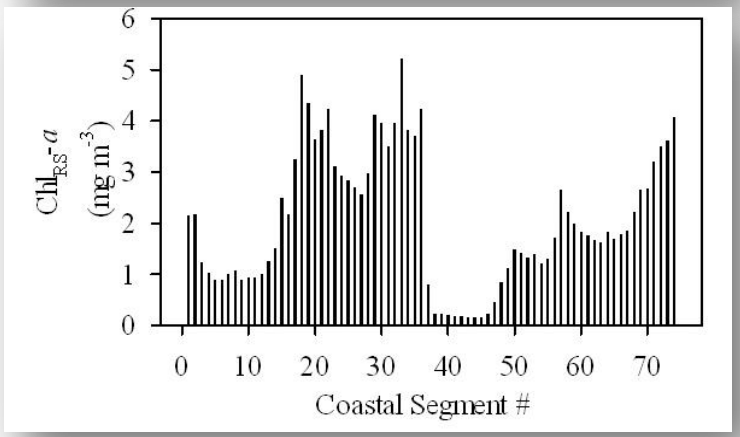


Sources: Lunetta et al. IJRS (*In Review*)

Coastal Numeric Nutrient Criteria

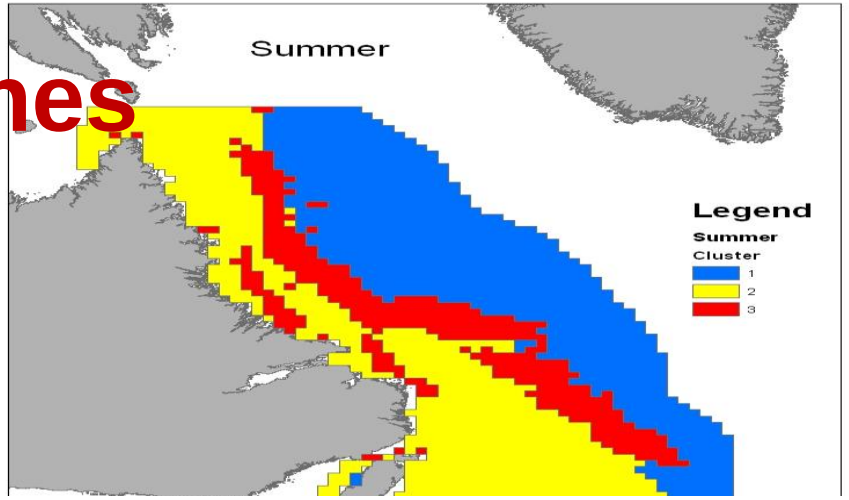
- State of Florida
- Criteria set w/ SeaWiFS
- Assessments from MODIS, VIIRS, PACE, and/or Sentinel-3

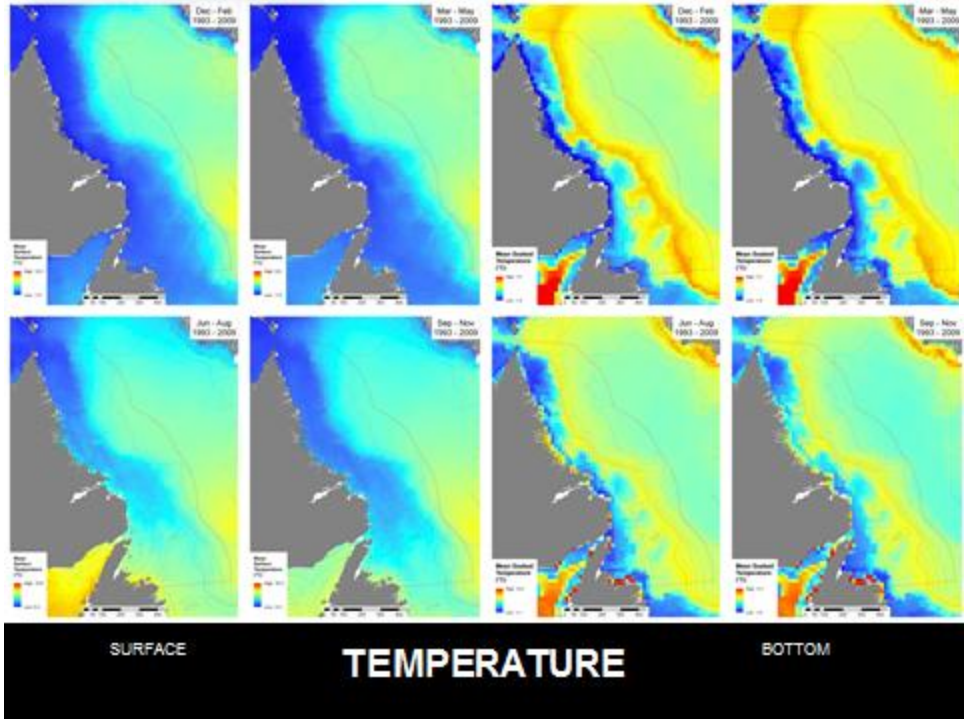


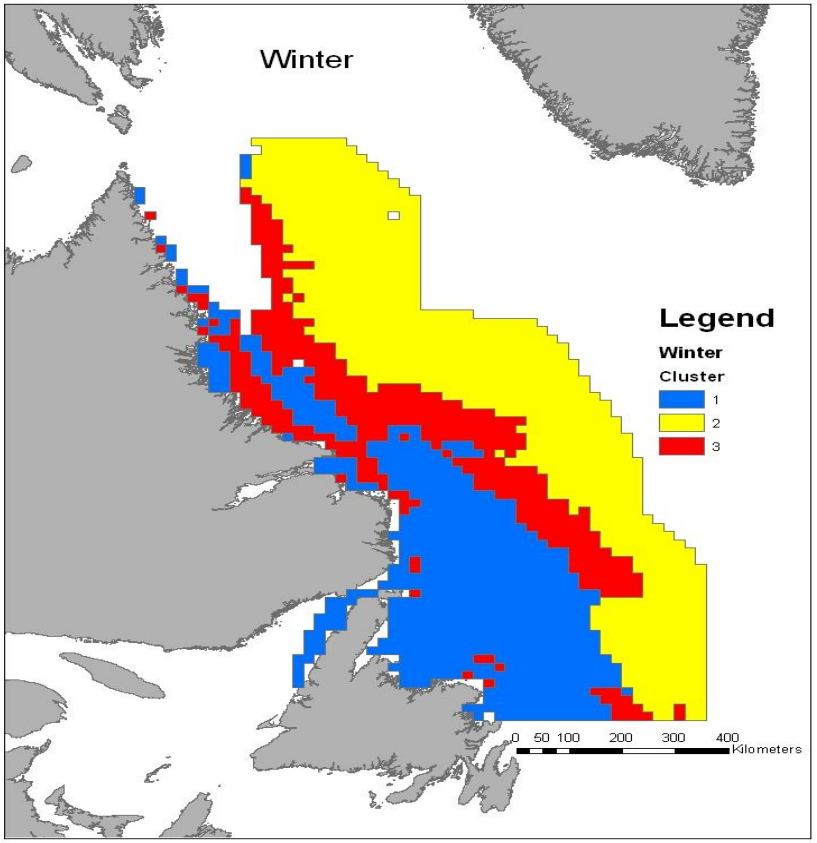


Sources: Schaeffer et al. ES&T (2012)
Schaeffer et al. JARS (2013)

Ecological Zones (DFO)







My Ocean GLORYS time series of physical and bgc variables to establish ecological zones.

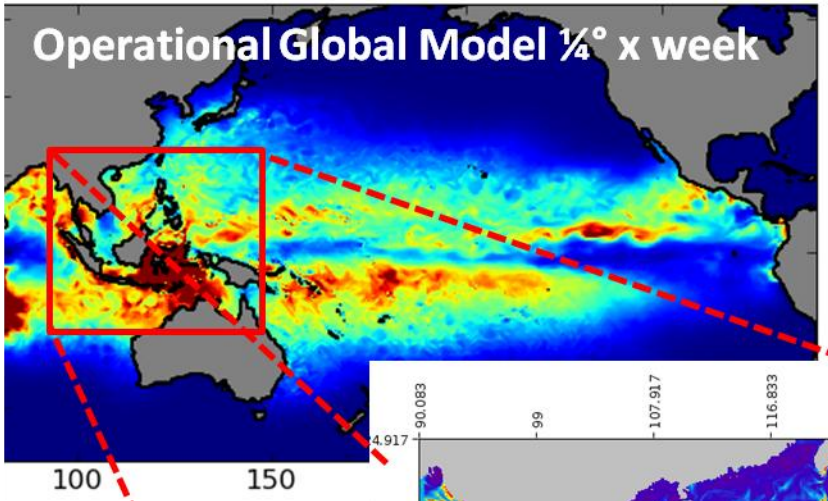
© Crown copyright Met Office

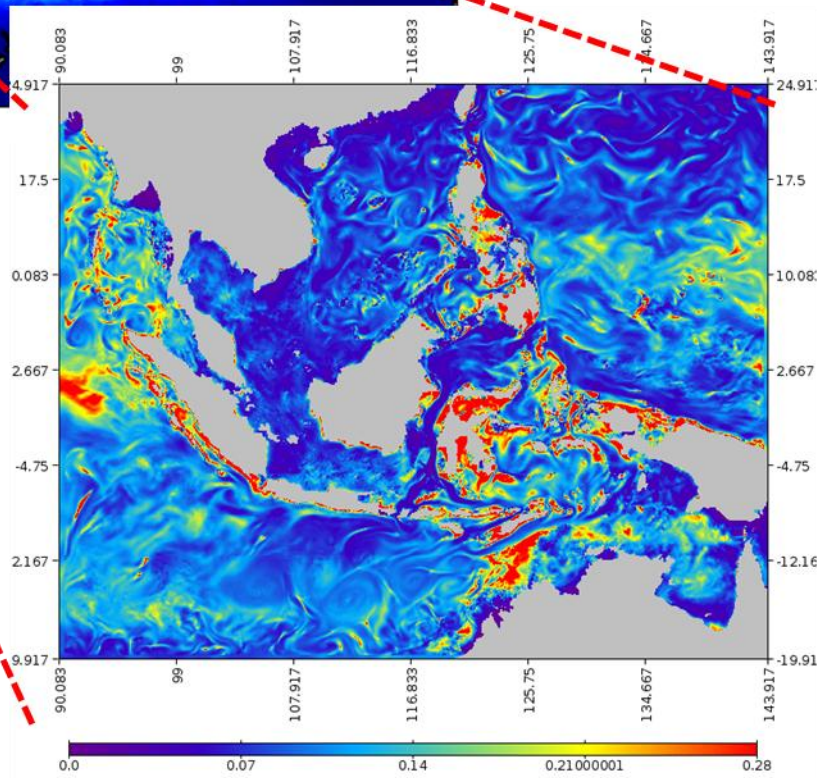
Tropical tuna fisheries (CLS)

Background:

Tropical tuna fisheries are multi-species and multi-fleets,70% of the global catch comes from the Pacific Ocean.

An operational global model is developed to monitor these fisheries and provide OBC to regional high resolution confisguration





Regional model
1/12° x 1day
with Open Boundaries Conditions provided from global model

See posters' session

Example of Emerging Application
Seasonal to Decadal Fisheries prediction?

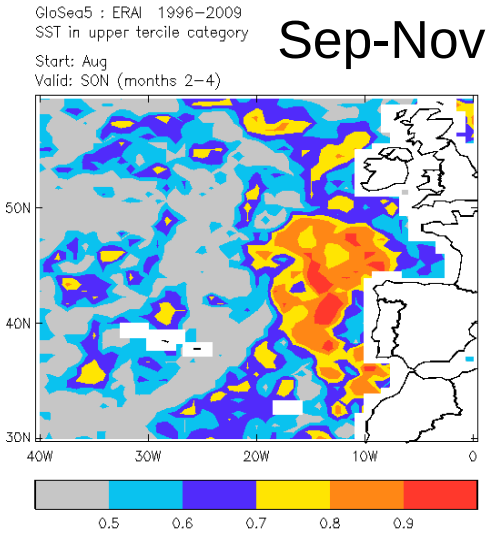
Met Office Hadley Centre

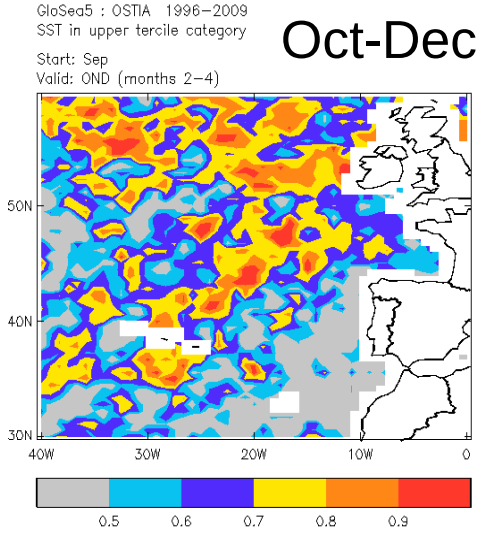
Sep-Nov

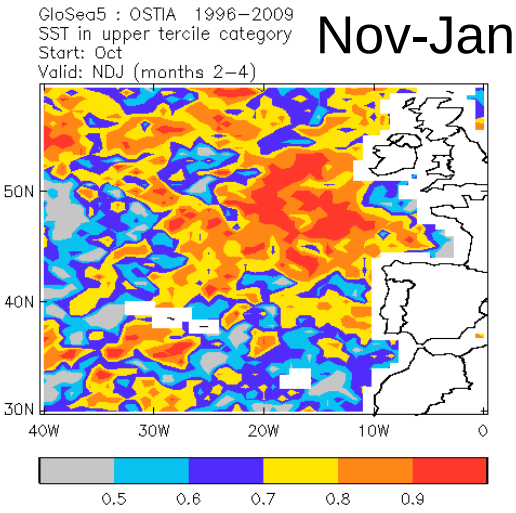
Oct-Dec

Nov-Jan

above







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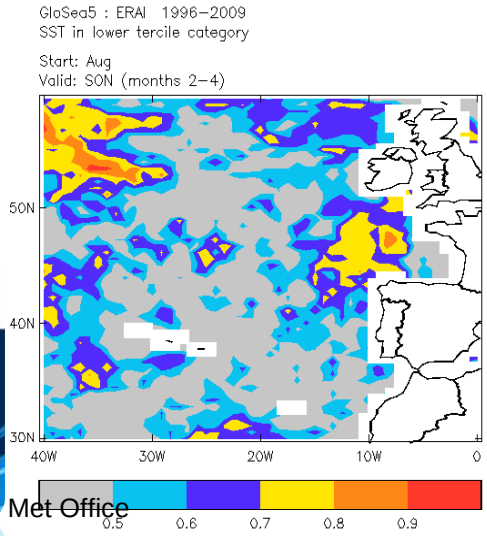

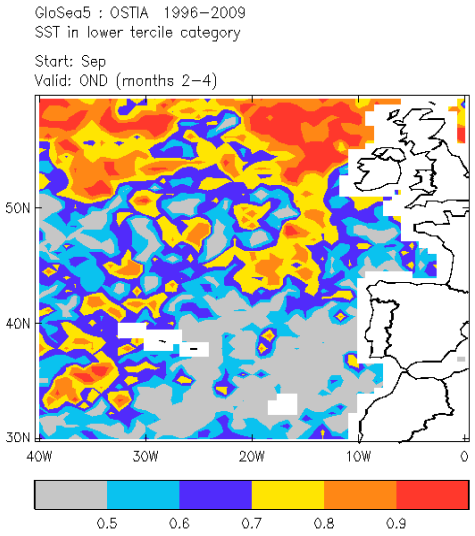

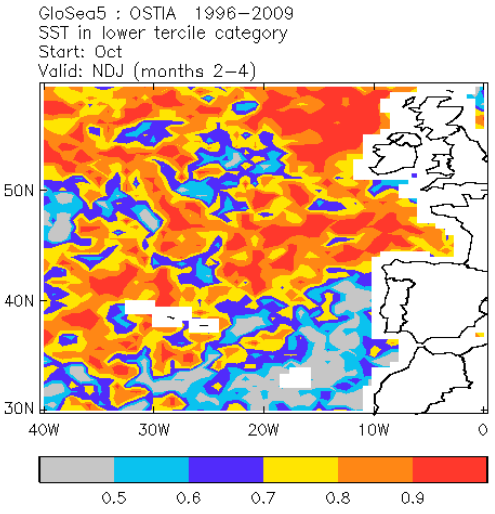

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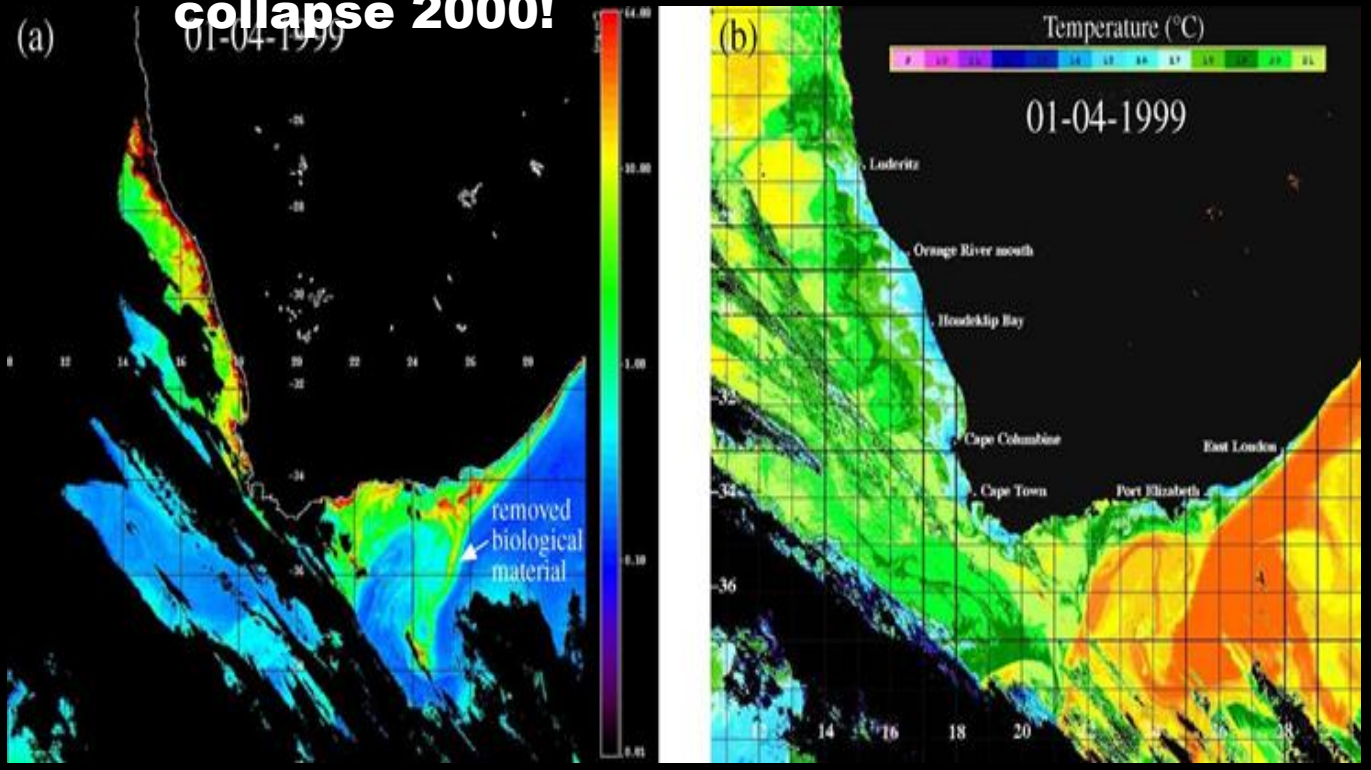
Early retroflection 1999 – squid fishery collapse 2000!



"Chokka crisis hits black business — demoralizing spates of poor catches threatens livelihood of 1000s" (Front page headline on the *Eastern Province Herald* 18 July 2001)

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Thank You!