SOCIB Balearic Islands Coastal Observing and Forecasting System

Strategy for Future Marine Operational Systems in the SES … in line with Blue Growth initiatives

(some examples from SOCIB)

Joaquín Tintoré (Research Prof. CSIC)
SOCIB and IMEDEA (CSIC-UIB)

Research and Innovation in the service of Economy and Society
EU Neighbourhood and the Black Sea region: "RInES. Thessaloniki, May 28-30, 2014

OUTLINE

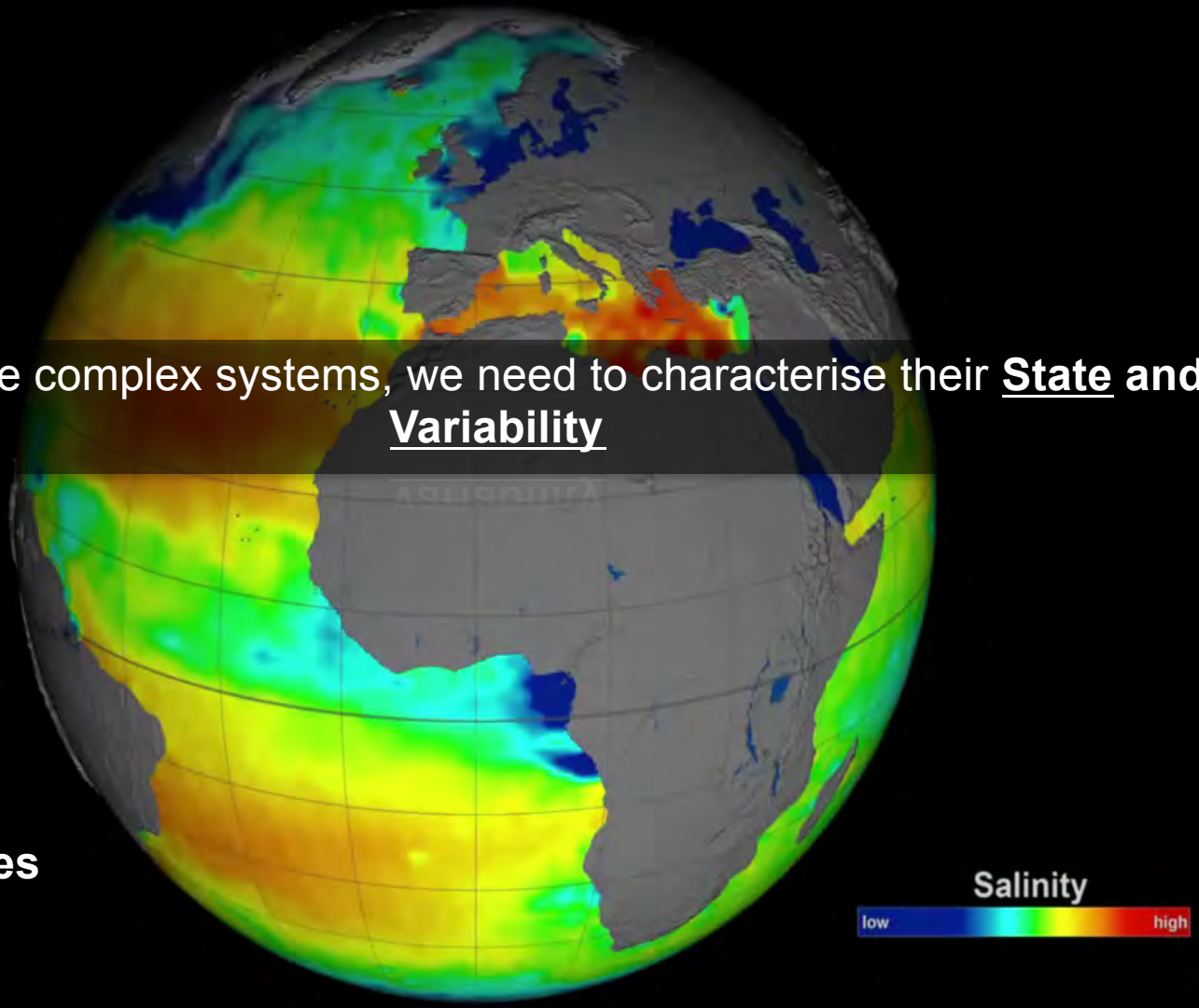
1. New Technologies: Paradigm Change Ocean and Coastal Observation. EU international leadership

2. Marine Research Infrastructures, Ocean Observatories: SOCIB, Integrated Science priorities, Technology Development and Society Needs

3. Innovation and Blue Growth: innovation in oceanography - gliders- (multi-disciplinary teams), data availability) and … "Turning Data into Jobs…"

Discussion: Are we ready for theses changes ? Do we have the framework and right structures to get all the benefits from these changes ? ("to enforce what we think has to be done…")

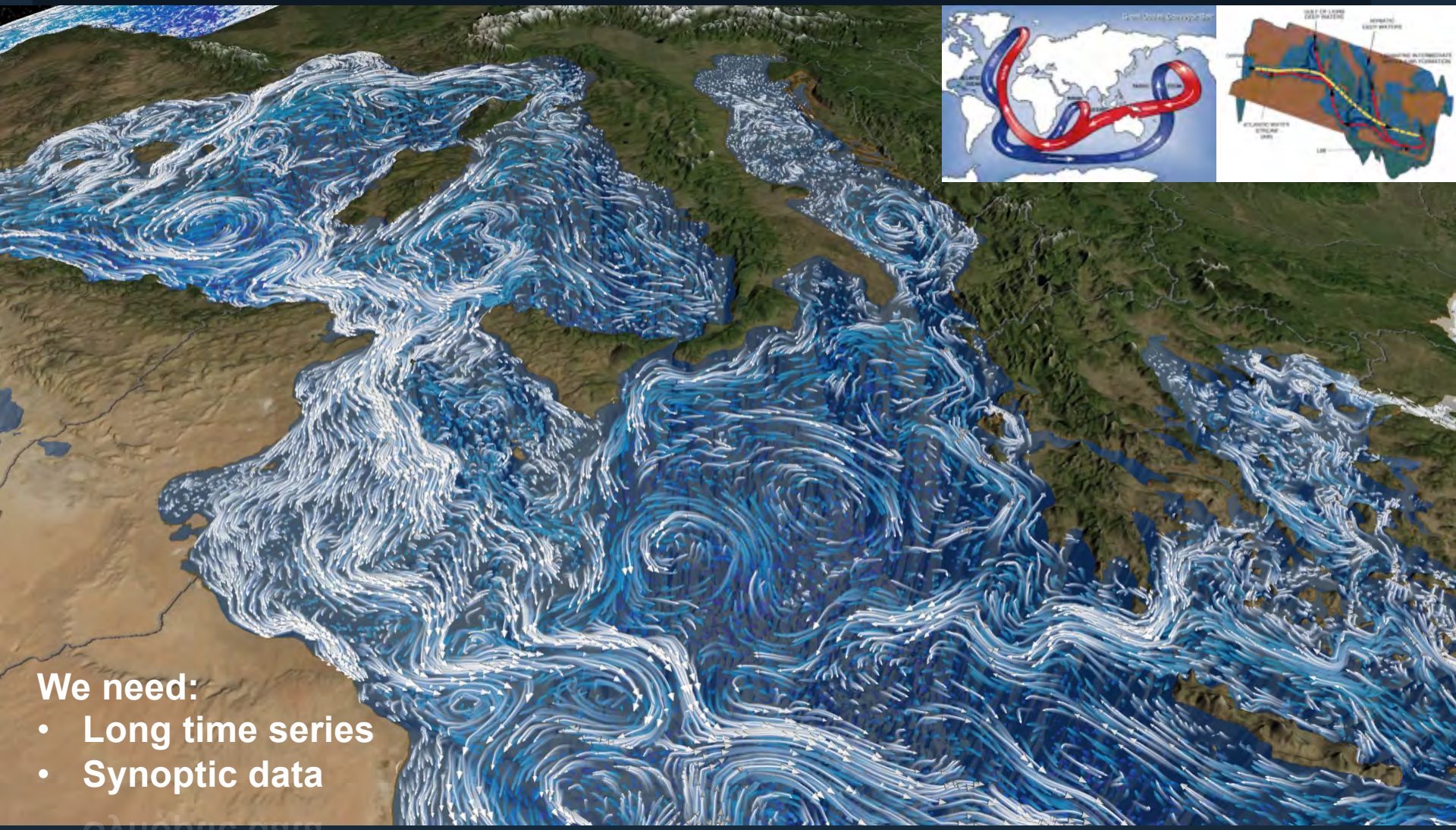
Oceans are complex systems, we need to characterise their **State and Variability**



We need:

- **Long time series**
- **Synoptic data**

NASA's Aquarius salinity, from December 2011 through December 2012



Mediterranean Sea: <u>Small Scale Ocean</u>, high relevance European Citizens (Science and Society)

NASA. Ocean current flows in the Mediterranean (2 mins. - 16 Feb 2005 through 16 January 2006). http://svs.gsfc.nasa.gov/goto?3820

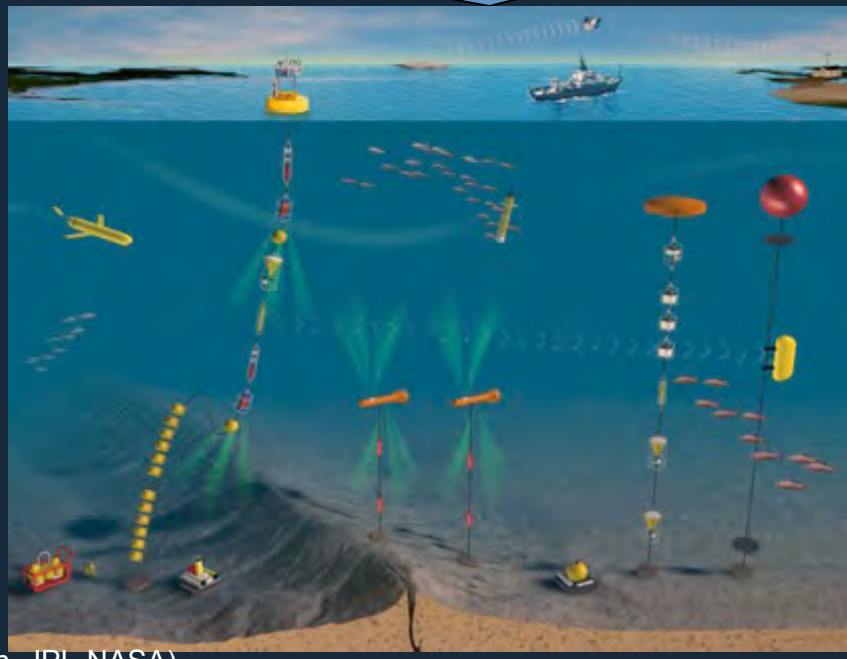
New Technologies: Paradigm Shift
➡ Ocean Observation

From: Single Platform - Ship based observation

To: Multi-platform observing systems

Platform-centric Systems

Network - distributed Systems



(Adapted from Steve Chien, JPL-NASA)

"A single ship can only be in one place at one time. We need to be present in multiple places in multiple times." (John Delaney, Nature, Sept. 25, 2013)

New Technologies: Paradigm Shift
→ Data Availability

From: Data only available 12-24 months/years after cruises….

To: Quasi-real time quality controlled data available

Data available for science and society

- Huge increase in human potential for analysis, models/data inter-comparison
- Allowing new science and knowledge based management oceans and coast
- More reliable knowledge based response under emergencies

"Le véritable voyage de découverte ne consiste pas à chercher de nouveaux paysages, mais à avoir de nouveaux yeux" – "The real voyage of discovery consists not in seeking new landscapes, but in having new eyes". (Marcel Proust)

NEW CHALLENGES: implies adaptation … Scientists, Society…

Key words:

- **Multi-disciplinary. Multi-platform. Free and Open Data. Integration**.
- Scientific career. Students. Science evaluation. Society response.

New Technologies: Paradigm Shift
⟶ Data Availability

ALBOREX, May 30, 2014 situation (1040h)

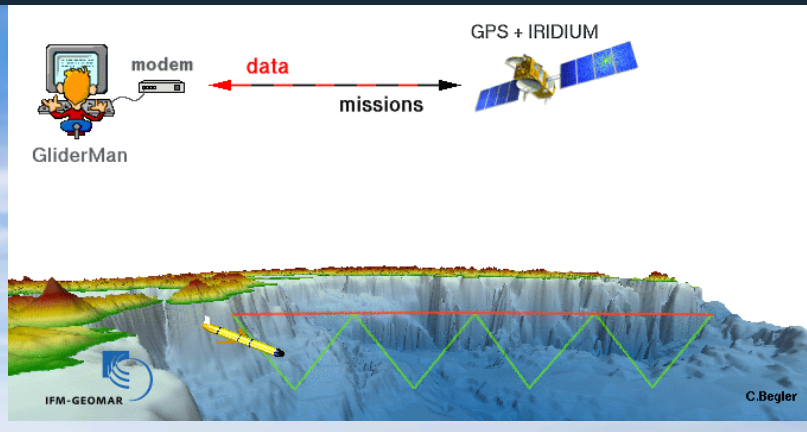
Ruiz et al., 2013: Anchovy landings x 10 related to Alboran gyre location…

SOCIB

http://apps.socib.es/dapp

PERSEUS

An Example of New Technologies: Autonomous Underwater Gliders



Why Ocean Observatories, why SOCIB, why now?

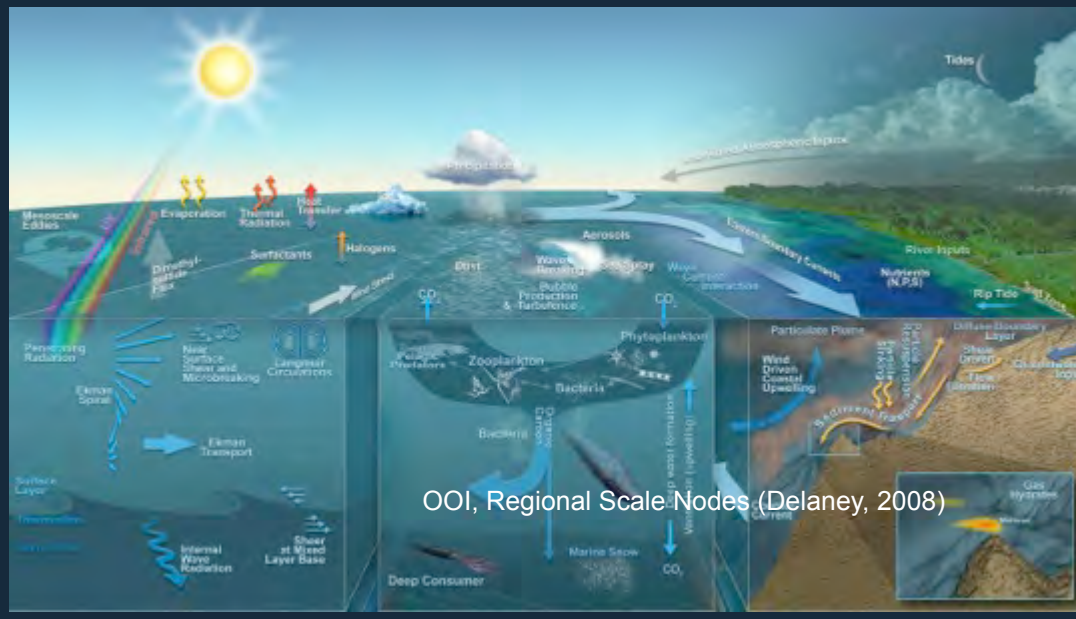
New Technologies triggered a paradigm change
New Approach to Marine and Coastal Research

Allow three-dimensional real time observations, that combined with forecasting numerical models, and data assimilation, …

A quantitative major jump, in scientific knowledge and technology development

The development of a new form of Integrated Coastal and Ocean Management

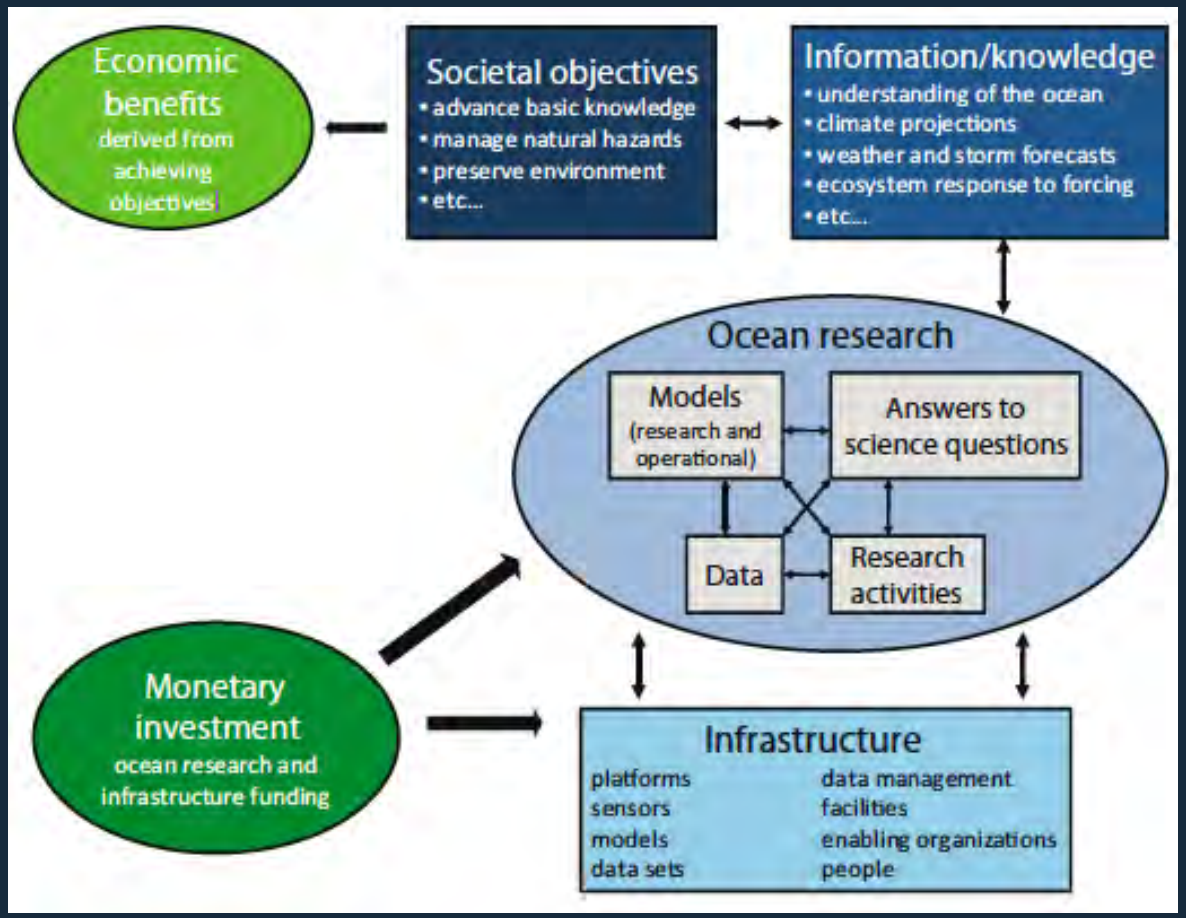
on a global change context (where climate change is one of the most important, but not the only one…), and following sustainability principles



OOI, Regional Scale Nodes (Delaney, 2008)

Are we ready for theses changes?
We need to open our minds, adapt scientific and educational structures, management procedures

Ocean Observatories, Marine Research Infrastructures: International Frame



[Committee on an Ocean Infrastructure: Strategy for U.S. Ocean Research in 2030. NRC (2011)]

SOCIB: MRI International Framework

Europe
- POSEIDON, Cosyna, MONGOOS, among others …
- ESFRI –

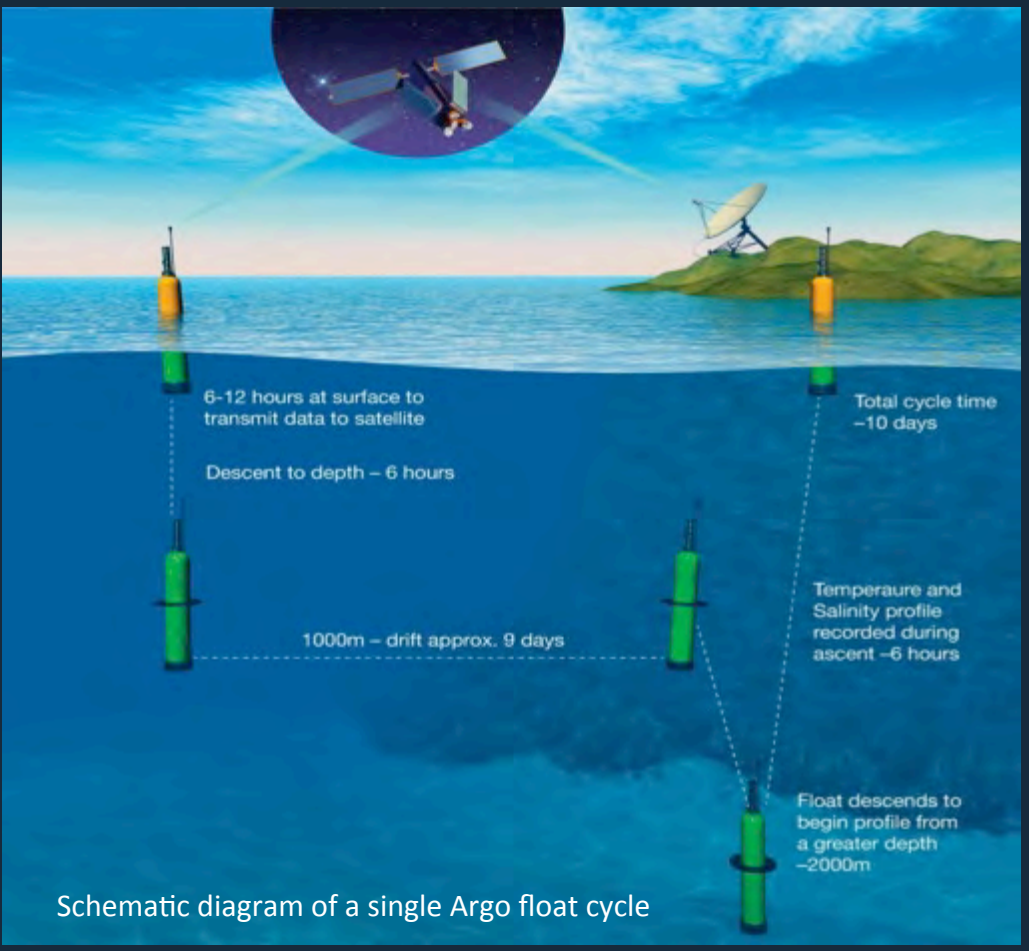
EEUU
- OOI (NSF research)

- IOOS (inter-agency operational)

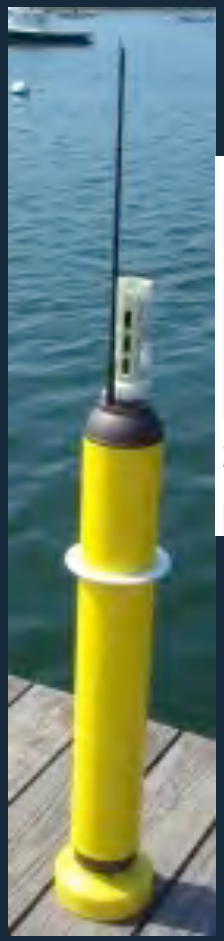
Canada
- NEPTUNE, VENUS,

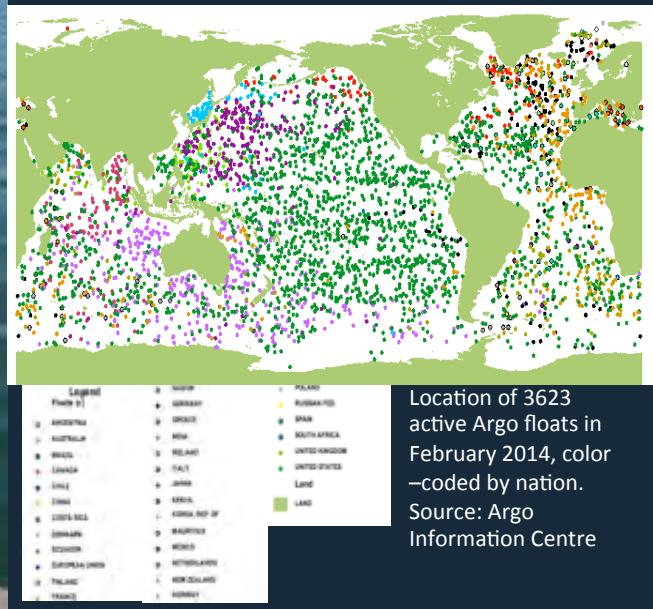
Australia
- IMOS: Integrated Marine Observing System

Why now ?: Last decade, successful Argo international programme, Euro-Argo



Schematic diagram of a single Argo float cycle





Location of 3623 active Argo floats in February 2014, color –coded by nation. Source: Argo Information Centre

http://www.euro-argo.eu

Argo Programme -combined with satellite altimetry- allowed characterisation

STATE OF LARGE SCALE OCEAN CIRCULATION

Why now ?: The real challenge today is Ocean Variability: monitoring at the right scales

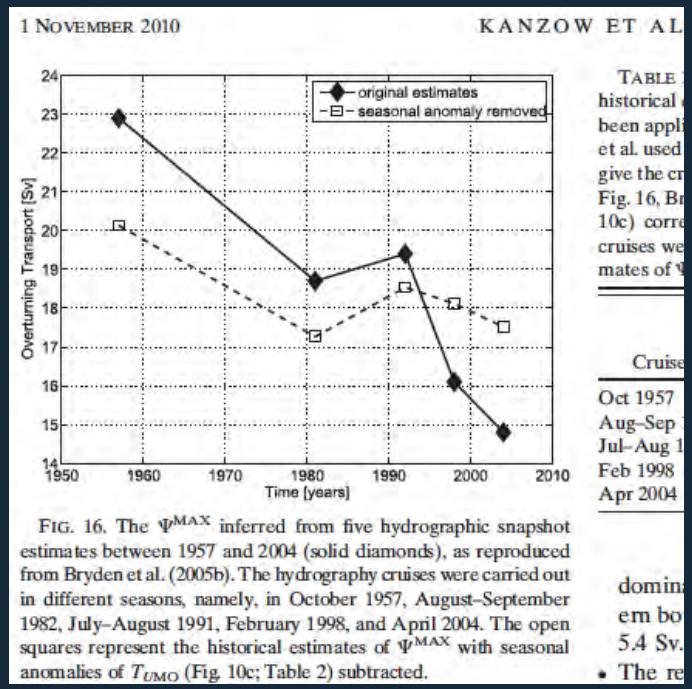


FIG. 16. The Ψ^{MAX} inferred from five hydrographic snapshot estimates between 1957 and 2004 (solid diamonds), as reproduced from Bryden et al. (2005b). The hydrography cruises were carried out in different seasons, namely, in October 1957, August–September 1982, July–August 1991, February 1998, and April 2004. The open squares represent the historical estimates of Ψ^{MAX} with seasonal anomalies of T_{UMO} (Fig. 10c; Table 2) subtracted.

TABLE
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An Example: AMOC, Atlantic Ocean Meridional Circulation

2005: decline.
2010: seasonal biases correction

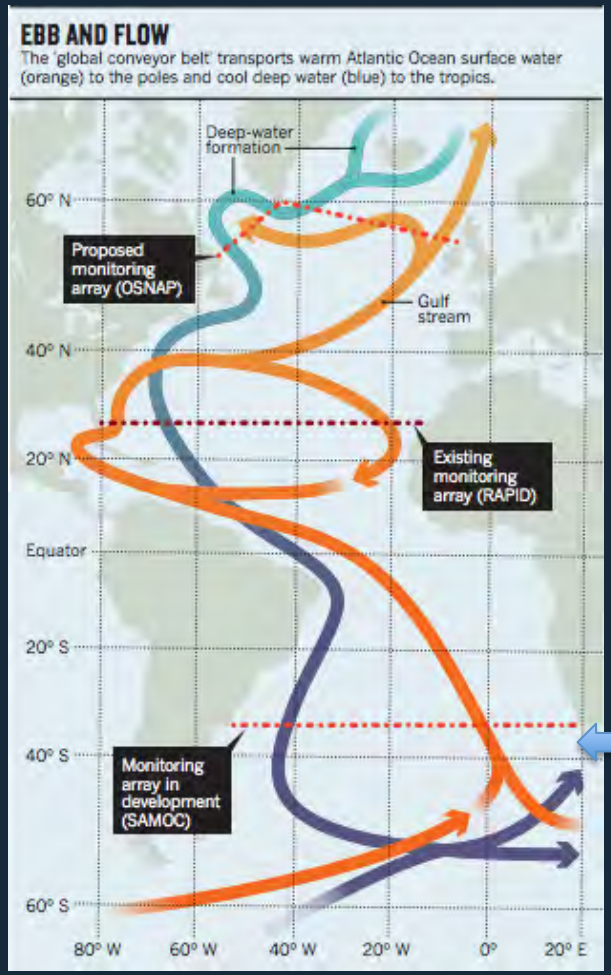

IN FOCUS NEWS

Oceans under surveillance

Three projects seek to track changes in Atlantic overturning circulation currents.

BY QUIRIN SCHIERMEIER

In April 2009, the array recorded[1] a 30% drop a crucial component of the conveyor belt; the

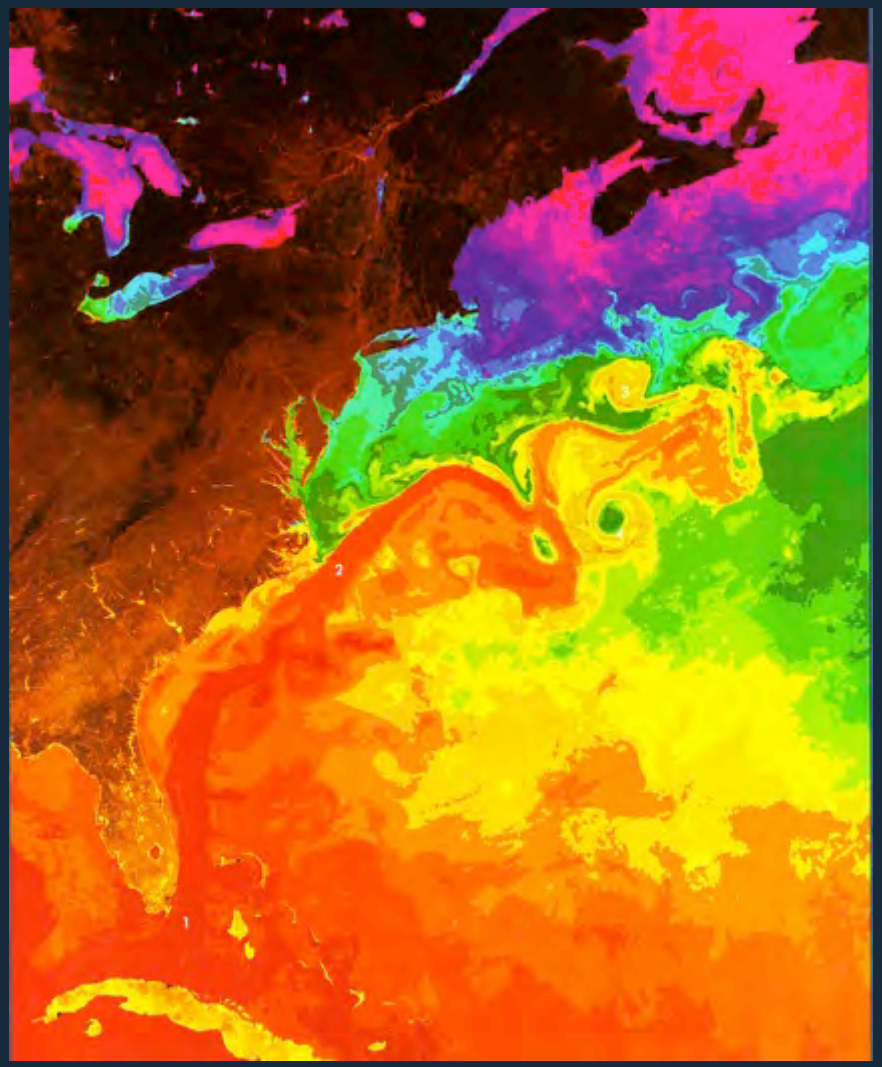


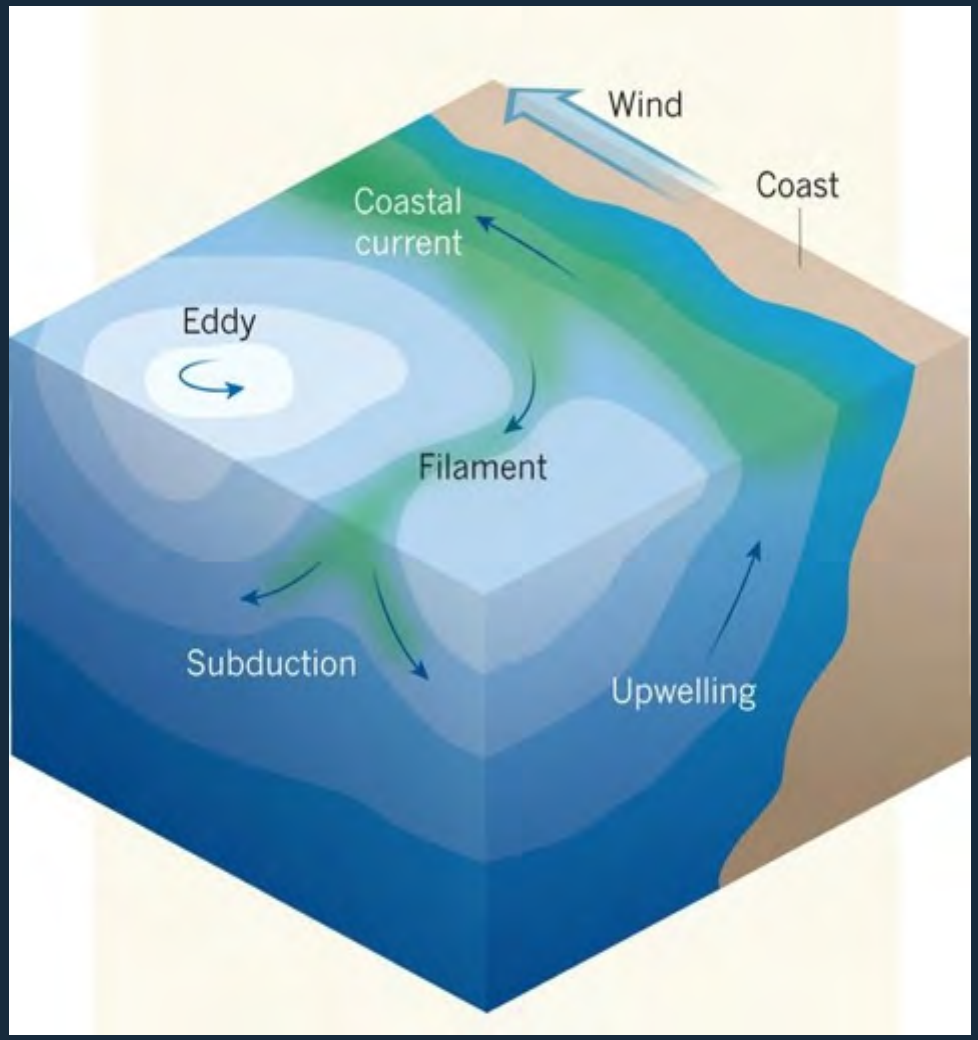
AMOC recent key milestones:

- 2005
- 2010
- 2012
- 2013

In April 2009, the array recorded a 30% drop in average current strength that persisted for a year, reducing the amount of heat transported to the North Atlantic

Ocean currents, eddies and instabilities: the mesoscale, the oceanic weather





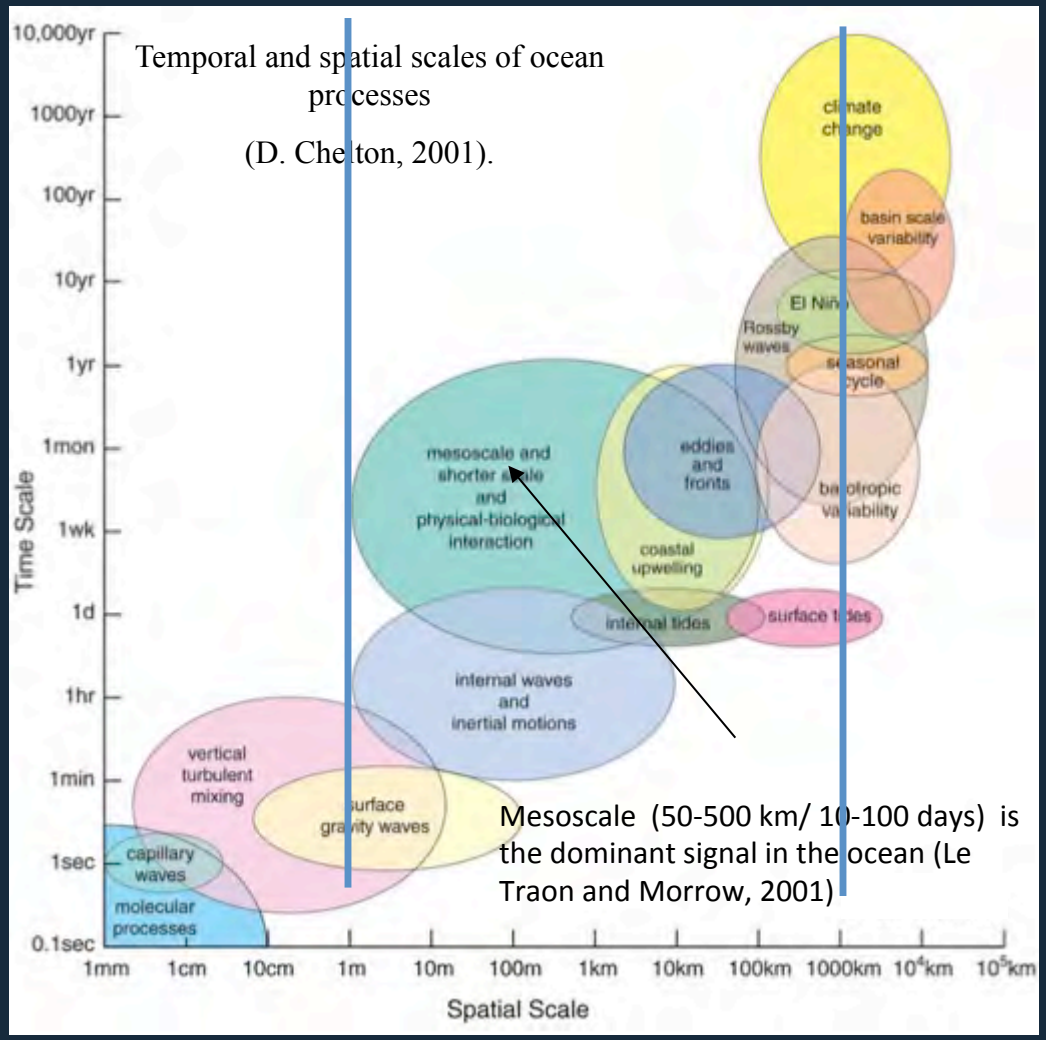
Mahadevan (Nature, 2014)

Why and how to focus on Variability at Mesoscale and Coastal interactions?

Theory and observations have shown that there is a maximum energy at the mesoscale (include fronts and eddies ~10-100km),

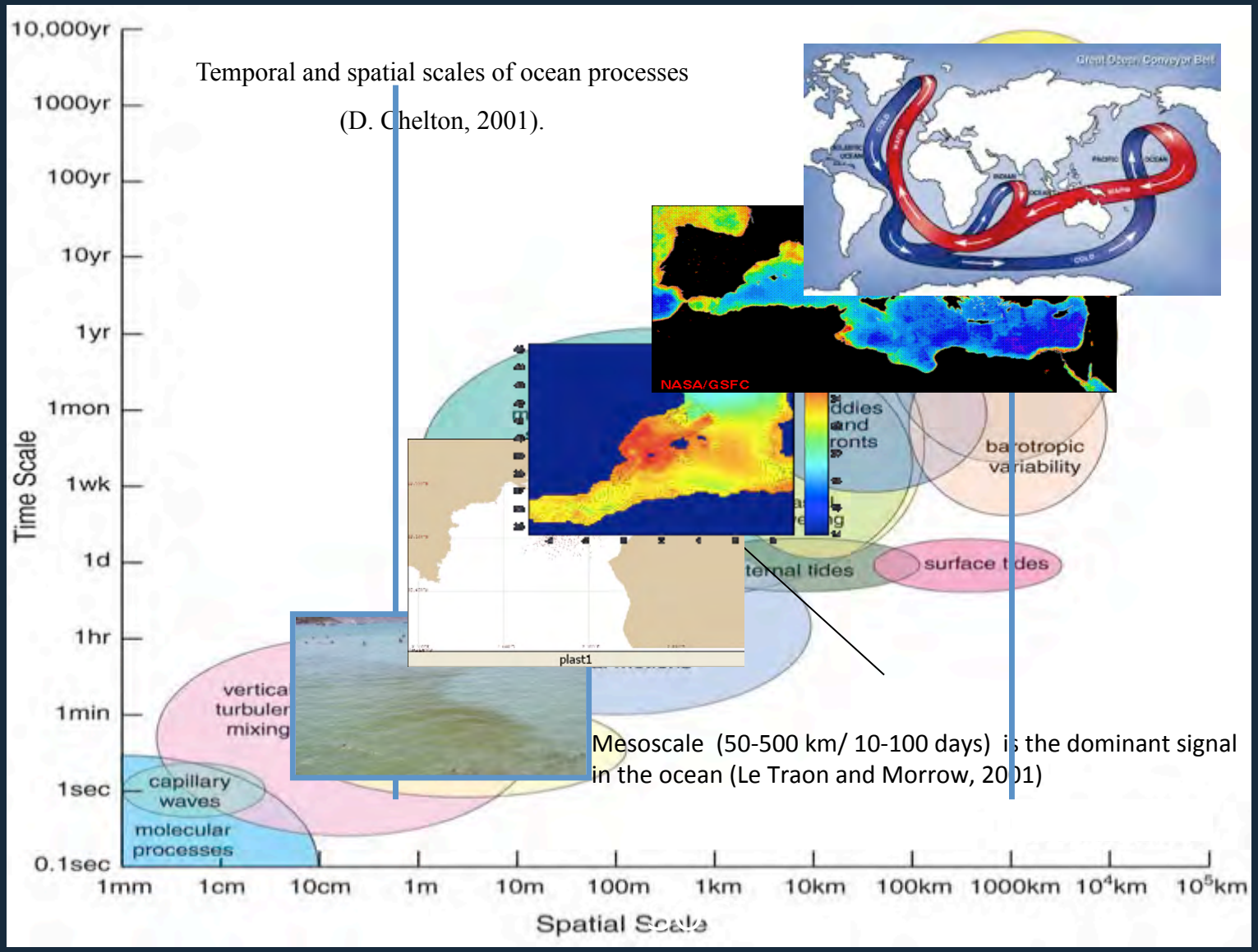
SOCIB focus: mesoscale & submesoscale and their interactions with general circulation and their effects on vertical motions, impact on ecosystem variability.

With inputs from 'both sides'....
(nearshore and coastal ocean and also seasonal/inter-annual and decadal variability)



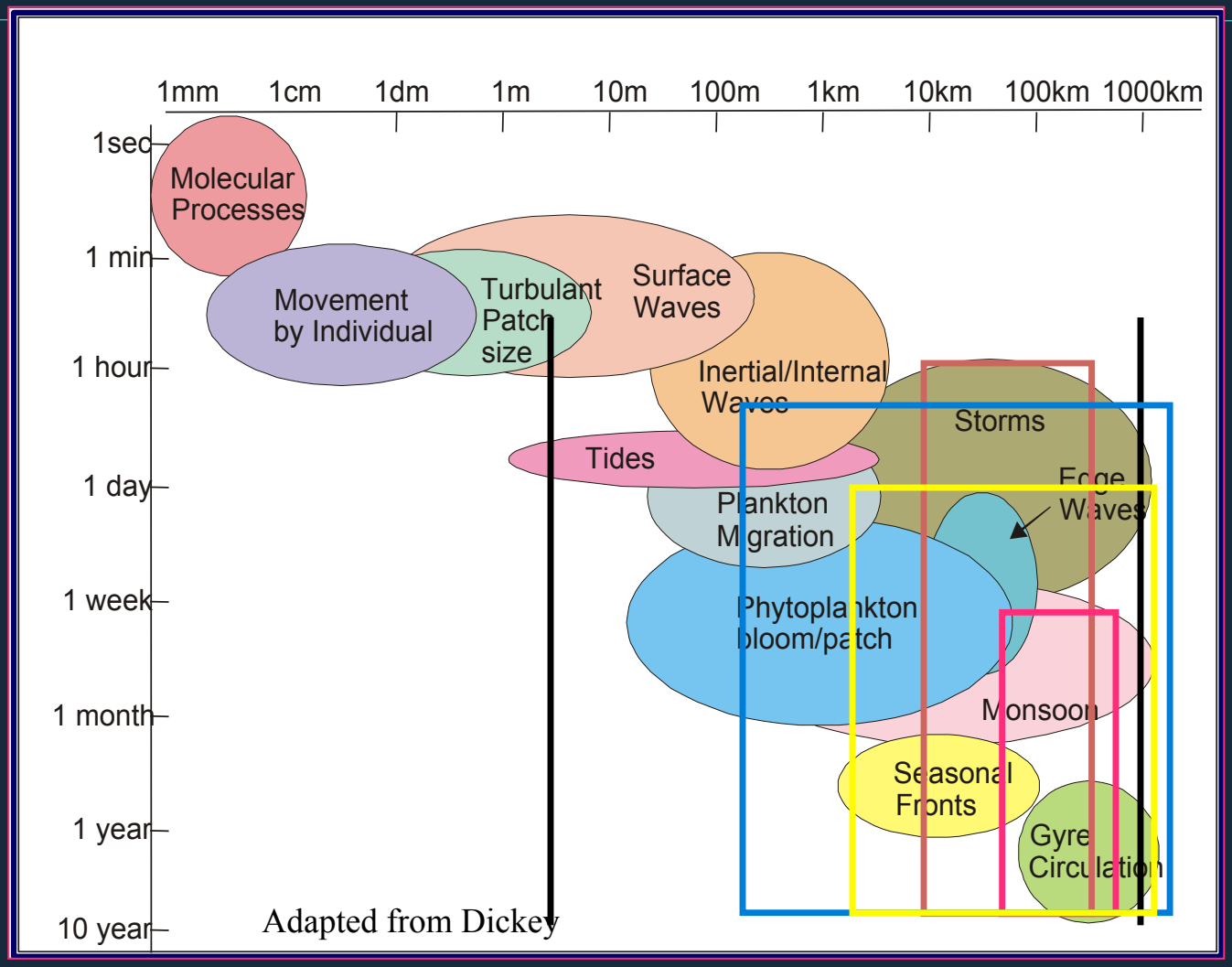
SOCIB scales

Why and how to focus on Variability at Mesoscale and Coastal interactions?



Mesoscale (50-500 km/ 10-100 days) is the dominant signal in the ocean (Le Traon and Morrow, 2001)

SOCIB scales and monitoring tools



Gliders

Fixed Platforms

HF radar

24 m R/V Catamaran

Satellite

The real challenge for the next decade…:

<u>To use and integrate</u> these new technologies to carefully and systematically

- Monitor the variability at small scales, e.g. mesoscale/ weeks, to
- Resolve the sub-basin/seasonal and inter-annual variability and by this
- Establish the decadal variability, understand the associated biases and correct them …

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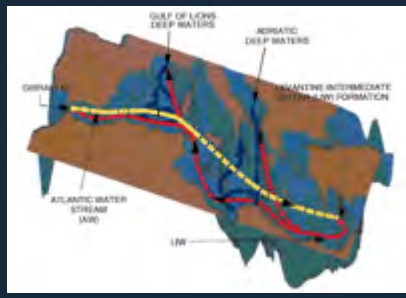
Why Mediterranean and why SOCIB, ?

Mediterranean

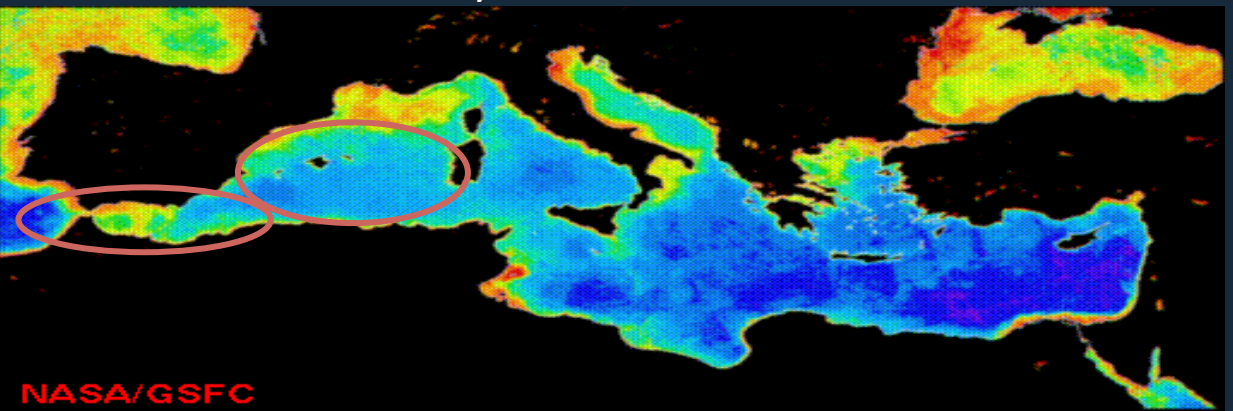
- Scientific relevance as small scale ocean, THC; (e.g., Malanote-Rizzoli et al., 2014).
- Society relevance: European citizens
- Leading ocean science, new technologies, data management,

  society response



Balearic Islands … after 25 years…

- Scientific know-how and technological infrastructures: leading international science
- Governmental unified joint support (MINECO and Balearic Gov); RIS3 Smart and Sustainable Tourism
- Civil Society endorsement



What is SOCIB? A multi-platform observing system,

www.socib.es

PAPER

SOCIB: The Balearic Islands Coastal Ocean Observing and Forecasting System Responding to Science, Technology and Society Needs

AUTHORS

Tintoré et al., 2013: *Marine*

What is SOCIB? A multi-platform observing system, from nearshore to open-ocean in Mediterranean

OBSERVING FACILITIES

Research vessel

HF Radar

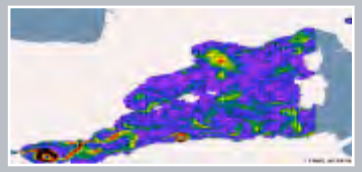
Gliders

Lagrangian platforms

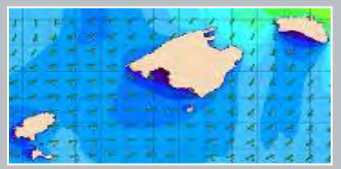
Fixed stations

Beach Monitoring

MODELLING FACILITY



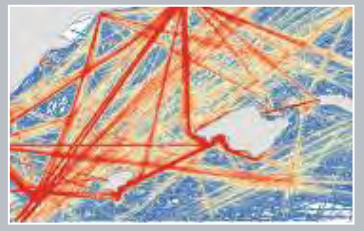
Currents (ROMS)



Waves (SWAN)

STRATEGIC ISSUES & APPLICATIONS FOR SOCIETY

Integrated Coastal Management



Marine Spatial Planning

DATA CENTER

Data access – Data Repository – Applications
Spatial data infrastructure – Real time monitor

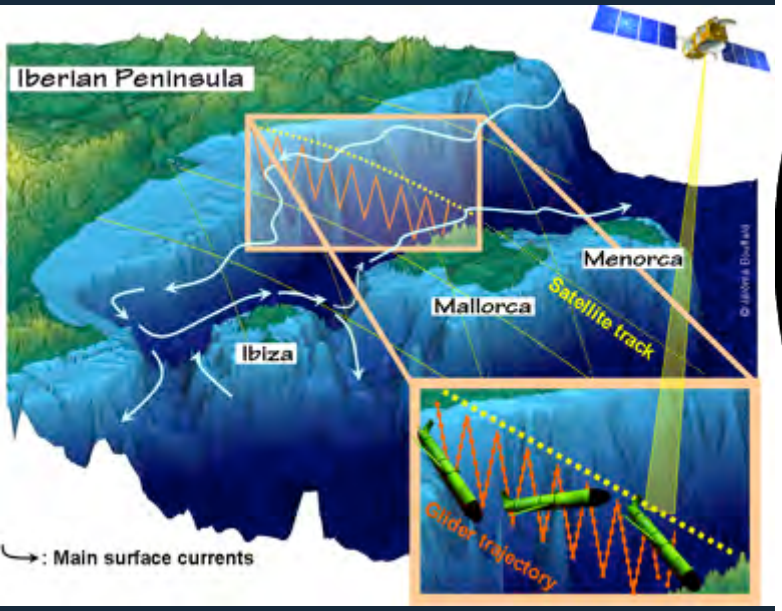
What is SOCIB? A multi-platform observing system, from nearshore to open-ocean in Mediterranean

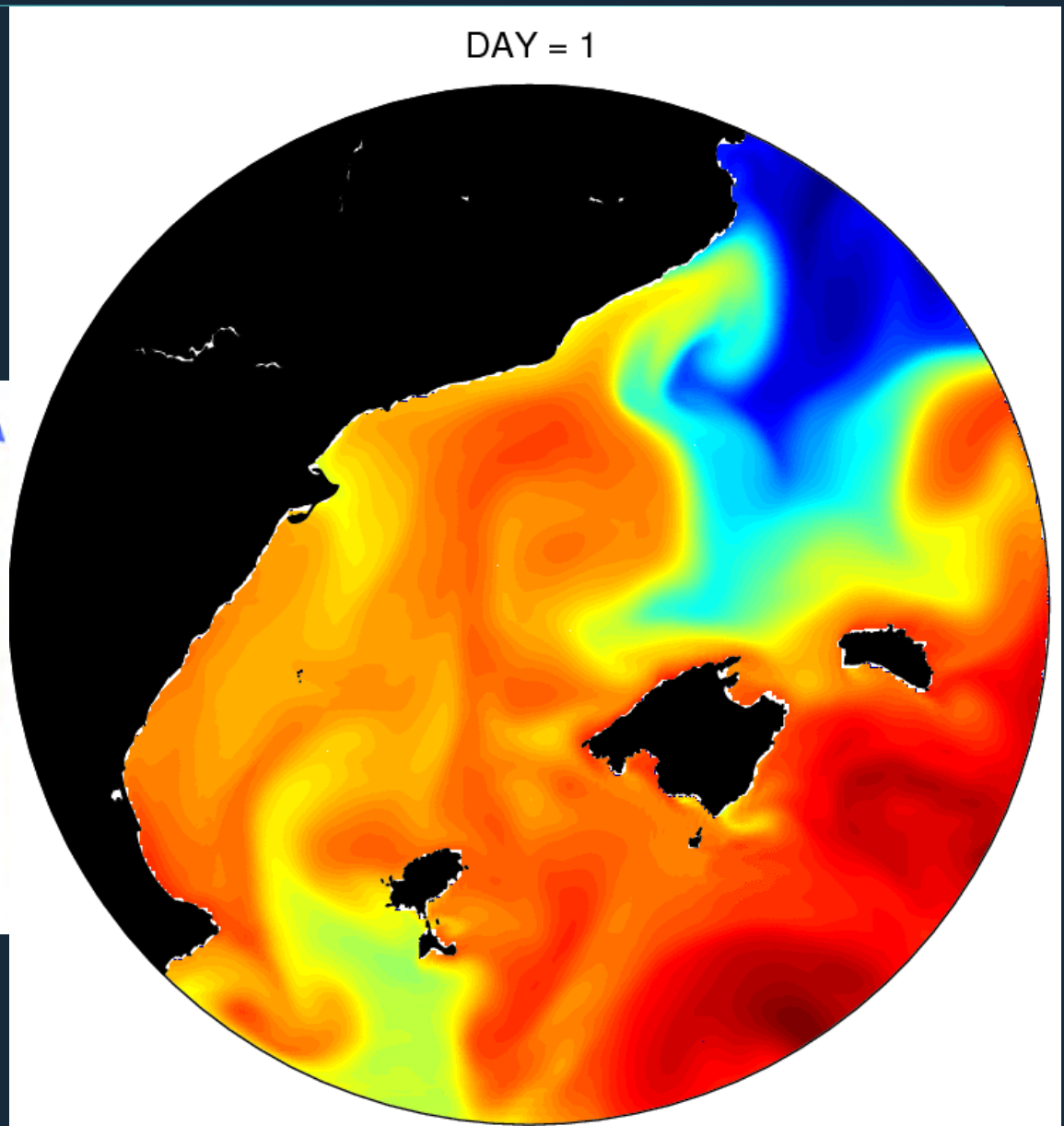
3 Drivers

- Science priorities
- Technology Dev.
- Society Needs

www.socib.es

Ocean Circulation Variability, an example in the Balearic Sea (biodiversity hotspot)





SOCIB Data Centre: Real Time, Free Access & Download, Quality Controlled, Interoperable Data

SESAME

myOcean

Copernicus

TOSCA
NETWORK FOR A BETTER RESPONSE TO MARITIME ACCIDENTS

MED ESS 4MS

GROOM

SEVENTH FRAMEWORK PROGRAMME

JERICO

PERSEUS
POLICY-ORIENTED MARINE ENVIRONMENT

EMODnet
European Marine Observation and Data Network

MedSea Portal

Gliders Facility: Science

Mesoscale – Submesoscale / Vertical motions - biogeo effects

GEOPHYSICAL RESEARCH LETTERS, VOL. 36, L14607, doi:10.1029/2009GL038569, 2009

Vertical motion in the upper ocean from glider and altimetry data

Simón Ruiz,[1] Ananda Pascual,[1] Bartolomé Garau,[1] Isabelle Pujol,[2] and Joaquín Tintoré[1]

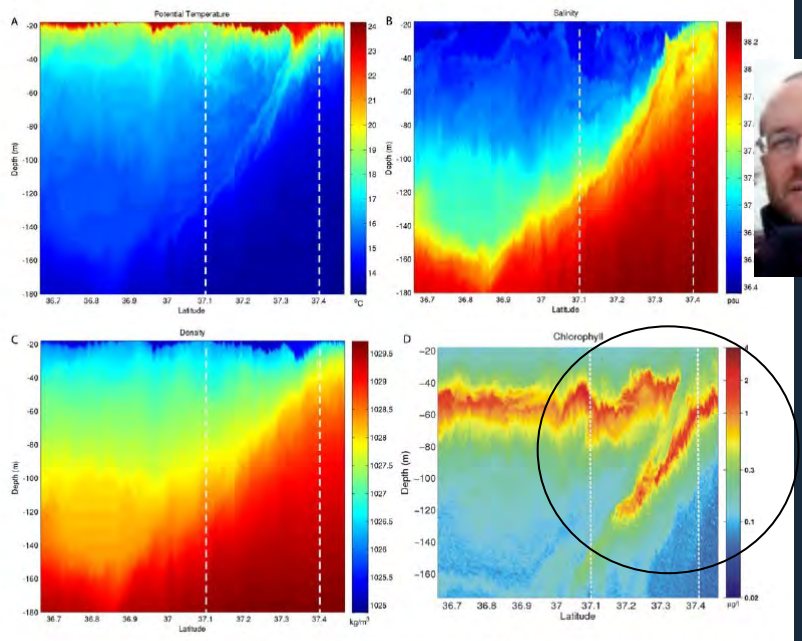
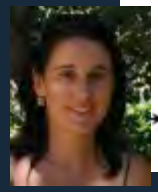


Figure 2. Vertical section of temperature (°C), salinity (PSU), density (kg/m^3) and chlorophyll (μg/l) from glider section 2 (dashed magenta in Figure 1). White dashed lines define sub-section in the northern part of the domain.

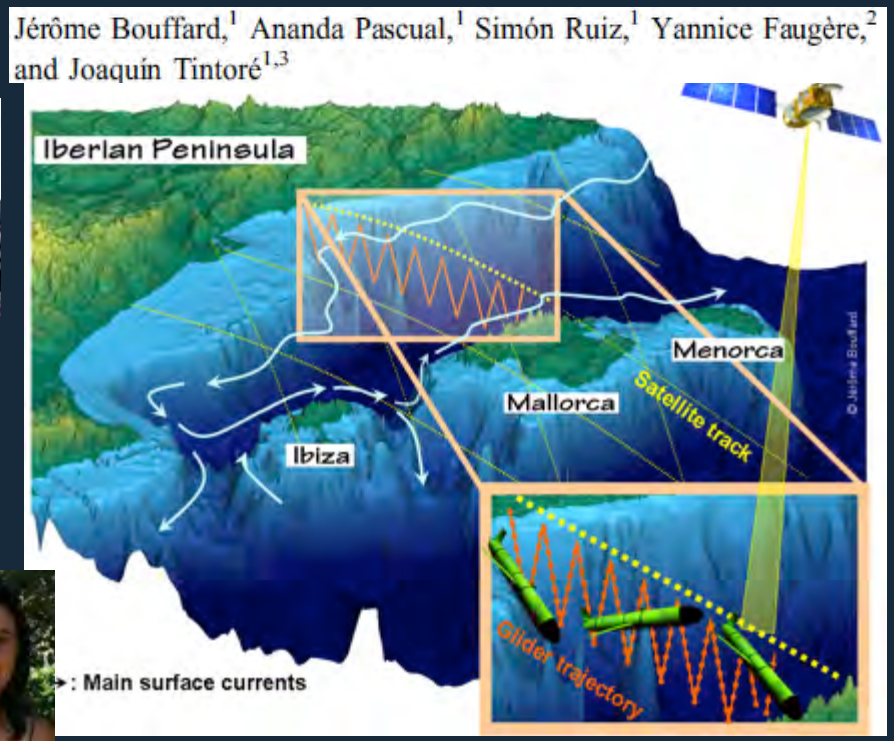


Eddy/mean flow interactions – Blocking effects General Circulation

JGR, 2010

Coastal and mesoscale dynamics characterization using altimetry and gliders: A case study in the Balearic Sea

Jérôme Bouffard,[1] Ananda Pascual,[1] Simón Ruiz,[1] Yannice Faugère,[2] and Joaquín Tintoré[1,3]



Gliders Facility: Operational

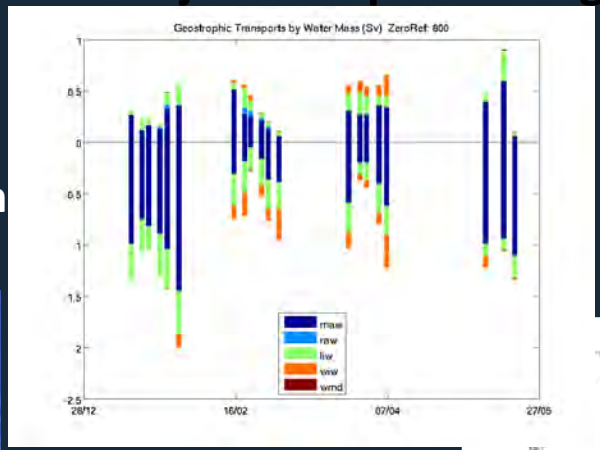
GEOPHYSICAL RESEARCH LETTERS, VOL. 39, L20604, doi:10.1029/2012GL053717, 2012

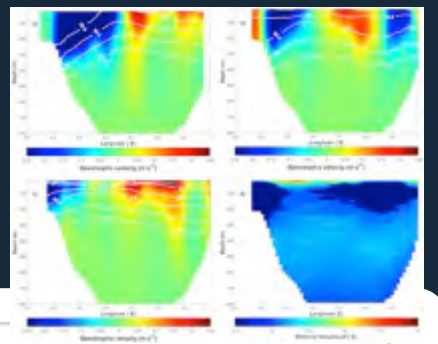
Autonomous underwater gliders monitoring variability at "choke points" in our ocean system: A case study in the Western Mediterranean Sea

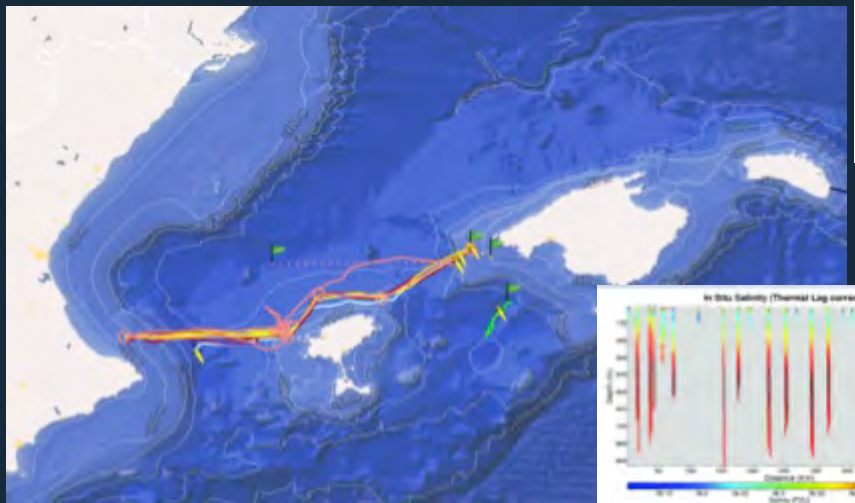
Emma E. Heslop,[1] Simón Ruiz,[1] John Allen,[2,3] José Luís López-Jurado,[4] Lionel Renault,[5] and Joaquín Tintoré[1,5]

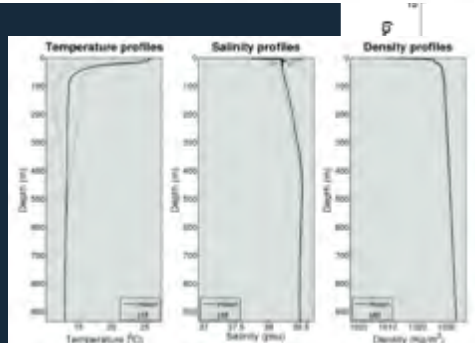
- After 32 glider missions (started in 2006), + 17.000 profiles (30 Euros/ profile)
- Since January 2011; routine operation

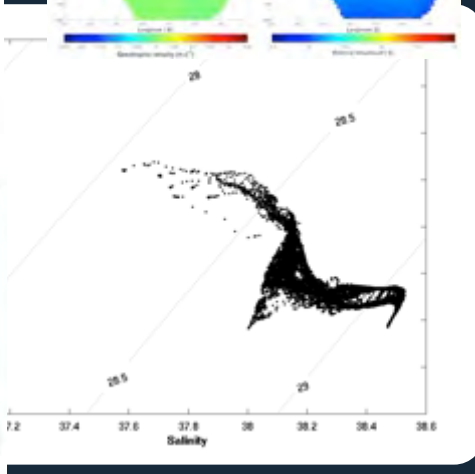
Major transport changes



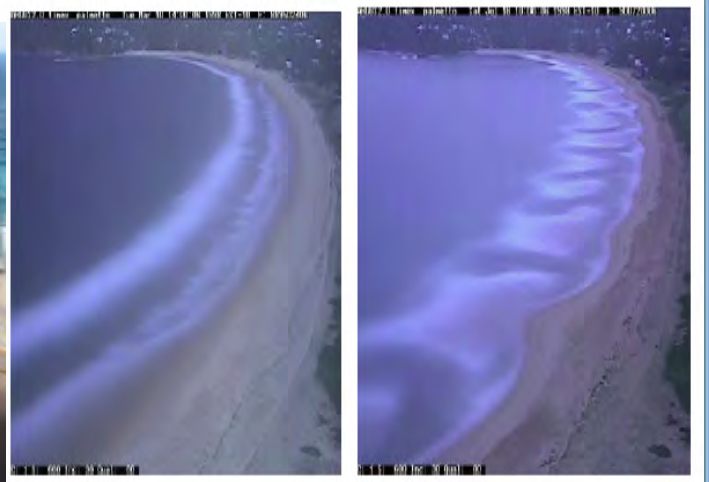


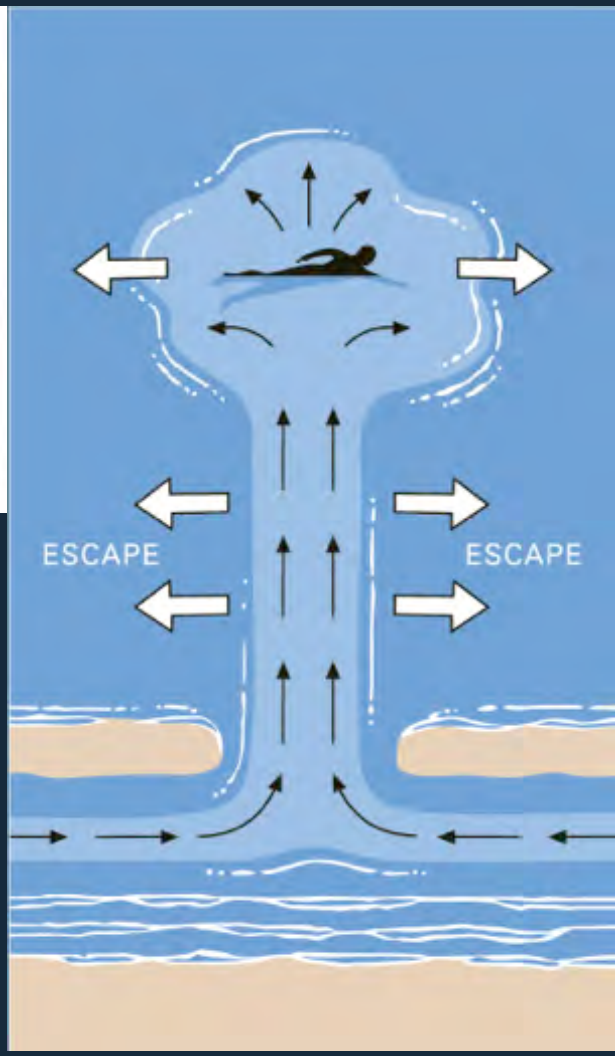


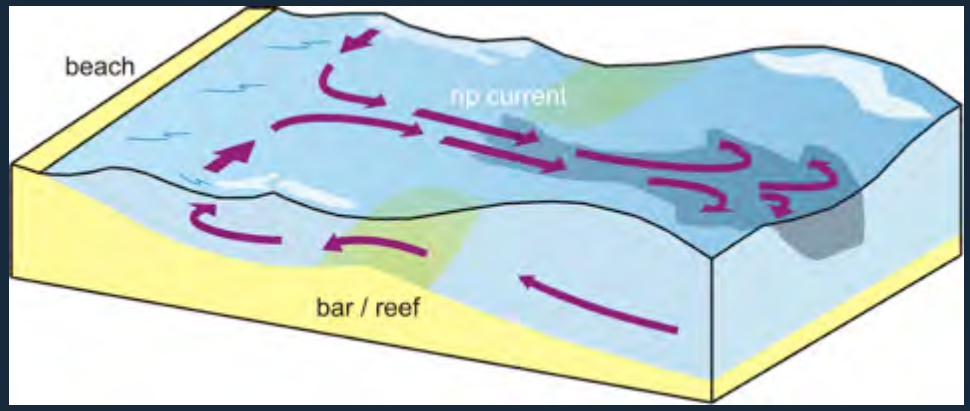




SOCIB Technology Development & Applications: Beach Safety -Rip Currents-



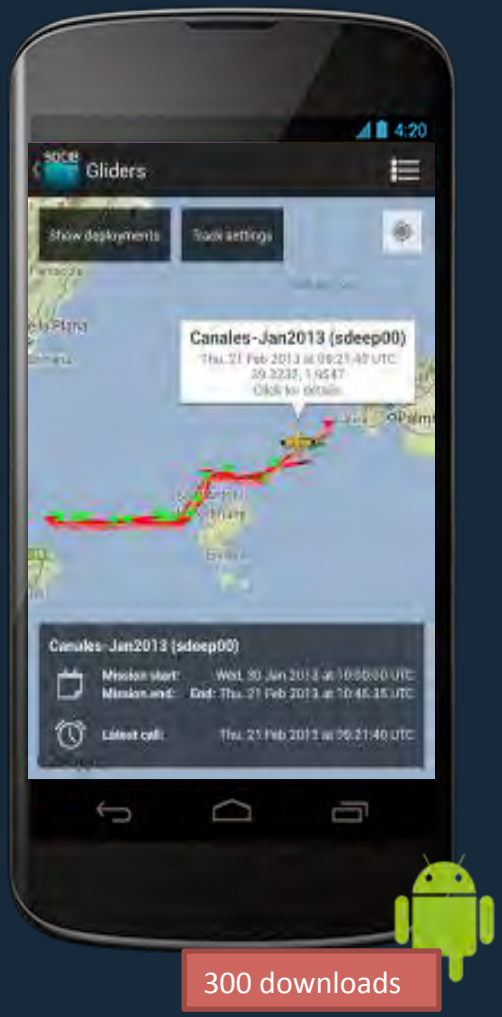




Beach monitoring using cameras, breakers, rips, bathymetry changes, etc.

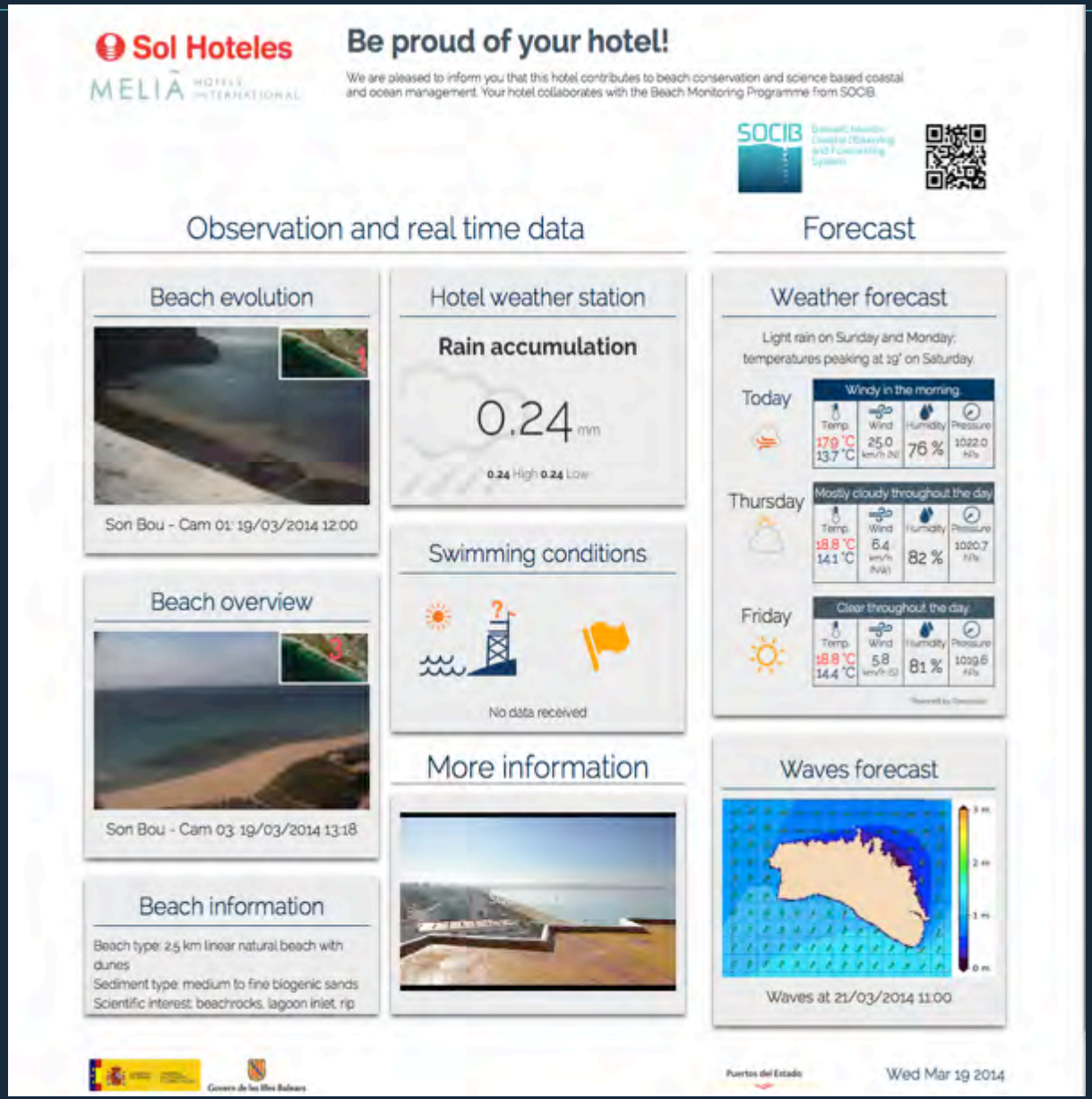
SOCIB Developments and Applications: Mobile Apps

900 downloads



300 downloads

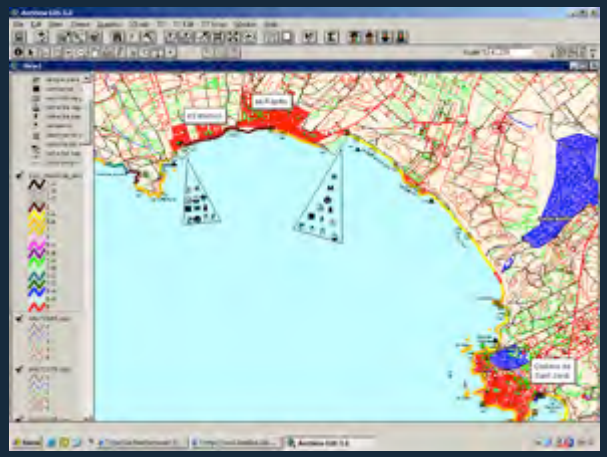
SOCIB Developments and Applications: Touristic sector



SOCIB Developments and Applications: Tools for Marine and Coastal Safety Decision Support

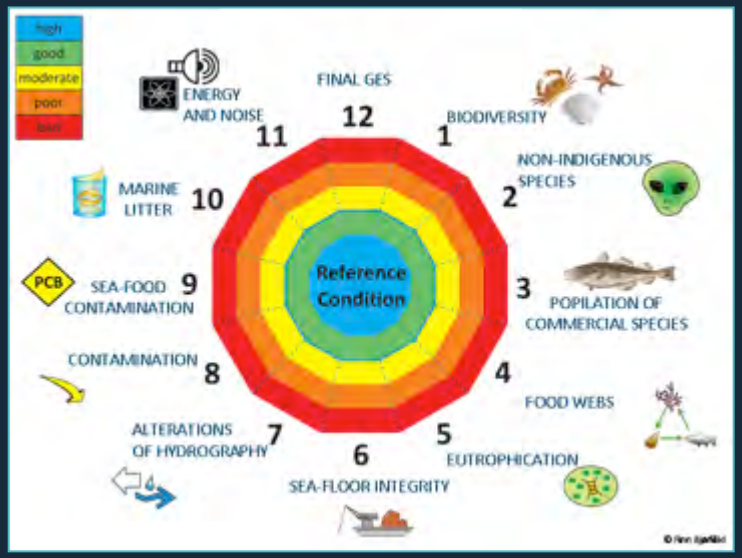
ESI (Environmental Sensitivity Index)

This system incorporates all the available information and identifies resources at risk, establishing protection priorities and identifying appropriate response.



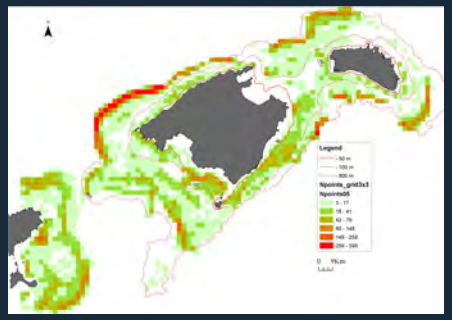
SOCIB Developments and Applications: Contribution to IMP, e.g., MSFD. Strong science for wise decisions.

MSFD A KEY SOCIETAL DRIVER:



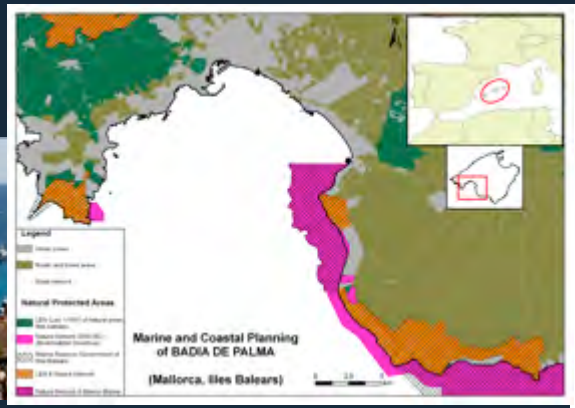
"What we measure affects what we do. If we have the wrong measures, we will strive for the wrong things" (Joseph Stiglitz, 2010)

"Bridging the science-policy gap is arguably the biggest current challenge to achieving sustainability" (Lubchenco and Sutley, 2010, Science).



PERSEUS

SOCIB Developments and Applications:
Sustainability indicators; Science and Society



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Balancing science and society through establishing indicators for integrated coastal zone management in the Balearic Islands

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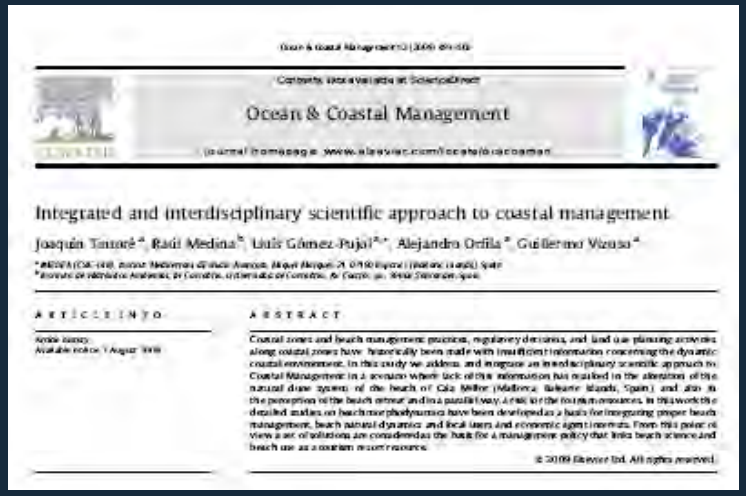
ABSTRACT

This paper explores the process by which indicators may be developed as tools for communicating science to decision-makers using the participatory approach demonstrated by the Balearic Indicators Project. This initiative reflects a series of compromises considered necessary to achieve the objective of generating an indicator system that is scientifically viable, comparative internationally yet locally relevant, and to facilitate its implementation. The article highlights questions regarding the utility of science for addressing current global issues related to sustainability and why science often fails to promote change at the societal level.

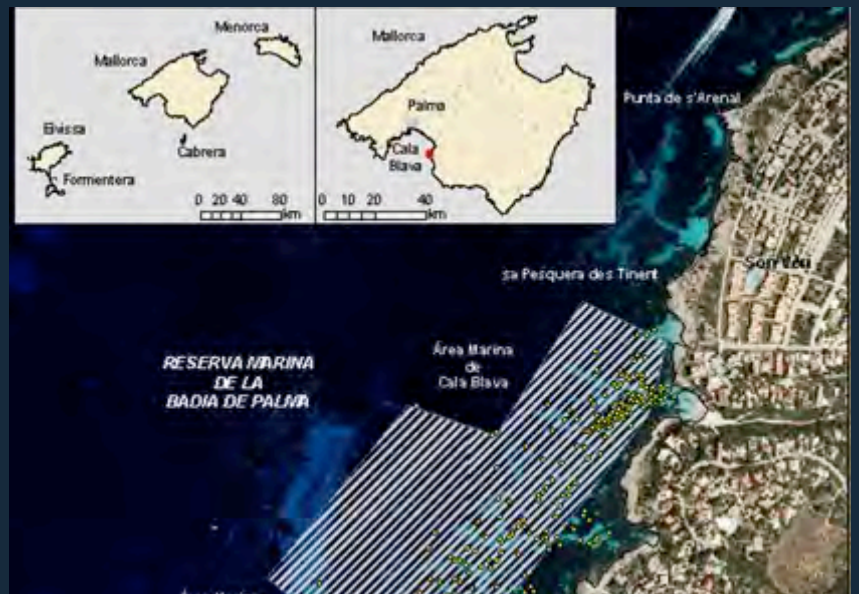
New tools: MSP, ICOM
Social and Economic Council.



SYSTEM OF INDICATORS
for Integrated Coastal Zone Management in the Balearic Islands

Official Opinion 5/2007 of the Economic and Social Council of the Balearic Islands

SOCIB Developments and Applications:
Socio-environmental studies carrying capacity beaches



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Multi-Method Approach to Exploring Social–Ecological Dimensions in a Mediterranean Suburban Beach Setting

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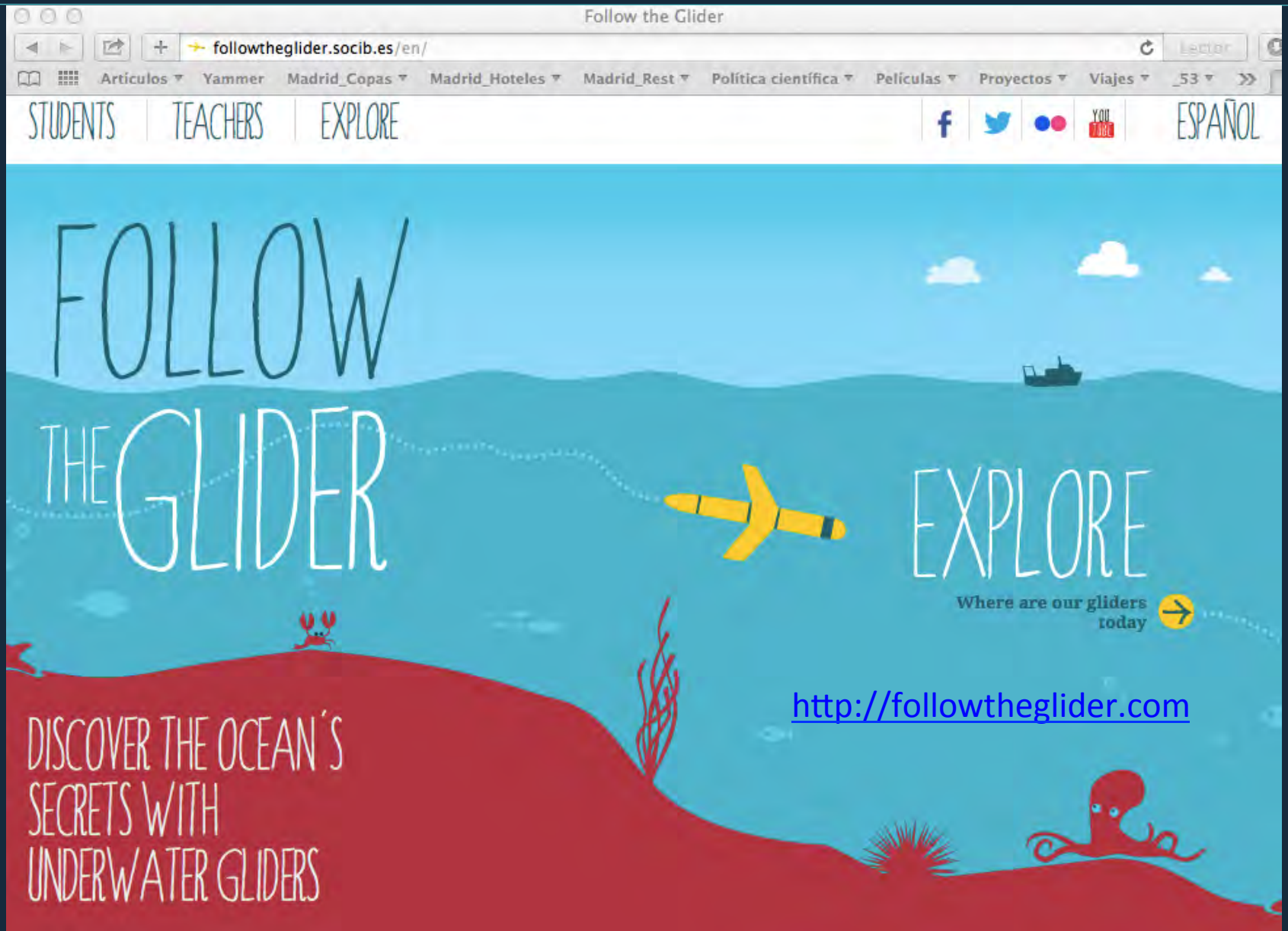
SOCIB Developments and Applications: Outreach



OUTLINE

1. New Technologies: Paradigm Change Ocean and Coastal Observation. EU international leadership

2. Marine Research Infrastructures, Ocean Observatories: SOCIB, Integrated Science priorities, Technology Development and Society Needs

3. **Innovation and Blue Growth: innovation in oceanography - gliders- (multi-disciplinary teams), data availability) and … "Turning Data into Jobs…"**

Discussion: Are we ready for theses changes ? Do we have the framework and right structures to get all the benefits from these changes ? ("to enforce what we think has to be done…")

Innovation in oceanographic instrumentation

We need:

- **Long time series**
- **Synoptic data**
- **Synoptic data**

3 elements:

- Oceans complexity imply and drive a need for improvement of instrumental capacities

- The innovation process, complexity and incubation time:
  . Incubation time: 15-30 years (computer mousse, 30 years). Gliders 10 years. WHY?

- The key to success

3

Innovation in Oceanographic Instrumentation

BY THOMAS B. CURTIN AND EDWARD O. BELCHER

INTRODUCTION

The tools of oceanography include instruments that measure properties of the ocean and models that provide continuous estimates of its state. Major improvements in tool capabilities lead to leaps in understanding, and this increased knowledge has many practical benefits. Advances in tool capabilities are sometimes viewed as an objective of basic research, a viewpoint reflected in the basic research funding category of "science and technology" (S&T).

The complexities of and incubation times for advancing instrumentation are often not fully appreciated, resulting in unrealistic expectations and discontinuous support. Greater understanding of the process of innovative instrument development can contribute to sustaining it. Innovation can be incremental or radical depending on performance gains (Utterback, 1994), stimulated or suppressed depending on institutional factors (Van de Ven, 1989; Office of Technology Assessment, 1995), and sustaining or disruptive depending on value propositions (Christensen, 1997). For example, going from a Nansen to a Niskin bottle was an incremental innovation, whereas going from bottle casts to CTD profiles was a radical innovation. Moored current meters incrementally advanced from film recording of gauges, to mechanically digitized signals on reel-to-reel tape, to solid-state analog, to digital conversion and memory. Radical innovation of current-field measurement came with the acoustic Doppler current profiler.

In large organizations, stimulated innovation often occurs in research departments, particularly when the projects have champions: "the new idea either finds a champion or dies" (Schon, 1963). In other parts of the same organization, innovation may be suppressed by the costs associated with re-integrating a system and minimal perceived competition. The incubation time of the computer mouse from inception to wide use was 30 years. In oceanographic observation, where synoptic coverage is an objective, a sustaining innovation would be a sampling platform with improved propulsion that doubles its speed. A disruptive innovation would be a new platform with much *slower* speed, but with much longer duration and a low enough cost to be deployed in great numbers. Here, we will focus on radical, stimulated, disruptive innovation that involves both science and engineering.

To motivate continued investment in basic research, the histories of many radical innovations, ranging from the transistor to radar to the Internet, have been documented (Bacher, 1959; Hetrick, 1959; Becker, 1980; Hove and Gowen, 1979; Allison, 1985; Abbate, 2000. The Defense Acquisition History Team at the US Army Center of Military History is also preparing a document on this subject.). These cases clearly demonstrate that "rapid" innovation in

(Curtin and Belcher, TOS, 2008)

The innovation process (for advancing instrumentation)

- 3 key decision centres:

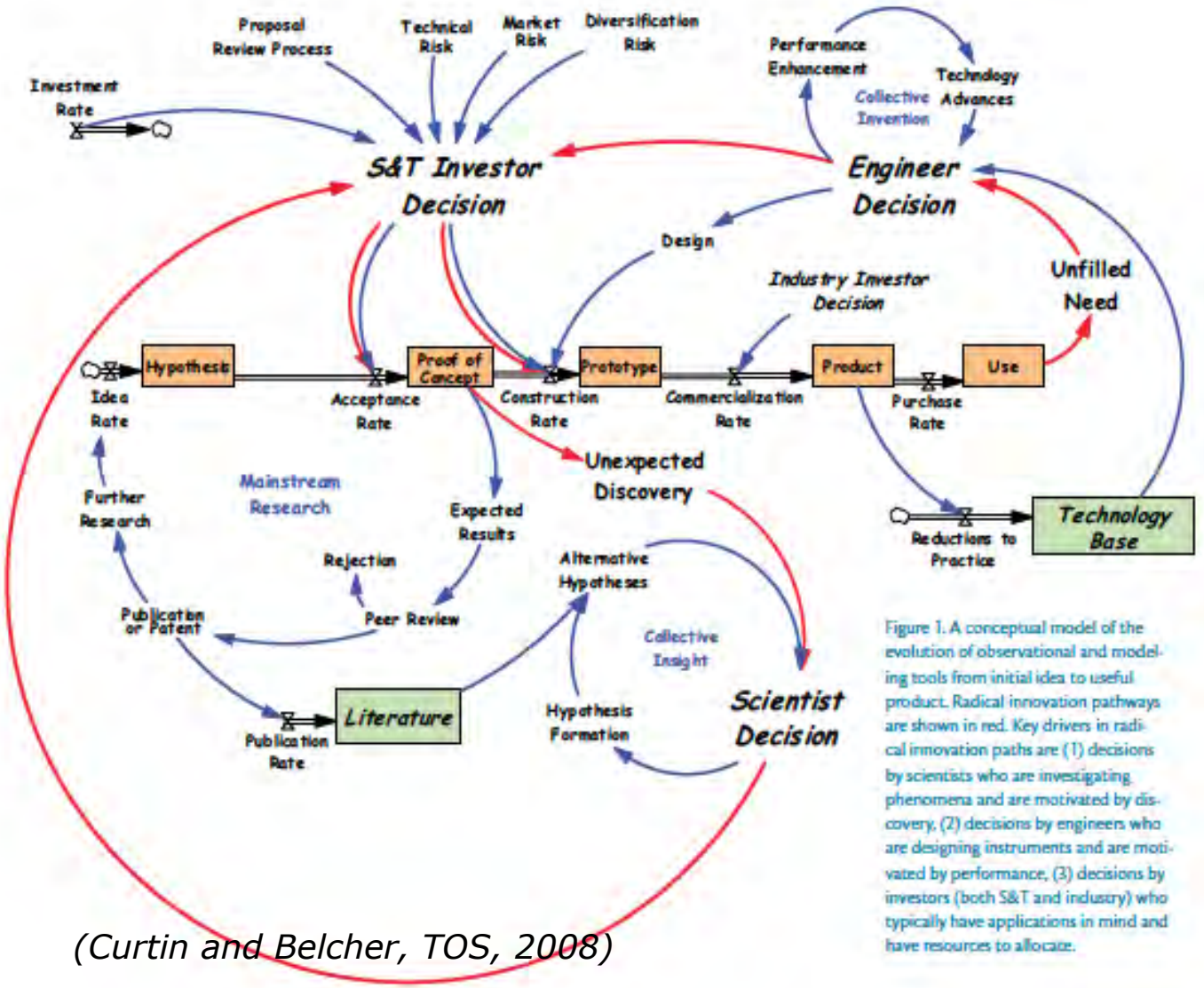


Figure 1. A conceptual model of the evolution of observational and modeling tools from initial idea to useful product. Radical innovation pathways are shown in red. Key drivers in radical innovation paths are (1) decisions by scientists who are investigating phenomena and are motivated by discovery, (2) decisions by engineers who are designing instruments and are motivated by performance, (3) decisions by investors (both S&T and industry) who typically have applications in mind and have resources to allocate.

(Curtin and Belcher, TOS, 2008)

The key to success for radical innovation in oceanographic instrumentation

1. Visionary leadership
2. Close coupling between science and engineering
3. A coherent investment strategy based on distributed, coordinated resources
4. Effective processes for communication, feedback, and contingency planning.
5. Incentive to assume responsibility for risky instrumentation development projects without undue career jeopardy.

In summary: work in collaborative, multidisciplinary teams, be tenacious and focused on long term objectives while producing short-term success, and find creative champions among funding agencies and investor organizations.

- MULTI-DISCIPLINARY APPROACH
- INTEGRATION

Data Availability….

OPEN DATA PRINCIPLES

- Discoverable and accessible
- Freely available
- Interoperable, standardized and quality controlled

EU FRAMEWORK

- MARINE KNOWLEDGE 2020;
- EU COM May 8, 2014;

  EU eyes oceans innovation as source of sustainable growth;

Turning DATA INTO JOBS (US - NOAA)….

The role of Ocean Observatories/new Marine Research Infrastructures-MRI- in H2020, Blue Growth, RIS3, …

- SOCIB, an example MRI capabilities to **respond to 3 drivers:**
  - Science Priorities (ok!)
  - Strategic Society Needs (more listening!: to policy makers & managers endorsement, MSFD -GES- Energy, Tourism, etc.).
  - New Technology Developments (to reach companies, social society endorsement)

- **Ocean Observatories/MRI are key innovation elements, well placed to fill science-policy gap in H2020:** mission, vision, critical mass, multi-disciplinary and integrated approach.

- Need to define a **JOINT STRATEGY at European** level, more than coordination, **Partnership**…

In Summary

1. New technologies/paradigm change Ocean Observation: Ocean Variability, with shift from Large Scale to Mesoscale and Coasts.

2. Marine Research Infrastructures/Observing Systems in Europe; international leadership -e.g., SOCIB-, & key elements in Blue Growth initiatives (**EU Oceans Innovation COM)** because their:
   - Critical mass
   - Multi-disciplinary approach
   - Integration capabilities of Science, Technology, Society

In other words: …

New observing systems with real time open data are key elements for real innovation initiatives
"Turning data into jobs"

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