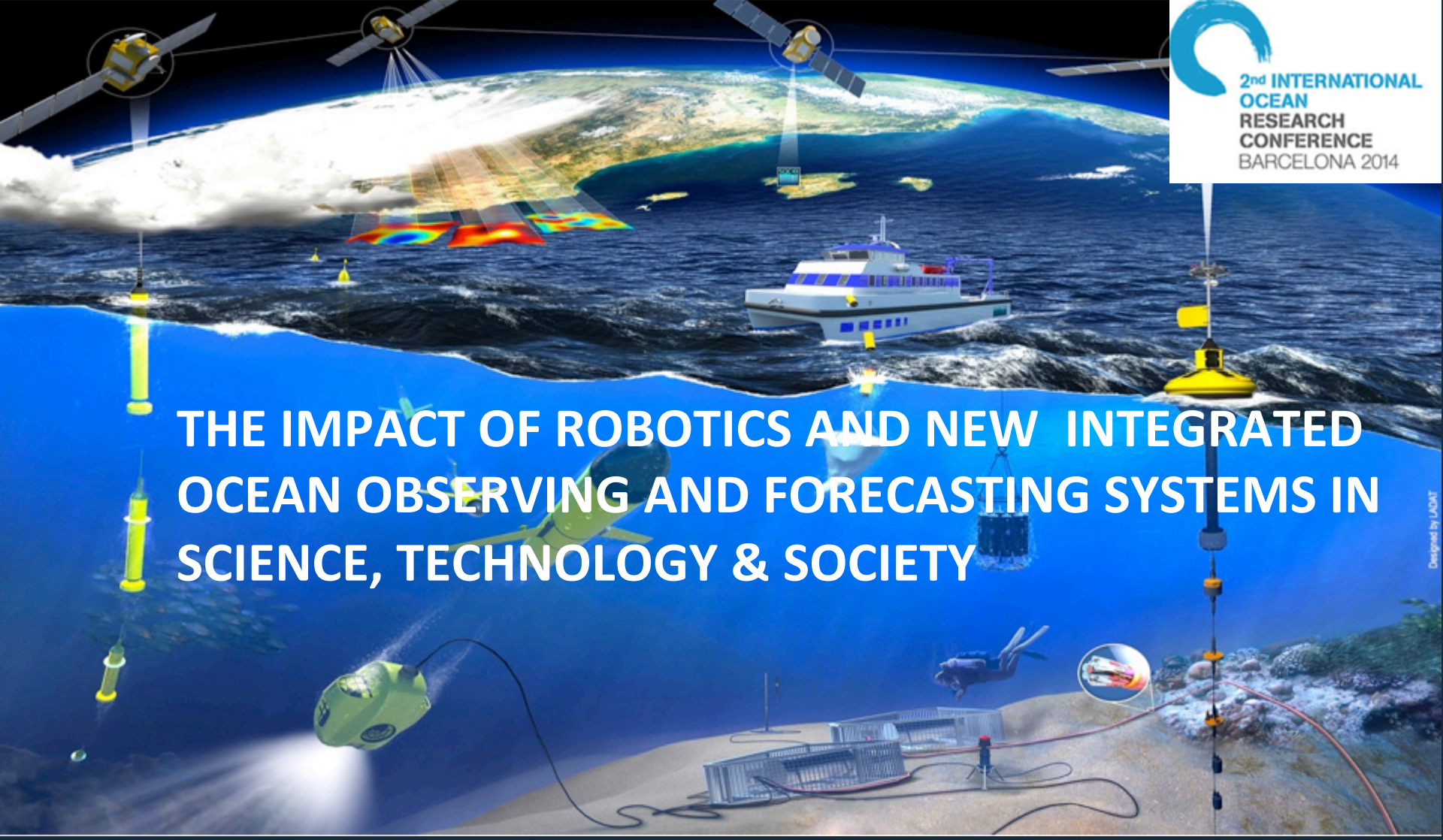


Combining Scientific Excellence & Technology Development

with… Impact and Relevance to and for Society

www.socib.eu

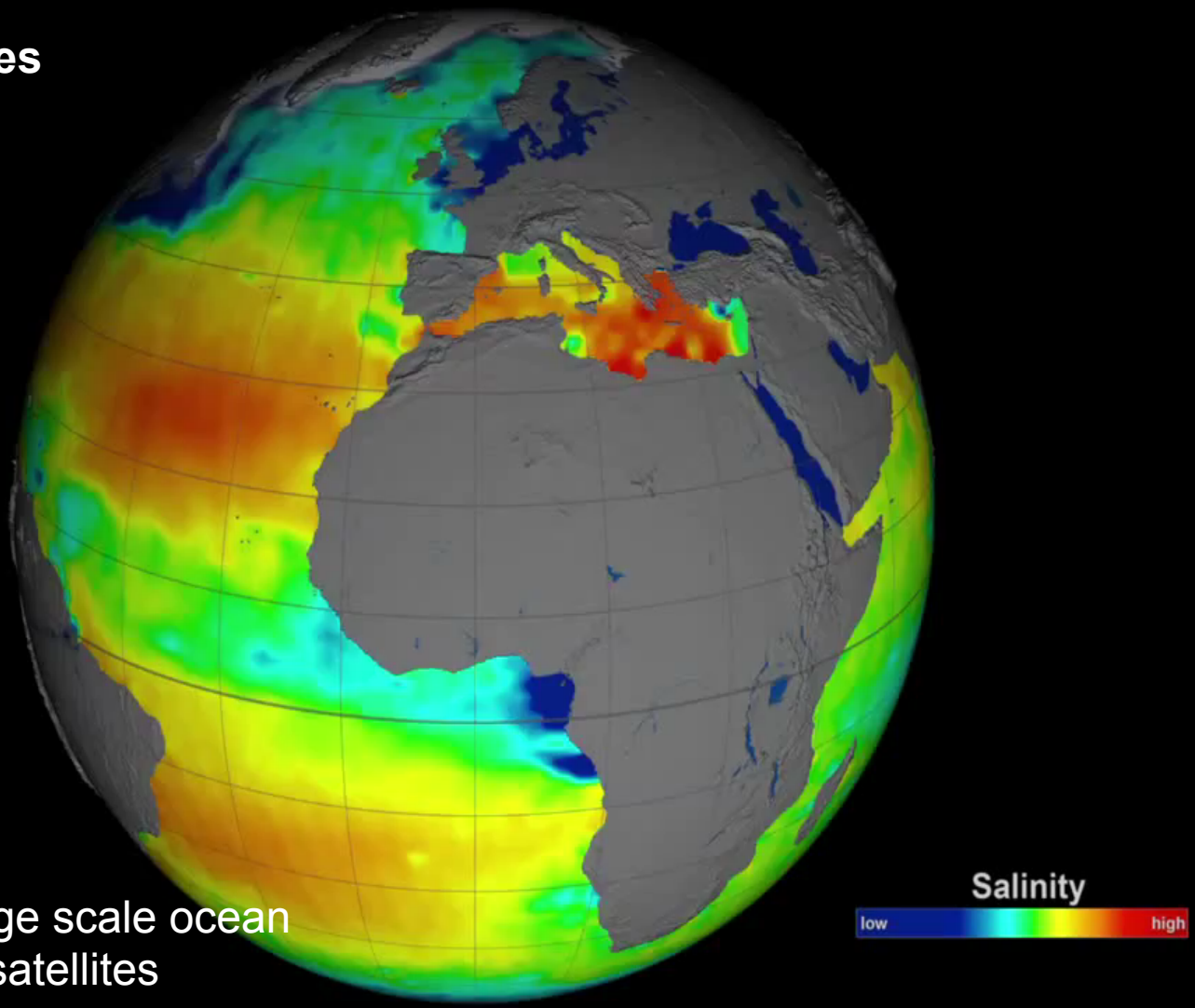
Our goal… characterise Ocean State AND Variability at Different Scales (basin, sub-basin, local & coastal interactions)

We need:

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

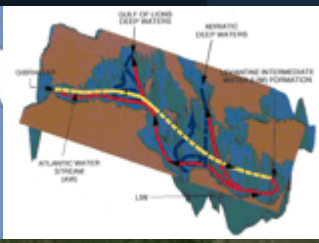
Walter Munk, 2001: "The last century of oceanography is marked by the degree of under-sampling".

Carl Wunsh, 2010: "We need data, … models are becoming untestable"



Last decade: ok large scale ocean circulation –Argo & satellites

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



We need:

- Long time series
- Synoptic data

Mediterranean Sea: Small Scale Ocean, 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

Mediterranean Sea and Balearic Sub-Basin

1. Small Scale Ocean (Ri=12 km) characterised by:
   - Thermohaline basin scale circulation
   - Intense mesoscale variability (Malanotte-Rizzoli et al., 2013)

2. Ideal Laboratory:
   - Interactions between mesoscale eddies and the basin scale circulation
   - Importance and need of adequately resolving mesoscale to understand the basin scale variability, seasonal, annual & inter-annual scales.

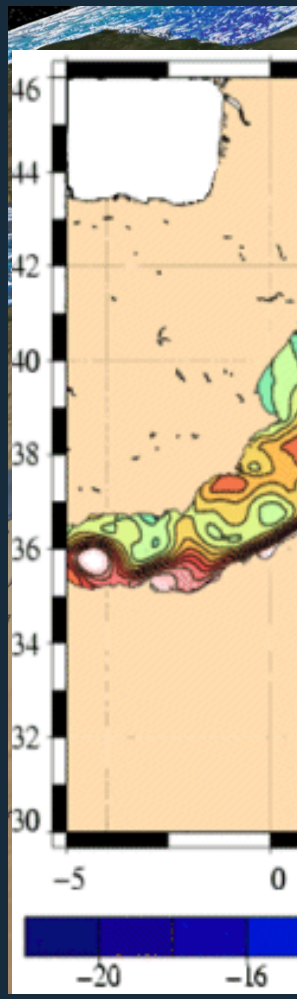
3. Balearic Sub-basin: ideal transition area Gulf Lion (D_W) and Alborán Sea (S_AW), strong mesoscale dynamics.

4. The Ibiza Channel, a key choke point

We need… Long time series … YES…. BUT ALSO….

Synoptic data and … Monitoring at the right scales

Mediterranean Sea: TH circulation & mesoscale e



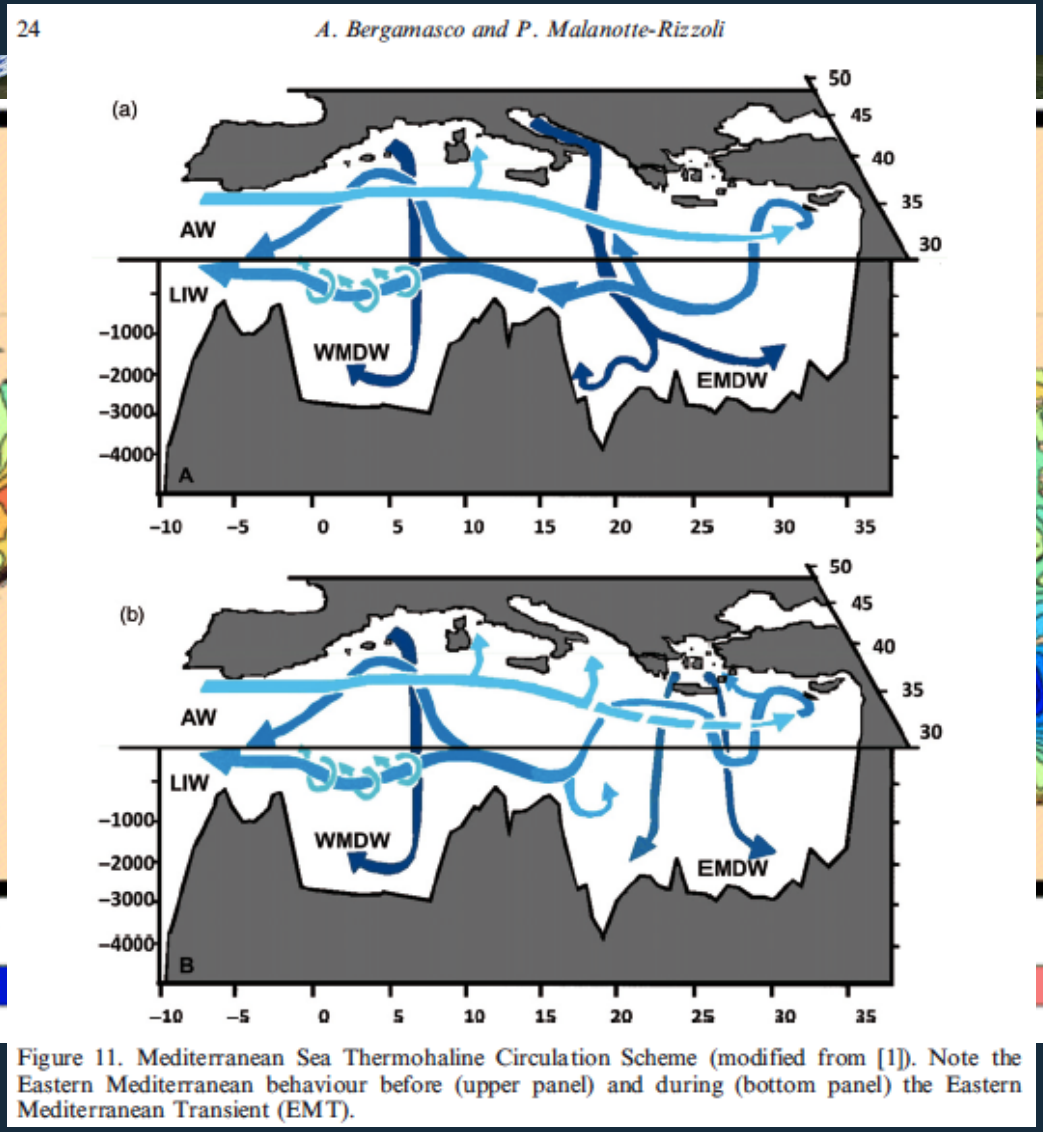
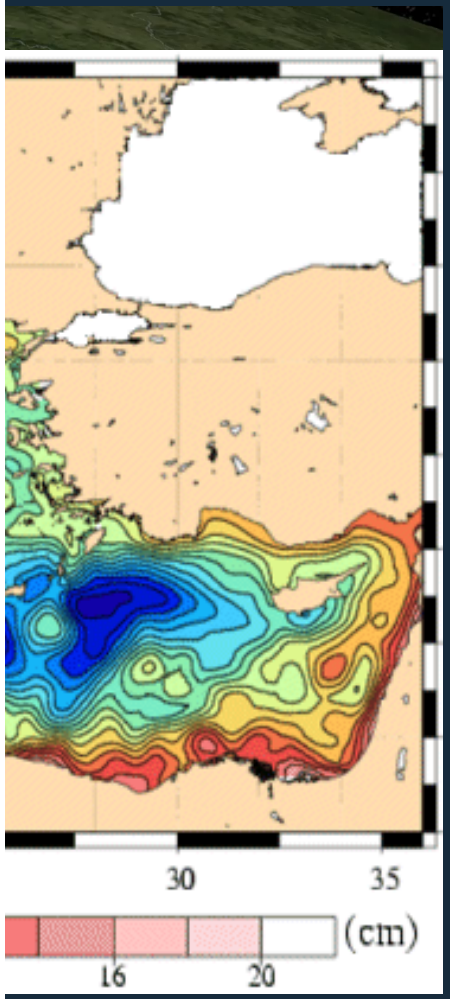


Figure 11. Mediterranean Sea Thermohaline Circulation Scheme (modified from [1]). Note the Eastern Mediterranean behaviour before (upper panel) and during (bottom panel) the Eastern Mediterranean Transient (EMT).

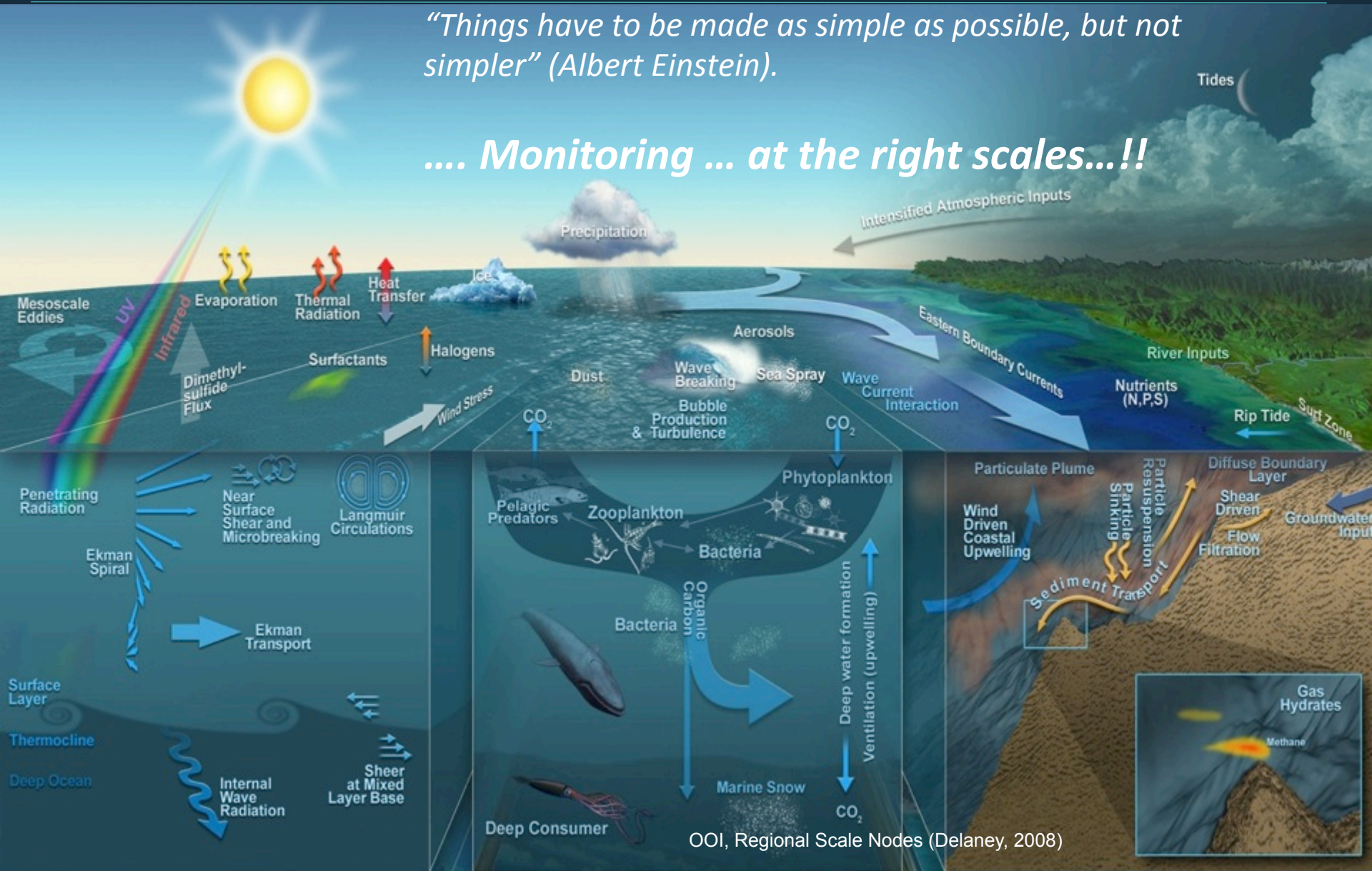


NASA. Ocean current flows in the Mediterranean (2 mins. - 16 Feb 2005 through 16 January 2006). http://svs.gsfc.nasa.gov/goto?3820

Oceans and coastal interactions. Scales interactions. Management is needed. No oversimplification.

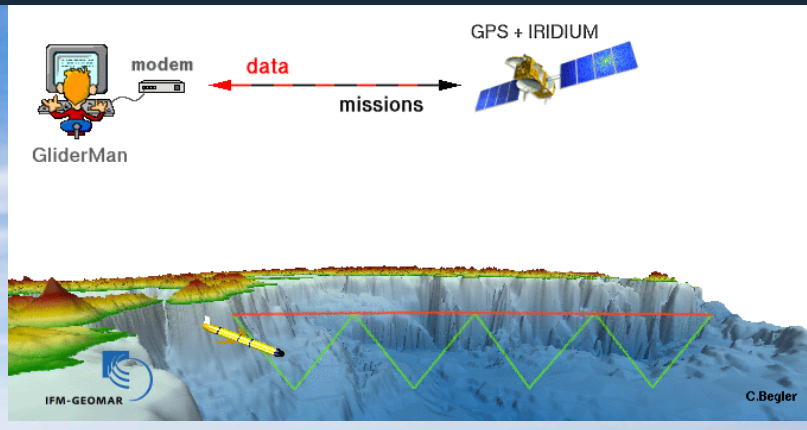
"Things have to be made as simple as possible, but not simpler" (Albert Einstein).

…. Monitoring … at the right scales…!!



OOI, Regional Scale Nodes (Delaney, 2008)

New Technologies: drivers of change…. (gliders just an example)



SOCIB Glider Facility: 05/2006-10/2014

- 54 missions, 896 days in water, 10.450 nm
- 26.185 profiles (30 Euros/profile)
- Bi-monthly routine operation (since 01/2011)

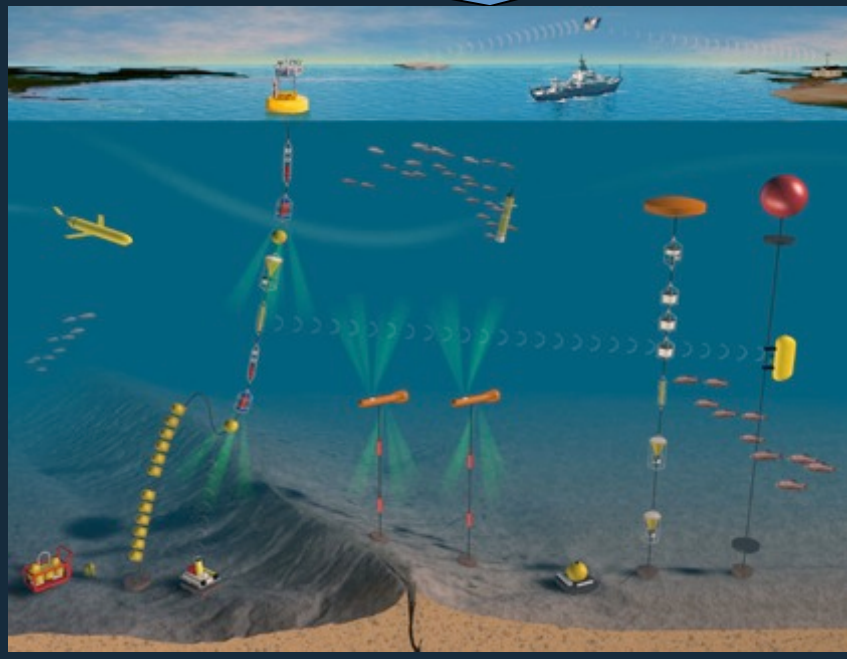
New Technologies: Paradigm Shift
➡ Ocean Observation

From: Single Platform - Ship based observation

To: Multi-platform observing systems

Platform-centric Systems

Network - distributed Systems



(Adapted from Steve Chien, JPL-NASA)

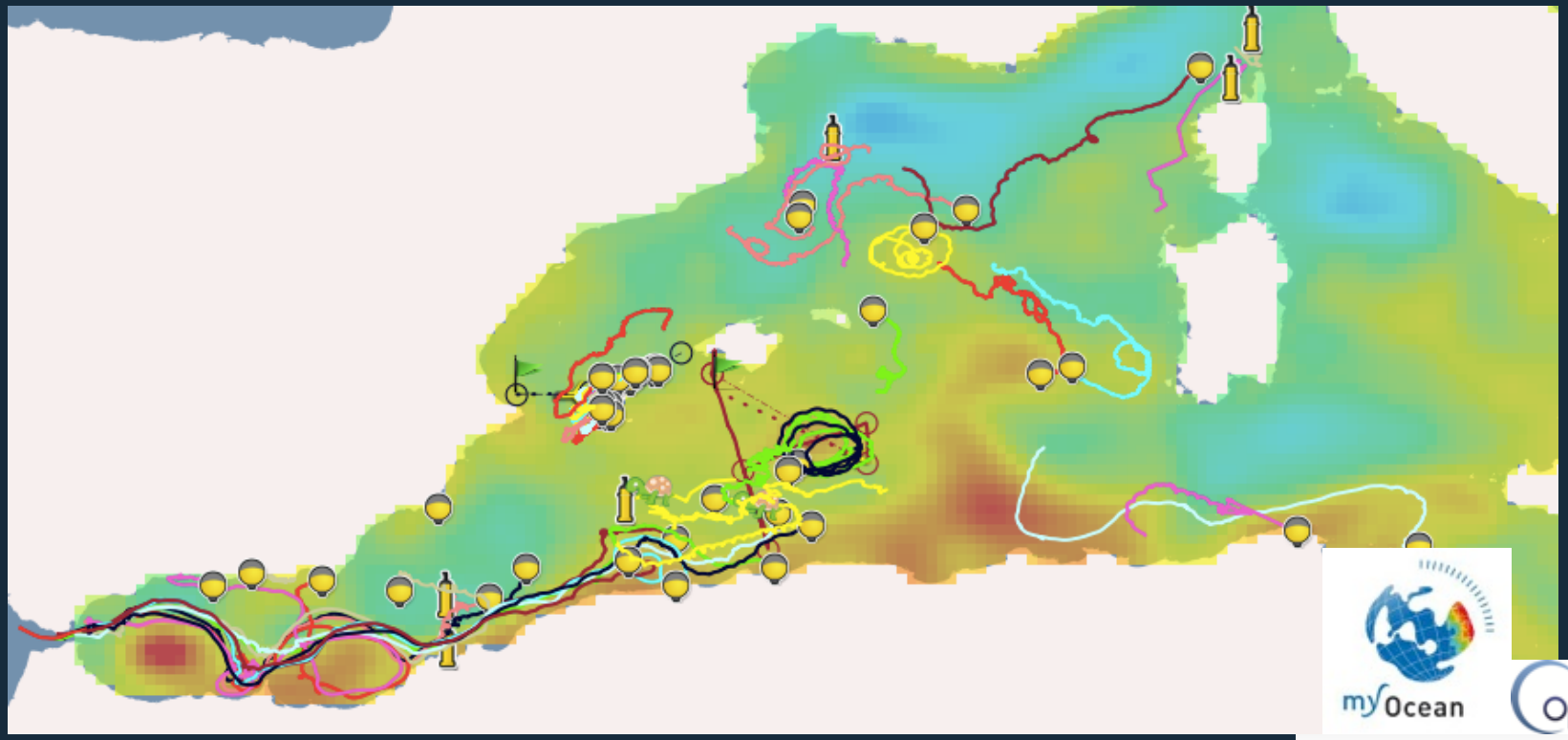
"A single ship can only be in one place at one time. We need to be present in multiple places in multiple times." (John Delaney, Nature, Sept. 25, 2013)

New Technologies: Paradigm Shift

SOCIB

→ Data Availability (Real time and QC 'at one click')

Dapp SOCIB: Nov – 2014, multi-platform real time data available: 40 surface drifters, 4 Argo profilers, 2 sea-turtles, 2 gliders, 2 fixed moorings, 7 tide gages, 3 real time beach monitoring systems). **REALLY ALL AVAILABLE** (not just on paper…)



→ SOCIETAL IMPLICATIONS: Alborán Gyres position and fisheries:
(Ruiz et al., 2013: Anchovy landings x 10)

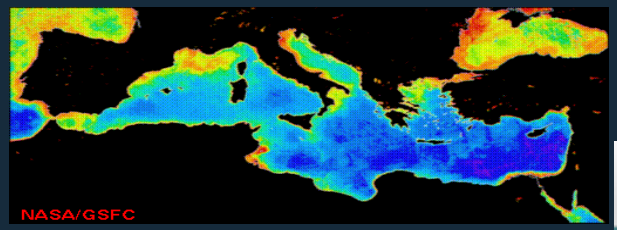
→ SCIENCE IMPLICATIONS: adaptive sampling with gliders…

http://apps.socib.es/dapp

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

3 DRIVERS

- Science priorities
- Technology Dev.
- Society Needs



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OPEN DATA PRINCIPLES

INTERNATIONAL FRAMEWORK

- IMOS, Neptune, OOI, IOOS, …
- EU: MARINE KNOWLEDGE 2020;

EU COM May 8, 2014
EU eyes oceans innovation as source of sustainable growth;

EOOS, COSYNA, POSEIDON, …

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

OBSERVING FACILITIES

Research vessel

HF Radar

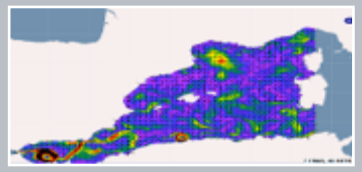
Gliders

Lagrangian platforms

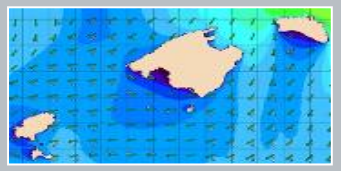
Fixed stations

Beach Monitoring

MODELLING FACILITY



Currents (ROMS)



Waves (SWAN)

STRATEGIC ISSUES & APPLICATIONS FOR SOCIETY

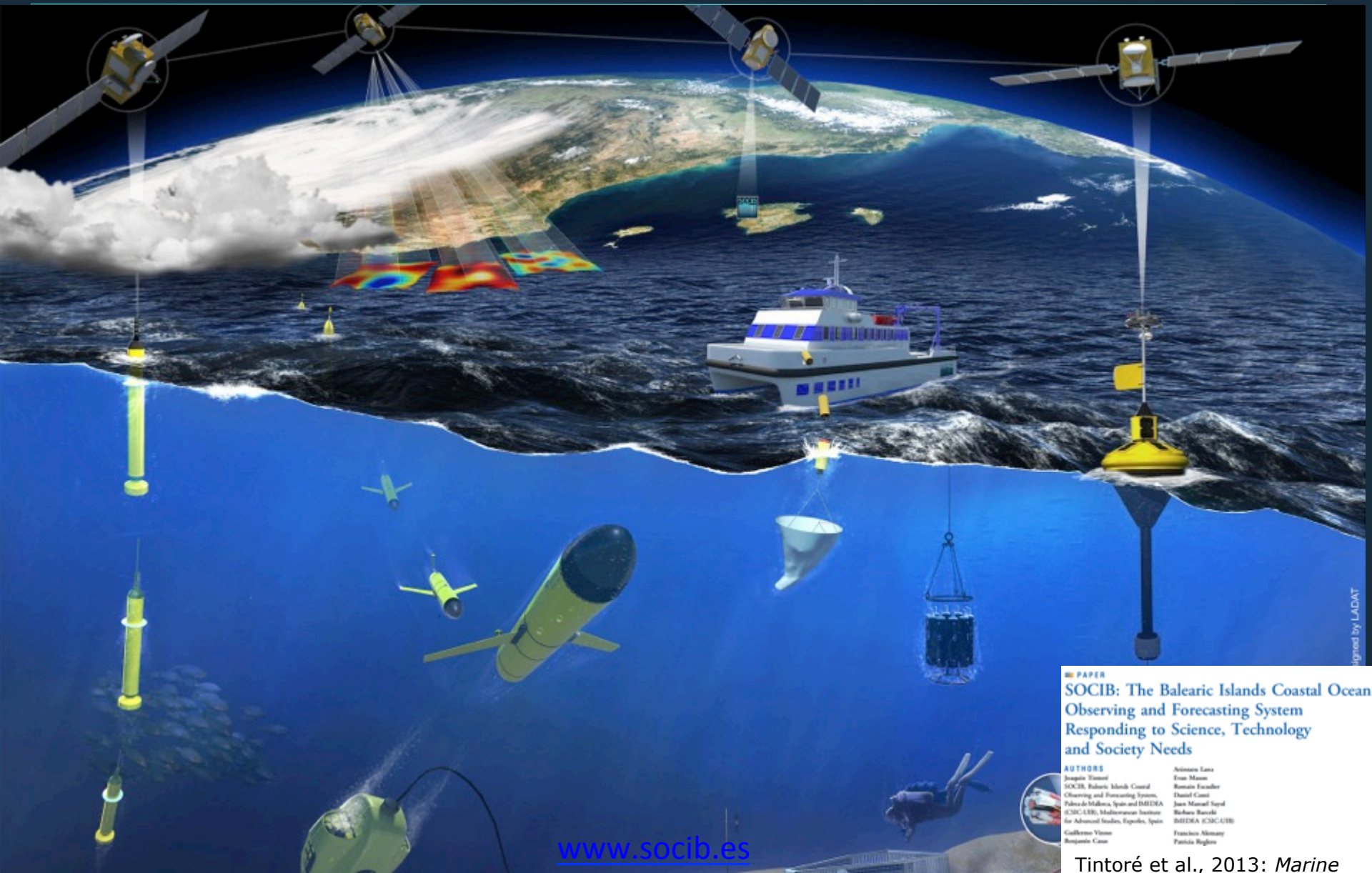
Integrated Coastal Management

Marine Spatial Planning

DATA CENTER

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

What is SOCIB? A multi-platform observing system,



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*

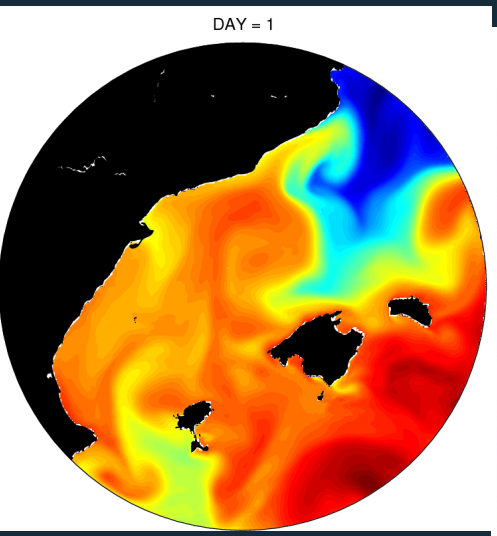
The real challenge for the next decade…:

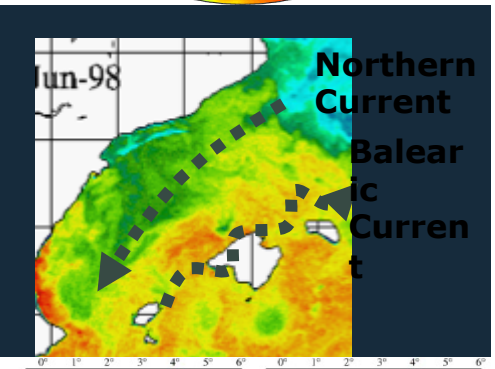
<u>To use and integrate</u> these new technologies to carefully and systematically

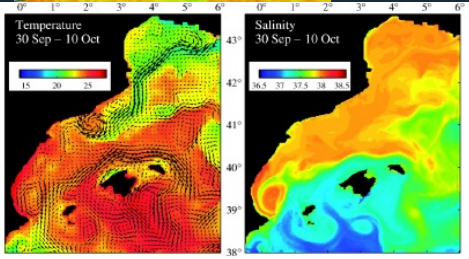
- Monitor the variability at small scales, e.g. mesoscale/ weeks, to
- Resolve the sub-basin/seasonal and inter-annual variability and by this
- Establish the decadal variability, understand the associated biases and correct them …

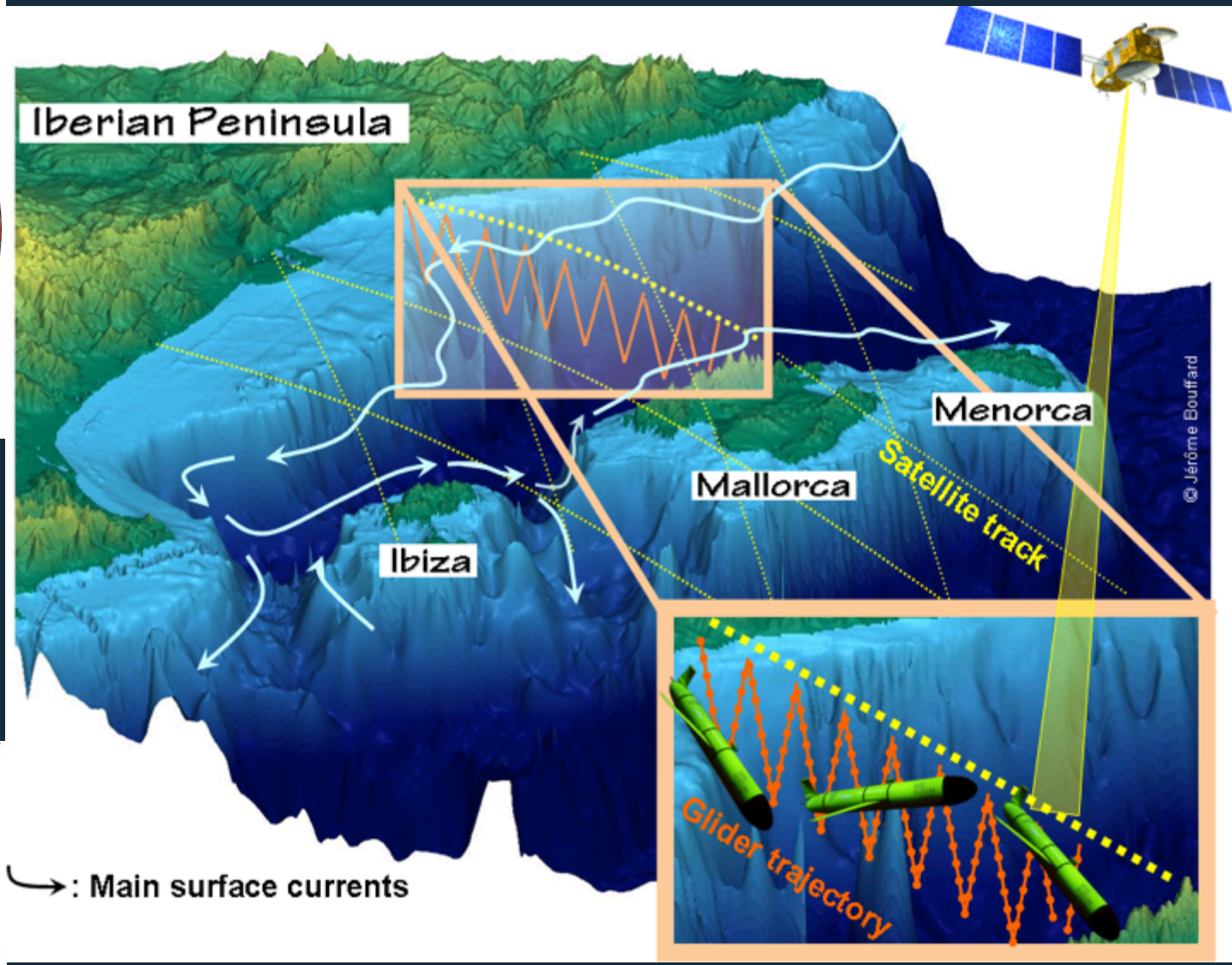
Balearic basin (fronts, mesoscale eddies, blocking, hotspot, ecosystem response)

…. Ideal lab to study global ocean problems









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

MERSEA

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

SOCIB Data Centre

DATA CENTER FACILITY

- Manage all multi-platform SOCIB Data
- Allow users to discover, gather, visualize and download
- Immerse in the international framework and EU funded projects

OPEN DATA PRINCIPLES

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

Turning DATA INTO JOBS (US - NOAA)….
Blue Growth

SOCIB Developments and Applications: Mobile Apps

900 downloads

300 downloads

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]

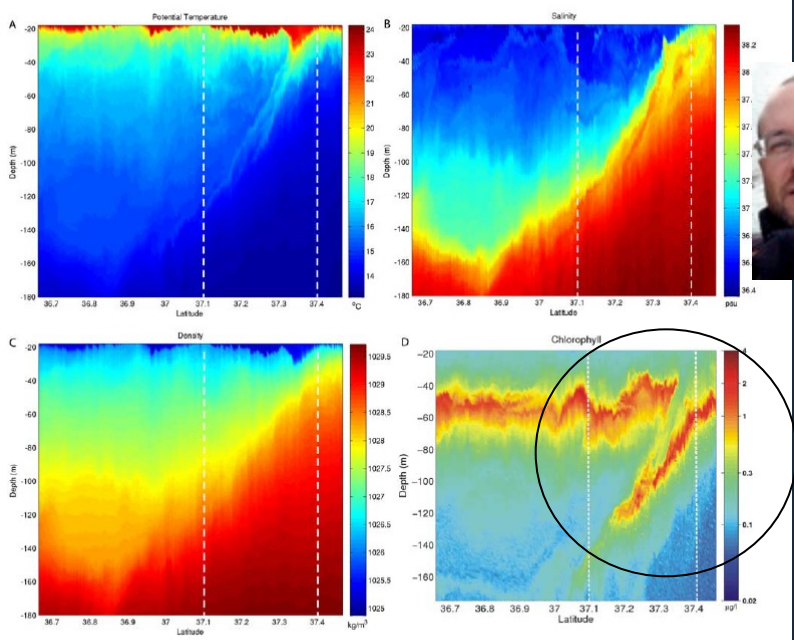
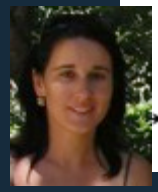


Figure 2. Vertical section of temperature (°C), salinity (PSU), density (kg/m^3) and chlorophyll (μg/l) from glider section 2 (dashed magenta in Figure 1). White dashed lines define sub-section in the northern part of the domain.

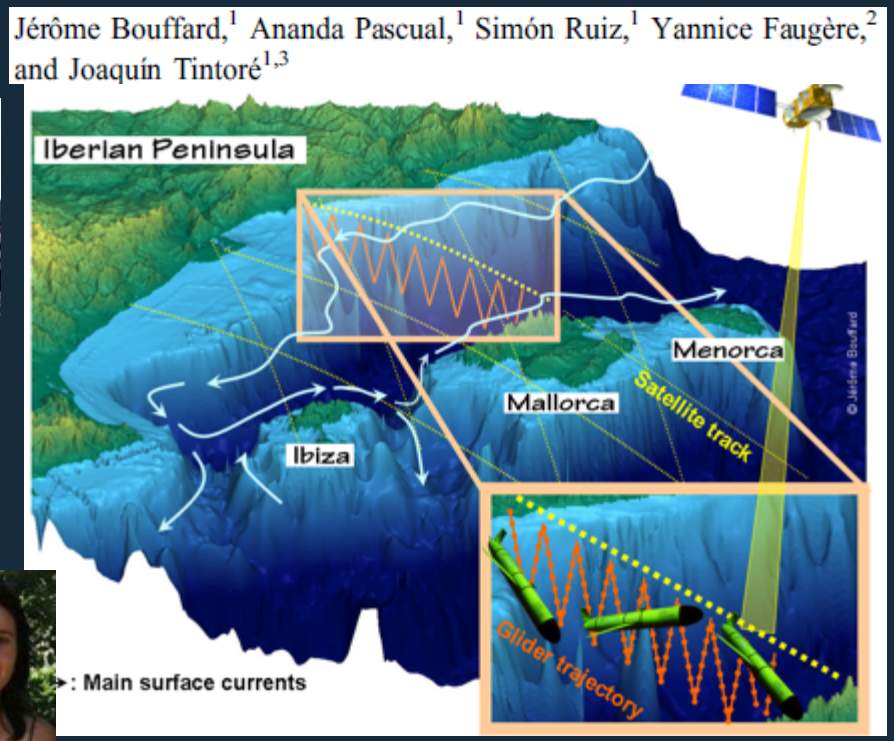


Eddy/mean flow interactions – Blocking effects General Circulation

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

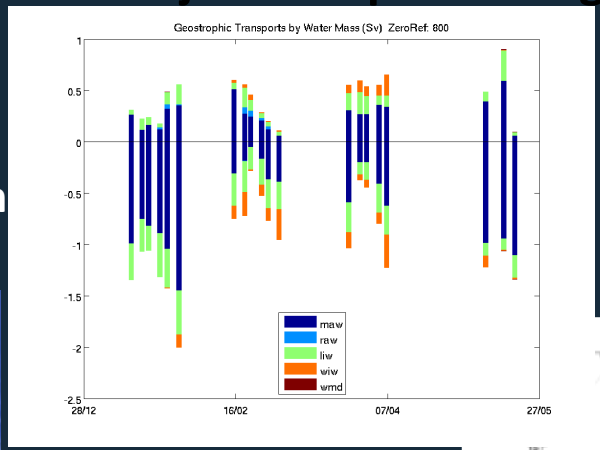
GEOPHYSICAL RESEARCH LETTERS, VOL. 39, L20604, doi:10.1029/2012GL053717, 2012

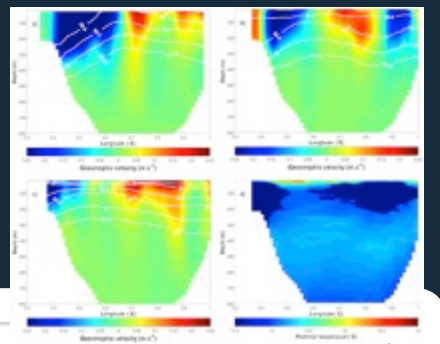
Autonomous underwater gliders monitoring variability at "choke points" in our ocean system: A case study in the Western Mediterranean Sea

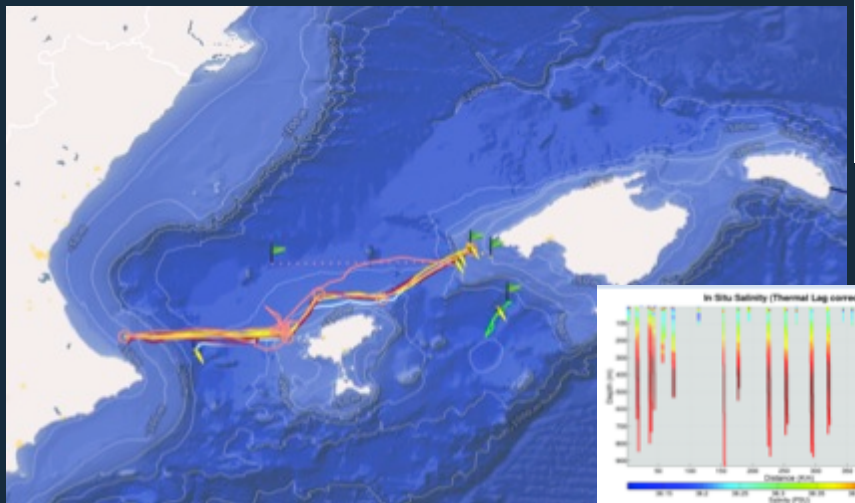
Emma E. Heslop,[1] Simón Ruiz,[1] John Allen,[2,3] José Luís López-Jurado,[4] Lionel Renault,[5] and Joaquín Tintoré[1,5]

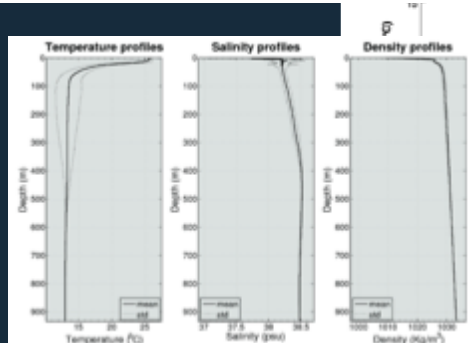
- After 32 glider missions (started in 2006), + 17.000 profiles (30 Euros/ profile)
- Since January 2011; routine operation

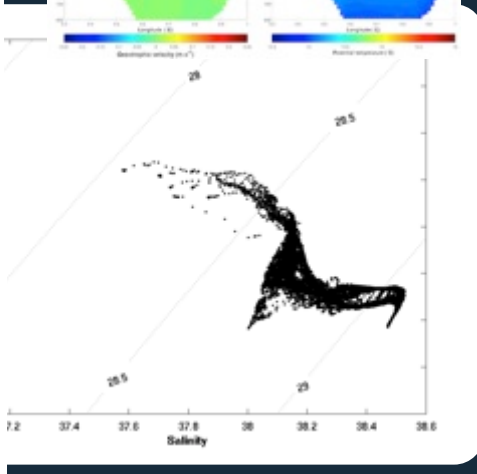
Major transport changes



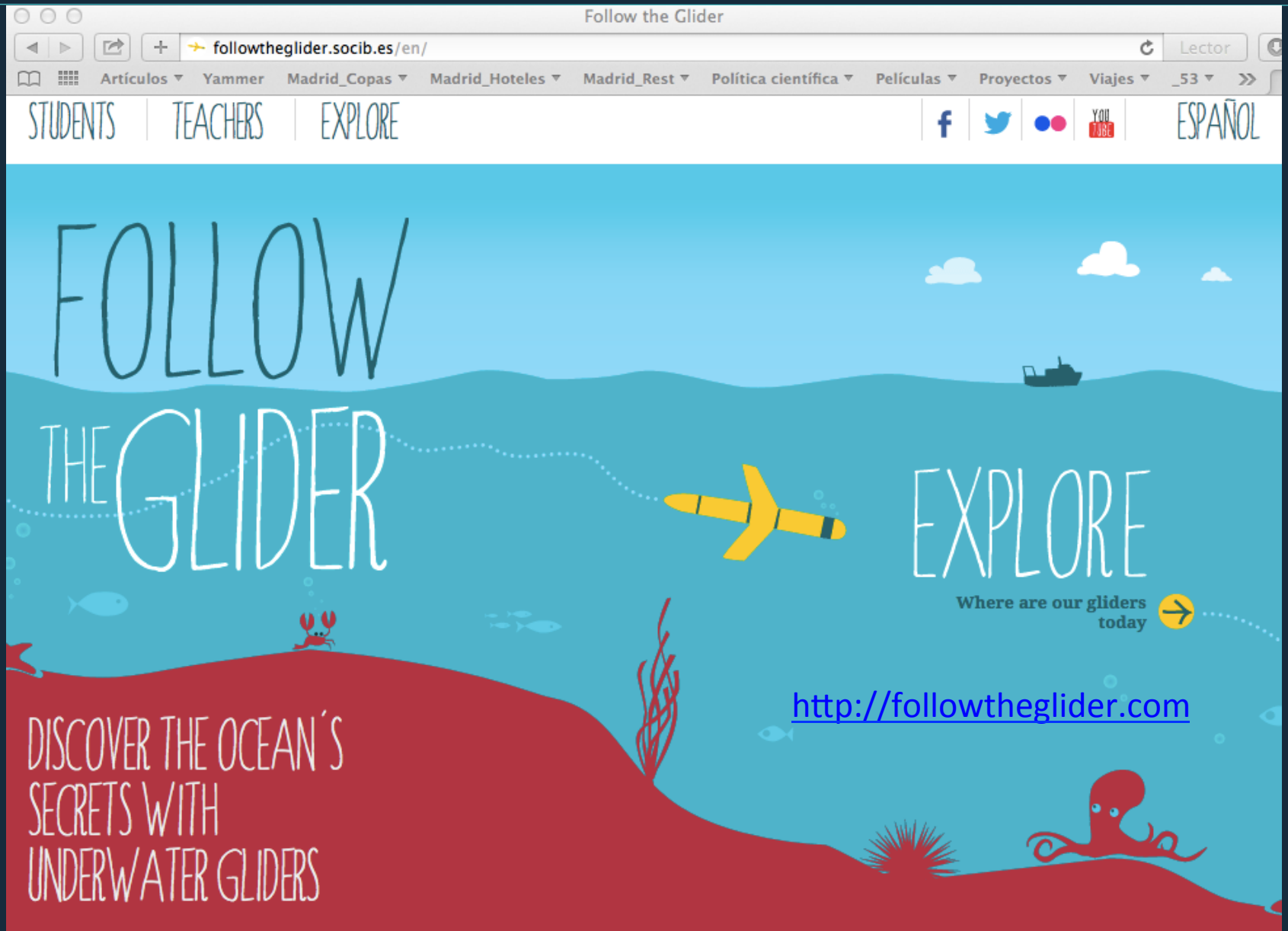








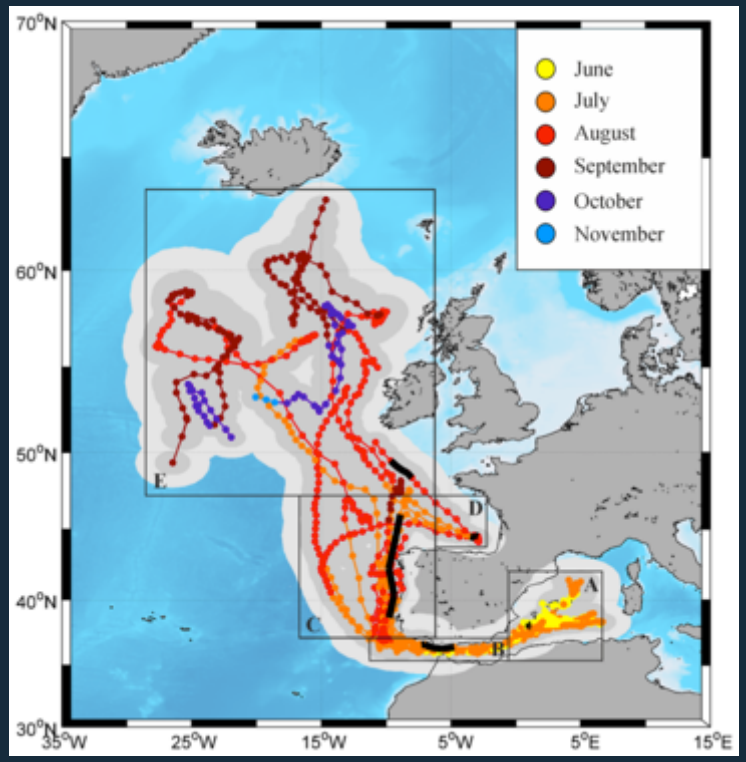
SOCIB Developments and Applications: Outreach



http://followtheglider.com

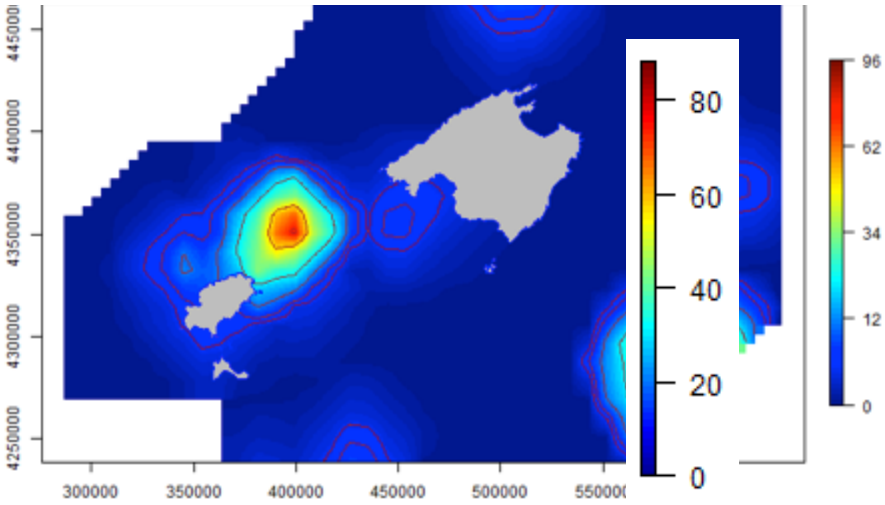
Bluefin Tuna; developing an operational oceanography tool for predicting spawning habitat in W. Med

Migration patterns along the year (Eastern Stock)

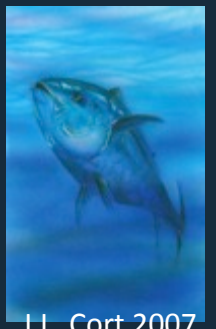


Aranda et al, PONE 2013

Spawning habitat arround Balearic Islands



Intensity(%)



J.L. Cort 2007

SOCIB Balearic Islands Coastal Observing and Forecasting System

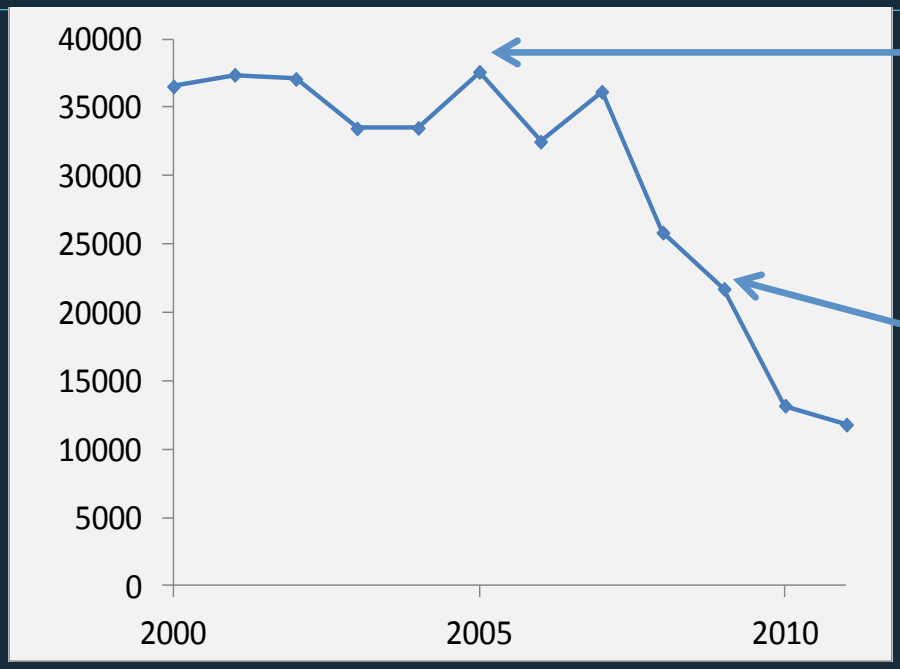
CSIC IMEDEA

College of Oceanic & Atmospheric Sciences

OSU Oregon State

Alvarez-Berastegui D. (dalvarez at socib.es)

Overfishing: Temporal evolution of the catch (2000-2011)



Fishing quota limitations

Stock assessment warned of fisheries collapse

Actual management of Bluefin tuna:

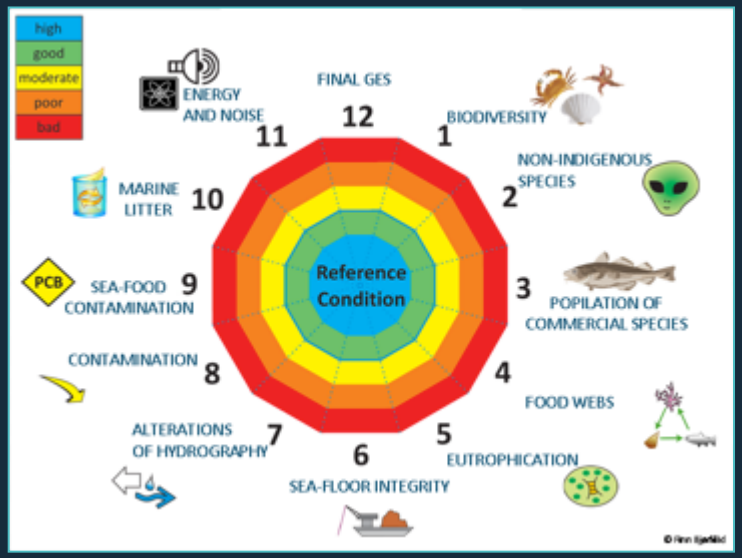
1- Fishing quota (after abundance indices calculated from adult catches)

2- Minimum fish length regulations

ACTUAL MEASUREMENTS TO CONTROL TUNA POPULATIONS DO NOT INCLUDE ENVIRONMENTAL VARIABILITY

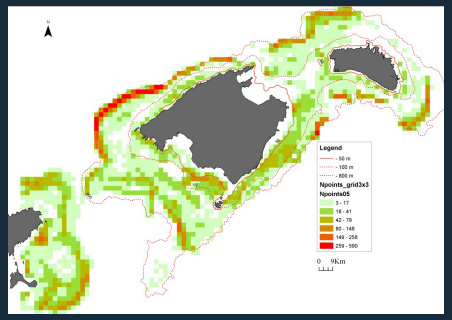
SOCIB Developments and Applications: Contribution to IMP, e.g., MSFD. Strong science for wise decisions.

MSFD A KEY SOCIETAL DRIVER:



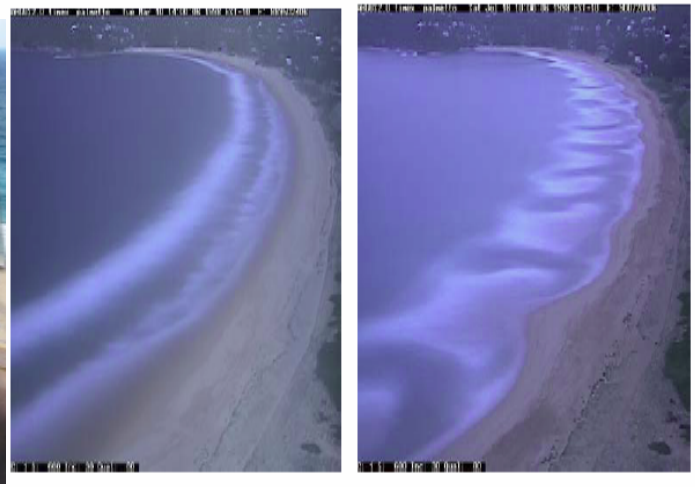
"What we measure affects what we do. If we have the wrong measures, we will strive for the wrong things" (Joseph Stiglitz, 2010)

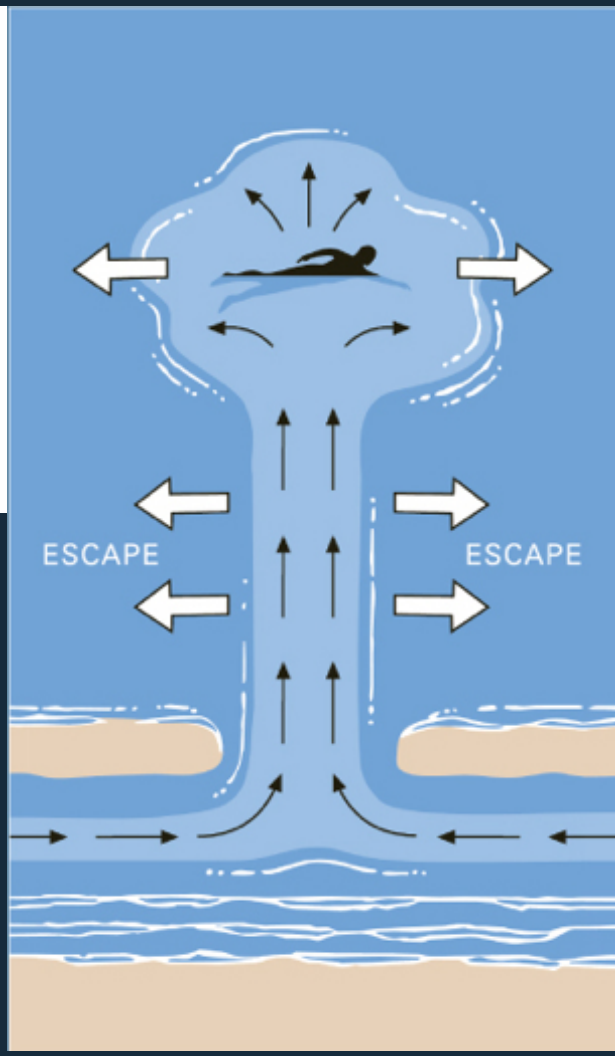
"Bridging the science-policy gap is arguably the biggest current challenge to achieving sustainability" (Lubchenco and Sutley, 2010, Science).

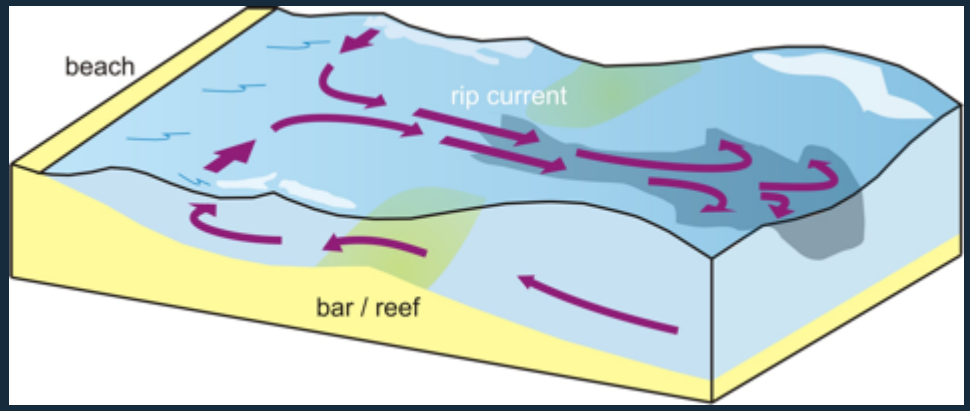


PERSEUS

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

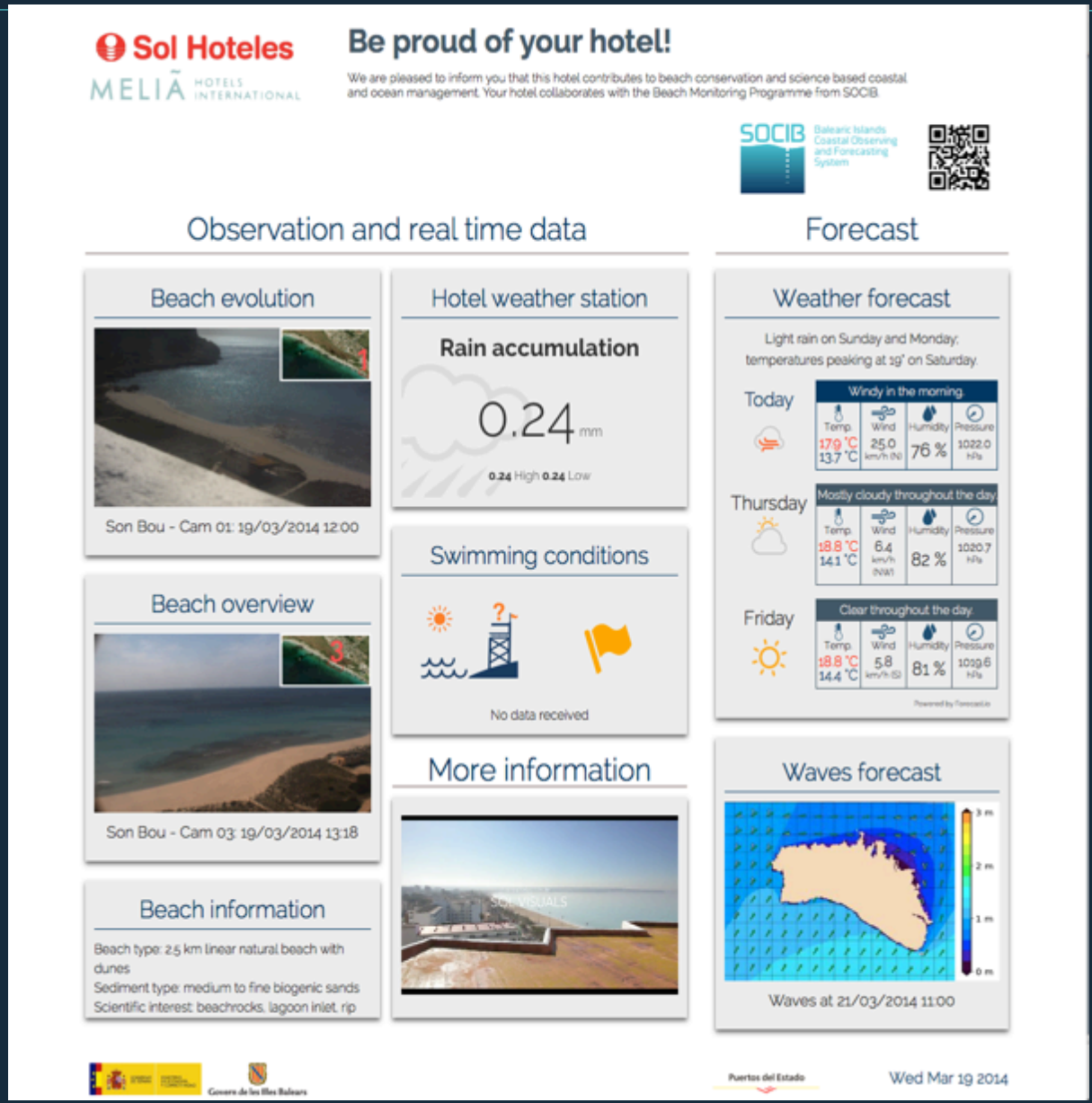






Beach monitoring using cameras, breakers, rips, bathymetry changes, etc.

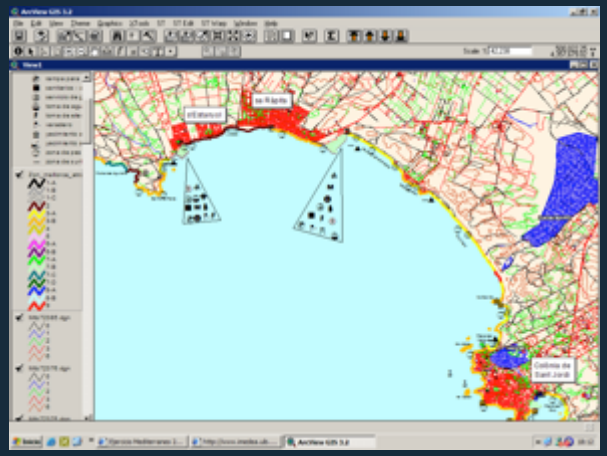
SOCIB Developments and Applications: Touristic sector



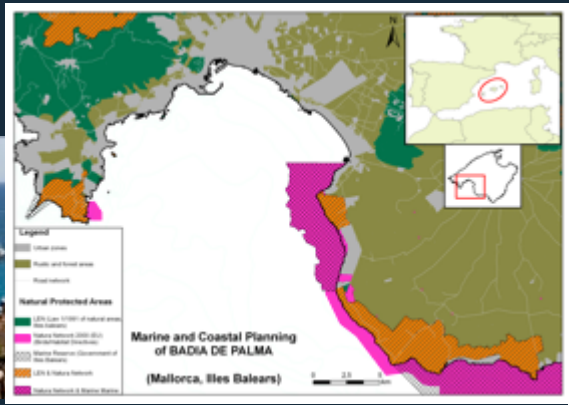
SOCIB Developments and Applications: Tools for Marine and Coastal Safety Decision Support

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:
Sustainability indicators; Science and Society



Marine Policy 34 (2010) 772–781

Contents lists available at ScienceDirect

Marine Policy

journal homepage: www.elsevier.com/locate/marpol

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

A. Diedrich [a,*], J. Tintoré [a], F. Navinés [b]

[a] IMEDEA (CSIC-UIB), Mediterranean Institute of Advanced Studies, Calle Miquel Marqués, 21, 07190 Esporles, Mallorca, Balearic Islands, Spain
[b] CES, Economic and Social Council of the Balearic Islands, Palau Reial, 19, 07001 Palma, Mallorca, Balearic Islands, Spain

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Science-policy gap
Balearic Islands
Spain

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.

Ocean & Coastal Management 52 (2009) 493–501

Contents lists available at ScienceDirect

Ocean & Coastal Management

journal homepage: www.elsevier.com/locate/ocecoaman

Integrated and interdisciplinary scientific approach to coastal management

Joaquín Tintoré [a], Raúl Medina [b], Lluís Gómez-Pujol [a,*], Alejandro Orfila [a], Guillermo Vizoso [a]

[a] IMEDEA (CSIC-UIB), Institut Mediterrani d'Estudis Avançats, Miquel Marqués 21, 07190 Esporles (Balearic Islands), Spain
[b] Instituto de Hidráulica Ambiental, IH Cantabria, Universidad de Cantabria, Av. Castros s/n, 39005 Santander, Spain

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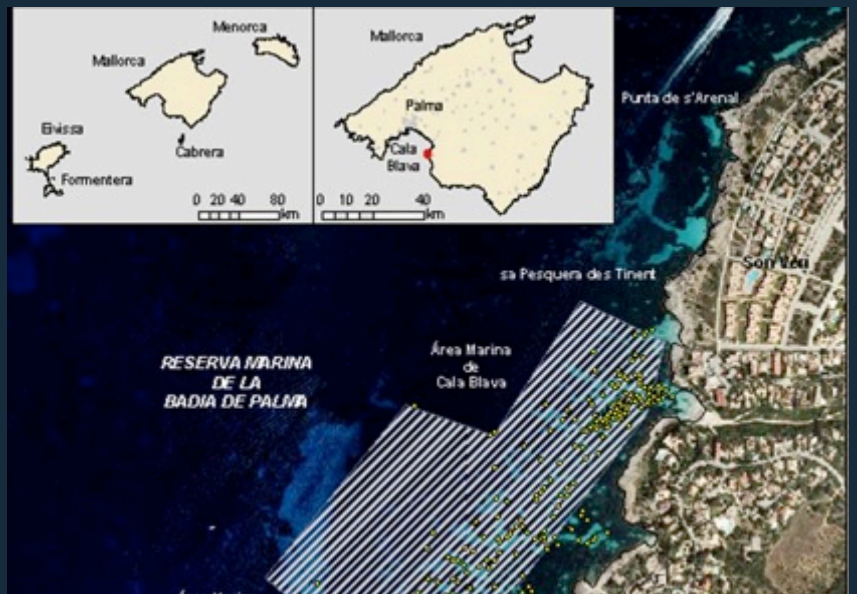
ABSTRACT

Coastal zones and beach management practices, regulatory decisions, and land use planning activities along coastal zones have historically been made with insufficient information concerning the dynamic coastal environment. In this study we address and integrate an interdisciplinary scientific approach to Coastal Management in a scenario where lack of this information has resulted in the alteration of the natural dune system of the beach of Cala Millor (Mallorca, Balearic Islands, Spain), and also in the perception of the beach retreat and in a parallel way, a risk for the tourism resources. In this work the detailed studies on beach morphodynamics have been developed as a basis for integrating proper beach management, beach natural dynamics and local users and economic agent interests. From this point of view a set of solutions are considered as the basis for a management policy that links beach science and beach use as a tourism resort resource.

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

AMY DIEDRICH[1] AND JOAQUÍN TINTORÉ[1,2]

[1]SOCIB (Balearic Islands Coastal Observing and Forecasting System)
Balearic Islands, Spain
[2]IMEDEA (CSIC-UIB) (Mediterranean Institute of Advanced Studies)
Balearic Islands, Spain

Innovation in oceanographic instrumentation

We need:

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

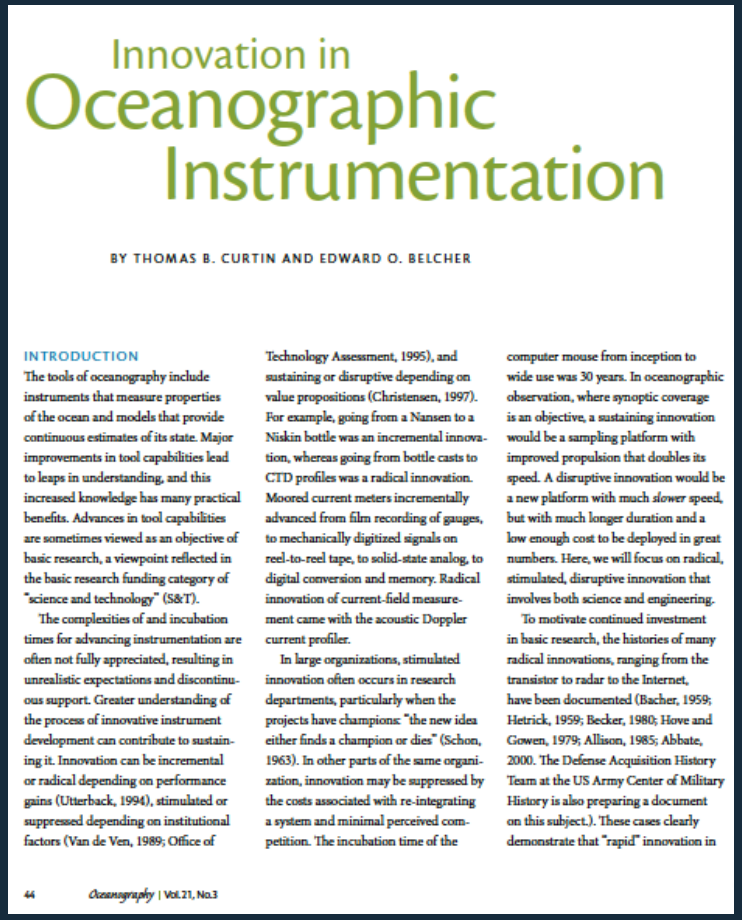
3 elements:

- 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

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(Curtin and Belcher, TOS, 2008)

The innovation process (for advancing instrumentation)

- 3 key decision centres:

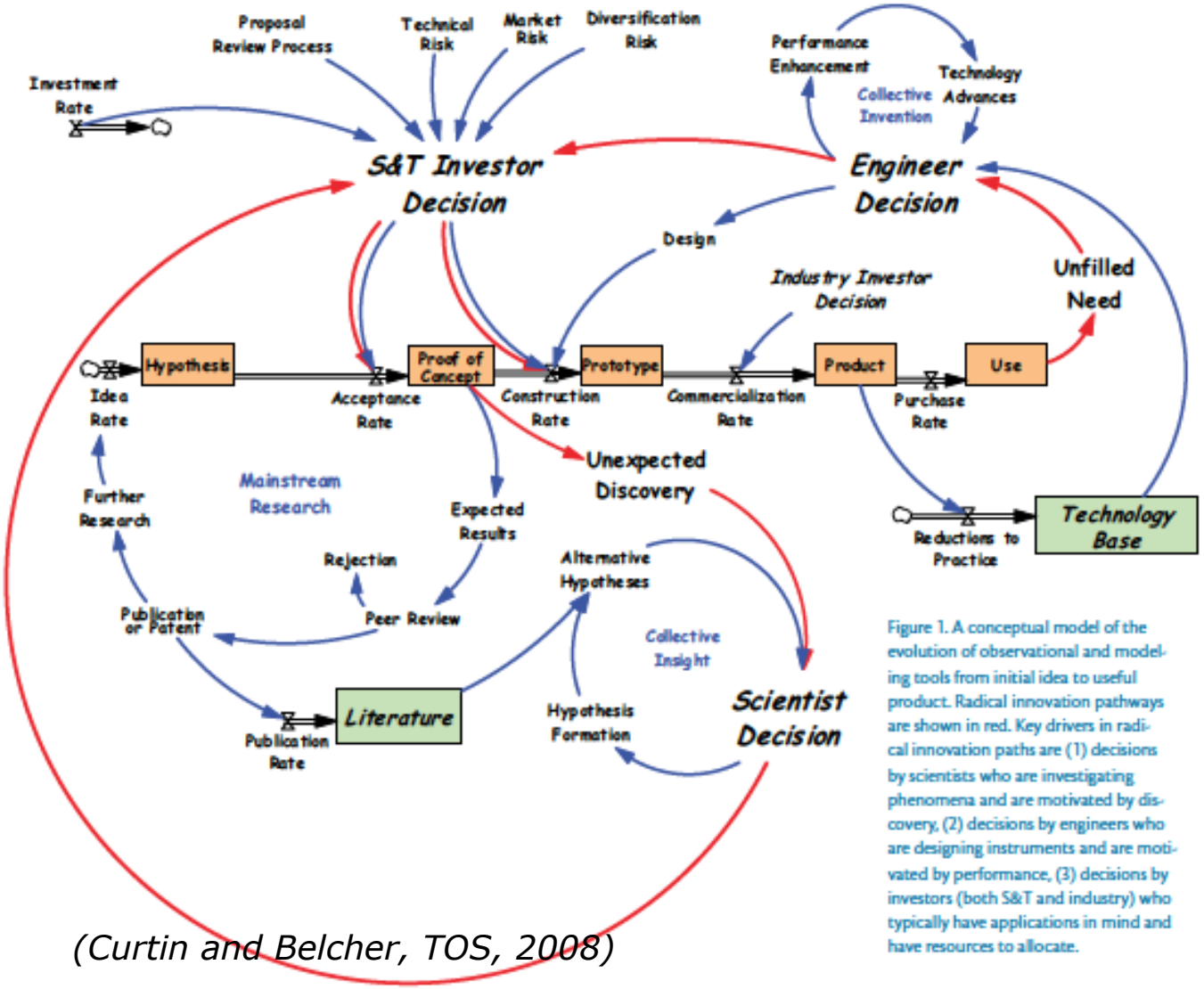

Figure 1. A conceptual model of the evolution of observational and modeling tools from initial idea to useful product. Radical innovation pathways are shown in red. Key drivers in radical innovation paths are (1) decisions by scientists who are investigating phenomena and are motivated by discovery, (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, …focused on long term objectives while producing short-term success, and find creative champions among funding agencies and investor organizations.

- MULTI-DISCIPLINARY APPROACH
- INTEGRATION

Summary: the new role of Ocean Observatories/Marine Research Infrastructures-MRI-

- 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)

Summary; …. We NEED A STRATEGY FOR INTEGRATION….. & Combine Excellent Science with IMPACT ON SOCIETY….

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"