Combining Scientific Excellence & Technology Development

with… Impact on Society

www.socib.eu

OUTLINE

1. New Technologies: Paradigm Change Ocean and Coastal Observation & Operational Oceanography: EU leadership.

2. Marine Research Infrastructures, Ocean Observatories: SOCIB

3. Innovation and Blue Growth: gliders disruptive innovation case study and data availability - “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…”)

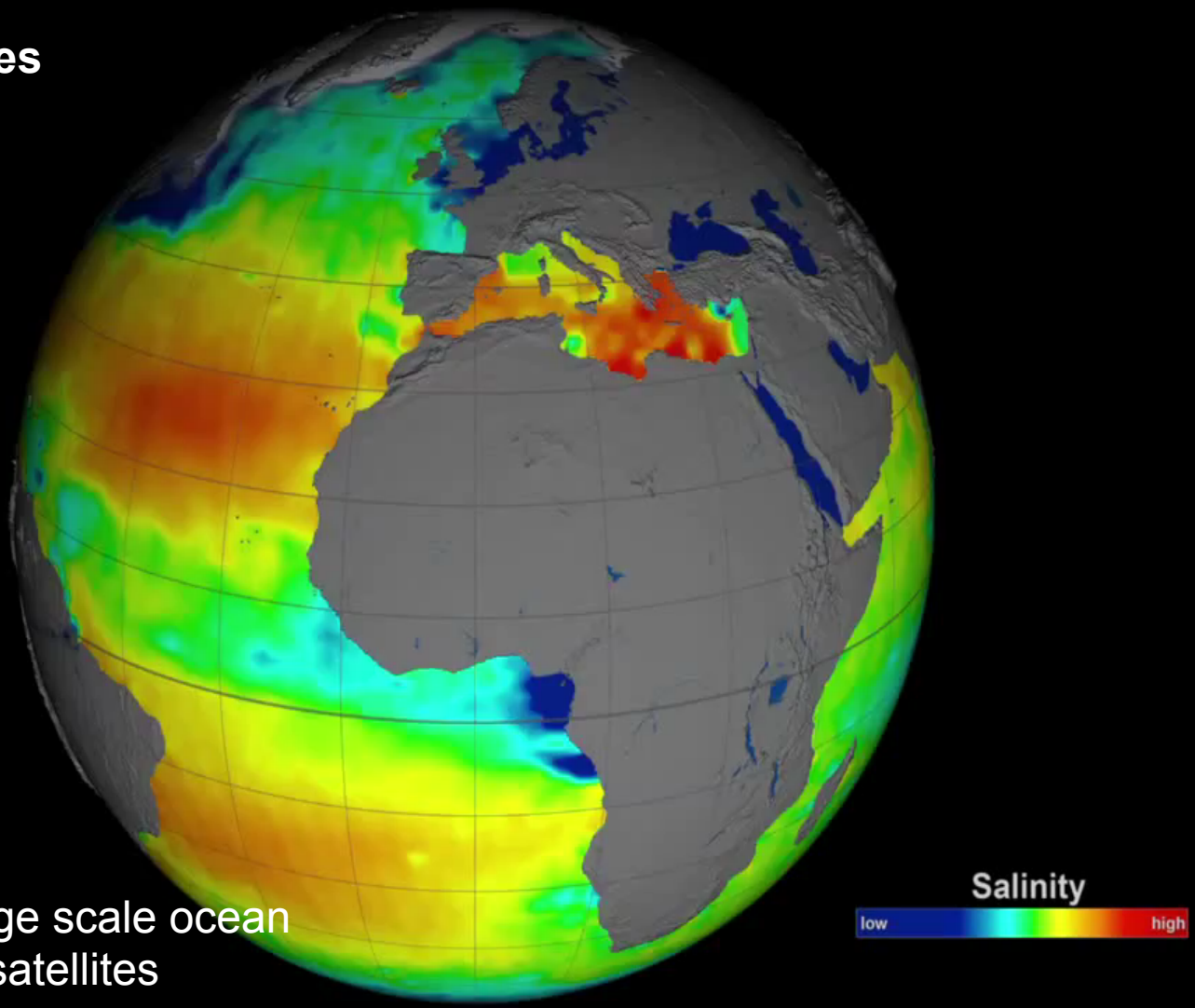
Our goal… characterise Ocean State AND Variability at Different Scales (basin, sub-basin, local & coastal interactions)

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"



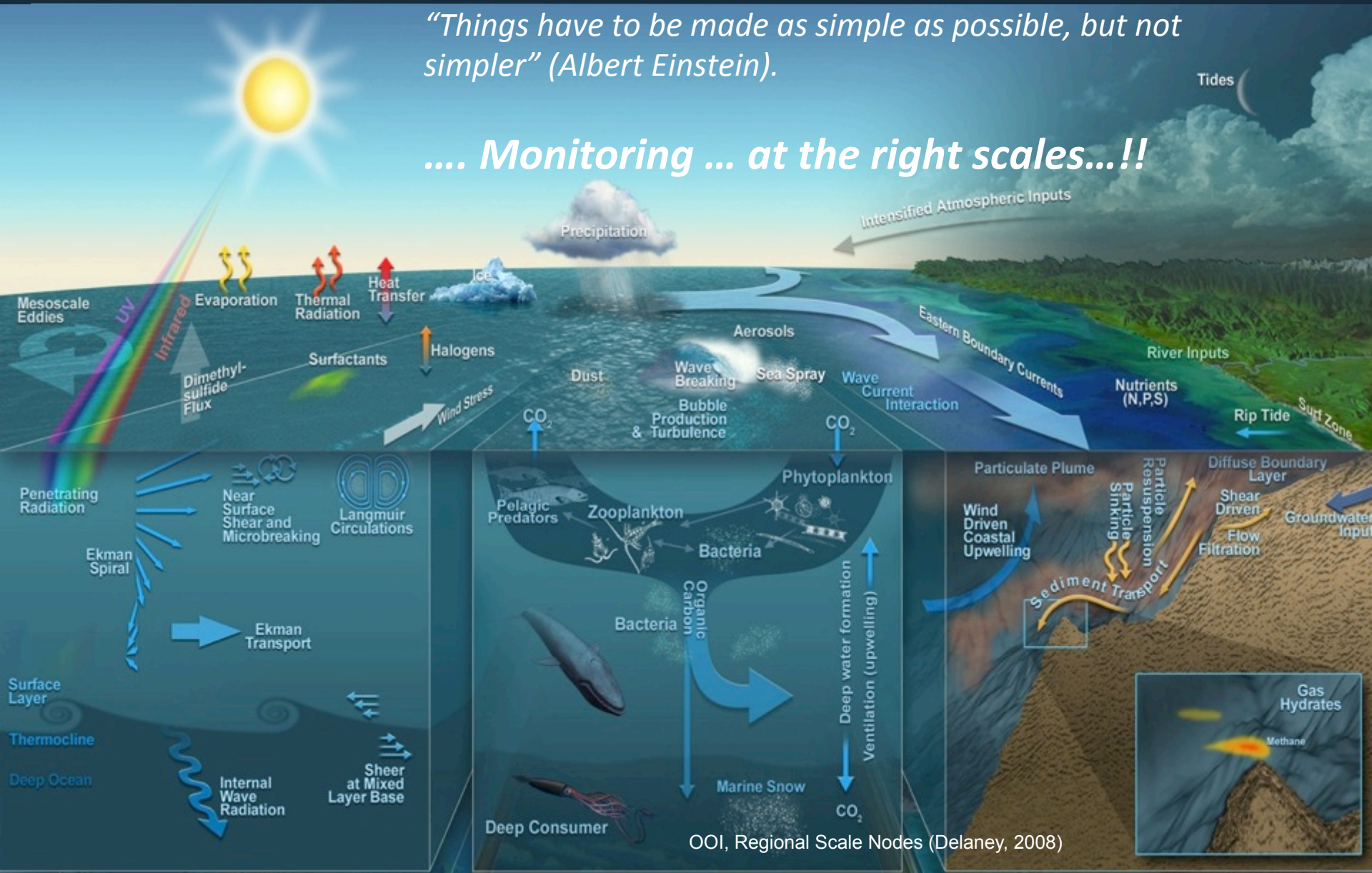
Last decade: ok large scale ocean circulation –Argo & satellites

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

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

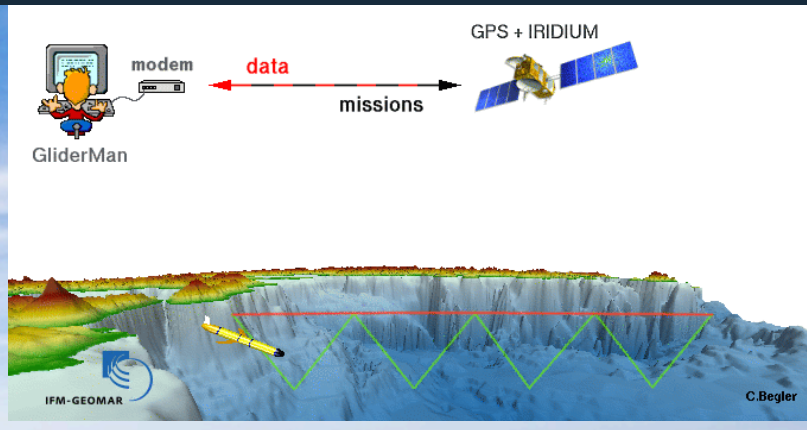
"Things have to be made as simple as possible, but not simpler" (Albert Einstein).

…. 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)

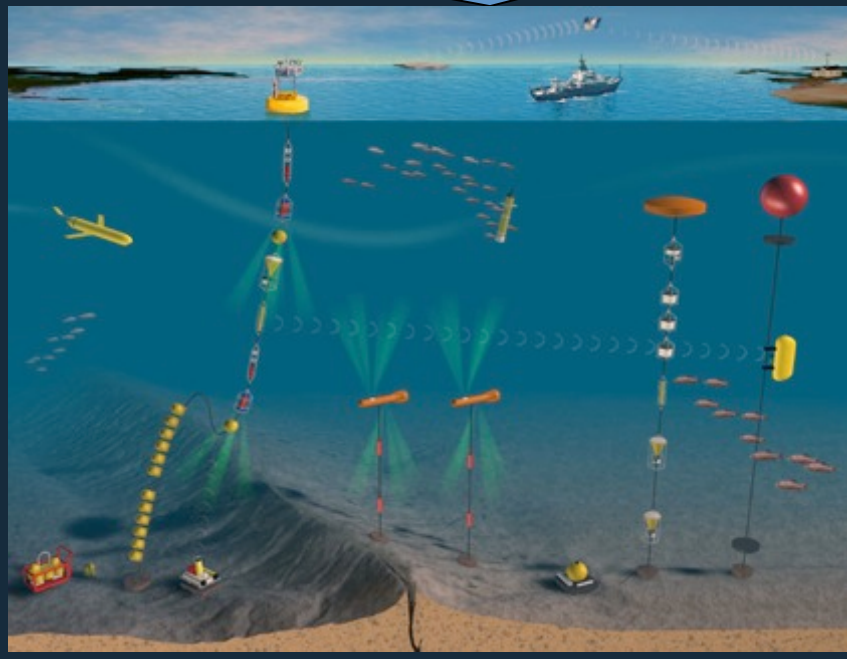
New Technologies: Paradigm Shift
➡ Ocean Observation

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
⟶ Data Availability

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

To: Quasi-real time quality controlled data available

A 2020 Vision for Ocean Science

JOHN R. DELANEY
University of Washington
ROGER S. BARGA
Microsoft Research

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.

Why Ocean Observatories, why SOCIB, why now?

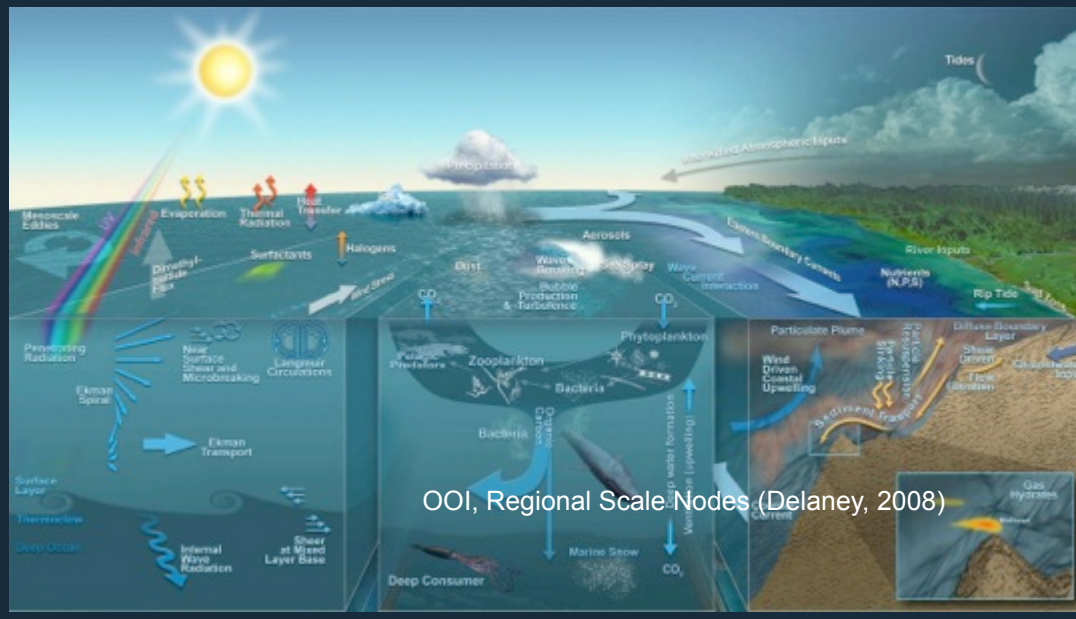
New Technologies triggered a paradigm change
New Approach to Marine and Coastal Research

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

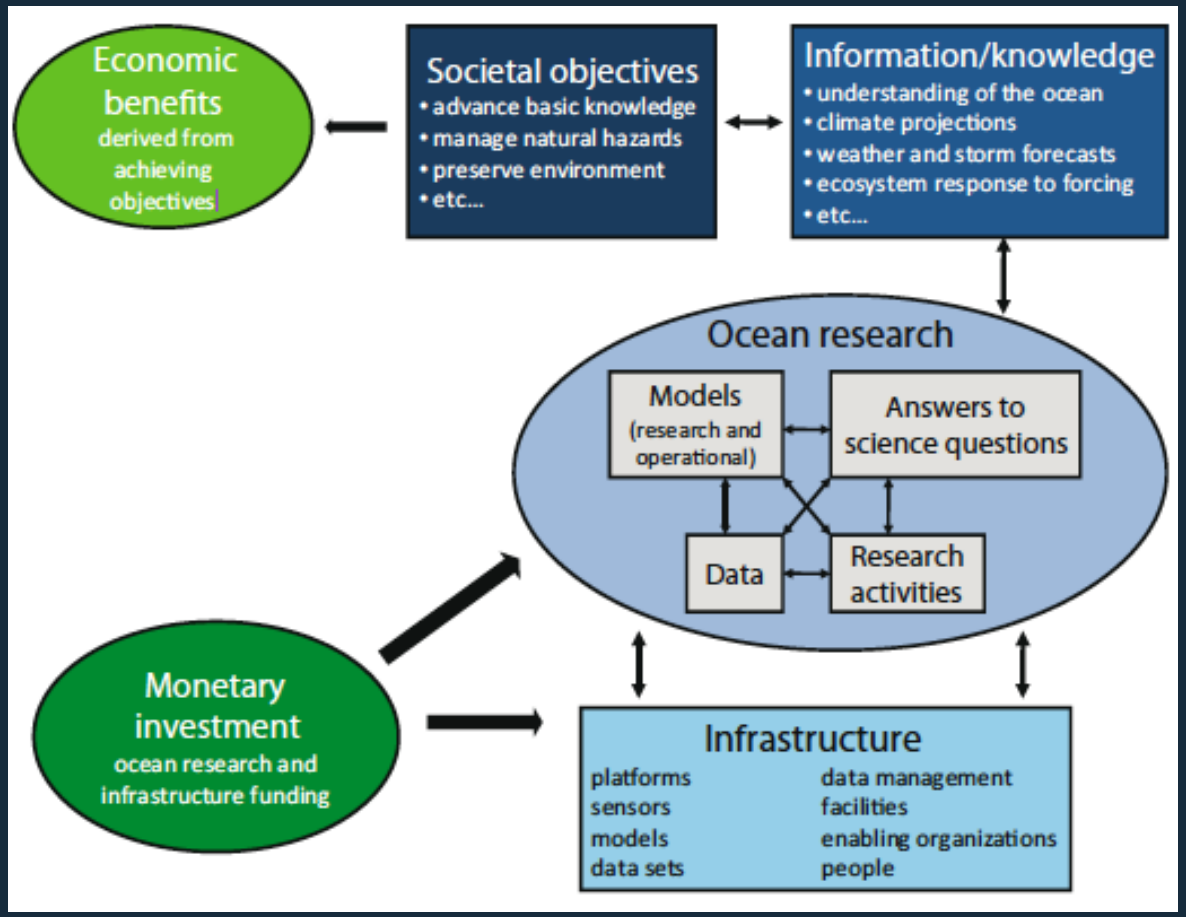


OOI, Regional Scale Nodes (Delaney, 2008)

- **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



EOOS

European MARINE BOARD
Advancing Seas & Oceans Science

IMOS

European Global Ocean Observing System

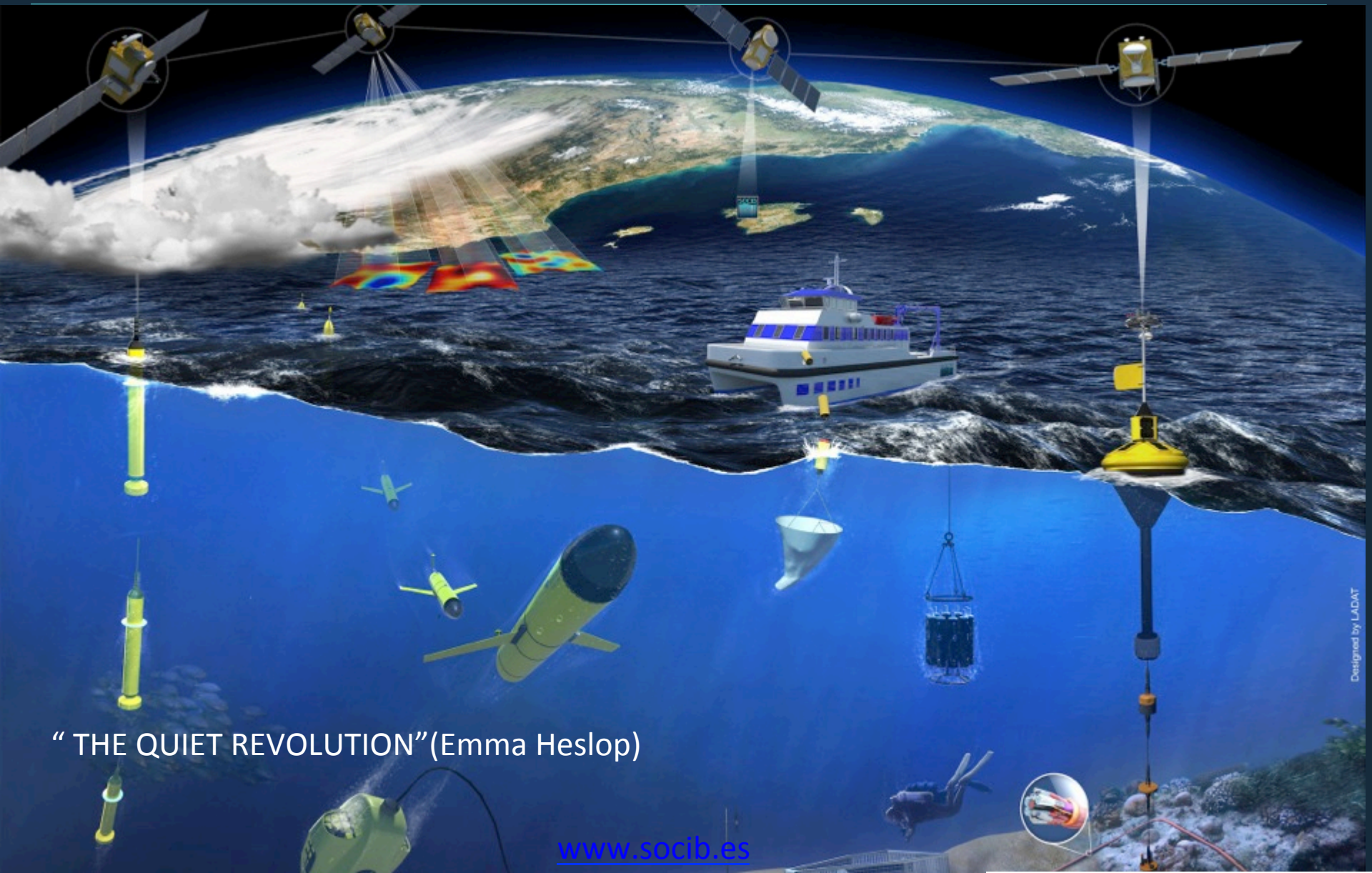
IOOS

NEPTUNE Canada

OOI
OCEAN OBSERVATORIES INITIATIVE

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

What is SOCIB? A multi-platform observing & forecasting integrated system, from nearshore to open ocean (NANOOS)



" THE QUIET REVOLUTION"(Emma Heslop)

www.socib.es

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

OBSERVING FACILITIES

Research vessel

HF Radar

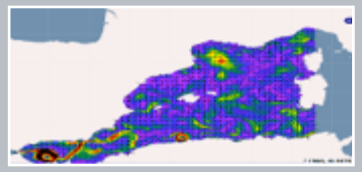
Gliders

Lagrangian platforms

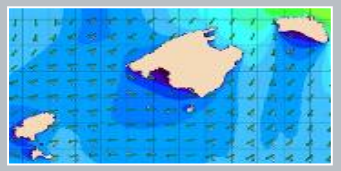
Fixed stations

Beach Monitoring

MODELLING FACILITY



Currents (ROMS)



Waves (SWAN)

STRATEGIC ISSUES & APPLICATIONS FOR SOCIETY

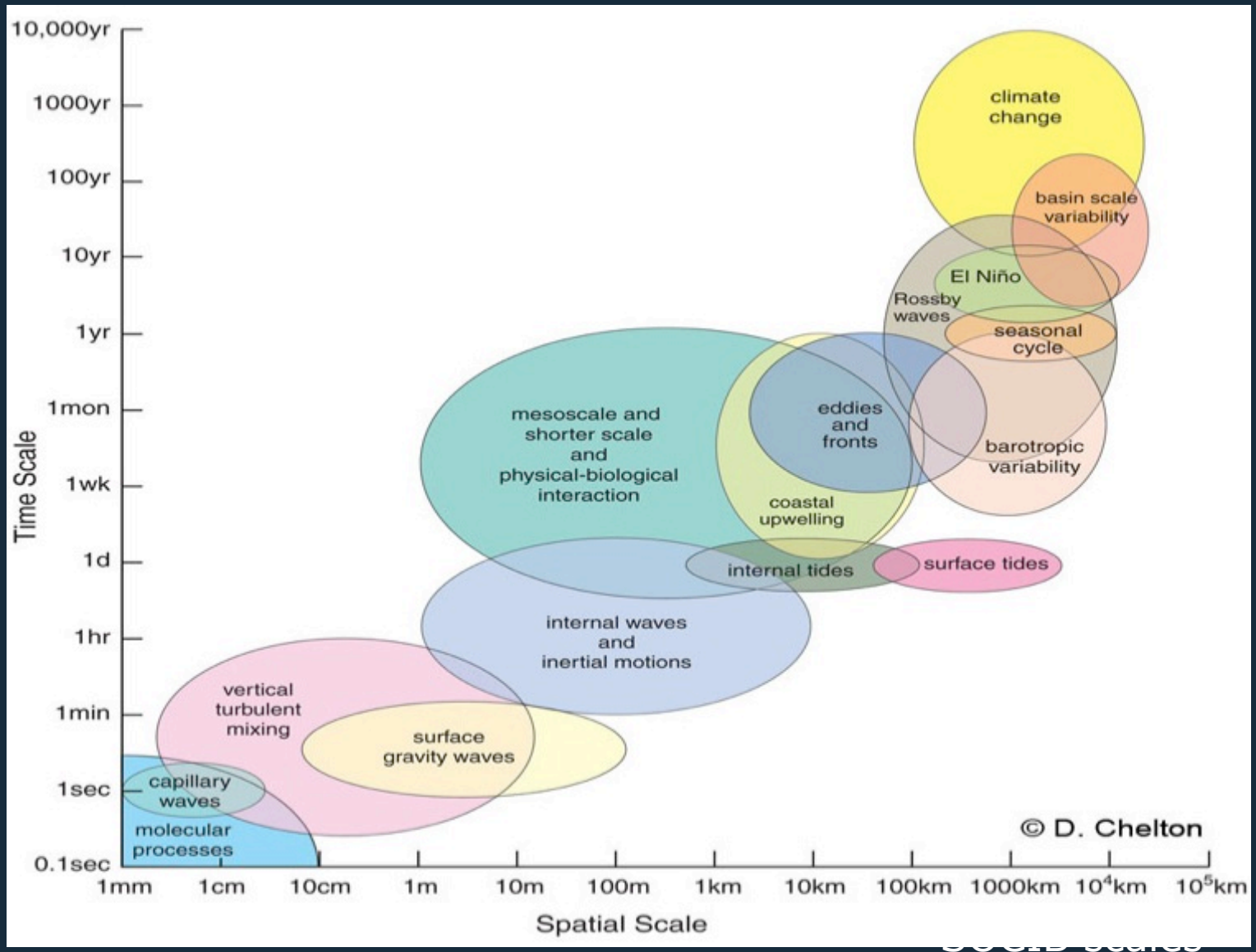
Integrated Coastal & Ocean Management

Bluefin Tuna

DATA CENTER

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

Focus on Variability at Meso and Submesoscale and Coastal interactions

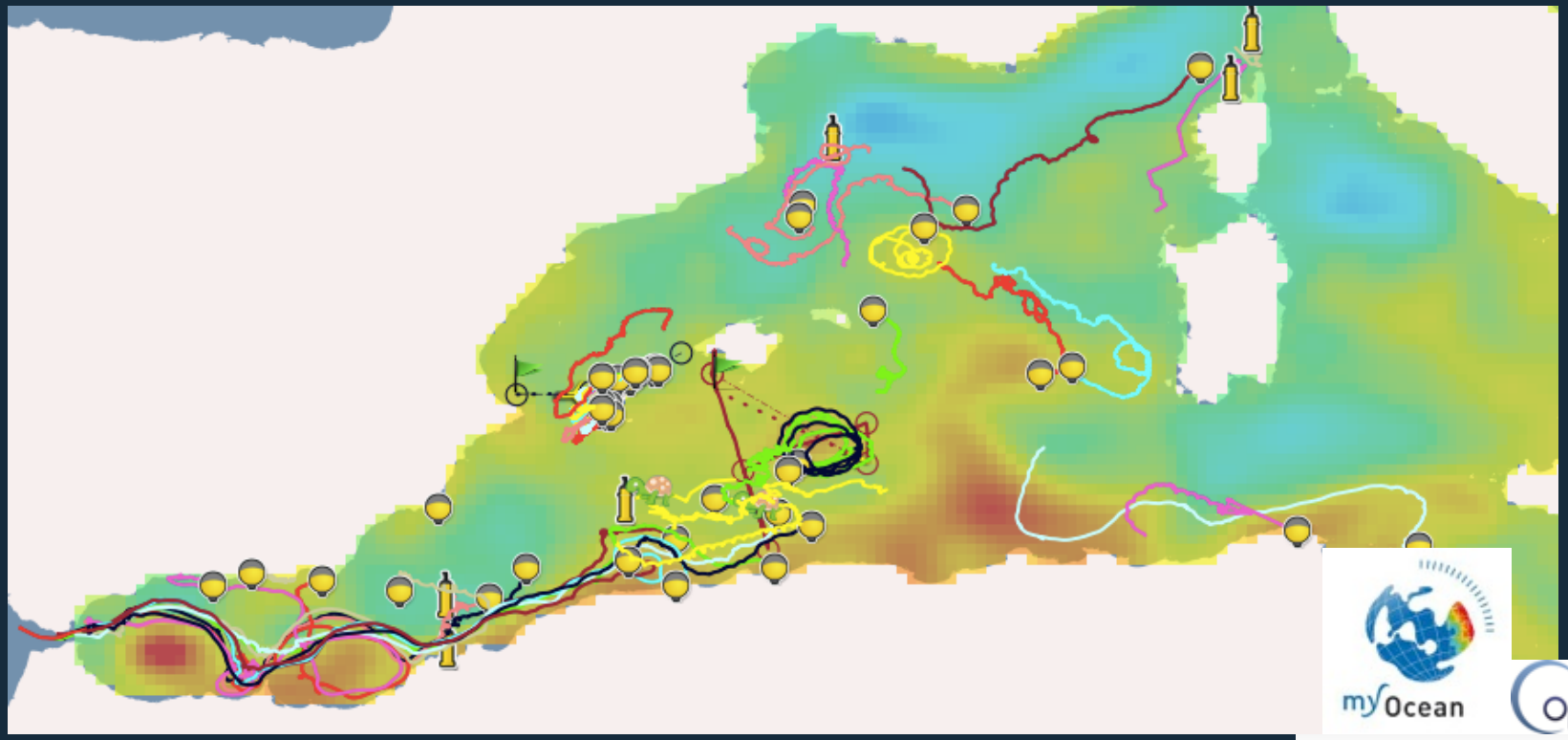


New Technologies: Paradigm Shift

SOCIB

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

Dapp SOCIB: Oct 29, 2014, 0800h, 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)

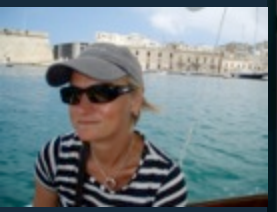
→ SCIENCE IMPLICATIONS: adaptive sampling with gliders…

http://apps.socib.es/dapp

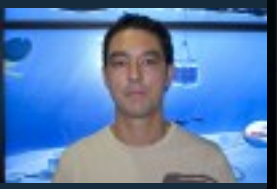
SOCIB at EuroGOOS - 2014:

www.socib.es

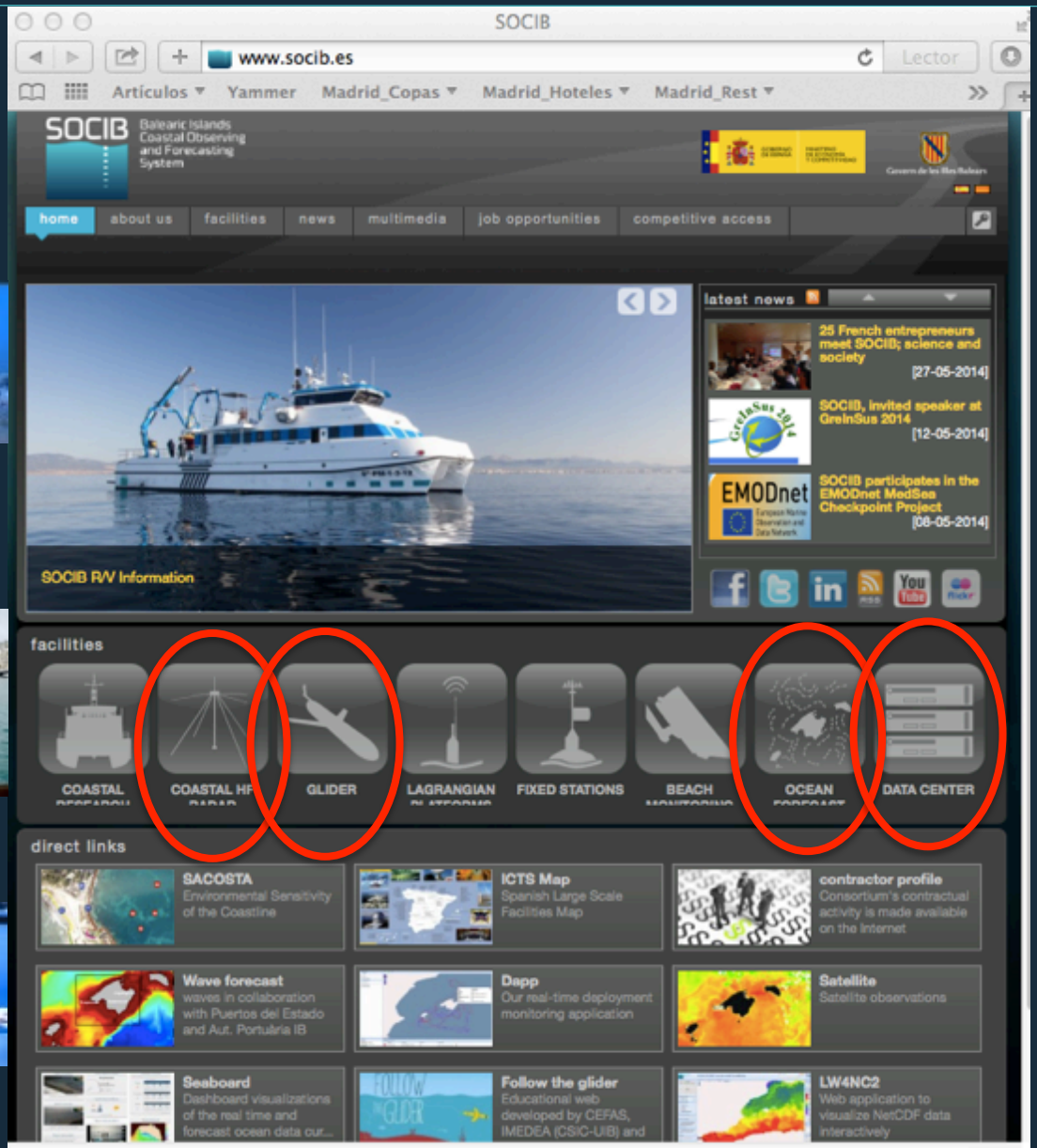
Charles Troupin



Emma Heslop



Diego Álvarez



3 Drivers

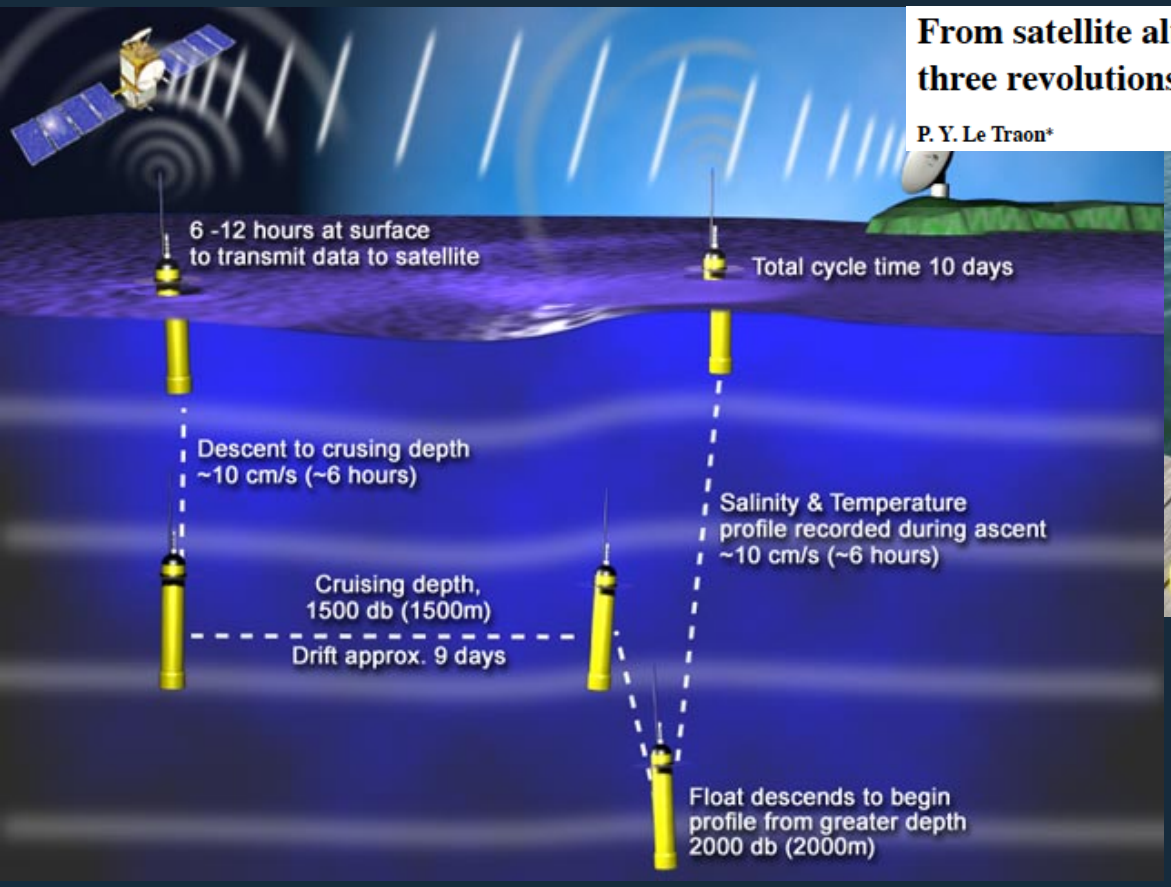
- Science priorities
- Technology Dev.
- Society Needs

Mélanie Juza

Baptiste Mourre

Charles Troupin

Last decade: successful Argo international programme -Euro-Argo-.

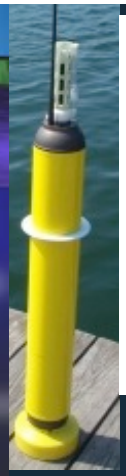


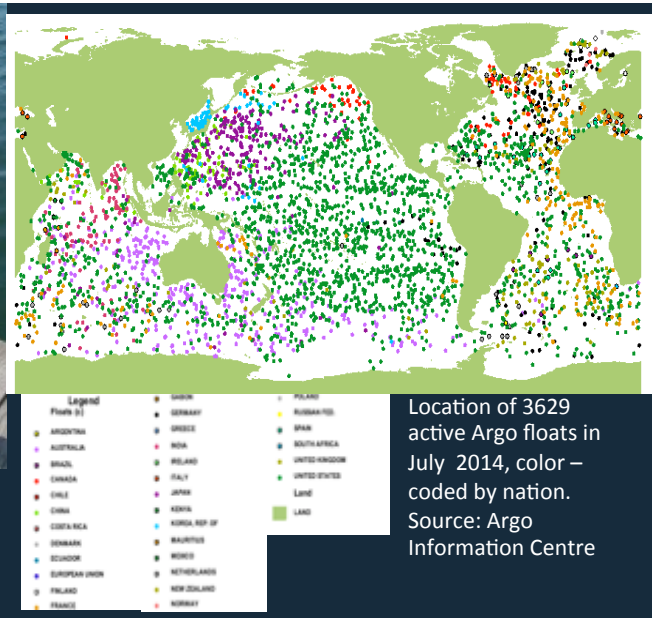
Schematic diagram of a single Argo float cycle

From satellite altimetry to Argo and operational oceanography: three revolutions in oceanography

P. Y. Le Traon*

Ocean Sci., 9, 901–915, 2013





Location of 3629 active Argo floats in July 2014, color – coded by nation. Source: Argo Information Centre

http://www.euro-argo.eu

262 floats with biogeochemical sensors

638 European floats (18%)

Argo Programme -combined with satellite altimetry- allowed characterisation:

STATE OF LARGE SCALE OPEN OCEAN CIRCULATION

Next decade… Ocean Variability

PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY A

Phil. Trans. R. Soc. A (2012) **370**, 5461–5479
doi:10.1098/rsta.2012.0397

Changing currents: a strategy for understanding and predicting the changing ocean circulation

BY HARRY L. BRYDEN[1,*], CAROL ROBINSON[2] AND GWYN GRIFFITHS[3]

[1] *Ocean and Earth Science, National Oceanography Centre Southampton, University of Southampton, European Way, Southampton SO14 3ZH, UK*
[2] *School of Environmental Sciences, University of East Anglia, Norwich Research Park, Norwich NR4 7TJ, UK*
[3] *National Oceanography Centre, University of Southampton Waterfront Campus, European Way, Southampton SO14 3ZH, UK*

Within the context of UK marine science, we project a strategy for ocean circulation research over the next 20 years. We recommend a focus on three types of research: (i) sustained observations of the varying and evolving ocean circulation, (ii) careful analysis and interpretation of the observed climate changes for comparison with climate model projections, and (iii) the design and execution of focused field experiments to understand ocean processes that are not resolved in coupled climate models so as to be able to embed these processes realistically in the models. Within UK-sustained observations,

IN FOCUS NEWS

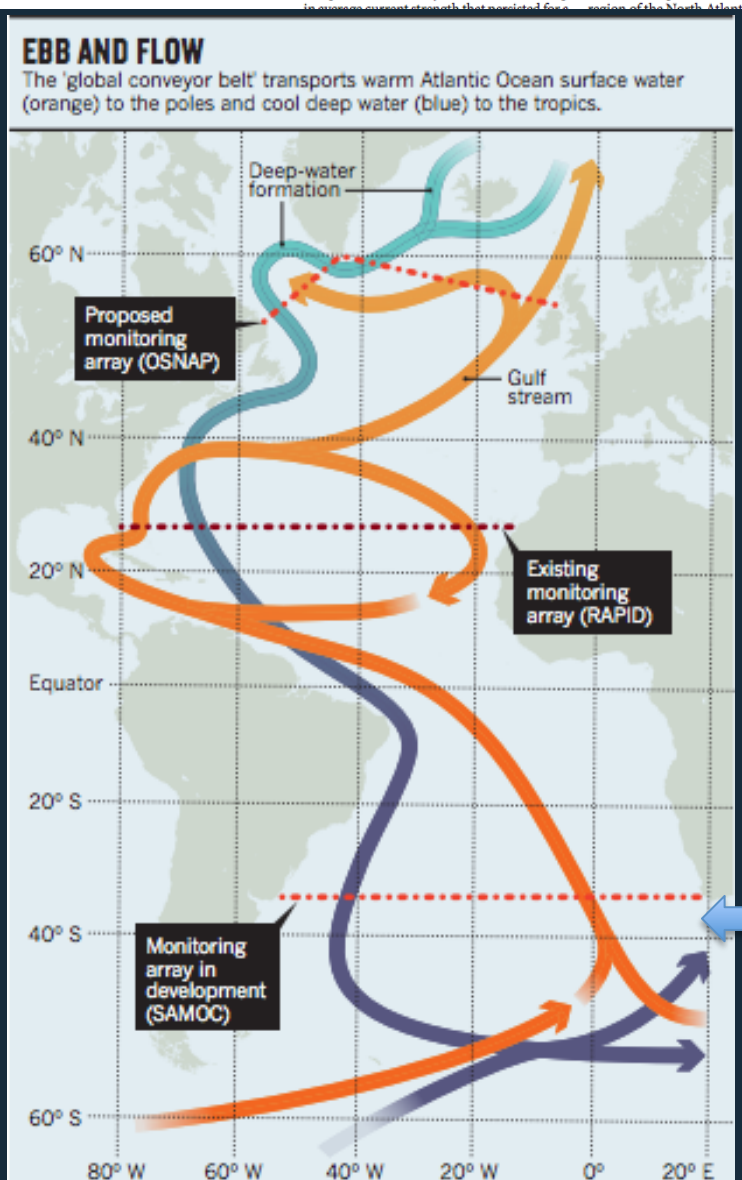
OCEANOGRAPHY

Oceans under surveillance

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

BY QUIRIN SCHIERMEIER

In April 2009, the array recorded[2] a 30% drop … a crucial component of the conveyor belt: the



Marine research in the past 20 years has focused on defining the **present day** ocean circulation. From these measurements of ocean circulation, we begin to understand how biogeochemical distributions are set and how the ocean and atmosphere interact to determine the present climate [4].

The key issue for the next 20 years is to understand how the ocean circulation varies on inter-annual to decadal time scales

And we need… **"Careful analysis and interpretation of climate changes"**

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

The real challenge for the next decade: Ocean Variability at the "right" scales…

To use and integrate these new technologies to:

carefully and systematically

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

This will also lead us to…:

Responding to Science and Society needs…(including technology development…)

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]

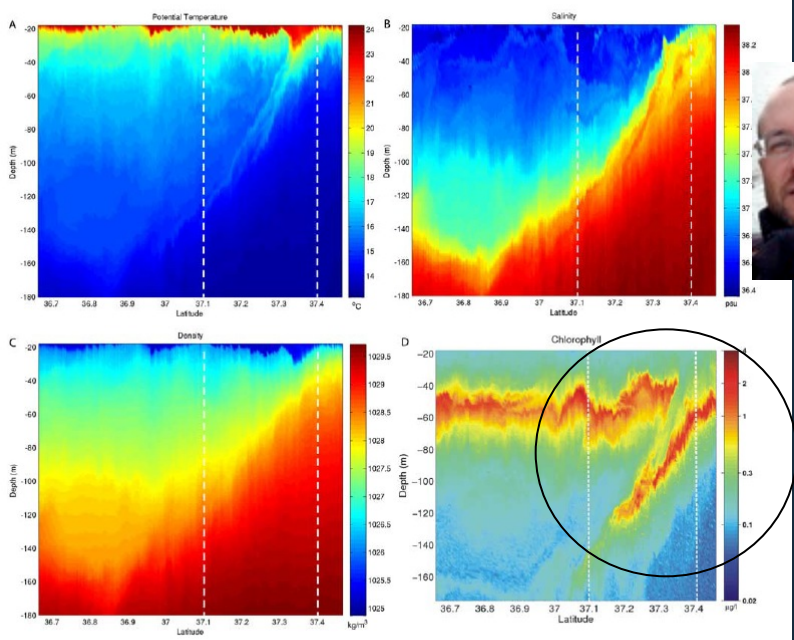
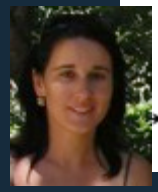


Figure 2. Vertical section of temperature (°C), salinity (PSU), density (kg/m^3) and chlorophyll (μg/l) from glider section 2 (dashed magenta in Figure 1). White dashed lines define sub-section in the northern part of the domain.

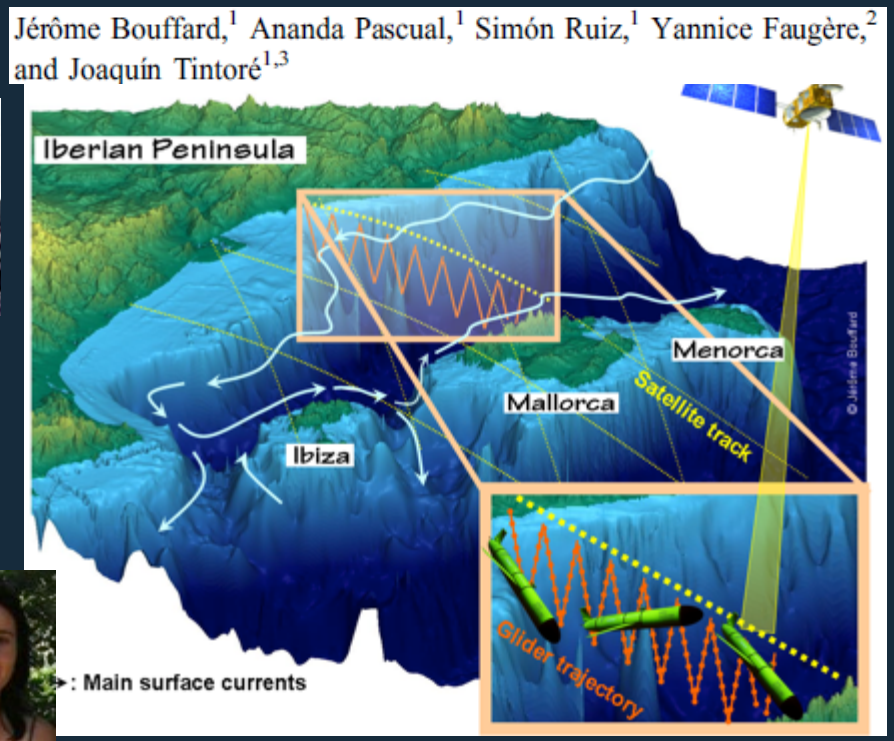


Eddy/mean flow interactions – Blocking effects General Circulation

JGR, 2010

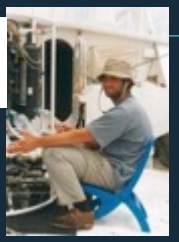
Coastal and mesoscale dynamics characterization using altimetry and gliders: A case study in the Balearic Sea

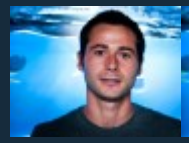
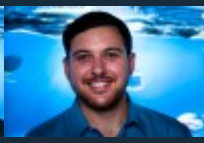
Jérôme Bouffard,[1] Ananda Pascual,[1] Simón Ruiz,[1] Yannice Faugère,[2] and Joaquín Tintoré[1,3]



Gliders Facility: Science & 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

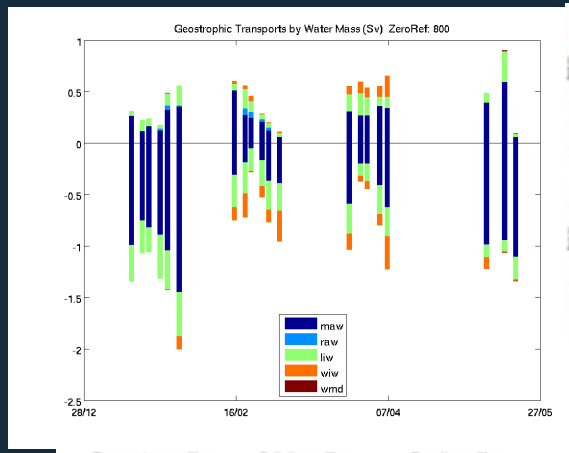
Emma E. Heslop,[1] Simón Ruiz,[1] John Allen,[2,3] José Luís López-Jurado,[4] Lionel Renault,[5] and Joaquín Tintoré[1,5]

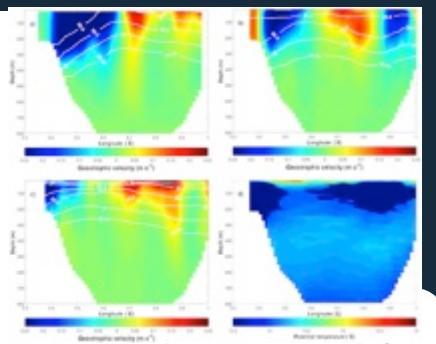
Glider Facility: 05/2006-10/2014

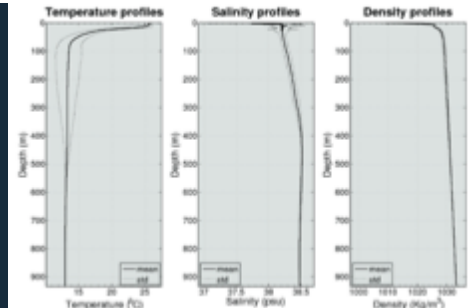
- **54 missions, 896 days in water, 10.450 nm**
- **26.185 profiles (30 Euros/profile)**

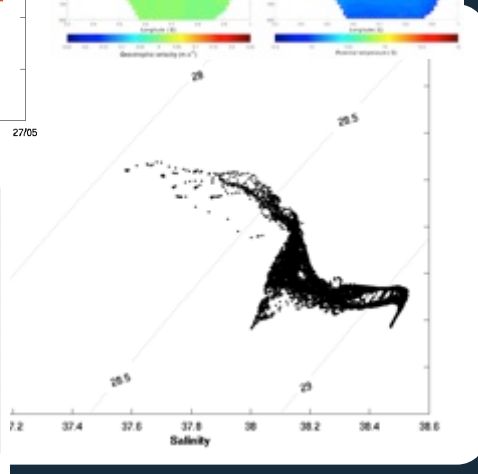
Since January 2011; routine operations

Major transport changes





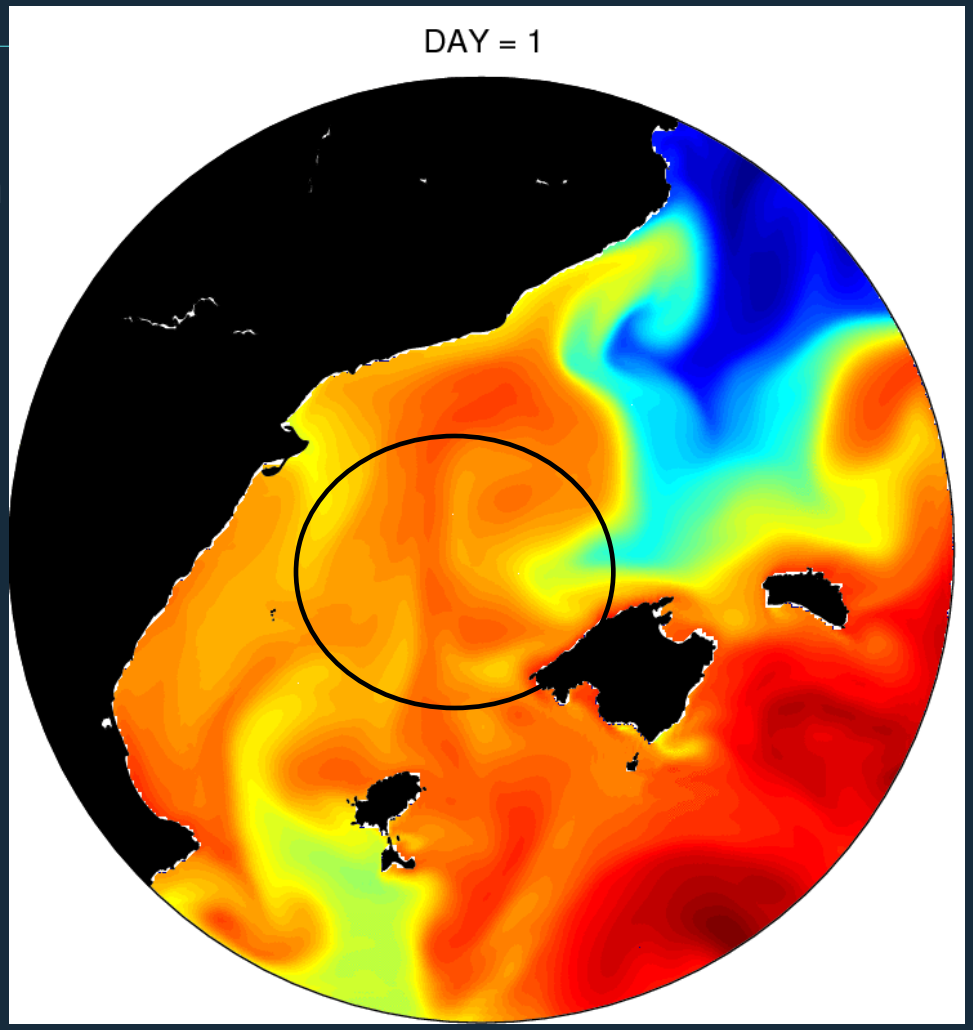




Modelling Facility

Operational Modeling: **ROMS,** 2km, to reproduce and maintain mesoscale features, interactions. In collaboration with PE and in the frame MFS/MOON. **WRF** Atmospheric Model. **SWAN** for coastal ocean wave Dynamics and Habors (with PE)

Aim :
- Validate the model with measurement (gliders, ...)
- From available data and model simulation (5 years), study the formation of mesoscale structures.
- Understand impact of meso/ submesoscale on circulation and on the ecosystem

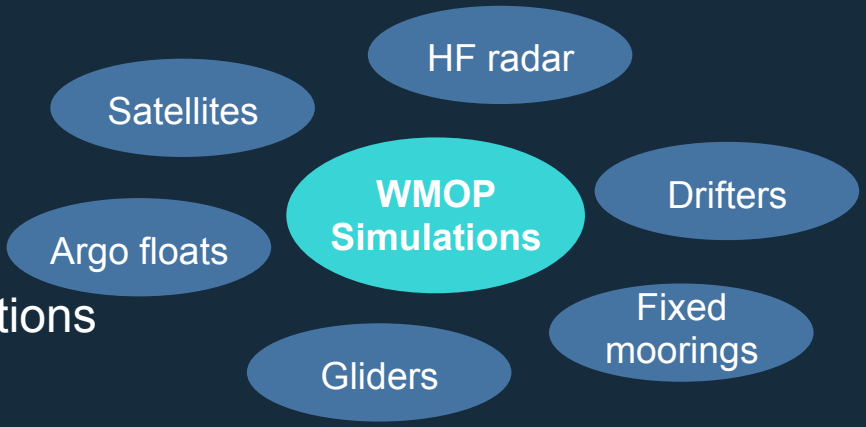


SST from 11/2008

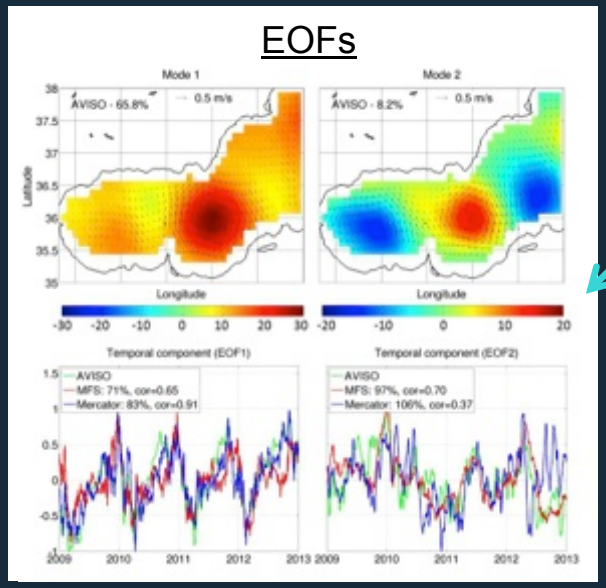
Modelling and Forecasting Facility

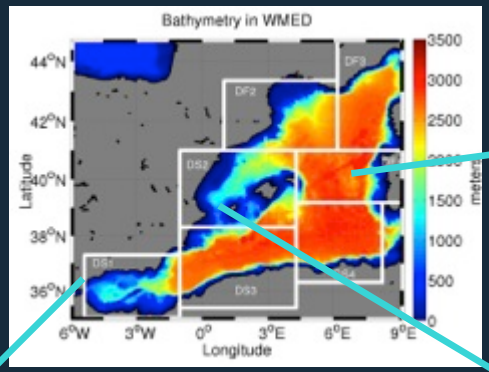
Validation approach

- Multi-platform observations with various spatial/temporal resolutions & coverage
- From basin to sub-basin and local scales assessment of hindcast and forecast simulations
- From large-scale to mesoscale features, circulation and variability, vertical structure, water masses



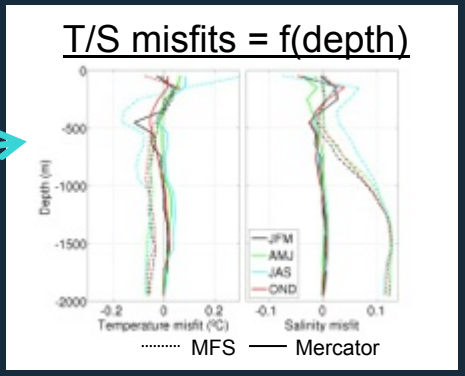
EOFs

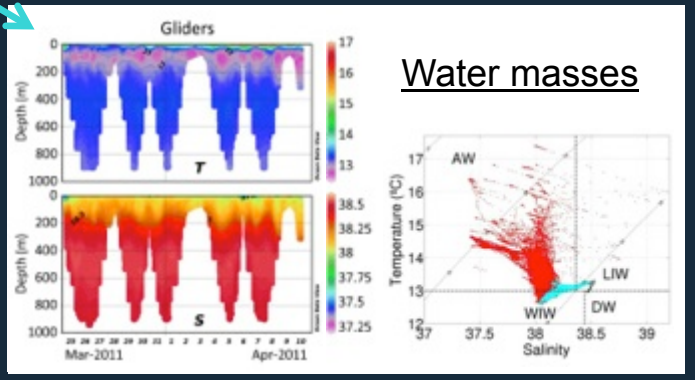




Regional boxes (*Manca et al.*, 2004) (typical sub-basin scale dynamics in the upper layer 0-200m)

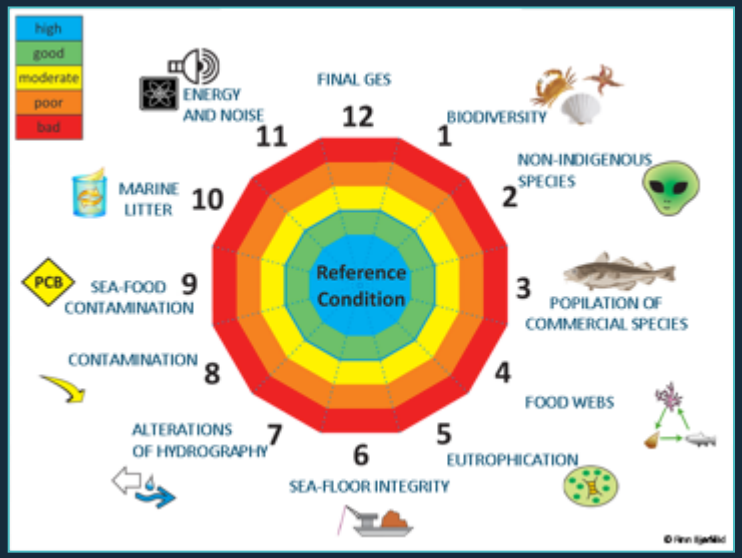
T/S misfits = f(depth)





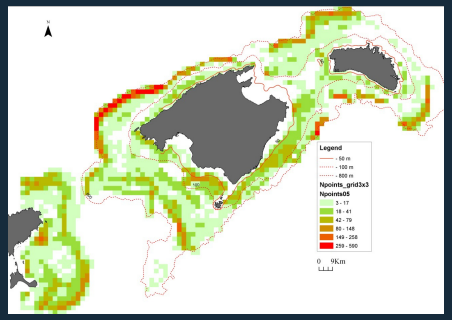
SOCIB Developments and Applications: Contribution to IMP, e.g., MSFD. Strong science for wise decisions.

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: Outreach

http://followtheglider.com

Innovation in oceanographic instrumentation

We need:

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

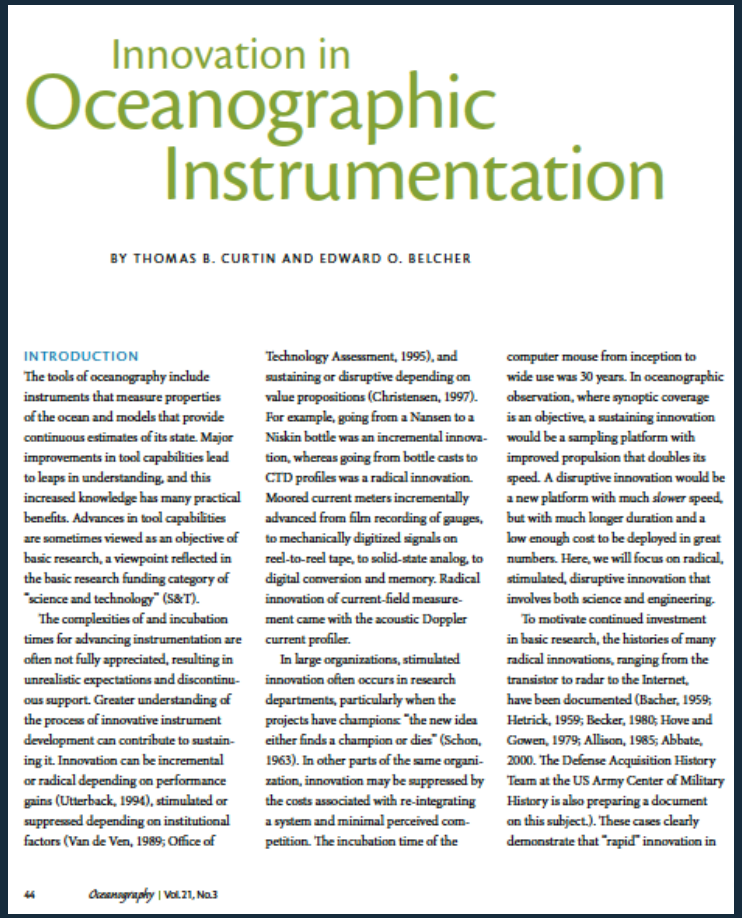
-The innovation process: , Disruptive innovations and incubation time:

3

- Incubation time: 15-30 years (computer mousse, 30 years).

- Gliders 10 years.

WHY?
What is the the key to success?



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

3 key decision centres:

3 PILARS .... As in H2020 - but here working together!-

3 PILARS, WORKING TOGETHER FOR A COMMON GOAL, WITH A WELL DEFINED STRATEGY…

OPERATIONAL OCEANOGRAPHY … well placed to take profit paradigm change & multi-platform approach

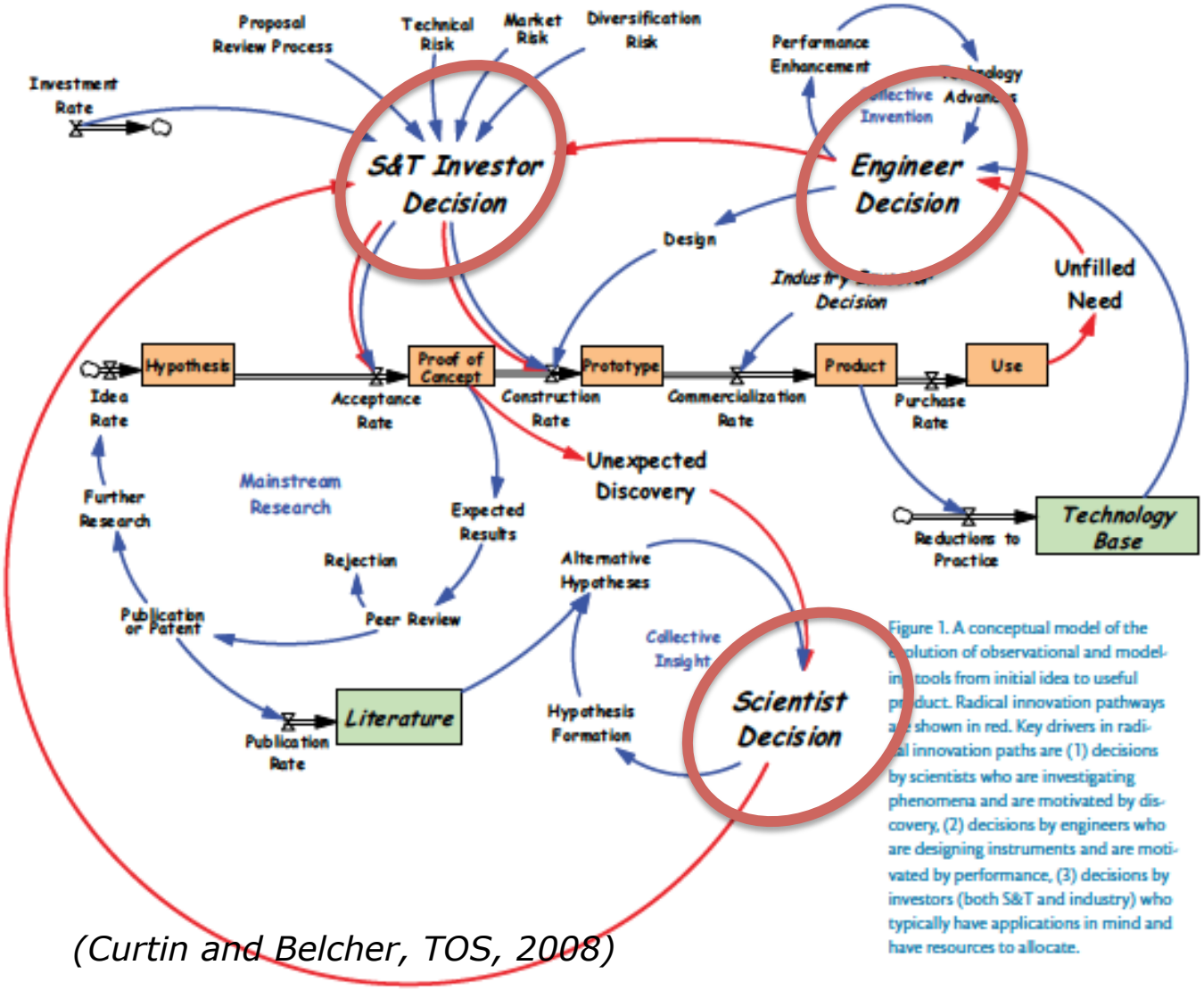

Figure 1. A conceptual model of the evolution of observational and modelling tools from initial idea to useful product. Radical innovation pathways are shown in red. Key drivers in radical innovation paths are (1) decisions by scientists who are investigating phenomena and are motivated by discovery, (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)

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"

Excellent Science & Technology Development with IMPACT ON SOCIETY…." A Strategy for…"

muito obrigado!!

– "The real voyage of discovery consists not in seeking new landscapes, but in having new eyes". (Marcel Proust)

"Le véritable voyage de découverte ne consiste pas à chercher de nouveaux paysages, mais à avoir de nouveaux yeux"

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*