Kostas Nittis Scientific and Strategic Workshop
Athens, 26-27 May 2015

Paradigm change in ocean studies: multi-platform observing and forecasting integrated approach in response to science and society needs

Combining Scientific Excellence & Technology Development

with… Impact and Relevance to and for Society

www.socib.eu

SOCIB & IMEDEA Team (Nov. 2104)

NATURE | RESEARCH HIGHLIGHTS: SOCIAL SELECTION

Fruit-fly paper has 1,000 authors

Genomics paper with an unusually high number of authors sets researchers buzzing on social media.

NATURE | NEWS

Physics paper sets record with more than 5,000 authors

Detector teams at the Large Hadron Collider collaborated for a more precise estimate of the size of the Higgs boson.

OUTLINE: CHANGES IN OCEANOGRAPHY 2020-2030

SOCIB

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

2. Marine Research Infrastructures, Ocean Observatories: SOCIB contributions to process studies and operational response and the real challenges for next decade

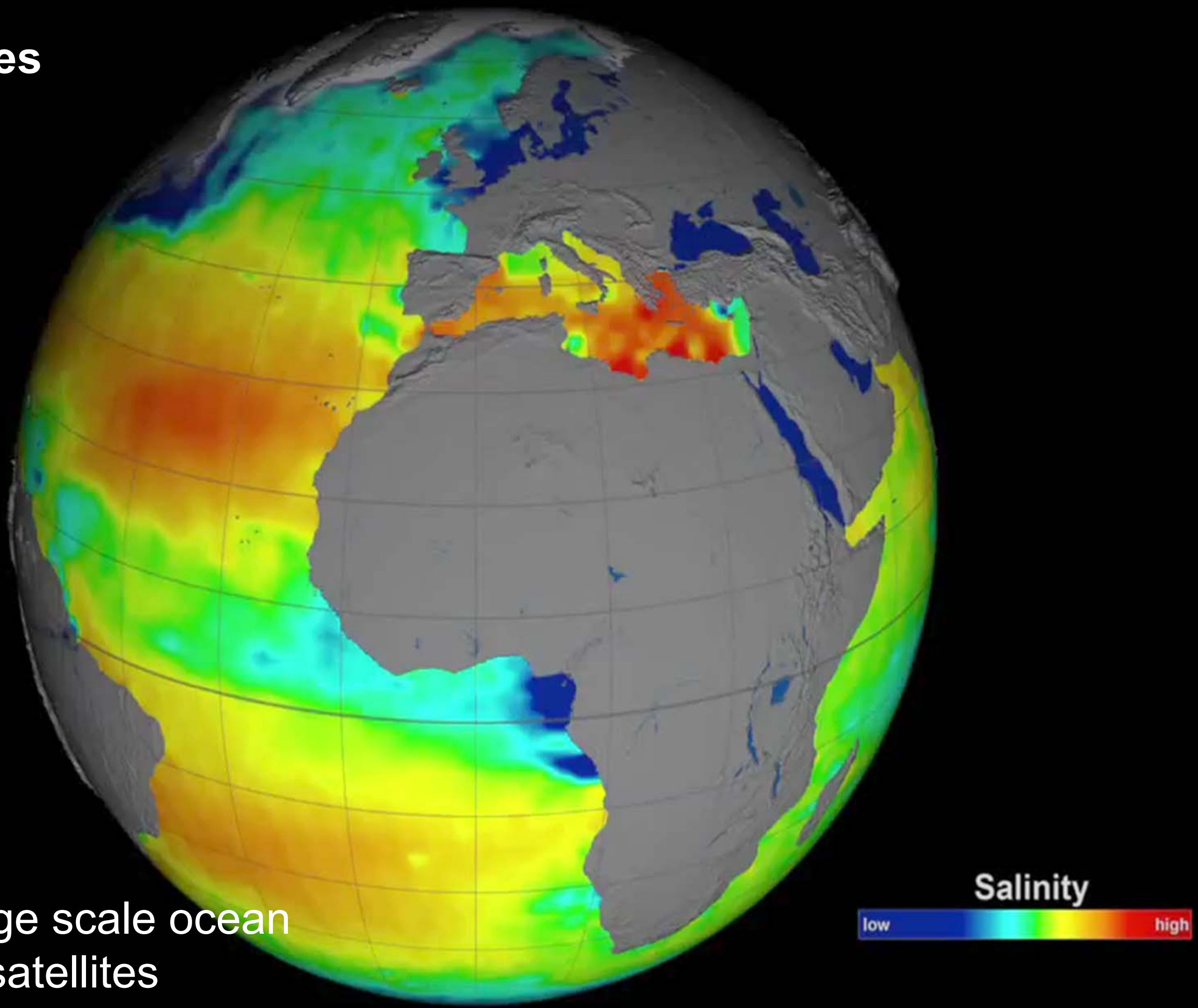
3. Discussion on changes in oceanography in last 10 years: Are we ready for theses changes ? Do we have the framework and right structures to get all the benefits from these changes?

4. New Partnership in the Mediterranean; 2016 and 2030 vision…

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"

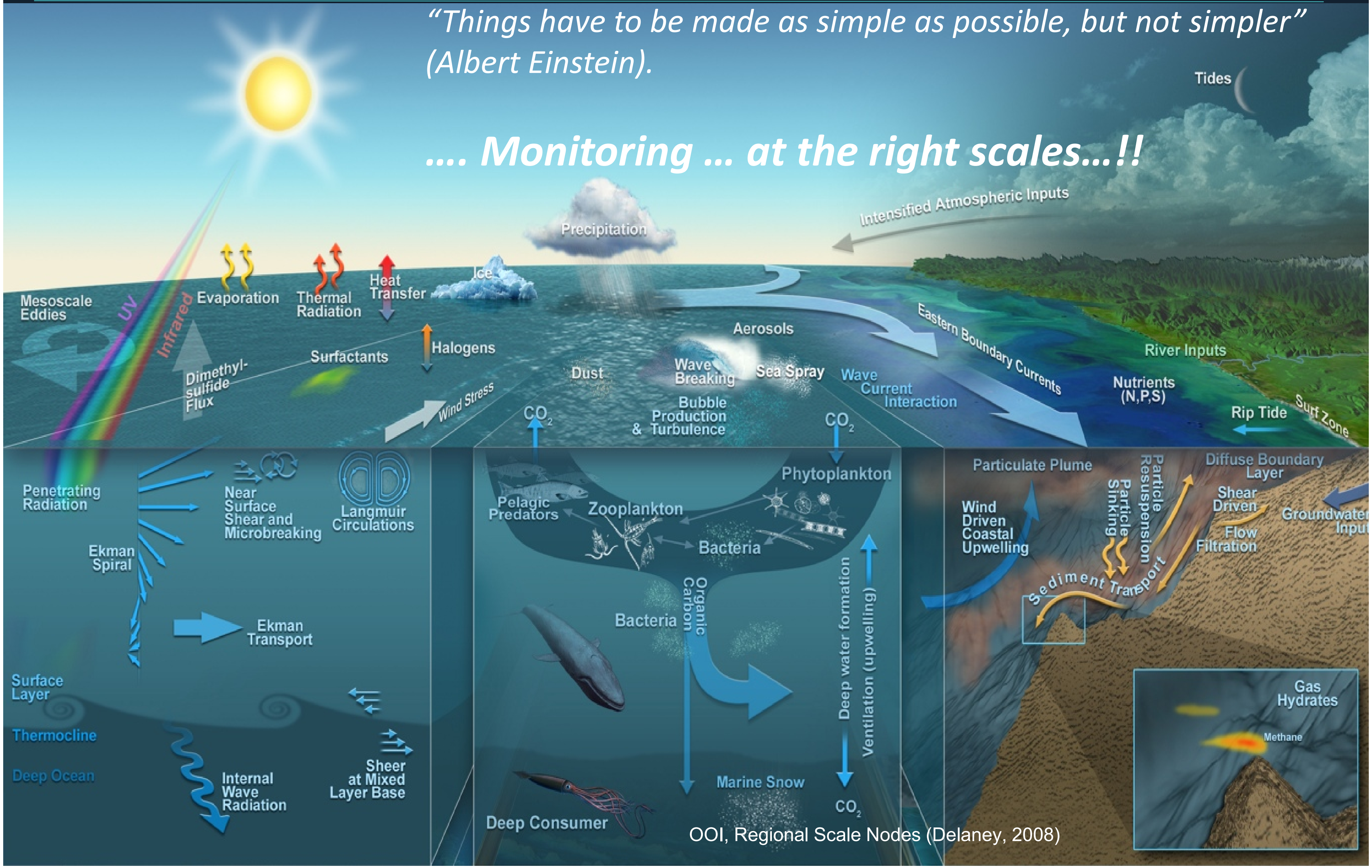
<u>Last decade</u>: ok large scale ocean circulation –Argo & satellites

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

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

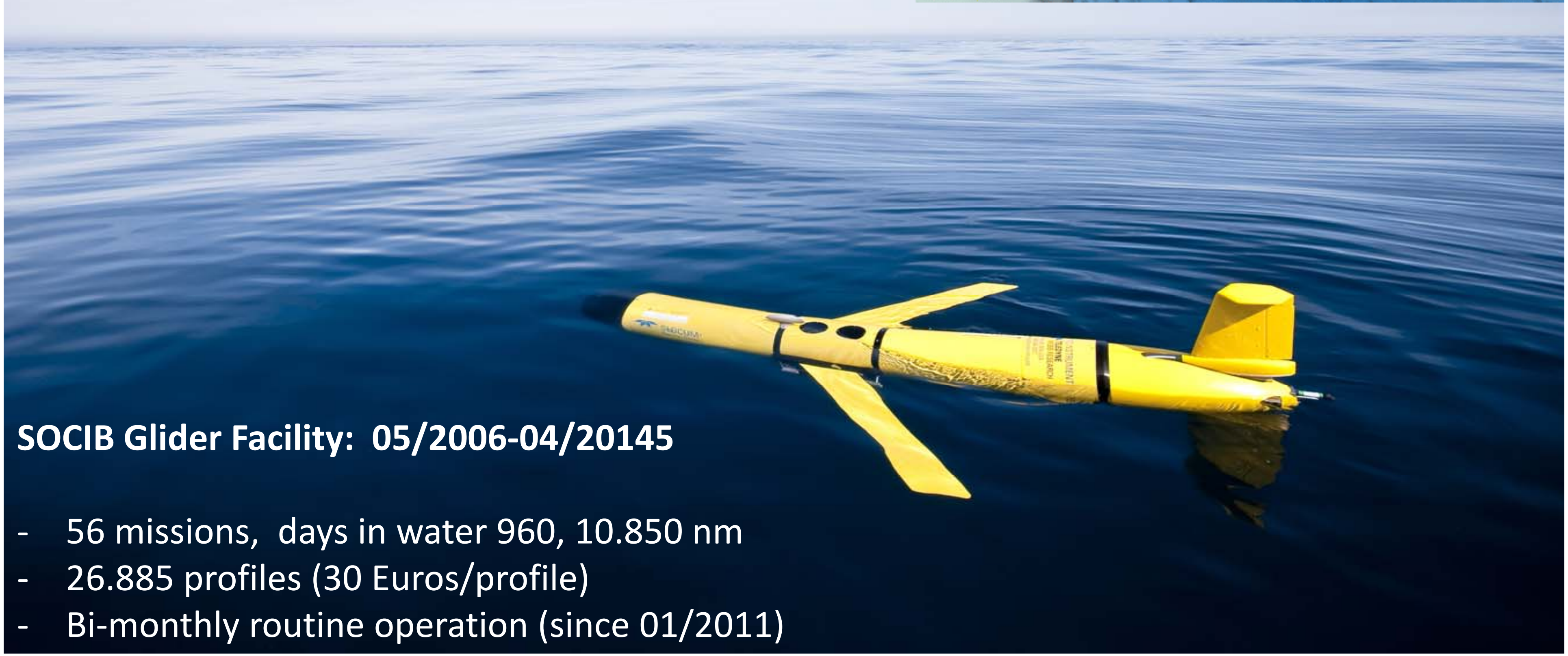
“Things have to be made as simple as possible, but not simpler” (Albert Einstein).

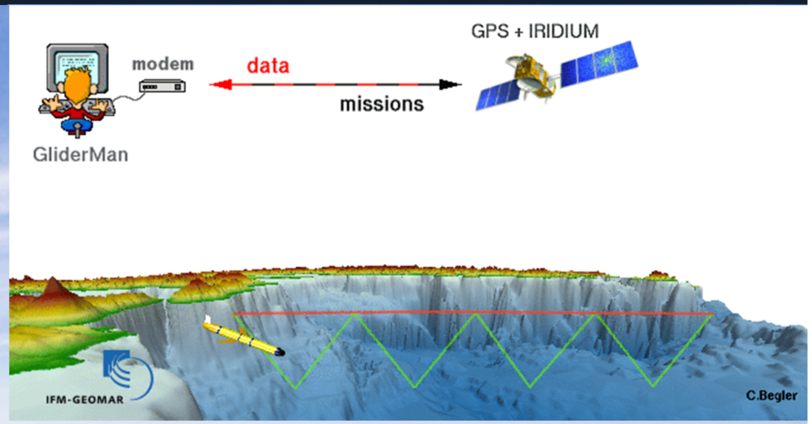
…. Monitoring … at the right scales…!!



OOI, Regional Scale Nodes (Delaney, 2008)

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





SOCIB Glider Facility: 05/2006-04/20145

- 56 missions, days in water 960, 10.850 nm
- 26.885 profiles (30 Euros/profile)
- Bi-monthly routine operation (since 01/2011)

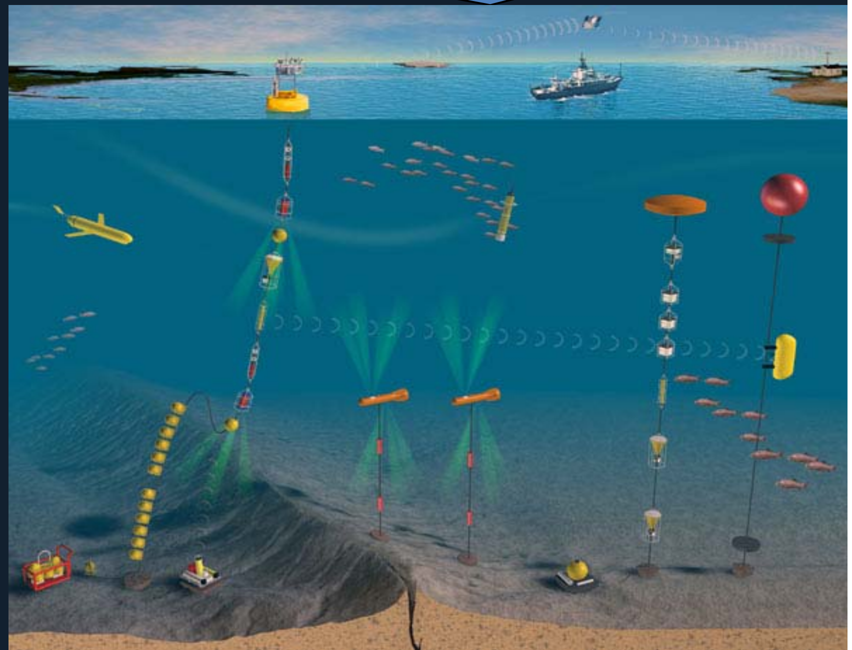
New Technologies: Paradigm Shift → Ocean Observation

From: Single Platform - Ship based observation

To: Multi-platform observing systems

Network - distributed Systems

Platform-centric Systems



(Adapted from Steve Chien, JPL-NASA)

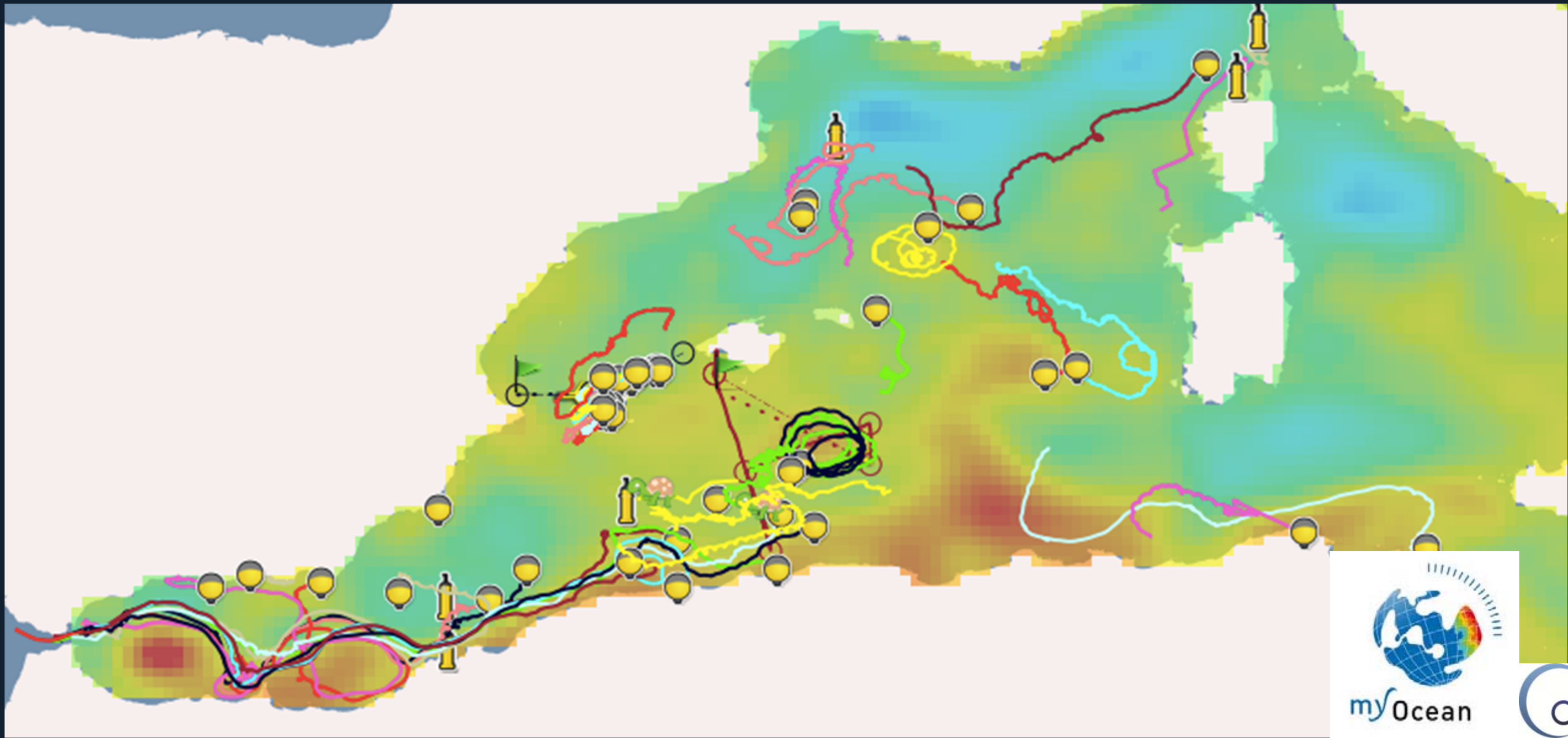
"A single ship can only be in one place at one time. We need to be present in multiple places in multiple times." (John Delaney, Nature, Sept. 25, 2013)

New Technologies: Paradigm Shift

→ Data Availability (Real time and QC <u>'at one click'</u>)

SOCIB

Dapp SOCIB: 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…)



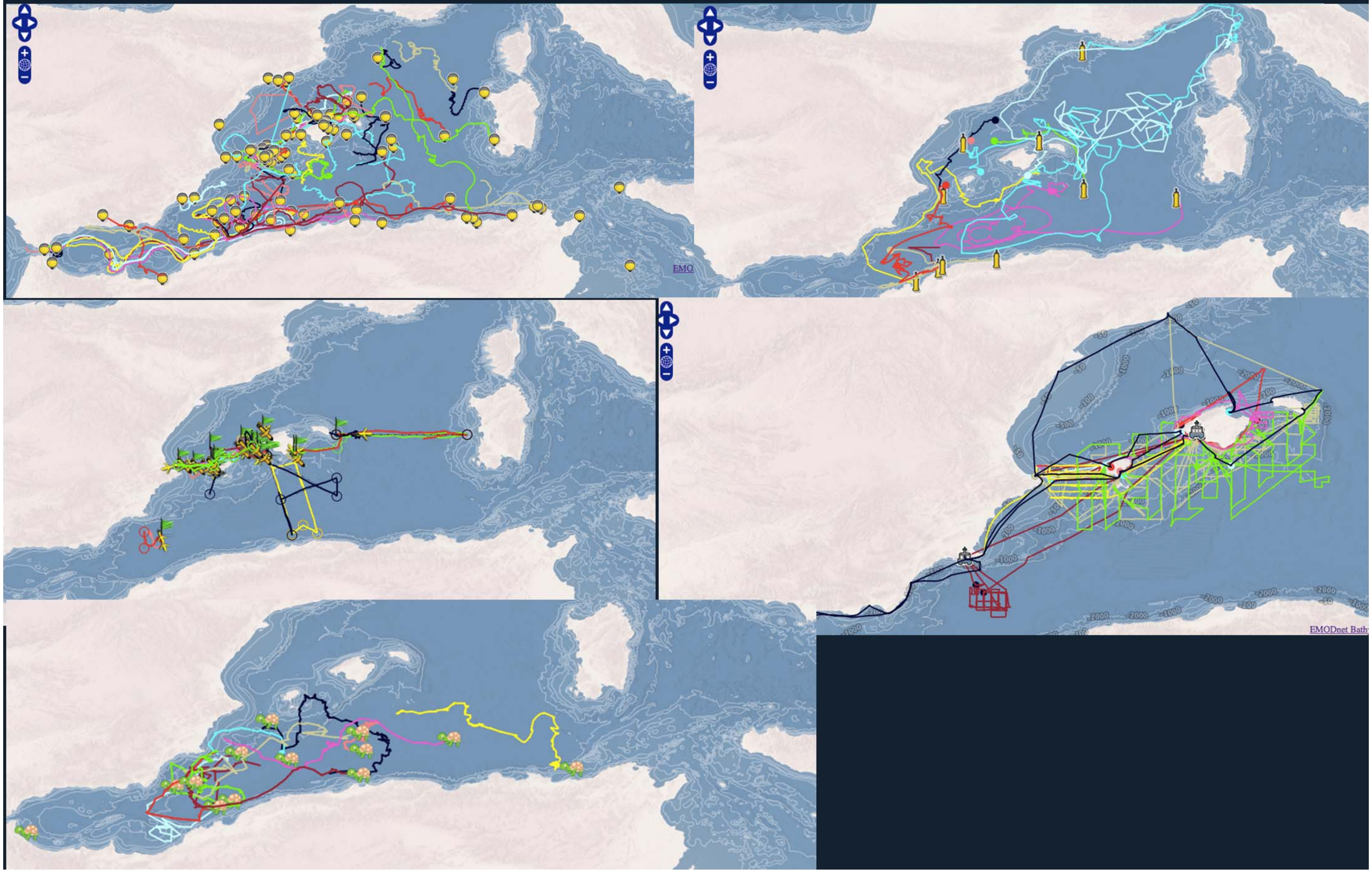
→ SOCIETAL IMPLICATIONS: Alborán Gyres position and fisheries: (Ruiz et al., 2013: Anchovy landings x 10)

→ SCIENCE IMPLICATIONS: adaptive sampling with gliders…

myOcean | Copernicus The European Earth Observation Programme | PERSEUS Policy-oriented marine environmental research in the southern European seas | JERICO

http://apps.socib.es/dapp

Southern Mediterranean monitoring recent efforts (2011-2015; SOCIB)

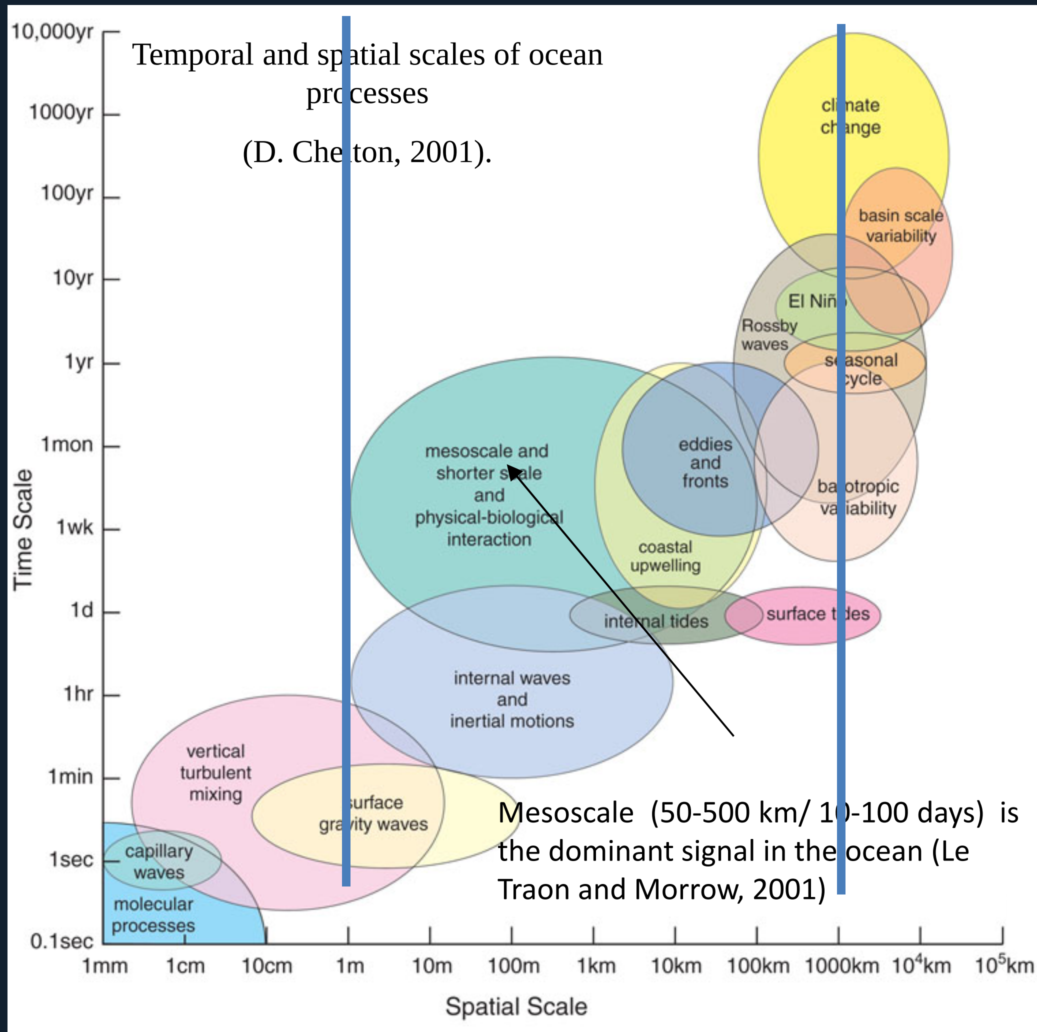


NOW we can….ocean variability at mesoscale/sub-mesoscale, interactions and ecosystem response

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

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

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



SOCIB scales

Multi-Platform integrated approach

….from local to basin scale

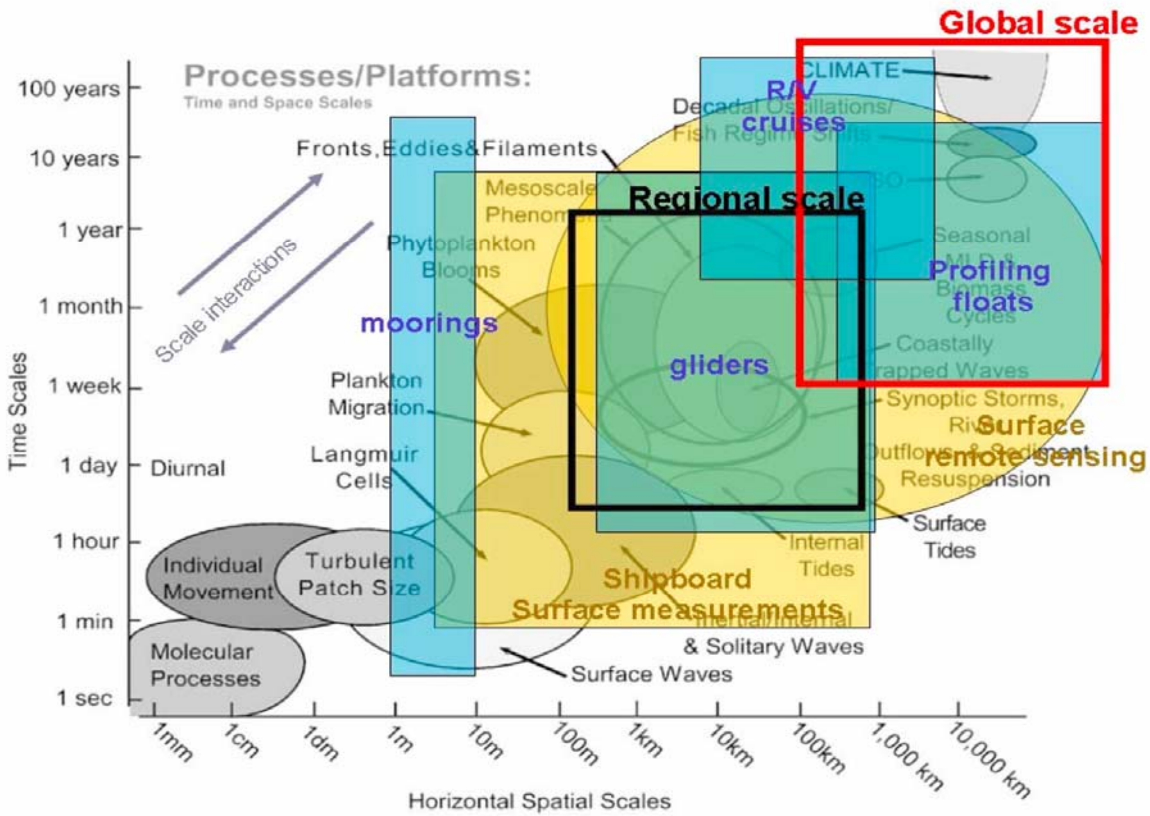


Figure 2. Space *vs.* time oceanic scales (processes) and the PERSEUS observing platforms; moorings, gliders, R/V, profiling and surface floats showing that today, the scales covered by platforms collecting in situ data (blue areas) can be considered equivalent to the ones collecting surface measurements (yellow areas).

"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](#))

Multi-Platform integrated approach

….from local to basin scale

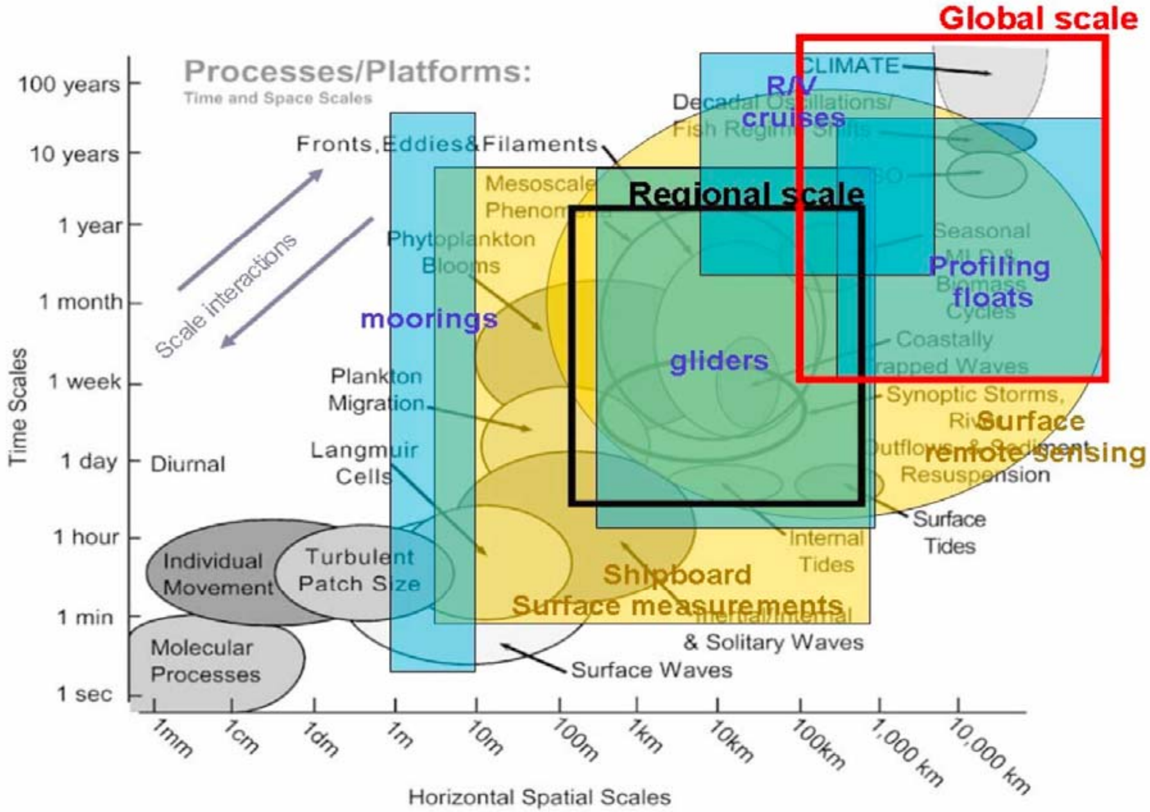


Figure 2. Space *vs.* time oceanic scales (processes) and the PERSEUS observing platforms; moorings, gliders, R/V, profiling and surface floats showing that today, the scales covered by platforms collecting in situ data (blue areas) can be considered equivalent to the ones collecting surface measurements (yellow areas).

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, …

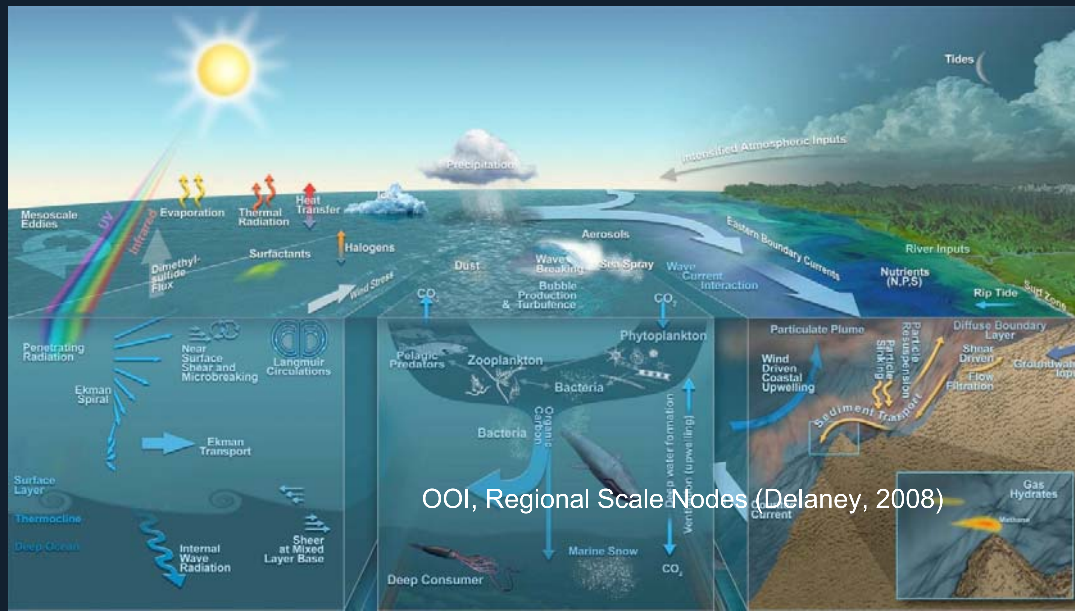
⬇

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

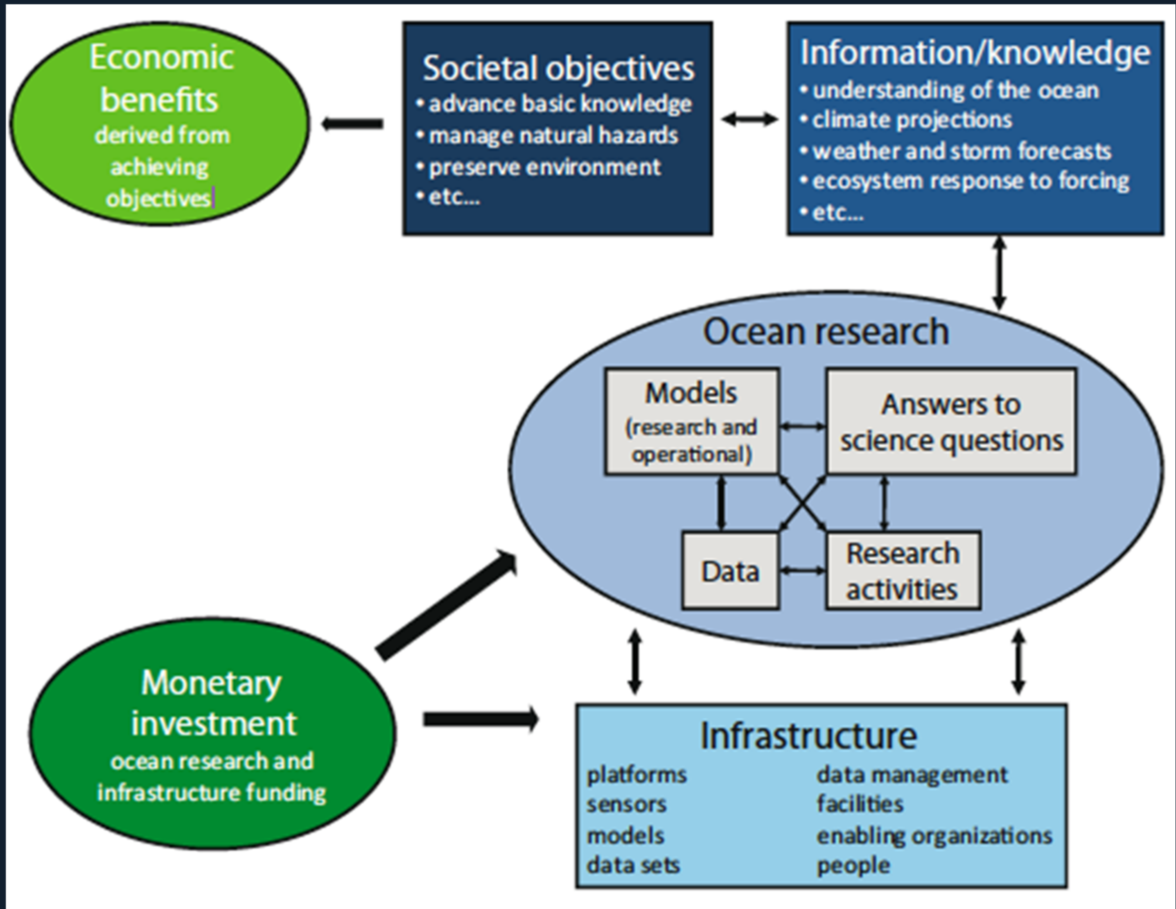


OOI, Regional Scale Nodes (Delaney, 2008)

- **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)

EOOS

OUTLINE: CHANGES IN OCEANOGRAPHY 2020-2030

SOCIB

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

2. **Marine Research Infrastructures, Ocean Observatories: SOCIB contributions to process studies and operational response and the real challenges for next decade**

3. Discussion on changes in oceanography in last 10 years: Are we ready for theses changes ? Do we have the framework and right structures to get all the benefits from these changes?

4. New Partnership in the Mediterranean; 2016 and 2030 vision…

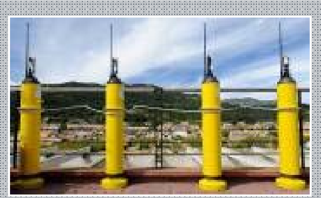
What is SOCIB? A multi-platform observing system, from nearshore to open-ocean in Mediterranean

OBSERVING FACILITIES

Research vessel

HF Radar

Gliders

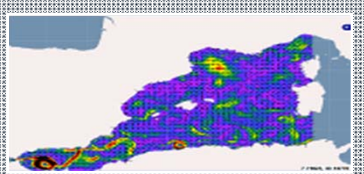


Lagrangian platforms

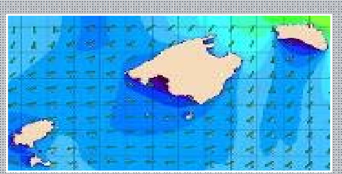
Fixed stations

Beach Monitoring

MODELLING FACILITY



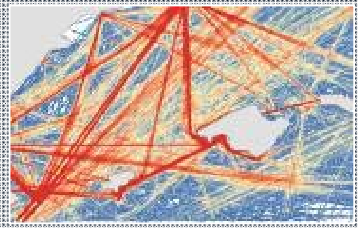
Currents (ROMS)



Waves (SWAN)

STRATEGIC ISSUES & APPLICATIONS FOR SOCIETY

Integrated Coastal Management

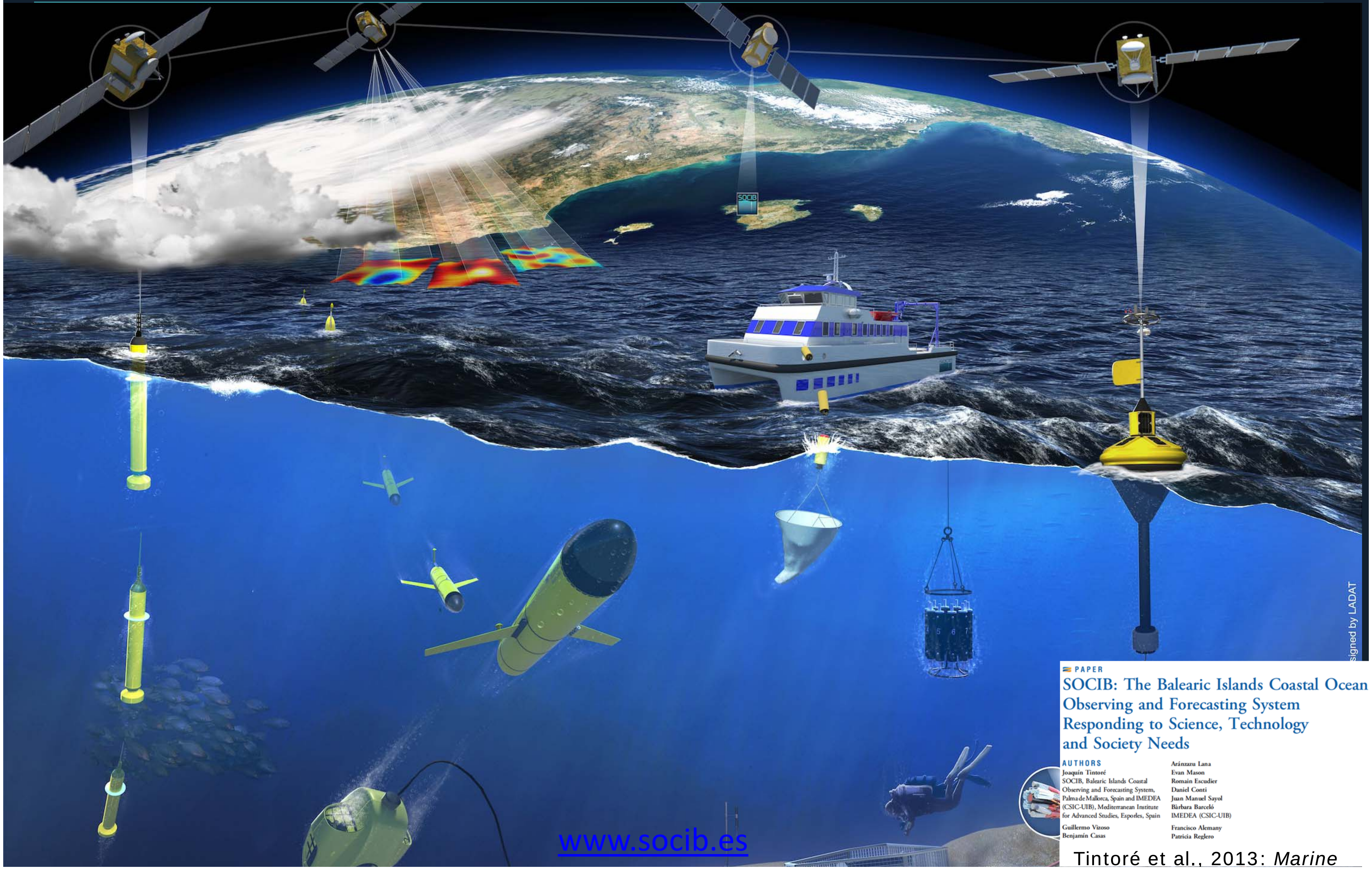


Marine Spatial Planning

DATA CENTER

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

What is SOCIB? A multi-platform observing and forecasting system, …



PAPER

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

AUTHORS
Joaquín Tintoré
SOCIB, Balearic Islands Coastal Observing and Forecasting System, Palma de Mallorca, Spain and IMEDEA (CSIC-UIB), Mediterranean Institute for Advanced Studies, Esporles, Spain
Guillermo Vizoso
Benjamín Casas
Aránzazu Lana
Evan Mason
Romain Escudier
Daniel Conti
Juan Manuel Sayol
Bàrbara Barceló
IMEDEA (CSIC-UIB)
Francisco Alemany
Patricia Reglero

www.socib.es

Tintoré et al., 2013: *Marine*

SOCIB Principles

- Scientific and technological excellence through peer review
- Science, technology and society driven objectives
- Support to R&D activities in the Balearic Islands (existing and new ones);
- Systems integration, multiplatform and multidisciplinary coordination
- Sustained, systematic, long term, monitoring, addressing different scales
- Free, open and quality controlled data streams
- Baseline data in adherence to community standards
- Partnership between institutions

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

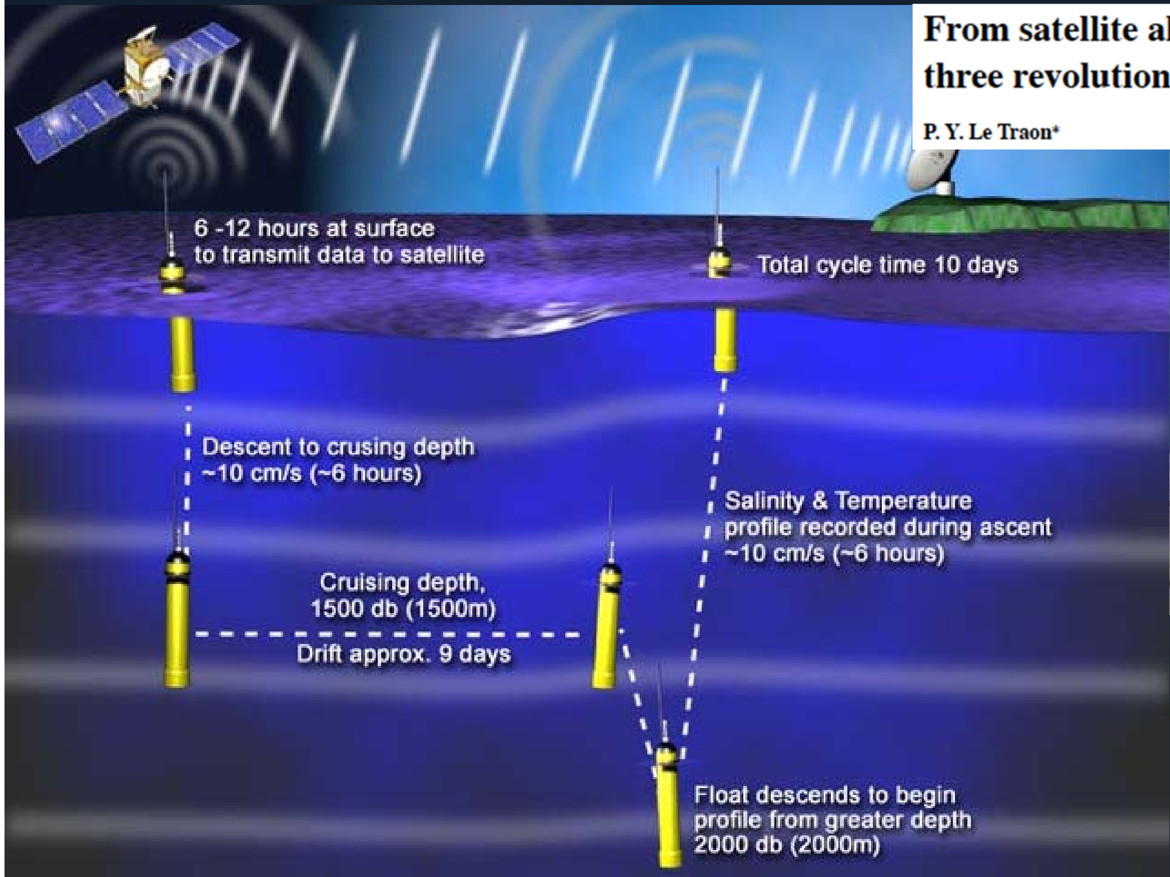
Charles Troupin

SOCIB Developments and Applications: Mobile Apps

900 downloads

300 downloads

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

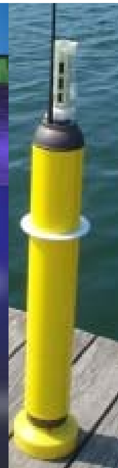


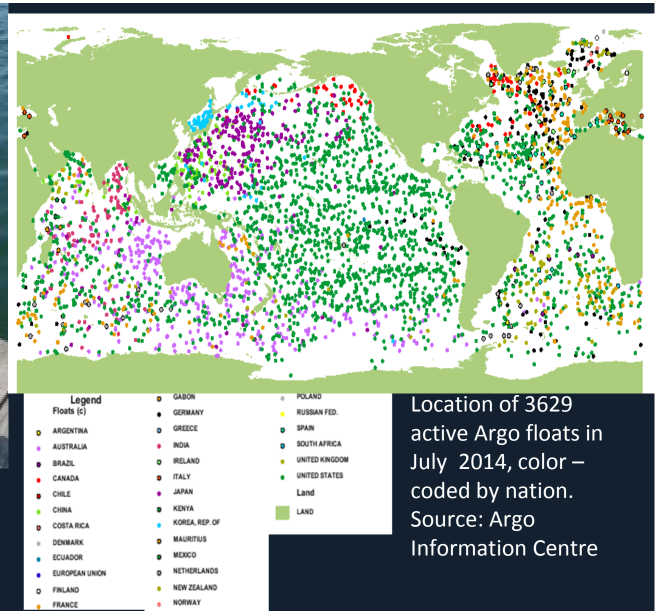
Schematic diagram of a single Argo float cycle

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

CrossMark

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

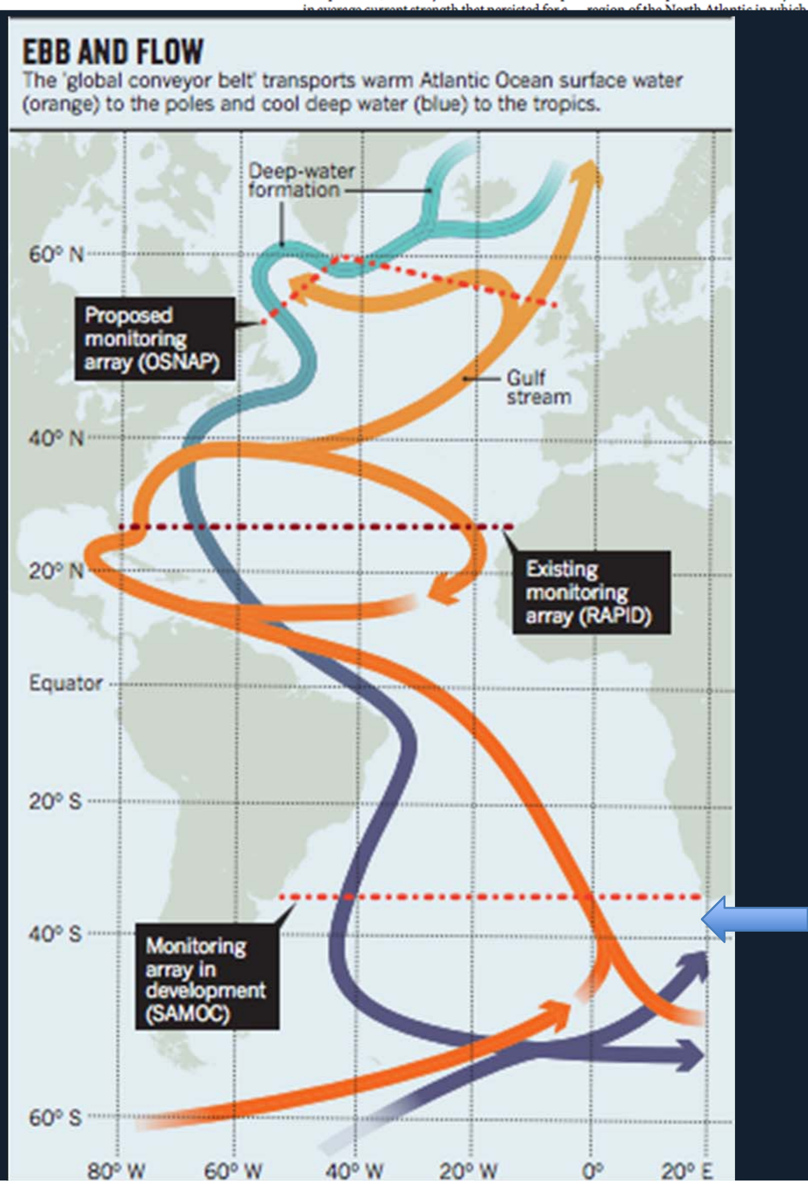
Oceans under surveillance

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

An … hanges”

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…:

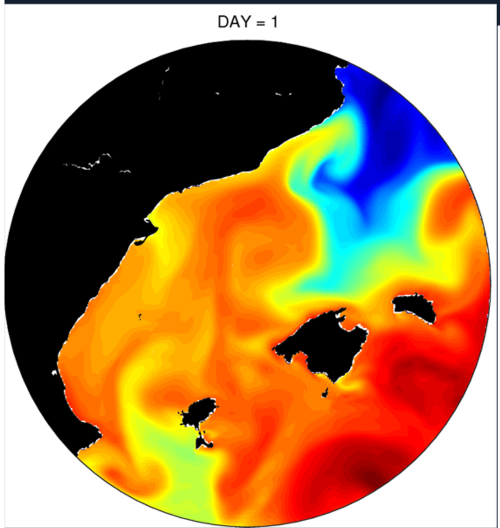
<u>To use and integrate </u>these new technologies to carefully and systematically

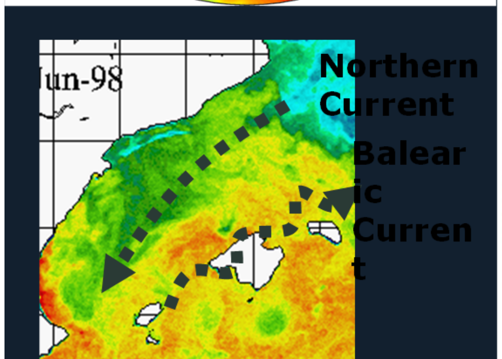
- Monitor the variability at small scales, e.g. mesoscale/weeks, to
- Resolve the sub-basin/seasonal and inter-annual variability and by this
- Establish the decadal variability, understand the associated biases and correct them …

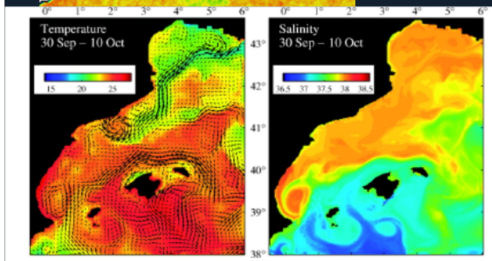
From Emergency Operational Response (days) to Policy Implementation support (e.g., MSFD, etc. - 5-10 years) and Climate Variability, resilience (long term, decades)

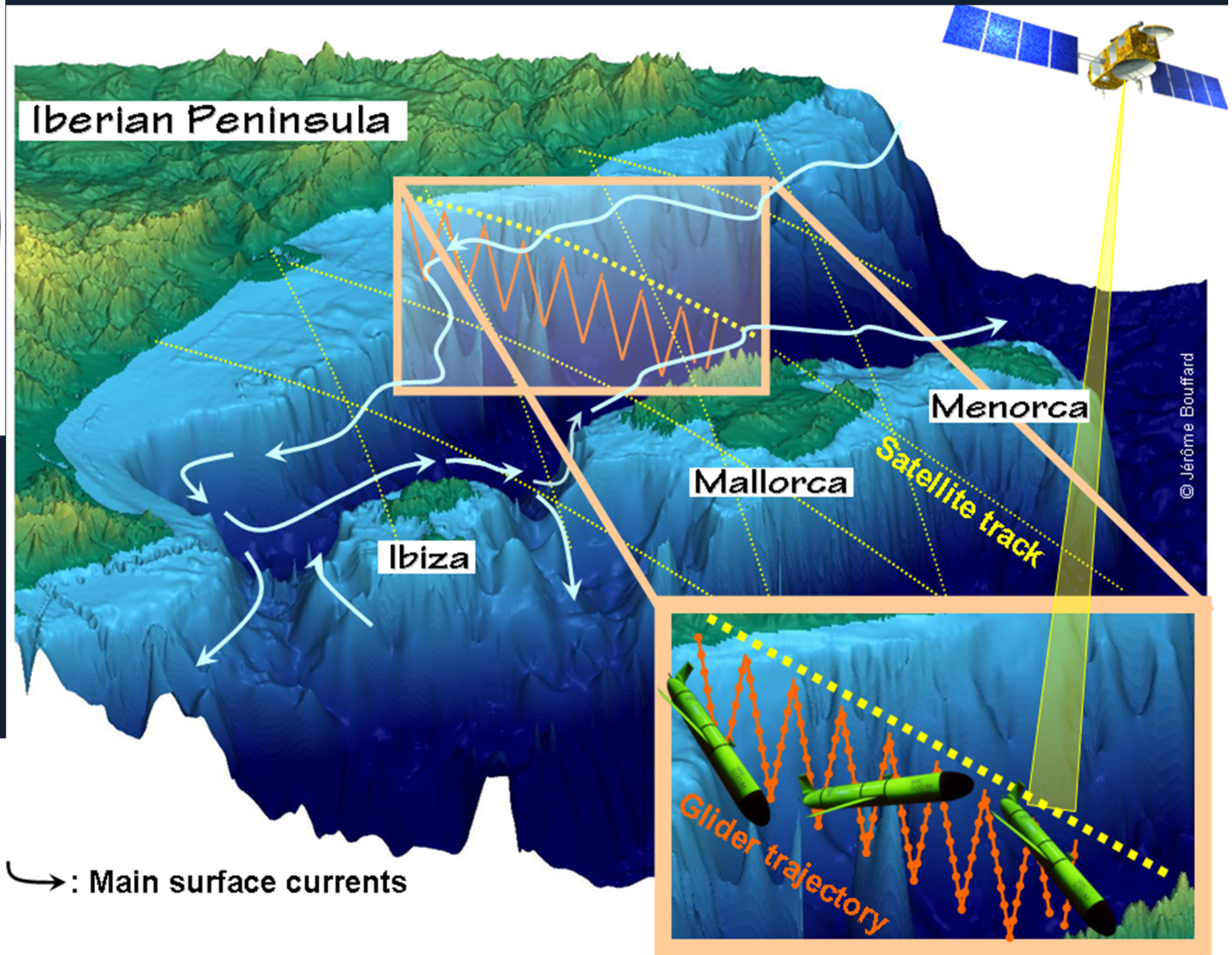
Balearic basin (fronts, mesoscale eddies, blocking, hotspot, ecosystem response)

…. Ideal lab to study global ocean problems

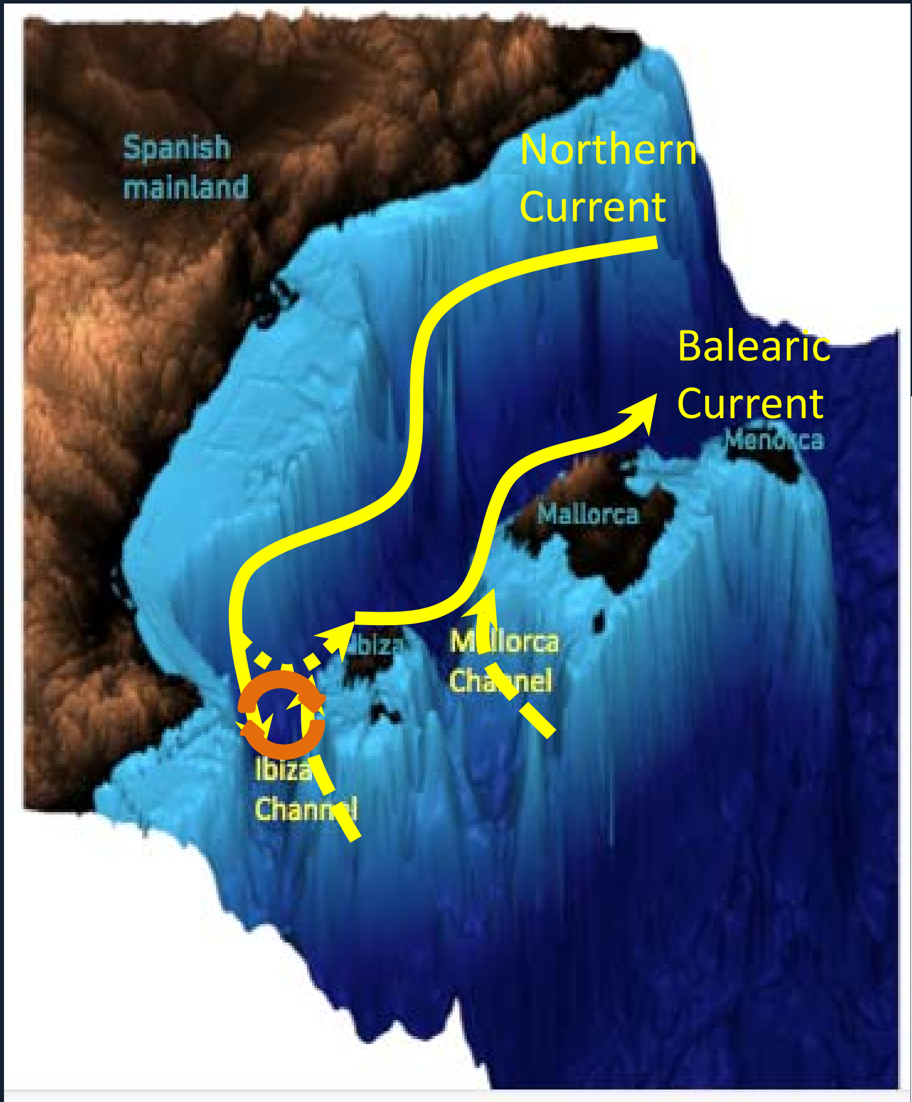




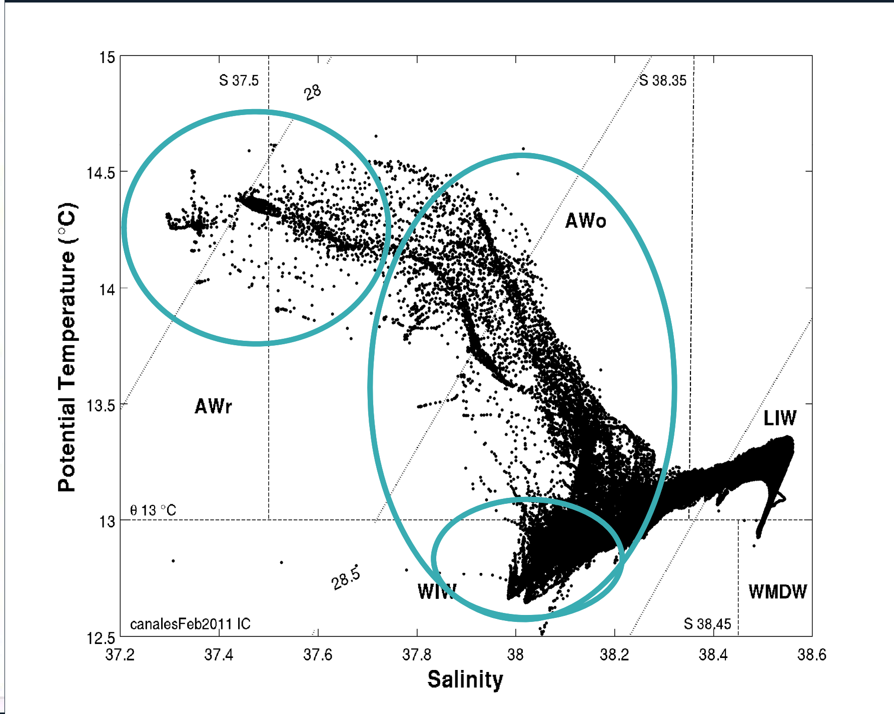




Balearic Basin: Ibiza Channel 'choke point'



- Narrow channel with sill
- Northern Current – south
- Inflows Atlantic Water (AW) - north
- 'Blocking' eddies (WIW)
- Governs important N/S exchange
- Impact spawning grounds Atlantic bluefin tuna



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]

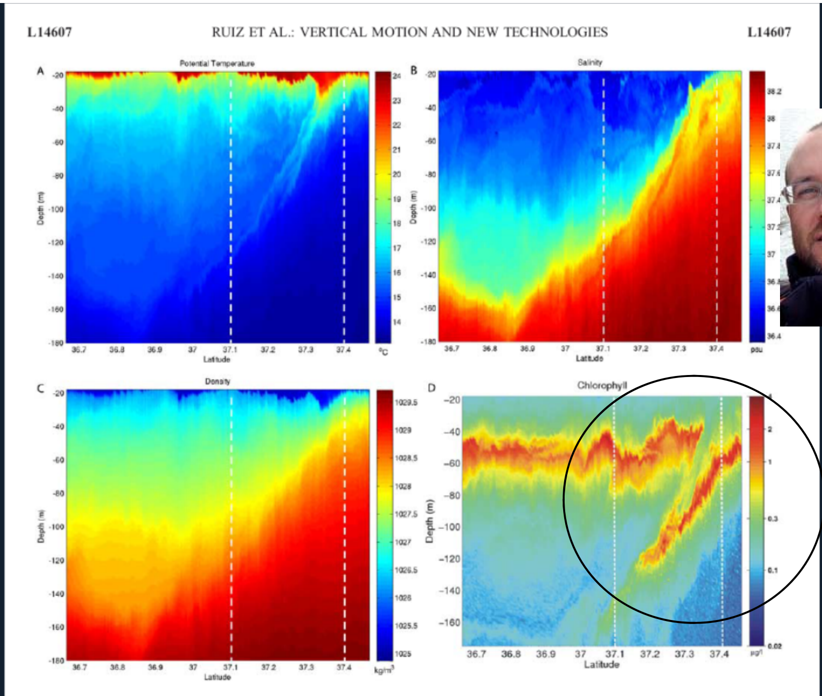


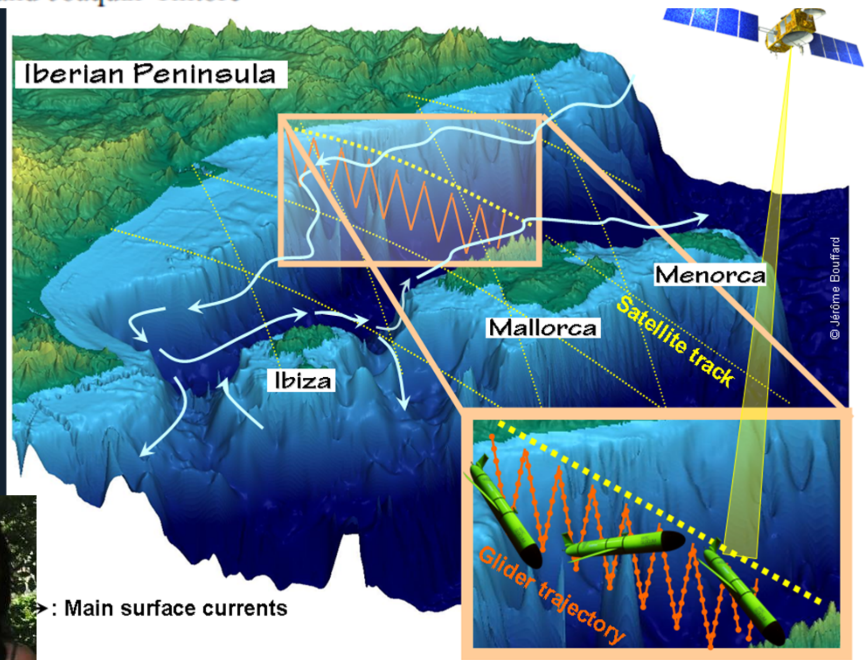
Figure 2. Vertical section of temperature (°C), salinity (PSU), density (kg/m^3) and chlorophyll (μg/l) from glider section 2 (dashed magenta in Figure 1). White dashed lines define sub-section in the northern part of the domain.

Eddy/mean flow interactions – Blocking effects General Circulation

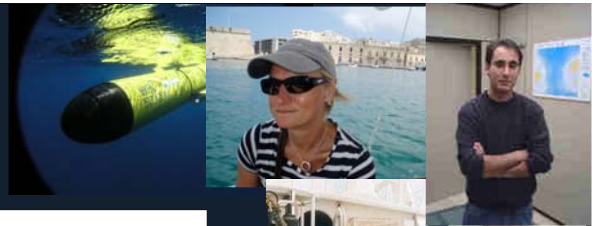
JGR, 2010

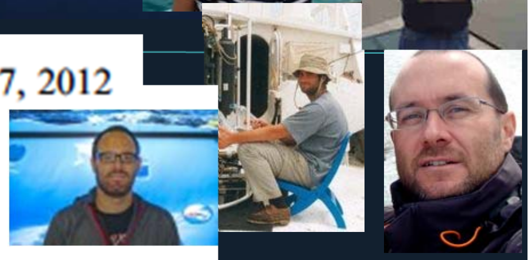
Coastal and mesoscale dynamics characterization using altimetry and gliders: A case study in the Balearic Sea

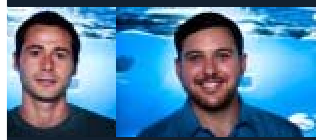
Jérôme Bouffard,[1] Ananda Pascual,[1] Simón Ruiz,[1] Yannice Faugère,[2] and Joaquín Tintoré[1,3]



Gliders Facility: Operational







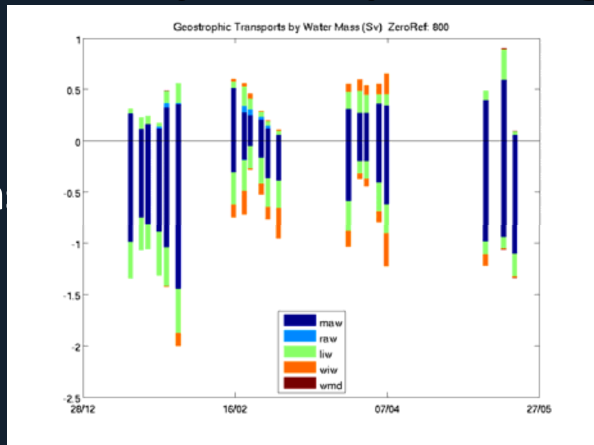
GEOPHYSICAL RESEARCH LETTERS, VOL. 39, L20604, doi:10.1029/2012GL053717, 2012

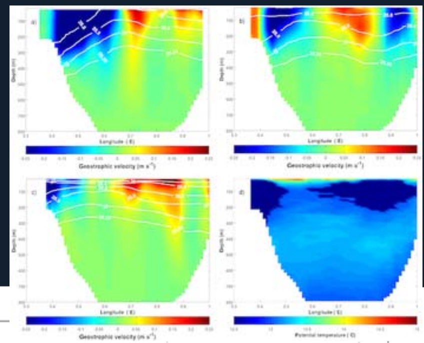
Autonomous underwater gliders monitoring variability at "choke points" in our ocean system: A case study in the Western Mediterranean Sea

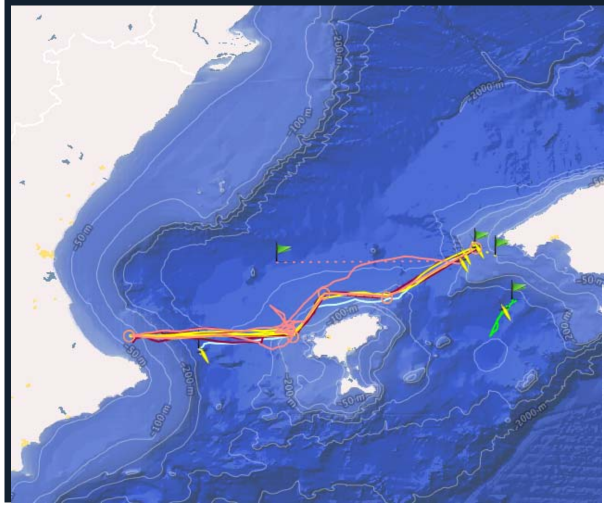
Emma E. Heslop,[1] Simón Ruiz,[1] John Allen,[2,3] José Luís López-Jurado,[4] Lionel Renault,[5] and Joaquín Tintoré[1,5]

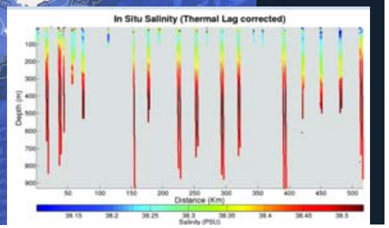
Major transport changes

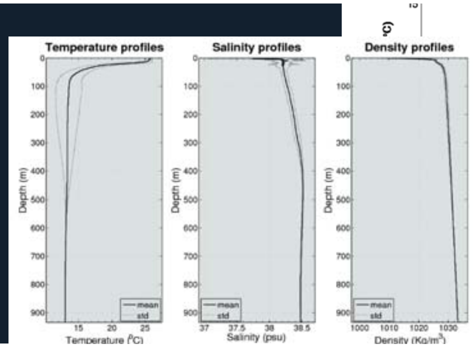
- After 32 glider missions (started in 2006), + 17.000 profiles (30 Euros/profile)
- Since January 2011; routine operation

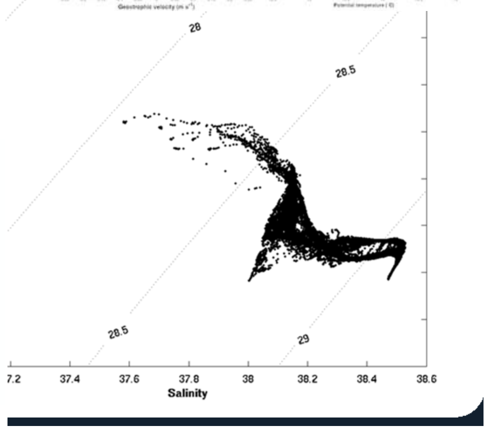












Conclusions Ibiza channel choke point:

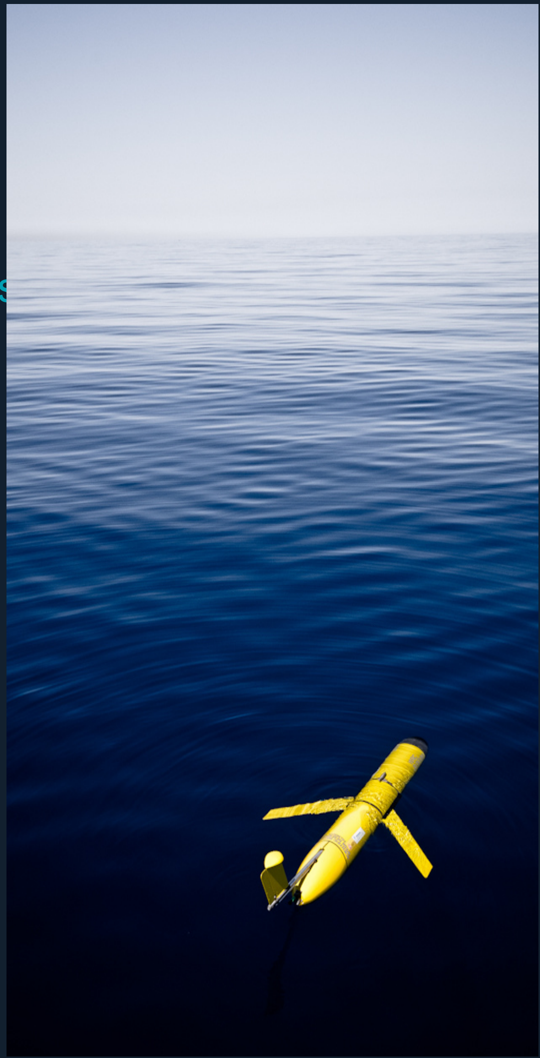
Unravel components of the variability:

- High sub seasonal variability - 3 causes
- Seasonal components are identified - NC and blocking eddies
- Non seasonal nature of inflows

Impact:

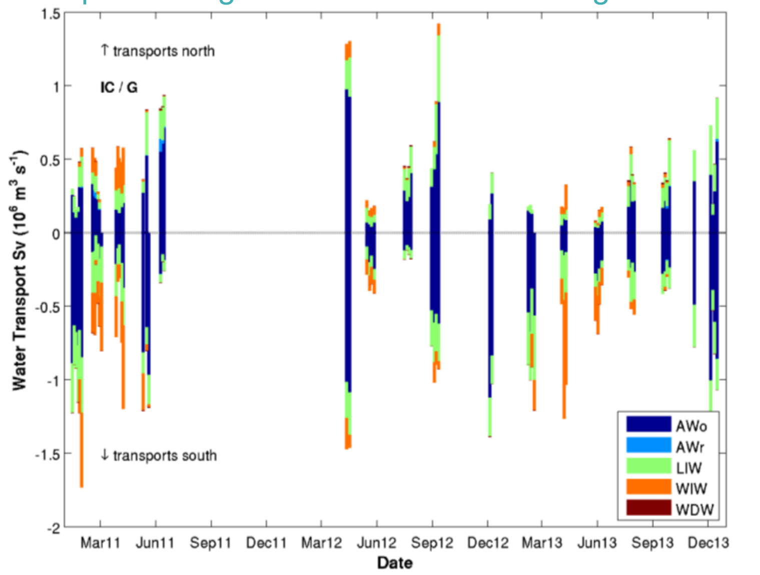
- Changes our view of the exchange
- Better constrain regional models
- Impact on fisheries
- Implications for basin scale circulation
- Place historical observations in context

>> a quiet revolution

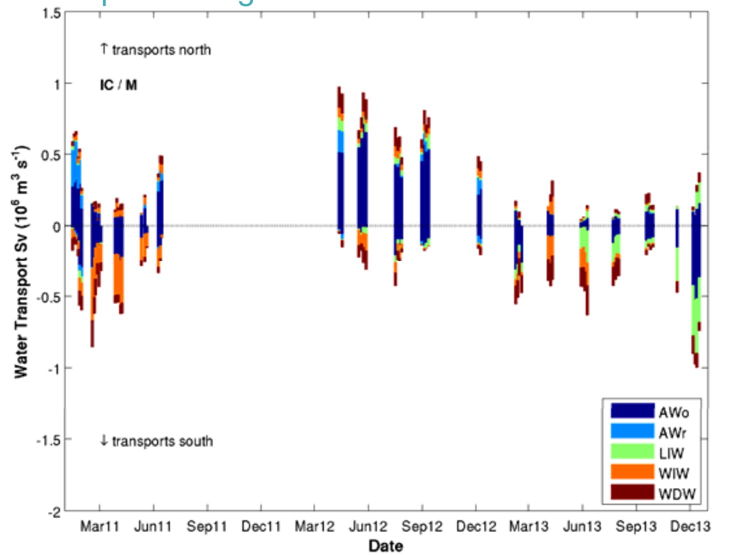


Glider and Modelling Facilities; Ibiza channel choke point variability

Transport through the Ibiza Channel from gliders



Transport through the Ibiza Channel from WMOP



Ibiza Channel transports

Transport through the Ibiza Channel (IC) provides a method of comparing circulation and water mass exchange. Glider to model can see clear similarities and differences.

WMOP 'gets right':

- Seasonal cycle in southward flow present, strongest in winter
- WIW is present in winter
- AW inflows represented

WMOP key differences:

- LIW is not always present
- Southward transport low

Geostrophic transport by water mass in the IC, from glider (above) and WMOP (below). Each bar represents the water mass transport for a single (2-day) transect of the deep (central) part of the IC. Total bar height is the total volume of water transported, water masses are in colour.

Next decade… Ocean Variability

PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY A
CrossMark
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

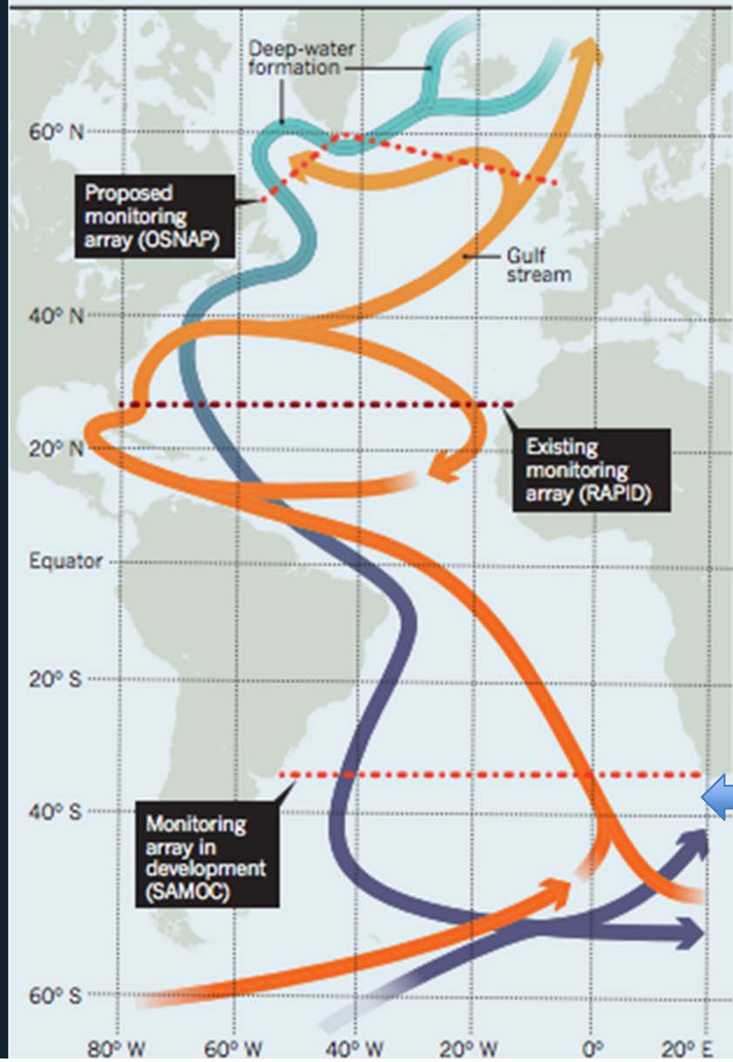
Three projects seek to track changes in Atlantic overturning circulation currents.

BY QUIRIN SCHIERMEIER

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

EBB AND FLOW

The 'global conveyor belt' transports warm Atlantic Ocean surface water (orange) to the poles and cool deep water (blue) to the tropics.



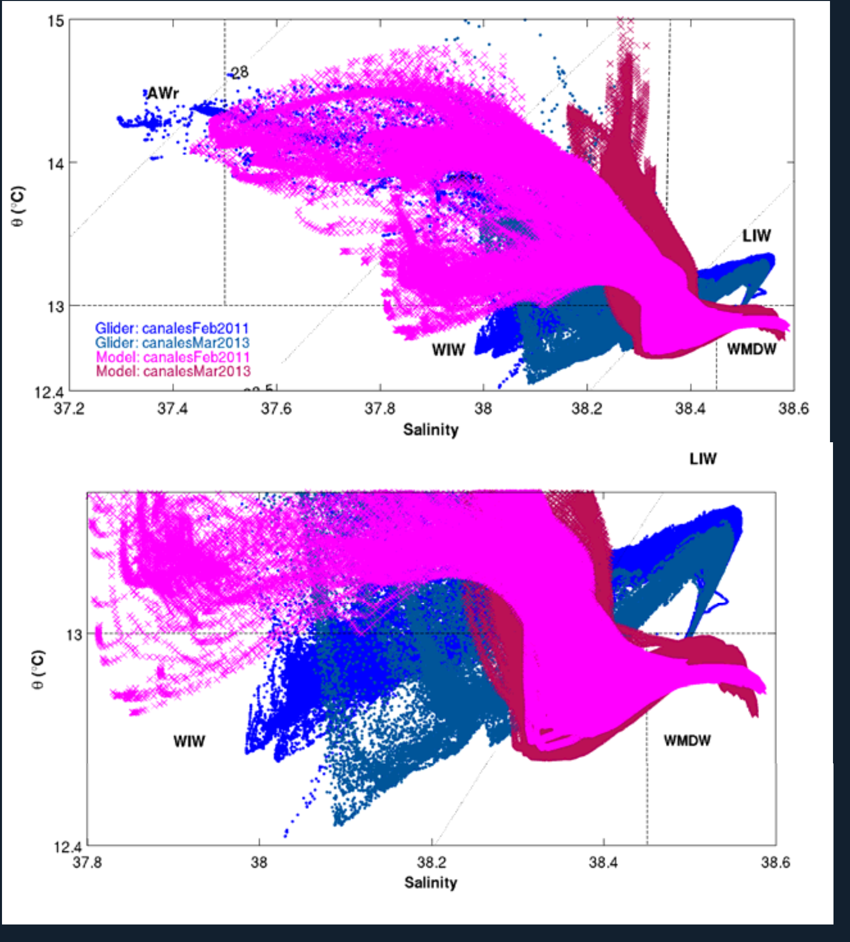
Marine research in the past 20 years has focused on defining the **present day** ocean circulation. From these measurements of ocean circulation, we begin to understand how biogeochemical distributions are set and how the ocean and atmosphere interact to determine the present climate [4].

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

An … anges”

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

Glider and Modelling Facilities; Ibiza channel choke point variability



Θ/S for glider (magenta) and WMOP (blue) in the IC for two missions canalesFeb2011 (02/2011) and canalesMar2013 (03/2013), glider and WMOP simulated.

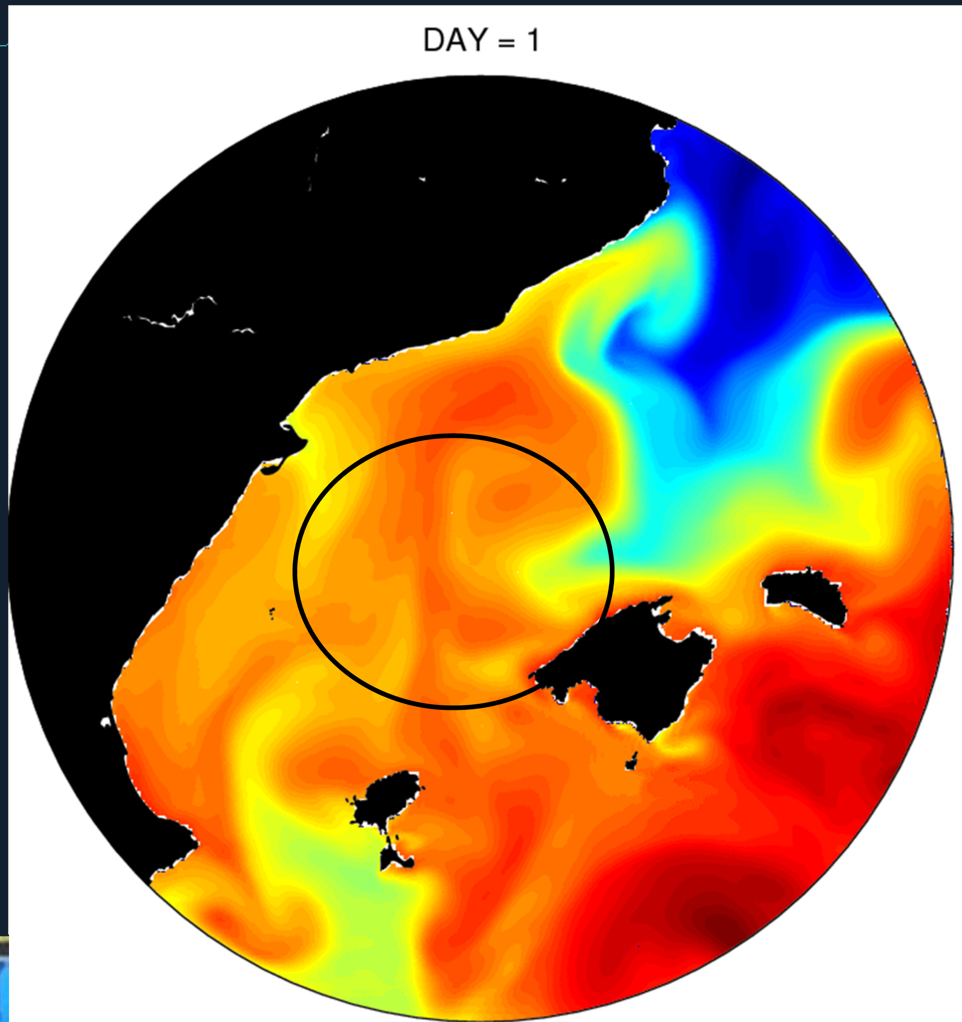
Water masses 2011 and 2013

- Feb 2011 no LIW is present in the model, deep waters mix to WIW and then to the surface
- Mar 2013 the waters with LIW characteristics are not typical LIW, there is no temperature and salinity maximum ‘elbow’ as in observations

SOCIB Ocean Forecasting Facility

Operational Modeling: ROMS, 2km, to reproduce and maintain mesoscale features, interactions.

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



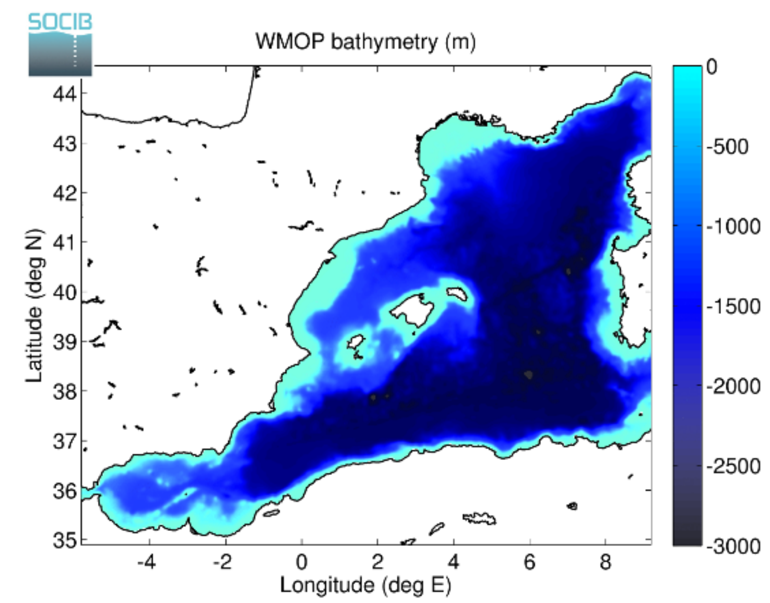
SST from 11/2008

Baptiste Mourre

Mélanie Juza

Romain Escudiier

SOCIB Ocean Forecasting Facility
WMOP: Western Mediterranean high-resolution OPerational model



Model domain

✓Regional configuration of the ROMS model

✓Horizontal resolution: ~ 2km (1/50º)

✓Initial & boundary conditions: Mediterranean Forecasting System (1/16º)

✓ Atmospheric forcing: AEMET Hirlam (3h, 5km)

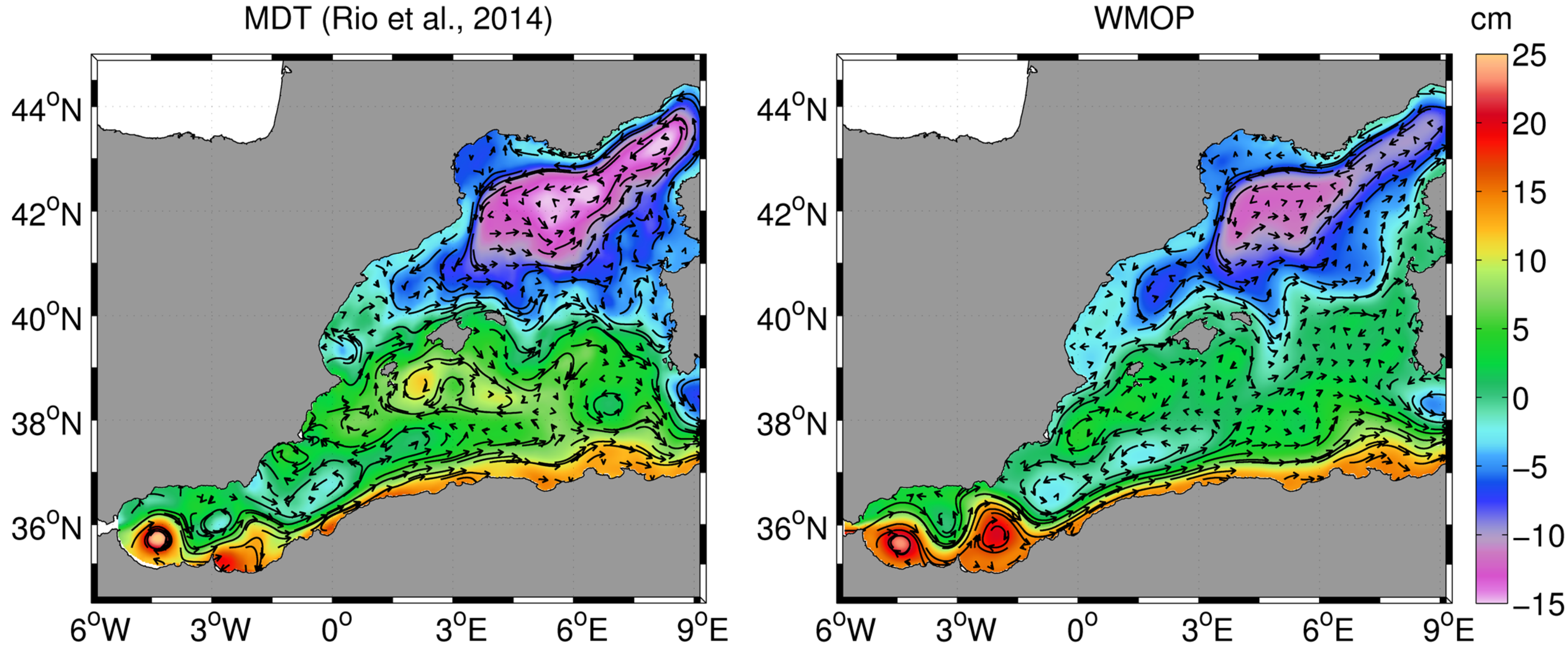
✓ Rivers
(Var, Rhône, Aude, Hérault, Ebro, Júcar)

✓ Output variables: temperature, salinity, currents, sea level, vertical velocities

➢ **High resolution mesoscale resolving**

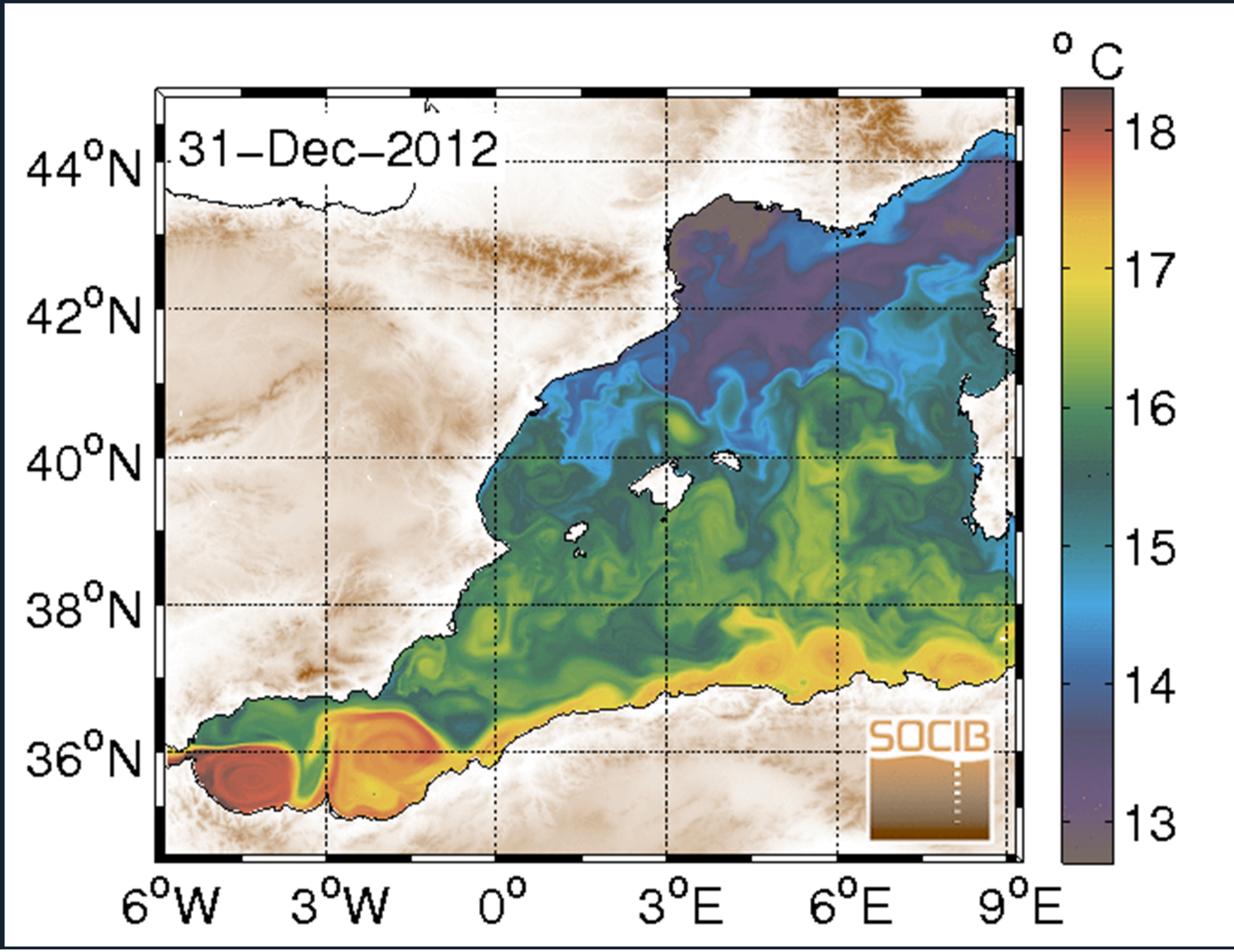
WMOP simulations: HINDCAST

Mean dynamic topography 1993-2012	Mean WMOP sea level 2009-2013

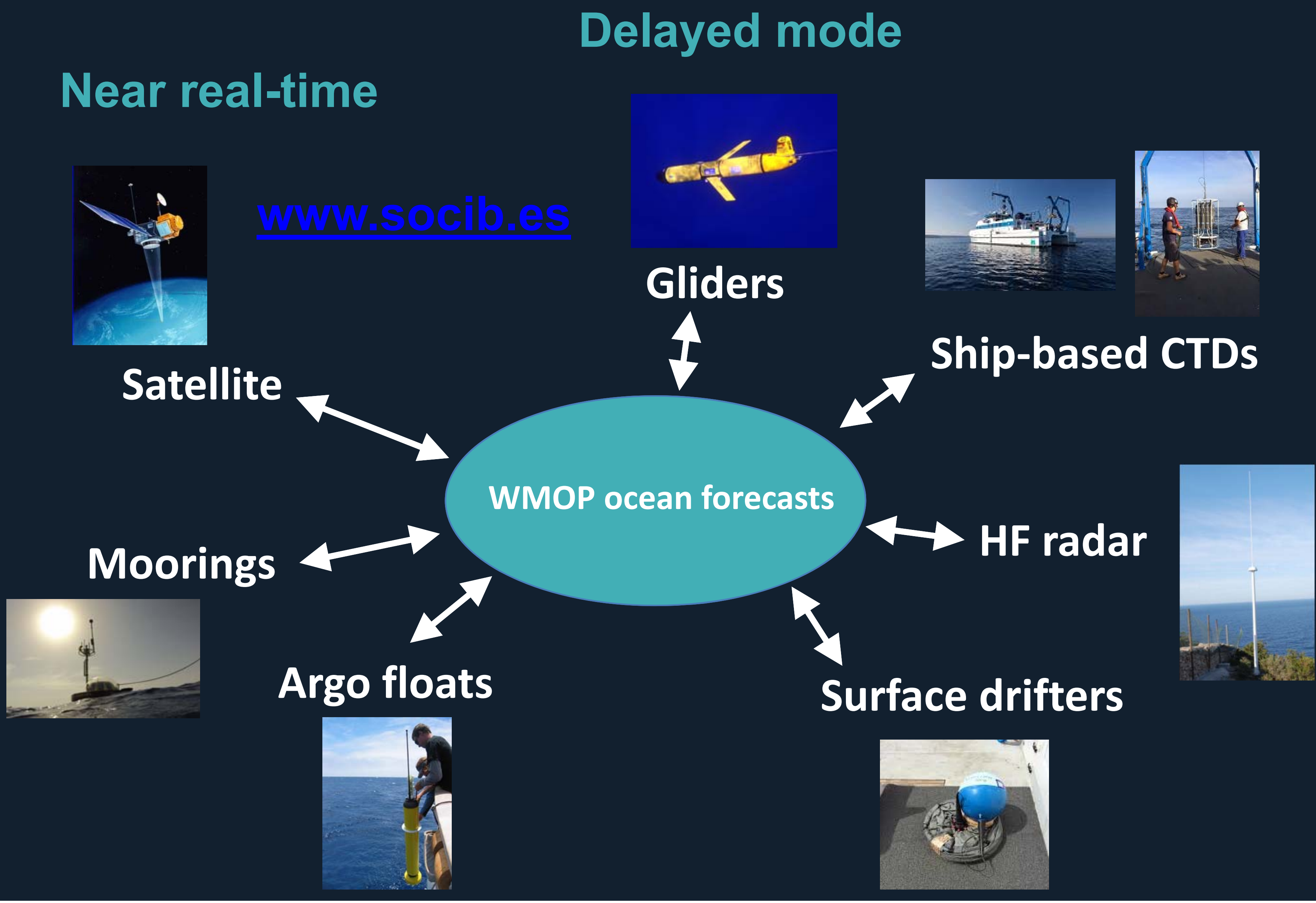


WMOP simulations: HINDCAST

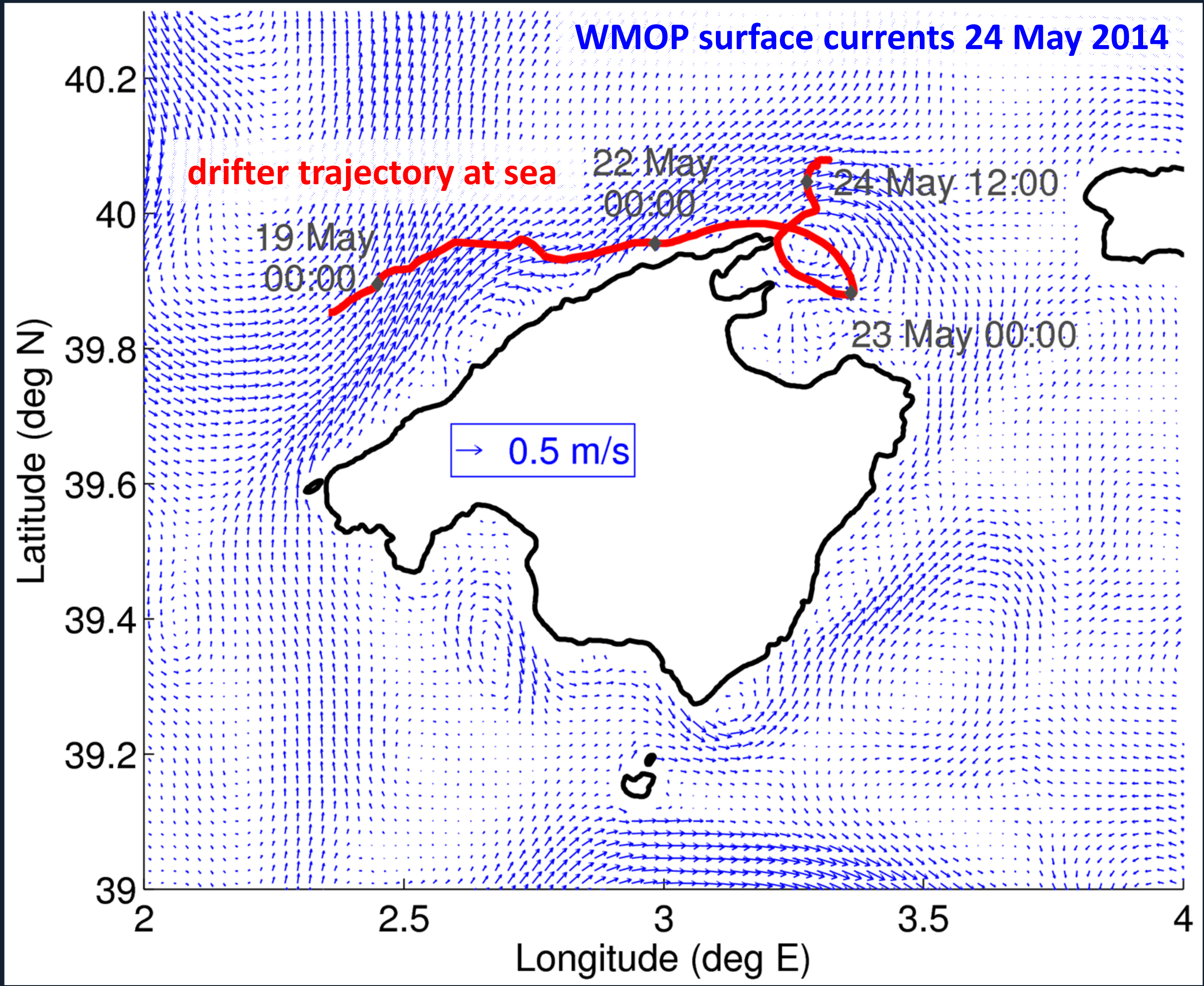
Sea Surface Temperature evolution - 1 year, 2013



WMOP forecasts systematic evaluation



WMOP forecasts: surface currents validation



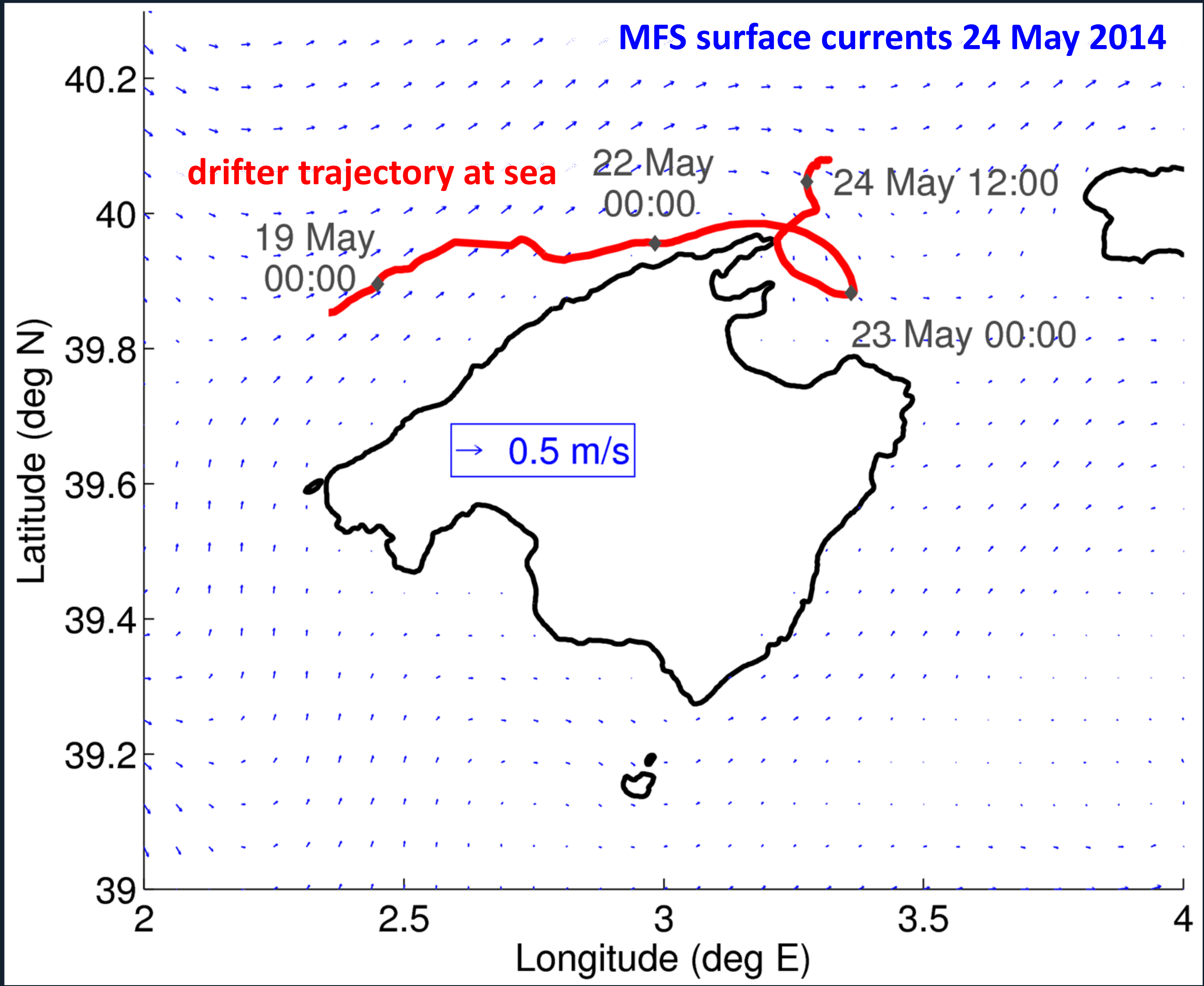
Mean velocity along the drifter trajectory:

drifter → 0.30 m/s

WMOP → 0.28 m/s

MFS → 0.16 m/s

WMOP forecasts: surface drifter validation



Mean velocity along the drifter trajectory:

drifter → 0.30 m/s

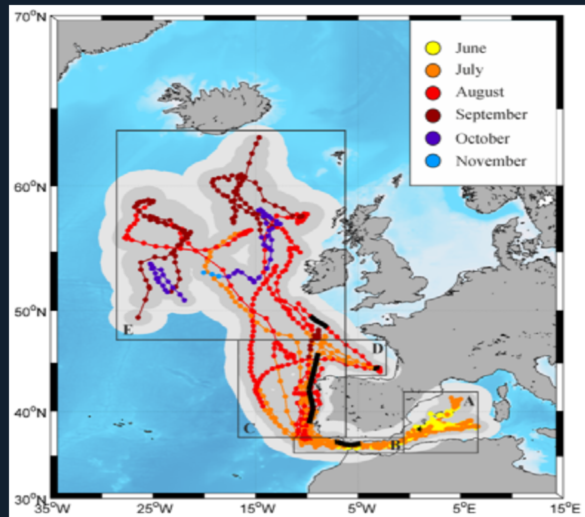
WMOP → 0.28 m/s

MFS → 0.16 m/s

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

J.L. Cort 2007

Migration patterns along the year (Eastern Stock)

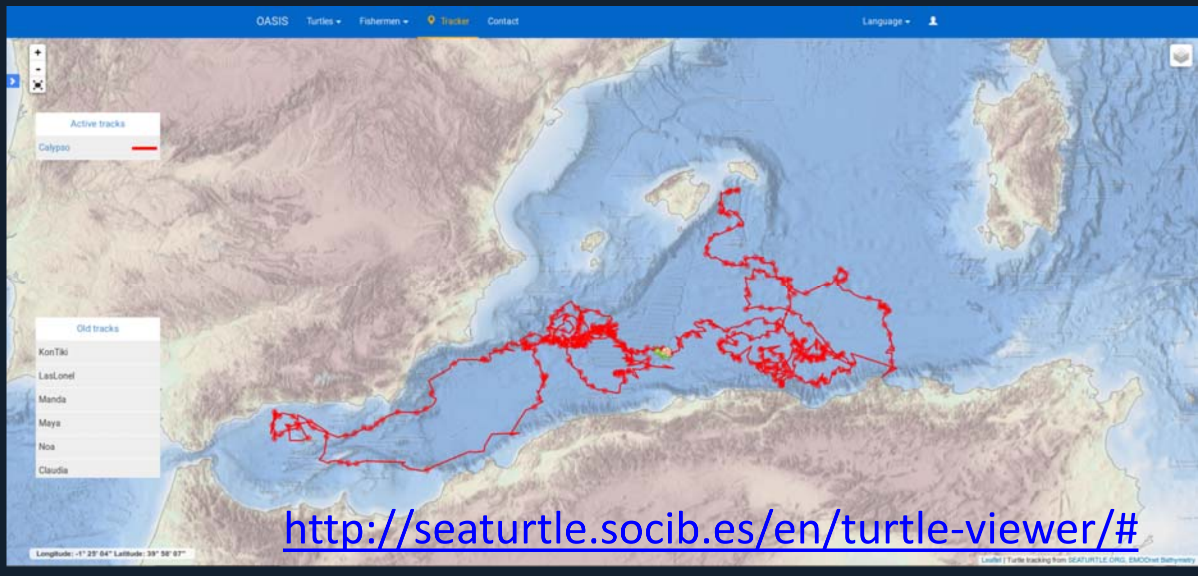


Aranda et al, PONE 2013

SOCIB Balearic Islands Coastal Observing and Forecasting System
CSIC
IMEDEA
College of Oceanic & Atmospheric Sciences
OSU Oregon State University

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

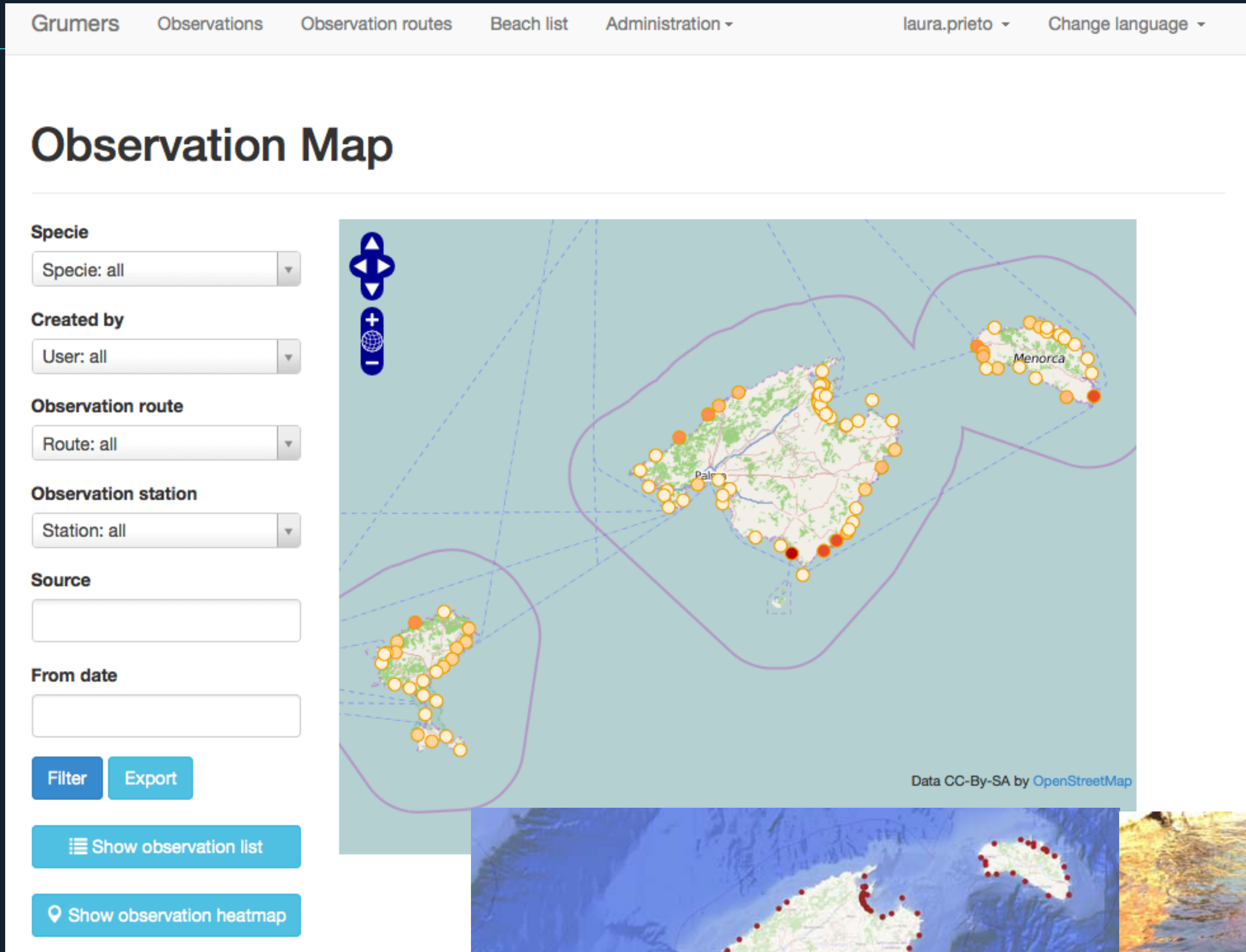
Sea turtles and its relation to the variability of ocean state – SOCIB&Alnitak OASIS project -

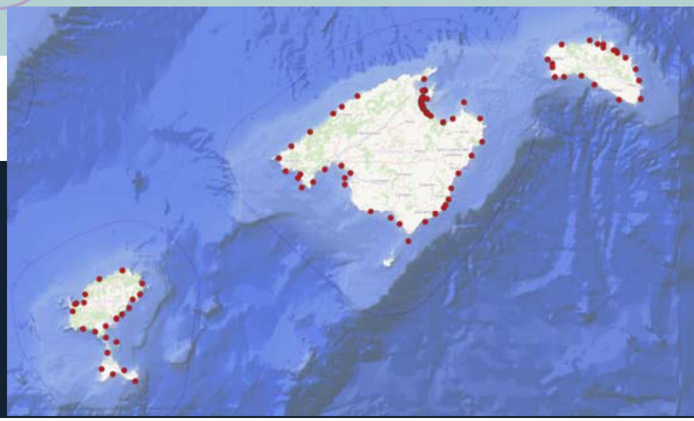


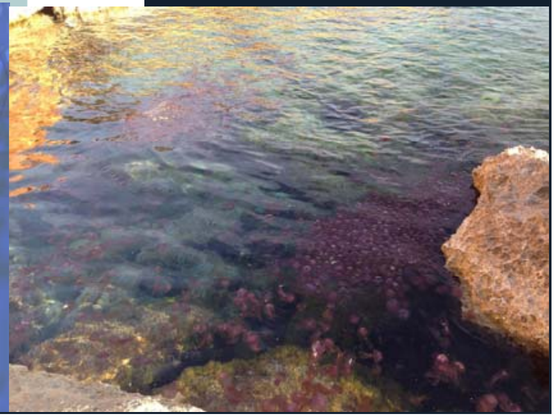
http://seaturtle.socib.es/en/turtle-viewer/#

New Jellyfish programe; 2014…

- M1
- ✓ M2
- M3
- M4
- M5
- M6
- M7



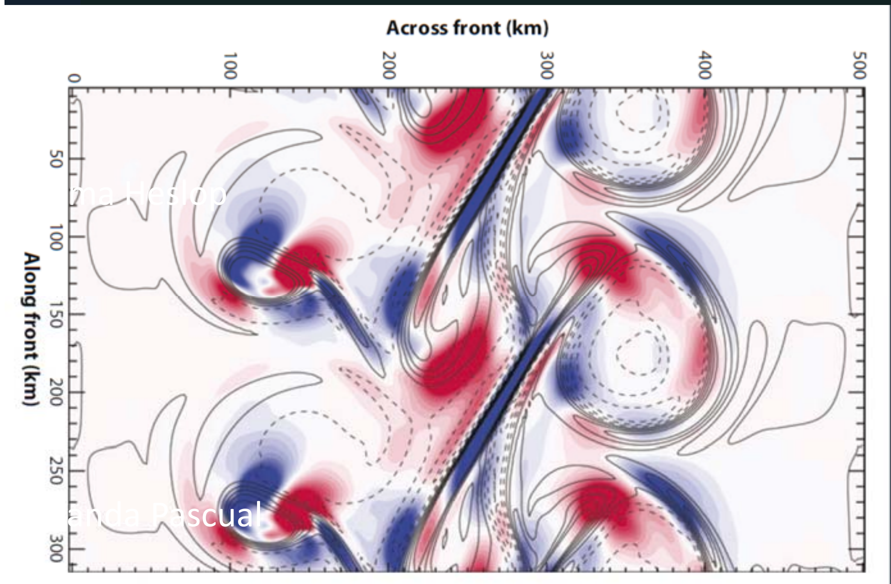




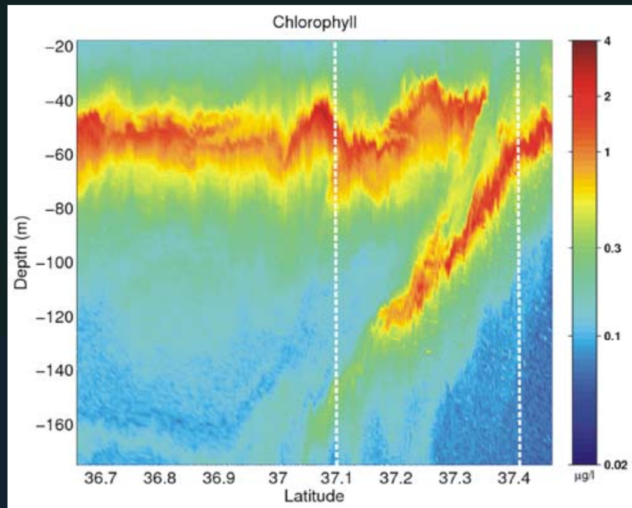
- 5 Áreas Marinas Protegidas (9 puntos de observación)
- 33 rutas de los servicios de limpieza con barcas (66 puntos obs.)
- 120 playas (DG Emergencia)

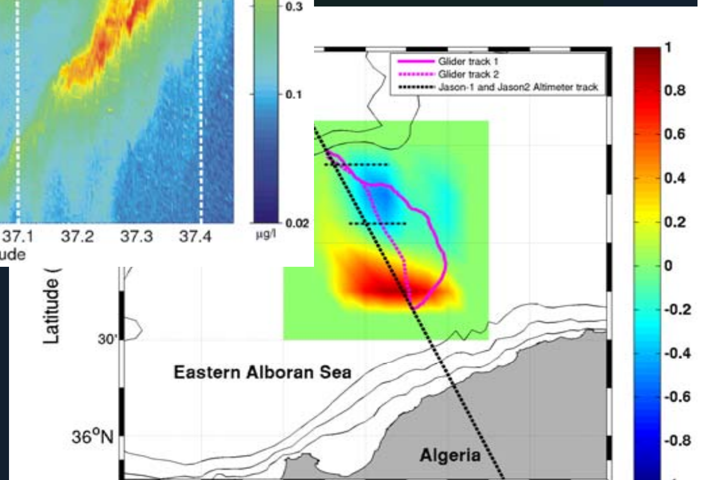
ALBOREX – Perseus project – May 2013. Multi-platform experiment in Alborán Sea

Scientific motivation: Capture the intense but transient vertical exchanges associated with mesoscale and submesoscale features, in order to fill gaps in our knowledge connecting physical process to ecosystem response.



Vertical velocities at 90 m from primitive equation simulations. Lévy et al. (2001); Klein & Lapeyre (2008).





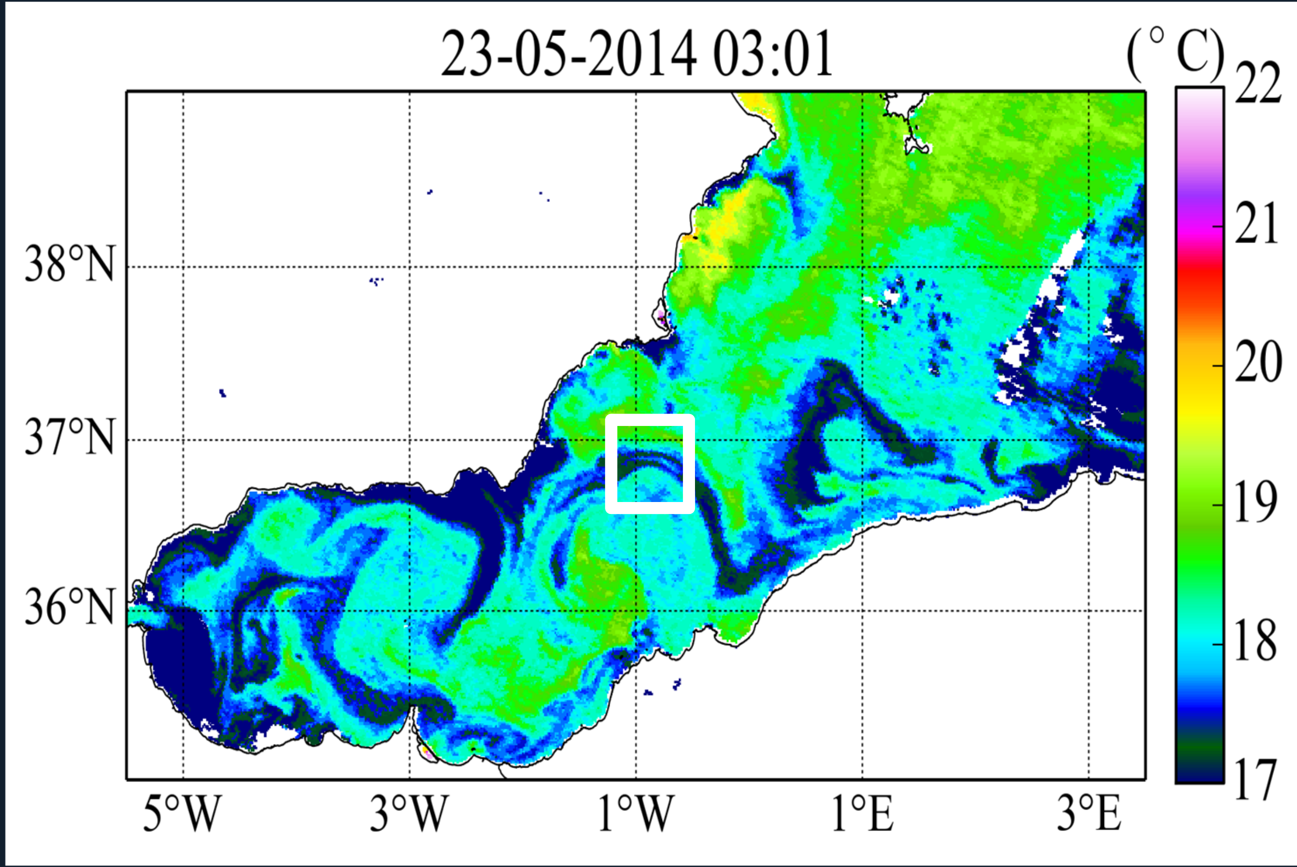
Top: Vertical section of chlorophyll from glider data. Bottom: Quasi-geostrophic vertical velocity at 75 m. Units are m day^{-1}. (Ruiz et al. 2009)

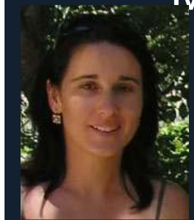
ALBOREX – Perseus project – May 2013. Multi-platform experiment in Alborán Sea

Dates: 24 May – 2 June 2014

Area: Eastern Alboran Sea
Ship: R/V SOCIB

- 25 drifters
- 2 gliders
- 3 Argo floats
- ADCP
- Thermosalinograph
- 80 CTDs
- Nutrients
- Chlorophyll
- Remote sensing
- Modeling

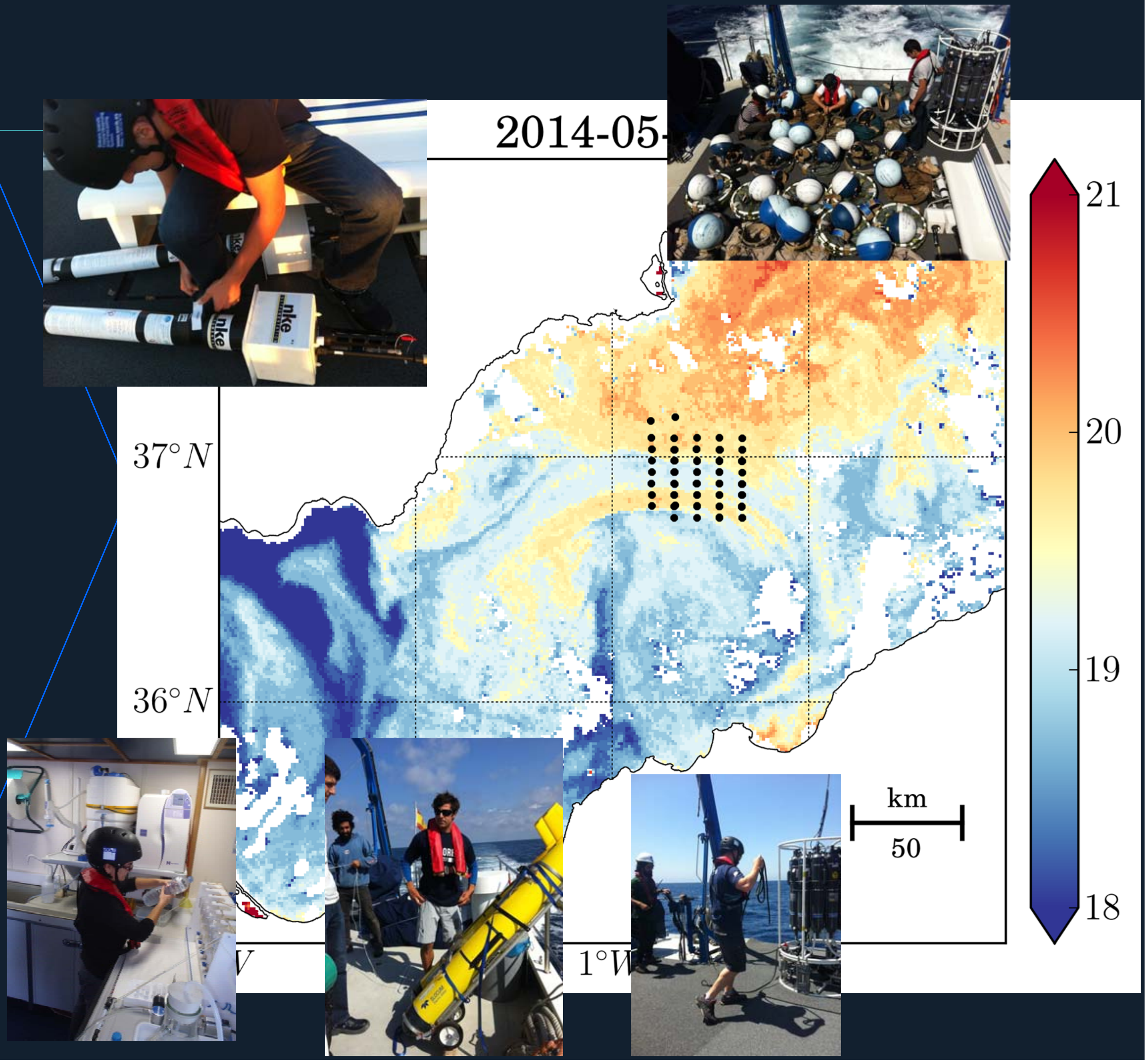




Lead by CSIC (Dr. Ananda Pascual) with strong involvement from SOCIB, OGS, CNR and collaborations with WHOI, IEO, UMA.

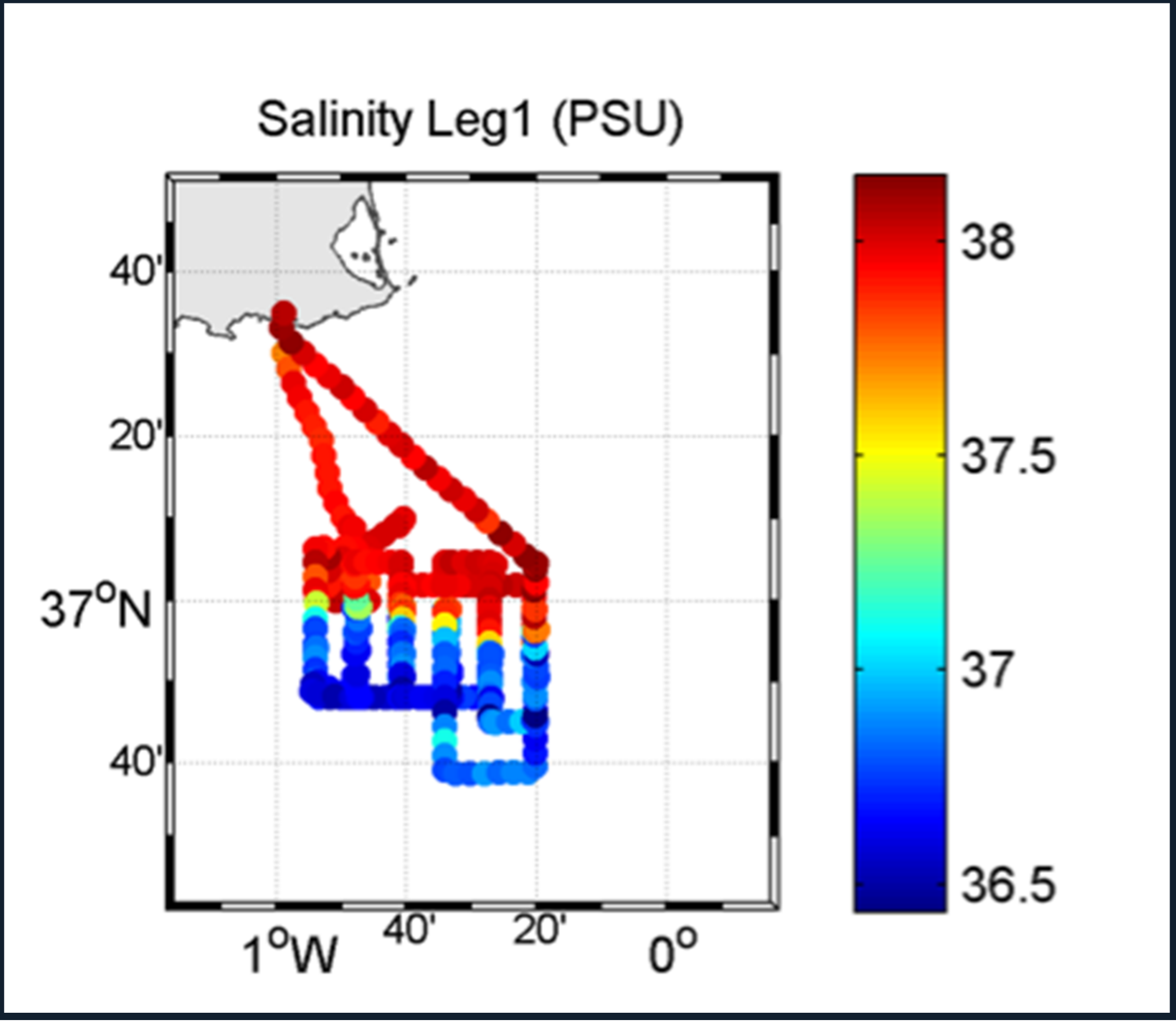
ALBOREX

Need for high-resolution observations (both in situ and satellite) and multi-sensor approaches in synergy with numerical simulations



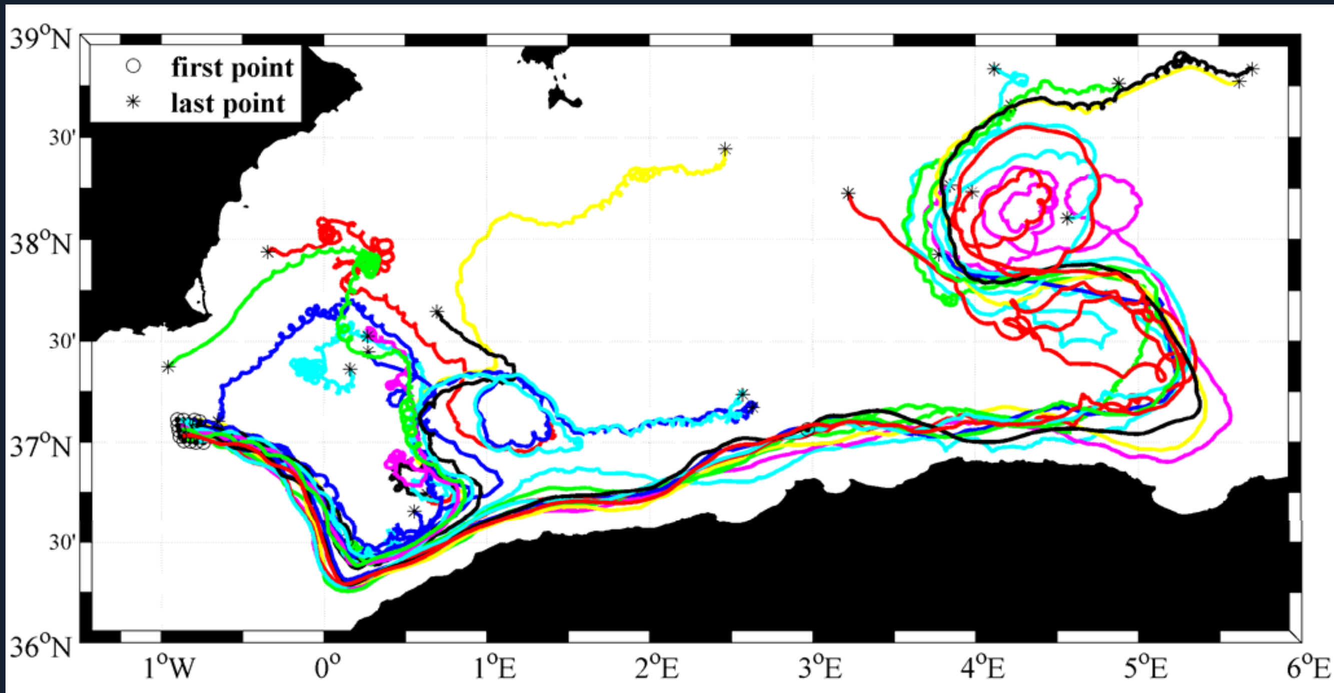
ALBOREX – Perseus project – May 2013. Multi-platform experiment in Alborán Sea

THERMOSALINOGRAPH: SHARP FRONT
CHANGES IN SALINITY FROM 36.4 TO 38.1



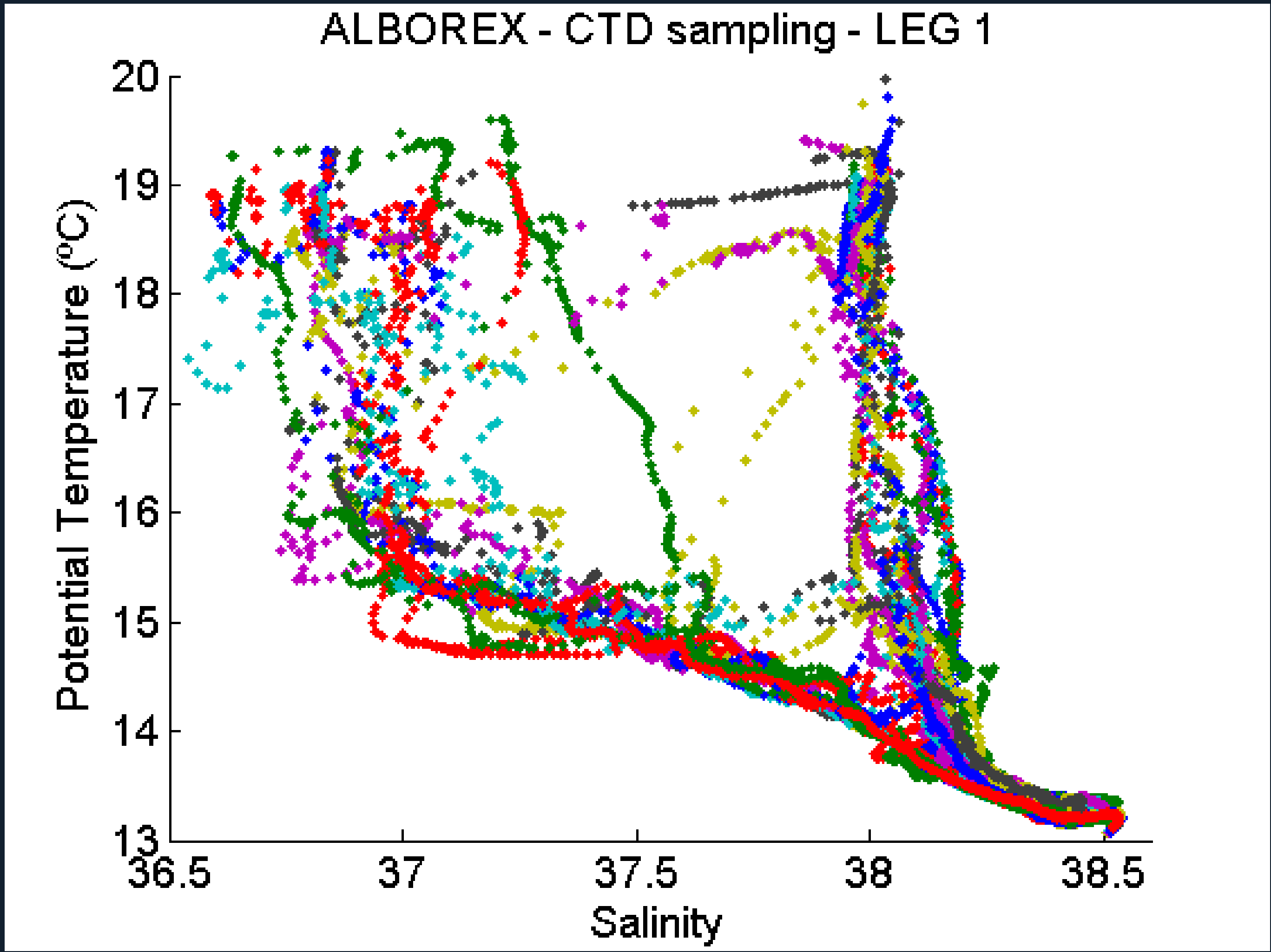
ALBOREX – Perseus project – May 2013. Multi-platform experiment in Alborán Sea

Drifters



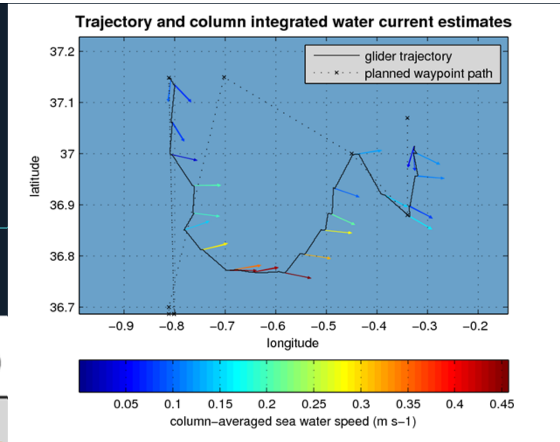
ALBOREX Multi-Platform Experiment

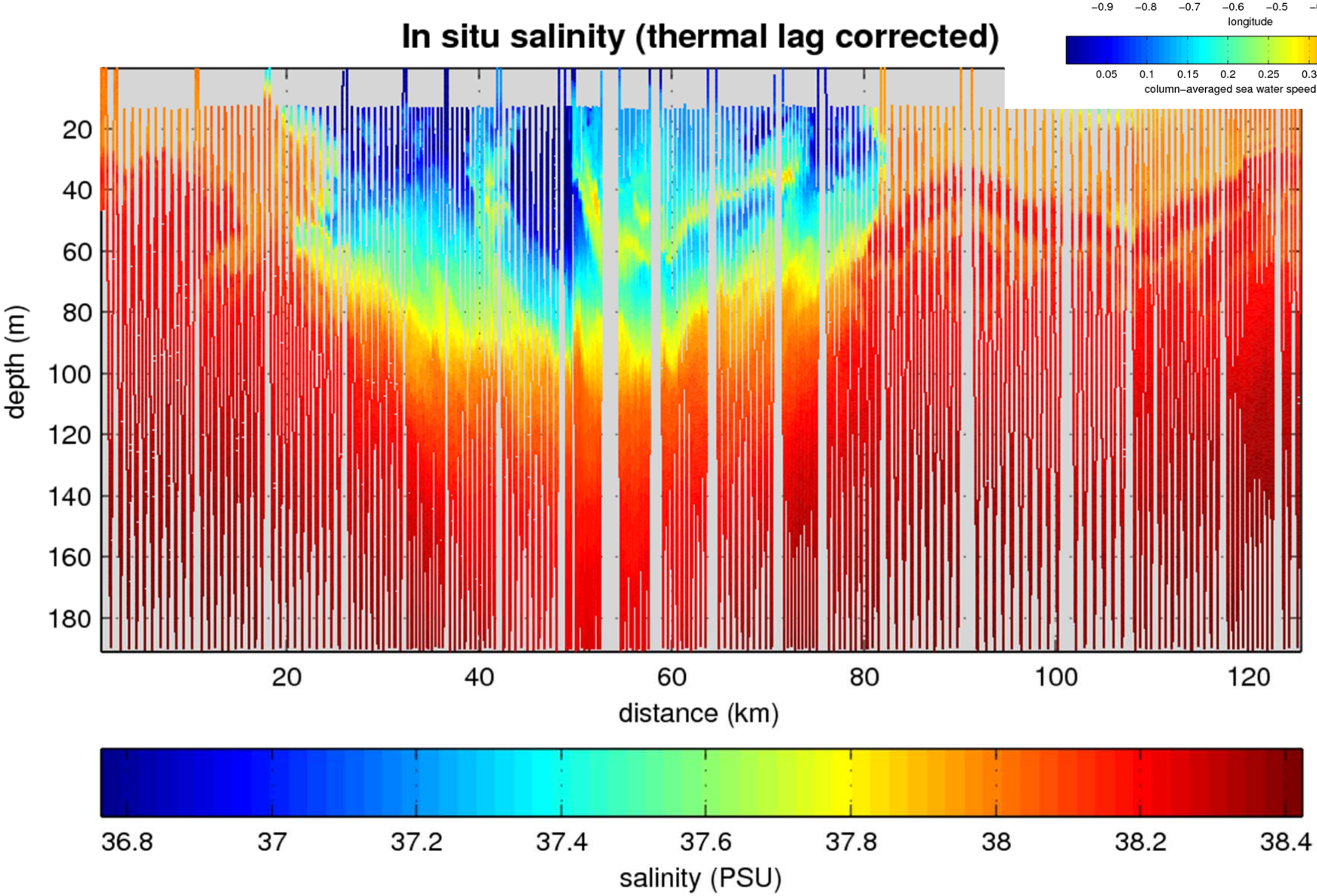
T-S DIAGRAM: ATLANTIC AND MEDITERRANEAN WATERS



ALBOREX Multi-Platform Experiment FINE STRUCTRE

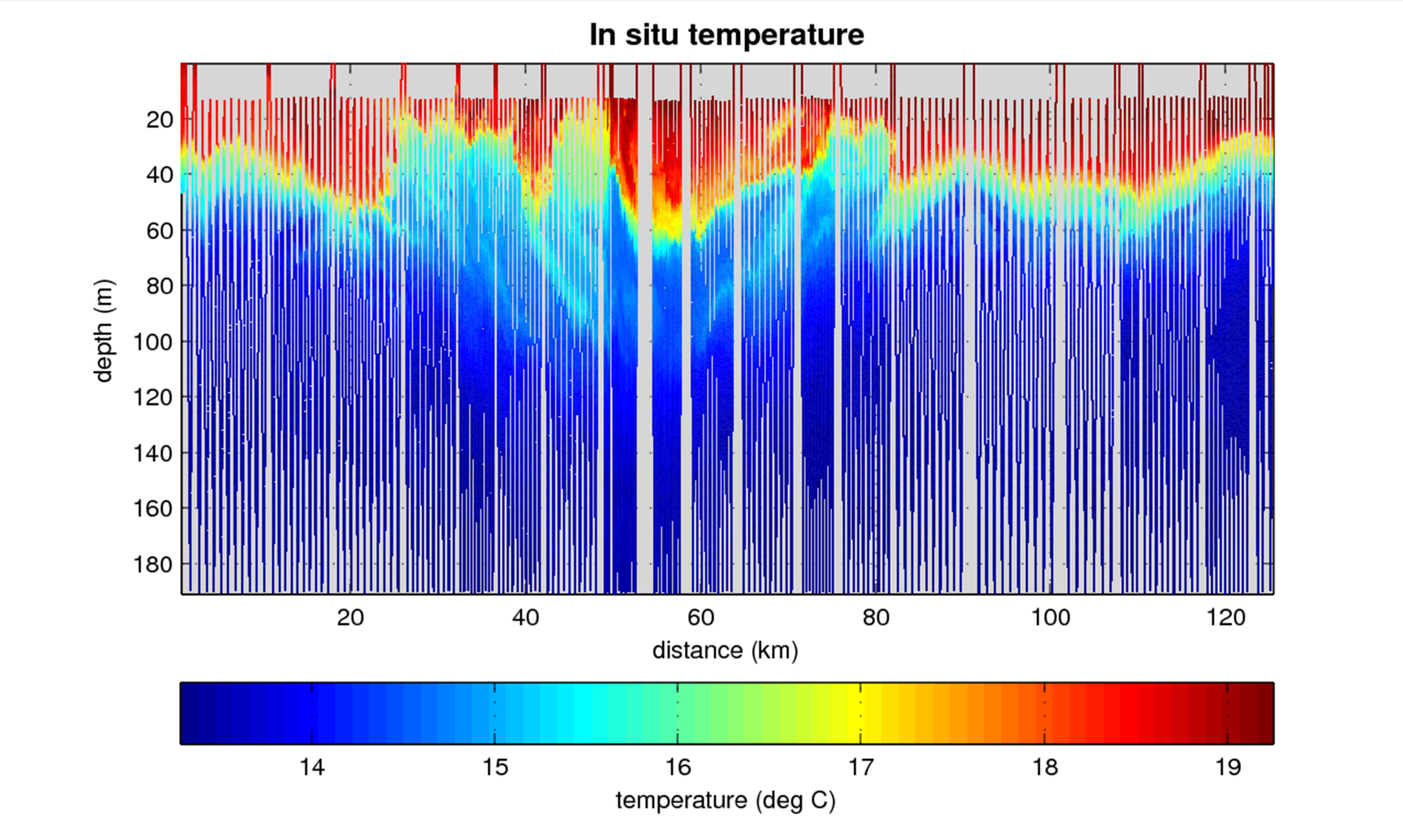
COASTAL GLIDER: RAW DATA





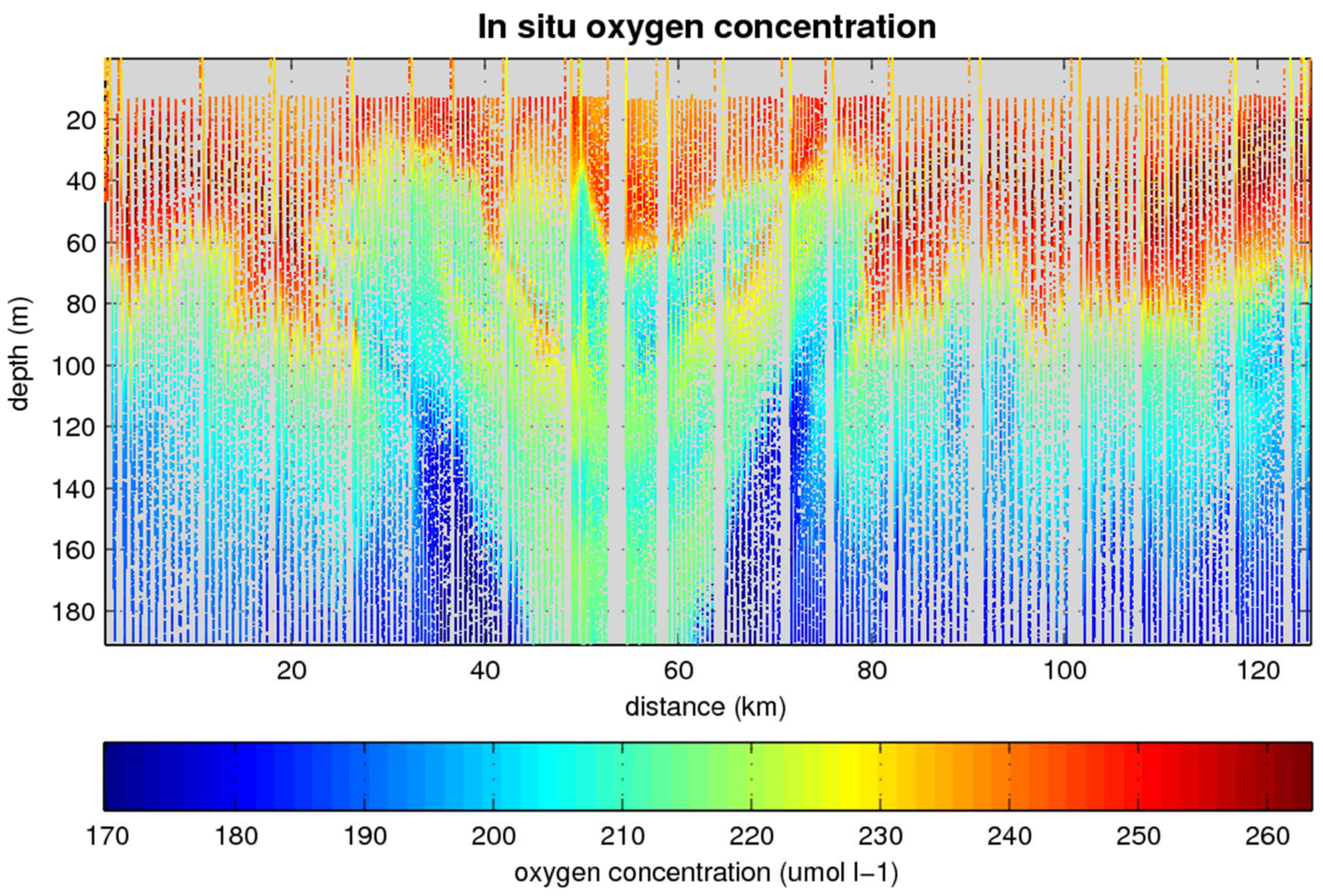
ALBOREX Multi-Platform Experiment
FINE STRUCTRE

COASTAL GLIDER: RAW DATA



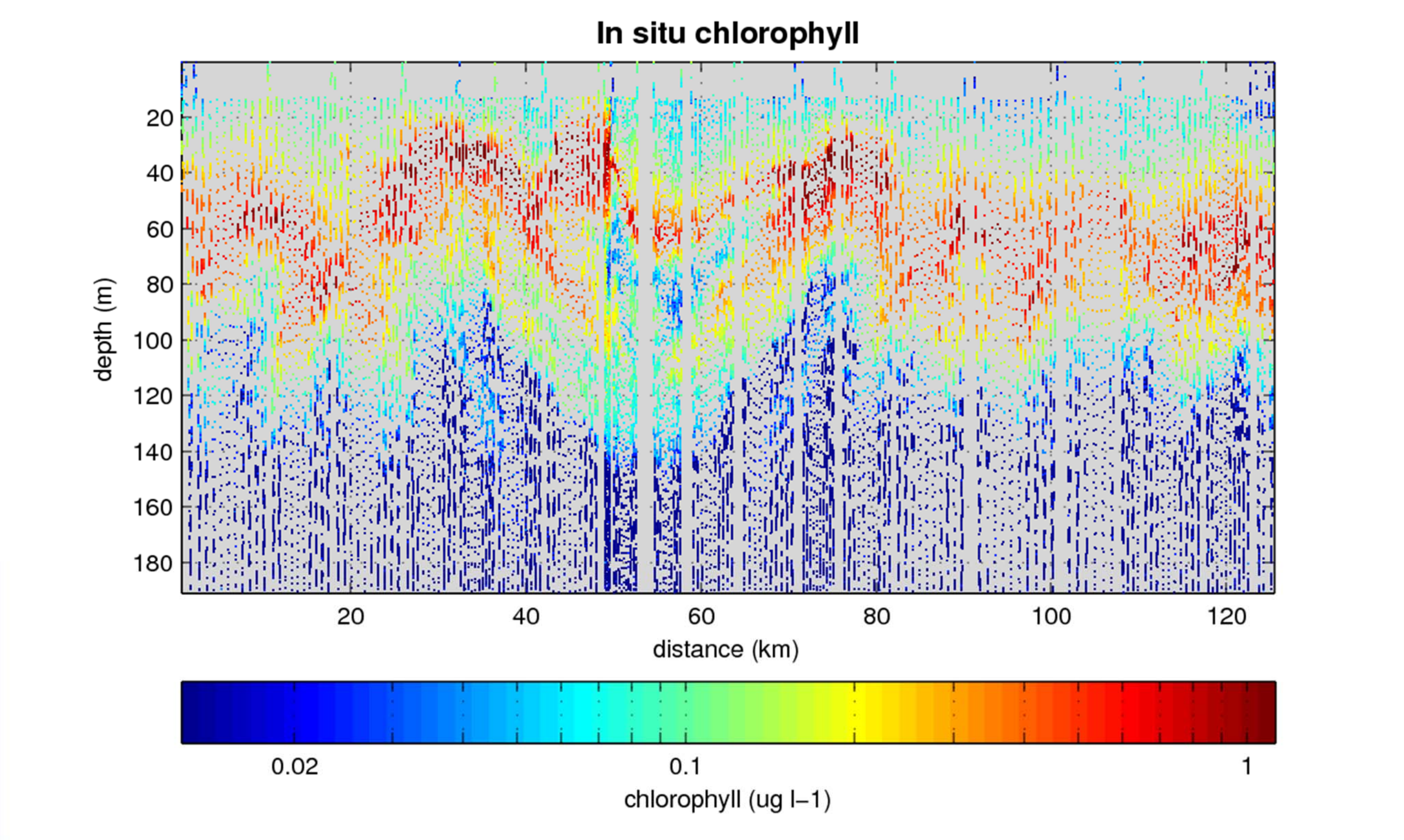
ALBOREX Multi-Platform Experiment
FINE STRUCTRE

COASTAL GLIDER: RAW DATA

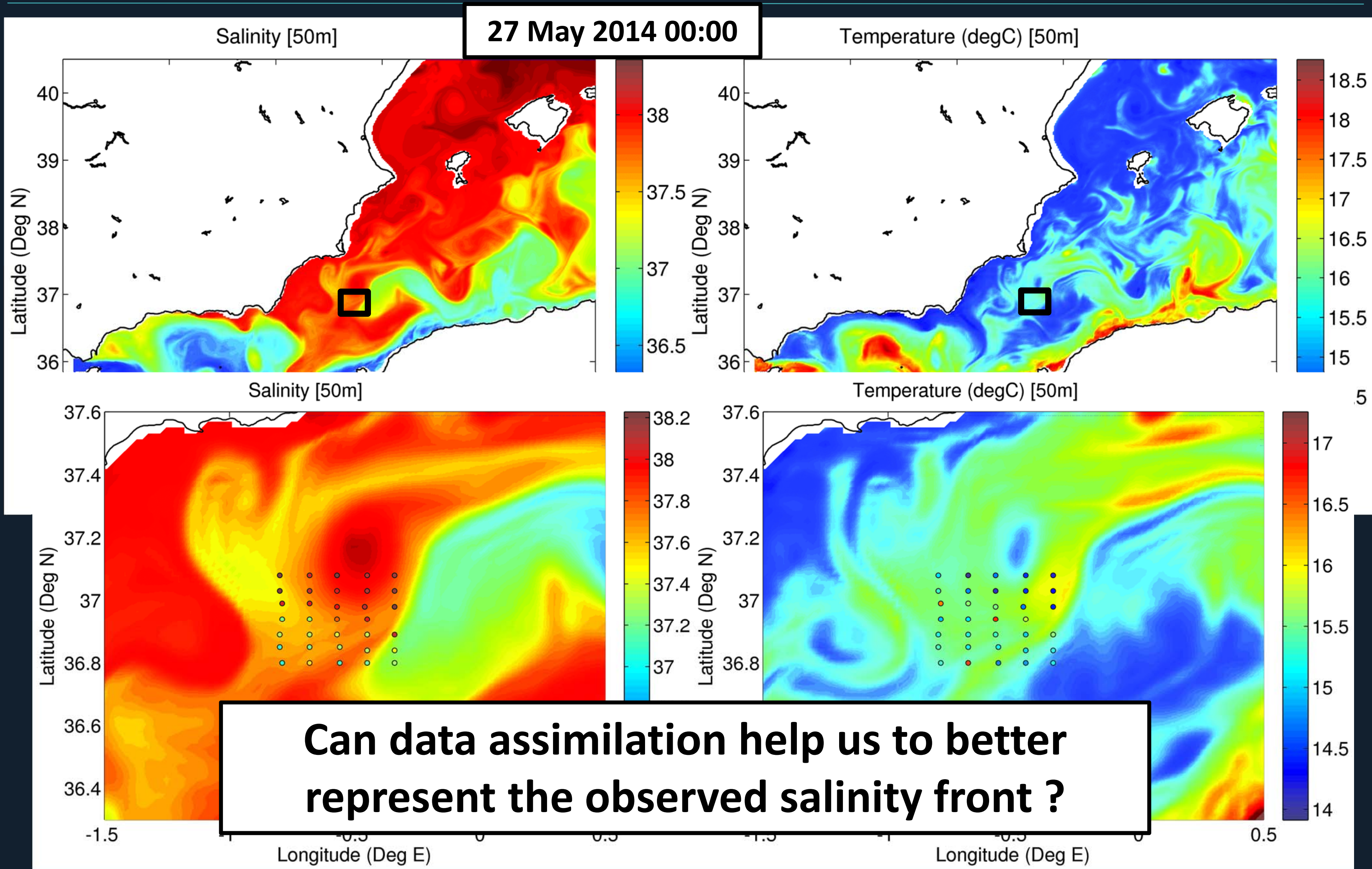


ALBOREX Multi-Platform Experiment
FINE STRUCTRE

COASTAL GLIDER: RAW DATA



ALBOREX: WMOP forecasts experiment



Can data assimilation help us to better represent the observed salinity front ?

ALBOREX data assimilation experiment

Data assimilation approach:

Local Multimodel Ensemble Optimal Interpolation

→Ensemble anomalies sampled from three 2009-2013 WMOP hindcast simulations.
The anomalies are considered within the same season as the analysis date after having removed the seasonal cycle.

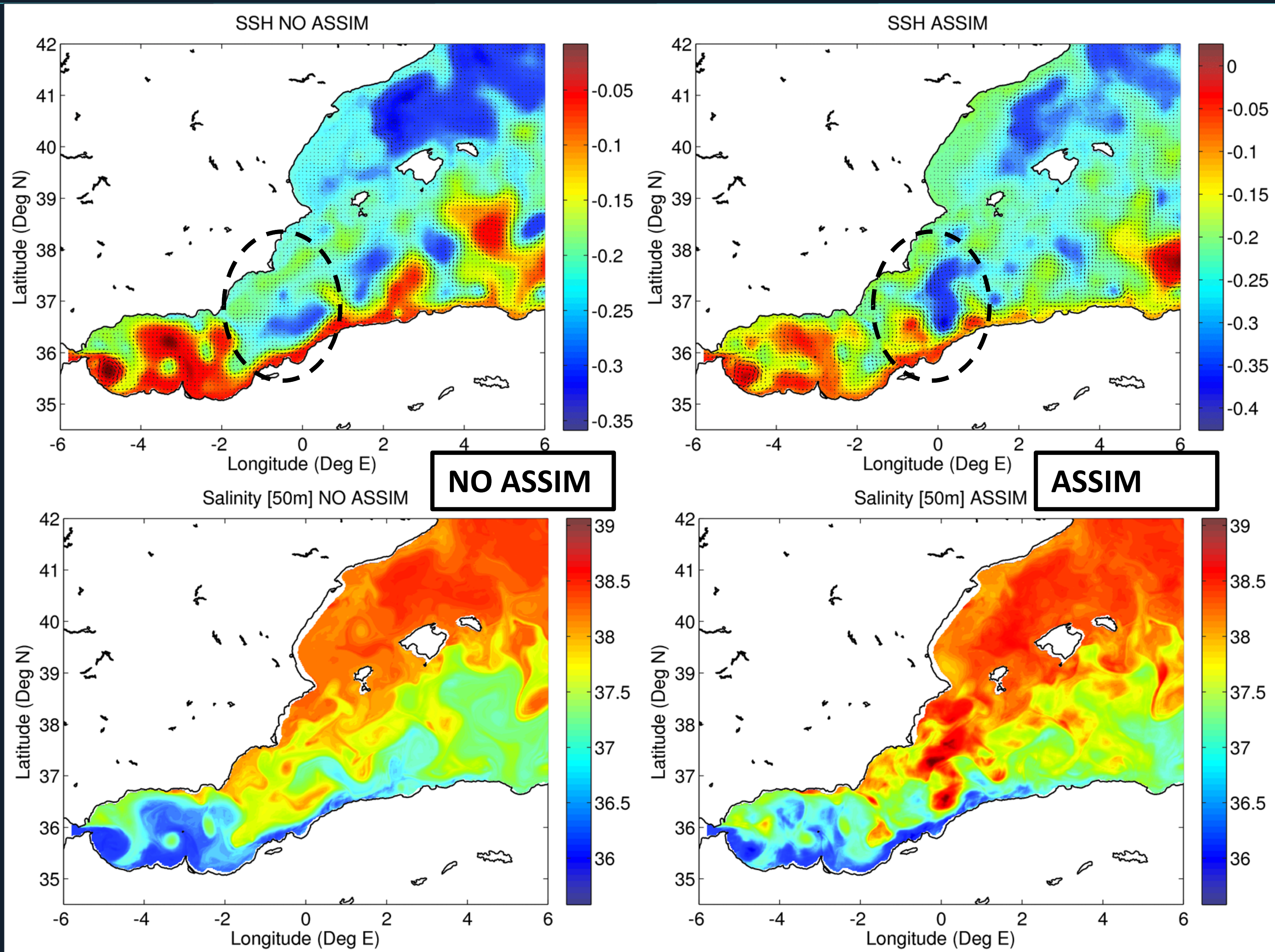
→ Multivariate, inhomogeneous and anisotropic model error covariances characteristic of the mesoscale variability of the season under consideration.

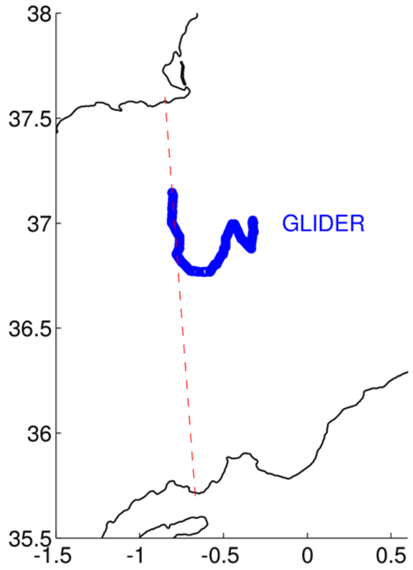
→Localization radius = 200km

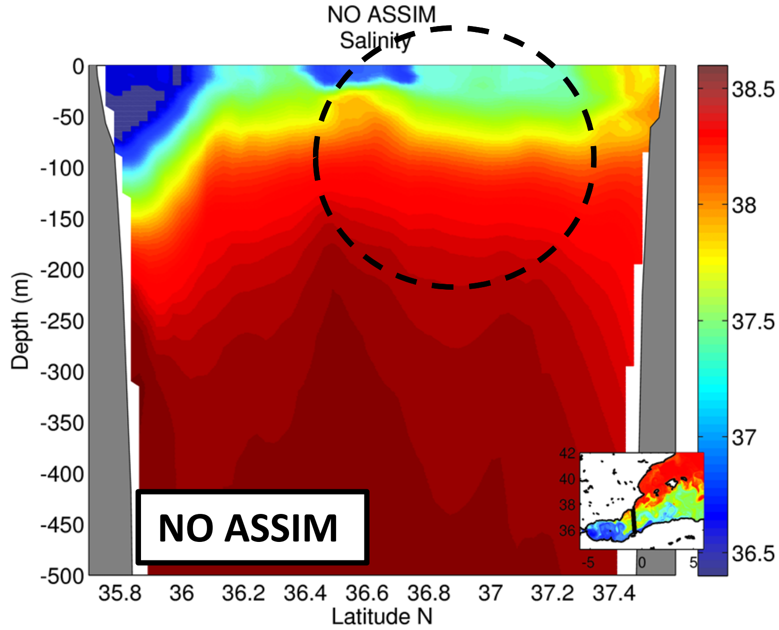
→80 ensemble members

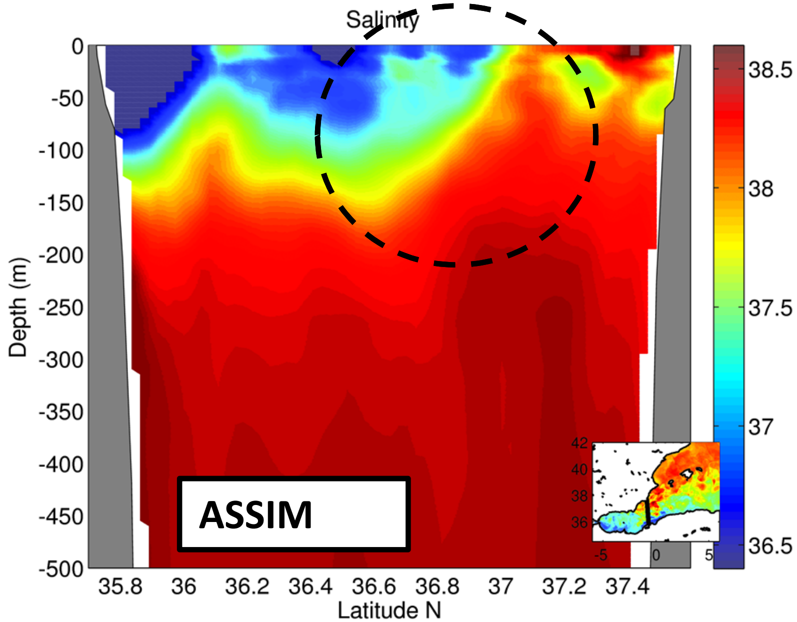
WMOP forecasts during ALBOREX experiment

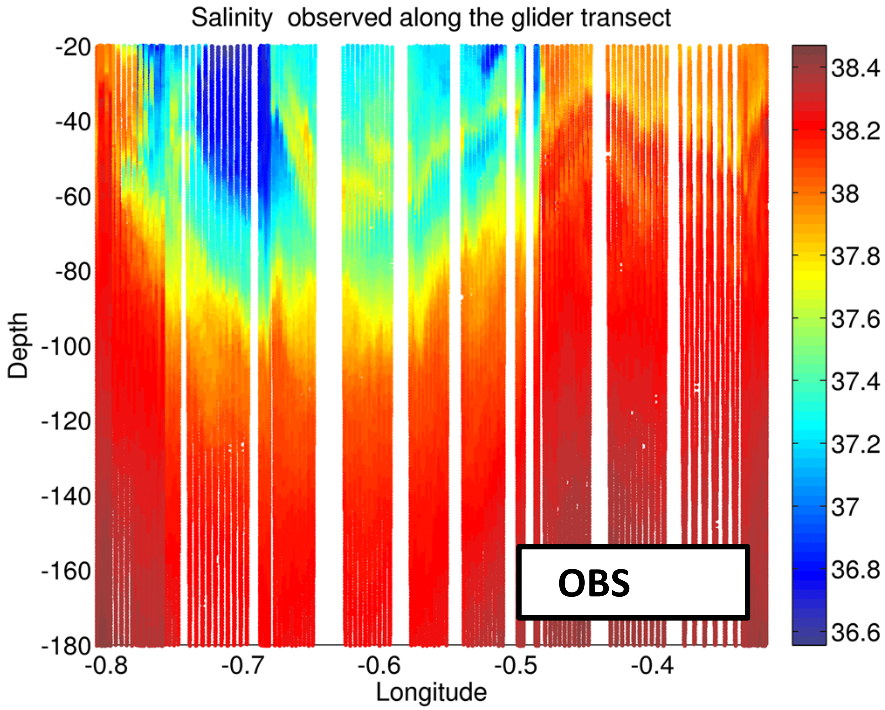
(Assimilating SST, SLA, ARGO + CTD's)

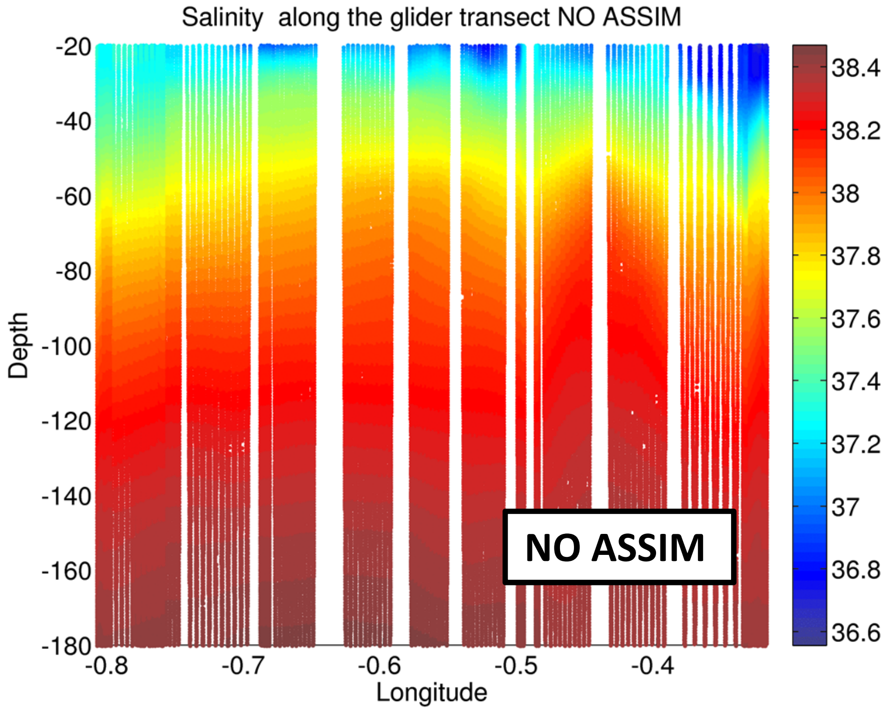


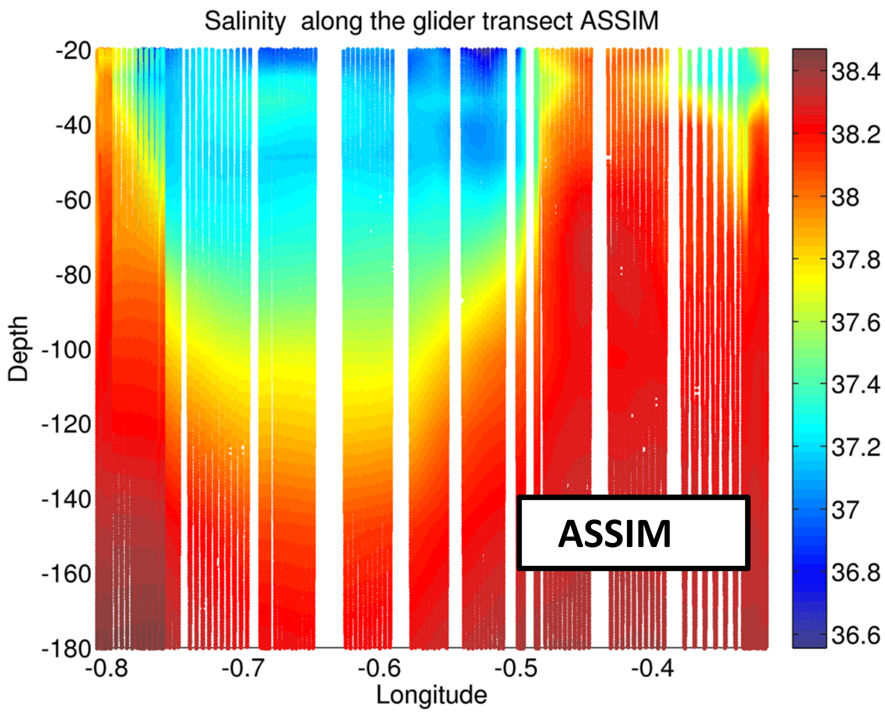

GLIDER
38
37.5
37
36.5
36
35.5
-1.5
-1
-0.5
0
0.5


NO ASSIM
Salinity
Depth (m)
Latitude N
NO ASSIM
0
-50
-100
-150
-200
-250
-300
-350
-400
-450
-500
35.8
36
36.2
36.4
36.6
36.8
37
37.2
37.4
38.5
38
37.5
37
36.5


Salinity
Depth (m)
Latitude N
ASSIM
0
-50
-100
-150
-200
-250
-300
-350
-400
-450
-500
35.8
36
36.2
36.4
36.6
36.8
37
37.2
37.4
38.5
38
37.5
37
36.5







Validation against independent glider data crossing the salinity front

ALBOREX data assimilation experiment Conclusions

- Data assimilation has been implemented to assimilate ALBOREX observations into WMOP

  → first data assimilation experiments in WMOP

  → Other examples in Poster from REP14-MED

- Preliminary results indicate that the assimilation of CTDs (leg1) + Argo + SST + SLA allows to reconstruct the observed salinity front,

Innovation in oceanographic instrumentation

We need:

- **Long time series**
- **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

(Curtin and Belcher, TOS, 2008)

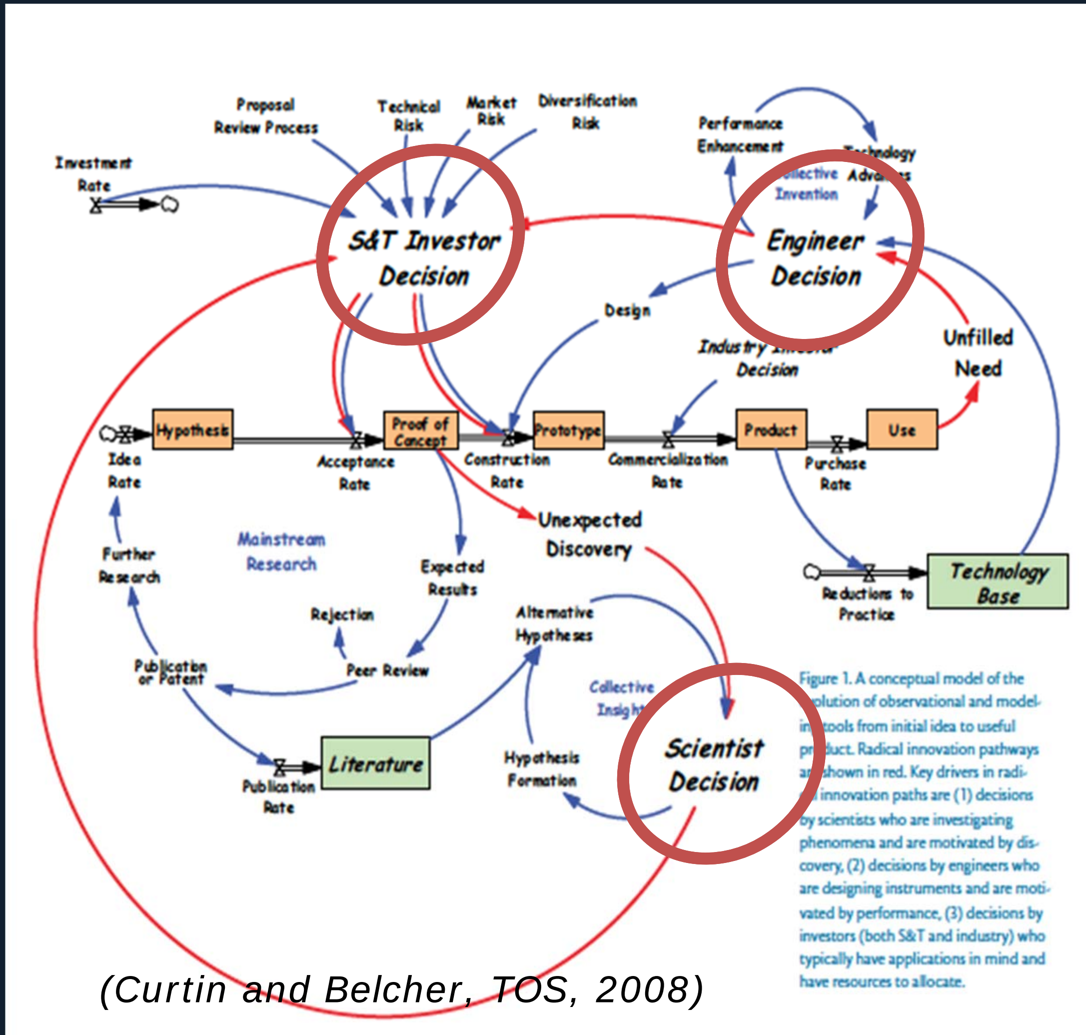
The innovation process

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...

- MULTI-DISCIPLINARY APPROACH
- INTEGRATION



(Curtin and Belcher, TOS, 2008)

OUTLINE: CHANGES IN OCEANOGRAPHY 2020-2030

SOCIB

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

2. Marine Research Infrastructures, Ocean Observatories: SOCIB contributions to process studies and operational response and the real challenges for next decade

3. **Discussion on changes in oceanography in last 10 years: Are we ready for theses changes ? Do we have the framework and right structures to get all the benefits from these changes?**

4. New Partnership in the Mediterranean; 2016 and 2030 vision…

What changes have occurred in last 10-15 years

SOCIB

- How we work (how many persons)
- How we work (methodologies, obs and models): multi platform, integrated and multidisciplinary approach (we are all convinced about this: but are we really acting like this…?)
- Data availability (same comment ?)

- The structures: from small university groups to large research centres based teams and new marine research infrastructures

- Science-Society/Policy relation: the science “use” by society has also changed: we have evolved from a science just been used/called upon under emergencies to a more science based management of oceans and coasts, planet…

Have we adapted to the changes?

SOCIB

But…

We are still working pretty much the same way we were taught

We are still planning and working with the structures from 20 years ago….

The question then is maybe… Are we ready for theses changes? :

We might need to open our minds, adapt scientific and educational structures, management procedures. or…in other words:

Do we have the framework and right structures to get all the benefits from these changes?

- Educational system/universities?
- Science system?
- Evaluation science?
- Science-Policy interactions?

OUTLINE: CHANGES IN OCEANOGRAPHY 2020-2030

SOCIB

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

2. Marine Research Infrastructures, Ocean Observatories: SOCIB contributions to process studies and operational response and the real challenges for next decade

3. Discussion on changes in oceanography in last 10 years: Are we ready for theses changes ? Do we have the framework and right structures to get all the benefits from these changes?

4. **New Partnership in the Mediterranean; 2016 and 2030 vision…**

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: …

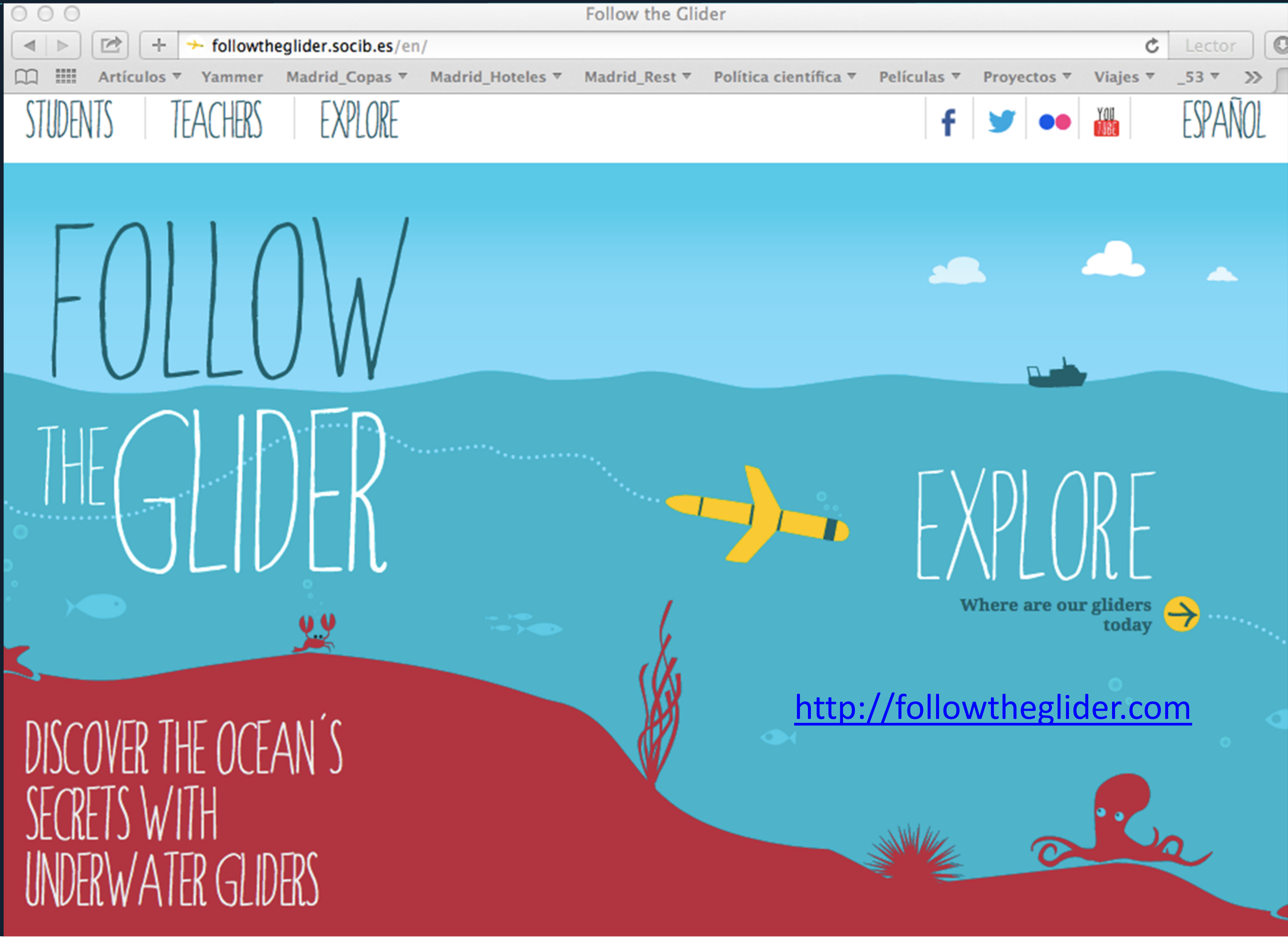
New observing systems with real time open data are key elements for new advances in oceanography

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

SOCIB, just an example research infrastructures 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)

SOCIB Developments and Applications: Outreach



http://followtheglider.com

SOCIB Outreach

SOCIB

The challenge for the next decade…:

Excellent Science & Technology Develop. with Impact on Society”

“Strong Science for Wise Decision”

Science with and for Society

Ciencia con y para la sociedad

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

Kostas legacy…

Efgaristó

Ευχαριστίες

– "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,

New Partnership in the Mediterranean; 2016 and 2030 vision…

THE MEDITERRANEAN INTEGRATED OBSERVING SYSTEM OF SYSTEMS:

IN 2016:

A catalyser of an international and well-coordinated reaction of observing and forecasting systems in the Mediterranean Sea, based on strong partnership and real multidisciplinary integration, evolving with scientific and technological advances, responding to science, technology and societal drivers, in line with open and interoperable data principles, and also involving key international organisations and sound governance.

2030 VISION:

A system of observing and forecasting systems in the Mediterranean, providing key ocean variables from days to decades and from the coast to the open sea, in response to science and society needs and contributing to citizens quality of life and welfare.