The impact of new information infrastructures in understanding and forecasting the European Seas (from "small" to large scales...): SOCIB, an **O**cean Observing and Forecasting **S**ystem based in the **B**alearic **I**slands

Joaquín Tintoré and the SOCIB/IMEDEA team

SOCIB and IMEDEA (UIB-CSIC)

http://www.socib.eu

SOCIB Balearic Islands Coastal Observing and Forecasting System

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OUTLINE

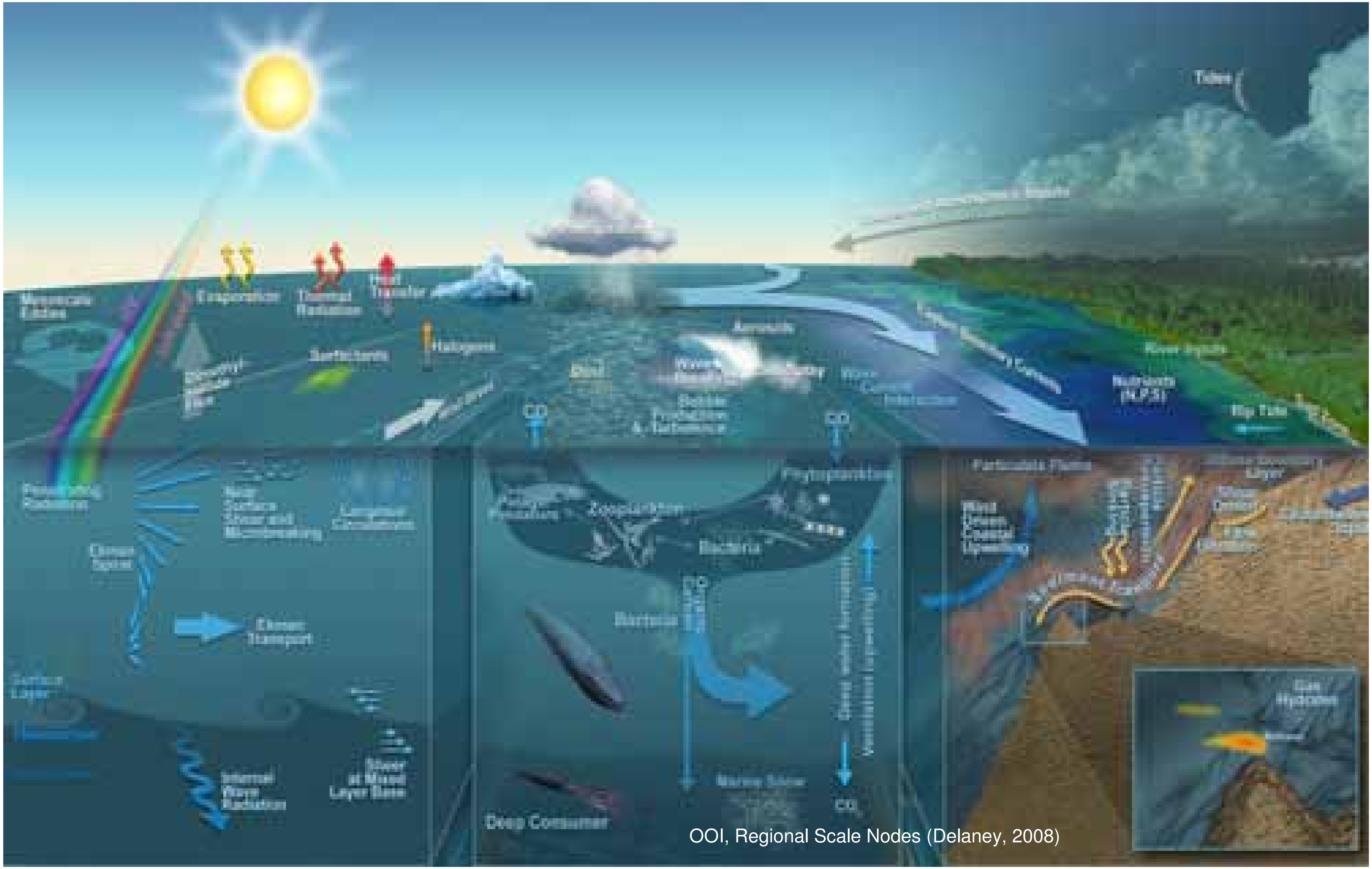
1. The 2012 Oceans' Challenges for Science, Technology and Society

2. Ocean Information for Society,… what we learned (some examples of global problems addressed)

3. SOCIB, a new multi-platform approach

1. SOCIB and the new role of Marine Research Infrastructures to respond to Science, Technology and Society needs

Oceans are complex and central to the Earth system



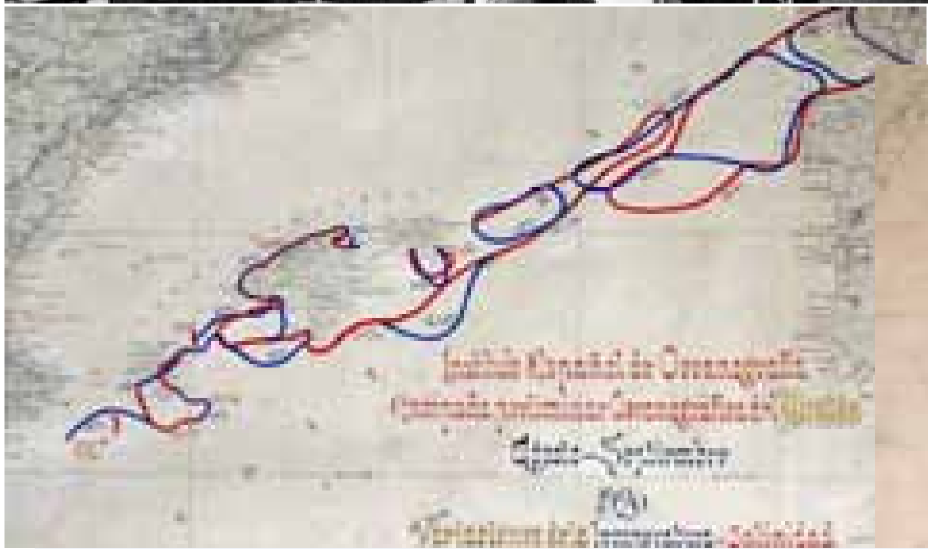
OOI, Regional Scale Nodes (Delaney, 2008)

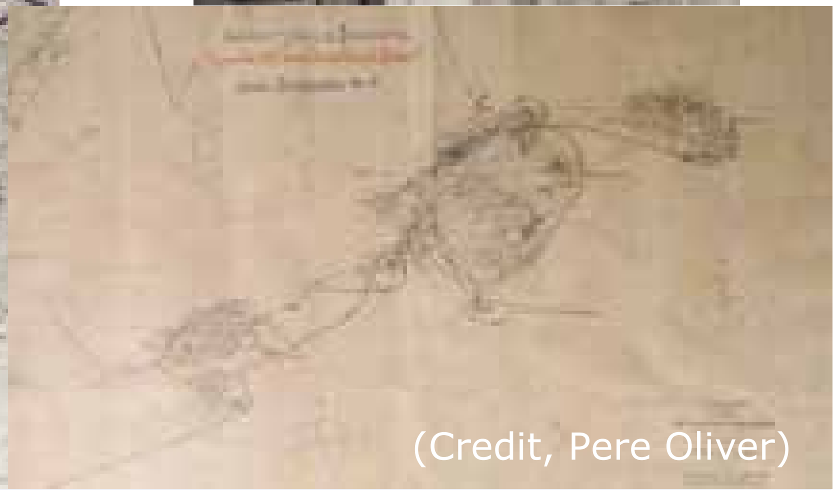
The oceans are chronically under-sampled

(Credit, Oscar Schoefield)

de les Illes Balears

The oceans are chronically under-sampled





(Credit, Pere Oliver)

OUTLINE

1. The 2012 Oceans' Challenges for Science, Technology and Society (Barnes, Wunsh, Visbek, Kanzow)
   - Paradigm change in Observing the Oceans
   - Why SOCIB and why now
   - What is SOCIB: a multi-platform OFS
   - SOCIB 3 drivers
2. Ocean Information for Society, what we learned,
   - Meso&submesoscale
   - Aliasing, therefore operational and decadal linked, from A to B….
   - What we are still not understanding, research needs…(esquema procesos…delayney)
3. SOCIB
   - SOCIB focus, scales, platforms and challenges
   - SOCIB view and Implementation timeline
   - Ongoing facilities and initial results
4. SOCIB drivers and the new role of Marine Research Infrastructures to respond to ST&S
   - Innovation in Oceanographic Instrumentation
   - Gliders, an example of rapid innovation
   - Data availability, real time and educational challenges…

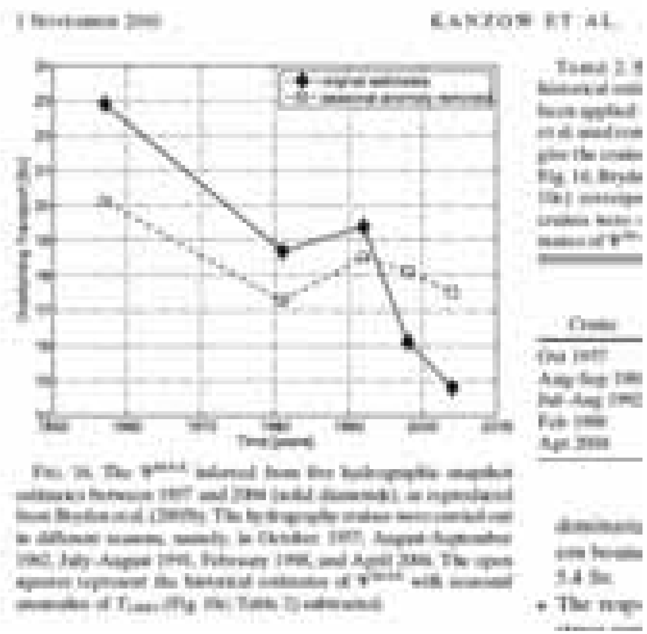
2012 Oceans' Challenges for Science, Technology and Society

- **The Oceans; a complex system, changing, under-sampled**

- 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"
- AMOC, Atlantic Ocean Meridional Circulation seasonal biases, … but that still needs to be managed…

Scientists role:…recognize ….

- GAPS in data and in knowledge, but also in GAPS in procedures such as in some cases data availability, optimization of resources, etc.
- PART of society, managing and understanding the oceans is a global enterprise: we need more than just coordination --- > Partnership
- Science-Policy Gap



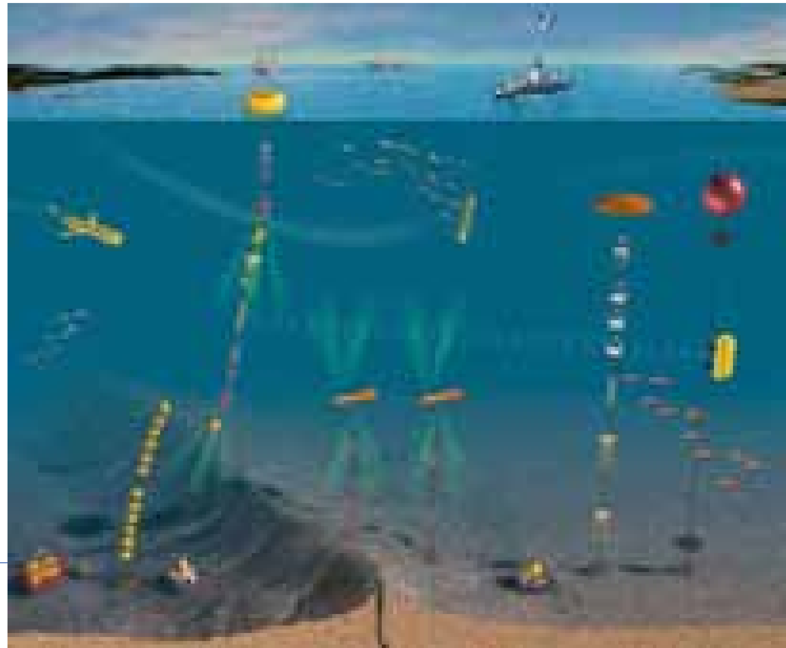
- **New Marine Infrastructures can help and must help to fill theses gaps** and Governing bodies should adapt to the new global situation.

Paradigm Shift in Ocean Observation

From: Ship based observation
To: Multi-platform observing systems

Platform-centric Sensing Systems

Net-centric, Distributed Sensing Systems



(Adapted from Steve Chien, JPL-NASA)

and Forecasting System

de les Illes Balears

What is SOCIB?

SOCIB is an Observing and Forecasting System, **a <u>multi-platform distributed</u> and <u>integrated</u> Scientific and Technological** Facility (a facility of facilities…)

- providing streams of oceanographic data and modelling services in support to operational oceanography
- contributing to the needs of marine and coastal research in a global change context.

The concept of Operational Oceanography is here understood as general, including traditional operational services to society but also including the sustained supply of multidisciplinary data and technologies development to cover the needs of a wide range of scientific research priorities and society needs.

In other words, SOCIB will allow a quantitative increase in our understanding of key questions on oceans and climate change, coastal ocean processes and ecosystem variability.

Why SOCIB, why Ocean Observatories, and **why now?**

A New Approach to Marine and Coastal Research

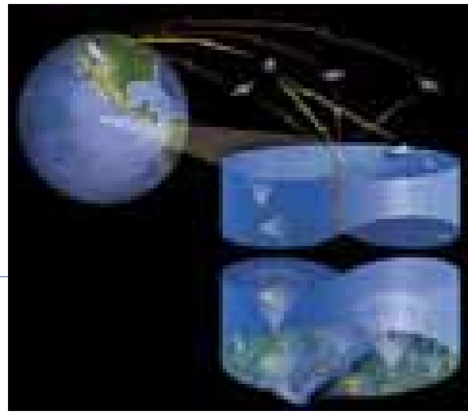
New technologies now allow three-dimensional real time observations, that combined with forecasting numerical models, and data assimilation, …

A quantitative major jump, in scientific knowledge and technology development

The development of a new form of Integrated Coastal Zone Management, based on recent scientific and technological achievements,

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)



Ocean Observatories, (Oceanus, 2006)

The SOCIB approach to sustained Marine RI

To assure the real sustainability of the seas and oceans and of the observing systems, in 2007 we designed SOCIB:

→ **RESPONDING TO 3 KEY DRIVERS**

- Science Priorities
- Strategic Society Needs
- Technology Developments

OUTLINE

1. The 2012 Oceans' Challenges for Science, Technology and Society

2. Ocean Information for Society,… what we learned in the Mediterranean

3. SOCIB, a new multi-platform approach

1. SOCIB and the new role of Marine Research Infrastructures to respond to Science, Technology and Society needs

Regional Issues (of global interest)

- Strait's outflow (Alborán Sea) and water masses interactions, fronts (AO front).
- Mesoscale and sub-mesoscale variability / characteristics, eddies and filaments (Balearic & Alborán sub-basins).
- 3d dynamics of mesoscale structures, w estimations using QG Omega and SQG, assimilation PE models, models experiments, induced vertical biogeochemical exchanges. Ecosystem response.
- Mesoscale effects on sub-basin scale circulation (Balearic Sea/Algerian sub-basin) and on local circulation (canyons).
- Mesoscale/sub-basin interactions with basin scale circulation: blocking effects, recirculation and with shelf / slope exchanges…
- Transient forcing episodes and its effects on sub-basin and basin scale circulation (Water Masses and also MLD) and beaches (!)
- New Technologies, for addressing the "scales and scales interaction problem" as well as the "synopticity problem"…: gliders

Motivation: the background… IMEDEA work since 1990 's… - Strategic Plan 2010-2013

20 years of **peer reviewed 'basic' Research Activity**: fronts, mesoscale eddies, shelf/slope exchanges, shelf dynamics, satellite altimetry, waves, sediments, beach variability, etc…

that evolved incorporating …

Technology Development (both transfer of technological products – spin off AMT- and transfer of management technologies –beach management, recreational boating carrying capacity, tools for decision support; ESI/NOAA, sustainability indicators-)

that evolved as requested by society…

Applications to respond to society needs (beach erosion, beach response extreme events, sand re-nourishment, socio-economic valuation, ICZM, ICOM, MSP).

(Available pdf file at:

http://imedea.uib-csic.es/tmoos)

Eastern Alborán Sea dynamics and basin scale interactions

OCTOBER 1988 J. TINTORE, P. E. LA VIOLETTE, I. BLADE AND A. CRUZAI

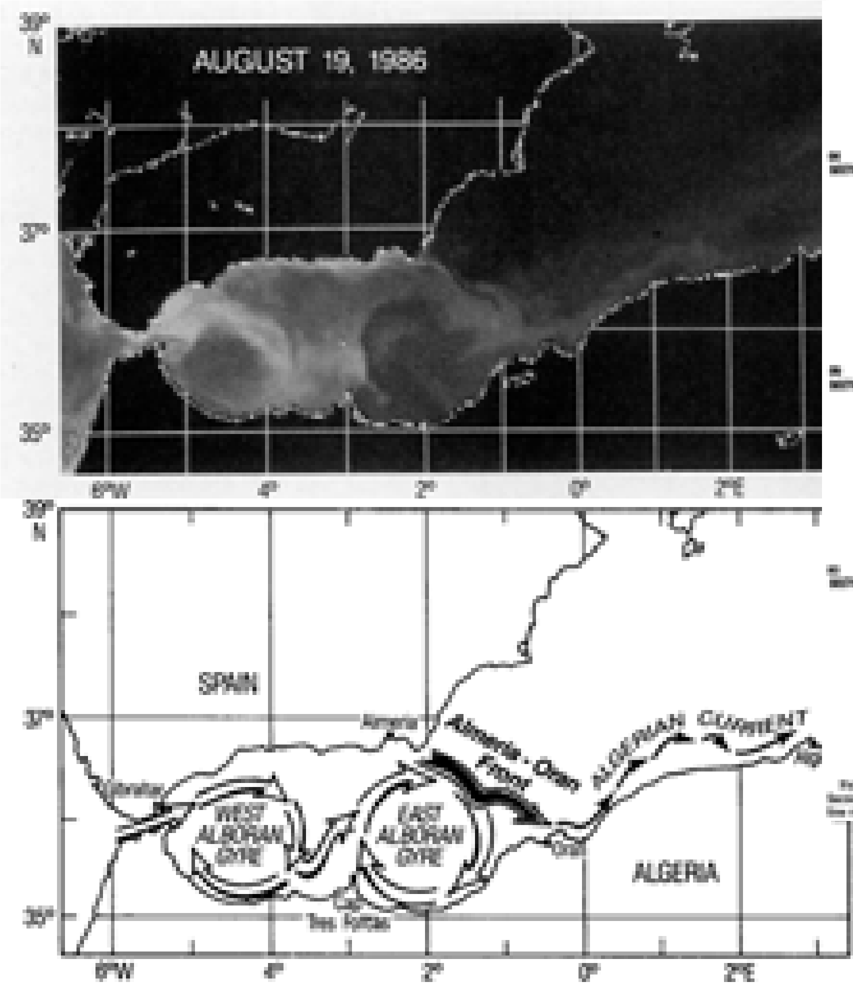
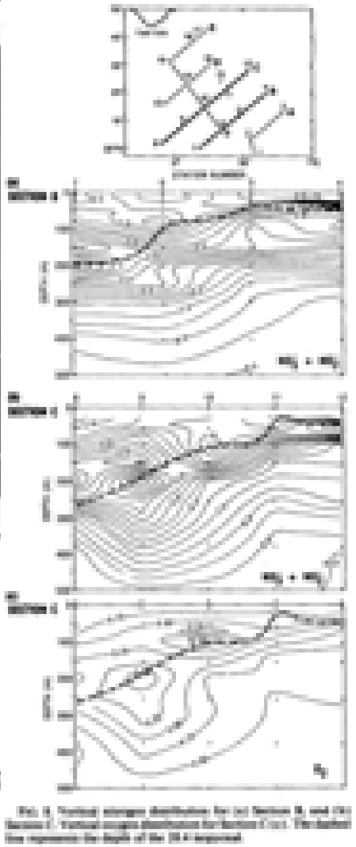
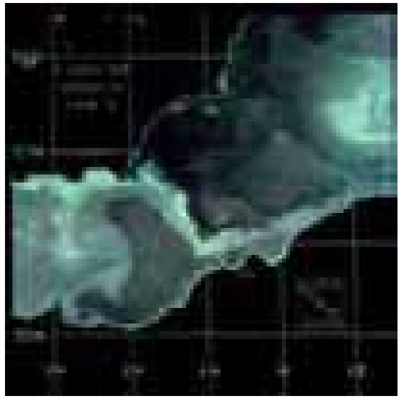
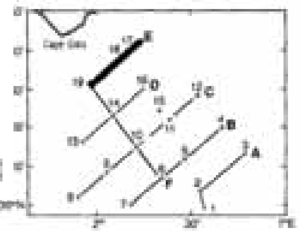


FIG. 1. (Top) A satellite thermal image of the Alboran Sea, showing the continuity of the regional circulation. As with the other satellite imagery in this paper, this NOAA AVHRR-IR image was registered to a Mercator projection and enhanced to show the ocean features. (Bottom) A schematic drawing of the circulation identifying the features displayed in the satellite thermal image (after Arnone et al. 1988).







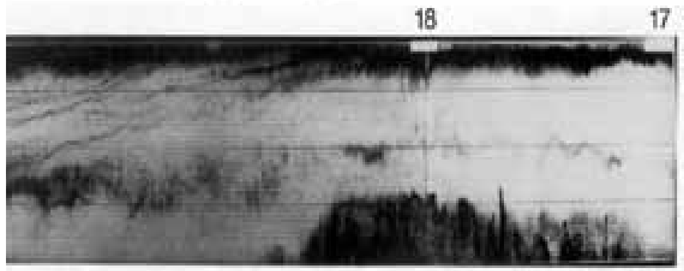
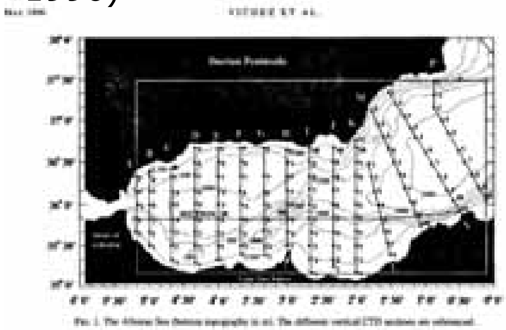


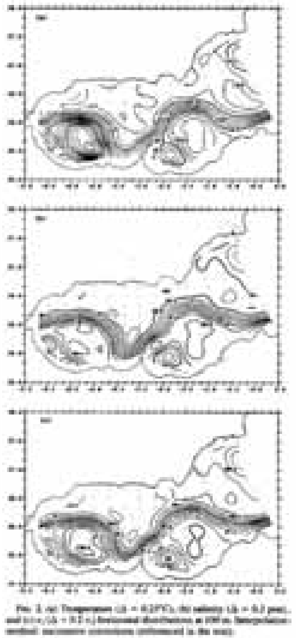
FIG. 10. Echosounder chart for Section E.

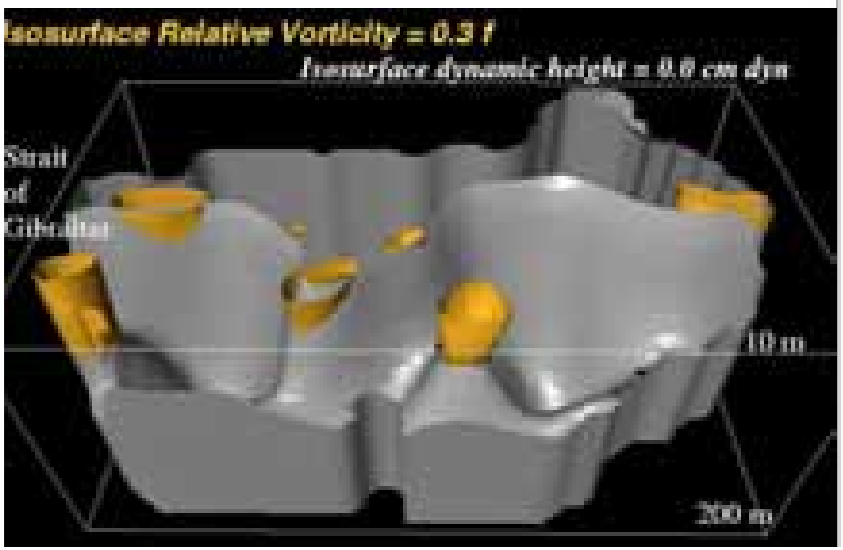
Mesoscale dynamics, vertical motions, size structure of phytoplankton, biogeochemical fluxes

(Viúdez, Tintoré, Haney, 1996)



17 Sept to 7 Oct. 1992, R/V García del Cid





floras, angiosperms typically constitute only a very small percentage of the total diversity—perhaps reflecting low pollen production and poor dispersal abilities associated with insect pollination. Similarly, with one strongly disputed exception angiosperm wood has not been recorded from Aptian or older rocks, and angiosperm leaves in Aptian or earlier floras are also extremely rare. However, exceptionally preserved whole plants reported from the Lower Cretaceous Crato Formation, Brazil, document that diverse herbaceous water plants were present by the Aptian–Albian and were a prominent part of the angiosperm assemblage of this flora[23]. These observations suggest that the apparent discrepancy between the diversity of angiosperm reproductive structures and the diversity of leaves and wood during the earliest phases of angiosperm diversification may in part be explained by the low potential of leaves and stems of herbaceous plants, including water lilies and monocots, to be preserved.

Acknowledgements

We thank P. K. Endress and J. Schönenberger for valuable comments and help; and P. von Knorring for preparing the reconstruction of the fossil flower. The work was supported by grants from the Swedish Natural Science Foundation (to E.M.F.), the Carlsberg Foundation (to K.R.P. and E.M.F.), the Danish Natural Science Research Council (to K.R.P.) and the US National Science Foundation (to P.R.C.).

Correspondence and requests for materials should be addressed to E.M. Friis.

Mesoscale vertical motion and the size structure of phytoplankton in the ocean

Jaime Rodríguez*, Joaquín Tintoré†, John T. Allen‡, José Mª Blanco*, Damià Gomis†, Andreas Reul*, Javier Ruiz§, Valeriano Rodríguez*, Fidel Echevarría§ & Francisco Jiménez-Gómez*‖

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Phytoplankton size structure is acknowledged as a fundamental property determining energy flow through 'microbial' or 'herbivore' pathways[1]. The balance between these two pathways determines the ability of the ecosystem to recycle carbon within the upper layer or to export it to the ocean interior[1]. Small cells are usually characteristic of oligotrophic, stratified ocean waters, in which regenerated ammonium is the only available form of inorganic nitrogen and recycling dominates. Large cells seem to characterize phytoplankton in which inputs of nitrate enter the euphotic layer and exported production is higher[2–4]. But the size structure of phytoplankton may depend more directly on hydrodynamical forces than on the source of available nitrogen[5–7]. Here we present an empirical model that relates the magnitude of mesoscale vertical motion to the slope of the size–abundance spectrum[8–10] of phytoplankton in a frontal ecosystem. Our model indicates that the relative proportion of large cells increases with the magnitude of the upward velocity. This suggests that mesoscale vertical motion—a ubiquitous feature of eddies and unstable fronts—controls directly the size structure of phytoplankton in the ocean.


Available online at www.sciencedirect.com
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Progress in Oceanography 66 (2005) 321–340
Progress in Oceanograp
www.elsevier.com/locate

Mesoscale, seasonal and interannual variability in the Mediterranean Sea using a numerical ocean model

Vicente Fernández [a,*], David E. Dietrich [a], Robert L. Haney [b], Joaquín Tint
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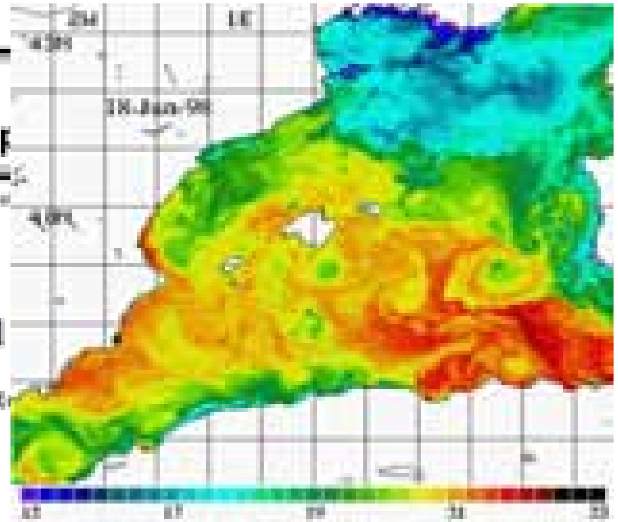
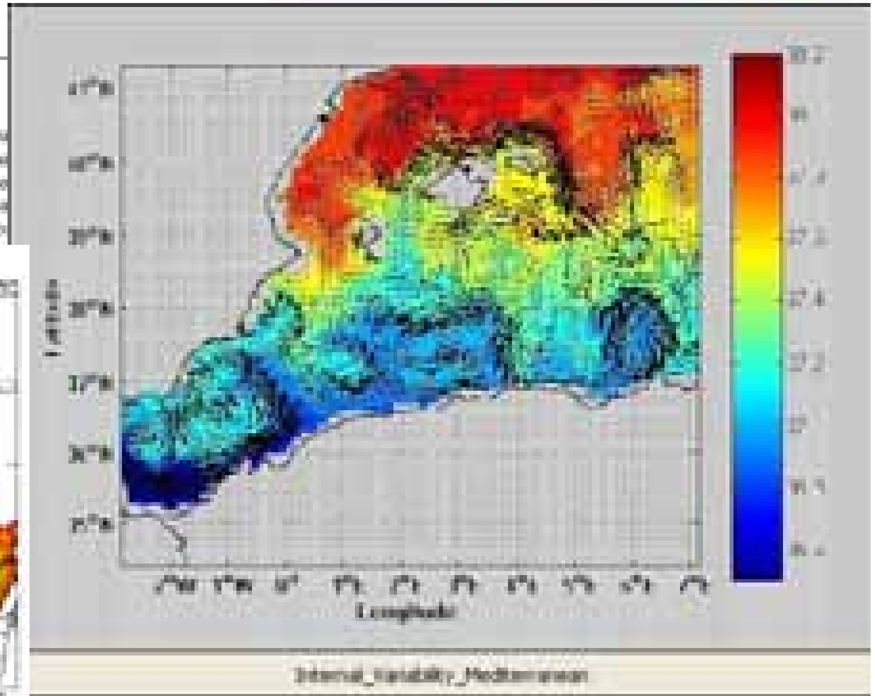
[b] Department of Meteorology, Naval Postgraduate School, Monterey, CA, USA

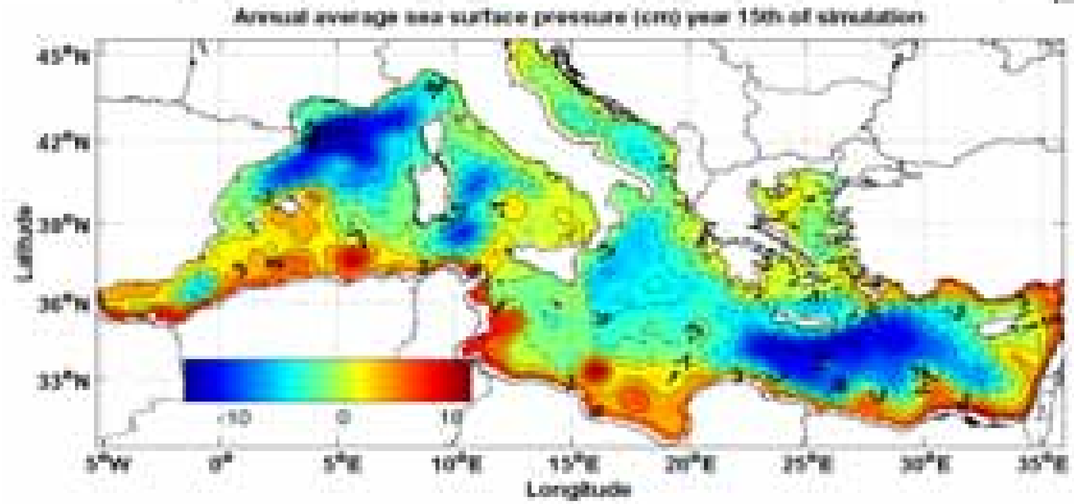
Received 4 November 2002; received in revised form 17 February 2003; accepted 2 July 2004
Available online 10 May 2005

Abstract

In this paper, we present the results from a 1/8° horizontal resolution numerical sim
using an ocean model (DieCAST) that is stable with low general dissipation and th
fourth-order numerics with reduced numerical dispersion. The ocean model is force
mean winds and relaxation towards monthly climatological surface temperature and sa
culation obtained is assessed by computing the volume transport through certain sectio







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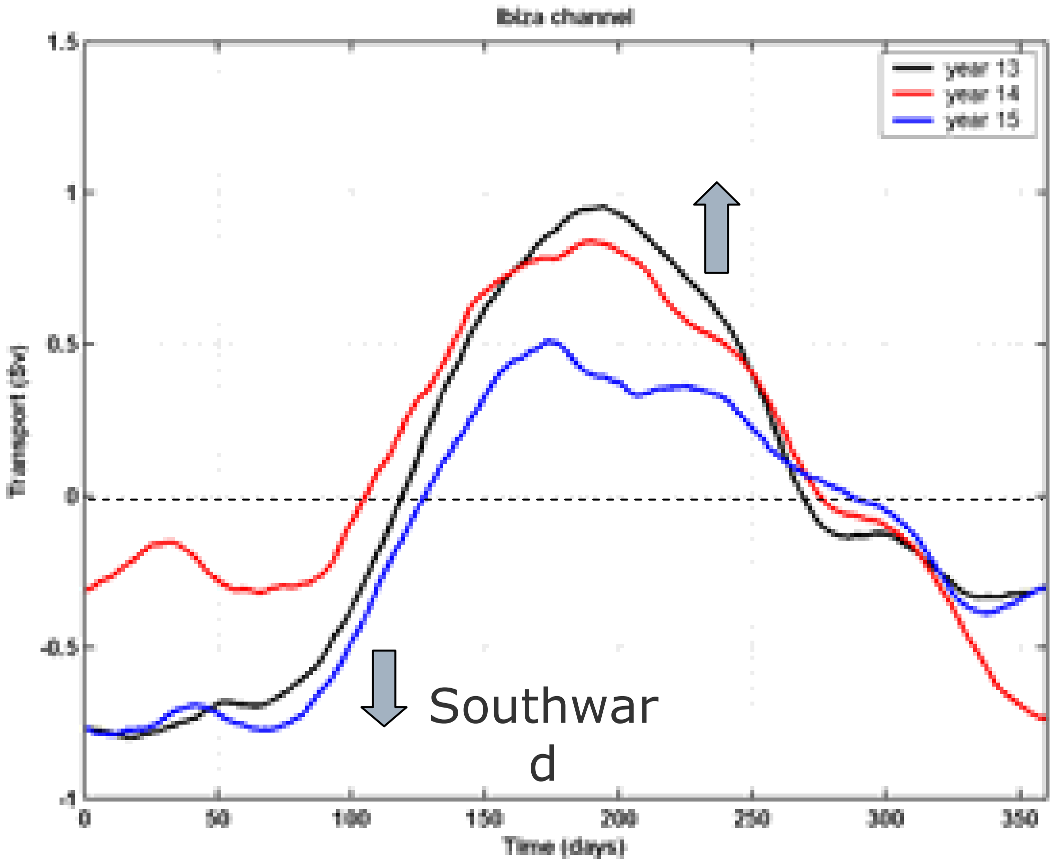
Interannual variability in the Mediterranean

Volume transports

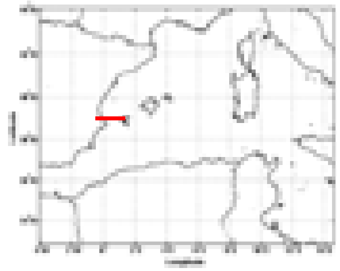


Fernandez, Dietrich, Haney, Tintoré, Prog. Oceanogr., 2003

Observations: Northward intrusion of 0.2 to 0.7 Sv in the summer

Southward transport of 1 to 1.5 in winter

(Pinot et al., 2002)



Coastal ocean forecasting, pre-operational Systems: Oil spill, Search and Rescue, etc…

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Journal of Marine Systems 71 (2008) 79–98
JOURNAL OF MARINE SYSTEMS
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A forecast experiment in the Balearic Sea

Reiner Onken [a,*], Alberto Álvarez [b], Vicente Fernández [b], Guillermo Vizoso [b], Gotzon Basterretxea [b], Joaquín Tintoré [b], Patrick Haley Jr. [c], Elvio Nacini [d]

[a] Institute for Coastal Research, GKSS Research Centre, Max-Planck-Straße 1, 21502 Geesthacht, Germany
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Available online 5 June 2007

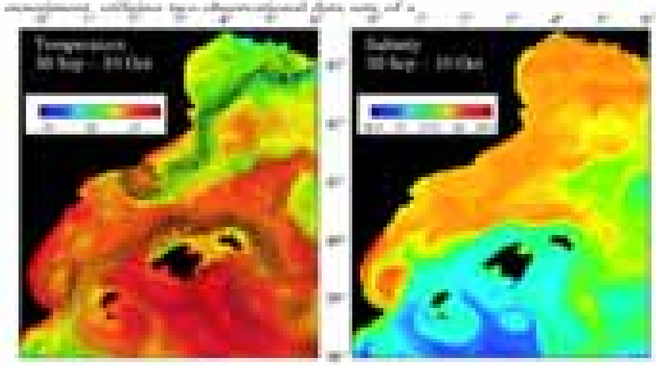
Abstract

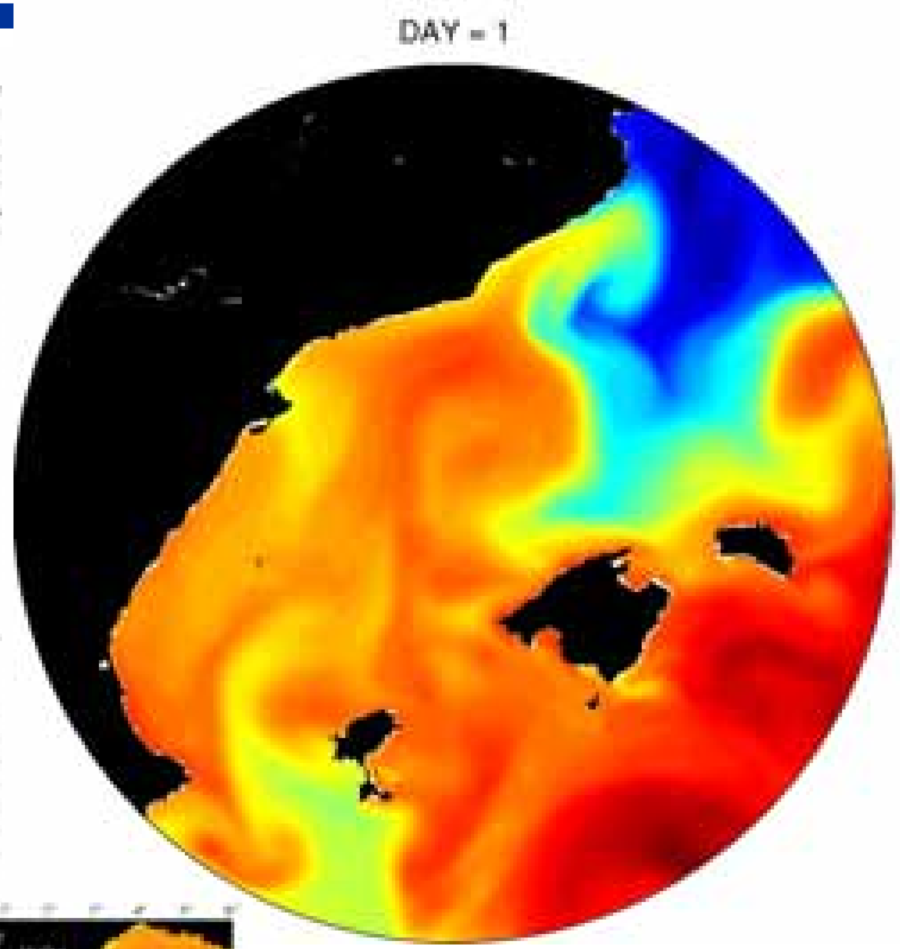
A forecast experiment in the Balearic Sea is presented which is based on the Harvard Ocean Prediction System (HOPS). HOPS is modular, containing a high-resolution primitive equations model, packages for objective analysis and data assimilation (Optimum Interpolation), an interface to implement atmospheric forcing and another interface for one-way nesting of HOPS into any other larger-scale circulation model. Here, to prevent false advection from open boundaries, HOPS is nested into the basin-scale DieCAST model [Dietrich, D.E., Haney, R.L., Fernández, V., Josey, S.A., Tintoré, J., 2004. Air–sea fluxes based on observed annual cycle surface climatology and ocean model internal dynamics: a non-damping zero-phase-lag approach applied to the Mediterranean Sea. J. Mar. Syst., 52, 145–165] and atmospheric forcing fields were provided in terms of HIRLAM fields by the Spanish National Institute of Meteorology.

The forecast capability of HOPS is demonstrated in terms of a hindcast …
subregion of the Balearic Sea which were acquired in mid September and …
used for model initialization, that of the second survey serves for validation …
is evaluated quantitatively by three different objective methods, compari…
fields, and pattern correlations, both for temperature and salinity. In five …
validation data set than the fields used for initialization, i.e. the forecast …

Taking into account further available options of HOPS (implementatio…
biological modules, two-way nesting), the system is operational for a wi…

Keywords: Mediterranean Sea; Balearic Sea; Operational model; Forecast model; …





SST from 11/2008

System

lles Balears

Shelf/slope exchanges – canyons interactions – mean flow/frontal instabilities

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Progress in Oceanography 66 (2005) 120–141

Progress in
Oceanogra

Shelf-slope exchanges by frontal variability in a steep submarine canyon

A. Jordi *, A. Orfila, G. Basterretxea, J. Tintoré

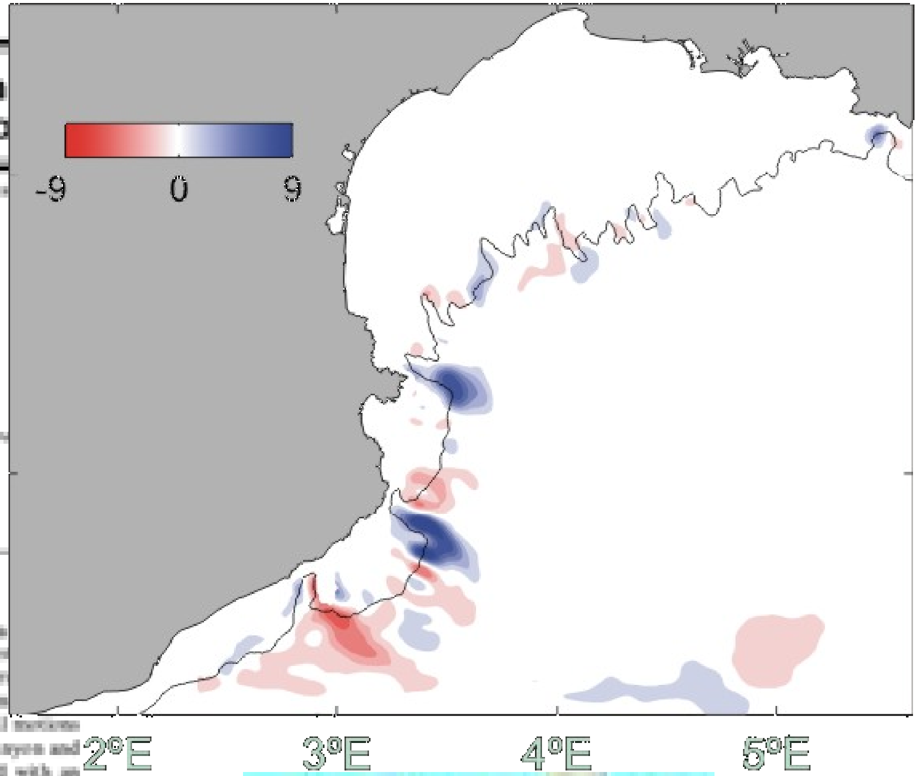
IMEDEA, Institut Mediterrani de Estudios Avanzados (CSIC-UIB), C/ Miquel Marqués, 21, 07190 Esporles, Sp

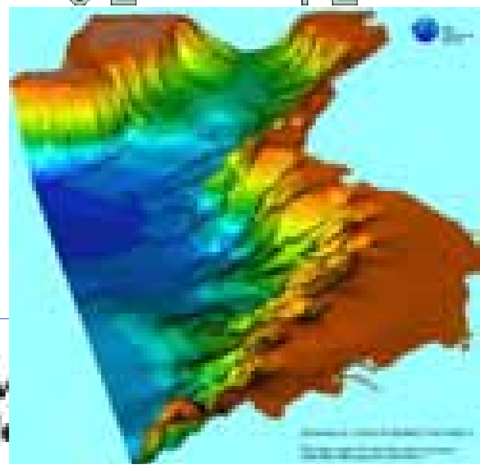
Received 9 October 2002; received in revised form 25 March 2003; accepted 29 July 20
Available online 13 May 2005

Abstract

We study the dynamics of a frontal jet and its short-timescale variability generated by the interaction with a ine canyon using a limited-area fine-resolution three-dimensional coastal ocean model. The focus is on the s narrow Palamós Canyon located off the northeast Catalan coast (northwestern Mediterranean) that is char by the presence of a permanent along-slope density-driven current. First, we analyse the stationary circulation with different jet locations and show a deflection of the flow in the vicinity of the canyon. Significant vertical motions develop as a result of these current adjustments; the general pattern such as downwelling upstream of the canyon and upwelling downstream are always observed. Second, we analyse the circulation and exchanges associated with an onshore displacement of the jet; thus produces a meander propagating with the flow that interacts with the canyon. We find that the resulting three-dimensional patterns present an oscillation characterized by an intense downwelling followed by upwelling. As a result of this interaction, shelf-slope exchanges and vertical motions are enhanced in the area compared with the passing of a meander above a shelf that is not indented by a submarine canyon. The resulting horizontal transports through the Palamós canyon represent up to 10% of the along-shore fluxes on the shelf and appear to be sufficient to exchange the shelf water of the Gulf of Lions and Catalan sea in 2.5 years. Considering the number of canyons existing in the area, we can estimate an exchange of all the shelf waters in less than 3 months.

Keywords: Submarine canyon; Shelf-slope exchange; Numerical coastal ocean model; Frontal variability; Northwestern Mediterranean

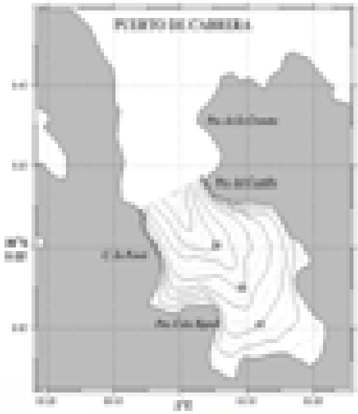


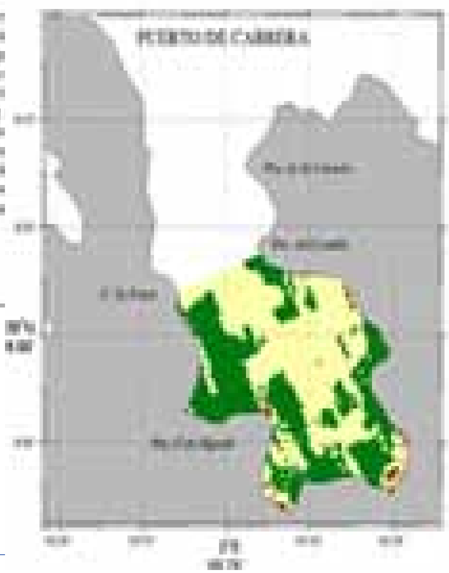


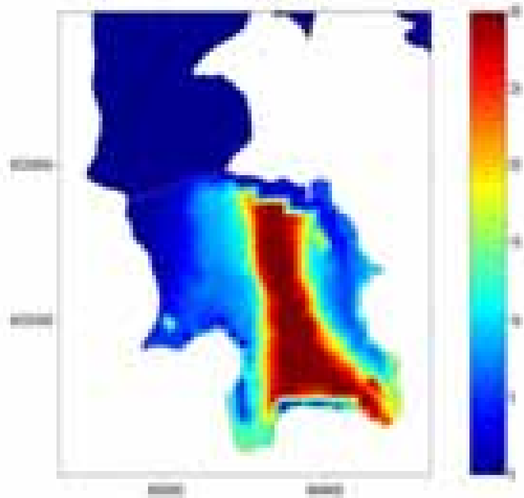
Residence time, coastal–open ocean exchanges, eutrofication

Residence time and *Posidonia oceanica* in Cabrera Archipelago National Park, Spain

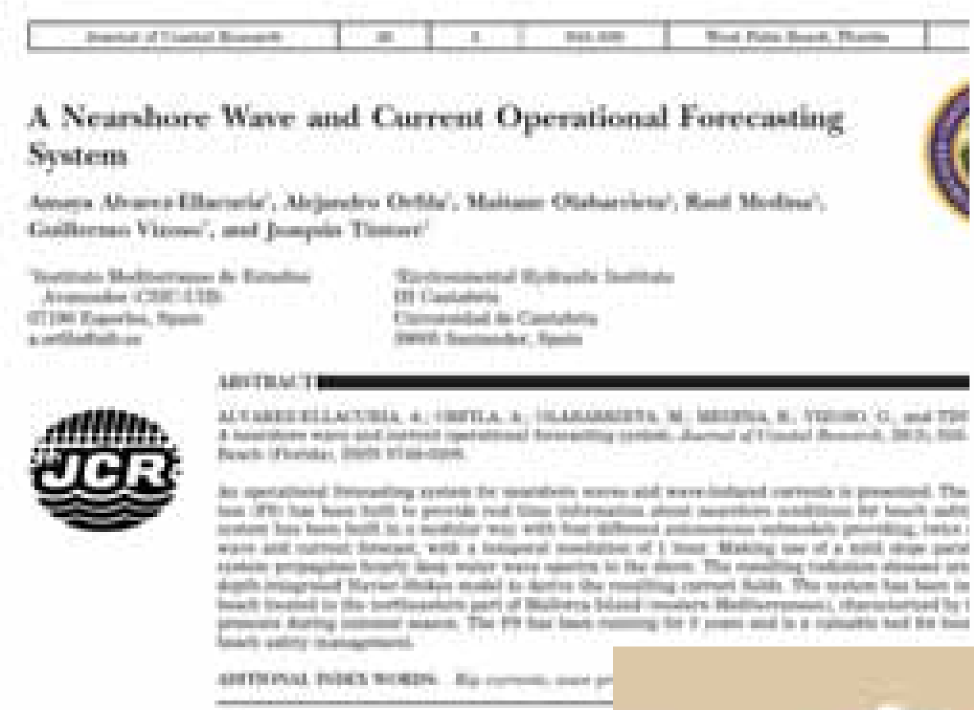
A. Orfila, A. Jordi, G. Basterretxea, G. Vizoso, N. Marbà, C.M. Duarte, F.E. Werner, J. Tintoré



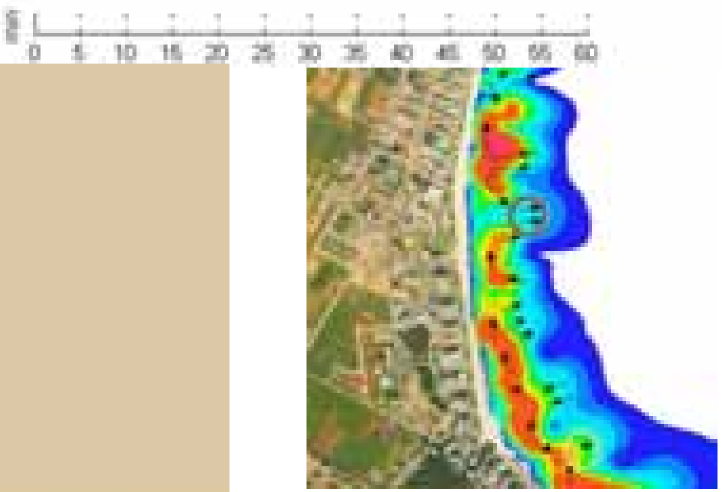




Pre-operational systems being implemented; coastal ocean and beaches


A Nearshore Wave and Current Operational Forecasting System

ABSTRACT



Oil-spill mapping

Land vulnerability

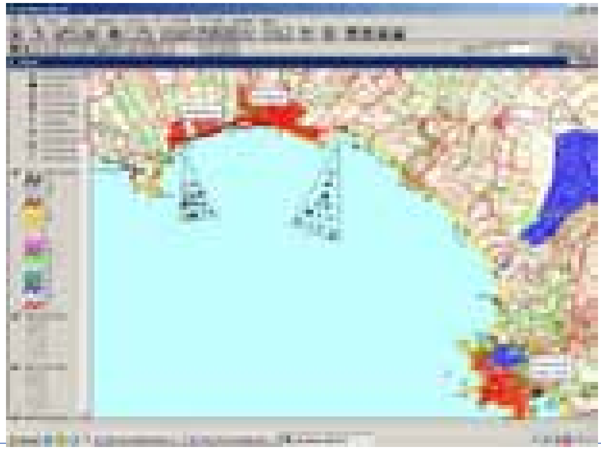
Security in beaches – rip currents

Prediction of trajectories from Tsunamis.

Tools for decision support under oil spill: ESI for all Balearic coast (1.200 km coastline)

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

ESI (Environmental Sensitivity Index)



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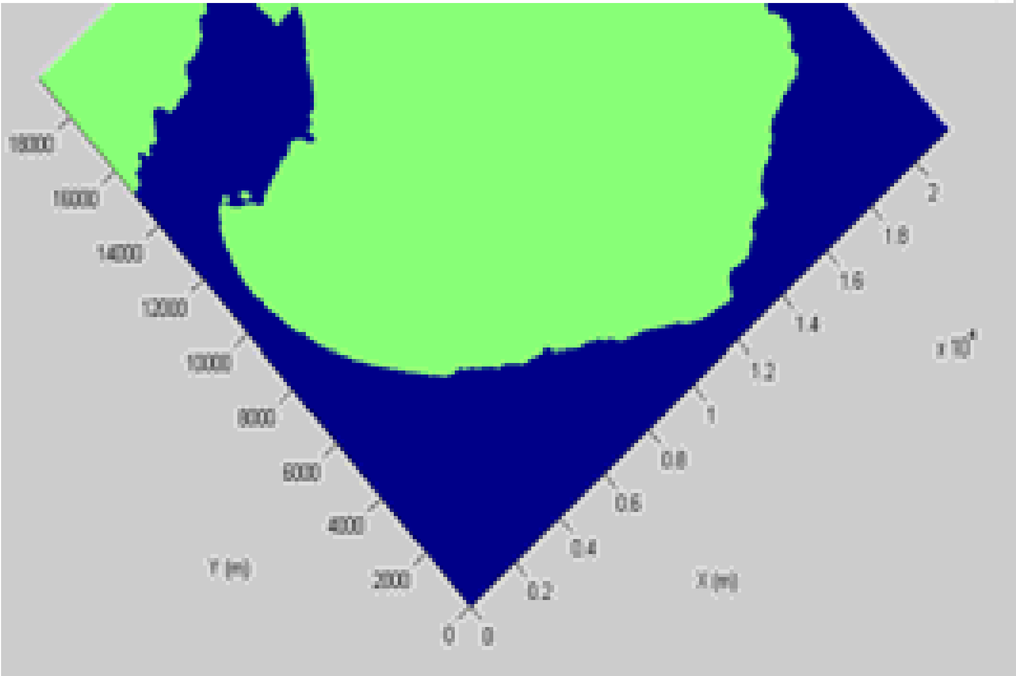
Results at local scale, beach and coastal infrastructures, harbours…


Ocean & Coastal Management

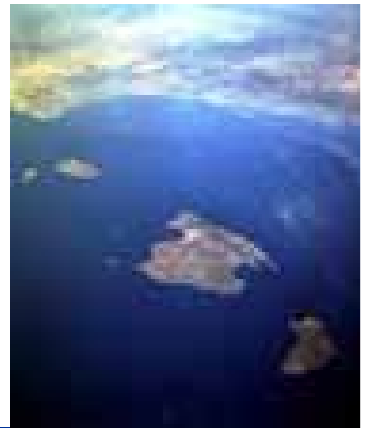
Integrated and interdisciplinary scientific approach to coastal management

Joaquín Tintoré, Raúl Medina, Lluís Gómez-Pujol, Alejandro Orfila, Guillermo Vizoso

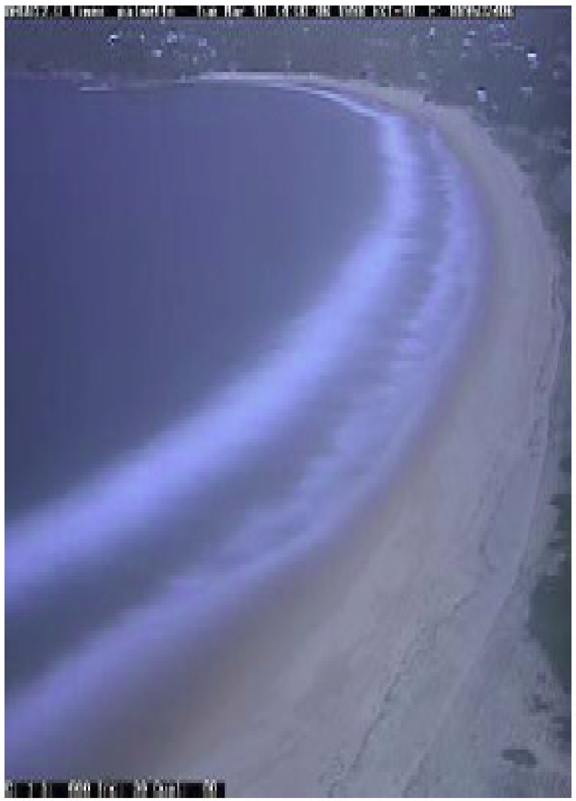


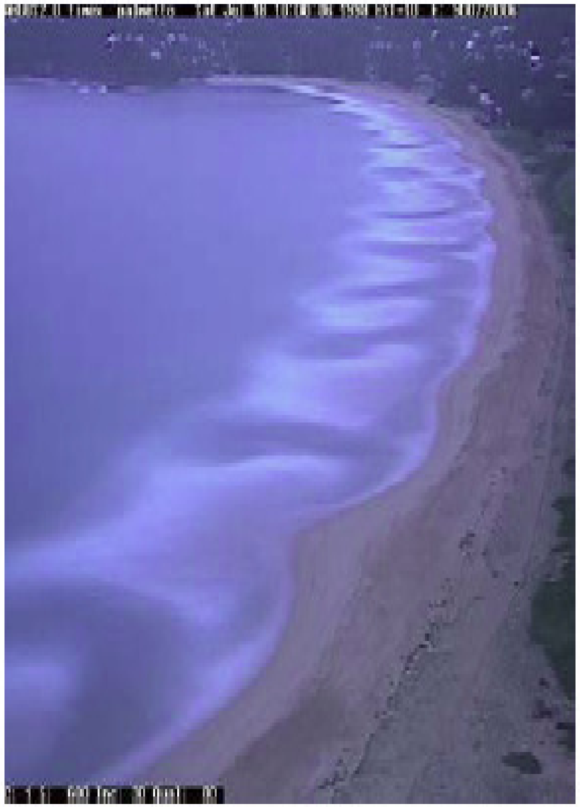
We know that with today's knowledge, actions undertaken in the past would be done differently

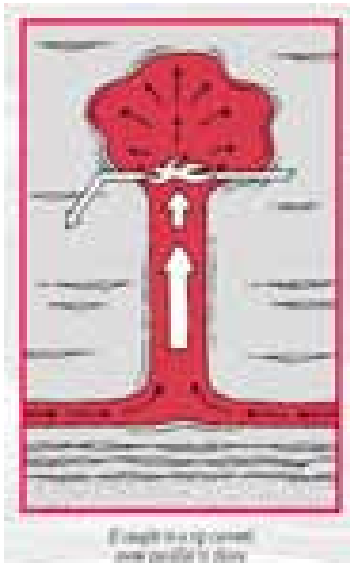
(extreme storms Nov. 2001)



Technology development







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

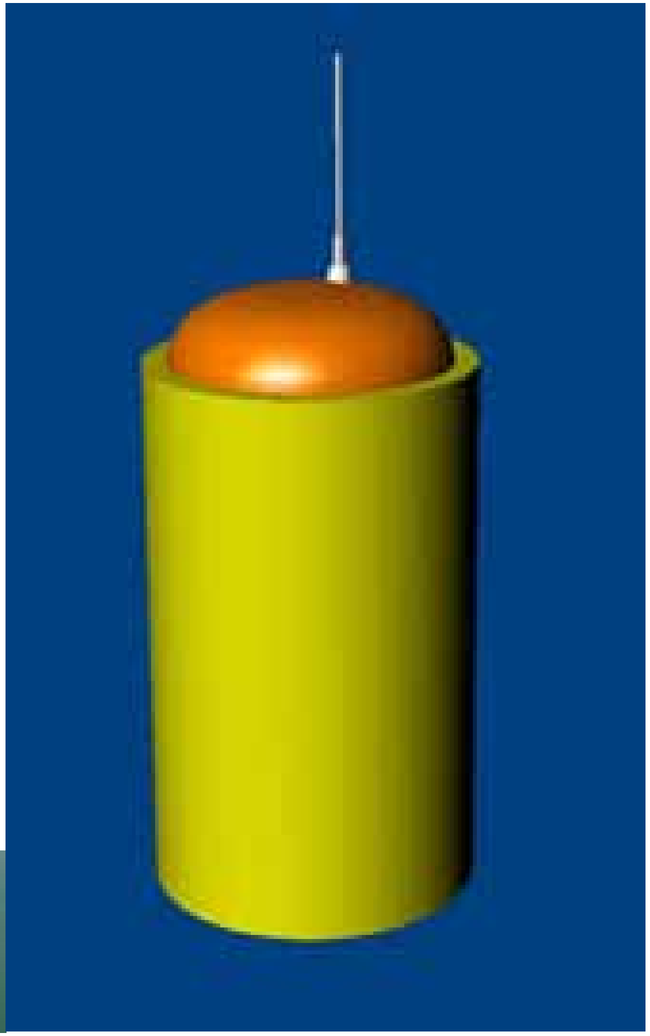
Technology Development, IMEDEA transfer to new spin off company AMT, UIB-CSIC / 2005)

AUV's

GSM and New Iridium drifters

Albatros Marine Technologies – Spin off -

ROV's



Technology Development, IMEDEA transfer to new spin off company AMT, UIB-CSIC / today 2011)

http://www.albatrosmt.com

SOCIB Balearic Islands Coastal Observing and Forecasting System

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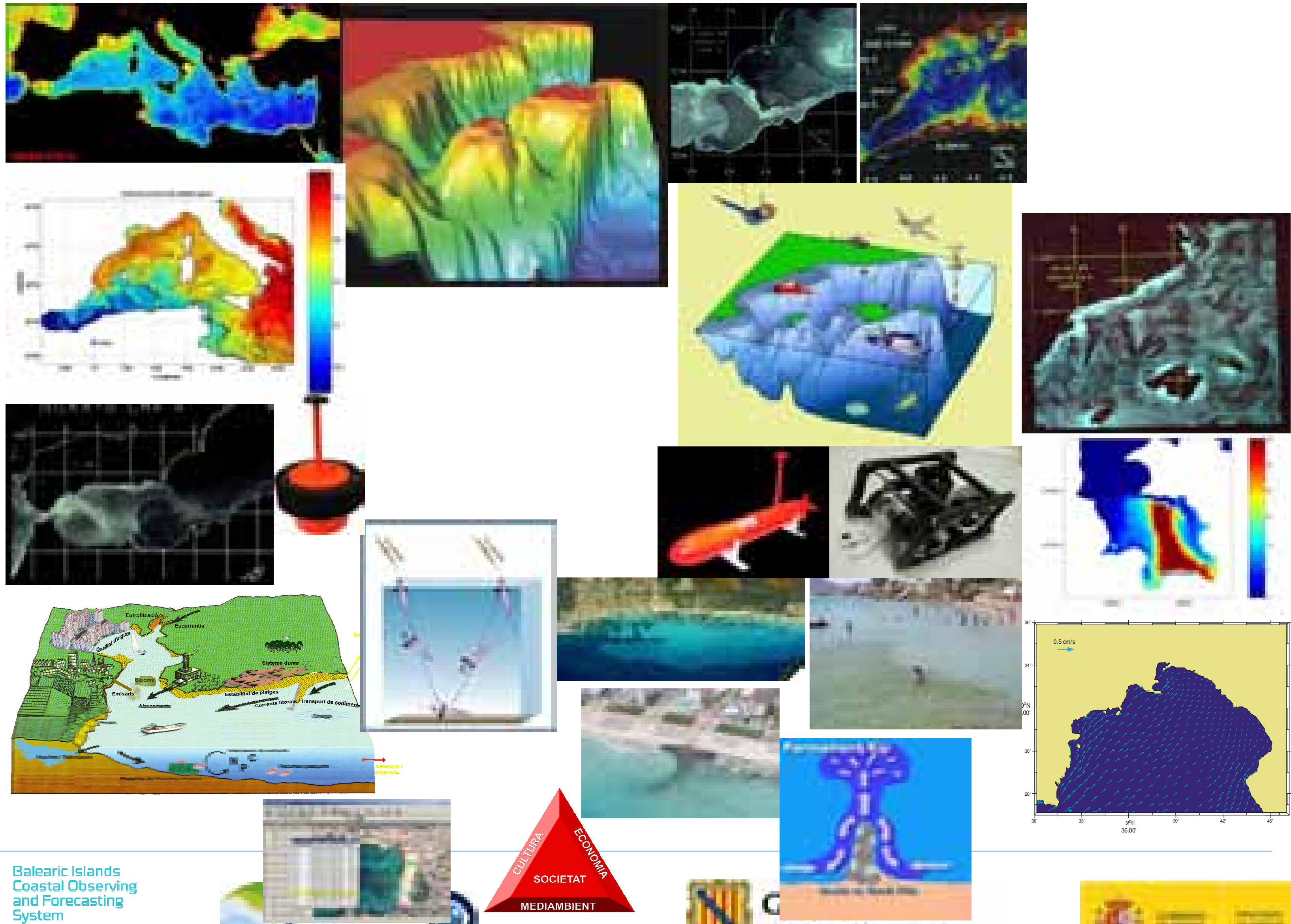
In summary, background…



In summary… addressed **regional issues of global interest**

Examples from **SCIENCE, TECHNOLOGY DEVELOPMENT AND APPLICATIONS FOR SOCIETY:**

Example… SCIENCE:

Strait's outflow (Alborán Sea), MAW-MW convergences, interactions, fronts (AO front).

Mesoscale and sub-mesoscale variability / characteristics, eddies and filaments (Balearic & Alborán sub-basins).

3d dynamics of mesoscale structures, w estimations using QG Omega and SQG, assimilation PE models, models experiments, induced vertical biogeochemical exchanges. Ecosystem response.

Mesoscale effects on sub-basin scale circulation (Balearic Sea/Algerian sub-basin) and on local circulation (canyons).

Mesoscale/sub-basin interactions with basin scale circulation: blocking effects, recirculation and with shelf / slope exchanges…

Transient forcing episodes and its effects on sub-basin and basin scale circulation (Water Masses and also MLD) and beaches (!)

New Technologies, for addressing the "scales and scales interaction problem" as well as the "synopticity problem"…: gliders

nature
www.nature.com/nature
Vol 450 | Issue no. 7171 | 6 December 2007

Patching together a world view

Data sets encapsulating the behaviour of the Earth system are one of the greatest technological achievements of our age — and one of the most deserving of future investment.

Now or never

Monitoring the Earth system requires great expertise, not just to build the instruments but to use them properly and interpret their output. Many scientists are, however, far from enthused by projects that do not involve the forming and testing of hypotheses. At worst, monitoring is traduced as stamp collecting and looked down on as drudgery.

Such attitudes must not be allowed to prevail. Testing hypotheses about how the world works requires not just information on the current state of the three-dimensional globe, but on its progress through the fourth dimension of time. Data on the colour of the seas that are not gathered today can never be gathered in the future — gaps left in the record cannot be filled (see page 782). And continuous data sets are going to be vital to the validation of the ever more informative models of the Earth system that we need.

This is why operational systems for data collection in which scientists play key roles are so important. Only they can give us multiscale and multifactor ways of seeing the world that are up to the challenges of the twenty-first century. When the expenditure needed to maintain these data flows conflicts with the funds needed to support fresh scientific research, researchers must acknowledge that there is a strong case for preferring continuous, operational monitoring. An accurate and reliable record of what is going on can trump any particular strategy for trying to understand it.

There is only one Earth, with only one history, and we get only one chance to record it. Ideas not followed through can be taken up again later. A record not made is gone for good. Long zooms in and out of our ever more detailed images of Earth will delight and inform us for years to come. But no digital trickery can replace the steady, fateful pan from past to future.

Responding Science… and Society issues

Project based – 3 years - Can be done!!

But is inneficient

Next Step

SOCIB

Eos, Vol. 92, No. 25, 21 June 2011

NEWS

Determining Critical Infrastructure for Ocean Research and Societal Needs in 2030

OUTLINE

1. The 2012 Oceans' Challenges for Science, Technology and Society

2. Ocean Information for Society,… what we learned in the Mediterranean

3. SOCIB, a new multi-platform approach

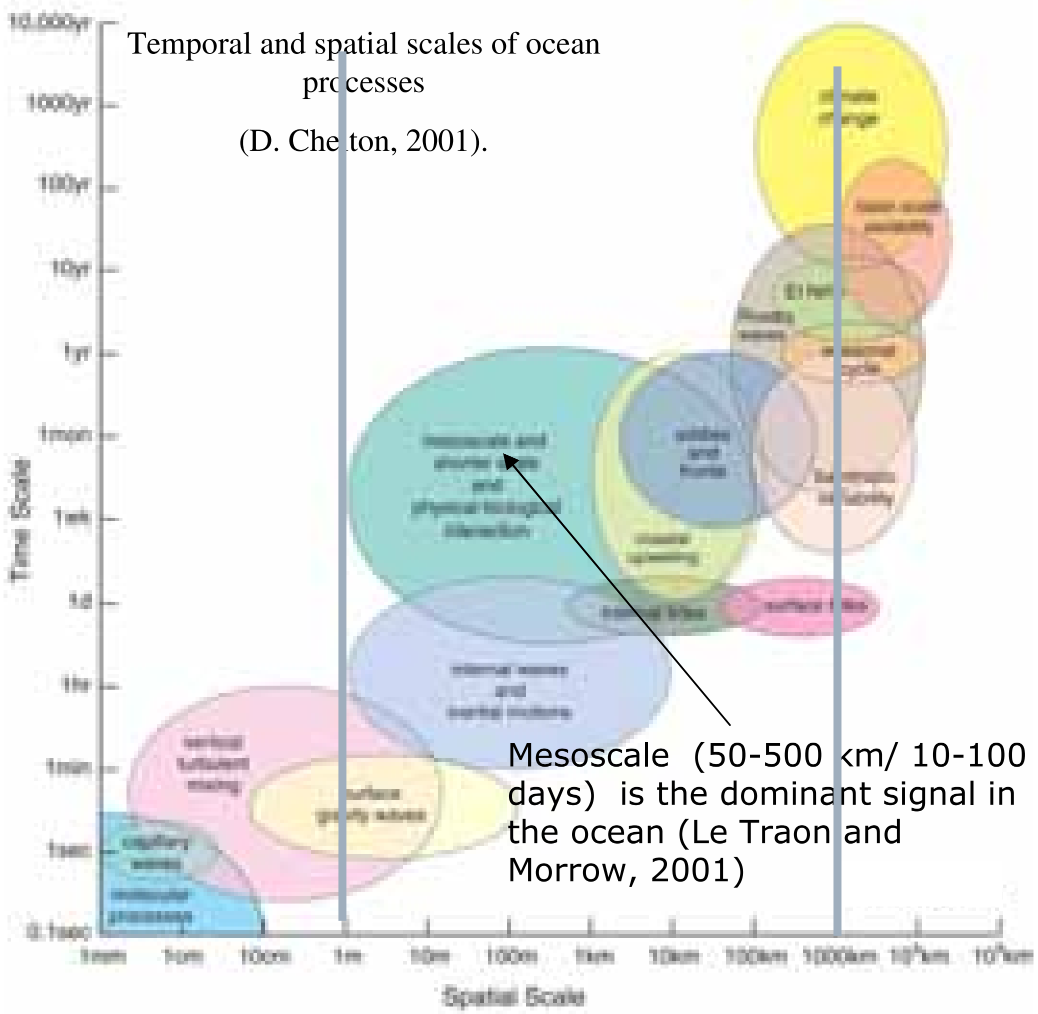
1. SOCIB and the new role of Marine Research Infrastructures to respond to Science, Technology and Society needs

SOCIB Scales Focus: 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),

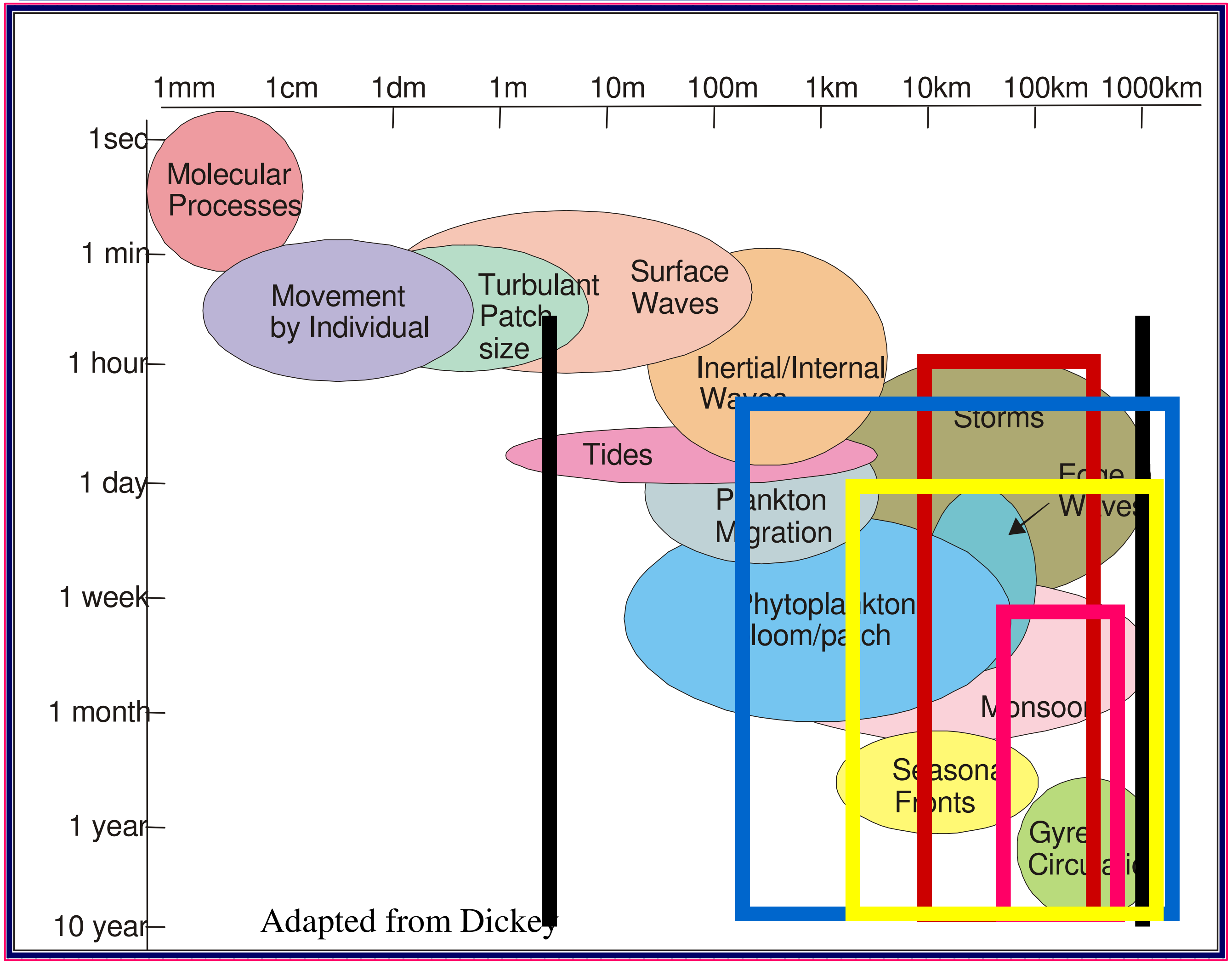
<u>SOCIB focus:</u> mesoscale & submesoscale and their interactions with general circulation and their effects on vertical motions, impact on ecosystem variability.

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



SOCIB scales

SOCIB scales and monitoring tools



Gliders

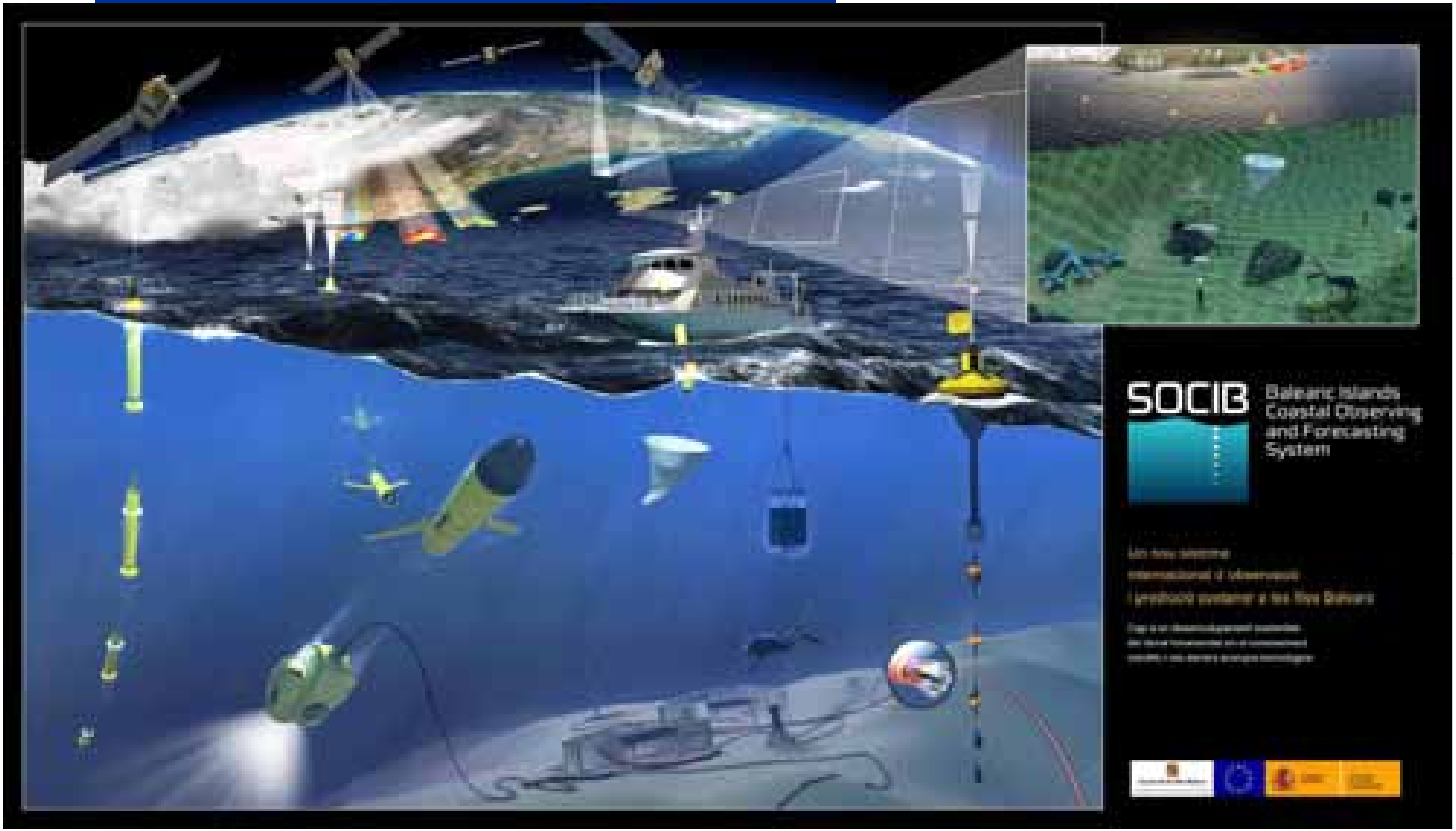
Fixed Platforms

HF radar

24 m R/V Catamaran

Satellite

SOCIB: the view….



SOCIB Balearic Islands Coastal Observing and Forecasting System

CSIC

Govern de les Illes Balears

The real challenge at SOCIB for the next decade…:

To <u>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 …

Implementation

	2009		2010				2011				2012		2013	
	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1/Q2	Q3/Q4	Q1/Q2	Q3/Q4
Systems, Operations and Support Division														
Observing Facilities:														
Coastal Research Vessel	CD	CD	PDP	LP	LP	C	C	C	C	C	IOC	OM	FOC	FOC
Coastal HF Radar	CD	CD	PDP	LP	LP	C	C	IOC	FOC	FOC	FOC	FOC	FOC	FOC
Gliders	CD	CD	PDP	LP	IOC	IOC	OM	OM	OM	OM	FOC	FOC	FOC	FOC
Drifters	CD	CD	PDP	PDP	PDP	PDP	LP	IOC	IOC	OM	FOC	FOC	FOC	FOC
Moorings	CD	CD	PDP	LP	C	IOC	OM	OM	FOC	FOC	FOC	FOC	FOC	FOC
Marine and Terrestrial Beach Monitoring	CD	CD	PDP	LP	C	C	C	C	C	C	IOC	FOC	FOC	FOC
Data Centre Facility	CD	CD	CD	PDP	PDP	IOC	IOC	OM	FOC	FOC	FOC	FOC	FOC	FOC
Modelling and Forecasting Facility	CD	CD	PDP	PDP	LP	C	C	IOC	IOC	OM	FOC	FOC	FOC	FOC
Engineering and Technology Development Division														
Facility Support and Technology Development	CD	CD	PDP	LP	IOC	IOC	OM	OM	FOC	FOC	FOC	FOC	FOC	FOC
Near Shore Station	CD	CD	CD	CD	PDP	LP	PDP	C	C	IOC	OM	FOC	FOC	FOC
Ships of Opportunity/Fishing Fleet Monitoring	CD	CD	LP	PDP	IOC	IOC	OM	OM	FOC	FOC	FOC	FOC	FOC	FOC
Strategic Issues and Application to Society Division	CD	PDP	IOC	IOC	OM	FOC	FOC	FOC	FOC	FOC	FOC	FOC	FOC	FOC
Services														
Management & Finance	PDP	IOC	OM	OM	FOC	FOC	FOC	FOC	FOC	FOC	FOC	FOC	FOC	FOC
Computing & IT	CD	C	OM	PDP	LP	C	IOC	OM	FOC	FOC	FOC	FOC	FOC	FOC
Outreach, Education, Training & Mobility	CD	CD	PDP	PDP	PDP	PDP	IOC	IOC	OM	FOC	FOC	FOC	FOC	FOC

Project Stages:

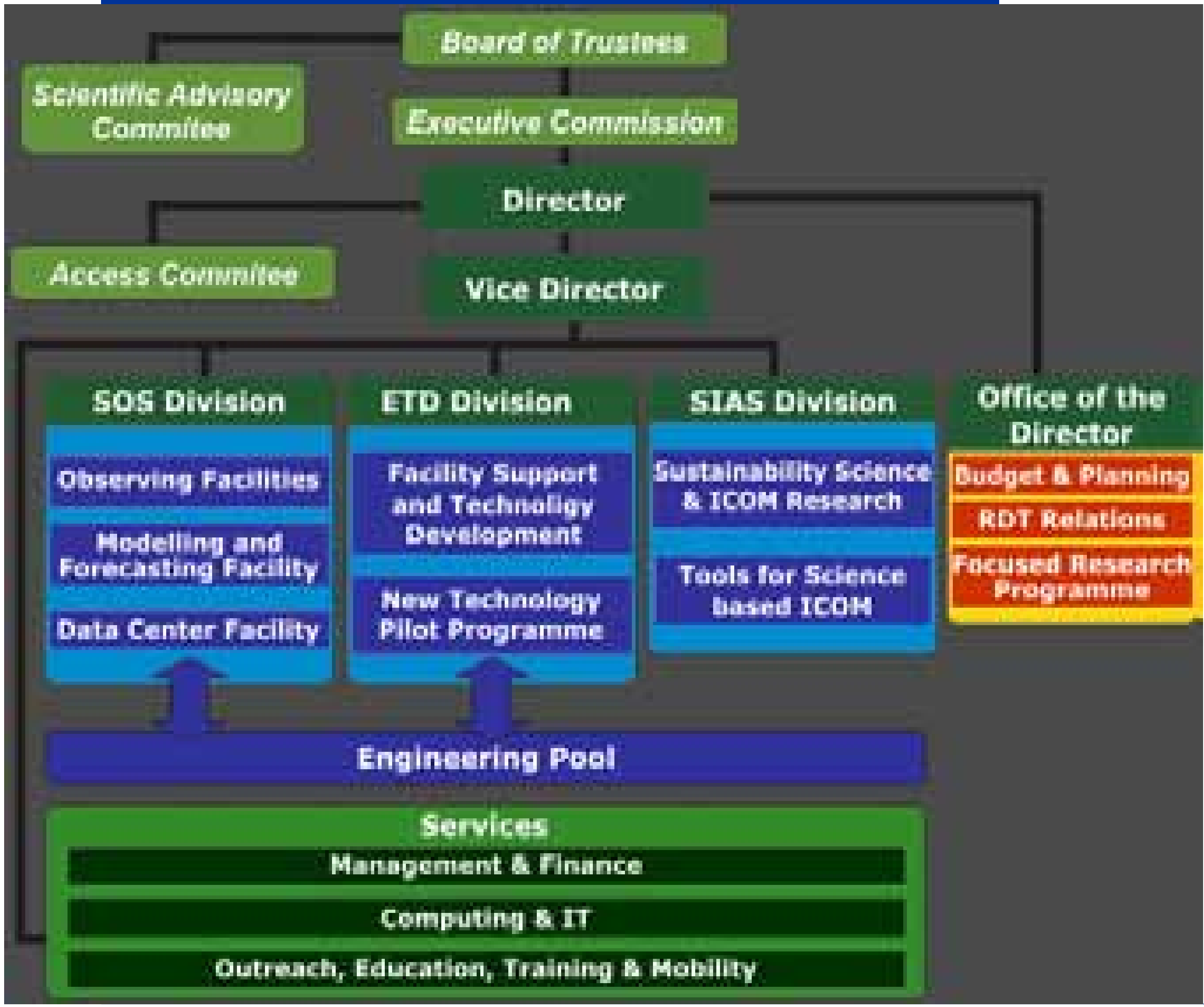
CD	Concept Development
PDP	Planning, Design and Pilots
LP	Legal Procedure/Purchase
C	Construction
IOC	Achieve Initial Operational Capability
OM	Operation and Maintenance
FOC	Final Operational Capability

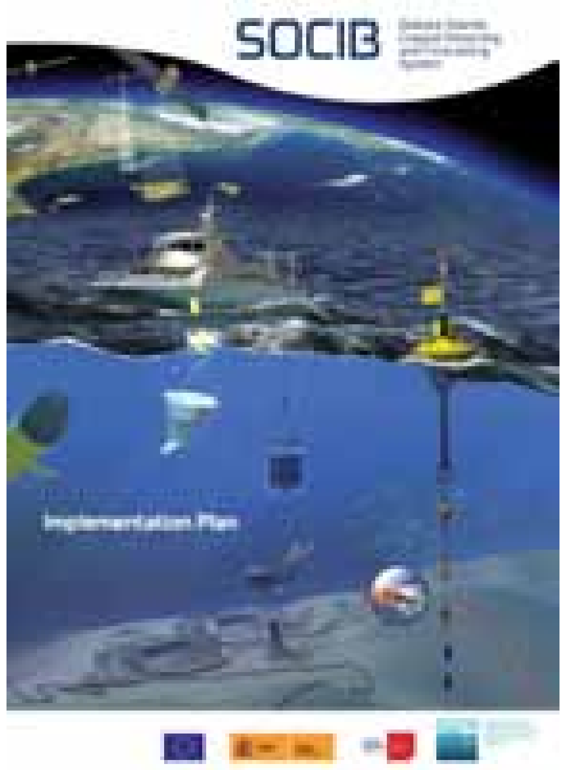
Table 2: Implementation Schedule Summary for the major SOCIB elements, detailed schedules are available in Annex 3. All available at www.socib.es

SOCIB Balearic Islands Coastal Observing and Forecasting System

Govern de les Illes Balears

SOCIB Structure and Implementation Plan





SOCIB Balearic Islands Coastal Observing and Forecasting System

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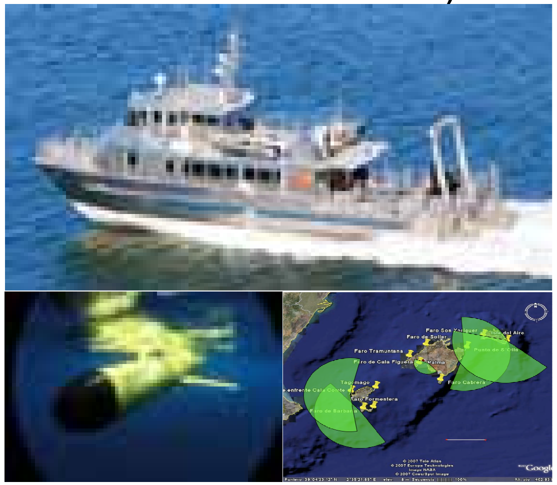
Systems Operations and Support Division

1. Observational Facilities (major elements)

- New Coastal Research Vessel (24 m LOA – 1.200 km coastline in the Islands)
- HR Radar
- Gliders
- Fixed Platforms and Satellite products
- ARGO and surface drifters
- Nearshore beach monitoring



2. Forecasting sub-system

- Ocean currents (ROMS) and waves (SWAN) at different spatial scales, forced by Atmospheric model (WRF) and ecosystem coupling (NPZ)

3. Data Centre

- Quality control and Web access in open source
- Effective data archiving, internationally accepted protocols, delivery and communication

SOCIB Facilities and Services – 2012 www.socib.es

Already from SOCIB and/or in kind from CSIC, IEO and UIB and agreement with PE:

SYSTEMS OPERATIONS AND SUPPORT DIVISION

OBSERVING:

- Glider Facility (7 Slocum + 2 iRobot gliders)
- Satellite remote sensing products
- ARGO profiles and Surface drifters Facility (pilot)
- Coastal Buoys real time Facility (pilot)
- Nearshore beach monitoring Facility (pilot)

MODELLING

- Numerical Forecasting Facility

DATA CENTER

- Data Center

•Proven capability

•Pilot projects

•Non sustained

Bluefin Tuna target project

APPLICATIONS AND STRATEGIC ISSUES SOCIETY DIVISION

- ICZM and Science based sustainable coastal and ocean management

ENGINEERING AND TECHNOLOGY DEVELOPMENT DIVISION

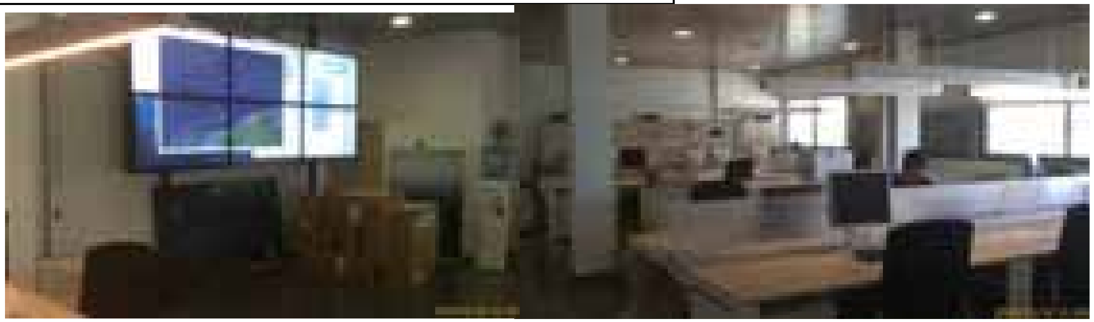
- New technologies

Parc Bit – office – Since August 2009

SERVICES

- Management and Finances
- Computing and IT's
- Outreach and Education

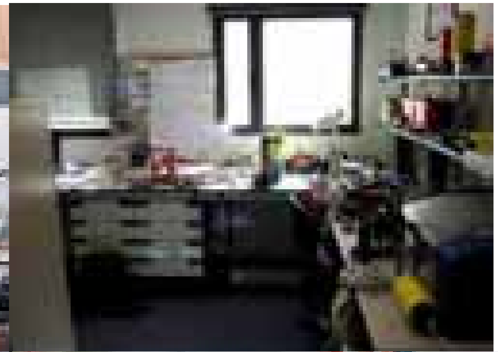
IMPLEMENTATION PLAN; approved July 2010



SOCIB Glider Facility

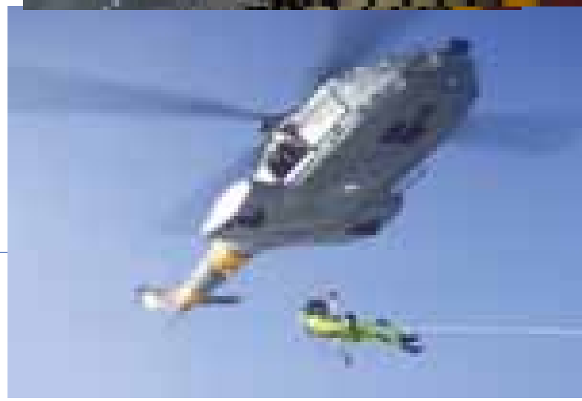
We have established new facilities for glider operations at IMEDEA

Electronics & Gliders Laboratory



Ballasting Lab & Pressure Chamber

Collaboration:
Search and Rescue
801 Squadron
and local authorities



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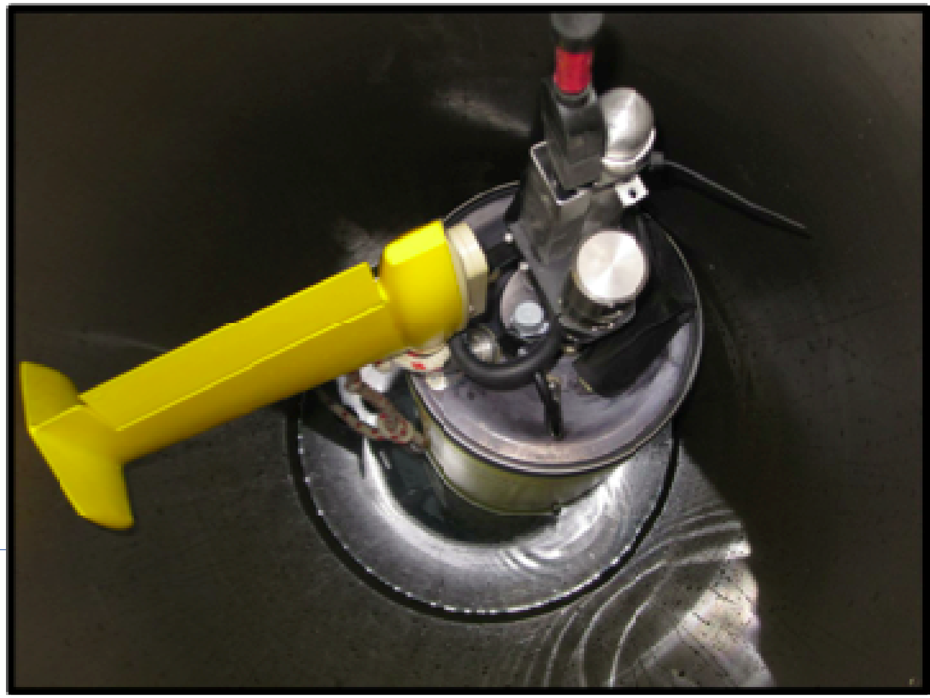
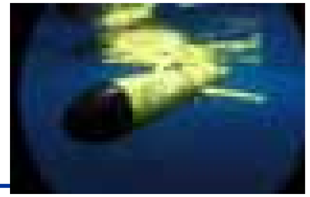


Gliders Facility: Science

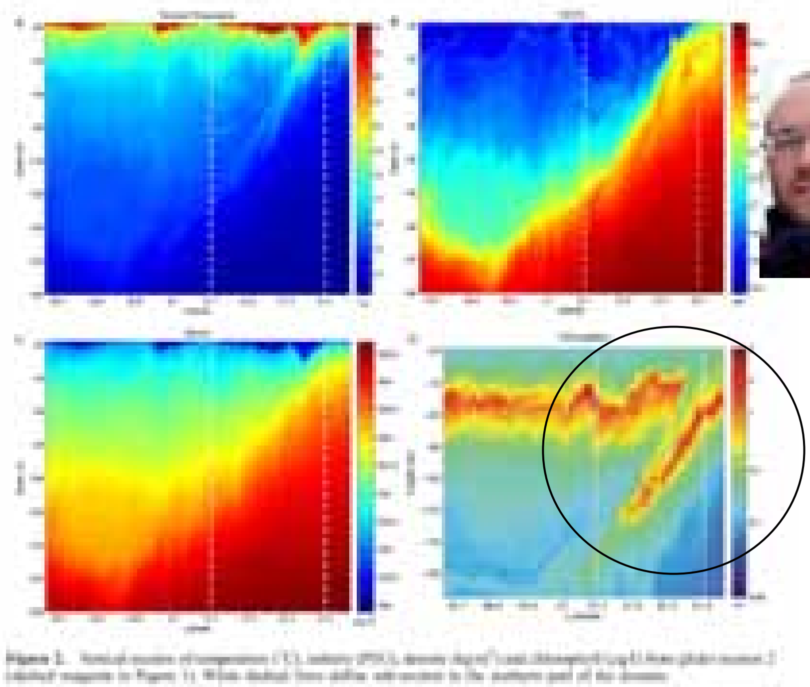


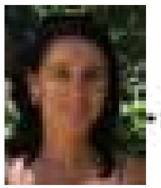
Mesoscale – Submesoscale / Vertical motions - biogeo effects

Eddy/mean flow interactions – Blocking effects General Circulation

Vertical motion in the upper ocean from glider and altimetry data

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

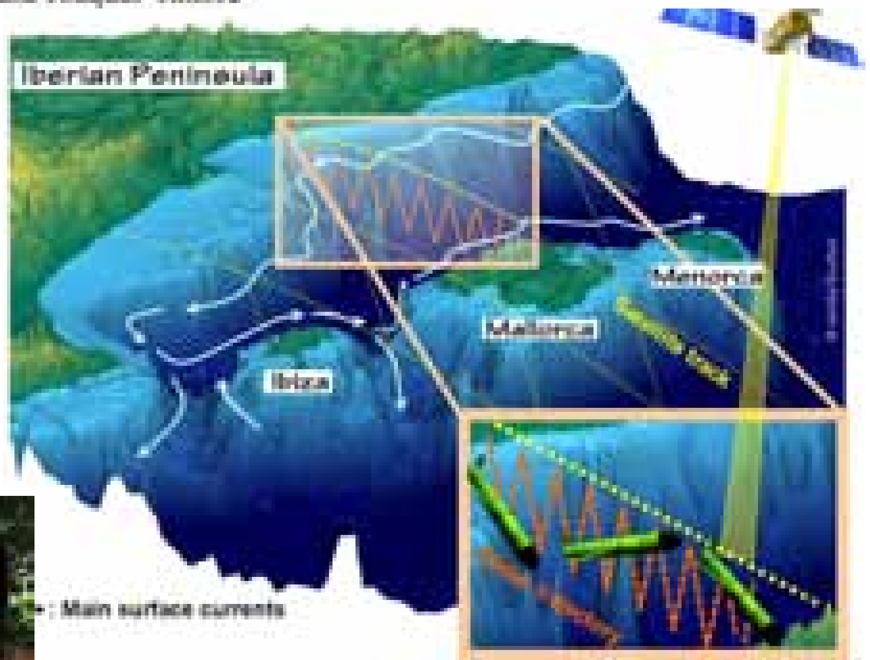




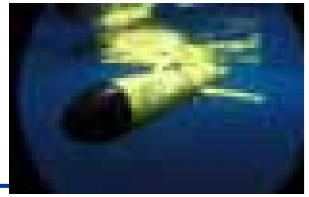
JGR, 2010

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



Heat content and MLD

GEOPHYSICAL RESEARCH LETTERS, VOL. 39, L01603, doi:10.1029/2011GL050078, 2012

Underwater glider observations and modeling of an abrupt mixing event in the upper ocean

Simón Ruiz,[1] Lionel Renault,[2] Bartolomé Garau,[2] and Joaquín Tintoré[1,2]

Received 20 October 2011; revised 1 December 2011; accepted 2 December 2011; published 13 January 2012.

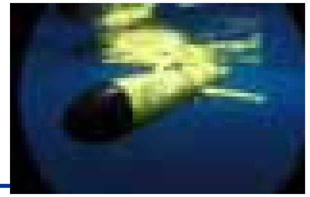
Main results:

-Intense winds (up to 20 ms-1) and buoyancy forcing during December 2009 induced strong vertical mixing of the upper ocean layer in the Balearic Sea.

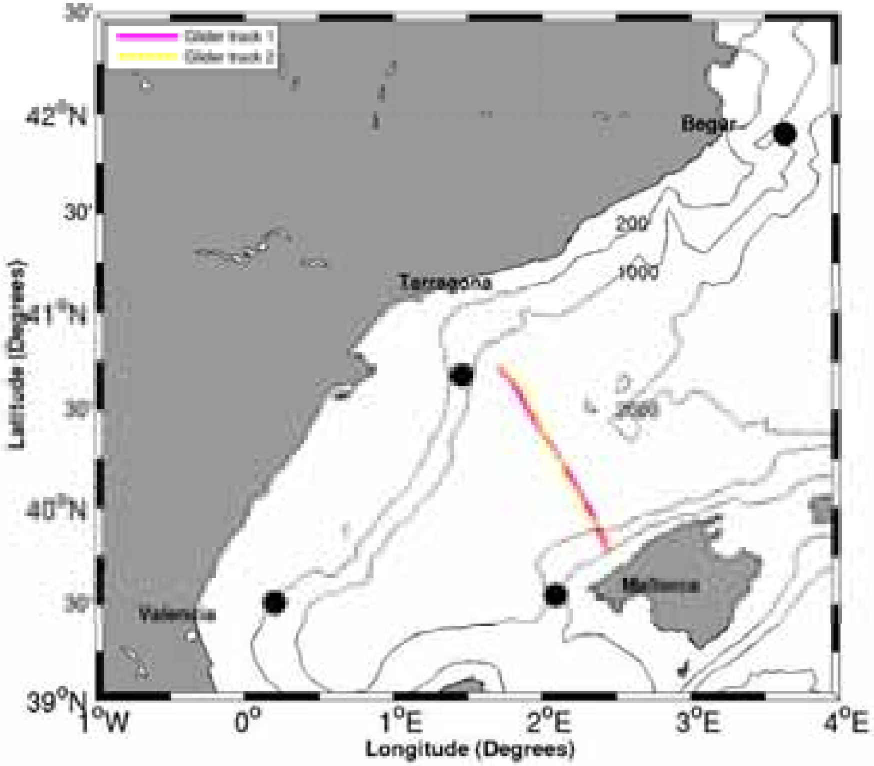
- High resolution glider data from a coastal glider reveal a surface cooling of near 2ºC and the deepening of the Mixed Layer Depth by more than 40 meters in the center of the basin.

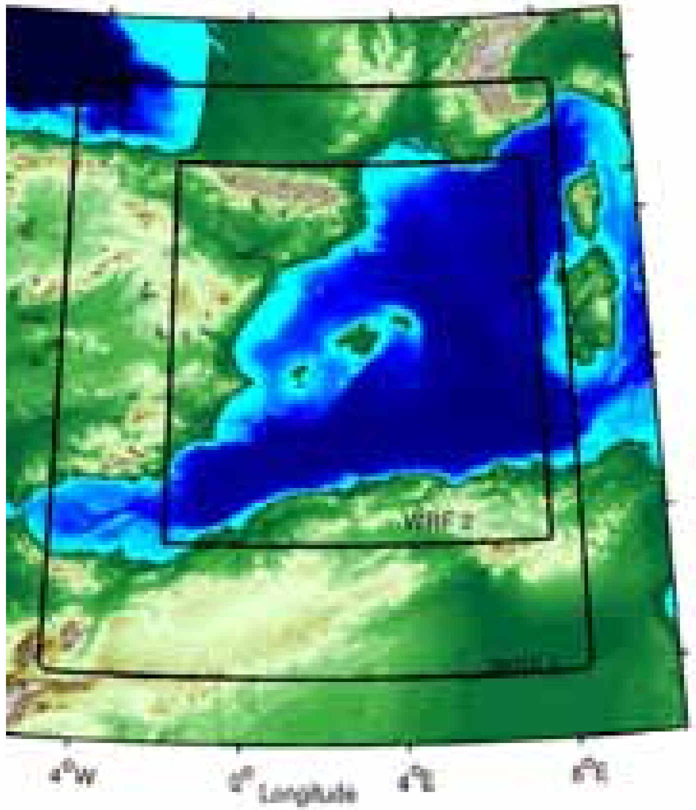
- The heat content released to the atmosphere by the upper ocean during this mixing event exceeds 1000Wm-2. Consistent WRF estimates.

Gliders Facility: Science, MLD



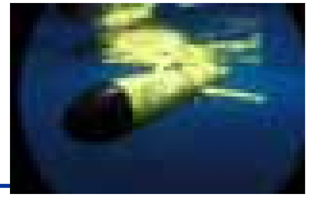
Study area and sampling



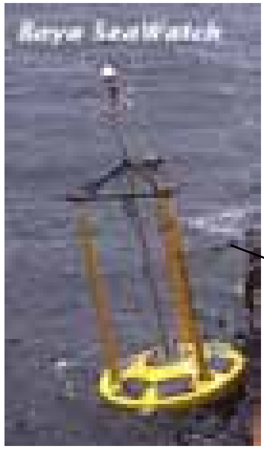


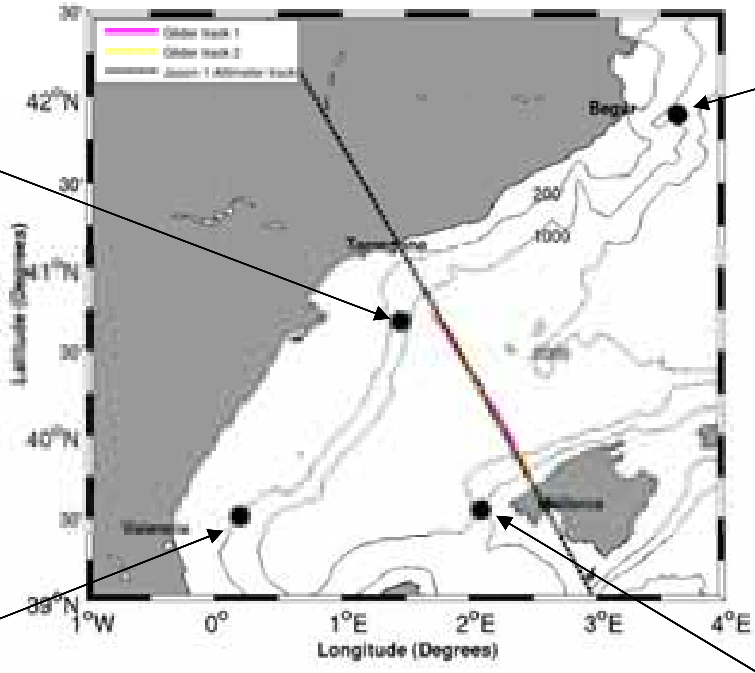
(left) Map of the study area in the Northwestern Mediterranean Sea. Glider tracks (magenta and yellow lines) are indicated. Black dots correspond to locations of the 4 oceanographic/ meteorological deep-buoys. (right) Model domains for the WRF model implementation.

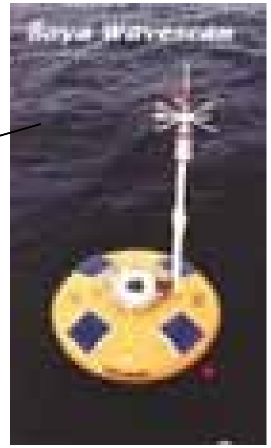
Gliders Facility: Science, MLD

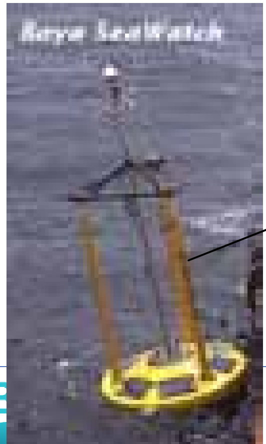


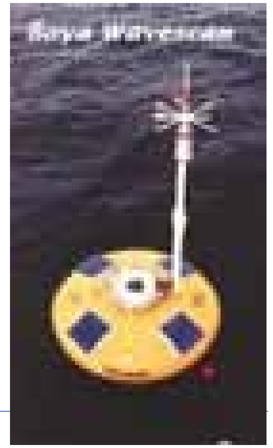
Data set: Puertos del Estado Deep buoys network in the WMED





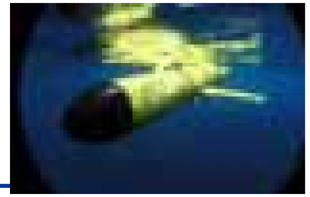




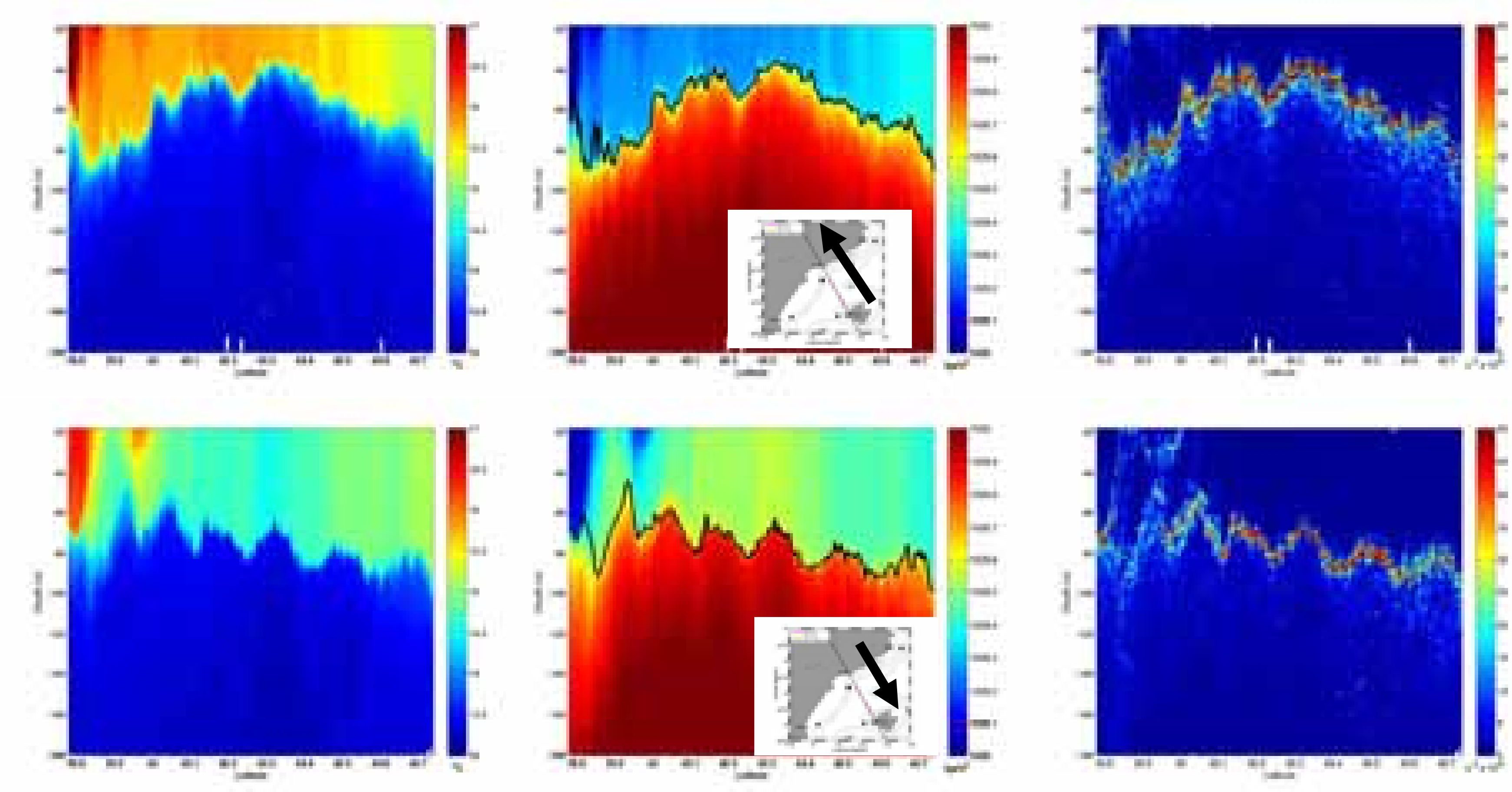


- Meteorologic, oceanographic and waves
- Hourly data
- Northwestern Mediterranean Sub-basin

Gliders Facility: Science, MLD



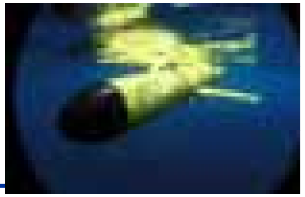
Temperature Density N



Vertical sections of high-resolution temperature , density and Brunt-Väisälä frequency obtained from glider (top) 'go' and (bottom) 'return.' The black line on the density field correspo

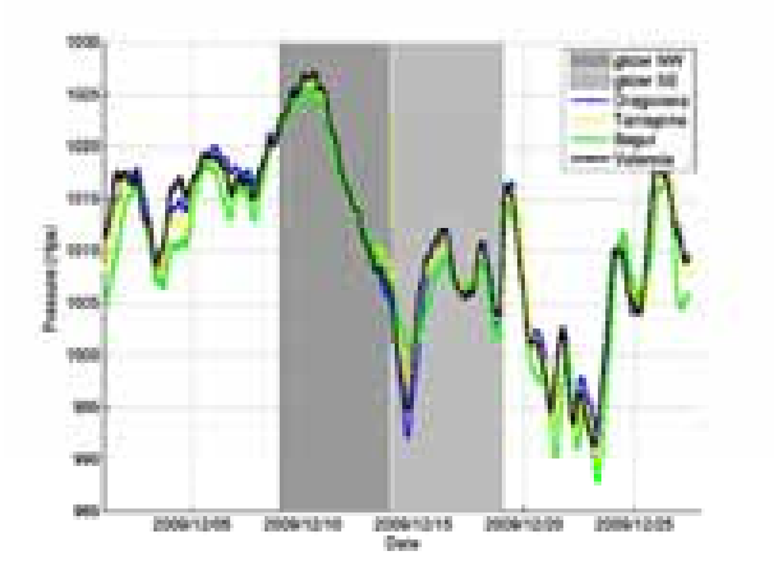
Ruiz et al., 2012, GR

Gliders Facility: Science, MLD

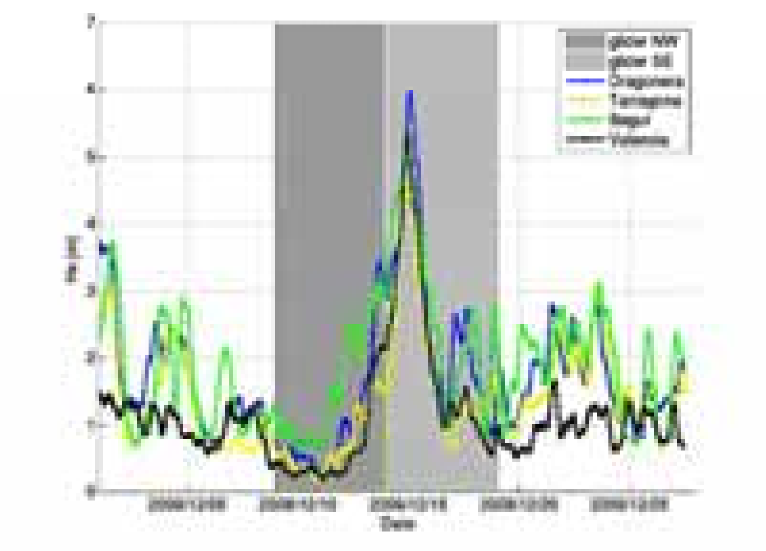


Results: Buoys PdE network

Atmospheric pressure

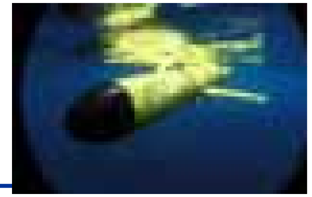


Significant wave height



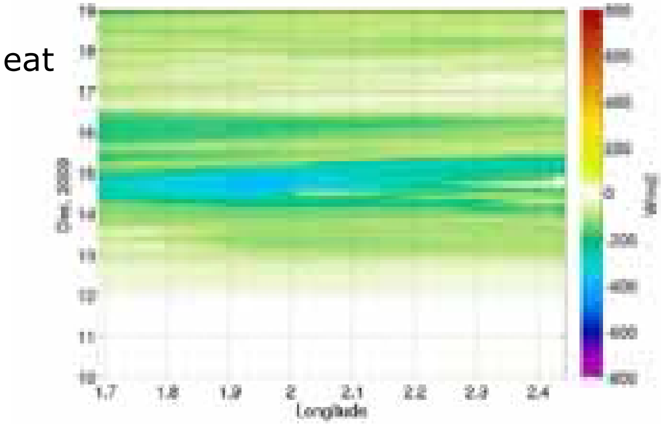
Atmospheric pressure and significant sea surface height measured during glider mission. Gray shadow colour indicates coincident period between glider and buoy measurements.

Gliders Facility: Science, MLD

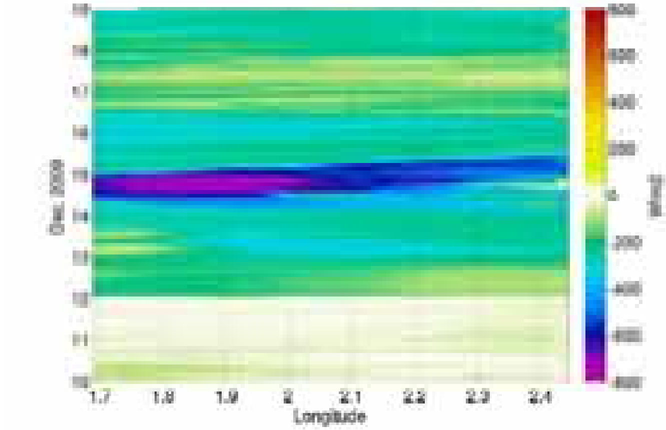


Results; Heat content, modelling and glider data

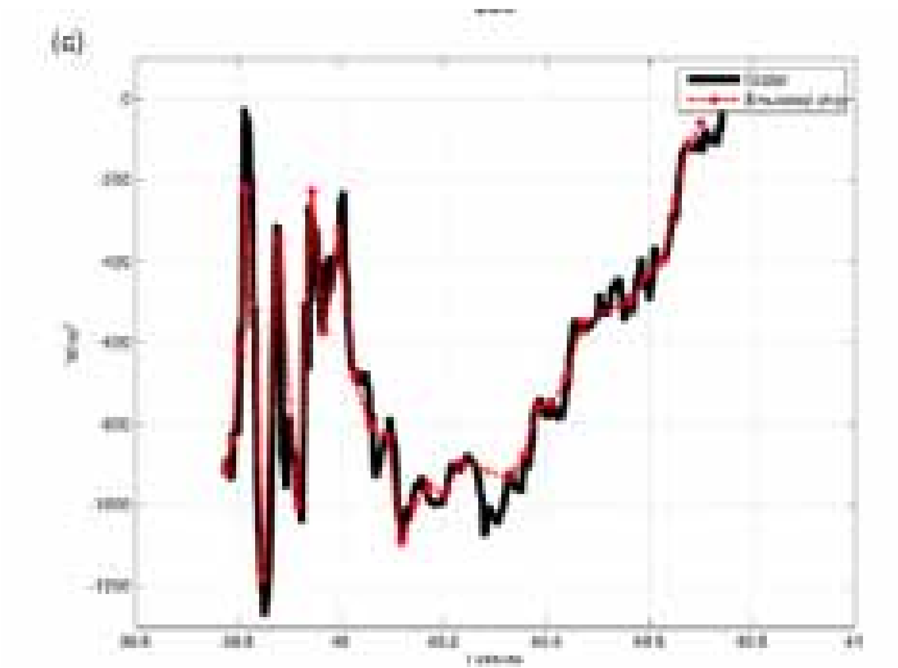
Sensible Heat



Latent Heat



From the WRF model



Heat content from glider data

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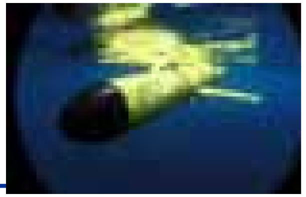
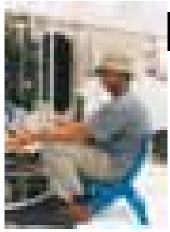
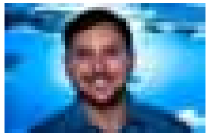
Ruiz et al., 2012, GR

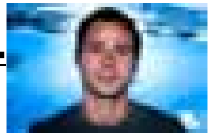
Gliders Facility: Operational



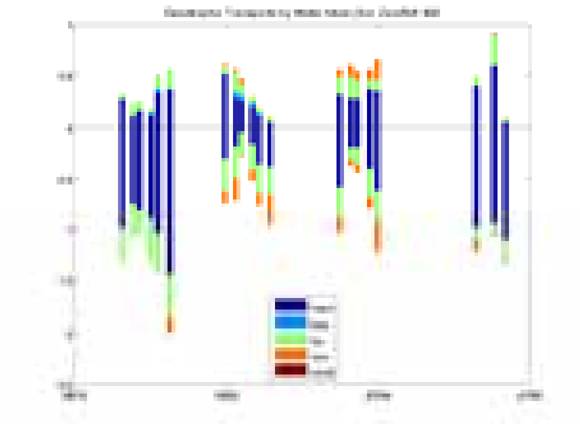
- **After 28 glider missions (started in 2006), + 10.000 profiles**
- **Since January 2011; routine operations in Ibiza and Mallorca Channels (150 miles section)**



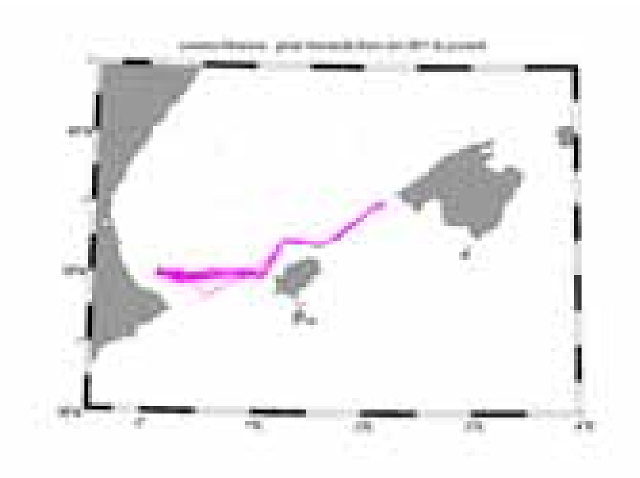




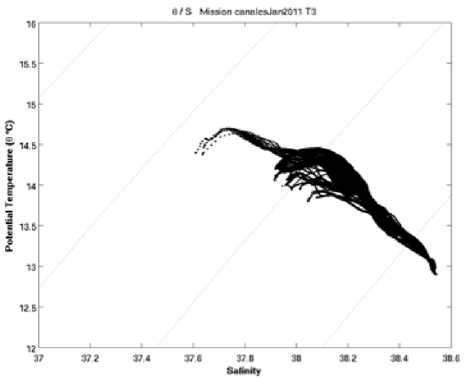
Major transport changes

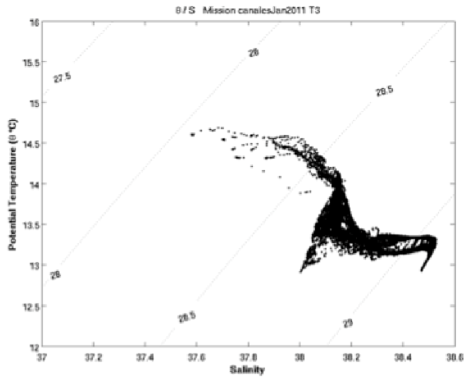


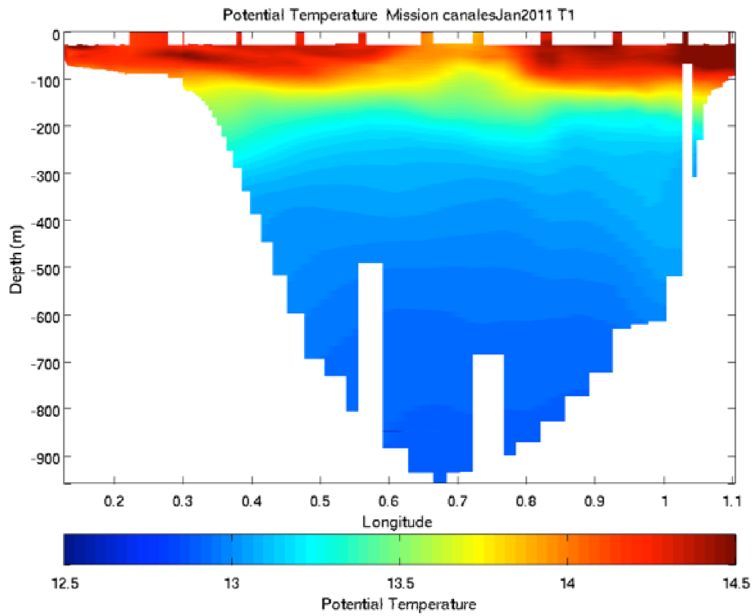
<u>NEED DEFINE KEY CONTROL SECTIONS EU</u>

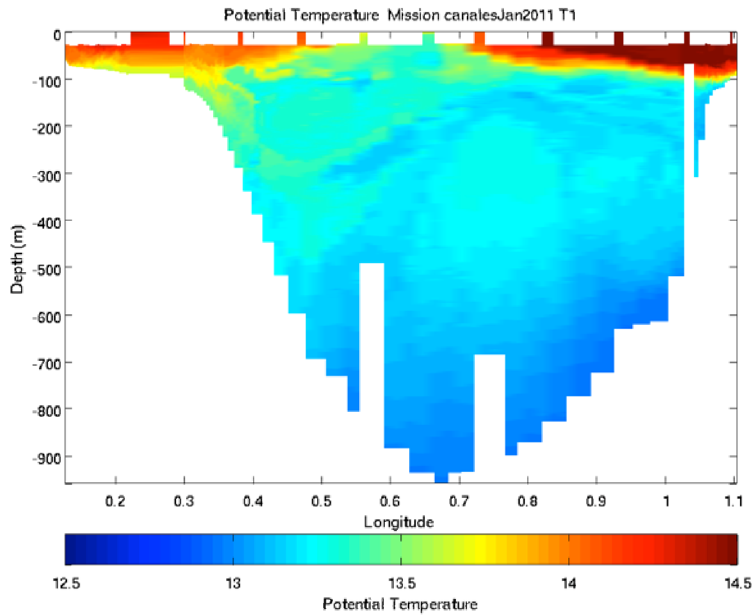


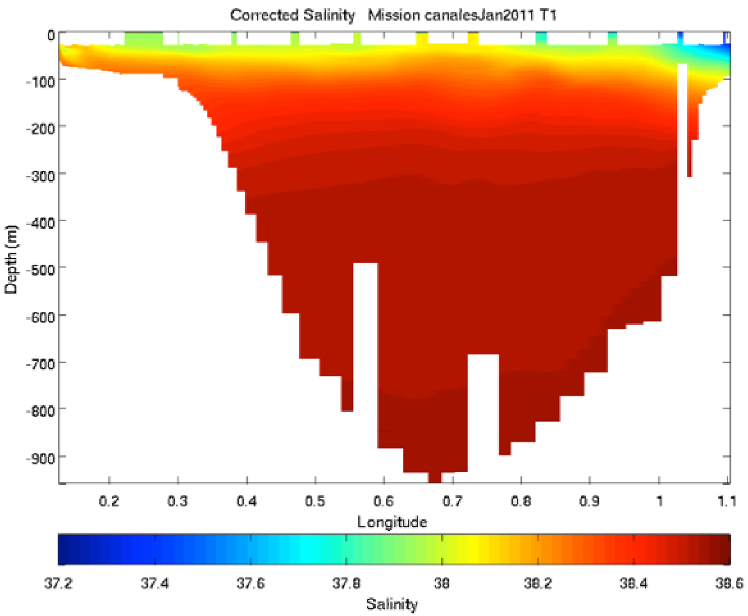
TS diagrams ROMS / Glider

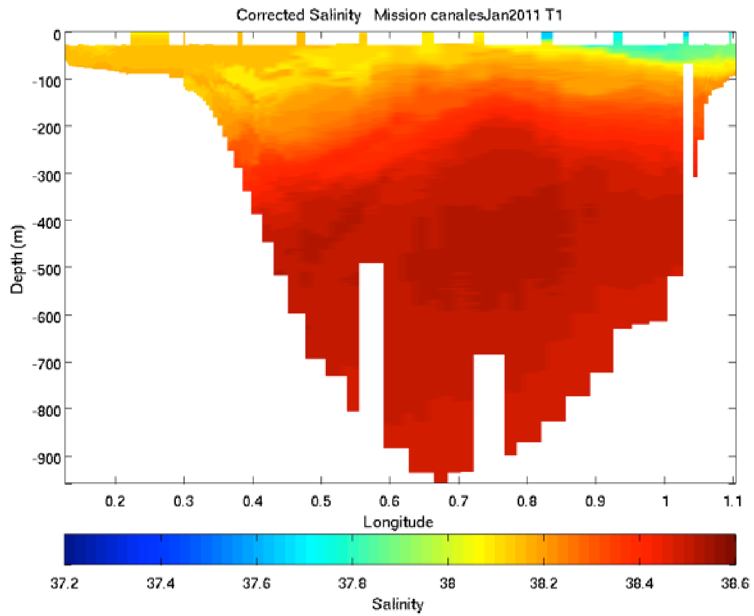





Potential Temperature Mission canalesJan2011 T1
Depth (m)
Longitude
Potential Temperature


Potential Temperature Mission canalesJan2011 T1
Depth (m)
Longitude
Potential Temperature


Corrected Salinity Mission canalesJan2011 T1
Depth (m)
0
-100
-200
-300
-400
-500
-600
-700
-800
-900
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
1.1
Longitude
37.2
37.4
37.6
37.8
38
38.2
38.4
38.6
Salinity


Corrected Salinity Mission canalesJan2011 T1
Depth (m)
0
-100
-200
-300
-400
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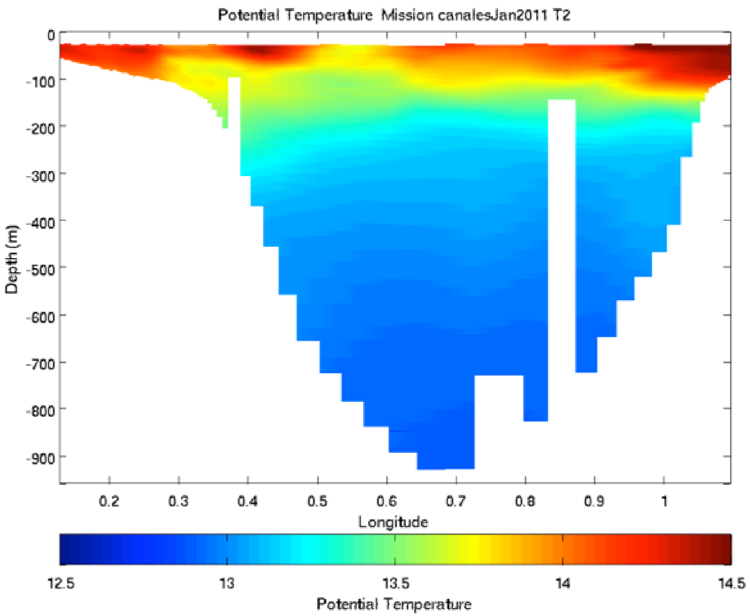
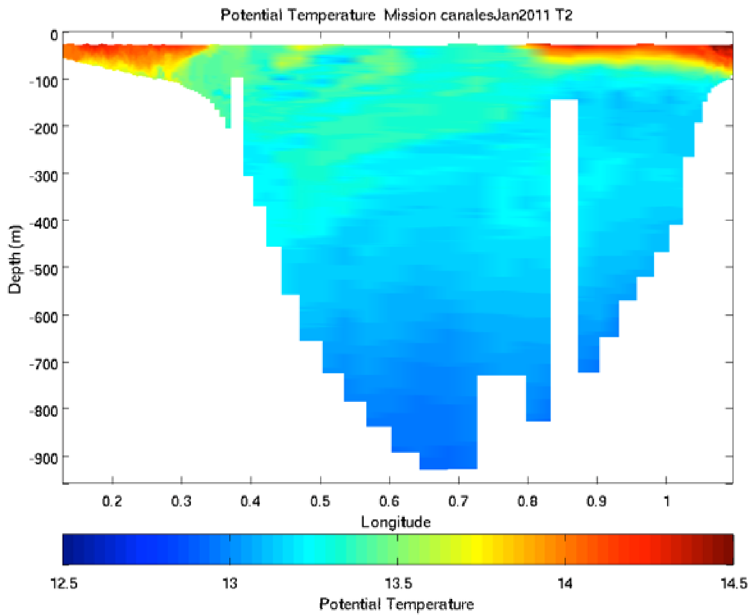
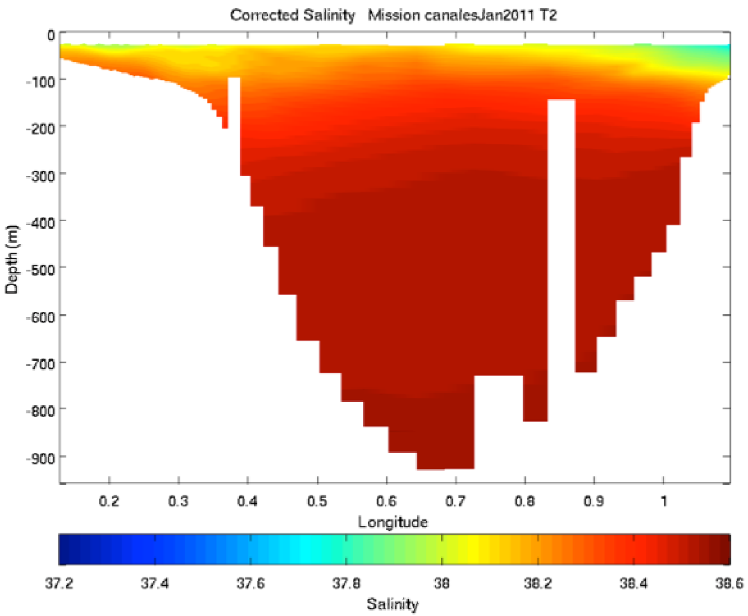
-600
-700
-800
-900
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
1.1
Longitude
37.2
37.4
37.6
37.8
38
38.2
38.4
38.6
Salinity

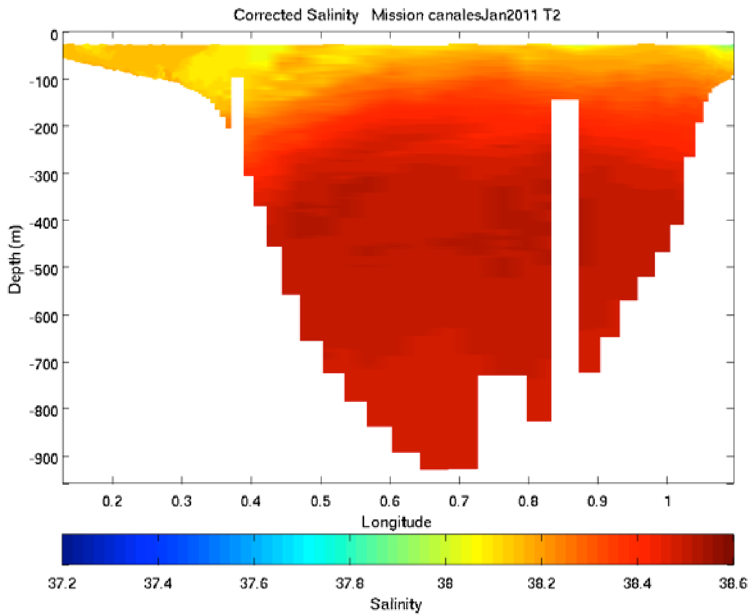
MODEL

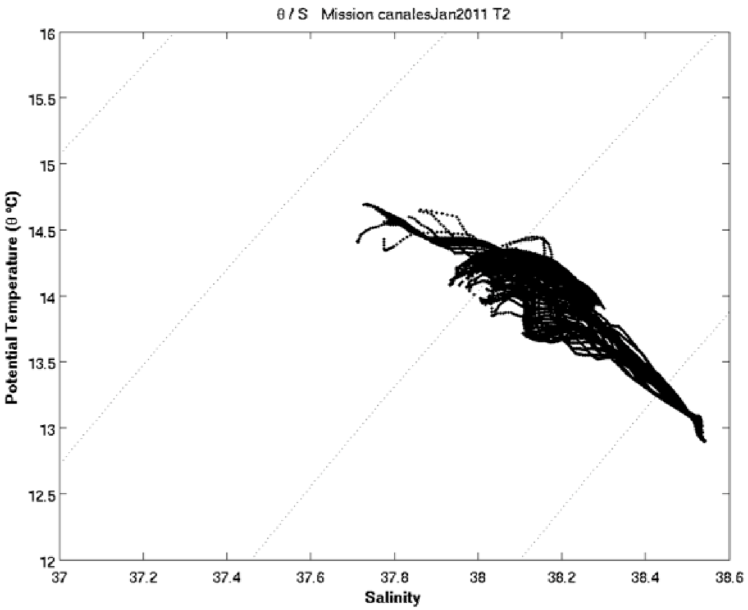
GLIDER

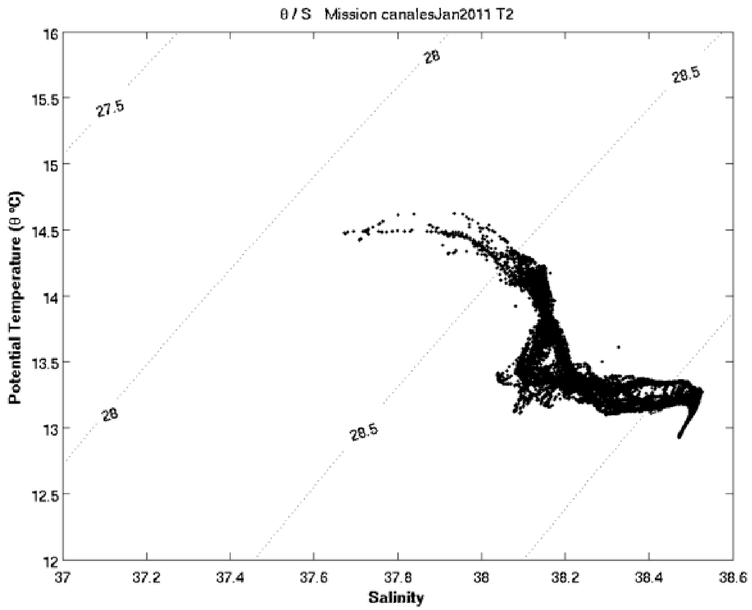


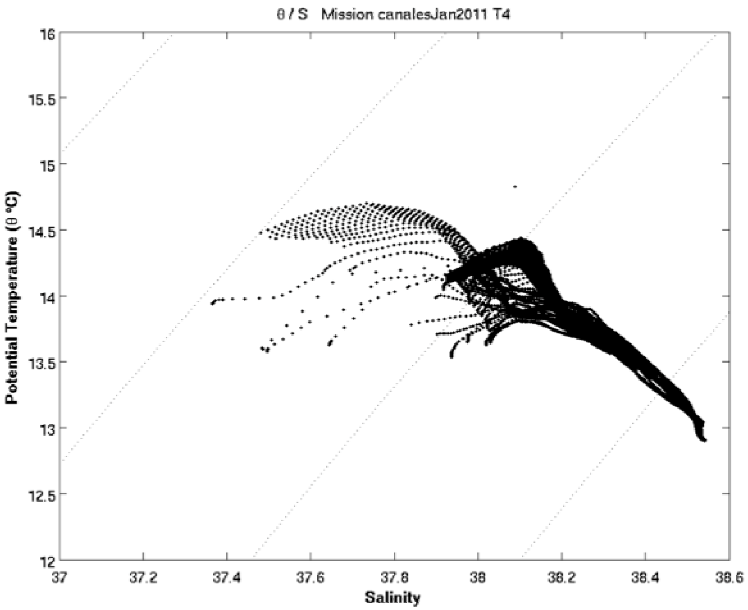


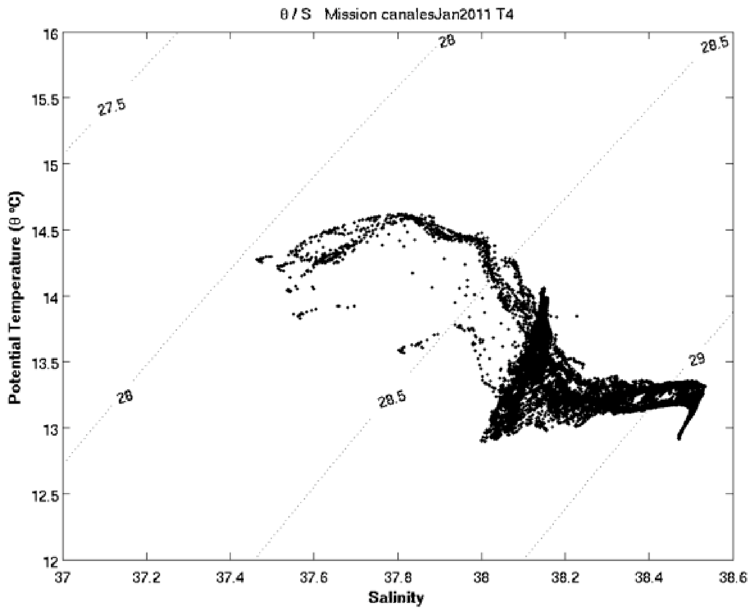

Corrected Salinity Mission canalesJan2011 T2
Depth (m)
Longitude
Salinity


Corrected Salinity Mission canalesJan2011 T2
Depth (m)
Longitude
Salinity


θ / S Mission canalesJan2011 T2
Potential Temperature (θ °C)
Salinity
16
15.5
15
14.5
14
13.5
13
12.5
12
37
37.2
37.4
37.6
37.8
38
38.2
38.4
38.6

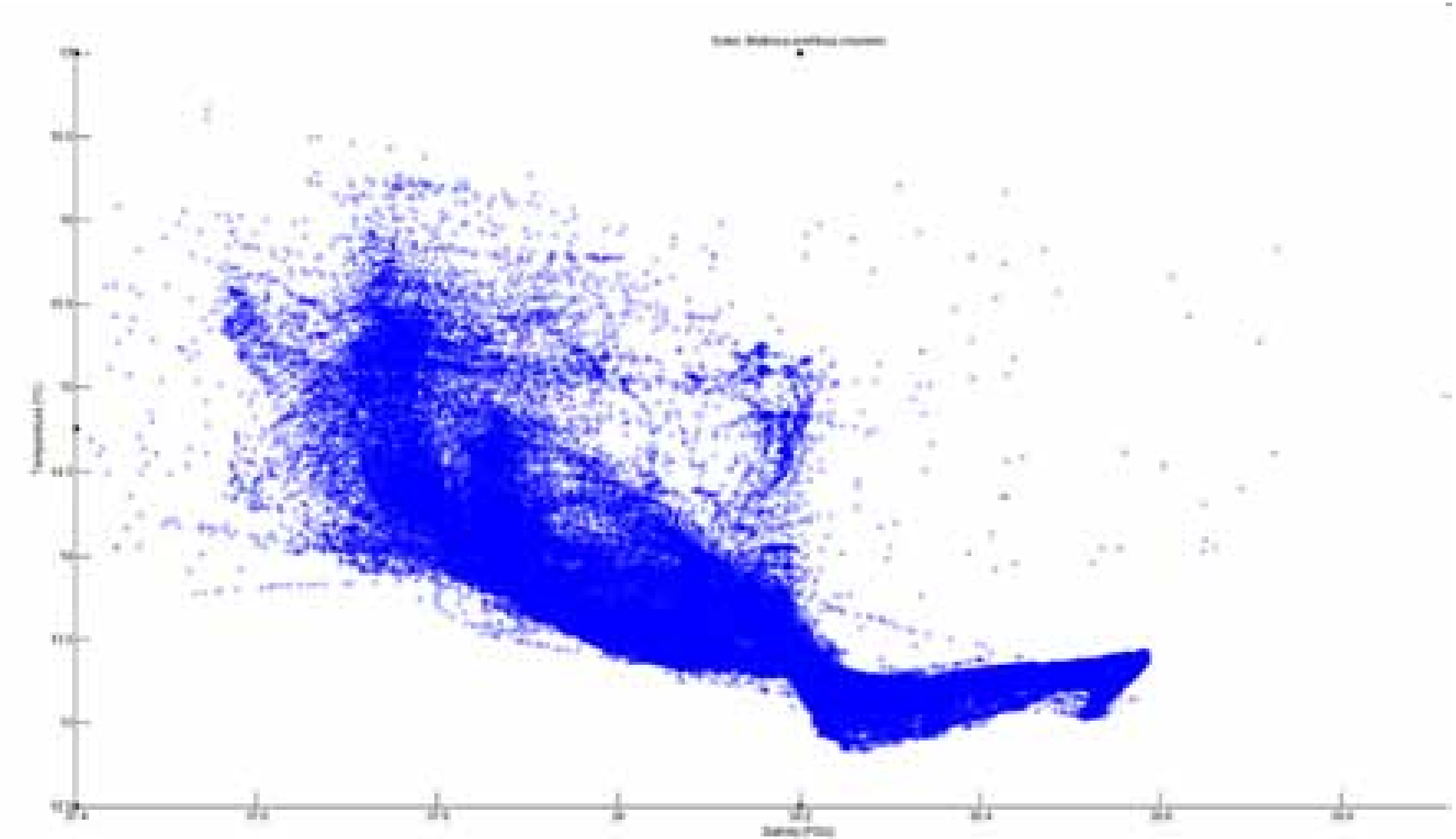

θ / S Mission canalesJan2011 T2
Potential Temperature (θ °C)
Salinity
27.5
28
28.5
28
28.5
16
15.5
15
14.5
14
13.5
13
12.5
12
37
37.2
37.4
37.6
37.8
38
38.2
38.4
38.6


θ / S Mission canalesJan2011 T4
Potential Temperature (θ ºC)
Salinity


θ / S Mission canalesJan2011 T4
Potential Temperature (θ ºC)
Salinity
27.5
28
28.5
29

1st SOCIB Seaglider mission (ongoing, April 19 reaching Ibiza): – April 2012 -

1st SOCIB Seaglider mission (ongoing, April 19 reaching Ibiza): – April 2012 -

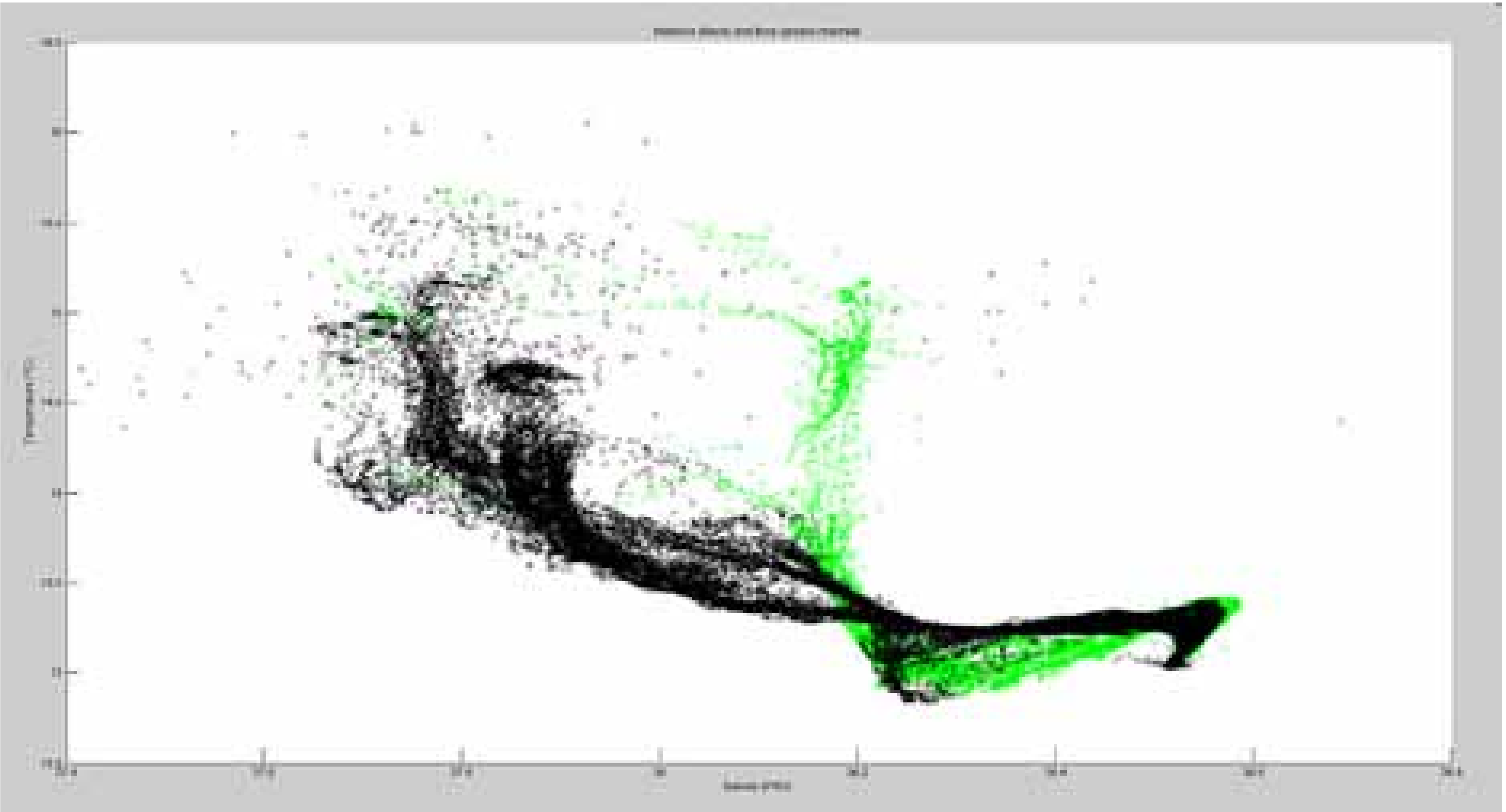


All dives, since deployment

Balearic Islands Coastal Observing and Forecasting System

Govern de les Illes Balears

1st SOCIB Seaglider mission (ongoing, April 19 reaching Ibiza): – April 2012 -



Mallorca channel (black), Ibiza channel (green)

SOCIB Glider Facility (Summary)

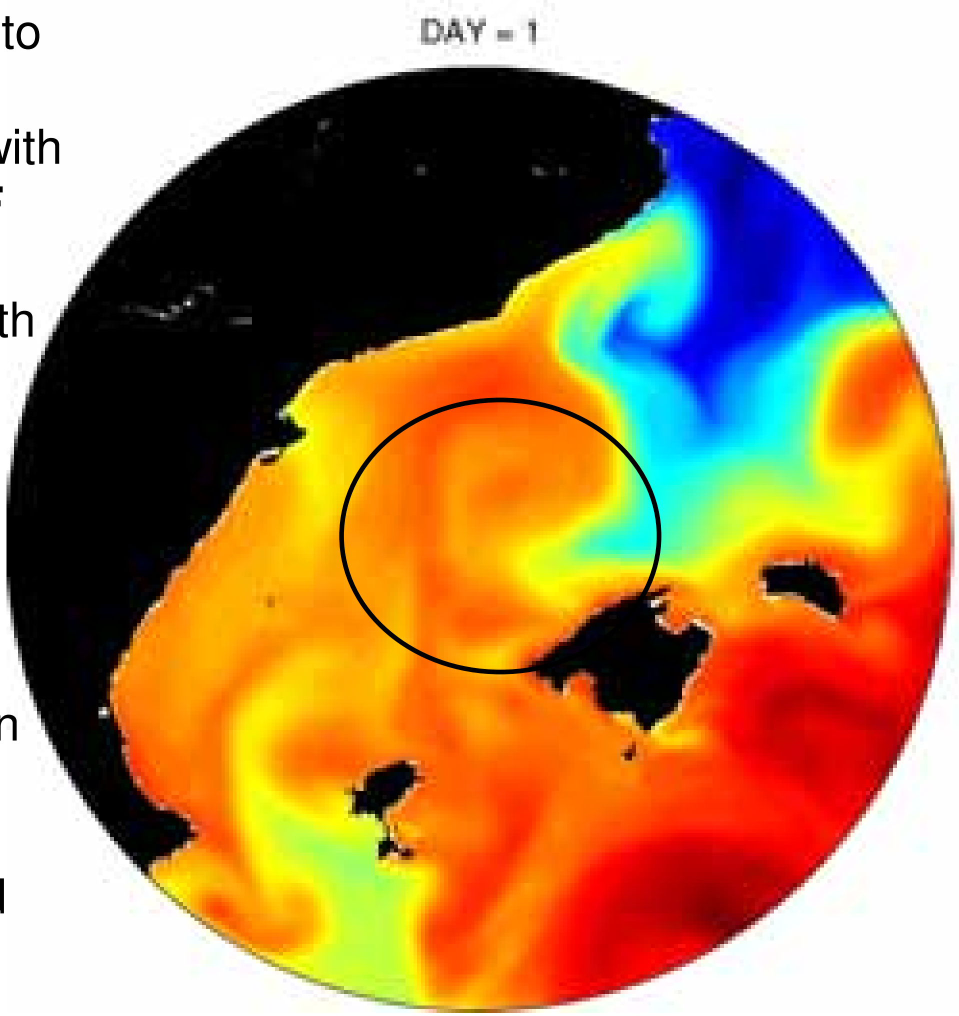
Gliders (a fleet of …) ?:

- They allow long term, sustained, multidisciplinary monitoring of the coastal ocean for example at key control sections.

- They are providing new evidences of the complexity of the coastal ocean, by resolving tridimensional mesoscale and submesoscale instabilities **never fully observed before**, showing the intrinsic dynamical relevance of theses instabilities, their interactions and effects on the mean circulation, and their role on the response of the ecosystem.
  - **A major observational breakthrough is appearing upfront**. It will trigger theoretical and numerical developments…
  - Examples from Balearic and Alborán Seas have been shown, suggesting the capabilities that will soon arise from monitoring with fleets of gliders, physical variability and ecosystem response at meso and submesoscale…

Modelling Facility

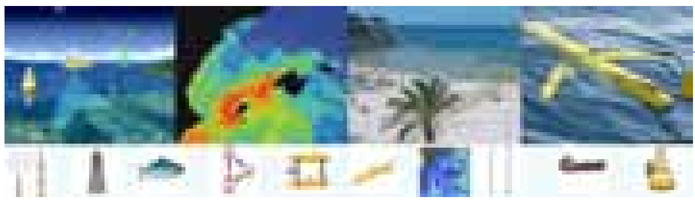
<u>Operational Modeling:</u> ROMS, 2km, to reproduce and maintain mesoscale features, interactions. In collaboration with PE and in the frame MFS/MOON. **WRF** Atmospheric Model. **SWAN** for coastal ocean wave Dynamics and Habors (with PE)



SST from 11/2008

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



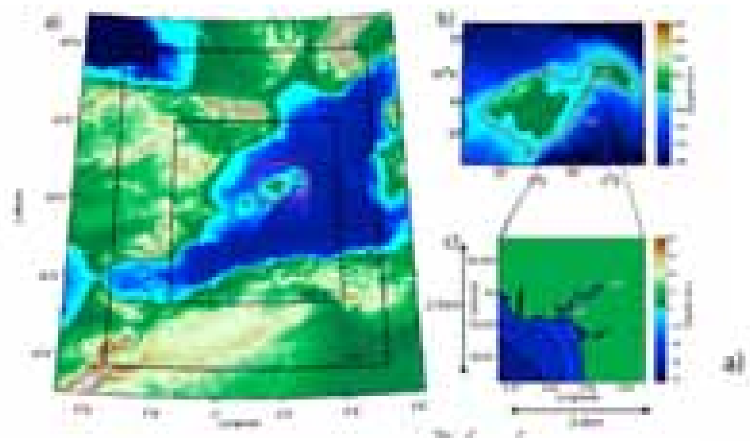
Modelling Facility; Meteotsunamis forecasting

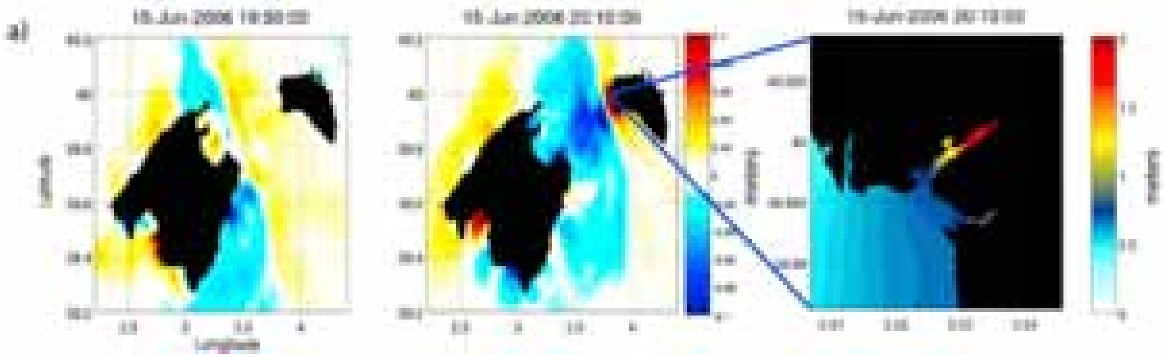
GEOPHYSICAL RESEARCH LETTERS, VOL. 38, LXXXXX, doi:10.1029/2011GL0

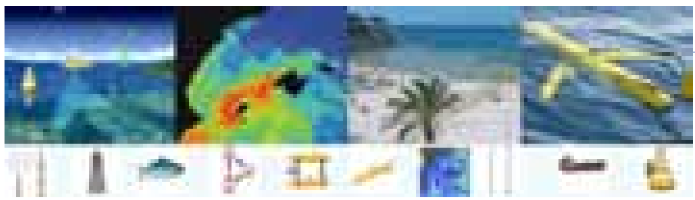
Toward the predictability of meteotsunamis in the Balearic Sea using regional nested atmosphere and ocean models

Lionel Renault,[1] Guillermo Vizoso,[2] Agustin Jansá,[3] John Wilkin,[4] and Joaquin Tintore

Received 4 March 2011; revised 29 March 2011; accepted 30 March 2011; published XX Month 2011.



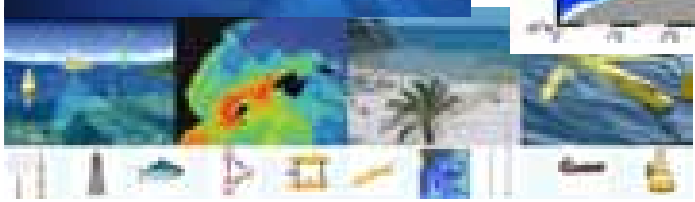


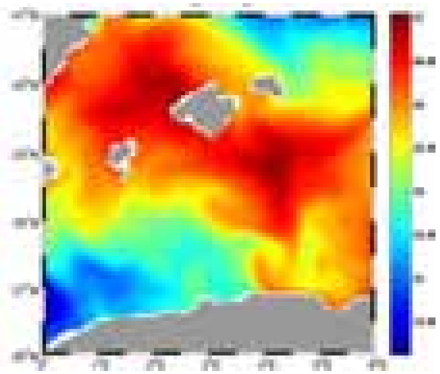


Bluefin Tuna Target Project: scientific problem solving for sustainable fisheries: at SOCIB since 2011

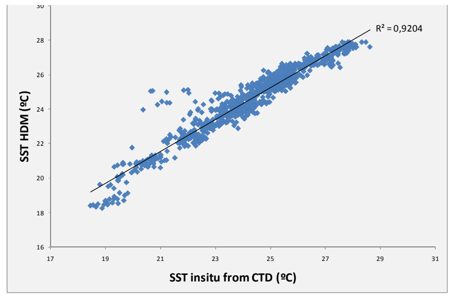
Initial Activities and First Results:

- Compilation of historical larvae data from various projects at IEO
- Link fishing data with ROMS, remote sensing and in situ hydrography
- Validate ROMS historical hydrographic data (SST and SSS) in the study area
- Development of an analysis framework and tools for modelling habitat-species relations.
- Development of field campaigns for studding specific key ecological questions
- Organize a inter-institutional working framework for data management and project flow control

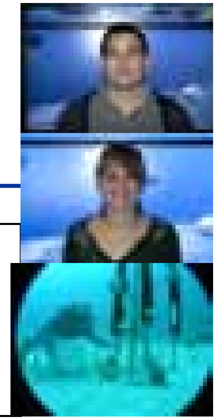




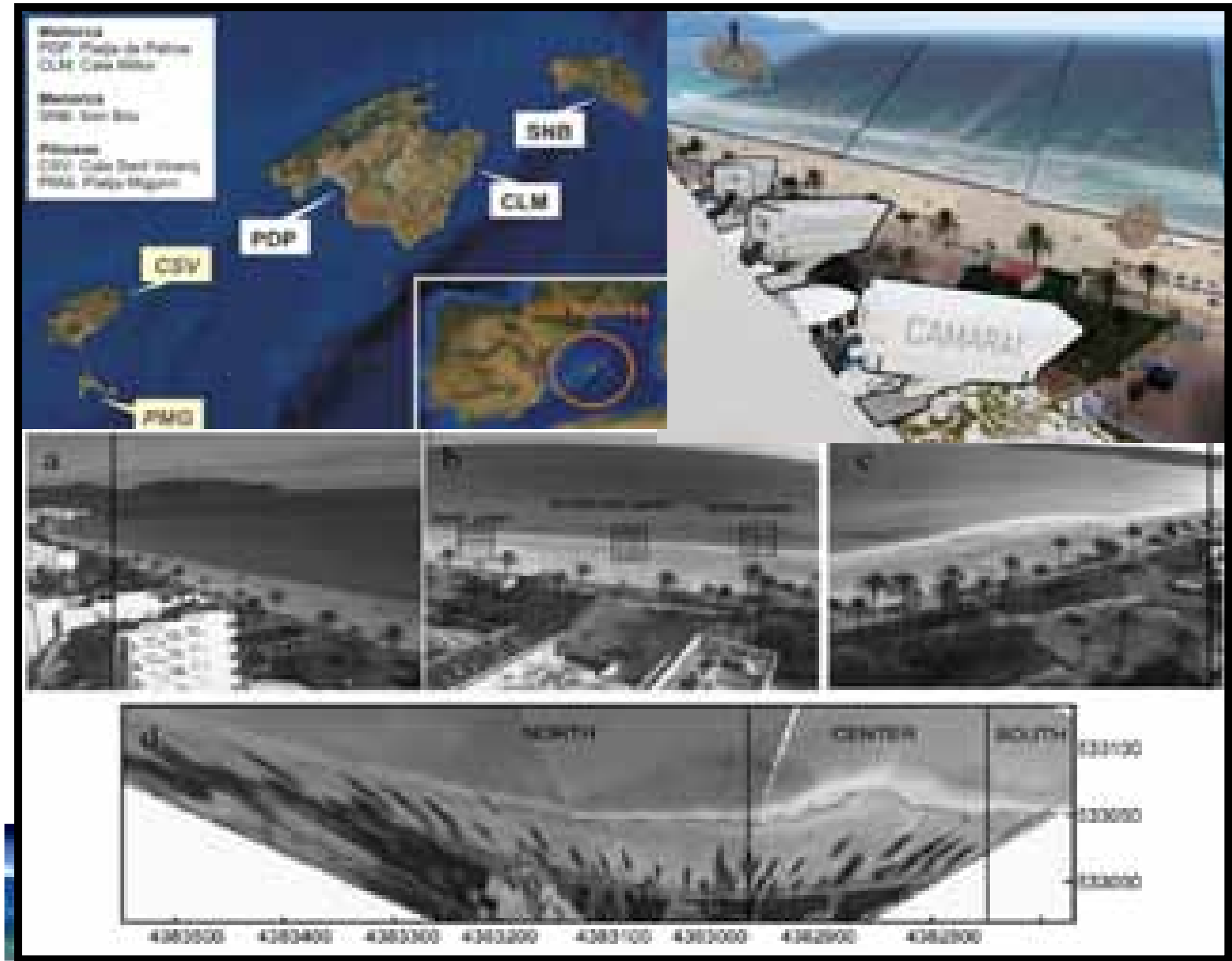
ROMS derived SST vs CTD



Marine and Terrestrial Beach Monitoring Facility



TMTBMF is a MODULAR SYSTEM designed to monitor continuously and in an autonomous way short and long term physical beach hydrological and morphological parameters.



MOBIMS

- Beach videomonitoring (SIRENA)
- Waves and currents (ADCPs)
- Bathymetry and beach profiles surveys
- Sediment parameters

PRODUCTS & SERVICES FOR BEACH MORPHODYNAMICS RESEARCH, BEACH SAFETY & COASTAL MANAGEMENT

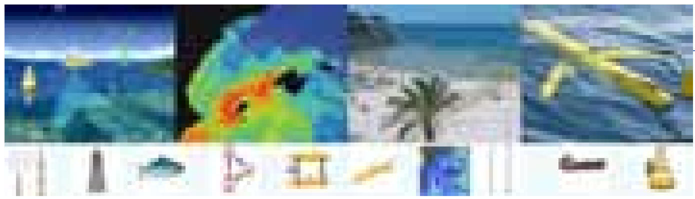
Data Centre Facility

A crucial element for real multi-platform integration, a pilot element for a Spanish Data Management strategy.

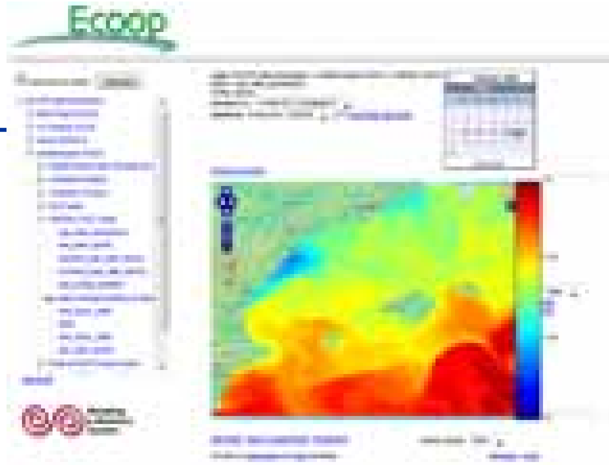
Goal: to provide researchers and users with a **system** that allow to **locate and download the data** of interest (near real time and delayed mode) to **visualize, analyze** and manage the information.

Principles of SOCIB Data Center: the data are,

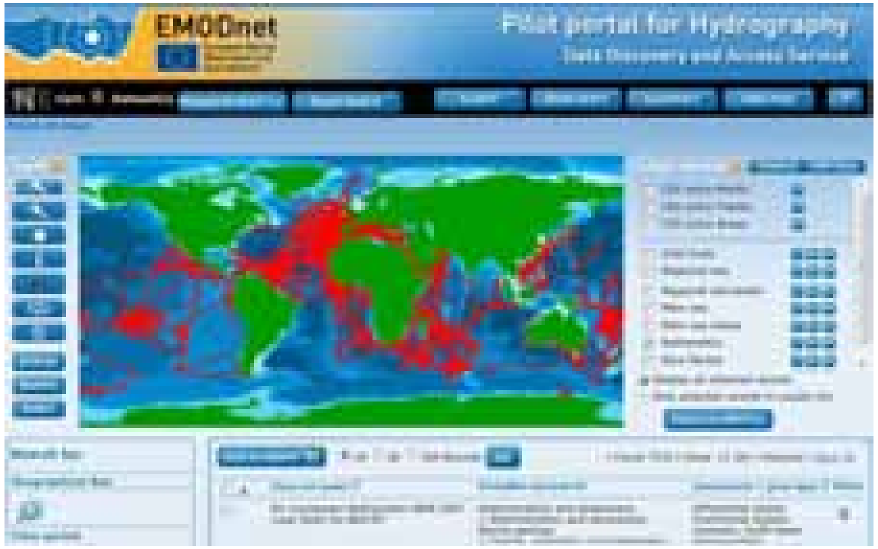
- Discoverable, accessible, 'collect once, use many' (data and metadada)
- Freely available
- Interoperability, standardization and sharing guarantee



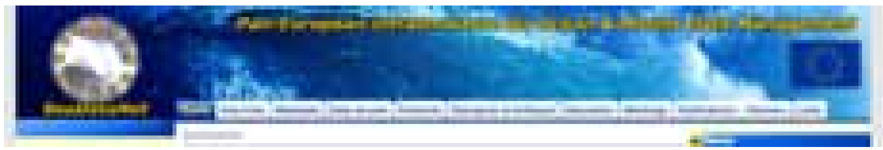
Data Centre Facility

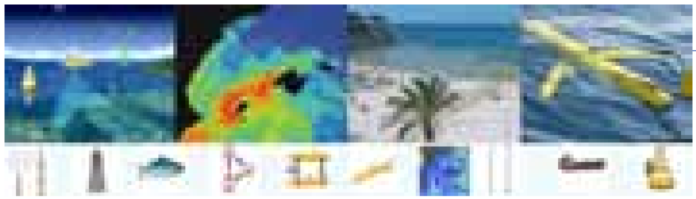


The European framework



The international framework



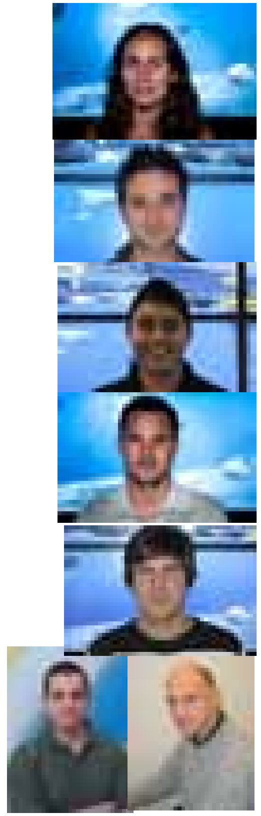


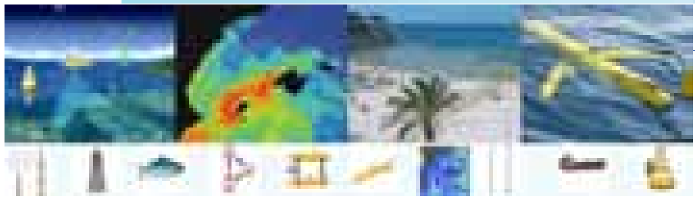
Data Center: Science and Technology

To accomplish the full lifecycle data (from the modeling and observing systems ingestion up to the user), the data center has defined seven steps for the Data Management Process:

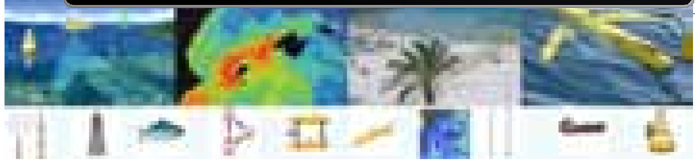
1. Platform management and communication
2. Quality Control assurance
3. Metadata Aggregation and Standardization
4. Data Archive
5. Data Search and Discovery
6. Data Policy and distribution
7. Data Viewing

Data Centre: Technologies





Data Centre (Technologies; example of Apps)



OUTLINE

1. The 2012 Oceans’ Challenges for Science, Technology and Society

2. Ocean Information for Society,… what we learned in the Mediterranean

3. SOCIB, a new multi-platform approach

1. SOCIB and the new role of Marine Research Infrastructures to respond to Science, Technology and Society needs

Innovation in oceanographic instrumentation

3 elements:

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

-The innovation process, complexity and incubation time

- The key to success

(Curtin and Belcher, TOS, 2008)


Innovation in
Oceanographic
Instrumentation

BY THOMAS B. CURTIN AND EDWARD O. BELCHER

INTRODUCTION

Oceans complexity, needs for improvement of instrumental capacities

Rationale:

The Oceans; a complex system, changing, under-sampled: tools to study them include

- Instruments to measure properties
- Models for continuous estimates of states and evolution

Improvements in tools capabilities

↓

Increase understanding → **Major practical benefits**

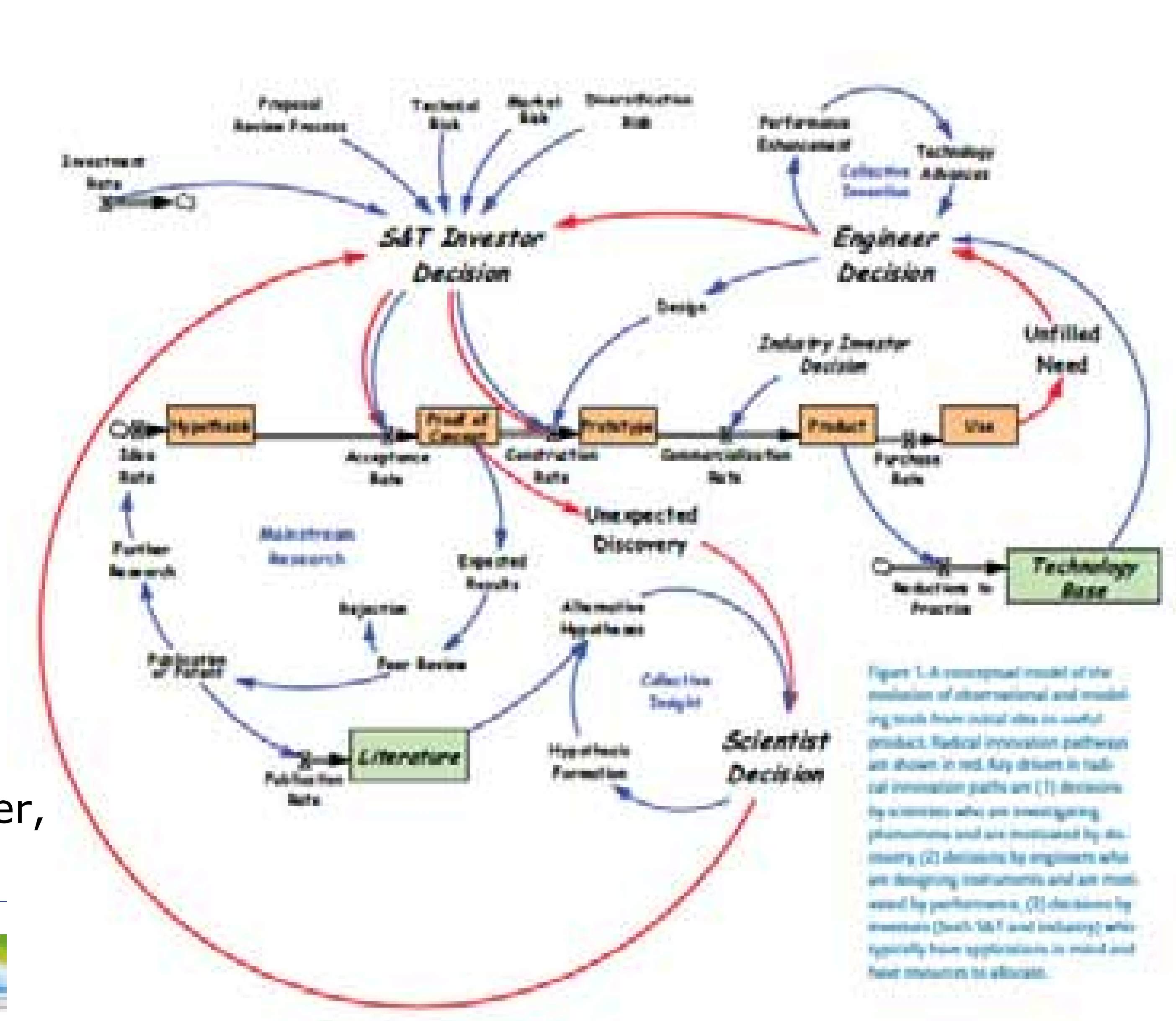
The innovation process (for advancing oceanographic instrumentation)

Complexity of innovation process: needs to be known, to avoid unrealistic expectations and/or discontinuous support.

Incubation time: 15-30 years (computer mousse, 30 years). Gliders 10 years. ¿?

Innovation can be incremental or radical, stimulated or suppressed.

The innovation process (for advancing instrumentation)



(Curtin and Belcher, TOS, 2008)

The innovation process (for advancing instrumentation)

Why is it important? : we need synoptic coverage

And… "Every time a new instrument has arrived, new key findings"…

Examples of innovations:

- Ships → Public – Private transfer
- Satellites → Ocean Weather…
- CTD → Micro-structure,
- Buoys- ARGO profilers →
- Currentmeters (rotor to ADCP) → Spectrum…
- Gliders → Submesoscale - …

The real challenge for the next decade…:

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/seasonal and inter-annual variability and by this**
- **Establish the decadal variability, understand the associated biases and correct them …**

The innovation process (disruptive, gliders)

Incubation time for gliders; ½

Why?:

… "A coherent set of scientists, engineers, and investors that envisioned the scientific goal, understood the technology potential and sustained the funding" (Curtin and Belcher, TOS; 2008).

The key to success for radical innovation in oceanographic instrumentation

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

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

The role of new marine research infrastructures (MRI/ICTS/Ocean Observatories….)

→ Need to…: **RESPOND TO THE 3 KEY DRIVERS**

- Science Priorities – (ok!)
- Strategic Society Needs (more listening!, policy makers&managers endorsement), MSFD (GES); Energy, Tourism, etc.
- New Technology Developments (companies, social society endorsement)

<u>Coastal Observing and Forecasting Systems are particularly well placed</u>

<u>AND</u> → Need to define a **JOINT STRATEGY** (European level in the international framework, more than coordination, <u>Partnership</u>…between Observing and Forecasting Systems !!!

Thank you!!!