The impact of new information infrastructures in understanding and forecasting the changing coastal ocean: SOCIB, an international **C**oastal **O**cean Observing and Forecasting **S**ystem based in the **B**alearic **I**slands:

Joaquín Tintoré and the SOCIB team

SOCIB and IMEDEA (UIB-CSIC)

http://www.socib.eu

SOCIB Balearic Islands Coastal Observing and Forecasting System
CSIC
Universitat de les Illes Balears
Instituto Mediterráneo de Estudios Avanzados
Govern de les Illes Balears
GOBIERNO DE ESPAÑA
MINISTERIO DE CIENCIA E INNOVACIÓN

SOCIB team

Objectives of this presentation

1. To present SOCIB to the OAPN community, SOCIB is a new Coastal Ocean Observing and Forecasting System, that will help responding to major scientific, technological and society driven questions.

2. To illustrate the importance of adopting a multidisciplinary, scientific, ecosystem based, integrated management approach for the preservation and restoration of European Seas (e.g. Mediterranean) and the coastal areas.

3. To show the relevance of high quality scientific research and new technology developments for achieving Integrated Coastal Zone Management (ICZM) as a way to advance towards a real sustainability, using specific examples from the Balearic Islands.

The coastal zone, complexity, problems and threats in a global change scenario

Environmental threats

- Climate change, sea level rises, ecosystem variability
- More frequent extreme events
- Beach erosion
- Loss of coastal dunes
- Degradation of *Posidonia oceanica* meadows
- Proliferation of invasive species
- Coastal artificialization
- Degradation of water quality, eutrofication
- Red tides, HABS
- Loss of fisheries resources
- Proliferation of jellyfish
- Marine debris
- Accidental oil spills

- Theses threats are already problems with significant **economic and social** effects. There is a strong pressure on the coastal zone as a resource

-**"The natural resource is not unlimited" (limitation concept)**

-Theses threats are not only local, **<u>global change scenario</u>**

How to proceed?

- **The basic underlying principle**: Sustainable Development
- **The way forward** (one of….): Science based management
- **Solid science and technology is a prerequisite**: examples of Research, Technology Development and Innovation (technological and/or services)
- But we also need**:… Transfer of Knowledge** (two directions!) and 'new'? **Strong coordination and Governance**

To achieve a European Marine and Maritime Strategy always based on the *more recent and established know how and technologies*.

Outline

1. **What** is SOCIB?
2. **Why SOCIB**, why Coastal Ocean Observatories, and **why now**?
3. **Background**
4. **Why** in the Mediterranean?, **Why** in the Balearic Islands
5. **Scales and major focus**
6. **Mission and Objectives**
7. **Principles**
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9. **Initial results** from ongoing SOCIB pilot facilities
10. **Summary**

Motivation: the background... IMEDEA - Strategic Plan 2010-2013

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

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Motivation:

We are convinced that knowledge, technology and transfer of know-how are increasing the capability to nowcast and forecast environmental conditions and open the possibility to build more reliable operational systems. Accordingly, managers and policy makers can now plan actions on the basis of scientific products and decision making tools.

‘Strong science for wise decisions’

EXCELLENT SCIENCE		ADVANCEMENT of KNOWLEDGE
NEW TECHNOLOGIES	TO CONTRIBUTE TO	
TRANSFER KNOWLEDGE		RESPOND TO SOCIETY NEEDS

What is SOCIB?

SOCIB is a Coastal Observing and Forecasting System, **a multi-platform distributed and integrated 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 to cover the needs of a wide range of scientific research priorities.

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.

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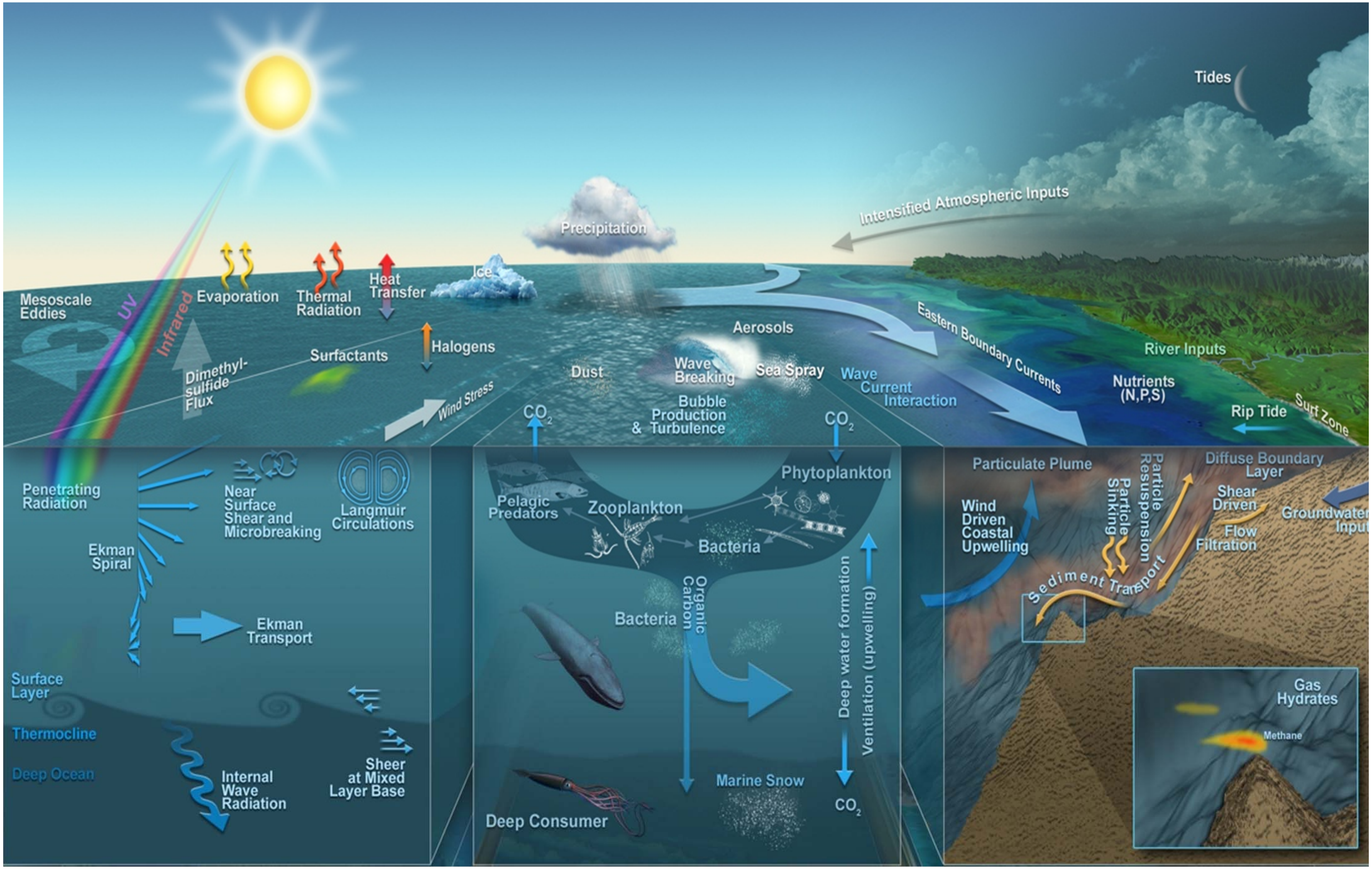
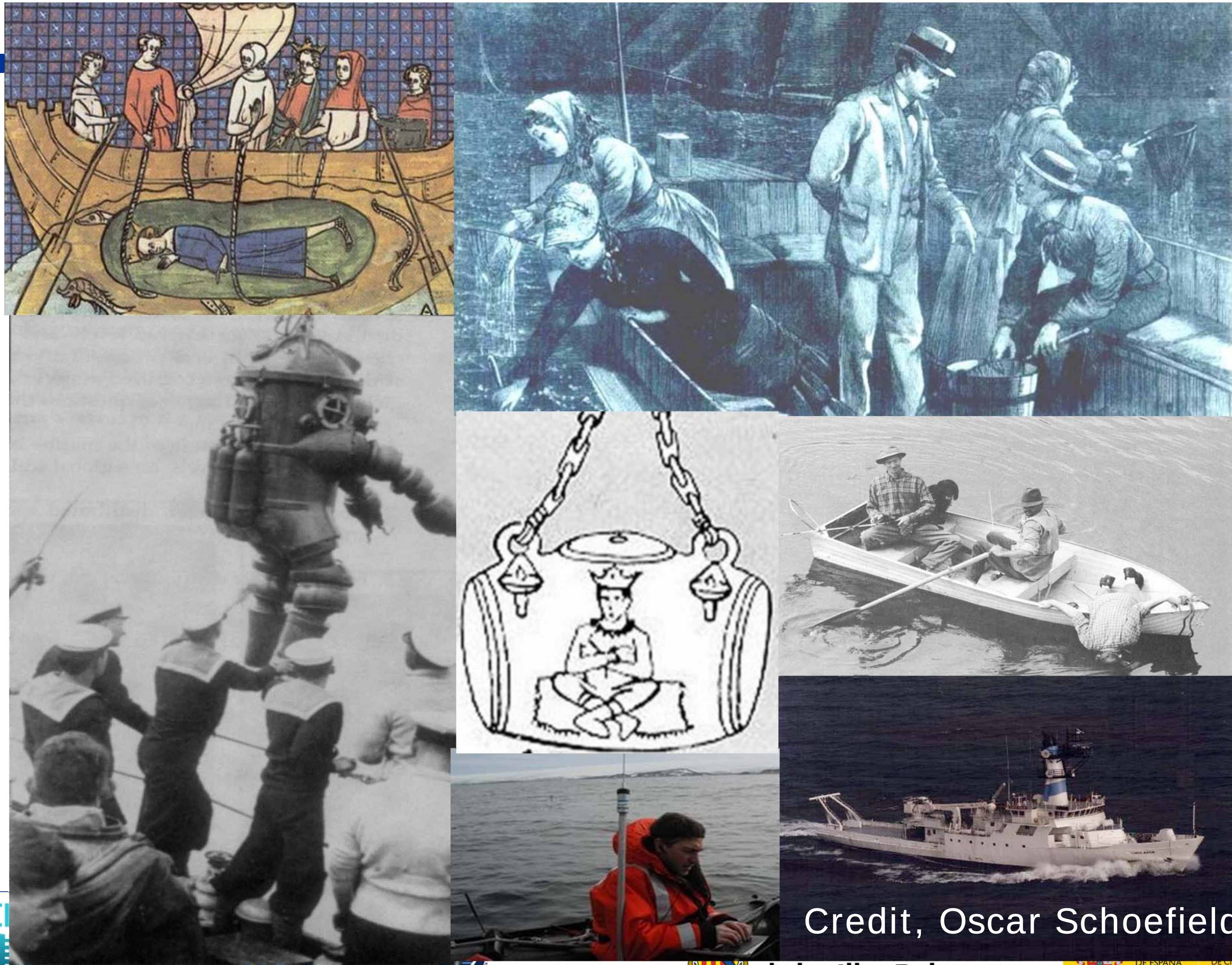
Oceans are complex and central to the Earth system



The oceans are chronically under-sampled



Credit, Oscar Schoefield)

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

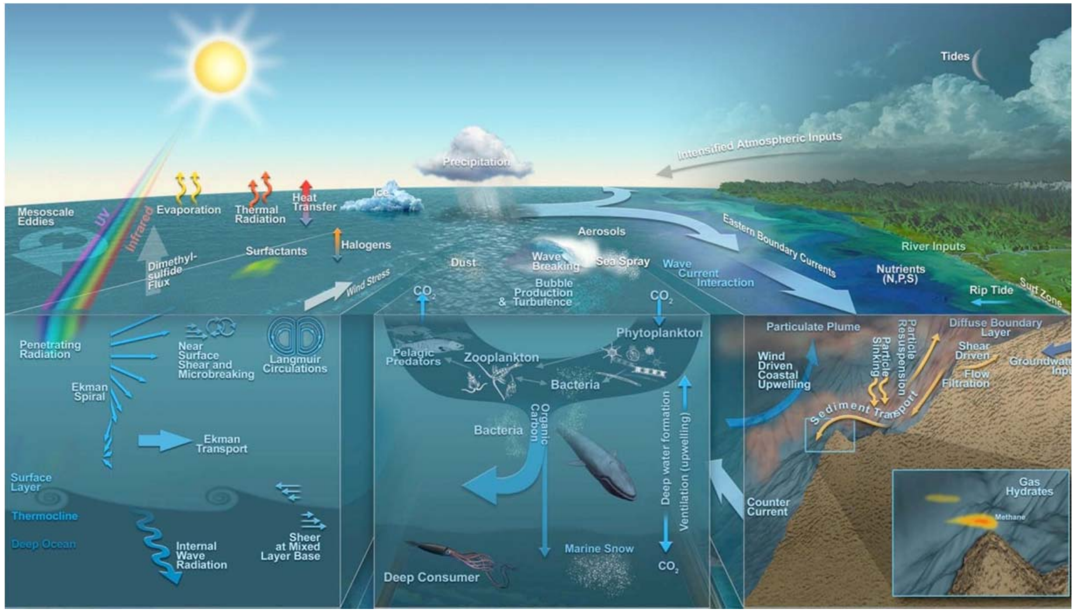
A New Approach to Marine and Coastal Research

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

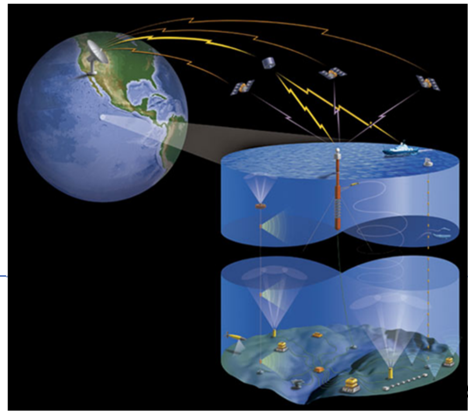
A quantitative major jump, in scientific knowledge and technology development

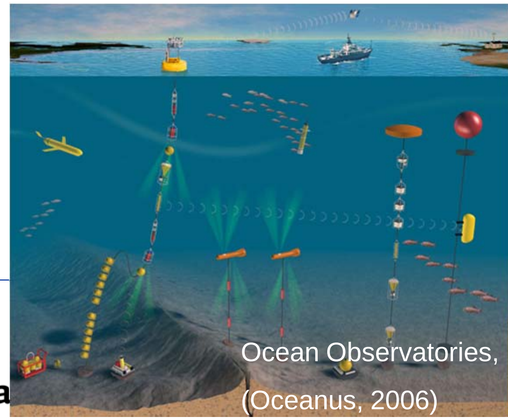
The development of a new form of Integrated Coastal Zone Management, based on recent scientific and technological achievements,

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)



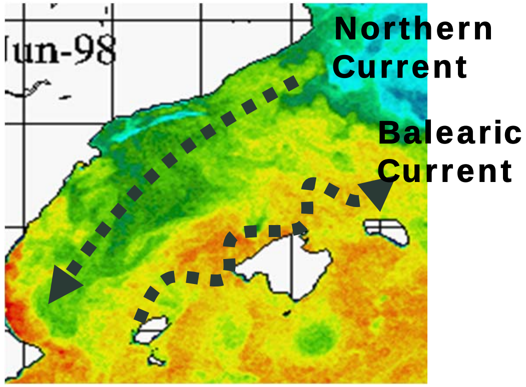


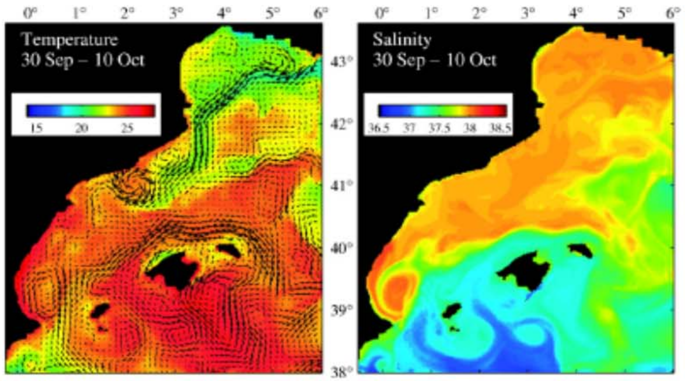
Ocean Observatories, (Oceanus, 2006)

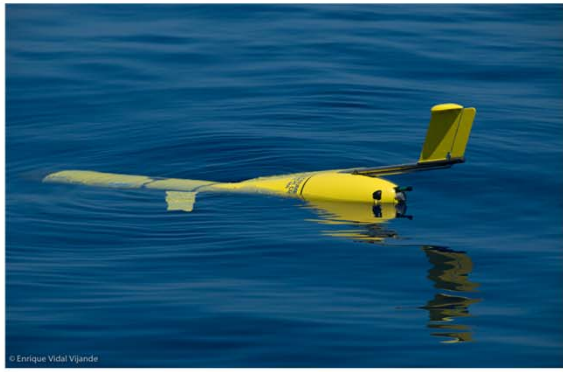
Why SOCIB, why Coastal Ocean Observatories, and why now?

New monitoring technologies are being progressively available for near real time coastal ocean 4D studies:

For example, **gliders** allow high-resolution sampling showing the existence of new features, such as submesoscale eddies with intense vertical motions that significantly affect upper ocean biogeochemical exchanges, an issue of worldwide relevance in the context of climate change (***Klein-Lapeyre, Ann Rev, 2008***).







These new technologies, integrated and used together, are delivering new insight into **coastal ocean variability,** which in turn will trigger **new theoretical developments**, increasing our u**nderstanding** of coastal and nearshore processes and contributing to a more science based and sustainable **management** of the coastal area.

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SOCIB: International Framework

Europe

- MFS, MOON, Liverpool Bay Marine Lab, POSEIDON, CYCOFOS, among other facilities…
- ESFRI – Marine Infrastructures ; http://cordis.europa.eu/esfri/publications-reports.htm
- EU Marine Strategy F. D. EU Water & Marine and Floods F. D., , Decision Com. Criteria Good Environm. Status (C(2010) 5956), Marine Knowledge 2020 Comm. (SEC(2010) 998&999). GMES ESA-EU initiative, ICZM EU Recm, etc…

EEUU

- OOI (NSF research) - http://www.joiscience.org/ocean_observing

  Collaborating to acquire research observing systems 10x what we have had. Requires making choices, consensus, priorities. Funding will go where the science interest is.
- IOOS (inter-agency operational). Coordination: http://www.ocean.us/

  Creating an operational observing system. Research supporting operations. Will support OOI and all basic ocean research. IOOS provides larger scale, long-term setting for OOI observatories. OOI provides process based research in a region leading to better IOOS observing schemes. OOI provides new technology and test bed for IOOS.…

Canada

- NEPTUNE, VENUS,

Australia

- IMOS: Integrated Marine Observing System - Marine Facilities Network , http://imos.org.au/ . Already ongoing implementation. Similar approach and strong similarities with SOCIB.

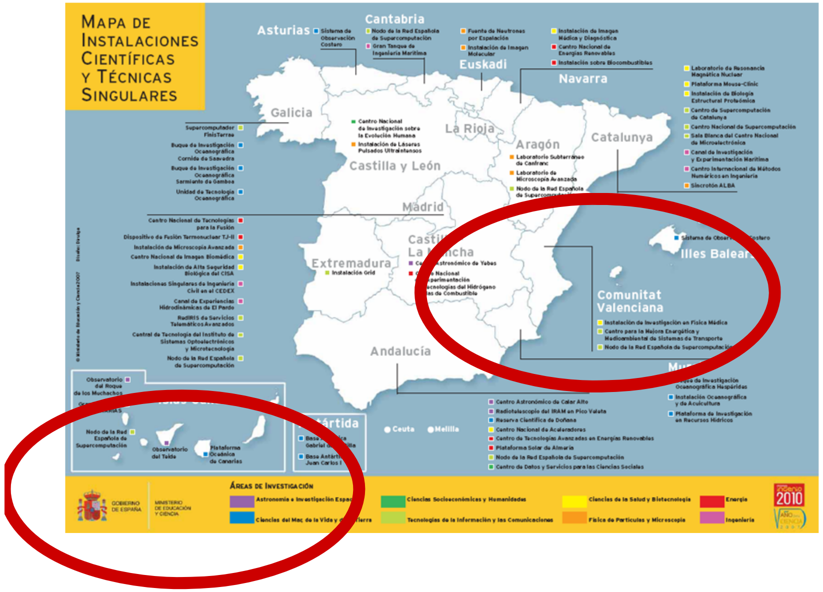
SOCIB: International Framework

What is an Observatory: The USA perspective.

- Ocean observatories are platforms for studying the ocean and its fundamental processes in real time, while returning continuous streams of data and imagery back to shore-based researchers. They include suites of instruments and sensors, power supplies, computer command and storage capability, and Internet connections or other advanced communications systems.
- A few ocean observatories and observing systems are already in operation or under construction, while several larger ones are now being planned by universities and research institutions in conjunction with NSF's Ocean Observatories Initiative (OOI), the NOAA-led Integrated and sustained Ocean Observation System (IOOS), and other international programs.
- To truly comprehend the ocean's dynamic behavior and to monitor how it affects us back on shore, scientists WHOI, Scripps, and Oregon State University and their partners have been charged with building and maintaining the infrastructure for coastal and global systems for their American scientific colleagues.

European framework: large scale

Spain: ICTS - MICINN



http://web.micinn.es/files/2008-folletook.pdf

Balearic Islands: R&D Plan

Govern de les Illes Balears
Conselleria d'Innovació, Interior i Justícia
Direcció General de Recerca, Desenvolupament Tecnològic i Innovació

http://dgtic.caib.es/www/plaCiencia/plaCiencia.ca.htm

Europe: (among other initiatives):

Marine and Maritime Strategy, **FP 7** projects (MyOcean, SESAME, ECOOP, etc...), **ESFRI** (European Strategy Forum on Research Infrastructures), **http://cordis.europa.eu/esfri/roadmap.htm**

MOON Science and Strategy Plan: field of actions

Ocean hydrodynamics: forecasts at basin, sub-regional and coastal scales

Water cycle and resources: river runoff, precipitation, underground waters

Biochemical fluxes and food webs: Predictions in coastal and open ocean areas

Marine pollution: oil in the open sea other contaminants in the coastal areas

Operational Fisheries: Hindcasts, forecasts and stock assessement

Sedimentary regimes and coastal erosion

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Why in the Mediterranean?

SOCIB will therefore take profit of:

- Strategic position of the Balearic Islands at the Atlantic/ Mediterranean Transition Area, one of the '**hot spots**' in world's oceans research and biodiversity

- Nature of this semi-enclosed sea, an ideal reduced scale ocean laboratory, where key ocean processes (**thermohaline circulation**, **deep convection**, shelf/slope exchanges, **mesoscale and submesoscale** dynamics, coastal interactions, etc.) can be studied at smaller scales than in other oceanic regions (Internal Rossby Radius of order 10 km).

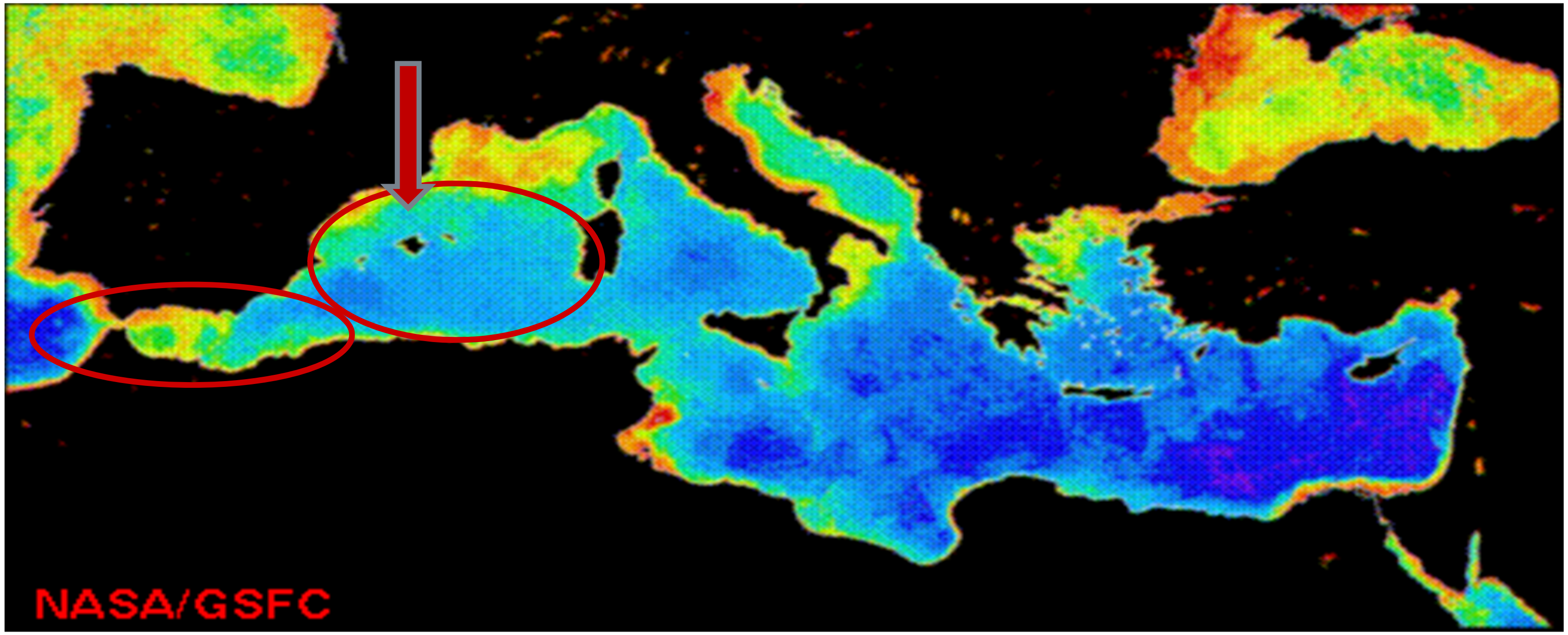
Physical mechanisms are thus better monitored and understood in this 'ocean basin', contributing to the advancement of knowledge of physical interactions and biogeochemical coupling at nearshore, local, sub-basin and global scales.

Regional monitoring: word of caution... with extrapolations to global scale ... **"Real-time'detection of secular changes in the oceanic overturning circulation by regional measurements is probably a mirage" (Wunsh,** Nature geoscience, 2008)

SOCIB activities

will be mostly (but not only) centred in the western Mediterranean, with focus in the Balearic Islands and adjacent sub-basins (specifically Algerian and Alborán/Gibraltar) and …

covering from the **nearshore** to the **open ocean**.



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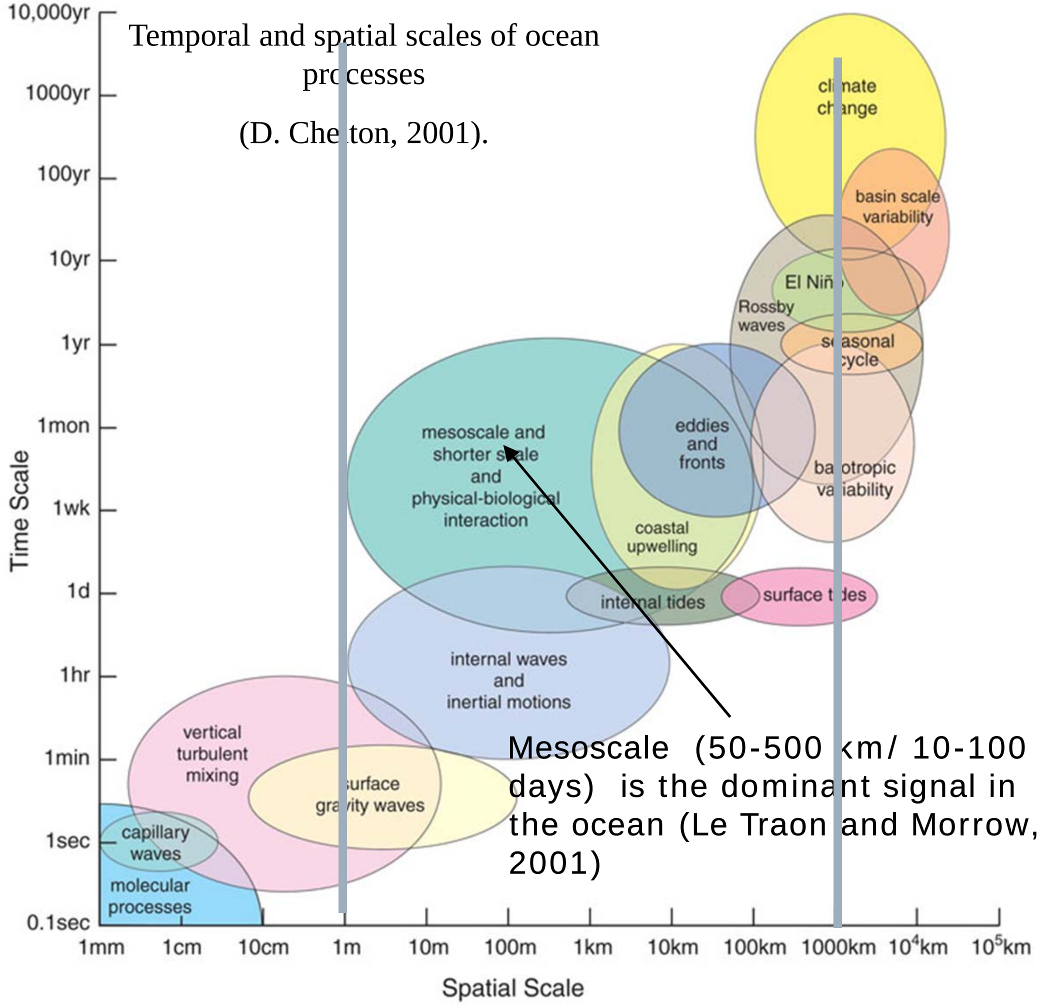
SOCIB Science Focus: coastal ocean variability at mesoscale/sub-mesoscale, interactions and ecosystem response

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 effects on vertical motions, impact on ecosystem variability.

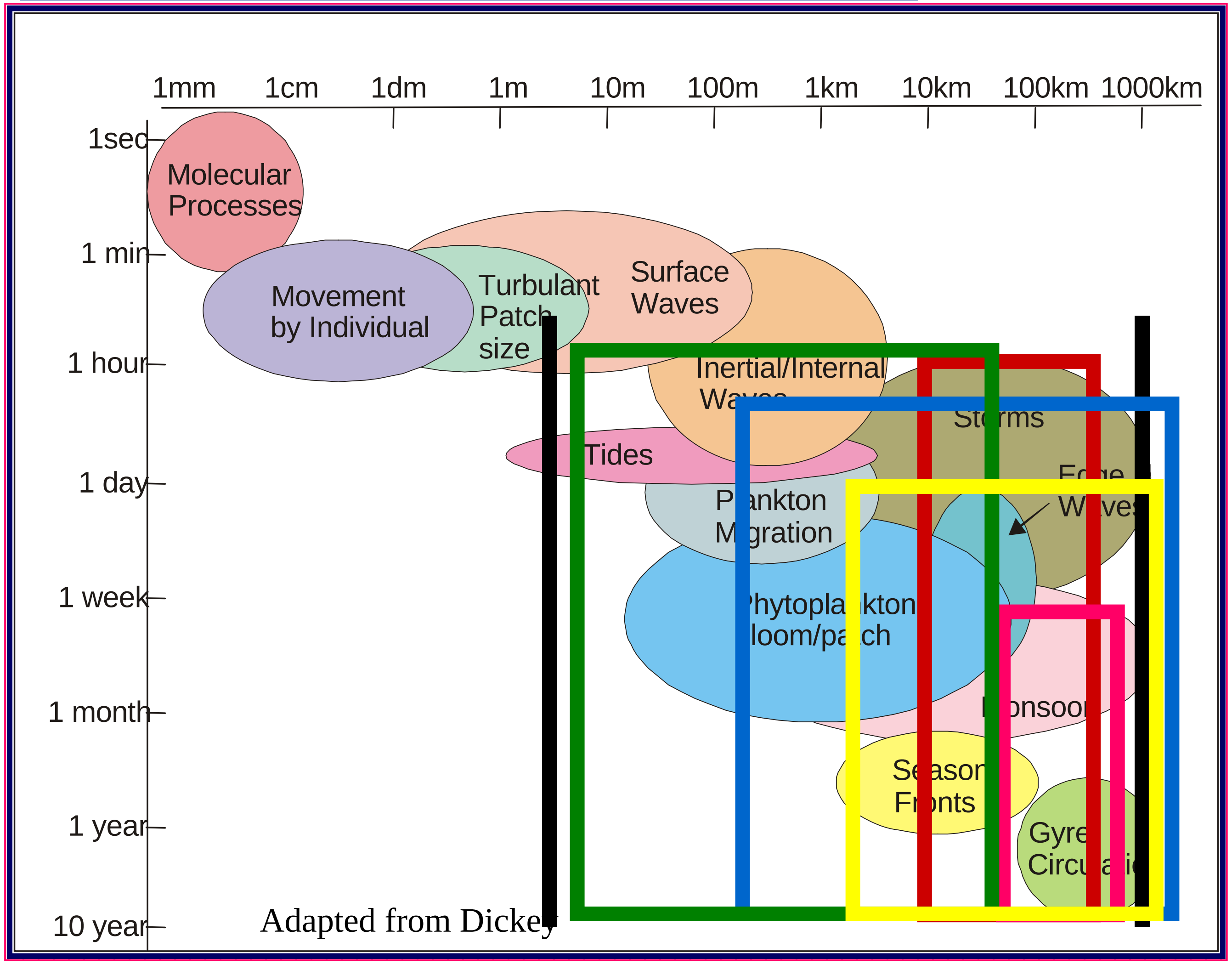
<u>With inputs from 'both sides'....</u>
(nearshore and coastal ocean and also inter-annual and decadal variability)



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

SOCIB scales

SOCIB Science Focus: monitoring at the right scale: from nearshore to coastal and regional



Gliders

AUV's

Time series

HF radar

Spatial survey

Satellite

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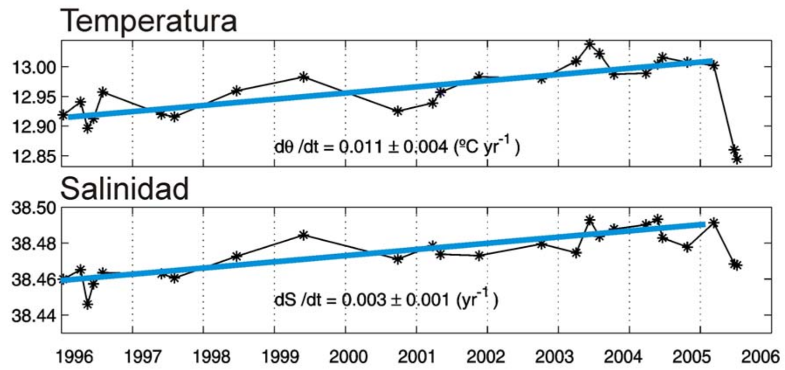
SOCIB mission and general objectives:

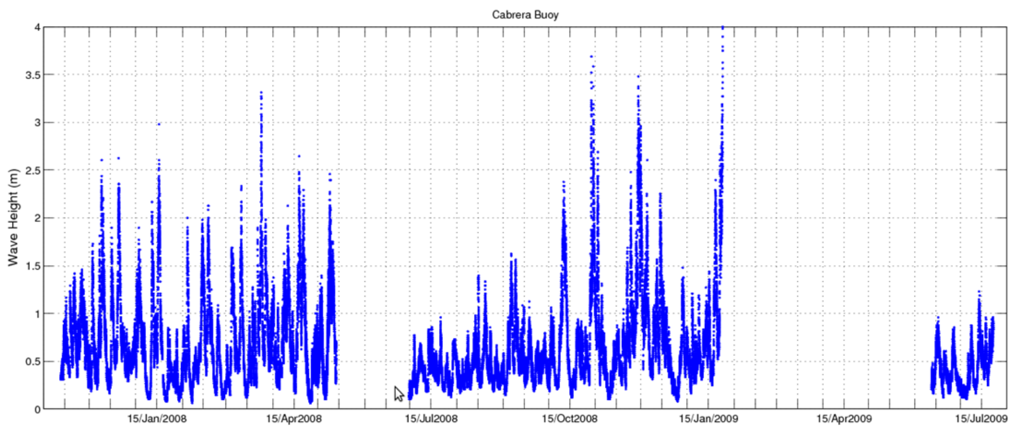
Why ?

- Detecting Changes Imply Monitoring.
- Need of reliable baseline data.

Changes in Mediterranean…



López-Jurado, J.-L. et al. (2005), *Geophys. Res. Lett.*,



Careful monitoring is needed with traditional and with new infrastructures, new tools, new technologies…

SOCIB expected contributions...

in the international frame of Operational Oceanography in the Coastal Zone in a global change context,

- to advance in the understanding of the physical processes, multidisciplinary coupling and non linear interactions,
- to detect and quantify changes in the coastal systems and ecosystems, understand the underlying mechanisms and forcing responsible for theses changes and to forecast their evolution under different scenarios.

SOCIB will also specifically address **society needs**:

- Providing services at different levels and for different types of final en users (therefore providing a continuous multidisciplinary and integrated **monitoring** of the coastal variability.

- Promoting the development of **new tools and technologies for decision support and risk assessment**.

SOCIB Scientific Objectives

… **we want to advance on the understanding of physical and multidisciplinary processes and their non linear interactions,**

- to detect and quantify changes in coastal systems,
- to understand the mechanism that regulate them and
- to forecast their evolution and or adaptation under, for example, different IPCC scenarios.

SOCIB will specifically address the preservation and restoration of the coastal zone and its biodiversity, the analysis of its vulnerability under global change and consider new approaches, such as connectivity studies and MPA's optimal design to advance and progressively establish a more science based and sustainable management of the coastal area (ICZM).

A specific multidisciplinary Bluefin tuna Programme will be launched to understand the variability of their spawning area, in relation to Atlantic-Mediterranean Variability (PI, IEO)

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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

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SOCIB Components and Structure

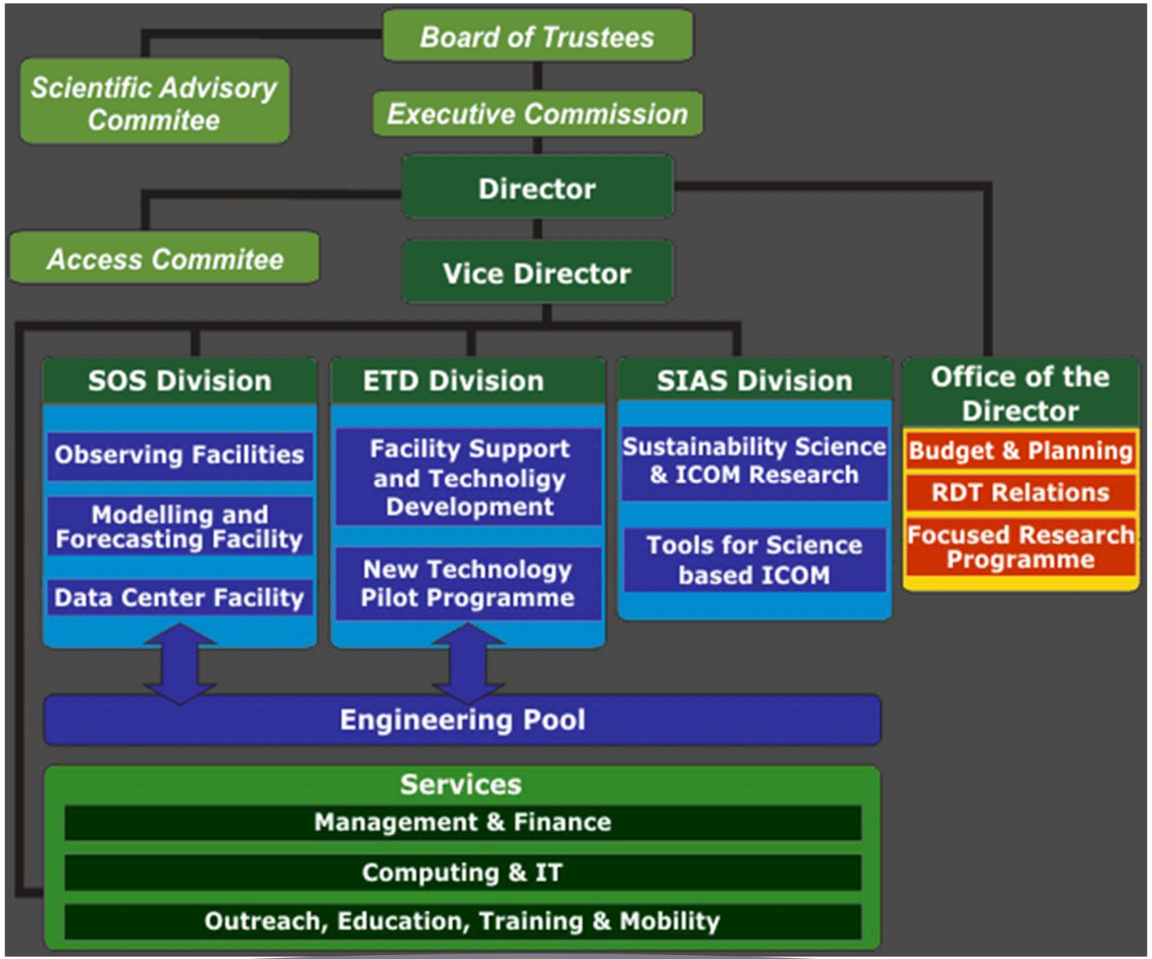
Components:

- Observational sub-system
- Forecasting sub-system
- Data Management sub-system

Structure:

- 3 Divisions and Units
- 3 Horizontal Services (C&IT, Outreach and Management)
  . An Access Committee
  . A Scientific Advisory Committee

SOCIB Structure



Marine and Coastal Center of Excellence,
(CSIC, IEO, UIB)

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SOCIB Systems Operations and Support Division

1. Observational Facilities (major elements)

- New Coastal Research Vessel (25 m LOA – 1.200 km coastline in the Islands)
- HR Radar
- Gliders and AUV's
- Moorings, tide gages and satellite products
- ARGO and surface drifters
- Nearshore beach monitoring and cable nearshore facility

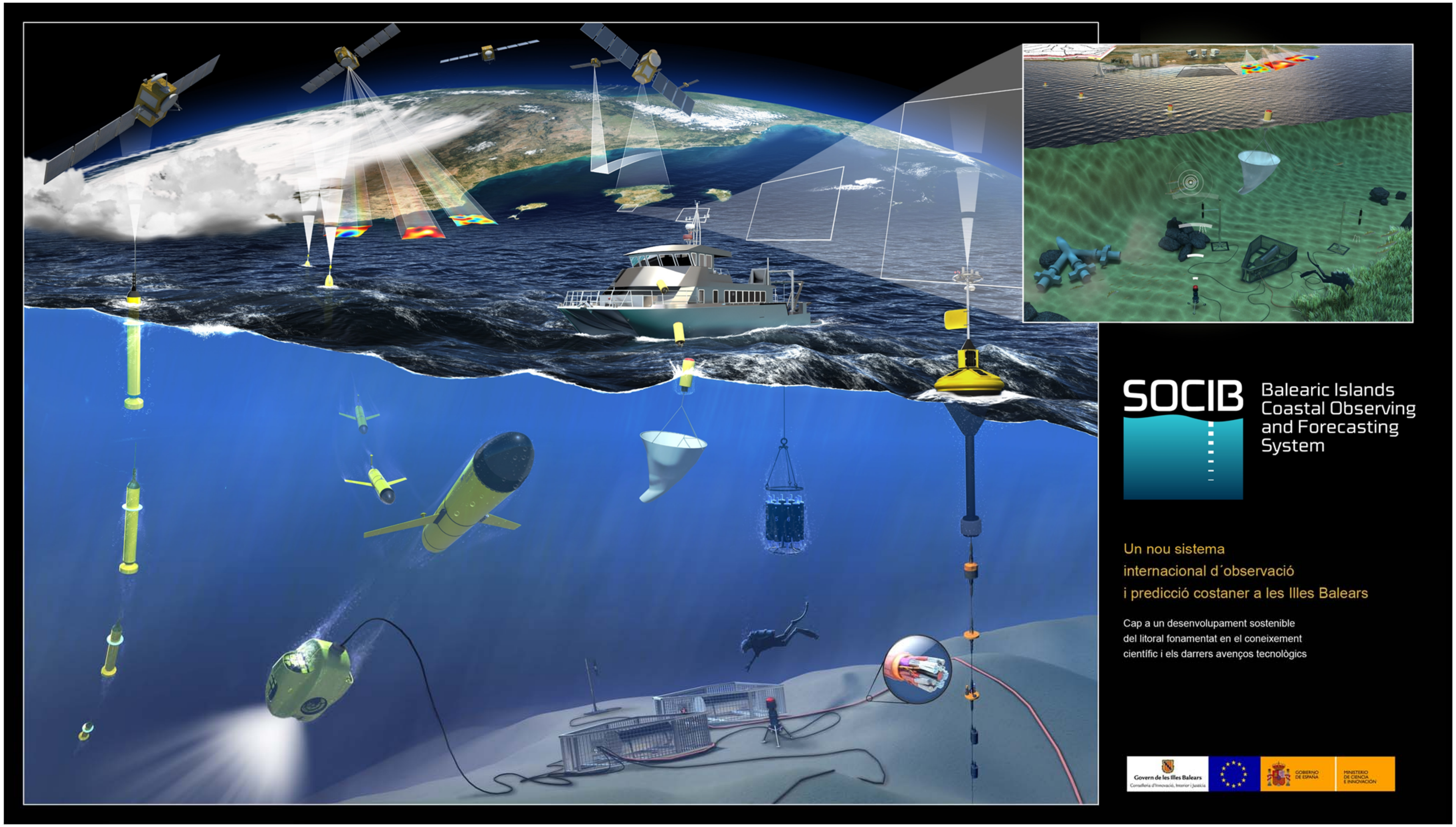
2. Forecasting sub-system

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

3. Data Centre

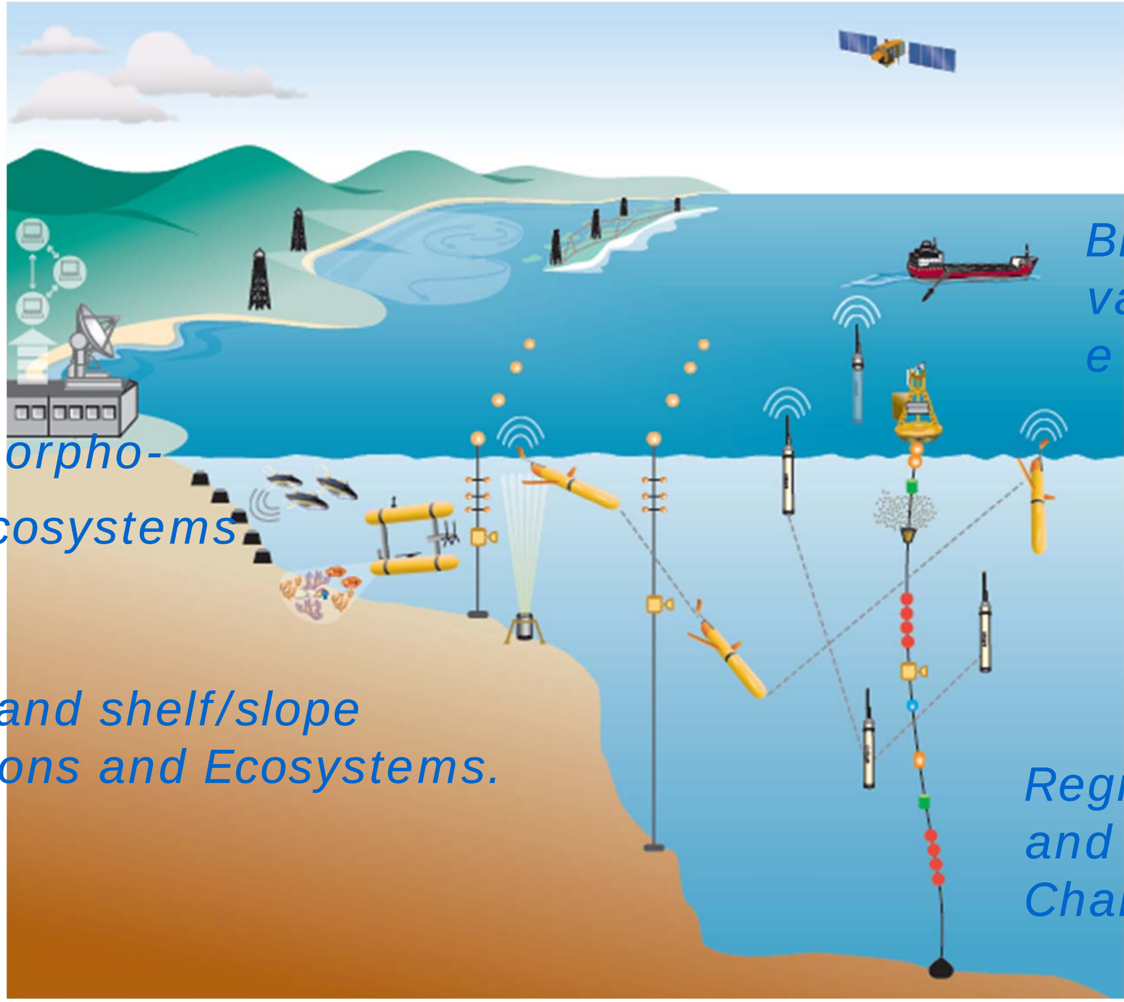
- Quality control and Web access in open source
- Effective data archiving, internationally accepted protocols, delivery and communication

SOCIB: the view….



SOCIB the view ...

Technology



Bluewater variability/climate

Nearshore morpho-dynamics

Nearshore ecosystems

Coastal and shelf/slope interactions and Ecosystems.

Regional sub-basin and Islands Channels

Adapted IMOS

Description of SOCIB Observing Facilities

- **Coastal Research Vessel**, to service moorings and to conduct spatial surveys (in-situ data). Catamaran, 25 m length approximately.
- **Gliders and AUV** fleet. Gliders are multi-sensor autonomous systems similar to a Argo float, which can traverse as well as profile, and are operated from a land base. AUV are autonomous vehicles monitoring of the coastal, benthic and nearshore environment.
- **Coastal Ocean Radar Network** for high resolution mapping of coastal currents and waves.
- **Mooring Network** – a network of reference stations, plus moorings on shelves and slopes.
- **Nearshore beach monitoring system**. Automated collection, analysis and storage of high-resolution digital pictures and in situ data used to observe and quantify coastal phenomena.

Other facilities that will be implemented and developed by the Engineering and Technology department

- **Argo** fleet. Profiling floats observing ocean physics to 2000 m
- **Surface Drifters**, measuring surface currents and properties such as temperature and salinity.
- Measurements on **Ships of Opportunity** – a set of underway observing systems for physical, chemical and biological oceanography on volunteer observing ships (merchant, fishing fleet, etc).

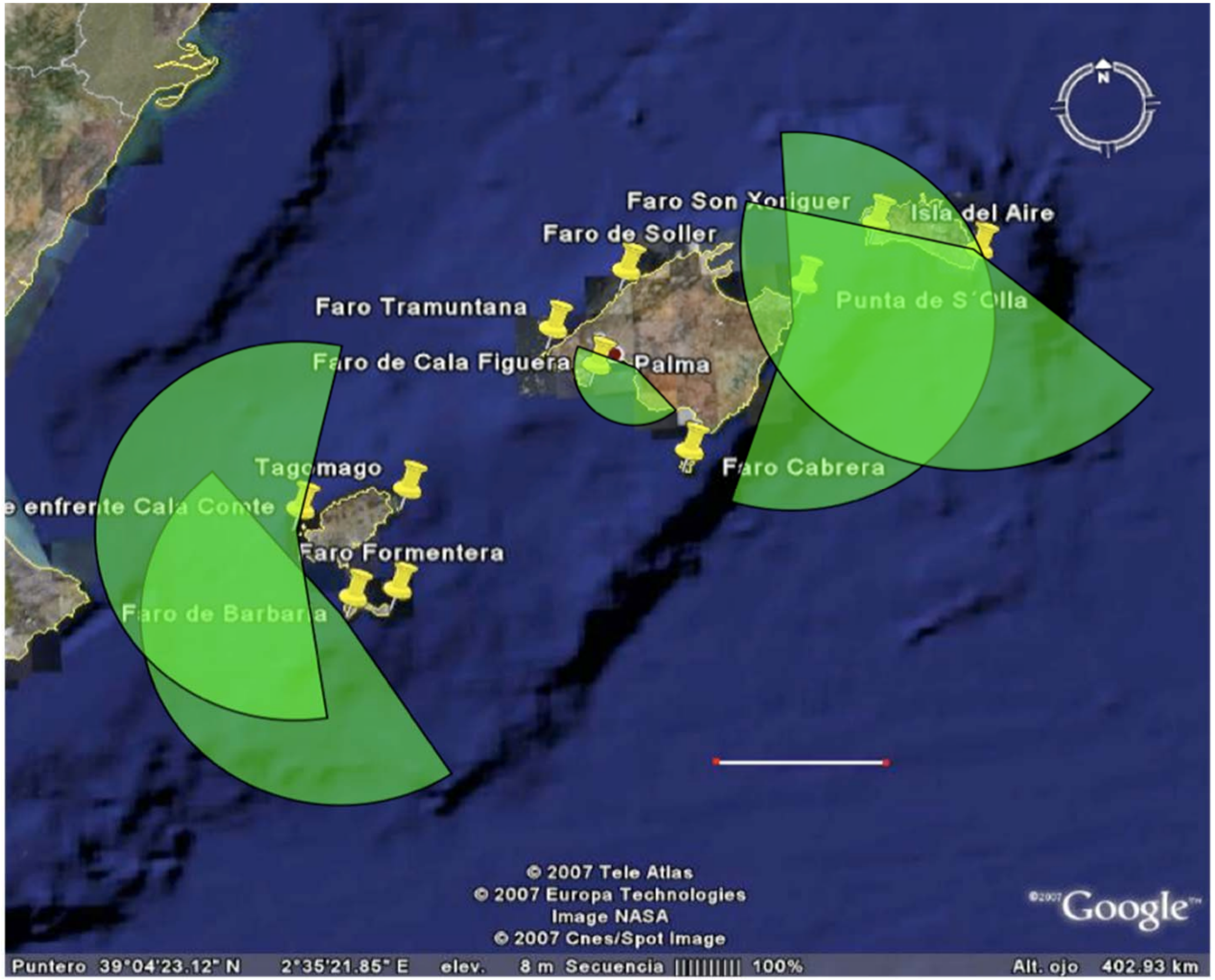
Satellite: enhancing Access to Ocean Remote Sensing Data – to make Satellite products to support research in coastal waters. (as part of Real Time and Support Unit).

(See www.socib.eu / Implementation Plan for further details)

Coastal Catamaran, R/V, 24 m LOA,
initial proposed design, NOOA R/V Manta

Coastal Catamaran, R/V

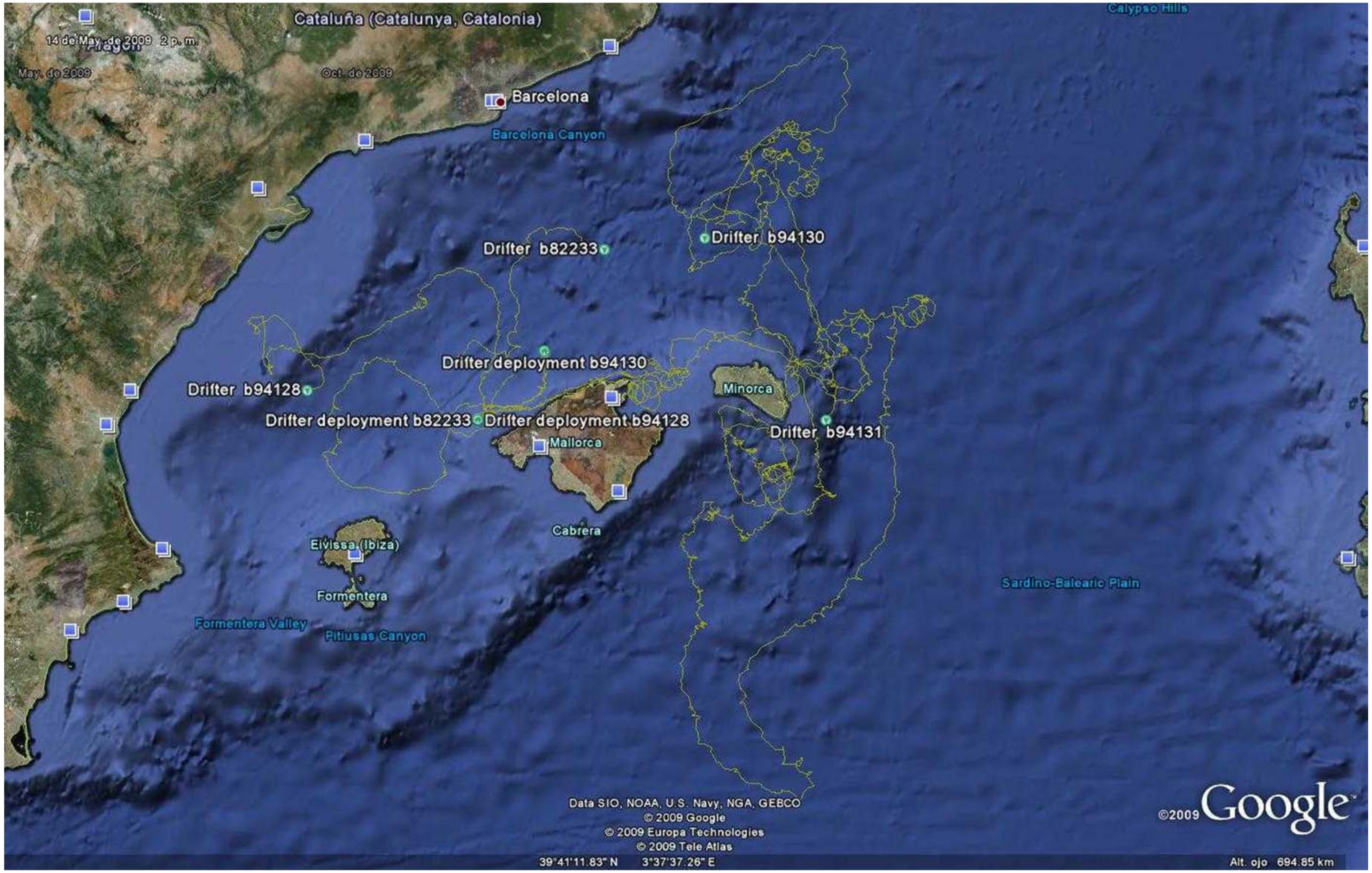
SOCIB HF Radar Facility



<u>**In 2011:**</u> Long range system in the Ibiza Channel

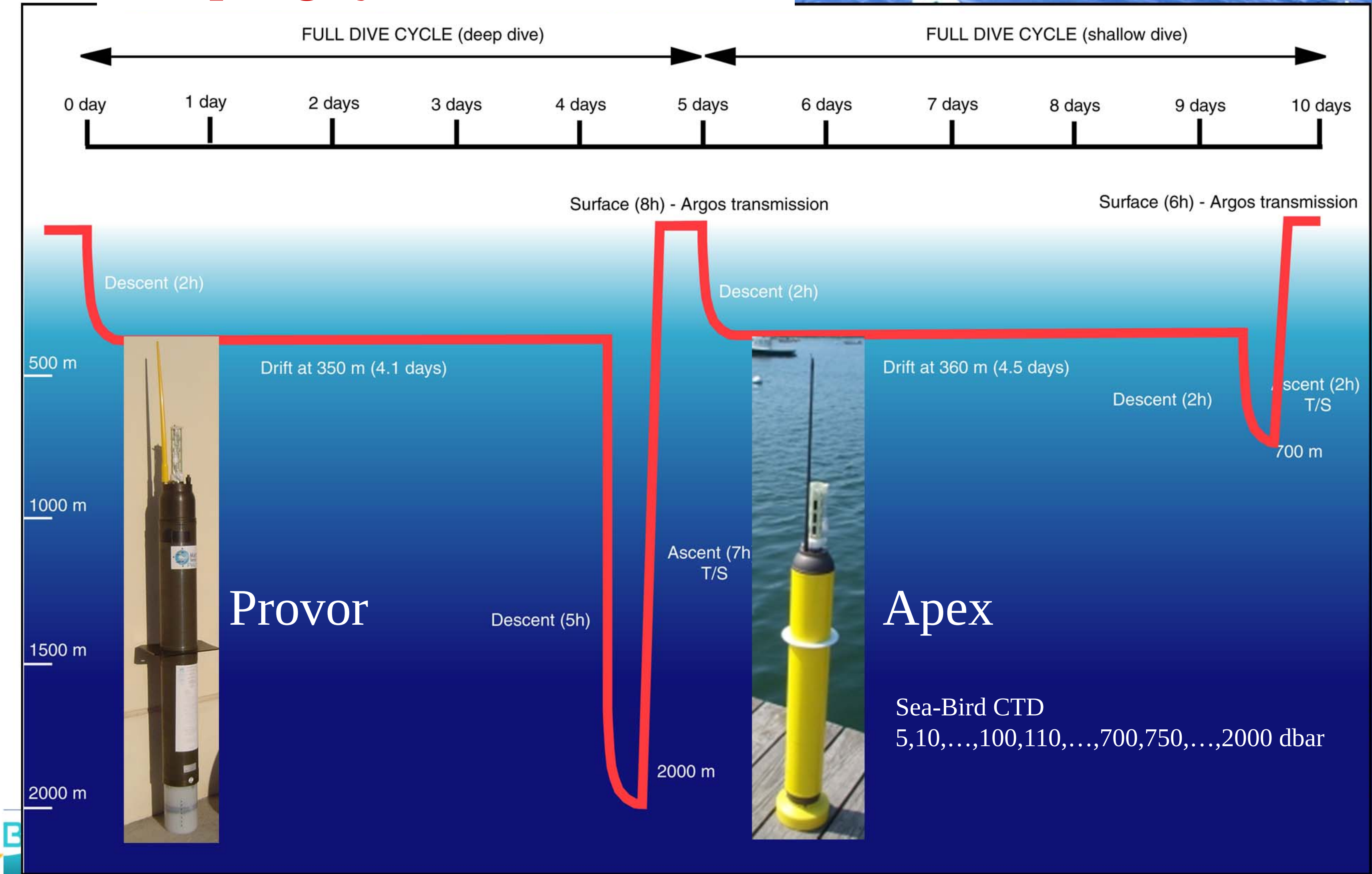
2nd Phase: Menorca Channel and High Resolution system in the Palma Bay

SOCIB Surface Drifter Facility (phase 0 – 2010 activities)



SOCIB ARGO Facility (phase 0 – 2011 activities)

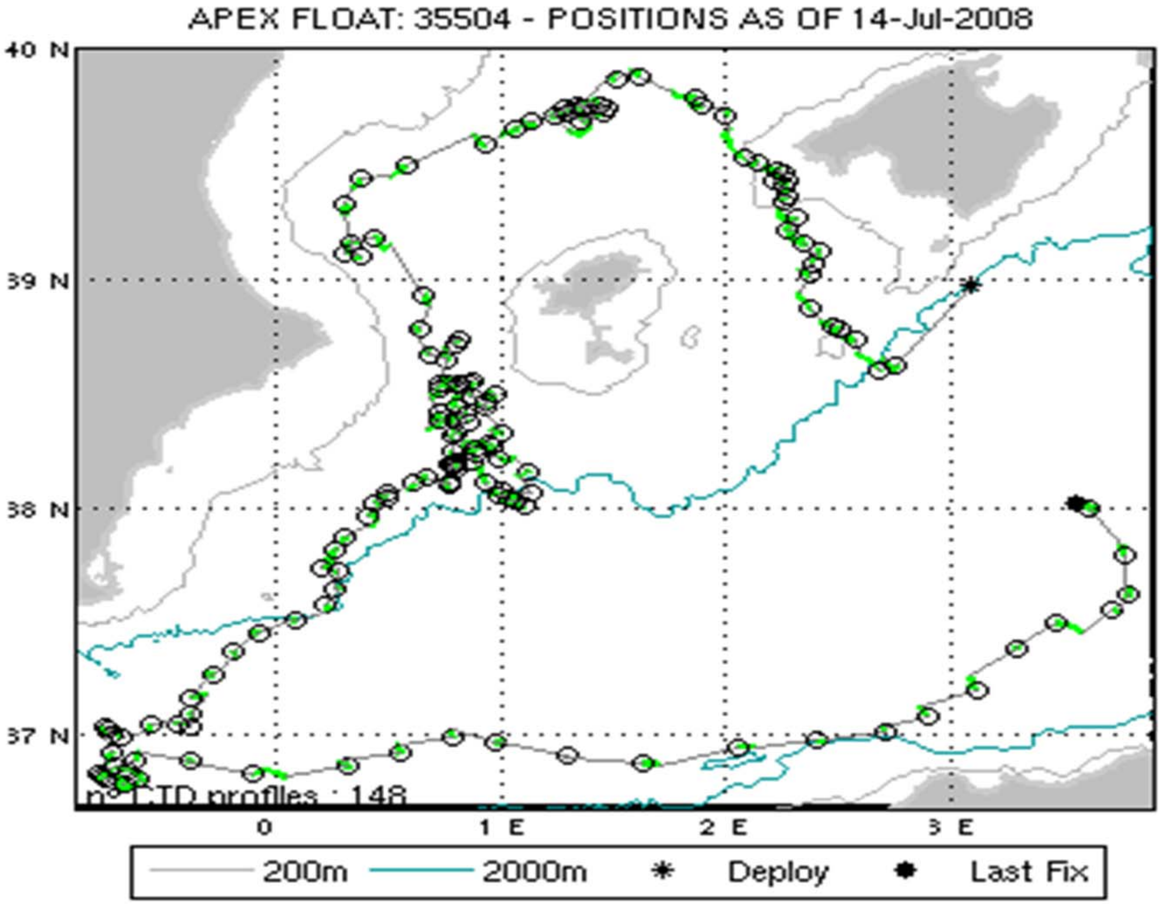
Sampling cycle characteristics



Courtesy, Pierre Poulain, MedARGO

SOCIB ARGO Facility (phase 0 – 2010 activities)

NEEDS UPDATE



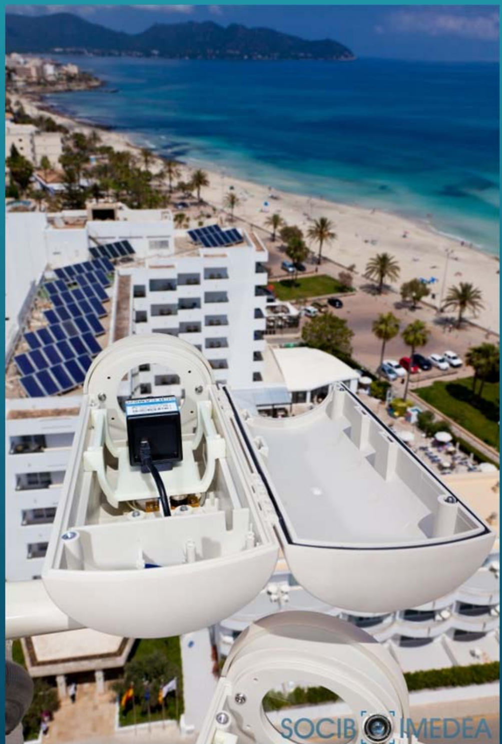
The SOCIB Marine and Terrestrial Beach Monitoring Facility (MTBMF) consists of MODULAR BEACH INTEGRAL MONITORING SYSTEMS (MOBIMS) which enable the autonomous ans sustained collection of physical data on beach morphology, hydrodynamics and sediment transport.

MOBIMS

- Beach videomonitoring SIRENA
- ADCPs
- Bathymetry and beach profiles surveys
- Sediment surveys

PRODUCTS & SERVICES FOR BEACH MORPHODYNAMICS RESEARCH & COASTAL MANAGEMENT

The SOCIB Marine and Terrestrial Beach Monitoring Facility (MTBMF) will operate at 4 locations in the Balearic Islands comprinsing more than 6 videomonitoring stations and 30 cameras, etc. Monitoring stations cover different types of beaches (natural, urban, exposed, sheltered, etc.)



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.

Observed variables

- •U, V (currents, surface and profile)
- •T (fixed point, profile, SST)
- •Hs, Hm, Tp, Dp (Waves)
- •S (fixed point, profile)
- •Beach morphology
- •Coastal bathymetry
- •Sediment samples
- •Sediment transport (OBS)
- •Fluorescence (profile)
- •Oxygen (profile)
- •Biogeochemical indicators (N, P, Si, larvae)

Observing Systems

Fixed

- •HF Radar installations
- •Coastal buoys
- •Beach video monitoring installations
- •Nearshore cable installation

Mobile

- •OceanBit R/V operations
- •Gliders and AUV's
- •ROV's
- •Argo and Drifter's
- •Fishing Fleet monitors

Model Systems

- •3D coastal ocean forecasting system (HOPS)
- •Operational currents forecasting system (ROMS)
- •Coastal ocean wave propagation model (WAVE)
- •Coupled (ROMS - atmospheric) high resolution operational forecasting system
- •Coupled (ROMS - NPZD) physical - biological ecosystem model

Products, Services & Outcomes

- •Data Centre archive and open access portal
- •Balearic Sea high resolution ocean currents forecast system
- •Balearic Sea high resolution wave forecast system
- •Early warning system for surge events
- •Oil spill / jelly fish invasion trajectory estimations
- •Balearic/Mediterranean beach system response to climate change
- •Beach erosion and variability monitoring
- •Beach safety and RIP currents
- •Beach carrying capacity (physical and social)
- •Tools for coastal zone decision makers
- •Science based coastal zone policy recommendation
- •Forecasting of Blue Fin Tuna spawning location and larval survival rates
- •Education, Outreach and Training
- •Step improvement in operational oceanography in the Balearic Islands
- •Adaptation to EU Framework legislation for the coastal zone
- •Technology development

Added value for science, technology & society

General:

- •Improve prediction, mitigation and management of impact of climate change and its affect on coastal zone
- •Improve management of natural disasters
- •Improve management of coastal ecosystems and resources
- •Develop new technologies tailored to the needs of coastal ocean observing
- •Contribute to European ocean monitoring framework, GMES, MOON

Specific:

- •Balearic Sea coastal ocean current variability
- •interannual variation in the north/south exchanges in the western Mediterranean
- •interannual variation in water mass properties
- •mesoscale/submesoscale eddies and fronts, dynamics and multidisciplinary interactions
- •sustained observations in the Balearic Seas to verify model output
- •hydrodynamics and sediment transport
- •physical/biological interactions focused on connectivity and MPA design
- •monitoring of water quality
- •identification of Blue Fin Tuna spawning sites/favorable habitats

Outline

1. **What** is SOCIB?
2. **Why SOCIB**, why Coastal Ocean Observatories, and **why now**?
3. Background
4. **Why in the Mediterranean?, Why in the Balearic Islands**
5. **Scales and major focus**
6. **Mission and Objectives**
7. Principles
8. Components, Structure and Functioning
9. **Initial results from ongoing SOCIB pilot facilities**
10. **Summary**

SOCIB Facilities and Services (phase 0: 2010 pilot activities and 2011 starting operational phase)

Already from SOCIB and/or in kind from CSIC and IEO and UIB:

SYSTEMS OPERATIONS AND SUPPORT DIVISION

OBSERVING:

- Glider Facility (4 Slocum gliders)
- Satellite remote sensing products Facility (pilot)
- 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

APPLICATIONS AND STRATEGIC ISSUES SOCIETY DIVISION

- ICZM and Science based sustainable coastal and ocean management

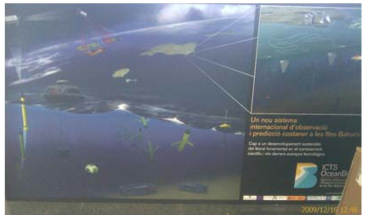
ENGINEERING AND TECHNOLOGY DEVELOPMENT DIVISION

- New technologies

SERVICES

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

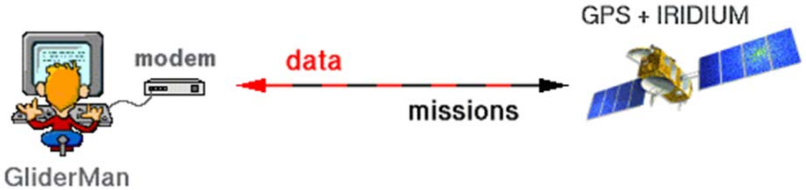
IMPLEMENTATION PLAN; approved July 2010



- Proven capability
- Pilot projects
- Non sustained

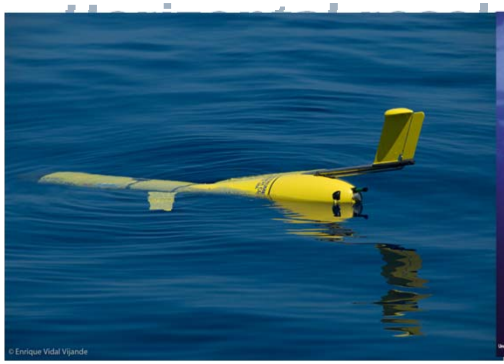
Parc Bit – office – August 2009

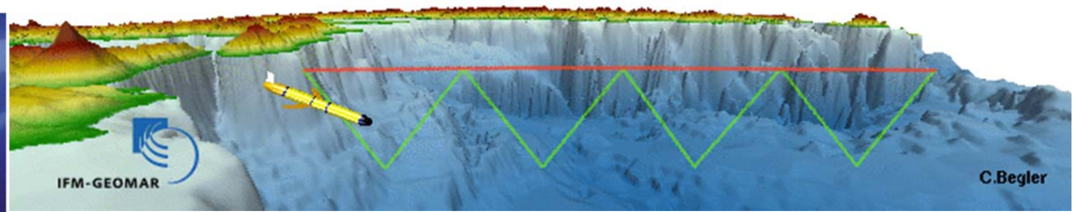
SOCIB Glider Facility (phase 0: 2009-2010 pilot activities)



Glider data

- **Variables: P, T, S**
- **Vertical extension: 10-180 m**





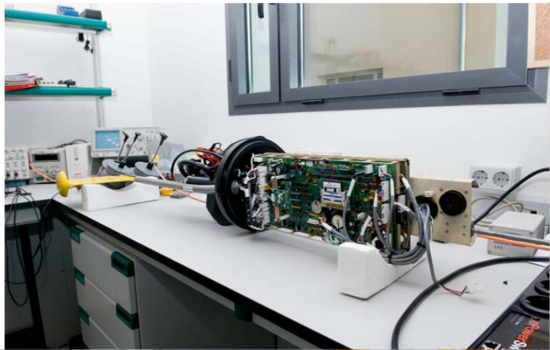
Envisat data

- **Along track SLA (AVISO/CLS) + MDT (Rio et al.)**
- **Delayed time product**
- **Mediterranean product**
- **Horizontal resolution: 7 km**

SOCIB Glider Facility (phase 0 – 2010 activities)

We have established new facilities for glider operations at IMEDEA

Electronics Laboratory



Ballasting Laboratory

Collaboration:
Search and Rescue
801 Squadron
and local authorities

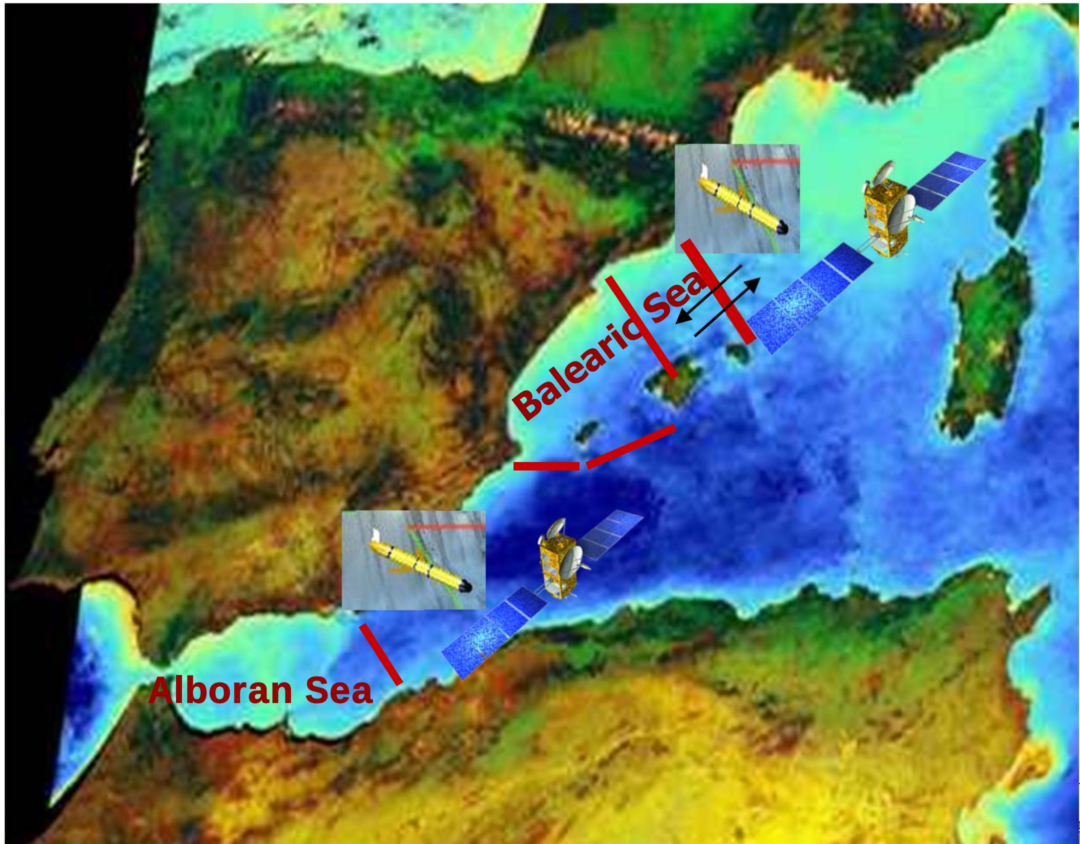
SOCIB Balearic Islands Coastal Observing and Forecasting System

CSIC Universitat de les Illes Balears Instituto Mediterráneo de Estudios Avanzados

SOCIB Glider Facility (phase 0: 2009-2010 pilot activities)

IMEDEA team has carried out **28** glider Missions from 11/2006 to 12/ 2010 in the Western Mediterranean Sea

- **8000 full CTD casts + oxigen, chlorophyll Turbidity**
- **50 Euros/profile (...)**



- Sustained glider observations along 773 ENVISAT track (every 70 days).
- Glider preparation and testing facilities at IMEDEA (CSIC-UIB)
- In collaboration with LODYC, Ifremer and also Rutgers Univ.
- Jason Altimeter track from Menorca to mainland and also in Eastern Alboran Sea, in collaboration with CLS.

and Forecasting System

CSIC

Instituto Mediterráneo de Estudios Avanzados

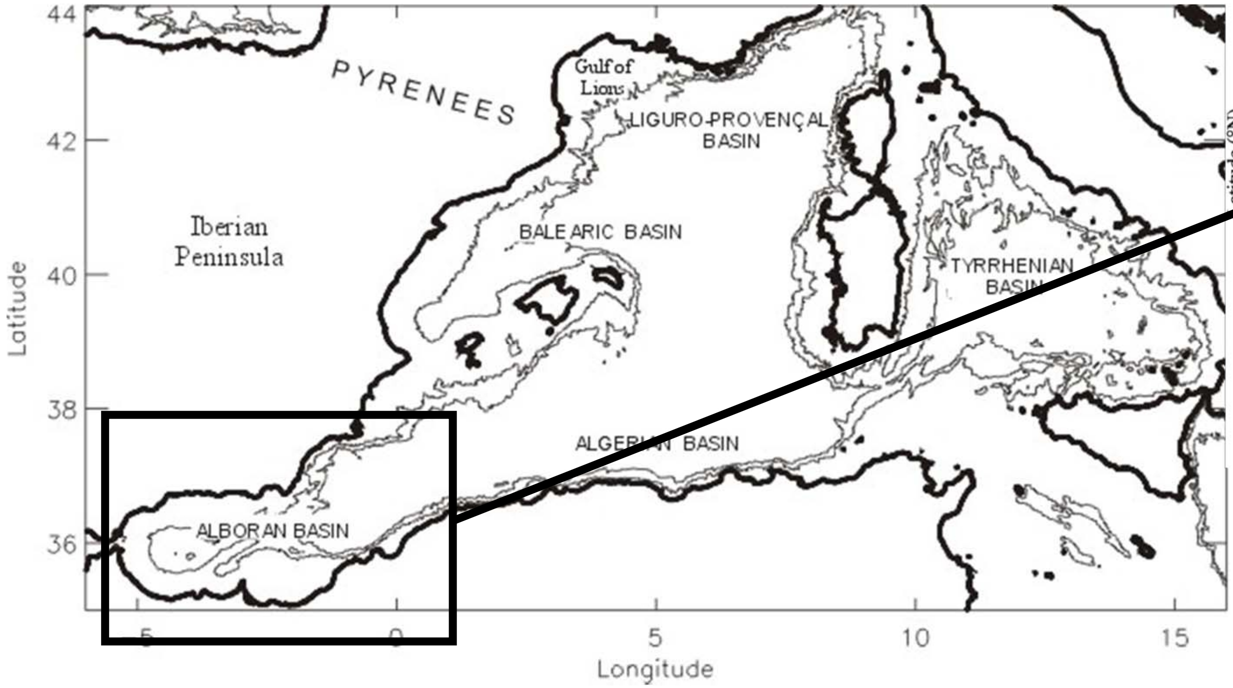
Universitat de les Illes Balears

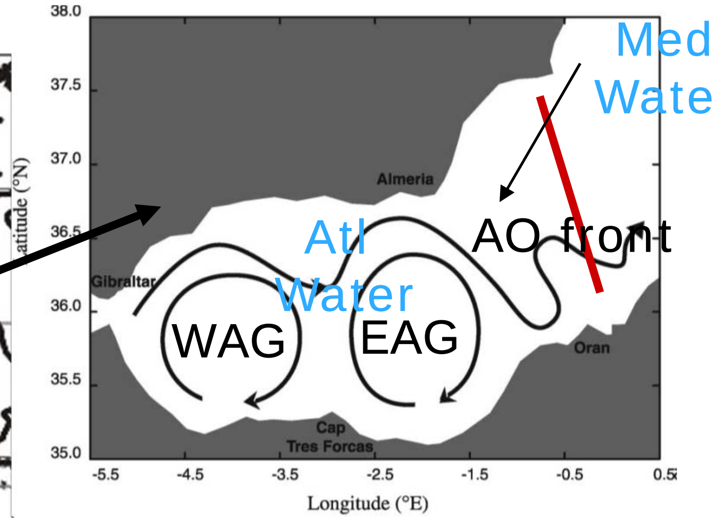
Govern de les Illes Balears

GOBIERNO DE ESPAÑA

MINISTERIO DE CIENCIA E INNOVACIÓN

SOCIB Glider Facility (phase 0: 2009-2010 pilot activities, Alborán July 2008)





Adjustment between AW/MW

Additonally: Altimetry Cal/val Jason1/2

-To improve our knowledge on the driving mechanism in the area: Mesoscale structures (filaments, eddies, etc) and associated vertical motion.
-To contribute to the physical and biogeochemical understanding in the area.

SOCIB Glider Facility (phase 0: 2009-2010 pilot activities, Alborán July 2008)

Slocum Coastal glider

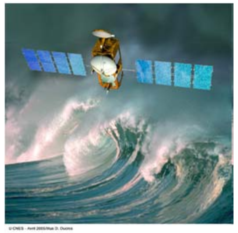
- 1311 profiles (CTD, fluorescence and turbidity) between the surface and 180 m.

From July 4 to 18, 2008 and was designed to cross the eastern Alboran Sea.

-The along-track glider data resolution is about 0.5 km.

- All variables gathered have been averaged vertically to 1 dbar bins.

-The glider trajectory was established to be coincident with the altimetry satellite track 172 of the tandem mission Jason-1 and Jason-2.



Jason-1 / Jason-2 altimeters

- Along track SLA (AVISO/CLS) + MDT (Rio et al.)

- Specific Mediterranean product

- Horizontal resolution: 7 km

Gridded products: 100 km (OI scheme with 100 km lengh scale)

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

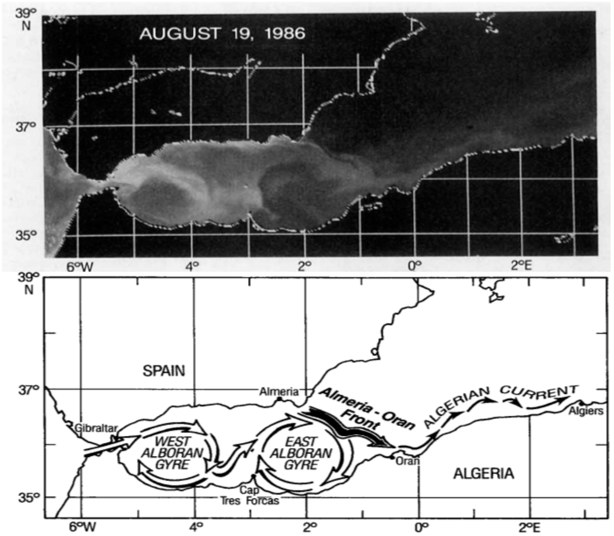
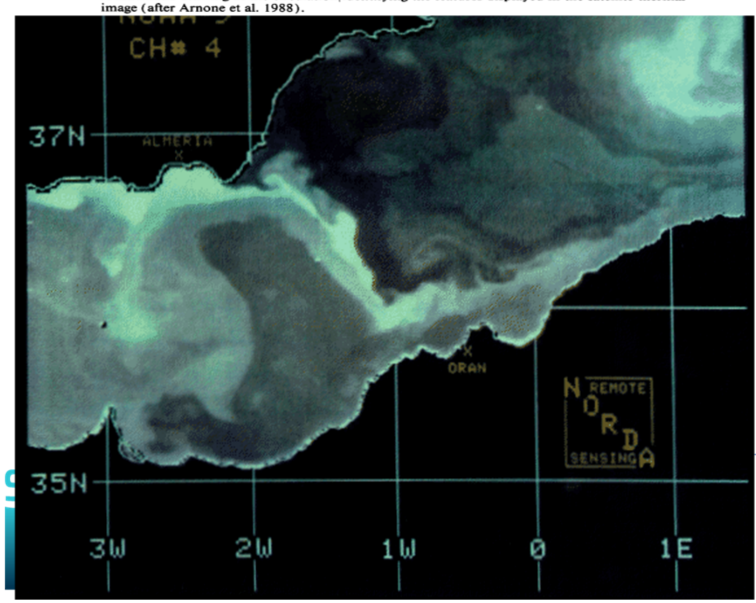


FIG. 1. (Top) A satellite thermal image of the Alboran Sea, showing the continuity of the regional circulation. As with the other satellite imagery in this paper, this NOAA AVHRR-IR image was registered to a Mercator projection and enhanced to show the ocean features. (Bottom) A schematic drawing of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



letters to nature

floras, angiosperms typically constitute only a very small percentage of the total diversity[15,17,29]—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[21]. 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.

Received 20 October; accepted 15 December 2000.

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

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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.

Eastern Alborán Sea dynamics and basin scale interactions

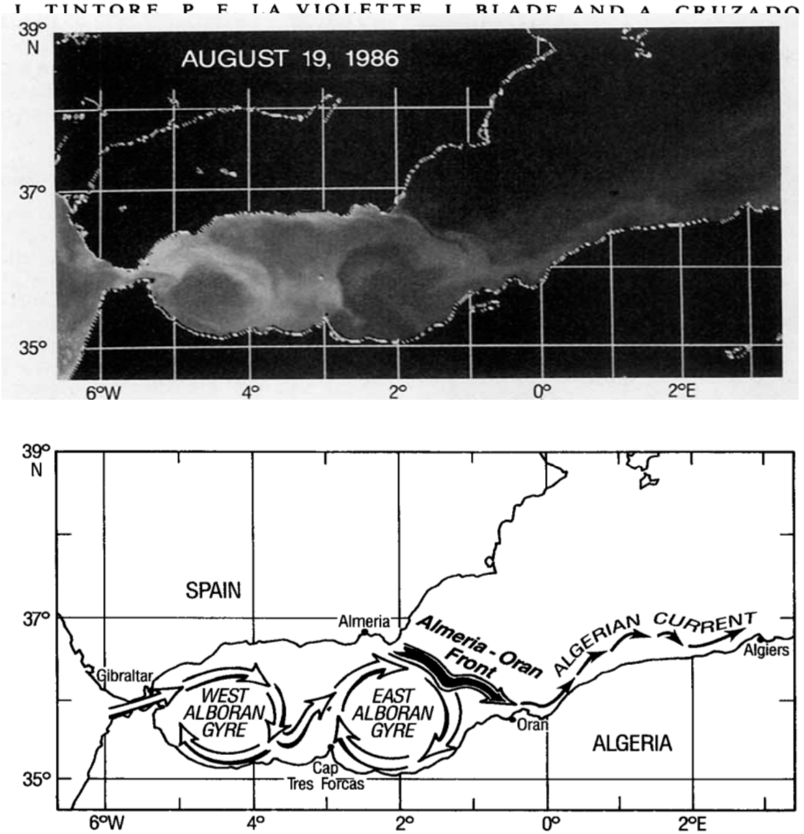
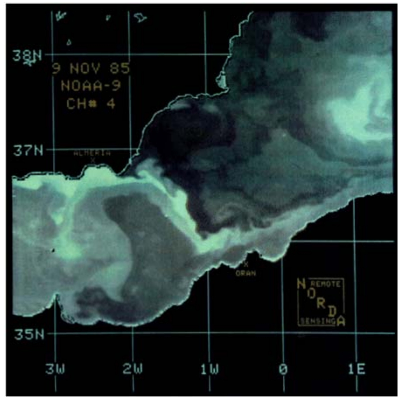
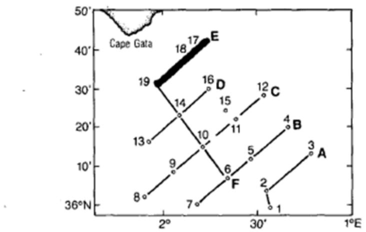


FIG. 1. (Top) A satellite thermal image of the Alboran Sea, showing the continuity of the regional circulation. As with the other satellite imagery in this paper, this NOAA AVHRR-IR image was registered to a Mercator projection and enhanced to show the ocean features. (Bottom) A schematic drawing of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





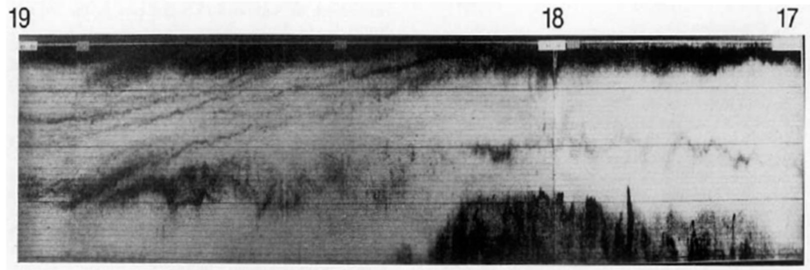


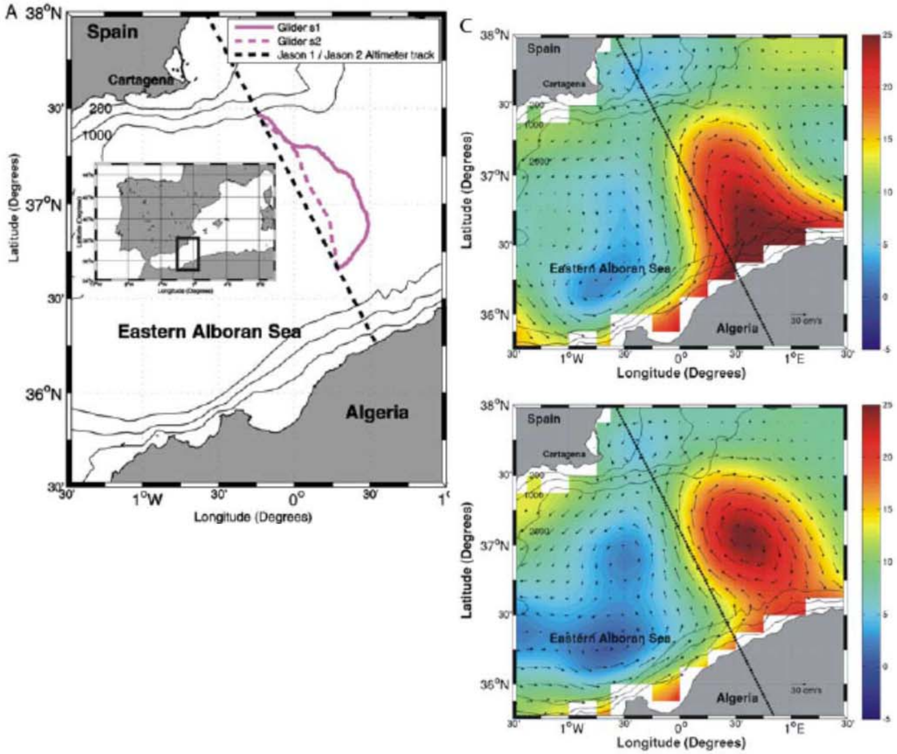
FIG. 10. Echosounder chart for Section E.

Results

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]



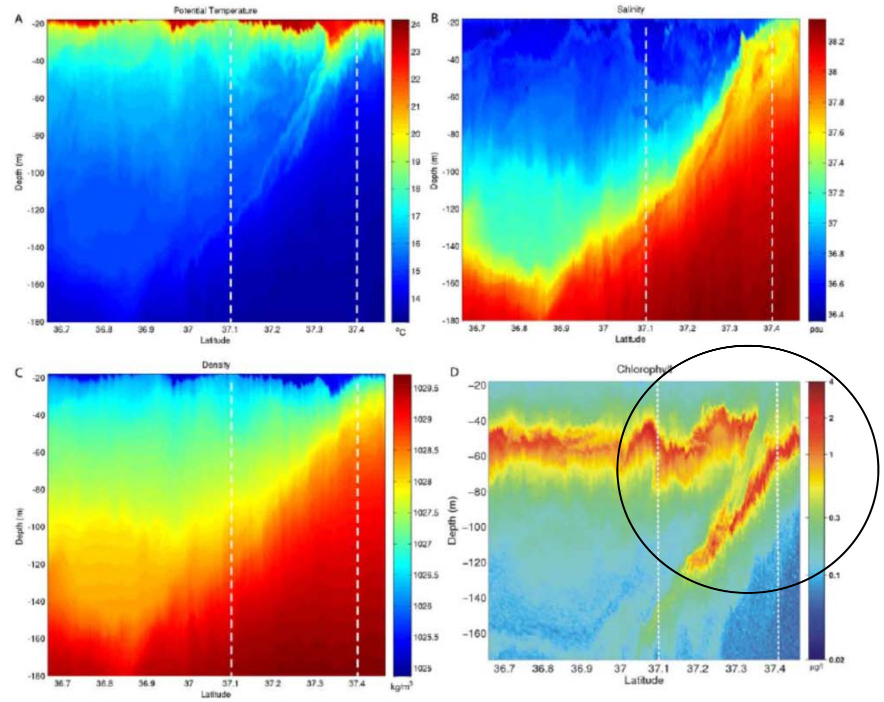
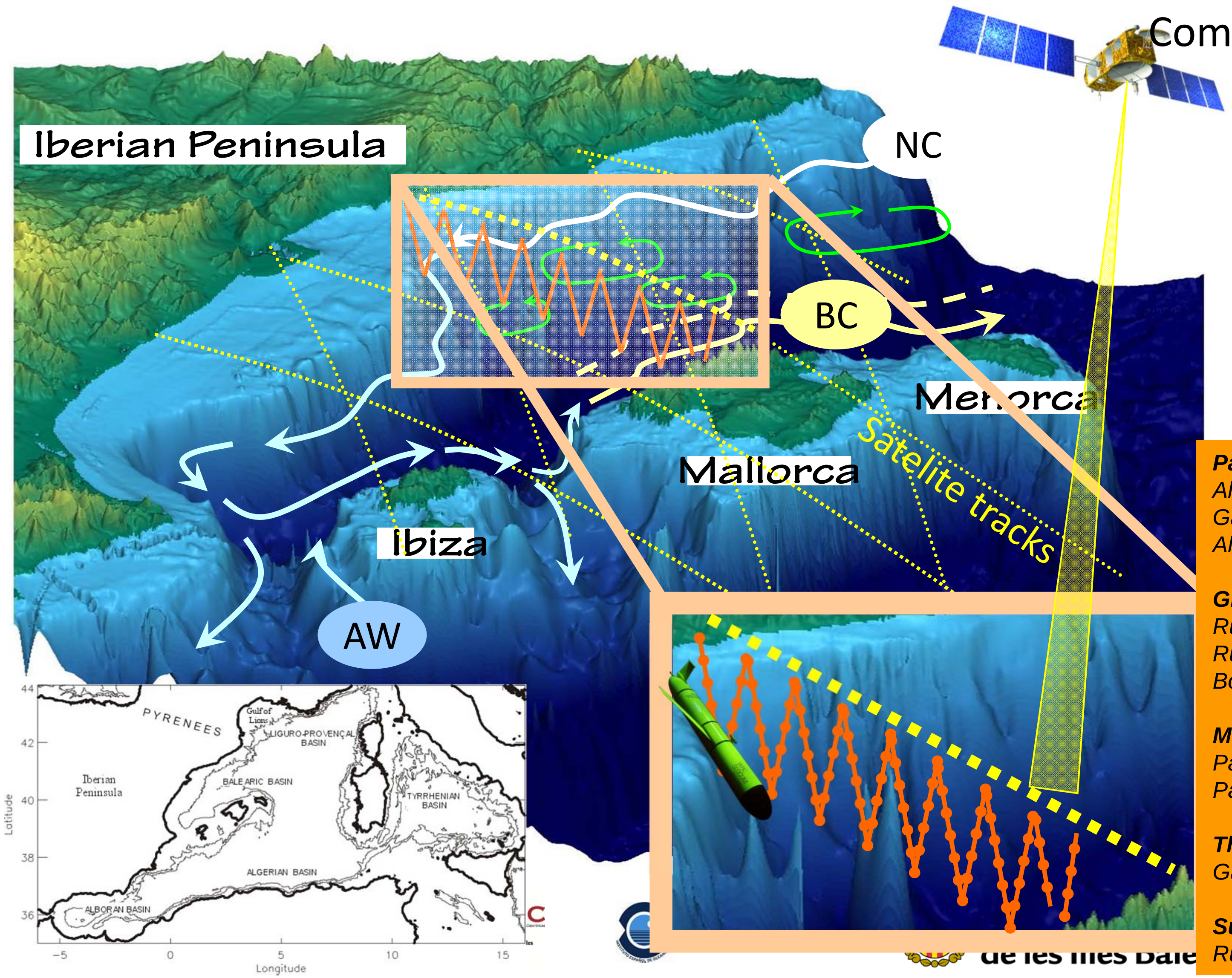


Figure 2. Vertical section of temperature (°C), salinity (PSU), density (kg/m^3) and chlorophyll (μg/l) from glider section 2 (dashed magenta in Figure 1). White dashed lines define sub-section in the northern part of the domain.

Gliders, Altimetry and Multi-Sensor approaches in the Balearic Sea: SINOCOP experiment



Complex dynamics

- At North: NC
- At south BC, its associated front and AW inflow
- In-between, mesoscale (eddies, meandering….) due tc

Path planning / adpative sampling
Alvarez et al., 2004, IEEE
Garau et al., 2006, IEEE
Alvarez et al., 2007, J. Mar. Sys.

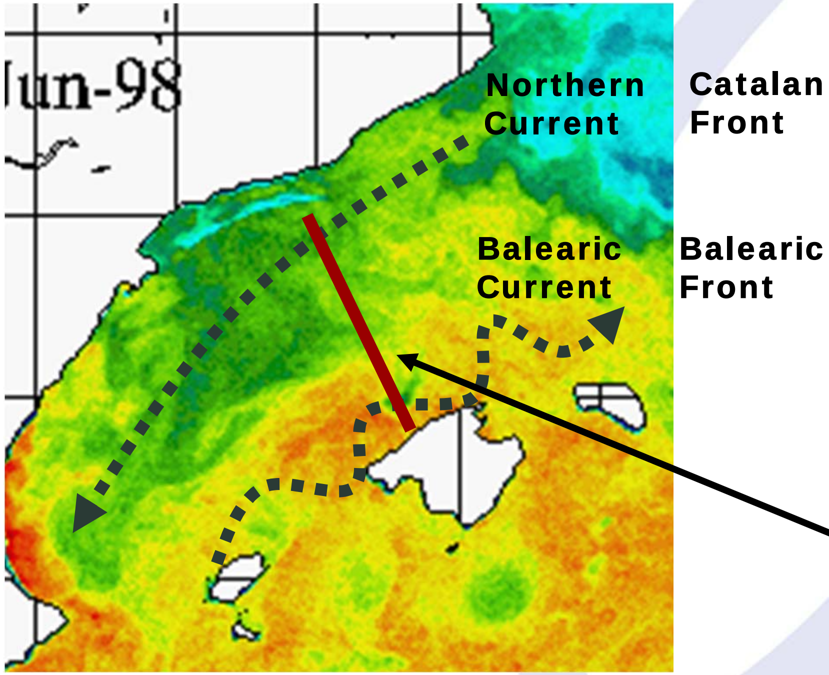
Glider and altimetry
Ruiz et al., 2009a , J.Mar.Sys.
Ruiz et al., 2009b, Geophy. Res. Lett.
Bouffard et al., 2010, J.Geophys.Res.

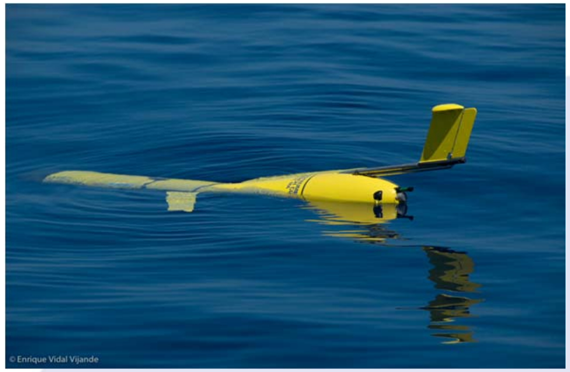
Multi-platform approach
Pascual et. al., 2010, Sea Tech.
Pascual et al., 2011, JGR (in preparation)

Thermal lag
Garau et al., 2011, JAOTech (accepted)

Summary of 5 years of glider activities
Ruiz et al., 2011, Sci. Mar.(submitted)

The Balearic Front





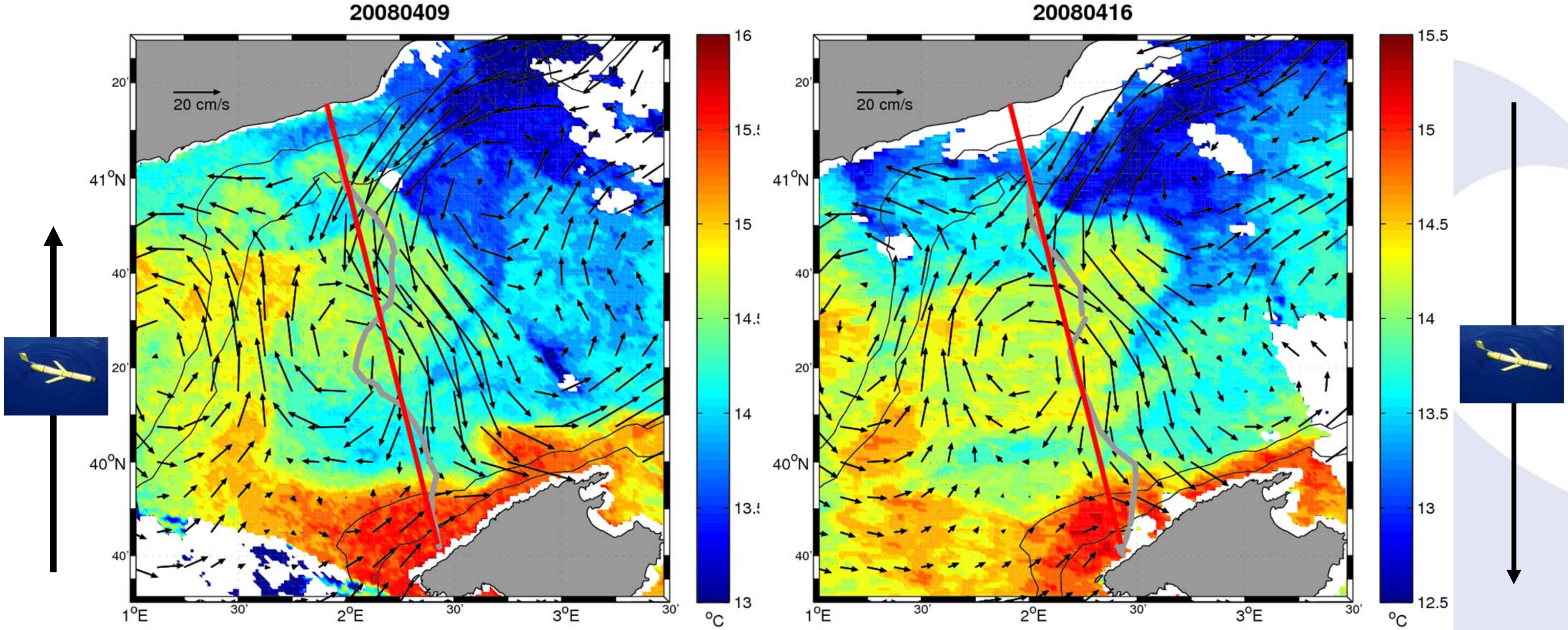
Sustained observational glider programme:

Missions simultaneous to Envisat passage along track 773 (perpendicular to the Balearic and Catalan fronts)

tecnología marina
oceanografía operacional
y sostenibilidad

April 2008 mission - an intense eddy

Sinoptic view from remote sensing data

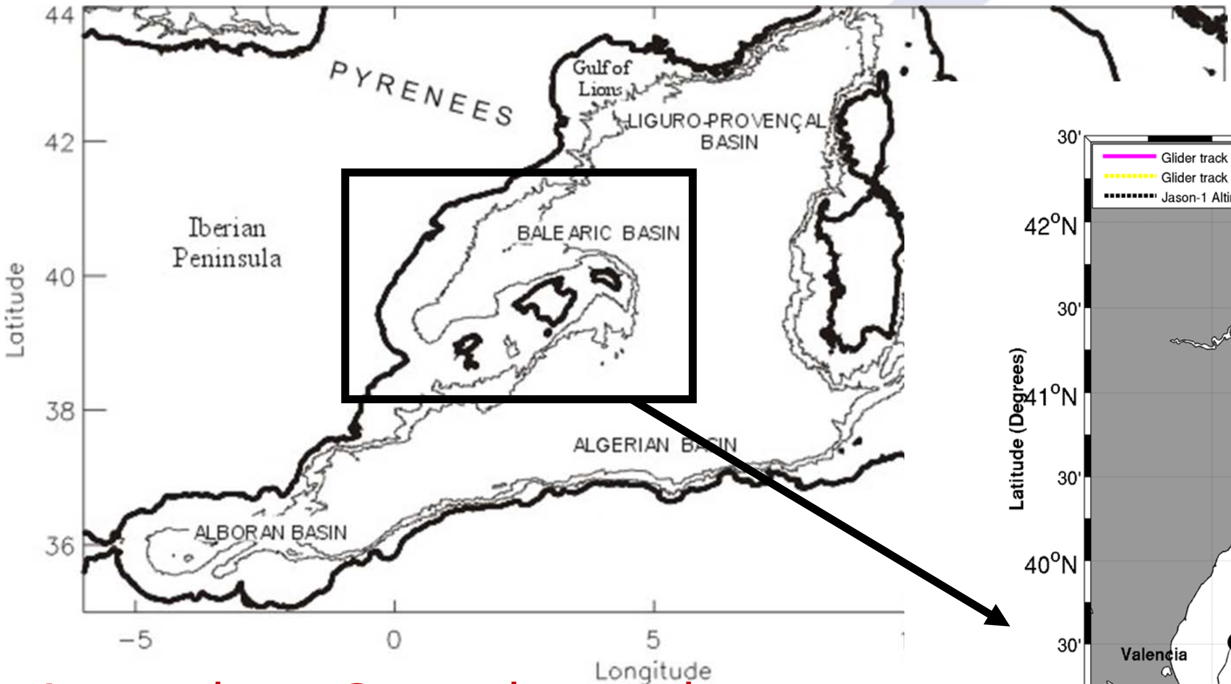


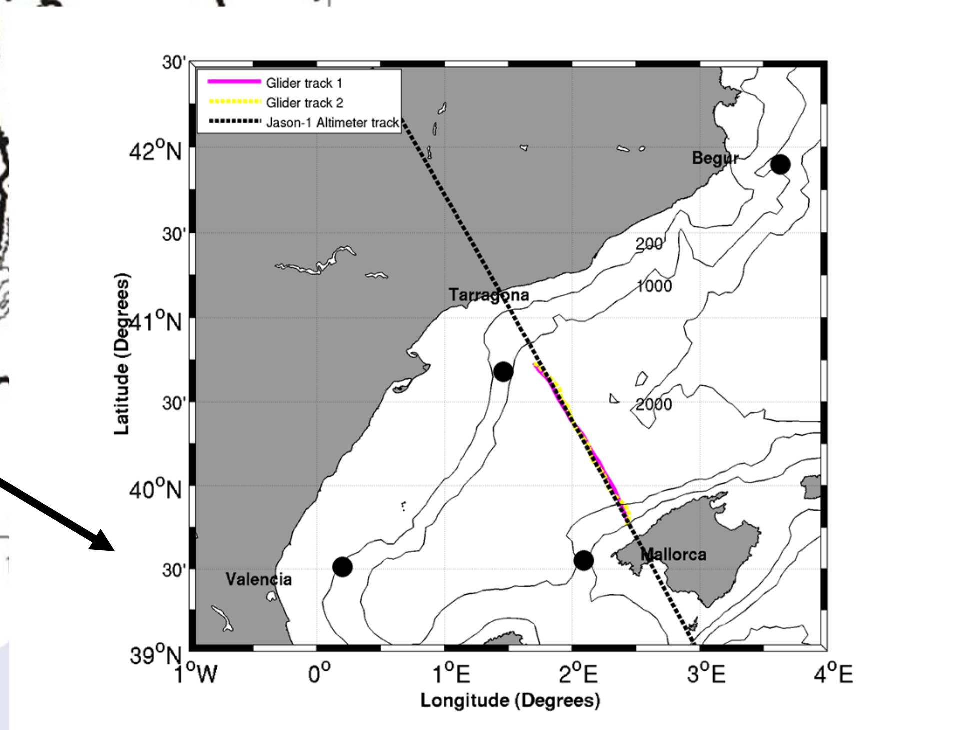
Color: SST. Source: ICM.
Vectors: Absolute geostrophic currents from DT merged altimeter gridded fields. Source: AVISO.

Grey line: glider track

tmoos tecnología marina oceanografía operacional y sostenibilidad

Study area and scientific objective





Atmosphere-Ocean interactions

- To investigate the impact of an atmospheric front on the ocean mixed layer
  - Atmospheric forcing.
  - Mixed layer (high resolution from glider data).
  - Heat content.

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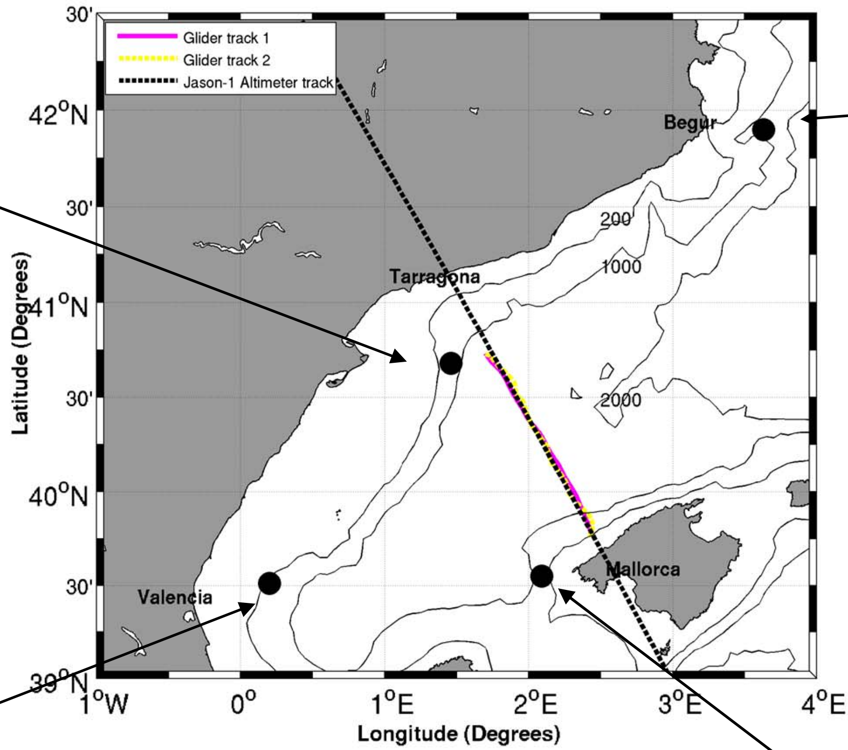
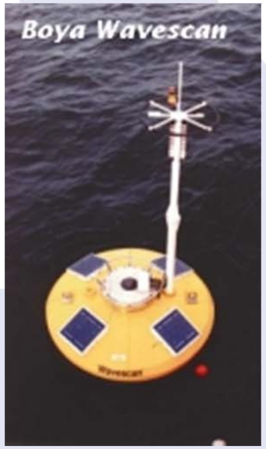
oceanografía operacional
y sostenibilidad

Deep buoys network in the WMED - Puertos del Estado





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

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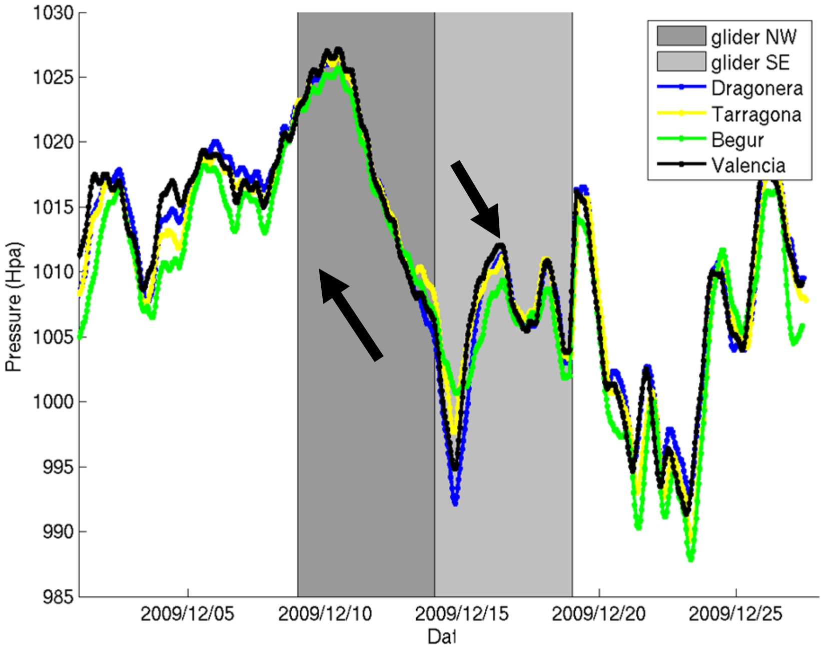
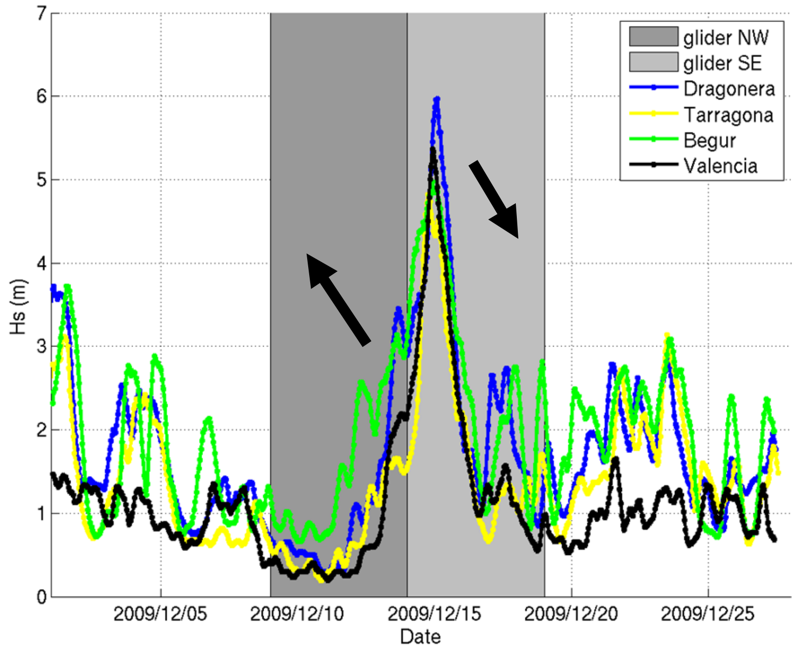
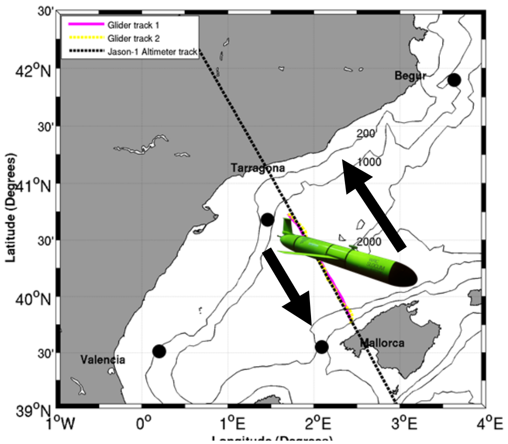
oceanografía operacional
y sostenibilidad

Results: Observations from Buoys PdE network



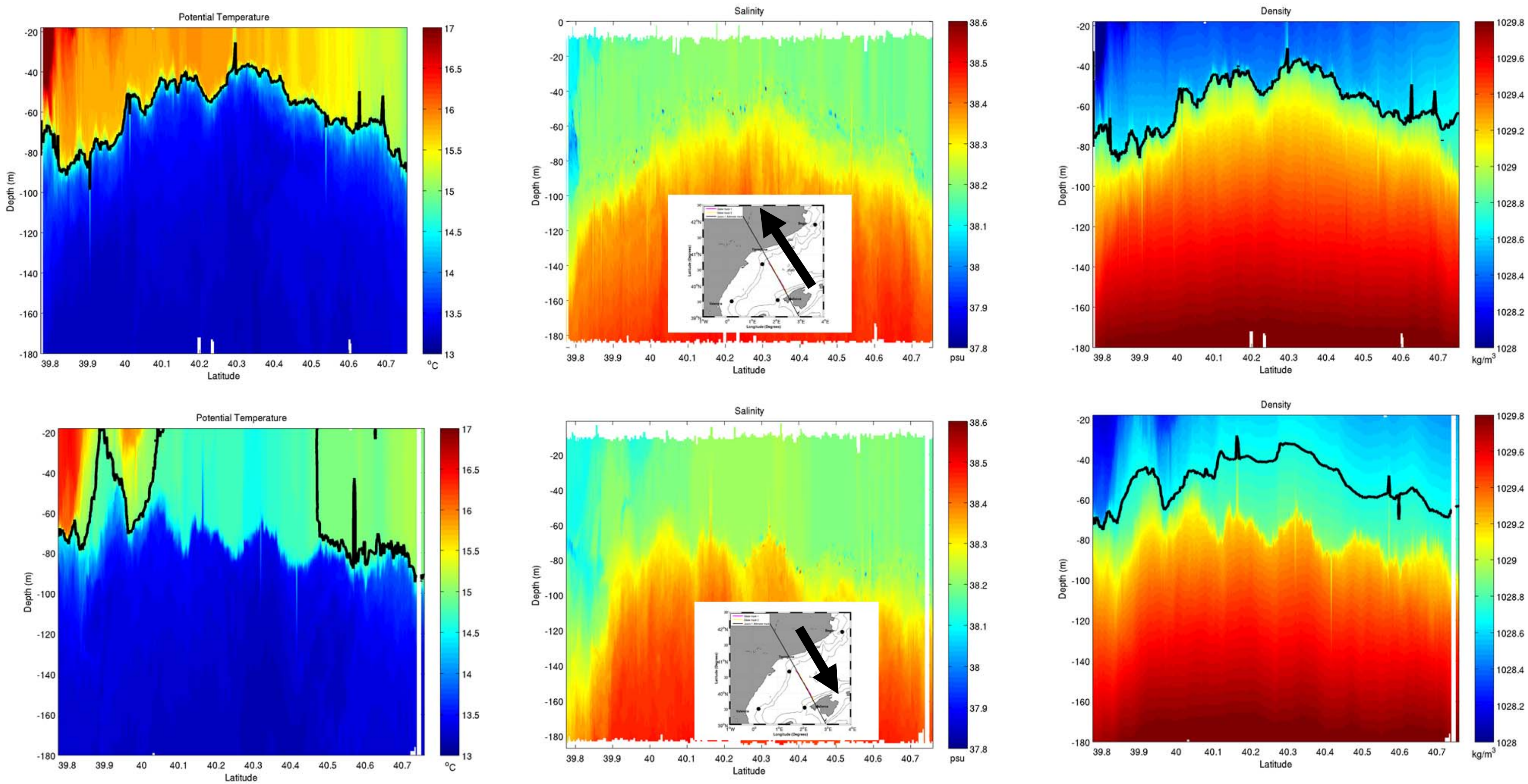




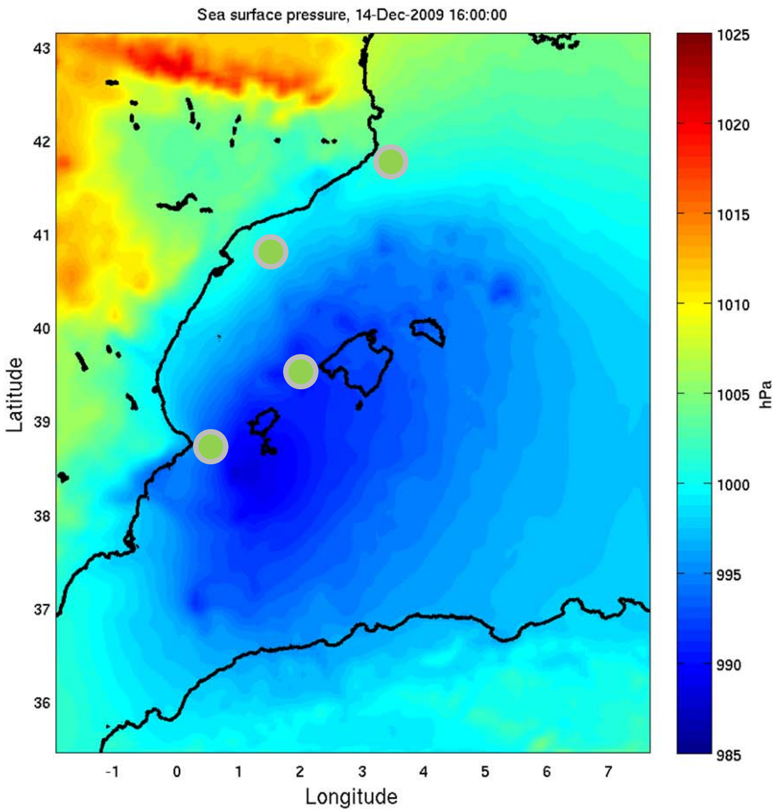
Atmospheric forcing over the sub-basin

tecnología marina
oceanografía operacional
y sostenibilidad

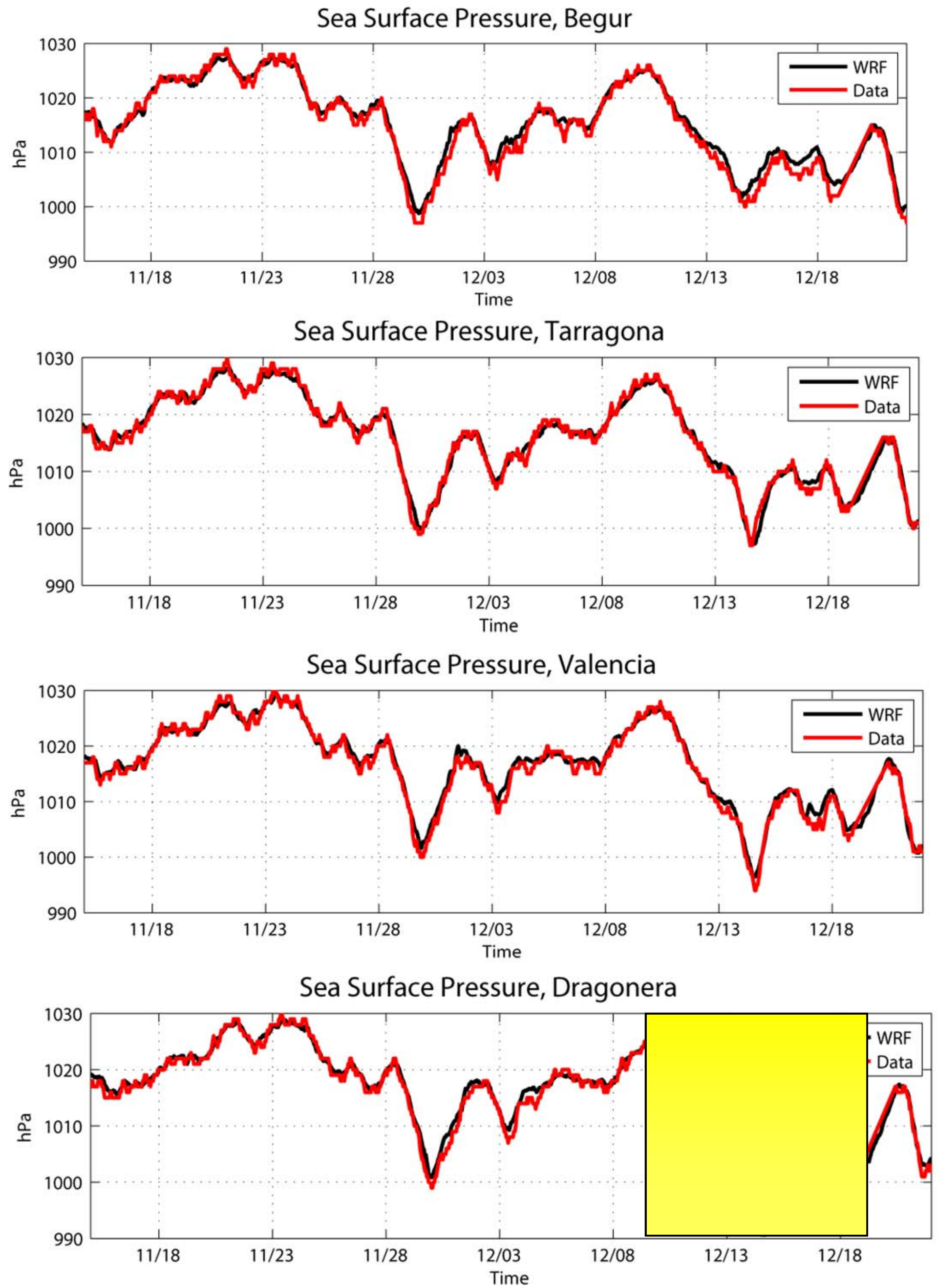
Glider Results: Hydrography

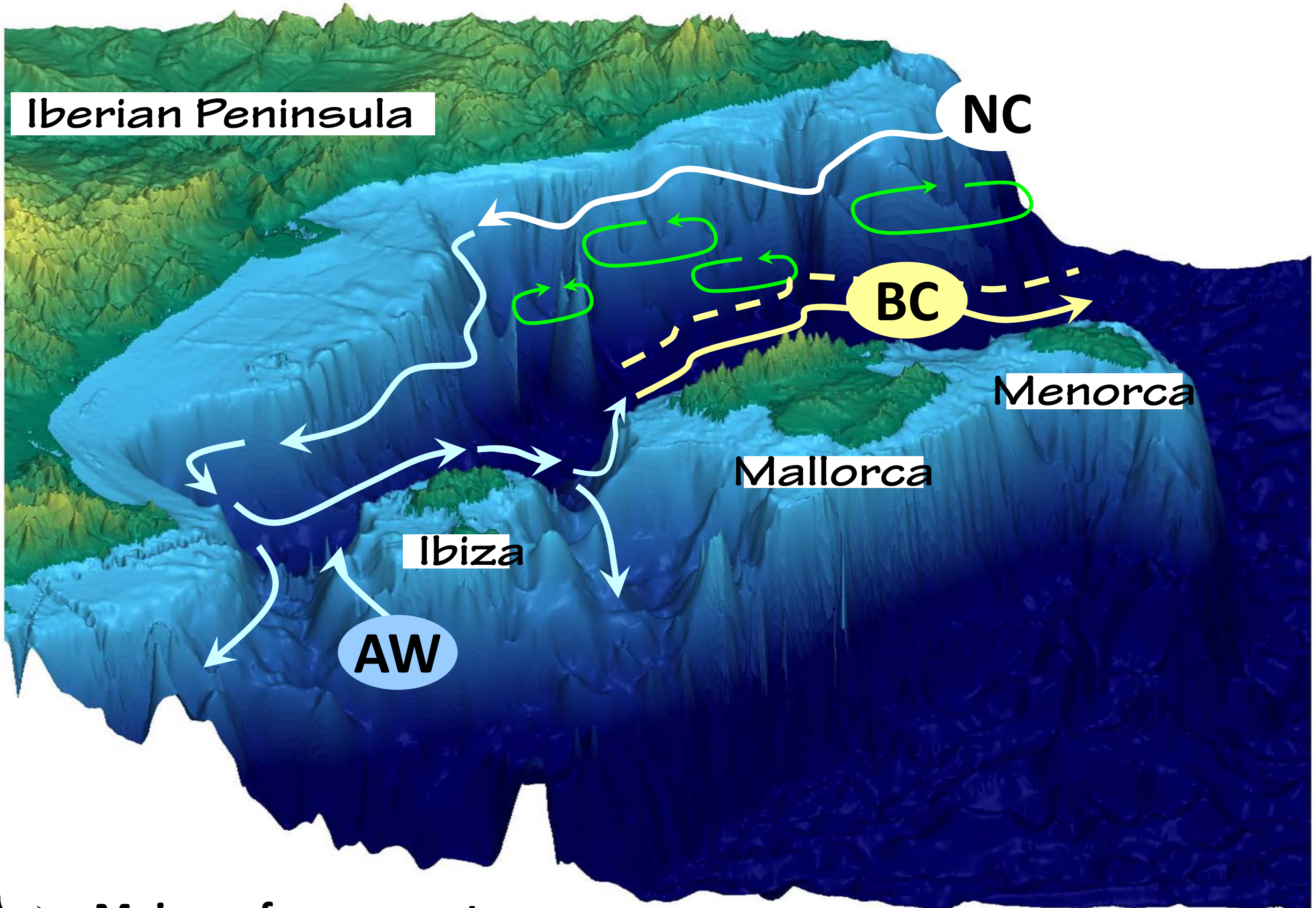


Results: atmos. model outpus



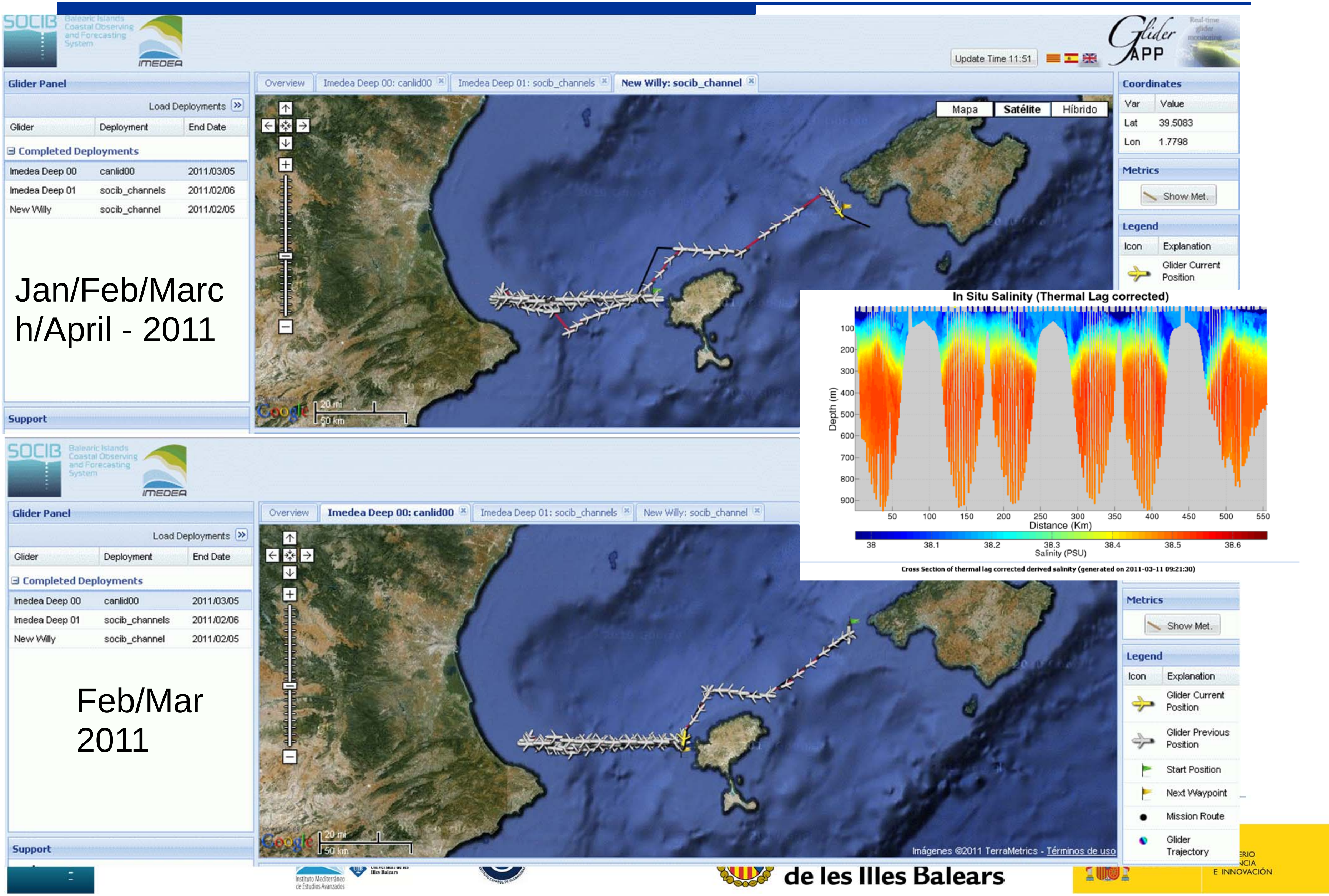
- Very good agreement with the observations
- Dragonera : 1020hPa → 990 hPa





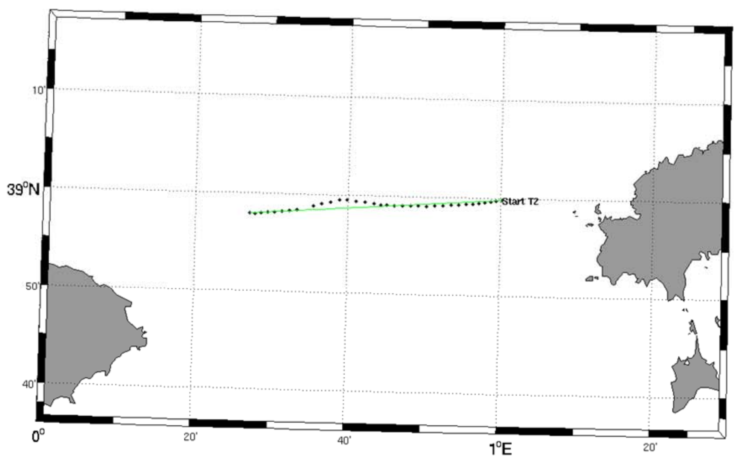
: Main surface currents

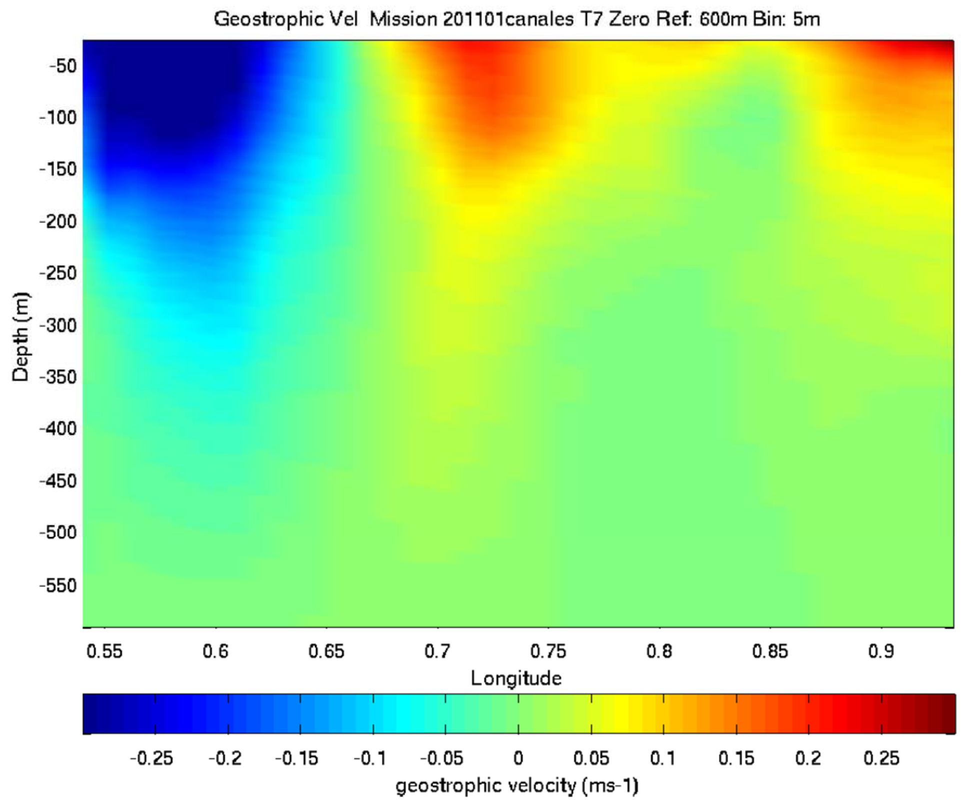
- Important exchanges and impact on biology
- Previous studies; NC stronger in winter, BC flow variable, retroflection ('blocking eddies'), variability in inflows


Glider APP
Update Time 11:51
Glider Panel
Load Deployments
Glider
Deployment
End Date
Completed Deployments
Imedea Deep 00 canlid00 2011/03/05
Imedea Deep 01 socib_channels 2011/02/06
New Willy socib_channel 2011/02/05
Jan/Feb/March/April - 2011
Support
Overview
Imedea Deep 00: canlid00
Imedea Deep 01: socib_channels
New Willy: socib_channel
Mapa
Satélite
Híbrido
Coordinates
Var
Value
Lat 39.5083
Lon 1.7798
Metrics
Show Met.
Legend
Icon
Explanation
Glider Current Position
In Situ Salinity (Thermal Lag corrected)
Depth (m)
Distance (Km)
Salinity (PSU)
Cross Section of thermal lag corrected derived salinity (generated on 2011-03-11 09:21:30)
Feb/Mar 2011
Glider Previous Position
Start Position
Next Waypoint
Mission Route
Glider Trajectory
Imágenes ©2011 TerraMetrics - Términos de uso
de les Illes Balears

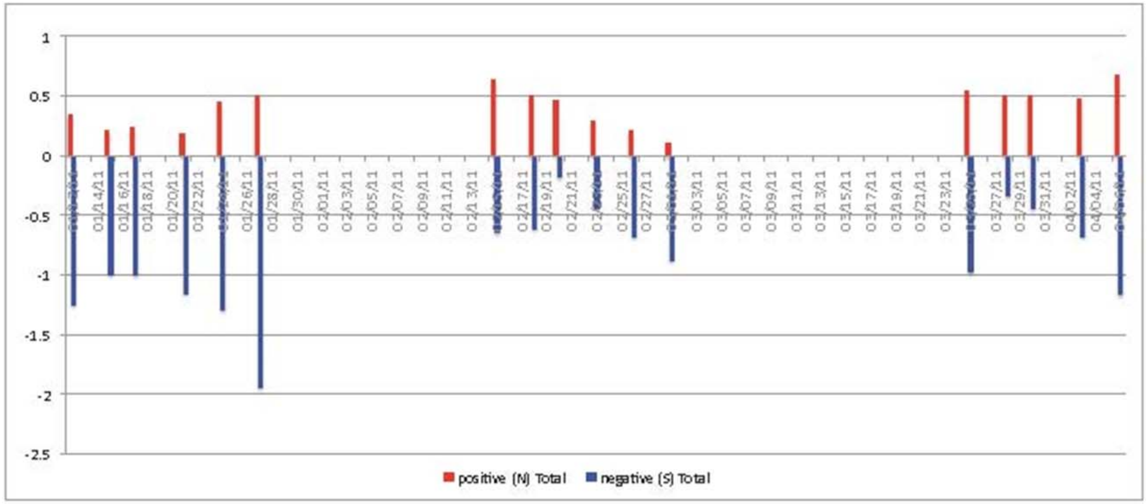
Results 1 – geostrophic current variance

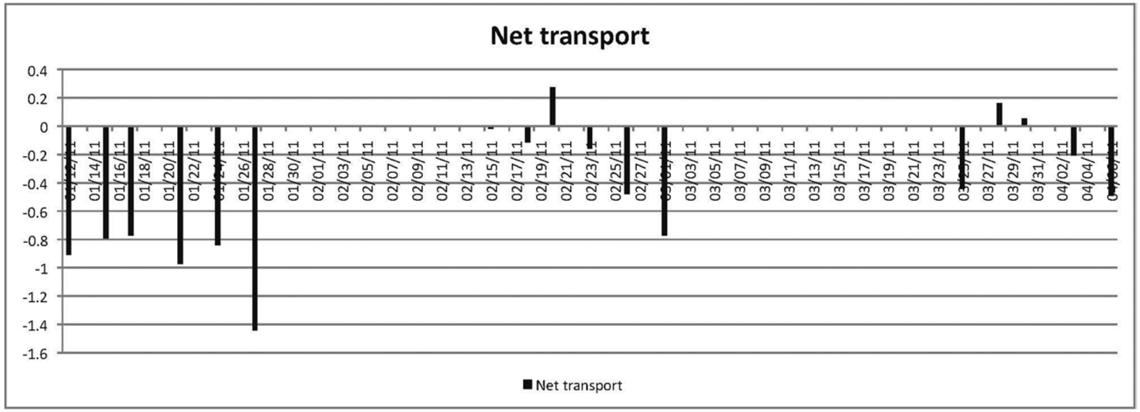
- Geostrophic current estimates, transect approx. 3 days
- Variability in strength and location NC and BC inflows





Ibiza Channel monitoring since January 2011





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 **<u>never fully observed before</u>**, 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 (phase 0: 2010 pilot activities)

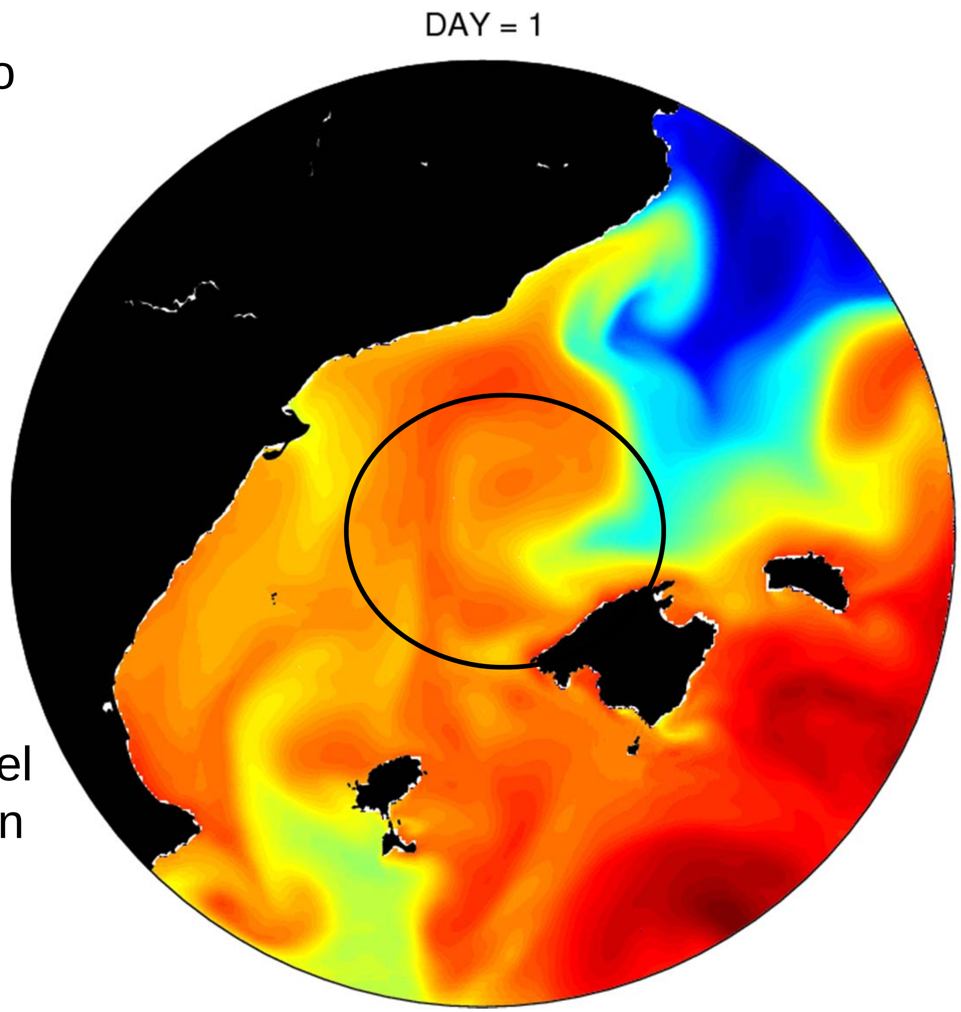
<u>Operational Modeling:</u> ROMS, 2km To reproduce and maintain mesoscale features, interactions. In collaboration with GKSS and Univ. Rutgers, in the frame MFS/MOON.

WRF Atmospheric Model

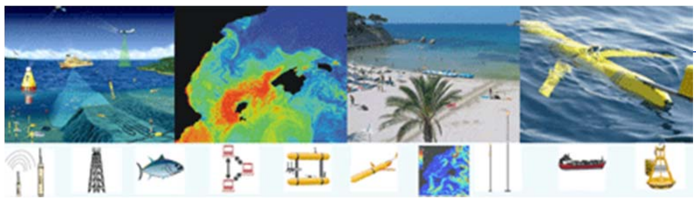
Also **SWAN** for coastal ocean wave Dynamics and Habors (with PE)

The aim :

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



SST from 11/2008



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

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Progress in Oceanography 66 (2005) 120–141

Progress in Oceanogra

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

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

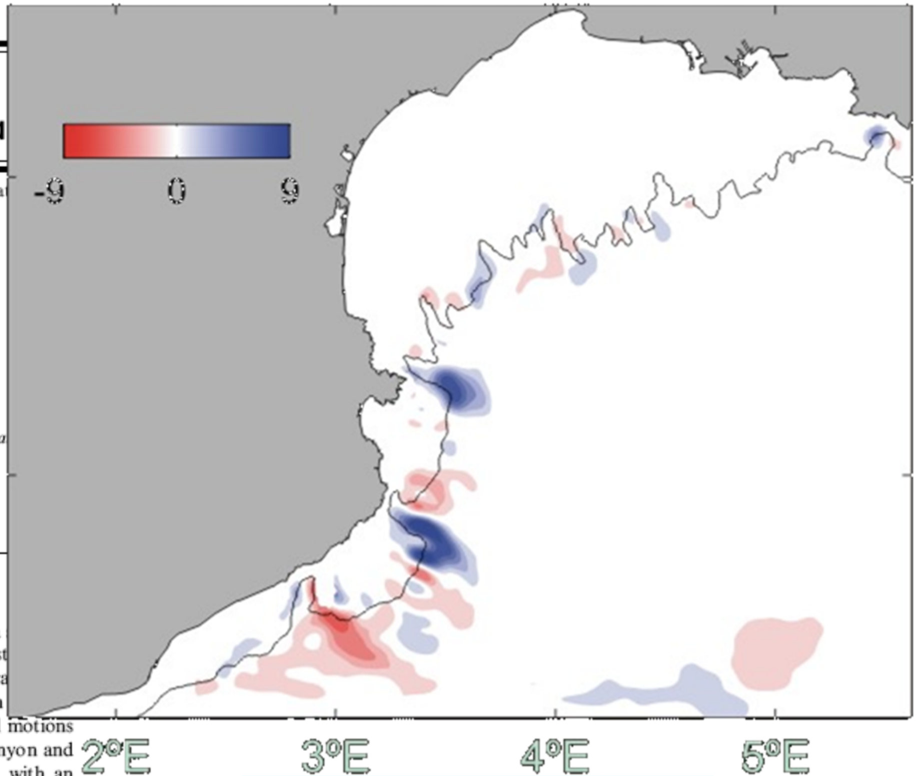
IMEDEA, Instituto Mediterráneo de Estudios Avanzados (CSIC-UIB), C/ Miquel Marqués, 21, 07190 Esporles, Spa

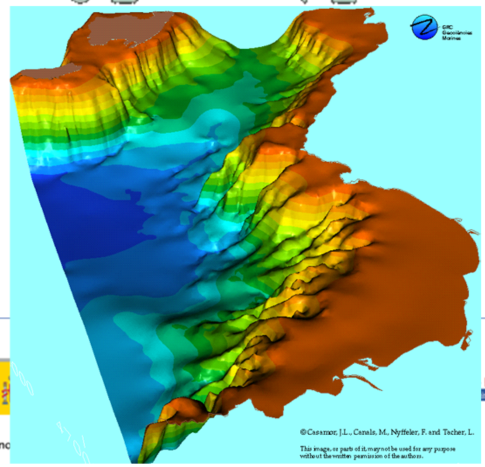
Received 9 October 2002; received in revised form 25 March 2003; accepted 29 July 20
Available online 13 May 2005

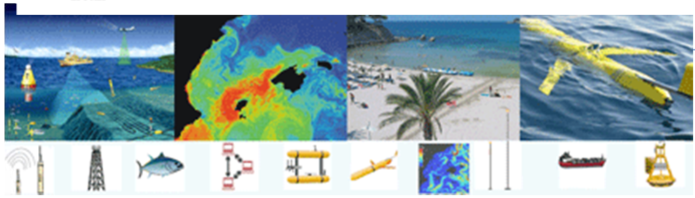
Abstract

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 st narrow Palamós Canyon located off the northeast Catalan coast (northwestern Mediterranean) that is chara 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







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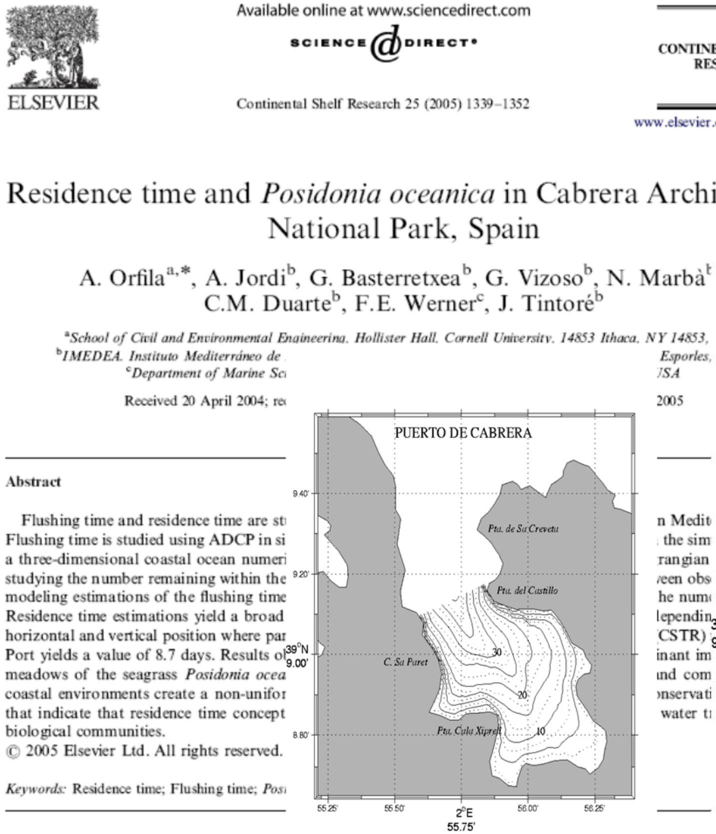
Direcció General de Recerca, Desenvolupament Tecnològic i Inno

M·E·D·E·A

CSIC

Residence time – coastal – open ocean exchanges



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Continental Shelf Research 25 (2005) 1339–1352

CONTINENTAL SHELF RESEARCH

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

A. Orfila[a,*], A. Jordi[b], G. Basterretxea[b], G. Vizoso[b], N. Marbà[b], C.M. Duarte[b], F.E. Werner[c], J. Tintoré[b]

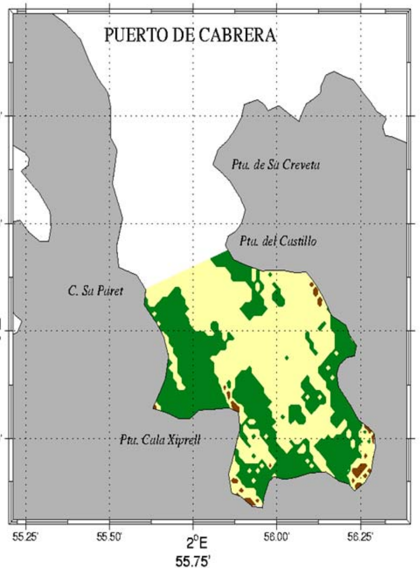
[a]School of Civil and Environmental Engineering, Hollister Hall, Cornell University, 14853 Ithaca, NY 14853,
[b]IMEDEA, Instituto Mediterráneo de ... Esporles,
[c]Department of Marine Sc... ...USA

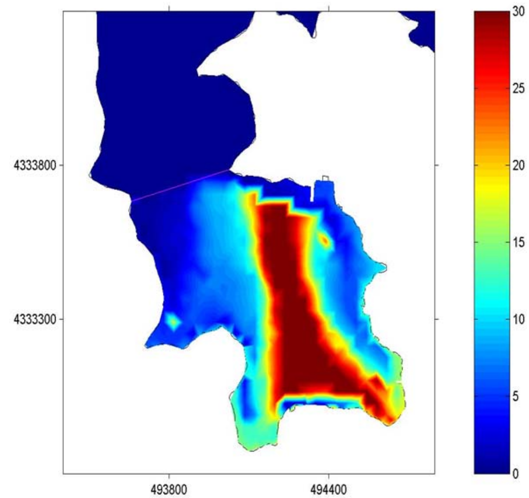
Received 20 April 2004; re... 2005

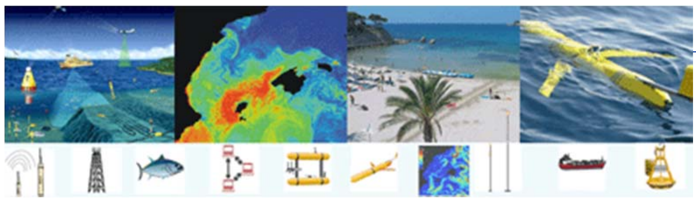
Abstract

Flushing time and residence time are st... n Medit... Flushing time is studied using ADCP in si... the sim... a three-dimensional coastal ocean numeri... rangian... studying the number remaining within the ...een obs... modeling estimations of the flushing time ... he num... Residence time estimations yield a broad ... lependin... horizontal and vertical position where par... (CSTR)... Port yields a value of 8.7 days. Results of ... inant im... meadows of the seagrass *Posidonia ocea*... and com... coastal environments create a non-unifor... onservati... that indicate that residence time concept ... water t... biological communities.
© 2005 Elsevier Ltd. All rights reserved.

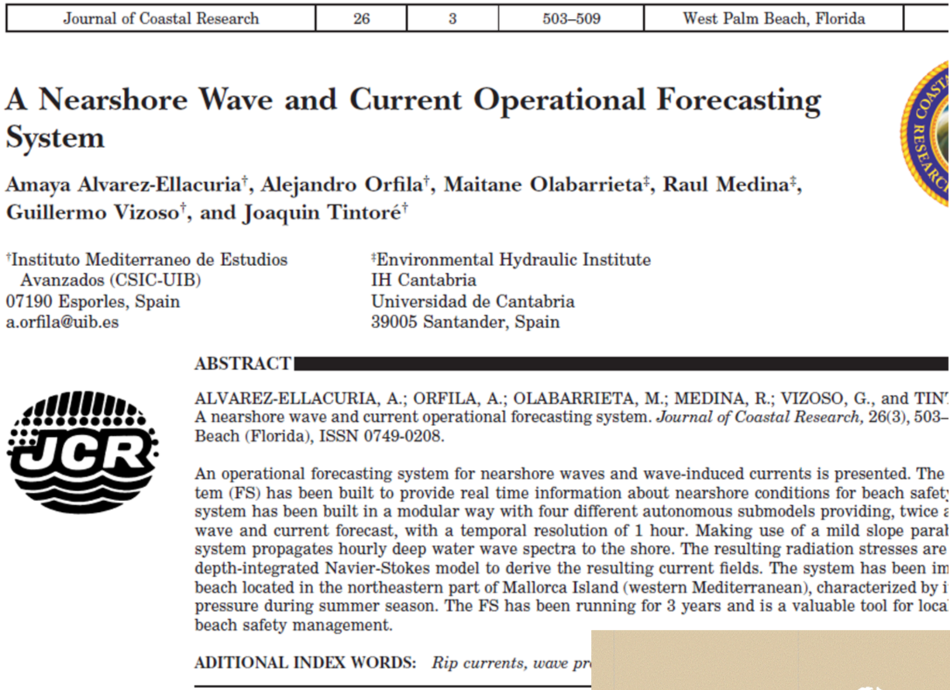
Keywords: Residence time; Flushing time; *Posi*...







Operational systems being implemented



Journal of Coastal Research | 26 | 3 | 503–509 | West Palm Beach, Florida

A Nearshore Wave and Current Operational Forecasting System

Amaya Alvarez-Ellacuria†, Alejandro Orfila†, Maitane Olabarrieta‡, Raul Medina‡, Guillermo Vizoso†, and Joaquin Tintoré†

†Instituto Mediterraneo de Estudios Avanzados (CSIC-UIB)
07190 Esporles, Spain
a.orfila@uib.es

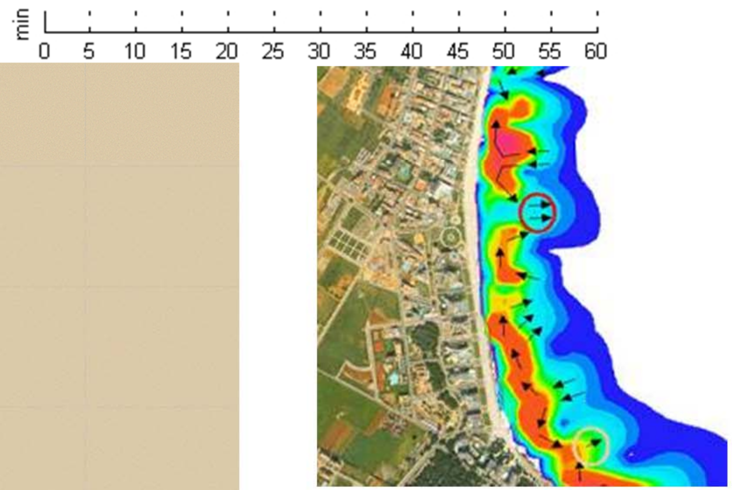
‡Environmental Hydraulic Institute
IH Cantabria
Universidad de Cantabria
39005 Santander, Spain

ABSTRACT

ALVAREZ-ELLACURIA, A.; ORFILA, A.; OLABARRIETA, M.; MEDINA, R.; VIZOSO, G., and TIN A nearshore wave and current operational forecasting system. *Journal of Coastal Research*, 26(3), 503– Beach (Florida), ISSN 0749-0208.

An operational forecasting system for nearshore waves and wave-induced currents is presented. The tem (FS) has been built to provide real time information about nearshore conditions for beach safet system has been built in a modular way with four different autonomous submodels providing, twice wave and current forecast, with a temporal resolution of 1 hour. Making use of a mild slope paral system propagates hourly deep water wave spectra to the shore. The resulting radiation stresses are depth-integrated Navier-Stokes model to derive the resulting current fields. The system has been im beach located in the northeastern part of Mallorca Island (western Mediterranean), characterized by i pressure during summer season. The FS has been running for 3 years and is a valuable tool for loca beach safety management.

ADITIONAL INDEX WORDS: *Rip currents, wave pr*

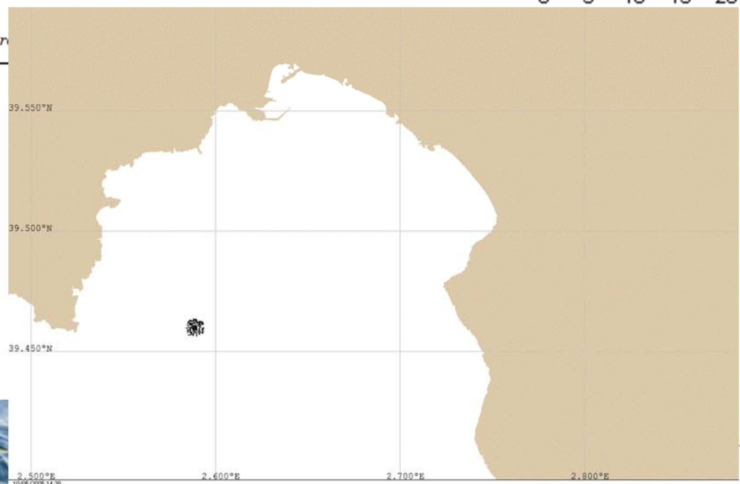


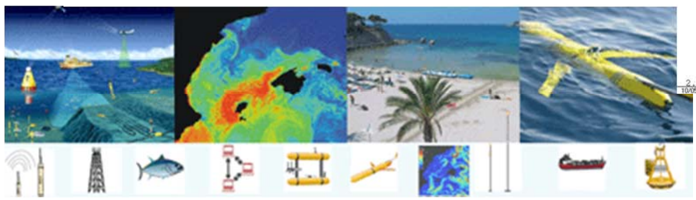
Oil-spill mapping

Land vulnerability

Security in beaches – rip currents

Prediction of trajectories from Tsunamis.





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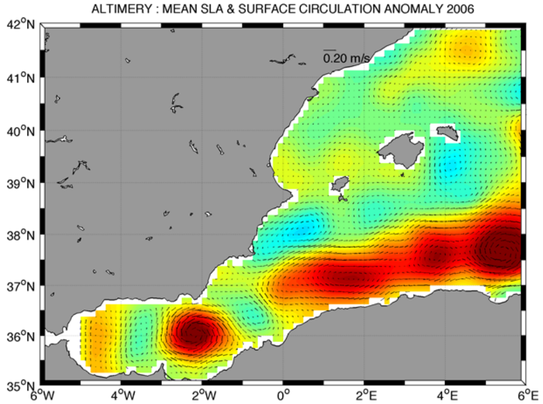
UIB

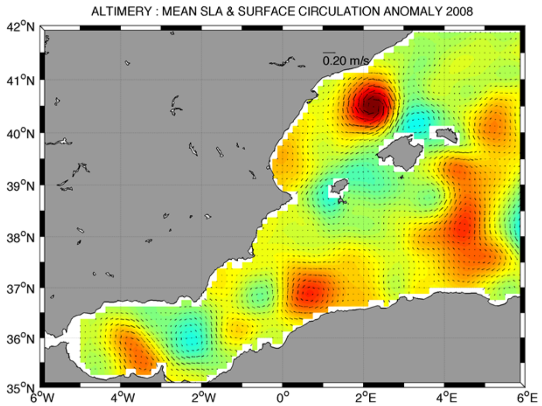
UIB I·M·E·D·E·A

CSIC

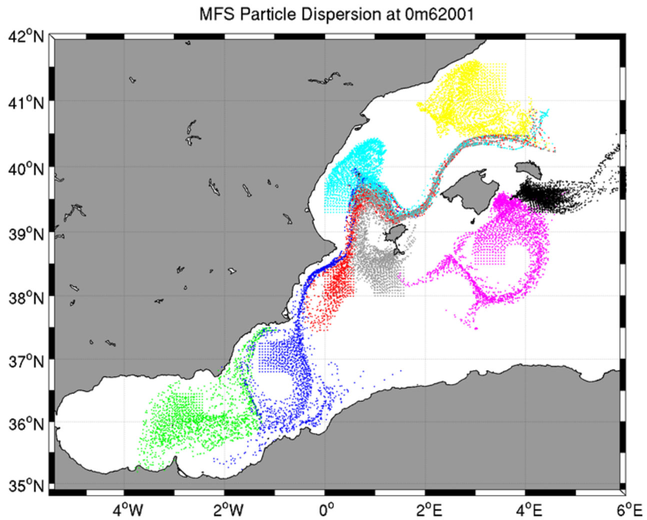
Inter annual variability circulation, Connectivity MPA's protection and optimal design network



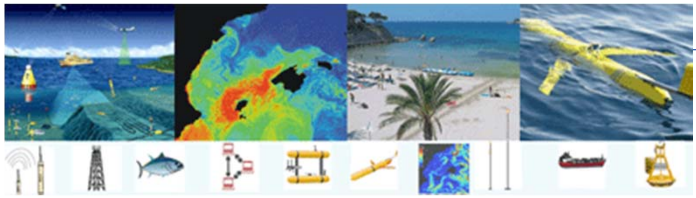
2006 SLA



2008 SLA



Trayectorias partículas...

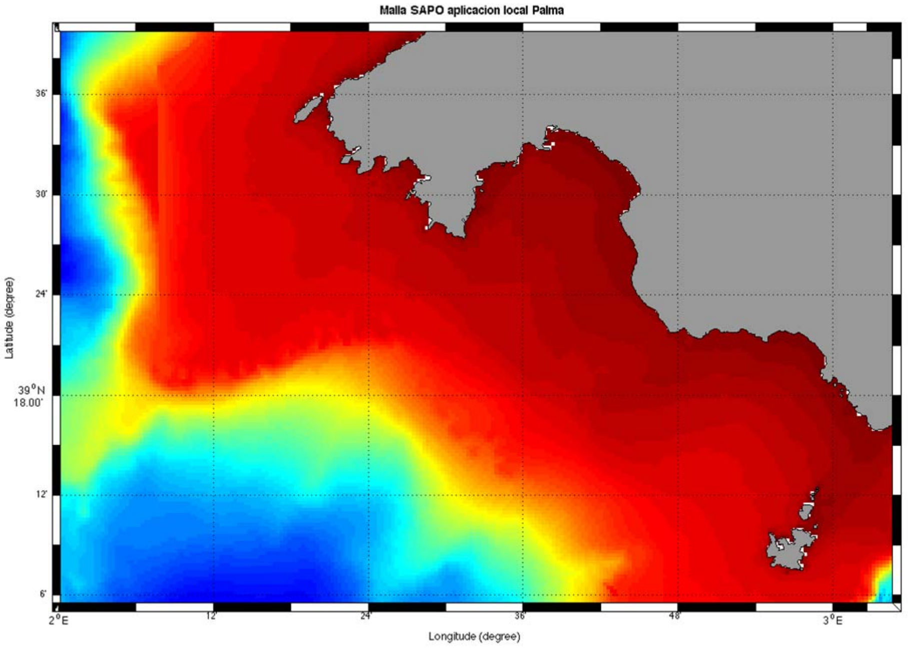


Aplicación local Puerto de Palma
Autoritat Portuària de Balears

Ports de Balears
Autoritat Portuària de Balears

Puertos del Estado

SOCIB Balearic Islands Coastal Observing and Forecasting System

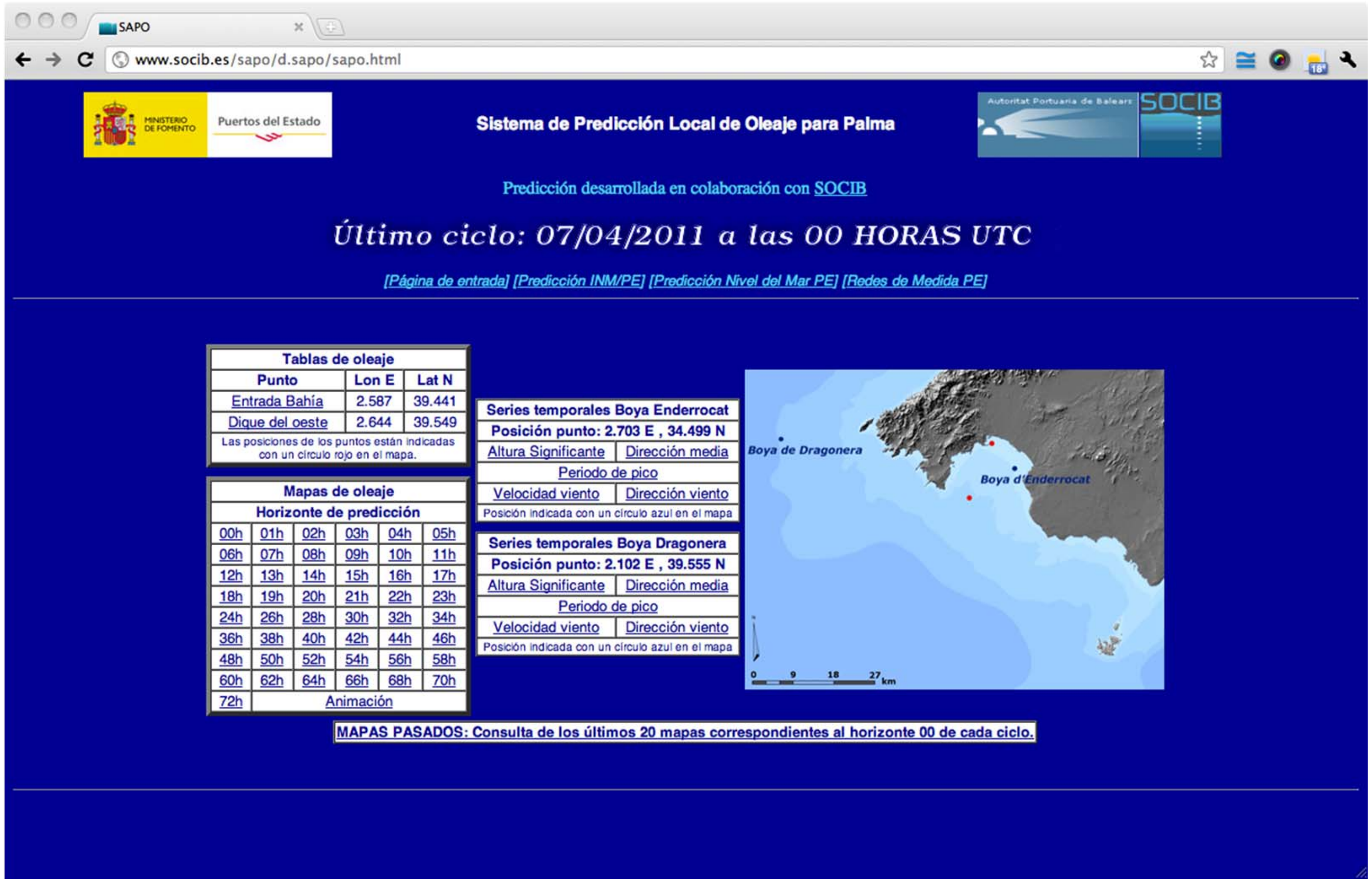


Aplicación local puerto de Palma de Mallorca:

- Modelo de oleaje: SWAN (Simulating Wave Nearshore)
- Malla: 236 x 136 puntos ; 400m de resolución espacial
- 2 ciclos diarios. Horizonte de predicción de 72 horas
- Campos de viento para forzar el modelos de oleaje procedente del HIRLAM (AEMET-PE) con resolución espacial de 0.16º y temporal de 6h
- Condiciones (oleaje entrante y saliente) procedentes del modelo del mediterráneo WAM de Puertos del Estado

Aplicación web

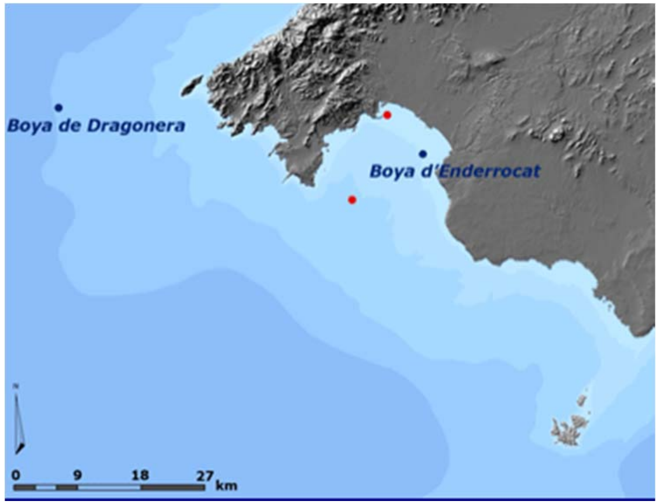
En fase de pruebas, accesible en www. socib.es/sapo



Principal información ofrecida:

1. Tablas de oleaje

Tablas de oleaje		
Punto	**Lon E**	**Lat N**
Entrada Bahía	2.587	39.441
Dique del oeste	2.644	39.549
Las posiciones de los puntos están indicadas con un círculo rojo en el mapa.		



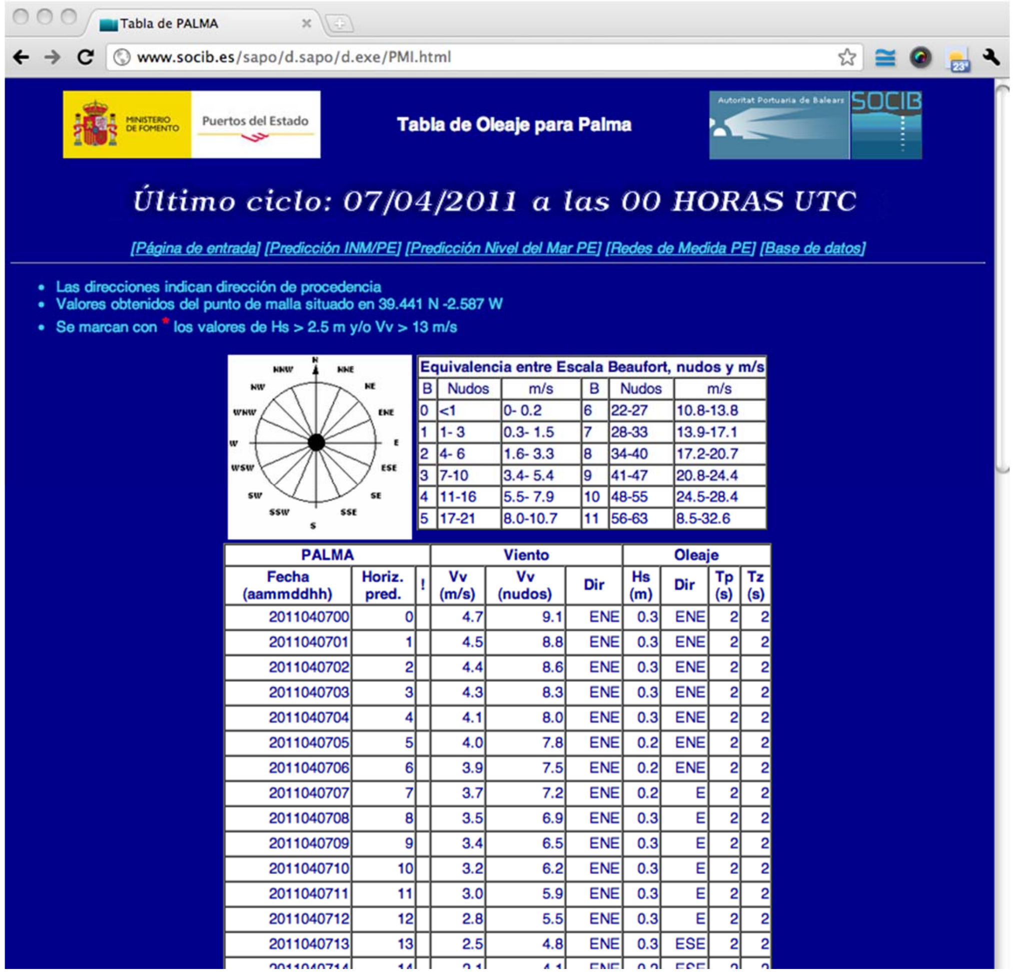


Tabla de Oleaje para Palma

Último ciclo: 07/04/2011 a las 00 HORAS UTC

[Página de entrada] [Predicción INM/PE] [Predicción Nivel del Mar PE] [Redes de Medida PE] [Base de datos]

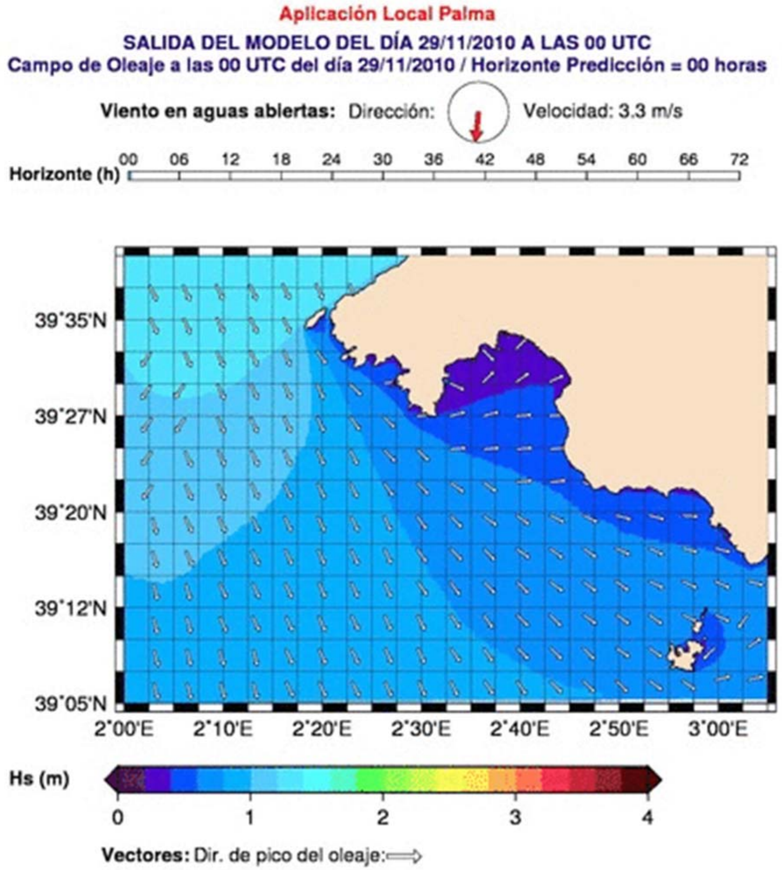
- Las direcciones indican dirección de procedencia
- Valores obtenidos del punto de malla situado en 39.441 N -2.587 W
- Se marcan con * los valores de Hs > 2.5 m y/o Vv > 13 m/s

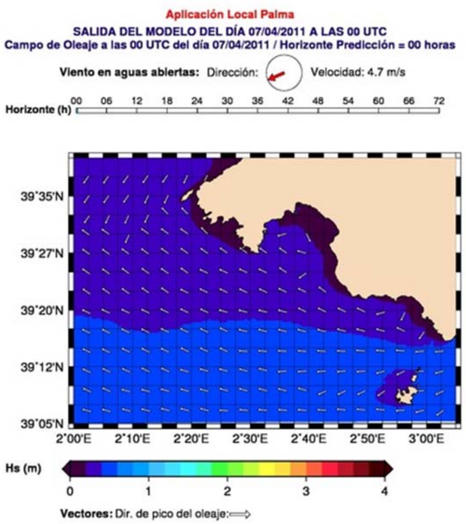
Equivalencia entre Escala Beaufort, nudos y m/s					
B	Nudos	m/s	B	Nudos	m/s
0	<1	0- 0.2	6	22-27	10.8-13.8
1	1- 3	0.3- 1.5	7	28-33	13.9-17.1
2	4- 6	1.6- 3.3	8	34-40	17.2-20.7
3	7-10	3.4- 5.4	9	41-47	20.8-24.4
4	11-16	5.5- 7.9	10	48-55	24.5-28.4
5	17-21	8.0-10.7	11	56-63	8.5-32.6

PALMA			Viento			Oleaje			
Fecha (aammddhh)	Horiz. pred.	!	Vv (m/s)	Vv (nudos)	Dir	Hs (m)	Dir	Tp (s)	Tz (s)
2011040700	0		4.7	9.1	ENE	0.3	ENE	2	2
2011040701	1		4.5	8.8	ENE	0.3	ENE	2	2
2011040702	2		4.4	8.6	ENE	0.3	ENE	2	2
2011040703	3		4.3	8.3	ENE	0.3	ENE	2	2
2011040704	4		4.1	8.0	ENE	0.3	ENE	2	2
2011040705	5		4.0	7.8	ENE	0.2	ENE	2	2
2011040706	6		3.9	7.5	ENE	0.2	ENE	2	2
2011040707	7		3.7	7.2	ENE	0.2	E	2	2
2011040708	8		3.5	6.9	ENE	0.3	E	2	2
2011040709	9		3.4	6.5	ENE	0.3	E	2	2
2011040710	10		3.2	6.2	ENE	0.3	E	2	2
2011040711	11		3.0	5.9	ENE	0.3	E	2	2
2011040712	12		2.8	5.5	ENE	0.3	E	2	2
2011040713	13		2.5	4.8	ENE	0.3	ESE	2	2

2. Mapas de oleaje

Mapas de oleaje					
Horizonte de predicción					
00h	01h	02h	03h	04h	05h
06h	07h	08h	09h	10h	11h
12h	13h	14h	15h	16h	17h
18h	19h	20h	21h	22h	23h
24h	26h	28h	30h	32h	34h
36h	38h	40h	42h	44h	46h
48h	50h	52h	54h	56h	58h
60h	62h	64h	66h	68h	70h
72h	Animación				

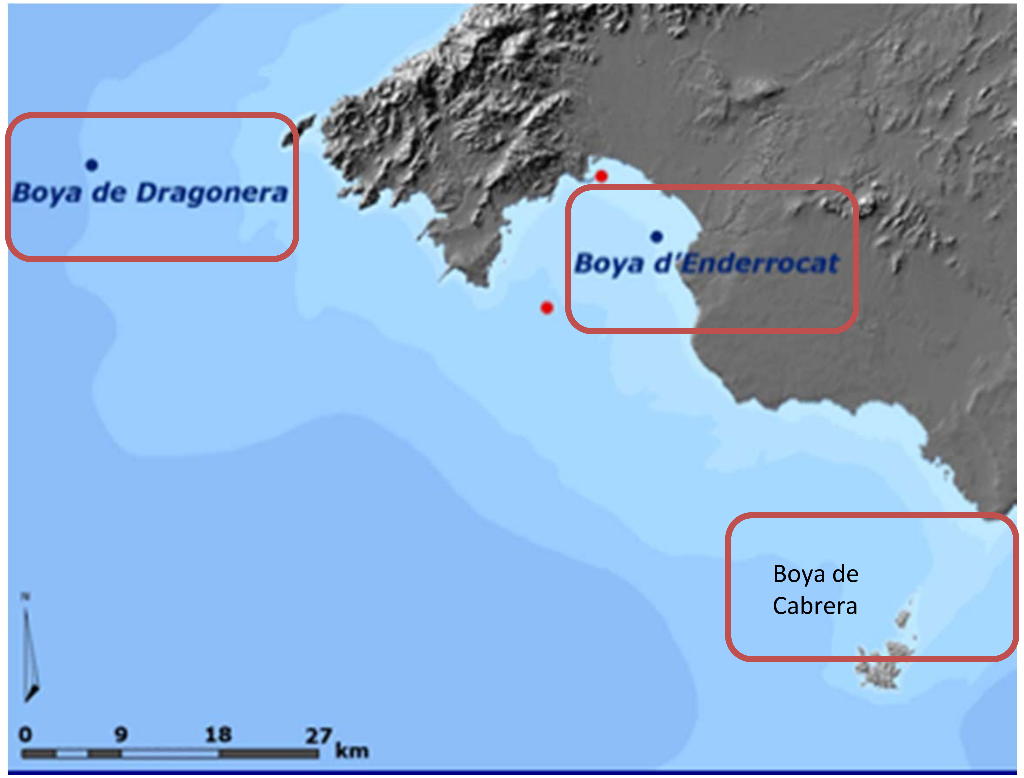




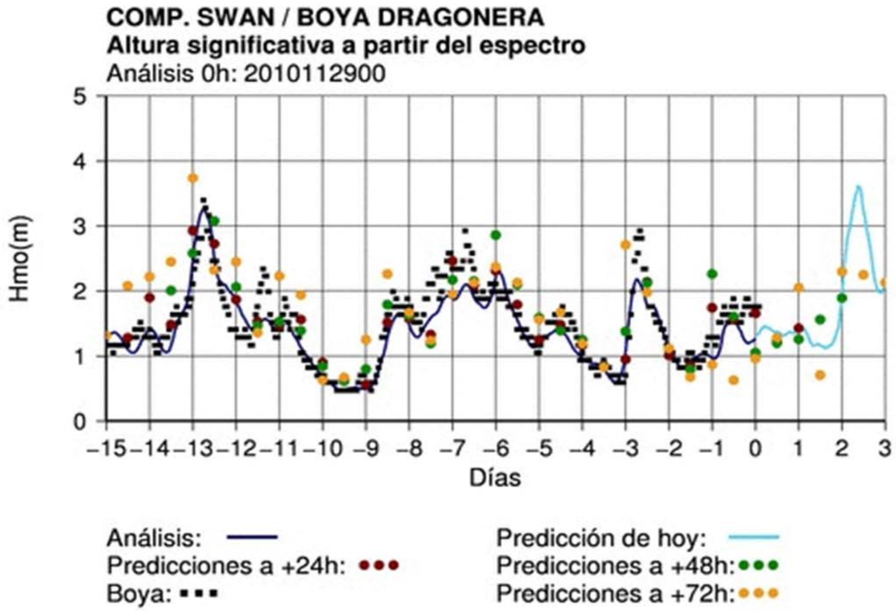
3. Series temporales y validación

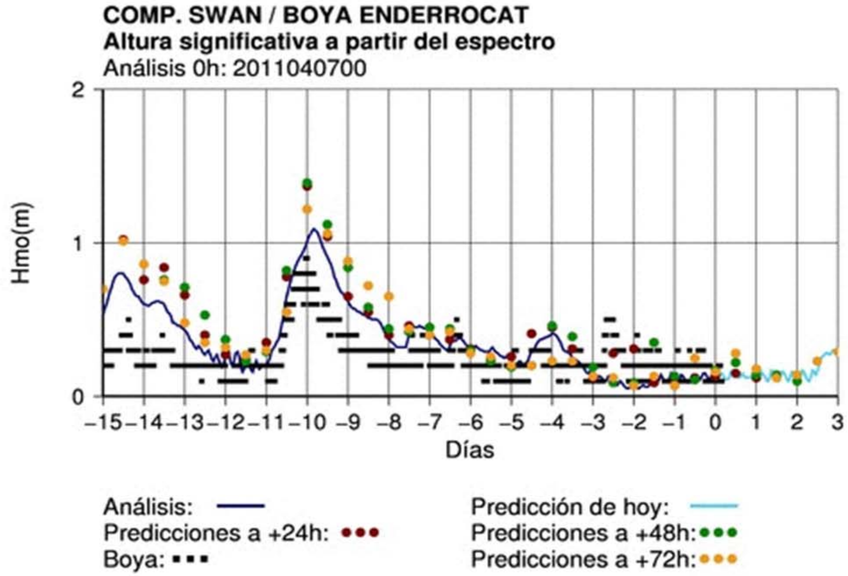
Series temporales Boya Enderrocat	
Posición punto: 2.703 E , 34.499 N	
Altura Significante	Dirección media
Periodo de pico	
Velocidad viento	Dirección viento
Posición indicada con un círculo azul en el mapa	

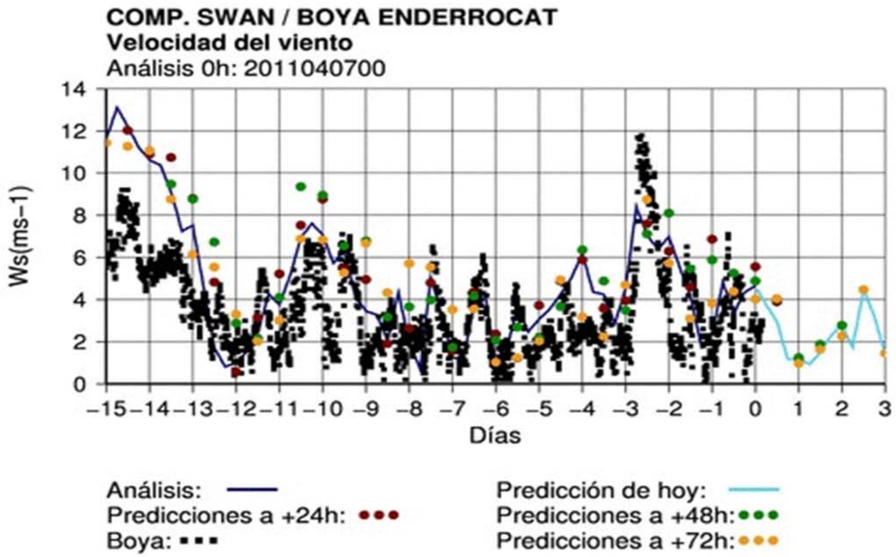
Series temporales Boya Dragonera	
Posición punto: 2.102 E , 39.555 N	
Altura Significante	Dirección media
Periodo de pico	
Velocidad viento	Dirección viento
Posición indicada con un círculo azul en el mapa	

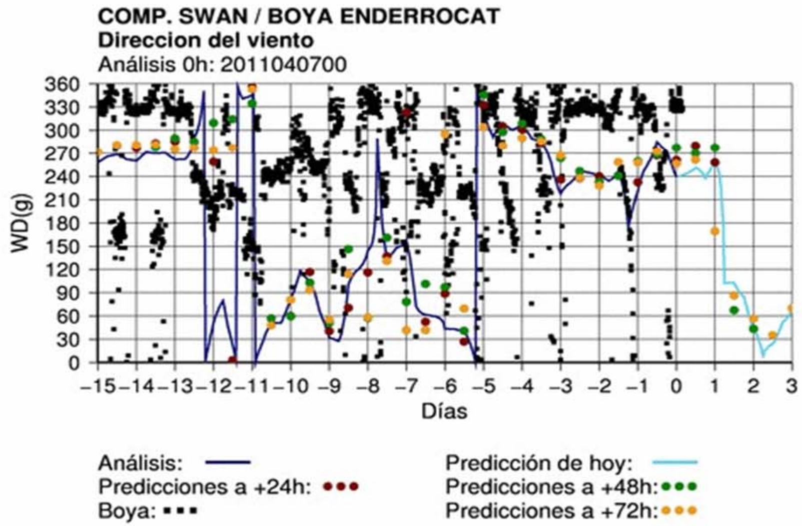


Series temporales y validación





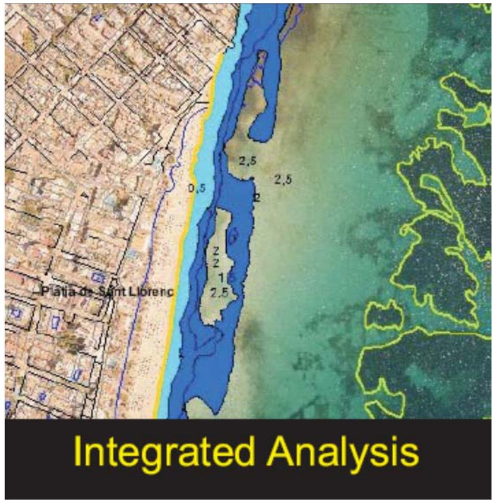


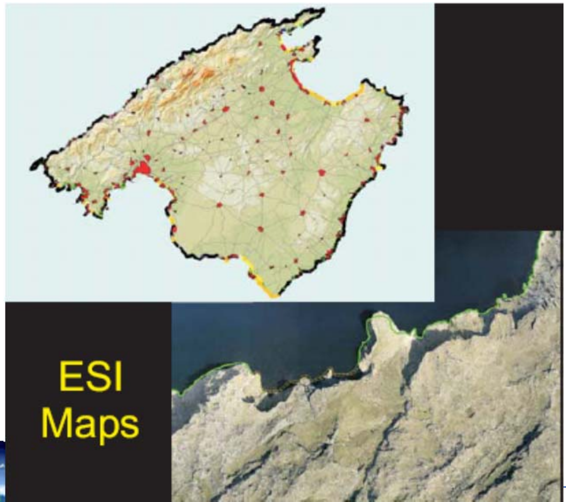


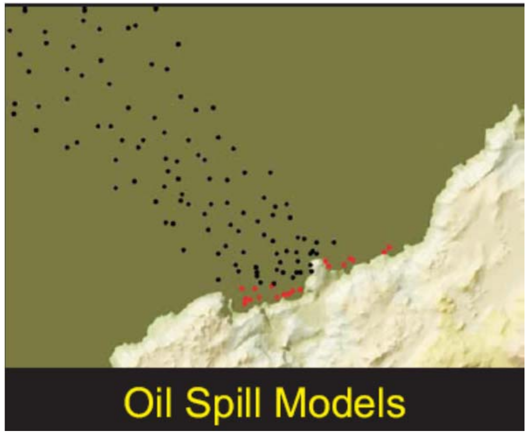
Coastal management

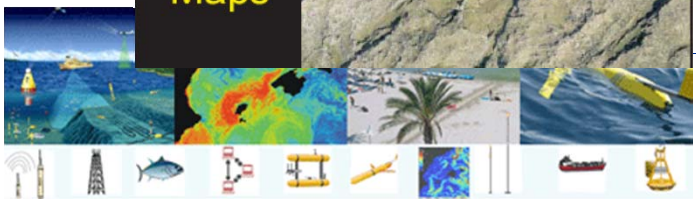
The management system is based on a geographical information system (GIS) for oil spill crisis management.

GIS are useful tool for storing, analyzing and displaying data to support management decisions and short term environmental protection planning.









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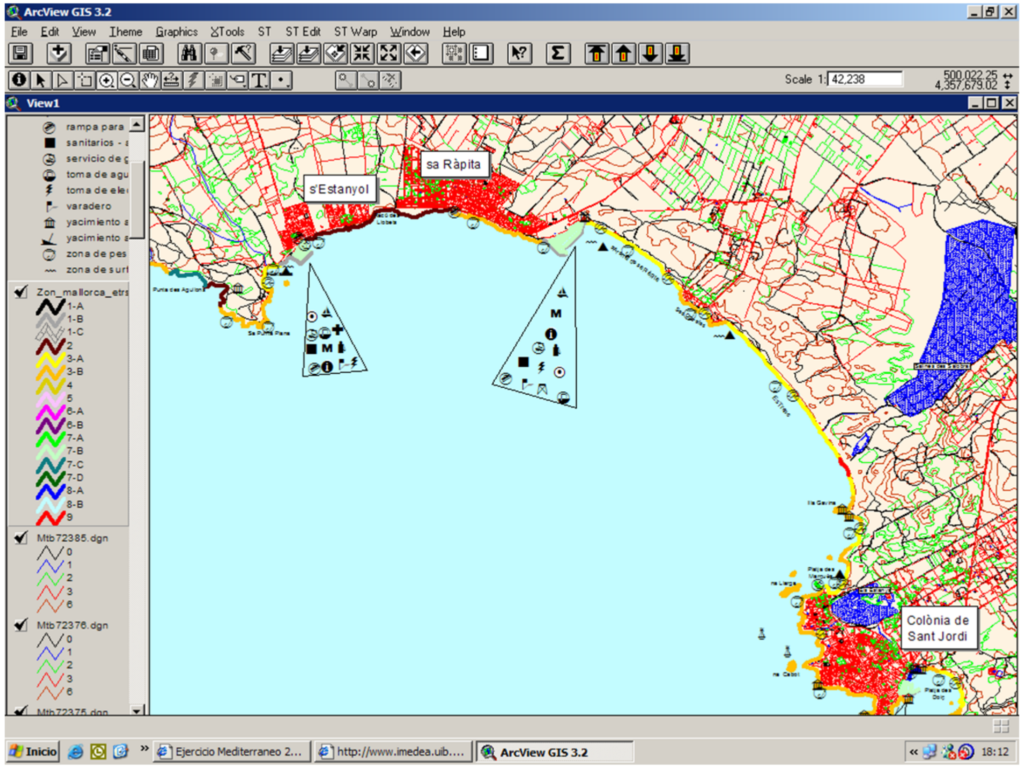
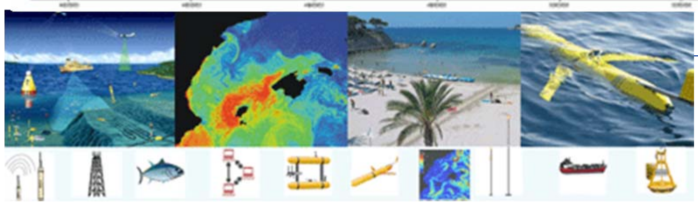
Coastal management

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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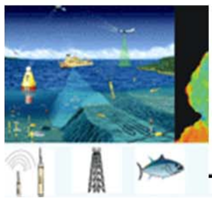
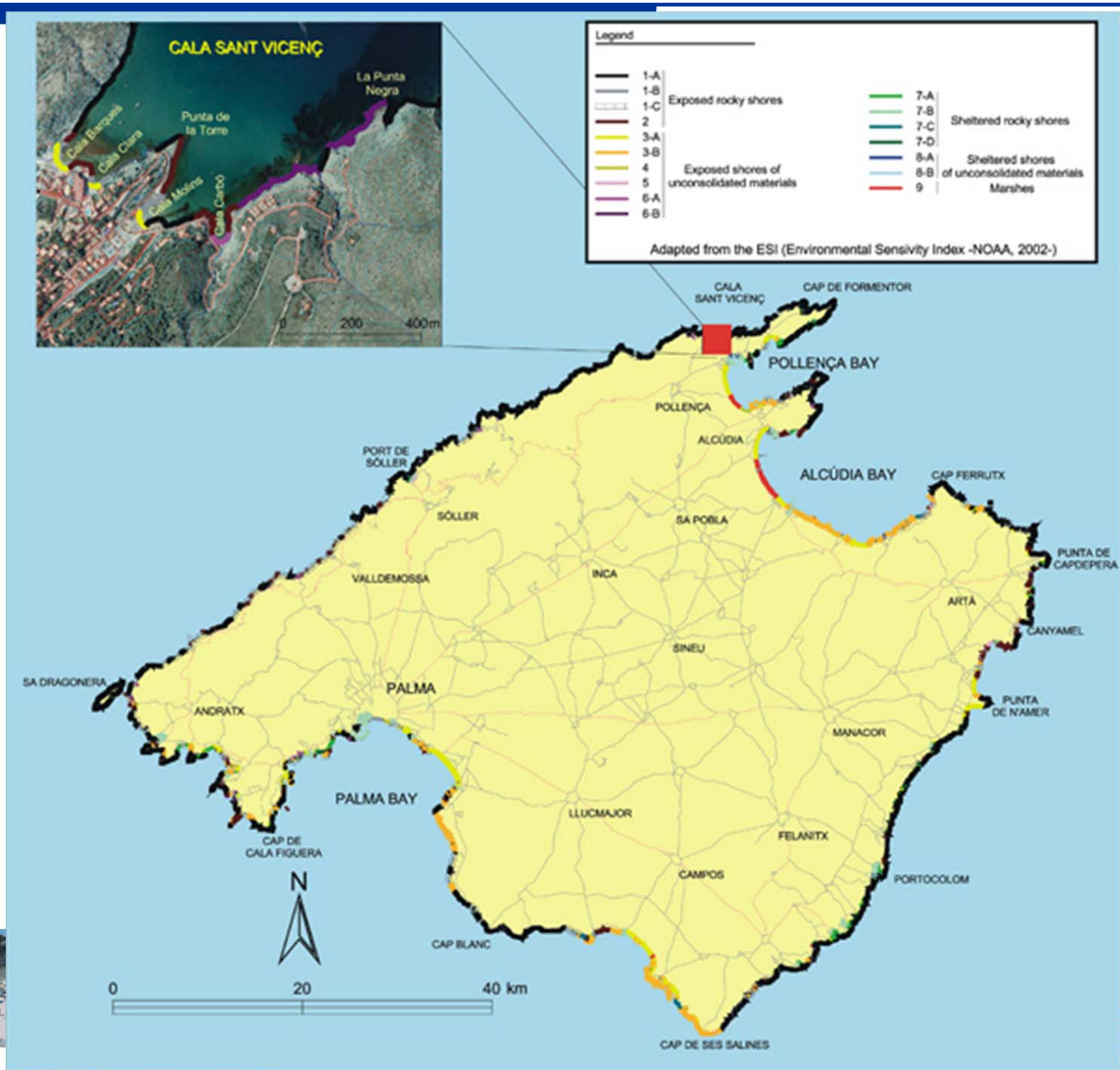
TIPOS DE COSTA
(Según el Índice de Sensibilidad Ambiental -NOAA, 2002)

- Costas rocosas altas y acantilados expuestos a zonas de elevada energía
- Estructuras artificiales expuestas a zonas de elevada energía
- Costas rocosas altas con depósitos de derrubios y acumulación de bloques en la base expuestas a elevada energía
- Costas rocosas bajas expuestas
- Playas de arenas finas y de tamaño medio
- Escarpes y costas de perfil escalonado formadas por conglomerados, arenas, limos y calcarenitas
- Playas de arenas gruesas
- Playas mixtas, formadas por arenas y gravas
- Playas de gravas, cantos rodados y bloques
- Costas rocosas bajas expuestas, de perfil escalonado y cóncavo con presencia de bloques y/o playas
- Costas rocosas de altura variable localizadas en zonas de baja energía
- Estructuras artificiales localizadas en zonas de baja energía
- Costas rocosas bajas con presencia de bloques y/o playas en zonas de baja energía
- Costas rocosas altas con depósitos de derrubios en la base localizadas en zonas de baja energía
- Playas formadas por fangos y arenas en zonas de baja energía
- Playas de gravas, cantos y bloques en zonas de baja energía
- Litorales en contacto o próximos a albuferas y marismas

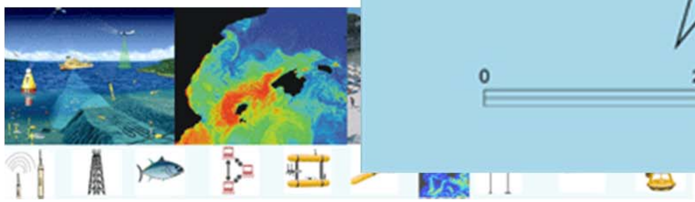
RECURSOS SOCIOECONÓMICOS

- Aeropuerto
- Base naval militar
- Club náutico - puerto deportivo - marina
- Duchas
- Emisario submarino
- Gasolinera - fuel
- Información meteorológica
- Mecánico motor
- Muelle - embarcadero
- Piscifactoria - centros de cría
- Playa
- Pórtico elevador
- Práctica de windsurf
- Primeros auxilios
- Puerto comercial
- Puerto pesquero
- Punto de inmersión de interés
- Rampa para embarcaciones
- Sanitarios - aseos
- Servicio de Grúa para embarcaciones
- Agua potable
- Toma de electricidad
- Varadero
- Zona de pesca recreacional
- Práctica del deporte de surf
- Yacimiento arqueológico submarino
- Yacimiento arqueológico subaéreo



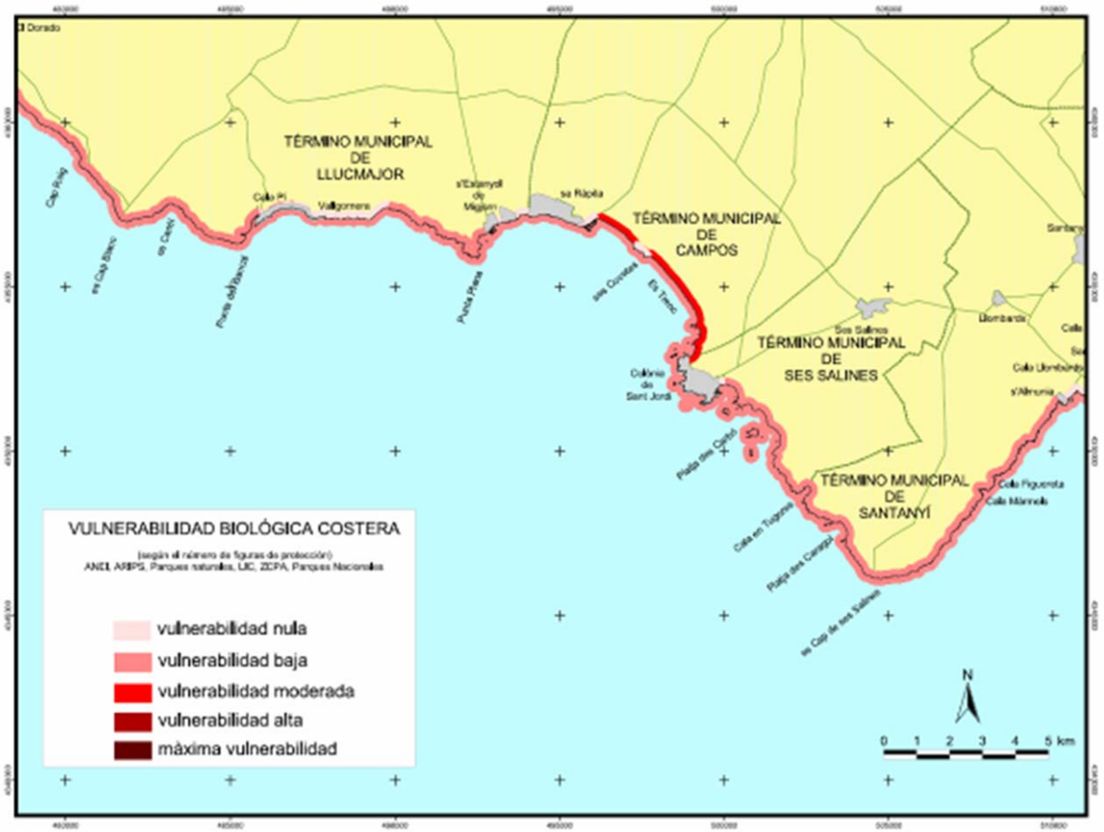


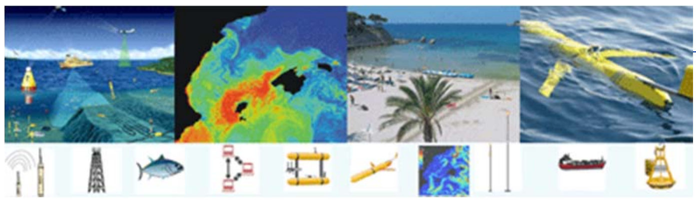
CALA SANT VICENÇ
La Punta Negra
Punta de la Torre
Cala Barques
Cala Clara
Cala Molins
Cala Carbó
0 200 400m
Legend
1-A
1-B
1-C
2
Exposed rocky shores
3-A
3-B
4
5
6-A
6-B
Exposed shores of unconsolidated materials
7-A
7-B
7-C
7-D
Sheltered rocky shores
8-A
8-B
Sheltered shores of unconsolidated materials
9
Marshes
Adapted from the ESI (Environmental Sensivity Index -NOAA, 2002-)
CALA SANT VICENÇ
CAP DE FORMENTOR
POLLENÇA BAY
POLLENÇA
ALCÚDIA
ALCÚDIA BAY
CAP FERRUTX
PORT DE SÓLLER
SÓLLER
SA POBLA
PUNTA DE CAPDEPERA
VALLDEMOSSA
INCA
ARTÀ
CANYAMEL
SINEU
SA DRAGONERA
PALMA
PUNTA DE N'AMER
ANDRATX
MANACOR
PALMA BAY
LLUCMAJOR
FELANITX
CAP DE CALA FIGUERA
CAMPOS
PORTOCOLOM
N
CAP BLANC
0
20
40 km
CAP DE SES SALINES



Coastal management

The Environmental Sensitivity Index (ESI) evaluates the coastal zone vulnerability combining physical, biological, geological and socio-economic parameters of the coastline into a single environmental sensitivity index to oil spills.





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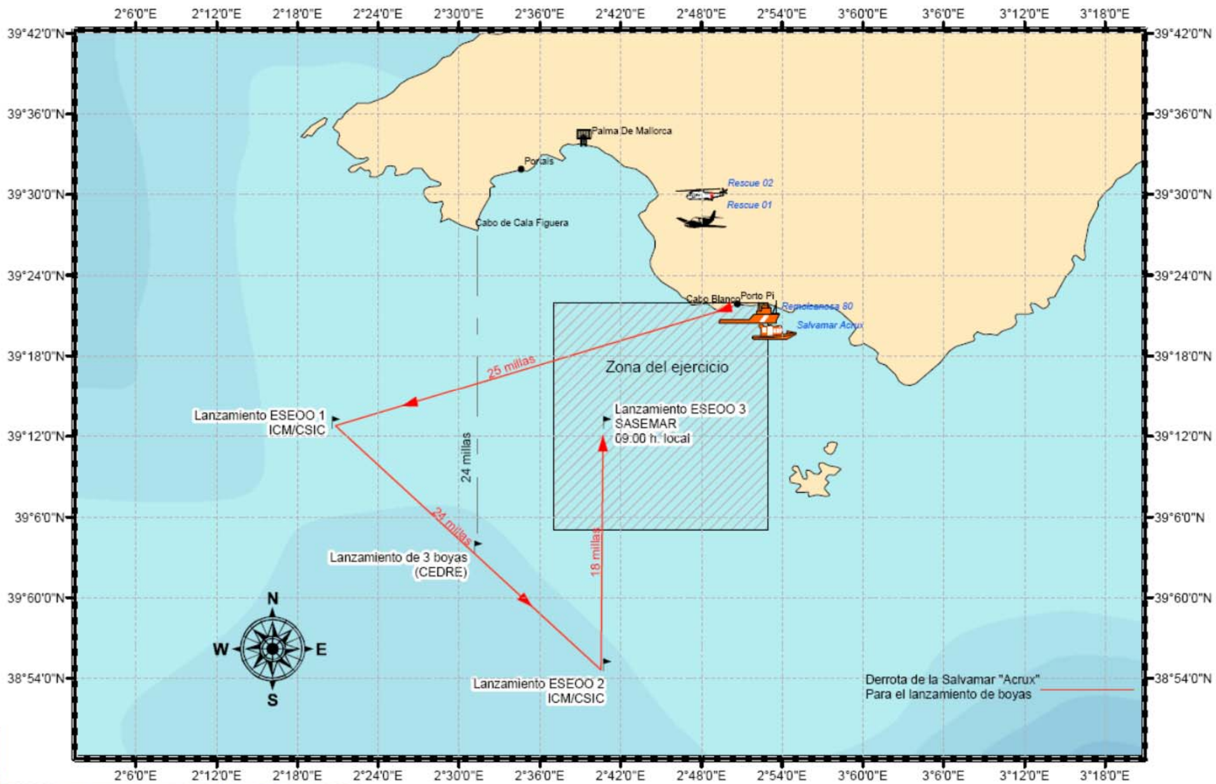
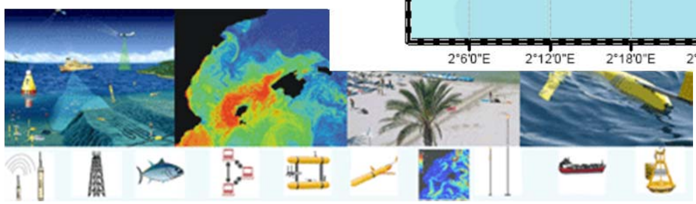
Application to Mallorca: MED05

MED05 exercise

10th – 11th – 12th May 2005





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Results at local scale

Ocean & Coastal Management 52 (2009) 493–505

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

Integrated and interdisciplinary scientific approach to coastal management

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

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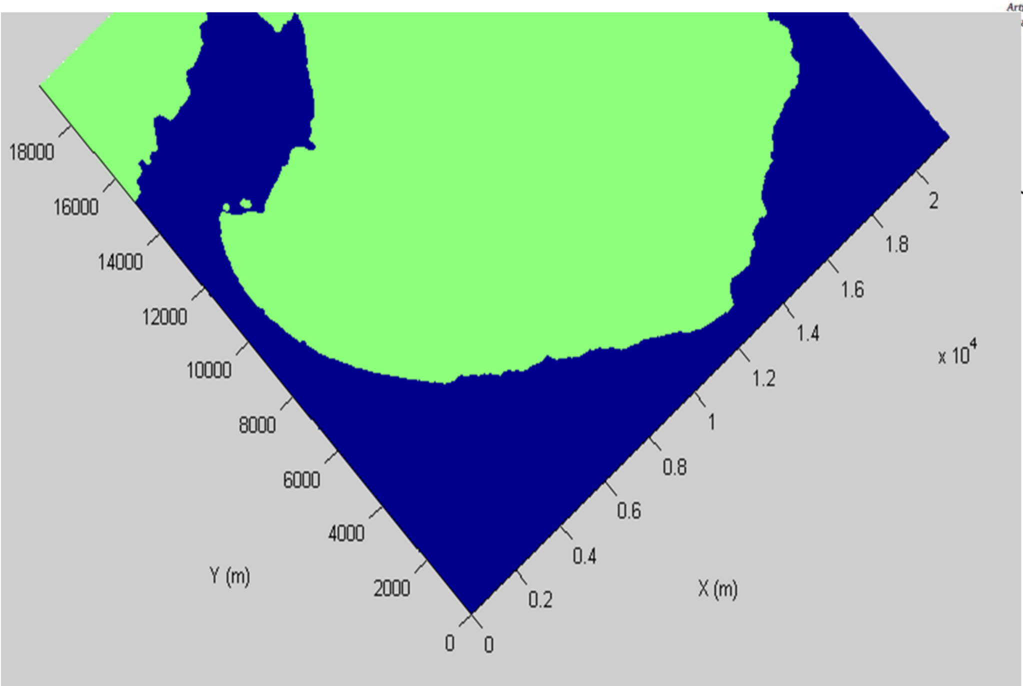
ARTICLE INFO

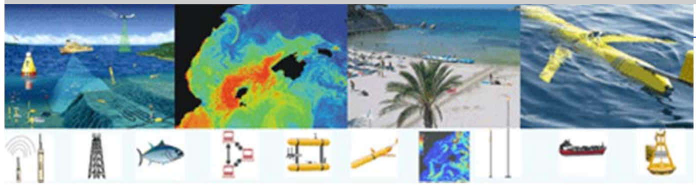
Article history:
ailable online 7 August 2009

ABSTRACT

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



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



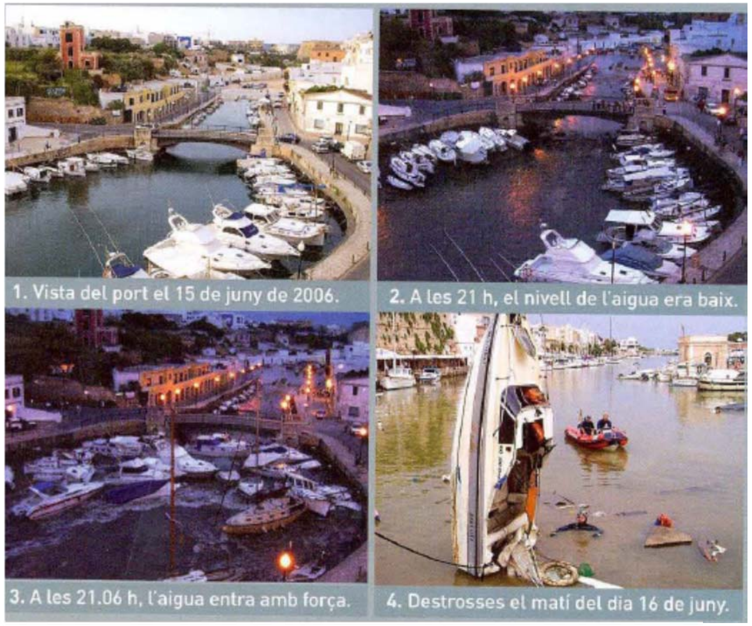
Modelling Facility (ongoing activities)

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 Tintoré[1,2]

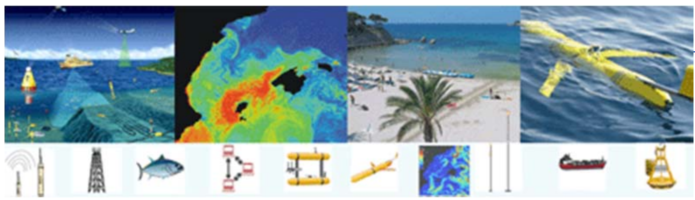
Received 4 March 2011; revised 29 March 2011; accepted 30 March 2011; published 18 May 2011.

[1] Meteotsunamis are oceanic waves that possess tsunami-like characteristics but are meteorological in origin. In the western Mediterranean, travelling atmospheric pressure oscillations generate these long oceanic surface waves that can become amplified and produce strong seiche oscillations inside harbors. We analyze a June 2006 meteotsunami event in Ciutadella harbor (Menorca Island, Spain), studying numerically the phenomenon during its full life cycle, from the early atmospheric stages to the atmosphere-ocean resonant phase and the final highly amplified harbor oscillation. The Weather Research Forecast (WRF) atmospheric model adequately reproduces the development of a convective nucleus and also reproduces the induced atmospheric pressure oscillations moving at a speed of 27 m/s. The oceanic response is studied using the Regional Ocean Modeling System (ROMS), forced by the WRF pressure field. It shows an inverse barometer wave front in the open ocean progressively amplified through resonant interactions in the different shelf and coastal regions. The predictive capability of this new WRF/ROMS modeling approach is then discussed. **Citation:** Renault, L., G. Vizoso, A. Jansá, J. Wilkin, and J. Tintoré (2011), Toward the predictability of meteotsunamis in the Balearic Sea using regional nested atmosphere and ocean models, *Geophys. Res. Lett.*, *38*, L10601, doi:10.1029/2011GL047361.



GEOPHYSICAL RESEARCH LETTERS, VOL. 38, L10601, doi:10.1029/2011GL047361, 2011

Large amplitude Oscillations



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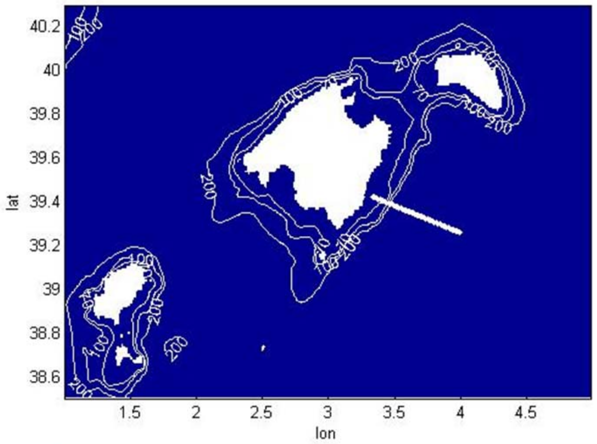
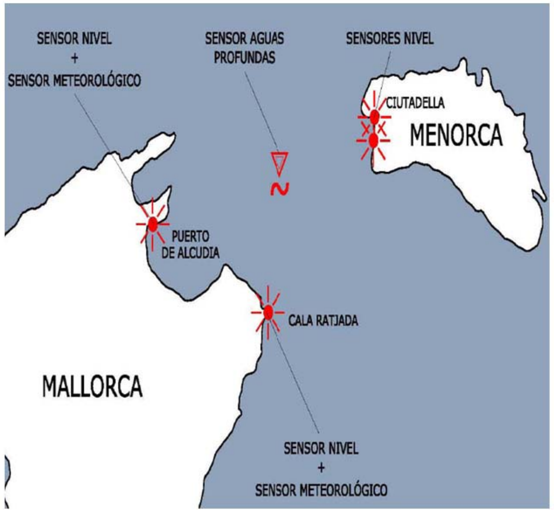
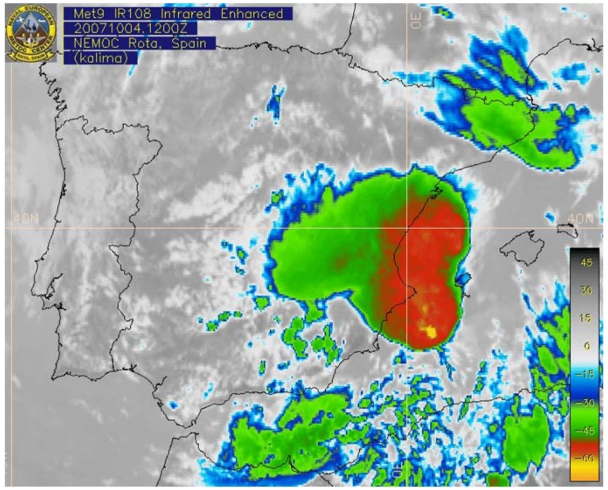
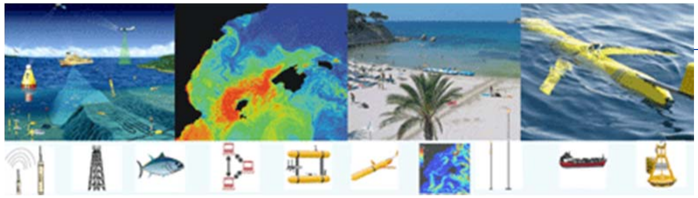






Oct_4, 2007



Modelling Facility

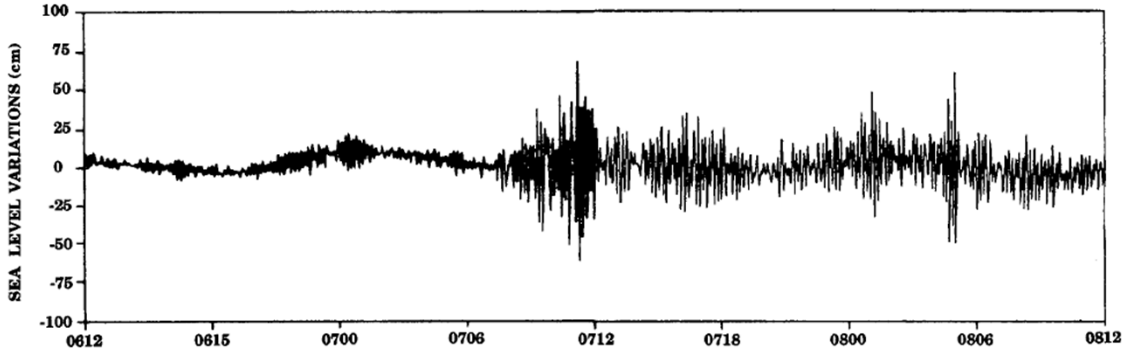


Fig. 2. Sea level record obtained in the inlet of Ciutadella, from July 6, 1988, at 1200 UT to July 8, 1988, at 1200 UT. The mean value has been subtracted, and periods shorter than 5 min have been removed by means of low-pass filtering. This record is the first instrumental evidence of the rissaga phenomenon. A more spectacular event, with sea level variations of more than 2 m, is reported by *Monserrat et al.* [1991*a*].

On June 21, 1992, a large-amplitude event was observed at Ciutadella inlet, and another less important event occurred on August 29. We recorded a few additional minor events in September, but for the present work, only the two major ones have been selected.

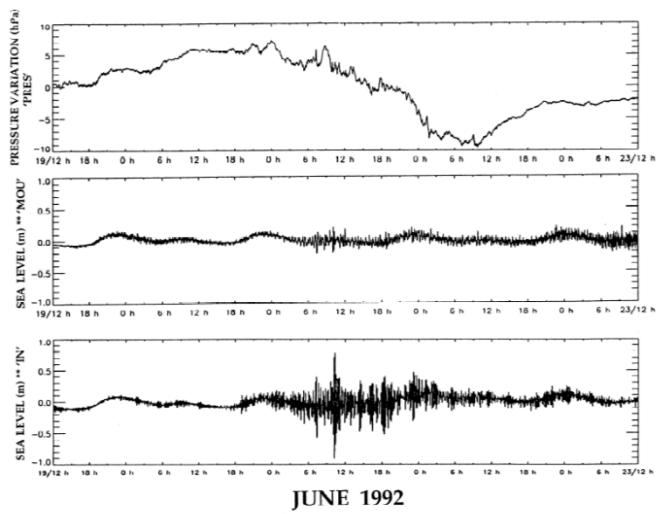
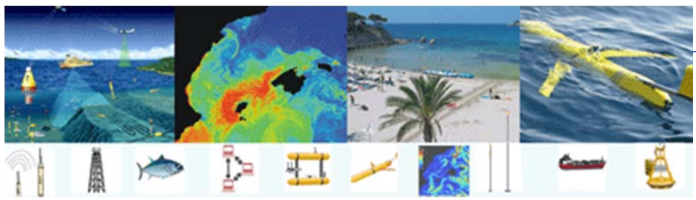


Figure 3. Atmospheric pressure variation at PRES and sea level from MOU and IN stations from 1200 UT on June 19 to 1200 UT on June 23, 1992, which corresponds to the first and most energetic event.



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Modelling Facility (ongoing activities)

GEOPHYSICAL RESEARCH LETTERS, VOL. 38, LXXXXX, doi:10.1029/2011GL047361, 2011

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[1,2]

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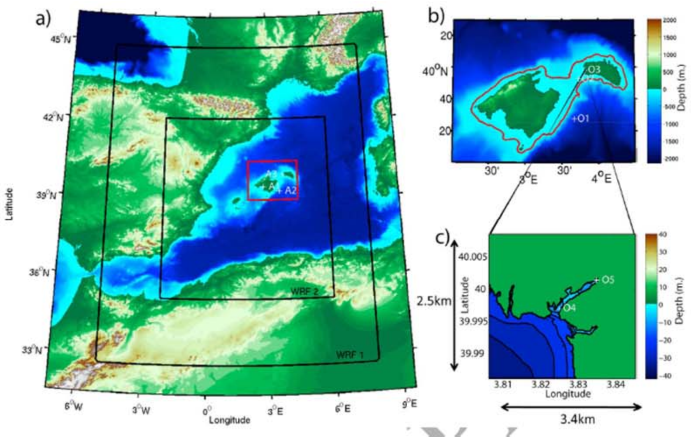
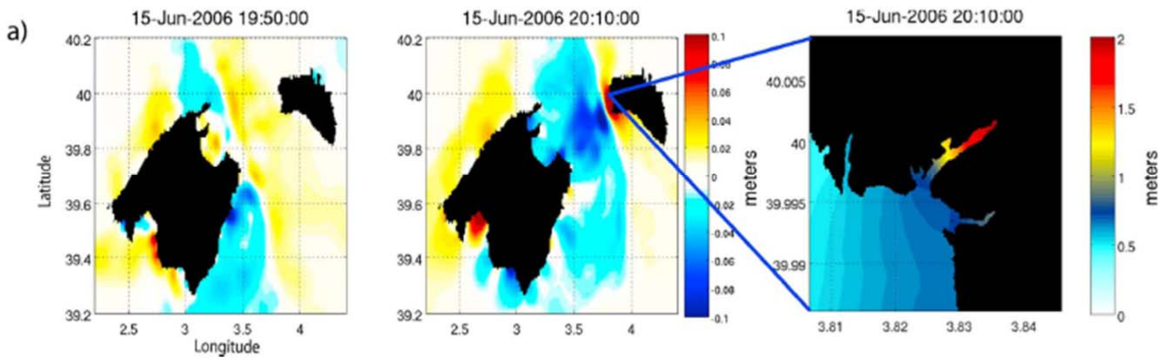
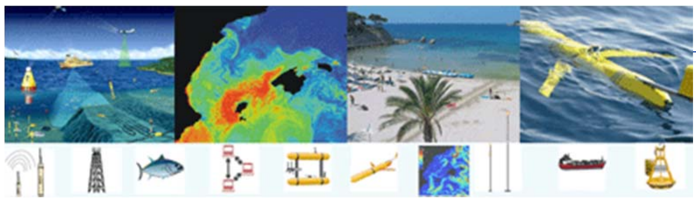






Data Centre Facility (phase 0: 2010-2011 pilot activities)

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

Goal: to provide researchers and users with a **system** that will 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 will be (in collaboration with IMOS eMII),

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

Data Centre Facility (phase 0: 2010-2011 pilot activities)

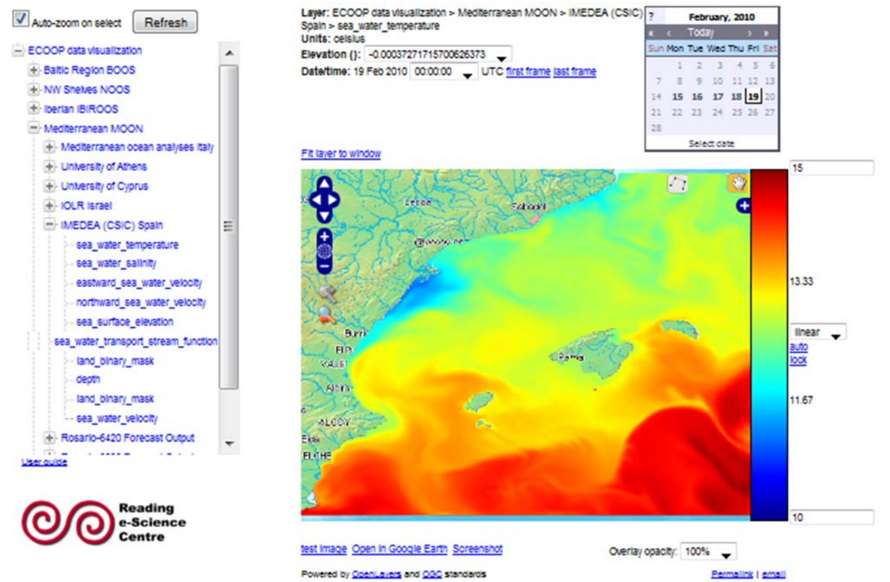
The European framework

MERSEA

Ecoop

myOcean

SESAME



Reading e-Science Centre

The international framework

IMOS

OOI OCEAN OBSERVATORIES INITIATIVE

IOOS

NEPTUNE Canada

SOCIB Data Center process

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

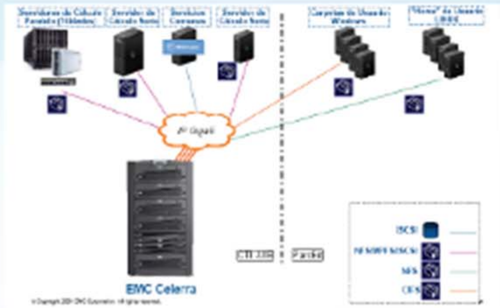
SOCIB Data Centre Facility. Technologies

The main technologies used are: OPeNDAP / THREDDS server hosting CF-compliant NetCDF; the open-source RAMADDA as a content management system and collaboration services for Earth Science data. Those technologies permit the distribution, cataloging and discovery over the oceanographic data.

1. Multi Platform Management

Alredyavailable:glidersdrifters,moorings,adcp, beach monitoring cameras, ... Real time monitoring and wide descriptions of data sets (standardscompliant).

2. Data Archive



Informatic infraestructure: to securely archive data and metadata and retrieve them on demand.

3. Distribution

OPeNDAP, WCS, WMS, HTTP, FTP, ... to access the data in an interoperable manner from client applications.

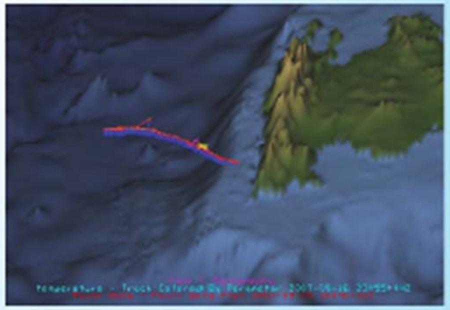
4. Catalog

THREDDS to organize data and Metadata to automatic harvesting.

5. Discovery

RAMADDA to search for and find data sets of interest for human interaction.

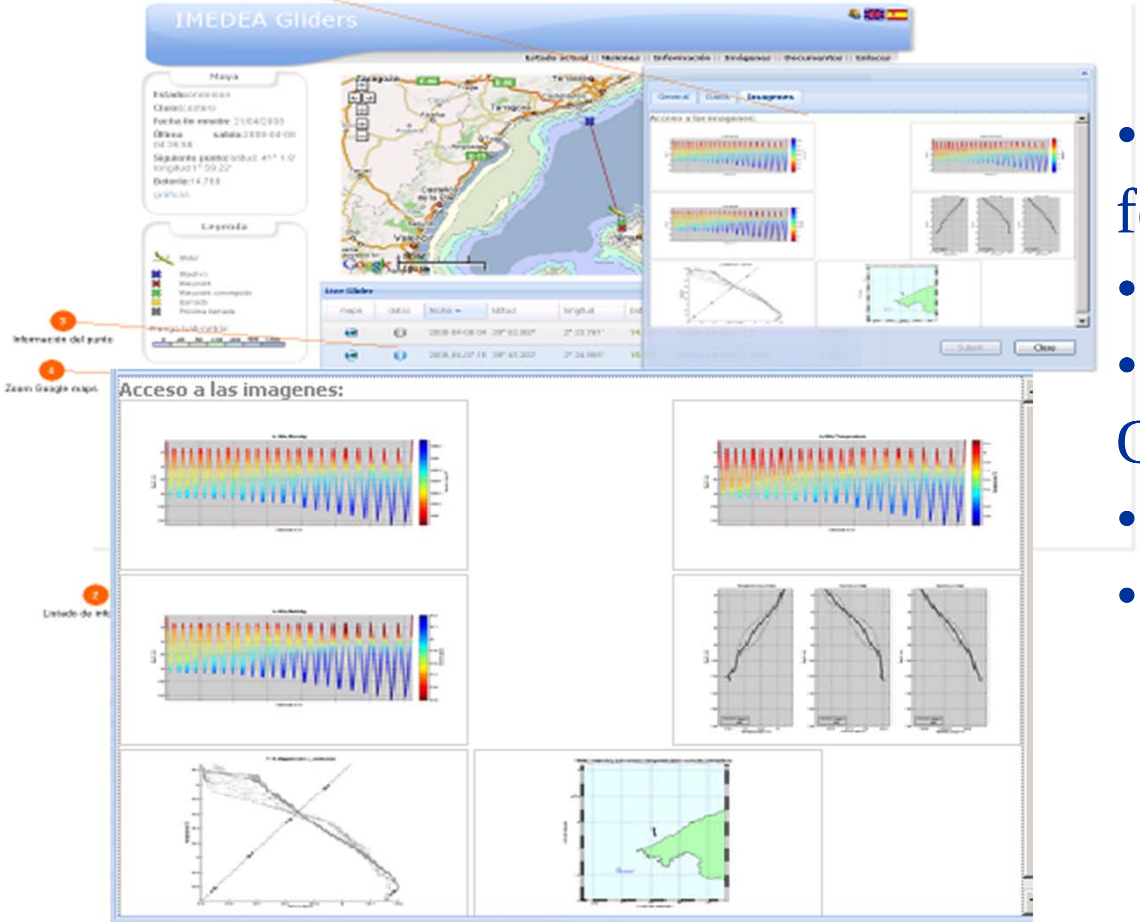
6.Analisis and Visualization



IDV, own Web Aplications, GODIVA, LAS,... capability to provide an integrated viewing service.

SOCIB Data Centre Facility (example of glider browser)

'e have developed a system for tracking glider missions in real time:
http://imedea.uib-csic.es/tmoos/gliders/

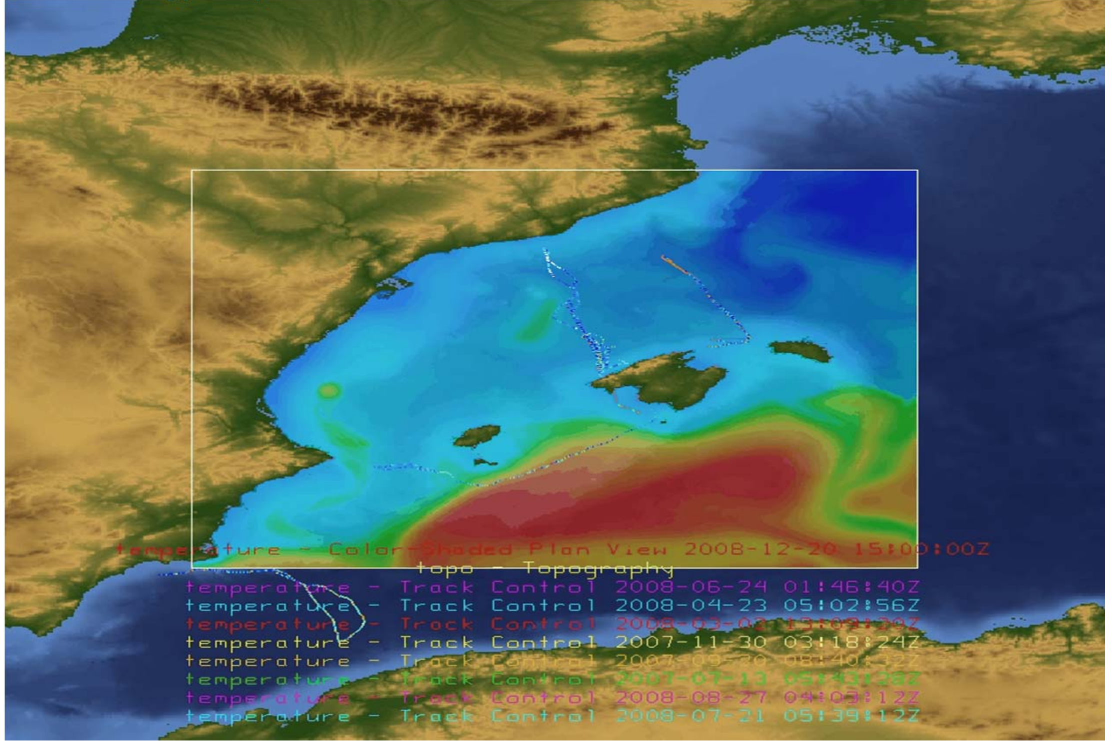


- Mission definition and feasibility analysis tool
- Quality control
- Data transmission to Coriolis, etc…
- Data download capability
- OpenDap, Thredds server

SOCIB Data Centre Facility. Example, viewing

3D Visualization Tools (IDV)

The Integrated Data Viewer (IDV) is a software developed by UNIDATA that allows the 3D visualization of data en NetCDF/CF-1.0 data. Permit the Thredds and RAMADDA catalog exploration.



The Image combines: all the temperature collected by the gliders, a surface section of the forecast model of temperature field and a bathymetry all in 3D.

(all data from the Thredds catalog)

Data Centre / Buoys and Moorings Facility (phase 0 – 2011 activities)

http://www.socib.es/?seccion=observingFacilities&facility=mooring

Mobile phone access

2011:
1 coastal buoy (Enderrocat)
3 tide gauge (Port Andratx, Pollensa, La Rápita)

Data access: Free and real time / historical
Delivery data: OPeNDAP /THREDDS server hosting CF-compliant netCDF
http://thredds.socib.es/thredds/catalog.html
http://thredds.socib.es/thredds/catalog/data/observational/mooring/catalog.html

Select instrument, select year and month, view using jwebchart and select variables….
http://www.socib.es/~jllodra/workspace/jwebchart/?file=http://thredds.socib.es/thredds/dodsC/data/observational/mooring/buoy_enderrocat/2011/201105_buoy_enderrocat.nc

SOCIB Engineering and Development (phase - 0 AUV – 2011 activities)

http://www.bluefinrobotics.com/

ISY AUV – Italy – 2008

NURC – beach monitoring field experiment – TMOOS –

A sample mosaic from the Autonomous Underwater Vehicle (AUV) taken at Ningaloo marine park, Western Australia showing sponge beds in 80m of water. The AUV was maintaining an altitude of 2m, giving a 1.5m swath, and traveling at 0.5m/s. The mosaic is composed of 40 images captured at 2Hz and represents a 10m transect.

SOCIB Applications and Strategic Issues Society (Background...)

OPINIÓN

INVESTIGACIÓN, MEDIO AMBIENTE Y SOSTENIBILIDAD: el nuevo papel de la ciencia y la contribución del IMEDEA

Joaquín Tintoré Subirana
Profesor de investigación del CSIC
Director del IMEDEA

El medio ambiente es, a principios del siglo XXI, uno de los temas de mayor interés en nuestro país y es evidente su importancia social, cultural y económica. Esto indica una mayor concienciación general sobre los efectos del desarrollo de las últimas décadas, y una preocupación por las condiciones del planeta que legaremos a las generaciones futuras. El medio ambiente del planeta Tierra es un sistema extremadamente complejo del que únicamente ahora empezamos a comprender algunos procesos o algunos mecanismos y fenómenos muy elementales. No es pretensión de uno insistir sobre la degradación de nuestro planeta ni hacer un diagnóstico del medio ambiente en nuestro país, sino plantear unos comentarios sobre la nueva relación entre investigación y medio ambiente, y la necesidad de avanzar hacia una nueva política de gestión sostenible de los recursos naturales, más basada en el conocimiento, más basada en criterios científicos y éticos al servicio del bienestar de la humanidad. Este es y ha sido desde hace ya más de 10 años el compromiso del IMEDEA, el Instituto Mediterráneo de Estudios Avanzados situado en Mallorca, un instituto de investigación mixto entre el CSIC y la UIB en el que más de 100 personas intentan, día a día, contribuir al avance del conocimiento en el ámbito de las ciencias marinas y el litoral intentando también responder de forma independiente a las necesidades de la sociedad. Una ciencia de calidad internacionalmente avalada y también

El desarrollo y la implementación de un sistema de indicadores para la GIZC en las Illes Balears desde la ICTS SOCIB (2006 – actualidad)

CES Illes Balears

IMEDEA CSIC Universitat de les Illes Balears

obsam

IBESTAT Institut d'Estadística de les Illes Balears

Govern de les Illes Balears

SOCIB Balearic Islands Coastal Observing and Forecasting System

Proyecto de Indicadores GIZC Baleares

- Iniciado en 2006 por el IMEDEA (CSIC-UIB) y el Consejo Económico y Social de las Illes Balears (CES), continuado por el SOCIB desde 2009.
- Este trabajo se enmarcó en las actividades del Proyecto I+D+i GIZC (2005 – 2008) del IMEDEA, creado en 2005 conjuntamente con el Govern de les Illes Balears, con el apoyo de la Direcció General de R+D+i del Govern de les Illes Balears.

Objetivo Principal

- Desarrollar e implementar una herramienta científica de apoyo a la toma de decisiones relacionadas con el desarrollo sostenible en la zona costera, siguiendo las grandes líneas internacionales, y recogiendo las necesidades de la sociedad de las Illes Balears.
- Un indicador es una medida que proporciona una visión simplificada de un fenómeno más complejo, o que proporciona una visión más detallada sobre una tendencia, o que simplemente, no puede ser observada. De este modo, los indicadores cuantifican y simplifican una información (WG-ID 2002).

Estructura del Proyecto I+D+i GIZC

www.costabalearsostenible.com

Research → Technological development → Innovation of technology and services

1. Disciplinary research

- 1.1.1 Coastal variability and global change
- 1.1.2 Biodiversity and global change
- 1.1.3 Water quality and public safety in the coastal zone
- 1.1.4 Operational oceanography and marine technology

1.1 Environment

- 1.2.1 Natural and cultural heritage
- 1.2.2 Population, territory and landuses
- 1.2.3 Economy, employment and tourism

1.2 Society, economy and culture

- 1.3.1 Provision of information to help generate and guide policy development
- 1.3.2 Evaluation of the governance system
- 1.3.3 Cooperation and coordination

1.3 Governance

2. Multidisciplinary research

The horitzontal projects respond to cross-cutting research needs requiring an interdisciplinary approach

- 2.1 Zoning criteria for implementing ICZM
- 2.2 Literature review
- 2.3 Development of a system of indicators for ICZM
- 2.4 Environemental Information System. SIABAL

3. Research aimed at technological development

Responds to the need for new scientific tools and technologies that support ICZM in the Balearics

- 3.1 GIS Database
- 3.2 Proposal for technological development

4. Transfer of Knowledge

Dissemination strategy, stakeholder participation and transfer of knowledge

- 4.1 Strategy for dissemination of results, stakeholder participation and transfer of knowledge

La situación ideal de las Illes Balears: idoneidad y oportunidades para alcanzar el reto de una sostenibilidad real y una GIZC basada en el conocimiento.

- (a) existe el conocimiento científico de base necesario para implementar una GIZC (SOCIB, IMEDEA, etc.),
- (b) existe un patrimonio natural y cultural globalmente bien preservado
- (c) existe la concienciación de la sociedad civil de la necesidad de preservar este patrimonio como elemento esencial del bienestar actual y futuro y como una estrategia clave de competitividad para asegurar la sostenibilidad del turismo, que es el motor principal de la actividad económica.

Metodología - Diseño del Sistema de Indicadores GIZC Balears

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

Resultados – Divulgación e implementación del Sistema

SOCIB Balearic Islands Coastal Observing and Forecasting System

Science to Society efforts

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

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

Dictamen del CES
(Consejo Económico y Social de Baleares, 2006-2009)

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

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ABSTRACT

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


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coastal zone mar
A. Diedrich a,*, J. Tinto
a IMEDEA (CSIC-UIB), Mediterranean
b CES, Economic and Social Council o
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SOCIB Balearic Islands Coastal Observing and Forecasting System
ICES Annual Science Conference 20-24 September 2010 Nantes, France
The importance of setting priority objectives for ensuring the effective use of science in ICZM
Amy Diedrich1 and Joaquin Tintoré1,2
1 SOCIB, Balearic Islands Coastal Ocean Observing and Forecasting System
2 IMEDEA (CSIC-UIB), Mediterranean Institute of Advanced Studies

Estudio Piloto – Implementación en Menorca

Implementación del Sistema de Indicadores para la Gestión Integrada de la Zona Costera en las Illes Balears: estudio piloto en Menorca

Informe Técnico

Octubre 2010

Equipo de Trabajo:

Sara Fernández, Joan Matamalas

IBESTAT (Instituto de Estadística de las Illes Balears)

Amy Diedrich, Sandra Espeja, Ferran Navinés, Joan Crespí, Pau Balaguer, Joaquín Tintoré*

SOCIB (Sistema de Observación y Predicción Costera en las Illes Balears)

*SOCIB e IMEDEA (CSIC-UIB)

David Carreras, Sònia Estradé, Joana Fullana

OBSAM (Observatorio Socioambiental de las Illes Balears)

Guía metodológica elaborada sobre 17 indicadores seleccionados como prioritarios según su idoneidad e importancia.

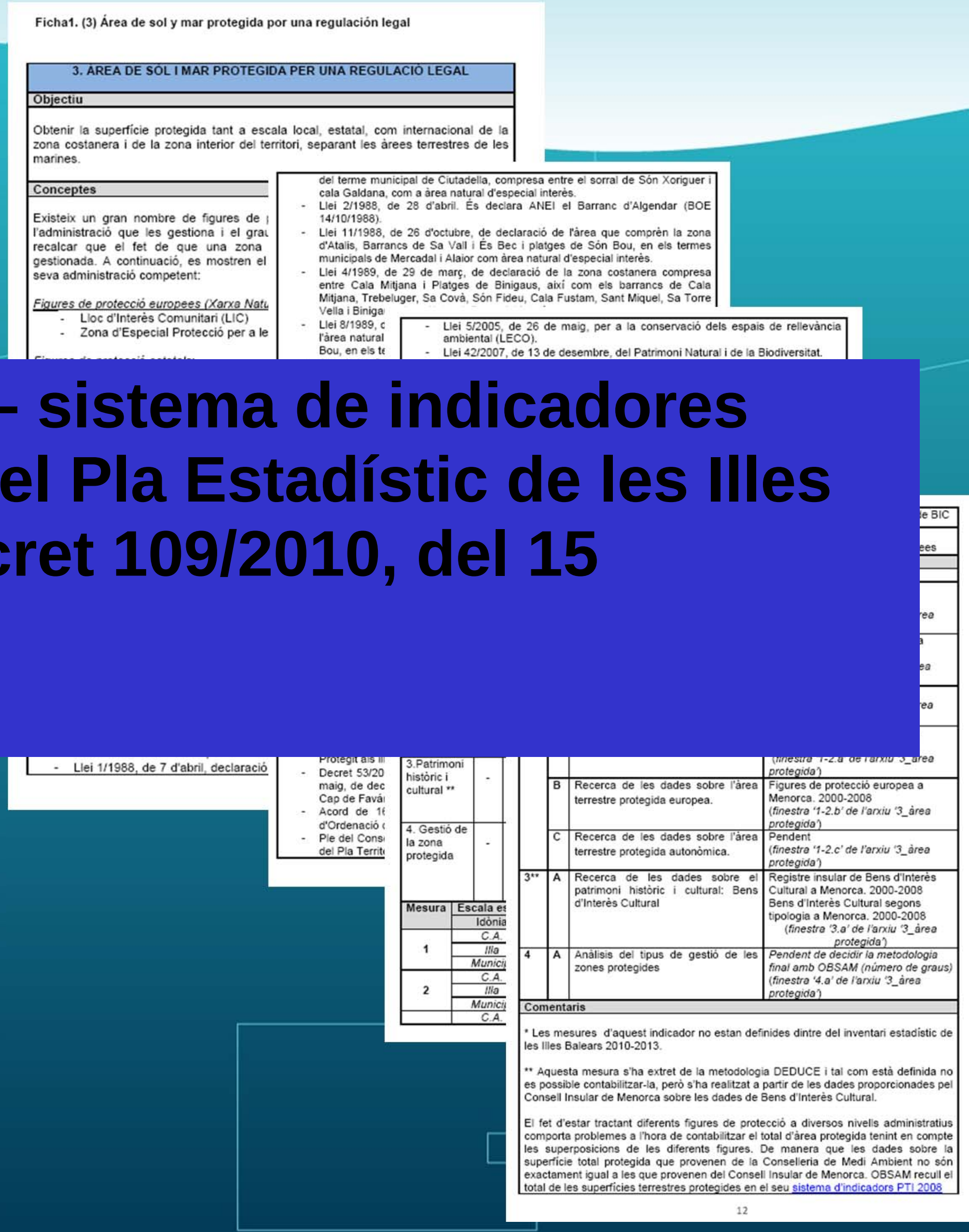
Colaboración: SOCIB, IBESTAT, OBSAM – IME (Observatorio socio-ambiental de Menorca)

El papel del OBSAM ha consistido en asesorar el trabajo del SOCIB y IBESTAT, sobretodo ofreciendo su experiencia en recopilación de datos de la administración pública y su transformación en indicadores.

Fichas técnicas

Nombre del indicador

- Objetivo
- Co
- Tip
- Dis
- Da
- Fu
- Pe
- Escala de datos: espacial y temporal
- Unidades
- Metodología
- Procedimiento: pasos a seguir
- Comentarios



Ficha1. (3) Área de sol y mar protegida por una regulación legal

3. AREA DE SÒL I MAR PROTEGIDA PER UNA REGULACIÓ LEGAL

Objectiu

Obtenir la superfície protegida tant a escala local, estatal, com internacional de la zona costanera i de la zona interior del territori, separant les àrees terrestres de les marines.

Conceptes

Existeix un gran nombre de figures de p... l'administració que les gestiona i el grau ... recalcar que el fet de que una zona ... gestionada. A continuació, es mostren el... seva administració competent:

Figures de protecció europees (Xarxa Natu...

- Lloc d'Interès Comunitari (LIC)
- Zona d'Especial Protecció per a le...

del terme municipal de Ciutadella, compresa entre el sorral de Són Xoriguer i cala Galdana, com a àrea natural d'especial interès.

- Llei 2/1988, de 28 d'abril. És declara ANEI el Barranc d'Algendar (BOE 14/10/1988).
- Llei 11/1988, de 26 d'octubre, de declaració de l'àrea que comprèn la zona d'Atalis, Barrancs de Sa Vall i Ès Bec i platges de Són Bou, en els termes municipals de Mercadal i Alaior com àrea natural d'especial interès.
- Llei 4/1989, de 29 de març, de declaració de la zona costanera compresa entre Cala Mitjana i Platges de Binigaus, així com els barrancs de Cala Mitjana, Trebeluger, Sa Covà, Són Fideu, Cala Fustam, Sant Miquel, Sa Torre Vella i Biniga...
- Llei 8/1989, ... l'àrea natural ... Bou, en els te...

- Llei 5/2005, de 26 de maig, per a la conservació dels espais de rellevància ambiental (LECO).
- Llei 42/2007, de 13 de desembre, del Patrimoni Natural i de la Biodiversitat.

Resultado importante – sistema de indicadores GIZC incluido dentro del Pla Estadístic de les Illes Balears 2010-2013 [decret 109/2010, del 15 d'octubre].

- Llei 1/1988, de 7 d'abril, declaració ...

B	Recerca de les dades sobre l'àrea terrestre protegida europea.	Figures de protecció europea a Menorca. 2000-2008 (finestra '1-2.b' de l'arxiu '3_àrea protegida')
C	Recerca de les dades sobre l'àrea terrestre protegida autonòmica.	Pendent (finestra '1-2.c' de l'arxiu '3_àrea protegida')
3** A	Recerca de les dades sobre el patrimoni històric i cultural: Bens d'Interès Cultural	Registre insular de Bens d'Interès Cultural a Menorca. 2000-2008 Bens d'Interès Cultural segons tipologia a Menorca. 2000-2008 (finestra '3.a' de l'arxiu '3_àrea protegida')
4 A	Anàlisis del tipus de gestió de les zones protegides	Pendent de decidir la metodologia final amb OBSAM (número de graus) (finestra '4.a' de l'arxiu '3_àrea protegida')

Comentaris

* Les mesures d'aquest indicador no estan definides dintre del inventari estadístic de les Illes Balears 2010-2013.

** Aquesta mesura s'ha extret de la metodologia DEDUCE i tal com està definida no es possible contabilitzar-la, però s'ha realitzat a partir de les dades proporcionades pel Consell Insular de Menorca sobre les dades de Bens d'Interès Cultural.

El fet d'estar tractant diferents figures de protecció a diversos nivells administratius comporta problemes a l'hora de contabilitzar el total d'àrea protegida tenint en compte les superposicions de les diferents figures. De manera que les dades sobre la superfície total protegida que provenen de la Conselleria de Medi Ambient no són exactament igual a les que provenen del Consell Insular de Menorca. OBSAM recull el total de les superfícies terrestres protegides en el seu sistema d'indicadors PTI 2008

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Outline

1. **What** is SOCIB?
2. **Why SOCIB**, why Coastal Ocean Observatories, and **why now**?
3. Background
4. **Why in the Mediterranean?, Why in the Balearic Islands**
5. **Scales and major focus**
6. **Mission and Objectives**
7. **Principles**
8. **Components, Structure and Functioning**
9. **Initial results** from ongoing SOCIB pilot facilities
10. **Summary**

SOCIB Summary

- SOCIB Consortium: a new way to fund marine research infrastructures, along lines of international initiatives such as IMOS, OOI, IOOS, etc.
- SOCIB: scientific excellence, science, technology and society needs driven.
- Partners and main actors: MICINN-ICTS & Balearic Islands Gov. and later, CSIC, IEO, UIB, etc. IMEDEA, IEO, specific crucial role.
- SOCIB total investment 36 M€ (2009-2021). 14 M€ equipments. 2M€ running costs for 11 years.
- SOCIB is/will be the main facility supporting the R&D activity in Operational oceanography in Balearic Islands.
- SOCIB is the first and only existing Large Scale ICTS Facility in the Balearic Islands.
- SOCIB will be an open access facility for any other R&D institution with similar concepts and focus.
- SOCIB has management, administration, budget and services autonomy and has own staff.
- Strong and active involvement and partnership with key Science and Technology institutions is a must for success of this initiative.
- Implementation Plan formally approved in July 2010, present pilot facilities ongoing and SOCIB build-up!
- Still many unknowns, but we are ºworking on them….

Muchas gracias!!!