Marine and Coastal Research Infrastructures: drive knowledge increase, transfer of technological products and management technologies for the public and private sector

(Or… 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

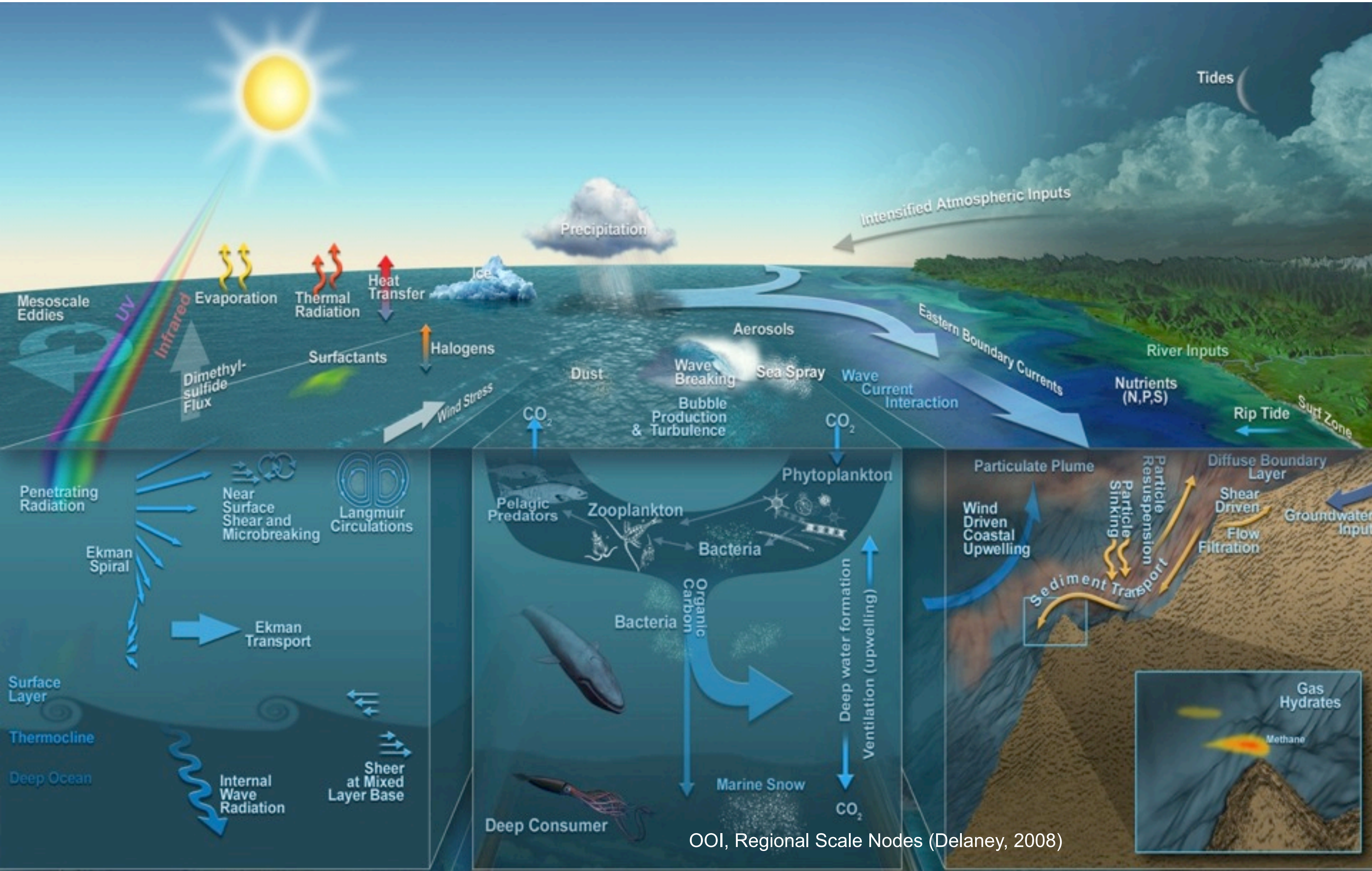
GOBIERNO DE ESPAÑA · MINISTERIO DE CIENCIA E INNOVACIÓN

Govern de les Illes Balears

Outline

1. **SOCIB: oceans complexity, monitoring, what, why, why now**
2. **Background: IMEDEA and/or 20 years of science, technology development and applications for society. Some examples of each…**
3. **SOCIB: why, scales, monitoring tools, particularities and ongoing activities; gliders, modeling, data center examples, ETD, SIAS**
4. **Innovation in oceanographic instrumentation: the case of ocean gliders.**
5. **The new role of Marine Research Infrastructures**

Oceans are complex and central to the Earth system



OOI, Regional Scale Nodes (Delaney, 2008)

The oceans are chronically under-sampled

The oceans are chronically under-sampled

(Credit, Pere Oliver)

SOCIB Balearic Islands Coastal Observing and Forecasting System

GOBIERNO DE ESPAÑA MINISTERIO DE CIENCIA E INNOVACIÓN

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Now… What is SOCIB?

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

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

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

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

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

A New Approach to Marine and Coastal Research

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

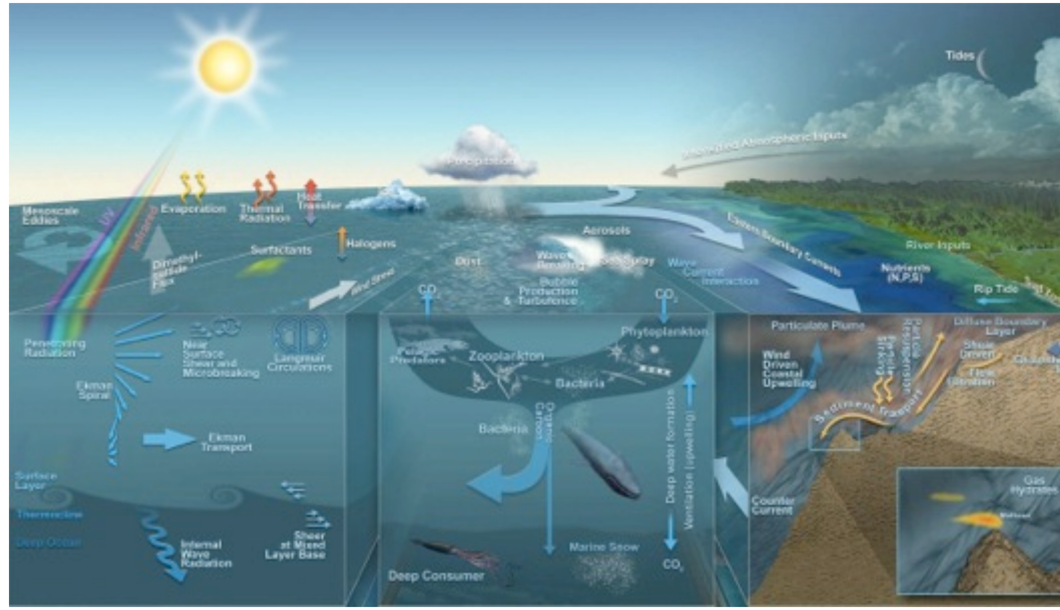
↓

A quantitative major jump, in scientific knowledge and technology development

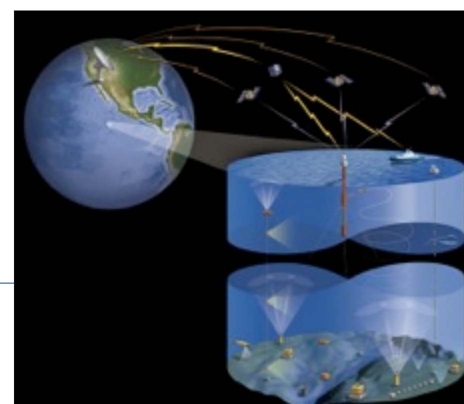
↓

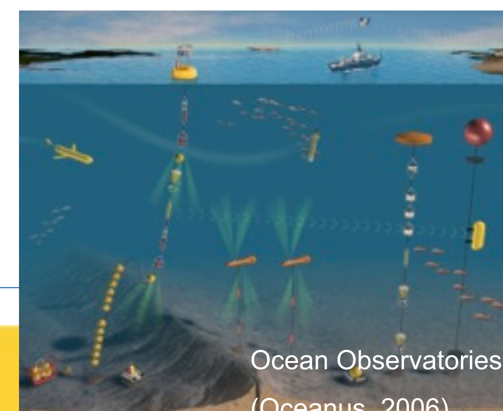
The development of a new form of Integrated Coastal Zone Management, based on recent scientific and technological achievements,

on a global change context (where climate change is one of the most important, but not the only one…), and following sustainability principles



OOI, Regional Scale Nodes (Delaney, 2008)





Ocean Observatories, (Oceanus, 2006)

Outline

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2. Background: IMEDEA and/or 20 years of science, technology development and applications for society. Some examples of each…
3. SOCIB: why, scales, monitoring tools, particularities and ongoing activities; gliders, modeling, data center examples, ETD, SIAS
4. Innovation in oceanographic instrumentation: the case of ocean gliders.
5. The new role of Marine Research Infrastructures

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

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

that evolved incorporating …

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

that evolved as requested by society…

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

(Available pdf file at:

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

Eastern Alborán Sea dynamics and basin scale interactions

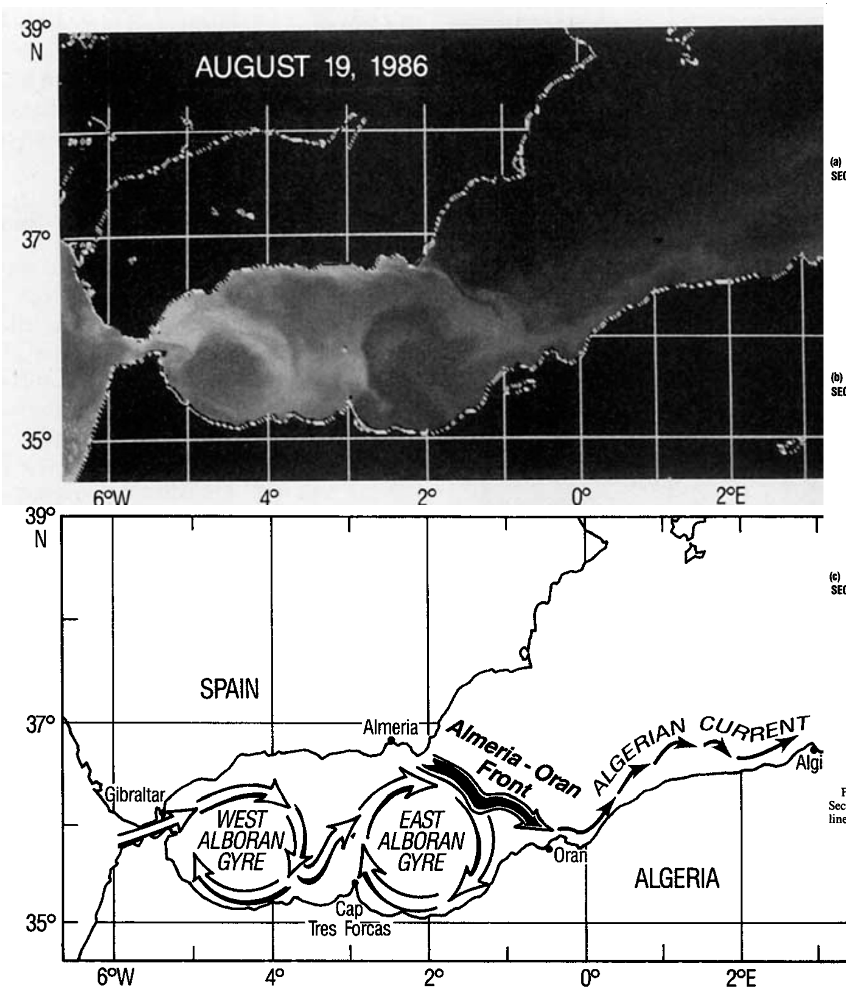


FIG. 1. (Top) A satellite thermal image of the Alboran Sea, showing the continuity of the regional circulation. As with the other satellite imagery in this paper, this NOAA AVHRR-IR image was registered to a Mercator projection and enhanced to show the ocean features. (Bottom) A schematic drawing of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

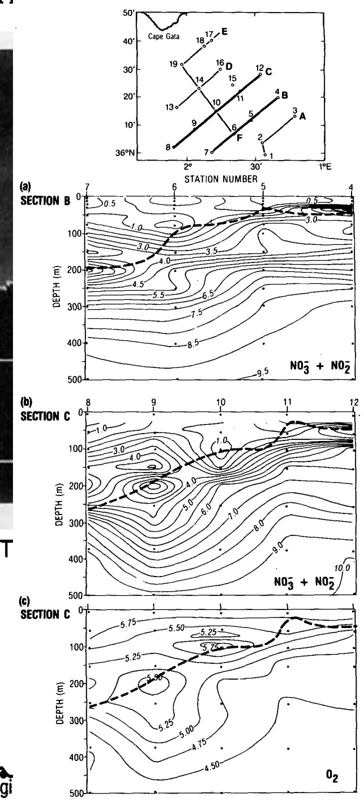
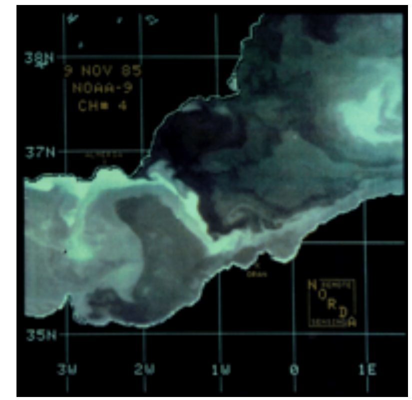
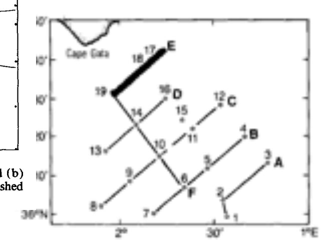


FIG. 8. Vertical nitrogen distribution for (a) Section B, and (b) Section C. Vertical oxygen distribution for Section C (c). The dashed line represents the depth of the 28.4 isopycnal.





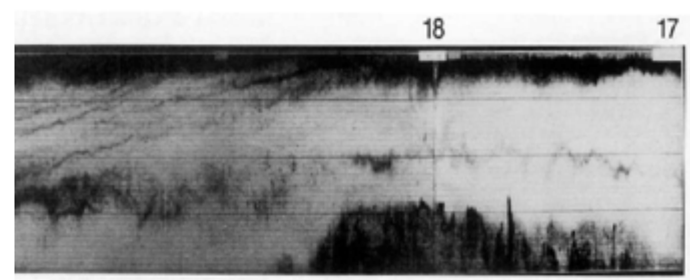


FIG. 10. Echosounder chart for Section E.

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

(Viúdez, Tintoré, Haney, 1996)

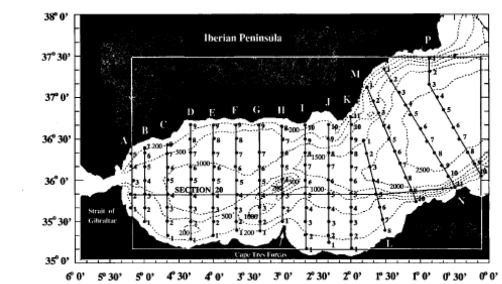


Fig. 1. The Alboran Sea (bottom topography in m). The different vertical CTD sections are referenced.

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

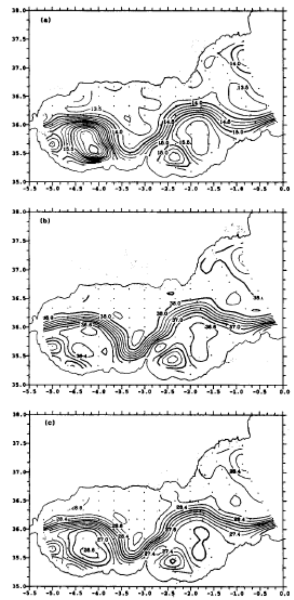
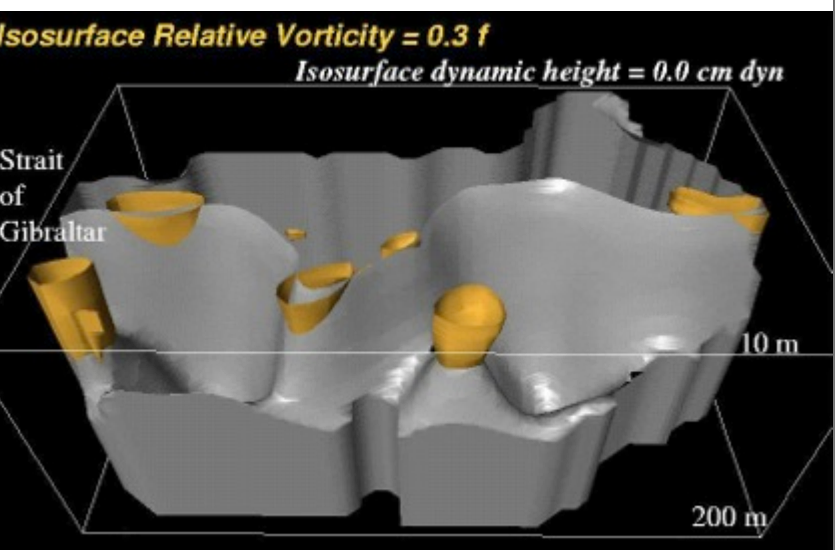


Fig. 2. (a) Temperature (Δ = 0.25°C), (b) salinity (Δ = 0.2 psu), and (c) σ_t (Δ = 0.2 σ_t) horizontal distributions at 100 m. Interpolation method: successive corrections (referenced in the text).



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.

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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.

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Progress in Oceanography 66 (2005) 321–340
Progress in Oceanograp
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Mesoscale, seasonal and interannual variability in the Mediterranean Sea using a numerical ocean model

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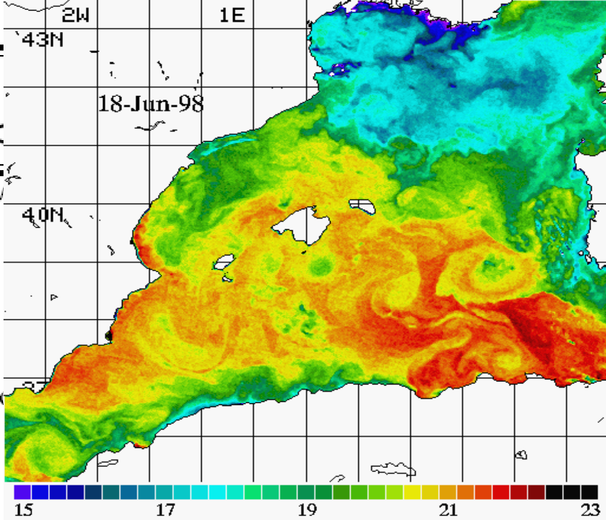
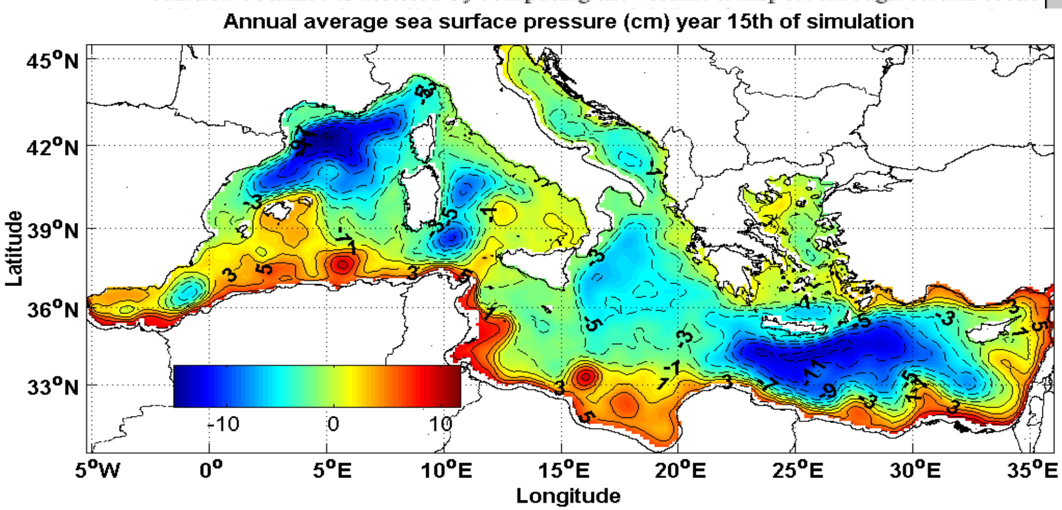
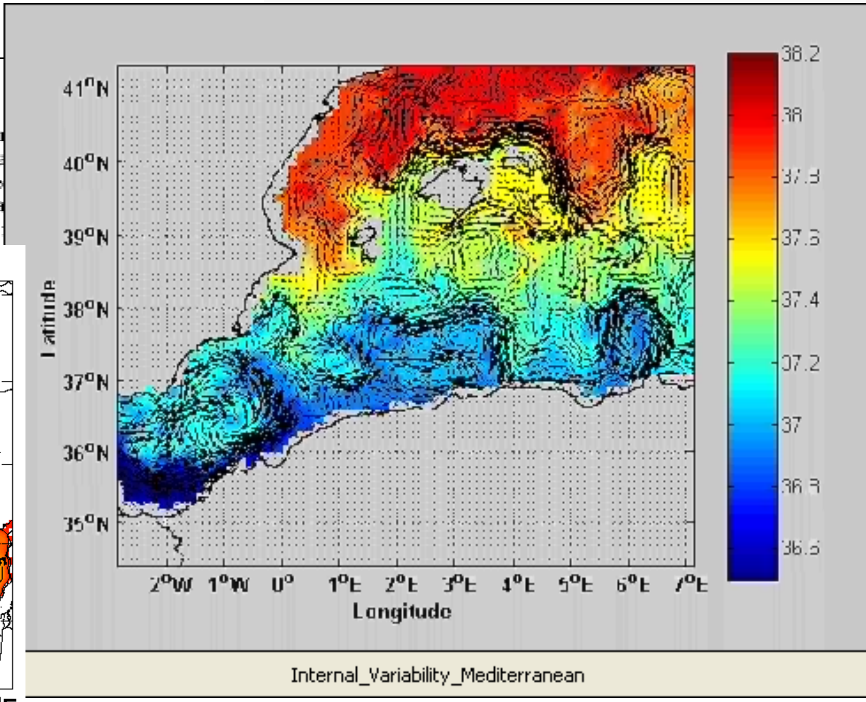
Available online 10 May 2005

Abstract

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







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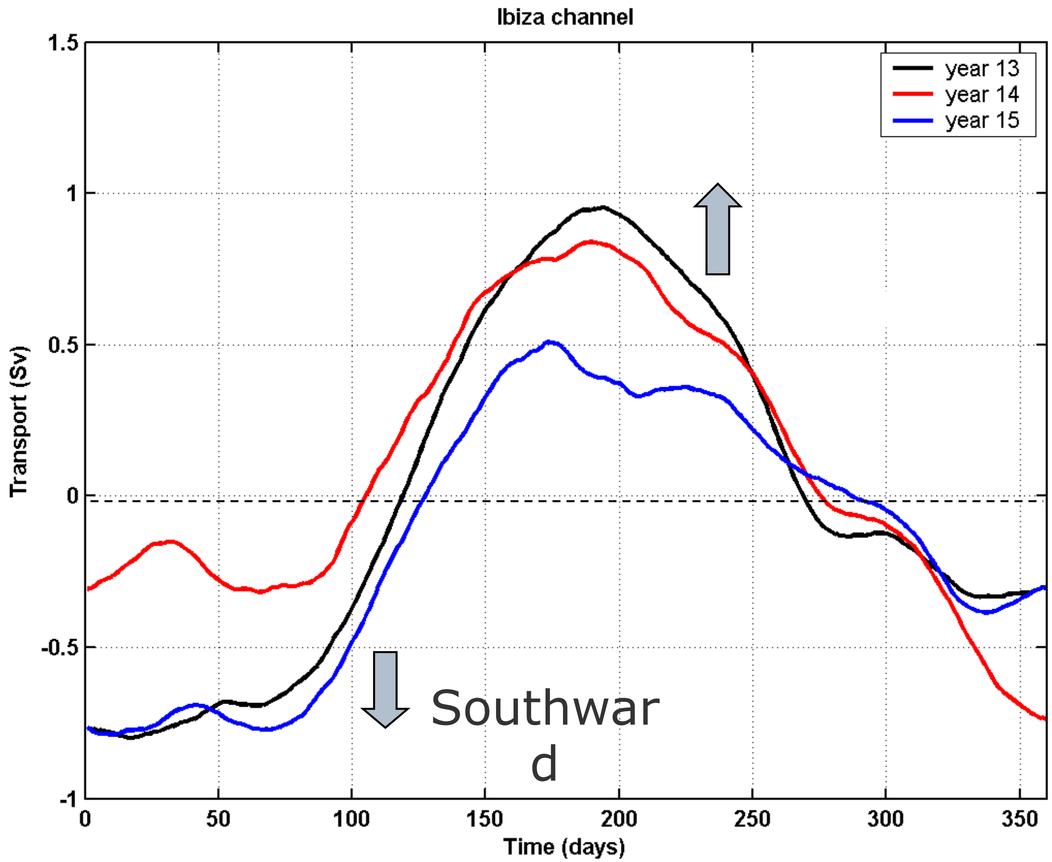
Interannual variability in the Mediterranean

Volume transports

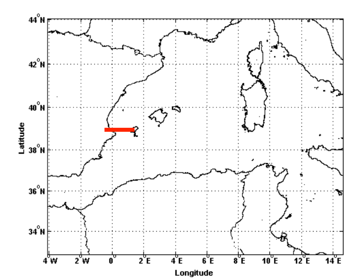


Fernandez, Dietrich, Haney, Tintoré, Prog. Oceanogr., 2003

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

Southward transport of 1 to 1.5 in winter

(Pinot et al., 2002)



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

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JOURNAL OF MARINE SYSTEMS

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A forecast experiment in the Balearic Sea

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Abstract

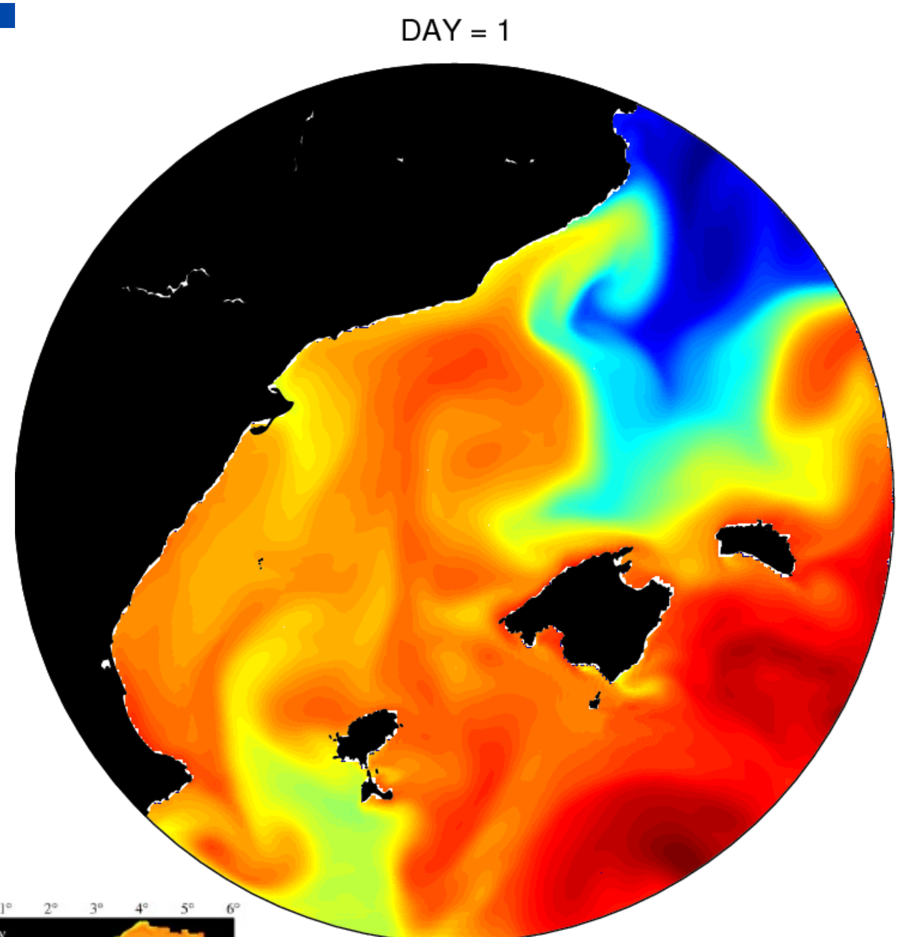
A forecast experiment in the Balearic Sea is presented which is based on the Harvard Ocean Prediction System (HOPS). HOPS is modular, containing a high-resolution primitive equations model, packages for objective analysis and data assimilation (Optimum Interpolation), an interface to implement atmospheric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

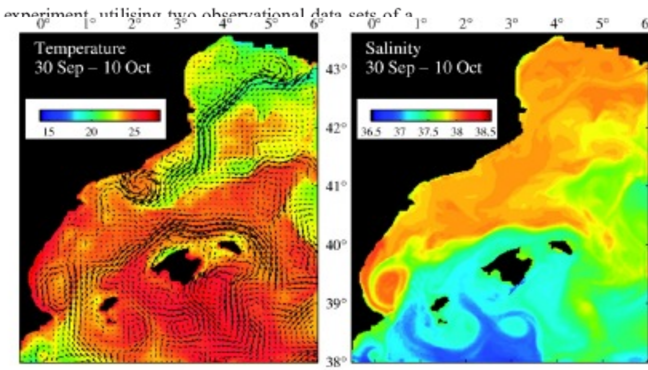
The forecast capability of HOPS is demonstrated in terms of a hindcast experiment utilising two observational data sets of a subregion of the Balearic Sea which were acquired in mid September and
used for model initialisation, that of the second survey serves for validation
is evaluated quantitatively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

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

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

System





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

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Progress in Oceanography 66 (2005) 120–141

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

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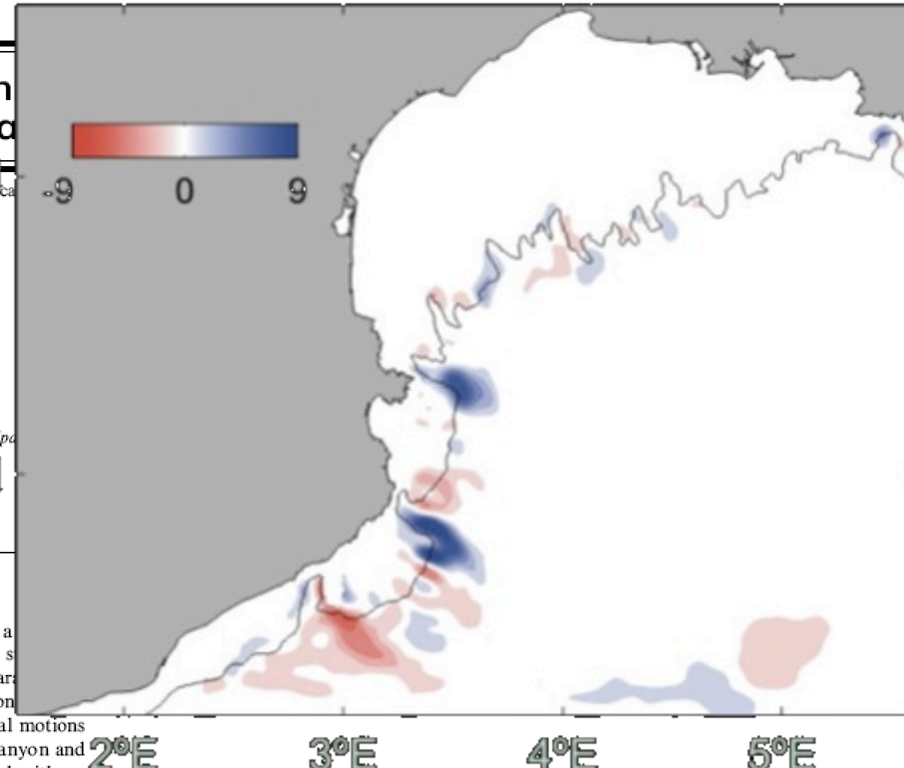
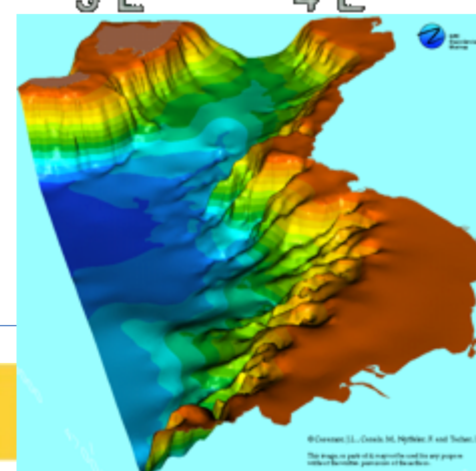
Available online 13 May 2005

Abstract

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

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





Residence time, coastal–open ocean exchanges, eutrofication

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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]

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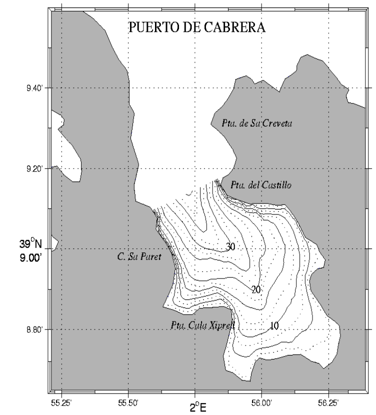
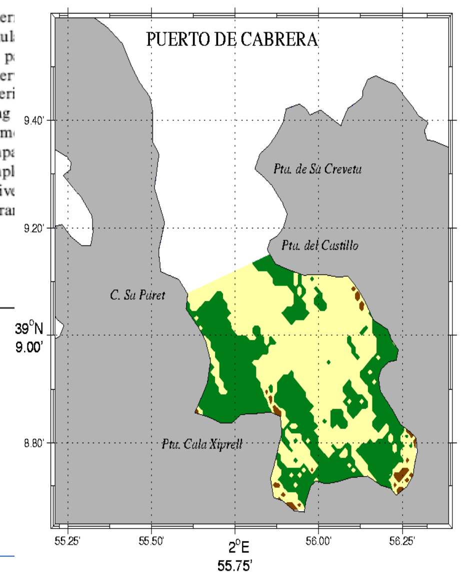
Received 20 April 2004; received in revised form 22 January 2005; accepted 25 January 2005
Available online 19 March 2005

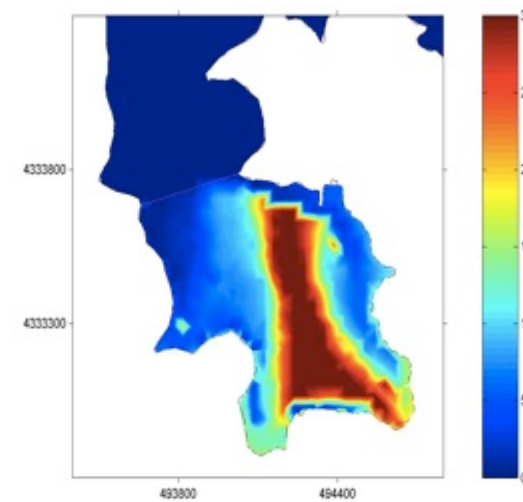
Abstract

Flushing time and residence time are studied in a small inlet in Cabrera National Park, Western Mediter
Flushing time is studied using ADCP in situ data. Observed flushing time data are compared with the simul
a three-dimensional coastal ocean numerical model. Residence time is assessed using virtual lagrangian p
studying the number remaining within the analyzed domain. Results show a good agreement between obser
modeling estimations of the flushing time (i.e. 6 days from the ADCP data and 5.6 days from the numeri
Residence time estimations yield a broad range of values, from 1 h in the Bay to over 30 days depending
horizontal and vertical position where particles were released. A continuous stirred tank reactor (CSTR) m
Port yields a value of 8.7 days. Results obtained for the residence time appear to have a determinant imp
meadows of the seagrass *Posidonia oceanica*, present inside the Port. Recirculation patterns and compl
coastal environments create a non-uniform distribution of the areas of accumulation of non-conservativ
that indicate that residence time concept is the correct approach when studying the impact of water tra
biological communities.

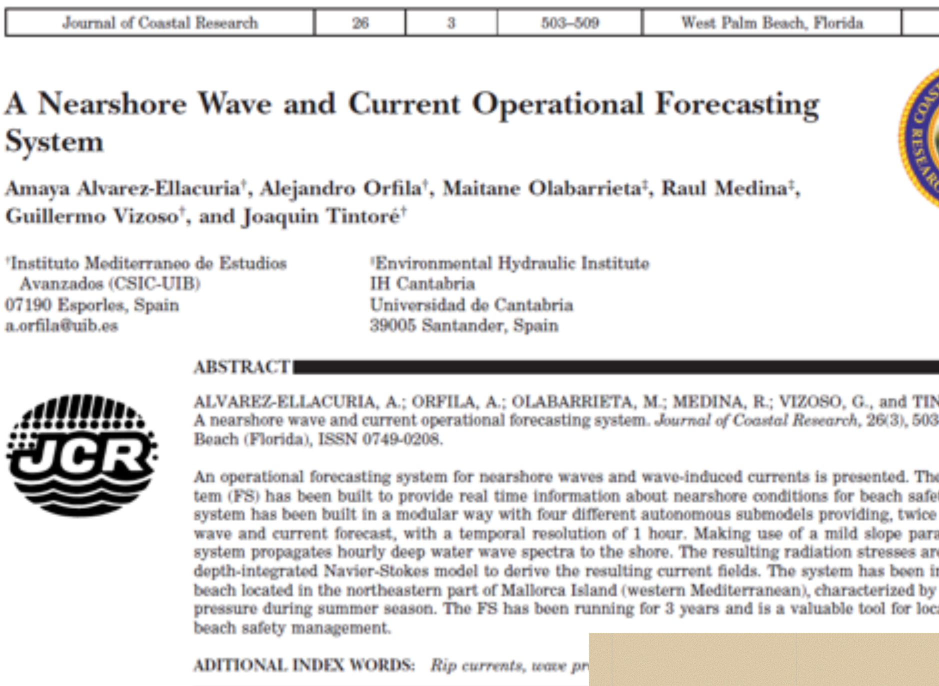
Keywords: Residence time; Flushing time; *Posidonia oceanica*







Pre-operational systems being implemented; coastal ocean and beaches


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[†]

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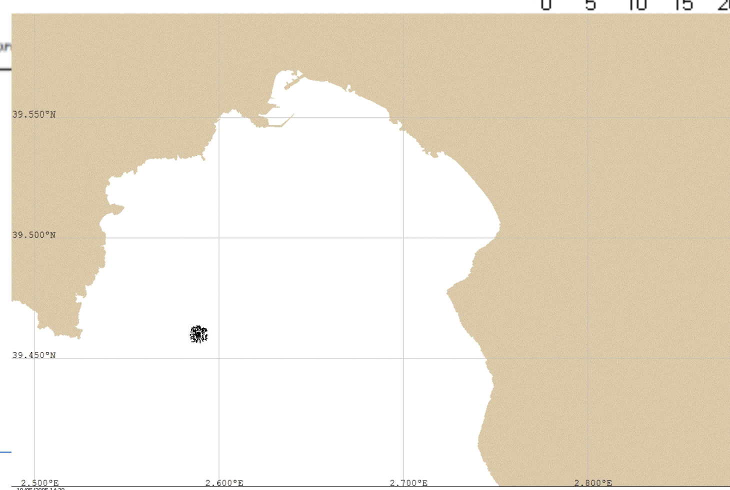
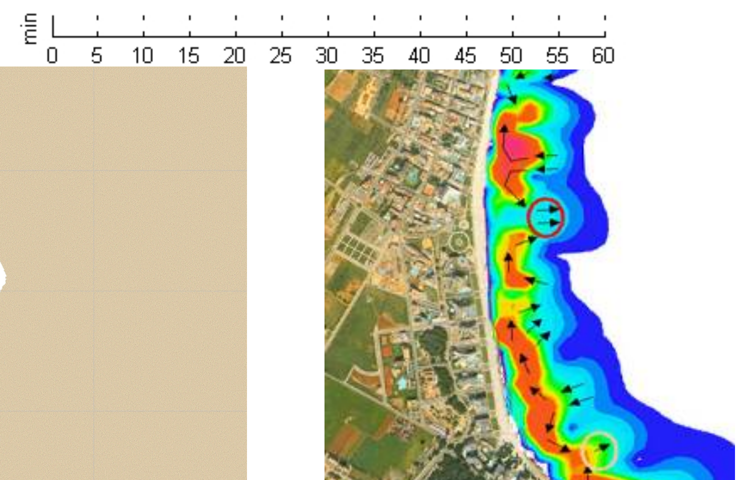
ABSTRACT

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 in beach located in the northeastern part of Mallorca Island (western Mediterranean), characterized by 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.

SOCIB Balearic Islands Coastal Observing and Forecasting System

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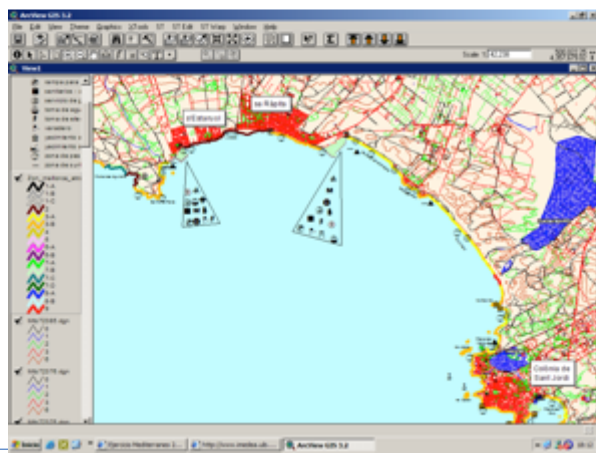
Govern de les Illes Balears

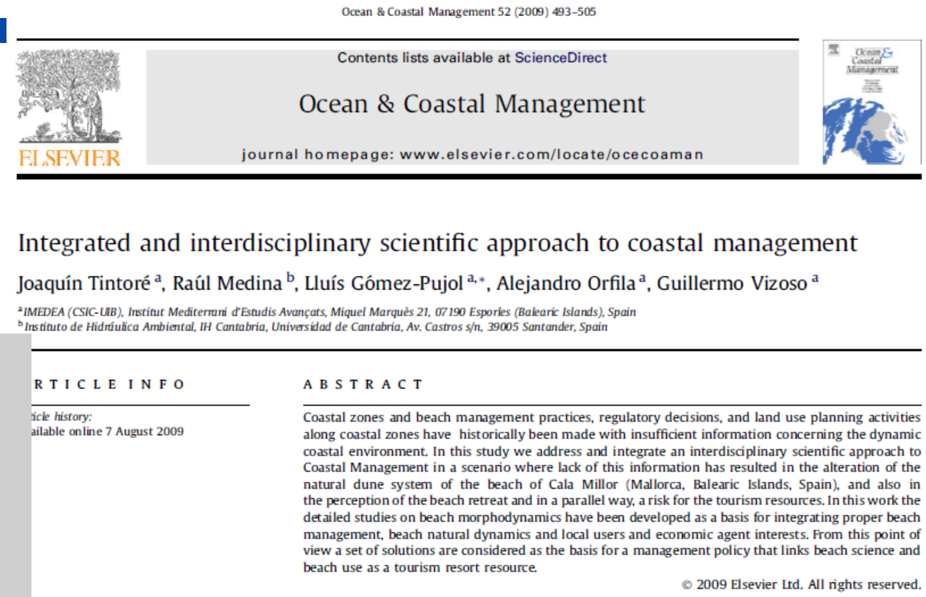
Tools for decision support under oil spill: ESI for all Balearic coast (1.200 km coastline)

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

ESI (Environmental Sensitivity Index)



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



Ocean & Coastal Management 52 (2009) 493–505

Contents lists available at ScienceDirect

Ocean & Coastal Management

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

Integrated and interdisciplinary scientific approach to coastal management

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

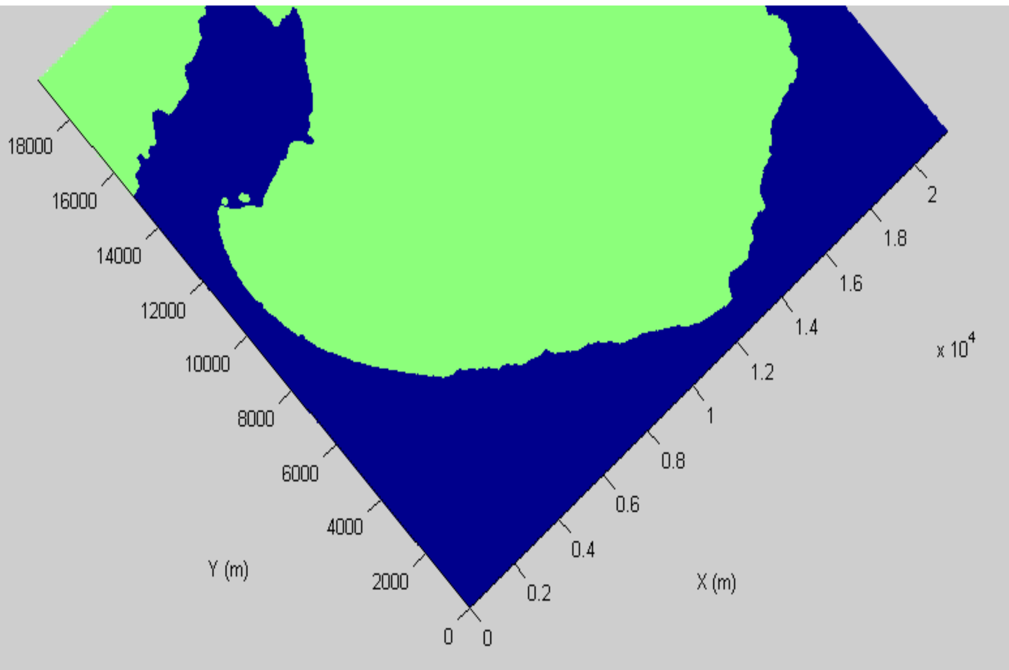
[a] IMEDEA (CSIC-UIB), Institut Mediterrani d'Estudis Avançats, Miquel Marquès 21, 07190 Esporles (Balearic Islands), Spain
[b] Instituto de Hidráulica Ambiental, IH Cantabria, Universidad de Cantabria, Av. Castros s/n, 39005 Santander, Spain

RTICLE INFO

ticle 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

(extreme storms Nov. 2001)

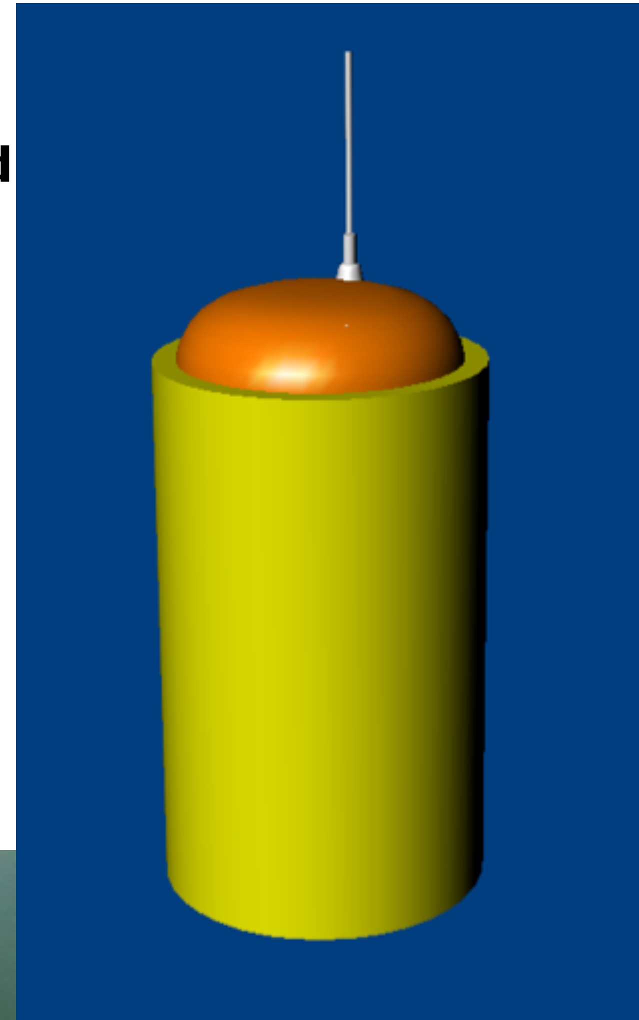
Technology Development, IMEDEA transfer to new spin off company AMT, UIB-CSIC / 2005)

AUV's

GSM and New Iridium drifters

Albatros Marine Technologies – Spin off -

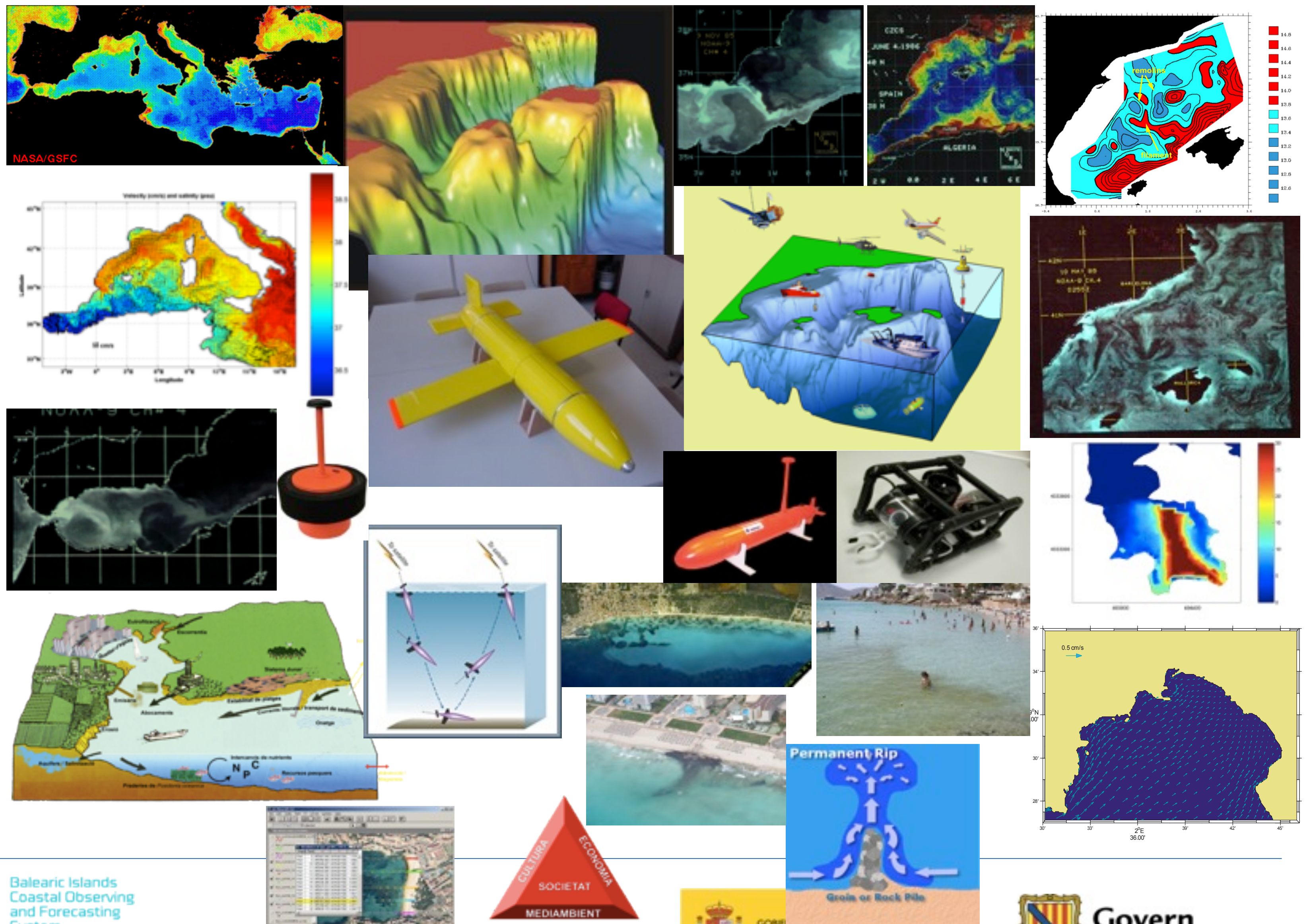
ROV's



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

http://www.albatrosmt.com

In summary, background…



SOCIB Balearic Islands Coastal Observing and Forecasting System

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Outline

1. SOCIB: oceans complexity, monitoring, what, why, why now

2. Background: IMEDEA and/or 20 years of science, technology development and applications for society. Some examples of each…

3. SOCIB: why, scales, monitoring tools, particularities and ongoing activities; gliders, modeling, data center examples, ETD, SIAS

4. Innovation in oceanographic instrumentation: the case of ocean gliders.

5. The new role of Marine Research Infrastructures

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

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

Example… SCIENCE:

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

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

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

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

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

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

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

nature

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

Patching together a world view

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

Now or never

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

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

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

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

Responding Science... and Society issues

Project based – 3 years - Can be done!!

But is inneficient

Next Step

SOCIB

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

NEWS

Determining Critical Infrastructure for Ocean Research and Societal Needs in 2030

PAGES 210–211

The United States has jurisdiction over 3.4 million square miles of ocean—an expanse greater than the land area of all 50 states combined. This vast marine area offers researchers opportunities to investigate the ocean's role in an integrated Earth system but also presents challenges to society, including damaging tsunamis and hurricanes, industrial accidents, and outbreaks of waterborne diseases. The 2010 Gulf of Mexico Deepwater Horizon oil spill and 2011 Japanese earthquake and tsunami are vivid reminders that a broad range of infrastructure is needed to advance scientists' still incomplete understanding of the ocean.

The National Research Council's (NRC) Ocean Studies Board was asked by the National Science and Technology Council's Subcommittee on Ocean Science and Technology, comprising 25 U.S. government agencies, to examine infrastructure needs for ocean research in the year 2030. This request reflects concern, among a myriad of marine issues, over the present state of aging and obsolete infrastructure, insufficient capacity, growing technological gaps, and declining national leadership in marine technological development; these issues were brought to the nation's attention in 2004 by the U.S. Commission on Ocean Policy.

increasing fundamental scientific understanding (10 questions). Many of the questions in the report (e.g., sea level rise, sustainable fisheries, the global water cycle) reflect challenging, multidisciplinary science issues that are clearly relevant today and are likely to take decades of effort to solve. As such, U.S. ocean research will require a growing suite of ocean infrastructure for a range of activities, such as high-quality, sustained time series observations or autonomous monitoring at a broad range of spatial and temporal scales. Consequently, a coordinated national plan for making future strategic investments becomes an imperative for addressing societal needs. Such a plan should be based on known priorities and be reviewed every 5–10 years to optimize the federal investment, the report states.

The committee examined the past 20 years of technological advances and ocean infrastructure investments (such as the rise in the use of self-propelled, uncrewed, underwater autonomous vehicles), assessed infrastructure that would be required to address future ocean research questions, and characterized ocean infrastructure trends for 2030. One conclusion was that ships will continue to be essential, especially because they provide a platform for enabling other infrastructure, such as autonomous and remotely operated vehicles; samplers and

The committee also provided a framework for prioritizing future investments in ocean infrastructure. It recommends that development, maintenance, or replacement of ocean research infrastructure assets be prioritized in terms of societal benefit, with particular consideration given to addressing important science questions; affordability, efficiency, and longevity; and the ability to contribute to other missions or applications. These criteria are the foundation for prioritizing ocean research infrastructure investments by estimating the economic costs and benefits of each potential infrastructure investment and funding those investments that collectively produce the largest expected net benefit over time. While this

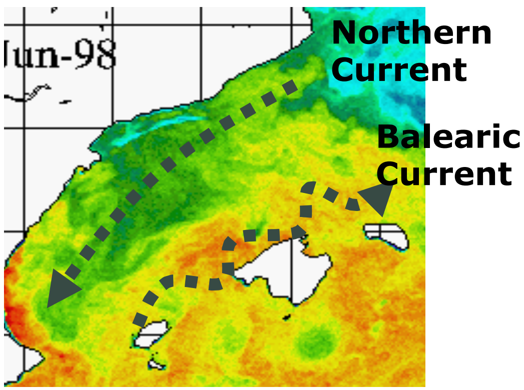
increasing fundamental scientific understanding (10 questions). Many of the questions in the report (e.g., sea level rise, sustainable fisheries, the global water cycle) reflect challenging, multidisciplinary science issues that are clearly relevant today and are likely to take decades of effort to solve. As such, U.S. ocean research will require a growing suite of ocean infrastructure for a range of activities, such as high-quality, sustained time series observations or autonomous monitoring at a broad range of spatial and temporal scales. Consequently, a coordinated national plan for making future strategic investments becomes an imperative

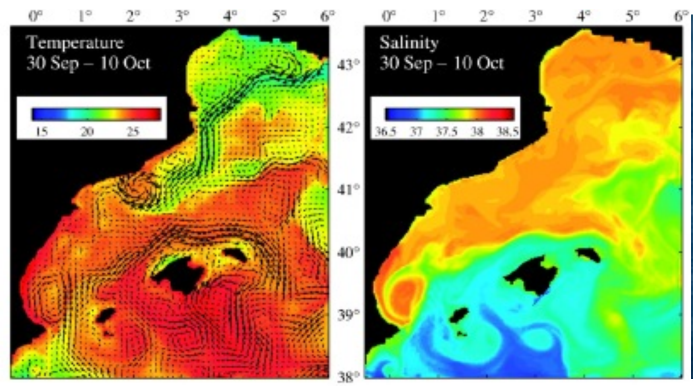
—DEBORAH GLICKSON, Ocean Studies Board, National Research Council, Washington, D. C.; E-mail: dglickson@nas.edu; ERIC BARRON, Florida State University, Tallahassee; and RANA FINE, Rosenstiel School of Marine and Atmospheric Science, University of Miami, Miami, Fla.

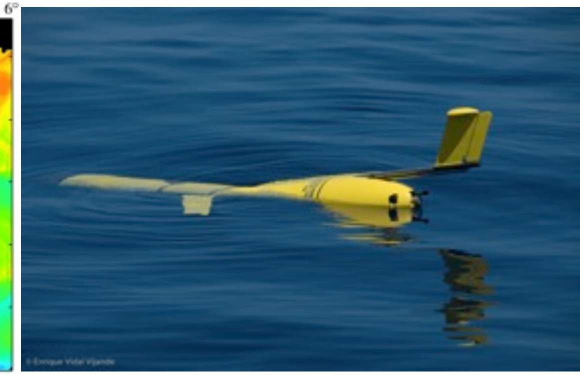
Why SOCIB, why Ocean Observatories, and **why now?**

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, <u>integrated and used together</u>, 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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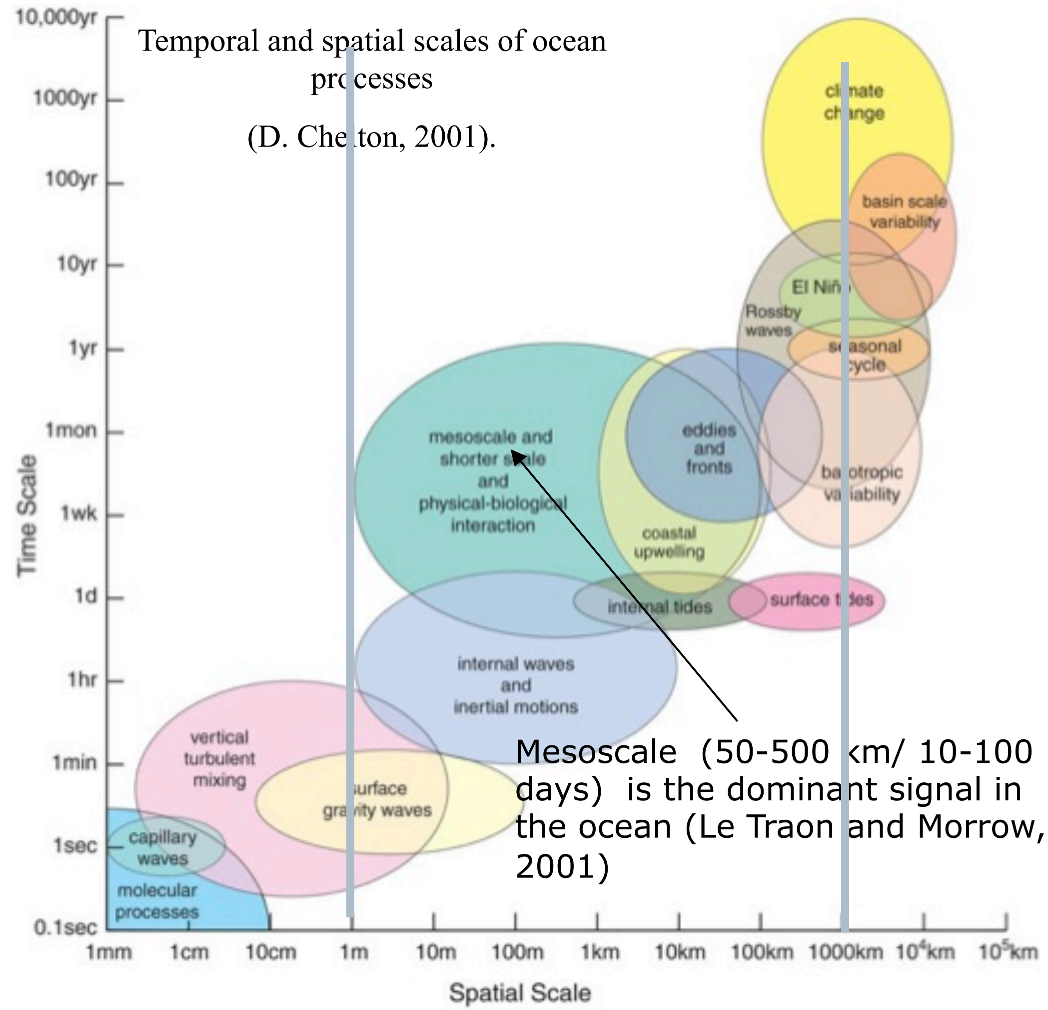
SOCIB Science Focus: coastal ocean variability at mesoscale/ sub-mesoscale, interactions and ecosystem response

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

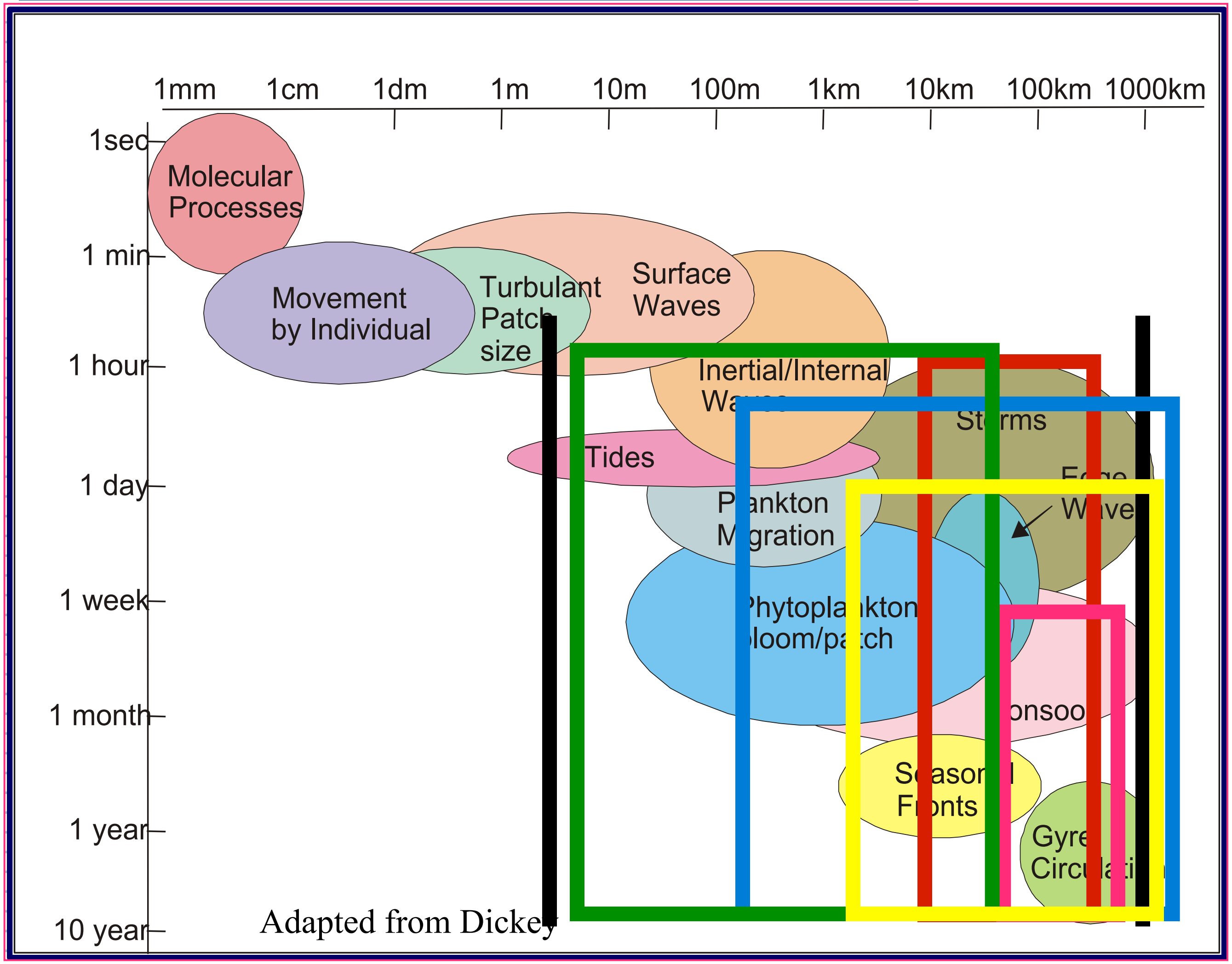
<u>SOCIB focus:</u> mesoscale & submesoscale and their effects on vertical motions, impact on ecosystem variability.

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



SOCIB scales

SOCIB scales and monitoring tools



Gliders

AUV's

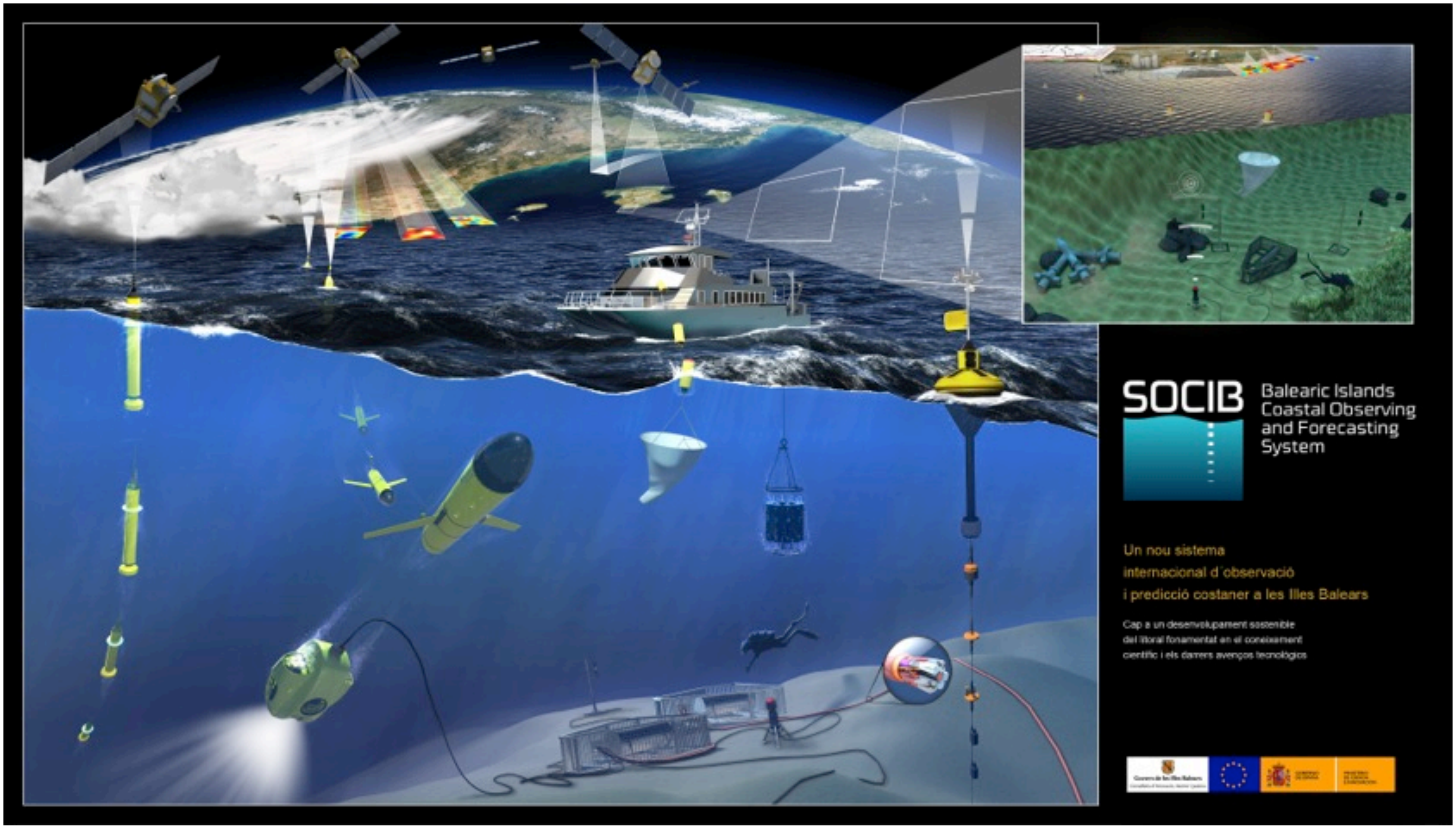
Time series

HF radar

Spatial survey

Satellite

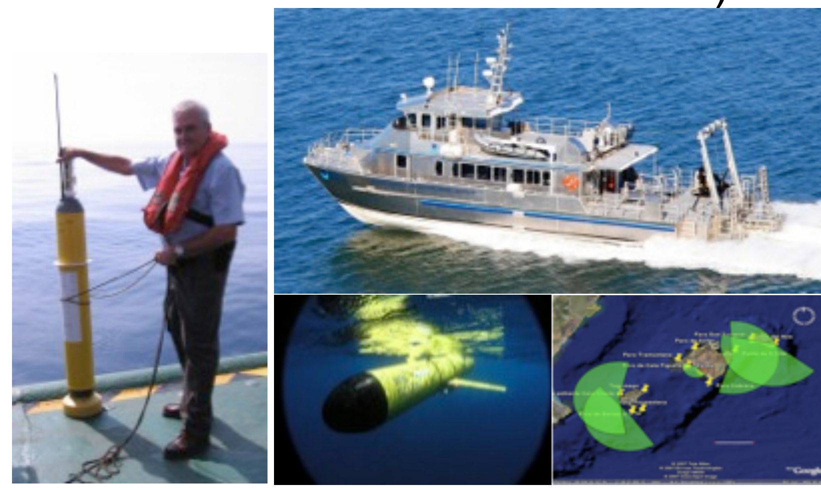
SOCIB: the view….



SOCIB - Systems Operations and Support

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



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

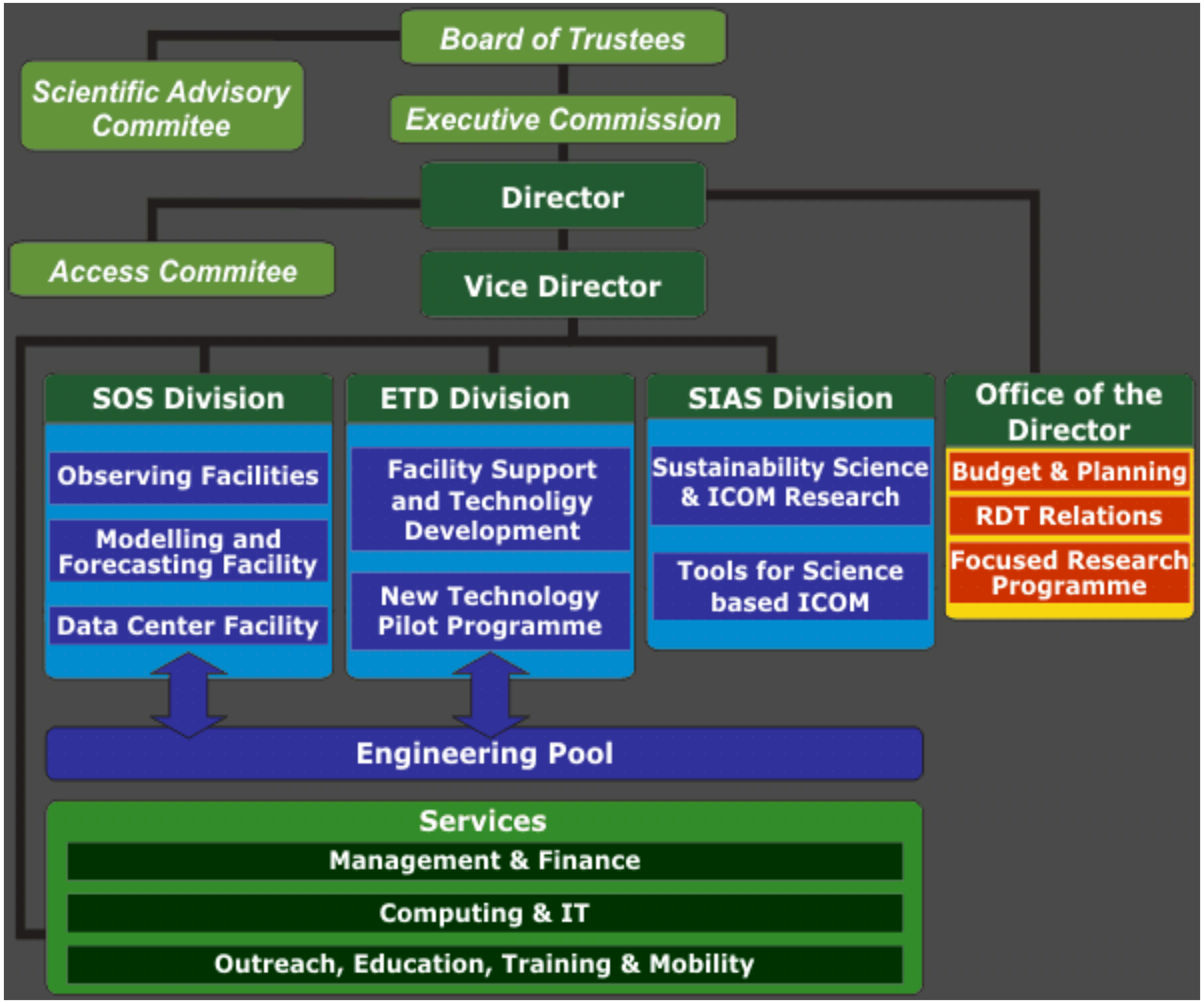
SOCIB particularities: drivers

SOCIB was designed (2006 proposal submitted to Spanish Large Scale Infrastructures Program) in response to:

3 KEY DRIVERS

- Science Priorities (scientific excellence)
- Technology Developments
- Strategic Society Needs

SOCIB particularities: structure



SOCIB particularities: 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

Products and Services: benefits for society, examples

- **Marine and Coastal Environment**
  - Harbors oscillations
  - Water quality in the coastal areas
  - Beach erosion, sediment transport
  - Sustainability science, indicators, baseline data, science based limits
  - ICZM, new science based integrated, multidisciplinary management of the coastal zone
  - Pollution management, marine debris, coastal impacts
- **Marine Safety: development of science based decision support tools**
  - Search & rescue operations at sea
  - Response to spills and mitigation procedures at sea and at the coast
- **Climate and Seasonal Forecasting**
  - Ocean climate variability and indicators
  - Sea level changes and impacts on coastal zone
  - Ecosystem response and variability in the Mediterranean
- **Marine Resources**
  - Ecosystem modeling, Marine Protected areas optimization and design
  - Responsible fisheries, variability, natural and anthropogenic
- **Technology development**
- **Education, public outreach and science**

SOCIB Value Chain

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

Goals Science, Society & Technology

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

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

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Implementation

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

Project Stages:

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

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

SOCIB Facilities and Services – 2011
www.socib.eu

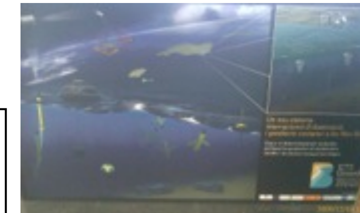
Already from SOCIB and/or in kind from CSIC and IEO and UIB:

SYSTEMS OPERATIONS AND SUPPORT DIVISION

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

MODELLING
- Numerical Forecasting Facility

DATA CENTER
- Data Center



- Proven capability
- Pilot projects
- Non sustained

Bluefin Tuna target project

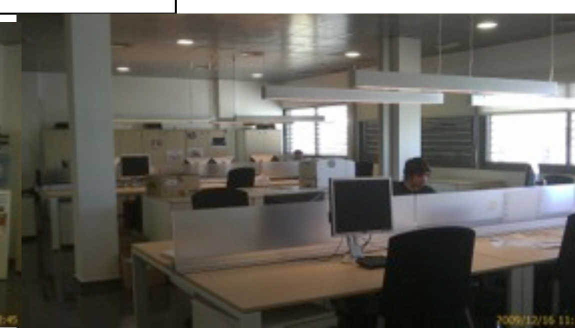
APPLICATIONS AND STRATEGIC ISSUES SOCIETY DIVISION

- ICZM and Science based sustainable coastal and ocean management

ENGINEERING AND TECHNOLOGY DEVELOPMENT DIVISION
- New technologies

Parc Bit – office – August 2009

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

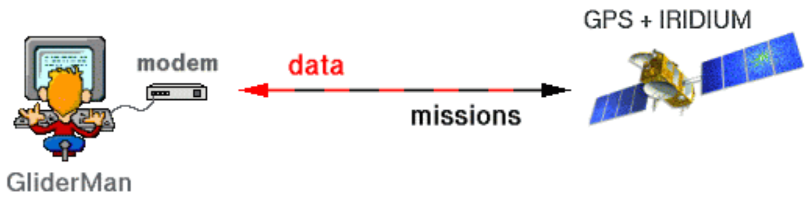


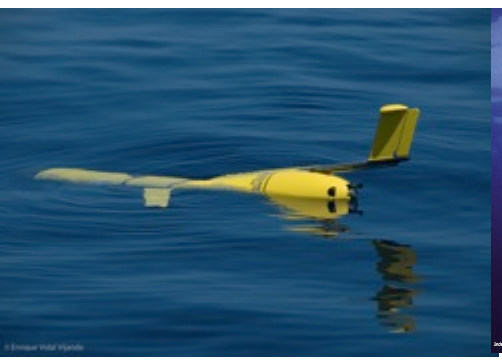
IMPLEMENTATION PLAN; approved July 2010

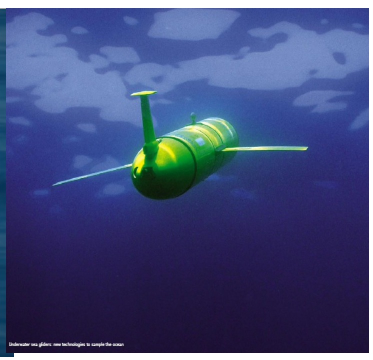
Glider Facility Activities

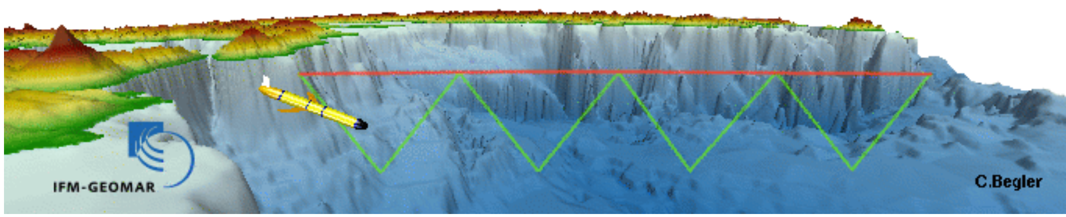
Glider data

- **Variables: P, T, S**
- **Vertical extension: 10-180 m**
- **Horizontal resolution: 1km**









Envisat data

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

Gliders Facility: Science

Mesoscale – Submesoscale / Vertical motions - biogeo effects

GEOPHYSICAL RESEARCH LETTERS, VOL. 36, L14607, doi:10.1029/2009GL038569, 2009

Vertical motion in the upper ocean from glider and altimetry data

Simón Ruiz,[1] Ananda Pascual,[1] Bartolomé Garau,[1] Isabelle Pujol,[2] and Joaquín Tintoré[1]

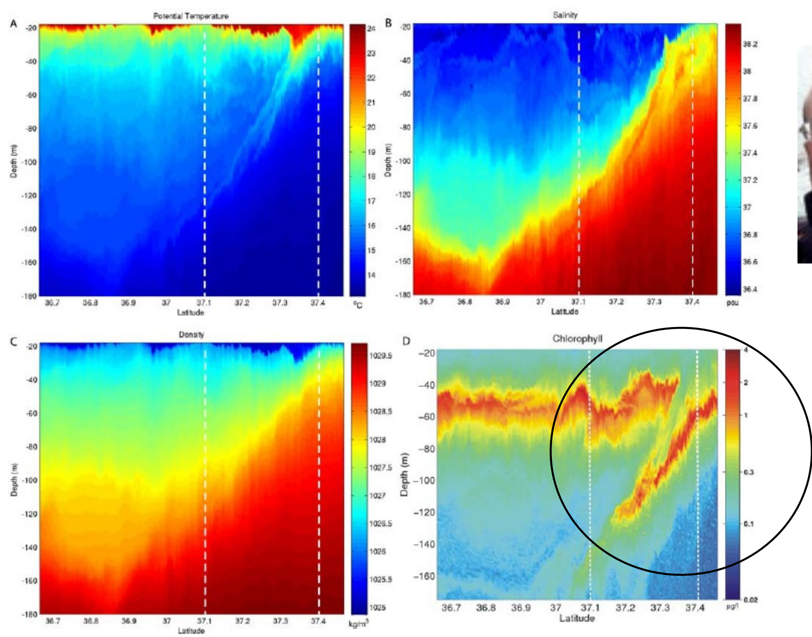


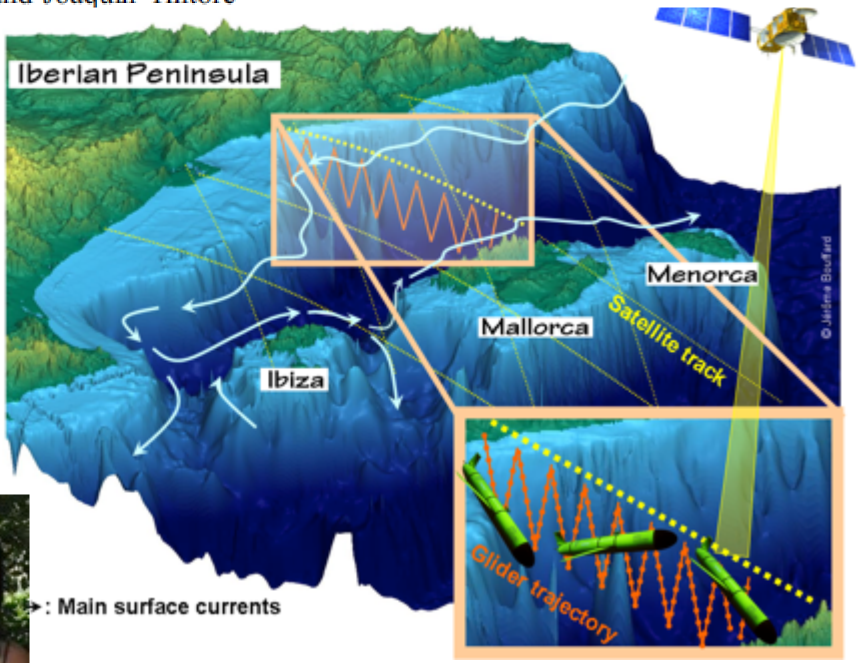
Figure 2. Vertical section of temperature (°C), salinity (PSU), density (kg/m^3) and chlorophyll (μg/l) from glider section 2 (dashed magenta in Figure 1). White dashed lines define sub-section in the northern part of the domain.

Eddy/mean flow interactions – Blocking effects General Circulation

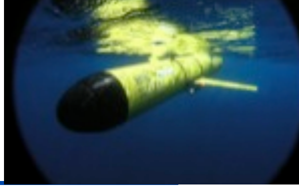
JGR, 2010

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

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



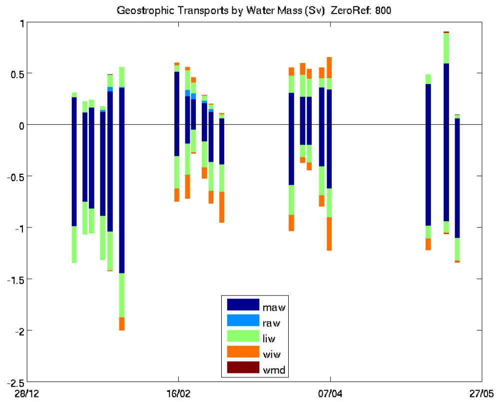
Gliders Facility: Operational

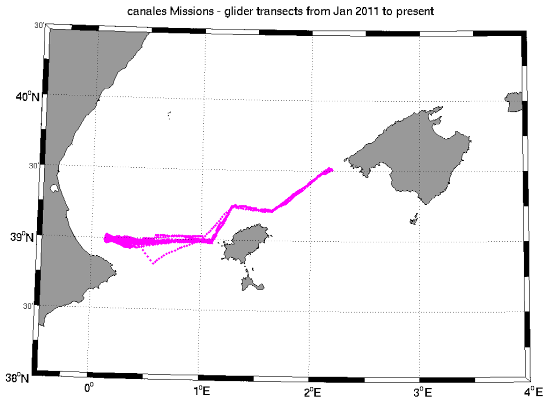


- **After 28 glider missions (started in 2006), + 10.000 profiles**
- **Since January 2011; routine operations in Ibiza and Mallorca Channels (150 miles section)**

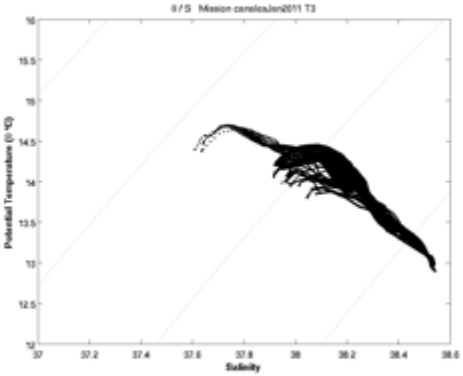
<u>NEED DEFINE KEY CONTROL SECTIONS EU</u>

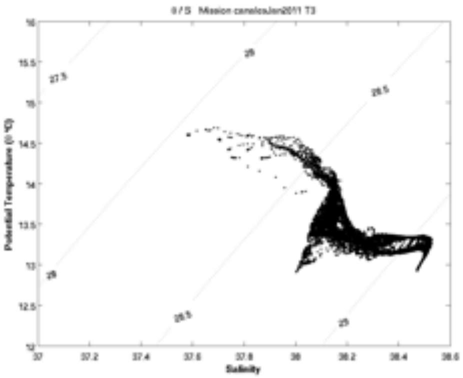
Major transport changes





TS diagrams ROMS / Glider





SOCIB Balearic Islands Coastal Observing and Forecasting System

GOBIERNO DE ESPAÑA MINISTERIO DE CIENCIA E INNOVACIÓN

Govern de les Illes Balears

SOCIB Glider Facility (Summary)

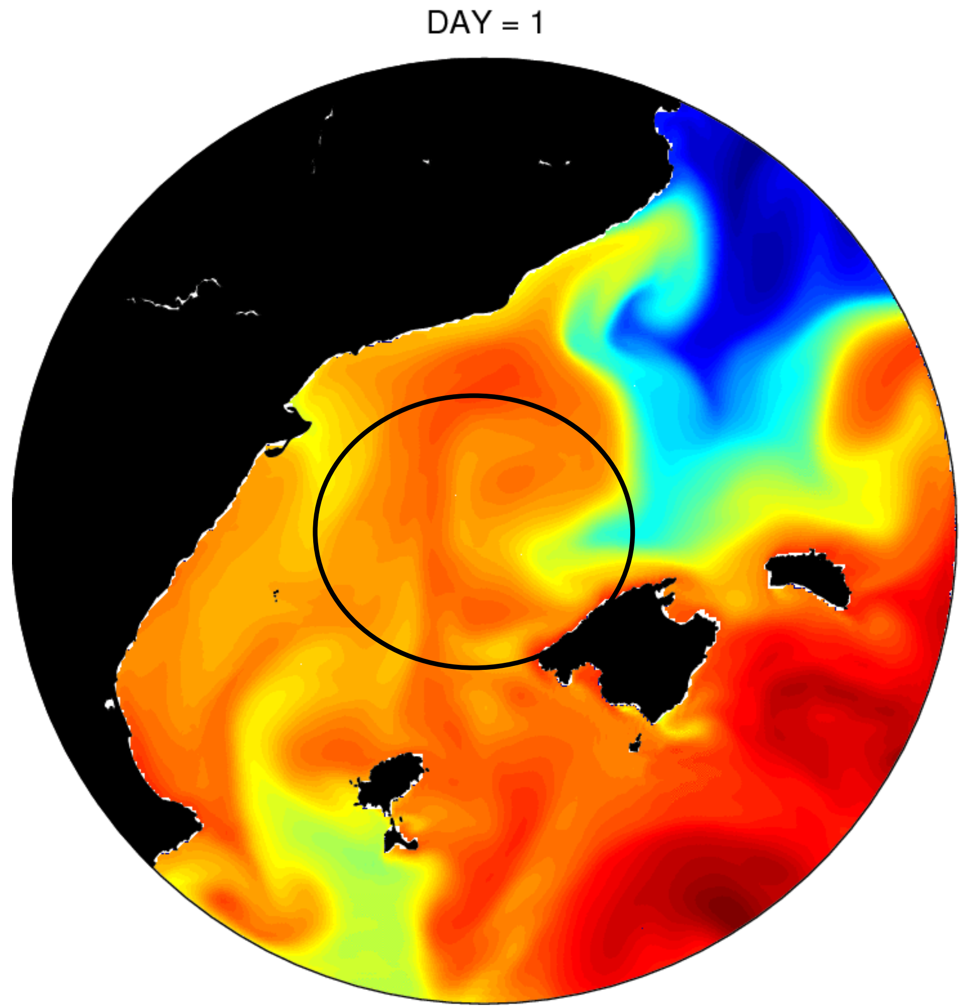
Gliders (a fleet of …) ?:

- 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: Science

<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

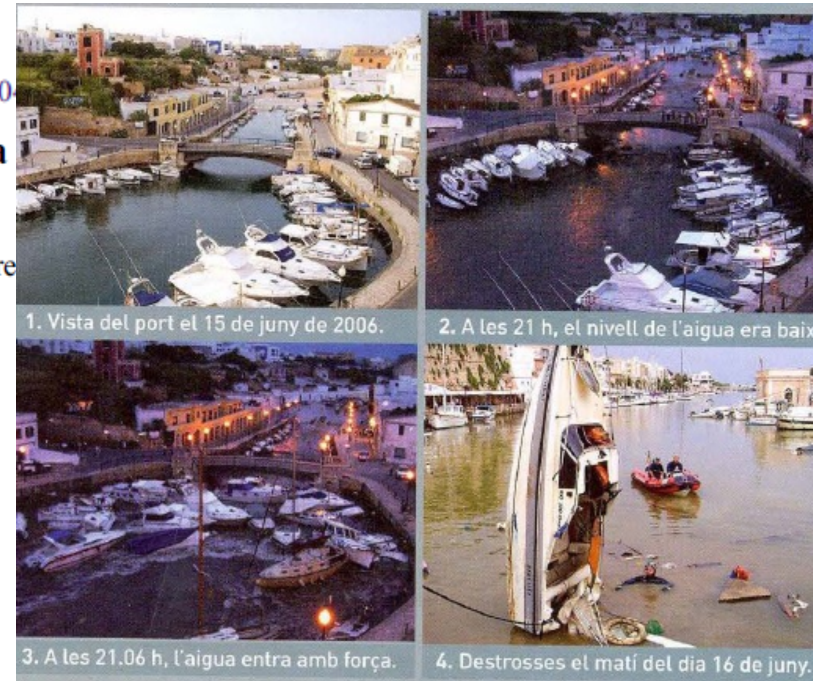
Modelling Facility: Technology tools: pre-operational, meteotsunamis forecasting

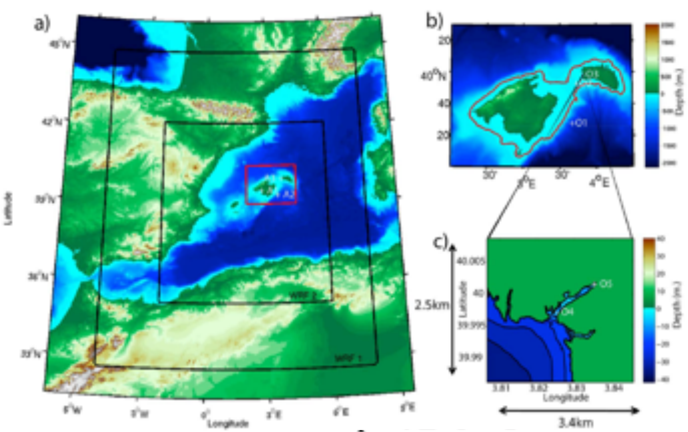
GEOPHYSICAL RESEARCH LETTERS, VOL. 38, LXXXXX, doi:10.1029/2011GL0

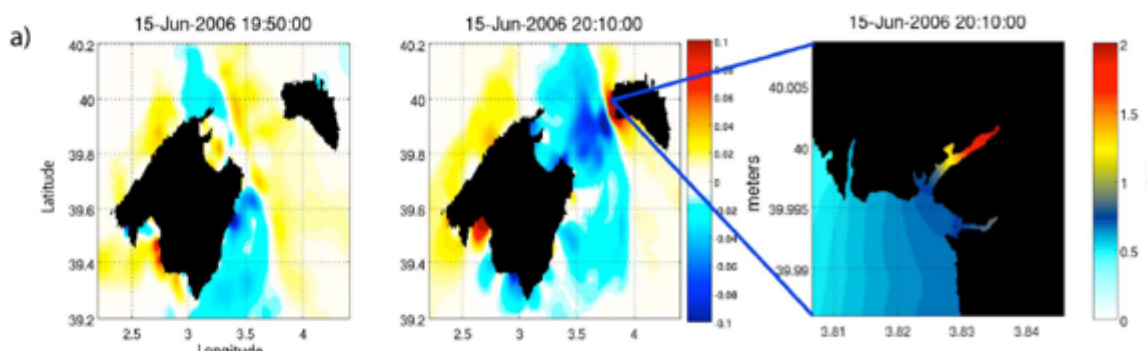
1 **Toward the predictability of meteotsunamis in the Balearic Sea**
2 **using regional nested atmosphere and ocean models**

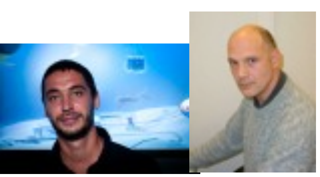
3 Lionel Renault,[1] Guillermo Vizoso,[2] Agustin Jansá,[3] John Wilkin,[4] and Joaquin Tintore

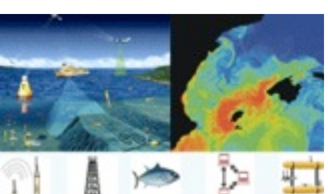
4 Received 4 March 2011; revised 29 March 2011; accepted 30 March 2011; published XX Month 2011.

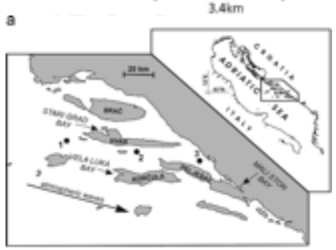


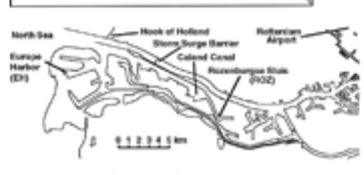










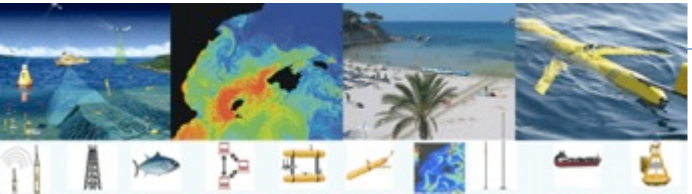


Bluefin Tuna Target Project: scientific problem solving for sustainable fisheries

- One of most emblematic top predator species in world's oceans. Bluefin Tuna Target Project aims at understanding physical-biological variability in support of fisheries ecology and management.
- Traditional management of big pelagic species in Mediterranean: based on quotas from capture data (uncertainties due to population stock calculation methods ; failures in controlling catches)

There have been proposals for management thought sanctuaries: design of pelagic MPAs will determine success of management measure

NEEDS:
- Improve management approaches with knowledge of species ecology and its dependence on the environment.
- Tools for operational monitoring of oceanographic conditions and assessing implications for species of interest



ICTS OceanBit

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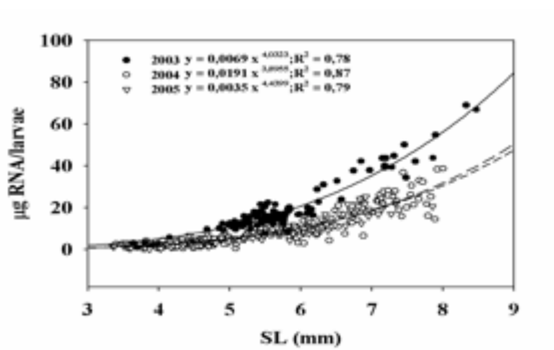
CSIC

Bluefin Tuna Target Project: scientific problem solving for sustainable fisheries (PI F. Alemany, IEO)

Historical research on Bluefin tuna ecology at IEO (TUNIBAL project) provides background to identify potential dependencies of live strategies with local mesoscale oceanography

Relation between ABT larvae and AW…



Progress in Oceanography 86 (2010) 21–38
Contents lists available at ScienceDirect
Progress in Oceanography
journal homepage: www.elsevier.com/locate/pocean
ELSEVIER

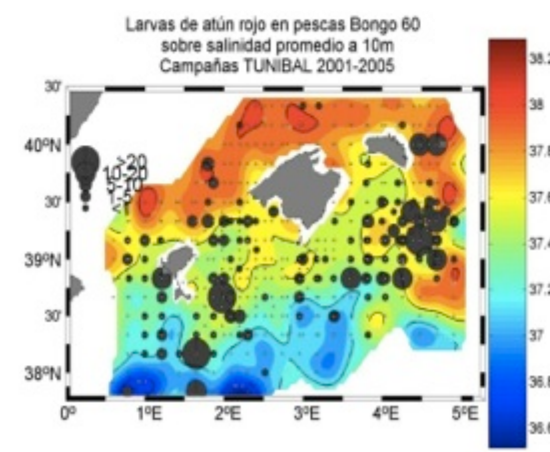
Characterization of the spawning habitat of Atlantic bluefin tuna and related species in the Balearic Sea (western Mediterranean)

F. Alemany[a,*], L. Quintanilla[b], P. Velez-Belchí[c], A. García[b], D. Cortés[b], J.M. Rodríguez[d], M.L. Fernández de Puelles[a], C. González-Pola[d], J.L. López-Jurado[a]

MARINE ECOLOGY PROGRESS SERIES
Mar Ecol Prog Ser

Cannibalism among size classes of larvae may be a substantial mortality component in tuna

P. Reglero[1,*], A. Urtizberea[2], A. P. Torres[1], F. Alemany[1], Ø. Fiksen[2,3]



Hydrodynamic models, remote sensing and insitu monitoring has demonstrated to be effective tools for improving the management of other tuna species.

(i.e Eastern Australia : A J Hobday, K Hartmann, Near real-time spatial management based on habitat predictions for a longline bycatch species, Fisheries Management and Ecology (2006) Volume: 13, Issue: 6, Pages: 365-380)

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Bluefin Tuna Target Project: scientific problem solving for sustainable fisheries – WHY SOCIB ?

Western Mediterranean is one of the two key locations in the world for Blue fin tuna spawning

Particular oceanography of the area with inputs of AW, mixture with MW and bottom topography drives location of spawning and larvae survival

SOCIB provides knowledge and technological resources for implementation of :

ROMS
remote sensing
glider facilities
...

Allowing acquisition of environmental data for operational models of habitat preferences and survival.

In situ larvae data base

▪IN SITU OCEANOGRAPHYC DATA
▪REMOTE SENSING
▪HYDRODYNAMIC MODELS

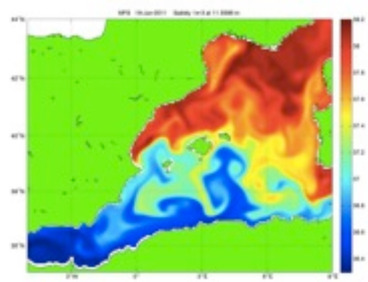
CHARACTERIZATION SPAWNING AREAS (stochastic modelling)

OPERATIVE MODEL OF POTENTIAL SPAWNING AREAS BASED ON RS/HM

SHORT TERM PREDICTIONS OF PROB. SPAWNING SITES

OTHER WORK:
-IBM + 3D H.D.
- REARING EXPERIMENTS

GLOBAL MODEL FOR LARVAL SURVIVAL PROBABILITIES AT POTENTIAL SPAWNING SITES



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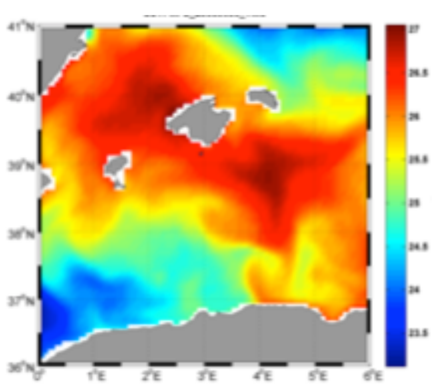
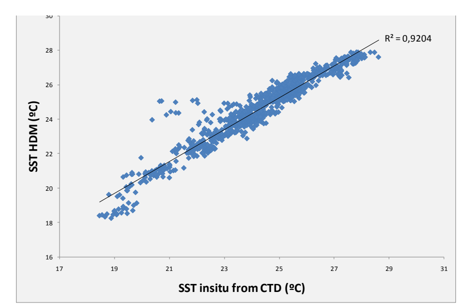
Bluefin Tuna Target Project: scientific problem solving for sustainable fisheries: at SOCIB since 2011

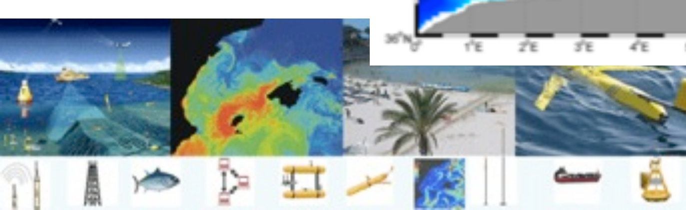
Initial Activities and First Results:

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

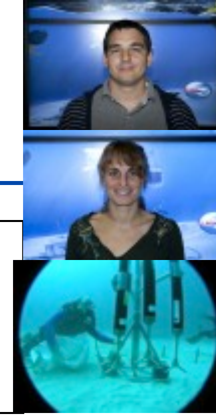


ROMS derived SST vs CTD

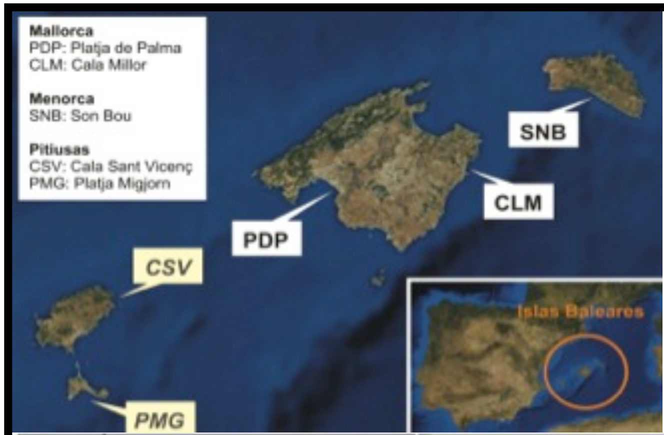


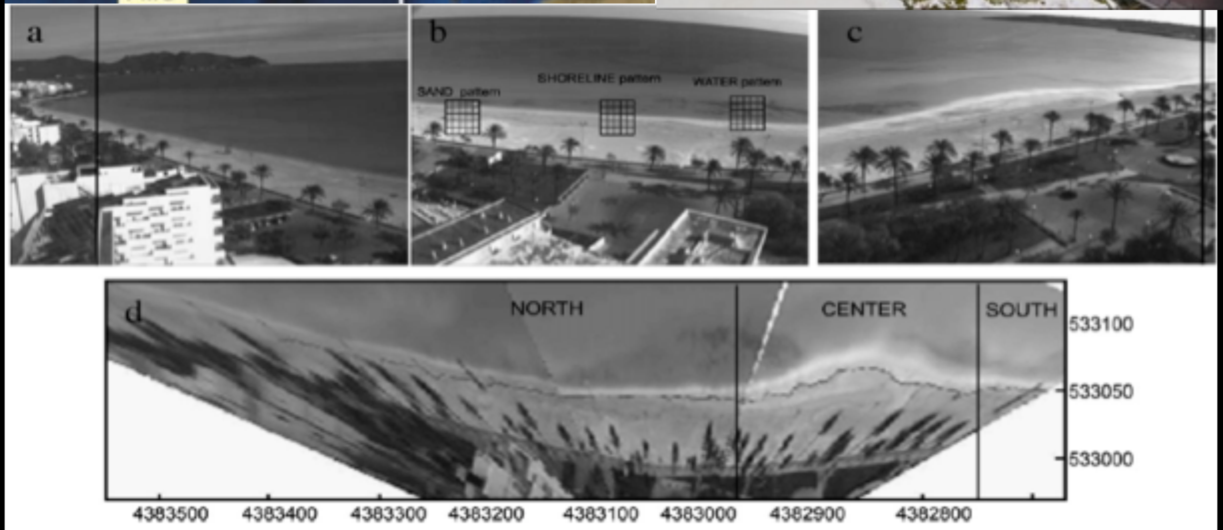


Beach Monitoring Facility: Science & Technology



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





MOBIMS

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

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

Hisenda i Innovació
Direcció General de Recerca, Desenvolupament Tecnològic i Innovació

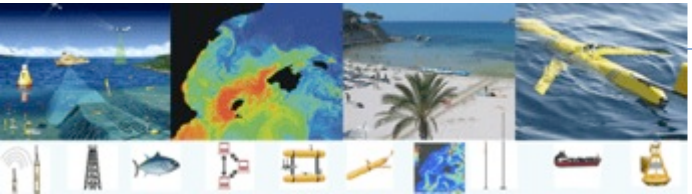
Data Centre Facility

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

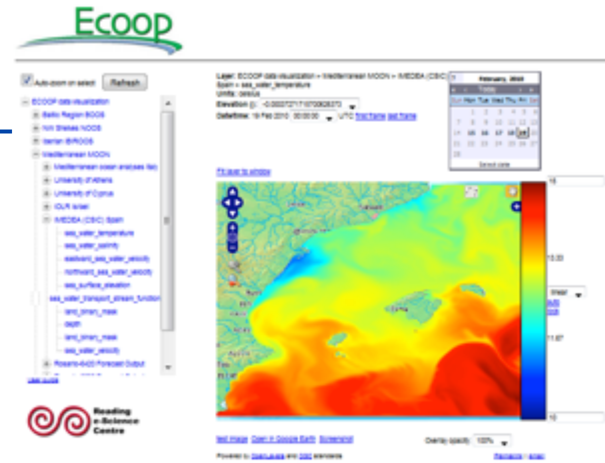
Goal: to provide researchers and users with a **system** that allow to **locate and download the data** of interest (near real time and delayed mode) to **visualize, analyze** and manage the information.

Principles of SOCIB Data Center: the data are,

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

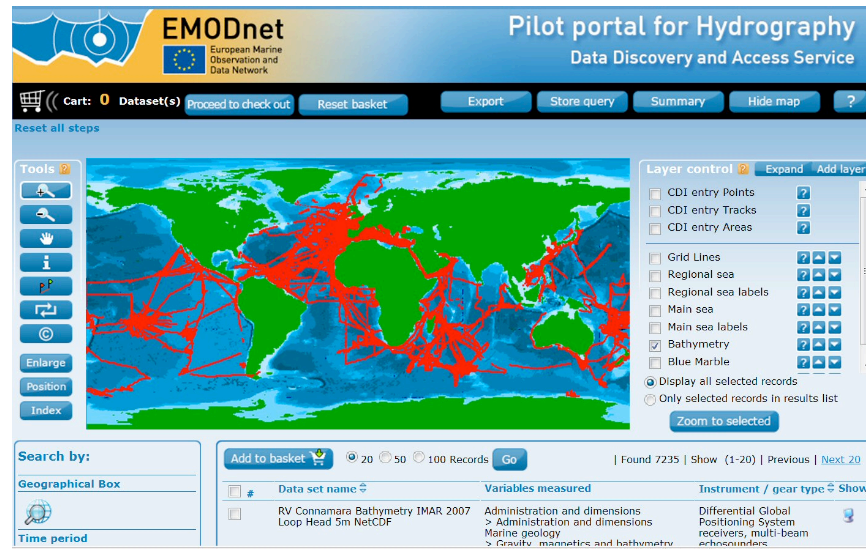


Data Centre Facility



The European framework

The international framework



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Data Center: Science and Technology

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

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

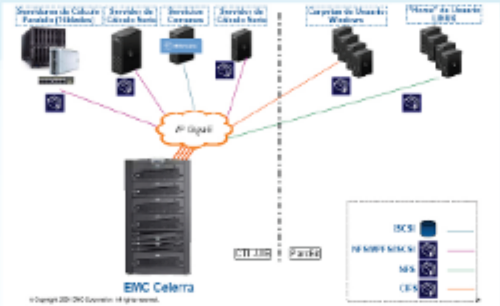
Data Centre: Technologies

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.

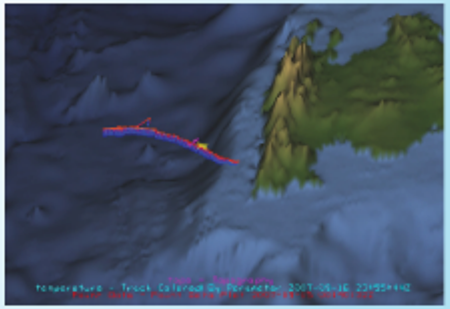
4. Catalog

THREDDS to organize data and Metadata to automatic harvesting.

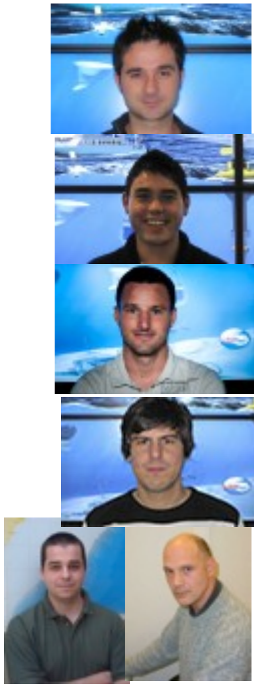
5. Discovery

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.



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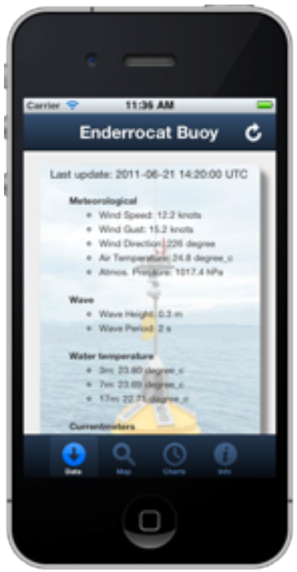
Data Centre (Technologies; example of Apps)



SOCIB Engineering and Technology Development; ETD Division (TMOOS based transferred AMT)

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October 2011 Issue

ENVIRONMENTAL MONITORING
REMOTE SENSING
& POLLUTION CONTROL

COVER

The Instituto Mediterráneo de Estudios Avanzados performs maintenance on its oceanographic and meteorological Enderrocat buoy in Palma Bay, Mallorca Island. The mooring produces atmospheric data variables (e.g., wind, atmospheric pressure and air temperature) and variables measured in the water column (e.g., currents and temperature) from the surface to a depth of 20 meters. It takes measurements every 10 minutes and transfers the data via VHF radio to the coastal station in Calanova, Spain. Data are then transferred via the Internet to servers for preprocessing, quality control and publication on the institute's website. (Photo credit: Eduardo Infantes Oanes)

32 *st* / JULY 2010

Monitoring the Eastern Alborán Sea Using High-Resolution Glider Data

The Challenge of Sampling Rough Upper-Ocean Areas With Underwater Vehicles

www.sea-technology.com MARCH 2009 / *st* 29

Combining New and Conventional Sensors To Study the Balearic Current

The SINOCOP Experiment Improves Understanding Of Coastal Mesoscale Processes in the Western Mediterranean Sea

By Dr. Ananda Pascual
Tenured Scientist

Also important are both the strategic position of the Balearic Islands in the Western Mediterranean Sea and the

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http://www.bluefinrobotics.com/

Complementary, not substitute….

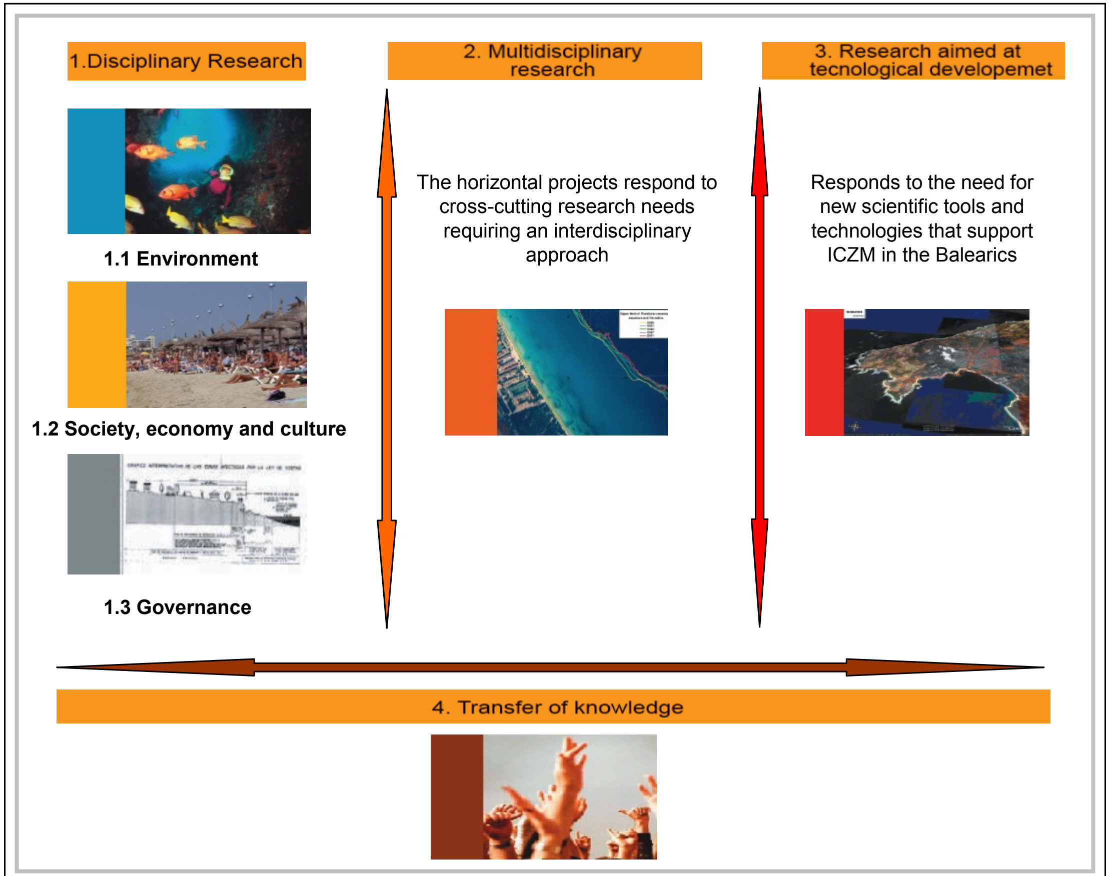
'Easier' for Data Management…

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.

ISY AUV – Italy – 2008

NURC – beach monitoring field experiment – TMOOS –

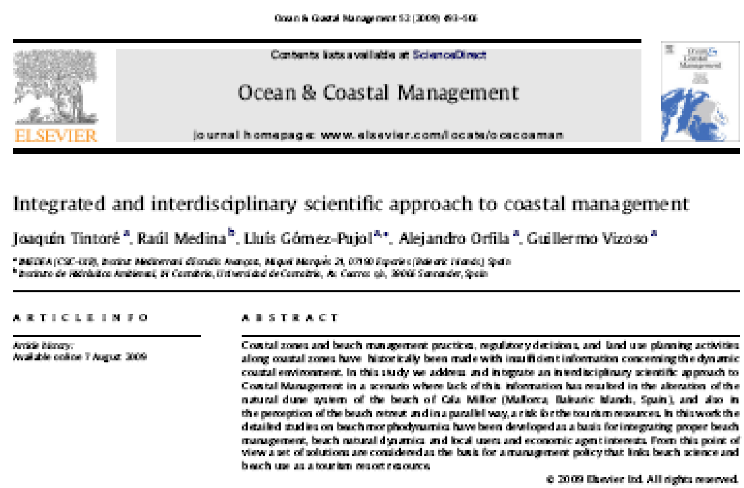
Technologies (Management technologies): SOCIB Applications and Strategic Issues Society Division



- From beach erosion 2001 to ICZM 2005, ICOM, MSP 2010,… Driven by interest from the Balearic Islands (gov&soc).

Example: Sustainability Indicators – together with CES Council. -

http://www.costabalearsostenible.es



Ocean & Coastal Management 52 (2009) 493–506

Contents lists available at ScienceDirect

Ocean & Coastal Management

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

Integrated and interdisciplinary scientific approach to coastal management

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

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

ARTICLE INFO

Article history:
Available 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.

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Technologies (Management technologies): SOCIB Applications and Strategic Issues Society Division

Sustainability Science and Integrated Coastal and Ocean Management, MSP

We are…

- Developing and evaluating science-based decision-making tools and methods to support ICMM, with particular emphasis on the integration of environmental and social dimensions

- Identifying and implementing indicators to assess, monitor, and predict limits to growth and critical thresholds,

- Integrating research with environmental governance and management systems to assure sound transfer two sides science to society and back!.

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

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

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

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Balearic Islands
Spain

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

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Ocean & Coastal Management
journal homepage: www.elsevier.com/locate/ocecoaman

Integrated and interdisciplinary scientific approach to coastal management

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

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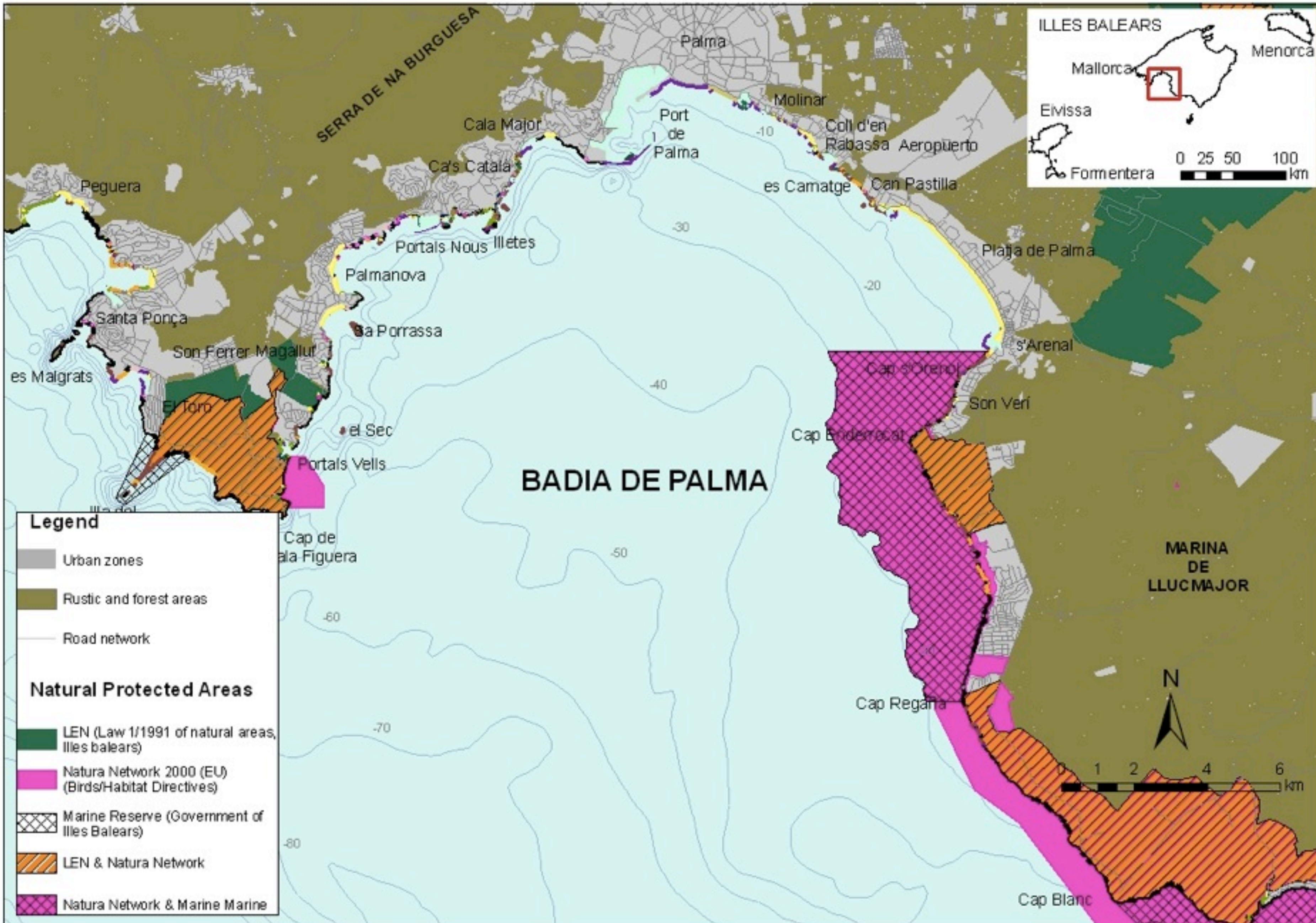
ABSTRACT
Coastal zones and beach management practices, regulatory decisions, and land use planning activities along coastal zones have historically been made with insufficient information concerning the dynamic coastal environment. In this study we address and integrate an interdisciplinary scientific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

SOCIB Balearic Islands Coastal Observing and Forecasting System

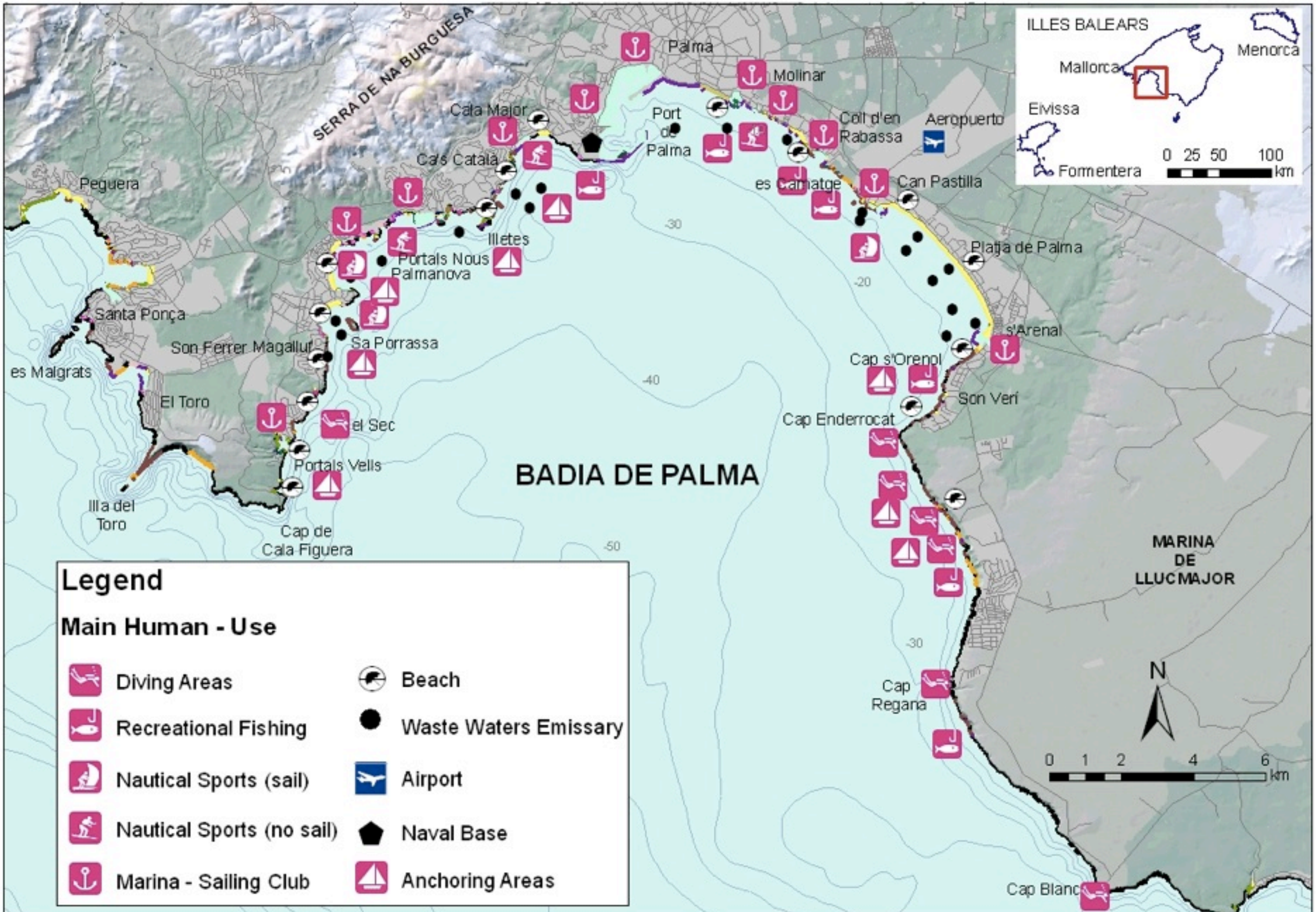
GOBIERNO DE ESPAÑA · MINISTERIO DE CIENCIA E INNOVACIÓN

Govern de les Illes Balears

MUNICIPALITY
OF
PALMA
MUNICIPALITY
OF
CALVIÀ
BADIA DE PALMA
MUNICIPALITY
OF
LLUCMAJOR
N
0
2.5
5
km



SERRA DE NA BURGUESA
Palma
Port de Palma
Molinar
Coll d'en Rabassa
Aeropuerto
Cala Major
Ca's Catala
es Camatge
Can Pastilla
Peguera
Portals Nous
Illetes
Platja de Palma
Palmanova
Santa Ponça
Sa Porrassa
Son Ferrer
Magalluf
s'Arenal
es Malgrats
Cap s'Orenol
El Toro
Son Verí
el Sec
Cap Enderrocat
Portals Vells
BADIA DE PALMA
Cap de Cala Figuera
MARINA DE LLUCMAJOR
Cap Regana
Cap Blanc
-10
-20
-30
-40
-50
-60
-70
-80
ILLES BALEARS
Mallorca
Menorca
Eivissa
Formentera
0 25 50 100 km
N
0 1 2 4 6 km
Legend
Urban zones
Rustic and forest areas
Road network
Natural Protected Areas
LEN (Law 1/1991 of natural areas, Illes balears)
Natura Network 2000 (EU) (Birds/Habitat Directives)
Marine Reserve (Government of Illes Balears)
LEN & Natura Network
Natura Network & Marine Marine



ILLES BALEARS
Menorca
Mallorca
Eivissa
Formentera
0 25 50 100 km
Palma
Molinar
SERRA DE NA BURGUESA
Cala Major
Port de Palma
Coll d'en Rabassa
Aeropuerto
Cas Català
Peguera
es Carnatge
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Portals Nous
Palmanova
Platja de Palma
Santa Ponça
Sa Porrassa
Son Ferrer Magalluf
s'Arenal
es Malgrats
Cap s'Orenol
El Toro
Son Verí
el Sec
Cap Enderrocat
Portals Vells
BADIA DE PALMA
Illa del Toro
Cap de Cala Figuera
MARINA DE LLUCMAJOR
-30
-20
-40
-50
Legend
Main Human - Use
Diving Areas
Recreational Fishing
Nautical Sports (sail)
Nautical Sports (no sail)
Marina - Sailing Club
Beach
Waste Waters Emissary
Airport
Naval Base
Anchoring Areas
Cap Regana
N
0 1 2 4 6 km
Cap Blanc

SOCIB FACILITIES
Beach Monitoring Facility (Platja de Plama)
Mooring Facility (Oceanographic buoy)
ILLES BALEARS
Mallorca
Menorca
Eivissa
Formentera
0 25 50 100 km
Palma
Molinar
Port de Palma
Coll d'en Rabassa
Aeropuerto
es Camatge
Platja de Palma
s'Arenal
Cap s'Orenol
Son Verí
Portals Vells
Illa del Toro
Cap de Cala Figuera
BADIA DE PA
Cap Blanc
-10
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SOCIB Balearic Islands Coastal Observing and Forecasting System
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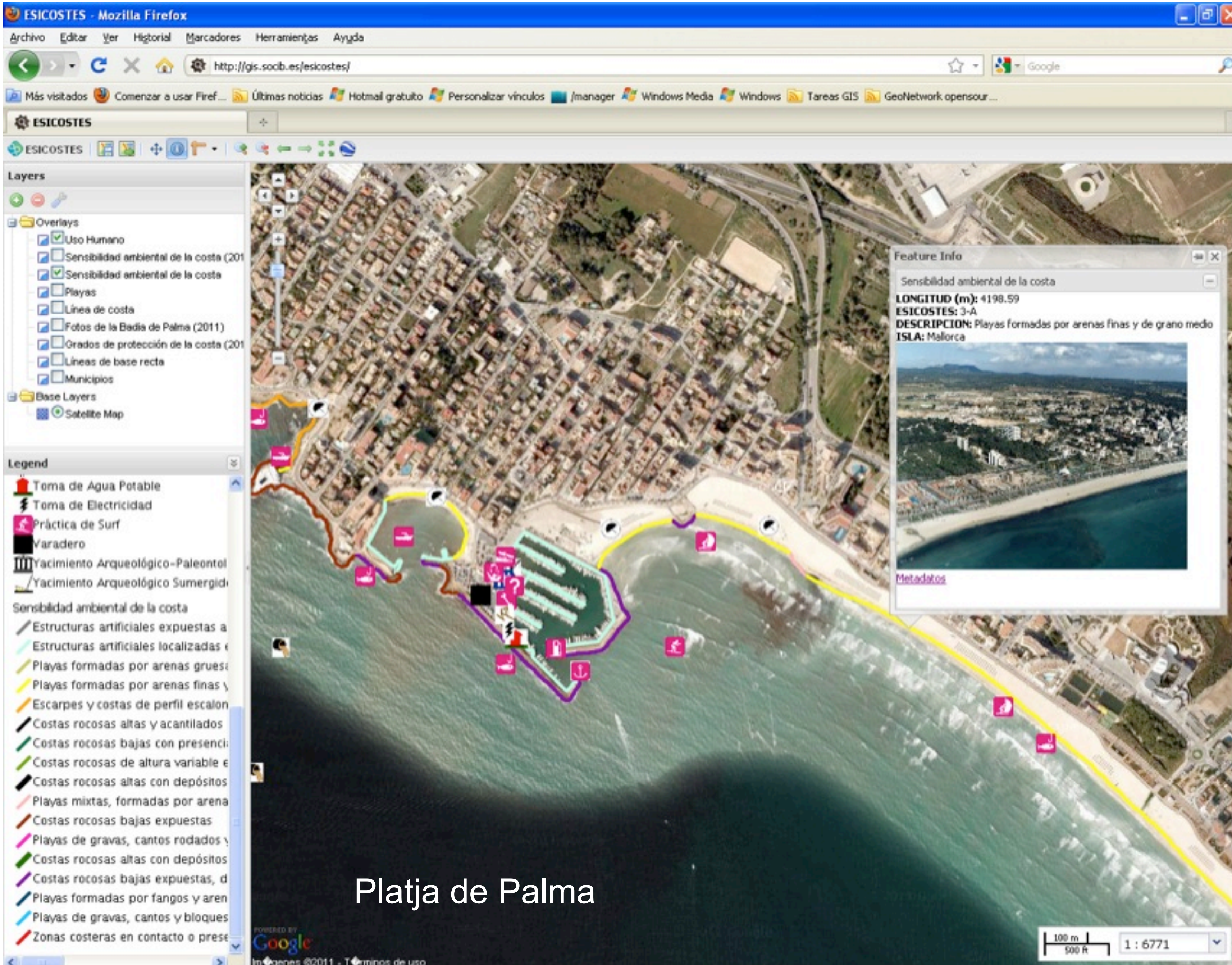


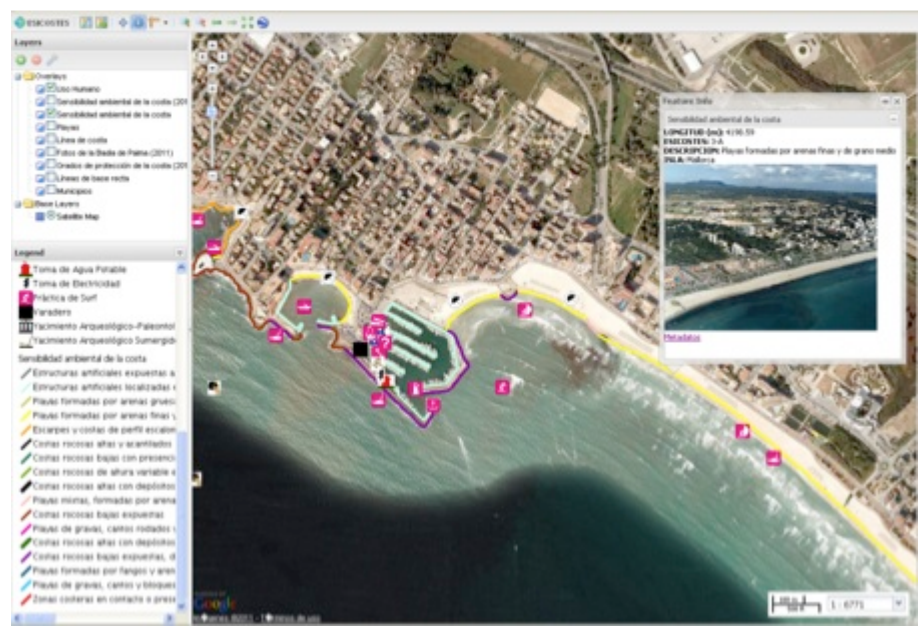
Platja de Palma

CATALOG APPLICATIONS

· Data discovery through Catalog Web Services (CSW)
· INSPIRE compilant metadata
· The use of interoperable and open standards allow the integration of different catalogues from multiple sources

WEB MAPPING SOLUTIONS

· Web applications allow the interaction and visualization of spatial data
· Specific web mapping applications can be developed for multiple pourposes and different end-users.
· Allow the integration of multiple data formats from differents thematic areas (eg. physical data with biological data).



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

Patching together a world view

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

Now or never

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

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

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

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

Science…
and
Society!

But… now

MORE EFFICIENT

HIGHER IMPACT

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

NEWS

Determining Critical Infrastructure for Ocean Research and Societal Needs in 2030

PAGES 210–211

The United States has jurisdiction over 3.4 million square miles of ocean—an expanse greater than the land area of all 50 states combined. This vast marine area offers researchers opportunities to investigate the ocean's role in an integrated Earth system but also presents challenges to society, including damaging tsunamis and hurricanes, industrial accidents, and outbreaks of waterborne diseases. The 2010 Gulf of Mexico Deepwater Horizon oil spill and 2011 Japanese earthquake and tsunami are vivid reminders that a broad range of infrastructure is needed to advance scientists' still incomplete understanding of the ocean.

The National Research Council's (NRC) Ocean Studies Board was asked by the National Science and Technology Council's Subcommittee on Ocean Science and Technology, comprising 25 U.S. government agencies, to examine infrastructure needs for ocean research in the year 2030. This request reflects concern, among a myriad of marine issues, over the present state of aging and obsolete infrastructure, insufficient capacity, growing technological gaps, and declining national leadership in marine technological development; these issues were brought to the nation's attention in 2004 by the U.S. Commission on Ocean Policy.

increasing fundamental scientific understanding (10 questions). Many of the questions in the report (e.g., sea level rise, sustainable fisheries, the global water cycle) reflect challenging, multidisciplinary science issues that are clearly relevant today and are likely to take decades of effort to solve. As such, U.S. ocean research will require a growing suite of ocean infrastructure for a range of activities, such as high-quality, sustained time series observations or autonomous monitoring at a broad range of spatial and temporal scales. Consequently, a coordinated national plan for making future strategic investments becomes an imperative for addressing societal needs. Such a plan should be based on known priorities and be reviewed every 5–10 years to optimize the federal investment, the report states.

The committee examined the past 20 years of technological advances and ocean infrastructure investments (such as the rise in the use of self-propelled, uncrewed, underwater autonomous vehicles), assessed infrastructure that would be required to address future ocean research questions, and characterized ocean infrastructure trends for 2030. One conclusion was that ships will continue to be essential, especially because they provide a platform for enabling other infrastructure, such as autonomous and remotely operated vehicles; samplers and

The committee also provided a framework for prioritizing future investments in ocean infrastructure. It recommends that development, maintenance, or replacement of ocean research infrastructure assets be prioritized in terms of societal benefit, with particular consideration given to addressing important science questions; affordability, efficiency, and longevity; and the ability to contribute to other missions or applications. These criteria are the foundation for prioritizing ocean research infrastructure investments by estimating the economic costs and benefits of each potential infrastructure investment and funding those investments that collectively produce the largest expected net benefit over time. While this

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—Deborah Glickson, Ocean Studies Board, National Research Council, Washington, D. C.; E-mail: dglickson@nas.edu; Eric Barron, Florida State University, Tallahassee; and Rana Fine, Rosenstiel School of Marine and Atmospheric Science, University of Miami, Miami, Fla.

Outline

1. **SOCIB: oceans complexity, monitoring, what, why, why now**

2. **Background: IMEDEA and/or 20 years of science, technology development and applications for society. Some examples of each…**

3. **SOCIB: why, scales, monitoring tools, particularities and ongoing activities; gliders, modeling, data center examples, ETD, SIAS**

4. **Innovation in oceanographic instrumentation: the case of ocean gliders.**

5. **The new role of Marine Research Infrastructures**

Innovation in oceanographic instrumentation

3 elements:

- Oceans complexity imply and drive a need for improvement of instrumental capacities
- The innovation process, complexity and incubation time
- The key to success

(Curtin and Belcher, TOS, 2008)

Innovation in
Oceanographic
Instrumentation

BY THOMAS B. CURTIN AND EDWARD O. BELCHER

INTRODUCTION

The tools of oceanography include instruments that measure properties of the ocean and models that provide continuous estimates of its state. Major improvements in tool capabilities lead to leaps in understanding, and this increased knowledge has many practical benefits. Advances in tool capabilities are sometimes viewed as an objective of basic research, a viewpoint reflected in the basic research funding category of "science and technology" (S&T).

The complexities of and incubation times for advancing instrumentation are often not fully appreciated, resulting in unrealistic expectations and discontinuous support. Greater understanding of the process of innovative instrument development can contribute to sustaining it. Innovation can be incremental or radical depending on performance gains (Utterback, 1994), stimulated or suppressed depending on institutional factors (Van de Ven, 1989; Office of Technology Assessment, 1995), and sustaining or disruptive depending on value propositions (Christensen, 1997). For example, going from a Nansen to a Niskin bottle was an incremental innovation, whereas going from bottle casts to CTD profiles was a radical innovation. Moored current meters incrementally advanced from film recording of gauges, to mechanically digitized signals on reel-to-reel tape, to solid-state analog, to digital conversion and memory. Radical innovation of current-field measurement came with the acoustic Doppler current profiler.

In large organizations, stimulated innovation often occurs in research departments, particularly when the projects have champions: "the new idea either finds a champion or dies" (Schon, 1963). In other parts of the same organization, innovation may be suppressed by the costs associated with re-integrating a system and minimal perceived competition. The incubation time of the computer mouse from inception to wide use was 30 years. In oceanographic observation, where synoptic coverage is an objective, a sustaining innovation would be a sampling platform with improved propulsion that doubles its speed. A disruptive innovation would be a new platform with much *slower* speed, but with much longer duration and a low enough cost to be deployed in great numbers. Here, we will focus on radical, stimulated, disruptive innovation that involves both science and engineering.

To motivate continued investment in basic research, the histories of many radical innovations, ranging from the transistor to radar to the Internet, have been documented (Bacher, 1959; Hetrick, 1959; Becker, 1980; Hove and Gowen, 1979; Allison, 1985; Abbate, 2000. The Defense Acquisition History Team at the US Army Center of Military History is also preparing a document on this subject.). These cases clearly demonstrate that "rapid" innovation in

Oceans complexity, needs for improvement of instrumental capacities

Rationale:

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

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

Improvements in tools capabilities

↓

Increase understanding → **Major practical benefits**

The innovation process (for advancing oceanographic instrumentation)

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

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

Innovation can be incremental or radical, stimulated or suppressed.

The innovation process (for advancing instrumentation)

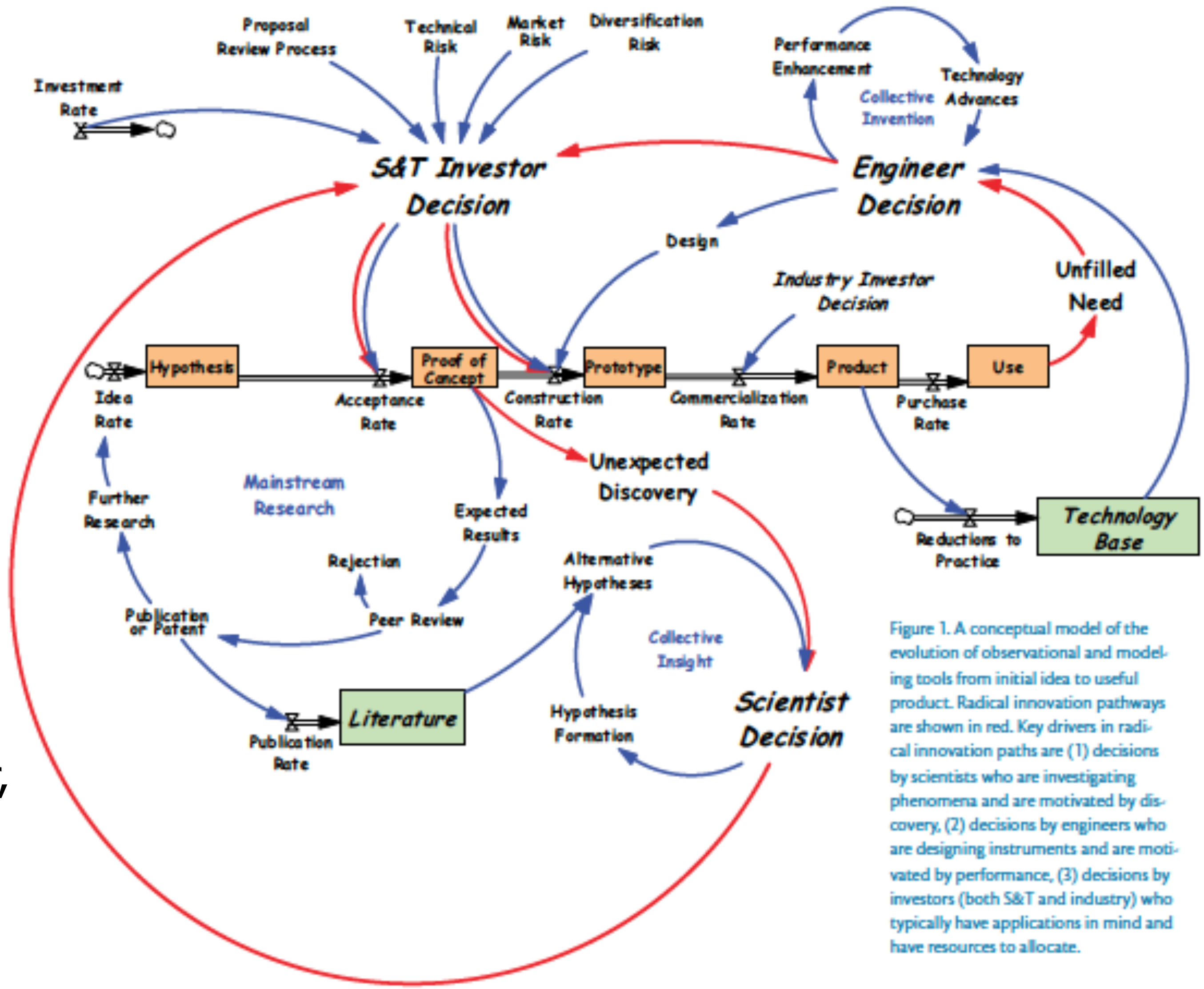

Figure 1. A conceptual model of the evolution of observational and modeling tools from initial idea to useful product. Radical innovation pathways are shown in red. Key drivers in radical innovation paths are (1) decisions by scientists who are investigating phenomena and are motivated by discovery, (2) decisions by engineers who are designing instruments and are motivated by performance, (3) decisions by investors (both S&T and industry) who typically have applications in mind and have resources to allocate.

(Curtin and Belcher, TOS, 2008)

The innovation process (for advancing instrumentation)

Why is it important? : we need synoptic coverage

And… “Every time a new instrument has arrived,

new key findings”…

Examples of innovations:

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

The real challenge for the next decade…:

To use and integrate these new technologies to carefully and systematically

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

The innovation process (disruptive, gliders)

Incubation time for gliders; ½

Why?:

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

The key to success for radical innovation in oceanographic instrumentation

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

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

Outline

1. SOCIB: oceans complexity, monitoring, what, why, why now
2. Background: IMEDEA and/or 20 years of science, technology development and applications for society. Some examples of each…
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5. The new role of Marine Research Infrastructures

In Summary… That's exactly what RI bring….

- State of the art research capacity
- Technology development and development of management tools for public and private sectors
- Ideal bridge for public-private partnership

The role of new marine research infrastructures,

→ To……: **RESPOND TO THE 3 KEY DRIVERS**

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

Marine RI are particularly well placed for this challenge…

But/And → Need to define a **JOINT STRATEGY** (European/ national level in the international framework, more than coordination, Partnership…)

Thank you !!!

SOCIB Balearic Islands Coastal Observing and Forecasting System

GOBIERNO DE ESPAÑA MINISTERIO DE CIENCIA E INNOVACIÓN

Govern de les Illes Balears