The Mediterranean Sea: new scientific and technological challenges in a reduced scale ocean

Observations (in near real time) and forecasting (at different scales basin, sub-basin, local and beach)

- From scientifically based forecasting to Operational Forecasting

- Towards science based Sustainability, Research & Technology & Innovation for real ICZM implementation

Prof. Joaquín Tintoré and co-workers

IMEDEA (CSIC-UIB)

Ocean_BIT

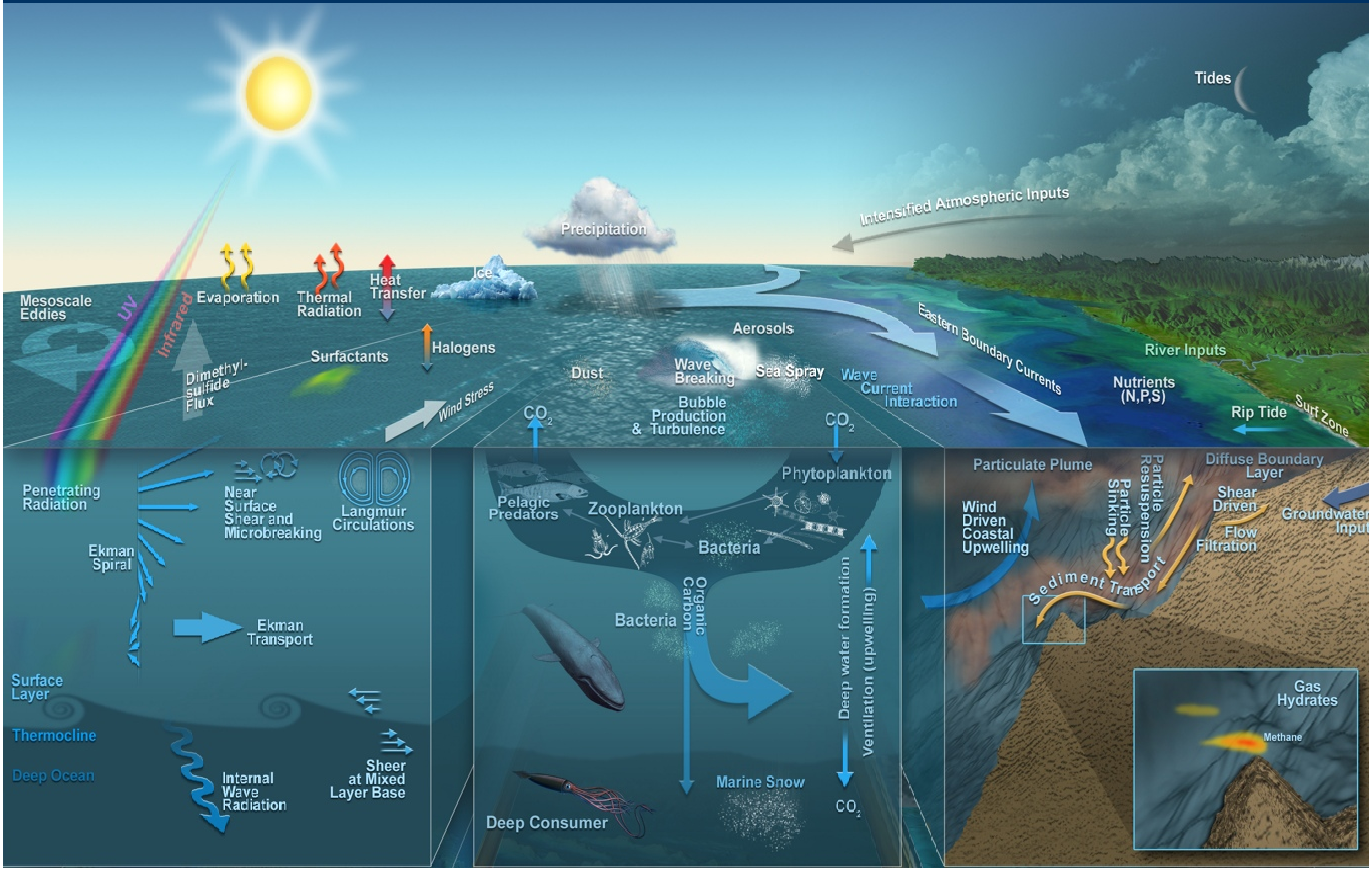
CVC
January 19, 2009

I·M·E·D·E·A
Institut Mediterrani d'Estudis Avançats

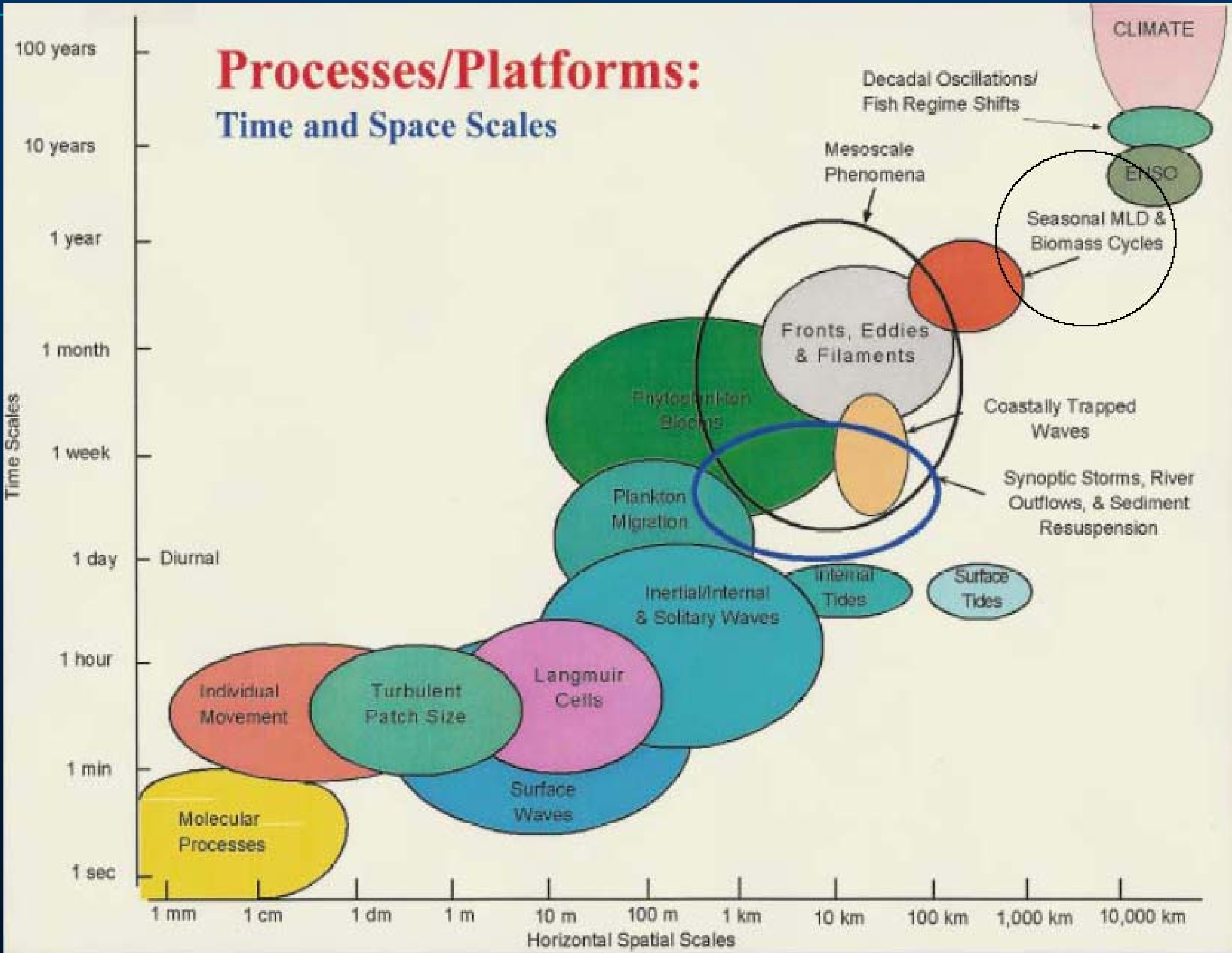
Outline / Logical Framework

1. The oceans and the coastal zone, complexity, problems and threats in a global change environment
2. General frame, basic underlying principles and challenges. Sustainability. Yes, but ... hard or soft ?. And how ?
3. The new role of science in XXI century: a new path for knowledge based decision making. some examples of coastal research and technology and/or know how transfer
4. ICZM: Integrated Coastal Zone Management
5. The future: real and measurable science based Sustainability thought a new process of ICZM
6. Coastal Observing and Forecasting Systems: Ocean_BIT
7. Conclusions

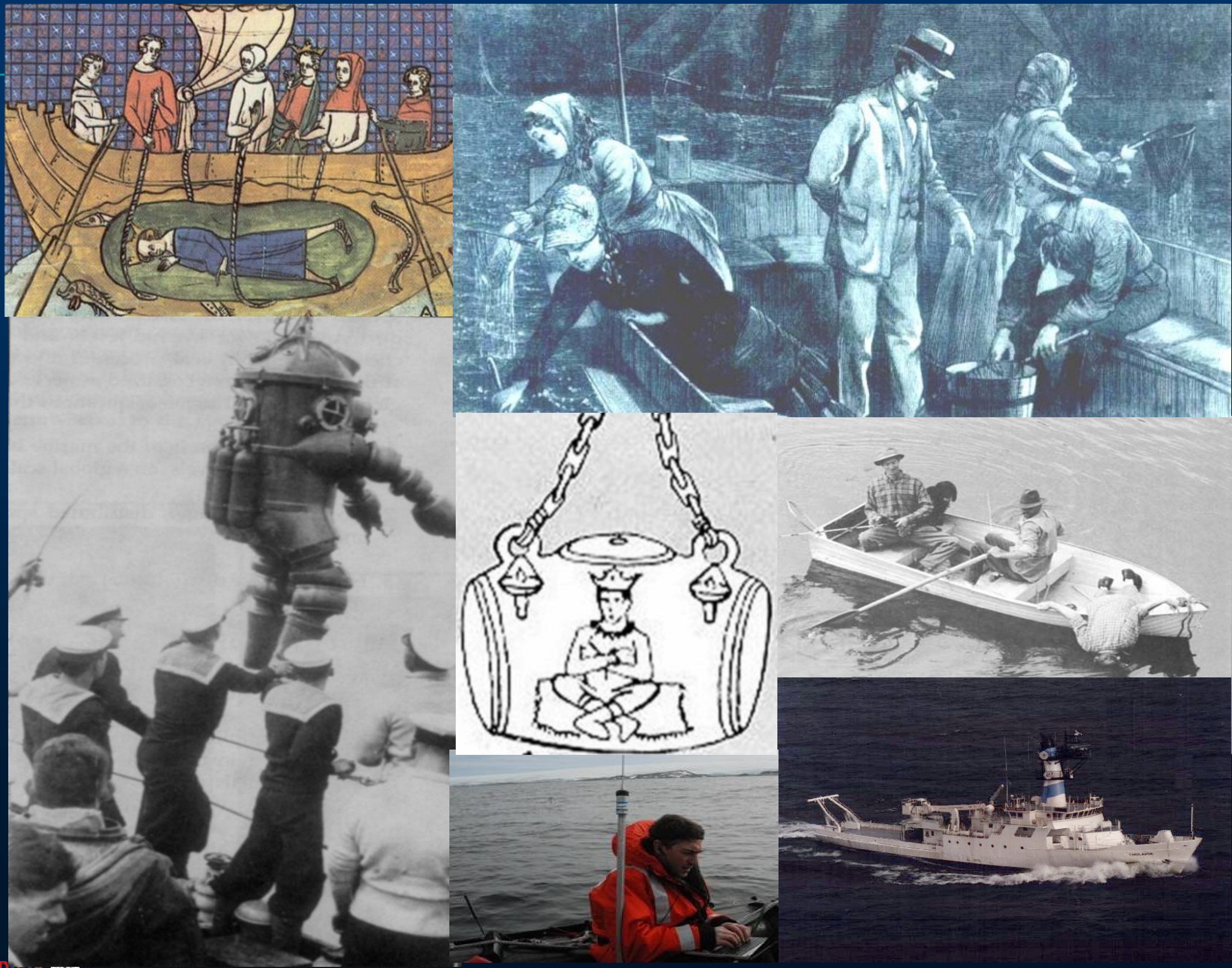
Oceans are complex and central to the Earth system



Ocean variability: scales

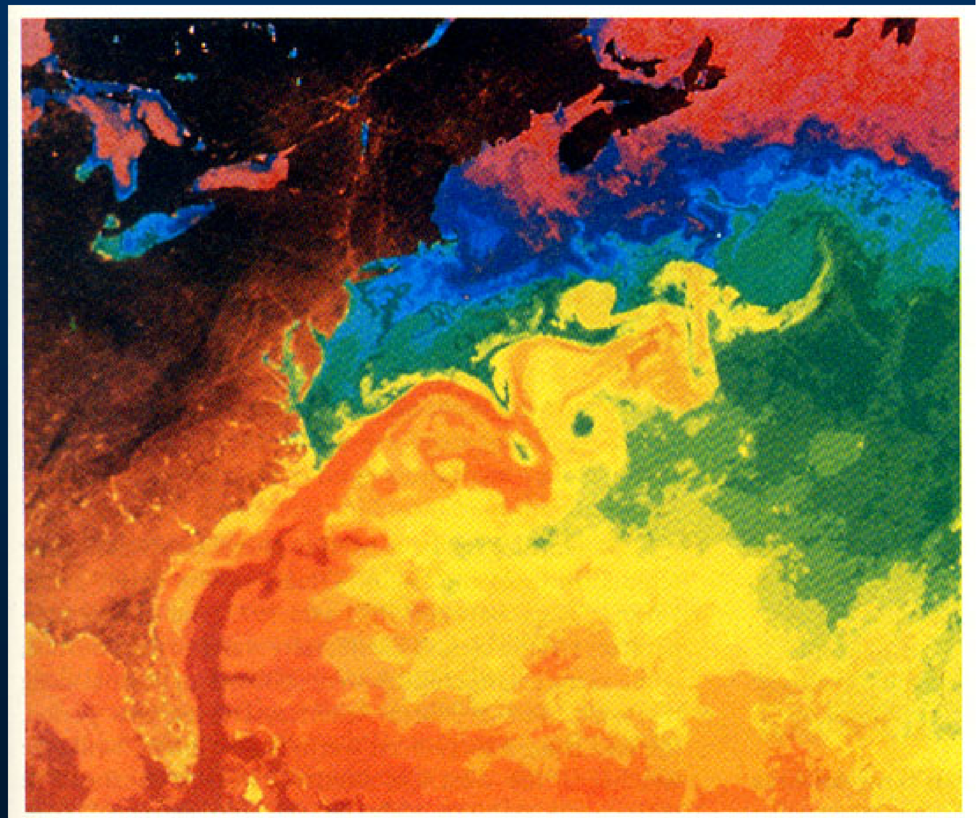


The oceans are chronically under-sampled



Ocean currents

Gulf Stream



Complex ocean: intense spatial and temporal variability

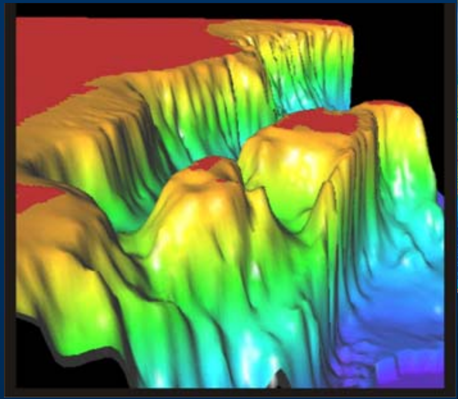
Oceanic weather

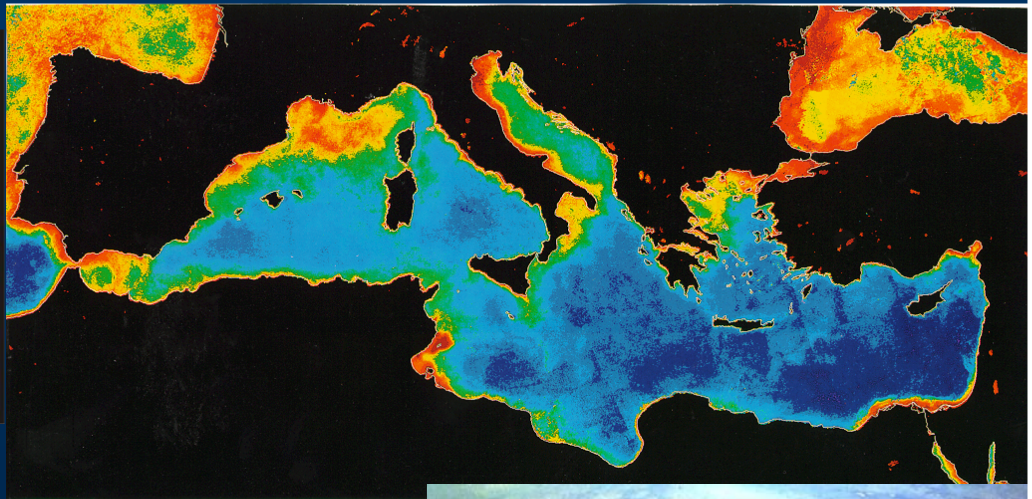
Wind induced circulation

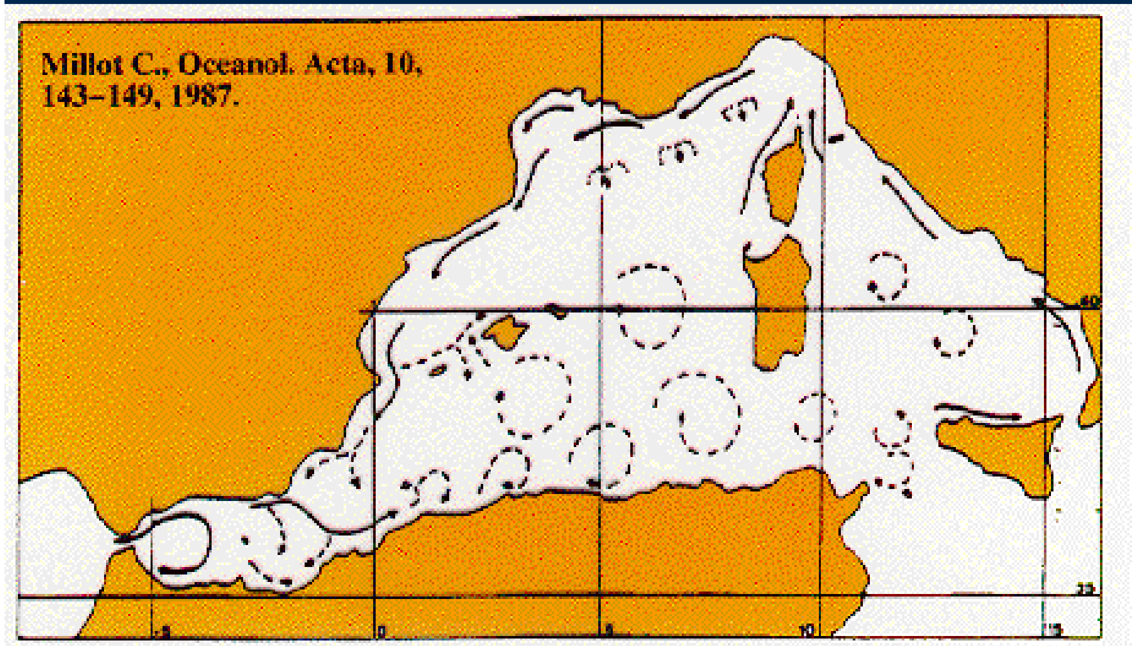
Thermohaline circulation

Mediterranean variability: ocean weather

Well defined temporal and spatial variability associated with thermo-haline circulation mostly concentrated on the slope areas.

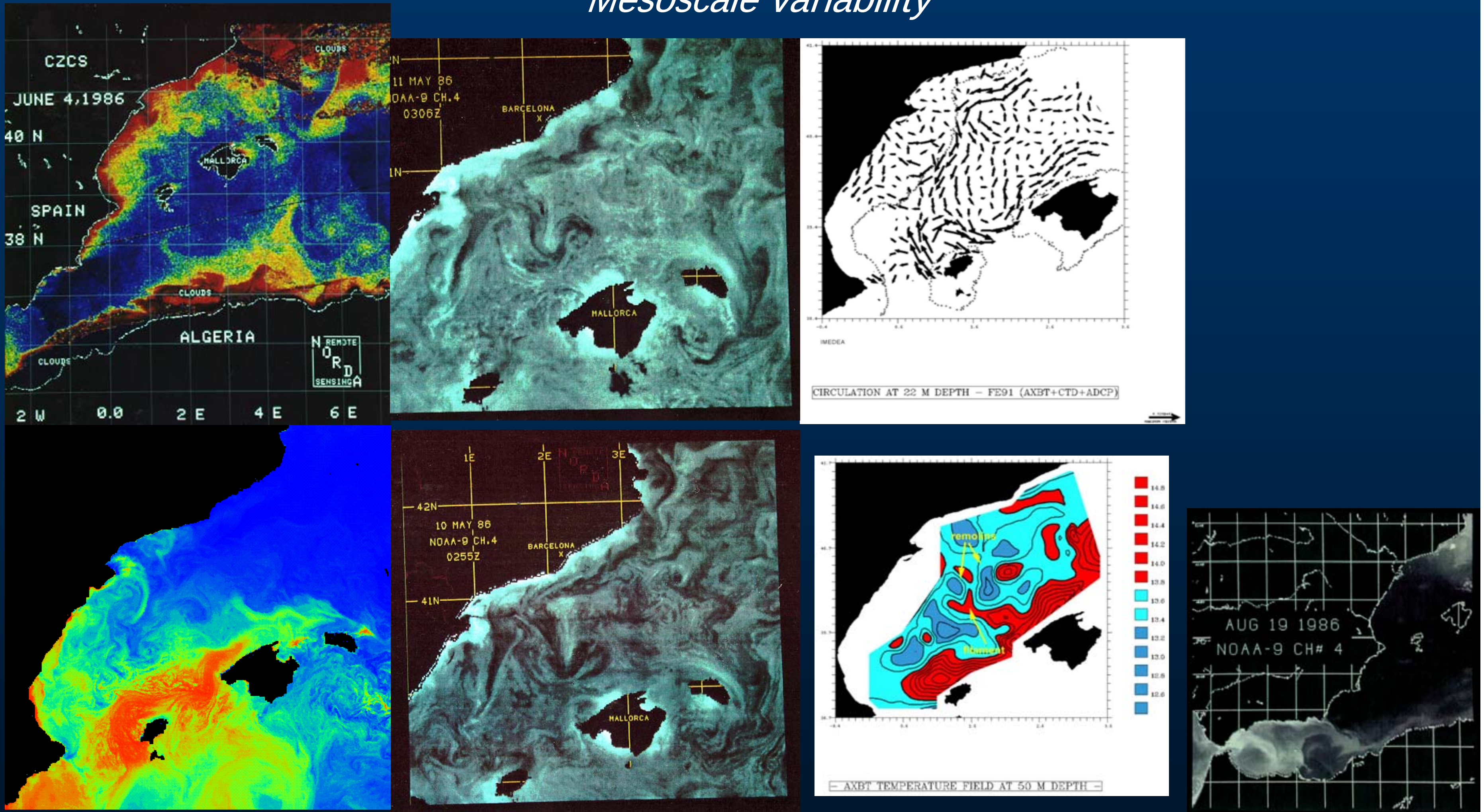






Some recent examples of Mediterranean variability
“Ocean weather”

Mesoscale variability



More than 50 papers in peer reviewd journal since 1988, mostly in Balearic and Alboran sub-basins

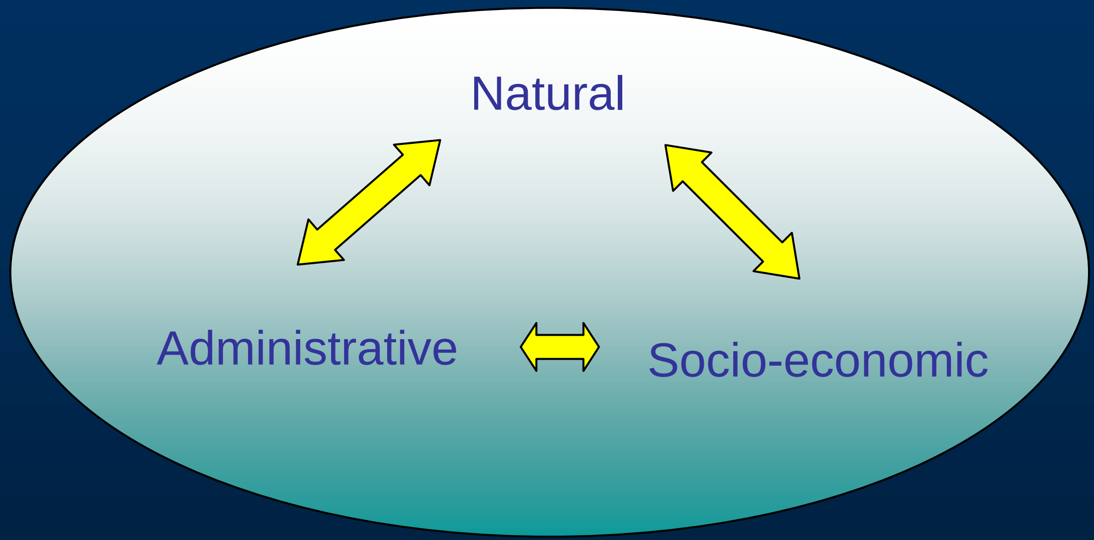
UIB I·M·E·D·E·A Institut Mediterrani d'Estudis Avançats CSIC

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

- It is a dynamic, fragile and complex area where a diversity of forces, processes and pressures are in place, all inter-related: waves, currents, sediment transport, bio-geochemical fluxes, biodiversity, socio-economic, cultural and institutional processes.
- It has a unique biodiversity in terms of flora and fauna: unique, fragile and scarce
- It provides a number of well known services and functions
- It is of high economic, social, cultural and recreational importance
- It has faced significant changes in the last 20-30 years
- A large number of administrations and institutions have competencies on the coastal zone.

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

Three sub-systems:



Very complex system

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

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

Environmental threats in the Mediterranean

- 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
- Red tides, HABS
- Loss of fisheries resources
- Proliferation of jellyfish
- Marine debris
- Accidental oil spills

Theses threats are not only local, **global change scenario**

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)

Marine Pollution: a specific problem

Pollution from land based sources:

- Solid waste
- Industrial
- Waste management

Specific issues: Eutrofication, Marine debris, Heavy metals

A new partnership for the Mediterranean:

- EU Water Directive, reach 2020 good state.
- UNEP-MAP, Medpol
- EEA
- ICZM EU Recommendation

Monitoring component: indicators, together with Blue Plan and EEA developing indicators to 3 elements:

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The concept

- Sustainable development:

"...the development that satisfies the needs from the present without compromising the capacities of future generations to fulfil their own needs"

Comisión Mundial del Medio Ambiente y Desarrollo, 1987, informe *Brundtland*

- Also:

"Sustainable development implies an increase in quality of life within the limits of the ecosystems"

Programa de Medio Ambiente de las Naciones Unidas y Fondo Mundial de la Naturaleza, 1991

Sustainability

The sustainability principle requires the sustainable management of environmental resources, whether in their pristine state or through sympathetic utilisation, to ensure that the legacy of our current activity does not impose excessive burden on future generations (Turner et al. 2001).

Cited from Ecological economics and coastal zone ecosystems' values: an overview. Turner, R. K., Bateman, I.J., Adger, W.N., Kluwer Academic Publications, Studies in Ecological Economics, ISBN 0-7923-6504-6, 2001.

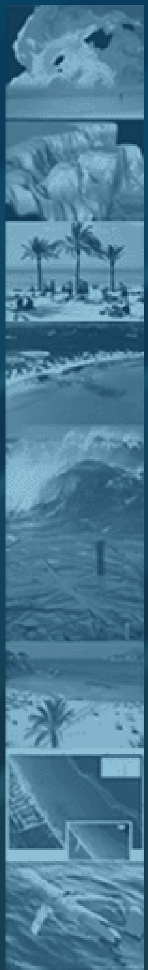
Sustainability

The concept of sustainability has been roughly partitioned into two approaches: weak sustainability and strong sustainability.

Weak sustainability requires that the total stock of capital, whether man made or natural, be maintained and rests upon the assumption of substitutability between these two types of capital (Pearce et al. 1989 and Turner 1993 in Turner et al. 2001).

Economic theory suggests that decreasing supplies of natural resources will tend to increase their price, encouraging more efficient use, substitution with other goods, and technological advancement. However, complete substitution will not always be possible due to availability of substitution opportunities (Turner et al. 2001).

Sustainability



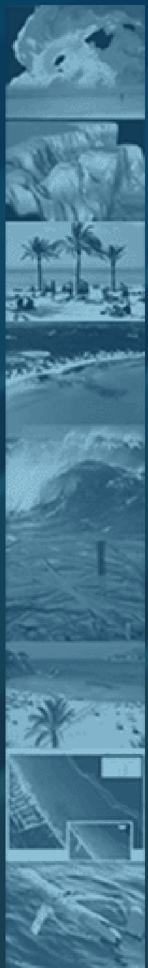
There is also the question whether man made capital is able to fully compensate for all functions provided by complex ecosystems and the existence of 'critical' natural capital and thresholds beyond which reversal is not possible. Hence, the more stringent interpretation of:

Strong sustainability requires that the total stock of natural capital be non-declining. Natural and man-made capital, rather than regarded as substitutes, can be interpreted as complements (Daly 1995 in Turner et al. 2001).

Sustainability

On the basis of strong sustainability criterion, projects considered in isolation are likely to be rejected since most development projects impinge to some degree on the environment.

In practical terms, application of such a sustainability constraint could involve investments to reduce as much as possible the overall net environmental damage, and adopting suitable projects which generate net environmental benefits as part of the portfolio of investments (Barbier et al. 1990 in Turner et al. 2001).



www.costabalearsostenible.es

The new role of science in XXI's century society

"It is not an exaggeration to assert that without science there can be no sustainable development"

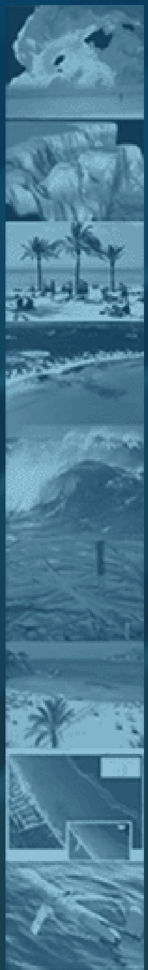
3ª Sesión de la Comisión de Desarrollo Sostenible UN, 1995

- Knowledge of the system is a key element to reach a true sustainable development. This implies high quality research, tools and instrumentation (data, indicators, thresholds, predictive capabilities, etc.)

A scientific approach should guarantee:

- A consensus by means of quantifications with reliable methodologies, reproducible and internationally established.
- A reliability of the data.
- A theoretical background internationally accepted.

Outline / Logical Framework



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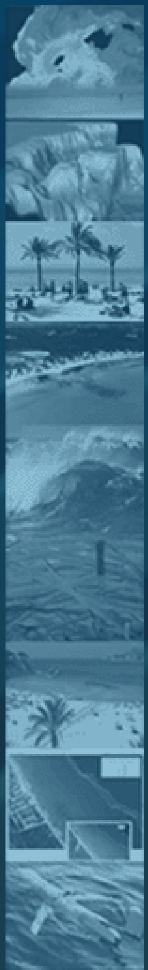
The new role of science in XXI's century society



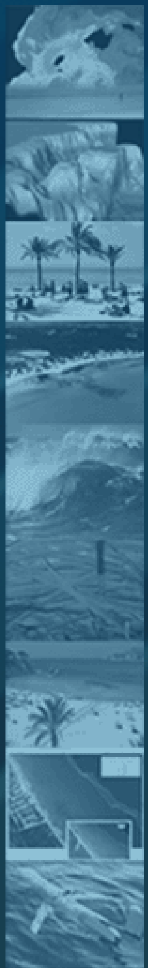
- Science progresses in last 5 – 10 years: we know that a significant number of management actions in the coastal environment would now have to be made differently !-
- Importance of knowledge transfer
- Society is turning towards science (multidisciplinary)
  - Not only during crisis or catastrophic events (health, environment, food, energy, etc.)
  - As an element of the decision making process that guarantees independence and reliability due to the existence of an evaluation system internationally accepted.

'Strong science for wise decision'

⇕

Sustainability science

The new role of science in XXI's century society

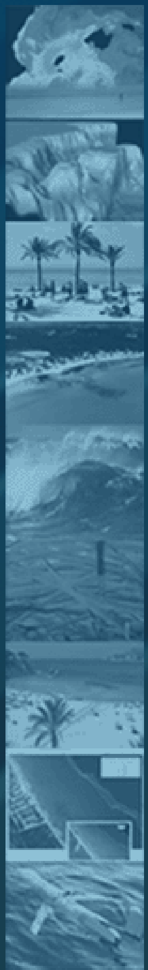


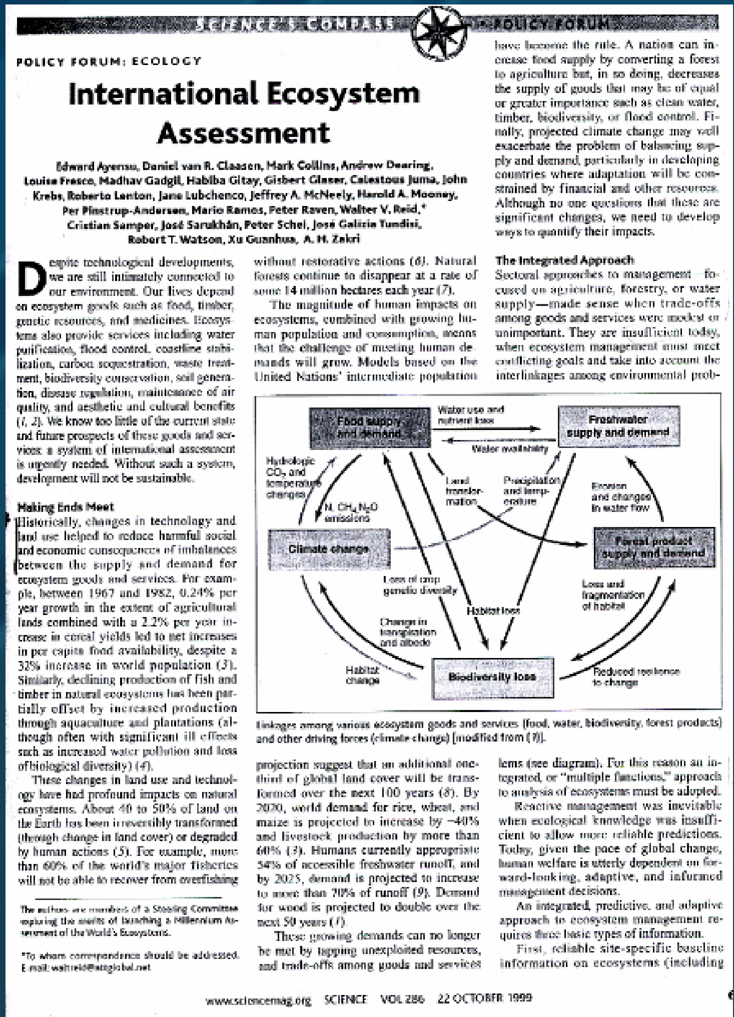
It is not an exaggeration to assert that without science there can be no sustainable development"

3rd session of the UN Commission for sustainable development, 1995

- Allows for an objective view of the situation.
- Isolates cause-effect relationships so that problems may be addressed at their sources.
- Allows for the classification and evaluation of large amounts of information.
- Determines which data are relevant and the most appropriate method to analyze them.
- Finds existing data and evaluate their relevance and quality.
- Clearly defines and prioritizes areas that need to be managed and the interrelations between them.
- Identifies information gaps so that actions may be taken to remediate the lack of understanding.
- Allows for monitoring and evaluation of ongoing actions.
- Acts as a communication tool among scientists, stakeholders, the public and decision-makers.

The new role of science in XXI's century society





SCIENCE'S COMPASS • POLICY FORUM

POLICY FORUM: ECOLOGY

International Ecosystem Assessment

Edward Ayensu, Daniel van R. Claasen, Mark Collins, Andrew Dearing, Louise Fresco, Madhav Gadgil, Habiba Gitay, Gisbert Glaser, Calestous Juma, John Krebs, Roberto Lenton, Jane Lubchenco, Jeffrey A. McNeely, Harold A. Mooney, Per Pinstrup-Andersen, Mario Ramos, Peter Raven, Walter V. Reid,* Cristian Samper, José Sarukhán, Peter Schei, José Galizia Tundisi, Robert T. Watson, Xu Guanhua, A. H. Zakri

Despite technological developments, we are still intimately connected to our environment. Our lives depend on ecosystem goods such as food, timber, genetic resources, and medicines. Ecosystems also provide services including water purification, flood control, coastline stabilization, carbon sequestration, waste treatment, biodiversity conservation, soil generation, disease regulation, maintenance of air quality, and aesthetic and cultural benefits (1, 2). We know too little of the current state and future prospects of these goods and services: a system of international assessment is urgently needed. Without such a system, development will not be sustainable.

Making Ends Meet

Historically, changes in technology and land use helped to reduce harmful social and economic consequences of imbalances between the supply and demand for ecosystem goods and services. For example, between 1967 and 1982, 0.24% per year growth in the extent of agricultural lands combined with a 2.2% per year increase in cereal yields led to net increases in per capita food availability, despite a 32% increase in world population (3). Similarly, declining production of fish and timber in natural ecosystems has been partially offset by increased production through aquaculture and plantations (although often with significant ill effects such as increased water pollution and loss of biological diversity) (4).

These changes in land use and technology have had profound impacts on natural ecosystems. About 40 to 50% of land on the Earth has been irreversibly transformed (through change in land cover) or degraded by human actions (5). For example, more than 60% of the world's major fisheries will not be able to recover from overfishing without restorative actions (6). Natural forests continue to disappear at a rate of some 14 million hectares each year (7).

The magnitude of human impacts on ecosystems, combined with growing human population and consumption, means that the challenge of meeting human demands will grow. Models based on the United Nations' intermediate population projection suggest that an additional one-third of global land cover will be transformed over the next 100 years (8). By 2020, world demand for rice, wheat, and maize is projected to increase by ~40% and livestock production by more than 60% (3). Humans currently appropriate 54% of accessible freshwater runoff, and by 2025, demand is projected to increase to more than 70% of runoff (9). Demand for wood is projected to double over the next 50 years (7).

These growing demands can no longer be met by tapping unexploited resources, and trade-offs among goods and services have become the rule. A nation can increase food supply by converting a forest to agriculture but, in so doing, decreases the supply of goods that may be of equal or greater importance such as clean water, timber, biodiversity, or flood control. Finally, projected climate change may well exacerbate the problem of balancing supply and demand, particularly in developing countries where adaptation will be constrained by financial and other resources. Although no one questions that these are significant changes, we need to develop ways to quantify their impacts.

The Integrated Approach

Sectoral approaches to management—focused on agriculture, forestry, or water supply—made sense when trade-offs among goods and services were modest or unimportant. They are insufficient today, when ecosystem management must meet conflicting goals and take into account the interlinkages among environmental problems (see diagram). For this reason an integrated, or "multiple functions," approach to analysis of ecosystems must be adopted.

Reactive management was inevitable when ecological knowledge was insufficient to allow more reliable predictions. Today, given the pace of global change, human welfare is utterly dependent on forward-looking, adaptive, and informed management decisions.

An integrated, predictive, and adaptive approach to ecosystem management requires three basic types of information.

First, reliable site-specific baseline information on ecosystems (including

Linkages among various ecosystem goods and services (food, water, biodiversity, forest products) and other driving forces (climate change) [modified from (8)].

The authors are members of a Steering Committee exploring the merits of launching a Millennium Assessment of the World's Ecosystems.

*To whom correspondence should be addressed. E-mail: waltreid@attglobal.net

Peer reviewed papers that establish solid theoretical backgrounds

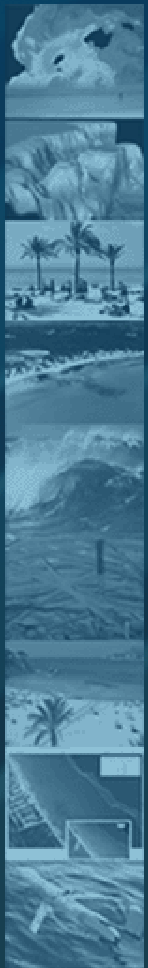
Independent system of evaluation

Science Citation Index

The new role of science in XXI's century society

Scientific needs:

Ocean Commission, 2004



Box 25.1 Examples of Ocean and Coastal Science Needs

Fundamental knowledge about oceans and coasts is essential for assessing and predicting the status of marine resources, finding beneficial new uses of ocean resources, and implementing an ecosystem-based management approach. Greater understanding of these environments will enable policy makers and managers to make wise, science-based decisions at the national, regional, state, tribal, and local levels. However, to achieve this level of understanding, significantly more research will be needed as indicated throughout this report. The list below gives some idea of the range of topics to be covered, although it is by no means a comprehensive list of all needed research.

Aquaculture
- determination of the environmental impacts of marine aquaculture and the development of best management practices
- knowledge about the impacts of aquaculture feeds, species introductions, and the use of chemicals and pharmaceuticals in aquaculture practices

Biodiversity
- baseline measurements of marine biodiversity on different scales (i.e., communities, populations, and individuals)
- methods to mitigate human activities that adversely affect biodiversity and marine ecosystems

Climate Change
- better understanding of the ocean's role in global carbon and heat cycling
- predictive models of the effects of global warming, including sea-level rise and changes in global circulation

Coastal Habitat
- knowledge about the structure and functioning of coastal habitats and how human activities and natural events affect them
- effective habitat restoration techniques

Coral Reefs
- measurements of ocean temperature, currents, and other variables that affect changes in coral communities
- prediction of the impacts of global climate change and other natural and human-induced events on coral communities
- comprehension about the distribution and ecology of cold water corals

Fisheries
- better understanding of the relationship between fisheries and ecosystem dynamics, including the identification of essential habitat
- measures of the social science and economic aspects of fisheries

International Science
- international scientific partnerships to enhance long-term ocean science and management capacity in other nations

Invasive Species
- comprehension of how or why certain species become invasive
- understanding about why certain factors make an ecosystem more susceptible to invasions
- new techniques for invasive species identification and eradication
- new ballast water treatment and exchange techniques

Marine Debris
- knowledge about debris behavior in the marine environment and its ecological effects on organisms and ecosystems
- effective debris control measures
- identification of marine debris sources

Marine Mammals and Protected Species
- expanded understanding of basic biology and population status
- understanding of the effects of noise, coastal development, offshore oil and gas exploration, vessel traffic, military activities, and marine debris on these species
- methods to mitigate harmful impacts on these animals

Natural Hazards
- basic understanding and site-specific knowledge about a range of natural coastal hazards
- new methods for tracking and predicting hazards and assessing risks
- techniques to mitigate hazard events

Oceans and Human Health
- discovery of new marine bioproducts
- elucidation of the interrelations and causal effects of marine pollution, harmful algal blooms, ecosystem alteration, and emerging marine diseases in disease events
- new methods to monitor and mitigate threats to human health in marine and freshwater systems

Offshore Energy and Minerals
- understanding of cumulative, low-level, and chronic impacts of oil and gas activities on marine environments
- evaluation of the risks to the marine environment due to aging pipelines
- evaluation of the environmental effects of OCS mineral and sediment use

Regional Understanding
- regional-scale research programs to understand ecosystem processes
- integration of biological, physical, and chemical research on a regional, ecosystem basis

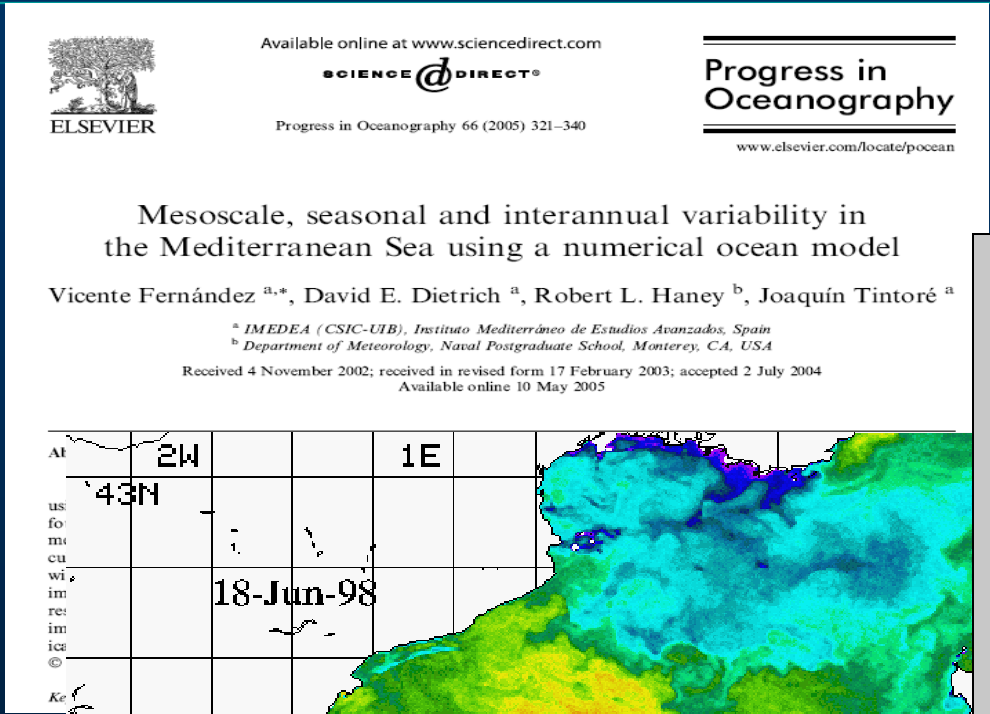
Sediment
- data on sediment processes in the marine environment on regional and national scales
- innovative techniques and technologies for managing marine sediment
- comprehensive information about the source, movement, volume, quality, and appropriate use or disposal of sediment—particularly contaminated sediment

Socioeconomic Science
- operational data on the economic factors and human dimension affecting ocean and coastal areas and activities

Vessel Pollution
- understanding of cumulative impacts of commercial and recreational vessel pollution on ecologically sensitive areas
- knowledge of impacts of vessel air emissions, particularly in ports and inland
- disposal options for concentrated sludge resulting from advanced sewage treatment on large passenger vessels

Water Pollution
- advanced treatment options for eliminating nitrogen, phosphorus, and other emerging contaminants, such as pharmaceuticals, from wastewater discharges
- new methods for removing nutrients and pathogens in coastal runoff
- new models and measures of atmospheric transport and deposition of pollutants

Mediterranean inter-annual variability: sub-basin basin scale interactions



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

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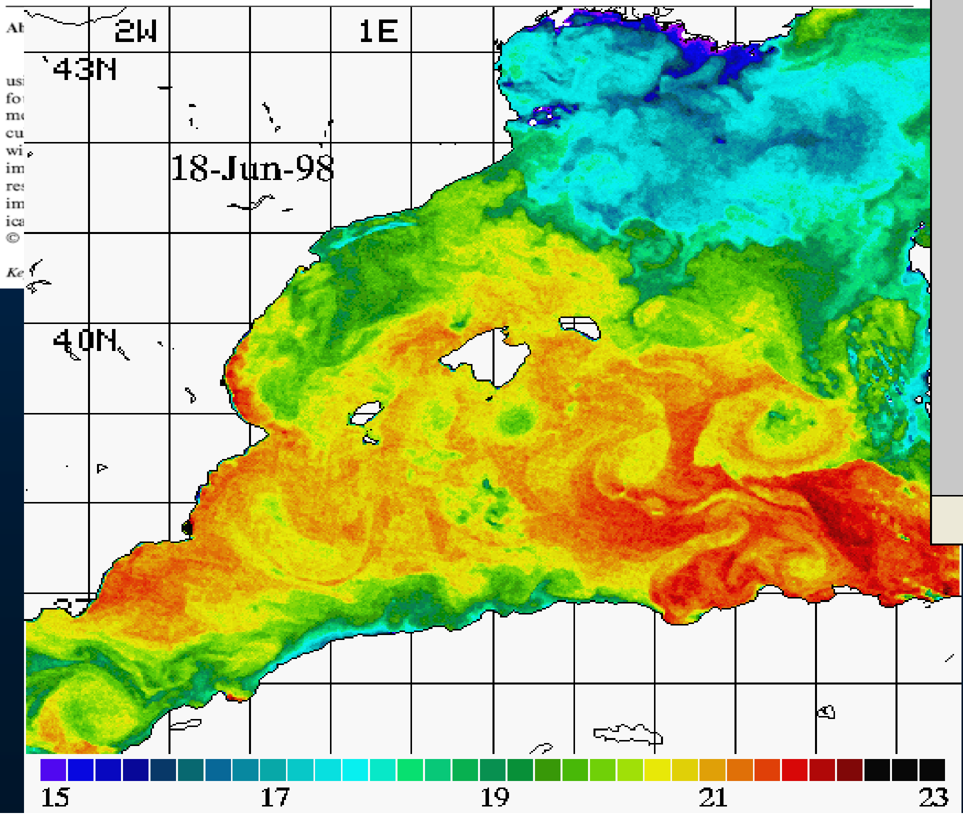
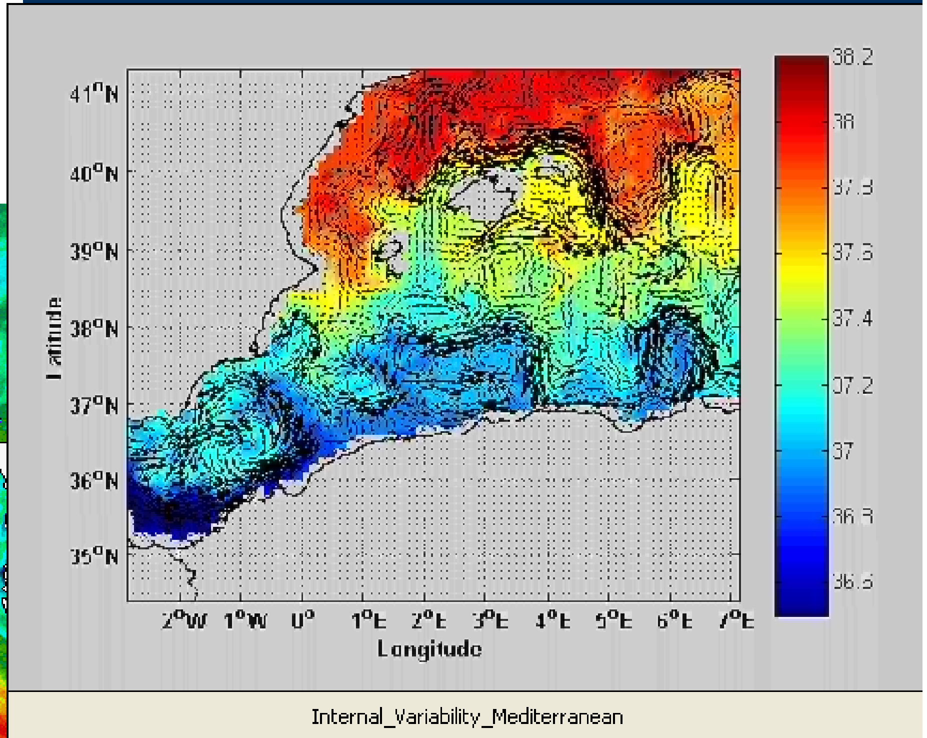




Mesoscale dynamics, vertical motions, size structure of phytoplankton, biogeochemical fluxes

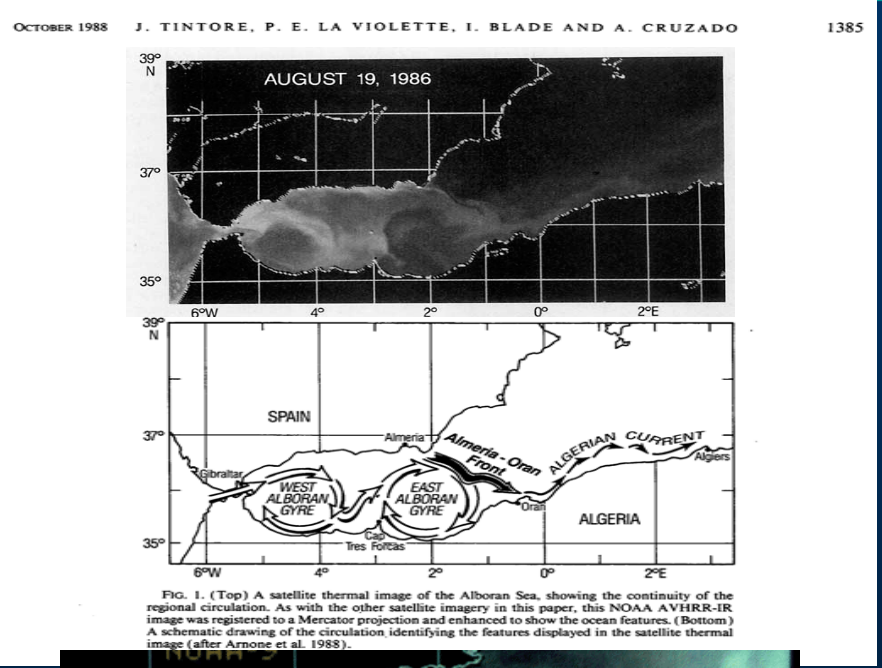
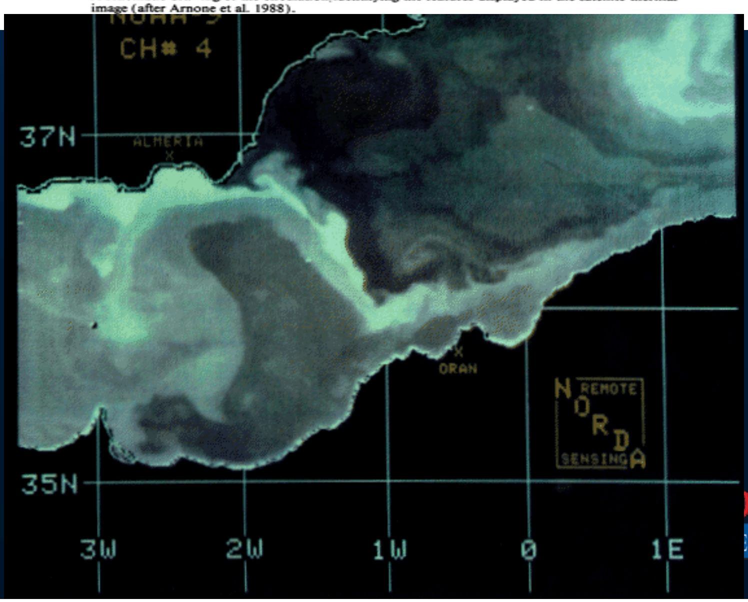


FIG. 1. (Top) A satellite thermal image of the Alboran Sea, showing the continuity of the regional circulation. As with the other satellite imagery in this paper, this NOAA AVHRR-IR image was registered to a Mercator projection and enhanced to show the ocean features. (Bottom) A schematic drawing of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



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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Acknowledgements

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

Correspondence and requests for materials should be addressed to E.M. Friis (e-mail: else.marie.friis@nrm.se).

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

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

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

Estudis Avançats

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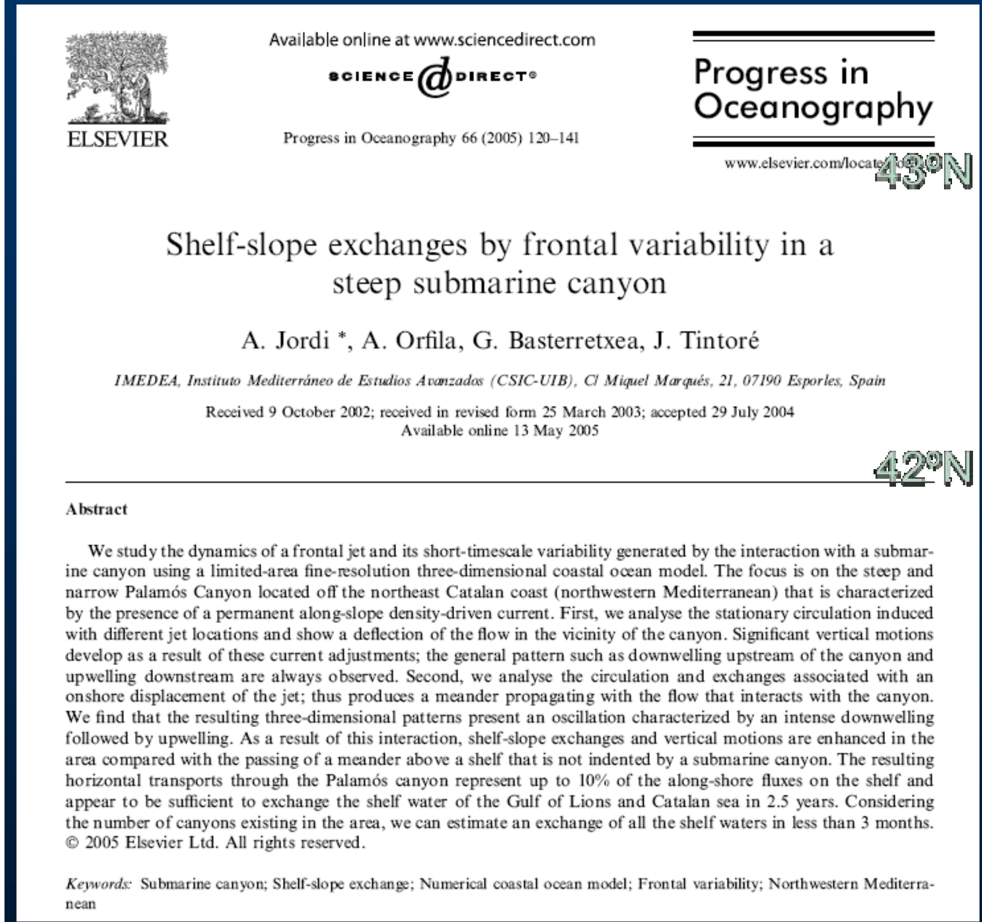
Shelf/slope exchanges – canyons interactions – mean flow/frontal instabilities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Progress in Oceanography 66 (2005) 120–141
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Shelf-slope exchanges by frontal variability in a steep submarine canyon

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

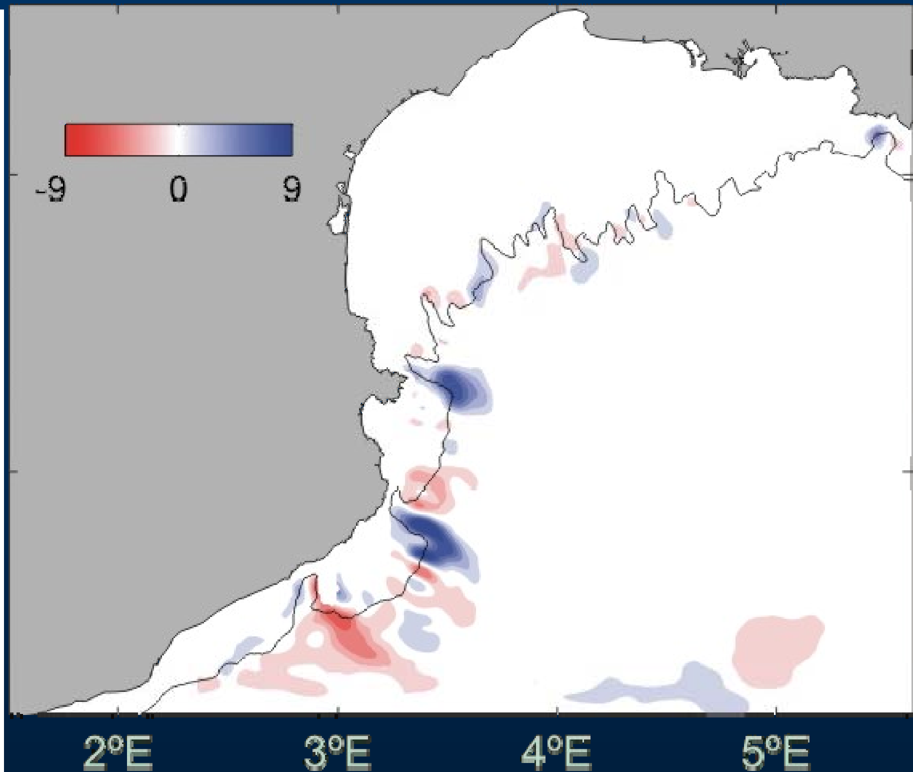
IMEDEA, Instituto Mediterráneo de Estudios Avanzados (CSIC-UIB), C/ Miquel Marqués, 21, 07190 Esporles, Spain

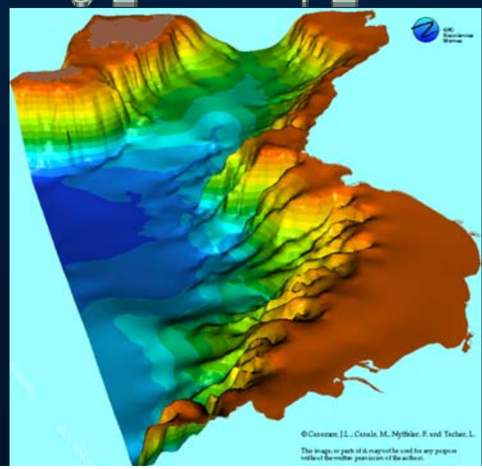
Received 9 October 2002; received in revised form 25 March 2003; accepted 29 July 2004
Available online 13 May 2005

Abstract

We study the dynamics of a frontal jet and its short-timescale variability generated by the interaction with a submarine canyon using a limited-area fine-resolution three-dimensional coastal ocean model. The focus is on the steep and narrow Palamós Canyon located off the northeast Catalan coast (northwestern Mediterranean) that is characterized by the presence of a permanent along-slope density-driven current. First, we analyse the stationary circulation induced 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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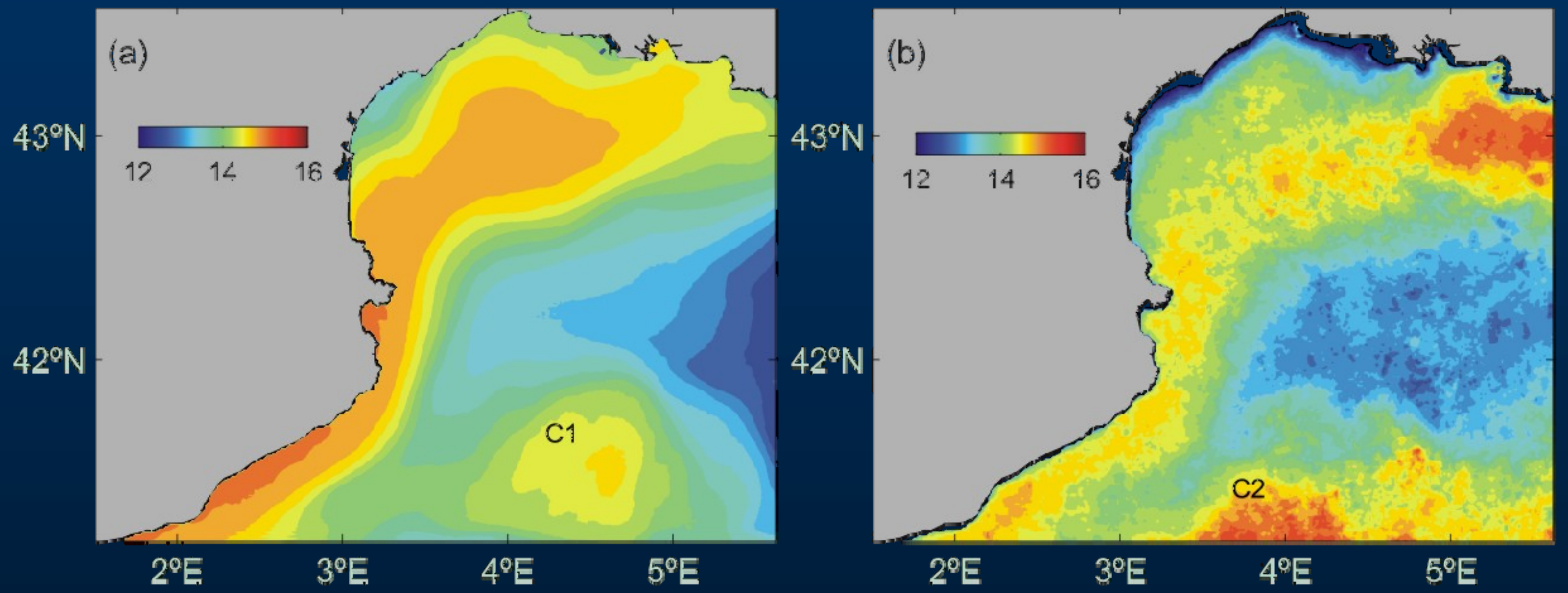
Results: Comparison with satellite data

Comparison between monthly averaged SST for December predicted by the model (a) and observed by satellite (b).



With some exceptions the large-scale pattern matches well with observations. Satellite temperature displays small-scale variability. The location of the anticyclonic eddy in the model (C1) is displaced to the northeast and presents a slightly colder core than satellite values (C2).

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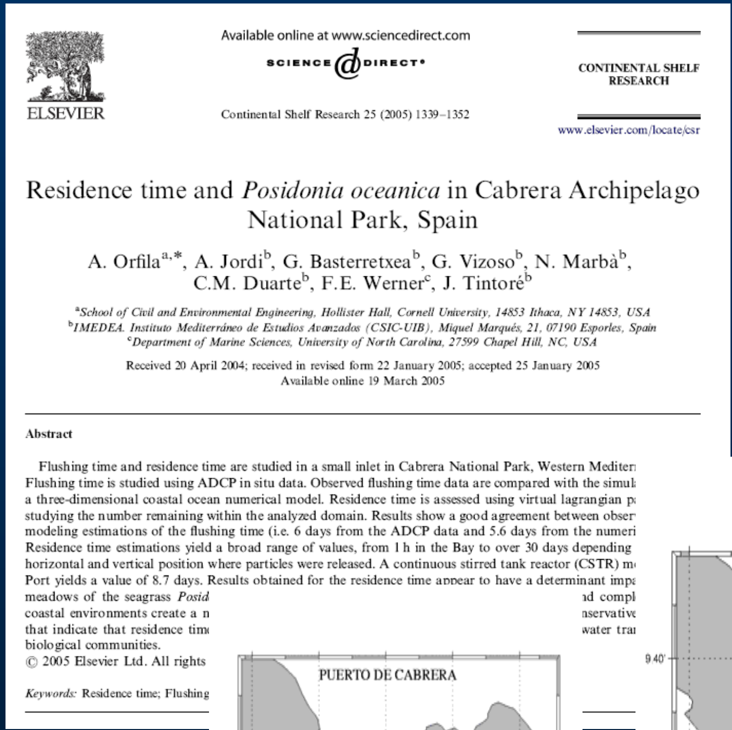
Residence time – coastal – open ocean exchanges



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Continental Shelf Research 25 (2005) 1339–1352
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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, USA
[b]IMEDEA. Instituto Mediterráneo de Estudios Avanzados (CSIC-UIB), Miquel Marqués, 21, 07190 Esporles, Spain
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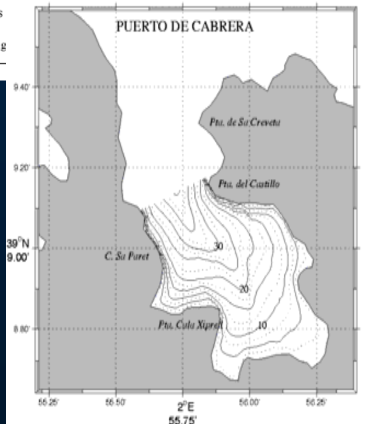
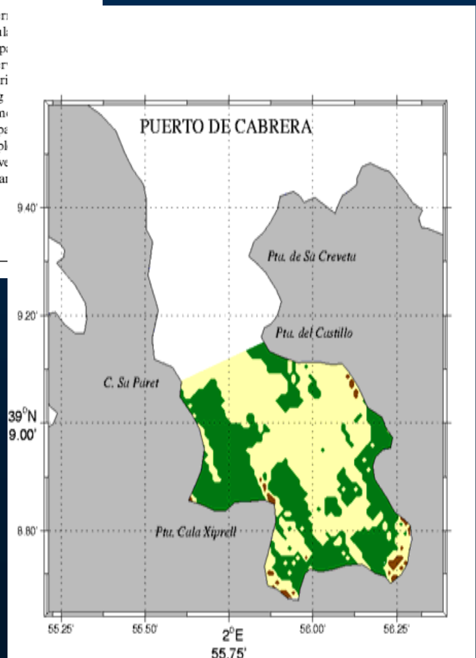
Received 20 April 2004; received in revised form 22 January 2005; accepted 25 January 2005
Available online 19 March 2005

Abstract

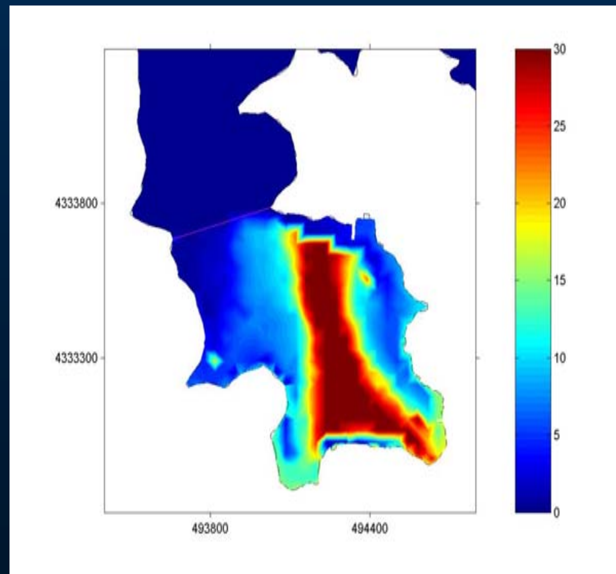
Flushing time and residence time are studied in a small inlet in Cabrera National Park, Western Mediter
Flushing time is studied using ADCP in situ data. Observed flushing time data are compared with the simul
a three-dimensional coastal ocean numerical model. Residence time is assessed using virtual 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 impa
meadows of the seagrass *Posid* ... nd compl
coastal environments create a n ... nservative
that indicate that residence tim ... water tra
biological communities.

Keywords: Residence time; Flushing



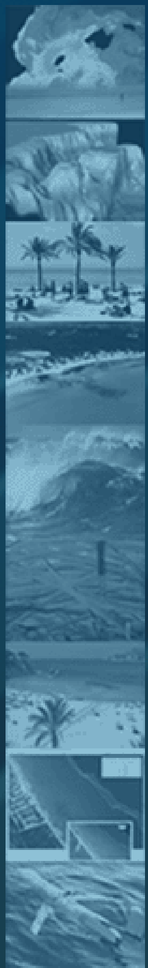


Cobertura de Posidonia oceanica



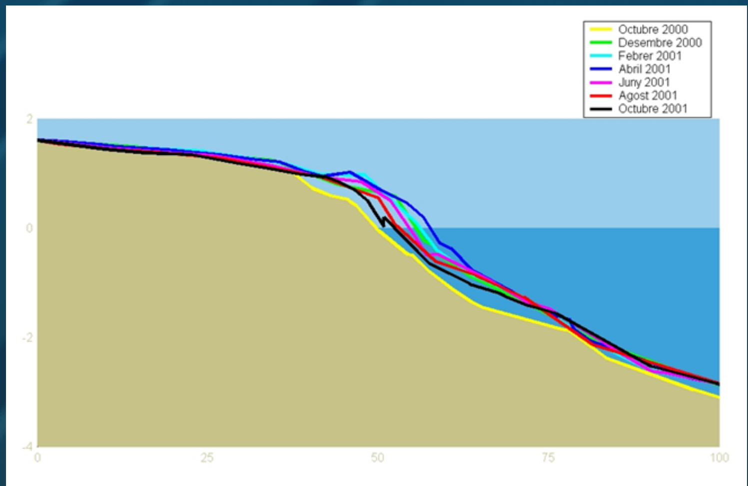
Tiempo de residencia (en días) cerca del fondo. z

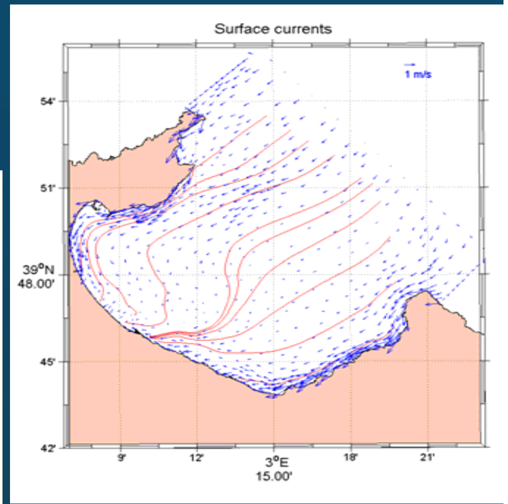
Results at local scale

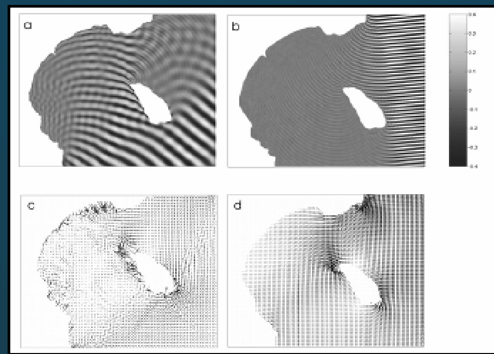


Coastal morphodynamics

Beach erosion and sediment transport





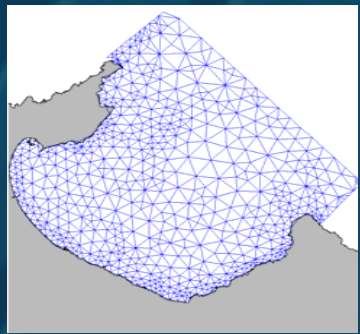


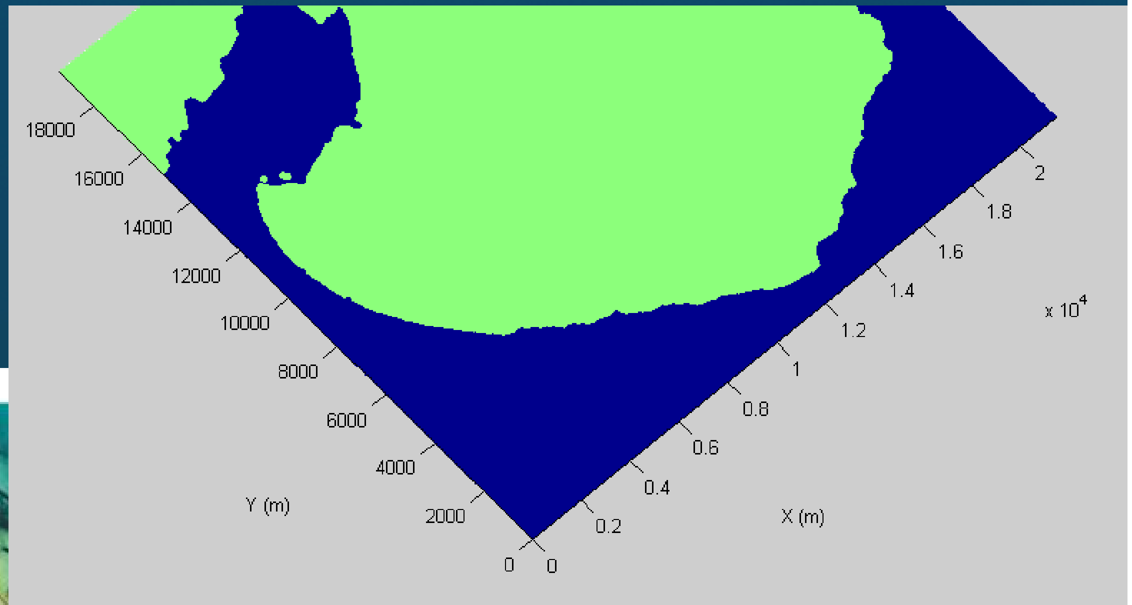
Main results: adjustment after extreme events, fine sediment resuspension by wind

Basterretxea et al., J. Coastal Res., 2004

Results at local scale

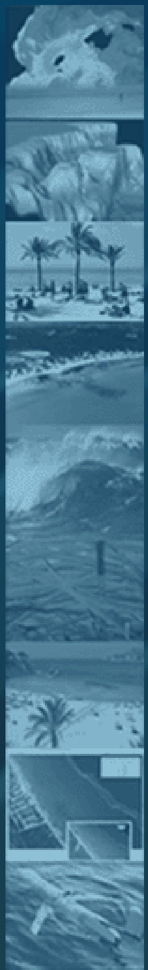
Variabilidad de la playa de Muro



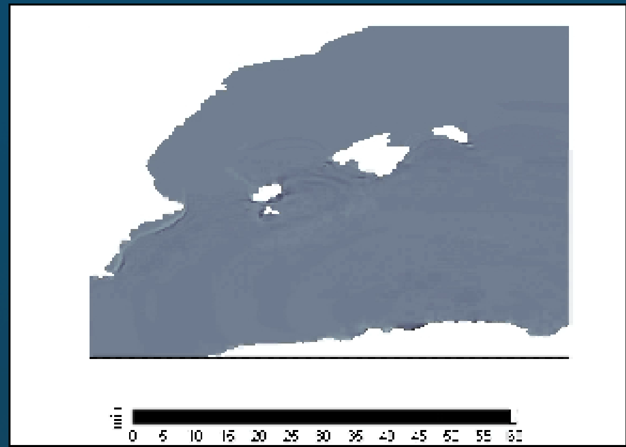


We know that with today's knowledge, actions undertaken in the past would be done differently

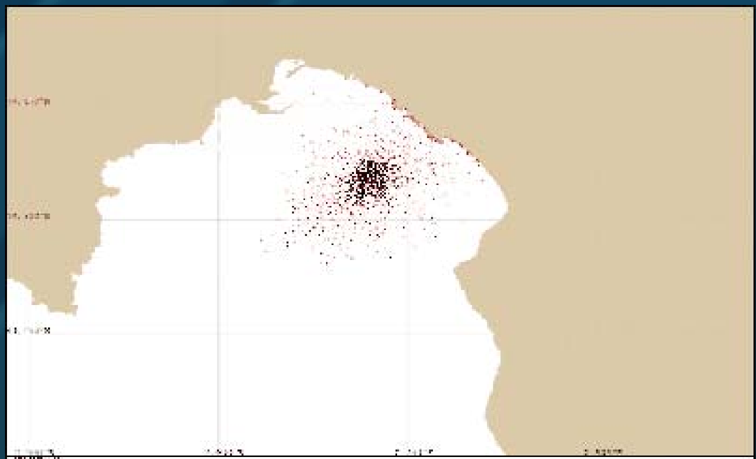
Operational systems being implemented



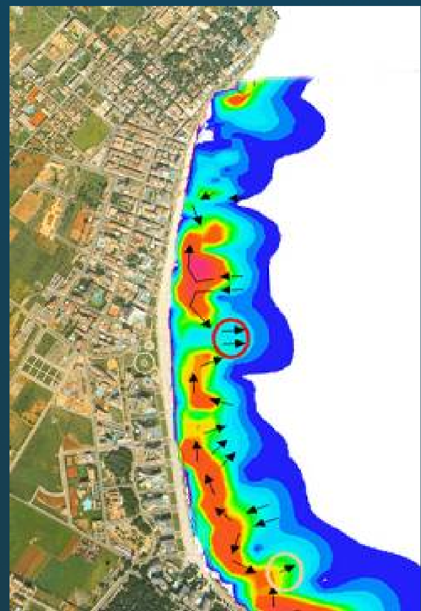
- Oil-spill mapping
- Land vulnerability
- Security in beaches – rip currents
- Prediction of trajectories from Tsunamis.



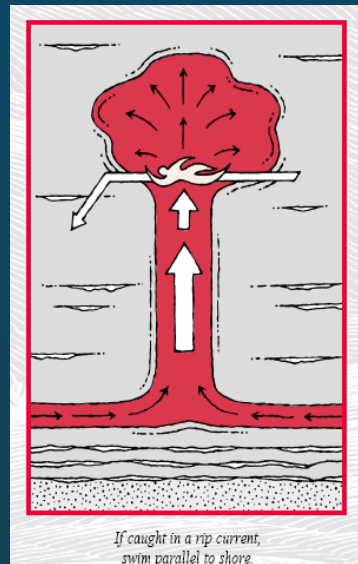
tsunami



plast1



Technology development

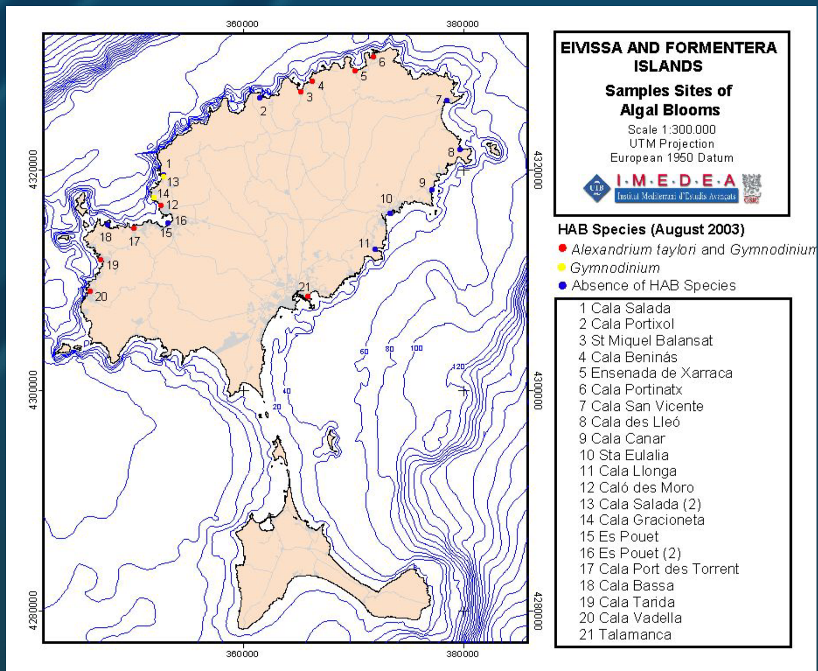


Beach monitoring using cameras, breakers, rips, bathymetry changes, etc.

www.costabalearsostenible.es

Results at local scale

Water Quality: HABS proliferation



Playa de Palmira (Calvià)

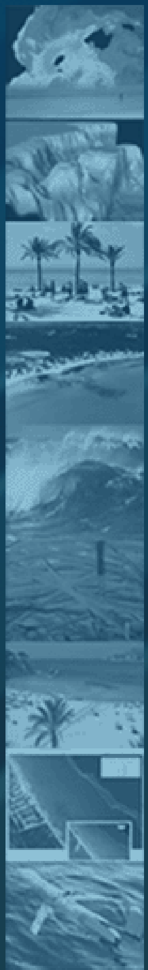
Water quality, eutrofication: massive proliferation of micro-alguae.

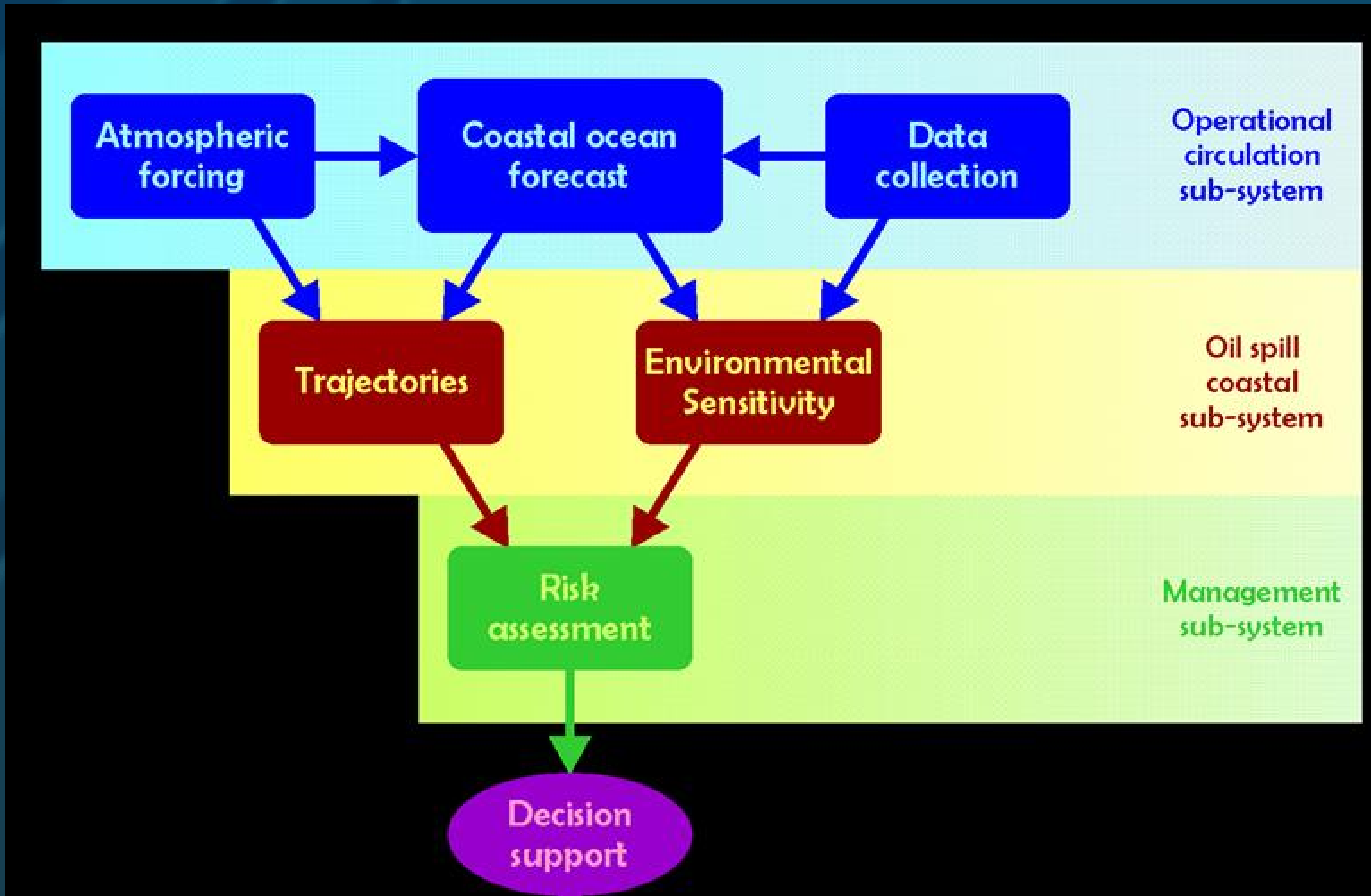
Ec reserach projects.

www.costabalearsostenible.es

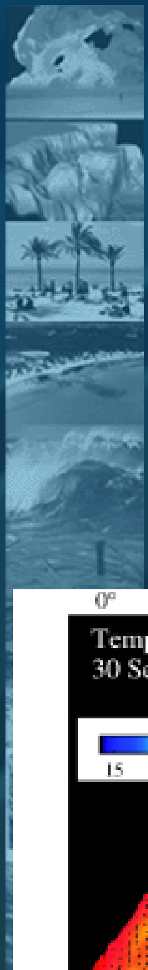
Basterretxea et al., Estuarine Coast. Shelf Science., 2004

Operational systems being implemented





Operational Systems: Oil spill, Search and Rescue, etc...



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A forecast experiment in the Balearic Sea

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

[a] Institute for Coastal Research, GKSS Research Centre, Max-Planck-Straße 1, 21052 Geesthacht, Germany
[b] IMEDEA, C/ Miquel Marquès 21, 07190 Esporles, Mallorca, Spain
[c] Harvard University, 29 Oxford Street, Cambridge, MA 02138-2901, USA
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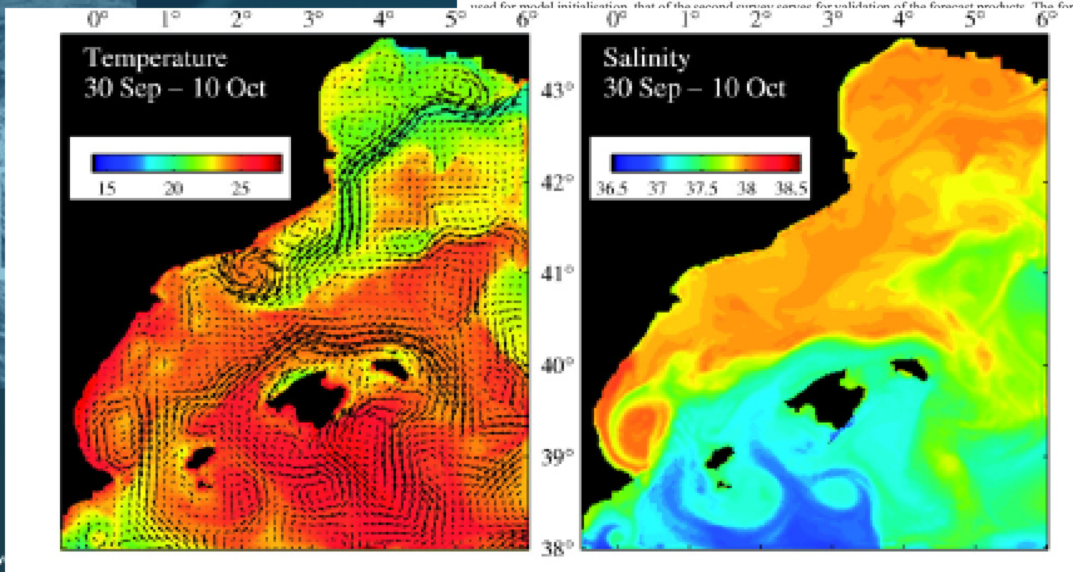
Received 20 October 2005; received in revised form 16 January 2007; accepted 10 May 2007
Available online 5 June 2007

Abstract

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

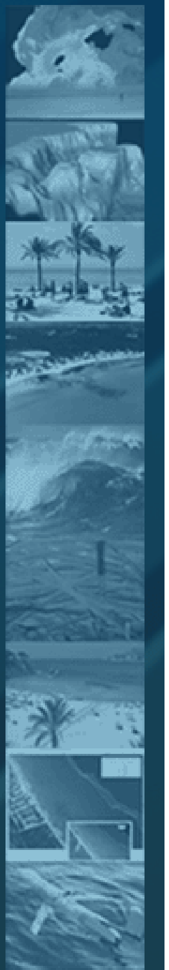
The forecast capability of HOPS is demonstrated in terms of a hindcast experiment, utilising two observational data sets of a subregion of the Balearic Sea which were acquired in mid September and early October 2002. While the data of the first survey is used for model initialization, that of the second survey serves for validation of the forecast products. The forecast skill of the system ... profiles and horizontal ... fields are closer to the ... t is successful. ... of Lagrangian part...



Gov... ...es

...ostanera de les Illes Balears

GIZC
GESTIÓ INTEGRADA DE LA ZONA COSTANERA



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 auxílios
- 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

Govern de les Illes Balears

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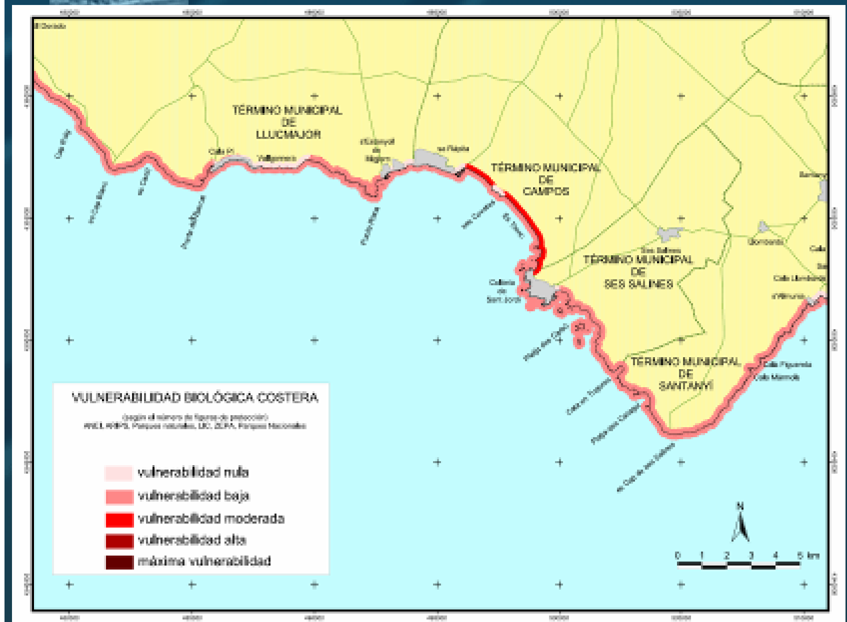
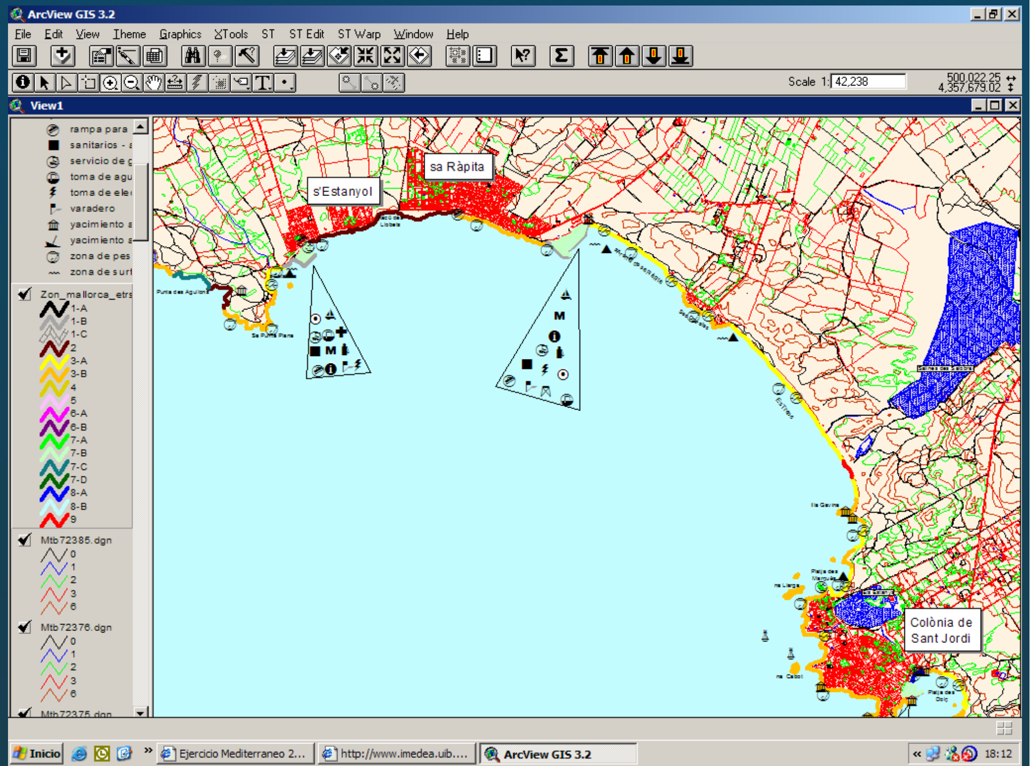
Coastal management

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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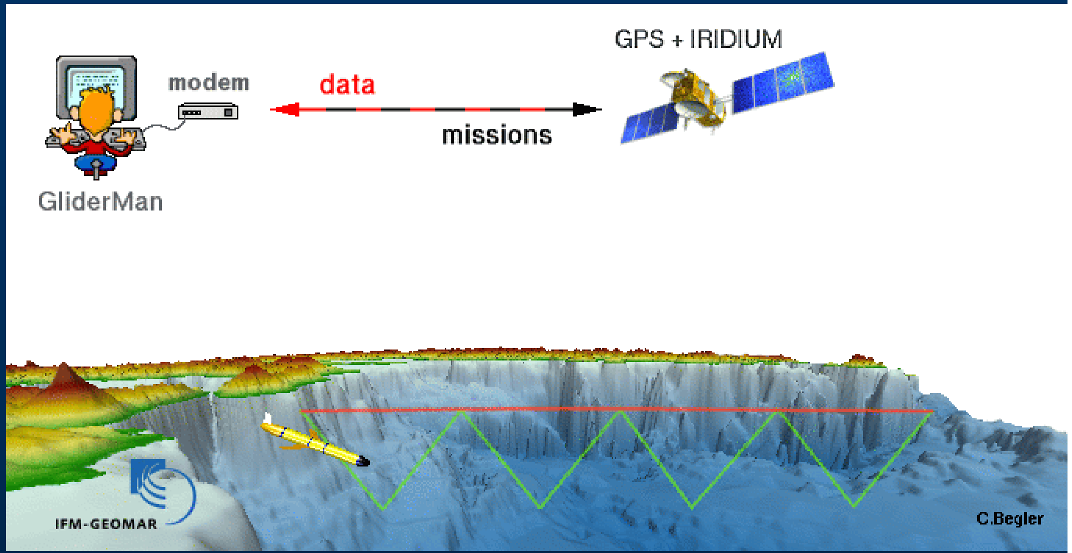
CSIC

An example of recent glider activities directly related to ICTS – Ocean_BIT



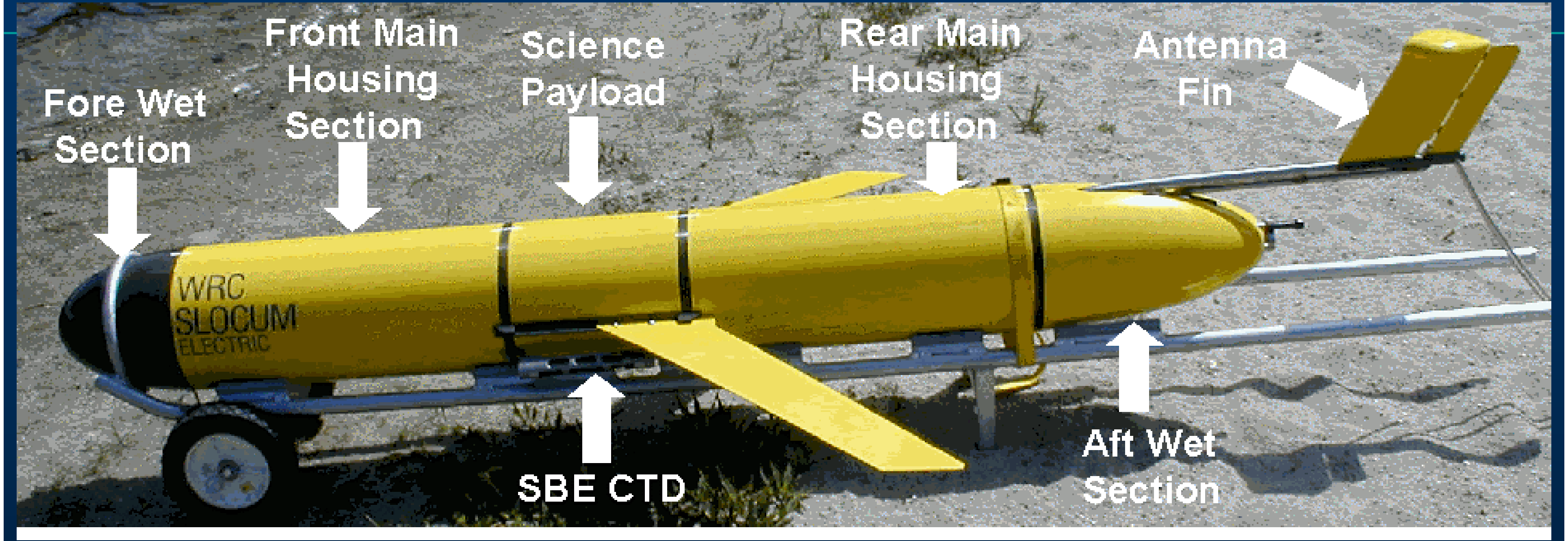
Glider data

- 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

Slocum Coastal Glider



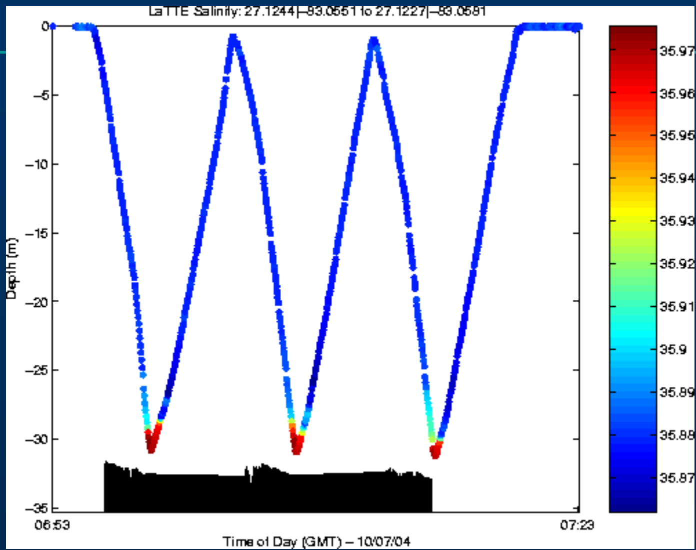
Glider Specs.

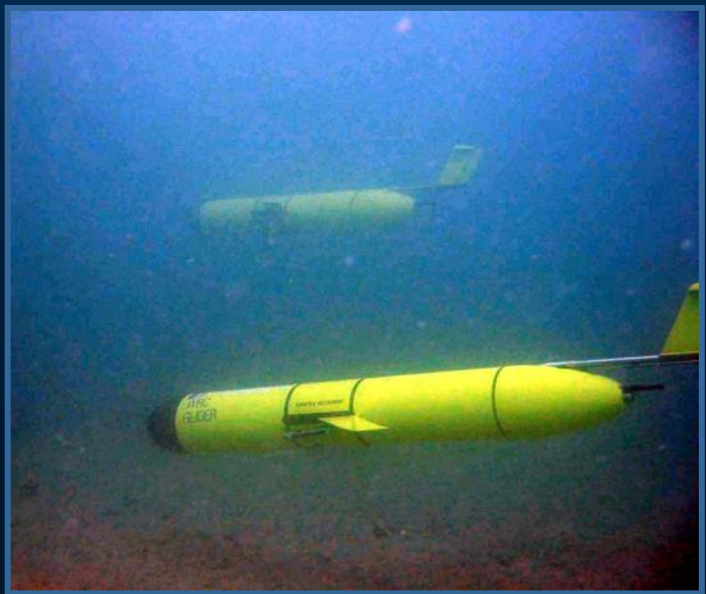
Length: 1.5 m Hull Diameter: 21.3 cm
Weight: 52 kg

Science Bay Specs.

Length: 30 cm Diameter: 21.3 cm
Max. Payload Weight: 4 kg

The Glider "Flight"

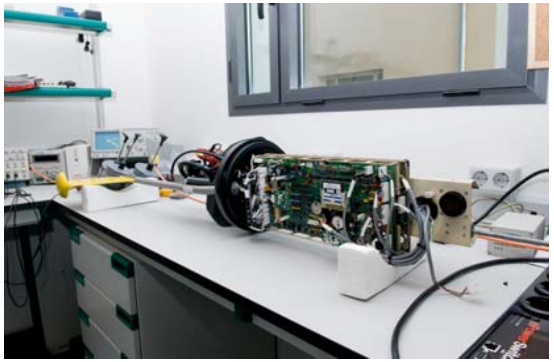


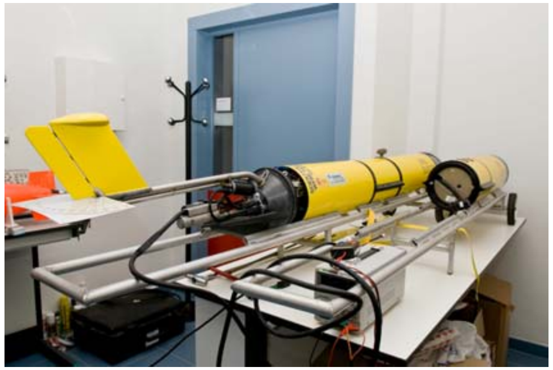


IMEDEA Facilities for glider (MERSEA, SESAME, etc.)

We have established new facilities for glider operations:

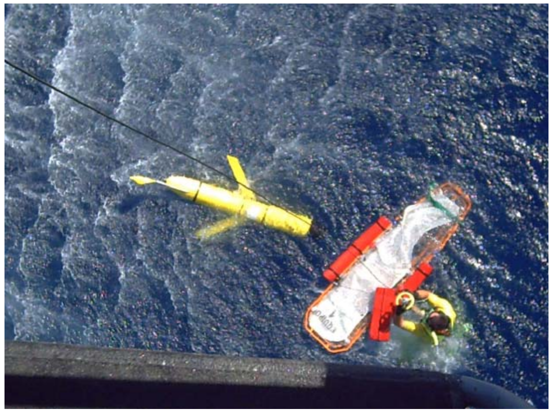
Electronics
Laboratory



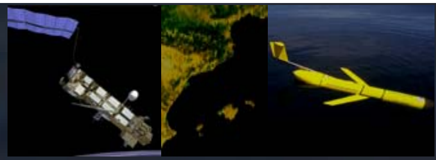


Ballasting
Laboratory

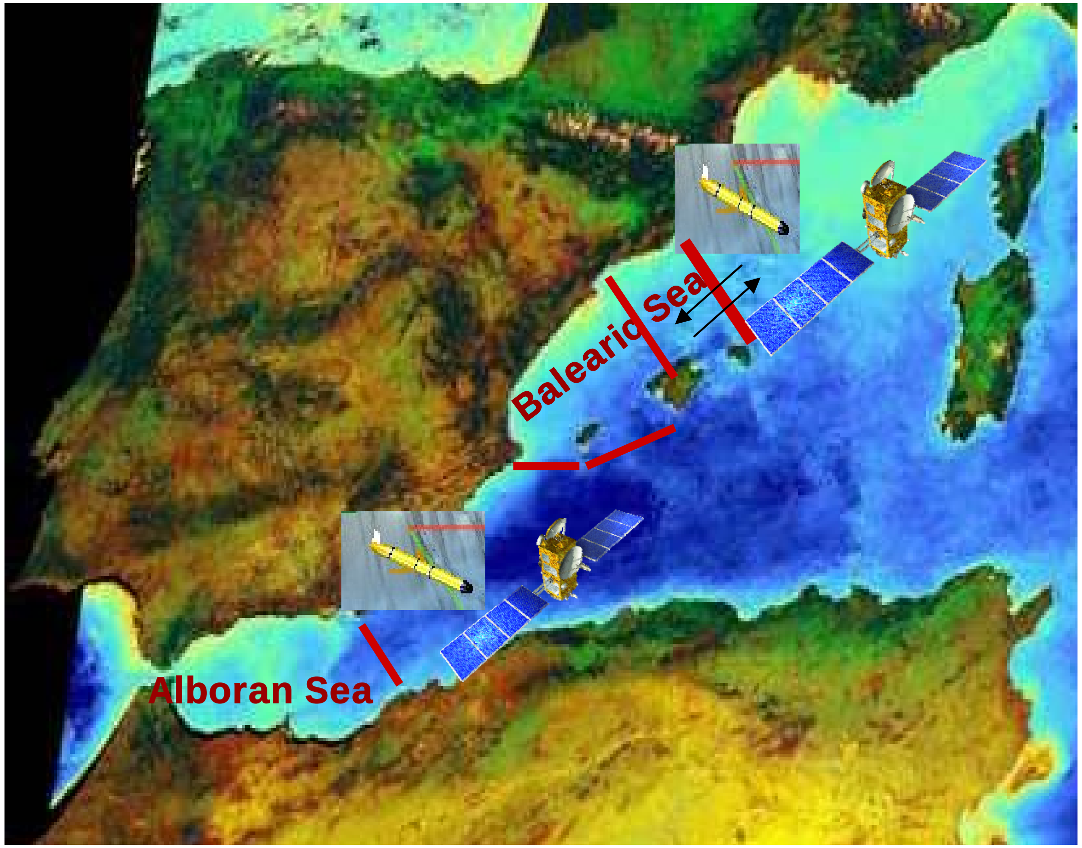
Collaboration:
Search and Rescue
801 Squadron
and local authorities



IMEDEA Glider Missions



We have carried out **16** glider missions from November 2006 to December 2008 in the Western Mediterranean Sea



5000 full CTD casts + oxigen, chlorophyll turbidity (180 m)

- Sustained glider observations along 773 ENVISAT track (every 70 days)

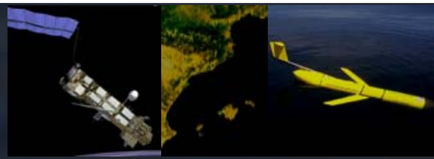
- Simultaneous sampling (2 gliders) of Balearic channels in collaboration with Ifremer

- Jason Altimeter track from Menorca to mainland

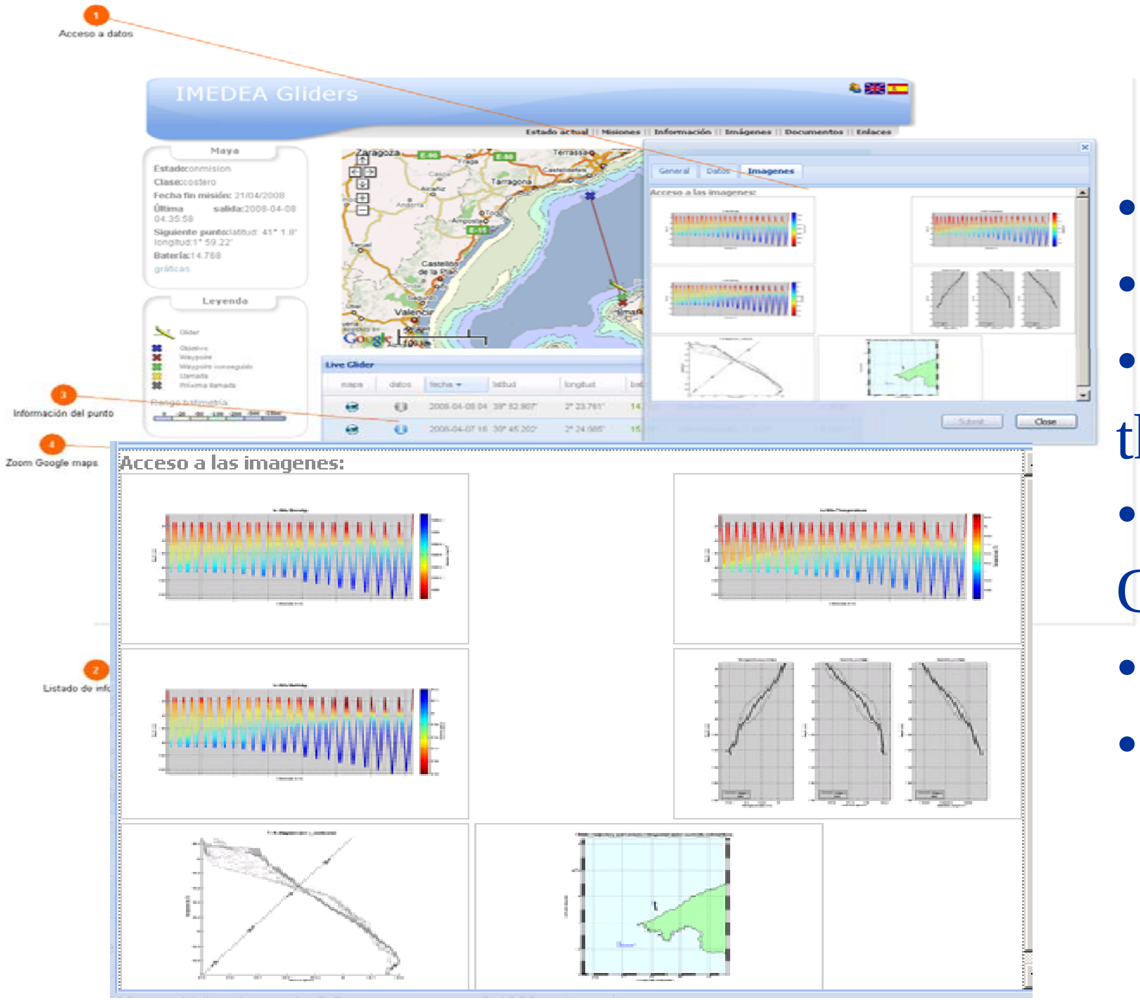
- Eastern Alboran Sea
- Complementary ship cruises

- Specific ship/glider experiment for thermal lag correction

Data management and web



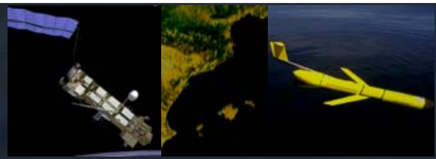
We have developed a system for tracking glider missions in real time:



- Mission definition
- Quality control
- Visualization (own and through ECOOP system)
- Data transmission to Coriolis, etc…
- Data download capability
- OpenDap, Thredds server

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

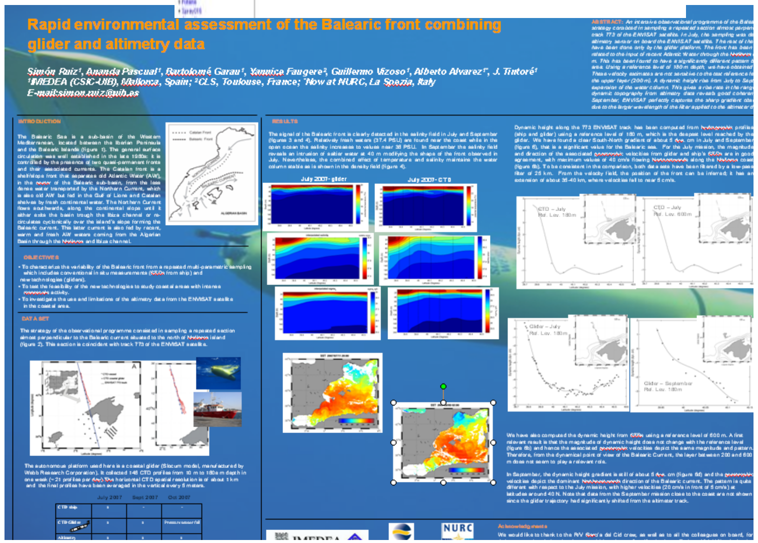
Events with IMEDEA participation



We have organized/co-organized the following events:

- International Glider School 2007 – IMEDEA
- 2nd EGO Workshop 2007 – IMEDEA

We have participated (talks and posters) in the following scientific conferences, meetings, etc:



- REA Conference, Sept. 2007, Italy
- EuroGoos 2008, UK
- EGU April 2008, Austria
- OST meeting, June 2008, L.A.,EEUU

Scientific Papers:

Mesoscale dynamics of the Balearic front integrating glider, ship and satellite data, Ruiz et al., J. Mar. Syst., 2009 in press.

2 other papers ongoing.

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4. ICZM: Integrated Coastal Zone Management, a well established international process to reach multidisciplinary, knowledge based sustainability in the coastal zone.
5. The future: real and measurable science based Sustainability thought a new process of ICZM
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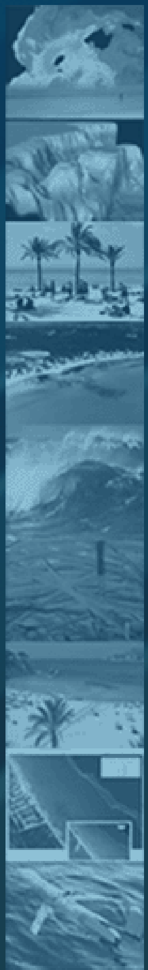
ICZM: Integrated Coastal Zone Management

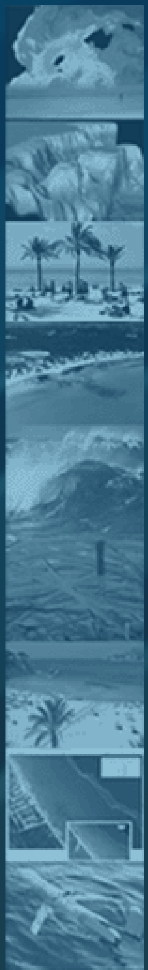


ICZM is "a continuous and dynamic process by which decisions are made for the sustainable use, development, and protection of coastal and marine resources" (Cicin-Sain and Knecht 1998).

ICZM is grounded in the concept that the management of coastal and ocean resources and space should be as fully integrated as are the ecosystems making up the coastal and ocean realms

ICZM: "The process is designed to overcome the fragmentation inherent in both the sectoral management approach and the splits in jurisdiction among levels of government at the land-water interface" (ibid).

Integrated Coastal Zone Management (ICZM)



- *ICZM (ICAM 2005)*

"A dynamic process of sustainable management and use of coastal zones taking into account at the same time the diversity of activities and users, the fragility of coastal ecosystems and their interaction"

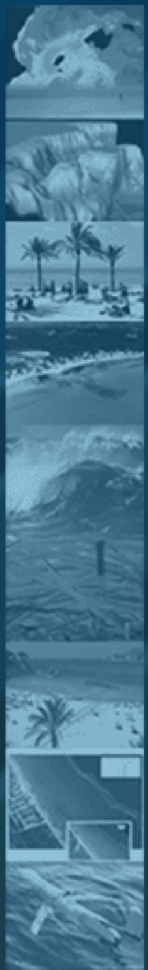
- *ICZM*

Temporal and spatial scales of managing ?

- *ICZM: involve all parties concerned in the management process. (from the beginning)*

Think globally, act locally

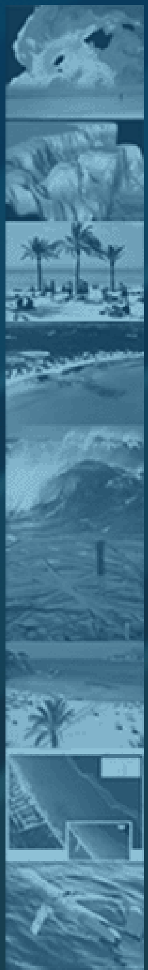
Integrated Coastal Zone Management (ICZM)



Background in Europe:

- 70's 80's: Several coastal laws (Spain, USA...)
- 1987: World Commission on Environment and Development (WCED), "sustainable development"
- 1992: Agenda 21 ; Convention on Biological Diversity
- 1995: Global Program of Action for the Protection of the Marine Environment from Land based Activities
- 1996: European Commission, GIZC
- 2002: European Commission, Recommendation 413
- 2002: Plan of Implementation for the World Summit on Sustainable Development
- 2005: Protocol on Integrated Management of Mediterranean Coastal Zones, ICAM
- 2008: EU Recommendation ICZM

Integrated Coastal Zone Management (ICZM)



Master plan for ICZM

Four main steps

1) Start: problem identification, characterization and diagnostic of the coastal zone (natural, socioeconomic and administrative)

2) Planning phase: options, alternatives

3) Implementation

4) Monitoring and evaluation

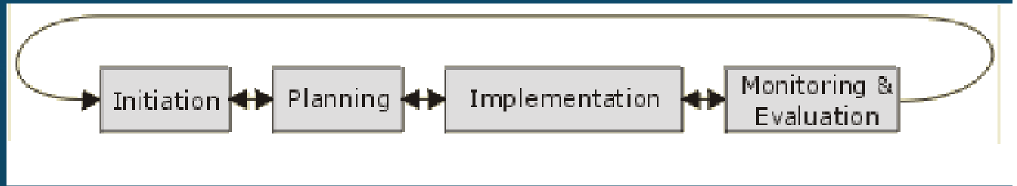
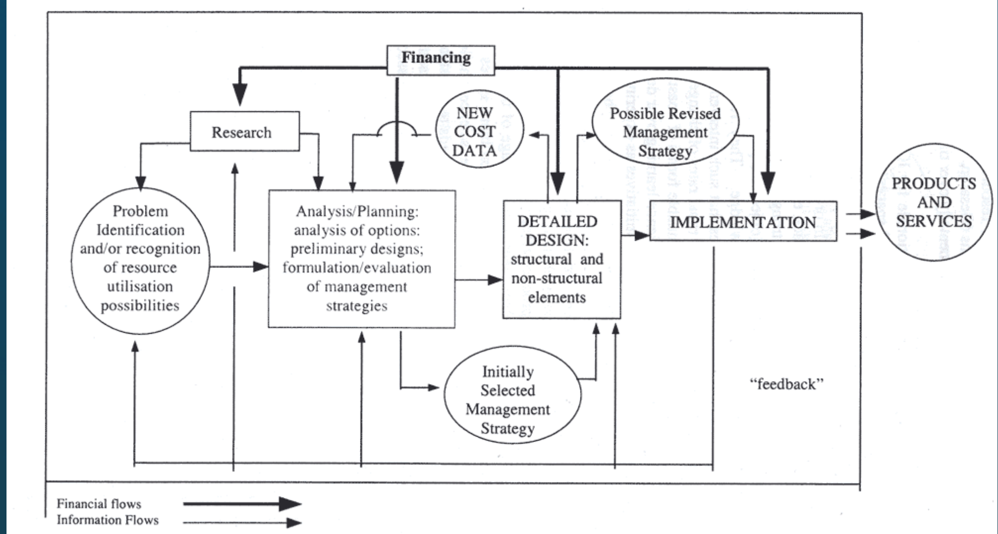


Figure 1.6 **Simple Schematic of the Elements of ICM**



Source: Bower and Turner (1998)

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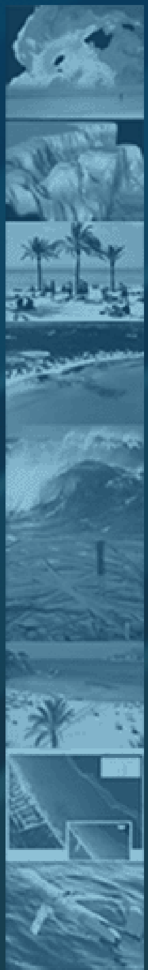
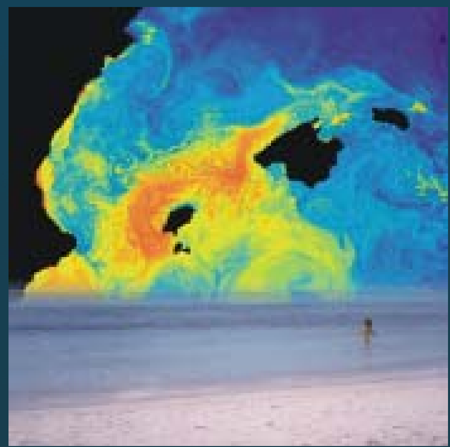
UIB I·M·E·D·E·A Institut Mediterrani d'Estudis Avançats CSIC

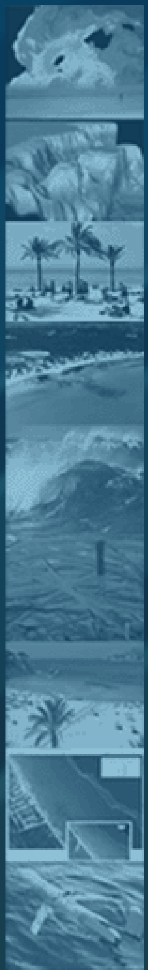


Objectives

- To use a multidisciplinary approach **to generate scientific knowledge to facilitate and inform the implementation of ICZM in the Balearic Islands.**
- To develop **new methods, tools and instruments** for both science and management and establish the bases and strategies necessary to achieve sustainability in the coastal zone of the Balearic Islands.
- To re-enforce the role of **scientific research as a critical basis for future decision-making in ICZM** at an international level.



The Balearic ICZM Project



Fundamental Principles

1. Development has economic, social and environmental dimensions and can only be sustainable if a balance is attained between these distinct factors, all of which have a profound influence on the quality of life of coastal residents.

2. Finding this balance needs to be based on the highest quality, internationally accepted scientific understanding available at any given time.

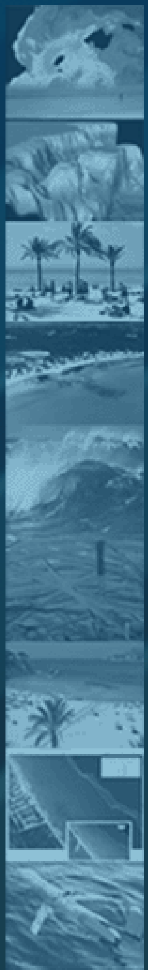
3. Moving towards sustainability principles requires that sustainability be treated as a quantifiable process.

4. Advancing towards sustainability is a positive change. The strategies represent a positive change with respect to employment and the quality of life of coastal residents.

5. Recognizing that there may be initial costs of adjustment in the short-term, sustainable development represents a clear medium to long-term strategic opportunity.

6. Institutional commitment and social consensus are key elements in the process of advancing towards sustainability.

The Role of Science in ICZM



It is not an exaggeration to assert that without science there can be no sustainable development"

3rd session of the UN Commission for sustainable development, 1995

- Allows for an objective view of the situation.
- Isolates cause-effect relationships so that problems may be addressed at their sources.
- Allows for the classification and evaluation of large amounts of information.
- Determines which data are relevant and the most appropriate method to analyze them.
- Finds existing data and evaluate their relevance and quality.
- Clearly defines and prioritizes areas that need to be managed and the interrelations between them.
- Identifies information gaps so that actions may be taken to remediate the lack of understanding.
- Allows for monitoring and evaluation of ongoing actions.
- Acts as a communication tool among scientists, stakeholders, the public and decision-makers.

RESEARCH → **TECHNOLOGICAL DEVELOPMENT** → **INNOVATION OF TECHNOLOGY AND SERVICES**

1.Disciplinary Research

1.1 Environment

1.2 Society, economy and culture

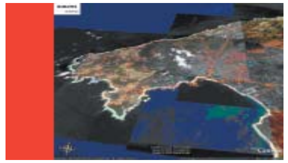
1.3 Governance

2. Multidisciplinary research

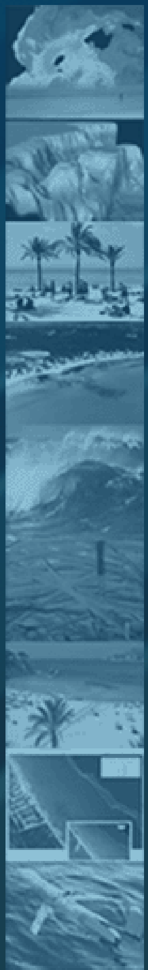
The horizontal projects respond to cross-cutting research needs requiring an interdisciplinary approach

3. Research aimed at tecnological developemet

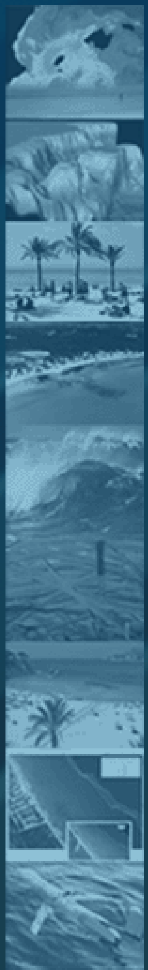
Responds to the need for new scientific tools and technologies that support ICZM in the Balearics



4. Transfer of knowledge



One specific project: Indicators for Assessing and Monitoring ICZM



54 Indicators: Science and CES Committees

For each indicator:

- Definition of the indicator category
- Brief explanation of its relevance to ICZM
- General objective / goal
- Specific objective related to each indicator
- List of indicators associated with each objective and reference used for obtaining it.
- Description of measurements associated with each indicator
- Specific definition of spatial and temporal scales for each indicator (where relevant).

4. Indicator Tables

Governance Indicators

"[D]esigned to measure the performance of the responses to mitigate human pressures on the coastal and marine environment. They also measure the progress and quality of the governance process itself, that is, the extent to which a programme in addressing the issue(s) that triggered the development of the programme in the first place" (IOC 2006).

Category	Specific Objective	Indicator (Reference)	Measurement	Spatial Scale	Temporal Scale
Institutions	To establish a network of organizations, at all levels of governance, that supports and facilitates the implementation ICZM.	1. Existence and activity level of organizations supportive of ICZM (IOC 2006)	Qualitative assessment of the following dimensions: - The number and characteristics of organizations (government, NGO, community level etc.) active in fields related to ICZM - Description and level of activities carried out by these organizations related to ICZM (participation in meetings, education, field projects, enforcement etc.) - Degree of influence such activities on the advancement of ICZM related activities	Region Island Municipality	Initial assessment followed by yearly re-evaluations.

4. Examples of Indicators

Socio-economic Indicators

"[D]esigned to capture interactions between human activities and coastal and marine environments. Socio-economic activities in the coastal zone are varied and encompass a number of dimensions including economic, environmental, public health and safety and social" (IOC 2006).

Category (Driver/Pressure)	Specific Objective	Indicator	Measurement	Spatial Scale(s)	Temporal Scale
Tourism	To achieve sustainable levels of tourism in the coastal zone.	17. Evolution of tourism supply (Sarda et al. 2005)	- Number of lodging places - Number of hotel rooms - Ratio of spaces in lodging places per 100 residents - Ratio of hotel rooms per 100 residents - Growth in lodging places and hotel rooms	Region Island Municipality Tourism Zones	1995 – present followed by yearly re-evaluations

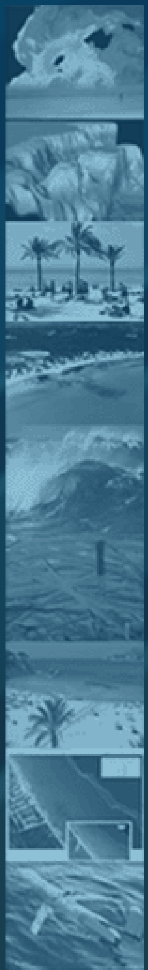
4. Examples of Indicators

Environmental Indicators

Environmental indicators measure the condition and trends of the state of the ecosystem, in particular its biological organization, vigour and geological, physical and chemical properties (IOC 2006).

Specific Objective	Indicator (Reference)	Measurement	Spatial Scale	Temporal Scale
Monitor ecosystem health through the identification and use of keystone and indicator species.	39. Keystone and indicator species (EITAC 1999)	- Identification of priority species that could serve as indicators of ecosystem health. - Measurement of quality (e.g. contaminant exposure, disease) and abundance of species identified above.	Geographic Information System (multiple scale options)	Seasonal evaluation of quality after initial evaluation of priority species.

El Resultado Final. El Dictamen 05/2007, CES



Consell Econòmic i Social de les Illes Balears

CES Illes Balears

Registre de sortida

Núm.: 5 442/07

Data: 19-12-07

Us tramet còpia del Dictamen del Consell Econòmic i Social núm. 5/2007, relatiu al sistema d'indicadors per a la Gestió Integrada de la Zona Costanera (GIZC) de les Illes Balears, aprovat pel Ple el 17 de desembre de 2007.

La secretària general (per designació de la C. Permanent)

Núria Garcia Canals

Palma, 19 de desembre de 2007

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ICTS – Ocean_BIT: Balearic Islands Coastal Observing and Forecasting System

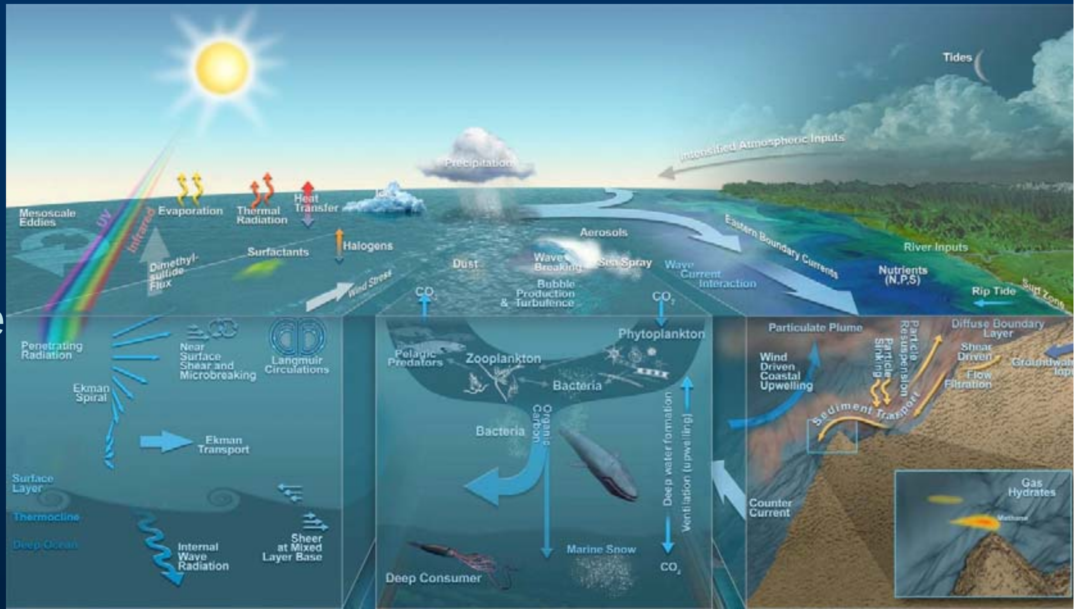
A New Approach to Marine and Coastal Research

New technologies, Three-dimensional observations in quasi real time, Forecasting numerical models and Data assimilation for ...

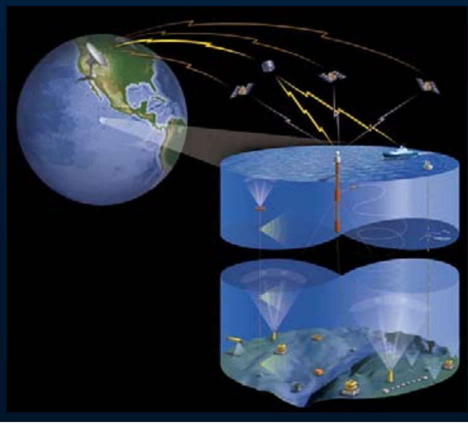
A quantitative major jump, advanceme of scientific knowledge and ...

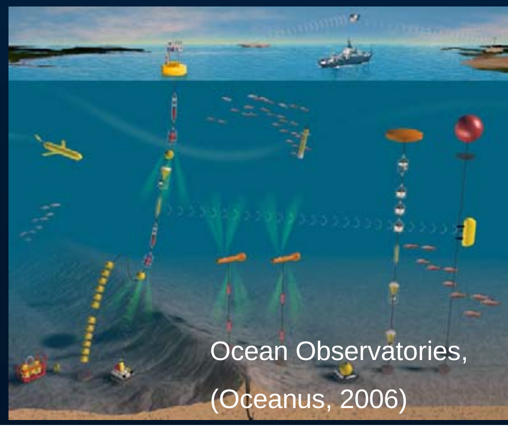
The development of a new form of Integrated Coastal Zone Management, based on recent scientific and technological achievements,

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)

Vision: what is Ocean_BIT?

- Ocean_BIT is a multi-platform distributed and integrated technological facility
  - providing streams of oceanographic data and modelling services **in support to operational oceanography R&D activities** in the Balearic Islands in a European and international frame,
  - 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 supply of multidisciplinary data to cover the needs of a wide range of scientific research priorities.

Ocean_BIT, a new way to fund research

- Ocean_BIT is a new way to approach marine and coastal research through new distributed networks of monitoring platforms, providing baseline data, open to international access... and also, specifically through peer reviewed applications ....

- Ocean_BIT therefore represents a very significant change in marine and coastal observing in the Balearic Islands (and also at European level), moving to an oriented, strategic regional approach with a view to establishing a sustained marine and coastal system.

- It is a pilot initiative at regional level that will be have to become a European Large Scale Facility and that can also be extended at national level.

Ocean_BIT basic components

1. **Observational sub-system**
   - in situ moored and drifting sensing systems
   - Coastal and offshore instrumented installations
   - Remote sensing from satellites
   - Shore-based remote sensing with radar

2. **Forecasting sub-system**
   - Ocean currents and wave at different scales
   - Ecosystem variability
   - Data assimilation and relevant analysis at overlapping spatial and temporal scales

3. **Data management and dissemination**
   - The latest in data server technology and internationally accepted protocols
   - Quality control
   - World Wide Web, open source
   - Effective data archiving, delivery and communication

4. **Outreach and education**
   - Focus on practical applications
   - Identify and assess needs and data preferences
   - Obtain user feedback
   - Targeting undergraduate and graduate student/teacher audience as end-users

5. **Training and mobility**

Ocean_BIT Outline

- Ocean_BIT Consortium: a new way to fund marine research infrastructures, along lines of international initiatives such as OOI, IMOS, etc.
- Partners and main actors: MICINN-ICTS & Balearic Islands Gov. and CSIC, IEO, UIB, etc.
- Initial Proposal: 12/2007 and formal start: 12/2007, published officially BOE-5 April 2008 (SGPT-MEC)
- Ocean_BIT total investment 36 M€ (2008-2021). 13,5 M€ equipments. 2M€ running costs. Equal investments
- Director: Joaquín Tintoré, 12/2008.
- To do 2009: implementation plan, including partnership with national and international key players

- Ocean_BIT will be the main facility supporting the R&D activity in Operational oceanography in Balearic Islands.
- Ocean_BIT will be an open access facility for any other R&D institution with similar concepts and focus.
- Ocean_BIT 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.

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Conclusions and Suggestions

Science and society: using state of the art scientific results, disciplinary excellence in multidisciplinary environments, involve stakeholders to guarantee real sustainability

ICZM, a process to reach real science based decision making. Establish basic principles, discuss limits to growth, thresholds for indicators in a global change environment

Coastal observing and forecasting system – new technologies, monitoring and forecasting capabilities: baseline data, know how as a basis for Operational oceanography and to contribute to the needs of marine and coastal research in a global change context.

Science and ethical values "***Science sans conscience n'est que ruine de l'ame***" (Rabelais).

Moltes gràcies