Department of Marine Technologies, Operational Oceanography and Sustainability - TMOOS

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IMEDEA (UIB-CSIC)

Research Line: PHYSICS AND TECHNOLOGY OF THE COASTAL OCEAN SYSTEM: OBSERVATION, FORECASTING AND INTERACTIONS

Rationale:

- The coastal ocean is a complex, multidisciplinary and vulnerable system: *"Things have to be made as simple as possible, but not simpler".*
- Still many questions exist (actually more, because of recent interest in coastal areas): Therefore, high quality research is needed, driven by science, technology and society interests.

Goal: to study, using a physical and mathematical background, the mechanisms and processes that can explain the dynamics of the coastal ocean, also addressing, its interactions with the near-shore and the open ocean, in a global change context.

- Over the shelf and the open ocean area, we focus on the understanding of the mesoscale, sub-mesoscale and mean field contributions to natural and anthropogenic oceanic variability, also progressively addressing biophysical coupling.

- In the nearshore, we focus on the study between coastal dynamics and coastal morpho-dynamics, specifically considering the interactions between currents and waves, bottom topography and sediment transport.

Our common goal is twofold: to contribute to the advancement of knowledge publishing in a variety of international leading journals and also to address and respond to specific problems and major questions raised by society in the coastal ocean in a frame given by the new sustainability science initiatives.

Research Line: PHYSICS AND TECHNOLOGY OF THE COASTAL OCEAN SYSTEM: OBSERVATION, FORECASTING AND INTERACTIONS

How?: we combine theoretical, observational (in situ and remote) and numerical modeling approaches, in particular (but not only) in the Mediterranean Sea, an ideal laboratory small scale ocean to understand physical processes, its multidisciplinary effects on the marine and coastal ecosystem, to test new ideas, develop and/or implement new technologies, and to support different maritime operations.

Technology Development: we develop and implement new marine technologies specifically needed to better respond to our scientific objectives introducing new instruments (i.e., gliders or ROV's for sampling) or new techniques (i.e., modeling, visualization or data mining, data fusion and data management). TMOOS new facilities, laboratories, and workshops. Spin off Company, Albatros Marine Technologies.

This research activity is carried out in the frame of peer-reviewed research projects and also more recently in the frame of new Large Scale Spanish Facilities such as **Ocean_BIT, a new Coastal Ocean Observing and Forecasting System in the Balearic Islands**. Ocean_BIT will provide a new way to approach marine and coastal research through new distributed and sustained networks of monitoring platforms, providing baseline data open to international access.

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

(From: TMOOS-IMEDEA (UIB-CSIC) Strategic Plan 2010-2013, version 1 October 2008)

TMOOS – IMEDEA Dept

Permanent Research staff

CSIC:

Prof. Joaquín Tintoré
Dr. Alberto Álvarez (presently at NURC)
Dr. Alejandro Orfila
Dra. Ananda Pascual

UIB:

Prof. Salvador Balle

Post docs

Dr. Simón Ruiz (Ramón y Cajal Fellow)
Dr. Lluis Gomez Pujol (JAE postdoct cont)
Dr. Jordi Solé
Dr. Sr. Pau Balaguer
Dra. Amy Diedrich
Dr. Jerome Bouffard

Ph. D. students

Amaya Álvarez
Tomeu Cañelles
Bartolomé Garau
Enrique Vidal
Alvaro Galán

Permanent Technical staff –General Services Unit, but working on TMOOS activities)

CSIC:

Guillermo Vizoso
Benjamín Casas

Technical staff under contracts

Dr. Lavinio Gualdessi
Miquel Martínez-Ledesma
Matías Bonet
Carlos Castilla
Marta Fuster
Saul Pitarch

Research Projects: ongoing peer reviewed projects funded by **EU** (MERSEA, SESAME, ECOOP, "MyOcean"), Spanish National Plan Res. (COOL), Regional Balearic Gov (UGIZC), MMA (Red Cambio Global, PN Cabrera), etc.

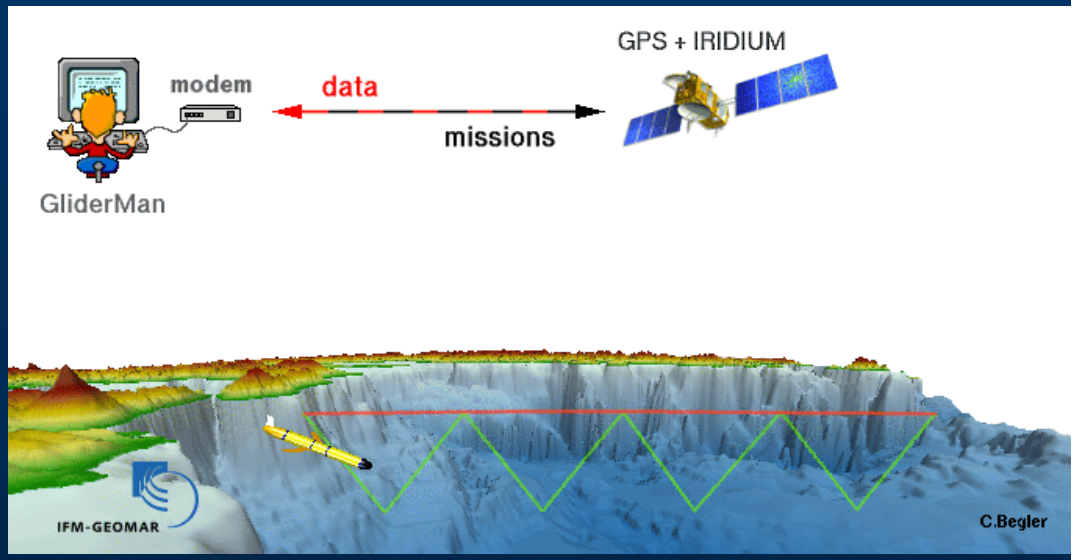
Publications: more than 100 peer reviewed in 5 years.

Transfer of Knowledge: spin off company Albatros Marine Technologies formally established in 2008.

TMOOS, an example of recent glider activities

Glider data

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



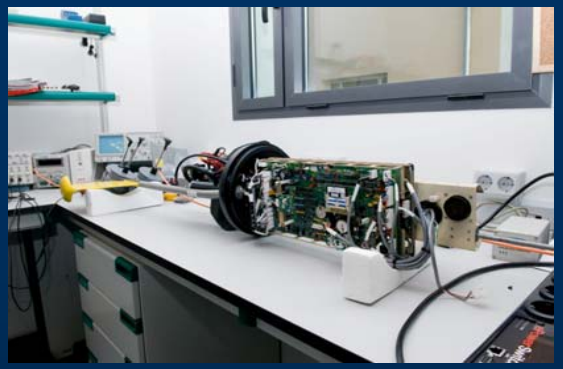
Envisat data

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

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

We have established new facilities for glider operations:

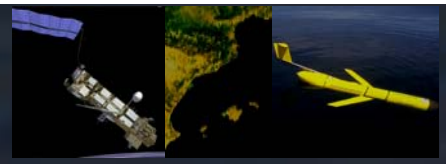
Electronics Laboratory



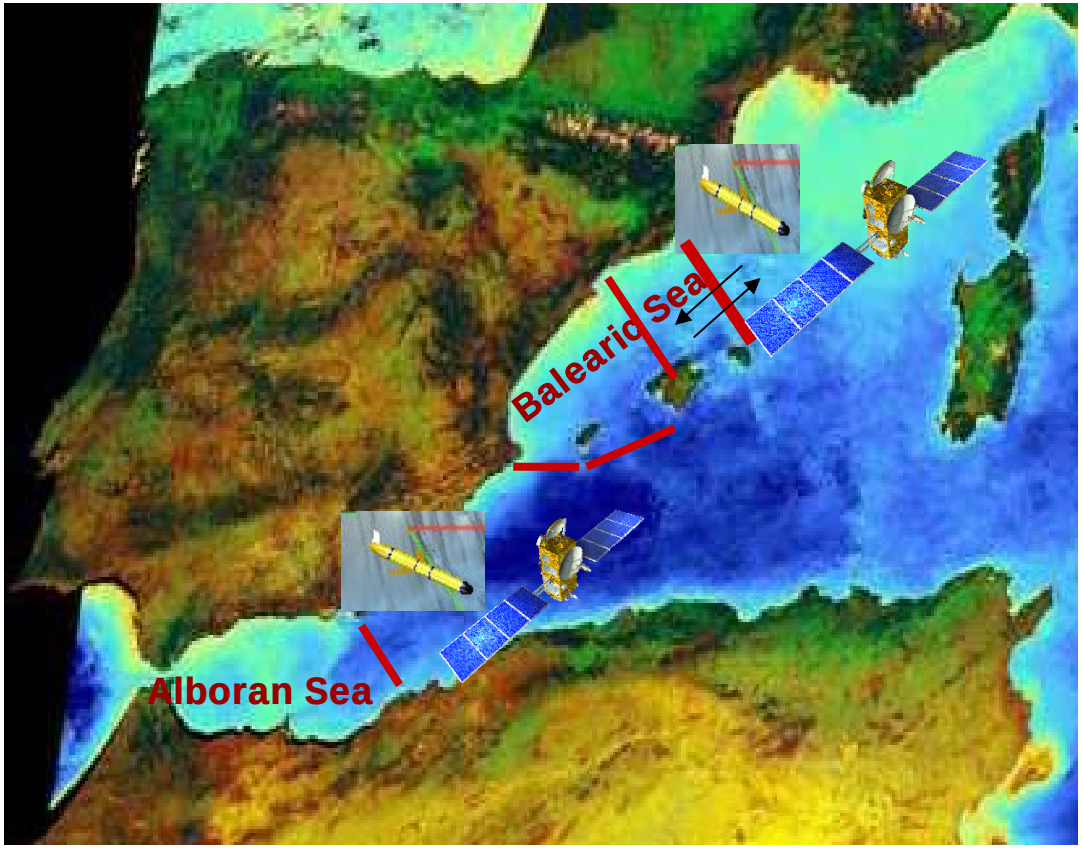
Ballasting Laboratory

Collaboration:
Search and Rescue
801 Squadron
and local authorities

IMEDEA Glider Missions



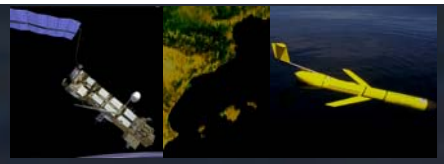
We have carried out **16** glider missions from November 2006 to December 2008 in the Western Mediterranean Sea



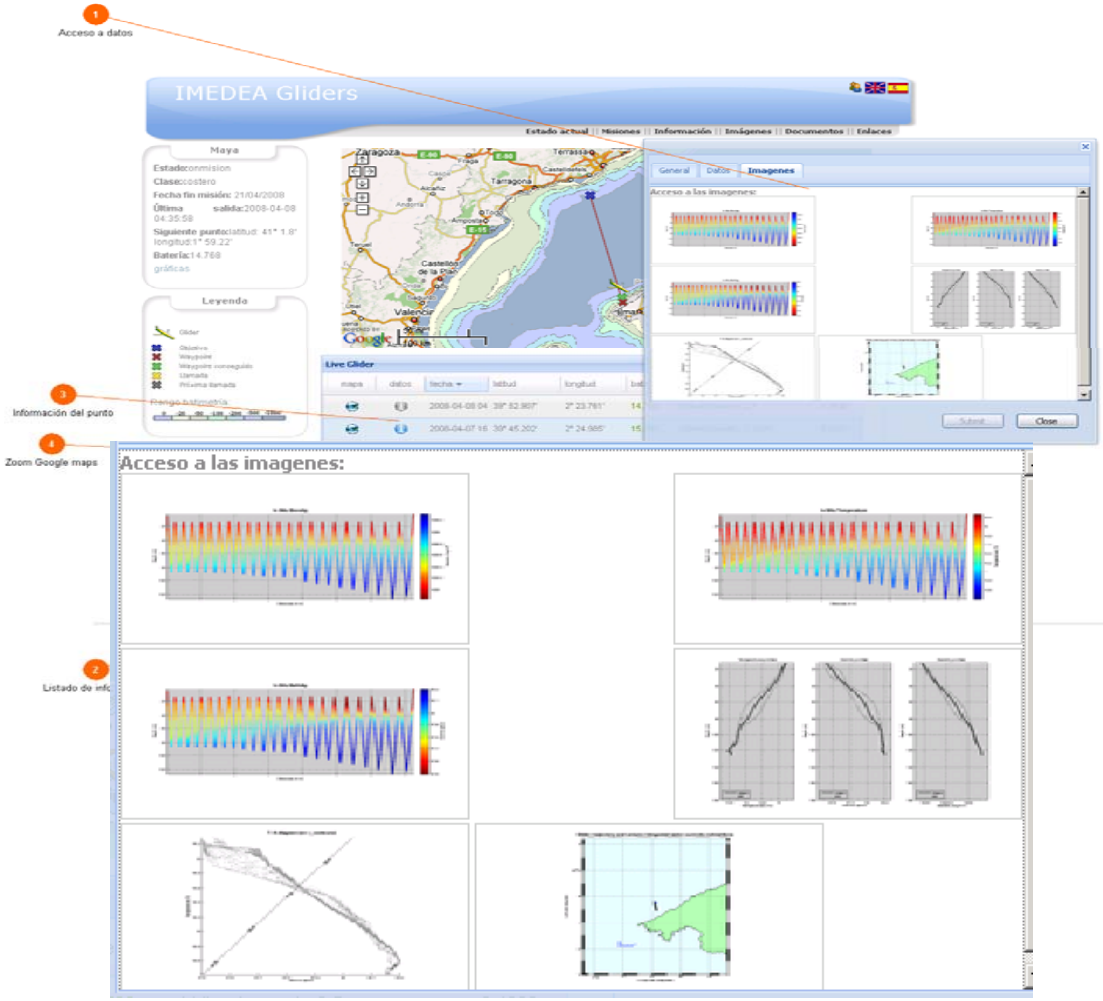
5000 full CTD casts + oxigen, chlorophyll turbidity (180 m)

- 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



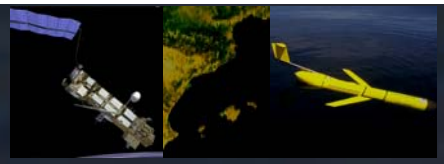
We have developed a system for tracking glider missions in real time:



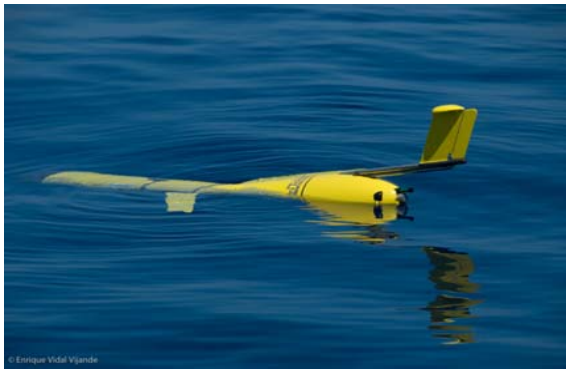
- Mission definition
- Quality control
- Visualization (own and through ECOOP system)
- Data transmission to Coriolis, etc…
- Data download capability
- OpenDap, Thredds server

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

Operational Systems



Ongoing work:
incorporate glider observations into the operational system in the Balearic Sea (data ssimilation)



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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]

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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 early October 2002. While the data of the first survey is used for model initialisation, that of the second survey serves for validation of the forecast products. The forecast skill of the system is evaluated quantitatively by three different objective methods, comparing the rms difference of vertical profiles and horizontal fields, and pattern correlations, both for temperature and salinity. In five out of six cases, the forecasted fields are closer to the validation data set than the fields used for initialisation, i.e. the forecast beats persistence and the forecast is successful.

Taking into account further available options of HOPS (implementation of additional tracers, tracking of Lagrangian particles, biological modules, two-way nesting), the system is operational for a wide field of possible applications.
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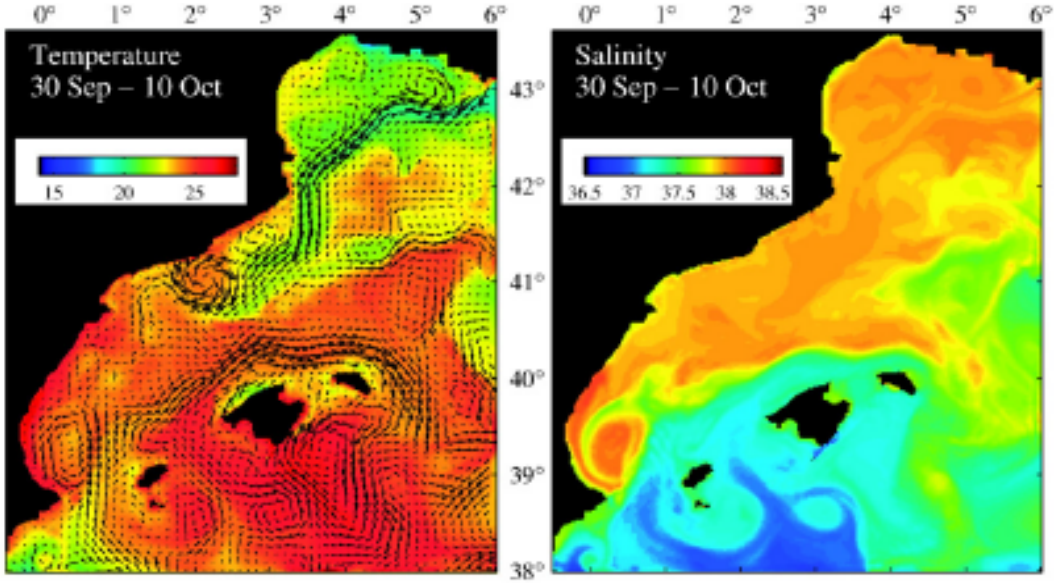
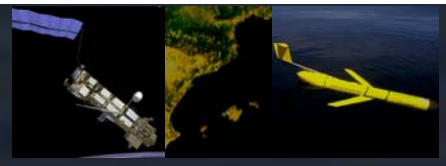
Keywords: Mediterranean Sea; Balearic Sea; Operational model; Forecast model; HOPS; SOFT



Modelled SST, velocity and salinity in the Balearic Sea, Onken et al., J.Mar.Syst. 2008 .

Results: Impact of canyons



Important changes in vertical and shelf/slope exchanges

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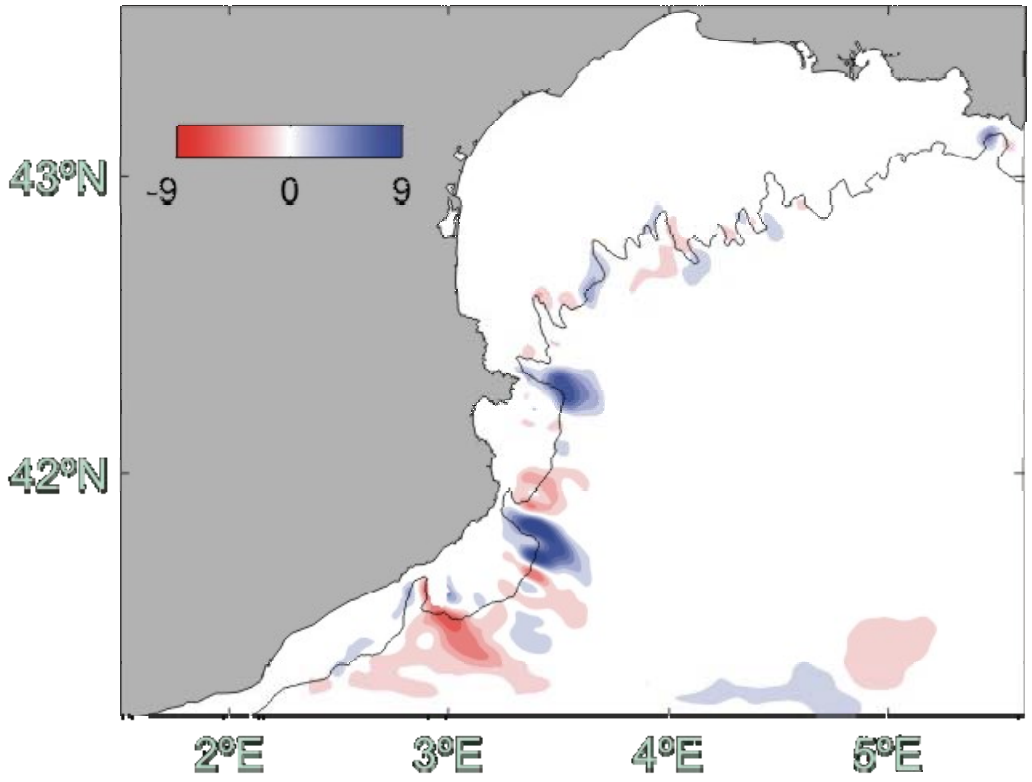
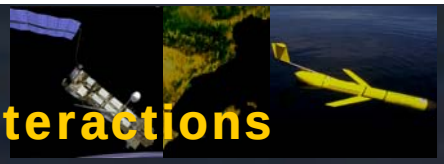
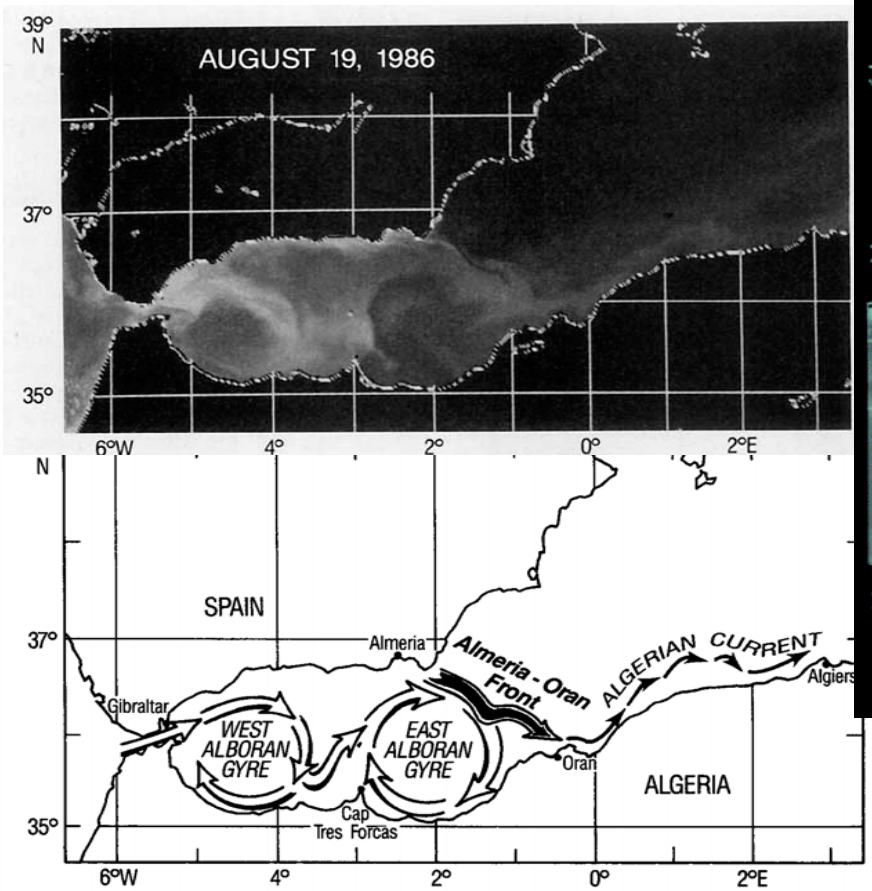
Importance of submesoscales structures, following Tintore et al., (2001)



Antisymmetrical structure of vertical motions with downwelling on the upstream walls of the canyons and upward motions on the downstream edges.

Eastern Alborán Sea dynamics and basin scale interactions





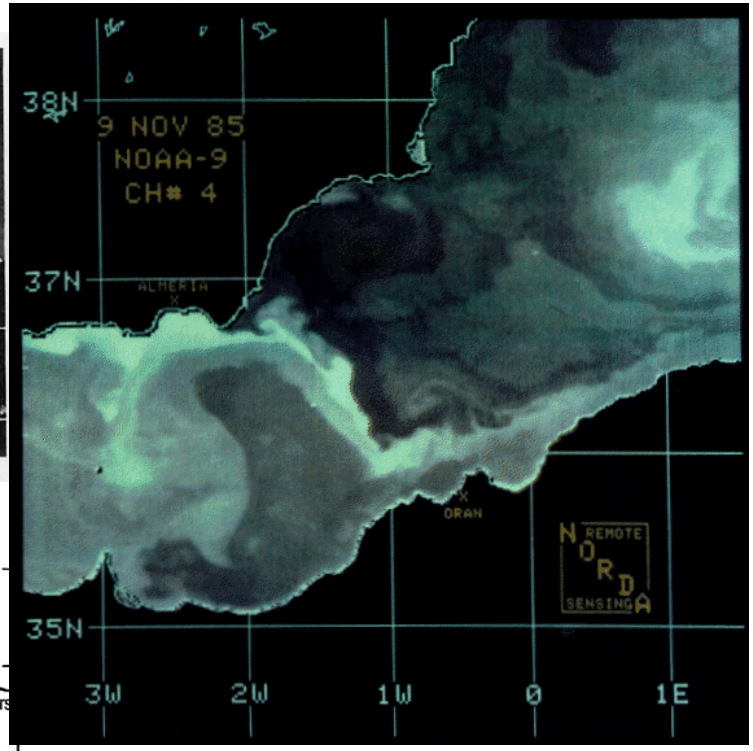
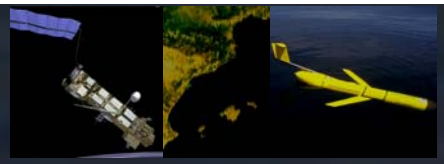
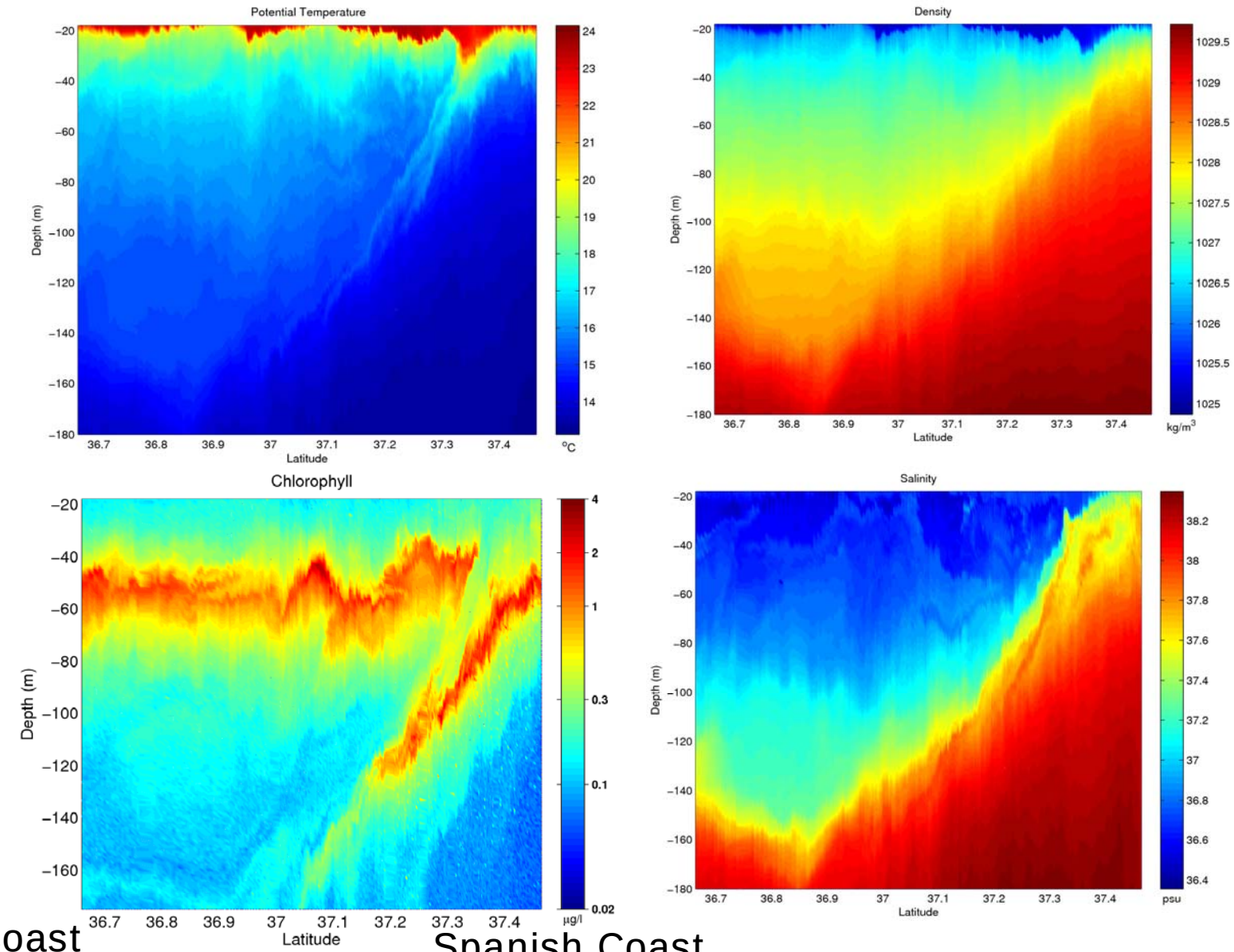


FIG. 1. (Top) A satellite thermal image of the Alboran Sea, showing the continuity of the regional circulation. As with the other satellite imagery in this paper, this NOAA AVHRR-IR image was registered to a Mercator projection and enhanced to show the ocean features. (Bottom) A schematic drawing of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

First results– Section 2





African Coast

Spanish Coast

TMOOS research activity key words

- Coastal Ocean dynamics
- Mesoscale and submesoscale dynamics, mean flow interactions, multidisciplinary effects, biogeochemical fluxes
- Shelf/slope exchanges, coupled bio-physical processes, and ecosystem interactions
- Sub-basin regional variability, interannual/decadal, ecosystem response

- Near-shore processes and dynamics
- Wave-current interaction
- Sediment transport

- Operational Oceanography
- Coastal Ocean Observing and Forecasting Systems
- Remote sensing, coastal altimetry
- Numerical modelling

- New sampling technologies
- Autonomous observing platforms: gliders and AUV's
- New sensors, laser technology

- Global Change and Sustainability Science
- Integrated Coastal Zone Management

http://www.costabalearsostenible.es

RESEARCH → TECHNOLOGICAL DEVELOPMENT → INNOVATION OF TECHNOLOGY AND SERVICES

1.Disciplinary Research

1.1 Environment

1.2 Society, economy and culture

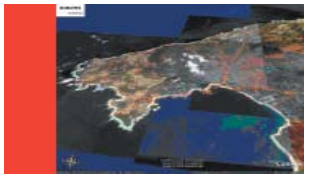
1.3 Governance

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

Merci!