The IEO coastal observatory: understanding variability of coastal circulation and ecosystem response off North and North West Iberia

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IEO tasks and duties

- To carry out **scientific research** in the fields of oceanography and sea sciences.
- To **advise the government** in terms of fishing and marine policies.
- To **represent Spain** in international organizations that have to do with fisheries and marine sciences (like ICES).
- To **promote cooperation** in terms of marine research among regional, national and international organizations.
- To **train marine researchers** and disseminate oceanographic knowledge.
IEO Oceanographic Sections Monitoring System

RADIALES (1989-...)
RADPROF-VACLAIN (2003-...)
Stoca (2010-...)
RAPROCAN (2006-...)
RadMed (1992-...)

Characterization of oceanographic conditions with monitoring cruises

Ruiz-Villarreal et al. 2006, Prestige special issue, MPB
Hydrodynamics + Biogeochemistry

- ROMS Rutgers version 3.5
- 30 vertical levels
- 3.5km horizontal resolution
- Rivers

Only hydrodynamics

- Operational model
  - Roms Agrif
  - One way nesting
  - Simulated period: from 2009 till January 2014
- New operational model
  - Roms Rutgers 3.7
  - One way nesting
  - Simulated period: from January 2014-now
Modeling approach

ICHTHYOP LAGRANGIAN MODEL (Lett et al., 2008)
- Advection and dispersion of particles (superindividuals)
- Biological behaviour
  - Growth depending on temperature for eggs and larvae + all the processes before

Offline coupling

ROMS PHYSICAL MODEL
- 3.5Km horizontal resolution
- OBC: MyOcean2 (Mercator)
- Atmospheric forcing: Meteogalicia.
- Rivers

Online coupling

ROMS ECOLOGICAL MODEL (Fennel et al, 2006)
- N2PZD2 model + chlorophyll
- OBC: Temperature/NO3 relationship obtained from IEO data (Vaclan cruises 2003-2008).

Offline coupling

- Zooplankton
Figure 1. Biological model schematic.

Nitrate: the limiting nutrient in the area

- **CLIMATOLOGY**: NODC World Ocean database 2009 (WOA2009)
- **T/NO₃ relationships**: We want to include nutrient variability through the boundaries!!!

### NW Iberia upwelling system

- Reliable characterization of the Eastern North Atlantic Central Water (ENACW).
  - Álvarez-Salgado et al., 2002
- IEO-VACLAN data
- WOA2009 data
Role of convective winter mixing on nutrient availability.

Hartman et al., 2010
Hartman et al., 2012
Role of convective winter mixing on nutrient supply.

Hartman et al., 2010
Hartman et al., 2012

Interannual variation in mixed layer depth (MLD) and Productivity (NCP) assessed using oxygen data

<table>
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<th>Year</th>
<th>MLD ARGO 0.5°C (m)</th>
<th>NCP (mol C m⁻²)</th>
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<tbody>
<tr>
<td>2005/2006</td>
<td>469</td>
<td>20.91</td>
</tr>
<tr>
<td>2006/2007</td>
<td>212</td>
<td>10.07</td>
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<tr>
<td>2007/2008</td>
<td>263</td>
<td>10.53</td>
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<td>439</td>
<td>19.91</td>
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<tr>
<td>2009/2010</td>
<td>476</td>
<td>16.91</td>
</tr>
</tbody>
</table>

C) Maximum NO₃ from Mercator temp. Year: 2006

D) Maximum NO₃ from Mercator temp. Year: 2007
The Radiales Program

Scientific origin, late 80's

Systematic sampling (hydrographical and biological) in 5 standard sections in Spanish N and NW Atlantic Waters

Monthly sampling in the Galician-Cantabrian area.

Santander Section. 7 stations, 1 in the shelf break, two over the deep ocean (2400 and 2800)

http://www.seriestemporales-ieo.net/
Temperature: Radiales (IEO) vs. model

2006

D) Radial Coruna. Station: 2. Year: 2006


2007


Chlorophyll: Radiales (IEO) vs. model

2006

D) Radial Coruna. Station: 2. Year: 2006


2007


Nitrate: Radiales (IEO) vs. model

2006

D) Radial Coruna. Station: 2. Year: 2006


2007


**Observed Temperature at 4 m**
- Field Min 12.15 Max 15.88
- Analyzed field Min 12.42 Max 15.72

**Modelled Temperature at 4 m**
- Field Min 12.81 Max 15.48
- Analyzed field Min 13.06 Max 15.49

**Observed Salinity at 4 m**
- Field Min 33.68 Max 35.69
- Analyzed field Min 34.18 Max 35.71

**Modelled Salinity at 4 m**
- Field Min 34.37 Max 35.75
- Analyzed field Min 34.62 Max 35.75
Variability of oceanographic conditions in response to wind events during Pelacus spring cruises

![Map of oceanographic conditions](image)

**Fig. 4.** Output of OOF$_2$ at IEO-A Coruña during the PELACUS cruise in spring 2008. The panels show surface salinity, currents and wind forcing between 5th and 8th of April 2008, when PELACUS sections on the northwestern and northern Galician coast (north from 43°N between 9.5°W and 7°W) were occupied. Easterly winds on the north coast on April 5th were associated with upwelling and offshore surface currents in the northern coast. During the relaxation of easterly wind and veering to northeasterly wind, surface flow turned mainly westwards in the northern Galician coast. Black solid lines represent the 200 and 1000 m isobaths.
Temporal and spatial variability of the spring bloom.
Autumn 2013: Dynophysis acuta (HAB species, DSP toxin) and Along-shore transport

1. Modelos: temperatura e correntes superficiais. Circulación na plataforma

<table>
<thead>
<tr>
<th>Date</th>
<th>Location</th>
<th>Map</th>
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<td></td>
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<tr>
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<tr>
<td>2013/09/30</td>
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Conclusions

- The IEO observing system in N-NW Iberia characterizes variability of hydrodynamics and of the ecosystem
- A modelling system is validated by the observing system at different scales (wind events, seasonal, interannual)
- Products for fisheries and aquaculture sectors are developed based in numerical model combined with observations
Instituto Español de Oceanografía
Founded in 1914

1916: Launching a plankton net on a cruise on board the Spanish Navy gunboat Hernán Cortés, 1916, in the coastal waters of northwest Spain

“Changes in ocean variables obey laws and cycles that must be known, it is necessary to gather data for a very long time...as a means to forecast the weather at sea to the advantage of seafarers and farmers”

Odón de Buen, as cited in Parrilla, 18(4) Oceanography, 2005