Modeling the spring bloom in North and North West Iberia by means of a N2PZD2 model

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and the invaluable advice of the biologists...  
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The IEO modeling group

- Providing insight on circulation off N and NW Iberia for ecosystem studies in support to the intense IEO ecosystem research in the area.
- The main interest is on high resolution shelf and slope processes (upwelling, river plumes, slope currents. . . )
- Coupling of the physical model to marine ecosystem models and Lagrangian models.

Project REPRODUCE
Marifish EraNet
Understanding the mechanisms that drive the recruitment process, i.e. the appearance of a new generation of individuals in a fish stock.

Project ASIMUTH
FP7 Space Theme
ASIMUTH aims to Develop forecasting capabilities to warn of impending harmful algal blooms (HABs).

In this talk...
1 IEO MODELS
   - Hydrodynamic model
   - Lower Trophic Level Model

2 Results
   - Seasonal time scale
   - Monthly time scale
   - Event scale

3 Conclusions
Configuration

ROMS Rutgers version 3.5
30 vertical levels
3.5km horizontal resolution.
23 rivers
Simulated period: 2006-2007
The adopted model

Configuration details: initial and boundary conditions

Nitrate: the limiting nutrient in the area

- **CLIMATOLOGY:** NODC World Ocean database 2009 (WOA2009)
- $T/NO_3$ relationships
**Configuration details: initial and boundary conditions**

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). New production of the NW Iberian shelf during the upwelling season...
  - IEO-VACLANN data
  - WOA2009 data
Role of convective winter mixing on nutrient supply.


Hartman et al., 2012. Seasonal and inter-annual variability in productivity in relation to winter nutrient concentrations in the BoB.
Role of convective winter mixing on nutrient supply.


Hartman et al., 2012. Seasonal and inter-annual variability in productivity in relation to winter nutrient concentrations in the BoB.

Inter annual variation in mixed layer depth (MLD) and Productivity (NCP) assessed using oxygen data.

<table>
<thead>
<tr>
<th>Year</th>
<th>MLD ARCO 0.5°C (m)</th>
<th>NCP arcpol (Mol C m⁻²)</th>
</tr>
</thead>
<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>
</tr>
<tr>
<td>2007/2008</td>
<td>322</td>
<td>10.63</td>
</tr>
<tr>
<td>2008/2009</td>
<td>439</td>
<td>19.91</td>
</tr>
<tr>
<td>2009/2010</td>
<td>476</td>
<td>16.91</td>
</tr>
</tbody>
</table>
Shift from diatoms to dinoflagelates as the bloom advances. E.g. Tilstone (2003)

Interest on the **spring bloom**: unique phytoplankton functional group will be DIATOMS (*Chaetoceros socialis*).


### Adapted parameters

- **$K_{NO3}$** (mmol NO3/m3): Half saturation constant for Nitrate uptake. $\frac{NO3}{K_{NO3}+NO3}$

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Default</th>
<th>Mixed diatoms Ria Vigo</th>
<th>Sel. value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$K_{NO3}$</td>
<td>0.5 (Fennel et al., 2006)</td>
<td>0.37 (Seeyave et al., 2013)</td>
<td>0.25</td>
</tr>
</tbody>
</table>

- $\alpha$: initial slope of the P-I curve (mol C g Chl$^{-1}$ (Wm$^{-2}$)$^{-1}$d$^{-1}$).

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Default</th>
<th>Sel. value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\alpha$</td>
<td>0.025 (Fennel et al., 2006)</td>
<td>0.05 (Bode and Varela, 1996, 1998)</td>
</tr>
</tbody>
</table>

- $g_{max}$: maximum grazing rate for zooplankton (day$^{-1}$).

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Default</th>
<th>Sel. value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$g_{max}$</td>
<td>0.6 (Fennel et al., 2006)</td>
<td>1 (based on Kone, 2005)</td>
</tr>
</tbody>
</table>
SST: AVHRR vs. Model

A) Winter 2006. SATELLITE

B) Winter 2006. MODEL

A) Winter 2007. SATELLITE

B) Winter 2007. MODEL

Satellite 2006

Model 2006

Satellite 2007

Model 2007
SST: AVHRR vs. Model

C) Spring 2006. SATELLITE
D) Spring 2006. MODEL

C) Spring 2007. SATELLITE
D) Spring 2007. MODEL
Chlorophyll-a: MODIS-OC3 vs. model
Chlorophyll-a: MODIS-OC3 vs. model

Chlorophyll-a: MODIS-OC3 vs. model

Seasonal time scale

E) Summer 2006, SATELLITE
F) Summer 2006, MODEL

Satellite 2006
Model 2006
Satellite 2007
Model 2007
Chlorophyll-a: MODIS-OC3 vs. model
Chlorophyll-a: MODIS-OC3 vs. model

Summarizing so far...

- Winter 2006 was colder than winter 2007 (MODEL/SATELLITE)
- Spring Chlo-a was higher at the open ocean in 2006 than in 2007 (MODEL/SATELLITE)
- NW Iberia Upwelling was weaker in Spring 2006 than in Spring 2007
  - SST was lower in NW Iberia shelf in 2007 than in 2006 (MODEL/SATELLITE)
  - Chlo-a was higher in NW Iberia shelf in 2007 than in 2006 (MODEL/SATELLITE)
- Upwelling was more intense in Summer 2007 than in Summer 2006
  - SST was lower in NW Iberia shelf in 2007 than in 2006 (MODEL/SATELLITE)
  - Chlo-a was higher in NW Iberia shelf in 2007 than in 2006 (MODEL/SATELLITE)
Chlorophyll-a: MODIS-OC3 vs. model

Seasonal time scale

Monthly time scale

Event scale

2006

2007
Chlorophyll-a: MODIS-OC3 vs. model

NRT (1-km around Iberia)
Operational Processing Chain 2006-2007

REPROCESSED (500 m around Iberia)
Summer 2012
Temperature: Radiales (IEO) vs. model
Chlorophyll: Radiales (IEO) vs. model

- Seasonal time scale
- Monthly time scale
- Event scale
Nitrate: Radiales (IEO) vs. model

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


Pelacus cruises: Springs 2006 and 2007

**Pelacus0407**: 27th of March 2007 to 23rd of April 2007.
Reasonable results in spite of the simplicity of the model.

1. In the simple model consider space and time varying $K_{NO3}$, $\alpha$, etc.
2. Expected increase in the complexity of the model by considering, at least, 2 phytoplankton and 2 zooplankton classes:
   - It would allow for a better representation of the spring bloom: shift from diatoms to dinoflagelates
   - Better coupling with Higher Trophic Levels

Be careful with the homogeneity of the data sets being compared

Our model is a valuable tool to estimate primary production and its temporal and spatial variability at different scales