Quantifying the ocean velocity contribution to the Alboran Sea primary production

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Outline

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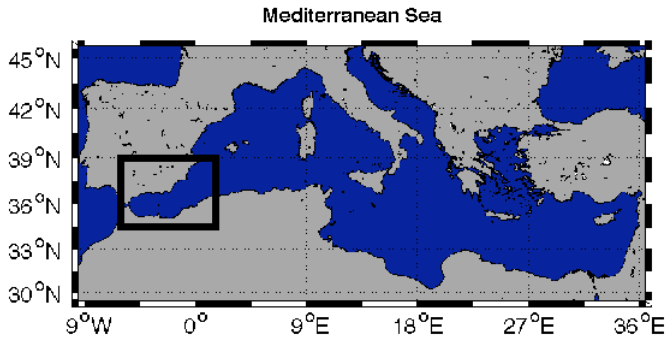
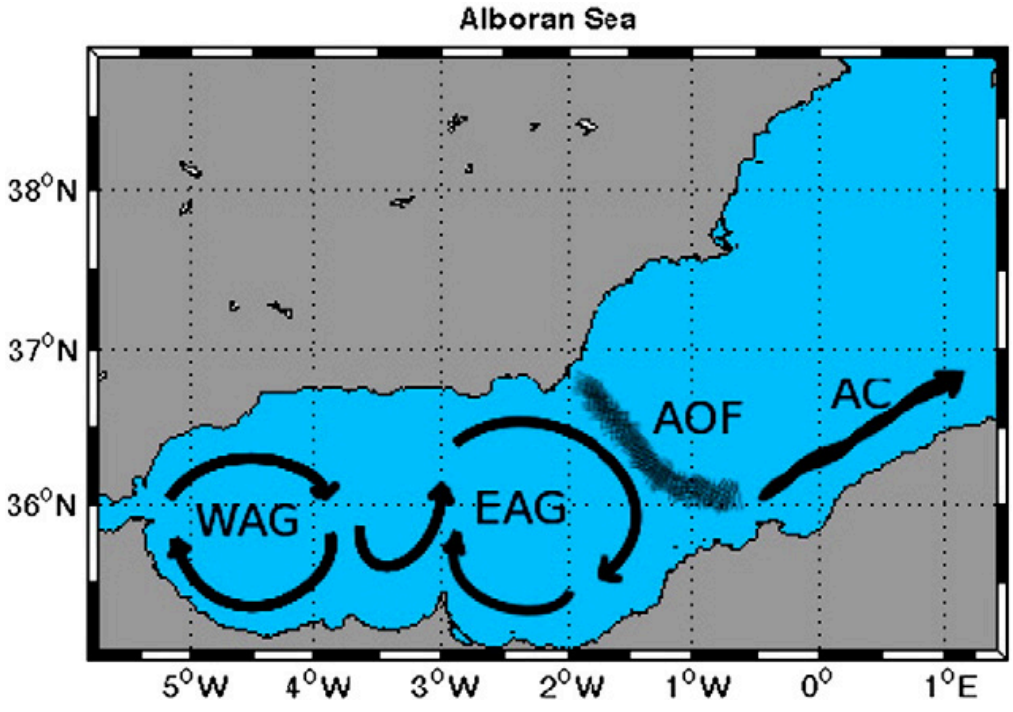
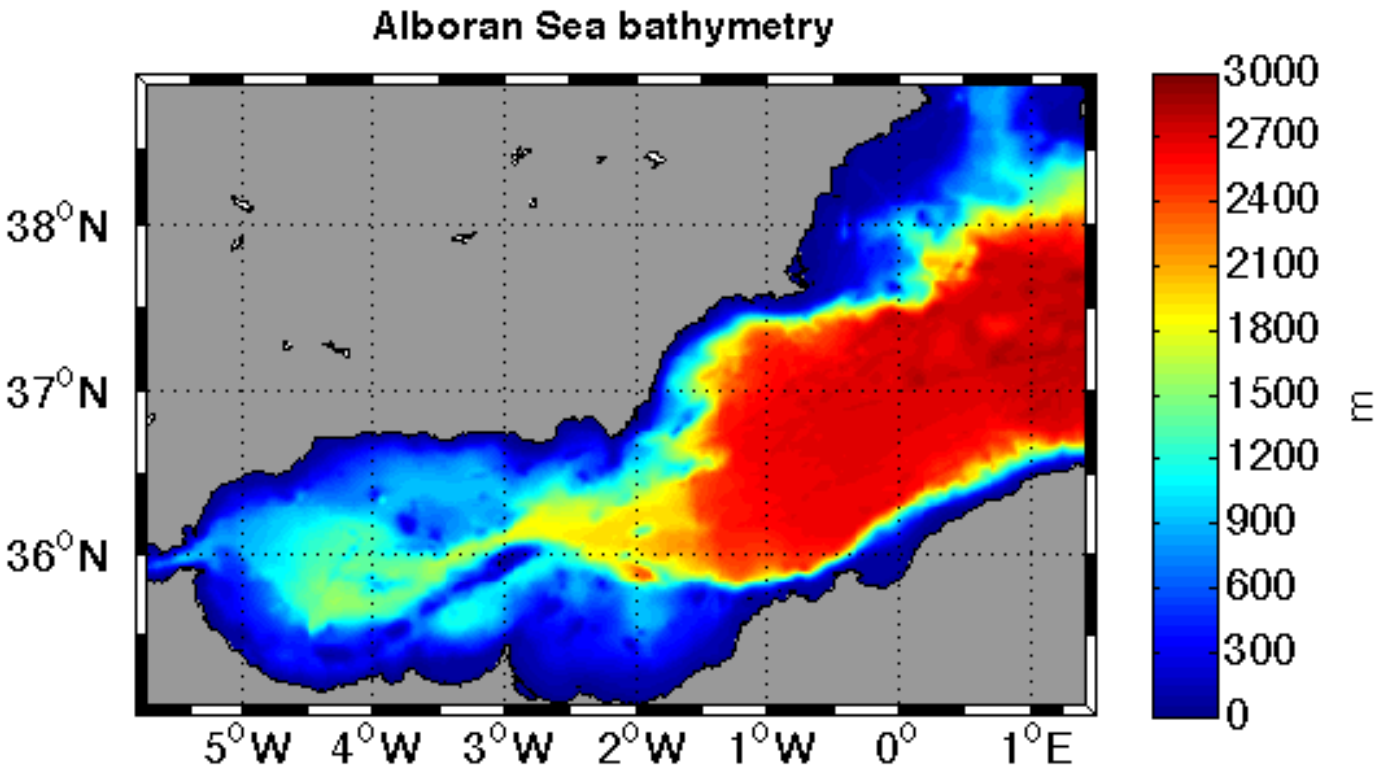
Alboran Sea location and surface dynamics





Alboran Sea bathymetry



Main relationships atmosphere-ocean-chlorophyll

- There is a seasonal behaviour in the wind and chlorophyll patterns in the basin.
- Alboran Jet and Gyres are influenced by Easterlies.
- Wind enhances biological activity by means of deflecting the AJ, inducing iberian coastal upwelling and off-shore circulation patterns (Macías et al. 2007).
- Zonal wind drives chlorophyll blooms and their variability (Solé et al. 2012).

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Reconstruction of Chl field from wind

We study the zonal wind influence on chlorophyll behaviour using wind 2D field (7 day means) and ocean color (7 days means) of a series of 9 years data (1998-2007):

1. Split both, zonal wind and chlorophyll fields, in trend, seasonal and residual parts (anomalies) adjusting a periodic function to the data (for each grid point).
2. Calculate Empirical Orthogonal Functions (EOF) of the anomaly for each variable.
3. Correlate the residual (anomalies) PCs of wind vs. Chl.
4. Divide the series in: analysis period (8 years) and test period (last year). Use the last year of our time-series to test the forecasting capability of the method to reconstruct Chl field.

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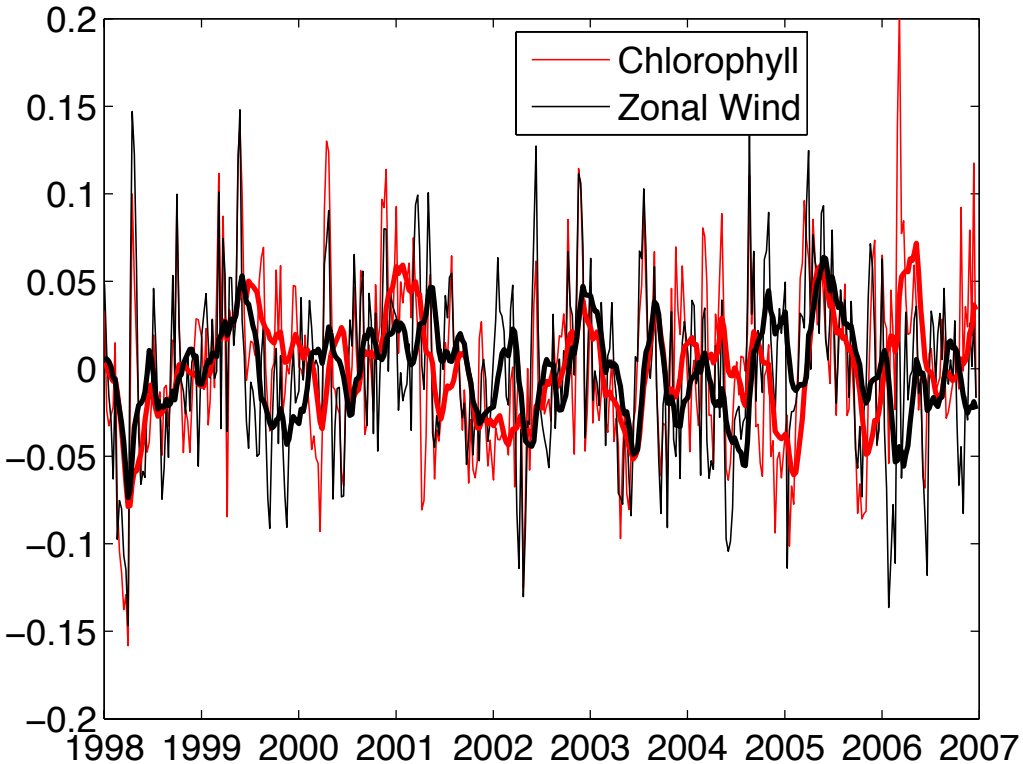
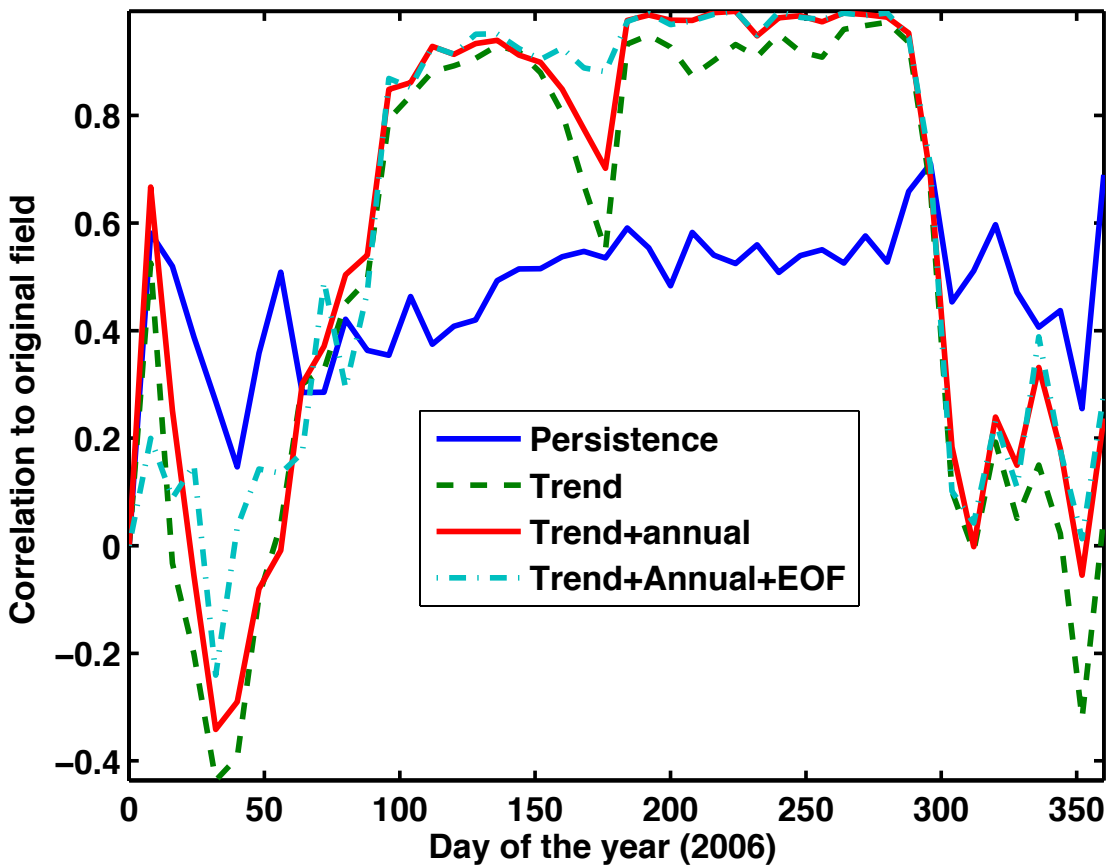
Anomalies first PC



We propose a linear relationship: $A_j^{Chl}(t) = aA_j^u(t) + b$

(Solé et al. 2012)

Original vs. reconstructed field



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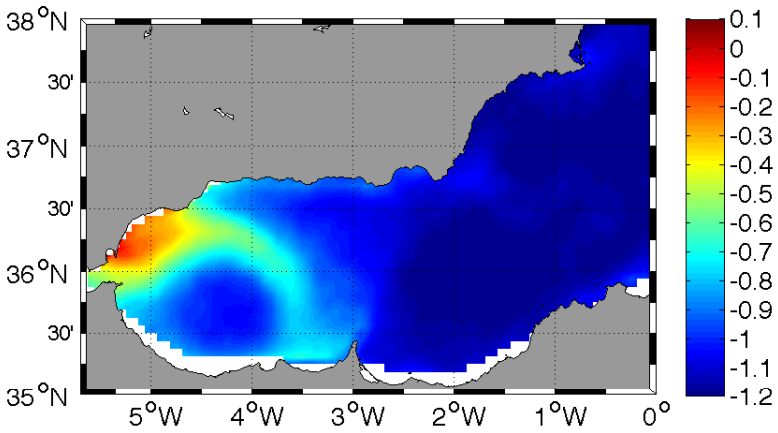
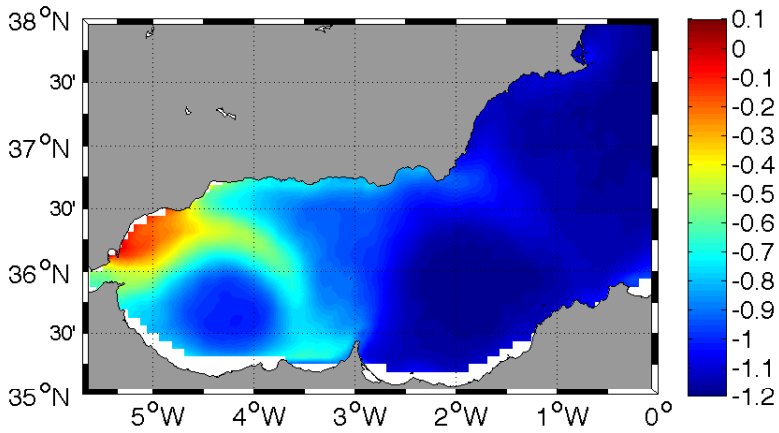
Example of reconstructed field



a



b

a) original field and b) reconstructed Chl field ($log_{10} mg/m^3$) for September 20th 2006. (Solé et al. 2012)

Question

- As zonal wind changes the ocean patterns driving the chlorophyll behaviour, is the ocean vertical velocity driving chlorophyll changes in the area?

ROMS Model Implementation

- ROMS model (www.myroms.org) + Biogeochemical model (Fennel model: NPZD Nitrogen based model)
- Boundary conditions: Climatology from MFS (Mediterranean Forecasting System: http://mfstep.bo.ingv.it/). Nudging in East and North OBC and clamped in West (Gibraltar Strait) following Pelliz et al. (2007)
- Meteorological forcing conditions: ECMWF (http://www.ecmwf.int/), QuickScatt for wind for the time period of cruise (21-26 July 2008)
- Grid 384x256 (2 km resolution) 40 levels in the vertical with more resolution in the surface.

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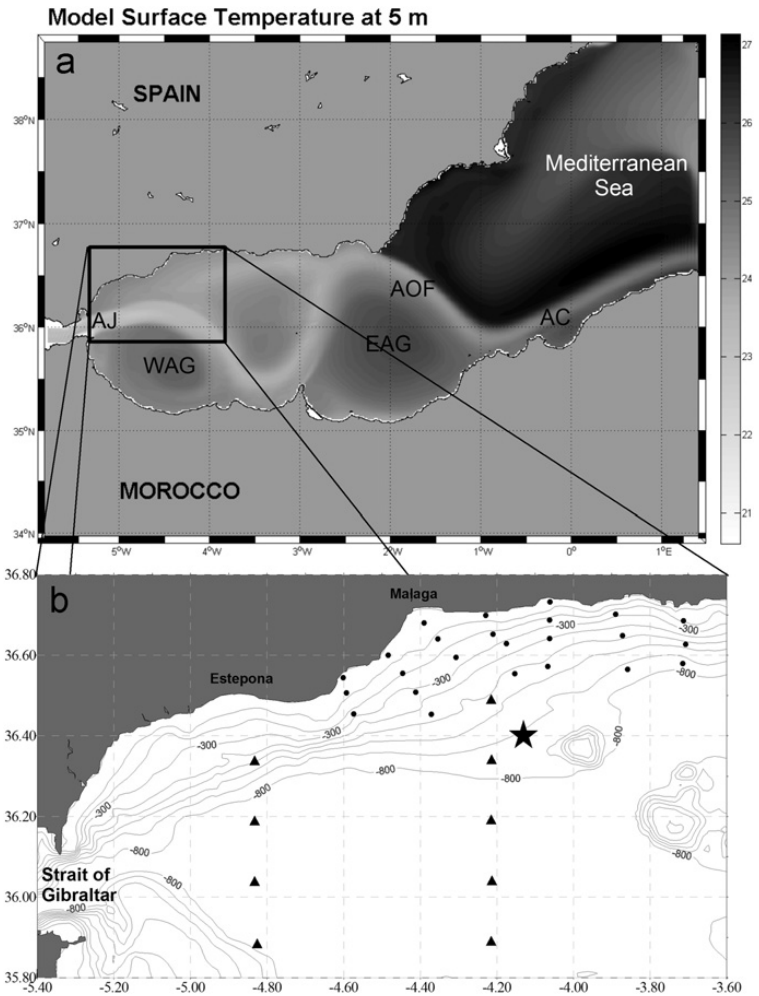
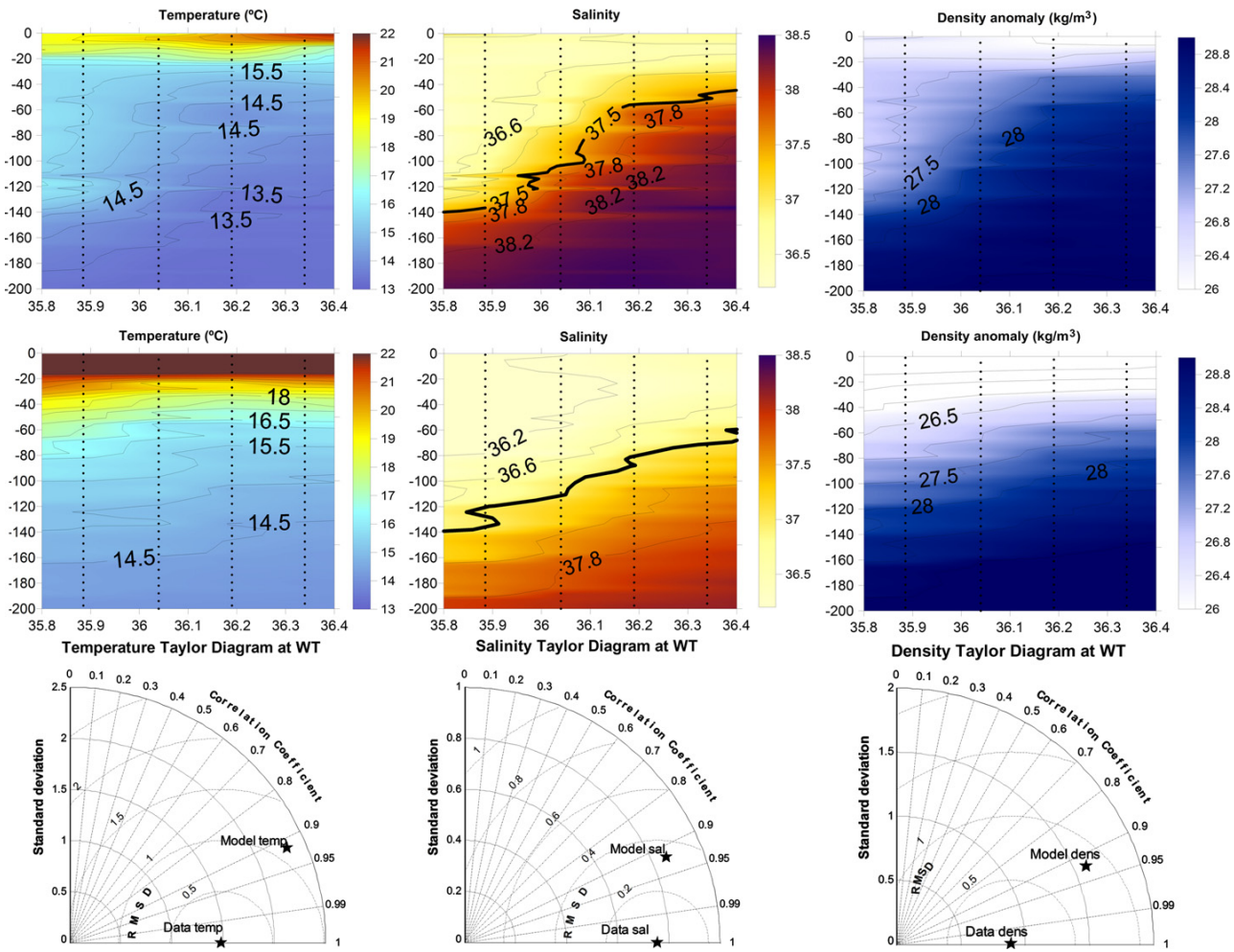
Alboran Sea Cruise



(Macías et al. 2011)

Cruise vs. model output July 08



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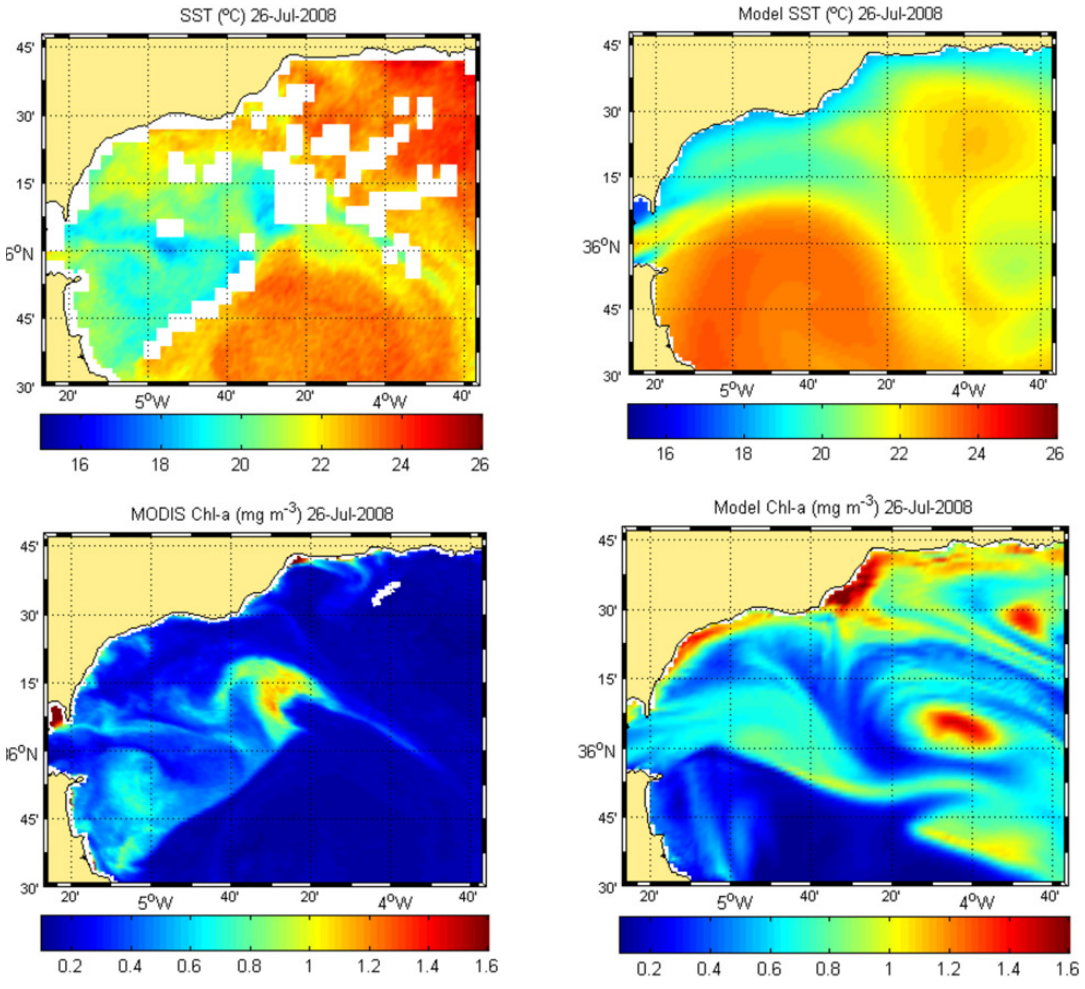
Satellite vs. model July 08



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Model simulations vs. field data

1. Model output, for the time period compared, represents reasonably well the main surface features.
2. Comparing cruise transects, the model represents rigth the position of termocline and halocline.
3. However the model overestimates the ocean temperature and underestimates the salinity.
4. In these simulations the Deep Chlorophyll Maximum is underestimated.

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Question we try to answer

- Is the ocean vertical velocity component driving chlorophyll changes in the area?
- We need to find quantitative relationships between model output ocean velocities and chlorophyll.

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Analysis of ocean velocity and chlorophyll

We study the three velocity components influence on chlorophyll behaviour in a **climatological run**:

1. Obtain a mean 2-dimensional field, averaging the first 20 meters, for the 4 variables: Chl, U, V, W.
2. Split the 4 different fields in seasonal and anomaly parts adjusting a periodic function to the data (for each grid point).
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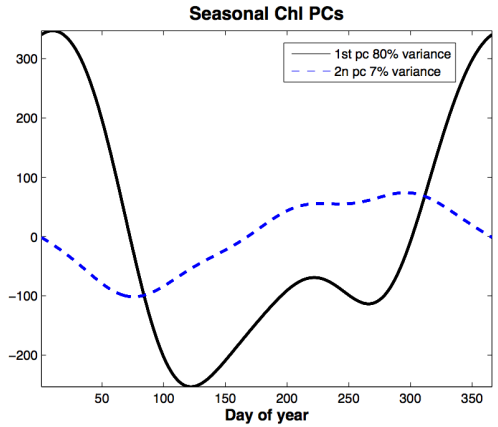
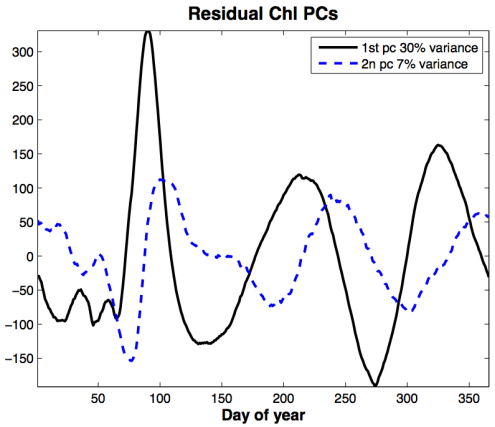
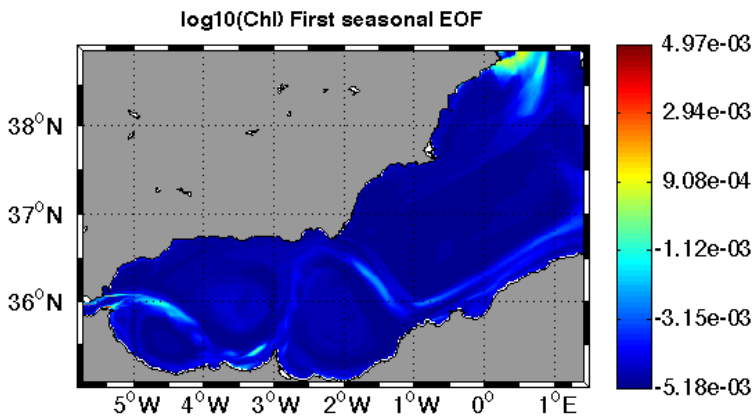
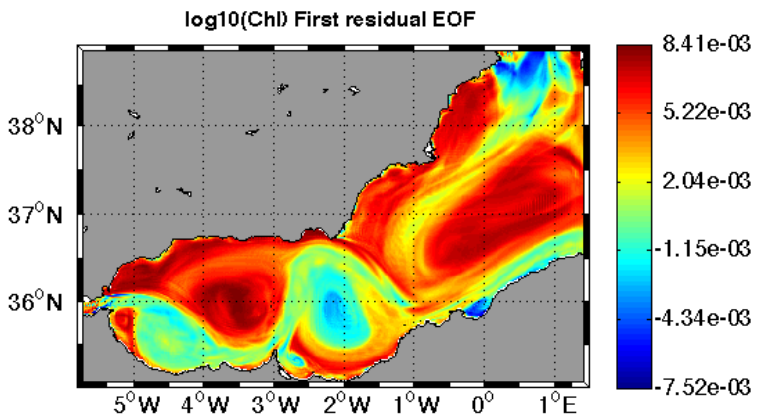
Chlorophyll EOFs and PCs

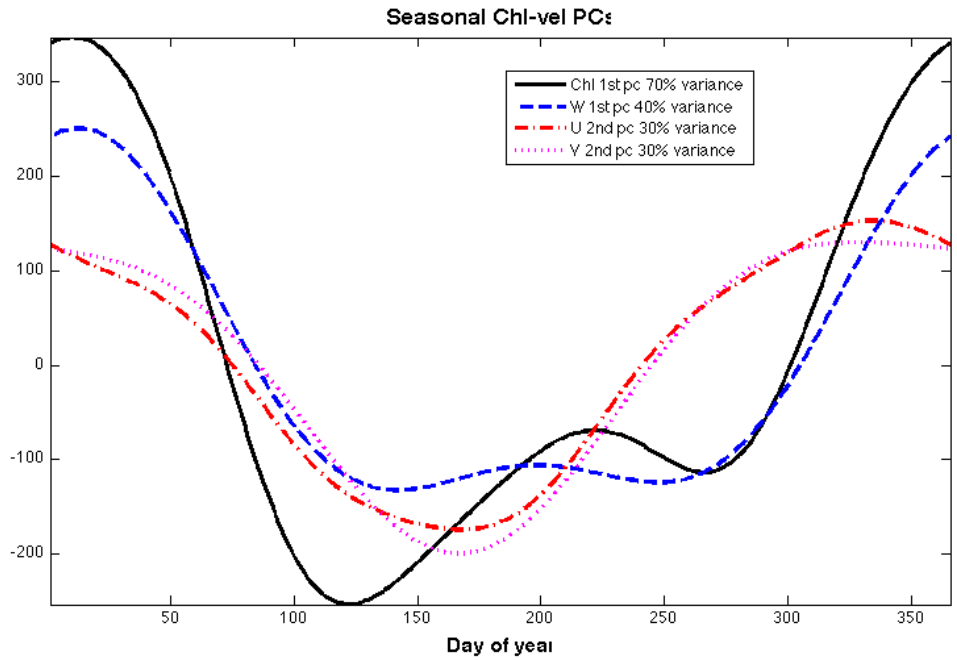


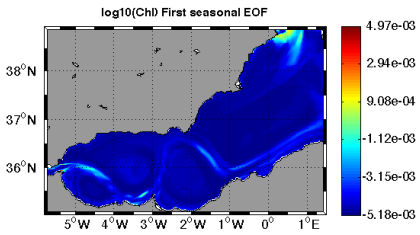


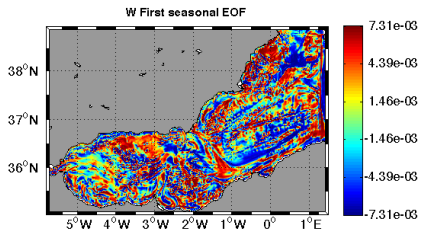


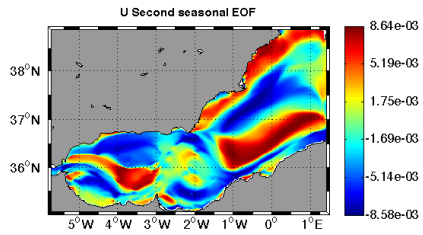


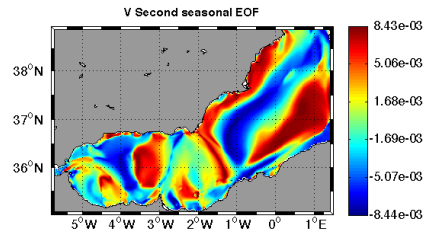
Seasonal part: EOFs and PCs











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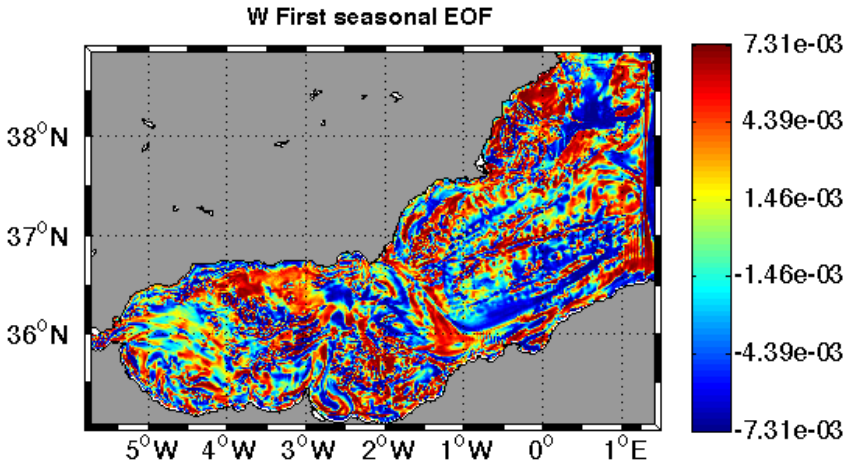
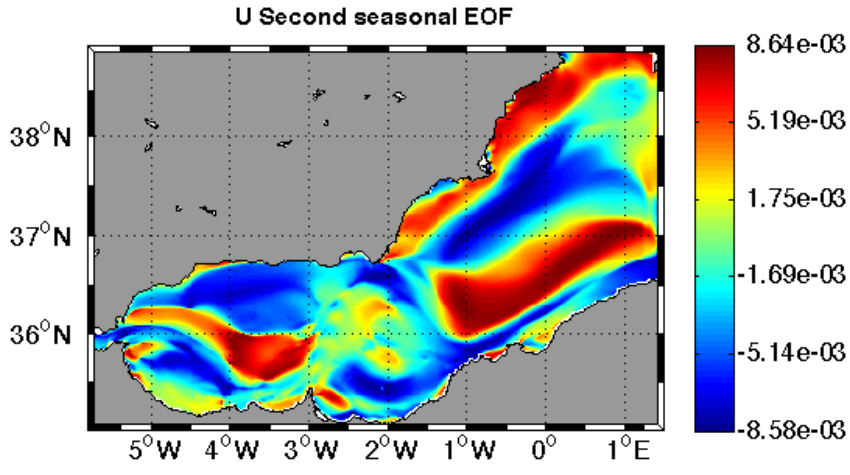
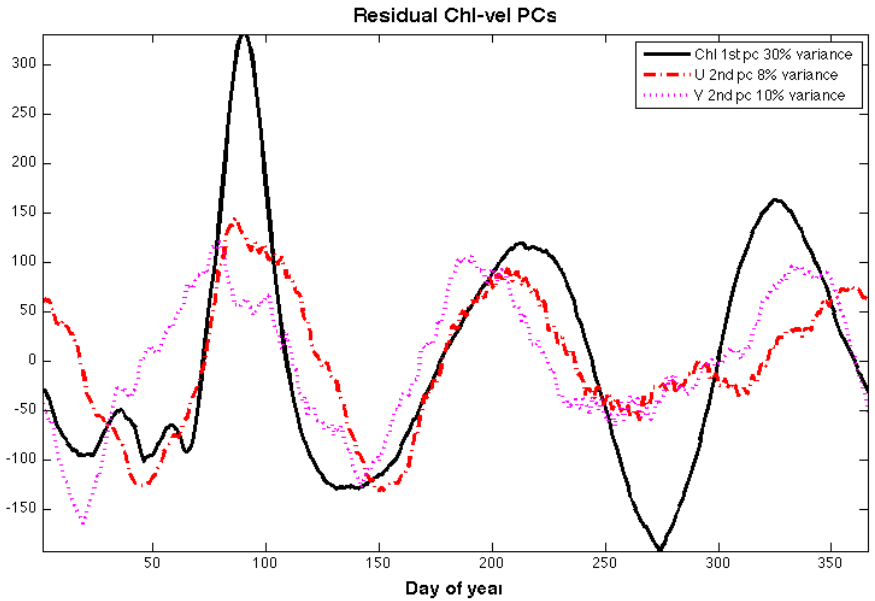
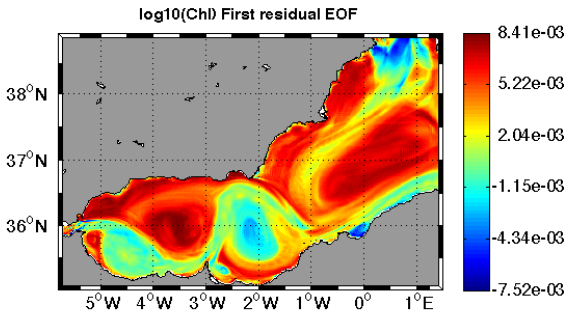
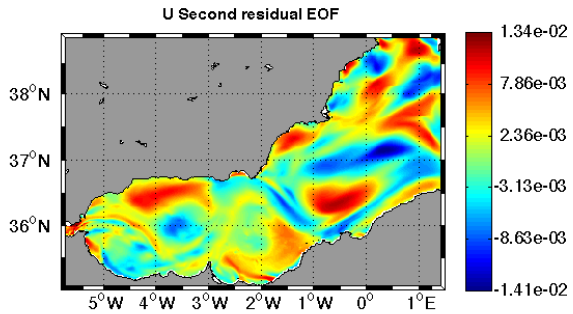


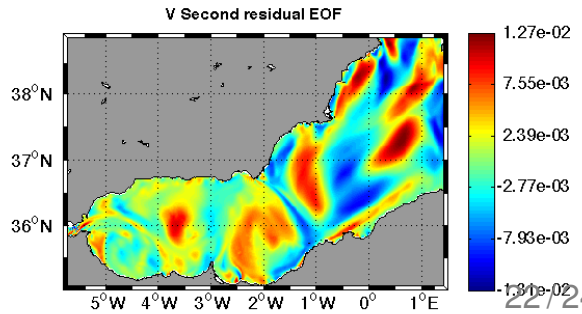


Residual part: EOFs and PCs









Conclusions and Ongoing Work

- We have succesfully modelized the main patterns of circulation in the Alboran Sea.
- We use the EOF and corresponding PC as a methodology to quantitatively relate model variables .
- Chlorophyll seasonal contribution of variability represents 2 times the anomaly one.
- Seasonal Chlorophyll behaviour depends on all velocity components but with a predominance of W first mode (*answer to question*).
- Residual variability depends mainly on horizontal velocity components (*answer to question*).
- **Ongoing work:** wind forcing should be analyzed and correlated with chlorophyll.

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Thank you!

This research has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration and JAE-Doc program (CSIC cofunded FSE)