Negative wind anomalies generated a diminution of productivity in the North Atlantic in 2010

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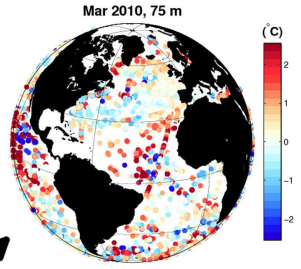
Summary

The weakening of the wind intensity in winter 2010, related to a low NAO index, generated unseen temperature anomalies and a significant decrease of biological activity in the Canary Current upwelling system.

Temperature at 75 m depth

Comparison of in situ measurements with respect to the World Ocean Atlas global climatology shows that the anomalies extends until a depth of 75 m.



Methods

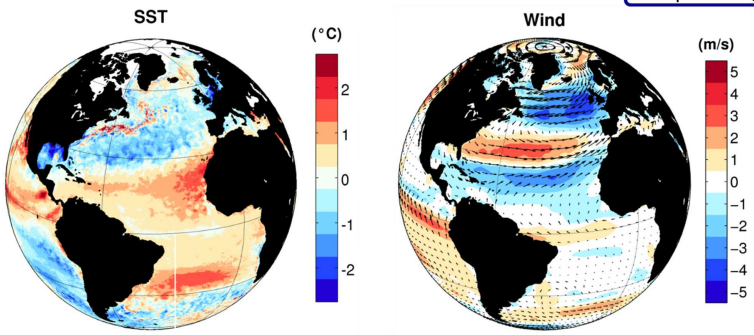
The background of this work is mainly observationa, and is based on:
- Publicly available data sets (in situ, remote sensing, etc).
- Simple methods to derive the anomalies.

Wind intensity and direction

The wind anomalies for winter 2010 shows:
- a clear structure with positive anomalies north of an imaginary line joining Florida to south Spain,
- negative anomalies south of this line;
- the zonal component (see arrows) of the wind is stronger;
- close to the coast of Northwest Africa, the wind anomaly has also a stronger northward component (anomalies around 2-3 m/s).

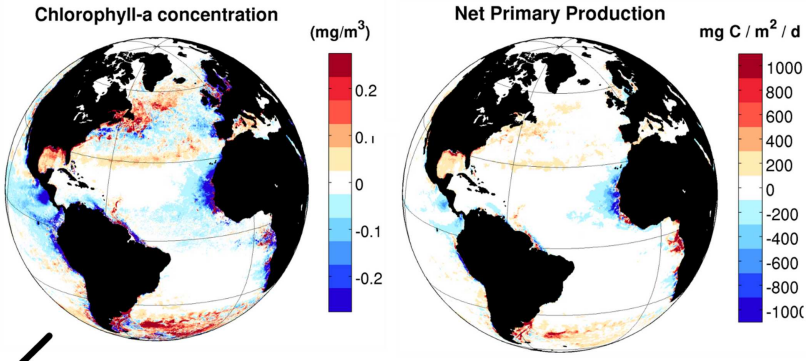
SST

The SST in the coastal area exhibits strong anomalies (>2° C) with respect to the climatology), because of the weakening of the wind-driven upwelling.
The positive anomalies cover a large part of the tropical and subtropical Atlantic Ocean.
The time series shows a westward propagation of the anomalies (Rossby waves).



Chlorophyll-a

The chlorophyll-a concentration anomalies are negative in the Canary upwelling system and positive in the region where the wind intensity has increased. In the open ocean, the anomalies are almost zero.

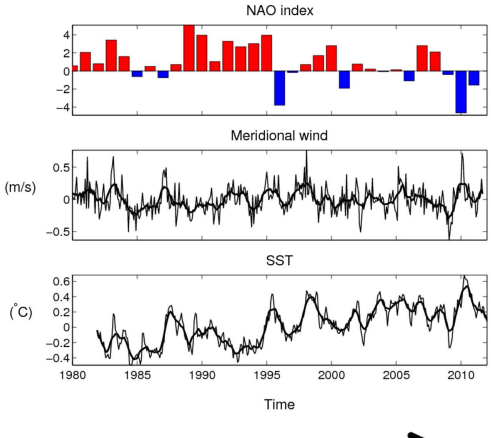


Net primary production

The NPP anomalies also exhibits negative values along Northwest Africa coast, null in the open ocean.

NAO index

The time series show the time series of NAO, north-south component of the wind and SST, averaged over the studied region (0-40°N, 0-80°W).
- The 2010 NAO index reaches its lowest value of the last 30 years.
- The meridional component of the wind is strengthened northward.
- The SST anomalies reach their maximum of the last 30 years.



Mechanism

- During the period with a very negative value of NAO, the wind structure was modified.

- The decrease of the wind intensity played two roles:
  1. a decrease of the mixing in the open ocean.
  2. a decrease of the coastal upwelling off Northwest Africa.

- The weakening of the upwelling directly translates into lower chlorophyll-a concentrations and lower primary production.