

Atmospheric Iron Flux and Surface Chlorophyll at South Atlantic Ocean: A case study Near Patagonia

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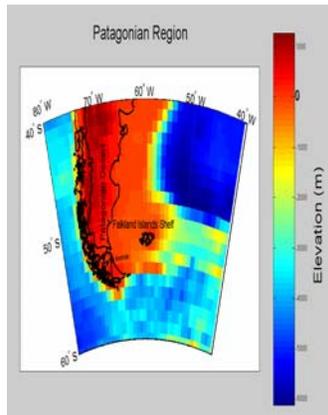
Introduction

•Iron is a limiting nutrient for biologic activity in much of the world ocean.

•The principal sources of iron to the upper ocean are wind transported mineral dust, upwelling and entrainment.

•Estimated Atmospheric deposition of iron ($\Psi_{Fe} = 96 \cdot 10^9 \text{ mol-Fe yr}^{-1}$) is larger than upwelling/entrainment supply ($0.9 \cdot 10^9 \text{ mol-Fe yr}^{-1}$).

Study Region



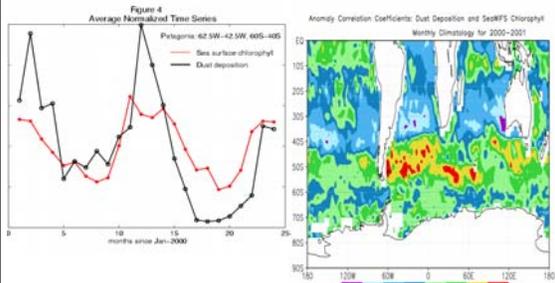
This oceanic region is influenced by several biogeophysical forcing. A striking feature is that the time variation of surface chlorophyll presents a high correlation with wind transported dust from Patagonian Desert.

The region is influenced by intense western boundary current, Brazil current and West wind drift (part of Antarctic Circumpolar Current).

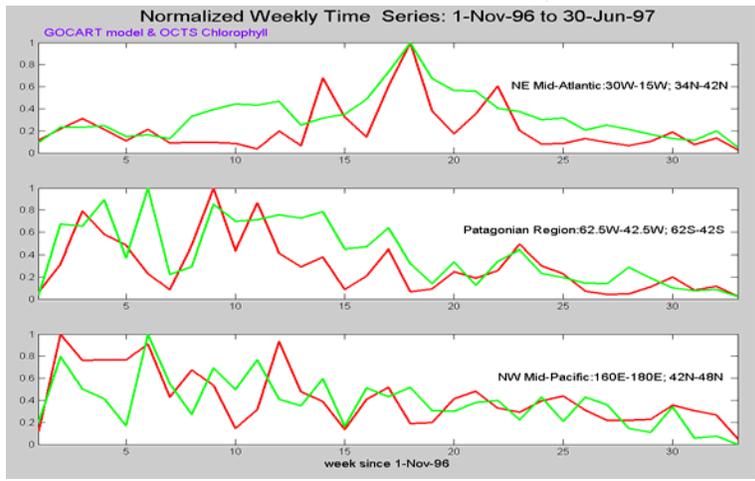
The cold and nutrient-rich Antarctic Circumpolar Current approach the southern tip of the South America from the west at around 50S.

Large continental shelf: Falkland Island Shelf

2000-2001 NASA-SeaWiFs [Chl] and Ψ_{Fe}



ADEOS-OCTS [Chl] and Ψ_{Fe}



The problem

- Considering surface chlorophyll global satellite observations and iron flux at different time resolutions, our previous analyses indicated that these fields coincide more in monthly than in weekly variation at several ocean regions. Low latitudes at Atlantic Ocean show consistent high correlation.
- Although we found regional high correlation between [Chl] and Ψ_{Fe} it is not enough to conclude a direct response between these two fields. We accomplished further analysis to locate the maximum response of chlorophyll to iron deposition and present a new objective analysis to explore such spatial response.

Hypothesis

- The monthly surface chlorophyll patterns should coincide to those of iron deposition if their time response is fast enough, such the ocean circulation is not significant in their monthly variation.

Our Goal

- To present an objective analysis to quantitatively address the response of ocean biology to inputs of atmospheric Fe associated with atmospheric dust.
- Monthly Regional longitude band centroides are obtained for Ψ_{Fe} and [Chl] using:

$$Y_i = \frac{\sum_j Y_{ij} f_{ij}}{\sum_j f_{ij}}$$

- This allows us to compute the latitude (Y_i), where the Ψ_{Fe} and [Chl] (designated by f_{ij}) are clustered.

Data and Methods

Ocean color satellite observations and the global distribution of dust aerosol from GOCART model are combined to evaluate the influence of sea surface iron flux in marine biogeochemistry.

We analyze the correlation between Fe deposition from this 3-D atmospheric model and a proxy for surface ocean biological activity, remotely sensed ocean color.

We present a time series anomaly correlation analysis and a spatial objective analysis to explore the response between the dust deposition and SeaWiFS data for 2000-2001 in the Patagonian region.

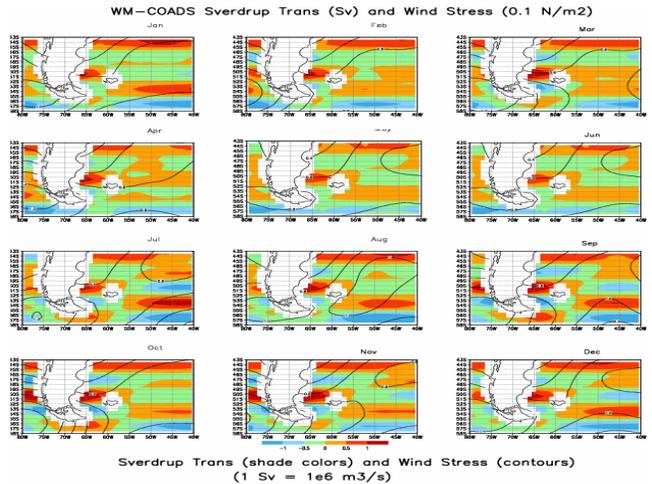
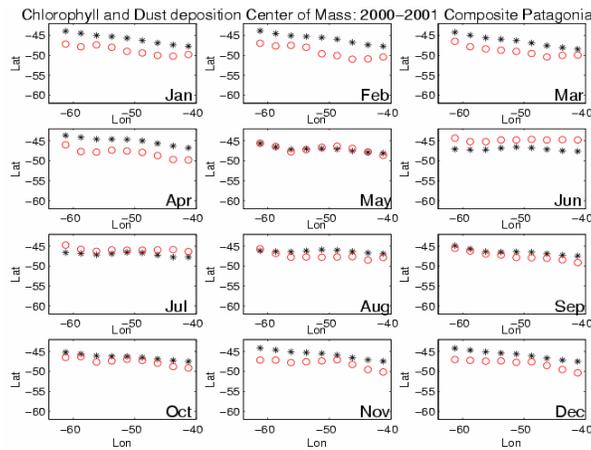
Sverdrup Transport and Meridional deviation

- There is a high degree of collocation for most of the Patagonian region between Ψ_{Fe} and [Chl], however some north-south deviation occur in the annual cycle.
- Because the patterns of ocean surface circulation result essentially from trade winds, the meridional Sverdrup transport (My) can explain such deviations.

$$My = \frac{Curl \tau}{\partial f / \partial y}$$

- Where $Curl \tau_n$ represents the vertical component of the rotational of wind stress and $\partial f / \partial y$ the variation of Coriolis parameter with latitude.

Results



Conclusions

- The spatial and temporal analysis for the ocean surface chlorophyll and iron deposition monthly have shown an high time correlation and degree of collocation in Patagonian region.
- The spatial objective analysis based on centroides for Ψ_{Fe} and [Chl], represents a potential unexplored tool in biogeochemistry for a further study when two fields show a high time correlation.
- The regional patterns of dust depositions can occur at some location little meridionally displaced to the chlorophyll patterns due to surface circulation greatly influenced by zonal wind stress transport.