PATAGONIA

Dust, Coccolithophore and Carbon Cycle

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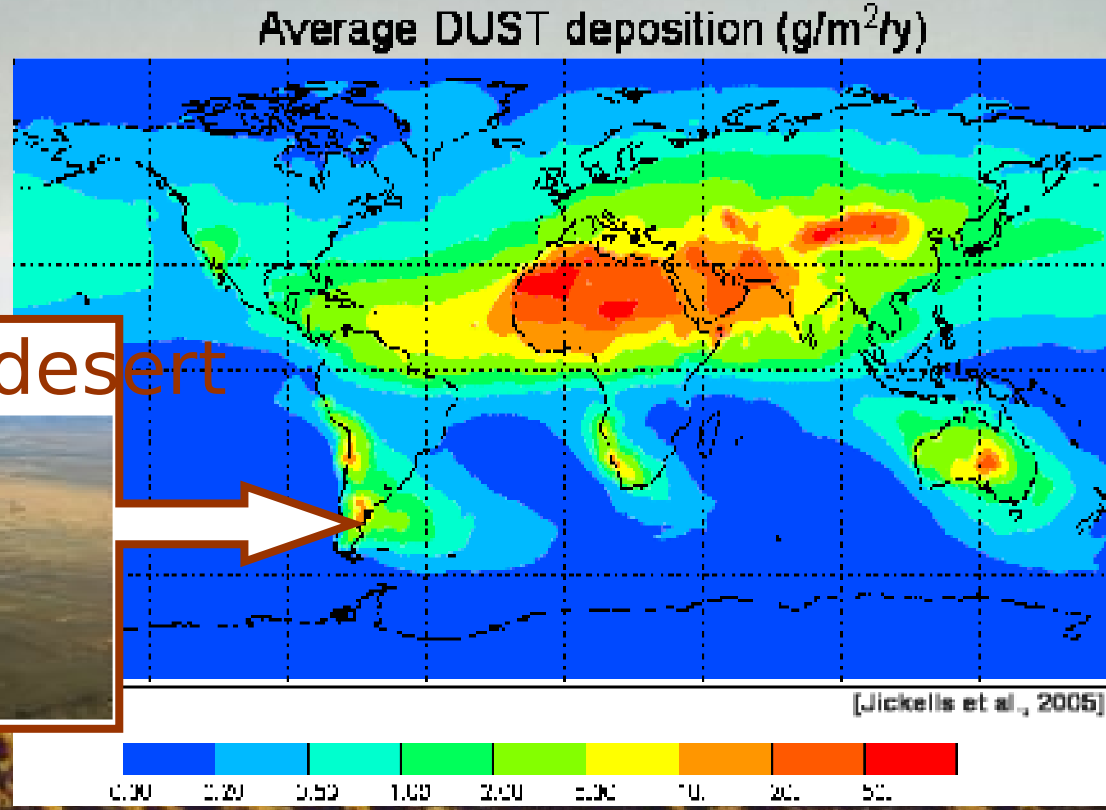
WHAT ARE THE SOURCES OF TRACE METALS IN THE ARGENTIN BASIN ?

✓ ATMOSPHERIC SOURCE

Patagonian desert



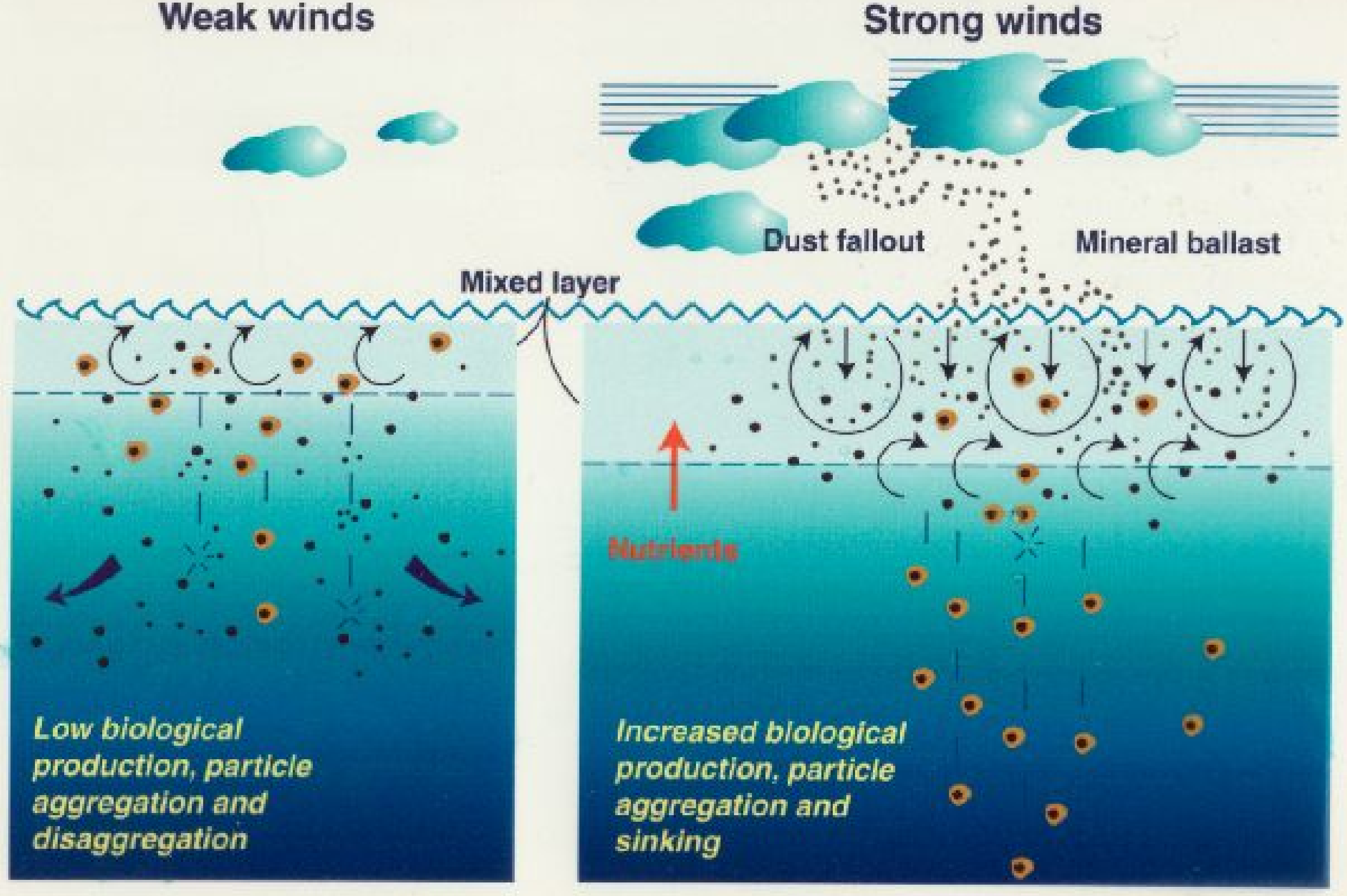
PATAGONIA: Dust

- Wind erodes soil if dry and produces dust
- Wind transports dust over long distances
- Dust chemistry evolves in the atmosphere, mainly in clouds. Dust becomes more soluble.
- Dust deposits itselve on the ocean

Hypothesis: Dust bring essential metals Fe, Co, Cd and Zn

WIND DRIVEN BIOLOGICAL PUMP ENHANCEMENT BY ATHMOSPHERIC DUST DEPOSITION OVER THE SEA

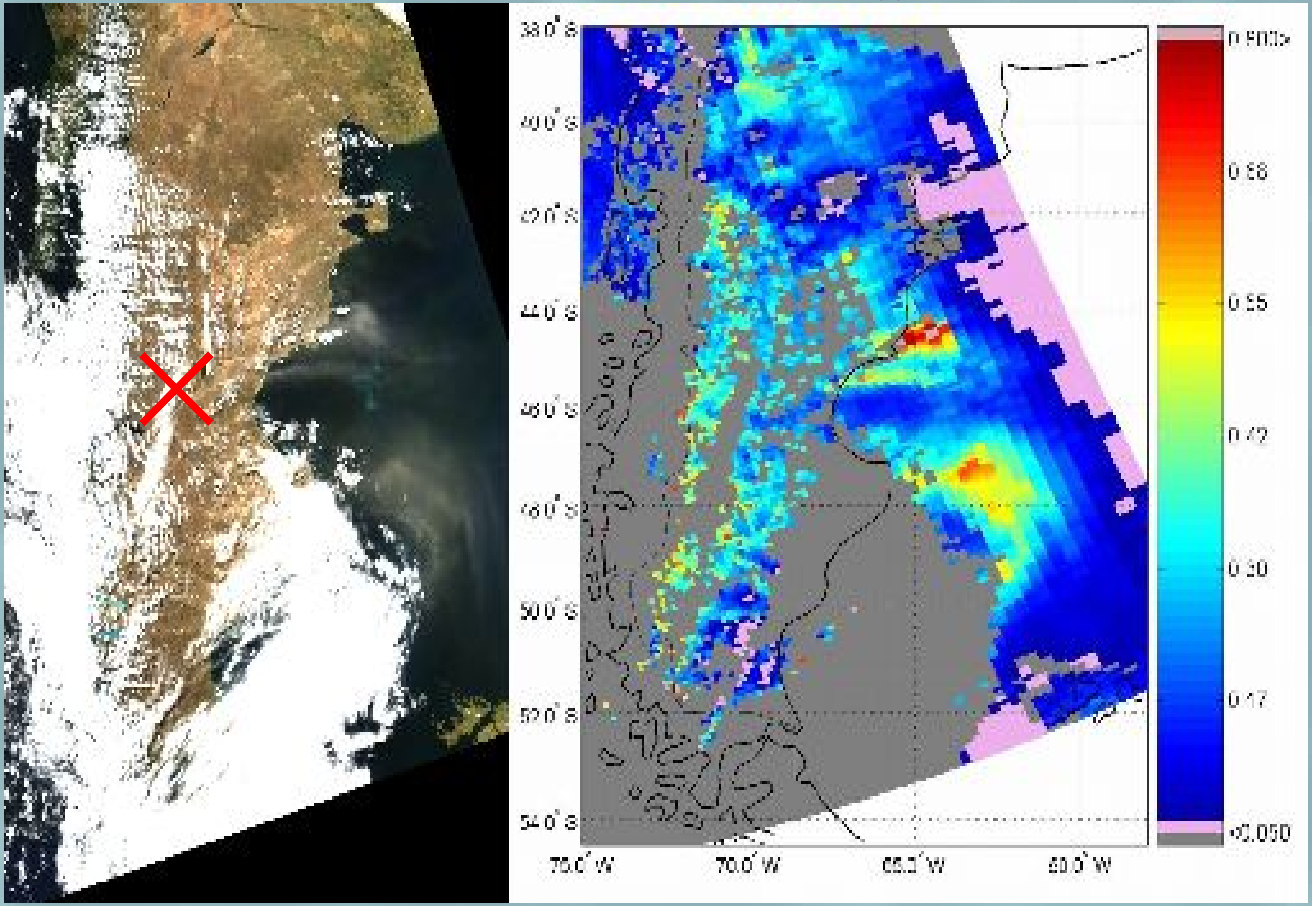
(Ittekot,1991)



Dust emisison: workplan

- To discover emission- local meteorology relationship: wind speed and humidity.
- To measure the chemistry of the emitted dust: chemical composition and solubility.
- To reseach possible evolution of the dust chemistry during transport: laboratory simulation of cloud processing.

Field



Observations of Dust Transport from Patagonia into the South Atlantic Ocean, *Image of the Week - July 3, 2005*, http://climate.gsfc.nasa.gov/viewImage.php?id=142

Dust deposition: strategy

- Ground based measurements: time series and deposit. Station at Puerto Madryin but be enhance by sampling station in SOuth Atlantic.
- On ship measurement, aerosol only but vertical profiles.
- Chemistry of the deposit: solubility

Deliverables

- Emission intensity from wind velocity and humidity
- Bioavailable metals (Fe, Co, Zn, Cd) transported to the ocean.

Why and How is produced the Coccolithophore bloom in the South Atlantic Ocean ?

Goals

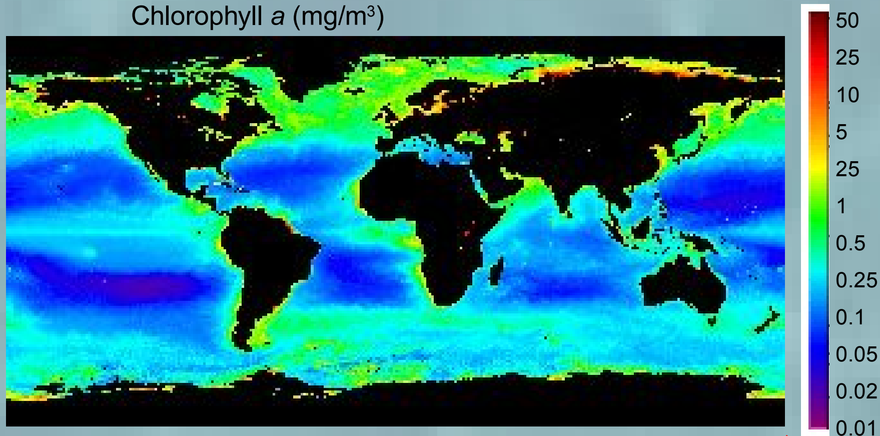
- Front Dynamic and Coccolithophore bloom at the mesoscale
- CO2 ⇄ Biocalcification ($CaCO_3$ Aragonite)
- Patagonian Dust and Calcareous (coccolithophore) vs Siliceuse Phytoplankton bloom (diatom)

Hypothesis : Patagonian Dust contribute to develop an extended and intense bloom in the South Atlantic Ocean

Why dust and bloom ?

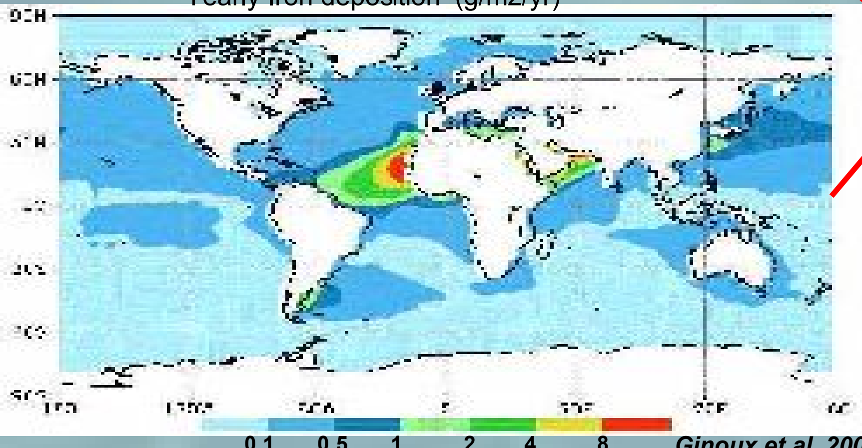
Phytoplankton in front of dust

Chlorophyll *a* (mg/m³)



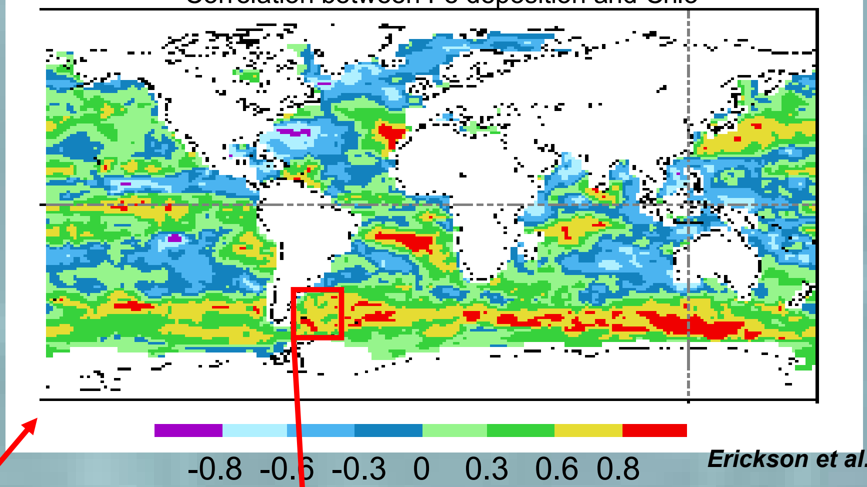
2001 SeaWiFs

Yearly Iron deposition (g/m2/yr)



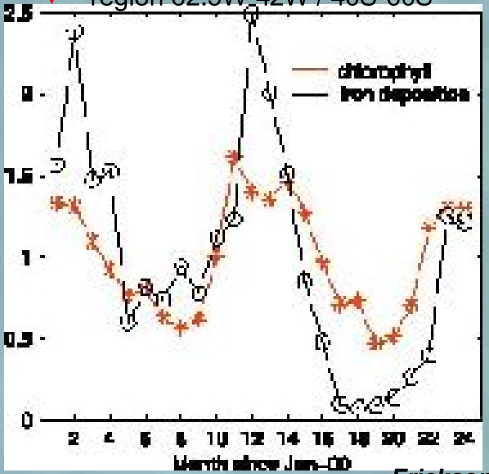
Ginoux et al. 2001

Correlation between Fe deposition and Chlo



Erickson et al. 2003

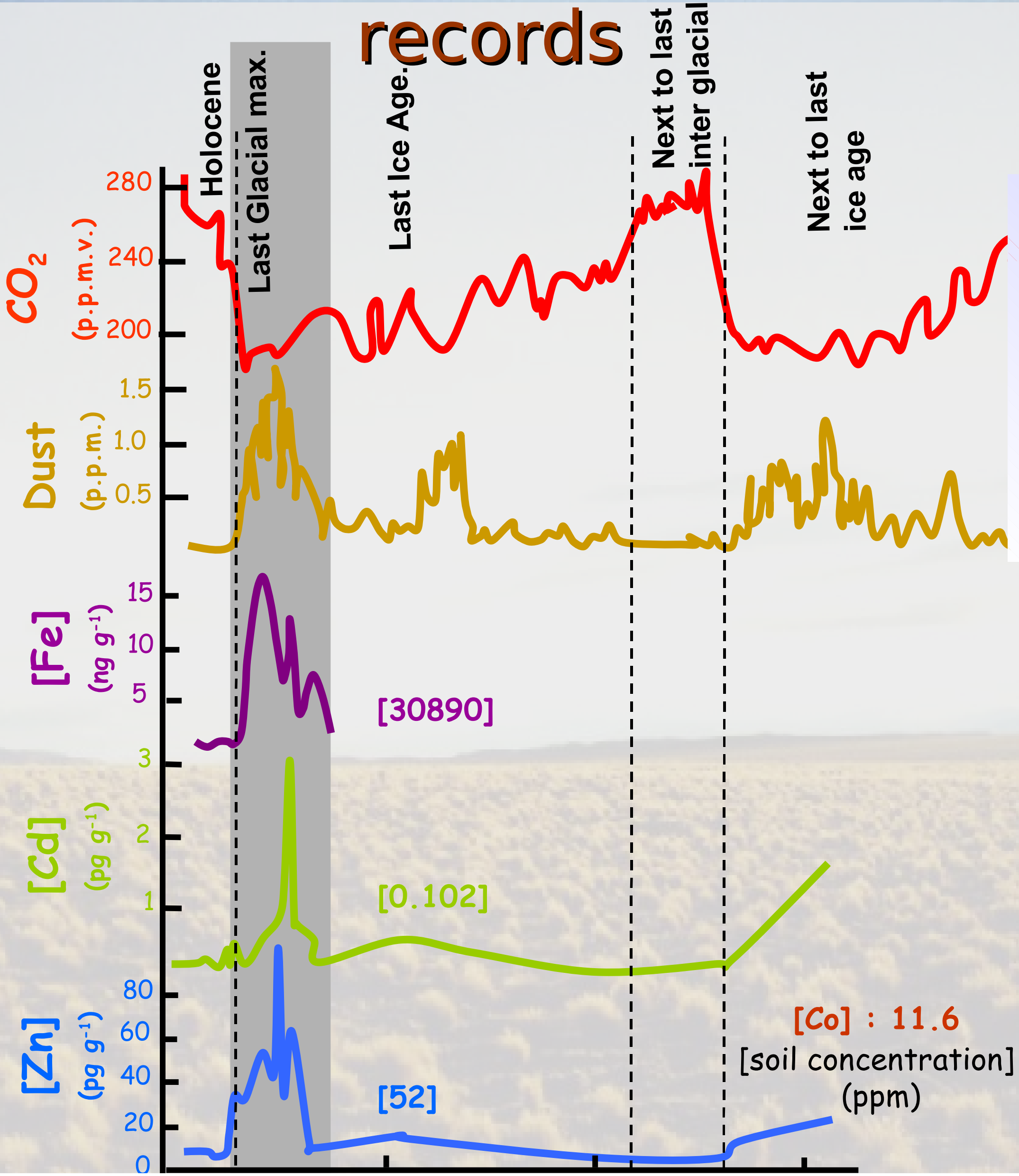
Chlo and Fe deposition
région 62.5W-42W / 40S-60S



Erickson et al. 2003

South Ocean Productivity more related to dust input !

Antarctic ice cores records



of Patagonian dusts and solubilities of trace metals

Why the South Atlantic Ocean is becoming white ?

Or the history of Coccolithophor bloom in the Argentina Sea

Why coccolithophore ?

- **Appearance** (**200.10**^{6} **year**) **before diatom** (**150.10**^{6})
- **Global calcite production from Coccos : 35% CaCO3** ***(Amat 2001)***

* **Double rol in oceanic carbon cycle**

1- **Sink C** Photosynthesis : $6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$

2- **Carbonate pump** Calcification : $Ca^{2+} + 2(HCO_3^-) \rightleftharpoons CaCO_3 + CO_2 + H_2O$

Precipitation $CacO_3$ -1DIC, -2AT

* **Increase and extended during hot period** → IG Positive feedback

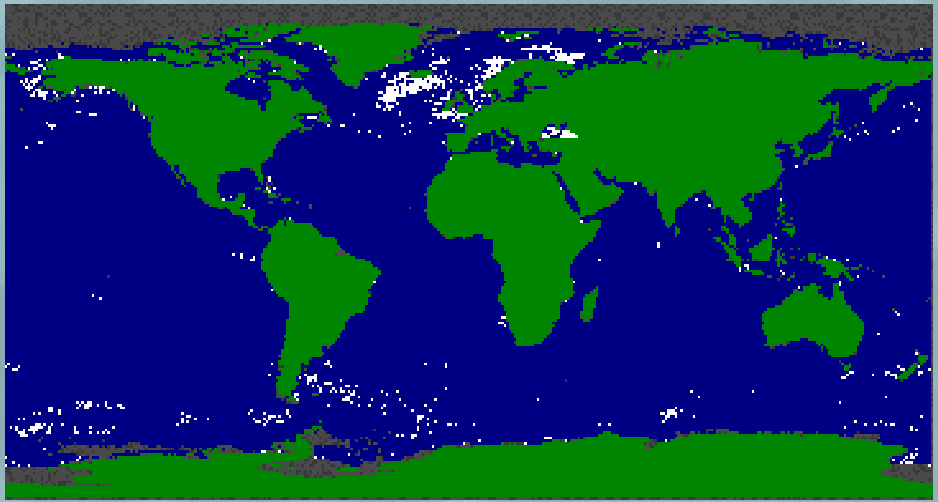
+100ppm atmopshere CO_2

… Paleoreconstruction (eg : Assemblage cocco, UK37...)

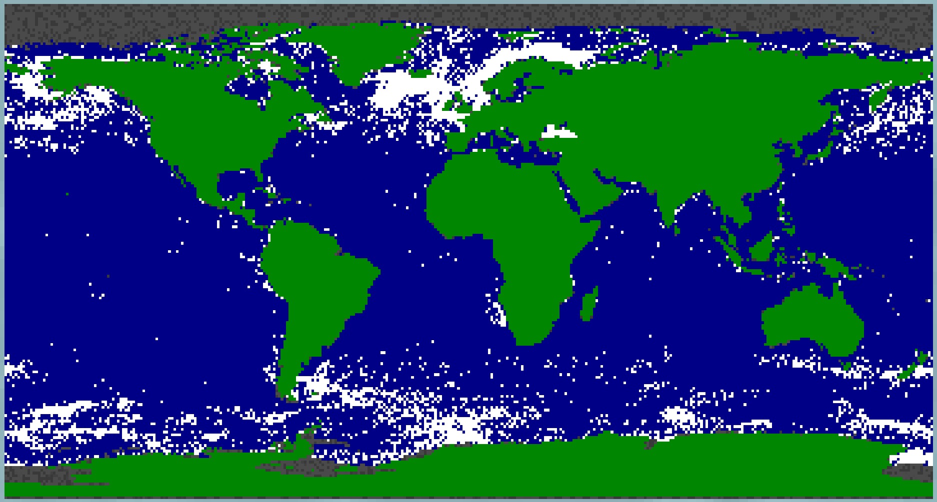
Global Climatic Change Cocco ↗ or ↘ ?

The South : the area where recently visible (satellite) bloom are decelable

blooms more visibles !



SeaWiFs 1997-1999
(Iglesias-Rodriguez 2003)



SeaWiFs 1997-2003
(Brown c.p.)

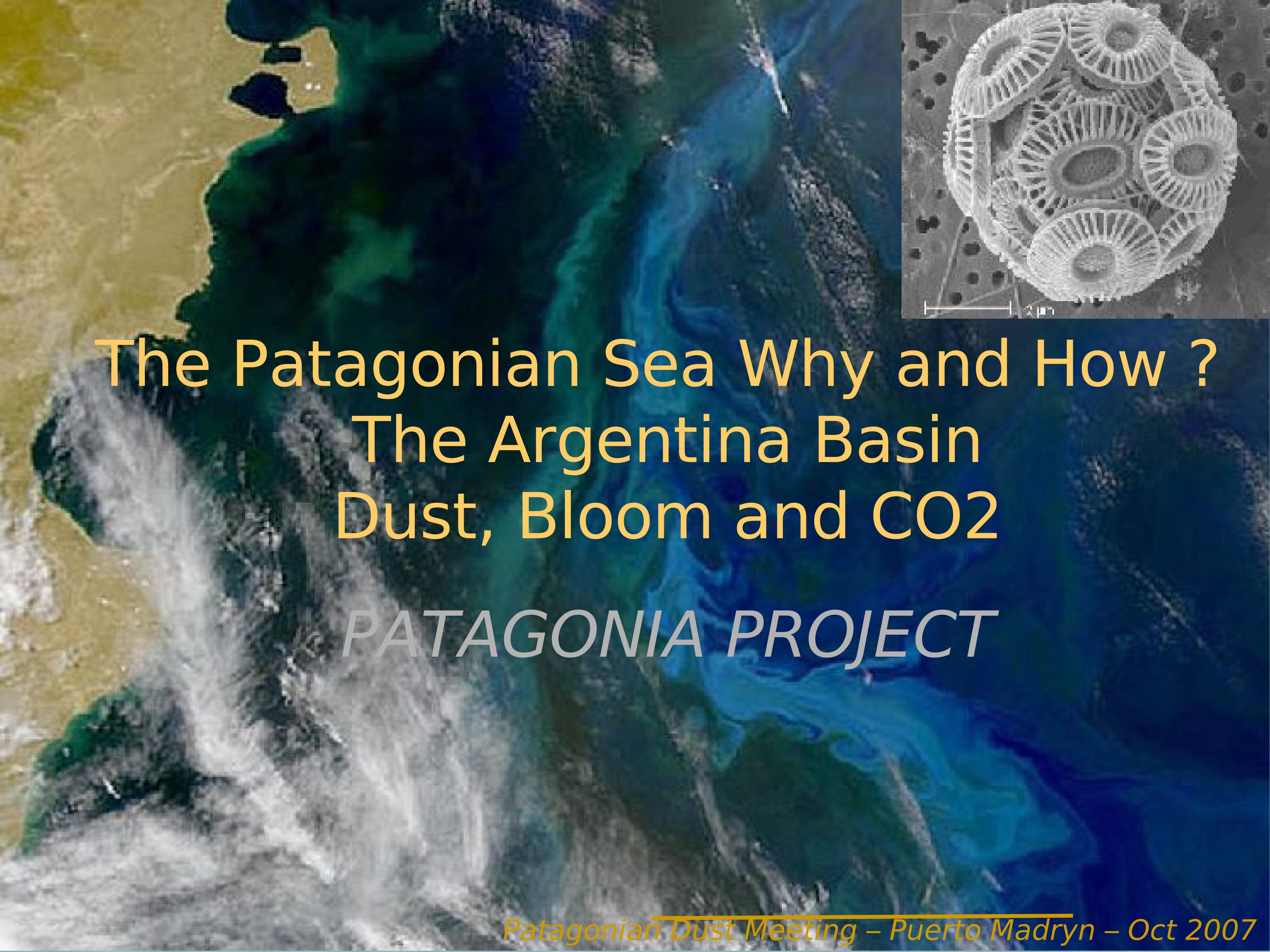
CaCO3 bloom total production = 5.4-8.3 MillT/an/ 1.4 Mill km2 (0.4% Ocean)
(Brown et Yoder 1994)

Atl Nord Bloom :

- production = 3.4-8.3 g/m2
- time scale = 31 days

NO_3 ↓
Fe-Metals Patagonia ↑

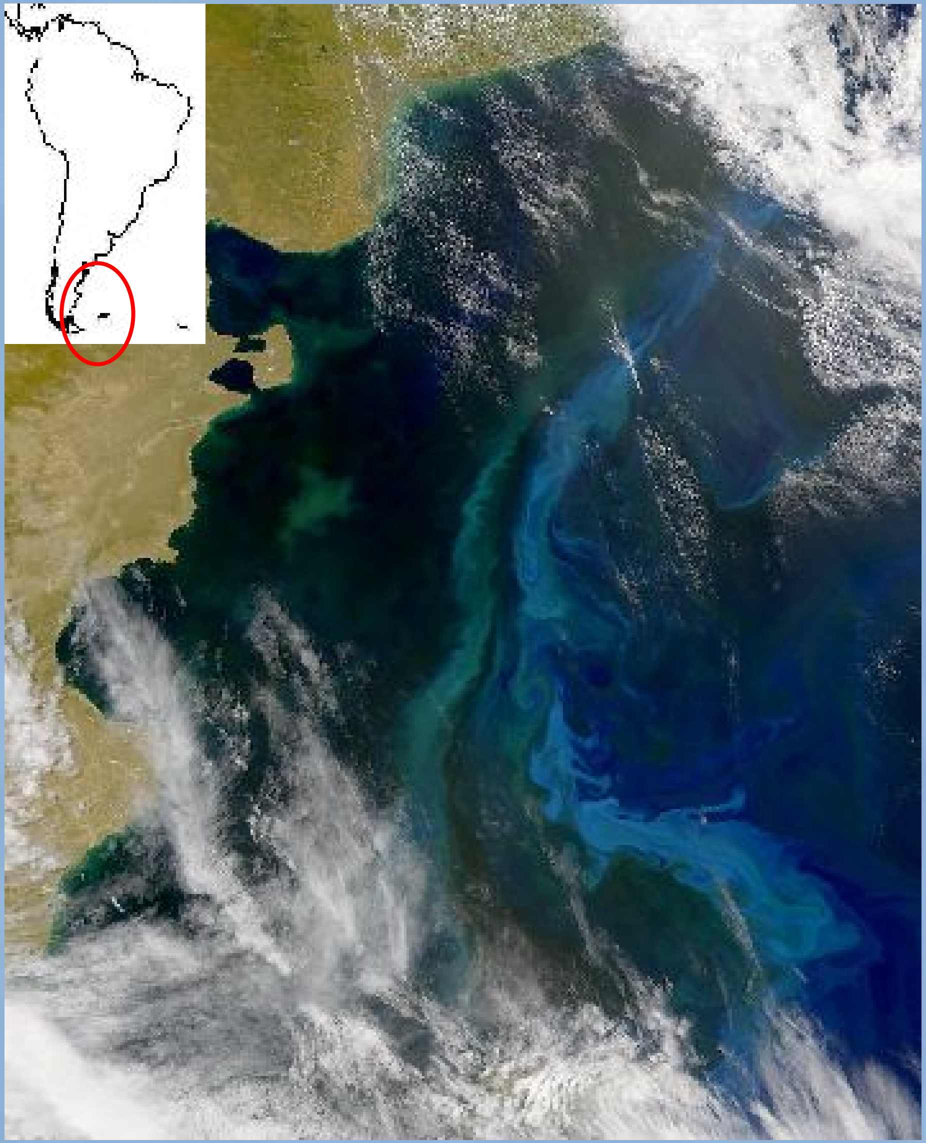
CO_2↑(pH↓), T°↑, S(Alk)↓ ?

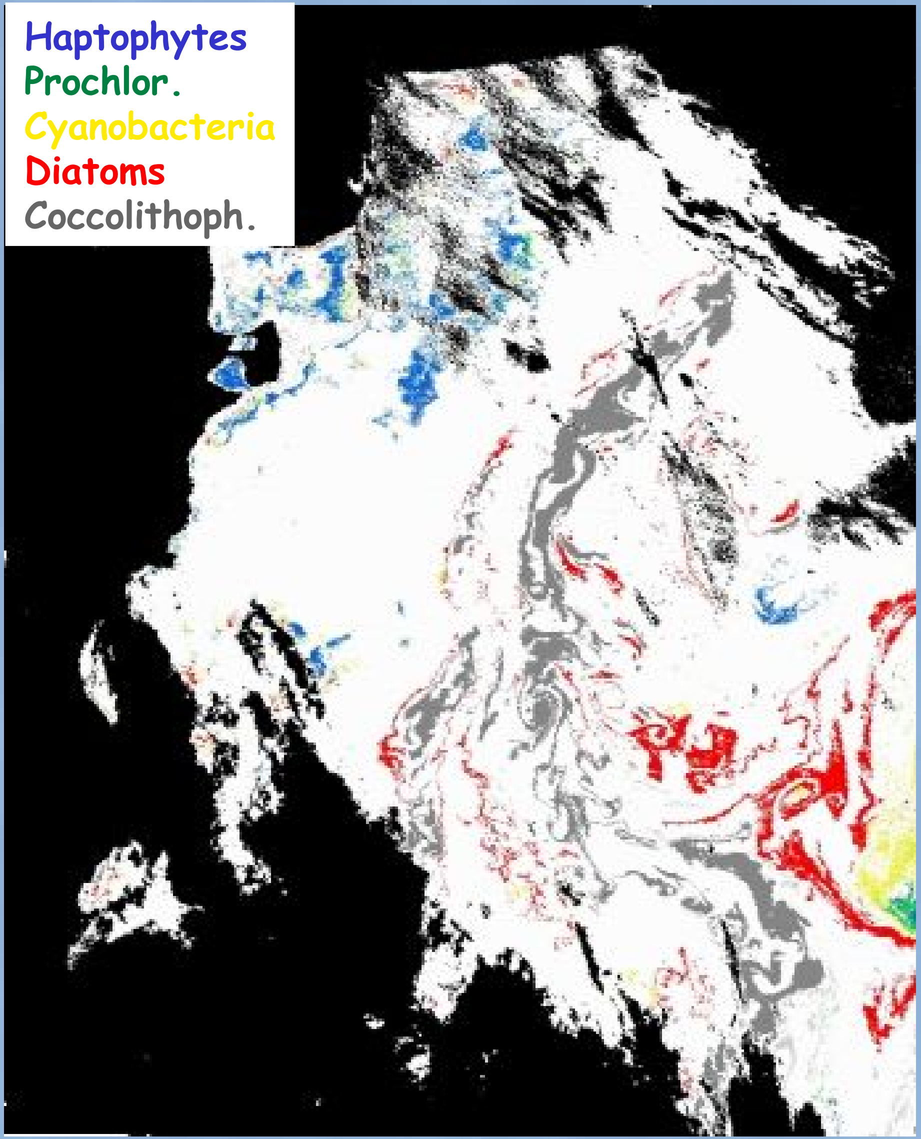


The Patagonian Sea Why and How ?
The Argentina Basin
Dust, Bloom and CO2

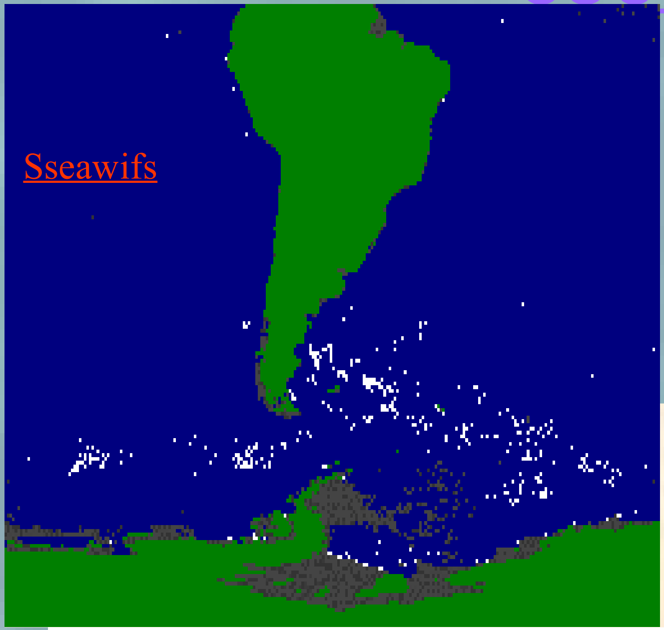
PATAGONIA PROJECT

Regional application PHYSAT and Phytoplankton speces



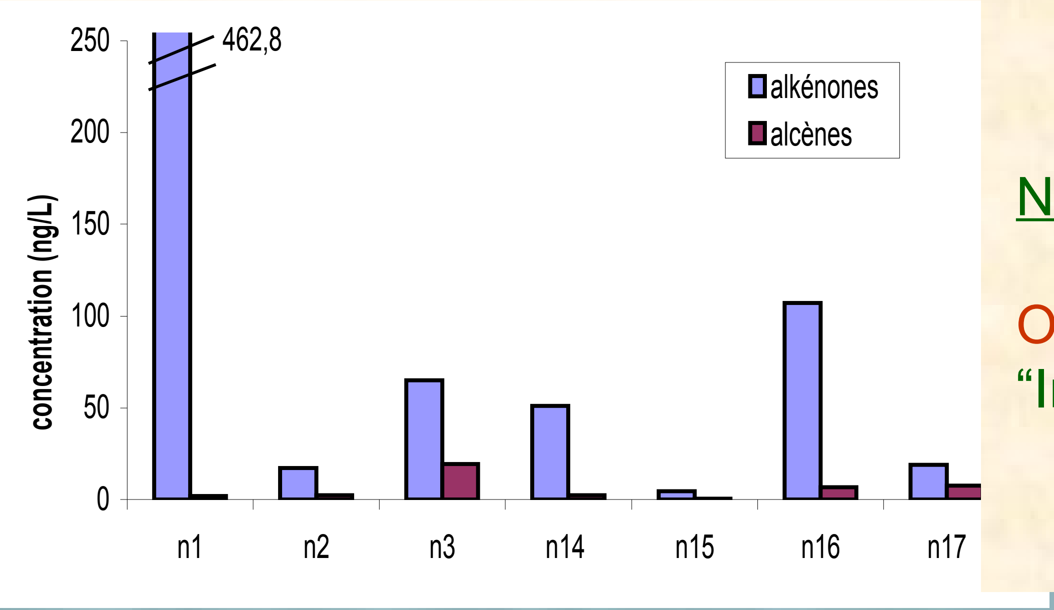


The unknown Patagonian coccolithophore Bloom



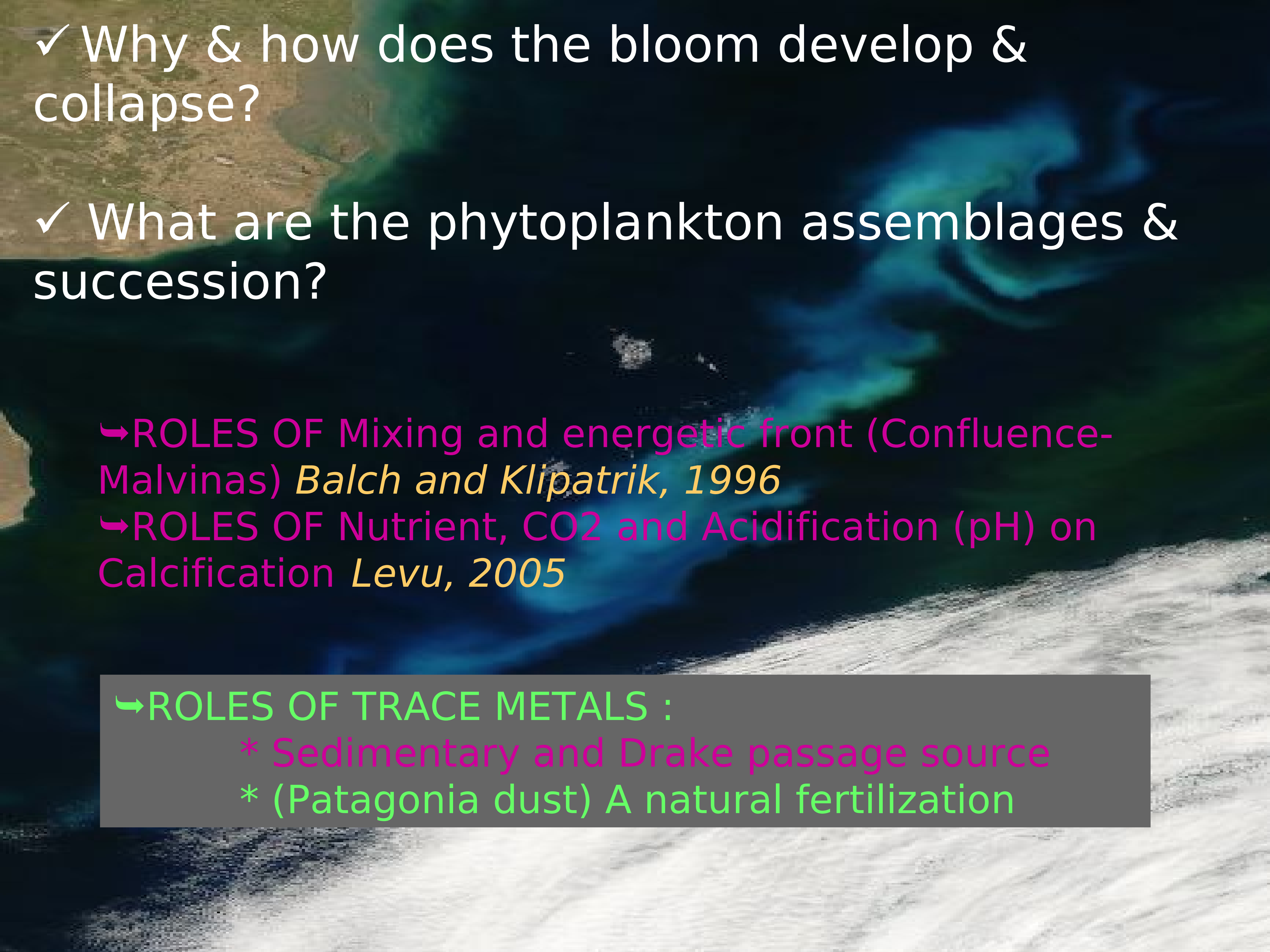
Satellite Coccolithophore mainly in the North of Polar front

Biomarker, pigments, microscop and genetic insitu data to validate Patagonian bloom (ARGAU 2000-2005 and PATAGONIA (2006), *Ruiz-Pino et al 2007*



North Atlantic :

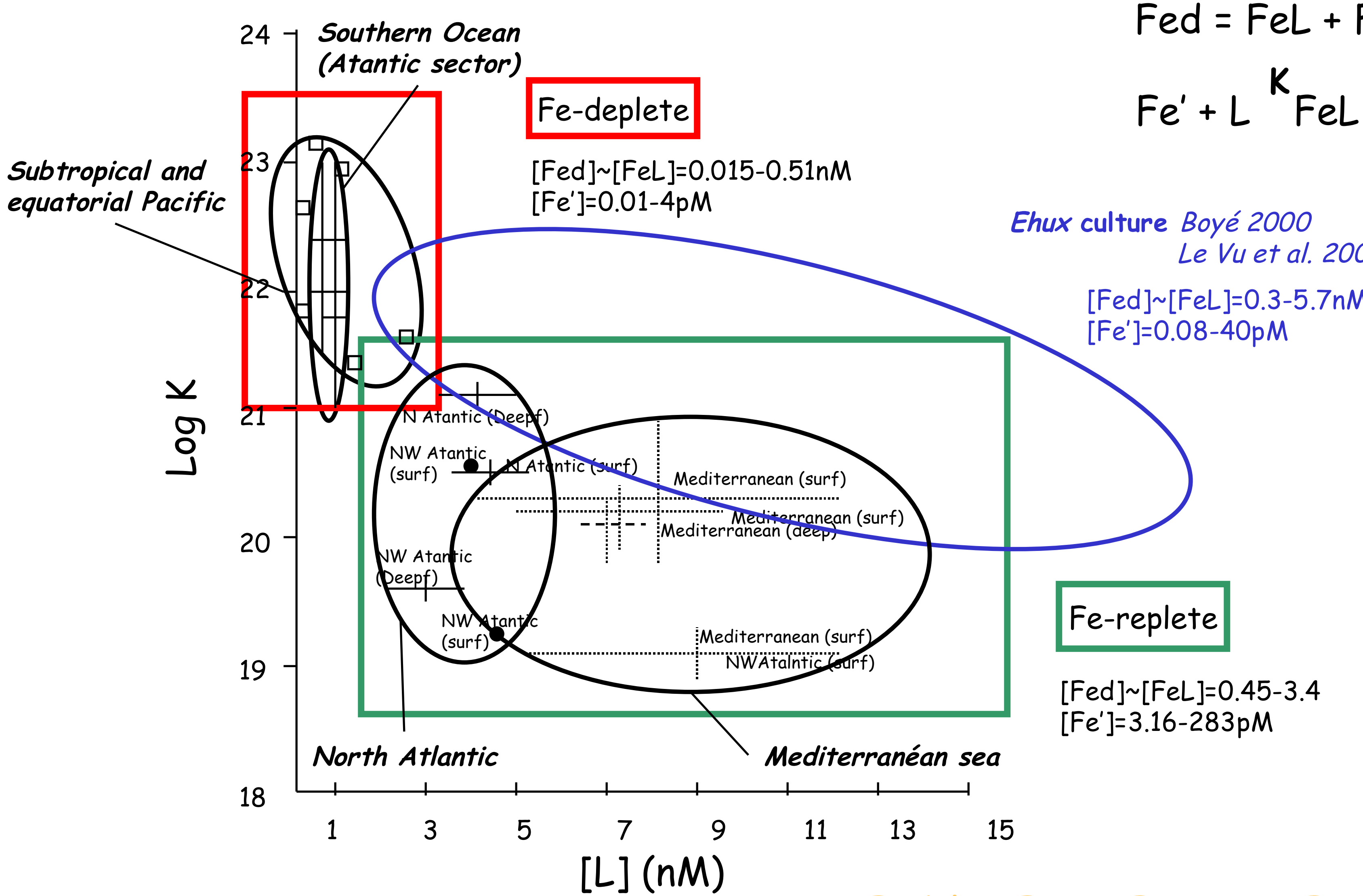
	ng/l	%
Out "bloom"	20-340	84-90
"Inside Bloom"	910-4640	80.2


✓ Why & how does the bloom develop & collapse?
✓ What are the phytoplankton assemblages & succession?
↪ROLES OF Mixing and energetic front (Confluence-Malvinas) *Balch and Klipatrik, 1996*
↪ROLES OF Nutrient, CO2 and Acidification (pH) on Calcification *Levu, 2005*
↪ROLES OF TRACE METALS :
* Sedimentary and Drake passage source
* (Patagonia dust) A natural fertilization

n front of dusts

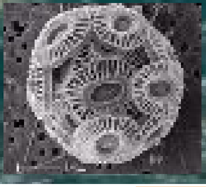
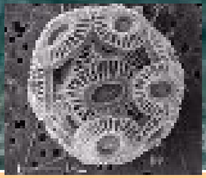
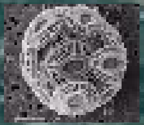
Fed = FeL + Fe'

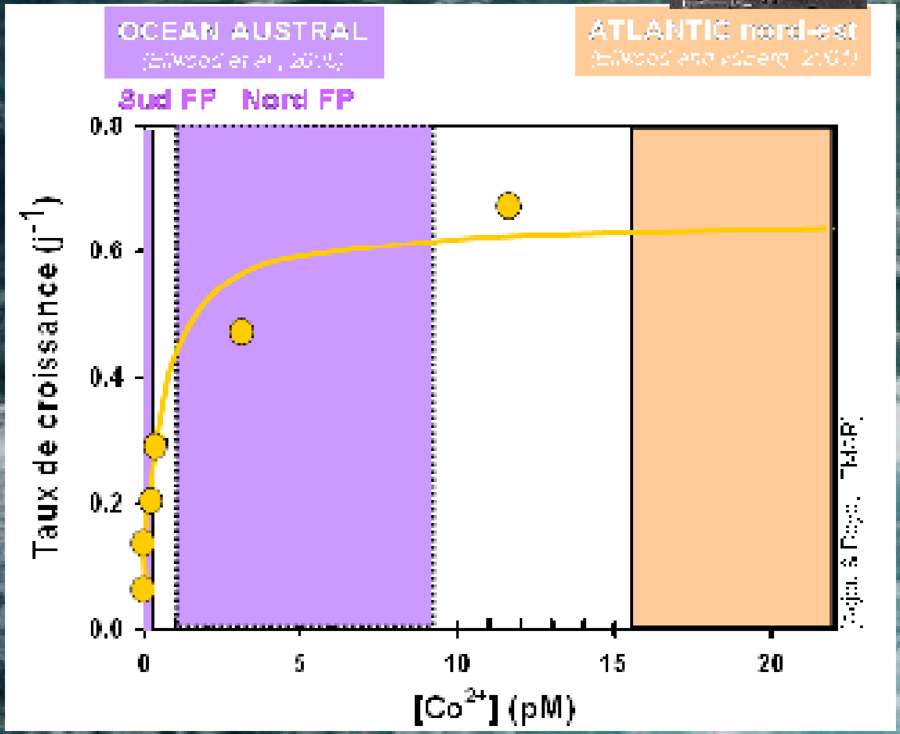
$Fe' + L \overset{K}{\rightleftharpoons} FeL$

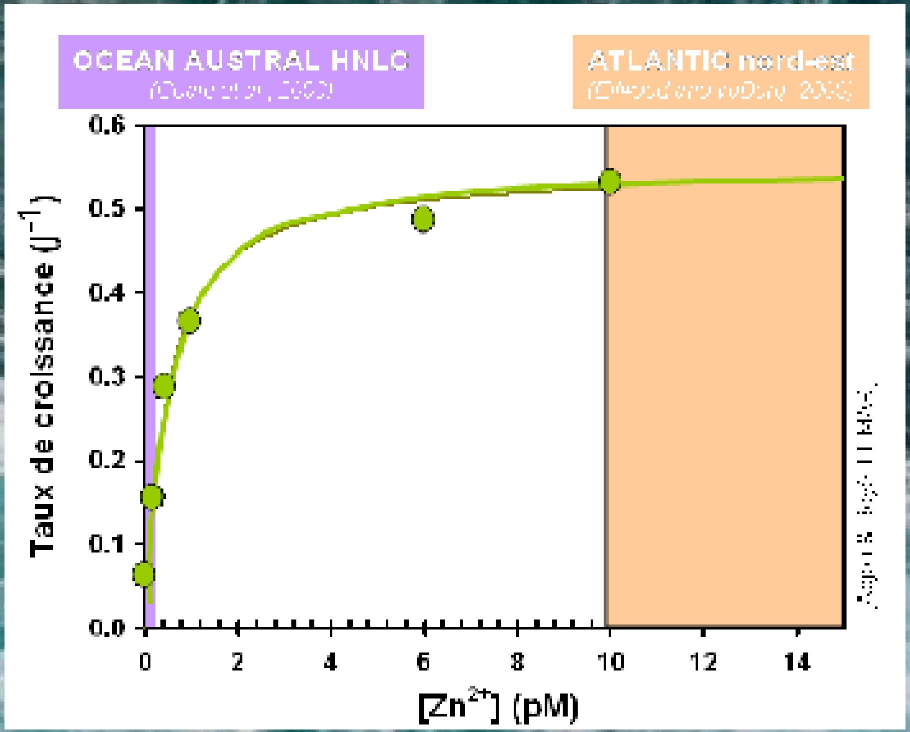


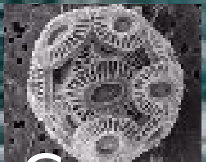
Faible [Fe] = Fort K = Faible [L]
Ehux = Large fenêtre

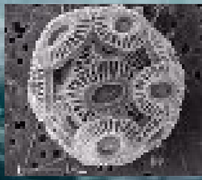
CULTURES vs OCEANIC CONCENTRATIONS



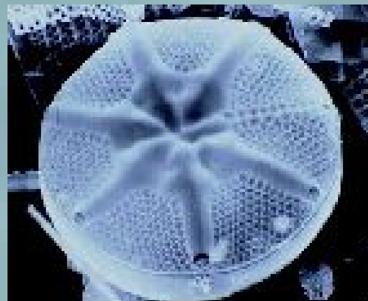




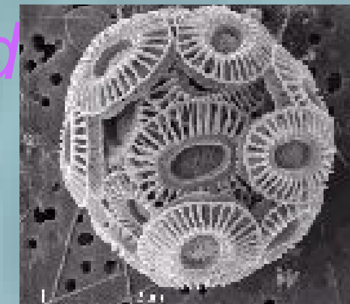


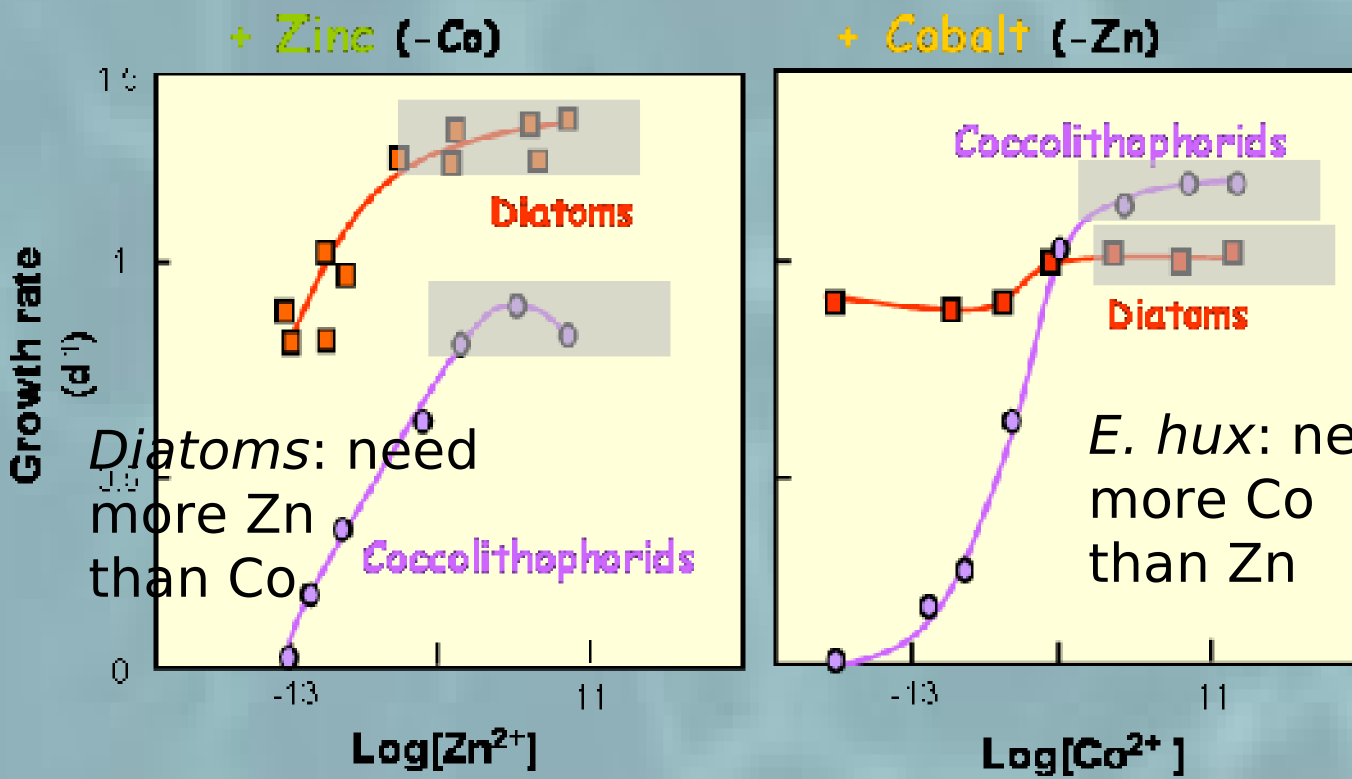
Concentrations in the Argentin Basin ?

TS OF TRACE METALS ON PHYTOPLANKTON GROWT



vs coccolithophorid





Diatoms: need more Zn than Co

E. hux: need more Co than Zn

[Sunda and Huntsman, 1995; 1992; 2000]

tio can impact the production & distribution of these 2 specie

PATAGONIA Oceanographic cruise

strategy

Where ? : Atlantic South-Ouest and Argentinian Basin

When ? : December 2008 – January 2009 (1 month)

How ? : El Puerto Deseado *Argentina SHN*

- Scientist from Argentina-France

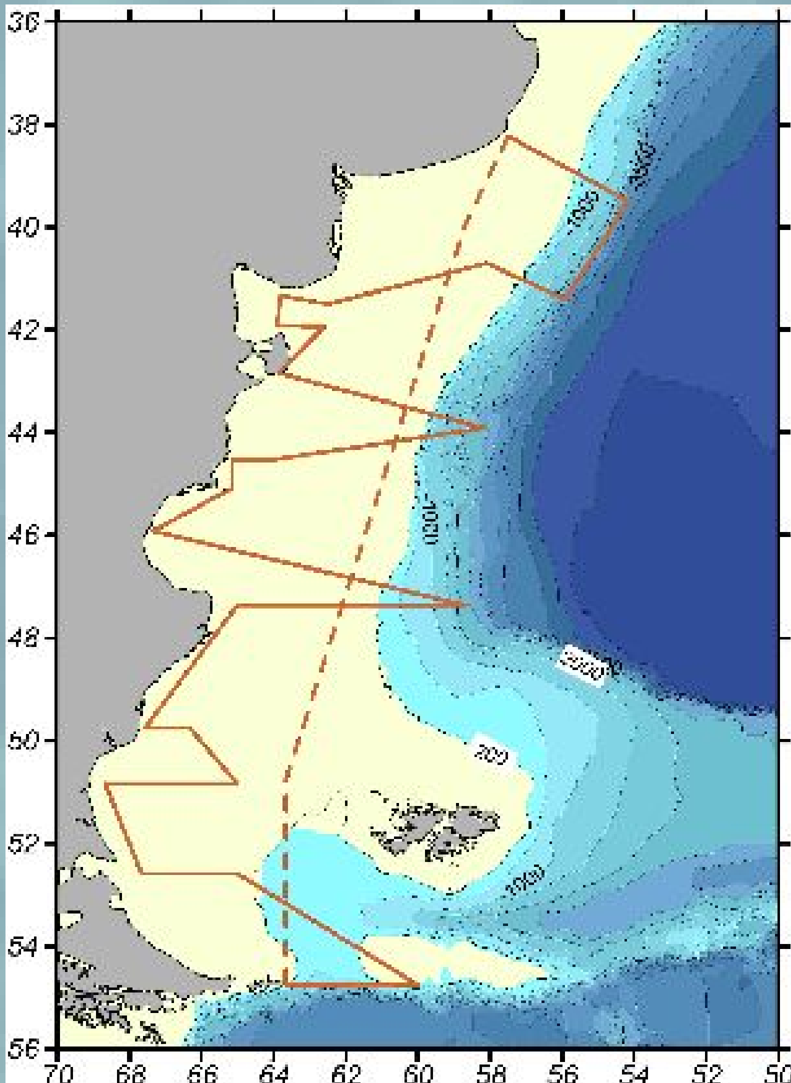
Atmosphere :

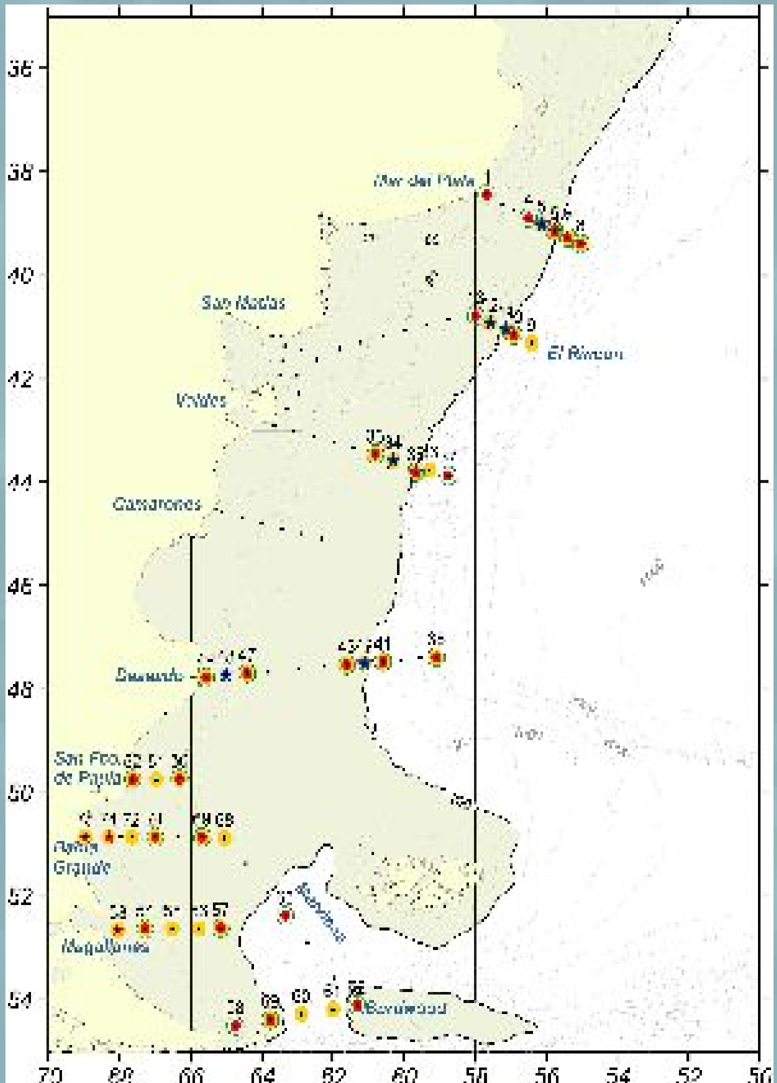
Dust, Meterorology, CO2

Ocean : 80 station and sea-surface

- Hydrology and Courent
- Chemistry : Nutrient, O2, TCO_2, pH, Alkalnity, pCO_2
- Biology : Coccolithophore, diatoms and other phytoplankton (speces and biomass)

Financial support : GEF, INSU-LEFE, ECOS-Sur, SHN

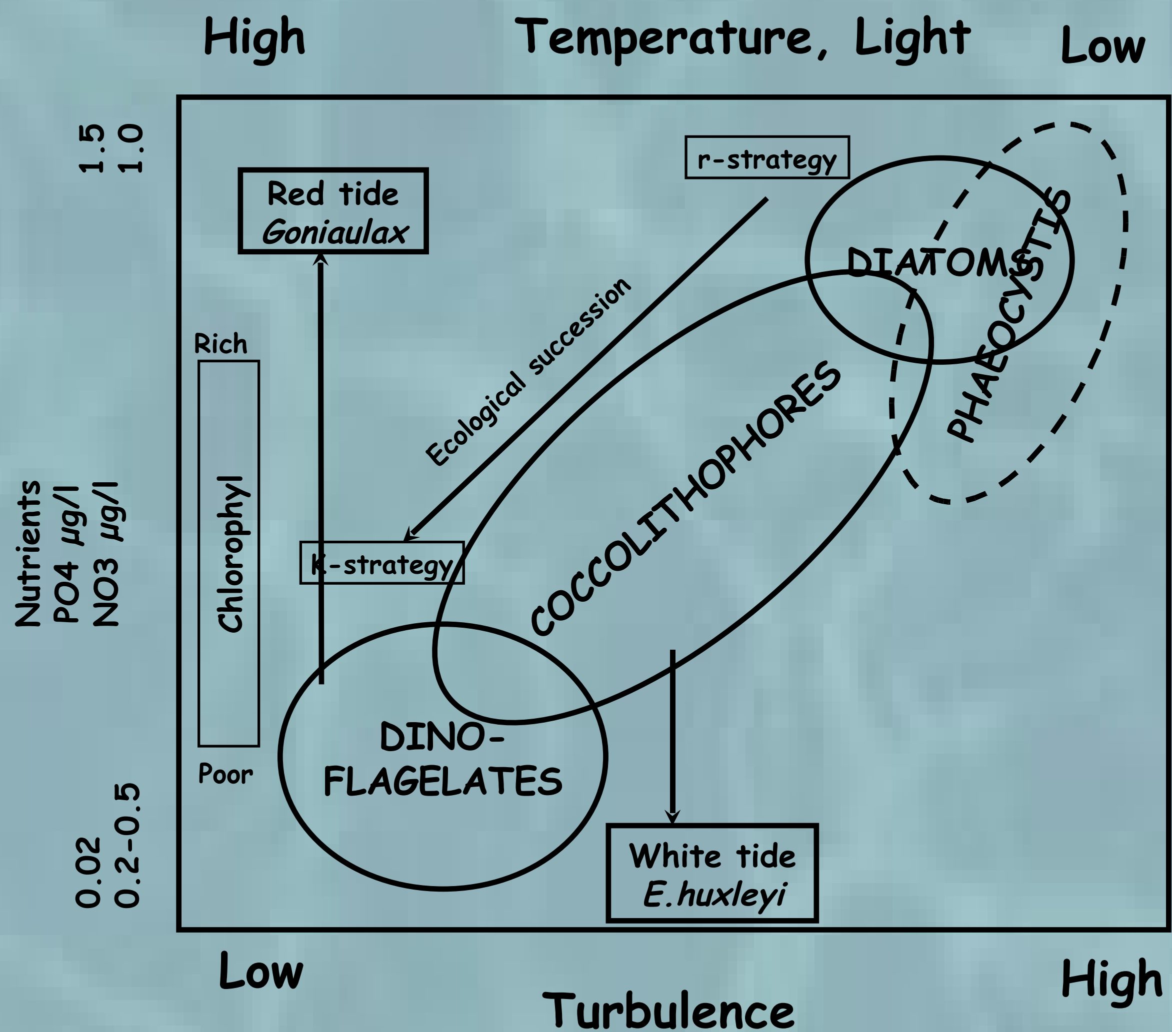




➥How ? A summer (2008-2009) Oceanographic cruise

Stratégie de vie

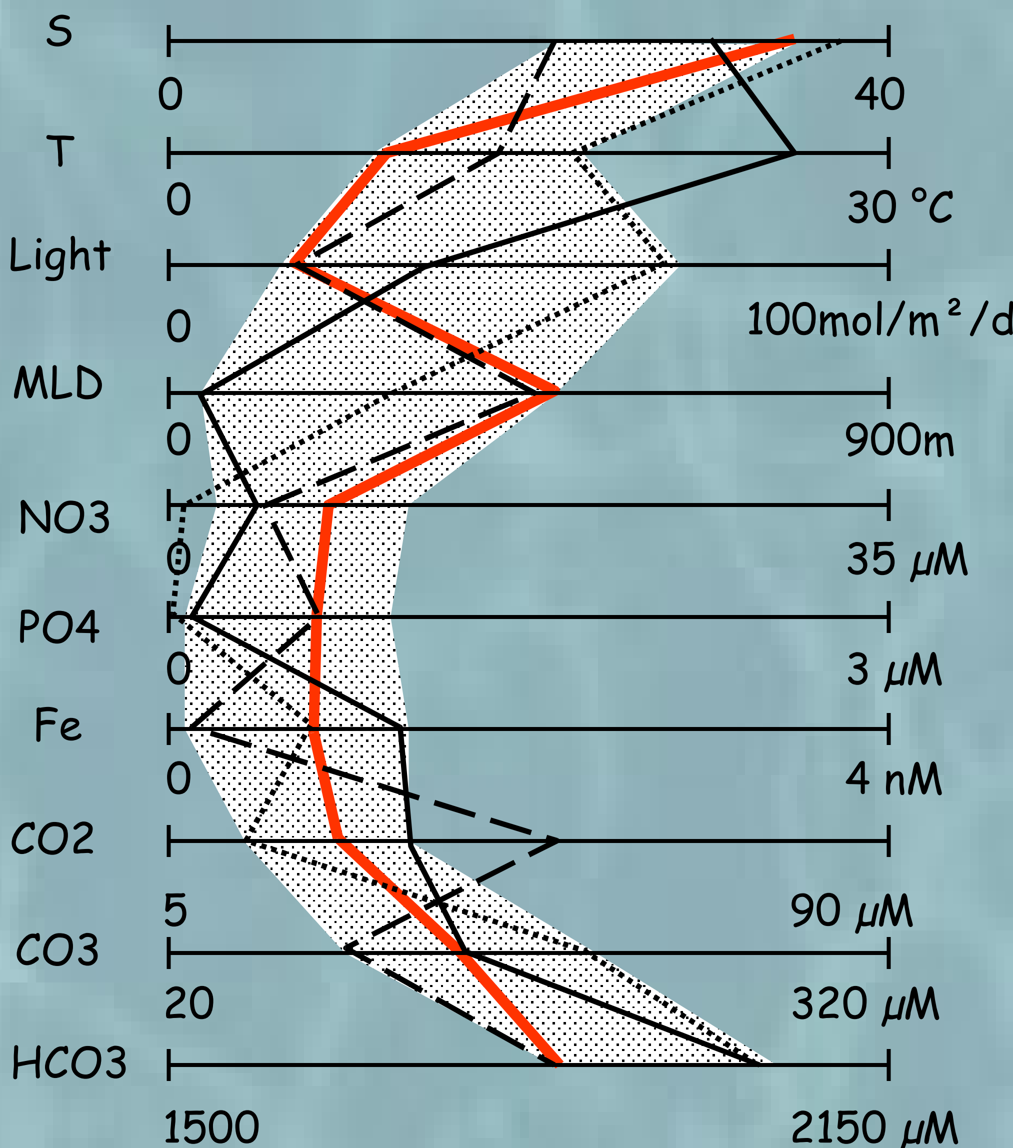
Compétition/ autres espèces et turbulence

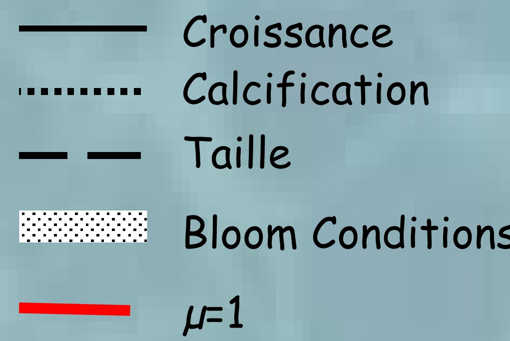


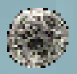
adapted from Margalef 1983 ; Cachao et al. 1998

Niches écologiques

Fourchettes







Visible

Dynamique physique donne la distribution

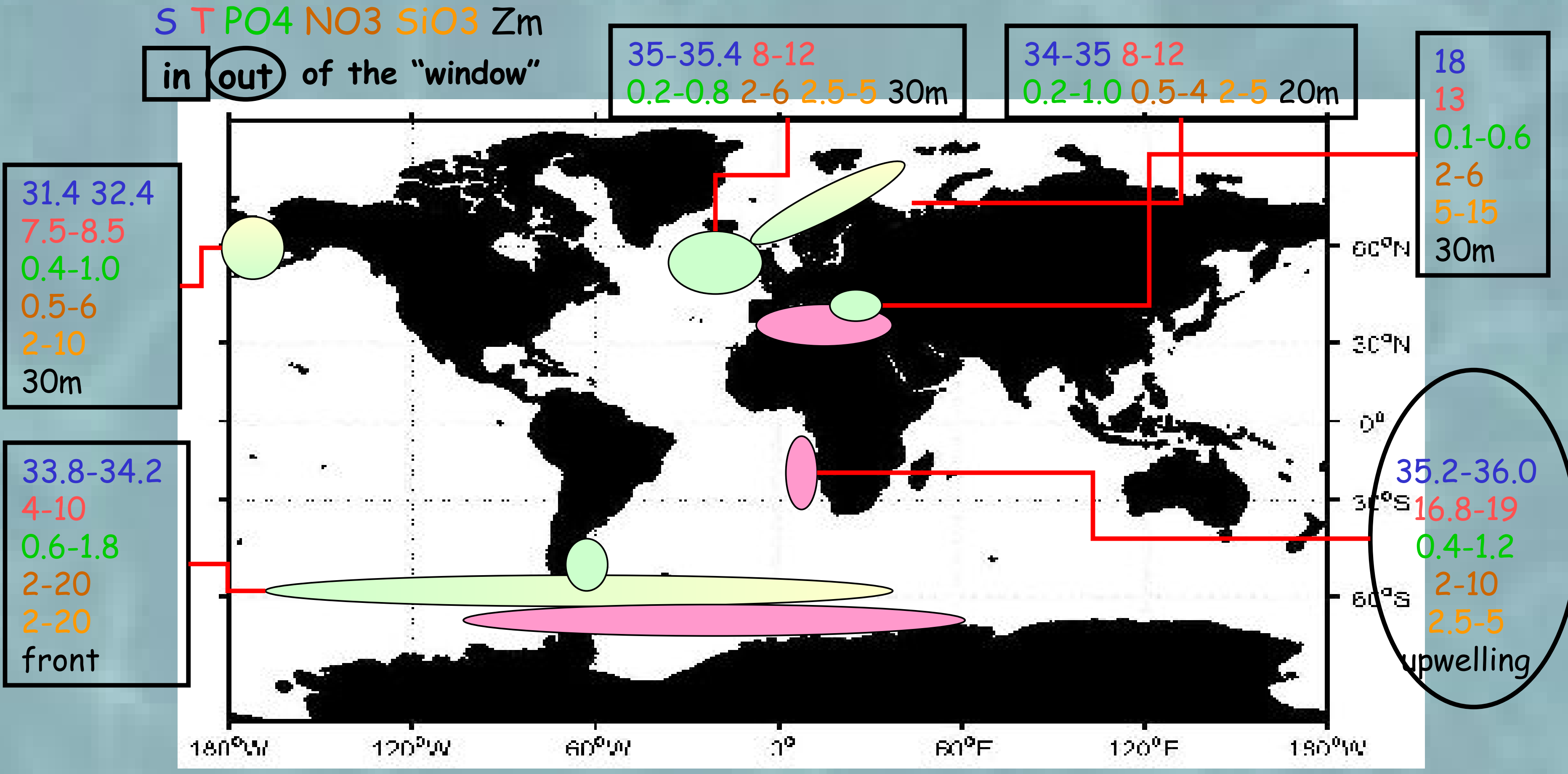
Invisible

PO4 limitant
non limitant µ stimule Calcif
mais pas détaahcment

Niches écologiques

Validation

visibles



WOCE global data base NODC, 1998