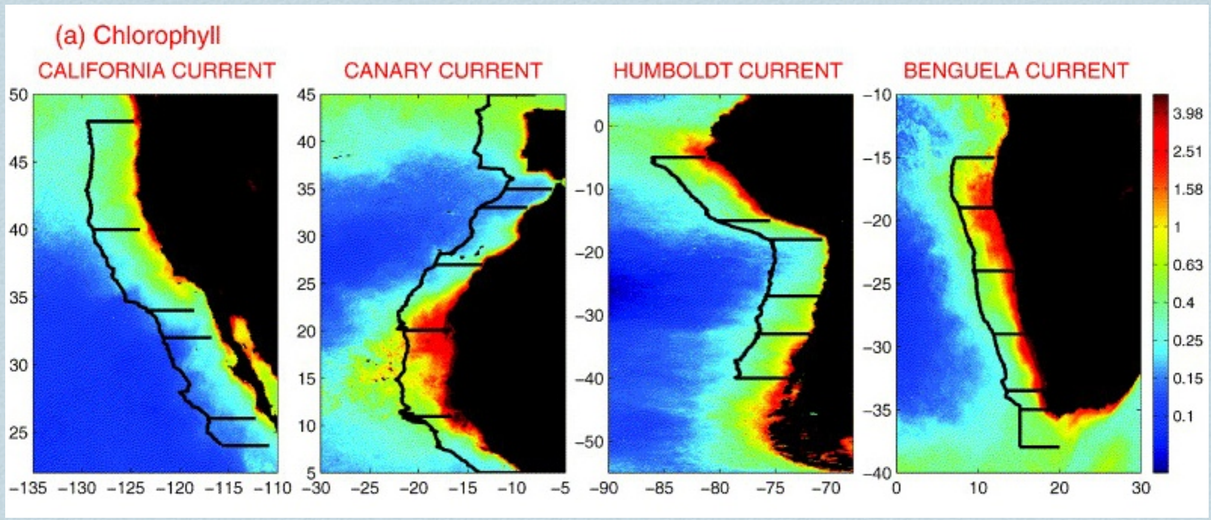
Biophysical 3D modeling approach of the Canary Current Ecosystem: a ROMS-PISCES coupling study

Yeray Santana Falcón

Supervised by
Evan Mason and Javier Arístegui Ruiz

- Eastern Boundary Currents account for the most productive coastal environments



Carr, 2002

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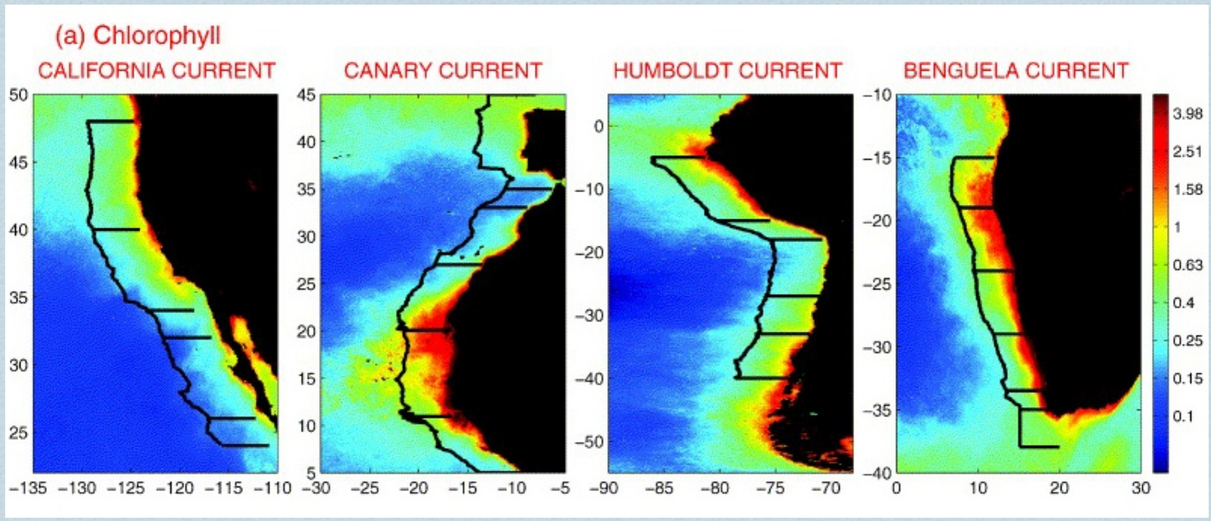
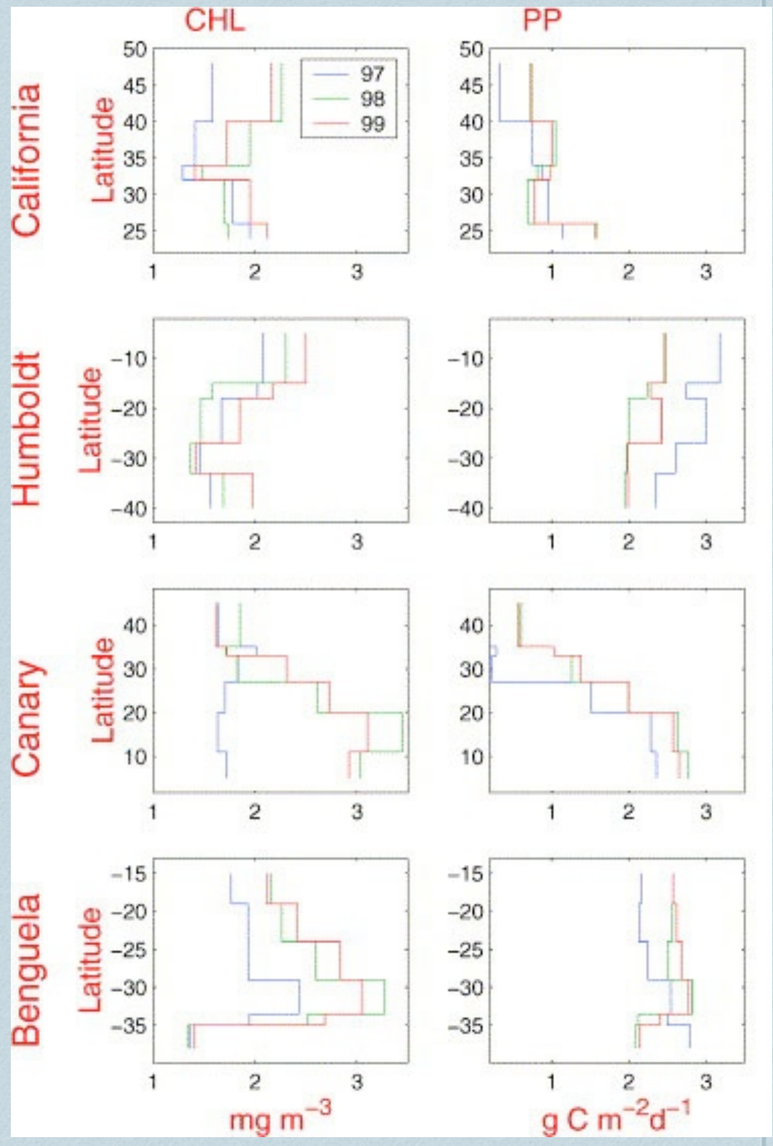
- Eastern Boundary Currents account for the most productive coastal environments

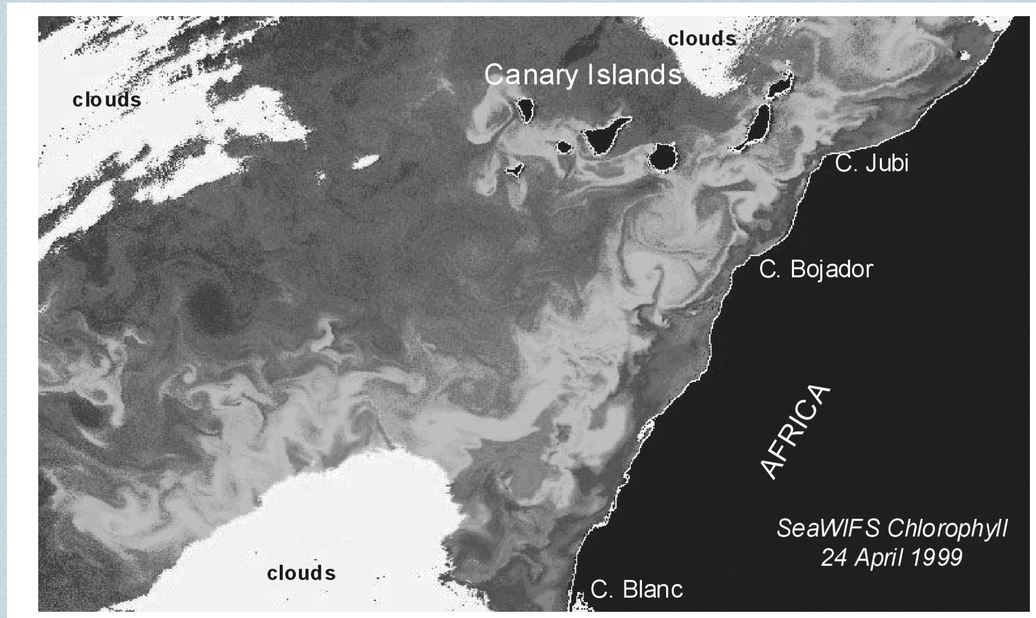


Carr, 2002



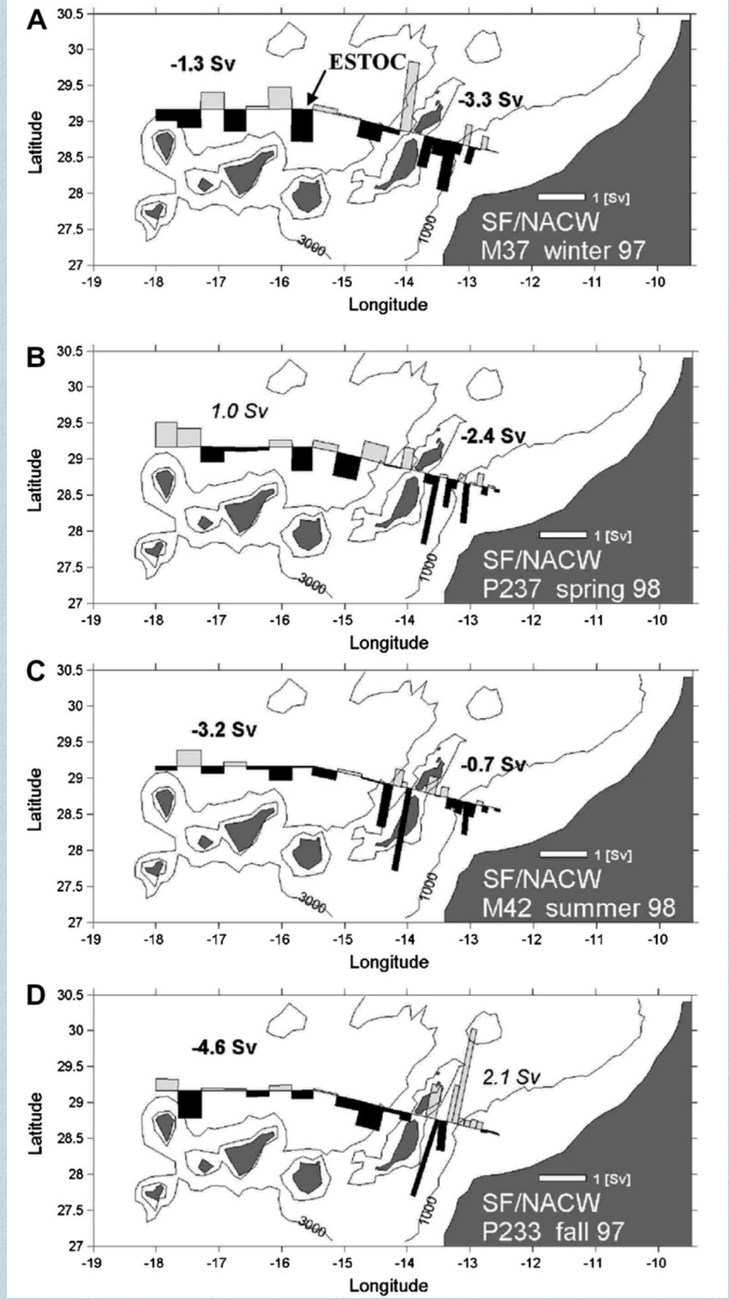
Carr, 2002

- Eastern Boundary Currents account for the most productive coastal environments
- Canary Current Ecosystem (CCE) has strong geographical diversity
- CCE oligotrophic?
- Impact of mesoscale EDDIES



Arístegui et al., 2004

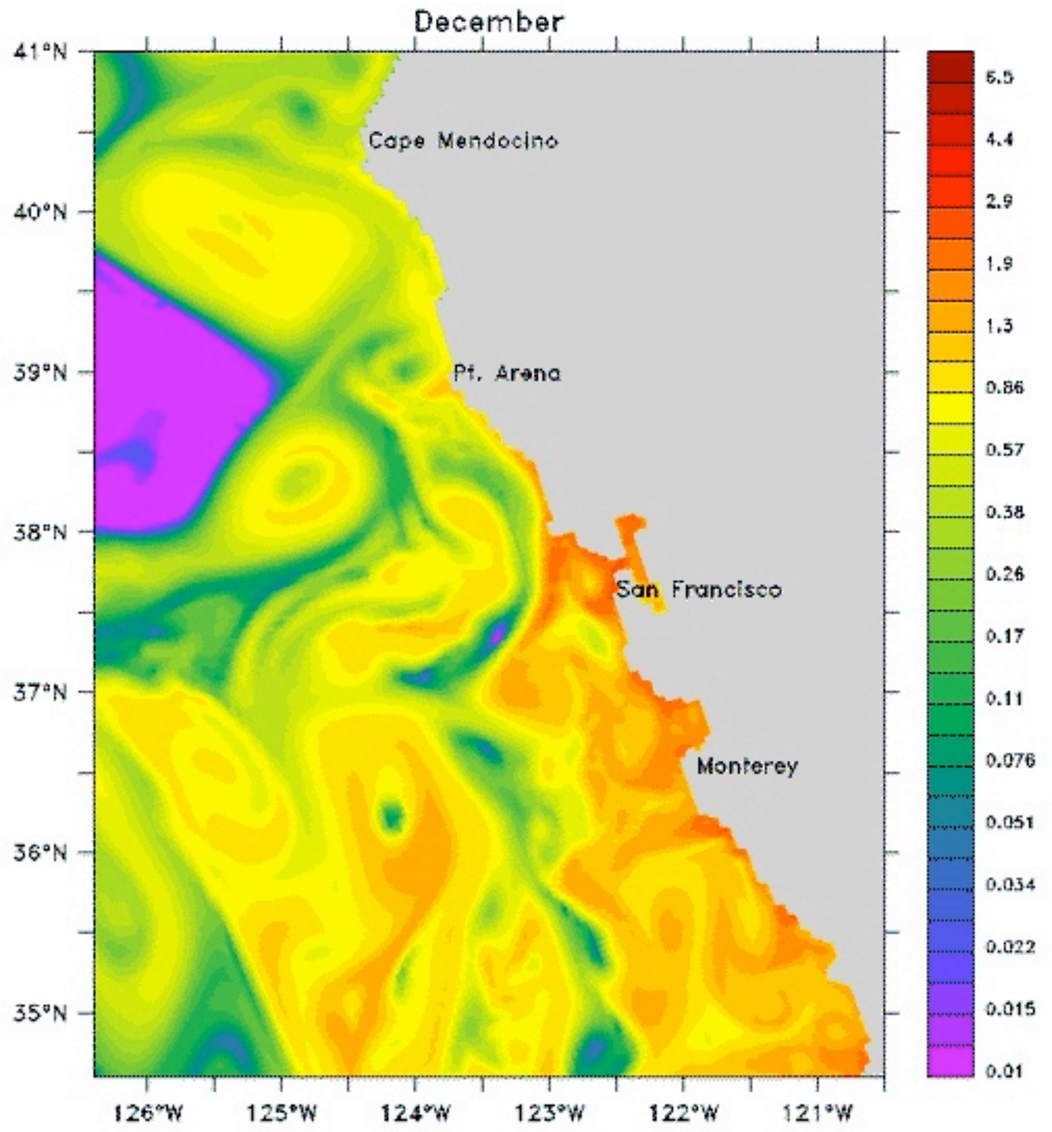
- Interannual variability of the CCE
  - Late-winter bloom
  - Summer
  - Autumn



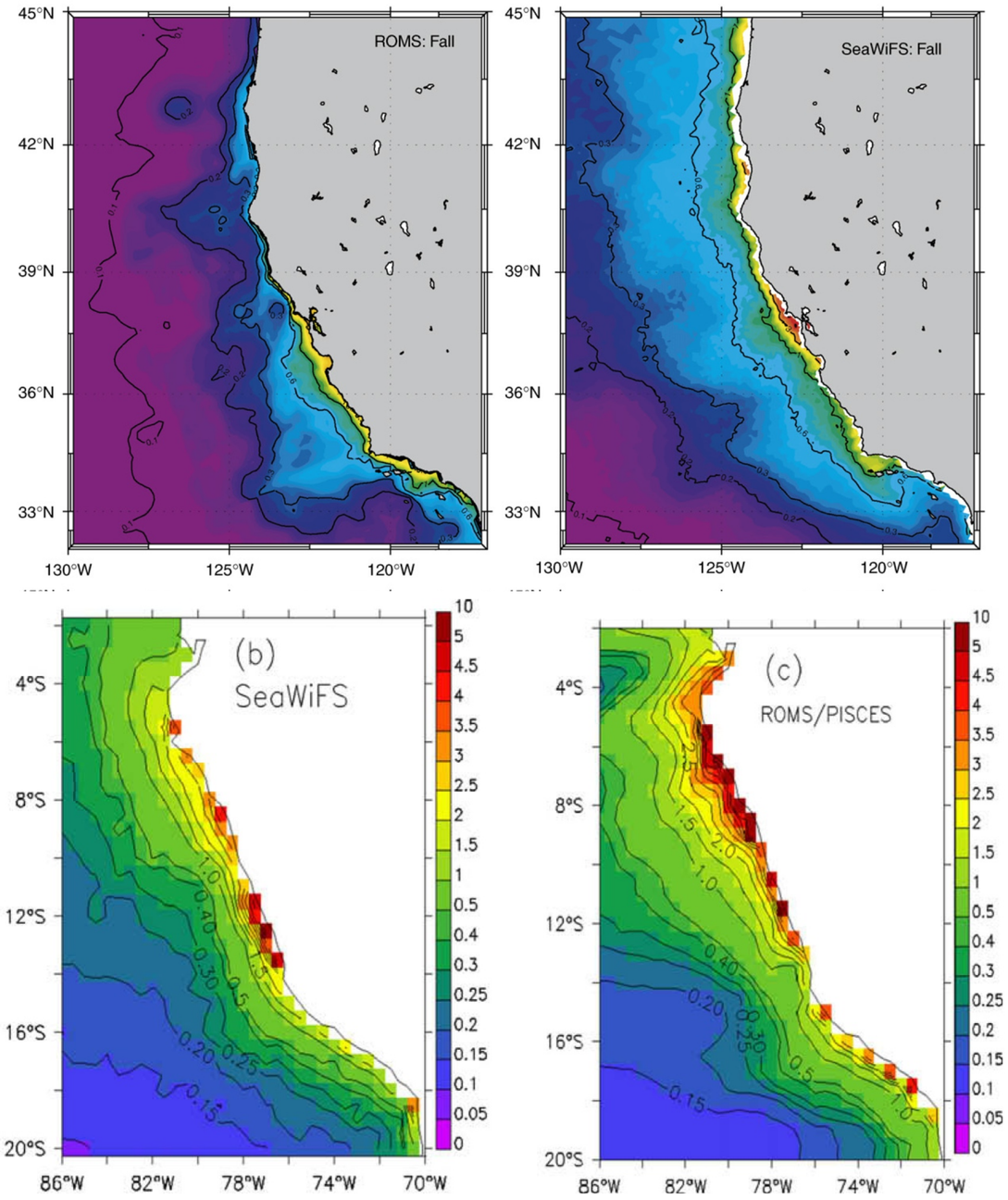
Neuer et al., 2007

- ROMS-PISCES combined for the first time for CCE
- Chlorophyll as the indicator of the model performance
- Qualitatively well reproduced chlorophyll patterns
- Quantitatively underestimation of chlorophyll concentrations

- IRD (Institut de Recerche per le Développement) version of ROMS (Regional Oceanographic Modeling System)
- Prognostic variables are:
  - Surface elevation
  - Barotropic and baroclinic horizontal velocities
  - Temperature, salinity and density

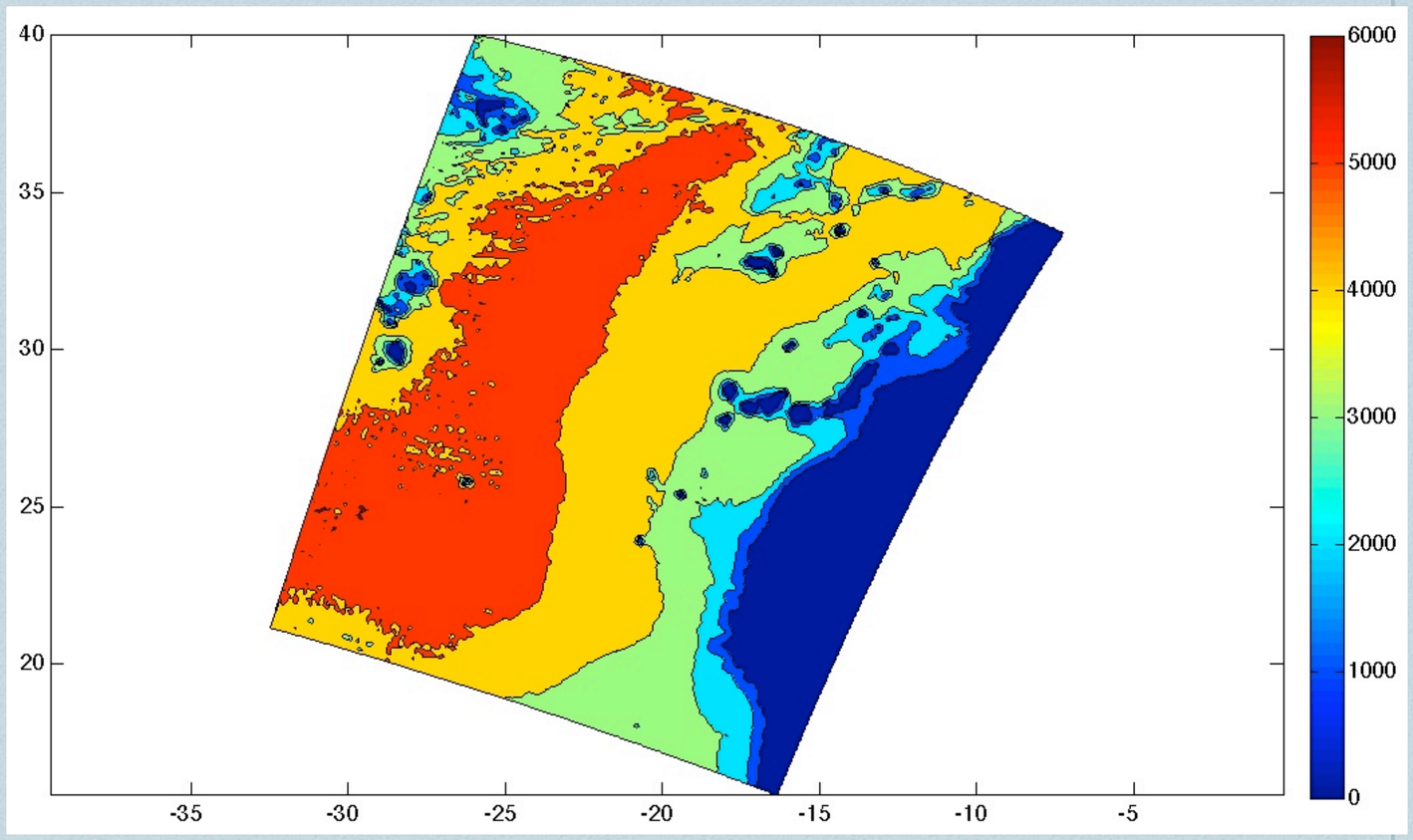


McWilliams, UCLA website



Echevin et al., 2008

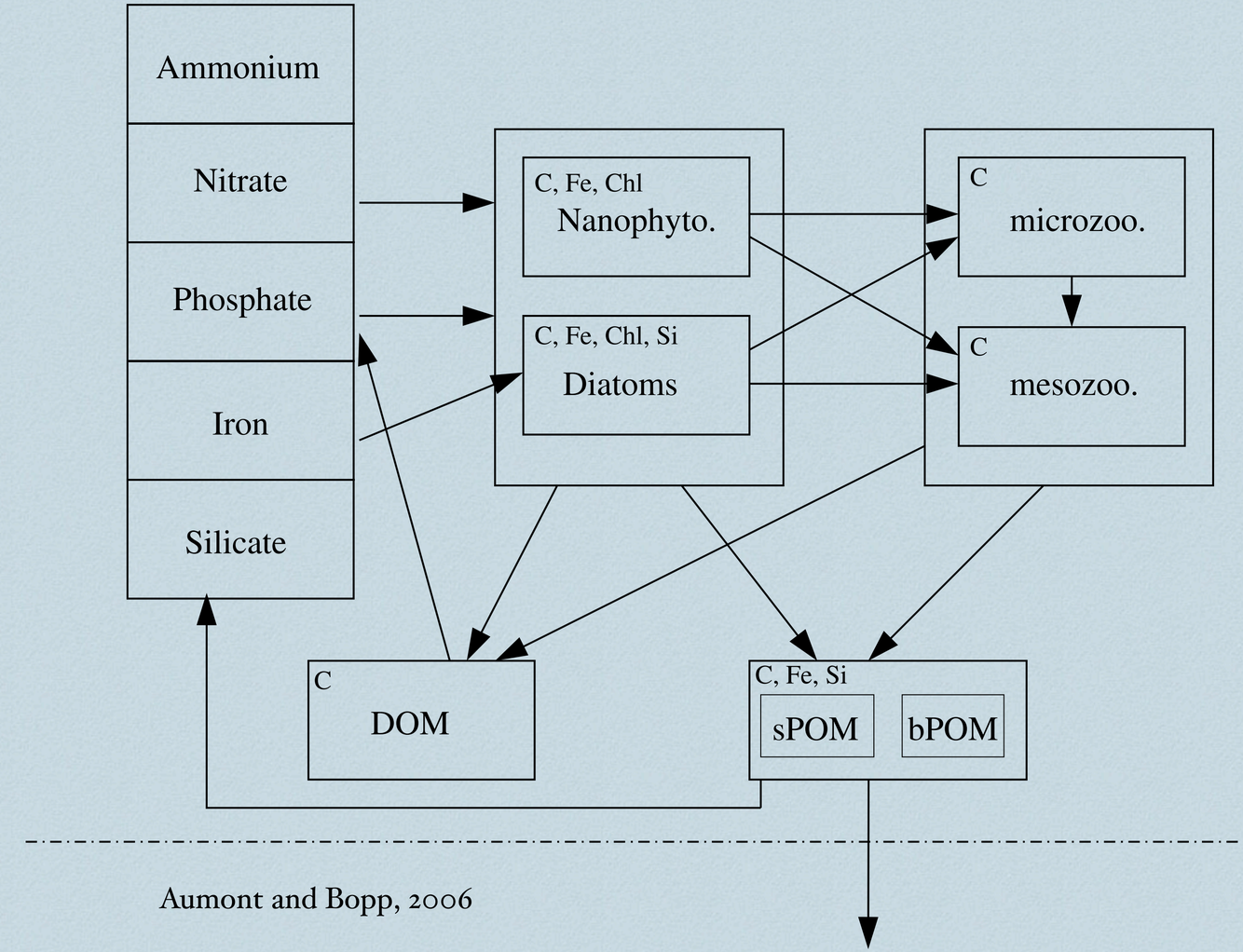
- Model configuration
  - roms2roms
  - 7.5km of resolution
  - 32 sigma-levels
- Forced by:
  - Mason et al. (2011)
  - COADS
  - QuikSCAT



Bathymetry (m)

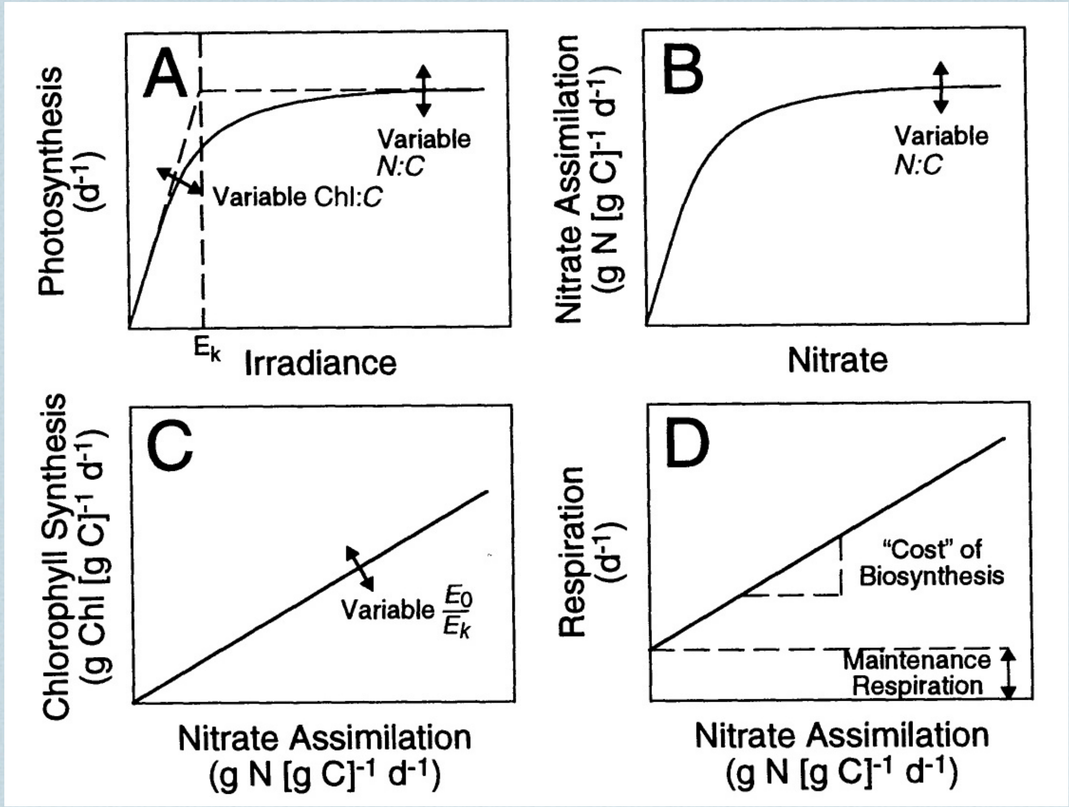
- Five limiting nutrients for phytoplankton growth
- Four living compartments; 2 phytoplankton and 2 zooplankton
- Three non-living compartments; DOC and two sizes of POC
- DIC, Alkalinity, dissolved O2

- Pelagic Interaction Scheme for Carbon and Ecosystem Studies (PISCES)



Aumont and Bopp, 2006

- Modeled chlorophyll
  - Predicted by external concentrations of the limiting nutrients
- Using photo-adaptive model of Geider et al. (1998)
- Depends on chlorophyll-to-carbon ratio



Geider et al., 1998

- Observational data
  - SeaWiFS chlorophyll
  - In situ data
    - COCA
- Barton et al. (1998)
- Arístegui and Montero (2005)
- Neuer et al. (2007)
- Alonso-González et al. (2009)

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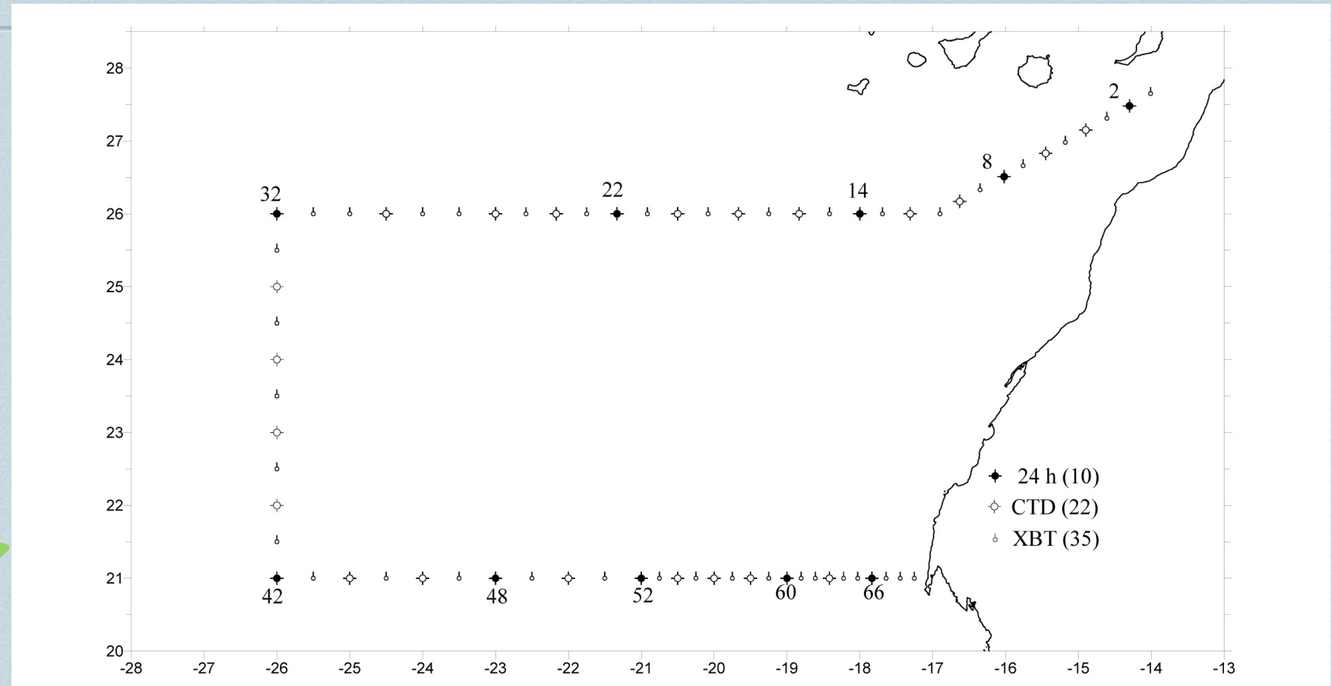

- Barton et al. (1998)
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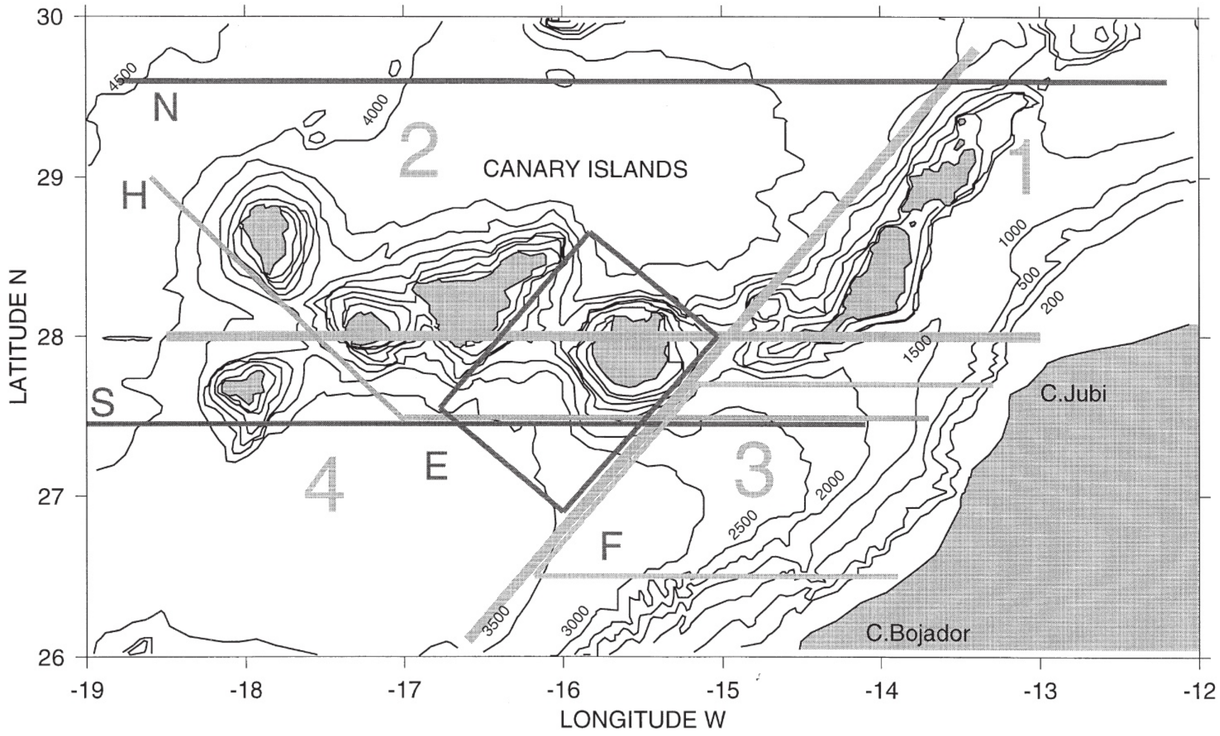

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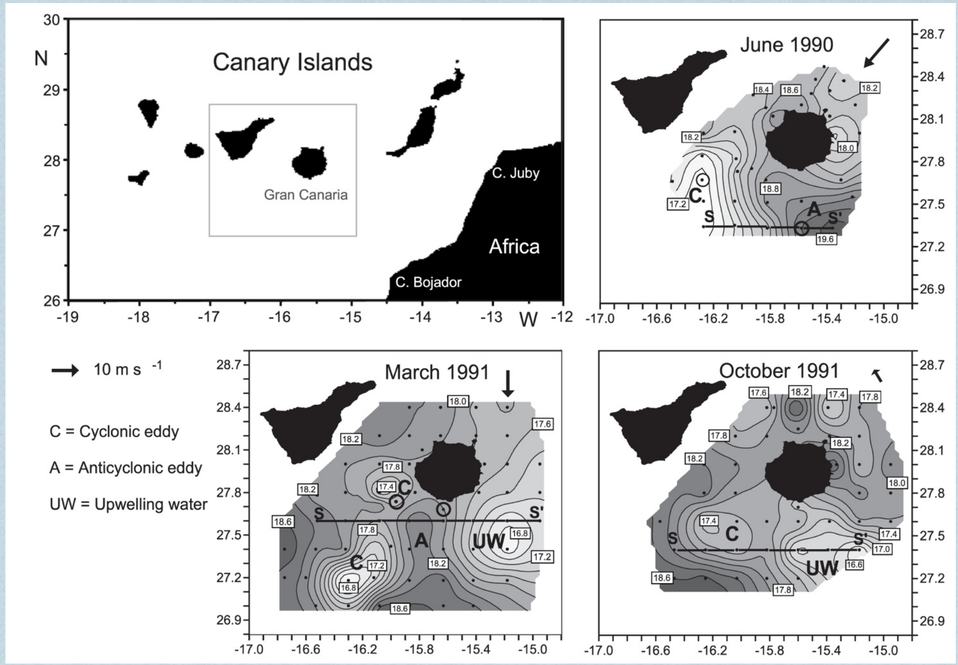

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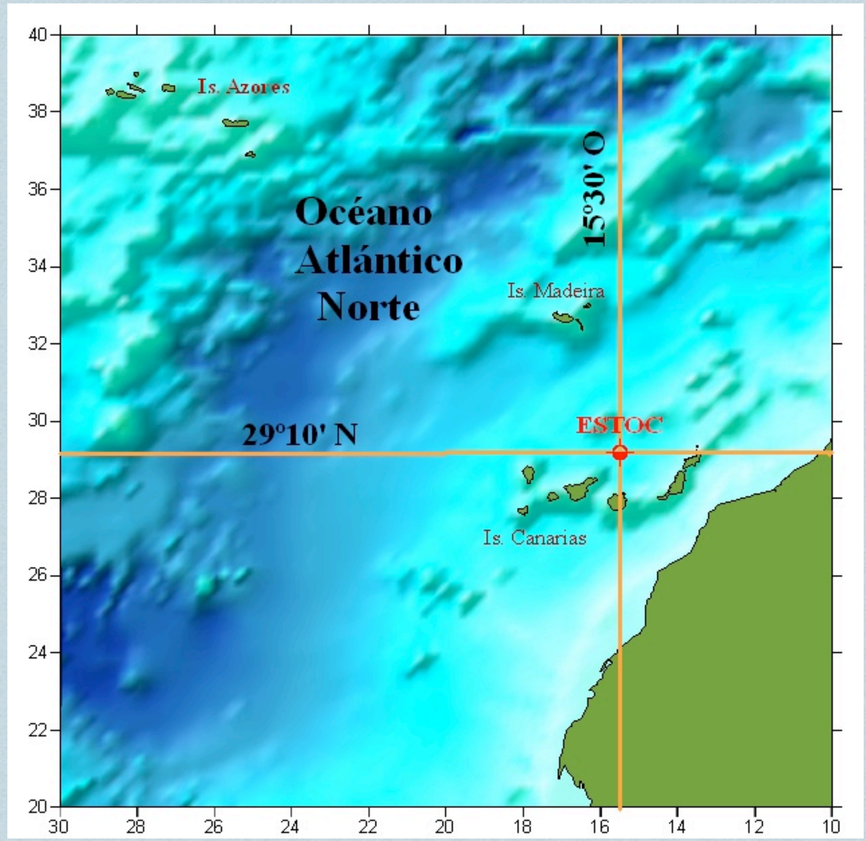

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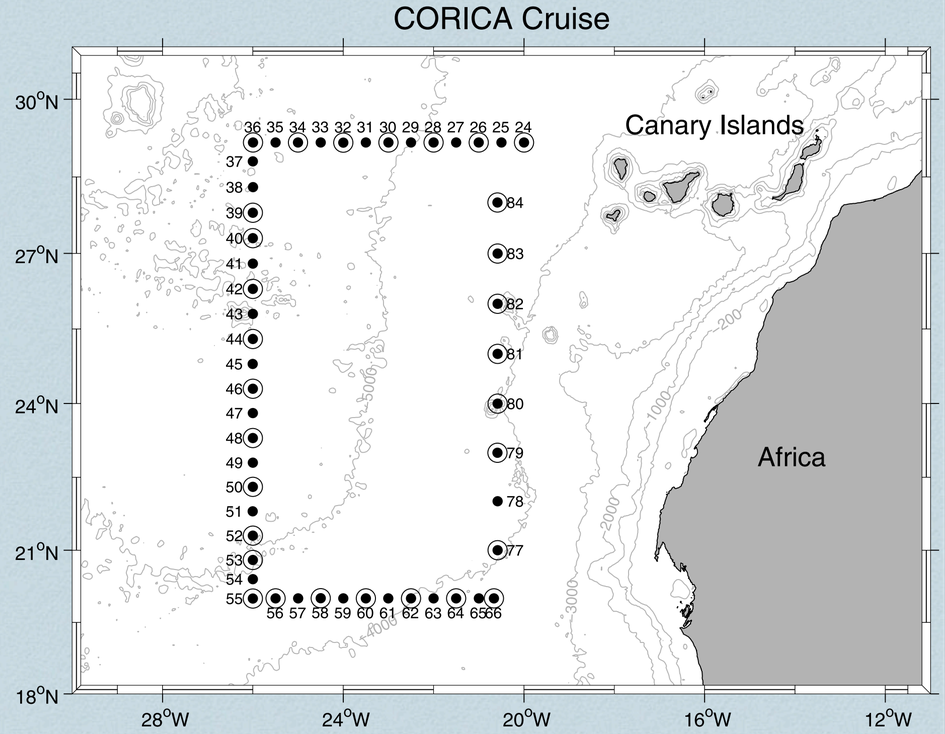

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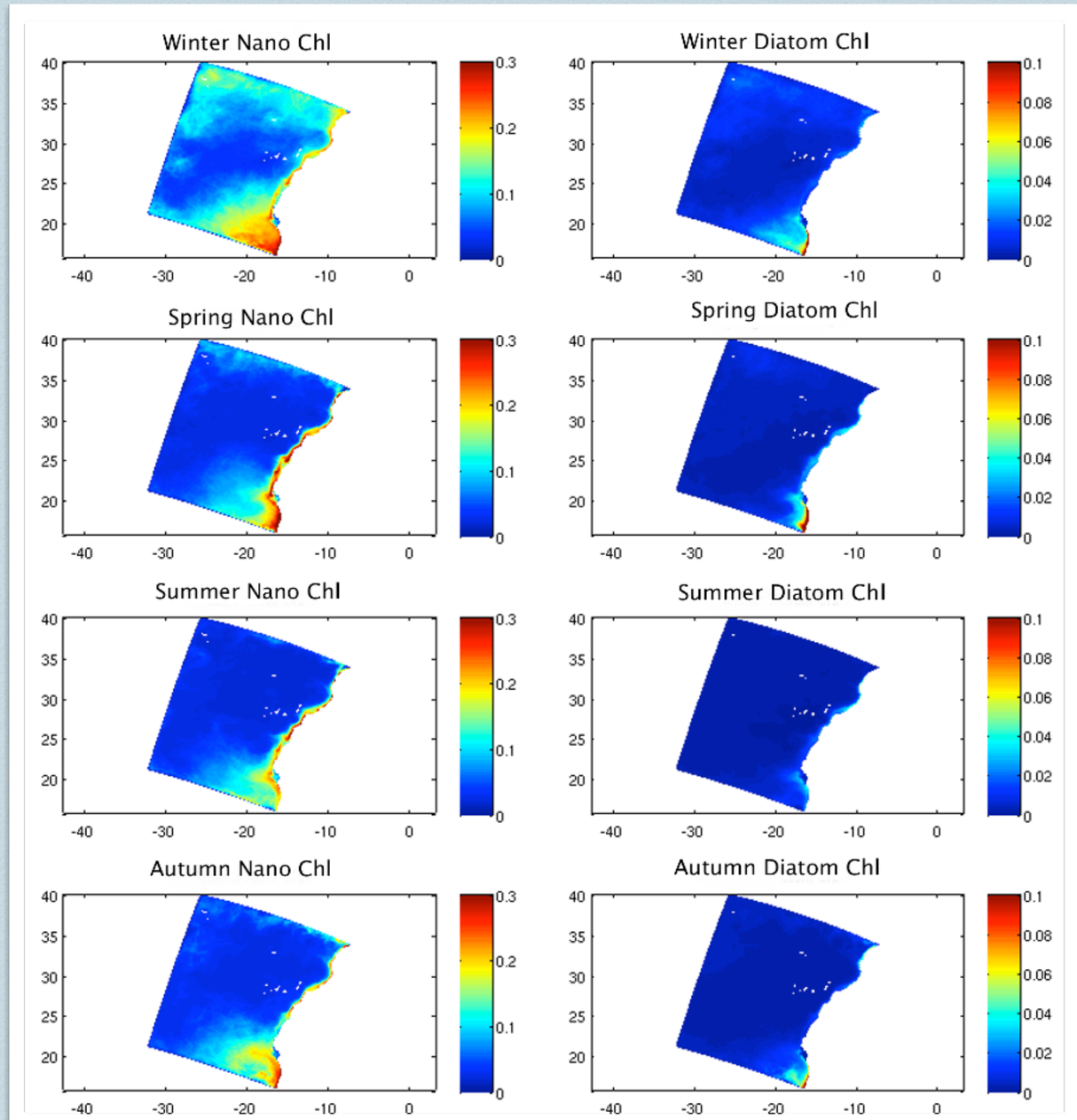
- Chlorophyll splits into two compartments
- NCHL
- DCHL



Modelled Chlorophyll (mg/m3)

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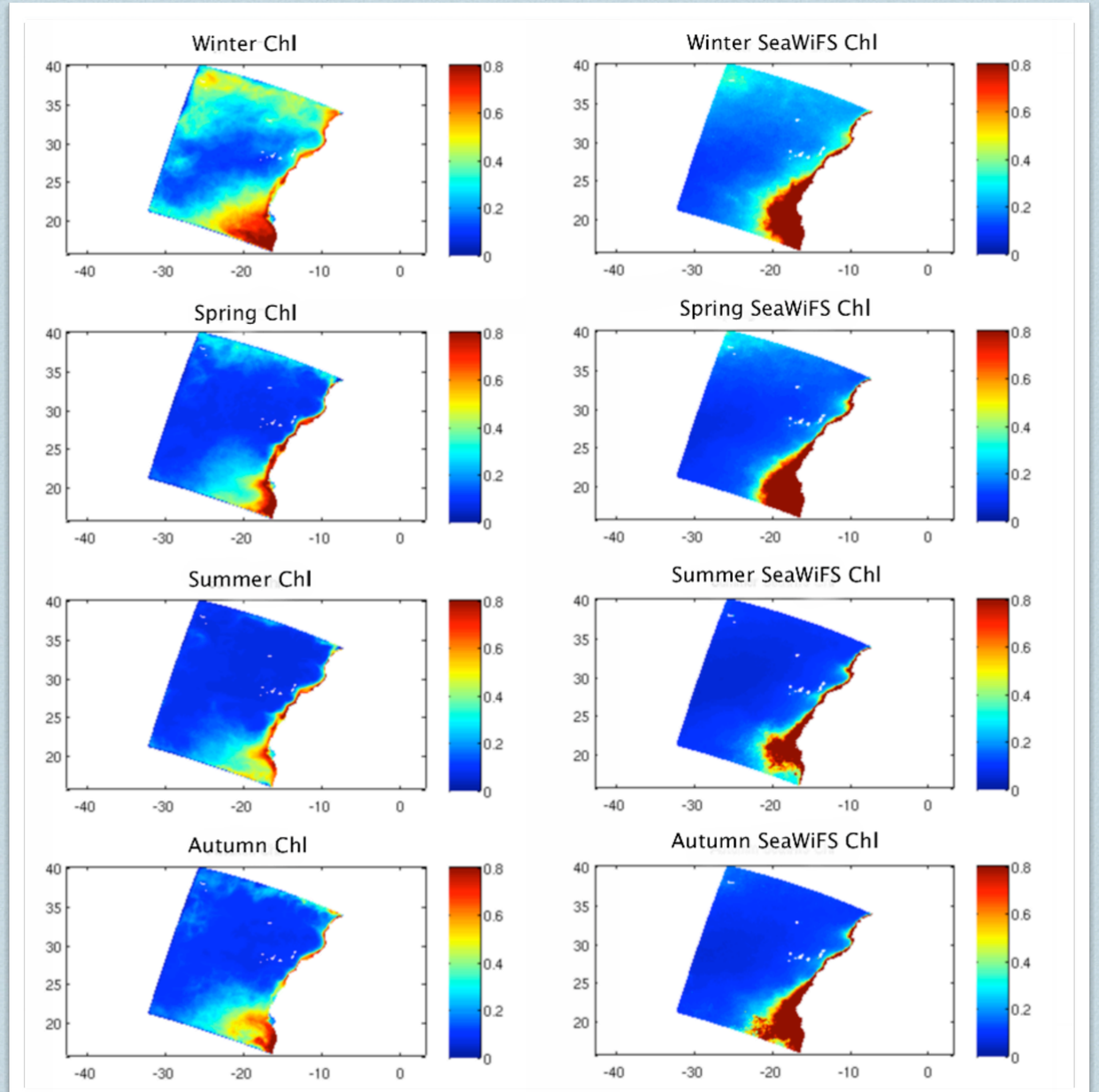
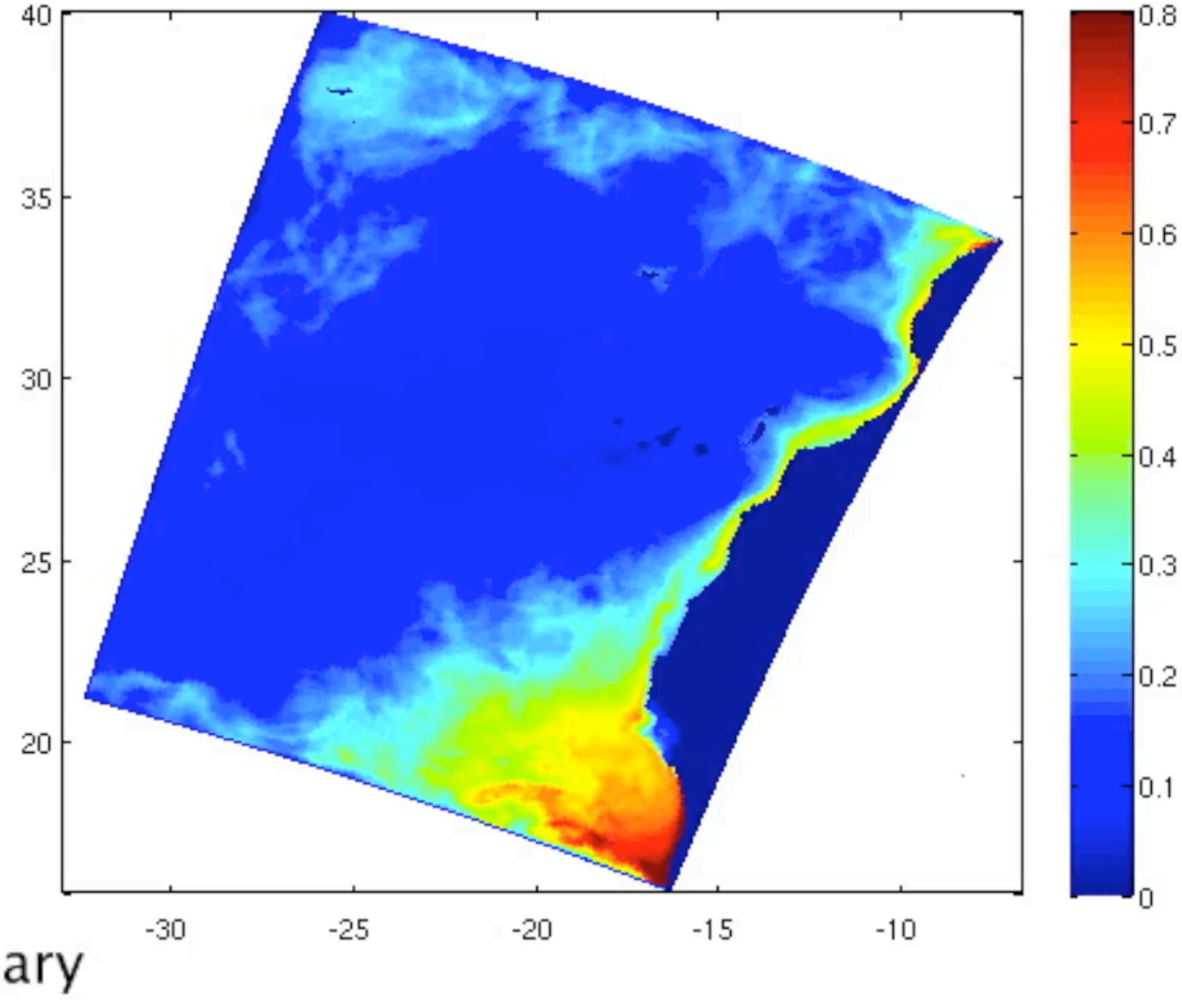
- Modeled vs SeaWiFS chlorophyll



Modelled Chlorophyll (mg/m3)


40
35
30
25
20
-30
-25
-20
-15
-10
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
January

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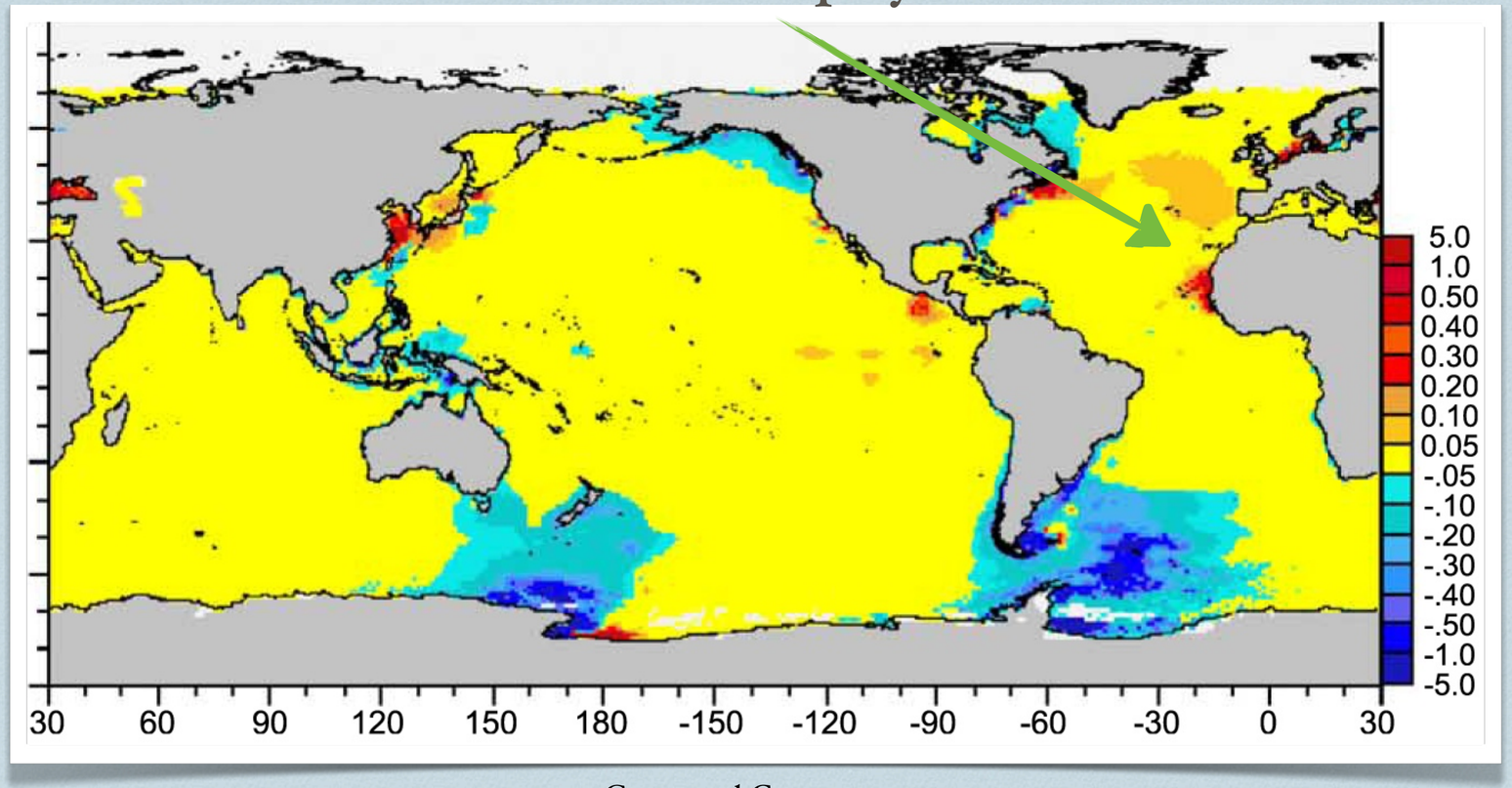
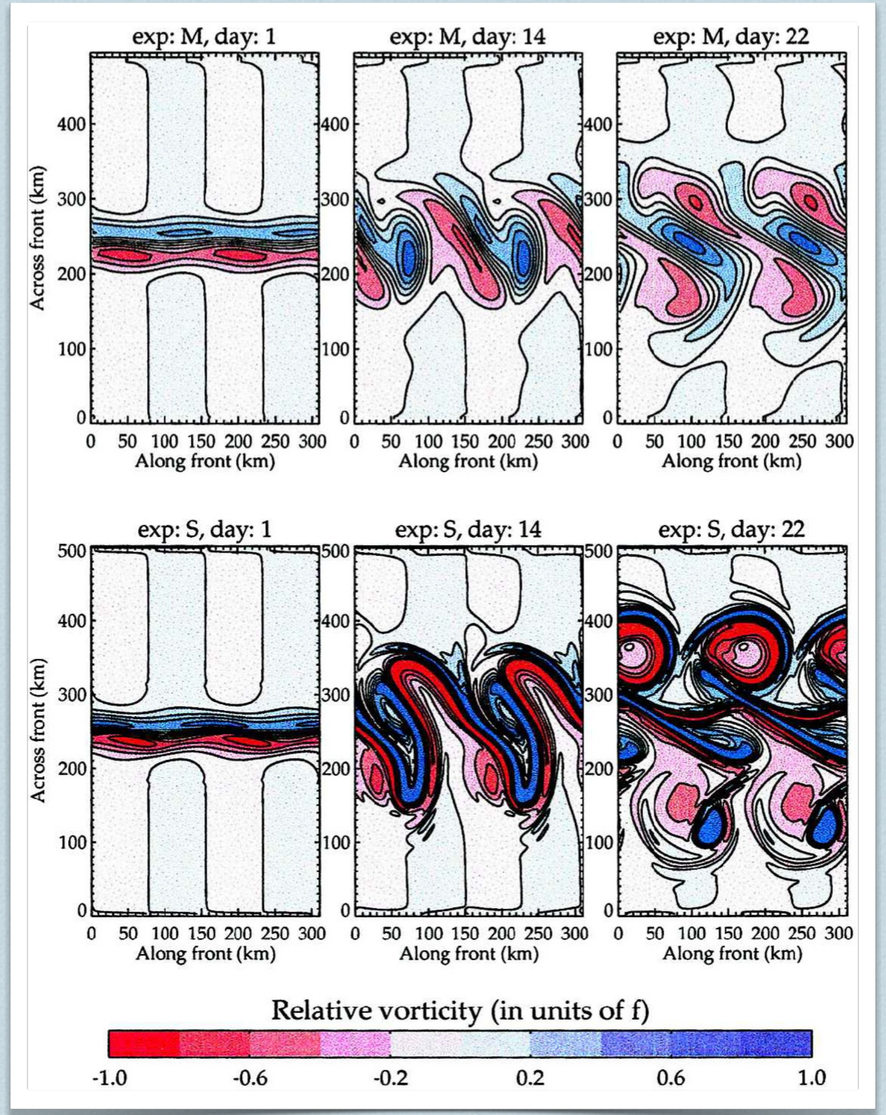
Overestimates Chlorophyll



Gregg and Casey, 2004

- Atmospheric Aerosol from Saharan Desert

- Submesoscale-non-resolving model
- Enhancement of vertical injection of nutrients
- Implications over primary productivity
- Eddy/wind interaction



Lévy et al., 2001

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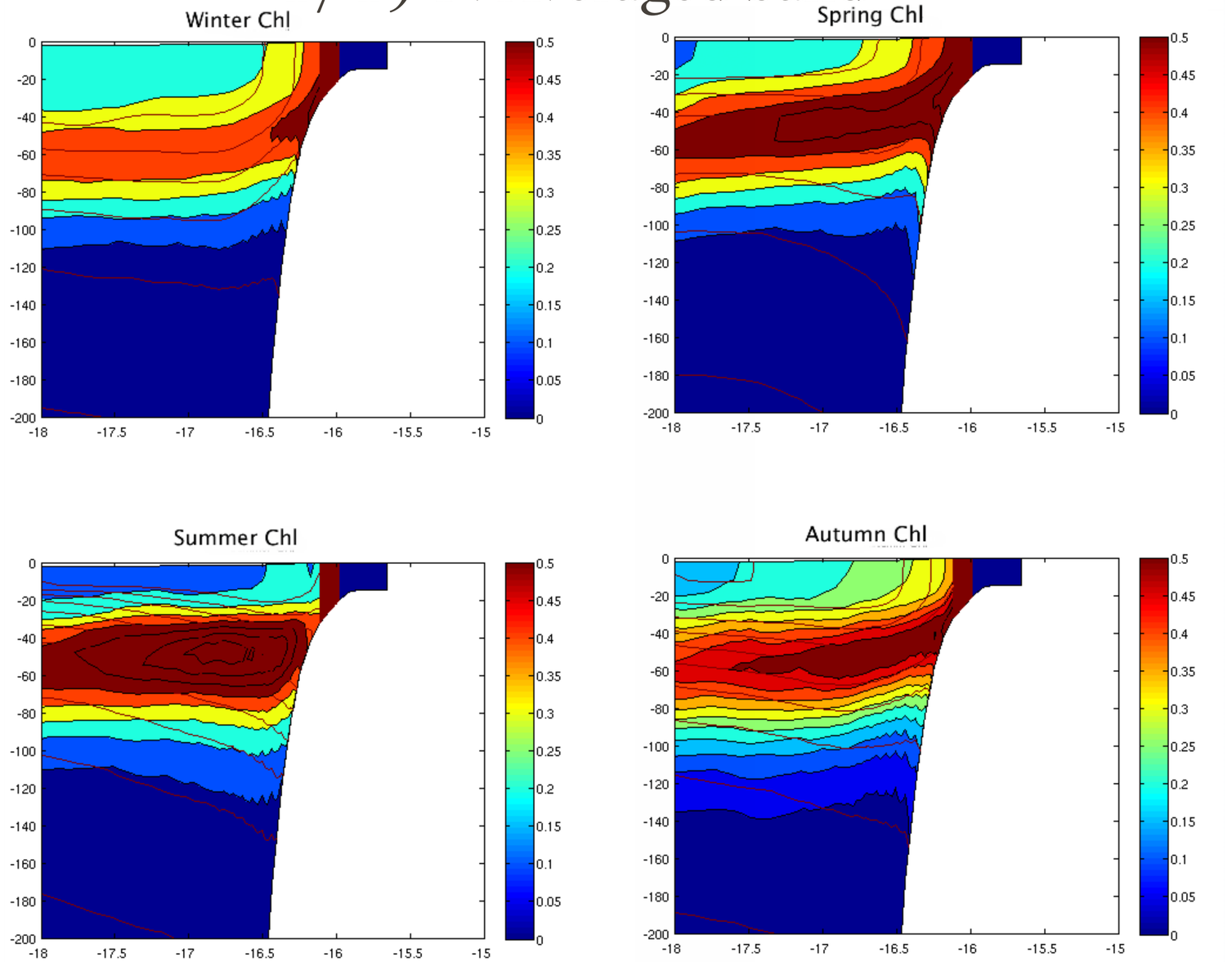
- Highest-values of 0.5-0.6 mg/m3
- DCM around 60-70 m

	Model	Barton	Neuer	Arístegui and Montero	COCA
DCM depth	60-70m	≈100m	75-100m	80-100	≈100m
Maximum values	0.5-0.6mg/m3	0.15 mg/m3	0.6-0.7mg/m3	≈0.8 mg/m3	0.35-0.45 mg/m3

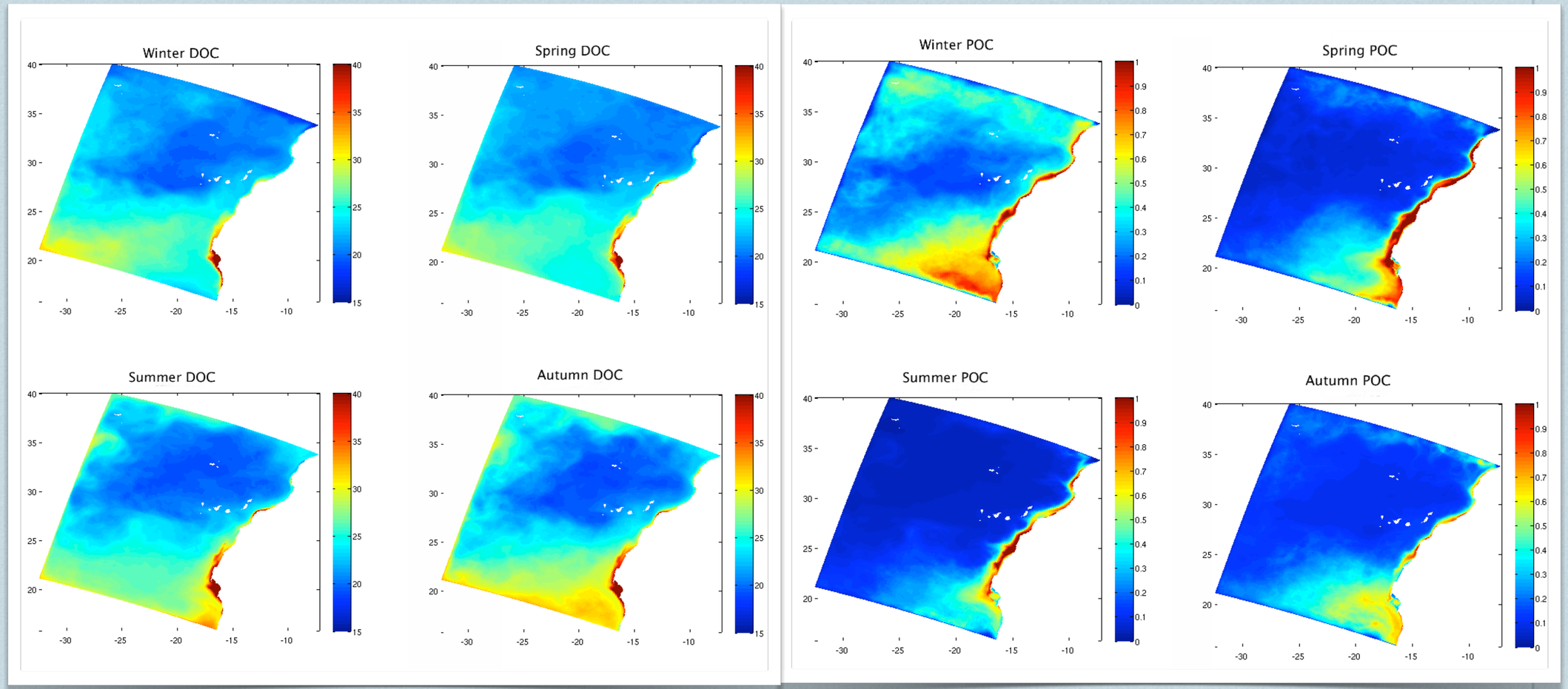
Modelled Chlorophyll (mg/m3)

27-29°N Averaged band



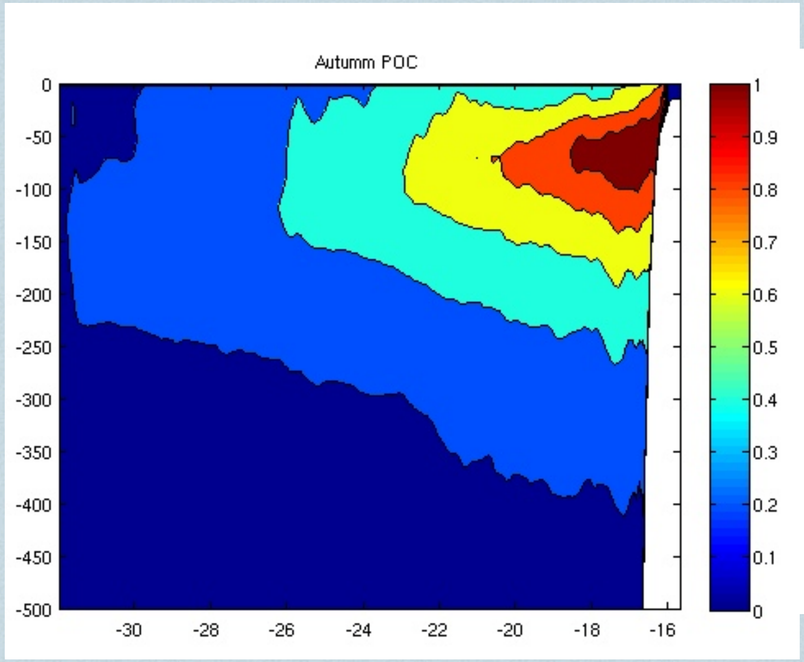
- Underestimation at surface
- DCM shallower
- Around 20% higher than COCA data
- Somewhat smaller than Arístegui and Montero (2005)
- Higher than Barton (1998)
- Slightly higher than Neuer (2007)

- Semi-labile DOC distribution
- POC (slow- and fast-sinking particles)

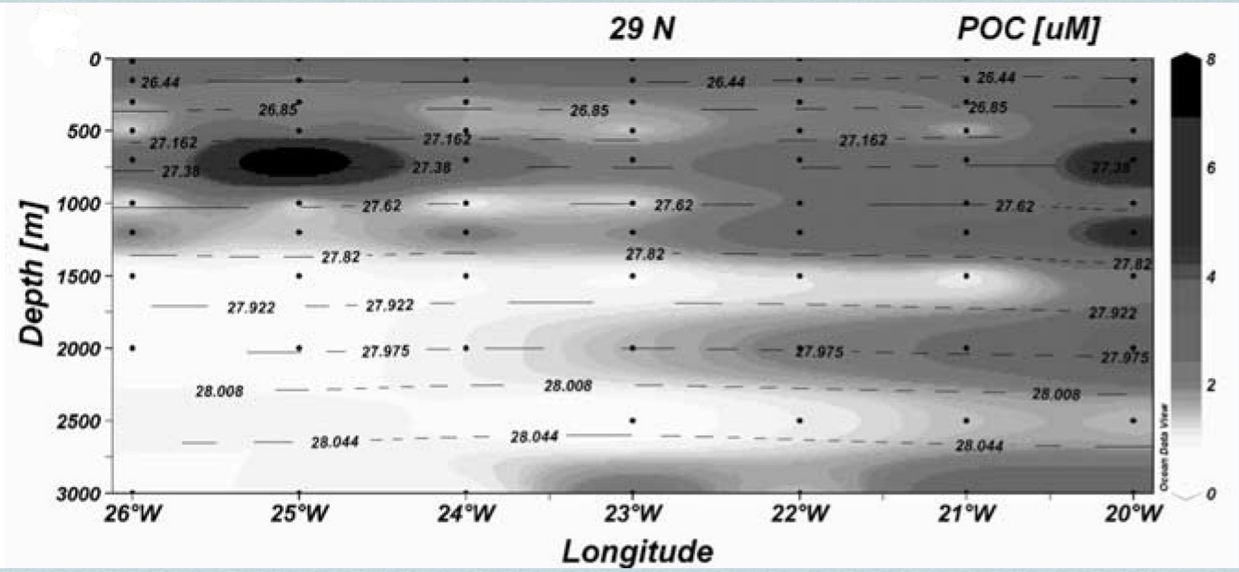


Modelled Organic Carbon (µmol C)

❖ POC profiles



Modelled Organic Carbon (µmol C)



Alonso-González et al., 2009

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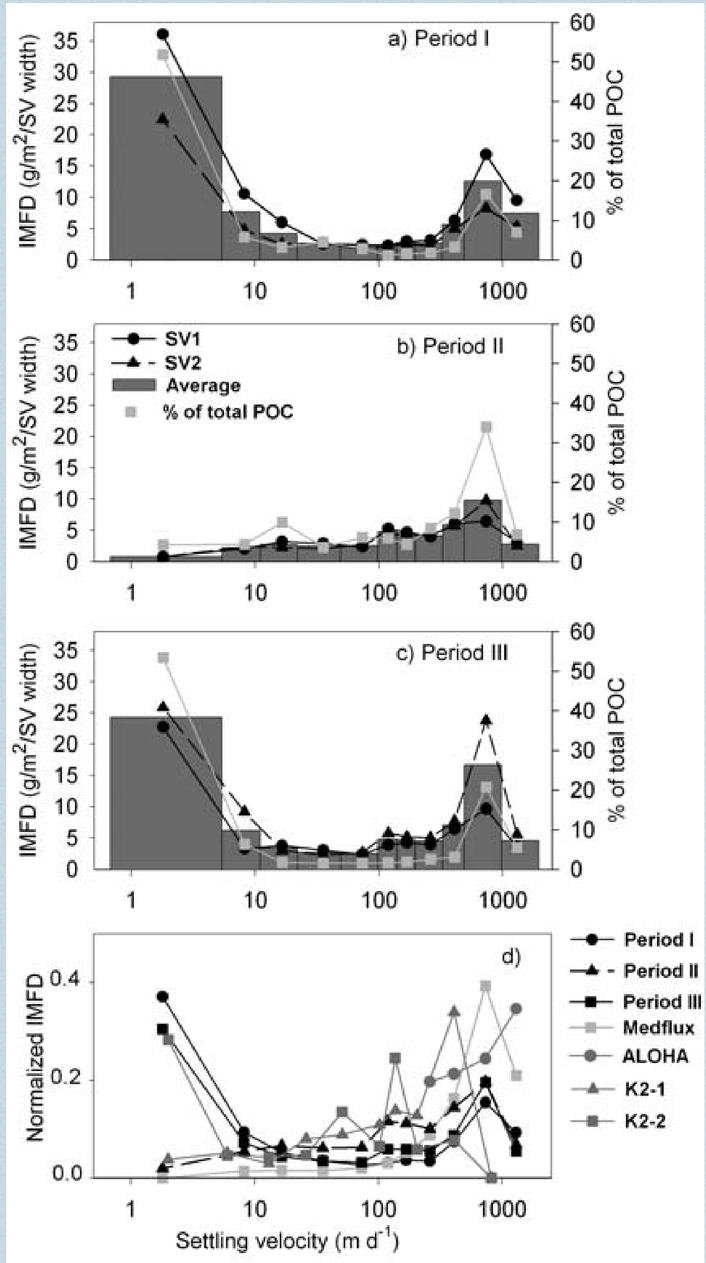
- POC profiles
- 2 periods of dominance
- Non modeled in our simulation
- Something to pay attention



Alonso-González et al. 2010

- Physical and biological simulations would be in phase
- Role of the mesoscale on enhancing primary production: Are submesoscale processes responsible of the injection of nutrients in the photic layer? Are mesoscale eddies? Are eddie/wind interactions?
- Increase resolution and adapt the coupling model to the Canary Current Ecosystem realm