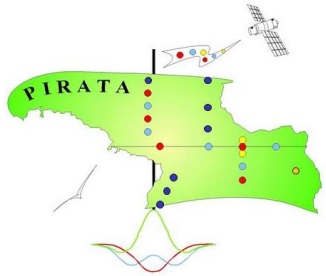
The Upper Layer Circulation in The Gulf of Guinea Revisited From In Situ Data and a High Resolution Numerical Model.

Herbert G., Bourlès B., Penven P., Grelet J.

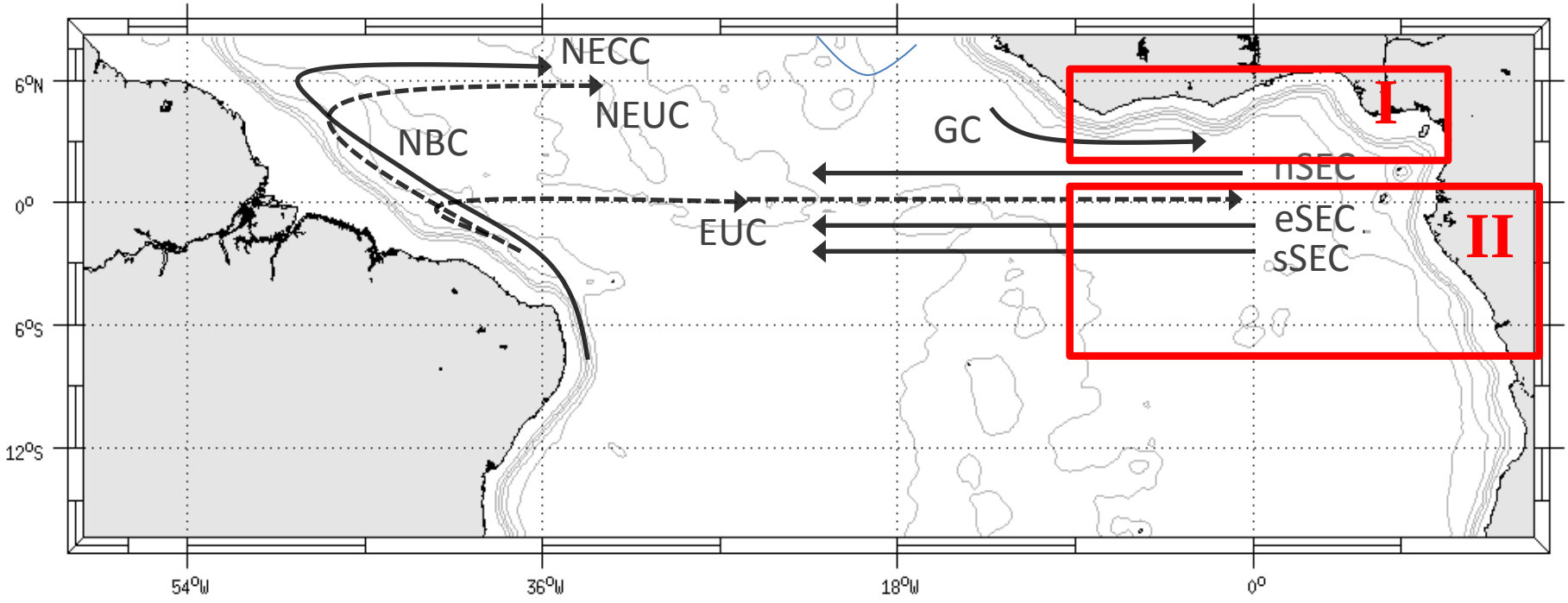


Optimising and Enhancing the Integrated Atlantic Ocean Observing Systems

Circulation in the tropical Atlantic

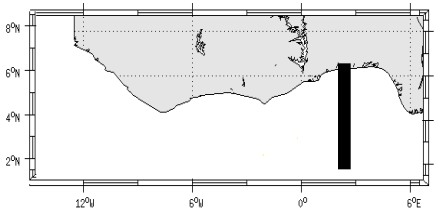
I. → Subsurface circulation north of GoG

II. → Cooling processes southeastern part of GoG

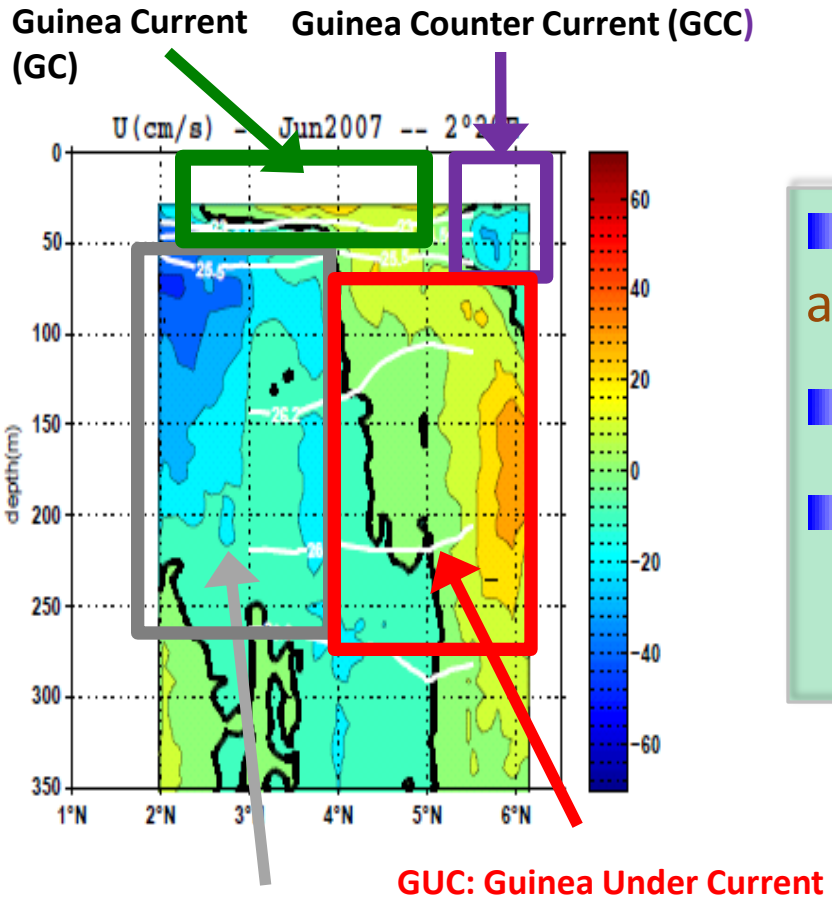


NORTH OF 2°N AND IN THE EXTREME SOUTHEASTERN PART OF GDG

→ FEW KNOWLEDGES OF THE CIRCULATION



I. Subsurface circulation north of Gulf of Guinea

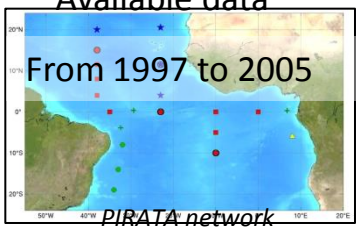


- Is the GUC a local current or extends along the northern coast ?
- What is its seasonal variability ?
- What is its origin ?
  Is it a local recirculation ?
  Is it an extension of the NEUC ?

I.1 Tools

In situ data from PIRATA/EGEE cruises

Available data

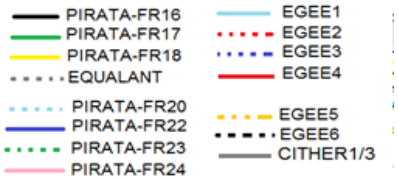


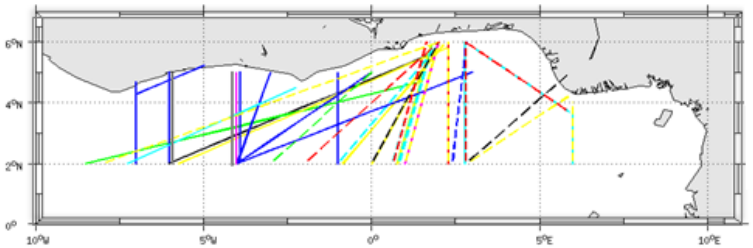
From 2006 to 2016

SADCP data Processing
Herbert et al, 2015

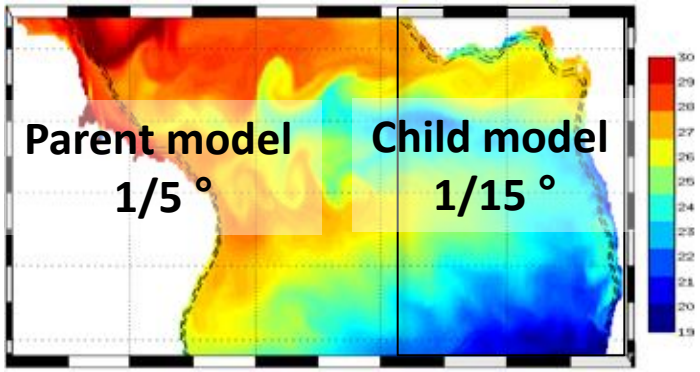
New current data

Herbert et al:
DOI: 10.17882/44635





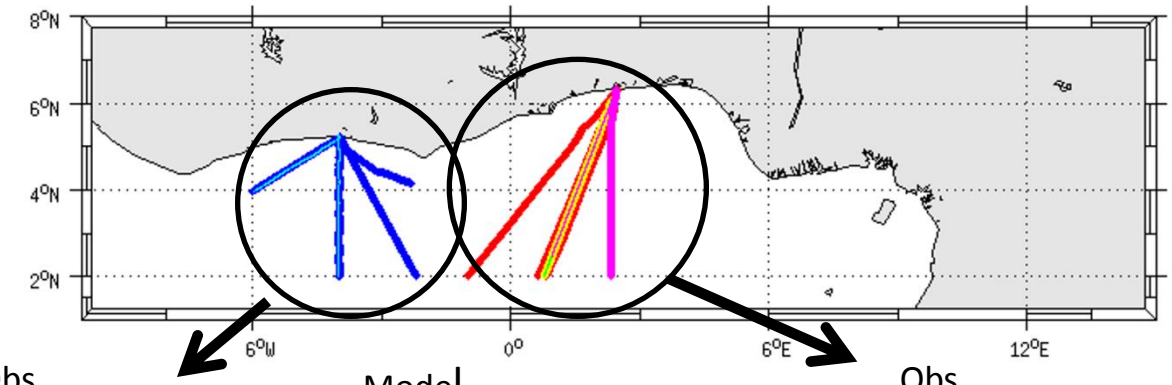
Numerical simulation



Simulation ID	OB and IC	Atm. forcing	Period	Outputs
RUN_CLIM	WOA09 (1°x1°)	COADS05 (1/2°x1/2°)	15 years	2 days
RUN_INTERA	SODA (1/2°x1/2°)	CFSR (1/4°x1/4; 6h)	1979-2008	2 days

I.2 GUC

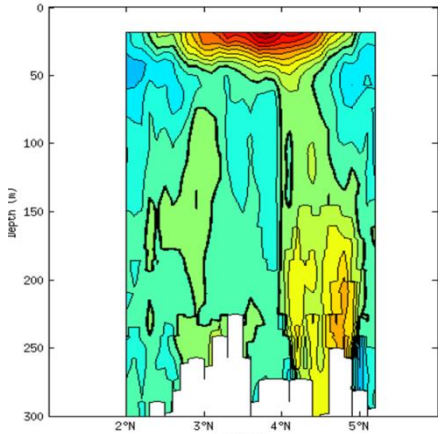
- **S-ADCP data –** Mean during spring



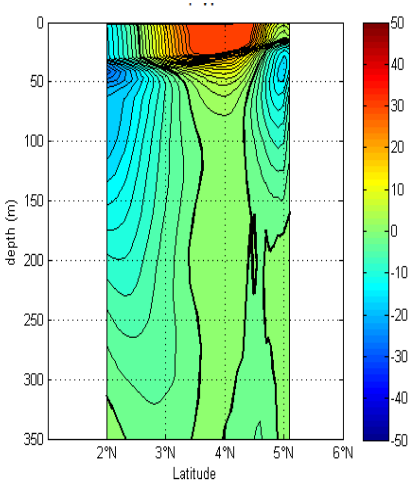
West Part
PIRATA-FR22
PIRATA-FR24

East Part
PIRATA-FR21
EGEE1
EGEE3
EGEE5

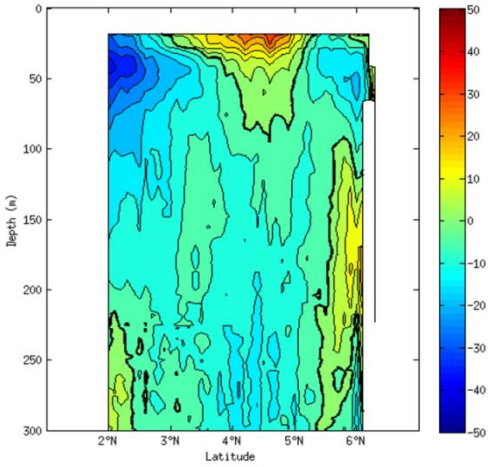
Obs



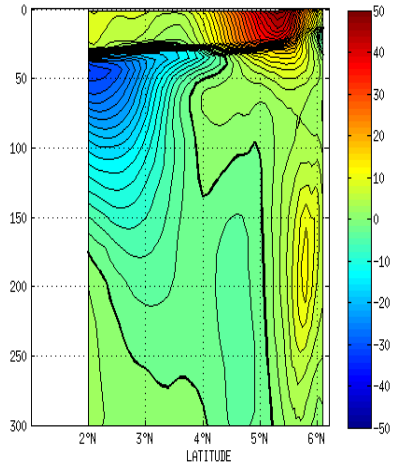
Model



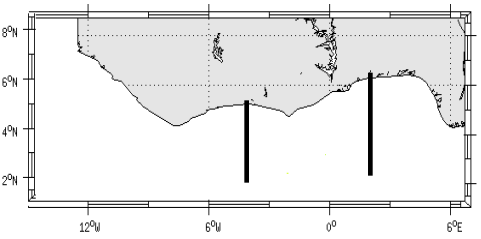
Obs



Model

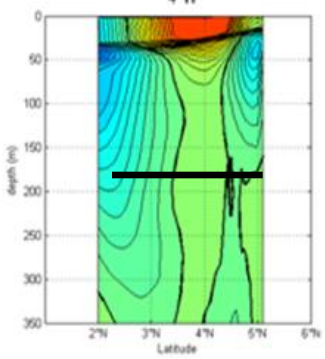


*From **Herbert et al. 2016***

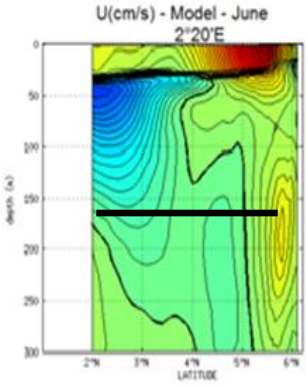


I.3 Seasonal variability

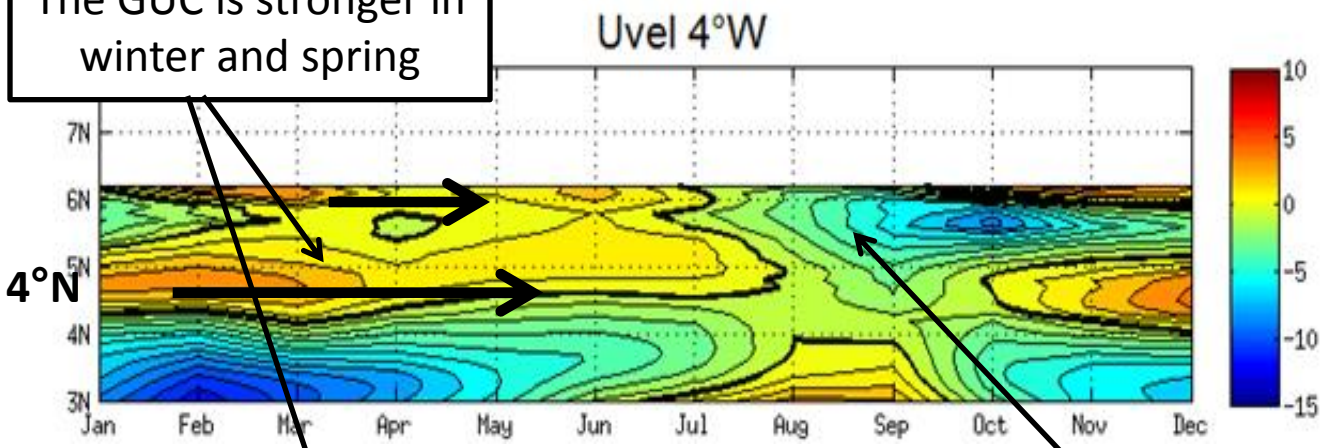
4°W

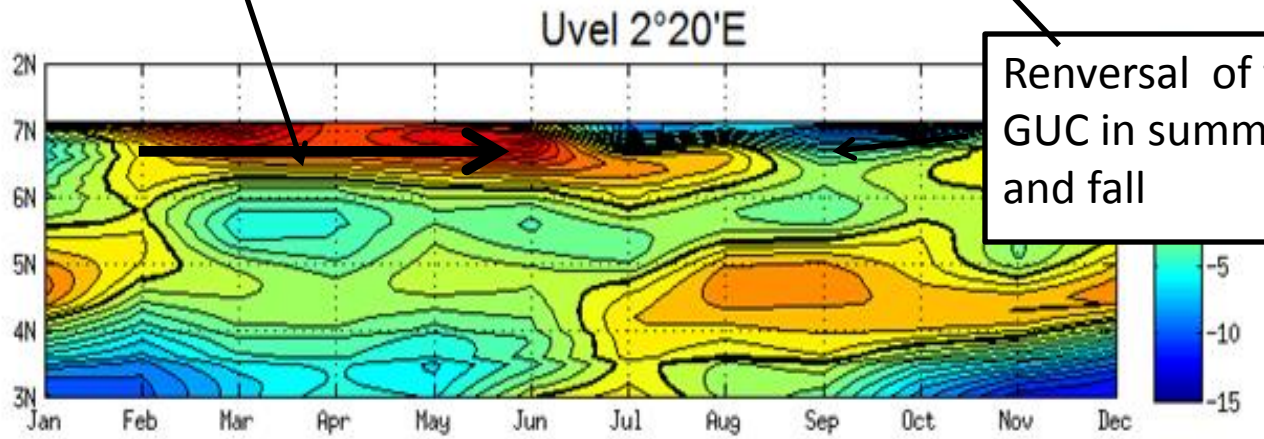


2°20'E



The GUC is stronger in winter and spring





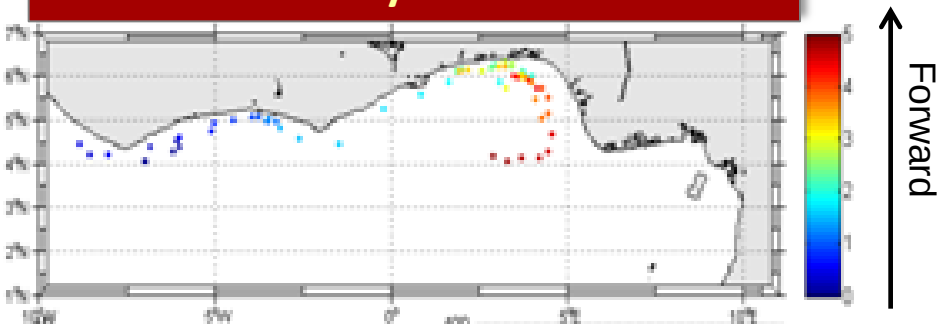
Renversal of the GUC in summer and fall

*From **Herbert et al. 2016***

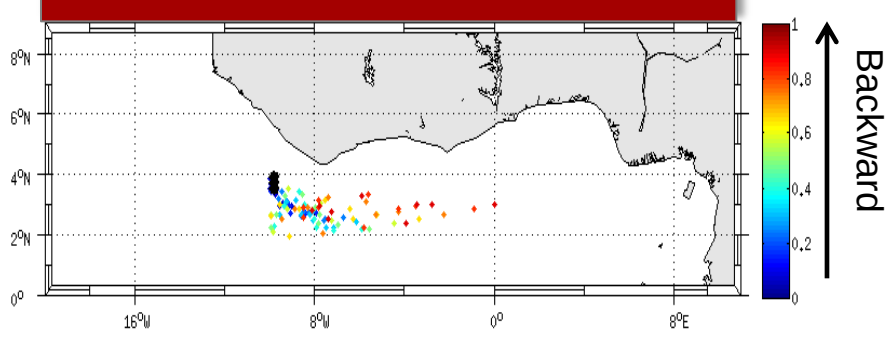
I.4 GUC pathway and sources

- **Lagrangian analysis with ARIANE code**

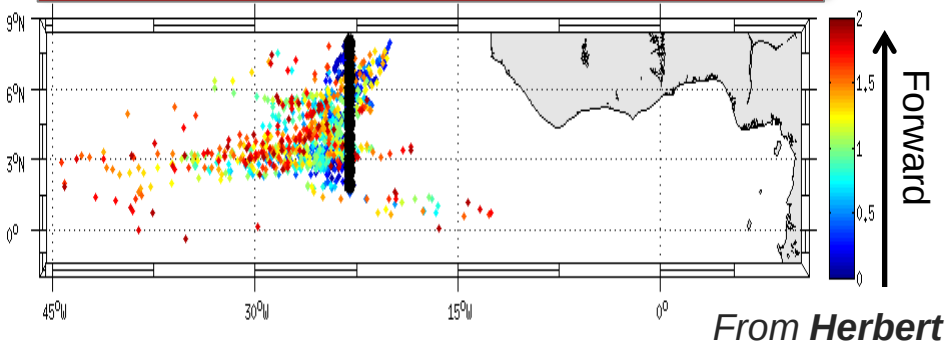
Pathway of the GUC



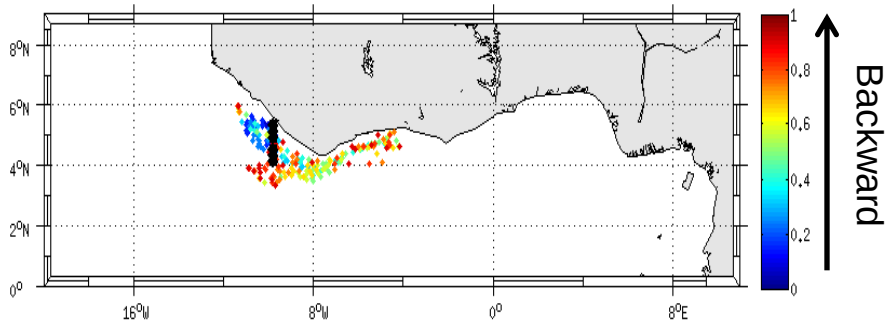
Sources of the GUC



Not the extension of the NEUC



c)



*From **Herbert et al. 2016***

I.5 Summary

- An eastward flow exists under the GC (100-300m depth): **we call it the GUC.**
- **GUC Seasonal variability:**
  - Stronger in winter and spring and reverses westward in summer.
- **GUC pathway :**
  - One branch along 4°N West of CTP which follows the coast East of CTP.
  - One branch close to the coast between the two Capes, **that we call NGCUC.**
- **GUC sources :**
  - Local recirculations & recirculation of the NEUC and nSEC
  - Supply from the north-west.
  - Not the eastward extension of the NEUC.

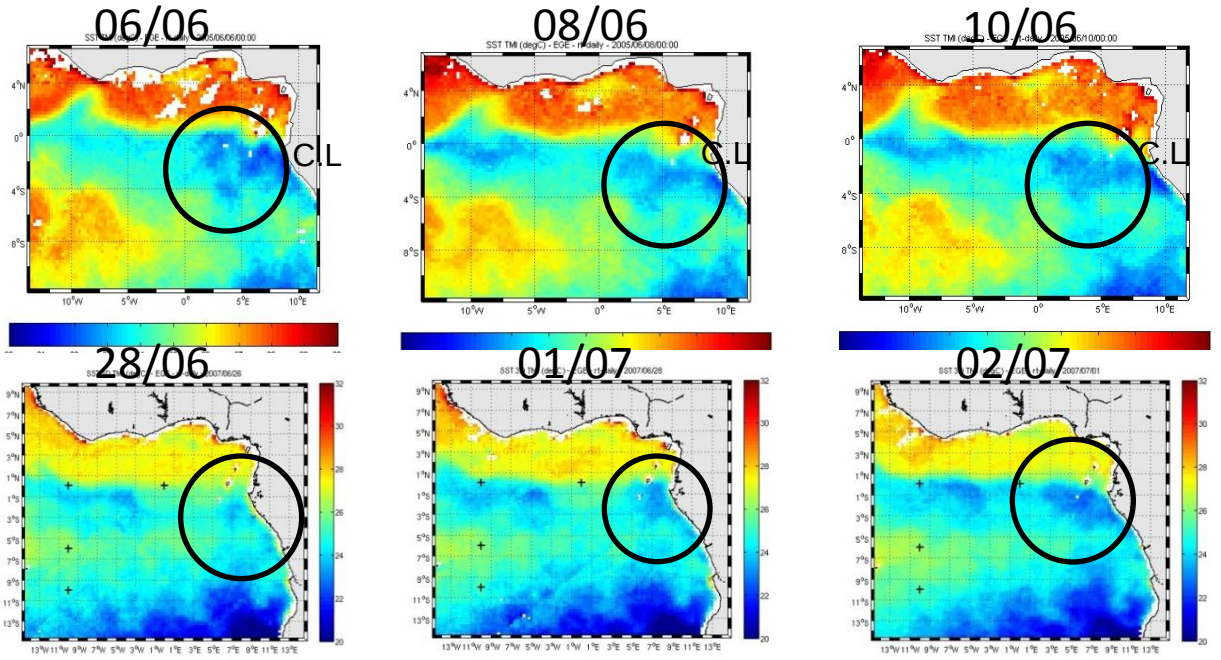
→ **Herbert, G., Bourlès, B., Penven, P., Grelet, J**, 2016, New insights on upper layer circulation north of the Gulf of Guinea. *Journal of Geophysical Research*.

II.1 Highlighting of cooling events in the SE-GoG

Satellite SST data during EGEE cruises

EGEE1 2005

EGEE3 2006

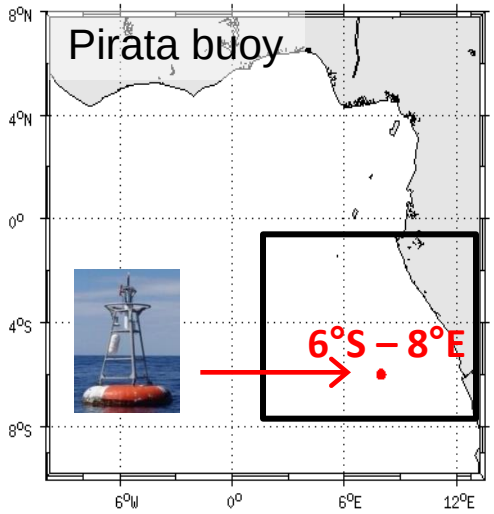


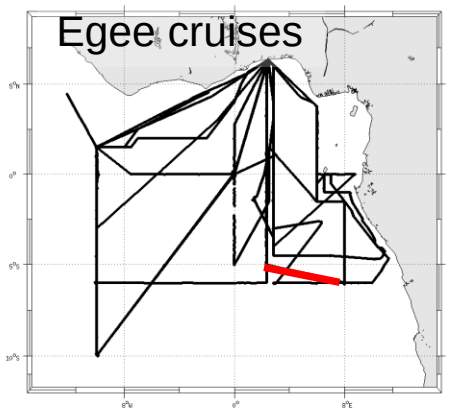
MAIN QUESTIONS:

- What is the dynamic and its seasonal variations front of Cape Lopez ?
- What are the mechanisms implied in the surface cooling front of C.L. ?
- Is it linked to the equatorial cooling ?

II.2 Validation of the model

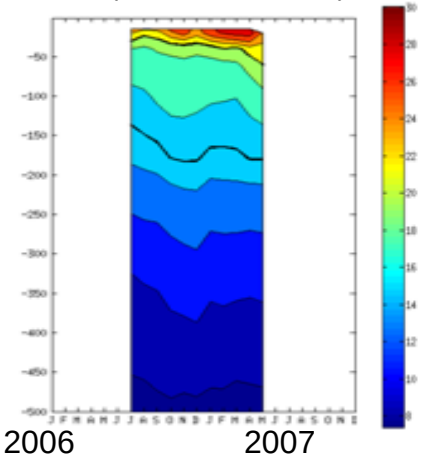
- **From PIRATA data**



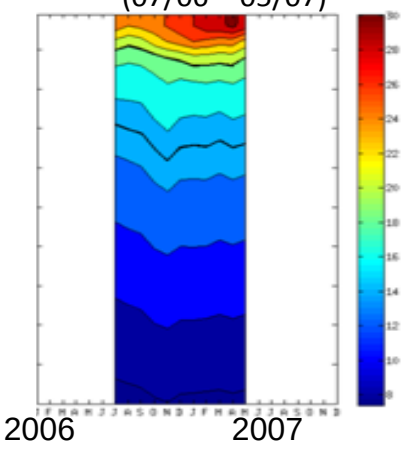


TEMP

OBS
(07/06 – 05/07)

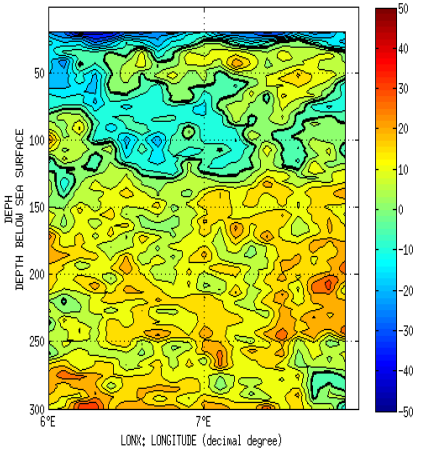


MODEL
(07/06 – 05/07)

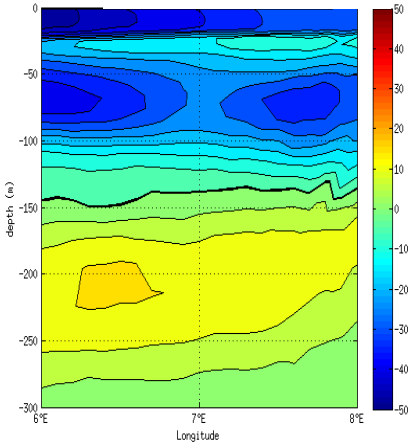


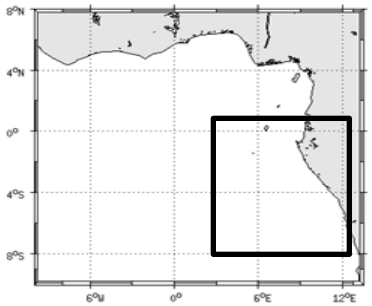
Uvel

OBS
24-25/06/2007



MODEL
24/06/2007





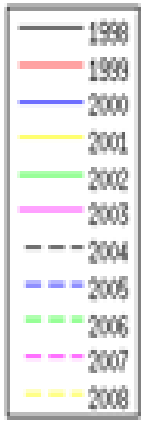
II.3 Seasonal Variability of T/U/Wind in S-E area

From numerical simulation

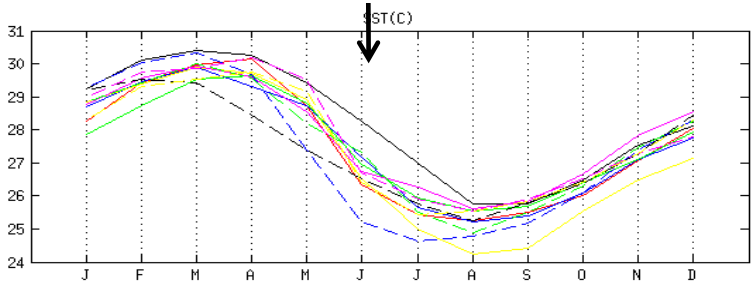
SST (°C)

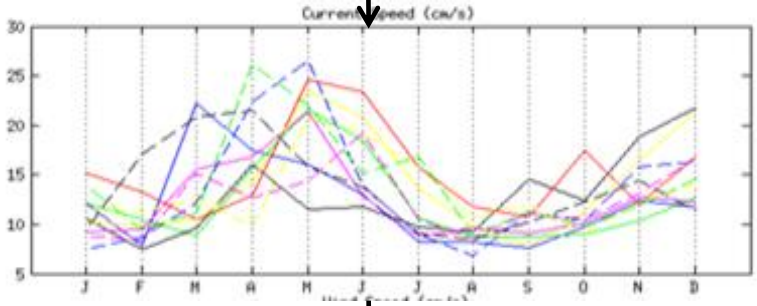
Current sp. (cm/s)

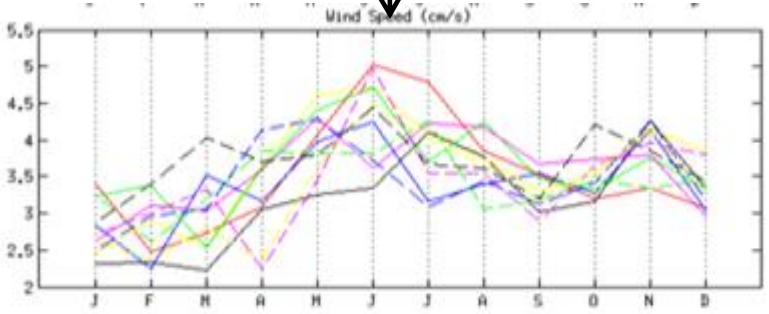
Wind Sp. (cm/s)



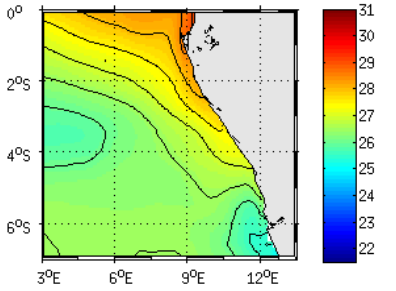
June

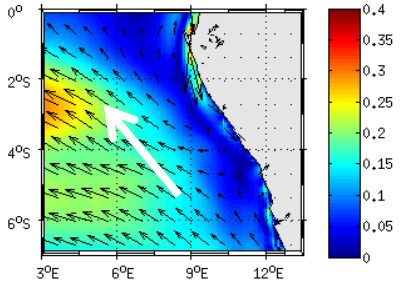


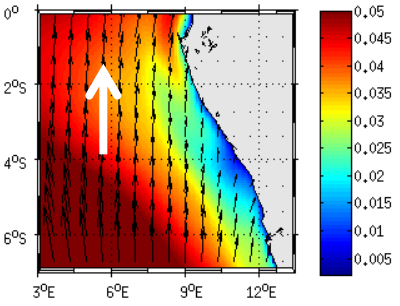




In June







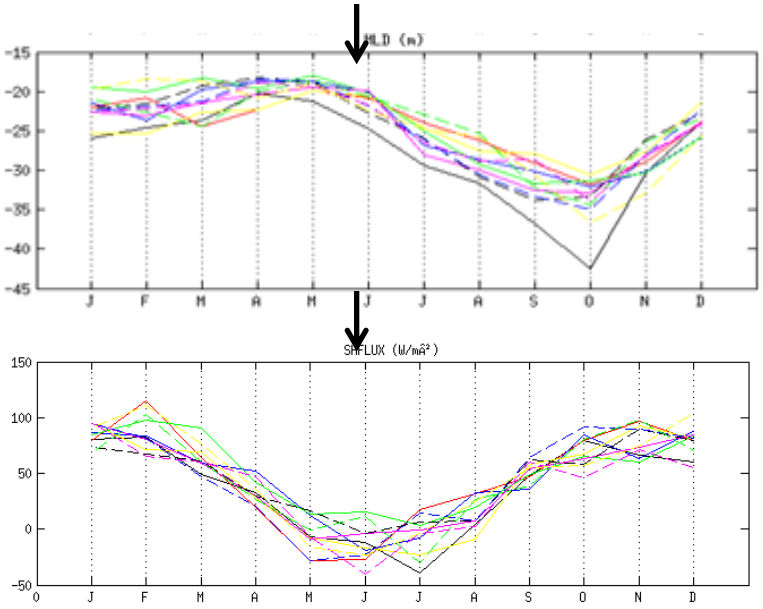
II.3 Seasonal Variability of MLD/SHFLUX in S-E area

- **From numerical simulation**

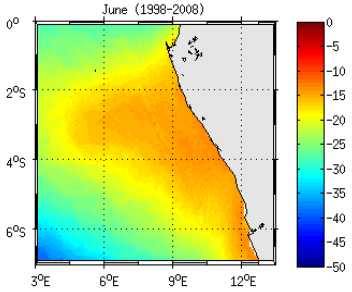
MLD (m)

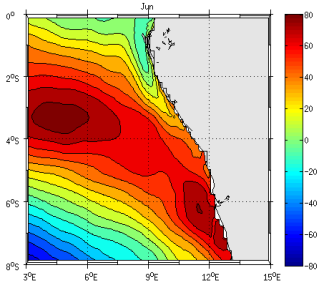
SHFLUX (W/m^2)

June



In June



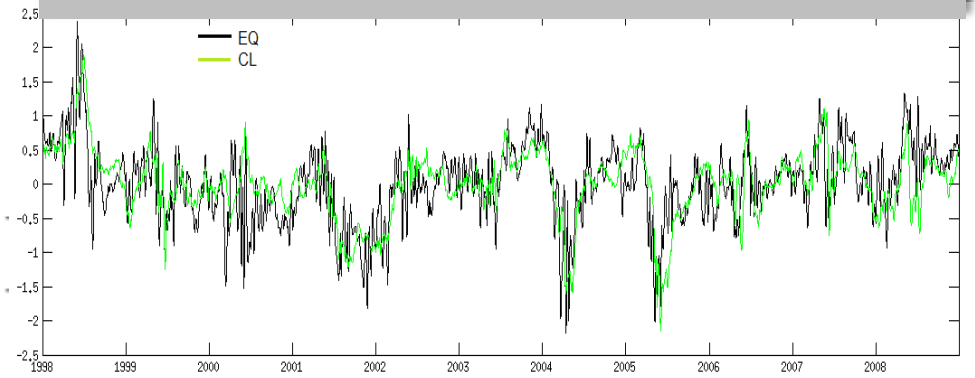


→ **Cooling mainly driven by the wind.**

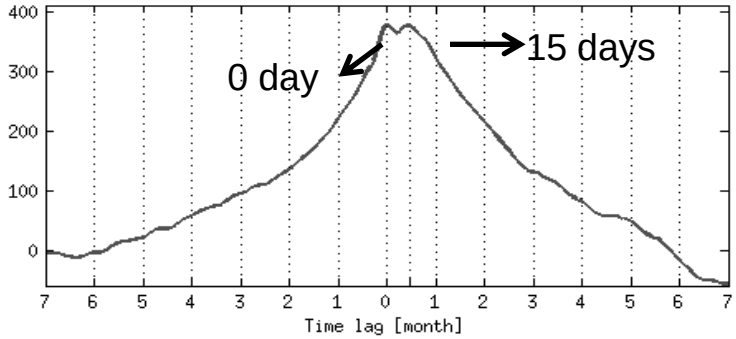
II.4 Cooling description at EQ and in S-E area

- From numerical simulation (—) and TMI data (—)

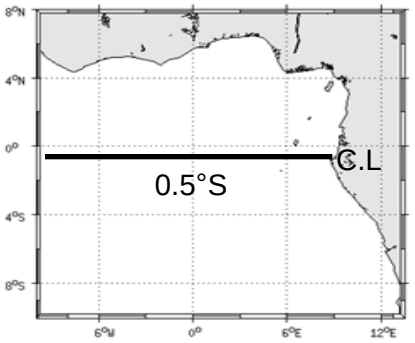
SSTa at EQ & CL (from 2daiily averaged outputs)



Cross - correlation



II.5 Surface cooling front of CL



Anomalies

Clim (98-08)

Zoom April-Aug.

2005

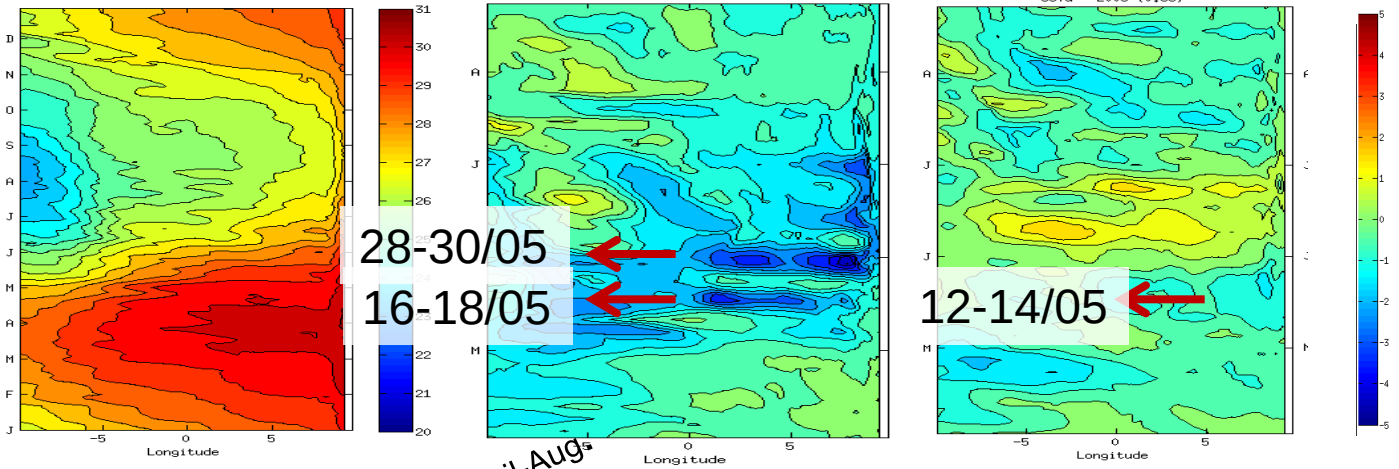
2006

SST- Model

28-30/05

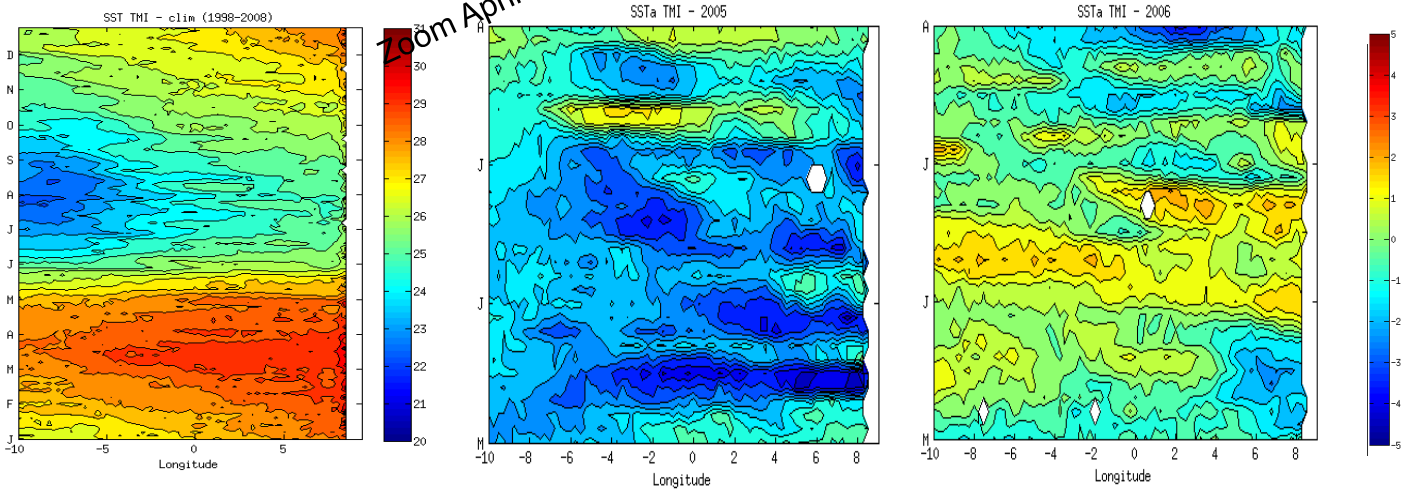
16-18/05

12-14/05



Zoom April-Aug.

SST- TMI



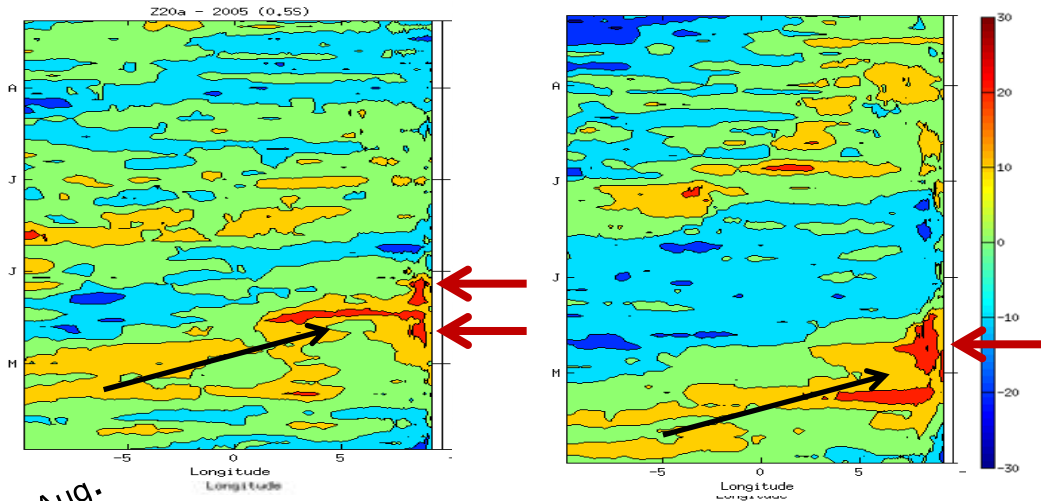
II.5 Surface cooling front of CL

Generated by a remote and local forcing

Zoom April-Aug.

2005

2006

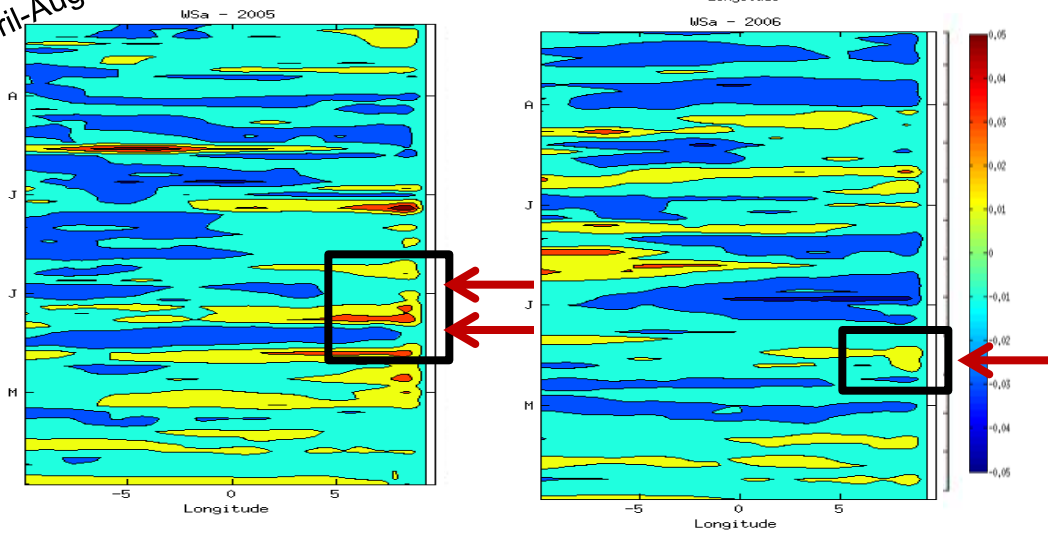


Z20 (m)

Equatorial wave → thin MLD

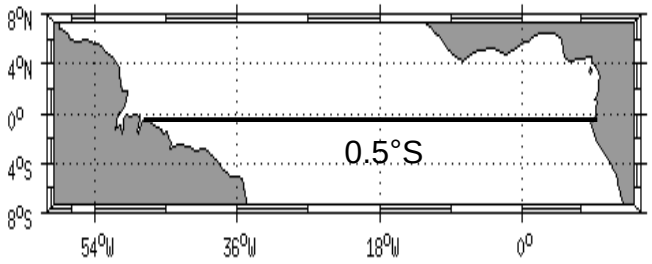
+

Zoom April-Aug.



Wind speed (m/s)

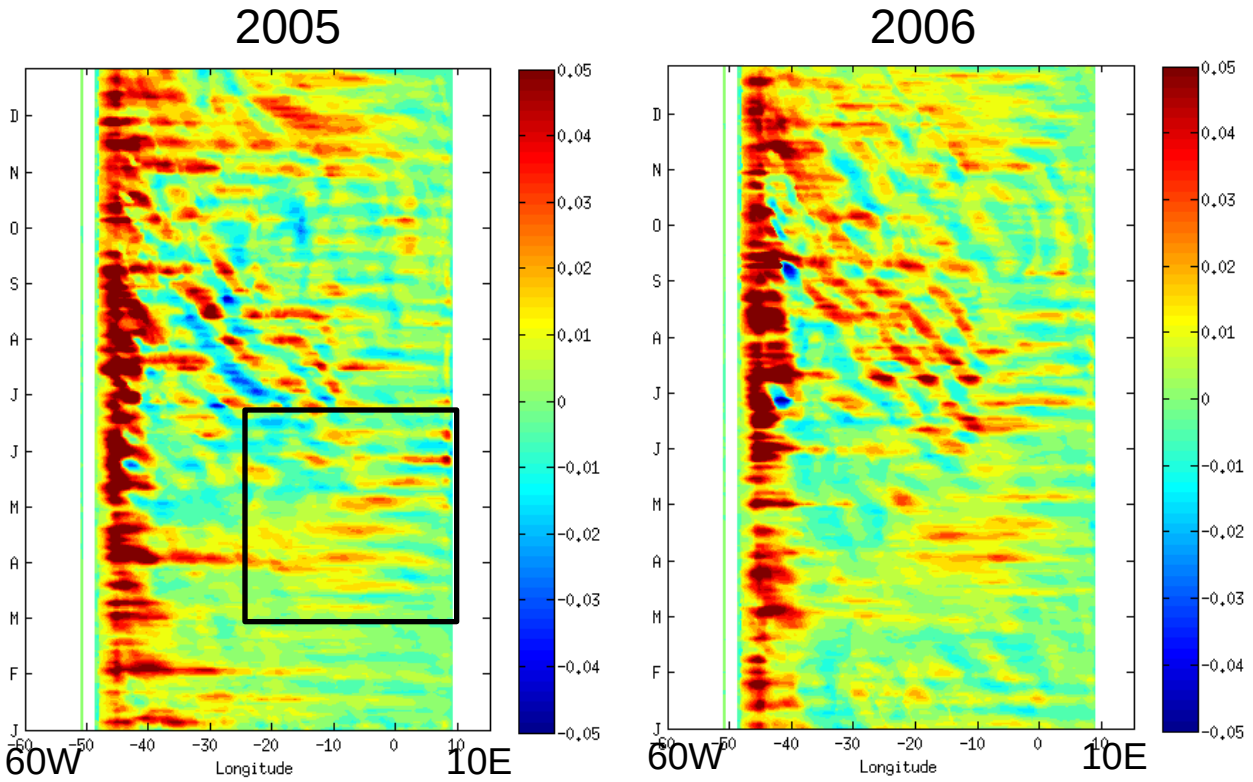
Coastal winds



II.5 Surface cooling front of CL

Remote forcing

Wind Energy Flux



Wind intensification in the centre of the bassin
and eastward propagation with about 15 days variability

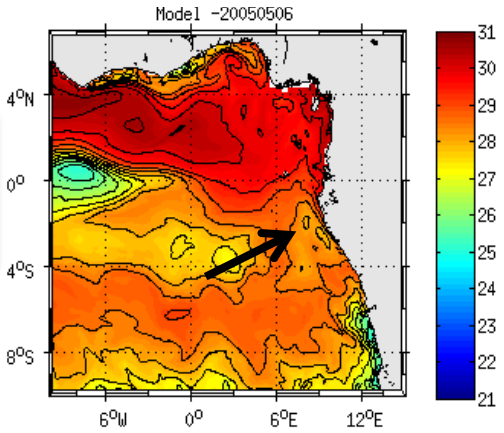
II.4 Westward propagation of the cooling

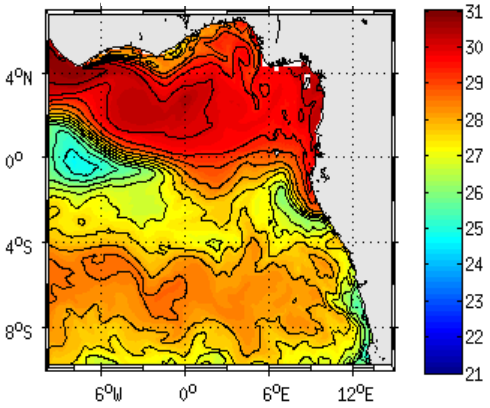
May 6 2005

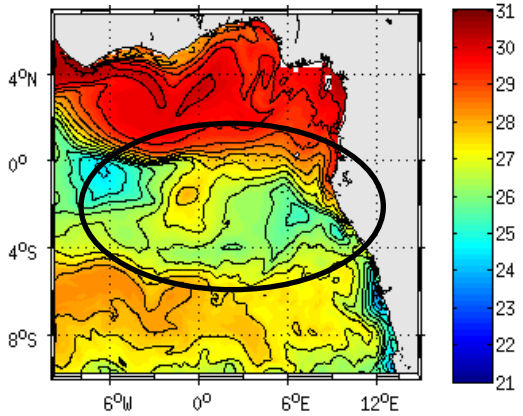
May 12 2005

May 18 2005

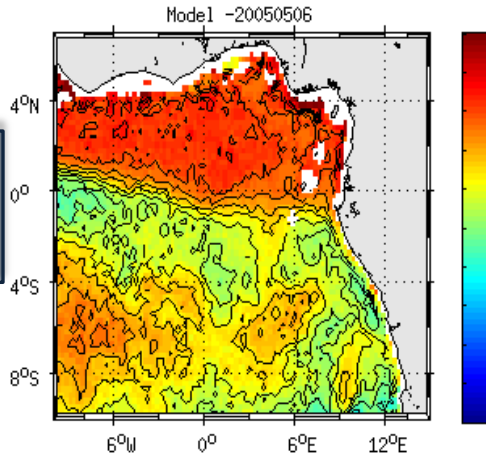
SST- Model

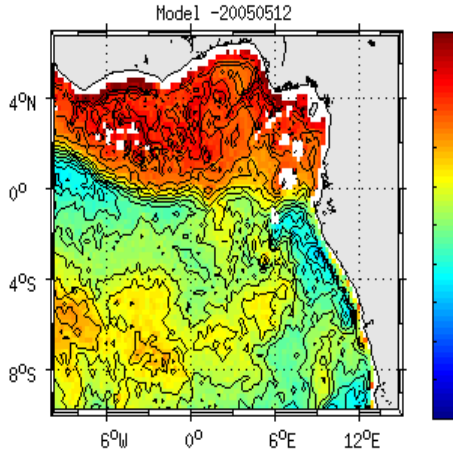


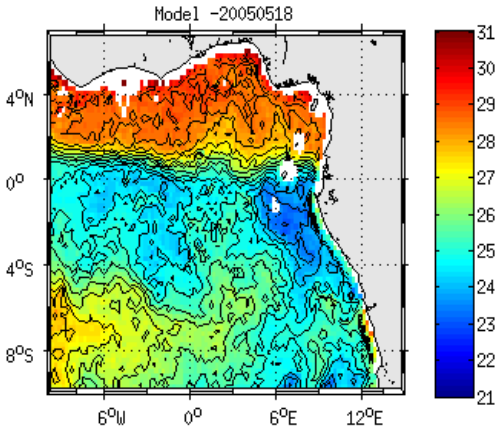


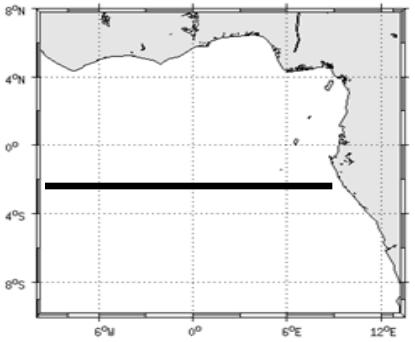


SST- TMI



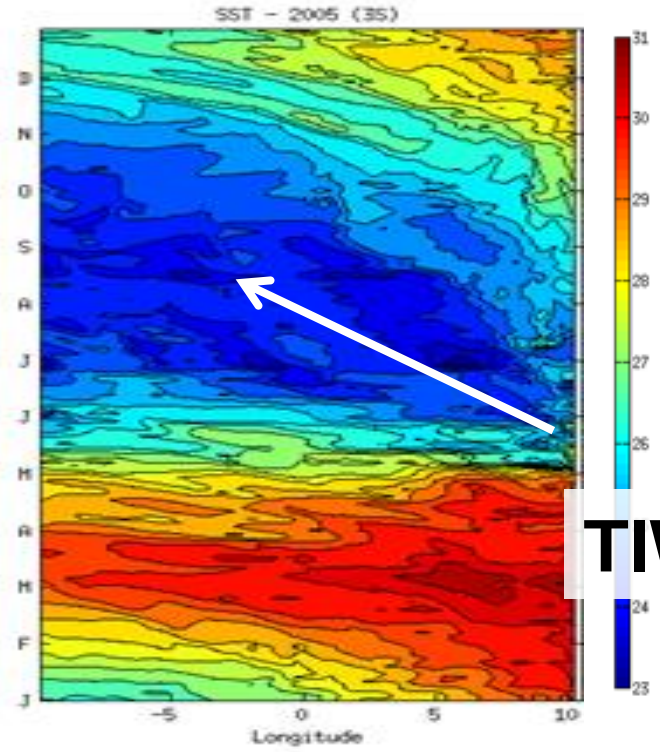




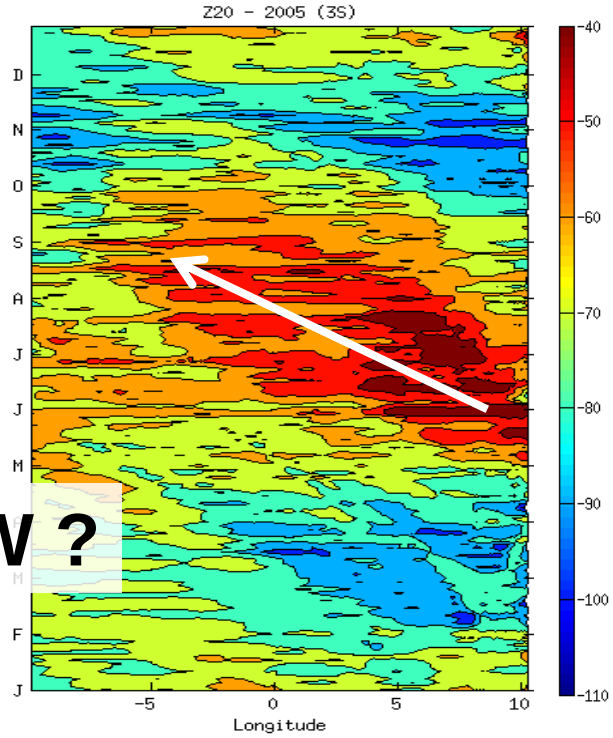


II.4 Westward propagation of the cooling

SST



Z20

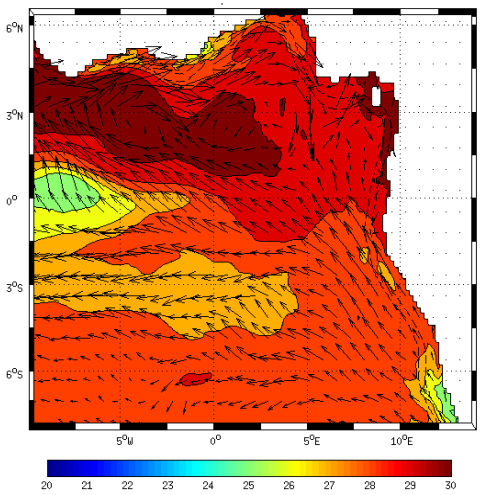


TIW ?

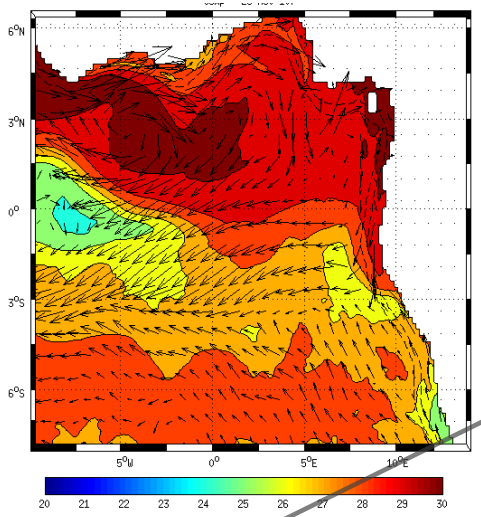
II.4 Westward propagation of the cooling

SST - Current

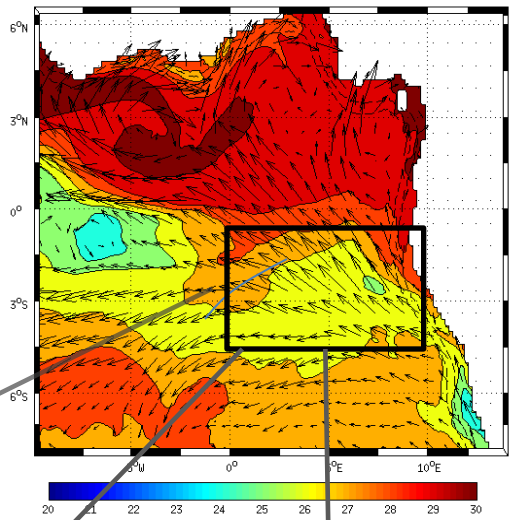
May 6 2005



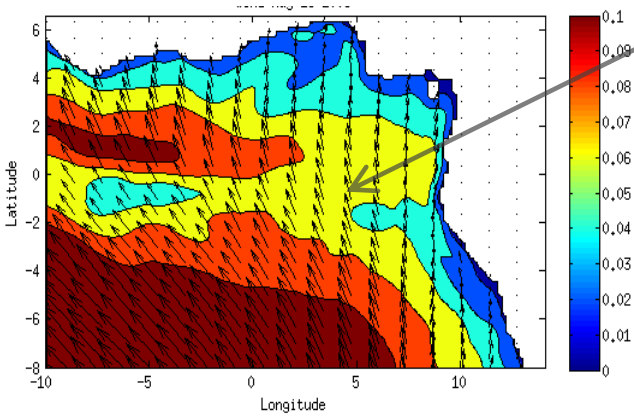
May 12 2005



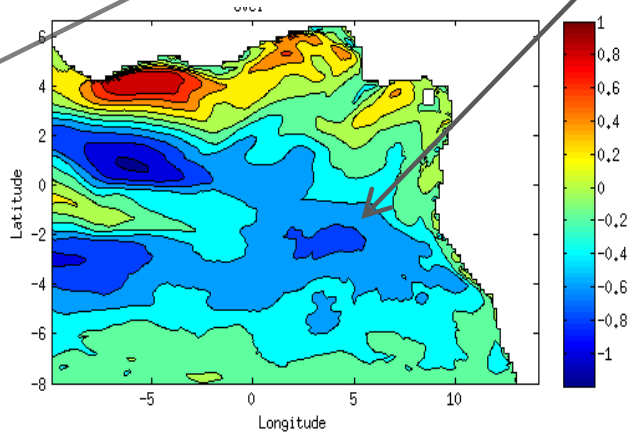
May 16 2005



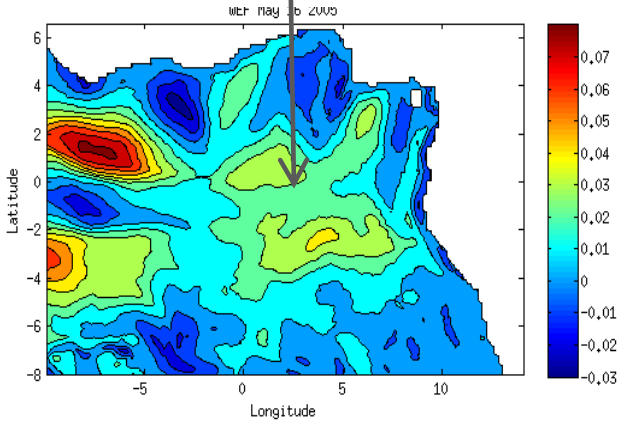
Wind



Uvel



Wind Energy Flux



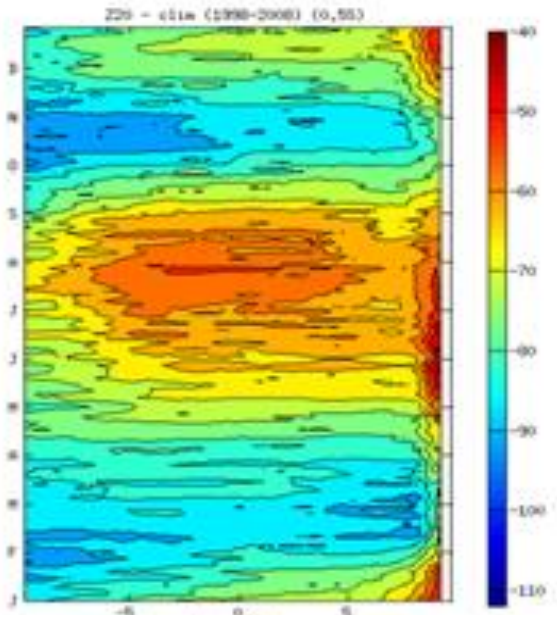
II.5 First conclusions and perspectives…

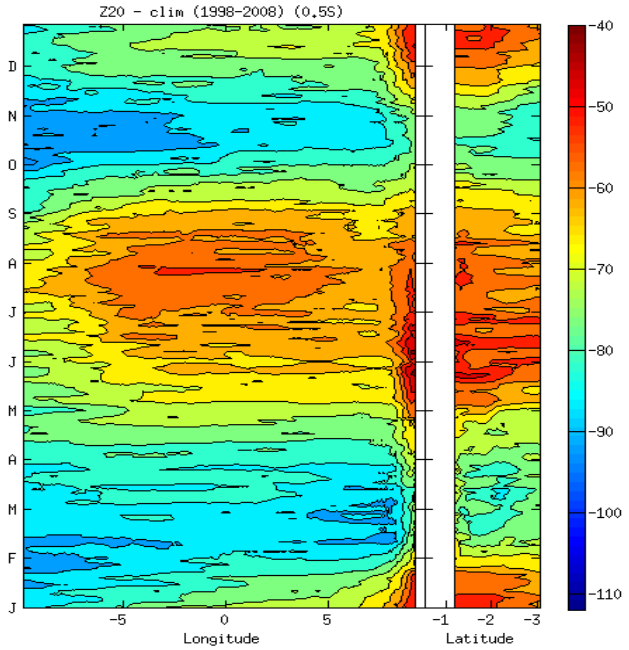
- Local upwelling mainly driven by Ekman process
- Remote and local effect through waves and local winds.
- Surface advection contribution in cooling.

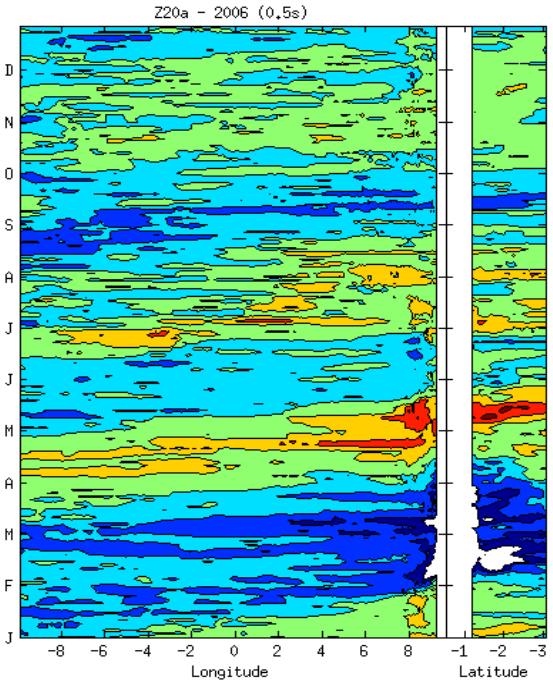
Perspectives :

Heat budget front of CL area to determinate the relative contribution of horizontal and vertical advection, mixing, entrainment, and heat flux.

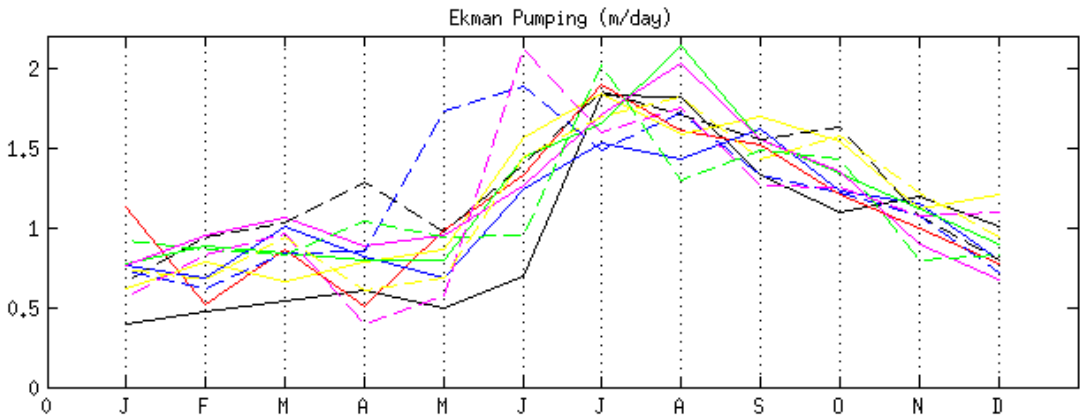
Thank you !

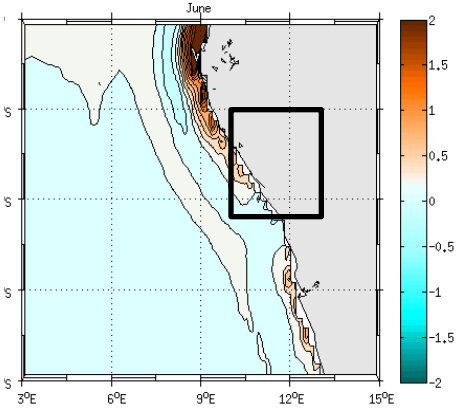


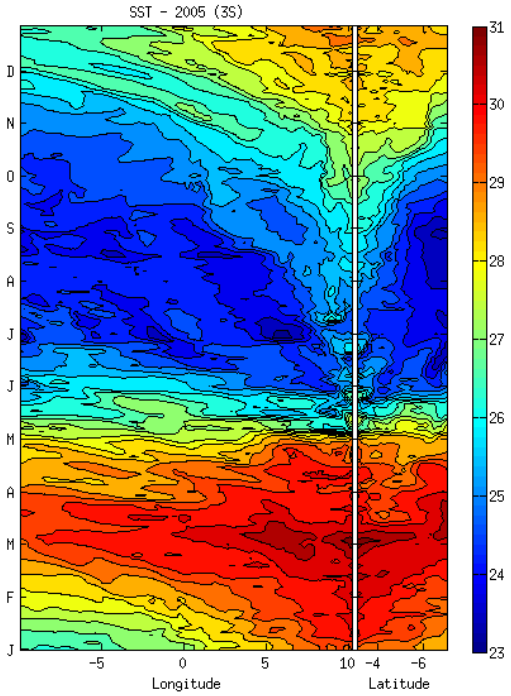

Z20 - clim (1998-2008) (0.5S)
D
N
O
S
A
J
J
M
A
M
F
J
-40
-50
-60
-70
-80
-90
-100
-110
-5
0
5
Longitude
-1
-2
-3
Latitude


Z20a - 2006 (0.5s)
D
N
O
S
A
J
J
M
A
M
F
J
-8
-6
-4
-2
0
2
4
6
8
Longitude
-1
-2
-3
Latitude

Ekman Pumping (m/day)






SST - 2005 (3S)
D
N
O
S
A
J
J
M
A
M
F
J
-5
0
5
10
Longitude
-4
-6
Latitude
31
30
29
28
27
26
25
24
23