

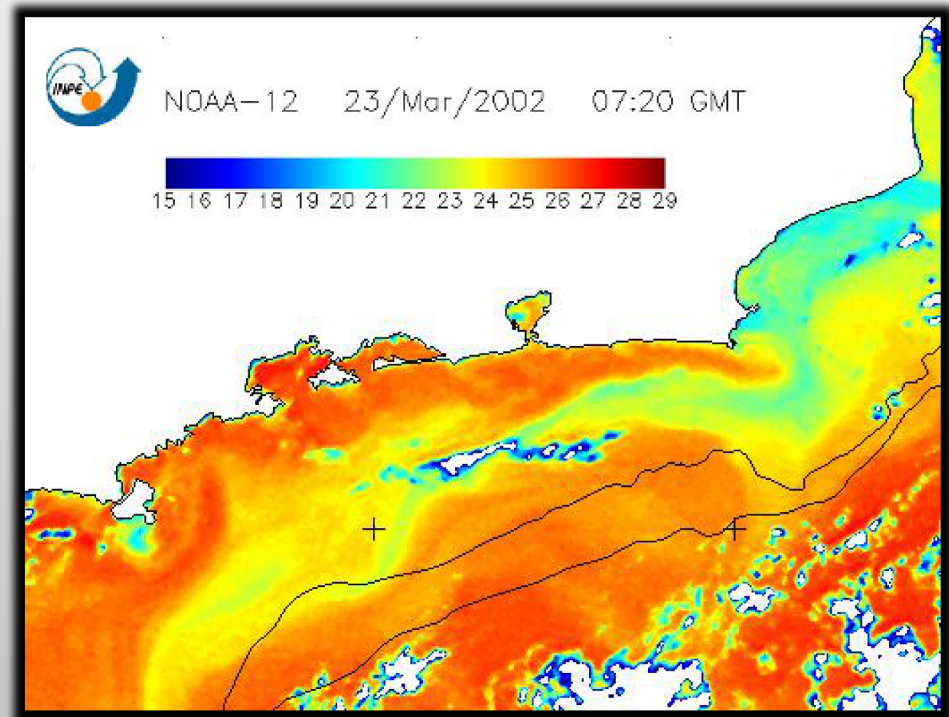
# Cabo Frio upwelling response to spatially variable remote wind forcing

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Brazilian Navy – IEAPM  
Ocean Dynamics Division

**Phellipe Couto**

Brazilian Navy – IEAPM &  
Universidade Federal do Paraná



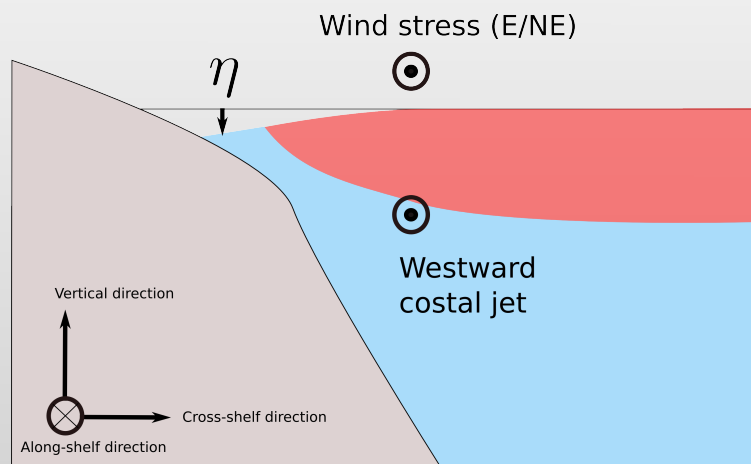
X OMAR-SAT – IEAPM  
Arraial do Cabo, RJ, 15-18 October 2013



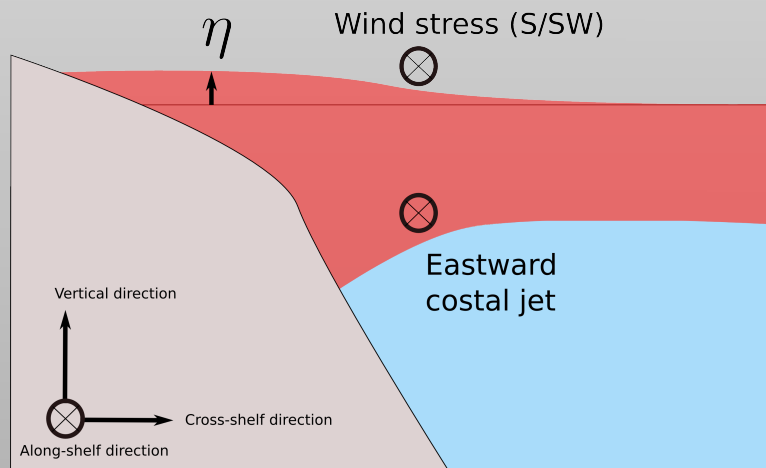
# Shelf Dynamics at RJ central coast

Typical steady upwelling/downwelling response to the wind

**E/NE winds** → Ekman dynamics → geostrophic adjustment → **westward coastal jet**

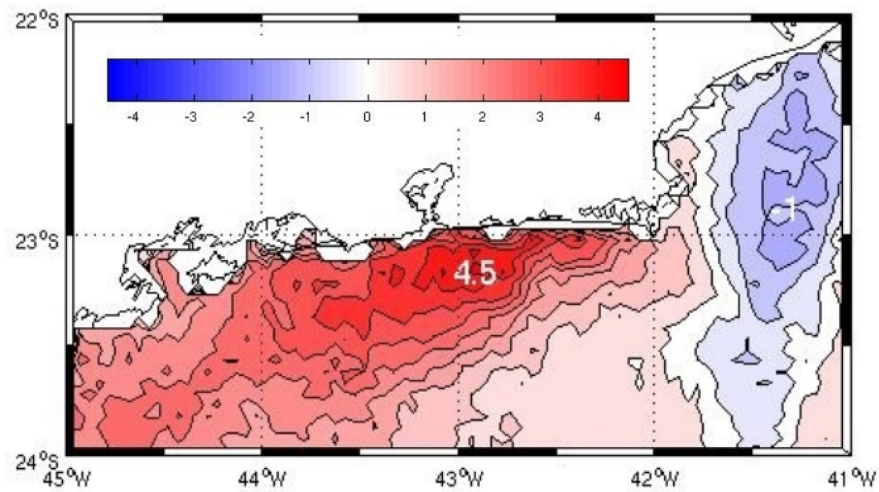


**S/SW winds** → Ekman dynamics → geostrophic adjustment → **eastward coastal jet**

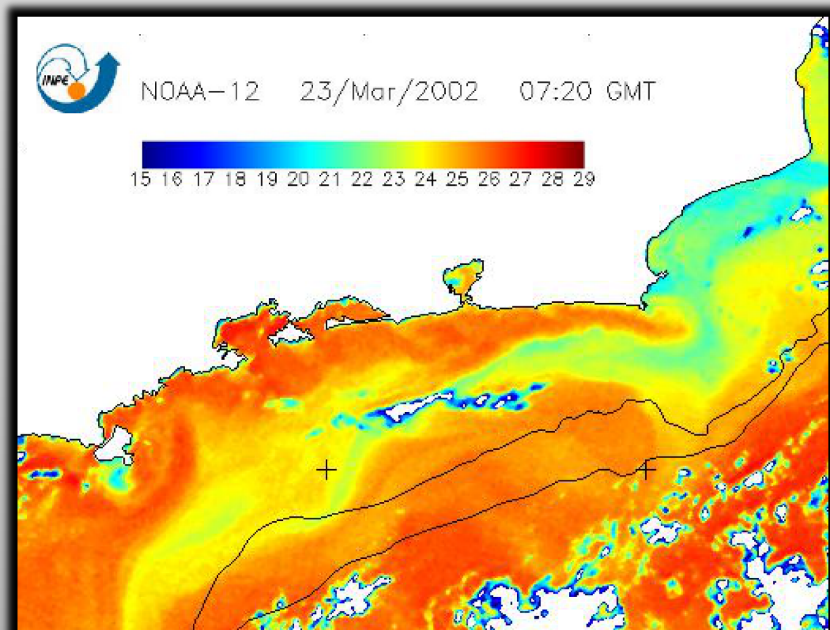


# Motivation

Positive SST anomalies during upwelling-favorable conditions



**January 2010 episode**  
Da Silva (2011)

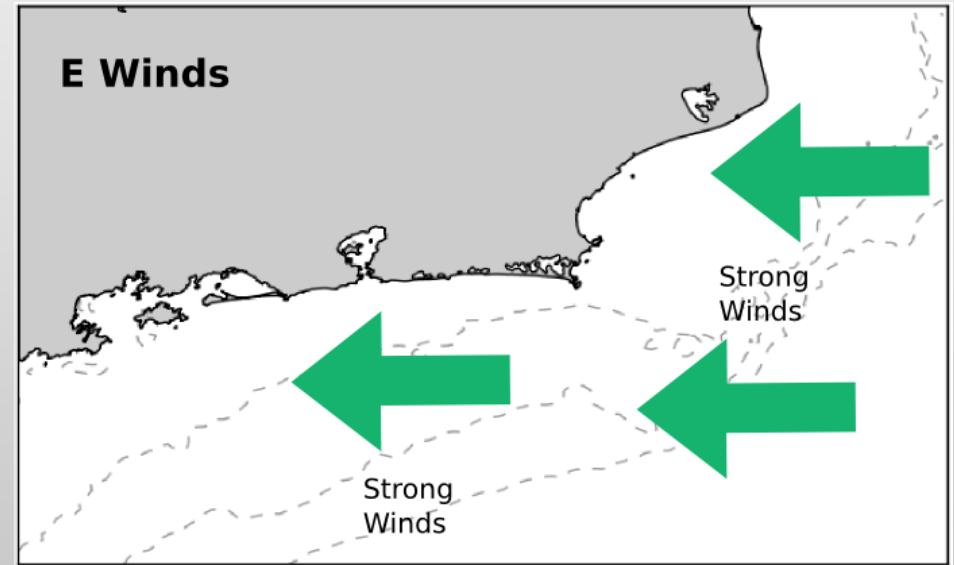
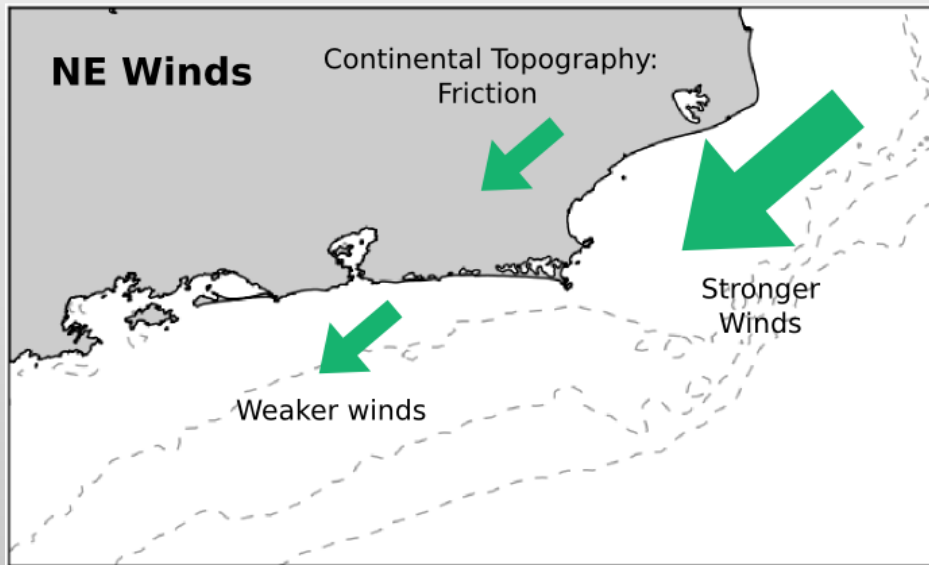


**March 2002**

# Motivation

Two types of upwelling favorable winds: E and NE

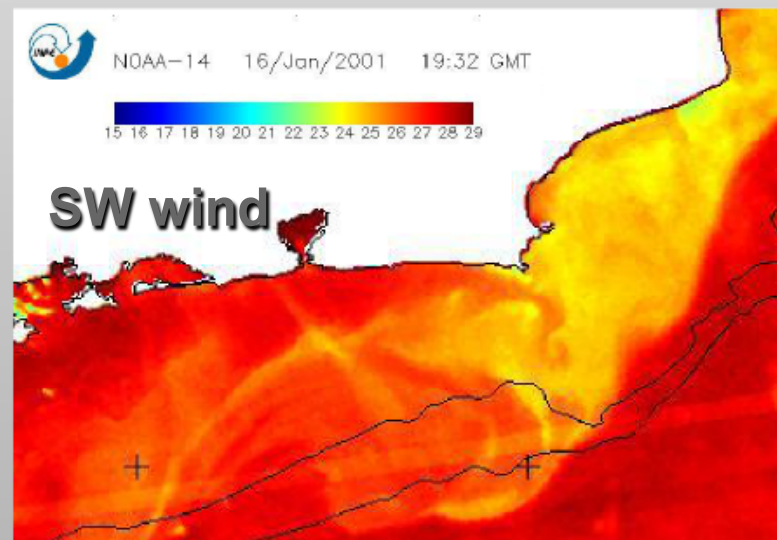
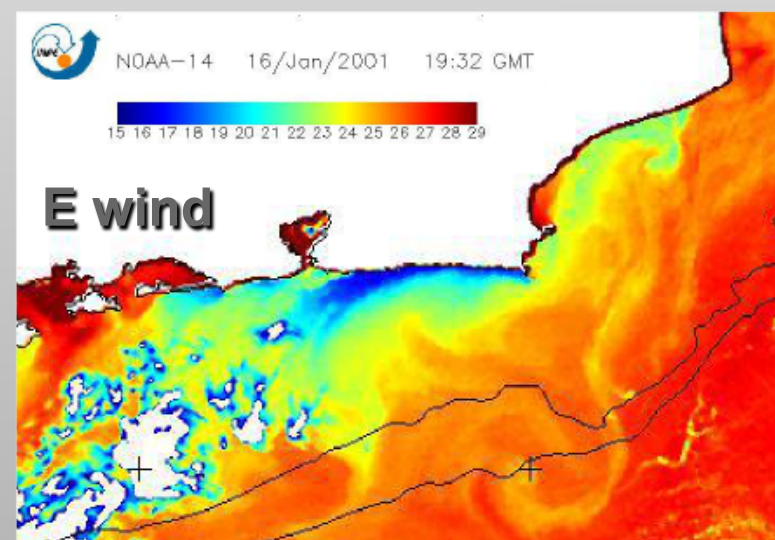
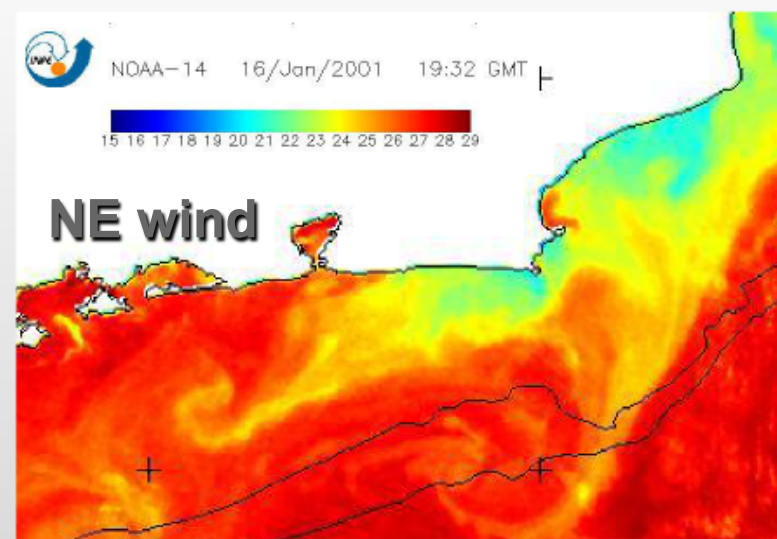
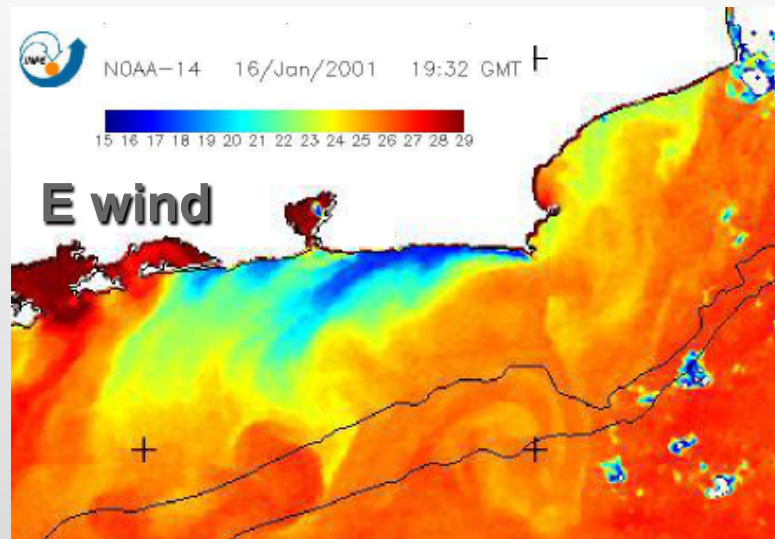
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# Motivation

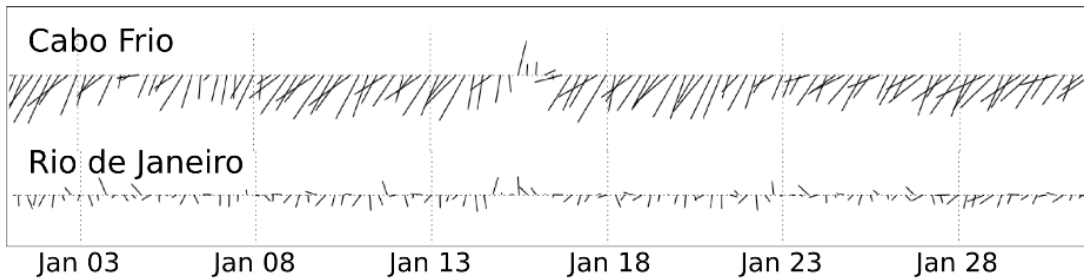
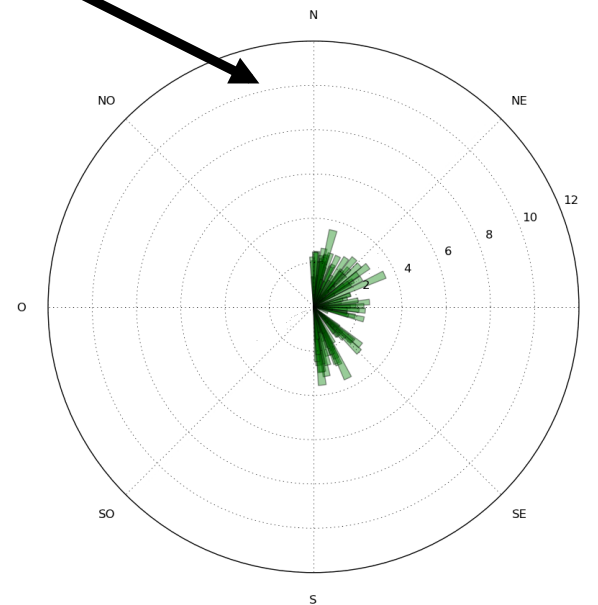
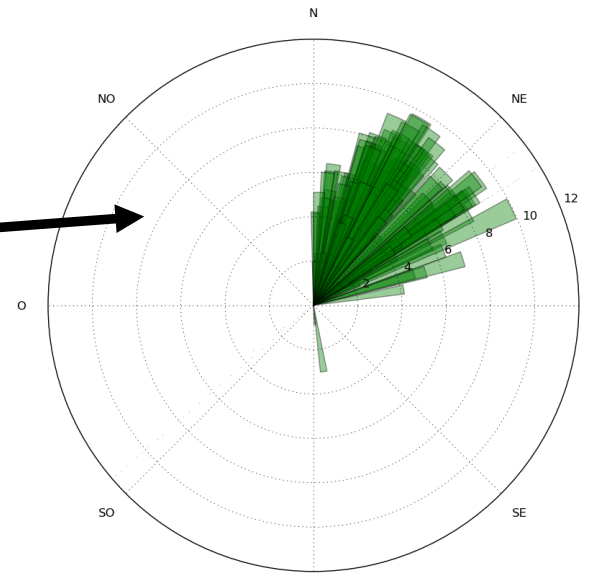
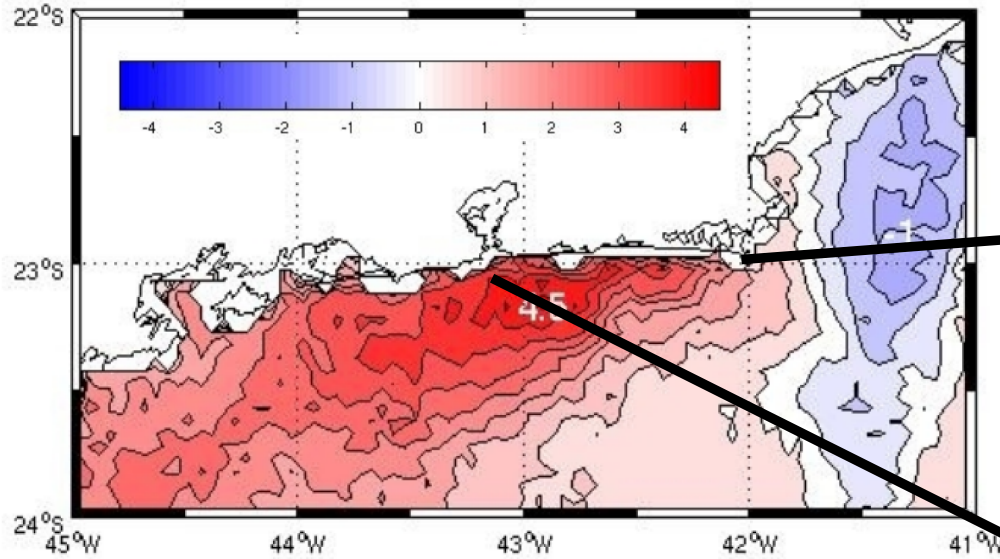
## Different spatial patterns of upwelling plume



Cortesy: Dr. João Lorenzetti - INPE

# Motivation

## Spatially variable winds during January 2010: *Da Silva (2011)*



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## **Hypothesis**

**Spatial variability in the wind field is correlated with positive sst anomalies during upwelling favorable events**

## **Objectives**

**Investigate the response of spatially variable wind forcing in Cabo Frio upwelling system**

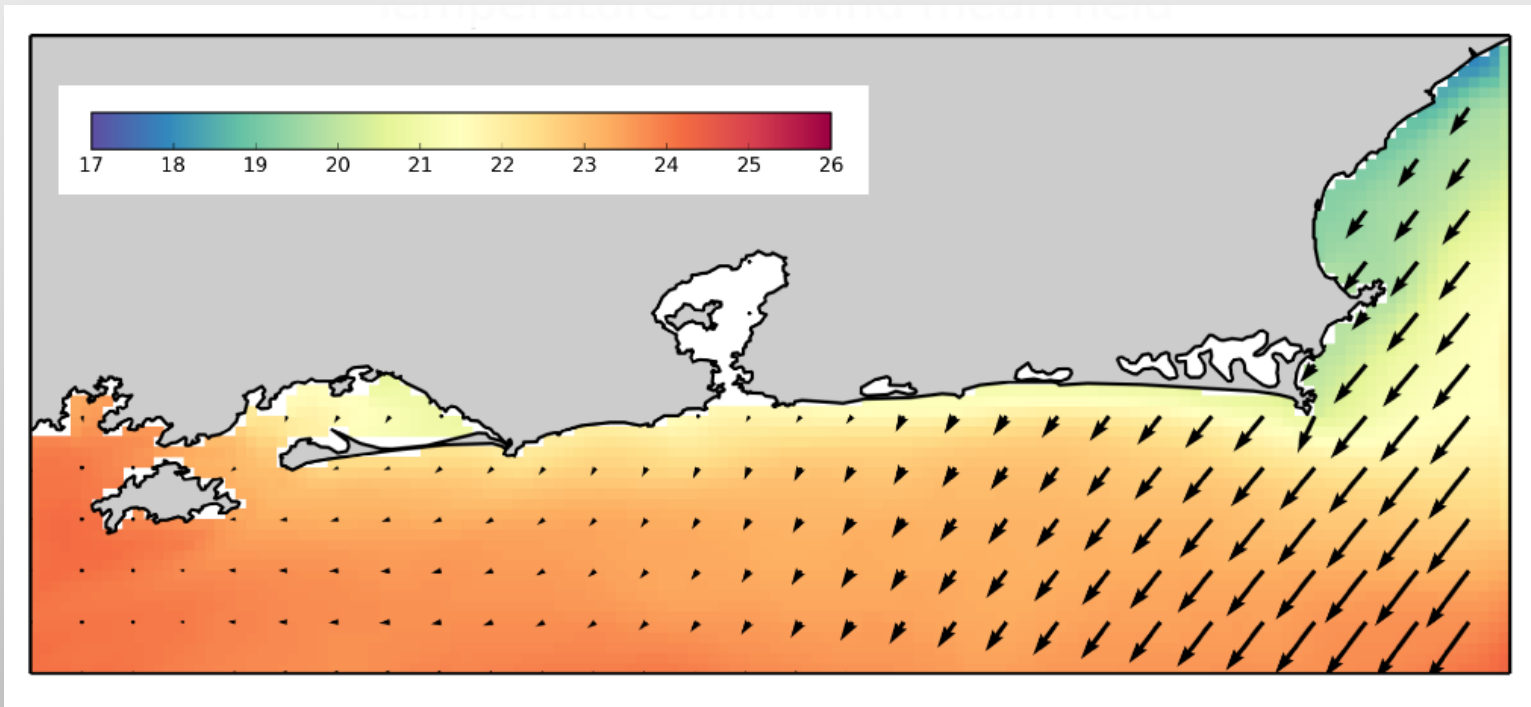
# Methodology

## Methodology synthesis

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### Process-study modeling

Semi-idealized experiment with constant but spatially variable wind field



CFSR snapshot during January 2010: date of the anomalous event described by *Da Silva (2011)*

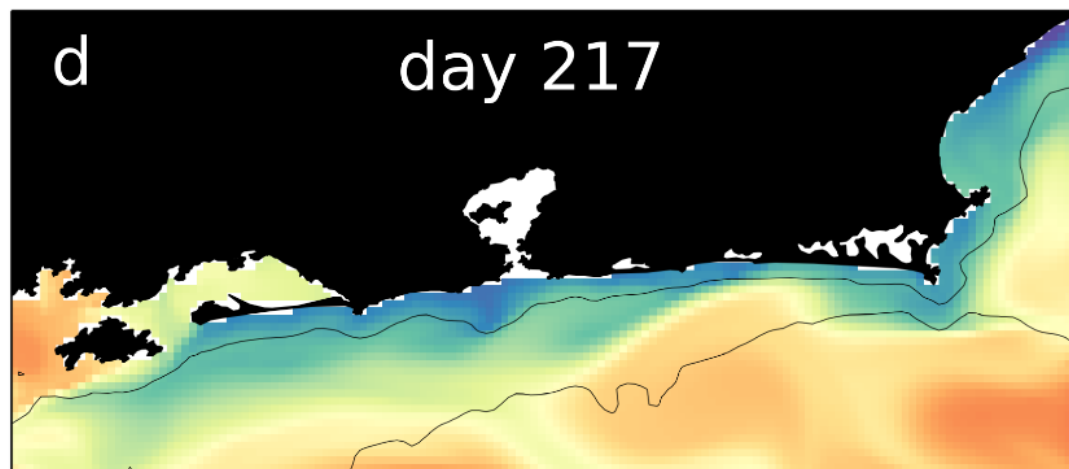
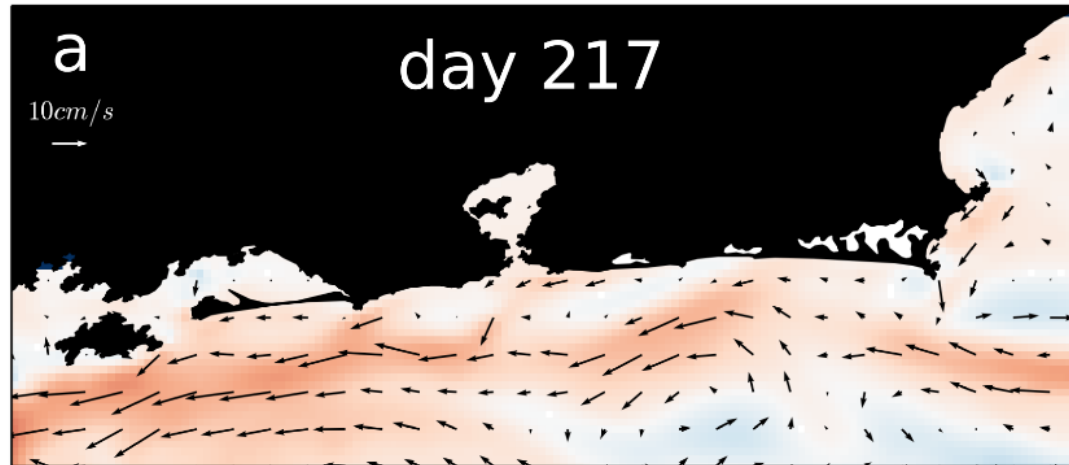
# Results

## Pressure gradient, velocity, and SST model 3-day moving averages

Cross-shelf barotropic  
Pressure gradient:  $m/s^2$

Barotropic velocity  
Vectors

SST





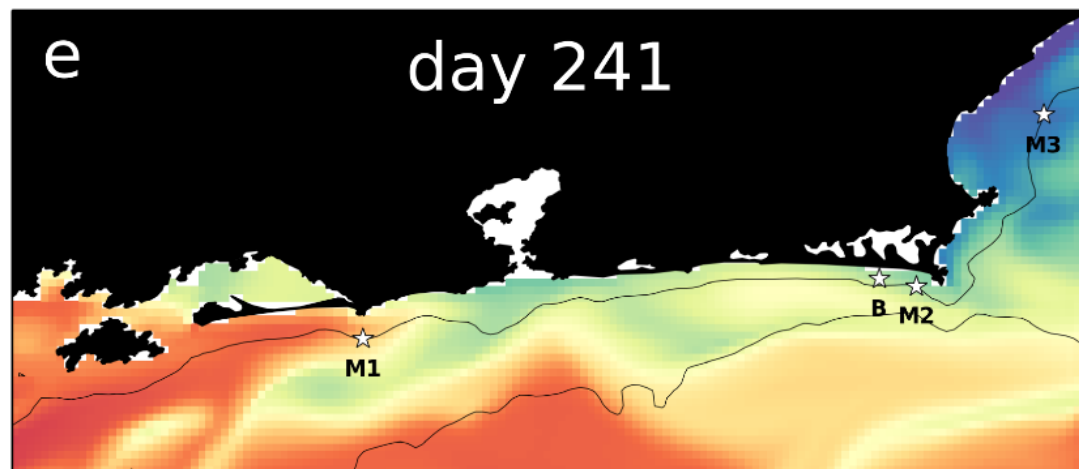
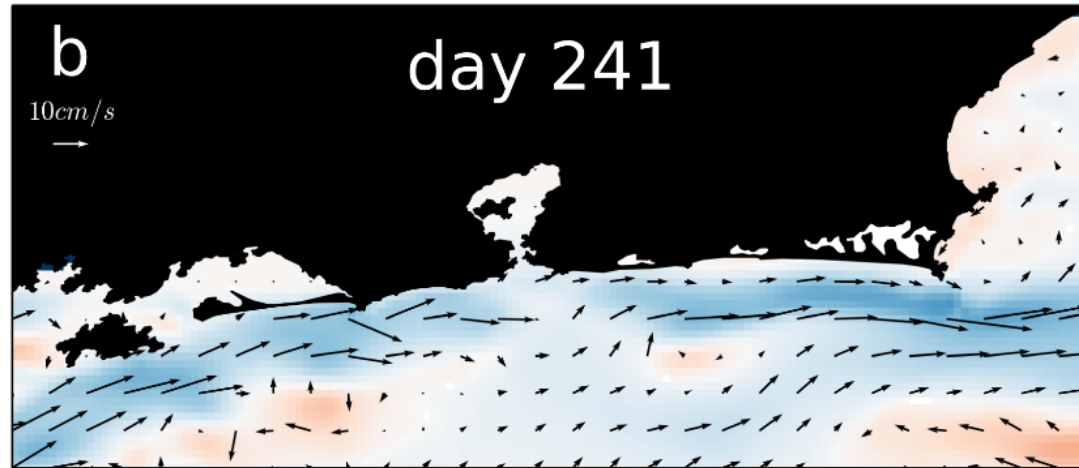
# Results

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Cross-shelf barotropic  
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Barotropic velocity  
Vectors

SST



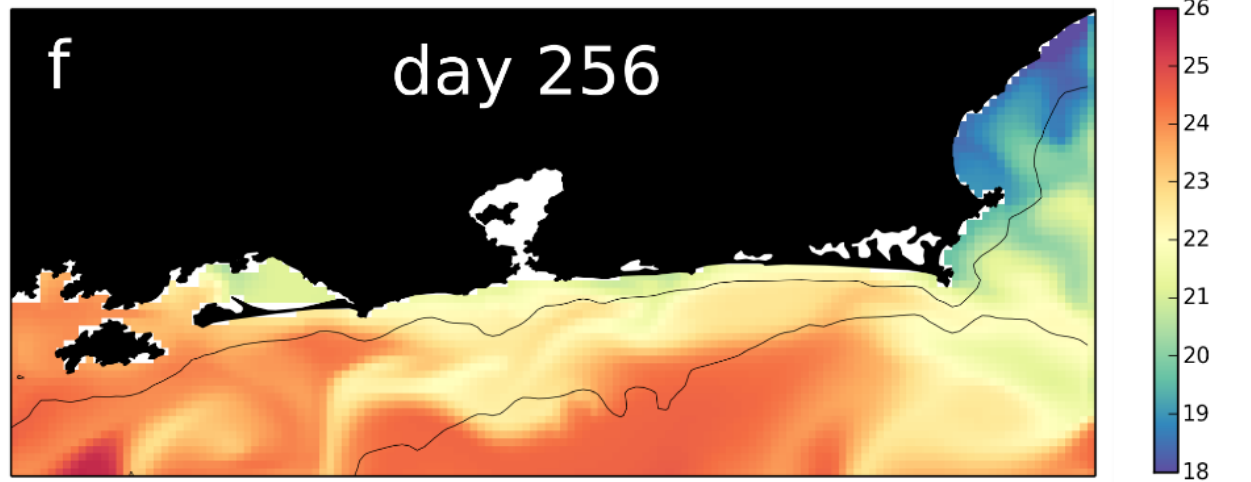
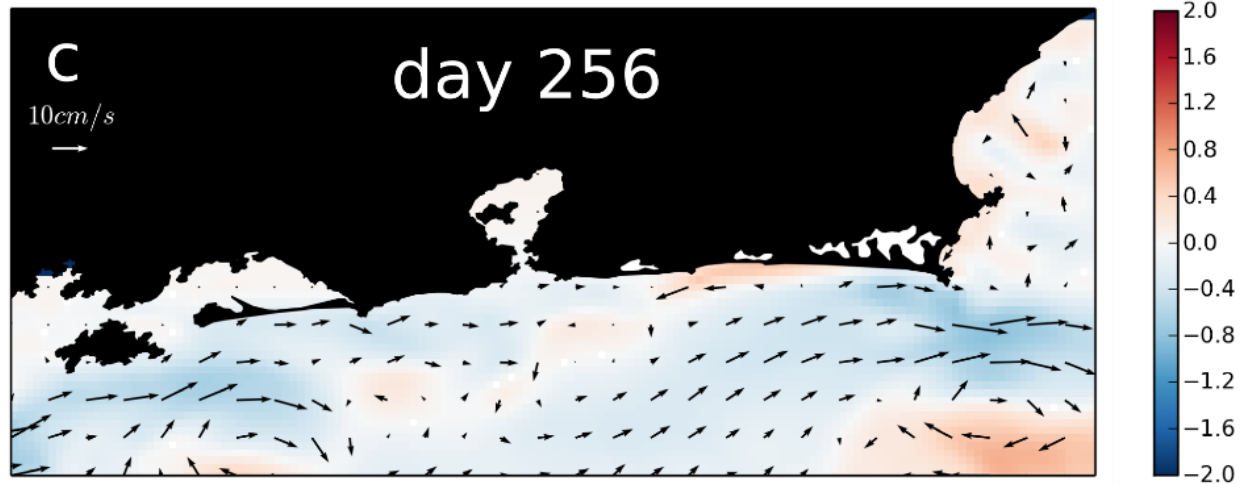
# Results

## Pressure gradient, velocity, and SST model 3-day moving averages

Cross-shelf barotropic  
Pressure gradient:  $\text{m/s}^2$

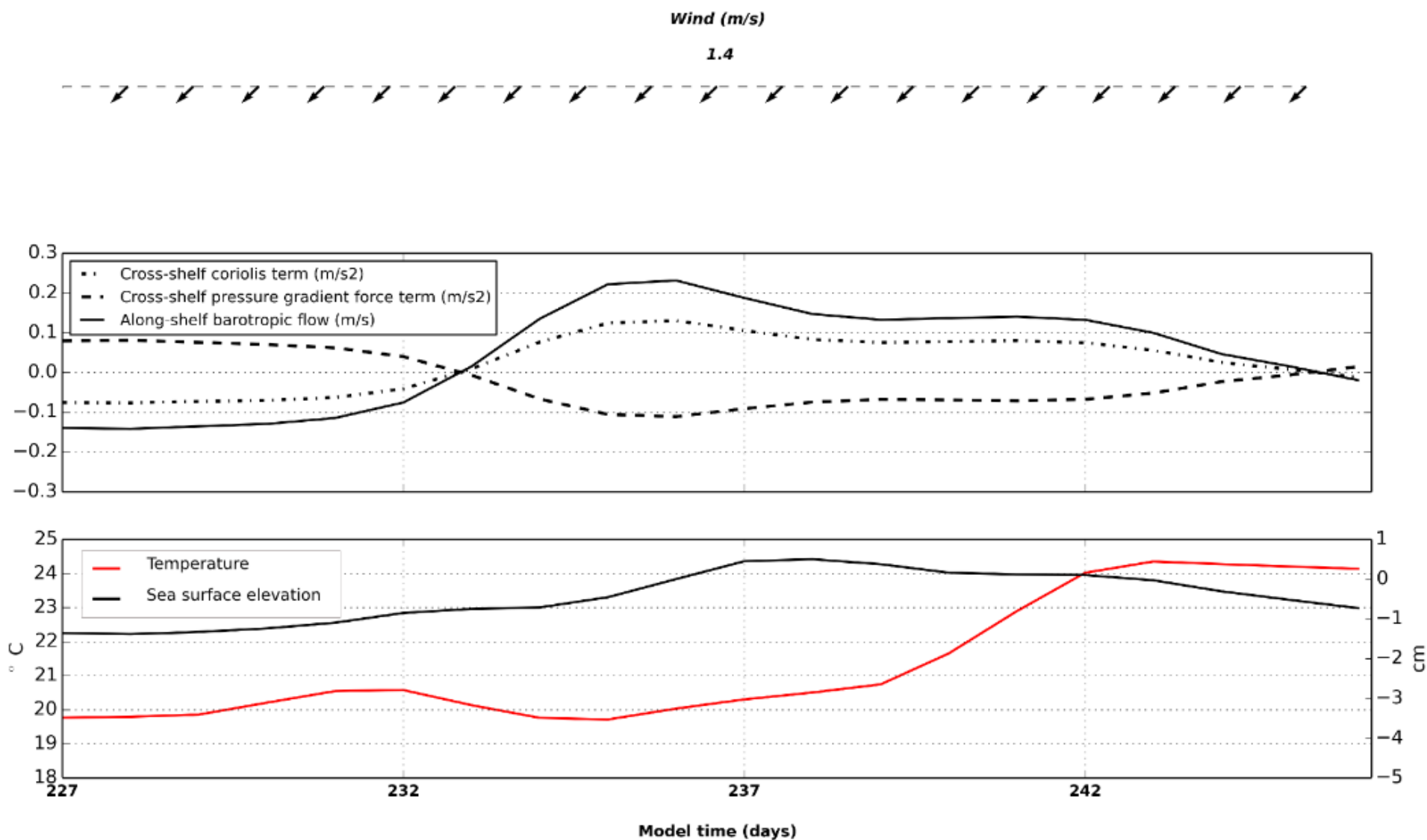
Barotropic velocity  
Vectors

SST



# Results

## Momentum Balance analysis: Sepetiba, inner to mid shelf

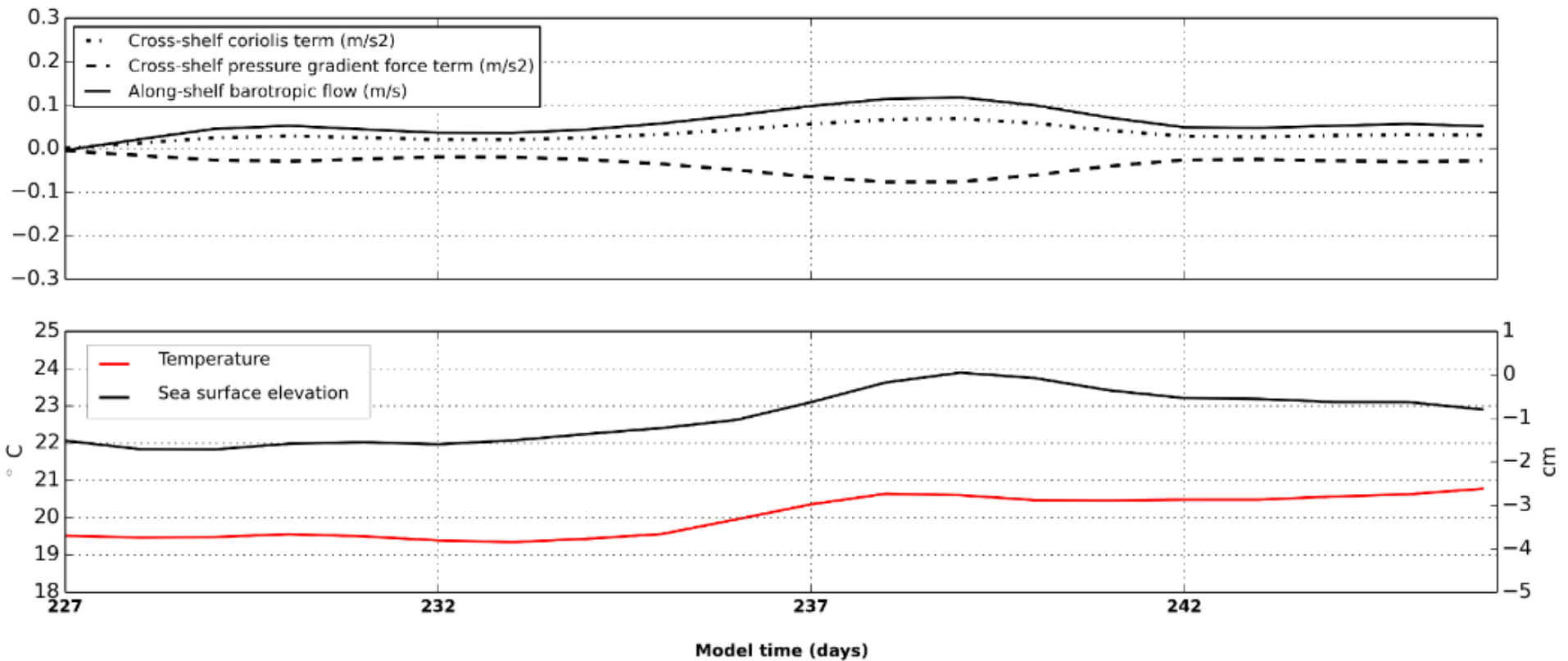
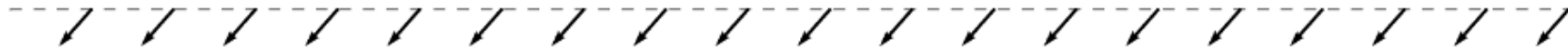


# Results

## Momentum Balance Analysis: Cabo Frio, inner to mid shelf

Wind (m/s)

3.2

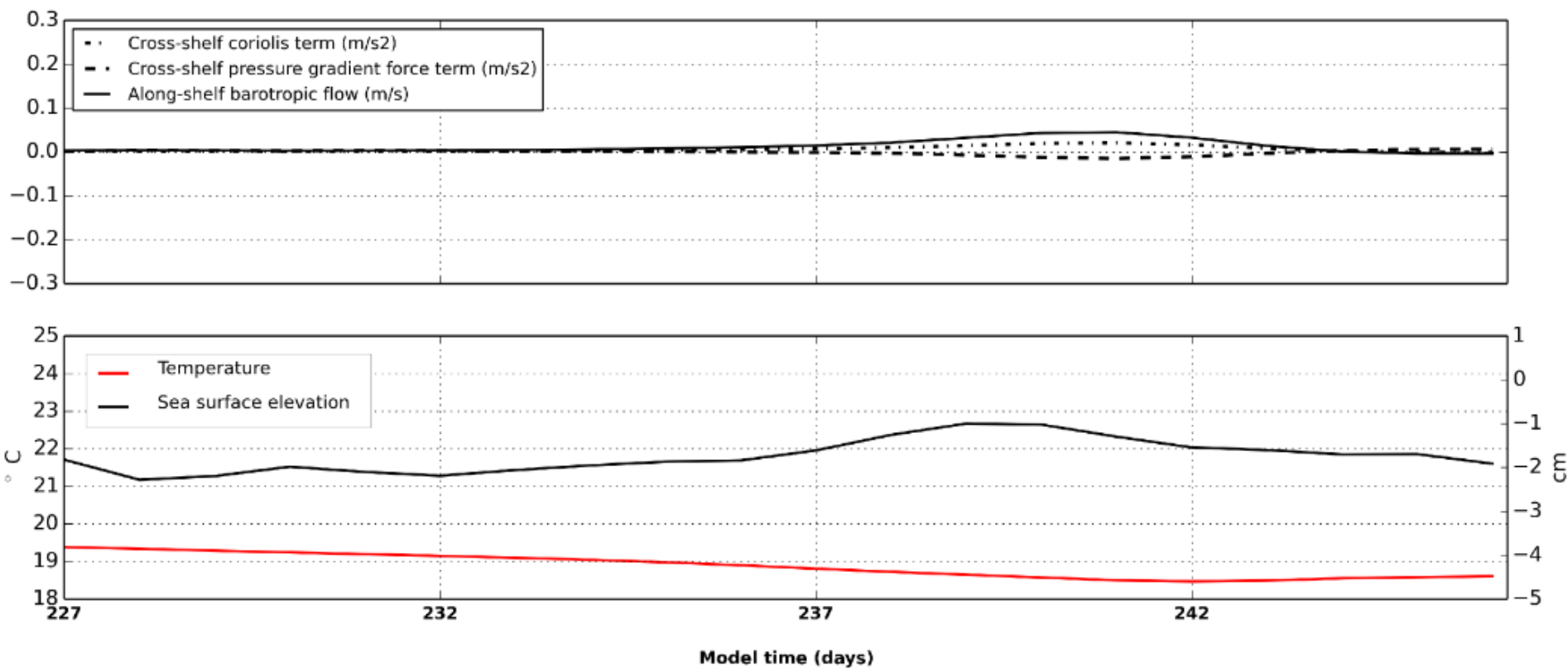
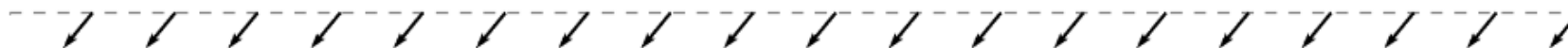


# Results

## Momentum Balance analysis: Macaé, inner to mid shelf

Wind (m/s)

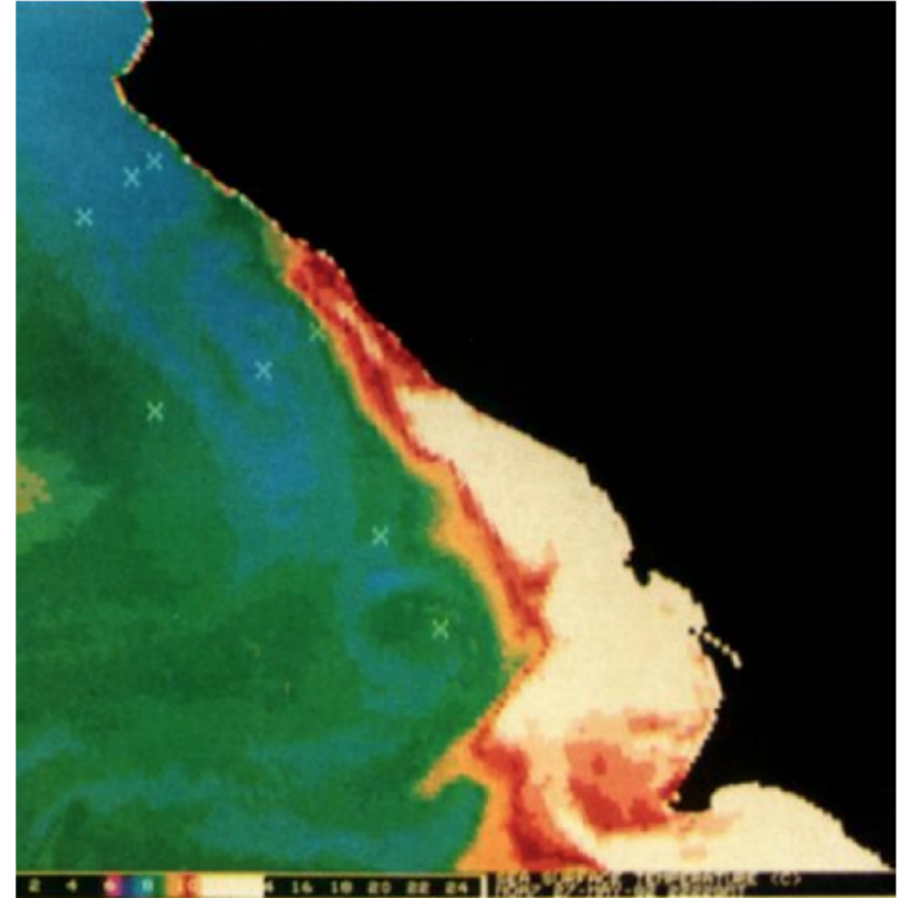
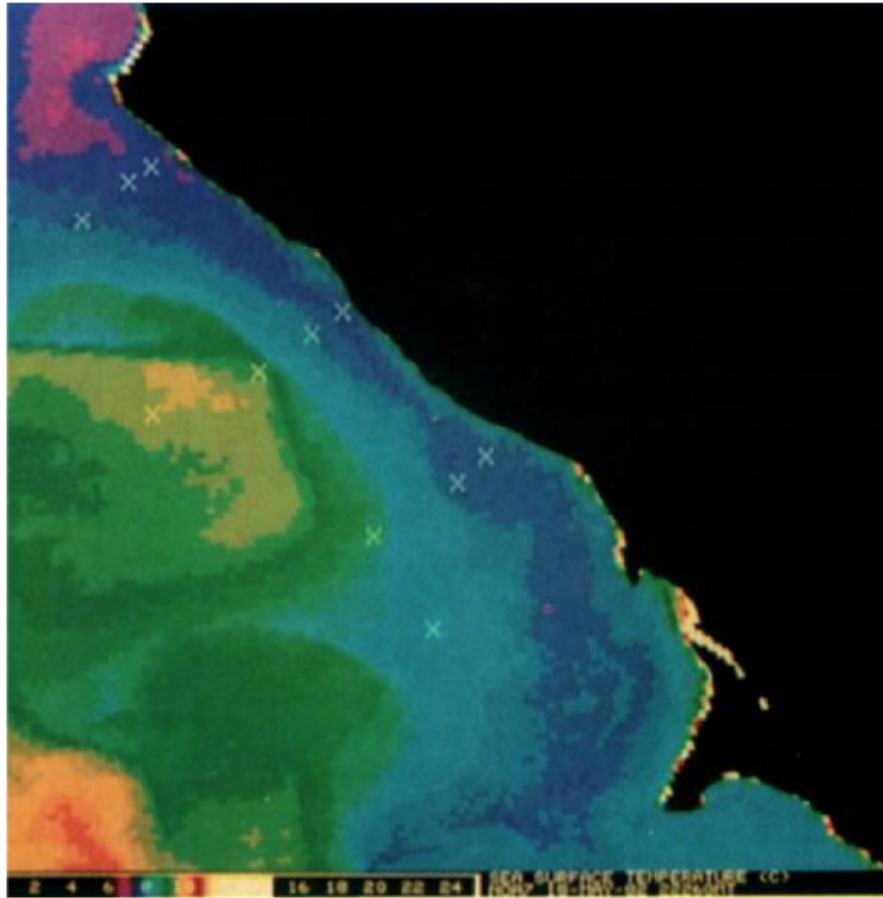
2.9





# Results

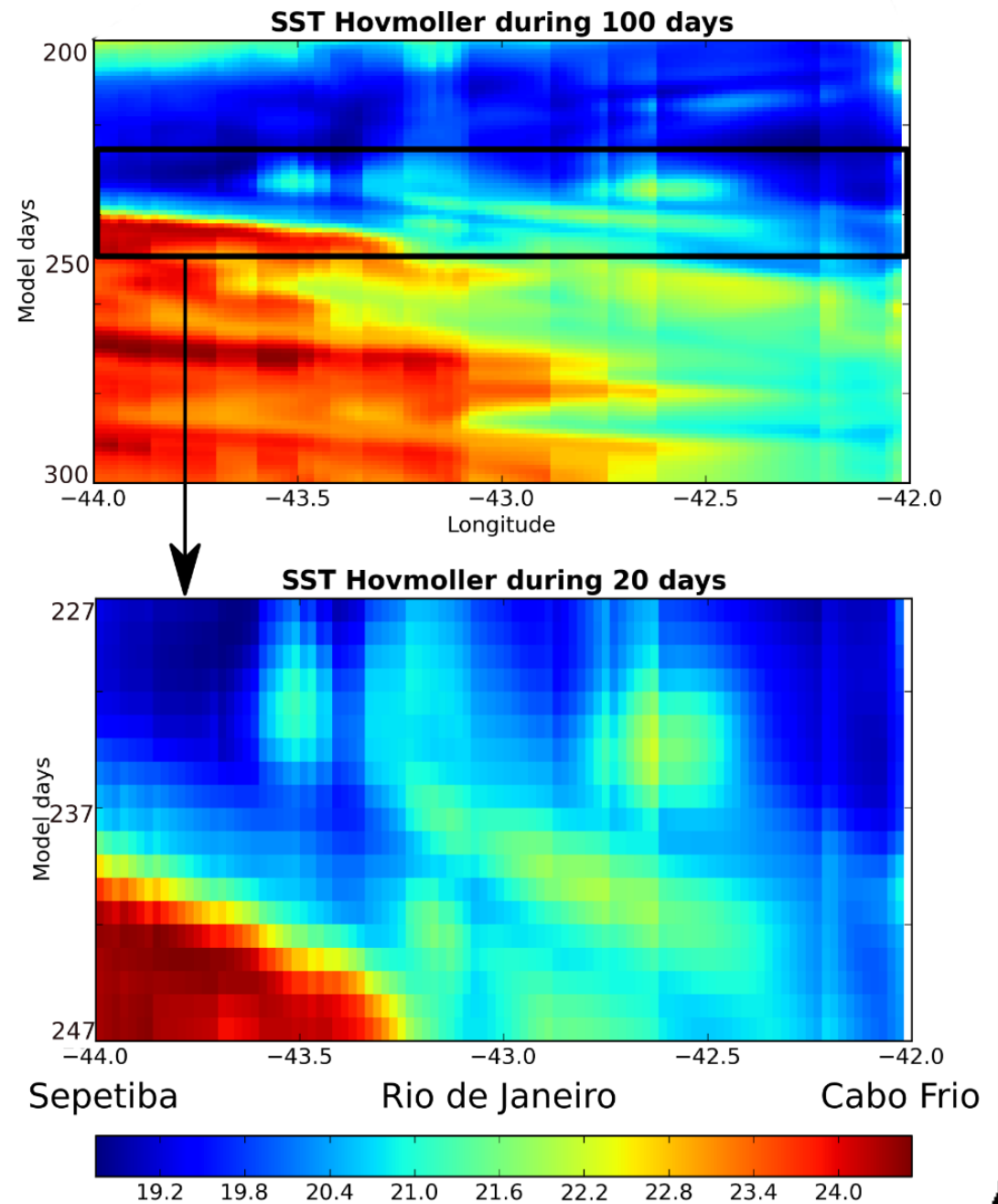
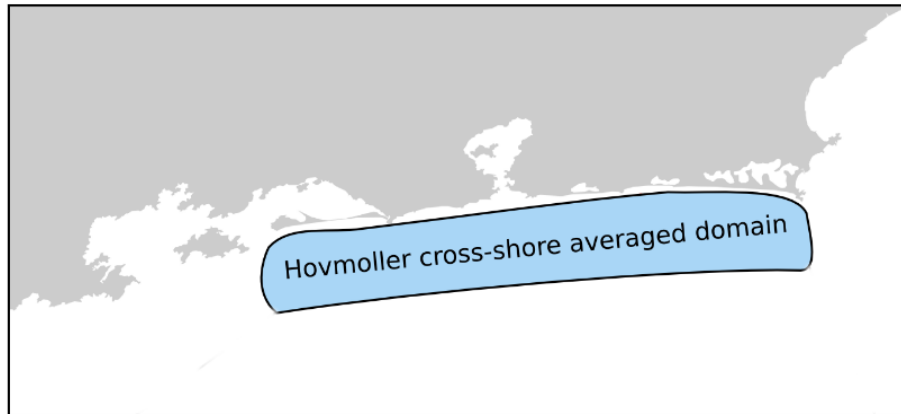
## Literature comparison



*Send et al. (1987)*

# Results

## Periodicity?



# Results

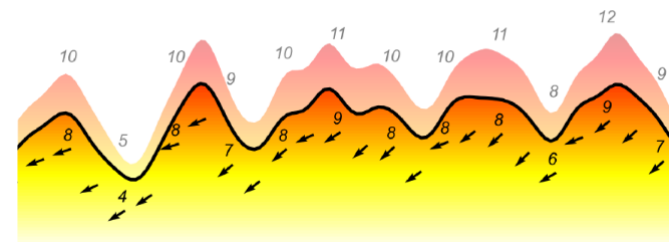
## Latest observed scenario – SIODOC Meteoceanographic Mooring

Meteoceanographic Buoy ( SIODOC/IEAPM )

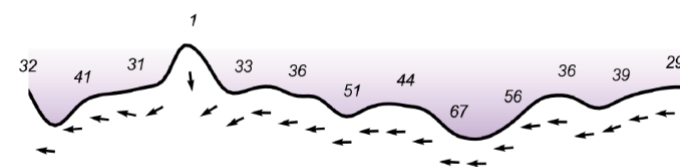
(lon:-42.18-lat:-22.99)

Wind & Gust (m/s)

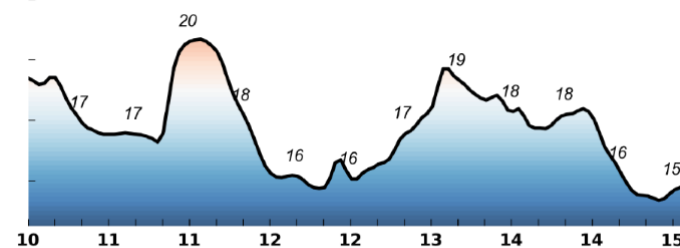
a



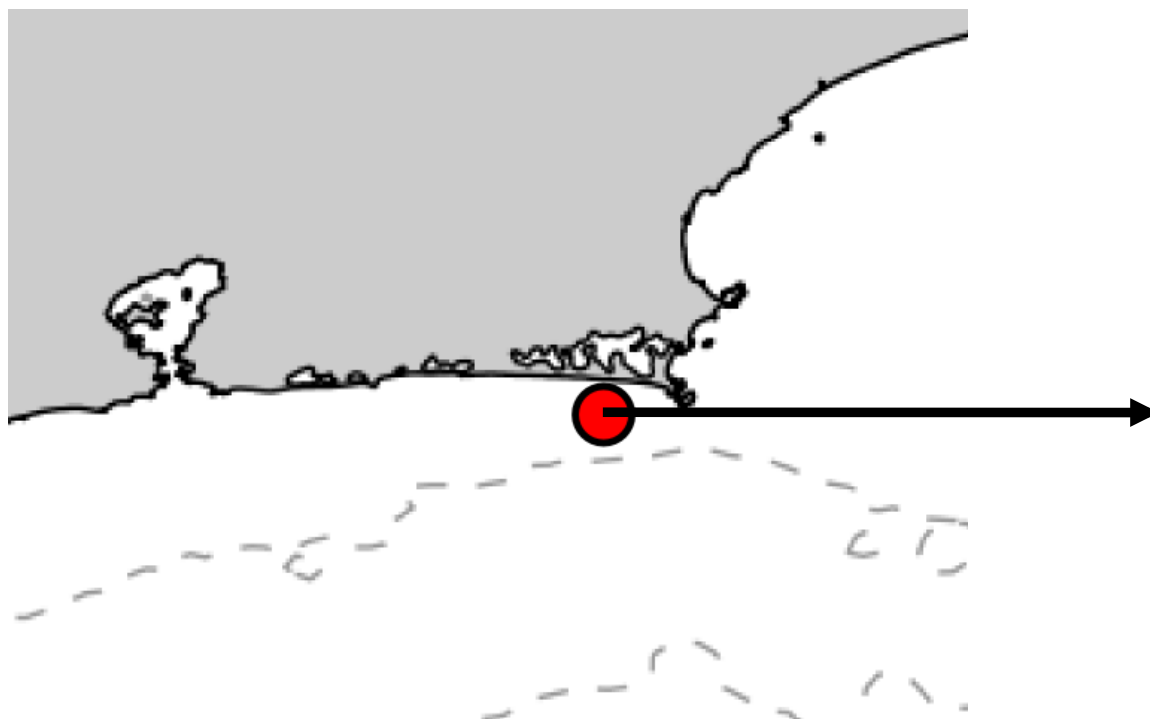
b



c

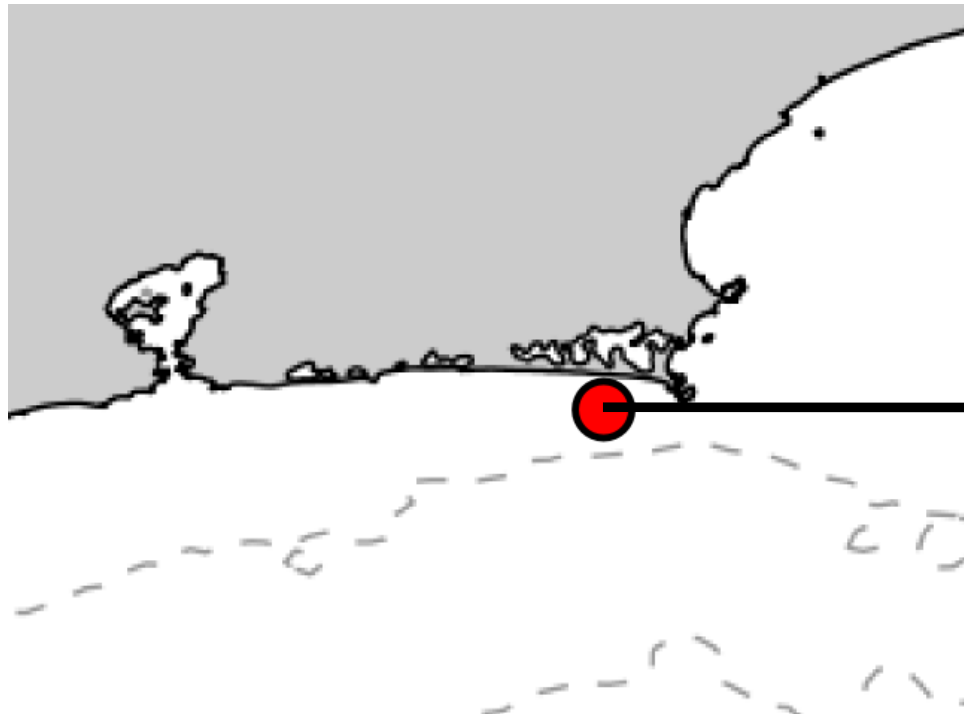


September 2013



# Results

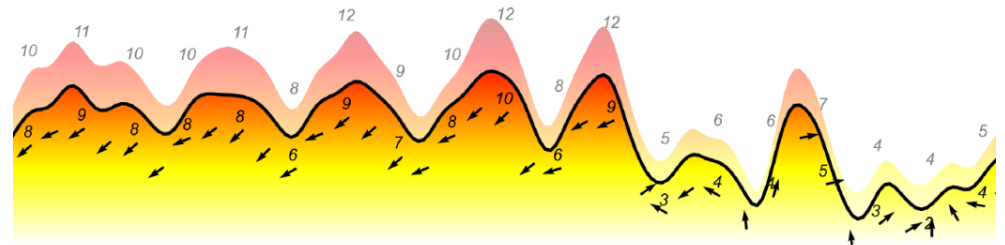
## Latest observed scenario – SIODOC Meteoceanographic Mooring



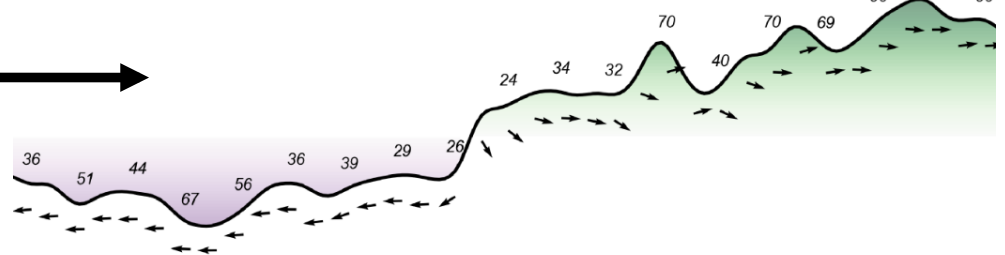
### Meteoceanographic Buoy ( SIODOC/IEAPM )

(lon : -42.18 - lat : -22.99)

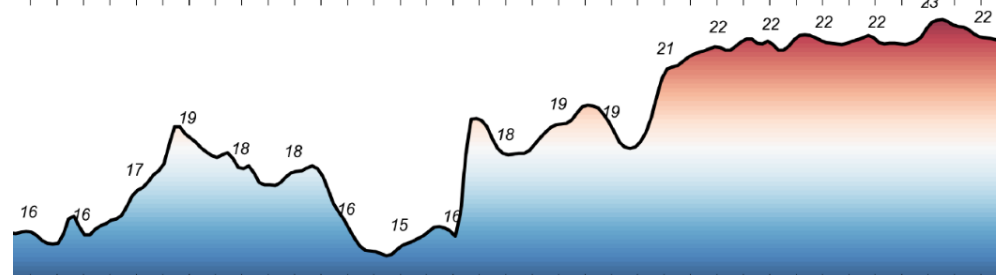
#### Wind & Gust (m/s)



#### Along-shelf surface flow (cm/s)



#### Sea surface temperature (°C)

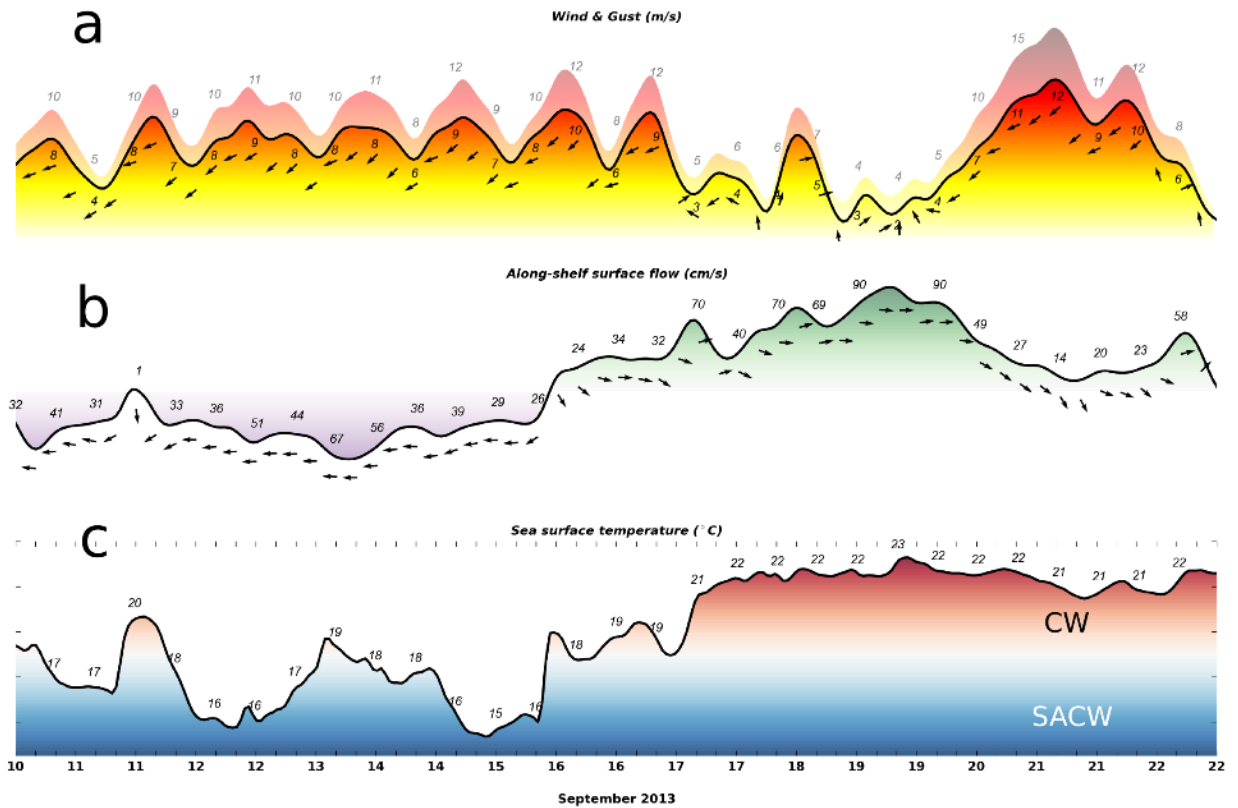


September 2013

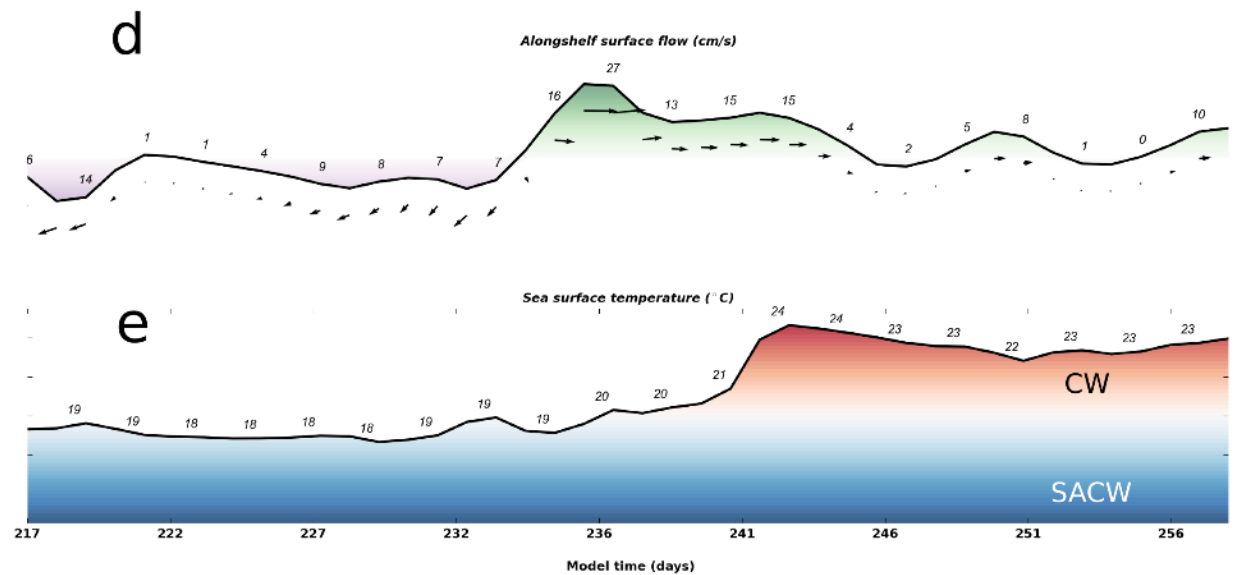
# Results

## Comparing with ROMS

Meteoceanographic Buoy ( SIODOC/IEAPM )  
(lon: -42.18 - lat: -22.99)



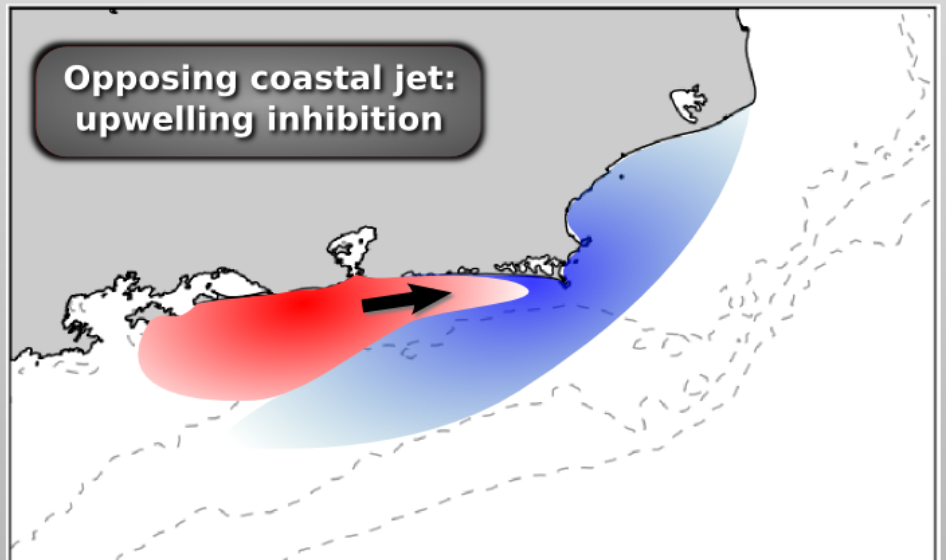
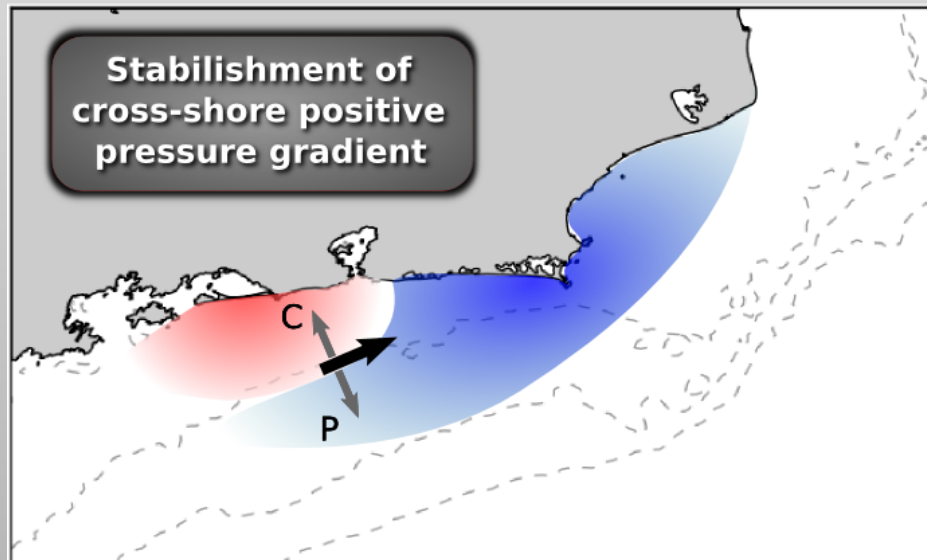
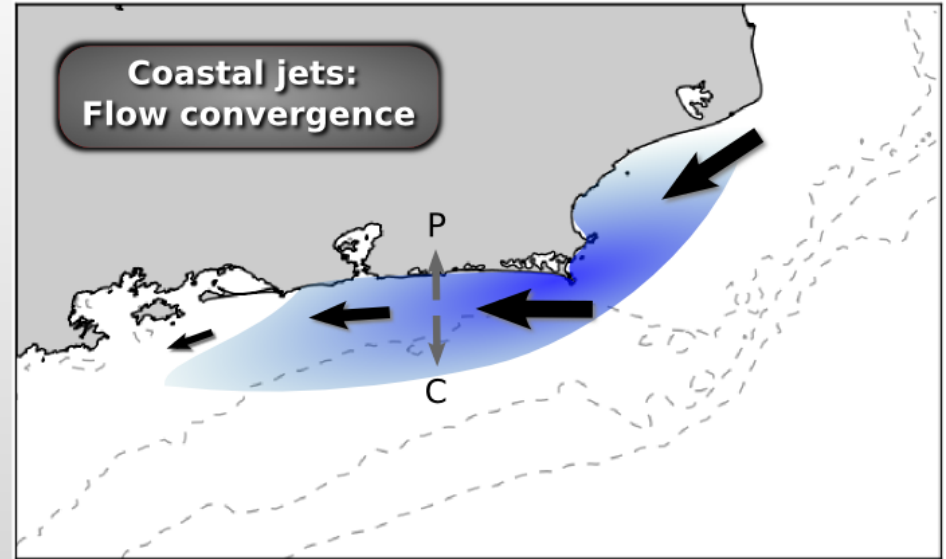
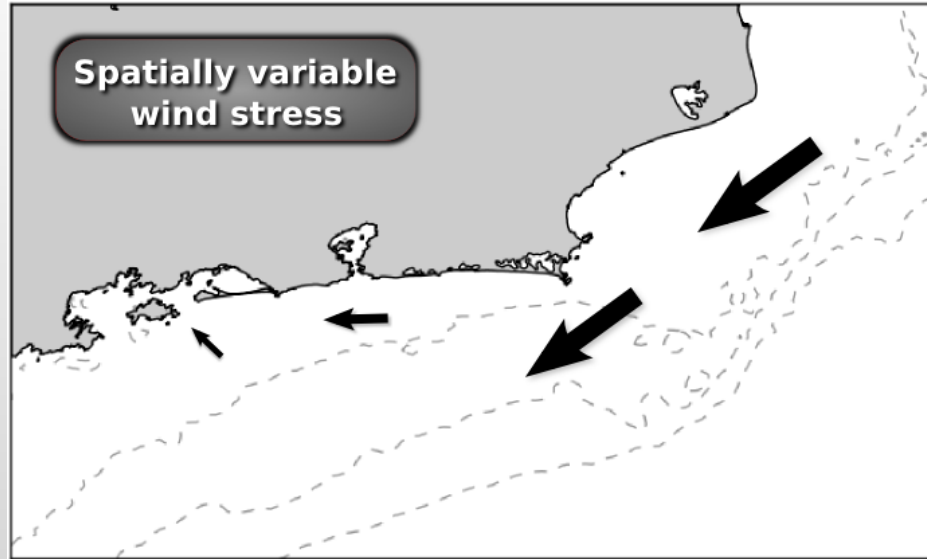
ROMS Results





# Summary

## Suggested mechanism



**Obrigado !**

**Thank you !**

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**Questions ?**

[phellipe.couto@gmail.com](mailto:phellipe.couto@gmail.com)  
[rsoutelino@ieapm.mar.mil.br](mailto:rsoutelino@ieapm.mar.mil.br)