Processes Connecting Coastal to Basin-Scale Ocean Circulation in the SW Atlantic Ocean: As Revealed by Combinations of: SSH, Salinity, Wind & SST

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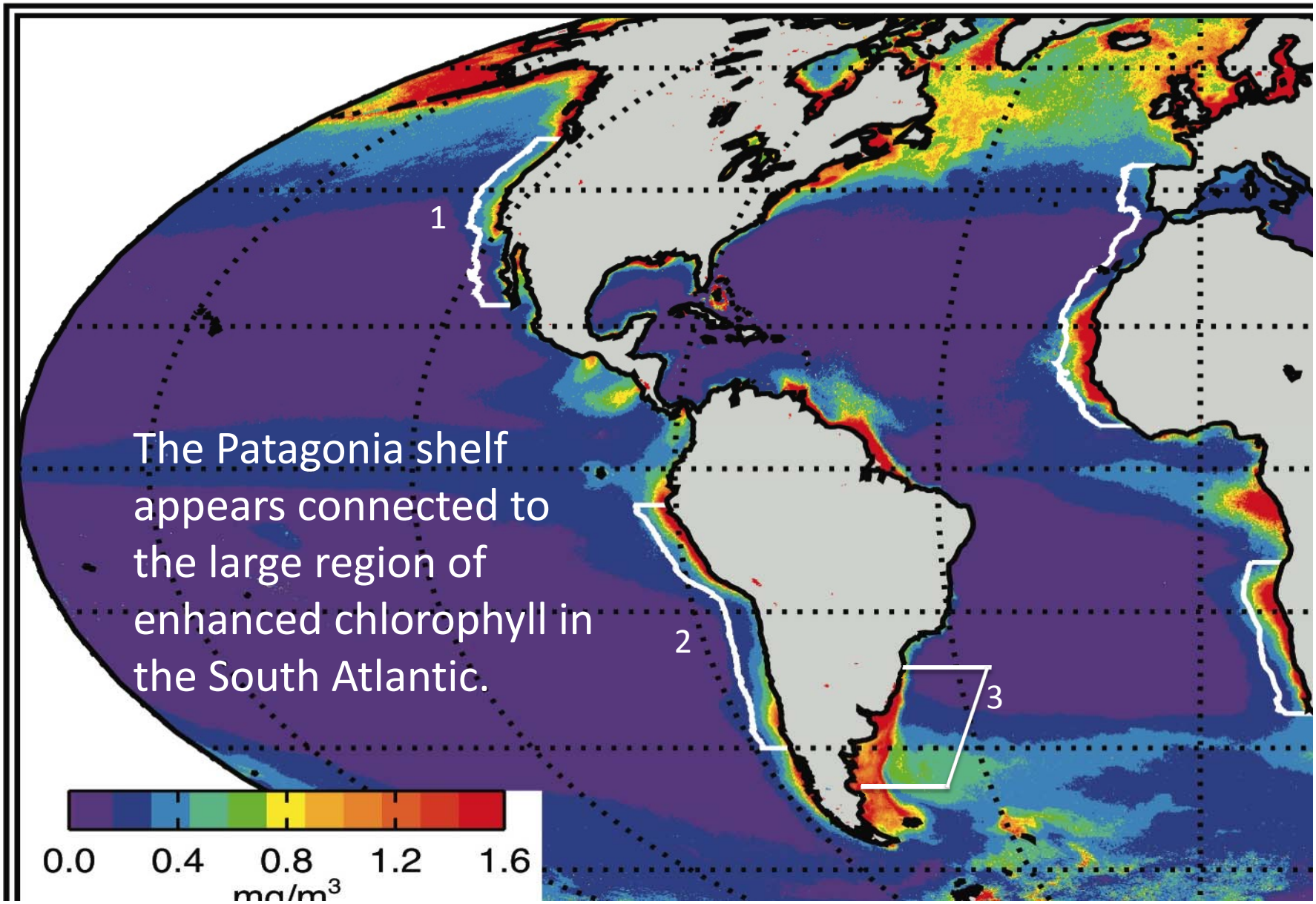
Elbio Palma, Martin Saraceno and Yi Chao

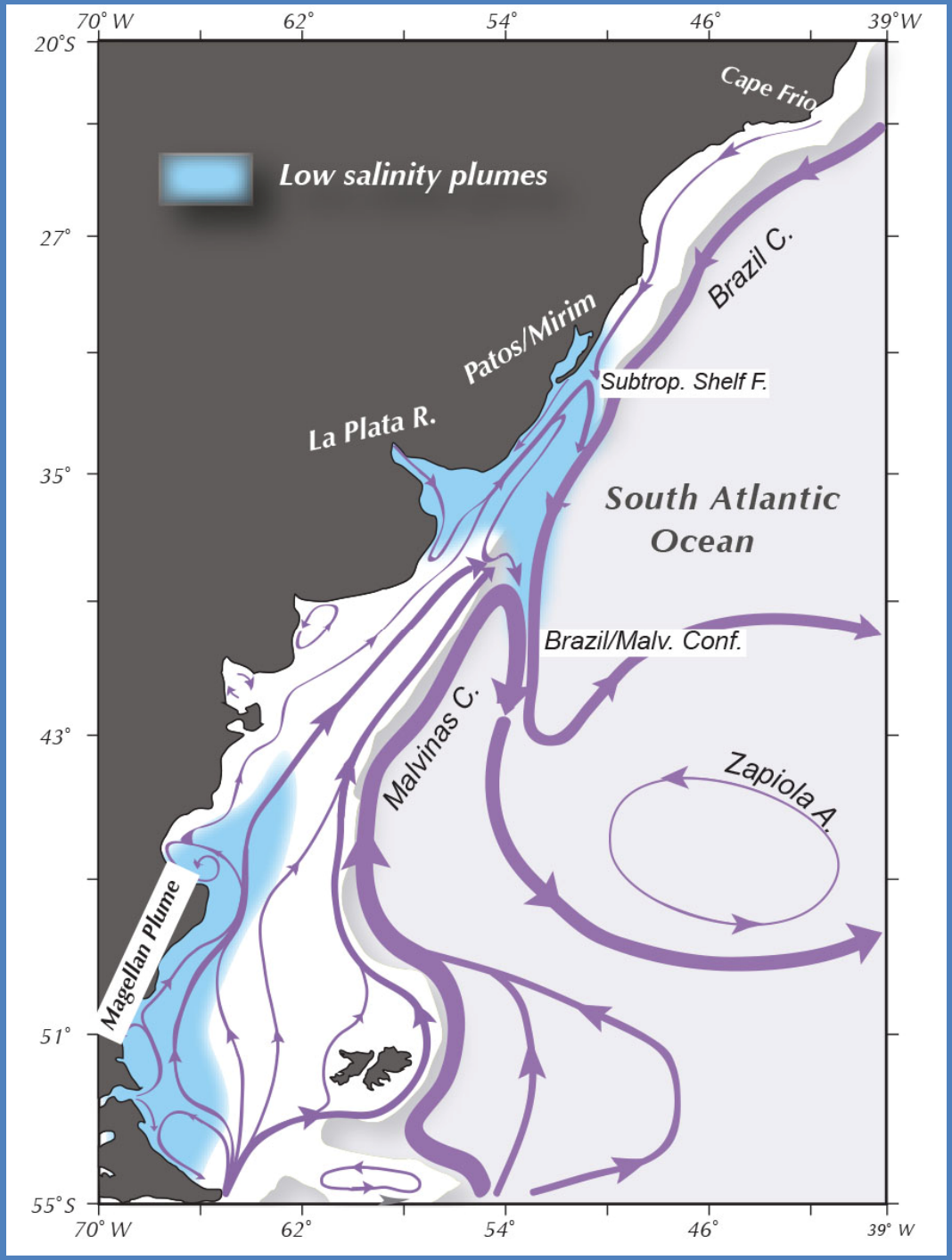
Three Regions of Interest: 2 EBC, 1 WBC

SeaWiFs
Chlorophyll-a



SW Atlantic – Patagonian Shelf

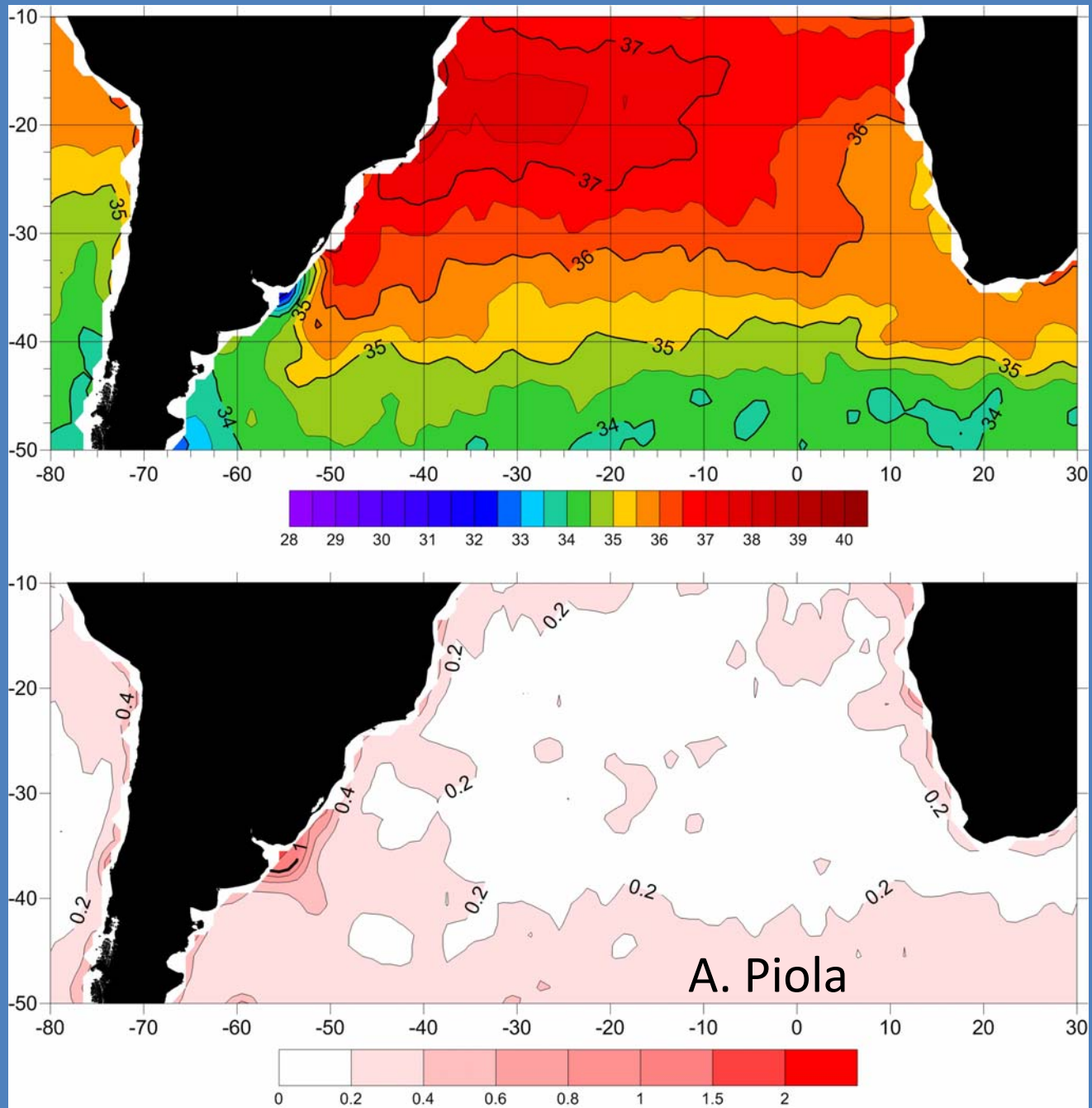
- Strong River Outflow
- Wide Shelf
- Energetic Confluence & Offshore Transport ~ 54°W, 40°S

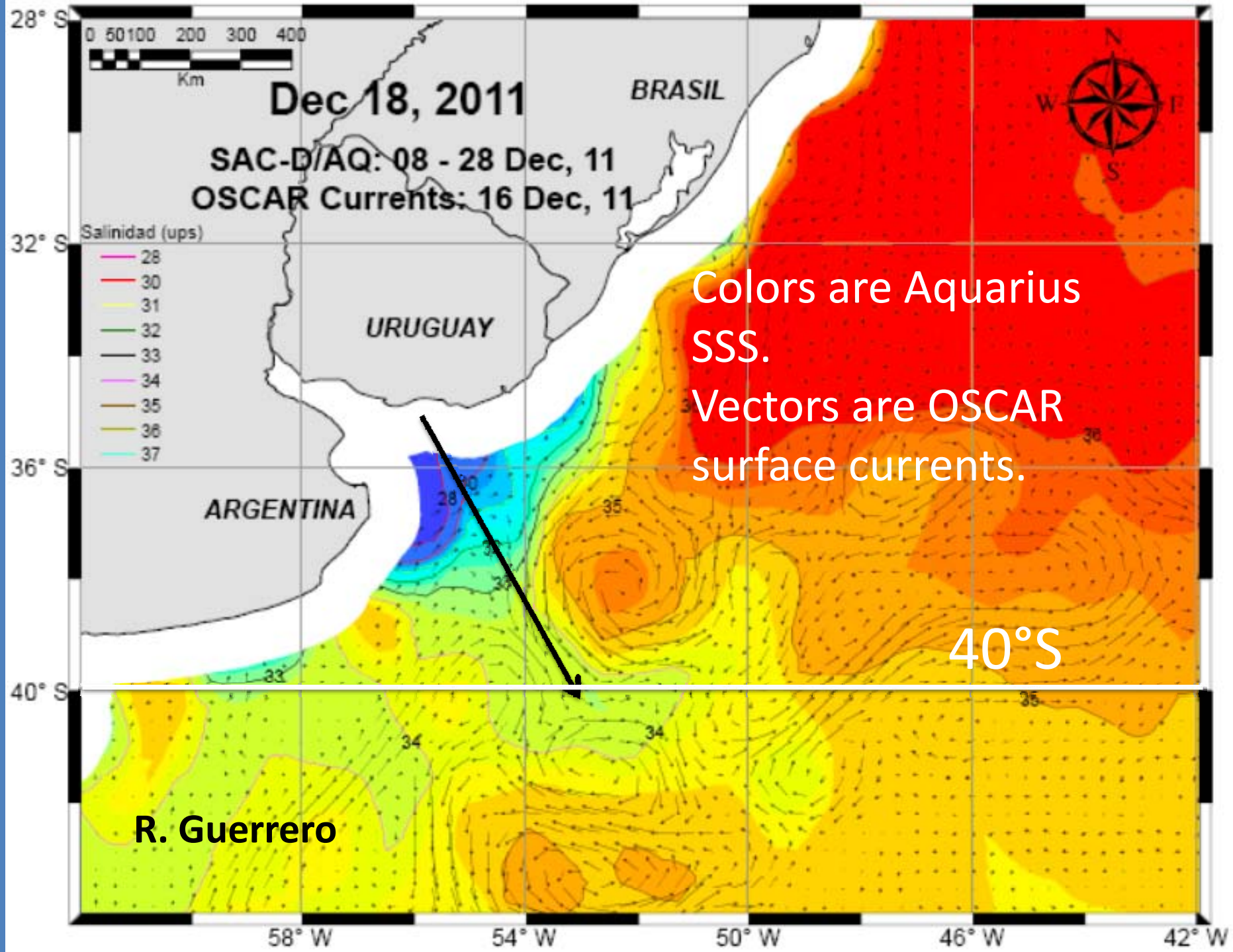


Aquarius Mean & St Dev SSS

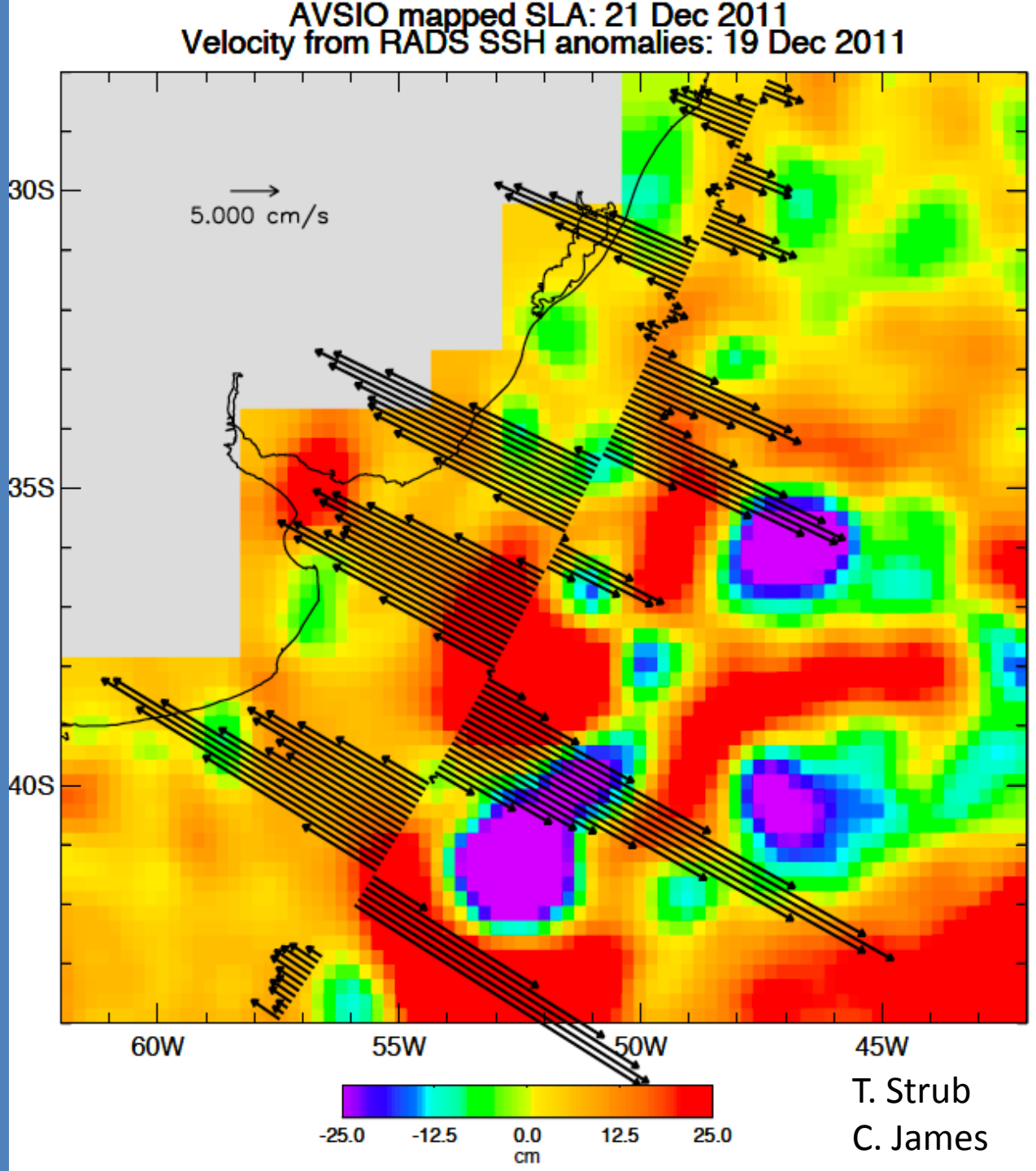
The outfall from the La Plata R. is the main feature in the subtropical South Atlantic.

Offshore of the outfall the change in SSS is 2-4 psu, while the standard deviation is > 1.0 psu.

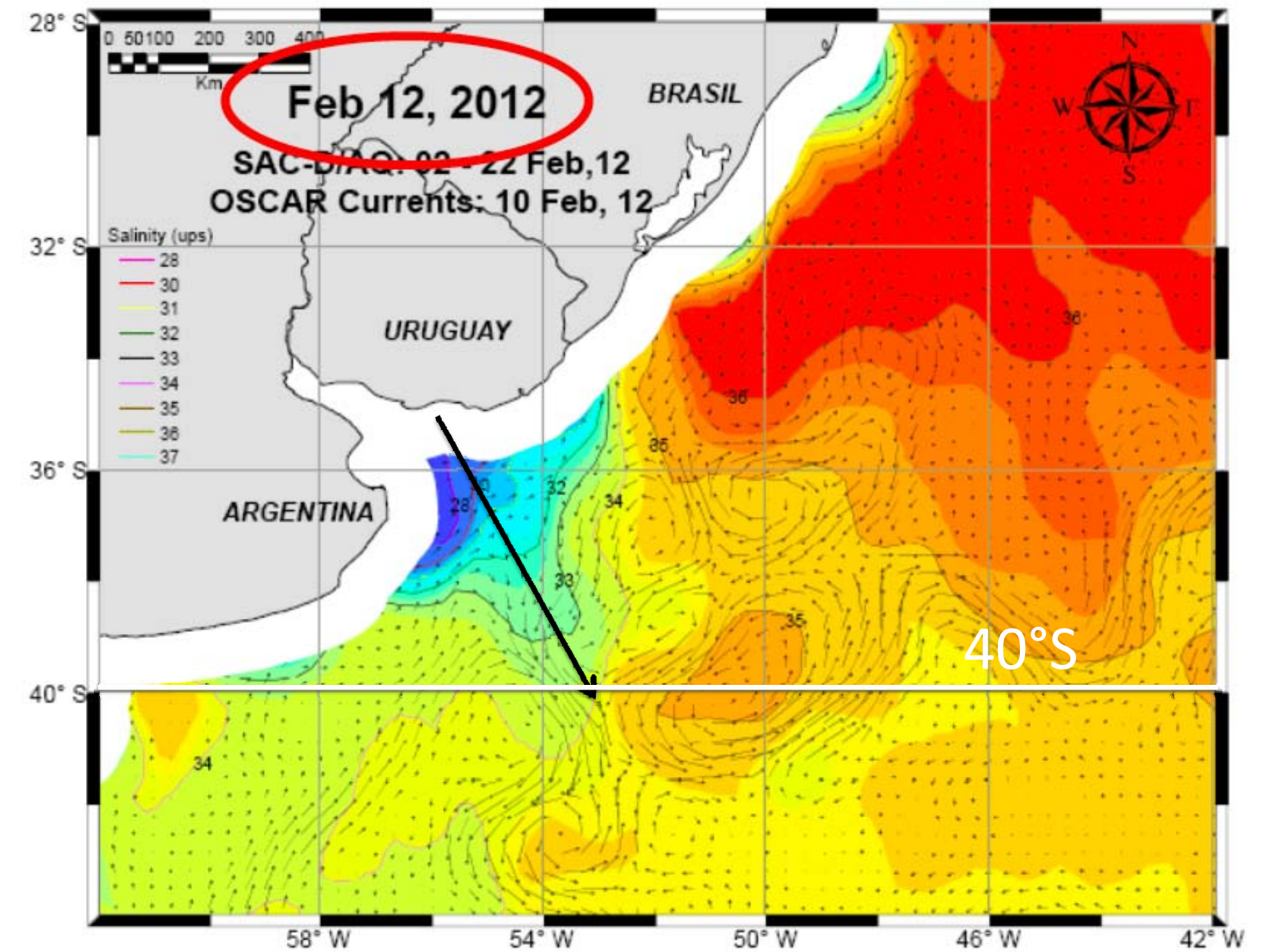



Dec 18, 2011
SAC-D/AQ: 08 - 28 Dec, 11
OSCAR Currents: 16 Dec, 11
BRASIL
URUGUAY
ARGENTINA
Salinidad (ups)
28
30
31
32
33
34
35
36
37
0 50100 200 300 400
Km
28° S
32° S
36° S
40° S
58° W
54° W
50° W
46° W
42° W
Colors are Aquarius SSS.
Vectors are OSCAR surface currents.
40°S
R. Guerrero

Colors are AVISO mapped SLA. Alongtrack Jason-2 data find the same eddy. Crosstrack geostrophic velocities are of order 0.5 m/s.



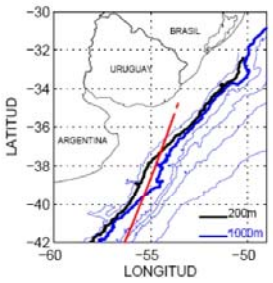
T. Strub
C. James

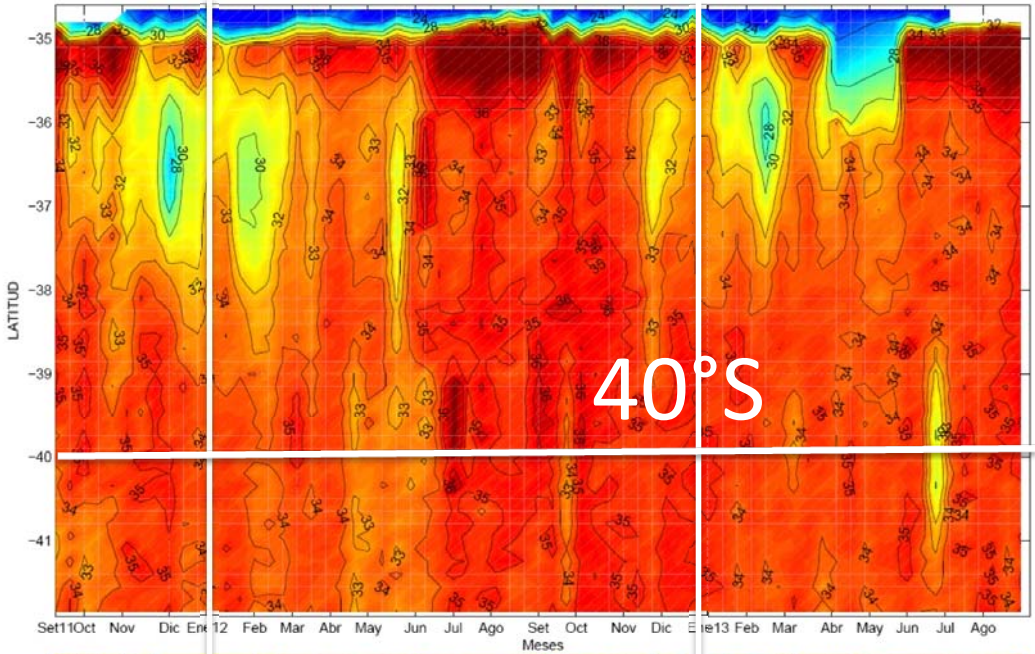

Feb 12, 2012
SAC-D/AQ: 02 - 22 Feb,12
OSCAR Currents: 10 Feb, 12
BRASIL
URUGUAY
ARGENTINA
Salinity (ups)
28
30
31
32
33
34
35
36
37
0 50100 200 300 400
Km
28° S
32° S
36° S
40° S
58° W
54° W
50° W
46° W
42° W
40°S

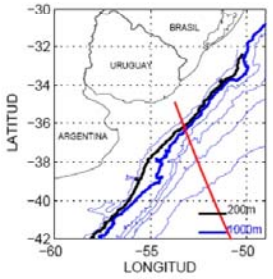
Seasonal Offshore Transport of Fresh Water

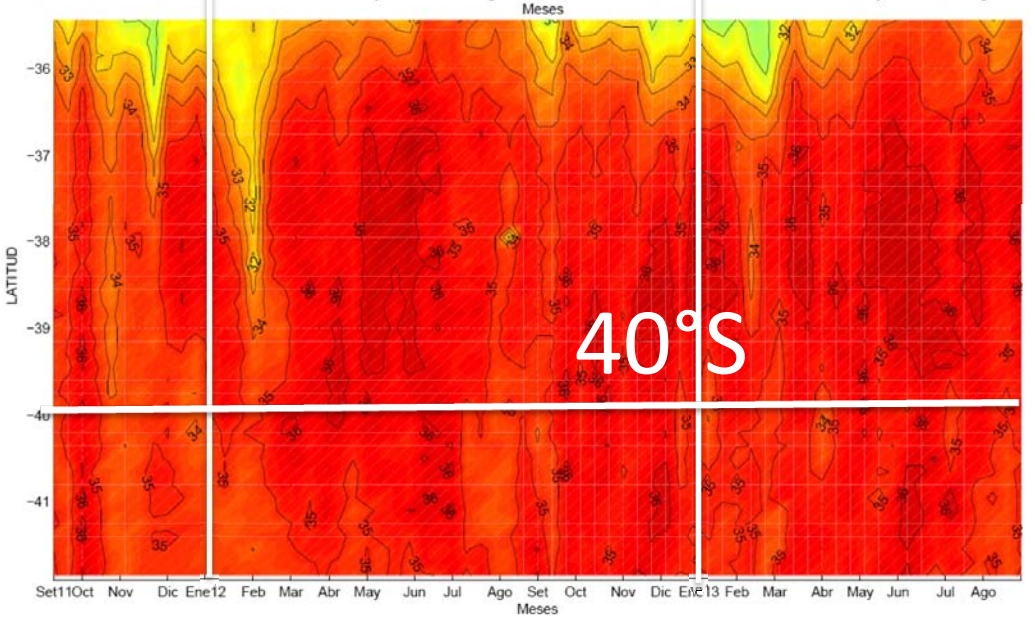
Fresh water moves offshore along and across Aquarius tracks in Oct-Mar

R. Guerrero





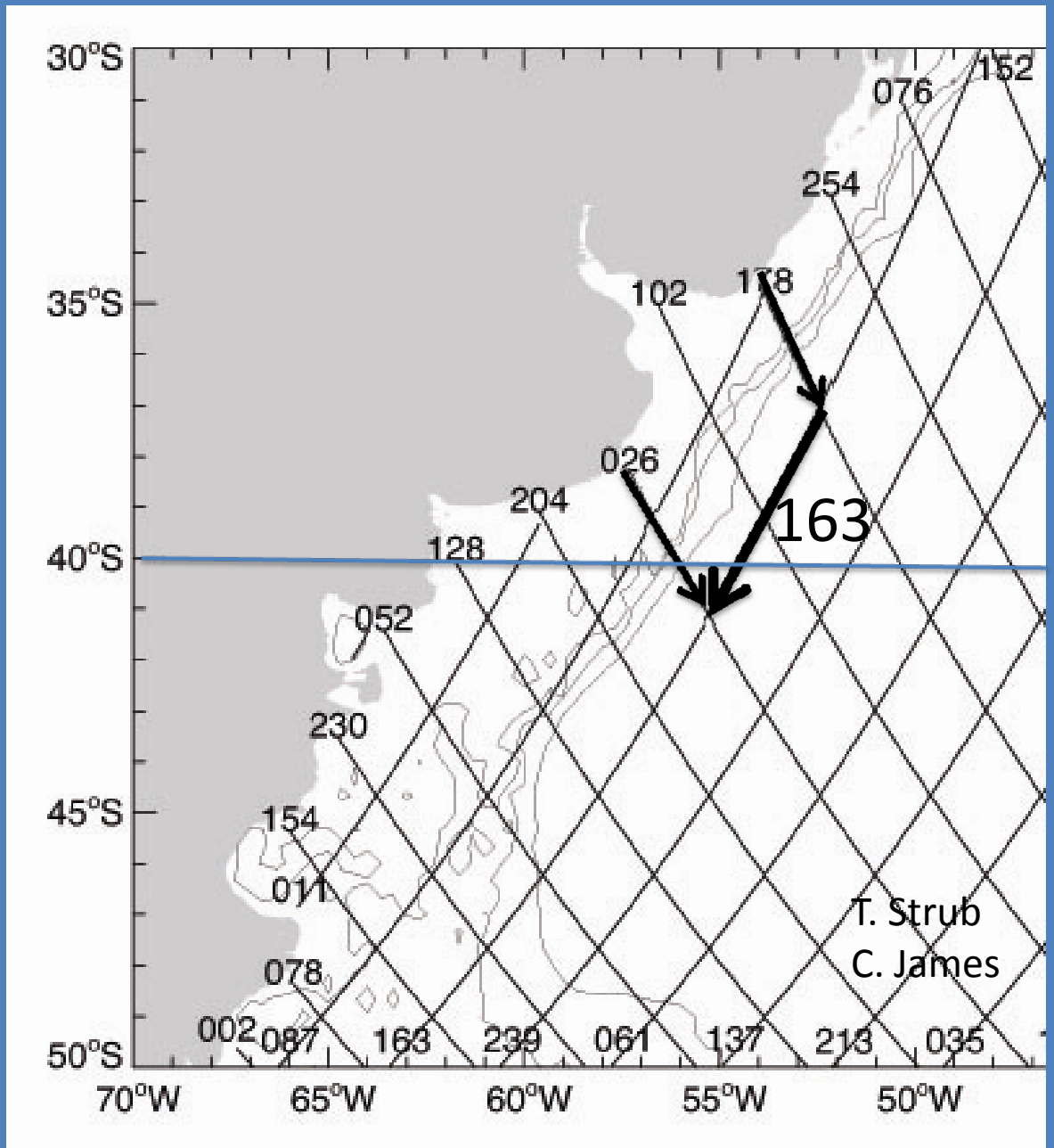




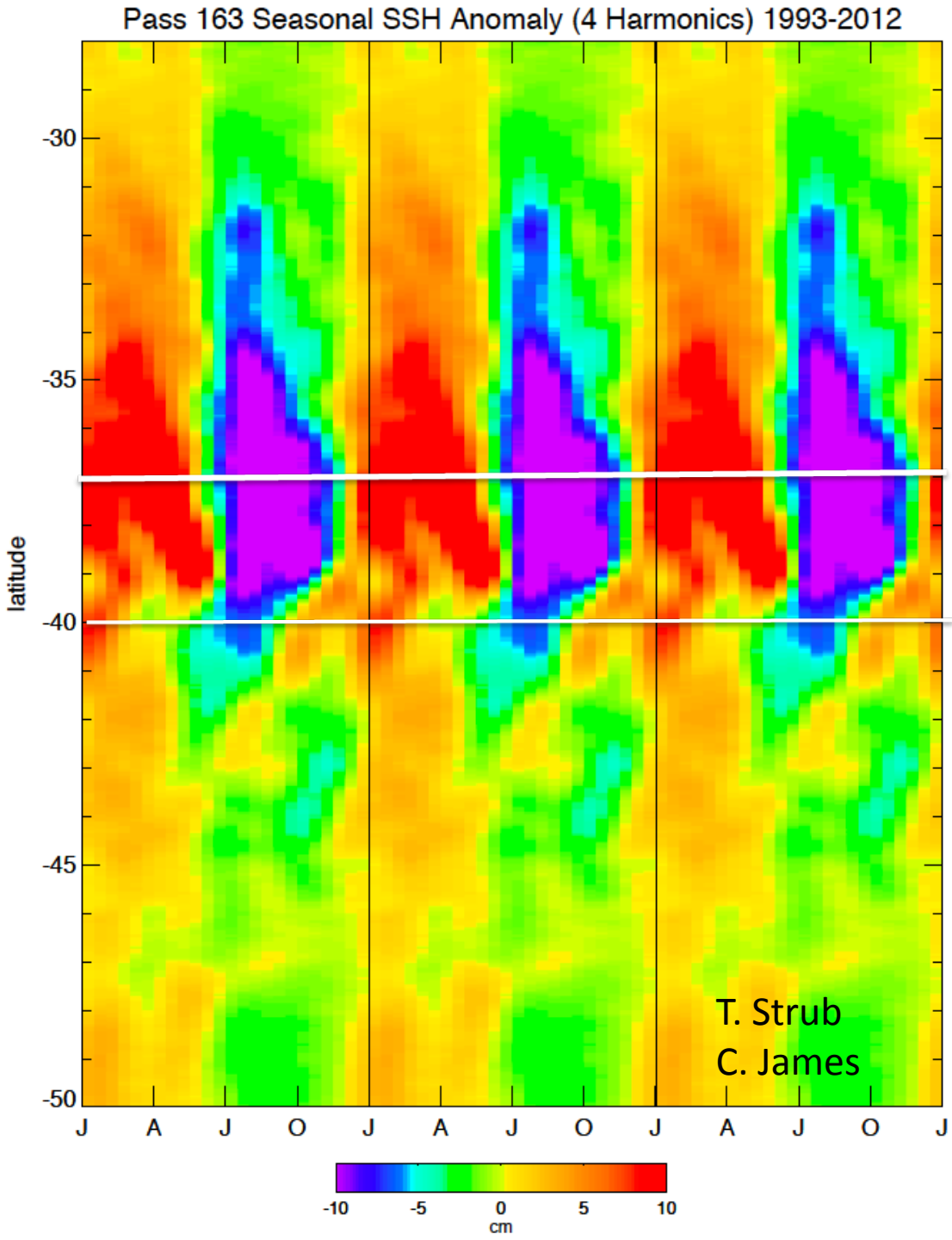
Alongtrack Altimeter Data Form Box Models for Transports

SLA and crosstrack velocities can be used to look at the seasonal development of the offshore plume and jet structures.

Look at SLA and velocities across track 163, which parallels the shelf edge in the deep ocean.



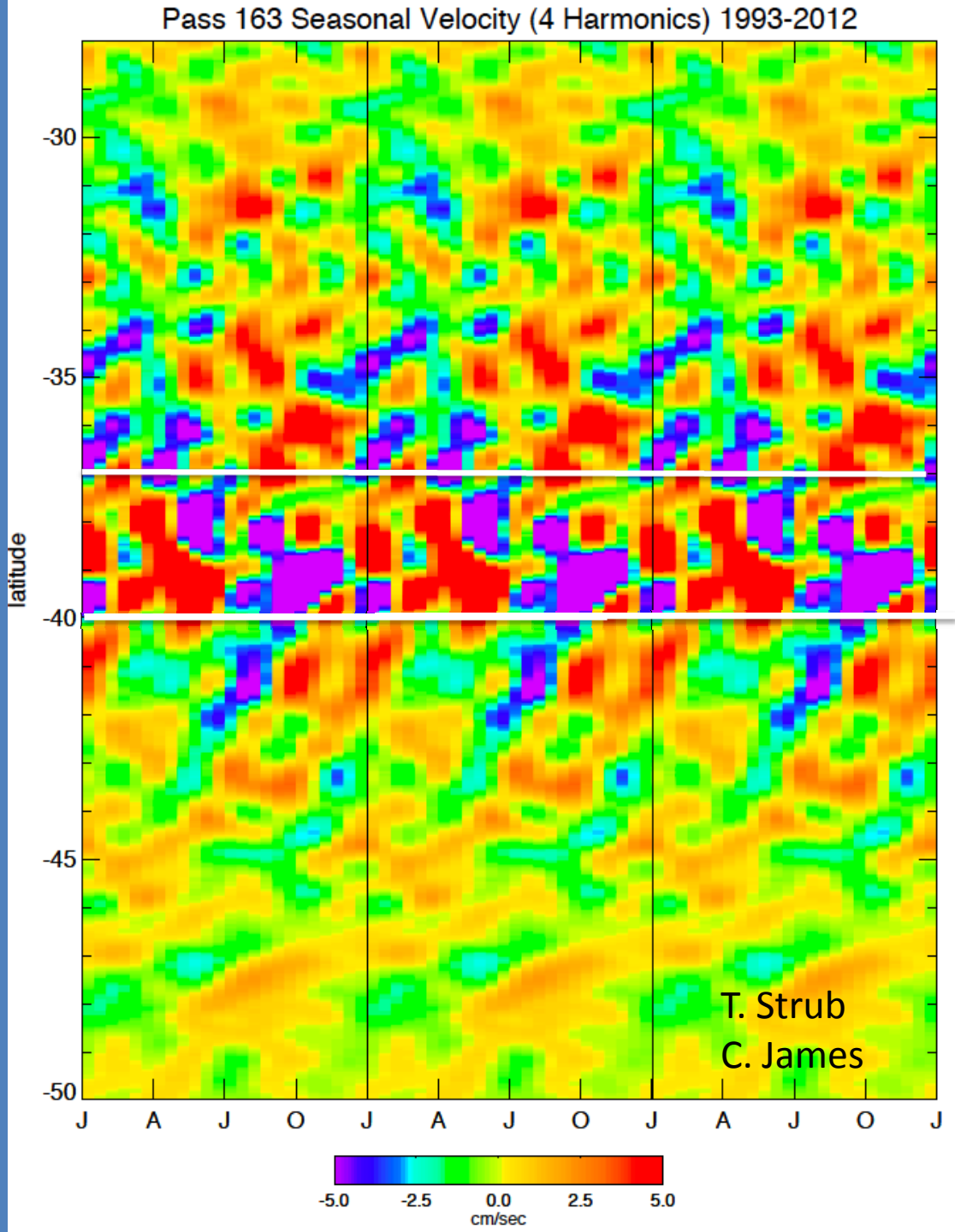
Along Track 163, the SLA signal is concentrated within the region between 35-40S. There should be a strong jet near 39-40S, offshore during Dec-June, onshore during July-Nov.



Along Track 163, between 37-41S, the transport is generally offshore during Dec-June, reversing in Aug-Nov.

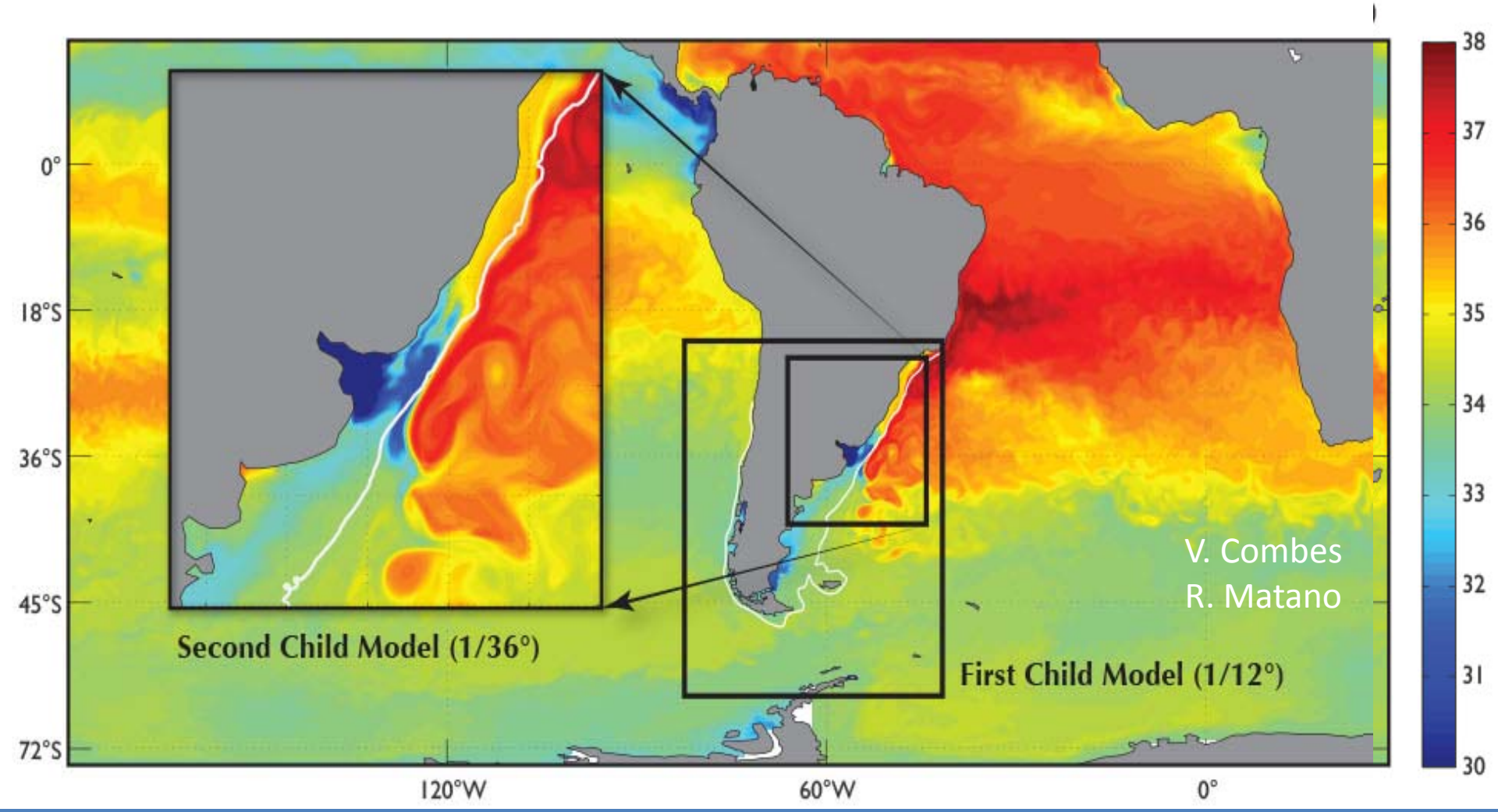
Thus, satellite SLA and salinity data suggest an offshore transport of fresh water in the half of the year between October-March.

What controls the timing and magnitude of that transport?



Dynamics of Offshore Flow

A doubly nested ROMS model with realistic wind forcing and outflow from the La Plata River lets us explore aspects of the seasonal offshore transport – What controls the timing of the offshore flow?

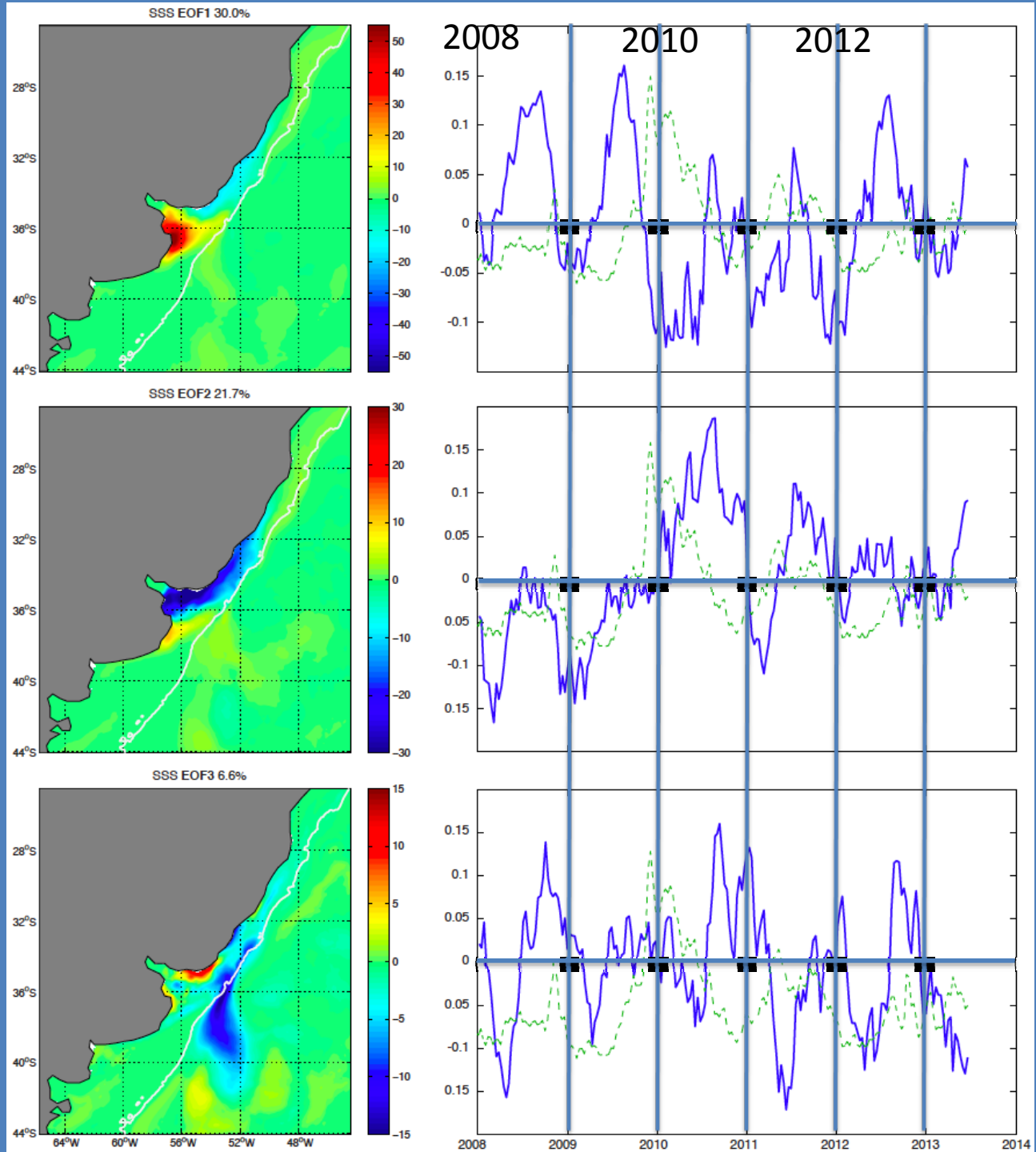


SSS EOFs: First 3

The time series of the first 3 SSS EOFs (blue) are plotted against the La Plata River outflow (dashed, green).

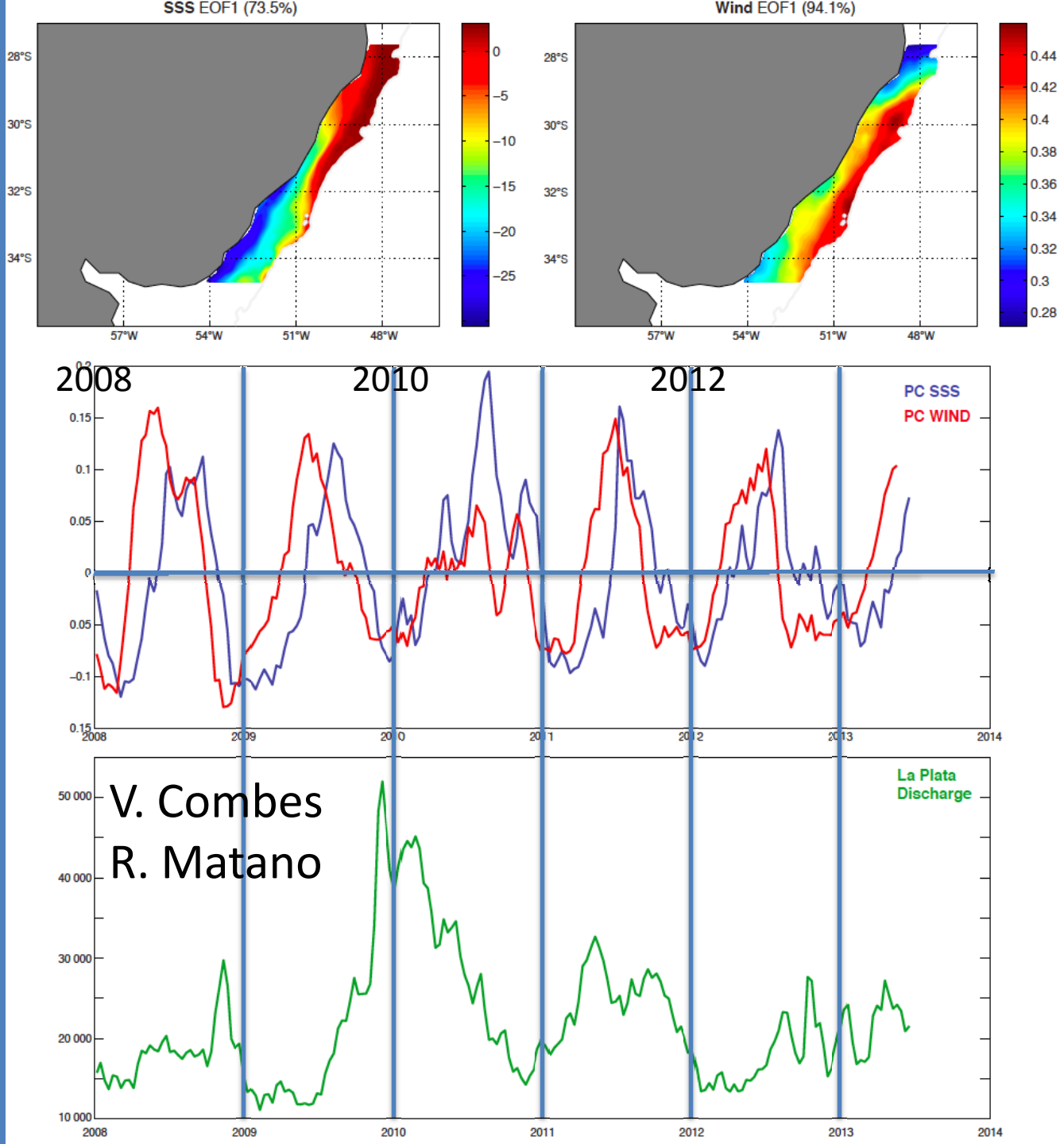
Only the second EOF seems related to the stronger outflow in 2009-2010.

V. Combes
R. Matano



Northern Coast: Wind Control

Along the coast north of the river, the first SSS EOF is negative during mid-year (blue line). Northward wind stress traps water next to the coast (red line). Only the 2010 pattern seems disrupted by the large discharge.



Offshore Plume Transport: Confluence Control

The freshwater plume is strongest in the Oct-March period, consistent with the altimeter offshore flow and snapshots with OSCAR and Aquarius currents and salinity.

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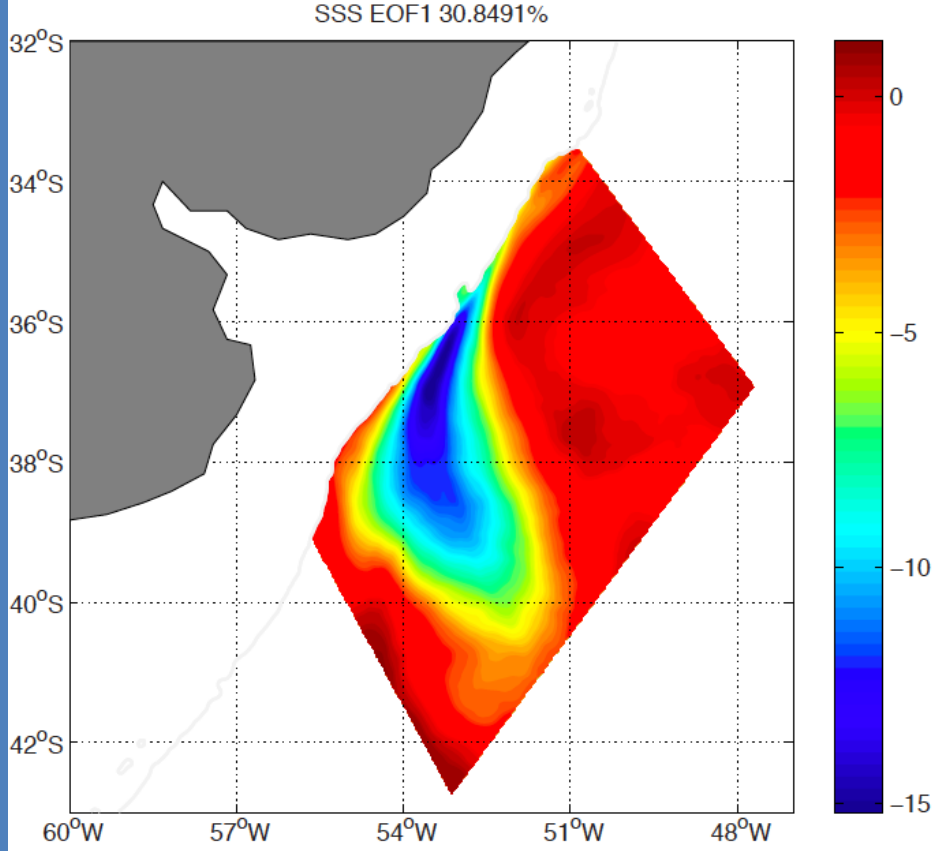
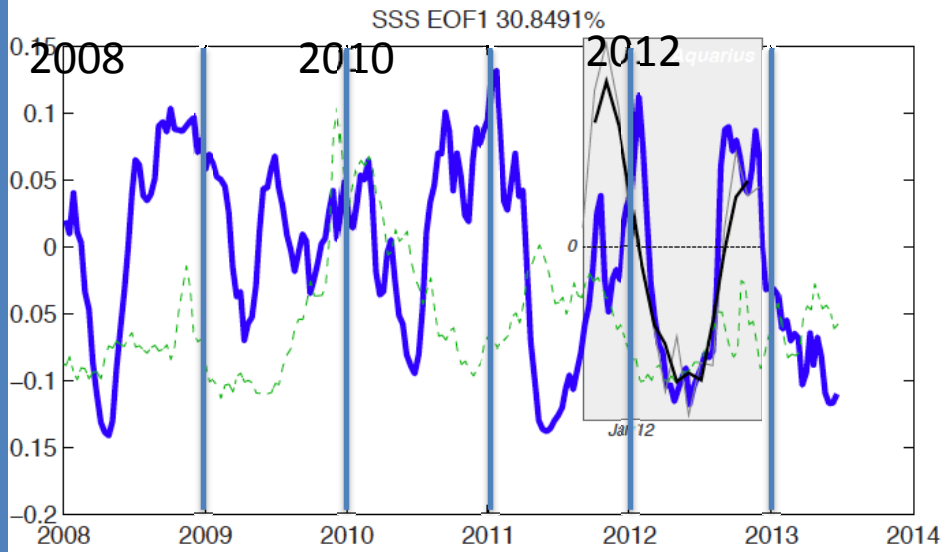
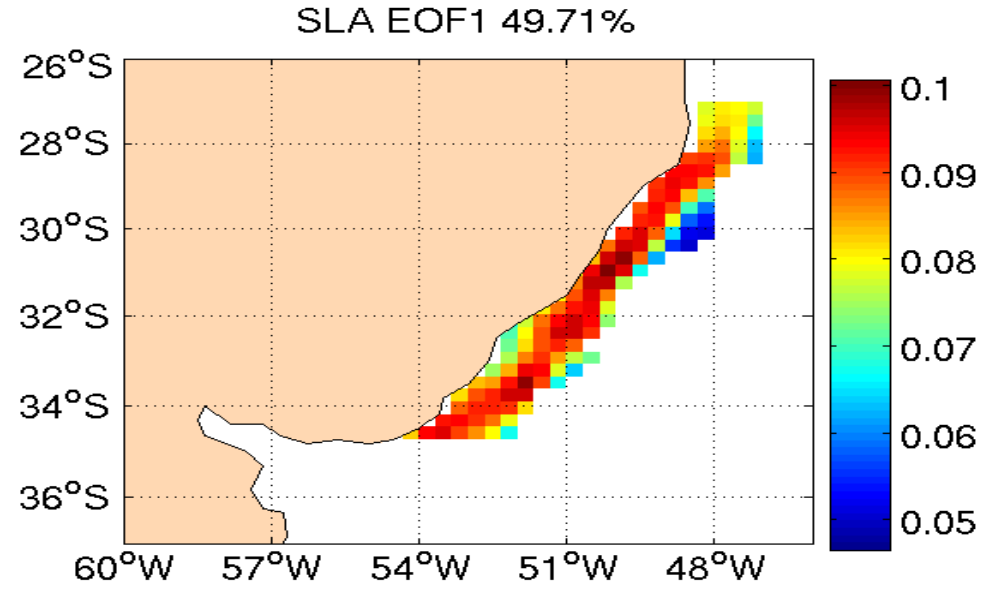
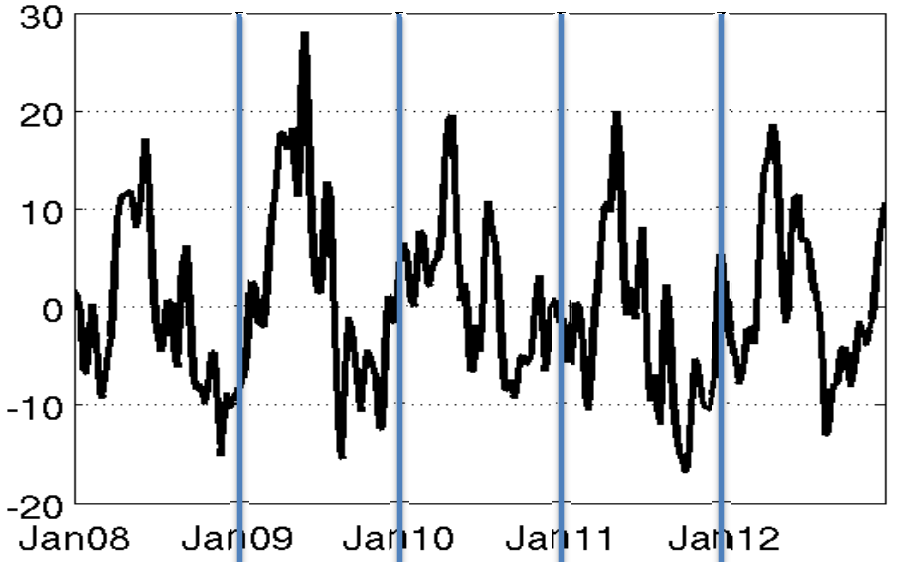
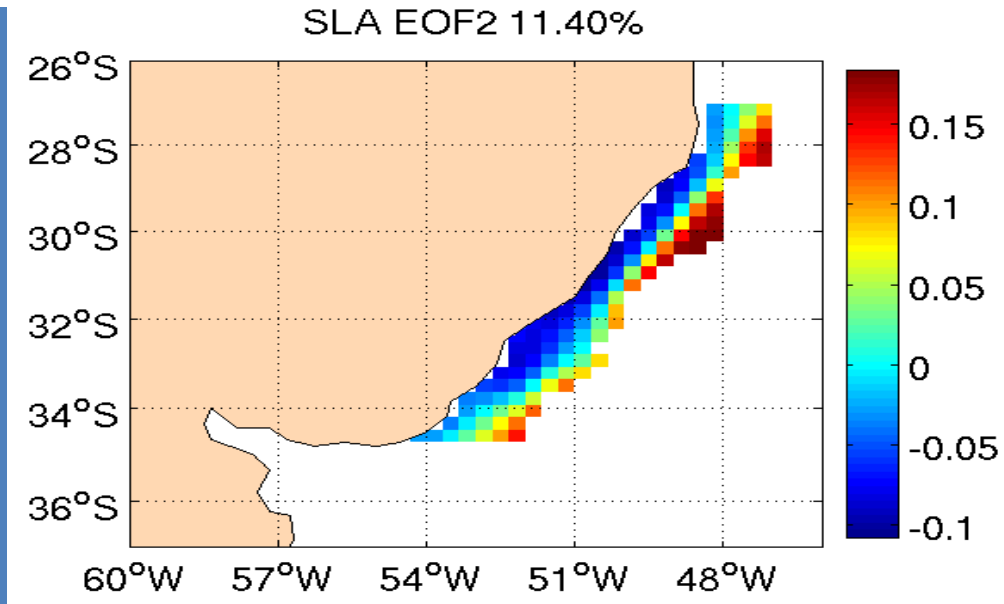
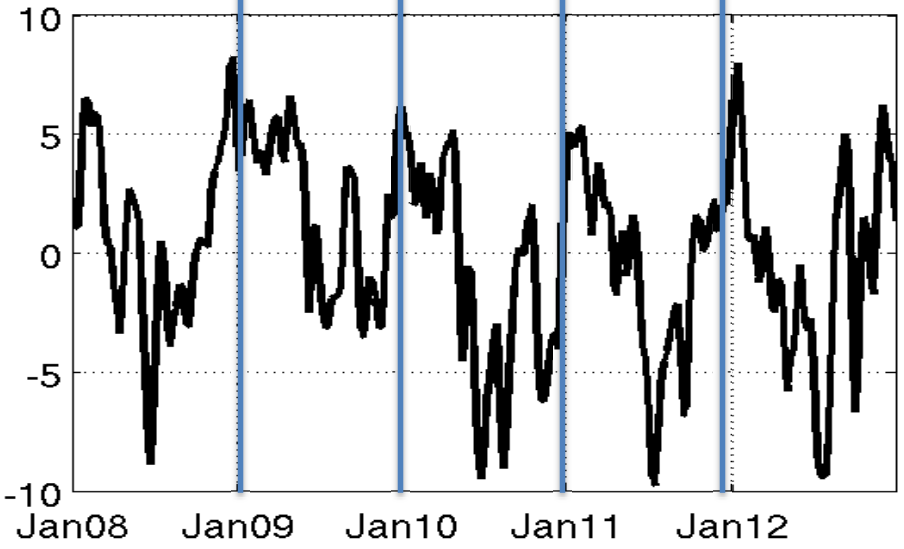





SLA EOF1 49.71%
26°S
28°S
30°S
32°S
34°S
36°S
60°W
57°W
54°W
51°W
48°W
0.1
0.09
0.08
0.07
0.06
0.05


30
20
10
0
-10
-20
Jan08
Jan09
Jan10
Jan11
Jan12


SLA EOF2 11.40%
26°S
28°S
30°S
32°S
34°S
36°S
60°W
57°W
54°W
51°W
48°W
0.15
0.1
0.05
0
-0.05
-0.1


10
5
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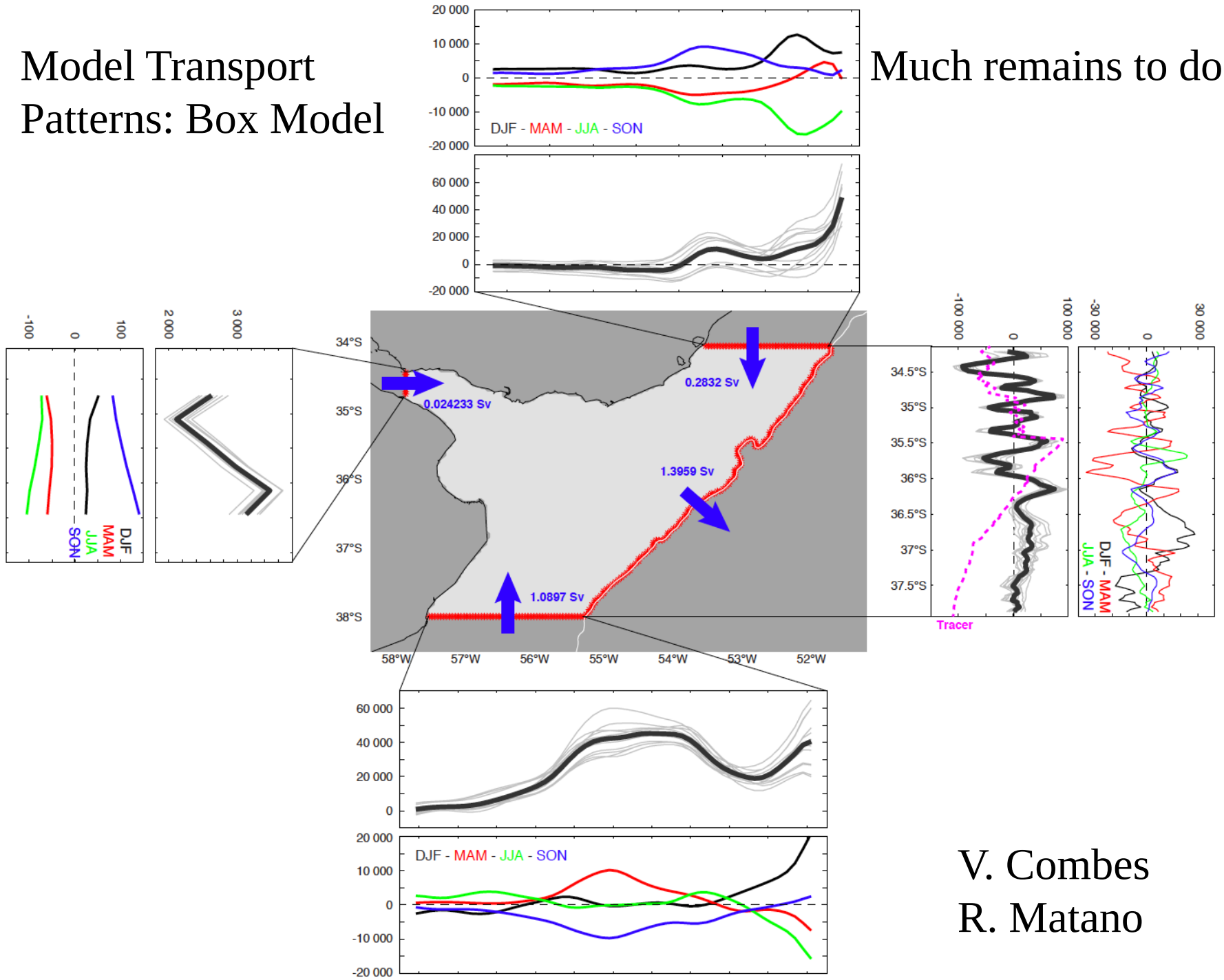
-5
-10
Jan08
Jan09
Jan10
Jan11
Jan12

Model Transport Patterns: Box Model

Much remains to do



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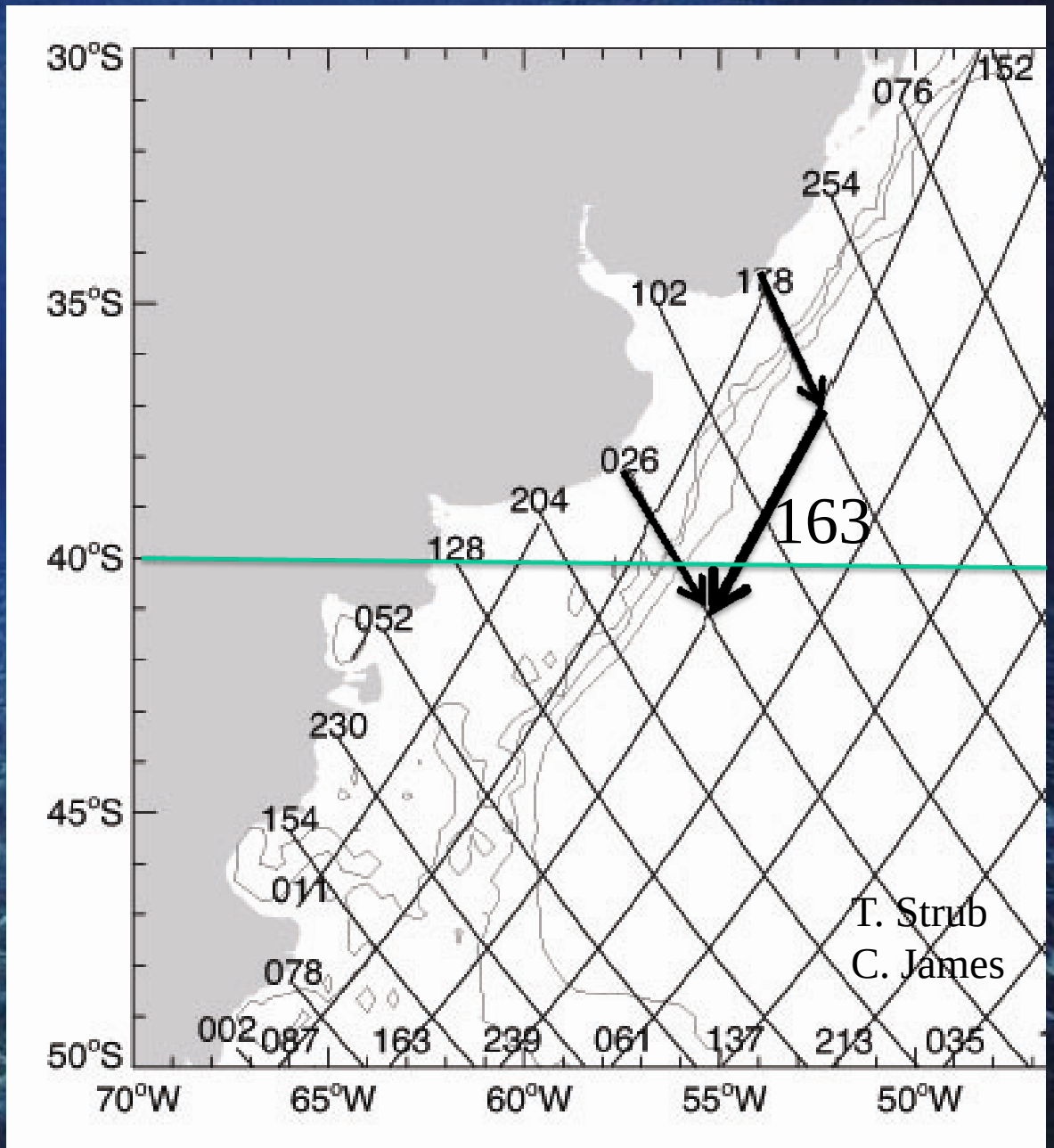
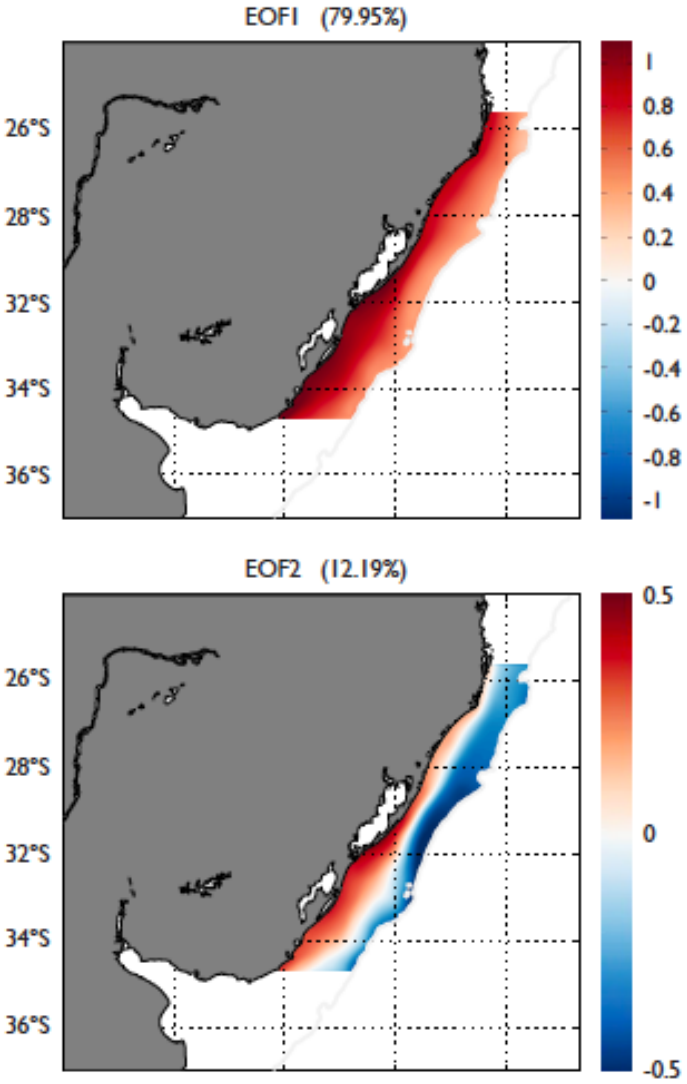


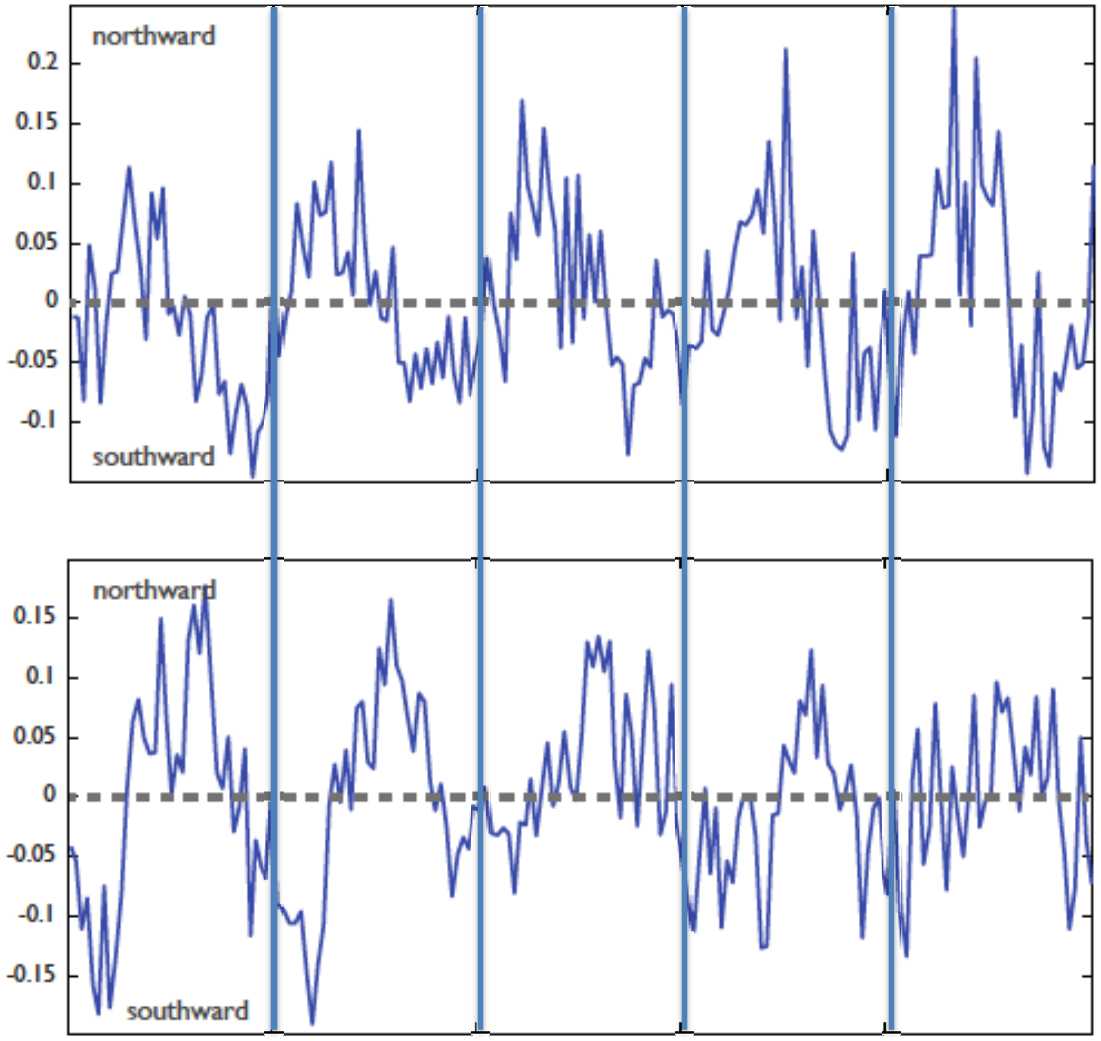
Summary

- The combination of altimeter SLA, Aquarius SSS, and wind data, along with fields of a realistically-forced regional ocean circulation model present a consistent picture:
  - The timing of the offshore transport of the fresh water is controlled by the wind, which traps the fresh water against the coast north of the river in winter, then lets it flow south and offshore in spring-summer.
  - The offshore transport due to the confluence of the Brazil and Malvinas Currents carries the plume offshore in summer.
  - Years with large discharge may disrupt the pattern, but the winds still delay the offshore transport until long after the discharge.
  - The continued fate of the water transported offshore in eddies and jets remains to be studied.
  - Longer time series are needed to understand the interannual variability of these processes. 2011-2013 may not be typical.

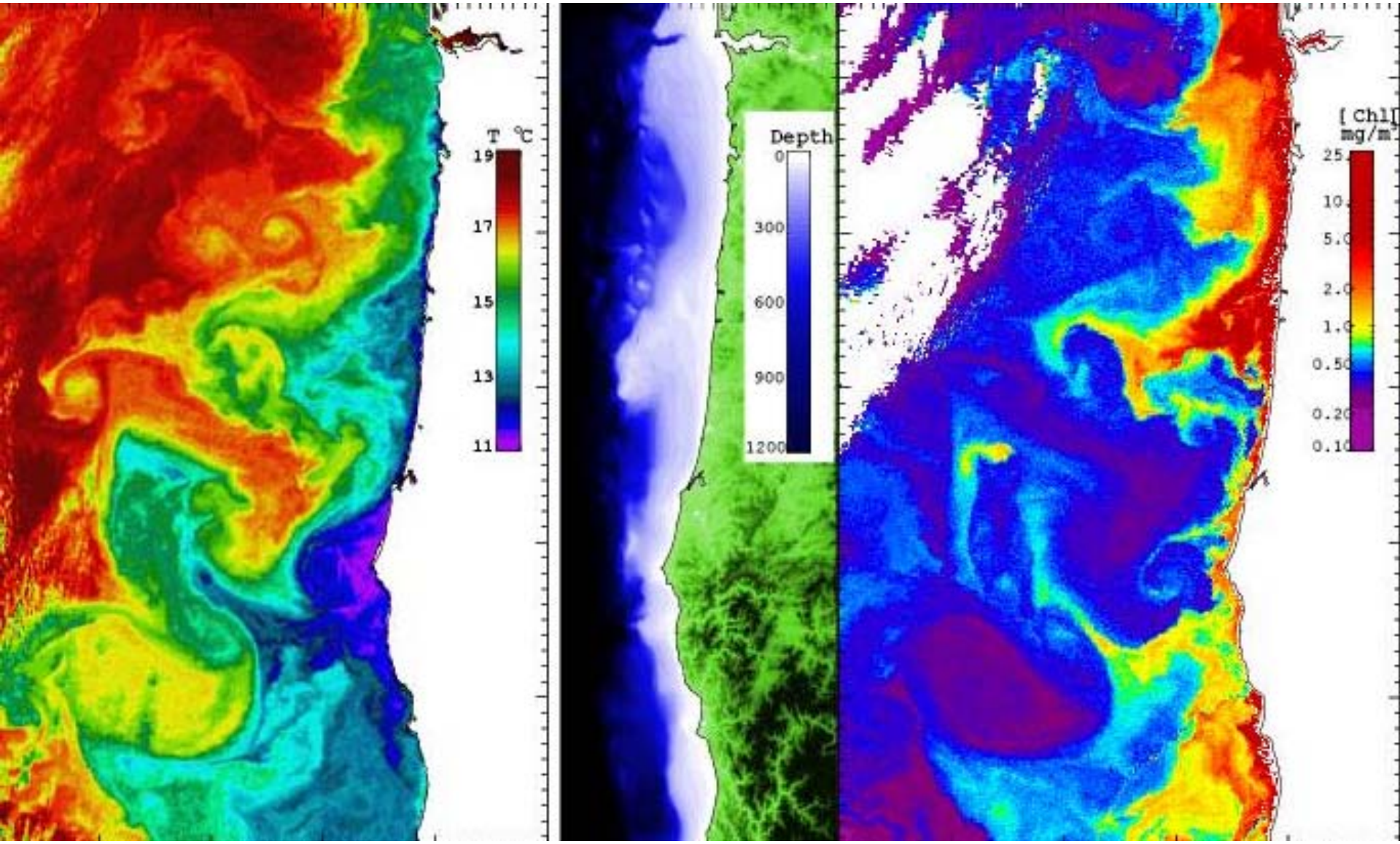
Extra

Model Sea Surface Height



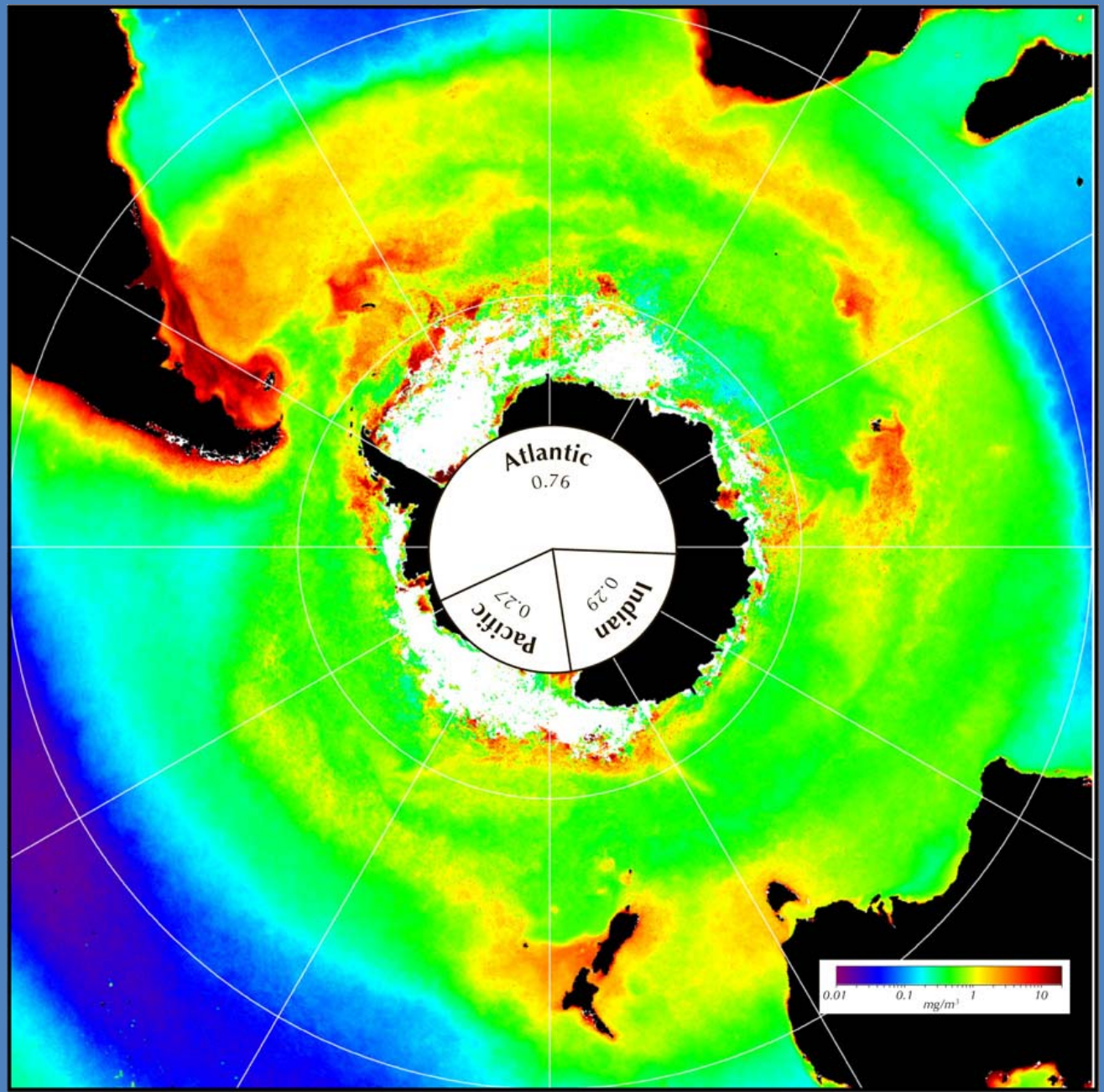


AVHRR SST – Sept 26, 1998 Bathymetry Chl-1 Pigment Conc – Sept 26-27, 1998



SeaWiFS Surface Chlorophyll-a Composite

Influence of shelf off Patagonia – Does it provide nutrients to the South Atlantic?



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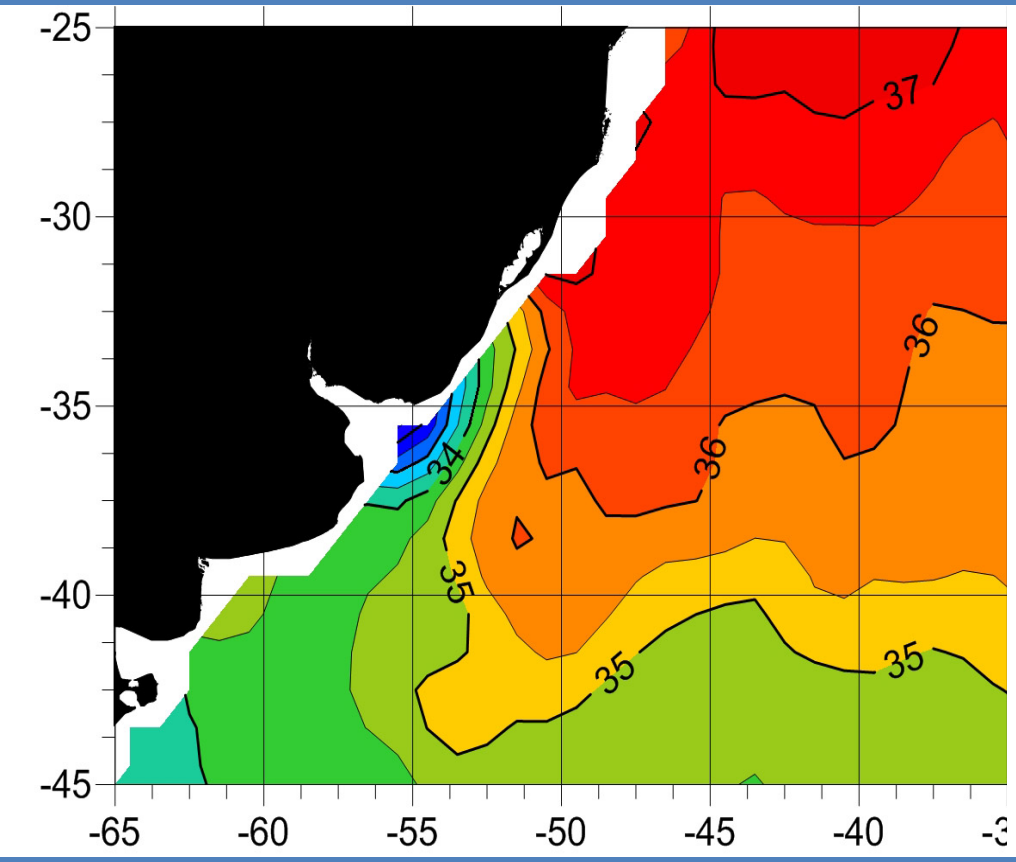

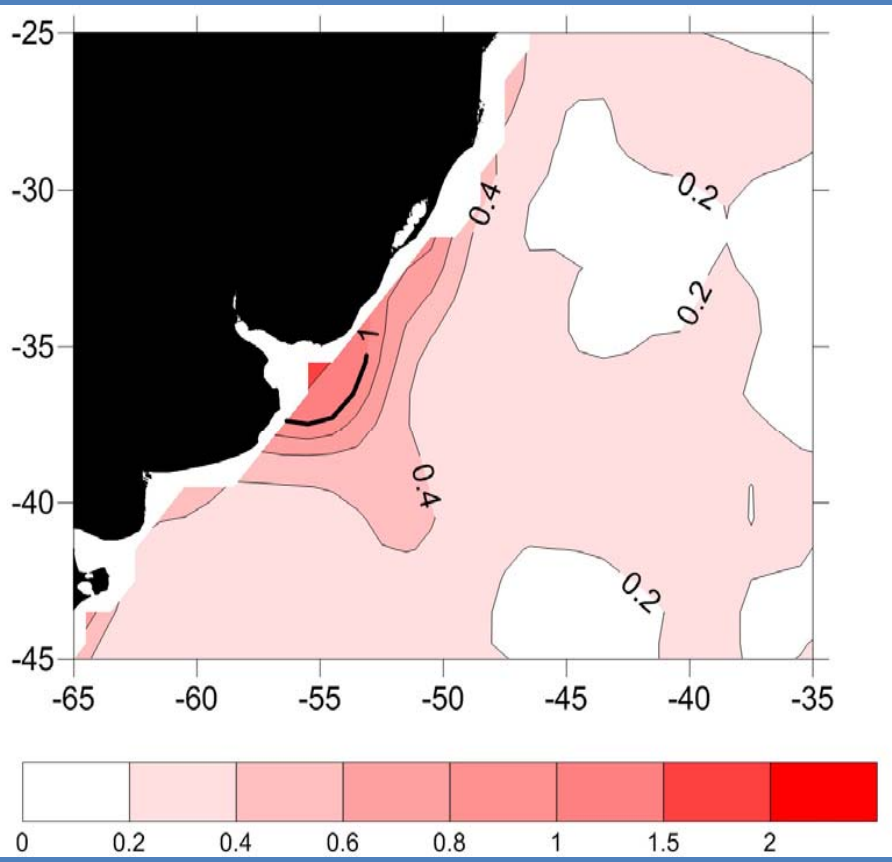

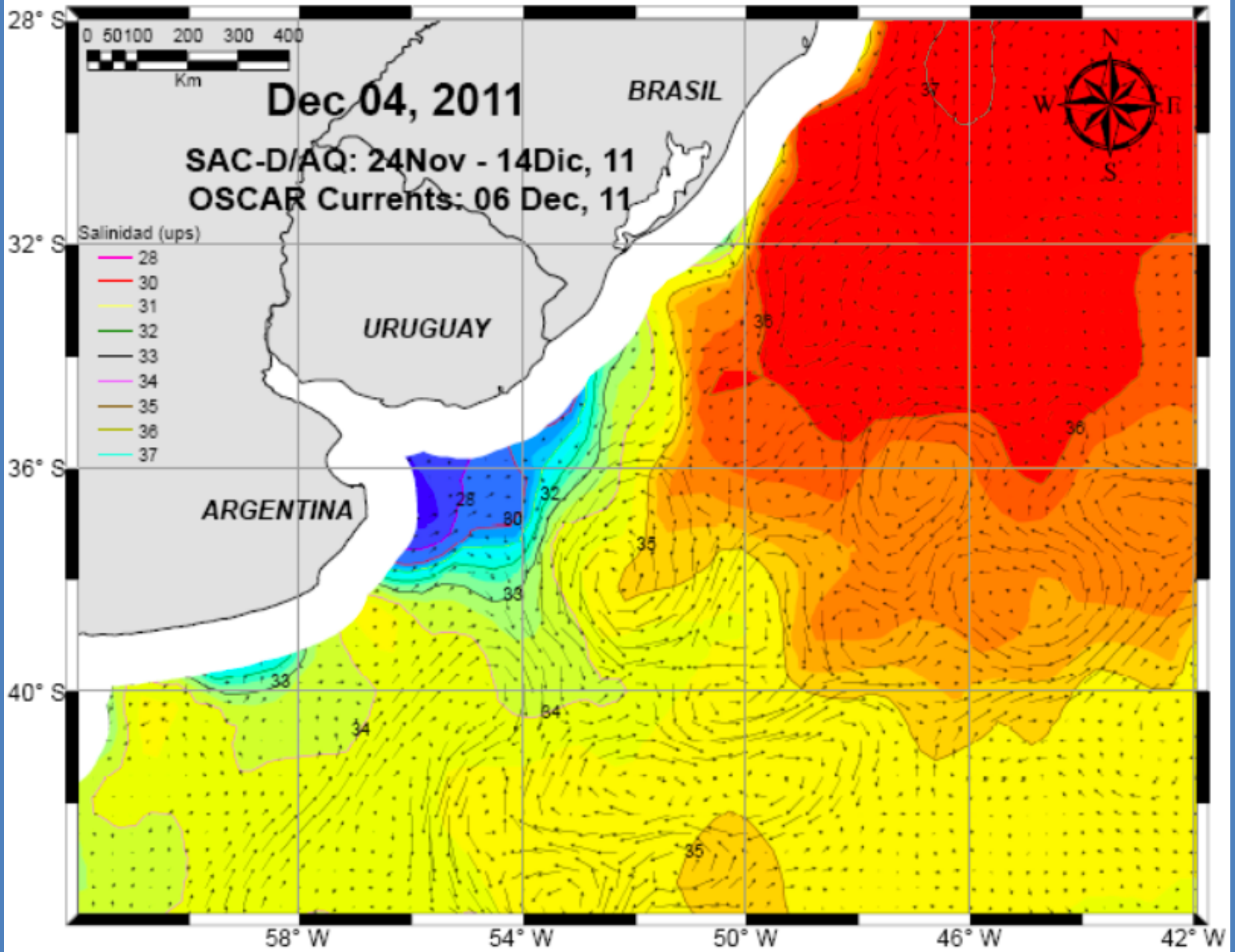
0 50100 200 300 400
Km
Dec 04, 2011
SAC-D/AQ: 24Nov - 14Dic, 11
OSCAR Currents: 06 Dec, 11
BRASIL
URUGUAY
ARGENTINA
Salinidad (ups)
28
30
31
32
33
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S
28° S
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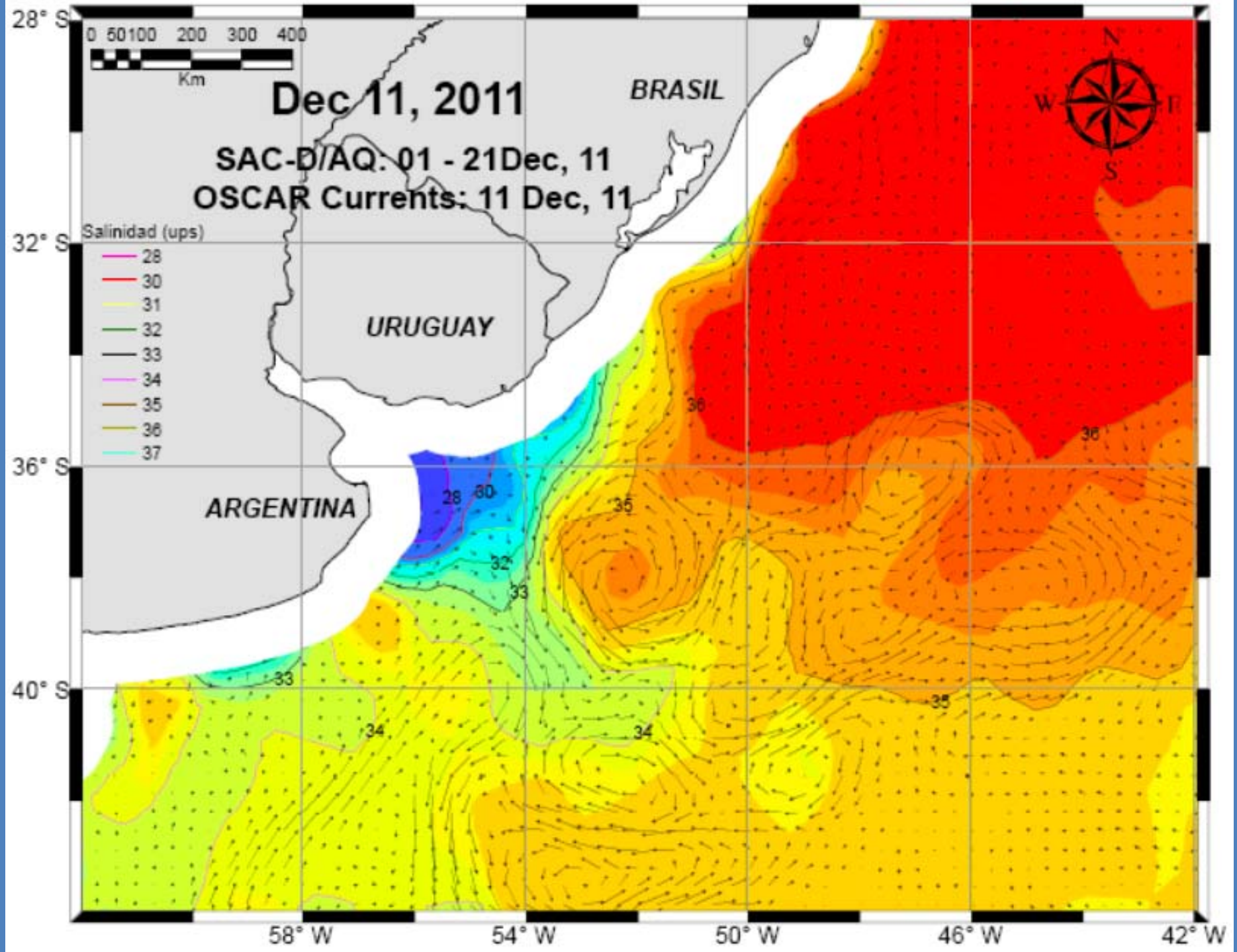
36° S
40° S
58° W
54° W
50° W
46° W
42° W


0 50100 200 300 400
Km
Dec 11, 2011
SAC-D/AQ: 01 - 21Dec, 11
OSCAR Currents: 11 Dec, 11
BRASIL
URUGUAY
ARGENTINA
Salinidad (ups)
28
30
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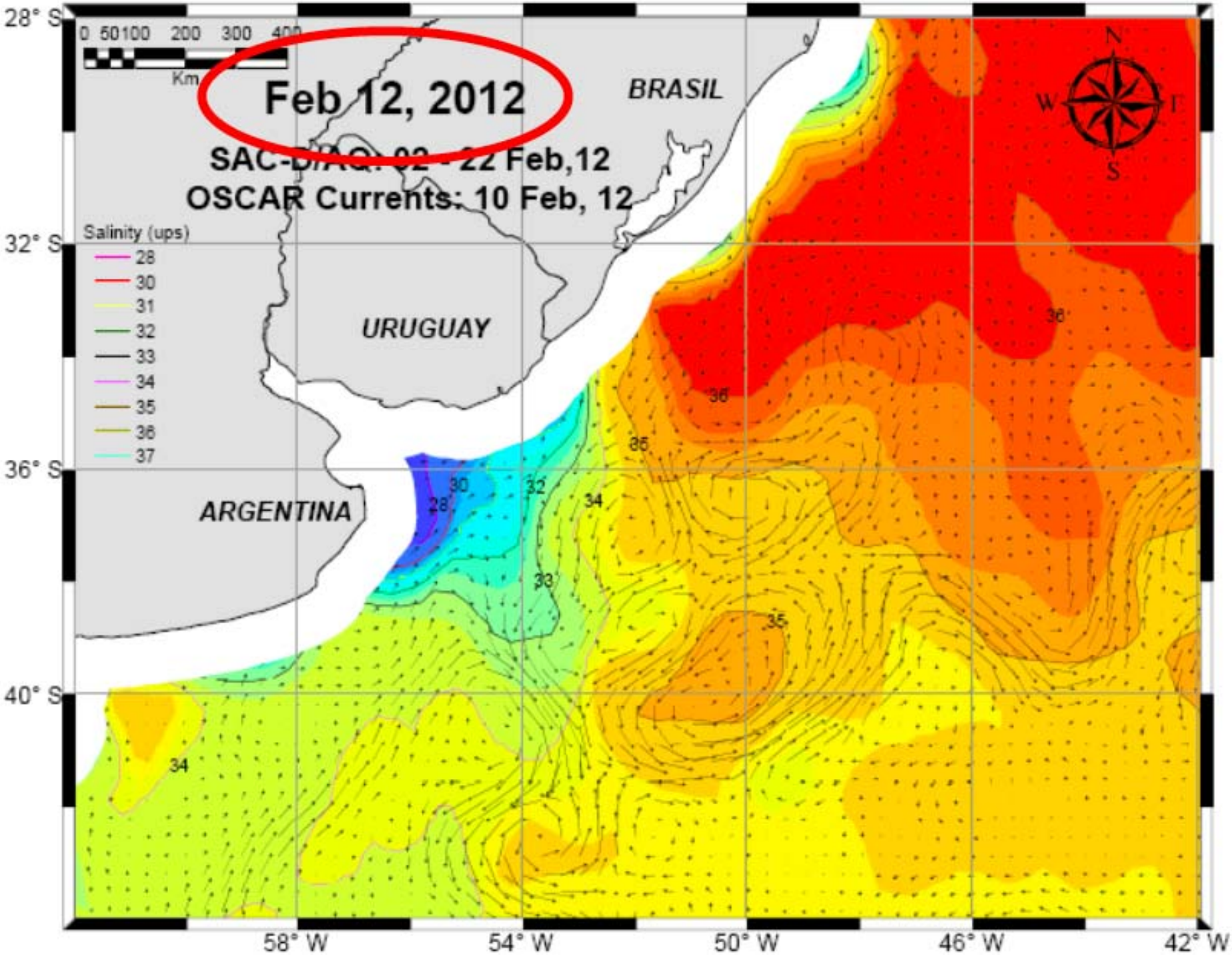
37
28° S
32° S
36° S
40° S
58° W
54° W
50° W
46° W
42° W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BRASIL
URUGUAY
ARGENTINA
Salinity (ups)
28
30
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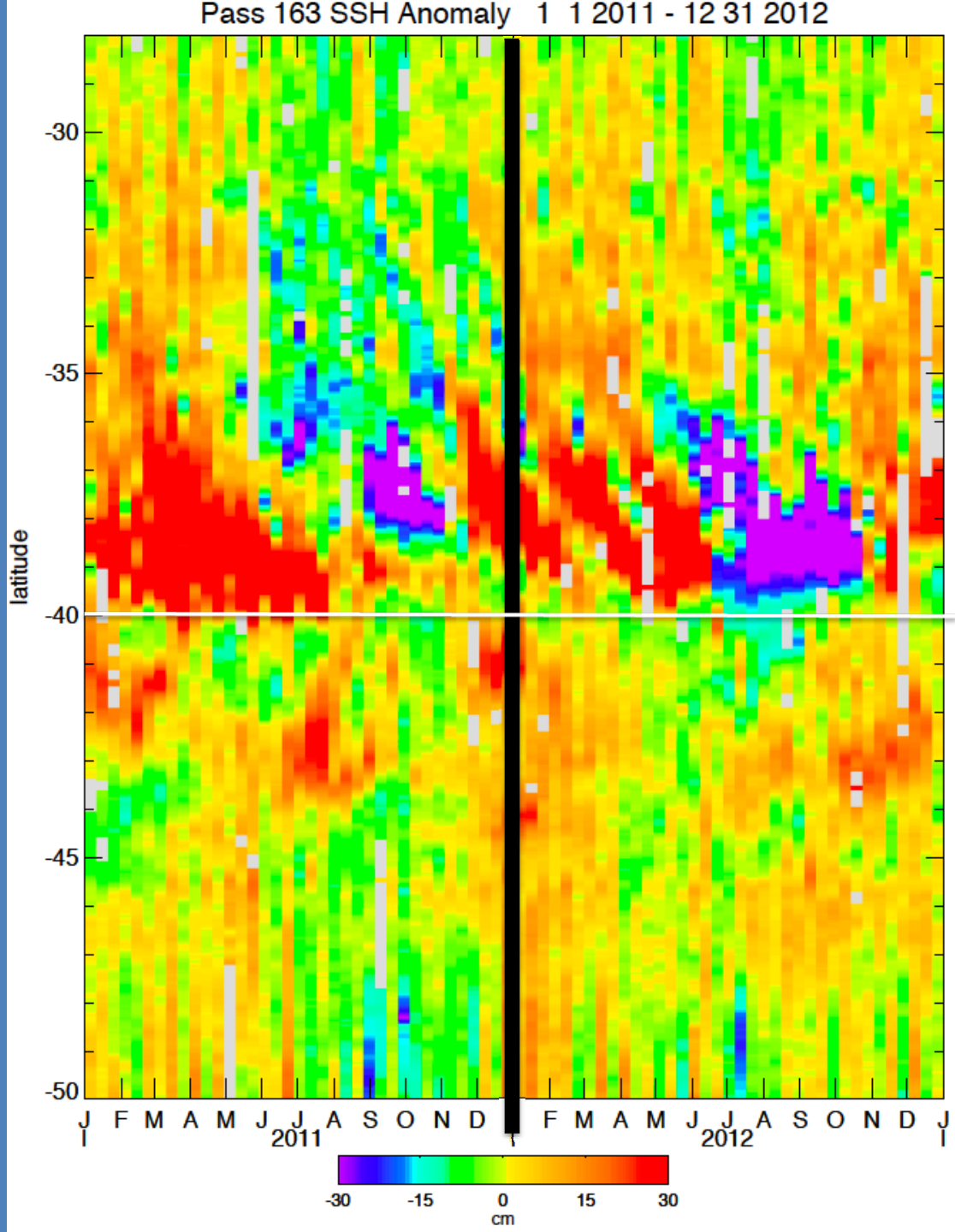
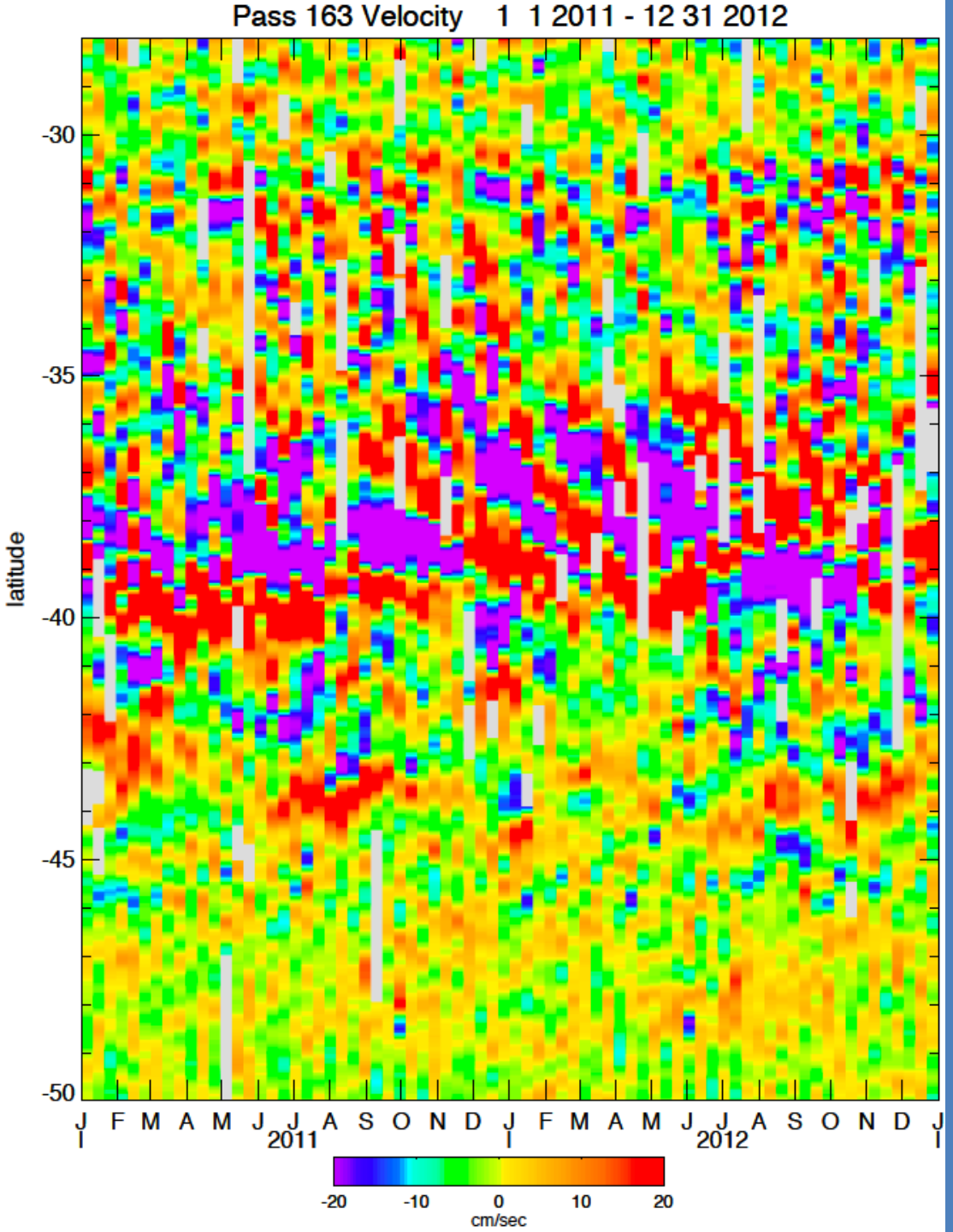
40° S
58° W
54° W
50° W
46° W
42° W


Pass 163 SSH Anomaly 1 1 2011 - 12 31 2012
latitude
-30
-35
-40
-45
-50
J F M A M J J A S O N D J F M A M J J A S O N D J
2011
2012
-30 -15 0 15 30
cm


Pass 163 Velocity 1 1 2011 - 12 31 2012
latitude
-30
-35
-40
-45
-50
J F M A M J J A S O N D J F M A M J J A S O N D J
2011
2012
-20 -10 0 10 20
cm/sec