The salinity signal of the shelf-deep ocean exchange in the SWA: Satellite observations

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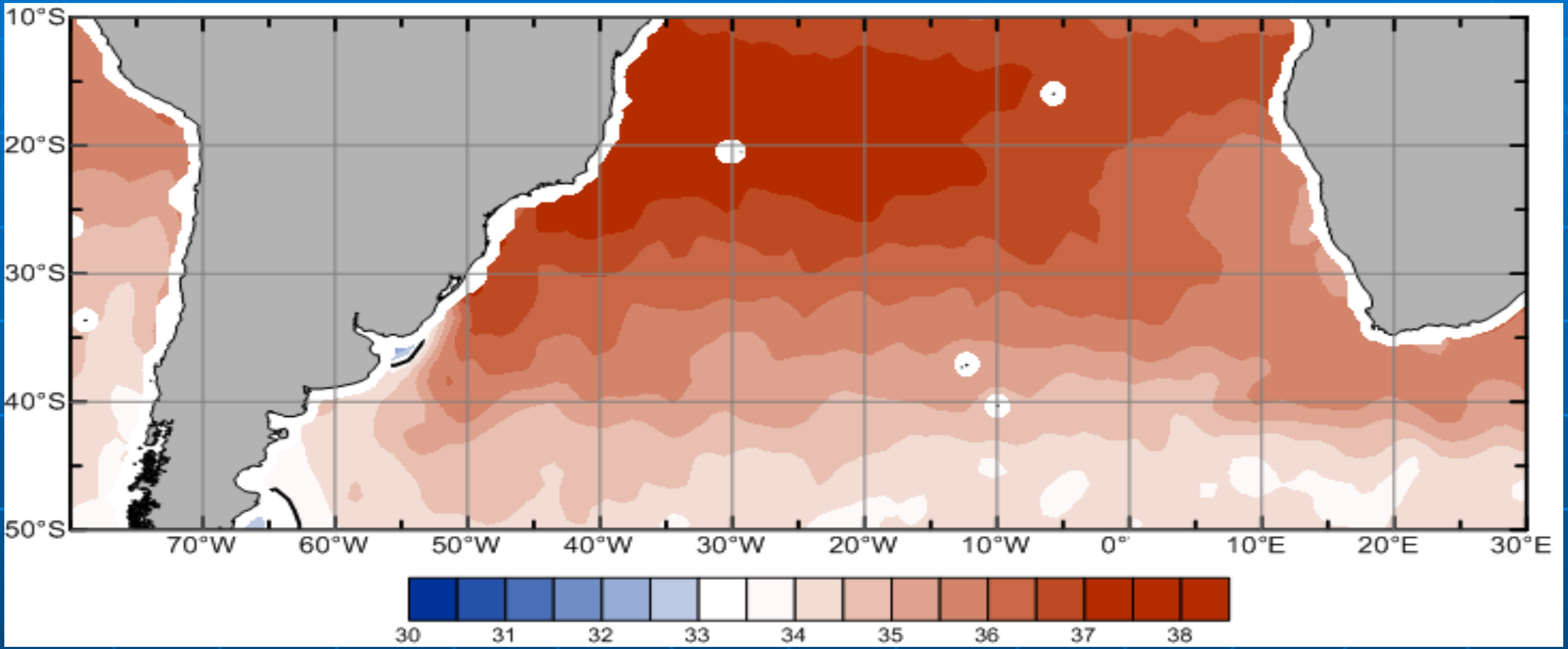
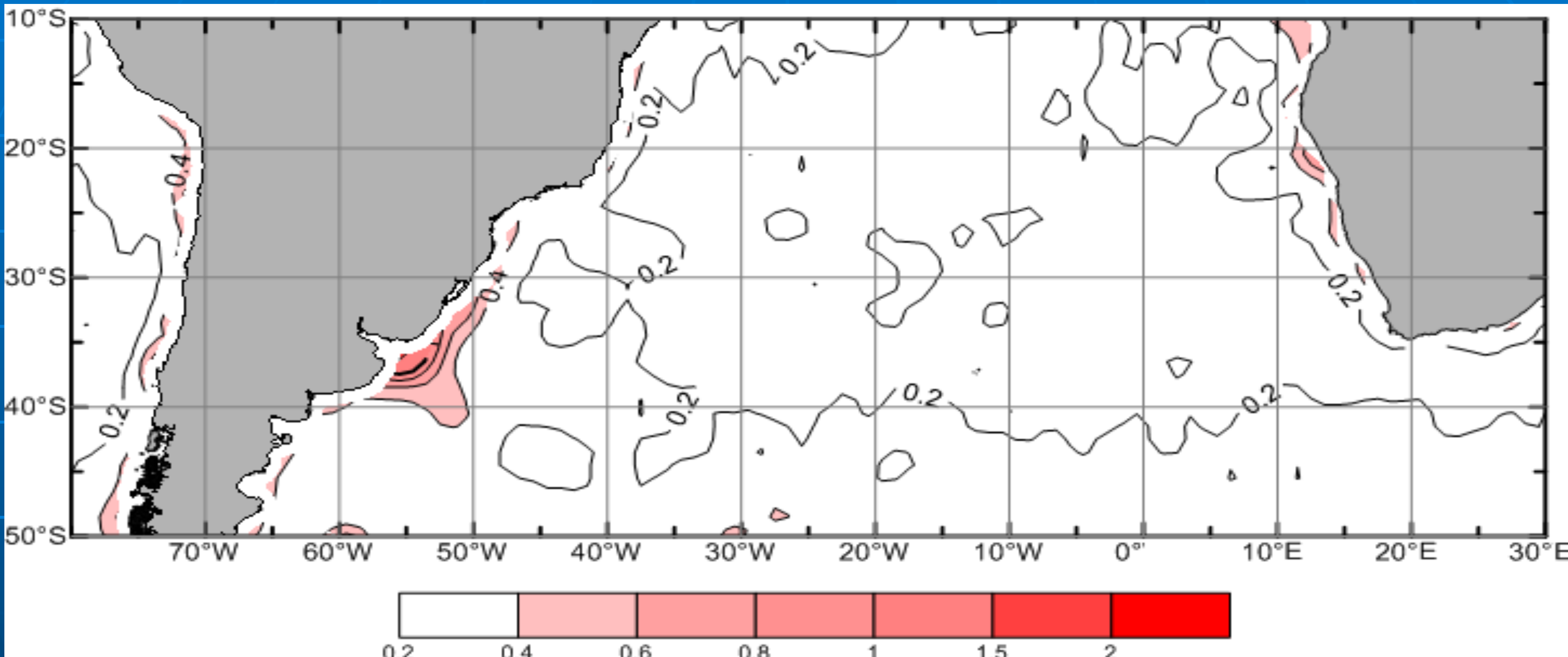
CONAE NASA ESR SAC-D/Aquarius Ministerio de Ciencia, Tecnología e Innovación Productiva Presidencia de la Nación INIDEP REPUBLICA ARGENTINA HIDROGRAFIA OSU Oregon State UNIVERSITY CONICET

Mean SSS-Aquarius



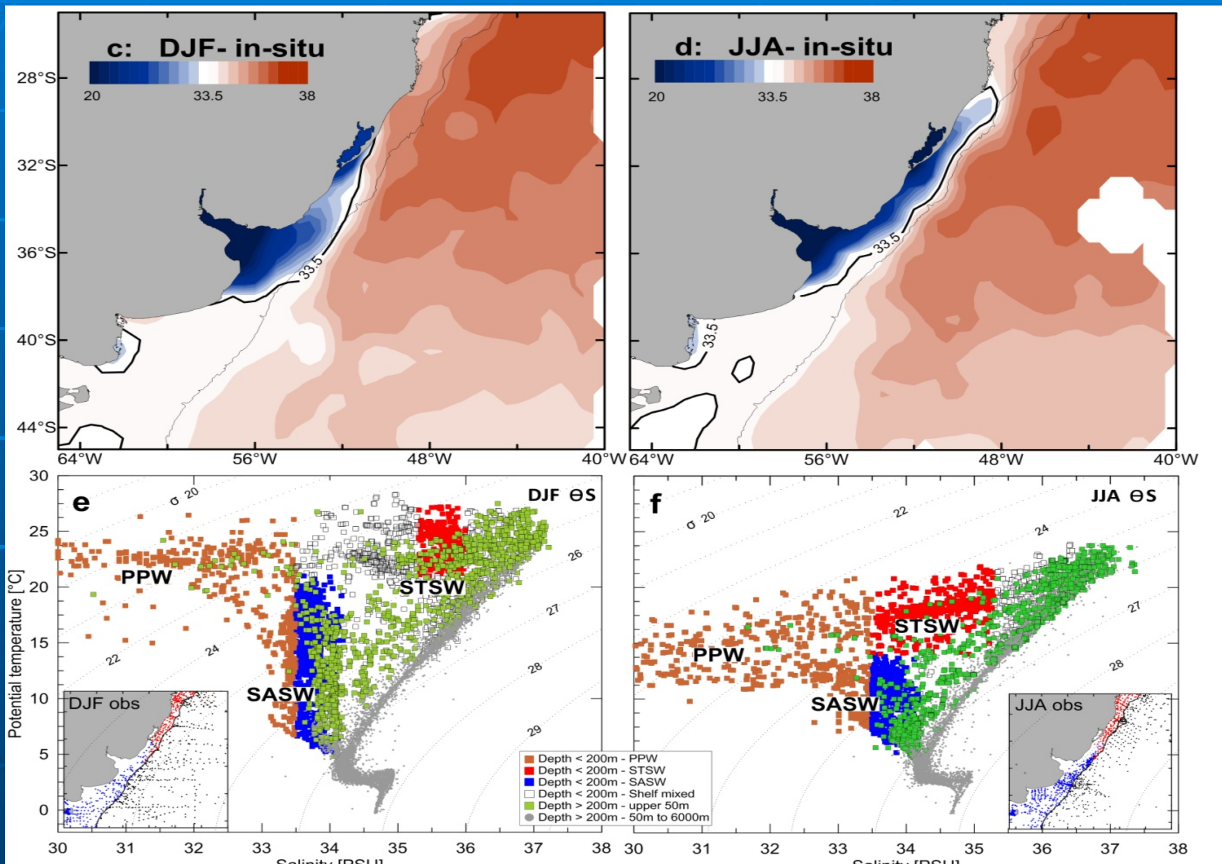
L3 (v2.0) -SSS from Aquarius shows the main ocean-basin features of the South Atlantic, already proven since the early results of the mission.

Stand.Deviation of SSS-Aquarius



The export of shelf waters to the deep ocean near 35°S creates the largest signal of SSS variability in the SA (south of the tropics).

SWA Shelf / Deep-Ocean SSS in-situ



PPW
Plata Plume Water

SASW
Subant. Shelf Water

STSW
Subtrop. Shelf Water

Deep ocean (>200m)
upper 50m water

MESO-SCALE processes

time scales → weeks
Spatial scales → 100 km

Remote SST ✓
Remote SSH ✓
Remote SSS ✗

Weights (60 ...
0,033051
0,032723
0,032407
0,031451
0,030847
0,029345
0,028508
0,026578
0,025577
0,023907
0,0237
0,023406
0,023367
0,022801
0,022279
0,02224
0,021288
0,020509
0,019943
0,019287
0,01884
0,018357
0,017749
0,017572
0,0174
0,016958
0,016887
0,016554
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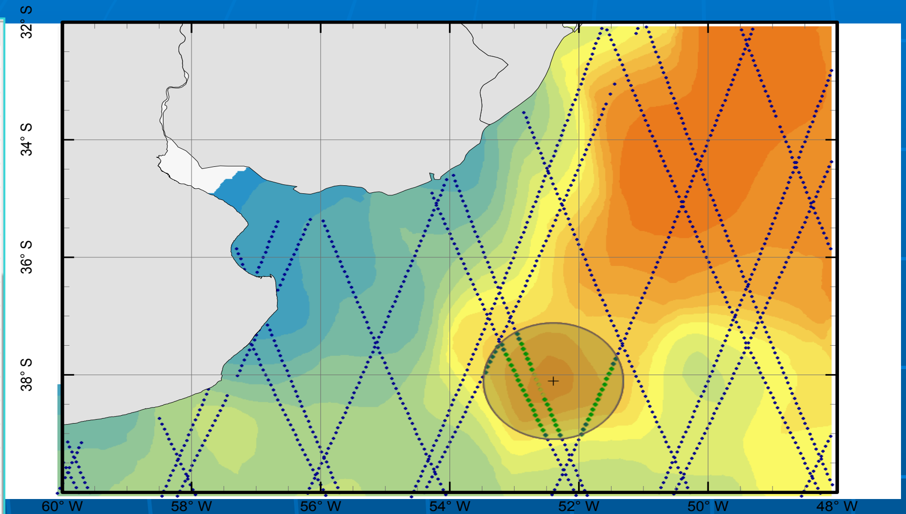
0,013703
0,013443



- Kernel density estimator (K)
- Gaussian function (k(z))
- Bandwidth = 0.75 (h)
- L2 – **weekly**
- SSS range: 20 → 38
- Grid size: **0.5 x 0..5**
- Search Radius = 1° x 1°
- Smoothing Factor = 0.001

A Challenge for Aquarius???
Gridding technique:

Local polynomial
(Lilly and lagerloef (2008)

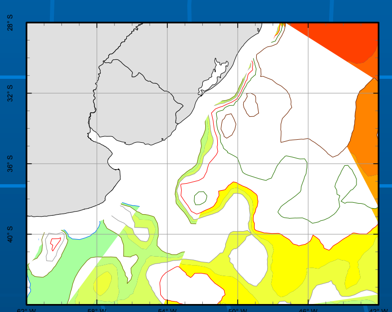
Individual polynomial adjustments every search radius; optimizing in its environment for a better representation of the local variation

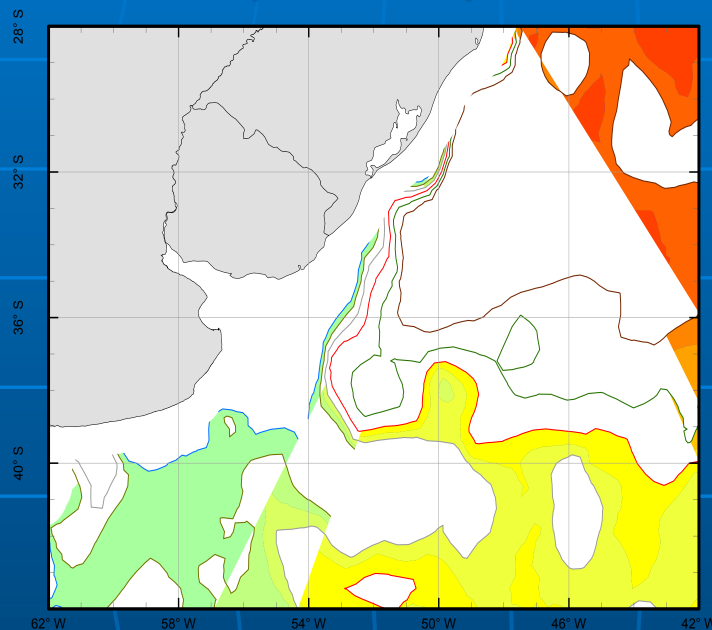
3 Weeks Weighted Moving Average (3WeMA)

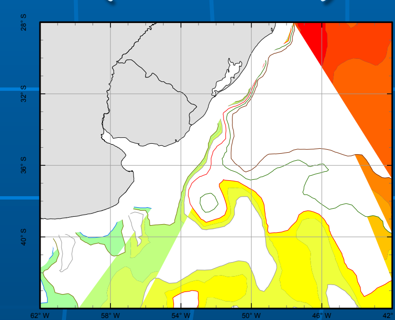
50%
(WEEK 2)

25%
(WEEK 1)

25%
(WEEK 3)



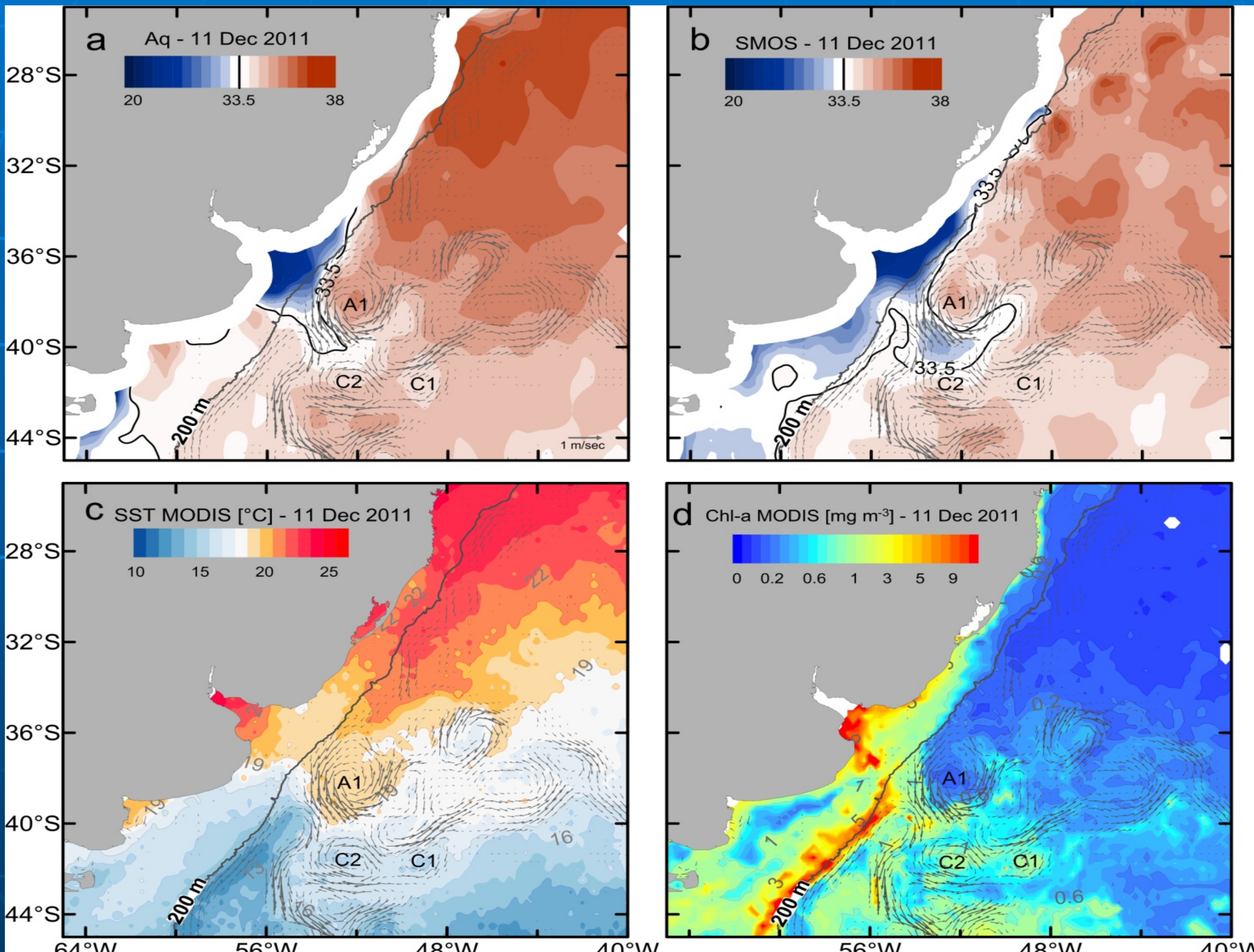




20-60-20% → 15-70-15%

In either case SEAM TO BE IMPROVEMENTS in the error levels

New L3 weekly for Dec11-2011
Aquarius (a) and SMOS (b)



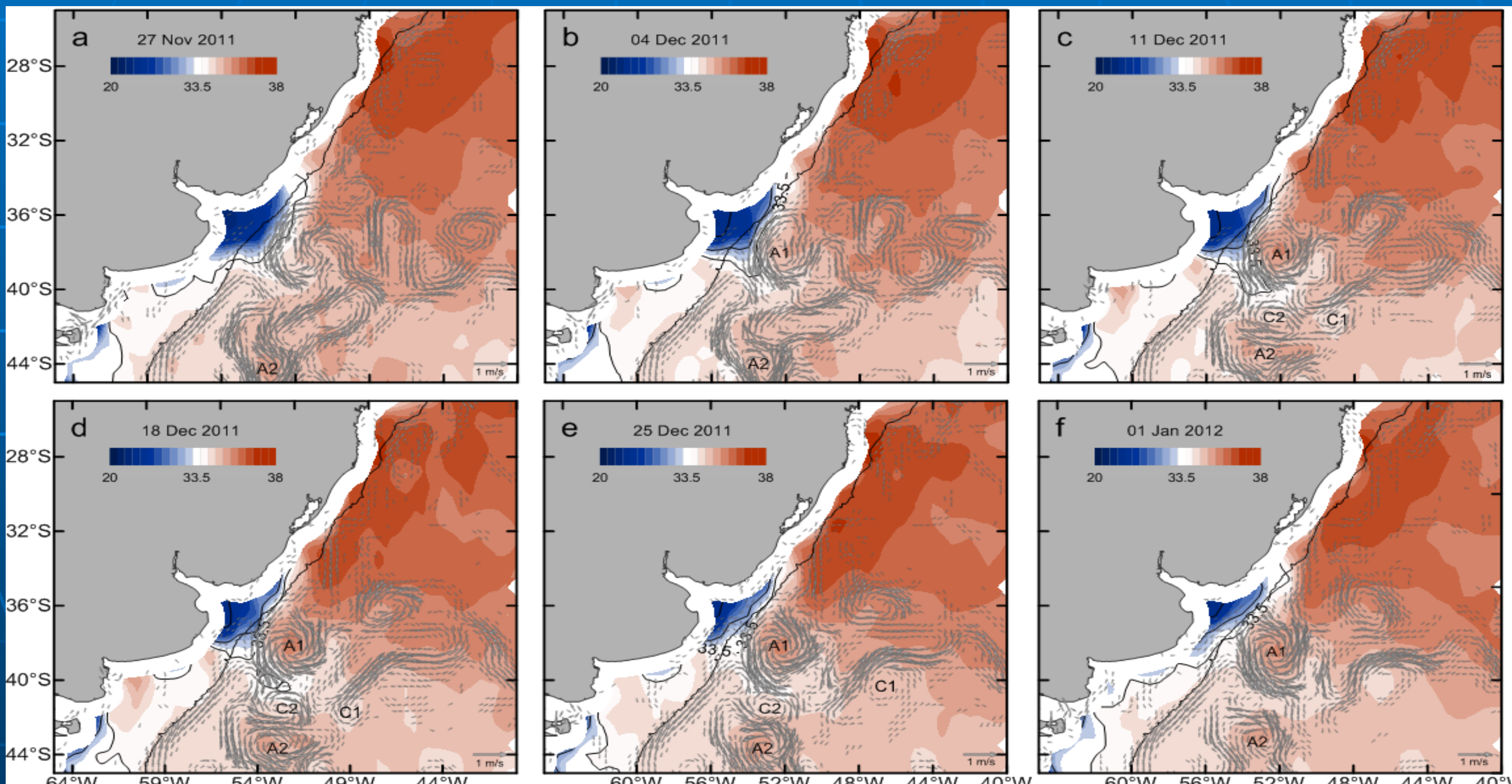
-LSW → deep ocean
Aquarius & SMOS

-Cyclonic (C2; C3)
-Anti-cyclinic rings (A1)

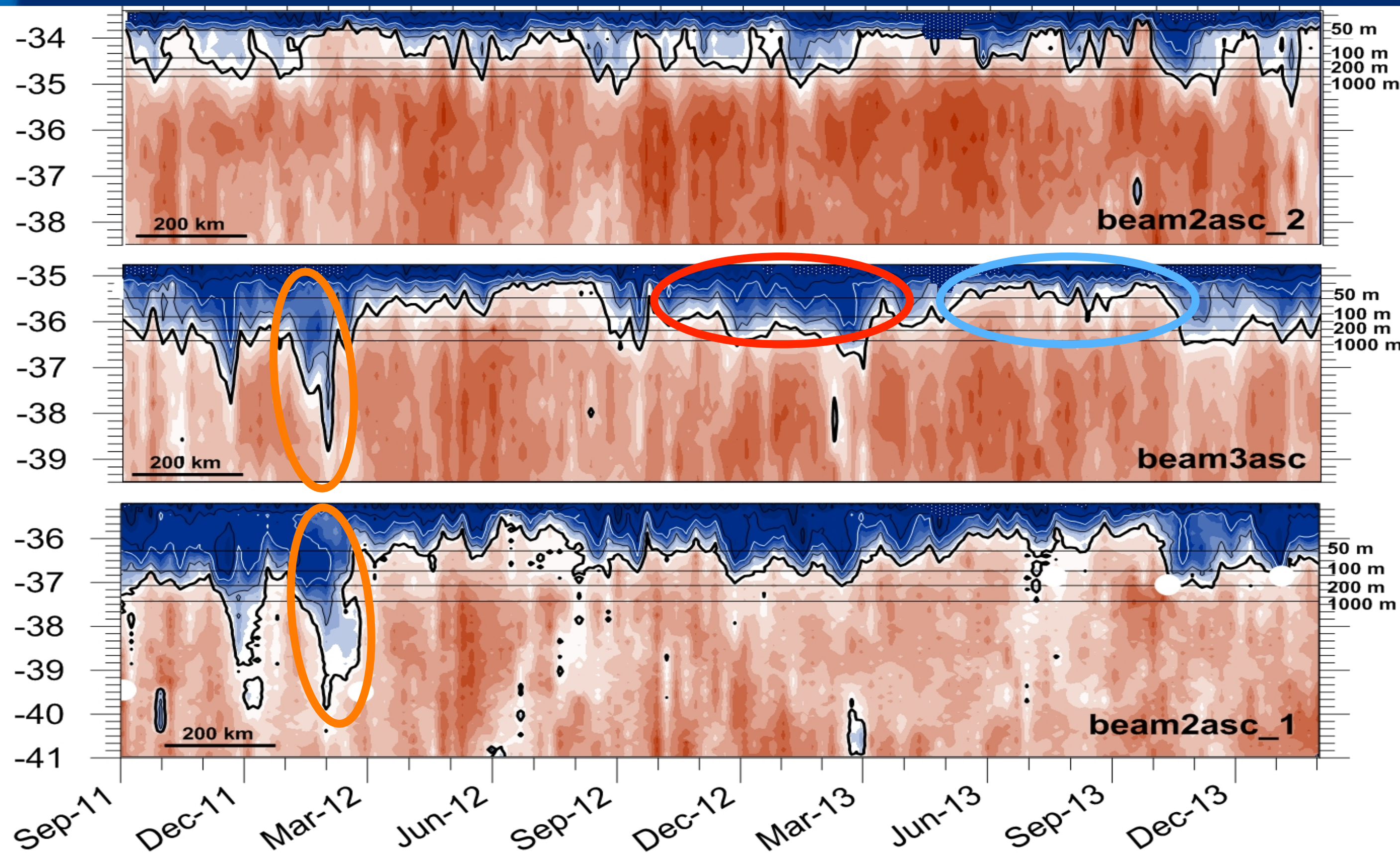
-Validated by:
Surface curr. (OSCAR)
SST (Modis)
Chla (modis)

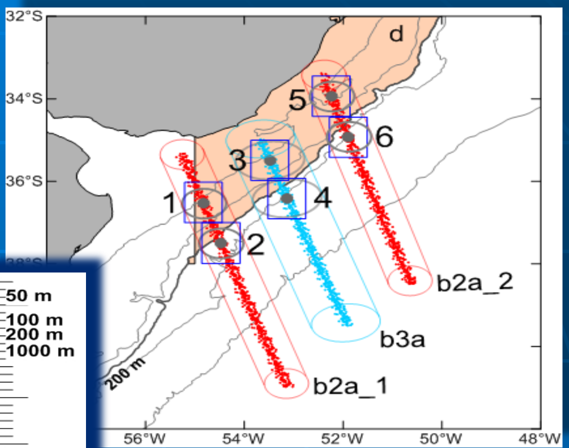
Time serie 27Nov-2011 / 1Jan-2012

Evolution of a Low SSS intrusion into the deep ocean and tracking of warn-salty and cold-fresh rings



SSS variability along tracks (cross shelf break)





Seasonal

- Fresher Spring-Summer

- Salty autumn and winter

Intra-seasonal

LSW detrainments into the deep ocean

Time series of SSSaq at central track

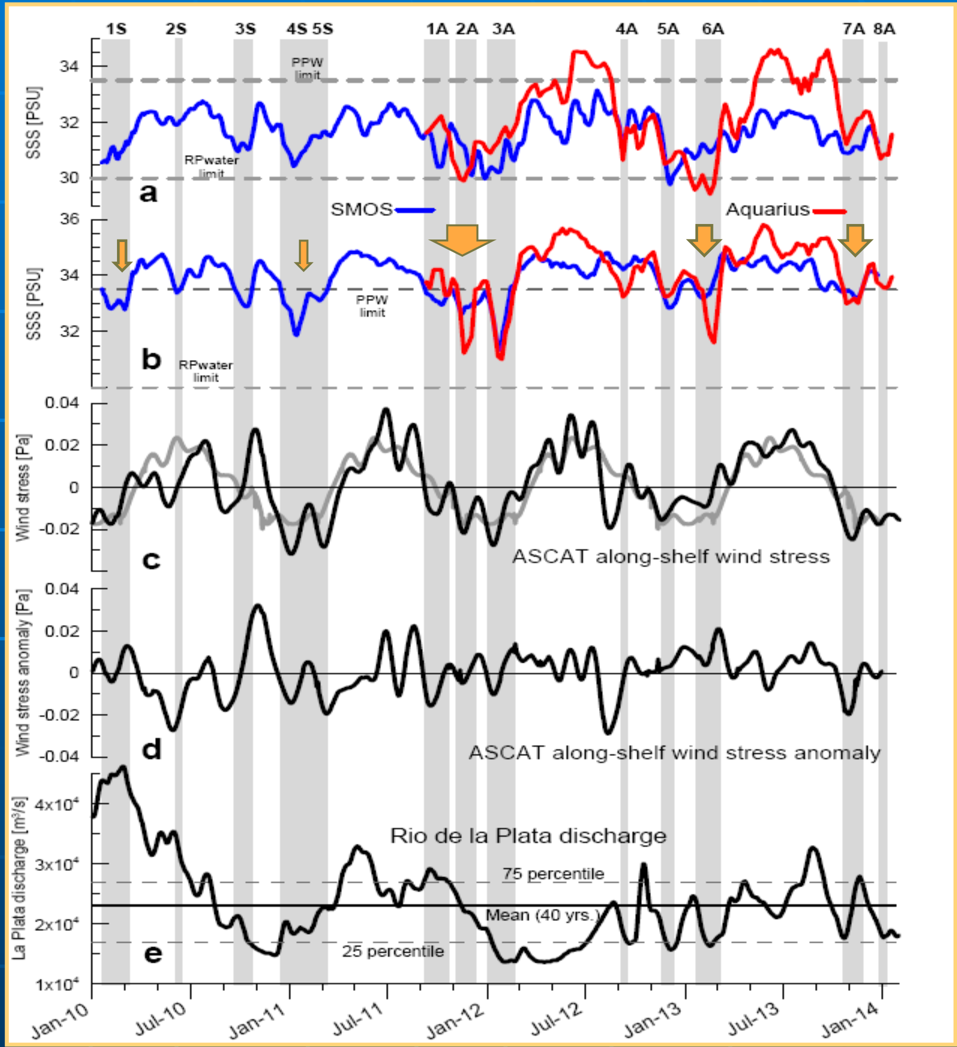
SSSAq and SMOS
a) Outer shelf (point 3)
b) Slope (Point 4)

Wind stress (Area "d")
c) ASCAT along shelf (obs and 2008-13 daily mean).
d) ASCAT WS anomaly (along.S.)

e) Rio de la Plata discharge

Seasonal SSS:
Fresher Spring and summer
Saltier Autumn and winter

SSS < 33.5 crossing the 200m
- Mostly spring-summer time
- When Wind stress reverse to SE
- No obvios influence from RdP disch

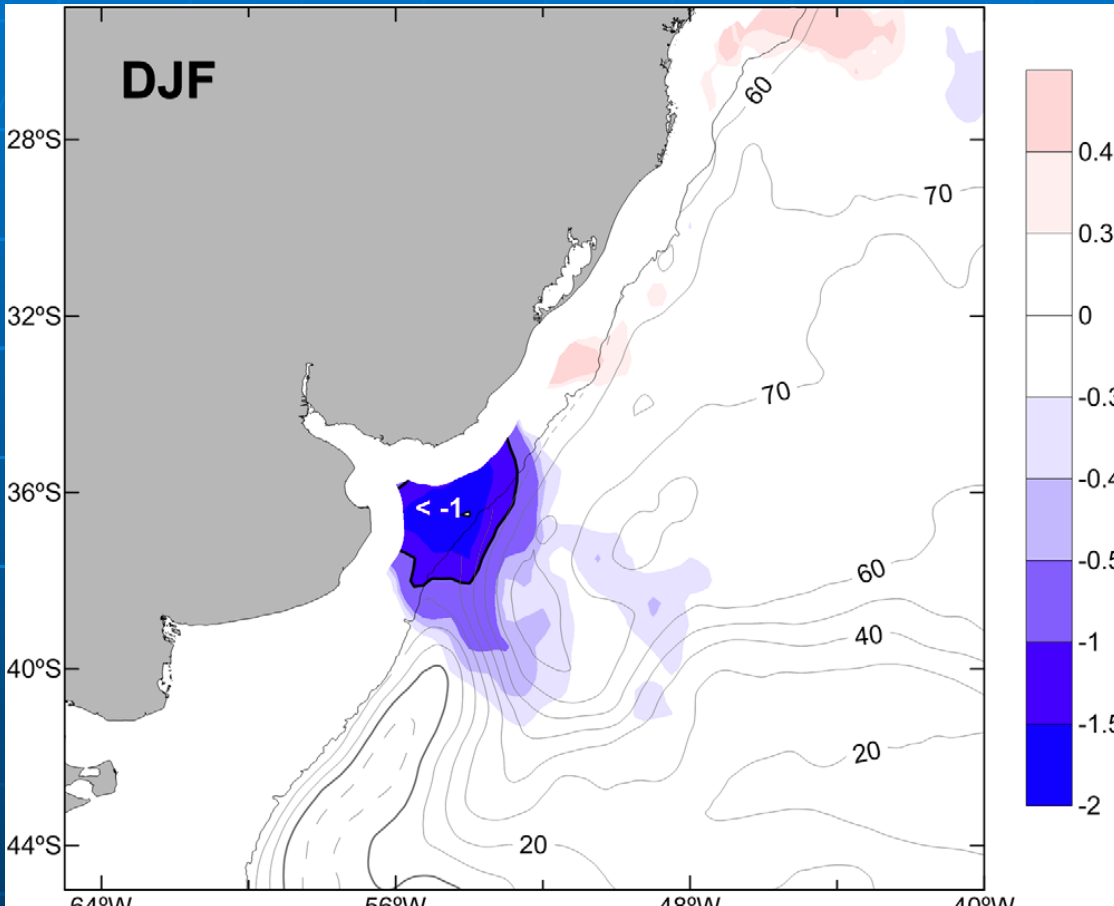


Detrainment events (SSS<33.5 crossing 200m)

Aquarius Track	Start date	Weeks at 200m	SSS min	SSS mean	Event number	Overlapped SMOS
Northern (NT)	22 Nov 2011	4.2	33.1	33.4	2A	6S
	3 Jan 2012	3.4	33.0	33.3	3A	7S
	21 Aug 2012	5.0	32.3	33.0	4A	8S
	8 Jan 2013	3.9	32.1	32.8	6A	10S
	8 Oct 2013	7.0	31.6	32.7	7A	11S
	17 Dec 2013	4.9	31.9	33.1	8A	-
Central (CT)	08 Oct 2011	7.3	28.6	32.2	2A	5S
	7 Jan 2012	7.7	30.4	31.8	3A	5S
	17 Nov 2012	5.4	32.5	33.0	5A	9S
	19 Jan 2013	8.1	30.6	32.4	6A	-
	19 Oct 2013	7.2	32.6	33.0	7A	11S
	28 Dec 2013	2.6	32.5	33.0	8A	-
Southern (ST)	1 Sep 2011	2.9	32.9	32.9	1A	5S
	19 Nov 2011	6.5	31.1	31.9	2A	5S
	14 Jan 2012	6.6	29.8	31.4	3A	5S

SMOS region	Start date	Weeks S<33.5	SSS min	SSS mean	Event number	Overlapped Aquarius
Northern (point 6)	09 Feb 2010	3.7	33.0	33.2	1S	-
	07 May 2010	8.4	32.5	32.9	2S	-
	11 Aug 2010	16.0	32.1	32.9	3S	-
	12 Dec 2010	6.3	32.5	32.9	4S	-
	17 Sep 2011	6.0	32.5	33.0	5S	1A
	22 Nov 2011	2.1	33.1	33.2	6S	2A
	25 Dec 2011	3.7	33.0	33.3	7S	3A
	12 Ago 2012	4.6	32.7	33.0	8S	4A
	25 Nov 2012	2.6	32.8	33.1	9S	-
	22 Dec 2012	5.0	32.8	33.0	10S	6A
	06 Sep 2013	11.4	32.7	33.0	11S	7A
Central (point 4)	19 Jan 2010	7.9	32.7	32.7	1S	-
	3 Jun 2010	2.6	33.1	33.1	2S	-
	19 Sep 2010	5.6	32.4	32.4	3S	-
	6 Dec 2010	15.0	31.7	31.7	4S	-
	5 Sep 2011	24.0	31.0	31.0	5S 6S 7S*	1A 2A 3A
	13 Nov 2012	15.1	32.3	32.3	9S	5A
	6 Sep 2013	11.9	32.6	32.6	11S	8A
Southern (point 2)	9 Feb 2010	4.1	32.8	33.2	1S	-
	10 Oct 2010	2.5	33.2	33.3	3S	-
	18 Dec 2010	13.7	31.0	32.2	4S	-
	2 Oct 2011	26.3	30.6	32.5	5S 6S 7S*	1A 2A 3A
	16 Nov 2012	5.1	32.6	33.0	9S	7A

Summer mean SSSaq anomaly and dynamic topography anomaly



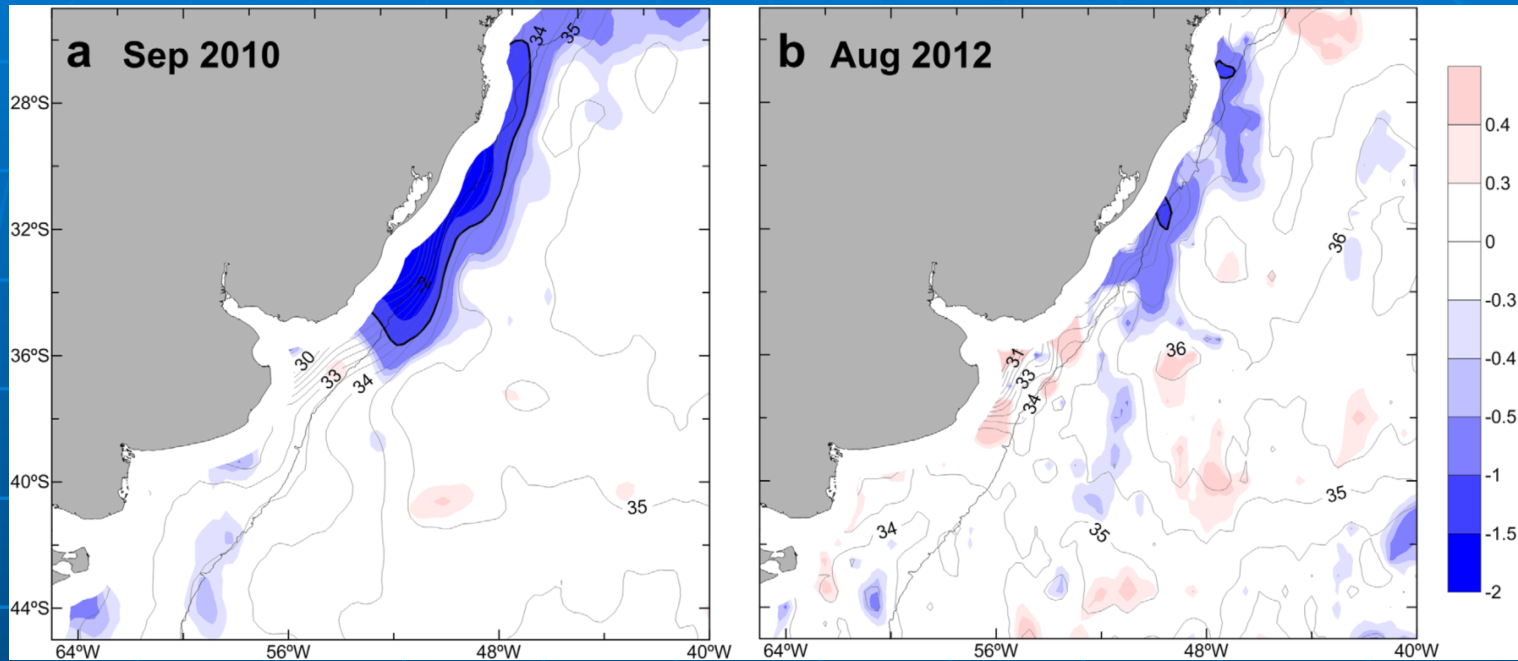
LSW along the BMC
Obs: Gordon 1989
Provost et al. 1996
Modelling: Palma et al. 2008

SSSaq and Smos
LSW derives from RdlP
Driven by the BMC and occurs mostly in late spring and summer.

Location ~ 37°S → In agrement with numerical simulations (Matano et al., 2014)

Winter SSS fields and anomalies (Smos and Aquarius)

Weaker detrainments in SSS:
- Fewer events
- Under wind reversal cond.
- NO RdlP discharge influ.



Location: 27°S → 35°S also in agrement with numerical simulations (Matano et al., 2014)

Still intense Low Salinity (< -.5) into the deep ocean (in contrast to Brazil Water) resulting in a warm variety of Shelf Waters (Gordon 1989; Piola et al., 2008)

Summary and Conclusions

- Aquarius and SMOS SSS capture the detrainment of shelf waters into the deep ocean

- The export of shelf waters near the RdlP causes the strongest salinity signal throughout the South Atlantic (south of 10°S)

- The detrainments of low-salinity waters present a strong seasonal signal which is associated with the alongshore wind stress variability over the shelf: Summer → 36-37°S; Winter 27-35°S

- The low-salinity waters cause an extensive negative salinity anomaly whose core follows the path of the BMC

- The general agreement with the numerical simulations and in situ observations indicate an outstanding overall performance of the satellite-based salinity sensors