esa

→ ATLANTIC FROM SPACE WORKSHOP

Improved satellite sea surface salinity maps to further the understanding of the Southern Ocean dynamics and to monitor its changes

by Estrella Olmedo[1]

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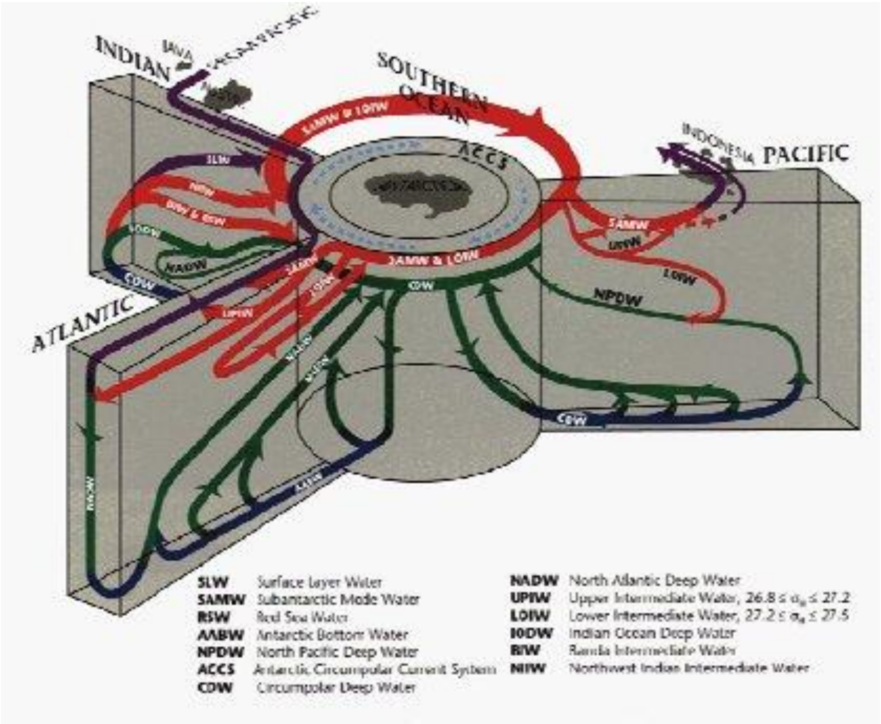
Introduction

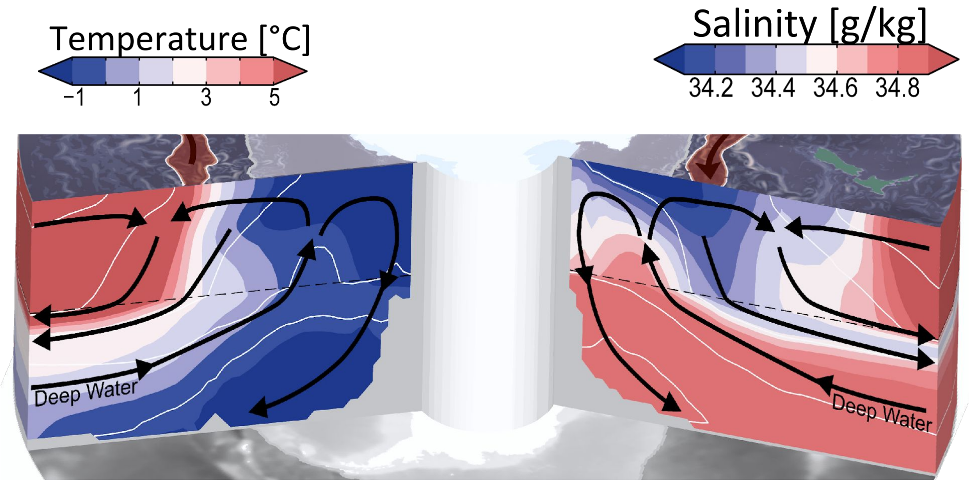
- The Southern Ocean (SO) is connected through the Atlantic, the Indian and the Pacific basins.
- Responsible for transporting vast amounts of salt, heat and nutrients across basins
- Direct influence in the global climate.



Introduction

- **Density structure in the SO (ocean circulation and variability) are governed by the salinity distribution and variability**:
  - Surface waters are very cold
  - Density stratification is only marginally stable
  - Due to the non-linearities in the density equation, small changes in salinity at low temperatures have a large effect.

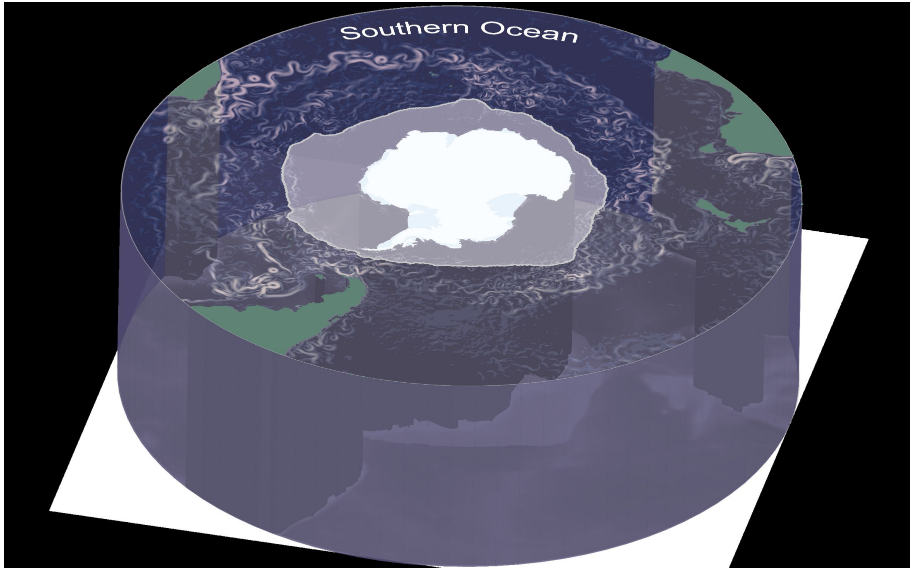
So, **if we understand and observe well the salinity distribution we can understand many of the other processes**!



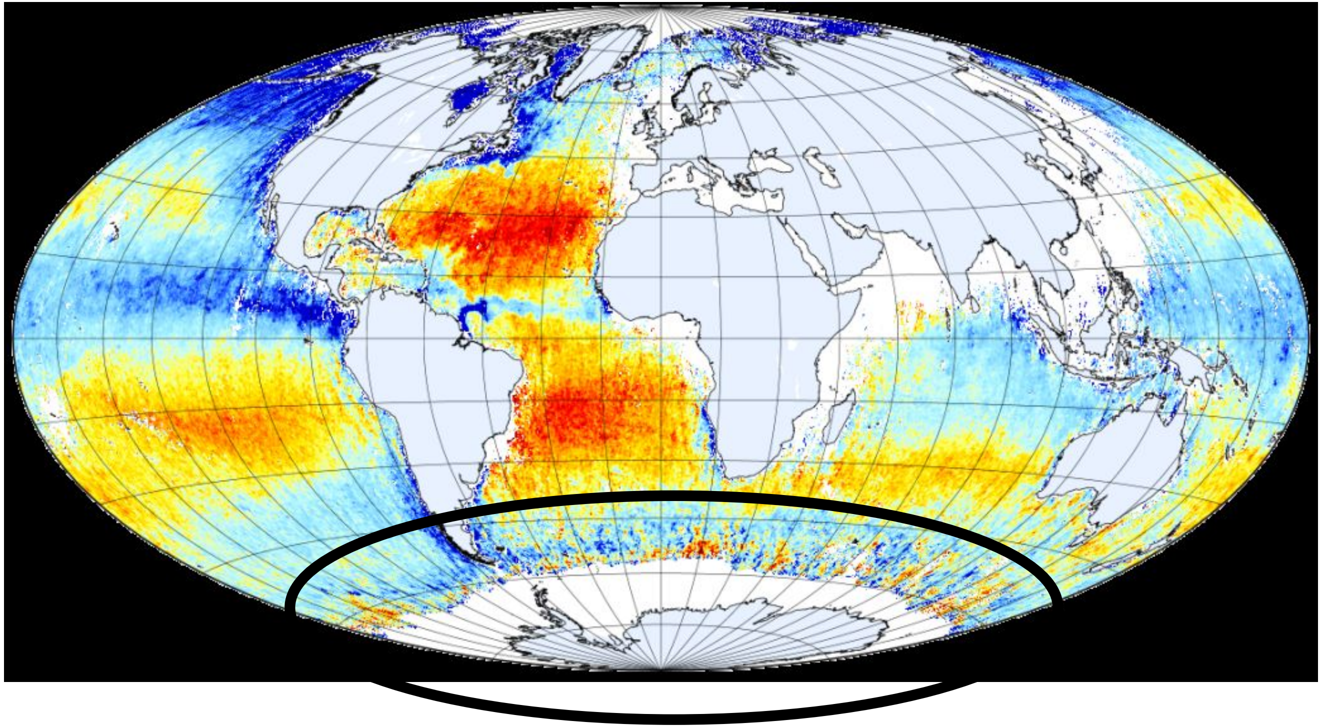
Introduction

The monitoring of the salinity dynamics in the SO is hampered by limited number of in situ.

The development of reliable satellite observations systems of Sea Surface Salinity at high latitudes can contribute to improve the understanding of Southern Ocean circulation and its seasonal and inter-annual variability and long-term trends.



SMOS SSS product in the SO:from past to present



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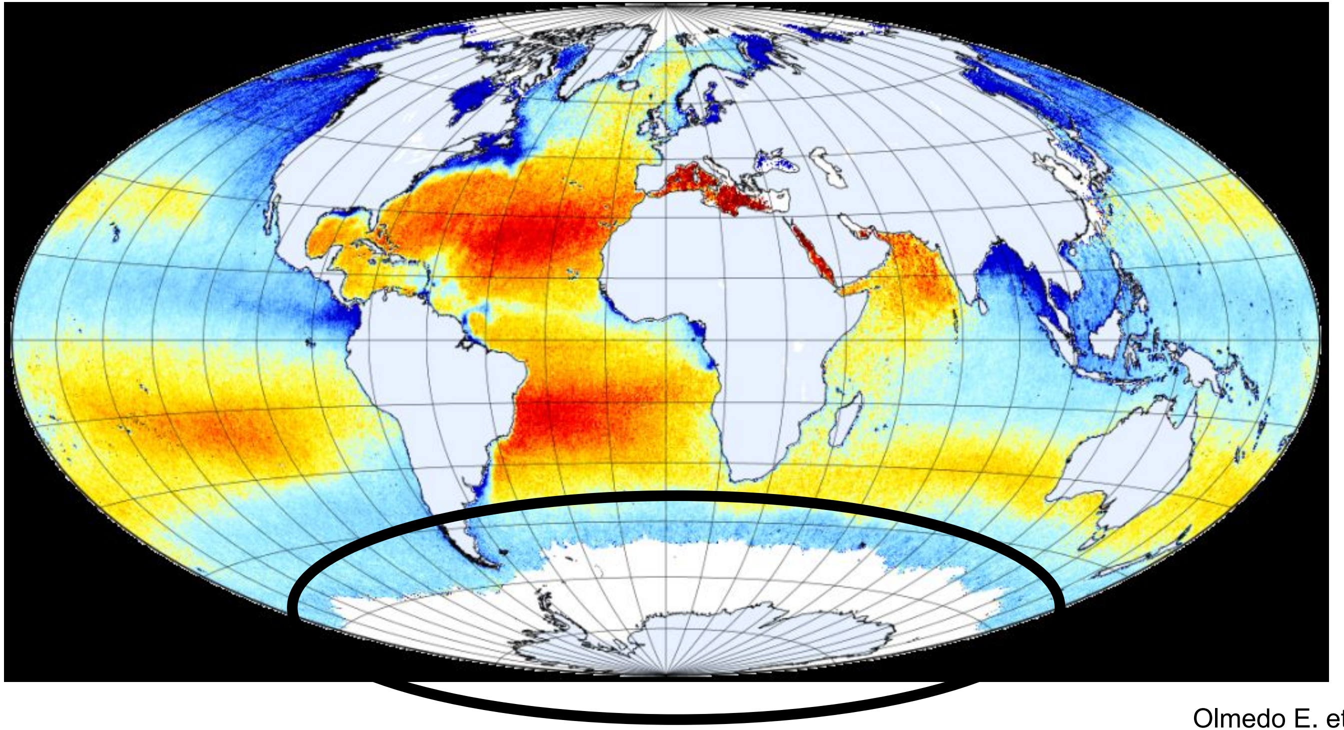
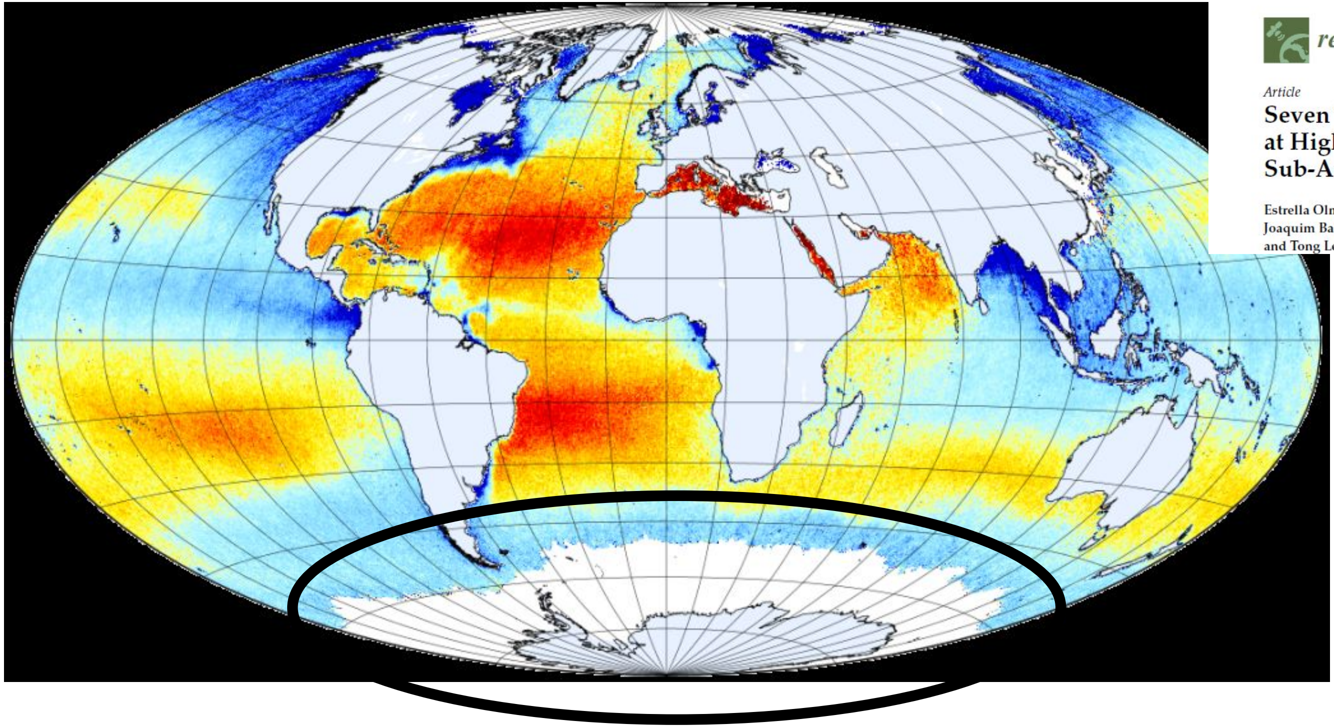


Olmedo E. et al (2017) Remote Sensing of Environment

SMOS SSS product in the SO:from past to present



remote sensing MDPI

Article

Seven Years of SMOS Sea Surface Salinity at High Latitudes: Variability in Arctic and Sub-Arctic Regions

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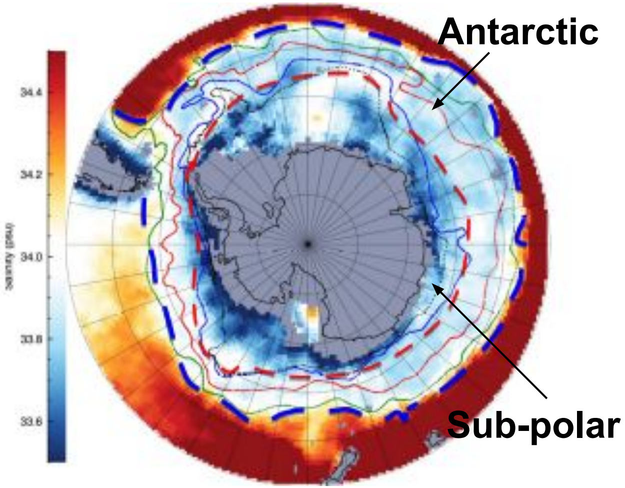
- We use the same methodology used in the Arctic Ocean for generating **7 years (2011-2017) of SMOS SSS** especially dedicated at high southern latitudes (**9-day 25km maps generated daily**)
- This product will be available very soon at http://bec.icm.csic.es/



Quality assessment approach

- We compare with **Argo salinity floats**

- We compare with **ship-based in situ data**. Three study cases:

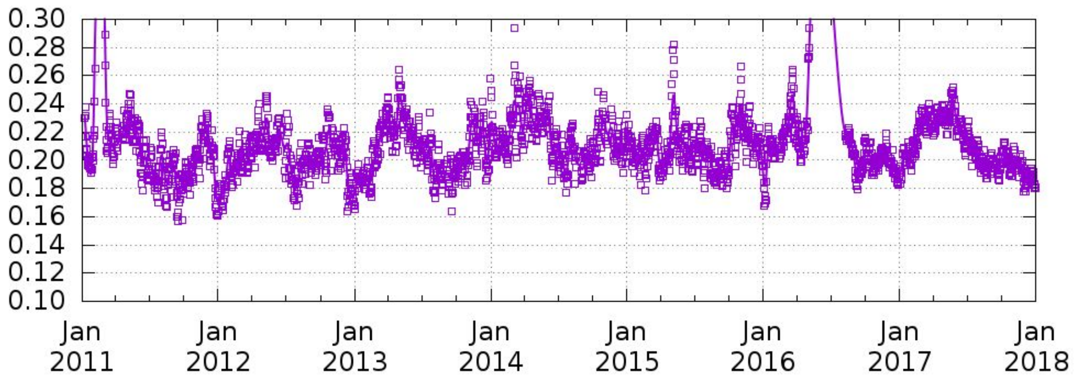
  - Case study 1: Akademik Treshnikov
  - Case study 2: Astrolab
  - Case study 3: Agulhas I and Agulhas II

- **Collocation approach**:
  - Temporal collocation of in-situ with the central day of the 9-day period used in the generation of the SMOS SSS map
  - Average of the in situ data available in a cell of SMOS SSS map (25kmx25km)

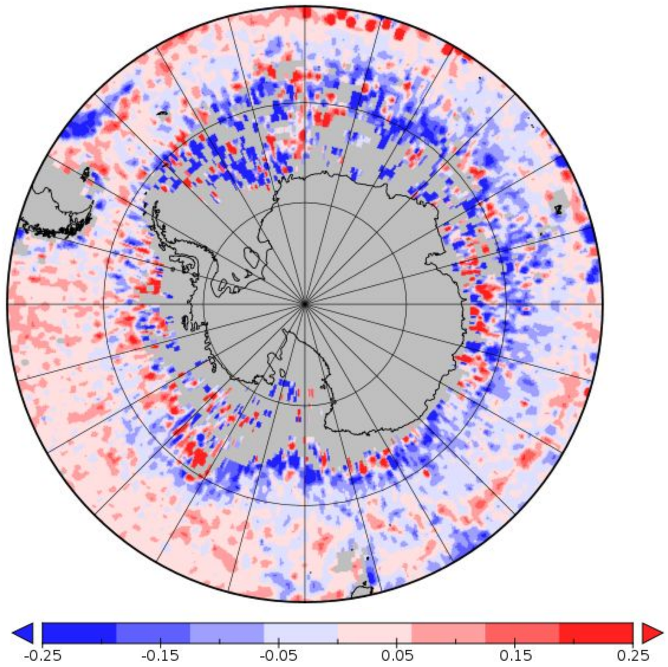
Std and RMS of SMOS-Argo SSS in 90-50ºS

	2011	2012	2013	2014	2015	2016	2017
STD	0.21	0.20	0.21	0.22	0.21	0.21	0.21
RMS	0.21	0.20	0.21	0.22	0.21	0.21	0.21

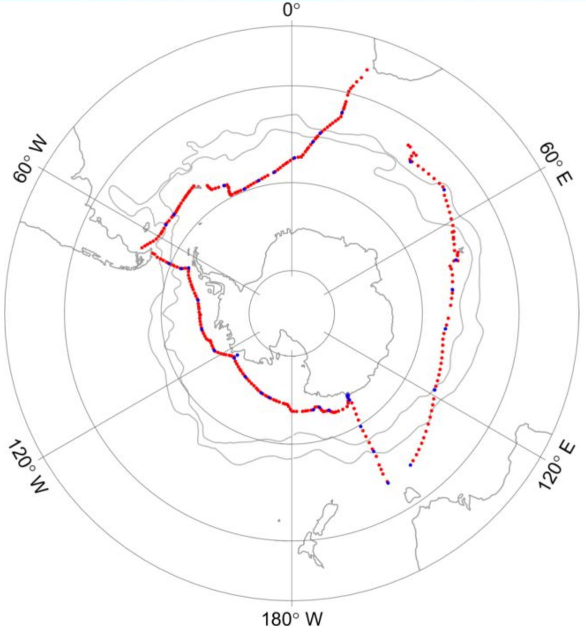
Standard deviation of the differences SMOS-Argo SSS

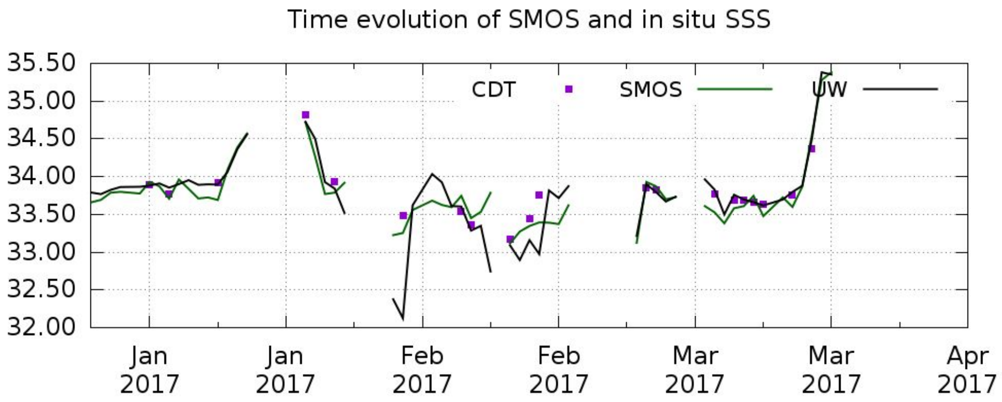


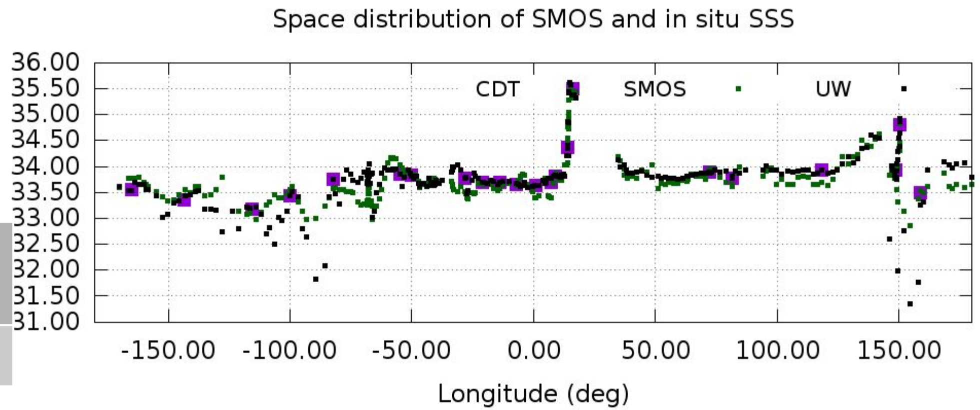
SMOS -ARGO: Spatial distribution of biases 2011-2017



SMOS against ship-based SSS: study case 1







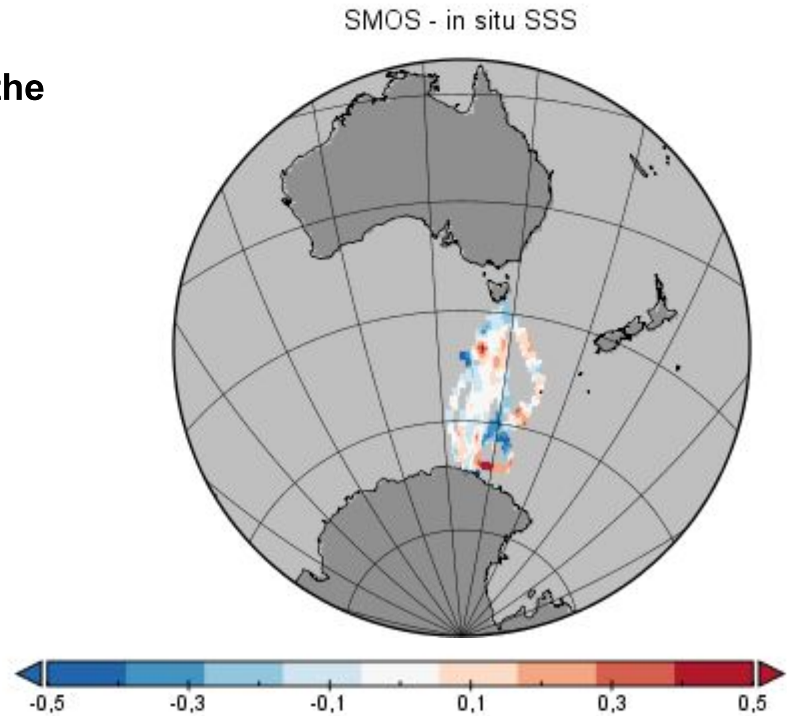
Num. Meas.	Mean	Std	Correlation
255	-0.01	0.32	0.81

SMOS against ship-based SSS: study case 2

Five years 2011-2015 of routine transects have been analyzed.

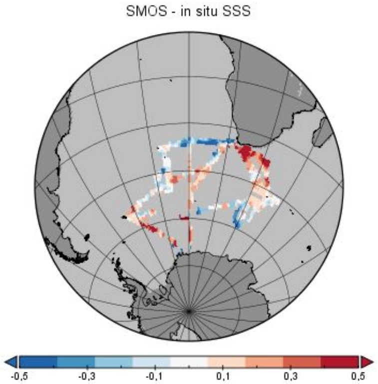
We **study the seasonal behavior of the errors by comparing the multi-year average of every month**.

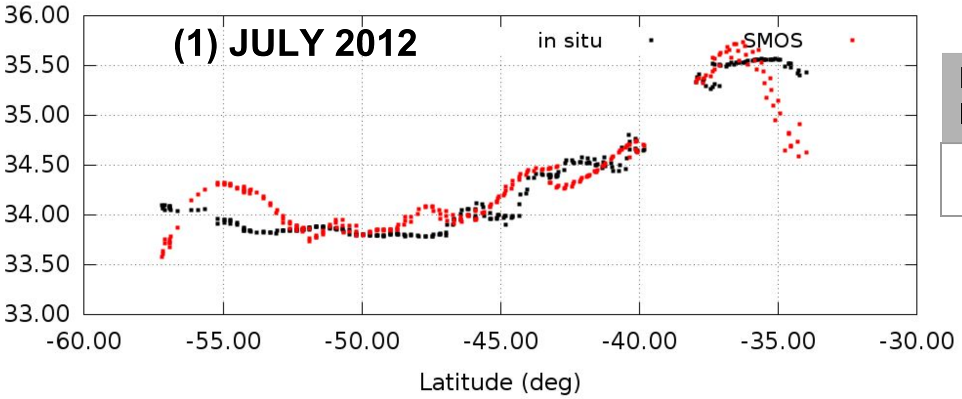
	OCT	NOV	DEC	JAN	FEB	MAR
Num. Meas.	613	772	518	953	1489	734
MEAN	-0,04	0.03	0.07	-0.04	-0.03	-0.10
STD	0.17	0.20	0.23	0.21	0.23	0.22
Cor.	0.91	0.92	0.89	0.92	0.91	0.91

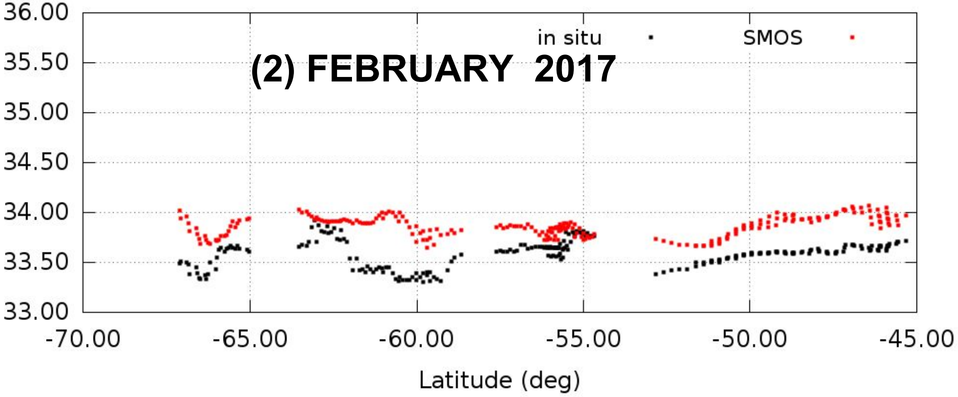


SMOS against ship-based SSS: study case 3

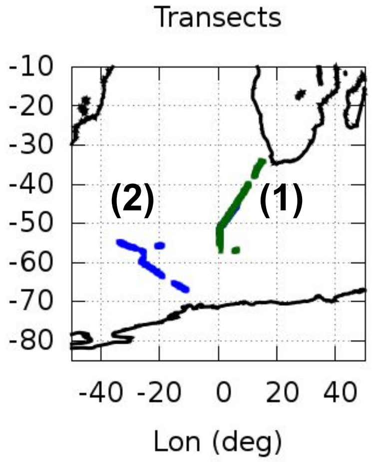
Seven years of routine transects have been analyzed 2010-2017.







Num. Meas	Mean	Std	Cor.
6692	0.04	0.33	0.90

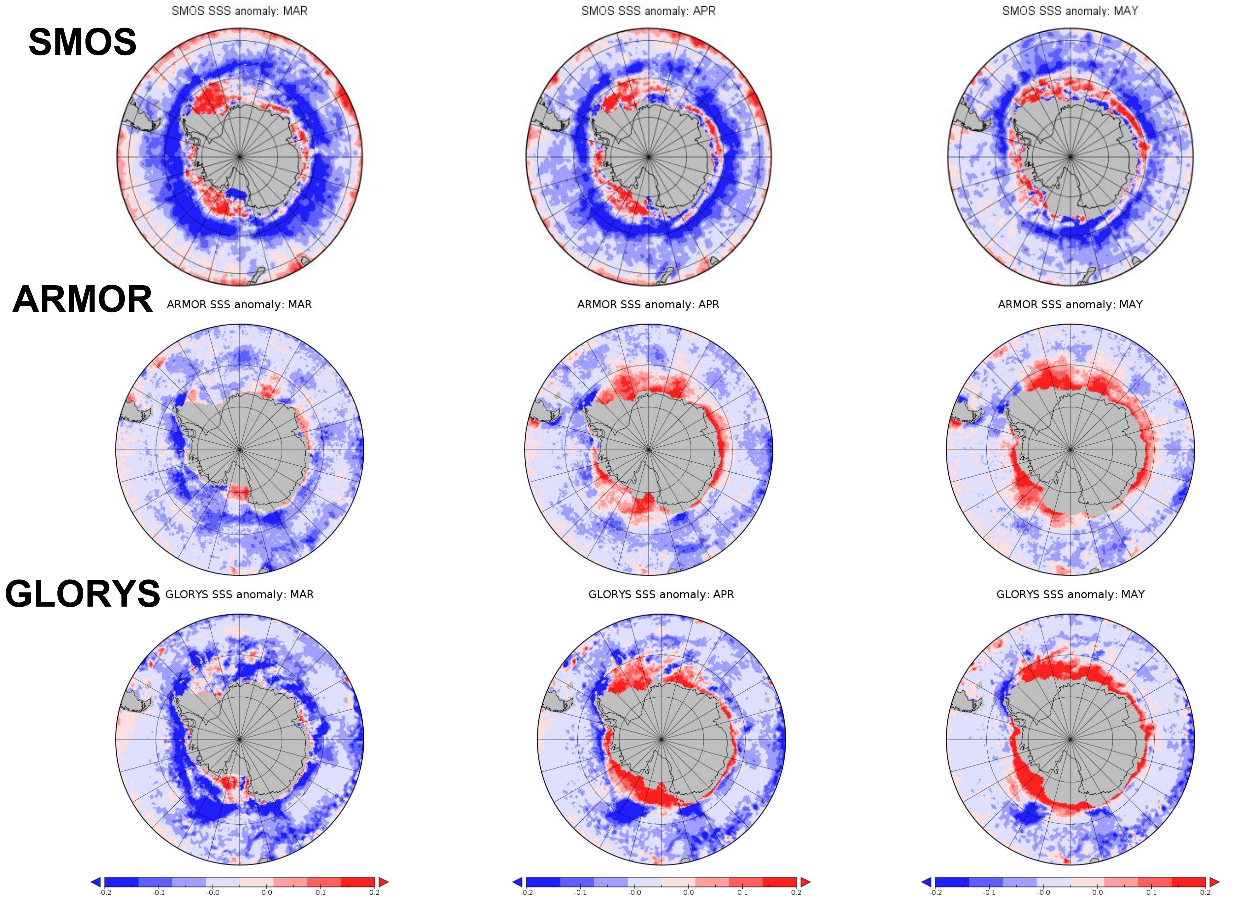


We compare the seasonal variability of: SMOS (satellite), ARMOR (reanalysis) and GLORYS (model)

1. Consider years 2011-2015
2. Compute a monthly climatology for every gridded product
3. Compute each own monthly anomaly by subtracting each own global mean (2011-2015)

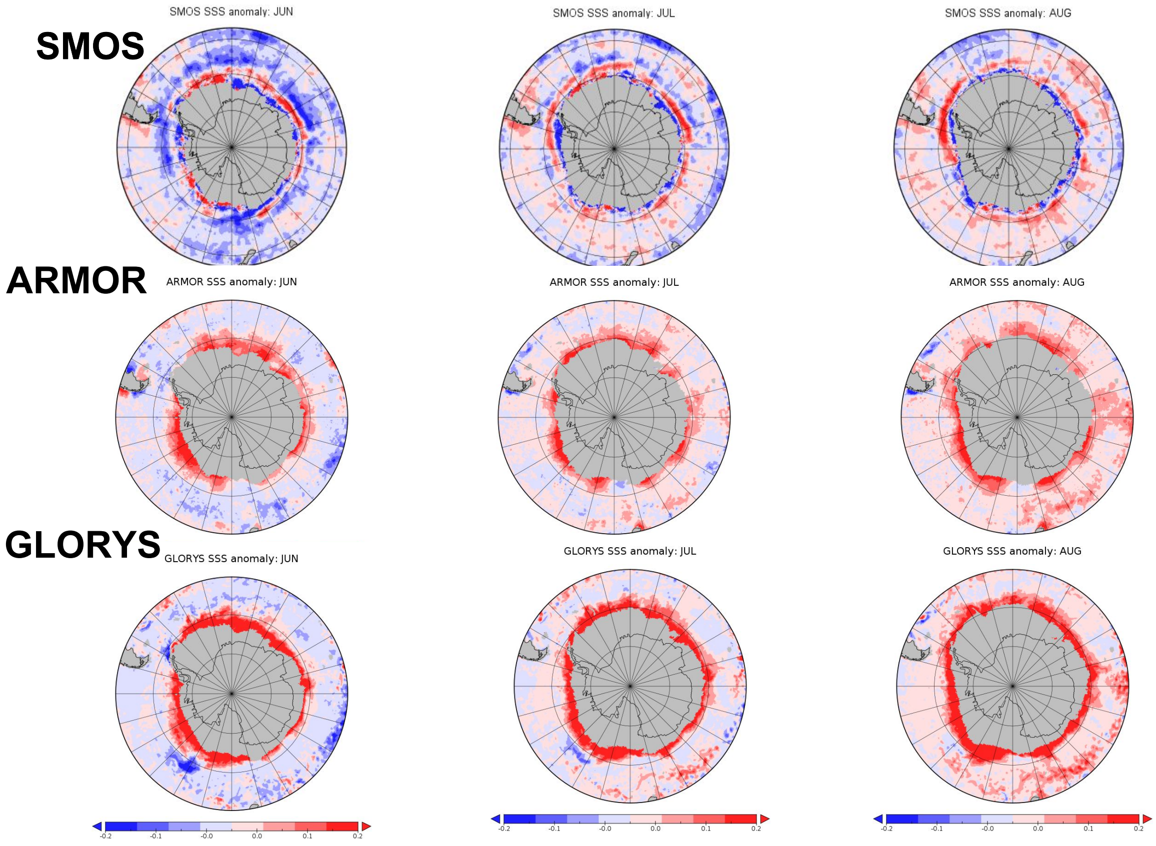
For this comparison we use the SMOS ice-mask.

Study of the seasonal variability: Autumn MAR-APR-MAY



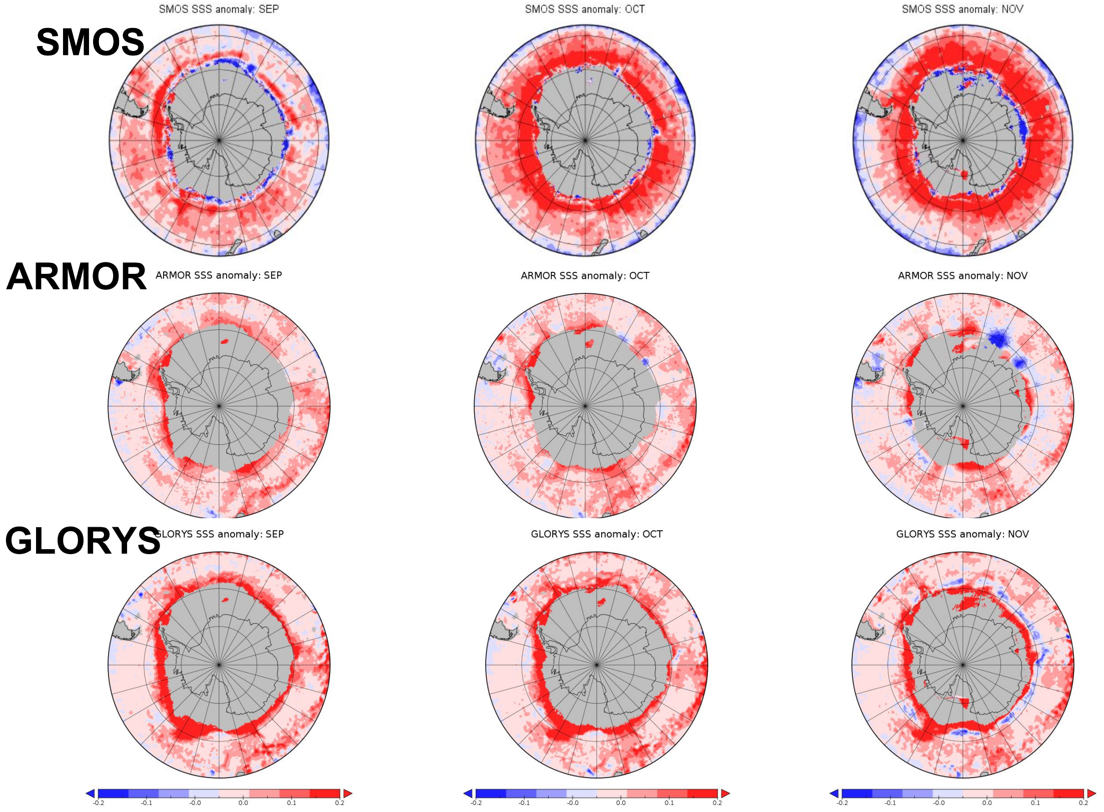
In Autumn **good agreement between SMOS and GLORYS** anomalies in the sub-polar and Antarctic bands

Study of the seasonal variability: Winter JUN-JUL-AUG



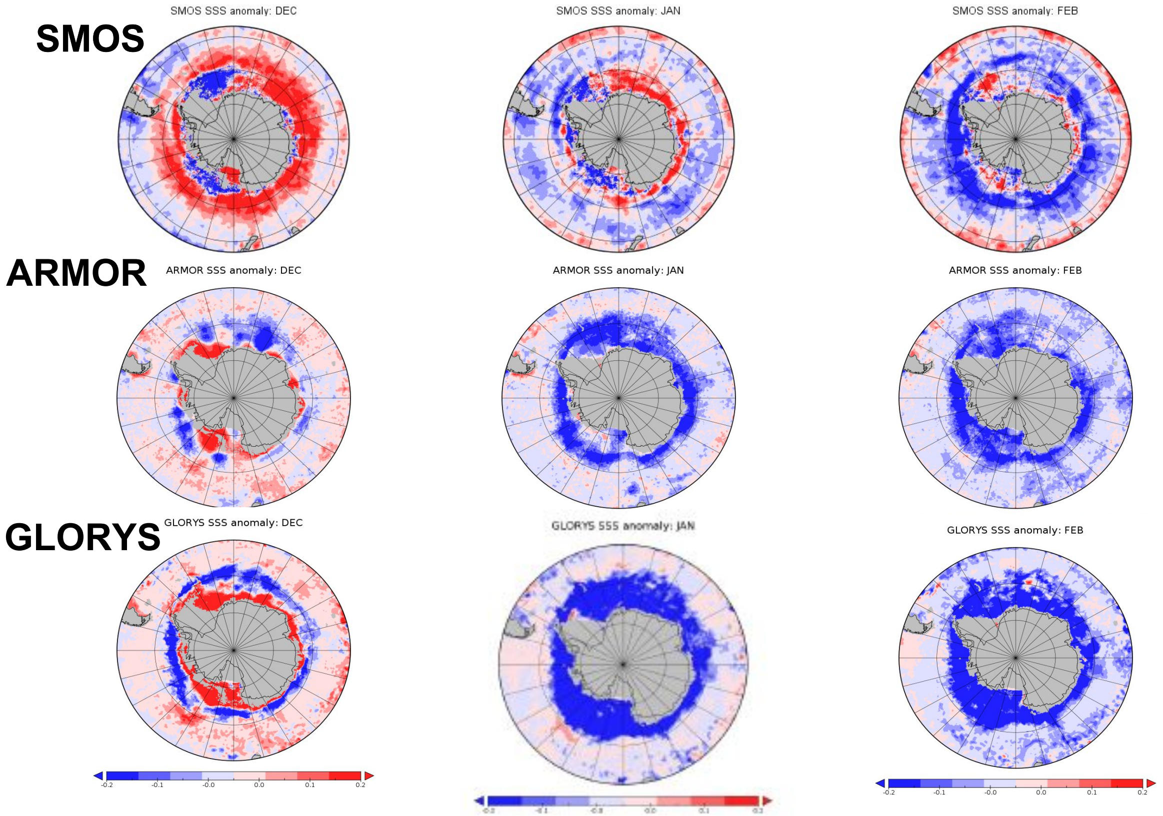
Increase of SSS in the Antarctic band which is especially strong in the ice-edge (three products agree on that) SMOS captures a dipole in the ice edge (real? ice-sea contamination?)

Study of the seasonal variability: Spring SEP-OCT-NOV



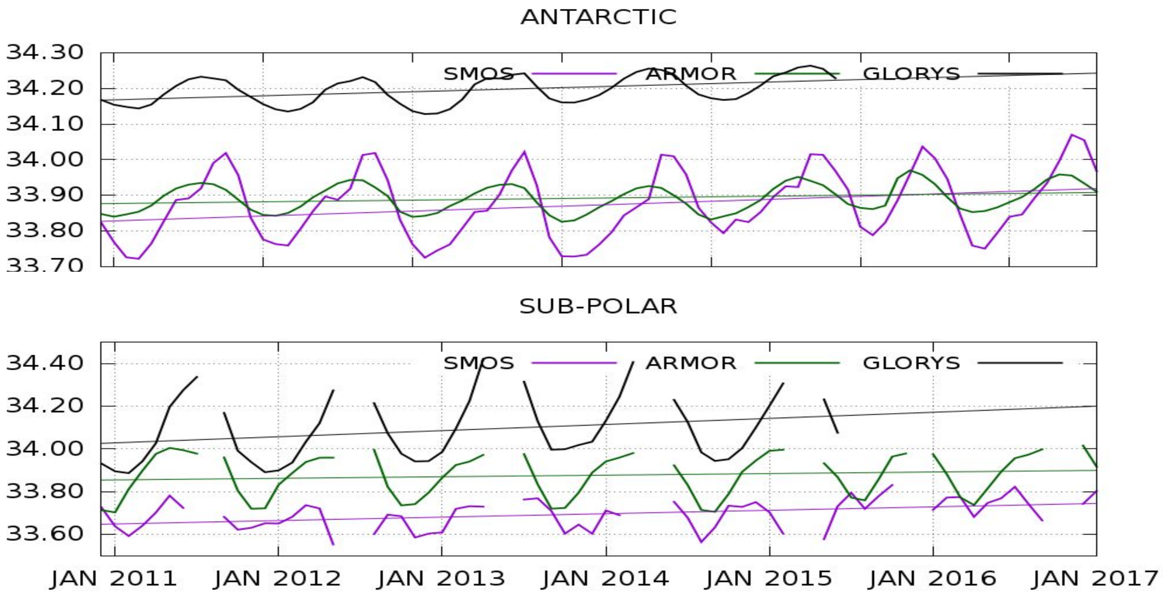
Maximum salty values of SSS in Antarctic band (three products agree on that) SMOS captures fresh SSS values in the ice edge which is coincident with the one shown by GLORYS in NOV.

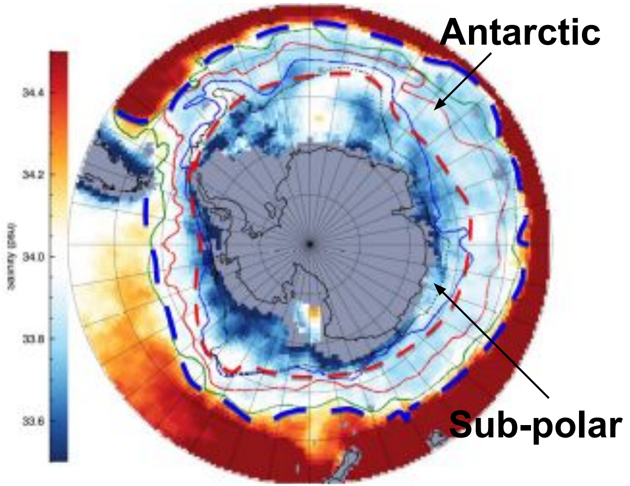
Study of the seasonal variability: Summer DEC-JAN-FEB



Decrease of SSS in the Antarctic band. Sub-Polar band is the region with major discrepancies although some patterns matches between SMOS and GLORYS in the sub-polar region

Interannual variability





	ANTARCTIC		SUB-POLAR	
	TREND PSU/YEAR	ERROR in estimation	TREND PSU/YEAR	ERROR in estimation
SMOS	0.005	38%	0.01	28%
ARMOR	0.001	45%	0.007	94%
GLORYS	0.01	28%	0.024	55%

Average of the monthly gridded products in two bands: Antarctic and sub-Polar.

1) 2011-2017 SMOS
2) 2011-2017 ARMOR
3) 2011-2015 GLORYS

Seven years (2011-2017) of 9-day maps at 25km especially dedicated at southern high latitudes have been generated and will be freely available soon at the BEC website

Quality assessment by comparing with in situ data:

- The **global error is approx. 0.22 PSU**
- No anomalous year or month is observed
- Sub-polar region is the one with the largest differences

The **seasonal dynamics**:

- In the **Antarctic band, good agreement** between SMOS, ARMOR and GLORYS.

- The **sub-polar region is the most challenging region:**
  - Some patterns coincident in SMOS and GLORYS
  - Some patterns shown by SMOS need to be studied

The **inter annual variability**:

- The **three products show a salidification in the Antarctic and sub-Polar regions in the last 7 years**

- **SMOS captures an increase of salinity of 0.005 PSU/YEAR in the Antarctic band and 0.01 PSU/YEAR in the sub-polar region**. Both trends in between of the one shown by GLORYS (largest trend) and the one shown by ARMOR (lowest trend)

THANK YOU VERY MUCH FOR YOUR ATTENTION!

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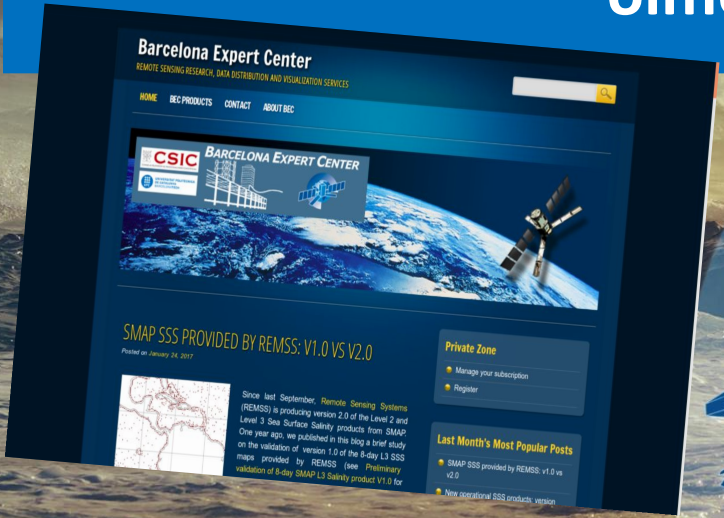

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