

Aquarius/SAC-D Science Team Meeting
11-13 April 2012, Buenos Aires

SMOS salinity data processing status and Some results



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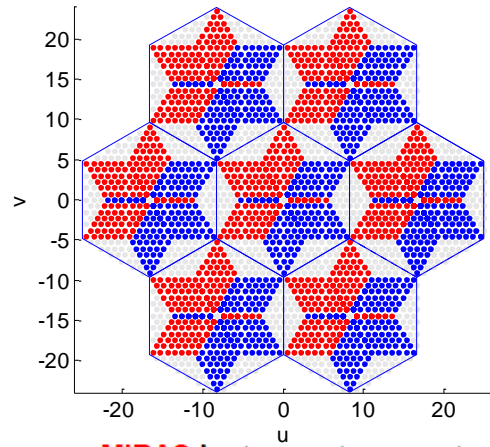
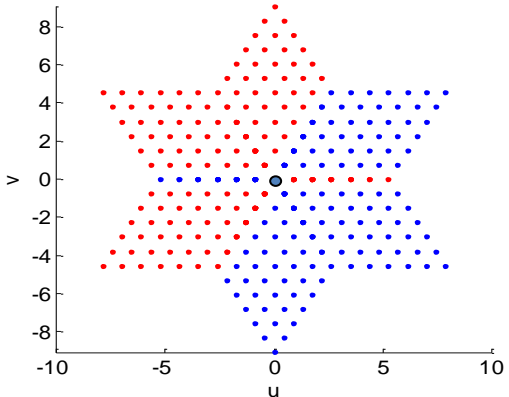
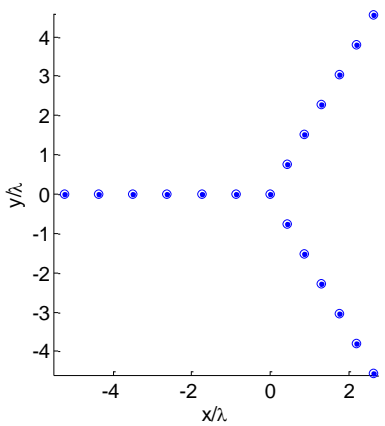
- Introduction
- Level 1 processor status
- Level 2 processor status
- Level 3 & 4 data products
- Qualitative comparisons of SMOS reprocessed data with Aquarius
- Conclusions

The Soil Moisture & Ocean Salinity ESA earth explorer mission

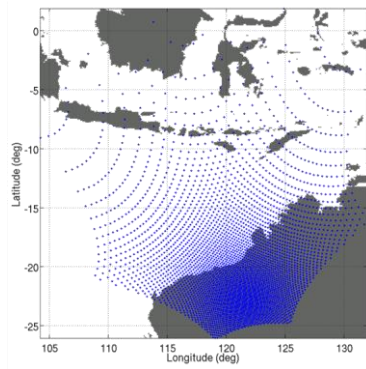
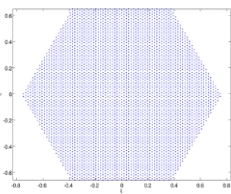
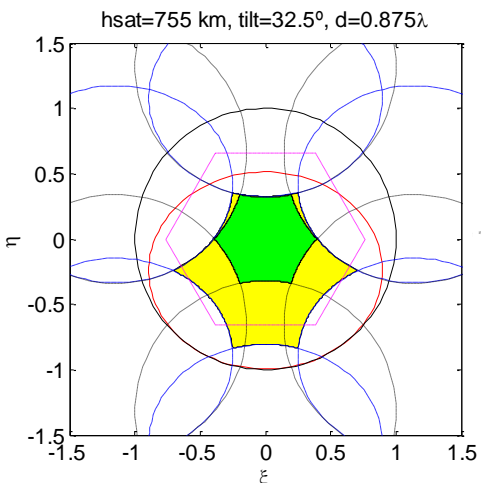


In orbit since November 2009 (heliosynchronous, Ascending 6am equator)

Microwave Imaging Radiometer using Aperture Synthesis (2D imaging by Fourier synthesis)



- **MIRAS instrument concept**
 - Y-shaped array (arm length ~ 4.5 m)
 - 21 dual-pol. L-band antennas / arm
 - spacing 0.875λ (~1400 MHz)
 - no scanning mechanisms,
 - 2D imaging by Fourier synthesis
 - (u,v) antenna separation in wavelengths



2D images formed by Fourier Synthesis (ideal case). Cross correlation of the signals collected by each antenna pair gives the so-called: **Visibility samples $V(u,v)$:**

$$V(u, v) = \langle b_1(t) b_2^*(t) \rangle = \mathcal{F} \left[\frac{T_B(\xi, \eta) - T_{ph}}{\sqrt{1 - \xi^2 - \eta^2}} |F(\xi, \eta)|^2 \right]$$

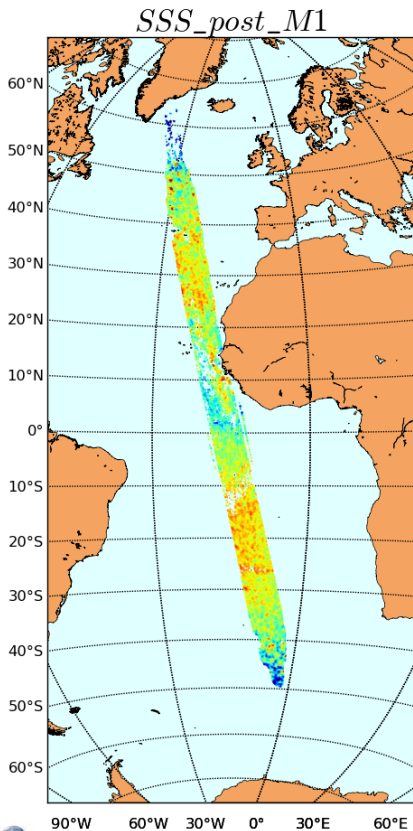
SMOS sea surface salinity status


- SMOS salinity data are provided by ESA as semi-orbit swath products (L2OS processor outputs)

SM_OPER_MIR_SCSF1C_20120227T063512_20120227T072831_504_001_1
 Meas: 27/02/12 06:35-07:28 L1c 5.04; Proc: 28/02/12 by DPGS with L2OP 5.50

#GP=26582/89014/130308

FullPol



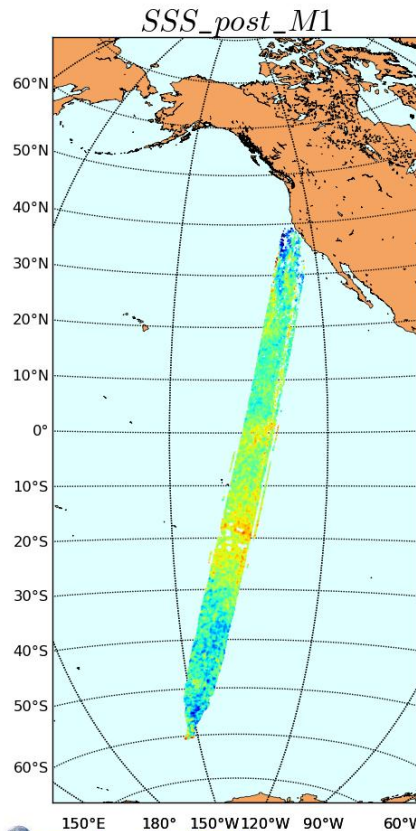

 Filters: Dg_quality_SSS,-1,150
 ARGANS


 esa

SM_OPER_MIR_SCSF1C_20120227T022507_20120227T031820_504_001_1
 Meas: 27/02/12 02:25-03:18 L1c 5.04; Proc: 27/02/12 by DPGS with L2OP 5.50

#GP=26832/80133/126182

FullPol




 Filters: Dg_quality_SSS,-1,150
 ARGANS


 esa

Example: one ascending and one descending semi-orbit from SMOS measurements on 27 Feb 2012

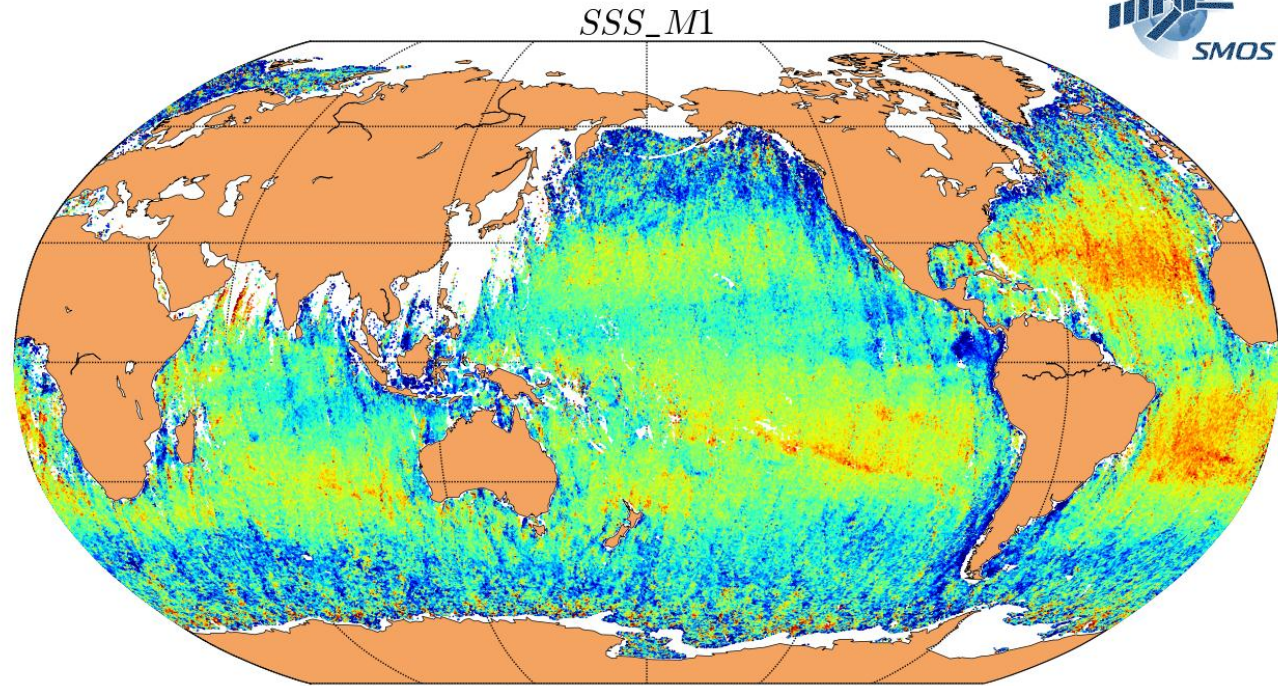
Three days (84 semi-orbits) needed for full Earth coverage

Level 2 very noisy, especially in the outer swath. Average needed

SMOS L2 products

- Superposition and averaging of L2 OS products

#GP=1392795, #Orbits=86
Orbits for: 18/02/2012, 19/02/2012, 20/02/2012



Filters: Fg_ctrl_poor_retrieval,0;Fg_ctrl_poor_geophysical,0

Three days of filtered SMOS L2OS products, 18-20 February 2012: full Earth coverage

- In operation since November 2011
 - Used to reprocess the full 2010-2011 data set
 - Principal modifications:
 - Reduction of short and long term drifts
 - Strong decrease in contamination near to land/ice
 - Better RFI detection/mitigation
 - Improved Sun impact correction
 - Caveats:
 - Fixed spatial bias (2.8K RMS) -> corrected at L2
 - Software anomalies: L1C sun glint flag not correctly set, corrupted measurements in polar region (Sea-ice conditions and salinity studies not possible)
- > Next L1C data reprocessing: April2012

- In operation since December 2011
- Used to reprocess the full 2010-2011 data set
- Principal modifications:
 - Time-varying residual spatial bias correction (Ocean Target Transformation); different ascending/descending
 - Roughness effect correction models tuned to SMOS data
 - Improved flagging /data filtering strategy

L3 & L4 SMOS products: CP34 & CATDS

SMOS level 3 and 4 data production centre:

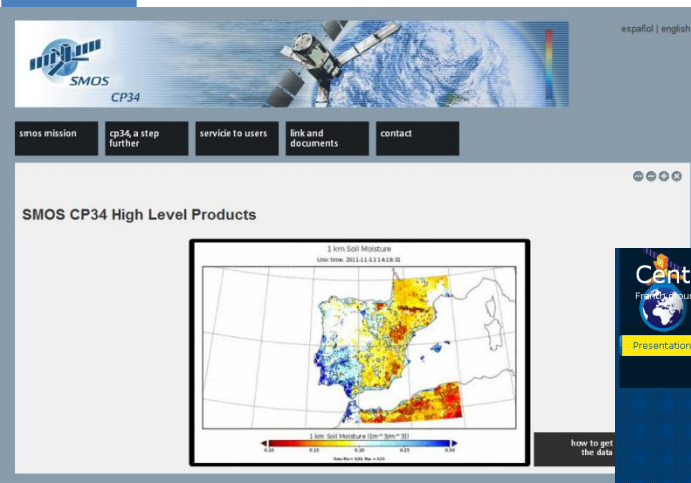
- **CP34:**

<http://www.cp34-smos.icm.csic.es/> for information

<http://www.cp34-users.cmima.csic.es/> for registration

- **CATDS:**

<http://catds.ifremer.fr/Data/Research-Products-from-Expertise-Centers>

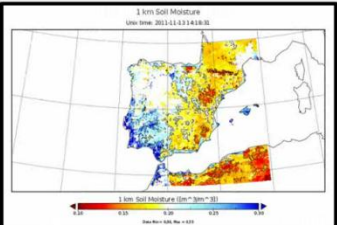


español | english

SMOS CP34

smos mission | cp34, a step further | service to users | link and documents | contact

SMOS CP34 High Level Products

1 km Soil Moisture

 1 km Soil Moisture (0m-30m) [0.00 0.05 0.10 0.15]

how to get the data



Centre Aval de Traitement des Données SMOS (CATDS)

From the ground segment for the SMOS Level 3 and 4 data



[Presentation](#) | [Production Center \(CPDC\)](#) | [Expertise Centers \(CEC\)](#) | [News](#) | [Data](#) | [Documents & tools](#) | [Help & Support](#)

You are at: Home > Presentation

Keywords: presentation

Presentation

SMOS : the "Global water cycle mission"

SMOS (Soil Moisture and Ocean Salinity) mission is a joint ESA / CNES / CDTI Earth Observation program. The SMOS mission proposed by CESBIO has been selected as the 2nd Earth Explorer Opportunity Mission. The SMOS satellite was launched the November 2, 2009.

The objective of the SMOS mission is to provide Soil Moisture (SM) and Ocean Salinity (OS) maps. Both SM and OS are key variables in climate monitoring, surface / vegetation / atmosphere transfers, and ocean / atmosphere cycles.

The SMOS Satellite Control Centre will be adapted by CNES from generic PROTEUS ground segment and installed in Toulouse within the CNES premises. A SMOS Mission Centre dedicated to level 1 and 2 products, is being developed and located in the ESA / Villafraanca centre. A specific Data Processing Centre dedicated to level 3 and 4 products is being developed by CNES (CATDS).

Soil Moisture and Ocean Salinity

More informations on the mission : [SMOS website at ESA](#) , [SMOS website at CNES](#)



SMOS CP34 Project

home | contact | sitemap

Login:
 Password:

Lost your password?

This web portal offers the possibility of obtaining level 3 and 4 products from the European Space Agency SMOS water cycle mission, for different ocean salinity and soil moisture research or application studies. It also offers to registered users a data processing and visualisation tools download service.

For getting started, click on Product Search: a sample products list will be display on screen. Try to download some product for testing, view some quicklook and download it. When you are familiarize with the environment, try to register and discover other services such as a documentation repository or a more extensive and complex product search.

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BEC L3-L4 Products Server

<http://tarod.cmima.csic.es>



SMOS-BEC Data distribution and visualization services

CP34 generates salinity maps in different averaging periods and grids. The original data are stored using several types of grids (SEA, 100x100km, ...). The SMOS-BEC converts the CP34 maps to a regular grid with different grid steps: 0.5, 1 and 2 degrees and distributes them in netCDF format through this data distribution and visualization service. Here, we offer interactive maps and data.

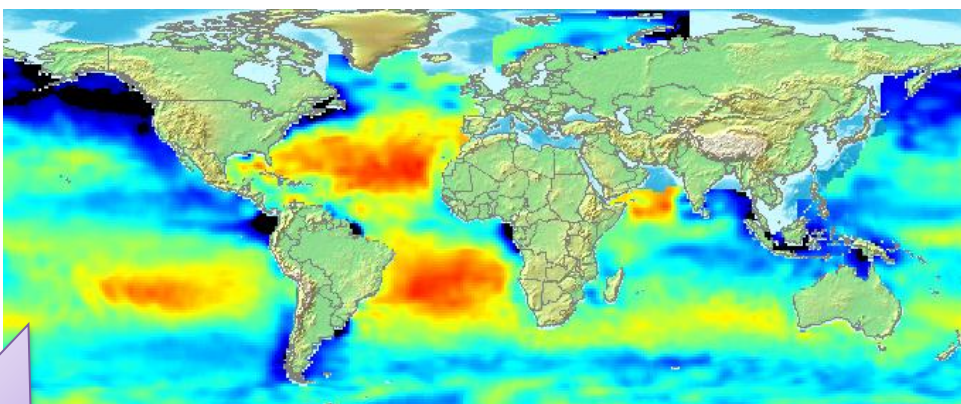
THREDDS service:
We serve netCDF data by means of a thredds server. NetCDF files from which the maps were made (and other additional files) can be downloaded from **THREDDS service**.

If you select a data set, you can consult their own catalogue. The data can be downloaded from each catalogue following the links: CP34ADP, HTTPServer or NetCobrowse. The data files are password protected but you can ask us for your login data at smos-bee@cmima.csic.es.

If you are interested in the CP34 data provided in the original GRID you must register into CP34 web site but you can download our **conversion tools**.

GODIVA2 interface:
To visualize and interact with the maps you can use our **netCDF Web Map Service**, developed by the Geodesic Center of the University of Seville. The viewer is a GODIVA2 (you can see the demonstration page) and it allows the user to create animations, plot time series for a given latitude and longitude, generate transects, save screenshots...

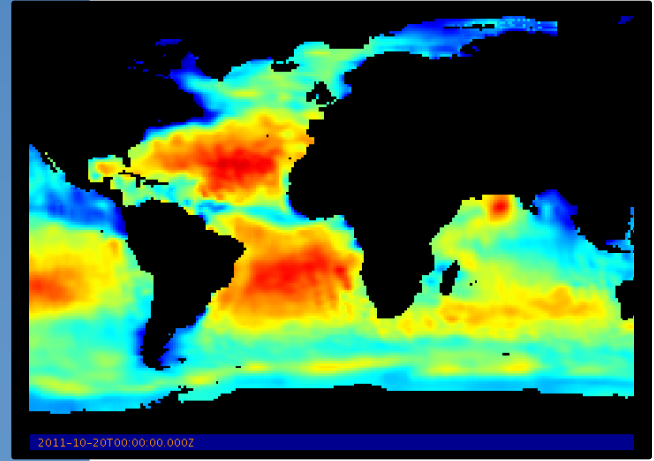
Once the desired map is selected (see left column), then select the variable. Then select the corresponding day from calendar. Available dates depend on the selected data set. No password is needed to see the maps.



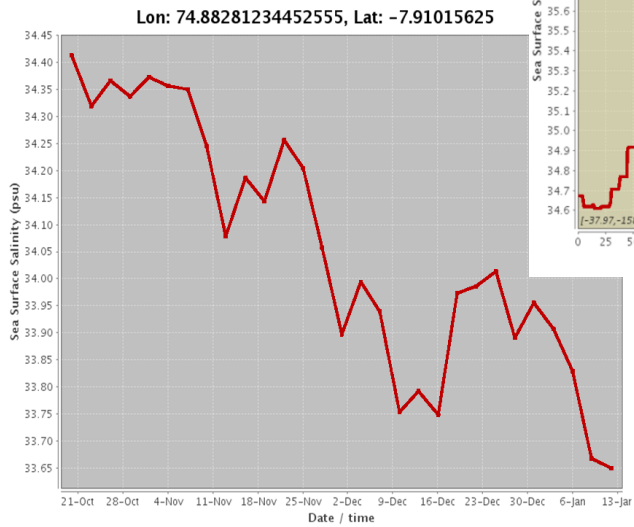
netCDF files

MAP VISUALIZATION TOOLS

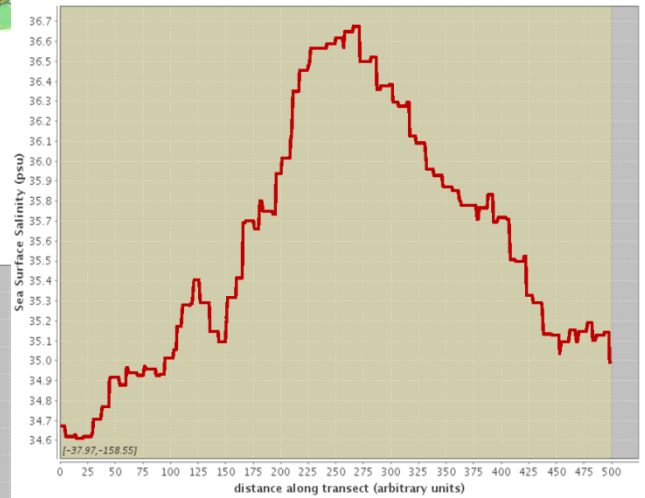
Temporal evolution



Animations



Transect for Sea Surface Salinity

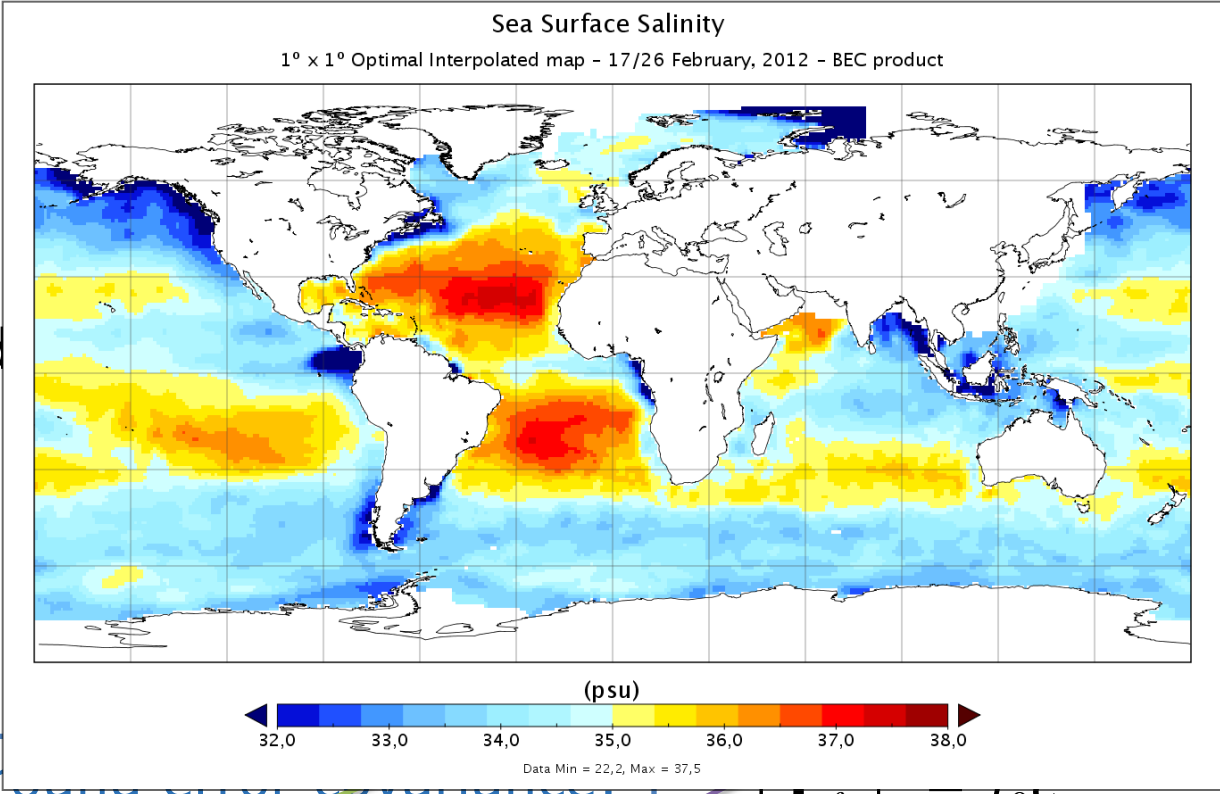


Transects

SMOS BEC L3 products

Objective analysis: Optimal interpolation

- We want to estimate the Sea Surface Salinity (SSS) from the SMOS observations
- From:
 - set of observations
 - and background error covariance



\mathcal{R}^n

$$\Delta y_{ij}^2 - C_{\Delta x_{ij} \Delta y_{ij}}$$

Background error covariance

Observation error covariance

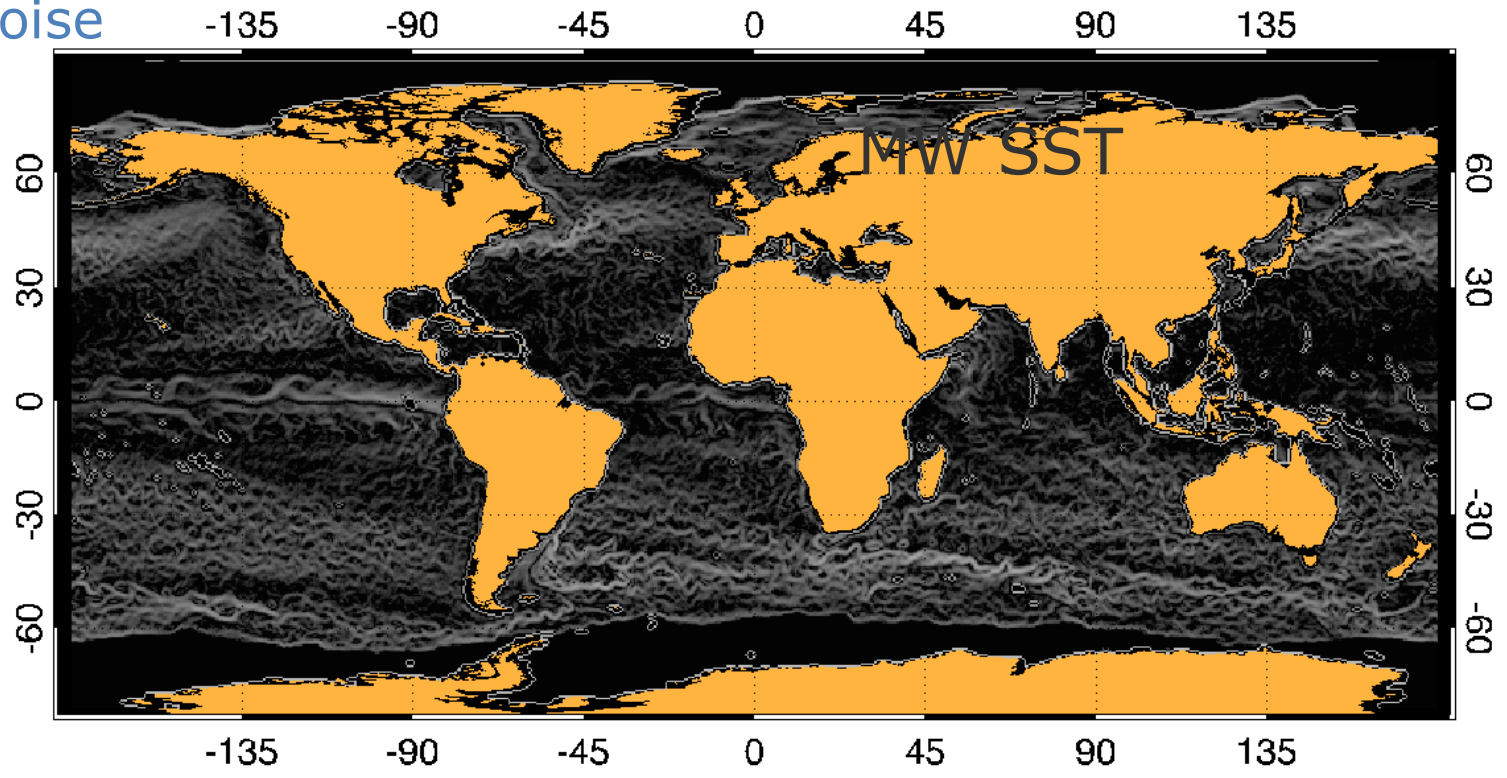
Innovation vector

$$[f]_{ij} J_0^e$$

Correlation parameters

SMOS BEC OS L4 products

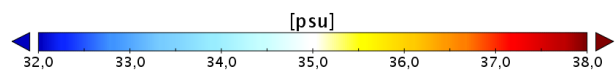
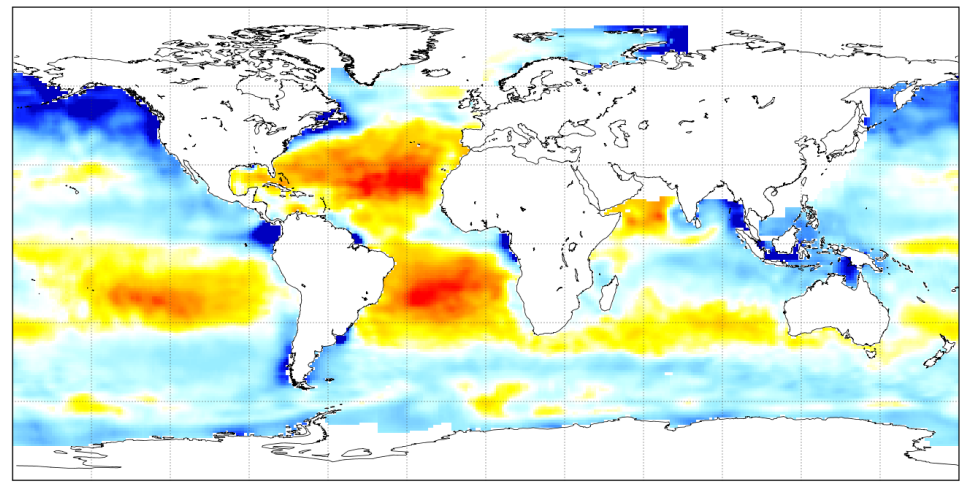
- Hence, singularity exponents are the same for any scalar.
- A new image processing technique allows to calculate singularity exponents with great accuracy.
- The analysis of the output of different numerical simulations confirm that SST and SSS have the same singularity exponents (synergic effect) related to the flow dynamics: they trace streamlines.
- This implies that locally there is a linear relation between SSS and SST \Rightarrow SST can be used as template to remove noise



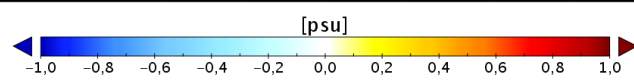
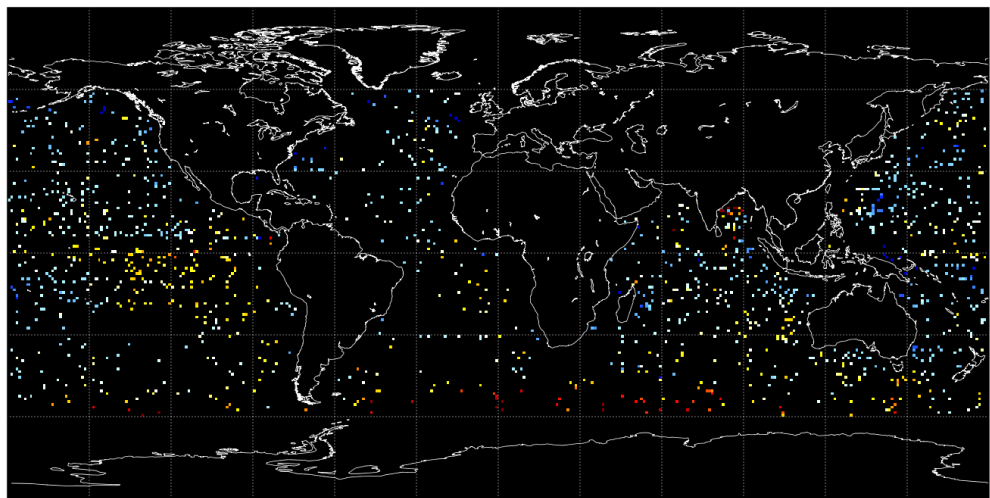
BEC OS products validation: L3

Sea Surface Salinity

1° x 1° Optimal interpolated map - 15/24 January, 2012 - BEC product

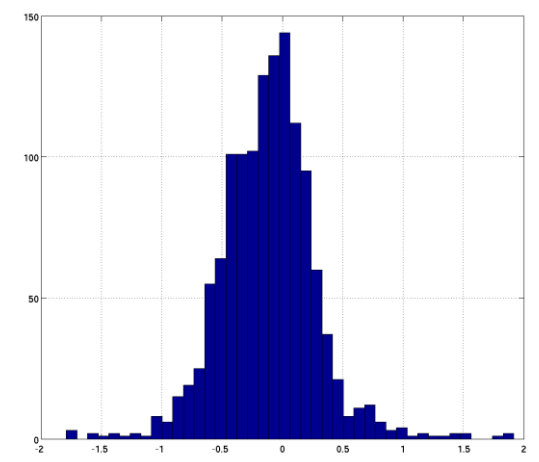


Optimal interpolated SSS - ARGO SSS
15/24 January 2012



Data Min = -1,8, Max = 2,6

- SMOS OS L3 map 1°x1°
- Optimal Interpolation using WOA2009 as background
- 15-24 Jan. 2012
- Argo SSS interpolated at **7.5m** depth

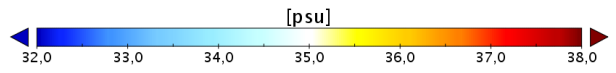
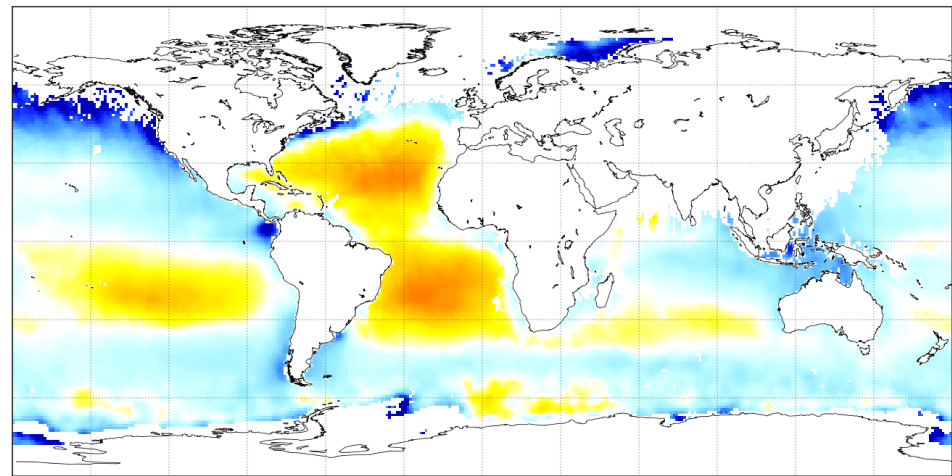


SMOS - Argo
 1299 points
 Bias = -0.11
 RMS = 0.42

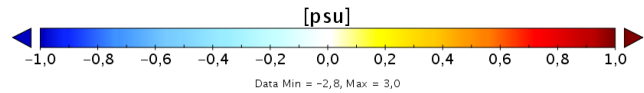
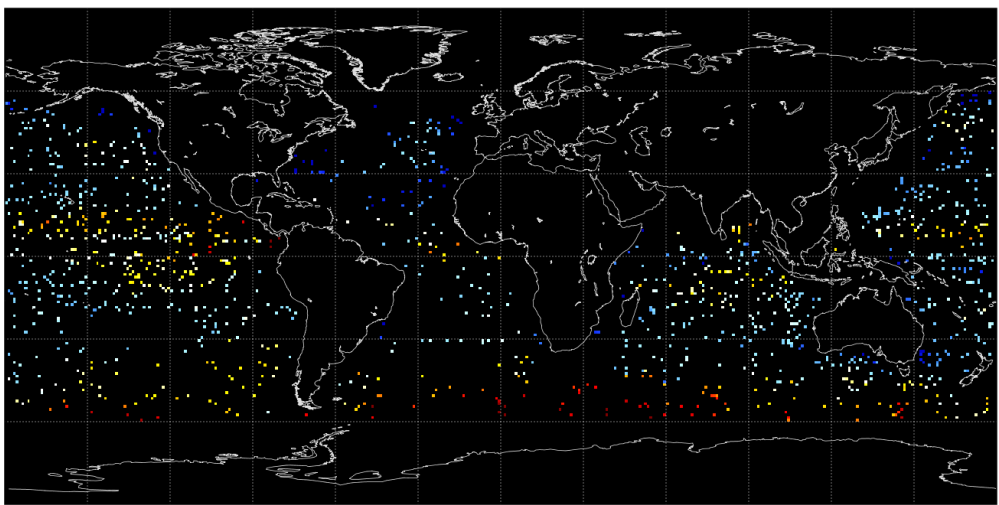
BEC OS products validation: L4

Sea Surface Salinity

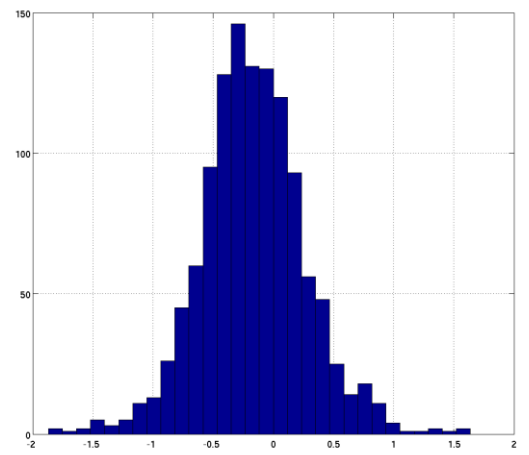
1° x 1° L4 from L2 binned map - 15/24 January, 2012 - BEC product



L4 SSS - ARGO SSS
15/24 January, 2012



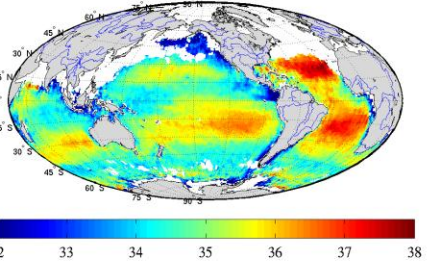
- SMOS OS L4 map 1°x1°
- Generated from L3 binned + SST singularity exponents
- 15-24 Jan. 2012
- Argo SSS interpolated at **7.5m** depth



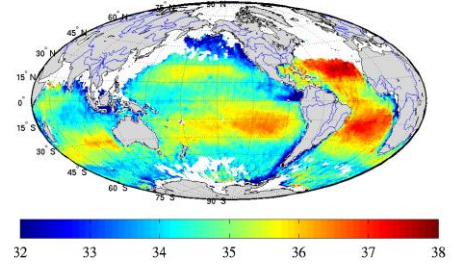
SMOS - Argo
 1202 points
 Bias = -0.17
 RMS = 0.49

Monthly bin averaged SMOS SSS (1°x1°) 2010

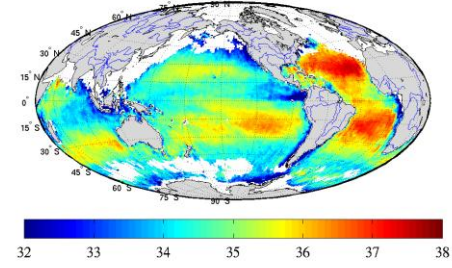
Retrieved SSS SMOS : 2010-01 (1° x 1°)



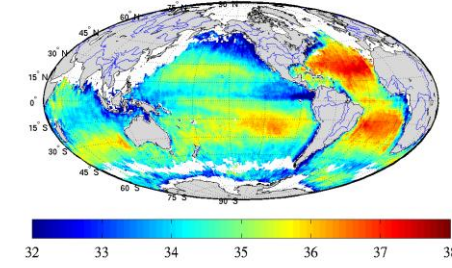
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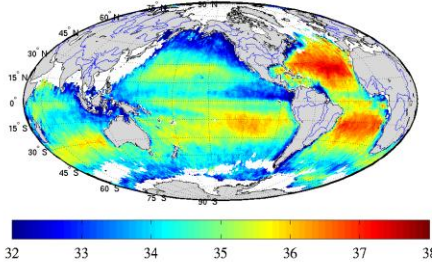
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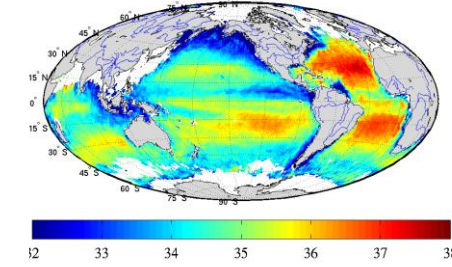
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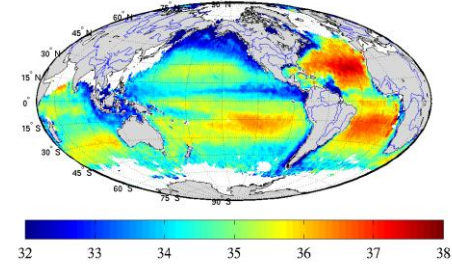
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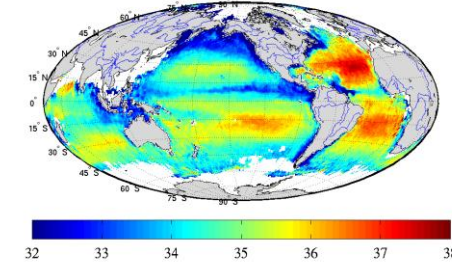
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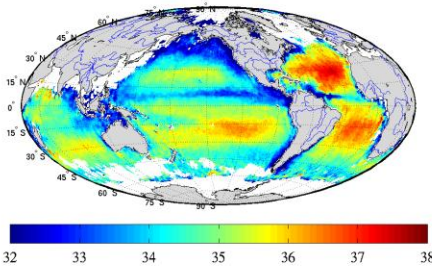
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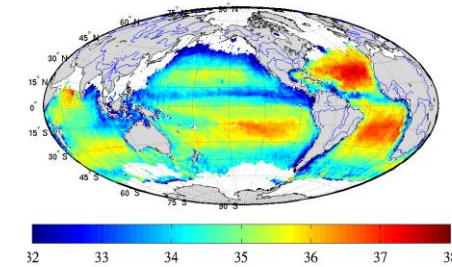
Retrieved SSS SMOS : 2010-08 (1° x 1°)



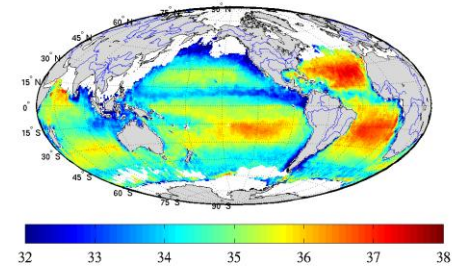
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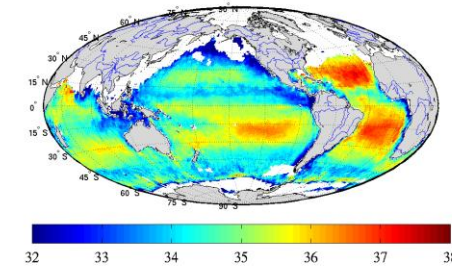
Retrieved SSS SMOS : 2010-10 (1° x 1°)



Retrieved SSS SMOS : 2010-11 (1° x 1°)

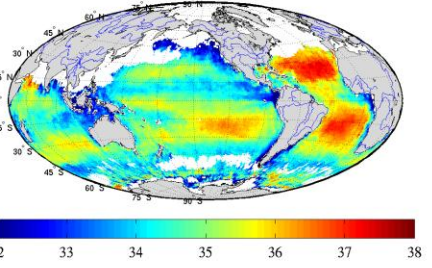


Retrieved SSS SMOS : 2010-12 (1° x 1°)

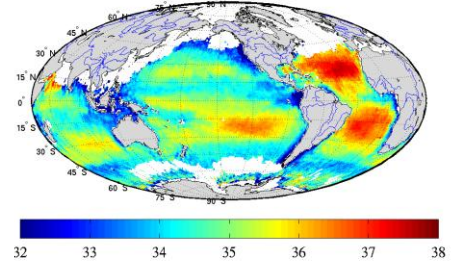


Monthly bin averaged SMOS SSS (1°x1°) 2011

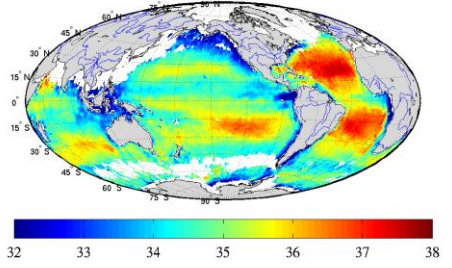
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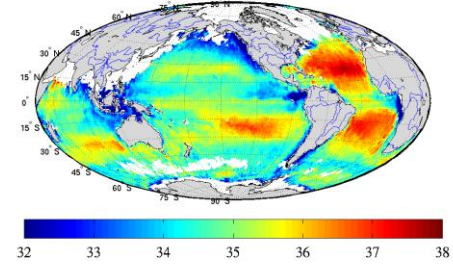
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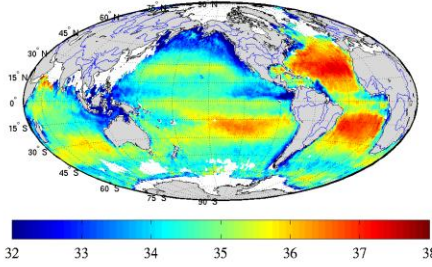
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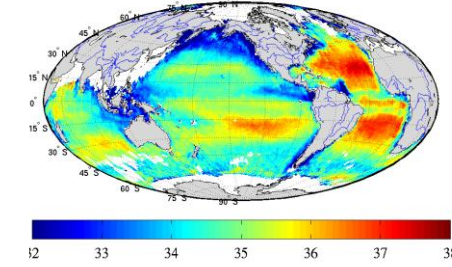
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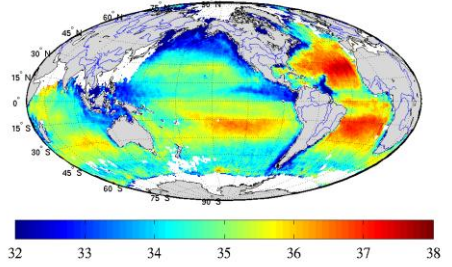
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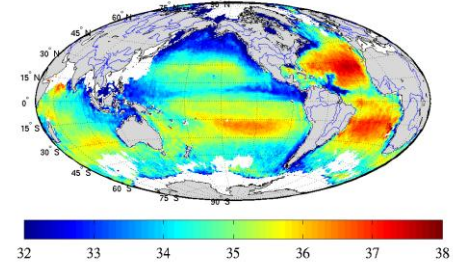
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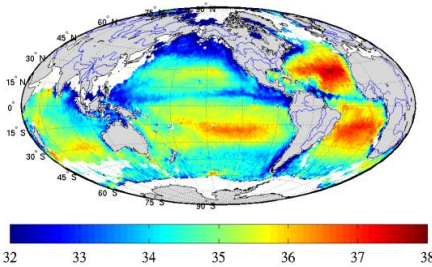
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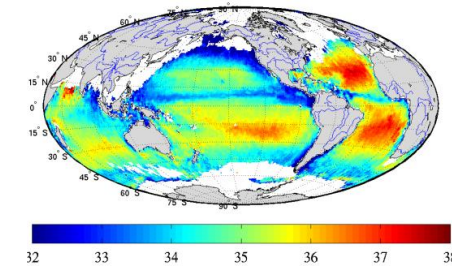
Retrieved SSS SMOS : 2011-08 (1° x 1°)



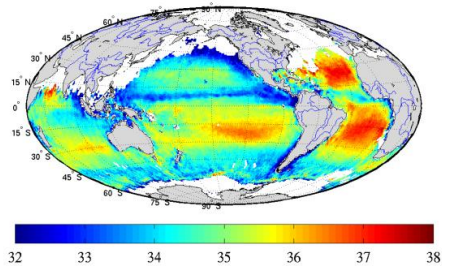
Retrieved SSS SMOS : 2011-09 (1° x 1°)



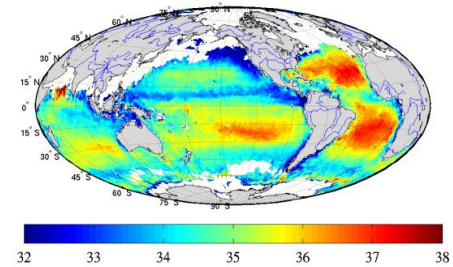
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Retrieved SSS SMOS : 2011-11 (1° x 1°)



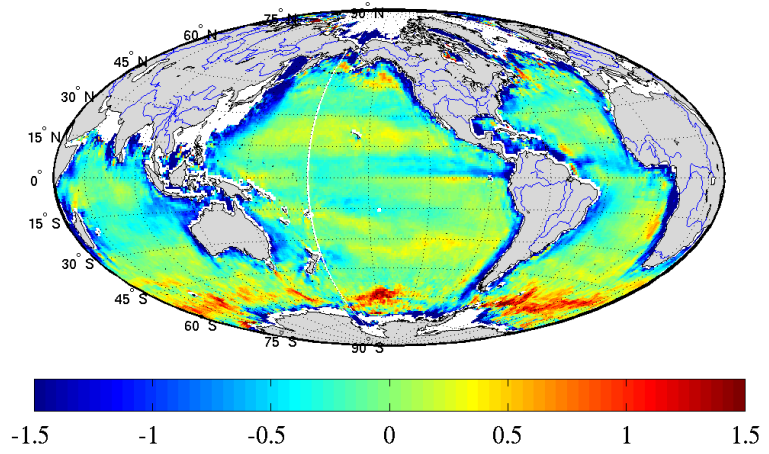
Retrieved SSS SMOS : 2011-12 (1° x 1°)



Yearly SMOS SSS anomalies

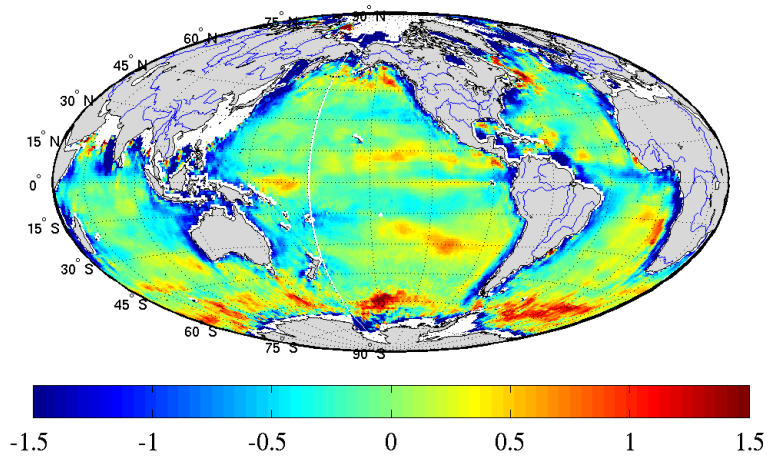
2010

L3 bin-averaged SSS anomaly : 2010 ($1^\circ \times 1^\circ$)



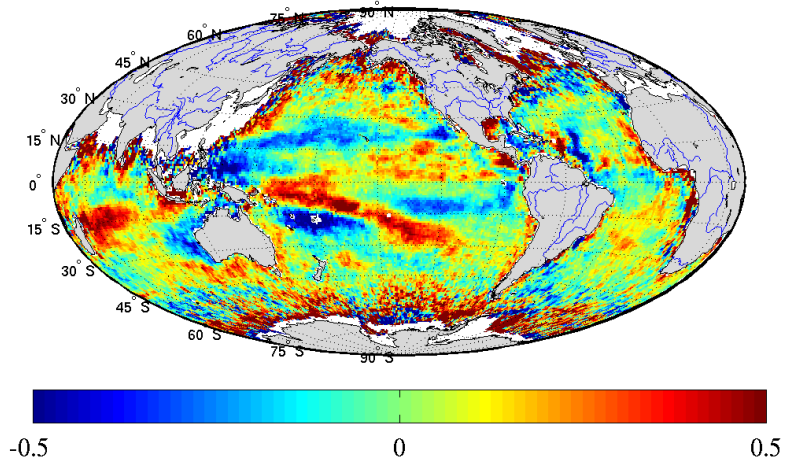
2011

L3 bin-averaged SSS anomaly : 2011 ($1^\circ \times 1^\circ$)



2011-2010

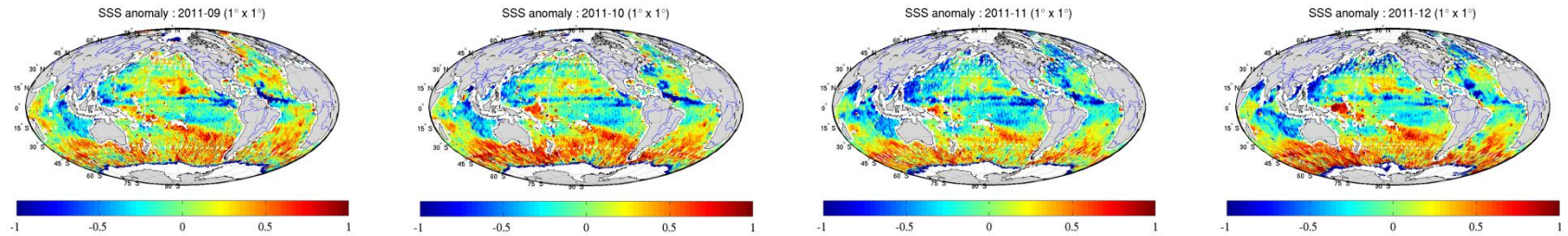
L3 bin-averaged SSS difference : 2011-2010 ($1^\circ \times 1^\circ$)



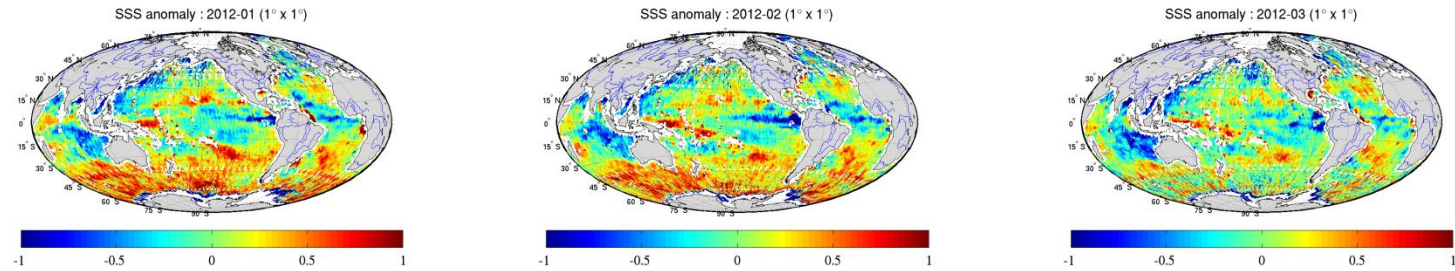
WOA 2009

L3 binned SSS anomaly (Aquarius-WOA09)

2011



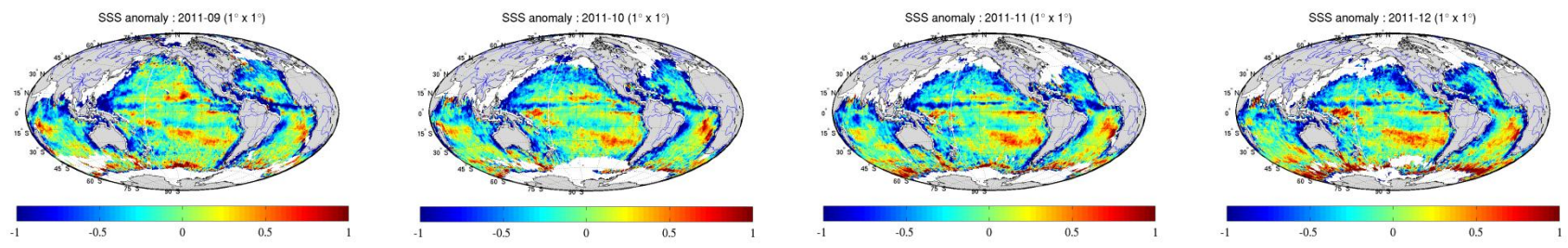
2012



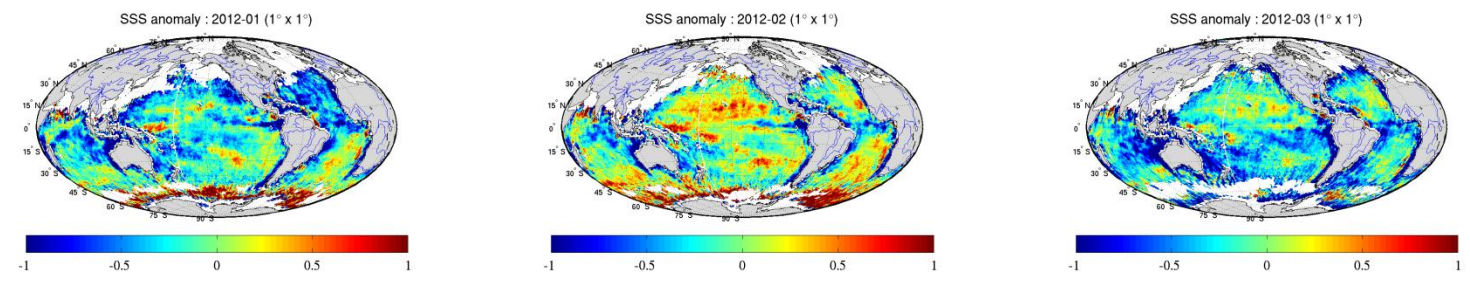
L2 v1.3 Aquarius data bin averaged on a regular grid of 1°x1°
Minus monthly World Ocean Atlas 2009 OI SSS

L3 binned SSS anomaly (SMOS-WOA09)

2011



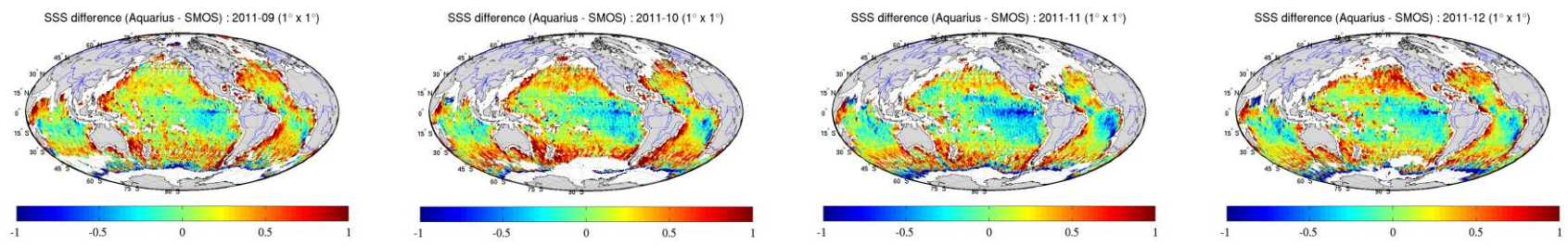
2012



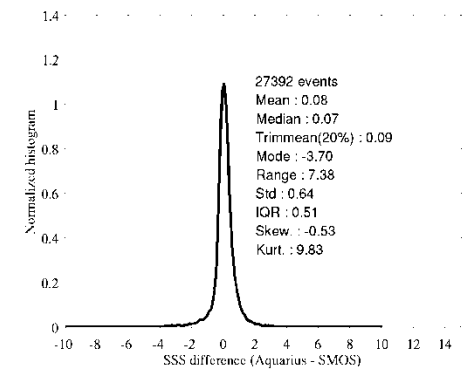
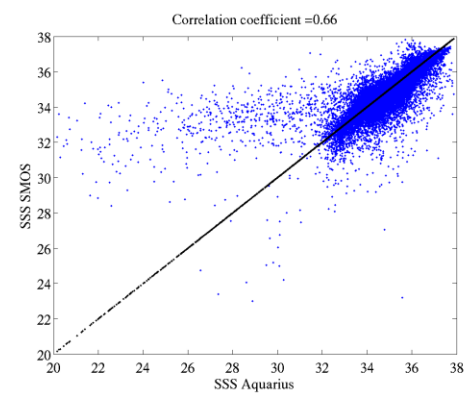
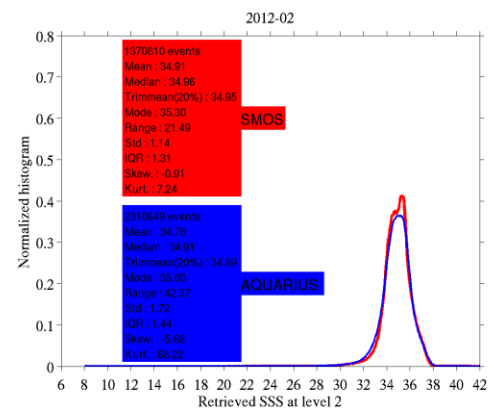
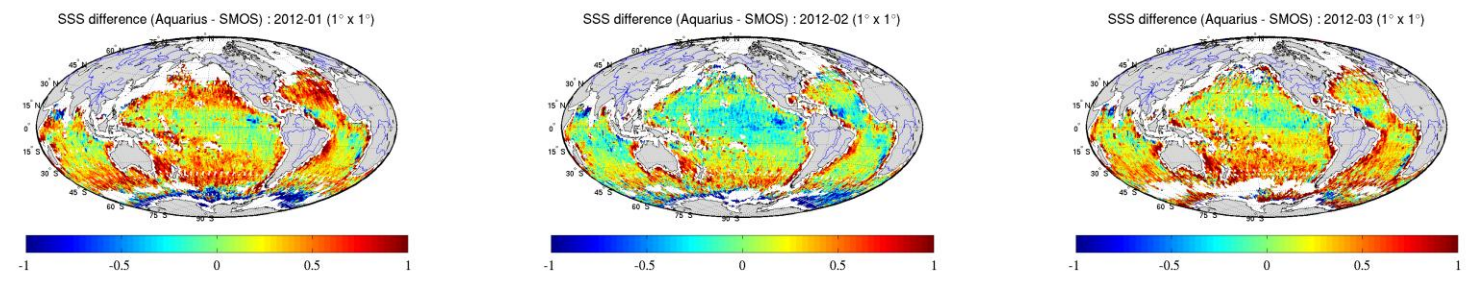
L2 reprocessed SMOS data bin averaged on a regular grid of $1^\circ \times 1^\circ$ minus monthly World Ocean Atlas 2009 OI SSS

L3 binned SSS difference (Aquarius-SMOS)

2011



2012



- Improving land/sea transition impact on L1 signal (Gibbs phenomenon)
- Better residual bias removal techniques under analysis (understanding the problem at L1; mitigating it as L2 pre-processing)
- Galactic noise degrades retrieval in function of region and season. New correction model at L2 tested and ready for operational implementation.
- Sun signal tails on alias-free field-of-view still a problem. Removal techniques under investigation
- RFI degrades/corrupts salinity retrieval in large areas. Switching-off illegal sources and improving mitigation procedures
- **SMOS salinity at L3 now validated within 0.3-0.4 .**

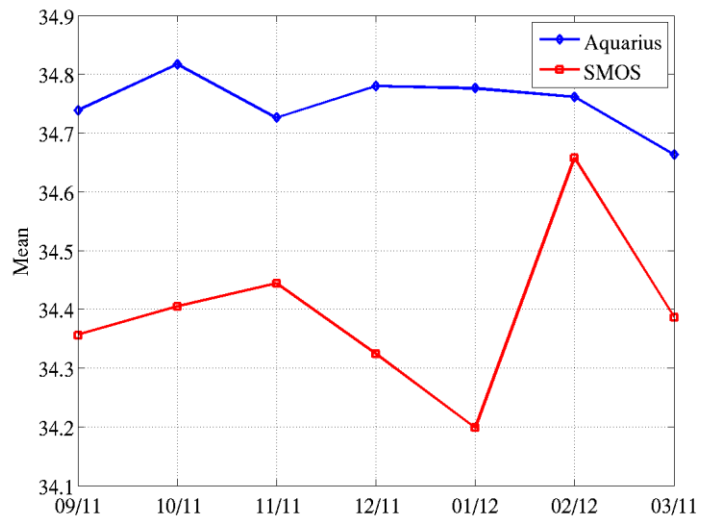
- ESA are provided SMOS Level 2 SSS products
- L3 & L4 are provided by Cp34 & CATDS
- At BEC, new data fusion algorithm for Level 4 products based on singularity exponents
- The synergy SMOS /Aquarius can begin

And if you have questions, I am sure you have,
I will try to answer them latter.

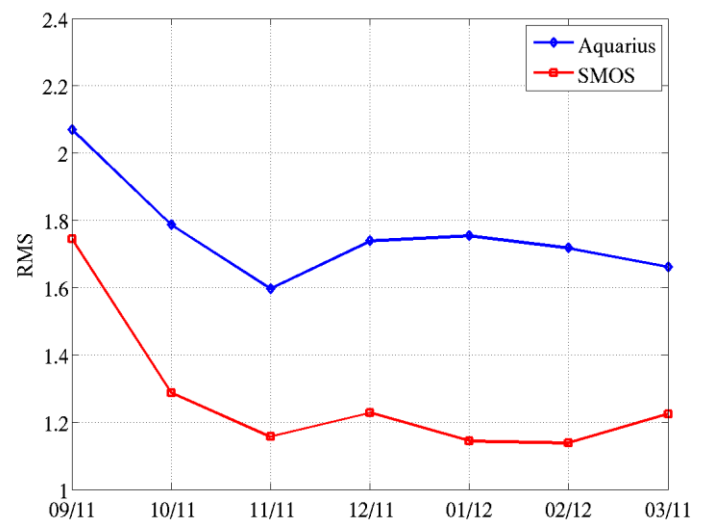
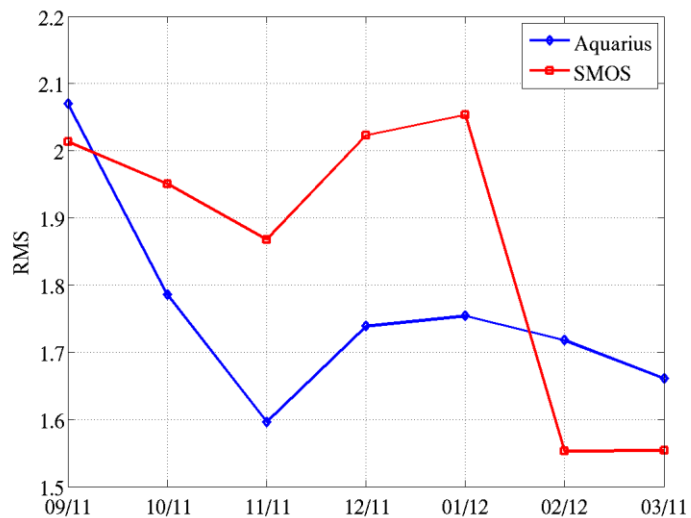
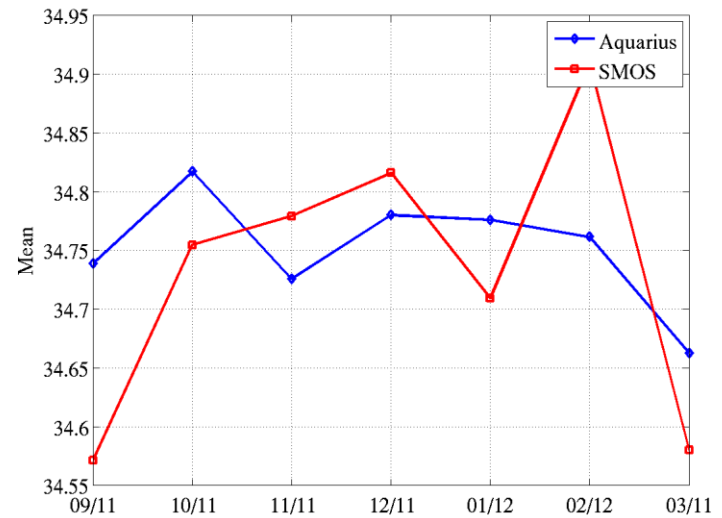
->No more time for question



NO filtering

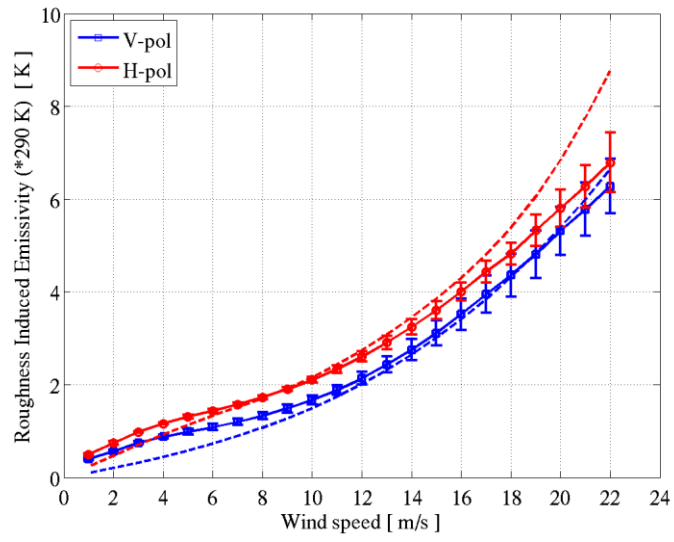


Filtered

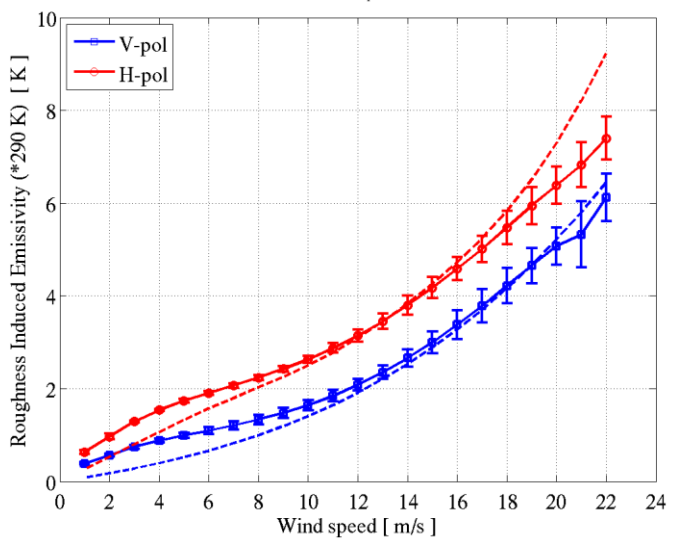


Roughness TB modulation

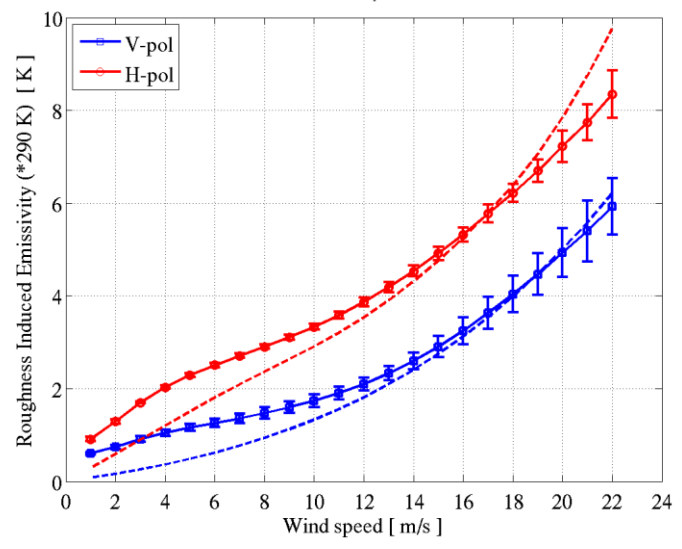
RAD 1 - $\theta_i = 28.8^\circ$



RAD 2 - $\theta_i = 37.9^\circ$



RAD 3 - $\theta_i = 45.6^\circ$

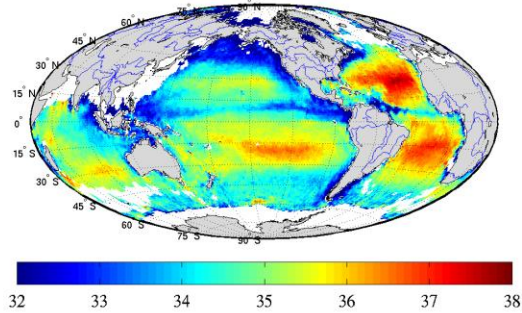


Sept-2011

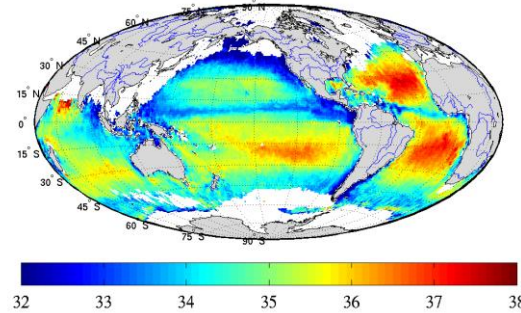
Oct-2011

Nov-2011

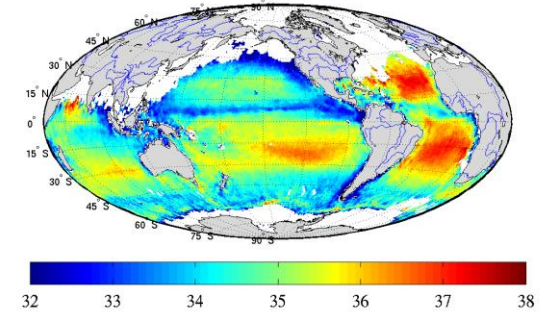
Retrieved SSS SMOS : 2011-09 ($1^\circ \times 1^\circ$)



Retrieved SSS SMOS : 2011-10 ($1^\circ \times 1^\circ$)



Retrieved SSS SMOS : 2011-11 ($1^\circ \times 1^\circ$)

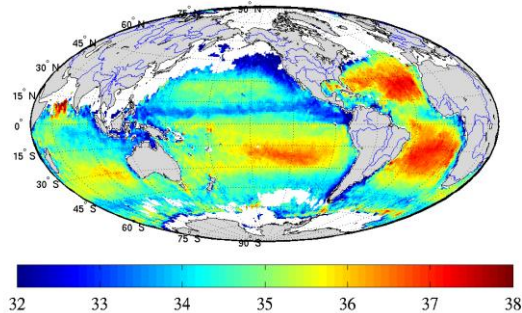


Dec-2011

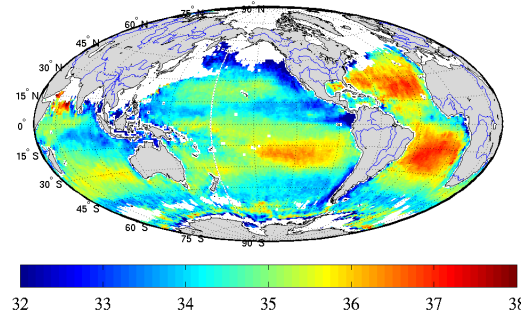
Jan-2012

Feb-2012

Retrieved SSS SMOS : 2011-12 ($1^\circ \times 1^\circ$)



Monthly averaged SSS (SMOS) : 01-2012 ($1^\circ \times 1^\circ$)



Monthly averaged SSS (SMOS) : 02-2012 ($1^\circ \times 1^\circ$)

