Processes analysis with DINEOF of SMOS SSS in North Atlantic Ocean and Mediterranean Sea

Gaëlle Parard, Aida Alvera-Azcárate, Alexander Barth, Jean-Marie Beckers
gaelle.parard@ulg.ac.be, a.alvera@ulg.ac.be, a.barth@ulg.ac.be, JM.Beckers@ulg.ac.be

POSTER N° PO34B-3049

Introduction

Sea Surface Salinity (SSS) is measured by the Soil Moisture and Ocean Salinity (SMOS) satellite mission since 2010, allowing to obtain an unprecedented spatial and temporal coverage. We use DINEOF (Data Interpolating Empirical Orthogonal Functions) to remove noise and errors from the SMOS SSS data in North Atlantic and Mediterranean Sea. The aim of this work is to reconstruct and analyse the SMOS SSS data. After that the noise and errors are detected and removed with DINEOF at the highest temporal and spatial resolution. We used several parameters (see below) to have more information to reconstruct a better product of SSS.

Materials and Methods

DINEOF [1,2]: Calculate daily SSS fields with low noise and reduced error with an EOF-based reconstruction of the missing data in a geophysical dataset. It uses a truncated EOF basis to infer the missing data.

SMOS :Level 2 Ocean Salinity User Data Product (UDP) version 5.50, (ESA for 2013) target accuracy of ∼0.2 over 100 km^2 30 days [3]. SSS is derived through the relation between brightness temperature (BT) and sea surface temperature (SST).

AQUARIUS (daily, 1°): L3 mapped salinity products are used version V4.

SST (daily, 0.25 °) [4]: Daily High-resolution Blended Analyses from Advanced very-high-resolution radiometer (AVHRR).

Chlorophyll MODIS (daily, 4 km): (or Moderate Resolution Imaging Spectroradiometer) Aqua satellites.

Precipitation (daily, 0.25 °): Tropical Rainfall Measuring Mission (TRMM), a joint mission of NASA and the Japan Aerospace Exploration Agency, was launched in 1997 to study rainfall for weather and climate research.

Reconstruction of SMOS SSS

The SMOS SSS data were reconstruct with DINEOF method and give us a product with a spatial resolution of 0.15° and at daily scale. DINEOF fill the gap in the Level 2 of SMOS data set. We used two types of reconstructions:

- SSS is reconstructed with just one parameter SSS from SMOS.
- SSS is reconstructed with several parameters : SSS from SMOS and AQUARIUS, SST, chlorophyll and precipitation (Figure 1).

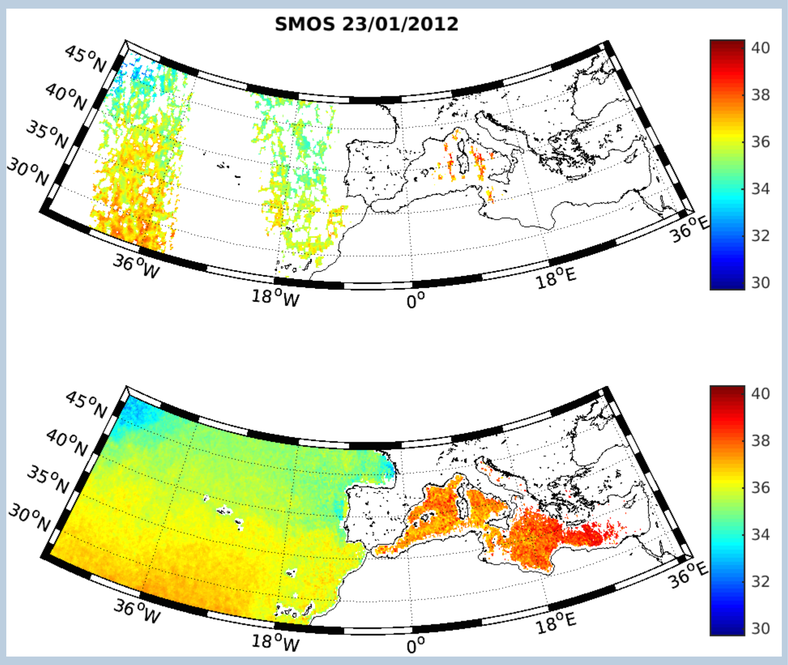

Figure 1: Example of SSS before (top) and after (bottom) reconstruction with DINEOF for the 23/01/2012.

Comparison salinity reconstruction

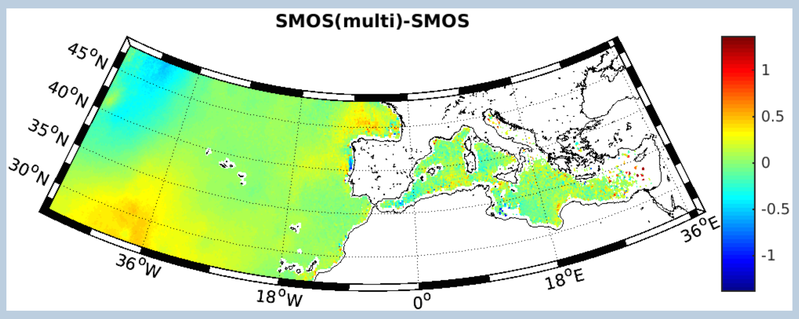

Figure 2: Difference with SSS after reconstruction with DINEOF with SSS from SMOS only and with SSS from SMOS and AQUARIUS plus SST, chlorophyll and precipitation.

- Error are removed and reduced from the SSS SMOS measurement with DINEOF method.
- Estimation of the SSS in the basin: SSS pattern well represented.
- SSS range between 32 and 38. High SSS in the South, low SSS in the North West and Low salinity near the river: Douro and Garonne.
- Difference between -1.4 and 1.4 with the two reconstruction from SMOS alone and SMOS multivariate.
- Higher difference observed along the coast and west of the basin.

Comparison with in-situ data

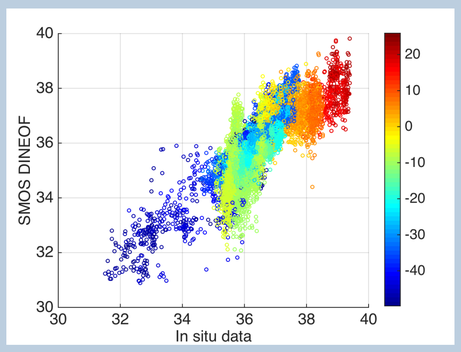

Figure 3: Comparison of in situ data and SMOS multivariate. The colorbar represent the longitude.

The comparison with in situ data gives a similar result with SMOS multivariate or alone in DINEOF (Table 1).

Data	SMOS		SMOS (M)	
Values	TSG	ARGO	TSG	ARGO
R	0.8	0.8	0.8	0.8
STD	0.9	0.6	0.6	0.5
BIAS	0.5	0.3	0.5	0.4
RMSE	0.8	0.7	0.8	0.7

Table 1: Comparison with the in-situ data with SMOS multivariate (SMOS(M)) and SMOS alone (SMOS)

The higher differences are observed near the coast and in Mediterranean where the difference can be higher than 2 in SSS (Figure 4).

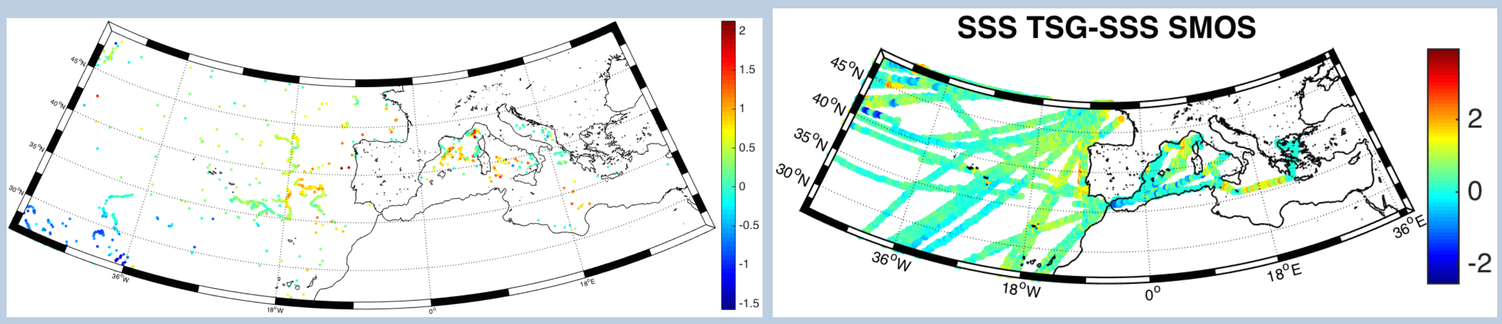

Figure 4: Comparison of SMOS multivariate with in-situ data. Moorings (left) and TSG (right).

In details some differences are observed between the two products. The value of SSS SMOS multivariate compared to the TSG are closer than SMOS alone (Figure 5 left). Differences are also higher along the coast, in the Mediterranean Sea and in North-East Atlantic Ocean.

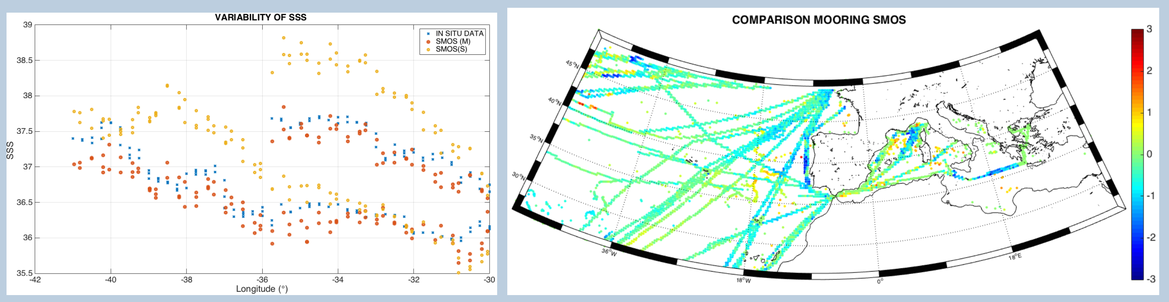

Figure 5: Evolution of SSS as a function of the longitude for TSG (blue), SMOS multivariate (red) and SMOS alone (orange) (left) and difference between SMOS alone and SMOS multivariate where we observed the in situ data (right).

Conclusion

- DINEOF allows to reconstruct at high spatial resolution (0.15 ◦) and a daily temporal resolution and give a full data set for SSS from 2012 and 2013.
- The reconstruction does not show higher difference in Mediterranean Sea than in Atlantic Ocean (Figure 3).
- The version of the reconstruction of SMOS multivariate (SST, chlorophyll , precipitation and SSS) seems better with local comparison (Figure 5 left).
- In the future, it will be great to remove the bias from the level 2 data , in order to reduce the Bias observed on our reconstruction and also apply neural network in the processes of DINEOF to enhance the effect of other variables on the SSS reconstruction.

References

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Acknowledgements: This work is funded by the European Space Agency 'Support to Science (STSE) PATHFINDERS' call. In situ data providers, Coriolis Data Centre (http://www.coriolis.eu.org) and World Ocean Database (http://www.nodc.noaa.gov/) are also acknowledged. Thank to Stephane Marchand from LOCEAN to sort and furnish TSG data from http://sss.sedoo.fr, http://www.legos.obs-mip.fr, http://www.gosud.org. Chlorophyll-a concentration were obtained through http://oceancolor.gsfc.nasa.gov/. SST were obtained on ftp//eclipse.ncdc.noaa.gov. SSS from AQUARIUS (http://podaac.jpl.nasa.gov/dataaccess).