# Analysis of SMOS salinity data in the North Atlantic ocean using DINEOF: detection of outliers and comparison with in situ data.

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http://tinyurl.com/dineof-smos







# **Objectives**

- Improve the quality of the L2 SSS SMOS data in order to compute L4 data
- Retain the highest temporal and spatial resolution
- Demonstrate the use of DINEOF with SSS data
- Demonstrate the added value of the remote-sensed dataset with respect to the pre-satellite SSS data
- Analyse SSS variability in North Atlantic Ocean

## **DINEOF** – Data Interpolating Empirical Orthogonal Functions

- Technique to fill in missing data in geophysical data sets
- Truncated EOF basis to calculate missing data (iterative method)
- Optimal number of EOFs?: reconstruction error by cross-validation
- Uses EOF basis to infer missing data: non-parametric in its basic form
- No need of a priori information (correlation length, covariance function...)
- Spatio-temporal coherence exploited to calculate missing values
- EOFs extract main patterns of variability

# Data used

- Level 2 Ocean Salinity User Data Product (UDP) for 2013, ascending orbits
- Sea surface salinity using Roughness Model 1 (SSS\_1)
- Flags used:
  - Fg\_ctrl\_poor\_geophysical (sun glint, galactic glint, wind speed, suspect ice...)
  - Fg\_ctrl\_poor\_retrieval
  - Dg\_quality\_SSS1
- A minimum/maximum range check is also done (pixel-by-pixel, wrt climatology)
- An additional outlier detection is applied (based in DINEOF)
- Initial spatial resolution: ~2.5 km
- Data downgraded (averaged) to  ${\sim}7.5~\text{km}$
- Full swath
- Daily fields



# **Detection of outliers**

- A first DINEOF analysis is performed on the initial data
- Three tests are applied to classify pixels as suspect:
  - Departure from the DINEOF truncated EOF basis
  - Departure from a local median
  - Proximity to clouds, land or missing values
- Weighted sum of these 3 tests
- For this particular configuration:
  - Equal weights (1/3) to the 3 tests
  - Threshold level to classify a pixel as outlier: 2.5

Details in Alvera-Azcárate et al, 2012 (Remote Sensing of Environment)

## **Example of outlier detection, 7 February 2015**



#### **Outlier detection: threshold**

36°W

 $18^{\circ}W$ 

0<sup>0</sup>

18°E

36°E



### **DINEOF reconstruction**

- $\rightarrow$  5 EOFs are retained
- $\rightarrow$  67% of initial variance
- $\rightarrow$  Cross-validation error: 0.78



DINEOF SSS, 07-Feb-2013 DINEOF SSS, 24-Oct-2013 40 45<sup>0</sup>N 45<sup>0</sup>N 40<sup>0</sup>N 40<sup>0</sup>N 35 35<sup>0</sup>N 35<sup>0</sup>N 30<sup>0</sup>N 30<sup>0</sup>N 30 36<sup>o</sup>W  $18^{\circ}W$ 0<sup>0</sup> 18<sup>0</sup>E 36<sup>o</sup>E  $18^{\circ}W$ 00 36<sup>0</sup>E 36°W 18<sup>0</sup>E

#### **Comparison with in situ and Aquarius SSS**

In situ data obtained from WOD and Coriolis for 2013

Comparison to **daily data** at ~7.5km



In situ	RMS	Bias	Correlation	# of data
Initial SMOS data	0.79	-0.34	0.49	50
DINEOF where SMOS initially present	0.60	-0.07	0.63	50
DINEOF	0.68	-0.21	0.74	1592

Aquarius	RMS	Bias	Correlation
Initial SMOS data	0.85	-0.37	0.73
DINEOF	0.63	-0.38	0.86
Med. Sea initial SMOS data	1.2	0.19	0.12
Med. Sea DINEOF	0.87	0.18	0.25

#### **EOF** basis used in **DINEOF**

Average SSS field removed before DINEOF (from monthly SSS in situ fields)



5

0

-5

-10



#### **EOF** basis used in **DINEOF**





-0.15 Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan

#### **EOF basis NOT used in DINEOF**



#### Erroneous data at the swath extremes removed by DINEOF

#### **Gulf Stream meanders**



Initial SMOS data -48 -47 -49

- Time series of SMOS SSS data at the GS
- DINEOF data provides information about duration and strength of GS meanders



#### Conclusions

DINEOF provides an efficient mean to improve the quality of SMOS SSS data

We work with daily fields at high spatial resolution to improve the data at their source

Comparison with in situ data shows an overall improvement of quality

#### **Future work**

Outlier threshold space dependent (e.g. stricter in Mediterranean Sea)

Use of additional data (Aquarius SSS, precipitation data...)

#### More about **DINEOF**

**Poster Y251:** Use of DINEOF with high frequency geostationary ocean colour data in the southern North Sea.



http://www.eos-cost.eu

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- better understanding of the value and use of ocean syntheses
- promote the use of ocean syntheses

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