

BESST



Inter-sensor Bias Estimation in Sea Surface Temperature

Using DINEOF in operational mode for correcting inter-sensor biases in sea surface temperature

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Overview

- **Sea Surface Temperature**: a key environment variable for:
 - Climate monitoring and detection of trends
 - Boundary conditions – ocean/meteorological models
 - Forecasting, fisheries management, study of mesoscale processes ...
- Different satellite sensors (IR/MW) indirectly measure SST:
 - AATSR, AVHRR, SEVIRI, IASI, AMSR-E, VIIRS, ... SLSTR
- Each sensor has **different characteristics**, **accuracy** and **error sources** → **BIASES**

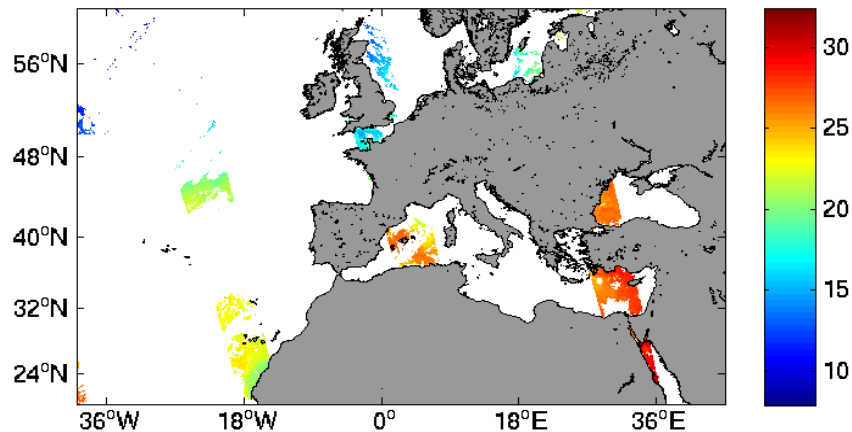
Objectives

- Analyse inter-sensor SST biases
- Use a reference SST sensor (AATSR, Metop-A) to improve SST derived from other sensors (AVHRR/SEVIRI, ...)
- Develop a methodology to derive more accurate SST bias fields based on DINEOF method
- Application in an operational context (Meteo-France)

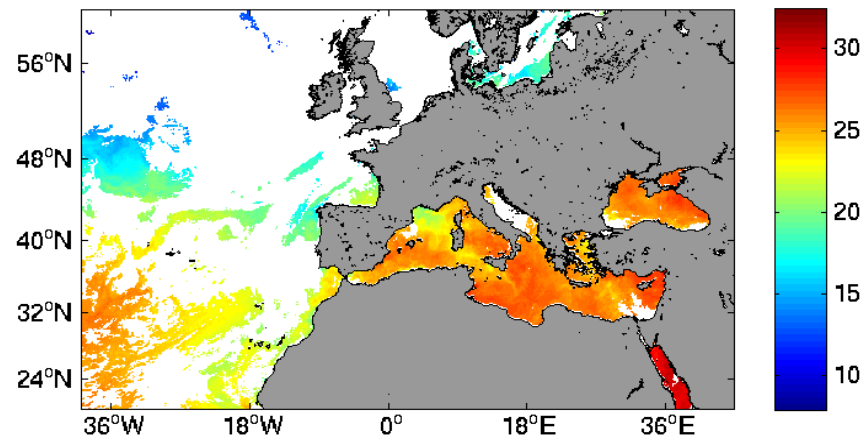
AATSR – SEVIRI difference -> instantaneous fields

SEVIRI: Spinning Enhanced Visible and Infra-Red Imager, geostationary satellite

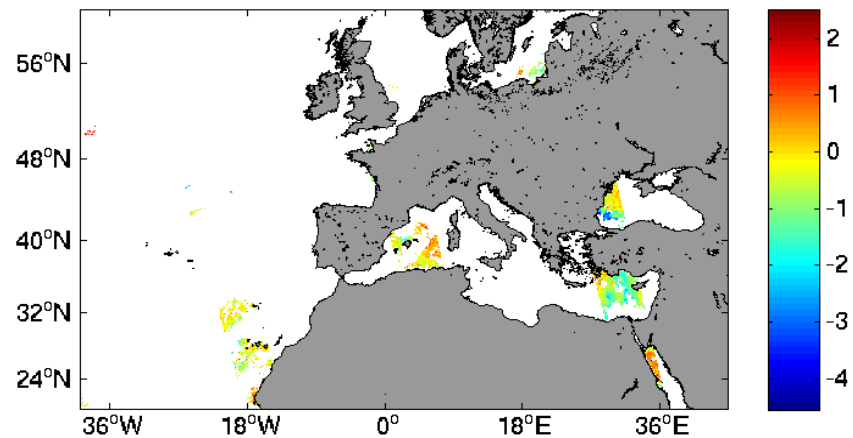
Night time AATSR SST 30 July 2010



Night time (04:00) SEVIRI SST 30 July 2010



Difference field 30 July 2010



Sea Surface Temperature bias correction: state of the art

Correction approach proposed by Meteo-France (Le Borgne et al, 2011):

Difference fields between AATSR and other sensors

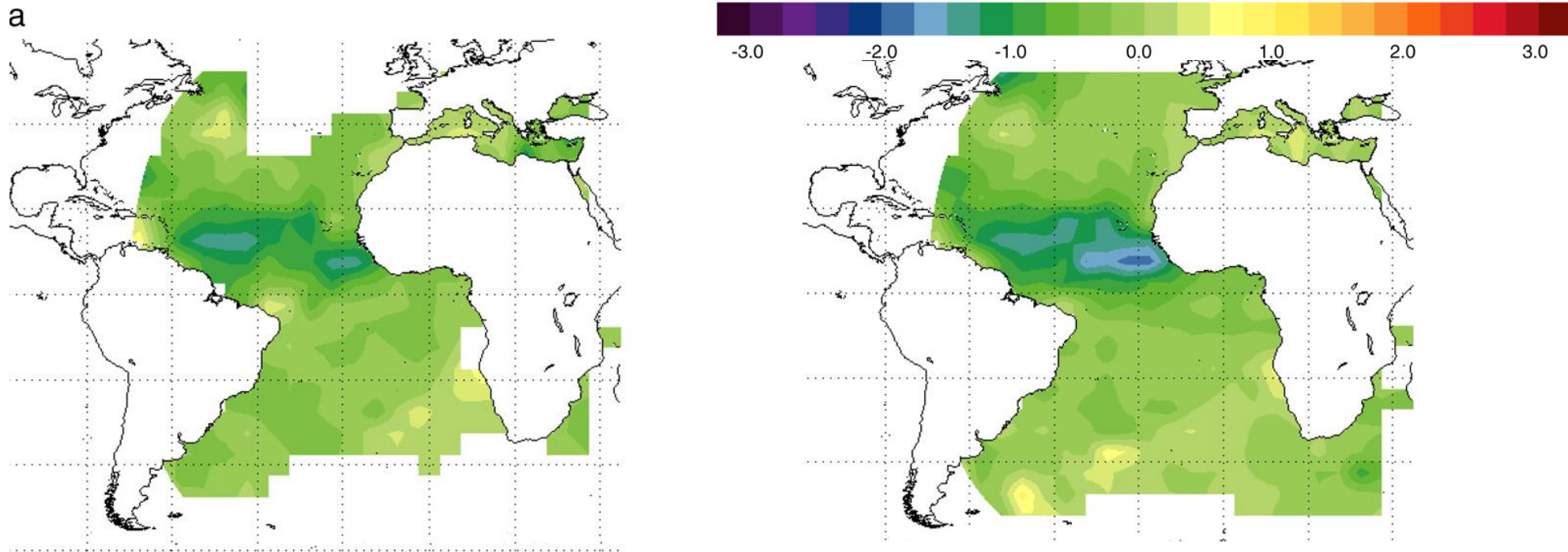
Night-time data at $0.1^\circ \times 0.1^\circ$ spatial resolution

Final correction field **averaged** over 10 days and $5^\circ \times 5^\circ$ to assure coverage and reduce artifacts

Only corrections at **large scales**

Regional-scale basins uncorrected (e.g. North Sea)

Persistent clouds (specially at high latitudes)



Average of the differences between SEVIRI and the AATSR SST calculated in $5^\circ \times 5^\circ$ boxes over 3 days (left) and 10 days (right)

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)

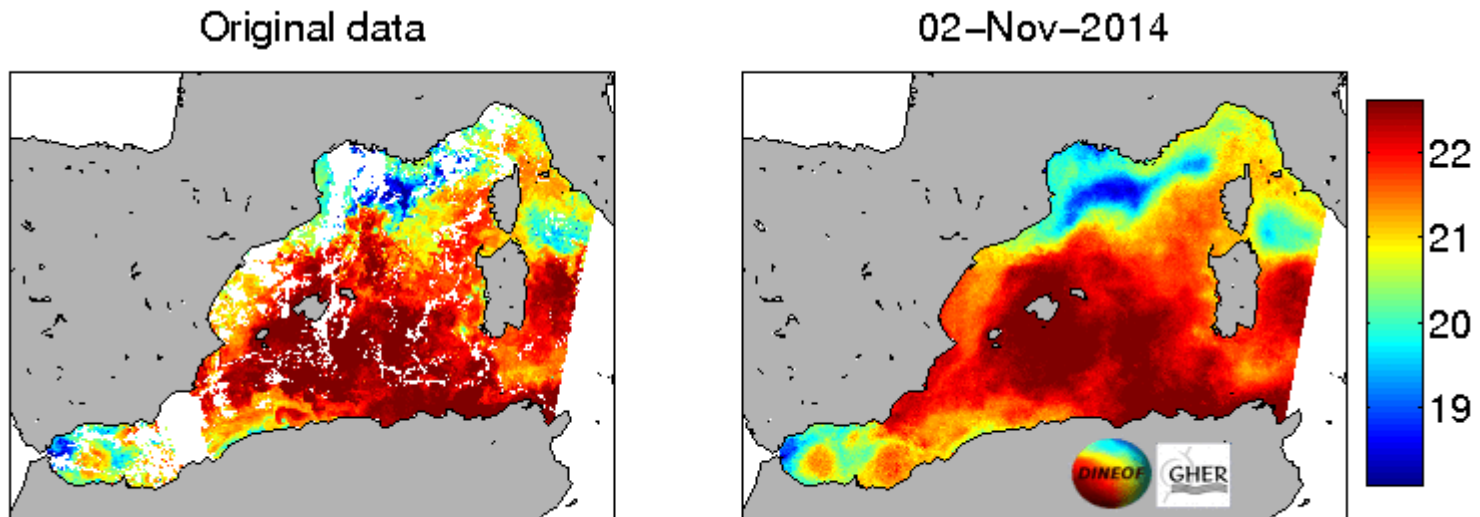
EOFs extract main patterns of variability

Optimal number of EOFs?: reconstruction error by cross-validation

Uses EOF basis to infer missing data: **non-parametric**

No need of a priori information (correlation length, covariance function...)

Spatio-temporal coherence exploited to calculate missing values

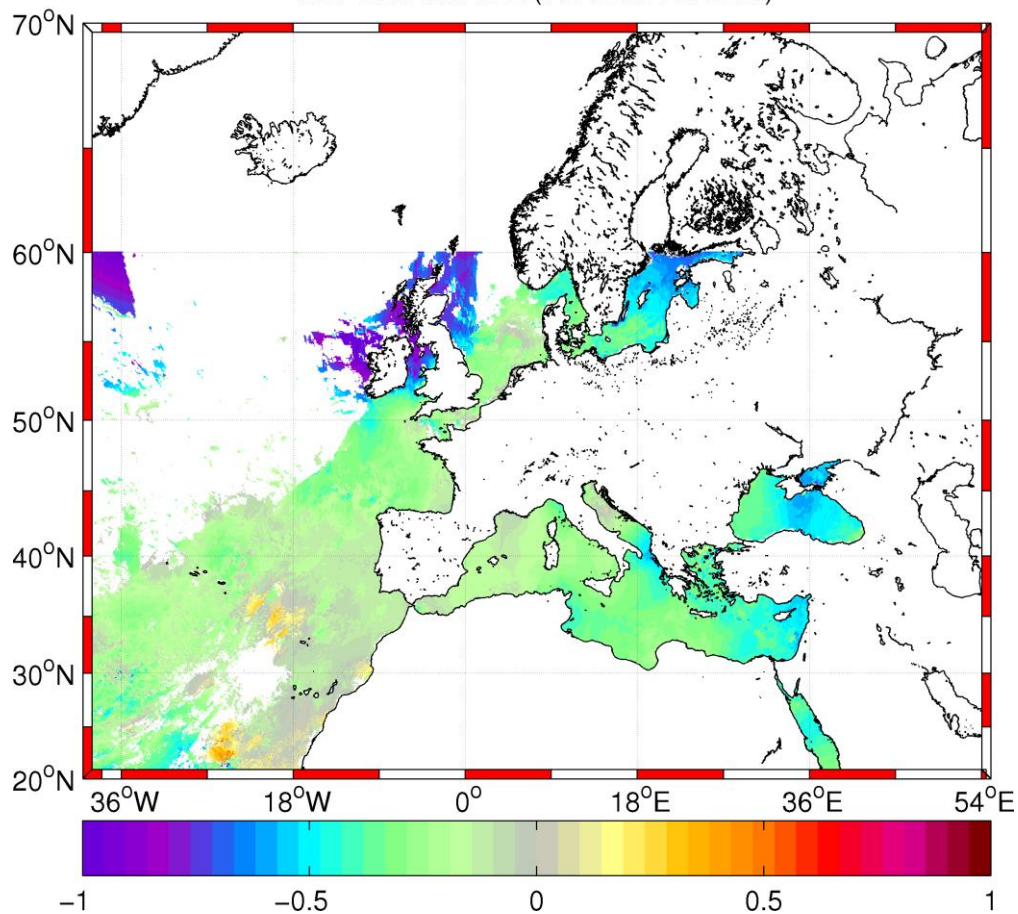


Infrared Sea Surface Temperature over western Mediterranean Sea

SEVIRI (Metop-A) – BIAS field

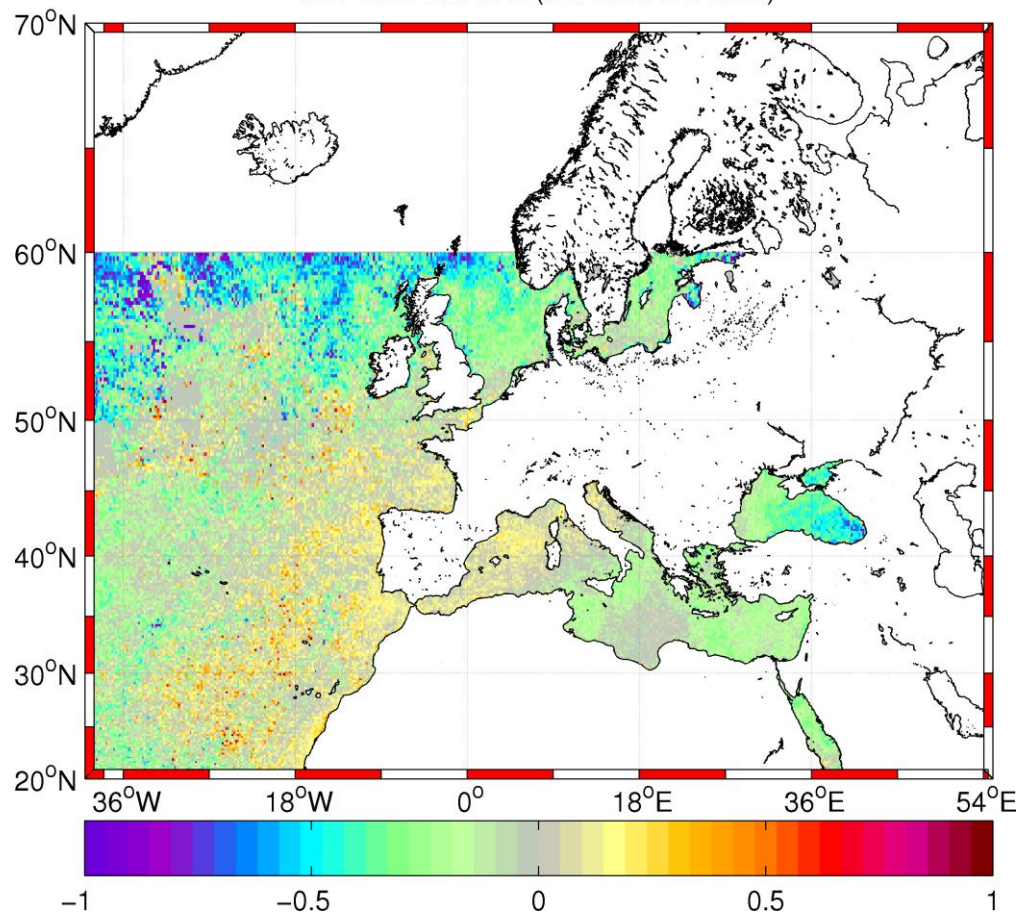
OI (MeteoFrance)

20110620–20110629:bias_svri_cms:bias_svri_cms::NIGHT;med;
:bs:-0.25 std: 0.22 (1979897/1979897)



DINEOF

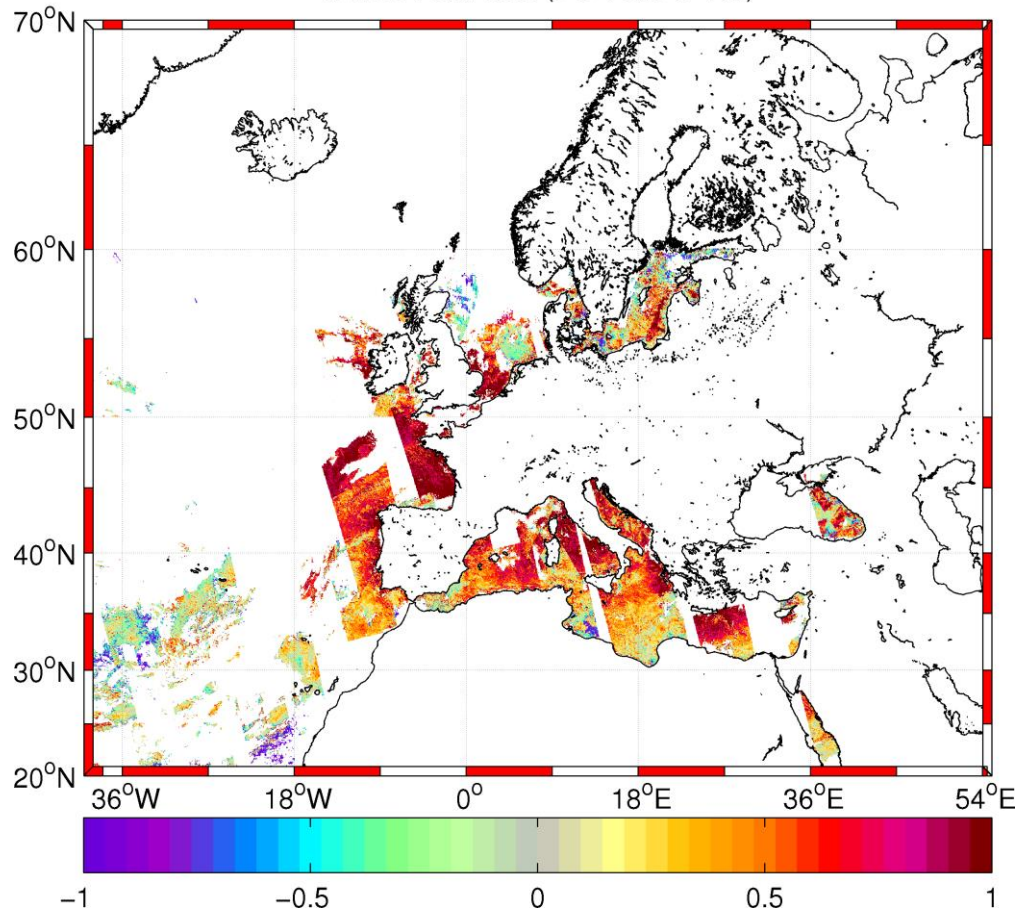
20110620–20110629:bias_svri_besst:bias_svri_besst::NIGHT;med;
:bs:-0.08 std: 0.20 (9214980/9214980)



SEVIRI (Metop-A) vs. AATSR

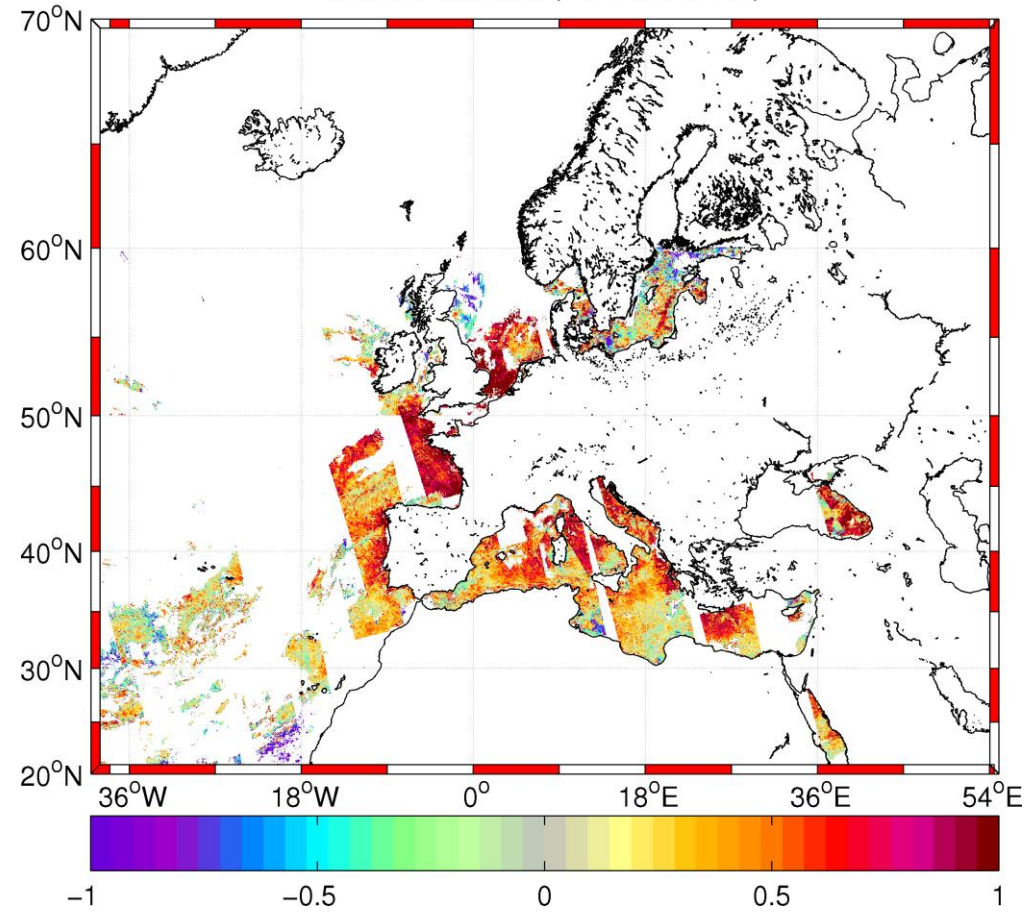
OI (MeteoFrance)

20110620–20110629:svri_aatsr_cms:svri_aatsr_cms::NIGHT;med;
:bs: 0.34 std: 0.55 (217418/217418)



DINEOF

20110620–20110629:svri_aatsr_besst:svri_aatsr_besst::NIGHT;med;
:bs: 0.26 std: 0.53 (217418/217418)

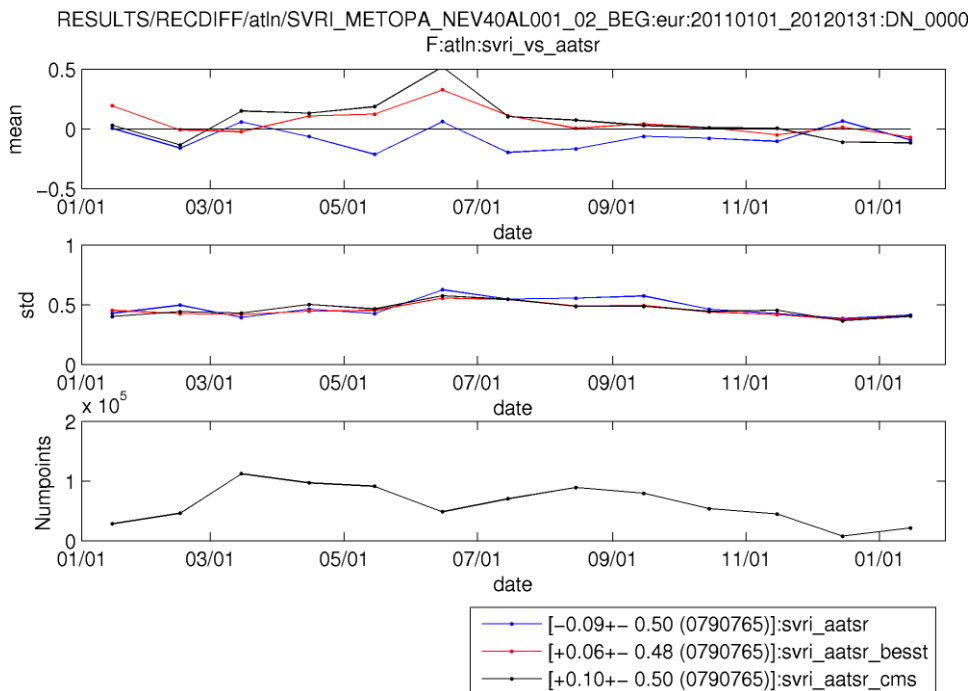


Temporal stability

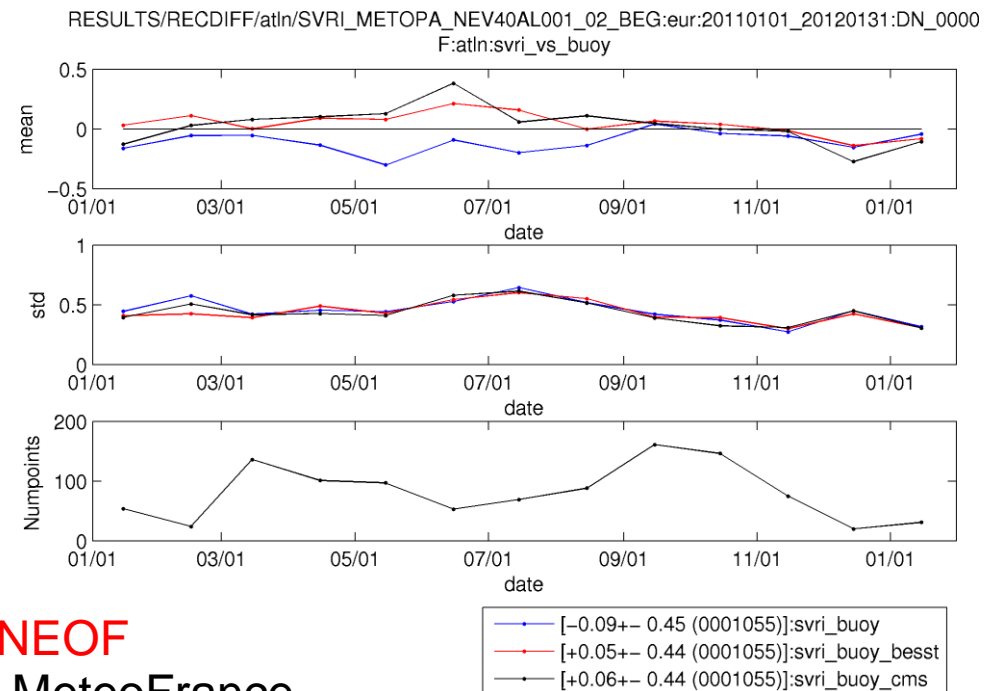
Monthly averaged biases and standard deviation over North Atlantic Ocean for SEVIRI corrected with Metop-A.

Validated against AATSR and in situ data

SEVIRI (MetopA) vs. AATSR




SEVIRI (MetopA) vs. buoy



DINEOF
OI MeteoFrance
No correction

 web DINEOF v3.9.6 Not signed in! [Help](#) [Sign-](#)

Please define all parameters for running DINEOF analysis:

Select dataset:	<input type="text" value="Please select dataset"/>	
Select variable:	<input type="text" value="Please select dataset variable"/>	
Select grid size (degrees):	<input type="text" value="Please select grid size"/>	
Select region:	<input type="text" value="Please select region"/>	
Select filtering:	<input type="text" value="Please select filtering variable"/>	
Define filtered out values between: NaN and NaN		
Min:[>=]	<input type="text"/>	
Max:[<=]	<input type="text"/>	
Define date range between: YYYY-MM-DD and YYYY-MM-DD		
Define starting date/time:	<input type="text"/>	
Define ending date/time:	<input type="text"/>	
Your email address:	<input type="text"/>	
DINEOF processing parameters		
Strength of the filter (alpha)	<input type="text" value="0.01"/>	
Number of iterations of the filter (numit)	<input type="text" value="10"/>	
Maximum number of modes (nev)	<input type="text" value="7"/>	
Maximum number of iterations (nitemax)	<input type="text" value="300"/>	
Min % of clear data from the whole scene (min_clear)	<input type="text" value="3.0"/>	

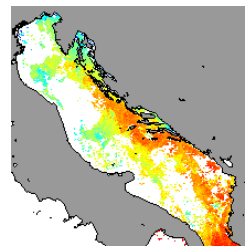
Run DINEOF

Conclusions from BESST

- Biases between Sea Surface Temperature sensors can be reduced when first reconstructing their differences with DINEOF
- Higher spatial and temporal resolution of corrections is obtained
- Operational SST correction in MeteoFrance is improved

And also...

- A web-based version of DINEOF is available (for SST so far)
- Please send your comments, questions to a.alvera@ulg.ac.be



1st: Demeaned matrix: missing data flagged and set to zero
Some data are set aside for cross-validation

2nd: EOF decomposition with **N=1 EOF**

Calculate missing values:

$$X_{i,j} = \sum_{p=1}^k \rho_p (u_p)_i (v_p^T)_j$$

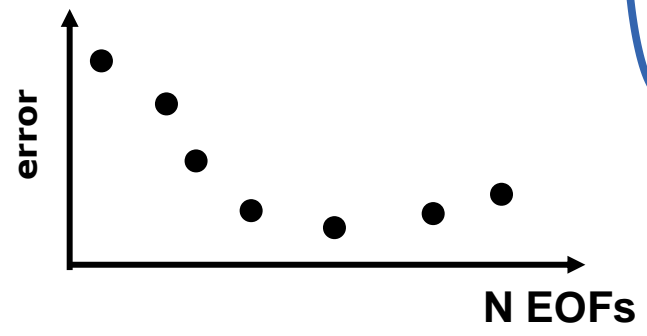
Improved guess for missing values

Convergence } best value for missing data with **1 EOF**
cross validation: error

EOF decomposition with **N = 2 EOFs**

Calculate missing values

Improved guess for missing values



Then we repeat with **N = 3 EOFs**

and so on...