

DINEOF analyses of Sea Surface Temperature data in the Black Sea

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<http://modb.oce.ulg.ac.be/DINEOF>



Objectives

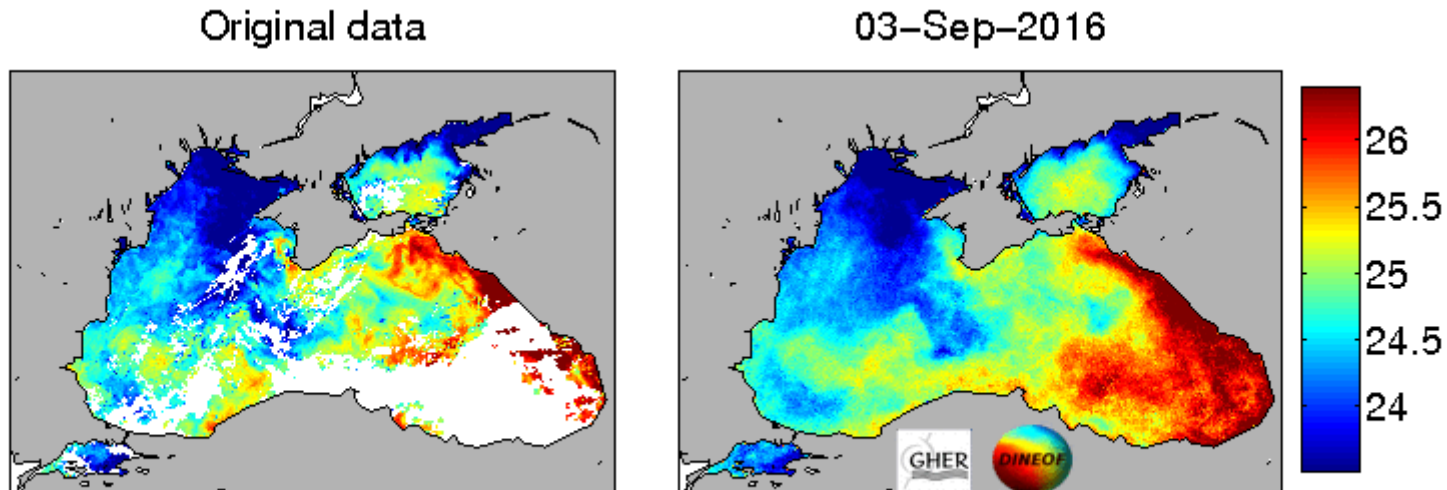
- To demonstrate the use of DINEOF (Data Interpolating Empirical Orthogonal Functions) in the Black Sea
- To develop a near-real time, operational SST product in the Black Sea
- To compare DINEOF to other state of the art L4 SST datasets

Main theoretical aspects of DINEOF

Technique to **fill in missing data** in geophysical data sets, based on a EOF decomposition

- **Truncated EOF basis** to calculate missing data (iterative method)
 - EOFs extract main patterns of variability
 - Reduced noise
- 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

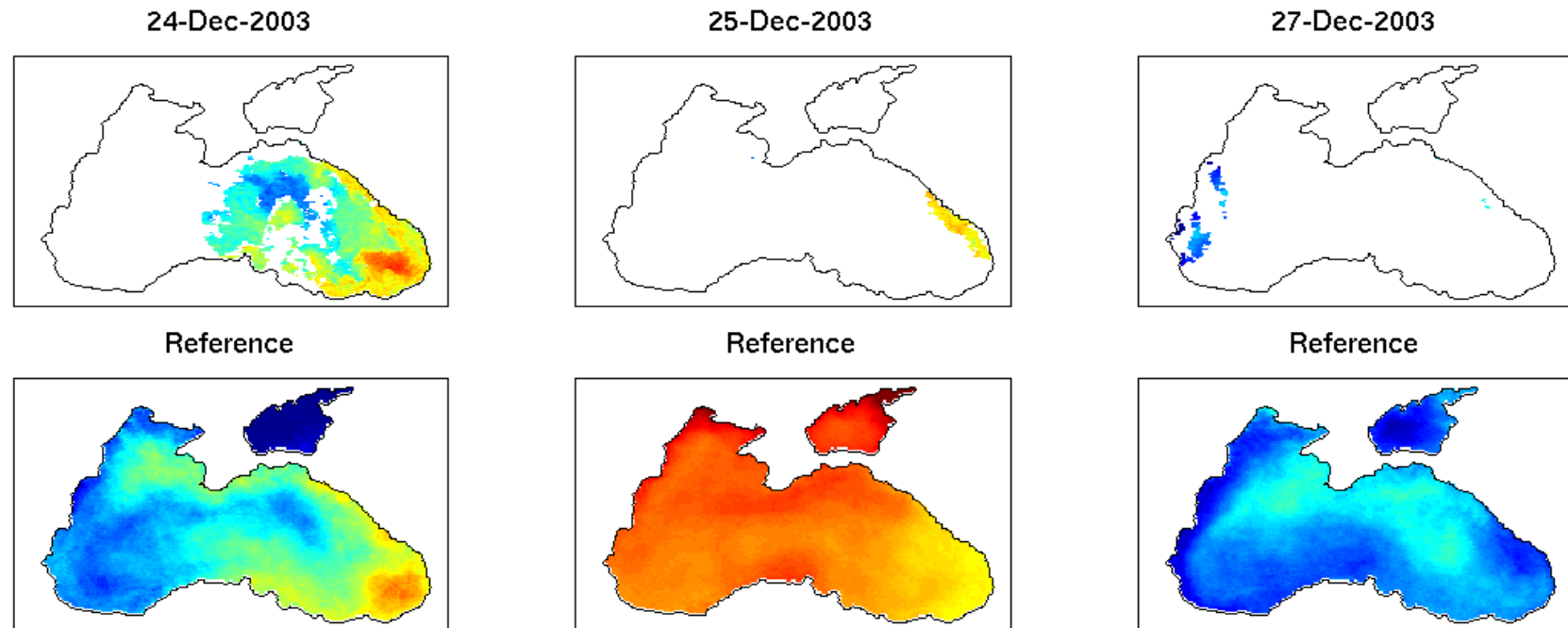
Beckers and Rixen (2003), Alvera-Azcárate et al (2005)



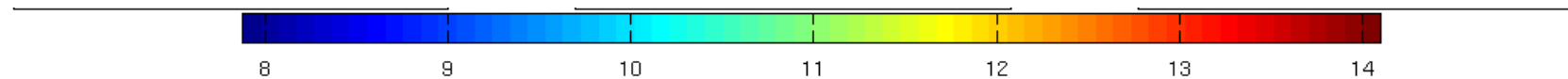
Near real time infrared Sea Surface Temperature over the Black Sea
http://www.dineof.net/DINEOF/dineof_Black.html

Temporal covariance matrix filter

When too few data are present: temporal EOFs poorly constrained: **unrealistic discontinuities**

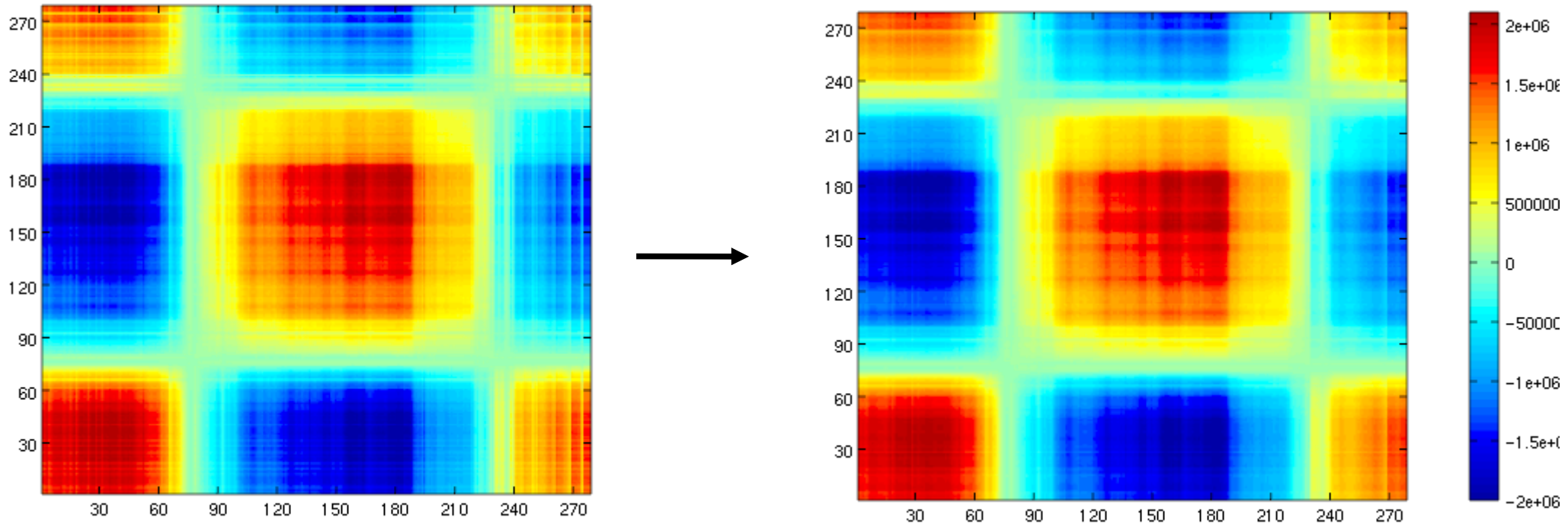


Sharp transition



Spike removal in temporal EOFs

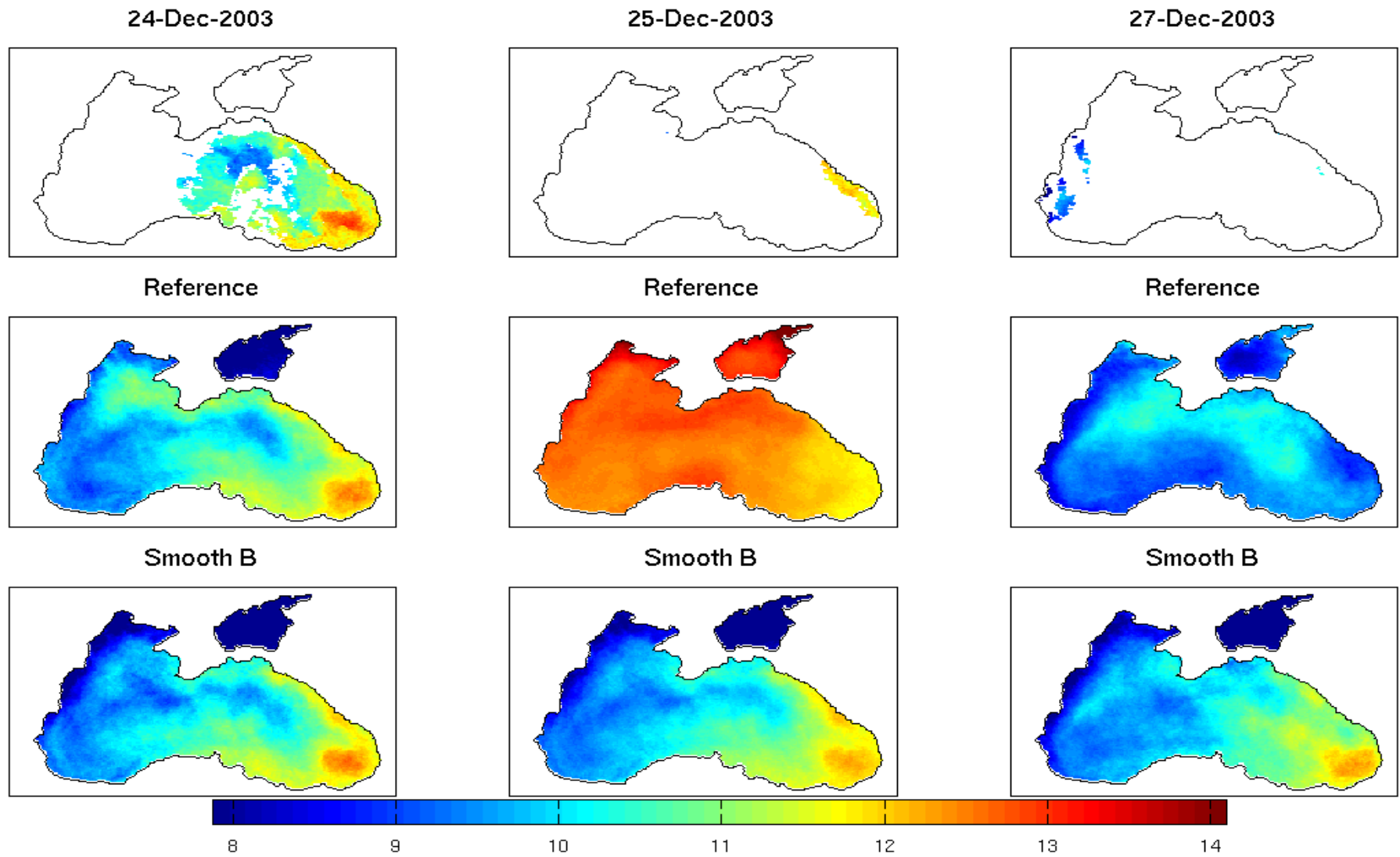
We apply a filter to the temporal covariance matrix



$$\tilde{\mathbf{C}} = \mathbf{F}^T \mathbf{C} \mathbf{F}$$

- \mathbf{F} is a Laplacian filter
- Filter on \mathbf{C} instead of \mathbf{X}
- Filter applied iteratively: more iterations, further reach of the filter

Spike removal in temporal EOFs



Near-real time SST reconstruction

- Automatic procedure to retrieve the latest data and make DINEOF analyses

Steps:

- Latest AVHRR data from Metop-A are downloaded daily from the Ifremer Medspiration FTP website
- A dataset with the latest 6 months of data is prepared. ~40% of missing data
- Run DINEOF for outlier detection
- Calculate and remove outliers from initial data set
- Re-run DINEOF on the cleaned data set
- Make plots, and display on web page:

http://www.dineof.net/DINEOF/dineof_Black.html

- The whole process takes less than 1 hour
- 16 EOFs are retained (latest reconstruction)
- Cross-validation error: 0.5°C

Near-real time SST reconstruction

Daily DINEOF SST reconstruction in the Black Sea - Mozilla Firefox

Daily DINEOF SST recon... x +

www.dineof.net/DINEOF/dineof_Black.html



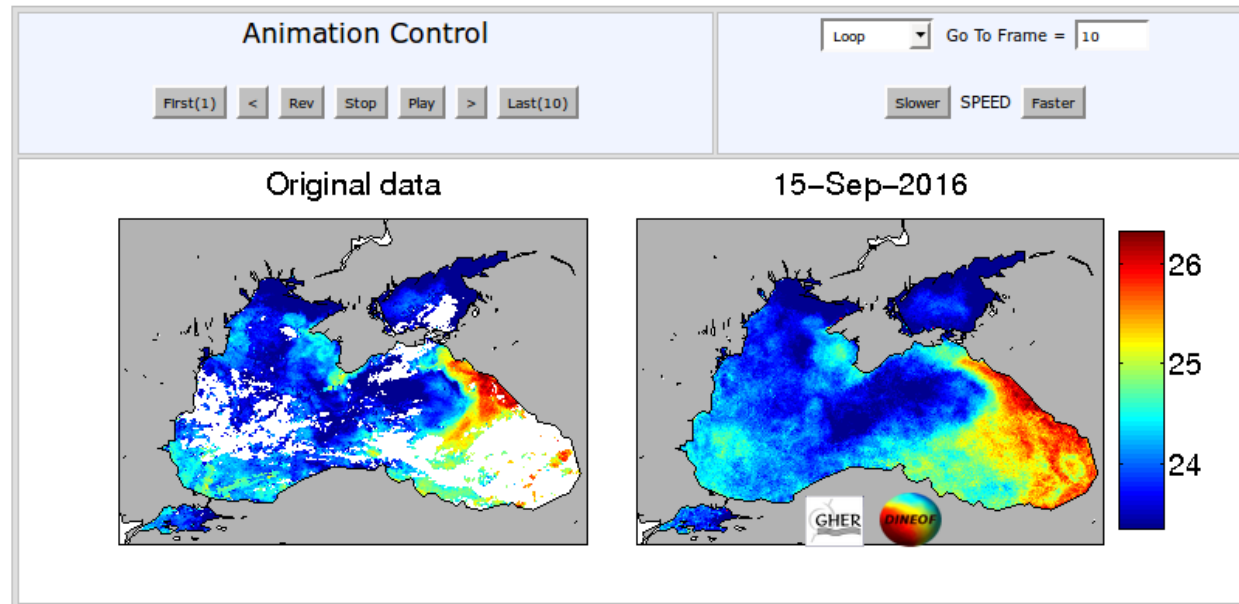
DINEOF daily cloud-free SST of the Black Sea

- [Reconstructed SST field](#)
- [Initial and Reconstructed SST fields](#)
- [Outliers field](#)
- [All fields](#)
- [DINEOF Wiki page](#)

See also:

- [Canary-Madeira SST](#)

DINEOF (Data INTERpolating Empirical Orthogonal Functions) is an EOF-based technique to reconstruct missing data in satellite images. In this page the initial cloudy data set and the reconstruction for the last 10 days are shown. This product is updated daily with the latest SST data.

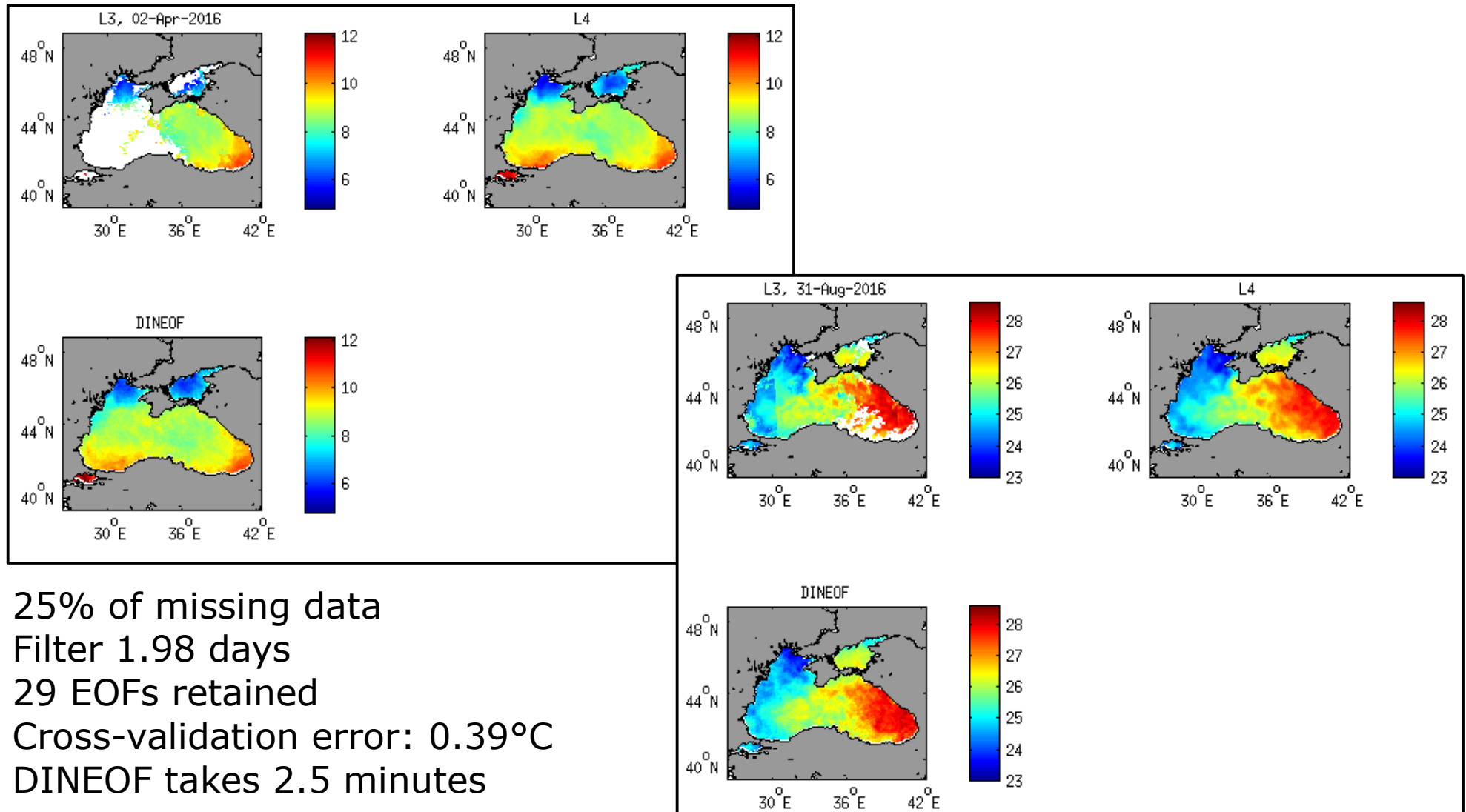


Note: Units are degrees Celsius

Here DINEOF is applied daily to NAR SST level 3 from the Ifremer Medspiration [ftp site](#).

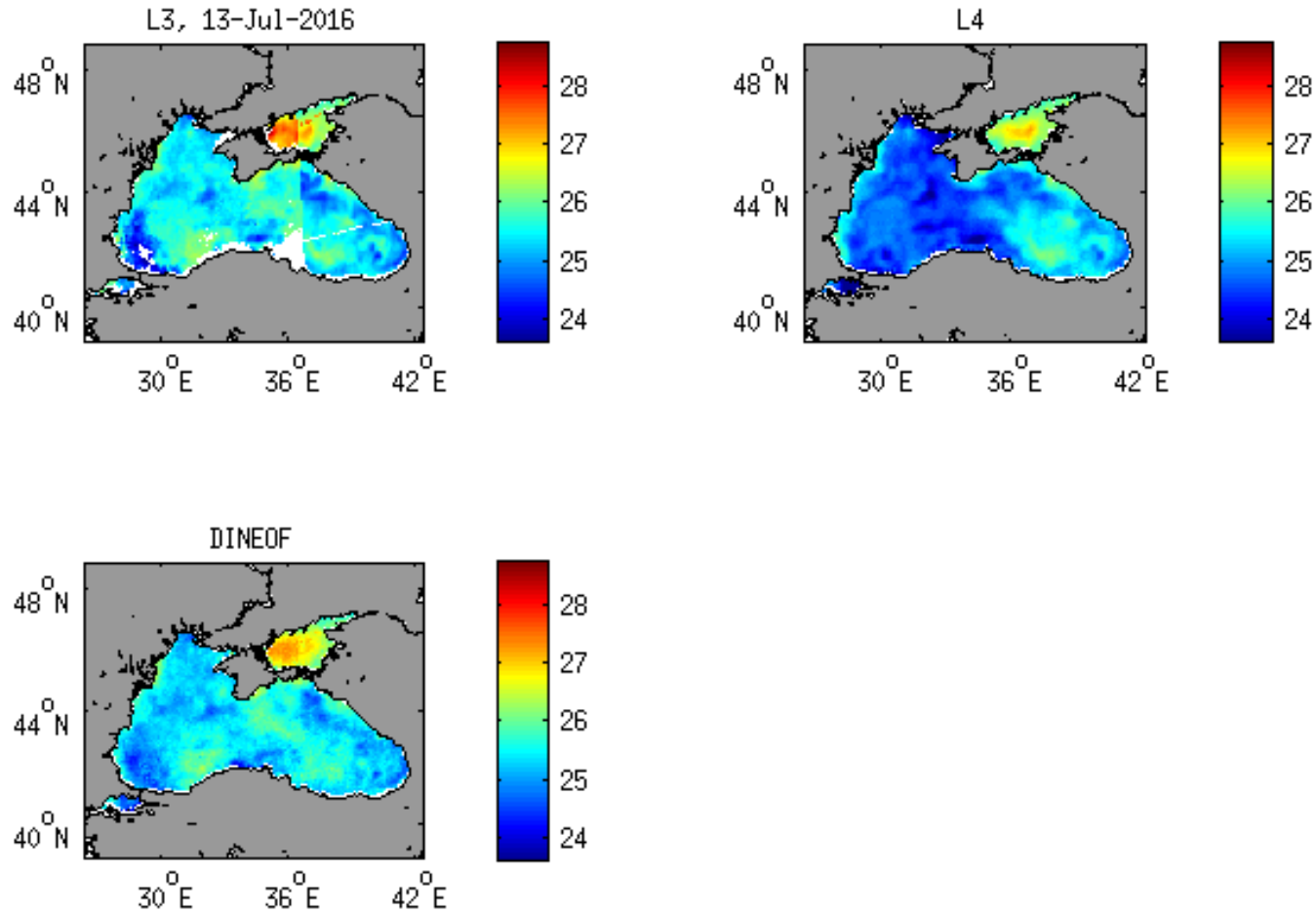
Comparison with other L4 products

- An off-line reconstruction (1 April to 31 August 2016) of SST data
- L3 and L4 Ultra-high resolution (0.01°) SST data from CMEMS are used (Buongiorno Nardelli et al, 2013)
- We reconstruct their L3 night data (supercollated) and compare it to their L4 data (obtained by OI from the L3 data)



Comparison with other L4 products

- The consistency between the CMEMS L4 result and the DINEOF result is large
- At some dates there is a high difference between both products:

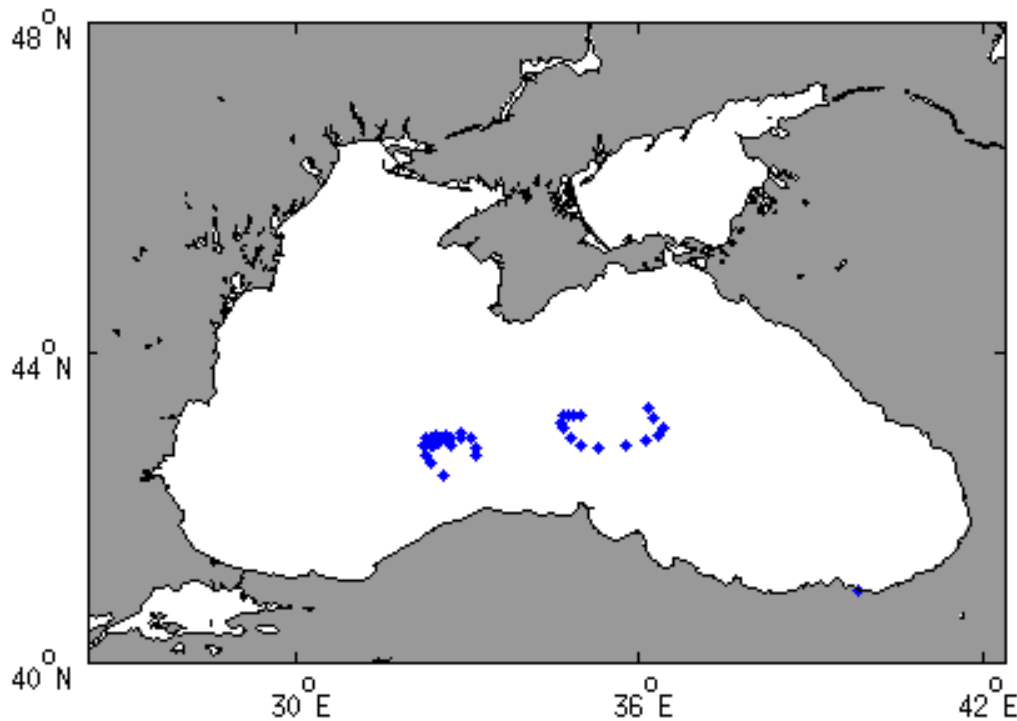


Comparison with other L4 products

Comparison with in situ data:

→ In situ data extracted from the Coriolis database (<http://www.coriolis.eu.org/>)

→ 46 data points found for the study period (from Argo trajectories)



RMS error:

L3 data: 0.38

L4 data: 0.57

DINEOF: 0.51

Bias:

L3 data: -0.11

L4 data: -0.10

DINEOF: -0.15

Conclusions

Two SST products over the Black Sea are presented:

- Near real-time reconstruction of AVHRR data

DINEOF is able to provide a high quality SST dataset in automated mode
Low computing time and CPU resources

- Reconstruction of L3 supercollated data

DINEOF provides high accuracy results, similar to other L4 SST products

DINEOF is provided to the scientific community (source code and binaries):

<http://modb.oce.ulg.ac.be/DINEOF>