HiSea
High resolution merged satellite sea surface temperature fields

BELSPO project SR/12/140

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Objectives of HiSea

Context

Need for high resolution satellite data (numerical weather prediction, ocean forecasting and climate research)

Polar satellites: high spatial resolution, low temporal resolution
Geostationary satellites: low spatial resolution, high temporal resolution

Main objective: to develop a methodology that allows to merge both sources of information

Most approaches use a parameterized error covariance matrix

Problem: error covariance matrix is very difficult to estimate

To overcome this difficulty, the error covariance matrix is expressed using a truncated spatial EOF basis calculated by analyzing data using DINEOF.

DINEOF (Data Interpolation Empirical Orthogonal Functions)

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

Multivariate analyses using extended EOFs

Error maps: based on an OI approach

background covariance : EOF basis from DINEOF

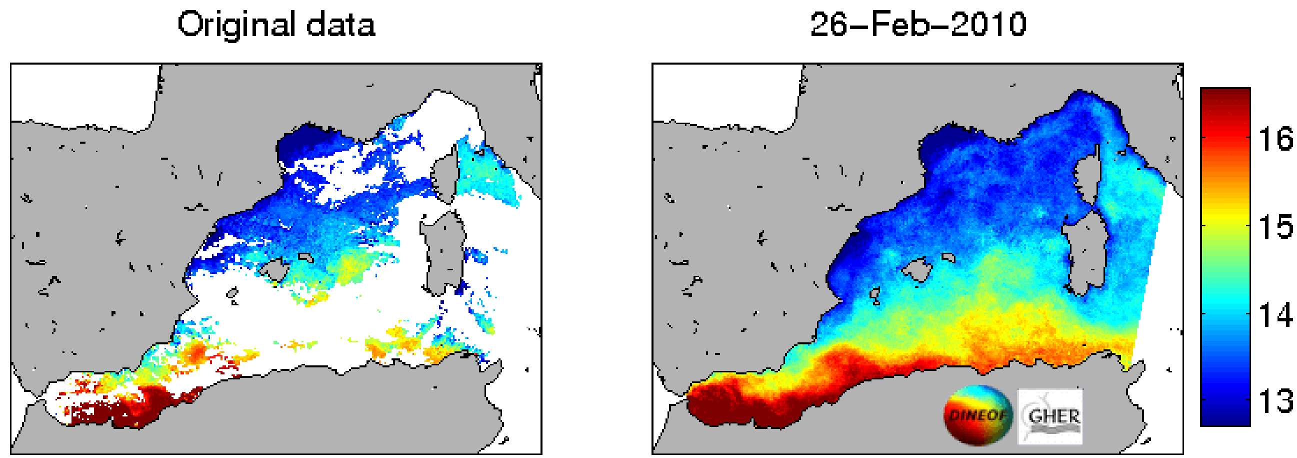
observational error variance: rejected variance (truncated EOF series)

Temporal covariance matrix filter: improves temporal coherence of reconstruction.

Outlier detection

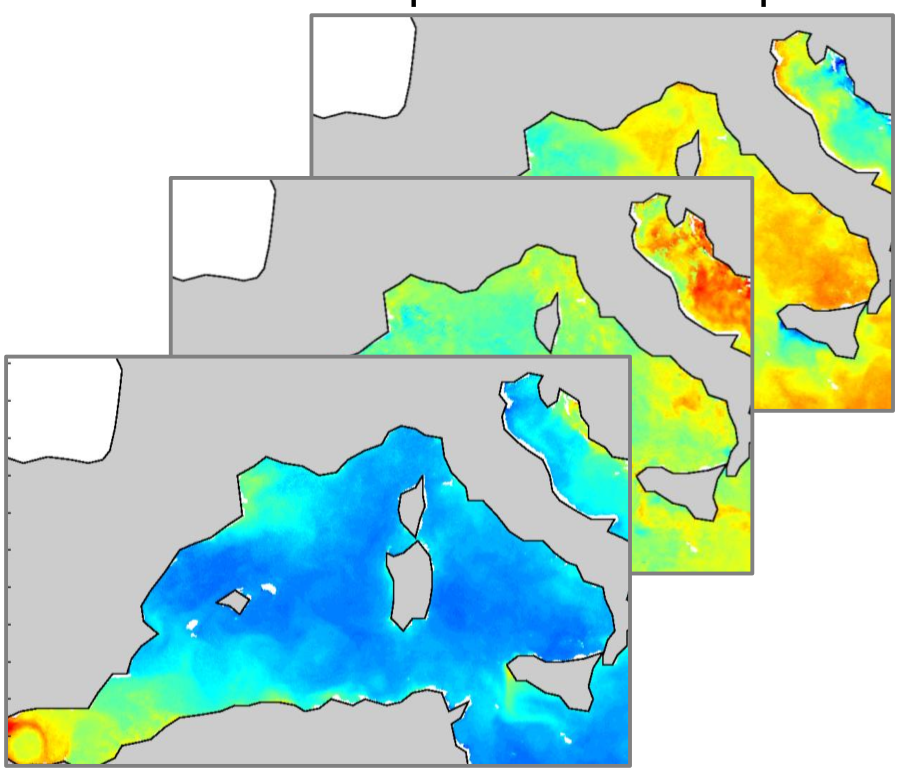
HiSea: merging data using DINEOF

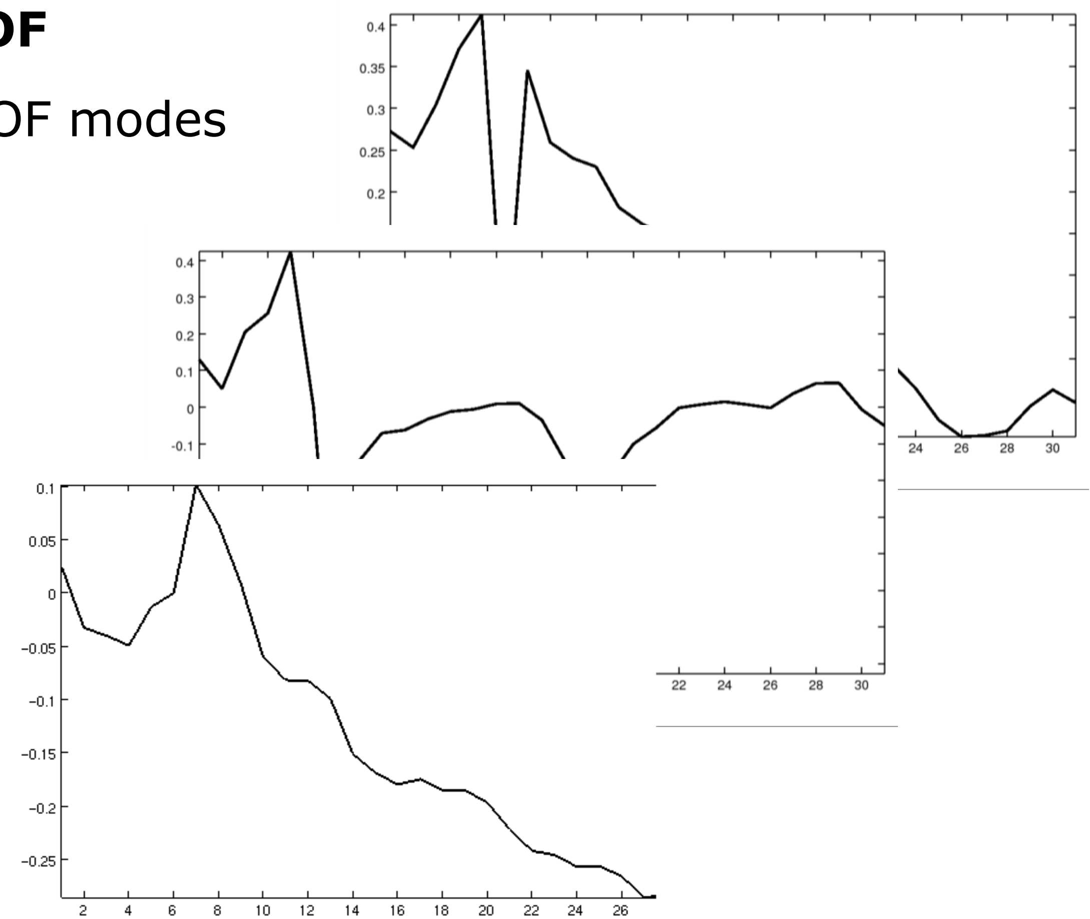
1) DINEOF applied to polar-orbiting data set



DINEOF

Spatial and temporal EOF modes

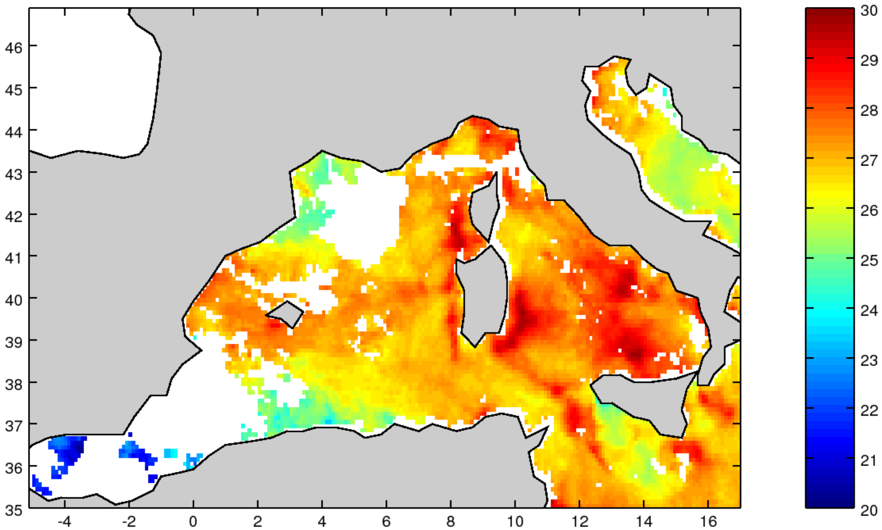




HiSea: DINEOF merging capabilities

2) EOF basis (high spatial resolution) used to reconstruct geostationary data (OI approach)

Geostationary data



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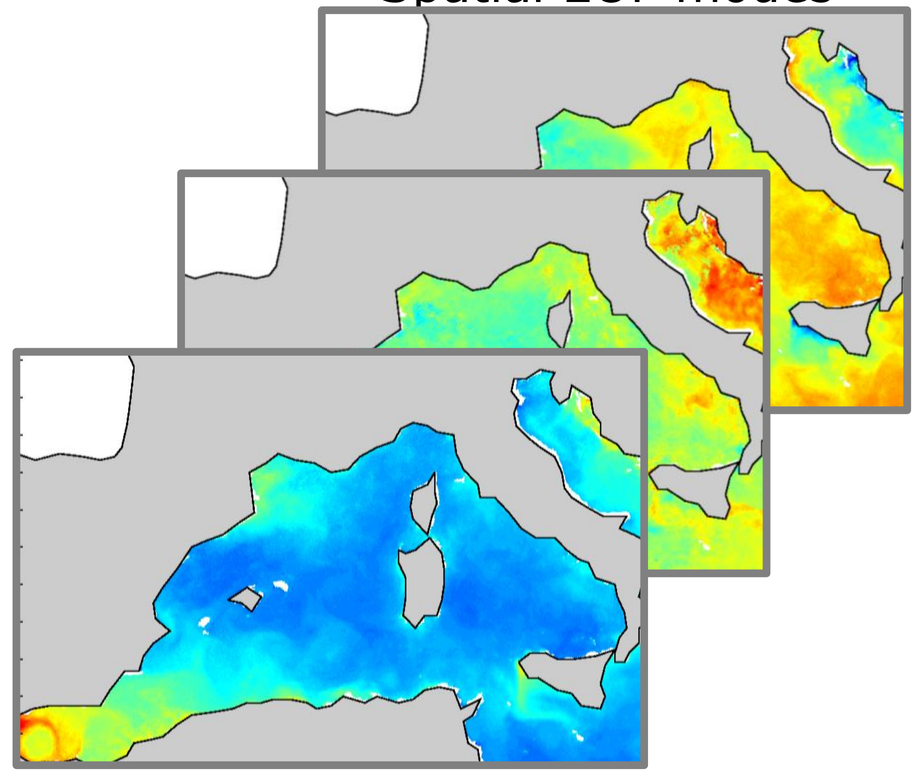
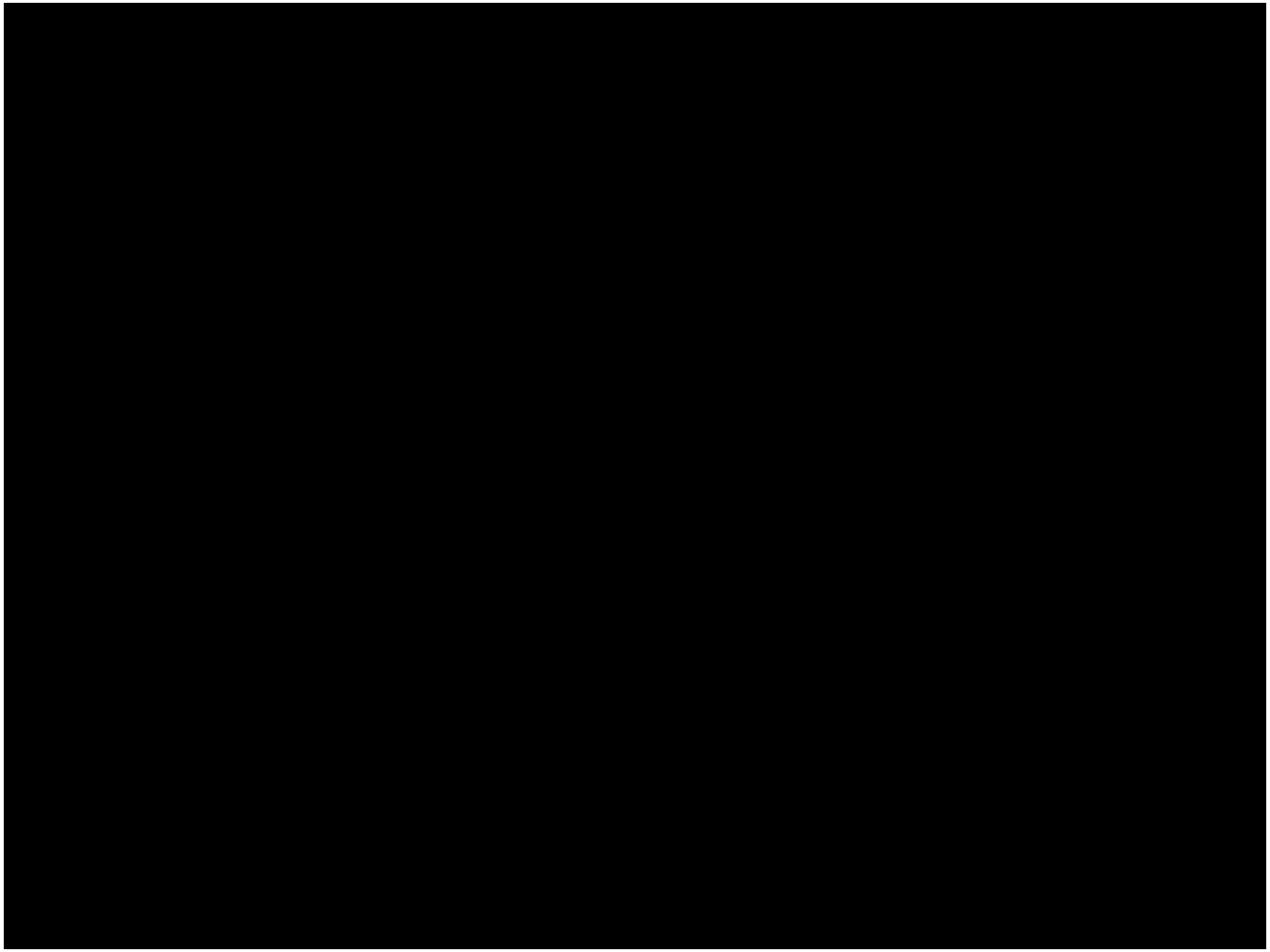
Spatial EOF modes



- Merged data set (polar + geostationary)
- Spatial resolution from polar data (~2km)
- Temporal resolution from geostationary data (~3h)

The analysis is based on the formalism of optimal interpolation (OI) but the **crucial difference is that the error covariance is not parametrized a priori using an analytical expression, but expressed using the spatial EOFs.**

DINEOF-OI on two satellite datasets

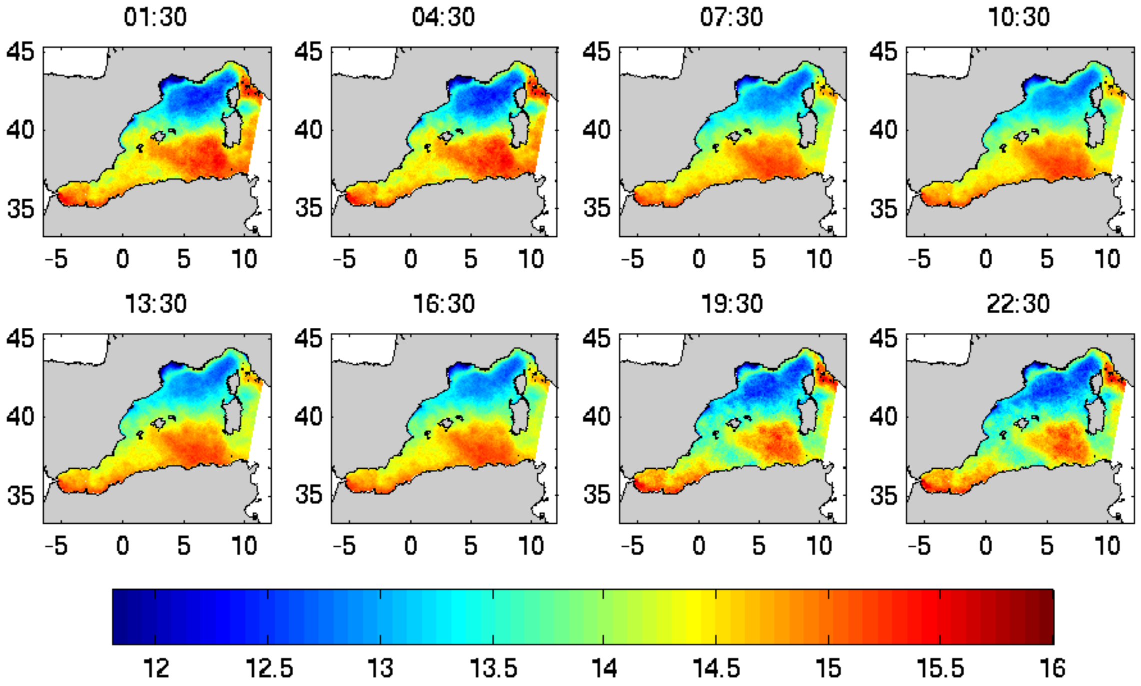


3-hourly variations

Final data have

- the spatial resolution of the polar dataset
- the temporal resolution of the geostationary dataset

20 January 2009



Validation:

	OSTIA		Coriolis in situ data	
	RMS (ºC)	Bias (ºC)	RMS (ºC)	Bias (ºC)
DINEOF-OI	0.39	-0.093	1.3	-0.13

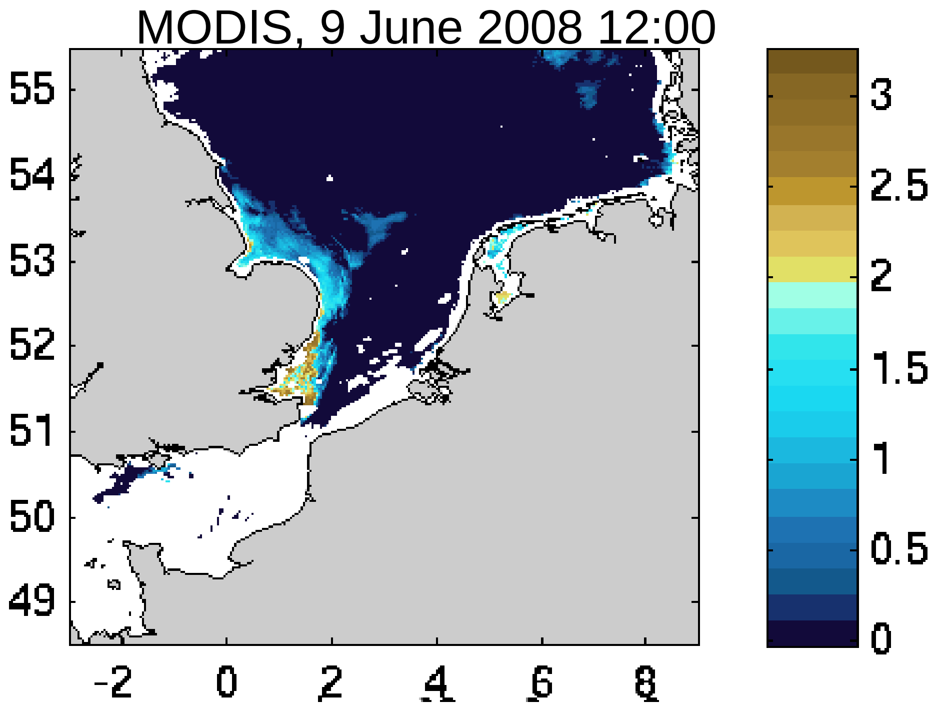
Application to colour data in North Sea

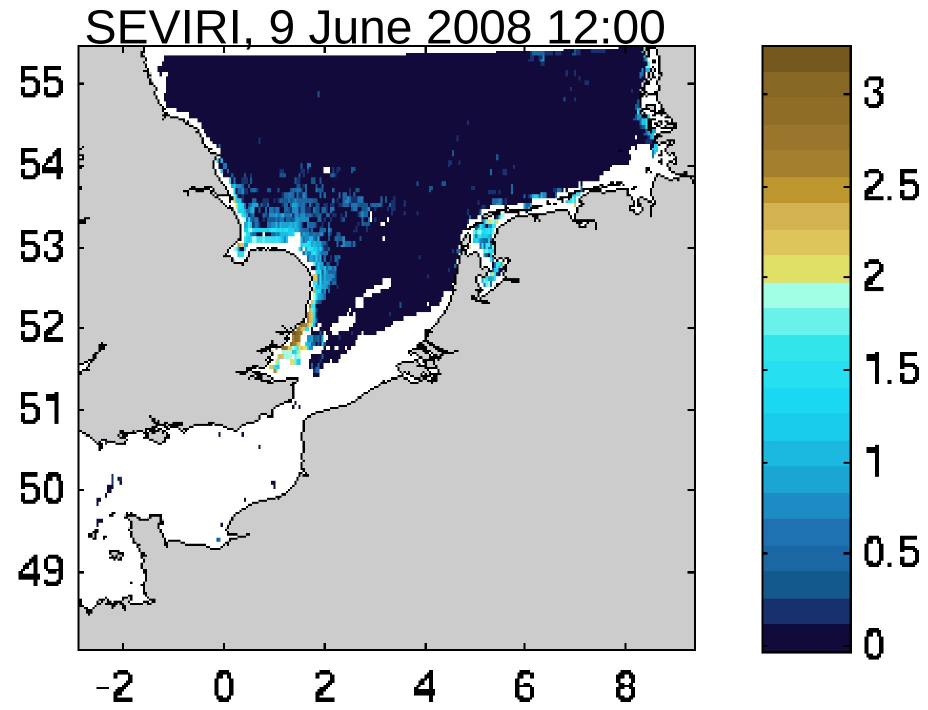
In the frame of the Geocolour project

Polar-orbiting data:
- MODIS
- ~ 2km spatial resolution
- 1 composite image per day

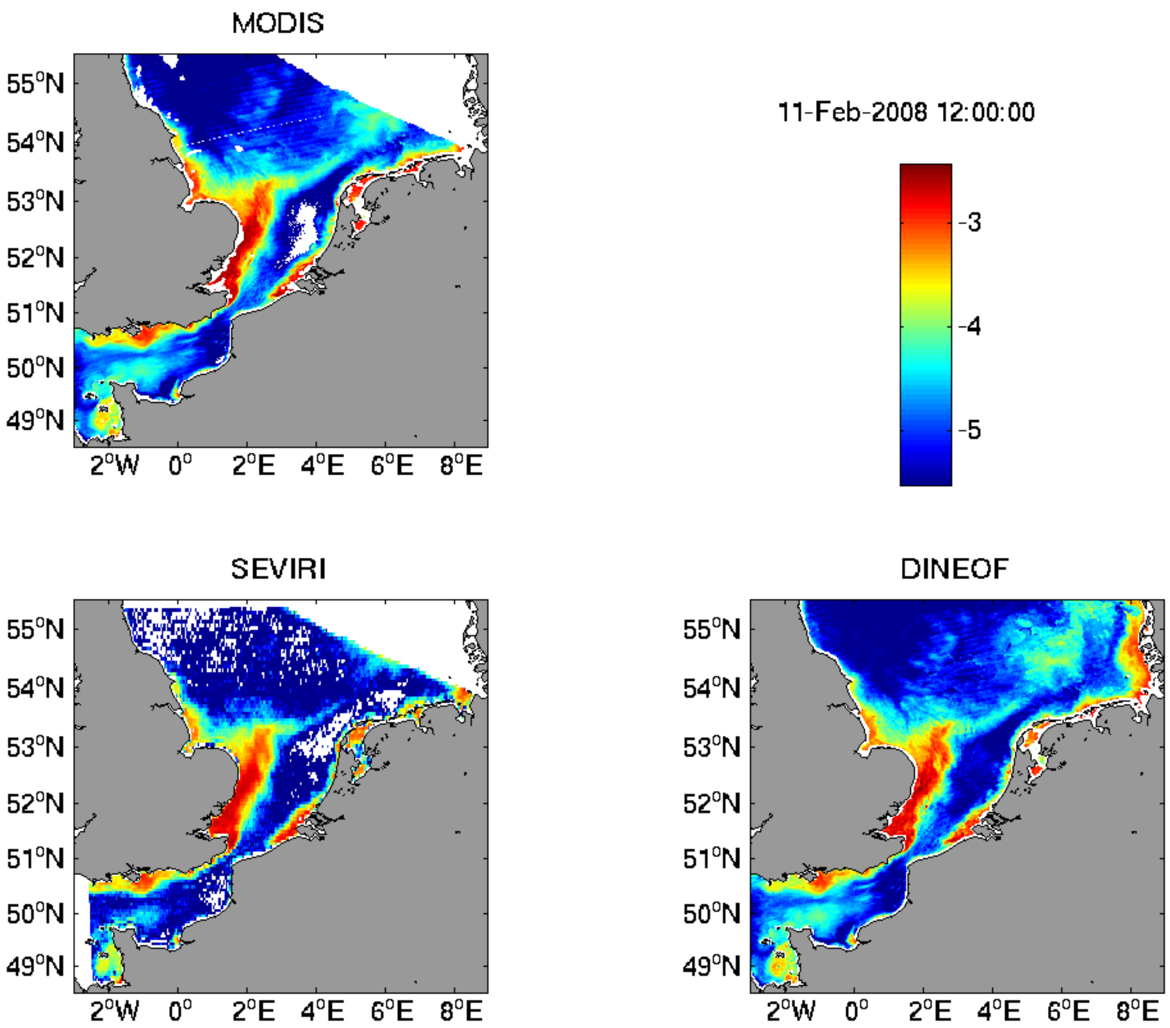
Geostationary data:
- SEVIRI
- ~ 6km spatial resolution
- 15 min temporal resolution

Domain: North Sea
Period: January to March 2008





Results using colour data in North Sea



Noise removed
High temporal resolution from SEVIRI retained
Small scale features from MODIS

Units : log(radiance)

Main conclusions reached through HiSea

- A new methodology has been developed to merged data from different platforms using DINEOF
  - Different spatial and temporal resolutions of initial data
  - Correlation of the error covariance matrix can be taken into account
  - Approach allows to retain highest spatial and temporal resolution

- DINEOF-OI has been applied to different variables (SST and colour) and domains (Mediterranean Sea and North Sea)

Future directions

Application of DINEOF-OI to new variables (e.g. sea surface salinity)

Code optimization for application in near-real time