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**
1) DINEOF applied to polar-orbiting data set
2) EOF basis (high spatial resolution) used to reconstruct geostationary data (OI approach)

- 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

Validation:

<table>
<thead>
<tr>
<th></th>
<th>OSTIA</th>
<th>Coriolis in situ data</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>RMS (°C)</td>
<td>Bias (°C)</td>
</tr>
<tr>
<td>DINEOF-OI</td>
<td>0.39</td>
<td>-0.093</td>
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</tbody>
</table>
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