Interpolation of SLA using Diva: Near-real time application during a multi-sensor experiment in the Ibiza Channel

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Abstract
Goal
Production of high-resolution, gridded maps of sea-level anomalies (SLA), absolute dynamic topography (ADT) and geostrophic velocity.

Region of interest: Balearic Island and Ibiza Channel.

Period of interest: summer 2013.

Tools: only free to use, non-commercial software.

Spatial interpolation
The Diva tool is made up of a set of bash scripts calling Fortran executables. It perfectly fits to our objective of setting up an automatic processing chain. The technique aims to provide a gridded field, also called to analysis, that satisfies several constraints:

- Observation constraint: the analysis is required to be relatively close to the observation.
- Smoothness constraint: the analysis has to exhibit a certain regularity.
- Behaviour constraint: the gridded field has to satisfy physical laws. These constraints are formulated mathematically in terms of a cost function, of which the minimum provides the reconstructed gridded field.

The similarities of this formulation with mechanic problems (plate bending) allows for the use of an efficient numerical method, namely a finite-element solver (Figure 3).

Figure 3: Finite-element mesh around the Balearic Islands. The typical size of the triangle is 1/8 km.

The relative importance of the constraints in the cost function are determined by a few parameters that can be estimated directly from the data. The a posteriori length scale, which measures the radius of influence of a data point, the signal-to-noise ratio, which measures the relative confidence in the measurements.

Geostrophic velocities
The geostrophic velocities are derived from the Absolute Dynamic Topography (ADT) and the Relative Dynamic Topography (MDT, derived from the SLA as Diva). The MDT is the new SOICIB-CLS Mean Dynamic Topography (Figure 4).

Figure 4: SOICIB-CLS Mean Dynamic Topography with the associated error field.

Table 2: Correlations between the radar velocity and the velocity derived from SLA (AVISO and Diva).

<table>
<thead>
<tr>
<th></th>
<th>u-component</th>
<th>v-component</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diva</td>
<td>0.097</td>
<td>0.112</td>
</tr>
<tr>
<td>AVISO</td>
<td>0.102</td>
<td>0.116</td>
</tr>
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Summary & future work
We described a method to obtain a gridded SLA in an automatic way. We applied the technique to the Ibiza Channel in summer 2013. We compared the results obtained through AVISO.

This work is preliminary and many improvements can be done:

- i) Processing (averaging, filtering) of the radar data.
- ii) Comparison over a longer period (up to now: only four days).
- iii) Improvement of the interpolation method by including advection constraint.

Acknowledgements
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References
- Beckers, J.-M.; Barth, A.; Troupin, C. & Alvera-Azcárate, A.

Some approximate and efficient methods to assess error fields in spatial gridding with Diva (Data Interpolating Variational Analysis), J. Atmos. Oceanic Tech., submitted.


- Zender, C. S.


Data & software

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Tools & software

- From the raw data files (NetCDF) to the final gridded map figures, only free software was used.

Unix utilities for the data preparation and processing:

- netCDF Operator (nco) toolbox for the conversion from NetCDF to a text format compatible with the interpolation software.

Python + Numpy (package for scientific computing) for the prediction of the geostrophic velocity.

Python + Matplotlib (package for scientific computing) for generation of the plots and km files.

Data

- Data are automatically prepared by CLS and uploaded on a data server every day. Each file contains the SLA measured by a given satellite for a given day. For the period of interest (summer 2013), three missions are running: Saral/AltiKa, Cryosat and Jason-2 (Figure 2).

A set of bash scripts using nco tools performs the transformation of NetCDF files into text files directly usable as an input for Diva.

- Conversion to ascii format.
- Merging of missions: all the measurements from different missions are merged into daily files.
- Time concatenation: for each day, a file containing the data for the 45 previous days is computed (Gaussian) according to the separation between the time of measurement and the time of the interpolation.

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