New developments in spatial interpolation methods of Sea-Level Anomalies in the Mediterranean Sea

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Introduction - what are the problems?

Interpolating sparse in situ data onto a regular grid (gridding) is a common task in ocean sciences. There are numerous ways to do it, leading to a wide range of result qualities and numerical performances. We present the application and the adaptations of the Data-Interpolating Variational Analysis (DIVA) to perform gridding on along-track sea-level anomaly (SLA) measurements.

Analysis parameters

Two main parameters determine an analysis with DIVA:

- The correlation length scale \( L \), which measures the radius of influence of a data point. \( L \) is estimated by fitting the data correlation function to a theoretical function. The estimated value is \( L \approx 0.5 \).
- The signal-to-noise ratio \( \lambda \), which translates the confidence in the data, not only considering the measurement noise, but also the representativeness error. \( \lambda \) is estimated by cross-validation: several tracks are removed, then the analysis field is computed at the locations of the removed points, and finally the value of \( \lambda \) that minimizes the RMS of the misfits (data minus analysis at data location) is selected. The estimated value is \( \lambda \approx 3.0 \) (no units), though the analysis is not sensitive to this parameter.

Results

The results obtained with DIVA, using the same data, are very close to AVISO maps (Figure 2). The different processing of the data (sub-sampling, filtering, ...) as well as the different interpolation methods explain the slight discrepancies between the fields.

Space and time-averaged analysed fields

The time series of mean SLA (Figure 4), computed from the data or from the gridded fields, display the same features, with a typical seasonal cycle with minimal (maximal) values in winter (summer). The close-up view evidences the smoothing effect of the gridding.

Numerical cost

In order to produce daily fields for a 20-year period, the interpolation process has to be repeated hundreds of times, thus the computation time for this interpolation plus the generation of the corresponding error field has to be kept as low as possible.

Data preparation

Download: SLA data (delayed-time, updated products, unfiltered and not sub-sampled) are obtained from the AVISO FTP server.

Conversion: the NetCDF files are converted into simple, column-structured text files with a format compatible with the Diva software.

Blending: measurements from different missions covering the same period (week or day) are gathered.

Time weighting: data points are assigned a weight depending on the time separation with respect to the selected date.

Method - variational analysis

The gridded field (or analysis) is obtained as the solution of a cost function that penalizes: 1. The misfit between the measurements and the gridded field and 2. the regularity of the gridded field. The minimization of the cost function is done with the help of a finite-element technique: the solution is computed in a set of triangles covering the domain of interest, and the continuity of the solution across the triangles is assured.

Analysis of the variances

The signal variance of DIVA and AVISO products is consistent (Figure 6) and the noise reduction due to the interpolation is evidenced in the right panel.

Conclusions - assets of the method

i) DIVA is consistent method with a limited number of parameters and a natural consideration of the domain geometry.

ii) The software can be easily tailored for automatic process and deal with large quantity of observations, without the need of sub-sampling or data reduction.

iii) The results of the interpolation are close to those provided by AVISO: the daily fields display the same features in the Mediterranean Sea (Figure 2), the seasonal cycles of the SLA are consistent with the along-track data (Figure 4) and the variance of the gridded fields follow the same evolution (Figure 6).

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References


How to get the code?