Application of the Data-Interpolating Variational Analysis (DIVA) to sea-level anomaly measurements in the Mediterranean Sea

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In ocean sciences, numerous techniques are available for the spatial interpolation of in situ data. These techniques mainly differ in the mathematical formulation and the numerical efficiency. Among them, DIVA, which is based on the minimization of a cost function using a finite-element technique (Fig. 1). The cost function penalizes the departure from observations, the smoothness or regularity of the gridded field and can also include physical constraints. The technique is particularly adapted for the creation of climatologies, which required a large to several regional seas or part of the ocean to generate hydrographic climatologies.

Sea-level anomalies (SLA) can be deduced from satellite-borne altimeters. The measurements are characterized by a high spatial resolution along the satellite tracks, but often a large distance between neighbour tracks. This implies the use of simultaneous altimetry missions for the construction of gridded maps. An along-track long wave-length error (correlated noise, e.g. due to orbit, residual tidal correction or inverse barometer errors) also affects the measurement and has to be taken into account in the interpolation.

In this work we present the application and adaptation of Diva to the analysis of SLA in the Mediterranean Sea and the production of weekly maps of SLA in this region.

Determination of the parameters

The two main parameters that determines an analysis with DIVA are the correlation length (L) and the signal-to-noise ratio (SNR). Because of the particular spatial distribution of the measurements, the tools implemented in Diva for the analysis parameter determination tend to underestimate L and overestimate SNR, leading to noisy analysis (the observation constraint dominates the regularity constraint). Some adaptations of the tools are necessary to solve this issue.

Numerical cost

Because of the large number of observations to be processed (in comparison with in situ measurements on a similar period), the interpolation method employed is expected to be numerically efficient. Improvements in the implementation of Diva further improved the numerical

performance of the method, especially thanks to the use of a parallel solver for the matrix inversion. The performance of finite-element mesh generator was also enhanced, so that interpolation of a data set of more than 1 million data points on a 100-by-100 grid can be performed in a few minutes on a personal laptop.

Analysis and error field

The analysis and error fields obtained over the Mediterranean Sea are compared with the available gridded products from AVISO. Different ways to compute the error field are compared. The impact of the use of multiple missions to prepare the gridded fields is also examined.

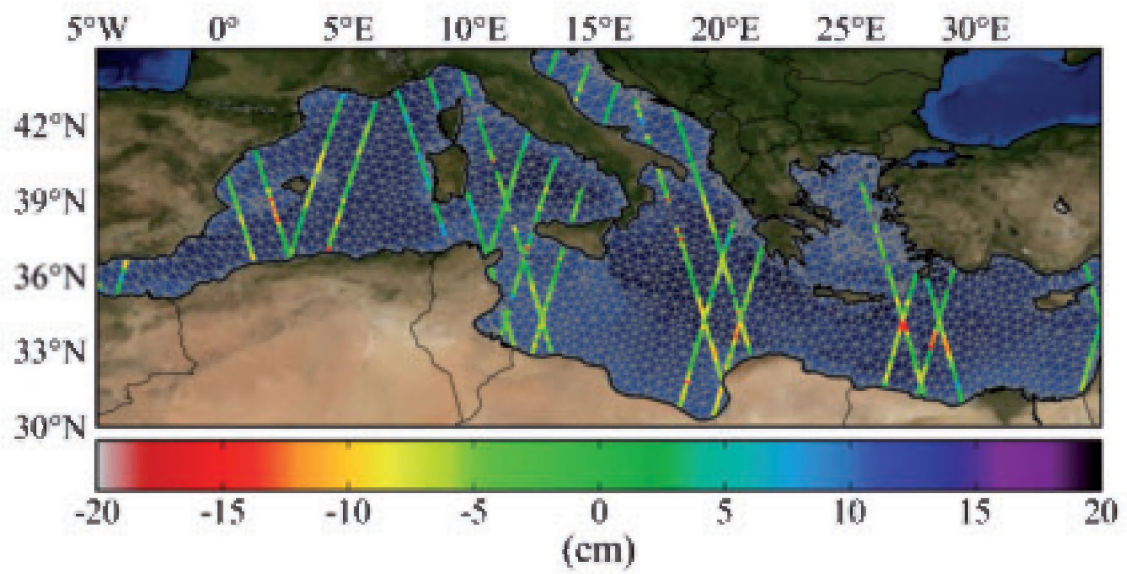

Fig. 1 - Area of interest, finite-element mesh and sea-level anomalies measurements (Envisat) for the period 6-13 May, 2009. [Data from AVISO].