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

Charles Troupin[1], Arancha Lana[1], Marie-Isabelle Pujol[2] & Ananda Pascual[1]

[1]IMEDEA (CSIC-UIB), Esporles, SPAIN; [2]CLS Space Oceanography Division, Ramonville Saint-Agne, FRANCE

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!

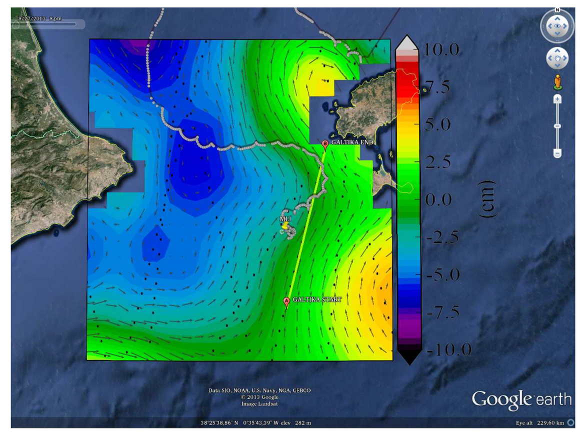

Figure 1: Ggraphical view of GaltiKa mission with google-earth.

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.

Data-Interpolating Variational Analysis (Diva) for the data interpolation.

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

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

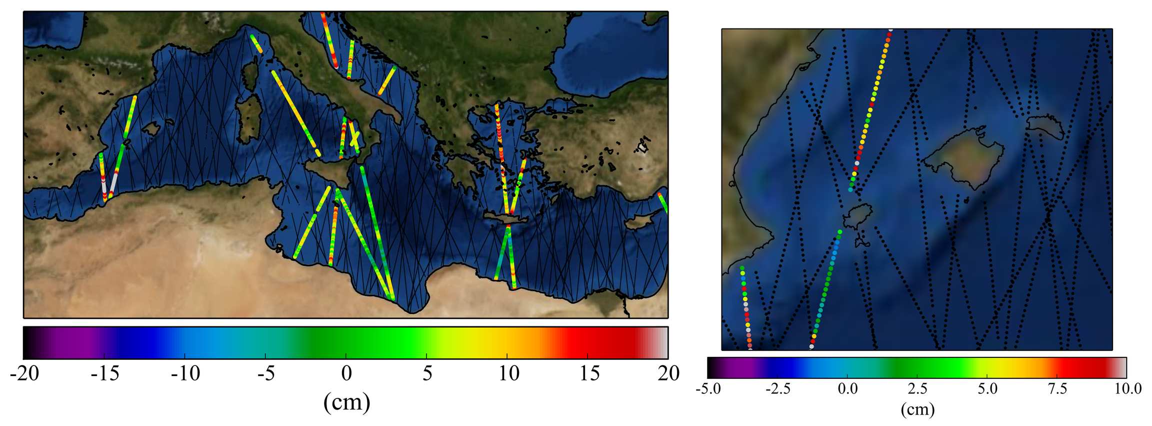

Figure 2: Along-track data for the last two weeks of July 2013 (black lines) and for August 1, 2013 (coloured dots). The SARAL/AltiKa track no.16 is visible in the right panel, close to Ibiza Island.

A set of bash scripts using nco tools performs the transformation of NetCDF files into text file 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 constructed.
- Application of different weights, according to time: the weight of each data point of the 45-day files is computed (Gaussian) according to the separation between the time of measurement and the time of the interpolation.

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 problem (plate bending) allows for the use of an efficient numerical method, namely a finite-element solver (Figure 3).

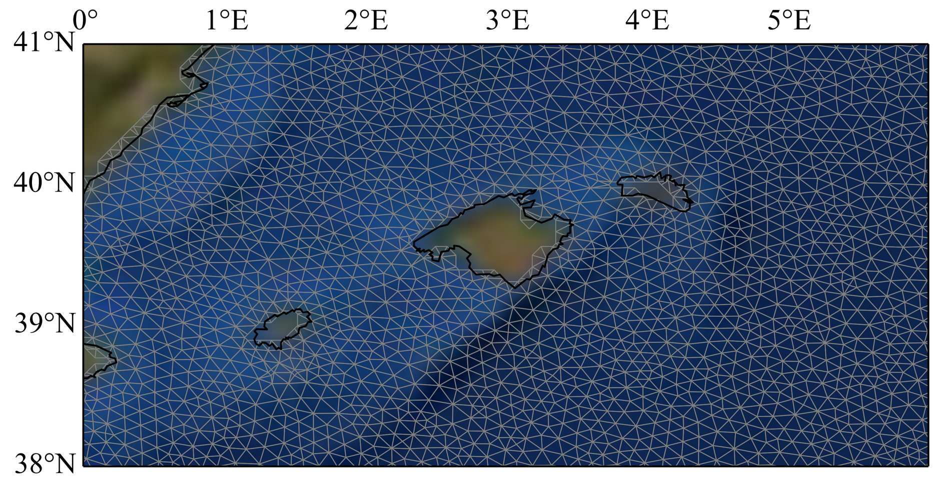

Figure 3: Finite-element mesh around the Balearic Islands. The typical size of the triangle is 1/6°*irc*.

The relative importance of the constraints in the cost function are determined by a few parameters that be estimated directly from the data:

the correlation 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:

$$ADT = SLA + MDT$$

- SLA is obtained from the interpolated maps
- MDT is the new SOCIB-CLS Mean Dynamic Topography (Figure 4).

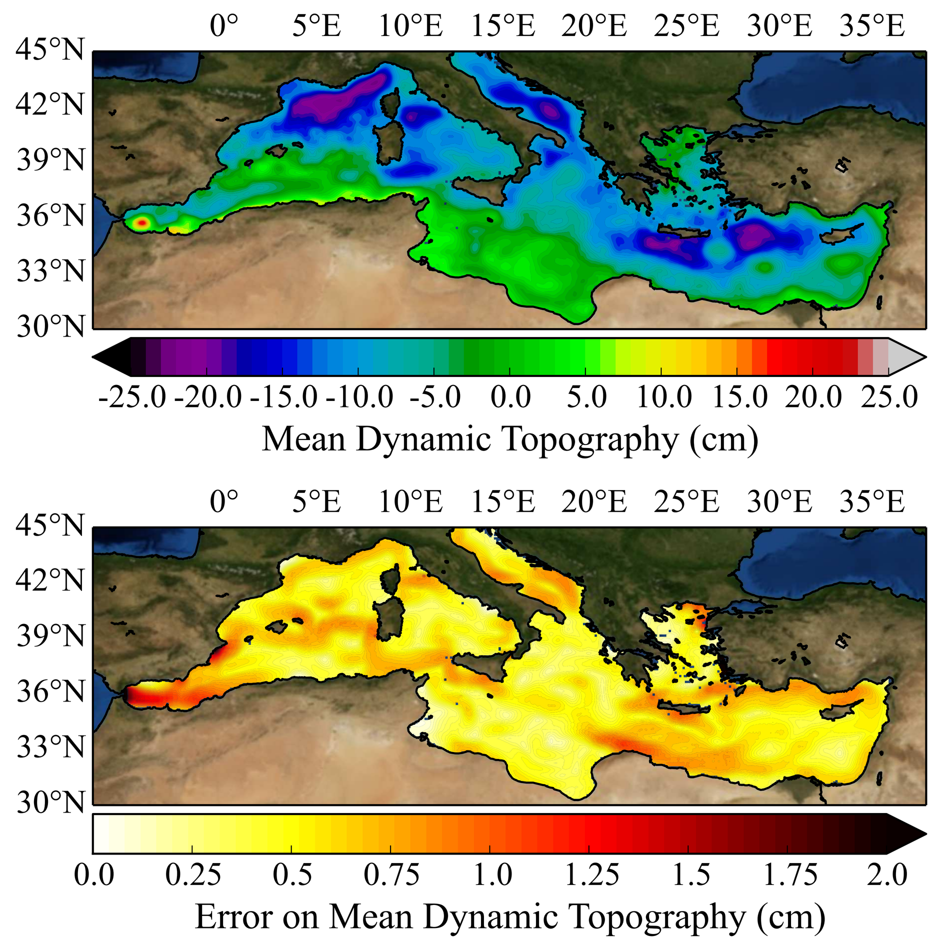

Figure 4: SOCIB-CLS Mean Dynamic Topography with the associated error field.

Comparison with radar data

Surface currents in the Ibiza Channel are provided by the SOCIB HF-radar facility. For comparison purpose, altimetry-derived velocities are interpolated onto the radar grid (Figure 5).

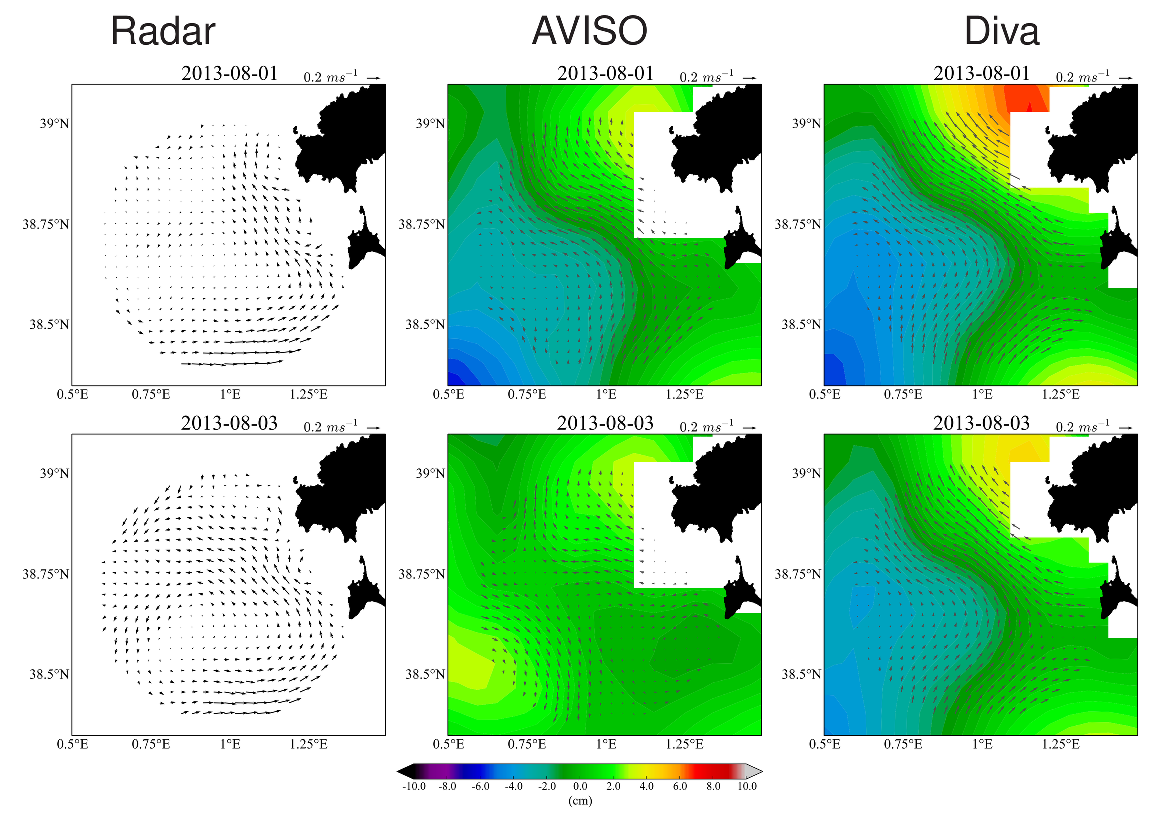

Figure 5: Radar velocity and altimetry-derived velocity on the radar grid for August 1 and 3, 2013.

The statistics from Tables 1 and 2 show comparable results for the two interpolation methods, especially for the meridional component.

Table 1: RMS (in cm s^{-1}) of the difference between the radar velocity and the velocity derived from altimetry (AVISO and Diva).

	u−component		v−component	
	AVISO	Diva	AVISO	Diva
1 Aug	0.052	0.08	0.065	0.072
2 Aug	0.047	0.066	0.064	0.07
3 Aug	0.075	0.05	0.079	0.074
4 Aug	0.085	0.04	0.073	0.066

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

	u−component		v−component	
	AVISO	Diva	AVISO	Diva
1 Aug	0.032	0.04	0.071	0.071
2 Aug	-0.036	-0.028	0.22	0.22
3 Aug	-0.08	-0.073	0.204	0.203
4 Aug	-0.089	-0.083	0.391	0.391

Comparison with drifter trajectory

A drifter was launched on August 2. The trajectories are filtered (interpolated and low-pass filtered with a 36-h cut-off) and overlaid on the ADT maps (Figure 6). During the first days of the mission, the velocities derived from altimetry do not agree with the drifter trajectory.

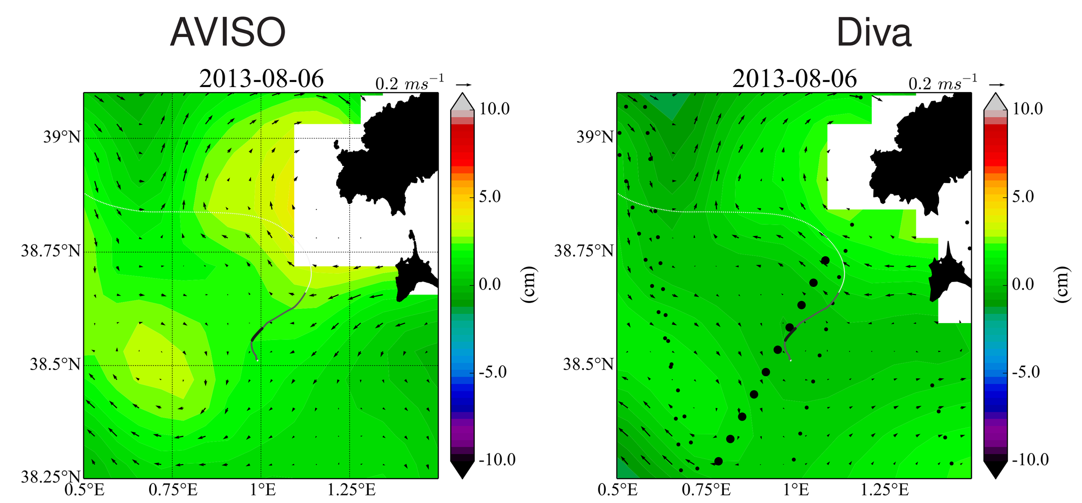

Figure 6: Drifter trajectory (start: August 2, 2013) and altimetry-derived velocities for August 6, 2013.

Table 3: RMS and correlation between the drifter and the altimetry velocities.

	u−component		v−component	
	AVISO	Diva	AVISO	Diva
RMS (cm s^{-1})	0.101	0.092	0.076	0.071
Correlation	0.475	0.269	0.830	0.645

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.

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- Zender, C. S. NCO User's Guide Department of Earth System Science, University of California, 2013.

Data & software

Along-track SLA: `ftp.aviso.oceanobs.com`

SOCIB radar data: `http://www.socib.es/?seccion=observingFacilities&facility=radar`

Drifter and glider: `http://apps.socib.es/dapp/`

Diva software: `http://modb.oce.ulg.ac.be/mediawiki/index.php/DIVA`

NCO tools: `http://nco.sourceforge.net/`