Sensitivity Study on the Use of Argo Data for the Validation of Altimeter products in the Mediterranean Sea

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ABSTRACT

We review the method of comparison between SLA and DHA in the Mediterranean Sea (regional scale) in order to validate altimeter sea level measurements with an increased confidence. We focus on the sensitivity of specific SLA gridded products provided by AVISO in the Mediterranean to the reference depth (400 or 900 dbars) selected in the computation of the Argo DH as an integration of the Argo T/S profiles (Coriolis-GDAC dataset) through the water column. The DHA were referenced to a synthetic climatology (400 or 900 m). To perform the comparisons, altimeter grids and synthetic climatologies were spatially and temporally interpolated at the position and time of each in-situ Argo profile by a mapping method based on an optimal interpolation scheme. Results show correlations higher than 0.70 between Altimetry and Argo data in all the experiments with a mean standard deviation of the differences between both datasets of around 4.40 cm.

MOTIVATION

The existing Argo network strongly complements the observations of the ocean surface from space, especially the observation of the surface topography with satellite altimeters. The comparison of Sea Level Anomalies (SLA) provided by satellite altimeters with in-situ Dynamic Heights Anomalies (DHA) derived from the T/S profiles of Argo network contributes to better characterize the error budget associated to the altimeter observations. However, the uncertainty associated with some of these results remains relatively high and some impact studies assessing to which extent the validation of altimeter measurements by comparison with in-situ steric heights derived from the Argo network is sensitive to these in-situ data and their processing are still needed.

DATA AND METHODS

Argo dataset

A quality control relative to the profile's position and vertical measurements is performed before the DH computation. Only profiles with a position quality flag of 1 (good data) have been employed (Figure 1.A). **However, the major restriction comes from the quality flag of salinity data close to the sea surface.** DHA is computed by referring DH to a synthetic climatology for the same depth than the reference levels (Figure 2). **The coarse spatial resolution of this climatology prevents us from using Argo data collected close to the coasts as well as the floats located south of the Sicily Strait and in the Alboran, Adriatic and Aegean seas** (see Figure 1.B).

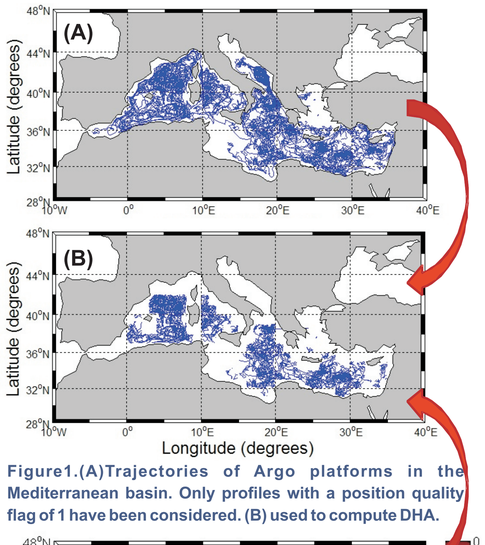


Figure1.(A)Trajectories of Argo platforms in the Mediterranean basin. Only profiles with a position quality flag of 1 have been considered. (B) used to compute DHA.

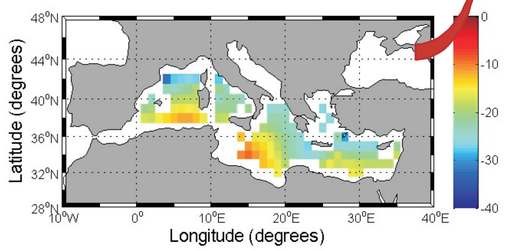
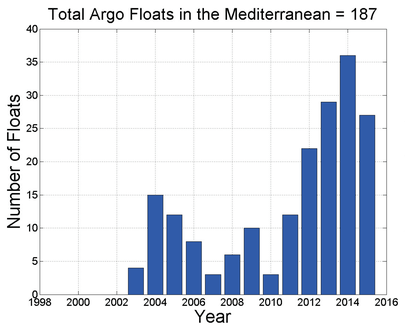
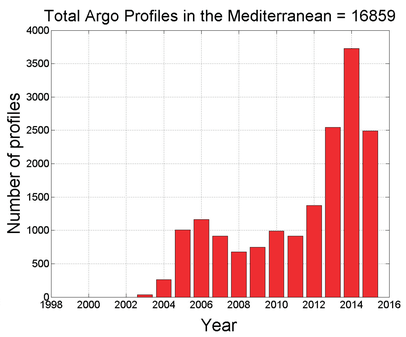
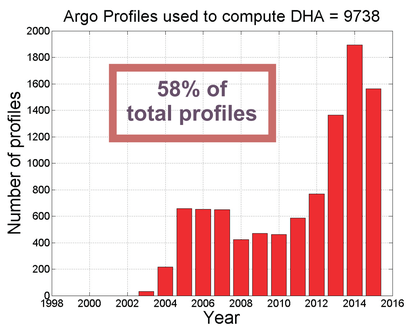


Figure 2. Synthetic climatology for the Mediterranean Sea computed for a reference depth of 400 dbars. Units are in cm.







Altimeter measurements

Altimeter data consists of a specific reanalysis gridded merged product for the Mediterranean available for the period 1993 – 2014. To make this product comparable to the Argo data (synthetic climatology used to compute DHA is referred to 2003 — 2011), the mean Sea Level Anomaly (SLA) of the whole Mediterranean for the time period spanning between 1st January 2003 and 31th December 2011 (mean value of 3.54 cm) has been subtracted from the original SLA time series.

To perform the comparison of altimetry with Argo data:

1. Altimeter grids and synthetic climatologies are spatially and temporally interpolated at the position and time of each in-situ Argo profile.

2. Statistics and coherence analyses are performed between altimetry and the in-situ Argo reference.

RESULTS

The collocation of altimeter data with each Argo profile is based on the new gridded altimeter product (1993-2014), which is computed by mapping method based on an optimal interpolation scheme.

Whole basin

	Ref. 400 m	Ref. 900 m
Floats	41	23
Profiles	2258	416
Mean (SLA - Argo)	0.63 cm	1.90 cm
STD (SLA - Argo)	4.50 cm	4.36 cm
R (SLA - Argo)	0.73	0.78

Table 1. Comparison of the correlation, mean and standard deviation of the differences between new AVISO product for the Mediterranean and Argo data, using 400 m and 900 m as reference level for anomalies.

	Ref. 400 m			Ref. 900 m		
	DH 5m	DH10m*	DH10m	DH 5m	DH 10m*	DH. 10 m
floats	41	41	86	23	23	63
Profiles	2258	2258	5265	416	416	2475
Mean (SLA - Argo)	0.63 cm	1.07 cm	1.57 cm	1.90 cm	2.34 cm	2.30 cm
STD (SLA - Argo)	4.50 cm	4.57 cm	4.29 cm	4.36 cm	4.39 cm	4.33 cm
R (SLA - Argo)	0.73	0.72	0.71	0.78	0.77	0.69

Table 2. Idem as Table 1 but DH computation is performed at 5 and 10 m depth; and the anomalies are referred to both 400 m and 900 m. (*) DH computation performed with the same profiles than the computation at 5 m depth.

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Eastern/Western sub-basins

	Reference depth of 400 m		
	Whole basin	Western basin	Eastern basin
floats	41	18	23
Profiles	2258	996	1262
Mean (SLA - Argo)	0.63 cm	0.54 cm	0.70 cm
STD (SLA - Argo)	4.50 cm	4.24 cm	4.70 cm
R (SLA - Argo)	0.73	0.78	0.69

Table 4. Idem as Table 1 but using 400 m as reference level for anomalies.

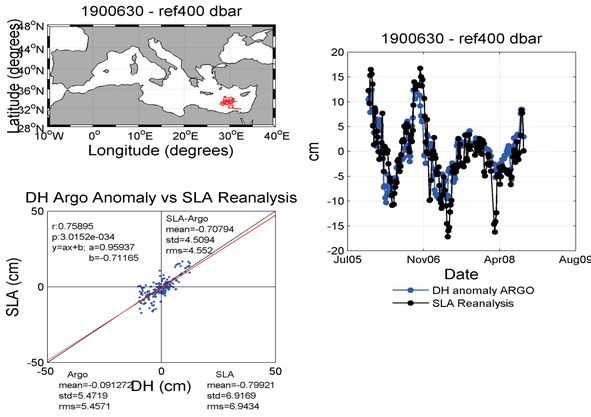

Figure 3. Top-left: 190630 Argo float trajectory. Left: DH anomaly (blue) from Argo float using a reference level of 400 m and SLA anomaly (black). Bottom-left: Linear regression between DH Argo anomaly and SLA reanalysis.

	All available profiles (ref. 400 m)	Profiles reaching 900 m (ref. 400 m)	All available profiles (ref. 900 m)
Floats	41	24	23
Profiles	2258	479	416
Mean (SLA - Argo)	0.63 cm	1.04 cm	1.90 cm
STD (SLA - Argo)	4.50 cm	4.34 cm	4.36 cm
R (SLA - Argo)	0.73	0.76	0.78

Table 3. Idem as Table 1 but using 400 m as reference level for anomalies, for the whole available Argo profiles and those reaching 900 m depth. The statistics of the differences for the whole available Argo profiles using 900 m as reference level for anomalies is also included for comparison proposes.

	Reference depth of 900 m		
	Whole basin	Western basin	Eastern basin
floats	23	8	15
Profiles	416	109	307
Mean (SLA - Argo)	1.90 cm	2.79 cm	1.42 cm
STD (SLA - Argo)	4.36 cm	4.45 cm	4.31 cm
R (SLA - Argo)	0.78	0.79	0.78

Table 5. Idem as Table 1 but using 900 m as reference level for anomalies.

CONCLUSIONS

1- The choice of the reference depth of Argo profiles in the Mediterranean impacts the number of available profiles used to compute DHA and therefore the coverage by the network.

2- The impact of the reference level in the computation of DH is not statistically significance since the standard deviation of the differences between DH computed from Altimetry and Argo data referred to reference depths of 400 m and 900 m are quite similar (4.50 cm and 4.36 cm, respectively).

3- The standard deviation of the differences between DHA computed form both datasets referred to a reference depth of 400 m is slightly reduced (4.34 cm against 4.50 cm) when shallow floats are not included in the computation. This fact, that makes also increase correlations between both datasets from 0.73 to 0.76, might be due to higher altimeter errors in the coastal band.

4- Sub-basin study: the DHA computation from Argo data referred to 400 m promotes lower values of the standard deviation of the differences between Altimetry and Argo data for the western sub-basin. The opposite when computing DHA from Argo data referred to 900 m. These differences between the western and eastern sub-basins could be linked to both the bottom topography of the sub-basins and the dynamics of the water masses within the Mediterranean Sea since LIW spreads over different fractions of the water column with longitude.

ACKNOWLEDGEMENTS

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