Use of Argo data in ocean numerical simulations

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Abstract

The motivation of this study is to investigate and highlight the use of Argo data in mathematical ocean simulations. The vertical profiles measured by the Argo floats are very important for the evaluation of ocean modeling, since the majority of the ocean measurements that cover the sea surface (e.g. satellite data, surface drifters) are static, without moving (e.g. buoys, gauge stations) or cover small-scale regions (e.g. cruises). The North Aegean Sea (Figure 1) is characterized by a significant number of deep basins and trenches. The intrusions of more saline waters from the South Aegean and the fresher Black Sea Waters (BSW) outflow through the Dardanelles Strait determine the physical oceanography of the entire region. The implementation and development of HYCOM (Hybrid Coordinate Ocean Model, http://hycom.org; Chassignet et al. 2007) in the North Aegean Sea (NAS-HYCOM) was firstly described by Androulidakis and Kourafalou (2011).

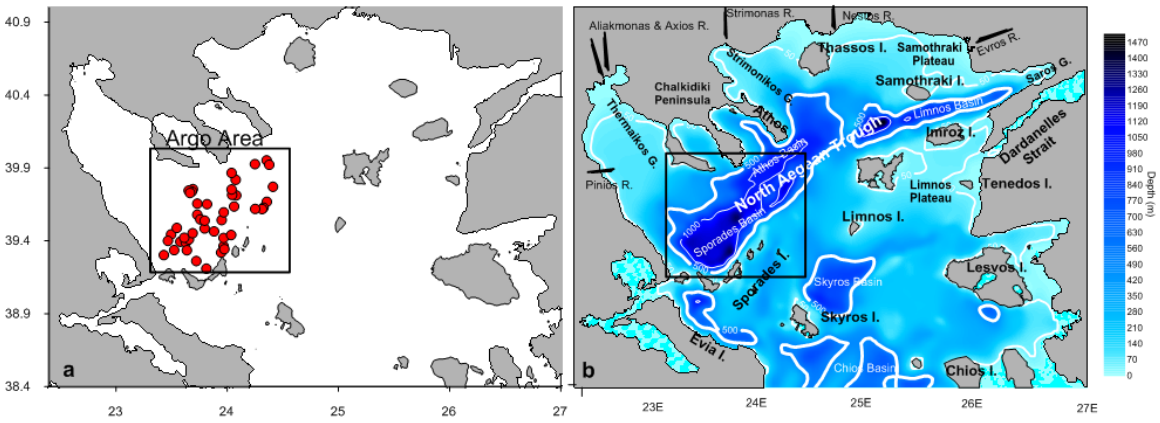

Figure 1. (a) Locations of the Argo float over the N. Aegean region (red points) and (b) the topography of the N. Aegean model domain. The major topographic attributes (deep basins, major rivers, the Dardanelles Strait, islands) and the 500 and 1000 isobaths are also presented. The black box indicates the Argo Area used in the study.

The simulated 2002-2008 period is used to build a "climatological" annual variation of Sea Surface Salinity (SSS) and Sea Surface Temperature (SST) over the Argo Area (Figure 1a), which represents the surface layer of the deep North Aegean Trough. An Argo float was released over the central N. Aegean Sea in October 2014 and traveled over a large part of the deep North Aegean Trough until May 2015 (Figure 1).

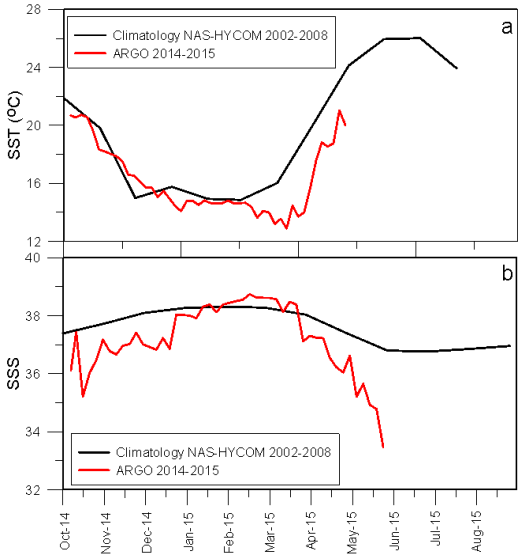

Figure 2 Evolution of (a) SST and (b) SSS as derived from the Argo measurements (2014-2015; red line) and the climatological NAS-HYCOM results (2002-2008; black line), averaged over the N. Aegean Argo Area (Figure 1a).

Both simulated and measured time-series show a similar seasonal SST variation with low values during the winter months (~14 $^{\circ}$C; Figure 2a). In mid-October the SST levels range around 20 $^{\circ}$C, whilst a sharp temperature increase is simulated in spring, as derived from all spring seasons of the 2002-2008 period. Respectively, the Argo float measured a strong SST increase during April-May of 2015. The high salinity levels during winter (>38; Figure 2b) indicate absence of brackish BSW over the study region as derived by both simulated and measured surface fields. The highest Dardanelles outflow rates appear during spring and summer (April-August), due to the highest Black Sea river outflow rates, while the lowest ones are observed during the autumn and winter months (Androulidakis et al. ,2012a). The increase of the BSW outflow during spring is probably the major reason for the simulated and observed SSS drop over the study region. The existence of the buoyant plume (e.g. BSW) also determines the mixed layer characteristics and affects the stratification structure of the upper ocean. The measured and simulated Brunt-Väisälä values (N) show similar seasonal variation during the October-May period (Figure 3). Higher values occur in mid-fall and the end of May, when BSW form a strong isolating layer over the Argo Area, and the stratification of the upper ocean becomes stronger due to the summer atmospheric conditions. The lower N values occur in January and in February for both Argo and NAS-HYCOM cases due to the intensive winter mixing over this N. Aegean region.

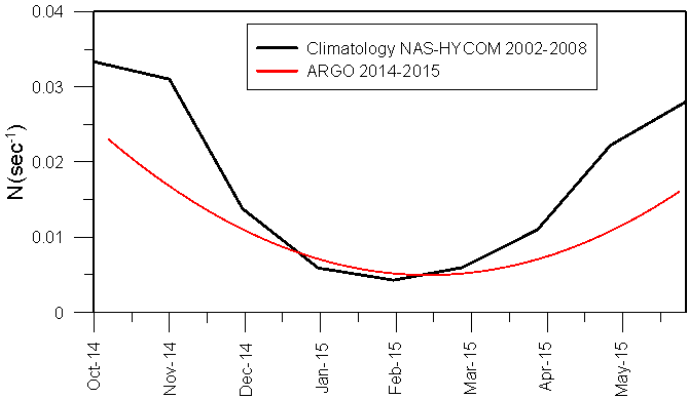

Figure 3 Evolution of the mean monthly stratification frequency N (sec^{-1}) over the upper 100 m as averaged over the Argo Area (Figure 1) from model results for the 2002-2008 period (black line) and from Argo float measurements (red line) for the October 2014 – May 2015 period.

Using available *in situ* measurements, in September 2005 and in April 2006 (R.V. "AEGAIO", HCMR) regarding Skyros Basin, the stratification frequency for the 300-400 m layer is calculated equal to 0.018 sec^{-1} and 0.017 sec^{-1} respectively, close to the observed and simulated values, presented here (Androulidakis et al., 2012b).

The use of Argo floats to evaluate the ocean modeling performance over the water column is a very important and necessary tool for the validation, configuration and improvement of 3-dimensional ocean models.

References

Androulidakis, Y.S., Kourafalou, V.H., 2011. Evolution of a buoyant outflow in the presence of complex topography: the Dardanelles plume (North Aegean Sea). J. Geophys. Res. 116, (C04019),

Androulidakis, Y. S., Krestenitis, Y. N., & Kourafalou, V. H. 2012a. Connectivity of North Aegean circulation to the Black Sea water budget. Continental Shelf Research, 48, 8-26.

Androulidakis, Y. S., Kourafalou, V. H., Krestenitis, Y. N., & Zervakis, V., 2012b. Variability of deep water mass characteristics in the North Aegean Sea: the role of lateral inputs and atmospheric conditions. Deep Sea Research Part I: Oceanographic Research Papers, 67, 55-72.

Chassignet, E., Hurlburt, H., Smedstad, O., Halliwell, G., Hogan, P., Wallcraft, A., Baraille, R., Bleck, R., 2007. The HYCOM (Hybrid Coordinate Ocean Model) data assimilative system. J. Mar. Syst. 65(1-4), 60-83.