Argo data in the Mediterranean Sea

Use of Lagrangian methods in optimizing Argo-float deployment locations in the Mediterranean Sea

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Context

In some cases, planning an Argo-float deployment campaign in the Mediterranean is not a trivial task. The diverse bathymetry and extruding shoreline of the Mediterranean in combination with potentially limited resources (i.e. number of available floats), calls for a higher level of preparation in order to maintain a float operational for longer periods. If the campaign is focused on gaining data from a specific area of interest, while in need of float retrieval at the end, it becomes obvious that random deployment will not provide optimum results. This work argues on the higher efficiency of float deployment in areas where there is a natural tendency of them remaining within the region, in terms of limiting the cost of float retraction or loss, and extending the available data set. This can be achieved by using datasets of current velocities in the Mediterranean (which is the main driver of float movement), and developing an algorithm for the estimation of float convergence locations. It is considered a safe approximation, to assume that drifting of Argo-floats in the Mediterranean happens mostly at their parking depth, where they spend most of the time. The initial approach was to locate areas of higher probability to obtain ARGO float positions (and thus profiles) via the computation of the divergence field at the parking depth. This did not provide useful information, as the signal was covered by numerical noise. Consequently, a simple two-dimensional semi-Lagrangian model of float motion was developed for the surface of 350 m in depth. The floats in this model are considered isobaric (i.e. retaining their initial pressure, set at 350 m) and thus not really Lagrangian, as vertical water motions are not followed. The instances that each float passes by each grid point were assessed, and a map of preferred region was constructed.

Dataset

In order to assess float movement patterns in the Mediterranean Sea, horizontal current velocity data of the region had to be utilized. For this reason, an available 23 year-long reanalysis of the Mediterranean circulation was used (1987 - 2010), from the MyOcean framework (http://marine.copernicus.eu/). The hydrodynamics are supplied by the Nucleus for European Modelling of the Ocean (NEMO). There was no spin-up of the model, and ERAinterim reanalysis was used for the atmospheric forcing. The temporal distribution after the reanalysis is in daily values [1]. For the purposes of this study only the u and v components of the velocity field, at the 350 meters level, were taken into account. The only action performed on the dataset, was to mask regions that fell outside the area of interest, namely, parts of the eastern Atlantic Ocean. The grid was finally cropped to a size of 253 grid-cells in latitude and 675 cells in longitude, containing the whole Mediterranean Sea area. For the initial conditions, floats are placed uniformly on the grid, with one float placed every 7 grid-cells in both directions (Fig. 1). For the boundary conditions it is considered that when a float falls on land it will remain at that point, until the component velocity forces it away from the walls.

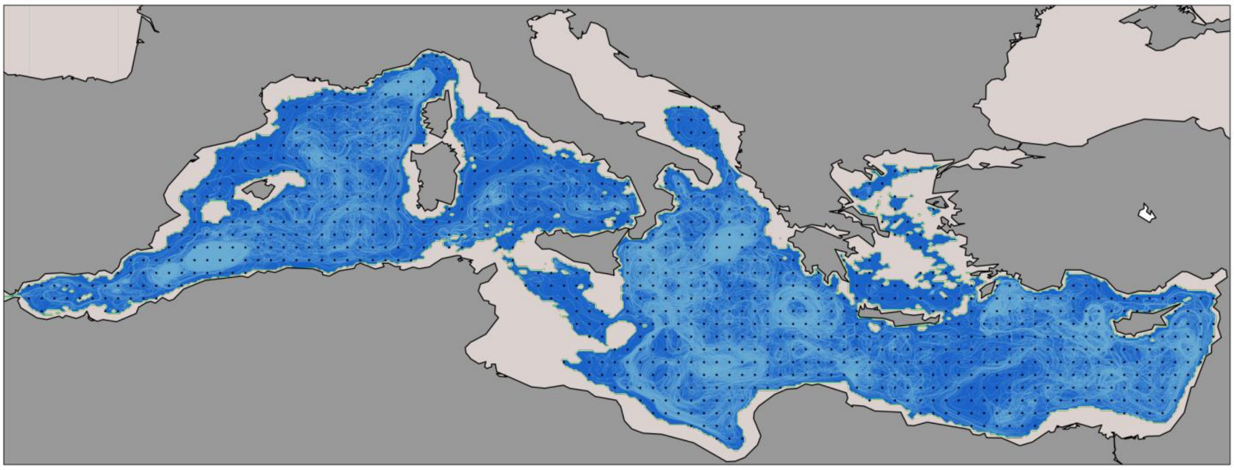

Figure 1: *The initial setup of the Lagrangian model. Floats are placed every 7 grid-cells in both directions. Contrails of the floats can be seen in pale blue for a one-year run (01/01/1990 – 31/12/1990).*

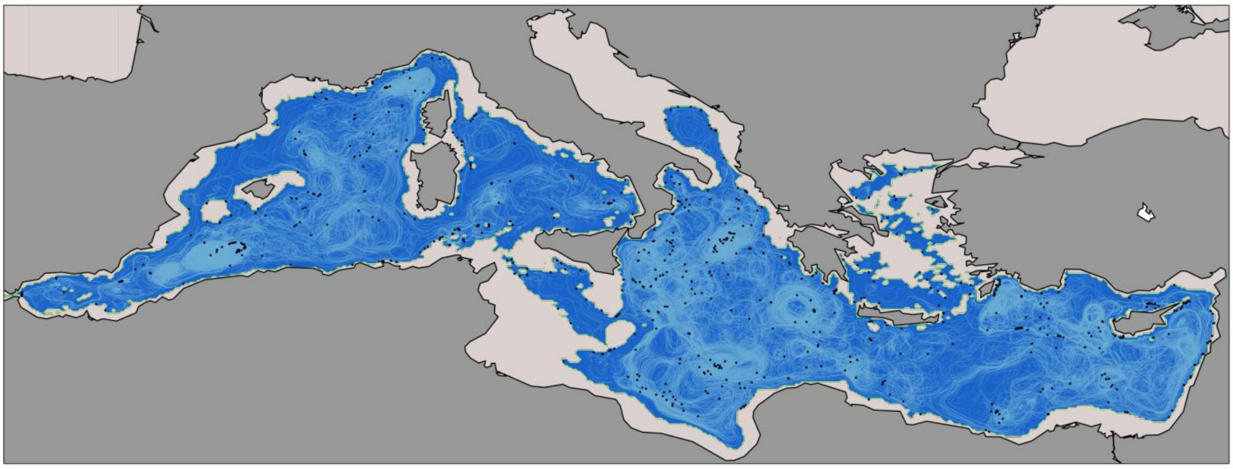

Figure 2: *Same run as in 1. Instance after 6 months (31/06/1990).*

Results and Discussion

Additionally, similar runs were performed for an 11-year range (1987 - 1996). The initial conditions for the model were set for the first of January and ran for one year. Accordingly, runs on the same year range were performed, by initializing the model on the first of April, the first of July and the first of October. Additionally, a function was applied, counting the passages of a float from each grid-cell in each time-step (Fig. 3).

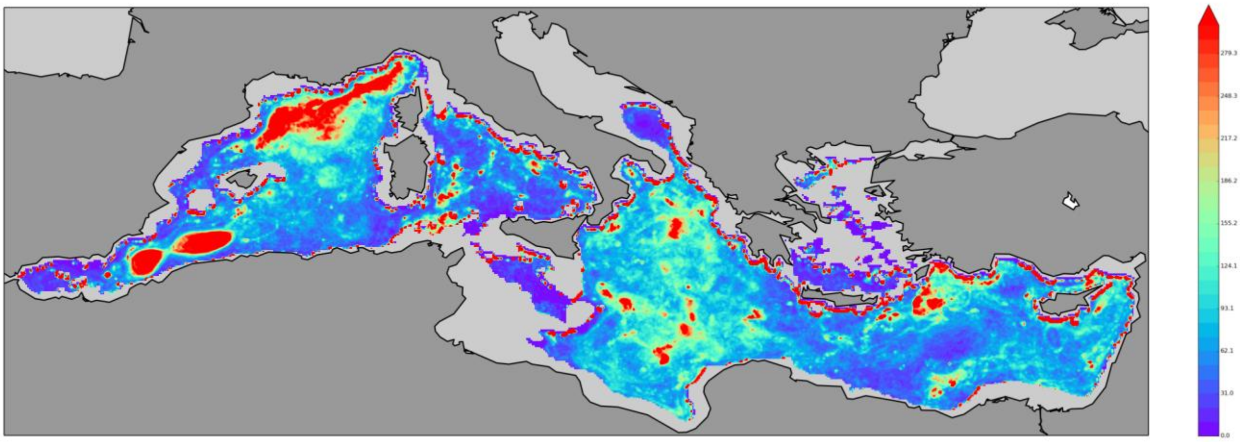

Figure 3: *Number of passages of floats from each grid-cell as average of all runs (initialized on each January, April, July and October for the years 1987-1996).*

Overall, the model showed that the areas we expect to obtain the most ARGO observations in the long run are areas along the northern slopes of the Mediterranean Sea, as well as the greater Gulf of Lions deep-water formation area. Further structures exhibiting higher observation probabilities are large mesoscale structures associated with the North-African current in the Alboran Sea, a sub-basin scale gyre in the center of the Northern Ionian Sea, parts of the Rhodes cyclone south of Rhodes Island and the eastern part of the Gulf of Syrtis. The above areas are probably associated with areas where neutral surfaces, or constant potential vorticity surfaces, intersect with the isobaric surfaces. Purely Lagrangian water elements and floats propagate along neutral surfaces, and this motion is mirrored by the tracks of isobaric floats when the above surfaces remain parallel to isobaric surfaces. We hereby propose that the isobaric floats will not be able to cross, and thus tend to propagate along lines of intersection of the neutral and isobaric surfaces. This question is under further investigation.

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