SURFACE CIRCULATION IN THE MARMARA SEA

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Abstract
We study the surface circulation of the Marmara Sea over about one year using CODE drifters. The pseudo-Eulerian statistics were computed using the whole dataset and in terms of deployment episodes and major wind regimes.
Keywords: Circulation Experiments, Marmara Sea, Surface Waters

The Marmara Sea is a small (70 km x 250 km) semi-enclosed sea connecting the Mediterranean to the Aegean (through the Dardanelles Strait) and to the Black Sea (through the Bosphorus Strait). It has a complex topography characterized by three deep sub-basins each greater than 1000m in depth separated by deep sills and is connected to the straits through canyons. Here, complex processes of two-way exchange flows, jets, eddies and gyres occur [1].

As part of the Turkish Straits System (TSS) experiment, the surface circulation dynamics of the neighboring Black, Marmara and Aegean Seas was studied at scales from inertial/tidal to seasonal using low-cost CODE Lagrangian drifters [2] over about a year (from September 2008 to May 2009). Particular focus was given to the Marmara Sea that was seeded in two seasonal episodes (September 2008 and February 2009). About 30 drifters were deployed in key locations to maximize the geographical coverage and mainly in small (1 nautical mile) clusters of three drifters.

In addition to the standard positioning and data telemetry (SST, battery) provided by the Argos Data Collection and Location System (DCLS) onboard polar-orbiting NOAA satellites (with 300-1000 m position accuracy and about every 100 min), the drifters were equipped with GPS receivers to have a better determination of their position (with less than 10 m of uncertainty) and more frequently (every 30 min).

On the whole, the drifters sampled adequately the Marmara Sea (Fig.1), but the southern part was covered by drifters mainly during the first experiment (September deployments) and the northern part mainly during the second one (February deployments). The lifetime of the drifters in the Marmara Sea is very low due to the recovery by seafarers and stranding (it span from a few days to 50 days) and the mean half lifetime is only 13 days.

The combined raw Argos and GPS positions were edited for outliers and spikes using statistical and manual techniques [3] and were interpolated at regular 2-hours intervals. Surface velocity were calculated by central finite differencing the interpolated positions.

The Pseudo-Eulerian statistics (mean flow, variance ellipses, MKE and EKE) were calculated [4, 5] using a spatial averaging scale of 0.1° x 0.1° overlapped bins for the whole dataset, for the two deployment episodes and for different wind regimes.

The map of the mean surface flow using the whole dataset (Fig. 2) shows two eddies located in the northern part of the sea which extend for about 30 km and reach the middle of the Marmara Sea (the western feature is anticyclonic and the eastern one is cyclonic). South of these large features, a flow of about 20 cm/s joins the Bosphorus to the Dardanelles and another cyclonic eddy is evident in the southeastern area of the Marmara Sea.

The TSS drifter data were included in the MedSVP (Mediterranean Surface Velocity Program) database (http://nettuno.ogs.trieste.it/sire/medsvp/) and will be used to deepen our understanding of the surface dynamics of the Mediterranean and Black Seas.

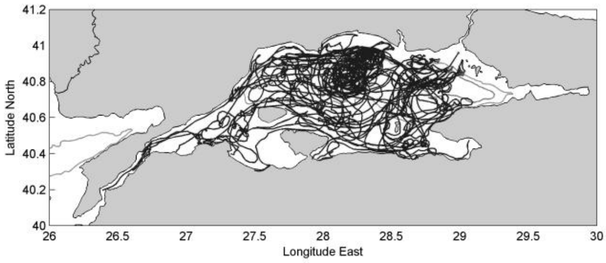

Fig. 1. Drifter spaghetti diagram in the Marmara Sea.

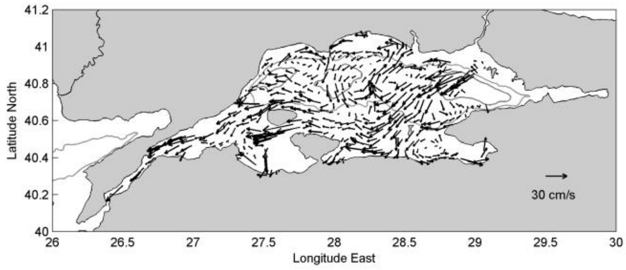

Fig. 2. Mean surface circulation in the Marmara Sea. The mean flow arrows are centred at the centre of mass of the observations in each bin. Data are grouped into 0.1° x 0.1° bins overlapped by 50%. Results for bins with less than 5 observations are not plotted.

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