A LAGRANGIAN VIEW OF THE EASTERN MEDITERRANEAN SURFACE CIRCULATION OVER THE LAST TWO DECADES

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Abstract
The surface circulation of the Eastern Mediterranean (EM) is studied using drifter data between 1990 and 2009, with particular attention to the Sicily Channel, and the Ionian and Levantine Seas. The drifter trajectories and the pseudo-Eulerian statistics computed from them (maps of mean circulation and eddy variability) reveal strong quasi-permanent surface currents over the continental slopes and in several anticyclonic gyres. Seasonal and interannual variability of the surface currents is mostly evident in the Sicily Channel and Ionian Sea.
Keywords: Circulation, Eastern Mediterranean

Surface drifters of various designs have been operated in the EM since 1990 as part of operational (military) and research programs to monitor the surface currents and the sea surface temperature. The most common drifter designs are the SVP and the CODE systems for which the water following characteristics are good and quantified [1]. All drifters were located by, and transmitted data to, the satellite Argos system. Recent models were also fitted with GPS receivers to increase the position accuracy and sampling frequency. The drifter data were processed and arranged in web-based databases under the MedSVP program. In particular, the data used in this work were interpolated (kriging) and low-pass filtered to exclude tidal and inertial motions. They were provided by a total of 487 drifters spanning the period January 1990 to November 2009 and amounting to a total of about 91 drifteryears. The drifter data (Figure 1) show the Atlantic Water (AW) entering in the Sicily Channel in two preferential paths, one close to the Tunisian coast (the Atlantic Tunisian Current), the other one located in the central and northern portion of the region, corresponding to the Atlantic Ionian Stream (AIS) [2, 3]. The surface currents are notably influenced by the wind forcing, with enhanced AW flow into the EM during NW Mistral winds prevailing in winter. This seasonality mainly driven by the winds is also evident in the southwestern Ionian [3]. In the northern Ionian, the drifters indicate both seasonal and interannual variabitlities with (1) a mean anticyclonic circulation dominating prior to mid-1997 and extending the AIS towards the NE [4]; (2) a general cyclonic circulation between mid-1997 and 1999, with the southern limb of the cyclone advecting AW towards the E in the central Ionian, and (3) alternating anticyclonic (cyclonic) circulation patterns in summer (winter) in 2006-2007 [3].

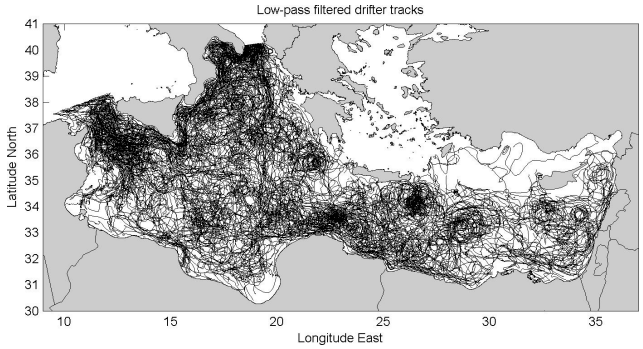

Fig. 1. Composite diagram of all the low-pass filtered drifter trajectories in the EM (excluding the Adriatic and Aegean Seas) between January 1990 and November 2009.

East of 20°E, the eastward motion of AW takes places in the Libyo-Egyptian Current (LEC) on the African continental slope and in the form of numerous anticyclonic eddies created by the instability of the LEC (Libyo-Egyptian Eddies, LEEs [3]), by the wind curl (Ierapetra and Pelops Eddies) and by topography. The northern limbs of some of these eddies in the open sea correspond to the Mid Mediterranean Jet put forward by the Physical Oceanography of the Eastern Mediterranean (POEM) project [5]. In the eastern Levantine Sea, the Lagrangian data reveals a strong coastal/slope northward current off the Middle East coast [3] along with several eddies presumably created by the instability of the coastal current. In particular, recent measurements in 2009 has confirmed the complexity of the surface circulation in this region and the persistence of strong eddies between Cyprus and Israel. In the northern Levantine, including the Cilician sub-basin, the drifter data are too scarce to deduct robust and significative results on the surface circulation. Pseudo-Eulerian statistics [2, 3] confirm the above results and provide a more quantitative description of the EM surface currents in terms of mean flow (Figure 2), eddy, seasonal and wind-induced variabilities. Kinetic energy levels of the mean (MKE) and fluctuating (EKE) components of velocity are high in the major currents and eddies mentioned above, and in general the EKE tend to exceed the MKE, indicating the predominance of the fluctuations with respect to the mean.

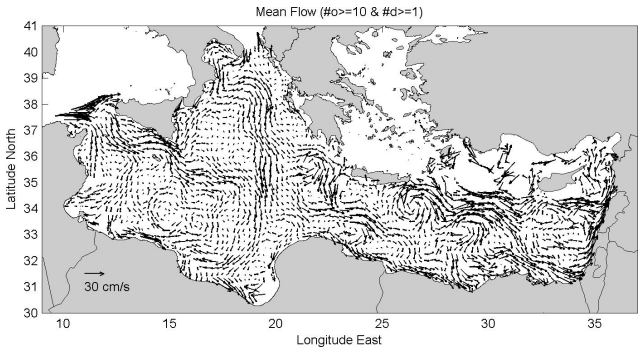

Fig. 2. Mean surface circulation of the EM based on the drifter data shown in Figure 1 averaged in bins of 0.25° x 0.25°.

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