SURFACE CIRCULATION IN THE EASTERN MEDITERRANEAN USING LAGRANGIAN DRIFTERS

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Abstract

In the period spanning from September 2005 to October 2006, 81 Lagrangian drifters were deployed in the Eastern Mediterranean using ships of opportunity or during oceanographic cruises. Surface circulation statistics, both Eulerian and Lagrangian, were performed using data recorded until 18 August 2006. The main circulation features of the area, together with their variability, are well delineated. The energy of the mean flow and of the fluctuating currents were also computed.

Keywords : Circulation Experiments, Eastern Mediterranean, Surface Waters.

As part of the EGITTO and EGYPT programs started in September 2005, the Eastern Mediterranean surface circulation was studied using Lagrangian drifters. A statistical description of the circulation based on the drifter data between September 2005 and August 2006 is presented.

Data and methods

A total of 81 SVP drifters were deployed from September 2005 to October 2006. In particular, 31 drifters were released in the Sicily Channel on a seasonal basis and 50 drifters were deployed in the southeastern Ionian, the Cretan Passage and the Levantine sub-basin during four oceanographic cruises/transits. All the drifters were equipped with a holey sock drogue centered at a nominal depth of 15 m to minimize the influence of the local winds and with a radio transmitter emitting every 90 seconds to send data (e.g., sea surface temperature) and be tracked by the Argos system aboard the NOAA near-polar orbiting satellites. The raw Argos positions provided until 18 August 2006 were edited for outliers and spikes using statistical and manual techniques [1] and interpolated at regular 2-hours intervals [2], filtered with a low pass Hamming filter of 36 hours to eliminate tidal and inertial currents and finally sub-sampled every 6 hours. Surface velocity was calculated by central finite differencing the interpolated positions.

Results

The drifters sampled adequately the Eastern Mediterranean with a maximum drifter density in the Cretan Passage and in the Sicily Channel, due to the high residence time (also because of the drifters released and trapped in the eddies) and to the large number of deployments in these areas (Fig.1). The drifter operational life is about 3-6 months because of the high probability of being picked-up by seafarer or stranding. As computed until 18 August 2006, the maximum drifter lifetime is 278 days and the mean half-life (the time after deployment for which 50% of the instruments still provide useful data) is about 110 days. The processed data include a total of 19.6 drifter-years and the maximum number of drifters operating simultaneously (34 units) occurred on the 24 April 2006. The mean flow and the variance were calculated for the whole period from the filtered data using a spatial averaging scale of 1° x 1° overlapping bins. The obtained surface currents show a strong flow of about 20 cm/s entering in the Sicily Channel and bifurcating southeast of Sicily, one branch going to the north and the other to the east. In the Ionian, the currents move southward and then veer to the west off the Libyan coast. In the Cretan Passage and Levantine Sub-basin the currents are strong (about 20-25 cm/s) and flow eastward along the continental slope off Egypt, Israel and Lebanon. Anticyclonic circulation features off the Libyan coast and in Ierapetra and Mersa Matruh areas are striking. The mean kinetic energy of the mean flow (MKE) (Fig.2a) and the mean kinetic energy of the fluctuations, also called eddy kinetic energy (EKE) (Fig.2b), were computed rejecting bins with less than 50 observation. The MKE is maximum southeast of Sicily, east of Crete, and in the eastern part of the Levantine sub-basin, with values that reach 500 cm^2/s^2, while the EKE, as expected, is maximum (with values higher than the MKE) in correspondence to the major anticyclonic eddies and in areas with well-known strong seasonal variability. Calculating the ratio EKE/MKE, the higher values (velocity fluctuations more energetic than the mean flow) are found in the Cretan Passage and in the Ionian, while strong currents with low variance are evident in the northern part of the Sicily Channel and along the slope, especially in the eastern Levantine Sub-basin. Lagrangian statistics were computed after the Eulerian mean flow had been subtracted from the drifter velocities. Energy levels, diffusivity and integral time scales are larger in the zonal direction. The covariance at zero time-lag is about 220 (200) cm^2/s^2 in the zonal and meridional directions respectively; diffusivity reaches an asymptote after about 4 days with values about 3 x 10^7 (2 x 10^7) cm^2/s. Additional drifters will be deployed in the Eastern Mediterranean until March 2007. The above-described statistics will be then re-computed using the upgraded dataset.

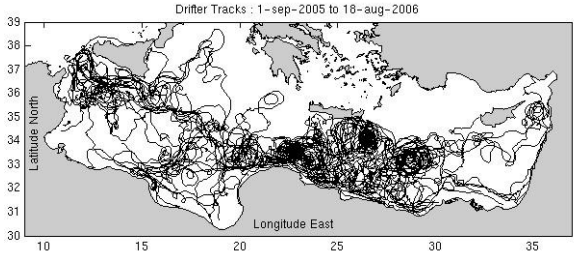

Fig. 1. Drifter trajectories between 1 September 2005 to 18 August 2006.

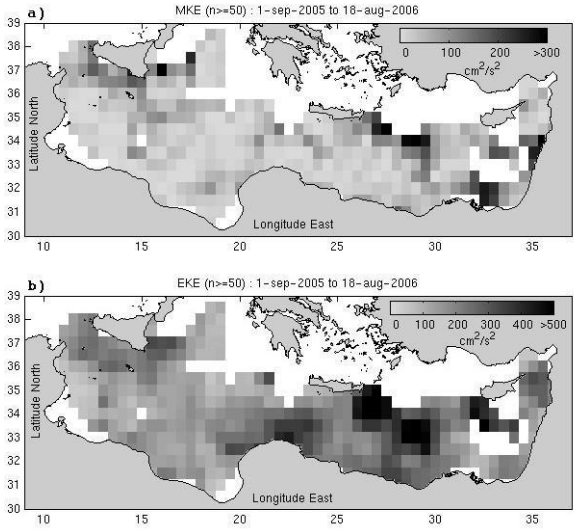

Fig. 2. MKE (a) and EKE (b) for the period 1 September 2005 - 18 August 2006. Only bins with more than 50 observations were taken into account.

References

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