GEOSTROPHIC CURRENTS AND KINETIC ENERGIES IN THE BLACK SEA

Milena Menna [1]* and Pierre M. Poulain [1]
[1] OGS - mmenna@ogs.trieste.it

Abstract
Drifter measurements and satellite altimetry data are combined to investigate the surface geostrophic circulation of the Black Sea in the period 1999-2009. Seasonal and interannual variability of currents and kinetic energy fields are described with particular attention to the mesoscale and sub-basin coastal eddies.

Keywords: Black Sea, Circulation, Surface waters

The upper-layer circulation of the Black Sea derives from a complex interaction among different and multi-scale processes. The main characteristics of the basin, sub-basin and mesoscale patterns are analysed using drifter data combined with satellite sea level anomalies.

The combination of these two independent datasets allows to remove the biases that arise from the irregular sampling of drifters and to enhance the accuracy of satellite data in the coastal areas. Regression models are used to remove the currents directly induced by the winds from the drifter velocities and to combine drifter and satellite altimetry data, following the methods of [1] and [2].

The combined dataset is used to estimate pseudo-Eulerian velocity statistics for different time periods and to describe the spatio-temporal variability of the surface circulation in different regions of the Black Sea. The pseudo-Eulerian statistics computed with the combined geostrophic currents are defined as 'unbiased' because they are less affected by the non-uniform drifter sampling ([1]; [2]).

The Rim Current is stronger in winter/spring (mean speeds of about 20-25 cm/s; maximum values larger than 40 cm/s along the Anatolia and Crimea coasts; Fig.1), forming a cyclonic loop that surrounds the Western and Eastern Gyres (speeds less than 15 cm/s). In summer/fall the Rim Current is weaker, with mean speeds of about 15-20 cm/s (Fig. 2).

The sub-basin Batumi Eddy is usually anticyclonic with a diameter of ~ 100 km and is located in the south-east corner of the basin (between 41°-42°N and 39.5°-42°E; Fig. 2). Periods of intense activity are observed in 2006 and 2008, when this structure shows higher dimensions (diameter of ~ 200 km) and speeds larger than 30 cm/s; occasional seasonal inversions of the circulation in the Batumi region, from anticyclonic to cyclonic pathway are observed in winter 2001-2002 and fall 2004, 2006 and 2008. The sub-basin Sevastopol Eddy, located off the western side of Crimea peninsula, has a less periodic nature with respect to the Batumi Eddy; it is usually observed in spring and summer with speeds of about 15-20 cm/s.

The interannual variability of mesoscale eddies located along the Anatolia, Caucasus and Crimea coasts is described in terms of kinetic energy of velocity residuals (KE). These eddies are permanent (Crimea, Sinop and Kizilirmak eddies), quasi-permanent (Bosphorus, Bartin, Sukhumi eddies) or intermittent (Caucasus, Sakarya, Kerch eddies) features and can interact and merge with each other showing values of KE between 200 cm^2/s^2 and 600 cm^2/s^2.

Results are compared to those in [3] based only on drifter data.

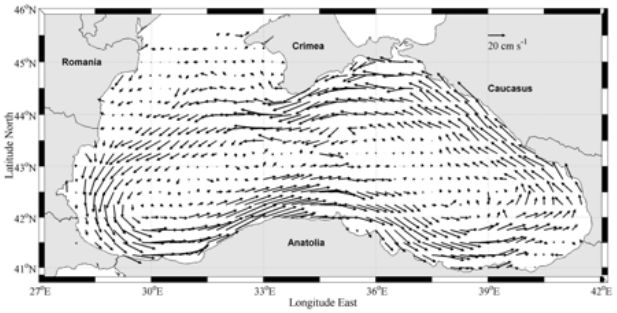

Fig. 1. Unbiased estimates of the surface geostrophic circulation in the Black Sea during winter/spring (December-May).

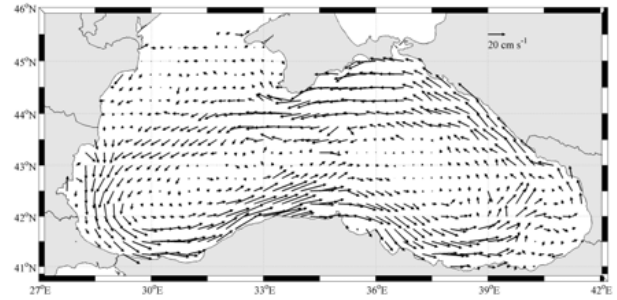

Fig. 2. Unbiased estimates of the surface geostrophic circulation in the Black Sea during summer/fall (June-November).

References

1 - Menna, M., Poulain, P.-M., Zodiatis, G. and Gertman, I., 2012. On the surface circulation of the Levantine sub-basin derived from Lagrangian drifter and satellite altimetry data. *Deep-Sea Res.* 65, 46–58.
2 - Poulain, P.-M., Menna M. and Mauri, E., 2012. Surface geostrophic circulation of the Mediterranean Sea derived from drifter and satellite altimeter data. *J. Phys. Oceanogr*., 42 (6), 973-990.
3 - Poulain, P.-M., Barbanti, R., Motyzhev, S., Zatsepin, A., 2005. Statistical description of the Black Sea near-surface circulation using drifter in 1999-2003. *Deep-Sea Res. I*, 52, 2250-2274.