ON THE DARDANELLES OUTFLOW IN THE AEGEAN SEA:IMPLICATIONS ON THE BASIN-WIDE CIRCULATION AND OPERATIONAL MODELING

Villy Kourafalou
Hellenic Centre for Marine Research (HCMR), Greece and University of Miami, RSMAS, U.S.A. - vkourafalou@rsmas.miami.edu

Abstract
The Mediterranean Sea and the Black Sea are connected through the Turkish Straits System and the biophysical processes that control the Aegean Sea circulation and ecosystem dynamics. The outflow of waters of Black Sea origin in the Aegean Sea through the Dardanelles Strait is a key mechanism in the coupling of the two basins. Results from observational and modeling studies will be employed to highlight the critical role of the outflow in the Aegean Sea dynamics, with implications on basin-wide Mediterranean flow and water mass characteristics. Improvements on operational forecasting in the Aegean and Eastern Mediterranean regions require comprehensive measurements of the Black Sea waters outflow to be used in the understanding and numerical representation of the Straits dynamics.
Keywords : Aegean Sea, Dardanelles, Danube Delta.

The Dardanelles outflow contains waters of Black Sea origin (BSW) that are generally cooler and with higher nutrient content than those of the oligotrophic Aegean Sea [1]. This allows the outflow to be detected in sea surface temperature (SST) and ocean color imagery [2]. The BSW is also fresher and responsible for the overall lower salinities in the northern Aegean; in this area, the frontal zones are related to the spreading of BSW above the saltier modified Levantine Intermediate Water (LIW), which originates in the southern Aegean [3-7].

A recent study of the Aegean Sea circulation, based on drifters deployed at different seasons [8], reveals the presence of an intensified rim current system that is consistent with the buoyancy introduced by the Dardanelles outflow and the prevailing along-axis wind forcing from the north. The overall tendency of the buoyancy forcing is to lead a cyclonic circulation around the Aegean. The dominant northerly winds favor downwelling along the western Aegean coast that tends to enhance the buoyancy driven current system; both buoyancy and wind forcings seem to contribute to a jet-like flow along the Evia island, which forms the major pathway for BSW waters to reach the southern Aegean, thus bridging the Black Sea and the Eastern Mediterranean. Implications on larger scale circulation and decadal time variability have been discussed in [5].

Based on a network of oceanographic buoys and a set of atmosphere and ocean numerical models, the Hellenic Center for Marine Research has developed the operational POSEIDON system, which has been providing regional sea monitoring and short term (72 hour) forecasts of meteorological and oceanic conditions in the Aegean Sea since 1999 ([9],[10]). The nesting in larger scale models and new environmental components of the system (pollutant and nutrient transport modeling) allow predictions associated with ecosystem functioning and dispersion forecasts of oil-spills or other pollutants in case of accidents in the Aegean Sea or the Eastern Mediterranean. As the POSEIDON operational system enters a new phase of development with substantial improvements in both its observational and modeling components, a new parameterisation of the Dardanelles outflow is essential to minimize current uncertainties in exchange rates and water properties, a result of observational limitations and the lack of a coupled Aegean and Black Sea modeling system.

Numerical experiments will be presented that highlight changes in the simulation of Aegean circulation features, depending on different representations of the Dardanelles plume. Analysis of hydrographic data [11], along with model and drifter computed particle trajectories will elucidate the influence of the Dardanelles outflow on Aegean circulation features and the sensitivity of model predictions on subtle changes in the representation of the development and evolution of the Dardanelles plume.

References

1 - Siokou-Frangou, I., M. Bianchi, U. Christaki, E. Christou, A Giannakourou, O. Gotsis, L. Ignatiades, K. Pagou, P. Pitta, S. Psarra, E. Souvermetzoglou, F. Van Wambeke, and V. Zervakis, 2002. Carbon flow in the planktonic food web along a gradient of oligotrophy in the Aegean Sea (Mediterranean Sea) *J. Mar. Sys.*, 33-34, 335-353.
2 - Zodiatis, G., S., Alexandri, P. Pavlakis, L. Jõnnson, G. Kallos, A. Demetropoulos, G. Georgiou, A. Theodorou, E. Balopoulos, 1996. Tentative study of flow patterns in the North Aegean Sea using NOAA-AVHRR images and 2D model simulations. *Ann. Geophysicae*, 14, 1221-1231.
3 - Zodiatis, G. and E. Balopoulos, 1993. Structure and characteristics of fronts in the North Aegean Sea. *Bull. Oceanol. Theor. Appl.*, XI, 113-124.
4 - Zodiatis, G., 1994. Advection of the Black Sea water in the north Aegean Sea. *Global Atmos. Ocean Syst.*, 2, 41-60.
5 - Zervakis, V., D. Georgopoulos and P. G. Drakopoulos, 2000. The role of the North Aegean in triggering the recent Eastern Mediterranean climate changes. *J. Geophys. Res.*, 105, 26,103-26,116.
6 - Kourafalou, V. H. and K. Barbopoulos, 2003. High-resolution simulations on the North Aegean Sea seasonal circulation. *Ann. Geophys.*, 21, 251-265.
7 - Kourafalou, V.H. and K.P. Tsiaras, 2007. A nested circulation model for the North Aegean Sea. Ocean Sci., 3, 1-16.
8 - Olson, D.B., V.H. Kourafalou, W.H. Johns, G. Samuels and M. Veneziani, 2007. Aegean Surface Circulation from a Satellite-tracked Drifter Array. *Journal of Physical Oceanography,* In Press.
9 - Nittis, K., V. Zervakis, E. Papageorgiou and L. Perivoliotis, 2002. Atmospheric and Oceanic observations from the POSEIDON buoy network: Initial results. *Global Atmos. Ocean Syst.*, special issue - POSEIDON: An Integrated Operational Oceanographic System, Vol. 8, 2-3, pp. 87-99.
10 - Nittis, K., L. Perivoliotis, G. Korres, C. Tziavos, I. Thanos, 2006. Operational monitoring and forecasting for marine environmental applications in the Aegean Sea. *Environmental Modelling and Software*, 21, 243-257.
11 - Kontoyiannis, H., V. H. Kourafalou and V. Papadopoulos, 2003. The seasonal characteristics of the hydrology and circulation in the Northwest Aegean Sea (Eastern Mediterranean): observations and modeling. *J. Geophys. Res.*, 108, C9, 3302, doi: 10.1029/2001JC001132.