DARDANOS: A WERA SYSTEM FOR MONITORING THE DARDANELLES OUTFLOW IN THE AEGEAN

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Abstract
The University of the Aegean and the Hellenic Centre for Marine Research have jointly installed a WERA HF radar system at the eastern coast of the island of Lemnos, Greece, in an effort to continuously monitor the surface Dardanelles current, a permanent feature carrying Black Sea Waters into the North Aegean Sea. Through this effort, the two Greek institutions aim ato estimating the volume flux of Black Sea Waters into the Aegean, as well as fluxes of biochemical properties responsible for the meridional oligotrophy gradient in this Mediterranean basin.
Keywords: Aegean Sea, Coastal Systems, Dardanelles, Black Sea

The Mediterranean and Black Seas are two neighboring seas of highly contrasting thermohaline and biochemical character, connected through the Turkish Straits System (TSS, i.e. the Dardanelles Strait, the Marmara Sea and the Bosphorus Strait). The water exchange through the Straits plays a critical role in the thermohaline and biogeochemical functioning of both seas. The deep layer of the Black Sea is continuously fed by Mediterranean waters through the subsurface Bosphorus current, maintaining the high salinity stratification of the basin [1] and thus, their permanently anoxic conditions [2]. The Black Sea waters (BSW) entering the Mediterranean as the surface Dardanelles current, form a light brackish layer over the North Aegean, playing a crucial role in controlling deep water formation processes in the region [3], and maintaining a meridional gradient in the oligotrophy of the Aegean Sea [4]. It is still unclear from climatic predictions whether the freshwater deficit of the Mediterranean, or the warming of the sea will prevail, thus contributing to lower or higher stratification of the sea. Thus, the insulating role of the BSW surface layer of the North Aegean may become even more crucial in controlling the thermohaline functioning of the basin. As the freshwater budget over the large Black Sea catchment area largely determines the characteristics of the exchange, the latter may become a significant climatic index for the region. For the above reasons, the University of the Aegean and the Hellenic Centre for Marine Research have recently installed a WERA High Frequency system for monitoring surface currents on the east coast of Lemnos island. The HF system, named "Dardanos", is able to monitor surface currents at semi-hourly intervals and 1.5 km resolution as far as the Dardanelles exit, thus providing a formidable tool for high-frequency monitoring of the surface circulation of the region (figure 1).

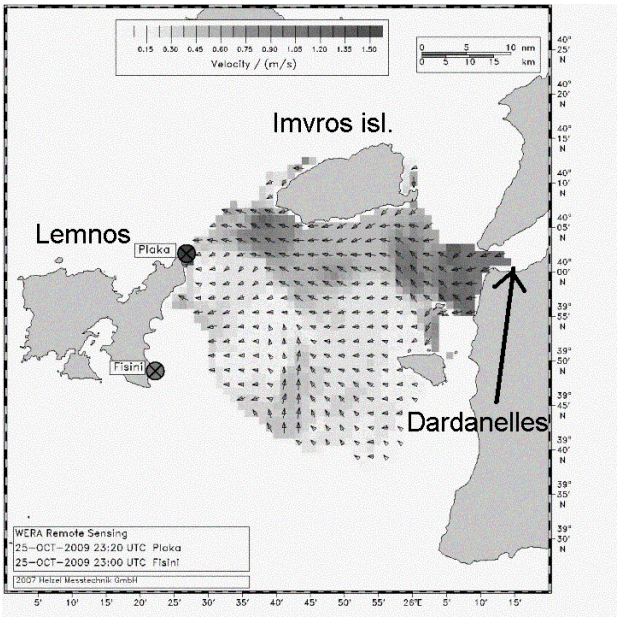

Fig. 1. Surface current map from October 25th, 2009. The darker shades at the northern part of the domain (corresponding to higher velocities) define the extent of the Dardanelles current

Our initial planning required that the system's range extends to the mouth of the Strait, in order to be able to separate the Dardanelles Current from a very energetic anticyclone that often contributes to the current through the Lemnos - Imvros channel. The HF system has been in operation since October 2009, and preliminary analysis of the data reveals that the system fulfills the above requirement about 30% of the time. Furthermore, the range of the system appears to vary depending on weather conditions. We examine the potential bias such behaviour could pose on the estimated Dardanelles volume fluxes.

A possible challenge is the estimation and removal of Stokes drift from the observed currents in order to assess the Dardanelles outflow. It should be noted that a linear antenna array (beam forming method) would permit a direct measurement of the wave field, however such a methodology was not applicable in this case due to topographic restrictions. Preliminary analysis has also revealed the sporadic presence of areas of erratic measurements, possibly due to electromagnetic noise in the region. Such errors should be readily removed through statistical methods.

While HF radars are being used worldwide mainly for operational purposes and for process studies (especially for coastal dynamics studies), it is -to our knowledge- the first time that such a system will be exploited in climatological monitoring of basin exchange and thermohaline functioning. The Department of Marine Sciences of the University of the Aegean aims at exploring different methodologies of estimating mixed-layer-depth and assume slab-layer behaviour in an effort to estimate the volume flux of Black Sea Waters into the Mediterranean. This time series will be compared with estimates from previous studies. The Hellenic Centre for Marine Research plans to exploit the information in improving its circulation predictions for their operational oceanography project and other climatological applications. The produced information will also be available for studies of the ecological functioning of the North Aegean, of pollutant dispersion (taking the Dardanelles exit as a potential point source of pollution in case of a marine accident), and in any related operational oceanography applications.

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