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Propagation of Mediterranean-origin water into the Black Sea interior: pathways, travel times and underlying mechanism

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About 300 km3 of warm saline Mediterranean-origin waters (MOW) are annually transported into the Black Sea by the lower current in the Bosphorus Strait. After passing through the Strait, saline and relatively dense MOW propagate over the shelf and descend down the continental slope, mixing with less saline and colder surrounding waters. As a result of this mixing, anomalously high- or low-temperature water plumes are formed, which laterally propagate in the Black Sea at intermediate depths (100-600 m). Recent studies suggest that lateral propagation of the MOW play a key role in maintenance of the stable thermohaline and hydrochemical structure of the water column in the Black Sea. This process is thought to be responsible for formation and maintenance of the main pycnocline and isothermal layer at the depths of 500-600 m, for ventilation of the anoxic waters at depths below the pycnocline and for the existence of the sub-oxic layer separating the oxic and anoxic waters of the Black Sea. This concept, however, is not flawless and not complete because of the absence of observation-based evidence of a regular or at least occasional propagation of the MOW throughout the entire Black Sea. To address this problem and to elucidate the mechanism(s) related to the inflow of the MOW and its spreading in the Black Sea, we compiled a comprehensive set of 2005-2009 data, which include hydrographic measurements from research vessels and Argo floats, meteorological data from weather stations near the Bosphorus Strait and available ADCP time series in the Strait. Based on the hydrographic data, we constructed a schematic chart showing the pathways of the MOW propagation into the Black Sea interior and estimated the MOW travel times along the pathways. A joint analysis of the atmospheric and marine data allowed us to reveal a direct link between passages of northward-moving deep cyclones over the Bosphorus Strait, blockage events in the Strait and occasional events of anomalously strong injections of the MOW into the Black Sea circulation system. Overall, the results strongly suggest that atmospheric conditions over the Bosphorus Strait and variability of the Bosphorus inflow control the basin-wide spreading of the MOW in the Black Sea and thus affect the large-scale hydrology of the Sea.