The Mediterranean and Black Seas: Analysis of Large Sea Level Anomalies

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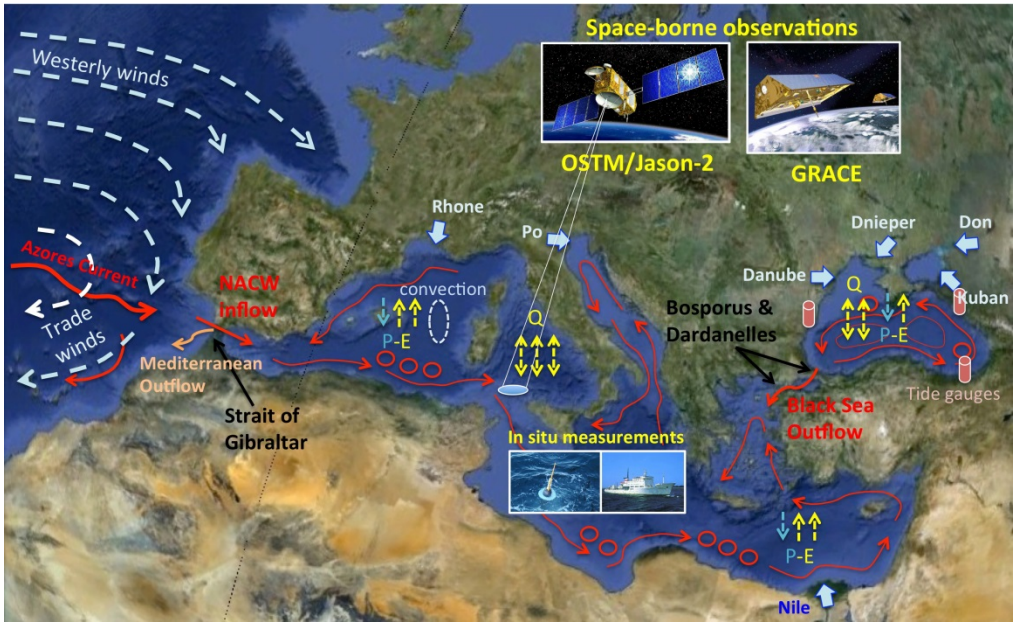
Satellite altimetry observations by OSTM/Jason-2 and Envisat missions have revealed extremely large sea level fluctuations that occurred in the Mediterranean and Black seas in the winters of 2010 and 2011. During this time the basin-wide non-seasonal sea level in the Mediterranean Sea increased by about 10 cm reaching the record maximum during the observational period. Similar anomalies were observed in bottom pressure derived from the gravity field measurements by the NASA's GRACE twin satellites. In the Black Sea, the associated sea level anomalies exceeded 20 cm lagging behind the sea level anomalies in the Mediterranean Sea by about 1 month. Understanding and quantifying the dynamics of sea level variations in these semi-enclosed seas is important because of the possible amplified sea level response to climate forcing, and because of the densely populated coasts in the region. This research is being conducted in collaboration with Dr. Felix Landerer from Jet Ppropulsion Laboratory, California Institute of Technology, as a contribution to NASA Ocean Surface Topography Science Team. Using satellite altimetry and gravity observations and an atmospheric re-analysis product we have found that the non-seasonal sea level and ocean mass fluctuations in the Mediterranean Sea are driven by concurrent wind stress anomalies over the adjacent subtropical North Atlantic Ocean, just west of the Strait of Gibraltar, and extending into the strait itself. Coupling satellite data to tide and river discharge gauges as well as to surface heat and freshwater fluxes we have provided a comprehensive up-to-date analysis of sea level variability in the Black Sea and quantified the role of different environmental factors that force the variability. In addition to the effect of freshwater fluxes, sea level in the Black Sea is found to respond to the non-seasonal fluctuations of the Mediterranean Sea level. The observed time lag of the response is due to friction that constrains the exchange through the Bosphorus Strait.



Scheme illustrating physical processes driving the variability of sea level in the Mediterranean and Black seas. Abbreviations: NACW – North Atlantic Central Water, Q – net surface heat flux, P-E means Precipitation-Evaporation. Red arrows illustrate surface circulation.