Long Term Variations in the Basin Circulation, Deep and Intermediate Water Formation, and Chemical/Biological Parameters in the Northern Levantine Sea

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Abstract

Recent measurements in the Levantine Basin indicate a strong signal of interannual variability, complementing the background seasonal signal, and modifying the hydrography and the basin-wide circulation over time scales of a few years. Stable sub-basin scale gyres and eddies and the interconnecting jets persist over long periods of time, while their form and meso-scale structure are slowly modified, leading to the transition from one state to another. The temperature-salinity relationship, abundance, and localization of the various water masses are simply the end product of this variability.

The variability appears to be linked with climatic events. It has recently become more appreciable that the interannual variability also impacts the periods and intensity of the water mass formation. The northern Levantine Sea is the primary source region for the Levantine Intermediate Water (LIW). The Bottom Water (BW) and the Deep Water (DW) of the Eastern Mediterranean should be distinguished from each other: the BW originates from the Adriatic Basin, and the overlying DW constitutes a transition between the BW and the intermediate water masses. Local contribution to the Eastern Mediterranean DW has been suggested, in the form of Aegean deep outflows, or local convection processes.

Observations in the northern Levantine Sea during March 1992 shed new light on the above processes, showing simultaneous formation of DW in the Rhodes Gyre (RG) and of LIW in the adjacent regions. The deep convection region coincides with the permanent dome structure of the Rhodes Gyre, where water is overturned by cooling only during sufficiently severe winters. The LIW is produced in a much larger area of the northern Levantine than previously thought, by direct surface cooling and mixing of the near-surface stratified waters. Earlier observations in 1989 showed massive formation of LIW in the northern Levantine, but the changes in the structure of the RG stopped short of overturning at the center. The only other known occurrence of DW formation in the RG is during 1987 from Russian observations.

The chemistry and primary production is well correlated with the flow structures such as eddies, jets and fronts. Dissolved nutrients follow the circulation features such that the nutricline (the depth in which the nutrient concentration rises rapidly to reach the deep reserve values) [rises (?)] to within the euphotic zone (from surface to the 70-120 m depth range) in the cyclonic regions such as the permanent upwelling center of the Rhodes Gyre, and dips below the euphotic zone in the other areas. The combined effects of light penetration and variation of nutricline depth with the eddy field determine the production. A deep

chlorophyll maximum (DCM) is observed persistently in the pelagic waters of the Levantine (at depths of 60-70m in the cyclonic regions and 110-120m in anticyclonic regions), since the phytoplankton habitate the depths of 1-10 % of surface irradiance, at which nutrients and light are simultaneously available. The average phytoplankton production in the Rhodes Gyre area is comparable to some areas of the Western Mediterranean. In the anticyclonic regions, only regenerative production is observed at depths (400-500m) much below the euphotic zone. An examination of chlorophyll data during the last several years shows peak production during the winter season (January - March), with large interannual variations.

The convective events such as during March 1992 are shown to lead to massive upwelling of nutrient rich water and blooms of plankton. The nutrients (both P and N) during this event were uniform from the surface to depths greater than 1000m and the accompanying intense burst of phytoplankton (the largest ever observed - since 1986) accounted for average concentrations that were at least twice as large (and far greater for some individual stations) as the previously measured values of the same seasonal period in the same region. A homogeneous distribution of plankton was observed in most of the region, as compared to the DCM structure observed at earlier times.

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ABSTRACTS