EFFECTS OF THE ADRIATIC-IONIAN BIMODAL OSCILLATING SYSTEM (BIOS) ON THE BIOGEOCHEMISTRY OF THE ADRIATIC SEA

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Abstract
The Adriatic-Ionian Bimodal Oscillating System (BiOS) is an internal mechanism capable to shape the thermohaline properties and the biogeochemical pool in the Southern Adriatic. The BiOS mechanism determines the upper-layer circulation (anticyclonic or cyclonic) in the Ionian Sea. Biogeochemically, the interfaces (i. e. the nutricline, and the oxygen minimum / nutrient maximum layer) at the border of the gyre in the northern Ionian are upwelled or downwelled depending on the circulation regime. This results in varying of the water characteristics advected northward through the Strait of Otranto, and the dynamics and the trophism of the Adriatic Sea.
Keywords: Adriatic Sea, Ionian Sea, Nutrients

Recently, the upper-layer circulation in the Ionian Sea has been associated with the deep thermohaline circulation [1] through a negative feedback mechanism [2], here called Adriatic-Ionian Bimodal Oscillating System (BiOS). In few words: the Ionian upper-layer circulation reverses from anticyclonic to cyclonic and viceversa (Fig. 1).

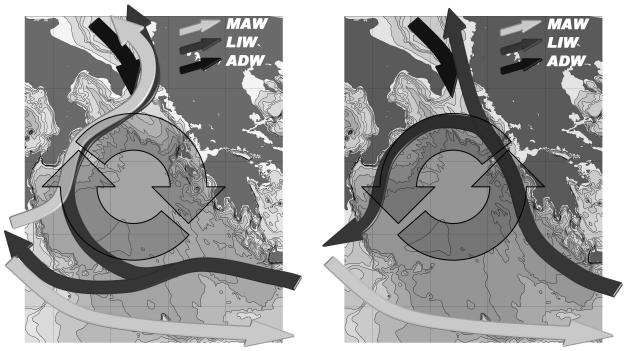

Fig. 1. Anticyclonic (left) and cyclonic (right) circulation modes and the consequent pathways of the major water masses according to the BiOS mechanism.

The anticyclonic circulation allows the modified Atlantic Water (AW) to enter the Adriatic, decreasing the average salinity there. In turn, the Adriatic produces and exports water with progressively lower density. Subsequently, the isopycnal surfaces along the pathway of the Adriatic Deep Water (AdDW) at the flanks of the Ionian deepen, the corresponding sea level increases, gradually weakening the anticyclonic upper-layer circulation and finally inverting the surface pressure gradient and the circulation from anticyclonic to cyclonic [2]. In turn, the cyclonic circulation favours the ingression of salty water of Levatine and/or Cretan origin, now no longer diluted by the presence of the AW. This increases the salinity in the Adriatic, lowering the sea level along the pathway of the exported water at the flanks of the Ionian, inverting the surface pressure gradient and finally re-establishing the upper anticyclonic circulation [2]. Due to the BiOS mechanism, the averaged thermohaline properties in the Southern Adriatic exhibit a quasi-periodic variability at a time-scale of about 10 years. The same behaviour, but with an opposite phase, is reported for the time series of averaged nitrate concentrations during the last 25 years (Fig. 2).

In this case, the decadal variability seems to be associated with the vertical displacement of the interfaces at the border of the Ionian gyre. The sequence of anticyclones and cyclones in the Ionian Sea causes a vertical oscillation of the nutricline and of the oxygen minimum/nutrient maximum layer, determining a significant variations of the biogeochemical averaged concentration of the portion of water column horizontally advected towards the Adriatic through the Strait of Otranto. The comparison of the long-term variations of nutrient concentrations in the Southern Adriatic and in the northeastern Ionian reveals that the two show coherent behaviour. Major differences in concentration values are reported for periods when strong winter convection occurs in the Southern Adriatic [3]. At the re-establishment of the stratification following the winter convective mixing, the nutrient in the enriched surface layer is consumed by the primary producers (phytoplankton). Satellite images clearly show the increase of biomass immediately after the stratification. Consequently, the nutrient pool is reduced as a function of the intensity and the number of convective events [3]. To conclude, we show that the Ionian upper-layer circulation has a great impact on the major water masses pathway and on the horizons of the biogeochemical interfaces. In turn, the Southern Adriatic represents a sensor for the Ionian circulation and for the state of the thermohaline cell of the Eastern Mediterranean. In this context, the intense activity of OGS and other Italian and Croatian institutions within the recent established Southern Adriatic Interdisciplinary Laboratory for Oceanographic Research (SAILOR) will be further implemented.

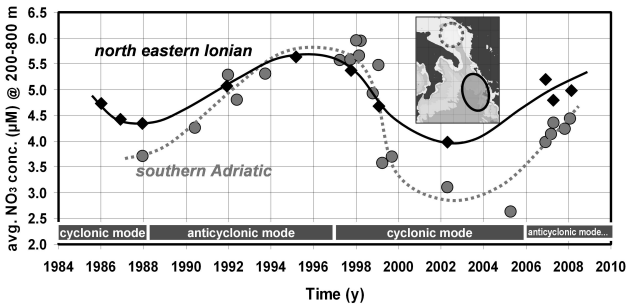

Fig. 2. Nitrate time-series in the southern Adriatic and northeastern Ionian averaged in the 200-800 m layer.

References
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