INTER-ANNUAL THERMOHALINE AND NUTRIENT DYNAMICS (2002-2014) IN THE LEVANTINE INTERMEDIATE WATER MASS, SE MEDITERRANEAN SEA

T. Ozer [1]*, I. Gertman [1], N. Kress [1], J. Silverman [1] and B. Herut [1]
[1] Israel Oceanographic & Limnological Research, Haifa 31080, Israel - tal@ocean.org.il

Abstract

A 13 years (2002-2014) dataset (Haifa section cruises, IOLR) was used to explore the relations between the physical and nutrient properties ofthe Levantine Intermediate water (LIW) in the eastern Levantine Basin. Decadal variations in LIW core were observed in nutrient levels and integrated chlorophyll a in nearly opposite phase with temperature and salinity. These variations occurred with a similar decadal periodicity, but in shifted phase of those observed in LIW mass in the Southern Adriatic and North Ionian Seas, attributed to decadal reversals in the North Ionian Gyre, i.e. Bimodal Oscillation System (BiOS).

Keywords: South-Eastern Mediterranean, Salinity, Temperature, Nutrients, Time series

The Mediterranean Sea (MS) is characterized by limited water exchange with the Atlantic Ocean through the Gibraltar Strait. Surface water from the Atlantic flows eastward and undergo continuous transformation due to air–sea heat and moisture fluxes resulting in the highest salinities in the Levantine Basin (LB). Levantine Surface Water (LSW) are the product of these Modified Atlantic Water (MAW) at the extreme eastern end of the Eastern MS. The LB is significantly influenced by the water exchange with the Ionian Basin (IB) via the Cretan passage, which isolates it from the rest of the MS. The BiOS mechanism controls the trajectory of the MAW flow to both the Southern Adriatic (SA) and the LB through decadal reversals in the North Ionian Gyre ([2]).

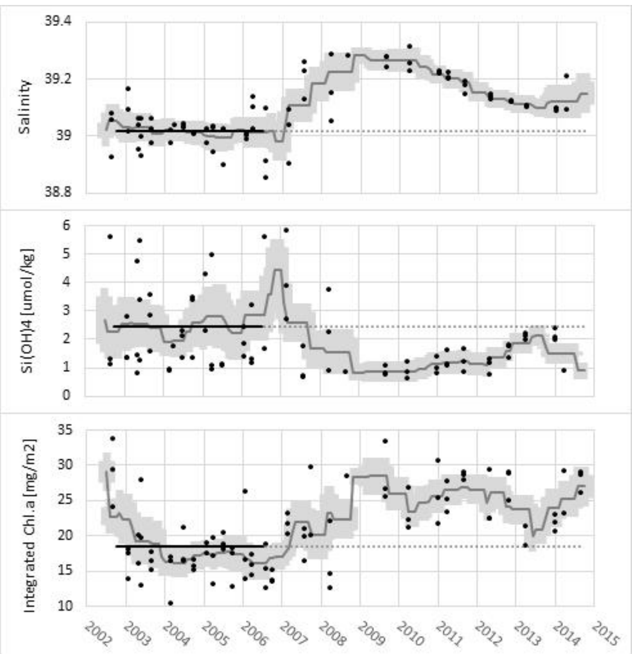

Fig. 1. Salinity, nitrate+nitrite and Integrated Chlorophyll a (0-200m) time series of measurements made in the LIW water mass from Haifa Section cruises (2002-2014). Station specific values are presented in dots, moving average in solid gray line and standard error ranges in light gray area.

The presented LIW investigation is derived from a 13 years dataset (2002-2014) including 3 deep stations (>1000m) of Haifa section cruises. The vertical position of LIW core was identified by the maximal salinity value within the depth limits of 130m to 350m attained from LIW analysis in >30 years dataset ([3]). Subsequently, physical and chemical LIW core values were averaged for each cruise and smoothed using a one-year window moving average. Additionally, Chl-a concentrations obtained from calibrated CTD Fluorescence readings were integrated over the photic zone (0-200db) and underwent the same procedure of averaging and smoothing. The smoothed salinity time-series of LIW was compared to the results of the >30 year analysis ([3]) and showed significant agreement. Temporal trends of nutrient levels starting in winter 2006-2007 corresponded with the evident shift in LIW physical properties. As salinity and temperature values rose nitrate+nitrite, phosphate and silicic acid levels decreased during 2006-2009 (Partially presented, Fig.1).

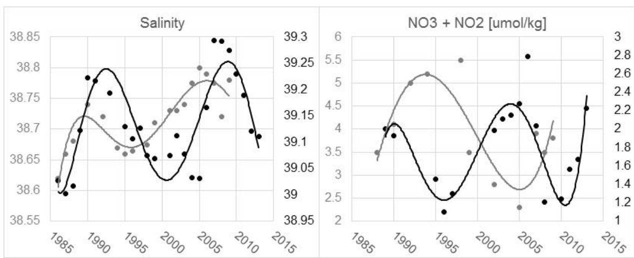

Fig. 2. Polynomial trend lines of salinity and nitrogen concentration (NO2+NO3) for LIW from the South Adriatic (Gary) and the South Eastern Levantine (Black).

The salinity peak in LIW can be attributed anticyclonic circulation in the north Ionian between 2006 and 2009 in linkage to the BiOS theory. Limited MAW advection to the LB prolonged residence time and caused a positive buoyancy flux which favored deeper winter convection increasing nutrient supply to the photic zone. The similar behavior of salinity and integrated Chl-a, and opposing phase of nutrient patters supports this proposition (Fig. 1). Such anti-phase relations, between salinity and nitrate levels were found in the SA and northeastern IB ([1]). Temporal variations of nitrate levels in the SA and the LB appear to be in shift-phase of about 9 years, offering evidence for the connection between the two observed phenomena (Fig. 2). Published estimates of the average travel time of LIW from the Rhodes Gyre to the Sicily Channel are in the range of 8 to13 years. It can be inferred that the travel time of LIW to the SA has a similar temporal range. The observed inter-annual variations in LIW thermohaline and nutrient properties may have profound consequences for biogeochemical processes. While the East MS is fed by several external sources of nutrients (atmosphere, rivers, terrestrial runoff and submarine groundwater) we believe that the thermohaline flux variations attributed to the BiOS mechanism have the most immediate and significant impact in magnitude on the available nutrients and the dynamics of the eastern basin primary productivity.

References

1 - Civitarese G., Gacic M., Lipizer M. and Borzelli G.L.E., 2010. On the impact of the Bimodal Oscillating System (BiOS) on the biogeochemistry and biology of the Adriatic and Ionian Seas (Eastern Mediterranean). Biogeosciences 7, 3987–3997.
2 - Gacic M., Borzelli G.L.E., Civitarese G., Cardin V. and Yari, S., 2010. Can internal processes sustain reversals of the ocean upper circulation? The Ionian Sea example. Geophys. Res. Lett. 37, L09608.
3 - Gertman I., Goldman R., Tal O. and Zodiatis G. (2013). Interannual changes in the thermohaline structure of the south eastern Mediterranean. Rapp. Comm. int. Mer Medit. (CIESM Congress Proceedings). Vol. 40: 211.