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Biogeosciences Discussions

Interactive comment on "Changes in the Adriatic oceanographic properties induced by the Eastern Mediterranean Transient" *by* I. Vilibić et al.

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We appreciate the comment given by Giuseppe Civitarese, which put a question on interpretation of biogeochemical variability provided in the paper. We agree that a role of the Bimodal Oscillation (BiOS) in nutrient dynamics is not provided in the paper following the interpretation given by Civitarese et al. (2010), so we plan to do it in the revision. However, some of our results are partially in conflict and cannot be explained as provided by Civitarese et al. (2010), and can be done only by assuming an inflow of intermediate Western Mediterranean waters (flowing below the surface Atlantic Water) to the Adriatic during the EMT period (mid 1990s).

Some of our arguments are already posted in the paper, namely, we found a decrease of TIN to HPO42− ratio between 1991 and 1998 compared to the overall period, mostly

in the surface waters, where the ratio indicated the transition toward the nitrogen limited conditions for primary production (following the Redfield ratio). That is in conflict with the explanation provided by Civitarese et al. (2010): if the upwelling in the northern Ionian Sea is the only relevant process that provided the nutrients to the Adriatic between 1991 and 1998, the ratio between TIN to HPO42− will remain similar as before, as the whole Eastern Mediterranean is phosphorus-limited for primary production (see third paragraph of Introduction); however, that was not the case. Also, Civitarese et al. (2010) does not document the HPO42− measurements, and discusses nitrogen compounds only.

To test the relationship between nutrients and salinity in the Palagruža Sill area, we performed a correlation analyses between these parameters. The series of 11-year moving average correlations and significance levers between HPO42− and salinity are plotted in Fig. 1. One can see that most of the investigated period the correlation is significant, implying that the advection of waters over the sill has the effect to the nutrient concentrations. These waters dragged from the SAP were characterized by high salinity and nutrients before 1980s, supporting the positive correlations between salinity and primary production found by Marasović et al. (1995) between 1965 and 1982. Then, a transition towards negative correlations occurred. Negative correlation between salinity and nutrients were present in 1990s, implying that lower salinity waters were richer of nutrients.

Another chemical parameter measured at the Palagruža Sill, pH, supports the dragging of the Western Mediterranean waters in the intermediate layer towards the middle Adriatic. Fig. 2 show pH series collected at station P5, which clearly denote sharp decrease in mid 1990s, larger in deep layers. The Western Mediterranean waters are characterised by much lower pH than of the Eastern Mediterranean (Touratier and Goyer, 2011); therefore, their presence below the euphotic level is supported by the distribution of pH values over the sill.

Furthermore, negative correlation between temperature and benthic Si fluxes found

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between 1991 and 1998, what is oppositely than documented for the Adriatic (Bertuzzi et al., 1996), additionally supports our thesis that Western Mediterranean water inflow is the main nutrient enrichment factor during the “lower than usual” temperature period from 1991 to 1998.

All of these findings can be explained only if assuming that not only surface nutrient-depleted waters of Atlantic origin but also the intermediate waters (not under the influence of nutrient-depletion) were dragged from the Western Mediterranean to the Adriatic in 1990s. Eventual dragging of intermediate Western Mediterranean waters towards the east is supported by the analysis of water masses over the Sicily Strait (Gasparini et al., 2005): rather sharp salinity increase observed there in 1992, being a consequence of the massive outflow of dense EMT waters, rapidly changed back a year later, indicating a strong counterflow of the Western Mediterranean waters. The lagged response of a thermohaline cell is normal in anti-estuarine circulation systems (e.g., the Adriatic dense water outflow induces several months lagged intermediate water inflow, Orlić et al., 2007). These waters were presumably deviated northward by the anticyclonic Ionian gyre together with surface nutrient-depleted waters of Atlantic origin, which extended to depths of about thousand meters (Borzelli et al., 2009). The advection of nutrient-rich intermediate Western Mediterranean waters to the northwestern Ionian perimeter will also explain an uplift of nutricline to the euphotic level (100 m) found by Civitarese et al. (2010).

I hope that these arguments, new results and discussion are elucidating the topic, which are presumably not properly and clearly written in the first version of the manuscript, so we plan to write it better in the eventual revision. Also, we plan to put the finding more cautiously, as hypotheses to be investigated in the future, and not as definite conclusions, as we are aware that the data coverage is not sufficient to provide definitive explanations and conclusions on these processes and topics. We hope that Giuseppe Civitarese will found our explanations feasible.

Additional references

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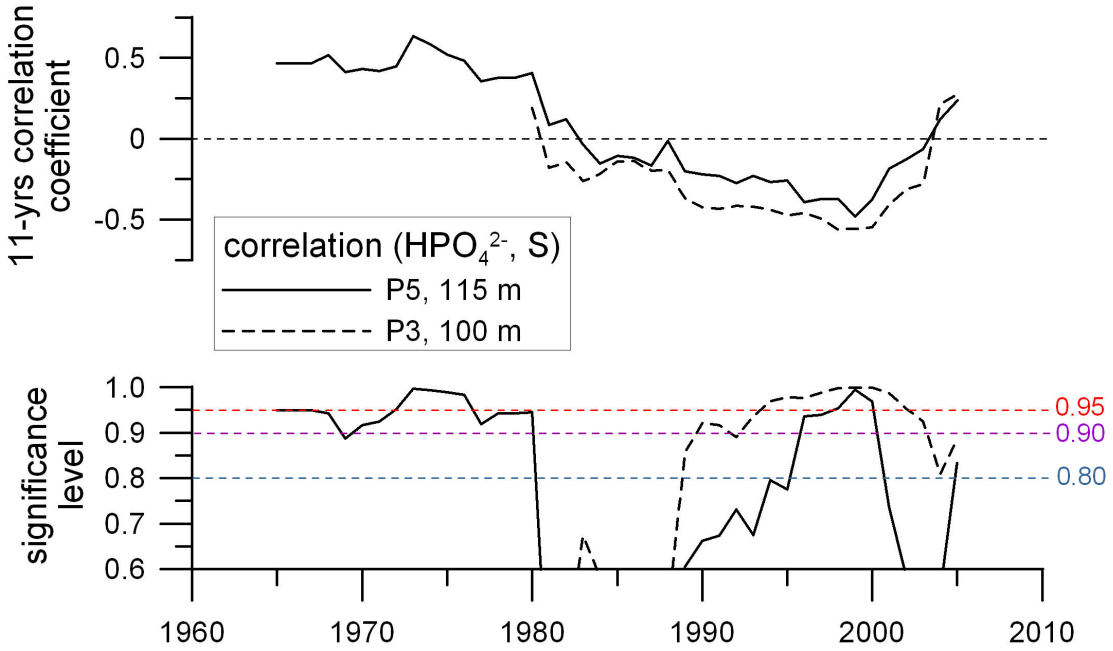

Fig. 1. Time series of 11-years linear correlation coefficient between salinity and orthophosphates and associated significances estimated for deep layers of stations P3 and P5.

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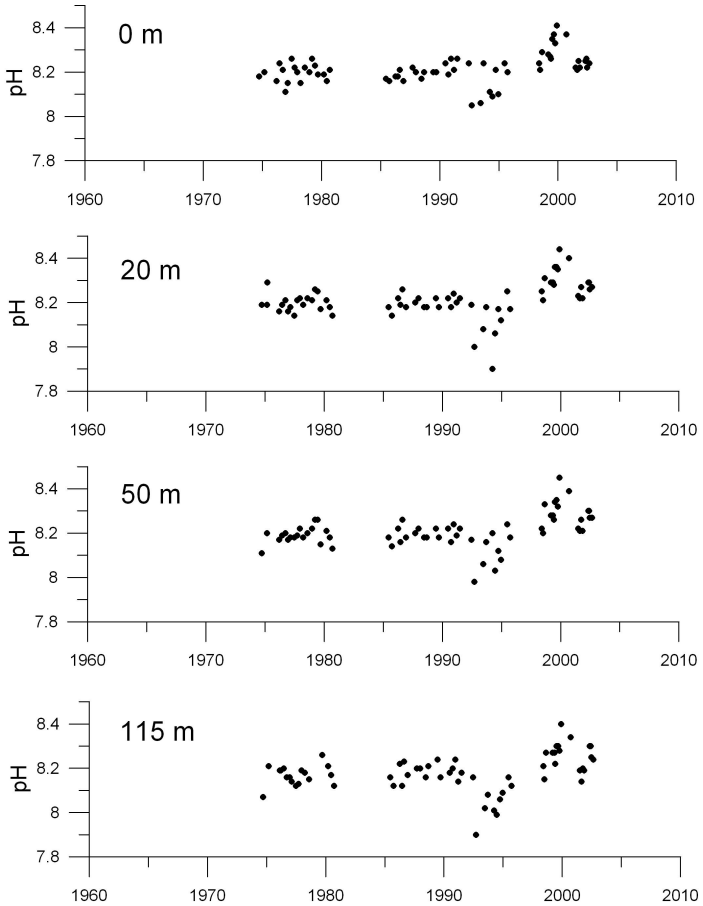

Fig. 2. Time series of pH values measured at station P5.

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