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Variability of the Mediterranean Sea biogeochemistry in the contemporary climate

G.Mattia (1), M.Vichi (2,3), B.W.An (2), M.Zavatarelli(1), P.Oddo(2)

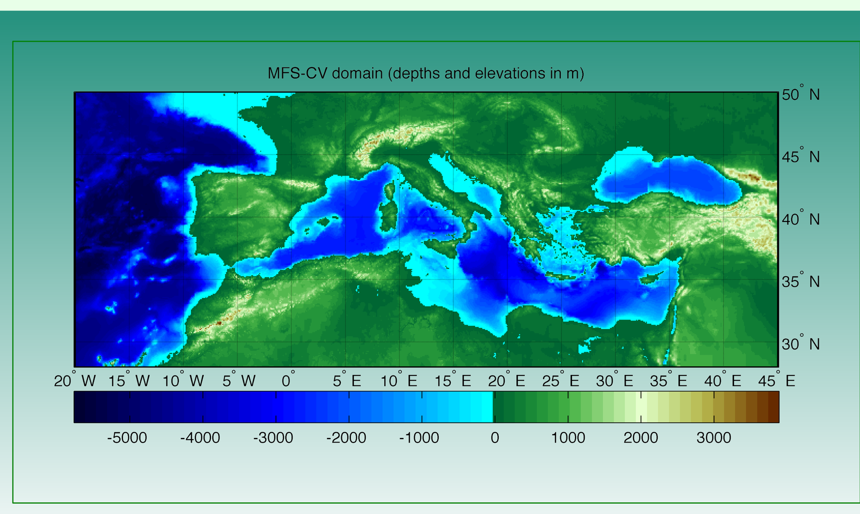
(1) ConISMa-Unibo, IT - (2) INGV Bologna, IT (3) CMCC Bologna,IT

INTRODUCTION AND OBJECTIVES

The Mediterranean Sea consists of several interconnected sub-basins characterised by strong thermohaline cells. The simulation of its physical and biogeochemical dynamics therefore requires high spatial resolution. Hindcast simulations for the period (1990-2000) were performed using the ECMWF ERA40 derived atmospheric forcing functions. The main focus is the interannual variability of the marine ecosystem dynamics. In particular, the biological model results are analyzed after year 1992 to evaluate the response of a strong event occurring in the eastern Mediterranean and depending the meteorological forcing functions and in the physical ocean dynamics.

MODEL CONFIGURATION

The modelling system is constituted by the on-line coupling of the BFM (Biogeochemical flux model, Vichi et al. (2007a,b) http://bfm.cmcc.it) and NEMO (Nucleus for European Modelling of the Ocean, Madec 2008 http:/www.nemo-ocean.eu).
The ocean model is a primitive equation model based on the Mediterranean Forecasting System (MFS) on a grid of 1/16 degree horizontal resolution and 72 vertical levels, which has been optimized for usage with the biogeochemical model. The ocean general domain configuration and physical setup is the same as described in Oddo et al.(2009).
The BFM is a generalized model of marine biogeochemistry that employs a biomass-based, multiple-nutrient description of lower trophic levels in the marine ecosystem.



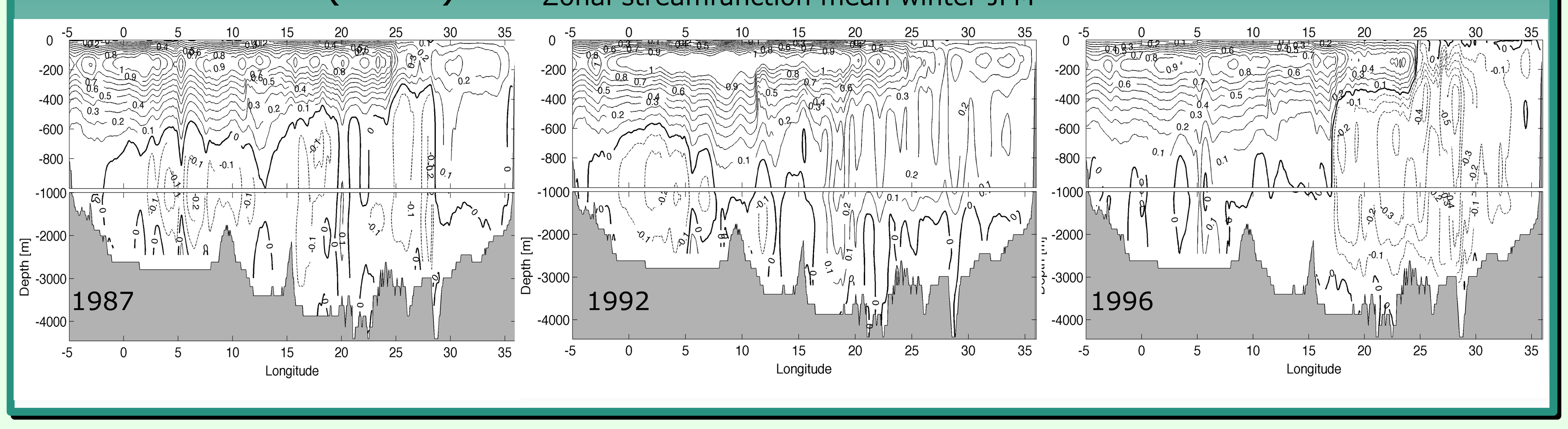
MODEL INITIAL CONDITION AND FORCING

ECMWF ERA40 atmospheric forcing functions
Iniitial conditions: nutrients and oxygen annual OA climatologies from SEADATANET project (http://www.seadatanet.org) merged with World Ocean Atlas climatology in the Atlantic box.
Nutrient river input: data from Sesame project (Ludwig et al. 2009)
Initial condition for biology: homogeneous guessstimates with vertical distributed analytical profiles.

A "TRANSIENT" EVENT IN 1992

1992 is caracterized by an interruption of the eastward transport of Modified Atlantic Waters (MAW).

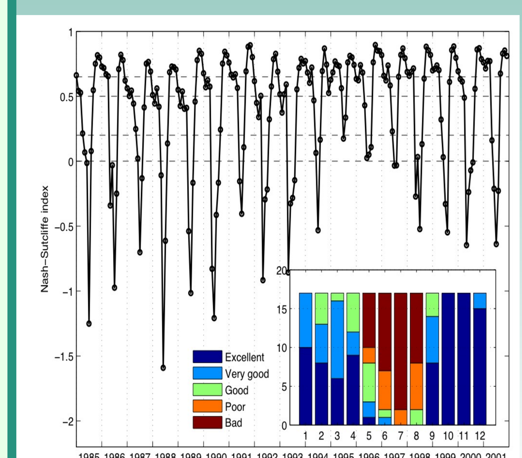
Zonal streamfunction mean winter JFM

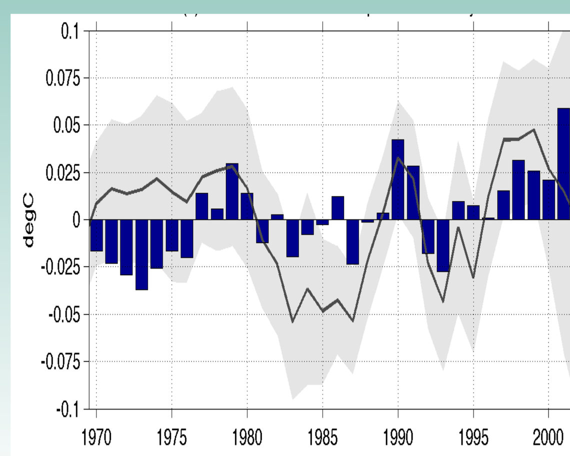


COMPARISON

PHYSICS

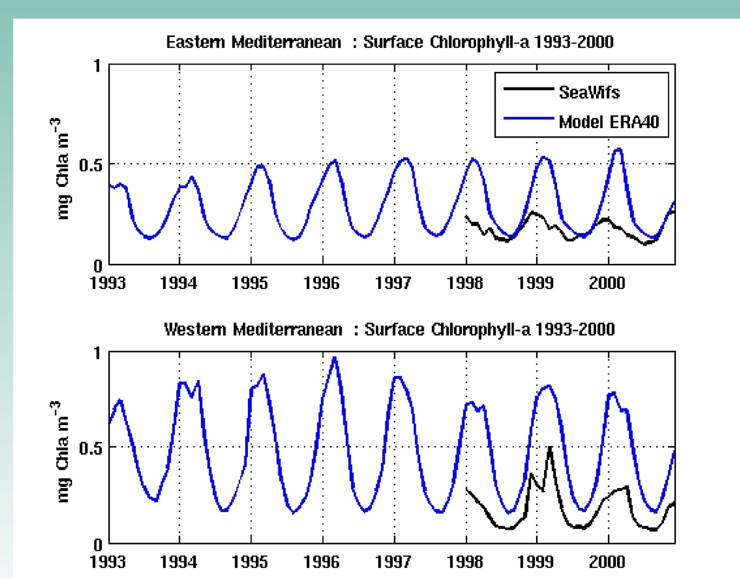
Left: Comparison of simulated monthly means of Sea Surface Temperature computed for the Mediterranean basin with satellite data expressed in terms of the Model Efficiency index (Nash and Sutcliffe, 1979).
Right: Comparison of mean annual volume temperature anomalies from the model (blu bar) with observations (continuous line) and error estimates (shaded area) by Rixen et al. 2005





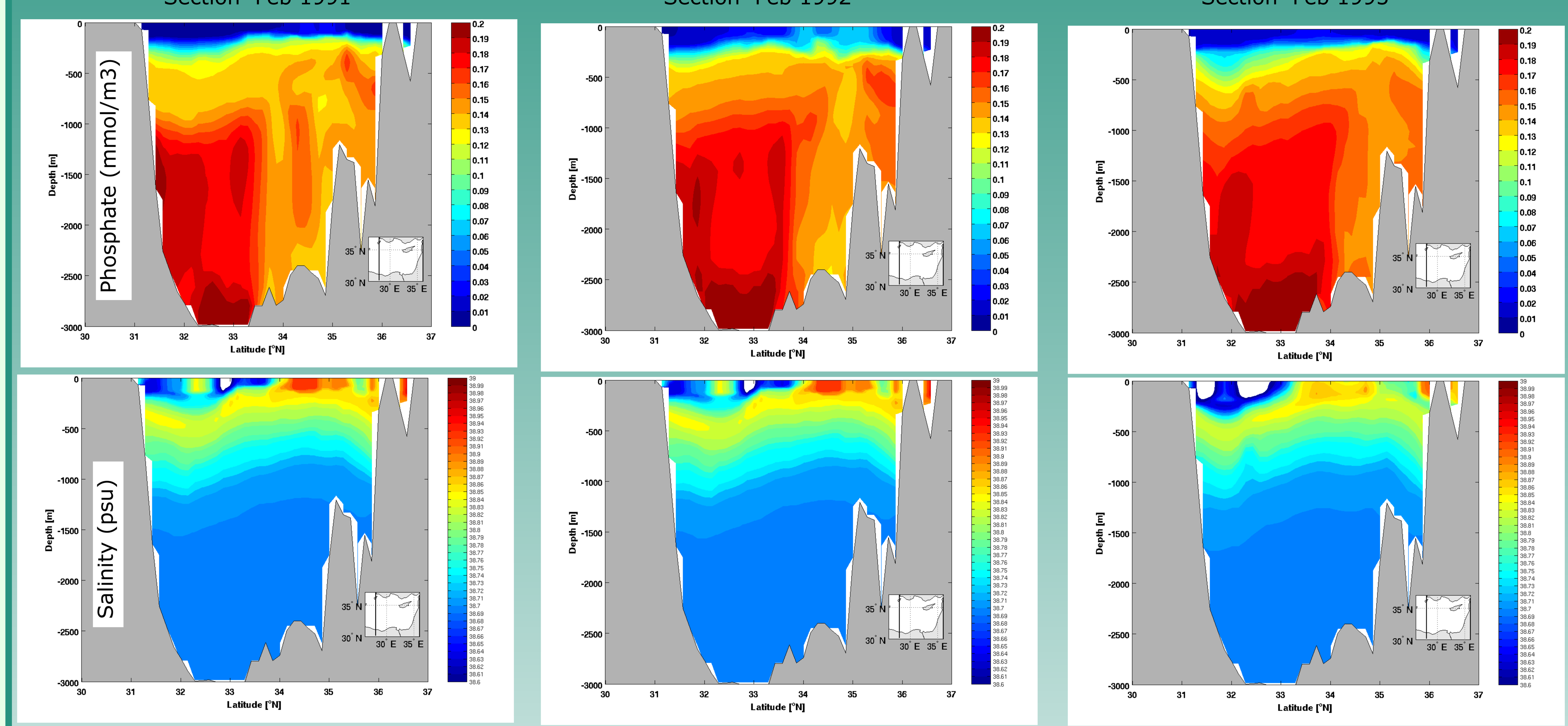
BIOGEOCHEMISTRY

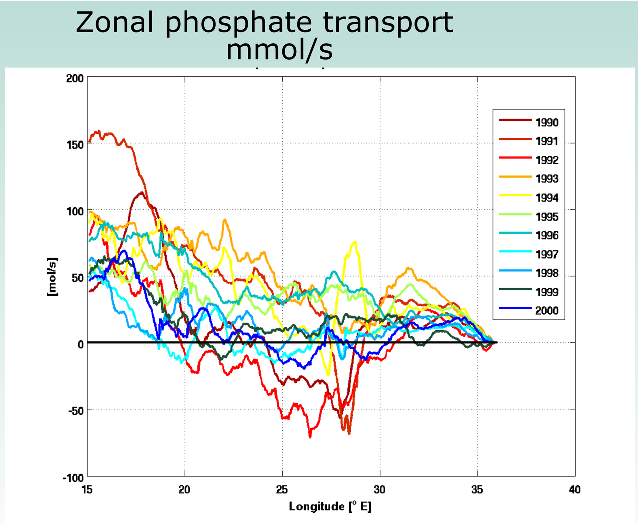
Comparison of simulated monthly averaged numerical Surface Chlorophyll-a concentration with satellite remote sensing data in the eastern and western Mediterranean sea.

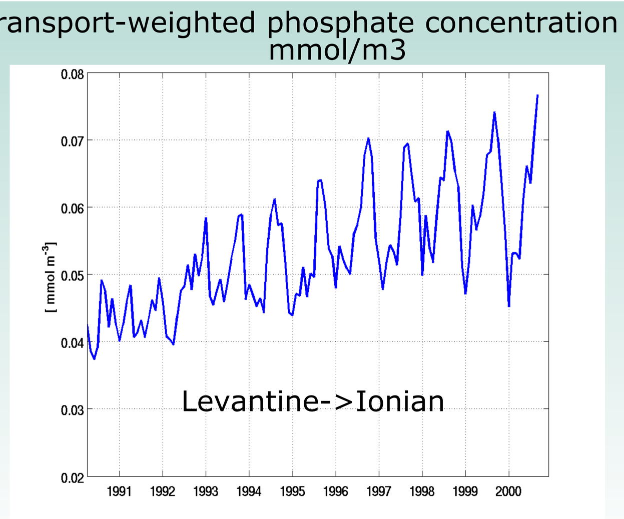


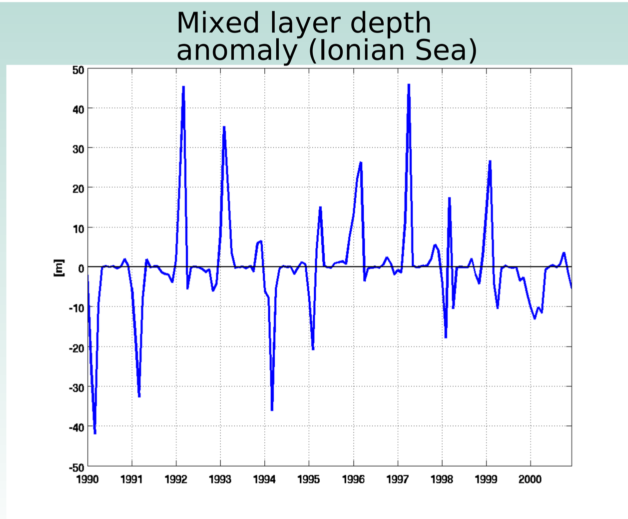
Response of biogeochemistry to the 1992 event

The region occupied by the simulated LIW down to 400-500 m (that are marked by a lower salinity level than the real LIW) was thus enriched in phosphorus, which can be transported westward. The reprise of the MAW/LIW system after 1992 is also visible in the presence of low salinity waters of Atlantic origin on the southern border.

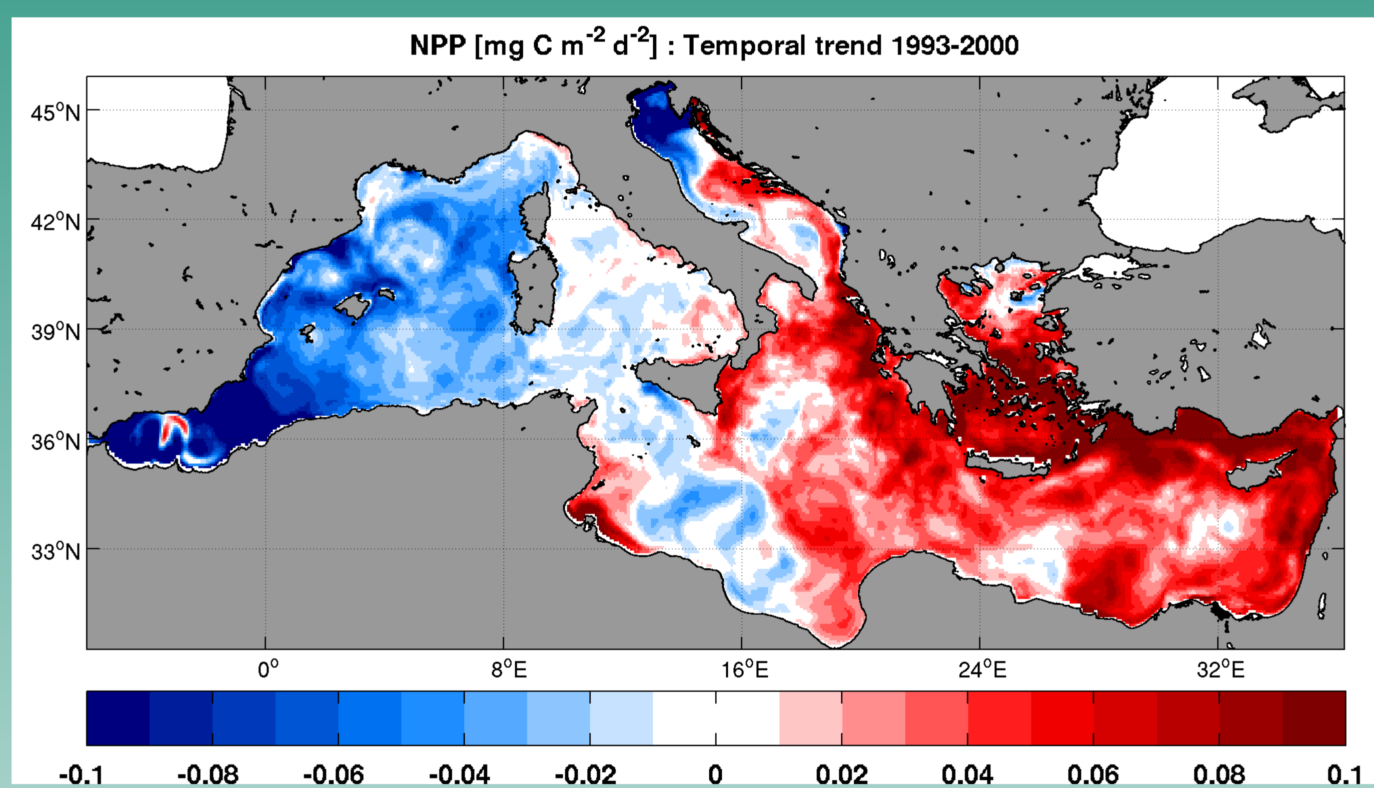


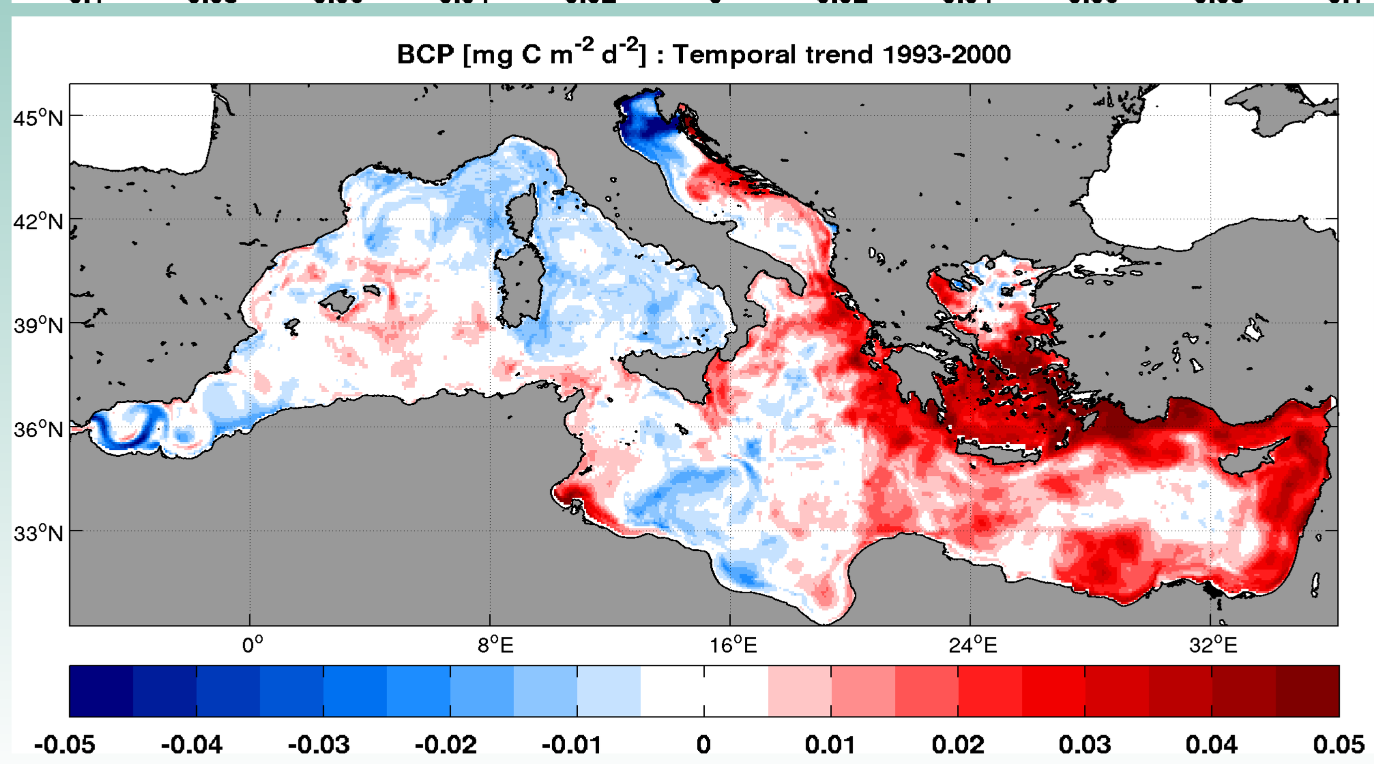






The trends of Net Primary Production and Bacterial Carbon Production are negative in the northern Adriatic Sea and increases in the eastern basin, particularly around Greece and in the north-eastern Levantine.





CONCLUSIONS

The misfit between model results and satellite observations appears systematic.
The Levantine basin experienced an upwelling of nutrients driven by Ekman pumping at the beginning of the 90s, with a peak in 1992 that uplifted the permanent nutricline. In subsequent years in the Ionian sea a strong vertical mixing events occurred. In combination with this process the model simulated a negative zonal net transport of phosphate that likely distributed part of the upwelled nutrients westward (Levantine to Ionian sea). Primary and bacterial production responded with a positive growth trend in the eastern Levantine, in the Aegean, northeastern Ionian and partly in the eastern Adriatic.

REFERENCES

Ludwig, W., E. Dumont, M. Meybeck, S. Heussner (2009). River discharges of water and nutrients to the Mediterranean an Black Sea: Major drivers for ecosystem changes during past and future decades?. Progress in Oceanography 80, 199-217.
Nash and Sutcliffe, 1979. J.E. Nash and J.V. Sutcliffe , River flow forecasting through conceptional models 1: a discussion of principles. Journal of Hydrology 10 (1979), pp. 282–290.
Oddo P., M. Adani, N. Pinardi, C. Fratianni, M. Tonani, and D. Pettenuzzo (2009). A nested atlantic-mediterranean sea general circulation model for operational forecasting.Ocean Science (5), 461–473.
Vichi M., N. Pinardi and S. Masina (2007a) A generalized model of pelagic biogeochemistry for the global ocean ecosystem. Part I: Theory. J. Marine Systems, 64(1-4), pp 89-109
Vichi M., S. Masina and A. Navarra (2007b) A generalized model of pelagic biogeochemistry for the global ocean ecosystem. Part II: numerical simulations. J. Marine Systems, 64(1-4), pp 110-134.

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