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A neural-based bio-regionalization of the Mediterranean Sea using satellite and Argo-float records

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The regionalization of the Mediterranean Sea has been the subject of many studies. It is a miniature ocean where most of the processes of the global ocean are encountered (Lejeusne et al., 2010). Several features of the Mediterranean (near-tropical ocean in summer with a well-formed thermocline, near-polar ocean in winter with deep convection, multiple basins with different characteristics) make it a hotspot of marine biodiversity (Coll and al., 2010) and consequently vulnerable to climate change. It is therefore important to characterize the present state of the Mediterranean Sea with robust estimators in order to study the long-term evolution of this mesocosm.

We present a partitioning of the Mediterranean Sea in regions having well defined characteristics with respect to Sea Surface Temperature and surface chlorophyll observed by satellite, and Argo mixed layer depth. This regionalization was performed by using an innovative classification based on neural networks, the so-called 2S-SOM. Its major advantage is to consider the specificity of the variables by adding automatically, through machine learning, specific weights to each of them, which facilitates the classification and consequently highlights the regional correlations. The 2S-SOM provided a well differentiated regionalization of the Mediterranean Sea waters into seven bioregions governed by specific physical and biogeochemical processes such as Intermediate-water formation in the Aegean Sea, large surface currents in the Adriatic and the Alboran, deep winter convection phenomena in the Balearic and stratification phenomena during summer in the eastern part of the Mediterranean Sea.

Besides, in order to highlight the phytoplankton diversity in these regions, we processed the satellite ocean color observations with a specific neural network approach (SOM-PFT, El Hourany et al., 2019). As a result, specific phytoplankton communities characterized by their seasonal variability are associated with the obtained Mediterranean bioregions; the dominance of the Nanophytoplankton groups is largely observed in the western basin during the period ranging from autumn to spring. While the dominance of different types of cyanobacteria Synechococcus and Prochlorococcus is highlighted in summer and more precisely in the waters of the eastern basin. Diatoms dominate throughout the year in the coastal and shallow regions, which can be explained by the presence of terrigenous input necessary for the development of this type of phytoplankton. Diatoms also largely benefit from the strong deep convection in the Balearic Sea

marked by a large bloom at the end of winter convection in March.

This work will be further extended to study the phytoplankton diversity at global scale using various data set from the Tara Oceans.

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