Impact of atmospheric and oceanic interannual variability on the Northwestern Mediterranean Sea pelagic planktonic ecosystem and associated carbon cycle

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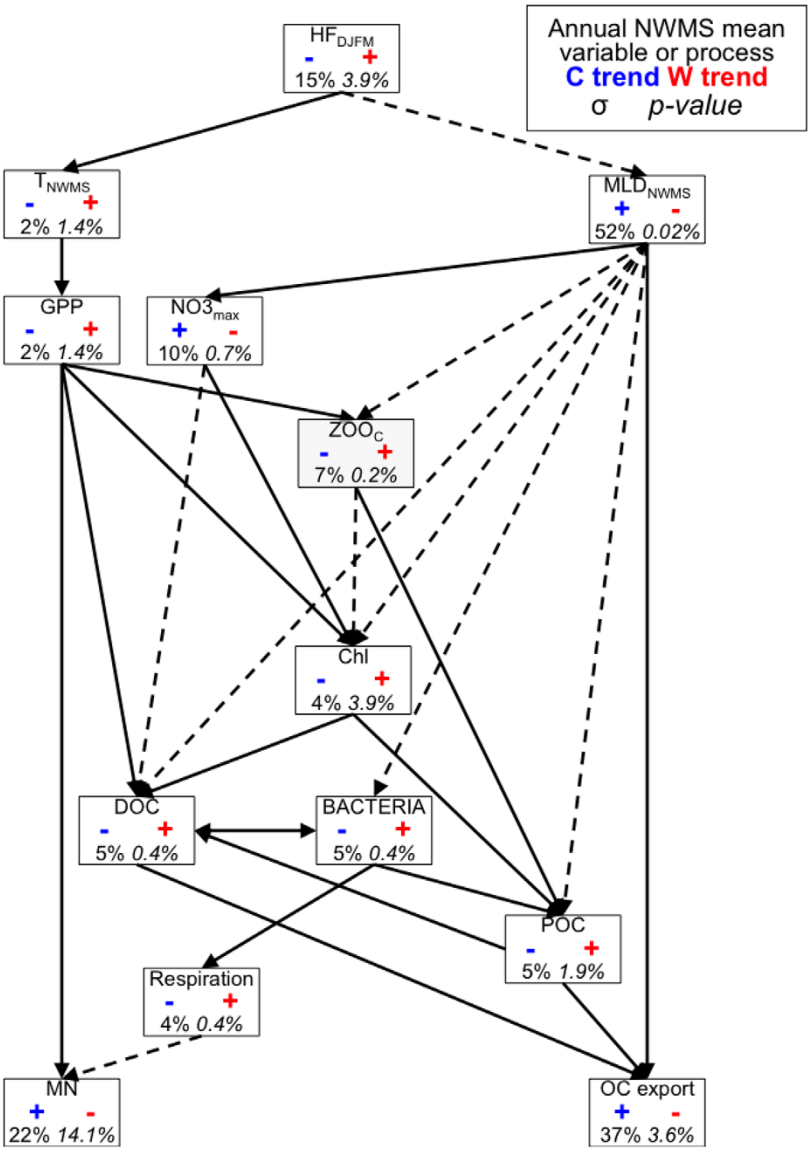
The Northwestern Mediterranean Sea (NWMS) is one of the most productive areas of the Mediterranean Sea. The NWMS pelagic planktonic ecosystem is strongly influenced by hydrodynamics, in particular winter deep convection. We investigated the response of this ecosystem and associated carbon cycle to oceanic and atmospheric winter conditions interannual variability. For that we developed a tridimensional coupled physical biogeochemical model (SYMPHONIE+Eco3M), ran 7 annual simulations forced by XXth climate conditions and performed statistical and budget analysis.

Our coupled model reproduces correctly the seasonal evolution of the NWMS pelagic planktonic ecosystem. It however overestimates the contribution of nanophytoplankton to the total phytoplanktonic biomass and GPP, underestimates the bacteria biomass and represents the spring bloom with 1 month delay. Our results confirm that the control of phytoplanktonic development and bacteria growth by the phosphorus availability is a marked specificity of the NWMS, that is, temporally reduced by deep convection. They confirm the relevance of the Behrenfeld (2010) hypothesis in explaining the bloom dynamics.



Synthetic scheme presenting the effect of interannual variability of winter atmospheric conditions on the NWMS ecosystem at the scale of the basin. Blue and red signs indicates the trend associated with the respectively Cold or Warm type years. Standard deviations among the seven annual averages of the given variable or process averaged annually and over the whole NWMS and associated p values are indicated below. Solid and dotted lines indicate the respectively positive and negative relationships between variables and/or processes.

The variability of the winter atmospheric conditions induces differences of vertical mixing and water temperature that propagate into the whole NWMS ecosystem through a chain of relationships. The high frequency filtering associated with averaging diagnostics explains that this variability seems weak at the NWMS scale. However for most of the variables and processes, differences induced by the winter atmospheric variability are significant at the annual scale. Net metabolism and deep carbon export are systematically positive and show larger variabilities related, respectively, to the water temperature and convection intensity.

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