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Benthic-Pelagic coupling in the Black Sea northwestern shelf

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A new approach for modeling the benthic compartment in 3D ocean models is applied to analyze the benthic-pelagic coupling in the Black Sea northwestern shelf (BS-NWS) and to review the contribution of sedimentary diagenesis to the BS-NWS biogeochemical cycles (nitrogen, oxygen and carbon). This approach combines an explicit representation of sediment organic matter deposition and resuspension, controlled by the bottom shear stress, and a parameterization of mineralization pathways control by bottom environmental properties.

The model reproduces the magnitude and inter-regional and seasonal variability depicted by in situ benthic fluxes estimates obtained by benthic chambers and sediment cores incubations. The model illustrates how this observed variability results from both variable sedimentation rate and variable diagenetic pathways in the sediment layer.

Three distinct areas are identified based on the analysis of the simulated seasonal cycle of bottom environmental conditions, benthic-pelagic fluxes and diagenetic processes. These areas extend along a gradient from the land-ocean interface to the open sea boundary and are each characterized by a particular diagenetic pathway, in a way similar as they succeed vertically in a sediment profile.
(1) In the hypoxic zone, high remineralization rates lead to a seasonal peak in anoxic diagenesis and under certain conditions to hydrogen sulphide effluxes from the sediment,
(2) in the denitrification zone, benthic denitrification rates are maximal and
(3) in the oxic zone, where organic matter accumulation are low, oxic diagenesis prevails and seasonality is less marked.

This study underlines that representing resuspension and deposition processes in coupled benthic-pelagic models is essential to realistically describe the horizontal distribution of benthic-pelagic fluxes and the export from the shelf region to the deep sea.