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Interannual and regional variability of ecosystem dynamics in the Black Sea

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A three-dimensional hydrodynamic ecosystem model developed for the Black Sea was used to investigate the influence of anthropogenic drivers on marine ecosystem functioning in the Black Sea with a special focus on regional differences. Data from the ECMWF 40 Year Re-analysis global atmospheric circulation model (ERA-40) were used to force a coupled hydrodynamic ecosystem model (BIMS) for a hindcast simulation from 1980-2000. Model skill was assessed by model comparisons with SeaWiFS surface chlorophyll distributions. We study the regional differences the introduction of invasive comb jelly Mnemiopsis leidyi has on modeled ecosystem dynamics as well as the regional influence of changing river nutrient loads on ecosystem dynamics.
We can demonstrate clearly that the appearance of M. Leidyi changes ecosystem functioning through exerting grazing pressure on zooplankton and thereby changing the seasonal cycle of phytoplankton and zooplankton species significantly. On the north-western shelf this effect is less pronounced than in the southeast Black Sea, where zooplankton is grazed down more heavily, allowing for higher phytoplankton biomass. In addition, the Black Sea ecosystem shows strong regional nitrate limitation, and high sensitivity to increased eutrophication: A 50% increase in nutrient loading causes a 48% increase in primary production in the eastern regions of the Black Sea, while the north-western shelf reacts more moderately. Despite an increase in primary production, chlorophyll-a concentrations typically respond weakly to changes in nitrate availability. This indicates that increased grazing closely mirrors an increase in productivity. This is confirmed by an increase in zooplankton biomass. It is important to note that for this reason simulated chlorophyll concentration is not a good indicator of eutrophication in the Black Sea. The reduction in the productivity of the entire Black Sea system associated with a reduction in riverine nutrient loadings is much greater than the increase in productivity associated with an increase in nutrient loadings. Hence the model simulations represent a Black Sea ecosystem, which is highly sensitive to a reduction in nutrient loadings, suggesting management of river water quality is vital for the improvement of the ecosystem state of the Black Sea.