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Spatio-temporal variations in water column oxygen concentrations at the Crimean Shelf and their effects o biogeochemical processes

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Dissolved oxygen concentrations in the water column and pore waters are controlled by physical, chemical and biological processes, and hence often subject to high temporal and spatial variability. Oxygen dynamics and especially hypoxia are an increasingly important topic due to large impacts on the ecosystems, living resources, and biogeochemical cycles. Water column and sediment may experience hypoxic events of very different duration, ranging from hours to seasonal events lasting weeks to months or even to persistent year-round conditions. With increasing duration of hypoxia, ecosystem health declines, affecting energy flow, biogeochemical processes and fauna.

During the research cruise MSM 15/1 to the Crimean shelf of the Black Sea we used autonomous in situ observatories and remotely operated instrument platforms to investigate the temporal and spatial dynamics of transport and turnover rates of oxygen and sulphide, and their effects on the biogeochemistry and the composition of the pelagic and benthic communities. Instruments included state-of-the-art CTD casts and benthic chamber and profiler investigations as well as innovative techniques like the non-invasive Eddy correlation technique for benthic fluxes, and Multi Fiber Optode (MuFO) and Benthic Boundary Layer (BBL) profiler for high-resolution investigations of the near-seafloor water column. All instruments were deployed along a transect covering depths between 100 and 200m on the Crimean shelf, thus ranging from permanently oxic to permanently anoxic conditions on the seafloor.

Combining several methods allowed us to map the hydrography, the distribution of oxygen as well as the habitat structure of the continental shelf ecosystems. Assessing spatio-temporal fluctuations in oxygen concentration on different scales required a high number of simultaneous measurements at an adequate resolution. Each set of deployments yielded several hours of continuous measurements of oxygen profiles within the benthic boundary layer (BBL) and measurements of the oxygen flux to the sediment. Data revealed that the lowermost water column (upper 8 m from the seafloor into the water column) was sometimes subject to strong fluctuations of the oxygen gradient with a period of $\sim$2 min. The oscillations coincided with a change in wind speed and direction and might be explained by internal waves. The vertical and temporal variability of oxygen could be related to the change of salinity and temperature suggesting that the oxygen variability in the BBL was mainly driven by the vertical displacement of the chemocline. These results clearly show that benthic communities at least in some parts of the Crimean Shelf are subject to rapid and substantial changes in water column oxygen concentrations. Corresponding benthic flux measurements however show only little variations in the sediment oxygen consumption. These were very low, indicating a low activity of the benthic community, possibly due to these extreme dynamics in oxygen availability.

This multidisciplinary and multi-scale study will help to better understand the interplay of varying water column oxygen concentration and (benthic) biogeochemical processes.

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