Seasonal dynamics of benthic O2 uptake in a semienclosed bay: Importance of diffusion and faunal activity

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ABSTRACT: The benthic O^2 uptake and the O^2 microdistribution in a coastal sediment of Aarhus Bay, Denmark, were investigated during a seasonal study. Measurements were performed in situ by a profiling lander and a flux chamber lander, as well as on recovered sediment cores. The O^2 penetration depth, the diffusive O^2 uptake, and the volumespecific O^2 consumption rate strongly depended on the seasonal changes in bottom water O^2 concentration and the sedimentation of organic carbon. The in situ O^2 penetration depth varied between 0.5 mm in summer and 4.5 mm in winter. The diffusive O^2 uptake varied between 8 and 30 mmol m^{-2} d^{-1}, whereas the volume-specific O^2 consumption rate varied by a factor of 13. The O^2 distribution was very sensitive to environmental controls, and microprofiles obtained in the laboratory tended to overestimate the in situ O^2 penetration depths and underestimate the in situ diffusive O^2 uptake. Three-dimensional O^2 flux calculations based on in situ microtopographic mapping showed that the actual diffusive exchange rate was ~10% higher than the simple one-dimensional, microprofilederived diffusive O^2 exchange. The total O^2 uptake measured in the laboratory showed less distinct seasonal variation, but on the average, it was ~20% higher than the diffusive O^2 uptake. The difference reflected the microtopography of the sediment surface and the contribution from benthic macrofauna. In situ total O^2uptake was generally twice as high as laboratory rates, reflecting a higher fauna-related O^2 consumption in the larger enclosures incubated in situ. Annually, the in situ three-dimensional diffusive O^2 consumption was 6.2 mol O^2 m^{-2}, whereas the additional benthos-mediated O^2 uptake was 3.9 mol O^2 m^{-2}. Thus, 40% of the total O^2 uptake was due to faunal activity and respiration. The present study demonstrates the importance of realistic faunal representation during sediment incubations in order to obtain correct benthic mineralization rates.