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Benthic remineralisation rates in southern North Sea - from point measurements to areal estimates

Andreas Neumann (1), Jana Friedrich (2), Justus van Beusekom (2,3), and Céline Naderipour (2)

(1) Alfred-Wegener-Institute for Polar and Marine Research, Wadden Sea Station Sylt (andreas.neumann@awi.de), (2) Helmholtz Zentrum Geesthacht Center for Materials and Coastal Research, (3) University of Hamburg, Institute for Hydrobiology and Fisheries Science

The southern North Sea is enclosed by densely populated hinterland with intensive use by agriculture and industry and thus substantially affected by anthropogenic influences. As a coastal subsystem, this applies especially to the German Wadden Sea, a system of back-barrier tidal flats along the whole German Bight. Ongoing efforts to implement environmental protection policies during the last decades changed the significance of various pollutants such as reactive nitrogen or phosphate, which raises the desire for constant monitoring of the coastal ecosystem to assess the efficiency of the employed environmental protection measures. Environmental monitoring is limited to point measurements which thus have to be interpolated with appropriate models. However, existing models to estimate various sediment characteristics for the interpolation of point measurements appear insufficient when compared with actual field measurements in the southern North Sea. We therefore seek to improve these models by identifying and quantifying key variables of benthic solute fluxes by comprehensive measurements which cover the complete spatial and seasonal variability.

We employ in-situ measurements with the eddy-correlation technique and flux chambers in combination with ex-situ incubations of sediment cores to establish benthic fluxes of oxygen and nutrients. Additional ex-situ measurements determine basic sediment characteristics such as permeability, volumetric reaction rates, and substrate concentration. With our first results we mapped the distribution of measured sediment permeability, which suggest that areas with water depth greater than 30 m are impervious whereas sediment in shallower water at the Dogger Bank and along the coast is substantially permeable with permeability between 10^{-12} m^2 and 10^{-10} m^2. This implies that benthic fluxes can be estimated with simple diffusion-type models for water depths $>$30 m, whereas estimates especially for coastal sediments require percolation modelling. We are further able to estimate sediment permeability and volumetric oxygen consumption rate on the basis of grain size distribution. Since grain size distribution is already mapped with high spatial resolution, we now have the prerequisites to interpolate two key variables for benthic consumption and influx of oxygen. With our next step we intend to assess model-based estimates of benthic oxygen and nutrient fluxes with our in-situ measurements as references to refine the underlying models.

Our field measurements contribute to the NOAH project (North Sea; Observation and Assessment of Habitats), the established methods for routine monitoring contribute to the WiMO project (Wissenschaftliches Monitoring / Scientific Monitoring).