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North Sea Sediment Dynamics

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The North Sea is a semi-enclosed shelf sea attached to the North-east Atlantic and in its south-eastern part receives significant matter from river discharge and atmospheric deposition: Anthropogenic nutrients, dissolved carbon and organic compounds have elevated pristine background concentrations in the coastal strip of the North Sea since about 250 years as a consequence of intensified agriculture and industrialisation since then,
In such a marine environment the legacy of old inputs and the influence of processes in the sediment on the biogeochemistry of the overlying water column increases with decreasing water depth. On the other hand the flux of particulate organic matter into the surface sediment ($\sim$15 cm depth) also increases with decreasing water depth or distance from the coast.
Both effects are also described by results of ECOHAM-M simulations, the coupled pelagic-benthic ecosystem model that includes a prognostic multi-layer sediment module adopted from the global biogeochemical model HAMOCC as part of the MPI-earth-system model (MPI-ESM).The transfer from deep sea to coastal applications required different adaptations, such as changes in porosity values, in dissolution and organic matter remineralisation rates, and stoichiometries. In the model, two pelagic detritus pools, one slowly sinking with semi-labile organic matter, and one fast sinking with labile organic matter are collected in one sediment pool. After a spin-up of several hundred years the 3d-coupled model for the southern and central North Sea attains equilibrium, where the local inputs and outputs of the pelagic and benthic module are balanced. From this equilibrium state we initialised a realistic decadal run (2000-2009). Analysing the seasonal and interannual model results we found that the variability of sediment efflux in the model is low compared to the more dynamic pelagic system components, but simulated (and observed) sediment pore water profiles clearly show concentration gradients from the coast into the central North Sea.
Data on organic matter concentration and quality in surface sediments along a comparable transect suggest that not only the loading with POM decreases with distance to land, but also the reactivity of organic matter, indicated by amino acid composition as a measure of the degree of protein degradation. This ageing or degradation effect can also be seen in a near-shore surface sediment core where the C/N ratio increases with depth, while the relative concentration of labile material in sedimentary organic matter decreases. We discuss how the quality of organic particulate matter could be integrated into the sediment model equations.