

Poster Presentation

Theme 3.1: Biogeochemical Processes - Processes Understanding and Human Impacts

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Exploring The Influence Of Organic Matter Reactivity On Benthic-Pelagic Coupling On The Global Coastal And Open Ocean

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Marine sediments are a key component of the global carbon cycle and climate system. The complex interaction of benthic biogeochemical processes controls not only the long-term burial of carbon, but also the benthic-pelagic exchange of nutrients, oxygen, dissolved carbon and alkalinity, with important implication for the biogeochemical dynamics of the sediment-ocean system. The degradation of organic matter (OM) is the engine behind this biogeochemical process interplay. As a result, the ability to quantify the rate of OM degradation in marine sediments and associated processes and fluxes is key to advancing our quantitative understanding of the climate system. This is particularly important in coastal oceans and estuarine environments, which cover a small portion compared to the global ocean area, but their CO₂ fluxes are disproportionately high when compared to the CO₂ between open ocean and atmosphere. Benthic-pelagic coupling is the indirect but tight link between shallow benthic environments and atmosphere. Reaction-transport models (RTMs) are, in combination with field observations, ideal tools to quantify these rates and fluxes. Yet, their application on the global scale is severely limited by the lack of a generic framework with which to constrain OM reactivity. Previously published global estimates assume that OM reactivity decreases with water depth. However, a global compilation of field observations and local RTM studies indicate that such an assumption is overly simplified. Here we apply a RTM across a global ocean transect from the shallow coastal ocean to the abyssal ocean to explore the sensitivity of global benthic burial and exchange fluxes to OM reactivity. The sensitivity analysis shows modelling results on complex patterns of OM degradation rates and associated redox fluxes, revealing non-linear properties which clearly are not only affected by water depth, but also by OM source and its transformation along its transportation pathway. While aerobic degradation and sulphate reduction are major contributors to total OM degradation, their relative contribution varies depending on OM reactivity, i.e. an OM with low reactivity will be mostly degraded through aerobic degradation, but as OM reactivity increases its contribution decreases, whereas the role of sulphate reduction increases to the point, where almost all OM is degraded through sulphate reduction and none through aerobic degradation. At even higher OM reactivity the relative contribution of sulphate reduction decreases rapidly, while aerobic degradation and eventually methanogenesis take over the OM degradation. This exemplifies the importance of OM reactivity on its degradation pathways, and on the resulting nutrient fluxes and, especially in shallow marine environments, its effect on atmospheric CO₂.

Poster Session (see poster session schedule)