Quantification of panarctic benthic-pelagic carbon and nutrients fluxes

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With climate change, the Arctic Ocean is experiencing unprecedented changes. While much attention is directed to apparent impacts such as sea ice melt, permafrost thaw, and coastal erosion, our quantitative understanding of the substantive contribution of the Arctic seafloor in regulating nutrients and sequestering carbon and how it might change under climate change is very limited. The Arctic Ocean is unique regarding carbon and nutrients cycling because (i) the ice-free fraction is often highly productive, with significant atmospheric CO2 uptake, and (ii) the world's largest shelf sea surrounds it. Hence, the seafloor experiences large organic carbon (OC) settling and burial fluxes. However, a comprehensive quantitative analysis of carbon and nutrients fluxes across the Arctic seafloor is unavailable. In this study, we quantify carbon and nutrients fluxes across the entire Arctic seafloor using a novel analytical diagenetic model. Two case studies, in the Barents Sea and in the East Siberian and Laptev Seas, are realised to evaluate the model's performance in resolving Arctic diagenetic dynamics. To simulate budgets for the entire Arctic seafloor, we force the model with sediment organic carbon contents and reactivities, sedimentation rates, and bottom water boundary conditions (i.e., depths, temperatures, oxygen, and nitrate concentrations) from previous published relations and databases.

Our results show that 24.22 Tg of OC is buried each year in Arctic sediments and that 3.76 Tg of Nitrogen (N) is released each year from the sediments to the water column. We find that this benthic nitrogen return flux is more than 10 times the riverine dissolved inorganic nitrogen flux, thus highlighting the importance of understanding nutrients regeneration from Arctic sediments. The vast majority of Arctic OC is preserved in shelf sediments (i.e., 95%), where sulfate reduction and aerobic respiration dominate organic matter degradation (52 and 35%, respectively). Considering the significant uncertainties in Arctic biogeochemical cycling and the region's high climate sensitivity, our results provide a crucial starting point for future Arctic carbon burial and nutrients projections.

Keywords
Arctic Ocean; Sediments; Biogeochemistry; Benthic-pelagic Fluxes; Carbon Cycle; Nutrients Cycle; Organic Matter; Nutrients; Modelling