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Benthic Cycling of Phosphate in the changing Arctic Ocean

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The Arctic Ocean is currently experiencing rapid oceanographic shifts and significant sea-ice loss as a result of regional atmospheric and oceanic warming. The Barents Sea is a notable example of these phenomena, having seen a near 40% decline of its April sea-ice extent since 1979, and a progressive northward expansion of Atlantic Water (i.e., Atlantification). Such changes affect primary productivity and nutrient cycling in ways that remain poorly understood. Longer ice-free periods and the inflow of warmer Atlantic Water are expected to lead to extended bloom seasons on short, near-future timescales and therefore increase nutrient uptake in upper water layers. The benthic recycling of nutrients is believed to play an important part in replenishing nutrient inventories in overlying waters thus maintaining high primary productivity over the continuously expanding growth season. Therefore, it is crucial to increase our understanding of nutrient dynamic controls in changing oceans to make more accurate predictions and decipher the complex feedbacks involved in these evolving environments. However, most efforts to constrain and quantify nutrient fluxes so far have been directed at silicon, nitrogen or iron. This study aims to provide specific insight into phosphorus (P) cycling through its response to OM fluctuations and coupling with iron cycling. An integrated data-model approach was used to investigate the dynamics of P cycling at the sediment-water interface across five locations along the 30°E meridian that were drilled in the framework of the ChAOS project in the Barents Sea. The model approach allowed to explore the sensitivity of P cycling to plausible ranges of reactive iron and OM inputs. Greater inputs of reactive iron were found to decrease benthic phosphate fluxes ($J_{P_{O4}}$) whereas greater inputs of OM increased phosphate return to the water column. The quality of these inputs is equally significant: $J_{P_{O4}}$ decreased when iron hydroxides were made more reactive and increased with more reactive OM. Our findings indicate that variation in climatically sensitive processes, such as burial of terrestrial sediments and iron cycling, could represent powerful feedbacks on $J_{P_{O4}}$ through adsorption/desorption mechanisms. Results also reveal significant oceanographic controls on $J_{P_{O4}}$, suggesting Atlantification of the Barents Sea will play into future phosphate availability.