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Nutrient inputs, utilization and cycling in the Laptev Sea constrained by macronutrient concentrations and stable silicon isotopes

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The Laptev Sea is a marginal Arctic shelf sea subject to rapid warming resulting in increased freshwater supply and ice-free conditions during summer. These changes affect the availability and stoichiometry of nutrients, thereby ultimately limiting or amplifying primary productivity. Investigating the combined distributions of macronutrients (DIN, DIP, DSi) and the dissolved Si isotope composition (δ^{30}DSi) in this region allows to determine the processes controlling nutrient supply, distribution and utilization and the consequences of reduced sea-ice coverage for changes in primary productivity. Samples recovered in the Laptev Sea in late winter 2012 and the summers of 2013 and 2014 depict a large range in nutrient concentrations and δ^{30}DSi (+0.9‰ - +3.8‰) reflecting year-round freshwater supply from the Lena River, advection of Atlantic-derived water and nutrient uptake during diatom growth. The highest nutrient and lowest δ^{30}DSi signatures are found in the southeastern Laptev Sea reflecting terrestrial input via the Lena River, while further north the admixture of Atlantic-derived water to shelf bottom waters is recorded by decreasing nutrient concentrations and heavier δ^{30}DSi. In addition, intense nutrient drawdown in the northern and northwestern Laptev Sea is observed at the surface suggesting efficient utilization of river-borne nutrients by phytoplankton. Primary production is further fueled by admixture of DIN-enriched Atlantic-derived water to the surface during seasonal stratification breakdowns. The observed diatom-driven Si isotope fractionation indicates closed system behavior consistent with pronounced nutrient input from the Lena river during the spring freshet and no significant further nutrient additions to the stratified surface layer during the summer months. A marked enrichment of DIP and DSi in bottom waters may be linked either to riverine inputs during winter or to local organic matter and diatom remineralization. The Laptev Sea is the main source region for the export of nutrients via the Transpolar Drift and ultimately controls primary production in the central Arctic Ocean. We therefore also discuss mechanisms of nutrient limitation in the Laptev Sea and their consequences for the future central Arctic Ocean biogeochemical cycles.