Enhanced river runoff and permafrost thaw affect Arctic shelf processes

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Abstract

Enhanced river runoff and coastal erosion are causing greater amounts of terrestrial material supply to Arctic shelf waters. Increasing freshwater export of carbon and nutrient loads from land (terr-OM) together with compositional shifts - due to changing hydrologic flow paths and permafrost thaw, can modify shelf water chemistry and biogeochemical processes. Here, we examine how shifts in land-ocean terr-OM supply may alter shelf primary productivity, respiration and ultimately net regional CO_2 air–sea fluxes. Unique insights into terr-OM dynamics and composition during transit through riverine, deltaic and shelf waters were collected through multiple field campaigns on the Lena River and Laptev Sea shelf region. Harnessing these field data, we examine the effects of contemporary and future terr-OM supply to shelf waters using newly developed 1-D and 3-D regional biogeochemical models specifically capable of parameterising terr-OM, composition and degradation.
In agreement with prior studies, we find that land-derived nutrients could strengthen coastal production sustaining up to ~50% of primary productivity under current terr-OM conditions. However, we also found that additional terr-OM supply caused increased light limitation in coastal waters, offsetting nutrient fertilization effects and stimulating zooplankton grazing. Model experiments indicate that future increases in terr-OM of between 25-50% and/ or shifts to more biologically reactive coastal OM -such as to be expected with permafrost thaw, will reduce net CO_2 uptake and lead to positive CO_2 feedback from Arctic shelf waters.

Our results question the capacity of the coastal Arctic Ocean to serve as a net sink for atmospheric CO_2 with future increasing land-ocean connectivity and terr-OM supply.