Universität Basel

Research Project

GreenMelt - Impact of Greenland ice melt and discharge on marine biogeochemistry, nutrient fluxes, and productivity

Third-party funded project

Project title GreenMelt - Impact of Greenland ice melt and discharge on marine biogeochemistry, nutrient fluxes, and productivity
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The Arctic Ocean is one of the prime sentinels of the Earth's climate. The (sub)polar Atlantic Ocean exerts important controls on the global ocean circulation, the distribution of nutrients in the ocean, and the meridional heat transport. Primary productivity (PP) is an important component of the ocean's biological carbon pump, controlling the partitioning of CO2 between the ocean and the atmosphere. The Greenland ice sheet (GIS) has been melting at unprecedented rates as a consequence of global warming, yet the potential impacts of ice melting on the nutrient availability and biological productivity of Greenland's marine ecosystem are still unclear, because physical and chemical effects are multifaceted, and can either operate in tandem or oppose each other. For example the release of meltwater at depth from marine-terminating glaciers can induce nutrient upwelling and fuel summertime phytoplankton blooms. In contrast, stratification induced by release of meltwater at the ocean surface can impede vertical nutrient supply, limiting primary productivity. Similarly, associated feedbacks and changes related to the air-sea exchange of greenhouse and aerosol-forming gases (CO2, N2O, DMS) are poorly understood.

The main objective of GreenMelt is to investigate the links between meltwater- associated nutrient flux to coastal- and open ocean ecosystems and related consequences for net primary and export production (NPP/EP) and the air-sea fluxes of climate-relevant gases, in the Arctic Ocean around Greenland. Two key nutrients, iron (Fe) and nitrogen (N), that are crucial for phytoplankton growth, will be the prime focus of investigations. Within four interconnected workpackages, which make use of a truly synergetic high-resolution sampling approach during the GLACE expedition, we aim at (i) quantifying the contribution of meltwater to micro- and macro- nutrient inventories in the coastal- and open-ocean waters around Greenland constraining the main lithogenic sources of nutrients, specifically, Si, N, P and Fe using stable Si, Fe, Zn and radiogenic Nd isotopes. Moreover, we will (ii) assess the consequences of melt-driven changes in nutrient availability and sea-ice loss on the primary and export production and CO2 exchange, as well as the impact of sea-ice melt on pelagic ecosystem diversity, phenology, and productivity. In this context we will also study spatial changes in the emission of PP-associated dimethylsulfide (DMS). Furthermore, we propose to iii) investigate the impacts of sea-ice melting on the contribution of N2 fixation to the net community production. We will address whether iv) the marine environment around Greenland is a source of N2O, and elucidate what the main N2O producing pathway is.

The synergistic, multidisciplinary approach (combining PP and N turnover rate measurements, community characterization and metagenomic analyses, trace metal and stable isotope measurements, as well as trace gas and organic particle observations), with integration of field measurements and laboratory experiments, and using an unprecedented array of instruments connected to the underway water supply, will allow us to elucidate the multifaceted impacts sea-ice melting is imposing on the productivity and biogeochemistry in polar marine environments. Results from the proposed research program will have important implications for understanding how predicted future climate change and continued sea ice retreat will ultimately affect arctic marine ecosystems and biologically-driven green house gas exchange between polar seas and the atmosphere, with important feedbacks on the global climate.

Keywords Iron, nitrate, N2 fixation, net community production, pCO2, N2O, DMS, photophysiology, community characterization, N isotope biogeochemistry, upwelling, meltwater flux
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