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Can a melting Greenland ice sheet act as a nutrient source that compensates projected nutrient deficits in Atlantic surface water masses?

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Numerous studies have shown that under severe climate warming the northern Atlantic Ocean is more stratified, because an enhanced hydrological cycle and warming of upper ocean layers hampers water mass exchange with deeper layers. Therefore the supply of nutrient-rich deep water masses, which replenish the nutrients in the photic zone, is weakened in many climate warming scenarios. Consequently biological activities in the photic zone are stronger limited by the availability of nutrients. On the other side several studies, addressing in particular the release of organic material from melting glaciers or outlet glaciers of Greenland, suggest that intensified melting of glaciers and ice sheet might impact the nutrient supply to the ocean. This leads to the question: Does a strongly melting Greenland ice sheet can compensate the restrained nutrient supply from deep water masses?

We've performed simulations with the MPI-ESM under different scenarios to address the question. A run under pre-industrial conditions serves as a base line experiment, while simulations under the strong warming scenario RCP8.5 shall represent the conditions in a warming world. To mimic the influence of a melting Greenland ice sheet, we discharge homogenously 0.1 Sv (10^5 m^3/s) of fresh water along the coast of Greenland for 40 years. The continuous discharge of 0.1 Sv comes from common hosing experiments, while the setup with the uniformly release along the coast follows two comprehensive studies about the melting water influence on the Atlantic Meridional Overturning Circulation (AMOC) under historical and future warming conditions (RCP8.5). Proportional to the melting strength, nutrients (NO_3, PO_4, SiO_2, and Iron) have been released, whereby the proportionalities have been compiled from a range of published values. In terms of release concentration a high end and a conservative setup have been analyzed.

The simulations highlight, that the additionally released nutrients, have indeed a significant impact on the nutrient distribution. The nutrients flow with the general circulation from the coastal areas of Greenland into the Labrador Sea and spread afterwards into the North Atlantic. In particular the primary production is much stronger than in scenarios where meltwaters have been released without nutrients. All in all it seems, that even in the here assumed high nutrient supply scenarios the loss of nutrients due to increased stratification cannot be compensated for by nutrient input of a melting Greenland ice sheet.