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The impact of Greenland melt water discharge on the Atlantic nutrient supply to the Northwest European Shelf

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Projected future shoaling of the wintertime mixed layer in the Northeast Atlantic has been shown to induce a change in the main nutrient supply pathway from the Atlantic to the Northwest European Shelf near the end of the 21st century. While reduced winter convection leads to a substantial decrease in the vertical nutrient supply and biological productivity in the open ocean, vertical mixing processes at the shelf break maintain a connection to the subpycnocline nutrient pool and thus productivity on the shelf.

Here we investigate how melt water discharge from the Greenland Ice Sheet (GIS) impacts the mixed layer shoaling and the regime shift in terms of both spatial distribution and temporal variability. To this end we have downscaled sensitivity experiments by a global earth system model for various GIS melting rates with a regionally coupled ocean-atmosphere climate system model. The model results indicate that increasing melt water discharge generally leads to an intensification of the regime shift. Both the ocean-shelf nutrient gradient during end-of-winter conditions as well as the interannual variability of on-shelf nutrient fluxes enhance due to (i) the influence of the additional salinity drop in the upper water column and (ii) changes in the atmospheric forcing. Moreover, the regime shift becomes initiated earlier in the century by about 1-2 decades, depending on the discharge rate. The effect on the onset timing, however, is found to be strongly damped by the resulting weakening of the Atlantic Meridional Overturning Circulation. A GIS melting rate that is even 10 times higher than expected for emission scenario RCP8.5 would lead to an onset of the regime shift not until the 2070s.