Do nutrients exported in Greenland Ice Sheet runoff impact coastal productivity and fisheries?

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Project description: The Greenland Ice Sheet (GrIS) exports >1000 km^3 of meltwater and ice annually to the surrounding oceans[1]. This freshwater input to the oceans is increasing and will continue to do so as rising air and ocean temperatures enhance rates of ice sheet melting and stimulate the collapse of floating glacier tongues/ice shelves. The coastal waters around the GrIS are some of the most productive ecosystems in the world, and boast high socio-economic value via fisheries (e.g. shrimp and halibut). Rising glacial meltwater input to these regions has the potential to cause ocean freshening and increased stratification and is likely to be associated with increased nutrient input from meltwaters which are rich in iron, phosphorus, nitrogen and silica. This PhD project aims to determine the influence of the export of nutrients in ice sheet runoff upon fjord and coastal primary productivity and fisheries, via an integrated field/numerical modelling approach. The overarching hypothesis for this project is that ***the physical and biogeochemical consequences of increased freshwater fluxes from the GrIS will alter the productivity of coastal regions around Greenland.*** The project has three main goals:

1) To determine the timing/magnitude of GrIS runoff nutrient fluxes in relation to rates of summer primary productivity (and nutrient limitation) within a major Greenland fjord system.
2) To use a 2d fjord model to constrain fjord nutrient budgets at the study site and the potential impact of the input of ice sheet nutrients on fjord primary productivity.
3) To estimate the potential magnitude of additional "food" sources for fisheries within the coastal zone arising from glacial runoff inputs.

Objective 1 will be addressed by two summer field seasons in Greenland where runoff from the ice sheet and its nutrient content will be quantified at Kangerlussuaq (Sondre Strømfjord). Inner fjord waters will be surveyed by boat at regular intervals in order to determine rates of primary productivity and their nutrient limitation. Objective 2 will be addressed via application of a 2d laterally integrated hydrodynamic model coupled to a biogeochemical fjord model, based upon previous work [2]. This will test the sensitivity of fjord primary productivity to changing nutrient fluxes and hydrodynamic conditions. Objective 3 will draw upon data from Objectives 1 and 2, also obtaining archived data upon fisheries in the region, to assess whether there is any correlation between fisheries and the magnitude, timing and spatial distribution of glacial nutrient inputs at the field site.

1. Bamber, J., et al., *Recent large increases in freshwater fluxes from Greenland into the North Atlantic.* Geophysical Research Letters, 2012. **39**.
2. Arndt, S., et al., *Nutrient dynamics and phytoplankton development along an estuary-coastal zone continuum: A model study.* Journal of Marine Systems, 2011. **84**(3-4): p. 49-66.