The biogeochemical cycle of ocean life: Numerical models reveal the physical drivers behind pelagic and sympagic primary production

I. Deschepper[1,5,6], P.G. Myers[2], T. Papakyriakou[3], D. Lavoie[4,5] and F. Maps[1,5,6]

[1] Université Laval [2] University of Alberta [3] University of Manitoba [4] Fisheries and Oceans Canada / Pêches et Océans Canada [5] Québec Océan [6] Takuvik

Digital Research Alliance of Canada | Alliance de recherche numérique du Canada

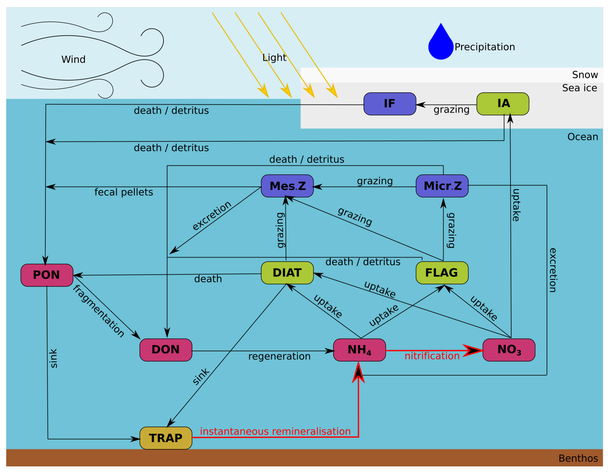
BACKGROUND:

Biogeochemical models are powerful tools that can help to understand areas that are hard to reach all year round. The Hudson Bay Complex (HBC) is a unique inland sea that experiences seasonal ice cover and large volumes of river runoff.

Using two biogeochemical models, coupled to the physical models; Nucleus for European Modelling of the Ocean (NEMO 3.6) which includes Louvian-la-Neuve sea-ice model version 2 (LIM2) sea ice model, we assess:

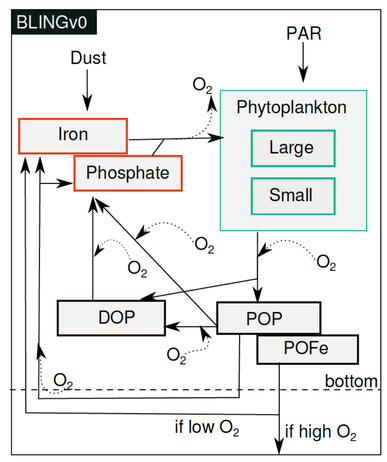
- The impacts on the total nutrient load
- The ability of the models to reproduce observed spatio-temporal patterns of chlorophyll-a

MODELS:



Bio**G**eo**C**hemical **I**ce **I**ncorporated **M**odel (**BiGCIIM**):

- Nitrogen limited
- More complex NPZD model
- Coupled sympagic (sea ice) and pelagic (water) systems
- Chlorophyll-a outputted

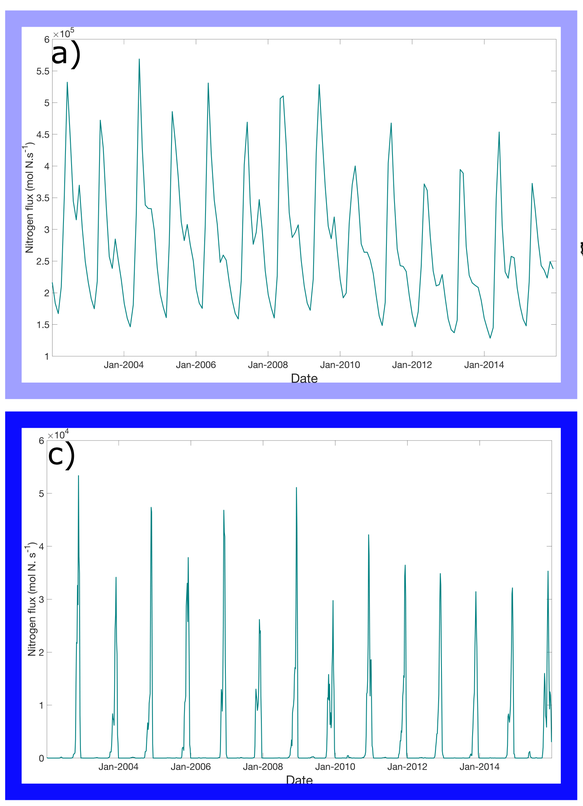


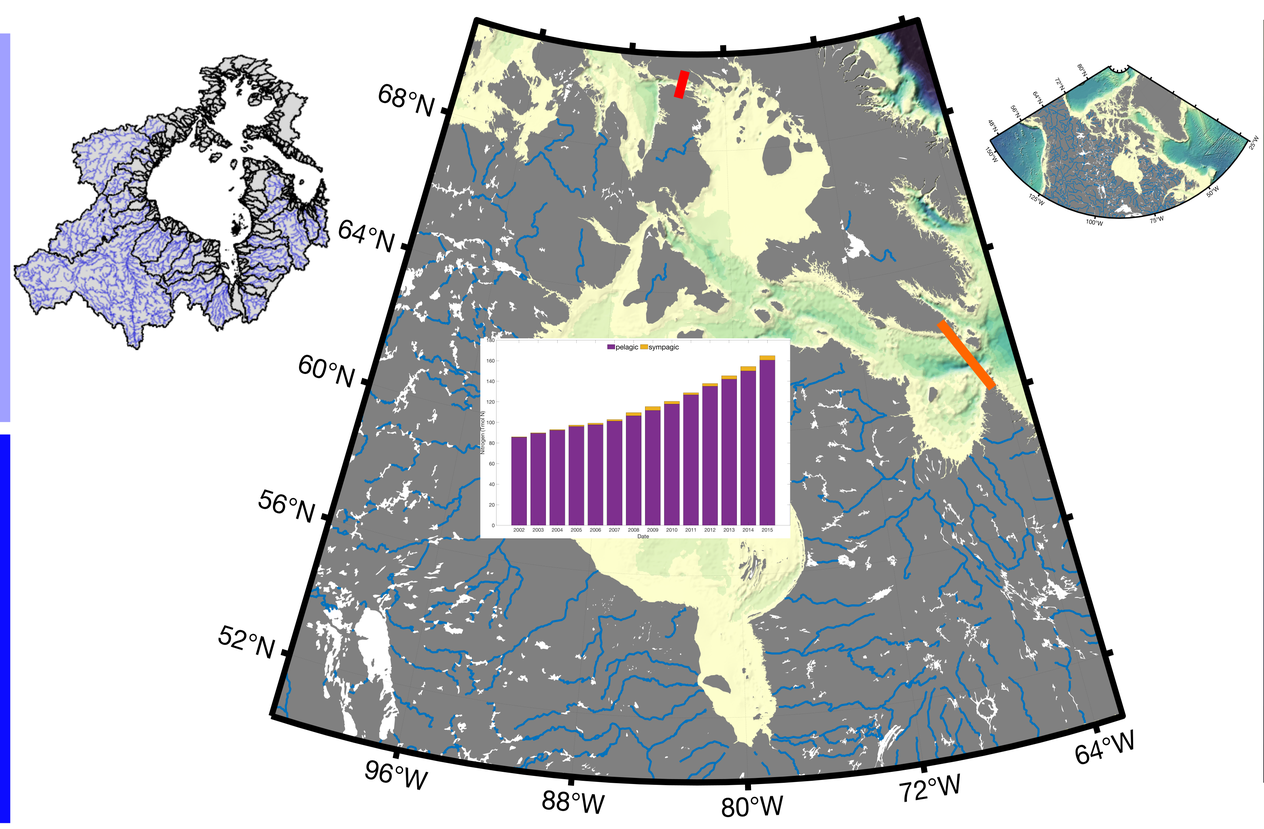
Biogeochemical, **L**ight, **I**ron, **N**utrient and **G**ases (**BLING**):

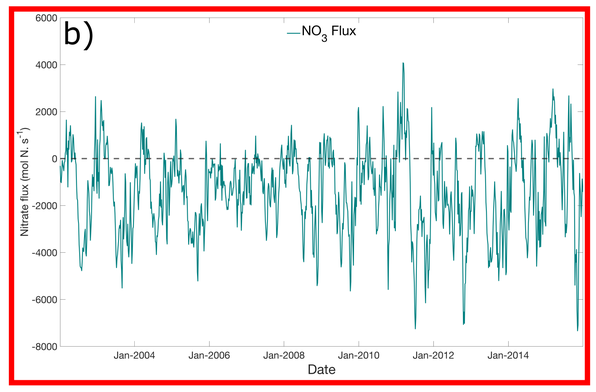
- Phosphate and iron limited (not nitrogen limited)
- Simplified NPZD model
- Only pelagic (water) components
- Chlorophyll-a outputted

IMPACTS OF BOUNDARY INPUTS ON TOTAL NUTRIENT LOAD:

Both biogeochemical models show a trend of increasing chlorophyll-a and total nutrient concentration. Below we assess the impacts of boundary flows (Fury and Hecla Strait and Hudson Strait), river and sea ice nutrient flux into the HBC total nutrient content for the BiGCIIM model.







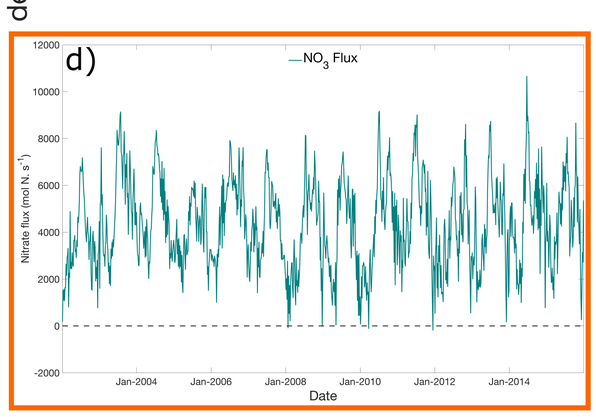


Figure 1: A map of the HBC (central) with the red line indicating Fury and Hecla Strait, and orange line Hudson Strait. The inserted map (left) indicates the river catchment area draining into the HBC. Inset bar graph shows the total nitrogen (Tmol N) with the proportion contributed to by pelagic (purple) and sympagic (yellow) in BiGCIIM. Line graphs indicate the nitrogen flux (molN/s) from the a) rivers, c) ice algae incorporation into the sea ice in the model over the whole HBC area, b) through the Furry and Hecla Strait and d) the Hudson Strait.

CHLOROPHYLL-A AND NUTRIENT COMPARISON:

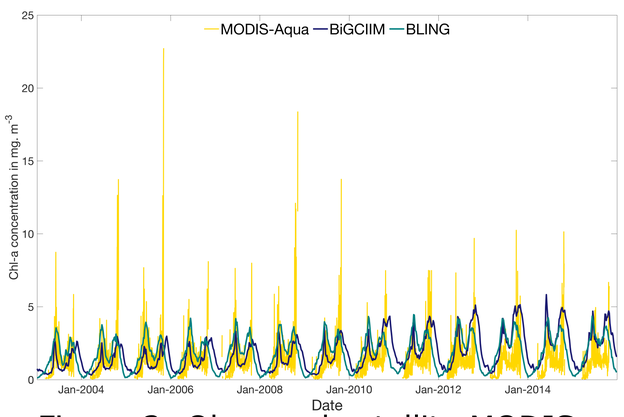


Figure 2: Observed satellite MODIS-Aqua (yellow) and modelled chlorophyll-a for BiGCIIM (dark blue) and BLING (light blue) from 2003 to 2015.

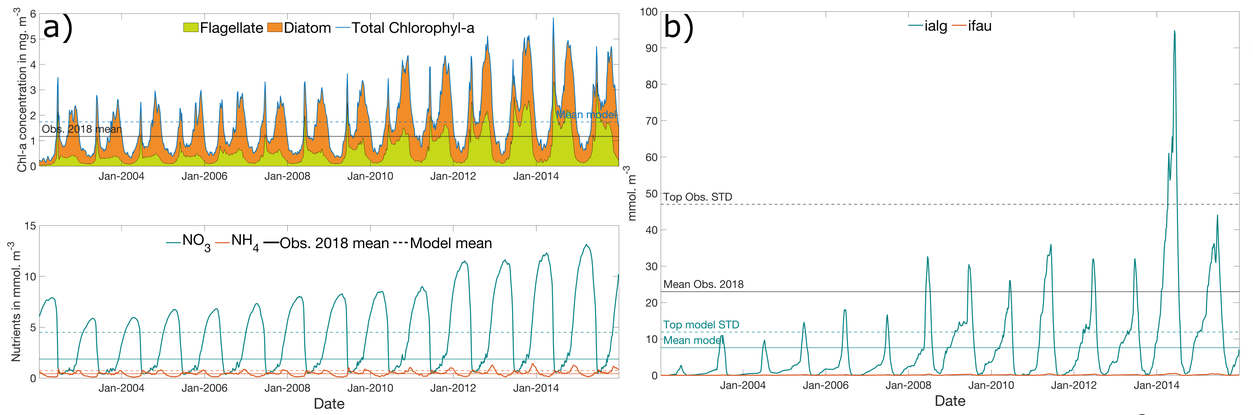


Figure 3: BiGCIIM modelled a) flagellate and diatom chlorophyll-a (mg/m^3) and the in water nitrate and ammonium concentrations (mmolN/m^3) within the mixed layer depth and b) ice algae and fauna concentrations (mmolN/m3) with mean observed and modelled concentrations and standard deviation (STD) levels indicated by the solid and dotted horizontal lines, respectively, from 2003 to 2015.

- Nutrient runoff (mean 2.74 x10^5 molN/s) and ice algae incorporation (mean 2.98 x10^3 molN/s) drive part of the total nitrogen increase
- Open boundaries nitrogen flux has a mean transport out of the HBC (2946 molN/s)
- The modeled nitrate concentration drives the over estimation of chlorophyll-a concentrations
- Both BiGCIIM and BLING represent the double bloom peaks
- BiGCIIM models ice algae concentrations to a reasonable range
- BiGCIIM allows for the prediction of flagellates and diatoms

Contact: Inge.deschepper.1@ulaval.ca