Marine ecosystems - Team 3

Elements of phase 2 report draft

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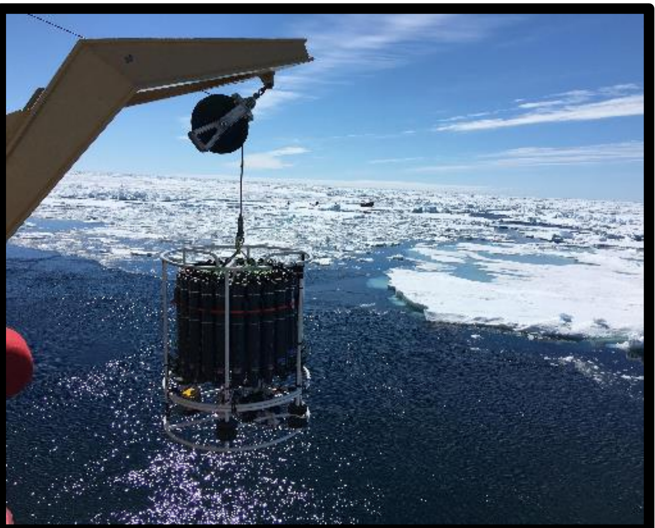


Team 3 – Marine ecosystems

Student	Supervisor	Title
Inge Deschepper	Frédéric Maps	Impacts of climate change and hydrology on the biogeochemical cycles in the Hudson Bay
Marie PierreJean	Philippe Archambault	Current and future impacts of climate change on benthic communities in the eastern Canadian Arctic
Sarah Schembri	Louis Fortier	Biodiversity, distribution and biomass of fish and zooplankton in the Hudson Bay
Loïc Jacquemot	Connie Lovejoy	Microbial diversity across freshwater gradients in the Hudson Bay
Lucas Barbedo de Freitas	Simon Bélanger	Impacts of Seasonal and Interannual Oceanographic Processes onPhytoplankton Primary Production and Phenology in Hudson Bay System
Janghan Lee	Jean-Éric Tremblay	Nutrient dynamics, nitrogen cycling and primary production in the Hudson Bay System
Lisa Matthes	C.J. Mundy	Light propagation in ice-covered environments: Seasonal progression and biological implications
Laura Dalman	C.J. Mundy	Physical gradient influences on sea ice algae in the Canadian Arctic

Central objective and working hypotheses

Assess how different drivers collectively affect biological productivity and the diversity and interaction of water column organisms and the benthos, with an aim to identify the fate of nutrients entering Hudson Bay through marine gateways and regulated versus unregulated rivers.

H3.1: Through their impacts on light transmission and mixed-layer thickness, sea ice/snow dynamics, winter convection and/or river runoff determine the timing of biological production

H3.2: River runoff and physical oceanic processes are both important drivers of nutrient loading, which controls productivity of the lower food web

H3.3: Processing of the inorganic and organic nutrients transported by rivers modulates their impact on Hudson Bay

Tasks and major results

Task 3.1 ***Assess the timing of biological production***

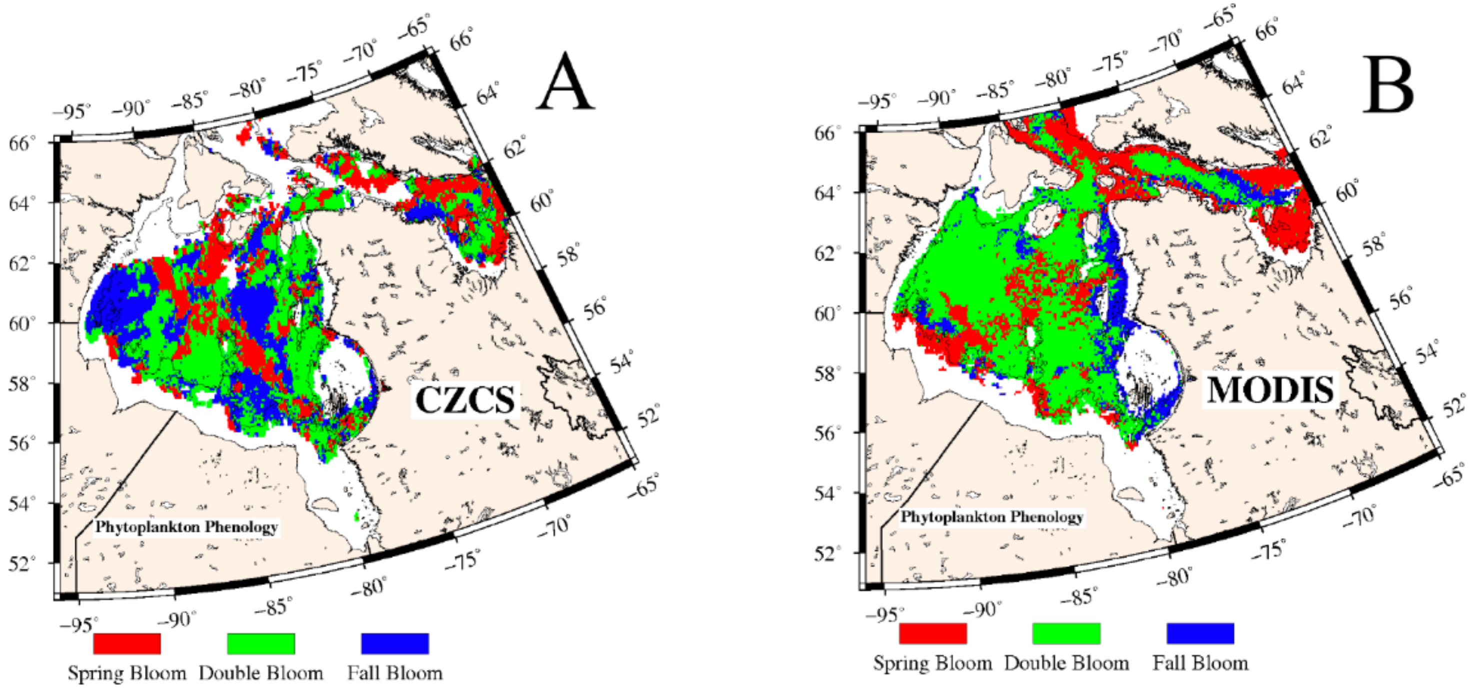
Task 3.2 ***Estimate the magnitude of biological production***

Task 3.3 ***Evaluate nutrient processing along freshwater-marine gradients***

Task 3.4 ***Biogeochemical modeling***

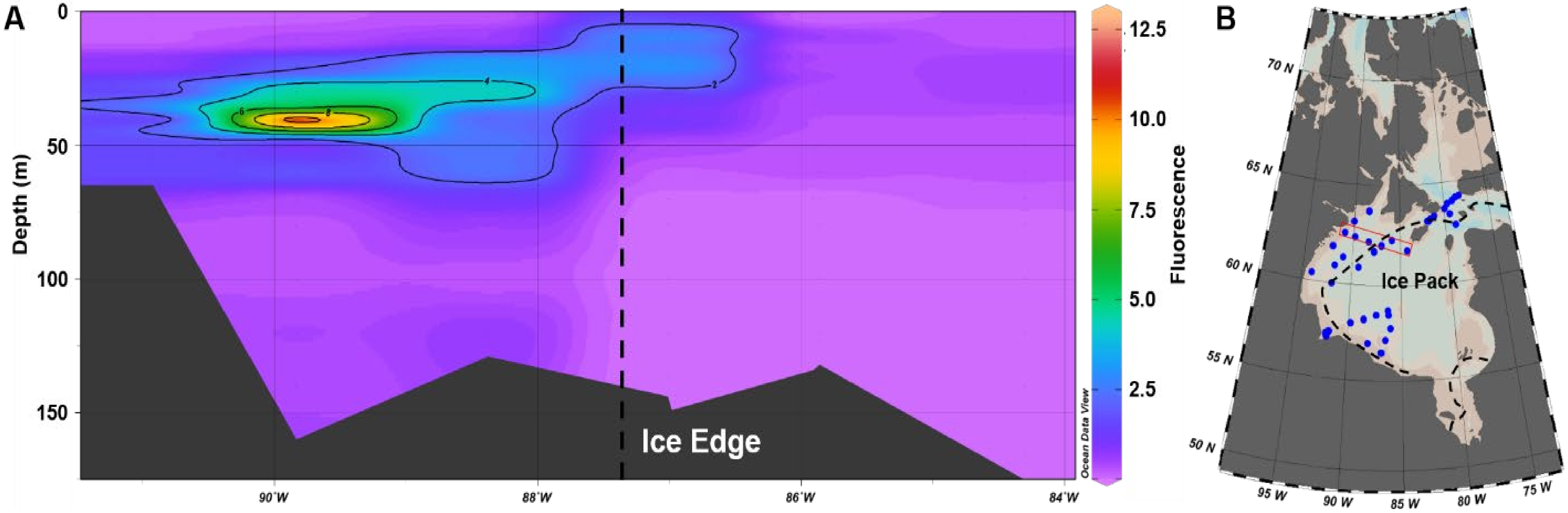
Task 3.1 Assess the timing of biological production

- During positive AO/NAO phases, stronger zonal winds (westerlies) favor dynamic polynya intensification in winter, resulting in an earlier bloom (not shown here).
- The seasonal distribution of PP has changed. In recent times, the incidence of a double bloom (spring and fall) has been much higher (B: MODIS, 2002-2014) than it used to be (A: CZCS era, 1978-83).



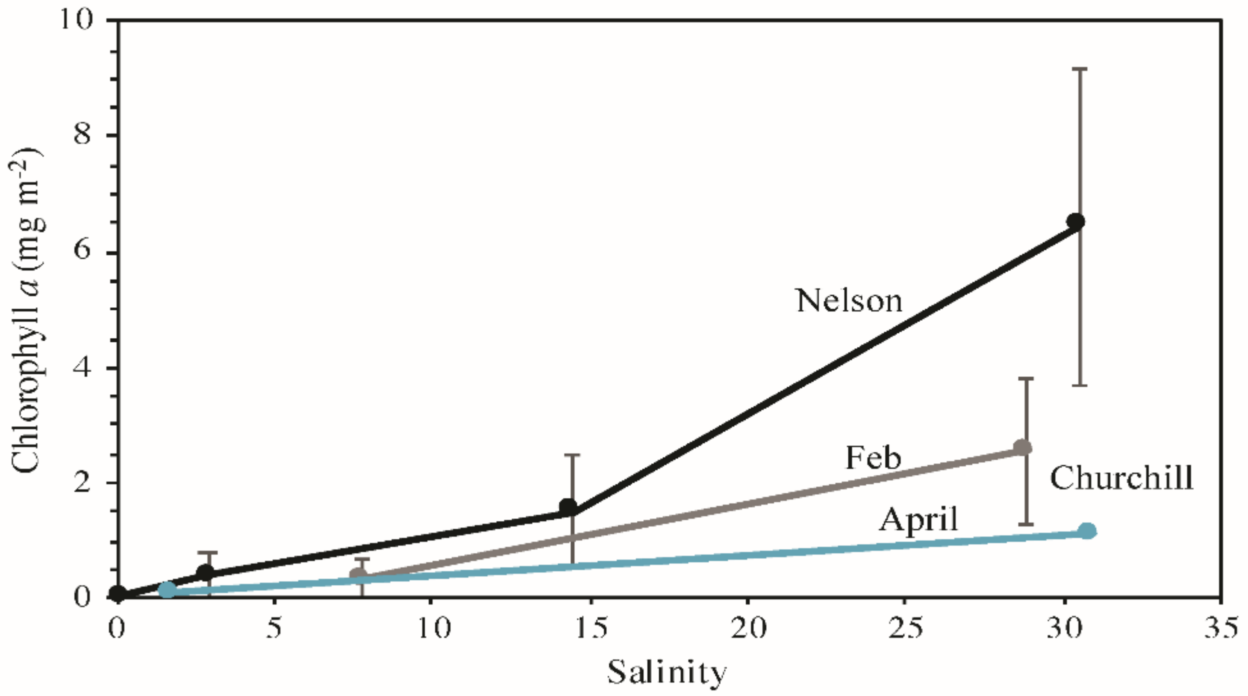
Task 3.1 Assess the timing of biological production

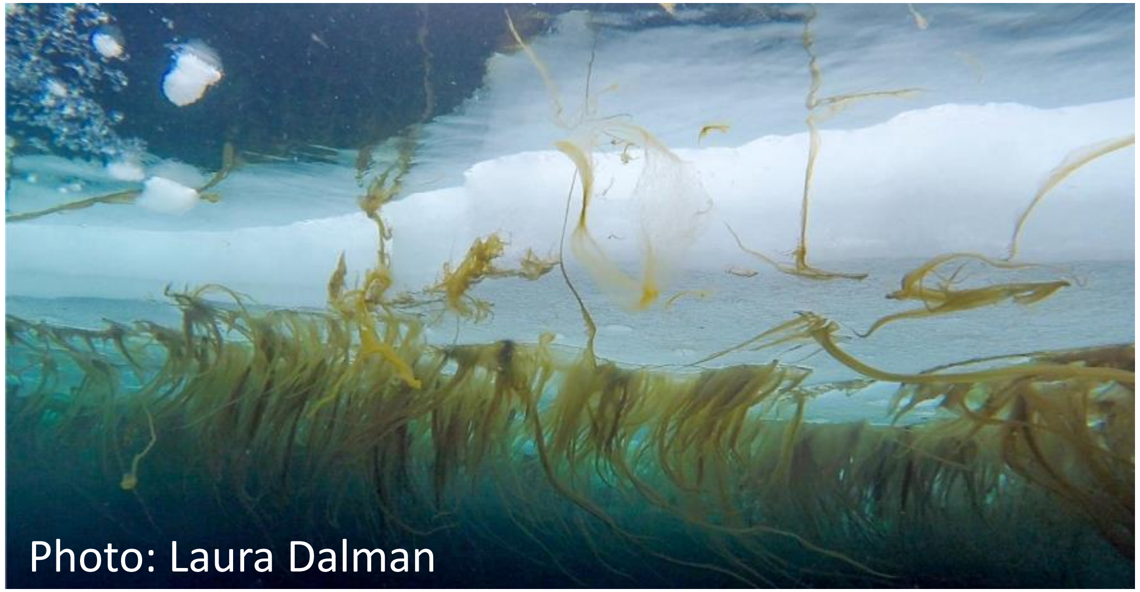
- A large phytoplankton bloom with a pronounced subsurface maximum (SCM) was observed in the north-western polynya (2018 expedition), highlighting the importance of ocean-atmosphere coupling for biological productivity.
- The relatively deep position of the SCM indicates that phytoplankton growth began a long time before sampling (to be assessed).



Task 3.1 Assess the timing of biological production

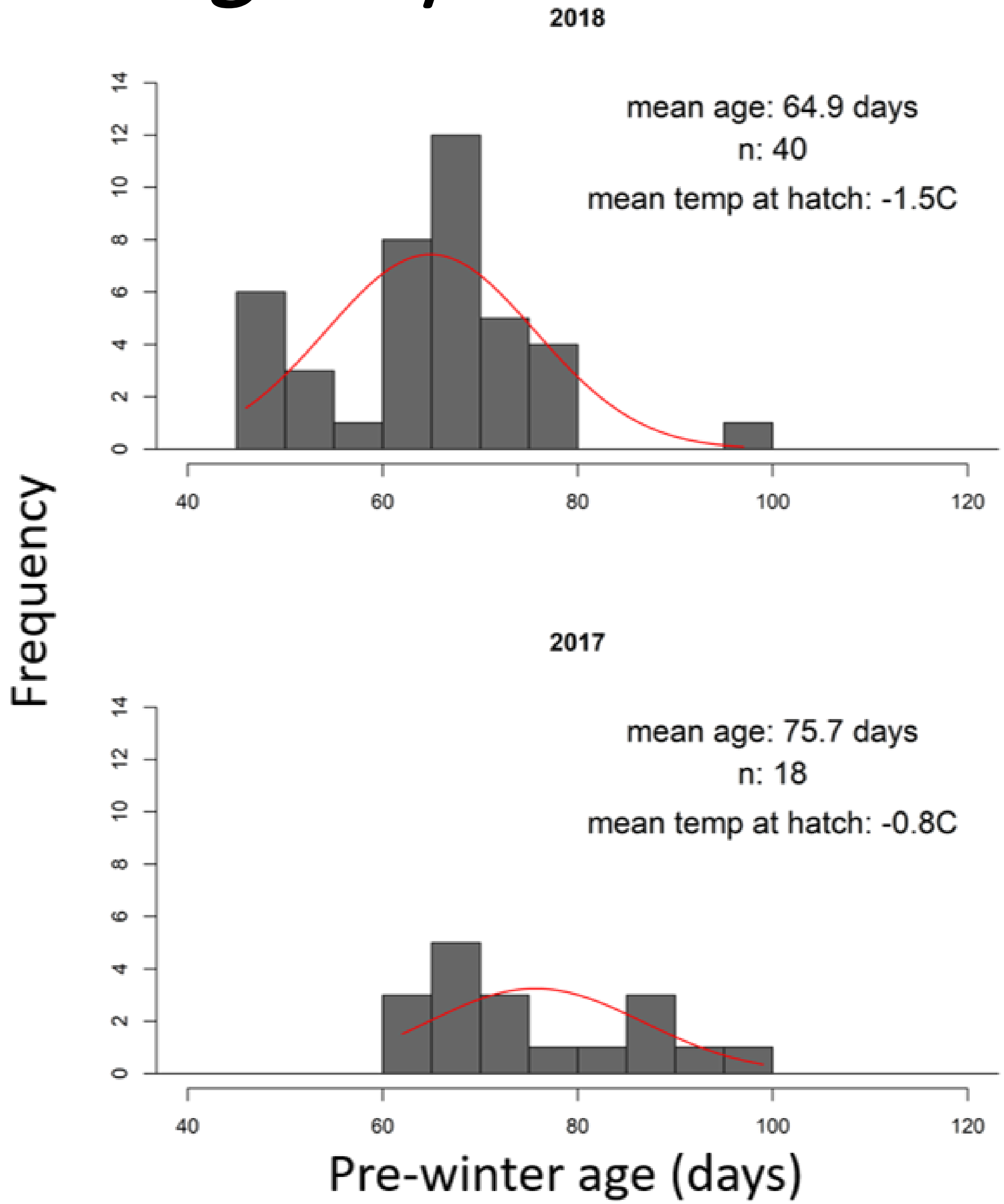
- In both the Nelson and Churchill estuaries during winter, ice-algal biomass increased away from rivers, reaching their maxima at marine sites.
- Unexpectedly high biomass of the ice-suspended algal community, dominated by *Melosira arctica,* were observed on the underside of first-year ice floes in the entrance to HB and the central northern section.





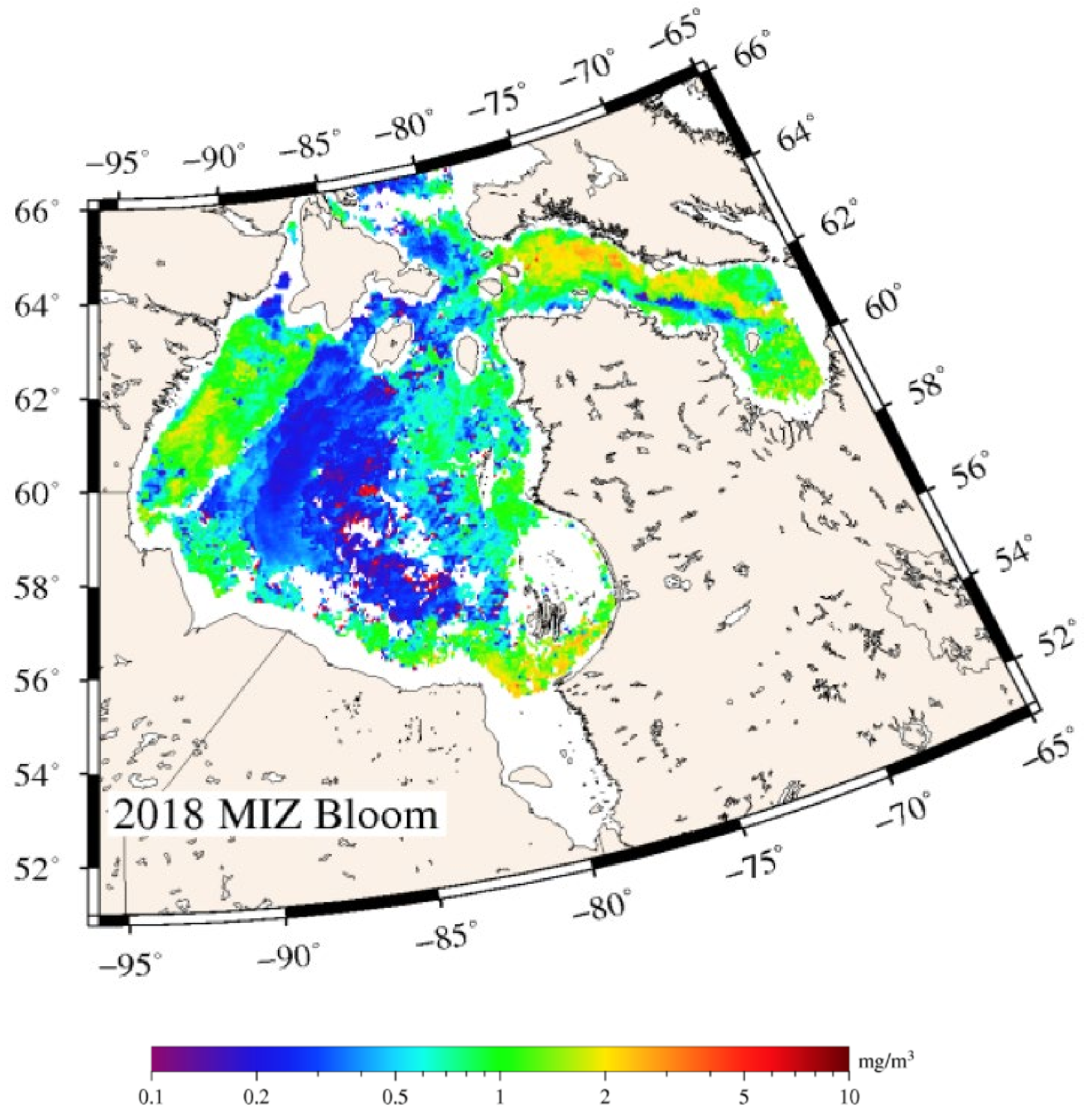
Task 3.1 Assess the timing of biological production

- The regulation of freshwater run-off possibly has an effect on the timing of Arctic cod hatching.
- Arctic cod that hatch earlier generally are more likely to be recruited into the adult population.



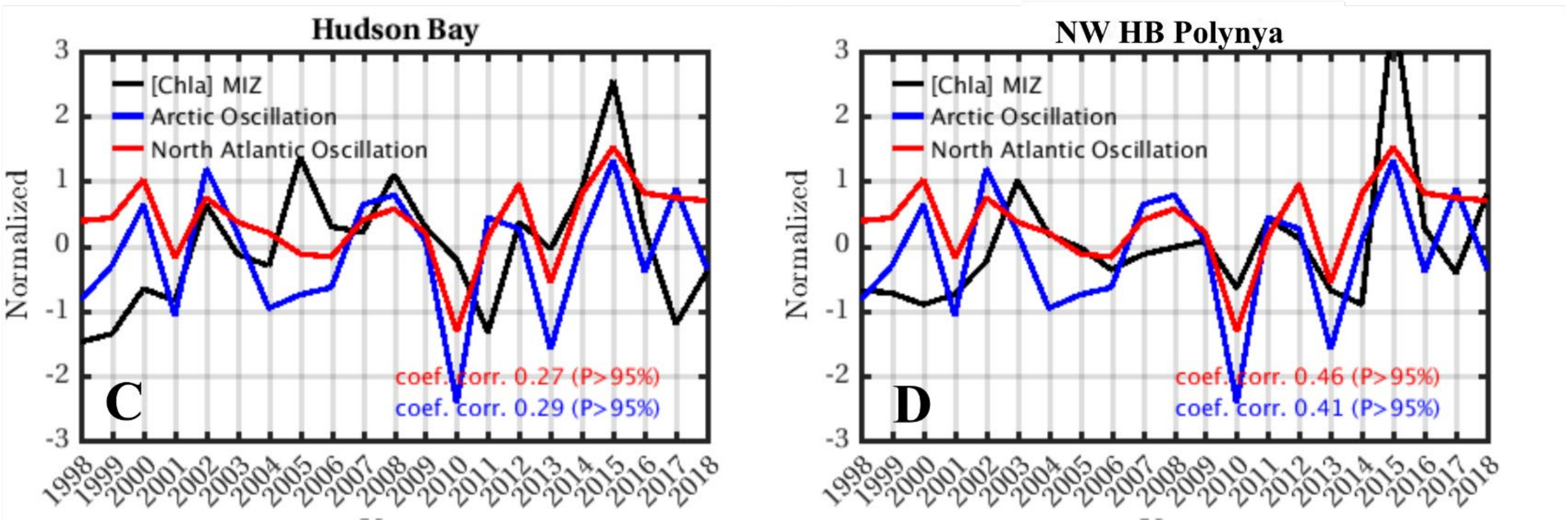
Task 3.2 Estimate the magnitude of biological production

- Strong spatial differences in the maximum chlorophyll biomass attained during the marginal ice zone bloom (example for 2018).
- Biomass is lowest in the central portion of the bay and generally highest at the periphery, with some indication of intensification near rivers.
- A coastal mask is used (white area) to exclude CDOM contamination.



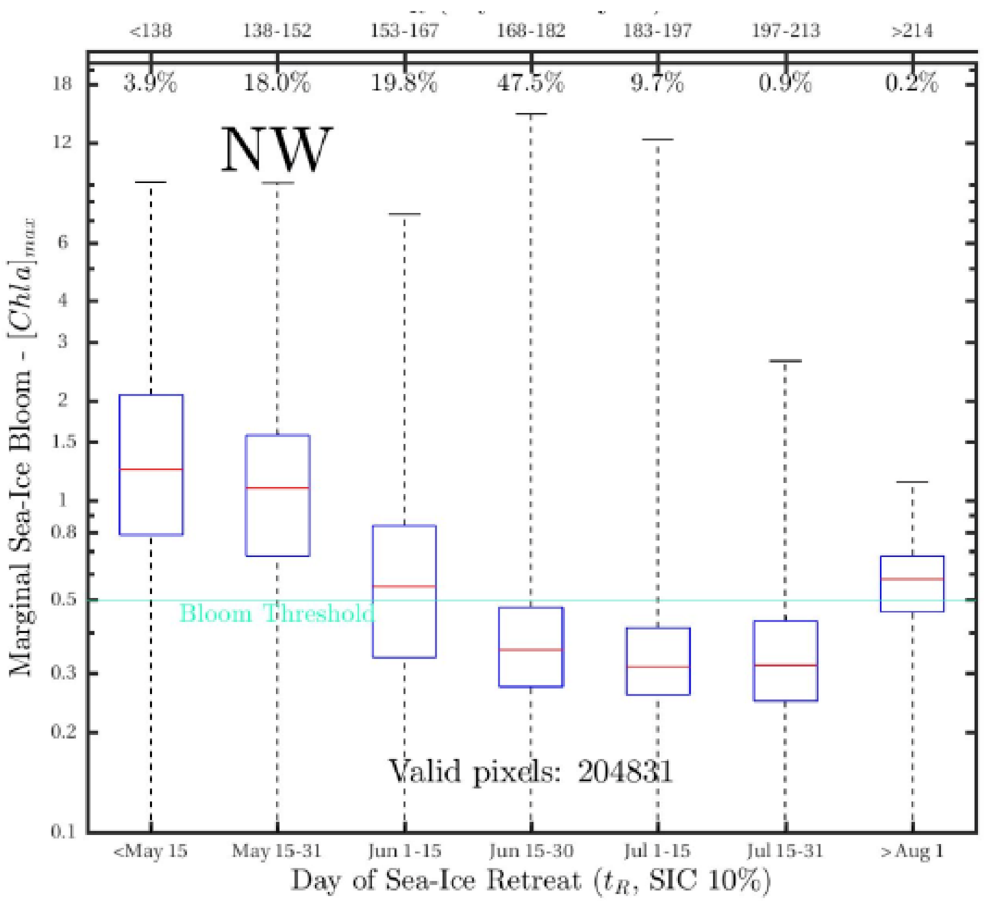
Task 3.2 Estimate the magnitude of biological production

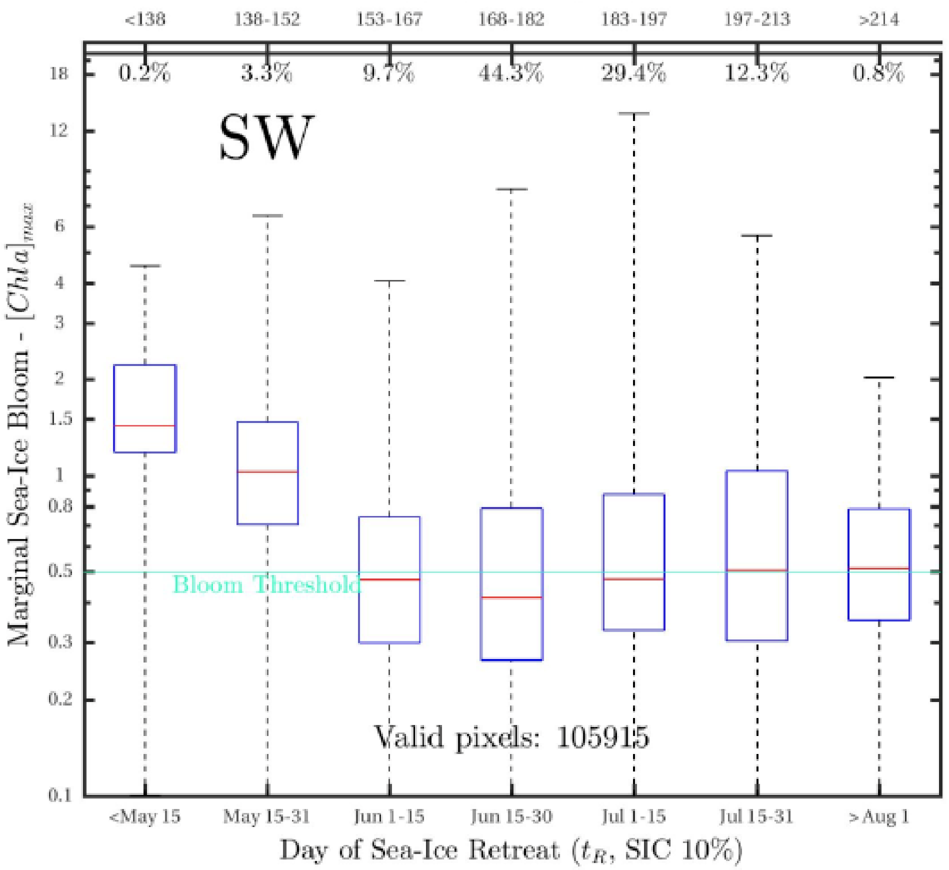
- The magnitude of phytoplankton blooms in the Northwestern HB polynya is sensitive to the Arctic Oscillation.



Task 3.2 Estimate the magnitude of biological production

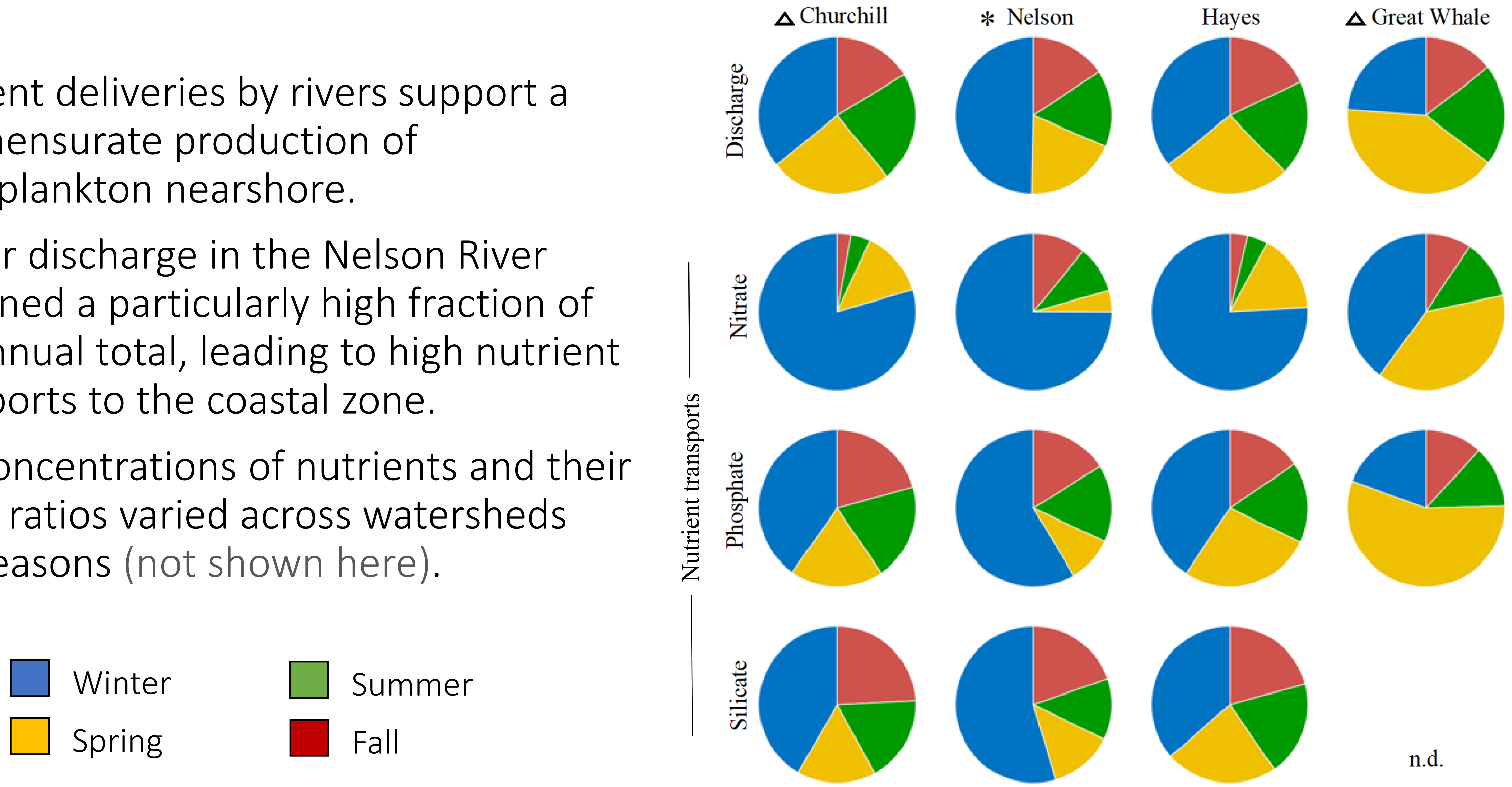
- Early blooms result in higher peak chlorophyll concentrations in the northwest (polynya) and the southwest.





Task 3.2 Estimate the magnitude of biological production

- Nutrient deliveries by rivers support a commensurate production of phytoplankton nearshore.
- Winter discharge in the Nelson River explained a particularly high fraction of the annual total, leading to high nutrient transports to the coastal zone.
- The concentrations of nutrients and their molar ratios varied across watersheds and seasons (not shown here).



Task 3.3 Evaluate nutrient processing along freshwater-marine gradients

- The community structure (molecular diversity) and abundance of algal communities were influenced by salinity in estuaries and by nutrients in marine water (not shown here).
- A transitional community of heterotrophic and mixotrophic microbes was observed at intermediate salinities.
- Spatial differences in benthic biomass and community structure were explained by river influence (salinity), organic matter input and water depth (not shown here).

Task 3.4 Biogeochemical modeling (feeds into 3.1 and 3.2)

- All observational data acquired during this project contributed to the refinement of a biogeochemical model of the Bay.
- Includes the dynamics of both the sympagic and the pelagic systems and their interactions.

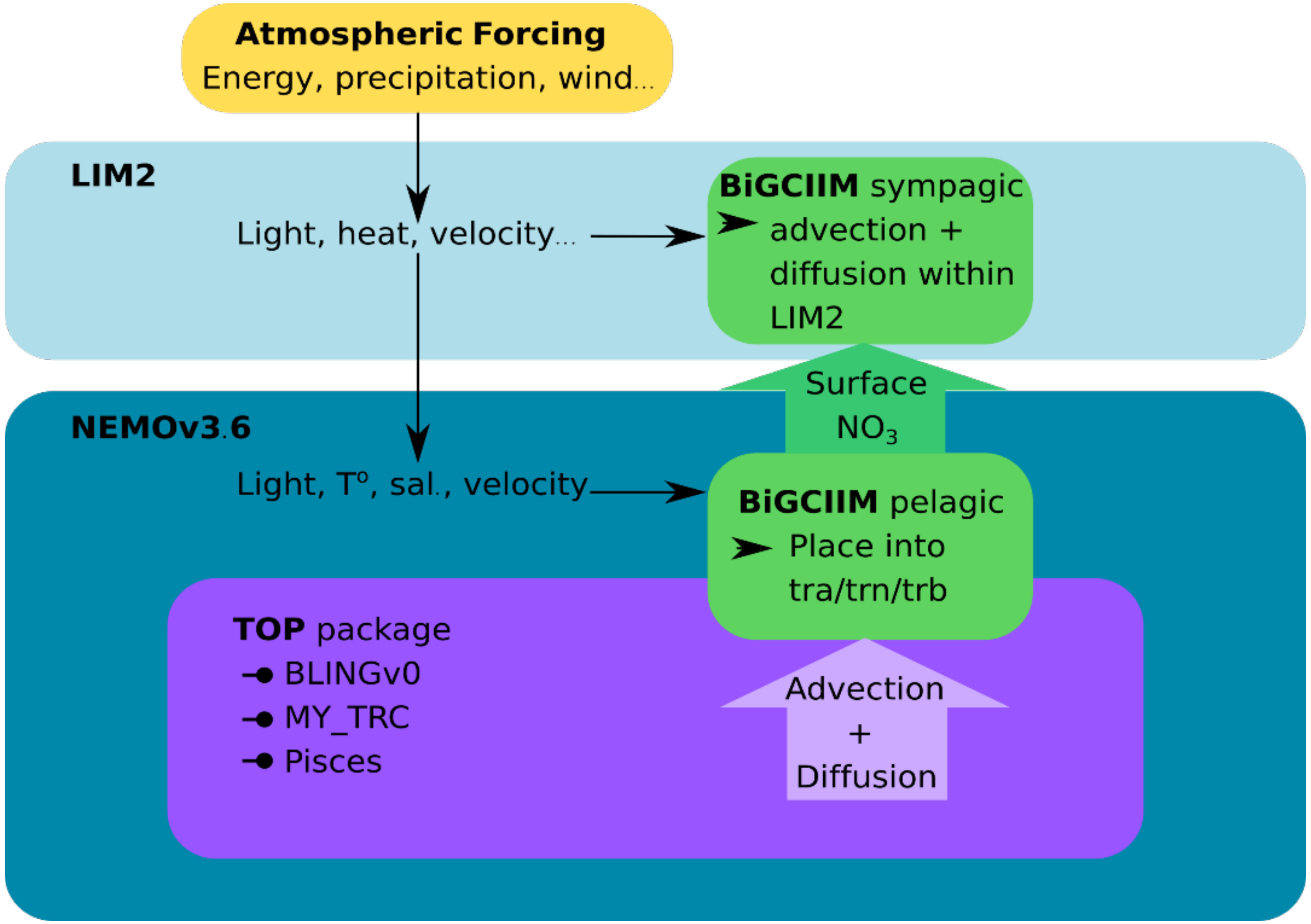
- Major improvements to the model:
  - Nutrient fluxes between biological compartments (nitrification, remineralisation)
  - Transfer of nutrients into the ice
  - Growth dependency of micro-algae on light
  - Addition of carbon flux component

-> Coupling to NEMO 3.6, the physical ocean and ice model used by team 6.

Task 3.4 Biogeochemical modeling (feeds into 3.1 and 3.2)

Results forthcoming!

Will be used to evaluate the effect of climate scenarios and river regulation on the timing and magnitude of biological productivity and fluxes of gases and carbon.



Working hypotheses wrap up

H3.1: Through their impacts on light transmission and mixed-layer thickness, sea ice/snow dynamics, winter convection and/or river runoff determine the timing of biological production

H3.2: River runoff and physical oceanic processes are both important drivers of nutrient loading, which controls productivity of the lower food web

H3.3: Processing of the inorganic and organic nutrients transported by rivers modulates their impact on Hudson Bay

H3.1 Through their impacts on light transmission and mixed-layer thickness, sea ice/snow dynamics, winter convection and/or river runoff determine the timing of biological production

- Positive effect of light transmission through sea-ice melt/break up on timing.
- Earlier onset of biological production near the coast due to deliveries of nutrients by rivers.
- Increased stratification and decreased upward nutrient supply in the central sector of the bay due to propagation of nutrient-depleted freshwater offshore.
- Negative influence of freshwater input on ice algal accumulation.
- Highest phytoplankton production in open water of north-western HB in contrast to low under-ice PP.
- Biogeochemical model will allow us to test a relationship between sea ice, mixed layer depth and river runoff with the timing of biological production (ongoing).

H3.2 River runoff and physical oceanic processes are both important drivers of nutrient loading, which controls productivity of the lower food web

- Nutrient loadings from rivers and upward nutrient supply through physical oceanic processes both determine the magnitude of biological production.
- By influencing local circulation, river regulation modulates nutrient concentrations as well as the position and composition of microbial communities across the estuarine transition zone.
- The impacts of nutrient loading will be tested using the biogeochemical model (ongoing).

H3.3 Processing of the inorganic and organic nutrients transported by rivers modulates their impact on Hudson Bay

- Most of the inorganic nitrogen transported by rivers into the bay is converted into new phytoplankton biomass locally (but accounts for a small portion of the overall PP at bay scale).
- Nutrients transported by rivers supported the development of a phytoplankton bloom in the estuaries at the time of sampling.

Questions?