In search of tipping points in the Arctic Ocean ecosystem

Oziel L., Schourup-Kristensen V., Hauck J.

CONTEXT

The Arctic Ocean is a sentinel for climate change as it warms more than twice faster than the global average[1]. A long list of alterations have already been documented (e.g. sea-ice in Fig. 1)

The future implications for primary producers and consequently for the entire ecosystem and biogeochemical cycles are still uncertain.

- The objective of this project is to identify tipping points in the Arctic **phytoplankton dynamics,** their environmental **drivers** and their implications for **biogeochemical cycles** using BGC modeling.

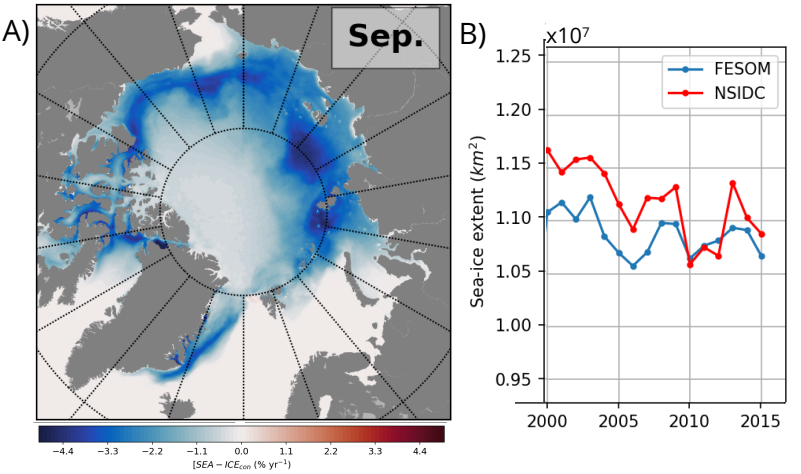

Figure 1: Decreasing (a) spatial and (b) temporal sea-ice concentration trends in September for the 2000-2015 period in the Arctic Ocean. NSIDC = satellite obs.

HYPOTHESIS

In summer, the sea-ice might disappear by the end of the century (SROCC 2019) and light not be limiting anymore. In this context, we hypothesize that future **primary production will be ultimately driven by nutrient supply**.

The input of 'new' nutrients can occur though different pathways: (1) Physical (e.g. wind-induces turbulent mixing, advection) (2) Biogeochemical (e.g. nitrification, N2 fixation)

➔ MOSAiC *in situ* dataset and collaboration with other related modeling projects

THE MODEL

We use Biogeochemical and high resolution modeling (FESOM 1.4-REcoM2) for the last 15 years[2]. FESOM use an unstructured mesh that allows to increase resolution in domains of interest at low computing cost (Fig. 2)

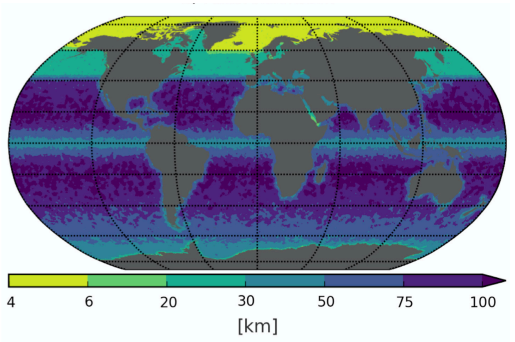

Figure 2: Horizontal resolution of the mesh used in this study

PRELIMARY RESULTS

1) The model successfully represents the increase in NPP in the inflowing shelves associated with increase in Chl *a*[3] (Fig. 3).

2) The increase in PP in the Greenland Sea has noy been evidenced by remotely sensed observations.

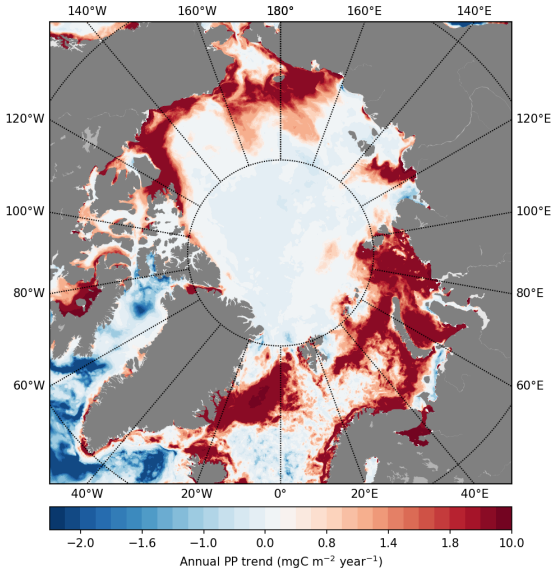

Figure 3: Spatially integrated annual Net Primary Production over the 2000-2015 period for the Arctic Ocean.

PERSPECTIVES

By analyzing historical runs and future simulation (CMIP6 forcing) using a bio-regional approach we will:

1) Refine past and future phytoplankton dynamics: assemblage, phenology, magnitude, distribution…

2) Identify **limiting factors** (light vs. nutrients, grazing …) and leading (changing?) mechanisms (e.g. vertical mixing vs. advection for nutrients)

3) Estimate possible **feedbacks** with biogeochemical cycles and **implications** for ecosystems

References:

(1) Serreze, M. C. & Barry, R. G. Processes and impacts of Arctic amplification: A research synthesis. Global Planet. Change 77, 85–96 (2011).

(2) Schourup-Kristensen, V., Sidorenko, D., Wolf-Gladrow, D. A., and Völker, C. A skill assessment of the biogeochemical model REcoM2 coupled to the Finite Element Sea Ice–Ocean Model (FESOM 1.3). Geosci. Model Dev. 7, 2769–2802. (2014).

(3) K. M. Lewis, G. L. van Dijken, K. R. Arrigo, Science 369, 198 (2020).

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