

The role of *Phaeocystis* spp. in the Arctic Ocean Biological Carbon Pump

Problem

- 1) Largest uncertainties in future projections of the biological carbon pump (BCP) by IPCC models are in the Arctic Ocean (AO)
- 2) Current biogeochemical models do not represent key processes governing the Arctic BCP
- 3) Here: Focus on phytoplankton community – especially the role of *Phaeocystis* spp.

Why *Phaeocystis* spp.?

- *P. pouchetii* is a significant primary producer **spreading in the AO**
- Increasing dominance due to better **tolerance** towards acidification, higher temperature and irradiance, poorer nutrient conditions

Methods

- Development of *Phaeocystis* spp. in REcoM3
- Implementation based on **literature** & 3D evaluation against **observations**:
 - Reassessment of temperature functions
 - Tuning of parameters for grazing, PI-curve, nutrient uptake, etc.
- Hindcast transient simulations (1970–2023)

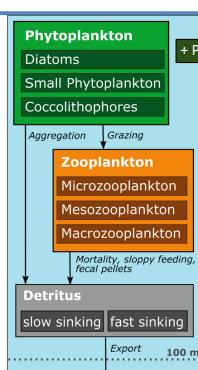
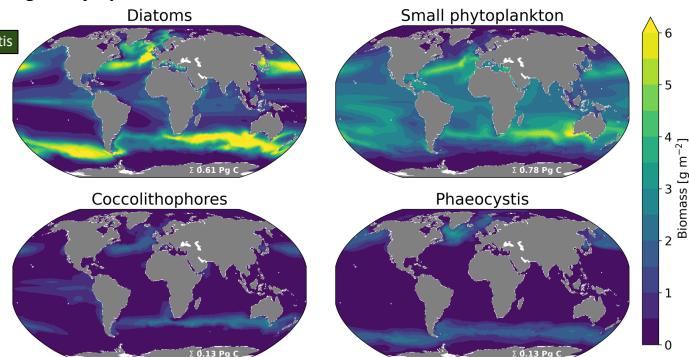


Fig 1: Phytoplankton biomass.



Phytoplankton Community Shift

- less diatoms, more *P. pouchetii* & coccolithophores & other small phytoplankton
- especially strong where sea-ice retreats, i.e. regions of regime shift (light to nutrient limited system)

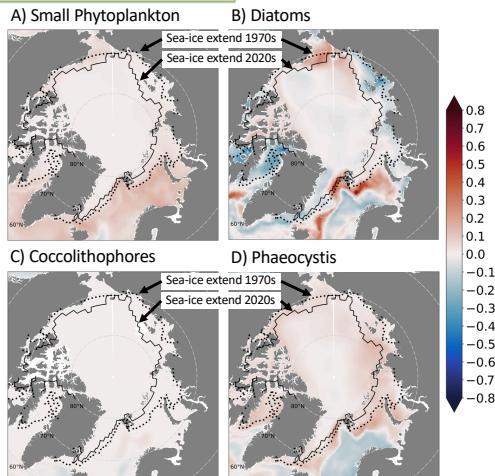


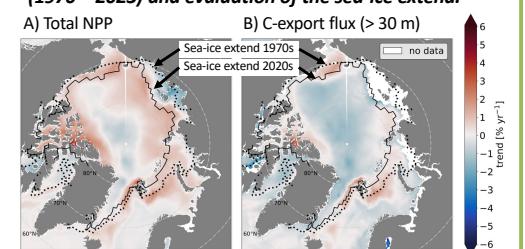
Fig. 2: Absolute changes of NPP (1970–2023) and evaluation of the sea-ice extend.

Unexpected Feedback ?

more NPP = less C-export flux
 → the shift to more *P. pouchetii* may be responsible for this, due to ...

- less ballasting compared to diatoms
- less grazing by large zooplankton
- lesser production of big particles

Fig. 3: Relative changes of NPP (A) and C-export flux at 30 m (B) (1970–2023) and evaluation of the sea-ice extend.



Outlook

- Will *P. pouchetii* further increase in the future AO?
- How and where will *Phaeocystis* spp. impact the BCP (NPP, C-export and storage) in the future?
- Investigation of interaction with ballasting/aggregation material (TEP, cryogenic gypsum, sea-ice algae, lithogenic material, etc.)

Abbreviations

AO – Arctic Ocean, BCP – biological carbon pump, C – carbon, FESOM – Finite Element Sea-Ice Ocean Model, IPCC – Intergovernmental Panel on Climate Change, NPP – net primary production, PI-curve – Photosynthesis-Irradiance curve, REcoM – Regulated Ecosystem Model, TEP – transparent exopolymer particles

Observational References for Model Evaluation:

WOA – Nutrients, Oxygen
 GLODAP, SOCCAT – Carbonates & CO₂ fluxes
 MAREDAT – Planktonic Biomass
 Satellites: Lewis and Arrigo, OC-CCI – Biomass and NPP
 Mouw et al. 2016 – Export fluxes

References

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