End-of-century Prediction of Marine Biogenic Aerosol Precursors

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Concept

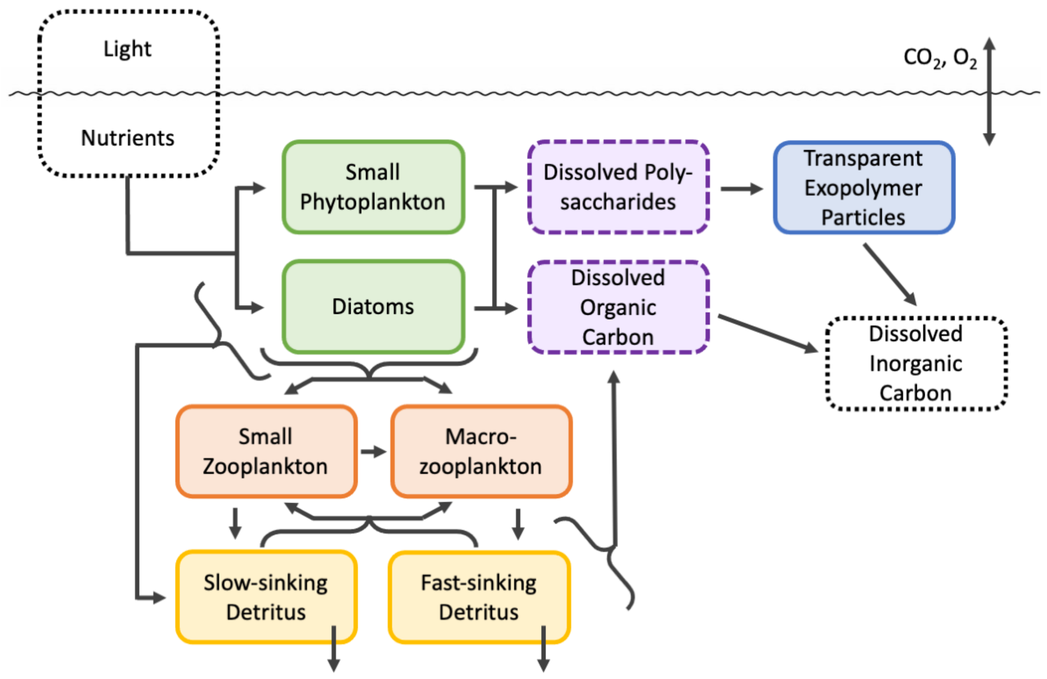
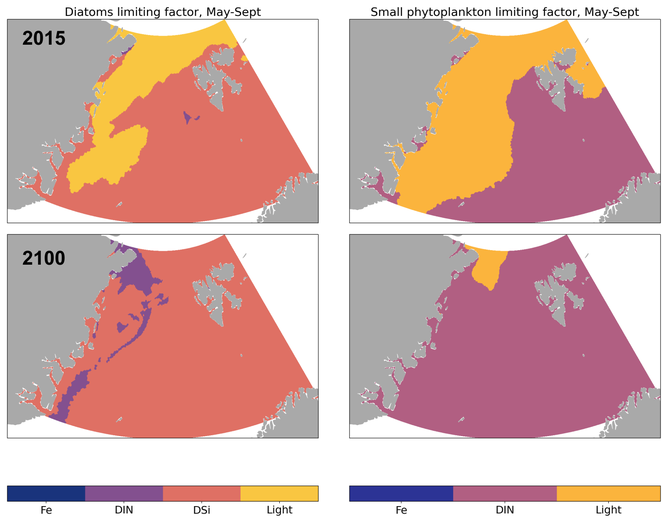


Fig. 1: Concept of organic carbon fluxes in REcoM3.

- **Integration of polysaccharides, Transparent Exopolymer Particles (TEP) into FESOM2.1-REcoM3 (Zeising et al., under review)**
- **Simulation based on AWI-CM ssp370 (Oziel et al., in prep; Semmler et al., 2020)**

Example: Limitations in Fram Strait



- **shift from light to nutrient limitation**
- **Diatoms: Silicate**
- **Small Phytoplankton: Nitrate**

Fig. 4: Most limiting factors for phytoplankton growths in Fram Strait for summer months MJJAS of 2015 and 2100.

Model Equations in REcoM3

$$\mathrm{S(DOC)} = \underbrace{(1-f_{PCHO})\cdot\varepsilon^{C}_{phy}\cdot f^{lim}_{phy}\cdot C_{phy}}_{\text{excretion by small phytoplankton}} + \underbrace{(1-f_{PCHO})\cdot\varepsilon^{C}_{dia}\cdot f^{lim}_{dia}\cdot C_{dia}}_{\text{excretion by diatoms}} + \underbrace{\varepsilon^{C}_{zoo1}\cdot C_{zoo1}}_{\text{excretion by zooplankton}} + \underbrace{\varepsilon^{C}_{zoo2}\cdot C_{zoo2}}_{\text{excretion by macrozoo.}} + \underbrace{\rho_{DetC}\cdot f_T\cdot C_{det1} + \rho_{DetC}\cdot f_T\cdot C_{det2}}_{\text{detritus remineralization}} - \underbrace{\rho_{DOC}\cdot f_T\cdot C_{DOC}}_{\text{remineralization to DIC}}$$

$$S(PCHO) = \underbrace{f_{PCHO}\cdot\varepsilon^{C}_{phy}\cdot f^{lim}_{phy}\cdot C_{phy}}_{\text{excretion by small phytoplankton}} + \underbrace{f_{PCHO}\cdot\varepsilon^{C}_{dia}\cdot f^{lim}_{dia}\cdot C_{dia}}_{\text{excretion by diatoms}} - \underbrace{\alpha_{PCHO}\cdot\beta_{PCHO}\cdot C_{PCHO}\cdot C_{PCHO}}_{\text{aggregation of PCHO with PCHO}} - \underbrace{\alpha_{TEP}\cdot\beta_{TEP}\cdot C_{PCHO}\cdot C_{TEP}}_{\text{aggregation of PCHO with TEP}}$$

$$S(TEP) = \underbrace{\alpha_{PCHO}\cdot\beta_{PCHO}\cdot C_{PCHO}\cdot C_{PCHO}}_{\text{aggregation of PCHO with PCHO}} + \underbrace{\alpha_{TEP}\cdot\beta_{TEP}\cdot C_{PCHO}\cdot C_{TEP}}_{\text{aggregation of PCHO with TEP}} - \underbrace{\rho_{TEP}\cdot f_T\cdot C_{TEP}}_{\text{remineralization to DIC}}$$

Summary

- Prediction of PCHO & TEP as biogenic aerosol precursors until end of century based on ssp370
- Long-term trends diverging: retreating sea ice impact on Net Primary Production
- Nutrient limitations of increasing importance

Preliminary Timeseries

- **decrease of Total Chlorophyll *a* across whole Arctic, only slight increase in parts of central basins**
- **lower nutrient availability (DSi!)**
- **increase of NPP in most regions**
- **in parts strongly pronounced increase of TEP**

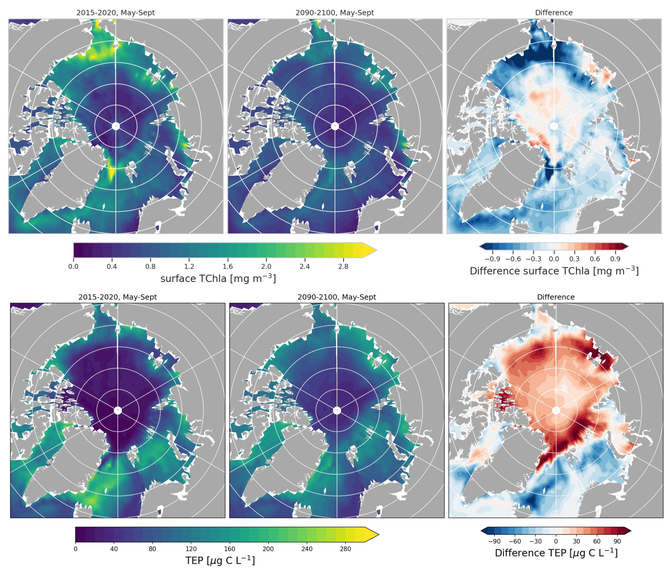
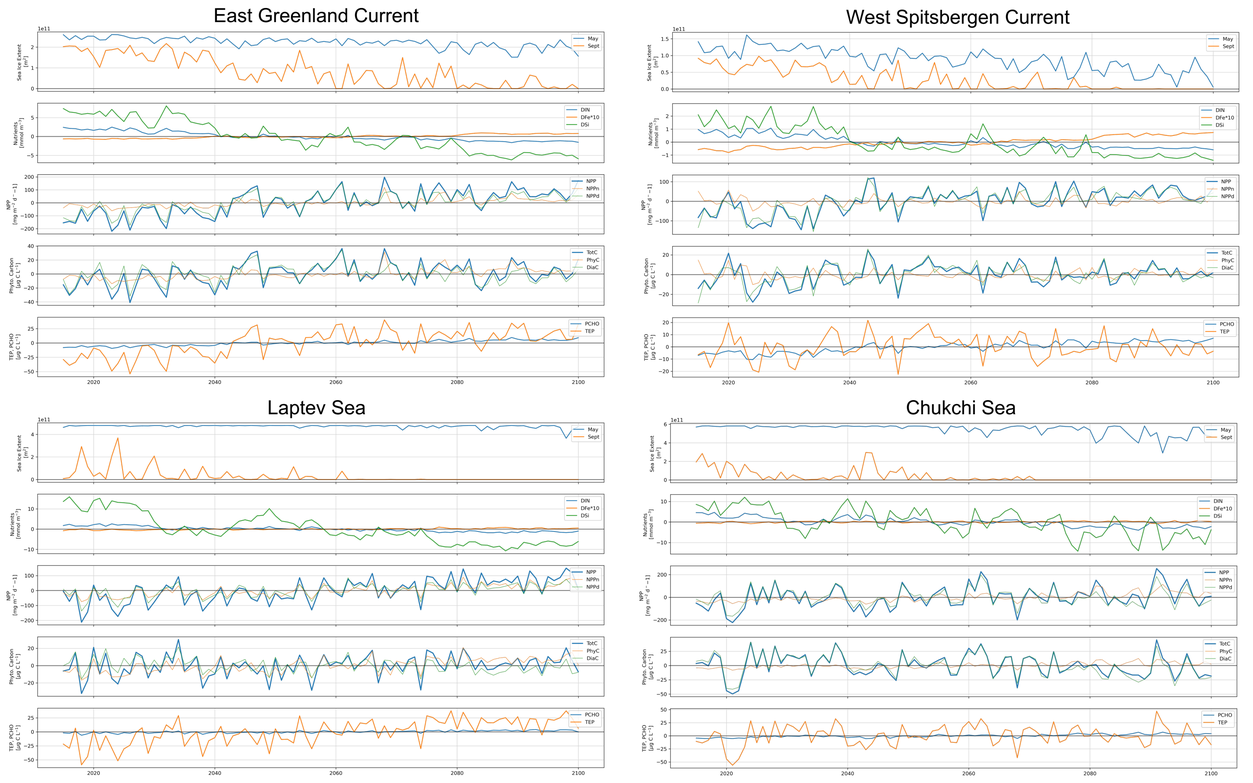


Fig. 2: Maps of Total Chlorophyll a and TEP comparing means of 2015-2020 to 2090-2100.

Fig. 3: Timeseries of anomalies of model variables for different regions spanning the years 2015 to 2100.



Trends: TEP & NPP

- **regionally diverging trends**
- **along retreating ice edge**
- **decrease of TEP in Fram Strait, Barents Sea, Kara Sea along NPP decrease**
- **increase of TEP in other Arctic seas and basins along NPP increase and low nutrient availability**

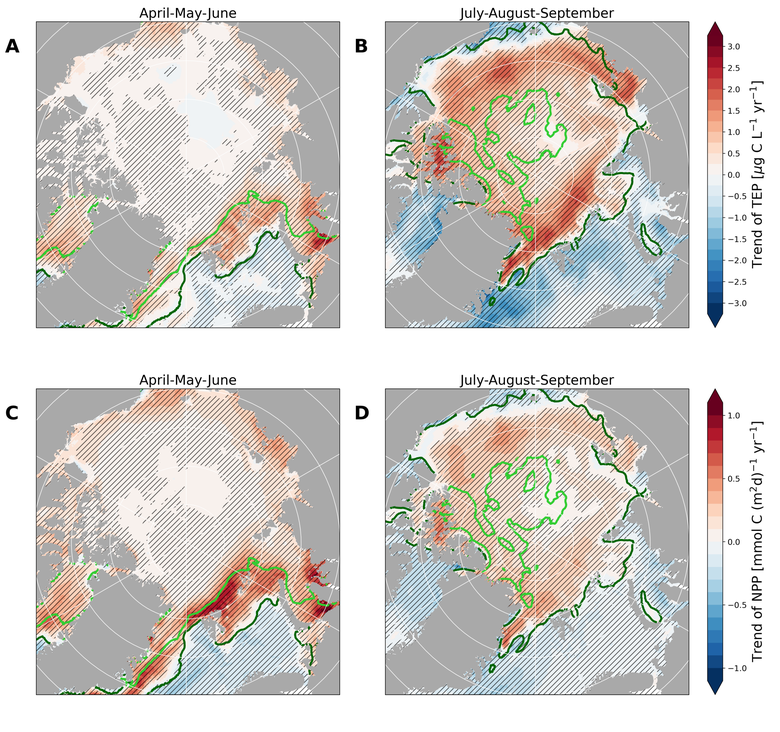


Fig. 5: Maps of trend of TEP (0-30 m) and Net Primary Production (NPP) of 2015-2100. Significant trends displayed as hatched areas.

- **trends per months differ within and in between regions**
- **in most regions prolonged season**
- **in East Greenland Current, Kara Sea, Chukchi Sea earlier production onset**

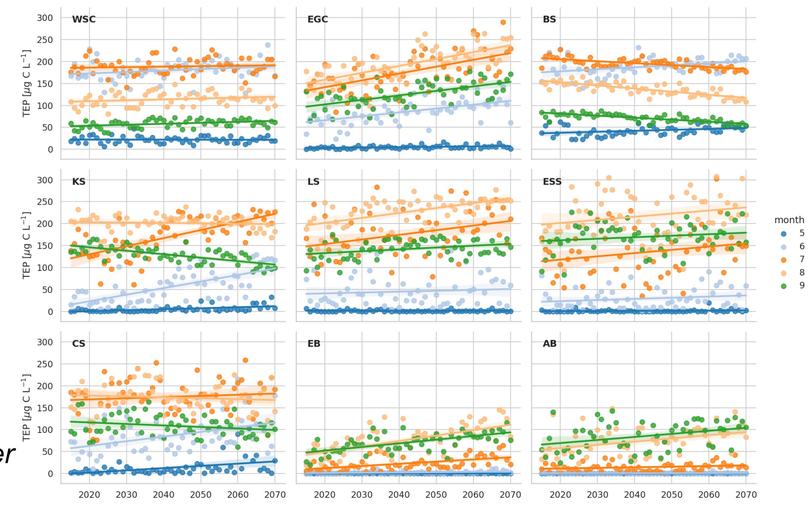


Fig. 6: Linear regression for TEP per region and per basin of 2015-2100.

References:
Oziel, L. et al. (in prep).
Semmler, T. et al. J. Adv. Modeling Earth Syst. 12, 1–34 (2020).
Zeising, M. et al. (under review in JGR Biogeoscience)

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