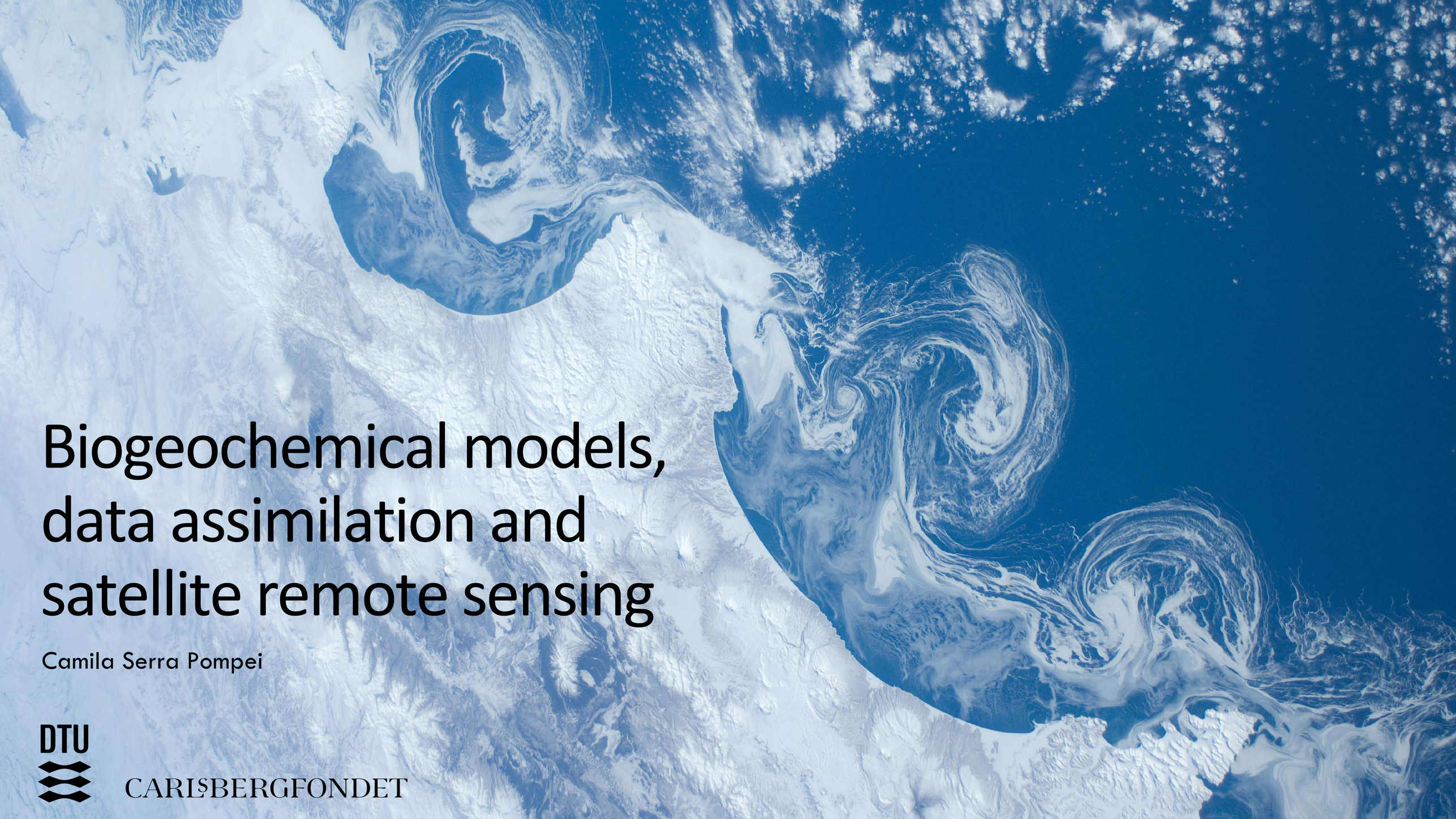
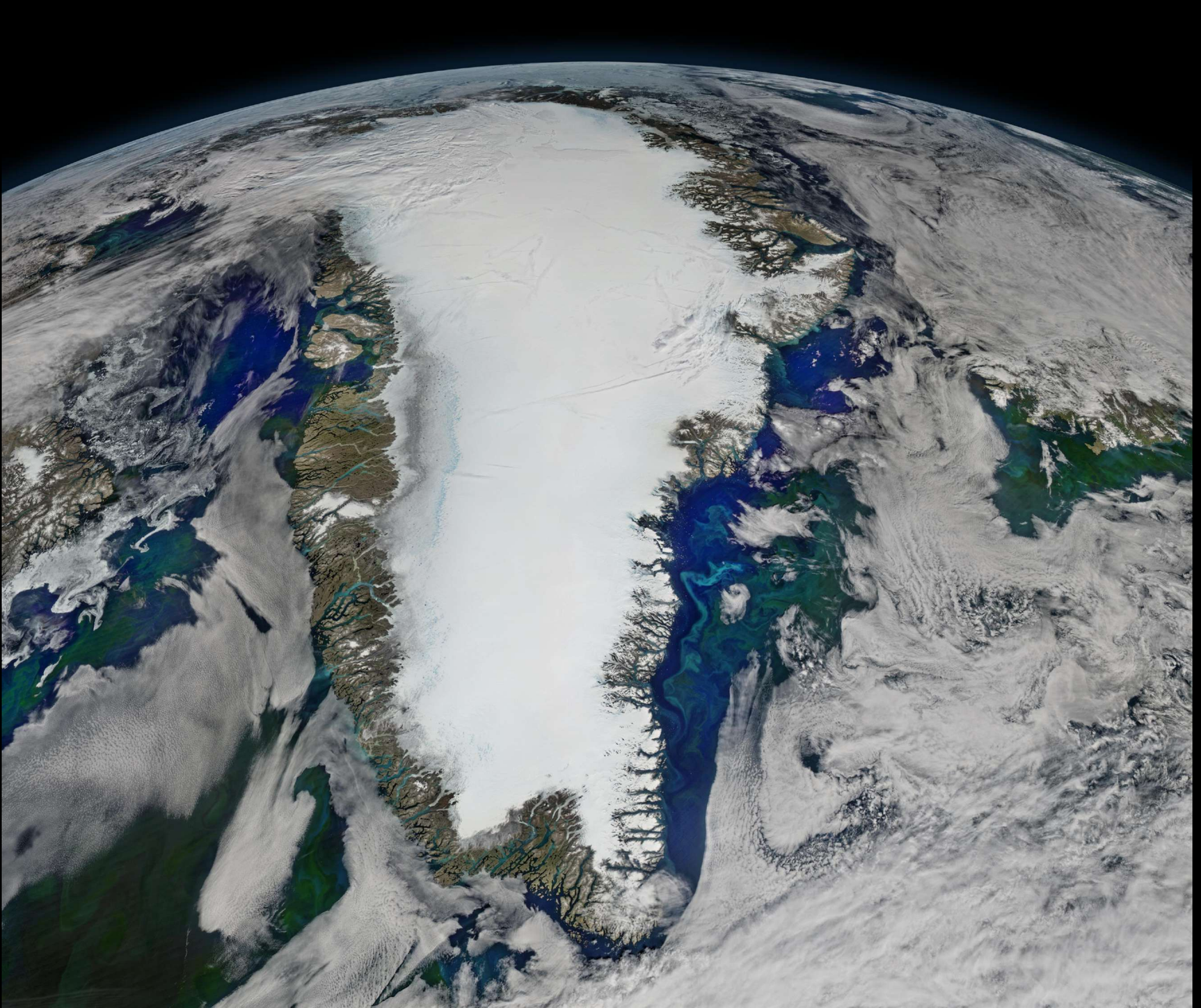


Biogeochemical models, data assimilation and satellite remote sensing

Camila Serra Pompei

DTU

CARLSBERGFONDET



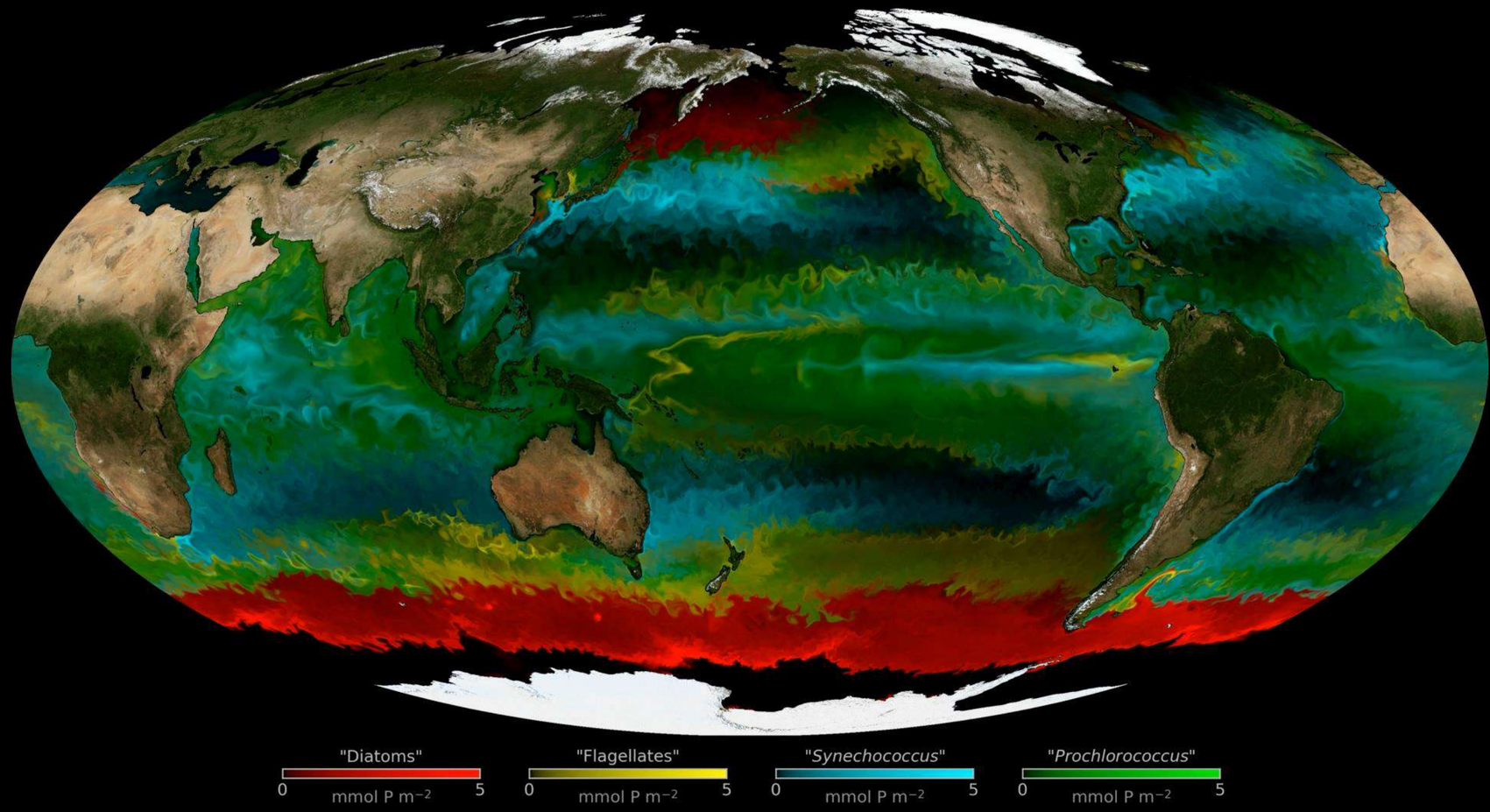
Data is scarce, and models can help fill the gaps.

But, Greenland is

a complex system of fjords, shelf regions, and slopes,

all influenced by the Ice sheet and sea-ice dynamics.

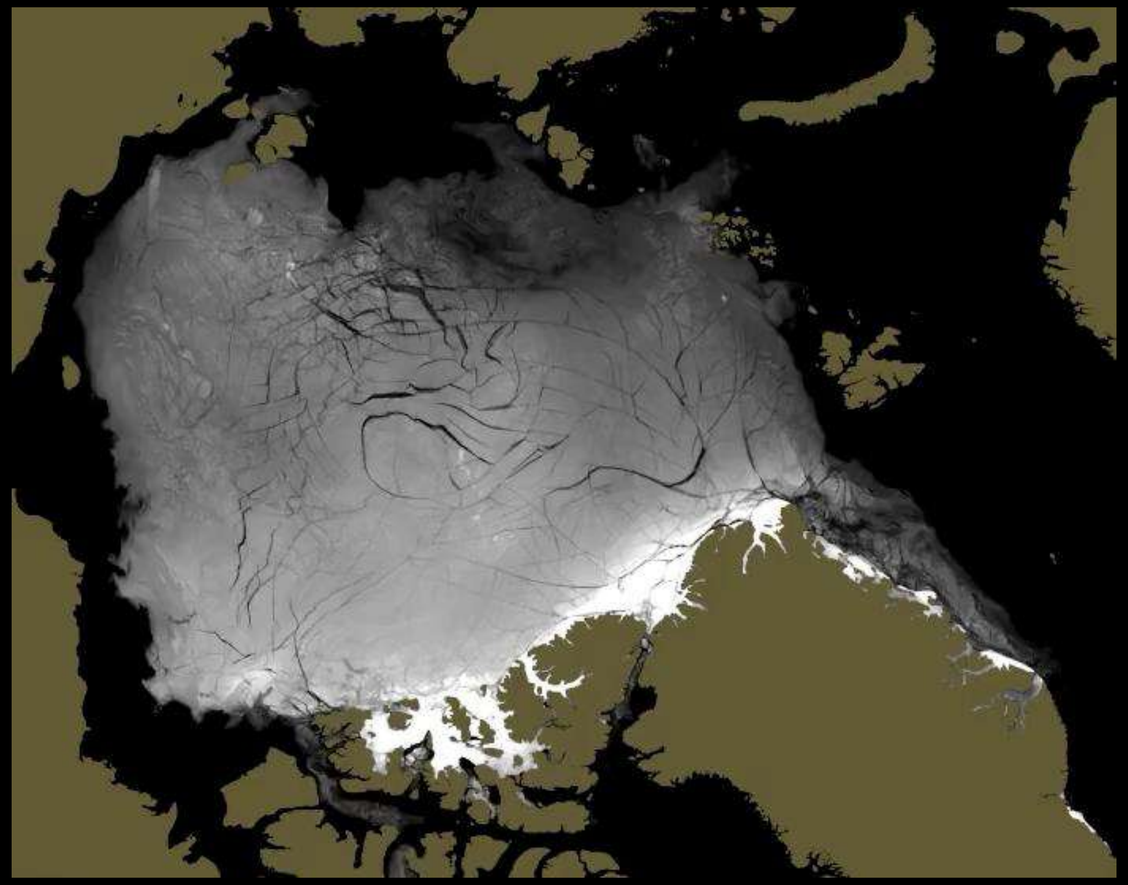
Global biogeochemical models



MITgcm, Biogeochemical module (the “Darwin model”). Video: Oliver Jahn

Global models

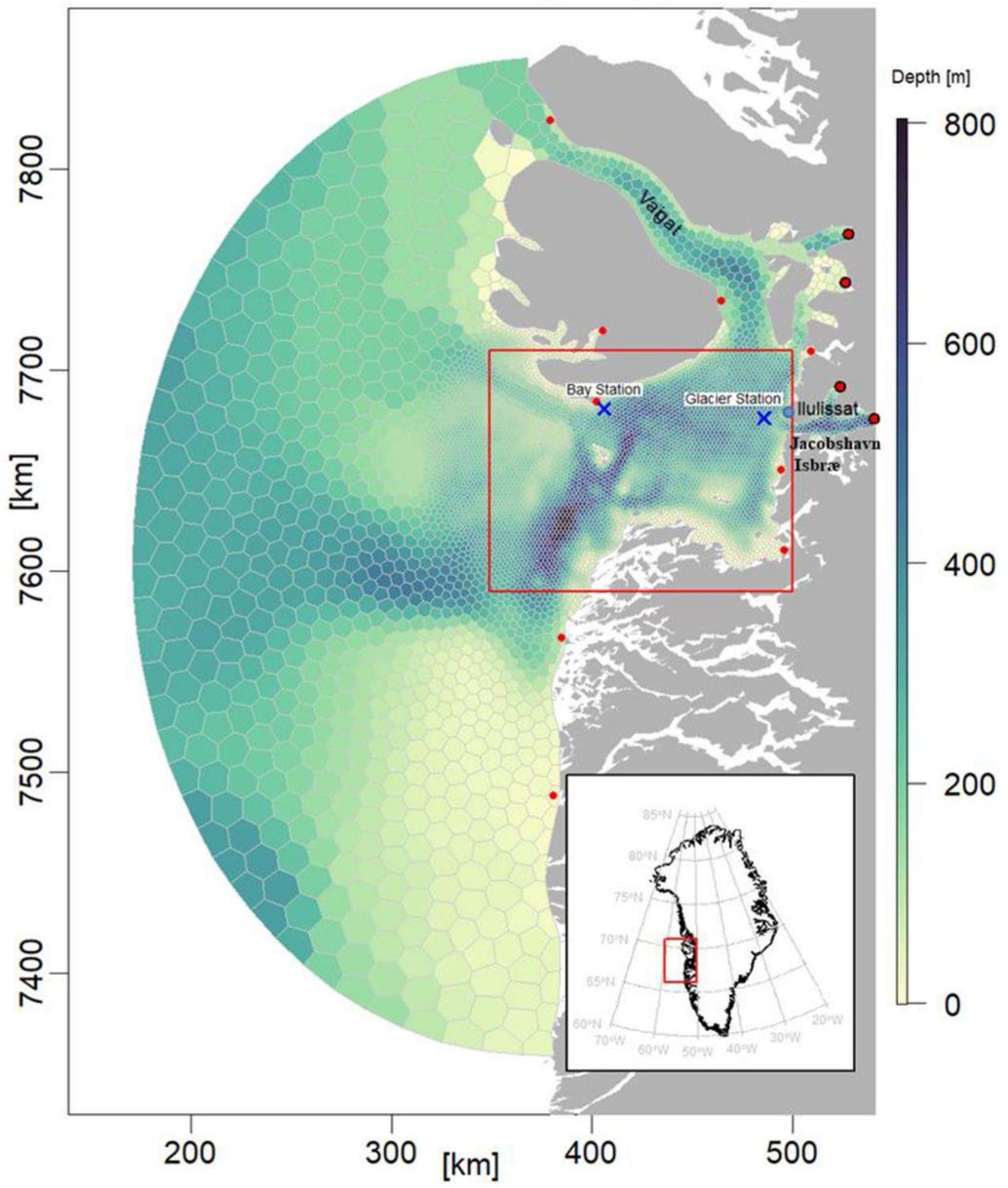
- Low Resolution for coastal systems
- Land-Ocean Aquatic Continuum processes might not be well represented



Effective ice thickness in the MITgcm ECCO model.

Regional models

- Higher resolution
- Land ocean aquatic continuum better represented
- Often of limited regions around Greenland (not for the entire Greenlandic marine ecosystem)
- Boundary conditions need to be defined



Friis Møller et al 2023

Disconnection between the global vs the regional modeling community

- Use the same ecosystem model globally and regionally (?)
  - Improve boundary conditions

- Efforts in the global modeling community to:
  - Increase the spatial resolution
  - Improve processes of the land-ocean aquatic continuum

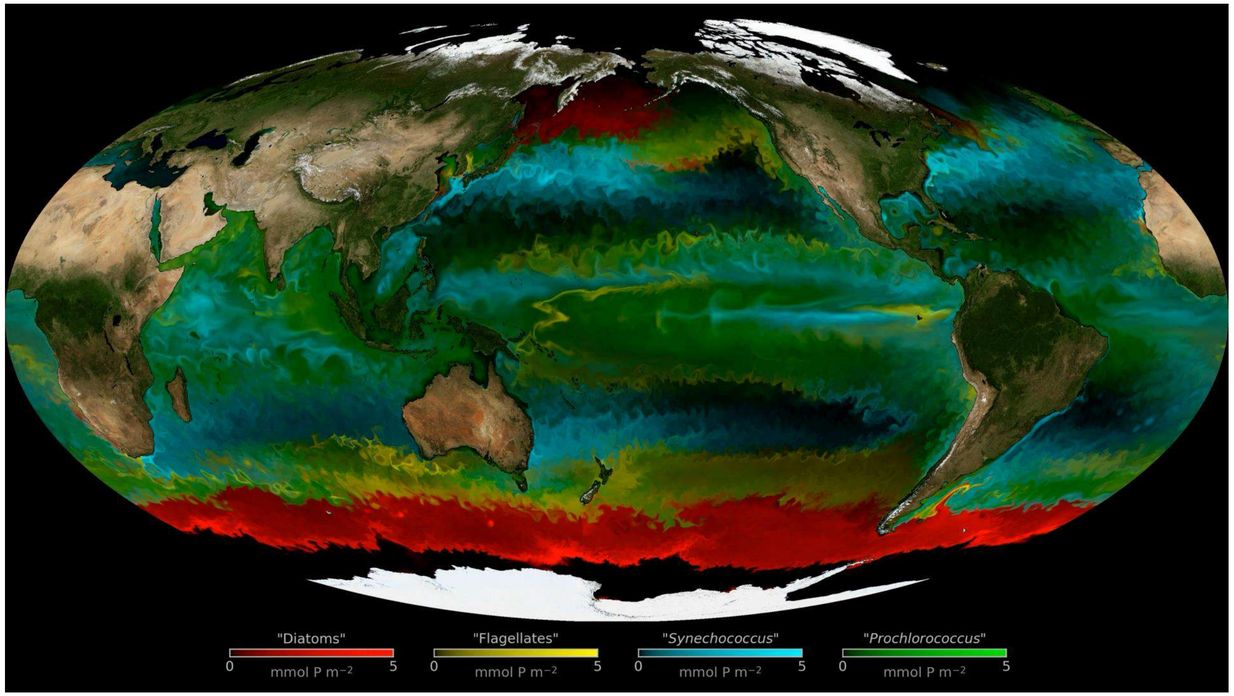
Ecological complexity

From simple “NPZ” models

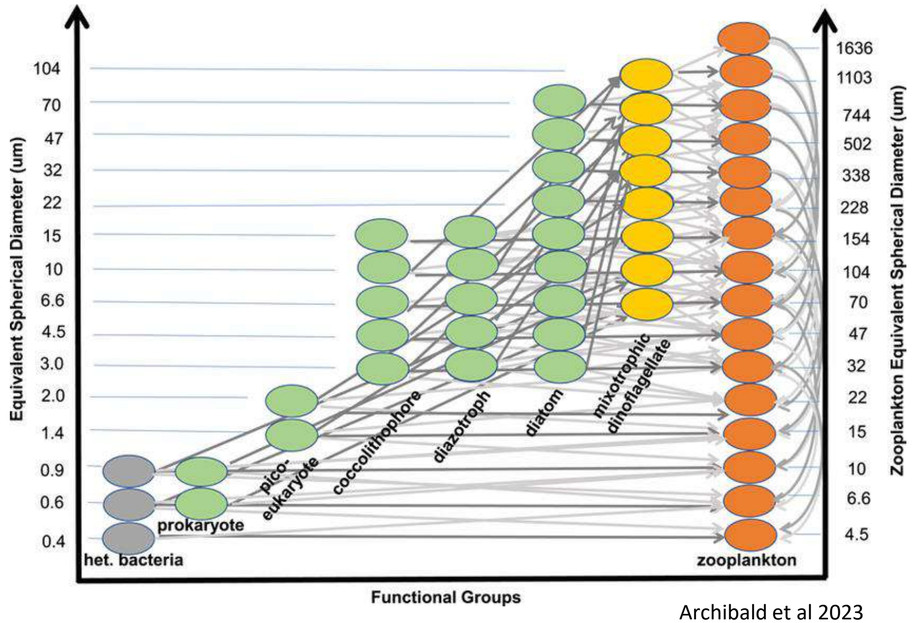
to

Complex size-resolved plankton functional groups

But often not correctly parameterized to represent Arctic ecosystems (at least in global models)



MITgcm, Biogeochemical module (the “Darwin model”). Video: Oliver Jahn



Archibald et al 2023

ArcFish - Digital twin

- Data assimilated
- Biogeochemical components
- Simulations of zooplankton biomass and production as indices for fish production

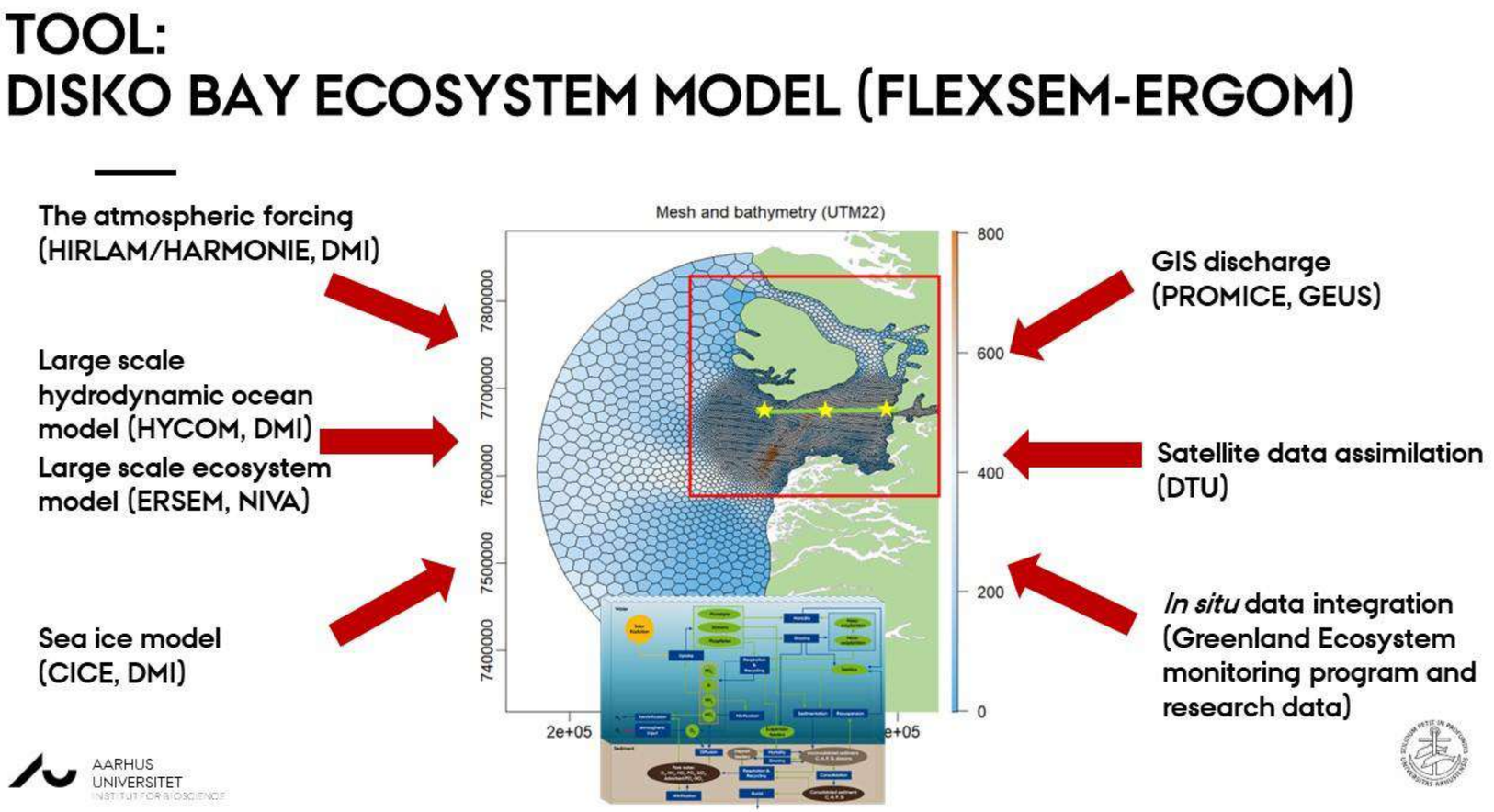


Image Credits: Marie Maar (Aarhus Universitet)

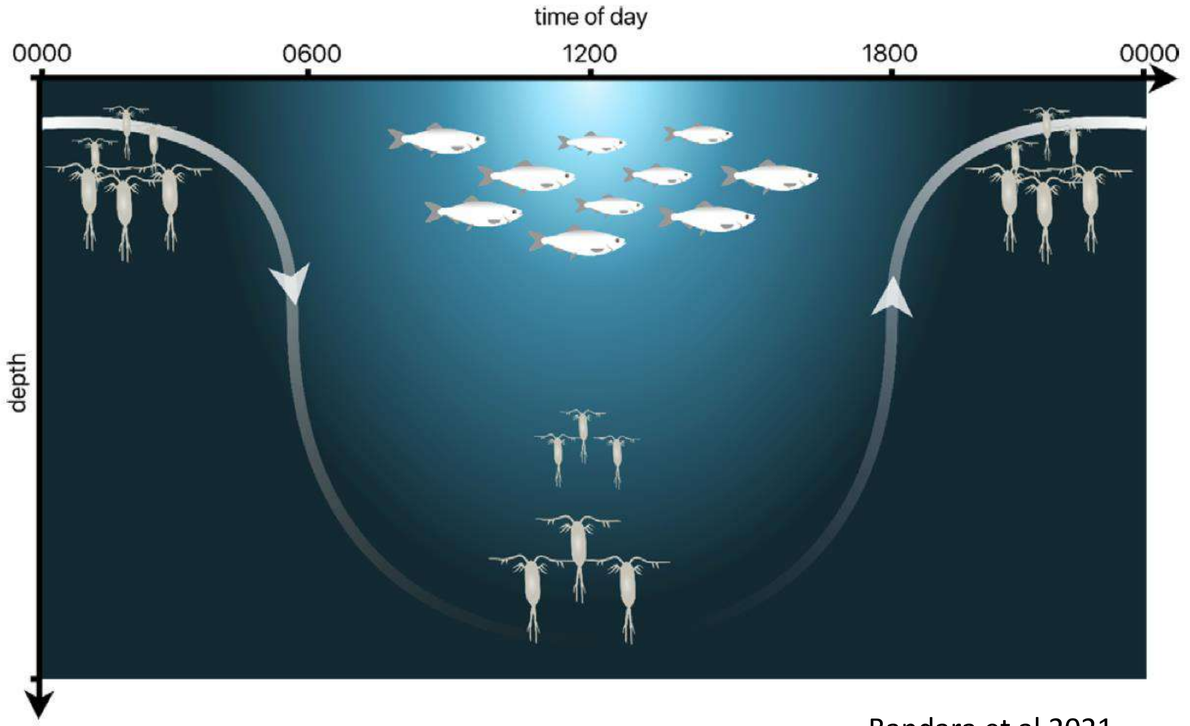
See ArcFish poster of Marie Maar

Lower vs higher trophic levels

- Most models center on lower trophic levels due to their relevance in biogeochemical cycles

- "Larger" multicellular organisms important for fisheries
  - But behaviour of "large" organisms needs to be implemented
  - Recent efforts on the simulation of vertical diel/seasonal migrations of copepods in regional models

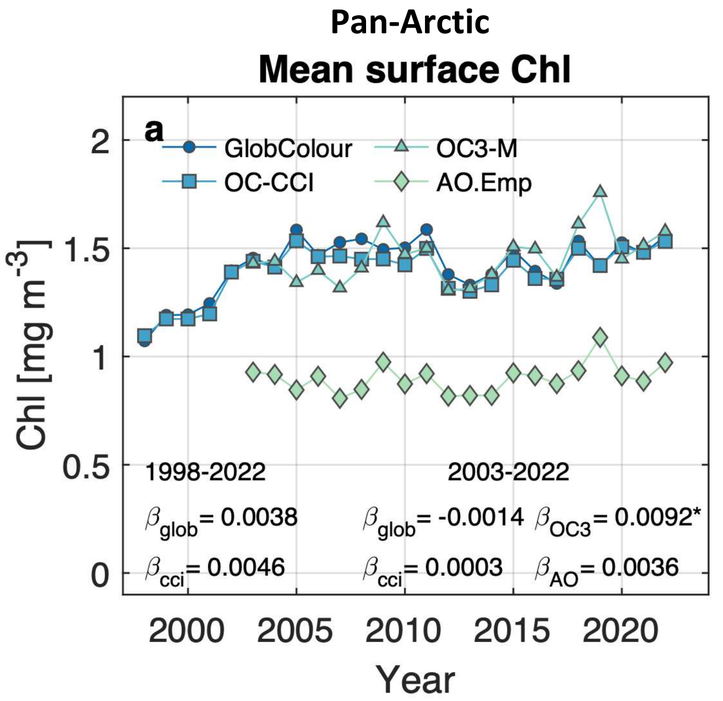
- Can be used as proxies for fisheries

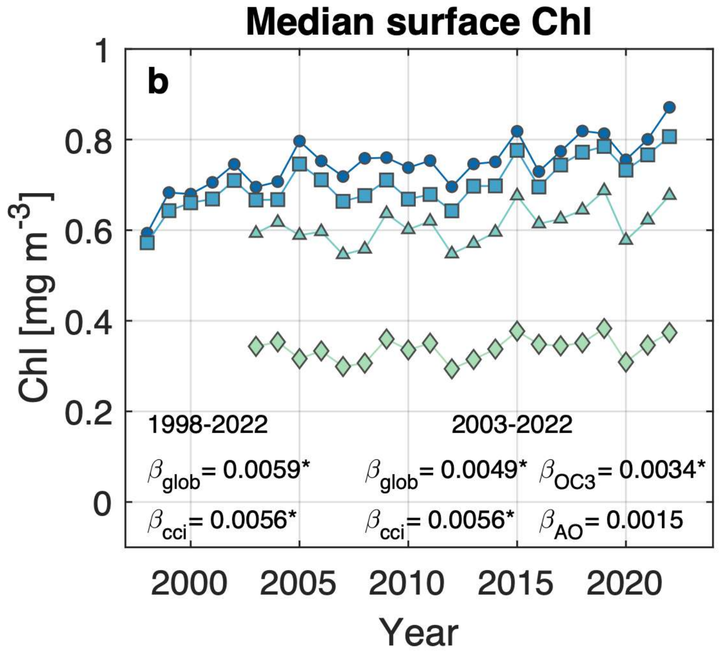


Bandara et al 2021

Data assimilation of biogeochemical variables

- Ecological data (e.g. phytoplankton/zooplankton biomass) is scarce, noisy and with high uncertainties
- Joint data-sets can be useful
- Satellite products can be very useful for assimilation, but:
  - No products for polar regions provided by agencies
  - Coastal products also not provided and often have high uncertainties

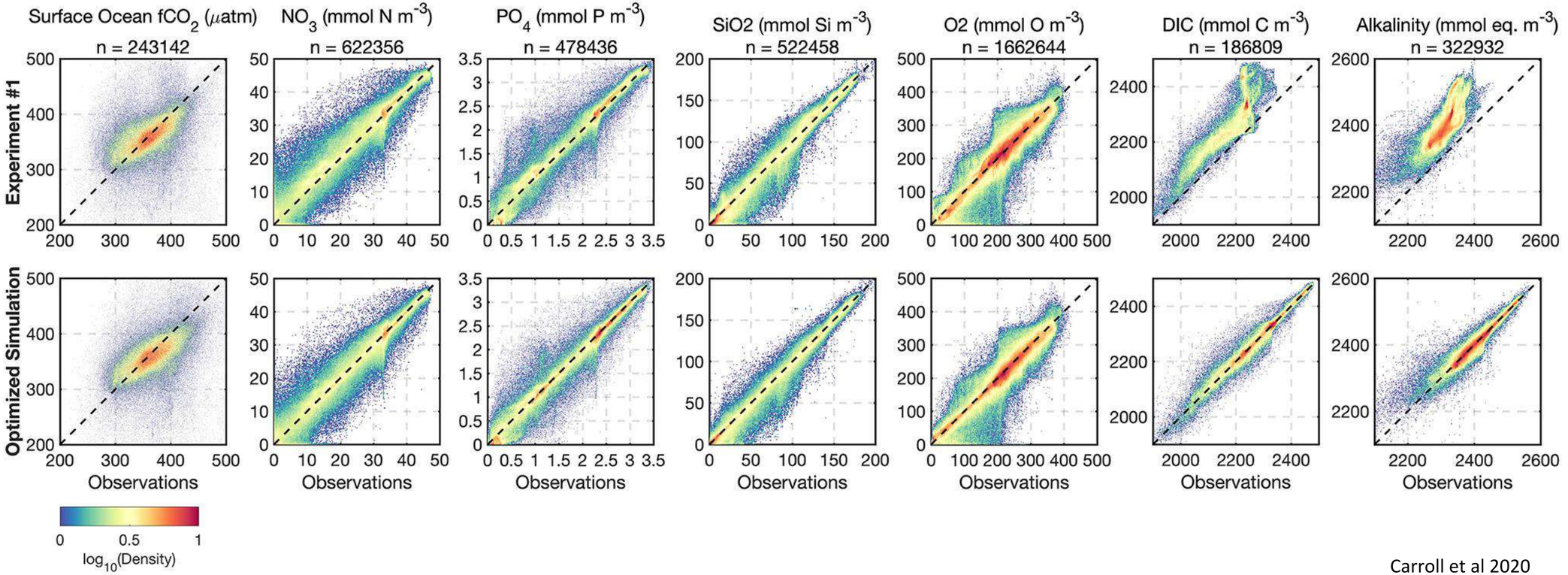




Serra-Pompei et al 2024. *In review*

ECCO-Darwin model

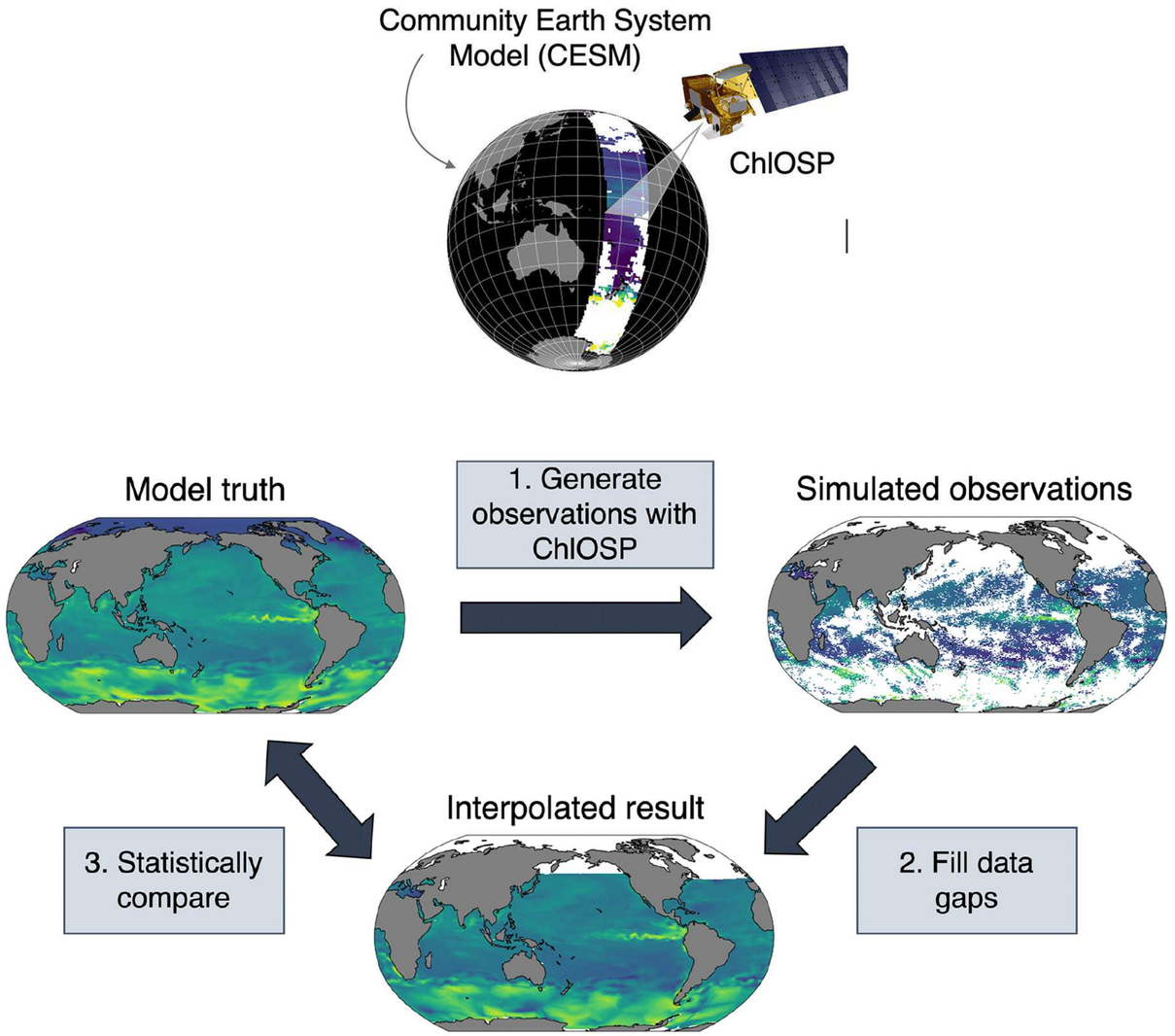
- "Estimating the Circulation and Climate of the Ocean" (ECCO) consortium model (NASA)
- Makes the best possible estimates of ocean circulation and its role in climate
- An Arctic version of the model is being developed



Carroll et al 2020

Using models as test-beds

- Provide a 3D interpretation of what satellites are seeing
  - Are changes in surface Chl representative of depth-integrated Chl changes?
- Effects of clouds and missing satellite data on predictions made with satellites
- Models that simulate Rrs and IOPs of components in the water can be used as test-beds for satellite algorithms



Clow et al 2024

Using models as test-beds

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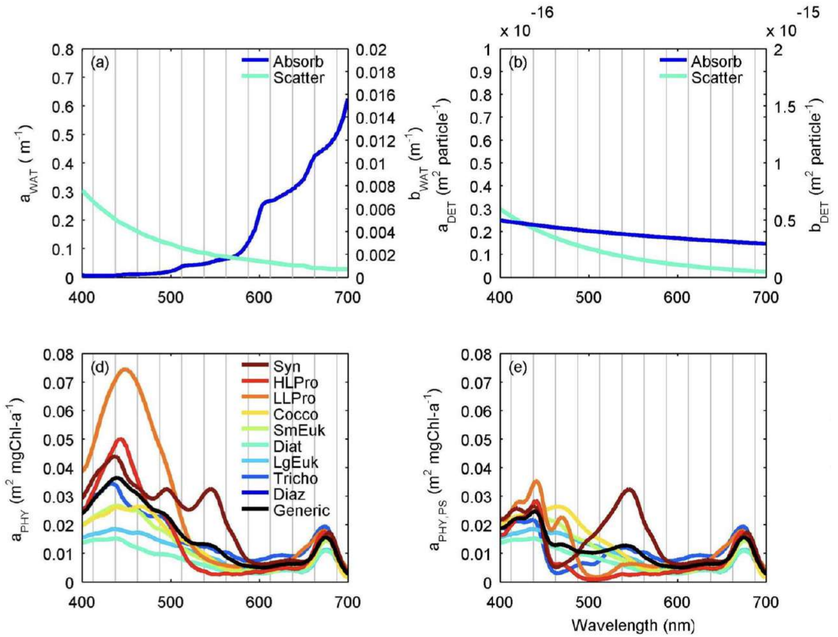
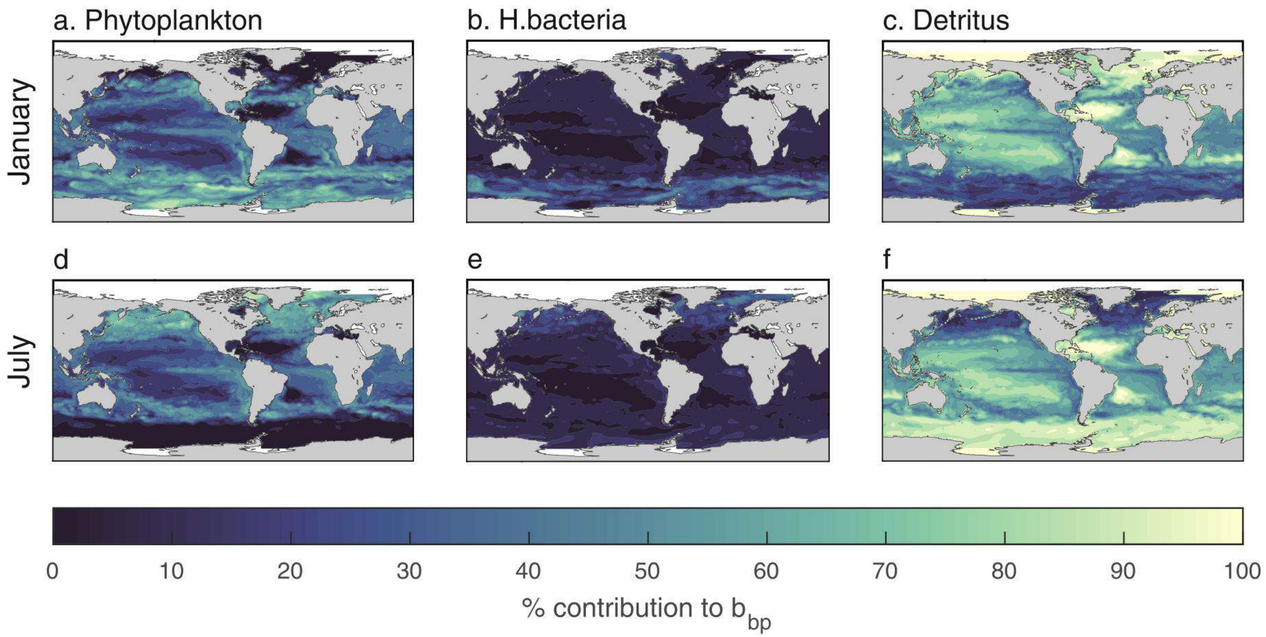


Dutkiewicz et al 2015



Serra-Pompei et al 2023

Priorities

- Communication between regional vs global modelers
- Improved representation of the land-ocean aquatic continuum in global models
- Satellite products for polar and coastal regions should be publicly available and of easy access (or at least reproducible from publicly available scripts)
- Common repositories where field data can be accessed
- Use of models as test-beds to organize campaigns or assess uncertainties of methods

Picture by Marcel Scheiwiller