Representing phytoplankton optical variability in spectrally-resolved biogeochemical models

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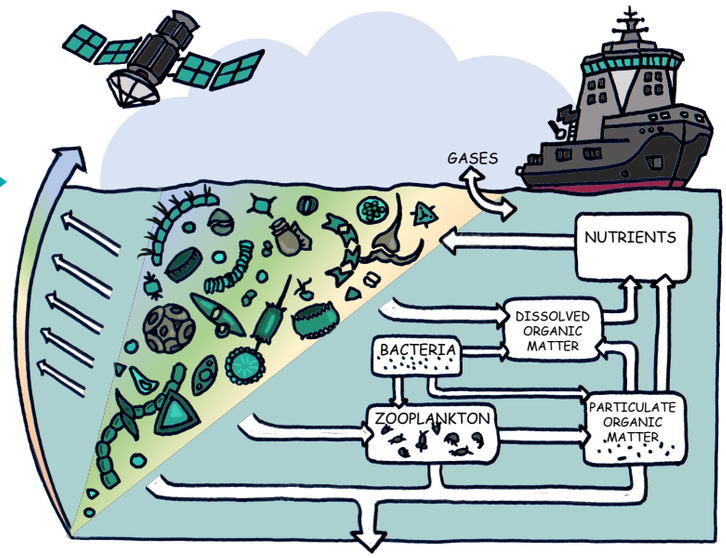
Background

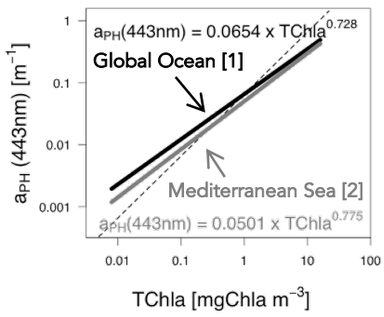
- Spectrally-resolved marine biogeochemical (BGC) models of the ocean describe the penetration of different wavelengths of light along the water column as they are attenuated by optically active constituents.

Schematic view of a medium-complexity BGC model that resolves spectrally the light transmission into the water column.



- Phytoplankton absorption (a_{PH}) depends on total biomass (**Chla**), pigment composition and size.

Absorption per unit of Chla (m^2 mg $Chla^{-1}$) decreases with increasing TChla concentration in the water.



- Reflecting changes in taxonomic composition and physiological state.

How do we represent such variability in BGC models?

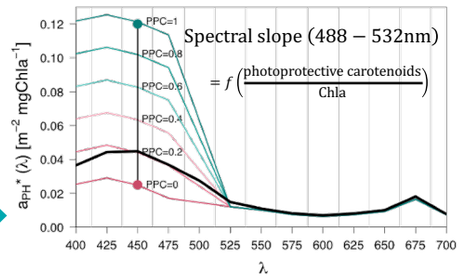
MITgcm-REcoM2:
- through pigments stoichiometry
- in the global ocean

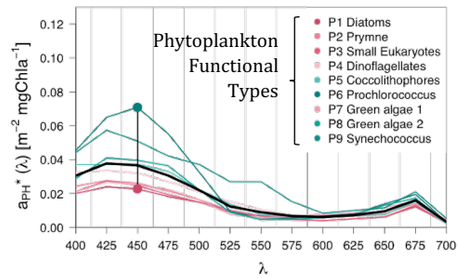
OGSTM-BFM:
- through functional diversity
- in the Mediterranean Sea

Method

Variability in the absorption cross-sections ($a^*_{PH}(\lambda)$) was represented as a function of the content in **photoprotective pigments** (PPC) [3] or by the inclusion of 9 optically different **Phytoplankton Functional Types**.

Phytoplankton absorption cross-sections (m^2 Chl^{-1}) and their range of variability represented in two BGC models.

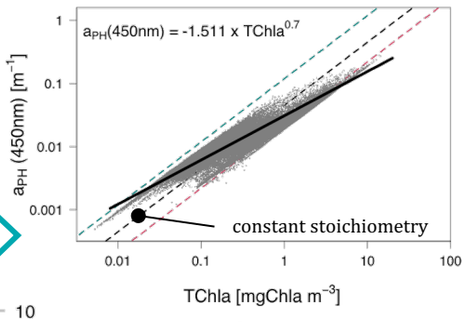


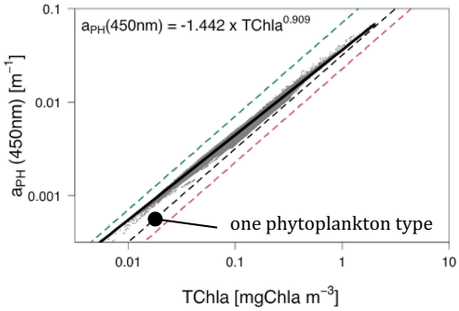


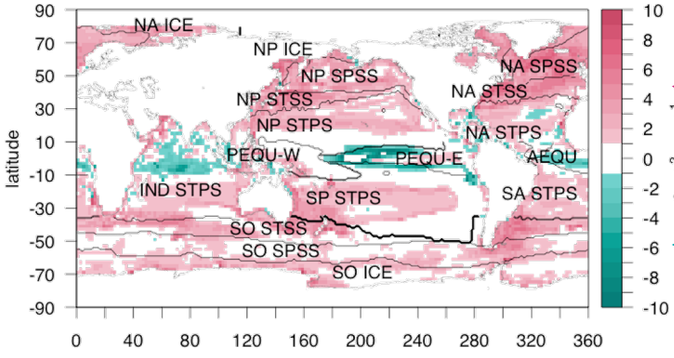
Result

Non-isometric relationships between a_{PH} at **450nm** and **Chla** emerged. Considering the impact of PPC pigments on absorption simulated exponents comparable to those observed. The representation of functional diversity is still a work in progress.

a_{PH}(450nm) as a function of total Chla in model simulations. Dashed lines indicate the range of variability represented.







Implication

The representation of the light absorption capabilities of the phytoplankton community influenced model simulations in terms of net primary production (NPP). Regional variable photoprotection (PPC:TChla) impacted **light attenuation** and therefore:
- increased NPP in higher latitudes,
- decreased NPP in low latitude oligotrophic regions.

Difference in annual integrated NPP between considering variable (through stoichiometry) $a^*_{PH}(\lambda)$ and constant $a^*_{PH}(\lambda)$ in ocean biomes [4].

References
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