R: Pico-phytoplankton controls on global ocean carbon export and C:N:P stoichiometry patterns

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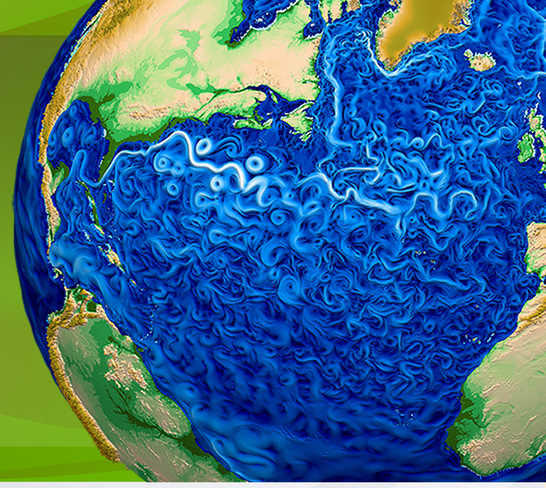
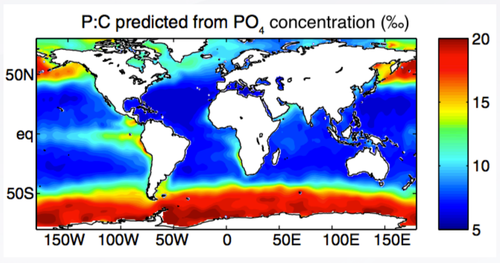
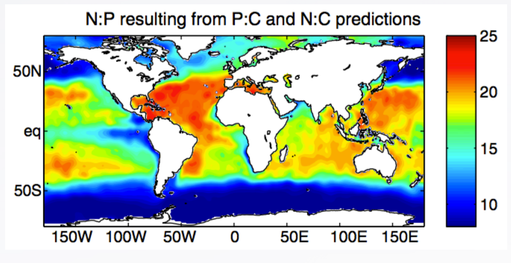


Objective

Additional marine phytoplankton types with variable C:N:P stoichiometry

Both laboratory and field populations of pico-sized (< 2 μm) marine phytoplankton exhibit plasticity in their cellular phosphorus, nitrogen, and carbon content in response to changing environmental conditions such as light and nutrient supply. Phylogenetic affiliation is an additional control on pico-phytoplankton cellular C:N:P stoichiometry. Variable carbon to nutrient stoichiometry for marine primary production has important implications for the carbon-climate feedback of the ocean's biological pump that remain largely unrepresented and unquantified in Earth System Models.



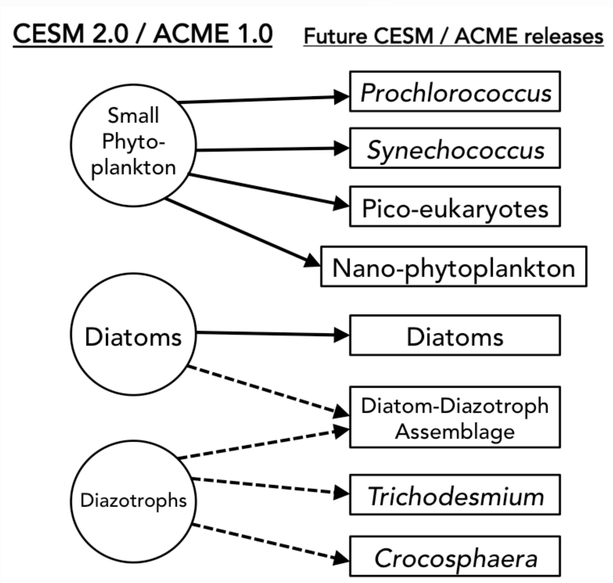


Predicted phytoplankton community P:C and N:P stoichiometry based on a cellular plasticity model with varying surface ocean [PO4], reproduced from Galbraith & Martiny, 2015 *PNAS*.

Approach

Add *Prochlorococcus*, *Synechococcus*, and pico-eukaryotes phytoplankton types to the CESM's BEC model

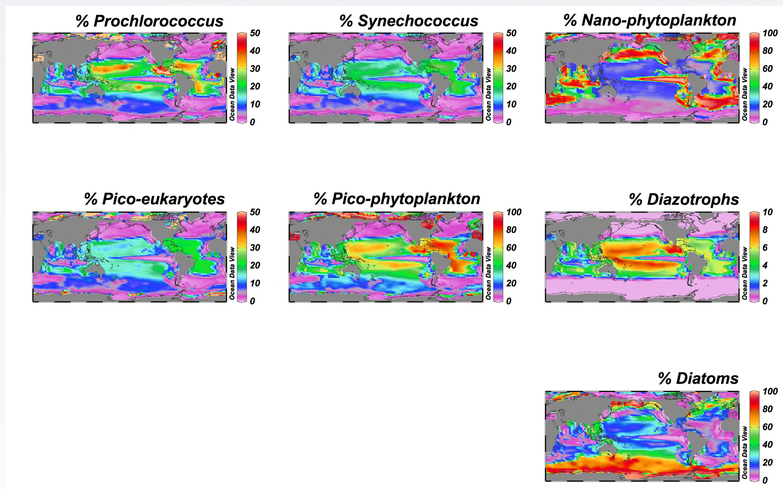
We have implemented three new explicit pico-phytoplankton groups (*Prochlorococcus*, *Synechococcus*, and pico-eukaryotes) for a total of six phytoplankton functional types with variable C:P stoichiometry within the CESM-BEC ocean biogeochemistry model. Variable phytoplankton C:P is modeled as a linear function of ambient [PO4] with differing max/min C:P for each group. Future work will add diazotrophic phytoplankton types (dashed arrows). Syncing of BEC to ACME plankton groups will be facilitated by MARBL.



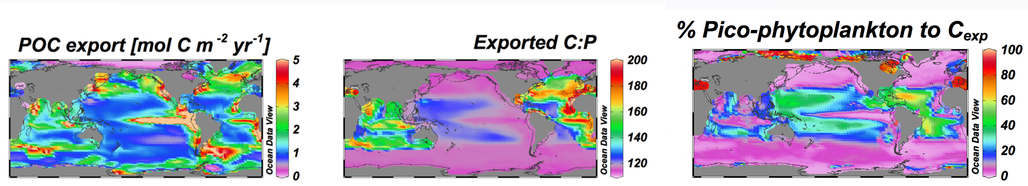
Current Developmental PFT's: 1. *Pro*, 2. *Syn*, 3. Pico-euks, 4. Nanos, 5. Diatoms, 6. Diazotrophs

Early Results

Phytoplankton Group Contributions to Net Primary Productivity



Pico-phytoplankton contribution to the global particulate carbon export flux



Impact

Pico-phytoplankton contribution to ocean carbon export

Pico-phytoplankton dominate the low-nutrient subtropical ocean gyres with their greater cellular C:P plasticity giving them a competitive advantage over larger plankton (nano-plankton, diatoms) with lower C:P stoichiometry. The pattern of high C:P plankton within the subtropics and lower C:P plankton in the equatorial and polar latitudes reduces the meridional gradient in carbon export predicted by most ocean models that assume a constant Redfield C:N:P stoichiometry. **Pico-phytoplankton contribute 10, 4, and 8%** to global carbon export for *Prochlorococcus*, *Synechococcus*, and pico-eukaryotes, respectively.

ACME Accelerated Climate Modeling for Energy

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