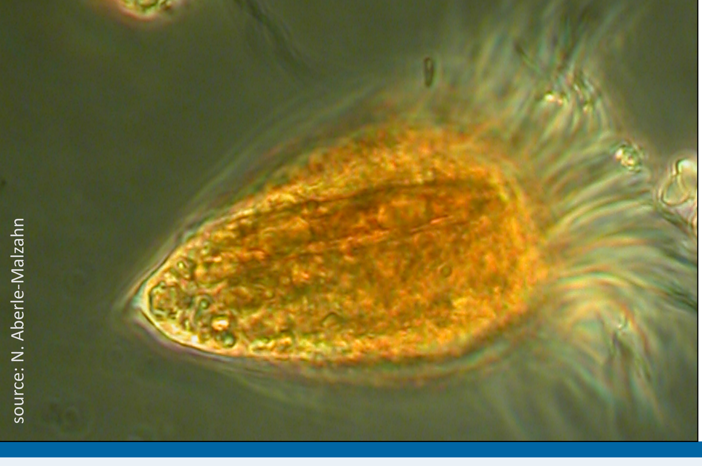

Modelling oceanic CO_2 uptake: the relevance of zooplankton grazing

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Plankton and CO_2 uptake

Understanding plankton dynamics is crucial to modelling ocean CO_2 uptake. Biogeochemical models are developed for simulating the plankton dynamics of one oceanic region. Yet many models perform poorly when applied to a fundamentally different oceanic region[1]. **Constructing a globally valid model to assess CO_2 uptake poses a challenge.**

Objective

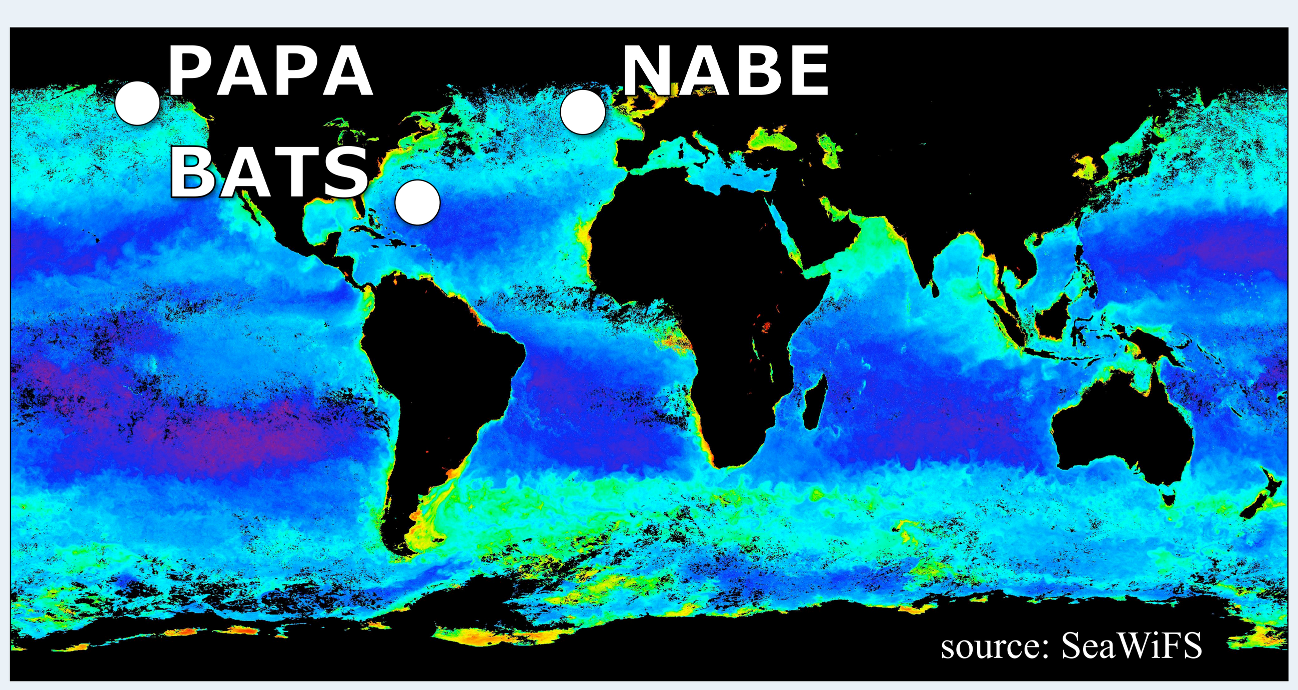
The objective is finding a model setup that fits available time-series data from stations across the globe.

Stations (see fig. 1)

For three fundamentally different stations, the data are sufficient to allow for model-data-comparisons:

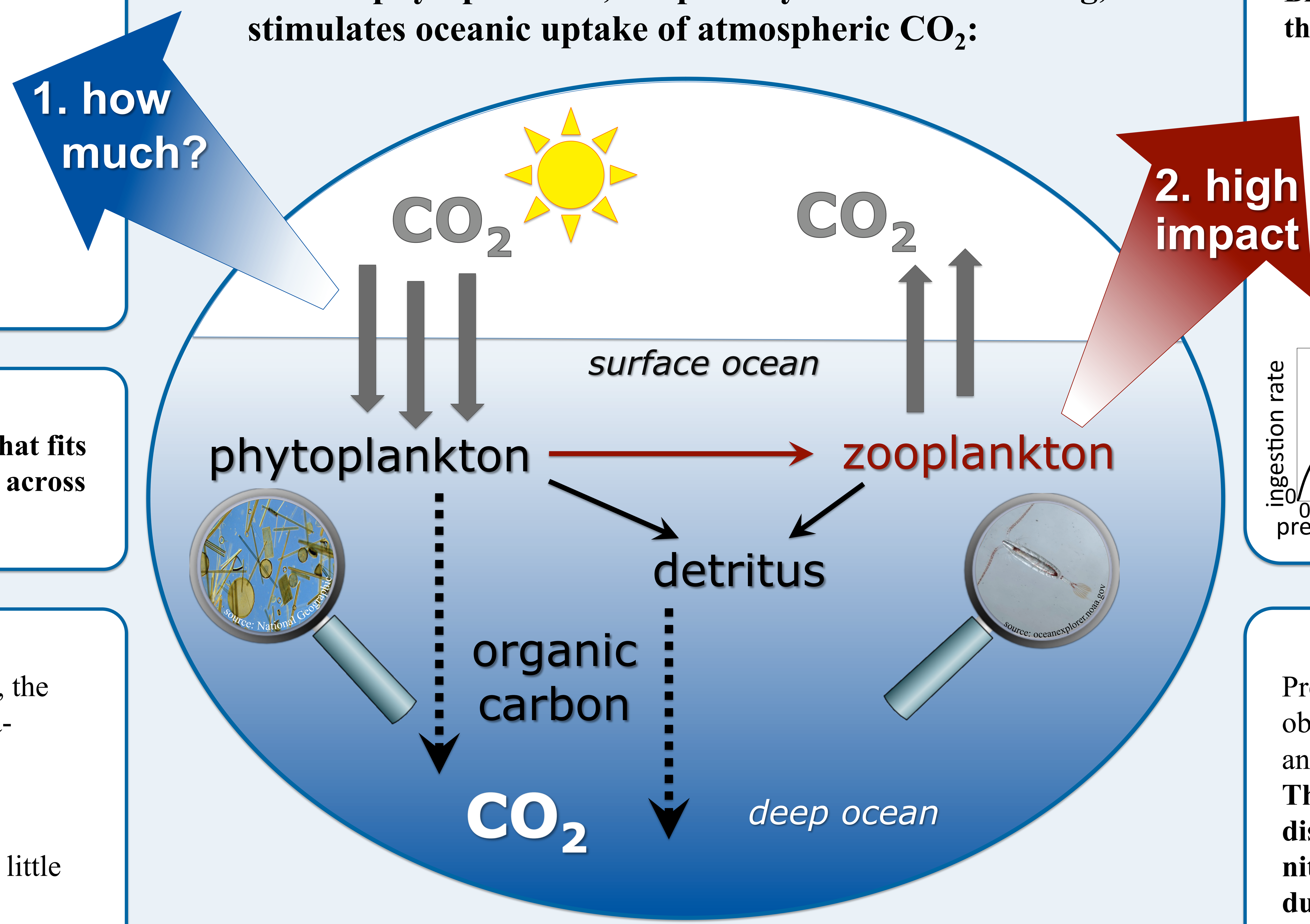
1. **BATS** (Bermuda Atlantic Time-Series Station); nutrient-poor
2. **PAPA** (Ocean Station P); nutrient-rich, little phytoplankton due to heavy grazing
3. **NABE** (Station of North Atlantic Bloom Experiment); nutrient-rich, supporting annual phytoplankton blooms

Fig. 1: Stations used for model validation



The Biological Pump:

Marine phytoplankton, via photosynthesis and sinking, stimulates oceanic uptake of atmospheric CO_2:



Modelling plankton dynamics

Characteristics of common models:

- Model compartments are characterized by differential equations
- Based on "currency" nutrient, mostly nitrogen
- Ratios of currency nutrient to other elements are fixed within organisms
- Dynamics of one functional group are described by a single (all-encompassing) equation
- Coupled to physical model of respective region

Specific characteristics of this model study:

- Equations for both phytoplankton carbon and nitrogen, allowing for **optimal phytoplankton growth**[2] (decoupled from nutrient uptake)
- **Grazing was implemented in five different ways to find the best suitable grazing function**

Model performance

Biogeochemical models are highly sensitive to the grazing function[3]**.**

Five different grazing functions were implemented, one of which allows for **a model setup that fits all three stations** (Peters' grazing[4], see fig. 2).

The grazing function most widely used (Holling III[5]) is not compatible with optimal phytoplankton growth.

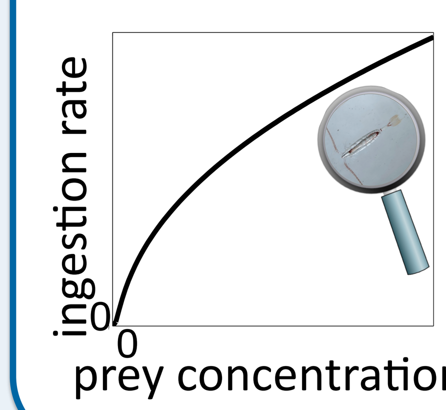
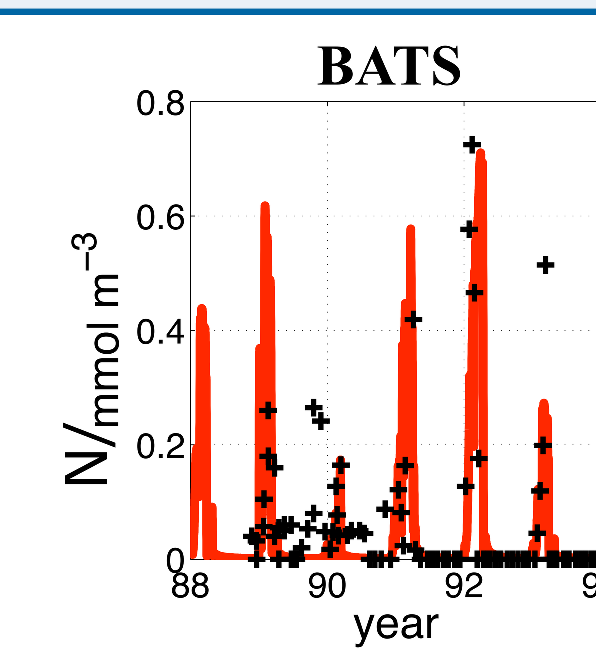
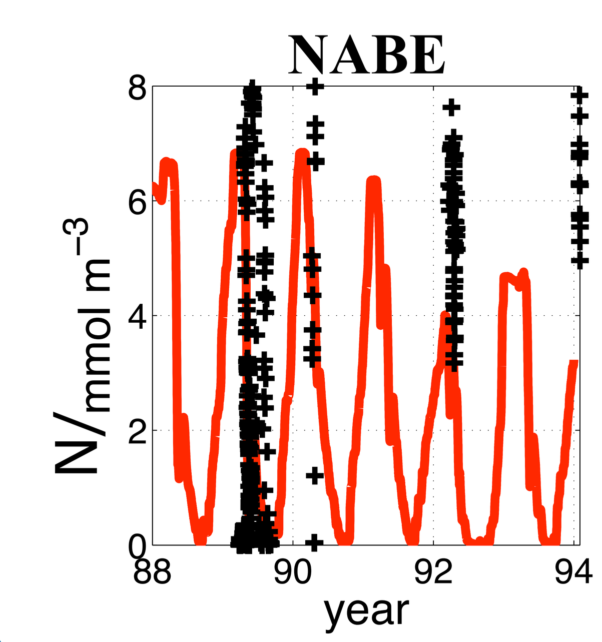


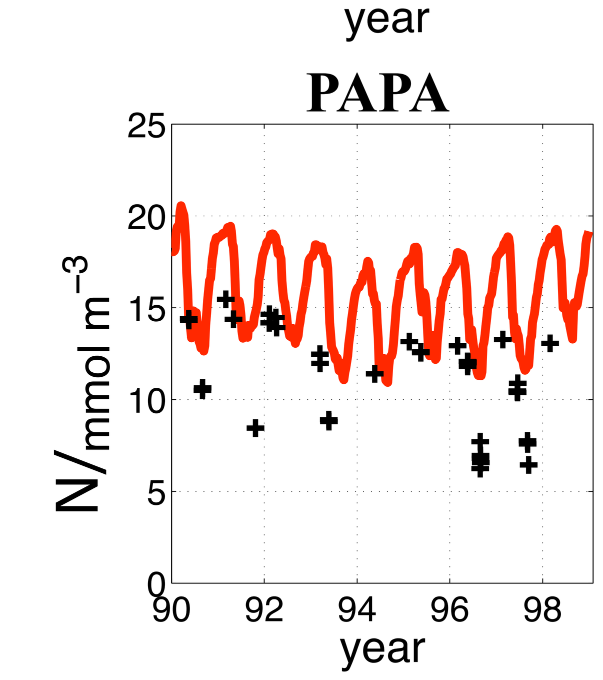
Fig. 2: **Peters' function**
Characteristics: steep beginning, then levelling off. **Strong grazing pressure at low food concentrations,** weaker at higher ones.

Results

Predicted (red) and observed (crosses) annual nitrogen cycles. **The annual cycle of dissolved inorganic nitrogen is reproduced at all stations.**







Conclusion

Choosing a suitable grazing function is crucial for model behaviour and enables fitting fundamentally different regions.

Acknowledgments

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