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Picophytoplankton physiology and the microbial loop

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Physiological observations are needed for a better understanding of the complexity of marine ecosystem processes. This information is important for a better model formulation and parameterisation to identify the consequences of, and feedbacks to, global change and to make future projections.

Picophytoplankton form the smallest component of the phytoplankton community ($\leq 3\mu$m) and show a substantial contribution to phytoplankton biomass in oligotrophic oceans. Here they also have an important function as primary producers in the microbial loop. They include cyanobacteria, represented by *Prochlorococcus* and *Synechococcus,* and picoeukaryotes.

The aim of this project is to achieve a better representation of picophytoplankton in the global biogeochemical model PlankTOM 10. PlankTOM 10 simplifies the complex ecosystem into 10 conceptual groups also known as plankton functional types (PFTs). These groups of organisms are defined by physiological and biochemical parameters (6 of phytoplankton, 3 of zooplankton and 1 of bacteria).

Furthermore, the question will be addressed, whether picophytoplankton are typical K-strategists with low minimum nutrient and high maximum chlorophyll quota relative to carbon, or by having superior nutrient uptake kinetics and light harvesting (high α^{Chl}).

Laboratory experiments showed that the smaller picoprokaryotes respond faster to increasing light intensities than their picoeukaryotic counterpart. Preliminary data show that the initial slope of the photosynthesis vs. irradiance curve (α^{Chl}) of picoprokaryotes is about 1.5 times higher than of picoeukaryotes. This is consistent with their common distribution at the deep chlorophyll maximum. The maximum chlorophyll quota are not significantly different. Temperature experiments confirmed that the maximum growth rates of picophytoplankton at the optimum temperature (0.47 $\pm$ 0.17 d^{-1} for prokaryotes and 1.05 $\pm$ 0.47 d^{-1} for eukaryotes) are significantly lower than of diatoms (1.57 $\pm$ 0.73 d^{-1}, Chollet et al. in prep.) and not significantly different from coccolithophores (0.68 $\pm$ 0.10 d^{-1}, Buitenhuis et al. 2008), consistent with the characterisation of picophytoplanton as K-strategists. Their optimum temperatures were found to be 22.7 $\pm$ 2.0 $^{\circ}$C for prokaryotes and 23.6 $\pm$ 3.1 $^{\circ}$C for eukaryotes.

Nutrient limitation experiments will be conducted to characterize the nutrient uptake and elemental composition of picophytoplankton. Finally the results of all experiments will then be used to improve the representation of picophytoplankton in PlankTOM10, evaluated against a recently compiled global database of picophytoplankton biomass.