# Effects of phytoplankton physiology on the biological carbon pump and climate: the role of variable stoichiometry

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Earth system climate models (ESCMs) are powerful tools for analyzing variations in climate, while resolving interdependencies between changes in the atmosphere, on land, and in the ocean. In this regard, the dynamic of marine ecosystems is a critical link. On long timescales, it regulates atmospheric $CO_2$ on the basis of biotic uptake of $CO_2$ over vast oceanic regions and due to the export of photosynthetically fixed carbon into the deep ocean, which affects the Earth's climate. Plankton–ecosystem models are widely applied to understand marine biogeochemical cycles, by estimating fluxes of major elements, e.g., nitrogen, phosphorus, and carbon, as well as the sources and sinks of marine oxygen. However, most of these models lack a sound mechanistic foundation, preventing them from explicitly accounting for the organisms' regulation of their internal physiological state. Specifically, the carbon : nitrogen : phosphorus (C:N:P) stoichiometry of phytoplankton is still often represented by static (Redfield) ratios, entirely ignoring its highly variable nature, which can affect model sensitivity to climate change and thus the projections of the future carbon pump.

In the first part of this talk, I will present my recent modelling work regarding an optimality-based ecosystem model that considers variable phytoplankton stoichiometry (C:N:P), and the effect of variable stoichiometry on the projection of 21st-century biological carbon pump. In the second part, I will talk about a sensitivity analysis aimed at resolving a fundamental question in marine biogeochemistry: why are particulate organic and dissolved inorganic N:P ratios in the ocean similar on the global scale? For the first time, this analysis also reveals a potential interdependence of phytoplankton physiology and global climate conditions. At last, I will introduce some applications of the Earth system modelling tool, including the reconstruction of paleo marine biogeochemistry, evaluation of the carbon dioxide removal techniques, and the projection of future marine biogeochemistry under various anthropogenic stressors.