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Feedback mechanisms between climate and the Redfield ratio

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The partitioning of CO_2 between the atmosphere and the ocean depends on the carbon:nutrient (Redfield) ratio of oceanic phytoplankton sinking into the deep ocean. Variations in the Redfield ratio may have contributed to changes in atmospheric CO_2 concentration between glacial and interglacial periods. In this contribution, we propose physically induced variations in the elemental composition of plankton as a new mechanism for changes in the Redfield ratio. Using our PINC (Phytoplankton Internal Nitrogen and Carbon) model, we have studied the influence of water temperature and mixed-layer depth on phytoplankton carbon:nutrient ratios. These ratios turn out to be strongly dependent on variations in mixed-layer depth and to increase with decreasing temperature. In this presentation, we will focus on the physico-biological mechanisms underlying this result within the context of the Dynamic Energy Budget theory for metabolic organisation. The new mechanism, which is not represented in the classical NPZD model that takes phytoplankton composition fixed, may turn out to be very important to understand CO_2 changes during glacial-interglacial transitions.