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Modelling pelagic calcite and aragonite biogeochemistry

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Increasing ocean uptake of anthropogenic CO_2 leads to a decrease in carbonate ion concentrations and a consequent shoaling of the aragonite saturation horizon. Model studies predict that the surface waters in the Southern Ocean may be undersaturated with respect to aragonite already by the end of this century. This may be especially threatening for aragonite producing pteropods as they may have difficulties with maintaining their shells in undersaturated waters. Changes in pteropod abundance could in turn influence the entire food chain up through higher trophic levels. Due to its higher solubility compared to calcite, aragonite may play a role for the short term neutralization of fossil fuel CO_2 making its contribution important for studies of feedback processes on atmospheric CO_2. The fore seen impacts of acidification on aragonite production, as well as its contribution to the CO_2 neutralization calls for an inclusion of aragonite in biogeochemical models. In the first part of this work we used the biogeochemical-ecosystem model PISCES coupled to the OPA/ORCA2 global-scale ocean general circulation model. In its standard version, the PISCES model distinguishes two phytoplankton and two zooplankton size classes. We have implemented aragonite as a new tracer in the model. The production of aragonite by pteropods is described by the distribution of their size class (mesozooplankton) as a function of saturation state. The first results for climatological aragonite production, dissolution and fluxes are generally consistent with existing literature estimates. The second part involves a combination of the ecosystem model PISCES and the Bern-3D model. The cost-efficient Bern-3D model is ideally suited for sensitivity studies which may further improve the model representation of the carbonate production and dissolution. This is an important step towards a better understanding of the global $CaCO_3$ budget,

its future evolution and the associated feedbacks on atmospheric CO_2.