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Large contribution of pteropods to shallow $CaCO_3$ export

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It's long been noted that there is an inconsistency between the shallow dissolution depth of a considerable amount of $CaCO_3$, and the known solubility of calcite, the main form of $CaCO_3$ that is found in sediment traps at depths (typically >2000 m). Several potential explanations have been put forward to explain this inconsistency, which includes shallow dissolution in acidic microenvironments, and the production of soluble aragonite by pteropods that is dissolved before it reaches sediment traps. Here we explore the possibility that the relative importance of the different groups of calcifying organisms might be responsible for discrepancies in the total carbonate budget. The recent publication of the MAREDAT atlas of plankton biomass distributions of 10 plankton functional types (PFTs) has provided an estimate of biomass for three calcifying PFTs: pteropods, coccolithophores and foraminifers. Here we present a synthesis of the turnover rates of those three calcifying PFTs. We incorporate these three PFTs in the PlankTOM Dynamic Green Ocean Model and use the model to test the hypothesis that the production and shallow dissolution of pteropod aragonite can reconcile the relatively large surface ocean $CaCO_3$ production rate of $\sim$1.1 Pg C/y (Lee 2001) with the lower sinking flux of $\sim$0.6 Pg C/y at 2000 m. The model can only reproduce both the observed pteropod biomass and the data-based $CaCO_3$ rates with substantial dissolution in under-saturated waters. We discuss the implications for understanding the impact of ocean acidification on marine ecosystems and biogeochemical fluxes.