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Interactive comment on “Sensitivity of pelagic $CaCO_3$ dissolution to ocean acidification in an ocean biogeochemical model” *by* A. Regenberg et al.

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This paper addresses the range in predicted water column dissolution of CaCO3 in the mineral form of calcite, an interesting and useful calculation. In particular the dependence of the dissolution rate law formulation is explored on the depth dependence of the dissolution response to ocean acidification.

The analysis does not deal with sedimentary CaCO3 dissolution, however, or water column dissolution of aragonite, which can have a significant impact on ocean alkalinity / total CO2 distributions to which the model results are compared. Presumably in areas where there is no CaCO3 in the sediments, the ocean biogeochemical model will get all of that CaCO3 dissolution flux, but in areas above the saturation horizon, organic carbon respiration can drive a significant fraction of the CaCO3 rain to the sea floor to dissolve. The systematics of sedimentary dissolution differ from those in the water column because of regulation of the dissolution rate by the diffusive pore water regime. I worry about tuning the ocean models to fit the observations while leaving out these pathways.

The derivation of the rate constants at different values of n, based on sediment trap data, also could be affected by the dissolution of aragonite. Short-deployment sediment trap fluxes from Acker seem to show attenuation with depth even where calcite is supersaturated. This has been modeled as resulting from dissolution in animal guts, as well as due to aragonite, but my recollection is that it's still hard to explain these results. Feely's water column alkalinity source flux calculations, based on water mass ages, also show a shallow-water source, and Milliman's water column alkalinity budgets. Given that the primary mechanism for explaining these observations is still unclear, it seems dodgy to simply fit the trap data to a calcite dissolution rate. At any rate the data and analysis should be presented. There's been a lot of literature on deriving the appropriate rate constant and reaction order for CaCO3 dissolution in sinking particles and in sediments. The analysis here seems like a reinvention of the wheel.

The fact that the reaction rate order is not easy to constrain in the ocean between values of 1 and 4.5 (with adjustment of the rate constant k) means that the data are noisy relative to this range. I would take this to mean that the results presented here, showing the sinking flux sensitivity to the reaction order, would be similarly sensitive to uncertainty in the rate constant. But this uncertainty wasn't really considered.

The statement "Ocean acidification proceeds from below" seems a bit off to me. The dissolution response may eventually be more intense in the high-pressure deep, but the pH shift is strongest in surface waters. Dissolution of CaCO3 also happens in the shallow water column, maybe due to aragonite, and decreased production also counts as a neutralization process, both of which may have already started. So stating in that

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same paragraph that carbonate compensation may start soon also seems off to me.

Respectfully,

David Archer

Interactive comment on Biogeosciences Discuss., 10, 11343, 2013.

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