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Biogeosciences Discussions

Interactive comment on "Manganese in the world ocean: a first global model" *by* Marco van Hulten et al.

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General response

All three reviews contain useful comments that resulted in discussion among the authors. Important themes of the discussion were the ommision of a biological cycle and O_2 and pH dependency, as well as moving the focus on the observational data.

The observations at the GA02 transect have not been published and already give some of the insights reached or confirmed by the model runs. For this reason we plan to restructure the paper, giving more space for a discussion on these observations.

As the reviewers correctly remark, and as we acknowledge in our discussion paper, Mn

does play an important role in biology. Therefore, we will also be adding a biological cycle but a dependency of Mn redox on pH and O_2 would not be possible to do within a reasonable amount of time. Here we depend on a carbon cycle and circulation model that may not be adequate for this purpose. This may already be true for the biological incorporation/remineralisation, but we do realise that a simulation with a constant Mn/P incorporation rate within our current model may be useful.

We have chosen a different dust deposition field (Mahowald et al. 1999) for our new simulations; one that has a bigger overall flux, especially in the Pacific Ocean, but is still within the observational uncertainty. This was necessary because the addition of a Mn biological cycle decreased dissolved Mn concentrations significantly in some parts of the ocean. Obviously the model-derived concentration of Mn in surface waters is a balancing act between supply mostly from (i) dust influx but also (ii) the Mn emanating from reducing sediments, and loss due to (iii) the biological Mn uptake and export, and (iv) the a-biological (i.e. adsorptive scavenging with or without oxidation) export flux. One of our sensitivity simulations will be with the original Hauglustaine et al. (2004) flux, which clarifies the change in dust field from the discussion paper to the final paper.

We are all very much aware that the reality in the oceans is far more complicated than what is actually being measured by seagoing oceanographers, and hence being simulated in models like ours. Most notably, all colleagues are aware that there exists for Mn, and other metals like Fe, a spectrum of colloids in a suite of size classes. If field data were available for at least one pool of colloidal Mn, then it would be worth considering to include such a separate pool in the model design. However, the datasets available thus far have been almost exclusively only for 0.2 micron or 0.4 micron seawaters filtered, i.e. operationally defined dissolved Mn, and one small dataset of particulate Mn, that is the Mn captured on a filter. Accordingly, the simulation model includes dissolved Mn and particulate Mn but, as yet, no colloidal Mn pool. More generally, the complexity of the model should not be (much) larger than what the observations can constrain. Of

course, more extensive modelling and observational studies should be done to arrive at a more complete knowledge of Mn, but the current study is only a first model.

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