Review of Wang et al.

Firstly, I would like to apologise to the authors for the lateness of my review.

Wang and co-authors present a modeling study examining the effects of sea ice on the marine iron cycle. In particular they focus on new parameterisations that examine the incorporation of iron into both Arctic and Antarctic sea-ice and its impact on biogeochemical cycling. Fluxes of iron associatd with the different components are quantified and the effects of interannual changes are discussed. The paper builds nicely on a recent Biogeosciences paper [*Lancelot et al.*, 2009; *Tagliabue and Arrigo*, 2006] but with a deeper examination of how to model sea ice iron and providing a global context. The paper therefore fits well into the scope for Biogeosciences and subject to a thorough revision should be suitable for publication.

I have two main issues with the paper:

1- Organization: the paper structure is a bit confused and could merit from a clearer structure. Essentially the authors seek to do two things: i) look at the impact of different sea ice iron parameterizations (figs 1-5) and ii) associated effects of interannual changes (Figs 6,7). I would argue these are two separate goals. The first set of questions would be more easily isolated in a simpler set of simulations that are not subjected to interannual variability since the authors only show snapshots and they are (correctly for me) interested in looking at how different choices impact iron distributions. When run interannually, I was then always wondering whether the result was biased by a particular choice of year. Having then established the impact of different parameterization choices it is then sensible to move onto part 2 and examine interannual aspects. In this case, comparing their model to the result obtained without sea ice iron would be instructive I feel.

2- Timescales: A discussion of timescales was for me not deep enough. One of the main aspects about sea ice is its seasonal variation and then subsequent to that its interannual changes. For example, does looking at the seasonal cycle more closely illuminate the importance of different processes? How does adding sea ice affect the modeled seasonal cycle in iron and biological productivity? Can satellite chlorophyll then help discern whether things are improved or not? Such questions would be equally true for the interannual timescales.

Specific Comments:

P2386: Hydrothermal vents are also a potential supply of iron to the surface waters of the Southern Ocean since this is where deep waters are ventilated [*Tagliabue et al.*, 2010]. Similarly, the authors mention atmospheric iron fluxes, but these are likely to be very low in the Southern Ocean are they not? (Particularly that part of the Southern Ocean that is sea ice covered). It is perhaps useful to note that sea ice fluxes of iron might be particularly important as an iron source once winter mixing has ceased [*Tagliabue et al.*, 2014].

P2389: I was unsure as to how the parameterization impacts the total iron budget. Some aspects seem to be sinks for seawater DFe and therefore don't change the total amount of iron in the system but redistribute it between the ocean and cryosphere. But the discussion of the additional take up of sedimentary iron seems to imply that overall more iron is added to the system? It would be nice if these aspects could be clarified and in particular how the different components affect the total iron budget.

P2391: the simulation plan was also not clear to me. Was the model spun up under interannually varying atmospheric forcings for 210 years until 2007 and then run on for a further 30 years? If so, what was the atmospheric forcing for this further 30 year period? Why not a repeated annual circulation?

P2392: please scatter the observations over the model fields for the Antarctic

P2394: What is the sensitivity to the fraction of DFe incorporated into sea ice during its formation?

P2394: please scatter the observations over the model fields for the Arctic

P2394: I did not really understand the text talking about Klunder's observations in the Barents and Kara Seas.

P2394: If you want to say that the model agrees that well with the data it is necessary to actually show some data-model comparison!

P2395: 'impacts of sea ice on iron concentrations' – this part needs an understanding of whether the total amount of iron in the system has changed or not!

P2396: I thought the Gerringa study referred more to glacial sources?

P2397: The species composition paragraph is very speculative, either solidify things or remove it.

P2399: Would be useful to compare the fluxes to those compiled elsewhere [*Boyd et al.*, 2012; *Tagliabue et al.*, 2010].

P2400: Some comparison to sea ice data would be helpful here, and inter-annual trends in productivity should be compared to those measured from satellite.

P2400: It would be useful to isolate the order of the different processes in driving the modeled interannual trends in productivity? For example, how much is simply due to the interannual changes in sea ice and the associated freshwater flux and how much is due to the iron aspects?

P2402: An interesting angle to the discussion is how, in reality, iron may be retained in bioavailable forms when supplied by sea ice because of the specific environment it is introduced to. In other words, the low temperature – high light

meltwater environment has been suggested to enhance photochemistry and retard oxidative losses of iron [*Tagliabue and Arrigo*, 2006].

References Cited:

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