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Interactive comment on "Sensitivity of ocean biogeochemistry to the iron supply from the Antarctic ice sheet explored with a biogeochemical model" *by* Renaud Person et al.

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Person Review by Raiswell This is an excellent contribution and is entirely suitable for Biogeosciences. The authors have used a biogeochemical model to examine the delivery of Fe from the Antarctic Ice shelf. I agree with their statement that iceberg and ice shelf delivery have largely been ignored in other biogeochemical modelling studies and this is a welcome attempt to address this issue. The model produces some important new insights which will need validating in further studies, when appropriate data are available. I also agree with the authors that; âĂć There is considerable uncertainty in the magnitude of all the different fluxes (and this applies just as much

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to atmospheric dust, as to the newer, less well-studied fluxes such as icebergs) âĂć There are also difficulties in using the data to examine the down-stream impacts on productivity and export. The value of this paper is in recognising these issues and making sensible attempts to address them. I would hope that this study is used by the community to focus on the main areas of uncertainty, and stimulate further observational studies. Especially as a particular difficulty the authors faced is that there are few relevant iceberg data sets and, in fact, there are more observational data from the Greenland ice-hosted sources than from the AIS. I commend the authors on reviewing the literature so thoroughly. I emphasize that I lack the expertise to comment on the models in detail but other comments below are keyed to page and line numbers. Page 2, line 3. The Raiswell reference is not the best as there are numerous studies of dust deposition to the SO. However the Raiswell data (I hope!) is more useful than many others because the extraction used relates to mineralogy, and specifically to ferrihydrite which is potentially the most bioavailable mineral form. You could move the Tagliabue ref to after 'SO' and before the colon, and then maybe cite a Boyd reference, perhaps the Mar Chem 2010 paper. The Raiswell reference would be better in the iceberg citations. Page 2, line 25. Delete 'through finely ground rocks'. The rock source is larger than the dissolved sources but the latter is not negligible and may be the most bioavailable. Page 2, line 27. Add 'fueling productivity in surface waters'. Page 3, line 3. Unfortunately the 50 samples are largely from Greenlandic icebergs and not Antarctica. Clarify this. Page 3, line 14. The impacts on productivity are the point at which my biological expertise starts to fail. The impact critically depends on how Fe affects on productivity and thus carbon export. The authors obviously need to explore this issue but an expression of caution would be wise. Maybe add 'cycles, depending on how Fe inputs relate to productivity and carbon export'. Page 3, line 18. I welcome the attempt to consider vertical distributions of iceberg Fe and their influence on the surrounding seawater. No doubt the distributions will turn out to be very variable, not least because the vertical iceberg Fe contents will alter as icebergs overturns. Page 3, line 25. 10% is OK but probably conservative. I would think that most ferrihydrite

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would be bioavailable, especially as ferrihydrite carries a significant fraction of ferrous iron. There is a brief discussion of this in my recent Frontiers paper, v. 6. No 222, doi: 10.3389/feart.2018.00222. You might be interested to look at this and at the EPSL 493, 92-101 paper by Hawkings. The Frontiers paper also raises the issue that ice is not inert and is able to catalyse the reduction of ferrihydrite. Also the freezing of sea ice produces pockets of Fe-enriched, chloride complexed brines that would be released early in melting. I am not suggesting that you need to cite these papers, I am only making the point, as you realise, that there are many areas of uncertainty which could profoundly alter the bioavailability percentage. It might be worth stating that you have not considered ice-water-mineral reactions. Page 4, line 23. Add wt.% after data. Page 4, line 30.Reword as 'no observational data are available that allow the shelf Fe fluxes from Antarctica to be constrained, as..' There is a very crude estimate of 5.3 Gmoles/yr in Raiswell et al (2016) Page 5, line 5. It would be good to have a table showing the fluxes and solubilities assumed for dust, sediments and sea ice in the CTL model. Page 6, line 30. This states that the 1.5 and 6.3 nmol/L values are over and above the CTL data. Can the authors clarify what is being derived here? I think the models produce 'dissolved Fe' (see the discussion in the Raiswell Frontiers paper). In any event the data would have to be compared with seawater measurements on water filtered through 0.45 micron, which is 'dissolved Fe'. These model values would be at the upper limit of actual seawater 'dissolved Fe' concentrations outside of coastal regions. Page 7, line 9. Sentence unclear. Page 7 line 30. The caption to fig. 5 needs to clarify which are the positive and negative areas. Page 8 line 17. The potential of this deep reservoir is one of the important insights that your study produces. Page 10, line 10 on. This seems reasonable. The whole point about icebergs is that they can transport, which is not true for ice shelf sources. But it is good to see this confirmed. Page 10, line 24. My figure 8 shows the difference in surface Fe concentrations, not chlorophyll. Has a diagram been incorrectly inserted? Page 11, line 11. Delete 'the' before Bouvet island. Paage 13, line 30 on. I agree that this difference is hard to understand but you make a crucial point; that modelling the ice-hosted sources is at present

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difficult; although the attempt is certainly valuable (see above). Page 15, line 25 on. Yes, delivery will vary as iceberg melting occurs. Page 16, line 5. I would prefer to be cautious here and describe the most labile source as' potentially bioavailable'. But I agree that there will be a range of Fe mineral reactivities each with different rates of reaction or dissolution or grazing interactions, and thus different bioavailabilities. Page 17, line 2. This is another useful finding, although again not unexpected that iceberg effects are spatially variable.

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