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Interactive comment on "Mechanisms of dissolved and labile particulate iron supply to shelf waters and phytoplankton blooms off South Georgia, Southern Ocean" *by* Christian Schlosser et al.

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We thank reviewer2 for their useful comments and hope to have addressed them appropriately in the following paragraphs.

Reviewer2 stated that the Fe budget is rather speculative and very uncertain. We agree with the reviewer that estimates for Fe budgets are challenging and in most cases contain large uncertainties. This is primarily the result of available flux data that is strongly limited temporally and spatially. Recently, I had a very interesting conversation about flux estimates with Prof Dr. Peter Brand from GEOMAR on research cruise M145 on RV Meteor, which is taking place right now in the tropical Atlantic Ocean. He pointed

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out that vertical diffusivity values, for instance, are strongly variable and that mean annual vertical diffusivity estimates, necessary for precise oxygen supply calculations, reached a high level of accuracy only after the same tropical region had been monitored for 12 years with more than 10 research cruises and high resolution CTD, glider and mooring deployments. However, the Southern Ocean is not such a well-investigated region, knowledge gaps are wide and values such as vertical advective and diffusive mixing critical for flux estimates are not well constrained. As correctly pointed out by reviewer2, even if such parameters are constrained for one region it does not mean that they can be used for other areas without introducing large uncertainties. Nevertheless, flux estimates even with large uncertainties can help to understand the degree of the nutrient supply vs. consumption by organisms and help to grasp the limitation of the estimates made. We agree with reviewer2 that our manuscript in the present stage falls to far short in discussing the degree of uncertainty of the Fe budget. Because of that we will add another set of paragraphs below chapter 3.4.5 to discuss the limitation of the Fe budget and the degree of uncertainty.

We agree that we should have provided a more rounded consideration of other potential processes for transporting Fe off the shelf, including non-biological candidate mechanisms. To explain other potential mechanisms we will add another paragraph into section 3.4.5. In relation to the specific mechanisms posed by the second reviewer, we agree that Fe freshly absorbed onto biogenic and non-biogenic material can be released and incorporated by phytoplankton and bacteria. However, the bioavailability of adsorbed and inorganic Fe changes over time! Both Chen and Wang (2001) and Wells et al. (1991) demonstrated that the bioavailability of freshly precipitated Fe oxyhydroxides and Fe adsorbed onto colloids/inorganic particles decreases over time. This is primarily due to the dehydration of the loosely packed structure that is subsequently transferred into amorphous FeOOH in the mineral structure Goethite. Because of this we suggest that the majority of Fe from inorganic FeOOH or Fe adsorbed onto particles must be released and utilized at an early stage of the voyage, mainly on the shelf or shortly after the shelf break. In contrast, suspended inorganic Fe particles or Fe

adsorbed onto particle surfaces farther away are older and became less bioavailable. These issues will be discussed in more detailed in our section 3.4.5.

Reviewer 2 argues that the supply of “new” Fe by krill feeding on sediment particles cannot be quantified. It is true that the experimental set-up did not allow us to specifically distinguish between “recycled” Fe from organic material and “new” Fe from krill grazing on sediments. However, Schmidt et al. (2016) concluded that zooplankton gut passage mobilizes lithogenic Fe, and showed that there are strong spatial patterns in the organic and lithogenic make-up of fecal pellets. This included an exponential decline in the quantity of lithogenic particles in krill stomachs with distance from sources of glacial flour on the northern South Georgia coast. For instance, the lithogenic content at one site on the shelf contributed ∼90% suggesting that a large quantity of the accessible Fe was remobilized from those inorganic particles. However, during the present study we were focusing mainly on net Fe fluxes and fewer on new and recycled Fe. Nevertheless, we are adding more insight into this problem in section 3.2.3., including a numerical exploration of a range of scenarios of the relative proportion of “new” and “recycled” Fe produced by krill

In section 3.3 we discussed the lateral distribution of LPFe and PFe along a NE – SW transect and applied an exponential curve fit to the three data points of LPFe and the 2 data points of PFe. Both reviewers argue that this is not appropriate. We understand that an exponential fit through 2 data points is meaningless. For three data points this approach is not much better. However, when we investigated the data in the early stage of the manuscript we were really surprised to see a very high R2 value for an exponential curve fit of the LPFe fraction. Because of that good R2 we thought it would be a good idea to share that finding with the readership of the article. However, we understand that such curve fittings can be wrongly interpreted and beside that do not contain a strong message for the manuscript. We are therefore removing the exponential equations and deleting the word “exponentially” from line 394.

References

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