Review of Tedesco et al., “Frazil ice formation as a pathway for iron enrichment in Antarctic sea ice” submitted to the Cryosphere journal.

Using observations from an Antarctic sea-ice core (including measurements of snow and ice thickness, ice texture, temperature, salinity, and dissolved iron (dFe) concentrations) together with seawater temperature, salinity, and dFe data, laboratory experiments, and a newly developed dFe entrainment model, this study suggests that frazil ice formation in the Southern Ocean can efficiently capture and store dissolved iron from seawater. Upon melting, this iron is released into surface waters, where it can stimulate phytoplankton blooms, thereby linking sea-ice processes to ocean productivity and carbon uptake.

The topic of the manuscript is highly relevant as very little knowledge exists on frazil ice formation and iron entrainment and as such it is worth publishing. The new dFe entrainment model, however, is subject to uncertainty, as it depends on several empirical parameters and assumptions necessitated by the paucity of observational data for calibration and validation. I find some of the presentations and argumentation difficult to follow and would like the authors to take my comments into account to make it clearer what is going on.

You state that you combine state-of-the-art field, laboratory, and model-based knowledge of frazil ice formation and consolidation into pack ice, particle scavenging, and resuspension to quantify dFe adsorption and entrainment into newly formed sea ice. However, there is no description of your laboratory experiment in your method. I would recommend you add more information of Figure 4 in the methods. How did you obtain the data? Why do you use such a poor fit for the data? Could you estimate some uncertainty in your model sensitivity by making different fits to the data?

With regard to absorption of iron into sea ice, you state that pFe is enriched in sea ice compared to seawater, and in your Figure 2 schematic representation of the key processes contributing to the high iron enrichment in Antarctic sea ice write that during winter, seawater supercooling leads to frazil ice formation, followed by the ***adsorption*** of dFe onto ice crystals. Could pFe not be the inoculum for frazil ice formation itself? Or could both things not happen? The pFe trapped in the frazil could then later enter the dissolved phase also.

Specific comments:

Figure 2: You could consider adding a red dot in some of the frazil ice crystals in winter also. See my comment above.

Figure 3: Could you plot the iron concentration data to this plot?

Figure 4: See comment above.

Table 1: Are data presented average of whole core measurements? - what is the difference from Table 2? Or the thickest ice corer?

Table 2: What are the " * " ? Estimated concentrations? If so – how did you do it? As I understand only corer 496 had iron concentration measurements.

Table 3: Raising velocity of aggregates are missing "time" in their unit! Right now, only in µm, but should be µm/time? What is the time? (

Line 215: Any data to back up supercooling of 0.040ºC? T,S profiles in the water column from the station seems to exist. Why not use data instead of assumed values?

Line 246-263: Could you include an estimate of uncertainty based on different fits og Fig 4?

Line 313-318: Why not include an a sensitivity analysis of turbulence depth, frazil crystal size distribution, and supercooling intensity as they are also expected to strongly influence enrichment. It should not take long.

Line 351: You need to include more information of the laboratory tests. Not possible to follow what you are doing when it is not included in the methods – that is mostly dealing with parametrization and assumptions in the model.