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The Cryosphere Discussions

Interactive comment on "Impacts of marine instability across the East Antarctic Ice Sheet on Southern Ocean dynamics" *by* S. J. Phipps et al.

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Response to Referee Comment 2: 'Reviewer Comment' by Anonymous Referee #2

This paper explores the impact of freshwater input from the Wilkes Basin on the broader Antarctic ice sheet and Southern Ocean. In particular the potential for loss of ice in the Wilkes Basin to trigger warming and further ice loss in the Weddell Sea sector is discussed. It builds on the work of Fogwill et al., (2015), with this paper differing in that freshwater hosing is applied to the East Antarctic as opposed to the West Antarctic. The paper is important given recent publications highlighting the sensitivity of the East Antarctic ice sheet to future anthropogenic climate change, but which lack potential ocean feedback effects. The paper is well written and the discussion and conclusions

are justified based on the results presented. I recommend publication once minor comments below are addressed.

We thank the referee for positive and constructive feedback on the manuscript.

Specific Comments:

1. The WEST/EAST/WILKES experiments are useful in highlighting the sensitivity of the model to the area that freshwater hosing occurs. In the discussion you could also touch on the assumption made that all ice lost from the Wilkes Basin would lead to localized meltwater delivery to the immediate George V Coast. As discussed there are various proposed mechanisms for collapse of the Wilkes Basin, which may affect the validity of this assumption.

We will revise the manuscript so that this assumption is clearly stated. We will also include a discussion of proposed mechanisms for the collapse of the Wilkes Basin, and include an explicit acknowledgement that our assumption may not be entirely valid.

2. I agree that using fixed pre-industrial CO2 makes sense for the purposes of a sensitivity test in order to isolate other effects. However around lines 30 on page 3 could you expand on the impact that elevated CO2 may have on these results, given that elevated CO2 is likely required to trigger a collapse of the Wilkes Basin. Ideally additional experiments would have been performed at elevated CO2 with and without freshwater hosing.

We have completed an additional experiment in which we increase the atmospheric CO_2 concentration to four times the pre-industrial concentration (1120 ppm) at 1% per year. We will incorporate this experiment into the manuscript. This will allow us to compare and contrast the response to increased freshwater input with the response to increasing atmospheric CO_2.

3. The a) and b) panels of Figures 5, 7 and 8 suggest that there would be surface cooling in the Weddell Sea sector and potentially at depths of 200-400m. This switches

to warming at depth, as discussed in the paper. Although a possible mechanism that could explain this surface cooling is discussed, the surface cooling in the Weddell Sea sector is not currently mentioned in the manuscript. Could you also include some discussion about how warming/cooling at different ocean depths may affect ice sheet stability in the Weddell Sea sector.

The surface cooling, in conjunction with warming at depth, is a consequence of reduced vertical mixing. Using the same climate model as us, this mechanism is studied by Fogwill et al. (2015). We will incorporate a discussion of the temperature changes in the Weddell Sea sector into the manuscript. This discussion will cover the underlying mechanisms and will address the consequences for ice sheet stability.

Fogwill, C. J., S. J. Phipps, C. S. M. Turney and N. R. Golledge: Sensitivity of the Southern Ocean to enhanced regional Antarctic ice sheet meltwater input, *Earth's Future*, 3, 317–329, doi:10.1002/2015EF000306, 2015.

Technical Corrections:

Page 4, line 5, could also include reference to Bintanja et al., 2013.

We will include a reference to this study:

Bintanja, R., G. J. van Oldenborgh, S. S. Drijfhout, B. Wouters and C. A. Katsman: Important role for ocean warming and increased ice-shelf melt in Antarctic sea-ice expansion, *Nature Geoscience*, 6, 376–379, doi:10.1038/NGEO1767, 2013.

We have also examined the sea ice changes within our experiments, and we will incorporate this analysis into the manuscript.

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