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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.

Anonymous Referee #1

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The authors examine the effects of enhanced meltwater release from the Wilkes Basin (East Antarctic Ice Sheet, EAIS) on bottom water formation and dynamics in the Southern Ocean, based on an ensemble modeling approach using the CSIRO Mk3L climate system model. The ocean and the atmosphere model components both have a relative coarse horizontal resolution, ideal for performing long climate integrations but limited in capturing the processes relevant for deep and bottom water formation in the Southern Ocean marginal seas.

General comments: The paper represents a very timely study following recent claims that the EAIS might be as vulnerable to ocean warming as the West Antarctic Ice Sheet (WAIS) with significant contributions to global sea-level rise. This study now considers the inverse interaction, showing that enhanced meltwater release along the EAIS coast warms the seas further downstream, thus providing additional heat for melting at the

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Discussion paper

base of, e.g., Amery and Filchner-Ronne ice shelves; the latter also fed from the WAIS.

The contribution can be considered as a sensitivity study of interest for the climate modeling community but with limited relevance for the 'real' processes controlling today's deep and bottom water formation, which mainly occurs along the continental shelf break. I.e., the authors miss to emphasize that most of today's climate models have the tendency to form on decadal timescales a large Weddell polynya, in which most of the model's Antarctic Bottom Water (AABW) is formed. Therefore, the claimed reduction in AABW formation, due to a meltwater induced stabilization of the water column in the central Weddell Sea, might be just a model artifact.

Therefore, I urge the authors to consider their new findings carefully in view of the existing model limitations, but if done, I recommend publication in TC after consideration of the comments/ corrections listed below.

Specific comments: 1. The model setup bears several limitations with the model resolution already mentioned. However, the use of a constant atmospheric CO2 concentration of 280 ppmV is another one. Especially in view of the stabilization of the water column in the Weddell Sea, a warmer and wetter atmosphere might be more efficient in hampering deep convection than meltwater advected thousands of kilometres and diluted by mixing and/or re-circulation as part of the gyre circulation.

2. The model results show a general warming of the water column downstream of the 'input sites' along the EAIS. While a warming of the deep layers can be explained by reduced deep convection, which brings warm waters to the surface and, in turn, cools the deep ocean, an explanation for the warming of the surface waters along the coast is missing. One can only speculate that this might be due to (a) a shorter lasting sea ice cover combined with an elongated period of solar heating of the surface waters and/or (2) the input of glacial melt at 0 degC instead of roughly -2 degC. Please provide a plausible explanation.

Technical corrections P5/L02: First time, but throughout the paper: The term 'coastal counter-currents' is unusual. Please use 'Antarctic slope current' or 'coastal current' instead. P5/L10: The greatest reduction in convective depth occurs in the western Weddell Sea. Note that the Weddell Sea extends at least up to 30o E. P5/L19: "Consistent with the greater decrease in AABW formation, ..."

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