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Interactive comment on "Impacts of Antarctic runoff changes on the Southern Ocean sea ice in an eddy-permitting sea ice-ocean model" *by* V. Haid et al.

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GENERAL COMMENTS Numerical models are the ideal tool for undertaking experiments on complex natural systems when attempting to understand the mechanics of the system and how it might change into the future. This paper presents the results of a set of numerical model experiments on one of Earth's major state changes, i.e. the freezing in autumn and winter of the Southern Ocean adjacent to the Antarctic Continent. What is more, Southern Ocean sea ice is baffling in that its extent has been increasing even as global air temperatures have increased. This paper investigates how much of the expansion of sea ice extent is caused by increased freshwater runoff from the Continent. The paper is therefore of interest not only for scientific reasons

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but also because of the politics surrounding global warming and this "poster child" for climate change sceptics.

The paper is well written and easy to understand. The investigation into how the spatial distribution of fresh water input changes sea ice is interesting. That there could exist a maximum freshwater input for sea ice extent increase (and above which extent decreases) is also an interesting result.

SPECIFIC COMMENTS I think the experimental method is reasonable and the choice of NEMO/LIM is a good one. My major question relates to the authors' choice of LIM version 2 rather than version 3. I realize that LIM2 is favoured by ocean modellers because it is more economical on computer time but this research is focusing on sea ice (and the waters that interact with it) rather than the ocean generally. In this application LIM version 3 seems to offer some advantages over the earlier version. The most important of these is accounting for ice rafting and also frazil ice growth. Both of these processes are important for Southern Ocean sea ice (and less so for Arctic Ocean sea ice). The paper reports that one of the consequences of increased runoff is thinner, more mobile ice. Rafting is common, possibly ubiquitous, in thin Southern Ocean sea ice (Worby et al, 2008) and can occur in relatively mild convergent conditions compared to those encountered by sea ice impacting land, ice shelves, or land-fast ice. The results show that the most thickening of ice from ridging occurs in highly convergent regions, e.g. western Ross Sea. It is possible that the model underestimates dynamic ice thickening in other regions because of the lack of rafting in LIM2. It may have been interesting to run a simulation where increased freshwater is added to all the Southern Ocean, i.e. approximating increased precipitation. This would isolate the thermodynamic contribution of increased freshwater to the ice extent increase. However, I realize that these suggestions would require re-running the model and so are not feasible. It would be desirable to explain why LIM2 was preferred to LIM3. The simulated winter ice concentration is higher than that of satellite observations as seen in the supplementary material. The model will report high ice concentration of very

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thin ice while the passive microwave observations will have problems distinguishing very thin ice from open water. However, thin ice also melts more quickly in spring and summer so I am not sure that the authors' argument is correct, i.e. that the higher winter ice concentration in the simulation accounts for the larger spring/early summer sea ice extent that the model produces. Extent includes open water south of the ice edge so maybe total ice area would give a better comparison? Using total ice area has its own problems of course. Also in the supplementary material the authors state that the quarter degree resolution is sufficient to capture most of the important aspects of atmosphere, ocean and thus the sea ice. I would agree with them in most respects but I wonder if they looked at how well the atmospheric forcing captured the katabatic winds which are so important for the formation of latent heat polynyas and therefore bottom water production?

TECHNICAL CORRECTIONS Poor grammar in places, e.g. page 8 lines 1: "In the central and eastern Weddell Sea, the fresh water addition causes the ice to thickened thermodynamically in S3." I think that "thickened" should be either "thicken" or "be thickened".

Worby, A.P., Geiger, Cathleen A., Paget, Matthew J., Van Woert, Michael L., Ackley, Stephen F., DeLiberty, Tracey L., 2008, "Thickness distribution of Antarctic sea ice", Journal of Geophysical Research, vol. 113 no. C05S92.

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