

Interactive comment on “Investigating future changes in the volume budget of the Arctic sea ice in a coupled climate model” by Ann Keen and Ed Blockley

Anonymous Referee #2

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General Comments

In this work the authors decompose in the coupled climate model HadGEM2-ES the global Arctic sea ice volume budget over the late 20th and 21st century into its main components – top melt, basal growth, basal melt, frazil ice formation, advection, snow-fall less sublimation.

In many ways this study appears as a follow up study of the earlier Keen et al., 2013 paper - see section 5 on 'modelled heat budget of the Arctic snow and ice' but instead of taking a local (per unit ice area) analysis here the authors present a global perspective that presents the advantage of explaining the mechanisms that control sea ice volume

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decline at the Arctic basin scale.

The main results of this study are:

- To present a detailed methodology of how to analyse the HadGEM2-ES Arctic sea ice volume budget components at the basin scale
- To characterise and rank in order of importance the different terms controlling the seasonal and inter-annual sea ice growth (and melt)
- To show that the changes in the volume budget are a function of the sea ice cover and not of the speed at which the sea ice retreats

My overall impression is that there is nothing fundamentally wrong with this paper but that at the same time that it does not contribute to any significant advances in the field.

I encourage the authors to explore one of the following possible extensions of their work in order to give it a wider audience:

- Explore impact of sea ice physics even at a simple level. Comparing results with results from HadGEM1 analyzed in Keen et al., 2013 could be informative. While it would be difficult to separate the impact of the different physics in the two models on the total volume budget it would show how model developments modify our understanding of the drivers of sea ice decline.
- Compare the model results with other climate models. In that sense the reader would get a better sense of inter-model variability. The authors suggest that their methodology is appropriate to analyse other models. Why not do it?
- If these options appear too ambitious the authors may at least consider improving the quality of the figures and explain in greater details how the decompositions presented in those figures help explain the future evolution of the sea ice cover and its role in the climate as a whole. For example what can we learn about the changing climate based on seasonal changes in the different terms in the volume budget. Similarly what do the figures 9 and 10 on the changes of effective thickness as a function of sea ice area tells us about climate change in the Arctic and beyond.