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Interactive comment on "Regional Grid Refinement in an Earth System Model: Impacts on the Simulated Greenland Surface Mass Balance" *by* Leonardus van Kampenhout et al.

Anonymous Referee #2

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This paper describes a (currently unsupported) configuration of the CAM+CLM atmosphere/land models in a set of short AMIP-style experiments where regional grid refinements have been made over Greenland. The focus of the analysis is on the impact of the local grid refinements on the simulated surface mass balance of the Greenland ice sheet, by comparison with observations and a benchmark regional model. The paper is timely and generally clear and well written. Although useful already, I think it would benefit significantly from a few key changes, if the authors could manage them

Major comments:

Some of what I'd like to see improved is already acknowledged by the authors in section

5, Limitations. To start with, is the model so expensive that even one further run cannot be done to properly quantify the impact of the erroneous input file, even if you can't go further and rerun both the VR simulations with the correct boundary files? Section 2.1.5 suggests this should only take a couple of days. Another matter highlighted here that would seem to be possible to address is that all results of CESM vs RACMO in the Tables are presented as area-integrated, absolute quantities, although the area of the ice sheet used in each case is different. The difference in areas considered does make it difficult to know how far the anomalies wrt the RCM are really down to the CESM-VR physics, especially in the crucial, high ablation zones at the edges. I think some common area could be defined for analysis purposes, even without formally separating out the main sheet from the peripheral glaciers in CESM as section 5 states cannot yet be done.

More generally, from the analysis that has been done the paper doesn't come to any firm conclusion as to why there's apparently a systematic trend towards lower Greenland ablation with higher resolution, nor whether this really represents an improvement or degradation in model physics or overall performance. Going further, one would really like to see how the changes play out when the CISM ice sheet is coupled into the system. On pg18, there is a scope-limiting statement that has been left right to the end of the paper - if this paper is a limited, "exploratory first step" I think it that should be stated earlier to set up the readers expectations appropriately. I don't think these matters should really be out of scope for this study, but we should at least be warned earlier if the authors are going to declare that they are.

Minor comments

pg1,line7: "starts developing": clarify that the growing bias is a function of resolution rather than eg time.

pg1,line13: I don't think you need "relative"

pg3,line9: I wasn't sure until it was noted as a Limitation in section 5 that there really

had only been a single, twenty year run conducted for each CESM configuration shown here. Could that be made clearer, earlier?

pg5,line4: "similar to what is done in two-way coupled setups..." this isn't very helpful for readers unfamiliar with the CISM coupling. Could you rephrase, or add a reference?

pg14, line 12: two full-stops after "resolution"

section 4.1: how do the circulation anomalies shown compare with the variability in CESM? Could they be further compared with CESM-ERA biases for the relevant period, to judge whether the VR has improved matters? I think our Editor has previously suggested that 700mb is the best altitude to assess temperature biases for relevance to Greenland climate?

section 4.2: The above-suggested comparison with ERA could usefully be extended to cloud properties, and the surface fluxes could be compared with those from RACMO?

I don't think the content in sections 4.3 and 4.4 is really extensive enough to deserve their own separate headings?

pg19,line27: Even though the VR configuration isn't supported yet, is it worth adding a link to where people can get CESM, and/or lodging your configuration description with the paper?

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