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Interactive comment on "ESM-SnowMIP: Assessing models and quantifying snow-related climate feedbacks" *by* Gerhard Krinner et al.

Anonymous Referee #1

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ESM-SnowMIP: Assessing models and quantifying snow-related climate feedbacks

Gerhard Krinner et al.

This is a slightly unusual paper in that it presents a comprehensive overview of a planned model intercomparison, with a few early results, rather than a critically assessed specific model development. However, what is being proposed is a very significant international effort to understand the representation of snow, and its interactions with the atmosphere and substrate, in earth system models. Consequently, it is worthy of presentation at this stage and is aligned to a suite of other papers in GMD that describe model experiments either directly part of, or running in parallel to, CMIP6. This

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paper is not just an advert for what is to come, which in itself would not be suitable for publication. In particular, there are some interesting early results from the tier 1 'Ref-Site' experiment. The paper is very well written and easy for a wider audience to understand, providing a valuable reference document for further publications as the results of each of the ten experiments materialize. Consequently, I only have a few comments that may improve description of the experimental framework, interpretation of results currently presented, as well as correcting a few minor typos in the current manuscript:

1. In the 'Objectives and Rationale' section can you specifically say what lessons have been learned from previous MIPs (especially SnowMIP 1 &2)? MIPs are often criticized (for good reason), for not providing clear and incisive direction for the way forward in model development. Rather they too often fall back on the conclusions that there are big spreads in model outcomes from which we cannot untangle the relative impact of uncertainties in input data, model parameters or model structure (to paraphrase an insightful pers com from Drew Slater). The relatively recent development of FSM and ES-CROC give the hope that this common failing will not be replicated in ESM-SnowMIP. However, in this section I strongly recommend that the authors explicitly say what has been unsatisfying in past snow related MIPs, what potential solutions are available, and specifically describe how ESM-SnowMIP will avoid these potential pitfalls.

2. A clear aim is to identify an 'optimum degree of complexity' (pg5, ln 4). A definition of model complexity and, more importantly, a useful and workable metric to quantify complexity requires clear guidance in this paper. This is a topic which is often broadly discussed, and which people can have a general feel for, but it rarely has a satisfying quantifiable definition and it varies with model purpose. As it seems like this will be mainstream to evaluations in ESM-SnowMIP experiments it is important this is clearly clarified here.

3. Figure 4 (and Pg7,ln 10) is a good analytical result. However, even in a paper

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of this introductory nature, there needs to be some critical comment of these results. Saying 'A couple of models do well, and a couple do poorly' is wholly inadequate. I'm not recommending any 'name and shame' approach, but can you at least name some of the models that do consistently well (e.g. the first ranked model)? Surely they are doing well for a reason that we can learn from? At the very least, or in combination with naming high performing models, is there potential to highlight models anonymously by Type (see Table 3). This may go some way to addressing the complexity issue (see previous point).

Pg2 ln 25: Citations are neither listed chronologically or alphabetically. This needs consistency throughout the manuscript.

Pg2 ln 28: Consider removing 'Thermal' at the start of the sentence to help improve readability; 'thermal is currently repeated three times within that sentence.

Pg3 ln4: Consider citing Sturm et al. (2017) (doi:10.1002/2017WR020840) in addition to Fyfe et al. (2017).

Pg3, ln13: consider adding 'microstructure' to the list of physical properties. Potentially use Räisänen et al. (2017) (doi:10.5194/tc-11-2919-2017) as a citation to corroborate its inclusion.

Pg3,ln19: Be specific about the important processes you are referring to here. I'm presuming it's thermal conductivity / snow microstructure as you cite Domine et al. (2016). If so, please say so specifically and highlight the suite of processes you deem most important to consider here.

Pg3, ln31: replace 'of' with 'for'.

Pg4, ln25: cite where this wealth of new large-scale observational data sets are described.

Pg5, ln27: remove comma after 'and'.

Pg7, ln 8: I like this evaluation metric. However, there is slight ambiguity, e.g. is the standard deviation of measured SWE at all sites? Please consider adding an equation here to explicitly define how this is calculated.

Pg7, ln 21: replace 'validation' with 'validation of'.

Pg7, ln 26: add citation(s) to support the difficulty to untangle feedback effects.

Pg 8, ln 8: will this experiment take place? If so leave it in, if there is doubt, consider removing this sentence.

Pg8, ln 24: why use such a large thermal conductivity, which is two orders of magnitude than physically measured by Sturm et al. (1997)? While the exact value is unlikely to be critical, this needs a better justification.

Pg9, ln 22: Author name missing in the citation – presume it is Mudryk et al. (2015)?

Pg10, ln 13: Provide a citation(s) for the satellite based observations of climatological SWE.

Pg11, ln 10: section number missing in cross-reference, currently says 'section 0'. Could section 3.2.1. just be cross-referenced here to prevent repetition?

Pg15, ln 10 & Table 1: As the schedule is tentative, could you just say 'post CMIP6' here and remove the column 'Run-Schedule' in Table 1, which I think is superfluous.

Pg16, ln 17: remove 'and particularly'.

Pg16, ln23: replace 'move into the' with 'become a'.

Pg17, ln18: replace 'deposed' with 'deposited'.

Pg17,ln19: impact on what – I presume albedo, but please state this here.

Pg17, 28: did you mean to say 'Ye.M.Gusev' rather than 'Y.M.Gusev'?

Figure 5: Caption – remove 'correct prescription', and just keep 'reference simulation'

as per main text body.

Table 3: Must add in citation(s) that describe each model so readers have a point of reference.

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