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Geoscientific Model Development Discussions

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

Anonymous Referee #2

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General comments

ESM-SnowMIP: Assessing models and quantifying snow-related feedbacks Krinner et al. 2018

This is the protocol description paper for ESM-SnowMIP, an international effort to systematically evaluate and compare different snow models across climate models. Next to listing and describing the experiments a lot of background information is provided as well as initial results from some first stand-alone point simulations, which aids in understanding the purpose of the entire exercise and makes it more enjoyable to read.

It is explained multiple times in the paper that ESM-SnowMIP builts upon the framework of one of the official CMIP6 efforts, namely LS3MIP. Indeed, it can be viewed as an

unofficial extension of that with more gridded sensitivity and single-point experiments geared specifically towards terrestrial snow, although in the final section of the paper the authors hint at including snow on sea ice in the future as well.

The manuscript is well structured and the level of detail is fine. However, the phrasing could be more accurate, given the fact this is a protocol paper. E.g. on P11 L9 it reads: "While a number of snow analyses are available to serve as prescribed SWE, we recommend the Mudryk et al. (2015) combined climatology." This can be interpreted as if it were that the decision on the dataset had still not been made. I suggest that the authors use more precise words like "propose" or "selected" in these circumstances.

Another problem is that sentences are sometimes quite long and therefore incomprehensible, e.g. P5 L4: "Global snow simulations are subject to uncertainty in the meteorological data used to drive models (whether provided by bias corrected reanalyses as in LS3MIP offline land model experiments (van den Hurk et al. 2016) or by coupling with atmospheric models as in CMIP6), global products providing vegetation and soil characteristics for model parameters are often contradictory, and global observations of snow properties for evaluation of models (e.g., for snow density and thermal conductivity) are limited." This is an extreme example but let's say that generally the readability could be improved by shortening and structuring sentences better, and removing parentheses where possible. This is a general comment that applies to the entire manuscript, and in the Specific Comments below I highlighted some more examples.

To conclude, this paper is definitely worthy of publication after the readability is improved and outstanding questions are resolved (see below).

Specific Comments

P1 L1 (title): suggest to change "assessing models" into "assessing global snow models"

P2 L15-18: it should be made more clear that ESM-SnowMIP is no official part of CMIP6, but will run parallel to it

P2 L21: suggest to replace “Northern” by “northern hemisphere” and “continental” by “terrestrial”

P2 L22: another important role of snow in the climate system is its ability to store / buffer large amounts of freshwater.

P2 L22 and beyond: “The former” indicates that there will be “a latter”, but that never comes. Instead, an enumeration follows of all interactions that snow has on the climate system, with a much wider spread than signaled to us in L21-L22. Suggest to rewrite this part of the introduction to make clear we are going to read a long enumeration.

P2 L24: suggest “main driver” rather than “thought to contribute”

P2 L29: order of citations seems random. Suggest chronological order. Applies to whole document.

P3 L2: water and energy availability, suggest to add citation Rhoades et al., 2015, J. App. Met. Clim.

P3 L13: suggest to add “prognostic albedo”

P3 L28: add reference Slater 2017 to list of thermal properties of snowpack

P3 L33: on top of that, imperfect meteorological boundary conditions ?

P4 L12: suggest to remove “and specifically to (..) which is part of CMIP6”, because it is basically said again in the next sentence and the sentence is already very long.

P4 L24: “see the section on reference site simulations” be more specific, which number?

P4 L25: “wealth of new large-scale observational data” -> please give an example or reference

P4 L30: what is meant with the term “mutually consistent”?

P4 L31: term AMIP is used but not explained – suggest to replace with “atmosphere only” Also, it is not clear why AMIP is mentioned at all. This paper does not use it?

P5 L4: suggest to rewrite into enumeration to improve readability. “We aim to (1) identify the optimum (. . .); (2) identify previously (. . .); and (3) identify feasible (..)”

P5 L9: second -> fourth? The authors need to work this part because the enumerations are not clear.

P5 L10: remove reference “van den Hurk 2016” to improve readability. Applies to all later occurrences in same context.

P5 L13: suggest to rewrite “To this end, diagnoses of (. . .)” and delete “complete this aspect of ESM-SnowMIP”

P5 L21: suggest to replace “supposed” by “mandatory” and rewrite second part of sentence using the word “exception”.

P5 L28: suggest to rewrite this sentence into two sentences. “First, we describe single-point experiments, some of which have already been carried out and analyzed. Then, the spatially distributed experiments are described, that naturally only will be carried out by a subset (. . .)”

P5 L21: suggest to rewrite to “the planned fully coupled ESM experiments”.

P6 L4 – L10 & L20-L22 : these sentences fit better in Section 3 – Experimental Design, explaining why the gridded simulations have been augmented by single-point simulations. Also, suggest to add a sentence saying that there are basically two groups of snow models participating: those doing the gridded AND point experiments, and those only doing the latter. It is implicitly clear from Section 3 but would be good to make explicit.

P6 L18: please quantify number of sites and years

P6 L20: Distinction between climate models and ESMs is superfluous? Nowadays, they basically mean the same thing, since the usual definition of ESM is a climate model with an active carbon cycle.

P6 L23: suggest to replace “sophisticated snow physics models” by “standalone snow models” since the word sophisticated is subjective.

P6 L26: at what frequency are these measurements typically available?

P7 L1: This phrasing is not very formal. Do you mean to say that the onset of melt is both under- and overestimated by models?

P7 L4: is this because there is no snow, thus no insulating effect?

P7 L15-16: suggest to split into two sentences. Further, I would say that soil temperature is also dependent on the amount of meltwater refreezing and the refreezing depth (see e.g. Van Kampenhout et al., 2017)

P7 L26: Suggest “metric” rather than “variable”

P7 L28: Please add reference for the statement “which approximates the CMIP5 multi-model mean peak snow albedo” if you have one.

P8 L3-L4: suggest to change “surface layer” to “atmospheric boundary layer” to avoid ambiguity with the top snow layer.

P8, L11: Please explain briefly why the ensemble members react differently, for people that don’t know FSM.

P8 L27-29: Unclear, please rewrite.

P8 L32: acronym GSWP3 is first used but not defined nor referenced

P9 L2: suggest to avoid the words “overestimate” and “underestimated” because these have negative connotations. What you mean to say is that there is a differences between the grid cell means and the measurement site because they differ in elevation.

P9 L3: is this coincidence, or is Sodankylä located in flat terrain? Probably good to mention.

P9 L5 – L10: I would not call bias-correction a form of downscaling. A (statistical) downscaling procedure would use the climate data as is, then projecting that onto a high resolution topography using lapse rates and possibly repartitioning of precip.

P9 L17: SCF first used but not defined

P10 L3: unclear what is meant with “fully characterized bias and error”

P10 L9: SCE first used but not defined

P10 L9 – L14: can we do even better by defining a unique threshold for each of the different snow products? Was this tested?

P10 L16 – L22: Unclear; make more clear that LS3MIP is used as a baseline or control experiment and that ESM-SnowMIP adds sensitivity experiments on top of that. Reference Kim 2018 should be given earlier, when GSWP3 is introduced.

P10 L25: and prescribed SCF? If not, mention that this is left up to the model (e.g. on P11 L4)

L11 L2: “by less than 10% or so” : too vague

P11, L9: on P9 L19 you wrote that “we have developed a blended dataset” which suggested that it was specifically developed for this MIP. This contrasts with the fact you now use the reference Mudryk 2015. Indicate if and how the blended dataset used is different from Mudryk 2015 and avoid inconsistencies.

P11 L10: section number missing

P11 L28: Aren’t all ESM-SnowMIP gridded experiments?

P12 L1 - L2: are these observational data for evaluation already known? If yes, mention them.

P12 L10: I don't see how the active layer depth can be diagnosed from the lowermost soil layer depth, which may vary across models.

P12 L27: "ESA 2017" citation is strange and refers to the user guide. Suggest to include these references instead: Poulter 2015 doi:10.5194/gmd-8-2315-2015

P12 L34: clarify what CCI 200 means

P13, L9 – L18: Please clarify this part. In particular unclear is this sentence "This LS3MIP experiment uses (. . .) and prescribes these in the LFMIP-rmLC experiment." What is meant with "scenario simulation" (mind that scenario = future in CMIP terminology) and "context of a transient run".

P13 L18: replace "we suggest carrying out" with "we propose". See earlier comment regarding protocol document.

P13 L19: Unclear whether the run being proposed here is SnowMIP-rmLC? Make explicit.

P13 L26: see earlier comment about the word "scenario"

P13 L27: remove sentence; has just been explained.

P14: this page breaks the general style of the manuscript by using bullet points extensively.

P14 L27 – L32: suggest to move this to the end of the section, P15 L3.

P16, L16: it should be made more clear whether the possible future extensions are intended for a follow-up project (ESM-SnowMIP Phase 2 or whatever) or as an integral part of the current effort.

P16, L24: and bottom heat flux, presence of salt

P18 Many citations are not up to date and contain either the word "Received" (e.g. L7) or they point to a discussions paper (e.g. L22). Next to that the use of URLs is

not consistent, e.g. L25 contains an URL that basically repeats the DOI. Suggest to remove all URLs and stick to DOI. Whole reference list needs a cleanup like this.

P21, L20: this work is not available under any DOI so reference should be removed.

P25, Figure 1: over what period was the average computed?

P27 Figure 5 – 7: suggest to replace "ensembles" with "ensemble members" and mention in each case how many ensemble members are present in the graph.

P27, Figure 5: What is meant with "Correct prescription"? Further, the word "period" is missing.

P29, Figure 10: The 7th dataset, MERRA, appears to be missing from the graph

P31, Table 2: suggest to put site abbreviations / tags in separate column for quick reference

Technical corrections

P2 L12 and L15: choose either "modelling" or "modeling" and be consistent throughout manuscript.

P2 L13: suggest to move "against local and global observations" to the end of the sentence

P2 L14: suggest to replace "at identifying" by "to identify" and remove "snow"

P3 L19: suggest to move "particularly in cold conditions" to end of the sentence to improve readability

P3 L31: suggest to replace "a large room of improvement" with "room for improvement"

P4 L3: PILPS is an acronym and should be capitalized.

P4 L3: "(. . .) Phase 2d (Slater 2001), Phase 2e (Bowling et al 2003), as well as SnowMIP Phase 1 (..) "

P4 L12: CMIP6 acronym has already been defined in abstract; no need to repeat.

P4 L27: suggest to replace “to profit” by “take advantage”

P5 L17 and L19: suggest to remove superfluous “rapid” in both places.

P5 L24: the word “Tier” should be capitalized, as is done later in the paper

P6 L10: suggest to replace “These process-based studies have been enabled” by “The single-point experiments are enabled”

P6 L13: suggest to replace “and aerosol” with “or aerosol”

P6 L15: Arctic should be capitalized

P6 L26: suggest to rewrite to “Snow water equivalent (SWE), depth measurements, and hence bulk snow density are available for all of the reference sites. Several sites also (. . .)” to improve readability

P6 L30 : suggest to rewrite “close to the model ensemble means”

P8 L17: rewrite to “(. . .) has a major climatic control on (. . .)”

P8 L18: rewrite to “(..) that is spatially and temporally variable and often (. . .)”

P8 L19: replace “attributed” with “assumed”

P9 L1: rewrite to “with an average elevation of 870 m”.

P9 L13: suggest to rewrite to “identifying unique priorities for development of each of the participating models.” thus removing repetition.

P9 L19: “dataset” is one word

P9 L19 & L24 & beyond: suggest to rephrase “snow analyses” to “snow products” which for me better covers the meaning. Also see caption of Figure 9.

P9 L22: reference is missing

P10 L14: Figure 10a

P11, L17: suggest to replace “erroneous” with “biased”

P11, L24: rewrite to “over ice sheets”

P12, L5: Suggest to rewrite to “this simulation will otherwise have” & then delete the part that reads “except (. . .) conductivity”

P13, L10: remove superfluous “combined”

P16 L7 : suggest to rephrase “large range of degrees of sophistication” to “a wide spread in their degree of complexity”.

P16, L14: suggest to replace “including” by “such as”

P17, L1: suggest to rewrite “yet scarce observations” to “high-quality observations”

P17, L10: replace ‘do’ by ‘does’

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