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The Cryosphere Discussions

Interactive comment on "NHM-SMAP: Spatially and temporally high resolution non-hydrostatic atmospheric model coupled with detailed snow process model for Greenland Ice Sheet" *by* Masashi Niwano et al.

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This paper presents a new RCM based simulation over the Greenland ice sheet. While the scientific interest of this paper is generally poor, this "model validation" paper deserves to be published in TC and opens the door to future applications over the GrIS using a new RCM in addition to the wide commonly used RCMs family (MAR, RACMO, HIRHAM).

In addition to the justified remarks from both other reviewers, I have additional remarks

that should be resolved before publication if it is not a too big job for the authors.

pg2, line 67: site rather Fettweis et al. (2017) here

pg5, section 2.2.1: What is the sensibility of the model results to the fresh snowfall density? With MAR, the sensibility is very small and MAR uses a minimum snowfall density of 200kg/m3. 300kg/m3 is a bit high for me.

MAJOR: pg 7, line 231: As the JRA-55 surface conditions are bad (Section 4.1, line 325), is an atmospheric spin-up of 6h enough to be independent of the initial near-surface atmospheric conditions? How are the results sensitive to this spin-up time? For me, performing 48h long simulations by keeping only the last 24h will be more robust.

pg9, section 4.1: As SMAP seems to underestimates the ablation (see Fig 8), the statistics over summer (JJA) should be provided at least in supplementary material? Is the model too warm or too cold in summer ?

MAJOR: pg 10, line 341: If a RCM is totally free, it should be normally independent of the surface biases in the forcing fields. A too short spin-up time of 6h starting from too warm JRA-55 based surface conditions explains likely these biases because MARv3.5.2 forced by JRA-55 is colder in winter than MARv3.5.2 forced by ERA-Interim. Therefore, extending the spinup time should better resolve this bias than changing of forcing reanalysis. Finally, SMAP seems to underestimate LWD in winter but overestimates temperature? This is very strange?? This issue should be discussed in the paper.

pg 10, section 4.2 : I do not see the interest of showing here the ability of SMAP only to simulate a single wind event. Outputs from JRA-55 should be added in the comparison to show the interest of SMAP in respect to JRA-55. MARv3.5.2 (at a resolution of 20km) forced by JRA55 underestimates also this event by a factor of 10-15m/s. The interest of using a non-hydrostatic model at 5 km should be highlighted here.

pg 12, lines 409-423: the fact that SMAP overestimates surface temperature but underestimates both LWD/SWD fluxes suggests that SMAP is likely too dependent of the forcing data. What about the latent and sensible heat fluxes? The authors suggests that near-surface snow density is likely too high. I am very sceptic about this explanation. The sensibility of the results to the near-surface snow density can be tested offline. For me, the problem comes from the JRA-55 fields which are too warm and which are used every day to reinitialise the SMAP atmospheric fields.

pg 12, lines 424-439: it is true that MAR overestimates albedo but as it also overestimates SWD. Due to error compensations (as explained in Fettweis et al., 2017), the MAR surface fields are OK. Here, it is strange that SMAP overestimates temperatures but overestimates albedo and underestimates SWD and LWD.

Pg 13, section 4.6 : the comparison with the melt extent is excellent! Adding here a 2D comparison (nbr of melt days in 2012 for example) should be interesting to evaluate if this agreement is also OK locally. The simulated total melt extent could be good for bad reasons and local overestimation/underestimation of melt can be compensated.

pg 13, line 479: A 2D comparison with other RCM based estimations (RACMO, MAR, ...) is needed here for me. The raw 20km MARv3.5.2 daily outputs forced by JRA55 are available here:

ftp://ftp.climato.be/fettweis/MARv3.5.2/Greenland/JRA-55_20km/

and could be used in this paper just by citing Fettweis et al. (2017).

MAJOR: pg 14, line 507: MAR at 20km is generally able to resolve the ablation zone. The 5 km resolution used here is not an issue here to explain the systematic SMB overestimation in the ablation zone by SMAP. RACMO at 11km works also already very well. Significant biases in energy balance fluxes could explain the underestimation of ablation.

pg 14, line 513: to test the problem of the overestimation of albedo in SMAP, an offline

simulation using a bare ice albedo of 0.2 could be carried out here and results should be shown in Fig 8.

pg 14, line 522, explicit comparison with MAR or RACMO is needed here for me. RACMO or MAR time series could be added in Fig 9.

pg 15, lines 532-540: such sensitivity to the irreducible water content is also simulated by MAR which uses a value of 8%.

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