The Cryosphere Discussions

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Comment on tc-2021-100

Anonymous Referee #1

Referee comment on "On the performance of the snow model Crocus driven by in situ and reanalysis data at Villum Research Station in northeast Greenland" by Daniela Krampe et al., The Cryosphere Discuss., https://doi.org/10.5194/tc-2021-100-RC1, 2021

This paper presents first a validation of ERA5 over the Villum Research Station (NE Greenland) in the aim afterwards to force the CROCUS snowmodel with ERA5 and to evaluate its results with observations made at this station. While the paper is well written and uncertainties well discussed, the main scientific message, relevance and originality of this paper is poor for a journal such TC. ERA5 has already been evaluated over Greenland, CROCUS has already been applied in Arctic/Greenland and the fresh snow density improvements proposed in this paper seems to not improve a lot the comparison.

Moreover, this paper shows notably that using observed precipitation as forcing of CROCUS overestimates the snow height and that, although improvements in the prescribed fresh snow density, CROCUS still underestimates snow density. This suggests for me that:

=> as the modelled snow density is biased, both modelled and observed snowpack should be compared in water equivalent as observed density is available. A large part of discrepancies shown in Fig6 could be due to problems in the modelled snow density and not to overestimation/underestimation of prescribed precipitation as forcing. This could change the discussion in this paper if it is well the case. In Fig6, the modelled snow height can at least be corrected with respect to the snow density bias with observation and in this case, we could likely see a systematic underestimation of modelled snowpack using ERA5 as forcing.

=> as mentioned in the discussion, it is also very likely that this area is highly impacted by the wind erosion (increasing snow density and eroding the snow pack) as well as by the wind transport of the snow (biasing the snowfall measurements and potentially bringing snow from elsewhere) decreasing a lot the relevance of this study knowing that the blowing snow processes are not resolved here. Therefore, it is very likely that a large part of discrepancies between CROCUS and observations could just be due to the fact that this process is missing here and this does not necesserly mean that CROCUS is not working well in Arctic. Comparison with RCM (RACMO, MAR) taking into account these

processes could help to evaluate the importance of these processes in this area.

Some more minor remarks:

- line78: I assume that this data is not assimilated into ERA5. Where is the closest weather station for which its observation is assimilated into ERA5?
- line 124: As the altitude of the ERA5 pixel is too high with respect to the station altitude, ERA5 is too cold and its surface pressure is too low. Converting all the precipitation to snow below 1°C will overestimate a lot the amount of snowfall with respect to rainfall knowing that ERA5 is already too cold.
- line 169, section 2.3: According to Fausto et al. (2018, A Snow Density Dataset for Improving Surface Boundary Conditions in Greenland Ice Sheet Firn Modeling, https://doi.org/10.3389/feart.2018.00051) using a fixed fresh snow density of 315 km/m3 is better than any parametrisation based on temperature and wind. In MARv3.11 model, a fixed value of 300 kg/m3 is for example used according to Amory et al. (2021, GMD). Have you tried to use for example as minimum value of 250kg/m3 for fresh snow density?
- line 141: what is the amount of measured precipitation which is missing by comparing the amount of ERA5 precipitation during the measured period vs the ERA5 precipitation during the missing period?