Interactive comment on “Surface mass balance downscaling through elevation classes in an Earth System Model: analysis, evaluation and impacts on the simulated climate” by Raymond Sellevold et al.

Anonymous Referee #3

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General synopsis This is a useful contribution about the novel application of using Earth System Models (ESM) with downscaling, via sub-gridcell elevation classes, to simulate Greenland Ice Sheet surface mass balance. Although it is fairly model-specific (based on the CESM1.0 ESM), this paper should be of broad interest to the GrIS SMB modelling and Greenland climate communities.

Some previous highly relevant literature is missing or can be better acknowledged (see comments below).
I wonder whether the CESM results can be compared with MAR as well as RACMO, for an independent RCM model check (and since MAR is the main alternative RCM currently used for Greenland)?

Specific comments


P2, L8: should also add there is a significant disparity between different model estimates of GrIS SMB (Fettweis 2018): Fettweis, X. (2018) The SMB Model Intercomparison (SMBMIP) over Greenland: first rltls. AGU Fall Meeting talk archived at: https://orbi.uliege.be/handle/2268/232923.


E Hanna, P Huybrechts, J Cappelen, K Steffen, RC Bales, E Burgess, ...(2011) Green-
land Ice Sheet surface mass balance 1870 to 2010 based on Twentieth Century Re-
analysis, and links with global climate forcing. Journal of Geophysical Research: At-
mospheres 116 (D24)

P2, L32: While the motivation for the study is good as stated, can you make it clear in
this sentence/paragraph whether you investigated precipitation downscaling as well as
temperature downscaling?

P3, L26: How was this number of elevation classes chosen? Would having a greater
number of classes improve the results?

P3, L34 “Incoming radiation, precipitation and wind are kept constant across all ECs” -
Is this a potential limitation of this study or could improvements be made here?

P5, L8 “snow when near-surface temperatures are between -7°C and -1°C” – the
latter value (-1°C) seems quite a low upper threshold for snow?

P10, LL4-5 “the first time the EC method for downscaling from a global climate model
of ~100 km to the much higher resolution (5 km) of an ice sheet model” – point out that
this kind and magnitude of statistical downscaling has been previously successfully
used in downscaling meteorological reanalysis data from ~100-km resolution to 5-km
I Janssens, J Cappelen, K Steffen, A Stephens (2005) Runoff and mass balance of
110 (D13) (Other two references details are above.)

P11, LL9-11: The recommended implementation of a precipitation phase downscaling
scheme doesn’t really solve the great challenge of overall elevation correction for pre-
cipitation. This paragraph therefore sounds a little weak as currently stated – can the
authors strengthen their argument here?

P12, L4 “Our sensitivity experiments reveal that a larger lapse rate for the temperature
correction results in higher melt energy gradients” – isn’t this rather an obvious and
unsurprising result? – perhaps rephrase?