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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.

Anonymous Referee #1

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General synopsis

This is a useful and original study of Greenland climate and surface mass balance conducted using a non-hydrostatic regional climate model. I would like to see some comparison of NHM-SMAP model output, for example as presented in Figures 9 and 10, with other RCM model output (e.g. MAR, RACMO, HIRHAM). The paper is generally well structured, written and illustrated, and should be publishable with relatively minor modifications. Citation of related work can be improved in places.

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Specific comments

p.2, l.35 Consider adding more recent relevant references, e.g. van den Broeke 2016 The Cryosphere, Hanna et al. 2013 Nature:

van den Broeke, M. R., Enderlin, E. M., Howat, I. M., Kuipers Munneke, P., Noël, B. P. Y., van de Berg, W. J., van Meijgaard, E., and Wouters, B.: On the recent contribution of the Greenland ice sheet to sea level change, The Cryosphere, 10, 1933-1946, doi:10.5194/tc-10-1933-2016, 2016. Hanna, Edward and Navarro, Francisco J. and Pattyn, Frank and Domingues, Catia M. and Fettweis, Xavier and Ivins, Erik R. and Nicholls, Robert J. and Ritz, Catherine and Smith, Ben and Tulaczyk, Slawek and Whitehouse, Pippa L. and Jay Zwally, H. (2013) Ice-sheet mass balance and climate change. Nature, 498 (7452). pp. 51-59. ISSN: 0028-0836.

p.2, l.66: Not just RCMs but also statistically-downscaled meteorological reanalysis data have been successfully used here (Hanna et al. 2005 & 2011, Wilton et al. 2017) – please add these relevant references:

Hanna, E. and Huybrechts, P. and Janssens, I. and Cappelen, J. and Steffen, K. and Stenhens, A. (2005) Runoff and mass balance of the Greenland ice sheet: 1958-2003. Journal of Geophysical Research Atmospheres, 110 (13). ISSN: 2169-897X. Hanna, E. and Huybrechts, P. and Cappelen, J. and Steffen, K. and Bales, R. C. and Burgess, E. and McConnell, J. R. and Steffensen, J. P. and Van Den Broeke, M. and Wake, L. and Bigg, G. and Griffiths, M. and Savas, D. (2011) Greenland Ice Sheet surface mass balance 1870 to 2010 based on Twentieth Century Reanalysis, and links with global climate forcing. Journal of Geophysical Research: Atmospheres, 116 (24). ISSN: 2169-897x. Wilton, D. J. and Jowett, A. and Hanna, E. and Bigg, G. R. and Van Den Broeke, M. R. and Fettweis, X. and Huybrechts, P. (2017) High resolution (1 km) positive degree-day modelling of Greenland ice sheet surface mass balance, 1870-2012 using reanalysis data. Journal of Glaciology, 63 (237). pp. 176-193. ISSN: 0022-1430.

p.3, ll.83-85: Consider emphasising more that a key advantage of using a non-hydostatic model is its ability to be run at much higher spatial resolutions («5 km) than hydrostatic models.

Bearing the above in mind, was it considered to run the JMA-NHM at higher spatial resolutions than 5km (p.6, l.204)?

p.6, l.218 "increased with altitude from 40 m NEAR the surface to…"

p.7, l.234: "for PRODUCING daily weather forecasts…"

p.9, l.307: add that PROMICE data were also used for validating 1x1-km statistically downscaled SMB based on ERA-I reanalysis data (Wilton et al. 2017, reference as above).

p.9, l.322 "were superior on average" – quantify by how much and say whether statistically significant.

p.9, l.324: "ME was WITHIN 2.3ˆoC at all sites".

p.10, l.338: change comma to colon.

p.10, l.354: "except for Summit" – why the difference there?

p.10, l.359 add the relevant reference Orr et al. (2005): Orr, Andrew and Hanna, Edward and Hunt, Julian C. R. and Cappelen, John and Steffen, Konrad and Stephens, Ag (2005) Characteristics of stable flows over Southern Greenland. Pure and Applied Geophysics, 162 (10). pp. 1747-1778. ISSN: 0033-4553

p.14, l.11 at end of sentence suggest to add "Moreover, Wilton et al. (2017) show generally favourable results from a 1x1-km statistical downscaling of reanalysis data, with results generally comparing well with MAR and RACMO RCM output.".

p.16, l.605 after "statistical downscaling or further dynamical downscaling", add "to a higher spatial resolution than used here, e.g. 1 km (Noel et al. 2016, Wilton et al.

2017)...".

p.27, Table 3: Suggest giving mean values in new row at bottom of table.

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