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Interactive comment on "Extreme temperature events on Greenland in observations and the MAR regional climate model" *by* Amber A. Leeson et al.

Anonymous Referee #1

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General synopsis

This is a generally useful and original analysis of extreme Greenland temperature events that has application to improving current and future Greenland Ice Sheet melt and surface mass balance model estimates (e.g. MAR but also other SMB models). The paper is a bit focused on MAR but there are good reasons for this. The paper is overall reasonably well presented but needs a better attribution of relevant background material in places. It should be of broad interest to Greenland modellers and the Arctic climate community, and should be publishable in THE CRYOSPHERE subject to some relatively minor revisions.

Specific comments

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Discussion paper

page 1, line 12 (Abstract) "short period variability in time" - please quantify what time range you mean here.

p.1, l.24 Re. GrIS recent significant mass loss, please add the following two highly relevant, more recent references to Shepherd et al. 2012: 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. 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, https://doi.org/10.5194/tc-10-1933-2016, 2016.

p.1, l.27 Re. recent episodes of rare and extreme surface melt (2012), please add the following two highly relevant references to Ngheim et al. (2012): Tedesco, M., Fettweis, X., Mote, T., Wahr, J., Alexander, P., Box, J. E., and Wouters, B.: Evidence and analysis of 2012 Greenland records from spaceborne observations, a regional climate model and reanalysis data, The Cryosphere, 7, 615-630, https://doi.org/10.5194/tc-7-615-2013, 2013. Hanna, Edward and Fettweis, X. and Mernild, S. H. and Cappelen, J. and Ribergaard, M. H. and Shuman, C. A. and Steffen, K. and Wood, L. and Mote, T. L. (2014) Atmospheric and oceanic climate forcing of the exceptional Greenland ice sheet surface melt in summer 2012. International Journal of Climatology, 34 (4). pp. 1022-1037.

page 2, line 39: after Noel et al., 2016 reference, suggest inert new sentence: "Alternative statistical downscaling techniques fulfill a similar purpose and give broadly comparable results (Wilton et al. 2017, Vernon et al. 2013), and add the following two relevant references. However, RCMs can also make...": 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 Green-

land ice sheet surface mass balance, 1870-2012 using reanalysis data. Journal of Glaciology, 63 (237). pp. 176-193. Vernon, C. L., Bamber, J. L., Box, J. E., van den Broeke, M. R., Fettweis, X., Hanna, E., and Huybrechts, P.: Surface mass balance model intercomparison for the Greenland ice sheet, The Cryosphere, 7, 599-614, https://doi.org/10.5194/tc-7-599-2013, 2013.

p.2, l.45 change to "fidelity at the regional OR SEASONAL scales does not...". p.2, l.53: GC-Net also needs Steffen et al. reference here. p.3, l.69 change "max" to "maximum". p.3, ll.74/75 slightly reword to "The MAR version 3.5 used here has been EXTENSIVELY evaluated in...". p.3, l.87 "MAR-Era data ARE available...". p.4, ll.97 & 99: "data set" -> "dataset". p.4, l.101 "below the threshold for three consecutive days" - based on daily mean temperature (and, if so, how is the latter calculated?) or what exactly? Needs a bit more detail/explanation since how this is defined can affect the results. p.5, l.127: Why is event frequency *positively* correlated with elevaton in North Greenland/the dry snow zone? p.5, l.154: change "∼decadal scale" to "decadal scale". p.6, l.158: change ">1.5ˆoC" ro ">=1.5ˆoC" since MAR_Era = 1.50ˆoC.

p.7, ll.216-218: "extreme melt years on Greenland have been attributed to an incfrease in the frequency and duration of high pressure conditions...Greenland Blocking Index" - please add the two highly relevant citations and add them in the reference list: Hanna, Edward and Cropper, Thomas E. and Hall, Richard J. and Cappelen, John (2016) Greenland Blocking Index 1851-2015: a regional climate change signal. International Journal of Climatology, 36 (15). pp. 4847-4861. Hanna, E. and Jones, J. M. and Cappelen, J. and Mernild, S. H. and Wood, L. and Steffen, K. and Huybrechts, P. (2013) The influence of North Atlantic atmospheric and oceanic forcing effects on 1900-2010 Greenland summer climate and ice melt/runoff. International Journal of Climatology, 33 (4). pp. 862-880.

p.8, l.247 needs punctuation correction to "...given its assimilation of observations; however, we note that...". p.9, l.259: "strongly controlled by geography" sounds a bit vague. Can you be more specific, e.g. say topography, elevation and ice/snow

facies etc.? p.18/Table 3: add units (e.g. ˆoC/yr?) for "rate of change of mean daily trremperature".

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