

Interactive comment on “Reconstructions of the 1900–2015 Greenland ice sheet surface mass balance using the regional climate MAR model” by Xavier Fettweis et al.

Anonymous Referee #2

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This is an original and thorough analysis of changes in Greenland Ice Sheet surface mass balance from 1900-2015 based on the regional climate model (RCM) MAR that was run with different climatic forcings from most currently-available reanalysis products (ECMWF ERA-Interim and ERA-40, 20CR, ERA-20C, NCEP/NCAR, JRA-55 etc.), with validation provided mainly based on PROMICE automatic weather station observations, and comparison of modelled melt with microwave satellite-derived melt extent.

Unsurprisingly there are significant differences in surface climate from the different RCM forcings but this kind of comparison is valuable as a current summary of the use and likely reliability of the various reanalysis products, as well as a useful guide for future work. The paper is therefore of significant interest to the GrlS community,

C1

especially given the recent widespread adoption of MAR.

However, there are quite a number of (mainly minor) problems with the writing style that need to be corrected before publication, and in general the paper needs a thorough copy-edit. I list some corrections below. I do not see a need to move some of the scientific results (which are all interesting and best presented together) into "Supplementary Information".

page 1, lines 1/2: "decrease RELATIVE to last century" p.1, l.10 (& elsewhere): "data set" -> "dataset". p.1, l.11 : insert comma after "some biases remain in MAR". p.1, l.14 "SMB was anomalously positive (~10%)" - I'm not sure it makes sense to have a percentage of SMB (which has no absolute zero reference point) - please clarify. p.1, l.17: "the result of an artefact in reanalysis THAT IS not WELL enough constrained". p.1, l.20: "Finally, ONLY the ERA-20C forced simulation suggests..."? p.2, l.6: should be "enhanced by Arctic amplification". p.2, l.11: insert comma after "since the end of the 1990's". p.2, l.14: "However, the NUMBER of in situ observations IS too sparse". p.2, l.28 "All PREVIOUS RCM-based SMB estimations". p.3, l.13 "ice sheet mask in MARv3.x allows THE COMPUTATION OF SMB outside the original MAR ice sheet mask (WITH the aim...". p.3, l.16 "weighted by the permanent cover of each grid cell (FOR CELLS covered by AT LEAST 50% of permanent ice)." - is this is what is meant? p.3, l.20: "with a minimum albedo SET to 0.7". p.3, l.24: "by slightly increasing the snowfall velocity, WHICH ENABLED more precipitation". p.4 list of reanalysis: was it also considered to use MERRA2 (state-of-the-art NASA reanalysis) in the comparisons for the 1979- period? p.5, l.10: "covered by all DATASETS used here and DURING WHICH SMB has been RELATIVELY stable". Add reference? NB: SMB was already starting to decline markedly during the late 1990s. p.5, l.17: I think that fig. 1c and fig. 1f references are the wrong way round here - please check. p.5, l.28: do you mean "enable a better comparison of MAR with in situ temperature measurements THAN WITH using unmodified 20CRv2 and ERA-20C..."? p.5, l.34: add comma after "which underestimates wind speed at 500 hPa". p.6, l.6: "However, when looking AT spa-

C2

tial differences". p.6, l.8: "MAR_ERA-40 SLIGHTLY OVERESTIMATES precipitation". p.6, l.9 "ERA-40 humidity scheme, WHICH WERE LATER corrected in ERA-Interim". p.6, l.24: "NCEPv2 relative humidity and IS then affected". p.6, l.32: "overestimates" -> "overestimate". p.7, l.8: "12 AWS's listed in Table 2 THAT HAVE an elevation difference WITHIN 100m OF the interpolated MAR". p.7, l.10 "ON average FOR the 12 AWS's". p.7, l.14: "MAR SLIGHTLY OVERESTIMATES". p.7, l.18: "(A bias of -18W/m², COMPARED WITH A daily variability OF 43 W/m²)". p.7, l.24 "Using other reanalyses (APART FROM ERA-INTERIM) as MAR forcing". p.7, l.26: "compare the best" -> "show the best agreement with PROMICE". p.7, l.27 "compares the worst" -> "shows the worst". p.8, l.5: "corrected AS A function of the elevation difference". p.8, l.9: "The data are not converted TO m W.E./yr". p.8, l.10: "with an elevation difference with the MAR topography OF LESS than 500m". p.8, l.16: "IN CONTRAST to the MAR-based reconstructions". p.8, l.29: "instead 0.4-0.55 INDICATE LATER CORRECTION of this overestimation". p.9, l.12: "recent decades, although the AMOUNT of assimilated data is larger. The LOWEST correlations...". p.9, l.18: "but overestimates versus BOX13 because THE LATTER dataset". p.9, l.25: "underestimates accumulation RELATIVE to BOX13 (WHERE THE LATTER IS based on RACMO2)." p.9, l.29: "suggesting that FURTHER accumulation measurement campaigns". p.10, l.18: delete "rather". p.10, l.19: "assimilated into BOX13, THE LATTER reconstruction perfectly matches". p.10, l.23: two cases of "MAR_20CRv2c" are mentioned but should these both be the same (is one of them possibly a typo)? p.10, l.26: "at end of the 1970's, WHICH ARE overestimated by...". p.11, l.20: "but IS LESS PRONOUNCED than in the MAR simulations". p.11, l.22: "suggesting that THE lower the amount of assimilated data, THE higher the spread". p.11, l.30: "part of this increase could just be due to AN artefact in THE 20CRv2(c)." p.12, l.15 "while NCEP-NCARv1 outperforms ERA-40/ERA-Interim since the 1950s" - do you mean more specifically from 1950 to 1980? p.12, l.19: "the highest SMB rates are reached over the 1970s-EARLY 1990s". p.12, l.25: "SIMILAR discrepancies can be seen in the MAR simulated". p.12, ll.27/28: "but TO a lessER extent than MAR, while Hanna et al. (2011)...". p.13, l.6: "the amount of DATA as-

C3

simulated into ERA-20C". p.13, l.7 "without enough gauge observations" - how many is "enough"? p.13, l.15: "suggesting that mass gain MAY WELL HAVE OCCURRED during this period, in agreement with...". p.13, l.18: "IS unprecedented". Figure 1 caption, change last sentence to: "DUE TO the aim of ONLY showing comparisons in the free atmosphere (700 hPa), and the datasets...". Table 1 caption, last two sentences correct to "The RUNOFF is the FRACTION of water from both surface melt and rainfall THAT IS NOT REFROZEN BEFORE reaching the ocean...asterisk WAS corrected..."

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C4