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Earth System Science Data Discussions

Interactive comment on "High-resolution (1 km) Polar WRF output for 79° N Glacier and the Northeast of Greenland from 2014–2018" *by* Jenny V. Turton et al.

Anonymous Referee #2

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General comments:

This paper presents new high-resolution atmospheric modelling output for Northeast Greenland, in particular in the region of the 79°N Glacier, from 2014 to 2018. The authors are using the Polar Weather Research and Forecasting (Polar WRF) model and optimize it for their area of interest. This is an important contribution which most certainly will be useful for a broad range of scientists from different disciplines working, e.g., on the drivers of the observed thinning of the 80-km long floating glacier tongue during the past two decades. They are in need of high-resolution atmospheric data to study, e.g., surface melt at the outlet glaciers of the Northeast Greenland Ice Stream

(i.e., mainly the 79°N Glacier and Zachariæ Isstrøm), changes in the fast-ice cover (that opens up more regularly since 2000 (Sneed and Hamilton, 2016) potentially triggering increased calving), and/or ocean variability for a better understanding of melting along the bottom of the glacier tongue (e.g., wind stress driving warm Atlantic waters onto the continental shelf toward the glaciers (Münchow et al. 2019, accepted at Journal of Physical Oceanography)).

Data is accessible via the given identifier, of high-quality, and usable in its current format and size. The article is appropriate to support the publication of the data set. By reading the article and downloading the data set I would be able to understand and re-use the data set in the future.

Methods and materials are described in detail. Still, I am missing one example plot (e.g. temperature map with wind arrows on top) of a comparison between the 1-km resolution WRF output for the 79 North Glacier region and existing atmospheric models (e.g., RACMO2 at 11 km). This would be much more intuitive for the reader to assess the advantage of the new data set compared to existing ones as well as provide information on how good the coverage of the 80 km long and 20 km wide glacier tongue as well as the complex topography (e.g., Dijmphna Sound) is. Furthermore, I would appreciate a discussion on the given error estimates (see below for more details).

With respect to the high-potential of the data set being useful for a broad community of meteorologists, oceanographers, and glaciologists, the uniqueness of the data set providing 1-km high-resolution atmospheric data at the Northeast coast of Greenland (which certainly must have been cost-intensive to produce), and the completeness of the data set, I believe the paper should be published after some minor revisions outlined below.

Specific comments:

1. Structure of the manuscript: - The subsection 2.3 seems rather short and redundant. The model evaluation is what is shown and described in detail in the following result

sections. I would suggest to merge 2.2 and 2.3, i.e., describing briefly what you will use the observational data for, leading over to the result section. - You are lacking section 4. (Section 3 are the results and section 5 is the conclusion.) - To be more precise, I would suggest to change the subtitles of the result sections to sth like 3.1 Model evaluation: Daily-means 3.2 Model evaluation: Sub-daily data

2. References/citations: Some references were not appropriate/missing.

Line 22: Schaffer et al 2017 cited similar content in their introduction but this is not the content of their paper. Furthermore, mass loss of the Greenland ice sheet increased not only due increased ice discharge along the margin of the ice sheet (linked to the retreat of marine terminating glaciers) but also due to increased surface melt. Please elaborate this a bit more and refer to recent publications (e.g., Shepherd, A., Ivins, E., Rignot, E. et al. Mass balance of the Greenland Ice Sheet from 1992 to 2018. Nature (2019) doi:10.1038/s41586-019-1855-2).

Line 34: Is 1 m/yr given as an average melting over the entire glacier tongue? Thinning of the glacier tongue and it's variability in time has been also discussed in Mayer et al 2018. Furthermore, Wilson et al 2017 (The Cryosphere) and Mayer et al 2018 point out that thinning is mainly due to enhanced melt along the glacier base. Thus, surface melt (triggered by atmospheric changes) seems to be of minor relevance. However, the atmosphere may be relevant e.g. for driving oceanic heat toward the glacier (Münchow et al 2018, accepted at Journal of Physical Oceanography) and below the glacier tongue. If there is space, you could include these information to point out the relevance of a better understanding of atmospheric conditions to study the observed changes at the 79°N Glacier.

Lines 36-39: I would suggest to compare/list atmospheric modelling studies only or make more clear what kind of models were used in the listed publications. Schaffer et al 2017 do not use model data.

Line 89: "Analysis nudging" – I am not a modeler, so I am not fully sure how common it

is to use analysis nudging. I suggest to give a reference or add a very brief explanation on how this works.

3. Scientific questions/add-ons

Line 43-45: I suggest to point out why a 1-km resolution makes a difference in the coastal area of Greenland. One reason that you did not mention (or I missed it) is, that the topography along the coast is very steep and complex with a number of narrow fjords and small islands most likely channeling/blocking/steering the wind in your area of interest.

Line 88: Did one of the studies show that SST and sea ice concentration from the AVHRR compare well to other observations/satellite data?

Lines 93-97: A map showing Spalte Glacier and marking the open-water grid points would certainly help to better understand what you are describing. Are you also referring to the fast-ice cover named Norske Øer Ice Barrier (Sneed and Hamilton, 2016, Annals of Glaciology) here? Furthermore, I would split this long sentence into two.

Lines 97-98: "given the small area of calving at 79°N during this period." – I understand what you like to say but I think you should be more precise. You are talking about a (negligible) area change caused from calving at/advancing of the glacier front. Furthermore, it is not clear to me which time period you are referring to. Please specify.

Figure 2: Please add the shape (in white?) of the 79 North Glacier and point out its location. If possible, also add the location of Spalte Glacier and the approximate extent of the fast-ice cover. I believe that the dark blue color is missing in the Figure. At least I cannot distinguish areas deeper sea level from areas between 0 – 200 m height. Just from the color code, it looks like the islands along the coast are half under water.

Section 2.3: As stated above you may want to merge/skip this section. In case you keep it, I like to make you aware that it reads as if you compare air temperatures for model evaluation only, which is not the case.

Table 2, Line 163: I am not fully sure what the correlation coefficient refers to. Do you correlate the time series from WRF and AWS data over the entire measurement period? What do you mean by “annual correlation”? Do you correlate the annual means, i.e., 5 time steps only?

Line 174: “is more variable” – better use sth like “deviates more from the ASW data”. Is that maybe due to the very steep topography presumably not covered by your 1-km resolution? Please discuss throughout the whole manuscript what may cause the described errors. How big are errors in the wind direction measured at the automatic weather stations?

Line 178: “is simulated better” – better use “more accurate” or “the model performs better in simulating. . .” or give specific numbers

Line 197: “WRF can simulate much higher wind speeds than observed“ – Are these higher wind speeds (more) realistic? I am missing an interpretation/assessment/discussion of this result.

Line 199: “WRF struggles to as accurately represent the wind direction“ – Please see my answer above to Line 174. I could imagine that this is a common problem at places with very steep and rugged topography along the Greenland coast, is it? How accurate is wind data measured at weather stations?

Line 224: Any idea why WRF underestimates summer air temperatures?

Line 236-239: On which time scales (how many days) do warm-air events occur? Can they really explain larger diurnal variability?

Technical corrections:

Lines 56: Repetition of the word “fields” in one line. Please rephrase. Furthermore, I would rephrase the sentence to “Here we present an evaluation . . . to demonstrate the applicability . . .”

Line 93: “floating tongue” – do you refer to the 79 North Glacier only? Otherwise it should be plural.

Line 103: spacing between both sentences is missing

Lines 102 – 112. This sentence is very long. I suggest to use bullet points for listing the different parameterizations.

Lines 155-: I suggest to shift the Table 2 to a new page, i.e., there should be some text directly after the heading of section 3.1.

Table 1: Please add °N/°W for units of the Location.

Figure 3: I suggest to use the same limits for the y-axis in a and b for easier comparison. (It would be easier to see that it gets colder at KPCU in winter.)

Figure 4: Please give more details in the Figure captions. What do the percentages tell us? Why are maximum ranges of percentages different?

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