

Weather Clim. Dynam. Discuss., referee comment RC1
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Comment on wcd-2021-26

Anonymous Referee #1

Referee comment on "Dynamical drivers of Greenland blocking in climate models" by Clio Michel et al., Weather Clim. Dynam. Discuss., <https://doi.org/10.5194/wcd-2021-26-RC1>, 2021

Review of "Dynamical drivers of Greenland blocking in climate models" by Clio Michel et al.

This manuscript investigates the drivers of atmospheric blocking in the Greenland region using several large ensembles of climate models. The representation of blocking and other dynamical features in each of the models is compared to ERA-Interim. Based on this analysis two models (ECHAM6.3-LR and MIROC5) are selected based on their performance in simulating historical blocking in the region of interest. The study continues to investigate several atmospheric features such as Rossby wave breaking and wind speed in present and future in order to identify the drivers behind the expected changes in winter blocking in the Greenland region. Interestingly, the authors find that different dynamical features seem to be driving blocking in the two models considered.

This is relevant and timely work on the underlying dynamics driving atmospheric blocking for one of the main blocking regions in the northern hemisphere. I think the study fits well into the scope of Weather and Climate Dynamics and generally I think it should be published and I have no major comments. However, I found the manuscript to contain a large number of smaller issues, inconsistencies, and ambiguities that made it very hard to follow the authors points and sometimes even impossible to be sure what the authors were referring to. I would urge the authors to carefully address these and particularly focus on a consistent description of their methodology as well as their figures.

Comments

35: CMIP actually stands for Coupled Model Intercomparison Project as far as I know

84: As additional information the author could state how much warming that is approximately compared to the present decade used in the paper.

Figure S1: I have to admit I've trouble interpreting that figure for several reasons:
- The caption is unclear to me: "Difference of blocking frequency where blocking is detected". Do both panels show blocking frequency or some kind of difference?
- I assume that the figure actually shows absolute blocking frequencies and not any kind of difference. So to show if there are "substantial changes in the results" (line 114 of the

main manuscript) the author should plot differences (or even relative difference even though I realize that this might be problematic as well).

- It is unclear to me what the data-basis for this plot is. 'All-Hist' in the title lets me assume that it refers to all 125 members of NorESM1 in the historical period but this does not seem to be the case as the blocking frequency looks too patchy for that – so is it possible that it is only one member?

- The high 'blocking' frequency in the Atlantic below 40 degree north is not normally defined as blocking (at least not in the classical sense), right? The authors focus on blocking over Greenland so I would suggest optimizing the colorbar to the blocking frequency there.

Section 2.3: Did the authors calculate the annual blocking frequency and then select Greenland blocking days in DJF from that or was the blocking frequency already calculated only for DJF? In the second case the first and last 4 days of each season will have a lower probability of blocking due to the 5 day persistence criterion I assume?. This should be made clear.

133: I assume GB stands for Greenland blocking?

134: Why is there a difference between the blocking and the anticyclone definition? Should blocking not just be a stationary anticyclone?

150: Figure S2 does not show that "none of the 30 climatologies of 9 consecutive winters [...] is significantly different from the total 40-year [...] climatology". as the authors seem to indicate here it just shows the blocking climatologies.

How was this established? Was that done on a grid-point level or somehow averaged? Would we not even expect about 10% of cases to be outside of the 90% range?

figure 1:

- I personally think that there should be an indication of what is shown as well as the units directly in the figure and not just in the caption.

- "Black lines show the 2, 4 and 6% contours for ERA-Interim (2006-2015)." For me these lines appear grey but that might just be my viewer.

- In panel f the black/grey contours do not seem to match the respective shading. This might just be due to different interpolation but it maybe should be clarified.

- I assume that the white areas without dots just have zero blocking frequency (rather than significant biases)?

165: Could the authors rephrase this? I did not count but it looks to me as if for all models there are more dotted than un-dotted grid cells even when only focusing on 'blue' areas so I don't think the concluding that "Most of the negative biases are significant" (except for MIROC6) is supported as it is.

168: This seems to partly contradict the earlier statement that 9 years are enough to establish a robust blocking climatology, right? (even though the argument there was only made for observations). I would argue that for a sufficiently long climatological period the blocking frequency should be a model property and not depend on the realization, right?

Figure 2: I am again not sure what is shown in this figure. The caption suggest to me that it shows the area average of blocking frequency over the GB region: "mean Greenland blocking frequency" but this is not correct, right? Frequencies are too high for that, so I assume it actually shows Greenland blocking days as defined in line 116? Please clarify.

Figure S3: The the unit of the shading should be somewhere in this figure.

Figure 3: I assume that for ERA-Interim not the ensemble mean but the mean over the

different periods is shown?

211: "MIROC5 and ECHAM6.3-LR are the models with the largest variability on the equatorward side of the mean jet and the smallest mean-state biases with respect to wind variability." Can the authors go into a bit more detail here? Looking at figure 3 I am not sure if I can see what the authors mean with this statement. In particular the standard deviation from MIROC5 does not seem to be higher southwards of its climatological jet than any other models'.

216: "Climatologies show that AWB is more frequent and located on the equatorward side of the jet

at both low and upper levels (solid contours in Fig. 4 left)"

What is meant by "low and upper levels" and where is this shown in figure 4?

This sentence somehow seems to suggest that the solid contours in figure 4 are an indication of the jet but to know the position relative to the jet the reader actually needs to compare figure 4 to figure 3f, right?

Section 3.3: It would be interesting to discuss these results in the light of this recent study as well: <https://onlinelibrary.wiley.com/doi/10.1029/2020JD034082>

l251: "ECHAM6.3-LR [...] slightly underestimates the Greenland blocking frequency" I'm not sure if I would call a mean underestimation of about 50% (if I read figure 2c correctly) 'slightly'.

Figure S8a: Again it would be interesting to see if the results are consistent with Drouard et al. (2021) when split by AWB and CWB.

291: CMIP5 was published around 2013 if I'm not mistaken. Can the authors check if the cited studies really all look at CMIP5 data?

292: "we note a decrease in the ensemble mean blocking frequency over Greenland, in particular for ECHAM6.3-LR (up to -0.6% of the time)..." It is this referring to Greenland blocking days as defined in line 116 or to blocking frequency directly as I would assume from this statement?

295: It seems to me that not the change relative to pre-industrial is important but the change relative to the historical period?

302: "The composites over the blocked days are very similar between the present and future experiments (Fig. 7)" Figure 7 does not show the present?

Figure S11: I assume this figure shows change between historical and future?

311: "Over the North Atlantic, CWB do not seem to change much (very weak values and noisy field; not shown)" What does 'not shown' mean in this context? CWB is shown in figure 8 and S11, right? There just happen to be not contours in the frame for the case of figure 8b? Or do I misunderstand something?

What does 'seem to change' mean? In a given model it either changes or not, right?

336: Except for AWB in MIROC5, right?

Technical comments:

42: 'have showed'

Figure 6: "(g,h,i) Same as (c,d) but for anticyclonic wave breaking frequency"

288: "CWB are"