

Weather Clim. Dynam. Discuss., referee comment RC3  
<https://doi.org/10.5194/wcd-2021-26-RC3>, 2021  
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## Comment on wcd-2021-26

Anonymous Referee #3

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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-RC3>, 2021

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Review of manuscript wcd-2021-26:

Dynamical drivers of Greenland blocking in climate models

by

Clio Michel et al.

In this study, the HAPPI large ensemble simulations are used to investigate the representation of Greenland blocking (GB) in the HAPPI models and the extent to which GB occurrence is associated with the occurrence of Rossby wave breaking, specifically cyclonic Rossby wave breaking (CWB) over the Labrador Sea / the south of Greenland (70-30W, 50-70N). It is found that most of the 5 HAPPI models considerably underestimate GB frequency; the best agreement with ERA-Interim GB frequency is seen in ECHAM6 and especially the MIROC5 models. Models also tend to underestimate CWB frequency, especially so MIROC5. An analysis of the relationship between CWB and GB occurrence shows that these two phenomena are closely associated in ERA-Interim and ECHAM6, but much less so in MIROC5, leading the authors to conclude that a different dynamical driver of GB must be acting in MIROC5.

Global climate models (GCMs) have long-standing biases in the representation of atmospheric blocking, which are still seen in the latest generation of GCMs. Studies into the nature of blocking (biases) in GCMs therefore remain important, and the present study illustrates an intriguing difference between two GCMs in how they represent GB and CWB. I therefore recommend the study for publication in WCD. I would like to make one suggestion for further analysis, other than that my comments are minor/presentational.

1)

The authors conclude that the dynamical link between CWB and GB is present but not the main ingredient triggering GB in MIROC5. This is, of course, very interesting and nicely illustrated in the paper but the question about the character of GB in MIROC5 is left open. Given the large negative CWB bias in MIROC, many blocking events will occur without CWC in that model.

I would like to suggest the following additional analysis: The authors have derived a set of days (or events) when CWC and GB occurs, respectively. This could be used to derive 2x2 contingency tables of co-occurrence of CWC and GB with frequency counts (No-No, No-Yes, Yes-No, Yes-Yes) for each of ECHAM, MIROC, and ERA-Interim. Furthermore, composites could then be shown with respect to three sets of these events (No-Yes, Yes-No, Yes-Yes), and potentially these could be more illustrative than the current Figures 5 and 6 – it is difficult to be sure, but I would like to encourage the authors to try if they have not already done so.

2) abstract

Make clear early on that this study is about the winter season.

3) page 1, line 23

Surely there are also more wide-ranging impacts of GB due to its association with the NAO and temperature anomalies across much of the Northern Hemisphere? Please add a brief discussion and some references; Chen et al. 2017 looks like a good start.

4) page 3, line 63

What does "enhanced" mean here? With respect to which reference? Maybe it can simply be omitted.

5) page 4, line 121

Typo: occur\*s\*

6) page 5, line 152

If I understand correctly, these 30 estimates are from overlapping time periods and therefore strongly dependent. Is this considered in the significance testing?

7) Section 3

It is nice to see from this section and the Supplement that the authors have conducted thorough model evaluation. A question that keeps coming up is what constitutes a "good enough" evaluation result to justify pursuing the main aim of the study. Where the authors clear about this before conducting the evaluation? I understand this question is hard and slightly philosophical, but, if possible, a short discussion of this point with respect to this study would be greatly appreciated!

8) page 7, line 208

"Similar standard deviation ..." – similar to ERA or to each other?

9) page 7, line 215

"More frequent ..." than what? Rephrase this sentence to make clearer that you are talking about a model bias.

10) Table 1

Given the central role of CWB, I suggest adding columns for CWB frequency to this table.

11) page 9, line 237

"zonal wind" – I would add the direction ("westerly").

12) Section 4.2

Please consider if some of the supplemental material referred to could be promoted to the main manuscript.

13) page 10, line 291

Please add the CMIP6 results, which are now also available (Davini & D'Andrea, 2020).

14) page 11, line 305

Please add appropriate figure cross-reference(s) here (Figures 5 & 7, I think).

15) page 11, line 330

"for the reasons cited above" ... please refer to the (sub)section here and/or add a brief reminder of what these reasons are.

16) Section 6

Please add a brief summary/conclusions from Section 5.

## References

Chen, X., & Luo, D. (2017). Arctic sea ice decline and continental cold anomalies: Upstream and downstream effects of Greenland blocking. *Geophysical Research Letters*, 44(7), 3411–3419. <https://doi.org/10.1002/2016GL072387>

Davini, P., & D'Andrea, F. (2020). From CMIP3 to CMIP6: Northern Hemisphere Atmospheric Blocking Simulation in Present and Future Climate. *Journal of Climate*,

33(23), 10021–10038. <https://doi.org/10.1175/JCLI-D-19-0862.1>