Weather Clim. Dynam. Discuss., referee comment RC1
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Comment on wcd-2021-47

Anonymous Referee #1

Referee comment on "Impact of climate change on wintertime European atmospheric blocking" by Sara Bacer et al., Weather Clim. Dynam. Discuss., https://doi.org/10.5194/wcd-2021-47-RC1, 2021

Summary

This study aims to investigate frequency, duration, and size of blocking under climate-change scenarios. This is an important topic. Weather type decomposition (WTD) is used in this study, which makes it original.

However, I have more than major reservations as outlined below.

Major comments

1. WTD

1a. Discussion on advantages and limitations of WTD

I find no discussion in the paper about advantages and limitations of WTD. (except description of how it is done and that it agrees with blocking indices). One of the limitations of WTD is that WTD is less flexible and it does not come with a native measure of blocking center and size.

1b. Fitness of WTD

I wonder how well WTD can summarize the Z500 variability. In the process of k-mean, is variance between cluster much larger than variance within the same cluster? Or do the 4 clusters explain a very high percentage of variance? Or is the clustering very clear cut?

1c. Interpretation of WTD

If the WTD clustering is not that clear cut, it is hard for me to interpret the results. When "cluster centroid" is found different in some models, what does it mean? Is it because reanalysis-blocking-like pattern occurs less frequent? Or is it because some boundary cases (under reanalysis clustering) occur more frequent and that the cluster boundary needs to be put elsewhere?

Also the "blocking frequency". Do changes come from the 5-day requirement, or the overall frequency of weather type? If it has to do with the overall frequency of weather type, the question again is whether it comes from changes in frequency of centroid-like patterns or boundary-case-like patterns?

Same question for the "blocking center". Does it come from the weather type shifting in location? If so, is it because of centroid-like patterns or boundary-case-like patterns?

1d. Insignificant results

If the WTD clustering is not that clear cut, I wonder if this will cause extra variability that stops you from drawing significant results. Most results using DeltaZ500_SSP are not statistically significant.

2. DeltaZ500_HIST may be irrelevant

Many results are based on DeltaZ500_HIST, in which the overall higher geopotential height in warmer climate is not removed. I cannot see how this overall higher geopotential height would link to weather impact or air pollution, which is likely why authors are interested in blocking. Measures of blocking based on DeltaZ500_HIST go too far, and become irrelevant to weather impacts.

Minor comments

3. Line 103: How do authors determine which (out of 4) weather regime is the European blocking weather regime?

4. I prefer to say “size” or “area” of blocking, in place of “extension”. The latter is not clear to me and let me think of temporal extension (duration), or some kind of extension of concept.

5a. Line 131: I suggest change “center method” to “composite method”. Because “composite” is really the step that differs from the “DG method”.

5b. But actually, the authors made a few modifications to the DG method that makes it very similar to the center method. For example, authors require DG blocking day to be a subset of WTD blocking day. Perhaps authors need to say what are the major remaining differences (if any) in the two method.

6. Line 7: I think your methodology to quantify size of blocking does not “rely on the WTD”. I don’t think it is WTD-native or WTD-specific. I don’t think this is sufficiently different from other studies (like Nabizadeh et al. 2019) that I would claim “new”.

7. Line 9: “Geopotential height increase” might be more accurate than “pressure increase”.

8. Explanations of methods are disordered. For example, the 3 paragraphs in section 3.1 go by talking first about WTD, then an overview of all steps, and lastly the calculation of Z500 anomaly (which is done before WTD).

9. Line 105: I would suggest to add a bracket “(including the mean)” after “annual cycle”. Because “annual cycle” can sometimes only refer to the seasonal variation from the mean.

10. Line 119: I am not sure the description on treatment of “hole” is complete that others can reproduce. Let 0 be non-blocking and 1 be blocking. What would the code say about 001010100, and 001110101011100?

11. Line 125: Is “hole” included in “blocking days”?

12. Line 136: I prefer a simpler phrase “non-zero” in place of “non vanishing”.

13. Line 136: I would suggest to mention the 75m/100m threshold here in main text, rather than having to find it in supplement.

14. Line 154: With Fig. 1, what is being evaluated is not ability to reproduce the "blocking weather regime" but "composites" (as defined in line 124-127).

15. Fig. 1: I assume this figure is based on DeltaZ500_HIST, so the overall higher geopotential height is included? From Fig. 3, I guess the overall Z500 increase is more than 25m in SSP2. Why don't I see an increase of RMSD because of this?

16. Table 1: The resolution of GFDL is said to be 1 degree on https://wcrp-cmip.github.io/CMIP6_CVs/docs/CMIP6_source_id.html. Could the authors please check? I assume the argument made in line 179 is based on the resolution when the model is run, not the resolution of the output.

17. Line 211/227: I am not sure the similarity between DeltaZ500_HIST and DeltaZ500_SSP is entirely interesting. The overall increase in geopotential height is a shift of all clusters in a hyper space. So by construction, it has no effect on the clustering result. The only difference is the seasonal variation around the mean. The similarity in results can only suggest the seasonal cycle does not alter enough from HIST to SSP to alter the clustering result.

18. Fig. 5: The peak of ERA5 at 27-28 days look suspicious.

19. Line 247: Perhaps you can clarify "variability". Do you mean inter-model variability, or inter-event variability?

20. Line 267: I don't think the 0.1% is a significant digit if the area only has two significant digits.

21. Line 270: I think Nabizadeh et al. 2019 is based on DeltaZ500_SSP. And the increase you are talking is drastically larger than 17% in Nabizadeh et al. 2019. I don't know if I would call this agreement.

22. Line 304-305: The sentence looks contradicting to me. ("may not match", "agrees well")

23. Supplement Step A: I assume this step applies both to the center method and the DG method. But the step uses “blocking center”. What is the “blocking center” for the DG method? Also, for the DG method, is there at most one such center/blob on each day, such that step 8 in the DG method only does temporal mean but not event mean?