Weather Clim. Dynam. Discuss., referee comment RC2
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Comment on wcd-2021-56

Anonymous Referee #2

Referee comment on "Atmospheric blocking and weather extremes over the Euro-Atlantic sector – a review" by Lisa-Ann Kautz et al., Weather Clim. Dynam. Discuss., https://doi.org/10.5194/wcd-2021-56-RC2, 2021

Review of "Atmospheric Blocking and Weather Extremes over the Euro-Atlantic Sector - A Review" from Lisa Kautz and coauthors.

The manuscript describes the relationship between atmospheric blocking over the Euro-Atlantic sector and a plethora of extreme events, starting from the more classical heat waves and cold spells up to droughts, extremes of precipitation and compound events.

The discussion is detailed, facing different aspects of both blocking and extreme dynamics, providing a comprehensive state-of-the-art of the scientific knowledge on the topic. Predictability and impacts of climate change are also analyzed.

My main concern is Figures 1 and 2 – the latter is not even referenced in the text! - as they appear as completely disconnected from the main body of the paper. Moreover, they provide much less information that what can be easily achievable with a short climatological/composite analysis.

However, the manuscript provides a useful reference for future studies on the topic, and highlights in which direction the scientific community is showing a lack of knowledge. Therefore, I believe that the manuscript can be easily published in Weather and Climate Dynamics after the suggested revisions are included in the new revision.

Major points

- As mentioned above, there is no discussion and refencing of Figure 2 in the text: furthermore, Figure 1 is barely described, and the different sectors highlighted in the panel are not analyzed in the text.
- In this direction I believe that Figure 1 will be much more informative if it shows a climatology of atmospheric blocking according to both one reversal and one anomaly index, in a similar fashion to what done by Woollings et al. 2018. This can go hand in hand with a defining, as currently done in Figure 1, a set of "blocking regions", which should be always used in the rest of the manuscript. There is no need of lon-lat definition, but at least something more detailed of "North Atlantic blocking" should be used. Indeed, several times in the text I spotted references to "Atlantic blocking": this is a rather vague entity since it depends on which index is used, and such blurry definition may confound the reader. This is particularly truev for this manuscript since we are discussing extremes, where the location of the blocking is fundamental.
- Similarly, Figure 2 would be much more informative if instead of the current simplified sketch – that is completely disconnected from the current discussion – the authors can provide a composite analysis – based on one or more regions of blocking defined in Figure 1 - bringing together all the dynamical fields they mention. It would be extremely useful if such figure can be divided in both summer and winter, and perhaps if it includes two blocking indices, so that the reader can assess by himself the different nuances of summer and winter blocking and the limitation induced by the blocking index definition (which has been mentioned by the authors in Section 8 has a key issue).
- Although the manuscript is in general well written, I found some imprecise discussion in the abstract and the introduction. I highlighted some of them in the minor points below, but I recommend the authors to double-check the text and the associated statements.

Minor points

- L1: “regarding associated impacts”. These last words seem not connected to the rest of the sentence, please rephrase.
- L9: I might have misunderstood, but why do you mention “longwave radiation warming” under clear sky condition? Perhaps you mean “shortwave” here?
- L11: I would say “meridional advection from higher latitudes” or “horizontal advection from continental landmasses”. Horizontal advection from high latitude is by definition meridional.
- L12: The connection between snowfall, blocking and storm track is a bit confusing, I am not sure the three things are robustly related, so that I wonder if it is fundamental to highlight this in the abstract. Extreme snowfall events over Europe are usually associated with easterly or northerly winds of Arctic origin, it is unclear to me what is the role of extratropical cyclones here. Please clarify.
- L28: The reference to derailed train, although fascinating, does not seem like a relevant information here (no reference is added).
- L30: please remove “layer up to 10-12 km”, the troposphere height is season and latitude dependent.
- L31: Why blocking is defined as a “self-sustaining tropospheric flow”? Blocking is not a flow – it blocks the flow - but rather an atmospheric pattern or structure.
- L37: The plural of blockings is not commonly used in English, while “blocks” is a generally used definition in this case.
- L88: I would say meridional gradients instead of horizontal gradients, since both the referenced indices uses a meridional gradient.
- L99: Northern Hemisphere
- L165: given that orography has been shown in the last years for being responsible of shaping the mid-latitude flow and having a relevant role in weather and climate model biases, I think this should be mentioned here (e.g., Jung et al 2012, Berckmans et al 2013, Pithan et al. 2016)
- L167: A recent work by Davini et al (2021) on seasonal blocking might be of interest here.
- L194: this sentence is a bit strange: a barotropic pressure positive anomaly will lead in the Northern Hemisphere to an anticyclonic circulation: colocation is not a requirement, is a definition. Please rephrase.
- L246: Why there should be adiabatic compression induced by horizontal advection? Please explain.
- L248: here – and in other instances, as far as I understand – the authors follow the perspective of an anomaly-based index. This a good choice, but it should be pointed out somewhere in the text that the authors follow this “view” (for this reason I suggest – see main points - showing a blocking climatology in Figure 1 and define a few clear geographical sectors). I would suggest the authors to pay attention to the geographical definition used in the different part of the manuscript, since for example reversal-based blocking indices will show the blocking discussed at these lines over Greenland. Indeed, when using a reversal index blocking in the “North Atlantic” might lead also to a poleward displacement of the jet.
- L249: Please remove “in the regions north of these cyclones”.
- L261-270: this section makes a bit of confusion among seasons. As an example, a warm extreme can be driven by blocking in winter due to advection of warm air from the ocean for a prolonged time. I would encourage the authors to reorganize this part taking the different seasons into consideration.
- L305: a brief discussion of marine heat waves and their relationship with blocking might have been interesting here.
- L324: Why Kautz reference has a *?
- L329: I guess that here we are talking about Greenland blocking (Hanna et al. 2016).
- L343: what drives the wet anomaly on the eastern flank of the blocking? I can see it coming on the western flank due to the moister low latitude air, but it is a bit unclear to me how this can occur on the downstream side. Is this depending on the geographical

placement, i.e., if a blocking is on land or on ocean?

- L480-492: this is another example where a clear geographical region or sector definition may help. It is unclear which kind of blocking episode leads to such dry spell. An "Atlantic blocking" as referred at L487 might have moved the storm track and leads to increase rainfall over Iberia.
- L545: again, it is not very clear here: a high latitude blocking event over the Euro-Atlantic sector might be over Scandinavia so that it can potentially have a limited effect on the storm track.
- L555: does orography – as the Alps - play a role in such configuration?
- L567: I wonder if this configuration reflects the double wave breaking structure discussed by Messori et al. (2019)
- L624: power plants?
- L703: a comprehensive analysis of blocking duration in future scenarios has been done also by Dunn Sigouin et al. (2013)
- L706: there are more recent references which analyze and discuss blocking trends, and I think some of the are also referenced in this manuscript (Masato et al 2013, Davini and D'Andrea 2020, etc…)
- L730: Screen (2014) might be referenced here.
- Figure3/Figure 4: is this geopotential or geopotential height? Those numbers seem a little too small to me for being m2/s2.

Some of the above references:

Berckmans, J., Woollings, T., Demory, M.-E., Vidale, P.-L. and Roberts, M. (2013), Atmospheric blocking in a high resolution climate model: influences of mean state, orography and eddy forcing. Atmos. Sci. Lett., 14: 34-40. https://doi.org/10.1002/asl2.412

Davini, P, Weisheimer, A, Balmaseda, M, et al. The representation of winter Northern Hemisphere atmospheric blocking in ECMWF seasonal prediction systems. *Q J R Meteorol Soc*. 2021; 147: 1344– 1363. https://doi.org/10.1002/qj.3974

Dunn-Sigouin, E., and Son, S.-W. (2013), Northern Hemisphere blocking frequency and duration in the CMIP5 models, *J. Geophys. Res. Atmos.*, 118, 1179– 1188, doi:10.1002/jgrd.50143.

Hanna, E., Cropper, T.E., Hall, R.J. and Cappelen, J. (2016), Greenland Blocking Index 1851–2015: a regional climate change signal. Int. J. Climatol., 36: 4847-4861. https://doi.org/10.1002/joc.4673

Messori, G., *et al.* On the low-frequency variability of wintertime Euro-Atlantic planetary wave-breaking. *Clim Dyn* **52,** 2431–2450 (2019). https://doi.org/10.1007/s00382-018-4373-2

Pithan, F., Shepherd, T. G., Zappa, G., and Sandu, I. (2016), Climate model biases in jet streams, blocking and storm tracks resulting from missing orographic drag, *Geophys. Res. Lett.*, 43, 7231– 7240, doi:10.1002/2016GL069551.

Screen, J. Arctic amplification decreases temperature variance in northern mid- to high-latitudes. *Nature Clim Change* **4,** 577–582 (2014). https://doi.org/10.1038/nclimate2268