

Report #1

This is my second review of this manuscript. Thank you to the authors for addressing my comments and for their work on the figures in particular. As mentioned in the first round I think that the study should be published in principle but there are still some open points I would ask the authors to consider as listed below.

Minor comments

line 90: I think this covers only part of the situation. There are different high level definitions of blocking (e.g. based on PV anomalies or GPH gradients), then there is different thresholds used in these definitions (see, e.g., Chan et al. 2019 where the parameters of blocking indices are tested against correlation with heat extremes), and finally there are different implementations of the definitions. The last point is quite technical but I can't help but notice that many blocking studies use their own implementation, rather than existing (available) implementation. It's (at least for me) hard to tell how large the differences due to different implementations of the same definitions are, but from experience I would assume that they exist.

Reply: We thank the reviewer for this comment. Following the reviewers' suggestion, we have added a sentence on this.

L97-98: "Please note that in some studies the indices mentioned are used in a modified form, which may lead to varying results (e.g., Schalge et al., 2011)."

Fig 1: I appreciate the revision the authors did for figure 1 and I think the new figure is more meaningful and better integrated in the text compared to the original one. However, I think it could still need some work to make the most out of it.

Beside the manifold definitions of blocking the lack of clear blocking regions is one of the problems that prohibits comparison of studies and can even lead to surprising or seemingly contradictory results (e.g. Masato et al. 2014 finding different trends than Anstey et al. 2013). The review this manuscript represents seems to be a good place to try and unify or clearly communicate the many blocking regions in existence.

As it is I think the regions in figure 1 are unclear mainly because it is unclear what they represent:

- Regions of blocking frequency maxima
- geographical regions in which blocking occurs
- regions with homogenous blocking behaviour/processes
- regions in which blocking leads to (homogenous) impacts
- regions used by blocking studies

It seems to me that it is a mixture of all these. I personally would recommend to take one of the above as guideline for the definition of the regions and clearly communicate it.

As it is I wonder what it means that the regions are overlapping. Is there something special about Greenland blocking processes so that they get their own region? Or is Greenland a separate region because it is often used in the literature? I assume it's the second one but it should be clearly communicated, potentially with some studies as reference. I use this example also because the Greenland blocking region as indicated in figure 1 is not identical to the widely used definition from

the literature as far as I can tell (e.g., Wachowicz et al. 2021, DOI: 10.1002/joc.6923; Hanna et al. 2016, DOI: 10.1002/joc.4673)

Reply: We agree with the reviewer that a fundamental problem in this topic is that no uniform study areas and/or definitions are used in the literature. However, it was not our aim in this review to provide a recommendation for a uniform framework here, as we think that this requires further analysis and it is not the main focus of our manuscript.

In the text, we provide references for the areas shown in Figure 1. As the reviewer correctly notes, the areas have been defined for different applications. Nonetheless, the areas considered in the referenced studies were always targeting the investigation of blocking occurring in a specific region. From our point of view, this justifies the representation in Figure 1. To address the reviewers concern, we point out that the boundaries may vary in different studies in the last sentence of the paragraph. In the revised manuscript, we have added that results from studies dealing with blocking may be sensitive to the choice of the blocking region's boundaries.

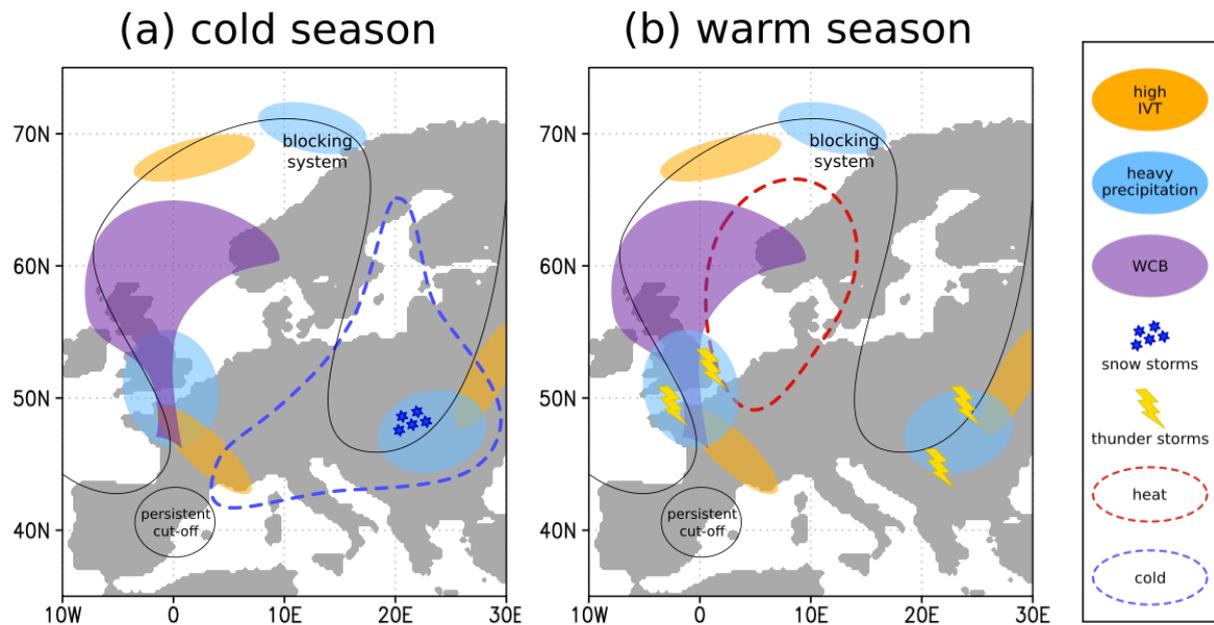
The overlapping areas indicate that (in an exemplary case) the same blocking event may be referred to in one study as North Atlantic blocking and as Greenland blocking in another. It would be thus important that in a study which examines the spatially distributed occurrence frequency of blocking in a certain area also considers the adjacent areas. However, such an investigation is not the subject of our article. For more clarity, we have revised the paragraph on how to understand the overlapping of the blocking regions.

L120-123: *"Scandinavian blocking can be understood as a subset of European blocking events, the southern parts of the North Atlantic and European blocking overlap with the area where subtropical high ridges can occur, and the southern part of the Greenland blocking area falls within the North Atlantic area, which means that southern Greenland blocks can also be categorized as North Atlantic blocks."*

L123-125: *"Please note that the precise definitions of these areas vary slightly in their boundaries between different studies (e.g., Rohrer et al., 2019; Wachowicz et al., 2021) which may have an influence on the results."*

Fig 2: Thank you to the authors for revising this figure and better integrating it into the text. As for figure 1, however, not all of my concerns are addressed. The authors write that "During the cold season (from October to March), low temperature anomalies may be observed in the southern and the eastern parts (at the eastern flank) of the blocking system (Fig. 2 (a))" (line 193). However, in the figure cold anomalies are only indicated in the south-east of the blocking center and not to the south AND to the east. Looking, for example, at figure 3b of this manuscript it seems to me that the text is more correct and cold anomalies are found along the entire southern side?

Reply: We agree with the reviewer that this was not yet consistent. Therefore, we have revised Figure 2 accordingly.



line 205: "...many impacts arise from one characteristic: the persistence of blocking systems. ... It leads to impact by enforcing prolonged periods of anomalous weather under which surface temperature and rainfall anomalies can build." This is an often used characteristic of blocking and to a certain degree it is true by definition because otherwise the system would not be a block in the classical sense. But in the context of this manuscript: could the authors provide some studies that address the influence of blocking persistence on its impacts? It seems intuitive but I'm wondering if it has been shown explicitly? On the contrary, looking, for example, at Chan et al. 2019 their results seem to suggest that blocking duration does not play a role at least for the setup they use (see their figure 2)?

Reply: We thank the reviewer for this comment and have revised the paragraph accordingly.

L211-216: "Blocking persistence can lead to extended periods of extreme weather and so has clear societal impact. While the severity of the meteorological impact can be related to the number of blocking days (Schaller et al., 2018; Lenggenhager et al., 2019), it is not clear that the persistence of individual blocking events is key here (Chan et al., 2019) or whether the recurrence of blocking may have similar impacts (Woollings et al., 2018). Moreover, the stalling of cyclones upstream of a blocking system as observed, for example, in winter 2013/2014 over Great Britain (Priestley et al., 2017) is a process which does not necessarily require the blocking system to be persistent."

line 769: "profit for targeted"

Reply: We have revised the sentence to increase readability.

L706-707: "Our understanding of the complex relationships between blocking, wind extremes, and/or compound events would greatly benefit from targeted research activities."

Report #2

I acknowledge the authors for having almost entirely accepted by suggestions. The new tables are very informative. Overall, I am happy with the new version of the manuscript, I have just noted a few minor comments here below.

(please note I am using line referencing for the tracked change version)

L125: I would stress out that the authors will use this nomenclature in the rest of the work.

Reply: We thank the reviewer for his/her comment but prefer not to add any further explanation. This is because we have already noted in the text that we show in Figure 1 the areas that we address in the study. In addition, we also use the abbreviations in Tables 1-3, but not in the text to ensure readability.

L204: “even if this has been observed in some sporadic circumstances”

Reply: We have corrected this.

L194-196: “Please note that although these extremes are shown schematically in the same plot, they do not necessarily occur simultaneously, even if this has been observed in some sporadic circumstances (e.g., Russian heat wave and Pakistan floods in summer 2010).”

L259: A reference to “Woollings, T., Hoskins, B., Blackburn, M., & Berrisford, P. (2008). A New Rossby Wave–Breaking Interpretation of the North Atlantic Oscillation, Journal of the Atmospheric Sciences, 65(2), 609-626” might be relevant here.

Reply: We have added the reference.

L249-251: “However, it is generally difficult to consider the North Atlantic blocking and NAO- separately, as the flow configuration during NAO- itself can be defined as blocking pattern (e.g., Woollings et al., 2008).”

Sec 3.4/Sec4.4/Sec5.3: I found this “challenges” sections a bit sketched: albeit I see their goal, I would suggest to merge or move them together with Section 8 where the research perspectives are discussed.

Reply: We thank the reviewer for this comment and also understand the advantages of merging them into Section 8. Nevertheless, we prefer to leave the subsections “Challenges” at the end of the respective sections, as an overview for later discussion. First, we want to emphasize the content of these subsections. Second, it provides the readers who want to inform themselves about a certain type of extreme event the possibility to find the crucial information in one place.

L635: “and” is missing

Reply: We have corrected this.

L577-578: “Blocking played a key role in the formation of a flood event in Southern Switzerland and Northern Italy in October 2000 (Lenggenhager et al., 2019).”