We thank the reviewers for their feedback and suggestions to improve the manuscript. Below, we respond to each comment point by point. The reviewer's comments are in **black,** our responses in **red**. At the end of the responses, we list the new references which are not listed in the submitted manuscript.

Reviewer 1:

The study uses atmospheric reanalyses (ERA5, ERA-20C, 20CRv3) and coupled model simulations (CMIP6) with historical and future forcing (SSP5-8.5) to investigate the link between atmospheric blocking and the occurrence of different types of extreme events (heatwaves, heavy precipitation and calms) in Germany. The key finding emerging from the reanalyses is that weather extremes, and particularly heatwaves, occur more frequently when associated with blocking than in the absence of blocking. This finding is also found in CMIP6 simulations but with considerable discrepancies and spread.

The main strength of the study is the large number of datasets that are analysed (3 reanalyses, 6 CMIP6 models with historical and future simulations), which gives robustness to the methodology. However, the novel contribution of the study with respect to existing literature is not clearly indicated. Some methodological assumptions are insufficiently justified, and their uncertainties should at least be discussed. Moreover, the presentation of results in the manuscript should be reconsidered – the authors use multiple data sources, but their figures practically only show ERA5, when it would be far more interesting to show a comparison between the different reanalyses and CMIP6 models for the metrics being investigated.

While there is potential for interesting results, I believe important work is needed to bring the manuscript to standards worthy of publication, particularly in the presentation of results and writing.

Comments

The motivation and questions of the study need clearer and stronger emphasis. The authors mention that previous studies have performed similar analyses on individual CMIP models, hence presumably the novelty lies in extending the analysis to more models and reanalyses. However, the link between previous research, the proposed scientific questions, and the original contribution of the study is unclearly conveyed.

One of the goals is to get a comprehensive overview of the relationship between blocking and extreme events. Comprehensive means in this context to investigate several extreme events and several reanalyses and climate simulations. The cited studies investigated only a limited number of climate simulations and reanalyses and these datasets are not the currently used datasets (ERA-Interim, ERA40, CMIP3/CMIP5 models). For example, Brunner et al. (2018) investigated ERA-Interim and CanESM2 (a model participating CMIP5), and Sillmann et al. (2011) compared ECHAM5/MPI-OM (a model participating CMIP3) to ERA-40. Hence, the added value of our study is to generalise and to update previous research by using multiple and current datasets (ERA5, ERA-20C, 20CRv3, CMIP6 models). Additionally, we investigated several CMIP6 simulations assuming the SSP5-8.5 scenario to asses changes in the relationship between blocking and extreme events in the future and to estimate uncertainties in the projections. We will add these explanations to the introduction of the manuscript to clarify more the motivation.

In their definition of heatwaves, the authors perform their analysis on a single grid point (51N, 10E). They point out that this point represents Germany, but this choice seems aleatoric and the authors provide no convincing explanation for this. The same applies to the analysis on heavy precipitation, where the authors consider two grid points in western and eastern Germany. The uncertainty of choosing single grid points (and why those specifically) should at least be discussed.

In recent decades, several extreme events related to blocking hit Central Europe (e.g. heatwaves 2003 and 2018, flood events in 2013 and 2021, calms in winter 2024/25). We want to quantify the relationship between blocking and extreme events and selected Germany as an example target area. Lhotka and Kysely (2015) and Lhotka and Kysely (2022) show that heatwaves are large-scale phenomena affecting several countries concurrently. The spatial extent of heatwaves is typically several million square kilometres (Lhotka and Kysely, 2022). Grams et al. (2017) show that weak winds occur widespread and quite homogeneously within high pressure systems. Thus, for heatwaves and calms, we picked a point in the centre of Germany (51°N, 10°E) to represent Germany and the surrounding area. Furthermore, we defined all extreme events based on percentiles to consider grid resolution and orographic effects. Heavy precipitation is spatially more inhomogeneous than heatwaves and calms: Hofstätter et al. (2018) show different weather regimes causing heavy precipitation in Central Europe. Depending on the investigated region in Central Europe, different weather regimes cause heavy precipitation events. Hofstätter et al. (2018) show that many heavy precipitation events in Western Germany are related to low pressure systems over the Atlantic. Many events in Eastern Germany are related to so called Vb-cyclones, a cyclone type moving from the central Mediterranean over the eastern Alps northward. With respect to these differences, we differentiate between heavy precipitation in Western and Eastern Germany. We think that a point represents Western, respectively Eastern Germany because we analyse 24-hour precipitation which reduces the impact of small-scale convective precipitation on the statistics compared to hourly precipitation. Heavy precipitation on daily timescale is mostly related to synoptic scale precipitation which affects at least several thousand square kilometres (Szemkus et al., 2025). We selected the grid points along 51°N because this is approximately in the centre of Germany with respect to north-south direction. We will add these arguments to the manuscript to clarify our selections.

I believe the choice of figures should be reconsidered. Other than Fig. 5, all figures show ERA5 only. This study would be considerably improved if all reanalyses were shown in the Figures, and their differences were also discussed. The text frequently refers to the mean of the 3 reanalyses, but this is not shown in the figures. Similarly, CMIP6 models are used but not shown in figures (except F5). A much better figure format for F1-4 would be showing the reanalyses and the CMIP6 MMM with model uncertainty/spread, perhaps including individual models in the SM. This would also help reduce the lengthy tables and make the text easier to follow in the Results section.

We will reconsider the figures. Instead of showing only ERA5, we will show the reanalyses and CMIP6 MMM of two conditional frequencies and the odds ratio giving a direct comparison between reanalyses and CMIP6 simulations. We will do this for summer and winter half-year. The plots will replace the tables we presented before. To show the spread, we will present each reanalysis and climate simulation in the SM.

The authors begin Results subsections (e.g., 3.1.2, 3.2, 3.3) by stating that they select regional domains based on the patterns emerging from Figures 2, 3, 4, respectively, which only show ERA5. This assumption should at least be justified. Determining the domains for the analysis based on ERA5 only, particularly when the spatial patterns of the other data products are never shown in the manuscript, seems hardly robust.

We will reconsider the selection of domains. Instead of using only ERA5, we will use the mean of the reanalyses. Replacing the tables by figures will reduce the sensitivity of the presented results to subjective selections. After the revision of the results section, only the last plot showing the odds ratio spread in reanalyses and CMIP6 simulations (F5 in the first version of the manuscript) will depend on the subjective selection of a domain.

The writing should be considerably improved, particularly in the Results and Discussion section. This includes using more specific and technical language; improving the logical flow of sentences; and ensuring that all statements are clearly supported either by published evidence or by the paper's results. Large parts of the Results section can be omitted or summarized more coherently. It would be beneficial to guide the reader more in the interpretation of new results and their implications in a broader context.

We will go through the text to improve the writing. Replacing the tables by figures will help to reduce the length of the results section.

Perhaps a more minor comment but including calms in the category of "extreme events" seems a little counterintuitive. The authors place the importance of calms in the context of impacts on energy production, but the distinction from other extremes should at least be better framed. Since the motivation (i.e., the impact on the energy sector) is not sufficiently discussed in the introduction, reader is left questioning whether the analysis on calms is relevant to the paper's objectives at all.

The importance of calms becomes apparent in Drücke et al. (2021). The authors of this study found that during some calm events the hourly wind energy production was less than 20% of the mean hourly wind energy production. Solar energy production could not compensate the wind energy shortfall in autumn and winter even during sunny periods. Furthermore, calm events can persist several days and affect whole Central Europe. The resulting wind energy production shortfalls require electricity imports from other European countries or an increased usage of conventional power plants using coal or gas. As a result of the shortage, spotlight prices increase by many times (up to the 10-fold of the average price) with high costs for companies ordering electricity from the spotlight market (https://www.br.de/nachrichten/wirtschaft/dunkelflaute-wenn-der-strom-zum-luxusgut-wird,UaWf3Sa last access 13.3.2026). We will add these information to the manuscript to show the relevance of calms.

The *Results*, *Discussion* and *Conclusions* section could all be shortened. When reviewing the text, it should be kept in mind that the frequent use of acronyms and repetitive sentences make the text quite difficult to follow.

We will check these sections for possibilities to shorten these. Replacing the tables by figures will help to shorten the text and to reduce the use of acronyms.

References:

Lhotka, O. and Kyselý, J. (2015). Characterizing joint effects of spatial extent, temperature magnitude and duration of heat waves and cold spells over Central Europe. Int. J. Climatol., 35: 1232-1244, https://doi.org/10.1002/joc.4050.

Lhotka, O., & Kyselý, J. (2022). The 2021 European heat wave in the context of past major heat waves. Earth and Space Science, 9, e2022EA002567, https://doi.org/10.1029/2022EA002567.

Szemkus, S., Buschow, S., and Friederichs, P. (2025). Revealing the structure of precipitation extremes: a spatio-temporal wavelet approach, EGUsphere [preprint], https://doi.org/10.5194/egusphere-2025-5922.