

Review of “Storm Boris (2024) in the current and future climate: a dynamics-centered contextualization, and some lessons learnt”

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The study examines Storm Boris, which caused heavy rainfall and severe flooding in central Europe. In particular, it attempts to understand how such storms may change as a result of climate change. Various methods are used, including a conditional (dynamic) method and a probabilistic method. The paper thus raises an important scientific question: to what extent does the method used to attribute climate change alter the result? It becomes clear that different processes (thermodynamic and dynamic) can have different and even opposite effects on such complex systems, as is the case for Storm Boris. The comprehensive analysis is a novelty and emphasizes that it is important to know the exact research question, but also that a comprehensive analysis is important in the attribution of climate change. The paper is well-structured and easy to follow. Therefore, I would suggest accepting this study after minor revisions.

Minor comments:

A general comment regarding CESM. I do not understand why the authors assume that CESM would be able to generate the same precipitation intensity as the clearly higher resolved (spatially and vertically) ERA5 data. To be fair, you would need to downscale the selected analogues to a resolution that resembles the one of ERA5. Therefore, I suggest excluding the paragraph around L390 to 403 and the second row of Fig. 7 (e-h).

L11: What exactly are ‘Boris-like’ events?

L16: ad -> at

L17: “–,” is a bit of a strange notation

L18ff: Starting at: The results obtained ... You do not specify what the results are of the unconditional method, which I think is interesting and important. I understand that the abstract is already quite long, but I think it is an important part of the study. Therefore, I suggest writing the first part of the abstract a bit more concisely, so that there is room for these results too.

L37f: Changing dynamics could also mean that the tracks of such Boris-like storms are less or more frequently used.

L40f: This sentence is rather long. I would recommend splitting and shortening it.

L58f: The description of the path sounds more like a ‘Vc’ rather than a ‘Vb’ track.

L102: European Centre for Medium Range Weather Forecasts -> ECMWF

L111: I am wondering if the 30 vertical levels might not be a limiting factor for your analysis. I will point out some locations later in the results again.

L126: The first figure you are mentioning is Fig. 6. Generally, it is expected that the numbering starts with the first figure.

L129: You are using PV at 250 hPa. What interpolation method from model to pressure levels was used for CESM data?

L130: What is the rationale behind choosing September 14th to represent the dynamics of Storm Boris when identifying analogues? Can you give an indication on how sensitive your results are with respect to this selection?

L132: "Furthermore, for each daily mean PV field, we subtract the spatial mean of the PV field ..."
This sentence is unclear to me. Do you subtract the daily spatial mean or some climatology?

L150: The bootstrapping method is unclear to me. Do you sample a 1000 times 1050 analogues? Maybe you can rephrase this part a bit to increase understandability.

L166: You mention that you are lowering the PV anomaly threshold, but it is the same number (-0.7 PVU) as in line 163. This is unclear.

L159: How can you obtain a resolution of 20 hPa in CESM with only 30 vertical levels?

L189: $1.5 \times 1.5 \rightarrow 1.5^\circ \times 1.5^\circ$

L195: I would not consider the 75th percentile as extreme precipitation. It might be strong precipitation, especially when considering the long simulation runs of CESM.

Section dynamical diagnostics: It is unclear why you are applying some of the tools/algorithms to operational ECMWF data and to ERA5 reanalysis.

L231: The fact that the impact region is more over eastern Europe could imply that Boris was more like a Vc cyclone.

L234: From what source/dataset do these 350 mm come from?

L246: Can you identify if the uplift of the 600 hPa is triggered by dynamics or orography?

L281: If I understand Fig. 3f correctly, all of the Mediterranean has an SST anomaly of more than 1 °C.

L289: What is meant by "all-year climatological distribution"? Is this based on daily means?

L328: "... is selected if a cyclone center is located close to where Storm Boris ...". How is close defined?

L332: South -> south

L335: Does "propagate into the target region from the North Atlantic" mean that the track passes by the Alps only on the northern side only?

L338ff: I do not understand this sentence.

L349: Also, the fact that Vb cyclones are only characterised by the track of their surface position justifies this refinement.

L369f: “the seasonal analogs do not display the same drying as the mean” This sentence is not very clear, as it could indicate that the drying pattern just looks different, but in fact, there is almost no drying visible.

L374ff: Could the small fraction of WCB detected also be related to the comparably low vertical resolution of CESM with only 30 levels?

L383f: This sentence is difficult to understand. First, you mention seasonal and yearly analogues, then you refer to the warming of the yearly and then the seasonal, but the numbers in the brackets are again for seasonal and then yearly. I suggest reorganising this sentence to make it more intuitive.

L386: I suggest using the word accumulated precipitation instead of cumulated precipitation. You will have to replace this on multiple occasions.

L388f: Why do you expect the same precipitation intensity between ERA5 and CESM? The resolution of these two data sets is quite substantially different, making it very hard for CESM to actually reach the same intensity as in ERA5. This is even true if you would regrid ERA5 to the CESM grid, as the underlying resolution is still much higher.

L389ff: “The mean precipitation decreases” with respect to what?

L391 to the end of the section: It is unclear to me why you are assuming that CESM should be able to capture the same intensity as ERA5. Therefore, I do not see the point of this analysis here.

L395: There is ‘estimate’, ‘estimation’ and ‘estimate’ in one sentence. Please rephrase

L415: Again, I think part of this is due to the resolution of CESM. It would be interesting to know how precipitation intensity increases for these events if downscaled to the same resolution as ERA5, which, of course, is beyond the scope of this study.

L445: Why are you looking at the 90th percentile here and not at the 75th percentile as mentioned in the method section?

L519ff: This sentence is unclear to me.

L545: I agree that CESM has a high temporal resolution with 6-hourly output, but the spatial and especially the vertical resolution is not really high.

L580: “..., that emerges yearly analogs are considered.” This part does not seem to fit into this sentence.

Figure 2: The difference between the blue and purple contours is difficult to see, at least in a printed version. Why is PV shown at 320 K and not at 250 hPa, as it was introduced in the method section?

Supplementary Figures: Make sure that they appear in an increasing order in the text. I think S16 is mentioned before S15 and S14.