# On the clustering of winter storm loss events over Germany

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Replies to R. Caballero

Dear Referee R. Caballero,

We are grateful for the helpful and pertinent comments and suggestions, which substantially improve our manuscript. Below you can find our point-to-point responses to your comments. All page and line numbers refer to the NHESSD document. The text in italics corresponds to the referee's comments. Changes in the manuscript are marked in red.

*Specific comments:*

1) *p.1920: The description of the method beginning in line 5 is not very clear: for instance, is the "gliding" window made up of consecutive disjoint 3-day segments, or do they overlap? (note also that the usual terminology is "sliding window"); what does it mean that the event is "aggregated to LI3D"? What do you mean with "if no clear maximum can be found"? I suggest a comprehensive re-write of this important section to make perfectly clear what it is that is being done.*

Answer: Both reviewers have posted comments that the description of the methods was hard to follow. We thank the reviewer for this comment. Indeed, the section was somewhat difficult to follow. We have rewritten this section to enhance clarity. The new text is as follows:

"In this study, the approach is adapted to identify individual, distinct events from daily maximum data. In the following overlapping three-day sliding time windows are analysed. Given that Germany is a comparatively small area, three days are reasonable for separating events. This also corresponds to the 72-hour event definition that is often used by insurance companies in reinsurance treaties (cf. Klawa and Ulbrich, 2003).

- The middle day of the three-day time window is defined as event if it is a local maximum of $LI_{raw}$ ($MI_{raw}$). If no maximum is identified within the three-day

window (for all $LIr_{aw} \neq 0$), the first day after a previous event (considering the last day of the three-day time window) is defined as event. For example in February 1990 Vivian and Wiebke are separated by only one day. Nevertheless, the method is able to identify both events, as the middle day of the three-day time window is a maximum (see Supplementary E).

In order to enable an accurate assignment of maximum wind values at individual grid points *ij* for all identified events the single grid points are analysed in more detail:

- For each grid point *ij*, the maximum of $\frac{v_{ij}}{v_{98_{ij}}}$ for the three-day time window is identified. If the determined maximum is not at the middle day, $\frac{v_{ij}}{v_{98_{ij}}}$ is replaced with the identified maximum value $max_{3D}\left(\frac{v_{ij}}{v_{98_{ij}}}\right)$ in $LI_{raw}$ ($MI_{raw}$).
- In rare cases, events are only separated by one day (e.g. 26.02.1990 and 28.02.1990). If $max_{3D}\left(\frac{v_{ij}}{v_{98_{ij}}}\right)$ is identified between both events (here 27.02.1990), it is allocated to the event with higher exceedance of $v_{98_{ij}}$.
- To guarantee spatially coherent wind fields, larger values occurring on the first or third day only substitute the values from the middle day if multiple (spatially contiguous) nearby grid points exceed the 98$^{th}$ percentile."

*2) Fig. 3: The text claims that the ERAI and NCEP results are very similar, but that is not really true – there are many winters in which the number of events is quite different in the two datasets. Yet the results derived from fitting a negative binomial (Table 2) do seem quite similar for the two reanalyses. Can you explain this apparent discrepancy?*

Answer: In the submitted version of the manuscript we had pointed out some of the small differences between datasets. In order to meet the reviewer's concern, we have slightly rephrased the text, to point out more clearly the differences between both reanalysis datasets. Please note that the overlap between the lists of top 30 events is 70% (21 events out of 30). For the two reanalysis datasets the number of events per winter shows only small permutations (see Supplementary B). Therefore the results derived from fitting a negative Binomial distribution are quite similar.

In section 4.1 we included:

“70% of the identified events in NCEP data are also found in ERAI and DWD data, the same is valid for DWD and ERAI.”

In section 4.2:

“In some cases, the number of events per winter differs from dataset to dataset. Still, all three datasets show a maximum of events for the winter 1989/1990 (Fig. 3a,b denoted 1990). Differences in the identified number of events at the 1-year return level are determined for eleven winters. For example, the winter 1983 features four 1-year events for ERAI, while NCEP only features two events. For stronger events exceeding a return level of 2-year or 5-year, seven/six years with a difference in the number of events are identified. For instance, for the storm series of 2000 (1999/2000, cp. Fig. 3a,b) and at the 2-year return level, two events for ERAI and no event for NCEP data are detected. This can be attributed to the limited representation of storms like “Lothar” (26.12.1999) in NCEP (cf. Ulbrich et al., 2001). However, both datasets are generally in good agreement, identifying clearly the winters with well-known storm series like in 1990 or 2007.”

*3) Fig. 5: This figure is referred to in the text, but there is no comment at all about the results it reports. I suggest adding more discussion of this figure, or removing it altogether if it does not add useful information.*

Answer: As Fig. 5 includes basically the same information as table 2, we removed it from the main manuscript. Nevertheless as it illustrates nicely the information of table 2, we preferred to move the figure in the Supplementary material (as Supplementary D) instead of deleting it.

*4) Suppl Table D: The detection of statistically significant overdispersion as quantified by seems like an important point in this paper, and I would suggest including this table in the main text. It would also be interesting to report the values of derived directly from the data (ie. by computing the sample variance and mean instead of using Eq. (9)).*

Answer: As suggested we included Supplementary D in the main text (as Table 3). Additionally we added the information of the Psi-values computed with equation 6 in Table 3b.

Table 3: Ψ-values for the different datasets. a) Calculated with equation (9) and with the information of the confidence interval. b) Computed with $\psi = \frac{\mathrm{Var(X)}}{\mathrm{E(X)}} - 1$.

| a) Return Level | ERAI | NCEP | GCM | $GCM_{corr}$ | $ESS_{corr}$ | $20C_{corr}$ | $CTRL_{corr}$ |
|---|---|---|---|---|---|---|---|
| 1 | 0.1595±0.1127 | 0.1972±0.1123 | 0.3062±0.0188 | 0.6383±0.0055 | 0.1777±0.0071 | 0.2919±0.0294 | 0.1020±0.0115 |
| 2 | 0.0727±0.0650 | 0.1962±0.0271 | 0.2081±0.0090 | 0.3168±0.0039 | 0.1297±0.0040 | 0.1661±0.0049 | 0.0713±0.0031 |
| 5 | 0.2464±0.0290 | 0.8186±0.1881 | 0.1161±0.0023 | 0.1095±0.0025 | 0.0491±0.0027 | 0.0908±0.0043 | 0.0240±0.0037 |
| **b) Return Level** | | | | | | | |
| 1 | 0.2414 | 0.1034 | 0.1756 | 0.2717 | 0.1863 | 0.1752 | 0.1604 |
| 2 | 0.0690 | 0.2069 | 0.1442 | 0.1707 | 0.1210 | 0.0925 | 0.0513 |
| 5 | 0.1724 | 0.8621 | 0.1033 | 0.1303 | 0.0741 | 0.0662 | 0.0004 |

Furthermore, we assimilated parts of the text.

In section 4.4:

“The Ψ-values calculated with equation 6 are different, with more clustering for frequent events (0.24 for 1-year return level events) and less clustering for extreme events (0.17 at the 5-year return level, Table 3b). Nevertheless, both methods identify overdispersion for the events.”

In section 4.5:

”The Ψ-values are also positive, but lower or similar when calculated with equation 6 (Table 3b).”

*Minor comments, typos:*

*1) p.1914 l.23: The correct citation is Hanley, J. and R. Caballero (2012): The role of large-scale atmospheric flow and Rossby wave breaking in the evolution of extreme windstorms over Europe. Geophys. Res. Lett., 39, L21708.*

Answer: Thanks for pointing out this mistake. The citation in the references at p.1934 l.10 was corrected as suggested:

“Hanley, J., and Caballero, R.: The role of large-scale atmospheric flow and Rossby

wave breaking in the evolution of extreme windstorms over Europe. Geophys. Res. Lett., 39, L21708, 2012."

*2) p.1921 l.19: The word "predictand" looks out of place here; $\lambda$ is usually called the "rate parameter".*

Answer: We changed the wording to rate parameter:

"For the Poisson distribution, the rate parameter $\lambda$ is equal to the variance (Var(x)) and mean (E(x)) at once."

*3) p. 1929 l.5: Analogue -> Analogously*

Answer: As suggested, we changed the wording to Analogously:

"Analogously to the historical data, a sensitivity analysis was performed regarding the GCM data."

*4) p. 1929 l.20: depend only little *on* the length*

Answer: We inserted *on* in the sentence:

"These results demonstrate that the estimation of return periods using the negative Binomial distribution is robust and depend only little on the length of dataset."