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Natural Hazards and Earth System Sciences
Discussions

Interactive comment on "An 18-year climatology of derechos in Germany" *by* Christoph P. Gatzen et al.

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Authors addressed climatological aspects of derecho events affecting Germany. Based on the analysis of severe wind reports, radar and lightning data they derived 40 cases that fulfilled derecho criteria. All cases were divided into a warm and cold season derechos. In addition to assessing preliminary derecho climatology, authors used sounding-derived variables derived from proximity observations to investigate thermodynamic and kinematic properties They also used reanalysis data to define typical synoptic patterns supporting development of a derecho. Although the sample size is relatively small, it allowed to obtain a certain signals characterizing atmospheric environments for both categories and their corresponding synoptic patterns.

I need to compliment authors for their efforts in investigating all potential cases over the period of 17 years since they stand for an excellent contribution to severe thunderstorm research over central Europe. Confirmation of each derecho event was certainly a challenging task and required a long and very detailed investigation. Overall, the paper is up to international standards, it is written in a good English, objective of the study is well-formulated and length is adequate. Methodology is described in a great details. References to literature are generally sufficient. However, authors focus mainly on comparing sounding-derived parameters over central Europe and climatological aspects of derechos in USA. Some further discussion on the derecho occurrence over central Europe in the context of general thunderstorm climatology and their corresponding environmental conditions may be considered to assess rarity of such events. Figures in the paper are of acceptable quality, but I believe there is some potential for improvements and space for additional plot. Summing up: the paper is a valuable contribution and should be published in NHESS, but some improvements are needed to increase its quality. Below I present general and specific comments:

General comments:

#1. What was the logic behind choosing a period from 1997 to 2014? Why not until 2018? At some point it may be even possible to investigate 2019 if there were any such cases, so the paper may include the most recent data.

#2. Did author try other indices? I am missing two very important variables. First is a mid-level shear (e.g. 0-3km) that is commonly used in investigating atmospheric potential for convective windstorms (e.g. https://doi.org/10.1175/811.1, https://doi.org/10.1175/1520-0434(2003)18<502:SCWOTN>2.0.CO;2, https://doi.org/10.1007/s00704-018-2728-6, https://doi.org/10.1175/WAF-D-13-00041.1). Second is a mid-level lapse rate (e.g. 800-500 hPa) that may be useful in characterizing cold-seasons derechos, that usually form in a steep temperature gradients. Also, most of the results in the paper are compared to severe wind events from Pucik et al. (2015) and Taszarek et al.

(2017), but I am wondering whether authors tried to use a larger number of soundings and define how derecho-related indices differ from the long-term climatological background (null-cases)? Alternatively, this can be derived from a central European sounding-climatology distributions (e.g. https://doi.org/10.1175/JCLI-D-17-0596.1).

#3. Did authors try producing scatterplots of selected pairs of variables? Combination of mixing ratio and lapse rates, or mixing ratio and 0-3km shear may very clearly indicate differences between cold and warm season derechoes (dwo clusters) and provide possibility to compare "coordinates" of these cases with previous or future studies dealing with convective parameters climatology (e.g. using Kernel Density Estimation of climatological background for soundings). In this way, it can be assessed how rare are such environments (see also general comment #2)

#4. I have a feeling that some further discussion on the climatological background of convective environments over Europe, synoptic patterns and overall thunderstorm frequency can be provided. Authors may discuss how unusual is the situation with a derecho given a background of convective activity over central Europe. I believe that the last section of the paper (conclusions) may be trimmed from repeating what was already written in the results, and instead, some space may be devoted for a deeper discussion.

Specific comments:

#1. P1: Abstract has 345 words. A usual standard for scientific publishing is around 200-250 words, authors may want to cut it down a bit.

#2. P1 L4: "mid-tropospheric" may be more appropriate than "500-hPa layer" (same for L11), also what authors mean by "intense"?

#3. P1 L9: To avoid repetition I suggest "strong 0-6 km wind shear with a median of 20 ms-1 and ..."

#4. P1 L10: I think that abbreviations shouldn't be used in the abstract, but if authors

intend to use CAPE, I suggest to mention "mixed-layer" only for the first time, and later just refer to CAPE without adding "mixed-layer" term, also in the whole manuscript body.

#5. P1 L16: It is possible that zero CAPE soundings were not representative enough for sampling a "true" environment in which derecho initially occurred? On the basis of what premise authors came to the conclusion that the choose sounding was representative?

#6. P2 L3: What do authors mean by "frequently"? I would suggest to remove this word.

#7. P2 L3-L17: Authors may want to mention also a recent powerful derecho case from Poland from 11 August 2017 where 6 people died being outdoors due to falling trees, including two teenage scouts camping in the forest (https://doi.org/10.1175/MWR-D-18-0330.1). This event had a very unique convective evolution and had a remarkable intensity given European windstorms, it was one of the most significant event over the last 20 years. Also, it took place very close to studied area.

#8. P2 L12-L17: I don't think references to ESSL twitter reports are needed, authors may just use a reference to ESWD (https://doi.org/10.1016/j.atmosres.2008.10.020) or ESSL (https://doi.org/10.1175/BAMS-D-16-0067.1).

#9. P3 L13-L15 & L26-L30: Please see comment #7.

#10. P5 L14: See general comment #1

#11. P6 L26-L31: Did wind measurements from the water surface were also used to estimate derecho intensity and duration? This may affect results that are presented in second paragraph of section 3.1, especially comparisons with U.S. climatologies where derechos usually do not travel through water surface where friction is lower and promotes stronger wind gusts (that can help reaching derecho criteria).

#12. P7 L9: Maybe it would be better to use a phrase of: "A similar patterns in 500 hPa geopotential field .."

#13. P7 L10-L11: Authors used ERA-Interim reanalysis to display derecho positions, GFS for PV intrusions and NCEP/NCAR reanalysis for clustering method. This is quite a mix. Why authors did not use just one source of data? (e.g. ERA-Interim?). Is it possible that the use of various data sources might have introduced inhomogeneities?

#14. P7 L12: No need to repeat a word "geopotential".

#15. P8 L3: What does exactly mean "10-m or surface"? Wouldn't be better to write that the shear was computed as a magnitude between first available level from the radiosonde up to 1 or 6 km AGL? (I assume this is the case) .

#16. P8 L10: "the year" is not needed (to be consistent with earlier part of the sentence "in 1998 and 2012").

#17. P8 L14: "based on the areas of each derecho path"

#18. P8 L21-25: Perhaps some short comment on the fraction of warm and cold season derechos in the spatial variability would be good.

#19. P10 L31: At this point I would like to highlight once again that among 0-1km, 0-3km and 0-6km shear parameters analyzed in a cited study, 0-3km shear demonstrated the best value in discriminating between extremely severe wind events and other categories. See also general comment #2.

#20. P11 L28-L30: Why authors use pressure values for LFC instead of m AGL? I am not sure if this information adds any value because we don't know what is its relation to the ground level (for each station and in a different synoptic pattern it will be different). Also, we cannot compare it with other studies since majority of them use m AGL. I believe authors should recompute LFC for m AGL. Same for P13 L34.

#21. P12 L8-L12: This shift may be related to a different peak in thunderstorm activity (compared to USA) based on central European climatolgy of thunderstorms (https://doi.org/10.1007/s00703-013-0285-1, https://doi.org/10.1175/JCLI-D-18-0372.1, https://doi.org/10.5194/nhess-16-607-2016), and European clima-

tology of convective environments (https://doi.org/10.1175/JCLI-D-17-0596.1, https://doi.org/10.1175/JAMC-D-17-0132.1). Peak in derecho frequency seems to overlap with these estimates. Some comparison to synoptic-favouring patterns for thunderstorms in central Europe in relation to patterns obtained in this study (in Figure 3) may be also worth to be done (https://doi.org/10.1016/j.atmosres.2014.07.011). Authors may use these aspects to provide some deeper discussion in the last section (in the exchange for repeating results in the conclusions), especially showing how unusual is the situation with a derecho given a background of convective activity and convective parameter climatology over central Europe (see general comment #4).

#22. P13 L10-P21: Authors may also provide some comment here on a typical high-shear low-CAPE environments that usually induce such events (https://doi.org/10.1175/WAF-D-13-00041.1).

#23. P14 L3: Is it possible to provide which value of ELT is "sufficiently low"? Would it be around -10C? (https://doi.org/10.1175/1520-0493(1996)124<0602:CTGLOF>2.0.CO;2).

#24. P14 L10: Can authors provide some additional discussion why ELT may rapidly change and briefly explain the mechanism leading to steepening of the temperature lapse rates (in a strongly synoptic-scale forced situations) that can "make" CAPE available? I suppose leading author of the paper may have something to say on this process.

#25. P14 L15: replace "than" with "as".

#26. P14 L19-L21: Awkward sentence construction, please split it for two sentences for clarity (after the bracket).

#27. P15 L31: Wasn't ML CAPE median 3 Jkg (Table 3?

#28. Table 1: Authors may consider including additional column with a measured peak wind gust. Also, "Centr" may be replaced with CNTRL for consistency.

#29. Figure 1. Color scale for orography may be a very confusing and indicate that Alps are up to 1500m.

#30. Figure 3. I want to compliment authors for this figure. This is an excellent display of various synoptic patterns supporting derecho occurrence over central Europe. However, it may be a bit confusing for readers that dendrogram indicates two patterns and authors display three at the top. It may be useful to add headings at the top of (a), (b) and (c) to denote something like "Warm-type", "11 April 1997", "Cold-type" - in this way it may be easier to catch what is really displayed on in these plots.

#31. Figure 5. This is a nice figure. Since this is a German derecho climatology I can understand that authors plot provinces, but I am not sure why provinces of Switzerland and Austria are included while others are not? This is not consistent. Perhaps a thicker line of German border would better highlight a country location.

#32. Figure 6. This is a very nice looking plot, I have two comments regarding this. (1) Did authors think about adding box-plots with some null-cases (e.g. only situations with ML CAPE > 0 J/kg) that can help to see how the distribution of a certain parameters looks on the background of a climatological mean? (see also general comment #2). (2) I see that due to different data ranges ML CAPE is splited into two different plots. Maybe authors can consider using WMAX (square root of two times CAPE) instead of ML CAPE (similar to Figure 6 in https://doi.org/10.1175/JCLI-D-17-0596.1). Values of ML CAPE can be still included on the axis for better readability. This solution may provide a more comfortable range of values and can fit both distributions on a single plot without a loss of details.

#33. (optional) – given that only 6 figures are in the paper, authors may consider to add one additional plot with a small histograms of (a) derecho path length (b) derecho duration and (c) derecho intensity categories – all which can be extracted from Table 1. It is nice to have this table, but additional histograms would help to asses distributions at certain values. Additional scatterplot may be also added (see general comment #3).

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