

Weather Clim. Dynam. Discuss., referee comment RC2
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Comment on wcd-2022-4

Anonymous Referee #2

Referee comment on "The role of cyclones and potential vorticity cutoffs for the occurrence of unusually long wet spells in Europe" by Matthias Röthlisberger et al., Weather Clim. Dynam. Discuss., <https://doi.org/10.5194/wcd-2022-4-RC2>, 2022

General comments:

In this study, Röthlisberger et al. examine, through illustrative case studies and systematic climatological analysis, the role of cyclones and PV cutoffs for the occurrence of unusually long wet spells in Europe, defined as the 20 longest wet spells at each grid point in the ERA-Interim reanalysis during 1979–2018. Overall, I found the manuscript to be well-written, and I believe that the topic has substantial scientific merit. In addition, the results may help to inform future work on predictability and climate change impacts for these events. Increased understanding of the synoptic-scale dynamical processes and weather systems that result in very long wet spells is clearly needed. The motivation for the study, the data and methods, and the results are described in a clear and concise manner. The figures are, for the most part, straightforward to interpret and support the conclusions drawn in the text.

In my review, I came up with a number of minor comments, suggestions, and questions for the authors to consider. Once these have been satisfactorily addressed, I believe that this manuscript will be acceptable for publication in *WCD*.

Specific comments:

Line 88–89: A brief discussion of the dynamical link between PV streamers and cutoffs and the process of Rossby wave breaking is needed here to provide a basis for later

discussions of wave breaking and the formation of PV streamers and cutoffs throughout section 3. Accordingly, a basic definition of Rossby wave breaking in the text would also be helpful.

Line 146: "(large-scale and convective)" It would be better to explicitly state that the precipitation amounts analyzed in this study are the sum of the large-scale and convective precipitation in the ERA-Interim data.

Line 147: Is there a particular reason why you limited the analysis to the 20 longest wet spells? Would not the statistics be more robust if you were to include, e.g., the 50 longest wet spells instead?

Line 175: How was this radius determined to be suitable for this analysis? How sensitive are the results to this radius? I suspect there are situations in which cyclones or cut-offs play an important dynamical role in a wet spell at a given location but are located farther than 400-km from the location. Of course in this type of analysis you need to choose discrete thresholds to define events/ features and to examine relationships between them. I am not arguing that you should change this radius, but I do think some discussion regarding why it was chosen would be helpful here.

Line 194–201: I find this explanation a bit confusing. It is not clear to me how climatological values for the number of distinct cyclones per spell are computed in this manner if all days of the year in any year corresponding to the $S20(x,y)$ are grouped. Perhaps I am misunderstanding the explanation of the methodology. It might be better to use the mean from the 1000-sample Monte Carlo distribution at each grid point as the "climatological value" as the Monte Carlo approach that you apply retains information about the consecutive days comprising each individual spell in the S20 sample.

Line 216: How much variability is there in the duration of the S20 cases at each location? Are there some locations where the duration is highly variable between the S20 cases?

Line 217: A map of the terrain elevation over the domain in Fig. 1 could aid the reader in interpreting the results.

Line 235: Are the climatological percentiles computed for all wet days in all months of the year, or do they vary seasonally based on when the wet spell occurred?

Line 258: An explanation is needed here regarding why these four particular cases and locations were selected.

Line 260: I really appreciate the concise yet information-dense synoptic analysis and discussion for the four selected wet spells. A main criticism I have for this study is that the synoptic analysis does not include quantitative diagnostics of processes and ingredients by which the cutoffs and cyclones support the persistent precipitation. While these processes are at times inferred or surmised in the text, no diagnostics for moisture transport, forcing for ascent, convective instability are provided. Inclusion of additional fields and diagnostics for each case would, of course, result in an increase in the number of figures and in the complexity of the manuscript, so perhaps it is outside the scope of this study. Could additional analyses and diagnostics be provided as online supplemental materials instead?

Line 260: Perhaps this is outside the scope of your study, but I wonder if it is possible to include analysis and/or discussion of the large-scale/planetary-scale conditions that contributed to the occurrence of the four selected wet spells. Were persistent weather regimes in place over the Atlantic/Europe region that favored the synoptic-scale dynamical processes operating in each archetypal synoptic story line?

Line 280: It could be useful to include more fields in the composite analyses for the four locations. Possible additional fields include sea level pressure anomalies, PV anomalies, and frequency anomalies of cyclones and cutoffs. Such additional fields could provide a more detailed, complete picture of the synoptic-scale conditions conducive to the S20 cases at each location.

Line 288: The information density in Figs. 3–6 is high. Overall, I think this is fine; I am able to read and interpret the figures fairly well. I do, however, recommend drawing the geographical boundaries and the SLP in different colors. This could help the reader distinguish the SLP field, especially when contours for several fields are superimposed.

Line 297: You clearly and convincingly describe how recurrence and/or persistence of weather systems is key to the long durations of the four wet spells analyzed. I propose that Hovmoller diagrams of, say, upper-level PV anomalies or upper-level meridional wind anomalies overlaid by the cyclone and cutoff masks averaged in some latitude band would help to more clearly illustrate the recurrence and persistence during the spells. These diagrams would nicely complement the plan-view analyses in Figs. 3–6.

Line 343: Physically this makes sense because PV cut-offs often form in association with Rossby wave breaking that results in meridional elongation of PV streamers equatorward of the midlatitude jet/waveguide. This location is too far north to be frequently impacted by cutoffs.

Line 367: What processes were conducive to recurrent wave breaking/cutoff formation in this case? It seems that the recurrence was associated with temporal clustering of cyclone developments and associated ridge building upstream along the waveguide over the North Atlantic. Was this flow evolution related to an anomalous configuration of the North Atlantic waveguide? It may be worthwhile to briefly speak to the upstream processes that

result in recurrent wave breaking.

Line 430: I understand the justification for plotting all of the PV cutoff and cyclone tracks in this figure. However, I find it very difficult to make sense of the messy bundles of tracks in the maps, with the exception being Fig. 7b in which the tracks are mostly zonal. Is there a way to more clearly illustrate the track information? Alternatively, could the tracks be removed from these figures without compromising the discussion?

Line 461: Can you briefly explain why the Pcyclone quantity is anomalously low nearly everywhere on the map?

Technical corrections:

Line 9: Define "PV" acronym here?

Line 67: "For unusually long-lasting wet spells, it is much less clear how and in association with which weather systems they form." This sentence is a bit clunky. Here is a possible alternative: "The mechanisms and weather systems contributing to the occurrence of unusually long-lasting wet spells are less clear."

Line 67–68: Change "Only few" to "few"

Line 109: Remove "responsible"

Line 163: Insert "the method of" before "Portmann"

Line 223: Insert "daily" before "precipitation rate"

Line 379: Start a new sentence with "The fifth"

Line 446: Insert "tend to" after "do not"

Line 522: Replace the colon with a period.

Line 525: Check whether "e.g.," is needed here.

Line 528: Replace "behaviour" to "characteristics" ?