

Authors' Response to Reviewer 4

General Comments. The authors here present an interesting study where they examine variability and relationships between numerous measures of intensity of extratropical cyclones in the North Atlantic in ERA5. This is a very comprehensive study and methodical in nature and presents very interesting results. The main results of interest are on the clusters of storms, their different geographic locations and also different populations in the wider intensity distributions. Due to the methodical nature of this study, it clearly presents very worthwhile findings, my only criticism of this work is that the study is incredibly long and in some places perhaps overly so. I understand why this is as the authors have conducted a lot of analysis, however in places brevity may be an option. I have other minor comments, which i have detailed below, and once these have been addressed i think this study will be an excellent addition to this journal.

Response: We would like to thank you for the feedback and valuable comments which helped improve the quality of our manuscript. To address the concerns about the length of the study, we have shortened the data section and throughout the manuscript individual sentences have been revised for the sake of brevity and clarity. We have also combined the discussion of Figure 9 with that of Figure 8 to reduce the amount of text. These reductions in text partly compensate the revisions made based on reviewer comments, but overall the length of the paper has remained unchanged. We have carefully addressed all other issues item by item as follows.

Minor comments:

Comment 1

L37/38 "However, in many cases, neither the minimum MSLP nor maximum VO correlates well with the impacts of a given ETC" needs a reference

Response:

We have added the following references to the sentence: Field and Wood (2007); Roberts et al. (2014); Sinclair and Catto (2023).

Comment 2

L52 - specify that you are referring to "average strength" cyclones

Response:

The word "average" has been changed to "average-strength".

Comment 3

L88 - typo in the statement of spectral resolution

Response:

The statement has been changed to T_L639 to avoid confusion.

Comment 4

Section 2.2 - do you also perform the tracking using 3-hourly resolution, or use the standard 6-hourly approach? Please specify in this section

Response:

We have added the sentence

The tracking is performed with 3-hourly VO data.

to make it clear that the ETC tracking is done with 3-hourly resolution.

Comment 5

L111 - I assume you are using VO at 850 hPa for tracking, but you do not state this initially, this needs to be done

Response:

We have added the sentence

The tracking is performed with 3-hourly VO data.

to make it clear that the ETC tracking is done with 850 hPa relative vorticity.

Comment 6

L161 - your baseline intensity measure is VO from the tracks. If this is the case you need to state that this is the T42 filtered vorticity, and not vorticity that you would get directly out of ERA5. Anyone trying to re-produce your results would have to do the tracking in order to get this variable

Response:

The sentence has been changed from

We use VO directly from the output of TRACK.

to

We use VO at the T42 resolution directly from the output of TRACK.

to make it clear that vorticity is used at the T42 resolution.

The T42 filtered vorticity values in the TRACK output are available in the Zenodo repository (Cornér et al., 2024).

Comment 7

L245 - i believe there is a brackets issue in this line

Response:

The notation $[0, \infty)$ means that the 0 is a closed end, i.e. the value can be zero, while the ∞ is an open end, i.e. the value cannot be exactly ∞ .

Comment 8

Section 4.3 - all sections here are very long and descriptive and i feel is an area where some text can be removed and sections shortened for the benefit of future readers.

Response:

Some text has been removed and paragraphs combined to shorten the section and the flow of the text has been improved. Individual sentences have been revised for the sake of brevity and clarity.

Comment 9

L500-511 - you state for this paragraph that the results of Fig 9 are the same as Fig 8, which is what you would expect as it is just the same data but presented in a different manner. If this paragraph (and Fig. 9) are not essential for your results i would consider removing.

Response:

We have combined the discussion of Figure 9 with that of Figure 8 to reduce the amount of text. However, we feel that it is necessary to include Figure 9 in the main text as it shows details which are not evident in Figure 8 (e.g. almost equal proportion of cluster HighSSI ETCs in each area and large proportion of cluster AvgMST ETCs in Europe). These reductions in text partly compensate the revisions made based on reviewer comments, but overall the length of the paper has remained unchanged. See also related Comment 2 of Reviewer 1.

Comment 10

Figure 10 - it would be good to state the trend value (and associated uncertainty) in each panel and the associated places in the text. Also, how much are your trends associated with modes of variability such as the NAO?

Response:

Equations for the trend values have been added to the figure and to the text, i.e. how much the number of ETCs per season change on average throughout the period. This trend value does not have an uncertainty associated with it but the p-value indicates how statistically significant the trend is.

According to Eade et al. (2022) the NAO index has been mostly positive within our study period from 1979 onwards and apart from a dip in the mid 1990's, the trend has been positive as well. This is qualitatively in line with our results which show less tracks

in Southern Europe and the Mediterranean (cluster Weak), a situation associated with a positive NAO index. It is also consistent with the results of (Laurila et al., 2021, Fig. 14) who found a positive correlation between the NAO index and 10 m wind speed in the North Atlantic and Finland, and a negative correlation in the Iberian peninsula. However, discrepancies arise with clusters Intense and AvgMST which both exhibit more tracks towards Northern Europe, a situation also associated with a positive NAO index. Their trends in number of ETCs as well as the signs of correlation with the NAO index are opposing for these two clusters (not shown). This discrepancy could be more related to the increase in precipitation in all ETCs rather than the location or orientation of ETC tracks. We of course need to keep in mind that the spatial distribution of ETCs in each cluster does not reveal their temporal variation and vice versa.

References

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