Review of egusphere-2023-2322 – Rousseau-Rizzi et al. – A storm-relative climatology of compound hazards in Mediterranean cyclones

The manuscript by Rousseau-Rizzi et al. discusses a system-relative climatology of compound events associated with Mediterranean cyclones focusing on wind-rain, rain-waves, and particulate matter-heat events. The study shows that compound events often happen during specific clusters, which is also helpful knowledge for forecasting future events. Overall, the work shows great value and is well written. However, I have two concerns discussed below that I think need attention before publishing.

Main concerns

1. **Only using one time step per cyclone**

   I understand that only using one time step simplifies this work tremendously. However, some of these hazards and dynamical features discussed occur during different times of a cyclone's life cycle (e.g., Hewson and Neu (2015) and more recently Eisenstein et al. (2023), although these works have been done over the North Atlantic and Central Europe). I see problems only using the time of minimum pressure as it will exclude a lot of information and hazards neglecting the development of a storm. Maybe some compound events happen sooner or later in the life cycle? Even though I understand how much work it would be to include more time steps, especially considering possible double-counting of cyclones as you mentioned, I believe this needs to be included to make this work even more meaningful. At least a detailed discussion about what would change, looking at other time steps with a few examples, must be added. Also, how important are hazards that are detected immediately after one another?

2. **Dynamical features**

   I am missing a clear description of the dynamical features, their hazards (wind, precipitation), etc. There are numerous studies of the features in extratropical cyclones (e.g., regarding wind: Hewson and Neu, 2015; Clark and Gray, 2018; Eisenstein et al., 2022,2023; regarding precipitation: Catto and Pfahl, 2013; Catto, 2016, …). Do they differ in the Mediterranean/how so?
   For example, regarding the WCB: Clarify whether you are only interested in winds (warm conveyor belt <u>jet</u>; see literature above) or also in the forming cloud head which is responsible for most of the precipitation (Catto, 2016), which I assume as you consider it up to a height of 400hPa. Maybe consider explaining the difference of the warm conveyor belt jet, responsible for the high surface winds, and the WCB forming the cloud head and precipitation.
   I believe a more in-depth explanation and discussion is needed, especially for readers less familiar with these dynamical features.

General comment:

- You include datasets based on ERA-Interim and ERA5. Please clarify what inconsistencies -if any- might occur in doing so.

Minor comments:

Abstract

- l. 5f Please be clearer about what kind of classification and the "few different large scale configurations".

Introduction

- l. 24 and later: You introduce pm10 here for particulate matter. Later (l. 117) you introduce it for particulate matter specifically of size 10µm. Please clarify this already in the beginning.
- You consider both winds and waves as hazards, so I would suggest including a quick explanation how both influence each other, see e.g., Gentile et al. (2021) and Gentile and Gray (2023; also including dynamical features)
- l. 44f: Please refer to these studies directly instead of a not-published thesis.
- l. 79f: Please introduce the abbreviations of all features in the same paragraph (→ l. 39) and then use these abbreviations throughout the manuscript.

Data and Methods

- l. 101 Which figures to you refer to by Fig. "X and Y"? I had a hard time following the different clusters. Please include at least a small description with characteristics and a similar figure to Givon et al. (2023) of the clusters in the appendix or supplementary material. Maybe also show and discuss Fig. 8 earlier. This would make it easier for the reader to follow your discussion.
- l. 114 This sentence is confusing to me. Do you mean you take the average height of the top 33% wave heights? Please clarify and rephrase this sentence.
- l.128 What do you mean by distinct? A few more details about the detection methods should be added for understanding.
- l. 132 Is there more work on this than a not yet published thesis that can already be cited here?
- Fig. 2 Consider swapping the subfigures to be consistent with the order of how they have been introduced. Also, add (a) and (b).
- l. 161: "30°C"
- l. 172f See main comment 2: Which hazards associated with fronts are you interested in – wind, precipitation, or both? Describe the hazards associated with the features.
- Is Cyclone ID = Storm ID?
- l. 206f I would suggest adding a half sentence explaining Monte-Carlo samples and/or include a reference.

Results

- l. 227 "have a points"
- l. 240 and throughout the chapter: Use Fig. X and Sect. X.
- l. 266 What do you mean with "cluster 2,4?" ?
- l. 297 Again, consider putting figures like this that you do not deem important enough for the main manuscript in the Appendix/Supplementary material.
- l. 303 I suppose these are some remnants of an earlier version/comments?

- l. 328 This seems to be similar to Central Europe then (Hewson and Neu, 2015; Eisenstein et al., 2023). Did you expect differences?
- l. 332 "has and intense"
- l. 335 and 228 Is this the cold conveyor belt (jet)? Or the precipitation associated with the cloud head/WCB? Please comment on this.
- Fig. 9,10,11 Consider using "row" instead of "line". Further, I suggest changing the caption to "Probabilities (shading) [...]."

Discussion

- How would events be taken into account that are detected shortly after one another (if you would look at more time steps, main comment 1)?
- l. 399 "shows that_ overlap […]"
- l. 452ff the reader would benefit from a clearer description of the WCB earlier here (see main comment 2)
- Same paragraph: What about turbulence of the features, affected area etc.
- l. 463 How come DIs tend to occur far from the cyclone centre comparing it to the figures of Browning (1997)?

Conclusion

- l. 506 "where"?