

Review of manuscript « Extreme Mediterranean cyclones under future climate change »

This manuscript analyses the most extreme precipitation, wind and precipitation-wind events induced by cyclones in the past and future climate using the regional downscaling of a long climate simulation. The results are interesting, and partially in accordance with previous literature on the topic, although the regions and periods of the analysis do not overlap with other studies. The topic is of strong interest, but lacks a more precise comparison with existing literature and a systematic assessment against observational reanalysis. For these reasons, I believe the work must undergo a major revision before being reconsidered for publication in WCD.

General Comments

The paper analyses changes in Mediterranean cyclone extremes in the future climate against the past climate (XIX century). This should be emphasised in the title and in the abstract, as the present version may be understood as future changes compared to the present climate.

In the title and in the text you should also specify you are considering « extremes induced by/associated with Mediterranean cyclones », rather than « extreme cyclones ». The second formulation can be read as a measure related to the intensity of the pressure low rather than the intensity of the cyclone impacts.

How do you know that the changes in the extremes (specially in wind) are not driven by changes in cyclone depth, and hence in the intensity of the gradients around the cyclone center ? Have you verified this ?

In my opinion, for the applicability of the results to the real context of the Mediterranean climate, it is not sufficient to say that « WRF reproduces the main cyclone hotspots and these results are in line with previous studies ». (Lines 366-367)

To assess the model performance and attendibility, it is necessary to :

- verify cyclone density in the model against ERA5.
- verify the cyclone-centered analysis of extrema against ERA5.

This should be done using the overlapping period between model simulation and ERA5.

Section 2.3 is not clear in describing the definition of cyclone-related extremes. For more details see the related Specific Comments.

Sections 3.2-3.4 : You can compare the position of extremes/compound extremes with the results by Rousseau Rizzi et al 2024.

Specific comments

Line 1 : You use the term « intense » although, as you say in second sentence of intro, Mediterranean cyclones are usually less intense than Atlantic cyclones.

Line 5 : Could you change the EXC acronym? EXCY or CYEXTR or other? EXC is a bit confusing as it is used as an abbreviation for excellency, except, exception, ..

Line 10-11 : Could you rephrase this sentence to improve clarity ?

Line 21 : windstorms are « strong » rather than « heavy ».

Line 25-26 : I find this sentence is unrelated with the previous. You could maybe say instead that climate change may play a rôle in aggravating the intensity of these extremes.

Line 27 : « influence » rather than « impact ».

Line 37 : « a reduction in the intensity or in the frequency of cyclones ».

Lines 47-50 : I would exchange the order of the two sentences, to first introduce PV streamers, and then talk about how these are reinforced by diabatic processes in the low levels.

Line 53 : Schermann et al does not support the statement that « Low-level diabatically produced PV is often the dominant source of PV in Mediterranean cyclones ». I would rather say that upper-level PV forcing is the dominant source in Mediterranean cyclones. Then diabatic PV contributes to the lower-level PV as specifically discussed in Schermann et al. Can you correct or explain/motivate your statement further ?

Lines 54-56 : Could you specify whether the works you cite refer to all extratropical cyclones, Mediterranean cyclones or cyclones from a specific geographic region ?

Line 55 : Is the wind speed in the warm sector reported by Priestley and Catto, 2022 linked to an increase in the low-level diabatic PV, as your sentence suggests ?

Line 66 : One big caveat using GCMs to... Could you complete by saying what you use the GCMs for ?

Line 84 : Does the global CESM model present any dynamical biases in jet position, intensity, or other features affecting the Mediterranean region ?

Line 125 : As in the article title, « extreme cyclones » is confusing, as readers may think of cyclones which are extreme in intensity rather than cyclones which lead to extreme weather in terms of wind and precipitation.

Line 126 : Is it correct that for every cyclone, at time of slp minimum, you find the grid value corresponding to the 95th percentile among the grid points within the 500 km radius ? And then do you use this value to select the 50 cyclones with most extreme wind ? Please describe more clearly.

Line 129 : For timing of peak precipitation in Mediterranean cyclones see also : Flaounas, E., V. Kotroni, K. Lagouvardos, S. L. Gray, J.-F. Rysman, and C. Claud. 2018. "Heavy Rainfall in Mediterranean Cyclones. Part i: Contribution of Deep Convection and Warm Conveyor Belt." *Climate Dynamics* 50: 2935–2949.

Line 130 : It is not clear what you mean with « the rolling summed 6 hourly 95th -percentile precipitation within the 500 km radius ». Please improve the description. Do you mean the 95th percentile value of 6h-accumulated precipitation among the grid points within the 500 km radius ?

Line 132 : Is t_{precip} the time when the 95th percentile in the 500 km radius is the highest ? Again this is not clear from the text.

Line 134-136 : I don 't understand the reason for transforming the data. Can you explain ?

Line 143 : Do you mean for the « seasonality » instead of « climatology »?

Line 152 : I think you should specify here that you select the 5 % most extreme cyclones in terms of the 95th percentile of the impact variable withing the 500 km radius around the cyclone at reference time. If this indeed corresponds to your methodological response.

Line 378-380 : Can you describe the regional dependences of these results and how they relate to the results of your work ? In fact, Zappa et al 2014 and Reale et al 2021 show many regional details, which may or may not be in accordance with your projections for EMED/WMED.

Line 386-388 : Can the increase in PV be associated with a greater occurrence of the cyclones over the surface of the sea ?

Line 400-401 : Can you outline how your results for wind extremes relate to previous literature on the topic ? How do you accomodate your results showing an increase in the intensity of cyclone-associated wind with the literature you cite in lines 43-44 ?

Line 403-404 : Unclear how this aspect impacts your results.

Line 426-427 : I think there is a logical inconsistence here. The number of extreme cyclones you consider does not depend ONLY on the number of ensemble members, as suggested by your sentence.