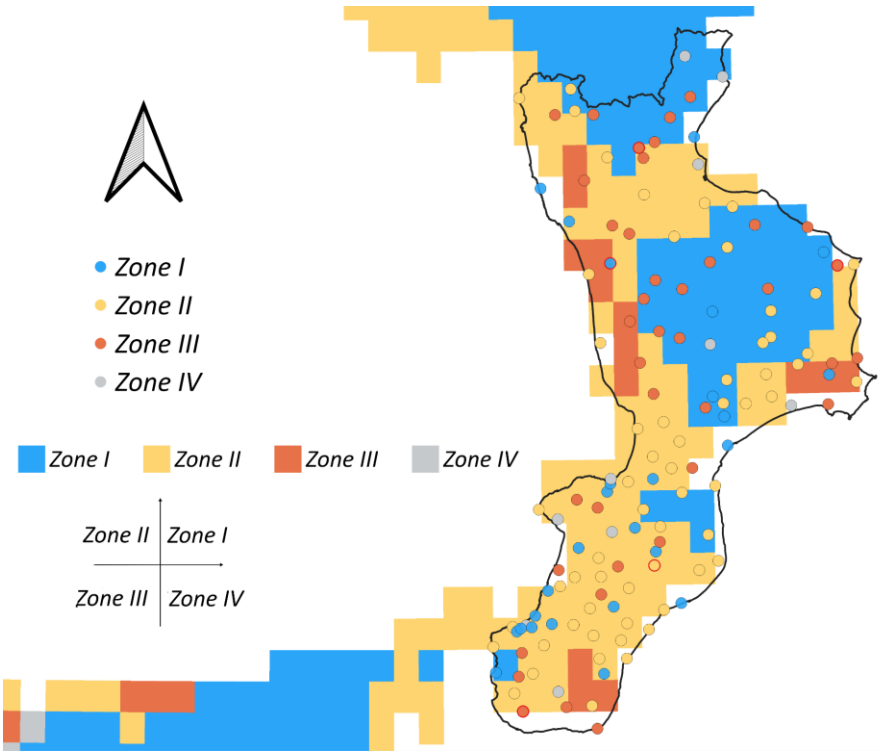
We would like to warmly thank the Referee for their thorough review of our paper. The comments and suggestions provided, some of which particularly sound from a technical point of view, will contribute significantly to improving the quality of our paper, making it more effective and clearer. Please find below our point-by-point responses (in red text).

In their study "Increasing Daily Extreme and Declining Annual Precipitation in Southern Europe: A Modeling Study on the Effects of Mediterranean Warming" the authors investigate how projected changes in SST would unfold with respect to precipitation extremes of the Mediterranean north shore and in particular for the region of Calabria. In addition they elaborate on the hypothesis that there is a general trend of decreasing total annual precipitation along with increasing daily maximums, based on an analysis of reanalysis data and local observations. The paper addresses an important topic and the rationale is reasonable. The analysis is sound and well structured. Some arguments and conclusions may require a deeper analysis and discussion than currently presented, also given the limited significance of the trend analysis.

We thank the referee for the positive feedback and acknowledge that some aspects of the analysis require further strengthening. Below, we attempt to address the suggested concerns and comments.

1. The analysis of the ERA5-Land data for the EURO-CORDEX area does show negative trends but they are only significant for the Iberian peninsula and some regions of northern Africa. The findings for RX1day are even weaker. This lack of robustness should be addressed in more detail in the discussion. From ERA5-Land it looks like for the Calabria region, most pixels are seen in zone I of Fig. 3 and only a few in zone II which would contradict your statement about the match of ERA5-Land and the local observations. If you skipped the non significant values in Fig. 5 only a few would remain. What's the reason for the non-significance? Are there recurrent outliers in the observations?

The issue of statistically non-significant trends will be addressed more carefully in the discussion, in which we will also expand our references to literature addressing the same topic, e.g., the very recent work by Beranová et al. (2025).
Regarding the behavior of ERA5-Land in the Calabria region, it is useful, as suggested by other referees (specifically, Referee #2, major comment no. 4), to provide a data comparison between the gridded dataset and observations. The figure below illustrates the compound annual trends of PRCPTOT and RX1day over Calabria from 1955 to 2023 derived from both gauge-based and ERA5-Land datasets. It reveals that ERA5-Land mainly represents zones I and II, whereas ground truth measurements indicate that zones II and III are the majority. Notably, the statement of a possible match and potential alignment between ERA5-Land and the local observations is more supported in zone II (please refer to our reply to Referee #2, major comment no. 4, for a comparison of the PRCPTOT and RX1day trends separately).



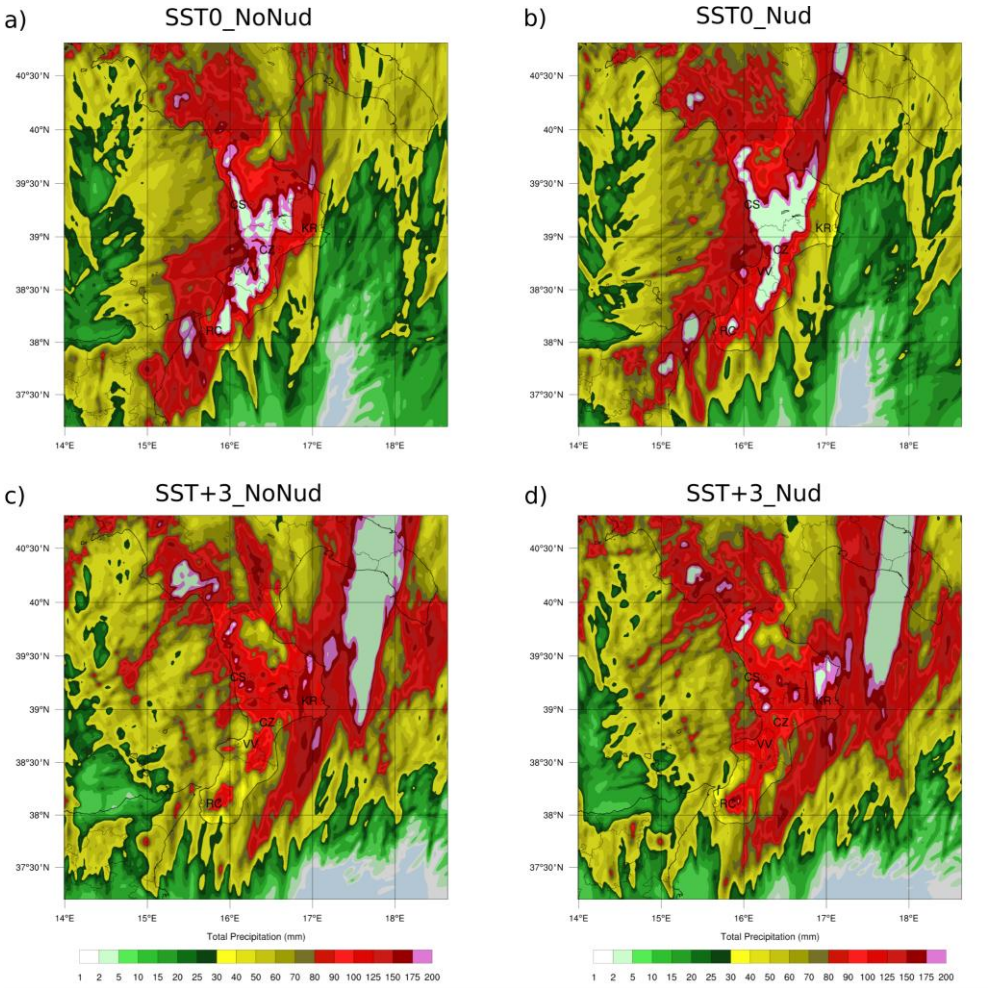
2. For the simulations with the regional atmospheric model it is assumed that just the SSTs are changing according to certain SSP scenarios. The atmospheric properties remain unchanged which creates an inconsistency for the described future conditions. In your WRF configuration, the GHG settings seem to be constant across your simulations. Later WRF versions, e.g., with the CAM radiation scheme allow for an adjustment of GHG concentrations and also support different SSPs. With these updated atmospheric settings, you should obtain a more realistic interplay between sea surface and the atmospheric boundary layer, mostly due to radiation effects.

The main aim of our paper is to investigate the extent to which Mediterranean Sea warming contributes to the seemingly counterintuitive increase in daily precipitation extremes in southern Europe, despite a general decline in annual precipitation. Our scientific objectives lie in a robust "research line aimed at disentangling the expected influence of sea surface warming, even combined with orography, on cyclonic events features in Southern Europe" (L339-340). Therefore, adjusting GHG concentrations according to specific or more SSPs goes beyond our scope. Incidentally, making this choice would inherently imply the prior choice of a particular scenario and time period, which is not our intention. On the other hand, we are currently conducting convection-permitting climate simulations in the study area (https://doi.org/10.5194/egusphere-egu25-15936), which represent an area of future investigation for us (L411).

3. Another concern is the influence of large scale dynamics and patterns. From the text it is not clear whether you applied the updated SSTs to both domains. I assume you did so also for the outer domain. Adding this much energy to the full extent of domain one could considerably change the larger scale dynamics, patterns and feedback. Therefore, to corroborate your findings of translocated precipitation events, I recommend to create another

set of simulations to apply some spectral nudging to the outer domain, at least for the geopotential, to ensure consistency of the large scale structures also with respect to ERA5.

We uniformly applied temperature changes (+3 °C and -1 °C) to the SST fields on both calculation domains, including the outer domain. This aspect will be better specified in the revised version of the manuscript, as required also by other referees.
Concerning spectral nudging, following the Referee's suggestions, we performed two new experiments, both applying spectral nudging to the outer domain (D01) on the geopotential (ERA5 source) at heights above 500 m, for SST0 and SST+3 scenarios. The figure below shows the results of event 12: a) SST0 without nudging; b) SST0 with nudging; c) SST+3 without nudging; d) SST+3 with nudging. While precipitation fields undergo slight changes, the effect of nudging is almost null concerning the extent of the eastward shift in precipitation, therefore confirming the robustness of our previous analysis.



4. Moreover, the effect of sea surface salinity should also be considered in your discussion or limitations section. Would the increase in SST and a decrease in total precipitation lead to increased salinity levels and how could that potentially diminish evaporation and consequently reduce severe precipitation events?

We will discuss this aspect in the discussion section of the revised manuscript. We thank the referee for pointing that out.

5. How relevant are gradients between the SSTs of the Tyrrhenian and Ionian Sea for the emergence of extreme precipitation events in the region?

Generally, changes in the SST distribution significantly impact the location of cyclone minima over the sea, and gradients between the SSTs of the Tyrrhenian and Ionian Sea could further enhance the emergence of extreme precipitation events in the region. Although particularly interesting, we believe that this question exceeds the scope of this study (it is worth noting that we perform spatially *homogeneous* variations of the SST fields across all domains) and could lead the reader to possible misunderstandings. Therefore, we will perform the analysis suggested for our study period and consider whether to include it in the manuscript or supplementary material in the next steps of the review process.

6. How are the main horizontal wind fields for the precipitation events (Fig. 12) organized? Is there any obvious clustering for the big events, e.g. all originate from the south? Is it possible to annotate the dots of the events with an arrow that shows the direction of the storm path?

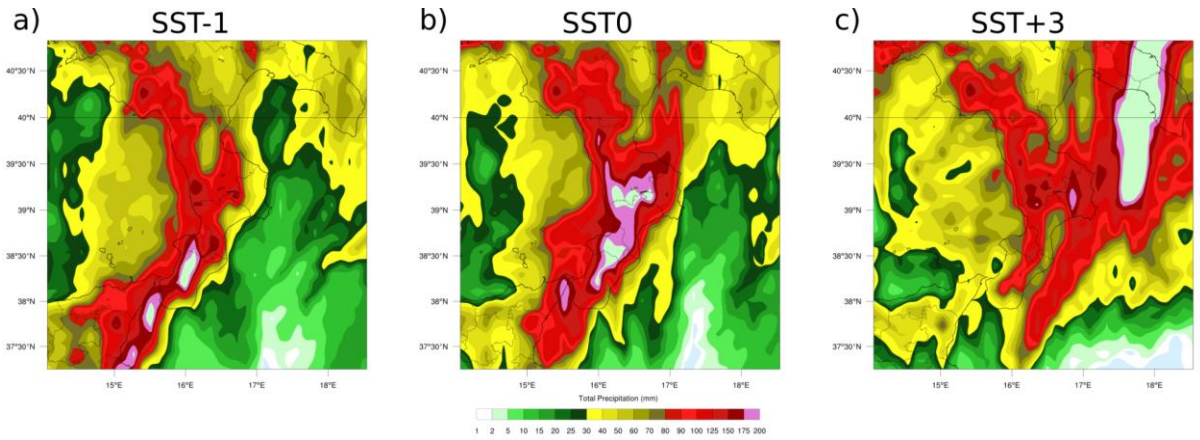
We thank the referee for this comment. Adding the direction of the storm paths will not be straightforward, but it would add another interesting piece of information to Figure 12. We will strive to find the most effective way to implement it. Concerning general circulation, broadly speaking, we have two main types of precipitation events, with fronts originating from the Tyrrhenian side (west/northwest) or the Ionian (south), which are typically those with the highest intensity. We provided a comprehensive study on weather patterns in the Mediterranean and their impact on the Calabria region in Mastrantonas et al. (2022).

7. Are the obtained spatial shifts of the event centers consistent for small perturbations (e.g. another PBL scheme or varied initial conditions)? Was there any spin-up performed to exclude impacts of imbalanced soil moisture?

We thank the Referee for this comment. About the spin-up: this is a single simulation from September 1st to December 31st, we did not consider the first potential event because it was simulated in the first week of the simulation, as can be observed from Fig. 9, where the event E1 is indeed the second event recorded in the study period. Small perturbations (i.e., using another PBL scheme) will be evaluated only for some events (e.g., event 12) to avoid excessive computational effort, and the results will possibly be shown in the revised version of the manuscript, either in the main text or as supplementary material.

8. How do these extreme events look like in the outer domain: Are the centers of precipitation mass identically located to what was found for the inner domain?

We will systematically analyze all centers of mass for the external domain and provide the results in the next steps of the review process. As a preview, the figure below illustrates the D01 precipitation fields simulated in the three different scenarios (a) SST-1; b) SST0; c) SST+3) for event no. 12. In the outer domain, the main features of the precipitation fields are confirmed, as precipitation shifts eastward and increases with increasing SST.



Minor

7. The title is probably not so ideal since your main focus is on SST sensitivity. Maybe better: "… on the Effects of Mediterranean Sea Warming"?

We thank the Referee for pointing that out. We will modify the title according to the Referee's comment, and following the same suggestion provided by Referee #3.

8. L33: Give the actual years instead of "In the last two years"

We will change the manuscript according to the comment and make the years 2023 and 2024 explicit.

9. L324: From Fig. 13 it seems that the storm system of event 12) travels along the coast in northward direction and that the high precipitation over the sea occurs after it traveled over the east part of the Calabrian coast rather than "exploding before".

We thank the Referee for pointing that out. We were referring to exploding before reaching the Apulia (north) coastline, but we agree the sentence is misleading. We will clarify this aspect in the revised manuscript.

10. L391: I think the investigation should not be called "comprehensive" since many real-world aspects had been left out in this PGW experiment.

The Referee is right, because we focus on SST increase. We will smooth such a sentence following the Referee's suggestion.

11. Figure 2: add the term ERA5-Land to the caption.

The term will be added in the caption. Furthermore, the figure will be slightly modified in accordance with Major Comment No. 2 of Referee #2.

12. Figure 3: add the term ERA5-Land to the caption. Increase image resolution.

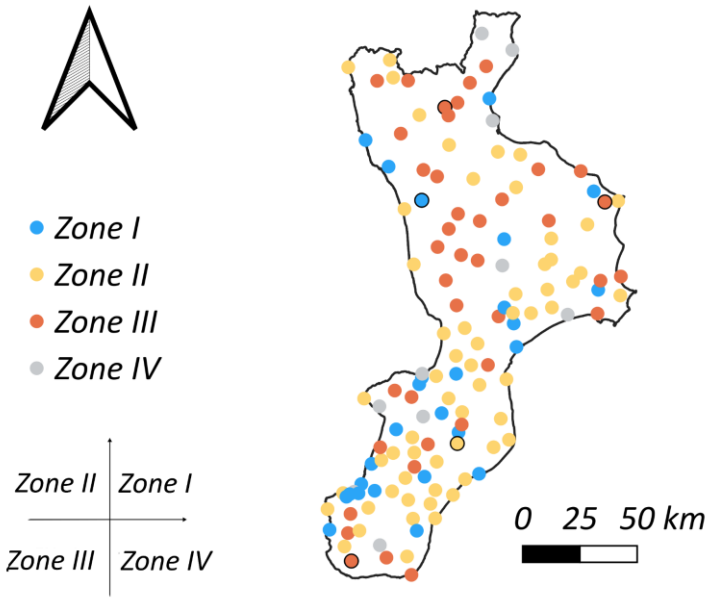
The term will be added in the caption. Furthermore, the figure will be modified in accordance with the specific comment about Figure 3 of Referee #2.

13. Figure 4: "Mann-Kendall and Sen's slope test for observations of a) ..."

The caption will be modified accordingly.

14. Figure 5: Increase image resolution. It would be good to scale the point size by the trend values. It's also hard to distinguish the significant values. A different color might be better to show them. Add "observations" to figure caption.

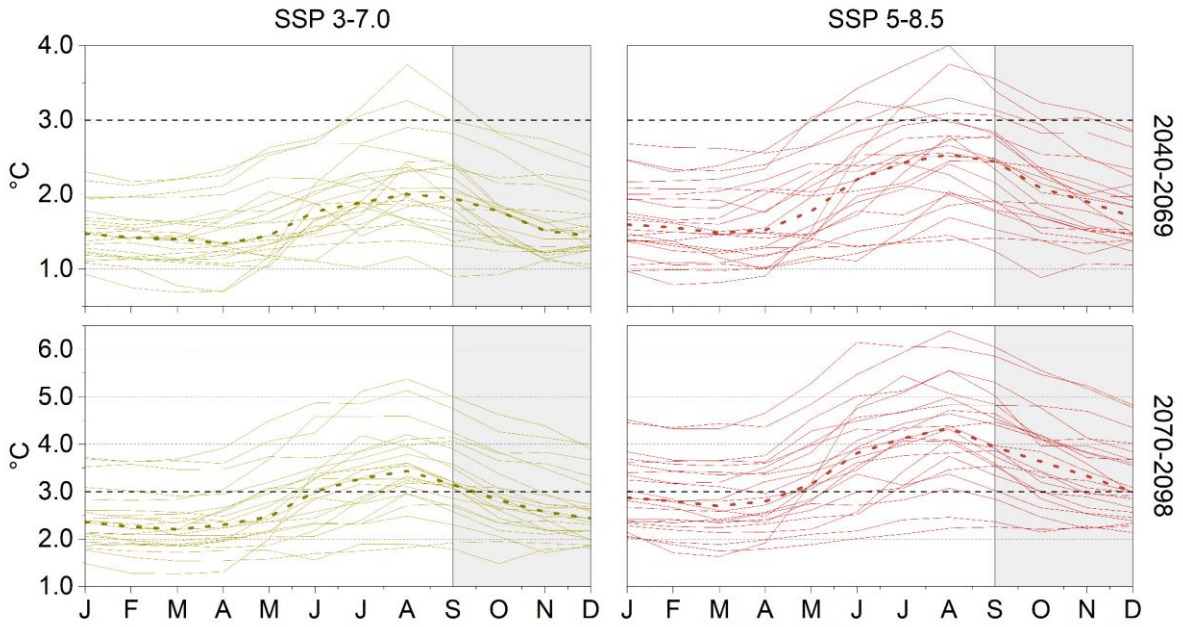
According to this comment and another from Referee #2 (specific comment related to Fig. 5), Figure 5 will be modified as shown below. Stations with significant values for both trends will have a thicker black border. Furthermore, the caption will be modified as suggested.



15. Figure 7 & 8: annotate the periods in the figure and add "GCM ID" or similar to the y-axis.

Concerns about Figs. 7 and 8 were also raised by other referees (Referee #1, Results and Discussion comment no.6, Referee #2, comment no.5, and Referee #3, comment no.5). Following Referee #2's suggestion, the representation of projected SST increase will be changed entirely, using only one multipanel figure with four spaghetti graphs, showing the SST increase compared to 1985-2014 in the periods 2040-2069 and 2070-2098, considering SSP3-7.0 and SSP5-8.5 scenarios, respectively. Additionally, according to Referee #1's comment, the area on which we will base our calculations is no longer the entire Mediterranean basin, but the external domain D01. The new figure is shown below (in the spaghetti graphs,

the dotted line represents the median behavior). We observed a slight increase in projected SST. Further details will be provided in the revised text.



16. Figure 10: Add "precipitation" somewhere in the figure caption

We will modify the caption as suggested.

17. Figure 13: Add red cross section line also to c) and e) and add the center of mass points for event 12; what is the unit of Omega?

We will add the red cross-section line and the center of mass points shown in Figure 12 in the sub-figures. Omega is formally defined as the variation of pressure over a time interval and is calculated in hPa h^{-1}. We will add units to the color bar legend.

References

Beranová, R., R. Huth, & V. Vít (2025). A multi-dataset analysis of precipitation trends in Europe. J. Hydrometeor., https://doi.org/10.1175/JHM-D-24-0114.1, in press.

Mastrantonas, N., Furnari, L., Magnusson, L., Senatore, A., Mendicino, G., Pappenberger, F., & Matschullat, J. (2022). Forecasting extreme precipitation in the central Mediterranean: Changes in predictors' strength with prediction lead time. Meteorological Applications, 29(6), e2101.