

## **Reviewer 1**

*This manuscript investigated historical and future wet-cold compound events (WCCEs) over Greece with observation data, reanalysis data and EUROCORDEX models. All models agreed that for the historical period, more events by the fixed threshold approach were found over mountainous regions while the percentile approach yielded more WCCEs over the eastern parts of the country and Crete. Furthermore, the projected changes in the number of WCCEs were investigated under RCP 4.5 and RCP 8.5. WCCEs obtained with percentile thresholds, were distributed mostly in Eastern Greece and Crete while their changes differed significantly among models.*

*This manuscript present too many elementary analysis about historical extremes for observations, reanalysis data and RCMs with different methods (24 figures) without giving a unified conclusion. On the other hand, the subject of this manuscript is compound extremes under climate change, but the discussion about changes in future compound extremes are too simple, with only spatial distribution of extremes. In my opinion, the historical results with obs, reanalysis and RCMS present the historical compound extremes and evaluate performance of RCMs in simulating compound extremes. Then changes in future compound extremes will be discussed in detail. I suggest the authors refine historical compound extremes analysis and reduce or combine some figures, give more discussion about future extremes. Additionally, many grammar errors should be corrected. Thus, major revision is needed.*

Answer: The authors would like to thank the reviewer for the valuable feedback to improve the manuscript. The figures about past period are reduced and greater analysis about the future period is provided.

*List of specific (major and minor) comments:*

1. *Abstract: Abstract mainly introduce data and methods used in this study without presenting the main results and conclusions. TX-RR, TN-RR, RCP should be given the fullname.*

Answer: Results presented briefly, fullnames written in new version.

2. *P1, L27: Please give full name of IPCC SREX.*

Answer: Full name is provided in revised version.

3. *P1, L35: "using projection data from and .": Not a complete sentence. Please confirm.*

Answer: Sentence is properly corrected in revised version.

4. *Introduction: Recently, there are plenty of studies about compound extremes, and please reorganize Introduction to show the most recent progress about compound extremes, especially for the study area.*

Answer: Thank you for the comment. The introduction has been re-organized. The investigation of compound extreme events is focused on wet-cold compound events. The few latest compound event studies referring to wet-cold compound events are discussed in the introduction.

5. P2, L66: *This study adopted EUROCORDEX under RCP 4.5 and 8.5. Why not considering CORDEX-CMIP6 under SSPs scenarios?*

Answer: We wanted to adopt models with the finest available resolution, because of the complex topography of Greece. EUROCORDEX at 0.11°. Future works of the authors will consider SSPs scenarios and regional downscaled simulations from CIMP6 global models.

6. P2, L71: *Is there citation about HNMS observations?*

Answer: HNMS does not provide a specific citation, only the site of the national service is available which has been added in the paper.

7. Figure 1: *The quality of the figure is too poor to see the details and the the fonts are too small. Please revise the figure and other related figure with higher resolutions and larger fonts.*

Answer: Figure 1 is replaced by a new version with clearer details and fonts.

8. L85: *Give full name of ECMWF.*

Answer: Corrected in script.

9. L94: *Please give the reason that such five models are adopted.*

Answer: This is answered in the manuscript. These models have the finest available spatial resolution, daily resolution for the periods we examine and also adopted and validated in Cardoso et al., 2019.

10. Section 3.1, L132-138: *It seems that the definitions of TN5p, TX5p, R95p, R20 are same as those in ETCCDI? If so, please cite it.*

Answer: Thank you for the comment ETCCDI has been added in the script. Also now the study focuse only in fixed thresholds.

11. Section 4: *In my opinion, this section mainly showed the historical results with obs, reanalysis and RCMS and evaluate performance of RCMs in simulating compound extremes in order to investigate future compound extremes with RCMs in Section 5. This section presents too many elementary analysis with too many figures, and some figures are mentioned with few words. Please consider combine similar figures, such as Figs 3-5, 6-8, 9-11 and so on. Additionally, I think compound extremes by observations and reanalysis data are used to evaluate the performance of RCMs in simulating extremes, so Section 5.1 should be mentioned together with observation in Section 4, as well as historical extremes by RCMs. And more deep discussion is also needed.*

Answer: The authors took into consideration this valuable comment and required changes have been applied in the paper by changing section and the context in sections 4,5 and 6.

12. L195: "4.3 HNMS" should be "4.1 HNMS...", L209: "4.4..." should be "4.2..."

Answer: Section numbers changed accordingly in revised paper.

13. *The captions of all figure should be given in more detailed description, such as the meaning of black points in Fig. 6, etc.*

Answer: Box-plots black points are discussed in methodology in revised version. Also, more detailed captions for all figures are provided.

14. L258: *Please confirm section number: "4.5.1 Empirical approach" and L280: "4.5.2 Copula".*

Answer: Section numbers changed in revised version.

15. *Since the manuscript mainly focused on compound extreme under climate change, changes in future compound extremes should be given in more detailed discussion. In current version, only spatial distribution of future compound extremes is discussed. Consider giving more discussion about changes in future compound extremes, such as their statistics, multi-model ensemble mean as well as their possible mechanisms, and so on.*

Answer: Mechanisms and further statistical analysis of compound extremes changes will be analyzed in future studies. Ensemble mean is added in the paper as suggested and used as the basis for the future changes of wet-cold compound events.

## **Reviewer 2**

*This paper focuses on the wet-cold compound events under climate change in Greece using a series of stations observation, reanalysis, and the historical and projection from the EURO-CORDEX. The research topic may be a relevant to the society, however, due to the poor writing and some infidelity in the data used for validation, I feel a major revision is needed, after a great and careful addressing of the following comments:*

### Major comments

*The writing of the whole paper is in a poor state, including some error in words, and vague expression including the title. The title is not good since it only uses a vague naming that covers the scope of the study, but failed with specific details, including the experiments, date time, etc. Such as, the reference seems to be investigating projection of compound events future projection, rather than climate change which may mean present and the future. Some*

*topics like “Investigation of the future extreme wet-cold compound events using EURO-CORDEX regional simulations from 2025-2049.”*

Answer: The paper has been changed radically as suggested as well as the title. Now the paper focuses only on fixed threshold wet-cold compound events and the analysis of future changes is conducted using the ensemble mean of the EUROCORDEX projection models. Title changed to “Investigation of the extreme wet-cold compound events changes between 2025-2049 and 1980-2004 using regional simulations in Greece”, since besides EURO-CORDEX simulations we use also the build in NCSRD WRF EC EARTH simulation.

*The picture used is in low quality. It is hard to see virtually every Taylor diagrams (Figs. 19-25) in the manuscript. Other than that, most of the figures are vague to see, poor in quality, which may need reproduction.*

Answer: All figures are corrected to the proper quality in revised version.

*Question the fidelity of using the reanalysis data since Greece is a mountainous region and the authors' conclusions seems to be largely associated with events on the mountains. There is potential of large cooling temperature and excess rainfall bias in the reanalysis data despite of the , the authors may find supplementary data from archives such as the Global summary of the day or month (<https://www.ncei.noaa.gov/access/metadata/landing-page/bin/iso?id=gov.noaa.ncdc:C00516>) for supplements to that of the reanalysis data for further evaluation, that would gain more fidelity of the study.*

Answer: Unfortunately, the dataset suggested by the reviewer does not contain observational timeseries in Greece. Also, authors could not find another validated dataset with observations for the historical period studied. Authors acknowledge the excess rainfall bias in low values, or days with zero precipitation, in the reanalysis data which however does not affect this study since its scope are extreme values and the upper tail of the precipitation distribution. Also, precipitation uncertainty is reduced during winter period since convective rainfall is rare during cold season over mountains.

*Creativity issue. The current study fails to go one step forward towards higher creativity. It is obvious that the study of the compound events is not uncommon, whatever the means. The authors haven't significantly separated themselves with these studies other than stating the regional uniqueness for this certain compound event examination. However, we need to note that creativity is insufficient just to use similar method and switching to another region. It may be better if the authors can separate themselves with that of the similar studies of other regions to counter this issue. One possibility is stating the uniqueness of the Greece mountainous regions, and how this trait affects the extreme compound event.*

Answer: The uniqueness of the Greece case is a combination of complex orography of the country which mostly affects fixed thresholds compound events since higher probabilities are spotted mainly in higher elevations. These events are mostly caused by the usual west-east movement of synoptic systems in these latitudes. However, Greece located in South Balkans can be affected in winter by Arctic air masses reaching Greece from North.

*What is the take-away message? The author may consider elaborating this part of the work, and how the conclusions drawn from the analysis may be applicable or vary to other mountainous regions around the world, such as that of the Tibetan Plateau, Rocky Mountains, the Andes, and the Alps. This may bring a more valuable message to the broader scientific community.*

Answer: Since the focus of the study now concerns only fixed thresholds, we expect that the rise of temperature will affect drastically the occurrence of wet-cold compound events in other regions of the planet too, although each area has its own unique characteristics\_

Minor comments

Line 1, the abstract lacks introduction with the compound events and how it is important to understand. One sentence at least should be used to state the importance.

Answer: A sentence added at the beginning of the abstract.

Line 35, “how the occurrence of these events will be affected by climate change. using projection data from and .”, there seems to be a dead sentence just here.

Answer: Error corrected in new version.

Line 57, “thence” -> “hence”

Answer: Error corrected in new version.