

#1 - Reviewer

The paper analyses weather events inflicting hazardous impacts over the Spanish northwest (NW) Mediterranean, such as floods and coastal storms characterized by high waves. The article analyses synoptic weather patterns (SWPs) conducive to compound events by combining an objective synoptic classification method based on principal component analysis and k-means clustering with Bayesian Networks (BNs). As the first method is a rather traditional method used in classifying synoptic patterns, the main innovation is adding BNs analysis. By adding BNs skills analysis to their classification method, the authors claim its advantage is characterizing the nonlinear relationship between SWPs and different variables for predicting compound extremes. The subdivision and research were done to contribute to understanding compound terrestrial-maritime phenomena in the study area and to assist in developing predictive and effective risk management strategies.

Dear Authors,

Your research is innovative by adding BNs to traditional methods. Your combined methodological framework shows promising results. However, my main issues are the work presentation, which is sometimes difficult to interpret, and your classification procedure. For example, the number of clusters you choose to describe the atmosphere seems too large. I.e., 18 weather types to describe 112 compound events? I have included my comments and suggestions below for you.

We appreciate the comments and time dedicated to the review and are very grateful for the accuracy of the observations. The revised version of the manuscript will address the two main issues pointed out by the reviewer, formal ones (work presentation) and the classification procedure. After considering the feedback from both reviewers, we are updating the manuscript. The revised version will now include an analysis of the model skill based on various factors: (i) different combinations of variables; (ii) domains; and (iii) number of clusters of the KMEANs approach “N”. Using the BN model skill results (synoptic skill) as a criterion, we will select the appropriate combination of domain, variables and N. We have nearly completed these tests, and preliminary results indicate that the number of clusters can be reduced for all types of events without a significant loss of model skill.

We will enhance the manuscript by emphasizing the BN results, both in methodology and results section. As a result, the description of weather types will be condensed and simplified. Additionally, we will improve the quality of figures, add corresponding label, and enhance figure captions in both the main manuscript and supplementary material.

Abstract

1. Line 26 – What do you mean by ‘reasonably’? Please give some quantitative estimates. Quantitative estimates will be given in the revised version of the manuscript, for the final combination of domain, variables and N.

Introduction

2. Line 56 – A few recent review articles on extreme weather in the Mediterranean region are missing from your reference list.

Flaounas, E., Davolio, S., Raveh-Rubin, S., Pantillon, F., Miglietta, M. M., Gaertner, M. A., Hatzaki, M., Homar, V., Khodayar, S., Korres, G., Kotroni, V., Kushta, J., Reale, M., and Ricard, D.: Mediterranean cyclones: current knowledge and open questions on dynamics, prediction, climatology and impacts, *Weather Clim. Dynam.*, 3, 173–208, <https://doi.org/10.5194/wcd-3-173-2022>, 2022.

Hochman A, Marra F, Messori G, Pinto JG, Raveh-Rubin S, Yosef I, Zittis G,. 2022. Extreme weather and societal impacts in the Eastern Mediterranean. *Earth System Dynamics* 13(2): 749-777. <https://doi.org/10.5194/esd-2021-55>

Zittis, G., Almazroui, M., Alpert, P., Ciais, P., Cramer, W., Dahdal, Y., et al. (2022). Climate change and weather extremes in the Eastern Mediterranean and Middle East. *Reviews of Geophysics*, 60, e2021RG000762. <https://doi.org/10.1029/2021RG000762>

[Thanks for the suggested references. They will be properly cited in the Introduction](#)

3. Line 61 – Do you mean ‘objective’ rather than ‘subjective’?

[Yes, indeed. This will be corrected.](#)

4. Lines 56 – 62 - A few articles on synoptic weather classification and their physical grounding are missing from your reference list. Please consider adding them.

For example:

The special issue entitled: Circulation-type classifications in Europe: results of the COST 733 Action .I would mention COST733 and describe its contributions in the introduction.

Hochman A, Messori G, Quinting J, Pinto JG, Grams C. 2021. Do Atlantic-European weather regimes physically exist? Geophysical Research Letters 48: e2021GL095574. <https://doi.org/10.1029/2021GL095574>

[Thanks for the suggested references. They will be included in the Introduction](#)

Data

5. Lines 120 – 125 – Please add more information on how wave height reconstruction was done. The following paragraph will be added to the section: “ The reconstruction process involved a multilinear regression technique, using five oceanic variables (significant wave height, total wave mean period, mean wave period based on the first moment, mean zero-crossing wave period and total wave peak period) and three atmospheric variables (mean sea level pressure, wind speed and wind direction at 10m) as predictors for the targeted buoy variables (Hs or Tp). To consider the influence of wind and the morphology of the Catalan coast, the data was divided into four groups based on wind direction (0° to 90°, 90° to 180°, 180° to 270°, and 270° to 360°), resulting in distinct regression coefficients for each group.”

6. Line 130 – Please add latitude and longitude to Figure 1.

[Figure will be corrected in the updated version.](#)

7. Figure 1 – Please increase the fonts of country labels. Please add the topography to the map.

[This will be corrected in the updated version.](#)

Methods

8. Line 146 – Please add detailed information in the caption of Figure 2 for the reader to be able to interpret your framework without looking it up in the main text. This comment can be applied to most of your figures.

Figure captions will undergo a thorough review following suggestions from both reviewers.

9. Line 161 – Typo remove ‘as.’

This will be corrected in the updated version.

10. In Line 185 and throughout the text, I think you mean ‘trough’ rather than ‘through.’

This will be corrected in the updated version.

11. Line 205 – Please add more information in the Figure 3 caption for the reader to be able to interpret without looking it up in the main text.

Figure captions will undergo a thorough review following suggestions from both reviewers.

12. Line 236 – Add information in the Figure 4 caption for the reader to be able to interpret without looking it up in the main text.

Figure captions will undergo a thorough review following suggestions from both reviewers.

Results

13. Line 246 – remove ‘affected.’

This will be corrected in the updated version.

14. Line 264 – Are 18 weather types for 112 events too large? How many clusters do you have, and what is the explained variance? The issue of selecting a priori number of groups is essential, and you should discuss it.

In the updated version of the manuscript, the BN-model skill will be used to determine the optimal number of clusters, comparing various classification domains and variables.

For compound and wave-only events, N values of 6,10 and 14 are under exploration, while for rain-only events, N values of 10, 18 and 26 will be considered. These different N values correspond to the varying number of each event type.

For example:

Falkena, S. K., de Wiljes, J., Weisheimer, A., Shepherd, T. G. (2020), Revisiting the identification of wintertime atmospheric circulation regimes in the Euro-Atlantic sector. Quarterly Journal of the Royal Meteorological Society, 146, 2801–2814. <https://doi.org/10.1002/qj.3818>

Thanks for the suggested reference.

15. Section 4.2 – I suggest significantly reducing the text amount in this section. It isn’t easy to read.

In response to the suggestions of both reviewers, this section will be restructured. The updated manuscript will place greater emphasis on the BN-skill analysis for the final classification and the posterior BN-characterization of weather types at the study site. Additionally, the description of weather types will be condensed in both the manuscript and the supplementary material.

16. Table 3 – Why is this table included in the text? Is it necessary, or can it be moved to the supplementary information?

This table will be moved to the supplementary material.

17. Figures 5, 6, and 7 – Please consider using anomalies in the figures rather than absolute values.

This point will be considered.

18. In all figures, please use letters (a, b, c..) for each panel so the reader knows what panel you are referring to in the text. Also, you mention these letters in the captions of the figures, but they need to be shown on the figure.

Figure captions and quality will be improved (and corresponding labels/letters will be added to the panels) both in the manuscript and in the supplementary material.

Discussion

19. The discussion section can be significantly shorter.

The updated discussion section will be reduced and adapted to the new version of the manuscript.

Supporting information

20. There are too many panels in the supporting information figures, which could be clearer to interpret.

Supporting material will be adapted to the new version of the manuscript.