Responses to Referee #2

Dear Referee,

We are very grateful for your comments on our article "Specific Climate Classification for Mediterranean Hydrology and Future Evolution Under Med-CORDEX RCM Scenarios".

We totally agree with all major and specific comments and recommendations. We propose to modify the manuscript in order to respond to all points raised especially about the link with hydrology and the discussion on the effects of the data resolution on the classification.

In this letter, the comments of Referee #2 are given in black and our responses in blue.

Kind regards,

Antoine Allam, Roger Moussa, Wajdi Najem, Claude Bocquillon

Overview

I am not very familiar with the climate subject. However, I find the paper very interesting. The methodology applied is very detailed, described and useful for other applications. Although the paper is well written, the take-home message is not clear. The paper claims to link climatic to hydrology. However, the link is not described. Some examples should be given to illustrate the link and the importance of hydrological modelling.

I think a flowchart with the step would improve the paper readability and facilitate the application of the proposed methods.

The authors need to elaborate more on the discussion in how their results affect the classification of climate and further on the predominant hydrological processes. Indeed, climate continuity seems vague.

We thank Referee #2 for all his comments and agree that the link to hydrology should be justified and detailed furthermore, the steps will be clarified in the methodology to improve the paper readability for further applications, and the discussion will be elaborated to show the impact of the classification on the Mediterranean hydrology.

We suggest modifying the text in section 3.1 as follows to show the link of the climatic indices to hydrology:

"The climatic indices were inspired from Köppen's definition of Mediterranean climates Csa and Csb to emphasize the precipitation and temperature variability between seasons and from the components of the water balance in its general form $P = Q + E$ (Where P = Precipitation, Q = Runoff, E = Evapotranspiration) to highlight the link between climate and hydrology. Hence Group I and III indices (I_s, $P_{25\%}$, $P_{75\%}$ and I_{Decal}) characterize Mediterranean Precipitation P in its seasonality and monthly distribution. Group II and IV indices (S_{PET}, I_{Arid} $T_{25\%}$ and $T_{75\%}$) characterize the hydrological loss to evapotranspiration in the Mediterranenan."

In section 3.6, we suggest modifying the methodology putting the gridded classification first, then the stations and last the catchment based one. The text will be as follows:

"The proposed methodology consisted first on calculating the grid based climatic indices using WorldClim-2 monthly data, second on reducing the number of indices with the PCA and third on classifying it using K-Means clustering. The gridded indices classification was later verified on the ground stations indices and then compared to the catchment scale averaged classification for future hydrological applications. In addition, a hierarchical decision tree was constructed to avoid repeating

the whole process when classifying projected indices. All PCA, K-Means and decision tree where calculated using SPSS software. Projected indices under RCP scenarios were calculated and classification evolution were then deduced."

Specific comments

What are the effects of the data resolution on the classification?

We agree that data resolution impact on the classification should be clarified furthermore, we suggest adding the following text in section 5:

"In this study, the climatic classification was applied and verified on three datasets of different resolutions, the grid based, the catchment based, and station based classification using the same climatic indices. The gridded data quality is limited by the spatial density and non-uniform distribution of the stations used for interpolation as they belong to different national and international networks, therefore, increasing the grid resolution can induce a loss of precision, data smoothing and increase uncertainty. Nevertheless, we can clearly notice that the grid based classification yielded the best resolution, however, despite the variability of the class boundaries between classifications, where some region shift from class to another, the overall classes setup was maintained from South to North."

How did you decide on the number of trees?

The maximum depth of the tree is set to 3 for Chi-square Automatic Interaction Detector (CHAID) method, however the level of the decision tree is automatically determined based on the classification rules to classify all the population, here gridded data. In this study the generated decision tree was of 3 levels and included 75 classification rules.

Why you need to reduce the number of indices, "random forest" does not do that already?

Thank you for this interesting comment, it let me deepen my knowledge in random forest.

We agree that "random forest" can be used for classification however it only allows the hyperparameter tuning while PCA performs dimensionality reduction, reduces the number of indices and allows a separate analysis for each parameter as we did in this article. Therefore, even with random forest we shall be applying PCA before either random forest or K-Means classification. In addition, this article advances the approach over the results, nevertheless "random forests" could be applied in future articles.

A more philosophical one: why not "R" or "Python"? The classification and machine learning methods are excellent, and it is easy to implement.

Ok, we agree that "R" and "Python" could have been better tools, however the SPSS is widely used for statistical analysis with a built in functions like PCA, K-Means and Decision trees and easy to use Graphical User Interface. In addition, we tried to emphasize the new classification and approach more than the tool.