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Reply on RC2

Camille Labrousse et al.

Author comment on "Declining water resources in response to global warming and changes in atmospheric circulation patterns over southern Mediterranean France" by Camille Labrousse et al., Hydrol. Earth Syst. Sci. Discuss., https://doi.org/10.5194/hess-2021-548-AC2, 2022

Dear referee and Editor

We are grateful for the valuable comments of our referees 1 and 2 (in the following R1 and R2) about our manuscript « Declining water resources in response to global warming and changes in atmospheric circulation patterns over southern Mediterranean France » that my co-authors and I submitted for publication to HESS. Please find in the following a detailed response to the comments provided by R2. Comments from R1 were already previously answered.

General comments

In line with the comments of R1, R2 also states that the manuscript is not clear enough with respect to the major objectives of our study. He/ she regrets that there are two distinct parts (the link between climate variables and teleconnection patterns on the one hand and statistical prediction of the evolution of future water resources on the other hand) which seem to be only loosely connected. We can see the point and will spent, in a revised version of the manuscript, additional efforts to emphasize more clearly our study objectives (which probably requires fully rewording of its introduction part). In fact, presentation of the statistical method which allows us to translate future T and P changes into future changes of surface water resources is not the major purpose of our paper, as this method has already been presented in a previous paper (Labrousse et al., 2020). We mainly use this method here to demonstrate that in the Mediterranean area where both air masses of Mediterranean and of Atlantic origins can control the evolution of surface water resources, prediction of future trends strongly depends on the specific influence of both regimes in a given study area and on the ability of climate models to reproduce these regimes in a realistic manner.

Specific comments

1 Introduction

52-64 : As mentioned above, the introduction will be reworded in order to make our study objectives more clear.

2 Materials and Methods

81 : Figure 1 has been re-edited and now also includes the gauging stations. It will be added in the revised version of the manuscript. We show it in the supplementary pdf linked to this reply.

87-89 : This statement will be replaced by « In our study, we use the gridded daily T and P data provided by Safran on a regular projected grid of 8 km x 8 km for the period 1959-2018 (Fig. 1). Safran is a mesoscale atmospheric system developed by the French meteorological agency Meteo-France that uses observation data as well as model outputs for the production of reanalysis data (Durand et al., 1993; Quintana-Seguí et al., 2008). »

92 : We will be more precise on this statement by saying « Although potential evapotranspiration (PET) can be directly extracted from the combination of Safran-Isba. Isba is a land surface model which uses the output data from Safran to compute water and surface energy budgets (Soubeyroux et al., 2008; Habets et al., 2008). »

94 : No PET was made available in the RCM we selected for our study. We used the formula from Folton and Lavabre (2007) because it's the one which was selected and validated for the reconstruction of annual water discharge for historical period in the previous study of Labrousse et al., (2020). This current article is the following of this previous work published in 2020, then it makes it more pertinent to use the same methodology.

101-108 : We will highlight this part in the revised version of the manuscript

120 : Here the text will be edited with **«** Reanalysis of monthly historical values for NAO and Scand were taken from the Climate and Prediction Center of the National Oceanic and 120 Atmospheric Administration of USA on the link https://www.cpc.ncep.noaa.gov/data/teledoc/telecontents.shtml. Reanalysis monthly historical values for MO and WeMO were made available by the Climatic Research Unit of the University of East Anglia on the link https://crudata.uea.ac.uk/cru/data/moi/. »

143 : A Morlet wavelet is a sinusoid modulated by a Gaussian function. It is therefore well suited to detect periodic oscillations at multiple time and frecuency scales for real-life signal such as non-stationary climate variables (Labat, 2005; Labat et al., 2005; Torrence and Compo, 1998).

148 : This was a proofreading omission, it was also criticized by R1, and we already corrected the Table in the case that we can use it in a revised version of our manuscript. We show it in the supplementary pdf linked to this reply.

3 Results

169 : For better clarity of the manuscript we will take into account this suggestion and rearrange our results accordingly in a revised version of the manuscript.

170 : RDI was the drought index which has been selected in the study of Labrousse et al. (2020) for the implementation of the statistical model. For the reason of continuity we maintained the same index in our present study.

K-means centroids were restricted to 2 or 3 because the study area is a relatively small region of 12000 km^2 and thus makes it more difficult and less consistent to study the relationships between climate and large-scale atmospheric pattern for a greater number of sub-units. In addition (and this is the main reason), in previous studies (Labrousse et al 2020, Lespinas et al. 2010, Lespinas et al. 2014) we could identify marked differences in

the average climatology of two distinct watersheds groups. One group with stronger precipitation seasonality is formed by the Herault, Orb and, to a smaller extent, Tech watersheds. These basins also showed a stronger warming trend in the last 60 years (Labrousse et al. 2020). The second group is formed by the Aude, Agly, and Tet watersheds which where less seasonal and for which the warming trends were lower. For those reasons is was pertinent to limit the K-means clustering to 2 centroids rather than more. Also a test with 3 centroids has been performed. As mentioned above, the Tech watershed showed characteristics situated in between the two other groups and this could translate the fact that a large part of the watershed is located in mountainous areas (the Pyrenees mountains) and thus its climatology and functioning could be impacted by this geographical feature. But the results of this test were less conclusive (see also our reply to R1) and we remained with our 2 centroid approach.

217 : Both P and T strongly depends on elevation and taking both parameters individually results in clusters which are mainly dominated by elevation differences. Combining both parameters as this is done in the RID-03 index outweighs to some extent the elevation effect on cluster formation and is therefore more suitable for the distinction of separate climate regimes.

264-265 : R2 is right here. It is more correct to say « variability » instead of « average values » as it better represents what is shown in Figure 4b. In a revised version of the manuscript, this would be changed.

281 : We agree. We could add the outputs for each GCMs in the Table 3 in a revised version of the manuscript

288 : We could change the « obs » label by «hist » which stands for historical reanalysis data. For figure 4b, we could think about a better way of presenting the time-series comparison between GCMs and historical reanalysis data

299 : This comment will be taken into account in a revised version of the manuscript.

4 Discussion

362 : We propose to reorganise the results and discussion sections accordingly in a revised version of the manuscript.

400 : Figure 6 shows the linear trends according to a scenario rcp 8.5 over the period 2006-2100. Therefore the reference period is the beginning of the time series. For water discharge, only simulated water discharge is computed here, from 2006 to 2100. Coherence of the statistical model used for the computation of the simulated series has been tested and validated in the study of Labrousse et al. 2020.

404 : Table 4 shows the linear trends for each RCMs and for each cluster. It means that we computed the trends (in %) for each RCMs and show the average results for the watersheds belonging to each cluster respectively.

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Please also note the supplement to this comment:
https://hess.copernicus.org/preprints/hess-2021-548/hess-2021-548-AC2-supplement.pdf