

SPATIO-TEMPORAL AND CROSS-SCALE INTERACTIONS IN HYDROCLIMATE VARIABILITY: A CASE-STUDY IN FRANCE

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1 Response to RC2

The authors want to thank RC2 for his comments, literature suggestions and very helpful detailed review. Responses to each point in RC2's additional pdf are provided below.

5 *Line36: non-stationary in the long-term (I imagine this is what the authors mean here)*

We use the strong stationarity definition that is, the joint probability distribution is not time dependent. Thus, a non-stationary signal is a signal with a joint probability distribution that changes with time. It is not tied to any long term period, or scale, and can be present at any time.

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Line 76: Maybe it is worth to add a paragraph explaining how the authors dealt with changes in river management: were there any dam construction, or management through direct water uptake, during the chosen period? This element could artificially modify the results.

15 The dataset used is a near-natural watersheds compilation by Giuntoli et al 2013, thus anthropogenic modifications were discarded as much as possible. We think discussing the methods used to determine the near naturalness of the watersheds is beyond the scope of this article, however, we mention the procedure used by Giuntoli et al. 2013, in the revised paper.

20 *Line 182. What do you mean with annual variability? Seasonal? Mixing seasonal and inter-annual variability is actually interesting for precipitation, in areas where the seasonal cycle is very low. In these regions, the seasonal cycle does not overwhelm other long-term variances, and this should be highly emphasized. In the NE and CE cluster the seasonal variability (1-year-period) is much lower than the 6-8-year variability. Instead, in areas featured by Mediterranean climate (SW and SE), almost only the seasonal cycle is detectable. These considerations deserve a wider description. Also, fig. 4c needs more*

25 *explanation on its physical meaning. It is not clear to me how significant can be, for instance, the NW cluster (light green) for the 8-year period. The 8-year cycle seems to be observed over a period shorter than 16 years (two cycles).*

In the article we use the terms "intra-seasonal", "annual" and "inter-annual" for corresponding wavelet periods of less than one year, one year, 2-4 and 5-8 years respectively. The terminology comes from the wavelet analysis framework, onto which cross-scale interactions analysis is also based. We have added a paragraph explaining the terminology in the methods section
30 (Wavelet analysis sub-section).

*Line 185. Figure 5 is almost neglected, while it is important because now the seasonal cycle and the interannual and multian-
nual scales are not mixed. Here too I have doubt on the statistical significance, though. The yellow cluster has its 6-year-cycle
only between 1989 and 1997? More physical insight is needed, I am still puzzled by these results.*

35

Both in the fuzzy clustering sub-section, and below figures showing wavelet transform, we omitted the precision that the clustering was made on the entire wavelet spectrum of each time series, and not just on the significant areas and that it is only for showing the differences between each region that we only show those significant areas in the Figures. The clustering is made on the entire wavelet spectrum because due to the nature of the statistical tests, significant areas in two regions may be
40 at a very similar frequency-time location but just slight shifted one versus the other. Also, the total area of significance on a wavelet spectrum is usually small (*i.e.* there are only few "circles") and thus those slight differences would bias the clustering, by giving too much weight in the estimation of the distance between two wavelet spectra to those slight differences. The areas outside of significant areas, even if they are true noise, are usually similar between wavelet spectra as well, so they tend to have a very small bias. It is thus more consistent to cluster entire wavelet spectra than just their significant areas. Note that in wavelet
45 analysis, significant areas are always areas of the highest variability, so those areas do show the most striking features of each region, but we may have mentioned such details in the paper. We revised both the wavelet analysis methodology sub-section and mention that in the figures, we show only significant areas for clarity reasons, that is, to be able to graphically compare the regions. We also added more discussion on Figure 5 (and subsequent inter-annual wavelet analysis figures).

50 *Line 222. yes, but on seasonal scale (e.g. Ardilouze et al., 2021), but on longer time-scales soil moisture hardly play a role (even if feedback mechanisms can prolong the effect of soil moisture on precipitation - Bellucci et al., 2021)*

We thank RC2 for providing us those very useful references, which we used in the framework of a deeper discussion, in conjunction with a deeper discussion of the feedback dynamics that are necessarily present in case of cross scales interactions
55 to offer some physical insight on the role of both climate and soil state forcing on the identified interactions.

Line 268: citation needed after soil moisture (Miralles et al., 2012; Matera et al., 2021)

