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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Evapotranspiration feedbacks shift annual precipitation-runoff relationships during multi-year droughts in a Mediterranean mixed rain-snow climate" *by* Francesco Avanzi et al.

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Dear Colleague,

Thank you very much for the thoughtful review of our paper. Please find below our point-by-point reply to comments, including our intended changes to the manuscript. Your comments are in italics, with our replies are in plain text.

Overall, this is a very interesting and relevant piece of work. However, authors tend to generalize and leave the reader hanging in some cases which raises some questions.

Please see below specific comments for your attention.

Thank you for your comments, which will be considered in our revision.

Title needs modification, it does not communicate the focus of the study, especially after reading the first sentence of the abstract.

Our choice was to summarize the main finding of this paper as title. Albeit infrequent, this choice is increasingly popular in hydrologic literature (https://www.the-cryosphere.net/8/257/2014/, https://www.pnas.org/content/110/38/15216, https://agupubs.onlinelibrary.wiley.com/doi/10.1002/2016GL071999, just to mention a few) and it does, in our opinion, communicate what is the main focus of the study, that is, the impact of droughts on the water balance of Mediterranean mixed rain-snow catchments.

At the same time, we acknowledge that some word choices in the current title may sound unfamiliar for the broad audience (e.g., precipitation-runoff relationships). We will therefore propose a revised title as follows: 'Evapotranspiration feedbacks during multi-year droughts shift the water balance of mixed rain-snow catchments'

Abstract

Did authors focus on the effect of drought on shifts in precipitation-runoff relationships and the performance of the model? Authors need to clarify the catchment/s studies. Or they use one catchment with sub-basins, and if so, the results reported should be for the basins?? The abstract has to be summarized and comprehensive.

We focused on three points: (1) we quantified shifts in precipitation-runoff relationships in four nested catchments of the Feather River; (2) we assessed performances of the PRMS model in these nested catchments during droughts and in particular during periods corresponding to shifts in the water balance; (3) by leveraging the fact that the performance of the model was sensitive to these shifts, we identified the water-balance term for which accuracy during droughts was statistically different from accuracy dur-

ing wet periods (ET). We concluded that a different functioning of ET between droughts and non-drought periods is the likely cause of these shifts.

This point is general and goes beyond the specific catchments we considered. In the current version of the abstract we thus focused on these general points. In the revised manuscript, we will add more details on results of the nested-catchment studies (e.g., differences between sub-surface-dominated and surface-runoff dominated catchments).

Introduction The motivation and novelty of the study is very week. The introduction lacks coherence. For example, the reader has to be able to identify:

1. overall effect of droughts on water balance in Med climate, with specific examples.

2. The approaches of examining precipitation-runoff relationships and how successful they have been in the same climate.

3. What has been done so far in relation to precipitation-runoff relationships or water balance studies within the same climate. This indicate the contribution of the work and its novelty.

We will fully revise the Introduction following reviewers' suggestions. We agree that the Introduction must focus more on droughts in regions with a Mediterranean climate.

Research questions: Authors need to improve and rewrite all their research questions to be clear. It's very difficult for the reader to understand them. They raise a lot of questions: what is the water-balance predictive skill? Are the authors referring to the potential of the model to predict shifts during drought and non-drought periods???

We will revise all questions for clarity. In so doing, we will avoid any wording that could sound too specific and unsuitable for a broader audience.

With 'water-balance predictive skill', we meant the performance of PRMS in predicting precipitation, ET, changes in sub-surface storage, and runoff. This will be also clarified.

What is the suitability of the generalized additive model in predicting ET for the catchment? Was it used before?

The procedure is a modification of the well-cited approach by Goulden et al. (2012), which has been used in multiple papers since then (see references to our work, below). The Rungee manuscript mentioned on P5 L4 and L6 will be submitted to HESS by R. Bales (Rungee has moved on to a new position), and if accepted as a discussion paper all methods related to the updated ET product we used here will be freely accessible online by the time the revised version of this manuscript will be submitted. The authors welcome public comments on the method in the Rungee manuscript, which moves from one independent variable (NDVI) in published papers by Goulden/Bales to 2 independent variables (NDVI and precipitation). Adding the additional variable both recognizes the responsiveness of ET to precipitation, independent of NDVI, and provides a lower error. The accuracy of this ET product will be also discussed in the revised version of this manuscript, and we will include an analysis of the 2-variable vs 1-variable approach in the supplement as needed. There is no independent, accurate spatial product for ET for the Feather River basin; however, we present a leave-one-out cross validation in the Rungee paper. Finally, we are also creating a DOI for the flux-tower datasets and ET products in that paper, which are published in the Rungee (2018) paper cited in our manuscript.

References

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6. A.W. Fellows | M. L. Goulden. Mapping and understanding dry season soil water drawdown by California montane vegetation, Ecohydrol.2017

Method

What were the characteristics of the Landsat-based annual-averaged NDVI? How was it derived? Is it a product or authors derived their own product through estimation? Any preprocessing of the image?

Landsat 5, 7 and 8 were used to map NDVI at 30-m resolution. Values were calculated from the Tier 1 surface-reflectance product downloaded from Google Earth Engine. NDVI values among different Landsat sensors were homogenized by cross-calibrating Landsat 7 (NDVI in 2012) and Landsat 8 (NDVI in 2013-2016) into Landsat 5. Annual Landsat NDVI maps were generated by averaging all pixels in a water year. Pixels with shadow, snow, or cloud were excluded from the calculation. We thought this too much detail for the manuscript, but can add it as needed.

Discussion,

I suggest authors use their main objectives as subheadings for the reader to understand the findings and their implications.

The three subsections of the Discussion do not directly relate to the main objectives

stated in the Introduction, but look at results from other perspectives to further clarify their implications. The main results of the paper and their link to our main objectives will be clarified in the first paragraph of the discussion.

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