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Comment on hess-2022-96

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Community comment on "FarmCan: A Physical, Statistical, and Machine Learning Model to Forecast Crop Water Deficit at Farm Scales" by Sara Sadri et al., Hydrol. Earth Syst. Sci. Discuss., https://doi.org/10.5194/hess-2022-96-CC2, 2022

Dear Authors,

Apologies for not sending my review on time. Please see three minor and four major comments below to initiate a fruitful discussion:

Major comments:

1) It is mentioned in the text that the key processes of the FarmCan model are the P, ET, PET, SM and RZSM. Also, as key climatic variables that link the water cyclic are the PET and SM, and that that the total energy of ET is more dependendable on SM. Please mention that the most important process that links the atmospheric water to the surface one, is the humidity (and all the related one, such as specific humidity, dew-point, etc.). This process is often either misused or forgotten; however, it is main link that drives the water-cycle (please see details and importance in a recent global analysis in https://hess.copernicus.org/articles/24/3899/2020/). Also, please consider mentioning how the FarmCan model takes into account changes in humidity, or whether it solely predicts precipitation.

2) It is mentioned in the analysis, that daily precipitation is predicted based on the Multi-Source Weighted-Ensemble Precipitation (MSWEP). Please mention that while these meteorological models are powerful in predicting changes in temperature, they often perfom very poor in precipitation (for example see such discussion, references and examples in https://www.tandfonline.com/doi/full/10.1080/02626667.2010.513518).

3) The so-called Hurst phenomenon (https://ascelibrary.org/doi/10.1061/TACEAT.0006518; power-law type of the autocorrelation function across lags and scales as comapred to the zero autoco-correlation of the white-noise) seems not to be taken into account in the analysis. This phenomenon (also known as long-term persistence or long-range dependence) is found in all key hydrological-cycle processes including the ones applied by the authors (see review, references, and results in https://www.mdpi.com/2306-5338/8/2/59). The Hurst phenomenon has been shown to explain a vast portion of the variability observed in these hydrological-cycle processes. Its existence is one of reasons that is difficult (or even impossible) to predict a hydrometeorological process' value beyond a specific time-window

(or else called time-window of predictability; https://www.tandfonline.com/doi/full/10.1080/02626667.2015.1034128). For example, in this work, the authors propose a 14-days. Finally, please note that the authors have not probably identify this phenomenon, since they only use data of 5 years of lengh, whereas the impact of the Hurst phenomenon takes place in the long-term scales (e.g., in more than 10-30 years). Therefore, it is expected that if a predictive model does not take it into account, in the long run it would end up underestimating the correlation of precipitation, evaportanspiration, etc.

4) Besides the Hurst phenomenon, which is responsible for the long-term auto-correlation function of each hydro-meteorological process, there is also the short-term auto-correlation structure, which is far from zero (i.e., in the case of independent variables). However, in the analysis, the authors mention that their applied method of Randon-forest can de-correlate the trees, and tackle the 'noise' sensitivity of the prediction. However, please note that even without the existence and impact of the Hurst phenomenon, the existence of a strong short-term auto-correlation function (i.e., at small lags and scales) cannot be easily get rid off by non-linear transformations. Therefore, the appearance of 'noise' is probably due to this impact, since all the processes applied by the authors at FarmCan (e.g., precipitation, evapotranspiration, PET, etc.) are shown to have a strong short-term auto-correlation function (for example, in https://www.mdpi.com/2306-5338/8/4/177/htm, in Figure 12, even after a 10 month period the correlation function of PET, as expressed through the climacogram, exhibits a value more than 0.5). Please consider estimating the auto-correlation functions (for several lags) of all processes inlcluded in FarmCan, so more light is shed in its impact to the prediction values and so as to further discuss this issue.

Minor comments:

1) In the Introduction, the water-food nexus is mentioned as an important impact of climatic variability; however, the water-food-energy nexus is more appropriate in my opinion (there are many works in literature about this triangle; see for example discussion in a recent one: https://www.mdpi.com/2673-4060/2/2/11/htm).

2) For the FarmCan model is mentioned that (ii) establishes a methodology to forecast PET, SM, and RZSM using P prediction. How about ET? Also, how is possible to derive the SM and RZSM value from the precipitation prediction? These two questions are not very clear for me in the text, please consider giving more information.

3) In the text it is mentioned that the assumption of an evenly distributed soil moisture across depth is used. Please consider giving some examples of how this assumption may affect the result and validity of the FarmCan prediction.

4) Please consider replacing (for the P, PET, ET, RZSM, and SM) 'variables' with 'processes', since all these processes are found to have strong auto-correlation structures and therefore, they cannot be mentioned as stochastic variables but rather as stochastic processes (the word 'variables' is used when there is absence of correlation, i.e., a white-noise behaviour; please see definitions and discussion in http://www.itia.ntua.gr/en/docinfo/2000/).

Sincerely,

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