Comment on hess-2021-569
Anonymous Referee #2

Referee comment on "Long-term trends in agricultural droughts over Netherlands and Germany: how extreme was the year 2018?" by Yafei Huang et al., Hydrol. Earth Syst. Sci. Discuss., https://doi.org/10.5194/hess-2021-569-RC2, 2021

The authors use Hydrus-1D to simulate water balance to test the impact of meteorological drought on the agricultural drought over 31 (over a 55-long period in 1965-2019) meteorological stations Germany and Netherlands by focusing on the exceptional drought in the year 2018.

The evaluation of this manuscript is based on the following questions:

- Is it a novel work based on a reliable scientific technique?
- Is it clearly structured and well-written?
- Are the experimental design and analysis of data adequate and appropriate to the investigation?

The manuscript is well-written and potentially interesting for HESS. It presents novel work on the extreme drought recorded in 2018 in continental Europe. Nonetheless, this manuscript requires substantial improvement before publication. The manuscript is not well-presented, model set up is oversimplified and data analysis is fair.

The main scientific question to the authors: is the 2018 drought an episodic event (as 1976 and 2003) or a consequence of a significant drying trend? From the abstract, the authors state that meteorological drought is episodic and SPI and other rainfall indeces indicate no significant declining trend while temperature-based ET is characterized by an increasing trend. The authors should quantify the probability related to this extreme episodic event from the SPI distribution. Same for the SSI as a consequence.
In summary, the increase of droughts is mainly related to increasing soil moisture deficits, and reduction in actual ET. The main driver is not a precipitation decrease, but an increase of potential ET.

Abstract

Abstract is generally OK. In order to get any feedback or relationship between climate and hydrological response through the use of indicees referred to six months or to the growing season makes sense. I recommend to remove indicees referred to 12 month duration since it ignores the fundamental impact of rainfall seasonality.

- Introduction

The state-of-the-art is well written. I list other interesting references on meteorological and agricultural droughts. Please see and comment about soil moisture index (Hunt et al., 2009).

- Data and Methodology

The authors should specify that the grass-reference potential evapotranspiration, \( ET_0 \) is converted into crop-specific potential evapotranspiration, \( ET_c \) by using a time-variant crop coefficient, \( K_c \). Then, \( ET_p \) is partitioned into potential transpiration, \( T_p \) and potential evaporation, \( E_p \) by using a time-variant leaf area index, LAI. Moreover, root depth is time-variant as the crop is annual and root distribution across the root zone needs to be specified. Actual evaporation, \( E_a \) and transpiration, \( T_a \) are calculated in Hydrus-1D depending on soil surface and root zone pressure head values, respectively. It is therefore clear that the simulation of \( E_a \) depends on time-variant crop characteristics and local soil hydraulic properties. In lines 174-177 I understand that \( K_c \) is ignored, LAI and root depth are considered as 2.0 (or 2.88) and 50 cm, respectively. The soil hydraulic properties should be ideally measured. If direct measurements are not available, it is highly recommended to use PTFs based on silt, clay, sand contents, bulk density and organic matter (Weihermüller et al., 2021; Nasta et al., 2021). This study is basically a sensitivity analysis by considering that the spatial variability is quantified only in terms of soil texture classes (the van Genuchten’s soil hydraulic parameters are crudely derived from tabulated values in Carsel and Parrish, 1988 in Table 3) and vegetation (assumed pastureland over the 31 stations) characteristics are constant in time and uniform in space.
In Eq. 2 remove P and ET from the Richards equation. P and \(E_p\) are the climate forcings on the upper boundary. \(T_p\) is reduced to \(T_a\) through the sink term, \(S\) in Eq. 2

- Results

Line 261: The strongest decrease in precipitation is in southern Germany (-2.2 mm/year) sounds really insignificant if compared to its mean annual value. From Fig. 2d, I see that the trend is from 800 mm/year (or so) to almost 700 mm/year (or so). Please explain.

Same problem for ET trends (Fig. 3)

To tell the truth, I don’t understand Fig. 7 and description of Fig. 7. Please, improve the presentation

- Discussion

Please, be more critical and evidence if there is room for future improvements

References

Hein, A., Condon, L., Maxwell, R. 2019. Evaluating the relative importance of precipitation, temperature and land-cover change in the hydrologic response to extreme meteorological drought conditions over the North American High PlainsHydrol. Earth Syst. Sci., 23, 1931–1950, 2019

Hunt, E.D., K.G. Hubbard, D.A. Wilhite, T.J. Arkebauer, and A.L. Dutcher. 2009. The development and evaluation of a soil moisture index. Int. J. Climatol. 29:747–759. doi:10.1002/joc.1749
Martínez-Fernández, J., González-Zamora, A., Gamuzzio, A. 2015. A soil water based index as a suitable agricultural drought indicator. Journal of Hydrology 522, 265–273

Nasta P., B. Szabó, N. Romano. 2021. Evaluation of Pedotransfer Functions for predicting soil hydraulic properties: A voyage from regional to field scales across Europe. Journal of Hydrology: Regional Studies 37, https://doi.org/10.1016/j.ejrh.2021.100903

Sánchez, N., Á. González-Zamora, M. Piles and J. Martínez-Fernández. 2016. A New Soil Moisture Agricultural Drought Index (SMADI) Integrating MODIS and SMOS Products: A Case of Study over the Iberian Peninsula. Remote Sensing. 8, 287; doi:10.3390/rs8040287

Van Loon, A.F. 2015. Hydrological drought explained. WIREs Water 2015, 2:359–392. doi: 10.1002/wat2.1085

von Gunten, D., T. Wöhling, C. P. Haslauer, D. Merchán, J. Causapé, and O. A. Cirpka. 2016. Using an integrated hydrological model to estimate the usefulness of meteorological drought indices in a changing climate. Hydrol. Earth Syst. Sci., 20, 4159–4175

Weihermüller, L., Lehmann, P., Herbst, M., Rahmati, M., Verhoef, A., Or, D., et al. (2021). Choice of pedotransfer functions matters when simulating soil water balance fluxes. Journal of Advances in Modeling Earth Systems, 13, e2020MS002404. https://doi.org/10.1029/2020MS002404