

Hydrol. Earth Syst. Sci. Discuss., author comment AC2
<https://doi.org/10.5194/hess-2022-28-AC2>, 2022
© Author(s) 2022. This work is distributed under
the Creative Commons Attribution 4.0 License.

Reply on RC2

Yongwei Liu et al.

Author comment on "Historical droughts manifest an abrupt shift to a wetter Tibetan Plateau" by Yongwei Liu et al., Hydrol. Earth Syst. Sci. Discuss.,
<https://doi.org/10.5194/hess-2022-28-AC2>, 2022

We appreciate the constructive criticisms and suggestions. We have addressed your concerns below.

Reviewer Comments 2:

The authors conducted this study to understand the historical trends and abrupt shift of droughts on the Tibetan Plateau (TP). They found that the TP is getting wetter, particularly after the middle of 1990s. I found this topic is relatively new, particularly using the soil moisture as the indicator to understand drought, and analyzing its trend. But I still have some concerns before considering for acceptance in HESS. Thus, this manuscript is subject to between moderate and major revision.

1 The validity of the soil moisture data. The authors claimed that the "soil moisture data of the TP simulated by the Noah model was proved to perform better than other datasets based on in situ observations". This is a good evidence to support the quality of the dataset. But it is worthwhile to note that "better than others does not mean the truth". Especially for trend analysis, which needs very high data quality. I think the authors need to collect and show more evidences to verify the reliability of the modelled soil moisture data. This is vital important in this study, since all the major conclusions are based on the modeling data from GLDASv2.0/Noah.

Response 1: Done. The reliability of soil moisture data was verified based on the in situ soil moisture observations from the International Soil Moisture Network (ISMN; <https://ismn.geo.tuwien.ac.at/en/>). Besides, a reanalysis dataset of ERA5 soil moisture was incorporated in the soil moisture data evaluation. A total of 111 ISMN soil moisture stations with a data record of 2008-2014 were used. The 111 soil moisture stations are coming from three, i.e. NGARI, CTP-SMITN, and MAQU observation networks, representing arid, semi-arid and dry sub-humid, and humid climate respectively (Figure R3). The 111 ISMN stations were divided into $0.25^\circ \times 0.25^\circ$ grids (26 grids in total: 5 in NAGARI; 12 in CTP-SMITN; 9 in MAQU). The mean soil moisture value of each grid was obtained by averaging the measurements of all stations falling within that grid pixel. The GLDAS and ERA5 monthly soil moisture were compared with the ISMN measurements over summer periods of May to September from 2008 to 2014 on 25 grids (with 1 grids in NAGARI has no ISMN observation records during 2008-2014). Generally, GLDAS shows lower bias and root mean square error (rmse), but higher unbiased rmse (ubrmse) and lower Pearson correlation coefficient (r) than ERA5 (Figure R4). ERA5 soil moisture seems more consistent with in situ observations in temporal variations than GLDAS during

summer periods. Specifically, Figure R5 shows that: for MAQU located in humid region, GLDAS soil moisture performs better in bias, but ERA5 is better in r and ubrmse. For NGARI in arid region, ERA5 is better in bias, r , and rmse, but worse in ubrmse than GLDAS. For CTP-SMTMN in semi-arid and dry sub-humid region, GLDAS performs better in bias and rmse, but ERA5 is better in r and ubrmse. ERA5 soil moisture performs better in MAQU and CTP-SMTMN than GLDAS without system bias considered. Therefore, to improve the reliability of the results, the ERA5 dataset were incorporated into our analysis of the climate wetting of the TP in the updated manuscript. The performance of ERA5 and GLDAS datasets were inter compared and the uncertainties were discussed.

Figure R3. Location of the in situ soil moisture observations from the International Soil Moisture Network and the Aridity index for the TP (from <http://ref.data.fao.org/map?entryId=221072ae-2090-48a1-be6f5a88f061431a&tab=about>).

Figure R4. Comparisons of the bias, Pearson correlation coefficient (r), root mean square error (rmse) and unbiased rmse (ubrmse) for GLDAS and ERA5 soil moisture in summer periods of May-September over 2008-2014 based on the soil moisture measurements from ISMN.

Figure R5. The bias, Pearson correlation coefficient (r), root mean square error (rmse) and unbiased rmse (ubrmse) for GLDAS and ERA5 soil moisture in summer periods of May-September over 2008-2014 based on the ISMN station measurements from the MAQU, NGARI and CTP-SMTMN observation network.

2 The language is readable, but still needs to be improved. I found quite some grammar errors. For instance, Line 344-345, "that is" should be "they are".

Response 2: Done. The grammar errors were revised carefully and the language was improved.

3 The quality of the figures needs to be improved, e.g. Figure 1. And please give full names in figures, for example Dr. Severity and Ave Prep in Figure 5.

Response 3: Done. Figure 1 and Figure 5 in the updated manuscript was improved (see below).

Figure 1. (a) Location of the Tibetan (TP) and the elevation; (b) Monthly average precipitation (Prep), (c) air temperature (T_{air}) and (d) soil moisture (SM) over the summer (May–September). Prep and Temp are based on the gauging interpolation data provided by the Chinese Meteorological Administration (CMA). SM is from the GLDASv2.0/Noah dataset with a depth of 0-10cm. The black, red, and blue arrows represent the Indian monsoon, the westerlies and the East Asian monsoon, respectively.

Figure 5. Variations of the (a) total annual SM drought severity, (b) yearly average precipitation (Prep), and (c) potential evapotranspiration (PET) over summer periods (May–September) from 1961 to 2014. The dotted black lines are the mean values over the periods of 1961–1994 and 1995–2014. The blue and red lines indicate the trend statistics for the period of 1961–1994 and 1995–2014, respectively.

Please also note the supplement to this comment:

<https://hess.copernicus.org/preprints/hess-2022-28/hess-2022-28-AC2-supplement.zip>