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Hydrology and Earth System Sciences Discussions

Interactive comment on "Analysis of long-term terrestrial water storage variations in Yangtze River basin" *by* Y. Huang et al.

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We would like to thank you for the opportunity to revise our manuscript for publication in HESS. We found your comments very useful, which gave us a possibility to address several issues that were initially overlooked.

Comment 1:

English should be corrected by a native English speaker. In the uploaded addendum I corrected already many awkward expressions and flaws. Also suggestions for improvement have been added.

Authors' response:

Thanks for your suggestions. They are now in the revised version.

Comment 2:

Fig.4 and Fig.5 have identical legends. What is the difference between both?

Authors' response:

Sorry, we made a mistake in the Fig.5 legend, 'TWS' should be replaced by 'TWSC'. TWSC means terrestrial water storage change.

Comment 3:

The statistical methods should be explained in more detail for the reader. E.g. the MK test, the MKS test, the concept of stationary and the principles of forward and backward sequencing with reference to inflections.

Authors' response:

More detail about MK test is added to the revised version as follows:

The MK test statistic is given by

Z= $\begin{pmatrix} (s-1)/\sigma & & S & > & 0 \\ 0 & if & S & = & 0 \\ (s+1)/\sigma & & S & < & 0 \end{pmatrix}$

(1)

where:

$s = \sum_{i=1}^{n-1} \sum_{j=i-1}^{n} Sgn\left(X_j - X_i\right)$

and

Sgn(x)= $\begin{pmatrix} +1 & & x & > & 0 \\ 0 & if & x & = & 0 \\ -1 & & x & < & 0 \end{pmatrix}$

(2)

The σ term is given by: $\sqrt{1/18\left(n(n-1)(n-5) - \sum_t t(t-1)(2t+5)\right)}$. Where X_j and X_i are the sequential data values, n is the data length, t is the extent of any given tie (the number of annual maxima in a given tie), and $\sum$ is the summation over all

ties. Positive and negative values of Z indicate increasing and decreasing trends, respectively. The statistic Z follows a normal distribution N (0,1) (Burn and Elnur, 2002).

More detail about MKS test is added to the revised version as follows:

Let $x_1, ..., x_n$ be the data points. For each element x_i, the numbers n_i of elements x_j preceding it ($j < i$) such that $x_j < x_i$ are computed. Under the null hypothesis (no trend), the test statistic $t_k = \sum_{i=1}^{k} n_i$ is normally distributed with mean and variance given by:

$\overline{t_k} = E(t_k) = \frac{k(k-1}{4}(3)$

$\overline{\sigma} t_k^2 = \text{var}(t_k) = \frac{k(k-1)(2k+5)}{72}$

(4)

Let $UF_k = (t_k - \bar{t}_k)/(\overline{\sigma} t_k^2)^(0.5)$ be the normalized variable, which is the forward sequence. This principle can be usefully extended to the backward sequence UB_k which is calculated using the same equation but with a reversed series of data.

Comment 4:

In Fig.1 many gauging stations are indicated. Nevertheless only the data of one gauging station are used for validation purposes. This is hardly representative for the catchment of the Yangtze and its upper middle and lower reaches, which have completely different mass flow regimes. I did not find the validation section where the gauging station data are used, unless in Fig.1 runoff is related to the gauging data form singular station. This is however not explicitly mentioned.

Authors' response:

Yes, indeed, only the data recoded at the Yichang Gauging station are used for validation purpose. Since Yichang gauging station is the exit of upper reaches of Yangtze River Basin, it can somehow be representative for the upper reaches. We also think using the data of one gauging station is not enough. However, no discharge data of other gauging station are available, so we also use precipitation data from GPCC and PERC/L to support the validation. In addition, we checked the error structures of ERA-Interim or GLDAS-Noah soil moisture data estimated using the triple collocation technique. The Interim reanalysis top layer soil moisture is characterized by a relatively low error in the Yangtze River basin.

We explained how to deal with the scale mismatch between point and pixel scales in detail, please revise our answer to Referee 1, comment 2.

Reference:

Burn, D. H. and Elnur, M.A.H.: Detection of hydrologic trends and variability, J. Hydrol., 255, 107-122, doi: 10. 1016/S0022-1694(01) 00514-5, 2002.