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Discussions

Interactive comment on "Seasonal cycles and trends of water budget components in 18 river basins across Tibetan Plateau: a multiple datasets perspective" *by* Wenbin Liu et al.

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Review Comments (Anonymous Referee #3): The authors exploited different sources of data to look at the variability and trend of water budget of the Tibetan Plateau. I find the paper generally well written, but language editing is required throughout the paper to fix the typos and grammar before the paper can be published. I will not give specific comments but the authors need to make good efforts to fix the language.

Thank you very much for your invaluable comments/suggestions. We have revised the manuscript accordingly (please see the point-to-point response below). The typos and grammar were double-checked and revised throughout the new version. Also, the following sentence was added in the acknowledgement section [Line 558-559 in the

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new version]: “We wish to thank the editors and reviewers for their invaluable comments and constructive suggestions to improve the quality of the manuscript”.

The paper is logically clear and gives some invaluable insights about the hydrology in the TP. However, while working with multiple datasets, the authors did not fully describe the advantage and disadvantages of each dataset in applying to the TP region, provided that these global data sets from either models or satellites have their own weakness when applied to the TP area. In particular, it's well known that land surface models have some difficulties when applying to TP (e.g., parameter tuning in boundary layer schemes), even though they have good performances in different regimes.

Thanks. We totally agree with you that the advantage/disadvantages of each global dataset in applying to the TP regions should be described. However, nowadays these global datasets (e.g., different ET products, SWE products, NDVI and LAI) has rarely been comprehensively assessed in the TP due to the lack of in situ observations. The advantages/disadvantages of different datasets are thus difficult to be fully described. Moreover, detailed validations of these products in the TP are beyond the scope of this study, which need be further investigated in the future works.

We have also tried to add more details in the uncertainty section through summarizing the limited studies available as follows [Line 473-485 in the new version]: “...due to their uncertainties inherited from different forcing data, algorithm used and varied spatial-temporal resolutions (Xue et al., 2013; Li et al., 2014; Liu W et al., 2016a). In particular, it is well known that land surface models have some difficulties (e.g., parameter tuning in boundary layer schemes) when applying to the TP (Xia et al., 2012; Bai et al., 2016). For example, Xue et al. (2013) indicated that GNoah_E underestimated theãĂŰ ETãĂŮ_wb in the upper Yellow River and Yangtze River basins on the Tibetan Plateau mainly due to its negative-biased precipitation forcing.The VIC_IGSNRR simulated and GlobaSnow-2 snow water equivalents have also not been validated in the TP due to the lack of in situ observations. However, they showed similar seasonal cycles and annual trends in some basins such as Zelinggou and Numaitilangan, which revealed the applicability of the SWE products for these basins. . .”

I think the paper is not doing well on uncertainty analysis in the water balance estimation and trend detection. In fact, no uncertainty assessment is done at all. The authors acknowledged that the multi-source data sets have their own uncertainties biases, but failed to address the implications in their analysis. In the trend analysis, it is unclear whether the self correlation is removed, and what uncertainties are associated with the derived trends..

This study may unavoidably associate with some uncertainty due to the use of multi-source datasets. We totally agree with the reviewer that the uncertainty should be quantified as well in the analysis. We have actually tried to consider the uncertainty in the analysis, for example, we compared the observed CMA precipitation with TRMM and IGSNRR_forcing data during 2000-2011. The water balance-based ETwb was also compared with other six global/regional ET products (including the mean and annual trends) during the period 1982-2006. Moreover, to minimize the uncertainty in the analysis we only analyzed the well-performed ET products together with the observed runoff, precipitation and ETwb of basic water balance components during 1982-2011.

However, adequately quantification of uncertainty for each water budget component is difficult. When we focused on the analysis of one variable during the period 1982-2011, few datasets can be used together in the TP to quantify its uncertainty due to the data availability. For example, we have observed CMA precipitation from 1982-2011, but the TRMM precipitation is only available since 2000. We can also calculate ETwb for the period 1982-2011, but Zhang_E is only available from 1983-2006. Moreover, the global datasets for NDVI, LAI, SWE and water storage changes are also limited which, to some extent, restricted our attempts to quantify the uncertainties in the analysis using multi-source datasets.

(2) For the trend analysis, we used the modified Mann-Kendall test which can consider (remove) the lag-i autocorrelation and related robustness of the autocorrelation through

the use of equivalent sample size. We have added the following details to describe the method to make it more clearly, especially for its consideration on the self correlation [Line 289-306 in the new version],

“. . .Pre-whitening is often used to eliminate the influence of lag-1 autocorrelation before the use of MK test, for example, in pre-whitening, the analyzed time series (X_1,X_2,. . .,X_n) will be replaced by (X_2-ãĂŰcXãĂŮ_1,X_3-ãĂŰcXãĂŮ_2,. . .,X_(n+1)-ãĂŰcXãĂŮ_n) if the lag-1 autocorrelation coefficient (c) is larger than 0.1 (von Storch, 1995). However, significant lag-i autocorrelation may still be detected after pre-whitening because only the lag-1 autocorrelation is considered in pre-whitening (Zhang et al., 2013). Moreover, it sometimes underestimate the trend for a given time series (Yue et al., 2002). Hamed and Rao (1998) proposed a modified version of MK test (MMK) to consider the lag-i autocorrelation and related robustness of the autocorrelation through the use of equivalent sample size, which has been widely used in previous studies during the last five decades (McVicar et al., 2012; Zhang et al., 2013; Liu and Sun, 2016). In the MMK approach, if the lag-i autocorrelation coefficients are significantly distinct from zero, the original variance of MK statistics will be replaced by the modified one. In this study, we used the MMK approach to quantify the trends of water budget components in18 TP basins and the significance of trend was tested at the >95% confidence level...“

The tables and figures are high quality. Figure 5, 6 and 7 show very similar seasonal behaviors in the hydrology and meteorology between the basins. So why divide the regions to these basins?

The TP climate is influenced by the westerly, East Asian summer monsoon and Indian summer monsoon (Tian et al. 2007; Yao et al., 2012), thus the basin-scale hydrological regimes may also different in different climate zones. Actually, in Figure 5 (first row), the hydrological regimes (e.g., precipitation amount and distribution, snow cover) in the westerly-dominated basins are different from those rest in other climate zones. We classified the basins in order to generally link the basin-scale results to different climate regimes in this study.

References: Tian, L., Yao, T., MacClune, K., White, J.W.C.., Schilla, A., Vaughn, B., Vachon, R., and Ichiyanagi, K.: Stable isotopic variations in west China: a consideration of moisture sources, J. Geophys. Res. Atmos., 112, D10112, 2007. Yao, T.D., Thompson, L., Yang, W., Yu, W.S., Gao, Y., Guo, X.J., Yang, X.X., Duan, K.Q., Zhao, H.B., Xu, B.Q., Pu, J.C., Lu, A.X., Xiang, Y., Kattel, D.B., and Joswiak, D.: Different glacier status with atmospheric circulations in Tibetan Plateau and surroundings, Nat. Clim. Change, 2, 1-5, 2012.

Figure 9, what is RËĘ2 here? Do you need to remove low frequency in the indices before calculating trends?

We have deleted the Rˆ2 and added the P-values for the trends detected in the revised version (figure R3 in this file). Moreover, we have also added the results of non-parametric trend detected by the modified Mann-Kendall test, which can consider (remove) the lag-i autocorrelation and related robustness of the autocorrelation through the use of equivalent sample size.

Please also note the supplement to this comment:
http://www.hydrol-earth-syst-sci-discuss.net/hess-2016-624/hess-2016-624-AC5-supplement.pdf

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Figure R3. Linear and non-parametric trends of westerly, Indian monsoon and East Asian summer monsoon during the period 1982-2011 revealed prospectively by the Asian Zonal Circulation Index, Indian Ocean Dipole Mode Index and East Asian Summer Monsoon Index.

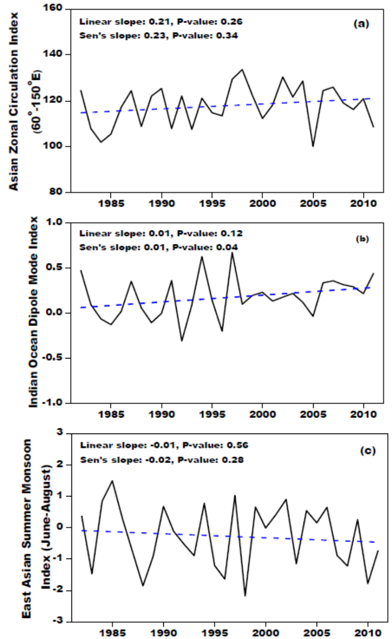

Fig. 1.

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