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Comment on hess-2021-616

Anonymous Referee #2

Referee comment on "Attribution of global evapotranspiration trends based on the Budyko framework" by Shijie Li et al., Hydrol. Earth Syst. Sci. Discuss.,
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The manuscript "Attributing of global evapotranspiration trends based on the Budyko framework" by Li et al. investigated the trend of evapotranspiration (ET) at global scale and its contributing factors, including precipitation (P), net radiation (R_n), air temperature (T₁), VPD, and wind speed (u), by using multiple datasets (GLEAM3.0a, Earth2Observe ensemble, GLDAS2.0-Noah and MERRA-Land). The methods and datasets used in this study is similar to a previous study (Li. et al., *Journal of Hydrology*, 2021) by the same author except this manuscript extends previous study in China to global.

This study is more like a numerical sensitivity exercise, suffers from methodological methodological flaws and does not provide insights to understand ET trend and its contributing factors.

Major comments ¼ □

- The Budyko equation assumes that precipitation is the only water supply for ET. At global scale during the study period (1980-2010), many regions have experienced long-term trends in groundwater storage. For example, in many regions (e.g., the North Plain in China, the High Plain in US, the northern India) where groundwater is used for agricultural irrigation, the depleted groundwater provides an additional source for ET. In this study, both the analytical framework (Budyko equation) and some of the datasets (e.g., GLDAS2-Noah) do not capture groundwater dynamics. Therefore, this study only investigated the climatic factors on ET trend and cannot provide a full picture of ET trend. Even if the ET trend caused by groundwater is captured (e.g., by the remote sensing based GLEAM ET product), this manuscript may mistakenly attribute ET trend caused by groundwater to climatic factors.
- The parameter w in Budyko equation in Equation 1 is obtained by regression using each set of data product (Line 7-8). I assume that the authors repeat the regression four times using the four sets of P, PET and ET data. The parameter w is usually associated

with land surface characteristics (e.g., land use, vegetation). However, this study assumes the parameter w is static. Therefore, the trends of ET caused by land surface characteristics are neglected.

- The parameter w is more sensitive to regression in arid climate than in humid climate based on Budyko Equation 1. Therefore, without a detailed study of w , the ET trend analysis in this study may be biased for different climate zones. In addition, as this study uses four sets of data, it is unclear how w 's obtained from each data set are different from each other.
- It is a bit confusing on the control experiment setup for sensitivity analysis. The impact of a contributing factor trend on ET trend is analyzed by the difference using 1980 data and the 1980-2010 average (Line 30-34). As there is inter-annual variability in the climate forcings, why comparing the 1980-year data to 1980-2010 average would reflect the true trend. For example, if a pixel has a decreasing trend in P during 1980-2010 and a dry year in 1980 (i.e., P in 1980 is below average), the experiment setup then would predict an opposite increasing P trend. Therefore, I am not sure if choosing a different year (e.g., 1981) would lead to different results on the trend analysis.