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Interactive comment on "Inter-annual variability of the global terrestrial water cycle" *by* Dongqin Yin et al.

Anonymous Referee #3

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This study tries to partition the inter-annual variability in precipitation (P), i.e., the source term in terrestrial water cycle, into variabilities in three sink terms in terrestrial water cycle (ET, Q, ΔS), and then to relate the partitioning of variabilities to various factors like temperature, aridity, and storage capacity. I think this type of study at global scale is rather new, if not first of its kind at global scale, and thus very interesting to the hydrology community. This is the case mostly because there has been a lack of "hydrologic reanalysis" (CDR) for such kind of analysis in the first place. At the same time, this effort couldn't fully answer many of the questions set forth at the beginning, leaving perhaps "more questions than answers" (as phrased by another referee). The authors have done a solid amount of thorough analysis and experiments toward the questions of interest and these analyses are also well designed too.

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Overall I consider this manuscript of good quality, both scientifically and technically, and thus publishable in HESS with several concerns addressed:

My primary concern is there is a lack of general “signal-to-noise” discussions to better inform readers to what extent the findings are significant signals from the underlying data (CDR, Zhang et al., 2018) and how much of it could be due to data uncertainties (or possible artifacts due to how the data is produced). For example, the ET products that went into the CDR (satellite products, reanalysis, etc.) share some similarity in their production methods (e.g., Penman-Monteith or Priestley-Taylor type of schemes). Such similarity may limit the variability of ET in CDR. Of course, the plants do apply a strong filter on the inter-annual variability based on their survival need. Such uncertainty analysis may be difficult but I think some qualitative and general assessment would be very beneficial.

Also, at the scale of the CDR (0.5 degree), I would say the partitioning is more complicated than just a result of several factors. The horizontal transport of water, seasonality, local water use, etc., can add a lot of noise. I wouldn’t say it is not possible to do it at 0.5 degree, but it would probably be less noisy at a slightly coarser scale. Also, there could be much more controlling factors for the partitioning than being investigated, e.g., land cover/land use, LAI, topography.

Finally, given that this study does tend to raise more questions than answers, I feel the authors should provide some more insights on what we can do from the analysis and findings in this study. What can we do with the numbers concluded here? Validating models? Improving single models like Budyko? Hydrologic/water risk analysis? Climate system behavior/sensitivity and hydrologic impacts of climate changes? And how can we improve our understanding in the future? What kind of new data at what scales would be critical to answering such questions? I feel this paper is incomplete without offering some of such insights.

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