# A worldwide analysis of trends in water-balance evapotranspiration

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**Comments to Authors**

Overall this is a very well written manuscript that presents a significant body of work that seeks to identify the key predictor variables explaining interannual variability of water-balance evapotranspiration. Following revision addressing my comments below this manuscript could become a valuable contribution to this area of research. However, for this manuscript to be acceptable for publication the authors need to address the following key issues, which are outlined in detail in the specific comments section below.

1. Assess how important the human disturbance correction is to their total annual runoff data and present results from this assessment.
2. Check whether their definition of a water year is appropriate across all of their catchments and whether a more appropriate definition would significantly impact their results and conclusions.
3. Briefly explain the variance partitioning technique and improve the presentation of the results from analyses using that technique.
4. Check the physical plausibility of the water balance of their key data sets used in the analysis. It is highly likely that physically implausible data are being analysed here and they will add noise to the results.

Once these issues have been addressed it will become possible to assess the results and conclusions presented in this manuscript with more confidence.

**Specific Comments / Corrections**

Page 5741, Lines 17-20: It would be worth mentioning here that different observed runoff data sets have produced different runoff trends. For example, Labat et al (2004), used by Gedney et al (2006), showed predominately increasing trends in runoff. While Dai et al (2009) and Milliman et al (2008) found mainly decreasing trends in runoff. The quality of the Labat et al (2004) runoff data set has been criticised due to the method used to infill and extend each runoff time series (see Legates et al., 2005; Peel & McMahon, 2006; Dai et al., 2009).

Page 5744, Line 3: What method is being used to calculate potential evapotranspiration here? A reference is provided for how it was calculated, but some basic information about the methodology used is required here. For example, is

potential evapotranspiration being estimated based on Penman, Penman-Monteith, Priestly-Taylor, Reference crop, etc or is it a point or areal estimate of potential evapotranspiration along the lines of the complimentary relationship?

Page 5744, Lines 11 – 16: The authors correctly note that this observed runoff data set will be impacted by human disturbances and they seek to address this impact by adding water consumption estimates from the WaterGap2 model to the observed runoff to obtain a 'naturalised' (my term, not used by the authors) runoff time series. There is nothing wrong with this approach per se. However, since actual evapotranspiration is estimated in this manuscript using the water balance, ET = Precipitation – Runoff, it is critical to know how important this water consumption correction is to the final runoff series being used in the water balance equation. The authors should calculate the % of total flow that is due to the water consumption correction at each catchment and present a histogram (or some other appropriate figure) of the results. This will provide insight into how important the correction is to the runoff data and hence how important the correction is to the conclusions drawn from this manuscript. If the % of total flow due to the water consumption correction is non-trivial then the correction may play a significant role in the results presented in this manuscript.

Page 5744, Line 18: The water year is defined as October to September. Is this definition applied across all catchments? If so, then it will be inappropriate for many catchments. Since this manuscript is investigating the interannual variability of ET using annual time series data, an appropriate definition of the water year should be used at each catchment. One definition frequently adopted is to start the water year in the month with the lowest mean monthly runoff at the catchment. Using an inappropriate water year definition can split the main flow months between two years and introduce a lag between annual precipitation and runoff.

Page 5745, Lines 21-23: The point based method is appropriate for large catchments, but can become problematic for smaller catchments. It would be helpful to know the distribution of catchment area (a histogram?) so the reader can assess the likely error introduced by this method.

Page 5746, Line 12: Define "PFT".

Page 5747, Lines 1-5: The authors should note that nutrients are not being modelled here. The response of vegetation to enhanced $CO_2$ is not solely limited by water; it can also be limited by nutrients (Körner, 2006).

Page 5747, Line 22: Results from the variance partitioning methodology form a major part of this manuscript. The authors need to explain this methodology briefly and in particular explain how cross-correlated predictor variables influence the results. I am certain the meteorological variables will show significant cross-correlation, which means they are not independent and hence may violate the assumptions of the variance partitioning technique.

End of Section 2: Significant energy has been spent collating and presenting various data sets and outlining models and analyses to be used. However, a presentation has not been made of the physical plausibility of the critical data (precipitation, runoff and potential evapotranspiration). I strongly recommend the authors present a diagram of the data along the lines of Figure 8 in Kauffeldt et al. (2013), Figure 1 of Le Moine et al (2007) or Figure 4 of Peel et al (2010) to assess the physical plausibility of the data set being used in the subsequent analyses. Catchments found to have implausible water balances could be removed from the subsequent analyses, which may remove some of the noise from the results and provide more confidence in the results.

Results section: In several places in this section results are discussed that are not shown in either the Tables or the Figures. For example, page 5749, line 21 "36-40 % and 43-49 % of ET" and page 5750, line 21 "42-49 %". These results are interesting, but it would be better to present them in the Tables and Figures so that the reader can see the results and assess how they were derived. Overall I found the discussion of the variance partitioning results difficult to assess as they are not presented (Tables 1 & 2 and Figure 2) in the form they are discussed.

Figure 2: I recommend a consistent scale is used for Figures 2a, 2b and 2c. The version presented uses a consistent set of colours, but the discretisation of the legend changes for each map, so the same colour represents a different $R^2$ of adjusted $R^2$ in each map, which is confusing.

**References**


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Kauffeldt A, Halldin S, Rodhe A, Xu C-Y & Westerberg IK (2013), Disinformative data in large-scale hydrological modelling, *Hydrol. Earth Syst. Sci. Discuss.*, **10**, 487–517, 10 doi:10.5194/hessd-10-487-2013.

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Milliman JD, Farnsworth KL, Jones PD, Xu KH & Smith LC (2008), Climatic and anthropogenic factors affecting river discharge to the global ocean, 1951–2000. *Global and Planetary Change*, **62**, 187–94.

Peel MC & McMahon TA (2006), Continental runoff: a quality-controlled global runoff data set. *Nature*, **444**, E14.