Dipanjan Dey
School of Ocean and Earth Science
University of Southampton
Southampton, UK
Email: dipanjanrocks01@gmail.com

November 14, 2022

Dear Dr. Wanders,

Please find our answers to the reviewers below. We have answered all questions and made all possible changes suggested by the reviewers. The revised version of the manuscript has been uploaded using the Hydrology and Earth System Sciences (HESS) online submission system.

Best regards,

Dipanjan Dey

**Reply to Dr. Ruud van der Ent** *Thank you for the response on our article. We are grateful for all your constructive suggestions, which have helped us improving the manuscript. Below you can see our answers. The line numbers are from the revised manuscript*

**Comments**

**L232: I think it would be good to have an explicit subheader 'limitations'**

***Answer :*** *Thank you for this important suggestion. We have now included a subsection named 'Limitations'.*

**L234-236: "449.5 $\pm$ 22.2 $\times 10^3$ km$^3$ year$^{-1}$ in Rodell et al. (2015), 460 $\times 10^3$ km$^3$ year$^{-1}$ in Van Der Ent and Tuinenberg (2017) and in the current study the *net* evaporation has been computed to be around 536 $\times 10^3$ km$^3$ year$^{-1}$". Let's look at these numbers (all in $10^3$ km$^3$ year$^{-1}$) in more detail. Rodell et al., (2015), interestingly also provide the uncertainty around their numbers. For ocean evaporation the standard deviation was 22.2 as you already indicated. Your estimate is 536-449.5=86.5, which is almost 4 standard deviations off. Now, let's look at evaporation on land: Rodell et al., (2015) = 70.6 $\pm$ 5.0 This paper (Table 1) = 0.20 + 0.48 +0.61 +3.30 = 4.59 $\times 10^9$ kg s$^{-1}$ (rounded down to 4.0 in Figure 7). Using the conversion indicated in this paper 31.536 then this amounts to 144.75 $\times 10^3$ km$^3$ year$^{-1}$. So the land evaporation is more than double and almost 15 standard deviations off. Therefore, I think it's rather unfair to only provide the calculation for oceanic evaporation. Moreover, it should be made clear that the estimates in this paper are not just a bit higher than previous ones, but that the estimates in this paper are simply not very good. I wish I could be more positive on that, but this is simply how it is.**

***Answer :*** *Thank you for a detailed evaluation of the surface water flux estimates.*

*We really appreciate your effort on this matter. We agree with your viewpoint and now compared the observed land evaporation values with our estimates on line no 236 - 240 as "The difference between the total global land evaporation in these studies with our estimated net evaporation is even higher. For example, the total evaporation over the global land has been observed to be 70.6 $\times 10^3$ km$^3$ year$^{-1}$ in Rodell et al. (2015) and 144.7 $\times 10^3$ km$^3$ year$^{-1}$ in the current study. This indicates the limitations associated with the way net evaporation (described below) has been calculated has a greater impact over the land. The overestimation of the reported water transports is also true for precipitation." Additionally, we have also modified the caption of Figure 7 to "It is important to mention that the net evaporation and net precipitation transports presented here are higher (with different magnitudes) than the previous estimates such as Trenberth et al. (2007); Chahine (1992) and it might be due to the way E - P has been computed in the present study which omits diffusive atmospheric water transport and time correlations." to indicate that all the overstimatation is not equally likely but with different magnitudes.*

**L249-258: "such as, time correlations between the wind speed and specific humidity. For an example, let us consider a grid box in which at time t=0 hrs the zonal wind is entering through its western wall with a velocity of 10 m s$^{-1}$ and specific humidity of 2 g kg$^{-1}$. The transport through all the other grid faces are assumed to be zero (for simplicity). This will lead to net precipitation transport of 20 m s$^{-1}$ g kg$^{-1}$ (to get a unit of kg s$^{-1}$ one has to multiply this quantity with $\triangle$ y $\triangle$ z and water density). At time t = 6 hrs let's say the zonal wind strengthened to 20 m s$^{-1}$ but as wind increases the specific humidity decreases to 0.5 g kg$^{-1}$. This will lead to an net precipitation of 10 m s$^{-1}$ g kg$^{-1}$. Now if we average over these two time steps we will get a net precipitation of 15 m s$^{-1}$ g kg$^{-1}$. However, averaging separately zonal wind and specific humidity will results in 15 m s$^{-1}$ and 1.25 g kg$^{-1}$ respectively and the net precipitation transport will thus be $\approx$ 19 m s$^{-1}$ g kg$^{-1}$. In the**

**present study the 6-hourly average zonal wind and specific humidity were taken from the ERA-Interim separately (not the product of them) and thus the net evaporation and net precipitation amounts might be leading towards overestimation." I like this hypothesis a lot. It could be that this is also something that goes wrong in other Lagrangian tracking schemes that infer E and P from the mass/water balance, which you may want to highlight.**

***Answer :*** *Thank you for the encouraging words. We have now incorporated your suggestion and included a sentence on line no: 262 - 264 as "This limitation on time correlation may also be one of the reasons associated with the surface water flux overestimations in other Lagrangian models such as FLEXPART (Stohl and James, 2004) where they try to infer evaporation and precipitation from the atmospheric water budget equation."*