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Interactive Comment

# *Interactive comment on* "Contrasting roles of interception and transpiration in the hydrological cycle – Part 2: Moisture recycling" *by* R. J. van der Ent et al.

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We thank referee Helge Goessling for his careful reading of our manuscript and helpful suggestions for its improvement. Remarks by the referee are in *italic* and our replies are in upright text.

## General comments

*The authors perform a diagnostic moisture tracing study to quantify continental moisture recycling with the new element that plant transpiration is treated separately from other continental evaporation fluxes. The methodology is sound and the results are well presented. My most substantial suggestion is to discuss the seasons separately in the first place instead of mainly discussing annual-mean results and discussing the seasonality on the sidelines. In the latter case, the interesting non-seasonal effects due to the different roles of transpiration and interception in moisture recycling are blurred by strong seasonal effects.*

While we understand the referee's comment, we think that the discussion of first the seasonal effects does not change the fact that the annual average pictures are blurred by seasonal effects. Moreover, we would like to present Fig. 1 as our main result and after showing that figure we think it is more logical to discuss the annual results. However, we do agree that the importance of seasonal effects should be highlighted more in the revised manuscript.

## Specific comments

*P284, L1–4: I think it would be appropriate to mention Trenberth (1999) here as well because he also showed local recycling estimates that can directly be translated to local length scales. (In fact, Trenberth (1999)'s estimates can be considered to be even more local as they are based only on the local conditions).*

While Trenberth (1999) indeed made an important contribution, that approach is very different. The results presented in that paper were regional precipitation recycling ratios for a certain length scale, thus scale-dependent, with the major assumption of parallel flow by Brubaker et al. (1993). This assumption is unlikely to hold over lengths of

500-1000 km. See also Burde and Zangvil (2001) why this assumption is problematic. The approach by Trenberth (1999) is thus different from the approach of Van der Ent Savenije (2011) that present local length scales based on calculated regional moisture recycling ratios for $1.5°$ grid cells.

*P288, Eq7: Maybe this splitting would become even more clear to the reader if it was mentioned also that $E_{o,i} + E_{c,i} = E_i$ and $E_{o,t} + E_{c,t} = E_t$.*

Good suggestion. We will add this information.

*P288, Eq8; P289, Eq9; Fig3a,c: In my view the "continental evaporation recycling ratio for interception/transpiration" as they are currently defined are more confusing than informative. The authors mention that these quantities carry mixed information, and consequently they focus their discussion on other metrics. I would go even further and not discuss them at all. Also, I think that the term "continental evaporation recycling ratio for interception/transpiration" is better suited for what is currently termed "continental evaporation recycling efficiency for interception/transpiration" because it is the ratio of the recycled part of an evaporative flux.*

We agree that it is important to keep the definitions straight, however, we would like to show that both Eqs. (8)+(9) and (10)+(11) are possible ways of defining the evaporation recycling metrics. They cannot both be called "ratio", thus we chose to name (10) and (11) efficiency. This may be considered suboptimal, but the alternatives would be suboptimal as well.

*P289–290, Sect2.2.2: "lifetime of continental precipitation/evaporation recycling" Again regarding terminology, to me it is strange to assign a lifetime to a process (e.g. precipitation recycling) rather than to an object (e.g. recycled precipitation). I consider it more elegant to keep the terminology of Trenberth (1998) and talk about the "timescale of continental precipitation/evaporation recycling" despite the methodological difference between Trenberth (1998) (upscaling of local conditions) and this study(explicit tracing).*



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We agree with the reviewer regarding the fact that it would be better to assign the lifetime to an object rather than to a process. We will modify this for the revised version. However, we disagree regarding the suggestion of calling it timescale. It is simply not a scale but an actual (although averaged) time that we have calculated. Naming this timescale would also be in conflict with the terminology in Van der Ent and Savenije (2011) where we actually calculated timescales following Trenberth's (1998) methodology.

*P294, L17–20: It would be nice if the authors could comment on the reasons for this 10 % difference. If it is not due to the forcing data, it appears that the introduction of a second layer leads, on annual and global average, to a lower continental moisture recycling estimate. Following Goessling and Reick (2013), this suggests that accounting for vertically sheared winds (reducing recycling estimates) outweighs the effect from accounting for fast evaporation (increasing recycling estimates), or something along these lines?*

Actually, from runs with WAM-2layers with just ERA-Interim we also found about 40 % continental precipitation recycling globally, but about 0.5 % less with unrounded numbers. Locally, we see that the continental recycling in some regions (e.g. West Africa) near the coast is reduced compared to WAM-1layer, but this is apparently almost compensated by other regions. We will add a comment about this in the revised version.

*P295, L22–23: "Regions with high evaporation recycling are important source regions for sustaining downwind precipitation." This holds only for regions that at the same time feature high evaporation rates. For example, the Arabian Peninsula has high evaporation recycling ratios, yet it has certainly no significance for downwind precipitation as the evaporation rate is close to zero throughout the year.*

We will add a comment that both the evaporation recycling ratio as well as evaporation must be high for this statement to be true.

*P296, L10–15: In my view, such seasonal effects should be separated more clearly*



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*from the different roles of transpiration and non-biophysical evaporation in a fixed large-scale meteorological setting (i.e. within a season), see my comment above.*

By explaining what according to us caused these differences, we think we already made sufficient effort to separate the seasonal effects.

*P298, L23–25: I fully agree with this interpretation and think that this kind of reasoning is central to the manuscript and, to repeat myself, should be clearly separated from seasonal effects by discussing intra-seasonal (January/July) results in the first place.*

We are glad the referee agrees with our reasoning. We shall emphasize the seasonal effects more in the revised version.

*P301, L22–27: I do not understand why the described results fit well into the picture drawn in those earlier studies, maybe the authors could be more precise on this?*

The relatively high local recycling components fits to the link of precipitation with soil moisture anomalies. The peak in external contribution of moisture in the onset of the monsoon is for a large part caused by (oceanic and terrestrial) Mediterranean evaporation. We will be more precise in the revised manuscript.

*P302, L15–18: This is a decent explanation for the fact that recycling of direct evaporation is faster and associated with shorter length scales compared to recycling of transpiration. The question remains, however, whether this is largely a passive effect due to the persistence of large-scale weather phenomena (particularly in the temperate zones), or whether the different recycling estimates for direct evaporation versus transpiration actually translate into a higher impact of direct evaporation compared to transpiration on local/regional/continental precipitation, leading once again to the question how telling diagnostic recycling estimates are regarding the importance of continental evaporation for precipitation as discussed in Goessling and Reick (2011).*

This is an excellent observation, we will add a comment about this in the revised version.

*P318, Fig1: If I am not mistaken, there should be no blue fraction in the arrow for* $\sum F_{\mathrm{out}}$*. To my mind the blue fraction would imply that the water advected to the continents and transported further to the ocean with intermediate recycling is also included, which is seemingly not the case.*

We are guessing that the referee means "without intermediate recycling" and not "with intermediate recycling". In reality there is also a fraction of moisture that is simply transported over the continents. Putting a number to that would, however, be a bit silly as this would be extremely sensitive to the inclusion or exclusion of many small islands. Thus the blue fraction is in fact correct. We hope that expanding the caption will facilitate the interpretation of the figure.

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Interactive comment on Earth Syst. Dynam. Discuss., 5, 281, 2014.