Hydrol. Earth Syst. Sci. Discuss., 11, C957–C964, 2014
www.hydrol-earth-syst-sci-discuss.net/11/C957/2014/

Hydrology and Earth System Sciences
Discussions

Interactive comment on "HESS Opinions: A perspective on different approaches to determine the contribution of transpiration to the surface moisture fluxes" *by* S. J. Sutanto et al.

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Received and published: 16 April 2014

We would like to thank the reviewer for the detailed comments and valuable suggestions. We agree with the suggestions and improve our manuscript based on the suggestions. In the following, we provide detailed information about the changes.

Comments: 1. The objective of the paper is unclear. a. The title seems to indicate that the objective of the paper is to look at different ways to determine transpiration relative to surface moisture fluxes. The manuscript however focuses on isotope techniques, and the fact that they underestimate transpiration fluxes when compared to

hydrometric measurements and land-surface models. Also, the term 'surface moisture flux' is somewhat misleading as one may expect it to include irrigation, precipitation, percolation etc. Isn't it clearer and more precise to replace 'surface moisture fluxes' with evapotranspiration?

AC: A good suggestion! Yes, we do focus in our review on isotope techniques, and when we talk about surface moisture fluxes we do indeed refer to evapotranspiration. We thank the referee for pointing this out and we changed the title to: "A perspective on isotope versus non-isotope approaches to determine the contribution of transpiration to total evaporation". We also adjusted the abstract accordingly (see c).

b. The abstract seems to indicate that the objective of the paper is to compare transpiration determined using isotopes versus using other techniques and possible discrepancies. This is more in line with the discussion and conclusion of the manuscript.

AC: This has been adjusted in the revised version.

c. The introduction however, states (L2587:10): "we provide a perspective on different approaches for disentangling the different fluxes contributing to the total evaporation." This seems to indicate all fluxes contributing to total evaporation are being investigated. But the rest of the introduction is focused only on transpiration.

AC: We changed the sentence accordingly, see also point 1.

2. L2586:5 "Transpiration is the largest contributor to the water flux from continental areas." Replace 'water flux' with evapotranspiration. The way this sentence is currently formulated could also include, e.g., water flowing in rivers to the oceans.

AC: We changed the sentence accordingly.

3. Assuming that the objective is to determine transpiration as a fraction of total ET, the fact that you can determine soil evaporation as the difference between total ET and transpiration (Line 2586:19) seems to come out of the blue. If evaporation from the soil is of interest, then why not mention interception from the canopy as well, as both

of these components are mentioned in L2586:1? Alternatively this sentence could be omitted.

AC: We did not mention evaporation from intercepted water because in many studies this component is neglected. We added some further explanations in the manuscript.

4. L2588:8-11: similar to comment #3. The heading of section 2 reads: "Methods to derive the transpiration fraction of total evaporation." A discussion of soil evaporation seems out of place, unless it is used to compute transpiration. That does not seem to be the case here.

AC: We agree and removed the discussion on soil evaporation.

5. L2588:23, 2590:7, 2596:10: here and elsewhere, 'evaporation' is sometimes used to describe all evaporation fluxes from a surface, at other times it describes the process. Sometimes continental or total evaporation is used. Please define the terminology used.

AC: We define evaporation as the total evaporation flux as described in the introduction. We describe this in the first sentence and use only the term evaporation in our manuscript to avoid confusion and also more explanations about evaporation term are described in the last paragraph in the introduction section.

6. L2589:4: Most lysimeters don't have a percolation meter; the 'losses' can be observed by weighing drainage water.

AC: We change the sentence accordingly.

7. L2590, equation 4; if the main objective is to quantify transpiration, perhaps the equation for soil evaporation is not necessary.

AC: We prefer to keep the soil evaporation equation since this is an important component of evaporation.

8. Section 2.2, Isotope-based method. This section describes how transpiration can

be estimated as a fraction of total evaporation. While section 2.3 describes the effect of canopy evaporation on total evaporation, this is not part of the discussion in the isotope section. Perhaps the reason isotope studies tend to overestimate transpiration is that they fail to correct for water lost through canopy evaporation?

AC: Canopy evaporation is not discussed in section 2.2 (now 2.1) because with the isotope-based methods canopy evaporation cannot be examined separately. This may be one factor contributing to the overestimation of the transpiration fraction. We discuss this in section 4.

9. L2594:8-9 "Global land models estimate the transpiration fraction to be less than 50%". This statement does not seem to concur with results shown in figure 1; where two studies are below 50%, one is about 50% and one is 80%. A fifth study, which may or may not be included in the term 'Global land model' is about 65%. It is unclear if 'Global land models' refer to the land-surface models that have global averages or to all the land-surface models. The figure describes land-surface models where some represent global averages whereas the text refers to global land models where some models represent global annual averages.

AC: We re-wrote this paragraph in order to describe the figure in more detail according to the suggestions of the referee. We define a global land surface model as a model that has global average results.

10. Section 3. This section is supposed to show that the transpiration fraction of total evaporation determined by isotope studies is high compared to studies using other methods (based on the introduction to section 4: "What can explain these systematic discrepancies between the isotope and non-isotope methods?"). This could be done in a more convincing manner. a. While distinction is made between global averaged and non-global averaged studies, there seems to be a huge difference in scale between studies, which is not really discussed. This may affect comparison between studies.

AC: We elaborate this in section 3 and explain that the difference in temporal resolution

between global land surface models and isotope-based results may explain the apparent underestimate of the transpiration fraction from global land surface model. We also discuss the effect of different methods to average the transpiration fraction.

b. L2595:16-2596:9 describe how “Different plant types exhibit a different transpiration fraction under similar climatic conditions.” The following paragraph (L2595:22-27) is confusing to me: “In China during summer, the maximum transpiration fractions of oaks and wheat are 96 and 80 %, respectively (Xu et al., 2008; Zhang et al.,2011). Hydrometric methods result in much lower transpiration fractions in Arizona US. A study from Cavanaugh et al. (2011) during summer in Shrubland area partitions transpiration fraction of 42–47 %. This is very low compared to an isotope-based study (85 %) in the same region although different plant types are examined.” It appears that the fact that a shrub land area in Arizona has lower transpiration fractions compared to oaks and wheat in China is ascribed to the use of hydrometric versus isotopic measurements. Is that what the authors are trying to say? Especially considering that the Arizona data is over a whole season and the data from China is for transpiration at its peak? The comparison to an isotope based study without a reference does not seem very convincing either.

AC: In this paragraph, we explain that different plants may have different transpiration fractions although the location and climatic conditions are the same. This is shown from few studies in US (Savanna woodland, grass, and steppe forest) and in China (oaks and wheat). It is also supported by Kool et al. (2014). However, a study from Cavanaugh et al. (2011) using hydrometric method shows a much lower transpiration fraction than the isotope-based method. This may not be a representative result since other studies in Europe and US using the same plants but different methods exhibit close results between the isotope-based method and the hydrometric method. In order to clarify the argument, we divide the paragraph into two paragraphs. In the first paragraph, we discuss the different transpiration fractions from different plant types with similar climatic conditions. Examples are given from the US and in China during

summer. In the second paragraph, we discuss the hydrometric results in comparison with the isotope-based method.

c. L2596:5-9. Comparison between hydrometric and isotopic measurements. The difference is 4% for transpiration (why mention evaporation?). What is the direction of the difference? Does it support the idea that isotopic measurements give higher transpiration than hydrometric measurements; or do the authors mean to say that the difference is quite small?

AC: We removed the soil evaporation value from the text and used only the transpiration value. The difference between midday and the periods before and after midday shows that first, the difference between the isotope-based method and the hydrometric method during midday period is small (4% in Williams et al., 2004) compared to after and before midday. Second, it shows that the steady state assumption (SSA) used in the isotope-based method is only achieved during the midday period, meaning that the isotope-based method using the SSA assumption tends to have higher results. This is explained in the section 4 (L2597:24).

d. L2596:15 the paper of Schlesinger and Jasechko 2014 shows that isotope studies tend to yield higher values for transpiration fraction compared to studies using other methods and models. They might be used as a reference.

AC: We add this reference in Figure 1.

e. L2596:16 Coenders-Gerrits et al 2014 show that Jasechko et al 2013 was overestimated; but they do it by using the same isotope data. This means that isotope data can be interpreted differently but is not necessarily overestimating transpiration. This is an important limitation and must be discussed.

AC: We elaborate on this paper in section 4.

f. L2596:25 “This systematic difference between isotope-based estimates and models. . .” The only obvious overestimation in transpiration fraction in isotope partitioning

studies so far, seems to be the paper by Jasechko et al 2013. AC: We agree with this evaluation and have reformulated the paragraph accordingly.

g. The study by Sutanto et al 2012 is the only study where the ability of HYDRUS-1D to estimate evaporation fluxes was tested, see Kool et al. 2014. To decide that isotope studies tend to overestimate transpiration based on a model that was not tested in any other way, seems a bad idea.

AC: We removed this part.

11. L2597:7-10 Why do we need hydraulic conductivity calculations? There is no error in saturated soil. Saturated soil at the bottom of the lysimeter results in conditions that are different from field conditions.

AC: Hydraulic conductivity calculations apparently are needed for soil-water models such as HYDRUS-1D. We agree that in principle we do not need hydraulic conductivity in the lysimeter method. We changed our sentence and wrote that the edge-flow water can produce a significant error in the calculation of water looses from the lysimeter.

12. The conclusion is clearly written and represents the discussion in the article well. The conclusion states the fact that "a few studies that compare estimates of evaporation at the same location and conditions using the isotope-based and hydrometric methods show that the results are in fairly good agreement." (L2600:13-16). Perhaps the article could expand more on the fact that, while there is good agreement between isotope studies and hydrometric studies there is a general trend of overestimation of transpiration fraction of total evaporation when using the isotope method. Currently the supporting material is unconvincing.

AC: This is related to comment 10 and we have discussed the issue of scale and different conditions in section 3. There we give few examples where the discrepancies between the two methods are small. An exception is the study by Cavanaugh et al. (2011), which the transpiration fraction calculated using hydrometric method is far too

low compared to isotope-based method.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 11, 2583, 2014.