

Review of S. Proulx-McInnis et al.: "Technical Note: Development of an automated lysimeter for the calculation of peat soil actual evapotranspiration" in HESSD, 8, 50009-5033, 2011

The measurement of actual evapotranspiration (AET) is not simple, but essential for the quantification of the soil water balance. According to our knowledge a large weighable outdoor lysimeter is the best method to quantify the soil water balance with high accuracy and to calculate AET. This measuring technique is mostly used for mineral soils, but weighable groundwater lysimeter types are also available peat soils ((e.g.: Bethge-Steffens, D., Meissner, R., Rupp, H.: Development and practical test of a weighable groundwater lysimeter for floodplain sites. J. Plant Nutr. Soil Sci., 167 (2004) No. 4, 516 - 524. Xiao, H., Meissner, R., Seeger, J., Rupp, H., Borg, H.: Testing the precision of a weighable gravitation lysimeter. J. Plant Nutr. Soil Sci., 172 (2009) No. 2, 194-200)). It is recommended to discuss this aspect in the introduction on page 5011, L. 12.

The authors present a modified *in situ* measuring approach to calculate AET for a peat soil site. The description of the measuring systems seems to be logic and plausible. Not clear to the reviewer is the function of the term "specific yield (S_y)" at page 5016, L. 14ff. You mentioned at page 5016, L. 23 that you assumed "a unit value for S_y , which is likely to lead to an overestimation of AET". A more detailed discussion regarding the mentioned parameter seems to be necessary for better understanding of the paper.

For a start, your chosen definition of S_y is not very fortunate (p. 5016, L. 16 - 17). How about replacing it with the following: "Specific yield (S_y) is defined as the amount of water released from the peat column, if the water table is lowered by a unit amount (e.g. 1 cm)". The next sentence (In the literature ...) can stay as it is. However, the one after that (Moreover ...) makes little sense: How do you know you overestimate AET? You used only one way of measuring it. Further, if you know your chosen S_y leads to an overestimate, why not use another value? Therefore, how about changing the last bit of this sentence (L. 22/23) to: "... led us to assume a single value for S_y , which may lead to an under- or overestimation of AET_i ."

Note that the sentence "A water level change ... in the soil" (p. 5016, L. 14/15) confuses the issue. Leave it out! The water level in the well and in the soil will be the same. However, the " S_y of the well" is different from that of the peat. By choosing an appropriate S_y for the whole system, this will be accounted for. Anyway, it is only an issue if the well covers a significant area of the lysimeter, which it does not.

To absolutely clarify the importance and meaning of S_y , why not give a brief sample calculation, e.g.: "We assume an S_y of 0.33 cm of water per 1 cm change of the water table (WT). So, if a WT change of 1.6 cm was observed, this translates into an estimated AET of $0.33 \cdot 1.6 = 0.528$ cm = 5.28 mm."

At various points in the paper (p. 5010, L. 4 - 6; p. 5011, L. 1) the authors say that the vegetation in peatlands is composed of nonvascular plants without stomatal resistance, which represents a special challenge to measure AET. I feel this makes it easier, not more difficult, because one variable (stomatal conductance) disappears. I can't see a problem. So, please explain precisely what the problem is supposed to be, or drop all references to a special challenge due to nonvascular plants. There is also a small inconsistency: In L. 9 on p. 5012 you state: "Typical vegetation ... consists of small trees and shrubs ...". Please add: "None were present on the actual site (see Fig. 2)." or something to that effect.

Interesting is the comparison between the AET and the PET (page 5017), but it is well known that there are differences between AET and PET. You know that, too, and the reviewer agrees with your arguments regarding the differences (page 5017 - Thornthwaite equation), but why did you use this ratio (AET/PET) as a parameter for the quality of your measuring system to estimate AET? If your aim is to measure AET, why spend so many words on PET. PET is not really needed for your purpose. Please downplay the PET aspect; even better drop it. You should definitely delete L. 15 -17 on p. 5010 (“The estimated potential was about 1.13.”) and L. 13 - 15 on p. 5023 (“The ratio AET/PET ... ecosystems.”), because PET is not the focus of this paper and deserves no place in the abstract or the conclusions. Also, L. 6 - 11 on p. 5011 state that formulas for PET overestimate AET. That is precisely what you would expect from the definition of PET. Drop this section.

The Thornthwaite approach is far from the best method to assess PET. Anything based on radiation works better. Isn't there a weather station which records radiation reasonably nearby. Doesn't the Deschambault station do it? Furthermore, as already mentioned, you do not really need PET at all in my opinion. Why bother with it?

Nevertheless, please check if there is an other mathematical approach available to calculate the AET (for example - Hays, K. B. 2003. Water Use by Salt Cedar (*Tamarix* spp.) and Associated Vegetation on the Canadian, Colorado and Pecos Rivers in Texas. M.S. thesis. College Station, TX: Texas A&M University. 132 p.).

You mentioned at page 5013, L. 10 that the aim of your study is to “measure hydrological budgets over a **long period** of time”, but you demonstrated in the paper only a measuring period between 12 and 27 July 2010. For this period the AET data are plausible, but you should give an outlook how the system will work for a longer time period.

On page 5018, L. 23 to 26 confused me. I don't know what you are trying to say. Is it this? “The higher AET after nighttime rain could be explained by the inability of the rainwater of the night to redistribute in the environment via lateral flow, which left more water for evapotranspiration the following day.” If so, say it in that way, if not, clarify what you really mean. The segment “since the system was balanced at midnight.” should go. The next sentence is ok.

As already mentioned, this reviewer feels that a discussion of PET is not necessary in your paper. There are various sections on p. 5019/5020 which could therefore go: L. 8 - 9 (On the other hand ...), L. 14 (p. 5019) - L. 11 (5020). Otherwise your paper requires a lengthy discussion of PET, which has nothing to do with its aim. Many equations for PET are calibrated to predict PET for a certain type of vegetation on mineral soils. I know none which was developed for vegetation on peat. Such an equation would have to take into account that peat soils can heat up quite significantly so that the temperature and thus the saturation vapor pressure at the evaporating surface increase markedly. You actually allude to that on p. 5020, L. 12 - 19, but not strong enough.

If you had a proper PET equation for peat soils, AET would always be lower than PET - it must be so by definition. If this is not the case, your PET estimate is garbage, or to put it more precisely, not valid for the system under consideration. The Thornthwaite approach was not developed to get a PET for peat environments. Hence, it does not apply and it is wrong to call the Thornthwaite values “PET” for your situation. As a consequence the whole discussion of PET as it stands right now is wrong, or at best misleading the uninitiated.

If you feel you must hang on to the Thornthwaite approach, do not call it PET, call it a reference ET for whatever vascular vegetation on a mineral soil the approach was developed. Then you can show that in your peat situation ET is sometimes higher and sometimes lower than the ET of the soil - plant combination Thornthwaite's equation was derived for. But again, was the aim of your paper to show how much evaporates from your peat environment compared to, say, a crop? If not, why bother? Your paper is rather good without it.

There is a final confusing section on p. 5021, L. 3 - 8. The water level in the lysimeter should be the same everywhere, since if a bit more water is taken out (or entered) at one place, it will quickly equilibrate again. Hence, the statements "An uncertainty overestimate the rate of evapotranspiration." are superfluous. Also, assuming a uniform peat porosity does not imply that there is no lateral movement of water. Hence, this part of L. 4 must be dropped ("and that there is").

Despite all the criticisms, the reviewer agrees in principle with the main content of the manuscript. However, before full acceptance of the paper it is recommended to discuss the above mentioned aspects in more detail.

Finally, here are some small details to attend to:

- p. 5010, L. 15: P has not been defined; please change L. 12 to: "... while accounting **for** the precipitation (**P**)."
- p. 5011, L. 13 and P. 5024, L. 26: Do you need the II in Loheide II?
- p. 5012, L. 5: Fig. 1 is not absolutely necessary. So, if space is a problem, you can leave it out.
- p. 5013, L. 5: Please change to: "... installed TDR **probes**."
- p. 5013, L. 14: It is not clear to me the acrotelm in which study you mean. Please clarify.
- p. 5014, L. 28: Please change to: "... described in more detail in Sect. 2.4."
- p. 5015, L. 9: Your explanation of this 5 mm error margin is a bit confusing. Please clarify in the sense of: "The water level inside the lysimeter was adjusted to that of the outside only if the difference was $> |5 \text{ mm}|$, because according to tests performed ..."
- p. 5016, L. 10: Shouldn't it read: " $\Delta W L_i + P_i = A E T_i$ ", that is not the absolute value of AET?
- p. 5021, L. 22 - 24: It should read: "The lack of information about the specific yield of these environments led us to assume a **single** value, which resulted in an overestimation of AET and thereby **the** AET/PET ratio."
- p. 5022, L. 20: Shouldn't it read: "... provide insight **into** ..."?
- p. 5030, Fig. 3: The source of the instruments need not be mentioned in the legend (CRX10 ..., PS9800 ...).
- p. 5033, Fig. 6: In the figure it says "Probe", in the legend "Sensor". Please use the same term in both.