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Hydrology and Earth System Sciences
Discussions

Interactive comment on "High-resolution estimation of the water balance components from high-precision lysimeters" *by* M. Hannes et al.

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Reply to the comments (Referee 2)

We would like to thank the reviewer for the valuable and constructive comments and suggestions which helped us to improve the paper. We have addressed all the comments and suggestions in our response letter and adapted the revised version of the manuscript accordingly. In the following, we provide detailed answers to all comments and suggestions.

The paper does not represent a substantial contribution to scientific progress, being poor in new concepts, ideas and methods. In this form, the paper shows a simple signal-processing

application rather than a lysimeter-based experiment.
However, I suggest a strong reorganization of the paper as technical note.
We agree with the reviewer that the paper is of very technical nature and does not describe a lysimeter-based experiment. However, for the large lysimeter community, filtering schemes for the new generation of high-precision lysimeters are highly important and build the basis for reliable scientific analyses of the terrestrial water balance components from lysimeter measurements which are used in many studies in agriculture, hydrology and climate sciences. The length of the paper required to explain the filtering procedures exceeds the length of *a few pages* as requested in the HESS guidelines for a Technical Note. When submitting the paper, we were inspired by the recent HESS paper by Peters et al. (2014) which is of similar technical nature and was also published as a regular research paper of comparable length. Hence, we would prefer keeping the study a research paper. In order to inform the reader early about the rather technical content of the paper and not to raise false expectations, we have changed the title to "A comprehensive filtering scheme for high-resolution estimation of the water balance components from high-precision lysimeters" and revised the abstract accordingly.

Experimental dataset is short in time extension (only 2 months) and poor in natural "water balance terms" variability. Results focus on little time windows, without interview longtime effect on water balance and emphasizing on the performance of the adopted filtering scheme.
We agree with the reviewer that the data set appears to be rather short in length. However, for discussing the effects of the filtering schemes on the data we need to look at them at very high resolution. A longer data set would have hidden the details of the filtering effects. We have discussed at which occasions (that are not included in the analysed time period) our filtering scheme would run into problems and we have not found many of them. Times which are always challenging to handle are dates where agricultural work (e.g. sowing, harvesting of crops, soil management (tillage), ...), which disturbes the weighing data, is conducted on the lysimeter. On these dates, manual filtering/data processing procedures will definitely be required before the automatic filtering routines can be applied. Other periods that might be challenging to handle are periods where the lysimeters are snow covered, since the snow cover

on the lysimeter is often connected to the snow cover outside the lysimeters which, in turn, heavily disturbs the weighing data. This, however, is a well known problem in lysimetry which by nature produces unreliable weighing data that also need to be removed manually from the data set. Here, of course additional information about the site conditions (snow cover) during winter is required. All other situations should be well evaluable with the current filtering scheme. We now discuss this issue in the new section 3.6 in the revised manuscript.

Abstract requires a strong rearrangement. Objects of the paper are poor and emphasize a simple mathematical application rather a lysimeter-based experiment P571-L1: precipitation or net precipitation? did you considered the intercepted precipitation? P571-L4: I do not agree that Eddy flux system is a direct method for ET measurement. ET value is an indirect estimation obtained from atmospheric measurements and "eddy flux", computed as a covariance between instantaneous deviation of wind speed and air water concentration.
We have revised the abstract and now focus more on the objectives of the new filtering scheme. We agree that Eddy flux is not a direct method and have removed this statement from the abstract. In fact, lysimeters are the only direct field method for estimating evaportranspiration this is why a careful analysis of the obtained data is so important.

The first period of the introduction is confused. The "boundary" term is improperly allocated. The bibliography on lysimeter study is poor. Moreover, the paper of Robinson et al. (2004) regards a study over the lysimeter water collection efficiency (geometrical aspect) and on the knowledge of radionuclides transport (soil physical aspects).
We have revised large parts of the first part of the introduction and now focus on the value of lysimeter measuerements as they are the only method that is able to provide direct estimates of all components of the terrestrial water balance, most importantly evapotranspiration. We also added futher references from climate and hydrological sciences (also large-scale studies) which have successfully used lysimeter data estimate evaportanspiration and to analyse hydrological trends or events (e.g. Seneviratne et al., 2012; Teuling et al., 2009). Nevertheless we would like

to point out that the intention of the paper is not to develop a complete review about lysimeter studies but to provide a comprehensive filtering scheme for providing high-quality data for subsequent analyses. A review of several existing papers dealing with the filtering of lysimeter data is provided in the second part of the introduction.

I suggest an overview on the error types and on their propagation theory. The period in P572-L16-29 is not clear. Is known that, when we obtain a water balance term from a difference operation, the errors are hidden in the computation.
This paragraph highlights the principal issue of measurement errors on the calculation of the separate components of the water balance. The reduction of these errors prior to this calculation is the objective of the paper and we now state this more clearly in the introduction. In the following paragraphs different kinds of error types and filtering examples are summarized and reviewed. The propagated error of a difference operation would simply be the sum of the error ranges of the two measurements but this is not the type of problem we are dealing with. We aim to reduce errors that are highly variable in time and depend on highly varying influences. The strategy followed in this paper is to minimize such errors prior to the mass balance calculations and to estimate the residual uncertainty by varying the filter parameters as described in the text.

P573-L25. . . ..However, for integrating evapotranspiration data from lysimeters into larger-scale hydrologic or climate models, adequate filtering algorithms are essential to provide the required data accuracy. . .. . .Relatively to the above sentence, question raised in my mind is related to the costs, especially when lysimeter method are used for regional scale study. Moreover, your data quality, obtained with sophisticate filtering procedure, is scientifically and economically justified when up-scaling errors are considered? I doubt on the applicability of lysimeter data for hydrological forecasting!!
This statement indeed was somewhat unfortunate and we have clarified these formulations in the introduction. Nevertheless, there exist a number of studies evaluating catchment- or even regional- or continental-scale hydroclimatic processes with the help of lysimeter data

such as the 2003 drought event in Europe (Seneviratne et al., 2012) or the evaluation of main drivers of evapotranspiration at continental scale by Teuling et al. (2009). In these studies, the lysimeter measurements are used as very valuable reference data as they provide estimates of all terrestrial water balance components, most importantly evapotranspiration. We do not advocate to use lysimeters as representative for the water balance at much larger scales. However there is a lot to learn from lysimeters on the separation of precipitation into the various flow components and on processes of plant-soil interactions. It is this knowledge that has the potential to be transferred to larger scales.

As explained in the abstract, objects emphasize a simple mathematical application rather a lysimeter-based experiment.
Please refer to our response to the first comment.

Relatively to the Smoothing filter (2.2.4), seem that Savitzky–Golay filter and moving average have the same performance to reduce the errors. Only when will set a 1st degree polynomial, SG filter has comparable performance with moving average. Moreover, SG has the capability of detects particular events (dew and rime) included into data series. The performance is linked to the choice of polynomial's degree and windows length.
Of course, the SG-Filter has different characteristics compared to the moving average depending on the used polynomial degree and the window length. For the filtering of lysimeter weighing data, the filtering with a SG filter (of a polynomial degree of 2 or larger) compared to the moving average has the adavantage of a lower tendency of blurring but the disadvantage of a tendency of overshooting which also leads to an additional error source. These advantages and disadvantages were discussed by Schrader et al. (2013). For low smoothing times as used in this study, the influence of blurring is highly reduced. Therefore we prefered the MA filter. The remaining influence of the effect of smoothing was discussed in detail. However, the difference of the various smoothing filter types will at least vanish for the limit of averaging times $t \rightarrow 0$, so that in the case of very low averaging times, the differences will be minor. In

the lysimeter community different preferences to smoothing filters exist, and it is possible to use the suggested filtering scheme with other smoothing filter types.

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