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A new filter routine to estimate evapotranspiration and precipitation from lysimeter data

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Weighing lysimeters yield the most precise and realistic measures for evapotranspiration (ET) and precipitation (P), which are of great importance for many questions regarding soil and atmospheric sciences. An increase or a decrease of the system mass (lysimeter plus seepage) indicate P or ET. These real mass changes of the lysimeter system have to be separated from measurement noise (e.g. caused by wind). A promising way to filter noisy lysimeter data is (i) to introduce a smoothing routine, like a moving average with a certain averaging window w, and then (ii) to apply a certain threshold value d, accounting for measurement accuracy, separating significant from insignificant weight changes. Thus, two filter parameters are used, namely w and d. Especially the time variable noise due to wind and strong signals due to heavy precipitation pose challenges for such noise reduction algorithms. If w is too small, data noise might be interpreted as real system changes. If w is too wide, small weight changes in short time intervals might be disregarded. The same applies to too small or too large values for d. Application of constant w and d lead either to unnecessary losses of accuracy or to faulty data due to noise.
The aim of this contribution is to solve that problem with a new filter routine, which is appropriate for any event, ranging from smooth evaporation to strong wind and heavy precipitation. Therefore, the new routine uses adaptive w and d in dependence on signal strength and noise (AWAT - Adaptive Window and Adaptive Threshold filter). The minimum threshold value and minimum window width are set to the scale resolution and temporal resolution of the measurement. The maximum values for both have to be defined by the user.
For comparison a moving average filter and the Savitzky-Golay filter with constant w and d were used, where w and d have to be defined by the user. All three filters were applied to real lysimeter data comprising the above mentioned events. The AWAT filter was the only filter which could handle the data of all events very well. A sensitivity study shows that the magnitude of the maximum threshold value has practically no influence on the results, so that only the maximum window width must be predefined by the user. From our analysis a maximum window width on 31 minutes was preferable.