ESTIMATING PRECIPITATION AND ACTUAL EVAPORATION FROM PRECISION LYSIMETER MEASUREMENTS

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SUMMARY

Large weighable lysimeters furthermore permit the quantification of the water balance of the soil and the precise measurement of water exchange at both the soil-atmosphere interface, by rain, dew, fog, and rime, and the flux below the root zone toward the groundwater. If well embedded into a similarly vegetated environment, they reach a hitherto unprecedented accuracy, avoiding errors made by traditional measurement systems, such as the wind error of Hellman rain samplers, or the island error of class-A pans, or the heterogeneity error that affects any readings from in situ instrumentation of soil water state variables. If the amount of seepage water is recorded separately, the time series of the lysimeter mass allows to identify the missing parts of the water balance equation: increasing mass shows precipitation, decreasing mass is the effect of evapotranspiration, the mass difference in the evaluation period indicates the change of stored water volume. Whereas the soil water mass balance (precipitation minus actual evapotranspiration) is definitely accurate in lysimeter systems, a problem arises in the separate estimation of the underlying precipitation and evapotranspiration, because increases and decreases in weight in specified time intervals are affected by random fluctuations in lysimeter weight, which might be caused by wind or other disturbances. Further problems arise from singular events, missing data, or vegetation harvest (Fig. 1). The analysis of precipitation, evapotranspiration and the change of stored water volume from the time series of the lysimeter mass will therefore need a strategy where a threshold parameter is applied that integrates random noise from different sources (technical noise, wind velocity ...). We use synthetic and real measured data from large lysimeters, to test which strategies of data management can be applied, and which degree of accuracy can be reached when estimating the actual soil-atmosphere boundary fluxes and the soil water balance from lysimeter data (Fig. 2).
Figure 1: Cumulative upper boundary flux at the Bad Lauchstädt lysimeter station [1], beginning in January 2012. Note the outlier on day 17, the negative offsets due to seepage water sampling on days 27 and 49, and the data gap around day 38.

Figure 3: (a) Data smoothing with a second-order Savitzky-Golay filter (1 hour window size) and (b) time dependent threshold for significant mass changes in a selected timeframe for a dataset from Wagna, Austria. Threshold values were obtained by a scaled moving median (window size as above) through the absolute residuals of (a).