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Determining water balance components at a lysimeter site in north-eastern Austria

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The water balance of a certain soil profile in a certain time interval is subjected to changes of soil water content within the respective profile, and fluxes at its upper and lower boundary such as evapotranspiration and percolation, respectively. Weighing lysimeters are valuable instruments for water balance studies. Typically, mass changes – thus, changes of soil profile water content – are detected by a weighing system, while percolating water is measured by a tipping bucket or a weighed storage tank, and precipitation is measured by a rain gauge. Consequently, evapotranspiration can be determined by solving a simple water balance equation. However, a typical problem is that using separately measured precipitation data may cause implausible (negative) evapotranspiration. As a solution, the quantities can be determined directly from lysimeter mass changes, which are assumed to be positive due to precipitation and negative due to evapotranspiration. This method requires short measuring intervals and precise data. In this regard, data management of primarily older lysimeter facilities may be improved to fulfil these criteria.

At an experimental site in north-eastern Austria hourly water balance components were determined using a reference lysimeter that was installed 1983 and equipped with lever-arm-counterbalance weighing system. A disadvantage of such systems is their sensitivity to external disturbances, mainly forces exerted by wind, which can significantly decrease measuring accuracy. Hence, we firstly studied the mechanical performance of the system regarding wind effects and oscillation behavior, and tested averaging procedures on noisy raw data to enhance measurement accuracy. The measurement accuracy for a wind velocity <5 m/s (measured in 10 m height) was $\pm$0.4 kg (equivalent to $\pm$0.14 mm); at a larger wind velocity the accuracy was three times lower, but there was no linear relationship. Modifying the averaging procedure would improve accuracy to $\pm$0.28 kg (0.1 mm) for a wind velocity <5 m/s. Beyond that, additional filtering and averaging was necessary to process noisy data with outliers, especially at larger wind velocities. Therefore, we tested two types of smoothing functions on a set of noisy lysimeter weighing data with regard to improved data interpretation. A basic piecewise sigmoid function was easy to fit and gave proper results of typical diurnal variation of evapotranspiration on single days without rainfall. However, on a longer time period with rainfall events, a polynomial spline function performed better. In such a way processed data served as basis for determining water balance components as described above. Precipitation measured with the lysimeter was generally greater than rain gauge values. Also dew formation was measured, though its total amount was small. Evapotranspiration calculated on daily and hourly base according to ASCE standards indicated good correlation with measured data, but measured values were considerably smaller. Both calculated and measured dew amount were of the same magnitude. Comparison of lysimeter evapotranspiration with daily calculations (neglecting dew) and hourly computation (considering dew) delivered similar results.