Geophysical Research Abstracts
Vol. 17, EGU2015-4864, 2015
EGU General Assembly 2015

Modelling the water balance of a precise weighable lysimeter for short time scales

Johann Fank, Gernot Klammler, and Gerhard Rock
RESOURCES - Institute for Water, Energy, and Sustainability, JOANNEUM RESEARCH, Graz, Austria
(johann.fank@joanneum.at)

Precise knowledge of the water fluxes between the atmosphere and the soil-plant system and the percolation to the groundwater system is of great importance for understanding and modeling water, solute and energy transfer in the atmosphere-plant-soil-groundwater system. Weighable lysimeters yield the most precise and realistic measures for the change of stored water volume (ΔS), Precipitation (P) which can be rain, irrigation, snow and dewfall and evapotranspiration (ET) as the sum of soil evaporation, evaporation of intercepted water and transpiration. They avoid systematic errors of standard gauges and class-A pans. Lysimeters with controlled suction at the lower boundary allow estimation of capillary rise (C) and leachate (L) on short time scales.

Precise weighable large scale (surface $>=$ 1 m^2) monolithic lysimeters avoiding oasis effects allow to solve the water balance equation (P – ET – L + C $\pm$ ΔS = 0) for a 3D-section of a natural atmosphere-plant-soil-system for a certain time period. Precision and accuracy of the lysimeter measurements depend not only on the precision of the weighing device but also on external conditions, which cannot be controlled or turned off. To separate the noise in measured data sets from signals the adaptive window and adaptive threshold (AWAT) filter (Peters et al., 2014) is used.

The data set for the years 2010 and 2011 from the HYDRO-lysimeter (surface = 1 m^2, depth = 1 m) in Wagna, Austria (Klammler and Fank, 2014) with a resolution of 0,01 mm for the lysimeter scale and of 0,001 mm for the leachate tank scale is used to evaluate the water balance. The mass of the lysimeter and the mass of the leachate tank is measured every two seconds. The measurements are stored as one minute arithmetic means.

Based on calculations in a calibration period from January to May 2010 with different widths of moving window the w_{max} – Parameter for the AWAT filter was set to 41 minutes. A time series for the system mass ("upper boundary") of the lysimeter has been calculated by adding lysimeter mass and the leachate tank mass for every minute. Based on the resolution of the scales and an evaluation of noise in periods without precipitation and evaporation a d_{min}-value of 0.002 to filter the leachate tank measurements and a d_{min}-value of 0.012 was used to filter the lysimeter weight data and the upper boundary data. A mandatory requirement for the quantification of P or ET from lysimeter measurements is that in a reasonably small time interval, either P or ET is negligible. With this assumption, every increase in upper boundary data is interpreted as P. Every increase of seepage mass is interpreted as L, every decrease as C. ΔS is evaluated from filtered lysimeter mass. ET is calculated using the water balance equation.

The evaluation results are given as water balance components time series on a minute scale. P measured with the lysimeter for the two years 2010 and 2011 is 105 % of precipitation measured with a standard tipping bucket gauge 100 m beside the lysimeter. While P during the summer season (April to September) is very close to standard precipitation measurement, P during the winter season is more than 120 % of tipping bucket precipitation. Meissner et al. (2007) showed that P includes precipitation of dewfall and rime. A detailed evaluation of the HYDRO-Lysimeter in Wagna showed, that precipitation in the night and not recognized with the standard tipping bucket (interpreted as dew or rime) is about 1 % of P, the highest monthly sums ($>$ 1 mm) are recognized from August to November.

Klammler, G. and Fank, J.: Determining water and nitrogen balances for beneficial management practices using lysimeters at Wagna test site (Austria). Science of the Total Environment 499 (2014) 448–462.

Meissner, R., Seeger, J., Rupp, H., Seyfarth, M., and Borg, H.: Measurement of dew, fog, and rime with a high-precision gravitation lysimeter, J. Plant Nutr. Soil Sci. 2007, 170, 335–344.

Peters, A., Nehls, T., Schonsky, H., and Wessolek, G.: Separating precipitation and evapotranspiration from noise – a new filter routine for high-resolution lysimeter data. Hydrol. Earth Syst. Sci., 18, 1189–1198, 2014.