Monolithic weighing lysimeter-based alfalfa evapotranspiration rates evaluation using micrometeorological instruments

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Abstract. Monolithic weighing lysimeters are considered as one of the most accurate methods to measure crop water evapotranspiration (ET) rates. The advantage of lysimeter compared to other ET measurement methods is that it can measure ET precisely using the soil water balance method. Lysimeters being considered as a reliable and accurate method, have been used globally to determine the crop coefficients (Kc) of various crops. This study explores the possible inaccuracies associated with the lysimeter ET measurement method. Large precision monolithic weighing lysimeters were found to be non-representative of the entire field when the lysimeter surface condition was different than the field surface condition. Based on the data analysis from 2009 to 2013 from the experimental alfalfa lysimeter field of Colorado State University (CSU) Arkansas Valley Research Center (AVRC) near Rocky Ford, Colorado, it was found that during periods when alfalfa was at reference height (> 30 cm tall), crop biomass and soil moisture content was larger inside the lysimeter box compared to the rest of the field. This reality caused larger alfalfa evapotranspiration (ETr) rates at the lysimeter box compared to the micrometeorological based ET measurement methods (viz. large aperture scintillometer (LAS), eddy covariance (EC) and surface aerodynamic tower (SAT)), which measured ETr from a larger footprint than the lysimeter. LAS, EC and SAT measurements of ETr agreed reasonably well among each other. This result suggested that the lysimeter ETr overestimated the actual ET and needed to be corrected based on the micrometeorological methods. In addition, when the air was drier, there was more discrepancy (up to 40 % mean biased error in 2012) between lysimeter ETr and the micrometeorological methods. The lysimeter ETr was then calibrated based on those micrometeorological methods. In 2012, the lysimeter ETr had mean biased error of 0.12 mm/h (40.4%), root mean squared error of 0.18 mm/h (60.9%) and Nash Sutcliffe coefficient of efficiency as 0.59 when compared to the micrometeorological methods. After the calibration of lysimeter ETr, mean biased error was zero, root mean squared error dropped to 0.08 mm/h (26.9%) and Nash Sutcliffe coefficient of efficiency was increased to 0.92.