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Computed reference evapotranspiration versus lysimeter measurements: Do rainfall and irrigation bias the correlation?

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Evapotranspiration models are widely used to estimate reference evapotranspiration (ET_{ref}) based on weather data. Evaluating such models – especially with respect to site-specific boundary conditions – is recommended to be able to interpret ET_{ref}-calculations in a realistic and substantiated manner. Measured ET-values, serving as a reference for evaluation, are traditionally determined by means of weighing lysimeters. Novel developments in data processing allow determining both ET and precipitation directly from lysimeter data. Using such procedures, rainy days do not have to be filtered, as it was done previously in many studies. Although this must be regarded advantageous, it raises the question if antecedent rainfall or irrigation might misrepresent the measurements. This could be the case, for instance, when measured ET-values involve additional evaporation from the wetted grass surface. Hence, the objective of this study was to analyse potential biases due to rainfall and irrigation when comparing ET_{ref}-calculations with lysimeter measurements.

The study site in north-eastern Austria (48˚12'N, 16˚34'E; 157 m) was characterized by a subhumid climate (according to Köppen: Cfb – temperate climate without dry season and warm summer) with mean annual precipitation and temperature of 550 mm and 10.7˚C, respectively. The measurement area of approximately 50×50 m was kept with short grass. Basic data included hourly values of air temperature, relative humidity, air pressure, wind velocity, and solar radiation. They served as input for computing ET_{ref} for hourly time steps applying the ASCE standardized equations (based on the well-known equation after Penman and Monteith). The estimated values were processed to sum-of-hourly (soh) values to represent daily ET_{ref}. The calculations were related to ET-values determined by a weighing lysimeter (ET_{lys}) with a surface area of 2.85 m^2 and frequently irrigated grass as reference crop.

The dataset covered the years 2004 to 2011 (n = 2185). Comparing ET_{ref} to ET_{lys} revealed overestimation of small ET_{ref}-values and underestimation of large values. Some of these values could be attributed to days at which the lysimeter was irrigated, but also antecedent rainfall could have had an influence. To examine if these limitations affected model validation, the available dataset was filtered with respect to preserving data pairs of days without rain and irrigation (n = 1153). This was done to avoid potential disturbing impacts from unintended evaporation. As the correlation was similar to the unfiltered data, it can be concluded that antecedent rainfall and irrigation events did not bias the presented ET measurements. Further filtering considered only days up to three days after rainfall and irrigation. This was done to guarantee satisfactory soil moisture distribution at the study site and to reduce advection of sensible heat from the surroundings. The gained dataset contained n = 740 data pairs, which is still comparable to sample sizes of other ET studies. The resulting correlation was again similar. The same was found by considering only days before irrigation (n = 182, representing dry conditions). Hence, dataset and results are supposed being consistent and not influenced by systematic measurement errors with respect to soil water distribution.