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Input selection and algorithm adjustment influence reference evapotranspiration: comparing FAO-56 Penman–Monteith and Hargreaves–Samani against lysimeter benchmarks

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Evapotranspiration (ET) is a key component of the water balance, and its reliable estimation is critical for water resources planning and agricultural water management, for instance. Lysimeters have long been used to quantify ET from vegetated surfaces and to develop and calibrate ET models. Reference evapotranspiration (ET_0) computed with the FAO-56 Penman–Monteith model (FAO-PM) has become a standard, supported by the broader availability of meteorological inputs. In Austria, users can access two main data categories via the GeoSphere Austria data hub: (i) point observations from stations – provided as daily and hourly time series – for meteorological variables; and (ii) spatially interpolated, gridded datasets. Beyond measured variables, derived products are also available, including modeled ET_0 based on the Hargreaves–Samani method (HSM) and climate indices. To make an informed choice, it is necessary to understand the differences among these options. Therefore, we examine how alternative input datasets and adjusted algorithms affect ET_0 estimates. For a site in northeastern Austria with lysimeter observations, we compute ET_0 with FAO-PM using two station datasets (daily values vs. daily averages from hourly data) and compare these with HSM computations, including a gridded ET_0 dataset with an adjusted algorithm. Meteorological and ET data are sourced from the GeoSphere Austria data hub (including the WINFORE dataset). ET data from a weighing lysimeter (3 m², grass, managed under reference conditions) serve as a benchmark. We compare the datasets covering a period of seven years using goodness-of-fit and error metrics as well as cumulated ET. The two FAO-PM results are most consistent with each other. However, they deviate slightly from the 1:1 line, which is likely due to the historically derived calculation method for daily wind data. The FAO-PM calculation based on hourly data (aggregated to daily) aligns best with lysimeter observations. During the growing season, FAO-PM cumulative ET_0 exceeds lysimeter evaporation by about 3 % on average. ET_0 based on HSM is larger by about 10 % relative to the lysimeter and by about 7 % relative to FAO-PM. This systematic overestimation should be considered in practical applications such as irrigation management. The FAO-PM vs. HSM comparison shows the largest bias and scatter, which requires further investigation.