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Evaluation of different methods for gap filling of actual evapotranspiration time series measured by lysimeters

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Terrestrial evapotranspiration (ET) is the second largest global water flux and it may return on average 60% to 65% of the precipitation from the land surface to the atmosphere. ET can be measured with many techniques. Weighable lysimeters are particularly precise and some very long time series of up to 50 years exist. However, the time series of actual evapotranspiration measured by lysimeters are usually affected by data gaps, for example related to sensors malfunctioning. It is necessary to fill these gaps in order to estimate lysimeter-based long-term trends in actual evapotranspiration. In this study, we explored four different gap filling methods including (i) potential evapotranspiration calculated according Penman-Monteith, (ii) a ratio method, (iii) an FAO-based water balance method and (iv) HYDRUS model calculations. The ratio method interpolates the ratio of actual ET/potential ET over temporal gaps. The four methods were evaluated for three time series of actual ET measured by lysimeters. Also exhaustive meteorological data are available at the sites. The following time series were included in the analysis: (i) Basel-Binningen, Switzerland (time period 1983-2011), (ii) Rheindahlen (North-Rhine Westphalia, Germany, time period 1985-2012) and (iii) Rietholzbach (northeast Switzerland, time period 1989-2007). The gap filling methods were evaluated for artificial data gaps that were created in the three time series. The results show that for the lysimeter stations Rietholzbach and Basel the ratio method outperforms the other three methods for gap filling. On the other hand, the Hydrus method outperforms the other methods for the Rheindahlen site. Although the ratio method results in larger errors if the temporal gap is larger, also for gaps as large as one month it outperforms the other methods for the Rietholzbach and Basel sites.