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Urban rainfall monitoring with crowdsourced automatic weather stations in Amsterdam

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The high density of built-up areas and resulting imperviousness of the land surface makes urban areas vulnerable to extreme rainfall, which can lead to considerable damage. In order to design and manage cities to be able to deal with the growing number of extreme rainfall events, rainfall data is required at higher temporal and spatial resolutions than those needed for rural catchments. However, the density of operational rainfall monitoring networks managed by local or national authorities is typically low in urban areas. A growing number of automatic personal weather stations (PWSs) link rainfall measurements to online platforms. Here, we examine the potential of such crowdsourced datasets for obtaining the desired resolution and quality of rainfall measurements for the capital of the Netherlands. Data from 63 stations in Amsterdam (~575 km^2) that measure rainfall over at least 4 months in a 17-month period are evaluated. In addition, a detailed assessment is made of three Netatmo stations, the largest contributor to this dataset, in an experimental set-up. The sensor performance in the experimental set-up and the density of the PWS-network are promising. However, features in the online platforms, like rounding and thresholds, cause changes from the original time series, resulting in considerable errors in the datasets obtained. These errors are especially large during low intensity rainfall, although they can be reduced by accumulating rainfall over longer intervals. Accumulation improves the correlation coefficient with gauge-adjusted radar data from 0.48 at 5 min intervals to 0.60 at hourly intervals. Spatial rainfall correlation functions derived from PWS data show much more small-scale variability than those based on gauge-adjusted radar data and those found in similar research using dedicated rain gauge networks. This can largely be attributed to the noise in the PWS data resulting from both the measurement setup and the processes occurring in the data transfer to the online PWS-platform. A double mass comparison with gauge-adjusted radar data shows that the median of the stations resembles the rainfall reference better than the real-time (unadjusted) radar product. Averaging nearby raw PWS measurements further improves the match with gauge-adjusted radar data in that area. These results confirm that the growing number of internet-connected PWSs could successfully be used for urban rainfall monitoring.