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CML precipitation estimates for hydrological modelling: A three-year experiment

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Commercial microwave links (CMLs), typically very dense in urban areas, allow for indirect path-integrated precipitation detection. There have already been studies confirming the potential of quantitative precipitation estimates (QPEs) from CMLs to improve rainfall data quality, especially when adjusting these estimates by rainfall information from rain gauges (e.g. Fencl et al., 2017). In this study, we aim on applying such data, using an extraordinarily extensive data set, to confirm their validity for applications in the field of urban hydrological modelling.

In a small urban catchment (1.3 km2) in Prague-Letňany, Czech Republic, we monitored 19 CMLs for a period spanning over three summer seasons. Furthermore, rainfall measurements from three traditional rain gauges (each in a distance of approximately 2.5 km from the catchment), as well as discharges at the outlet of the local stormwater drainage system, were monitored during the period. We compare the runoff measured at the drainage system outlet with outputs of a rainfall-runoff model of the studied catchment operated using the following rainfall data sets with one minute resolution: (i) QPEs from CMLs adjusted by distant rain gauges (mean over all 19 CMLs) and (ii) rainfall data from distant rain gauges alone.

We use the following metrics to assess the model performance for each of 70 simulated rainfall-runoff events: (i) the relative error of the total runoff volume (dV, [-]), (ii) the rel. error of the maximal discharges (integrated over 8-min period) (dQmax, [-]) , (iii) the timing of the discharge maximum (Δt_Qmax, [h]), and (iv) the Nash–Sutcliffe efficiency coefficient (NSE, [-]). To be able to evaluate the overall model performance for a given data set, we as well calculate the mean and the standard deviation for all above mentioned metrics.

Our results show that QPEs from CMLs adjusted by distant rain gauges, when compared to distant rain gauge data, improve rainfall-runoff modelling results especially in terms of event dynamics. The improvement is demonstrated by the dQmax and NSE metrics, which both reach lower standard deviations and the mean is closer to 0 for the former and closer to 1 for the latter. On the other hand, we observe no conclusive improvement for the timing of the maximum and the dV metric reaches better values when using the rain gauge data alone.

When analysing the results for events with various spatiotemporal variability, we observe no distinctive differences. This suggests that exploiting the adjusted CML data can improve urban rainfall data quality as well for rainfalls with lower spatiotemporal variability, for which the problem of insufficient representativeness of traditional rainfall measurements is not considered to be so pronounced.

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References:

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