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Calibrating microwave link rainfall retrieval model using runoff observations

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Commercial microwave links (CMLs), point-to-point radio connections widely used as cellular backhaul, can provide path-integrated quantitative precipitation estimates (QPEs) as they operate at frequencies where radio wave attenuation caused by raindrops is almost proportional to rainfall intensity. CML networks are typically very dense in urbanized areas, and thus, they represent a promising source of rainfall observations for applications where rainfall information of high spatiotemporal resolution is required, such as urban rainfall-runoff modelling.

The relationship between the raindrop-induced attenuation and rainfall intensity is robust and well understood. Nevertheless, in order to obtain unbiased QPEs, the raindrop-induced attenuation has to be separated from other components of total (observed) attenuation. Baseline attenuation is usually identified from dry-weather attenuation levels, however, estimating attenuation caused by antenna wetting, so called wet antenna attenuation (WAA), remains a challenge, as it is a complex process highly dependent on site-specific conditions and characteristics of each single CML unit (e.g. antenna radome diameter, age, or coating).

Current methods for WAA estimation have been typically derived from specialized experiments, and thus, they are often unable to take into account all the case-specific factors. Therefore, incorrect WAA estimation is a common source of errors in CML QPEs. When compared to the raindrop-induced attenuation, WAA is relatively large especially for short CMLs (path lengths < 2000 m). Therefore, the errors due to incorrect WAA estimation affect most gravely QPEs from these short CMLs, which are, however, potentially very informative for urban rainfall-runoff modelling, as their path lengths typically correspond well to spatial scales of urban subcatchments.

We propose a backwards-hydrology approach where WAA is estimated using discharges observed at the outlet from a catchment, which represent transformed rainfall information. In order to account for the case-specific conditions and to minimize the bias in QPEs from short CMLs, we suggest estimating WAA separately for each of the examined CMLs.

The proposed method is validated on a calibrated rainfall-runoff model of a small urban catchment (1.3 km2) in Prague-Letňany, Czech Republic, using data from 19 CMLs and one flow meter collected for three summer seasons. First results show that this approach can improve especially QPEs from short CMLs (rel. error reduction on average by 0.4), which are most sensitive to the accuracy of WAA estimation. The improvement observed in QPEs from long CMLs is much less significant (rel. error reduction max. by 0.1). Although these first results are encouraging, further research is necessary to determine whether this way of WAA estimation can be applied also without prior rainfall-runoff model calibration.

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