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Effect of diverse microwave link characteristics on rainfall retrieval errors

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Commercial microwave links (CMLs), point-to-point radio connections forming the backbone of cellular networks, can be used as opportunistic rainfall sensors and provide rain rate at high temporal resolution. The CML rainfall retrieval methods have been mostly developed for devices operating between 13 – 40 GHz where attenuation-rainfall relation is relatively insensitive to drop size distribution. New deployments have, however, an extensive share of E-band CMLs operating at 71 – 81 GHz frequency where drop size distribution (DSD) represents a major source of errors (Fencl et al., 2020). This study investigates for the first time the joint use of 13-40 GHz and 71-86 GHz CMLs with focus on evaluating different sources of errors.

Rainfall retrieved from 250 CMLs located in the city of Prague and its vicinity are compared to the quantitative precipitation estimates from C-band weather radar adjusted to the local network of 23 municipal rain gauges. Diverse path-lengths and frequencies of CMLs enable us to distinguish between different sources of errors. Shorter CMLs operated at lower frequencies are dominantly disturbed by errors related to antenna wetting whereas E-band CMLs are significantly more affected by DSD variability and non-uniform distribution of rain rates along the CML path. Moreover, longer E-band CMLs suffer from outages during heavy rainfalls. In general, E-band CMLs are more sensitive to low rain rates and thus suitable for retrieving light rainfalls whereas CMLs operating at lower frequencies are more accurate during heavy rainfalls.

Diverse characteristics of CMLs typically occurring in real-world cellular networks pose a challenge as each CML is affected by the instrumental errors in a different manner. On the other hand, the diversity in CML characteristics can be also exploited to quantify and possibly reduce these errors, especially in cities, where CML networks are usually dense and thus often provide collocated (redundant) rain rate measurements.

References:

Fencl, M., Dohnal, M., Valtr, P., Grabner, M., and Bareš, V.: Atmospheric observations with E-band microwave links – challenges and opportunities, 13, 6559–6578, https://doi.org/10.5194/amt-13-6559-2020, 2020.

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