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E-band rainfall observation: uncertainties in quantitative measurements and long-term statistics of outages

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The deployment of E-band CMLs in high-capacity communication networks is increasing however, studies investigating how suitable they are for rainfall monitoring are still rare.

The analysis explores three-year long dataset from an E-band CML from the Prague network accompanied by five reference weather stations. The 4.5 km link, operating with two sublinks at 73.25 GHz and 83.25 GHz, offers a low rainfall detection threshold, making it sensitive to light rainfall intensities. However, the E-band signal is particularly susceptible to heavy rainfall attenuation leading to outages in rainfall monitoring.

The first objective of the study is to evaluate the impact of rainfall type and rainfall (non)uniformity on the accuracy and precision of the signal attenuation and rainfall intensity relationship. The second analysis focuses on the missing higher rainfall intensities in the observations and statistically assesses them.

The parameter sets were optimised for power-law approximation of the relation between attenuation and rainfall for convective and stratiform rainfall types (based on drop size distribution from nearby disdrometer). While improvements in correlation and RMSE for ITU and optimised parameters are negligible, the bias was reduced from -0.26 to -0.06 for convective rainfalls and from -0.05 to -0.03 for stratiform rainfalls in average for both sublinks. The variability of rainfall along the link path also influences the optimal parameter selection. For the most variable rainfalls (with CV of reference rainfall between 0.75 and 2), the relative bias improved from -0.20 to -0.04 in average for both sublinks.

CML outages caused by signal attenuation are clearly linked to rainfall intensity. During rainfalls exceeding path-averaged intensity 35 mm/h the outages occur about 75 % of time. Moreover, technically no E-band CML observation is available for rainfall intensities over 55 mm/h.

The study demonstrates that the suitability of E-band CMLs for rainfall observation is not fully explored, although these opportunistic sensors are becoming increasingly widespread. The employment of different parameter sets for different rainfall types reduces errors; however, it involves additional information about the rainfall type. Long E-band CMLs are prone to outages due to intense rainfall, this analysis addresses a knowledge gap regarding the distribution of outages in E-band CML data.

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