EGU2020-20217
https://doi.org/10.5194/egusphere-egu2020-20217
EGU General Assembly 2020

Effect of drop size distribution on microwave link rainfall retrieval at E-band

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Rainfall retrieval with commercial microwave links (CMLs) relies on the relation between radiowave attenuation and rainfall intensity. The CMLs used to operate predominantly at 15-40 GHz frequency region where the relation between rainfall and attenuation was close-to-linear and only slightly dependent on drop size distribution (DSD) (Berne and Uijlenhoet, 2007). New generation of CMLs operated within cellular backhaul utilizes increasingly the E-band frequencies, specifically frequency region 71 - 86 GHz. The attenuation-rainfall relation at this region is, however, substantially more dependent on DSD.

One year of DSD data retrieved from Parsivel OTT disdrometer is used to simulate theoretical attenuation and quantify the effect of DSD on CML rainfall estimates. The results show that E-band CMLs are highly sensitive to DSD. The relative error related to DSD variability reaches up to 40%, which is about two to three times higher value compared to errors by CMLs operated at 15-40 GHz. These errors can be, however, reduced to approx. 20% when distinguishing between stratiform and convective rainfalls and introducing two different parameter sets for attenuation-rainfall relation, accordingly. The improvement of CML rainfall estimates when adapting parameters of attenuation-rainfall relation is demonstrated on real attenuation data acquired from 4.8 km long E-band CML operated within cellular backhaul in Prague (CZ).

Variable drop size distribution represents a significant source of uncertainty in rainfall estimates retrieved from E-band CMLs. This uncertainty can be substantially reduced by adapting parameters of attenuation-rainfall model to rainfall type (DSD).

References:

Berne, A., Uijlenhoet, R., 2007. Path-averaged rainfall estimation using microwave links: Uncertainty due to spatial rainfall variability. *Geophys. Res. Lett. 34*, L07403. https://doi.org/10.1029/2007GL029409