Geophysical Research Abstracts
Vol. 20, EGU2018-970-4, 2018
EGU General Assembly 2018

Estimating wet antenna effect from long-term attenuation statistics of short commercial microwave links

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Commercial microwave links (CMLs), pairs of telecommunication antennas widely used as a cellular backhaul, were proposed about decade ago to be used as non-traditional rainfall sensors. CMLs are attenuated by raindrops along their path and the attenuation rate is almost linearly related to the rainfall intensity (Messer et al., 2006). One of the major uncertainties in CML rainfall estimates is related to additional attenuation due to antenna wetting, which leads to systematic overestimation of rainfall estimates. Several models have been suggested in recent years to correct CMLs for wet antenna attenuation (WAA), however, their description of WAA process differs significantly and it is therefore not clear how to choose the most suitable one, especially when no reference rainfall data is available. Moreover, it is not understood to which extend WAA is hardware specific, i.e. if different devices are affected (biased) similarly.

This contribution presents analysis of two years of data from eight short (48-497m) commercial microwave links operated at frequencies of 37.3-39.2 GHz within the cellular backhaul. WAA is quantified from the complementary cumulative distribution functions of measured attenuation, which is compared with theoretical ones calculated from rainfall data from nearby rain gauges. WAA dominates over path attenuation during light rainfalls ($R < 2$ mm/h) reaching 1.5-2.75 dB and increases for all eight links up to a probability level of 1 % ($R \leq 10$ mm/h) reaching 3-5 dB. Maximal wet antenna attenuation observed during heavy rainfalls ($R \approx 100$-140 mm/h) at a 0.01 % probability level is between 5-12 dB.

The WAA substantially contributes to total CML attenuation, especially by shorter CMLs. The results imply that wet antenna attenuation is dependent on rainfall intensity and increases exponentially towards a maximal value. The constant value of WAA used in previous studies may, therefore, lead to a significant underestimation of peak rainfalls. However, a wide range of estimated magnitudes during heavy rainfalls indicates that antenna wetting may also be dependent on other (unmeasured) environmental variables than rainfall as well as on antenna properties. Direct estimation of WAA from short links proposed in this study might, therefore, be convenient approach to account for WAA bias, especially when no reference rainfall data are available.

This work was supported by Czech Science Foundation grant No. 17-16389S, 'Hydrological estimates from radiowave propagation in terrestrial microwave network '.

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