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Water vapour monitoring with E-band microwave links of cellular backhaul

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Water vapour observations represent an important input e.g. for predicting mesoscale initiation of convective precipitation or estimating evapotranspiration. E-band commercial microwave links (CMLs), which are increasingly used in cellular backhaul, might be used as unintentional water vapour sensors accessible remotely from a network operation centre. E-band CMLs operate at frequencies between 71 and 86 GHz where water vapour causes substantial attenuation of electromagnetic waves. This attenuation can be related to water vapour density along a CML path, nevertheless, it has to be properly separated from other sources of attenuation, especially rainfall-induced attenuation, and wet antenna attenuation caused by wet surface of antenna radomes. Moreover, the relation between attenuation and water vapour density is also dependent on temperature (Fencl et al., 2020).

This contribution evaluates capability to estimate water vapour density on a 4.86 km long full-duplex CML being operated within cellular backhaul at frequencies 73.5 GHz and 83.5 GHz. Three rain gauges are deployed along its path, two of them being equipped with an air humidity sensor. The evaluation period is between August to December 2018. The results show that estimation of water vapour density is feasible when there is now rain and antenna radomes are dry, which is only about 50% of time. Estimated water vapour density during dry weather is highly correlated with humidity observations ($r = 0.7$). The highest correlations are observed during summer season ($r = 0.9$) and lowest during December ($r = 0.3$) when amplitude of water vapour fluctuations are small. In contrast, mean absolute error is highest during August (approx. 1 g/m^3) and lowest in December (0.2 g/m^3). Most of the outliers were encountered during October, probably due to multipath inferences occurring during clear-sky conditions.

Unintentional sensing of water vapour density with E-band CMLs is feasible by sufficiently (several kilometres) long CMLs. Currently, 20 % of new CML deployments are operated E-band. E-band CMLs might thus greatly increase continental coverage of water vapour ground observations.

Fencl, M., Dohnal, M., Valtr, P., Grabner, M. and Bareš, V.: Atmospheric observations with E-band microwave links – challenges and opportunities, Atmospheric Measurement Techniques, 13(12), 6559–6578, https://doi.org/10.5194/amt-13-6559-2020, 2020.