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Title: Missing extremes in CML rainfall estimates due to total loss of signal

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Attenuation data from commercial microwave links (CMLs) has proven to provide useful rainfall information. With their high density in urban areas, CMLs offer a great potential to estimate and study rainfall variability on small scales. Since the transmission power of CML hardware is limited, heavy rainfall can, however, lead to a complete loss of signal at the receiving end. As a consequence, very high rain rates can be missing in CML-derived rainfall information. The rain rate for which a specific CML experiences complete loss of signal depends on its length and frequency as well as on its dynamic range which is defined by transmit power, receiver noise level and antenna gain.

We analyze the occurrence and effect of such complete losses of signal, which we term “blackouts”, using two different datasets. First, a CML dataset with one minute temporal resolution consisting of 4000 CMLs in Germany is used to investigate the blackouts in real CML attenuation data over a period of three years. Second, the gauge-adjusted radar climatology RADKLIM-YW from the German Meteorological Service is used to derive synthetic rain induced attenuation data for each CMLs path with 5-minute temporal resolution for a period of 20 years.

For the real CML observations we introduce and apply a new algorithm to detect rain induced blackout gaps. This allows us to quantify the number and length of the blackout gaps stemming from heavy rainfall. Using the path-averaged RADKLIM-YW data as reference, we then quantify the rain rates and rainfall amount that is missed due to the CML blackout gaps. We find that longer CMLs are more likely to be affected by blackout gaps. This effect occurs even though the CMLs in our dataset are configured so that longer CMLs have a larger dynamic range to account for the increasing attenuation with increasing length. Using the dynamic range of each CML, we derive the long-term statistics of potential blackout occurrence from the synthetic attenuation data based on RADKLIM-YW. We find a pattern similar to the one in the real CML attenuation data, albeit with a smaller fraction of time steps affected by blackouts for all CMLs.

Our results provide a reliable basis for researchers to judge the capability of their CML dataset to capture rainfall extremes. Furthermore, it can serve as an improved basis for planning the layout and configuration and thus the dynamic range of individual CMLs.