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Estimation of path-average precipitation using a 27 GHz microwave link

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Between May and July 1999 we operated a 27 GHz microwave link over a 5 km path between the towns of Rhenen and Wageningen in the Netherlands. The instrument, which was built at Eindhoven University of Technology, measures the power arriving at the receiving antenna with a sampling frequency of 18 Hz. During dry weather conditions, it can be used as a microwave scintillometer, i.e. the (turbulent) fluxes of sensible and latent heat can be estimated from the variance of the received power fluctuations. Here we focus on the use of the instrument during rainy conditions, where it can be used to measure the path-integrated attenuation of the microwave signal due to intervening rain between the transmitting and the receiving antenna. Owing to the fact that the specific attenuation at this particular microwave frequency (in dB/km) is closely proportional to the rainfall rate (in mm/h), as we demonstrate using disdrometer observations from the Cabauw Experimental Site for Atmospheric Research (CESAR), this instrument is well suited for path-average rainfall estimation. This parameter is highly relevant for various hydrological and meteorological applications. We present analyses for several rainfall events during the mentioned period, where we have compared the path-average rainfall estimates from the microwave link with rainfall measurements from a colocated line configuration of tipping bucket rain gauges. Although the results of this comparison are found to be promising, the need for an accurate absolute calibration remains a serious drawback of single-frequency microwave links. We employ CESAR disdrometer observations to investigate the potential and limitations of dual-frequency microwave links for path-average rainfall estimation in The Netherlands.