



## Measuring urban rainfall using microwave links

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The estimation of rainfall using commercial microwave links is a new and promising measurement technique. Commercial link networks cover large parts of the land surface of the earth and have a high density, particularly in urban areas. Rainfall attenuates the electromagnetic signals transmitted between antennas within this network. This attenuation can be calculated from the difference between the received powers with and without rain and is a measure of the path-averaged rainfall intensity. This study uses a large, 18-day data set of on average 33 single-frequency links from 2009 to estimate rainfall in the Rotterdam region, a densely populated urban area in The Netherlands ( $\sim 700 \text{ km}^2$ ,  $> 0.5$  million inhabitants), a delta city. A methodology is proposed in which nearby links are used to remove signal fluctuations that are not related to rainfall, in order to be able to reliably identify wet and dry weather spells. Subsequently, received signal powers are converted to rainfall intensities taking into account the temporal sampling protocol and attenuation due to wet antennas. Link-based rainfall depths are compared with those based on radar data. In addition, the rainfall retrieval algorithm is applied to an independent data set of 10 rainy days in 2010 with on average 11 single-frequency links in the same region. Rainfall retrievals are compared against gauge-adjusted radar rainfall estimates over the link path. Moreover, the retrieval algorithm is also tested using high-resolution research link data to investigate the algorithm's sensitivity to temporal rainfall variations. All presented comparisons confirm the quality of commercial microwave link data for quantitative precipitation estimation over urban areas.