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Rainfall maps from cellular communication networks: Assessing uncertainties

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Several studies show the potential applicability of commercial cellular communication networks in the retrieval of rainfall fields, sometimes even for an entire country. The key principle of rainfall monitoring using microwave links is based on the attenuation, due to rainfall, of the electromagnetic signals transmitted from one telephone tower to another. By measuring the received power at one end of a microwave link, as a function of time, the path-averaged rainfall intensity can be estimated.

This study focuses on the quality of country-wide rainfall maps derived from commercial microwave link data compared to a quality-controlled gauge-adjusted radar rainfall data set, considered as ground-truth. Part of the differences can be attributed to the interpolation methodology, as well as to the much higher spatial resolution ($\approx$38.000 pixels of 0.9 by 0.9 km^2) of the radar data compared to the relatively low density of the microwave link network ($\approx$1700 microwave links with an average length of 3.1 km). The magnitude of these factors is assessed by simulating microwave link rainfall depths from the radar rainfall data set.

The Ordinary-Kriging (OK) methodology is used to obtain rainfall maps based on the simulated and real microwave link data. This work quantifies what percentage of the errors in link-based rainfall maps can be attributed to the interpolation methodology itself and the limited spatial density of the microwave link network. Moreover, the spatial distribution of the error in rainfall maps is quantified in relation to the spatial density and temporally variable availability of links, which is highly relevant since the microwave link data are non-uniformly distributed in space or time. Finally, the applicability of the OK-methodology is tested over Dutch areas with different spatial densities of commercial microwave links.