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Sources of Uncertainty in Rainfall Maps from Cellular Communication Networks

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Accurate measurements of rainfall are important in many hydrological applications, for instance, flash-flood early-warning systems, hydraulic structures design, agriculture, weather forecasting, and climate modelling. Rainfall intensities can be retrieved from (commercial) microwave link networks. Whenever possible, link networks measure and store the decrease in power of the electromagnetic signal at regular intervals. The decrease in power is largely due to the attenuation by raindrops along the link paths. Such an alternative technique fulfills the continuous strive for measurements of rainfall in time and space at higher resolutions, especially in places where traditional rain gauge networks are scarce or poorly maintained.

Rainfall maps from microwave link networks have recently been introduced at country-wide scales. Despite their potential in rainfall estimation at high spatiotemporal resolutions, the uncertainties present in rainfall maps from link networks are not yet fully comprehended. The aim of this work is to identify and quantify the sources of uncertainty present in interpolated rainfall maps from link rainfall depths. In order to disentangle these sources of uncertainty, we classified them into two categories: (1) those associated with the individual microwave link measurements, i.e., the physics involved in the measurements such as wet antenna attenuation, sampling interval of measurements, wet/dry period classification, drop size distribution (DSD), and multi-path propagation; (2) those associated with mapping, i.e., the combined effect of the interpolation methodology, the spatial density of the network, and the availability of link measurements.

We computed ~ 3500 rainfall maps from real and simulated link rainfall depths for 12 days for the land surface of The Netherlands. These rainfall maps were compared against quality-controlled gauge-adjusted radar rainfall fields (assumed to be the ground truth). Thus, we were able to not only identify and quantify the sources of uncertainty in such rainfall maps, but also to test the actual and optimal performance of one commercial microwave network from one of the cellular providers in The Netherlands.