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Precipitation quantification by cellular-network backhaul-link signal attenuation and a monostatic atmospheric transmission experiment

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Future water resource management calls for additional measurement techniques to improve resolution and accuracy of precipitation observation, particularly in regions with a coarse station network density or high spatial precipitation variability. A new solution in this field is to exploit the attenuation of microwave signals of cellular backhaul link networks to quantify ground level precipitation and fill the gap between rain radar and rain gauge information. We present results from the first application of this technique in a pre-alpine region of Southern Germany.

The region is characterized by an orographical complex terrain, where traditional station- and radar derived precipitation fields are often not of sufficient quality for hydrological modeling purposes. The main focus of our work is to develop and improve algorithms relating the attenuation rate of cellular network backhaul link signals to rainfall intensity and to develop new statistical methods to estimate spatial rainfall fields. Data from a commercial cell phone provider supported by hydrological and meteorological data from an own observation site build the scientific ground base for this challenge. To get attenuation data from the commercial backhaul links small data acquisition modules with GSM connection are installed at several sites. They monitor the transmitted power by recording the automatic gain control level every minute and transfer it via ftp to a database server. As a first step, 12 links in the mountainous region around Garmisch-Partenkirchen/Germany are exploited, all operating in a frequency range between 15 GHz and 35 GHz. For the spatial rainfall estimation the attenuation data along with data from own and DWD rain gauges plus radar information is used.

For the investigation of the interaction of microwaves with hydrometeors, additionally an own polarimetric transmission experiment is set up. It operates at frequencies 22,235 GHz and 35 GHz and is fully polarization agile. The configuration is monostatic using a trihedral mirror as reflector to make the system fully coherent. Thus, besides just recording the amplitude for H- and V-polarization, it is also capable of measuring the phase shift and its fluctuations produced by hydrometeors with a single sideband bandwidth of up to 25 kHz.