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Line integrated precipitation and humidity observation with a coherent microwave transmission experiment at 22.235 GHz and 34.8 GHz

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Near surface water vapor and precipitation (intensity, type, drop size distribution) are central hydrometeorological observables which are still difficult to quantify accurately above the point scale. Both play an important role in modeling and remote sensing the hydrologic cycle. We developed and operate a microwave based system that is capable of providing line integrated estimates of both humidity and precipitation near the surface.

The developed transmission experiment supports precipitation estimates based on commercial microwave backhaul link microwave attenuation and offers new insights into the interaction of microwave radiation with hydrometeors and humidity. This is accomplished with a setup that allows for high bandwidth fluctuation analysis and very precise phase measurements. A folded monostatic configuration was chosen to reduce the complexity and expenses necessary for a phase coherent architecture. It uses a combined transmitter/receiver unit and a 70 cm trihedral reflector. The necessary discrimination between unwanted backscatter and the transmission component is accomplished via a pulsed transmitter and receiver stage that does range gating. Path length is kept short at 650 m to minimize the likelihood of different precipitation types and intensities over the path length. The system operates two transmitter/receiver units at 22.235 GHz and 34.8 GHz simultaneously. Polarization is switched between horizontal and vertical for every pulse. Together with the high sampling rate of 12.5 kHz this allows for the first studies and correlation analysis of precipitation caused statistical fluctuations in both amplitude and phase for two frequencies and polarizations simultaneously. Due to the coherency and the high phase stability of the system it further allows for a very sensitive observation of the line integrated water vapor content by measuring the propagation phase delay. For comparison and correlation analysis with other atmospheric conditions besides precipitation, we apply further meteorological measurements (EC-stations and distrometers) at the prealpine test site "Fendt" within the TERENO observatory.

The experiment is accompanied by numerical simulation of electromagnetic volumetric Mie-scattering at hydrometeors in rain fields. We are able to model the rain induced attenuation and phase fluctuations up to the same bandwidth as the experiment.

We present results from the first six month of operation showing line integrated humidity measurements and drop size distribution dependent amplitude and phase fluctuations with high temporal resolution.