A dual-polarization dual-frequency transmission experiment for precipitation and humidity remote sensing

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It is still difficult to quantify near-surface water vapor and precipitation accurately above the point scale. Both play an important role in modeling and remote sensing of the hydrologic cycle.

Here we present details on the development of a new microwave transmission experiment that is capable of providing line integrated estimates of both humidity and precipitation near the surface. The system is located at a hydrometeorological test site (TERENO pre-alpine) in Southern Germany. Path length is kept short at 660 m to minimize the likelihood of different precipitation types and intensities along the path. It uses a monostatic configuration with a combined transmitter/receiver unit and a 70 cm trihedral reflector. The transmitter/receiver unit simultaneously operates at 22.235 GHz and 34.8 GHz with alternating horizontal and vertical polarization, which enables the analysis of the impact of the changing drop size distribution on the rain rate retrieval. Due to the coherence and the high phase stability of the system, it allows for a sensitive observation of the propagation phase delay. Thereof, time series of line integrated refractivity can be determined. This proxy is then post-processed to absolute humidity and compared to station observations.

We present the design of the system and show an analysis of selected periods for both, precipitation and humidity observations. The theoretically expected dependence of attenuation and differential attenuation on the DSD was reproduced with experimental data. A decreased performance was observed when using a fixed A–R power law. Humidity data derived from the phase delay measurement showed good agreement with in situ measurements. In addition we present preliminary results for line integrated DSD estimation using the four independent attenuation measurements enabled by our dual-frequency dual-polarization experiment.