

Differential absorption G-band radar for Arctic clouds and water vapor observations

Sabrina Schnitt, Mario Mech, Jens Goliash, Davide Ori, Thomas Rose, Susanne Crewell

The Arctic climate is changing at fast pace. The contribution of low-level clouds to Arctic amplification feedback processes remains challenging to quantify as model evaluation requires continuous, high-quality observations in a demanding environment. Advancing the understanding of governing processes in mixed-phase clouds, ubiquitous in the Arctic, calls for temporally high-resolved measurements of cloud and precipitation microphysical properties as well simultaneous quantification of water vapor amount and profiles in all-weather conditions.

We present the novel and worldwide unique G-band Radar for Water vapor profiling and Arctic Clouds (GRaWAC) system, suitable to deliver these measurements. GRaWAC is a FMCW G-band radar with Doppler-resolving capabilities and simultaneous dual-frequency operation at 167 and 175GHz. The Differential Absorption Radar technique is applied to the measurements to derive temporally continuous water vapor profiles in cloudy and precipitating conditions, which closes a current gap in observational state-of-the-art instrumentation.

We reveal first measurements from a mid-latitudinal ground site and airborne test flights to illustrate GRaWAC's potential for water vapor, cloud and precipitation profiling measurements. Based on instrument simulations, we outline the benefits of such observations at an Arctic ground-based supersite, such as the AWIPEV station, Ny-Alesund, Spitsbergen. There, the G-band radar measurements will be embedded in a synergy of remote sensing instruments, including an operational microwave radiometer and a Ka- and W-band cloud radar, respectively. We highlight future applications of these synergistic measurements, and therein especially the multi-frequency radar space, for model evaluation studies targeting an improved representation of mixed-phase clouds in the Arctic.