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

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Millimeter wavelength cloud radars have emerged as state-of-the-art instrumentation to advance cloud and precipitation microphysical studies in past decades. In the Arctic, where climate is changing at fast pace, highly resolved, continuous radar measurements are indispensable to improve the understanding of cloud feedback processes and their representation in models. Compared to existing W-band radar technology, radar observations at higher frequencies such as the G-band are required to improve the sensitivity to small ice hydrometeors and super-cooled liquid droplets in prevailing mixed-phase clouds.

We present the novel and worldwide unique G-band Radar for Water vapor profiling and Arctic Clouds (GRaWAC) system. GRaWAC is a FMCW G-band radar with Doppler-resolving capabilities and simultaneous dual-frequency operation at 167.3 and 174.7 GHz. The Differential Absorption Radar technique is applied to GRaWAC measurements to derive temporally continuous water vapor profiles in cloudy and precipitating conditions.

First measurements from a mid-latitudinal ground site reveal continuous, weather-insensitive, and automatic measurements with a vertical resolution of up to 20m. The lower channel reaches a sensitivity of xx at 1 km, 1 s . Depending on the radar's vertical and temporal resolution, water vapor profiles with up to 200 m vertical resolution can be derived. Additional airborne test flights in Northern Sweden highlight the improved sensitivity of GRaWAC compared to W-band radar observations in detecting fog over ice.
We highlight future applications of multi-frequency Ka-, W-, and G-band radar measurements at the German-French AWIPEV research base in Ny-Ålesund, Svalbard. These measurements will benchmark model evaluation studies targeting an improved representation and understanding of mixed-phase clouds in the Arctic.