Arctic multi-frequency radar observations including the G-band Differential Absorption Radar GRaWAC

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Clouds are a central component in the complex interplay of feedback processes impacting the amplified warming observed in the Arctic. Occurring in mixed or ice phase, clouds cover the Arctic ubiquitously. Their phase and microphysical properties strongly shape their radiative impact. Multi-frequency radar observations can deliver valuable insights on cloud properties that are in-turn related to leading cloud evolution and precipitation processes. State-of-the-art approaches combine Ka- and W-band cloud radars for liquid water profiling or ice sizing retrievals. Yet, adding a frequency in the G-band to Ka- or W-band measurements has been recently demonstrated to improve retrievals' sensitivity and uncertainties.

We highlight these benefits based on our recently obtained multi-frequency radar data sets from the Arctic, including the G-band Radar for Water vapor and Arctic Clouds (GRaWAC). GRaWAC is a Doppler-capable, FMCW G-band radar with simultaneous dual-frequency transmission at 167 and 175GHz. Our measurements include a 6-weeks observational period at AWIPEV station, Ny-Alesund with a Ka-, W-, G configuration, 4 months of W-G-combination aboard the RV Polarstern in the central Arctic, and selected flights aboard AWI's Polar-6 aircraft with a W-G configuration. By applying the Differential Absorption Radar technique, we additionally derive in-cloud water vapor profiles in all-weather conditions. During all deployments, additional remote sensing instruments such as microwave radiometer or disdrometer were installed to complement the suite.

We here give an overview on the respective data sets and assess their potential for future retrieval developments based on the differential radar measurements. By forward simulating the obtained multi-frequency measurements to model output variables using the Passive and Active Microwave TRAnsfer (PAMTRA) tool, we highlight suitable applications for model evaluation of cloud and precipitation representation in high-resolution ICON modeling experiments.