GRAWAC: G-band Radar for Water vapor profiling and Arctic clouds

Arctic mixed-phase clouds play a key role in the warming Arctic climate system. Cloud life time and microphysical properties are strongly coupled to moisture availibility and its vertical distribution. Yet, a continuous quantification of this interplay remains challenging with current remote sensing measurement techniques. Accurate measurements are needed to both advance process understanding and to improve the representation of mixed-phase clouds and their moisture environment in weather and climate models. The novel G-band radar system GRAWAC contributes to closing this observational gap by simultaneously profiling clouds and water vapor.

GRAWAC is designed as a Doppler-capable, two-antenna FMCW dual-frequency system transmitting and receiving simultaneously between 167 and 175 GHz. Based on the dual-frequency measurements, the Differential Absorption Radar technique can be applied to retrieve water vapor profiles in cloudy conditions. High frequencies paired with a high sensitivitiy of -40dBZ at 1km and 1s resolution will increase the sensitivity to small hydrometeors compared to W-band radars; and will allow profiling throughout the boundary layer in case of airborne deployment.

In order to study GRAWAC‘s potential for a ground-based and airborne deployment in the Arctic around Svalbard, we use synthetic measurements generated by the radiative transfer model PAMTRA based on ICON-LEM simulations from recent Arctic airborne field campaigns. We investigate the expected reflectivity and Doppler velocity signals, analyze sensititivies to water vapor conditions, and outline the added value of GRAWAC when deployed in synergy with Ka- and W-band radars as well as passive microwave radiometry between 22 – 340GHz.