The vertical water vapor distribution is a key variable for weather and climate monitoring and prediction. Existing techniques, meanwhile, are limited by low temporal, spatial or vertical resolution, or cannot be applied in cloudy or precipitating conditions. In the Arctic, where water vapor is a central component of multiple feedback processes contributing to Arctic Amplification optical techniques are additionally challenged by polar night. The Differential Absorption Radar (DAR) technique offers to overcome some of these challenges as water vapor profiles can be retrieved in cloudy and precipitating conditions independent of solar incidence angles.

The G-band radar for water vapor and Arctic Clouds (GRaWAC) is a novel and unique Doppler-capable FMCW Differential Absorption Radar with simultaneous dual-frequency operation at 167.3 and 174.7GHz. Both transmitted frequencies are referenced to a single oscillator with signal generation from Direct Digital Synthesis. The generated chirp signals are fully synchronized and multiplied to transmitted RF frequencies of 167.3GHz and 174.7GHz, also providing local oscillator signals for the receiver downconversion mixers. GRaWAC's high sensitivity of -43dBZ at 1km range and 1s integration time, and vertical resolution of up to 20m enables promising retrieval possibilities even in low humidity conditions. GRaWAC's versatile design facilitates an operation from ground, ship or aircraft in harsh environmental conditions.

We present measurements from recent deployments at AWIPEV station, Ny-Alesund, Svalbard; aboard the RV Polarstern on the PS144 cruise through the central Arctic and aboard the Alfred-Wegener Institute's Polar-6 research aircraft. Based on these measurements, we highlight technical advantages and limitations of the system. We discuss the performance of the G-band radar compared to conventional cloud radars at lower frequencies, assess the stand-alone water vapor retrieval capabilities and investigate synergy options with simultaneous passive microwave radiometer measurements.