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Calibration of a 35-GHz Airborne Cloud Radar: Lessons Learned and Intercomparison with a 94-GHz Airborne Cloud Radar

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Clouds play an important role in the climate system since they have a profound influence on Earth's radiation budget and the water cycle. Uncertainties associated with their spatial characteristics as well as their microphysics still introduce large uncertainties in climate change predictions. In recent years, our understanding of the inner workings of clouds has been greatly advanced by the deployment of cloud profiling microwave radars from ground as well as from space like CloudSat or the upcoming EarthCARE satellite mission. In order to validate and assess the limitations of these spaceborne missions, a well-calibrated, airborne cloud radar with known sensitivity to clouds is indispensable.

Within this context, the German research aircraft HALO was equipped with the high-power (30kW peak power) cloud radar operating at 35 GHz and a high spectral resolution lidar (HSRL) system at 532 nm. During a number of flight experiments over Europe and over the tropical and extra-tropical North-Atlantic, several radar calibration efforts have been made using the ocean surface backscatter. Moreover, CloudSat underflights have been conducted to compare the radar reflectivity and measurement sensitivity between the air- and spaceborne instruments. Additionally, the influence of different radar wavelengths was explored with joint flights of HALO and the French Falcon 20 aircraft, which was equipped with the RASTA cloud radar at 94 GHz and a HSRL at 355 nm.

In this presentation, we will give an overview of lessons learned from different calibration strategies using the ocean surface backscatter. Additional measurements of signal linearity and signal saturation will complement this characterization. Furthermore, we will focus on the coordinated airborne measurements regarding the different sensitivity for clouds at 35 GHz and 94 GHz. By using the highly sensitive lidar signals, we show if the high-power cloud radar at 35 GHz can be used to validate spaceborne and airborne measurements at 94 GHz and which differences are to be expected. Furthermore, the coordinated measurements are used to explore the reflectivity cut-offs of CloudSat and future spaceborne constellations and compare them to ground-based systems.