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Assessing Arctic low-level clouds and precipitation from above - a radar perspective

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According to satellite-based estimations, a lot of clouds over the Arctic Ocean occur below 2 km. Most information on Arctic low-level clouds come from CloudSat radar measurements. However, CloudSat lacks a complete representation of low-level clouds because the blind zone masks the lowest kilometer and the coarse spatial sampling conceals cloud patterns. Thus, higher resolved observations of cloud characteristics are needed to determine how the cloud fraction varies close to the ground and how it depends on surface characteristics and meteorological situation.

Our study investigates the low-level hydrometeor fraction of Arctic clouds over the ocean using airborne remote sensing measurements by the Microwave Radar/radiometer for Arctic Clouds (MiRAC) flown on the Polar 5 aircraft. Four campaigns have been conducted in the vicinity of Svalbard during different seasons: ACLOUD, AFLUX, MOSAiC-ACA, and HALO-AC3. We convolute the MiRAC radar reflectivity measurements to adapt the fine MiRAC and coarse CloudSat resolution. The convoluted measurements are compared with the original airborne observations over all campaigns to investigate the effects of CloudSat's spatial resolution, clutter mask, and sensitivity on the low-level hydrometeor fraction. Measurements reveal high hydrometeor fractions of up to 60% in the lowest 1.5 km, which CloudSat would miss due to the blind zone. CloudSat would especially underestimate half of the total precipitation. During cold air outbreaks, when rolling cloud structures evolve, CloudSat overestimates the hydrometeor fraction most. Moreover, CloudSat does not resolve the separate layers of multilayer clouds but rather merges them because of its coarse vertical resolution.