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Investigation of Arctic mixed-phase clouds in different synoptic and sea ice regimes by airborne remote sensing and in situ observations during ACLOUD

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In May/June 2017 the aircraft field campaign ACLOUD (Arctic CLoud Observations Using airborne measurements during polar Day) has successfully been completed. Two identical but complimentary equipped research aircraft, Polar 5 & 6 by the Alfred Wegener Institute for Polar and Marine Research, Germany, were operated from Longyearbyen at Spitzbergen to investigate Arctic boundary layer clouds by in situ and remote sensing measurements, the aerosol distribution and composition, the variability of turbulent fluxes in the boundary layer over sea ice, the marginal ice zone and open sea water. Flight pattern were coordinated with satellite overpasses and ground-based measurements at Ny Ålesund and the research vessel Polarstern, which operated a two-week ice camp in about one-hour flight distance.
Here we report on first results of the observations which cover different Arctic synoptic regimes, cold air outbreaks and warm air intrusions, and the contrast of clouds above sea ice and the sea ice free ocean. The majority of observed boundary-layer clouds showed the typical characteristics of Arctic mixed-phase clouds dominated by liquid droplets at cloud top but containing also significant amount of ice particles. The measurements showed a clear transition of the boundary layer and cloud structure when air masses passed the sea ice edge even in case of a relative weak cold air outbreak. Over sea ice, very thin and partly broken clouds with cloud top below 500 m were frequently observed while over the ocean the cloud top inversion was located higher. The radiative energy budget below the cloud layer was found to be influenced not only by the cloud properties but also by the sea ice cover and the surface temperatures. The chemical composition of ambient and cloud residual aerosol particles was analysed and also showed a dependence on the synoptic regimes. These measurements illustrate the potential of collocated airborne observations for detailed characterization of Arctic clouds. Exemplary highlights of the measurements, their link to ground-based observations and associated model simulations will be presented.