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Multi-Phase Polar Stratospheric Cloud Observations from Airborne High Spectral Resolution Lidar

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In the winter 2015/16, low planetary wave activity led to a stable vortex with exceptionally cold temperatures. Extended areas with temperatures below the ice frost point T_{ice} in the Arctic stratosphere were observed. These extreme conditions promoted the formation of widespread polar stratospheric ice clouds (ice PSCs). In this winter, the space-borne Cloud-Aerosol Lidar with Orthogonal Polarization CALIOP instrument continuously measured ice PSCs for over a month. Also the spatial extension of Arctic ice PSC fields in winter 2015/16 was exceptional within the 8 years of the CALIOP data record.

On 22 January 2016, the WALES (Water Vapor Lidar Experiment in Space - airborne demonstrator) lidar on board the High Altitude and Long Range Research Aircraft HALO measured an ice PSC with a horizontal extension of more than 1400 km. The ice PSC extended between 18 and 24 km altitude and was surrounded by nitric acid trihydrate (NAT), supercooled ternary solution (STS) droplets and particle mixtures. The high spectral resolution capability of the WALES lidar enabled the determination of the lidar-ratio at 532 nm wavelength for different types of PSCs, a quantity needed by the retrieval algorithm of simpler backscatter lidars. With the additional backscatter channel at 1064 nm wavelength also the color ratio can in be used to extend the optical phase space analyses usually based on backscatter ratio and depolarization. As an application it will be shown how the airborne lidar data in combination with 8-days domain filling back trajectories and matches with previous CALIOP measurements can be used to shed new light on ice-PSC nucleation, suggesting an additional nucleation mechanism where ice is formed on pre-existing NAT particles.