Optical and geometrical properties of Arctic clouds over northern Finland during PaCE campaign in 2019

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In the Arctic areas the influence of climate change is being felt at a higher degree than elsewhere. Enabling a better understanding of the environment in region is of high importance. Clouds play a significant role in the energy budget and the hydrological cycle of the Earth's atmosphere system. In order to provide insights into Arctic cloud processes for Arctic cloud-climate studies, the field campaign PaCE (Pallas Cloud Experiment) was organized during autumn and winter 2019; the campaign was focusing on aerosol and cloud vertical profiling using in-situ and remote sensing techniques.

During the campaign, a ground-based multi-wavelength Raman polarization lidar Polly\textsuperscript{XT} performed continuous measurements from September to December 2019, at the Kenttärova station (N 67\textdegree59'14", E 24\textdegree14'35", 347 m above sea level) at Pallas, in the northern Finland. This is a background station surrounded by the forest, where the atmosphere is quite clean. Cloud vertical structures and optical properties have been determined from lidar analysis. During day-time, the Klett method is applied to retrieve the vertical profiles of cloud extinction and backscatter coefficient at three wavelengths (355 nm, 532 nm and 1064 nm). During night-time, the standard Raman method is used to provide additional lidar ratio profiles at 355 nm and 532 nm. The actual linear depolarization ratio at two wavelengths (355 nm and 532 nm) are also retrieved. With water vapor channel at 407 nm, the relative humidity profile are also available for received signal with good signal-to-noise ratio. The combined use of near and far field telescopes provides reliable vertical profiles of optical properties from 0.25 km to 10 km above ground level. The temperature and thickness dependencies on optical properties have also been studied in detail. Geometrical properties of cloud are retrieved using both lidar and ceilometer, statistic values of cloud height, and thickness are shown.
