Geophysical Research Abstracts
Vol. 20, EGU2018-10686, 2018
EGU General Assembly 2018

Investigating the impact of anthropogenic pollution on cloud properties derived from ground based remote sensors at the North Slope of Alaska

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When acting as cloud condensation nuclei (CCN) or ice nucleating particles (INPs), aerosols have a strong potential to influence cloud properties. In particular, they can impact the number, size, and phase of cloud particles and potentially cloud lifetime through aerosol indirect and semi-direct effects. In polar regions, these effects are of great importance for the radiation budget due to the shortwave albedo and longwave emissivity of mixed-phase clouds.

The Department of Energy (DOE) Atmospheric Radiation Measurement (ARM) program operates two super sites equipped with state of the art ground-based remote sensing instruments in northern Alaska. The sites are both coastal and are highly correlated with respect to large scale synoptic patterns. While the site at Utqiaġvik (formerly known as Barrow) generally represents a relatively pristine Arctic environment lacking significant anthropogenic sources, the site at Oliktok Point, approximately 250 km to the east, is surrounded by the Prudhoe Bay Oil Field, which is the largest oil field in North America. Comparing both sites allows to identify the impact of anthropogenic pollution on cloud properties.

Based on aircraft measurement, the authors recently showed that differences in the properties of liquid clouds properties between the sites can be attributed to local emissions associated with the industrial activities in the Prudhoe Bay region (Maahn et al. 2017, ACP). However, aircraft measurements do not provide a representative sample of cloud properties due to temporal limitations in the amount of data. In order to investigate how frequently and to what extent liquid cloud properties and processes are modified, we use ground based remote sensing observations such as e.g., cloud radar, Doppler lidar, and microwave radiometer obtained continuously at the two sites. In this way, we are able to quantify inter-site differences with respect to cloud drizzle production, liquid water path, frequency of cloud occurrence, and cloud radiative properties.