A Characterization of Arctic Aerosols as Derived from Airborne Observations and Their Influence on the Surface Radiation Budget

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The Arctic climate is influenced by aerosols that affect the radiation balance at the surface and within the atmosphere. Impacts depend on the composition and concentration of aerosols that determine opacity, which is quantified by the measure of aerosol optical depth (AOD). During winter and spring aerosols are transported into the Arctic from lower latitude industrial regions. During April 2009, a trans-Arctic flight of the German Polar-5 provided an opportunity to collect a comprehensive data set from which properties of the aerosol were derived, including AOD. Measurements were made from near the surface to over 4 km in altitude during a flight from Svalbard, Norway to Pt. Barrow, Alaska, passing near the North Pole (Figure 1). These measurements, along with ancillary measurements of particle size and black carbon content (BC), provide a three-dimensional characterization of the aerosols encountered along track. The horizontal and vertical distribution of Arctic haze, in particular, was evaluated. During April 2009, the Arctic atmosphere was variably turbid with total column AOD (at 500 nm) ranging from ~ 0.12 to > 0.35, where clean background values are typically < 0.06. The haze was concentrated within and just above the surface-based temperature inversion layer. BC was observed at all levels at moderately low concentrations compared with historical records. Few distinct elevated aerosol layers were observed, although lidar observations revealed evidence of volcanic aerosol at upper levels. Enhanced values of AOD above 4 km are attributed to an accumulation of industrial pollutants, in combination with volcanic aerosol from the March/April 2009 eruptions of Mount Redoubt in Alaska. The presence of aerosols in the Arctic atmosphere during April 2009 reduced the diurnally-averaged net shortwave irradiance, which can cause cooling of the surface, depending on its Albedo (reflectivity). An overview of the campaign will be given with results presented in the context of historical observations and current thinking about the impact aerosols have on the Arctic climate.

Figure 1. On 10 April, 2009 the German Research aircraft, Polar-5, landed on an ice runway prepared by the crew of the Russian ice station, North Pole-35. Along the route from Svalbard, Norway to Pt. Barrow, Alaska, a comprehensive set of data was collected to evaluate Arctic aerosol characteristics.