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A comprehensive climatology of Arctic aerosol properties on the North Slope of Alaska

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Evaluating aerosol properties has implications for the formation of Arctic clouds, resulting in impacts on cloud lifetime, precipitation processes, and radiative forcing. There are many remaining uncertainties and large discrepancies regarding modeled and observed Arctic aerosol properties, illustrating the need for more detailed observations to improve simulations of Arctic aerosol and more generally, projections of the components of the aerosol-driven processes that impact sea ice loss/gain. In particular, the sources and climatic effects of Arctic aerosol particles are severely understudied. Here, we present a comprehensive, long-term record of aerosol observations from the North Slope of Alaska baseline site at Barrow. These measurements include sub- and supermicron (up to 10 μm) total mass and number concentrations, sub- and supermicron soluble inorganic and organic ion concentrations, submicron metal concentrations, submicron particle size distributions, and sub- and supermicron absorption and scattering properties. Aerosol extinction and number concentration measurements extend back to 1976, while the remaining measurements were implemented since. Corroboration between the chemical, physical, and optical property measurements is evident during periods of overlapping observations, demonstrating the reliability of the measurements. During the Arctic Haze in the winter/spring, high concentrations of long-range transported submicron sea salt, mineral dust, industrial metals, pollution (non-sea salt sulfate, nitrate, ammonium), and biomass burning species are observed concurrent with higher concentrations of particles with sizes that span the submicron range, enhanced absorption and scattering coefficients, and largest Ångström exponents. The summer is characterized by high concentrations of small biogenic aerosols (< 100 nm) and low extinction coefficients. Fall is characterized by clean conditions, with supermicron sea salt representing the dominant aerosol type supporting the highest single scattering albedos. This complete set of aerosol properties can be used to improve our knowledge of the sources of aerosols found in the Arctic.