

A Comprehensive Climatology of Arctic Aerosol Properties on the North Slope of Alaska

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Evaluating aerosol properties has implications for the surface radiation budget and the formation of clouds in the Arctic, resulting in impacts on cloud lifetime, precipitation processes, and radiative forcing (Figure 1). 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 Arctic climate. Here, we present a comprehensive, long-term record of aerosol observations from the NOAA North Slope of Alaska site at Barrow. These measurements include total mass and number concentrations, chemical composition, particle size distributions, and optical property measurements. Aerosol extinction and number concentration measurements extend back to 1976, while the remaining measurements were implemented since. Corroboration between the ground-based 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. In addition to evaluating the aerosol properties themselves, linkages between aerosol source and cloud ice water content in single layer mixed phase clouds are investigated during the winter/spring haze season, when the large influence from transported aerosols have the greatest potential to influence cloud formation. When used in unison, this complete set of aerosol and cloud measurements can be used to improve our knowledge of the climatic impact and characteristics of aerosols found in the Arctic.

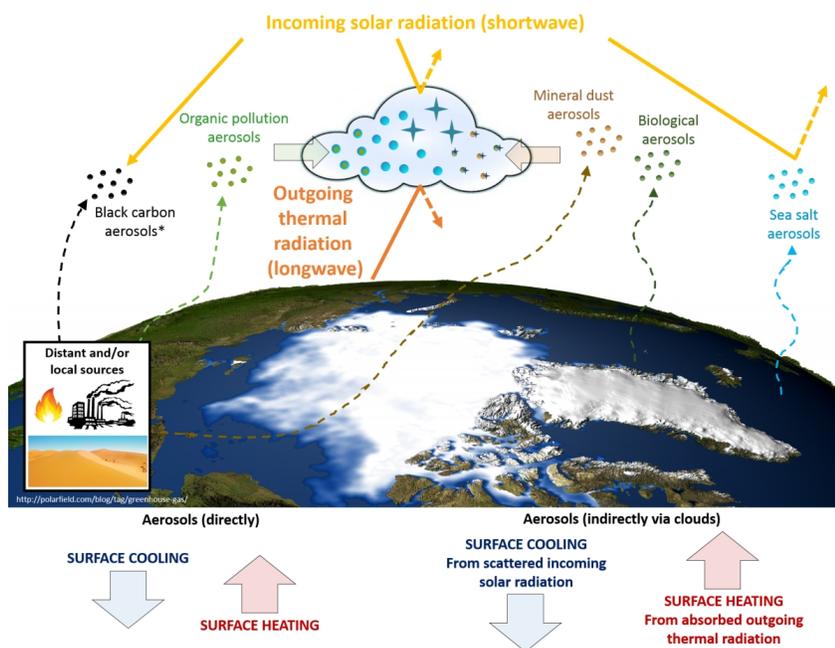


Figure 1. Conceptual schematic of potential aerosol impacts on Arctic sea ice cover. The surface heating (cooling) would enhance (inhibit) sea ice reduction. *Note that black carbon absorbs shortwave radiation, heating the air surrounding it. Depending on its proximity to the surface, the magnitude of warming it induces at the surface is likely a function of its altitude. Mineral dust and organic aerosols can both scatter and absorb shortwave radiation, depending on their particle composition.