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Pollution effects on cloud emissivity and longwave fluxes in the Arctic

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In a phenomenon known as ‘‘Arctic haze”, the Arctic is exposed to high concentrations of episodic anthropogenic pollution in winter and spring. Although these aerosol likely perturb the microstructures of low-level arctic stratus, evidence of this effect is sparse due to the absence of aircraft measurements during the dark months. Because the sun is low or absent at this time or year, the influence of aerosol on shortwave radiative fluxes (as expected from the Twomey effect) is minimal. However, arctic stratus are sufficiently thin to be graybodies in the infrared; in the absence of other changes, the magnitude of the susceptibility of emissivity to changes in droplet concentration is similar to that expected for shortwave cloud albedo - approximately 1 %/cc. Correspondingly, the effect of haze on downwelling longwave fluxes at the surface is potentially of order several watts per square meter. Here we show how the radiative properties of arctic stratus are changed by Arctic haze based on continuous surface based measurements of aerosols and radiation from Barrow, Alaska. The remote sensing techniques used to retrieve cloud effective radius, number concentration, and optical depth (Mahesh et al. 2001; Dong and Mace, 2003) apply year-round, and show good agreement with seasonal measurements from airborne campaigns.