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Higher Values of Arctic Cloud Longwave Emissivity associated with Pollution from Mid-Latitudes

T. J. Garrett and C. Zhao

Department of Meteorology, University of Utah, Salt Lake City, USA (tgarrett@met.utah.edu)

The climate of the Arctic is changing rapidly compared to the planet as a whole. While the precise mechanisms and feedbacks behind such amplification remain poorly understood, Arctic surface warming is closely tied to longwave (LW) thermal emission by low-level clouds. An additional consideration is that the Arctic is subject to a seasonal phenomenon, known as "Arctic Haze", in which anthropogenic aerosols from mid-latitudes accumulate over the Arctic winter due to low precipitation. Previous studies into effects from anthropogenic aerosols on cloud radiative properties have emphasized their potential contributions to planetary cooling. In the Arctic winter and early spring, however, even when sunlight is present, any such influence is limited by low solar elevations and an already bright surface. Instead, the Arctic surface radiation balance is more likely to be perturbed by increases to cloud LW emissivity under polluted conditions. From four years ground-based aerosol and radiation measurements obtained near Barrow, Alaska, we find the difference in cloud emissivity between the upper and lower quartile of pollution conditions is, on average, between 0.05 and 0.08. This thermal indirect effect of aerosols is calculated to correspond to an estimated Arctic surface warming under cloudy skies between 3.3 and 5.2 W m^{-2}, or 1 and 1.6 °C.