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Title: *Boundary layer mixing state and vertical distribution of aerosol at high latitude locations*

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Of the uncertainties surrounding our understanding of global climate, one of the largest involves the relationships between aerosols and clouds, and the resulting impacts on atmospheric radiation and precipitation. In order to overcome limitations resulting from a lack of aerosol profile measurements, traditional studies of these relationships have used surface aerosol measurements as a proxy for aerosol at cloud height. In many locations, clouds occur in well mixed boundary layers allowing for such assumptions. At high latitudes, however, the atmosphere is often very stable and aerosol particles are often advected from remote source regions. The stable atmosphere only features limited vertical mixing, meaning aerosol properties at the surface and cloud height may be very different from one another. Therefore, the conclusions from previous attempts at quantifying aerosol-cloud interactions for Arctic clouds using surface based aerosol measurements are challenging to interpret. In the current work, we use measurements from various high latitude locations to demonstrate the relationship between surface and elevated aerosol properties under different boundary layer mixing states. Mixing state is derived from a combination of temperature profiling devices (e.g. radiosondes) and remote sensors (e.g. Millimeter Cloud Radar), while aerosol measurements come from both surface and aircraft-based sensors. Measurements will come from several campaigns, including the Indirect Semi-Direct Aerosol Campaign (ISDAC), the Mixed-Phase Arctic Clouds Experiment (M-PACE) and the Arctic Summer Cloud Ocean Study (ASCOS). We will demonstrate under what conditions surface aerosol properties can and cannot be used to evaluate aerosol cloud interactions for low-level Arctic clouds.