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Understanding rapid changes in phase partitioning between cloud liquid and ice in an Arctic stratiform mixed-phase cloud

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In the Arctic, a region particularly sensitive to climate change, mixed-phase clouds occur as persistent single or multiple stratiform layers. For many climate models, the correct partitioning of hydrometeor phase (liquid vs. ice) remains a challenge. However, this phase partitioning plays an important role for precipitation processes and the radiation budget. To better understand the partitioning of phase in Arctic clouds, observations using a combination of surface-based remote sensors are useful.

In this study, the focus is on a persistent low-level single-layer stratiform Arctic mixed-phase cloud observed during March 11-12, 2013 at the US Department of Energy‘s (DOE) Atmospheric Radiation Measurement (ARM) North Slope of Alaska (NSA) permanent site in Barrow, Alaska. This case is of particular interest due to two significant shifts in observed precipitation intensity over a 36 hour period. For the first 12 hours of this case, the observed liquid portion of the cloud cover featured a stable cloud top height with a gradually descending liquid cloud base and continuous ice precipitation. Then the ice precipitation intensity significantly decreased. A second decrease in ice precipitation intensity was observed a few hours later coinciding with the advection of a cirrus over the site.

Through analysis of the data collected by extensive ground-based remote-sensing and in-situ observing systems as well as Nested Weather Research and Forecasting (WRF) simulations and ECMWF radiation scheme simulations, we try to shed light on the processes responsible for these rapid changes in precipitation rates. A variety of parameters such as the evolution of the internal dynamics and microphysics of the low-level mixed-phase cloud and the influence of the cirrus cloud are evaluated.