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Cloud property retrievals from downwelling infrared radiances from polar atmospheres

Penny Rowe

NorthWest Research Associates, Redmond, WA, USA

Abstract

Clouds exert a strong influence on Earth's energy budget through interactions with shortwave and longwave radiation. At the same time, clouds remain a major source of uncertainty in climate models. This is particularly acute in polar regions, where measurements are sparse. Measurements made by infrared radiance spectrometers, which measure passive infrared radiation either from the surface or from space, can help fill this gap. These instruments can be used to characterize the state of the atmosphere, potentially including the thermodynamic structure of the atmosphere, trace gas concentrations, cloud properties, and aerosol properties. Because atmospheric water vapor is low in polar regions, polar atmospheric radiances are well-suited for retrieving cloud properties.

Here, cloud properties are retrieved from measurements made using surface-based infrared spectrometer measurements in the Arctic and Antarctic:

- At the North Slope of Alaska (NSA) in 2015/2016 (U.S. Department of Energy (DOE) Atmospheric Radiation Measurement (ARM) program)
- In the Arctic on board the Polarstern in summer 2017 (Arctic Amplification: Climate Relevant Atmospheric and Surface Processes andFeedback Mechanisms, or (AC)3)
- In the Antarctic at McMurdo Station in 2016 (ARM West Antarctic Radiation Experiment; AWARE)
- At South Pole Station in 2001 (South Pole Atmospheric Radiation and Cloud Lidar Experiment; SPARCLE).

Cloud optical depth, ice fraction, effective radii of liquid droplets and ice crystals and (at South Pole) cloud height are retrieved using the CLoud and Atmospheric Radiation Retrieval Algorithm (CLARRA). In the Arctic, optical depth, liquid fraction, and liquid effective radius are typically found to be greater compared to the Antarctic. Finally, the potential for retrieving aerosols from polar downwelling radiances is discussed.