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Infrared Radiative Effects during Wet Growth of Aerosols in the Arctic Winter

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Abstract

We observe activated aerosol particles using a ground-based Fourier Transform InfraRed Spectrometer (NYAEM-FTS), measuring the infrared downwelling emission from the atmosphere. From the observations of FTS, we find hygroscopic aerosols, sea salt, and sulfate, emit more longwave downward radiation (LWD) in activated conditions than in dry conditions. This closes the gap of the effect on downwelling emission during aerosols forming clouds via aerosol activation.

The enhancement of LWD caused by the aerosol wet growth process is significantly influenced by four factors: aerosol composition, aerosol density, ambient RH, and temperature. Combined with the radiance measurements from the Baseline Surface Radiation Network (BSRN), Cloudnet data, Radiosonde data, and FTS measurements, the relationship between LWD and those four factors is investigated in this study.

We find that the amount of LWD suddenly increases when the ambient relative humidity (RH) reaches the aerosol deliquescence point, which is dependent on the aerosol composition. From our study, compared with the LWD of dry aerosol, less than 10 Wm^{-2}, the enhancement of LWD caused by wet aerosol is about 19.3 ± 12.0 Wm^{-2} (on average) and can even up to 92.7 ± 10.7 Wm^{-2}. The observation indicates that the deliquescence points of the prevalent hygroscopic aerosols in Ny-Ålesund predominantly occur within the RH range of 70% to 80%, identified as sea salt based on FTS measurements.