Long-Term Statistics of Arctic Mixed-phase Clouds Properties Retrieved from Doppler Spectra Measured at the North Slope of Alaska Site

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Introduction

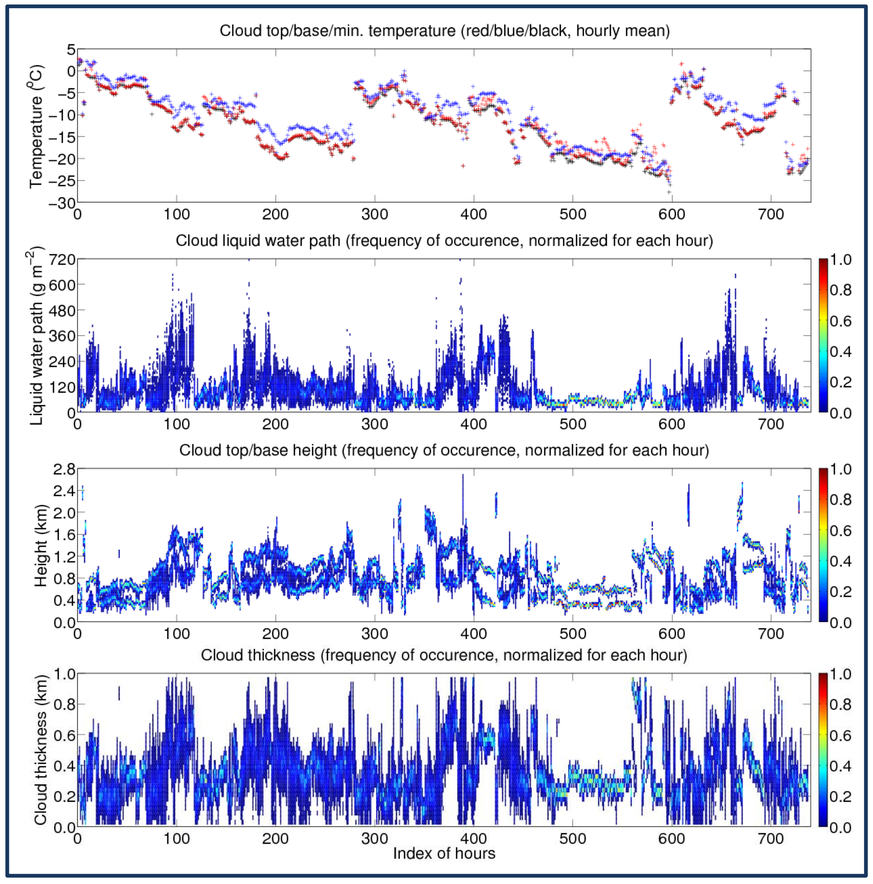
- The contributions from the cloud liquid drop mode and the precipitation mode to the Doppler spectra measured by KAZR are separated with an algorithm based on the continuous wavelet transform and fuzzy logic techniques (Yu *et al*., 2014).
- Cloud liquid drop and precipitation reflectivities, vertical air motions, and reflectivity-weighted mean fall velocities of the precipitation particles are retrieved for 737 hours of observations of single-layer mixed-phase clouds collected at ARM's NSA site from September to December, 2011 to 2013.

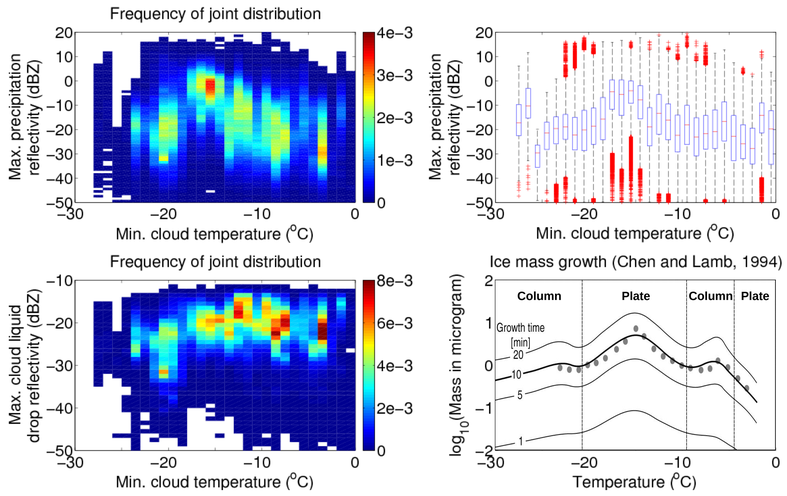
Data

- KAZR moments and spectra
- Temperature/moisture profiles
- Liquid water paths from MWR
- Cloud base heights from ceilometer

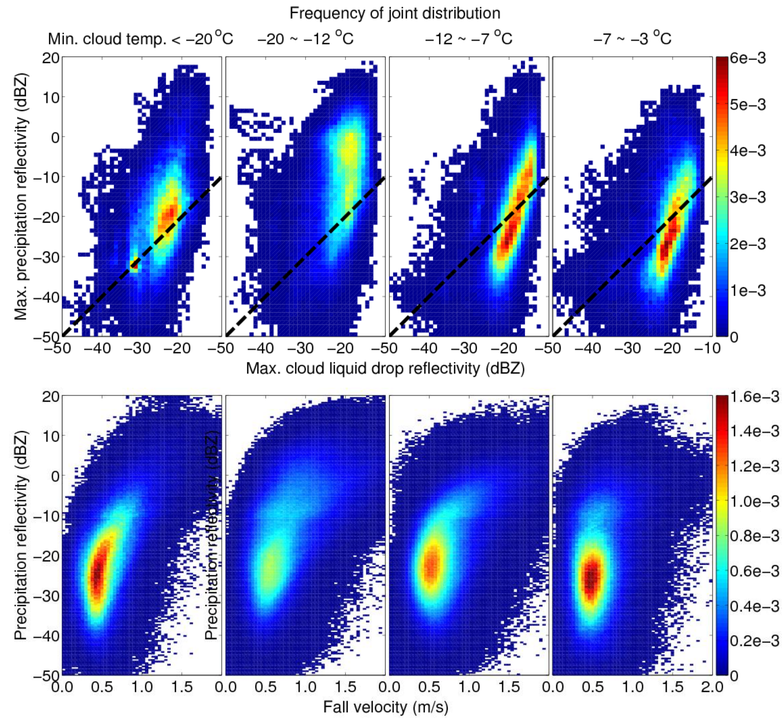
Case Selection

- Cloud layer temperature between -40 °C and 0 °C
- Standard deviation of cloud base height less than 50 m
- Cloud liquid water path greater than 25 g m^{-2}
- Cloud top height lower than 2500 m
- Cloud thickness between 200 and 1000 m

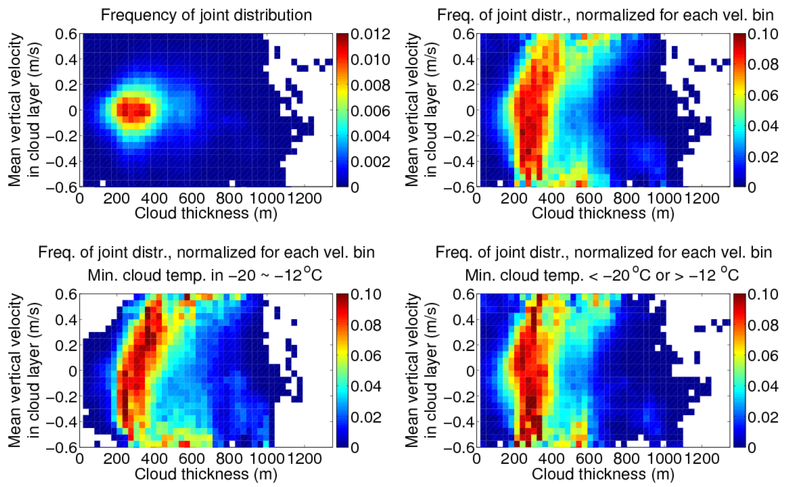




- **The relationship between the most probable maximum precipitation reflectivity and the minimum cloud temperature in each radar profile shows remarkable resemblance to the relationship between the ice crystal mass growth by vapor deposition and the temperature** reported by Chen and Lamb (1994).
- The most probable maximum cloud liquid drop reflectivity varies much less with the minimum cloud temperature.
- Given the same maximum cloud liquid drop reflectivities, clouds with minimum temperatures between -20 and -12 °C tend to produce higher maximum precipitation reflectivities.



- In this temperature range, it is also more likely to observe precipitations with both high reflectivity and fall velocity, indicating the presence of large particles, for example, aggregates.



In updrafts, the mean updraft speed increases with cloud thickness. This feature is mainly contributed by cases with minimum cloud temperatures between -20 and -12 °C. The converse in downdrafts is not evident.

Summary

- The temperature dependence of the most probable maximum precipitation reflectivity shows resemblance to that of the ice crystal mass growth by vapor deposition. This resemblance could be a result of the temperature dependence of the mass growth in the observed clouds. However, other factors, for example, different scattering properties of ice particles found in different temperature ranges, could also play a role.
- Preliminary results reveal some features in the relationships among the macro- and micro-physics, thermodynamics, and dynamics of single-layer Arctic mixed-phase clouds. However, further research is required to confirm that these features represent general characteristics of these clouds.

Acknowledgements. This research was supported by the Office of Biological and Environmental Research of the U.S. Department of Energy via Grant No. DE-FG02-05ER64058 as part of the Atmospheric Radiation Measurement Program.