Snowflake Mixtures in Coastal Northeast United States Winter Storms
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Introduction

Heavy accumulations of snow and ice from cold-season extratropical cyclones in the northeastern United States can shut down cities for extended periods. Snow and mixed-phase precipitation accumulation are influenced by many characteristics including the number and size of particles, particle crystal shape, degree of riming, and density. Prior research has shown that denser, more rimed snow is expected close to the cyclone low-pressure center while less dense, less rimed snow occurs along the northwest edge of the storms. Riming occurs when a snowflake falls through a cloud with supercooled water droplets, which adhere to the snowflake and freeze. Improved understanding of snowfall characteristics can yield better estimates of snow from radar since reflectivity alone is too unconstrained.

Methods

Our dataset is comprised of vertically-pointing radar data from a Micro Rain Radar (MRR) and snowflake data from a Multi-Angle Snowflake Camera (MASC). The data have been collected together at Stony Brook University (SBU) on Long Island, New York since December 2014. Time-height plots show MRR reflectivity, spectral width (a proxy for turbulence), and Doppler velocity (w) overlaid on the MRR plots are MASC 5-minute totals for in-focus large aggregates, graupel, and the number of camera triggers (≤ # of particles).

Conclusions

Snowfall within winter storms in the coastal northeastern United States frequently contains mixtures of different degrees of riming and different habits falling at the same time. Individual aggregates can contain components that are more heavily and more lightly rimed. Graupel (heavily rimed) constitutes < 5% of particles at SBU. In this location, pristine snow crystals are rare. The majority of the particles reaching the surface exhibit light to moderate riming. There is a lack of a consistent relation between locally higher radar reflectivity and the occurrence of graupel at the surface. The distributions of fallspeeds of graupel versus all other snow particles have modes that differ by less than 0.33 m/s. These graupel fallspeed results from a coastal area near sea level are similar to fallspeed distributions from an inland, mountain location (Alta, Utah; Garrett and Yuter 2014).

Data Analysis and Results

26-27 January 2015:
Storm onset featured aggregates of mixed habits including needles. An unusual vertically-oriented reflectivity band evident at 03:00 UTC had a high number concentration of particles with predominately aggregates and individual snowflakes observed at the surface. Around 07:00 UTC another reflectivity band nearer the observation site and aggregates were common. The peak number of camera triggers occurred after the peak in near surface reflectivity. Increasing near-surface spectral width at the end of the storm corresponded to an increase in degree of riming.

02 February 2015:
Rimed and unrimed, sectored plates and hexagonal plates occurred near the beginning of the storm coincident with low spectral width. A transition to rain from around 10:10 UTC to 18:00 UTC was followed by a snow period from 18:30 UTC to 22:00 UTC. During this later snow period, spectral width increased while a mixture of aggregates, graupel, and individual snowflakes including dendrites fell at the surface.

Definitions
- **Aspect Ratio**: From the calculated center of the snow particle, a set of 502 lines are drawn at each angle from 0 to 360. Value is the variance of the lengths of these lines.
- **Max Diameter**: Max particle length in camera view (15°) is usually a real max diameter.
- **Aspect Ratio**: Ratio of minor and major axes of best-fitting ellipse.

Acknowledgements

Special thanks to Spencer Rhodes, Laura Tomkins, Luke Allen, and Daniel Hueholt for their advice. This research is supported by National Science Foundation grant AGS-1347951.

Travel grant provided by the NC State Office Of Undergraduate Research.