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Characteristics of Falling Snow and its Variability during GCPEx

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Knowledge of the microphysical properties of falling snow is required for the precipitation retrieval algorithms of the NASA's Global Precipitation Measurement Mission (GPM). Specifically, the parametric forms of size distribution, fall velocity, and density of falling snow are the key elements of the precipitation retrieval algorithms. Moreover, the variability of falling snow within the field of view of the satellite's sensor is one of the key uncertainties of the precipitation retrieval algorithms.

This study investigates the microphysical properties of falling snow and its spatial variability using in-situ precipitation measuring devices that were operated during GPM Cold-season Precipitation Experiment (GCPEx). The field study was conducted in Southern Ontario, Canada during Winter 2011-12. A two-dimensional video disdrometer (2DVD), two autonomous laser-optical OTT Parsivel2 disdrometers were collocated with weighing bucket gauges at 5 differences sites throughout the experiment.

There were at least 6 major snow events (two synoptic and four mesoscale lake-effect) where all instruments except for 2DVD were reporting in all sites. Parsivel2 based absolute bias in unmelted snow accumulation ranged from 19% to 67% between the sites. The weighing bucket based absolute bias in water equivalent snowfall was between 10- 20%. Parsivel2 recorded higher snowfall rates than the 2DVD when the snowfall rates was less than 10 mm/h, while a good agreement was evident between the two instruments at higher snowfall rates.

The processing of 2DVD snowfall observations between the manufacturer and Huang/Bringi algorithm showed higher snowflake concentration in the latter algorithm for the flakes less than 3 mm in apparent diameter. This results in substantial differences in total concentrations and parameters of fitted size distributions. Both polynomial and power law relations were applied to the fall velocity drop size relations using 2DVD observations and there were significant differences between the events as well as between the two processing algorithms.

Both 2DVD and Parsivel2 observations shows a linear relationship between the mass-weighted drop diameter and its standard deviation. These rather simplified relations can be useful in deriving the size distribution parameters from GPM dual-frequency radar measurements. Bulk density particle size relations were derived through the ratio of the disdrometers and weighing bucket gauges precipitation rates. Bulk density depends on the integration period and the choice of disdrometer-gauge pair. The spatial variability of snowfall was studied adopting stretched exponential function to the correlations of snowfall parameters between the four stations, which were separated between 7-23 km. This segment of the study was conducted using Parsivel2 and not all the events showed an expected decrease in correlation with the distance. This is an ongoing study and the findings should be considered as preliminary.