The Motion of Mesoscale Snowbands in Northeast U.S. Winter Storms

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ABSTRACT

The distribution of snowfall accumulation attending winter storms is a product of both precipitation intensity and duration. Many heavy snowfall events are associated with distinct mesoscale snowbands, which strongly modulate snowfall accumulation. Mesoscale snowbands are known to be favored within environments characterized by frontogenetical forcing in the presence of weak moist symmetric or gravitational stabilities. Although the development of mesoscale snowbands often can be successfully anticipated at 24−36 h forecast ranges, anticipating band duration at a fixed location remains a forecasting challenge. However, given that snowband duration is closely related to attributes of snowband motion, improved understanding of band motion presents an opportunity to improve snowfall accumulation forecasts.

This study investigates the synoptic and mesoscale features associated with specific snowband motion characteristics. A classification scheme for snowband motion will be described, wherein bands are categorized into four modes: laterally translating, laterally quasi-stationary, hybrid, and pivoting. Laterally translating bands exhibit predominantly cross-axis motion, thereby favoring uniform snowfall accumulation along their paths. In contrast, laterally quasi-stationary bands exhibit near-zero cross-axis motion, favoring heavy snowfall accumulation along a narrow corridor. Hybrid bands are dominated by along-axis motion, but with a concurrent cross-axis component of motion, favoring snowfall accumulations on an intermediate spatial scale. Finally, pivoting bands exhibit pronounced rotation over a limited region, yielding a quasi-stationary band in that region, where heavy snowfall accumulation is particularly favored. Using archived WSR-88D data, 71 heavy snow cases in the Northeast U.S. (spanning the years 2005−2010) have been classified according to this scheme. Gridded data from the 0.5° resolution NCEP Climate Forecast System Reanalysis are used to identify synoptic and mesoscale features associated with these cases.

Preliminary results suggest that low- to mid-tropospheric temperature advection, flow confluence/diffluence, and flow curvature in the near-band environment are useful in distinguishing between environments favoring laterally translating, laterally quasi-stationary, hybrid, or pivoting snowband modes. These environmental attributes may be described by partitioning the Q-vector into along- and cross-isentrope components and along- and cross-stream components. Composite fields that typify the synoptic and mesoscale environments attending each snowband mode will be presented, along with selected case studies.