Mechanisms for Transient and Long-Duration 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 can often be successfully anticipated at 24−36 h forecast ranges, anticipating band duration at a fixed location remains a forecasting problem. 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 synoptic and mesoscale features associated with transient and long-duration (i.e., locally persistent) snowbands. A new snowband classification scheme is proposed, wherein long-duration snowbands are classified according to specific modes of band motion: lengthwise translation and pivoting. Lengthwise translation occurs when the cross-axis component of band motion is approximately zero, thereby favoring heavy snow accumulation along a narrow, along-axis corridor. Pivoting occurs when a snowband rotates cyclonically over a limited region, yielding a quasi-stationary band in that region. Using archived WSR-88D data, 71 heavy snow cases in the Northeast U.S. (spanning the years 2005−2010) are being classified according to this scheme, from which a limited snowband motion climatology will be constructed. 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 lower-tropospheric temperature advection and confluent versus diffluent flow in the near-band environment are useful in distinguishing between environments favoring transient, lengthwise-translating, or pivoting snowband modes. In turn, these respective modes of snowband motion are associated with characteristic vertical wind shear profiles. Partitioning of the Q-vector into along- and cross-isentrope components also suggests that snowband pivoting is associated with substantial rotational frontogenesis, which is largely absent with lengthwise translation. Three cases that typify these respective snowband modes and their attendant synoptic and mesoscale environments will be presented.