Mesoscale Snow Band Forecast Problems

Mesoscale banded snowfall is a common occurrence over the Midwest during the cold season. Forecasting such small-scale phenomena is extremely difficult for operational meteorologists. This is in part, due to the inability of today’s current operational numerical models to resolve these small-scale structures.

1) These are small-scale bands, often 5-50 km wide and 100-200 km in length.
2) They often form far away from synoptic-scale boundaries.
3) They often form in low-level northwesterly flow, associated with cold air advection.
4) They often form in the vicinity of Arctic highs.
5) They are associated with high snow-to-liquid ratios (e.g., 20 : 1).
6) Key parameters (frontogenesis, instability, etc) are weak, nothing to write home about.
7) These bands are associated with light snowfall but still cause socioeconomical problems.

These snowbands have the potential to cause a variety of socioeconomical problems. According to Weather Information for Surface Transportation (2002):

1) 74% of the National Highway System is in the nation’s snowbelt.
2) 69% of the U.S. population live in areas that normally receive more than five inches of snowfall each year.
3) 28% of all highway crashes and 19% of all fatalities are directly or indirectly related to adverse weather conditions.
4) Weather-related crashes have an estimated annual economic impact of nearly 42 billion USD.
5) City, state, and county highway maintenance agencies spend 2.1 billion USD per year to treat snow and ice on roadways.
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The objective of the present study is to focus upon the horizontal and vertical location, depth, and variability of the magnitude of key processes as they synergistically interact to modify upward vertical motion. Mesoscale instability, and depth of moisture in the formation process as they synergistically interact to modify upward vertical motion.

Frontogenesis is defined as the change of the potential temperature gradient following a parcel along the flow. The response is a direct thermal circulation (DTC). 

Snofall is found on the warm side of the frontogenesis axis (upward branch of the DTC). 

Frontogenesis is the magnitude component, oriented normal to the potential temperature gradient. Fv is associated with frontal scale circulations (Keyser et al., 1988, 1992). 

Fv is associated with circulations on the scale of synoptic disturbances (Keyser et al., 1988, 1992). The banded nature of the mesoscale bands is more closely related to the Fv component than the Fu component (Banacos-2003).

Keyser et al. (1988, MWR) and Augustine and Cassano (1994, WAF): 

Other Conceptual Models

What Makes This Conceptual Model Different?

1) These snow bands are associated with weak surface cyclogenesis (1006 hPa or greater).
2) The surface cyclone is not always a prominent feature. So, the position of the 900 hPa circulation is used instead.
3) The intensity of the mid-level frontogenesis is weak (< 0.7 K per 100 km per 3 h). 
4) Instability is typically WSS over the region of banded snowfall.
5) The snowfall is associated with low-level northeasterly flow, which maintained a cold and sometimes very shallow, stable lower tropospheric layer.
6) Typically, a southerly low-level jet is not directly associated with the area of snowfall.
7) The trough does not appear, diagnostically, to be a contributor to the area of snowfall.