A Multiscale Examination of

Surface Flow Convergence in the

Mohawk and Hudson Valleys

Abstract of

A thesis presented to the Faculty

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Michael E. Augustyniak
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Abstract

Forecasters have surmised that the unique terrain found in eastern New York and western New England plays a pivotal role in modulating various weather phenomena in the region. Several studies have examined the interplay between low-level channeled airflow within the Mohawk and Hudson River valleys, the surrounding hilly terrain (i.e., the Adirondack, Catskill, Green, and Berkshire Mountains), and the overall effect on warm-season severe weather events. To date, however, the impact on cold-season weather events of low-level flow channeling in eastern New York and western New England has gone largely unmentioned in the peer-reviewed literature.

The goal of this study is to examine, on the synoptic and mesoscale, the occurrence of a low-level convergence zone, which forms during the cold season from time to time, where the Mohawk and Hudson valleys intersect. Known to pose a challenge to local forecasters and referred to colloquially as the “Mohawk–Hudson convergence zone” (MHC), the development of the convergence zone generally does not lead to high-impact weather; however, convergence-related precipitation can wreak havoc if it occurs with little or no warning or at peak travel times. Such was the case on 27 November 2002, when a localized area of light-to-moderate snow persisted over eastern New York and western New England for several hours following the conclusion of synoptic-scale snowfall from an “Alberta Clipper.” The nascent interest generated following that event led to a total of seven observational studies of MHC events, all of which occurred between November 2002 and January 2008.

Several noteworthy similarities were observed from case to case, all of which control the physical processes necessary to generate a MHC event. These include: (1) a

positive north–south (west–east) sea-level pressure difference along the Hudson (Mohawk) Valley, which drives the confluent flow; (2) an absence of strong cold air advection, which precludes strong subsidence and drying of the boundary layer; and (3) a statically stable atmospheric stratification, which prevents downward transport of higher-speed air aloft to the surface that would tend to reduce or eliminate the local terrain-induced surface wind signature.

The empirical nature of this study led to the development of a conceptual model of MHC in the form of a composite map containing the synoptic and mesoscale weather features present during an event. These features include: (1) an intensifying surface cyclone over the western Atlantic Ocean, which moves east and/or south of 40°N, 70°W; (2) a trough of surface low pressure, which extends westward from the low center along the New York–Pennsylvania border; (3) a geopotential-height trough at 300 hPa, which places eastern New York and western New England under the left-entrance region of a jet streak, an area that favors sinking air. Furthermore, sea-level isobars are generally arranged in the shape of a reverse-S, with higher pressures located to the north (west) of Poughkeepsie, New York (Pittsfield, Massachusetts).

Finally, an effort is made to increase the predictability of future MHC events through the use of an operational forecasting scheme. To this end, a decision tree for forecasters is developed and presented in this study.

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Figure 3.42: As in Fig. 3.10, except for (a) 0000, (b) 0600, (c) 1200, (d) 1800 UTC 16 December 2002, (e) 0000, and (f) 0600 UTC 17 December 2002.

Figure 3.43: As in Fig. 3.13, except for (a) 0000, (b) 0600, (c) 1200, (d) 1800 UTC 16 December 2002, (e) 0000, and (f) 0600 UTC 17 December 2002.

Figure 3.44: Regional surface analysis for eastern New York and New England at 0300 UTC 17 December 2002. Isobars (solid) every 4 hPa. Isotherms (dashed) every 4°C. Temperature (°C) is plotted above visibility at several stations; missing station data have been omitted. (Data source: the University at Albany DEAS archives, with supplemental data provided by the Historical Weather Data Archives of NSSL).

Figure 3.45: As in Fig. 3.17, except from 1800 UTC 16 December to 0600 UTC 17 December 2002. (Data source: the University at Albany DEAS archives, with supplemental data provided by the Historical Weather Data Archives of NSSL).

Figure 3.46: As in Fig. 3.18, except from 1800 UTC 16 December to 0800 UTC 17 December 2002).

Figure 3.47: As in Fig. 3.19, except for (a) 1200 UTC 16 December 2002 and (b) 0000 UTC 17 December 2002. (Data source: 0-h gridded, initialized 1.0° NCEP GFS analyses).

Figure 3.48: As in Fig. 3.23, except for 2345 UTC 16 December 2002.

Figure 3.49: As in Fig. 3.15, except for (a) 1600, (b) 1800, (c) 1958, (d) 2202 UTC 23 January 2003, (e) 0004, and (f) 0159 UTC 24 January 2003.

Figure 3.50: As in Fig. 3.7, except for (a) 1200, (b) 1800 UTC 23 January 2003, (c) 0000, and (d) 0600 UTC 24 January 2003.

Figure 3.51: As in Fig. 3.10, except for (a) 1200, (b) 1800 UTC 23 January 2003, (c) 0000, and (d) 0600 UTC 24 January 2003.

Figure 3.52: As in Fig. 3.13, except for (a) 1200, (b) 1800 UTC 23 January 2003, (c) 0000, and (d) 0600 UTC 24 January 2003.

Figure 3.53: As in Fig. 3.16, except for 2100 UTC 23 January 2003.

Figure 3.54: As in Fig. 3.17, except from 1500 UTC 23 January to 0600 UTC 24 January 2003. (Data source: the University at Albany DEAS archives, with supplemental data provided by the Historical Weather Data Archives of NSSL).

Figure 3.55: As in Fig. 3.18, except from 1500 UTC 23 January to 0600 UTC 24 January 2002. (Data source: the University at Albany DEAS archives, with supplemental data provided by the Historical Weather Data Archives of NSSL).

Figure 3.56: As in Fig. 3.19, except for (a) 1200 UTC 23 January 2003 and (b) 0000 UTC 24 January 2003.

Figure 3.57: As in Fig. 3.23, except for 2045 UTC 23 January 2003.

Figure 3.58: As in Fig. 3.15, except for (a) 1003, (b) 1201, (c) 1359, (d) 1558, (e) 1803, and (f) 2001 17 January 2005.

Figure 3.59: As in Fig. 3.7, except for (a) 0000, (b) 0600, and (c) 1200 UTC 17 January 2005.

Figure 3.60: As in Fig. 3.7, except for (a) 0000, (b) 0600, and (c) 1200 UTC 17 January 2005.

Figure 3.61: As in Fig. 3.13, except for (a) 0000, (b) 0600, and (c) 1200 UTC 17 January 2005.

Figure 3.62: As in Fig. 3.16, except for 1200 UTC 17 January 2005.

Figure 3.63: As in Fig. 3.17, except from 1000 to 1800 UTC 17 January 2005.

Figure 3.64: As in Fig. 3.18, except from 1000 to 1800 UTC 17 January 2005. (Data source: University at Albany DEAS archives).

Figure 3.65: As in Fig. 3.19, except for (a) 1200 UTC 17 January 2005 and (b) 0000 UTC 18 January 2005.

Figure 3.66: As in Fig. 3.23, except from GOES-12 at 1145 UTC 17 January 2005.

Figure 3.67: As in Fig. 3.15, except for (a) 0000, (b) 0202, (c) 0359, (d) 0601, (e) 0757, and (f) 0901 UTC 3 March 2006.

Figure 3.68: As in Fig. 3.7, except for (a) 0000, (b) 0600, and (c) 1200 UTC 3 March 2006.

Figure 3.69: As in Fig. 3.10, except for (a) 0000, (b) 0600, and (c) 1200 UTC 3 March 2006.

Figure 3.70: As in Fig. 3.13, except for (a) 0000, (b) 0600, and (c) 1200 UTC 3 March 2006.

Figure 3.71: As in Fig. 3.16, except for 0300 UTC 3 March 2006.

Figure 3.72: As in Fig. 3.17, except from 0000 to 1200 UTC 3 March 2006.

Figure 3.73: As in Fig. 3.18, except from 0000 to 1200 UTC 3 March 2006. (Data source: University at Albany DEAS archives).

Figure 3.74: As in Fig. 3.19, except for (a) 0000 UTC 3 March 2006 and (b) 1200 UTC 3 March 2006.

Figure 3.75: As in Fig. 3.23, except from GOES-12 at 0401 UTC 3 March 2006.

Figure 3.76: As in Fig. 3.15, except for (a) 0757, (b) 1004, (c) 1201, (d) 1357, (e) 1604, and (f) 1801 UTC 2 January 2008.

Figure 3.77: As in Fig. 3.7, except for (a) 0600, (b) 1200, and (c) 1800 UTC 2 January 2008.

Figure 3.78: As in Fig. 3.10, except for (a) 0600, (b) 1200, and (c) 1800 UTC 2 January 2008.

Figure 3.79: As in Fig. 3.13, except for (a) 0600, (b) 1200, and (c) 1800 UTC 2 January 2008.

Figure 3.80: As in Fig. 3.17, except from 0600 to 2000 UTC 2 January 2008. (Data source: the Historical Weather Data Archives of NSSL).

Figure 3.81: As in Fig. 3.80, except for (a) KSYR, (b) KGFL, (c) KALB, and (d) KPOU.

Figure 3.82: Sea level pressure time series (hPa) from 0600 to 2300 UTC 2 January 2008 for KSYR, KGFL, KALB, KPOU, and KPSF (trace and data point markers according to the legend). (Data source: the University at Albany DEAS archives).

Figure 3.83: Skew *T*–log *p* radiosonde observations at KALY (72518) of air temperature (red line, in °C), dewpoint (blue line, in °C), and wind (to the right of the sounding; m s^{-1}, with pennant, full barb, and half barb denoting 25, 5, and 2.5 m s^{-1}, respectively) for 1200 UTC 2 January 2008. Various thermodynamic parameters are reported in green text at the top of the sounding. (Data source: Ohio State University weather archives).

Figure 4.1: Schematic of the key features observed during a prototypical MHC event on the (a) synoptic-scale and (b) mesoscale. Shown in (a) are: an intensifying area of surface low pressure located southeast of 40°N, 70°W, and moving northeastward (red “L”); sea level isobars (solid black lines); a trough of surface low pressure; the attendant areas of synoptic-scale snow (white shading) and rain (green shading); the axis of 300-hPa maximum winds (heavy pink line) and jet streaks (pink shading); weak low-level cold advec-tion from the north; the area which bounds the MHC domain (red box). Shown in (b) are: the Mohawk and Hudson Rivers (royal blue line) and their associated valleys (light blue shading); low-level channeled flow (red arrows); sea level isobars with higher pressures indicated to the north and west (solid black lines); the approximate location of mesoscale snow forced by MHC effects (stippled shading); the locations of bellwether surface observation sites used in seven case studies (red circles and corresponding station codes.

Figure 4.2: A decision tree for forecasting MHC. Adapted from Fig. 2 of Whitney et al. (1993).