2. Data and Methodology

2.1 Data Sources

The main dataset used to construct a broad overview of synoptic-scale weather features present during each case study is from the gridded 1.0° National Centers for Environmental Prediction (NCEP) Global Forecast System (GFS) initialized analyses. Vertical motion and temperature advection profiles are derived from the three-hourly initialized analyses of the 32 km NCEP North American Regional Reanalysis (NARR; Mesinger et al. 2006). These data were chosen in favor of the greater spatial, temporal, and vertical resolutions they provide (as compared to GFS data), in an effort to better capture the subtle synoptic and mesoscale features associated with MHC.

Standard radiosonde data were obtained from the archives of the University at Albany Department of Earth and Atmospheric Sciences (DEAS) and from the archives of Ohio State University. Zero-hour gridded, initialized 1.0° NCEP GFS analyses were used to compensate for missing radiosonde data during the December 2002 case study. Time–height wind profile data for Schenectady, NY, were obtained from the National Oceanic and Atmospheric Administration (NOAA) National Profiler Network (NPN) archive [http://www.profiler.noaa.gov/].

Standard regional surface data, comprising observations from Automated Surface Observing System (ASOS) sites, and buoy and ship observations, were retrieved from the archives of the University at Albany DEAS. In the few instances where hourly surface observation data were missing from this data set (e.g., on 28 November 2002, 17 December 2002, and 24 January 2003), supplementary data were obtained from the

Historical Weather Data Archives of the National Severe Storms Laboratory (NSSL) in Norman, Oklahoma [http://data.nssl.noaa.gov].

Satellite imagery was obtained from the Comprehensive Large Array-data Stewardship System (CLASS) at NOAA [http://www.class.noaa.gov/]. The 2-km composite NOWrad radar imagery [marketed by Weather Services International Corporation (WSI)] was obtained from the archives of the Mesoscale and Microscale Meteorology (MMM) Division of the National Center for Atmospheric Research (NCAR) [http://locust.mmm.ucar.edu/imagearchive1/WSI/]. Imagery from the East Berne, NY (KENX), Weather Surveillance Radar-1988 Doppler (WSR-88D) was obtained from the National Climatic Data Center (NCDC) archive [http://hurricane.ncdc.noaa.gov/pls/plhas/has.dsselect].

Public forecasts and area forecast discussions for the November 2002 MHC event, issued by the Albany office (KALY) of the National Weather Service (NWS), were retrieved from the archives of the University at Albany DEAS. Context for the overall societal impact of the November 2002 MHC event was provided through a storm summary compiled by the meteorologists at television station WRGB-TV, located in Schenectady, NY, which is available online [http://www.cbs6albany.com/sections/weather/historical/daily/]. Monthly climatological precipitable water values for the Albany, NY, area were obtained from the website of the Rapid City, South Dakota, NWS Forecast Office [http://www.crh.noaa.gov/unr/?n=pw]. Topographic maps of the MHC domain and surrounding areas were generated using graphical information systems (GIS) data obtained through the Environmental Systems

Research Institute, Incorporated (ESRI) Geography Network [http://geographynetwork.com/].

2.2 Methodology

As no published research regarding MHC exists, case studies of the phenomenon were conducted. A thorough synoptic and mesoscale analysis was completed for six cases, spanning November 2002 to January 2007. A more cursory analysis of a seventh case (January 2008), which occurred while this thesis was being written, is included for completeness.

Each case was investigated to determine whether synoptic-scale forcing mechanisms were responsible for generating convergence episodes. The parameters examined include frontal forcing, static stability, jet streak dynamics, temperature advection in the lower troposphere, advection of 500 hPa geostrophic absolute vorticity, and advection of 700 hPa relative vorticity by the thermal wind over the 1000–500 hPa layer. Describing, to the first order, the quasi-geostrophic forcing for vertical motion in a synoptic scale system,

$$-\vec{V}_T \bullet \nabla \zeta_{700} \qquad (2.1)$$

denotes the advection of 700 hPa relative vorticity by the thermal wind, where ζ_{700} is the geostrophic relative vorticity. The thermal wind is calculated by subtracting the lower-level (1000-hPa) geostrophic wind from the upper-level (500-hPa) geostrophic wind

$$\vec{V}_T = \vec{V}_{500} - \vec{V}_{1000}, \qquad (2.2)$$

and the definition of geostrophic relative vorticity in the 700 hPa layer is standard, given by

$$\zeta_{700} = \frac{g}{f}\nabla^2 Z_{700}, \qquad (2.3)$$

where Z_{700} represents the geopotential height field at 700 hPa.

An analysis of surface wind direction and SLP was also conducted across the six cases for several sites including Albany, NY (KALB), Glens Falls, NY (KGFL), Utica, NY (KUCA), and Syracuse, NY (KSYR). Surface wind observations, collected hourly while MHC-related precipitation was ongoing, were aggregated and plotted on wind roses, creating a climatology of surface wind direction at each station during MHC events. SLP differences between pairs of stations were also plotted on X–Y plots (scatterplots) in an effort to determine what role pressure-gradient magnitude may play in MHC formation.