**Results**

Warm Cases:

Warm cases of MHC typically occur with very weak or no synoptic scale forcing. Figure 2a shows the 1000-hPa wind composite of the warm cases. The composite shows an overall west to southwesterly flow across the Capital District during the peaks in MHC events. The composite wind in the Hudson Valley is generally less than 2 m s-1, while winds in the Mohawk Valley are typically slightly stronger, but generally less than 6 m s-1. The southerly component of the winds allow for channeling up the Hudson River valley while the westerly component allows for channeling down the Mohawk River valley. The deceleration in the wind as well as the confluent components of the wind being funneled down the valleys is an indicator of weak surface convergence. This surface convergence in a high convective available potential energy (CAPE) environment is enough forcing to cause upward vertical motion to initiate convection.

The pure warm cases also typically occur in before the frontal passage and in environments which lack forcing from a prefrontal trough (Fig. 3a). The warm case composite surface low is directly north of the region situated over southern Quebec and during the time of peak MHC. Generally, the cyclones which forced these events have the minimum composite mean sea level pressure of only 1012-hPa and generally weaker composite gradient. This is important because as seen in the wind analysis weak surface winds are necessary to induce channeling in the valleys.

At 850 hPa, weak cold air advection in the prefrontal environment occurs during the onset of these events over most of New York State (Fig. 4a). The composite shows weak warm air advection on the order of 0.4 *°*C h-1. Warm air advection to the east and cold air advection to the west is indicative of a cold front approaching the region.

Weak advection of 500-hPa cyclonic vorticity occurs during the warm events in most of eastern and central New York (Fig. 5a). Weak cyclonic curvature upstream is indicative of shortwaves upstream in the composite mean. It is the vorticity from these shortwaves being advected in to the region.

At 300 hPa (Fig. 6a), a weak composite jet is centered to the northeast of the region over New Brunswick extending southwest into southern Quebec. Through upper level divergence associated with the equatorward entrance region the jet should be forcing a broad area of ascent over Northeast New York and Northern New England. Overall warm MHC cases had some sufficient forcing for upper level ascent.

The composite sounding (Fig. 7a) shows a warm surface around 28 *°*C and surface dew points around 19 *°*C. With a warm, moist surface, the lack of any significant capping inversion, and steep mid-level lapse rates, there is abundant surface-based CAPE. Surface southwesterly winds are around 5 knots and the winds veer with height. Winds veering with height are representative of warm air advection, which was seen in the 850-hPa map. Weak upward vertical motions through the lower atmosphere coupled with instability leads to the development of convection in the Mohawk–Hudson convergence zone.

Cold Cases:

Like the warm MHC events, the cold cases of MHC also typically occur in the absence of synoptic scale forcing, typically after the passage of the synoptically forced precipitation. 1000-hPa winds in the Hudson River valley are typically northerly while winds in the Mohawk River valley are more northwesterly (Fig. 2b). The magnitudes of the wind vary between 6 m s-1 in the Mohawk Valley to near 3 m s-1 in the northern Hudson Valley. The magnitude of the wind in the cold cases across the region is reasonably larger than that of the warm cases because the departing cyclones in the cold cases are associated with stronger pressure gradients and therefore a stronger pressure gradient force. The western component of the northwesterly winds flow down the Mohawk Valley and converge with the winds flowing down the Hudson Valley from the north. This convergent flow can create weak upward vertical motion in this convergence zone.

Cold case composite sea level pressure (Fig. 3b) shows that during the peak of cold MHC events a cyclone is generally located east of New England. The mean sea level pressure in these cases composited to be around 1004-hPa. The composite gradient in sea level pressure is much higher than that of the warm cases which is consistent with the increased magnitude of the winds. The surface geostrophic wind is from the north, northwest direction.

850-hPa cold air advection dominates the region where cold season MHC occurs (Fig. 4b). The cold air advection in the region is stronger than in the warm cases and is approximately but in the Capital District region there is nearly neutral temperature advection. Strong warm air advection occurs in the warm sector of the strengthening cyclone over the northwest Atlantic. Cold air advection in the low to middle levels acts to increase stability by creating a weak inversion seen in many of the cold MHC cases.

There is a maximum in 500-hPa relative vorticity over the region (Fig. 5b), implying anticyclonic vorticity advection upstream of the 500-hPa trough axis. The anti-cyclonic vorticity advection indicates at upper level descent in the atmosphere.

A strong 300-hPa jet maximum in the composite can be seen to the south of the region pushing off the northern North Carolina coast (Fig. 6b). The jet maximum peaks at over 100 knots. The location of this jet maximum puts the Capital District region in an area favorable for neither upper level divergence nor upper level convergence, as it is not collocated in an entrance or exit region of the jet. Strong upper-level forcing occurs offshore, downstream of the trough axis and in the poleward exit region of the jet maximum, in the vicinity of the surface cyclone in (Fig. 3b).

The composite sounding in (Fig. 7b) backing through the mid-levels of the atmosphere, consistent with the presence of weak cold air advection in the region. Though the composite can smooth out detailed features of the individual events, the remnants of a weak inversion can be seen in the mid-levels around 900-hPa. The sounding is saturated from the surface to 800-hPa and is entirely below 0 *°*C. Any precipitation that occurs in this environment is fairly shallow. With the only forcing coming from the lower levels with some weak upper level descending motion convection is confined to the lower levels of the atmosphere.

Case Study- 2 January 2008:

The 2 January 2008 MHC event occurred as an area of surface low pressure deepening off the coast of eastern New England moved offshore. This cyclone caused a few brief periods of heavy snow in eastern New York and western New England before departing. This case is particularly significant because of its duration, intensity, and low predictability in the Capital Region. Officially an additional 0.8 cm was reported at KALB, but weather observers reported more significant accumulation attributed to MHC in various parts of the region. As much as 12.7 cm more snow was reported in Cohoes, NY, on top of what the cyclone actual produced. Outside of this narrow area extremely little or no additional snow accumulations were reported.

At the surface (Fig. 9),much like in the composite there is a low located off the eastern New England coast with a central pressure lower than 1004 hPa. The cyclone tracked slightly west of 40°N, 70°W and eventually moved to the northeast nearing Newfoundland.

On the back side of this storm there was very little in the way of cold air advection at 850-hPa, as shown in figure 10. There was actually a small nose of warm air advection located over the Capital District. Warm air advection was on the order of 0.4 *°*C h-1..

Most of the 500-hPa cyclonic vorticity (Fig. 11) was located in the base of the trough and is being advected off the coast of eastern New England where the cyclone was deepening as it moved away from Eastern New England. Neutral or very weak anti-cyclonic vorticity advection was occurring in the Capital District.

A 300-hPa jet maximum of over 100 knots (Fig. 12) was located just southeast of eastern New York and western New England. The areas of maximum upper-level divergence and convergence were displaced from the Capital Region. Like in the composite cold cases, the region is not in an area of the jet favorable for upper level divergence of upper level convergence.

Figure 13 shows the observed sounding from KALB at 1200 UTC 2 January 2008. Like in the composite case the boundary layer is very moist with temperatures less than 0*°*C. The winds in the observed sounding veer in the lower layers from the surface to around 900-hPa, consistent with low level warm air advection. The winds above this level begin to back, which is consistent with the cold air advection through the remainder of the troposphere. Like in the composite sounding precipitation is exclusively occurring in the low levels, with the forcing explicitly coming from the weak lower level warm air advection and convergent wind flow.

**Summary and Conclusion**

Unique terrain in eastern New York pays a pivotal role in the Capital District Region. Through compositing cases we could understand the typical synoptic scale setup common to these types of events to produce better forecasts.

The synoptic setup for warm cases of Mohawk-Hudson Convergence is a broad trough at 300-hPa over the eastern United States with weak cyclonic vorticity advection and weak cold air advection. Most importantly weak south or southwesterly winds can channel westerly down the Mohawk valley and southerly up the Hudson valley supplying rich and unstable air to the greater Capital District Region. The winds are also typically weak in Albany during the onset of these types of events.

The synoptic setup for cold cases of Mohawk-Hudson Convergence is a strong jet with trough over the East Coast with the jet maximum off the coast of southern Virginia. Strong cyclonic vorticity leads to a deepening of the low off the New England Coast increasing the surface pressure gradient over eastern New York. This leads to moderate northerly flow in the Hudson valley and northwesterly flow in the Mohawk valley. These events happen largely away from synoptic scale forcing. Cold events are also characterized by a moist boundary layer with dry air in the upper levels.

These types of events are hard to predict because of their seemingly innocuous conditions on a large-scale. But can quickly with slight assent from the river valleys cause upward vertical motion lead to thunderstorms and quick bursts of precipitation.