Results

1. Warm Cases:

Warm cases of MHC typically happened in events with very weak or no synoptic scale forcing. Figure 1a represents the 1000-hPa wind composite of the warm cases. The composite shows an overall west to southwesterly flow across the Capital District region during the peaks in MHC events. The magnitudes of the winds in the Hudson Valley were generally less than 2 m s-1, while winds in the Mohawk Valley were slightly stronger and generally less than 6 m s-1. The southerly component of the winds allows 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 warm cases also occurred in prefrontal environments which lacked forcing from a prefrontal trough. This is illustrated in figure 2a which represents the composite of mean sea level pressure. The surface low was directly north of the region situated over southern Quebec and during the time of peak MHC intensity the surface front was located just to the west of the region. Generally the cyclones which forced these events did not have extremely strong pressure gradients, with the minimum composite mean sea level pressure of only 1012-hPa. This is important because as seen in the wind analysis weak surface winds are necessary to induce channeling in the valleys.

 At 850-hPa as illustrated in figure 3a weak cold air advection in the prefrontal environment was occurring during the onset of these events over most of western New England. The composite shows weak cold air advection on the order of -0.4 *°*C h-1. Warm air advection can result in weak vertical motion but in this case not enough to initiate region wide convection on its own.

Figure 4a shows the relative vorticity at 500-hPa. Extremely weak advection of cyclonic vorticity occurred during the warm events in most of eastern and central New York. This suggests that cyclonic vorticity advection provided little help in the way of assisting the upward vertical motion in the region during the peaks of the warm MHC events. As with the weak 850-hPa warm air advection, the cyclonic vorticity advection in the region was insufficient to create region wide convection.

 At 300-hPa in figure 5a, a weak jet was centered to the northeast of the region over New Brunswick extending southwest into southern Quebec. With the jet this far removed most of the vertical motion associated with the upper level divergence in the right entrance region of the jet should be occurring over Northeast New England. Overall warm MHC cases lacked upper level forcing.

The composite sounding in figure 6a shows a warm surface around 28 *°*C and surface dew points around 19 *°*C. With a warm moist surface there is abundant CAPE. Surface 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 firing of convection in the Mohawk Hudson convergence zone.

1. Cold Cases:

Like the warm MHC events the cold cases of MHC also typically happen in the absence of synoptic scale forcing. In figure 1b 1000-hPa winds in the Hudson River valley were typically northerly while winds in the Mohawk River valley were more northwesterly. The magnitudes of the wind varied between 6 m s-1 in the Mohawk Valley to winds 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.

The composite consisting of these departing cyclones can be seen in figure 2b, which shows mean sea level pressure. The composite shows that during the peak of cold MHC events the cyclone is generally located east of New England. The mean sea level pressure in these cases composited to 1004-hPa. The gradient in sea level pressure is much higher than that of the warm cases which is consistent with the increased magnitude of the winds.

 In figure 3b at 850-hPa cold air advection dominates. The cold air advection in the region is generally stronger than in the warm cases and is around -0.8 *°*C h-1. Strong warm air advection is occurring in a majority of the western Atlantic due to the strengthening cyclone. Cold air advection in the low to middle levels acts to build stability by creating a weak inversion seen in many of the cold MHC cases.

Taking a look at figure 4b there is a maximum in 500-hPa relative vorticity over the region. This means the anti-cyclonic vorticity advection is occurring behind the 500-hPa trough. The anti-cyclonic vorticity advection indicates at least weak upper level descent in the atmosphere.

At 300-hPa depicted in figure 5b an intense jet stream maximum in the composite can be seen to the south of the region pushing off the northern North Carolina coast. 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. From 300-hPa there is no forcing for upper level ascent of decent.

 The composite sounding in figure 6b shows backing through the mid layers 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 will be 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.

1. 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 away. 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 watchers reported measurements of an additional 2.5-9.4 cm in various parts of Clifton Park, NY. 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 in figure 7, 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 8. Values of cold air advection were less than 0.04 *°*C h-1 in the Capital Region, with much more prominent cold air advection occurring in the southeast United States.

 In figure 9, 500-hPa vorticity is shown. At this time most of the cyclonic vorticity 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 jet maximum of over 100 knots at 300 hPa was located just southeast of eastern New York and western New England, which can be seen figure 10. 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 11 shows the observed sounding from KALB at 1200 UTC on 2 January 2008. Like in the composite case the boundary layer is very moist and stable with temperatures less than 0*°*C. The winds in the observed sounding veer in the lower layers from the surface to around 900-hPa, this is 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 happening in the low levels, with the forcing explicitly coming from the weak lower level warm air advection and convergent wind flow.