**Southerly or “Reverse” Mohawk-Hudson River Convergence Events**

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**1. Introduction**

 Forecasting cumuliform convection has always and continues to be a challenge for mesoscale weather prediction models. By nature, cumuliform clouds develop by a sort of chaos theory, more commonly known as butterfly effect, where the minutest variations in temperature and humidity across an area can cause of prohibit clouds and storms from forming. Models such as the High-Resolution Rapid Refresh model (HRRR), the Rapid Refresh model (RAP), and the Weather Research and Forecast model (WRF) attempt to predict the initiation and location of such events, and while sometimes they are accurate on a larger spatial scale, they often fail to correctly forecast more localized weather phenomena.

 There are many ingredients that need to be present for precipitation-sustaining cumuliform convection to form. The air mass in question needs to be warm, humid, and in an area where instability is or will in the near future be present.Given these three ingredients are present, there must also be a “trigger” to initiate the convection. A trigger can be either synoptic- a jet streak, jet phasing region, or mid-level vorticity advection, or it can be mesoscale- a prefrontal trough, a convective thermal, or orographic lift to name a few.

 The specific trigger this project seeks to study is one involving the collision, or convergence, of winds channeled through two local river valleys. Sometimes when the wind around a synoptic low comes from certain angles through connected valleys such that the winds meet where the valleys connect, the convergence can force upward motion, leading to convection in the immediate region.

This type of phenomenon has been observed in cold season cases in a couple of river valleys in the Unites States- the Columbia and Snake River valleys in Washington, the Saint Lawrence River Valley of Canada, and the Mohawk and Hudson River valleys in Upstate New York. **[brief Washington & Lawrence examples go here.]** The Hudson River runs north to south, spanning over 320 kilometers from near Lake Champlain down to New York City. This places the bulk of the Hudson River watershed in the forecast regions of Brookhaven, NY (OKX) and Albany, NY (ALY). The Hudson River is bordered by a total of four mountain ranges- the Adirondacks and Catskills on the west side, and the Greens and Taconics on the east side. Relief on either side of the river can reaches about 1000 meters (USGS Digital Elevation Map). Between the Catskills and Adirondacks lies the Mohawk River valley which extends west to east across upstate New York, spanning about 160 kilometers from Rome to Albany where it empties into the Hudson River. The Mohawk River shares a similar relief shape with the Hudson valley and meets the Hudson River at a nearly orthogonal angle.

A study by Mike Augustyniak (2008) found that the geography of these two river valleys influences the flow of the wind through them. Wind tends to flow either northerly or southerly through the Hudson Valley dependent on the position of highs and lows, even when the synoptic patterns and mean gradient wind indicate a westerly or easterly flow. The northerly case tends to occur with a departing coastal low in the cold season, and when the westerly winds along the Mohawk Valley meet the northerly Hudson Valley winds over the Capital Region, this leads to a phenomenon known as Mohawk-Hudson Convergence (MHC). Though the weather resulting from this event is non-life threatening, it can lead to additional precipitation in winter storms, usually in the form of snow, and can happen with little warning. (Augustyniak, 2008). **[give an example- Jan 16 1983 or Jan 10(?) 2011]**

 In the warm season, a passing low over Ontario, Canada can create a southwest mean wind gradient over the state. This induces a south to southeasterly flow up the Hudson Valley with southwesterly winds over the terrain of the Catskills and westerly winds in the vicinity of the Mohawk Valley. This unique wind pattern, unseen in the previously mentioned Snake and Columbia river valleys and Saint Lawrence Valley, can create low-level convergence of the winds just north of Albany, along with slightly higher dew points in the Hudson Valley that lead to a localized humidity gradient **[discuss how in methodology]**.This type of event is known as "reverse” or southerly Mohawk-Hudson Convergence (SMHC), and this low-level convergence can enhance or even spark new convection ahead of a line or batch of disorganized thunderstorms. If low-level shear is great enough in the area of convergence, SMHC even has the potential to produce supercell thunderstorms. (One such case that occurred on 22 June 2008 will be specifically examined in this study.)

 SMHC is exceptionally tricky to forecast, as the production of convection resulting from its occurrence is very sensitive to the slightest changes in wind direction and humidity, and often on days when SMHC would be expected to occur, it either does not or fails to produce any significant weather phenomena. Conversely, there are also times when SMHC occurs and the results are majorly enhanced convection and even supercell development on very rare occasions. Because of the potential of SMHC to produce severe weather in a region of over one million residents and the busy Albany International Airport (ALB), it is important to be able to forecast these events accurately. The purpose of this study therefore is to estimate how often convergence-based convection occurs by building a climatology of positive and null cases, then building a set of specific parameters under which SMHC is most likely to produce convection by selecting a positive and a null case to more thoroughly examine. In these case studies, synoptic setup, mesoscale influence, and triggering mechanisms will be investigated to determine what caused convection to form or not to form.

**[mention how lone out-of-the-blue storm can bring air traffic to halt]**

**2. Methodology**

 In order to get a better understanding of what SMHC cases look like and to have a collection of cases from which a more in-depth study can be conducted, an archive of SMHC events was built from the summers of 2007 to 2012 with a few cases from 2004. In order to identify and classify events, Advanced Weather Interactive Processing System(AWIPS) archived radar data from documented severe weather cases was examined in the Weather Event Simulator (WES) environment. Because a climatological survey on this particular type of convergence has never been build before, the following unique parameters for identifying SMHC cases were decided on by the research party.

1. Convective Available Potential Energy (CAPE)

For convection to initiate in the appropriate region, low-level instability must be present, and ample amounts of CAPE are the most commonly used variable for measuring low-level convective instability for thermally-driven rising parcels. During case studies of SMHC, it was determined that surface-bound CAPE levels usually exceeded 1000 J/kg for the Capital Region of Upstate New York, 1000 with the highest amounts being found in the Hudson River Valley. Any amounts equal to or greater than the 1000 J/kg threshold should be sufficient enough for convective thermals to rise and condense given they can break any existing cap.

1. Wind Direction and Speed

The convergence of winds in the vicinity of the Capital Region is a result of winds being channeled through the Hudson and Mohawk river valleys in a way that they collide where the two rivers meet. For this to occur, the wind field over the Hudson River, Mohawk River, and Catskill Mountains must be observed for favorable wind velocities. Generally the Automated Surface Observing System (ASOS) in Albany is checked for a south to south-southeasterly wind and the ASOS in Rome is checked for a more westerly to west-northwesterly wind. Winds across the Catskills from the Hudson Valley clockwise up to the Mohawk River should take a gradually turn from southerly to westerly.

In addition to direction, wind speed is also an important factor. For these events, it is favorable to see wind speeds of around 5-10 knots. Convection associated with SMHC is similar to airmass thunderstorm development in that it requires minimal speed shear to be present. If vertical wind speed shear is too great, then convective storms created by the convergence would be torn apart. Vertical direction shear, however, is expected as the southerly wind through the Hudson Valley is a result of the orography of the region. Above the extent of the mountains, winds usually take the lower-level synoptic direction of more westerly.

1. Areal Extent

SMHC is a very localized phenomenon, occurring only in the vicinity of the Capital Region. For the purpose of this study, the areal extent of SMHC influence is defined as approximately within twenty kilometers of the Albany International Airport- more specifically, the region bound by Selkirk to the south, Troy to the east, Clifton Park to the north, and Altamont to the west. It is especially important to specify the farthest eastern extend because the Taconic Range induces orographic lift, which can almost appear like SMHC-driven convection in radar imagery. Convection caused by either these two forcing mechanisms must be kept distinct and separate during the climatological classification process when possible. (Sometimes convection be can influenced by both, but more on that will be discussed in section **[add section # here later]**.)

**[add a map figure]**

1. Forcings

With CAPE and a favorable wind field present, the main ingredient left that is needed to initiate convection would be a forcing mechanism. The typical synoptic setup of a low to the north or northwest in southwest Quebec or southern Ontario creates the wind pattern needed for SMHC, but otherwise synoptic-level forcing does not play a major role in initiating SMHC convection. Upper level winds in several examinations were found to be fairly light, and the area of interest was located well away from the greatest synoptic forcing. This makes sense considering SMHC is a mesoscale phenomenon, and therefore as expected, associated convection is initiated mostly by mesoscale forcing. Convection due to SMHC usually occurs ahead of a cold front or prefrontal trough. This is better defined as a gradient boundary, specifically in moisture, measured by dew point. **[discuss the specifics of boundary forcings with Hugh- discontinuity disrupts air flow & produces convergence along boundary. Prefrontals usually more significant in midsummer- Hugh to send a paper]**

Cases

* POSITIVE- June 22 2008
* NULL BUT INTERESTING- June 17 2011 (see list, should’ve happened but didn’t- Albany bubble; )
* ENHANCED- July 16 2003

Other notes

* see about looking up 1953 tornado- SMHC event? (may be worth mentioning)
* 239 Lenox Dr.- Hugh’s address

Case Studies

* possible WRF simulation
* record all variables
* POSITIVE- June 22 2008
* NULL BUT INTERESTING- June 17 2011