**An analysis of precipitation events associated with terrain-generated convergence in the Mohawk–Hudson River valleys**

1. Abstract
   1. Difficult forecast problem
   2. Happens in both warm and cold seasons but under different synoptic patterns
   3. Cold: moist, stable low-levels with a northerly wind, low off the coast
   4. Warm (enhanced and pure): unstable, low-level southwesterly wind, low to the north
   5. MHC impacts
      1. Warm cases: severe weather and potential significant impacts at Albany International Airport
      2. Cold cases: unexpected, locally heavy precipitation after the “main event”
2. Introduction
   1. Topographic roles
      1. Mass and Clifford (1981): Puget Sound Convergence Zone; convergence of winds usually just after cold frontal passage. Increased precipitation in the Seattle region. Accompanied by light to moderate northwesterly winds
      2. Wasula et al. (2002): Provides evidence that distribution of severe weather was affected by underlying terrain. Southwest flow severe weather days more likely from the Mohawk Valley west and Albany north into the southern Adirondacks
      3. Anders et al. (2006): Mountain ranges strongly influence the spatial distribution of precipitation in the Olympic Mountains of Washington State
      4. Zhong (2008): Presence of topography can lead to thermally and dynamically induced mesoscale wind fields
   2. Valley channeling effects
      1. Gross and Wippermann (1987): Rhine Valley in Germany (shallow valley 500 m) could channel flow. You don’t need deep valleys or large terrain to get channeled flow.
      2. Whiteman and Doran (1993): There are four mechanisms from classical mechanics to create channeled flow. (1) Thermally driven, (2) downward momentum transport, (3) forced channeling, and (4) pressure driven channeling
      3. LaPenta et al. (2005) and Bosart et al. (2006): Terrain channeled southerly flow creates low-level veering (seen in both the Great Barrington and Mechanicville tornadoes). Inflow of supercell also possibly channeled as it did not move on velocity radar.
      4. Augustyniak (2008): Cold MHC events seem to be driven by pressure channeling, as in a “Reverse-S” pattern in isobars in response to departing costal cyclones.
      5. Carrera (2009): Looked at the three ASOS stations YUL (Montreal), YQB (Quebec City) and BTV (Burlington). Downward momentum transport was the driving force of channeling as YUL, Pressure driven channeling at YQB and Forced channeling present in all seasons at BTV
      6. Razy (2011): Wind channeling in the St. Lawrence River Valley is an important contributor to weather patterns around Montreal. The predominantly pressure driven channeling.
      7. Jeglum and Hoch (2016): In northwest Utah complex terrain was found to have an effect on the climatological features of the surface winds
   3. Impacts of MHC events
      1. Unexpected, moderate to heavy precipitation that can effect a small region. Can also create initialization of severe thunderstorms.
3. Data and methodology
   1. Case selection
      1. Warm cases
         1. Every case of lightning at KALB, event was analyzed (in warm cases)
         2. If convection started within a 10-mile radius of Albany Airport and reached 30 dBZ it was considered a possible case
         3. Verify the abundance of SBCAPE (usually over 1500 J kg-1)
         4. Though enhanced cases were able to be determined for warm events they were removed to keep constancy with the cold cases which were only pure
      2. Cold cases
         1. Cases with costal lows, events were analyzed (in cold cases)
         2. Any cold case with lake effect near the region was removed
         3. Cold cases were only selected if other forcing features were not present, as it was difficult to determine any enhanced cases of cold MHC events
      3. All cases
         1. Surface analysis looking for prefrontal features and frontal features.
         2. Observations in the Mohawk and Hudson Valleys to show channeling
         3. Position of low pressure
      4. Radar analysis
         1. Look for evidence of boundaries such as fronts, troughs, or cold pools
         2. Isolated precipitation event that increases in intensity within the MHC convergence zone
   2. CFSR (Climate Forecast Systems Reanalysis) composites
      1. Warm (n=19) and cold (n=12) events from 2003 to 2013
      2. Sounding
      3. 0.5°resolution
   3. RAP/RUC
      1. 2 January 2008 cold case
      2. 13 km resolution
      3. Initialized at 1200 UTC
      4. Sounding
         1. 21 km resolution for cases before 2011
         2. 13 km resolution for cases after 2011
   4. Observations and radar
      1. Surface observations: Iowa State Archived Data
      2. Sounding data (KALB) for cold case
      3. Radar: National Climate Data Center
4. Results
   1. Composite synoptic setup
      1. Warm cases
         1. 300-hPa jet: weak, fairly zonal
         2. 500-hPa vorticity: weak cyclonic vorticity advection
         3. 850-hPa temp advection: weak warm air advection
         4. 1000-hPa wind: weak winds in Hudson Valley (south/southwesterly), westerly winds down Mohawk Valley (1.75 m s-1); valley convergence
         5. Mean sea level pressure: low pressure situated to the north of the region
         6. Sounding: weak southwesterly wind at the surface veering, unstable
      2. Cold cases
         1. 300 hPa jet: stronger jet with trough over the East Coast, jet max just off the coast of southern Virginia
         2. 500 hPa vorticity: stronger cyclonic vorticity advection southeast of New England
         3. 850 hPa temp advection: weak cold air advection over New England
         4. 1000 hPa wind: generally stronger winds than warm MHC cases (around 3.5 m s-1)
         5. Mean sea level pressure: low pressure situated off the New England coast
         6. Sounding: weak to moderate northerly flow, fairly stable with moisture at surface
   2. Case study: 2 January 2008
      1. 300 hPa jet: amplified jet, trough over East Coast, jet max off the coast of North Carolina/Virginia
      2. 500 hPa vorticity: strong cyclonic vorticity advection southeast of Long Island, Rhode Island, and Massachusetts
      3. 850 hPa temp advection: weak cold air advection over most of New England
      4. Sounding: weak northwesterly flow at surface, with northerly winds
      5. Analysis of radar evolution and surface observations: weak northerly flow in the Hudson Valley, northwesterly flow in the Mohawk Valley
5. Summary and conclusions
   1. Warm MHC
      1. Characterized by weak forcing (weak CVA, weak WAA)
      2. Southwesterly winds near surface
   2. Cold MHC
      1. Characterized by almost no forcing
      2. Cyclone usually situated southeast of the New England Coast
      3. Moderate to weak northerly flow at the surface in the Hudson Valley, northwest flow in the Mohawk Valley
      4. Moist and stable at the surface
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   3. Lance Bosart
   4. Daniel Keyser
   5. NWS ALY
   6. NWS ALY–UAlbany DAES Internship Program
7. References
   1. Jeglum and Hoch (2016): Multiscale Characteristics of Surface Winds in an Area of Complex Terrain in Northeast Utah
   2. Razy at al. (2011): Synoptic-Scale Environments Conducive to Orographic Impacts on Cold-Season Surface Wind Regimes as Montreal, Quebec
   3. Carrera (2009): Observational Study of Wind Channeling within the St. Lawrence River Valley
   4. Augustyniak (2008): A multiscale examination of surface flow **convergence** in the **Mohawk** and **Hudson** valleys
   5. Zhong (2008): Climatology of high wind events in the Owens Valley, California
   6. Bosart et al. (2006): Supercell Tornadogenesis over Complex Terrain: The Great Barrington, Massachusetts, Tornado on 29 May 1995
   7. Andres et al. (2006): Small-Scale Spatial Gradients in Climatological Precipitation on the Olympic Peninsula
   8. Wasula et al. (2002): The Influence of Terrain on the Severe Weather Distribution across Interior Eastern New York and Western New England
   9. Whiteman and Doran (1993): The relationship between overlying synoptic-scale flows and winds within a valley
   10. Gross and Wippermann (1987): Channeling and countercurrent in the upper Rhine

Valley: Numerical Simulations

* 1. Mass and Clifford (1981): Topographically forced convergence in western Washington State