

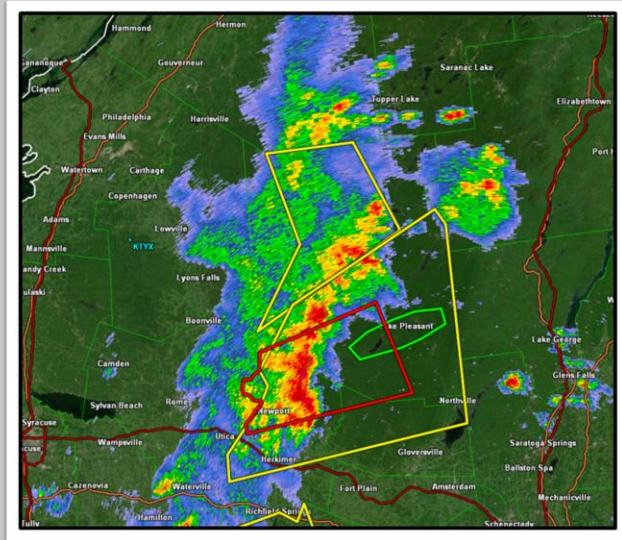
June 21<sup>st</sup>, 2021  
Severe Weather Event  
Eastern New York

*K<sub>DP</sub> Applications for Forecasting  
Significant Wind Damage in Severe Thunderstorms*

John England | Brian Frugis

# Case Study Outline

- Synoptic Overview
- Mesoscale Analysis
- Dual-Pol Radar Products
- $K_{DP}$  Applications
- $K_{DP}$  Analysis
- Summary

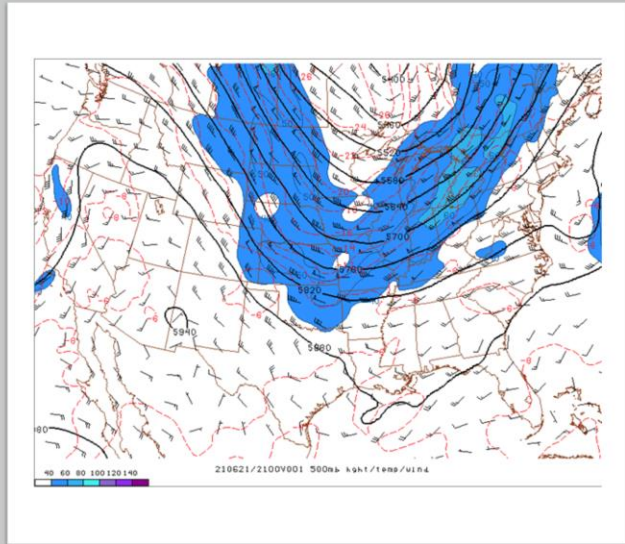


*KENX Reflectivity 2301z, Tornado Warned Thunderstorm, Herkimer County, New York*

## 500mb Winds

June 21<sup>st</sup>, 2021  
21:00z

- Mid-level flow pattern follows strengthening trough tracking eastward over the Great Lakes region.
- Incoming trough sets up moderately strong jet streak spanning from northern Ohio into southern Quebec.
- Mid-level flow over ALB at 21z from the south-west at 40kts, increasing in a westerly component into the night.

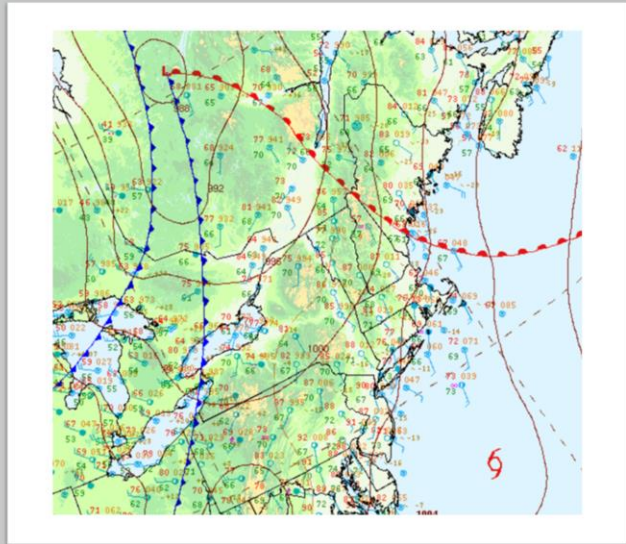


SPC Hourly Mesoscale Analysis Page, 500mb, 21z, Monday June 21<sup>st</sup>, 2021

## WPC Surface Plot

June 21<sup>st</sup>, 2021  
21:00z

- Surface Temperatures in the Mohawk and Hudson Valleys in the mid 80's
- Dewpoints ranged from mid 60's to low 70's in the Mohawk and Hudson Valleys.
- A morning warm front moved out from central New York heading into the upper Northeast. Behind the warm front, an approaching cold front provided a focus for convection.



WPC Surface Analysis 21z, Monday June 21<sup>st</sup>, 2021

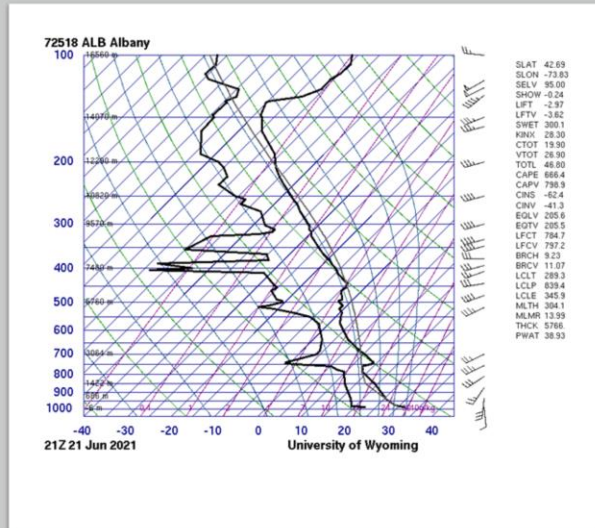
# ALB Sounding

Additional 21z Sounding\*

June 21<sup>st</sup>, 2021

21:00z

- Surplus of warmth and humidity at the surface shows a mixed layer from the surface to 800mb. Very steep lapse rates from 750mb to 600mb show a secondary mixed layer aloft (Elevated Mixed Layer). MLCAPE value is only 666 J/kg, however the implied SBCAPE is much higher.
- EML's prevents deep moist convection until higher instability is achieved. If instability is achieved, deep convection occurs in localized areas of enhanced divergence such as frontal boundaries and terrain features. These pockets of strong convection create strong isolated storms, that tend to be quite severe due to little competition for moisture and warmth (as opposed to widespread storms).

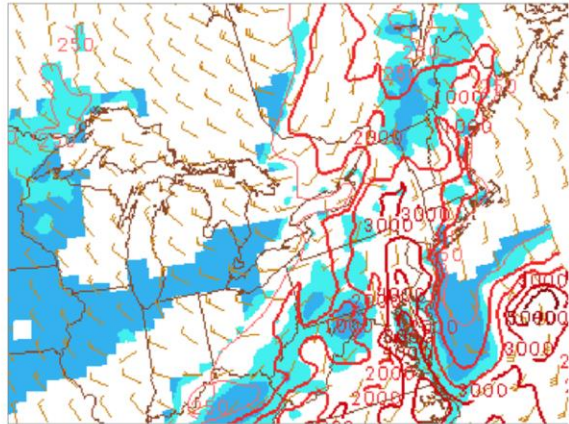


University of Wyoming Weather Web - 18z Sounding from NWS Albany 21z, Monday June 21<sup>st</sup>, 2021

## SBCAPE

- The storm prediction center's meso-analysis at 21z indicated significant instability, with SBCAPE values over eastern NY and western New England near 3000 J/kg.
- Southerly surface winds advect warm moist air from the south and warm surface temperatures before the passing of the cold front. Strong surface winds behind the cold front push cooler air into Western New York from the Great Lakes region..
- With 3000 J/kg of CAPE in ALB at 21z, any kind of forcing will be significant enough to break the environmental cap set by the EML (from 21z sounding).

21z SPC Meso-Analysis of SBCAPE

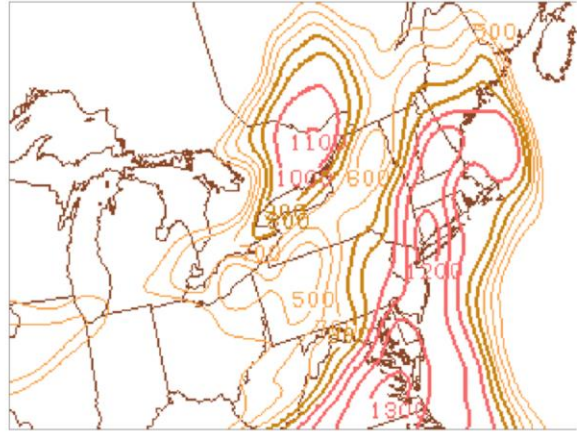


SPC Hourly Mesoscale Analysis Page, SBCAPE, 21z, Monday June 21<sup>st</sup>, 2021

## DCAPE

- The storm prediction center's meso-analysis at 21z had downdraft CAPE values northwest and southeast of the Adirondack Park region over 1000 J/kg, indicating plenty of potential for enhanced downdrafts and wet microbursts.
- Much lower DCAPE regions over Adirondack Park, western NY and central NY at approximately 500 – 600 J/kg

21z SPC Meso-Analysis of DCAPE



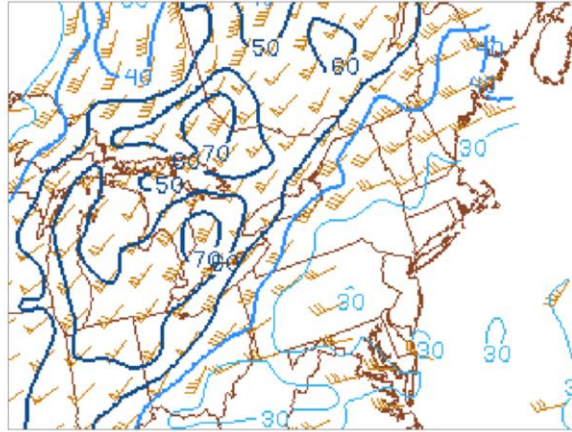
SPC Hourly Mesoscale Analysis Page, DCAPE, 21z, Monday June 21<sup>st</sup>, 2021



## 0-6km Shear Vector

- Strongest deep layer shear was located farther to the north, in access from the Great Lakes region, into northern NY and into northern New England.
- Shear values at 30-40Kts along with SBCAPE at 3000 J/kg places Central, NY in a LSHC environment.
- *LSHC*: Low Shear, High CAPE
  - Environment often associated with poorly detected severe weather.

21z SPC Meso-Analysis of 0-6km Shear Vector



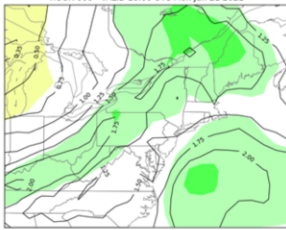
SPC Hourly Mesoscale Analysis Page, 0-6km Shear Vector, 21z, Monday June 21st, 2021



## Standardized Anomaly of PWAT and Q

Precipitable water was about 1-2 Standard deviations higher than normal across the north-east in late June. Specific Humidity was about 2-3 Standard deviations higher than normal across the north-east in late June.

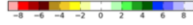
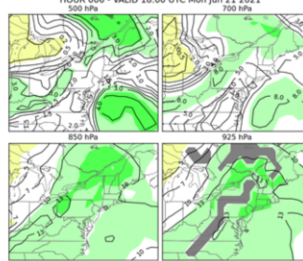
NAEFS Mean Precipitable Water (in) and Standardized Anomaly  
HOUR 006 - VALID 18:00 UTC Mon Jun 21 2021



Relative to the 11-Jun to 02-Jul 1979-2009 CFSR climatology



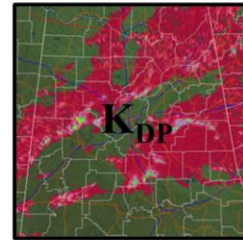
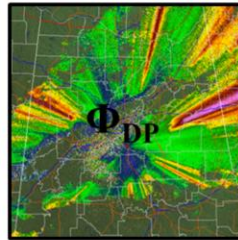
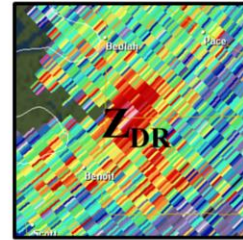
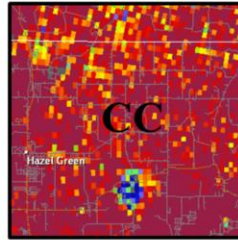
NAEFS Mean Specific Humidity (g/kg) and Standardized Anomaly  
HOUR 006 - VALID 18:00 UTC Mon Jun 21 2021



## Dual-Pol Radar Products and Derived Products

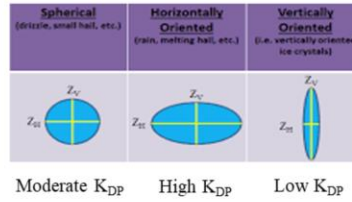
- Dual-Polarization Radar provides forecasters with three base products:
  - Correlation Coefficient (CC)
  - Differential Reflectivity ( $Z_{DR}$ )
  - **Differential Phase Shift ( $\Phi_{DP}$ )**
- There are also products derived from the base products of Dual-Pol and existing radar products:
  - **Specific Differential Phase ( $K_{DP}$ )**
  - Melting Layer (ML)
  - Hydrometeor (HC)
  - Etc.

*(Case Study will Focus on  $\Phi_{DP}$  and  $K_{DP}$ )*

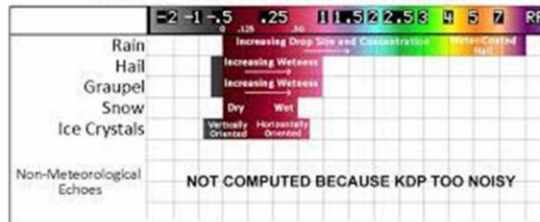


# K<sub>DP</sub> Applications

- Specific Differential Phase (K<sub>DP</sub>) is a derived product that shows the change in the differential phase shift ( $\Phi_{DP}$ ) on a scale of -2 to 10. High K<sub>DP</sub> values indicate greater phase shift in the horizontal than the vertical.
- Increasing K<sub>DP</sub> is an indication of an increase in the size and concentration of rain drops, and thus, an increase in rain rate. This means that K<sub>DP</sub> is useful for pinpointing areas where the heaviest rainfall is occurring.

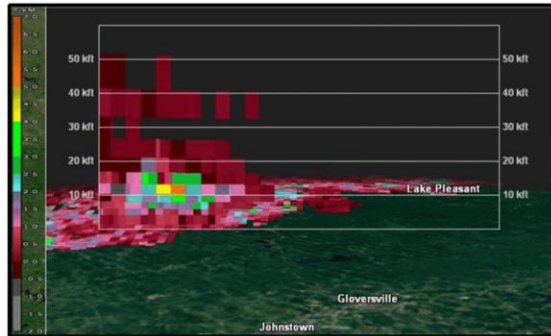


## Typical Values for KDP (deg/km)



## K<sub>DP</sub> Applications

- Research by Brian Frugis from NWS Albany has showed that building columns of K<sub>DP</sub> inside of thunderstorms can be of significant interest to forecasters. If K<sub>DP</sub> higher values remain elevated these columns of K<sub>DP</sub> can collapse to the surface.
- When these columns collapse within severe or ordinary thunderstorms, wet microbursts can be observed at the surface and cause severe thunderstorm wind damage.
- In this case study we will observe 4 areas that received significant wind damage reports. Then we will compare the aloft K<sub>DP</sub> values with respect to the given area using GR2 Analyst.



*Above images and K<sub>DP</sub> Application Information:  
The Use of Collapsing Specific Differential Phase Columns to Predict Significant  
Severe Thunderstorm Wind Damage across the Northeastern United States  
Brian J. Frugis  
NOAA/National Weather Service, Albany, NY*

## Summary of All Areas

4 Areas

19:25z - 23:28z

14 Severe Wind Reports (4 Areas)

70 Total Severe Wind Reports (All Areas)

### Timeline of event:

Significant instability and little forcing begins initial convection.

17z - 19z

Isolated Severe Thunderstorms across Central and Eastern NY.

19z - 1z\*

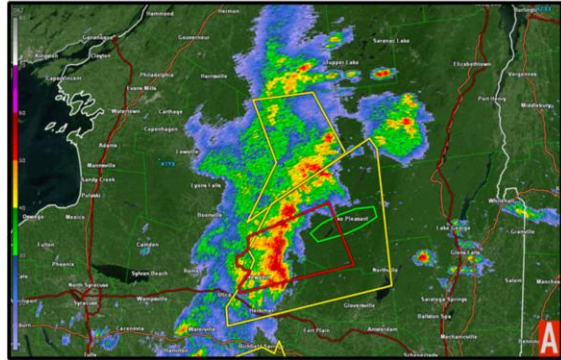
Cells become organized along cold front moving through Central/Eastern NY.

1z - 3z

Line of storms along cold front pushes into Western New England (moving out of AOI) while significantly weakening into the night.

3z - 4z

*Timeframe that all 4 AOI's occur\**



A: KENX Reflectivity 230Z, Tornado Warned Thunderstorm, Herkimer County, New York

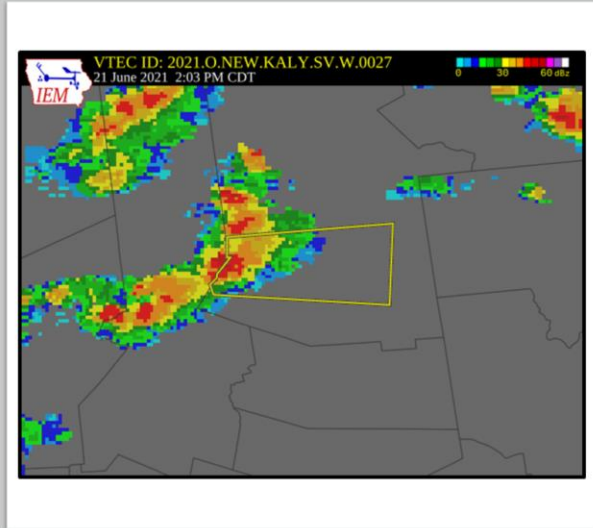
B: KENX Reflectivity 0055Z, Eastern New York

C: KENX Reflectivity 0255Z, Eastern New York and Western New England

# Severe Wind Damage Reports Area 1:

*Hamilton County, NY  
19:25z – 19:45z  
4 Severe Wind Reports*

Date, Time	Time After Warning	Location	Type	Description
06/21 19:25	22 minutes	2.1NE PISECO, Hamilton	TSTM WIND DMG	TREES DOWN NEAR ARIETTA TOWN COURT ALONG OLD PISECO ROAD.
06/21 19:35	32 minutes	5.5 SPECULAT CO, Hamilton	TSTM WIND DMG	TREES DOWN AT MOFFITT BEACH NEAR ROUTE 8.
06/21 19:38	35 minutes	2.8W PISECO, Hamilton	TSTM WIND DMG	NUMEROUS POWER POLES AND TREES DOWN ALONG COUNTY ROUTE 24 ON THE BACKSIDE OF PISECO LAKE.
06/21 19:45	42 minutes	2.8SW PISECO, Hamilton	TSTM WIND DMG	TREES AND WIRES DOWN ON SOUTH SHORE ROAD.



## Severe Wind Damage Reports Area 1:

*Hamilton County, NY*  
19:25z – 19:45z  
4 Severe Wind Reports

Warning Issued 19:03z

Isolated severe thunderstorm shows  
high K<sub>DP</sub> values at 20kft above the  
surface and begin collapsing. 19:11z

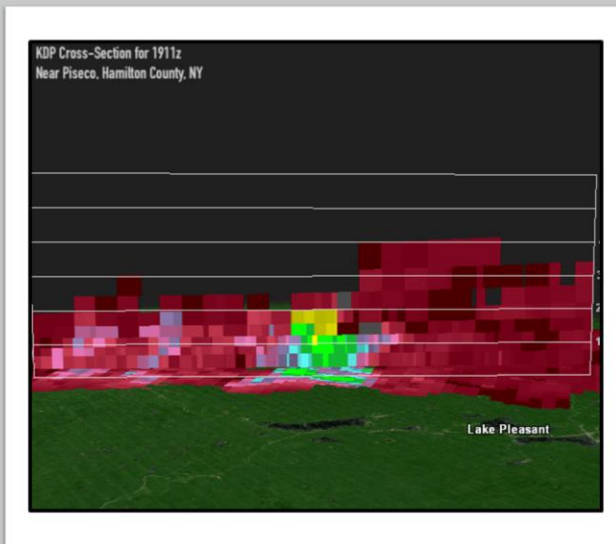
K<sub>DP</sub> values come crashing to the  
surface. 19:25z

Severe Wind Report 1 19:25z

Severe Wind Report 2 19:35z

Severe Wind Report 3 19:38z

Severe Wind Report 4 19:42z

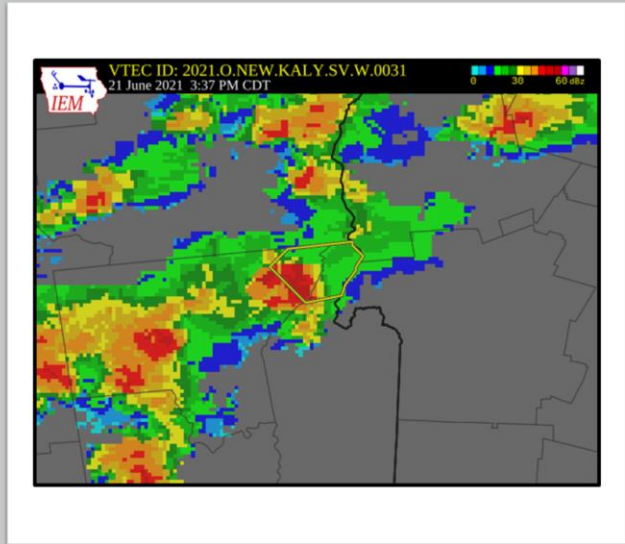




# Severe Wind Damage Reports Area 2:

Warren, NY; Washington, NY  
20:40z – 20:45z  
3 Severe Wind Reports

Date, Time	Time After Warning	Location	Type	Description
06/21 20:40	0 minutes	<a href="#">HAGUE</a> Warren	TSTM WIND DMG	TREES AND WIRES DOWN NEAR ROUTE 8 AND 9N.
06/21 20:45	8 minutes	<a href="#">SENEHAGUE</a> Washington	TSTM WIND DMG	TREE ACROSS ROADWAY ON COUNTY ROUTE 1.
06/21 20:45	8 minutes	<a href="#">SENEHAGUE</a> Washington	TSTM WIND DMG	TREE AND WIRES DOWN.



## Severe Wind Damage Reports Area 2:

Warren, NY, Washington, NY

20:40z – 20:45z

3 Severe Wind Reports

Warning Issued 20:37z

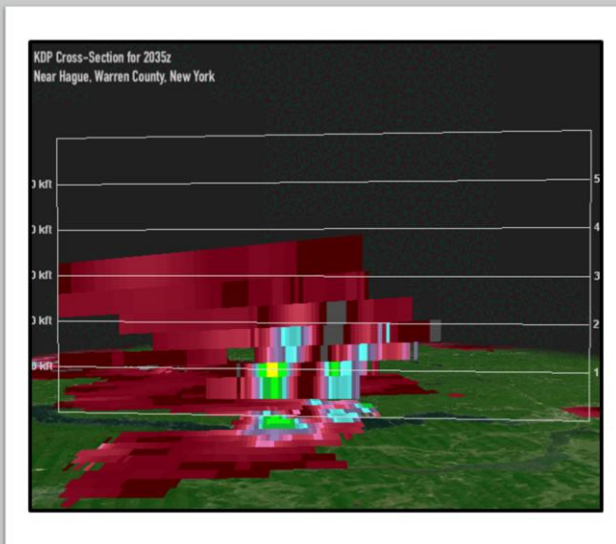
Isolated severe thunderstorm shows high K<sub>DP</sub> values at 10kft above the surface and collapsing. 20:35z

K<sub>DP</sub> values come crashing to the surface. 20:41z

Severe Wind Report 1 20:40z

Severe Wind Report 2 20:45z

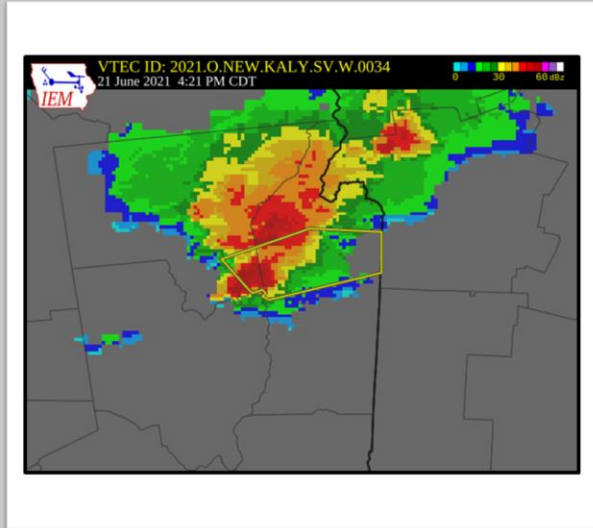
Severe Wind Report 3 20:45z



# Severe Wind Damage Reports Area 3:

*Granville NY, Washington, NY*  
 21:25z – 21:50z  
 4 Severe Wind Reports

06/21 21:21	Time After Warning	Location	Type	Description
06/21 21:25	4 minutes	2 ENE GLENS FALLS AIRPC Washington	TSTM WINDM G	TREE ON POWER LINES ON BARDIN RD IN KINGSBURY.
06/21 21:25	4 minutes	2 ENE GLENS FALLS AIRPC Washington	TSTM WINDM G	TREES AND WIRES DOWN IN KINGSBURY.
06/21 21:40	19 minutes	2 NW GRANVILLE Washington	TSTM WINDM G	TREES AND WIRES DOWN IN MIDDLE GRANVILLE.
06/21 21:50	29 minutes	4 N GRANVILLE Washington	TSTM WINDM G	TREE AND WIRES DOWN ON CROSS AND BUTLER ROAD INTERSECTION.



## Severe Wind Damage Reports Area 3:

*Granville NY, Washington, NY*  
21:25z – 21:50z  
4 Severe Wind Reports

Warning Issued 21:21z

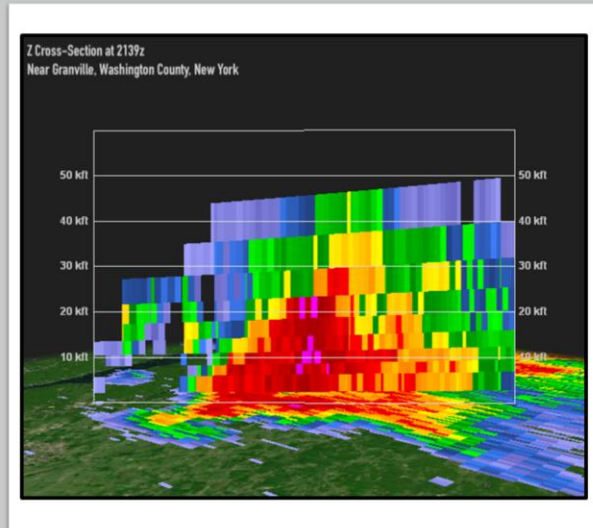
Supercell Thunderstorm shows no  
observable K<sub>DP</sub> collapse. 21:39z

Severe Wind Report 1 20:25z

Severe Wind Report 2 20:25z

Severe Wind Report 3 20:40z

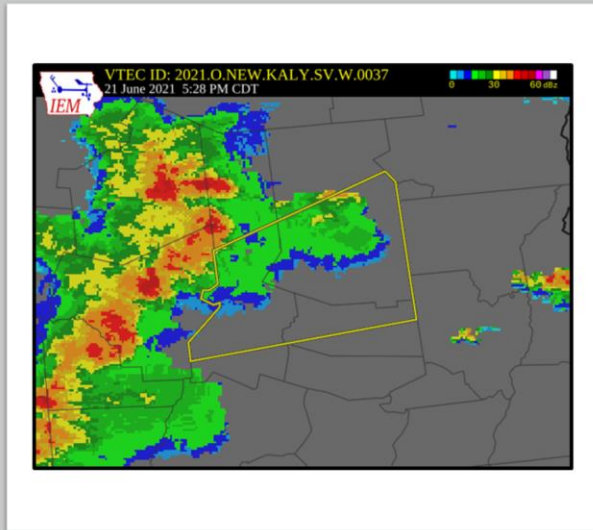
Severe Wind Report 4 20:50z



# Severe Wind Damage Reports Area 4:

*Herkimer, NY*  
23:04z – 23:28z  
3 Severe Wind Reports

06/21 23:30	Time After Warning	Location	Type	Description
06/21 23:04	36 minutes	<a href="#">SALISBURY,</a> HERKIME R,NY	TSTM WIND DMG	MULTIPLE TREES DOWN
06/21 23:07	39 minutes	<a href="#">LITTLE FALLS,</a> HERKIME R,NY	TSTM WIND DMG	TREES DOWN
06/21 23:28	50 minutes	<a href="#">ZENE PISCOCO,</a> HERKIME R,NY	TSTM WIND DMG	TREES DOWN NEAR ROUTE 8 IN LAKE PLEASANT TOWN CENTER.



## Severe Wind Damage Reports Area 4:

*Herkimer, NY*  
23:04z – 23:28z  
3 Severe Wind Reports

Warning Issued 22:28z

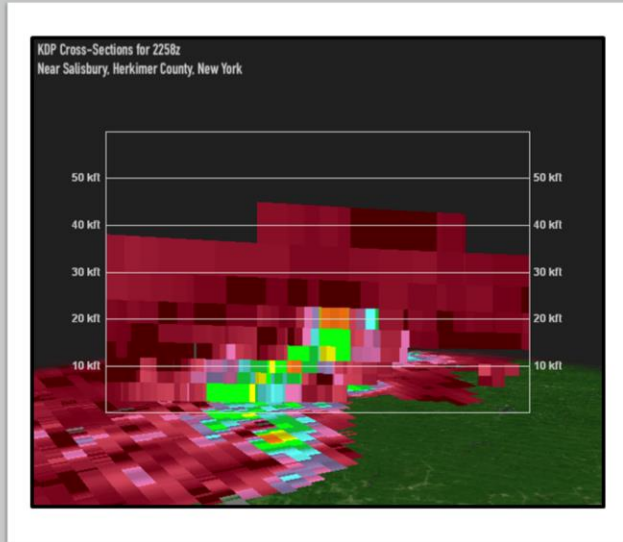
Isolated severe thunderstorm shows  
high K<sub>DP</sub> values over 20kft above  
the surface and collapsing. 22:58z

K<sub>DP</sub> values come crashing to the  
surface. 23:09z

Severe Wind Report 1 23:04z

Severe Wind Report 2 23:07z

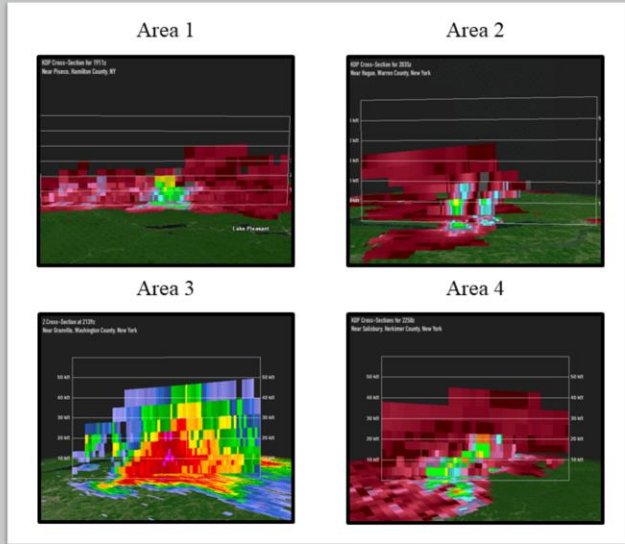
Severe Wind Report 3 23:28z



# Conclusion

After observing all 4 areas of damage:

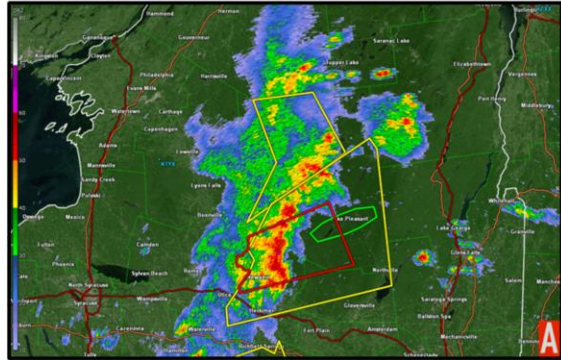
- Areas 1,2,4:  
Great examples of  $K_{DP}$  values in each thunderstorm collapsing and causing severe wind damage reported and verified by the public. These reports were all sent in within 20 minutes of their respected collapsing  $K_{DP}$  column. This is likely due to user differences in timing when reporting.  
(Some users may report during event or 10mins after)
- Areas 3:  
Good example of severe wind damage from a mature supercell thunderstorm, however when observed, there was no falling  $K_{DP}$  values, rather the values aloft were low and remained aloft for the duration of the supercell.





## Summary

- A High CAPE / Low to Moderate Shear severe weather event impacted Central and Eastern NY on June 21<sup>st</sup>, 2021.
- Radar analysis such as GR2 Analyst gave signals for localized severe thunderstorm wind events.
- Professional forecasters can look for building columns of  $K_{DP}$  within thunderstorms. If values remain elevated and reach critical levels near the top of the mixed layer, a warning decision forecaster can anticipate an increased amount of damage when the column collapses to the surface.



*For additional information see:*

*The Use of Collapsing Specific Differential Phase Columns to Predict Significant Severe Thunderstorm Wind Damage across the Northeastern United States  
Brian J. Frugis NOAA/National Weather Service, Albany, NY*