

The Unprecedented Severe Hail Event of 30 December 2019

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WFO Albany Fall Station Meeting

This is a presentation about a severe thunderstorm that occurred within a multi-hazard winter event on December 30, 2019.

Background Information

- Our area experienced a high impact multi-hazard winter storm on 29-30 December 2019.
- Significant accretion of freezing rain occurred across the higher terrain areas of the region with up to 0.75" in NW CT.
- In addition to the ice, up to 3 inches of snow/sleet fell in some high terrain areas. Valley areas saw sleet/rain, with total liquid equivalent over an inch in some areas.
- Gusty winds impacted the high terrain of the Taconics with gusts up to 50 mph.
- Tidal flooding occurred on the Hudson River near Poughkeepsie.
- A **severe thunderstorm** occurred across NW CT with a report of hail measuring 1.00 in diameter on the afternoon of 30 December

A multi-hazard storms impacted the region at the end of December in 2019. While the main aspect of the storm was a significant ice storm across the high terrain, it also produced gusty winds, heavy rainfall, sleet, snow and tidal flooding. In addition, a severe thunderstorm moved across Northwest Connecticut which produced large hail.

Severe Hail in the Cool Season?

- Severe t-storm winds thanks to low-topped convection occur on occasion during the cool season
 - Events such as 25 February 2017 & 24-25 February 2016 are recent examples of events like this
- However, the severe thunderstorm from 30 December produced severe **hail** not wind
- This raises the question...

How Often Does Severe Hail occur outside the warm season?

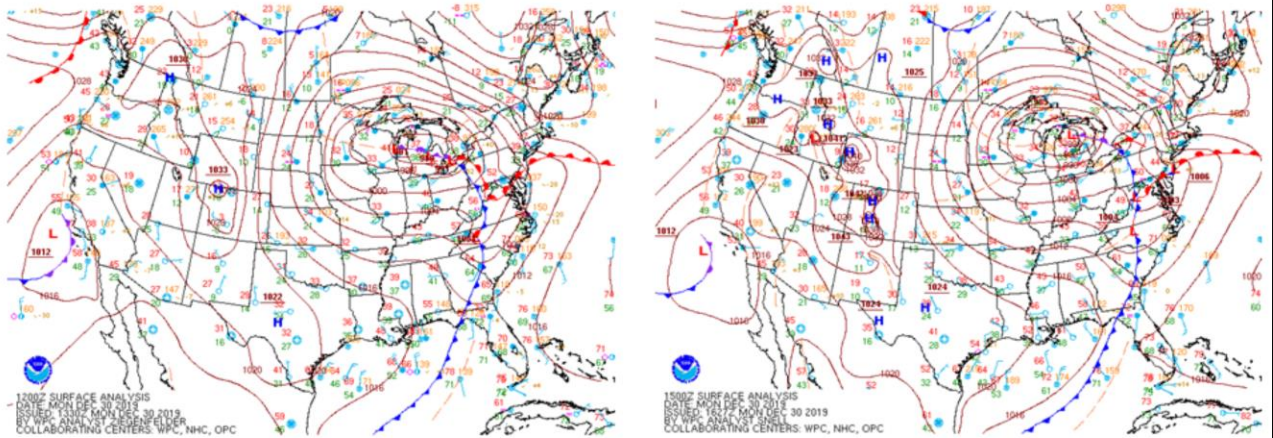
With the occurrence of large hail during this storm, it raised the question of how often has severe hail happened during the cool season? Usually, severe thunderstorms within the cool season produce damaging winds and hail seemed to be unusual for this storm.

The Answer: Very, very infrequently...

- Hail Events from November 1st through March 31st (via NCEI/StormData)
 - November 1, 1959: 1.75" hail in Albany County (largest hail report in cool season on record for ALY CWA)
 - November 4, 1997: 0.75" hail in Pleasant Valley (Dutchess County)
 - January 9, 1998: 0.88" hail in Little Falls (Herkimer County)
 - November 6, 2005: 4 reports of 0.75" hail from Cold Brook (Herkimer County), Cobleskill (Schoharie County), Richmondville (Schoharie County) and Fultonville (Montgomery County)
 - February 17, 2006: 0.75" hail in Buskirk (Rensselaer County)
 - **December 30, 2019: 1.00" hail in both Norfolk & Colebrook (Litchfield County)**
 - March 29, 2020: 1.00" hail in Savoy (Berkshire County)
- The 30 December Event was only the 2nd severe hail on record since 1950 in the ALY CWA. (late March 2020 became the 3rd, but was probably more warm season in type)
- No hail 0.75" or greater has occurred since 1950 in NW CT until this event

When data was examined from NCEI (StormData), it turned out that large hail almost never occurs from November to March across eastern New York and western New England. There has been only a handful of times hail penny size (0.75") or larger has occurred and only a few of them had been severe (1.00" or greater). The hail event that occurred on December 30, 2019 was the largest hail event during the cool season since 1959 across eastern New York and western New England.

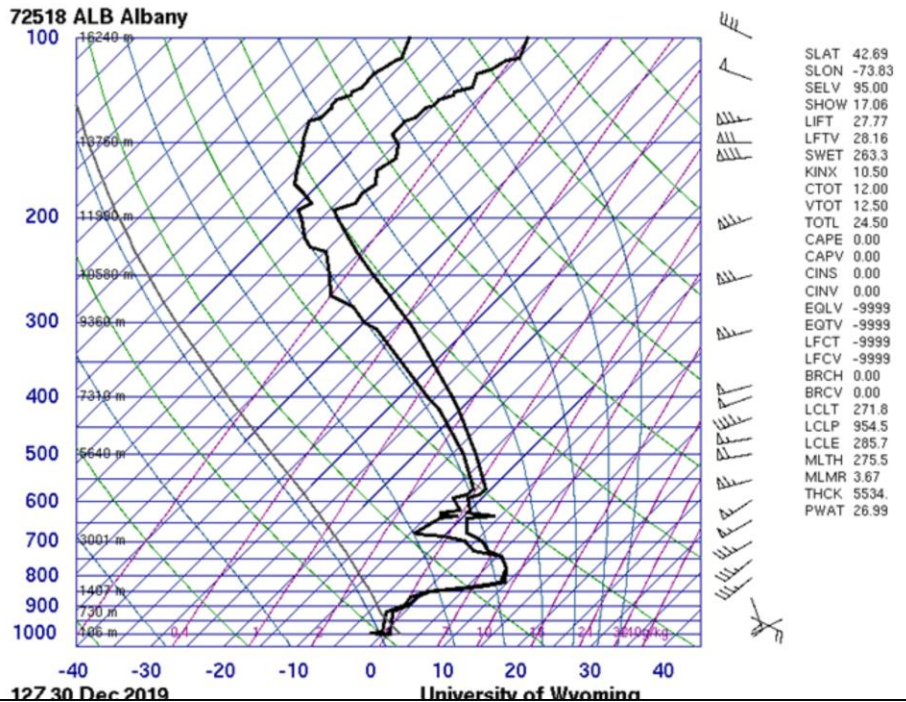
30 December 2019 - Morning Surface Maps



The surface maps during the morning hours on December 30, 2019 showed a mature cyclone situated across the Great Lakes, which was slowly moving eastward. An occluded front extended out from this storm across the upper Ohio River Valley, with a cold front extending southward across the mid-Atlantic and Southeastern States. Meanwhile, strong surface high pressure over Quebec allowed for cold air at low levels to remain in place across Upstate New York and New England.

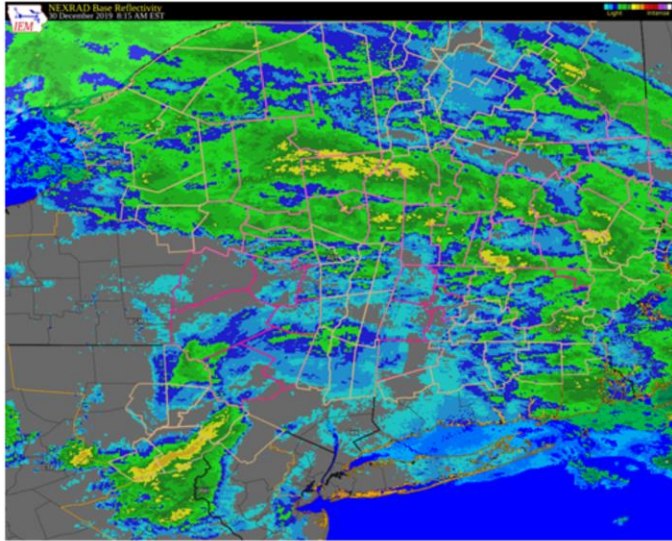
12z KALY Sounding

- Very stable below 800 hpa
- Light below beneath inversion, but strong winds aloft
- Moist profile throughout sounding
- Typical sounding for a winter event, with a freezing rain/rain p-type expected
- Not exactly screaming severe thunderstorms will occur today...



The 12z morning sounding at KALY showed a thermodynamic setup typical for a mixed precip storm across eastern NY. A strong inversion and warm nose was located at 800 hpa, with plenty of cold air at low levels thanks to a light e-ne flow at low levels. The profile was moist throughout the column and lapse rates were rather low. Strong westerly flow was in place aloft. This sounding would not suggest the area would be expecting severe thunderstorms later in the day.

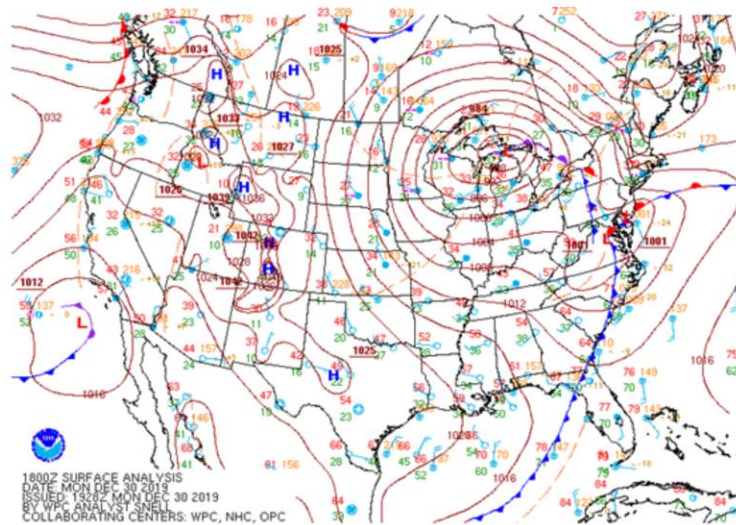
Morning Radar Shows a Typical Winter Event...



...but the end of the loop is starting to be interesting

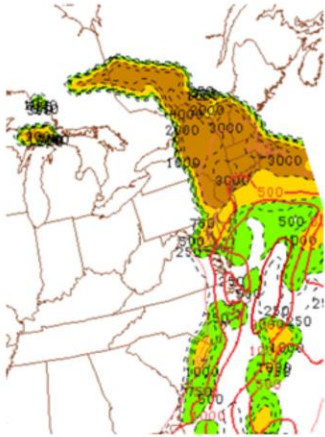
The regional radar loop shows bands of light to moderate precipitation through much of the morning hours. Towards midday, there was a break across southern areas and some areas of precipitation with embedded convective elements can be seen forming across the Poconos and heading northeast towards the Catskills and Mid Hudson Valley.

18z Surface Map



By the early afternoon, the surface map continues to show the mature, stacked cyclone located over the Upper Great Lakes. Meanwhile, a secondary area of low pressure has developed along the storm's triple point and is starting to take over near the mid-Atlantic coastline. A front extended eastward from this low, which separated milder, marine air from the chilly air that has remaining place thanks to the blocking high to the north.

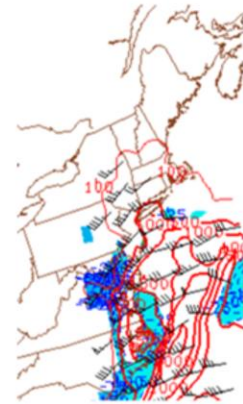
Mesoanalysis starting to show some interesting things by afternoon...



20z MUCAPE & lifted parcel level (SPC)

Lapse Rate °C/km													
300	4.5	4.4	5.7	6.6	6.9	7.1	7.3	7.2	7.4	7.3	7.4	7.3	6.5
350	4.3	4.1	5.5	6.7	7.0	7.3	7.5	7.4	7.7	7.6	7.9	8.1	
400	3.7	3.5	5.1	6.4	6.7	7.1	7.3	7.1	7.5	7.3	7.6		
450	3.2	2.9	4.7	6.2	6.6	6.9	7.2	7.0	7.5	7.0			
500	2.6	2.2	4.3	6.0	6.5	6.9	7.3	6.9	8.0				
550	1.7	1.1	3.5	5.5	6.0	6.5	6.9	5.8					
600	0.9	0.2	2.9	5.4	6.1	6.9	6.2						
650	-0.5	-1.7	1.4	4.4	4.9	5.5							
700	-1.9	-3.8	-0.1	3.8	4.3								
750	-3.7	-6.7	-2.5	3.3									
800	-6.3	-12.2	-6.6										
850	-8.0	-15.9											
900	6.4												
	950	900	850	800	750	700	650	600	550	500	450	400	350

20z Lapse Rates for Canaan, CT (BUFKIT)

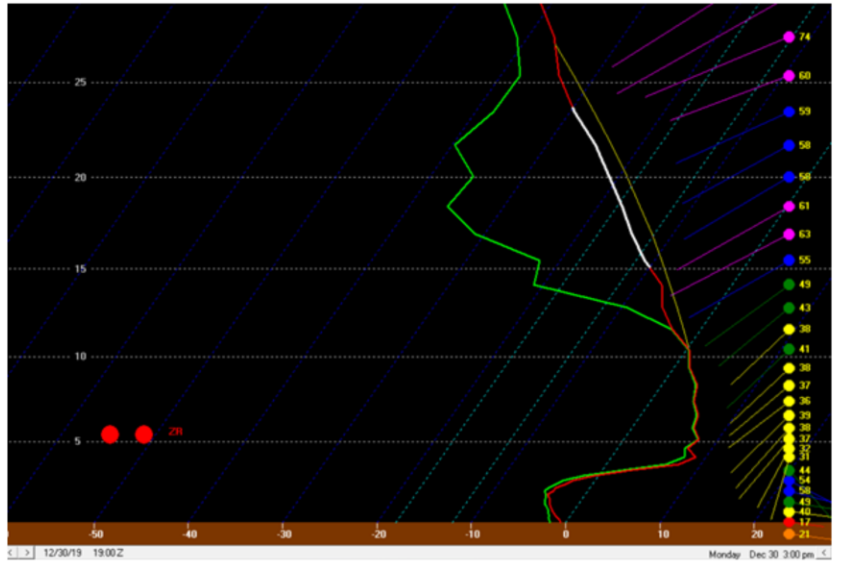


20z MUCAPE & Effective Bulk Shear (SPC)

The 20z SPC Mesoanalysis site is starting to show some interesting values across eastern New York and western New England. MUCAPE values range from 100-500 J/kg across the area, with highest values to the south. Effective bulk shear is also around 30 kts for southern areas as well. BUFKIT is showing mid-level lapse rates had increased to 6-7 deg C/km across northwestern CT.

20z NAM BUFKIT Sounding Canaan, CT

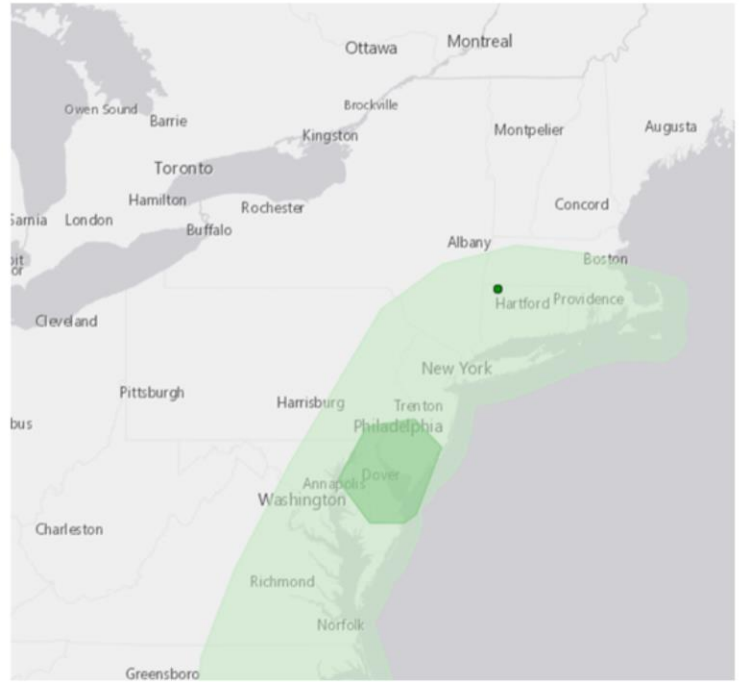
- Strong low-level inversion still in place with sub-freezing temps at the surface
- However, very steep mid level lapse rates above 10,000 feet
- BUFKIT sounding shows an elevated area of CAPE aloft (just a few hundred J/kg), but located within the hail growth zone (highlighted in white)
- Dry air aloft within hail growth region
- Last 0°C level around 10,000 ft
- -20°C level about 19,000 ft



The 20z NAM BUFKIT sounding for Canaan, CT continues to show cold air in place at low-levels beneath a strong inversion around 5000 ft. However, there is now considerable cooling and drying aloft compared to the morning 12z KALY sounding. BUFKIT shows an elevated area of CAPE aloft, which is located within the hail growth zone.

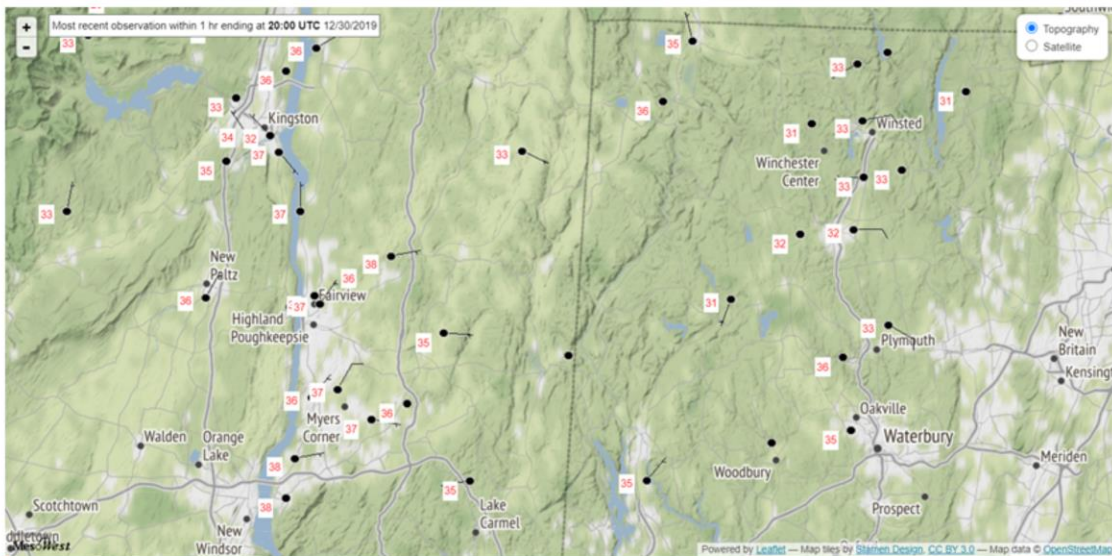
1630Z Day 1 SPC Convective Outlook

General thunder extended across southeastern parts of the CWA. There was a small marginal area over southern NJ/Delaware/Maryland.



SPC was showing the threat for general thunder across the southern half of the area. There was a marginal risk for severe storms, but this was located further south towards south Jersey and Delaware.

Surface Temps: 20z



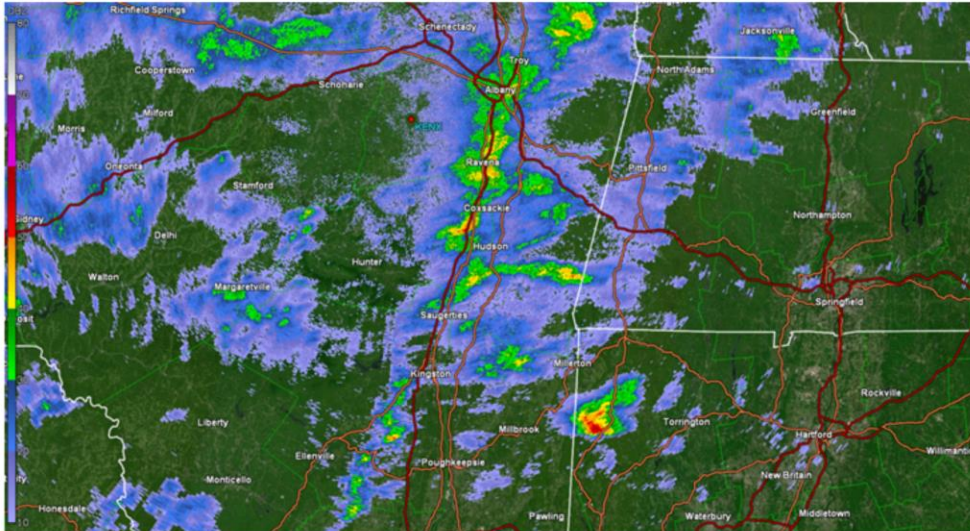
At 20z, surface temperatures continued to be only in the low to mid 30s across Dutchess and Litchfield Counties. Many spots within the high terrain were still below freezing.

Convection Over Catskills & Additional Development in mid Hudson Valley



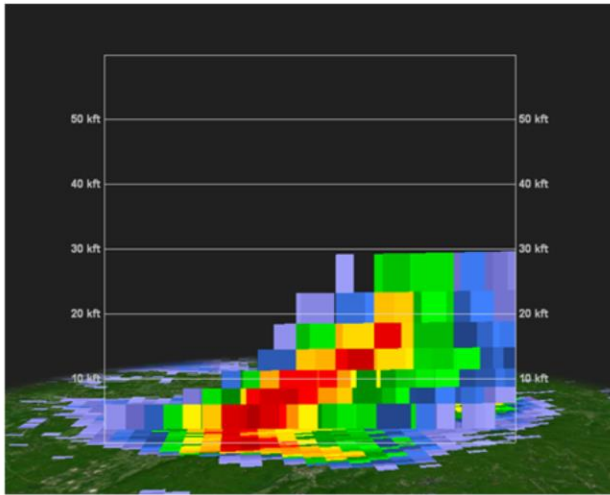
During the early afternoon hours, the area of convection that moved into the Catskills is heading northeastward for the mid-Hudson Valley and Taconics. This activity weakened, but did produce lightning and impressive cloud tops on satellite imagery (not shown). Another batch of convection began to form across southern Dutchess County, which was rapidly strengthening as it lifted towards western Connecticut.

Thunderstorm Continues to Intensify and Grow as it Crosses Northwestern CT KENX Reflectivity (Z) 30 Dec 2019 19:45Z to 20:50Z

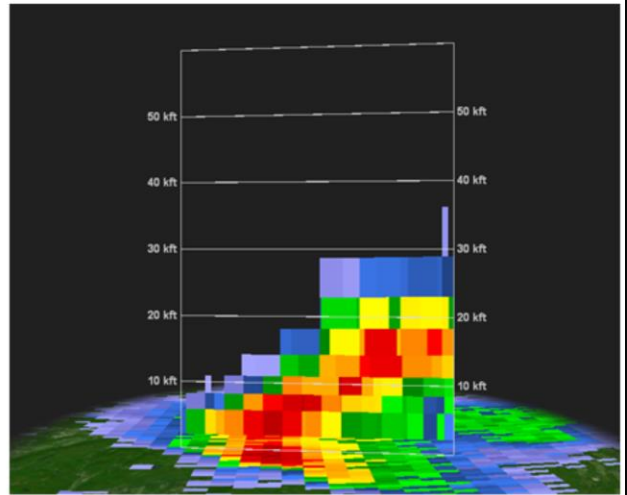


During the mid-afternoon hours, the convection that moved into Northwestern Connecticut continued to strengthen, which eventually headed towards central Massachusetts. This storm maintained its strength and structure, despite the cold air in place at low levels, and took on a supercell-like appearance on radar imagery. After receiving reports of severe hail in our area, NWS Boston issued a severe thunderstorm warning for the Springfield area. Amazingly, this warning was only for hail and not wind, which is very unusual for the cool season.

KENX Reflectivity (Z) Vertical Cross-sections over NW Connecticut



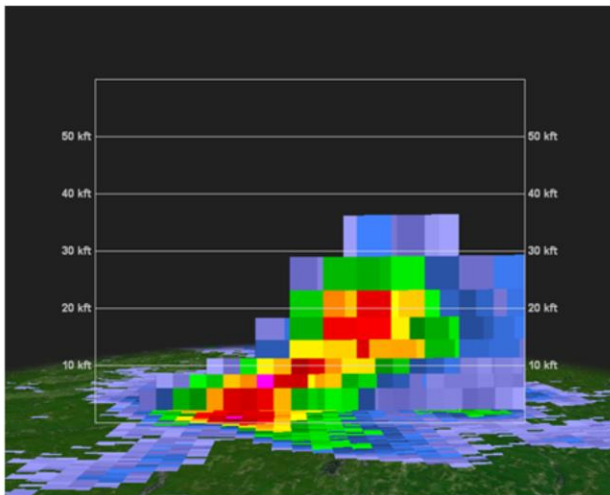
30 Dec 2019 1939Z



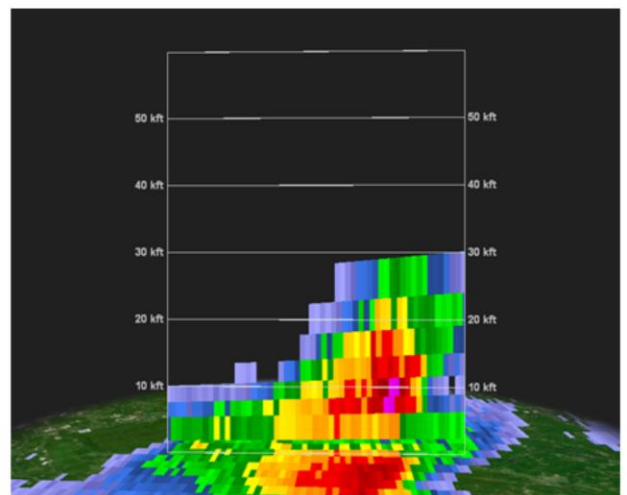
30 Dec 2019 1945Z

Vertical cross-sections from KENX show 50 dBZ reaching close to 20,000 by 2:45 PM. The storm had a tilted structure, with max DBZ values near 60 dBZ within the core of the storm.

KENX Reflectivity (Z) Vertical Cross-sections over NW Connecticut



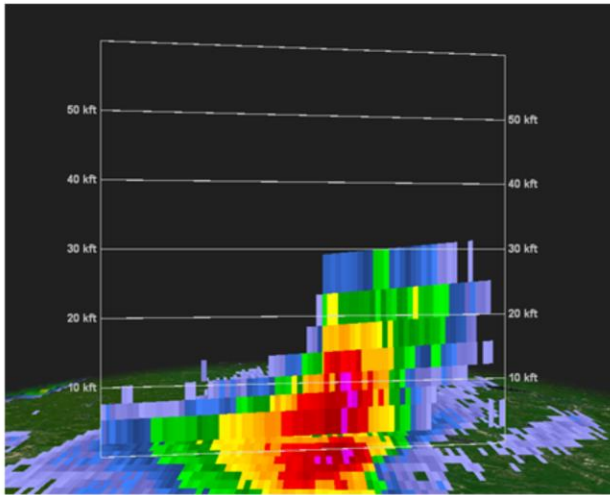
30 Dec 2019 1951Z



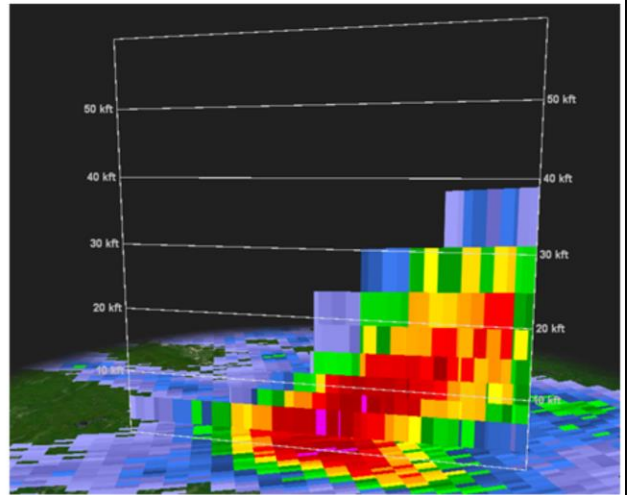
30 Dec 2019 1957Z

By 3 PM, 50 dBZ values have increased in height, reaching about 20,000 ft. This is above the -20 C by several thousand feet. Meanwhile, 65+ dBZ values can be seen suspended around the freezing level, showing the possibility of some hail aloft. The radar structure suggests a storm typical of the warm season (not late December).

KENX Reflectivity (Z) Vertical Cross-sections over NW Connecticut



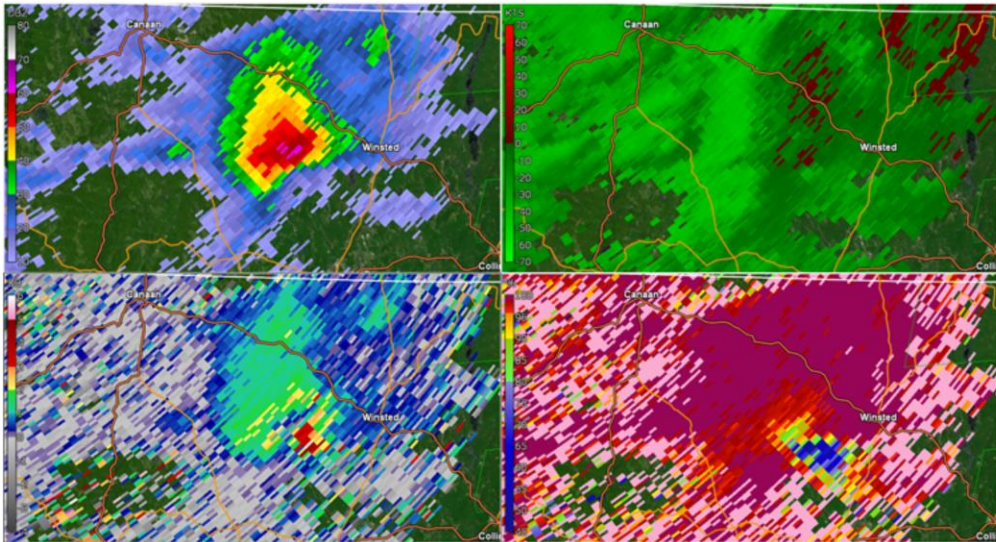
30 Dec 2019 2003Z



30 Dec 2019 2009Z

Shortly after 3 pm, KENX vertical cross-sections continue to show high reflectivity values aloft, which are starting to shift down towards the surface. This is the time when hail was occurring in Northwest CT.

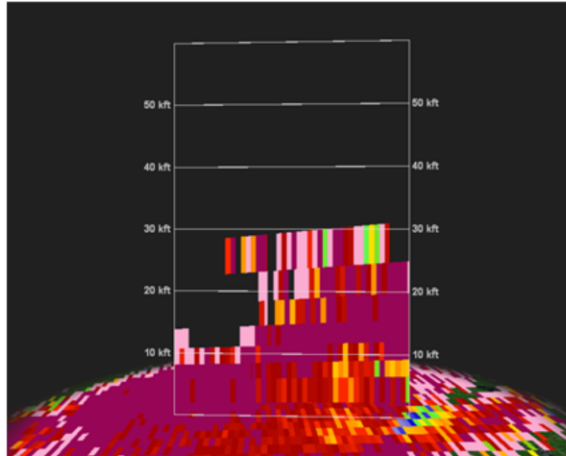
KENX 4-panel 0.5° 20:03z



Top left: Reflectivity (Z), Bottom left: Differential Reflectivity (ZDR), Top right: Velocity (V), Bottom Right: Correlation Coefficient (CC)

KENX radar imagery was examined at 2003z, which is when severe hail was falling across northwestern Connecticut. The 0.5 degree reflectivity, velocity, differential reflectivity and correlation coefficient is displayed. Although there is some attenuation, there is also signs of a hail spike, indicative of falling hailstones aloft.

KENX Correlation Coefficient (CC) Vertical Cross-Section 30 Dec 2019 20:09 Z



A vertical cross-section of KENX Correlation Coefficient across northwestern CT showed values around 0.90 aloft. This depicts mixed hydrometeors, which are probably a mix of rain and hail. Some sleet could also be occurring, but hail is the more likely candidate based on the reflectivity structure seen earlier.

Hail Fell at 20:09Z in Norfolk



Sally Charlton
@easter_sweaters

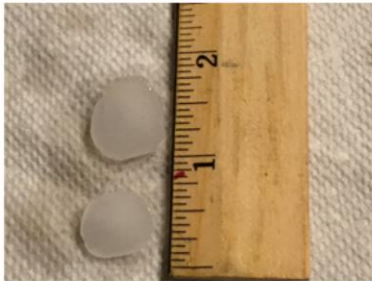
Hail that just fell in Norfolk, CT! [@ryanhanrahan](#)
[@WeatherJosh](#) [@NBCCConnecticut](#)



**Photo from Sally Charlton on
Twitter**

A member of the public showed hailstones had fallen in Norfolk, CT on Twitter around 309 pm.

Hail Fell at 20:10Z in Colebrook



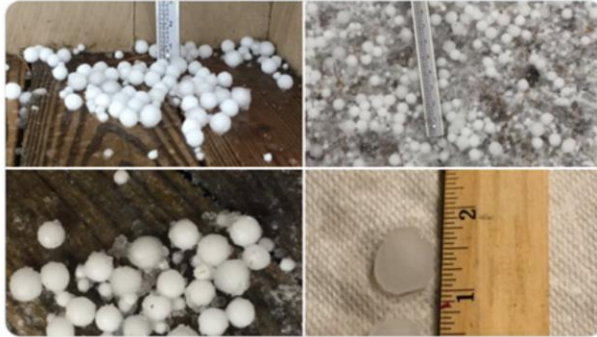
**Photos from Norfolk, CT COOP
Observer & Connecticut Weather
Historian Russell Russ**

More reports of hail from well-known Norfolk, CT COOP observer Russell Russ. These were also shared via Twitter.



Russell Russ
@RussellRuss7

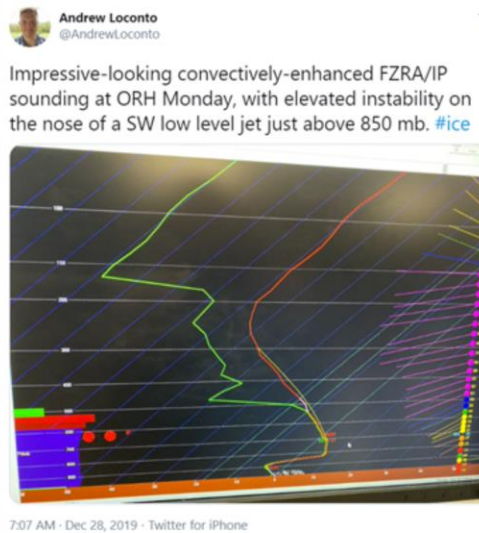
Several loud rumbles, one very close, in Colebrook, CT.
3:00-3:15 pm. Followed by very large hail. I think it's
hail...#thundersnow @NWSAlbany



<https://twitter.com/RussellRuss7/status/1211754690746241024>

Russell Russ (Norfolk, CT) also showed video footage of the falling hailstones on Twitter, which was accompanied by thunder, snow and sleet.

While some did suspect some thunder was possible...



... No one was really anticipating severe hail!

A few days prior to this event, NWS Boston forecaster Andrew Loconto did discuss the potential for elevated convection and thunder on Twitter. However, no one was anticipating this degree of severe weather.

Lessons Learned from This Event

- In most cases, small pieces of graupel (super-cooled water coated snowflakes) are the embryo for hail.
 - In this particular event, it appears that small sleet pellets could have been the initial hail embryo
- Severe Thunderstorms are possible all year round!
 - A stable layer near the surface doesn't always mean no severe weather will occur!
- Always stay on top of mesoanalysis
 - The SPC mesoanalysis page is a great resource, even in the cool season
- Strong winter storms can do weird things
 - Always be prepared for the unexpected!
 - Steve D. always reminds us of the potential for these multi-hazard events

Some wondered if these were true hailstones. Based on the radar imagery shown, it is most likely true hail. However, it is theorized that the embryos for these hailstones started as sleet pellets, instead of graupel. This goes to show that severe t-storms are possible all year round. The SPC mesoanalysis webpage is very helpful, even in the the cool season. Strong winter storms have been known to be true multi-hazard events and we need to be prepared for all different types of hazards within these events.

Thanks for listening!
Any questions?

This is the end. Please email brian.frugis@noaa.gov with any questions or comments. Thank you!