NATIONAL WEATHER SERVICE

An Unusual Mid-Winter HSLC Event Across Northern Ohio on January 19, 2023

May 25, 2023

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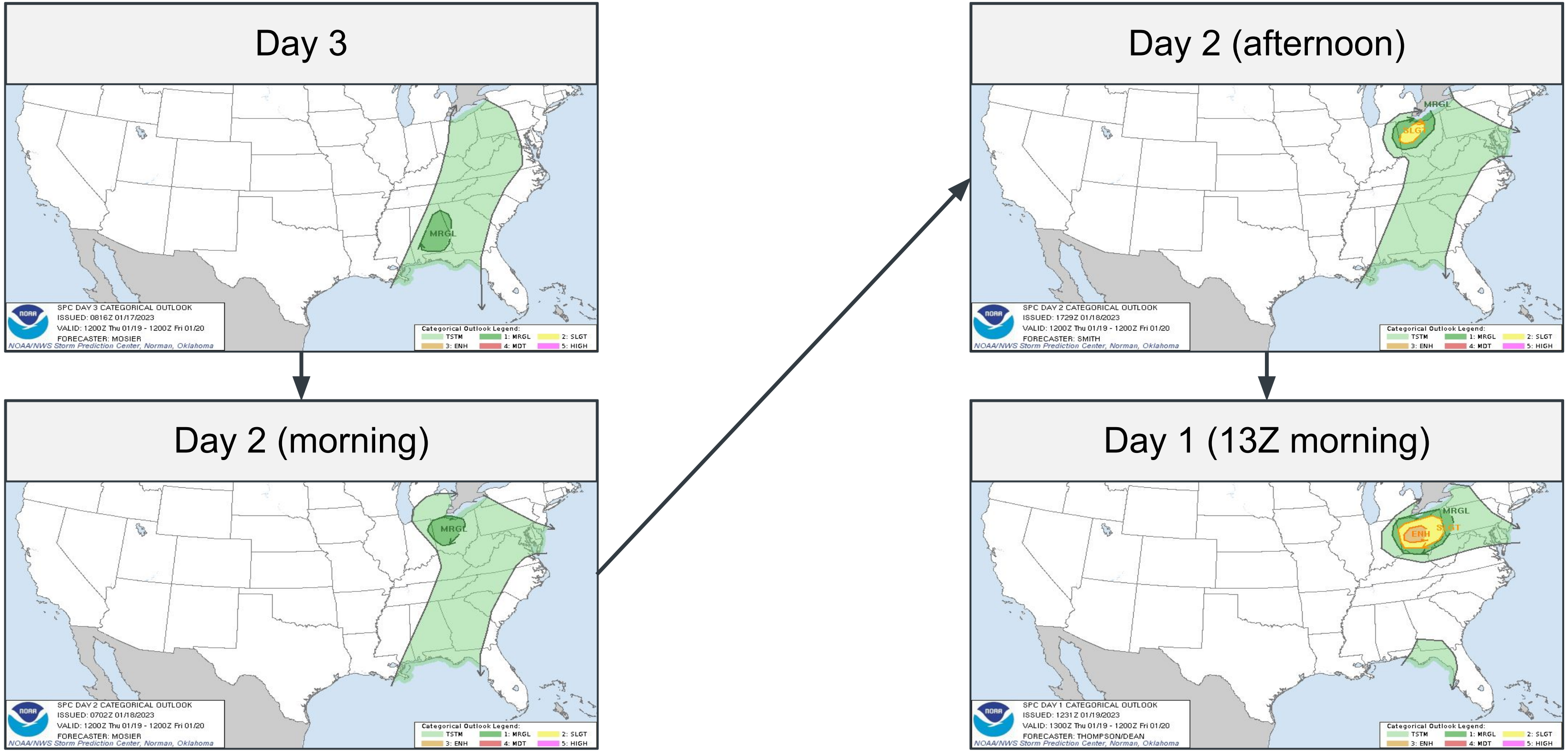
Outline

- Overview of the event.
- Forecast progression.
- Mesoscale environment (incl sounding comparisons).
- Satellite & radar imagery from the event.
- Introduction to “Pseudo” WES-in-the-cloud (NESDIS geoCloud instance in conjunction with the TOWR-S team)

Quick Facts

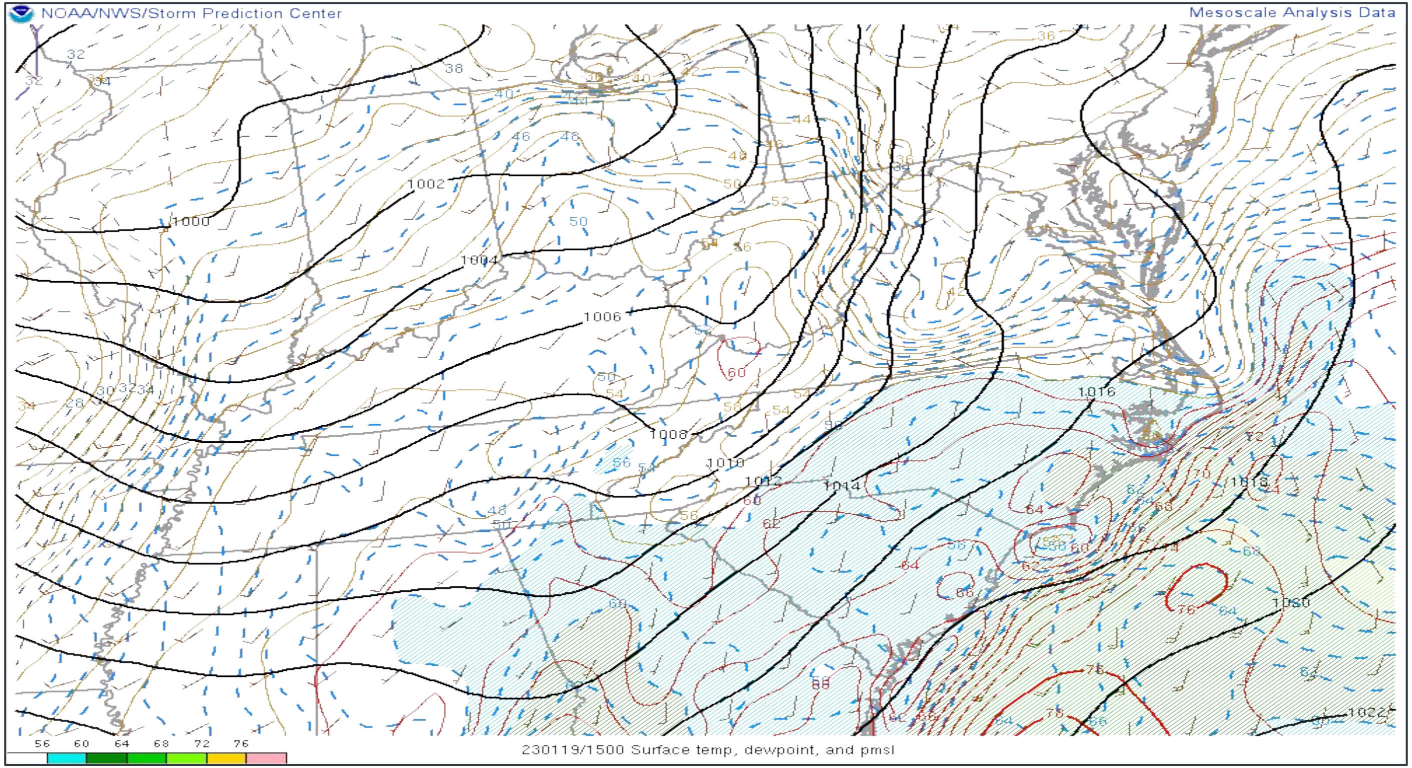
- A high shear, low CAPE environment developed across the OH Valley and Lower Great Lakes region on January 19, 2023.
- The environment was most favorable for damaging wind gusts, with limited tornado potential.
- A combination of thunderstorm and non-thunderstorm wind gusts occurred across Ohio.
  - A few occurrences of hail were also found upstream across portions of central Indiana.
- The event was moderately-well forecast, with an SPC slight risk on day 2, followed by an upgrade to an enhanced risk on day 1 (13Z update).
  - There were a lack of thunderstorm reports across the southern half of the enhanced risk area
- WFO ILN launched a special 19Z sounding on January 19, 2023.
- Relatively clear skies allowed for favorable NUCAPS retrievals across the region.

The Forecast



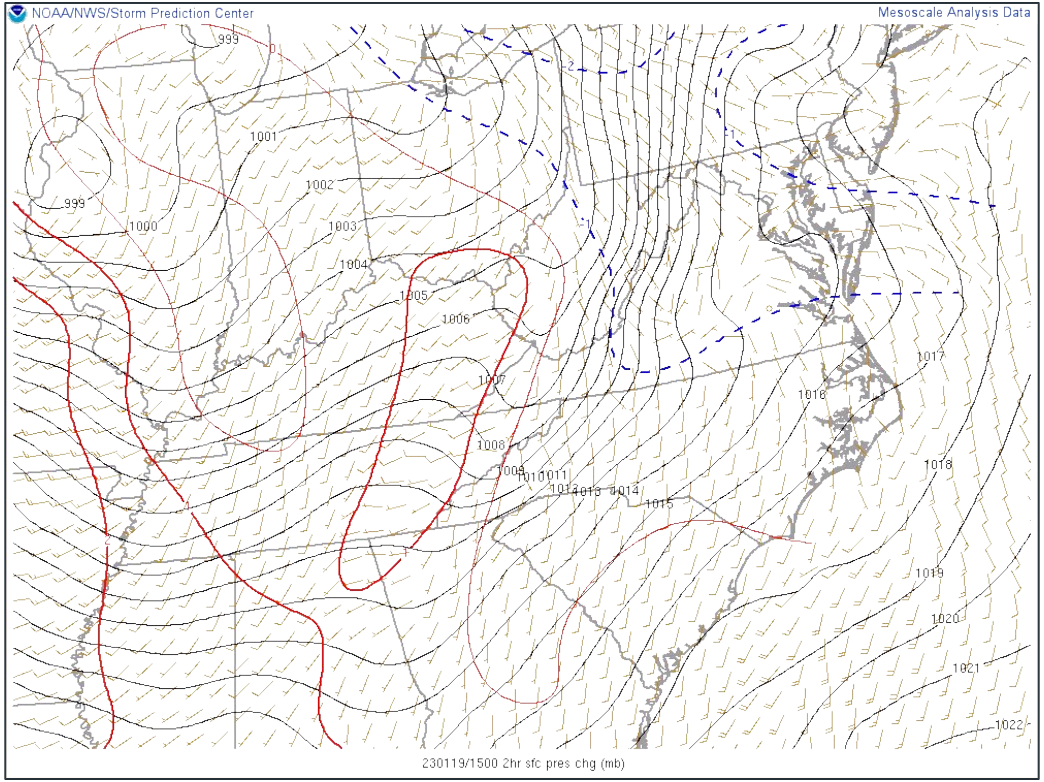
SPC forecasts, days 1, 2, and 3 for the overall severe weather risk.

SPC Mesoanalysis (15Z-00Z)



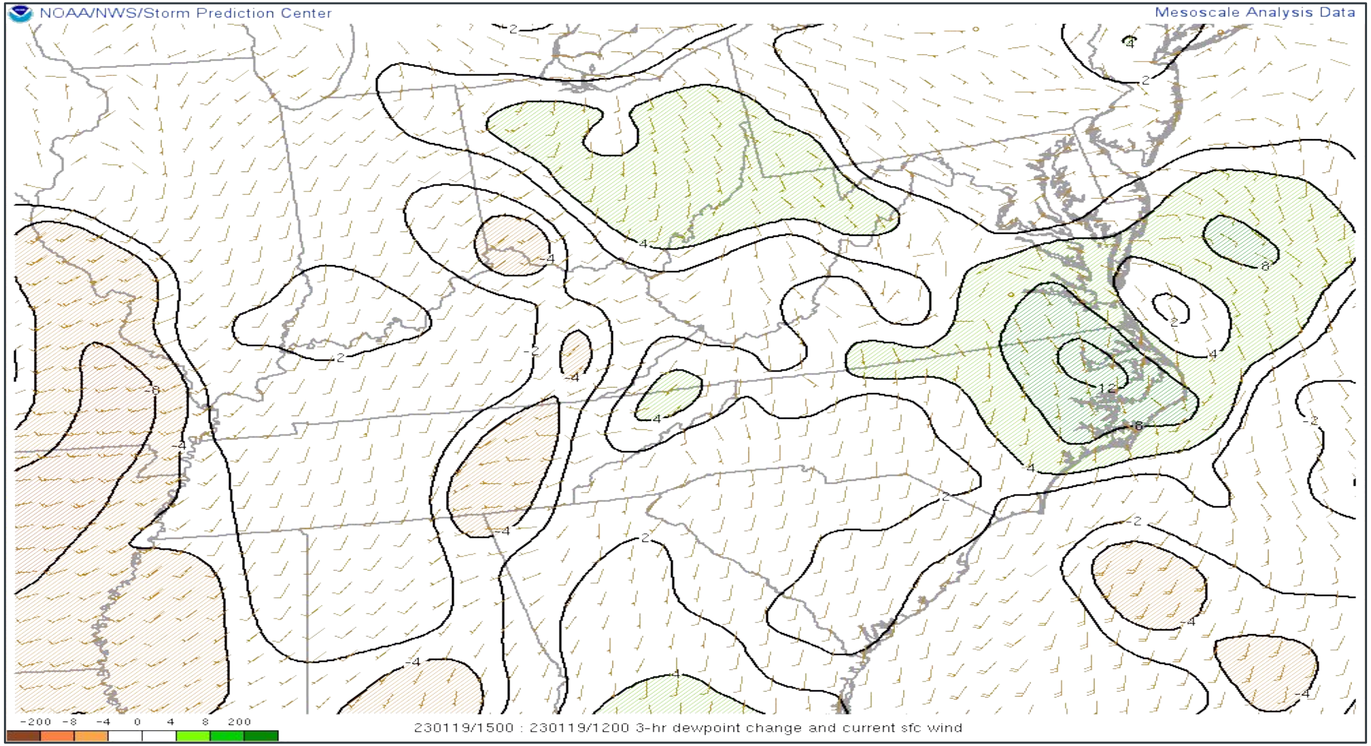
Surface temperature, dewpoint, and pressure.

SPC Mesoanalysis (15Z-00Z)



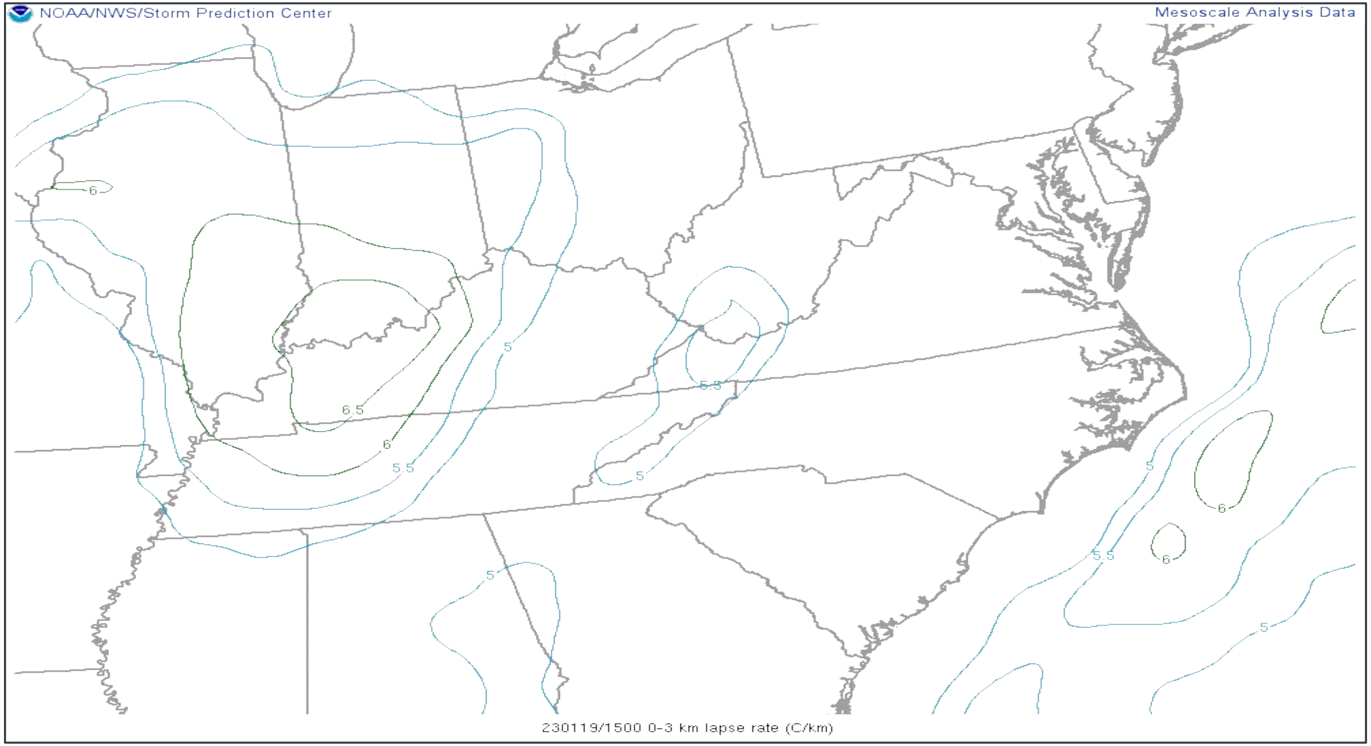
2-hour pressure changes (rises in red & falls in blue).

SPC Mesoanalysis (15Z-00Z)



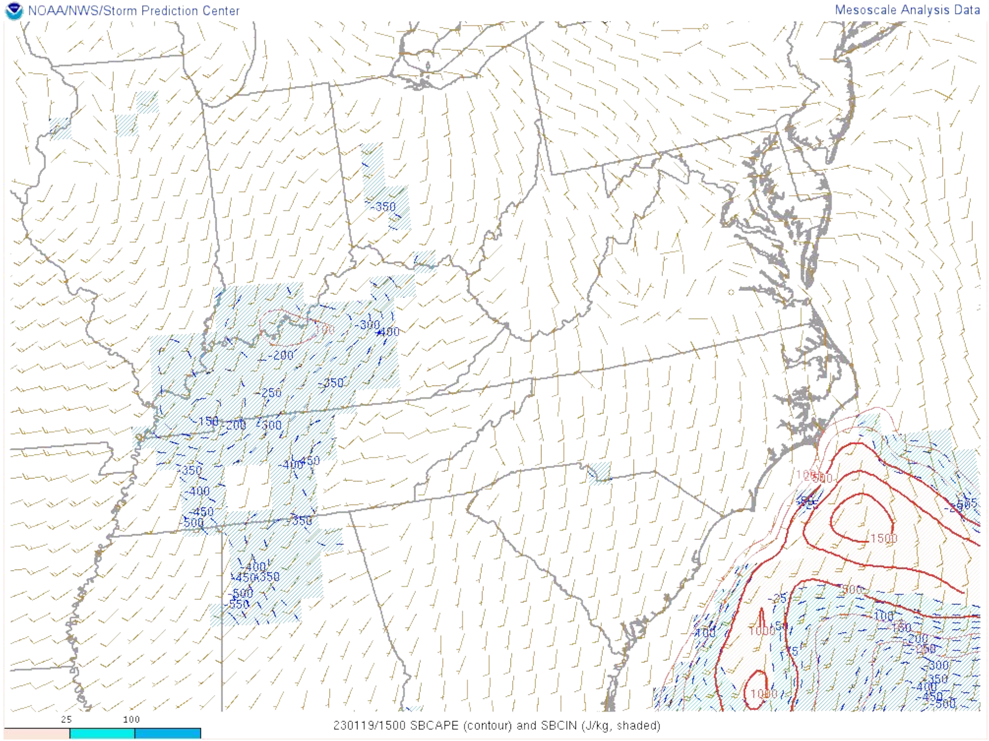
3-hour dewpoint changes.

SPC Mesoanalysis (15Z-00Z)



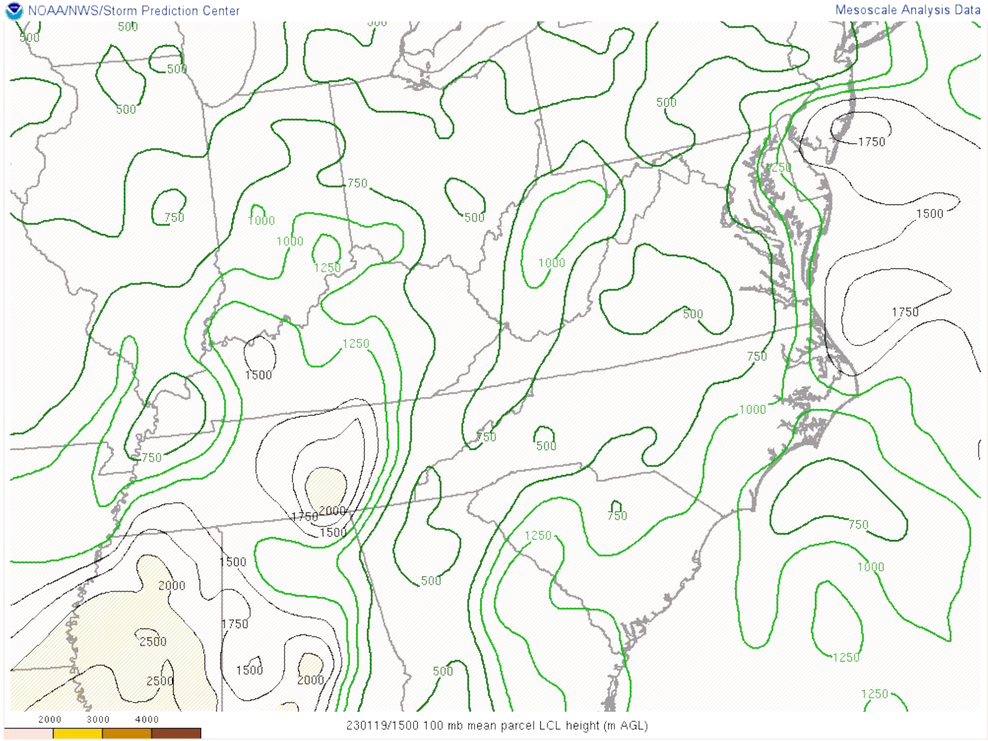
Low-level (0-3 km) lapse rates (C/km).

SPC Mesoanalysis (15Z-00Z)



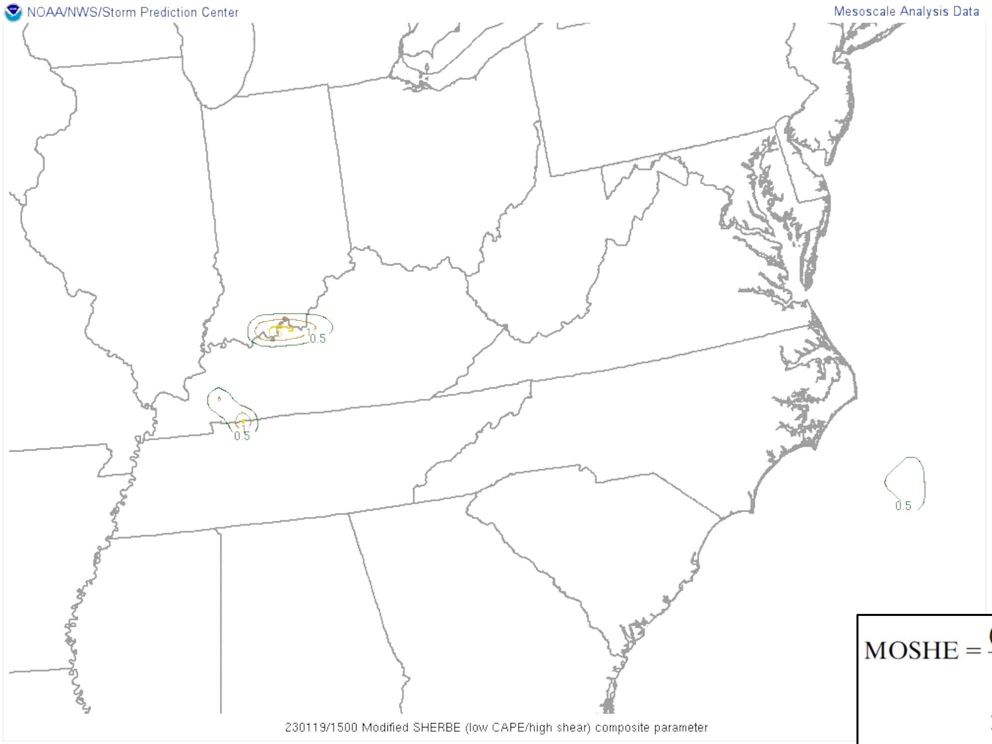
Surface-based CAPE & CIN.

SPC Mesoanalysis (15Z-00Z)



LCL heights (m AGL).

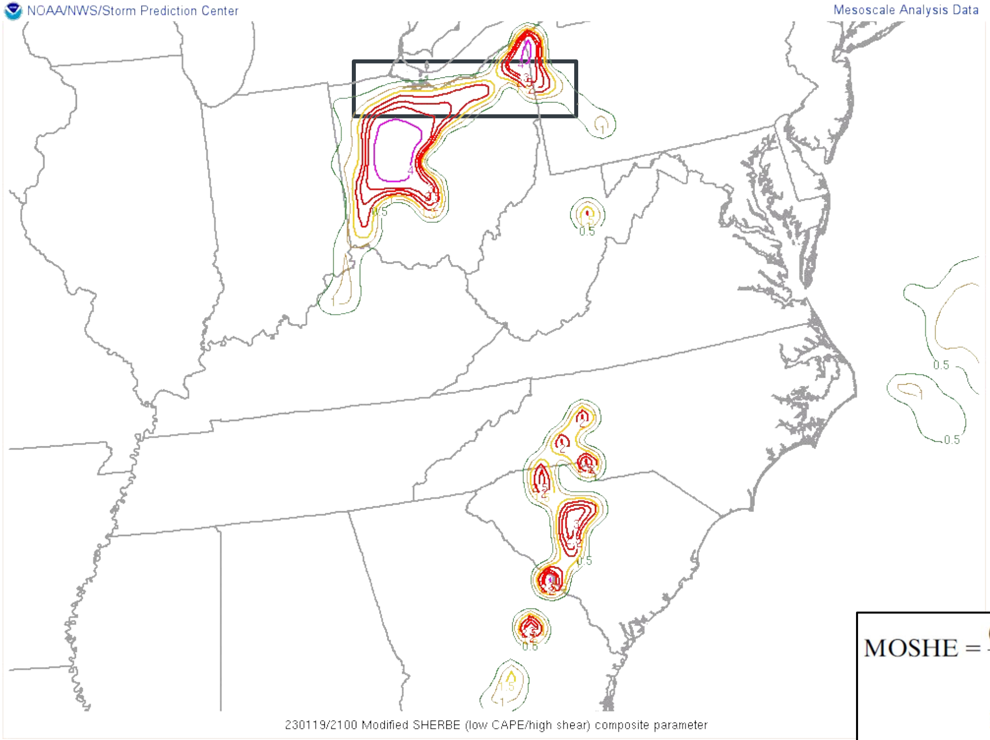
SPC Mesoanalysis (15Z-00Z)



Modified SHERBE (MOSHE).

$$\mathrm{MOSHE} = \frac{(\mathrm{LLLR} - 4\,\mathrm{K\,km^{-1}})^2}{4\,\mathrm{K^2\,km^{-2}}} \times \frac{(\mathrm{S15MG} - 8\,\mathrm{m\,s^{-1}})}{10\,\mathrm{m\,s^{-1}}} \times \frac{(\mathrm{ESHR} - 8\,\mathrm{m\,s^{-1}})}{10\,\mathrm{m\,s^{-1}}} \times \frac{(\mathrm{MAXTEVV} + 10\,\mathrm{K\,Pa\,km^{-1}\,s^{-1}})}{9\,\mathrm{K\,Pa\,km^{-1}\,s^{-1}}},$$

SPC Mesoanalysis (21Z)



Modified SHERBE (MOSHE) at 21Z on Jan 19, 2023.

$$\mathrm{MOSHE} = \frac{(\mathrm{LLLR} - 4\,\mathrm{K\,km^{-1}})^2}{4\,\mathrm{K^2\,km^{-2}}} \times \frac{(\mathrm{S15MG} - 8\,\mathrm{m\,s^{-1}})}{10\,\mathrm{m\,s^{-1}}} \times \frac{(\mathrm{ESHR} - 8\,\mathrm{m\,s^{-1}})}{10\,\mathrm{m\,s^{-1}}} \times \frac{(\mathrm{MAXTEVV} + 10\,\mathrm{K\,Pa\,km^{-1}\,s^{-1}})}{9\,\mathrm{K\,Pa\,km^{-1}\,s^{-1}}},$$

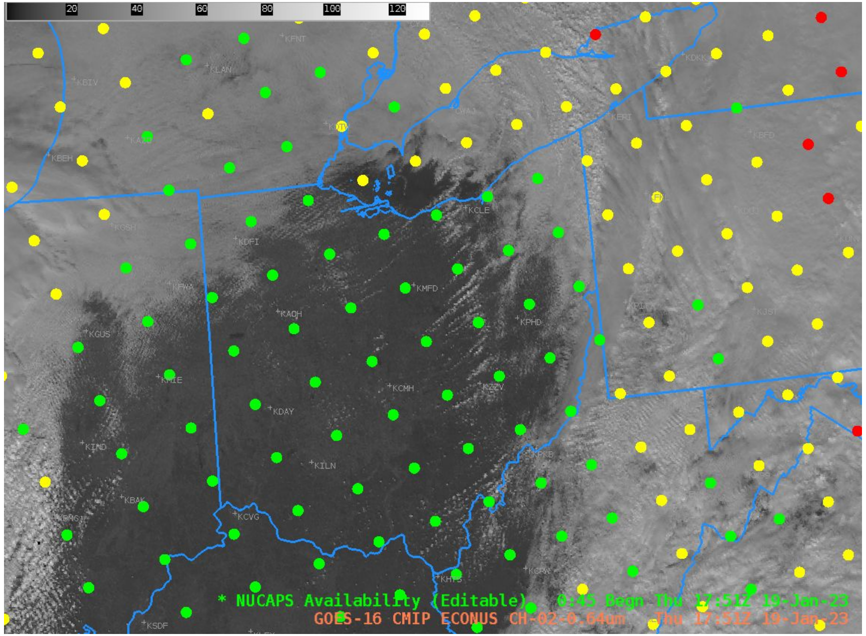
Satellite (NUCAPS)

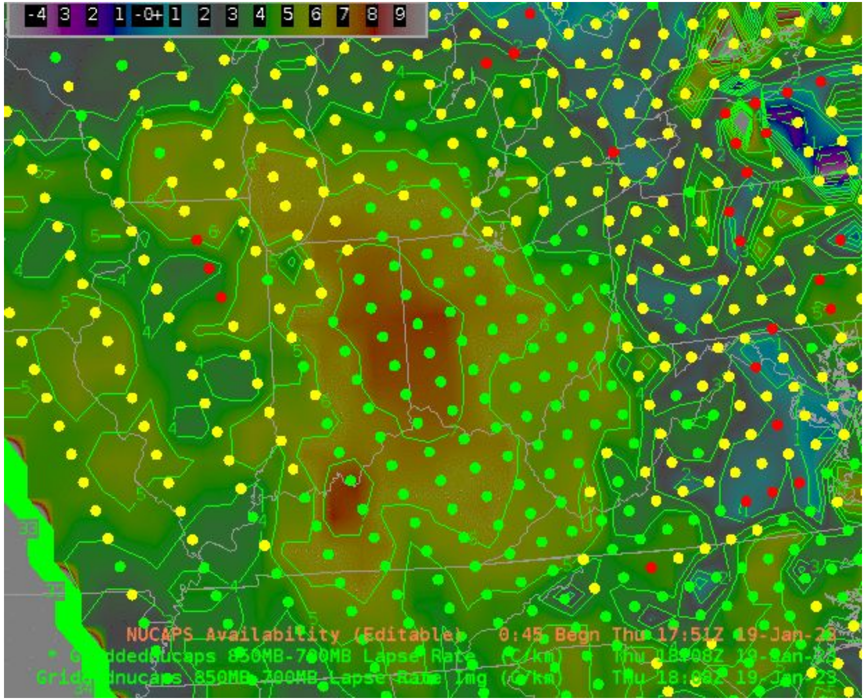
- NUCAPS is an algorithm that is used to process temperature and moisture information from sounders (CrIS & ATMS) onboard the S-NPP and NOAA-20 satellites.
    - NOAA-21 was launched in late 2022 and will replace S-NPP once fully operational (sometime later in 2023?)

PROS	CONS
NUCAPS represents the real atmosphere in partly to cloud-free areas	Data quality poor in cloudy/thick-cloud areas
Can edit the NSHARP sounding as you wish using surface observations	Temporal data is lacking - satellite passes usually between 6-7Z and 18-19Z across the Lower Great Lakes
Good for pre-convective environments, perhaps even for winter weather	Boundary layer smoothing - don't expect to see micro-scale perturbations (6 to 10 levels of temperature data, 4 to 6 levels of moisture data)

NUCAPS Web Viewer

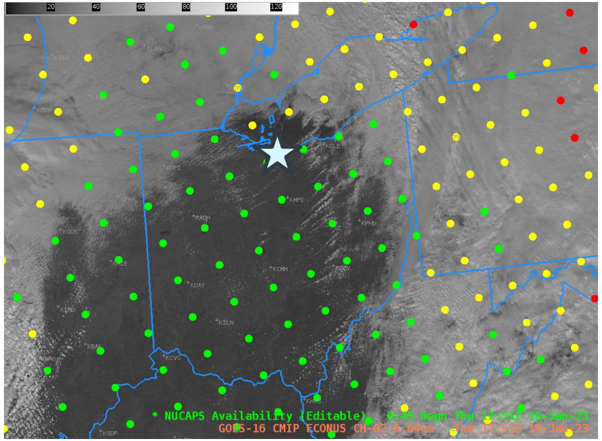
Satellite (NUCAPS)





NUCAPS availability overlaid with visible satellite (left). NUCAPS availability overlaid with gridded NUCAPS Total Totals, toggled with gridded NUCAPS mid-level (850-700 mb) lapse rates (right). Images courtesy of Scott Lindstrom/CIMSS.

Satellite (NUCAPS) - Sandusky, OH



PARCEL	CAPE	CIN	LCL	LI	LFC	EL
SURFACE	0	0	875m	4	M	2870'
ML 100 mb	0	0	1236m	4	M	4057'
FCST SFC	60	0	1564m	2	1564m	13306'
MU (932 mb)	0	0	1042m	4	M	3419'
EFF LAYER	0	0	875m	4	M	2870'
USER DEF	0	0	1691m	5	M	5548'

PW = 0.34in 3CAPE = 0J/kg WBZ = 3474' WNDG = M
K = 5 DCAPE = 362J/kg FZL = 4525' ESP = 0.00
MidRH = 24% DownT = 40F ConvT = 58F MMP = 0.00
LowRH = 64% MeanW =4.6g/kg MaxT = 58F NCAPE =0.00

sfc-3km Agl LapseRate= 21C/7.0C/km
3-6km Agl LapseRate= 19C/6.3C/km
850-500mb LapseRate= 27C/6.5C/km
700-500mb LapseRate= 16C/6.4C/km

Supercell= M
STP(eff)= 0.0
STP(fixed)= 0.0
SHIP= 0.0

Sum2	SRH(m^2/s^2)	Shear(kt)	MnWind	SRW
SFC-1km	M	M	M	M
SFC-2km	M	M	M	M
SFC-3km	M	M	M	M
Eff Inflow	M	M	M	M
SFC-6km		M	M	M
SFC-8km		M	M	M
LCL-EL(Cloud Layer)		M	M	M
Eff Shear(EBWD)		M	M	M

BRN Shear = M
4-6km SR Wind = M
Corfidi Downshear = -9999/-9999 kt
Corfidi Upshear = 0/0 kt
Bunkers Right = -9999/-9999 kt
Bunkers Left = -9999/-9999 kt
STP(eff)LR = 0.0 1km & 6km AGL Wind Ba
LGHAIL = 0.0 MOSHE = 0.0

PARCEL	CAPE	CIN	LCL	LI	LFC	EL
SURFACE	437	-10	903m	-1	903m	18769'
ML 100 mb	105	-12	1335m	1	1335m	14197'
FCST SFC	156	-2	1432m	1	1432m	15096'
MU (959 mb)	437	-10	903m	-1	903m	18769'
EFF LAYER	413	-2	1083m	-1	1083m	18769'
USER DEF	0	0	1691m	5	M	5548'

PW = 0.36in 3CAPE = 76J/kg WBZ = 3474' WNDG = M
K = 5 DCAPE = 430J/kg FZL = 4525' ESP = 0.00
MidRH = 24% DownT = 40F ConvT = 60F MMP = 0.00
LowRH = 62% MeanW =5.1g/kg MaxT = 59F NCAPE =0.09

sfc-3km Agl LapseRate= 24C/8.1C/km
3-6km Agl LapseRate= 19C/6.3C/km
850-500mb LapseRate= 27C/6.5C/km
700-500mb LapseRate= 16C/6.4C/km

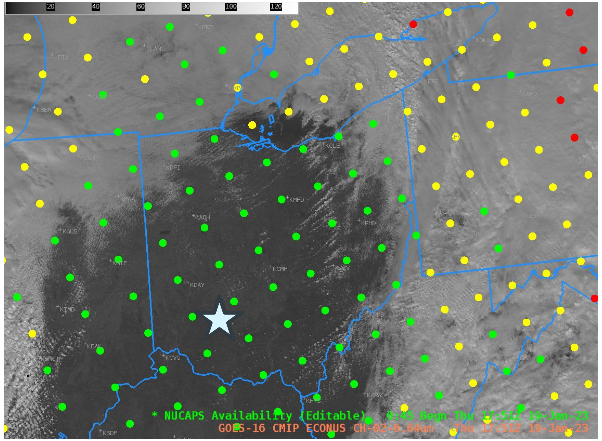
Supercell= M
STP(eff)= 0.0
STP(fixed)= 0.0
SHIP= 0.0

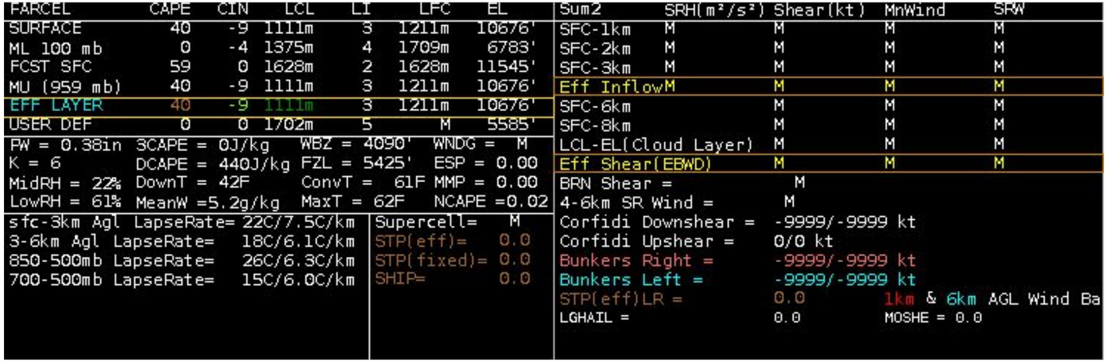
Sum2	SRH(m^2/s^2)	Shear(kt)	MnWind	SRW
SFC-1km	M	M	M	M
SFC-2km	M	M	M	M
SFC-3km	M	M	M	M
Eff Inflow	M	M	M	M
SFC-6km		M	M	M
SFC-8km		M	M	M
LCL-EL(Cloud Layer)		M	M	M
Eff Shear(EBWD)		M	M	M

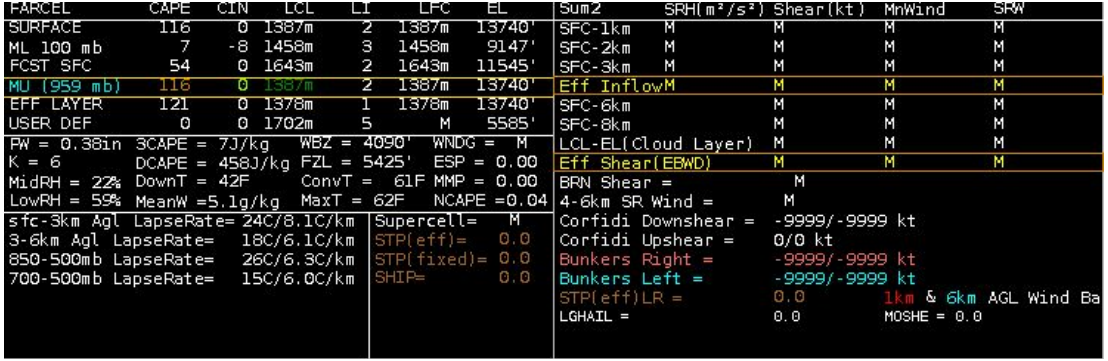
BRN Shear = M
4-6km SR Wind = M
Corfidi Downshear = -9999/-9999 kt
Corfidi Upshear = 0/0 kt
Bunkers Right = -9999/-9999 kt
Bunkers Left = -9999/-9999 kt
STP(eff)LR = 0.0 1km & 6km AGL Wind Ba
LGHAIL = 0.0 MOSHE = 0.0

The top image shows the raw NUCAPS point readout from Sandusky, OH, while the bottom image shows an adjusted data readout using surface observations. Images courtesy of Scott Lindstrom/CIMSS.

Satellite (NUCAPS) - Wilmington, OH

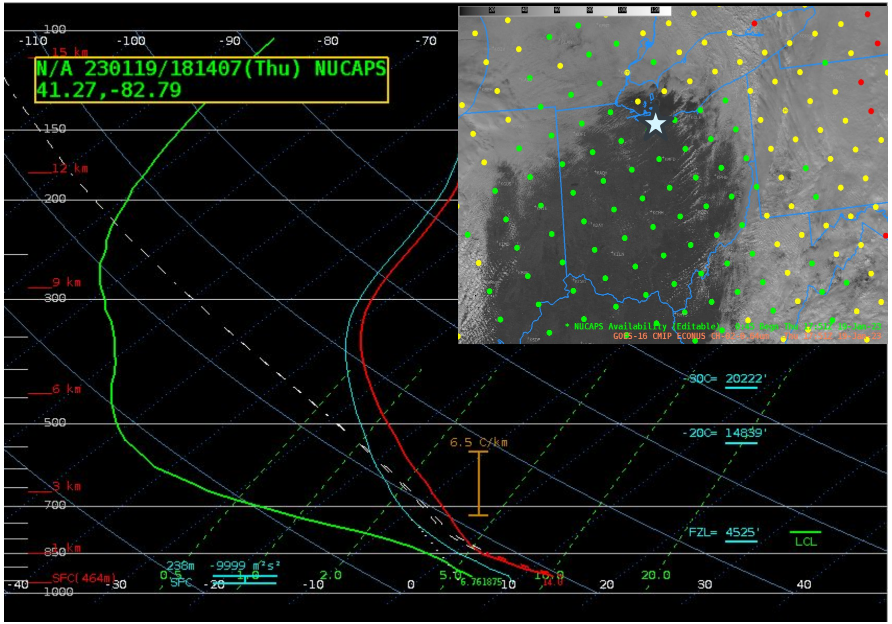


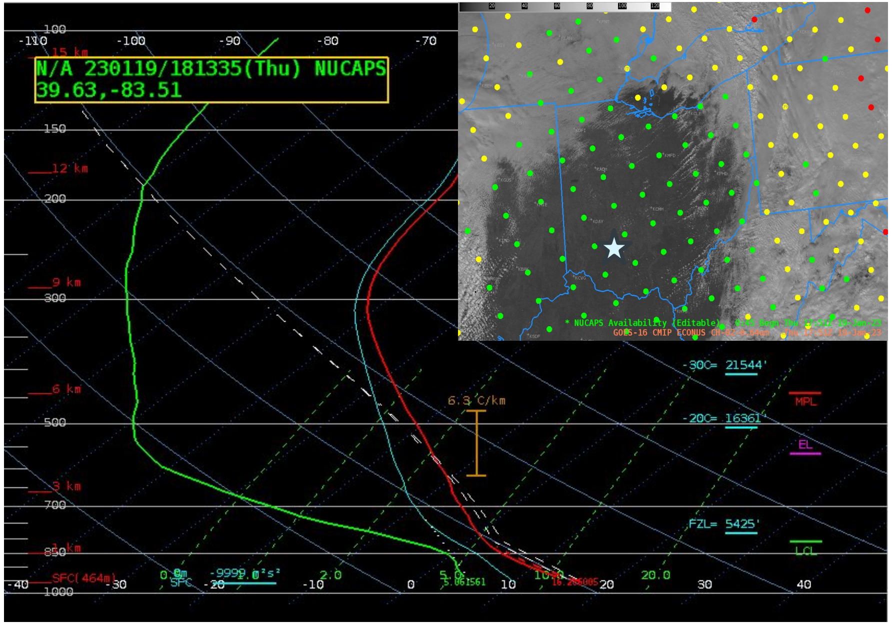




The top image shows the raw NUCAPS point readout from Wilmington, OH, while the bottom image shows an adjusted data readout using surface observations. Images courtesy of Scott Lindstrom/CIMSS.

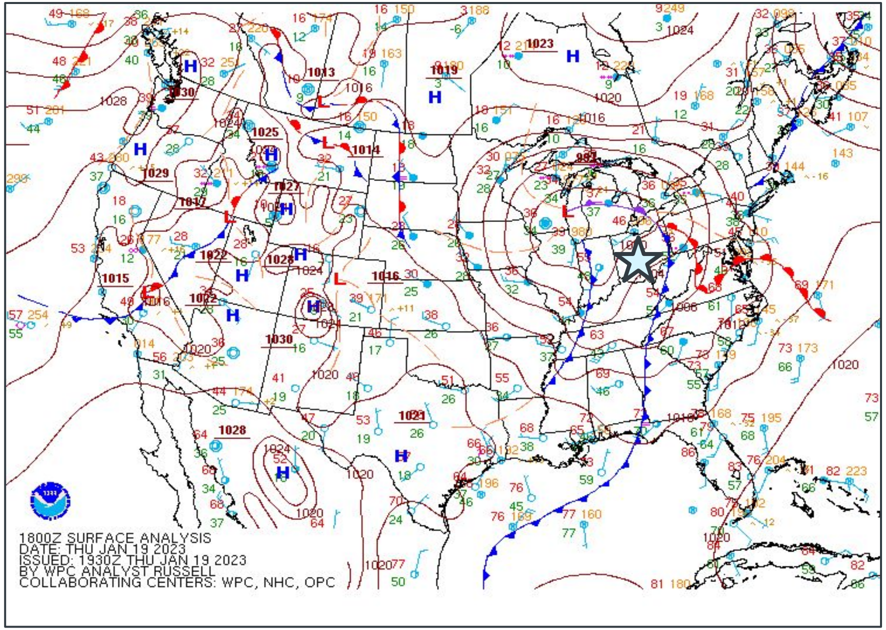
Satellite (NUCAPS) - Sounding Comparison

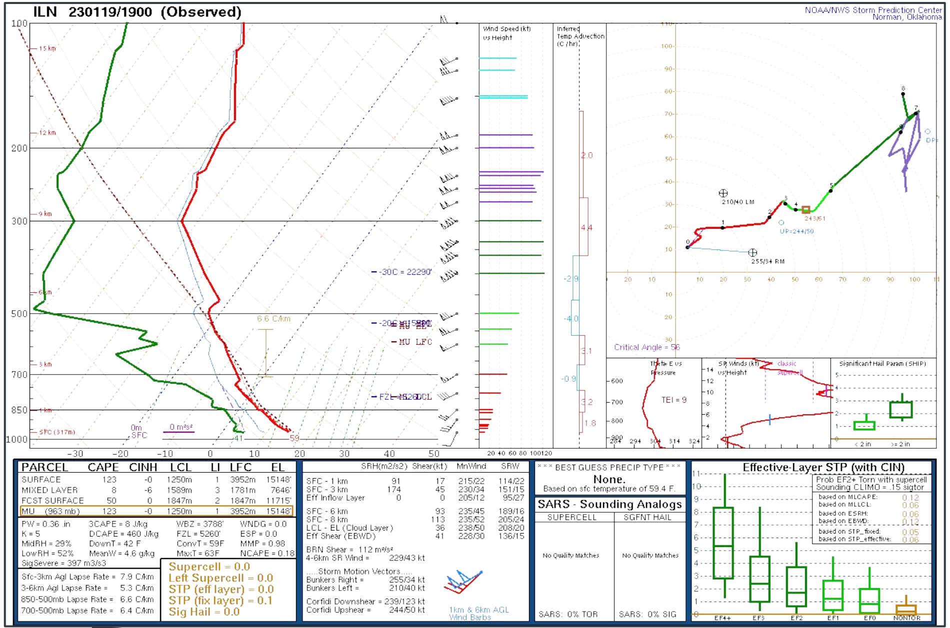




The image on the left shows the modified NUCAPS sounding from Sandusky, OH while the image on the right shows the modified NUCAPS sounding from Wilmington, OH. Images courtesy of Scott Lindstrom/CIMSS.

Surface & Upper-Air Observations

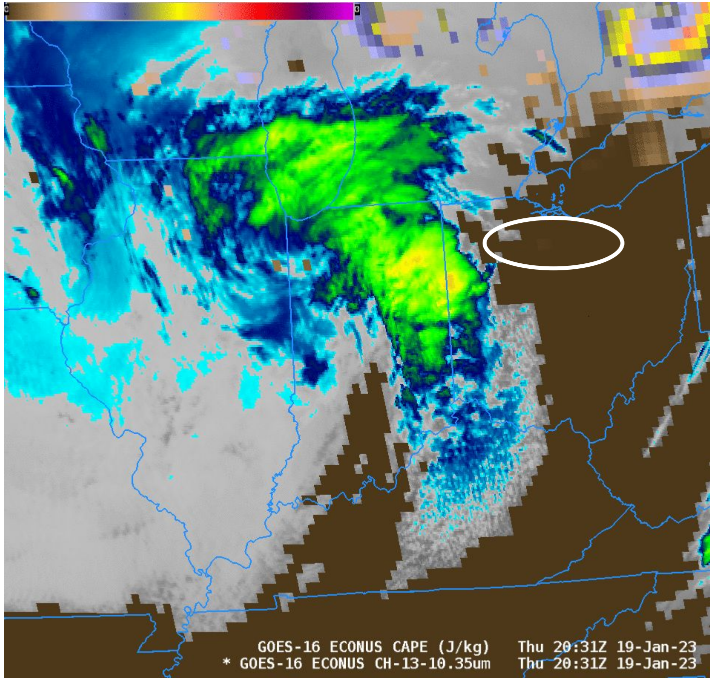




WPC surface analysis at 18Z on Jan 19, 2023 (left). The star denotes the observed sounding from WFO ILN at 19Z on Jan 19, 2023 (right).

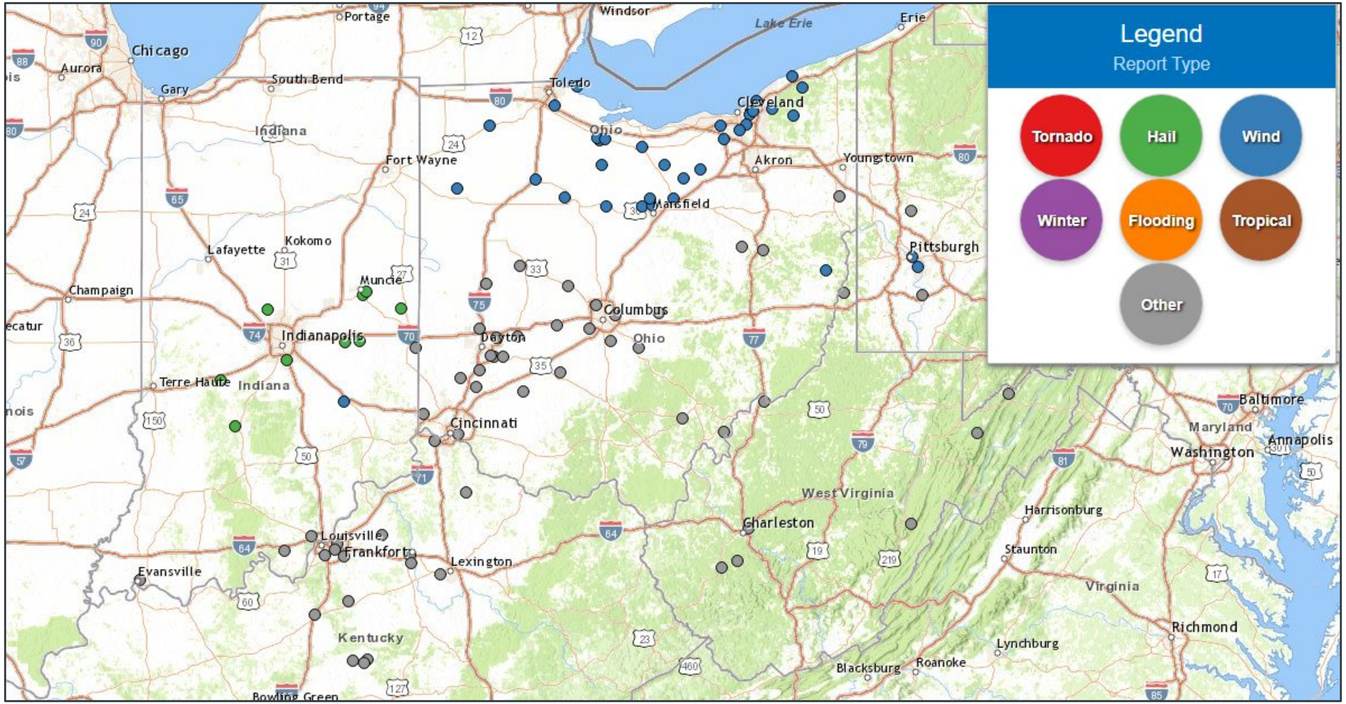
Sfc-3km Agl Lapse Rate = 7.9 C/km
3-6km Agl Lapse Rate = 5.3 C/km
850-500mb Lapse Rate = 6.6 C/km
700-500mb Lapse Rate = 6.4 C/km

Other Satellite Imagery



GOES-16 derived lifted index overlaid with infrared satellite (left). GOES-16 derived CAPE overlaid with infrared satellite (right). All satellite products are user-defined scaled down in order to capture the high shear, low CAPE environment. Image courtesy of Scott Lindstrom/CIMSS.

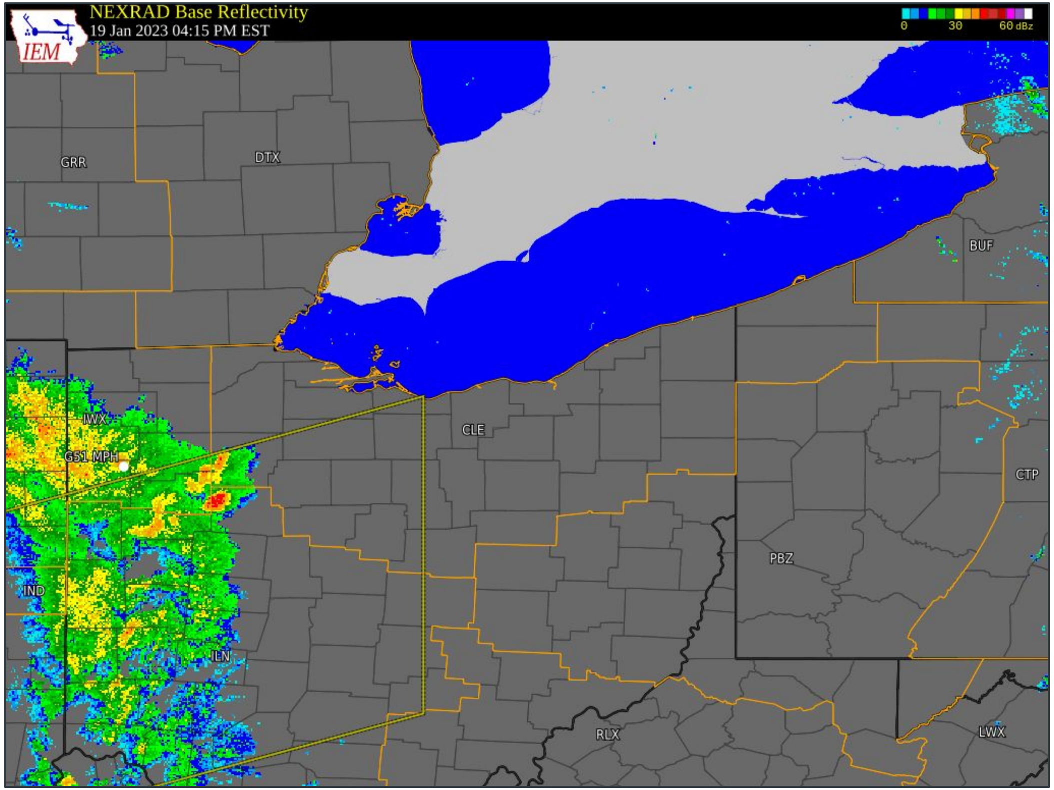
So What Happened?



Storm reports across the region, including both thunderstorm (blue points) and non-thunderstorm reports (grey points). There were even a few hail reports (green points) upstream across Indiana.

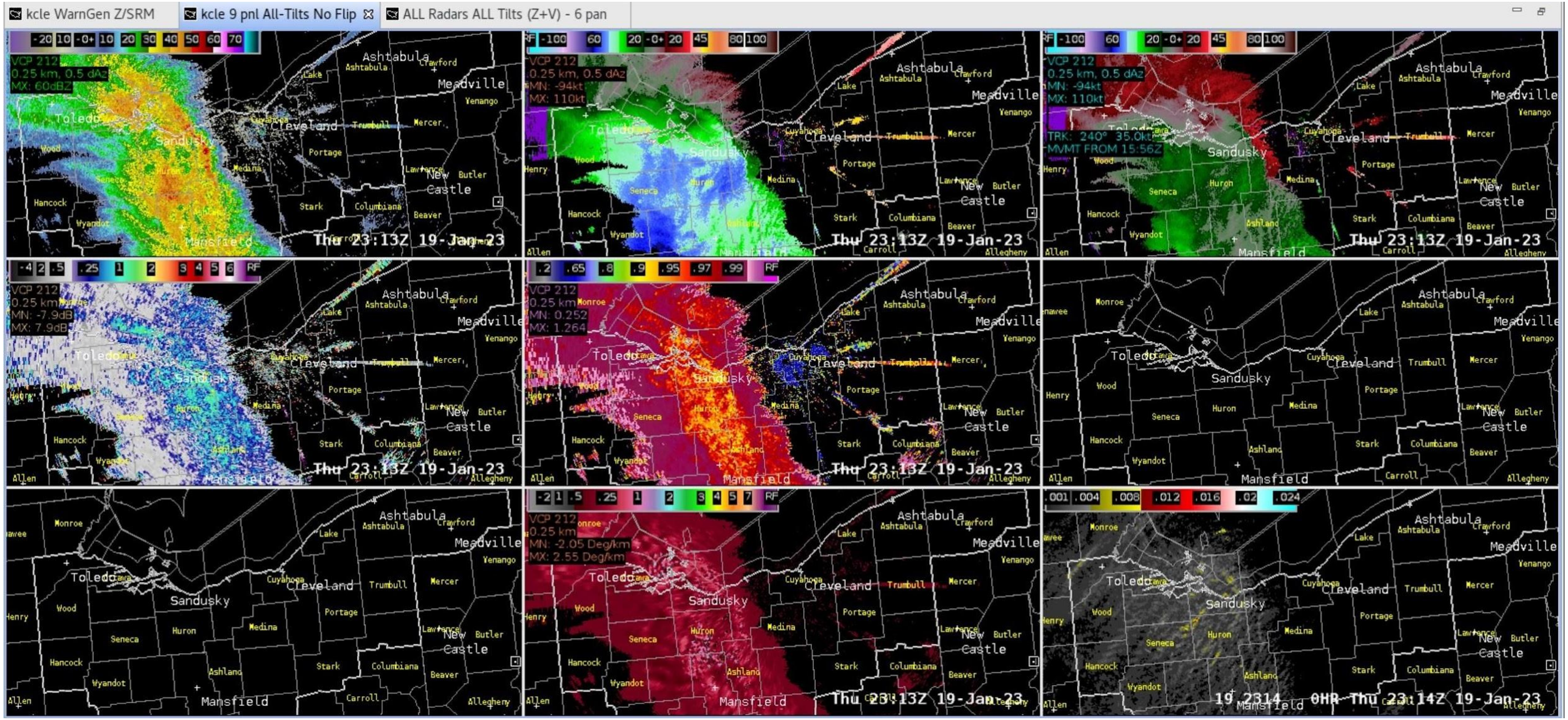
So What Happened?

- Radar imagery from 21Z on Jan 19, 2023 through 2Z on Jan 20, 2023.
- Loop includes local storm reports and convective warnings.
- Note a lack of convective intensity towards the southern flank of the line.



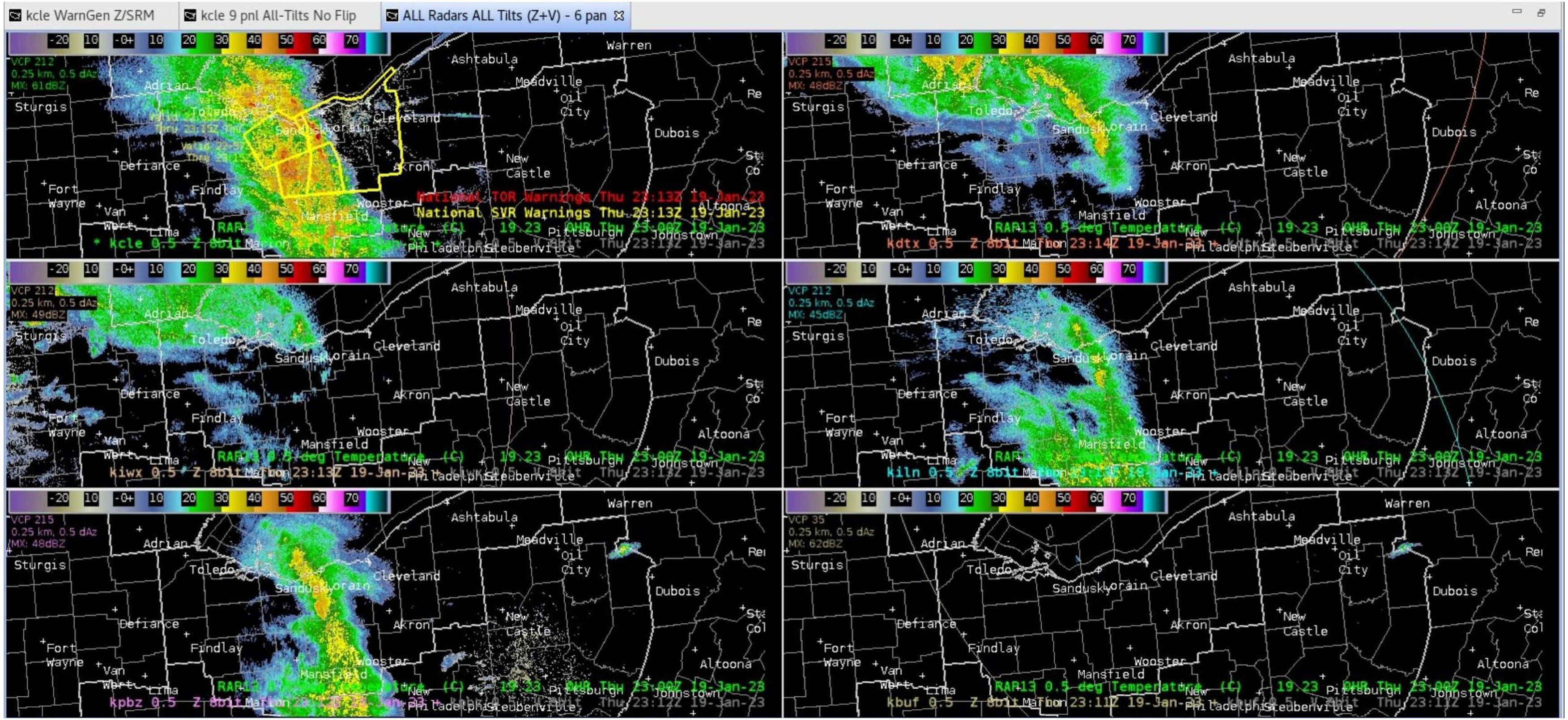
Radar loop from 415 PM through 9 PM EST, including convective warnings.

Future WES-in-the-cloud (left monitor)



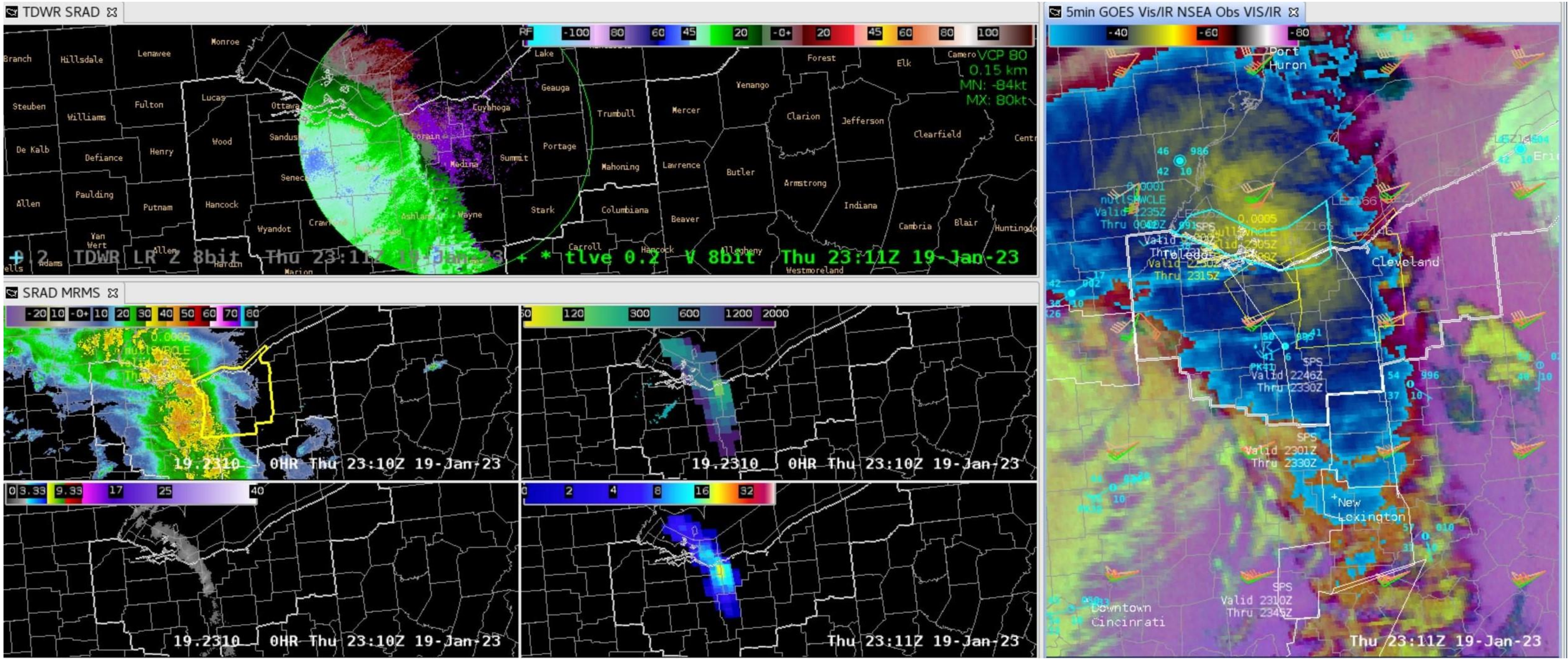
Radar all-tilt 9-panel procedure for a specific radar, including base & dual-pol products. Can be altered for any radar.

Future WES-in-the-cloud (left monitor)



Radar 6-panel “all”-tilt procedure for nearest radars.

Future WES-in-the-cloud (right monitor)



Top left panel, TDWR Z/V. Bottom left panel, MRMS reflectivity (top left), VII (bottom left), MESH track + GLM MFA (top right), GLM FED - user modified + total ENTLN (bottom right). Right panel, user modified IR overlaid with Nighttime Microphysics RGB.

Summary

- A high shear, low CAPE environment across the OH Valley and Lower Great Lakes region resulted in numerous thunderstorm wind damage reports.
  - The overall reports were perhaps not as widespread as the enhanced risk suggested, given dry air entrainment across the OH Valley which resulted in lower surface dewpoints and thus low-level moisture.
- The MOSHE parameter (especially the gradients, similar to CAPE), proved useful in determining where severe storms may form and persist.
- Relatively clear skies allowed for good-quality satellite retrievals, including NUCAPS.
  - A special 19Z ILN sounding also aided in mesoanalysis, providing a “ground-truth”.
- “Pseudo” WES-in-the-cloud showed utility for future replacement of the legacy WES systems at NWS WFOs

Questions?

- A Preliminary Study of Severe Wind-Producing MCSs in Environments of Limited Moisture in: Weather and Forecasting Volume 21 Issue 5 (2006) (ametsoc.org).