July 16, 2024, Upstate New York Tornado Outbreak: An Analysis

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Background & Objective

Background: On July 16, 2024, a decaying derecho that was responsible for tornadoes in the Chicago area entered Upstate New York and began to re-intensify. This event produced 10 tornadoes, including an EF-2 in Rome.

Objective: To identify what differentiated the atmospheric conditions near Rome from other NY locations to produce the strongest tornado.

Data & Methods

Data:

-ERA5 Reanalysis[1] dataset including variables: RH, temperature, and U&V wind components for all latitudes, longitudes, and pressure levels.

-NOAA storm reports[2] for tornado paths

-NOAA NCEI Radar Data[3]

Methods: Along the trajectory of the storm, analyzed instability, profiles, and winds at selected locations using CAPE, soundings, hodographs, shear, and helicity calculated and plotted using MetPy and Python.

Time	Location
15Z	Buffalo, NY
16Z	Wyoming, NY
17Z	Clifton Springs, NY
18Z	Auburn, NY
19Z	Rome, NY
20Z	Lake Pleasant, NY
21Z	Lake George, NY

Table 1: Selected locations along storm path, determined by location of storm at that time.

Results

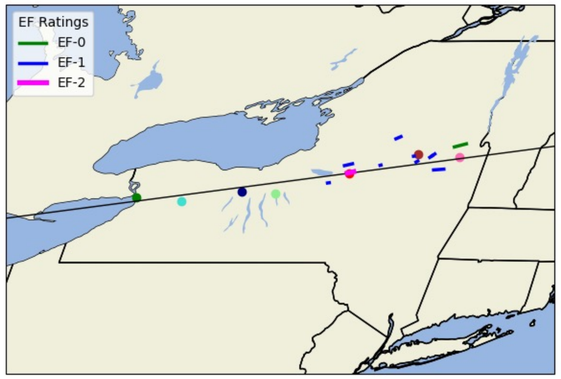


Figure 1: Map containing tornado tracks, storm path, and selected locations for analysis

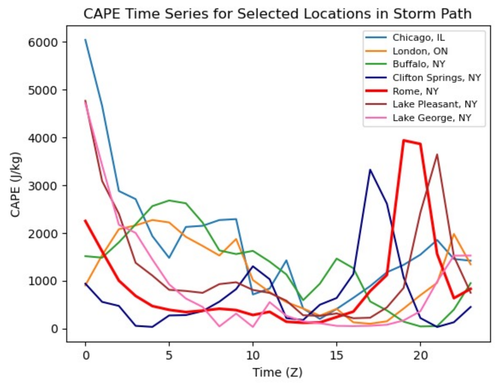


Figure 2: Time series of CAPE as storm moved from Chicago through New York.

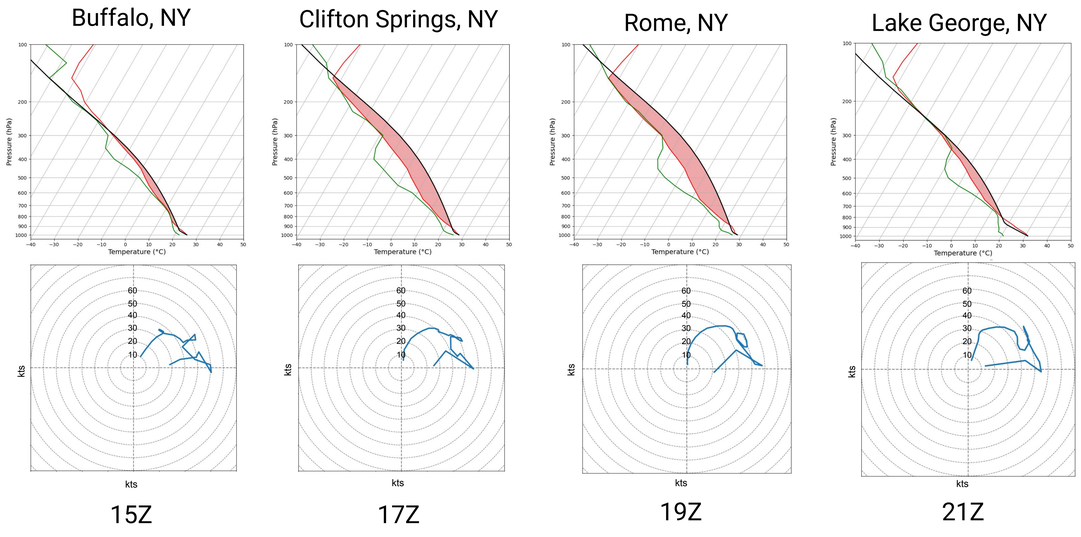


Figure 3: Time series containing soundings and hodographs for selected path locations every other hour.

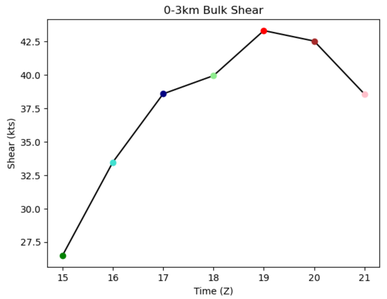


Figure 4: 0-3km Bulk Shear plotted at selected locations once storm entered NY.

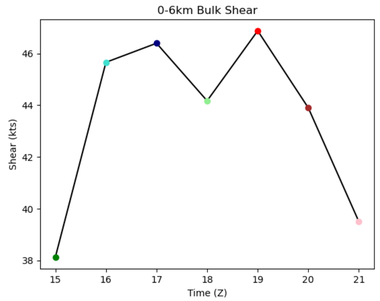


Figure 5: 0-6km Bulk Shear plotted at selected locations once storm entered NY.

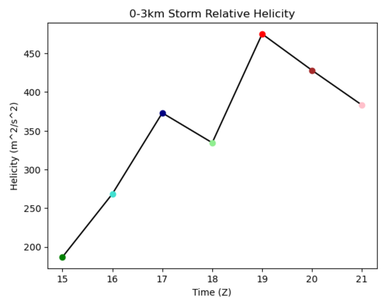


Figure 6: 0-3km Storm Relative Helicity plotted at selected locations once storm entered NY.

Discussion

CAPE: Once entering New York, CAPE increased until Rome, where it peaked at ~4000 Jkg^{-1} before decreasing

Soundings: At Rome, low level moisture was highest, and lapse rates were the steepest (from 880-650mb).

Hodographs and Wind Data: Rome recorded the highest 0-3 km and 0-6 km bulk shear (~43 kts and ~47 kts) and 0-3 km SRH (~460 m^2/s^2). According to SPC guidelines, these values fall in the significant tornado category at Rome, while locations east and west are in the weak tornado category[4].

Conclusions

During this outbreak, a combination of instability (driven by low level moisture and lapse rates) and wind behavior set Rome apart from other locations across New York. In areas to the west and east of Rome, CAPE values were lower, and wind parameters primarily fell into the weak tornado category. This combination allowed the strongest tornado to occur in Rome, as opposed to other locations.

References

[1]Hersbach, H. et al. (2023). *ERA5 hourly data on pressure levels from 1940 to present* [Dataset]. https://doi.org/10.24381/cds.bd0915c6

[2]*NOAA Storm Events Database*. (2024). [Dataset]. https://www.ncdc.noaa.gov/stormevents/

[3]*NOAA NCEI Radar Data*. (2024). [Dataset]. https://www.ncei.noaa.gov/maps/radar/

[4]Rich Thompson. (n.d.). *Explanation of SPC Severe Weather Parameters*. https://www.spc.noaa.gov/exper/mesoanalysis/help/begin.html