Essential Synoptic-to-Mesoscale Forecast Applications Ahead of the 20 June 2021 Chicago Area EF3 Tornado

Matthew T. Friedlein & Kevin M. Donofrio, NOAA/National Weather Service Chicago, IL & Anthony W. Lyza, Cooperative Institute for Mesoscale Meteorological Studies at University of Oklahoma, Norman, OK

Introduction

- Shortly after 11 P.M. CDT on 20 June 2021, a tornado developed and rapidly intensified over the southwest Chicago metro in northeast Illinois.
- With a 17.6-mile (28.3 km) track over 23 minutes, this tornado reached a peak intensity of EF3 with 140 mph (122 kt) winds and injured 11.
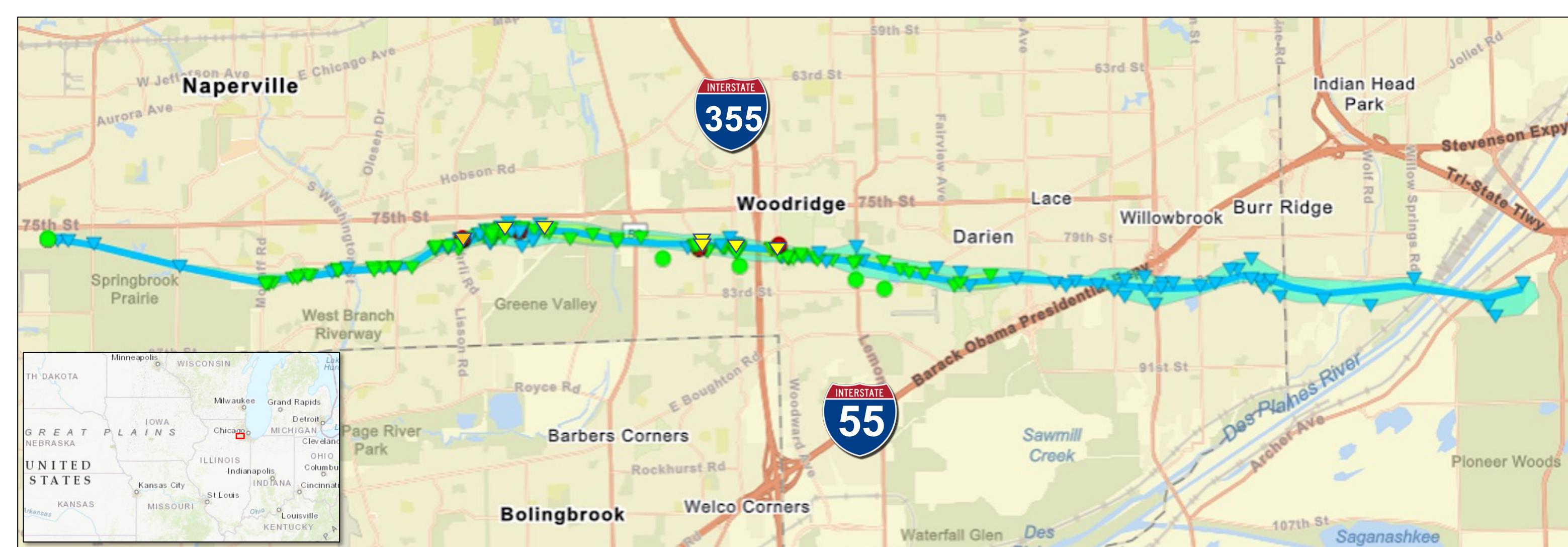

Figure 1: Tornado track with EF Scale damage indicators plotted, with blue = EF0, green = EF1, yellow = EF2, and orange = EF3, while red = a non-EF damage indicator.

- In the community of Naperville (Illinois' 4th largest city), 231 structures had some level of damage, including 19 declared uninhabitable.
- Nearby Woodridge, IL had 640 structures damaged with 31 becoming uninhabitable homes, while Darrien, IL had 50 homes damaged.

Figure 2: Photos from damage surveys conducted by NWS Chicago and the University of Illinois Wind Engineering Research Laboratory. Upper left: Destroyed home in Naperville where tornado was peak intensity. Lower left: Vehicle rolled in Woodridge. Upper right: Home damage in Naperville. Lower right: I-355 exit sign that was tossed 6 mi. (~9.7 km).

- Nocturnal significant tornadoes (EF2+) in the late spring and summer are not rare in the Corn Belt and Great Lakes regions (IA, IL, IN, MI, MO, WI); in fact, during the decade of 2011 to 2020 there were 33 such tornadoes between 2000 CDT and 0500 CDT, responsible for 4 deaths and 65 injuries.

Synoptic Pattern Recognition
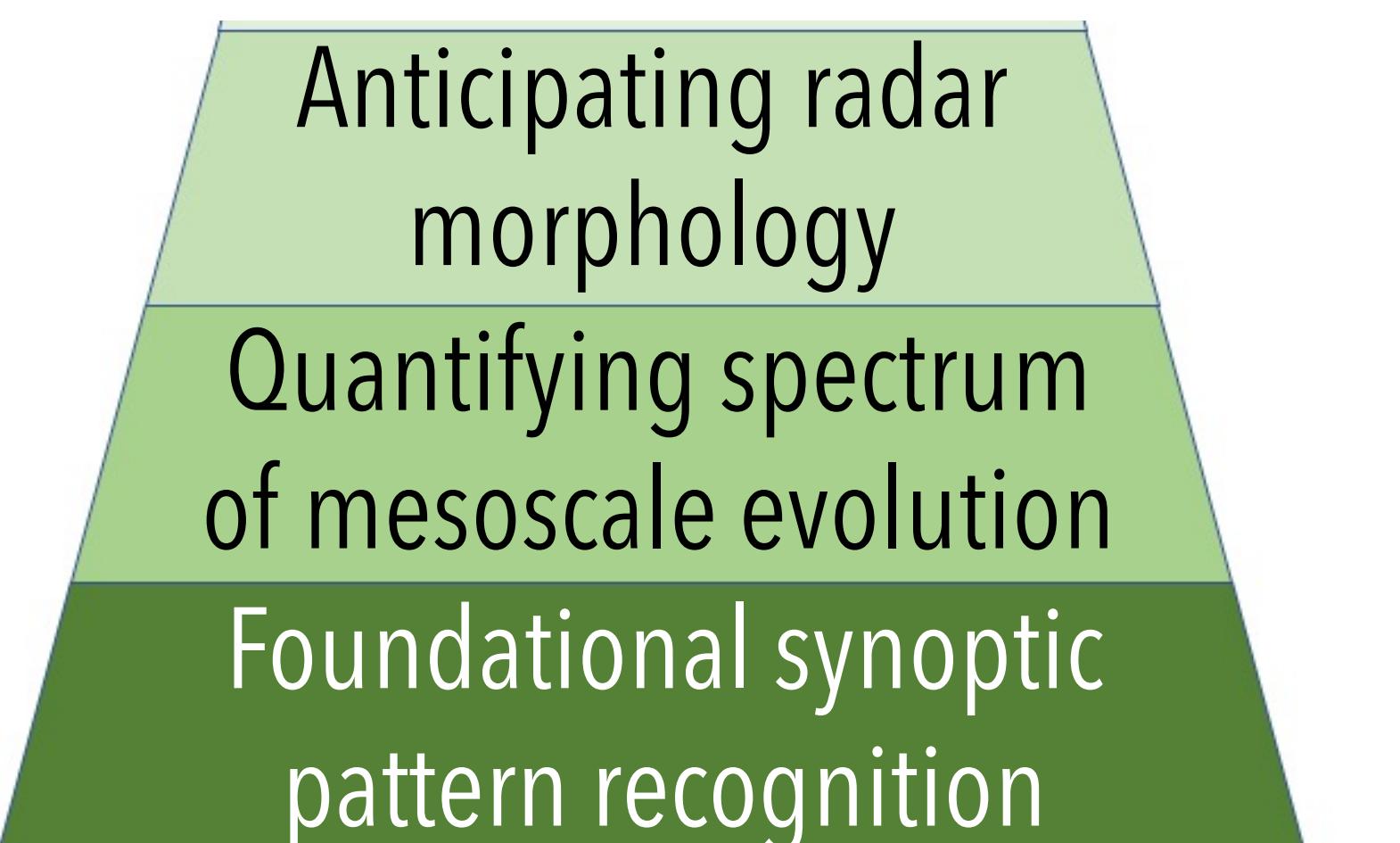
Figure 3: Conceptual visualization of severe thunderstorm environment forecasting. With a foundation of pattern recognition through experience, training, post mortem application, and learning local climatology, NWS forecasters can be better positioned to spatiotemporally target high impact weather as the hazard enters the short term.
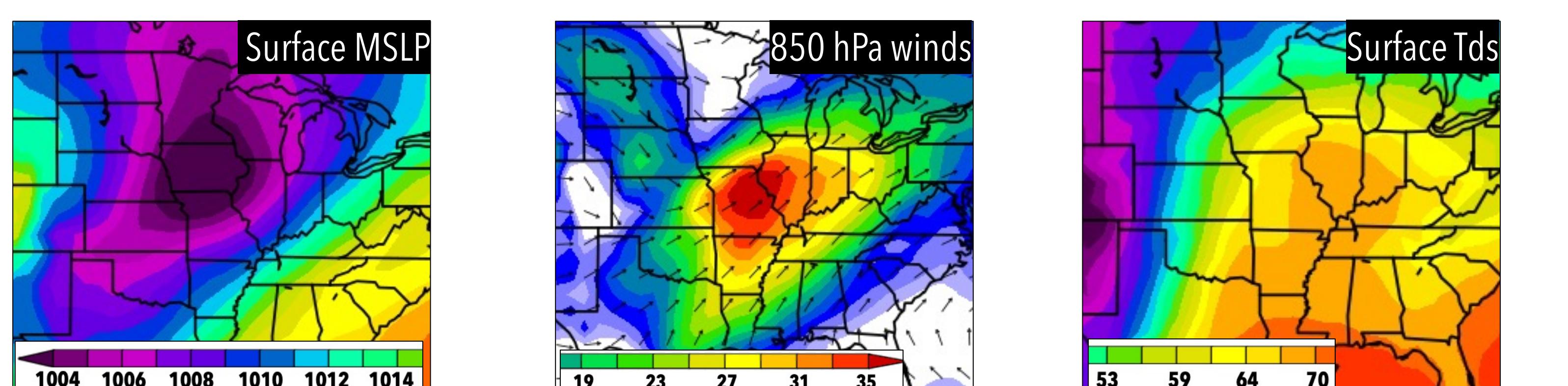

Figure 4: NCEP North American Regional Reanalysis (NARR) from 20 significant tornado event days in the NWS Chicago CWA from 2000-2020. These are at T-3 hours of an event's first significant tornado in the CWA. Plots are mean sea-level pressure (left) in hPa, 850 mb winds (center) in kt, and 2m dew points (right) in °F.

- Such placement and magnitude of mass fields not only favor potential tornado setups, but depending on timing, also a propensity for low-level warm sectors to stay mixed after loss of solar insolation. This maintains some severe threat, even at times increasing at peak low-level jet time.
- Local training on QLCS setups and pattern recognition were applied in interrogation of NWP guidance solutions, as shown in forecast discussions:

19 June 2021 2:30 P.M. CDT NWS Chicago Area Forecast Discussion excerpt: "…conditions favor development of a QLCS that will feed off a quickly recovering low-level airmass on a 50-60 kt low-level jet. A few embedded tornadoes are also possible with the increasing low-level shear."
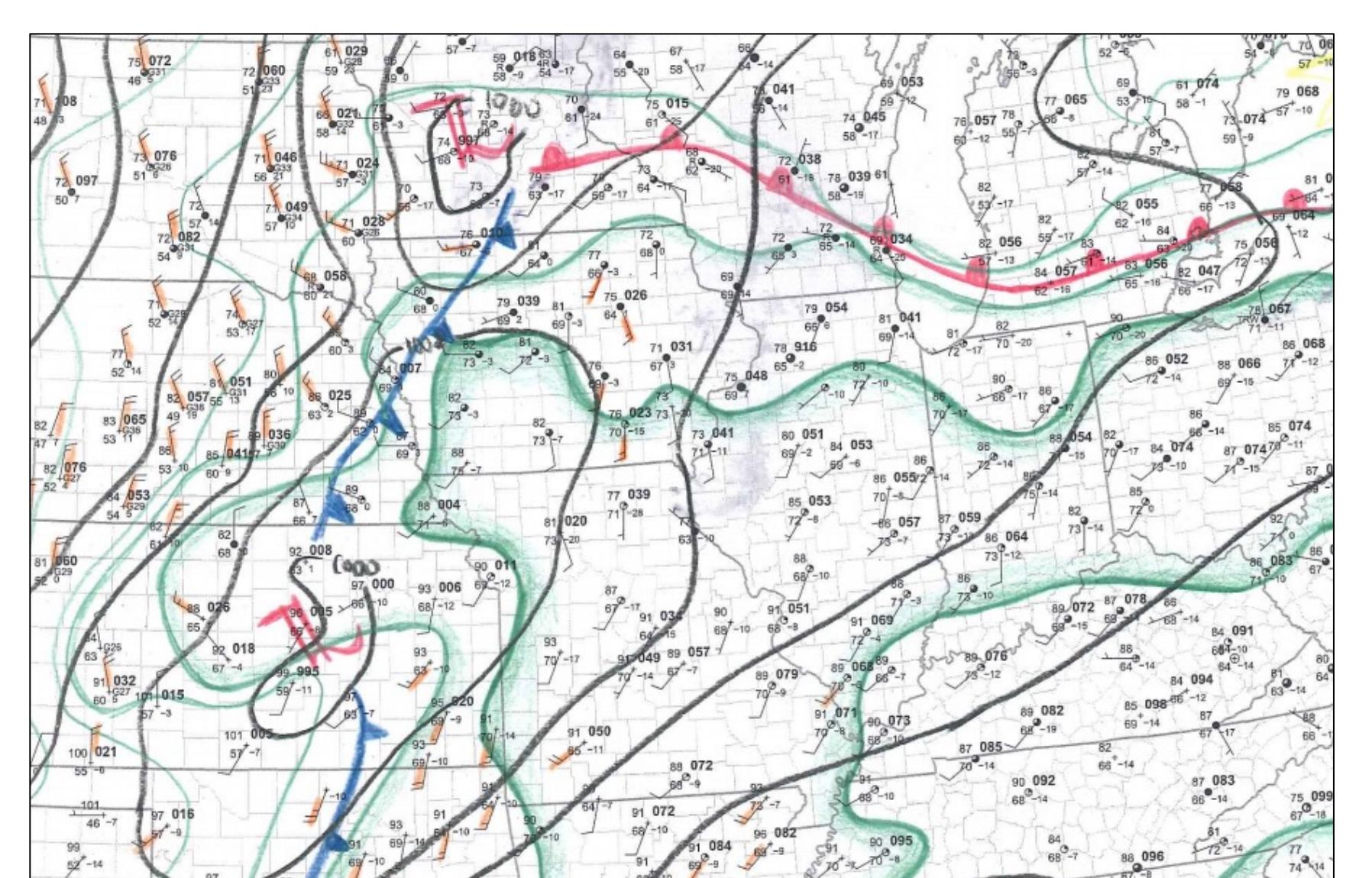

Figure 5: Hand surface analysis from 2 P.M. CDT on 20 June 2021, with a similar pressure and warm sector pattern to the above composites.
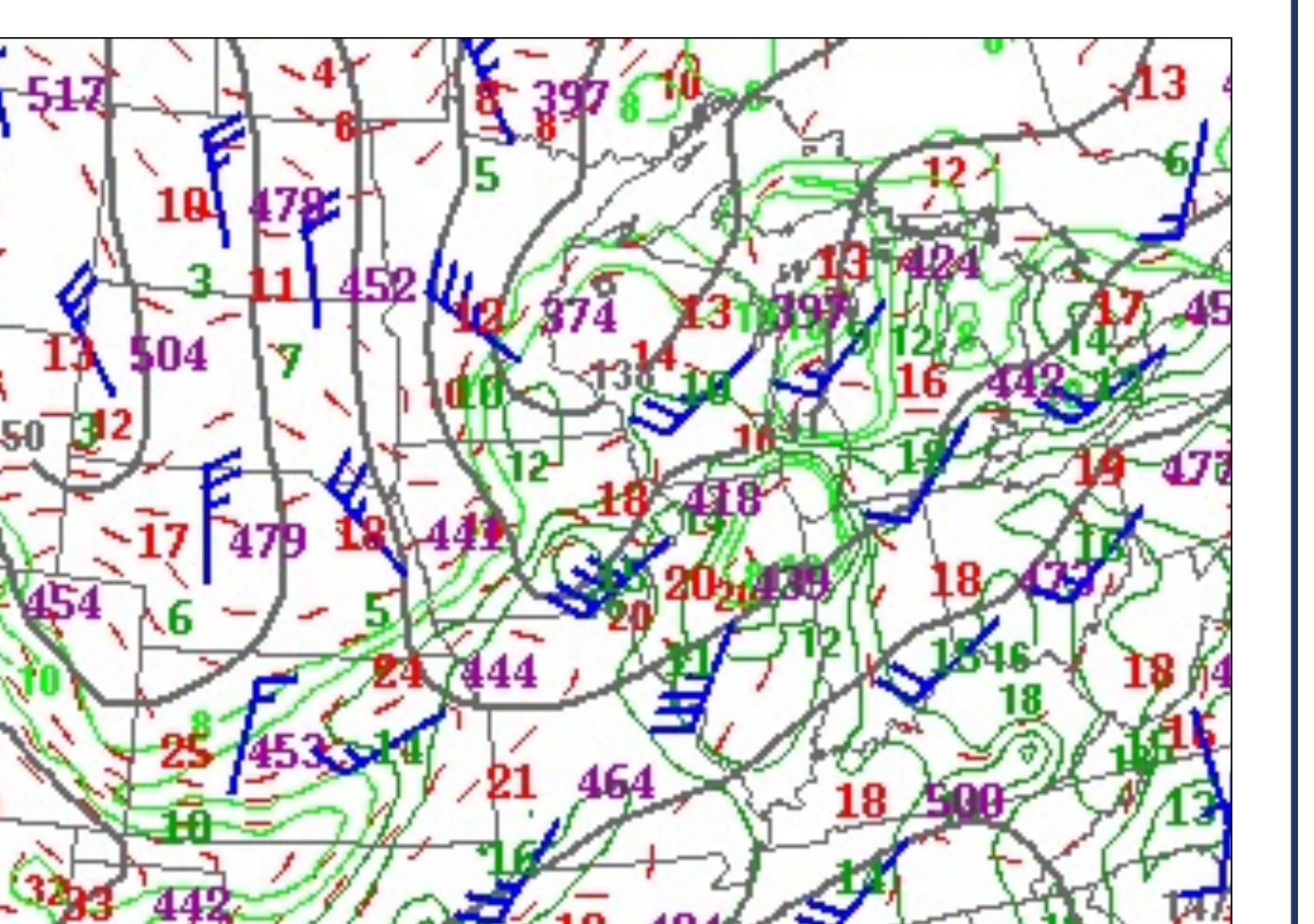
Figure 6: 00 UTC 21 June 2021 850 mb RAOB plots and objective analysis of heights, temperatures, winds, and dew points.

Continuous Mesoanalysis

- The spectrum of possible mesoscale evolution on 20 June 2021 was fairly large, even just 1-2 hours prior, though recognized was some potential for a longer-lived, stronger tornado threat given the environment.
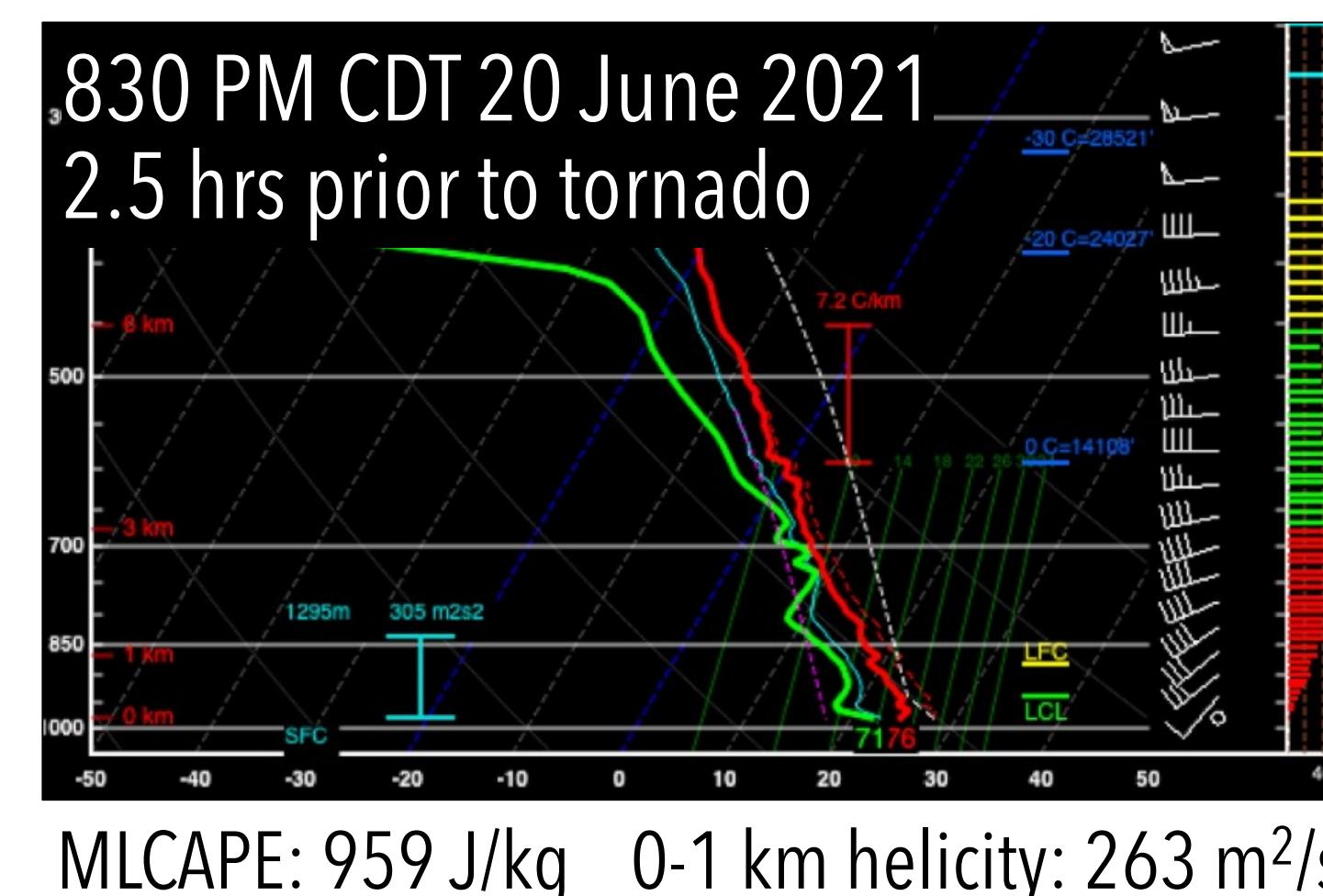
MLCAPE: 959 J/kg   0-1 km helicity: 263 m²/s²   MLCAPE: 1,026 J/kg   0-1 km helicity: 478 m²/s²
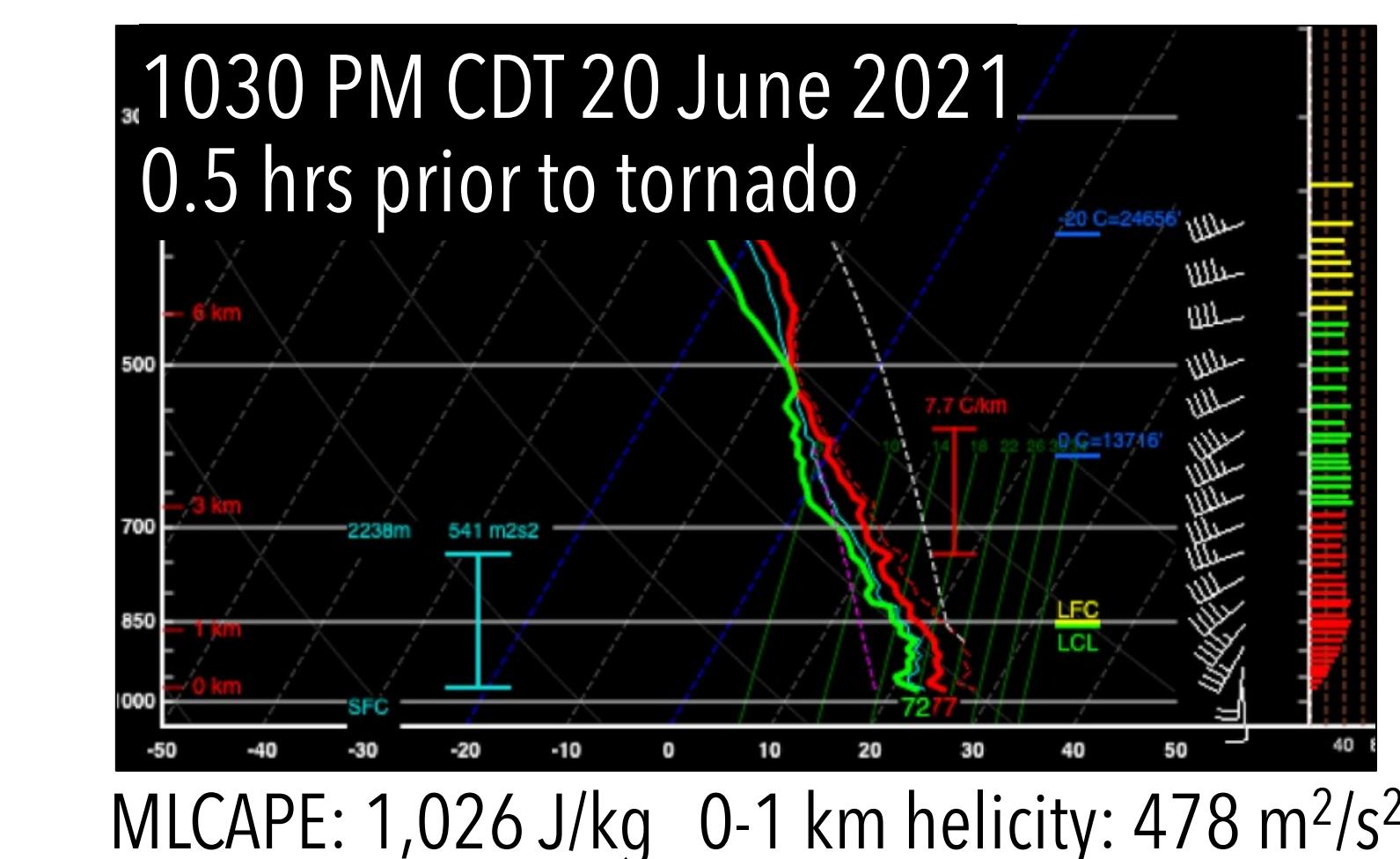
Figure 7 (above): Composite Aircraft Meteorological Data Relay (AMDAR) soundings modified for surface temperatures, dew points, and winds in the southwest Chicago suburbs.
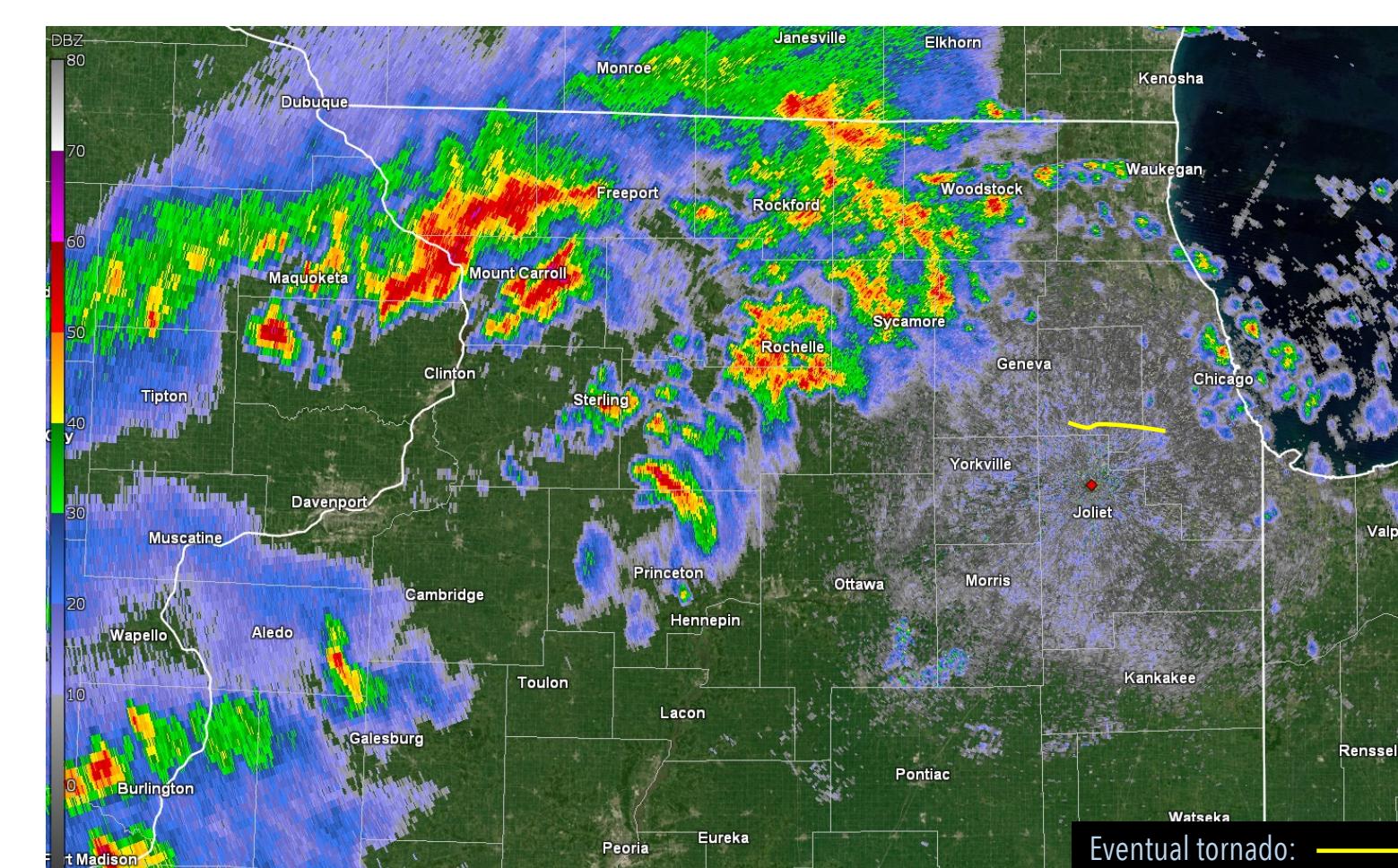

Figure 8 (above): 9 PM CDT KLOT 0.5° base reflectivity, showing a mixed convective mode.
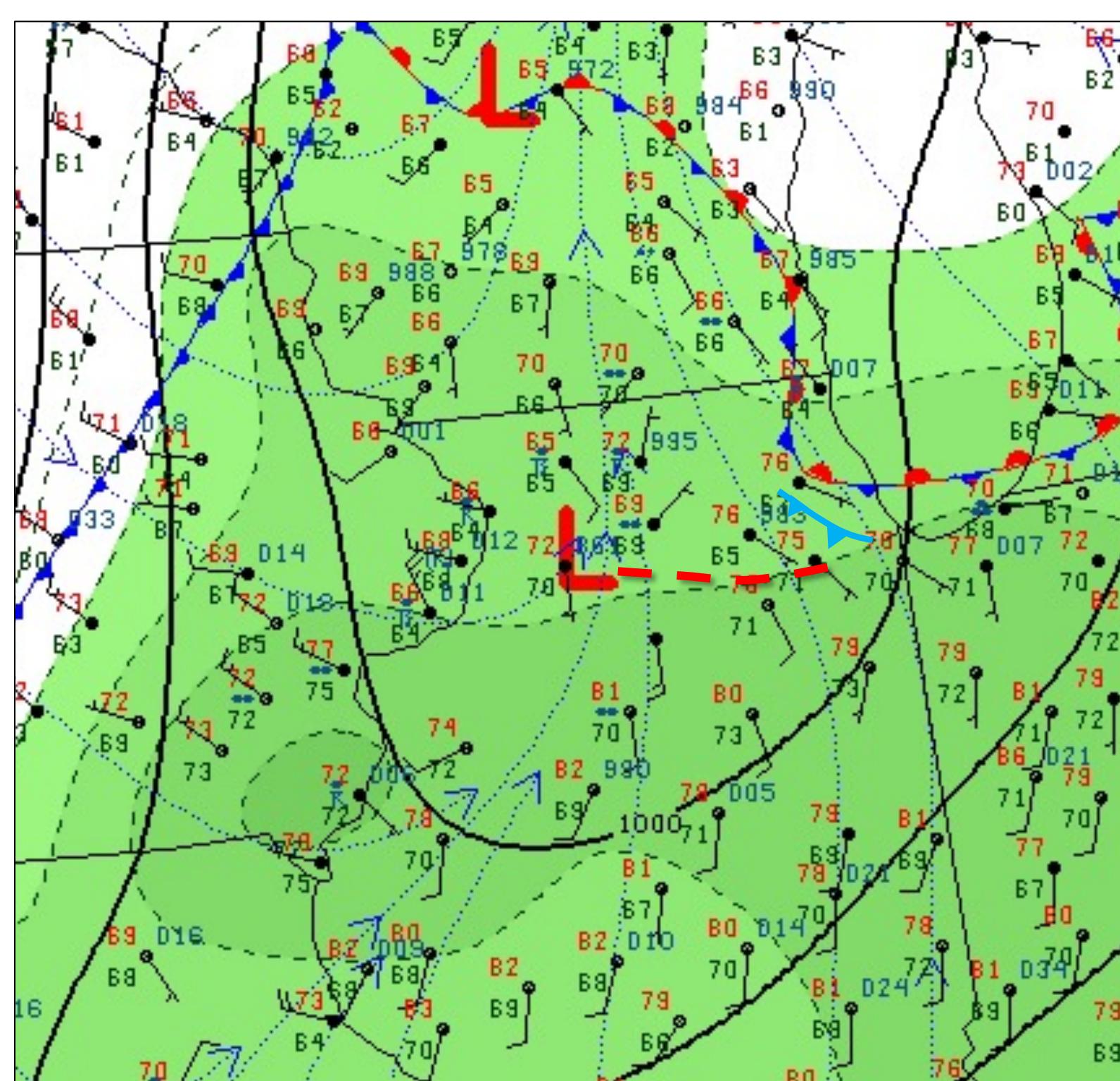
Figure 9 (right): 10 PM CDT surface analysis with key boundaries and contoured dew points.
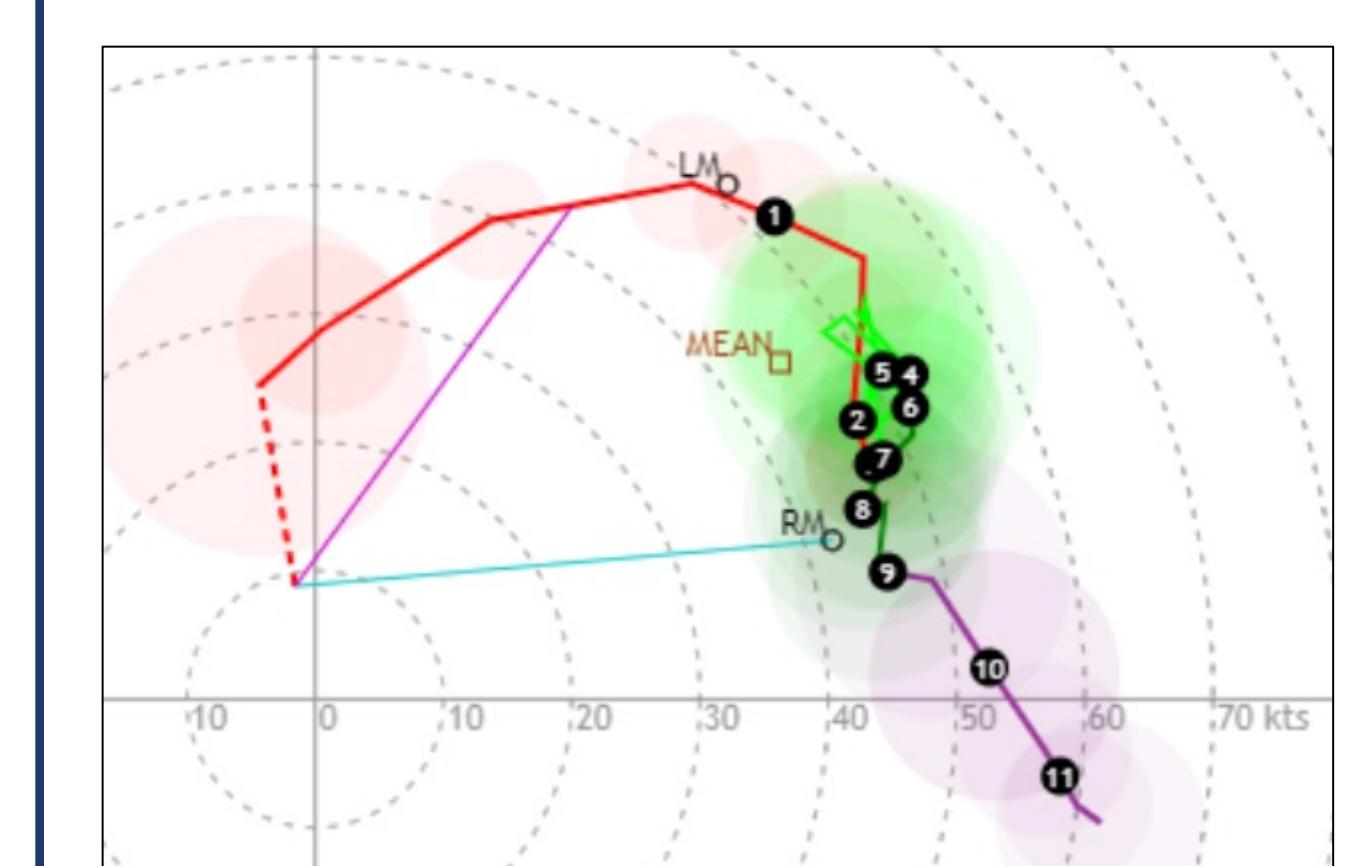
Figure 10: The KLOT hodograph at 11 P.M. CDT (tornadogenesis time). 0-1 km helicity of 540 m²/s².[1]

Figure 11 (right): 10:25 P.M. CDT KLOT 0.5° base reflectivity. Highlighted are confidence builders from the three ingredients method for identifying meso-vortexgenesis in QCLS structures.
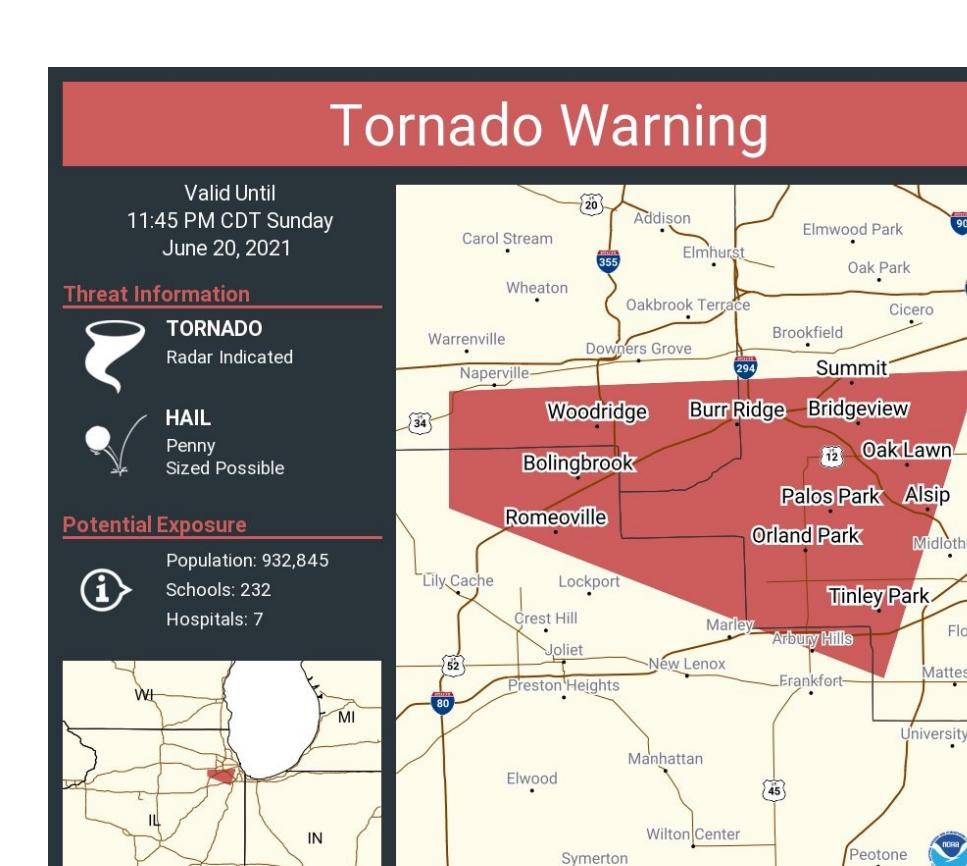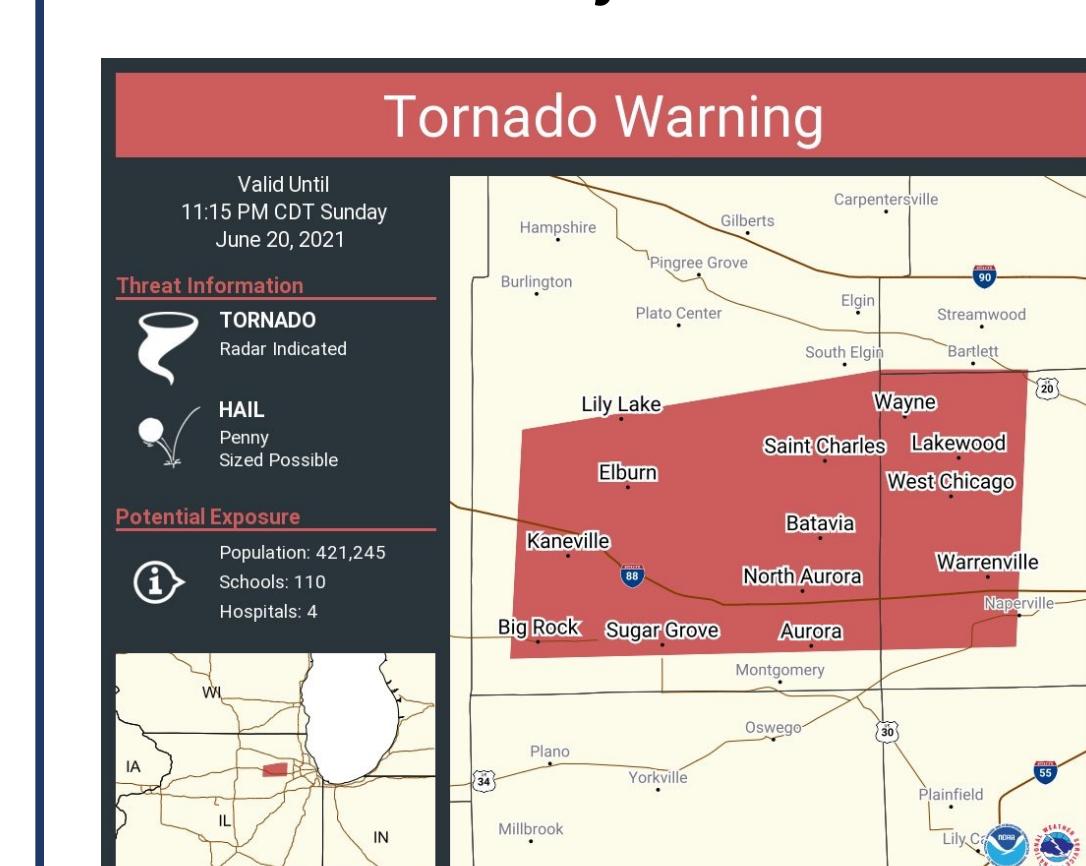

Figure 12 (far left): Tornado Warning issued at 10:43 P.M. into the southwest Chicago suburbs.

Figure 13 (left): Downstream Tornado Warning issued at 11:05 P.M. This warning included what would be hardest hit area.

[1] Supine, Tim/AutumnSky, 2021: AutumnSky VWP Hodographs, Accessed 20 June 2021, http://autumnsky.us/vad/

[2] NOAA WDTD, 2018: Three Ingredients Method, Accessed 13 December 2021, training.weather.gov/wdtd/courses/woc/documentation/severe/three-ingredients-timebudget

Contact: Matt.Friedlein@noaa.gov   Past Events: weather.gov/chicago/events