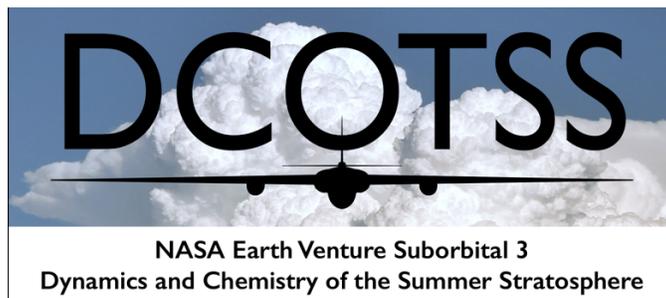


# DCOTSS ER-2 Mission Scientist Flight Summary Report



**Flight identifier:** RF08

**Science goals:** Intensively sample recent (0-1 day old) overshoot material over Illinois

**Start of flight (UTC):** 2021-08-10 13:58Z

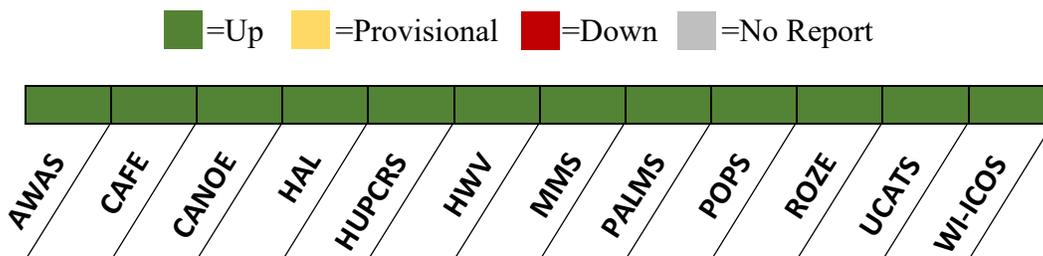
**End of flight (UTC):** 2021-08-10 21:22Z

**ER-2 Pilot:** Dean Neeley

**Mission Scientist:** Kristopher Bedka

Version	Report date and time (UTC)	Author
1	2021-08-11 21:30Z	Kristopher Bedka
2	2021-08-16 18:00Z	Kristopher Bedka, Ken Bowman, Frank Keutsch

## Instrument Performance:



**Aircraft Performance:** Good

## Science Objectives:

During the overnight and early morning hours of 10 August 2021, overshooting top producing storms occurred in northern Illinois and northwestern Kansas (Figure 1). The overshooting persisted for 5 hours (03-08 UTC) and reached ~60 kft in altitude in Kansas, and for 6 hours (22-04 UTC) and reached ~56 kft in Illinois (Figure 2). These echo top heights reached approximately 2 km above the lapse rate tropopause over the two regions. Overshooting had also occurred throughout the Midwest U.S. on 8-9 August (purple and red shading in Figure 1), leaving residual aged material across the Midwest primarily in the 46-58 kft layer. (Figure 3). The intent of RF08 was to sample overshooting from these very recent Kansas and Illinois storms, in addition to sampling any aged outflow that may have been present along the flight

track. Weak stratospheric winds atop the recent convection enabled the outflow plumes to remain very near the region where the overshooting occurred. Figures 4 and 5 summarize the flight plan, showing a map of the path and a curtain of the forecast GridRad overshoot material along planned flight path, respectively.

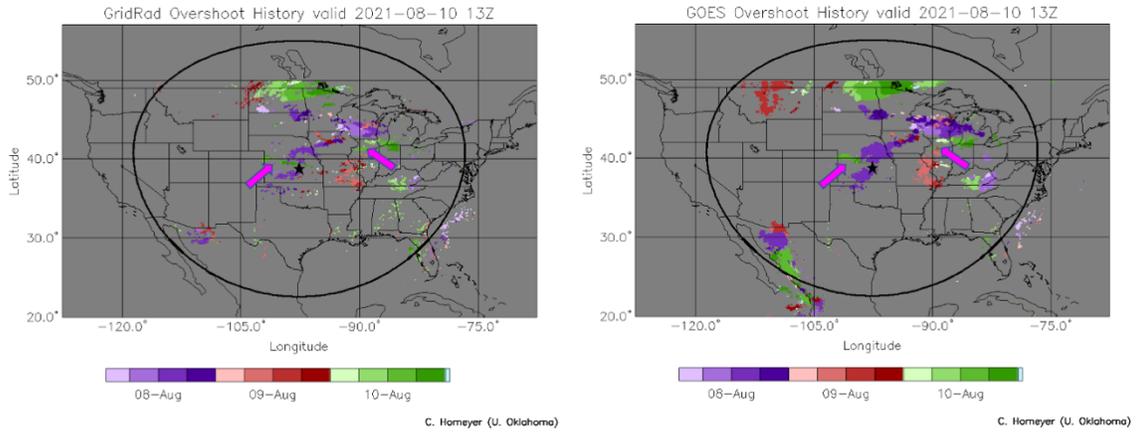


Figure 1: Overshoot material forecast from (left) GridRad and (right) GOES, valid 13 UTC on 10 August 2021. Overshooting storms of interest for RF08 are denoted with magenta arrows.

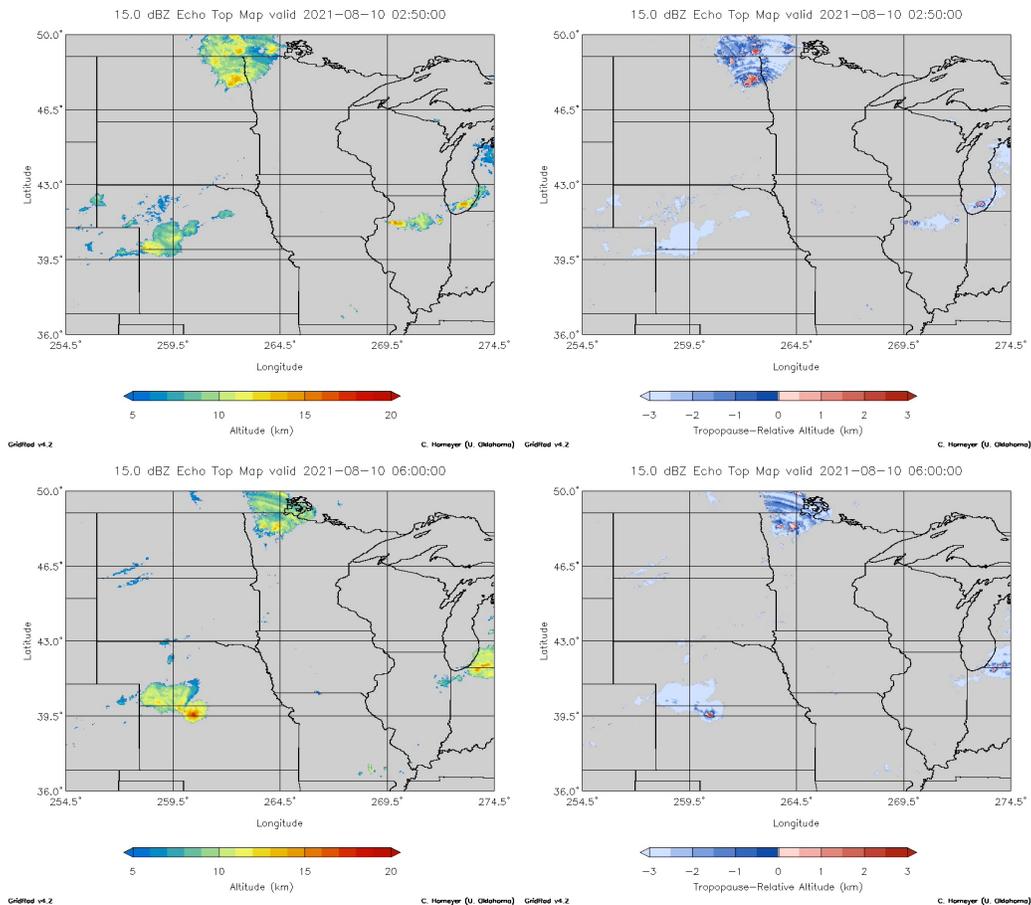


Figure 2: GridRad echo top height (left) and tropopause-relative echo top height (right) near the time of peak storm intensity for the Illinois (top) and Kansas (bottom) overshooting storms that generated outflow that RF08 sought to sample.

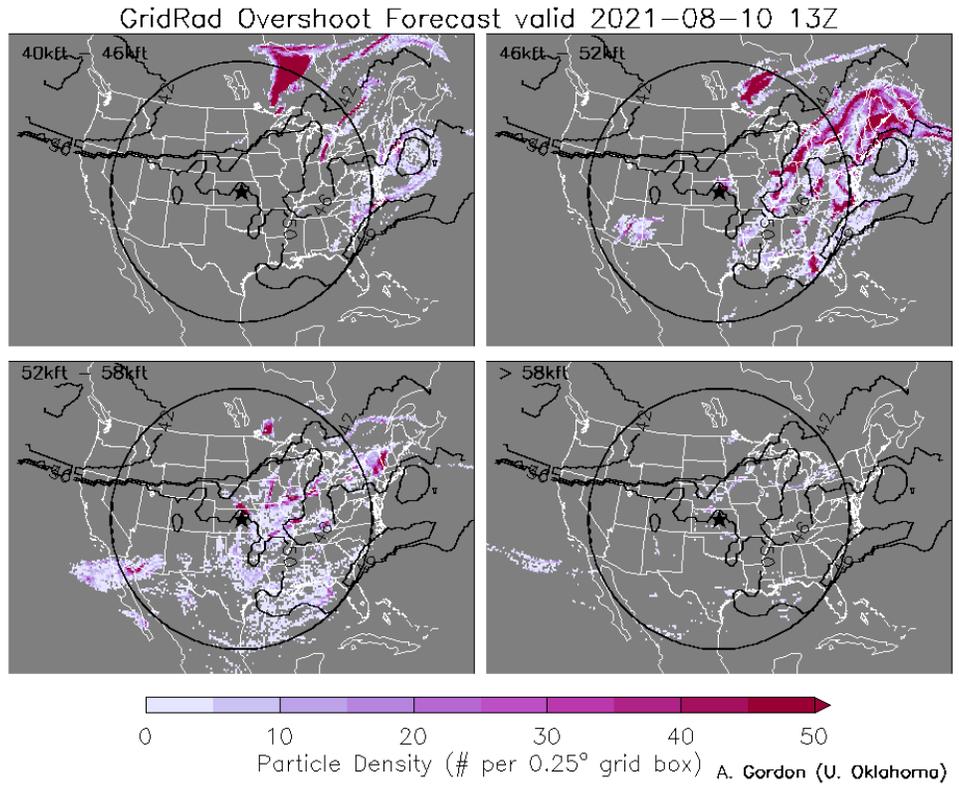


Figure 3: Forecast density of GridRad overshoot trajectory particles by altitude layer, valid 13 UTC on flight day.

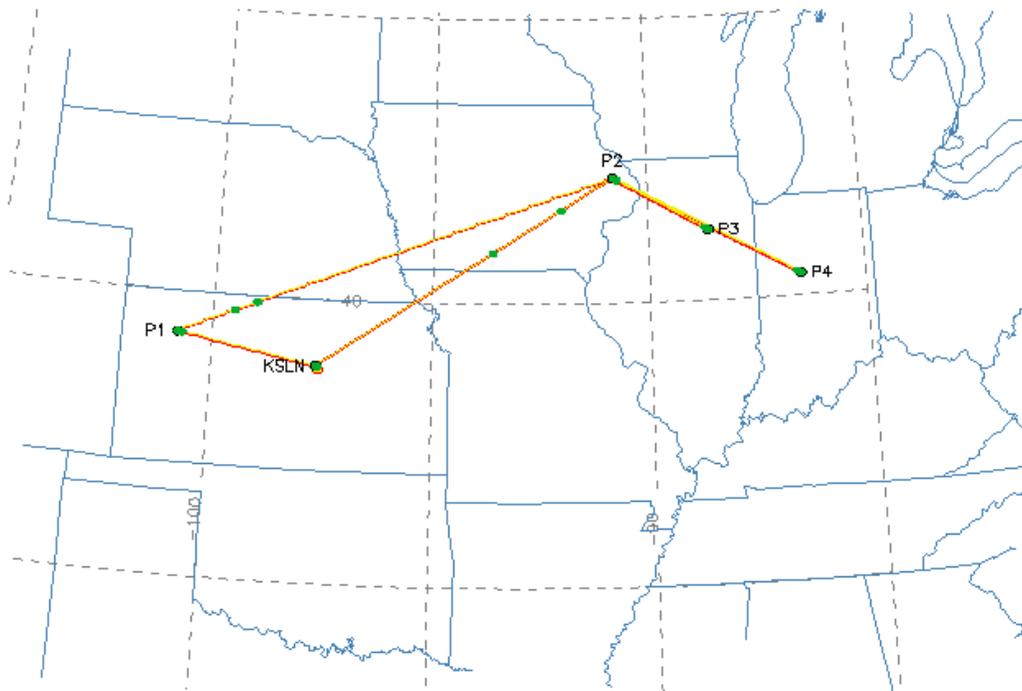
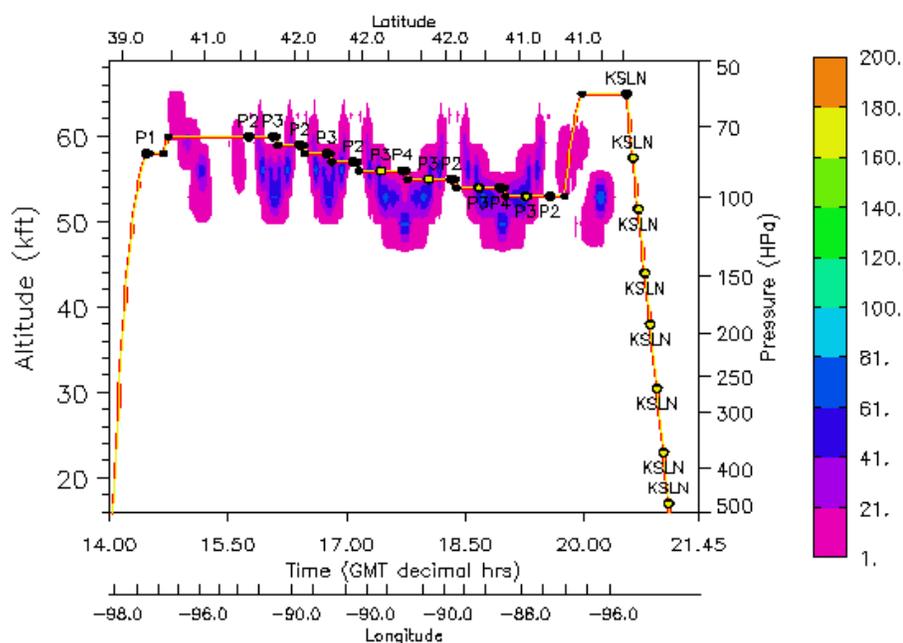


Figure 4: Map of the RF08 flight plan

2021-08-10T17:30 UTC (10-hr fcst)

count (Hours)



ER2 808: dectee\_r108\_2021-08-10\_NAS/808 v. v2a

Figure 5: Curtain of the forecast density of GridRad overshoot trajectory particles with the flight plan superimposed.

### Flight Summary:

After takeoff at 1358 UTC, the aircraft initially headed northwest of Salina to reach a 58 kft altitude at waypoint P1 (Figure 5), then ascended to 60 kft with the hope of sampling the outflow from the very recent Kansas storm. During ascent from 58 kft to 60 kft, the pilot reported turbulence that caused the aircraft to briefly pitch upward and downward in a wave-like motion, which may have been associated with gravity waves generated by the Kansas storm. Despite our best efforts to align the track to sample the very narrow fresh outflow plume, real-time display of GridRad forecast trajectory in MTS at the time of flight indicated that the track was very slightly (~ 5 miles) south of the plume location. No water vapor (WV) enhancement was observed along this segment (Figure 6-top). The aircraft progressed to waypoint P2 in eastern Iowa shortly before 1600 UTC, and performed nearly stacked vertical legs at 1 kft intervals across northern Illinois in the 57-60 kft layer to focus on a higher altitude portion of the recent outflow plume (Figure 6-bottom). The stacked legs were then extended into western Indiana to sample the 53-56 kft layer where a lower altitude portion of the plume was forecast (Figure 6-bottom).

One possible small and brief WV enhancement above 5 ppmv was observed in the 57 kft segment. Much greater but also brief enhancements were observed in each of the 53-56 kft segments, most notably at 54 kft where 23 ppmv was observed by the HWV instrument with ROZE ozone near 600 ppmv. The duration of enhancements was less than 1 minute, suggesting that the overshooting updrafts were quite small and short-lived. No WV notable enhancements were observed in eastern Illinois and western Indiana, but given the high density of GridRad

outflow parcels in this region, it is possible that enhancements were located at levels slightly beneath the aircraft.

After completing the MMS maneuver at 53 kft shortly before 2000 UTC, the aircraft then headed back toward Salina. Thunderstorms rapidly developed in regions across the Midwest throughout the flight. The ER-2 camera was rotated several times to observe various intense storms. Ice crystals can be seen in an ER-2 photo emanating outward from an overshooting updraft located in eastern Iowa that cannot be seen in a nearly simultaneous GOES-16 satellite visible image (Figure 7). A spiral descent around the projected balloon location was conducted, and after a slightly delay due to air traffic control, the aircraft landed safely at 2140 UTC.

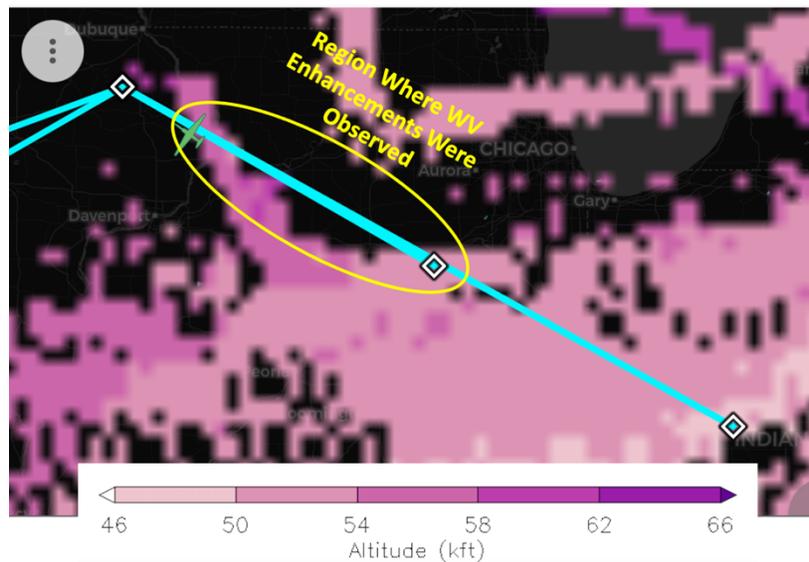
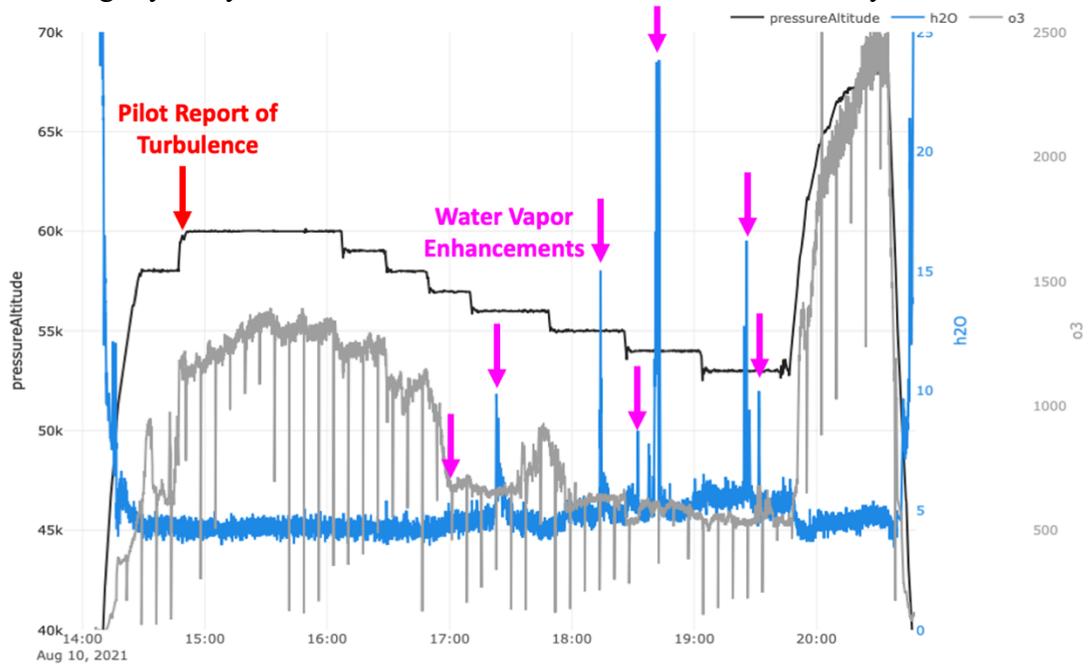
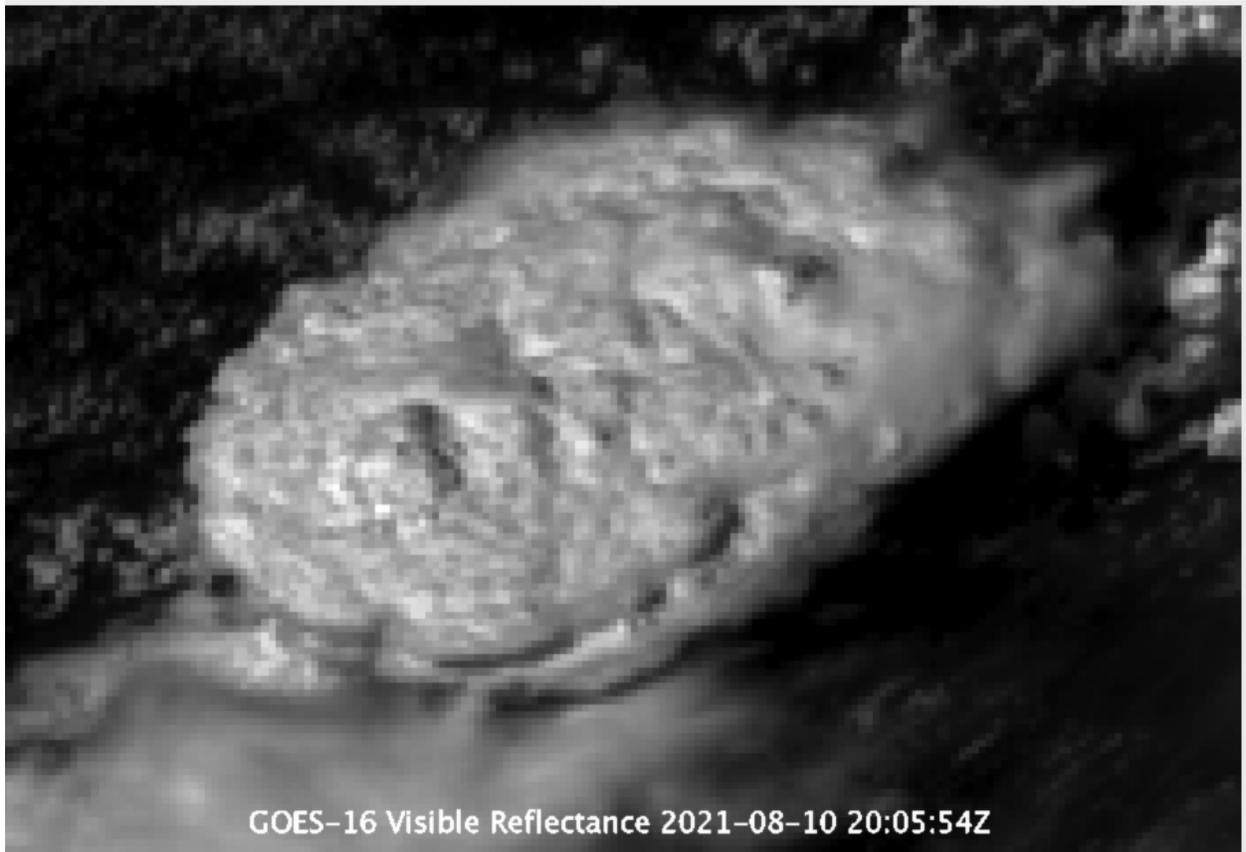


Figure 6: (top panel) Timeseries of MMS aircraft pressure altitude, ROZE ozone, and HWV LyA water vapor from MTS. Time periods during the 1-kft horizontal legs where evidence of enhanced water vapor (relative to typical background concentrations) was observed are indicated by magenta arrows. (bottom panel) GridRad overshoot trajectory forecast overlaid with the general region where WV enhancements were observed.



*Figure 7: (top) Image capture from the ER-2 of a storm with an overshooting top near Marshalltown, Iowa at 2005 UTC. (bottom) GOES-16 visible satellite image of this storm collected with 45 seconds of the ER-2 photo.*