

National Transportation Safety Board

Office of Aviation Safety

Washington, DC 20594



DCA25LA197

METEOROLOGY

Environmental Conditions

May 15, 2025

NWS Surface Depiction

The NWS Aviation Weather Center's surface observations with the composite radar overlaid for 1700Z is included as figure 1. The surface fronts and other features from 1500Z are also depicted, which indicated an outflow boundary immediately west of the area. The composite radar overlaid depicted several extreme intensity echoes generally in a north-northeast to south-southwest orientation. The strong echoes in the middle of the display is the area related to this event.

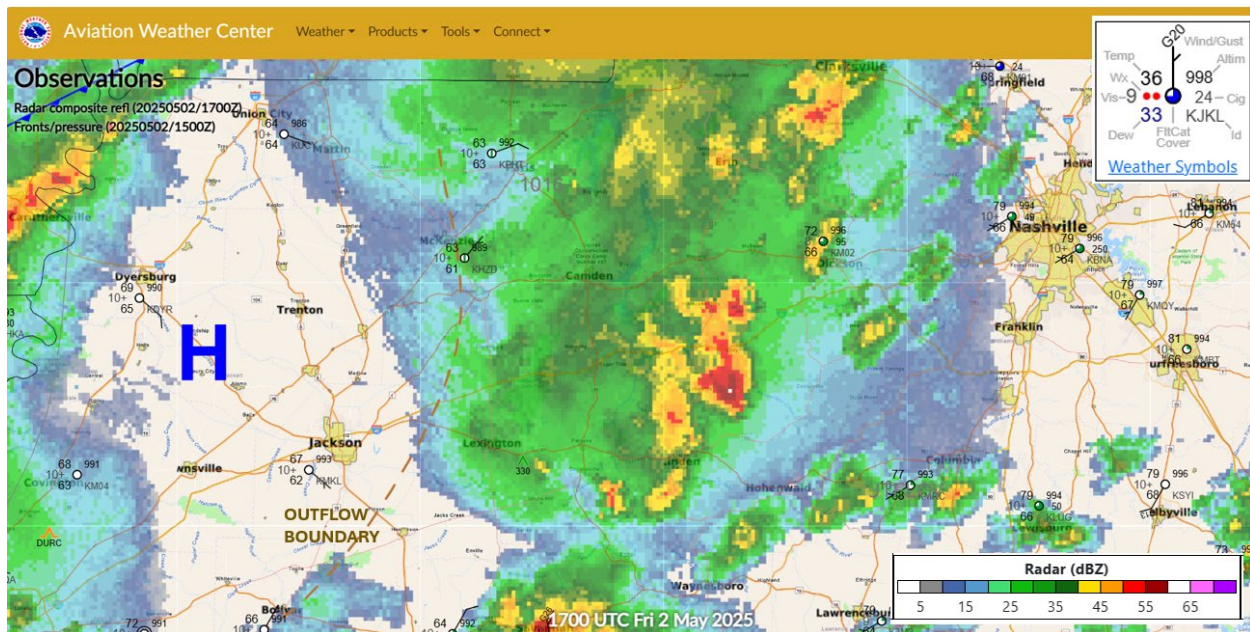


Figure 1 - NWS Aviation Weather Center observation display at 1700Z.

Review of Weather Radar Imagery

The closest NWS Weather Surveillance Radar 1988 Doppler (WSR-88D) to the hail encounter was from Nashville (KOHX), Tennessee, located about 58 miles east-northeast. The Level II radar data was obtained from the National Center for Environmental Information (NCEI) using the Hierarchical Data Storage System and displayed using the NWS NEXRAD Interactive Viewer and Data Exporter software and the GR2 Analysis program.

During the period the KOHX WSR-88D was operating in the precipitation mode using volume scan pattern 212 (VCP-212) where the radar makes 14 different elevation scans in 4 ½ minutes. Based on the KOHX distance and radar antenna elevation of 676 ft, the lowest elevation scan of 0.54° typically viewable on most apps and weather sites was centered near 6,230 ft over the hail encounter. While the elevation scan 4.0° was

scanning the altitudes between 24,560 ft through 30,400 ft over the flight track at the time of the hail encounter and represents what reflectivities the flight penetrated.

Elevation	Center	Base	Top	Width
0.53°	6,230 ft	3,300 ft	9,150 ft	5,840 ft
3.12°	22,080 ft	19,160 ft	25,000 ft	5,840 ft
4.00°	27,480 ft	24,560 ft	30,400 ft	5,840 ft

Reflectivity is the measure of the efficiency of a target in intercepting and returning radio energy. With hydrometeors, it is a function of the drop size distribution, number of particles per unit volume, physical state (ice or water), shape, and aspect. Reflectivity is normally displayed in decibels (dBZ) and is a general measure of echo intensity. Figure 2 relates the NWS former video integrator and processor (VIP) intensity level (1-6) versus the WSR-88D's display levels (0-15), precipitation mode reflectivity in decibels (DBZ) and rainfall rates.

NWS VIP/DBZ CONVERSION TABLE			
NWS VIP	WSR-88D LEVEL	PREC MODE DBZ	RAINFALL
0	0	< 5	
	1	5 to 9	
	2	10 to 14	
1 Very Light	3	15 to 19	.01 in/hr
	4	20 to 24	.02 in/hr
	5	25 to 29	.04 in/hr
2 Light to Moderate	6	30 to 34	.09 in/hr
	7	35 to 39	.21 in/hr
3 Strong	8	40 to 44	.48 in/hr
4 Very Strong	9	45 to 49	1.10 in/hr
5 Intense	10	50 to 54	2.49 in/hr
6 Extreme	11	55 to 59	>5.67 in/hr
	12	60 to 64	
	13	65 to 69	
	14	70 to 74	
	15	> 75	

Figure 2 - NWS video integrated process (VIP) levels and corresponding reflectivity levels in dBZ, and expected rainfall rates.

The FAA Aviation Weather Handbook defines the echoes intensity and how the FAA air traffic controller would provide advisories to users. Where echoes less than 30 dBZ as "light" in intensity, "moderate" echoes 30-40 dBZ, "heavy" with echoes of >40-50 dBZ, and "extreme" intensity with echoes above >50 dBZ. The following table are the standard radio phraseology terms used by air traffic controllers to describe weather echo intensity conditions to pilots. Light rain is typically reported at the surface when reflectivities reach 20 dBZ, while air traffic control weather displays typically do not

display echoes less than 30 dBZ or light intensity echoes on their weather displays, and airborne weather radar and other FIS-B do not include echoes less than 20 dBZ.

Reflectivity (dBZ) Ranges	Weather Radar Echo Intensity Terminology
<30 dBZ	Light
30-40 dBZ	Moderate
>40-50 dBZ	Heavy
>50 dBZ	Extreme

Figures 3-5 are the KOHX WSR-88D base reflectivity images for the elevation scans for 0.53°, 3.1° and 4.0° for 1702Z with SWA2231's flight track every 30 seconds ending at 1704Z. The images depict the flight passing through an area of extreme intensity echoes up to 65 dBZ at lower elevation scans and 58.5 dBZ at the aircrafts flight level. The Sever hail algorithm indicated hail to 1.58 inches in the vicinity of the flight track during the period with the maximum height of the 18.5 dBZ echoes or echo tops to FL446.

Figure 6 is an approximate GR2 Analysis cross section of the KOHX WSR-88D image for 1702Z with the flight track of SWA2231 overlaid in white and depicted the flight overflying a maximum reflectivity core of 60 dBZ and in echoes of 56.0 dBZ along the track.

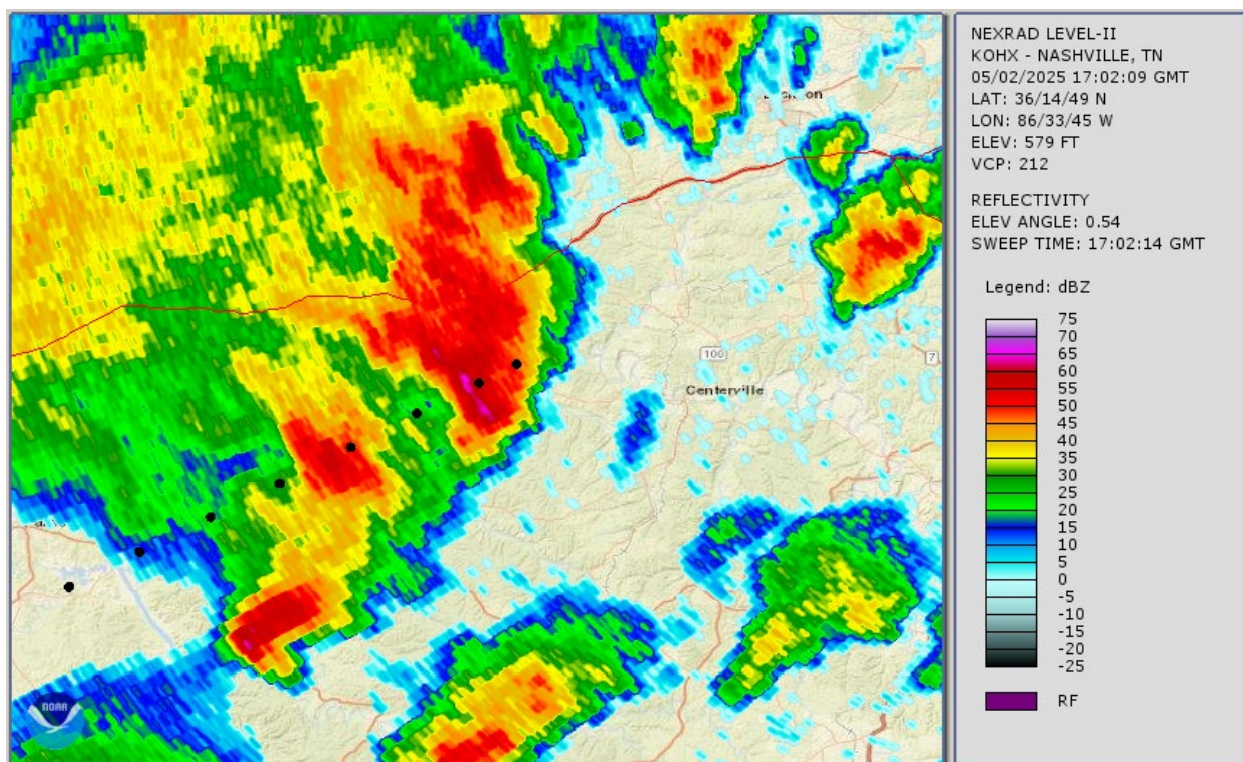


Figure 3 - NWS Nashville WSR-88D 0.54° base reflectivity image for 1702Z with flight track ending at 1704Z overlaid.

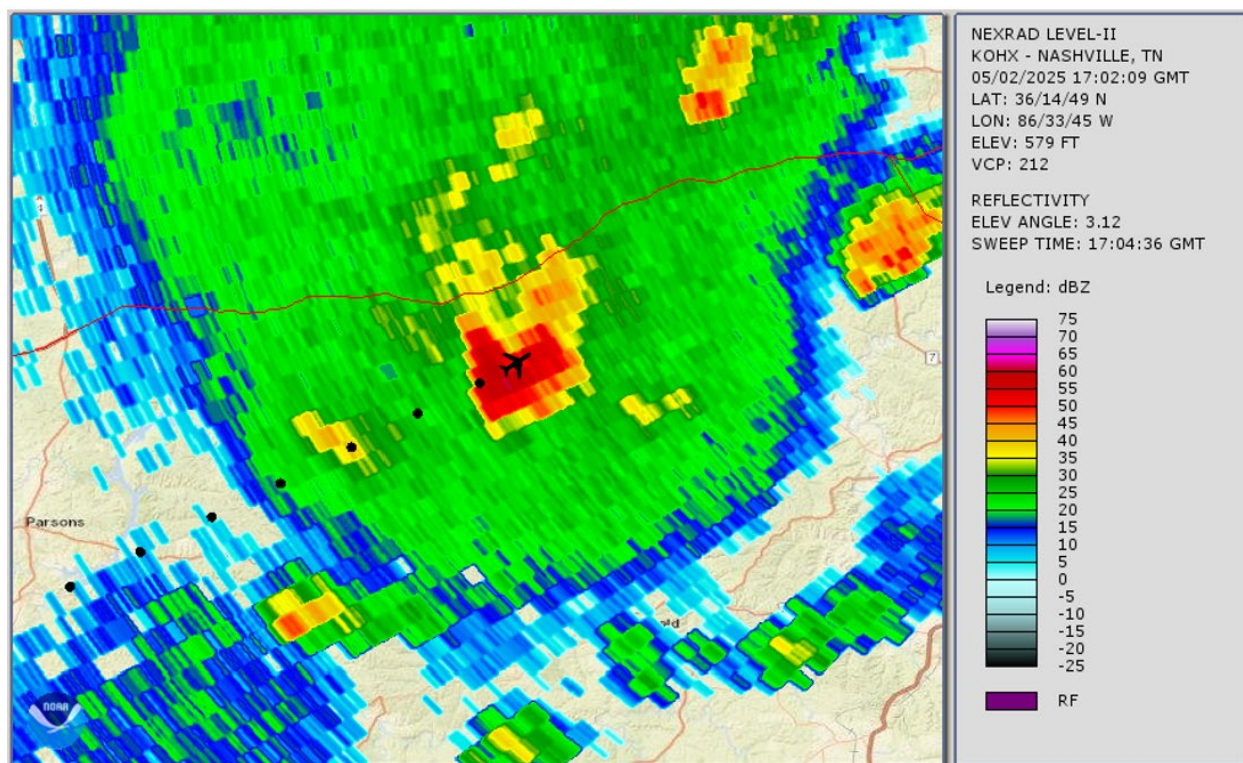


Figure 4 - NWS Nashville WSR-88D 3.12° base reflectivity image for 1702Z with flight track ending at 1704Z overlaid depicting conditions near.

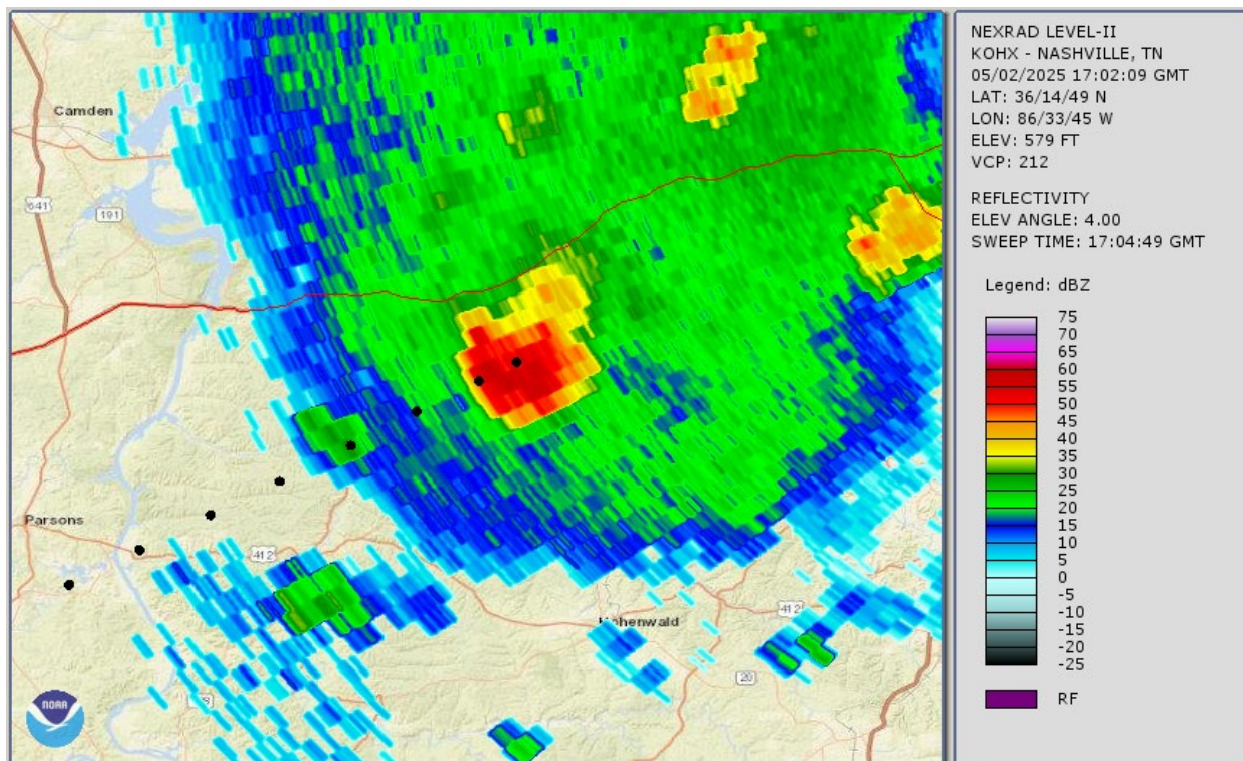


Figure 5 - NWS Nashville WSR-88D 4.0° base reflectivity image for 1702Z with flight track ending at 1704Z overlaid.

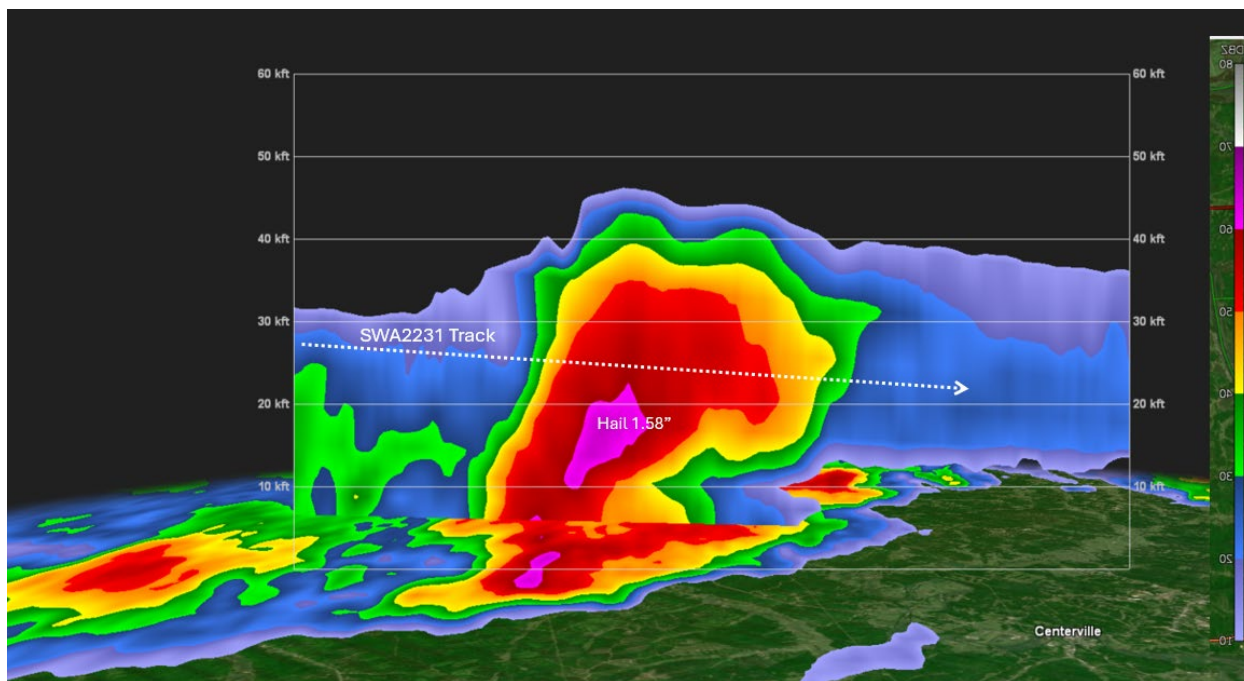


Figure 6 - NWS KOHX WSR-88D cross section at 1702Z with the approximate flight path of SWA2231 overlaid.

Figure 7 is the FAA Consolidated Storm Prediction for Aviation (CoSPA) image for 1700Z available to the FAA supervisor personnel and aircraft dispatchers with the location of SWA2231 at 1703Z exiting the VIL level 6 return which was depicted with a maximum echo tops to FL500 with multiple cloud-to-ground lightning strikes. The image clearly shows an extreme intensity echo over the hail encounter location.

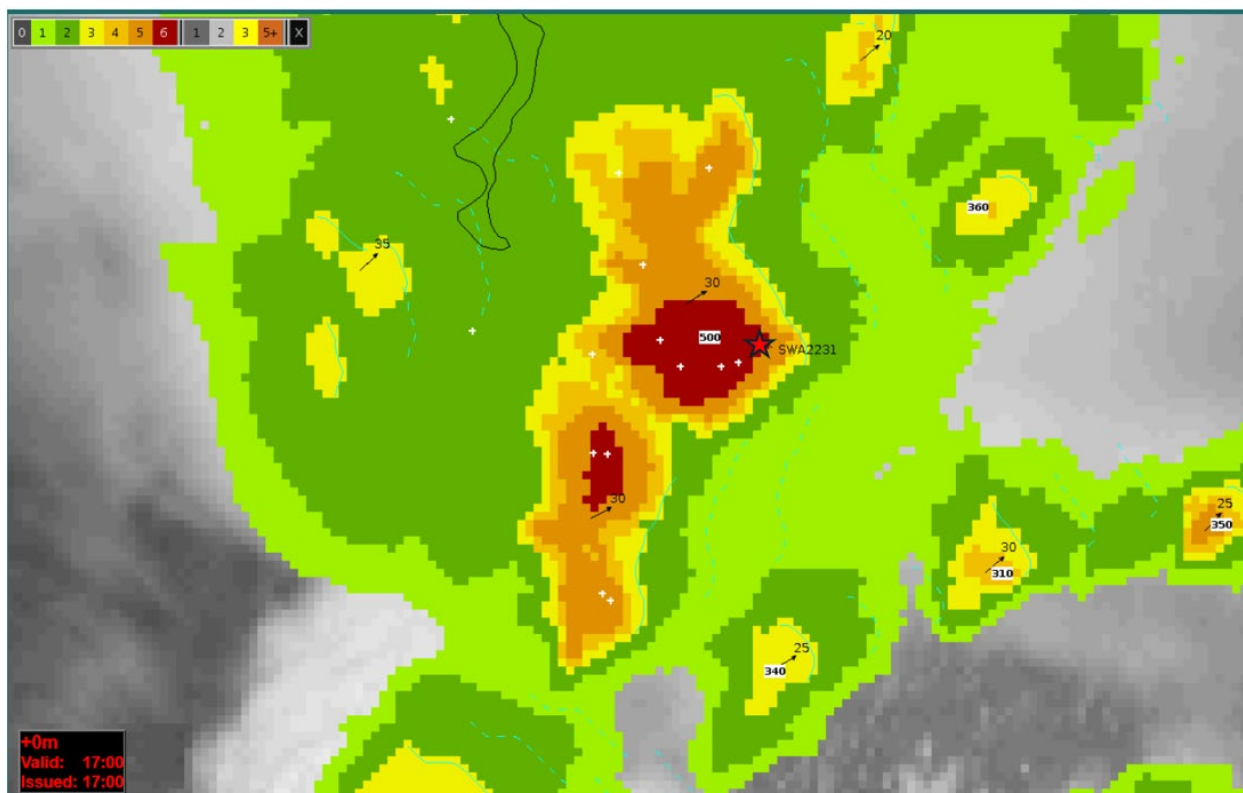


Figure 7 - FAA COSPA image for 1700Z with the location of SWA2231 at 1703Z exiting the extreme intensity echo.

Inflight Weather Advisories

Figure 8 is a depiction of the NWS Convective SIGMETs issued for the period.

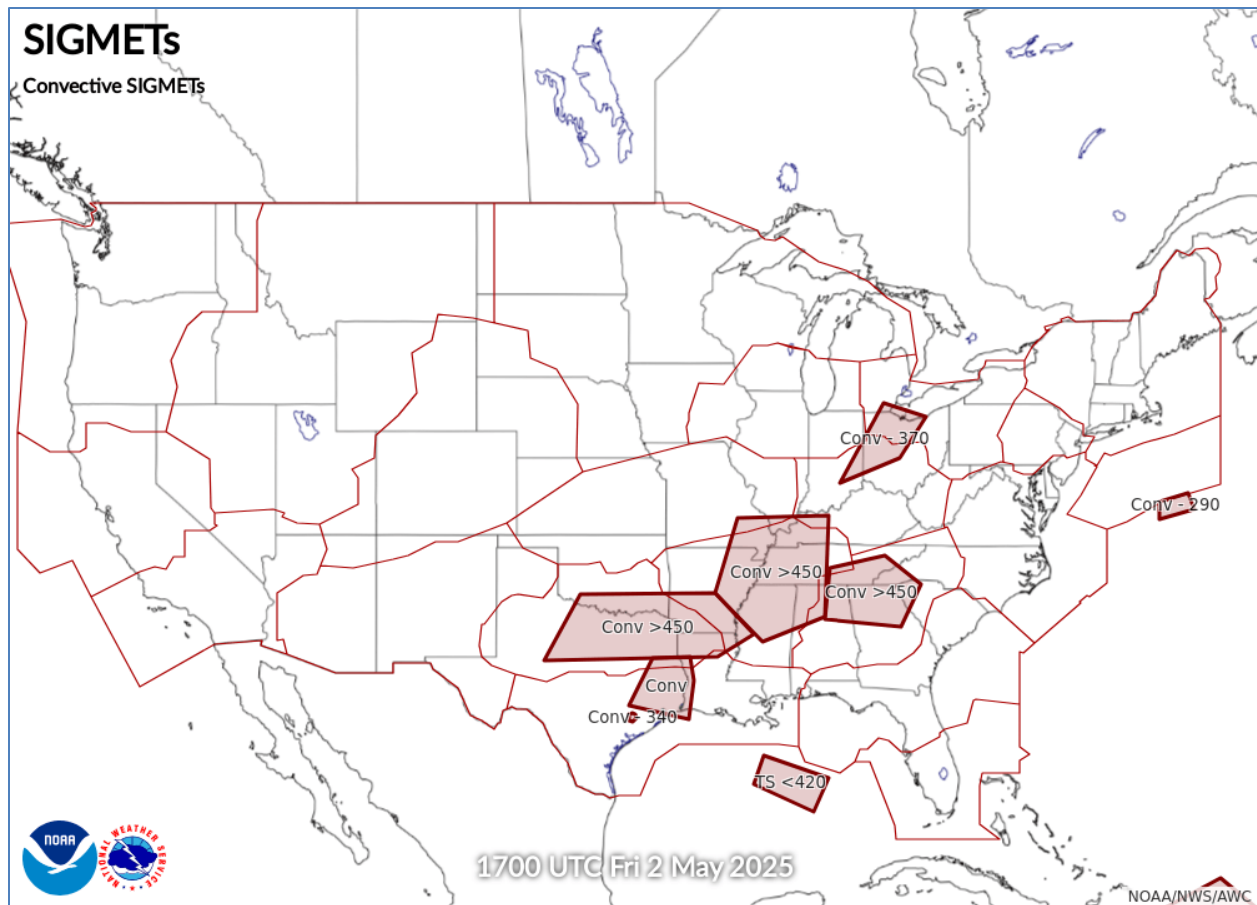


Figure 8 - NWS Aviation Weather Center Convective SIGMETs issued for 1655Z

The NWS Aviation Weather Center (AWC) had issued Convective SIGMET 99C at 1655Z which was extended over the area for an area of severe embedded thunderstorms moving from 250° at 40 knots, with maximum tops above FL450. Hail to 1 inch in diameter and wind gusts to 50 knots were possible with the storms.

WSUS32 KPCI 021655
 SIGC
 CONVECTIVE SIGMET 99C
 VALID UNTIL 1855Z
 TN KY AL IL MS MO AR
 FROM 50WSW IJU-10E VUZ-20NE MHZ-LIT-40W FAM-50WSW IJU
 AREA SEV EMBD TS MOV FROM 25040KT. TOPS ABV FL450.
 HAIL TO 1 IN...WIND GUSTS TO 50KT POSS.

The NWS Storm Prediction Center had issued a severe thunderstorm weather watch at 1456Z for a line of severe thunderstorms moving across Tennessee. The aviation alert was as follows.

SAW9
 WW 209 SEVERE TSTM AL AR KY MS TN 021500Z - 022200Z
 AXIS..70 STATUTE MILES NORTH AND SOUTH OF LINE..

55SW MEM/MEMPHIS TN/ - 75ESE BWG/BOWLING GREEN KY/
..AVIATION COORDS.. 60NM N/S /49SW MEM - 58WSW LOZ/
HAIL SURFACE AND ALOFT..2 INCHES. WIND GUSTS..60 KNOTS.
MAX TOPS TO 500. MEAN STORM MOTION VECTOR 25035

The NWS KOHX Weather Forecast Office (WFO) also had a sever weather warning posted for the area.

Submitted by:

Donald Eick
Senior Meteorologist