



NATIONAL TRANSPORTATION SAFETY BOARD

Office of Aviation Safety
Washington, D.C. 20594

July 3, 2019

Weather Study

METEOROLOGY

CEN19FA119

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A. ACCIDENT

Location: New Albany, Mississippi
Date: April 13, 2019
Time: about 1514 central daylight time
2014 Universal Coordinated Time (UTC)
Airplane: Rockwell International Sabreliner NA-265-65; Registration: N265DS

B. METEOROLOGIST

Don Eick
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Operational Factors Division (AS-30)
National Transportation Safety Board

C. SUMMARY

On April 13, 2019 about 1514 CDT, a Rockwell International NA-265-65 airplane, N265DS, impacted terrain near New Albany, Mississippi, following a reported electrical malfunction. The two commercial pilots and one passenger were fatally injured. The airplane was destroyed. The airplane was registered to Classic Aviation Inc. and operated as a 14 *Code of Federal Regulations* Part 91 personal flight. Instrument meteorological conditions were reported at the accident site and along the route of flight about the time of the accident, and the flight was operated on an instrument flight rules flight plan. The flight originated from University-Oxford Airport (UOX), Mississippi at 1506 and was destined for Marion County-Rankin Fite Airport (HAB), Georgia.

D. DETAILS OF THE INVESTIGATION

The National Transportation Safety Board's Senior Meteorologist was not on scene for this investigation and conducted the meteorology phase of the investigation from the Washington D.C. office, collecting data from official National Weather Service (NWS) sources including the Weather Prediction Center (WPC) and the National Center for Environmental Information (NCEI). All times are central daylight time (CDT) based upon the 24-hour clock, local time is -5 hours from UTC, and UTC=Z. NWS airport and station identifiers use the standard International Civil Aviation Organization 4-letter station identifiers versus the International Air Transport Association 3-letter identifiers, which deletes the initial country code designator "K" for U.S. airports. Directions are referenced to true north and distances in nautical miles. Heights are in feet (ft) above mean sea level (msl) unless otherwise noted. Visibility is in statute miles and fractions of statute miles.

The accident site plotted in this report are based on the coordinates of latitude 34.382500° N and longitude 88.956111° W, at an elevation of approximately 292 ft.

E. WEATHER INFORMATION

1.0 Synoptic Conditions

The synoptic or large scale migratory weather systems influencing the area were documented using standard NWS charts issued by the National Center for Environmental Prediction located in College Park, Maryland. These are the base products used in describing weather features and in the creation of forecasts and warnings. Reference to these charts and all the other weather products documented in this report can be found in the joint NWS and Federal Aviation Administration (FAA) Advisory Circular “Aviation Weather Services”, AC 00-45H change 1.

1.1 Surface Analysis Chart

The southeast section of the NWS Surface Analysis Chart for 1600 CDT with the accident marked by a red star is included as figure 1. The chart depicted a low pressure system at 998-hectopascals (hPa) over eastern Texas associated with an occluded front which extended eastward into Louisiana, where the triple point of the front was located with a second low-pressure system at 998-hPa. A cold front extended south-southwestward from the triple point in Louisiana into the Gulf of Mexico, with a warm front extending from the triple point east-northeastward across Louisiana, Mississippi, Alabama, Georgia into South Carolina where the front became stationary. To the north of the warm front a dissipating stationary front was depicted extending from northern Louisiana, southern Arkansas, northern Mississippi, into Tennessee. The accident site was located between the dissipating stationary front and north of the warm front in the cool air side of the front, in an area favorable for overrunning clouds and precipitation.

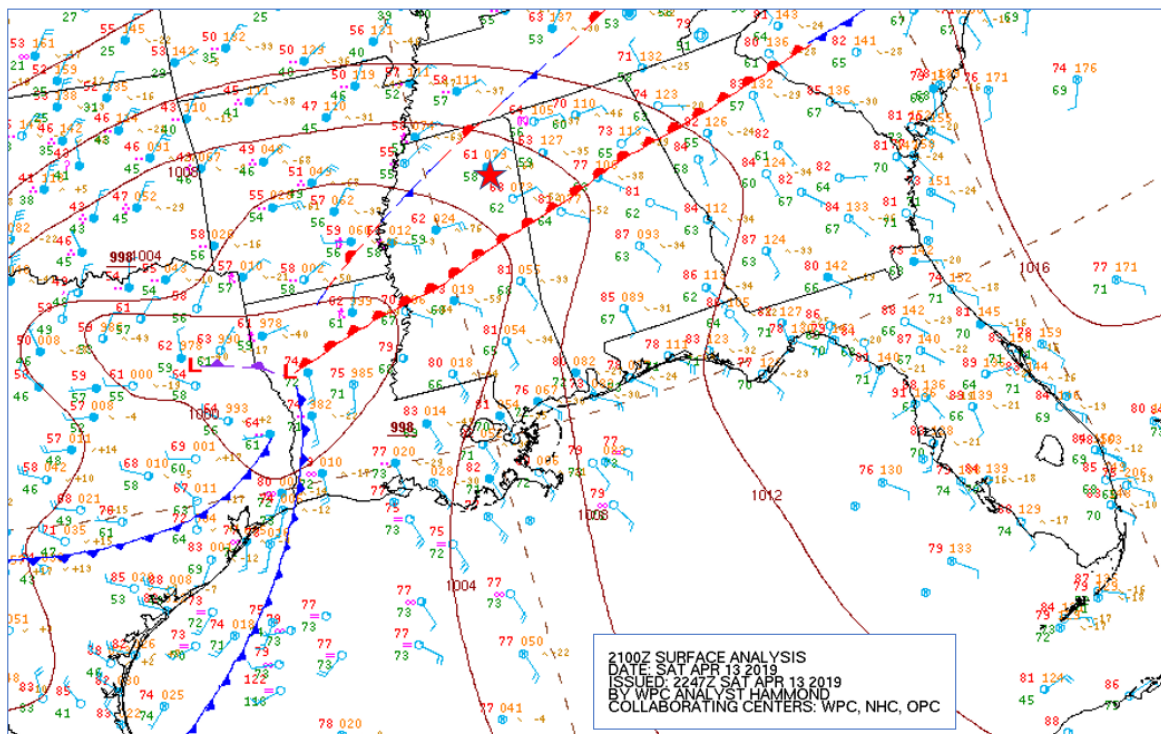


Figure 1 - Surface Analysis Chart for 1600 CDT

The station models on the chart depicted an extensive cyclonic wind flow pattern associated with the low-pressure systems and the fronts. In the immediate vicinity of the accident site the station model depicted wind from the east at about 10 knots, with broken to overcast sky cover, a temperature of 61° Fahrenheit (F), with dew point temperature of 58° F, with a sea-level pressure of 1007.3-hPa. Numerous station models over Louisiana, western Mississippi, Arkansas, into Tennessee, and northern Alabama reported thunderstorms, moderate to light rain.

1.2 Constant Pressure Chart

The NWS Storm Predict Centers (SPC) Constant Pressure Chart for 500-hPa taken from the upper air soundings for 1900 CDT is included as figure 2. The 500-hPa chart depicted the conditions of the mean atmosphere at approximately 18,000 ft. The chart depicted an upper level low pressure system over northern Texas with a long wave trough extending southward from the low. Ahead of the low a band of 70 to 80 knots winds from the south were noted from the Gulf of Mexico northward across Louisiana, Arkansas, Mississippi, and Alabama. The accident site was located ahead of the upper low near the apex of the trough to ridge, in an area favorable for rising motion and the formation of clouds and precipitation if sufficient lift and moisture were present.

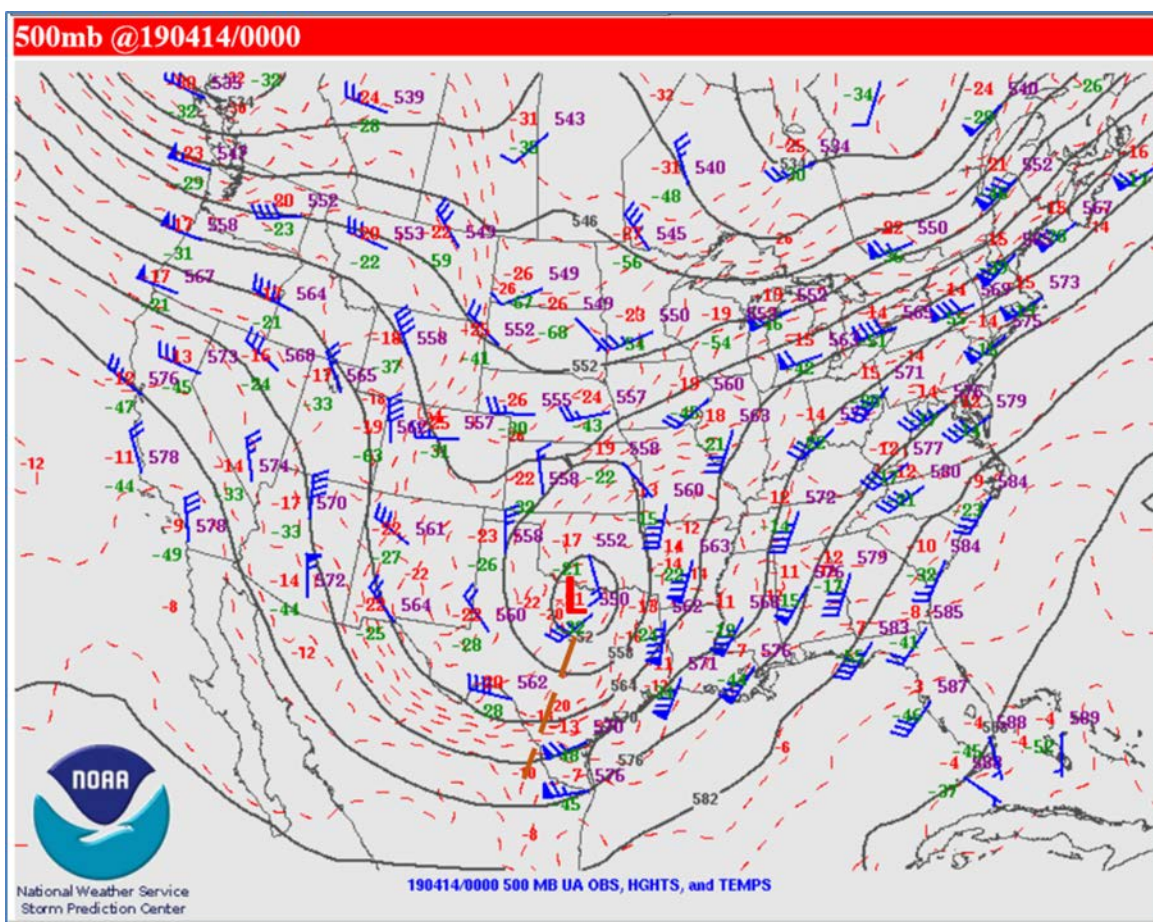


Figure 2 - NWS Constant Pressure Chart for 500-hPa at 1900 CDT

1.3 National Composite Radar Mosaic

The southcentral National Mosaic Radar¹ around 1500 CDT is included as figure 3 which showed a large area of precipitation wrapping around the occluded frontal system. The accident site was located in the eastern edge of the band of precipitation and immediately south and east of the strongest echoes.

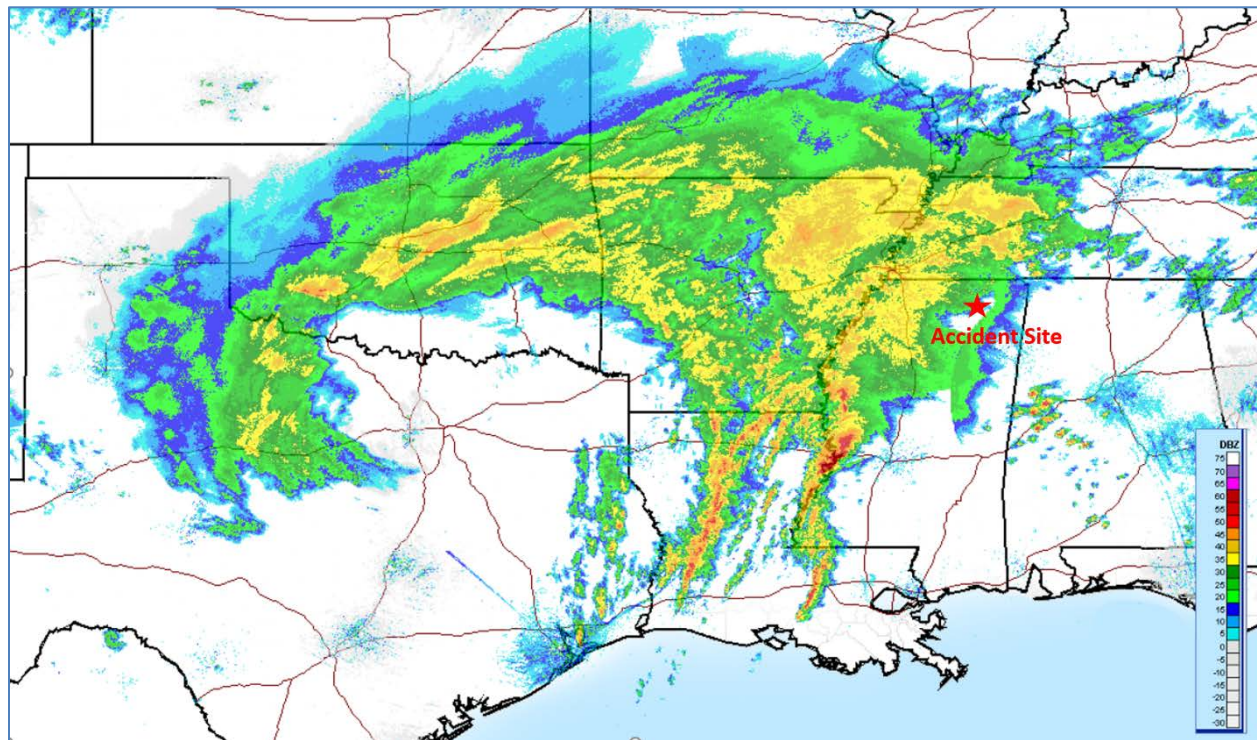


Figure 3 - Southcentral section of the National Mosaic Radar near 1500 CDT

Figure 4 is the NWS National Composite Radar Mosaic image for 1515 CDT with the approximate accident site and the surrounding airports marked obtained from the NCEI archive data. The mosaic depicted a large area of precipitation extending over the area with the accident site on the southern edge of the area of precipitation. Strong echoes in the range of 45 to 60 dBZ were depicting surrounding the departure airport (KUOX), Tupelo (KTUP), and in the vicinity of the destination airport (KHAB), with echoes of 30 to 35 dBZ or moderate intensity echoes extended over the accident site.

¹ This NWS National Mosaic image utilized base reflectivity data from the lowest tilt of the corresponding WSR-88D's to create the mosaic versus composite data, which utilizes all the elevation scans to present the maximum intensity of the echoes.

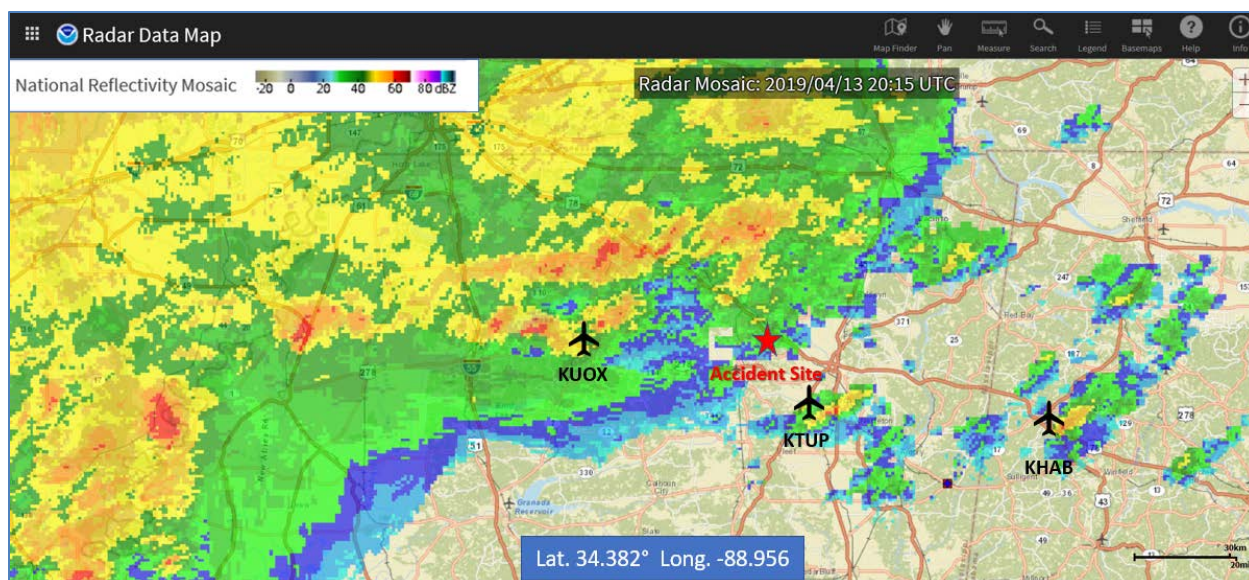


Figure 4 - National Composite Radar Mosaic for 1515 CDT over the accident site

Based on the detection of potential strong echoes in the immediate vicinity of the accident site, the closest weather surveillance radar will be document in section 5.0 of this report.

1.4 Convective Outlook

The NWS SPC Day 1 Convective Outlook graphic issued at 1228 CDT for the 24-hour period is included as figure 5 followed by the text bulletin (AC) current for the period. The Convective Outlook is designed to provide users a quick reference to where strong to severe organized convection or thunderstorms² are expected within the next 24-hours, with the text bulletin providing a description of the meteorological conditions, the threat potential, and general timing in the forecast. The outlook expected a moderate risk of organized severe thunderstorms from east Texas, northern and central Louisiana, into central and western Mississippi. An enhanced risk³ surrounding that area and included the accident site.

² Severe thunderstorm – is defined as a thunderstorm that produces a tornado, surface hail with a diameter of 1-inch or more, or wind gusts of 50 knots or more. Severe thunderstorms also imply severe to extreme turbulence, severe icing, localized Instrument Flight Rule (IFR) conditions, lightning, and the potential for microbursts, low-level wind shear, and flash flooding.

³ An enhanced risk implied that numerous severe thunderstorms were possible and were expected to be more persistent and/or widespread, with a few intense storms capable of producing a tornado, large hail, and/or damaging winds over 50 knots.

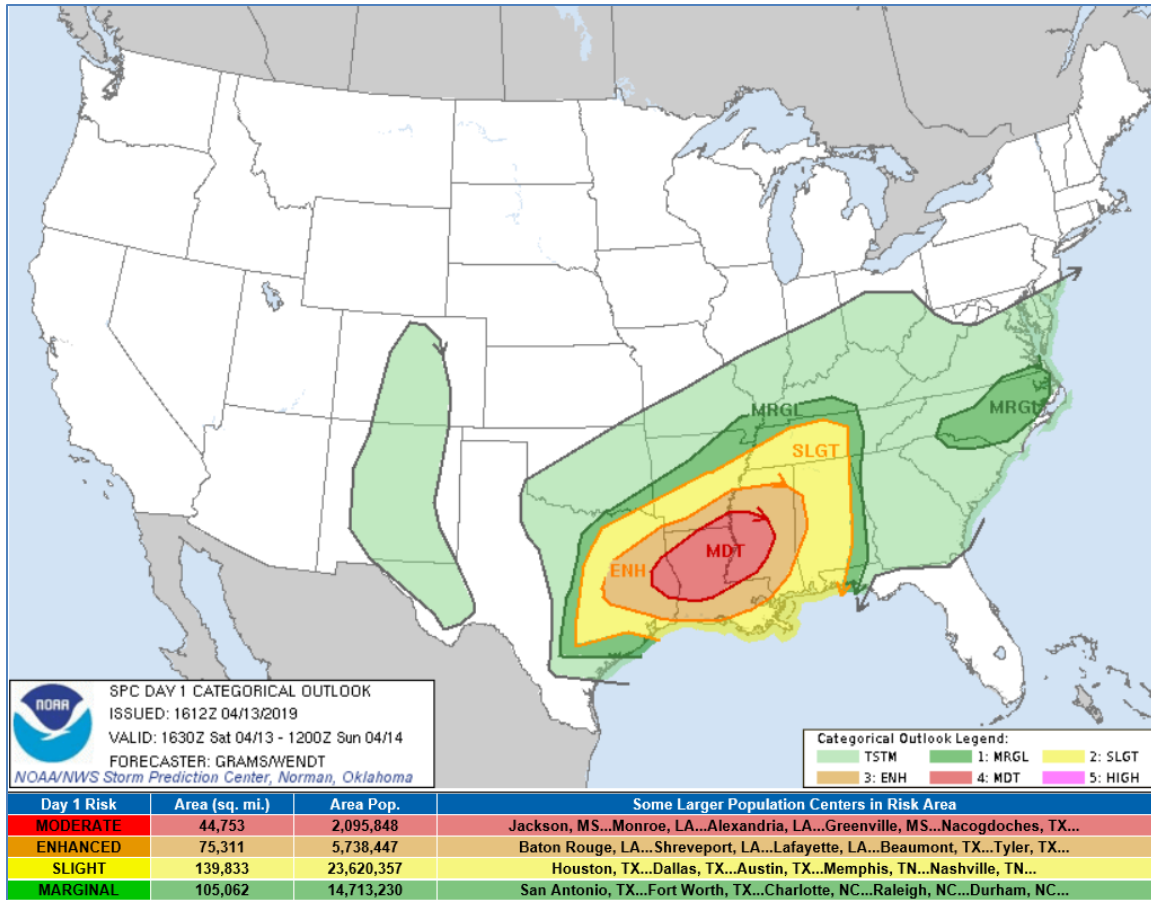


Figure 5 – Graphic Convective Outlook issued at 1112 CDT

Day 1 Convective Outlook
NWS Storm Prediction Center Norman OK
1112 AM CDT Sat Apr 13 2019

Valid 131630Z - 141200Z

...THERE IS A MODERATE RISK OF SEVERE THUNDERSTORMS EAST TEXAS...NORTHERN AND CENTRAL LOUISIANA...WESTERN AND CENTRAL MISSISSIPPI...

...SUMMARY...

Numerous to widespread severe thunderstorms are expected across parts of the south-central to southeast states through tonight. The most likely region for strong tornadoes is from east Texas to Mississippi, with the most dangerous period for tornadoes being between about 2 to 8 PM CDT.

...TX to TN Valley...

No substantial changes to categorical areas with this outlook (beyond reducing area behind the convective line in TX).

Surface cyclone near College Station should move northeast towards northwest LA and then across the Mid-South through tonight, as a warm front advances north from southeast TX/central LA. Parameter space is very supportive of supercells, with persistent warm-advection north of the front yielding a risk for large hail. Along and south of the front, main uncertainties are longevity and discreteness of favorable storm mode. A deeply moist boundary layer with upper 60s to lower

70s dew points will spread north, supporting preconvective MLCAPE ranging from 2000-3000 J/kg across southeast TX and southern LA. Such buoyancy will be quite favorable for all forms of severe, amid strengthening deep shear related to the approach of the mid/upper trough. Furthermore, low-level shear vectors and hodograph sizes will be quite large along and south of the warm front (from the Sabine Valley eastward), with forecast soundings yielding 250-600 J/kg effective SRH. Any sustained supercells in this environment will be capable of significant tornadoes.

With time this evening and overnight, convection should organize into a roughly north/south-aligned band over the Lower Mississippi Valley region, as deep convergence becomes better-focused in the mass response ahead of the synoptic wave. As this occurs, the main threat in a bulk sense may become damaging wind tonight. However, given the strong inflow-layer SRH, tornadoes still will be probable from both embedded supercells and QLCS mesovortices.

...Central/eastern NC...

Scattered thunderstorms are expected to develop through this afternoon, offering the potential for locally strong wind gusts and marginally severe hail.

Mid/upper-level support will be lacking, beneath a belt of southwesterlies aloft. But the region will straddle a low-level moist axis characterized by surface dew points generally in the mid/upper 60s F, supporting preconvective MLCAPE from 1000-2000 J/kg. Though low-level flow will be weak, limiting boundary-layer shear and hodograph size, the height gradient will remain sufficiently tight aloft to support strong storm-relative winds in upper levels, and effective-shear around 40-45 kt. As such, a few organized multicells and sporadic supercell structures will be possible. Storm intensity will diminish after sunset.

..Grams/Wendt., 04/13/2019

1.5 12-hour Surface Prognostic Chart

The NWS 12-hour Surface Prognostic Chart current during the period is included as figure 6 and was issued at about 1100 CDT and was valid for 0100 CDT on April 14, 2019. The chart depicted the low-pressure system having moved to the northeast Texas, Louisiana, and Arkansas border with the occluded front extending eastward to the triple point near the Louisiana and Mississippi border. A stationary front continued northeastward into Tennessee and then became a warm front eastward across Kentucky. A cold front was depicted from the triple point southward across western Mississippi, into Louisiana, and into the Gulf of Mexico. A large area of precipitation wrapped around the occluded frontal system, with a greater than 55% probability of thunderstorms ahead of the cold front across the Gulf Coast, southeastern Louisiana, Mississippi, Alabama, into Tennessee.

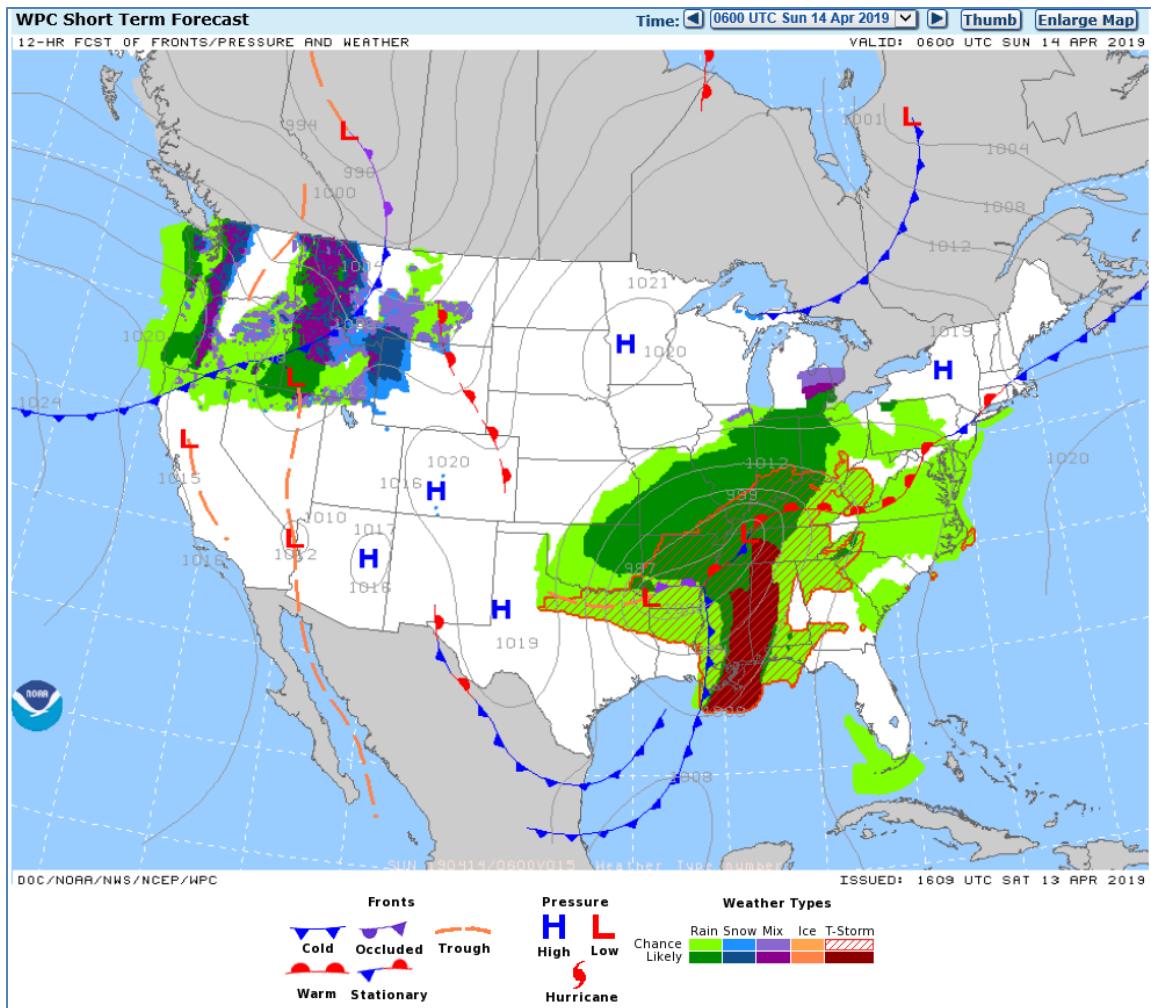


Figure 6 – NWS 12-hour Surface Prognostic Chart valid for the period

2.0 Observations

The surrounding area was documented using official Meteorological Aerodrome Reports (METAR) and Specials (SPECI) reports. The area had a magnetic variation of 5° West based on the sectional chart for the area. Cloud heights are reported in height above ground level (agl) in the following section.

2.1 Tupelo, Mississippi

The closest weather reporting facility to the accident site was Tupelo Regional Airport (KTUP), Tupelo, MS, located 13 ½ miles southeast of the accident site at an elevation of 346 ft. The airport had an ASOS was augmented by tower personnel during the period. The following conditions were reported surrounding the time of the accident:

KTUP special weather observation at 1505 CDT, wind from 050° at 8 knots, visibility 10 miles in light rain, ceiling broken at 1,200 ft agl, overcast at 4,000 ft, temperature 16° C, dew point 14°

C, altimeter 29.82 inches of mercury. Remarks: automated observation system, lightning distant northwest through north, hourly precipitation trace, temperature 15.6° C, dew point 13.9° C, maintenance required on system.

KTUP special weather observation at 1524 CDT, wind 050° at 7 knots, visibility 10 miles with thunderstorm in vicinity⁴, light rain, scattered clouds at 1,200 ft agl, ceiling broken at 4,900 ft, overcast at 8,000 ft, temperature 16° C, dew point 14° C, altimeter 29.80 inches of Hg. Remarks: automated observation system, lightning distant north and northwest, hourly precipitation 0.01 inches, temperature 15.6° C, dew point 13.9° C, maintenance required on system.

The general flight categories⁵ which are color coded and the raw observations in standard code, abbreviations, and time in UTC that were disseminated between 1353 and 1553 CDT were as follows:

VFR METAR KTUP 131853Z 05009KT 10SM FEW014 OVC046 16/14 A2989 RMK AO2 LTG DSNT W
RAB36E51 PRESFR SLP121 P0001 T01610139 \$=

MVFR SPECI KTUP 131913Z 04009KT 10SM BKN014 OVC046 16/14 A2987 RMK AO2 PRESFR T01560139 \$=

VFR SPECI KTUP 131944Z 05009KT 10SM VCTS SCT013 BKN042 16/13 A2984 RMK AO2 LTG DSNT W-N
T01560133 \$=

MVFR METAR KTUP 131953Z 05008KT 7SM VCTS -RA BKN013 OVC042 16/14 A2983 RMK AO2 LTG DSNT N
AND NW RAB45 SLP101 P0000 T01560139 \$=

MVFR SPECI KTUP 132005Z 05008KT 10SM -RA BKN012 OVC040 16/14 A2982 RMK AO2 LTG DSNT NW-
NE P0000 T01560139 \$=

Accident 2015Z

MVFR SPECI KTUP 132024Z 05007KT 10SM VCTS -RA SCT012 BKN049 OVC080 16/14 A2980 RMK AO2
LTG DSNT N AND NW P0001 T01560139 \$=

VFR SPECI KTUP 132044Z 05008KT 10SM FEW019 SCT034 OVC046 16/14 A2979 RMK AO2 LTG DSNT NE
RAE37 P0001 T01560139 \$=

VFR METAR KTUP 132053Z 06008KT 10SM FEW020 BKN045 OVC055 16/14 A2977 RMK AO2 LTG DSNT
NE RAE37 PRESFR SLP079 P0001 60002 T01610144 58060 \$=

⁴ Vicinity is defined as not at the airport but between 5 and 10 miles of the airports center point.

⁵ As defined by the NWS and the FAA Aeronautical Information Manual (AIM) section 7-1-7 defines the following general flight categories based on weather conditions reported:

- Low Instrument Flight Rules (LIFR*) – ceiling below 500 ft above ground level (agl) and/or visibility less than 1 statute mile.

- Instrument Flight Rules (IFR) – ceiling between 500 to below 1,000 feet agl and/or visibility 1 to less than 3 miles.

- Marginal Visual Flight Rules (MVFR**) – ceiling from 1,000 to 3,000 ft agl and/or visibility 3 to 5 miles.

- Visual Flight Rules (VFR) – ceiling greater 3,000 ft agl and visibility greater than 5 miles.

* By definition, IFR is a ceiling less than 1,000 ft agl and/or visibility less than 3 miles while LIFR is a sub-category of IFR.

**By definition, VFR is a ceiling greater than or equal to 3,000 ft agl and visibility greater than 5 miles while MVFR is a sub-category of VFR.

2.2 Oxford, Mississippi

The accident airplane departed University-Oxford Airport (KUOX), Oxford, MS, at approximately at 1506 CDT, with the accident site located approximately 33 miles east of the airport. The airport had an Automated Weather Observation System (AWOS) and issued observations every 20-minutes. The airport listed an elevation of 452 ft and reported the following conditions at the time of departure and immediately after the accident.

KUOX weather observation at 1455 CDT, automated, wind from 050° at 12 knots gusting to 18 knots, wind variable from 020° and 080°, visibility 5 miles in moderate rain with thunderstorms in the vicinity, scattered clouds at 900 ft agl, ceiling broken at 1,200 ft, broken at 2,700 ft, temperature and dew point 13° C, altimeter 29.82 inches of Hg. Remarks: automated station with a precipitation discriminator, lightning distant all quadrants.

KUOX weather observation at 1515 CDT, automated, wind from 060° at 12 knots gusting to 17 knots, visibility 2 miles in moderate rain with thunderstorms in the vicinity, ceiling broken at 900 ft agl, broken at 1,200 ft, overcast at 2,000 ft, temperature and dew point 13° C, altimeter 29.82 inches of Hg. Remarks: automated station with a precipitation discriminator, lightning distant all quadrants, visibility ¾ mile variable 5 miles.

The general flight categories and observations between 1355 and 1555 CDT were as follows.

VFR METAR KUOX 131855Z AUTO 06015G22KT 10SM VCTS DZ SCT013 SCT021 BKN042 14/13 A2989
RMK AO2 LTG DSNT SE-W=

VFR METAR KUOX 131915Z AUTO 07015G27KT 7SM -TSRA FEW009 SCT014 BKN040 13/13 A2986 RMK
AO2 LTG DSNT ALQDS=

IFR METAR KUOX 131935Z AUTO 06016G28KT 2SM -TSRA FEW009 FEW014 SCT036 13/13 A2983 RMK
AO2 LTG DSNT ALQDS=

MVFR METAR KUOX 131955Z AUTO 05012G18KT 020V080 5SM VCTS RA SCT009 BKN012 BKN027
13/13 A2982 RMK AO2 LTG DSNT ALQDS=

Departure 2005Z
Accident 2014Z

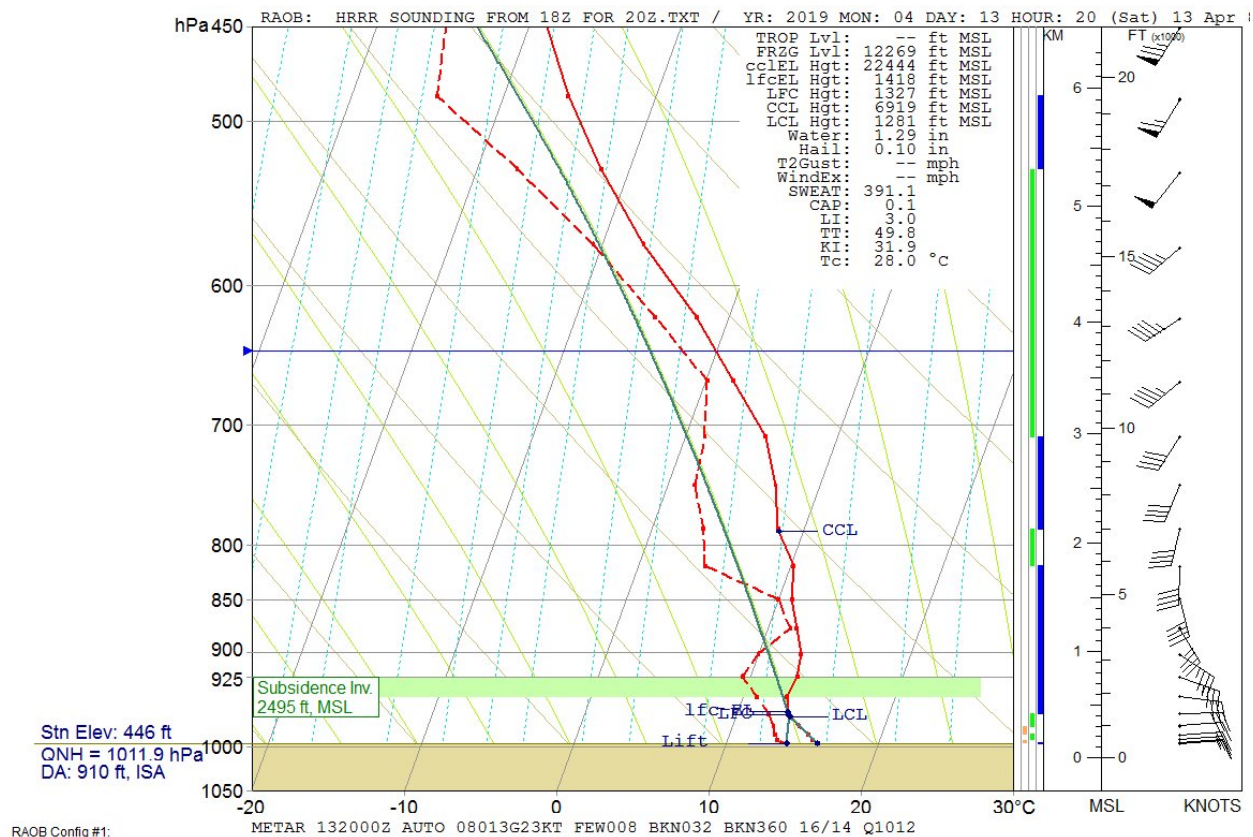
IFR METAR KUOX 132015Z AUTO 06012G17KT 2SM VCTS RA BKN009 BKN012 OVC020 13/13 A2982
RMK AO2 LTG DSNT ALQDS VIS 3/4V5=

MVFR METAR KUOX 132035Z AUTO 06012G20KT 3SM -DZ BKN010 OVC014 13/13 A2979 RMK AO2 LTG
DSNT ALQDS=

MVFR METAR KUOX 132055Z AUTO 07013G26KT 9SM BKN010 OVC013 13/13 A2976 RMK AO2 LTG DSNT
W-NE=

3.0 Sounding

A High-Resolution Rapid Refresh (HRRR)⁶ numerical model data was obtained from archive data from the NOAA Air Resource Laboratory (ARL) and plotted on a standard Skew T log P diagram⁷ over the accident site coordinates from the surface to 450-hPa or approximately 21,000 ft using the complete Rawinsonde Observation RAOB program software⁸, and is included as figure 7.



The Lifted Index (LI) was 3.0, and the most-unstable LI was 0, which indicated a stable to conditional unstable atmosphere. The most-unstable convective available potential energy (CAPE) was 20 J/kg and indicated weak updraft and downdraft potential, with the maximum vertical velocity (MVV) at 12 knots.

The HRRR wind profile indicated a surface wind from the east at 13 knots with wind veering to the south-southwest with height with increasing speeds with height. A low-level jet was identified at 4,800 ft with wind from 168° at 40 knots, with the mean 0 to 6 kilometer (km) or 18,000 ft wind was from approximately 200° at 37 knots. Strong shear existed immediately above the temperature inversion with the potential for moderate and greater turbulence between 2,500 and 4,800 ft.

Figure 8 is a table of the HRRR model parameters of height, pressure (Pres), temperature (T), dew point temperature (Td), relative humidity (RH%), wind direction and speed, and RAOB derived potential for clear air turbulence (CAT), LLWS, and icing from the surface to approximately 21,300 ft. The accident airplane reached an altitude of approximately 11,000 ft, which indicated a temperature of 2.7° C, a dew point of 0.4° C, a relative humidity of 85% which supported clouds at that level. The wind at 11,000 ft was from 225° at 43 knots.

Height (ft-MSL)	Pres (hPa)	T (C)	Td (C)	RH (%)	DD / FF (deg / kts)	CAT (FAA)	LLWS	Icing - Type (AFGWC method)
446	996	16.0	14.0	88	85 / 13			
474	995	16.0	13.6	86	85 / 12	LGT	MODRT	
558	992	15.6	13.3	86	85 / 17	LGT	LIGHT	
727	986	15.2	13.0	87	85 / 20			
982	977	14.4	12.7	90	85 / 22			
1354	964	13.4	12.1	92	88 / 24	MDT	LIGHT	
1875	946	12.9	10.9	88	98 / 28	MDT	LIGHT	
2495	925	13.1	9.5	79	112 / 34	MDT		
3191	902	12.8	10.0	83	127 / 36	XTR		
3966	877	11.9	11.5	97	151 / 37	SVR		
4858	849	10.9	10.0	94	168 / 40	MDT		
5877	818	10.2	4.4	67	182 / 41	MDT		
6999	785	8.3	3.4	71	193 / 40	LGT		
8307	748	7.1	1.8	69	201 / 38	LGT		
9750	709	5.3	1.3	75	211 / 39	MDT		
11419	666	1.8	0.1	88	228 / 44			
13260	621	-2.1	-4.8	82	234 / 45			
15340	573	-7.3	-10.6	77	227 / 45	LGT		
17352	529				217 / 52			
17462	527	-11.9	-17.4	64		MDT		
19482	486	-15.8	-24.4	48	210 / 65	MDT		
21329	451				211 / 77			

Figure 8 - HRRR model parameters

The closest upper air site to the accident site was from NWS Jackson (KJAN), MS, located approximately 140 miles south. The KJAN sounding for 1900 CDT is included as figure 9. The KJAN sounding indicated a surface temperature of 25° C (77° F), a dew point of 17° C (63° F), with the LCL at 3,348 ft agl, the convective condensation level (CCL) at 5,385 ft agl, and the LFC at 7,490 ft agl. The sounding had a precipitable water content of 1.57 inches and the LI and most

unstable LI was -2, with a CAPE of 142.6 J/kg. The freezing level was identified at 12,765 ft and supported icing in -clouds and in-precipitation above that level.

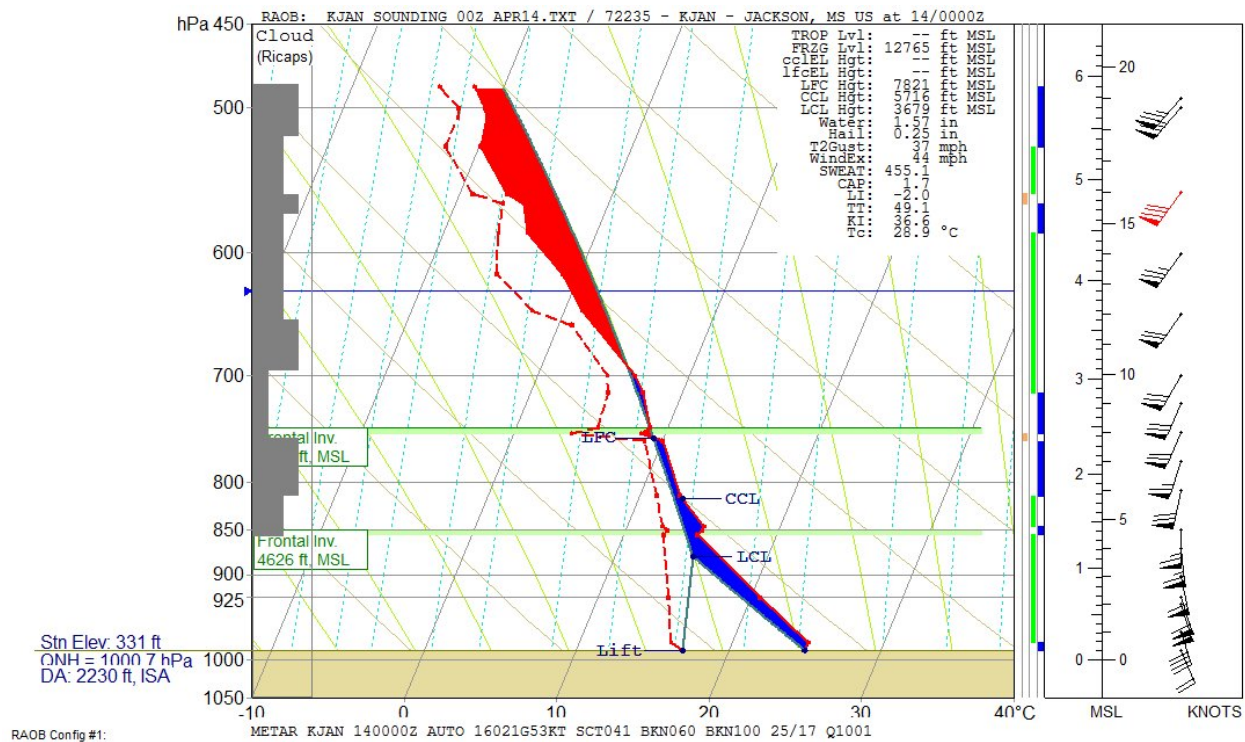


Figure 6 - KJAN observed sounding for 1900 CDT

The KJAN sounding wind profile indicated a surface wind from the south or from 160° at 21 knots with wind veering to the southwest with height and increasing in speed rapidly with height. The mean 0 to 6 km wind was from 200° at 65 knots.

4.0 Satellite Imagery

The Geostationary Operational Environmental Satellite number 16 (GOES-16) data was obtained from an archive at the Space Science Engineering Center at the University of Wisconsin-Madison in Madison, Wisconsin, and processed using the Man-computer Interactive Data Access System (McIDAS) software. The infrared long wave and visible imagery were obtained surrounding the time of the accident, with the images closest to the time of the accident documented below. The infrared long wave imagery (band 13) at a wavelength of 10.3 microns (μm) provided radiative cloud top temperatures with a nominal spatial resolution of 2 km. The visible (band 2) at a wavelength of 0.64 μm images at a resolution of 0.5 km.

Figure 10 is the GOES-16 infrared image at 4X magnification with a standard MB temperature enhancement curve applied to highlight the higher and often colder cloud tops associated with deep convection and cirriform clouds at 1516 CDT. The accident site is noted by a small white square under an enhanced area of clouds. The image depicted an area of multiple low, mid, and high clouds over Mississippi and the accident site. The radiative cloud top temperature over the

Figure 11 is the GOES-16 visible image for 1516 CDT at normal magnification with the surface fronts from 1600 CDT overlaid. The accident site is noted by the red square north of the warm front and in the immediate vicinity of the stationary front. The image depicts some low and mid clouds over the area, with some higher cirriform clouds obscuring the accident site.

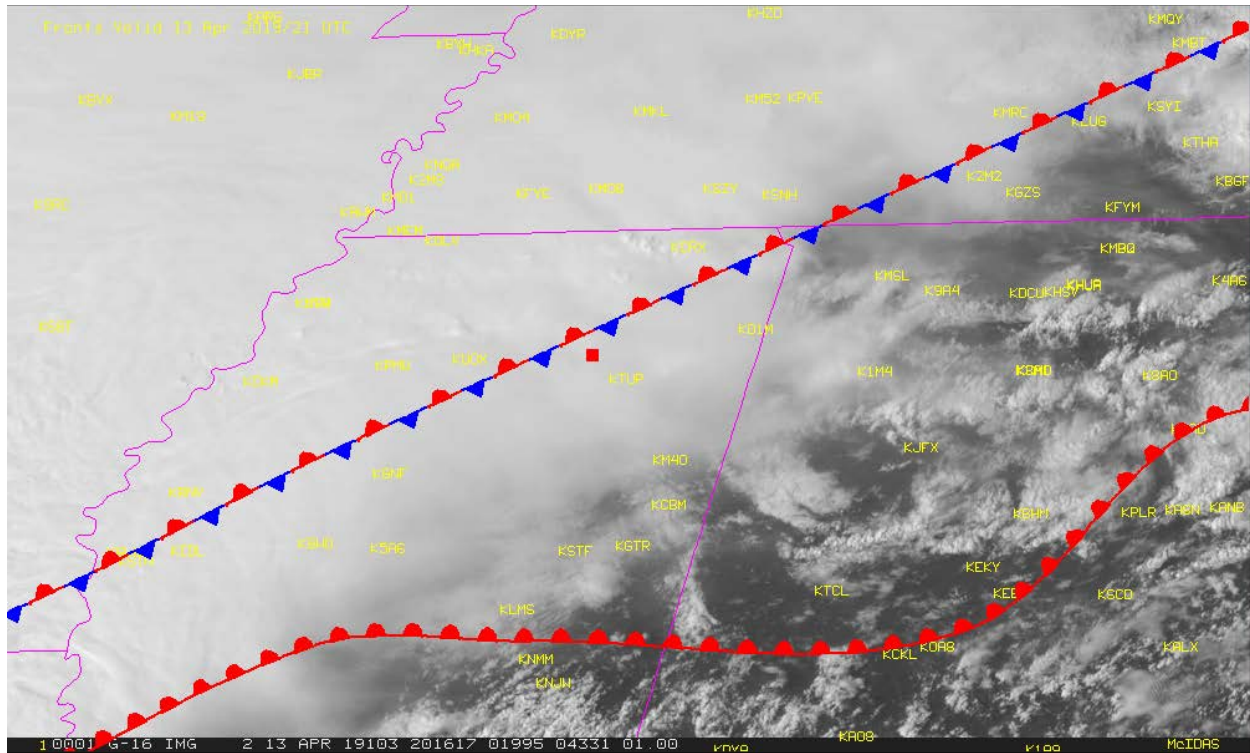


Figure 8 - GOES-16 visible image at 1516 CDT

5.0 Weather Surveillance Radar Imagery

The Department of Defense Columbus Air Force Base (KGWX)⁹, Weather Surveillance Radar 1988 Doppler (WSR-88D) was located approximately 42 miles southeast of the accident site in Greenwood Springs, MS. The level II archive data was obtained from the NCEI using the Hierarchical Data Storage System and displayed using the NWS NEXRAD Interactive Viewer and Data Exporter software.

The WSR-88D is a S-band 10-centimeter wavelength radar with a power output of 750,000 watts, with a 28-foot parabolic antenna concentrating the energy into a 0.95° beam width. The radar produces three basic types of products reflectivity, radial velocity, and spectral width.

5.1 Volume Scanning Strategies

During the period on April 13th the KGWX WSR-88D was operating in the precipitation mode volume scan pattern 212 (VCP-212), where the radar makes 14 different elevation scans in 4 ½ minutes. The following chart provides the beam height for the various elevation scans based on the distance to the accident site and the antenna height of 590 ft.

⁹ The KGWX WSR-88D was located approximately 16 miles north-northeast of the Columbus AFB airport (KCBM) to provide better weather observation and alerting capability for the airport and general area.

Beam Elevation	Center	Base	Top	Width
0.5°	3,990 ft	1,870 ft	6,100 ft	4,230 ft
0.88°	5,770 ft	3,650 ft	7,880 ft	4,230 ft
1.32°	7,640 ft	5,520 ft	9,750 ft	4,230 ft
1.80°	9,770 ft	7,660 ft	11,890 ft	4,230 ft

5.2 Reflectivity

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 (dBZ¹⁰) and is a general measure of echo intensity. The chart below (figure 12) relates the NWS video integrator and processor (VIP) intensity levels (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 9 - WSR-88D VIP reflectivity levels and rainfall rates

The FAA has taken the NWS previous VIP levels 1 to 6 intensity levels and has redefined the referenced the levels for pilots in Advisory Circular AC 00-24C - "Thunderstorm". That AC further defines 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. These

¹⁰ dBZ - 10 log Ze

are the new standard radio phraseology terms used by air traffic controllers to describe weather conditions to pilots as shown in figure 13.

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

Figure 10 - FAA defined reflectivity and weather echo intensity terminology chart

5.3 Base reflectivity Images

Figures 14 and 15 are the KGWX WSR-88D 0.5° and 1.8° base reflectivity image for 1514 CDT respectively with the flight track and accident site overlaid. The image depicted the flight track immediately south of an east-to-west band of heavy to extreme echoes, with echoes in the range of 10 to 23 dBZ or light intensity echoes along and under the flight path, with echoes of 5 to 15 dBZ at altitude. While the accident airplane was not in the intense section of a defined cumulonimbus type system to the north, the echoes implied the accident airplane was in light precipitation and clouds at the time of the accident and thus in instrument meteorological conditions (IMC). Approximately 20 miles southeast of the accident site was a small multicell system with a maximum reflectivity value of 50.0 dBZ or extreme intensity with echo tops near 30,000 ft.

The KGWX WSR-88D echo tops product indicated echoes to 22,000 ft over the accident site, and maximum echo tops near 32,000 ft approximately 30 miles north.



Figure 11 - KGWX WSR-88D 0.5° base reflectivity image for 1514 CDT



Figure 12 - KGWX WSR-88D 1.8° base reflectivity image at 1514 CDT

5.4 Lightning Images

A search of archive lightning data from Earth Networks indicated that a total of 181 lightning strikes occurred between 1500 and 1515 CDT within a 20-miles radius of the departure airport KUOX, with 123 in-cloud lightning flashes and 58 cloud-to-ground strikes. Of these strikes there were 6 in-cloud lightning flashes within 5 miles of the departure airport and near the flight patch between 1501 and 1507 CDT with the activity centered between 10,160 and 17,600 ft. Figure 13 is a plot of the lightning over the KGWX WSR-88D 0.5° base reflectivity image at 1514 CDT.

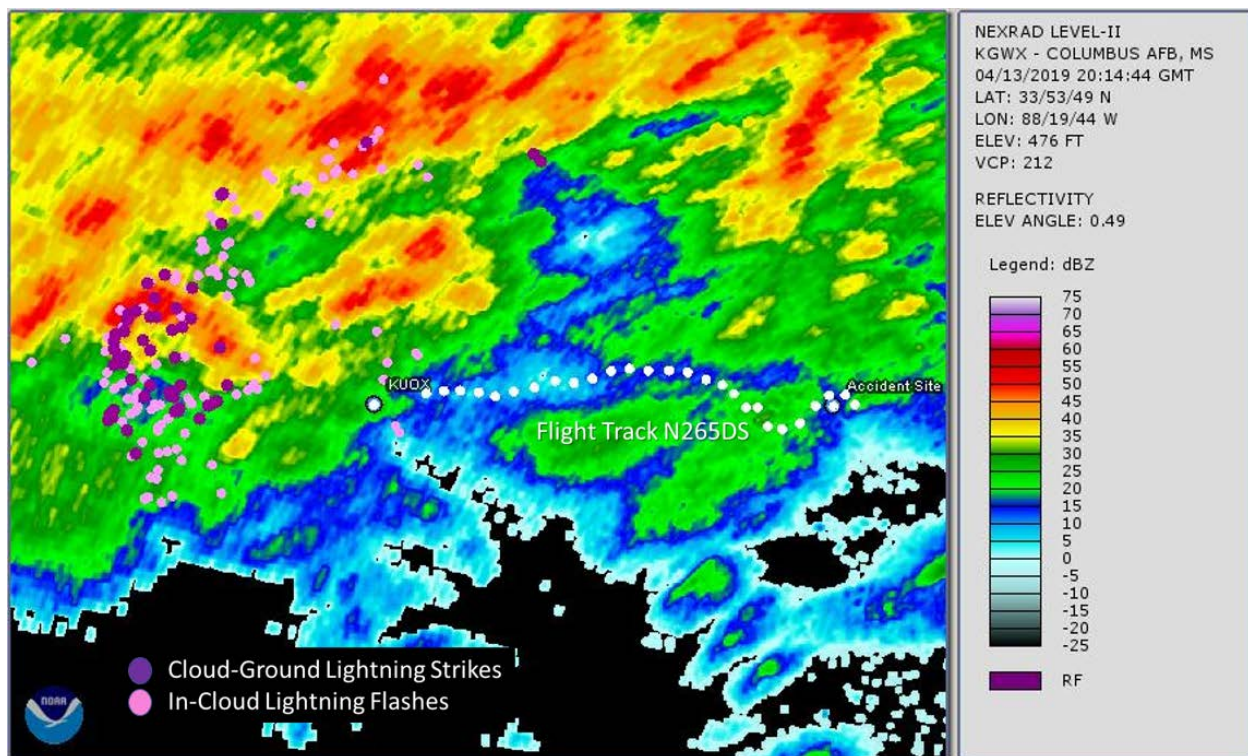


Figure 13 - KGWX WSR-88D 0.5 base reflectivity with cloud-to-ground and in-cloud lightning strikes

The following table lists the in-cloud lightning flashes near the flight track between 1500 and 1515 CDT.

Time	Latitude	Longitude	Peak Current	IC-flash Height	Number sensors
1501:32.5654	34.3541	-89.4259	-22,937	16,112 ft	20
1501:32.6235	34.3617	-89.4306	-2,507	17,645 ft	6
1507:45.2836	34.4117	-89.4434	3,786	16,051 ft	18
1507:45.3843	34.4302	-89.4391	2,920	15,643 ft	13
1507:45.3890	34.4403	-89.4085	6,265	10,160 ft	16
1507:45.4306	34.4638	-89.4508	-3,234	15,626 ft	13

6.0 Pilot Reports

There were two pilot reports or PIREPs recorded over the area surrounding the period. The report is standard code and abbreviations is included below and followed by the decoded observation with time converted to local.

TUP UA /OV TUP360015/TM 1540/FL200/TP B737/TA M18/IC MOD RIME 220-200/RM ALSO BY E145/ZME

Tupelo routine pilot report (UA); Over – 15 miles north of TUP; Time – 1040 CDT; Altitude – 20,000 ft; Type aircraft – Boeing B737 air carrier jet; Temperature – minus 18° C; Icing – moderate rime type icing between 22,000 and 20,000 ft; Remarks – also reported by Embraer EMB-145 regional air carrier jet, entered by Memphis Center.

TUP UA /OV OTB315015/TM 2002/FL170/TP H25B/TB MOD/RM ZME

Tupelo routine pilot report (UA); Over – the Tupelo VOTAC (OTB) on the 315 azimuth and 15 miles; Time – 1502 CDT; Altitude – 17,000 ft; Type aircraft – British Aerospace Hawker HS-25 corporate business jet; Turbulence – moderate; Remarks – entered by Memphis Center.

7.0 NWS Forecasts and Advisories

The following NWS forecast and advisories relating the accident were issued.

7.1 Terminal Aerodrome Forecast

The NWS Memphis (KMEG), Tennessee Weather Forecast Office (WFO) was responsible for the issuance of the Terminal Aerodrome Forecast (TAF) for KTUP. A TAF is a concise statement of the expected meteorological conditions at an airport during a specified period (usually 24 hours). TAFs are valid for a 5 mile radius around an airport's center point. The forecasts issued surrounding the period relevant to the preflight planning and the time of the accident were as follows.

*TAF KTUP 131727Z 1318/1418 05011KT 6SM -RA BR BKN035 OVC060
FM132000 10013G21KT P6SM VCSH BKN040 OVC080
FM140200 15020G30KT P6SM VCTS SCT025CB OVC035 WS020/17055KT
TEMPO 1404/1408 VRB25G40KT 1SM +TSRA OVC010CB
FM140900 19011G17KT 6SM BR VCSH BKN025 OVC050
FM141400 25014G20KT P6SM VCSH OVC020=*

The initial forecast issued at 1227 CDT expected winds from 100° at 13 knots gusting to 21 knots, visibility 6 miles or more with showers in the vicinity, ceiling broken at 4,000 ft agl, and overcast at 8,000 ft. Thunderstorms were expected in the vicinity after 2100 CDT, with the main impact of the storms between 2300 and 0400 CDT. The forecast was amended at 1430 CDT and was as follows:

*AMD TAF KTUP 131930Z 1320/1418 06011KT 6SM -SHRA BR VCTS SCT015CB OVC045
FM132200 10013G21KT P6SM VCTS BKN035CB OVC080
FM140200 15020G30KT P6SM VCTS SCT025CB OVC035 WS020/17055KT
TEMPO 1404/1408 VRB25G40KT 1SM +TSRA OVC010CB*

FM140900 19011G17KT 6SM BR VCSH BKN025 OVC050
FM141400 25014G20KT P6SM VCSH OVC020=

The amended forecast issued at 1430 CDT which expected MVFR conditions to prevail through 1700 CDT with a wind from 060° at 11 knots, visibility 6 miles in light rain showers and mist, with thunderstorms in the vicinity, scattered clouds at 1,500 ft agl in cumulonimbus clouds, ceiling overcast at 4,500 ft.

7.2 Area Forecast Discussion

The NWS KMEG WFO Area Forecast Discussion (AFD) issued during the period was as follows.

*FXUS64 KMEG 131734
AFDMEG
Area Forecast Discussion
National Weather Service Memphis TN
1234 PM CDT Sat Apr 13 2019*

*.UPDATE...
See the 18z aviation update.*

.PREV DISCUSSION.../issued 1110 AM CDT Sat Apr 13 2019/

DISCUSSION...15Z Surface analysis this morning places a surface low just east of Austin Texas. A warm front extends from the low into Louisiana, Mississippi, and Alabama near the Gulf Coast. KNQA WSR-88D radar trends indicate rain showers with an occasional thunderstorm occurring across areas along and south of I-40 late this morning. As of 10 AM CDT, temperatures across the Mid-South are in the 50s at most locations.

Short term models including Convective Allowing Model (CAM) solutions suggest the aforementioned warm front will begin to move north this afternoon, perhaps reaching North Mississippi towards sunset.

*Overall forecast into this afternoon is on track and no changes planned at the moment.
CJC*

*.AVIATION...
/18z TAFs/*

Widespread rain showers continue across the area at this time and we anticipate a bit of a lull in the convection this afternoon. However, strong to severe storms will move across the area from west to east this evening, continuing into the early morning hours. The primary hazard at the forecast terminals will be damaging wind and tempos have been continued showing to potential for 40+ kt winds. Convection will move east of the area overnight with scattered light showers possible through Sunday afternoon.

Strong easterly winds will develop across portions of the Mid-South this afternoon as a deepening surface low treks across the region. Winds will eventually diminish overnight but will result in reduced arrival rates given the orientation of the wind. Expect generally VFR conditions this afternoon, although lower ceilings and visibility are expected within convection. Conditions will deteriorate overnight with low ceilings anticipated late tonight and much of Sunday.

Johnson

7.3 Inflight Weather Advisories

Inflight Aviation Weather Advisories are forecasts to advise en route aircraft of development of potentially hazardous weather. Inflight aviation weather advisories in the conterminous U.S. are issued by the NWS AWC, as well as from the Center Weather Service Units (CWSU) associated with FAA ARTCCs. There are four basic types of inflight aviation weather advisories: the Significant Meteorological Information (SIGMET), the Convective SIGMET, the AIRMET, and the Center Weather Advisory (CWA). Inflight advisories serve to notify en route pilots of the possibility of encountering hazardous flying conditions which may not have been forecast at the time of the preflight briefing. Whether or not the condition described is potentially hazardous to a particular flight is for the pilot to evaluate on the basis of experience and the operational limits of the aircraft. The following advisories were current during the period.

Convective SIGMETs

The NWS AWC issued two Convective SIGMETs 76C and 77C for thunderstorms during the period. The advisories were issued at 1455 CDT and valid for a 2-hour period. The text 76C which enclosed the accident site warned of area of embedded thunderstorms moving from 180° at 40 knots, with tops to 35,000 ft. Immediately south of this advisory and the accident site Convective SIGMET 76C warned of an area of severe embedded thunderstorms with the area moving from 270° at 30 knots, and cells moving from 200° at 50 knots, with tops above 45,000 ft. A plot of the advisory as issued from the AWC is included as figure 14 with the approximate accident site marked by a red star.

*WSUS32 KKC1 131955
SIGC
MKCC WST 131955
CONVECTIVE SIGMET 76C
VALID UNTIL 2155Z
TN MS AR TX OK
FROM 50W ARG-40ENE MEM-40WSW MSL-50WNW GGG-40SE OKC-50W ARG
AREA EMBD TS MOV FROM 18040KT. TOPS TO FL350.*

*CONVECTIVE SIGMET 77C
VALID UNTIL 2155Z
MS LA AR TX
FROM 40WSW MSL-30E LSU-30W IAH-50WNW GGG-40WSW MSL
AREA SEV EMBD TS MOV FROM 27030KT. TOPS ABV FL450.
TORNADOES...HAIL TO 2.5 IN...WIND GUSTS TO 65KT POSS.
CELL MOV FROM 20050KT.*

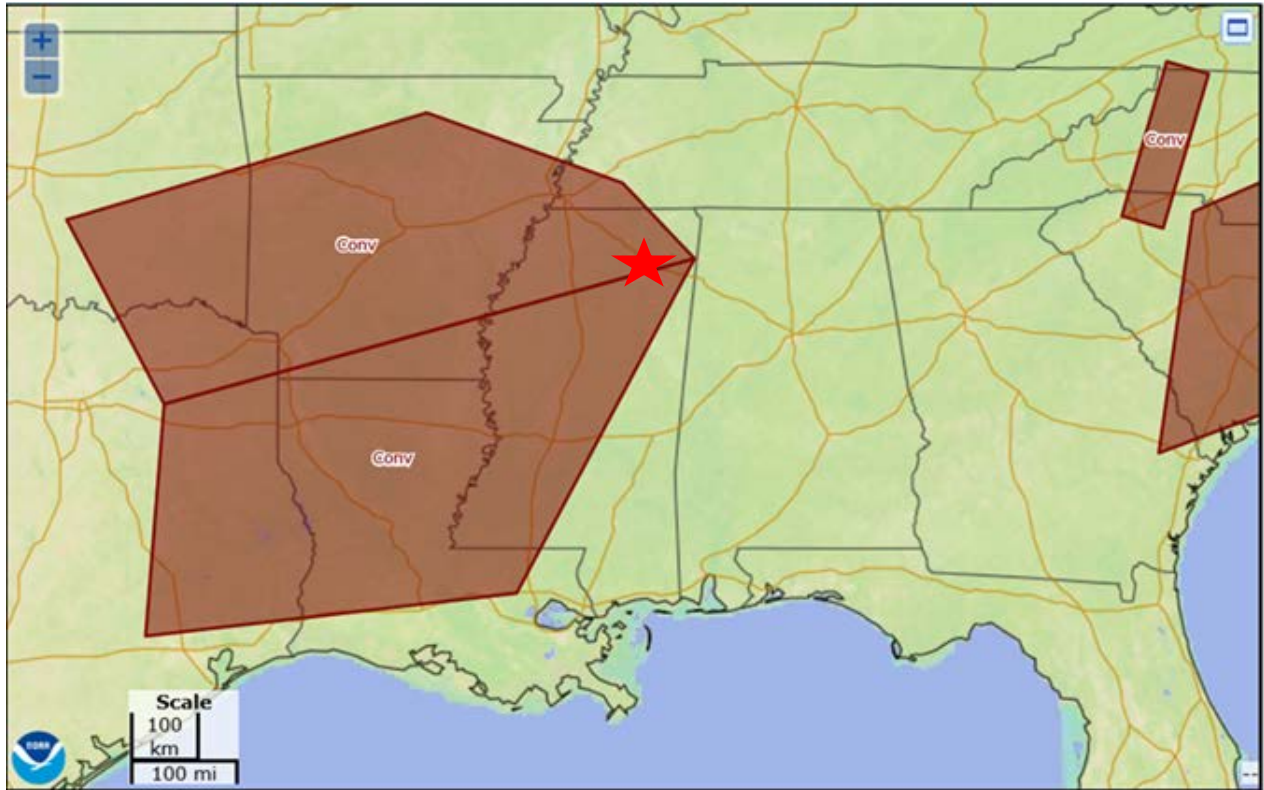


Figure 14 - Convective SIGMETs 76C and 77C issued at 1455 CDT

Weather Watches

Aviation Watch Notification Message (SAW)¹¹ is issued by the NWS SPC to provide an area threat alert for the aviation meteorology community to forecast organized severe thunderstorms that may product tornadoes, large hail, and/or convective damaging winds. At 1420 CDT the NWS SPC issued the following advisory over southern Mississippi, Louisiana, and western Arkansas which was included in portions of Convective SIGMET 77C above. Figure 15 is a plot of the watch location and the accident site.

AWW
 WW 54 TORNADO AR LA MS 131920Z – 140200Z
 AXIS..65 STATUTE MILES EAST AND WEST OF LINE..
 35WSW MCB/MC COMB MS/ - 20ENE GLH/GREENVILLE, MS/
 ..AVIATION COORDS.. 55NM E/W /34NNE BTR – 20WNW SQS/
 HAIL SURFACE AND ALOFT..2 INCHES. WIND GUSTS ..65 KNOTS.
 MAX TOPS TO 550. MEAN STORM MOTION VECTOR 21040.

 LAT...LON 30.97N 92.11W 33.58N 91.79W 33.58N 89.52W 30.97N 89.91W

¹¹ Formerly known as the Alert Severe Weather Watch Bulletin (AWW).

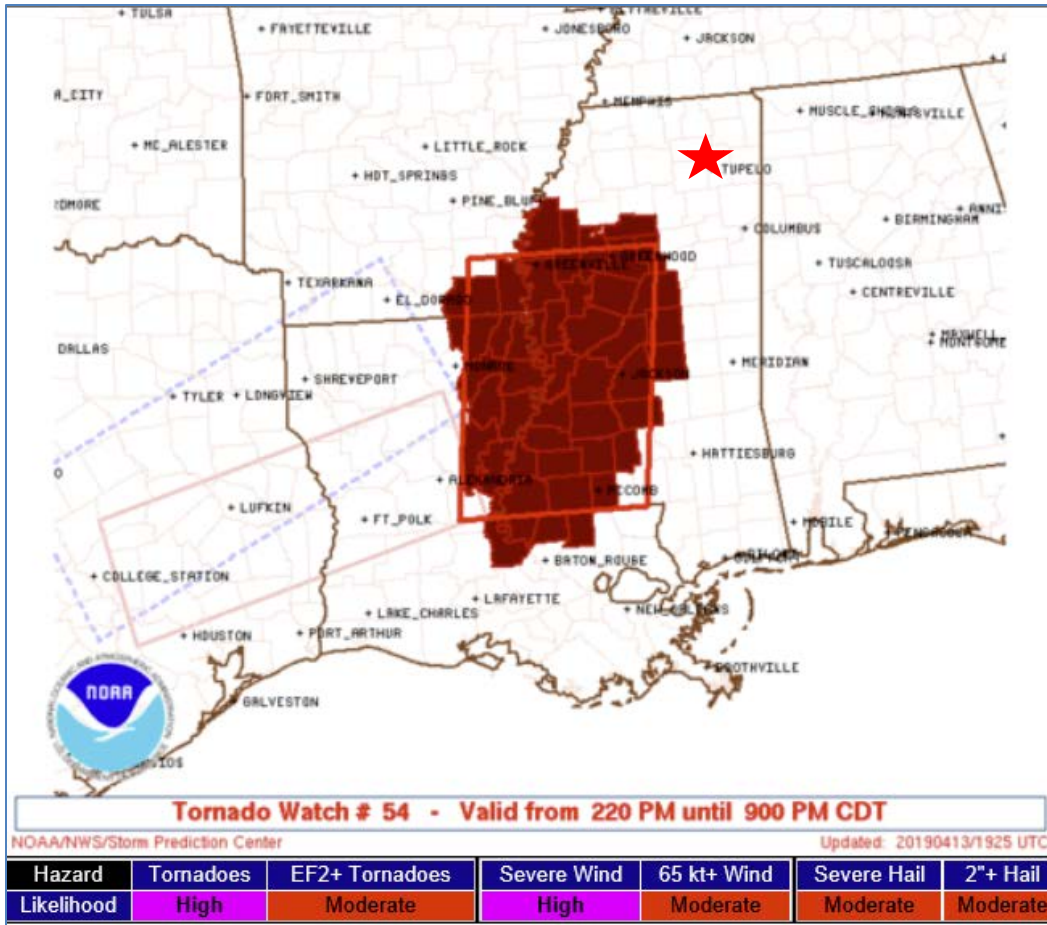


Figure 15 - Severe Weather Forecast Alert (AWW) number 54 for tornadic thunderstorms

Center Weather Advisories

During the period the Memphis (KZME) Air Route Traffic Control Center (ARTCC) issued no advisories relating to severe weather for their airspace.

AIRMETs

The NWS AWC had the following AIRMET advisories current for IFR conditions, moderate turbulence, low-level wind shear (LLWS), and icing current for the area. The text AIRMET is followed by the Graphic-AIRMET for the period in figures 16 and 17.

WAUS44 KKCI 131656 AAA

WA4S

-DFWS WA 131656 AMD

AIRMET SIERRA UPDT 5 FOR IFR AND MTN OBSCN VALID UNTIL 132100

.

AIRMET IFR...OK TX AR TN LA MS AL AND CSTL WTRS...UPDT
FROM 30SE ARG TO 30NNW MSL TO 60SE SJI TO 40ESE LSU TO 80SW LEV
TO 120SSW LCH TO 100SE PSX TO 20ESE PSX TO 40SSE IAH TO 50WNW

IAH TO 20SSW SAT TO 50SSW JCT TO 40W ABI TO ADM TO 30SE ARG
CIG BLW 010/VIS BLW 3SM PCPN/BR. CONDS CONTG BYD 21Z THRU 03Z.

SIERRA 2019-04-13 18:00:00

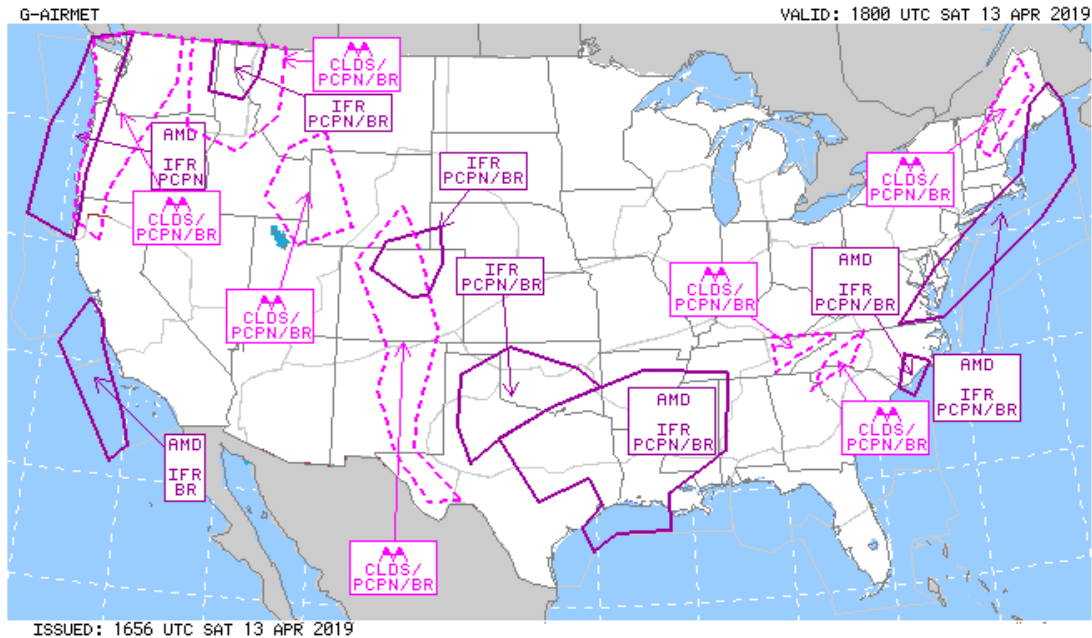


Figure 16 - Graphic-AIRMET Sierra for IFR conditions

WAUS44 KPCI 131919 AAB

WA4T

-DFWT WA 131919 AMD

AIRMET TANGO UPDT 4 FOR TURB AND LLWS VALID UNTIL 132100

AIRMET TURB...OK TX AR TN LA MS AL SD NE KS MN IA MO WI LM LS MI LH IL IN KY
FROM 40NW SSM TO YVW TO 30SE ECK TO FWA TO CVG TO 20SW VUZ TO 20WSW SAT TO
30NNW DLF TO 40SSE MRF TO 60W INK TO INK TO 30ESE TBE TO 50W LBL TO GLD TO
20SE SNY TO 70SW BRD TO 40NW SSM
MOD TURB BTN FL180 AND FL390. CONDS CONTG BYD 21Z THRU 03Z.

AIRMET TURB...OK TX AR TN LA MS AL KS MO IL KY
FROM 20W COU TO 20S PXV TO 60ESE BNA TO 30W LGC TO LSU TO 30SE LFK TO 50WSW
SAT TO 50SSE FST TO 60SW LBL TO 40E GCK TO 20W COU
MOD TURB BLW FL180. CONDS CONTG BYD 21Z THRU 03Z.

LLWS POTENTIAL...OK TX AR TN LA MS
BOUNDED BY 20NW DYR-20SW SQS-30ESE LCH-20SE IAH-30NNE PSX-50NE
MAF-60SSE MMB-20SE END-RZC-20NW DYR
LLWS EXP. CONDS CONTG BYD 21Z THRU 03Z.

TANGO 2019-04-13 18:00:00

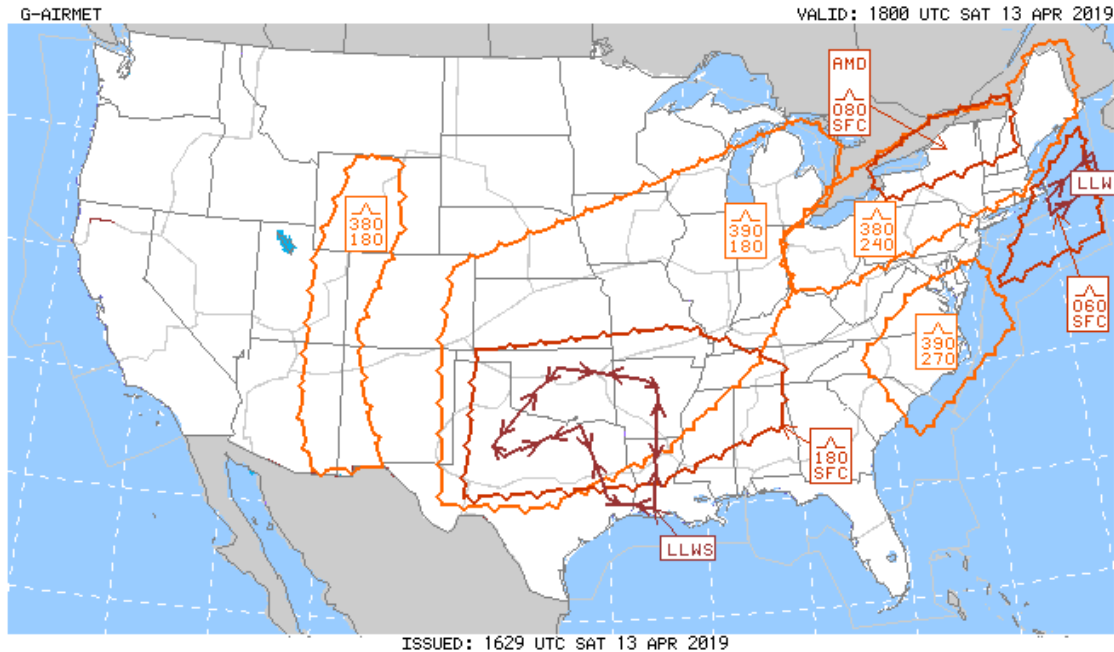


Figure 17 - Graphic-AIRMET Tango for turbulence and low-level wind shear

WAUS44 KKCI 131445

WA4Z

-DFWZ WA 131445

AIRMET ZULU UPDT 2 FOR ICE AND FRZLVL VALID UNTIL 132100

AIRMET ICE...AR TN MS AL MO IL IN KY

FROM 30ESE CVG TO HNN TO HNV TO GQO TO 30S LGC TO 30ESE MEI TO 40WNW IGB
TO 50SSW MEM TO 20WNW LIT TO 60ESE FAM TO 60SSE AXC TO 30ESE CVG

MOD ICE BTN FRZLVL AND FL240. FRZLVL 090-130.

CONDS CONTG BYD 21Z ENDG 00-03Z.

8.0 Weather Briefing Information

The pilot filed an IFR flight plan at 1457 CDT for the trip, with an estimated time enroute of 0:21 minutes with a requested cruising altitude of 11,000 ft, with 2:12 of fuel on board. No alternate airport was listed, and the estimated time of departure was at 1515 CDT.

The pilot obtained a weather briefing from ForeFlight which a copy is included as attachment 1. The briefing included Convective SIGMETs 76C and 77C, AIRMET Sierra update 5 for IFR conditions, AIRMET Tango 4 for moderate turbulence below 18,000 ft, and AIRMET Zulu for moderate icing conditions above the freezing level which was estimated above 12,000 ft. No urgent pilot reports were in the briefing, and no CWAs were current. The departure weather noted thunderstorms and light rain at KUOX with lightning noted in the remarks. The route briefing included some LIFR conditions along the route with ceilings as low as 300 ft agl, with widespread

thunderstorms and rain, with visibility as low as 1 statute mile. The narrative of enroute station reported numerous stations reporting MVFR conditions with several others IFR to LIFR conditions.

9.0 Astronomical Conditions

The United States Naval Observatory website provided the following astronomical conditions on April 13, 2019 for New Albany, Union County, Mississippi. The time of the accident has been added in italic bold print for reference.

Sun	Time
Begin civil twilight	0602 CDT
Sunrise	0627 CDT
Sun transit	1257 CDT
<i>Accident</i>	<i>1514 CDT</i>
Sunset	1926 CDT
End civil twilight	1975 CDT

F. LIST OF ATTACHMENTS

Attachment 1 – ForeFlight Weather Briefing

Submitted by:

Don Eick
Senior Meteorologist

Appendix 1 – Weather Briefing