NATIONAL TRANSPORTATION SAFETY BOARD

Office of Aviation Safety
Washington, D.C. 20594

March 7, 2017

Group Chairman's Factual Report

METEOROLOGY

ERA17FA066

Table Of Contents

A. AIRCRAFT ACCIDENT

Location: Camilla, Georgia
Date: December 5, 2016
Time: 2222 eastern standard time
0322 Coordinated Universal Time (UTC) on December 6, 2016
Airplane: Fairchild SA-227; Registration: N765FA

B. METEOROLOGIST

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

C. SUMMARY

On December 5, 2016, about 2222 eastern standard time, a Fairchild SA227-AC, N765FA, operating as Key Lime Air Flight LYM308, was destroyed during a descent and subsequent inflight breakup near Camilla, Georgia. The airline transport pilot was fatally injured. Night instrument meteorological conditions prevailed and an instrument flight rules flight plan was filed. The flight originated at Northwest Florida Beaches International Airport (ECP) Panama City, Florida and was destined for Southwest Georgia Regional Airport (ABY) Albany, Georgia. The on-demand cargo flight was conducted under the provisions of 14 *Code of Federal Regulations* Part 135.

D. DETAILS OF THE INVESTIGATION

The National Transportation Safety Board's (NTSB) 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 eastern standard time (EST) based upon the 24 hour clock, local time is +5 hours to UTC, and UTC=Z. Directions are referenced to true north and distances in nautical miles. Heights are above mean sea level (msl) unless otherwise noted. Visibility is in statute miles and fractions of statute miles.

The accident site was located at 31.21977° North latitude and 84.15496° West longitude, at an elevation of approximately 190 feet.

E. FACTUAL 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 (NCEP) located in Camp Springs, Maryland. These are the base products used in describing weather features and in the creation of forecasts and warnings. Reference to these charts can be found in the joint NWS and Federal Aviation Administration (FAA) Advisory Circular "Aviation Weather Services", AC 00-45H.

1.1 Surface Analysis Chart

The southeast section of the NWS Surface Analysis Chart for 2200 EST (0300Z on December 6, 2016) is included as figure 1. The chart depicted a low pressure system over Louisiana at 1004-hectopascals (hPa)[1] along a frontal wave with a cold front extending southward into the Gulf of Mexico and a stationary front eastward along the Gulf coast into the Florida panhandle and southern Georgia then into the Atlantic Ocean. A high pressure system at 1020-hPa was located over North Carolina. The stationary front was depicted over the route of flight and in the vicinity of the accident site.

The station models generally depicted a general easterly wind flow north of the stationary front, with southerly winds south of the front. However, the station models in the immediate area surrounding the accident site showed a cyclonic or counterclockwise wind flow pattern suggesting a low pressure area developing along the stationary front. The surrounding stations also reported moderate to heavy rain and/or thunderstorms. The station model for Albany, Georgia reported a wind from the north at approximately 10 knots, moderate rain, overcast cloud cover, a temperature and dew point of 60° Fahrenheit (F). To the south of the front over the Florida panhandle southerly winds of 10 to 15 knots were indicated with temperature and dew points in the 70's.

[1] Hectopascals (hPa) is the new standard for pressure used by the NWS and is interchangeable with the term millibars (mb) with the same units. Standard sea level pressure is 1012.25-hPa.

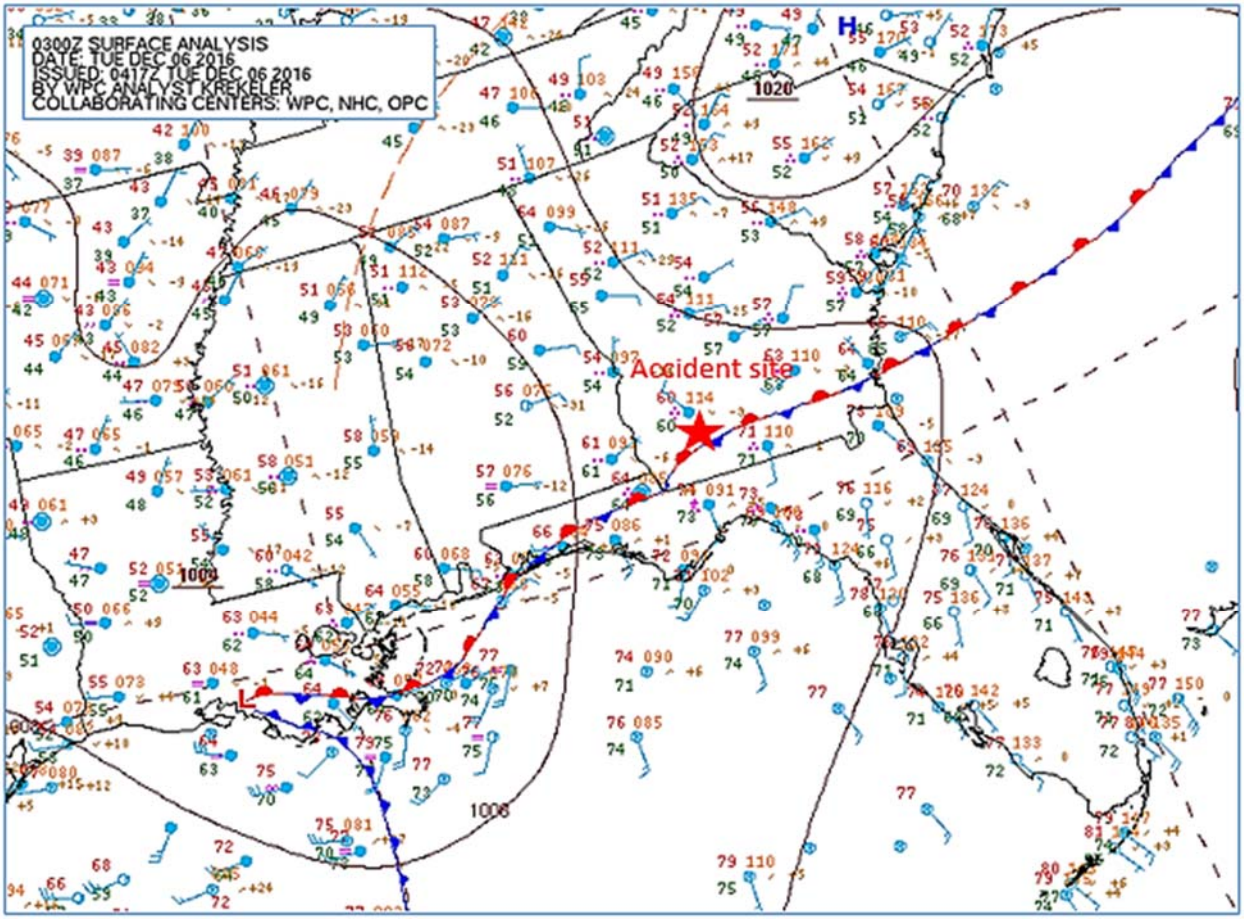

Figure 1 - Southeast section of NWS Surface Analysis Chart for 2200 EST

1.2 National Composite Radar

The NWS National composite radar image obtained from the NCEI archive for 2220 EST (0320Z) for the southeast is included as figure 2 with the approximate accident site marked by a red star. The accident site was located along the leading edge of a line of convection with reflectivity's, which ranged from 50 to 60 decibels (dBZ) immediately west of the site. The line extended from the Gulf of Mexico immediately west of Panama City, Florida northeastward to the cities of Albany, Vidalia, Statesboro and then eastward through Savana, Georgia and into the Atlantic. Other more scattered or less organized areas of echoes were located across northern Florida south and east of Tallahassee to west of Jacksonville, and into southeastern Georgia. A narrow corridor clear of echoes extended from Panama City to Tallahassee, FL to Moultrie, GA or immediately east of the accident site.

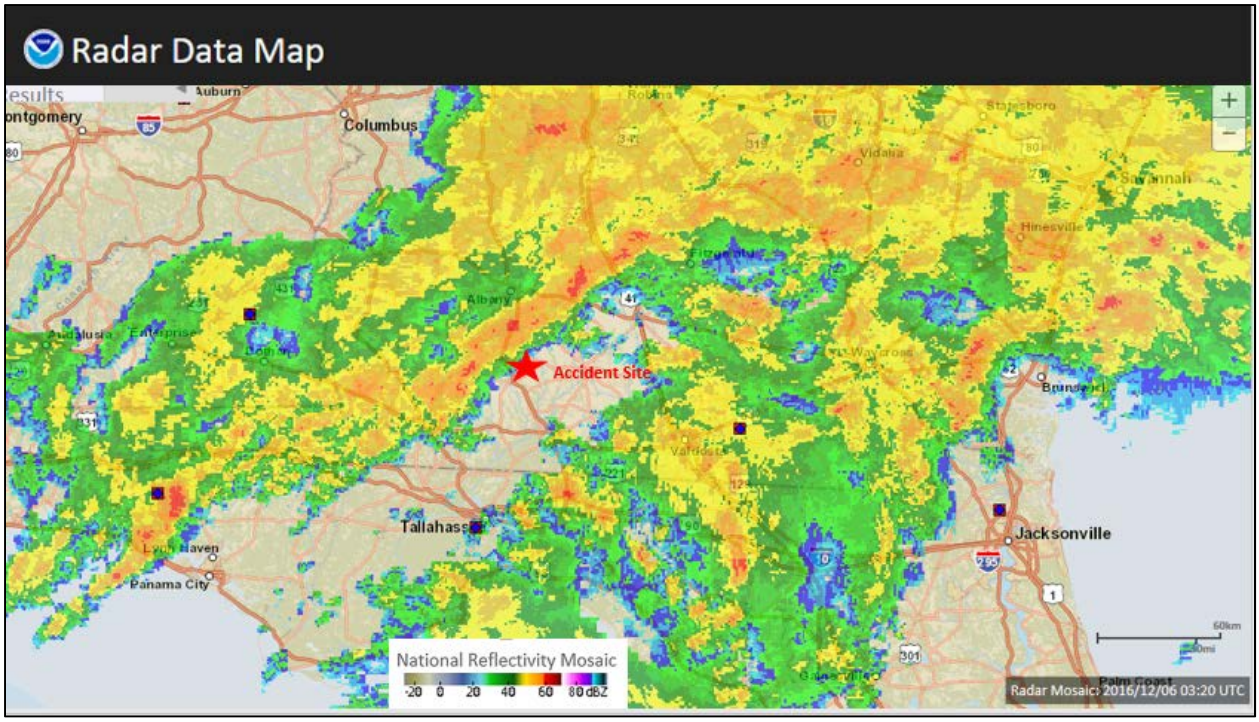

Figure 2 - National Composite Radar image at 2220 EST

Since weather echoes were in the immediate vicinity of the accident site, the closest NWS weather surveillance radar will be further documented in detail in section 5.0 of this report.

1.3 Convective Outlook

The NWS Storm Prediction Center (SPC) located in Norman, Oklahoma, graphic Convective Outlook which was issued at 2000 EST (0100Z on December 6, 2016) and valid for the period is included as figure 3. The chart depicted where the NWS SPC expected organized thunderstorms and the potential for severe thunderstorms[2] during the period. The chart depicted a slight risk of severe thunderstorms over extreme southeast Louisiana and Mississippi, southern Alabama, southwest Georgia, and the Florida panhandle, which included the accident site. A marginal risk of thunderstorms surrounded the area and included southern Alabama and Georgia, and northern Florida. Some of the larger population centers specifically mentioned under the risk area included Albany, Georgia. The slight risk area implied an area of organized scattered severe storms were possible, with either short-lived and/or not widespread, isolated intense storms possible. It also implied that one or more tornadoes, reports of strong winds, and hail to approximately 1 inch and possible 2 inch hail were expected within the designated area.

The SPC products and full narrative of the Convective Outlook (AC) bulletin, which is issued with the graphic is included under section 11.0 of this report.

[2] Severe thunderstorm – is defined as a thunderstorm which produces damaging winds of 50 knots or more, hail of one inch or larger, or a tornado. Severe thunderstorms imply severe to extreme turbulence, severe icing, frequent lightning, and a higher potential for low-level windshear including microbursts.

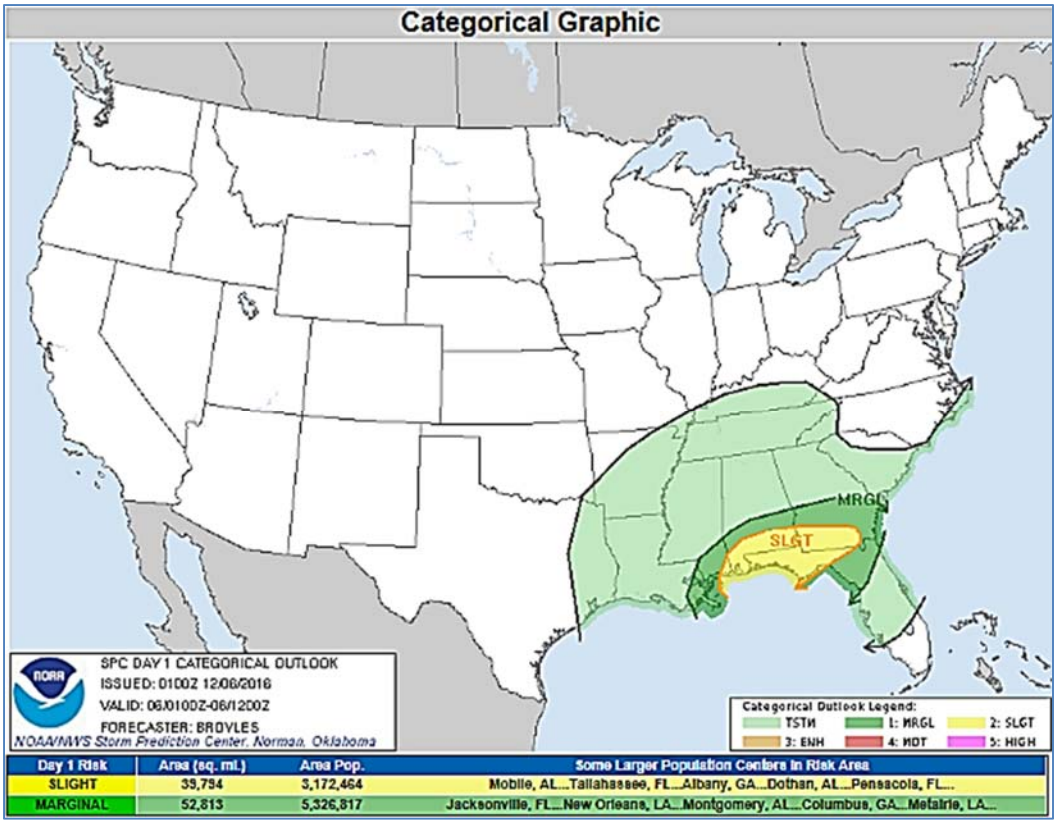

Figure 3 - NWS Convective Outlook issued at 2000 EST

1.4 Constant Pressure Charts

The NWS Constant Pressure Charts for 850-, 700-, 500-, and 300-hPa for 1900 EST (0000Z on December 6, 2016) were documented and are included as figures 4 through 8. The charts represented the conditions at approximately 5,000 feet, 10,000 feet, 18,000 feet, and 30,000 feet, and are included as figure 4 through 8.

The 850-hPa chart (figure 4) depicted the low-level conditions at approximately 5,000 feet. The chart depicted an upper level low pressure system over the Texas and Oklahoma panhandle with a long wave trough extending south-southeastward across Texas into the Gulf of Mexico. Further to the southeast off southeast Florida a high pressure system was depicted. The pressure systems resulted in a southerly flow of warm-moist tropical airmass being advected northward over the cooler airmass over the stationary front across the southeast, and supported low cloud and visibilities. The warm air advection which was indicated by the nearly perpendicular orientation of the isotherms[3] and contour[4] lines over the region, further supported rising motion and a destabilizing atmosphere over the southeast during the period. The station model depicted in the northwest Florida was Tallahassee (KTLH), which indicated a southerly wind of 45 knots, a temperature of 15° Celsius (C), a temperature-dew point spread of 1° C indicating near saturated

[3] Isotherm - is a line of equal temperature and are drawn at 5° Celsius (C) intervals on the constant pressure charts.

[4] Contour line – is a line of equal height drawn in meters on the chart.

conditions at that level, with a 30 meter height fall in the last 12-hours or approximately 100 feet which inferred rising motion over the area.

The 700-hPa chart (figure 5) continued to depict the vertical structure of the low pressure system over the Texas and Oklahoma panhandles with the long wave trough extending southward. The KTLH station model continued to depict a southerly wind of 45 knots, a temperature of 7° C, a temperature-dew point spread of 1° C, and a 30 meter height fall.

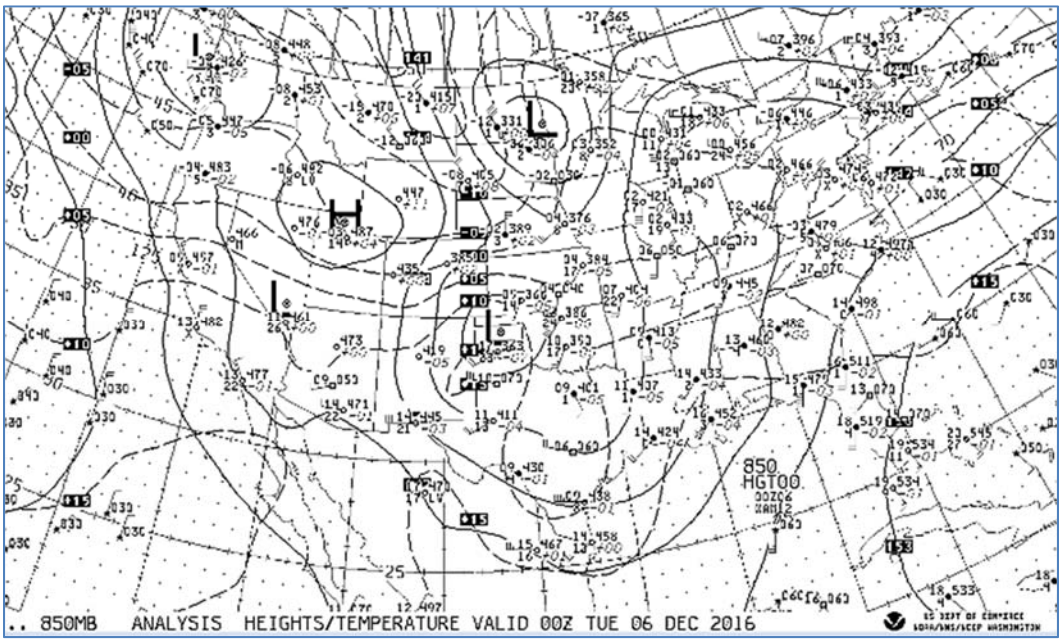

Figure 4 - 850-hPa Constant Pressure Chart for 1900 EST

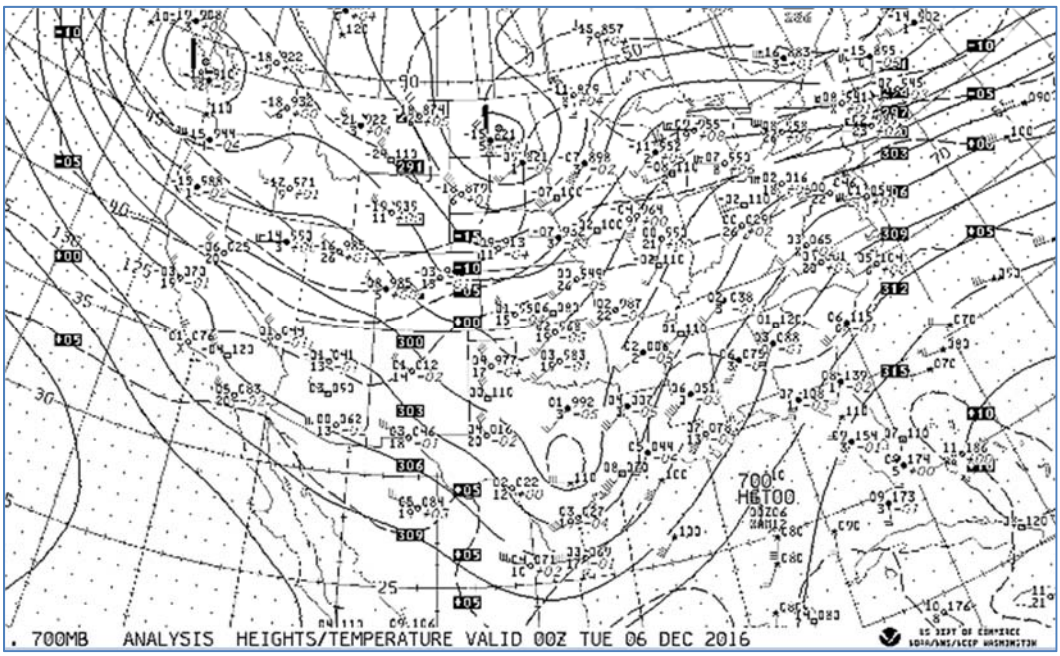

Figure 5 - 700-hPa Constant Pressure Chart for 1900 EST

The 500-hPa constant pressure chart (figure 6) depicted the conditions at approximately 18,000 feet, which is also the mean atmosphere with regards to pressure and considered the steering level for most weather systems in the lower atmosphere. The chart continued to depicted an upper level low pressure system over Texas with a long wave trough southward, with the inflection point between the trough and ridge over the southern Alabama, northwest Florida, and Georgia region supporting upper level divergence over the region and rising motion. The KTLH station model depicted a southwest wind of 55 knots, a temperature of -9° C, a temperature-dew point spread of 2° C, and a 30 meter height fail over the region.

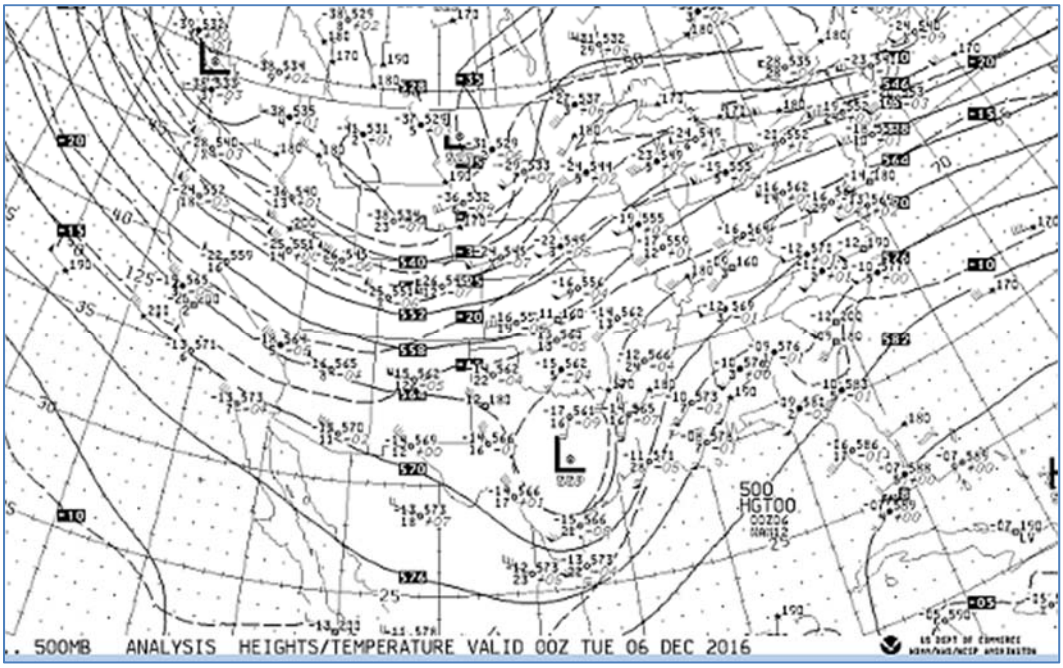

Figure 6 - 500-hPa Constant Pressure Chart for 1900 EST

The 300-hPa chart (figure 7) depicted conditions at approximately 30,000 feet. The chart continued to depict a nearly a low pressure system over Texas with a trough extending southward. The chart depicted isotachs which were shaded beginning at 70 knots to depicted the extent of the jet stream, which showed a branch of a 110 knot jet core over eastern Texas into Louisiana and another major core over the northeast with a maximum winds near 150 knots. The station model for KTLH indicated a westerly wind of 45 knots, a temperature of -33° C, and a temperature-dewpoint spread of 3° C.

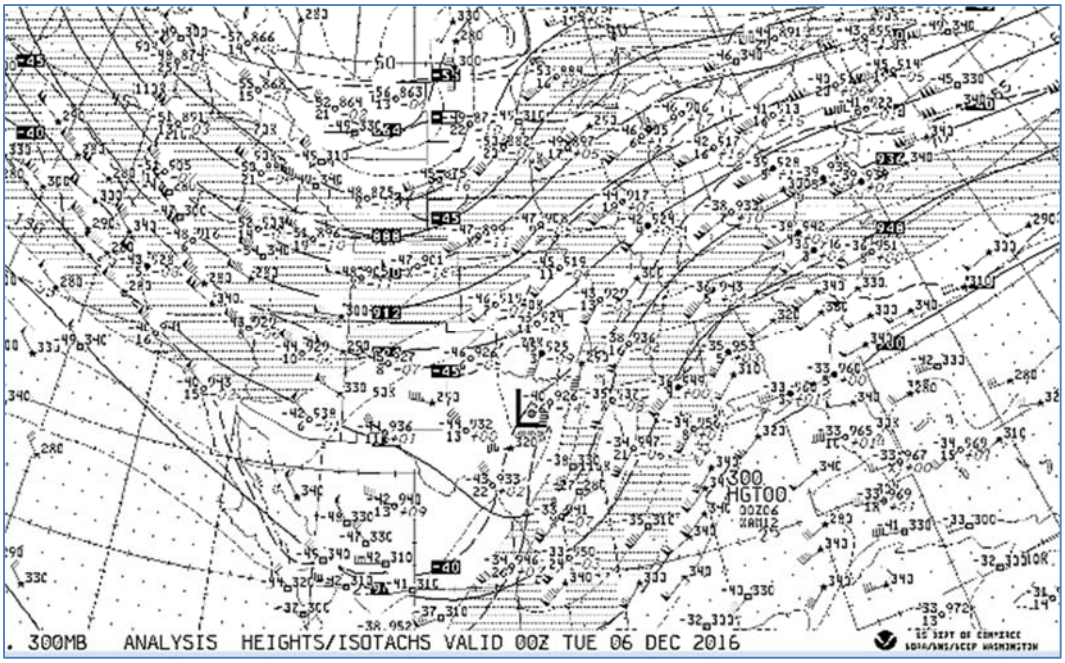

Figure 7 - 300-hPa Constant Pressure Chart for 1900 EST

1.5 Surface Prognostic Chart

The NWS WPC 12-hour Surface Prognostic Chart issued for the period was valid for 0700 EST on December 6, 2016 is included as figure 8. The chart depicted the low pressure system over Louisiana expected to move northeastward into northern Alabama and continue to intensify or deepen to 997-hPa. The low was depicted with a fully developed occluded frontal system over Georgia, with the cold front extending into southern Georgia into the Florida panhandle and into the Gulf of Mexico, and with a warm front extending eastward from the triple point across central Georgia into South Carolina. A large band of precipitation was expected with the system over the southeast with greater than a 50% probability of precipitation indicated in the dark green shading, which included accident site. Thunderstorms, indicated by the red hatched area, were also expected over Georgia, Florida, and South Carolina. The system also depicted winter weather conditions over the mid-Atlantic region with freezing precipitation depicted over western Virginia, Maryland, Washington, D.C. area, into Pennsylvania.

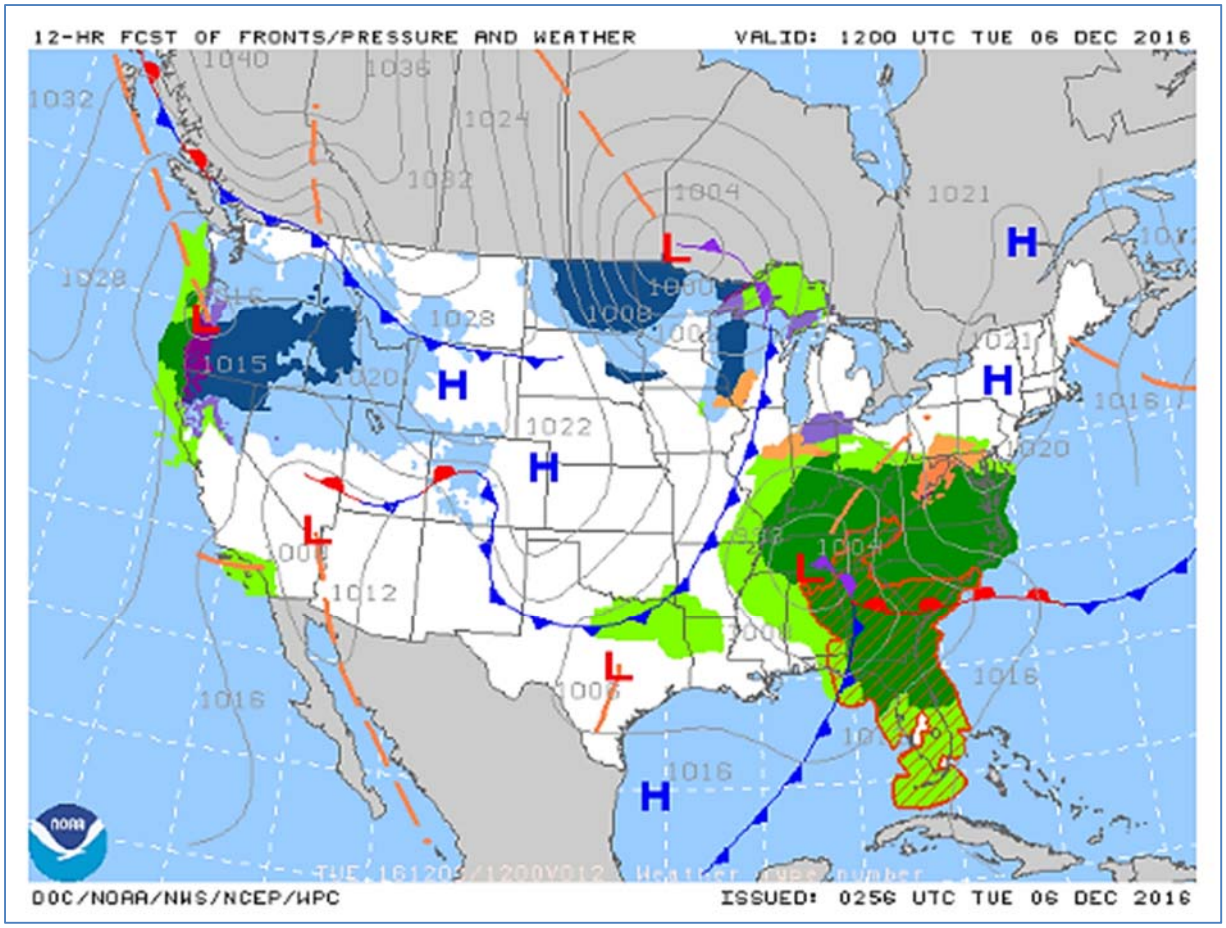

Figure 8 - 12-Hour Surface Prognostic Chart valid for 0700 EDT

The 12- and 24-hour Low-Level Significant Weather Prognostic Chart issued during the period is included in figure 9. The chart includes the basic forecast flight categories[5], freezing level data, and expected non-convective turbulence to 24,000 feet. The 12-hour forecast valid for 0700 EST on December 6, 2016 on the left expected a large area of instrument flight rule (IFR) conditions by the red line over the entire southeast United States and included the accident site. The area was surrounding by a larger area of marginal visual flight rule (MVFR) conditions by the blue scalloped line. The freezing level was also depicted by a light blue dashed line and was expected to be above 12,000 feet over the region.

[5] As defined by the NWS and the FAA Aeronautical Information Manual (AIM) section 7-1-7 defines the following general flight categories:

- Low Instrument Flight Rules (LIFR*) – ceiling or lowest layer of clouds reported as broken, overcast or the vertical visibility into a surface based obscuration below 500 feet 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 feet agl and/or visibility 3 to 5 miles.
- Visual Flight Rules (VFR) – ceiling greater 3,000 feet agl and visibility greater than 5 miles.

* By definition, IFR is a ceiling less than 1,000 feet 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 feet agl and visibility greater than 5 miles while MVFR is a sub-category of VFR.

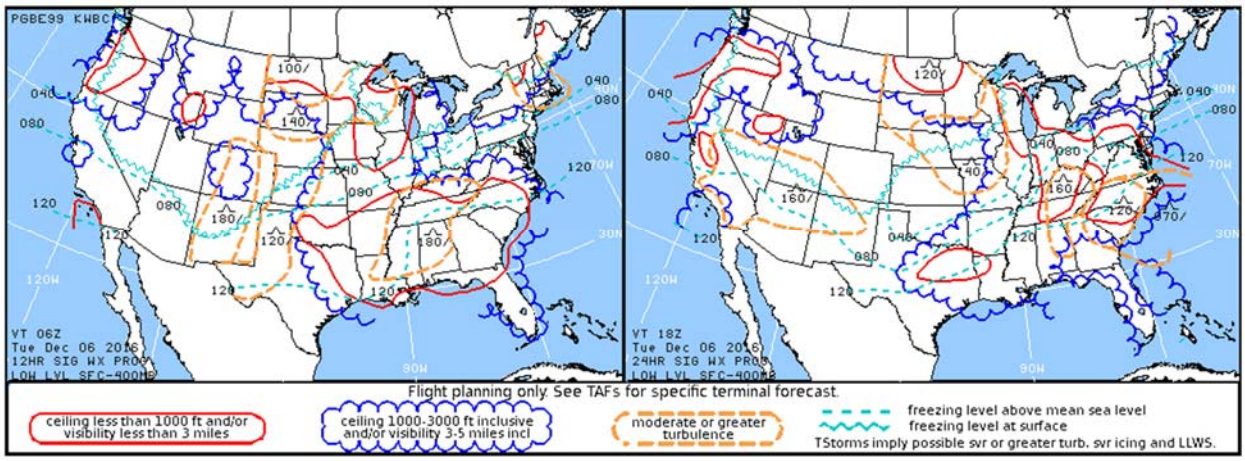

Figure 9 – NWS 12-hour and 24-hour Low-Level Significant Weather Prognostic Chart

2.0 Surface Observations

The official NWS Meteorological Aerodrome Reports (METARs) and special reports (SPECIs) and Remote Automated Weather Stations (RAWS) sites surrounding the period were documented for the area. The magnetic variation over the area was estimated at 5° West based on the latest AirNav sectional map for the area. The cloud heights are reported above ground level (agl) in the following section

2.1 Destination - Albany, Georgia

The accident airplane was destined for Southern Georgia Regional Airport (KABY), Albany, Georgia, which was located approximately 19 miles north of the accident site at an elevation of 196 feet. The airport had a federally installed and maintained Automated Surface Observation System (ASOS), which was augmented by tower personnel as needed when in operation. The following weather conditions were reported at the approximate time of the accident:

> Southern Georgia Regional Airport special weather observation at 2221 EST, automated[6], wind from 090° at 13 knots, visibility 8 miles with thunderstorms in the vicinity and light rain, sky conditions scattered clouds at 2,600 feet agl, ceiling broken at 12,000 feet, temperature and dew point 16° C, altimeter 29.81 inches of mercury (Hg). Remarks: automated observation system with a precipitation discriminator, hourly precipitation 0.26 inches, temperature 16.1° C, dew point 16.1° C.

A review of the observations indicated that the day started with low ceilings and visibility in fog/mist, with rain starting at 1517 EST and continuing through the time of the accident with multiple periods of thunderstorms and heavy rain. The estimated rainfall total for the day at the time of the accident was 4.03 inches.

[6] The inclusion of "automated" indicates that there has been no human augmentation of the report or no one logged into the system.

The raw observations and general flight categories surrounding the period from approximately an hour prior to departure to an hour after the accident were as follows (Attachment 1 includes a larger summary of the observations surrounding the period):

LIFR METAR KABY 060153Z AUTO 06012KT 4SM TSRA BR BKN004 BKN024 OVC050 17/17 A2982 RMK AO2 LTG DSNT ALQDS TSB20E35B39 SLP098 P0028 T01670167=

IFR SPECI KABY 060200Z AUTO 05006KT 1 3/4SM +TSRA BR BKN004 BKN019 OVC024 17/17 A2983 RMK AO2 LTG DSNT E-SW P0010 T01670167=

IFR SPECI KABY 060209Z AUTO 02007KT 3/4SM VCTS +RA BR BKN004 OVC010 17/17 A2983 RMK AO2 LTG DSNT E AND W TSE09 P0029 T01670167=

IFR SPECI KABY 060212Z AUTO 03009KT 1SM VCTS +RA BR SCT004 OVC010 17/17 A2982 RMK AO2 LTG DSNT E AND W TSE09 P0033 T01670167=

IFR SPECI KABY 060223Z AUTO 36006KT 3SM VCTS RA BR FEW004 BKN008 OVC018 17/17 A2982 RMK AO2 LTG DSNT NE AND E AND W TSE09 P0036 T01670167=

LIFR SPECI KABY 060227Z AUTO 36005KT 3SM RA BR BKN004 BKN011 OVC018 17/17 A2983 RMK AO2 LTG DSNT NE AND E AND W TSE09 P0040 T01670167=

LIFR SPECI KABY 060230Z AUTO 01007KT 1 3/4SM +RA BR BKN004 BKN011 OVC018 17/17 A2983 RMK AO2 LTG DSNT ALQDS TSE09 P0049 T01670167=

IFR SPECI KABY 060237Z AUTO 34007KT 1SM +RA BR SCT004 BKN008 OVC018 16/16 A2985 RMK AO2 LTG DSNT ALQDS TSE09 PRESRR P0065 T01610161=

IFR SPECI KABY 060239Z AUTO 34007KT 3/4SM +RA BR SCT006 BKN010 OVC018 16/16 A2985 RMK AO2 LTG DSNT ALQDS TSE09 P0070 T01610161=

IFR METAR KABY 060253Z AUTO 33010KT 3/4SM +RA BR FEW005 OVC014 16/16 A2987 RMK AO2 LTG DSNT SW AND W TSE09 SLP114 P0102 60202 T01560156 55003=

Departed at 0254Z

IFR SPECI KABY 060301Z AUTO 06006KT 1SM +RA BR FEW005 OVC019 16/16 A2984 RMK AO2 LTG DSNT SW AND W P0017 T01560156=

MVFR SPECI KABY 060316Z AUTO 08015KT 3SM -RA BR BKN023 BKN120 16/16 A2981 RMK AO2 PRESFR P0024 T01610161=

VFR SPECI KABY 060321Z AUTO 09013KT 8SM VCTS -RA SCT026 BKN120 16/16 A2981 RMK AO2 P0024 T01610161=

Accident at 0322Z

VFR SPECI KABY 060341Z AUTO 13012KT 10SM -RA FEW005 FEW047 BKN110 17/17 A2982 RMK AO2 LTG DSNT E P0025 T01720172=

VFR SPECI KABY 060348Z AUTO 11013KT 9SM VCTS -RA FEW005 SCT055 OVC110 17/17 A2981 RMK AO2 LTG DSNT E AND S P0026=

VFR METAR KABY 060353Z AUTO 09010KT 7SM VCTS RA FEW006 SCT044 OVC110 17/17 A2981 RMK AO2 WSHFT 0336 LTG DSNT E-S SLP095 P0026 T01720172=

VFR SPECI KABY 060403Z AUTO 11006KT 10SM -RA FEW006 SCT055 OVC100 18/18 A2983 RMK AO2 LTG DSNT SE P0001 T01780178=

MVFR METAR KABY 060453Z AUTO 14007KT 3SM +RA BR FEW019 BKN095 OVC110 18/18 A2981 RMK AO2 SLP093 P0016 T01780178 401780111=

The large number of special observations reported were due to variable visibility and rapidly changing precipitation intensities. The start and end of the occurrence of a thunderstorm also requires a special observation. The "*AUTO*" indicated no human augmentation was involved during the period.

2.2 Closest Weather Reporting - Camilla, Georgia

Camilla-Mitchell County Airport (KCXU), Camilla, Georgia was located 4 miles west of the accident site an elevation of 176 feet. The airport had an unaugmented Automated Weather Observation System (AWOS) and issued observations every 20-minutes. The following conditions were reported at the approximate time of the accident:

> Camille-Mitchell County Airport weather observation at 2215 EST, automated, wind from 360° at 8 knots, visibility 3/4 mile[7], ceiling overcast at 600 feet agl, temperature and dew point 18° C, altimeter 29.81 inches of Hg. Remarks: automated observation system, temperature 17.9° C, dew point 17.9° C.

The raw observations and general flight categories surrounding the period were as follows:

IFR METAR KCXU 060135Z AUTO 04004KT 1 1/4SM SCT005 BKN014 OVC019 17/17 A2980 RMK AO2 VIS 1/2V5 T01680167=

MVFR METAR KCXU 060155Z AUTO 08007KT 5SM SCT004 OVC014 17/17 A2979 RMK AO2 T01700168=

LIFR METAR KCXU 060215Z AUTO 00000KT 5SM BKN004 OVC014 17/17 A2980 RMK AO2 T01700167=

LIFR METAR KCXU 060235Z AUTO 00000KT 10SM BKN004 OVC010 17/17 A2980 RMK AO2 T01700168=

IFR METAR KCXU 060255Z AUTO 34004KT 10SM OVC006 17/17 A2981 RMK AO2 T01720171=

IFR METAR KCXU 060315Z AUTO 36008KT 3/4SM OVC006 18/18 A2981 RMK AO2 T01790179=

Accident 0322Z

IFR METAR KCXU 060335Z AUTO 05006KT 1 3/4SM BKN006 BKN013 OVC025 18/18 A2980 RMK AO2 VIS 1V3 T01820180=

IFR METAR KCXU 060355Z AUTO 00000KT 1/2SM BKN006 OVC011 18/18 A2981 RMK AO2 T01830181=

MVFR METAR KCXU 060415Z AUTO 06003KT 3SM SCT011 BKN022 OVC041 18/18 A2980 RMK AO2 T01830181=

[7] Weather type is normally reported when visibility is 6 miles or less in METARs; but for some reason not identified, the AWOS system did not report weather type of what was causing the visibility restriction during the period. The visibility was likely reduced due to heavy rain showers at the time based on the closest weather radar imagery.

MVFR METAR KCXU 060435Z AUTO 09004KT 4SM SCT012 BKN042 OVC050 18/18 A2980 RMK AO2 T01820180=

2.3 Diversion Airport - Tallahassee, Florida

Tallahassee International Airport (KTLH), Tallahassee, Florida was located approximately 50 miles south of the accident site at an elevation of 83 feet. The airport had an ASOS and reported the following conditions at the time of the accident:

> Tallahassee International Airport special weather observation at 2200 EST, wind from 180° at 11 knots, visibility 7 miles in thunderstorms and light rain, a few clouds at 800 feet, ceiling broken at 1,200 feet, overcast at 2,100 feet in cumulonimbus clouds, temperature and dew point 23° C, altimeter 29.80 inches of Hg. Remarks: automated observation system, occasional lightning in-cloud overhead, thunderstorm overhead moving northeast, hourly precipitation 0.02 inches, temperature 23.3° C, dew point 22.8° C, maintenance required on system.

The raw observations and general flight categories surrounding the period were as follows:

IFR METAR KTLH 060153Z 17011KT 3SM +TSRA BR BKN007CB OVC012 23/23 A2982 RMK AO2 LTG DSNT S TSB44 SLP098 OCNL LTGIC OHD TS OHD MOV NE P0028 T02330228=

IFR SPECI KTLH 060201Z 19015G27KT 1/2SM +TSRA FG BKN007CB OVC012 23/22 A2982 RMK AO2 PK WND 20027/0159 LTG DSNT E OCNL LTGIC OHD TS OHD MOV NE P0024 T02280222=

MVFR SPECI KTLH 060229Z 19015KT 6SM TSRA BR SCT006 OVC019CB 23/22 A2980 RMK AO2 PK WND 20027/0159 OCNL LTGIC OHD TS OHD MOV NE P0061 T02280222 $=

MVFR METAR KTLH 060253Z 18011KT 6SM TSRA BR SCT010 BKN015 OVC021CB 23/23 A2980 RMK AO2 PK WND 20027/0159 SLP091 OCNL LTGIC OHD TS OHD MOV NE P0068 60099 T02330228 50005 $=

MVFR SPECI KTLH 060300Z 18011KT 7SM -TSRA FEW008 BKN012 OVC021CB 23/23 A2980 RMK AO2 OCNL LTGIC OHD TS OHD MOV NE P0002 T02330228 $=

Accident 0322Z

IFR SPECI KTLH 060334Z 19016KT 10SM -RA BKN008 OVC012 24/23 A2979 RMK AO2 TSE33 CIG 006V010 P0004 T02390233 $=

MVFR SPECI KTLH 060346Z 19016KT 4SM -RA BR BKN010 OVC013 23/23 A2978 RMK AO2 TSE33 P0009 T02330228 $=

IFR METAR KTLH 060353Z 19016KT 10SM BKN009 BKN013 OVC095 23/23 A2978 RMK AO2 RAE53 TSE33 SLP084 P0009 T02330228 $=

VFR SPECI KTLH 060416Z 19008KT 10SM -RA SCT009 SCT047 OVC095 23/22 A2978 RMK AO2 RAB03 P0000 T02330222 $=

VFR METAR KTLH 060453Z 20012KT 10SM SCT014 OVC110 23/22 A2980 RMK AO2 RAB03E17 SLP089 P0000 T02280217 402390206 $=

3.0 Sounding

The closest upper air sounding or rawinsonde observation (RAOB) was from the NWS Tallahassee (KTLH), Florida, Weather Forecast Office (WFO) designated site number 72214, location approximately 47 miles south of the accident site at an elevation of 59 feet on the campus of Florida State University. The 1900 EST sounding (0000Z on December 6, 2016) was plotted on a standard Skew-T log P diagram[8] from the surface to 500-hPa or 18,000 feet utilizing RAOB software[9], and is included as figure 10.

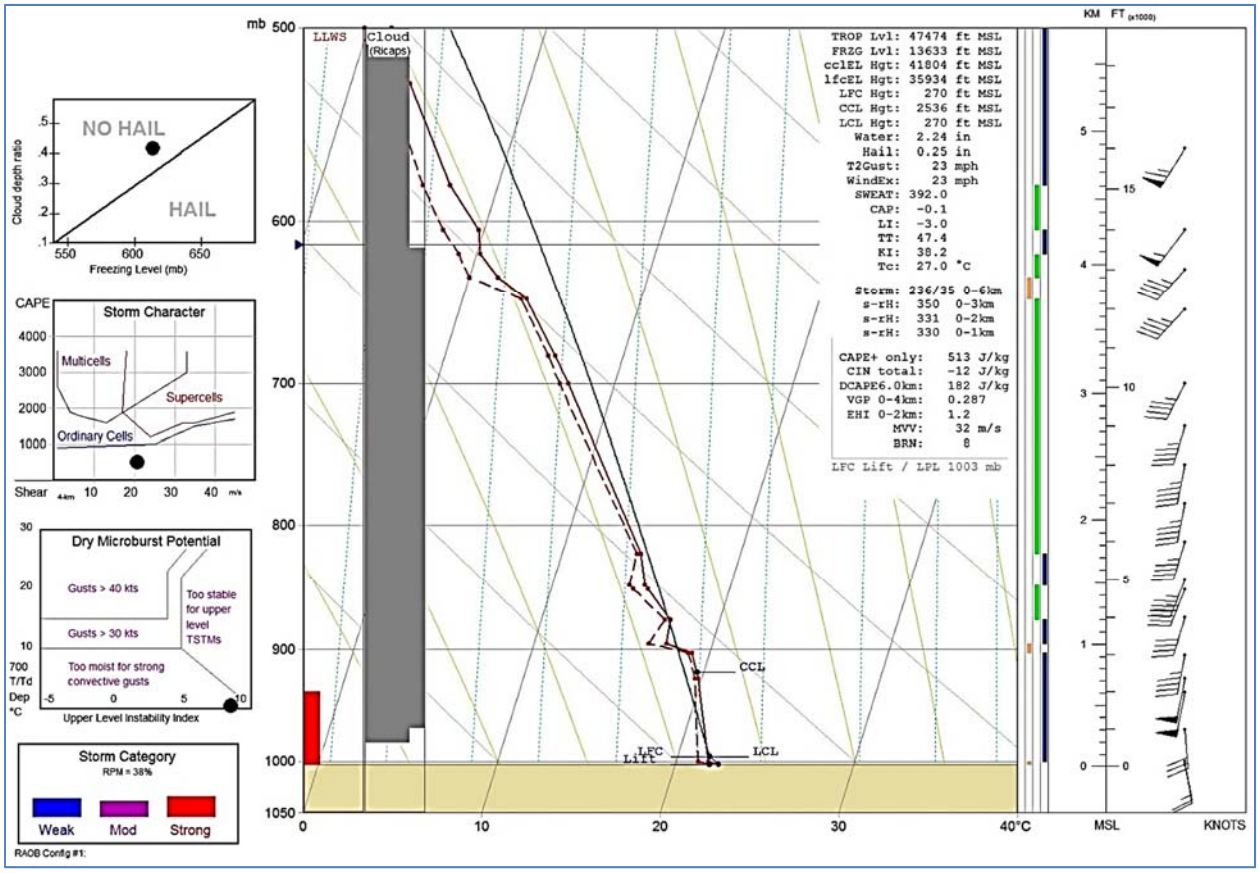

Figure 10 - Tallahassee 1900 EST sounding

The sounding depicted a surface temperature of 22.4° C (72° F), a dew point of 21.9° C (71° F), with a relative humidity of 97%, and with wind from 170° at 11 knots. The environment was moist with a relative humidity greater than 90% from the surface through 13,000 feet and more than 80% through 19,000 feet. The lifted condensation level (LCL)[10] and level of free convection

[8] Skew T log P diagram – is a standard meteorological plot or thermodynamic diagram using temperature and the logarithmic of pressure as coordinates, used to display winds, temperature, dew point, and various indices used to define the vertical structure of the atmosphere.

[9] RAOB – (The complete Rawinsonde Observation program) is an interactive sounding analysis program developed by Environmental Research Services, Matamopras, Pennsylvania.

[10] Lifting Condensation Level (LCL) - The height at which a parcel of moist air becomes saturated when it is lifted dry adiabatically.

(LFC)[11] were identified at 211 feet agl, and a convective condensation level (CCL)[12] at 2,477 feet agl. The equilibrium level (EL)[13] or expected top of convective clouds was at 35,900 feet with the tropopause at identified at approximately 47,500 feet. The freezing level was identified at approximately 13,600 feet and supported icing in clouds above that level. The atmosphere was characterized as unstable with a Lifted Index (LI)[14] of -3, a K-Index[15] of 38.2, and a Convective Available Potential Energy (CAPE)[16] value was 512.887 Joules/kilogram (J/kg), which indicted an approximate 80% probability of thunderstorm development. The maximum vertical velocity (MVV) of the potential updrafts ranged from 32 to 44 meters/second (m/s) or 64 to 88 knots. The sounding also indicated a potential for surface hail potential of 0.25 inch and at the wet bulb level before melting of 1.48 inch, the sounding also had a high precipitable water value of 2.25 inches. The microburst index or WINDEX and the T2 Gust indicated outflow winds with the maximum estimated wind gusts of 20 knots. The Bulk Richardson Number (BRN)[17] was 8 and the BRN Shear value was 63.7 (m^2/s^2), which favored strong multicellular to squall line type thunderstorms. The expected storm movement was from 236° at 35 knots, which is based on a 30° deviation from the mean wind and 75% of the 500-hPa wind speed.

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[11] Level of Free Convection (LFC) -The level at which a parcel of saturated air becomes warmer than the surrounding air and begins to rise freely. This occurs most readily in a conditionally unstable atmosphere.

[12] Convective Condensation Level (CCL) - The height to which a parcel of air, if heated sufficiently from below, will rise adiabatically until condensation starts. This is typically used to identify the base of cumuliform clouds, which are normally produced from surface heating and thermal convection.

[13] Equilibrium Level (EL) - On a sounding, the level above the level of free convection (LFC) at which the temperature of a rising air parcel again equals the temperature of the environment. The height of the EL is the height at which thunderstorm updrafts no longer accelerate upward. Thus, to a close approximation, it represents the height of expected (or ongoing) thunderstorm tops. However, strong updrafts will continue to rise past the EL before stopping, resulting in storm tops that are higher than the EL. This process sometimes can be seen visually as an overshooting tops or anvil dome. The EL typically is higher than the tropopause, and is a more accurate reference for storm tops.

[14] Lifted Index (LI) - A common measure of atmospheric instability. Its value is obtained by computing the temperature that air near the ground would have if it were lifted to 500-hPa or approximately 18,000 feet and comparing that temperature to the actual temperature at that level. Negative values indicate instability - the more negative, the more unstable the air is, and the stronger the updrafts are likely to be with any developing thunderstorms.

[15] K-Index - The measure of thunderstorm potential based on the vertical temperature lapse rate, the moisture content of the lower atmosphere and the vertical extent of the moist layer. The higher the K-Index value the greater the probability of air mass type thunderstorm development across the region.

[16] Convective Available Potential Energy (CAPE) – is a measure of the amount of energy available for convection. CAPE is directly related to the maximum potential vertical speed within an updraft; thus, higher values indicate greater potential for severe weather.

[17] Bulk Richardson Number (BRN) - is the ratio of the buoyancy (CAPE) of a lifted parcel to the vertical wind shear of the environment in which the parcel is lifted. It correlates well with observed storm type (single, multicellular, and supercells). BRN's less than 45 tend to support supercell structures, with multicellular convection favored over 45. While the BRN has shown some value as a predictor of storm type, it is a poor predictor of storm rotation.

The wind profile indicated southerly winds at the surface, which veered[18] to the south-southwest with height through 18,000 feet with wind speeds increasing with height. A low-level jet stream was identified at 2,000 feet with a wind from 190° at 49 knots, which funneled warm moist unstable air northward. The mean 0 to 6 kilometer or 18,000 feet wind was from 206° at 47 knots. The level of maximum wind associated with the jet stream was identified at 46,000 feet from 265° at 91 knots and was located below the tropopause, which was at 47,500 feet.

4.0 Satellite Imagery

The Geostationary Operational Environmental Satellite number 13 (GOES-13) 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 imagery (band 4) at a wavelength of 10.7 microns (μm) provided standard satellite image with radiative cloud top temperatures with a resolution of 4 km surrounding the period of the accident.

Figure 11 is the GOES-13 infrared image at 2215 EST at 4X magnification and with a standard MB temperature enhancement curve applied to highlight the higher and colder cloud tops typically associated with deep convection. The accident site was located under the leading edge of a line of cumulonimbus clouds with a radiative cloud top temperature of 228° Kelvin or -45.16° C, which corresponded to cloud tops near 37,000 feet based on the KTLH sounding. Higher cloud tops were located west through north and northeast (light and darker blue shades) surrounding the accident site.

[18] Veering refers to the clockwise change in direction with height in the northern hemisphere, due to the reduction in friction and increasing pressure gradient forces in the wind.

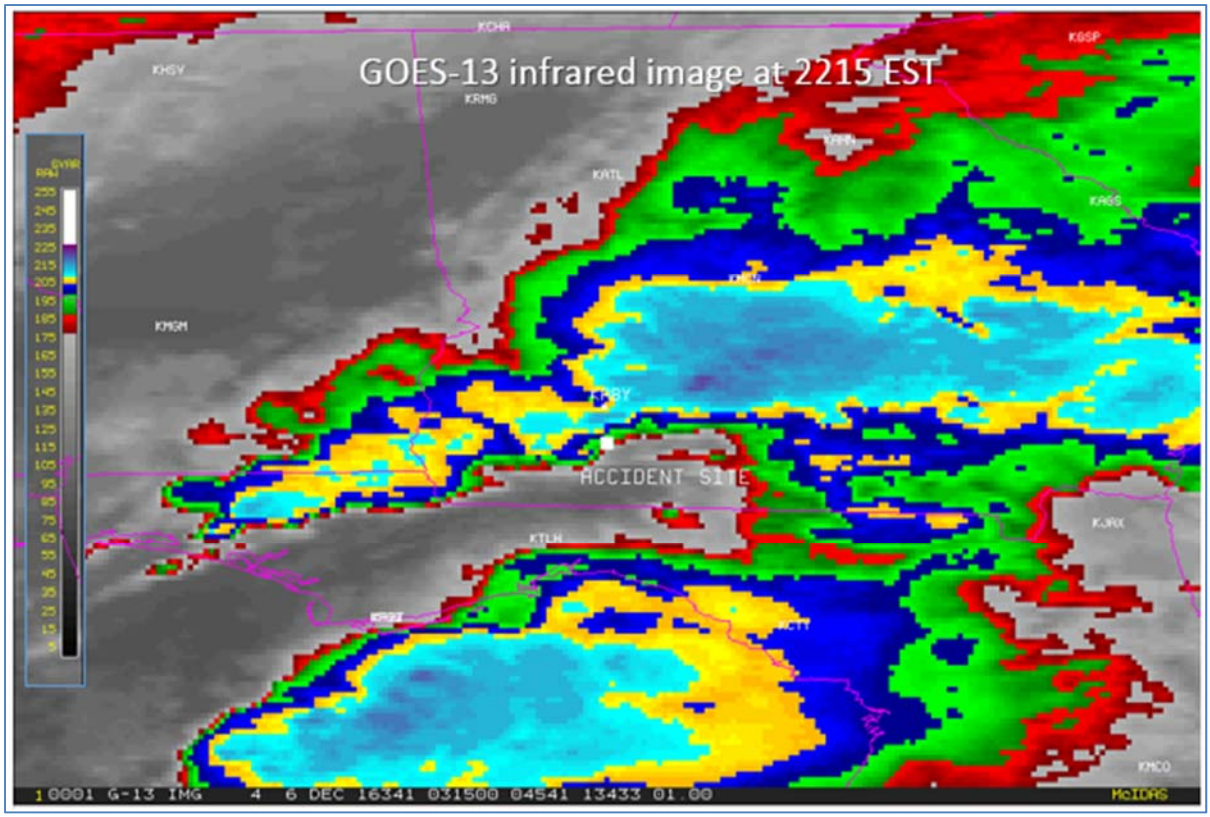


Figure 11 - GOES-13 infrared image at 2215 EST with temperature enhancement curve applied

5.0 Weather Radar Imagery

The closest Weather Surveillance Radar-1988, Doppler (WSR-88D) to the accident site was from the NWS Tallahassee (KTLH) location approximately 50 miles south of the accident site. The level II and III archive data were obtained from the NCEI utilizing the Hierarchical Data Storage System (HDSS) and displayed using the NWS NEXRAD Interactive Viewer and Data Exporter software.

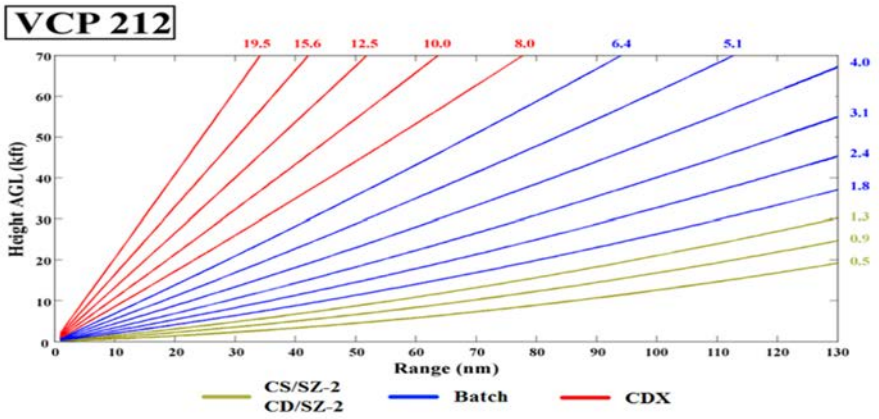
The WSR-88D is a S-band 10 centimeter wavelength radar with a power output of 750,000 watts, with a 28-foot parabolic antenna concentrating the energy into a 0.95° beam width. The radar produces three basic types of products reflectivity, radial velocity, and spectral width.

The WSR-88D is a computer controlled radar system, which automatically creates a complete series of specific scans in a specific sequence known as a volume scan. Individual elevation scans are immediately available on the WSR-88D's Principle Users Processor (PUP). Products that require data from multiple elevation scans are not available until the end of the volume scan, which can range from 4 to 10-minutes depending on the scan being utilized.

5.1 Volume Scan Strategy

The WSR-88D operates in several different scanning modes, identified as Mode A and Mode B. Mode A is the precipitation scan and has multiple scanning strategies, which are used when

significant weather echoes are present or severe weather is occurring or is anticipated. The most common is the non-severe convective mode where the radar makes 9 elevation scans from 0.50° to 19.5° every six minutes. This particular scanning strategy is documented as volume coverage pattern 21 (VCP-21). Mode B is the clear air mode, which is used when there is no detectable precipitation or when precipitation intensity is light and/or areal extent is small, such as light stratiform precipitation or snow. In the clear air mode the radar makes 5 elevation scans during a ten minute period. During the period surrounding the accident the KTLH WSR-88D radar was operating in the precipitation mode VCP-212 where the radar makes 14 different elevation scans in 4 ½ minutes. This mode is typically used by the NWS during periods when rapidly evolving wide spread severe convection is expected, and allows for improved low-level vertical resolution of the storms. The following chart provides an indication of the different elevation angles in this VCP, and the approximate height and width of the radar beam with distance from the radar site.



5.2 Beam Height Calculation

Assuming standard refraction[19] of the 0.95° radar beam of the KTLH WSR-88D with an antenna height of 170 feet and a distance of 50 miles from the radar, the following table shows the approximate beam height and width information of the radar display over the site of the accident. The heights have been rounded to the nearest 10 feet.

Antenna Elevation	Beam Center	Beam Base	Beam Top	Beam Width
0.5°	4,480 feet	1,960 feet	7,000 feet	5,040 feet
0.9°	6,600 feet	4,080 feet	9,120 feet	5,040 feet
1.3°	8,720 feet	6,200 feet	11,240 feet	5,040 feet

Based on the radar height calculations, the 0.5° elevation scan[20] depicts the conditions encompassing the altitude between 1,960 to 7,000 feet during the minutes of the flight prior to the accident. This was determined to be the most representative of the conditions encountered during

[19] Standard Refraction in the atmosphere is when the temperature and humidity distributions are approximately average, and values set at the standard atmosphere.

[20] Actual lowest elevation angle used was 0.47°, which is rounded up to 0.5° for general purposes and documentation.

the period associated with the accident. While the 0.9° elevation scan best correlates to the conditions at the accident airplanes cruising altitude of 7,000 feet prior to let down. While the 1.3 elevation scan depicted conditions above the cruising level in the area. The accident airplane operated the enroute phase in echo free areas.

5.3 Reflectivity

Reflectivity is the measure of the efficiency of a target in intercepting and returning radio energy. With hydrometeors[21], 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[22]), and is a general measure of echo intensity. The chart below relates the old NWS video integrator and processor (VIP) intensity levels versus the WSR-88D's display levels, precipitation mode reflectivity in decibels, 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	3	15 to 19	.01 in/hr
Very Light	4	20 to 24	.02 in/hr
	5	25 to 29	.04 in/hr
2	6	30 to 34	.09 in/hr
Light to	7	35 to 39	.21 in/hr
Moderate			
3	8	40 to 44	.48 in/hr
Strong			
4	9	45 to 49	1.10 in/hr
Very Strong			
5	10	50 to 54	2.49 in/hr
Intense			
6	11	55 to 59	>5.67 in/hr
Extreme	12	60 to 64	
	13	65 to 69	
	14	70 to 74	
	15	> 75	

Air traffic control (ATC) weather display systems also use radar weather processors with the ability to determine precipitation intensity, with controllers instructed to describe the intensity to pilots based on the following table. One exception is that the centers weather and radar processor

[21] Hydrometeors are any product of condensation or sublimation of atmospheric water vapor, whether formed in the free atmosphere or at the earth's surface; also, any water particles blown by the wind from the earth's surface. Hydrometeors are classified as; (a) Liquid or solid water particles suspended in the air: cloud, water droplets, mist or fog. (b) Liquid precipitation: drizzle and rain. (c) Freezing precipitation: freezing drizzle and freezing rain. (d) Solid (frozen) precipitation: ice pellets, hail, snow, snow pellets, and ice crystals. (e) Falling particles that evaporate before reaching the ground: virga. (f) Liquid or solid water particles lifted by the wind from the earth's surface: drifting snow, blowing snow, blowing spray. (g) Liquid or solid deposits on exposed objects: dew, frost, rime, and glaze ice.

[22] dBZ - 10 log Ze

(WARP) system does not display light intensity echoes below 30 dBZ. This table is also referenced for pilots in Advisory Circular AC 00-24C - "Thunderstorm".

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

5.4 Composite Reflectivity Imagery

Composite reflectivity images utilize all the elevation scans during each volume scan to create the image, and is composed of the greatest echo intensity (reflectivity) from any elevation angle seen by the radar. It is used to reveal the highest reflectivity in all of the elevation scans over a location. Figure 12 is the Composite Reflectivity image at 2221 EST on December 5, 2016 with the flight track overlaid of N765FA. The accident site is located along the leading edge of a line of echoes with maximum reflectivity of 45 to 50 dBZ or heavy intensity echoes immediately west of the accident site and echoes of 30 dBZ or less over the accident site or light to moderate intensity.

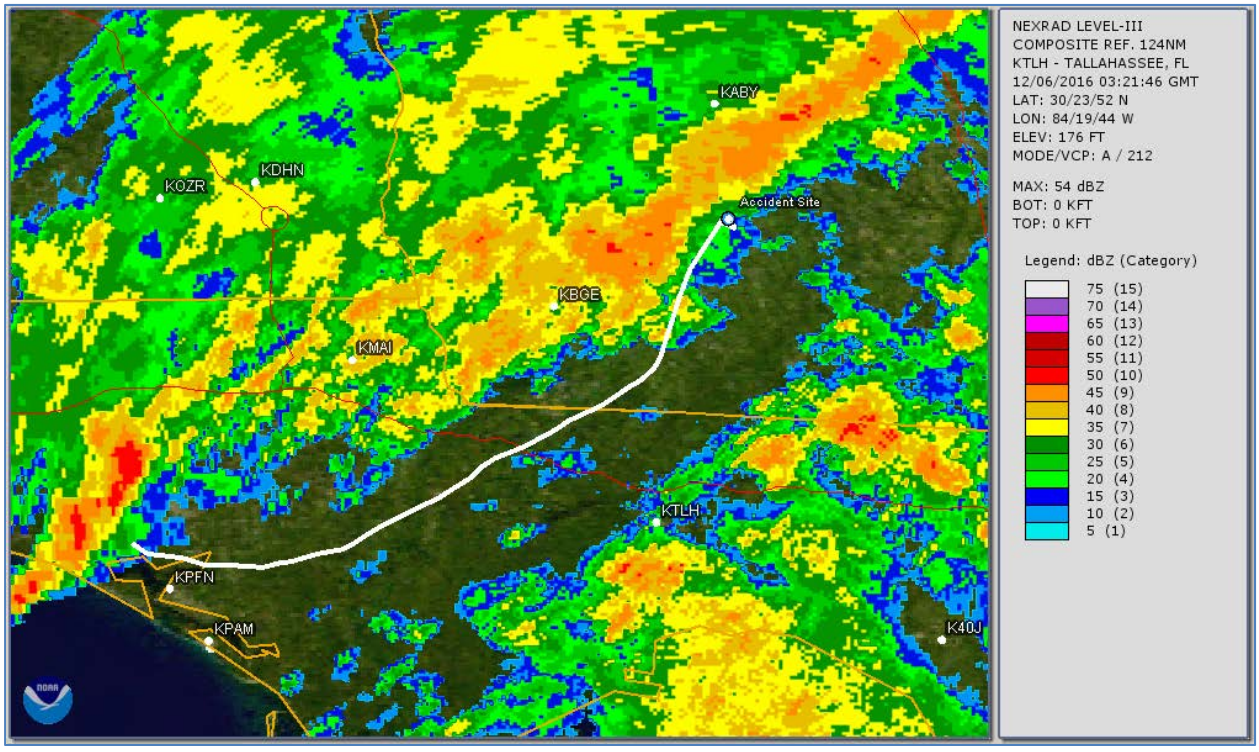


Figure 12 - KTLH WSR-88D composite reflectivity image at 2221 EST with flight track

5.5 Base Reflectivity Imagery

Figure 13 is a close up of the KTLH WSR-88D base reflectivity image for the 0.5° elevation scan at 2221:47 EST with the flight track from 2218:59 to the time of the accident overlaid. The image has a resolution of 0.5° x 0.13 miles (0.25 km). The flight track is located along the leading edge of the line of heavy intensity echoes in echoes of 5 to 20 dBZ or light intensity precipitation echoes. The flight track then begins a turn to the right when communications with the aircraft are lost.

Figure 14 is the next KTLH WSR-88D base reflectivity image for the 0.5° elevation scan at 2228:12 EST with the flight track overlaid and the accident site labelled. The image shows developing echoes over the immediate flight track with echo intensity of 43.5 dBZ or heavy intensity precipitation over the position at 2218 EST. The image depicts rapidly developing echoes over the flight track and the accident site.

Figure 15 is the KTLH WSR-88D base reflectivity image for the 0.5° elevation scan at 2234:39 EST which continues to show echoes increasing in intensity over the accident site with reflectivity's between 40 and 52 dBZ or heavy to extreme intensity, with echo tops near 40,0000 feet. Several small bowing segments are also indicated to the southwest.

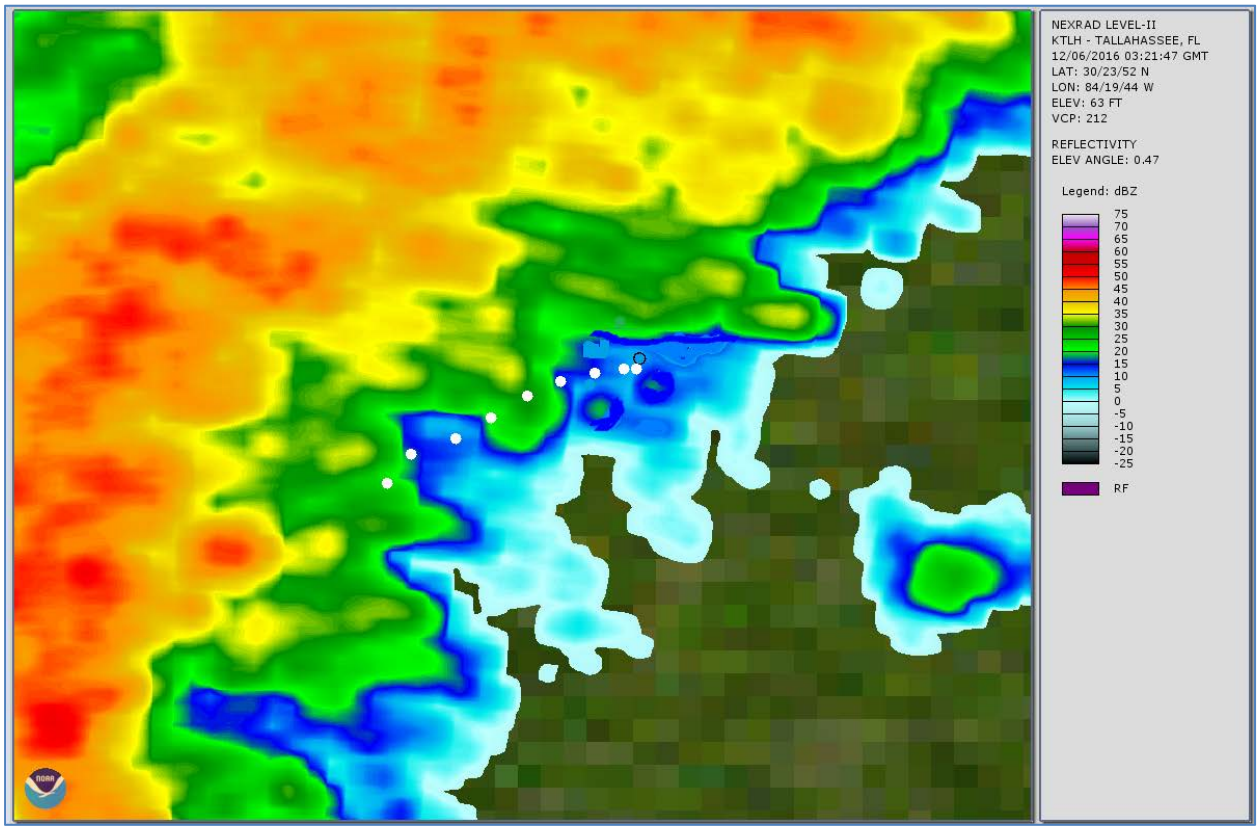


Figure 13 - KTLH WSR-88D 0.5° base reflectivity image at 2221:47 EST

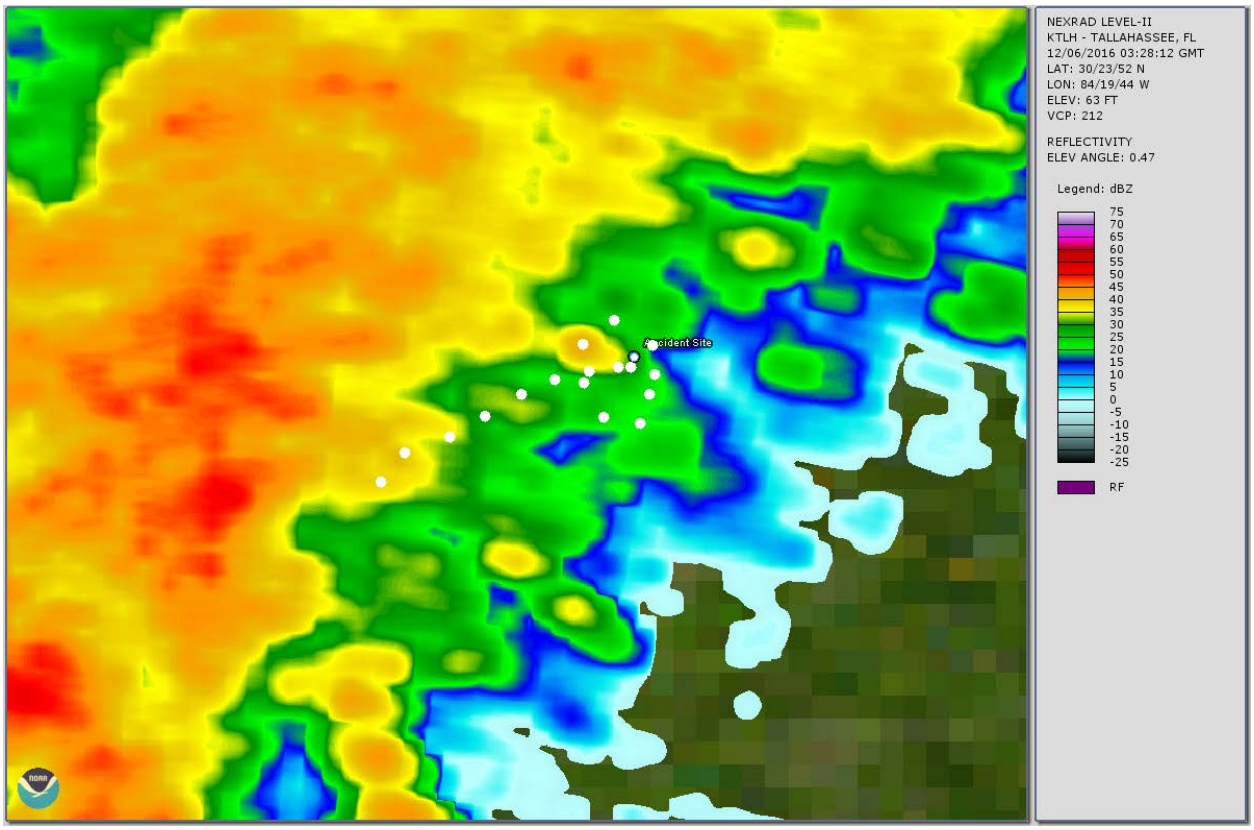


Figure 14 - KTLH WSR-88D 0.5° base reflectivity image at 2228:12 EST

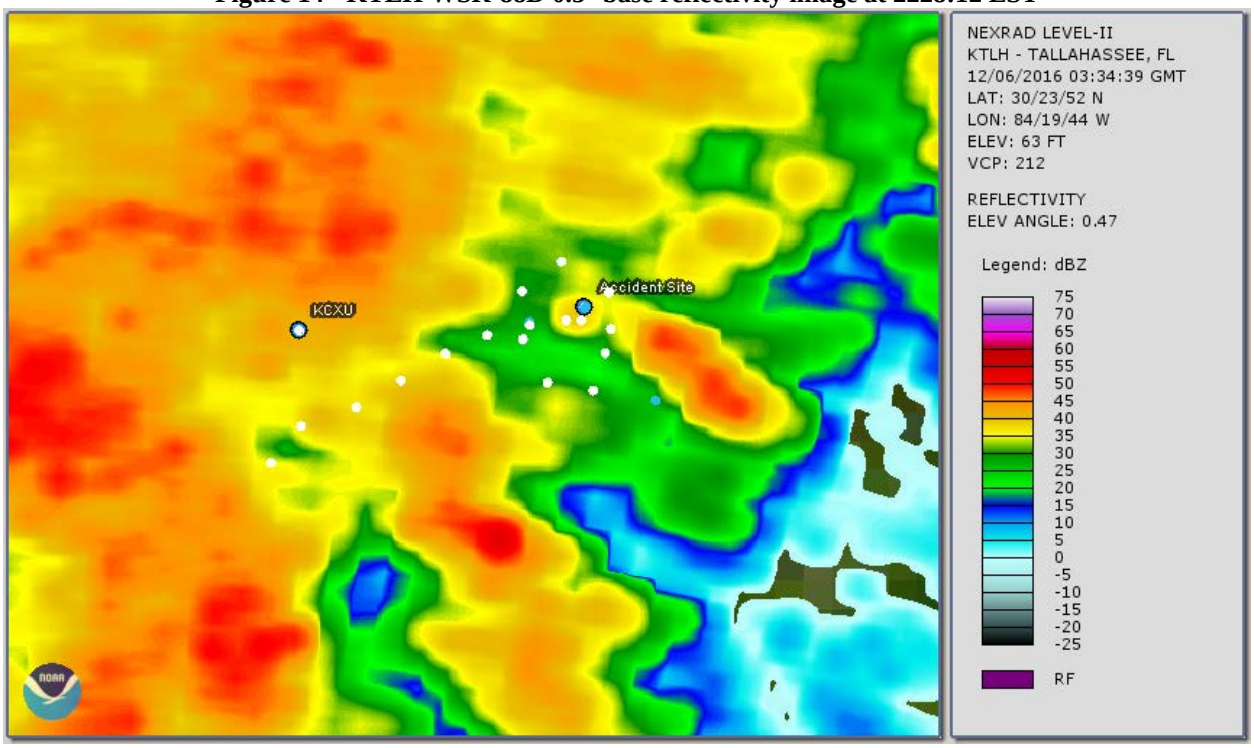


Figure 15 - KTLH WSR-88D 0.5° base reflectivity image at 2234:39 EST

5.6 Radial Velocity Imagery

Figure 16 is the KTLH WSR-88D base velocity image for the 0.5° elevation scan at 2221:47 EST with a resolution of 0.5° x 0.13 miles. The green shading areas indicated targets moving towards the antenna and red shades moving away from the radar site. The image depicts winds of 50 to 64 knots from the south over the flight track and accident site. The black boundary immediately east of the track is an echo free area, where winds could not be determined. The image at 2228 EST provided similar findings.

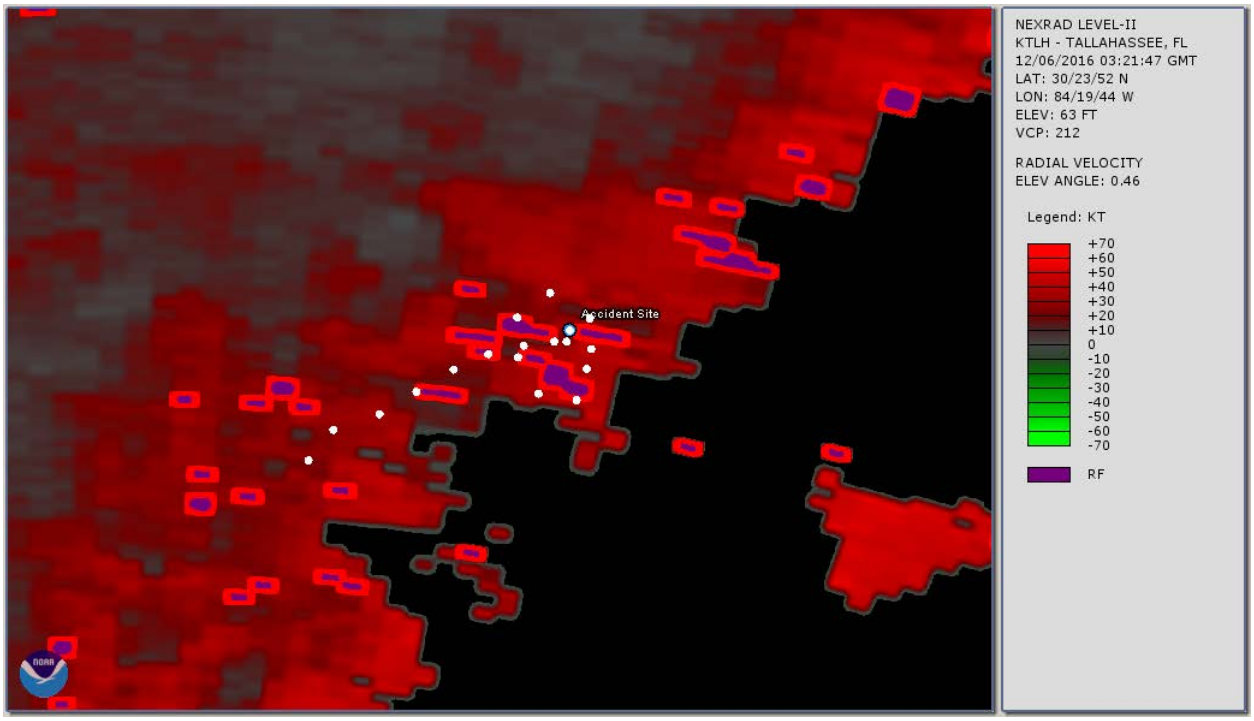


Figure 16 - KTLH WSR-88D 0.5° radial velocity image at 2221:47 EST

The spectrum width (SW) product was also examined which is a measure of the variance on velocity within the observation bin and has been useful in detecting turbulence. The product depicted strong wind shears along the eastern leading edge of the line, but provided little additional value to be depicted for additional information.

5.7 Echo Tops Imagery

The KTLH WSR-88D echo tops product depicting the maximum height of 18.5 dBZ echoes for 2221 and 2228 EST are included in figure 17. The image shows echo tops near 30,000 to 35,000 feet over the last four minutes along the flight track and the accident site, with echo tops to 45,000 feet immediately west of Camille.

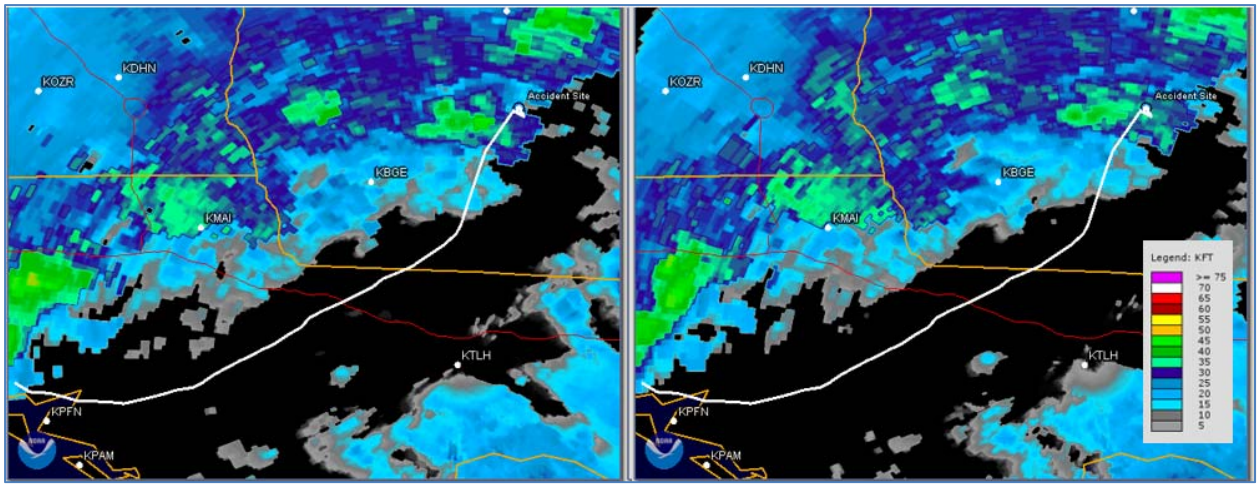


Figure 17 - KTLH WSR-88D echo tops product at 2221 (left) and 2228 EST (right) with flight track overlaid

5.8 Velocity Azimuth Display Wind Profile

The Velocity Azimuth Display (VAD) Wind Profile (VWP) for the period is included as figure 18. The image depicts a profile of the wind over the period from 2123 through 2228 EST every 1,000 feet. The image depicted winds from the south-southwest at 25 knots slowly veering to the west-southwest with height with increasing wind speeds. The wind at 3,000 feet was from the south-southwest at 45 knots and 4,000 feet at 50 knots. The maximum wind observed was at 30,000 feet from the west-southwest at 72 knots. No significant changes in the wind profile were noted during the period. The profile indicated strong deep layer shear favorable for strong convection.

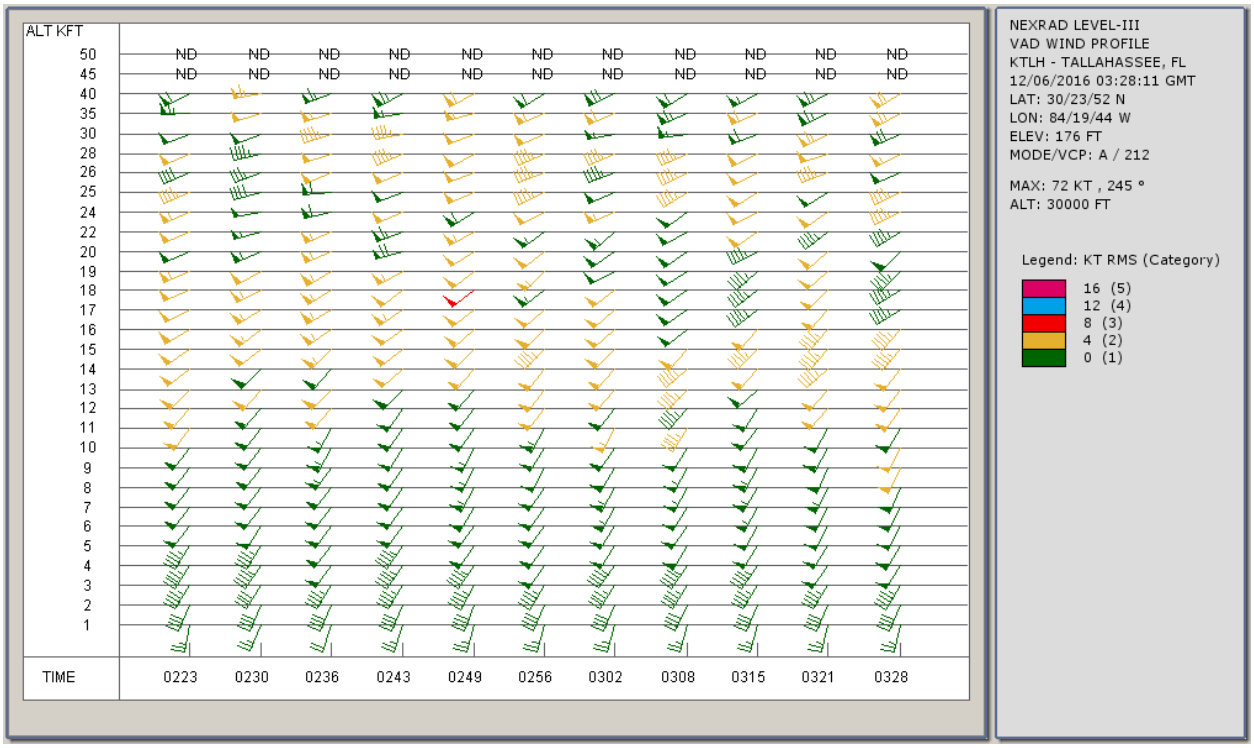


Figure 18 – KTLH WSR-88D Vertical Azimuth Display Wind Profile during the hour

6.0 Pilot Reports

The following pilot reports or PIREPs were noted over the region prior to the accident, with only the low-level reports below 18,000 feet included below. Above 18,000 feet, there were numerous reports of turbulence and icing conditions but these conditions were documented well above the cruising level of the accident flight. The reports were transcribed from standard code and abbreviation, time converted to local and provided in plain language. The reports were as follows:

Atlanta, GA (ATL) routine pilot report; Over – landing runway 10 at Hartsfield-Jackson Atlanta International Airport; Time – 1613 EST; Flight Level – during descent; Type aircraft – McDonnel Douglas MD88 air carrier jet; Sky condition – bases at 300 feet overcast with tops at 600 feet, broken clouds above.

Columbus, GA (CSG) routine pilot report; Over – CSG; Time – 1617 EST; Flight Level – unknown; Type aircraft – Falcon business jet (FA50); Sky cover – overcast at 1,000 feet with tops at 3,700 feet; Remarks – during descent.

Pensacola, FL (PNS) routine pilot report; Over – 3 miles north of PNS; Time – 1640 EST; Flight Level – during descent; Type aircraft – Canadair Bombardier regional jet (CRJ9); Sky cover – overcast at 800 feet; Remarks – braking action good, encountered 7-8 knot tailwind on final for runway 17.

Columbus, GA (CSG) routine pilot report; Over – CSG; Time – 1705 EST; Flight Level – unknown; Type aircraft – Canadair Bombardier regional jet (CRJ2); Sky cover – broken at 700 feet with tops at 10,000 feet; Weather – heavy rain; Remarks – during descent.

Atlanta, GA (ATL) routine pilot report; Over – landing runway 10 at ATL; Time – 1710 EST; Flight Level – during descent; Type aircraft – Canadair Bombardier regional jet (CRJ9); Sky condition – broken clouds at 400 feet.

Atlanta, GA (ATL) routine pilot report; Over – 3 miles northeast of ATL; Time – 1734 EST; Flight Level – 300 feet; Type aircraft – McDonnel Douglas MD90 air carrier jet; Sky condition – overcast clouds at 300 feet; Turbulence – occasional moderate turbulence; Remarks – during climb.

7.0 Area Forecast

The Area Forecast (FA) is a forecast of visual flight rules (VFR) clouds and weather conditions over an area as large as the size of several states. It must be used in conjunction with the AIRMET Sierra (IFR) bulletin for the same area in order to get a complete picture of the weather. The area forecast together with the AIRMET Sierra bulletin are used to determine forecast enroute weather and to interpolate conditions at airports which do not have a terminal forecast (TAF) issued. The NWS Aviation Weather Center (AWC) located in Kansas City, Missouri, issues the FA at regular intervals and issues specials reports as necessary usually in the form of an AIRMET.

The forecast that was current at the time of the accident was issued immediately prior to the flights departure at 2045 EST is included below. The forecast for the Florida Panhandle and southwestern Georgia expected overcast clouds at 1,000 feet with tops to 30,000 feet with visibility 3 to 5 miles in scattered rain showers and widely scattered thunderstorms possibly severe. Cumulonimbus cloud tops were expected to 40,000 feet. The thunderstorms implied the potential for severe or greater turbulence, severe icing, low-level wind shear, and localized IFR conditions. The forecast was as follows:

FAUS42 KKCI 060145
FA2W
-MIAC FA 060145
SYNOPSIS AND VFR CLDS/WX
SYNOPSIS VALID UNTIL 062000
CLDS/WX VALID UNTIL 061400...OTLK VALID 061400-062000
NC SC GA FL AND CSTL WTRS E OF 85W
.
SEE AIRMET SIERRA FOR IFR CONDS AND MTN OBSCN.
TS IMPLY SEV OR GTR TURB SEV ICE LLWS AND IFR CONDS.
NON MSL HGTS DENOTED BY AGL OR CIG.
.
SYNOPSIS...LOW PRES 200ESE SIE WITH CDFNT FM LOW PRES-SW GA BECMG
WRMFNT SW GA-FAR W PNHDL FL. 20Z LOW PRES CSTL NC-CDFNT FM LOW
PRES-CNTRL FL-100WNW EYW. TROF SE OH-WRN NC. HI PRES RMNDR.
.
GA
NRN...OVC020-030 TOP FL250 VIS 3-5SM -RA BR. ISOL -TSRA. CB TOP FL350.
OTLK...IFR CIG RA BR 18Z MVFR CIG SHRA.
SWRN...OVC010 TOP FL300. VIS 3-5SM SCT SHRA/WDLY SCT TSRA POSS SEV. CB TOP FL400.
12Z BKN010 TOP 170. VIS 3-5SM BR. WDLY SCT -SHRA. OTLK...MVFR CIG SHRA BR 17Z VFR.
SERN...OVC010 TOP FL300. VIS 3SM -RA BR. WDLY SCT -TSRA POSS SEV. CB TOP FL400.
OTLK...IFR CIG TSRA BR 18Z MVFR CIG SHRA.
.
FL
PNHDL...OVC010 TOP FL300. VIS 3-5SM SCT TSRA POSS SEV. CB TOP FL400.
BECMG 1012 TOP 120. VIS 3SM BR. ISOL -SHRA. OTLK...MVFR CIG BR 18Z VFR.
NRN...BKN035 BKN070 LYRD FL300. WDLY SCT -SHRA. BECMG 0609 OVC010 TOP FL300.
VIS 3SM BR. SCT SHRA/WDLY SCT TSRA POSS SEV. CB TOP FL400. OTLK...MVFR CIG SHRA BR.
CNTRL...SCT025 SCT050 06Z SCT-BKN030 LYRD FL300. VIS 3-5SM BR.
09Z WDLY SCT -SHRA/ISOL -TSRA. CB TOP FL400. OTLK...MVFR CIG SHRA 18Z MVFR CIG TSRA.
SRN...SCT025 SCT050. 06Z BKN010 TOP 030. VIS 3-5SM BR.
OTLK...MVFR CIG BR 18Z VFR TSRA.
KEYS FL...SKC. 06Z SCT015 SCT050 BKN CI. ISOL -SHRA. OTLK...VFR.

The previous area forecast was issued at 1345 EST and expected broken clouds at 1,000 feet with tops to 25,000 feet with visibility 3 to 5 miles in light rain, with scattered thunderstorms possibly severe. Cumulonimbus cloud tops to 35,000 feet. The header warned that the forecast was amended by AIRMET Sierra for IFR conditions and mountain obscuration and provided the synoptic conditions. The forecast was as follows:

FAUS42 KKCI 051845
FA2W
MIAC FA 051845
SYNOPSIS AND VFR CLDS/WX

SYNOPSIS VALID UNTIL 061300
CLDS/WX VALID UNTIL 060700...OTLK VALID 060700-061300
NC SC GA FL AND CSTL WTRS E OF 85W
.
SEE AIRMET SIERRA FOR IFR CONDS AND MTN OBSCN.
TS IMPLY SEV OR GTR TURB SEV ICE LLWS AND IFR CONDS.
NON MSL HGTS DENOTED BY AGL OR CIG.
.
SYNOPSIS...19Z LOW PRES NC WTRS WITH CDFNT SC WTRS-SRN GA BECMG
WRMFNT FL PNHDL. HIGH PRES NWRN FA RGN. 12Z OCLD LOW NWRN GA WITH
WRMFNT CNTRL GA-SC WTRS AND CDFNT FL PNHDL.
.
GA
NRN...BKN020 TOP FL250. VIS 3-5SM -RA BR. 02Z VIS 3SM -RA BR. OTLK...IFR CIG RA BR.
SWRN...BKN010 TOP FL250. VIS 3-5SM -RA. 22Z VIS 3SM SCT –TSRA POSS SEV. CB TOP FL350.
06Z VIS 3SM BR. SCT -SHRA. OTLK...IFR CIG SHRA BR.
SERN...BKN010 TOP FL250. VIS 5SM -RA. 01Z VIS 3-5SM SCT -TSRA. CB TOP FL300.
OTLK...IFR CIG SHRA BR.
.
FL
PNHDL...BKN010-015 TOP FL300. VIS 3-5SM SCT -TSRA POSS SEV. CB TOP FL400.
03Z BKN010. VIS 3SM RA BR. ISOL -TSRA. CB TOP FL300. OTLK...IFR CIG RA/SHRA BR.
NRN PEN...SCT015 BKN025 TOP FL200. OCNL VIS 5SM SCT -SHRA/ISOL -TSRA. CB TOP FL270.
02Z BKN015. VIS 4-5SM -RA BR. OTLK...MVFR CIG SHRA/TSRA BR.
CNTRL PEN...SCT025 BKN040 LYRD FL200. ISOL -SHRA. 03Z TOP 150. OCNL VIS 5SM BR.
OTLK...MVFR CIG BR.
SRN PEN...SCT020 BKN150 TOP FL200. TIL 00Z CSTL PTNS OCNL WND SE G25KT.
OTLK...VFR 09Z NWRN PTN MVFR CIG BR.

8.0 Terminal Forecast

The NWS Tallahassee WFO was responsible for issuing the Terminal Aerodrome Forecast (TAF) for KABY and issuing any amendments as required. The forecast current prior to the accident airplanes departure was issued at 1820 EST and expected IFR to LIFR conditions to prevail. The forecast expected an easterly wind or from 090° at 5 knots, visibility of 5 miles in mist with thunderstorms in the vicinity, ceiling overcast at 500 feet agl in cumulonimbus clouds, with a temporary period between 1900 and 2200 EST of visibility 2 miles in thunderstorms and moderate rain, ceiling overcast at 300 feet in cumulonimbus clouds. Thunderstorms were expected to end by 2400 EST or midnight local, with rain and low ceilings expected to continue through 1000 EST on December 6, 2016. The TAF in its origin form was as follows:

TAF KABY 052320Z 0600/0624 09005KT 5SM BR VCTS OVC005CB
TEMPO 0600/0603 2SM TSRA BR OVC003CB
FM060500 17006KT 3SM -RA BR OVC003
FM061100 19012KT 4SM +SHRA OVC010
FM061500 25012G18KT P6SM SCT020=

The TAF was amended at 2214 EST immediately prior to the accident to adjust the time of the temporary period of thunderstorms and LIFR conditions to between 2200 and 2400 EST, with little other changes to the forecast. The forecast current at the time of the accident was as follows:

KABY 060314Z 0603/0624 09005KT 5SM BR VCTS OVC005CB
TEMPO 0603/0605 2SM TSRA BR OVC003CB
FM060500 17006KT 3SM -RA BR OVC003
FM061100 19012KT 4SM +SHRA OVC010
FM061500 25012G18KT P6SM SCT020=

9.0 Area Forecast Discussion

The NWS Tallahassee WFO issued the Area Forecast Discussion (AFD) concerning the area at 1856 EST describing the conditions over the area and the reasoning behind their forecast for the Albany area. The forecast discussion was as follows:

FXUS62 KTAE 052356
AFDTAE
Area Forecast Discussion
National Weather Service Tallahassee FL
656 PM EST Mon Dec 5 2016

.AVIATION [Through 00Z Wednesday]...
IFR/LIFR conditions persisting overnight, with a few areas of patchy fog possible at times where winds end up staying on the calmer side. Another round of showers and stronger thunderstorms is expected early Tuesday morning after a slight lull in activity later tonight*. Conditions will rapidly improve to MVFR/VFR from west to east throughout Tuesday morning as any remaining activity pushes east. As conditions transition winds will be increasing, becoming westerly by mid morning.*
&&

.PREV DISCUSSION [328 PM EST]...
.NEAR TERM [Through Tonight]...
Isentropic ascent over a well defined front has generated a scattering of storms over the northern Gulf, spreading north as a heavy rain shield with embedded storms across the Florida panhandle into southeast Alabama. Modest deep layer shear has allowed for some of the storms over the water to become strong to severe, with the potential for damaging winds and small hail. Until the warm front moves inland the severe potential will remain offshore, and just how quickly it moves inland is uncertain now that stratiform rain is cooling the airmass north of the front. ***Later this evening as a surface low moves across LA/MS, low level winds will increase and assist in moving the front northward. At the same time, low level and deep layer shear will be increasing and subsequently the severe weather potential. As the low-layer shear increases, the potential for an isolated tornado will as well. Storms will most likely be of a discrete nature (embedded within a large rain shield) through most of the night, ahead of an approaching cold front. As the front moves into southeast Alabama and the Florida panhandle near morning, it will continue the threat for damaging winds and an isolated tornado.***

.SHORT TERM [Tuesday Through Wednesday Night]...
The mid-upper level shortwave driving our disturbed pattern will eject across the Tennessee valley and into the mid-Atlantic Tuesday, with the surface cold front quickly sweeping west to east through our area Tuesday morning. Models show 0-1 km shear of 30-35 kts and 0-6 km shear of 40-50 kts across the area, with a tongue of 600-1000 J/kg SBCAPE over the FL Big Bend and into SW GA. Strong to severe storms will remain possible Tuesday morning ahead of and along the cold front, with ***the main potential hazards being damaging winds and isolated tornadoes****. Tuesday night through Wednesday night we'll be in a more quiet pattern characterized by a broad long wave trough covering most of the CONUS and weak low level ridging over the southeast. Morning lows will be in the upper 40s to low 50s and highs Wednesday will be in the mid 60s to around 70.*

.TAE WATCHES/WARNINGS/ADVISORIES...
FL...High Rip Current Risk until 10 PM EST /9 PM CST/ this evening for Coastal Gulf-South Walton.
GA...None.

AL...None.
GM...Small Craft Advisory from 1 AM to 7 PM EST Tuesday for Coastal waters from Apalachicola to Destin FL out 20 NM-Waters from Apalachicola to Destin FL from 20 to 60 NM.

10.0 Inflight Aviation 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 AWC, as well as from the Center Weather Service Units (CWSU) associated with FAA Air Route Traffic Control Center's (ARTCCs).

There are four basic types of inflight aviation weather advisories: the Significant Meteorological Advisory (SIGMET), the Convective SIGMET, the Airmen's Meteorological Information (AIRMET), and the Center Weather Advisory (CWA). All of these advisories use the same location identifiers (either VORs, airports, or well−known geographic areas) to describe the hazardous weather areas. The Severe Weather Watch Bulletins (WWs), with the associated Alert Messages (AWW) supplements these Inflight Aviation Weather Advisories.

10.1 SIGMETs

There we no SIGMETs issued for the area for any severe turbulence, or icing outside of convective activity.

10.2 Convective SIGMETs

The NWS had issued Convective SIGMET 3E at 2055 EST, which warned of an area of embedded thunderstorms moving to the north-northeast or towards 030° at 30 knots with tops above 45,000 feet. The advisory implied severe or greater turbulence, severe icing, low−level wind shear, and localized IFR conditions. An additional advisory was issued for an area south of Tallahassee into the Gulf of Mexico. The advisories were as follows:

WSUS31 KKCI 060155
SIGE
MKCE WST 060155
CONVECTIVE SIGMET 3E
VALID UNTIL 0355Z
FL GA AL AND FL GA CSTL WTRS
FROM 50WSW IRQ-70SE SAV-30N CTY-50SSW CEW-20ENE MGM-50WSW IRQ
AREA EMBD TS MOV FROM 22030KT. TOPS ABV FL450.

CONVECTIVE SIGMET 4E
VALID UNTIL 0355Z
FL AND CSTL WTRS
FROM 20S TLH-210S CEW
LINE TS 40 NM WIDE MOV FROM 21030KT. TOPS ABV FL450.

OUTLOOK VALID 060355-060755
FROM VUZ-140SSE ILM-220ENE OMN-TRV-100WSW PIE-200SE LEV-VUZ
WST ISSUANCES POSS. REFER TO MOST RECENT ACUS01 KWNS FROM STORM PREDICTION CENTER FOR SYNOPSIS AND METEOROLOGICAL DETAILS.

Convective SIGMET 5E was issued at 2155 EST immediately after departure from Panama City, Florida, and was broadcasted approximately 3 minutes prior to the flight contacting the Jacksonville center controller. Therefore it is unknown if the pilot received this advisory, which continuing to warn of an area of embedded thunderstorms moving north-northeastward at 30 knots with tops above 45,000 feet. The advisory also warned that tornadoes, hail to 1 inch, and wind gusts to 55 knots were possible with these storms. This advisory updated and cancelled the previous advisory 3E. A second advisory was also issued for the coastal waters off Florida south of the Tallahassee area. The advisory also referred users to see Weather Watch number 516, which was current at the time and to see the latest convective outlook for additional thunderstorm information. A plot of the Convective SIGMETs current at the time of accident is included in figure19.

WSUS31 KKCI 060255
SIGE
MKCE WST 060255
CONVECTIVE SIGMET 5E
VALID UNTIL 0455Z
SC FL GA AL AND FL SC GA CSTL WTRS
FROM 40S IRQ-80SE SAV-30NNW CTY-50SSW CEW-40SSE LGC-40S IRQ
AREA EMBD TS MOV FROM 22030KT. TOPS ABV FL450.
TORNADOES...HAIL TO 1 IN...WIND GUSTS TO 55KT POSS.

CONVECTIVE SIGMET 6E
VALID UNTIL 0455Z
FL AND CSTL WTRS
FROM 60SSW TLH-30WSW CTY-130W PIE-170S CEW-60SSW TLH
AREA TS MOV FROM 21030KT. TOPS ABV FL450.

OUTLOOK VALID 060455-060855
FROM VUZ-140SSE ILM-220ENE OMN-TRV-100WSW PIE-200SE LEV-VUZ
REF WW 516.
WST ISSUANCES POSS. REFER TO MOST RECENT ACUS01 KWNS FROM STORM PREDICTION CENTER FOR SYNOPSIS AND METEOROLOGICAL DETAILS.

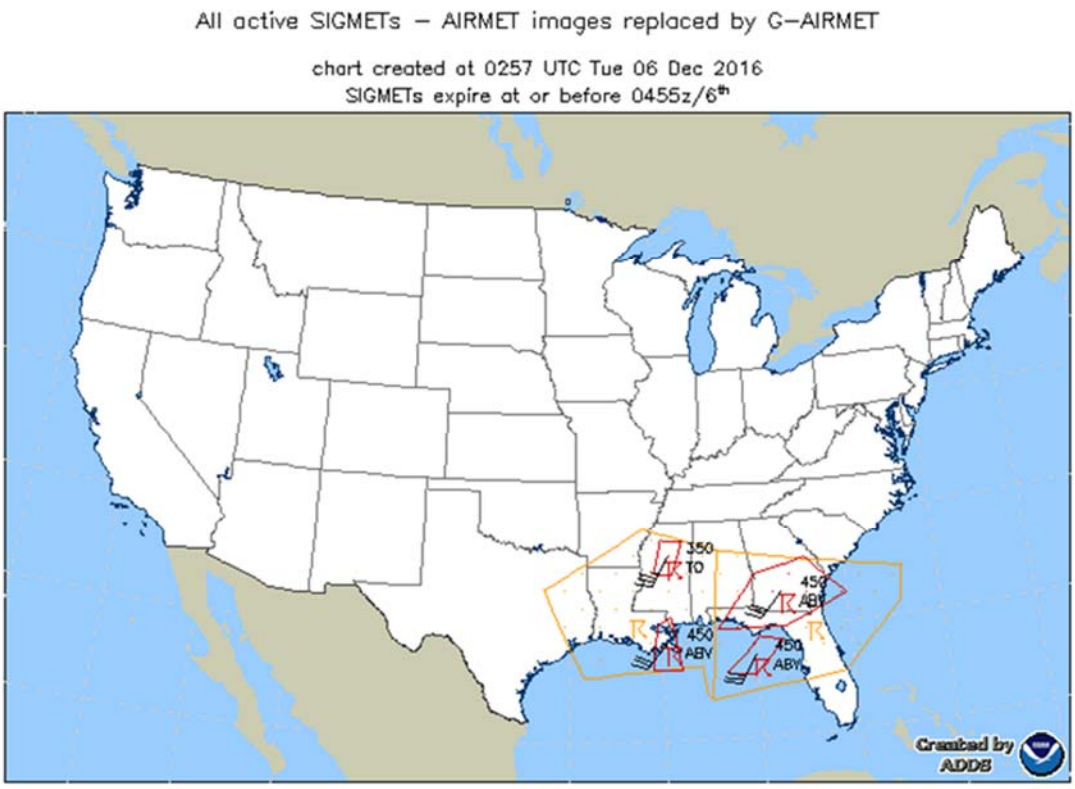


Figure 19 - Convective SIGMET 5E current for the area for embedded thunderstorms

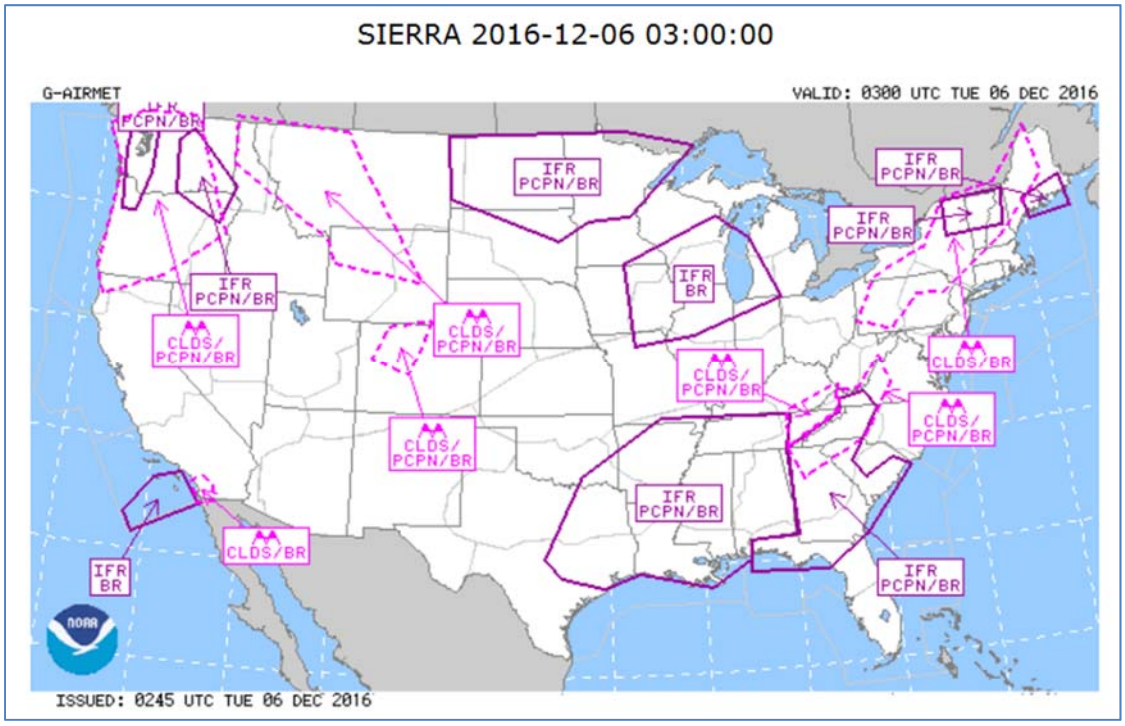
10.3 AIRMETs

The NWS AWC had a full series of AIRMETs current for a large area of IFR conditions over the regions, moderate turbulence between 5,000 and 12,000 feet, low-level wind shear, and icing conditions above 10,000 feet at 2145 EST. The advisories are documented below.

AIRMET Sierra was issued for low ceilings and visibility in precipitation and mist, the advisory current at the time was as follows with the plot of the advisory included in figure 20.

WAUS42 KKCI 060245
WA2S
MIAS WA 060245
AIRMET SIERRA FOR IFR AND MTN OBSCN VALID UNTIL 060900
.
AIRMET IFR...NC SC GA FL WV VA AND CSTL WTRS
FROM HNN TO 30SE EKN TO 20NNE GSO TO 80SE ECG TO 30NNE CRG TO 20NE TRV TO 40SW ORL TO 30SW CTY TO 90SSE SJI TO 40W CEW TO 50SW PZD TO GQO TO HMV TO HNN
CIG BLW 010/VIS BLW 3SM PCPN/BR. CONDS CONTG BYD 09Z THRU 15Z.
.
AIRMET MTN OBSCN...NC SC GA WV MD VA
FROM 50SSW JST TO 30WSW CSN TO CLT TO ATL TO GQO TO HMV TO 20S HNN TO 50ESE HNN TO 50SSW JST
MTNS OBSC BY CLDS/PCPN/BR. CONDS CONTG BYD 09Z THRU 15Z.
.
OTLK VALID 0900-1500Z

AREA 1...IFR NC SC GA FL OH WV VA AND CSTL WTRS
BOUNDED BY FWA-40SW CLE-50SSW AIR-190ESE ECG-130SSE ILM-80E CHS- 40NNE CRG-20NNE TRV-SRQ-30SW CTY-90SSE SJI-40W CEW-50SW PZD-GQO- HMV-HNN-CVG-FWA
CIG BLW 010/VIS BLW 3SM PCPN/BR. CONDS CONTG THRU 15Z.
.
AREA 2...MTN OBSCN NC SC GA WV MD VA
BOUNDED BY 20SSE AIR-20WNW EMI-CLT-ATL-GQO-HMV-HNN-20SSE AIR
MTNS OBSC BY CLDS/PCPN/BR. CONDS CONTG THRU 15Z.



106

Figure 20 - AIRMET Sierra for IFR conditions and mountain obscurations valid for 2200 EST

The NWS advisories for turbulence and low-level wind shear not related to thunderstorms is included in figure 21. AIRMET Tango series were as follows:

WAUS42 KKCI 060245
WA2T
MIAT WA 060245
AIRMET TANGO FOR TURB STG WNDS AND LLWS VALID UNTIL 060900
.
AIRMET TURB...NC SC GA FL AND CSTL WTRS
FROM 30E VXV TO 30S GSO TO 30SSW ILM TO 20NNE CRG TO 50SW PZD TO GQO TO 30E VXV
MOD TURB BTN 050 AND 120. CONDS CONTG BYD 09Z THRU 15Z.
.
AIRMET TURB...NC SC GA ME NH VT MA RI CT NY LO NJ PA OH LE WV MD
DC DE VA AND CSTL WTRS
FROM 70NW PQI TO 60NE PQI TO 200SE ACK TO 160SE SIE TO 30ENE ECG
TO 40SW GSO TO 30N LGC TO GQO TO HMV TO HNN TO CVG TO FWA TO
30SE ECK TO YOW TO YSC TO 70NW PQI
MOD TURB BTN FL220 AND FL390. CONDS CONTG BYD 09Z THRU 15Z.
.
LLWS POTENTIAL...SC GA FL AND CSTL WTRS

BOUNDED BY 30NNE CAE-30SSE CHS-20WSW CRG-30WSW TLH-40S LGC-40ESE ATL-30NNE CAE
LLWS EXP. CONDS CONTG BYD 09Z THRU 15Z.
.
OTLK VALID 0900-1500Z
AREA 1...TURB NC SC GA FL WV VA AND CSTL WTRS
BOUNDED BY 40S HNN-60SW CSN-30SE ECG-20N CRG-50SW PZD-GQO-HMV-40S HNN
MOD TURB BTN 050 AND 150. CONDS CONTG THRU 15Z.
.
AREA 2...STG SFC WNDS NC SC GA FL CSTL WTRS
BOUNDED BY 50SSE ILM-130SSE ILM-210SE CHS-60E CRG-50S CHS-50SSE ILM
SUSTAINED SURFACE WINDS GTR THAN 30KT EXP. CONDS DVLPG 12-15Z.
CONDS CONTG THRU 15Z.

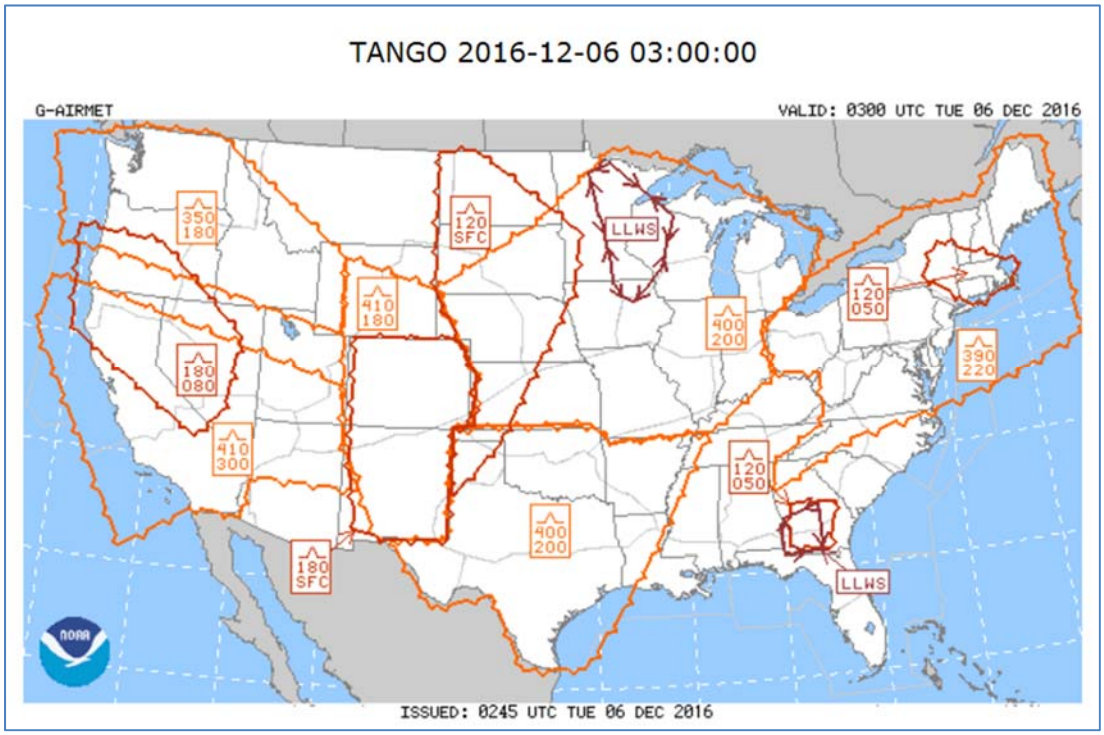


Figure 21 - AIRMET Tango for turbulence and low-level wind shear valid at 2200 EST

The NWS also had an AIRMET Zulu current for icing conditions over the area well above the accident airplanes cruising level. The advisory is included below with the plot of the advisory included as figure 22.

WAUS42 KKCI 060245
WA2Z
MIAZ WA 060245
AIRMET ZULU FOR ICE AND FRZLVL VALID UNTIL 060900
.
AIRMET ICE...NC SC GA WV MD DE VA AND CSTL WTRS
FROM EKN TO 20NW SBY TO 160SE SIE TO 190ESE ECG TO 130SSE ILM TO
100SE SAV TO 40WSW AMG TO 40WNW PZD TO GQO TO HMV TO HNN TO EKN
MOD ICE BTN FRZLVL AND FL260. FRZLVL 090-130.
CONDS CONTG BYD 09Z THRU 15Z.
.

OTLK VALID 0900-1500Z...ICE NC SC GA RI NY NJ PA OH WV MD DC DE VA AND CSTL WTRS
BOUNDED BY 20ENE CYN-200S ACK-160SE SIE-190ESE ECG-130SE ILM-30WSW CHS-20SSE IRQ-20SSE PZD-20S LGC-GQO-HMV-HNN-PSK-20ENE CYN
MOD ICE BTN FRZLVL AND FL260. FRZLVL 080-130. CONDS CONTG THRU 15Z.
.
FRZLVL...RANGING FROM 105-155 ACRS AREA
120 ALG 30ENE GQO-20SW SPA-70S ECG-170ESE ECG

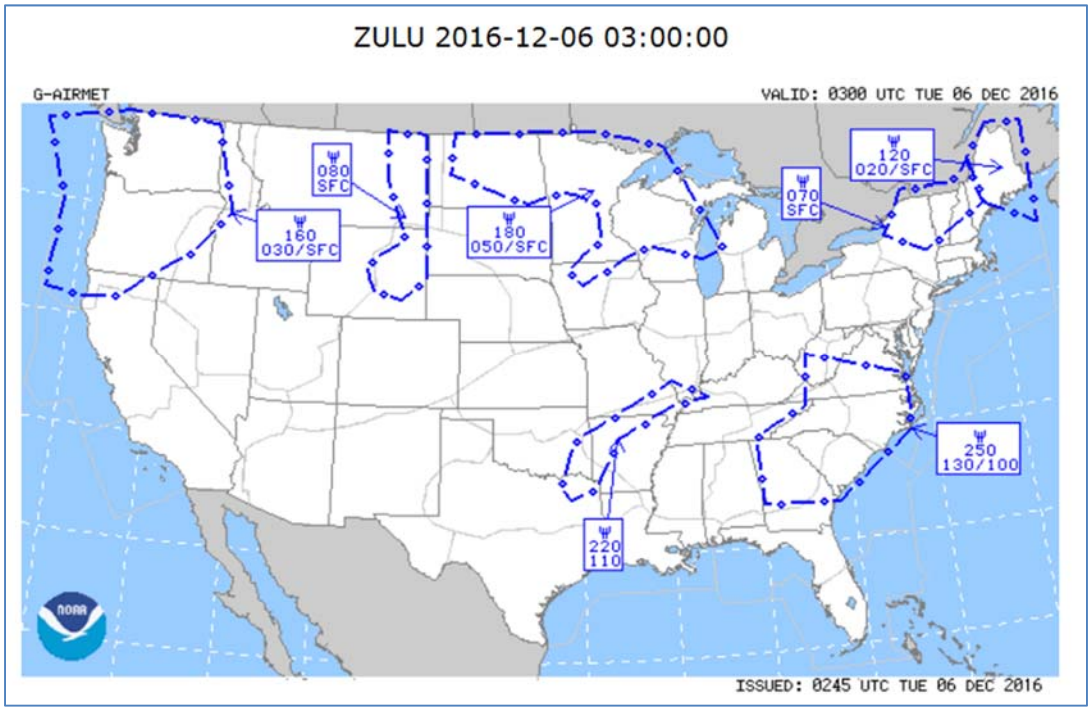


Figure 22 - AIRMET Zulu for icing conditions valid at 2200 EST

10.4 Center Weather Advisory

Center Weather Advisories (CWAs) are unscheduled inflight, flow control, air traffic, and air crew advisory issued by the CWSU for their respective center. By nature of its short lead time, the CWA is not considered a flight planning product. It is generally a Nowcast or short term forecast for conditions beginning within the next two hours and usually supplement an existing advisory or when reported or observed weather conditions meet SIGMET or AIRMET criteria and warrant an advisory.

The FAA Jacksonville (KZJX) ARTCC CWSU was responsible for the area and no advisories were current at the time of the accident and the unit closed at their normal period at 2200 EST. A review of the Atlanta (KZTL) CWSU also indicated no advisories current during the period.

10.5 Aviation Watch Notification Message

The NWS SPC issues Watch Notification Messages to provide an area threat alert for forecast organized severe thunderstorms that may produce tornadoes, large hail, and/or convective damaging winds within the continental United States. The Aviation Watch Notification Message or formerly known as the Alert Severe Weather Watch Bulletin (AWW) number 516 was issued

at 2100 EST for the potential for tornadic thunderstorms over the southeast section of Alabama, southwestern Georgia and the Florida panhandle and extended over the route and accident site. See section 11.3 for the graphic and public forecasts relating to the weather watch area. The advisory was as follows:

AWW
WW 516 TORNADO AL FL GA CW 060200Z - 061000Z
AXIS..65 STATUTE MILES NORTH AND SOUTH OF LINE..
35WNW PFN/PANAMA CITY FL/ - 40ENE VLD/VALDOSTA GA/
..AVIATION COORDS.. 55NM N/S /34SE CEW - 33SSW AMG/
HAIL SURFACE AND ALOFT..1 INCH. WIND GUSTS..55 KNOTS.
MAX TOPS TO 450. MEAN STORM MOTION VECTOR 24040.

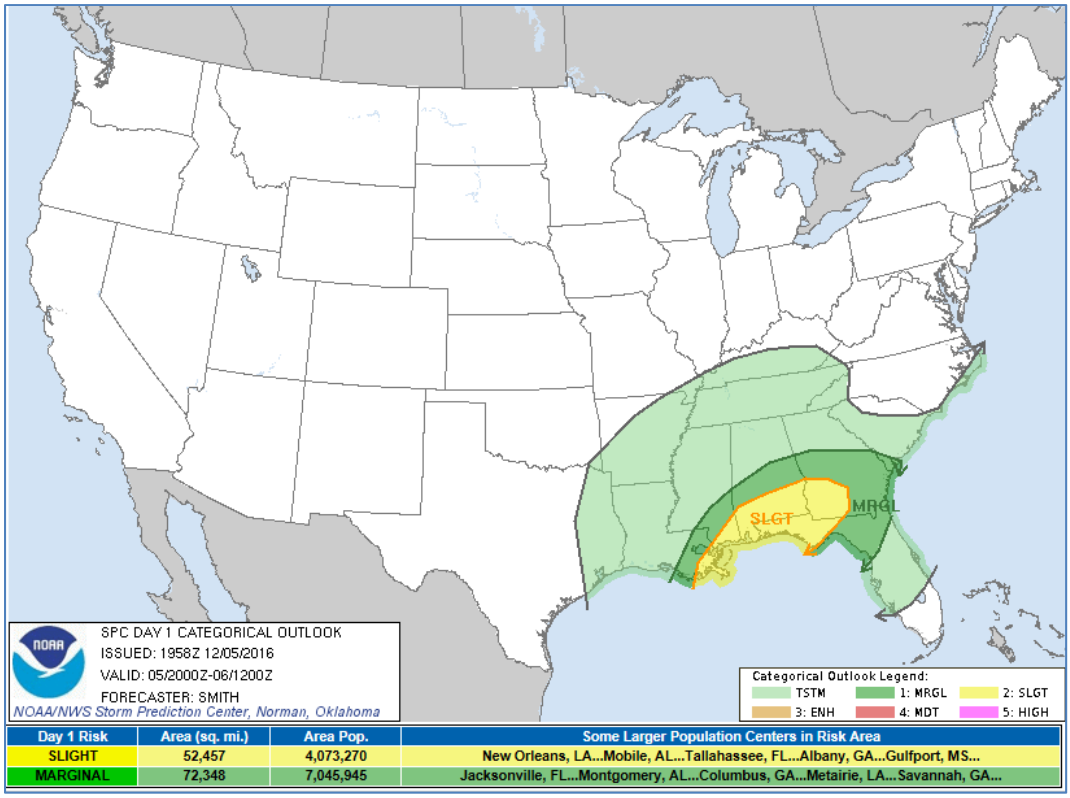
The advisory warned that potential tornadic thunderstorms were possible over the region with storms moving to the northeast or 040° at 40 knots, with cumulonimbus cloud tops to 40,000 feet. This bulletin was available to ATC and would have been broadcasted upon issuance in addition to the Convective SIGMETs. ATC data indicated that the advisories were issued on frequency prior to the flight making contact.

11.0 Storm Prediction Center Products

The NWS SPC Convective Outlook (AC) and Aviation Watch Notification Message (AWW) are two basic products designed for aviation use and are discussed and documented in AC 00-45H and the Aeronautical Information manual (AIM). The other products like the Mesoscale Discussion (MSD) which are typically issued before the alert message (AWW) and weather watches (WW) are also documented in this section.

11.1 Convective Outlook

As documented in section 1.3 above, the narrative of the convective outlooks issued at approximately 1500 and 2000 EST are included below warning of a slight risk of severe thunderstorms over the region. The narratives were as follows:



Day 1 Risk	Area (sq. mi.)	Area Pop.	Some Larger Population Centers in Risk Area
SLIGHT	52,457	4,073,270	New Orleans, LA...Mobile, AL...Tallahassee, FL...Albany, GA...Gulfport, MS...
MARGINAL	72,348	7,045,945	Jacksonville, FL...Montgomery, AL...Columbus, GA...Metairie, LA...Savannah, GA...

Figure 23 - Convective Outlook issued at 1500 EST

SPC AC 051958
DAY 1 CONVECTIVE OUTLOOK
NWS STORM PREDICTION CENTER NORMAN OK
0158 PM CST MON DEC 05 2016

VALID 052000Z - 061200Z

...THERE IS A SLGT RISK OF SVR TSTMS FOR PARTS OF
LA...MS...AL...GA...AND FL...

...THERE IS A MRGL RISK OF SVR TSTMS FOR PORTIONS OF THE SOUTHEAST STATES...

...SUMMARY...
A FEW STRONG TO SEVERE STORMS WITH POTENTIAL FOR DAMAGING WINDS AND A COUPLE TORNADOES ARE POSSIBLE THIS AFTERNOON AND TONIGHT OVER PARTS OF THE SOUTHEAST.

...DISCUSSION...
NO APPRECIABLE CHANGE WAS MADE FOR THIS OUTLOOK UPDATE. REMOVED 5-PERCENT WIND PROBABILITIES ACROSS SOUTHWESTERN INTO SOUTH-CENTRAL LA AND SOUTHWESTERN MS BASED ON CURRENT OBSERVATION TRENDS AND FORECAST SOUNDINGS SUGGESTING A LOW-LEVEL STABLE LAYER.

..SMITH.. 12/05/2016

.PREV DISCUSSION.../ISSUED 1027 AM CST MON DEC 05 2016/

...SOUTHEAST STATES...

WATER VAPOR LOOP CONFIRMS A COMPACT UPPER LOW LIFTING NORTHEASTWARD ACROSS NORTHERN MEXICO INTO TX. THIS FEATURE WILL MOVE INTO THE WESTERN GULF OF MEXICO LATER TODAY...PROMOTING LOW-LEVEL CYCLOGENESIS ALONG A REMNANT SURFACE BOUNDARY OVER THE NORTHERN GULF. MODELS INDICATE THAT THE BOUNDARY AND SURFACE LOW WILL LIFT NORTHWARD AND SLOWLY INLAND THIS AFTERNOON AND TONIGHT. A MOIST AND MARGINALLY UNSTABLE AIR MASS ALONG AND SOUTH OF THE WARM FRONT WILL SUPPORT SURFACE-BASED CONVECTION AND A RISK OF DAMAGING WIND GUSTS. LOW LEVEL WIND FIELDS ARE ALSO FORECAST TO STRENGTHEN BY EVENING... SUGGESTING SOME RISK OF A COUPLE OF TORNADOES ALONG THE BOUNDARY. MAIN CHANGES FOR THIS OUTLOOK UPDATE ARE TO TRIM THE NORTHERN EXTENT OF THE SLIGHT RISK AREA DUE TO UNCERTAINTY HOW FAR INLAND THE WARM FRONT WILL MOVE...AND TO EXTEND THE RISK AREAS EASTWARD INTO MORE OF GA/FL DUE TO AN OVERNIGHT RISK OF A FEW STRONG STORMS TRACKING ALONG THE FRONT.

The forecast was updated at 2000 EST, with little change in the area coverage:

SPC AC 060100
DAY 1 CONVECTIVE OUTLOOK
NWS STORM PREDICTION CENTER NORMAN OK
0700 PM CST MON DEC 05 2016

VALID 060100Z - 061200Z

...THERE IS A SLGT RISK OF SVR TSTMS ACROSS PARTS OF THE CENTRAL AND EASTERN GULF COAST...

...THERE IS A MRGL RISK OF SVR TSTMS ACROSS PARTS OF THE CENTRAL AND EASTERN GULF COAST STATES...

...SUMMARY...
A FEW STRONG TO SEVERE STORMS WITH POTENTIAL FOR DAMAGING WINDS AND A COUPLE TORNADOES ARE POSSIBLE THIS EVENING AND TONIGHT OVER PARTS OF THE CENTRAL AND EASTERN GULF COAST.

...CENTRAL AND EASTERN GULF COAST...
THE LATEST RADAR IMAGERY SHOWS A LARGE AREA OF RAIN OVER SOUTHEASTERN ALABAMA AND ACROSS MUCH OF GEORGIA. THIS WIDESPREAD RAIN HAS PRODUCED A STABLE AIRMASS ACROSS MUCH OF THE EASTERN GULF COAST REGION. AN EAST TO WEST BAND OF THUNDERSTORMS IS LOCATED FROM THE WESTERN FLORIDA PANHANDLE EASTWARD ACROSS SOUTHERN GEORGIA. THIS WARM ADVECTION RELATED CONVECTION SHOULD CONTINUE TO HAVE AN ISOLATED SEVERE THREAT THIS EVENING WHERE A TORNADO AND/OR WIND DAMAGE THREAT WILL BE POSSIBLE WITHIN THE STRONGEST OF CELLS. FURTHER TO THE WEST...THE LATEST WATER VAPOR IMAGERY SHOWS AN UPPER-LEVEL TROUGH IN THE SOUTHERN PLAINS. THIS FEATURE ALONG WITH THE CORRESPONDING SURFACE LOW HAS BEEN SLOWER THAN WAS ORIGINALLY FORECAST BUT THE SYSTEM WILL STILL MOVE NORTHEASTWARD ACROSS THE LOWER MISSISSIPPI VALLEY DURING THE OVERNIGHT PERIOD. IN RESPONSE... MOISTURE ADVECTION WILL DEVELOP ACROSS THE CENTRAL GULF COAST STATES AS THE TROUGH APPROACHES AFTER 06Z.

SURFACE WINDS SHOULD ONCE AGAIN GRADUALLY TURN TO THE EAST AND THEN SOUTH ACROSS SOUTHERN ALABAMA AND THE WESTERN FLORIDA PANHANDLE. SURFACE DEWPOINTS ARE STILL EXPECTED TO RETURN INTO THE LOWER TO

MIDDLE 60S FAHRENHEIT IN SOUTHERN ALABAMA AS IS SUGGESTED BY THE LATEST HRRR. THIS COMBINED WITH SOME DESTABILIZATION...INCREASING LARGE-SCALE ASCENT AND MAINTENANCE OF THE LOW-LEVEL FLOW SHOULD RESULT IN A SEVERE THREAT DURING THE 06Z TO 12Z TIMEFRAME. DUE TO DELAYED ONSET OF MOISTURE ADVECTION...WILL TRIM THE SLIGHT RISK SOUTHWARD OUT OF MOST OF THE BIRMINGHAM CWA. THE NORTHERN EDGE OF THE SLIGHT RISK AREA IS NOW PLACED WHERE MID 60S SURFACE DEWPOINTS ARE EXPECTED LATE IN THE PERIOD WITH THE MARGINAL RISK CUTTING OFF AT THE 60 DEGREE ISODROSOTHERM. RAP FORECAST SOUNDINGS AFTER MIDNIGHT IN SOUTHERN ALABAMA AND THE WESTERN FLORIDA PANHANDLE CONTINUE TO SHOW STRONG DEEP-LAYER SHEAR WITH 0-3 KM STORM RELATIVE HELICITIES IN 250 TO 350 M2/S2 RANGE. THIS COULD BE ENOUGH FOR A TORNADO OR TWO WITH DISCRETE CELLS THAT INITIATE NEAR THE COAST AND MOVE NORTHEASTWARD ACROSS THE SLIGHT RISK AREA AFTER MIDNIGHT. A WIND DAMAGE THREAT WOULD ALSO ACCOMPANY ANY CELL THAT CAN BECOME ORGANIZED.

..BROYLES.. 12/06/2016

11.2 Mesoscale Discussion

A Mesoscale Discussion #1869 was issued at 1626 EST for a developing threat of strong to severe thunderstorms developing over the Florida panhandle supporting the previous Weather Watch #515 over the region. Figure 24 is the narrative with the bulletin following.

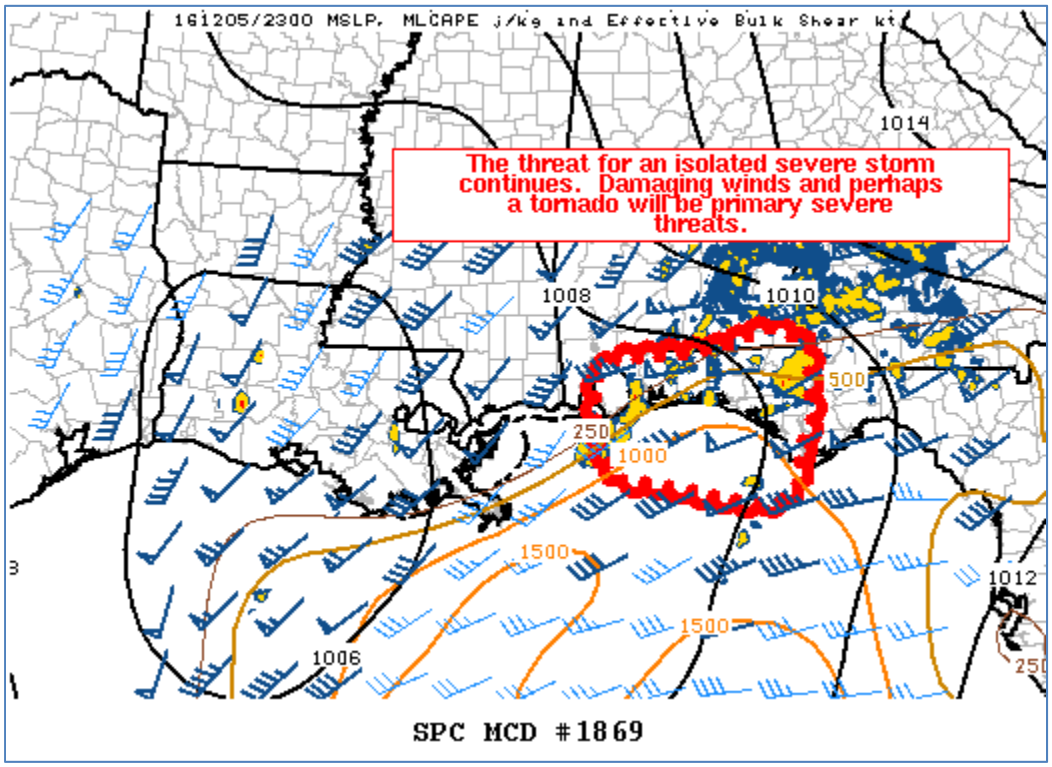


Figure 24 - Mesoscale Discussion #1869 for severe thunderstorms over the Florida panhandle

MESOSCALE DISCUSSION 1869
NWS STORM PREDICTION CENTER NORMAN OK

0526 PM CST MON DEC 05 2016

AREAS AFFECTED...PORTIONS OF SOUTHWEST AL...FL PANHANDLE

CONCERNING...TORNADO WATCH 515...

VALID 052326Z - 060130Z

THE SEVERE WEATHER THREAT FOR TORNADO WATCH 515 CONTINUES.

SUMMARY...THE POTENTIAL FOR AN ISOLATED SEVERE THUNDERSTORM WITH DAMAGING WINDS AND PERHAPS A TORNADO CONTINUES THROUGH 02Z.

DISCUSSION...SURFACE MESOANALYSIS AT 23Z SHOWS A NEARLY STATIONARY FRONTAL BOUNDARY EXTENDING FROM LOW PRESSURE OVER THE NORTHWEST GULF OF MEXICO EAST TO NEAR FT. WALTON BEACH AND EXTREME SOUTHERN GEORGIA. WARM/MOIST ADVECTION IN THE 850-700 MB LAYER CONTINUES TO RESULT IN WIDESPREAD PRECIPITATION NORTH OF THE FRONTAL BOUNDARY... AND AS A RESULT LITTLE TO ONLY VERY SLOW NORTHWARD MOVEMENT OF THE FRONT. APPRECIABLE SURFACE-BASED INSTABILITY REMAINS OFFSHORE OR VERY NEAR THE COAST...AND ANY ADDITIONAL INLAND DESTABILIZATION WILL LIKELY BE TOWARDS THE END OF THE VALID TIME OF WW 515 WHEN LOW-LEVEL FLOW INCREASES WITH THE APPROACHING UPPER-LEVEL TROUGH.

RADAR IMAGERY SINCE 22Z HAS SHOWN OCCASIONAL AND SHORT-LIVED BOWING SEGMENTS NEAR THE COAST...AND ADDITIONAL SIMILARLY-STRUCTURED CONVECTIVE ELEMENTS WILL REMAIN POSSIBLE THROUGH 02Z WITH STRONG/DAMAGING GUSTS THE MAIN CONCERN. AS THE LOW-LEVEL FLOW STRENGTHENS THROUGH EARLY EVENING...THE POTENTIAL FOR A TORNADO OR TWO WILL INCREASE WITH STRONGER STORMS AS EFFECTIVE SRH VALUES AVERAGE 300-350 M2/S2.

..BUNTING.. 12/05/2016

Another Mesoscale Discussion #1870 was issued at 1821 EST for the area, which included the accident site and indicated another Weather Watch was likely to be issued due to the favorable conditions for severe weather across the region. Figure 25 is the graphic of the discussion.

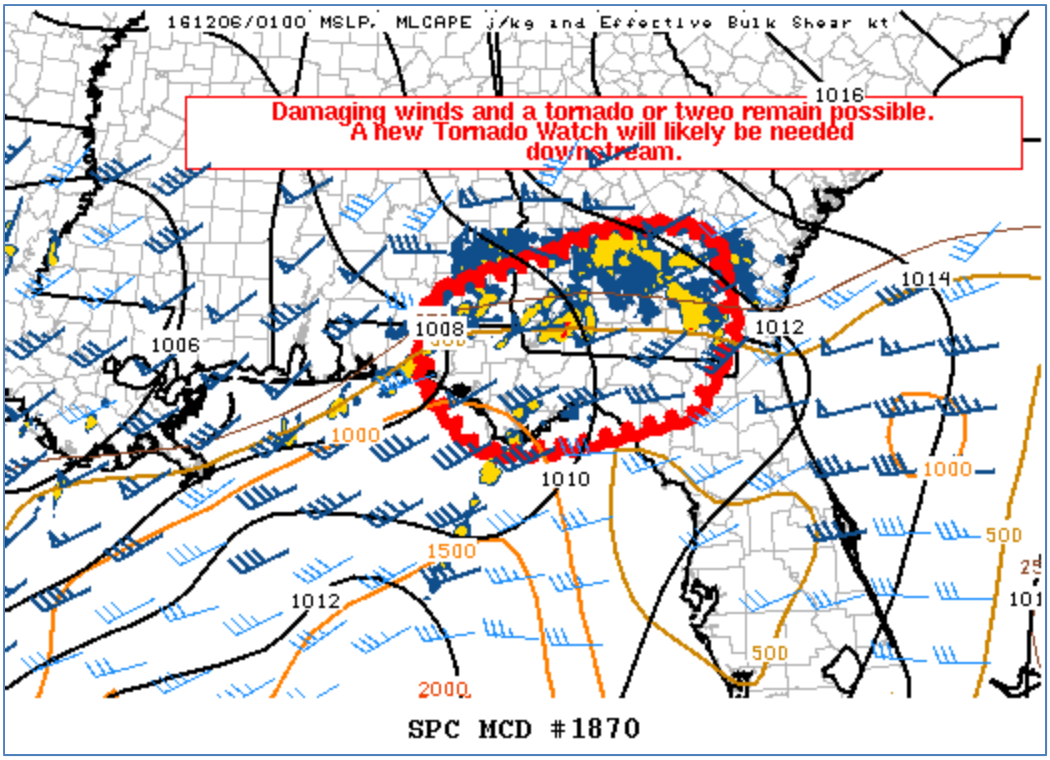


Figure 25 - Mesoscale Discussion #1870 for severe thunderstorms

MESOSCALE DISCUSSION 1870
NWS STORM PREDICTION CENTER NORMAN OK
0721 PM CST MON DEC 05 2016

AREAS AFFECTED...PORTIONS OF THE FL PANHANDLE AND NORTH FL...SOUTHERN GA

CONCERNING...TORNADO WATCH 515...

VALID 060121Z - 060315Z

THE SEVERE WEATHER THREAT FOR TORNADO WATCH 515 CONTINUES.

SUMMARY...THE THREAT FOR DAMAGING WINDS AND A TORNADO OR TWO CONTINUES ACROSS THE REMAINING VALID COUNTIES IN TORNADO WATCH 515. A NEW TORNADO WATCH WILL LIKELY BE NEEDED FOR EASTERN PORTIONS OF THE CURRENT WATCH AREA AND EAST ACROSS PORTIONS OF NORTHERN FLORIDA AND EXTREME SOUTHERN GEORGIA.

DISCUSSION...SEVERAL SHORT-LIVED BOWING SEGMENTS WITH LOW-LEVEL ROTATION HAVE BEEN OBSERVED IN THE VICINITY OF A NEARLY STATIONARY FRONTAL BOUNDARY EXTENDING FROM NEAR DESTIN...FL EAST-NORTHEAST ACROSS EXTREME SOUTHERN GA AS OF 01Z. SURFACE OBSERVATIONS SUGGEST A WEAK MESOLOW HAS DEVELOPED ALONG THE FRONT NEAR DESTIN. IN THE SHORT TERM...BOWING SEGMENTS WITH DAMAGING WIND POTENTIAL AND PERHAPS A TORNADO WILL REMAIN POSSIBLE ACROSS THE FL PANHANDLE AND EXTREME SOUTHWEST GA EAST OF THE MESOLOW WHERE VWP DATA AND SHORT-TERM GUIDANCE SUGGEST EFFECTIVE SRH VALUES IN EXCESS OF 300 M2/S2 WILL REMAIN IN PLACE.

BEYOND 02Z...STRENGTHENING LOW-LEVEL FLOW ACROSS THE CENTRAL/EASTERN FL PANHANDLE NORTHWARD INTO EXTREME SOUTHERN GA MAY ALLOW THE FRONT/MODEST SURFACE-BASED INSTABILITY TO SHIFT SLIGHTLY NORTHWARD OVER SOUTHERN GA. FORECAST SOUNDINGS FOR 06Z FROM THE LATEST RAP GUIDANCE SHOW CURVED LOW-LEVEL HODOGRAPHS AND EFFECTIVE SRH OF 300-400 M2/S2 IN THE VICINITY OF THE FRONT OVER SOUTHERN GA. AS LARGE-SCALE ASCENT WITH THE APPROACHING UPPER TROUGH INCREASES OVER THE DISCUSSION AREA...SOME INCREASE IN THUNDERSTORM COVERAGE IS EXPECTED LATE THIS EVENING AND INTO THE OVERNIGHT TIME FRAME. GIVEN THESE TRENDS...A NEW TORNADO WATCH IS LIKELY THAT WILL INCLUDE EASTERN PORTIONS OF WW 515 EAST ACROSS EXTREME SOUTH-CENTRAL GA AND PORTIONS OF NORTH FL.

..BUNTING.. 12/06/2016

Mesoscale Discussion #1871 followed at 2235 EST or immediately after the accident for the continued threat of strong to severe thunderstorms across the region. Figure 26 is the graphic followed by the narrative.

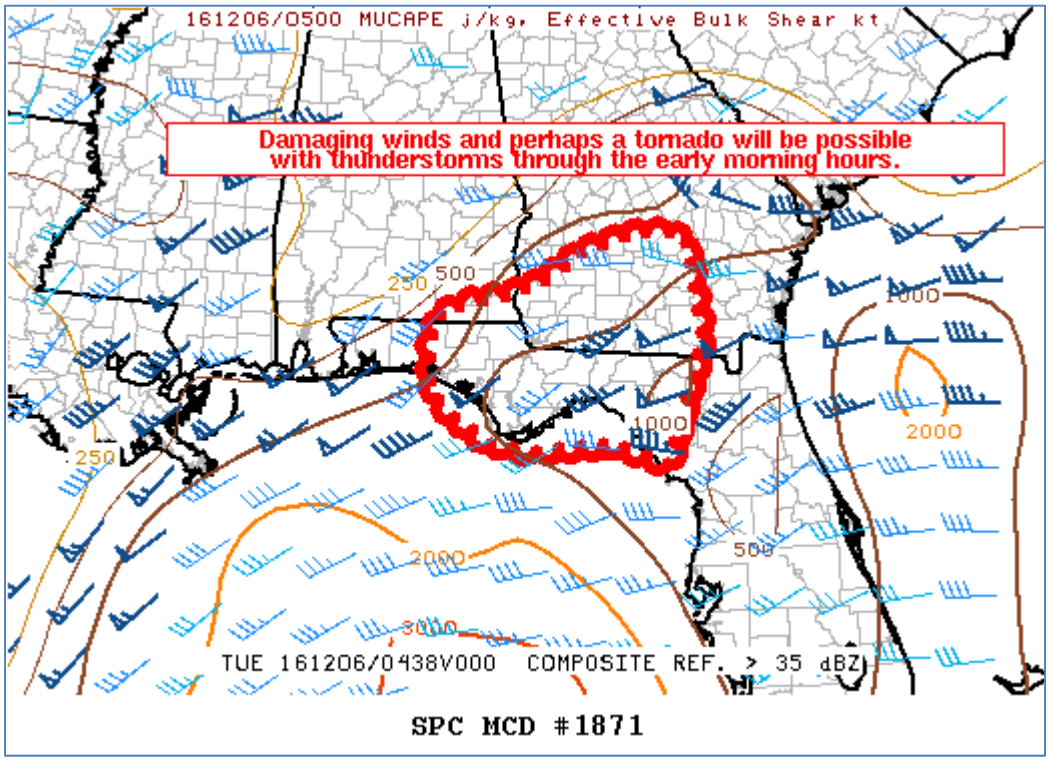


Figure 26 - Mesoscale Discussion #1871 issued at 2235 EST

MESOSCALE DISCUSSION 1871
NWS STORM PREDICTION CENTER NORMAN OK
1135 PM CST MON DEC 05 2016

AREAS AFFECTED...PORTIONS OF SOUTHEAST AL...FLORIDA PANHANDLE AND NORTH FL...EXTREME SOUTHWEST/SOUTH-CENTRAL GA

CONCERNING...TORNADO WATCH 516...

VALID 060535Z - 060730Z

THE SEVERE WEATHER THREAT FOR TORNADO WATCH 516 CONTINUES.

SUMMARY...THE THREAT FOR DAMAGING WINDS AND A COUPLE TORNADOES CONTINUES...AND IS EXPECTED TO INCREASE SOMEWHAT IN THE 06Z-10Z TIME FRAME AS AN UPTICK IN THUNDERSTORM COVERAGE IS ANTICIPATED.

DISCUSSION...LATEST MESOANALYSIS SHOWED A COLD FRONT EXTENDING SOUTH FROM A SURFACE LOW OVER SOUTHWEST MS INTO THE CENTRAL GULF OF MEXICO. A QUASI-STATIONARY FRONTAL BOUNDARY EXTENDED FROM NEAR BOOTHVILLE...LA EAST-NORTHEAST ACROSS THE FL PANHANDLE AND INTO FAR SOUTHERN GA. LITTLE DISCERNIBLE NORTHWARD MOTION HAS OCCURRED WITH THIS FRONT OVER THE PAST FEW HOURS...AND ANY NORTHWARD SHIFT OVER THE NEXT FEW HOURS WILL LIKELY BE MODEST AND PRIMARILY OVER SOUTHERN GA.

DATA FROM A SUPPLEMENTAL 04Z UPPER-AIR SOUNDING AT TALLAHASSEE REVEALED 0-1 KM AND DEEP-LAYER SHEAR OF 31 KTS AND 44 KTS... RESPECTIVELY...AND WEAK SURFACE-BASED INSTABILITY.
IN ADDITION VWP DATA FROM THE KVAX WSR-88D SAMPLED SUBSTANTIAL LOW-LEVEL HODOGRAPH CURVATURE AND 35-40 KTS OF 0-1 KM SHEAR.

THUNDERSTORMS OVER THE NORTHEAST GULF SOUTH OF TALLAHASSEE WILL CONTINUE TO MOVE INLAND OVER THE NEXT FEW HOURS WHILE ADDITIONAL STORMS FORM OVER THE DISCUSSION AREA AS FORCING FOR ASCENT ASSOCIATED WITH AN UPPER-LEVEL LOW NEAR THE TX-LA BORDER INCREASES. STORMS ALONG THE COLD FRONT MAY ALSO INTENSIFY AS THE FRONT MOVES STEADILY EAST INTO WESTERN PORTIONS OF THE WW. BOWING LINE SEGMENTS WITH EMBEDDED CIRCULATIONS WILL POSE A RISK FOR DAMAGING WINDS AND ALSO A TORNADO THROUGH THE EARLY MORNING HOURS.

..BUNTING.. 12/06/2016

11.3 Weather Watches

Weather Watch #516 current at the time of the accident was depicted in figure 27 over the radar current at the time, with the full text of the watch following. The plot includes the counties under the watch as well as the general aviation boundary (pink). A moderate risk of small Enhanced Fujita (EF)[23] EF0 to EF1 tornadoes were expected of limited width and ground tracks were expected over the area, with low threats of damaging winds and hail. Note the aviation section of the advisory warned of severe to extreme turbulence potential with the thunderstorms.

[23] Enhanced Fujita scale (EF-Scale) rates the intensity of tornadoes in the United States and Canada based on the damage they cause from EF0 minimal or no damage to EF6 total destruction of buildings. EF0 tornadoes typically have wind speeds of 60 to 80 knots, and are the most frequent at 57% in occurrence, with damage typically limited to peeled roofs, damage to gutters or siding, branches broken off trees, shallow-rooted trees pushed over. EF1 tornadoes are moderate damage with roofs severely stripped, mobile homes overturned or badly damaged, loss of exterior doors, windows, and glass typically broken. At the other extreme, EF6 tornadoes have winds over 200 knots, and produce total destruction of buildings, with strong-framed houses leveled off foundations, steel-reinforced concrete structures are also critically damaged.

Figure 27 - Weather Watch #516 county and aviation plot

AWW
WW 516 TORNADO AL FL GA CW 060200Z - 061000Z
AXIS..65 STATUTE MILES NORTH AND SOUTH OF LINE..
35WNW PFN/PANAMA CITY FL/ - 40ENE VLD/VALDOSTA GA/
..AVIATION COORDS.. 55NM N/S /34SE CEW - 33SSW AMG/
HAIL SURFACE AND ALOFT..1 INCH. WIND GUSTS..55 KNOTS.
MAX TOPS TO 450. MEAN STORM MOTION VECTOR 24040.

WW
URGENT - IMMEDIATE BROADCAST REQUESTED
TORNADO WATCH NUMBER 516
NWS STORM PREDICTION CENTER NORMAN OK
900 PM EST MON DEC 5 2016

THE NWS STORM PREDICTION CENTER HAS ISSUED A

** TORNADO WATCH FOR PORTIONS OF*
SOUTHEAST ALABAMA
PARTS OF NORTHERN FLORIDA AND THE FLORIDA PANHANDLE
SOUTHWEST AND SOUTH CENTRAL GEORGIA
COASTAL WATERS

** EFFECTIVE THIS MONDAY NIGHT AND TUESDAY MORNING FROM 900 PM UNTIL 500 AM EST.*

** PRIMARY THREATS INCLUDE...*
A COUPLE TORNADOES POSSIBLE
ISOLATED DAMAGING WIND GUSTS TO 65 MPH POSSIBLE

SUMMARY...SCATTERED SHOWERS AND THUNDERSTORMS WILL CONTINUE THROUGH THE OVERNIGHT HOURS ACROSS THE WATCH AREA...WITH A FEW OF THE STRONGER STORMS CAPABLE OF PRODUCING LOCALLY DAMAGING WINDS AND/OR TORNADOES.

THE TORNADO WATCH AREA IS APPROXIMATELY ALONG AND 65 STATUTE MILES NORTH AND SOUTH OF A LINE FROM 35 MILES WEST NORTHWEST OF PANAMA CITY FL TO 40 MILES EAST NORTHEAST OF VALDOSTA GA. FOR A COMPLETE DEPICTION OF THE WATCH SEE THE ASSOCIATED WATCH OUTLINE UPDATE (WOUS64 KWNS WOU6).

PRECAUTIONARY/PREPAREDNESS ACTIONS...

REMEMBER...A TORNADO WATCH MEANS CONDITIONS ARE FAVORABLE FOR TORNADOES AND SEVERE THUNDERSTORMS IN AND CLOSE TO THE WATCH AREA. PERSONS IN THESE AREAS SHOULD BE ON THE LOOKOUT FOR THREATENING WEATHER CONDITIONS AND LISTEN FOR LATER STATEMENTS AND POSSIBLE WARNINGS.

&&

OTHER WATCH INFORMATION...CONTINUE...WW 515...

AVIATION...TORNADOES AND A FEW SEVERE THUNDERSTORMS WITH HAIL SURFACE AND ALOFT TO 1 INCHES. EXTREME TURBULENCE AND SURFACE WIND GUSTS TO 55 KNOTS. A FEW CUMULONIMBI WITH MAXIMUM TOPS TO 450. MEAN STORM MOTION VECTOR 24040.

...GOSS

12.0 Collaborative Convective Forecast Product

The NWS AWC produces a Collaborative Decision Making (CDM) Collaborative Convective Forecast Planning (CCFP) guidance product, which is produced by computer model algorithms. The product is designed to cover areas of convection with a coverage greater than 5,000 square miles, with thunderstorms that have an aerial coverage of at least 25%, with tops above 25,000 feet, and confidence of at least 25%. The product is intended to be used as a strategic planning tool for air traffic flow management, to reduce delays, and for rerouting air traffic, and not necessarily for pilot weather briefing purposes. Figure 28 is the 2-hour forecast issued at 1700 EST and valid for 1900 EST, which expected a sparse area of thunderstorms over Alabama, southern Georgia, Gulf of Mexico, and the Florida panhandle with tops between 30,000 and 34,000 feet. Within that area was a medium area and greater coverage with tops to 39,000 feet over the Florida panhandle and extreme southern Alabama, immediately west of the route of flight and the accident site.

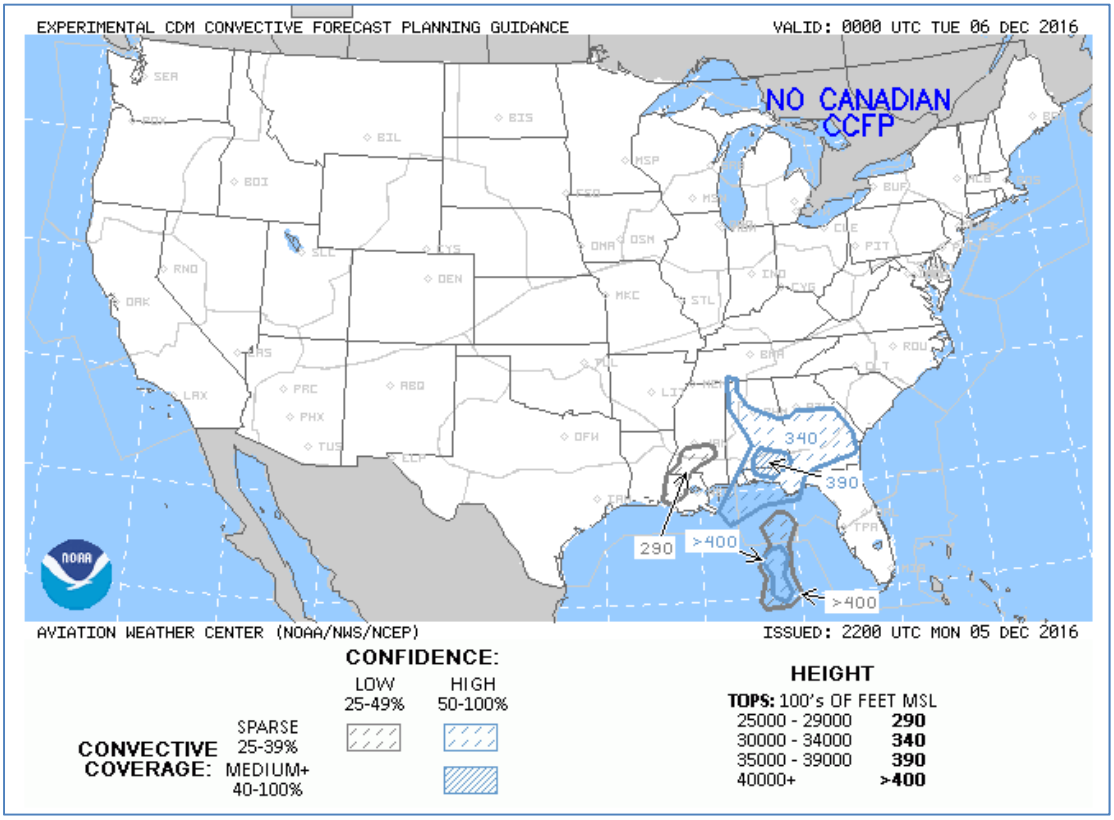


Figure 28 - 2-hour CCFP guidance issued at 1700 EST and valid at 1900 EST

Figure 29 is the updated 2-hour forecast issued at 1900 EST and valid for 2100 EST, which continued to show a high confidence of sparse thunderstorms over Alabama, Georgia, and the Florida panhandle and in the Gulf of Mexico with tops to 34,000 feet. Within the large area was a medium risk area over extreme southwest Georgia, southeast Alabama, and the Florida panhandle with tops to 34,000 feet. Figure 30 is the 4-hour forecast valid for 2300 EST, which continued to expected the medium area of coverage moving over southwestern Georgia, extreme southeast Alabama, and the Florida panhandle, and extending over the accident site.

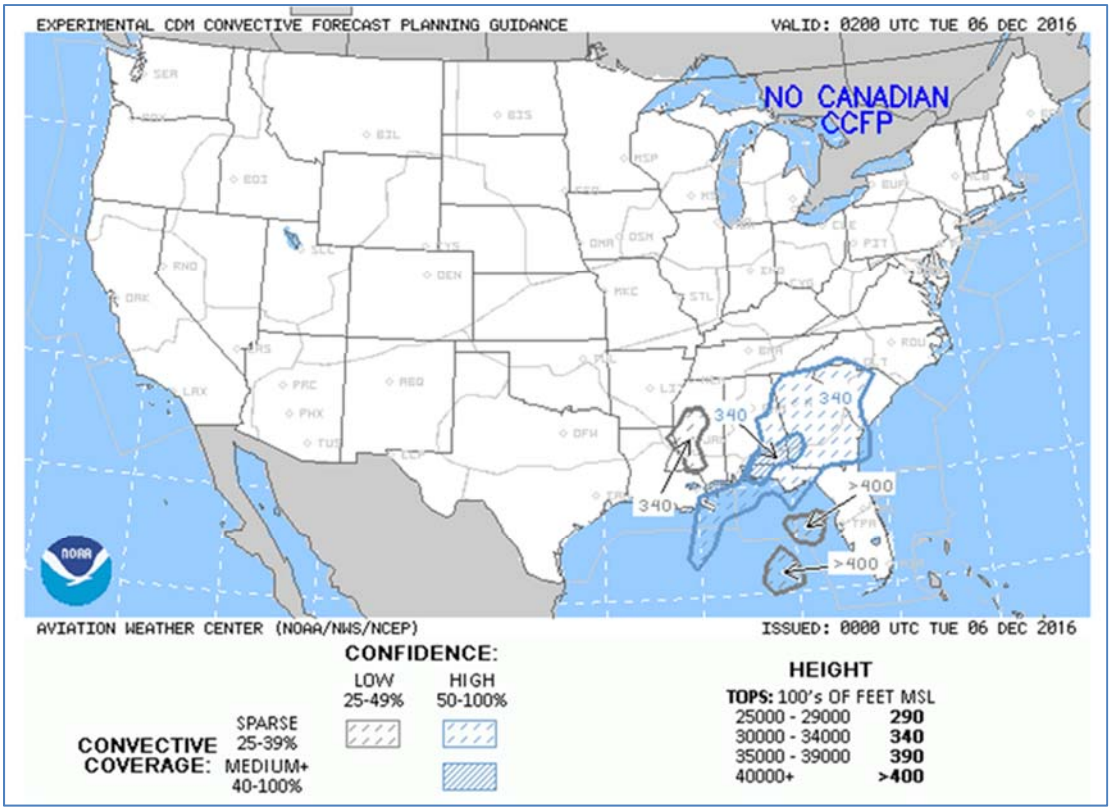


Figure 29 – 2-hour CCFP guidance issued at 1900 EST and valid at 2100 EST

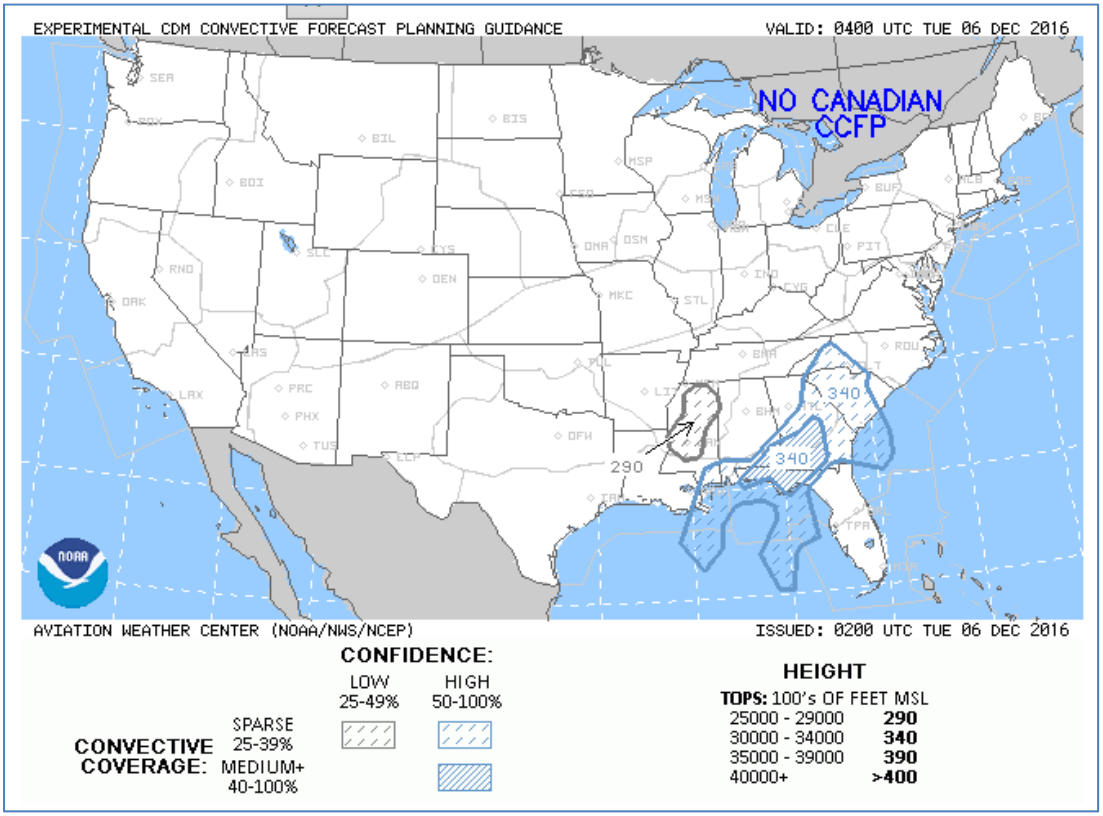


Figure 30 – 4-hour CCFP guidance issued at 1900 EST and valid for 2300 EST

13.0 FAA Weather Display

The FAA Consolidated Storm Prediction for Aviation (CoSPA) weather display, which integrates several of the NWS and FAA weather systems into a single display, with lightning and convective initiation and growth into a single display surrounding the period is documented below. The CoSPA display is located near the ATC supervisor's position in the Air Route Traffic Control Center (ARTCC) in Atlanta.

Figures 31 through 34 are the CoSPA radar displays at 2215 through 2230 EST at 5-minute intervals, with reflectivity or VIP Levels 1 through 6[24], echo tops, storm movement, lightning strikes, and gust front boundaries indicated in light blue. The images depicts the accident site under reflectivity levels 1 to 2 and along the eastern edge of a line of echoes reaching level 4 to 5 intensity between the accident site and KABY, and immediately west of KCXU. The echoes were noted moving northeast at 40 to 45 knots with echo tops between 39,000 and 44,000 feet. Several lightning strikes were noted between 2215 and 2220 EST in the heavy precipitation area immediately north of the accident site, and south and east-southeast of KABY. No lightning was detected within 5 miles of the accident site during the period.

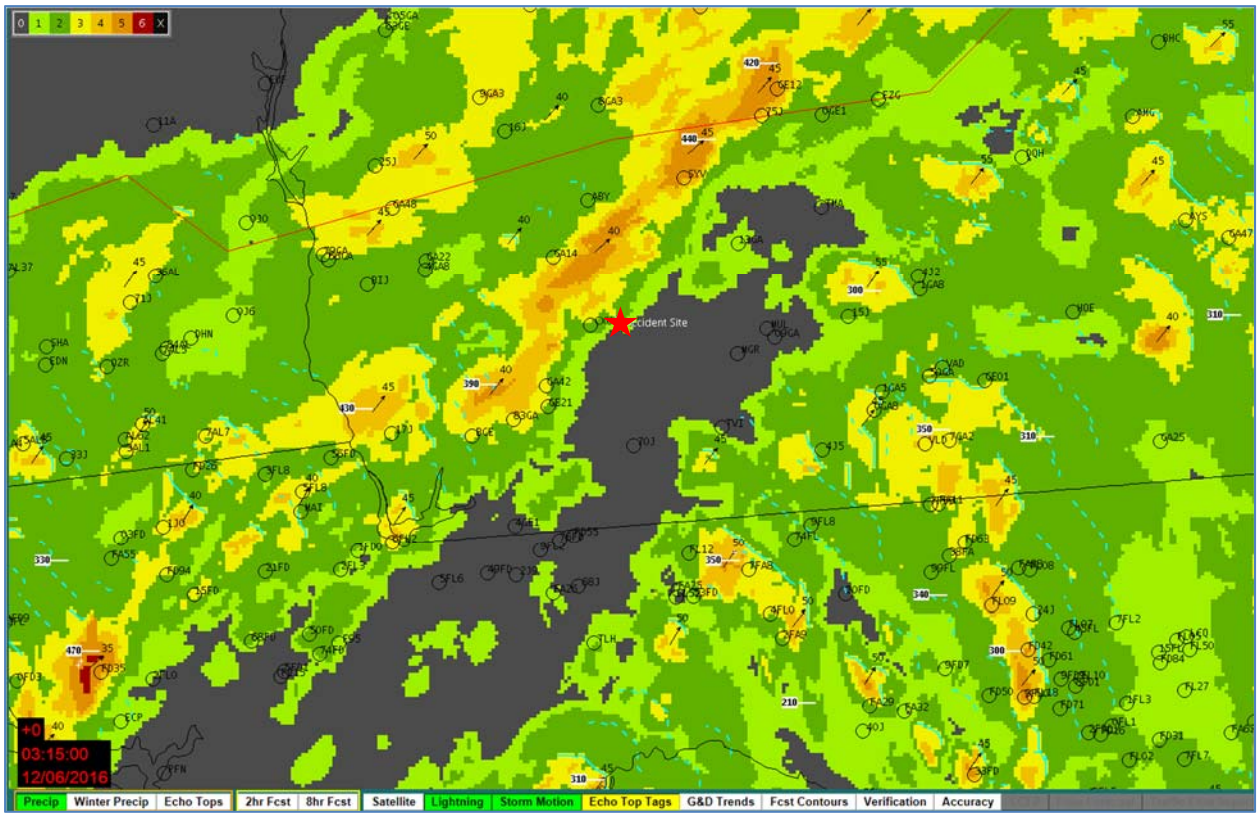


Figure 31 - CoSPA radar display at 2215 EST

[24] See Weather Radar Reflectivity section 5.3 above for the VIP Level 1 to 6 reference.

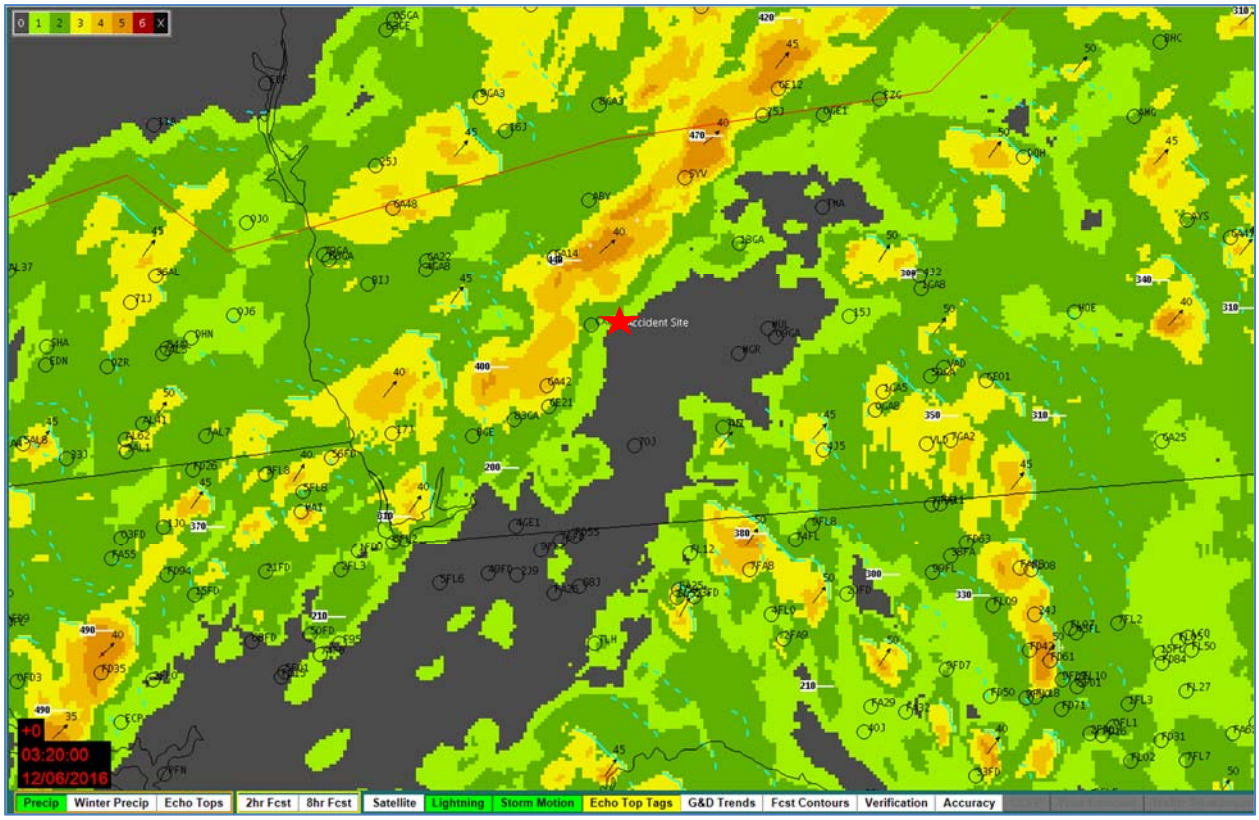


Figure 32 - CoSPA radar display at 2220 EST

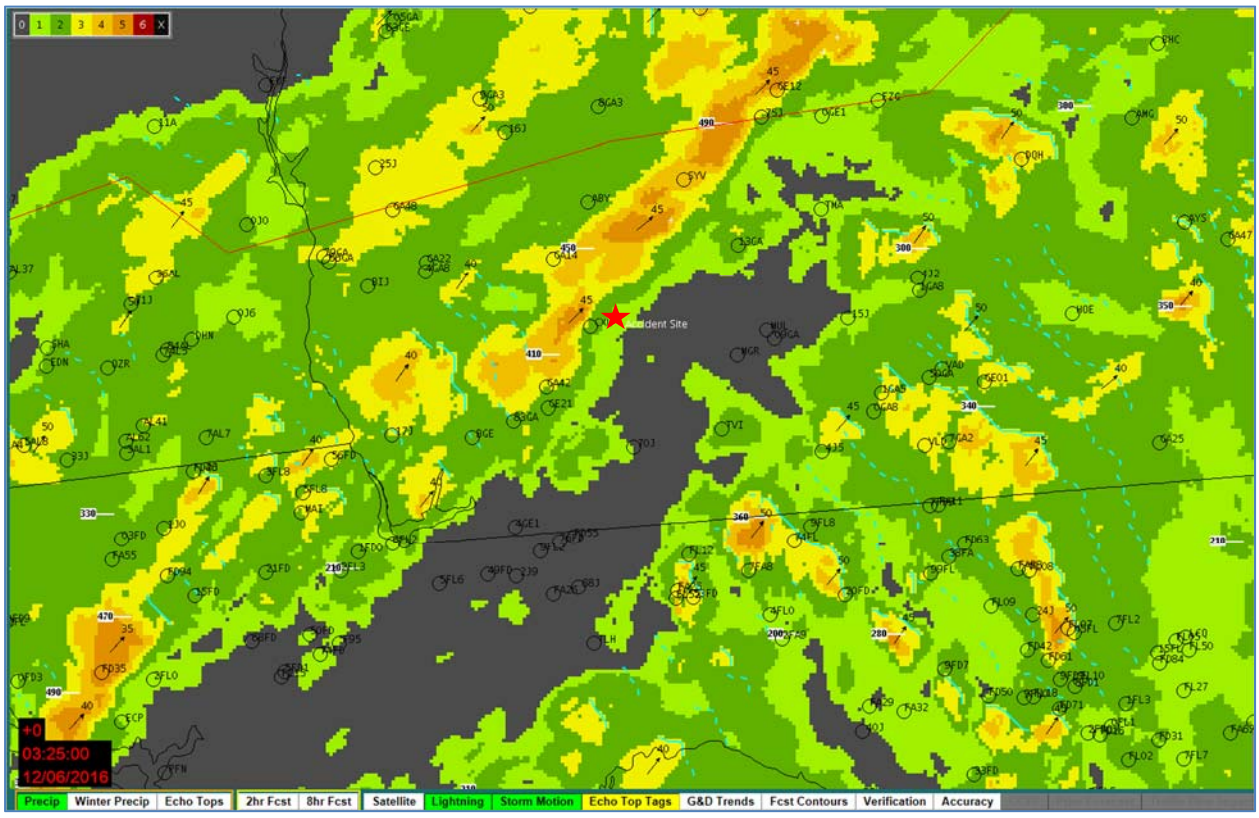


Figure 33 - CoSPA radar display at 2225 EST

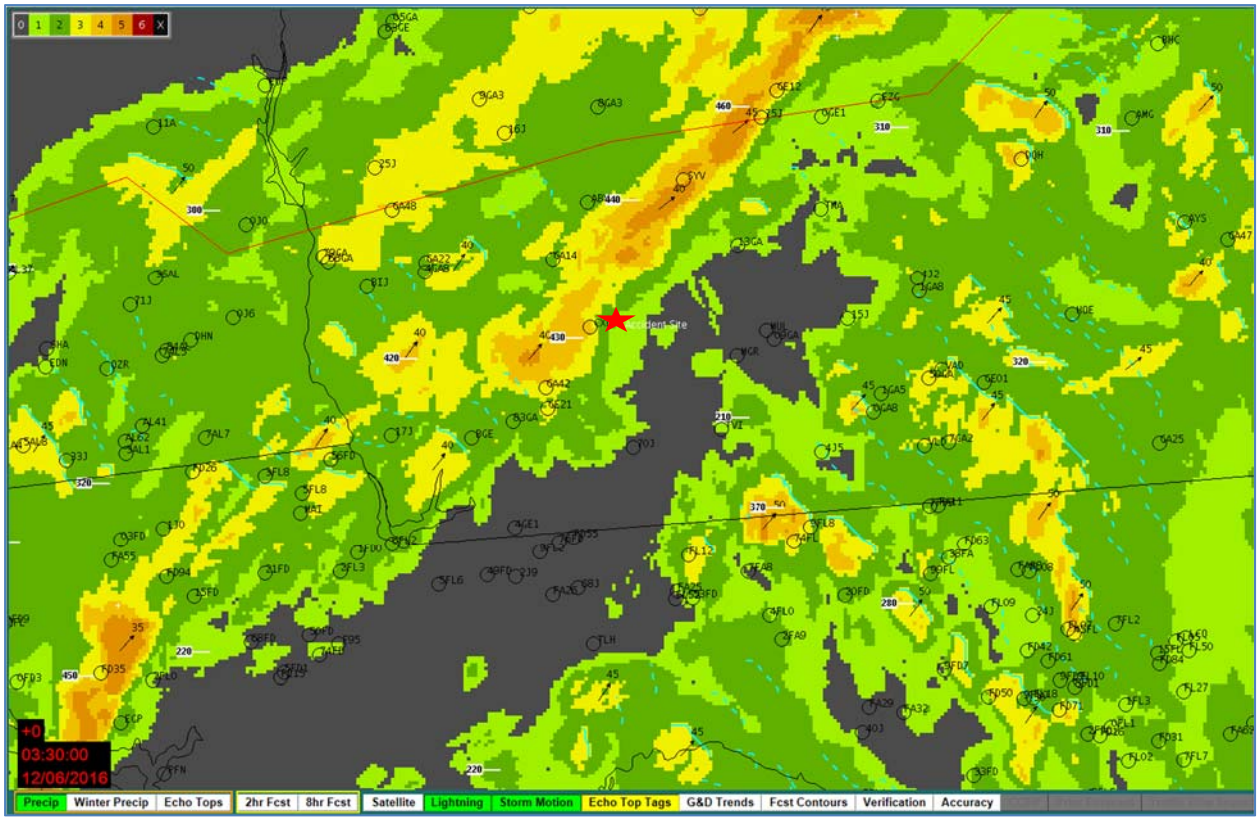


Figure 34 - CoSPA radar display at 2230 EST

14.0 Preflight Weather Briefing

Key Lime Air does not provide any dispatch or flight following services to their flights, and all preflight planning and briefing is the responsibility of the individual pilots in command. The standing company policy for the company is that the pilot obtains his weather briefing from an approved source. In searching what weather information the pilot may have obtained prior to departure, there was no record of the pilot contacting the FAA contract Automated Flight Service Station (AFSS) or accessing the Direct Users Access Terminal Service (DUATS) provider on December 5th, 2016. An additional search of ForeFlight weather, another major weather provider also revealed that the pilot had an account but weather briefing requests were provided to the pilot during the period. It is therefore unknown what weather information the pilot reviewed prior to departure.

15.0 Numerical Model of Convectively Induced Turbulence

Figure 35 is a still image of a vertical slice through a numerical model of an area of thunderstorms and the turbulent kinetic energy (TKE) generated, with the turbulence indicated in blue shades of values of >7 m^2/s^2. It has long been known that the leading edge of thunderstorms is where some of the most intense updrafts are located and the potential turbulence is generated. This model image shows turbulence below the cloud base, and in areas within the cumulus clouds

towers along the leading edge through the upper boundaries or echo tops where convectively induced turbulence (CIT) can be encountered. The model shows the turbulence is possible prior to reaching the precipitation echo and in light echoes near the leading edge. The Clark-Hall cloud model was developed by the National Center for Atmospheric Research (NCAR) and depicts a convective storm near Fort Collins and Greeley, Colorado on June 24, 1992. Attachment 2 is a full animation of the turbulence potential in and near convection.

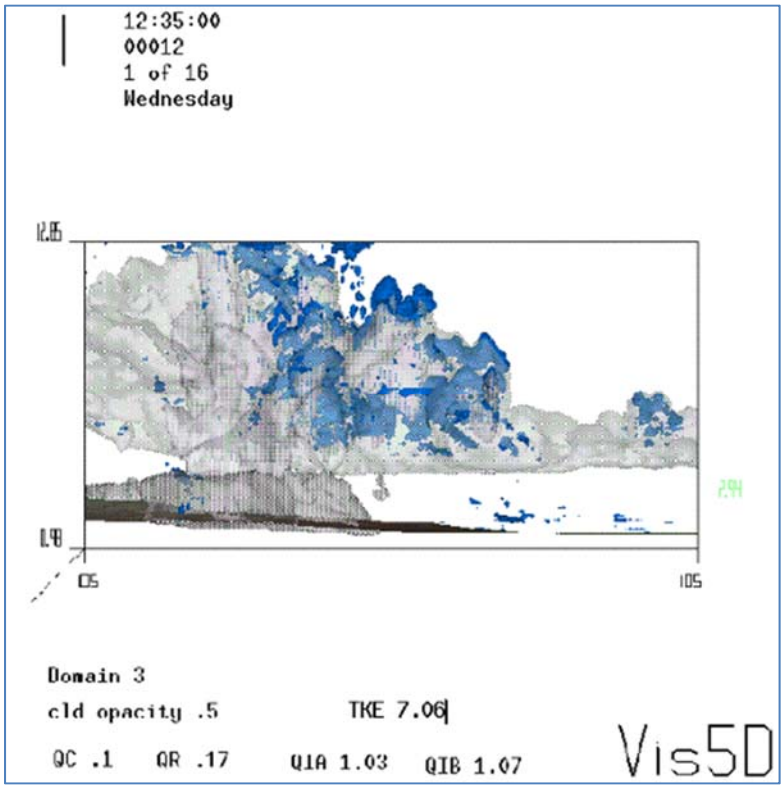


Figure 35 – NCAR Clark-Hall cloud numerical model of turbulence in developing convection

16.0 Astronomical Conditions

The following astronomical conditions were obtained from the United States Naval Observatory's website for Albany, Dougherty County, Georgia on December 5, 2016.

Begin of civil twilight	0655 EST
Sunrise	0722 EST
Moonrise	1151 EST
Sunset	1733 EST
End of civil twilight	1800 EST
Accident	2222 EST
Moonset	2314 EST

At the time of the accident, the Moon was approximately 9° above the horizon at an azimuth of 250°. The phase of the Moon was a waxing crescent with 37% of the Moon's visible disk illuminated.

F. LIST OF ATTACHMENTS

Attachment 1 – METAR observations for Southern Georgia Regional Airport (KABY), Albany, Georgia and general flight category on December 5-6, 2016

Attachment 2 - NCAR Clark-Hall numerical model of turbulence generated in convective

Submitted by:

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Don Eick
Senior Meteorologist