National Transportation Safety Board

Office of Aviation Safety
Washington, D.C. 20594-2000
February 14, 2008

WEATHER STUDY

DCA05RA093

A. ACCIDENT

Location: Machiques, Venezuela
Date: August 16, 2005
Time: 0335 Atlantic daylight time (0735 UTC[1])
Aircraft: West Caribbean Airways Boeing MD-82, registration: HK-4374X

B. METEOROLOGICAL SPECIALIST

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C. SUMMARY

On August 16, 2005, at about 03:35 Atlantic daylight time, a West Caribbean Airways MD-82 crashed near Machiques, Venezuela after the pilot reported engine problems. The 8 crewmembers and 152 passengers onboard were fatally injured and the airplane was destroyed. The airplane was being operated as a charter flight from Panama City, Panama, to Fort de France, Martinique. The investigation is being conducted by the Venezuela Comite de Investigacion de Accidentes Aereos.

D. DETAILS OF INVESTIGATION

The National Transportation Safety Board's (NTSB) meteorology specialist was not on scene for this investigation and gathered all the weather data for this investigation from the Washington D.C. office from official National Oceanic and Atmospheric Administration

[1] UTC – is an abbreviation for Coordinated Universal Time.

(NOAA), National Weather Service (NWS), and National Climatic Data Center (NCDC) sources. All times are Coordinated Universal Time (UTC) based upon the 24 hour clock. Local time of Atlantic daylight time (ADT) is +4 hours to UTC, and UTC=Z. Directions are referenced to true north and distances are in nautical miles. Heights are above mean sea level (MSL) unless otherwise noted. Visibility is in statute miles and fractions of statute miles.

1.0 Synoptic Situation

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.

1.0.1 Surface Analysis Chart

The section of the unanalyzed NWS Tropical Surface Analysis Charts for 0000Z on August 16, 2005, is included as figure 1. The chart depicted a cyclone or low pressure system with a central pressure of 1008-hectopascals (hPa) over western Venezuela in the immediate vicinity of the accident site. The station models surrounding the low indicated cumulus type clouds with scattered reports of precipitation. Thunderstorms were reported in Panama and over eastern Venezuela along the Caribbean coast.

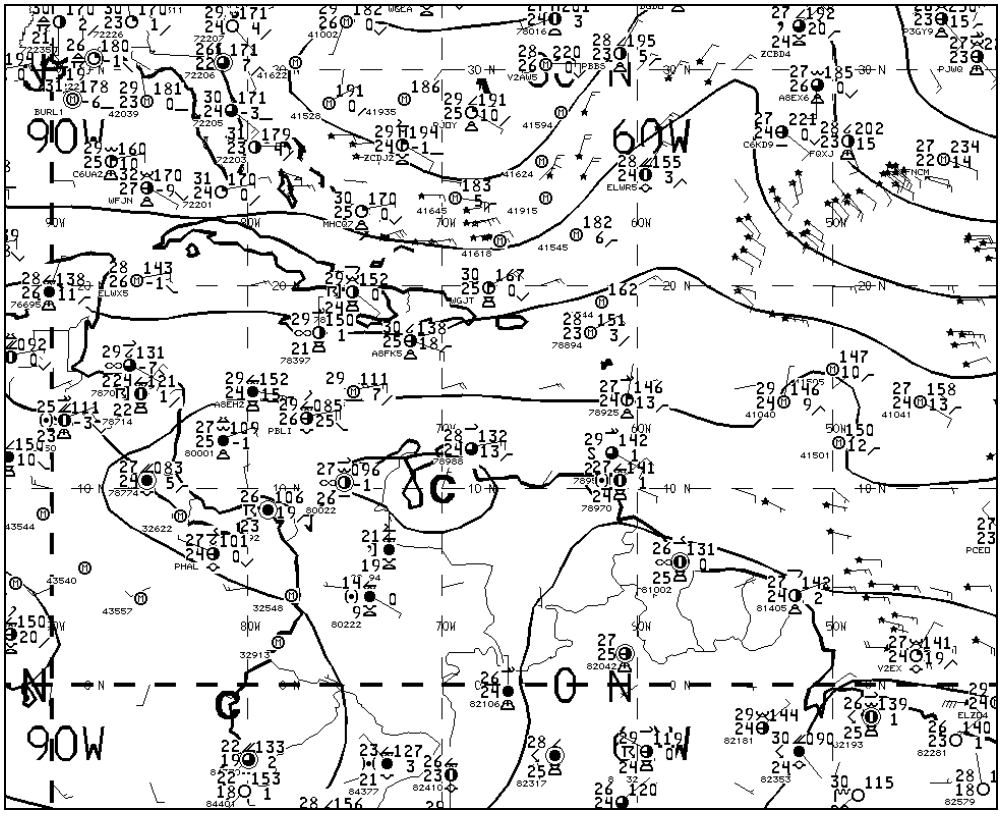

Figure 1 – NWS Surface Analysis Chart for 0000Z

The NWS Atlantic Tropical Surface Analysis for 0600Z is included as figure 2. The chart depicted a tropical easterly wave moving across the western Caribbean Sea extending south of western Cuba, a Tropical Depression approaching the Windward Islands, and Hurricane Irene at latitude 36.6° north and longitude 63.5° west off the mid Atlantic coast with a central pressure of 983-hPa with sustained winds of 75 knots gusting to 90 knots. In the immediate vicinity of the accident site, the 1008-hPa low pressure system was depicted over northern Columbia, southwest of the accident site.

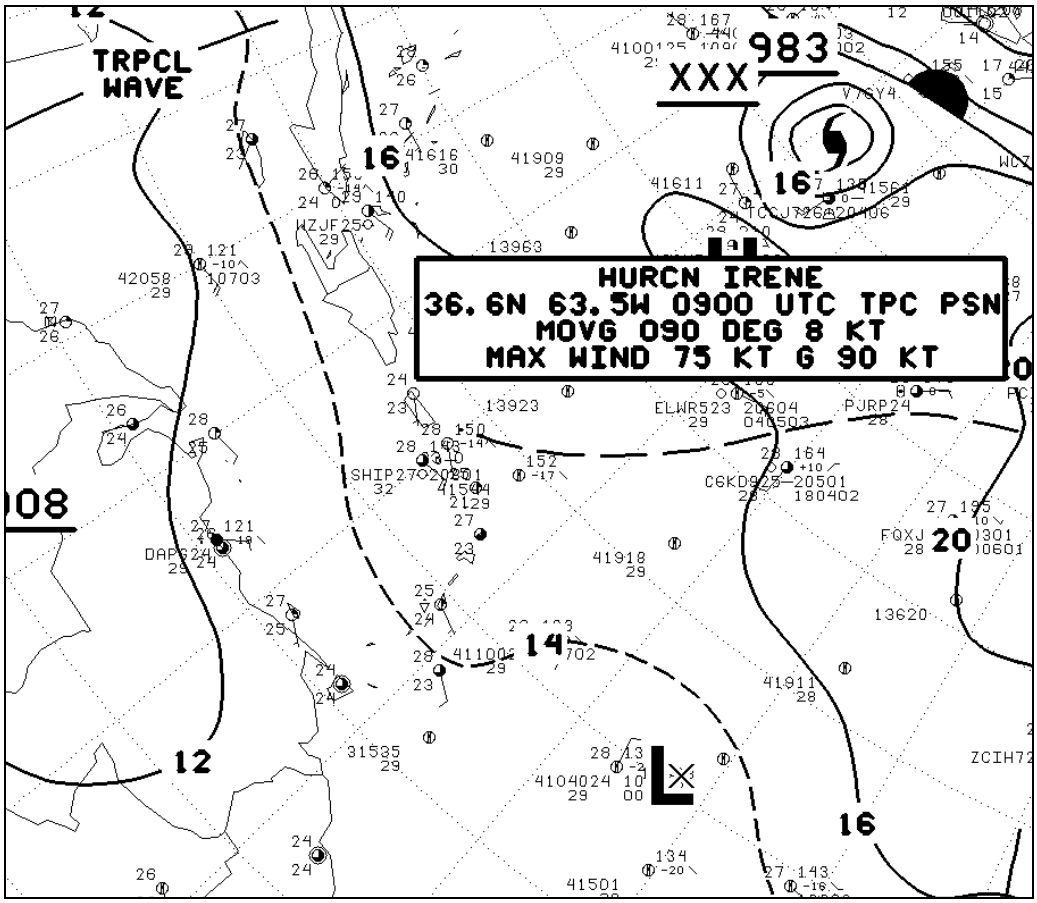

Figure 2 - NWS Tropical Analysis for 0600Z

The unanalyzed NWS Tropical Surface Analysis Charts for 1200Z is included as figure 3. The chart was unanalyzed and did not depict any closed isobars or low pressure system over the area. The station models surrounding the accident site depicted towering cumulus to cumulonimbus clouds.

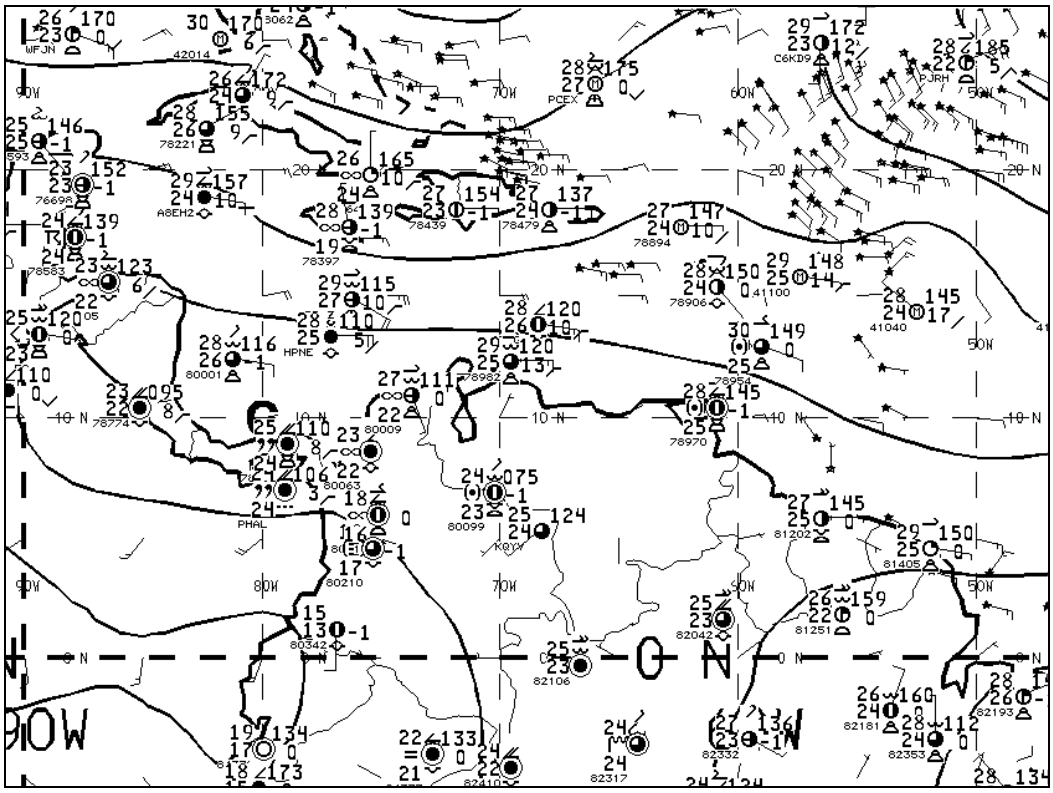

Figure 3 – NWS Surface Analysis Chart for 1200Z

2.0 Upper Air Data

The closest upper air sounding or rawinsonde observation (RAOB) was from Hato (TNCC), Curacao, site number 78988, located approximately 250 miles northeast of the accident site at an elevation of XX feet msl. The observation was obtained from the University of Wyoming's Internet site. The observation was then plotted and analyzed utilizing RAOB[2] software. The 1200Z sounding on August 16, 2005, from TNCC plotted on a standard Skew-T log P diagram[3] with the observed and derived stability parameters and is included as figure 6 from the surface to 100-mb or 52,000 feet.

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

[3] Skew T log P diagram – is a standard meteorological plot 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.

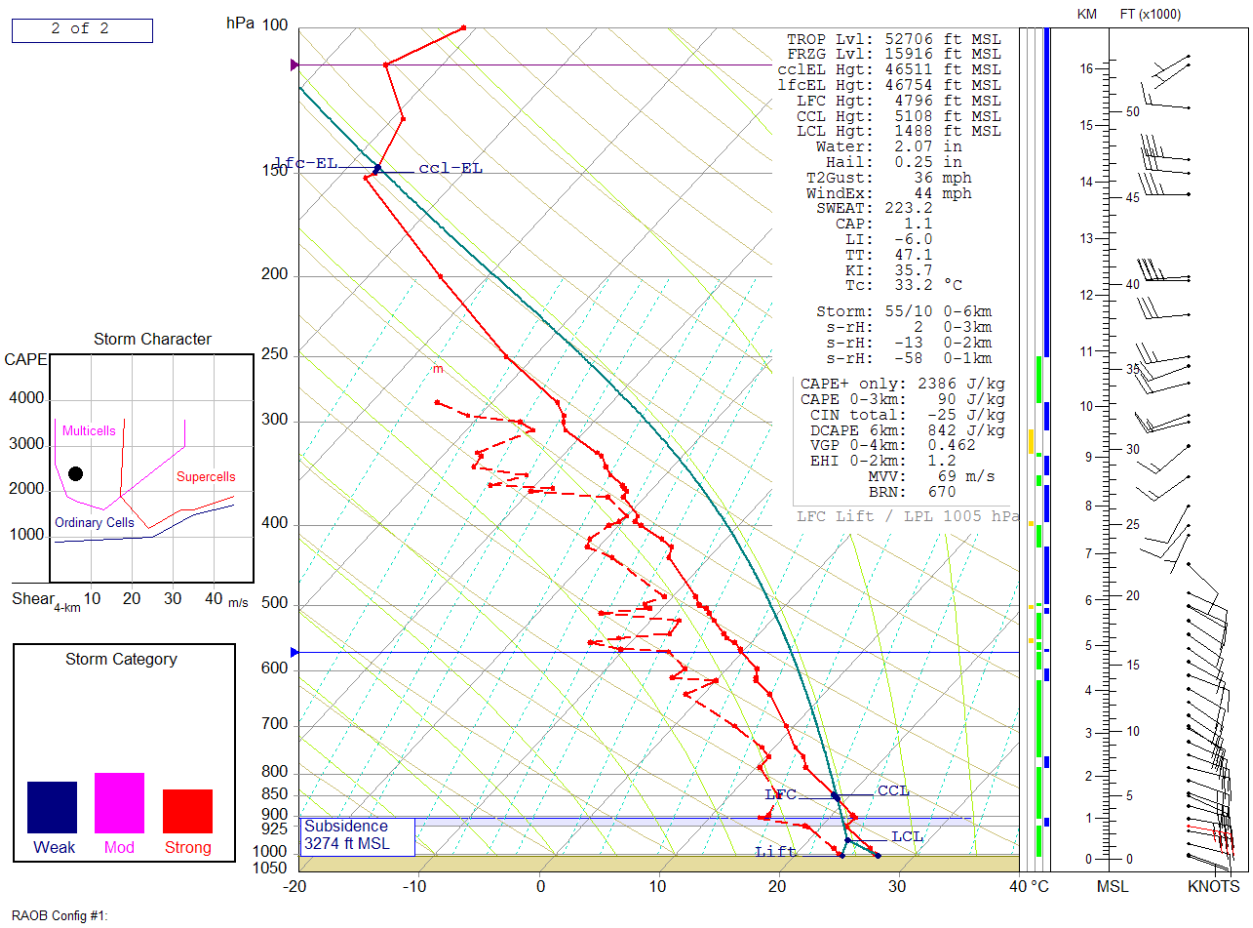

Figure 4 –TNCC 1200Z sounding

The sounding depicted a moist low-level environment with a relative humidity of 75 percent or more from the surface to approximately 10,000 feet. The Lifted Condensation Level (LCL)[4] at 962-hPa or at 1,488 feet, a Convective Condensation Level (CCL)[5] at 847-hPa or 5,108 feet, and a Level of Free Convection (LFC)[6] at 857-hPa or 4,795 feet. The Equilibrium Level (EL)[7] or expected top of convective clouds was 149-hPa or 46,511 feet.

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

[5] Convective Condensation Level (CCL) - is 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.

[6] 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.

[7] 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

The tropopause height was identified at 52,706 feet. The precipitable water value was 2.07 inches.

The sounding parameters indicated the warm moist low–level environment from the surface to 850-mb and the Lifted Index (LI)[8] stability index of –6.0 indicating an absolutely unstable environment favorable for thunderstorm development. The K-index[9] of 35.7 indicated an approximately 80 percent chance of air mass type thunderstorms. The Convective Available Potential Energy (CAPE)[10] index was 2,386 joules per kilogram. The Total Totals Index (TTI)[11] indicated 47.1 and supported scattered moderate to a few severe thunderstorms. The maximum vertical velocity (MVV) of the potential convective updrafts in the thunderstorms was determined to be 69 meters per second (M/S) or 138 knots. The WINDEX or microburst potentials measure of the downdraft instability supported wet microburst development with estimated outflow winds near 44 knots.

The sounding wind profile depicted easterly winds below 20,000 feet with a low-level jet at 2,600 feet with winds from 100 degrees at 37 knots. Winds veered to the west above 20,000 feet with height through the upper troposphere. The level of maximum wind was identified immediately below the tropopause at 45,000 feet with winds from 275 degrees at 37 knots.

3.0 Satellite Data

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an overshooting tops or anvil dome. The EL typically is higher than the tropopause, and is a more accurate reference for storm tops.

[8] 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 some higher level (around 18,000 feet, usually) 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.

[9] 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, the greater the probability of air mass type thunderstorms development.

[10] 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. Observed values in thunderstorm environments often may exceed 1,000 joules per kilogram (j/kg), and in extreme cases may exceed 5,000 j/kg. However, as with other indices or indicators, there are no threshold values above which severe weather becomes imminent. CAPE is represented on a sounding by the area enclosed between the environmental temperature profile and the path of a rising air parcel, over the layer within which the latter is warmer than the former. (This area often is called positive area.)

[11] Total-Totals Index - A stability index and severe weather forecast tool, equal to the temperature at 850-hPa plus the dew point at 850-hPa, minus twice the temperature at 500-hPa. The total-totals index is the arithmetic sum of two other indices: the Vertical Totals Index (temperature at 850-hPa minus temperature at 500-hPa) and the Cross Totals Index (dew point at 850-hPa minus temperature at 500-hPa). As with all stability indices there are no magic threshold values, but in general, values of less than 50 or greater than 55 are considered weak and strong indicators , respectively, of potential severe storm development in the continental United States.

The Geostationary Operations Environmental Satellite number 12 (GOES-12) data was obtained and displayed on the National Transportation Safety Board's Man-computer Interactive Data Access System (McIDAS) workstation. The infrared imagery was obtained surrounding the time of the accident. The infrared imagery (band 4) at a wavelength of 10.7 microns (μm) provided a 4-kilometer (km) resolution with radiative cloud top temperatures. The visible imagery (band 1) at a wavelength of 0.65 μm provided a resolution of 1 km. The satellite imagery surrounding the time of the accident were reviewed and the closest images documented below.

Figures 5 and 6 are the GOES-12 infrared band 4 image at 1645Z and 1715Z respectively at 4X magnification with a standard MB temperature enhancement curve applied to highlight the higher and colder cloud tops associated with deep convection. The images depicts a large area of cumulonimbus clouds associated with a tropical Mesoscale Convective System (MCS)[12] over the Columbia and Venezuela, with several other cumulonimbus clouds extending eastward into Venezuela extending over the accident site. The radiative cloud top temperature over the accident site was observed at 200.30 degrees Kelvin (K) or –72.86 degrees Celsius (C) at 0645Z and 195.70 degrees K or –77.46 degrees C at 0715Z, which corresponded to cloud tops in the range of 50,000 to 52,000 feet.

[12] A Mesoscale Convective System (MCS) is a complex of thunderstorms which becomes organized on a scale larger than the individual thunderstorms, and normally persists for several hours or more. MCSs may be round or linear in shape, and include systems such as tropical cyclones, squall lines, and Mesoscale Convective Complexes (MCCs). MCS often is used to describe a cluster of thunderstorms that does not satisfy the size, shape, or duration criteria of an MCC.

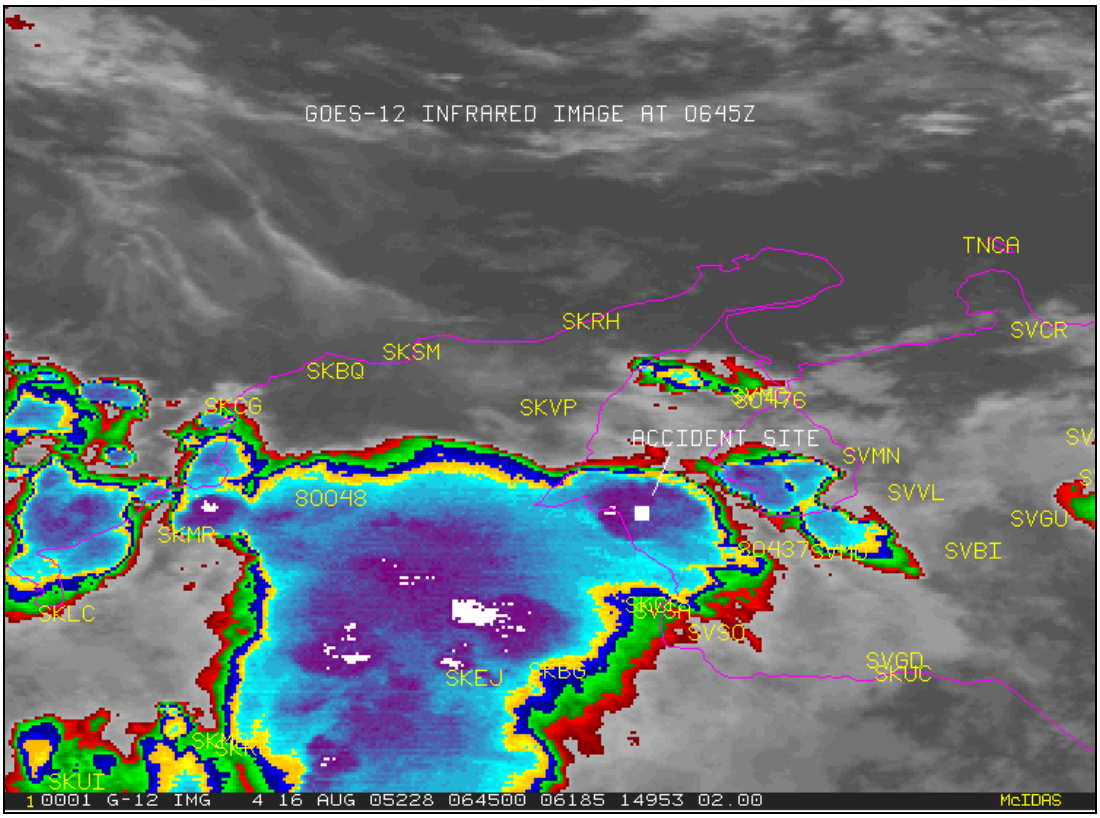

Figure 5 – GOES-12 infrared image at 0645Z

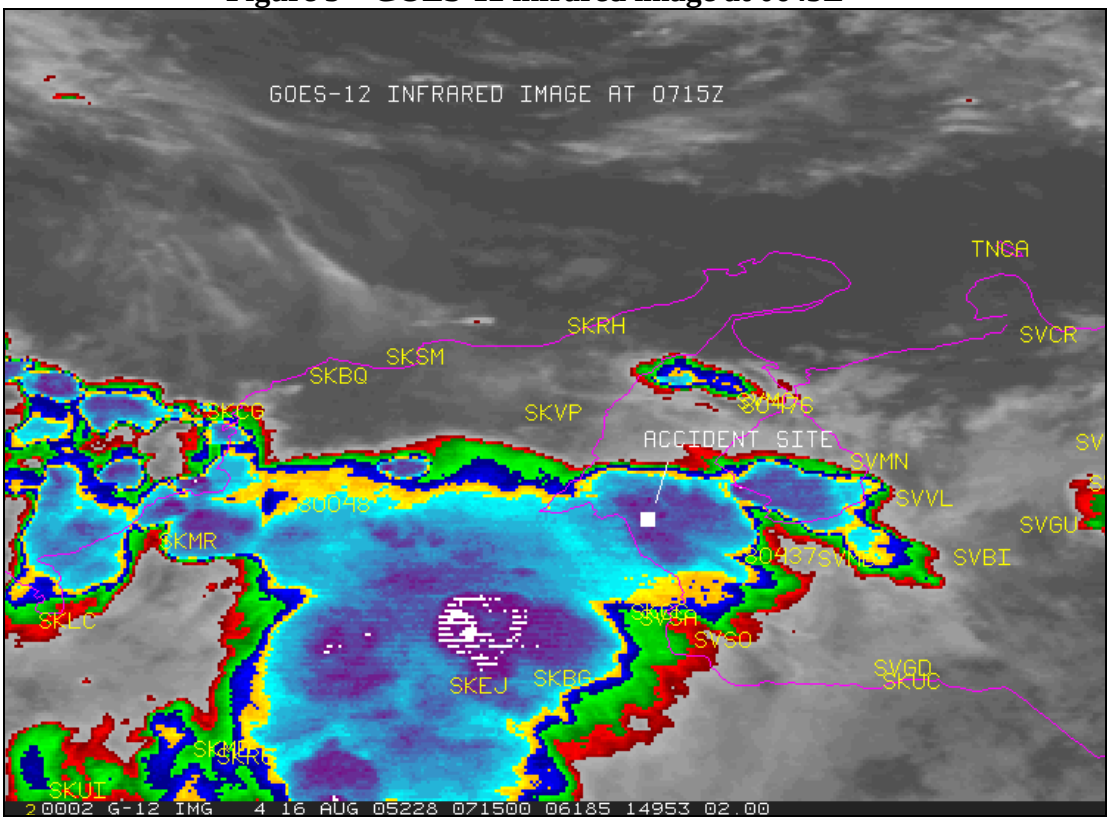

Figure 6 – GOES-12 infrared image at 0715Z

Aircraft research into thunderstorms from the “Thunderstorm Project”, which penetrated 76 thunderstorms over Florida and Ohio, recorded over 1,362 penetrations characterized as air mass to multicellular non-severe thunderstorms. Of these convective clouds the maximum tops was 56,000 feet, with the modal height between 35,000 to 40,000 feet. The maximum updraft encountered was 84 feet per second (ft/s) or 26 m/s, the maximum downdraft was 55 ft/s or 17 m/s. During low-level penetrations they found the maximum downdraft at 5,000 feet were 30 to 40 ft/s or 11 m/s, with 58 percent of the penetrations having altitude displacements more than 55 feet. Hail was encountered in 10 percent of the penetrations. They frequently encountered gust loads stronger than 20 ft/s, which typically increased with altitude. The project determined that most penetrations experienced maximum vertical gust velocities greater than 4.5 m/s, and classified them as heavy or severe. They also determined that for lightning to form, updrafts speeds had to be greater than 8 m/s, and reach temperatures of -15 to -20 degrees C.

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