NATIONAL TRANSPORTATION SAFETY BOARD

Office of Aviation Safety
Washington, D.C. 20594

April 12, 2019

Weather Study

METEOROLOGY

WPR19FA079

Table Of Contents

A. ACCIDENT

Location: Yorba Linda, California
Date: February 3, 2019
Time: 1345 Pacific standard time
2145 Coordinated Universal Time (UTC)
Aircraft: Cessna 414, Registration: N414RS

B. METEOROLOGIST

Paul Suffern
Senior Meteorologist
Operational Factors Division (AS-30)
National Transportation Safety Board

C. DETAILS OF THE INVESTIGATION

The National Transportation Safety Board's (NTSB) Meteorologist did not travel for this investigation and gathered the weather data for this investigation from official National Oceanic and Atmospheric Administration (NOAA) National Weather Service (NWS) sources including the National Centers for Environmental Information (NCEI). All times are Pacific standard time (PST) on January 28, 2019, and are based upon the 24-hour clock, where local time is -8 hours from UTC, and UTC=Z (unless otherwise noted). 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 miles.

The accident site was located at latitude 33.8719° N, longitude 117.7867° W, at an approximate elevation of 525 feet (ft).

D. FACTUAL INFORMATION

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 and the Weather Prediction Center, located in College Park, Maryland. These are the base products used in describing synoptic weather features and in the creation of forecasts and warnings for the NWS. 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] https://www.faa.gov/regulations_policies/advisory_circulars/index.cfm/go/document.information/documentID/1030235

1.1 Surface Analysis Chart

The southwestern United States section of the NWS Surface Analysis Chart for 1300 PST is provided as figure 1 with the location of the accident site marked within the red circle. The chart indicated a surface trough[2] located east of the accident site oriented south to north from southcentral California stretching northward into western Nevada. Troughs can act as lifting mechanisms to help produce clouds and precipitation if sufficient moisture is present.

The station models around the accident site depicted air temperatures in the low 50's to low 60's degrees Fahrenheit (°F), dew point temperatures in the low 50's °F with a temperature-dew point spread of 9° or less, a southwest wind between 5 and 10 knots, overcast cloud cover and light rain.

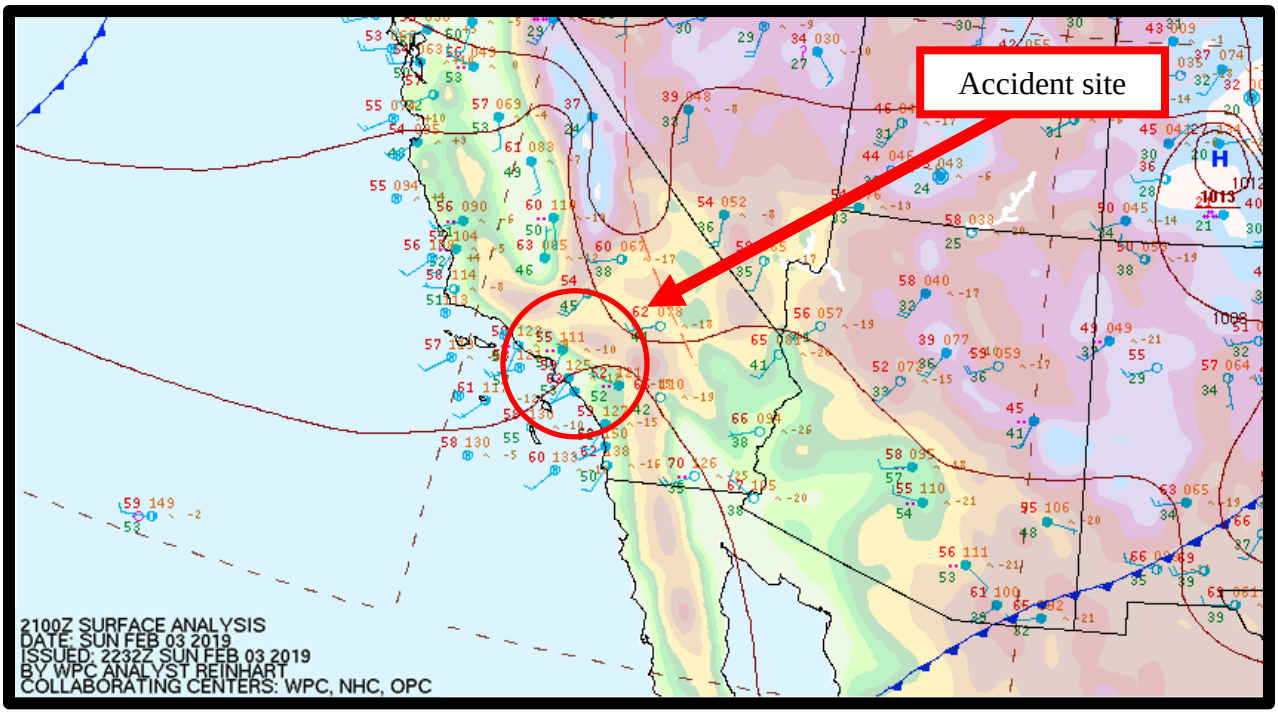

Figure 1 – NWS Surface Analysis Chart for 1300 PST

[2] Trough – An elongated area of relatively low atmospheric pressure or heights.

1.2 Upper Air Charts

The NWS Storm Prediction Center (SPC) Constant Pressure Charts for 1600 PST at 925-, 850-, 700-, 500-, and 300-hectopascals (hPa) are presented in figures 2 through 6. There were low- and mid-level trough directly to the east and the west of the accident site from 925- through 500-hPa. The wind was from the west-southwest at 5 to 10 knots at 925- and 850-hPa with the wind becoming westerly at 50 knots by 500-hPa (figure 5). At 300-hPa, the wind was from the west-northwest between 80 and 100 knots (figure 6).

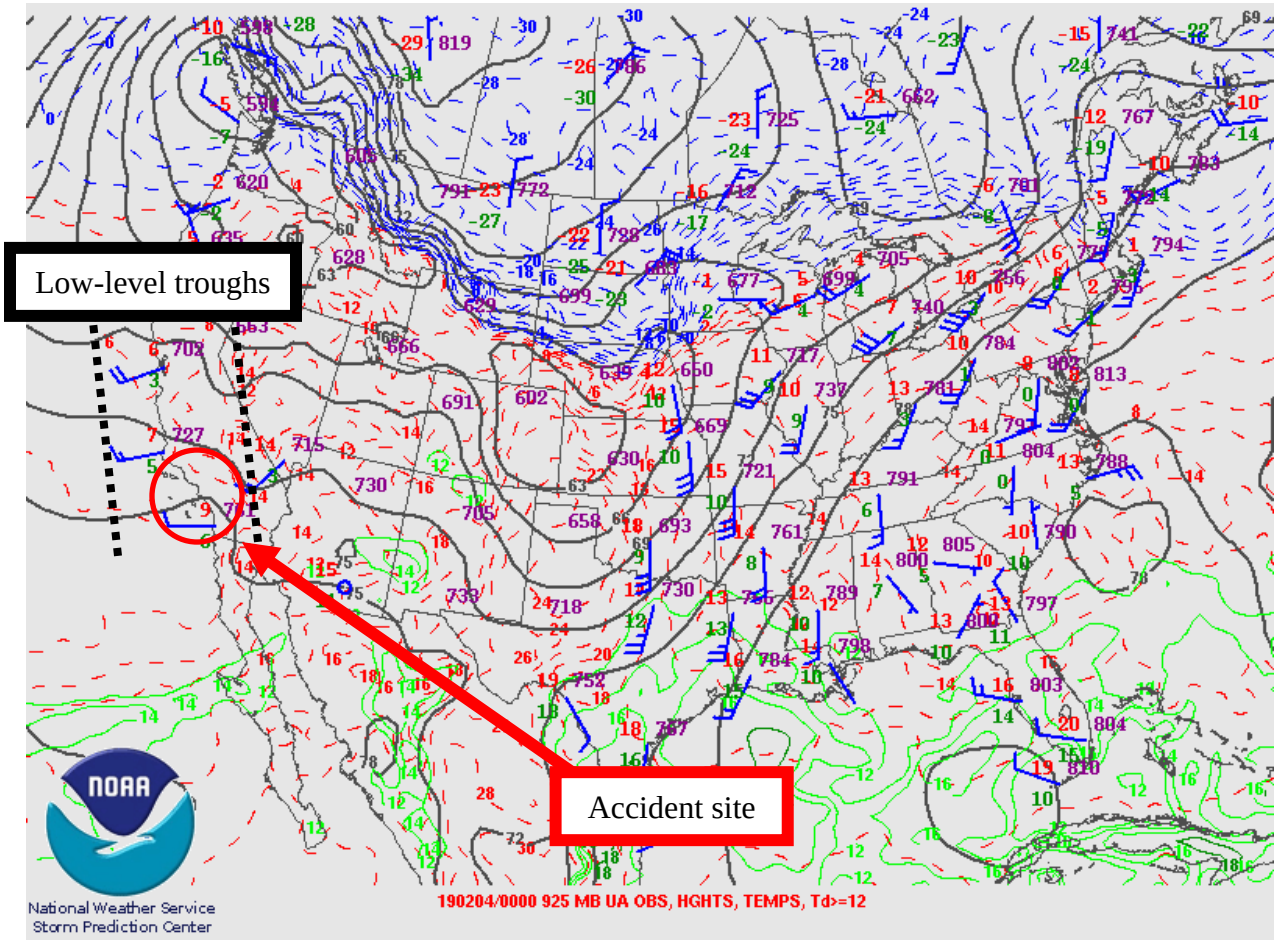

Figure 2 – 925-hPa Constant Pressure Chart for 1600 PST

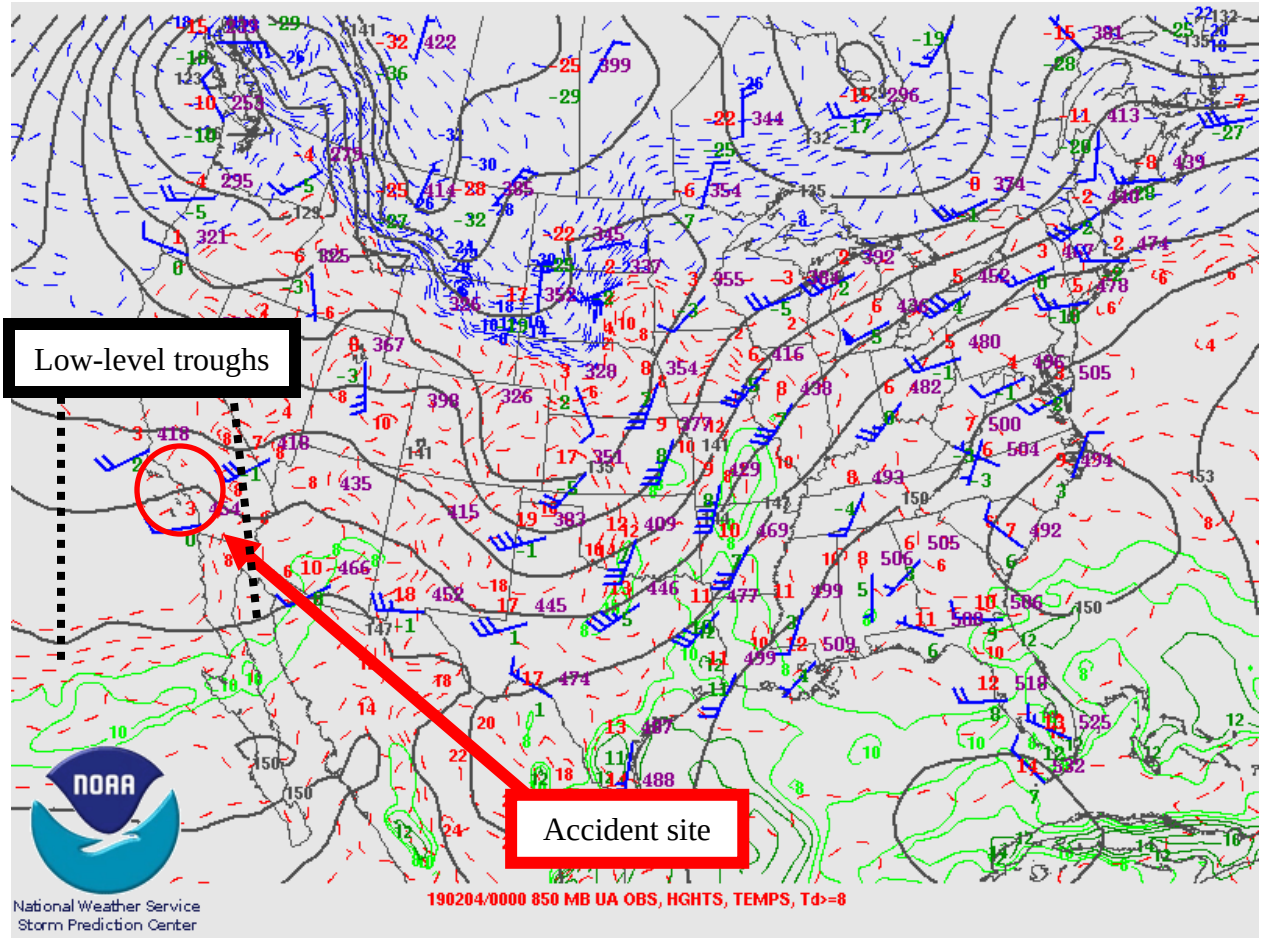

Figure 3 – 850-hPa Constant Pressure Chart for 1600 PST

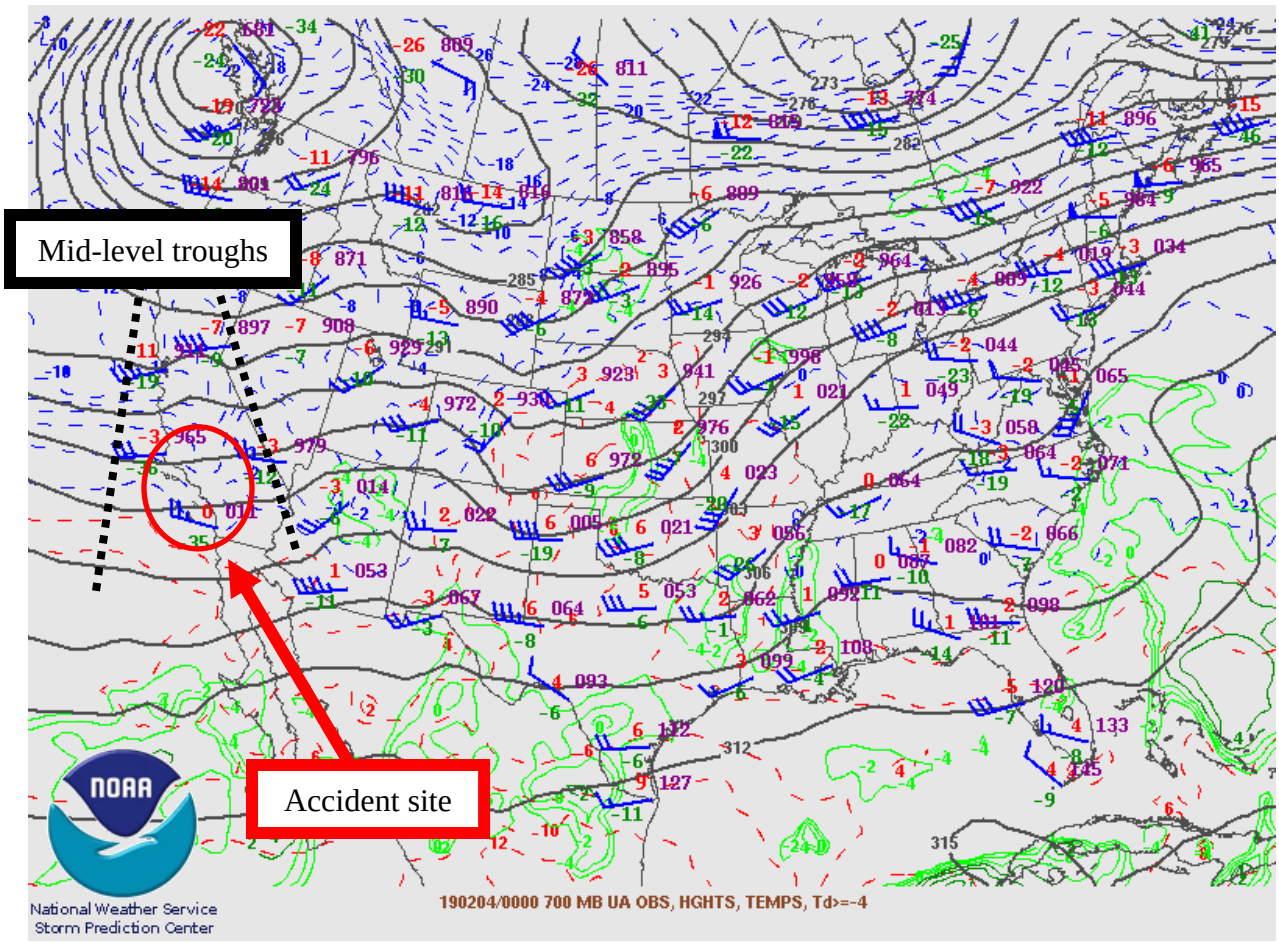

Figure 4 – 700-hPa Constant Pressure Chart for 1600 PST

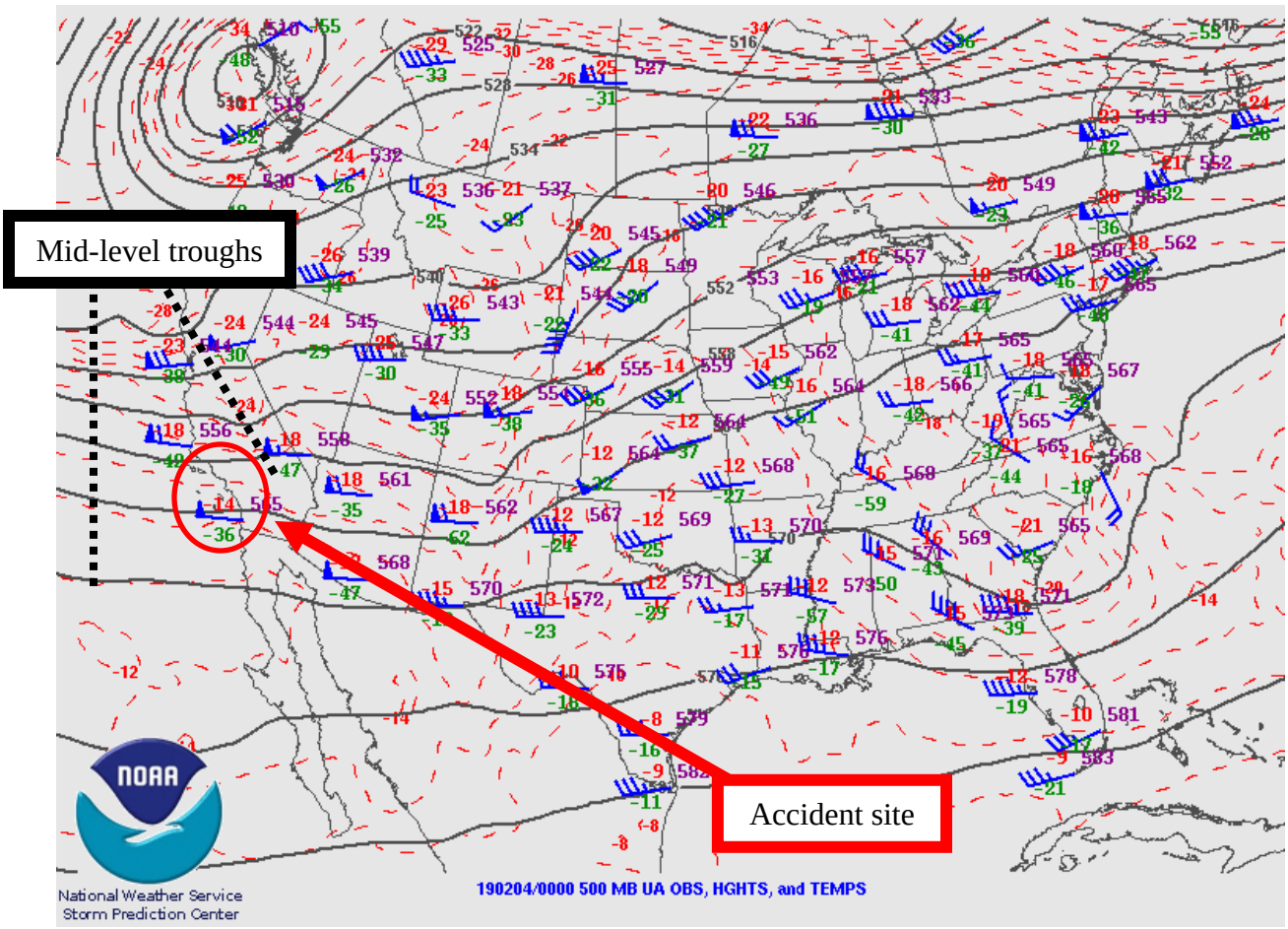

Figure 5 – 500-hPa Constant Pressure Chart for 1600 PST

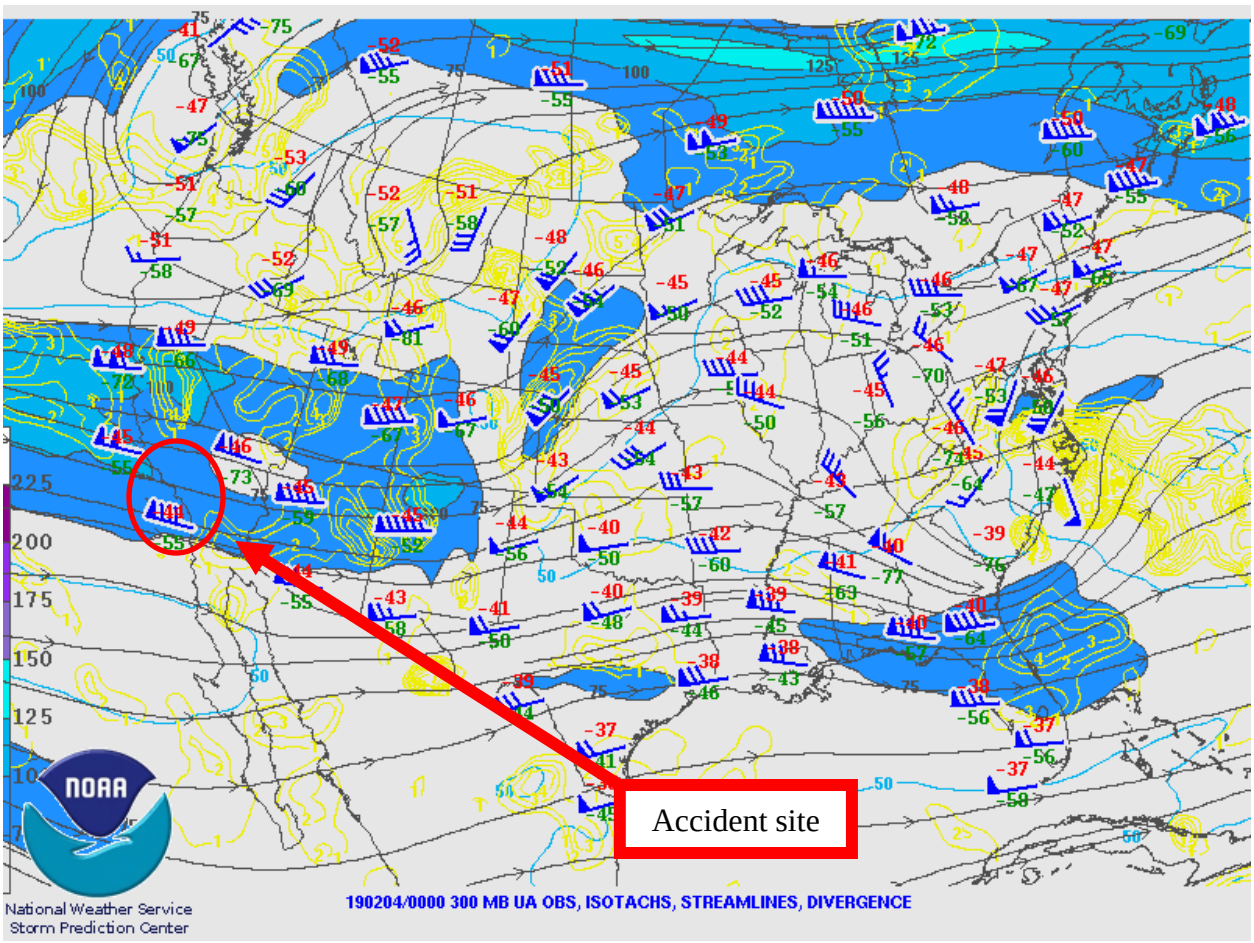

Figure 6 – 300-hPa Constant Pressure Chart for 1600 PST

2.0 SPC Products

No thunderstorms were forecast by SPC for the accident site at the accident time.

3.0 Surface Observations

The area surrounding the accident site was documented using official Meteorological Aerodrome Reports (METARs) and Specials (SPECIs). Figure 7 is a sectional chart with the accident site and the closest weather reporting locations to the accident site marked.

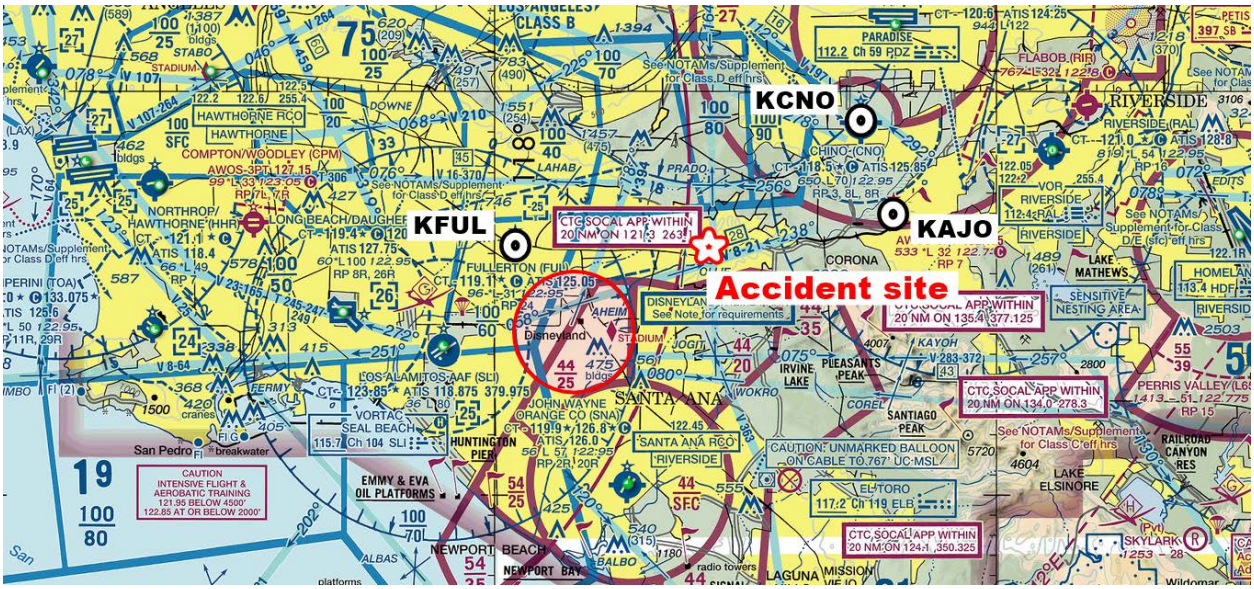

Figure 7 – Sectional chart of accident area with the location of the accident site and the closest surface observation sites

The closest official weather reporting facility to the accident site was from Corona Municipal Airport (KAJO), Corona, California, at an elevation of 533 ft, and was 9 miles east-north of the accident site. KAJO had an Automated Weather Observing System (AWOS[3]) whose reports were not supplemented and had a 12° easterly magnetic variation[4] (figure 7). The following observations were taken and disseminated during the times surrounding the accident:[5]

[1119 PST] SPECI KAJO 031919Z AUTO 00000KT 10SM SCT027 OVC034 12/11 A2994 RMK AO2=

[1127 PST] SPECI KAJO 031927Z AUTO 32003KT 8SM BKN027 OVC033 12/11 A2994 RMK AO2=

[1156 PST] METAR KAJO 031956Z AUTO VRB03KT 10SM SCT023 BKN033 OVC060 13/11 A2993 RMK AO2 RAB30E51 SLP149 P0000 T01280111=

[1251 PST] SPECI KAJO 032051Z AUTO 25008KT 6SM -RA BR BKN017 BKN026 OVC035 13/11 A2991 RMK AO2 RAB16E30B49 P0000=

[1256 PST] METAR KAJO 032056Z AUTO 26007KT 5SM -RA BR BKN017 BKN026 OVC035 13/11 A2991 RMK AO2 RAB16E30B49 SLP143 P0000 60000 T01280106 56013=

[3] AWOS – Automated Weather Observing System is equipped with meteorological instruments to observe and report temperature, dewpoint, wind speed and direction, visibility, cloud coverage and ceiling up to twelve thousand feet, and altimeter setting.

[4] Magnetic variation – The angle (at a particular location) between magnetic north and true north. Latest measurement taken from https://skyvector.com/

[5] Bolded sections in this report highlight information that directly reference the weather conditions that affected the accident location around the accident time.

[1320 PST] SPECI KAJO 032120Z AUTO VRB03KT 10SM SCT021 BKN037 OVC044 13/10 A2990 RMK AO2 RAE07 P0000=

ACCIDENT TIME 1345 PST

[1349 PST] SPECI KAJO 032149Z AUTO VRB04KT 10SM -RA BKN023 BKN028 OVC060 14/10 A2989 RMK AO2 RAE07B47 P0000=

[1356 PST] METAR KAJO 032156Z AUTO 27009KT 9SM -RA BKN023 OVC028 13/11 A2989 RMK AO2 RAE07B47 SLP138 P0000 T01330106=

[1456 PST] METAR KAJO 032256Z AUTO VRB04KT 10SM SCT021 SCT025 OVC031 13/09 A2989 RMK AO2 RAE54 SLP138 P0001 T01280094=

KAJO weather at 1256 PST, automated, wind from 260° at 7 knots, 5 miles visibility, light rain, mist, broken ceiling at 1,700 ft above ground level (agl), broken clouds at 2,600 ft agl, overcast clouds at 3,500 ft agl, temperature of 13 °Celsius (C), dew point temperature of 11 °C, and an altimeter setting of 29.91 inches of mercury (inHg). Remarks: automated station with a precipitation discriminator, rain began at 1216 PST, rain ended at 1230 PST, rain began at 1249 PST, sea level pressure 1014.3 hPa, a trace of precipitation since 1156 PST, 6-hourly precipitation of a trace, temperature 12.8 °C, dew point temperature 10.6 °C, 3-hourly pressure decrease of 1.3 hPa.

KAJO weather at 1320 PST, automated, variable wind at 3 knots, 10 miles visibility, scattered clouds at 2,100 ft agl, broken ceiling at 3,700 ft agl, overcast clouds at 4,400 ft agl, temperature of 13 °C, dew point temperature of 10 °C, and an altimeter setting of 29.90 inHg. Remarks: automated station with a precipitation discriminator, rain ended at 1306 PST, a trace of precipitation since 1256 PST.

KAJO weather at 1349 PST, automated, variable wind at 4 knots, 10 miles visibility, light rain, broken ceiling at 2,300 ft agl, broken clouds at 2,800 ft agl, overcast clouds at 6,000 ft agl, temperature of 14 °C, dew point temperature of 10 °C, and an altimeter setting of 29.89 inHg. Remarks: automated station with a precipitation discriminator, rain ended at 1307 PST, rain began at 1347 PST, a trace of precipitation since 1256 PST.

KAJO weather at 1356 PST, automated, wind from 270° at 9 knots, 9 miles visibility, light rain, broken ceiling at 2,300 ft agl, overcast clouds at 2,800 ft agl, temperature of 13 °C, dew point temperature of 11 °C, and an altimeter setting of 29.89 inHg. Remarks: automated station with a precipitation discriminator, rain ended at 1307 PST, rain began at 1347 PST, sea level pressure 1013.8 hPa, a trace of precipitation since 1256 PST, temperature 13.3 °C, dew point temperature 10.6 °C.

Fullerton Municipal Airport (KFUL), Fullerton, California, was the departure airport located at an elevation of 96 ft, and was 10 miles west of the accident site (figure 7). KFUL had an Automated Surface Observing System (ASOS[6]) whose reports were supplemented by air traffic control (ATC) between 0700 and 2100 local time. The following observations were taken and disseminated during the times surrounding the accident:

[1115 PST] SPECI KFUL 031915Z 00000KT 3SM -RA BR FEW010 BKN034 OVC043 13/11 A2993 RMK AO2 P0003 T01280111=

[1153 PST] METAR KFUL 031953Z 00000KT 10SM FEW010 BKN040 OVC048 14/11 A2992 RMK AO2 RAE23 SLP132 P0003 T01390111=

[1217 PST] SPECI KFUL 032017Z VRB04KT 10SM SCT014 BKN020 OVC050 15/12 A2991 RMK AO2 T01500117=

[1233 PST] SPECI KFUL 032033Z 22009KT 2SM -RA BKN013 BKN020 OVC060 14/11 A2991 RMK AO2 RAB32 P0003 T01440111=

[1241 PST] SPECI KFUL 032041Z 22003KT 2SM -RA FEW013 BKN032 OVC060 14/11 A2990 RMK AO2 RAB32 P0005 T01390111=

[1253 PST] METAR KFUL 032053Z 21004KT 9SM -RA FEW017 BKN065 OVC075 14/11 A2990 RMK AO2 RAB32 SLP124 P0005 60018 T01390111 56015=

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[1353 PST] METAR KFUL 032153Z 23006KT 10SM SCT022 BKN041 OVC050 15/11 A2988 RMK AO2 RAE2057 SLP118 P0000 T01500106=

[1408 PST] SPECI KFUL 032208Z 29004KT 10SM FEW014 BKN020 OVC047 15/11 A2988 RMK AO2 T01500111=

[1427 PST] SPECI KFUL 032227Z 26005KT 10SM -RA SCT016 BKN036 OVC049 15/11 A2988 RMK AO2 RAB18 P0000 T01500111=

KFUL weather at 1241 PST, wind from 220° at 3 knots, 2 miles visibility, light rain, few clouds at 1,300 ft agl, broken ceiling at 3,200 ft agl, overcast clouds at 6,000 ft agl, temperature of 14 °C, dew point temperature of 11 °C, and an altimeter setting of 29.90 inHg. Remarks: automated station with a precipitation discriminator, rain began at 1232 PST, 0.05 inches of precipitation since 1153 PST, temperature 13.9 °C, dew point temperature 11.1 °C.

[6] ASOS – Automated Surface Observing System is equipped with meteorological instruments to observe and report wind, visibility, ceiling, temperature, dewpoint, altimeter, and barometric pressure.

KFUL weather at 1253 PST, wind from 210° at 4 knots, 9 miles visibility, light rain, few clouds at 1,700 ft agl, broken ceiling at 6,500 ft agl, overcast clouds at 7,500 ft agl, temperature of 14 °C, dew point temperature of 11 °C, and an altimeter setting of 29.90 inHg. Remarks: automated station with a precipitation discriminator, rain began at 1232 PST, sea level pressure 1012.4 hPa, 0.05 inches of rain since 1153 PST, 6-hourly precipitation of 0.18 inches, temperature 13.9 °C, dew point temperature 11.1 °C, 3-hourly pressure decrease of 1.5 hPa.

KFUL weather at 1353 PST, wind from 230° at 6 knots, 10 miles visibility, scattered clouds at 2,200 ft agl, broken ceiling at 4,100 ft agl, overcast clouds at 5,000 ft agl, temperature of 15 °C, dew point temperature of 11 °C, and an altimeter setting of 29.88 inHg. Remarks: automated station with a precipitation discriminator, rain ended at 1257 PST, sea level pressure 1011.8 hPa, a trace of precipitation since 1253 PST, temperature 15.0 °C, dew point temperature 10.6 °C.

KFUL weather at 1408 PST, wind from 290° at 4 knots, 10 miles visibility, few clouds at 1,400 ft agl, broken ceiling at 2,000 ft agl, overcast clouds at 4,700 ft agl, temperature of 15 °C, dew point temperature of 11 °C, and an altimeter setting of 29.88 inHg. Remarks: automated station with a precipitation discriminator, temperature 15.0 °C, dew point temperature 11.1 °C.

Chino Airport (KCNO), Chino, California, was the next closest airport located at an elevation of 650 ft, and was 10 miles northeast of the accident site (figure 7). KCNO had an ASOS whose reports were supplemented by air traffic control (ATC) between 0700 and 2100 local time. The following observations were taken and disseminated during the times surrounding the accident:

[1053 PST] METAR KCNO 031853Z 33005KT 4SM -RA BR FEW002 BKN023 OVC035 12/11 A2996 RMK AO2 SLP143 VIS 2 N NW P0000 T01220111=

[1153 PST] METAR KCNO 031953Z 00000KT 5SM HZ SCT012 BKN017 OVC055 14/11 A2994 RMK AO2 RAE1859B42E51 SLP135 P0000 T01390111=

[1216 PST] SPECI KCNO 032016Z 00000KT 1 1/2SM -RA FEW012 BKN017 OVC060 14/11 A2993 RMK AO2 RAB12 P0002 T01390111=

[1251 PST] SPECI KCNO 032051Z 23008KT 1 1/2SM -RA BR FEW009 BKN030 OVC041 13/12 A2992 RMK AO2 RAB12 P0009=

[1253 PST] METAR KCNO 032053Z 22006KT 1 1/2SM -RA BR SCT015 BKN030 OVC041 13/12 A2992 RMK AO2 RAB12 SLP129 P0009 60009 T01330122 58013=

[1318 PST] SPECI KCNO 032118Z 21005KT 4SM BR SCT015 BKN030 OVC041 13/13 A2990 RMK AO2 RAE18 P0001 T01330128=

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[1353 PST] METAR KCNO 032153Z 23008KT 5SM -RA BR FEW024 BKN049 OVC055 14/12 A2989 RMK AO2 RAE18B41 SLP122 P0001 T01390117=

[1406 PST] SPECI KCNO 032206Z 23010KT 2 1/2SM -RA BR FEW017 BKN022 OVC055 13/11 A2990 RMK AO2 P0001 T01330111=

[1453 PST] METAR KCNO 032253Z 19004KT 6SM BR FEW017 SCT030 OVC046 13/12 A2990 RMK AO2 RAE40 SLP122 P0003 T01330122=

KCNO weather at 1253 PST, wind from 220° at 6 knots, 1 1/2 miles visibility, light rain, mist, scattered clouds at 1,500 ft agl, broken ceiling at 3,000 ft agl, overcast clouds at 4,100 ft agl, temperature of 13 °C, dew point temperature of 12 °C, and an altimeter setting of 29.92 inHg. Remarks: automated station with a precipitation discriminator, rain began at 1212 PST, sea level pressure 1012.9 hPa, 0.09 inches of precipitation since 1153 PST, 6-hourly precipitation of 0.09 inches, temperature 13.3 °C, dew point temperature 12.2 °C, 3-hourly pressure decrease of 1.3 hPa.

KCNO weather at 1318 PST, wind from 210° at 5 knots, 4 miles visibility, mist, scattered clouds at 1,500 ft agl, broken ceiling at 3,000 ft agl, overcast clouds at 4,100 ft agl, temperature of 13 °C, dew point temperature of 13 °C, and an altimeter setting of 29.90 inHg. Remarks: automated station with a precipitation discriminator, rain ended at 1218 PST, 0.01 inches of rain since 1253 PST, temperature 13.3 °C, dew point temperature 12.8 °C.

KCNO weather at 1353 PST, wind from 230° at 8 knots, 5 miles visibility, light rain, mist, few clouds at 2,400 ft agl, broken ceiling at 4,900 ft agl, overcast clouds at 5,500 ft agl, temperature of 14 °C, dew point temperature of 12 °C, and an altimeter setting of 29.89 inHg. Remarks: automated station with a precipitation discriminator, rain ended at 1318 PST, rain began at 1341 PST, sea level pressure 1012.2 hPa, 0.01 inches of precipitation since 1253 PST, temperature 13.9 °C, dew point temperature 11.7 °C.

KCNO weather at 1406 PST, wind from 230° at 10 knots, 2 and a half miles visibility, few clouds at 1,700 ft agl, broken ceiling at 2,200 ft agl, overcast clouds at 5,500 ft agl, temperature of 13 °C, dew point temperature of 11 °C, and an altimeter setting of 29.90 inHg. Remarks: automated station with a precipitation discriminator, 0.01 inches of precipitation since 1353 PST, temperature 13.3 °C, dew point temperature 11.1 °C.

The observations from KAJO, KFUL, and KCNO surrounding the accident time indicated predominately MVFR[7] conditions with visibility conditions dropping into the IFR[8] category during the accident time period with light rain. Winds were mainly from the west to southwest between 5 and 10 knots. For more information including the 1- and 5-minute ASOS data from KFUL and KCNO please see attachments 1 and 2.

[7] Marginal Visual Flight Rules – Refers to the general weather conditions pilots can expect at the surface. MVFR criteria, which is a sub-category of VFR conditions, are a ceiling 1,000 to 3,000 ft agl and/or 3 to 5 miles visibility.
[8] Instrument Flight Rules (IFR) – Refers to the general weather conditions pilots can expect at the surface. IFR criteria means a ceiling below 1,000 ft agl and/or less than 3 miles visibility.

4.0 Upper Air Data

A High-Resolution Rapid Refresh (HRRR)[9] model sounding was created for the accident site for 1400 PST with station elevation of 397 ft.[10] The 1400 PST HRRR sounding was plotted on a standard Skew-T Log P diagram[11] with the derived stability parameters included in figure 8 with data from the surface to 600-hPa (or approximately 14,000 ft msl). This data was analyzed using the RAOB[12] software package. The sounding depicted the lifted condensation level (LCL)[13] at 627 ft agl (1,024 ft msl), the level of free convection (LFC)[14] at 632 ft agl (1,029 ft msl), and the convective condensation level (CCL)[15] at 1,608 ft agl (2,005 ft msl). The sounding had a greater than 90% relative humidity from the surface through 8,000 ft msl. The freezing level was located at 6,546 ft msl. The precipitable water value was 0.75 inches.

[9] The HRRR is a NOAA real-time three-kilometer resolution, hourly-updated, cloud-resolving, convection-allowing atmospheric model, initialized by three-kilometer grids with three-kilometer radar assimilation. Radar data is assimilated in the HRRR every 15 minutes over a one hour period.
[10] HRRR sounding was created using NOAA Air Resource Laboratory: https://ready.arl.noaa.gov/READYamet.php
[11] 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.
[12] RAOB – (The complete Rawinsonde Observation program) is an interactive sounding analysis program developed by Environmental Research Services, Matamoras, Pennsylvania.
[13] LCL - The height at which a parcel of moist air becomes saturated when it is lifted dry adiabatically.
[14] 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.
[15] CCL – The level in the atmosphere to which an air parcel, if heated from below, will rise dry adiabatically, without becoming colder than its environment just before the parcel becomes saturated.

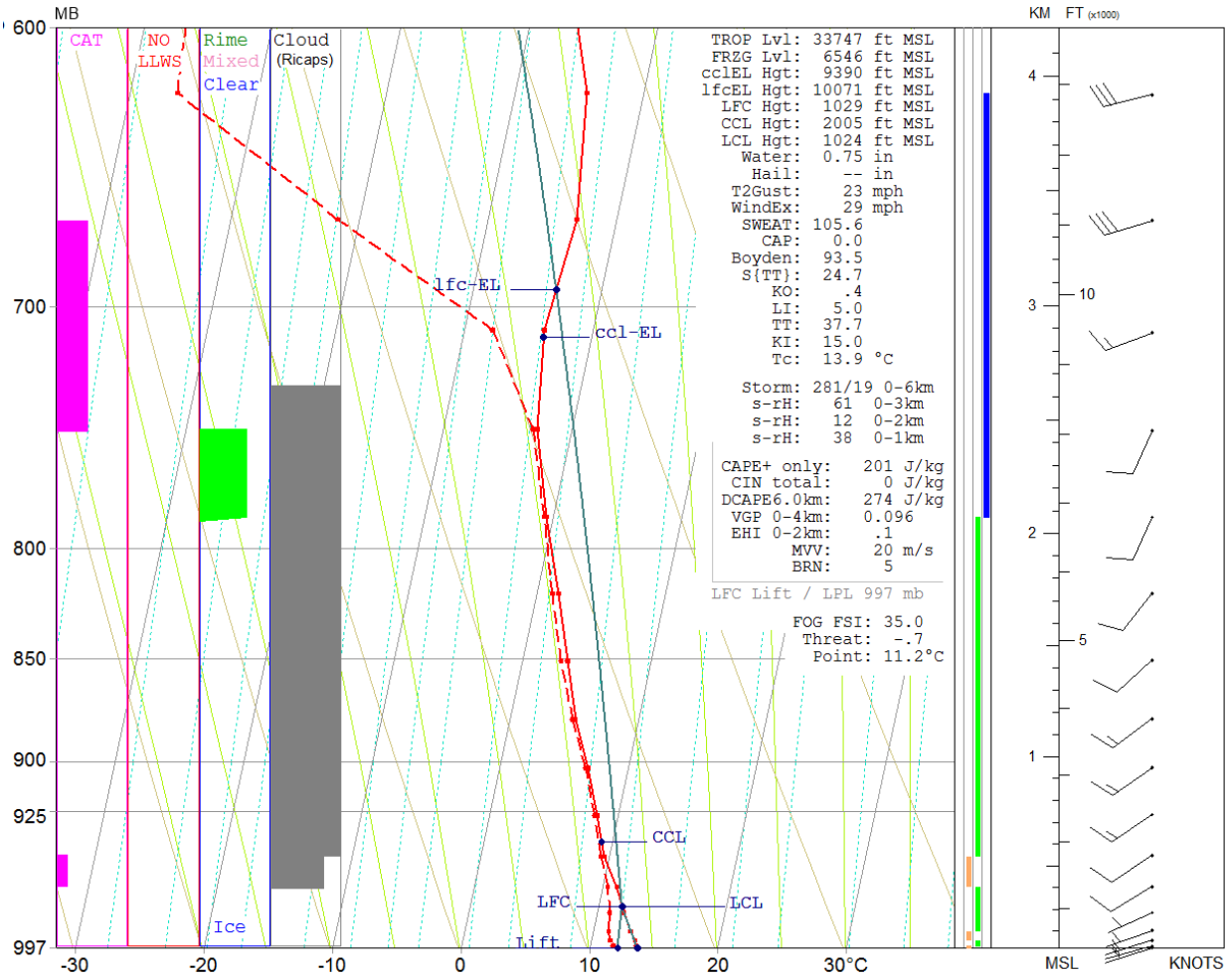


Figure 8 – 1400 PST HRRR sounding for the accident site

The 1400 PST HRRR sounding for the accident site indicated an unstable to conditionally unstable environment from the surface through 6,500 ft, with a stable layer above 6,500 ft through 14,000 ft. RAOB identified the possibility of clouds from 1,100 ft agl (~1,500 ft msl) through 9,000 ft msl. 201 Joules/kilogram (J/kg) of CAPE[16] were indicated on the sounding with the maximum vertical velocity (MVV) for this atmosphere was calculated as 20 meters/second (about 3,937 ft per minute).[17] Downdraft CAPE (DCAPE; 6 kilometers agl)[18] was measured at 274 J/kg. If rain showers or thunderstorms formed the 1400 PST HRRR sounding indicated the strongest wind speeds possible with a microburst, outflow boundary, or gust front would have been 23 mph (20 knots) as indicated by the T2 Gust parameter, or 29 mph (25 knots) as indicated by the WindEx parameter.

[16] Convective Available Potential Energy (CAPE) – CAPE is a measure of the amount of energy available for convection and is directly related to the maximum potential vertical speed within an updraft.

[17] MVV is not usually considered a realistic estimate for maximum vertical velocity in a storm. Anecdotes suggest considering a value of MVV/2, however it is not well understood when or where such a half-value should be applied.

[18] The DCAPE can be used to estimate the potential strength of rain-cooled downdrafts within thunderstorm convection, and is similar to CAPE. Larger DCAPE values are associated with stronger downdrafts.

The 1400 PST HRRR sounding wind profile indicated a surface wind from 251° at 3 knots with the wind remaining from the southwest through 5,000 ft msl. The wind speed increased to 15 knots by 2,000 ft msl. RAOB did not indicate the possibility of low-level wind shear (LLWS). RAOB indicated a small chance of light clear-air turbulence existed between 1,500 ft msl and 2,000 ft msl. The mean storm motion vector was from 281° at 19 knots.

5.0 Satellite Data

Data from the Geostationary Operational Environmental Satellite number 17 (GOES-17) 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 software. Visible and infrared (bands 2 and 13) imagery at wavelengths of 0.64 microns (μm) and 10.3 μm were retrieved for the period. Satellite imagery surrounding the time of the accident, from 1100 PST through 1700 PST at approximately 5-minute intervals were reviewed, and the closest images to the time of the accident are documented here.

Figures 9 and 10 present the GOES-17 visible imagery from 1330 and 1345 PST at 3X magnification with the accident site highlighted with a red square. The GOES-17 imagery indicated broken to overcast cloud cover above the accident site at the accident time with the cloud cover moving from southwest to northeast (attachments 3 and 4). The visible satellite imagery indicated several bands of cumuliform clouds moving across the region and over the accident site during the period.

Figure 11 presents the GOES-17 infrared imagery from 1345 PST at 6X magnification and with a temperature enhance curve applied with the accident site highlighted with a red square. Inspection of the infrared imagery indicated abundant cloud cover over the accident site at the accident time. The brightness temperatures were relatively uniform (red and orange colors) across and around the accident site at the accident time. Based on the brightness temperatures above the accident site (271° Kelvin) and the vertical temperature profile provided by the 1400 PST HRRR sounding, the approximate cloud-top heights over the accident site were 8,000 ft at 1345 PST. It should be noted these figures have not been corrected for any parallax error.

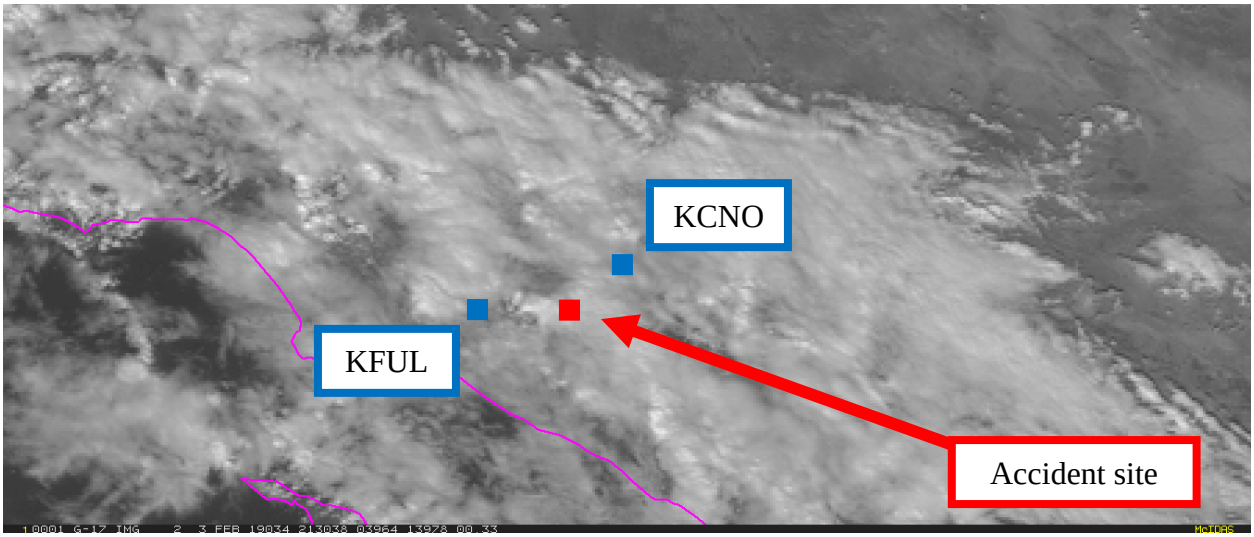


Figure 9 – GOES-17 visible image at 1330 PST

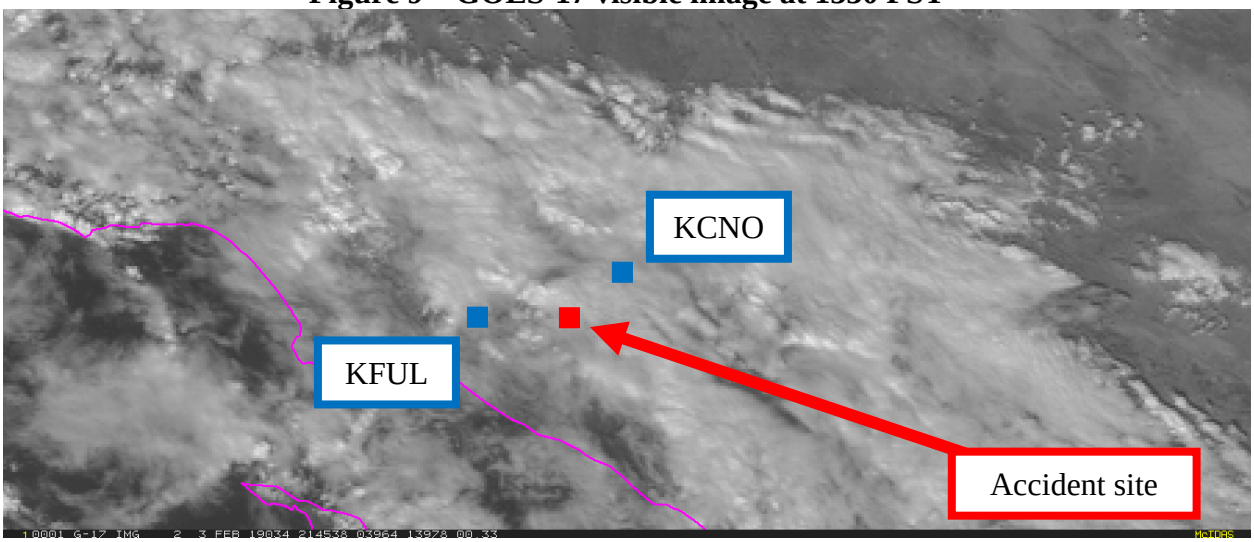


Figure 10 – GOES-17 visible image at 1345 PST

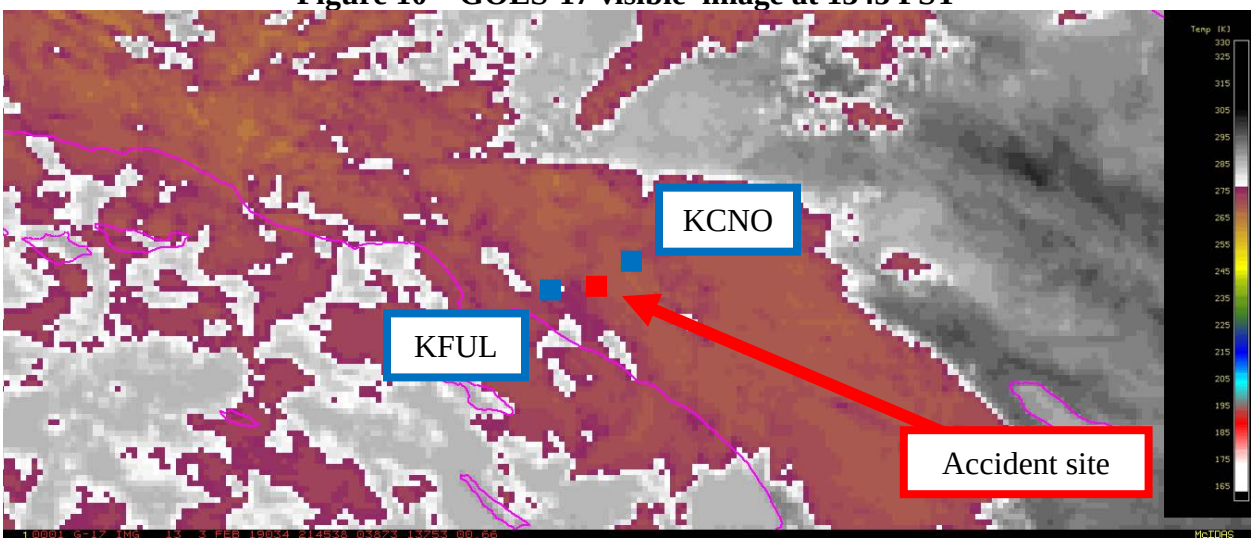


Figure 11 – GOES-17 infrared image at 1345 PST

6.0 Regional Radar Imagery Information

A regional view of the NWS National Composite Radar Mosaic is included as figure 12 for 1345 PST with the approximate accident site marked by a red circle. The image depicted no echoes above the accident site at the accident time.

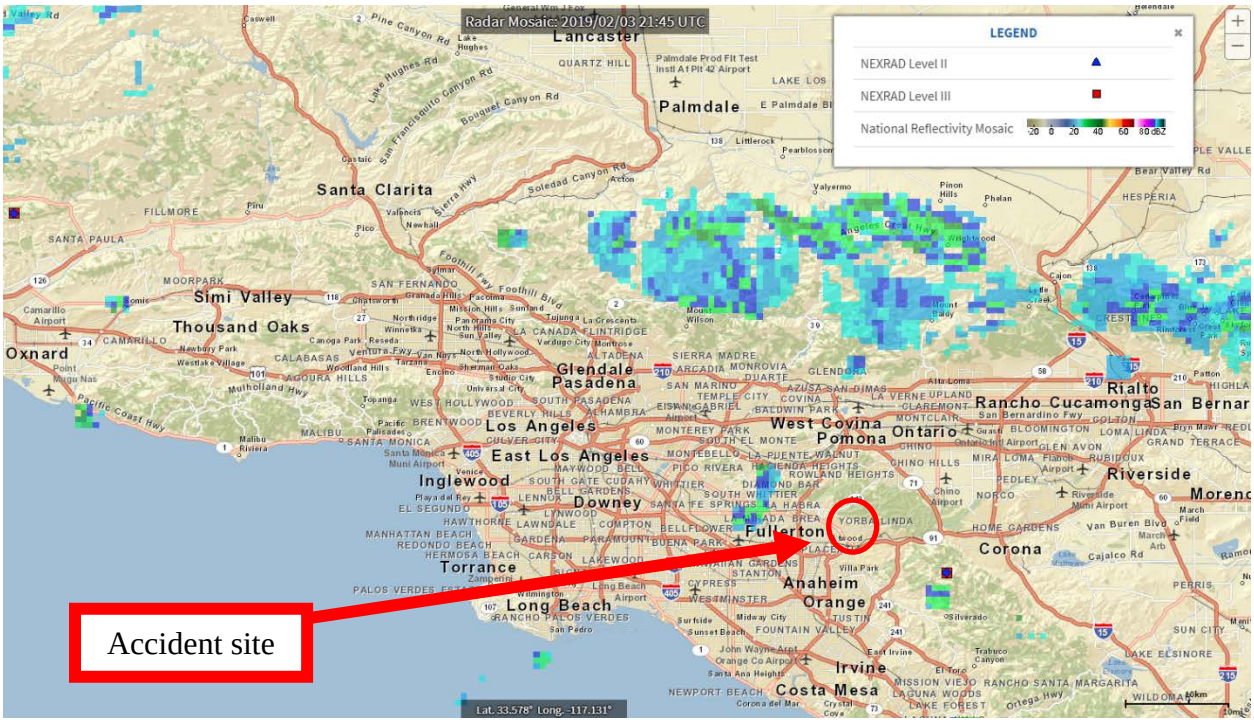


Figure 12 – Regional Composite Reflectivity image for 1345 PST

7.0 Radar Imagery Information

The closest NWS Weather Surveillance Radar-1988, Doppler (WSR-88D)[19] to the accident site was Santa Ana Mt, California, (KSOX) located 8 miles east-southeast of the accident site. At the time of the accident KSOX was down for maintenance due to a faulty part (attachments 5 and 6). Therefore data from the WSR-88D in San Diego, California, (KNKX) was reviewed and used in this accident as KNKX was the next closest WSR-88D, located 68 miles southeast of the accident site. Level II archive radar data was obtained from the NCEI utilizing the NEXRAD Data Inventory Search and displayed using the NOAA's Weather and Climate Toolkit software.

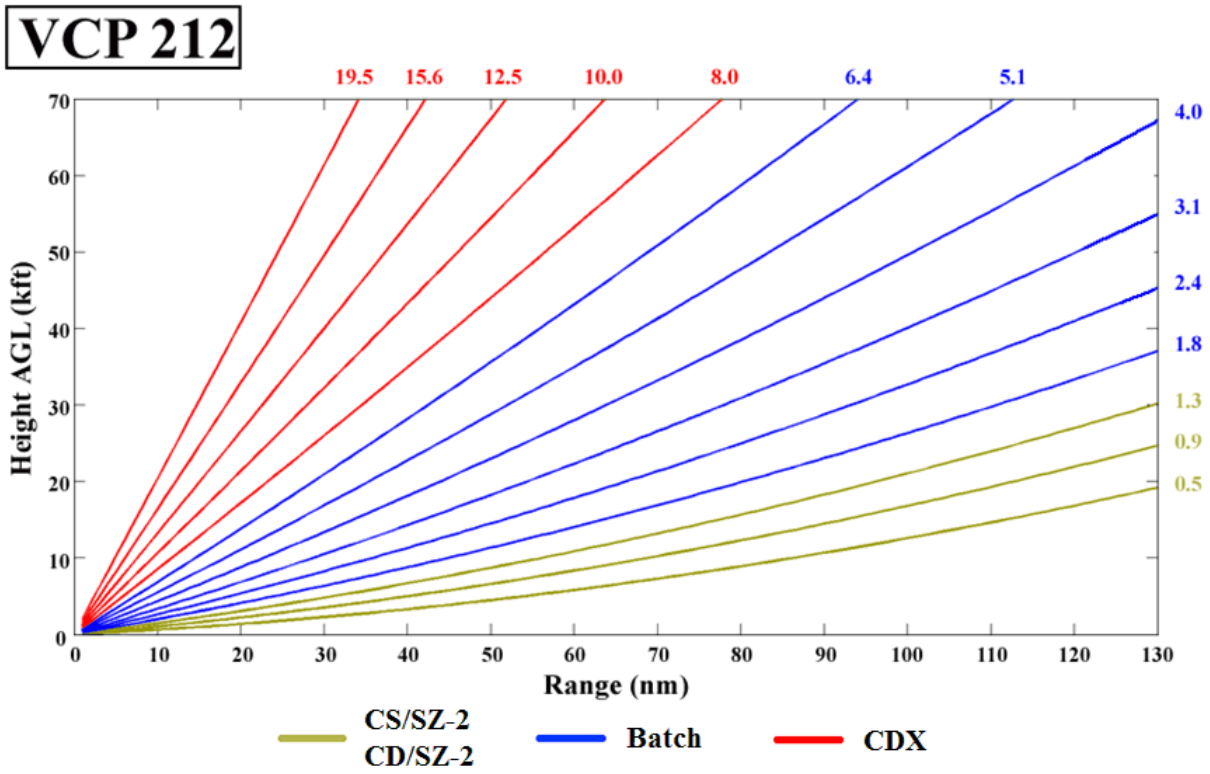
7.1 Volume Scan Strategy

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

[19] The WSR-88D is an S-band 10-centimeter wavelength radar with a power output of 750,000 watts, and with a 28-foot parabolic antenna that concentrates the energy between a 0.87° and 0.96° beam width. The radar produces three basic types of products: base reflectivity, base radial velocity, and base spectral width.

are immediately available. Products that require data from multiple elevation scans are not available until the end of the five to ten-minute volume scan.

The WSR-88D operates in several different scanning modes, identified as Mode A and Mode B. Mode A is the precipitation scan and has three common scanning strategies. The most common is where the radar makes 14 elevation scans from 0.5° to 19.5° every four and a half minutes. This particular scanning strategy is documented as volume coverage pattern 212 (VCP-212). Mode B is the clear-air mode, where the radar makes 5 elevation scans during a ten-minute period. During the period surrounding the accident, the KNKX WSR-88D radar was operating in the precipitation mode VCP-212. 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.



VCP-212 Precipitation Mode Scan Strategy[20]

[20] Contiguous Surveillance (CS)--The low Pulse Repetition Frequency (PRF) scan of the split cut. Gives a high R_{max} value to determine proper target location and intensity, but a low V_{max} value limits the velocities that can be measured. Contiguous Doppler (CD)--The high PRF scan of the split cut. Gives a low R_{max} value causing more range folded (multiple trip) echoes, but a high V_{max} value to get higher, more accurate velocity values.
Batch Mode – Uses alternating low and high PRFs on each radial for one full rotation at each elevation angle. The two resulting data sets (low PRF and high PRF) are combined to resolve range ambiguity. Used in the middle elevation angles.
W – With range unfolding (W)
WO – Without range unfolding (WO)

7.2 Beam Height Calculation

Assuming standard refraction[21] of the WSR-88D radar beam with the antenna elevation at 1,052 ft (KNKX), and considering a beamwidth[22] of 0.95°, the following table shows the approximate heights for the radar beam center, top and base for antenna elevations over the accident site. These heights have been rounded to the nearest 10 ft.

ANTENNA ELEVATION	BEAM CENTER	BEAM BASE	BEAM TOP
KNKX 0.5°	8,010 ft	4,660 ft	11,360 ft

Based on the radar height calculations, the elevation scan listed in the above table depicted the conditions between 4,660 ft and 11,360 ft msl over the accident site and these scans "saw" the closest altitudes to the ground and the accident aircraft's flight level.[23]

7.3 Reflectivity

Reflectivity is the measure of the efficiency of a target in intercepting and returning radio energy. With hydrometeors[24] 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 dBZ[25], and is a general measure of echo intensity. FAA Advisory Circular AC 00-24C[26], "Thunderstorms," dated February 19, 2013, also defines the echo intensity levels and weather radar echo intensity terminology associated with those levels. For dBZ values less than 30 the weather radar echo intensity terminology should be "light." For dBZ values between 30 and 40, the terminology should be "moderate." "Heavy" terminology is used for dBZ values greater than 40 dBZ but less than 50 dBZ, inclusive. Finally, any dBZ values above 50 dBZ shall be described as "extreme." From the NWS, precipitation conditions at the surface can be inferred from VIP Levels described in the chart below:

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

[22] Beamwidth - the angular separation between the half power points on the antenna radiation pattern, where the gain is one half the maximum value.

[23] For more information please see ATC data located in the docket of this accident.

[24] 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 glazed ice.

[25] dBZ – A non-dimensional "unit" of radar reflectivity which represents a logarithmic power ratio (in decibels , or dB) with respect to radar reflectivity factor, Z.

[26] https://www.faa.gov/regulations_policies/advisory_circulars/index.cfm/go/document.information/documentID/1020774

- VIP 1 (Level 1, 18-30 dBZ) - Light precipitation
- VIP 2 (Level 2, 30-38 dBZ) - Light to moderate rain
- VIP 3 (Level 3, 38-44 dBZ) - Moderate to heavy rain
- VIP 4 (Level 4, 44-50 dBZ) - Heavy rain
- VIP 5 (Level 5, 50-57 dBZ) - Very heavy rain; hail possible
- VIP 6 (Level 6, >57 dBZ) - Very heavy rain and hail; large hail possible

7.4 Base Reflectivity and Lightning Data

Figures 13, 14, 15, and 16 present the KNKX WSR-88D base reflectivity images for the 0.5° elevation scans initiated at 1335:39, 1339:40, 1343:21, and 1347:02 PST, respectively, with a resolution of 0.5° X 250 m. Reflectivity values between 10 and 25 dBZ or very light intensity echoes were located above the accident site at the accident time and along the accident aircraft's flight track (pink line). The reflectivity bands were moving from southwest to northeast (attachment 7).

There were no lightning strikes around the last ATC target point at the accident time.[27]

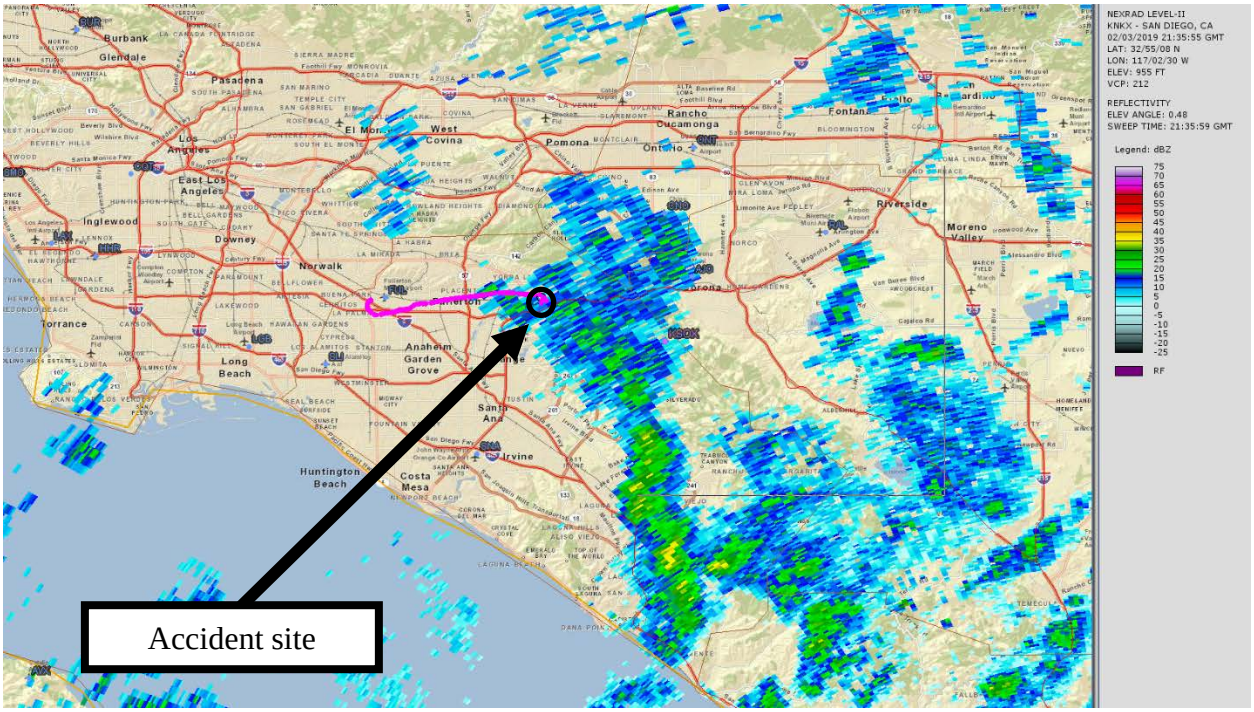


Figure 13 – KNKX WSR-88D reflectivity for the 0.5° elevation scan initiated at 1335:59 PST with the accident site marked with black circle, the accident flight track in pink

[27] A review of Earth Networks Total Lightning network was done.

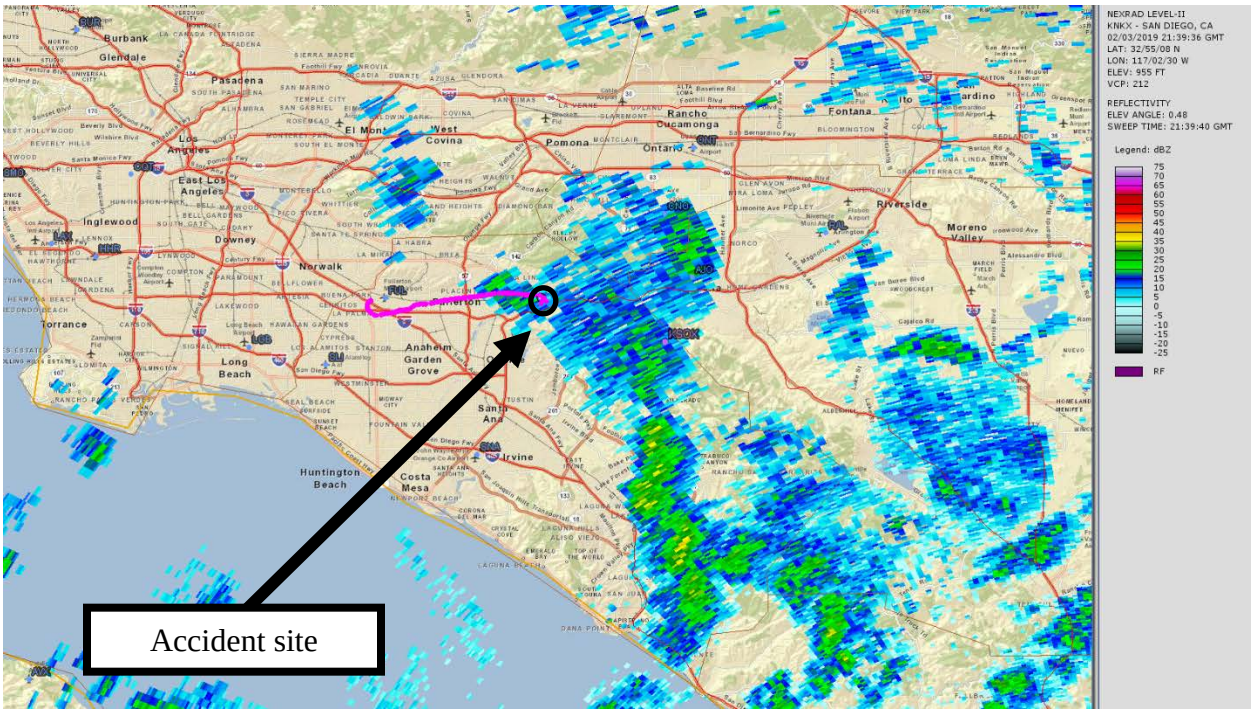


Figure 14 – KNKX WSR-88D reflectivity for the 0.5° elevation scan initiated at 1339:40 PST with the accident site marked with black circle, the accident flight track in pink

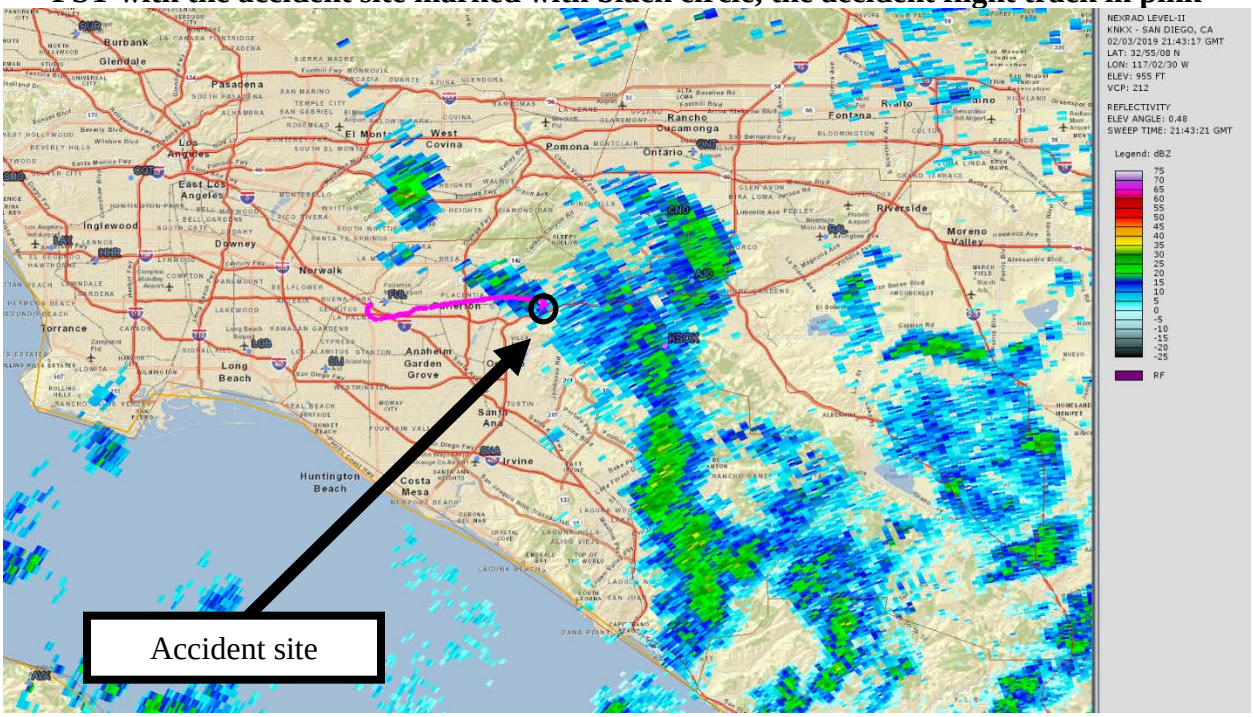


Figure 15 – KNKX WSR-88D reflectivity for the 0.5° elevation scan initiated at 1343:21 PST with the accident site marked with black circle, the accident flight track in pink

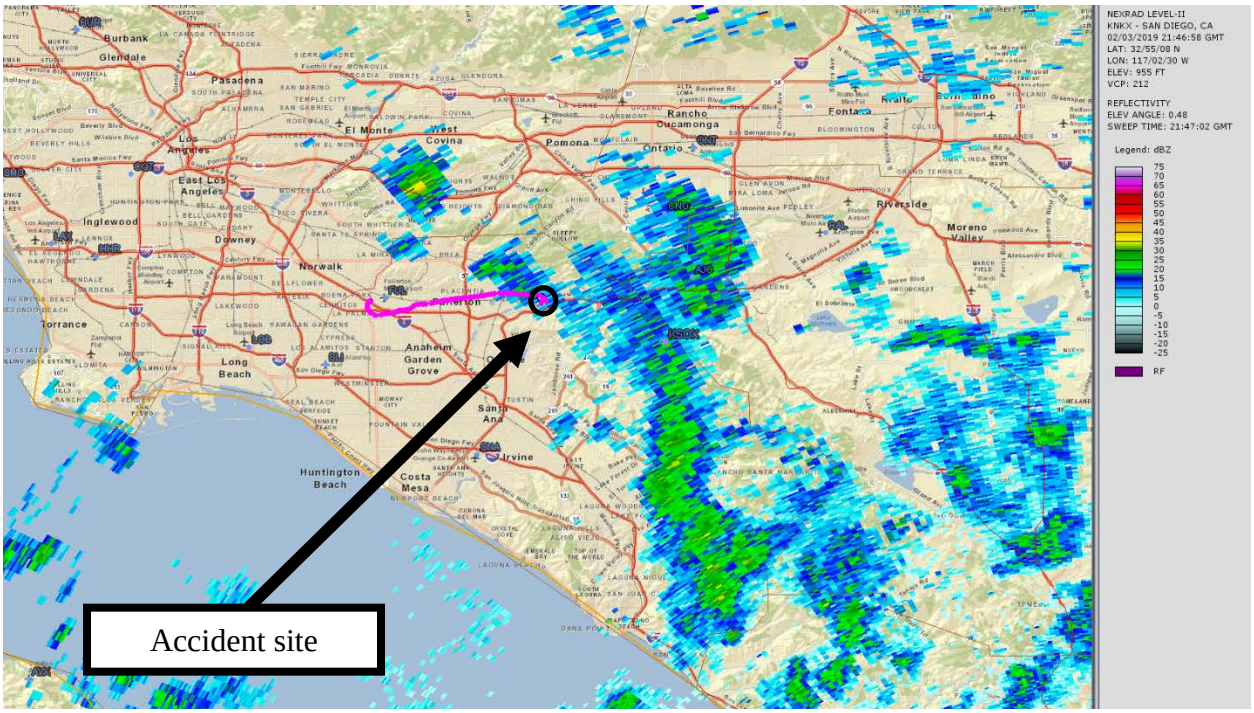


Figure 16 – KNKX WSR-88D reflectivity for the 0.5° elevation scan initiated at 1347:02 PST with the accident site marked with black circle, the accident flight track in pink

8.0 Pilot Reports[28]

All pilot reports (PIREPs) within 80 miles of the accident site in California from about two hours prior to the accident time to about one hour after the accident time for below FL200[29] are provided below:

RIV UA /OV HDF/TM 1945/FL095/TP P28R/TA 05/IC LGT RIME/RM COR SA-ID AND TEMP. ZLA CWSU

CRQ UA /OV CRQ/TM 1957/FL090/TP GLF4/SK OVC017-TOP090/RM COR SKY. ZLA CWSU

RNM UA /OV RNM270004/TM 2000/FL035/TP C172/SK BKN035/RM COR SKY. ZLA CWSU

SNA UA /OV KSNA/TM 2005/FL090/TP B757/SK OVC-TOP090/RM COR SKY. ZLA CWSU

SMO UA /OV SMO030004/TM 2015/FLUNKN/TP C510/SK SCT013/RM DURD. COR ALT. ZLA CWSU

SNA UA /OV KSNA/TM 2020/FL039/TP B737/SK BKN039/RM COR SKY. ZLA CWSU

CNO UA /OV CNO/TM 2020/FL020/TP BE58/TB LT TB

[28] Only pilot reports with the World Meteorological Organization (WMO) header UBCA**, UBNV**, and UBAZ** identifier were considered.

[29] Flight Level – A Flight Level (FL) is a standard nominal altitude of an aircraft, in hundreds of ft. This altitude is calculated from the International standard pressure datum of 1013.25-hPa (29.92 inHg), the average sea-level pressure, and therefore is not necessarily the same as the aircraft's true altitude either above mean sea level or above ground level.

LAX UA /OV 3354N 11827W/TM 2028/FL092/TP A320/SK OVC-TOP092/RM OV PYPES. HHR-LGB AREA RPTD VIA TOPMM SID. COR LOCTN AND ALT AND SKY. ZLA CWSU

CNO UA /OV CNO/TM 2048/FL020/TP M20P/SK BKN013-TOPUNKN/WX FV01SM/TB NEG/RM DURD RY26R CNO. BRAKING ACTION GOOD

TOA UA /OV TOA090004/TM 2059/FL020/TP C182/SK OVC020

LAX UUA /OV LAX060001/TM 2104/FL003/TP B738/RM LLWS +/- 10KTS RWY 24R

LAX UA /OV LAX060003/TM 2201/FL010/TP CRJ7/SK BKN010

VNY UA /OV APPROACH 16R/TM 2245/FL025/TP CL35/SK BASES REPORTED AT 025

The reports in plain language taken from standard code and abbreviations, with cloud heights in msl, and time converted to local were as follows:

Routine pilot report (UA) March Air Reserve Base (RIV); Over - Riverside, (HDF); Time – 1145 PST (1945Z); Altitude – 9,500 ft; Type aircraft – Piper PA-28 Cherokee; Temperature – 5 °C; Icing – Light rime; Remarks – Corrected station, identifier, and temperature. From Los Angeles Air Route Traffic Control Center (ZLA) Center Weather Service Unit (CWSU).

Routine pilot report (UA) Mc Clellan-Palomar Airport (CRQ); Over - CRQ; Time – 1157 PST (1957Z); Altitude – 9,000 ft; Type aircraft – Gulfstream IV; Sky – Overcast clouds at 1,700 ft with tops at 9,000 ft; Remarks – Corrected sky. From ZLA CWSU.

Routine pilot report (UA) Ramona Airport (RNM); Over - 4 miles from RNM on the 270° radial; Time – 1200 PST (2000Z); Altitude – 3,500 ft; Type aircraft – Cessna 172; Sky – Broken clouds at 3,500 ft; Remarks – Corrected sky. From ZLA CWSU.

Routine pilot report (UA) John Wayne-Orange County Airport (SNA); Over - SNA; Time – 1205 PST (2005Z); Altitude – 9,000 ft; Type aircraft – Boeing 757; Sky – Overcast clouds with tops at 9,000 ft; Remarks – Corrected sky. From ZLA CWSU.

Routine pilot report (UA) Santa Monica Municipal Airport (SMO); Over - 4 miles from SMO on the 030° radial; Time – 1215 PST (2015Z); Altitude – Unknown; Type aircraft – Cessna Citation Mustang; Sky – Scattered clouds at 1,300 ft; Remarks – During descent. Corrected altitude. From ZLA CWSU.

Routine pilot report (UA) SNA; Over - SNA; Time – 1220 PST (2020Z); Altitude – 3,900 ft; Type aircraft – Boeing 737-700; Sky – Broken clouds at 3,900 ft; Remarks – Corrected sky. From ZLA CWSU.

Routine pilot report (UA) Chino Airport (CNO); Over - CNO; Time – 1220 PST (2020Z); Altitude – 2,000 ft; Type aircraft – Beechcraft Baron; Turbulence – Light turbulence.

Routine pilot report (UA) Los Angeles International Airport (LAX); Over - 33° 54 minutes north, 118° 27 minutes west; Time – 1228 PST (2028Z); Altitude – 9,200 ft; Type aircraft – Airbus A320; Sky – Overcast skies with tops at 9,200 ft; Remarks – Over PYPES. Hawthrone (HHR)

through Long Beach (LGB) area reported via tops missing SID. Corrected location and altitude and sky. From ZLA CWSU.

Routine pilot report (UA) CNO; Over - CNO; Time – 1248 PST (2048Z); Altitude – 2,000 ft; Type aircraft – Mooney M20; Sky – Broken clouds at 1,300 ft with tops at unknown level; Weather – Flight visibility 1 statute mile; Turbulence – Negative; Remarks – During descent into Runway 26R at CNO. Braking action good.

Routine pilot report (UA) Zamperini Field Airport (TOA); Over - 4 miles from TOA on the 090° radial; Time – 1259 PST (2059Z); Altitude – 2,000 ft; Type aircraft – Cessna 182; Sky – Overcast clouds at 2,000 ft.

Urgent pilot report (UUA) LAX; Over - 1 mile from LAX on the 060° radial; Time – 1304 PST (2104Z); Altitude – 300 ft; Type aircraft – Boeing 737-800; Remarks – LLWS +/- 10 knots on approach to runway 24R.

Routine pilot report (UA) LAX; Over - 3 miles from LAX on the 060° radial; Time – 1401 PST (2201Z); Altitude – 1,000 ft; Type aircraft – Bombardier CRJ700; Sky – Broken clouds at 1,000 ft.

Routine pilot report (UA) Van Nuys Airport (VNY); Over - approach to runway 16R; Time – 1445 PST (2245Z); Altitude – 2,500 ft; Type aircraft – Bombardier Challenger 300; Sky – Bases reported at 2,500 ft.

9.0 SIGMET

There were no convective or non-convective Significant Meteorological Information (SIGMET) advisories valid for the accident site at the accident time.

10.0 CWSU Advisories

No CWSU Center Weather Advisories (CWA) or Meteorological Impact Statements (MIS) were valid for the accident site at the accident time.

11.0 AIRMETs

There were Airmen's Meteorological Information (AIRMET) advisories Tango and Sierra that was valid for the area that included the accident site. The 1245 PST AIRMETs warned of moderate turbulence below 12,000 ft and mountain obscuration conditions due to clouds, precipitation and mist:

WAUS46 KKCI 032045
WA6T
-SFOT WA 032045
AIRMET TANGO UPDT 6 FOR TURB VALID UNTIL 040300
.
AIRMET TURB...WA OR ID MT WY NV UT CO NM
FROM 40NW HVR TO 50NNW ISN TO 70SW RAP TO BFF TO GLD TO 20ESE

TBE TO FTI TO 20NW ABQ TO MTU TO 40SE LKV TO 50NNW EPH TO 20NNW
HLN TO 40NW HVR
MOD TURB BTN FL180 AND FL390. CONDS CONTG BYD 03Z ENDG BY 06Z.
.
AIRMET TURB...CA NV AND CSTL WTRS
FROM 50NNW RBL TO 70S BAM TO BTY TO 40NNW HEC TO EHF TO 30ENE
MOD TO 140WSW SNS TO 130WSW ENI TO 50NNW RBL
MOD TURB BTN FL180 AND FL390. CONDS CONTG BYD 03Z THRU 09Z.
.
AIRMET TURB...CA AND CSTL WTRS
FROM 40NNW FMG TO 40SSW FMG TO EED TO BZA TO 20SE MZB TO RZS TO 30W ENI TO 40SSW RBL TO 40NNW FMG
MOD TURB BLW 120. CONDS CONTG BYD 03Z THRU 09Z.
.
AIRMET TURB...WA OR AND CSTL WTRS
FROM 40WSW YDC TO 60NW EPH TO 20SSE EPH TO 60SSW GEG TO 30NNE
BKE TO 80SW BKE TO 30SW DSD TO 30S ONP TO HQM TO TOU TO 30W HUH
TO 40WSW YDC
MOD TURB BLW 140. CONDS ENDG 00-03Z.
.
OTLK VALID 0300-0900Z
AREA 1...TURB OR CA ID WY NV UT CO AZ NM AND CSTL WTRS
BOUNDED BY 20NW DDY-20NW BFF-GLD-50NNW CME-140SW SNS-140WSW FOT-50NNW RBL-30NE TWF-20NW DDY
MOD TURB BTN FL180 AND FL390. CONDS CONTG THRU 09Z.
.
AREA 2...TURB WA OR AND CSTL WTRS
BOUNDED BY 20NW YDC-40SSE SEA-BTG-60WNW ONP-30NW TOU-20NW YDC
MOD TURB BTN FL240 AND FL370. CONDS DVLPG 03-06Z. CONDS CONTG
THRU 09Z.
....

WAUS46 KKCI 032045
WA6S
-SFOS WA 032045
AIRMET SIERRA UPDT 5 FOR IFR AND MTN OBSCN VALID UNTIL 040300
.
AIRMET IFR...WA OR ID MT WY
FROM 20SW YXC TO 50NNW ISN TO 70SW RAP TO 20NW DDY TO 20NE DNJ
TO 70E DSD TO 60NNE DSD TO 30W YKM TO 20SW YXC
CIG BLW 010/VIS BLW 3SM PCPN/BR/FG. CONDS CONTG BYD 03Z THRU 09Z.
.
AIRMET IFR...OR CA
FROM 20W LKV TO 70SE LKV TO 30SSW FMG TO 20S OAL TO 30NNW EHF TO
20S ENI TO 40S FOT TO 40W OED TO 20W LKV
CIG BLW 010/VIS BLW 3SM PCPN/BR. CONDS CONTG BYD 03Z THRU 09Z.
.
AIRMET MTN OBSCN...WA OR CA
FROM 50WSW YXC TO 50SE REO TO 40SE LKV TO 40SSW FMG TO 20SSW LAS TO 30SE HEC TO 30WSW BZA TO 20SE MZB TO 20SE LAX TO 30WSW RZS TO 40WSW ENI TO 20SW FOT TO HQM TO TOU TO 20E HUH TO 50WSW YXC
MTNS OBSC BY CLDS/PCPN/BR. CONDS CONTG BYD 03Z THRU 09Z.
.
OTLK VALID 0300-0900Z...IFR WA OR ID MT WY NV UT CO
BOUNDED BY 40SW YXC-50NNW ISN-70SW RAP-40SSW BOY-50ENE SLC-50E
BAM-60ESE DSD-60WSW PDT-20WSW YKM-40SW YXC

CIG BLW 010/VIS BLW 3SM PCPN/BR/FG. CONDS CONTG THRU 09Z.
....

12.0 Graphical Forecasts for Aviation

The Graphical Forecasts for Aviation (GFA) products made available before the accident flight are shown in attachment 8. The GFA surface forecast products indicated MVFR to IFR conditions near the mountainous terrain with VFR[30] conditions to the south of the mountains in the Los Angeles Basin. Rain showers were indicated as likely (greater than 60 percent chance) for both 1000 and 1300 PST with a surface wind from the southwest at 5 to 10 knots. The GFA cloud forecast products indicated a cloud ceiling between 2,800 and 3,000 ft msl with cloud tops to 9,000 ft msl. For more information please see attachment 8.

13.0 Terminal Aerodrome Forecast

SNA/KSNA was the closest site with a NWS Terminal Aerodrome Forecast (TAF). KSNA was located 12 miles south-southwest of the accident site. The KSNA TAF valid at the accident time was issued at 1155 PST and was valid for a 22-hour period beginning at 1200 PST. The 1155 PST TAF for KSNA was as follows:

KSNA 021955Z 0220/0318 **15022G38KT 2SM RA FEW020 BKN050**
FM030300 22008KT P6SM -SHRA BKN020 OVC035
FM030600 VRB05KT P6SM VCSH SCT035 BKN060
FM031600 20010G17KT P6SM OVC050=

The TAF expected a wind from 150 at 22 knots with gusts to 38 knots, 2 miles visibility, moderate rain, a few clouds at 2,000 ft agl, and a broken ceiling at 5,000 ft agl. The Long Beach Airport (KLGB) had a similar TAF before the accident time and before departure by the accident aircraft from KFUL. KLGB TAF would have been the closest NWS TAF to the departure airport of KFUL.

14.0 NWS Area Forecast Discussion

The NWS Office in San Diego, California, issued the following Area Forecast Discussion (AFD) at 1000 PST (closest AFD to the accident time with an aviation section). The aviation section of the AFD discussed ceilings between 2,500 and 5,000 ft msl with tops to 7,000 ft msl and isolated to scattered rain shower activity. The coastal mountain slopes were forecast to remain obscured:

FXUS66 KSGX 031800
AFDSGX

Area Forecast Discussion
National Weather Service San Diego CA
1000 AM PST Sun Feb 3 2019

[30] Visual Flight Rules – Refers to the general weather conditions pilots can expect at the surface. VFR criteria means a ceiling greater than 3,000 feet agl and greater than 6 miles visibility.

.SYNOPSIS...
Cool and showery weather will continue through Wednesday. Showers will be most numerous Monday and Tuesday nights. Periods of light snow will continue over the higher mountains, with possible heavier snowfall returning Monday night though early Wednesday morning while snow levels lower. It will be cool all week, but fair and dry conditions Thursday and Friday should lead to slightly warmer weather then. Another chance for showers returns next weekend.

&&

.DISCUSSION...FOR EXTREME SOUTHWESTERN CALIFORNIA INCLUDING ORANGE... SAN DIEGO...WESTERN RIVERSIDE AND SOUTHWESTERN SAN BERNARDINO COUNTIES...

...Update...

Moist, cyclonic flow continues. This will continue a cool weather regime along with scattered showers. The showers will be most prevalent and more persistent along the coastal mountain slopes of the San Bernardinos due to continued upslope wind flow. There are more showers upstream on radar to the west and indications are that an uptick in shower activity will occur later this afternoon and tonight. Nothing heavy, but fairly persistent in the mountains and more scattered from the coast to the valleys. Amounts will not be heavy, but snow will continue to accumulate above 6000 FT, leading to slippery travel conditions. Additional snowfall accumulations in the Big Bear area are forecast to range from 2-5" through tonight, highest at ski resort level.

Latest rainfall and snowfall reports as well as peak wind gusts on Saturday and storm reports are all headlined on our webpage at weather.gov/sandiego

...Previous Discussion (Issued at 316 AM PST Sun Feb 3 2019)...

At 3 AM PST...radar still showed isolated, light showers around SoCal, most numerous to the north and brushing San Bernardino County. Over the past hour the only precip accumulation being reported was near the mountain slopes. The freezing level was near 5500 feet, so some light snow was likely falling above that in the San Bernardino Mts. Most wind gust reports had fallen below 35 MPH except in the San Diego Mts where a few sites still had peak gusts between 40 and 60 MPH. Strong sfc pressure gradients continued from KSAN to SW NV at around 13 MBS.

A broad low pressure trough will persist over the far EastPac and West Coast through next week. Numerous waves will amplify through the trough with cyclonic flow aloft continuing over SoCal. The stronger impulses will enhance the shower activity at times, while cooler than normal conditions prevail. For now it appears that shower enhancement will occur on Mon/Tue nights. This will be followed by a dry period Thu/Fri. The trough strengthens again next weekend as a strong wave moves through it, but the operational

GFS/ECMWF model solutions are not in agreement with the timing and strength. This has resulted in low POPS spread across the weekend period.

With all of the persistent shower activity, We will have a shot at another one to 1.5 inches of rain across the coast and valley areas, perhaps another one-quarter to one-half inch in the deserts,and 2 to 4 inches of liquid equivalent in the mountains by the time all this is over sometime Wednesday.

The main concern will be for wintry weather, especially over the higher mountains. A winter Storm Warning remains in place over the San Bernardino Mts, with a Winter Weather Advisory over the Riverside County Mts through early Wednesday. While periods of light snow will continue, true Winter Storm conditions may be elusive until late Monday or Monday night when southwest winds are forecast to increase and snow showers to become more numerous and heavier. The snow level is forecast to hold around 5500 to 6000 feet through Monday, then fall from near 5500 feet Mon night, to around 3000 feet early Wed morning. Rough snowfall estimates through Monday morning of around 4 to 8 inches in the most populated areas, should increase to 10 to 20 inches late Monday through early Wednesday as snowfall increases. In the coldest and wettest areas, the snow will be measured in feet by the time Wednesday rolls around. Even the San Diego Mountains should get some snow by late Tuesday as the snow level falls.

&&

.AVIATION...
031625Z...ISO-SCT showers continuing over and west of the mountains and occasionally in the high desert through Monday morning. CIGS generally 2500-5000ft MSL with tops to 7000 ft MSL...rising to 10000 ft MSL Monday morning. CIGS possibly lowering to 2500 ft MSL in SHRA with vis 4-6 SM. Coastal mountain slopes will remain obscured.

Low deserts: FEW-SCT clouds AOA 6000 ft MSL and unrestricted vis through Monday morning.

&&

.MARINE...
Combined seas will build to 7-12 ft this morning, then subside tonight. A Small Craft Advisory is in effect through 9 PM this evening for large seas.

Southwest winds will increase Monday night through Wednesday evening with gusts near 20 kt.

&&

.BEACHES...
A long period west swell of 10-11 ft/14-15 sec from 280 degrees will generate surf of 4-7 ft with locally higher sets in Orange County and 5-8 ft with sets to 10 ft in San Diego County. A High Surf Advisory is in effect until 11 AM Monday. Strong rip currents are

likely. Swell and surf will subside through the day Monday.

&&

.SKYWARN...
Skywarn activation is not requested. However weather spotters are
encouraged to report significant weather conditions.

&&

.SGX WATCHES/WARNINGS/ADVISORIES...
CA...Winter Storm Warning until 4 AM PST Wednesday for San Bernardino
County Mountains.

Winter Weather Advisory until 4 AM PST Wednesday for Riverside
County Mountains.

Beach Hazards Statement until 6 AM PST Sunday for Orange County
Coastal Areas-San Diego County Coastal Areas.

High Surf Advisory from 6 AM Sunday to 11 AM PST Monday for
Orange County Coastal Areas-San Diego County Coastal Areas.

PZ...Small Craft Advisory until 10 AM PST Sunday for Waters from San
Mateo point to the Mexican Border Extending 30 to 60 nm out
including San Clemente Island.
&&

$$

15.0 Winds and Temperature Aloft Forecast

The NWS 1159 PST Winds and Temperature Aloft forecast valid for 1600 PST for the closest point to the accident site is included below:

```
FBUS31 KWNO 031959
FD1US1
DATA BASED ON 031800Z
VALID 040000Z   FOR USE 2000-0300Z. TEMPS NEG ABV 24000

FT  3000    6000    9000   12000   18000   24000  30000  34000  39000
ONT 2316 2419+01 2521-04 2532-03 2545-16 2658-29 278943 760052 268750
```

The accident site was closest to the Ontario, California, (ONT) forecast point. The ONT forecast for use between 1200 PST and 1900 PST indicated a wind at 3,000 ft from 230° at 16 knots, at 6,000 ft a wind from 240° at 19 knots with a temperature of 1 °C, and at 9,000 ft a wind from 250° at 21 knots with a temperature of -4 °C.

16.0 Pilot Weather Briefing

The accident pilot did not request a weather briefing through Leidos, or through ForeFlight, or any other documented weather vendors. It is unknown if the accident pilot checked or received any weather information before or during the accident flight.

17.0 Astronomical Data

The astronomical data obtained from the United States Naval Observatory for the accident site on February 3, 2019, indicated the following:

SUN	
Begin civil twilight	0620 PST
Sunrise	0646 PST
Sun transit	1205 PST
Accident	**1345 PST**[31]
Sunset	1724 PST
End civil twilight	1750 PST

E. LIST OF ATTACHMENTS

Attachment 1 – 1- and 5-minute ASOS data from KFUL

Attachment 2 – 1- and 5-minute ASOS data from KCNO

Attachment 3 – GOES-17 visible animation from 1300 through 1500 PST

Attachment 4 – GOES-16 visible animation from 1247 through 1447 PST

Attachment 5 – Correspondence with NWS regarding why KSOX was down due to maintenance part 1

Attachment 6 – Correspondence with NWS regarding why KSOX was down due to maintenance part 1

Attachment 7 – KNKX WSR-88D base reflectivity animation from 1328 to 1350 PST

Attachment 8 – GFA products available before the accident flight for around the accident time

[31] Inserted accident time for reference and context.

Submitted by:

_____

Paul Suffern
Senior Meteorologist

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