



NATIONAL TRANSPORTATION SAFETY BOARD

Office of Aviation Safety
Washington, D.C. 20594

October 27, 2021

Specialist's Factual Report

METEOROLOGY

WPR20LA169

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A. ACCIDENT

Location: Redlands, California
Date: June 5, 2020
Time: 0801 Pacific daylight time
1501 coordinated universal time (UTC)
Airplane: Cessna 175; Registration: N9217B

B. METEOROLOGIST SPECIALIST

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

C. SUMMARY

On June 5, 2020, about 0801 Pacific daylight time, a Cessna 175, N9217B, was substantially damaged when it was involved in an accident near Redlands, California. The pilot and two passengers were fatally injured. The airplane was operated as a Title 14 *Code of Federal Regulations* Part 91 personal flight.

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 Pacific daylight time (PDT) based upon the 24-hour clock, local time is +7 hours to UTC, and UTC=Z. Directions are referenced to true north and distances in nautical miles. Heights are in feet (ft) above mean sea level (msl) unless otherwise noted. Visibility is in statute miles and fractions of statute miles.

This report provides a meteorological review on the weather conditions and NWS aviation weather products applicable to the region around the accident time. The accident site was based on the coordinates at latitude 34.064723° N and longitude 117.080001° W at an elevation of approximately 2,875 ft, which was near the ridge on Crafton Hills and within ½ mile of Zanja Peak at 3,543 ft.

E. WEATHER INFORMATION

1.0 Synoptic Conditions

The synoptic or large-scale migratory weather systems influencing the area were documented using standard NWS charts issued by the National Center for Environmental Prediction (NCEP) located in College Park, Maryland. These are the base products used in describing weather features and in the creation of forecasts and warnings. Reference to these charts and other weather products documented in this report can be found in the joint NWS and Federal Aviation Administration (FAA) Advisory Circular “Aviation Weather Services”, AC 00-45H change 2.

1.1 Surface Analysis Chart

The NWS Surface Analysis Chart for the southwest for 0800 PDT is included as figure 1 with the approximate accident site marked by a red star.

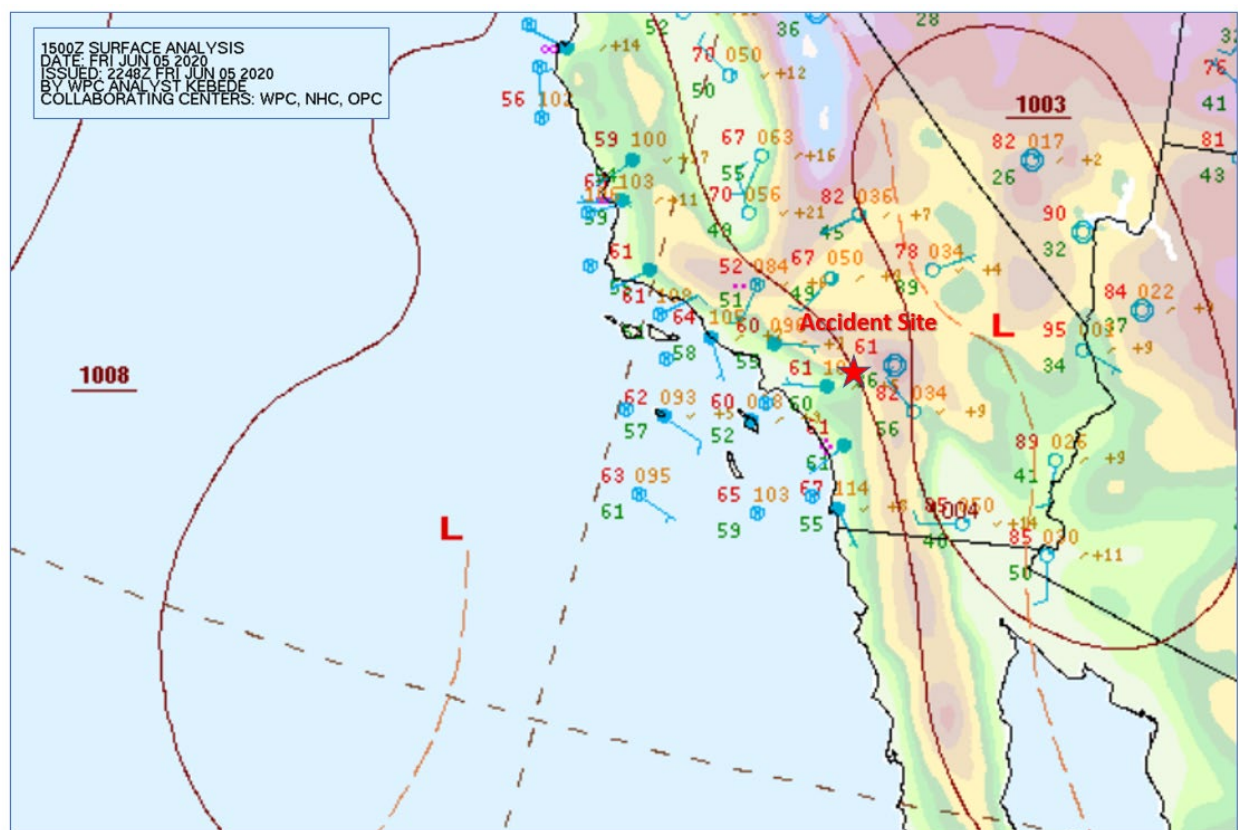


Figure 1 - Southwest section of the Surface Analysis Chart for 0800 PDT with approximate accident site

The surface analysis chart depicted a thermal low-pressure system¹ at 1003-hectopascals (hPa) over southeast California near the Arizona and Nevada borders with troughs of low pressure

¹ A thermal low (or heat low) is an area of low atmospheric pressure near the surface resulting from heating of the lower troposphere and the subsequent lifting of isobaric surfaces and divergence of air aloft. Thermal lows have generally weak and diffuse cyclonic circulations and often have thermal surface troughs of low pressure extending from them but are nonfrontal. Recurring thermal lows and thermal troughs are common to the continental subtropics

extending north and south. A second low-pressure system was off the southern California Pacific coast at 1008-hPa associated with a coastal eddy², which was expected to move inland during the afternoon into the overnight hours. The accident site was located between these two low-pressure systems in an area identified as a col³.

1.2 Streamline Analysis

Figure 2 is a streamline analysis of the wind field for 0800 PDT created from the Plymouth State weather archive database⁴ with the approximate accident site marked by the red star, and the center of the col and the thermal low-pressure system. The chart depicted the accident site east of the col and west of the thermal low in an area with westerly winds.

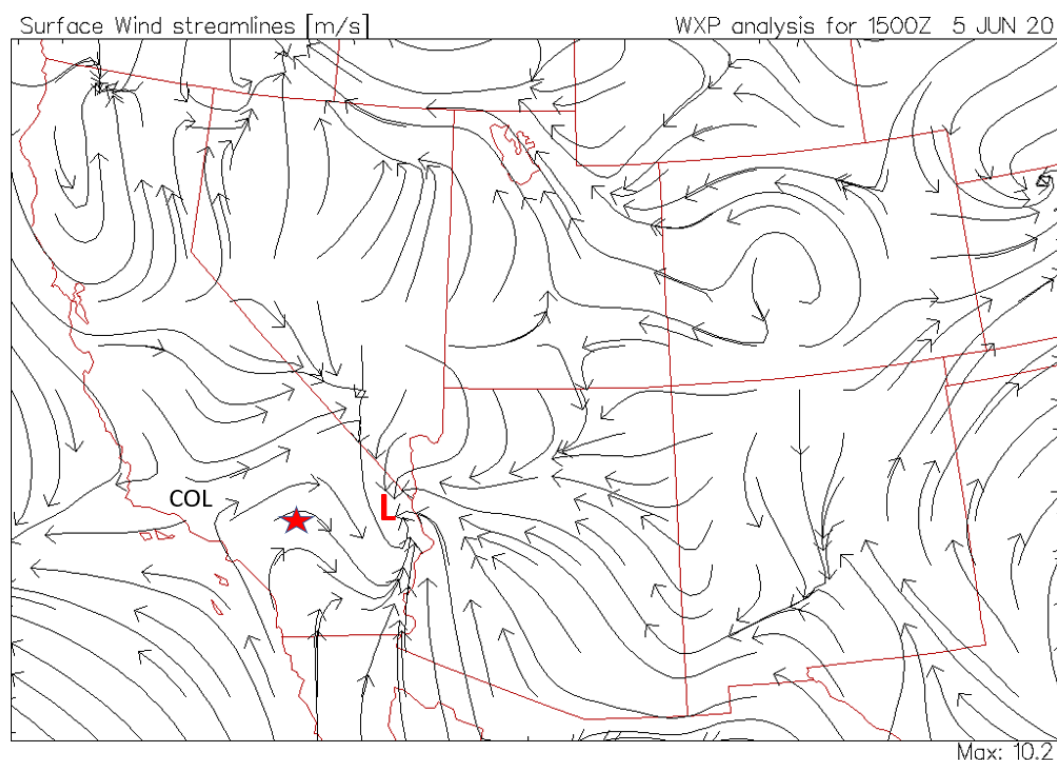


Figure 2 - Streamline analysis for 0800 PDT with accident site marked

1.3 12-hour Surface Prognostic Chart

The 12-hour Surface Prognostic Chart issued by the NWS WPC and displayed on the Aviation Weather Center's webpage that was current at the time of departure is included as figure 3. The chart valid for 1100 PDT depicted the coastal low-pressure system moving closer to the southwest

in the warm season and remain stationary over the warm surface areas that produce them.

² The ocean is a huge body of water that is constantly in motion. General patterns of ocean flow are called currents. Sometimes these currents can pinch off sections and create circular currents of water called an eddy.

³ A col or saddle point is the point of relatively lowest pressure between two highs and the point of relatively highest pressure between two lows.

⁴ <https://vortex.plymouth.edu/myowxp/sfc/pltnmap-a.html>

California coast and the thermal low near the California/Arizona border with the trough extending north and south of the low. An area of scattered rain showers and thunderstorms were depicted west and north of the accident site over southern California.

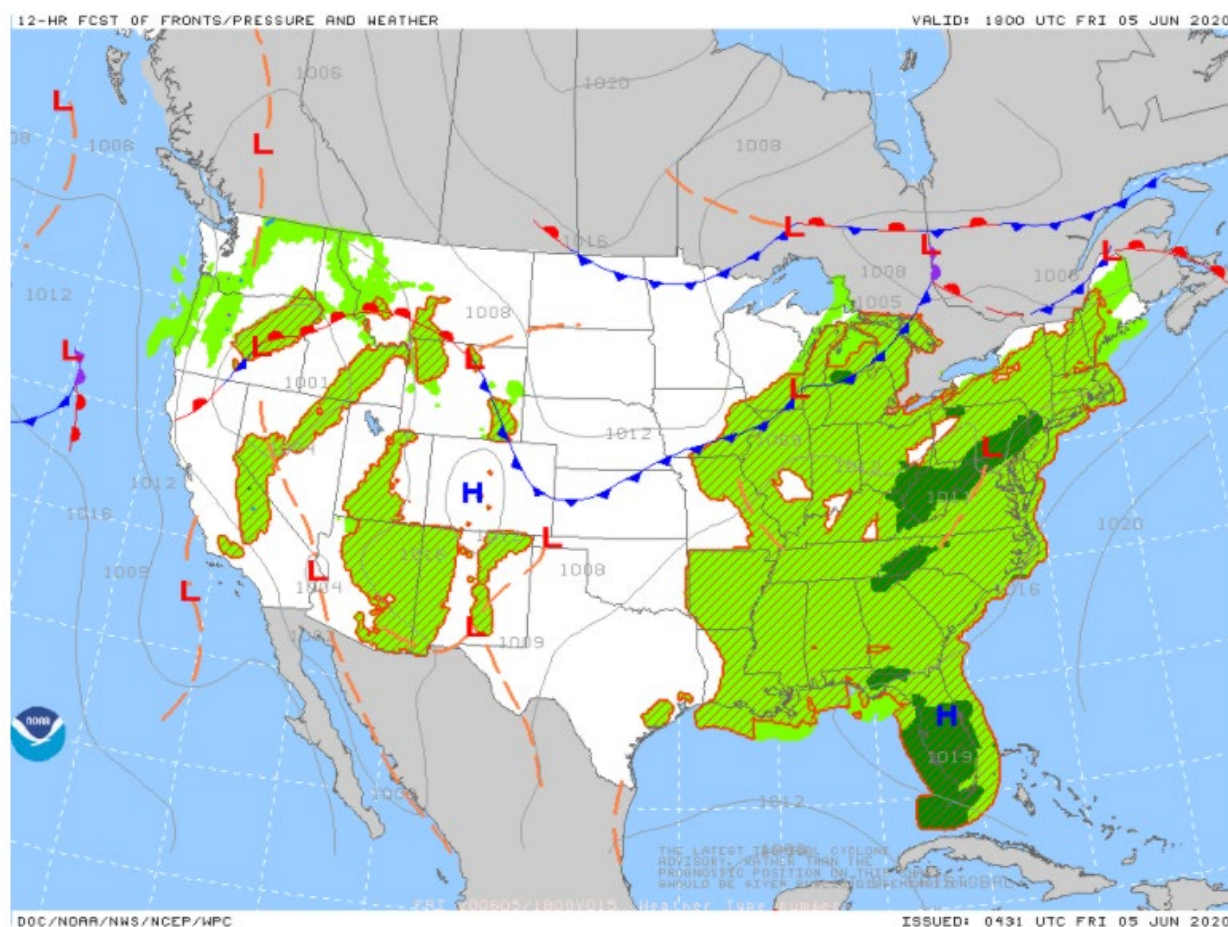


Figure 3 - 12-hour Surface Prognostic Chart valid for 1100 PDT

2.0 Surface Observations

The official NWS Meteorological Aerodrome Reports (METARs) and Special Reports (SPECIs) disseminated longline⁵ surrounding the period were documented for the area. The cloud heights are reported above ground level (agl) in the following section, and the magnetic variation over the region was estimated as 13° east based on the sectional chart for the area. A depiction of the closest reporting sites is included in figure 4 below.

⁵ Longline refers to the dissemination of weather observations on national databases for accessibility to the NWS, FAA, weather vendors, and the general public. The observations are available typically every minute to pilot's on the station's Very High Frequency (VHF) broadcast to the local area for landing and takeoff operations.

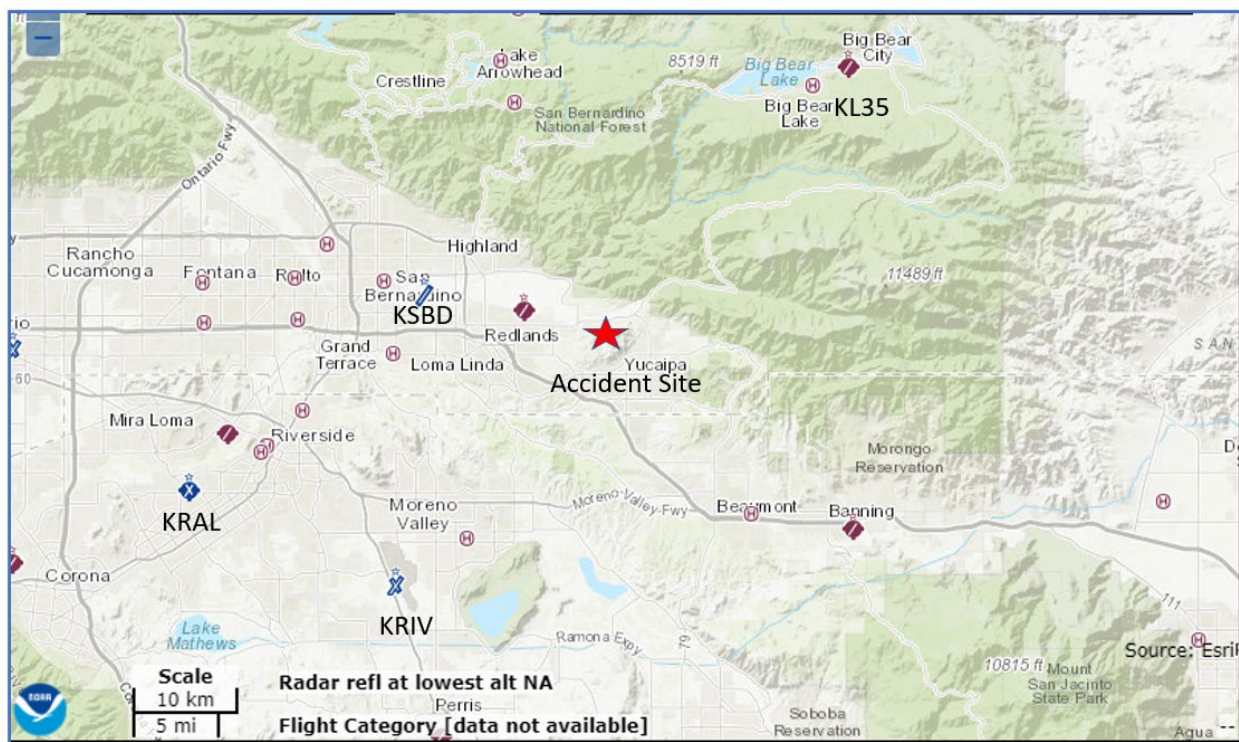


Figure 4 - Map of weather reporting facilities and topography in the area in the vicinity of accident site

2.1 San Bernardino, California

The closest weather reporting location to the accident site was San Bernardino International Airport (KSBD), San Bernardino, California, located approximately 8 miles west (283°) of the accident site at an elevation of 1,159 ft. The airport had an Automated Weather Observation System (AWOS) which was augmented by air traffic control personnel during normal hours of operations. The following conditions were reported surrounding the time of the accident.

KSBD weather observation at 0750 PDT, wind from 230° at 6 knots, visibility 4 miles in haze, ceiling⁶ overcast at 1,100 ft agl, temperature 17° Celsius (C), dew point temperature 14° C, altimeter 29.84 inches of mercury (inHg).

The general flight categories⁷ and raw observations in standard code and time referenced UTC surrounding the period from 0900 through 1100 PDT were as follows. The observations near the time of the accident decoded above are highlight in bold italic print.

⁶ A ceiling is defined as the lowest layer of clouds as reported as broken or overcast, or the vertical visibility into a surface-based obscuration.

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

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

MVFR METAR KSBD 051200Z AUTO 24005KT 7SM OVC014 18/14 A2983 RMK AO2 T01800136=

MVFR METAR KSBD 051220Z AUTO 23004KT 7SM OVC014 18/14 A2983 RMK AO2 T01790137=

MVFR METAR KSBD 051240Z AUTO 24006KT 7SM OVC014 18/14 A2983 RMK AO2 T01800138=

Data missing 1300Z-1440Z

MVFR METAR KSBD 051450Z 23006KT 4SM HZ OVC011 17/14 A2984=

Accident 1501Z

IFR SPECI KSBD 051612Z 22005KT 2SM RA OVC011 17/14 A2987=

MVFR METAR KSBD 051646Z 23005KT 3SM BR OVC010 17/14 A2987=

MVFR METAR KSBD 051747Z 23006KT 3SM BR BKN010 OVC015 17/14 A2988=

IFR SPECI KSBD 051755Z 25005KT 1 3/4SM DZ BKN008 OVC012 17/14 A2988=

A gap in observations was noted between the 0600 through 0740 PDT when tower personnel logged into the AWOS system and immediately after the accident between 0800 and 0912 PDT for unknown reason.

2.2 Riverside, California

The next closest weather reporting location was March Air Reserve Base (KRIV), Riverside, California, located about 14 miles southwest of the accident site at an elevation of 1,536 ft. The airport had a military equivalent of an Automated Surface Observation System (ASOS) and reported the following conditions surrounding the accident time.

KRIV weather observation at 0758 PDT, wind calm, visibility 3 miles in light drizzle and mist, ceiling overcast at 400 ft agl, temperature 16° C, dew point temperature 15° C, altimeter 29.84 inHg. Remarks; automated station with a precipitation discriminator, sea level pressure 1009.6-hPa, hourly precipitation less than 0.01 inches, 6-hour precipitation less than 0.01 inches, temperature 15.7° C, dew point temperature 14.7° C, 3-hour pressure tendency risen 0.6-hPa.

The general flight categories and raw observations between about 0500 through 1000 PDT were as follows.

statute mile.

- Instrument Flight Rules (IFR) – ceiling between 500 to below 1,000 feet agl and/or visibility 1 to less than 3 miles.
- Marginal Visual Flight Rules (MVFR**) – ceiling from 1,000 to 3,000 ft agl and/or visibility 3 to 5 miles.
- Visual Flight Rules (VFR) – ceiling greater 3,000 ft agl and visibility greater than 5 miles.

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

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

IFR METAR KRIV 051158Z 33005KT 7SM SCT006 OVC008 16/14 A2982 RMK AO2A CIG 006 RWY14 SLP086 T01640144 10167 20158 55000=

IFR SPECI KRIV 051213Z AUTO 33005KT 8SM OVC009 17/14 A2983 RMK AO2 CIG 006 RWY14 SLP089=

IFR SPECI KRIV 051248Z AUTO 33006KT 5SM BR OVC008 16/15 A2983 RMK AO2 CIG 005 RWY14 SLP090=

IFR METAR KRIV 051258Z AUTO 33006KT 6SM BR OVC006 16/14 A2983 RMK AO2 CIG 006V008 CIG 005 RWY14 SLP090 T01610144=

IFR SPECI KRIV 051318Z 33006KT 8SM OVC007 16/14 A2983 RMK AO2A SLPNO=

IFR SPECI KRIV 051345Z 32006KT 5SM -DZ BR OVC007 16/15 A2984 RMK AO2A DZB45 CIG 004 RWY14 SLP095=

IFR METAR KRIV 051358Z 31005KT 5SM -DZ BR OVC005 16/15 A2983 RMK AO2A DZB45 CIG 005V007 CIG 004 RWY14 SLP091 P0000 T01580147=

LIFR SPECI KRIV 051424Z 30005KT 2 1/2SM -DZ OVC004 16/15 A2983 RMK AO2A SLP092=

LIFR SPECI KRIV 051451Z 28004KT 3SM -DZ BR OVC004 16/15 A2984 RMK AO2A SLP096=

LIFR METAR KRIV 051458Z 00000KT 3SM -DZ BR OVC004 16/15 A2984 RMK AO2A SLP096 P0000 60000 T01570147 51006=

Accident 1501Z

LIFR SPECI KRIV 051526Z COR 00000KT 5SM BR OVC003 16/15 A2986 RMK AO2A DZE26 SLP103 COR 1529=

IFR SPECI KRIV 051532Z 29004KT 6SM -DZ BR OVC005 16/15 A2986 RMK AO2A DZE26B32 SLP103=

LIFR SPECI KRIV 051553Z 30005KT 5SM -DZ BR BKN004 OVC009 16/15 A2986 RMK AO2A DZE26B32 SLP103=

LIFR METAR KRIV 051558Z 31005KT 5SM -DZ BR OVC004 16/15 A2985 RMK AO2A DZE26B32 SLP100 P0001 T01560146=

LIFR SPECI KRIV 051619Z 31006KT 6SM BR BKN004 OVC009 16/15 A2986 RMK AO2A DZE19 SLP104=

IFR SPECI KRIV 051629Z 33008KT 10SM OVC005 16/15 A2986 RMK AO2A DZE19 SLP104=

LIFR SPECI KRIV 051635Z 32006KT 3SM -DZ BR OVC004 16/15 A2986 RMK AO2A DZE19B35 OVC V BKN SLP104=

LIFR METAR KRIV 051658Z 31006KT 3SM -DZ BR OVC004 16/15 A2986 RMK AO2A DZE19B35 OVC V BKN SLP104 P0001 T01570147=

Another reporting site at Riverside Municipal Airport (KRAL) was located about 20 miles west-southwest from the accident site at an elevation of 819 ft. The airport had an ASOS and was augmented by air traffic control personnel during normal hours of operation. The following conditions were reported at the approximate time of the accident.

KRAL weather observation at 0753 PDT, wind from 270° at 7 knots, visibility 4 miles in mist, ceiling broken at 800 ft agl, overcast 2,000 ft, temperature 16° C, dew point temperature 14° C, altimeter 29.84 inHg. Remarks; automated station with a precipitation discriminator, sea level pressure 1009.1-hPa, temperature 16.1° C, dew point temperature 13.9° C, 3-hour pressure tendency risen 0.4-hPa.

The general flight categories and raw observations between 0500 through 1100 PDT were as follows.

IFR METAR KRAL 051153Z AUTO 29005KT 3SM BR BKN005 OVC012 16/14 A2983 RMK AO2 CIG 003V010 SLP084 T01610144 10183 20161 51005

LIFR SPECI KRAL 051211Z AUTO 28005KT 4SM BR BKN004 OVC008 16/14 A2983 RMK AO2 CIG 002V006 T01610144=

MVFR SPECI KRAL 051237Z AUTO 28006KT 7SM SCT003 SCT008 OVC014 16/14 A2983 RMK AO2 T01560144=

LIFR METAR KRAL 051253Z AUTO 29005KT 6SM BR BKN004 OVC014 16/14 A2984 RMK AO2 SLP090 T01560144=

LIFR SPECI KRAL 051315Z AUTO 28005KT 2 1/2SM BR BKN004 OVC008 16/14 A2984 RMK AO2 CIG 002V006 T01610144=

LIFR SPECI KRAL 051340Z AUTO 29005KT 4SM BR BKN004 OVC008 16/14 A2984 RMK AO2 CIG 002V006 T01560144=

IFR METAR KRAL 051353Z 29004KT 9SM SCT004 BKN008 OVC020 16/14 A2984 RMK AO2 SLP090 T01560144=

IFR METAR KRAL 051453Z 27007KT 4SM BR BKN008 OVC020 16/14 A2984 RMK AO2 SLP091 T01610139 51004=

Accident 1501Z

IFR METAR KRAL 051553Z 28005KT 2SM -RA BR OVC008 16/14 A2986 RMK AO2 RAB48 CIG 005V010 SLP098 P0000 T01610144=

IFR METAR KRAL 051653Z 27005KT 5SM HZ OVC008 17/14 A2985 RMK AO2 RAE11 SLP097 P0000 T01670139=

IFR METAR KRAL 051753Z 29007KT 5SM BR BKN008 OVC014 16/14 A2987 RMK AO2 RAB30E42 CIG 005V011 SLP103 P0000 60000 T01610144 10172 20156 51011=

2.3 Big Bear City, California

The accident airplane departed from Big Bear City Airport (KL35), Big Bear City, at approximately 0745 PDT, which was located 17 miles northeast of the accident site, at an elevation of 6,752 ft. The airport had an AWOS which was not augmented by any human observers and reported the following conditions at the time of departure.

KL35 weather observation at 0730 PDT, wind calm, visibility 10 miles or more, sky clear below 12,000 ft, temperature 13° C, dew point temperature 4° C, altimeter 30.02 inHg. Remarks; automated station with a precipitation discriminator.

The general flight categories and raw observations were as follows.

VFR METAR KL35 051155Z AUTO 00000KT 10SM CLR 08/00 A3003 RMK AO2

VFR METAR KL35 051215Z AUTO 00000KT 10SM CLR 08/00 A3003 RMK AO2

VFR METAR KL35 051235Z AUTO 00000KT 10SM CLR 08/00 A3003 RMK AO2

VFR METAR KL35 051255Z AUTO 00000KT 10SM CLR 07/00 A3003 RMK AO2

VFR METAR KL35 051315Z AUTO 00000KT 10SM CLR 07/00 A3003 RMK AO2

VFR METAR KL35 051335Z AUTO 00000KT 10SM CLR 08/00 A3003 RMK AO2

VFR METAR KL35 051355Z AUTO 00000KT 10SM CLR 10/02 A3003 RMK AO2

VFR METAR KL35 051415Z AUTO 00000KT 10SM CLR 11/03 A3002 RMK AO2

VFR METAR KL35 051430Z AUTO 00000KT 10SM CLR 13/04 A3002 RMK AO2

Departed 1445Z

VFR METAR KL35 051455Z AUTO 00000KT 10SM CLR 16/02 A3002 RMK AO2

Accident 1501Z

VFR METAR KL35 051515Z AUTO 00000KT 10SM CLR 17/03 A3001 RMK AO2

VFR METAR KL35 051535Z AUTO 00000KT 10SM CLR 19/02 A3001 RMK AO2

VFR METAR KL35 051555Z AUTO 11005KT 7SM CLR 22/00 A3000 RMK AO2

VFR METAR KL35 051615Z AUTO 15007G19KT 104V174 10SM CLR 22/M01 A2999 RMK AO2

VFR METAR KL35 051635Z AUTO 12006G16KT 10SM CLR 22/00 A3000 RMK AO2

VFR METAR KL35 051655Z AUTO 10009G17KT 10SM CLR 22/00 A2999 RMK AO2

VFR METAR KL35 051715Z AUTO 13012G19KT 094V154 7SM CLR 22/00 A2999 RMK AO2

3.0 Sounding

A High-Resolution Rapid Refresh (HRRR)⁸ numerical model data were retrieved from the NOAA Air Resources Laboratory archive for the accident site coordinates. The HRRR numerical model was then plotted on a standard Skew T log P diagram⁹ using the Universal RAwinsonde Observation (RAOB) program software¹⁰. Figure 5 is the HRRR sounding for 0800 PDT plotted from the surface to 450-hPa or approximately 19,000 ft over the accident site.

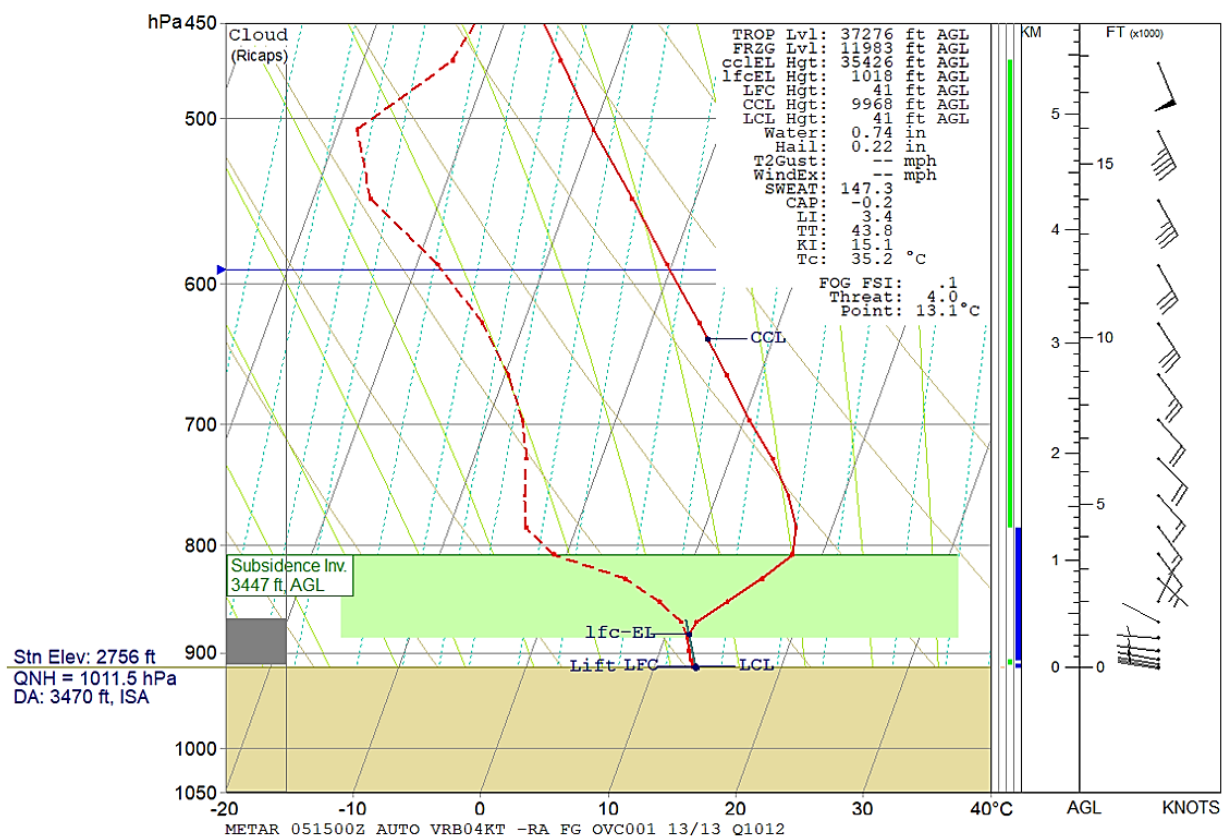


Figure 5 - HRRR numerical model sounding for 0800 PDT over the accident site

The HRRR numerical sounding for 0800 PDT depicted a general surface wind from the west at 4 knots, a surface temperature and dew point temperature of 13° C, with a relative humidity of 100%, and approximate elevation of 2,756 ft. The lifted condensation level (LCL)¹¹ and level of free convection (LFC)¹² were identified at 41 ft agl (2,797 ft msl). A temperature inversion (green

⁸ The HRRR is a National Oceanic and Atmospheric Administration (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.

⁹ 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.

¹⁰ RAOB – (The Universal RAwinsonde OBServation program) is an interactive sounding analysis program developed by Eosonde Research Services (ERS) previously known as Environmental Research Services, The Villages, Florida.

¹¹ Lifted Condensation Level (LCL) - the level at which a lifted parcel becomes saturated. The LCL height corresponds to cloud base height for forced ascent.

¹² Level of Free Convection (LFC) - the last level where a parcel becomes buoyant, or "warmer" than the

shaded area) where temperature increased with height due to subsidence was identified from 3,786 ft to 6,199 ft msl, with drier air identified above the layer. The sounding was saturated between the surface to 4,300 ft with the freezing level at about 14,800 ft. The precipitable water content was 0.74 inches. The atmosphere was characterized as stable with a Lifted Index¹³ of 3.4. The RAOB analysis program indicated nimbostratus type clouds from the LCL/LFC to 4,350 ft msl, with light rain and mist supported by RAOB at the surface, with another higher layer of clouds between approximately 24,000 and 26,000 ft (not shown).

The HRRR wind profile indicated light westerly winds at low altitudes below the inversion with winds shifting to the southeast with increasing wind speeds with height. The mean 0 to 6 km (or 18,000 ft) wind was from 155° at 28 knots, with the level of maximum wind at 34,500 ft from 190° at 94 knots.

Figure 6 is a table of the HRRR sounding parameters of height, pressure (Pres), temperature (T), dew point temperature (Td), relative humidity (RH), and wind direction and speed (DD/FF) and the RAOB program potential for clear air turbulence (CAT), low-level wind shear (LLWS), icing, and mountain wave conditions from the surface through 10,300 ft. The HRRR sounding depicted a potential for light to moderate turbulence between 4,757 ft through 7,047 ft, with no LLWS or icing conditions below 10,000 ft.

Height (ft-MSL)	Pres (hPa)	T (C)	Td (C)	RH (%)	DD / FF (deg / kts)	CAT (FAA)	LLWS	Icing - Type (AFGWC method)
2756	915	13.4	13.3	99	279 / 4			
2786	914	13.1	13.1	100	280 / 4			
2877	911	13.0	13.0	100	279 / 4			
2999	907	12.7	12.7	100	280 / 4			
3274	898	12.3	12.3	100	277 / 4			
3676	885	11.8	11.8	100	274 / 3			
4147	870	12.1	10.9	92	299 / 2			
4757	851	13.9	8.6	70	24 / 1	LGT		
5452	830	16.0	5.3	49	136 / 4	MDT		
6203	808	17.7	-1.0	28	146 / 10	LGT		
7047	784	17.2	-4.0	23	146 / 14	LGT		
8024	757	15.7	-5.0	24	141 / 17			
9144	727	13.4	-5.9	26	138 / 20			
10301	697	10.5	-7.3	28	141 / 22			

Figure 6 - HRRR sounding parameters

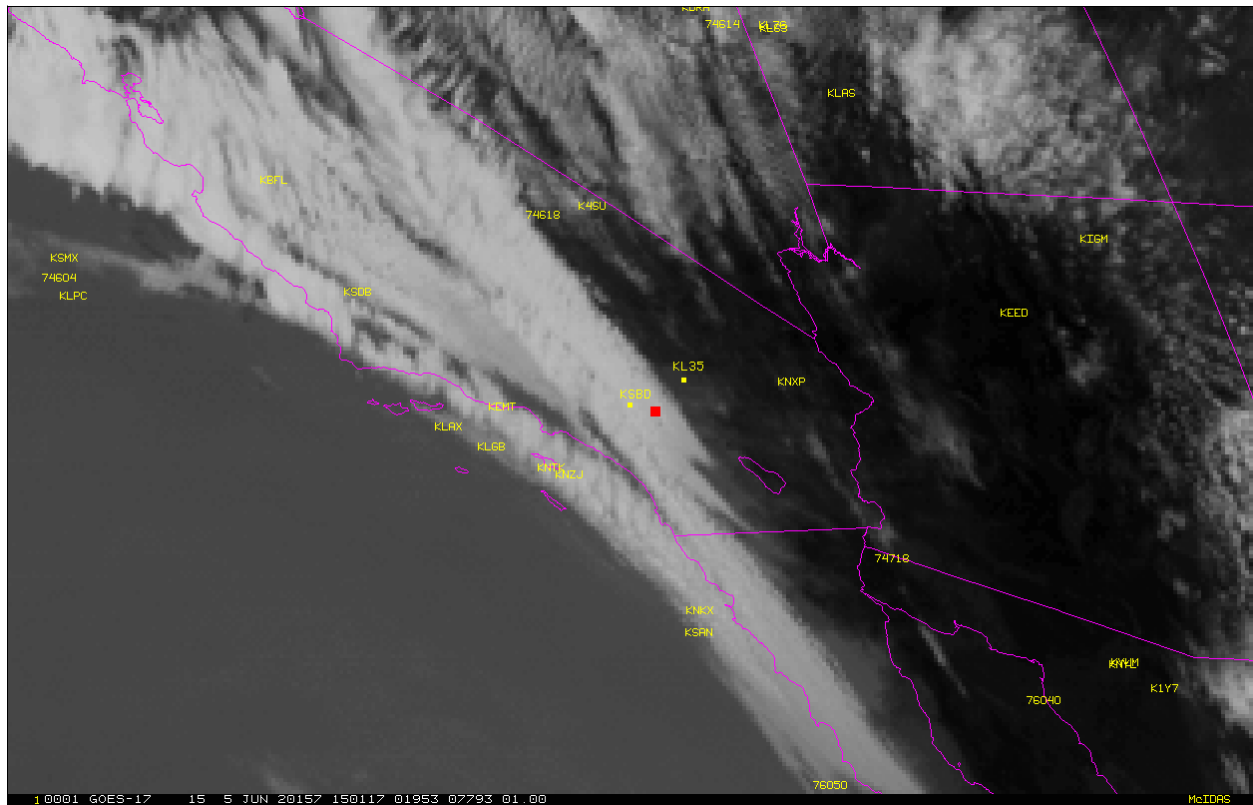
4.0 Satellite Imagery

The Geostationary Operational Environmental Satellite number 17 (GOES-17) data were obtained from an archive at the Space Science Engineering Center (SSEC) at the University of Wisconsin-Madison in Madison, Wisconsin, and processed using the Man-computer Interactive Data Access System (McIDAS) software. The infrared and visible imagery were reviewed surrounding the period, and the closest images to the accident time documented. The infrared long

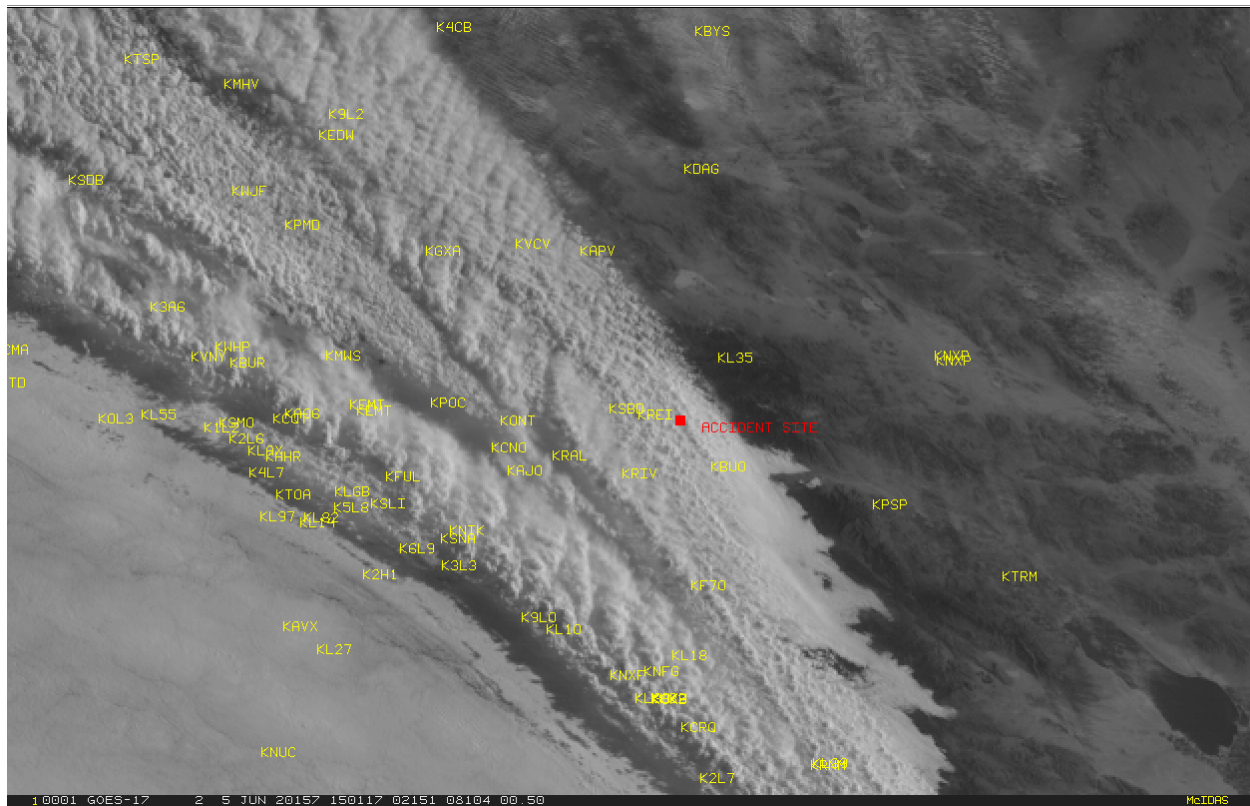
environmental temperature at the same level. The LFC represents the bottom of the layer containing CAPE.

¹³ Lifted Index (LI) - the difference between the lifted parcel temperature at 500 mb and the 500 mb temperature in the sounding. Negative values denote parcels that are warmer than the background 500 mb temperatures and are thus buoyant or "unstable".

wave imagery (band 15) at a wavelength of 12.3 microns (μm) provided radiative cloud top temperatures with a nominal spatial resolution of 2 km. The visible (band 2) at a wavelength of 0.64 μm provided images at a resolution of 0.5 km.



The GOES-17 visible image at 0801 PDT at 2X magnification with the accident site marked by the red square is included as figure 8. The image depicted clear skies over the departure airport (KL35) with multiple layers of low and mid-level clouds extending between the departure and the destination airport and continuing towards the coast. The visible image depicted some vertical development in the clouds in the vicinity of the accident site indicative of some vertical motion near the higher terrain and the cloud structure with potential precipitation. Fog or mist was also noted filling the valleys to the southeast of the accident site.



5.0 Weather Surveillance Radar Data

The closest NWS Weather Surveillance Radar 1988 Doppler (WSR-88D)¹⁴ was Santa Ana Mountains (KSOX) located approximately 31 miles southwest of the accident site. The level II data were obtained from the NCEI archive and displayed using the NWS NEXRAD Interactive Viewer and Data Exporter software. During the period surrounding the accident the computer-controlled radar was operating in the clear air mode, volume coverage pattern 35 (VCP-35), where the radar makes 9 overlapping elevation scans every 7-minutes.

Assuming a standard refraction¹⁵ of the WSR-88D 0.48° radar beam with the KSOX antenna height of 3,106 ft and a distance of 31 miles from the accident site, the 0.48° elevation scan saw the altitudes from about 3,760 ft through 6,880 ft over the accident site. With the next elevation scan of 1.49° scanned the altitudes from 7,080 ft through 10,200 ft over the accident site.

¹⁴ 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.

¹⁵ Standard Refraction in the atmosphere is when the temperature and humidity distributions are approximately average, and values set at the standard atmosphere.

5.1 Reflectivity

Reflectivity is the measure of the efficiency of a target in intercepting and returning radio energy. With hydrometeors¹⁶, 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 (dBZ¹⁷) and is a general measure of echo intensity. Figure 9 is a table of the NWS former video integrator and processor (VIP) intensity levels (1-6) versus the WSR-88D's display levels (0-15), precipitation mode reflectivity in decibels (dBZ), and expected rainfall rates. Typically echoes over 15 dBZ are associated with precipitation reaching the surface.

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

Figure 9 - NWS VIP levels, WSR-88D levels, Reflectivity in dBZ, and rainfall rates

The FAA has taken the NWS previous VIP levels 1 to 6 intensity levels and has redefined the intensity levels for pilots in Advisory Circular AC 00-24C - "Thunderstorm". That AC further defines echoes less than 30 dBZ as "light" in intensity, "moderate" echoes 30-40 dBZ, "heavy" with echoes of >40-50 dBZ, and "extreme" intensity with echoes above >50 dBZ. These are the new standard radio phraseology terms used by air traffic controllers to describe weather conditions to pilots as shown in figure 10.

¹⁶ Hydrometeors are any product of condensation or sublimation of atmospheric water vapor, whether formed in the free atmosphere or at 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.

¹⁷ dBZ - $10 \log Z_e$

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

Figure 10 - Reflectivity values and precipitation intensity terminology

5.2 Base Reflectivity Weather Radar Imagery

The NWS WSR-88D base reflectivity images are the individual elevation scan images for the VCP being operated. Figure 11 is the KSOX WSR-88D 0.48° base reflectivity image at 0805 PDT with the accident airplane's flight track overlaid in purple. The image depicted a thin curved band of echoes a few miles wide that stretched west to east north of San Bernardino then southeastward to near Banning, California, where isolated echoes in the band reached from 30 to 58 dBZ. The echoes were located near the higher terrain and were less defined at higher elevation scans. The echoes along the flight track ranged from 5 to 30 dBZ at the accident airplanes operating altitudes during the period. Figure 12 is the KSOX WSR-88D 1.49° base reflectivity scan for the same period of 00805 PDT which depicted echoes of 5 to 10 dBZ along the flight path with isolated cells of 30 dBZ east of the accident site. An animation of the echoes shown several echoes moving eastward while other remained nearly stationary with time.

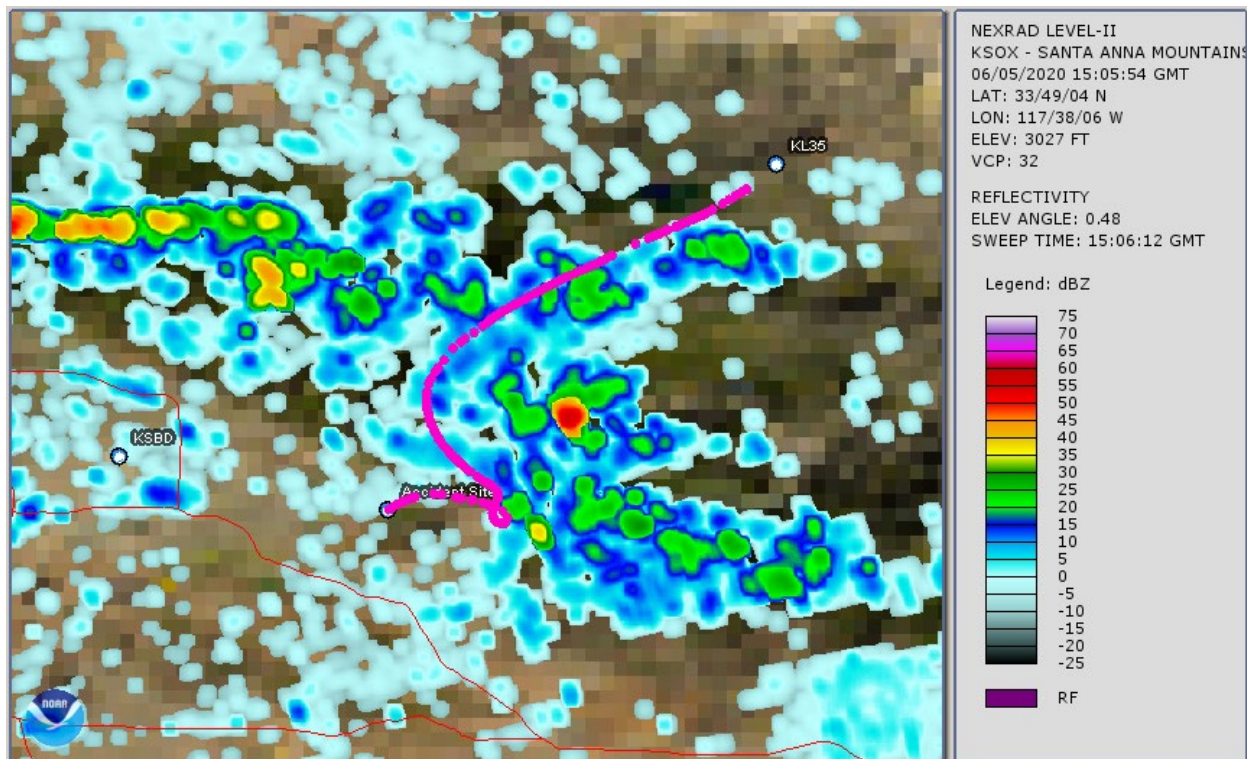


Figure 11 - KSOX WSR-88D 0.48° base reflectivity image for 00805 PDT with accident flight track overlaid

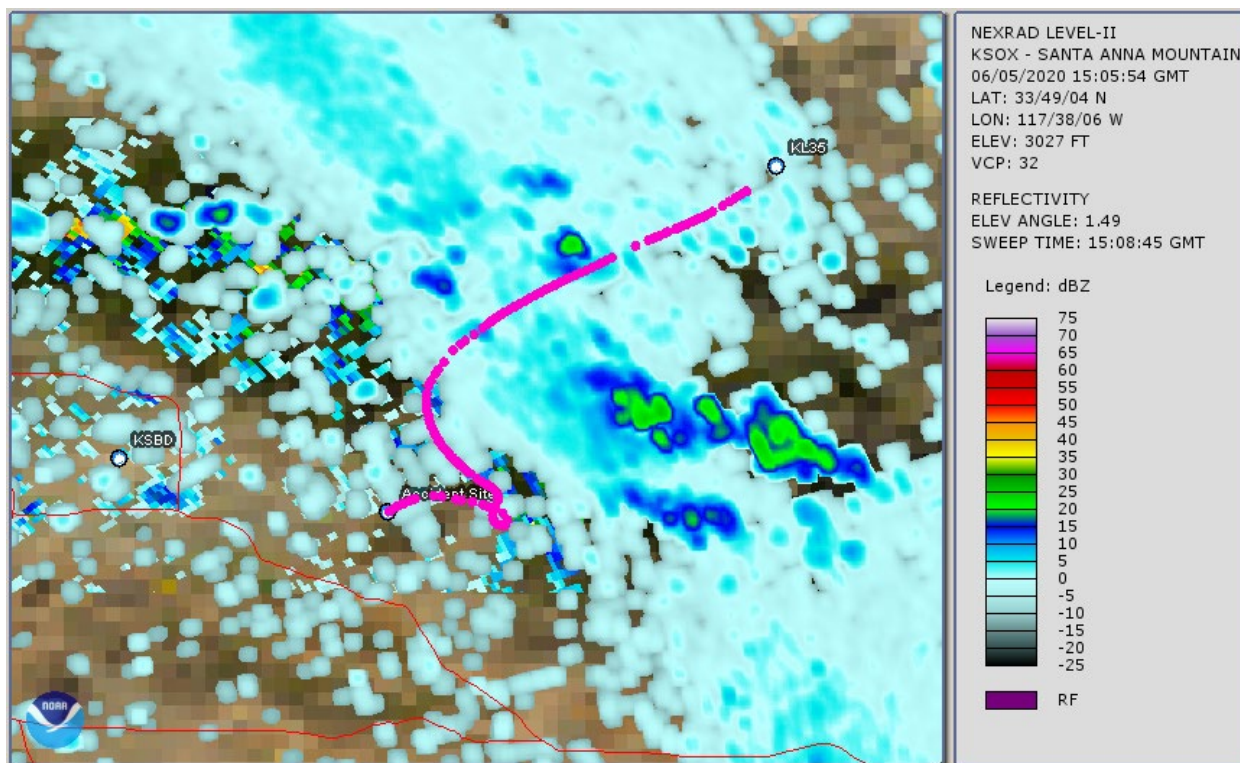


Figure 12 - KSOX WSR-88D 1.49° base reflectivity image for 0805 PDT with flight track overlaid

6.0 Pilot Reports

A search of pilot reports or PIREPs within 120 miles of the accident site below 12,500 ft from 0600 through 1100 PDT were documented. The reports are provided first in standard code and abbreviations with time referenced to UTC, followed by a decoded report in plain language and local time. Altitudes are reported in msl heights.

LAX UA /OV KLAX/TM 1400/FL030/TP E75L/SK OVC030-TOP045/RM DURD RWY 24R. COR LOCTN AND SKY. ZLA CWSU

Los Angeles International Airport (LAX) routine pilot report; Over – KLAX approximately 60 miles west of KSBD; Time – 0700 PDT; Altitude 3,000 ft; Type aircraft – Embraer ERJ 170-200 regional air carrier jet; Sky cover – overcast clouds at 3,000 ft with tops at 4,500 ft; Remarks – during descent for runway 24R.

VCV UA /OV KIFP-KAPV /TM 1435 /FL085 /TP P28A /WX FV99SM /TB NEG /RM HYR CLDS ABV

Southern California Logistics Airport (VCV); Over – between Laughlin/Bullhead International Airport (KIFP) and Apple Valley Airport (KAPV) about 30 miles north of KSBD; Time – 0735 PDT; Altitude – 8,500 ft; Type aircraft – Piper PA-28 Cherokee; Weather – flight visibility 99 miles or more; Turbulence – none; Remarks – higher clouds above.

LAX UA /OV KLAX/TM 1510/FL024/TP B737/SK OVC026/RM BASES 026-028 DURD RWY 24R. COR LOCTN AND SKY. ZLA CWSU

LAX routine pilot report; Over – KLAX; Time – 0810 PDT; Altitude – 2,400 ft; Type aircraft – Boeing 737; Sky cover – overcast clouds at 2,600 ft; Remarks – bases 2,600 to 2,800 ft during descent to runway 24R.

BUR UA /OV VNY/TM 1520/FL044/TP CRJ2/SK BKN020 OVC027/WX 10SM/RM TOPS AT 044 ON RWY 15 DEPARTURE FROM KBUR

Bob Hope Airport (KBUR), Burbank routine pilot report; Over – Van Nuys Airport (VNY)VORTAC¹⁸ located about 63 miles west; Time – 0820 PDT; Altitude – 4,400 ft; Aircraft type – Bombardier CRJ; Sky cover – broken clouds at 2,000 ft and overcast at 2,700 ft; Weather – visibility 10 miles; Remarks – cloud tops at 4,400 ft on departure from runway 15 from KBUR.

LGB UA /OV VPLQM/TM 1537/FL045/TP C172/SK OVC017-TOP045/RM TOPS OVR QUEEN MARY

Long Beach Airport (LGB) routine pilot report; Over – fix VPLQM at 33.45N 118.11W; Time -0837 PDT; Altitude – 4,500 ft; Aircraft type – Cessna 172 Skyhawk; Sky cover – overcast at 1,700 ft with tops at 4,500 ft; Remarks – tops over Queen Mary fix – entered by Los Angeles Center Weather Service Unit (CWSU).

RNM UA /OV RNM270002/TM 1538/FL022/TP PA32/SK BASES BKN022

Ramona Airport (RNM) routine pilot report; Over – 270° and 2 miles from RNM or approximately 65 miles south of KSBD; Time – 0838 PDT; Altitude – 2,200 ft; Type aircraft – Piper PA-32 Cherokee Six; Sky cover – bases of broken clouds at 2,200 ft.

SEE UA /OV SEE /TM 1605 /FL060 /TP C182 /RM -RA NW-NE

Gillespie Field Airport (SEE) routine pilot report; Over – SEE approximately 77 miles south of KSBD; Time – 0905 PDT; Altitude – 6,000 ft; Type aircraft – Cessna 182 Skylane; Remarks – light rain northwest through northeast.

VNY UA /OV VNY/TM 1605/FL024/TP GLEX/SK OVC024/RM TOPS 040

Van Nuys Airport (VNY) routine pilot report; Over – VNY VORTAC about 63 miles west of KSBD; Time – 0905 PDT; Altitude – 2,400 ft; Type aircraft – Bombardier Global Express; Sky cover – overcast clouds at 2,400 ft; Remarks – tops of clouds at 4,000 ft.

LAX UA /OV POM295004 /TM 1609 /FL100 /TP B737 /TB MOD CAT/RM AWC-WEB

LAX routine pilot report; Over – 295° azimuth and 4 miles from Pomona VORTAC (POM); Time – 0909 PDT; Altitude 10,000 ft; Type aircraft – Boeing 737; Turbulence – moderate CAT; Remarks – entered through AWC website.

ONT UA /OV POM/TM 1615/FL080/TP B737/SK TOPS 055/TB MOD TURB 080 TO 140

Ontario International Airport (ONT) routine pilot report; Over – Pomona VORTAC (POM); Time – 0915 PDT; Altitude – 8,000 ft; Type aircraft – Boeing 737; Sky cover – cloud tops 5,500 ft; Turbulence – moderate turbulence between 8,000 and 14,000 ft.

EMT UA /OV KEMT130002/TM 1619/FL013/TP AS50/SK OVC020/WX FV07

San Gabriel Valley Airport (EMT) routine pilot report; Over – 130° azimuth and 2 miles from KEMT or about 40 miles west of KSBD; Time – 0919 PDT; Altitude – 1,300 ft; Type aircraft – Eurocopter AS-350 helicopter; sky cover – overcast clouds with bases 2,000 ft; Weather – flight visibility 7 statute miles.

¹⁸ A VORTAC is a radio-based navigational aid for aircraft pilots consisting of a co-located VHF omnidirectional range (VOR) beacon and a tactical air navigation system (TACAN) beacon for distance measuring equipment (DME) that provides azimuth and distance from the station. Unless otherwise noted the name of the VORTAC is co-located with the city name.

LAX UA /OV KLAX/TM 1635/FL023/TP A320/SK OVC023-TOP055/RM DURD RWY 25L. COR LOCTN AND SKY. ZLA CWSU

LAX routine pilot report; Over – KLAX approximately 60 miles west of KSBD; Time – 0935 PDT; Altitude – 2,300 ft; Type aircraft – Airbus A-320; Sky cover – overcast clouds bases 2,300 ft with tops to 5,500 ft; Remarks – during descent to runway 25L.

PMD UA /OV PMD070010/TM 1638/FL100/TP GLF5/TB MOD 140-100/RM DURD JANNY5.

Palmdale USAF plant 42 Airport (PMD) routine pilot report; Over – 070° azimuth and 10 miles from Palmdale VORTAC or approximately 53 miles northwest of KSBD; Time – 0938 PDT; Altitude – 10,000 ft; Type aircraft – Gulfstream G-5; Turbulence – moderate turbulence between 14,000 to 10,000 ft; Remarks – during descent on Janny5 approach.

VCV UA /OV VCV346007/TM 1641/FL170/TP H25B/WX VIRGA

Southern California Logistics Airport (VCV) routine pilot report; Over – 346° azimuth and 7 miles from Victorville VORTAC about 40 miles north of KSBD; Time – 0941 PDT; Altitude – 17,000 ft; Type aircraft – Raytheon Hawker 800 business jet; Weather - VIRGA

CNO UA /OV KCNO/TM 1659/FL020/TP P28A/SK BKN018/RM DURD RWY 26R.

Chino Airport (CNO) routine pilot report; Over – KCNO; Time – 0959 PDT; Altitude – 2,000 ft; Type aircraft – Piper PA-28 Cherokee; Sky cover – broken clouds base at 1,800 ft; Remarks – during descent to runway 26R.

PMD UA /OV PMD070010/TM 1715/FL130/TP GLF5/TB MOD/RM MOD 140-100 LGT 090-080 DURGD JANNY5

PMD routine pilot report; Over – 070 azimuth and 10 miles from Palmdale VORTAC; Time – 1015 PDT; Altitude – 13,000 ft; Type aircraft – Gulfstream G-5; Turbulence – moderate between 14,000 to 10,000 ft and light between 9,000 to 8,000 ft during JENNY5 approach.

RNM UA /OV RNM270003/TM 1740/FL025/TP C172/SK BKN026-TOP040

Ramona Airport (RNM) routine pilot report; Over – 270° azimuth and 3 miles from RNM about 65 miles southwest of KSBD; Time – 1040 PDT; Altitude – 2,500 ft; Type aircraft – Cessna 172 Skyhawk; Sky cover – broken clouds bases at 2,600 ft with tops at 4,000 ft.

7.0 NWS Forecasts

A review of the basic NWS aviation forecasts issued during the period and applicable for the flight were as follows.

7.1 Terminal Aerodrome Forecasts

A Terminal Aerodrome Forecast (TAF) is a concise statement of the expected meteorological conditions at an airport during a specified period, usually 24 hours. TAFs are valid for a 5-mile radius around an airport's center point. The NWS San Diego Weather Forecast Office (WFO) was responsible for the San Bernardino and Riverside forecast area. The forecast issued for KSBD and available prior to departure was issued at 0427 PDT and was as follows.

TAF KSBD 051127Z 0512/0612 VRB03KT P6SM OVC014

FM051700 25008KT 6SM HZ BKN018

FM052100 25012G22KT P6SM BKN025

FM060400 25011KT P6SM VCSH BKN025

The forecast for KSBD expected from 0500 through 1000 PDT for MVFR conditions to prevail with winds variable at 3 knots, visibility better than 6 miles, with ceiling overcast at 1,400 ft agl.

7.2 Area Forecast Discussion

The NWS Area Forecast Discussions (AFD) are issued by each WFO to describe the short-term weather conditions within their region with an aviation section that includes the general conditions as they relate to the creation of the TAF. These are useful for additional aviation-related issues that cannot be encoded into the TAF. The discussion also gives some reasoning behind the forecast. These are generated roughly every 6 hours and corresponds to the release of the latest TAFs for that office. The KSAN WFO issued the AFD at 0332 PDT which follows less than long term forecast section.

FXUS66 KSGX 051032

AFDSGX

Area Forecast Discussion

National Weather Service San Diego CA

332 AM PDT Fri Jun 5 2020

.SYNOPSIS...

A low pressure system moving inland through southern California tonight will spread cooling inland through Saturday, increase clouds, bring stronger and gusty southwest so west winds in the mountains and deserts through Saturday night, and bring some light precipitation along and west of the mountains into Saturday morning. It will be breezy and a little warmer for Sunday and Monday. High pressure to the southeast will bring greater warming for Tuesday and Wednesday followed by cooling late next week as another trough of low pressure moves toward the West Coast.

.DISCUSSION...FOR EXTREME SOUTHWESTERN CALIFORNIA INCLUDING ORANGE...

SAN DIEGO...WESTERN RIVERSIDE AND SOUTHWESTERN SAN BERNARDINO COUNTIES...

.SHORT TERM (Today through Sunday)...

A low pressure system to the southwest will move across southern California tonight, then move east as another trough of low pressure over the eastern Pacific moves to near the West Coast on Saturday and into the western states on Sunday.

The marine layer continues to deep with coastal low clouds extending inland across most of the valleys. There will be some drizzle from this deepening marine layer this morning from the coast into portions of the valleys. As the low pressure system moves into southern California, there is a chance for light precipitation from the coast onto the coastal mountain slopes for tonight into Saturday morning.

Cooling will continue to spread inland today with slight additional cooling for Saturday with Sunday around 5 degrees warmer. Onshore flow will strengthen with stronger and gusty southwest to west winds in the mountains and deserts for this afternoon through Sunday night with the strongest winds for tonight

.AVIATION...

051030Z...Coast/Valley...OVC010-018 tops 025 well into the inland valleys through 17Z with areas of drizzle. After 17Z...CIGS lifting to 015-025 tops 035 with gradual clearing through 22Z, but CIGS could linger at some TAF sites throughout the afternoon.

Mountains and deserts...FEW-SCT clouds at or abv 20000 feet MSL with unrestricted vis this morning. West winds increasing to 20-30 kt with gusts to 45 kt Friday afternoon and continuing through Friday night.

.MARINE...

A coastal eddy will bring southerly winds from 5-15 kt today. There is a chance for light showers through Saturday morning as a trough of low pressure moves across SoCal. Winds will shift to the northwest Saturday afternoon and increase to 25 kt over the outer waters Saturday evening through Sunday night.

.BEACHES...

A long-period southwest swell will generate surf of 3 to 5 ft through Sunday with occasional sets to 6 ft. Strong rips are likely.

.SKYWARN...

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

.SGX WATCHES/WARNINGS/ADVISORIES...

CA...Wind Advisory from 3 PM this afternoon to 5 AM PDT Sunday for Coachella Valley-Riverside County Mountains-San Diego County Deserts-San Diego County Mountains-San Geronio Pass Near Banning.

PZ...NONE.

7.3 Graphic Forecast for Aviation

Due to archive date limitations the NWS issued Graphic Forecast for Aviation surface and cloud products were not available for documentation surrounding the period of the accident.

7.4 Winds and Temperatures Aloft Forecast

The NWS Winds and Temperature Aloft Forecast for the general route of flight valid 0500 PDT and for use between 0100 and 0800 PDT was as follows.

WINDS ALOFT FORECASTS

DATA BASED ON 050600Z

VALID 051200Z FOR USE 0800-1500Z. TEMPS NEG ABV 24000

FT	3000	6000	9000	12000	18000	24000	30000	34000	39000
ONT	2405	9900+18	1613+14	1519+07	1637-10	1759-23	188638	199546	199755
WJF		2407+19	1510+14	1519+07	1531-11	1655-23	178539	189647	199854
SAN	1710	2012+17	1723+13	1628+06	1648-09	1771-22	188837	199345	209355

The closest forecast site to the accident site was Ontario, California (ONT) located approximately 20 miles west of the accident site. The forecast available at the time of departure expected a wind at 3,000 ft from 240° at 5 knots, at 6,000 ft light and variable winds at less than 10 knots with a temperature of 18° C, and for 9,000 ft a wind from 160° at 13 knots with a temperature of 14° C. The other neighboring stations of General William J. Fox Airfield (WJF), Lancaster, and San Diego International Airport (SAN) showed similar wind profiles.

8.0 Inflight Weather Advisories

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

Figure 13 is the NWS AWC Graphic-AIRMET Sierra issued at 0456 PDT and valid for 0800 PDT for the area for IFR conditions with ceilings below 1,000 ft agl and visibility below 3 miles in precipitation and mist, and an advisory for mountain obscuration conditions due to clouds and mist. The approximate accident site is marked by a red star.

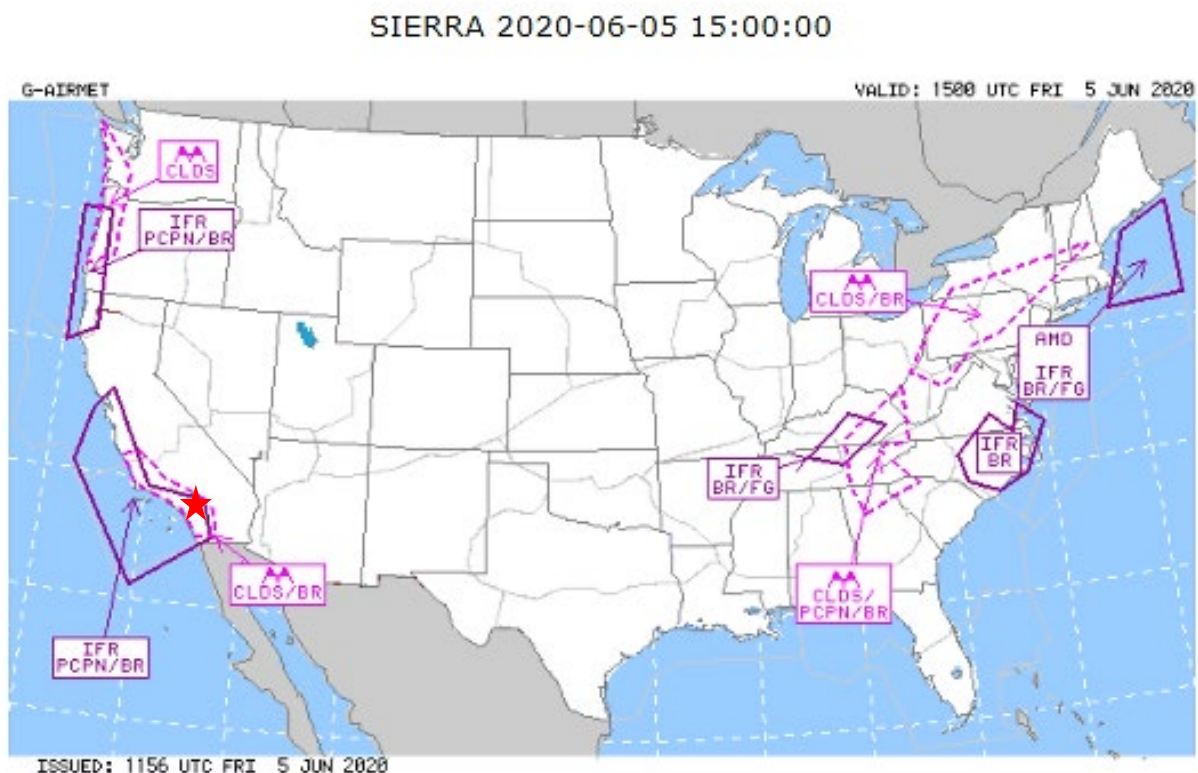


Figure 13 - Graphic-AIRMET for IFR and mountain obscuration conditions valid for 0800 PDT

9.0 Weather Briefing Information

A search of the FAA Automated Flight Service Station (AFSS) contract provider Leidos indicated that they had no contact with the pilot of N9217B for any weather briefing on the day of the accident and no third-party vendors utilized their system made any requests for weather data or to file any flight plans. It is therefore unknown what information the pilot may have familiarized himself before departure or enroute regarding the weather conditions.

10.0 Astronomical Conditions

The astronomical conditions over the accident site obtained from the United States Naval Observatory's Multiyear Interactive Computer Almanac (MICA) software provided the following conditions for KTSP. The time of the accident has been added in bold italic print for reference.

<u>SUN</u>	<u>Time (PDT)</u>
Begin civil twilight	0507
Sunrise	0536
<i>Accident</i>	<i>0801</i>
Cumulative	1246
Sunset	1957
End civil twilight	2026

At the time of the accident the Sun was 27° above the horizon at an azimuth of 80°.

Submitted by:

Don Eick
Senior Meteorologist