



## **NATIONAL TRANSPORTATION SAFETY BOARD**

Office of Aviation Safety  
Washington, D.C. 20594

November 17, 2015

### **Group Chairman's Factual Report**

# **METEOROLOGY**

**CEN15FA051**

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## **A. ACCIDENT**

Location: 13 miles southeast of Pagosa Springs, Colorado  
Date: November 14, 2014  
Time: approximately 1725 mountain standard time (0025 UTC<sup>1</sup> on November 15)  
Aircraft: Mooney M20, registration: N6466U

## **B. METEOROLOGY GROUP**

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## **C. SUMMARY**

For a summary of the accident, refer to the *Accident Summary* report, which is available in the docket for this investigation.

## **D. 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 the NTSB's Washington D.C. office and from official National Oceanic and Atmospheric Administration (NOAA) National Weather Service (NWS) sources including the National Climatic Data Center (NCDC). All times are mountain standard time (MST) on November 14, 2014, and are based upon the 24-hour clock, where local time is -7 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 statute miles.

The accident location was located at latitude 37.15° N, longitude 106.83° W, elevation 8,890 feet.

## **E. FACTUAL INFORMATION**

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<sup>1</sup> UTC – is an abbreviation for Coordinated Universal Time.

## **1.0 Synoptic Situation**

The synoptic or large scale migratory weather systems influencing the area were documented using standard NWS charts issued by the National Center for Environmental Prediction (NCEP) and the Weather Prediction Center (WPC), 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-0045G CHG 1.

### **1.1 Surface Analysis Chart**

The NWS Surface Analysis Chart for 1700 MST is provided as figure 1, with the approximate location of the accident site marked. The chart depicted a stationary front stretched from southeastern Wyoming southward into southern New Mexico. A surface trough<sup>2</sup> was located from western New Mexico into southern Utah. A surface low pressure center with a pressure of 1008-hectopascals (hPa) was located in northwestern New Mexico. A surface high pressure center with a pressure of 1014-hPa was located in southwestern Colorado and a surface high pressure center with a pressure of 1015-hPa was located in eastern Utah. The station models around the accident site depicted two different weather environments. At, and to the west of, the accident site air temperatures were in the mid 30’s to mid 20’s Fahrenheit (F), with temperature-dew point spreads of 2° F or less, variable winds at or below 10 knots, cloudy skies, and light to heavy snow. To the east and south of the accident site air temperatures were in the mid to upper 40’s F, with temperature-dew point spreads of 15° F or more, a southwest to west wind between 5 and 15 knots, partly cloudy skies, and some light rain.

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<sup>2</sup> Trough – An elongated area of relatively low atmospheric pressure or heights.

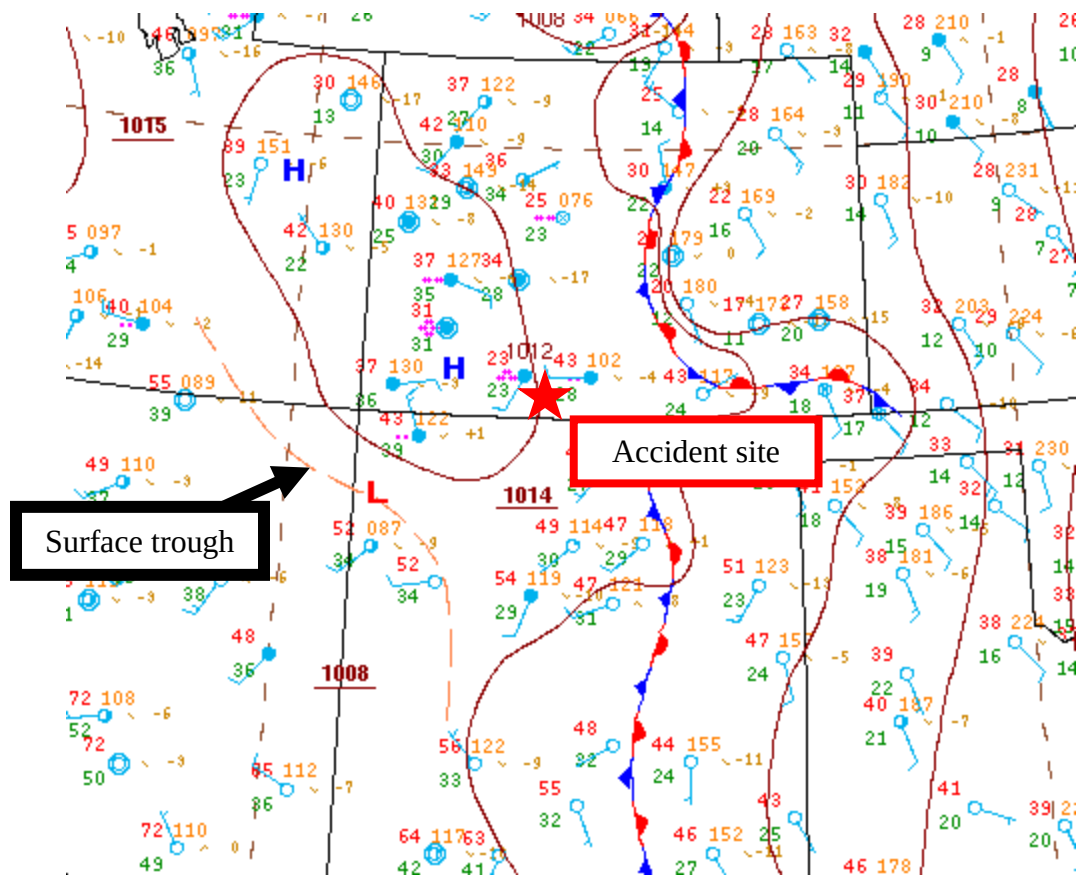
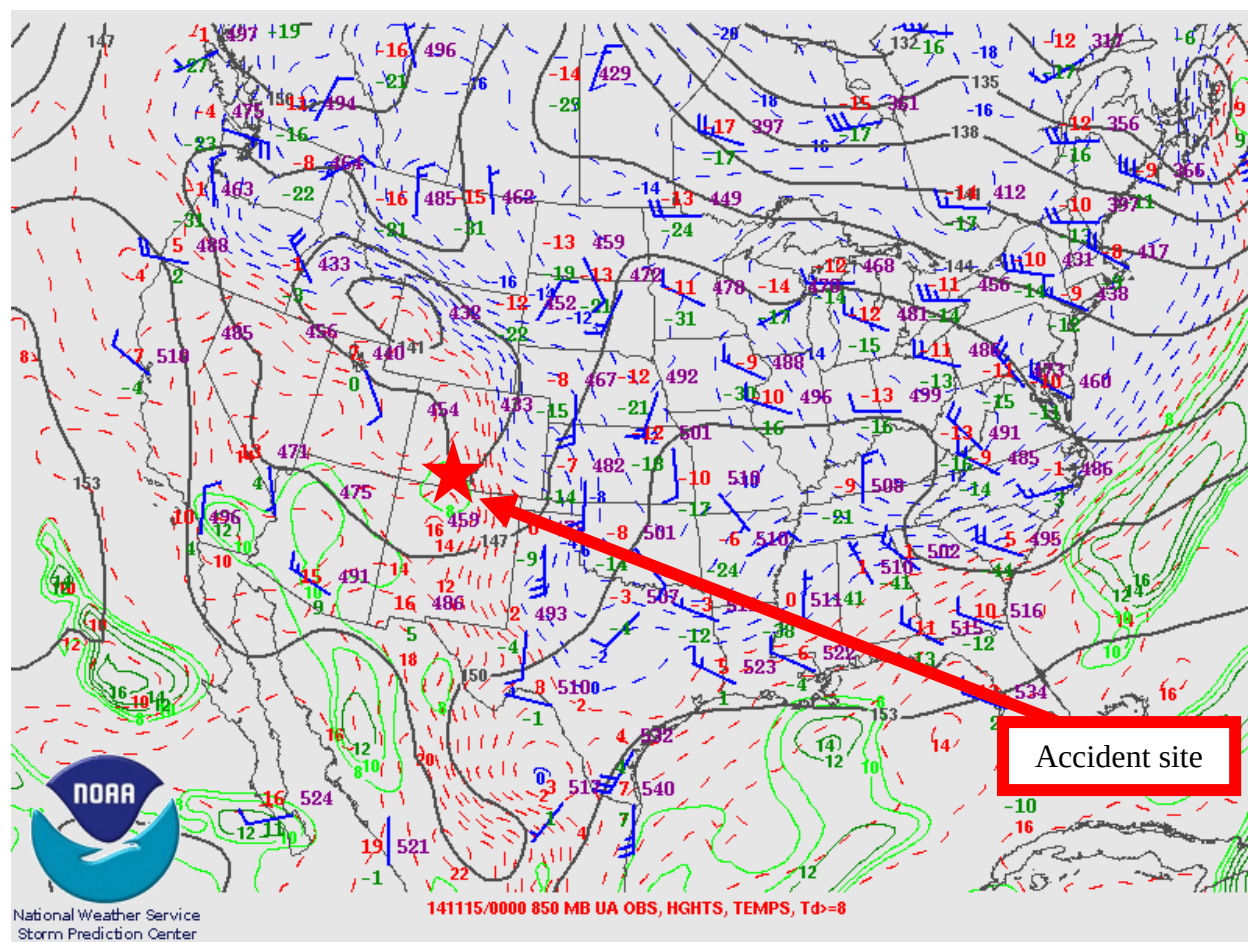


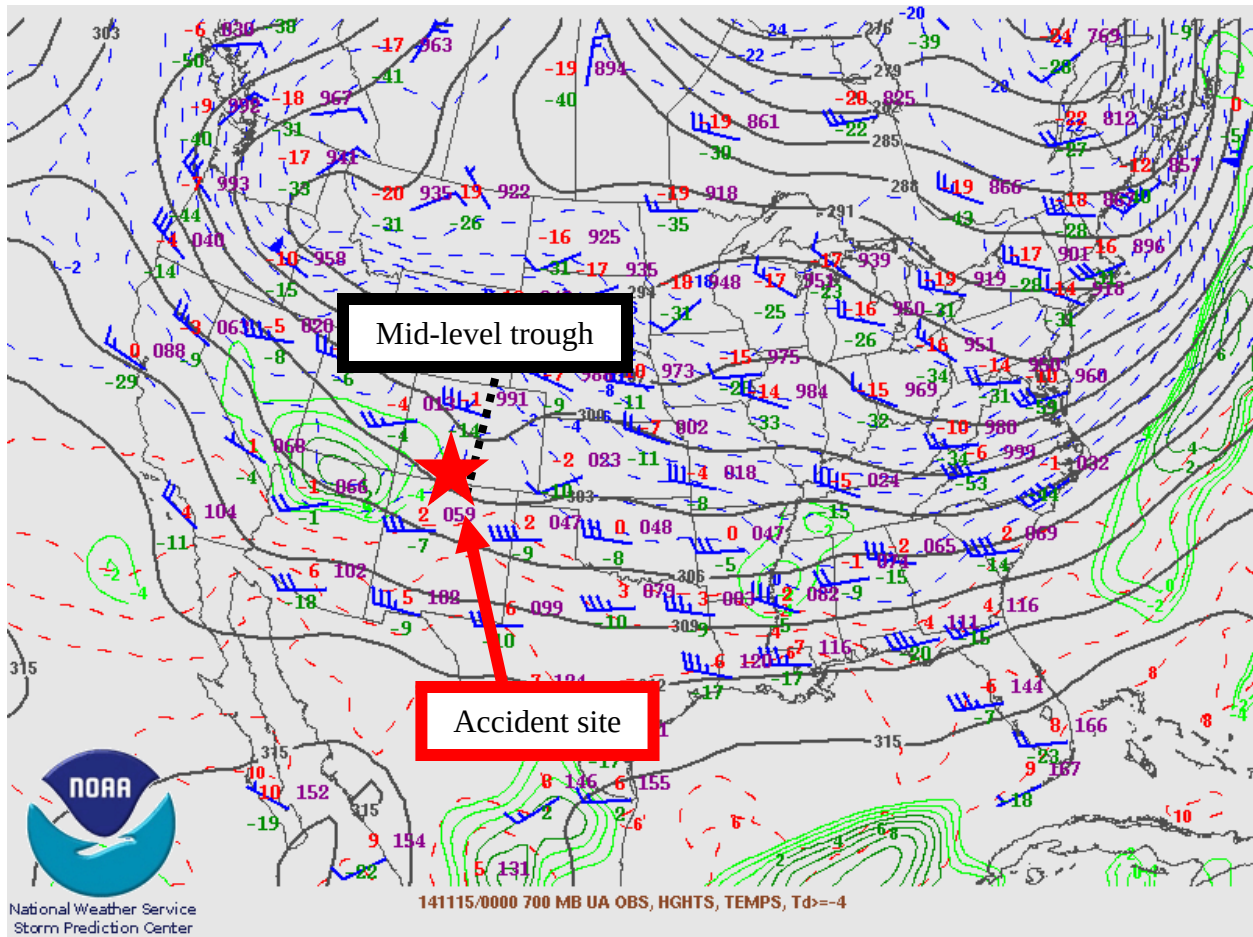
Figure 1 – NWS Surface Analysis Chart for 1700 MST

## 1.2 Upper Air Charts

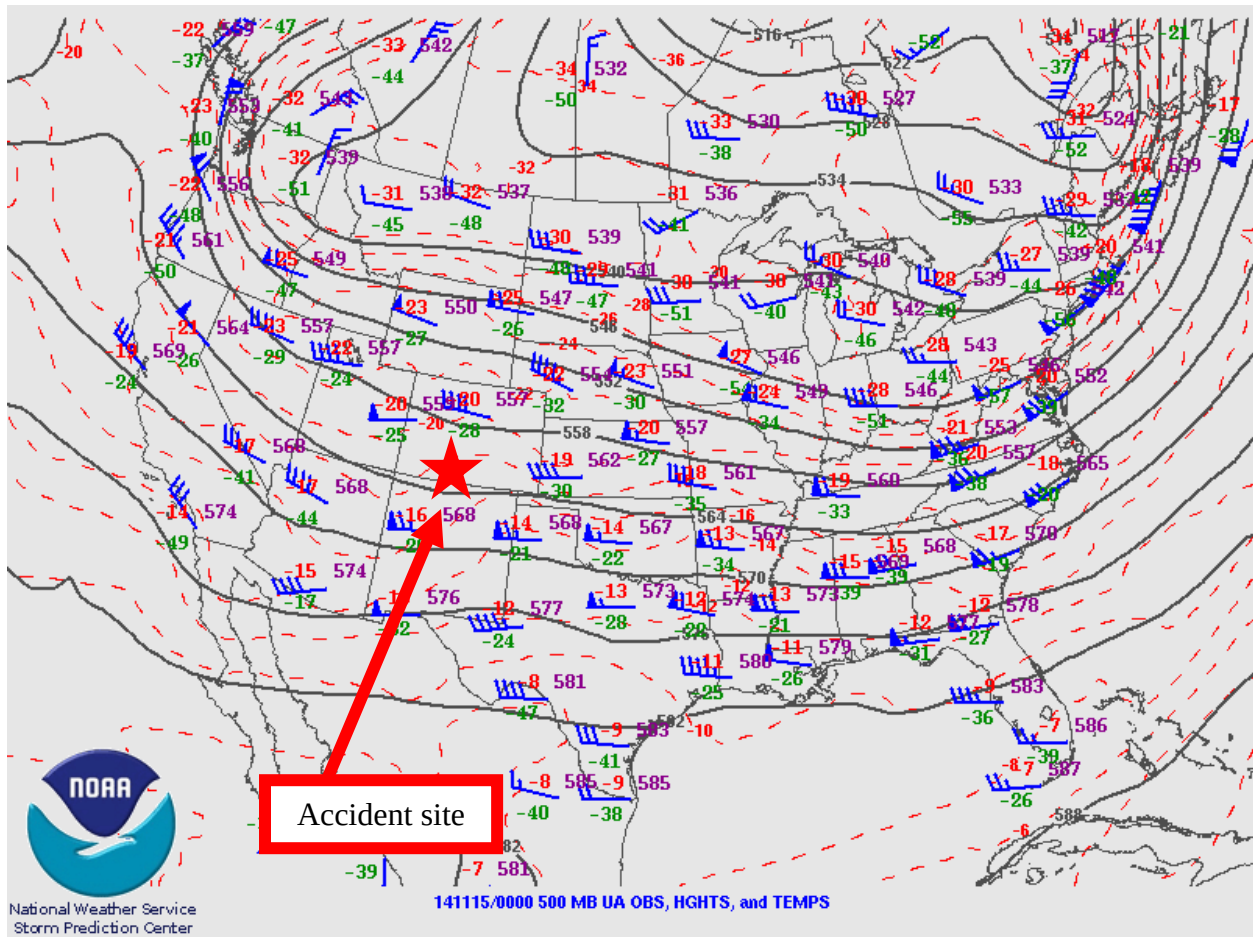
The NWS Storm Prediction Center (SPC) Constant Pressure Charts for 1700 MST at 850-, 700-, 500-, and 300-hPa are presented in figures 2 through 5. The 700-hPa charts depicted a mid-level trough over or just to the east of the accident site around the accident time. Areas near and ahead of troughs are typically areas where enhanced lift, clouds, and precipitation can occur. The wind remained out of the west to southwest from 700- through 300-hPa with the strongest wind at 700-hPa, near 30 knots, with the wind increasing to around 90 knots by 300-hPa.



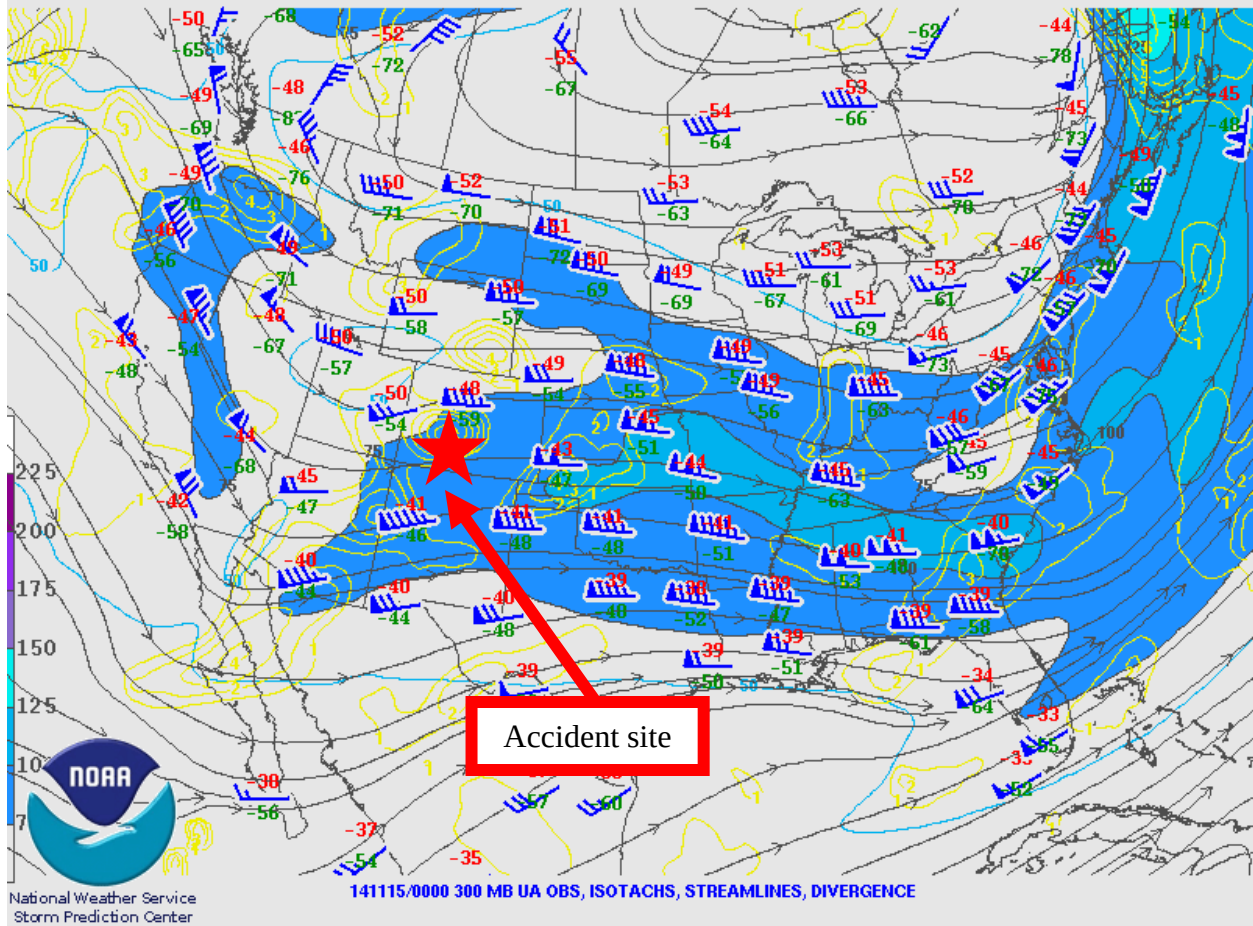
**Figure 2 – 850-hPa Constant Pressure Chart for 1700 MST**



**Figure 3 – 700-hPa Constant Pressure Chart for 1700 MST**



**Figure 4 – 500-hPa Constant Pressure Chart for 1700 MST**



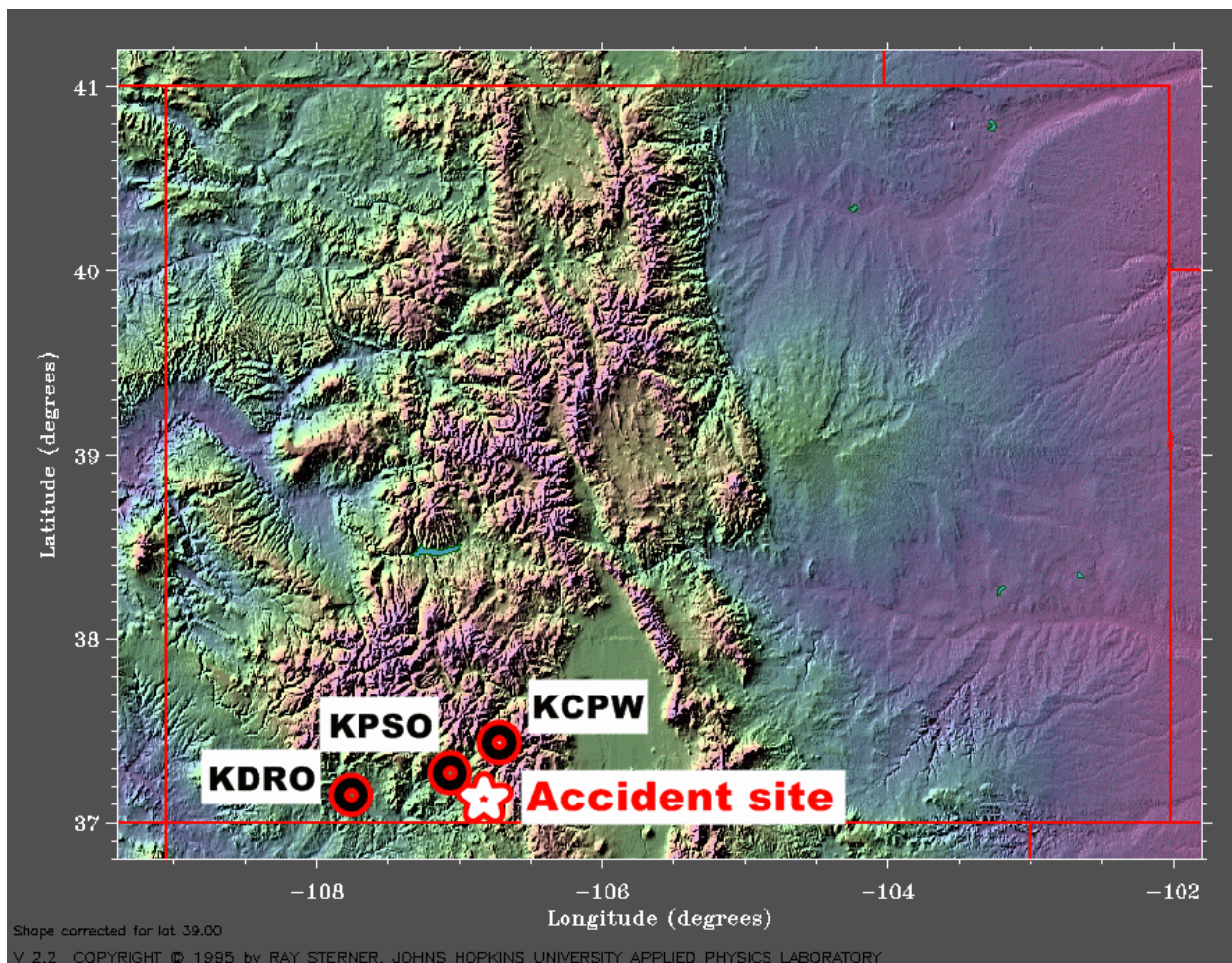
**Figure 5 – 300-hPa Constant Pressure Chart for 1700 MST**

## 2.0 Storm Prediction Center Products

No thunderstorms or severe storms were forecast.

## 3.0 Surface Observations

The area surrounding the accident site was documented utilizing official NWS Meteorological Aerodrome Reports (METARs) and Specials (SPECIs). The following observations were taken from standard code and are provided in plain language.



**Figure 6 – Map of Colorado with the location of the accident site and surface observation sites**

Stevens Field Airport (KPSO) was the closest official weather station to the accident site located 3 miles northwest of Pagosa Springs, Colorado, and had an Automated Weather Observing System (AWOS<sup>3</sup>) whose reports were not supplemented. KPSO was located 14 miles northwest of the accident site, at an elevation of 7,664 feet, and had a 10° easterly magnetic variation<sup>4</sup> (figure 6). The following observations were taken and disseminated during the times surrounding the accident<sup>5</sup>:

[1535 MST] KPSO 142235Z AUTO 00000KT 3/4SM SN OVC002 01/01 A2995  
RMK AO2 LTG DSNT W T00120012=

<sup>3</sup> 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.

<sup>4</sup> Magnetic variation – The angle (at a particular location) between magnetic north and true north.

<sup>5</sup> The bold sections in this NWS product and the rest of products in the weather factual report are to highlight the individual sections that directly reference the weather conditions that are or will affect the accident location around the accident time.

[1555 MST] KPSO 142255Z AUTO 22004KT 3/4SM -SN OVC005 01/01 A2995  
RMK AO2 LTG DSNT S T00120012=

[1615 MST] KPSO 142315Z AUTO 00000KT 5SM -SN OVC005 01/01 A2994  
RMK AO2 T00110011=

[1635 MST] KPSO 142335Z AUTO 10003KT 1/2SM FG OVC003 01/01 A2993  
RMK AO2 T00100010=

**[1655 MST] KPSO 142355Z AUTO 00000KT 1/2SM -VCTSSN OVC001 01/01  
A2992 RMK AO2 LTG DSNT SW T00100010 10055 20010=**

**[1715 MST] KPSO 150015Z AUTO 26003KT 3/4SM VCTSSN OVC001 01/01  
A2994 RMK AO2 LTG DSNT S T00100010=**

**ACCIDENT TIME 1725 MST**

**[1735 MST] KPSO 150035Z AUTO 00000KT 1 1/4SM -SN OVC001 01/01 A2993  
RMK AO2 T00100010=**

**[1755 MST] KPSO 150055Z AUTO 19005KT 1/2SM TSSN OVC003 01/01 A2994  
RMK AO2 T00100010=**

[1815 MST] KPSO 150115Z AUTO 00000KT 2SM -SN OVC003 01/01 A2995  
RMK AO2 T00100010=

[1835 MST] KPSO 150135Z AUTO 00000KT 4SM -SN OVC003 01/01 A2995  
RMK AO2 T00100010=

[1855 MST] KPSO 150155Z AUTO 20004KT 10SM OVC003 01/01 A2995 RMK  
AO2 T00100010=

[1915 MST] KPSO 150215Z AUTO 00000KT 3SM BR OVC005 01/01 A2995  
RMK AO2 T00110011=

KPSO weather at 1655 MST was reported as wind calm, a half mile visibility, vicinity<sup>6</sup> thunderstorms and light snow, an overcast ceiling at 100 above ground level (agl), temperature of 1° Celsius (C), dew point temperature of 1° C, and an altimeter setting of 29.92 inches of mercury. Remarks: automated station with precipitation discriminator, lightning distant<sup>7</sup> southwest, temperature 1.0° C, dew point temperature 1.0° C, 6-hourly maximum temperature of 5.5° C, 6-hourly minimum temperature of 1.0° C.

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<sup>6</sup> In the vicinity of the airport is defined as a weather phenomenon within 5-10 miles of the airfield, but not over the airfield.

<sup>7</sup> Distant indicated that the lightning was beyond 10 miles but less than 30 miles from the center of the airport (or airport location point, ALP).

KPSO weather at 1715 MST was reported as wind from 260° at 3 knots, three quarters of a mile visibility, vicinity thunderstorms and moderate snow, an overcast ceiling at 100 agl, temperature of 1° C, dew point temperature of 1° C, and an altimeter setting of 29.94 inches of mercury. Remarks: automated station with precipitation discriminator, lightning distant south, temperature 1.0° C, dew point temperature 1.0° C.

KPSO weather at 1735 MST was reported as wind calm, 1 and a quarter mile visibility, light snow, an overcast ceiling at 100 agl, temperature of 1° C, dew point temperature of 1° C, and an altimeter setting of 29.93 inches of mercury. Remarks: automated station with precipitation discriminator, temperature 1.0° C, dew point temperature 1.0° C.

KPSO weather at 1755 MST was reported as wind from 190° at 5 knots, a half mile visibility, thunderstorms and moderate snow, an overcast ceiling at 300 agl, temperature of 1° C, dew point temperature of 1° C, and an altimeter setting of 29.94 inches of mercury. Remarks: automated station with precipitation discriminator, temperature 1.0° C, dew point temperature 1.0° C.

Pagosa Springs, Wolf Creek Pass (KCPW), had an AWOS whose reports were not supplemented. KCPW was located 18 miles north-northeast of the accident site, at an elevation of 11,759 feet (figure 6). The following observations were taken and disseminated during the times surrounding the accident:

[1534 MST] KCPW 142234Z AUTO 22012G20KT 1/4SM SN OVC001 M05/M05  
A2998 RMK AO2 P0004=

[1555 MST] KCPW 142255Z AUTO M1/4SM +SN OVC001 M05/M05 A2997 RMK  
AO2 P0007 LTG DSNT S=

[1615 MST] KCPW 142315Z AUTO 22012G21KT 1/4SM SN OVC001 M05/M05  
A2998 RMK AO2=

[1633 MST] KCPW 142333Z AUTO 22014G24KT 1/4SM SN OVC001 M05/M05  
A2997 RMK AO2 P0002=

***[1653 MST] KCPW 142353Z AUTO 21010G14KT 1/4SM SN OVC001 M05/M05  
A2996 RMK AO2 P0005 LTG DSNT SW=***

***[1714 MST] KCPW 150014Z AUTO 22016G24KT 1/2SM SN OVC001 M05/M05  
A2995 RMK AO2 P0002 LTG DSNT S=***

#### **ACCIDENT TIME 1725 MST**

***[1726 MST] KCPW 150026Z AUTO 22020KT 1/2SM +SN OVC001 M05/M05  
A2994 RMK AO2 P0003=***

**[1751 MST] KCPW 150051Z AUTO 22014G28KT 181V241 1/2SM -TSSN OVC001  
M05/M05 A2994 RMK AO2 P0008=**

[1814 MST] KCPW 150114Z AUTO 22016KT 1/4SM +SN OVC001 M05/M05  
A2997 RMK AO2 P0004=

[1835 MST] KCPW 150135Z AUTO 21013KT 1/2SM SN OVC001 M05/M05 A2997  
RMK AO2 P0005=

KCPW weather at 1653 MST was reported as wind from 210° at 10 knots with gusts to 14 knots, a quarter mile visibility, moderate snow, an overcast ceiling at 100 feet agl, temperature of -5° C, dew point temperature of -5° C, and an altimeter setting of 29.96 inches of mercury. Remarks: automated station with precipitation discriminator, one-hourly precipitation of 0.05 inches, lightning distant southwest.

KCPW weather at 1714 MST was reported as wind from 220° at 16 knots with gusts to 24 knots, a half mile visibility, moderate snow, an overcast ceiling at 100 feet agl, temperature of -5° C, dew point temperature of -5° C, and an altimeter setting of 29.95 inches of mercury. Remarks: automated station with precipitation discriminator, one-hourly precipitation of 0.02 inches, lightning distant south.

KCPW weather at 1726 MST was reported as wind from 220° at 20 knots, a half mile visibility, heavy snow, an overcast ceiling at 100 feet agl, temperature of -5° C, dew point temperature of -5° C, and an altimeter setting of 29.94 inches of mercury. Remarks: automated station with precipitation discriminator, one-hourly precipitation of 0.03 inches.

KCPW weather at 1751 MST was reported as wind from 220° at 14 knots with gusts to 28 knots, wind variable between 181° and 241°, a half mile visibility, thunderstorms and light snow, an overcast ceiling at 100 feet agl, temperature of -5° C, dew point temperature of -5° C, and an altimeter setting of 29.94 inches of mercury. Remarks: automated station with precipitation discriminator, one-hourly precipitation of 0.08 inches.

Durango-La Plata County Airport (KDRO) was located 10 miles southeast of Durango, Colorado, and had an Automated Surface Observing System (ASOS<sup>8</sup>) whose reports were not supplemented. KDRO was located 44 miles west of the accident site, at an elevation of 6,685 feet, and had a 10° easterly magnetic variation (figure 6). The following observations were taken and disseminated during the times surrounding the accident:

[1640 MST] KDRO 142340Z AUTO 00000KT 8SM -RA SCT021 BKN026 OVC050  
04/03 A2991 RMK AO2 LTG DSNT S AND SW RAB2258 P0006 T00390028=

[1647 MST] KDRO 142347Z AUTO 32004KT 10SM VCTS -RA FEW019 BKN033  
OVC048 04/02 A2992 RMK AO2 LTG DSNT SE-SW RAB2258 P0006=

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<sup>8</sup> ASOS – Automated Surface Observing System is equipped with meteorological instruments to observe and report wind, visibility, ceiling, temperature, dewpoint, altimeter, and barometric pressure.

[1648 MST] KDRO 142348Z AUTO 31004KT 10SM VCTS -RA FEW017 BKN033  
OVC050 04/02 A2992 RMK AO2 LTG DSNT SE-SW RAB2258  
SLP130 P0006 60021 T00390022 10067 20033 55009=

[1703 MST] KDRO 150003Z AUTO 25007KT 3SM VCTS +RA BR FEW011 BKN017  
OVC034 04/03 A2993 RMK AO2 P0006 T00390028=

**[1706 MST] KDRO 150006Z AUTO 26014KT 3SM RA BR BKN013 BKN017 OVC034  
04/03 A2994 RMK AO2 P0007 T00390028=**

**[1713 MST] KDRO 150013Z AUTO 27015KT 8SM -RA SCT010 BKN015 OVC024  
04/03 A2995 RMK AO2 P0008 T00390028=**

**ACCIDENT TIME 1725 MST**

**[1727 MST] KDRO 150027Z AUTO 27006KT 9SM -RA BKN013 OVC029 04/02  
A2993 RMK AO2 LTG DSNT SE AND S P0009 T00390022=**

**[1734 MST] KDRO 150034Z AUTO 29007KT 10SM -RA FEW009 SCT014 OVC039  
03/02 A2993 RMK AO2 P0009 T00330022=**

[1753 MST] KDRO 150053Z AUTO 26008KT 10SM SCT046 SCT065 BKN120  
03/02 A2992 RMK AO2 RAE50 SLP136 P0009 T00330022=

[1853 MST] KDRO 150153Z AUTO 24007KT 10SM FEW037 BKN044 BKN055  
04/02 A2993 RMK AO2 RAB10E40 SLP137 P0000 T00390017=

[1953 MST] KDRO 150253Z AUTO 24004KT 10SM SCT043 BKN050 BKN070  
04/02 A2993 RMK AO2 RAB06E23 SLP132 P0000 60009 T00390022 52003=

[2053 MST] KDRO 150353Z AUTO 23006KT 10SM FEW050 FEW070 03/02  
A2993 RMK AO2 RAB0254E11 SLP127 P0000 T00330017=

KDRO weather at 1706 MST was reported as wind from 260° at 14 knots, 3 miles visibility, moderate rain, mist, a broken ceiling at 1,300 agl, broken skies at 1,700 feet agl, overcast skies at 3,400 feet agl, temperature of 4° C, dew point temperature of 3° C, and an altimeter setting of 29.94 inches of mercury. Remarks: automated station with precipitation discriminator, hourly precipitation of 0.07 inches, temperature 3.9° C, dew point temperature 2.8° C.

KDRO weather at 1713 MST was reported as wind from 270° at 15 knots, 8 miles visibility, light rain, scattered clouds at 1,000 feet agl, a broken ceiling at 1,500 agl, overcast skies at 2,400 feet agl, temperature of 4° C, dew point temperature of 3° C, and an altimeter setting of 29.95 inches of mercury. Remarks: automated station with precipitation discriminator, hourly precipitation of 0.08 inches, temperature 3.9° C, dew point temperature 2.8° C.

KDRO weather at 1727 MST was reported as wind from 270° at 6 knots, 9 miles visibility, light rain, a broken ceiling at 1,300 agl, overcast skies at 2,900 feet agl, temperature of 4° C, dew point temperature of 2° C, and an altimeter setting of 29.93 inches of mercury. Remarks: automated station with precipitation discriminator, lightning distant southeast and south, hourly precipitation of 0.09 inches, temperature 3.9° C, dew point temperature 2.2° C.

KDRO weather at 1734 MST was reported as wind from 290° at 7 knots, 10 miles visibility, light rain, few clouds at 900 feet agl, scattered clouds at 1,400 feet agl, an overcast ceiling at 3,900 feet agl, temperature of 3° C, dew point temperature of 2° C, and an altimeter setting of 29.93 inches of mercury. Remarks: automated station with precipitation discriminator, hourly precipitation of 0.09 inches, temperature 3.3° C, dew point temperature 2.2° C.

#### **4.0 Upper Air Data**

A North American Mesoscale (NAM) computer model upper air sounding for the accident site was generated for 1700 MST. The 1700 MST sounding was plotted on a standard Skew-T log P diagram<sup>9</sup> with the derived stability parameters included in figure 7 (with data from the surface to 400-hPa, or 23,000 feet msl). This data was analyzed utilizing the RAOB<sup>10</sup> software package. The sounding depicted the Lifted Condensation Level (LCL)<sup>11</sup> at 9,173 feet msl, a Convective Condensation Level (CCL)<sup>12</sup> of 10,869 feet, and a Level of Free Convection (LFC)<sup>13</sup> at 9,173 feet. The freezing level was located at 9,469 feet. The precipitable water value was 0.41 inches.

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<sup>9</sup> 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.

<sup>10</sup> RAOB – (The complete Rawinsonde Observation program) is an interactive sounding analysis program developed by Environmental Research Services, Matamoras, Pennsylvania.

<sup>11</sup> Lifting Condensation Level (LCL) - The height at which a parcel of moist air becomes saturated when it is lifted dry adiabatically.

<sup>12</sup> Convective Condensation Level (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.

<sup>13</sup> Level of Free Convection (LFC) – The level at which a parcel of saturated air becomes warmer than the surrounding air and begins to rise freely. This occurs most readily in a conditionally unstable atmosphere.

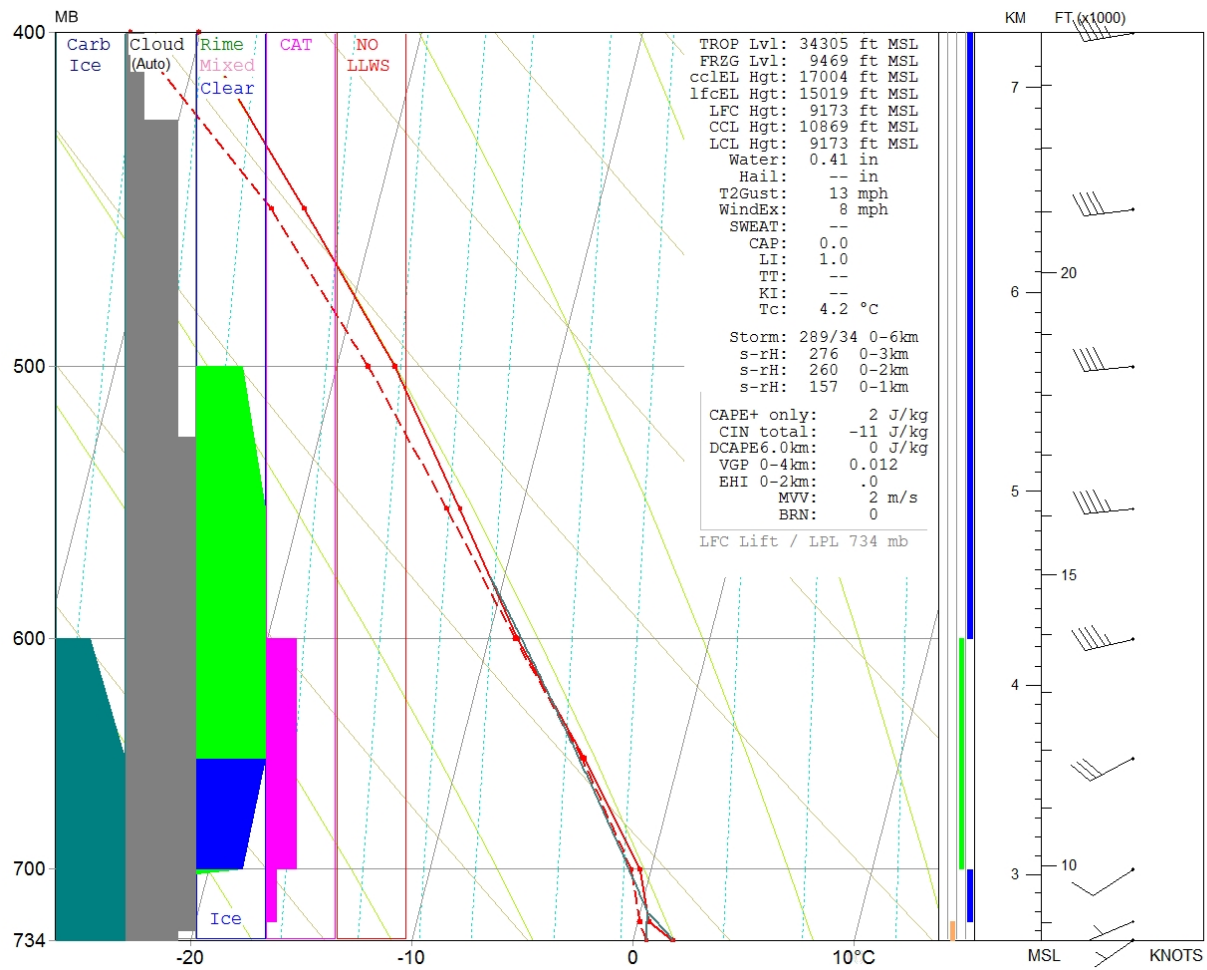


Figure 7 – 1700 MST NAM sounding

The 1700 MST NAM sounding indicated a relatively moist vertical environment from the surface through 23,000 feet msl with a layer of conditional instability. This environment would have been conducive of cloud formation as indicated by RAOB from the surface to 23,000 feet. Icing (clear and rime) was indicated by RAOB between 9,500 and 19,000 feet msl. The NAM sounding was also close to saturation between 0° C and -20° C (between 9,100 and 20,000 feet msl) which is considered a temperature range supportive of the growth of super cooled liquid water droplets (Cober et al. 2001, Bernstein et al. 2007, and Williams et al. in press).<sup>14</sup> In addition, vertical updraft development was supported with the positive Convective Available Potential Energy (CAPE) values indicated on the 1700 MST NAM sounding. Any surface location around the accident site having warmer surface temperatures would have had increased vertical instability and greater updraft speed potential based on CAPE calculations.

The sounding wind profile indicated there was a surface wind from 233° at 6 knots and the wind remained out of the west through 23,000 feet with the wind magnitude between 30 and 45 knots. Low-level wind shear (LLWS) was not indicated by RAOB in the lowest 2,000 feet. A layer of possible clear-air turbulence was identified by RAOB from the surface through 14,000 feet.

## 5.0 Satellite Data

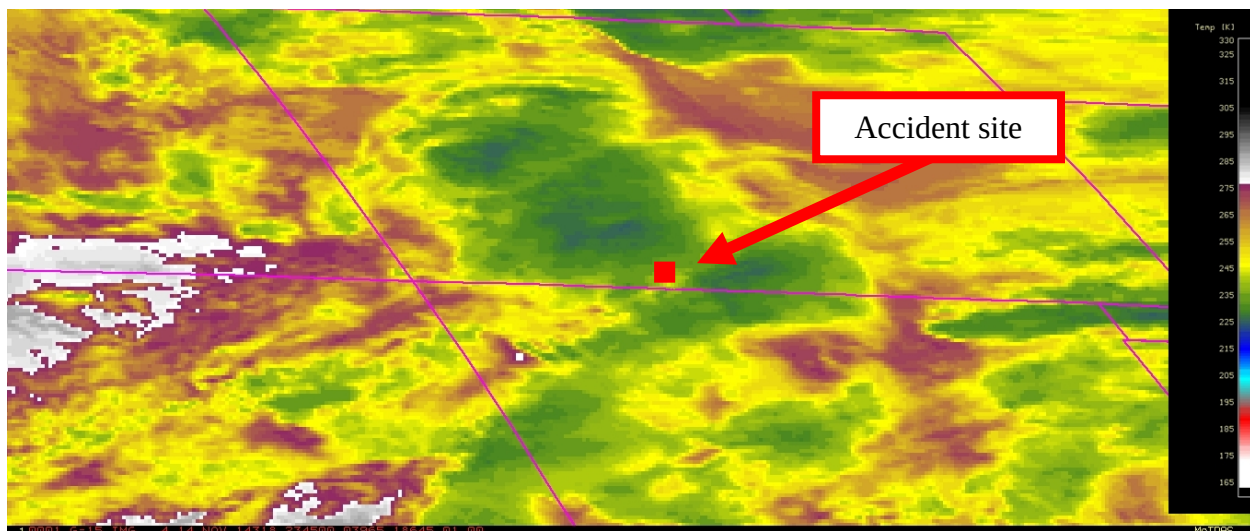
Visible and infrared data from the Geostationary Operational Environmental Satellite number 15 (GOES-15) was obtained from the NCDC and processed with the NTSB's Man-computer Interactive Data Access System (McIDAS) workstation. Visible and infrared imagery (GOES-15 bands 1 and 4) at a wavelength of 0.65 microns (μm) and 10.7 μm retrieved brightness temperatures for the scene. Satellite imagery surrounding the time of the accident, from 1300 MST through 1900 MST at approximately 15-minute intervals, were reviewed and the closest images to the time of the accident are documented here.

Figures 8, 9, and 10 present the GOES-15 infrared imagery from 1645, 1700, and 1730 MST at 4X magnification with the accident site highlighted with a red square. Inspection of the infrared imagery indicated a general west to east movement of the clouds over the accident site at the accident time. The more enhanced bands (greens, and blues, higher cloud tops) were moving eastward over the accident site around the accident time. Based on the brightness temperatures above the accident site and the vertical temperature profile provided by the 1700 MST NAM sounding, the approximate cloud-top heights over the accident site were 29,000 feet at 1730 MST.

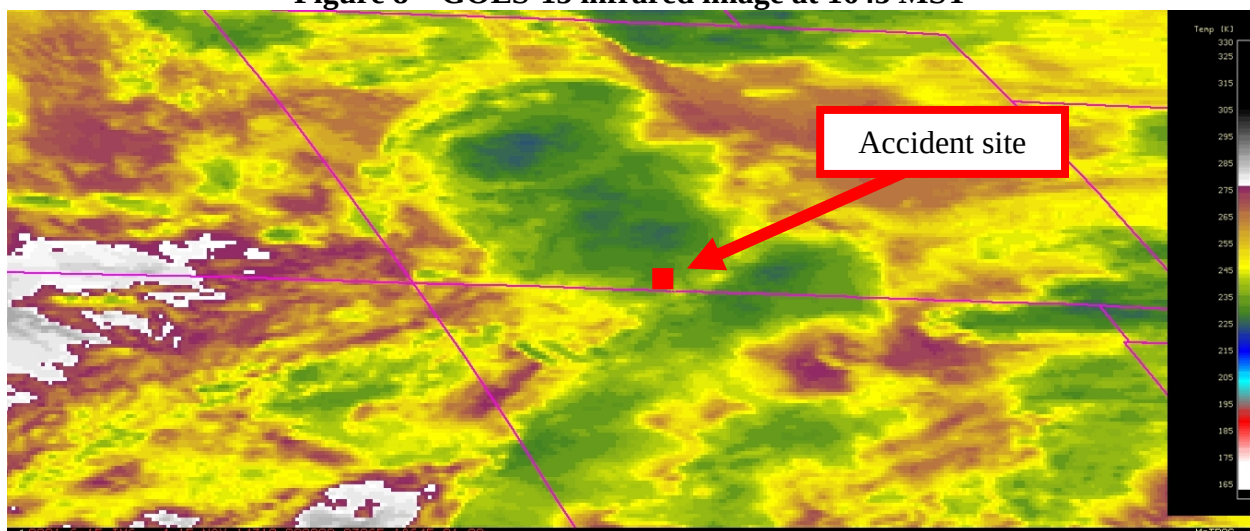
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<sup>14</sup> S.G. Cober, G. A. Isaac, and J. W. Strapp, Characterizations of Aircraft Icing Environments that Include Supercooled Large Drops (Journal of Applied Meteorology, 2001), pp. 1984-2002.  
B.C Bernstein, C.A. Wolff, and F. McDonough, An Inferred Climatology of Icing Conditions Aloft, Including Supercooled Large Drops. Part I: Canada and the Continental United States (Journal of Applied Meteorology and Climatology, 2007), pp. 1857-1878.

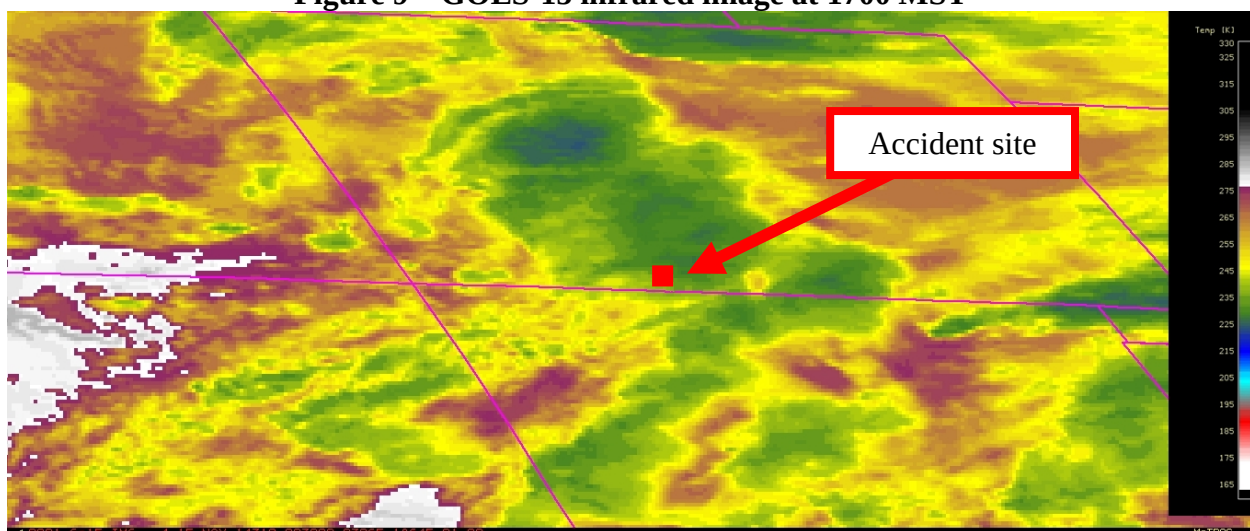
Williams, E.R., D.J. Smalley, M.F. Donovan, R.G. Hallowell, K.T. Hood, B.J. Bennett, R. Evaristo, A. Stepanek, T. Bals-Elsholz, J. Cobb, J. Ritzman, A. Korolev, M. Wolde, Measurements of Differential Reflectivity in Snowstorms in Warm Season Stratiform Systems (Journal of Applied Meteorology and Climatology, 2015), pp. 573-595.



**Figure 8 – GOES-15 infrared image at 1645 MST**



**Figure 9 – GOES-15 infrared image at 1700 MST**



**Figure 10 – GOES-15 infrared image at 1730 MST**

## 6.0 Radar Imagery Information

The closest NWS Weather Surveillance Radar-1988, Doppler (WSR-88D)<sup>15</sup> was KABX located in Albuquerque, New Mexico, located 120 miles south of the accident site with an elevation of 5,951 feet. Level II and III archive radar data was obtained from the NCDC utilizing the NEXRAD Data Inventory Search and displayed using the NOAA's Weather and Climate Toolkit software.

### 6.1 Volume Scan Strategy

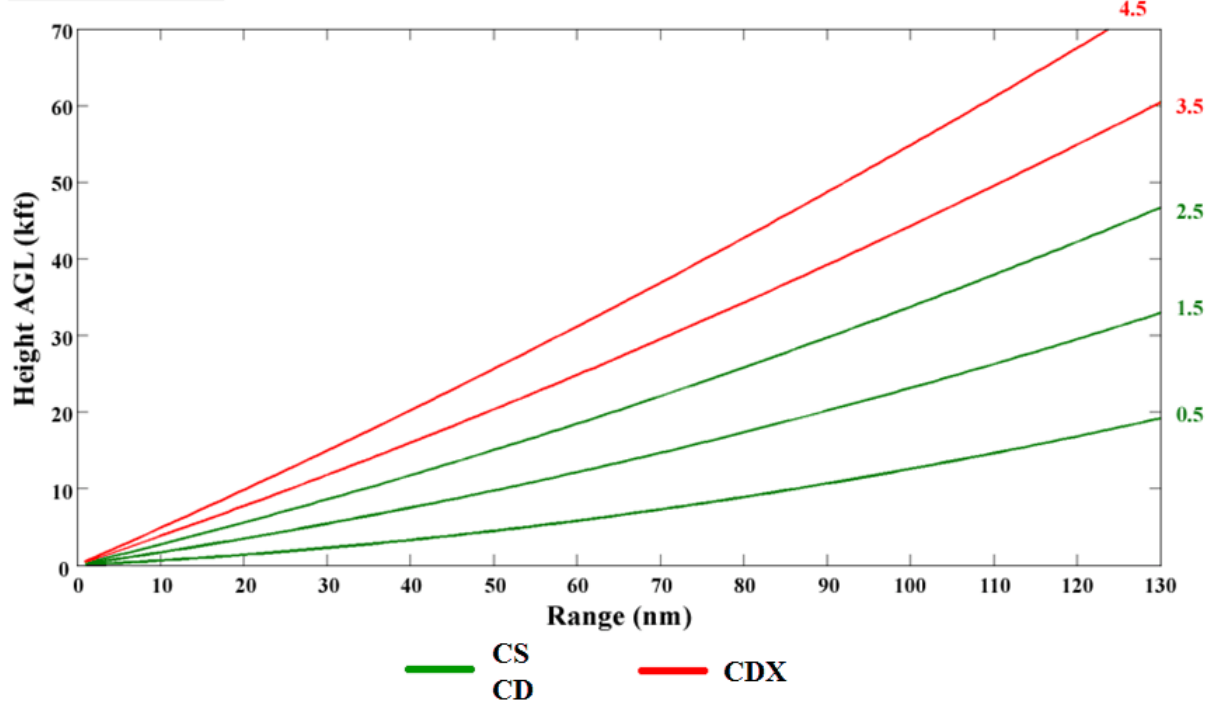
The WSR-88D is a computer-controlled radar system, which automatically creates a complete series of specific scans in a specific sequence known as a volume scan. Individual elevation scans are immediately available on the WSR-88D's Principle Users Processor (PUP). Products that require data from multiple elevation scans are not available until the end of the 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 minutes. This particular scanning strategy is documented as volume coverage pattern 12 (VCP-12). 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 KABX WSR-88D radar was operating in the clear-air mode (Mode B, VCP-31). 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.

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<sup>15</sup> 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.

# VCP 31



**VCP-31 Clear-air Mode Scan Strategy**

## 6.2 Beam Height Calculation

Assuming standard refraction<sup>16</sup> of the WSR-88D 0.95° wide radar beam, the following table shows the approximate beam height and width<sup>17</sup> information<sup>18</sup> of the radar display over the site of the accident. The heights have been rounded to the nearest 10 feet.

| ANTENNA ELEVATION | BEAM CENTER | BEAM BASE   | BEAM TOP    | BEAM WIDTH  |
|-------------------|-------------|-------------|-------------|-------------|
| 0.5°              | 22,770 feet | 16,850 feet | 28,690 feet | 11,840 feet |

Based on the radar height calculations, the 0.5° elevation scan depicted the conditions between 16,850 feet and 28,690 feet msl over the accident site and these are the closest altitudes to the accident flight level before the accident occurred.<sup>19</sup>

<sup>16</sup> Standard Refraction in the atmosphere is when the temperature and humidity distributions are approximately average, and values set at the standard atmosphere.

<sup>17</sup> Beam width – A measure of the angular width of a radar beam.

<sup>18</sup> Beamwidth values are shown for legacy resolution products. Super resolution products would have an effective beamwidth that would be approximately half these values.

<sup>19</sup> For more information please see the ATC report.

### 6.3 Reflectivity

Reflectivity is the measure of the efficiency of a target in intercepting and returning radio energy. With hydrometeors<sup>20</sup> it is a function of the drop size distribution, number of particles per unit volume, physical state (ice or water), shape, and aspect. Reflectivity is normally displayed in decibels (dBZ<sup>21</sup>), and is a general measure of echo intensity. The chart below relates the NWS video integrator and processor (VIP) intensity levels versus the WSR-88D's display levels, precipitation mode reflectivity in decibels, and rainfall rates.

**NWS VIP/DBZ CONVERSION TABLE**

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

<sup>20</sup> 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.

<sup>21</sup> 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.

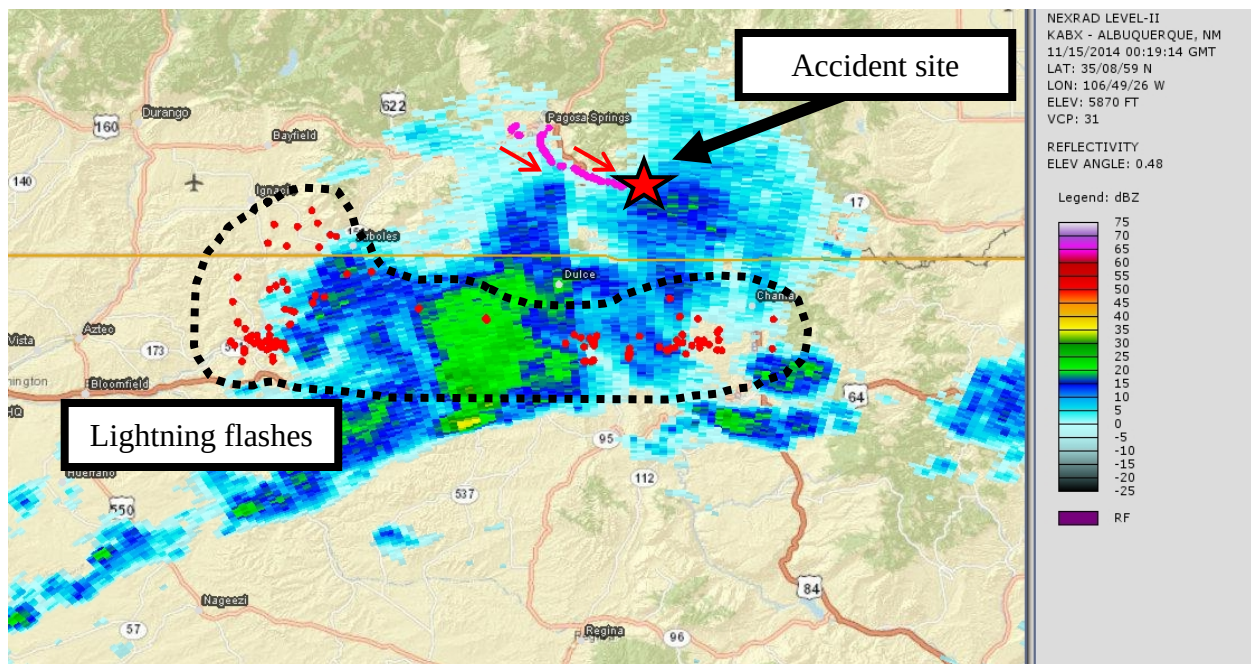
Federal Aviation Administration (FAA) Advisory Circular AC 00-24B, “Thunderstorms,” dated January 2, 1983, also defines the echo intensity levels and potential weather phenomena associated with those levels. If the maximum VIP Level is 1 “weak” and 2 “moderate”, then light to moderate turbulence is possible with lightning. VIP Level 3 is “strong” and severe turbulence is possible with lightning. VIP Level 4 is “very heavy” and severe turbulence is likely with lightning. VIP Level 5 is “intense” with severe turbulence, lightning, hail likely, and organized surface wind gusts. VIP Level 6 is “extreme” with severe turbulence, lightning, large hail, extensive surface wind gusts and turbulence.

#### **6.4 Base Reflectivity and Lightning Data**

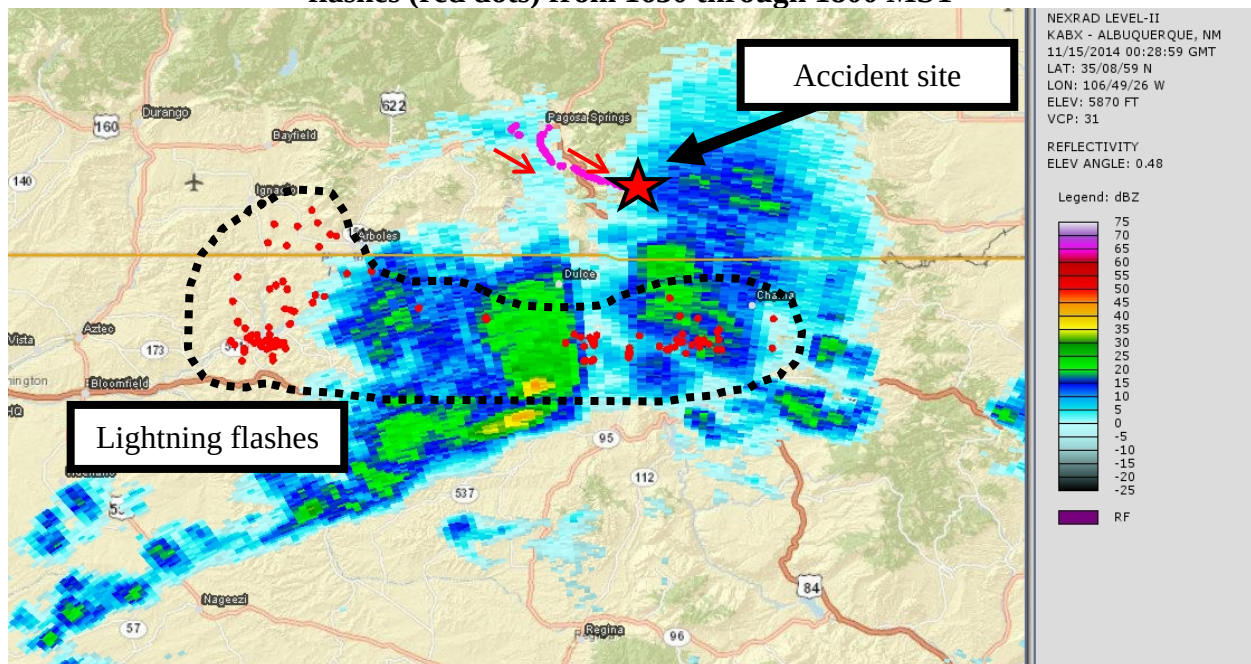
Figures 11, 12, and 13 present the KABX WSR-88D base reflectivity images for the 0.5° elevation scans initiated at 1719, 1729, and 1739 MST with a resolution of 0.5° X 250 m. The ATC flight track (pink dots) is also included with the arrows pointing in the direction of travel (figures 11, 12, and 13). 5 to 20 dBZ base reflectivity values (VIP level 0 to 1) are located over and along the route of flight with the precipitation targets moving from west to east between 1719 and 1739 MST. These reflectivity values corresponded to very light precipitation targets (section 6.3) between 16,850 and 28,690 feet msl over the accident site. Between Pagosa Springs, Colorado, and the accident site there were some radar beam blockage issues due to rising terrain closer to the KABX radar. These radar beam blockage issues caused the base reflectivity to greatly diminish or disappear just east of Pagosa Springs, Colorado, then “reappear” at or just east of the accident site. There were 113 lightning flashes (red dots) near the accident site between 1630 and 1800 MST (figures 11, 12, and 13). The lightning flashes<sup>22</sup> east of the longitude of Dulce, New Mexico, all occurred after 1735 MST.

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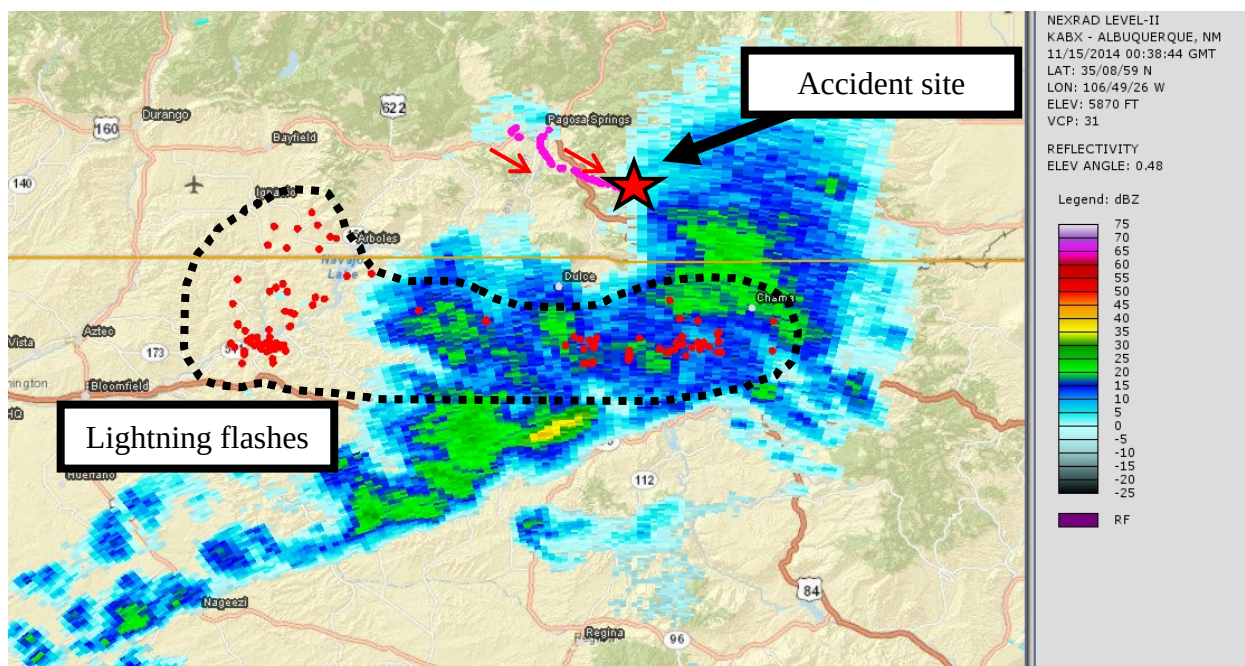
<sup>22</sup> Lightning Flash – This is one contiguous conducting channel and all the current strokes/pulses that flow through it. There are two types of flashes: ground flashes and cloud flashes.



**Figure 11 – KABX WSR-88D reflectivity for the 0.5° elevation scan initiated at 1719 MST, with the ATC flight track (pink dots) and arrows pointing in direction of travel, and lightning flashes (red dots) from 1630 through 1800 MST**



**Figure 12 – KABX WSR-88D reflectivity for the 0.5° elevation scan initiated at 1729 MST, with the ATC flight track (pink dots) and arrows pointing in direction of travel, and lightning flashes (red dots) from 1630 through 1800 MST**



**Figure 13 – KABX WSR-88D reflectivity for the 0.5° elevation scan initiated at 1739 MST, with the ATC flight track (pink dots) and arrows pointing in direction of travel, and lightning flashes (red dots) from 1630 through 1800 MST**

## 7.0 Pilot Reports

All pilot reports (PIREPs) were reviewed close to the accident site from around two hours prior to the accident time to around two hours after the accident time and are displayed below:

FMN UA /OV RSK090020/TM 2300/FL110/TP C208/TB MOD/IC LGT RIME/RM ZDV=

DRO UA /OV DRO/TM 2354/FLDURD/TP DH8D/TA M05/RM FL160-FL100 ZDV=

DRO UA /OV SRO285015/TM 0049/FL280/TP A320/TB MOD/RM FL270-280/ZDV=

ALS UA /OV ALS090030/TM 0059/FL280/TP MD83/TB MOD CHOP/RM ZDV=

Routine pilot report (UA); 20 miles from Farmington, New Mexico, on the 090° radial; Time – 1600 MST (2300Z); Altitude – 11,000 feet; Type aircraft – Cessna C208; Turbulence – Moderate; Icing – Light rime.

Routine pilot report (UA); Over Durango, Colorado; Time – 1654 MST (2354Z); Altitude – During descent; Type aircraft – de Havilland Dash 8; Temperature – -5° C; Remarks – From 16,000 feet down to 10,000 feet.

Routine pilot report (UA); 15 miles from unknown, Colorado, on the 285° radial; Time – 1749 MST (0049Z); Altitude – FL280<sup>23</sup>; Type aircraft – Airbus A320; Turbulence – Moderate; Remarks – Between FL270 and FL280.

<sup>23</sup> Flight Level – A Flight Level (FL) is a standard nominal altitude of an aircraft, in hundreds of feet. This altitude is

Routine pilot report (UA); 30 miles from Alamosa, Colorado, on the 090° radial; Time – 1759 MST (0059Z); Altitude – FL280; Type aircraft – McDonnell Douglas MD-83; Turbulence – Moderate chop.

## 8.0 SIGMET and CWSU Advisories

No Significant Meteorological Information (SIGMET) was valid for the accident site at the accident time.

No Center Weather Service Unit (CWSU) Advisory (CWA) was valid for the accident site at the accident time.

No Meteorological Impact Statement (MIS) was valid for the accident site at the accident time.

## 9.0 AIRMETs

Airmen's Meteorological Information (AIRMET)s Sierra, Tango, and Zulu issued between 1345 MST to 1641 MST were the AIRMETs valid for the accident site at the accident time. The AIRMETs forecasted IFR<sup>24</sup> conditions with precipitation and mist, mountain obscuration, moderate turbulence between the surface and FL350, and moderate icing conditions between the freezing level and FL200 (with the freezing level between the surface and 10,000 feet msl):

WAUS45 KPCI 142341 AAA  
WA5S  
\_SLCS WA 142341 AMD  
AIRMET SIERRA UPDT 5 FOR IFR AND MTN OBSCN VALID UNTIL 150300  
.  
AIRMET IFR...ID MT WY NV UT OR...UPDT  
FROM HLN TO 80SW DIK TO 60SW RAP TO BFF TO 40SE OCS TO 40E SLC  
TO 50SSE MLD TO 50N BAM TO 40W DSD TO HLN  
CIG BLW 010/VIS BLW 3SM PCPN/BR. CONDS CONTG BYD 03Z THRU 09Z.  
.  
**AIRMET IFR...CO...UPDT**  
**FROM CHE TO 50SSW CYS TO 20SSW TBE TO RSK TO DVC TO JNC TO CHE**  
**CIG BLW 010/VIS BLW 3SM PCPN/BR. CONDS CONTG BYD 03Z THRU 09Z.**  
.  
**AIRMET MTN OBSCN...ID MT WY NV UT CO AZ NM WA OR**  
**FROM GTF TO 20NNE BIL TO 20N SHR TO 20SSE LAR TO 20NNW FTI TO**  
**60ENE PHX TO 30S DRK TO 60N PGS TO 60N OAL TO 60SSW FMG TO 40ESE**  
**LKV TO 60WSW OED TO 80WNW OED TO 40N ONP TO 50SSW YKM TO GTF**  
**MTNS OBSC BY CLDS/PCPN/BR. CONDS CONTG BYD 03Z THRU 09Z.**  
....  
WAUS45 KPCI 142254 AAA

---

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.

<sup>24</sup> Instrument Flight Rules – Refers to the general weather conditions pilots can expect at the surface. IFR criteria means a ceiling below 1,000 feet agl and/or less than 3 miles visibility.

WA5Z  
 \_SLCZ WA 142254 AMD  
 AIRMET ZULU UPDT 5 FOR ICE AND FRZLVL VALID UNTIL 150300  
 .  
 ...SEE SIGMET XRAY SERIES...UPDT  
 .  
**AIRMET ICE...ID MT WY NV UT CO AZ NM OR**  
**FROM 70SE HLN TO 20NNE CZI TO 100SE MLS TO 70SW RAP TO SNY TO**  
**30WNW DEN TO PUB TO LAA TO 60SSE TBE TO 60SSE FTI TO 30ESE INW TO**  
**60ENE FMG TO 80WNW BAM TO 60SSE DSD TO 20SW BOI TO 70SE HLN**  
**MOD ICE BTN FRZLVL AND FL200. FRZLVL SFC-100. CONDS CONTG BYD 03Z**  
**THRU 09Z.**  
 .  
 FRZLVL...RANGING FROM SFC-130 ACRS AREA  
 MULT FRZLVL BLW 130 BOUNDED BY 60NNW BFF-BFF-GLD-50W LBL-  
 30ESE TBE-20SSW INK-40SW TCC-30E CIM-20SSE PUB-20E DEN-30S  
 LAR-60NNW BFF  
 SFC ALG 40ESE REO-60SW TWF-40SE MLD-20SSW MTU-30ESE CIM-30ESE  
 TCC  
 080 ALG 40SE ALS-40SE CIM-70WSW LBB  
 080 ALG 20W FMG-50WNW DTA-20NNW HVE-40SE JNC  
 120 ALG 40ESE BZA-30W DMN-60SW CME-50W INK  
 ....  
 WAUS45 KPCI 142045  
 WA5T  
 \_SLCT WA 142045  
 AIRMET TANGO UPDT 3 FOR TURB VALID UNTIL 150300  
 .  
 AIRMET TURB...NV AZ CA AND CSTL WTRS  
 FROM 30SW PGS TO 60ESE BZA TO BZA TO 20S MZB TO 140SW MZB TO 40N  
 LAX TO 30WNW HEC TO 30SW PGS  
 MOD TURB BTN FL240 AND FL370. CONDS ENDG 00-03Z.  
 .  
**AIRMET TURB...UT CO AZ NM**  
**FROM 40SSE SNY TO GLD TO 50W LBL TO 30ESE TBE TO 70SSE TBE TO**  
**70SSW ALS TO 20WSW TBC TO 60S MTU TO 40SSE SNY**  
**MOD TURB BTN FL180 AND FL350. CONDS ENDG 00-03Z.**  
 .  
**AIRMET TURB...WY CO NM**  
**FROM 50SSW JAC TO 60NNW BFF TO 20E SNY TO 20NNW GLD TO 50W LBL**  
**TO 30ESE TBE TO INK TO ELP TO 30SSW DMN TO 50E SJN TO 30S JNC TO**  
**40NNE MTU TO 50SSW JAC**  
**MOD TURB BLW FL180. CONDS CONTG BYD 03Z THRU 09Z.**  
 .  
 AIRMET TURB...ID NV UT OR CA  
 FROM 30NNE EUG TO 40WSW BKE TO 30NNW PIH TO 40ENE PIH TO 50SSE  
 MLD TO 30SW BVL TO 20ESE BAM TO 60NE FMG TO 40ESE RBL TO 30W OED  
 TO 30NNE EUG  
 MOD TURB BLW 140. CONDS CONTG BYD 03Z THRU 09Z.  
 ....

## 10.0 Area Forecast

The Area Forecast, issued by the NWS Aviation Weather Center, issued at 1345 MST, valid at the accident time, forecasted a broken ceiling at 10,000 feet msl with tops to 16,000 feet, visibilities between 3 and 5 miles with scattered light rain and snow showers. Isolated thunderstorms with light snow and rain were also forecast, with the thunderstorms tops to FL350:

FAUS45 KPCI 142045

FA5W

\_SLCC FA 142045

SYNOPSIS AND VFR CLDS/WX

SYNOPSIS VALID UNTIL 151500

CLDS/WX VALID UNTIL 150900...OTLK VALID 150900-151500

ID MT WY NV UT CO AZ NM

.  
SEE AIRMET SIERRA FOR IFR CONDS AND MTN OBSCN.  
TS IMPLY SEV OR GTR TURB SEV ICE LLWS AND IFR CONDS.  
NON MSL HGTS DENOTED BY AGL OR CIG.

.  
SYNOPSIS...ALF...LGT-MOD FLOW WL CONT ACRS NRN SXNS OF THE AREA  
WITH MOD-STG WNW FLOW ELSW. A WK SHRTWV TROF WILL EXTEND FROM  
UT-AZ BY 06Z AND INTO CO AND NM BY 15Z. AT SFC...A STNR FRONT  
WILL SLOWLY SAG SWD AND EXTEND FROM NRN CA CSTL WTRS TO NRN UT  
AND NRN CO BY 15Z.

.  
ID

N 1/3...SKC. OTLK...VFR.

S 2/3...OVC050 TOP 100. OTLK...MVFR CIG.

CNTRL MTNS...OVC050 TOP 100. VIS 5SM WDLY SCT SHSN. OTLK...MVFR  
CIG SN.

SWRN...OVC060 TOP FL180. VIS 3-5SM -RASN. 06Z BKN060. SCT -SHSN.

OTLK...MVFR CIG SHSN.

SERN...OVC070 TOP FL180. VIS 3-5SM -SNRA. 02Z BKN070 TOP FL200.

WDLY SCT -SHSN. OTLK...MVFR CIG SHSN.

.  
MT

CONTDVD WWD...

N 1/3...SKC. OTLK...VFR.

S 2/3...BKN070 TOP 130. VIS 5SM WDLY SCT -SHSN BR. 23Z OVC060.

VIS 3-5SM -SN BR. OTLK...MVFR CIG SHSN.

SWRN MTNS...OVC070 TOP FL180. VIS 3-5SM SN BR. OTLK...IFR CIG  
SHSN.

ERN SLOPES OF CONTDVD...SCT100. TIL 23Z ISOL -SHSN. OTLK...VFR.

N CNTRL-NERN...SCT040. ISOL -SHSN. OTLK...VFR.

S CNTRL...BKN100 TOP 160. 23Z SCT080 BKN120. ISOL -SHSN.

OTLK...VFR.

SERN...SCT120. 22Z BKN120 TOP 160. OTLK...VFR.

.  
WY

NWRN MTNS...OVC070 TOP FL180. VIS 3-5SM -SN. OTLK...IFR CIG SN.

SWRN MTNS...BKN080 TOP 150. ISOL -SHSN. OTLK...MVFR CIG.

S CNTRL-SERN SXNS...BKN100 TOP FL180. ISOL -SHSN. OTLK...VFR.

N CNTRL-NERN SXNS...BKN100 TOP FL180. ISOL -SHSN. 01Z OVC070. VIS

3-5SM -SN. OTLK...IFR CIG SN.

.

NV

NWRN 1/4...SCT-BKN080 TOP 160. ISOL -SHSN. OTLK...MVFR CIG.

NERN 1/4...BKN090 TOP 160. WDLY SCT -SHSN. OTLK...MVFR CIG

SHRASN.

SRN 1/2...SCT150 BKN CI. OTLK...VFR.

.

UT

NRN HLF...BKN100 TOP 160. WDLY SCT -SHRASN. OTLK...MVFR CIG

SHRASN.

SRN HLF...BKN100 TOP FL200. WDLY SCT -SHRA/ISOL TSRA. CB TOP

FL350. OTLK...VFR.

.

CO

PLAINS...SCT CI. 00Z SCT150 WITH BKN CI ABV. OTLK...VFR.

MTNS E OF CONTDVD...BKN080 TOP 150. VIS 5SM WDLY SCT -SHSN.

OTLK...MVFR CIG SHSN.

**MTNS W OF CONTDVD...BKN100 TOP 160. VIS 3-5SM SCT -SHSNRA. ISOL  
-TSSNRA S 1/4. CB TOP FL350. OTLK...MVFR CIG SHSN.**

.

AZ

NW-N CNTRL...BKN090 TOP FL220. WDLY SCT -SHRA/ISOL -TSRA. CB TOPS  
FL350. OTLK...VFR.

NERN...BKN090 TOP FL220. ISOL -SHRA/-TSRA. CB TOPS FL350.

OTLK...VFR.

SWRN...SCT120 BKN CI. OTLK...VFR.

SERN...SCT100 BKN CI. OTLK...VFR.

.

NM

MTNS AND W...

N 1/3...BKN100 TOP FL200. WDLY SCT -SHRA/ISOL -TSRA. CB TOP

FL350. 01Z OVC100. SCT -SHRASN/ISOL -TSRASN. OTLK...VFR.

S 2/3...SCT-BKN CI. 02Z SCT100 WITH BKN CI ABV. OTLK...VFR.

PLAINS...

NRN SXNS...SCT090 SCT140. 00Z SCT150 WITH BKN CI ABV. OTLK...VFR.

SRN SXNS...SCT070 SCT CI. 00Z BKN CI. OTLK...VFR.

....

## 11.0 Terminal Aerodrome Forecast (TAF)

KDRO was the closest site with a NWS TAF. The TAF valid at the time of the accident was issued at 1638 MST and was valid for a 24-hour period beginning at 1700 MST. The TAF forecast for KDRO was as follows:

TAF KDRO 142338Z 1500/1524 **22006KT 6SM -RA BR FEW010 BKN025 OVC035**

FM150200 VRB04KT P6SM VCSH SCT030 OVC050

TEMPO 1502/1504 6SM -RA BR BKN025

FM150400 25006KT P6SM SCT020 OVC050

FM151800 26012KT P6SM SCT050 BKN090=

The forecast expected a wind from 220° at 6 knots, 6 miles visibility, light rain, mist, few clouds at 1,000 feet agl, a broken ceiling at 2,500 feet agl, and overcast skies at 3,500 feet agl around the time of the accident.

## 12.0 National Weather Service Area Forecast Discussion

The National Weather Service Office in Grand Junction, Colorado, issued an Area Forecast Discussion (AFD) at 1452 MST. The aviation section of the AFD mentioned lowering ceilings and visibilities south of Interstate 70 with isolated thunder possible across southern Colorado, but left isolated thunder out of the TAFs because confidence level of occurrence was low:

FXUS65 KGJT 142152

AFDGJT

AREA FORECAST DISCUSSION

NATIONAL WEATHER SERVICE GRAND JUNCTION CO

252 PM MST FRI NOV 14 2014

.SHORT TERM...(THIS EVENING THROUGH SATURDAY NIGHT)

ISSUED AT 219 PM MST FRI NOV 14 2014

LEAD PACIFIC SHORTWAVE TROUGH MOVING ACROSS UT/CO THIS EVENING HAS ALREADY SPREAD SHOWERS ACROSS AREAS MAINLY SOUTH OF INTERSTATE 70 AND THIS WILL CONTINUE THROUGH ABOUT MID EVENING. THE FOCUS OF STEADIER AND HEAVIER PRECIPITATION WILL BE SOUTH OF MONTROSE OVER THE SAN JUAN MTNS. INSTABILITY EVIDENCED BY LIGHTNING DETECTED OVER SRN UT WILL ALSO ENABLE ISOLATED THUNDERSTORM ACTIVITY ACROSS SRN CO...ENHANCING PRECIP RATES EARLY TONIGHT. IN THE WAKE OF THIS SHORTWAVE...MODERATELY MOIST WNW FLOW WILL CONTINUE OVERNIGHT AHEAD OF THE APPROACHING STRONG NORTHERN STREAM TROUGH. THIS WILL CONTINUE MAINLY OROGRAPHICALLY DRIVEN SNOWFALL FOR THE HIGHER TERRAIN.

FRONTAL FORCING AND UPPER LEVEL JET DYNAMICS MOVE SOUTH OVER THE FORECAST AREA DURING THE DAY SATURDAY. FRONTAL TIMING LOOKS TO BE INTO NE UT/NW CO BY 8 AM...I-70 CORRIDOR AROUND 2 PM...AND OVER SRN UT/CO BETWEEN 5 PM AND MIDNIGHT SATURDAY NIGHT. ATTENDANT WITH THIS FRONTAL PASSAGE WILL BE A BURST OF PRECIPITATION FOR MOST AREAS. SNOWLEVELS WILL BE TRICKY FOR THE LOWER VALLEYS AND DEPENDING ON EXACT TIMING...THE PRECIP COULD REMAIN ALL LIQUID. IMMEDIATELY FOLLOWING THE FRONT PASSAGE THE FLOW TURNS MORE NORTHERLY AND WILL PROVIDE A PERIOD OF OROGRAPHICALLY DRIVEN SNOWFALL FOR THE FAVORED NORTHERLY FLOW UPSLOPE AREAS UNTIL THE MOISTURE PLUME DRIES UP.

WILL MAINTAIN CURRENT WINTER STORM WARNINGS AND ADVISORY...AND HAVE ADDED ZONE 8...THE UPPER INTERSTATE 70 CORRIDOR TO AN ADVISORY FOR LATE TONIGHT THROUGH SATURDAY NIGHT. AN ADDITIONAL 6 TO 15 INCHES OF SNOW CAN BE EXPECTED IN THE MOUNTAINS...AND 1-4 IN THE HIGHER VALLEYS THROUGH SATURDAY NIGHT. SOME LOWER VALLEYS COULD SEE A TRACE TO ONE INCH OF SNOW EITHER TONIGHT OR POST-FRONT LATE SATURDAY.

.LONG TERM...(SUNDAY THROUGH FRIDAY)

ISSUED AT 219 PM MST FRI NOV 14 2014

ARCTIC AIR WILL BE ENTRENCHED OVER THE AREA SUNDAY AND MONDAY WITH TEMPERATURES WELL BELOW NORMAL. AREAS ALONG AND SOUTH OF INTERSTATE 70 WILL LIKELY SEE THE COLDEST MIN TEMPS OF THE SEASON MONDAY MORNING WITH LOWS IN THE SINGLE DIGITS AND TEENS. NORTH TO NORTHWEST UPPER LEVEL FLOW WILL CONTINUE INTO THE MID WEEK AND SQUEEZE OUT ADDITIONAL SNOW SHOWERS OVER THE DIVIDE SUNDAY AND SUNDAY NIGHT...BUT SNOWFALL SHOULD BE LIGHT.

HEIGHTS GRADUALLY RISE WITH SHARP RIDGE ALONG THE WEST COAST

DEAMPLIFYING AND MOVING EAST. WILL SEE SOME WARMING THROUGH THE WEEK...BACK TO NEAR NORMAL LEVELS BY WEDNESDAY. PACIFIC MOISTURE FLOWS OVER OUR AREA THURSDAY...MAINLY OVER THE NORTH...WHICH WILL PROVIDE A CHANCE FOR SNOW IN THE FLAT TOPS...PARK AND GORE RANGES. LOOKS CONTINUED ACTIVE INTO NEXT WEEKEND...BUT DETAILS UNCERTAIN. HAVE ACCEPTED THE LOW POPS GENERATED BY A BLEND OF MODEL SOLUTIONS FOR NEXT FRIDAY NIGHT.

&&

**.AVIATION...(FOR THE 18Z TAFS THROUGH 18Z SATURDAY AFTERNOON)  
ISSUED AT 1036 AM MST FRI NOV 14 2014**

**CHALLENGING TAF PERIOD WITH THE APPROACHING SHORTWAVE DUE TO AFFECT AREAS MAINLY SOUTH OF INTERSTATE 70 LATE THIS AFTERNOON THROUGH TONIGHT. HAVE FOLLOWED THE CONSENSUS OF MODELS THAT KEEP STEADIER PRECIP SOUTH OF A LINE FROM KMTJ TO KASE AND TRIED TO TIME THIS PERIOD AND ASSOCIATED LOWER VSBY AND CIG THROUGH THE TAF SITES. WILL LIKELY HAVE IFR MINIMUMS REACHED AT KTEX AND KASE OVERNIGHT AND POSSIBLY AT KEGE. ISOLATED THUNDER POSSIBLE OVER AND SOUTH OF SAN JAN MTNS...BUT DID NOT MENTION IN THE TAFS DUE TO CONFIDENCE LEVEL. SOME IMPROVEMENT IN CONDITIONS TEMPORARILY SAT MORNING BEFORE NEXT SURGE OF PRECIPITATION MOVES IN FOR THE LATTER HALF OF THE DAY NORTH TO SOUTH.**

&&

**.GJT WATCHES/WARNINGS/ADVISORIES...**

**CO...WINTER STORM WARNING UNTIL MIDNIGHT MST SATURDAY NIGHT FOR  
COZ004-005-009-010-012>014.**

**WINTER STORM WARNING UNTIL 6 AM MST SUNDAY FOR COZ018-019.**

**WINTER WEATHER ADVISORY UNTIL MIDNIGHT MST SATURDAY NIGHT FOR  
COZ017.**

**WINTER WEATHER ADVISORY FROM 1 AM SATURDAY TO MIDNIGHT MST  
SATURDAY NIGHT FOR COZ008.**

**WINTER STORM WARNING UNTIL 6 PM MST SATURDAY FOR COZ002.**

**UT...WINTER STORM WARNING UNTIL MIDNIGHT MST SATURDAY NIGHT FOR  
UTZ028.**

&&

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### **13.0 National Weather Service Winter Weather Products**

The National Weather Service Office in Grand Junction, Colorado, issued a set of winter weather warnings and advisories for western and southern Colorado on November 14. The most updated and current warning valid for the accident site at the accident time was a winter storm warning issued at 1445 MST for the Southwestern San Juan Mountains. The winter storm warning warned of heavy snow with 8 to 14 inches of snow accumulation, west wind 15 to 25 mph with gusts to 45 mph above 9,500 feet msl, and poor visibility due to the combination of snow, fog, and drifting and blowing snow:

WWUS45 KGJT 142145

WSWGJT

URGENT - WINTER WEATHER MESSAGE

NATIONAL WEATHER SERVICE GRAND JUNCTION CO

245 PM MST FRI NOV 14 2014

.WEATHER RADAR INDICATES HEAVIER PRECIPITATION TRACKING EAST ACROSS SOUTHCENTRAL AND SOUTHEAST UTAH. A FEW THUNDERSTORMS ARE EMBEDDED IN THE SHOWERS CURRENTLY OVER SOUTHEAST UTAH. ANOTHER BAND

OF RAIN AND SNOW SHOWERS IS CONTINUING ACROSS I-70 FROM SILT AND EAST. SNOW IS EXPECTED TO PICK UP IN INTENSITY OVER THE SAN JUANS THROUGH THE EVENING HOURS AND SPREAD INTO THE NORTHERN MOUNTAINS AS WELL.

COZ004-009-010-012-013-150545-

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ELKHEAD AND PARK MOUNTAINS-GRAND AND BATTLEMENT MESAS-

GORE AND ELK MOUNTAINS/CENTRAL MOUNTAIN VALLEYS-

WEST ELK AND SAWATCH MOUNTAINS-FLATTOPS-

INCLUDING THE CITIES OF...TOPONAS...SKYWAY...ASPEN...VAIL...

CRESTED BUTTE...MARBLE...BUFORD...TRAPPERS LAKE

245 PM MST FRI NOV 14 2014

...WINTER STORM WARNING REMAINS IN EFFECT UNTIL MIDNIGHT MST SATURDAY NIGHT...

\* TIMING...SNOW SHOWERS WILL INCREASE IN COVERAGE AND INTENSITY LATE THIS AFTERNOON AND OVERNIGHT. PERIODS OF HEAVY SNOW WILL BE POSSIBLE TONIGHT THROUGH SATURDAY EVENING.

\* SNOW ACCUMULATION...ADDITIONAL 6 TO 14 INCHES WITH LOCALLY HIGHER AMOUNTS POSSIBLE.

\* WINDS...ABOVE 9500 FEET...WEST 20 TO 30 MPH WITH GUSTS UP TO 40 MPH.

\* IMPACTS...ALL MOUNTAIN PASSES WILL BE ICY AND SNOWPACKED. THE COMBINATIONS OF SNOW...FOG...AND DRIFTING AND BLOWING SNOW OVER MOUNTAIN PASSES WILL MAKE TRAVEL CHALLENGING DUE TO POOR VISIBILITY. THIS INCLUDES MCCLURE...VAIL AND RABBIT EARS PASSES... HIGHWAY 65 OVER GRAND MESA AND HIGHWAY 50 OVER MONARCH PASS.

PRECAUTIONARY/PREPAREDNESS ACTIONS...

A WINTER STORM WARNING MEANS SIGNIFICANT AMOUNTS OF SNOW ARE EXPECTED OR OCCURRING. STRONG WINDS AND BLOWING SNOW ARE ALSO POSSIBLE. THIS WILL MAKE TRAVEL VERY HAZARDOUS OR IMPOSSIBLE.

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COZ018-019-150545-

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NORTHWEST SAN JUAN MOUNTAINS-SOUTHWEST SAN JUAN MOUNTAINS-

INCLUDING THE CITIES OF...OURAY...TELLURIDE...LAKE CITY...

SILVERTON...RICO...HESPERUS

245 PM MST FRI NOV 14 2014

...WINTER STORM WARNING REMAINS IN EFFECT UNTIL 6 AM MST SUNDAY...

\* TIMING...SNOW SHOWERS ARE BEGINNING TO INCREASE IN COVERAGE AND MODERATE SNOW WILL BECOME WIDESPREAD LATE THIS AFTERNOON AND OVERNIGHT. SNOW WILL BE HEAVY AT TIMES WITH RATES IN EXCESS OF INCH PER HOUR. EXPECT PERIODS OF SNOW TO CONTINUE INTO SUNDAY MORNING.

\* SNOW ACCUMULATION...ADDITIONAL 8 TO 14 INCHES WITH LOCALLY HIGHER AMOUNTS UP TO 18 INCHES.

\* WINDS...ABOVE 9500 FEET...WEST 15 TO 25 MPH WITH GUSTS UP TO 45 MPH.

\* IMPACTS...ALL MOUNTAIN PASSES WILL HAVE ICY AND SNOWPACKED CONDITIONS. THE COMBINATIONS OF SNOW...FOG...AND DRIFTING AND BLOWING SNOW OVER MOUNTAIN PASSES WILL MAKE TRAVEL CHALLENGING DUE TO POOR VISIBILITY.

PRECAUTIONARY/PREPAREDNESS ACTIONS...

A WINTER STORM WARNING MEANS SIGNIFICANT AMOUNTS OF SNOW ARE EXPECTED OR OCCURRING. STRONG WINDS AND BLOWING SNOW ARE ALSO

**POSSIBLE. THIS WILL MAKE TRAVEL VERY HAZARDOUS OR IMPOSSIBLE.**

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COZ005-150545-

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UPPER YAMPA RIVER BASIN-

245 PM MST FRI NOV 14 2014

...WINTER STORM WARNING REMAINS IN EFFECT UNTIL MIDNIGHT MST

SATURDAY NIGHT...

\* TIMING...A DOWNTURN IN SNOWFALL IS OCCURRING WITH PASSING SHOWERS ONLY PRODUCING LIGHT SNOW. THE SNOW WILL PICK UP IN COVERAGE AND INTENSITY TONIGHT...AND OCCASIONALLY BE HEAVY AT TIMES THROUGH SATURDAY AFTERNOON.

\* SNOW ACCUMULATION...AN ADDITIONAL 5 TO 10 INCHES.

\* IMPACTS...ROADS WILL STAY ICY AND SNOWPACKED.

PRECAUTIONARY/PREPAREDNESS ACTIONS...

A WINTER STORM WARNING MEANS SIGNIFICANT AMOUNTS OF SNOW ARE EXPECTED OR OCCURRING. STRONG WINDS AND BLOWING SNOW ARE ALSO POSSIBLE. THIS WILL MAKE TRAVEL VERY HAZARDOUS OR IMPOSSIBLE.

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CENTRAL YAMPA RIVER BASIN-

INCLUDING THE CITIES OF...CRAIG...HAYDEN...MEEKER

245 PM MST FRI NOV 14 2014

...WINTER STORM WARNING REMAINS IN EFFECT UNTIL 6 PM MST

SATURDAY...

\* TIMING...A DOWNTURN IN ACTIVITY WILL CONTINUE TODAY WITH ONLY LIGHT ACCUMULATIONS FROM PASSING SNOW SHOWERS. BY THIS EVENING THE SNOW WILL INCREASE IN COVERAGE AND INTENSITY AND BE HEAVY AT TIMES THROUGH SATURDAY AFTERNOON.

\* SNOW ACCUMULATION...ADDITIONAL 3 TO 7 INCHES.

\* IMPACTS...ROADS WILL STAY ICY AND SNOWPACKED.

PRECAUTIONARY/PREPAREDNESS ACTIONS...

A WINTER STORM WARNING MEANS SIGNIFICANT AMOUNTS OF SNOW ARE EXPECTED OR OCCURRING. STRONG WINDS AND BLOWING SNOW ARE ALSO POSSIBLE. THIS WILL MAKE TRAVEL VERY HAZARDOUS OR IMPOSSIBLE.

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COZ014-150545-

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UPPER GUNNISON RIVER VALLEY-

INCLUDING THE CITIES OF...GUNNISON...CIMARRON

245 PM MST FRI NOV 14 2014

...WINTER STORM WARNING REMAINS IN EFFECT UNTIL MIDNIGHT MST

SATURDAY NIGHT...

\* TIMING...SNOW WILL BE PICKING UP IN COVERAGE AND INTENSITY THIS EVENING AND OVERNIGHT ACROSS THE GUNNISON BASIN AND CERRO SUMMIT. HEAVY SNOW WILL BE POSSIBLE AT TIMES.

\* SNOW ACCUMULATION...STORM TOTAL 3 TO 6 INCHES IN THE LOWER GUNNISON BASIN. 5 TO 9 INCHES NEAR CERRO SUMMIT.

\* IMPACTS...WITH TEMPERATURES REMAINING NEAR TO BELOW FREEZING...ROADS WILL REMAIN ICY AND SNOWPACKED.

PRECAUTIONARY/PREPAREDNESS ACTIONS...

A WINTER STORM WARNING MEANS SIGNIFICANT AMOUNTS OF SNOW ARE

EXPECTED OR OCCURRING. STRONG WINDS AND BLOWING SNOW ARE ALSO POSSIBLE. THIS WILL MAKE TRAVEL VERY HAZARDOUS OR IMPOSSIBLE.

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LA SAL AND ABAJO MOUNTAINS-

245 PM MST FRI NOV 14 2014

...WINTER STORM WARNING REMAINS IN EFFECT UNTIL MIDNIGHT MST SATURDAY NIGHT ABOVE 8500 FEET...

\* TIMING...SNOW WILL INCREASE IN COVERAGE AND INTENSITY EARLY THIS EVENING AND CONTINUING THROUGH SATURDAY NIGHT.

\* SNOW ACCUMULATION...ADDITIONAL 4 TO 8 INCHES ABOVE 8500 FEET.

\* WINDS...WEST 15 TO 25 MPH WITH GUSTS UP TO 45 MPH.

\* IMPACTS...ROADS WILL BECOME ICY AND SNOWPACKED. IN ADDITION... BLOWING SNOW WILL REDUCE VISIBILITY SIGNIFICANTLY AT TIMES.

PRECAUTIONARY/PREPAREDNESS ACTIONS...

A WINTER STORM WARNING MEANS SIGNIFICANT AMOUNTS OF SNOW ARE EXPECTED OR OCCURRING. STRONG WINDS AND BLOWING SNOW ARE ALSO POSSIBLE. THIS WILL MAKE TRAVEL VERY HAZARDOUS OR IMPOSSIBLE.

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COZ008-150545-

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CENTRAL COLORADO RIVER BASIN-

INCLUDING THE CITIES OF...GLENWOOD SPRINGS...EAGLE...CARBONDALE

245 PM MST FRI NOV 14 2014

...WINTER WEATHER ADVISORY IN EFFECT FROM 1 AM SATURDAY TO MIDNIGHT MST SATURDAY NIGHT...

THE NATIONAL WEATHER SERVICE IN GRAND JUNCTION HAS ISSUED A WINTER WEATHER ADVISORY FOR SNOW...WHICH IS IN EFFECT FROM 1 AM SATURDAY TO MIDNIGHT MST SATURDAY NIGHT.

\* TIMING...SNOW SHOWERS ARE EXPECTED TO INCREASE IN COVERAGE AFTER MIDNIGHT TONIGHT. MODERATE TO HEAVY SNOWFALL WILL BE POSSIBLE OVERNIGHT TONIGHT THROUGH SATURDAY NIGHT.

\* SNOW ACCUMULATION...2 TO 4 INCHES.

\* WINDS...WEST 10 TO 20 MPH.

\* IMPACTS...ROADS WILL BECOME ICY AND SNOWPACKED.

PRECAUTIONARY/PREPAREDNESS ACTIONS...

A WINTER WEATHER ADVISORY MEANS THAT PERIODS OF SNOW AND/OR BLOWING SNOW WILL CAUSE TRAVEL DIFFICULTIES. BE PREPARED FOR SLIPPERY ROADS AND LIMITED VISIBILITIES...AND USE CAUTION WHILE DRIVING.

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UNCOMPAHGRE PLATEAU AND DALLAS DIVIDE-

245 PM MST FRI NOV 14 2014

...WINTER WEATHER ADVISORY REMAINS IN EFFECT UNTIL MIDNIGHT MST SATURDAY NIGHT ABOVE 7500 FEET...

\* TIMING...MODERATE TO HEAVY SNOWFALL WILL BE POSSIBLE THIS EVENING THROUGH SATURDAY EVENING.

\* SNOW ACCUMULATION...ABOVE 7500 FEET AND ADDITIONAL 3 TO 6 INCHES WITH AMOUNTS UP TO 12 INCHES ABOVE 9000 FEET.

\* WINDS...ABOVE 9000 FEET...SOUTHWEST 10 TO 20 MPH WITH GUSTS UP

TO 35 MPH.  
\* IMPACTS...ROADS WILL BECOME ICY AND SNOWPACKED. IN ADDITION...  
BLOWING SNOW WILL REDUCE VISIBILITY AT TIMES.  
PRECAUTIONARY/PREPAREDNESS ACTIONS...  
A WINTER WEATHER ADVISORY MEANS THAT PERIODS OF SNOW AND/OR  
BLOWING SNOW WILL CAUSE TRAVEL DIFFICULTIES. BE PREPARED FOR  
SLIPPERY ROADS AND LIMITED VISIBILITIES...AND USE CAUTION WHILE  
DRIVING.  
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#### **14.0 Pilot Weather Briefing**

A search of official weather briefing sources, such as Lockheed Martin Flight Service (LMFS) and Direct User Access Terminal Service (DUATS), did not reveal the pilot received a weather briefing prior to departure. There is no knowledge of any additional weather briefing information the accident pilot received.

#### **15.0 Astronomical Data**

The astronomical data obtained from the United States Naval Observatory for the accident site on November 14, 2014, indicated the following:

| <b>SUN</b>           |          |
|----------------------|----------|
| Begin civil twilight | 0618 MST |
| Sunrise              | 0645 MST |
| Sun transit          | 1152 MST |
| Sunset               | 1658 MST |
| End civil twilight   | 1726 MST |

#### **F. LIST OF ATTACHMENTS**

None.

Paul Suffern  
NTSB, AS-30