



NATIONAL TRANSPORTATION SAFETY BOARD

**Office of Aviation Safety
Washington, D.C. 20594**

December 23, 2013

Group Chairman's Factual Report

METEOROLOGY

CEN14FA032

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A. ACCIDENT

Location: Castle Rock, Colorado
Date: October 28, 2013
Time: About 1900 mountain daylight time (0100 UTC¹)
Airplane: Glasair Sportsman GS-2; registration N535SP

B. METEOROLOGY GROUP

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C. SUMMARY

On October 28, 2013, about 1900 mountain daylight time, a Glasair Sportsman GS-2, N535SP, impacted terrain after contact with a utility wire near Castle Rock, Colorado. The commercial pilot sustained serious injuries and the aircraft was substantially damaged. The aircraft was registered to and operated by a private under the provisions of 14 Code of Federal Regulations Part 91 as a positioning flight. Instrument meteorological conditions prevailed for the flight, which operated on an instrument flight rules flight plan. The flight originated from Yampa Valley Airport (KHND), Hayden, Colorado at 1743, and Front Range Airport (KFTG), Denver, Colorado was the intended destination.

According to the Federal Aviation Administration, the flight was in radio and radar contact with Denver TRACON assisting the pilot through weather into Centennial Airport (KAPA). The airplane was last seen at 6,800 feet mean sea level before radar and radio contact was lost. No distress calls or further communications were received from the accident airplane.

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 National Climatic Data Center (NCDC). All times are mountain daylight time (MDT) based upon the 24 hour clock, local time is +6 hours to UTC, and UTC=Z. Directions are referenced to true north and distances in nautical miles. Heights are above mean sea level (msl) unless otherwise noted. Visibility is in statute miles and fractions of statute miles. All NWS observations and forecasts use the International Civil Aviation Organization (ICAO) four-

¹ UTC – is an abbreviation for Coordinated Universal Time.

letter station identifiers. All airports in the 48 contiguous states begin with the letter “K” for the country code followed by the three-letter identifier for the airport.

The accident site plotted in this report and based on the reported accident site located at latitude 39.4241° N and longitude 104.8455° W.

E. FACTUAL INFORMATION

1.0 Synoptic Situation

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

1.1 Surface Analysis Chart

The NWS Surface Analysis Chart for 1800 MDT (0000Z October 29, 2013) is included as figure 1 with the approximate accident site indicated. The chart depicted a low pressure system at 998-hectopascals (hPa) over Idaho associated with an occluded front that extended southeastward into Utah to another low at 998-hPa, where the occluded front became a cold front and extended south-southwest across Utah and into Nevada. Another stationary front was located immediately east over Idaho into southern Wyoming, and then due south across central Colorado along the Rockies into the Oklahoma and Texas Panhandle to another low pressure system at 1008-hPa. The accident site was in the immediate vicinity of the stationary front.

The station models for Denver International Airport along the stationary front depicted easterly wind of 5 knots or less, visibility restricted in mist, overcast skies, with temperature and dew point at 31° Fahrenheit (F). Further to the south, stations in southern Colorado in the vicinity of the stationary front depicted winds of 5 to 10 knots, clear skies, with temperatures in the 40’s °F, with dew points in the 30’s °F.

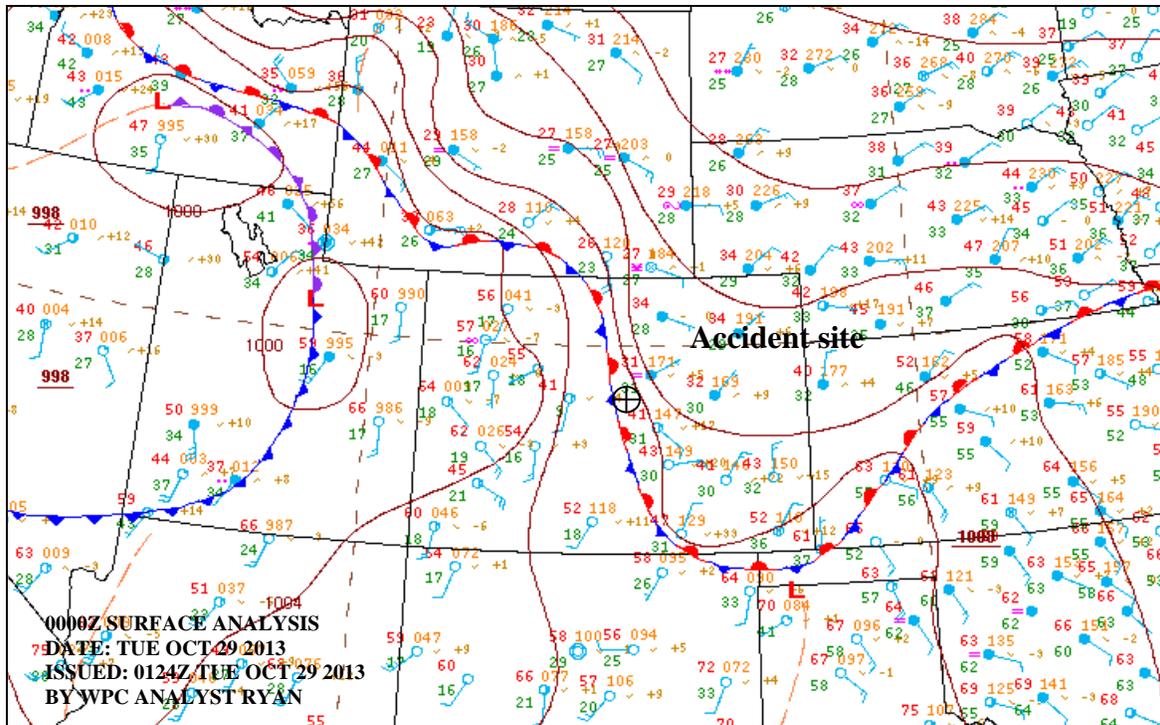


Figure 1 - NWS Surface Analysis Chart for 1800 MDT

1.2 Weather Depiction Charts

The NWS Weather Depiction Charts for 1600 and 1900 MDT (2200Z and 0100Z) respectively are included in figure 2, and depicted the general flight categories² across the region. The charts depicted an extensive area of instrument flight rule conditions (IFR) by a shaded contour line over central and northern Colorado into Wyoming, and western Nebraska and South Dakota. The area of marginal visual flight rule (MVFR) conditions were depicted by an unshaded contour that surrounded the IFR area and extended into Kansas and Oklahoma. Visual flight rule (VFR) conditions were depicted over western Colorado in the Hayden, Colorado area into southeastern Colorado. There was little variation in the area coverage over Colorado between the two periods.

² NWS defines the following general flight categories:

- Low Instrument Flight Rules (LIFR*) – ceiling or lowest layer of clouds reported as broken, overcast or the vertical visibility into a surface based obscuration below 500 feet agl and/or visibility less than 1 statute mile.
- Instrument Flight Rules (IFR) – ceiling between 500 to below 1,000 feet agl and/or visibility 1 to less than 3 miles.
- Marginal Visual Flight Rules (MVFR**) – ceiling from 1,000 to 3,000 feet agl and/or visibility 3 to 5 miles.
- Visual Flight Rules (VFR) – ceiling greater 3,000 feet agl and visibility greater than 5 miles.

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

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

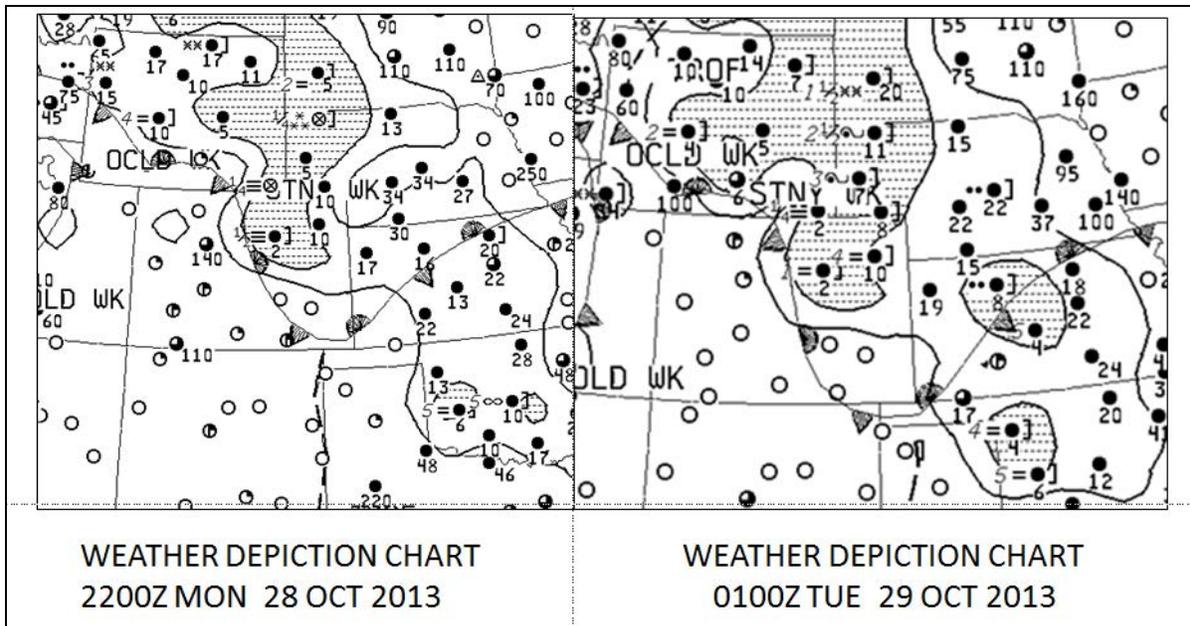


Figure 2 - NWS Weather Depiction Charts for 1600 and 1900 MDT

The station model for Denver International Airport (KDEN) depicted at 1600 MDT (left panel) visibility ½ mile in fog with an overcast ceiling at 200 feet agl within the hour. At 1900 MDT (right panel) Denver was reporting visibility of 1 mile in mist and a ceiling overcast at 200 feet agl.

1.3 Weather Radar Mosaic

The NWS National radar mosaic for the Denver area at 1900 MDT (0100Z) is included as figure 3 below. The radar mosaic depicted several areas of very light intensity echoes along the Rocky Mountains with several other areas of light echoes scattered around the region. No large areas of echoes associated with rain or snow showers was detected on the radar east of the mountains or in the vicinity of the accident site.

The National radar mosaic utilizes a ground clutter and false echo suppression which will often remove very light intensity echoes and other false returns around the radar sites. At times this can eliminate real weather targets; therefore the closest weather radar will be reviewed in further detail in section 6.0 of this report to eliminate the possibility of echoes along the final flight track.

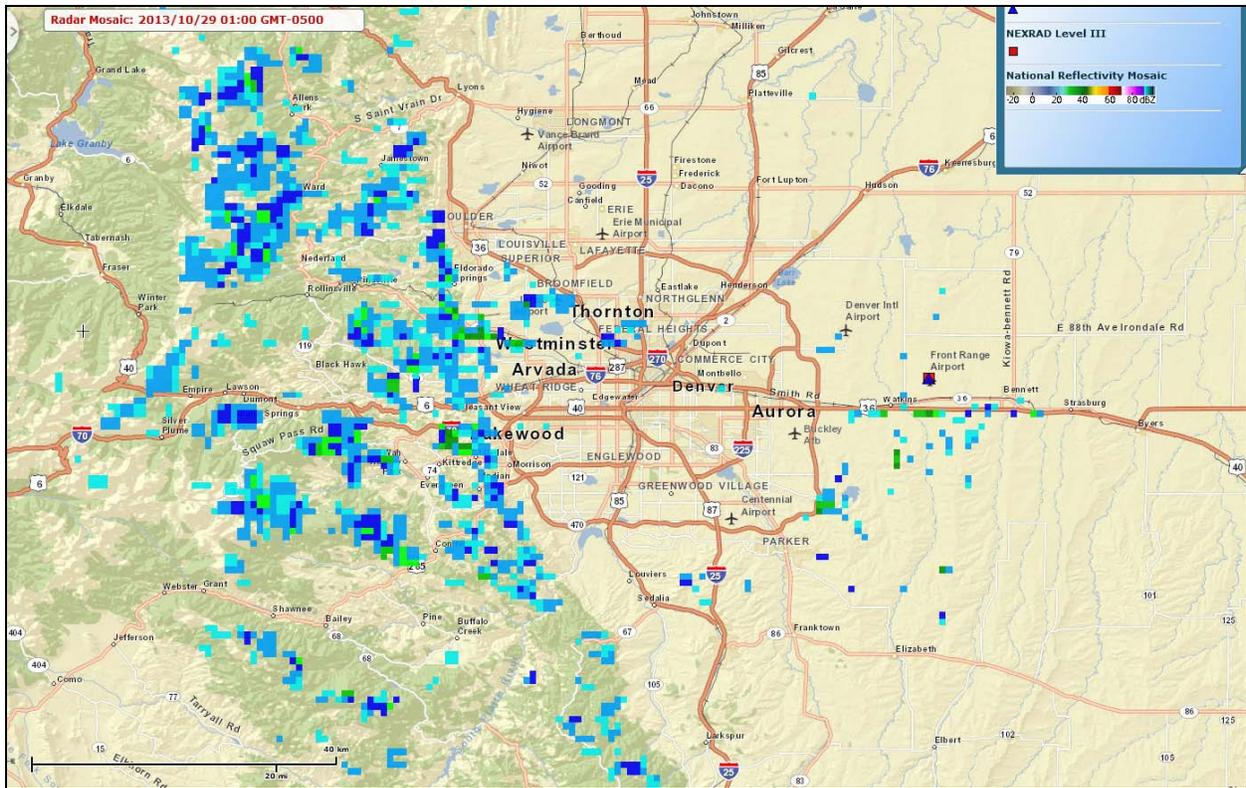


Figure 3 - NWS National Radar Mosaic for 1900 MDT

2.0 Surface Observations and Forecasts

The official NWS Meteorological Aerodrome Reports (METARs) and special reports (SPECIs) surrounding the period were documented for the area. The cloud heights are reported above ground level (agl). The Terminal Aerodrome Forecasts (TAFs) issued for the corresponding airports are also included.

2.1 Centennial Airport (KAPA), Denver, CO

Centennial Airport (KAPA), Denver, was located approximately 9 miles north of the accident site at elevation of 5,885 feet msl, and had a magnetic variation of 8° E. KAPA had an Automated Surface Observation System (ASOS) and was augmented by a NWS certified weather observer. The following conditions were reported at the approximate time of the accident:

Centennial Airport weather observation at 1853 MDT, wind from 110° at 6 knots, visibility 2 miles in mist, ceiling overcast at 400 feet agl, temperature and dew point -1° Celsius (C), altimeter 30.03 inches of mercury (Hg).

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

LIFR METAR KAPA 282153Z 03004KT 3SM BR OVC003 01/00 A2999 RMK AO2 SLP158 T00060000=
 LIFR METAR KAPA 282253Z 06005KT 3SM BR OVC004 01/M01 A3000 RMK AO2 SLP163 T00061006=

LIFR SPECI KAPA 282342Z 07006KT 1 1/2SM BR OVC004 M01/M01 A3000 RMK AO2 SFC VIS 2=
LIFR METAR KAPA 282353Z 06006KT 1 1/2SM BR OVC004 M01/M01 A3001 RMK AO2 SLP171 60000
T10061006 10022 21006 53005=
LIFR SPECI KAPA 290043Z 08005KT 2SM BR OVC004 M01/M01 A3002 RMK AO2=
LIFR METAR KAPA 290053Z 11006KT 2SM BR OVC004 M01/M01 A3003 RMK AO2 SLP187 T10061006=
Accident 0100Z
LIFR SPECI KAPA 290117Z 11006KT 2SM BR OVC004 M01/M01 A3003 RMK AO2=
LIFR METAR KAPA 290153Z 11005KT 2SM BR OVC004 M01/M01 A3004 RMK AO2 SLP194 T10061011=
LIFR METAR KAPA 290253Z 12004KT 2SM BR BKN004 OVC009 M01/M01 A3003 RMK AO2 SFC VIS 5
SLP191 T10061011 50005=
LIFR SPECI KAPA 290302Z 11004KT 5SM BR BKN004 OVC010 00/M01 A3003 RMK AO2=

The Terminal Aerodrome Forecast (TAF) was issued for KAPA by the NWS Denver/Boulder Weather Service Forecast office (WSFO). The forecast current at the time of the preflight briefing prior to the departure was an amended forecast issued at 1611 MDT and expected LIFR conditions with a wind from 060° at 5 knots, visibility 3 miles in mist, ceiling broken at 300 feet agl, overcast at 600 feet, with a temporary period from 1600 through 2000 MDT of visibility 1 mile in light drizzle and mist.

The next scheduled forecast was issued at 1729 MDT, or within ½ hour of the departure from Hayden, which expected the LIFR conditions to continue with a temporary period of light freezing drizzle and mist from 1600 through 2000 MDT.

The raw forecasts in standard code were as follows:

TAF AMD KAPA 282211Z 2822/2918 06005KT 3SM BR BKN003 OVC006
TEMPO 2822/2902 1SM -DZ BR
FM290200 08007KT 1 1/2SM BR VCSH BKN002 OVC006
FM291000 09006KT 1SM BR VV002
FM291300 30005KT 1/4SM FZFG VV002
FM291600 VRB04KT 1SM BR BKN003 OVC006
FM291700 VRB04KT 5SM BR SCT006 BKN012=

TAF KAPA 282329Z 2900/2924 06005KT 2SM BR BKN003 OVC006
TEMPO 2900/2902 1SM -FZDZ BR
FM290200 08005KT 1 1/2SM BR VCSH BKN002 OVC006
FM291000 09004KT 1SM BR VV002
FM291200 30005KT 1/4SM FZFG VV002
FM291500 VRB04KT 1SM BR BKN003 OVC006
FM291700 VRB04KT 5SM BR SCT006 BKN012
FM291800 05007KT P6SM SCT012 BKN025
FM292000 04008KT P6SM SCT025 SCT070 BKN120=

2.2 Buckley Air Force Base (KBKF), Aurora, CO

The next closest weather reporting was location approximately 17 miles north of the accident site from Buckley Air Force Base (KBKF), Aurora, at an elevation of 5,664 feet. The airport is a military airport and requires permission to operate into the airport. The airport had an ASOS and reported LIFR conditions and intermittent periods of unknown freezing precipitation (UP) and light freezing rain prior to and after the accident. The following was reported at the approximate time of the accident:

Buckley Air Force Base weather at 1858 MDT, automated, wind from 100° at 7 knots, visibility 9 miles, Runway visual range for runway 32 at 5500 feet, ceiling overcast at 300 feet agl, temperature and dew point -1° C, altimeter 30.05 inches of Hg. Remarks: automated observation system, unknown precipitation began at 1815 and ended 1827 MDT, sea level pressure 1018.2-hPa, hourly precipitation less than 0.01 inch, temperature -0.6° C, dew point -0.8° C.

The raw observations were as follows:

LIFR METAR KBKF 282158Z AUTO 06008KT 3SM UP BR OVC002 00/00 A3001 RMK AO2
UPB2119E2120B2147 SLP159 P0000 T10001002=
LIFR SPECI KBKF 282200Z AUTO 06007KT 3SM BR OVC002 00/00 A3001 RMK AO2 UPE2200=
LIFR SPECI KBKF 282205Z AUTO 07007KT 2 1/2SM BR OVC002 00/00 A3001 RMK AO2 VIS 2 1/2V4
UPE2200=
LIFR SPECI KBKF 282216Z AUTO 08009KT 2SM UP BR OVC002 00/00 A3001 RMK AO2 VIS 2V2 1/2
UPE2200B2216=
LIFR SPECI KBKF 282220Z AUTO 07008KT 2SM -FZRA BR OVC002 00/00 A3002 RMK AO2 VIS 2V2
1/2 RAB2220UPE2200B2216E2220=
LIFR SPECI KBKF 282236Z AUTO 08007KT 2 1/2SM BR OVC002 00/00 A3002 RMK AO2 VIS 2V2 1/2
RAB2220E2236UPE2200B2216E2220=
LIFR SPECI KBKF 282246Z AUTO 07006KT 3SM BR OVC002 00/00 A3002 RMK AO2
RAB2220E2236UPE2200B2216E2220=
LIFR SPECI KBKF 282256Z AUTO 06008KT 2 1/2SM BR OVC002 00/00 A3002 RMK AO2 VIS 2 1/2V3
RAB2220E2236UPE2200B2216E2220=
LIFR METAR KBKF 282258Z AUTO 06008KT 3SM BR OVC002 00/00 A3002 RMK AO2 SLP167 P0000=
LIFR SPECI KBKF 282324Z AUTO 07007KT 3SM UP BR OVC002 00/00 A3002 RMK AO2 UPB2324=
LIFR SPECI KBKF 282329Z AUTO 08006KT 2 1/2SM UP BR OVC002 00/00 A3002 RMK AO2 VIS 2
1/2V4 UPB2324=
LIFR SPECI KBKF 282334Z AUTO 08006KT 2 1/2SM BR OVC002 00/00 A3002 RMK AO2 VIS 2 1/2V3
UPB2324E2334=
LIFR SPECI KBKF 282339Z AUTO 07008KT 3SM BR OVC002 00/00 A3002 RMK AO2 UPB2324E2334=
LIFR METAR KBKF 282358Z AUTO 09006KT 6SM BR OVC002 M01/M01 A3003 RMK AO2
UPB2324E2334 SLP170 P0000 60000 T10071008 10021 21007 53005=
LIFR SPECI KBKF 290003Z AUTO 08007KT 6SM BR OVC003 00/00 A3003 RMK AO2=
LIFR SPECI KBKF 290015Z AUTO 08008KT 3SM UP BR OVC003 00/00 A3003 RMK AO2 UPB0015=
LIFR SPECI KBKF 290020Z AUTO 10007KT 4SM R32/4000FT UP BR OVC002 00/00 A3003 RMK AO2
UPB0015=
LIFR SPECI KBKF 290027Z AUTO 09007KT 3SM R32/4000FT BR OVC002 00/00 A3004 RMK AO2
UPB0015E0027=
LIFR SPECI KBKF 290037Z AUTO 09007KT 6SM R32/5000FT BR OVC003 00/00 A3004 RMK AO2
UPB0015E0027=
LIFR SPECI KBKF 290052Z AUTO 10006KT 9SM OVC003 00/00 A3004 RMK AO2=
LIFR SPECI KBKF 290057Z AUTO 10007KT 9SM R32/5500FT OVC003 00/00 A3005 RMK AO2
UPB0015E0027=
LIFR METAR KBKF 290058Z AUTO 10007KT 9SM R32/5500FT OVC003 M01/M01 A3005 RMK AO2
UPB0015E0027 SLP182 P0000 T10061008=
Accident 0100Z
LIFR SPECI KBKF 290128Z AUTO 10007KT 5SM R32/4500FT BR OVC003 00/00 A3005 RMK AO2=
LIFR SPECI KBKF 290152Z AUTO 09007KT 5SM R32/4500FT UP BR OVC003 00/00 A3005 RMK AO2
UPB0152=
LIFR METAR KBKF 290158Z AUTO 10005KT 5SM R32/4500FT UP BR OVC003 M01/M01 A3005 RMK
AO2 UPB0152 SLP182 P0000 T10051006=
LIFR SPECI KBKF 290203Z AUTO 10006KT 4SM R32/4500FT BR OVC003 00/00 A3005 RMK AO2

UPE0203=
LIFR SPECI KBKF 290206Z AUTO 10005KT 4SM R32/4500FT -FZDZ BR OVC003 00/00 A3005 RMK
AO2 DZB0206UPE0203=
LIFR SPECI KBKF 290235Z AUTO 11006KT 5SM R32/4500FT BR OVC003 00/00 A3005 RMK AO2
DZB0206E0235UPE0203=

The forecast from Buckley Air Force Base issued by the United States Air Force (USAF) Air Weather Service at 1500 MDT expected LIFR conditions with a wind from 060° at 9 knots, visibility 3 miles (4800 meters) in mist, ceiling overcast at 300 feet agl with a forecast altimeter setting of 29.98 inches of Hg. The forecast was amended at 1700 MDT to include visibility 3 miles in light freezing rain and mist with a ceiling overcast at 300 feet through 0500 MDT.

The raw TAF forecasts were as follows:

TAF AMD KBKF 2821/2923 06009KT 4800 BR OVC003 QNH2998INS
BECMG 2903/2904 08009KT 4800 BR BKN006 OVC015 QNH2998INS
BECMG 2914/2915 16009KT 9999 NSW SCT010 BKN030 QNH2993INS
BECMG 2920/2921 06009KT 9999 SCT020 BKN050 QNH2990INS
TX10/2921Z TN00/2912Z AMD 282125=

TAF AMD KBKF 2823/2923 06009KT 4800 -FZRA BR OVC003 690009 QNH2998INS
BECMG 2903/2904 08009KT 4800 -FZRA BR BKN006 OVC015 690009 QNH2998INS
BECMG 2911/2912 08009KT 4800 BR SCT006 BKN015 QNH2998INS
BECMG 2914/2915 16009KT 9999 NSW SCT010 BKN030 QNH2993INS
BECMG 2920/2921 06009KT 9999 SCT020 BKN050 QNH2990INS
T10/2921Z T00/2912Z AMD 282314=

2.3 Denver International Airport (KDEN), Denver, CO

The next closest weather reporting site was from Denver International Airport (KDEN), Denver, located 27 miles north of the accident site at an elevation of 5,433 feet. The airport had an ASOS and was also augmented by NWS certified weather observer. The following conditions were reported surrounding the period:

Denver International Airport weather at 1853 MDT, wind from 090° at 06 knots, tower visibility³ 1 mile in mist, ceiling overcast at 200 feet, temperature and dew point -1° C, altimeter 30.04 inches of Hg. Remarks: automated observation system, surface visibility 5 miles, sea level pressure 1017.7-hPa, temperature -0.6° C, dew point -1.1° C.

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

LIFR METAR KDEN 282053Z 06011KT 1/4SM R35L/3500VP6000FT FG OVC002 00/M01 A3000 RMK AO2
TWR VIS 1/2 FZDZB02E25SNB00E02 SLP160 P0000 60000 T00001006 56011=
LIFR SPECI KDEN 282119Z 06008KT 1/2SM R35L/3000V4000FT FZFG VV002 M01/M01 A3001 RMK AO2=
LIFR METAR KDEN 282153Z 07007KT 1/2SM R35L/4500VP6000FT FZFG OVC002 M01/M01 A3001 RMK
AO2 SLP164 T10061011=

³ Tower visibility is typically recorded when visibility is less than 4 miles and differs from the normal surface prevailing visibility. The lower value of the tower or surface visibility is placed in the main body of the report, and the other in the remarks section. At certain locations with high air traffic control towers like KDEN, the tower can be in a lower stratus cloud layer and report significantly lower visibility than the surface observation location.

LIFR METAR KDEN 282253Z 07007KT 1/2SM R35L/4500VP6000FT BR OVC002 M01/M01 A3001 RMK AO2 SFC VIS 1 SLP166 T10061011=
LIFR METAR KDEN 282353Z 10008KT 1/2SM BR OVC002 M01/M01 A3002 RMK AO2 SFC VIS 2 SLP170 60000 T10061011 10011 21006 53004=
LIFR SPECI KDEN 290034Z 10008KT 1SM BR OVC002 M01/M01 A3003 RMK AO2 SFC VIS 4=
LIFR METAR KDEN 290053Z 09006KT 1SM BR OVC002 M01/M01 A3004 RMK AO2 SFC VIS 5 SLP177 T10061011=
Accident 0100Z
LIFR SPECI KDEN 290127Z 10007KT 1 1/4SM BR OVC004 00/M01 A3005 RMK AO2 SFC VIS 5=
LIFR METAR KDEN 290153Z 11006KT 3/4SM -SN BR OVC004 M01/M01 A3005 RMK AO2 SFC VIS 2 SNB48 SLP179 P0000 T10061011=
LIFR SPECI KDEN 290238Z 11006KT 3/4SM -FZDZ OVC004 M01/M01 A3004 RMK AO2 SFC VIS 2 FZDZB37SNE37 P0000=
LIFR METAR KDEN 290253Z 11006KT 3/4SM -FZDZ OVC004 00/M01 A3005 RMK AO2 SFC VIS 2 1/2 FZDZB37SNE37 SLP180 P0000 60000 T00001011 51008=
LIFR METAR KDEN 290353Z 09006KT 3/4SM -FZDZ BKN002 OVC008 00/M01 A3004 RMK AO2 SFC VIS 2 1/2 SLP176 P0000 T00001011=

The forecast for KDEN available at 1456 MDT expected LIFR conditions with a visibility restricted in mist and a ceiling at 200 feet with a temporary period from 1500 through 1900 MDT of visibility 1 ½ miles in freezing drizzle and freezing fog. LIFR conditions continued to be expected through the evening with visibility of 1/4 mile in freezing fog and a ceiling of 200 feet from 0400 through 1000 MDT on October 29, 2013. The raw forecasts are as follows:

TAF AMD KDEN 282056Z 2821/2924 06009KT 1 1/2SM BR BKN002 OVC006
TEMPO 2821/2901 1/2SM -FZDZ FZFG
FM290400 08007KT 1SM BR VCSH BKN002 OVC006
FM291000 09006KT 1/4SM FZFG VV002
FM291400 30005KT 1/4SM FZFG VV002
FM291600 VRB04KT 1SM BR BKN003 OVC006
FM291800 VRB04KT 5SM BR SCT006 BKN012
FM291900 06007KT P6SM SCT012 BKN025
FM292100 04008KT P6SM SCT025 BKN070=

TAF KDEN 282329Z 2900/3006 06007KT 1 1/2SM BR VCSH BKN003 OVC006
FM290400 08007KT 1SM BR VCSH BKN002 OVC006
FM291000 09004KT 1/4SM FZFG VV002
FM291400 30005KT 1/4SM FZFG VV002
FM291600 VRB04KT 1SM BR BKN003 OVC006
FM291800 VRB04KT 5SM BR SCT006 BKN012
FM291900 06007KT P6SM SCT012 BKN025
FM292100 04008KT P6SM SCT025 SCT070 BKN120
FM300300 35008KT P6SM SCT010 SCT070 BKN120=

2.4 Front Range Airport (KFTG), Denver

The accident airplane's intended destination was Front Range Airport (KFTG) located approximately 19 miles northeast of KAPA, at an elevation of 5,512 feet. The airport has an AWOS installed and broadcasts observations locally but has a history⁴ of not routinely

⁴ According to the local NWS office the observations are entered by the tower, which is not full time.

transmitting observations on weather circuits, and as a result data is sparse and not available in any archive. What was available during the period was as follows:

Front Range Airport weather at 1550 MDT, wind from 070° at 5 knots, visibility 1/2 mile in fog, ceiling overcast at 200 feet agl, temperature and dew point 0° C, altimeter 30.02 inches of Hg.

LIFR METAR KFTG 281648Z 05008KT 1/2SM FG OVC002 03/02 A3006
LIFR METAR KFTG 281848Z 04009KT 1/4SM FG OVC002 02/01 A3003
LIFR METAR KFTG 282150Z 07005KT 1/2SM FG OVC002 00/00 A3002=
Accident 0100Z

2.5 Air Force Academy Airport (KAFF), Colorado Springs, CO

The Air Force Academy Airport (KAFF), Colorado Springs, was located approximately 28 miles south of the accident site at an elevation of 6,572 feet msl. The airport is located in alert area airspace and is also a military airport, requiring prior approval to operate into the airport. The airport had an ASOS and reported the following conditions at the approximate time of the accident:

Air Force Academy Airport weather at 1858 , automated, wind from 160° at 10 knots, visibility 10 miles, ceiling broken at 1,900 feet, overcast at 2,600 feet, temperature 4° C, dew point -1° C, altimeter 30.00 inches of Hg. Remarks: automated weather observation system, ceiling 1,900 variable 2,300 feet, sea level pressure 1014.1-hPa, temperature 3.7° C, dew point -1.0° C.

The raw observations and flight categories were as follows:

VFR METAR KAFF 282258Z AUTO 34009KT 10SM CLR 06/M01 A2996 RMK AO2 SLP121 T00571006=
VFR METAR KAFF 282358Z AUTO 35006KT 10SM FEW032 03/M01 A2998 RMK AO2 SLP140 T00331007
10089 20033 52010=
MVFR SPECI KAFF 290013Z AUTO 32004KT 10SM BKN029 03/00 A2998 RMK AO2=
MVFR SPECI KAFF 290053Z AUTO 16012KT 10SM BKN020 OVC026 04/M01 A3000 RMK AO2 CIG 020V026
MVFR METAR KAFF 290058Z AUTO 16010KT 10SM BKN019 OVC026 04/M01 A3000 RMK AO2 CIG
019V023 SLP141 T00371010=
Accident 0100Z
MVFR SPECI KAFF 290148Z AUTO 16009KT 10SM OVC014 03/M01 A3001 RMK AO2=
MVFR METAR KAFF 290158Z AUTO 19010KT 10SM OVC013 03/M01 A3002 RMK AO2 SLP155 T00251011=

The forecast issued by the USAF Air Weather Service was as follows:

TAF AMD KAFF 2823/3001 05012KT 9999 SCT120 520009 QNH2991INS
BECMG 2903/2904 16009KT 9999 FEW005 SCT090 520009 QNH2995INS
BECMG 2915/2916 20015G25KT 9999 SCT120 BKN200 520009 QNH3005INS
BECMG 3000/3001 18012KT 9999 SCT120 BKN200 520009 QNH3003INS
TX13/2921Z TNM02/2912Z AMD 282323 LAST NO AMDS AFT 2823=

2.6 Colorado Springs Municipal Airport (KCOS)

Colorado Springs Municipal Airport (KCOS) was also located 37 miles south of the accident site, had an ASOS and reported the following conditions:

Colorado Springs Municipal Airport weather at 1854 MDT, wind from 090° at 9 knots, visibility 10 miles, scattered clouds at 2,900 feet, temperature 2° C, dew point -1° C, altimeter 30.02 inches of Hg. Remarks: automated observation system, sea level pressure 1015.8-hPa, temperature 1.7° C, dew point -1.1° C.

The raw observations and flight categories were as follows:

VFR METAR KCOS 282254Z 11006KT 10SM FEW100 SCT200 09/M01 A2997 RMK AO2 SLP125 T00941006
VFR METAR KCOS 282354Z 13010KT 10SM FEW035 SCT100 SCT200 05/M01 A2999 RMK AO2 SLP147
T00501006 10133 20050 53017=
VFR METAR KCOS 290054Z 09009KT 10SM SCT029 02/M01 A3002 RMK AO2 SLP158 T00171011 \$=
Accident 0100Z
VFR METAR KCOS 290154Z 06006KT 10SM FEW013 SCT022 01/M01 A3003 RMK AO2 SLP167 MTN TOPS
OBSCD T00111011 \$=
MVFR METAR KCOS 290254Z 20005KT 10SM BKN013 00/M02 A3004 RMK AO2 SLP179 T00001017 51013 \$

3.0 Upper Air Data

The closest upper air sounding or rawinsonde observation (RAOB) was from the NWS Denver launch site (KDNR), number 72469, located approximately 20 miles north of the accident site at the old Denver Stapleton Airport at an elevation of 5,331 feet. The 1800 MDT (0000Z on June 13, 2012) sounding was plotted on a standard Skew-T log P diagram⁵ utilizing RAOB⁶ software is included as figure 4 from the surface to 500-hPa or 18,000 feet.

⁵ 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.

⁶ RAOB – (The complete Rawinsonde Observation program) is an interactive sounding analysis program developed by Environmental Research Services, Matamoras, Pennsylvania.

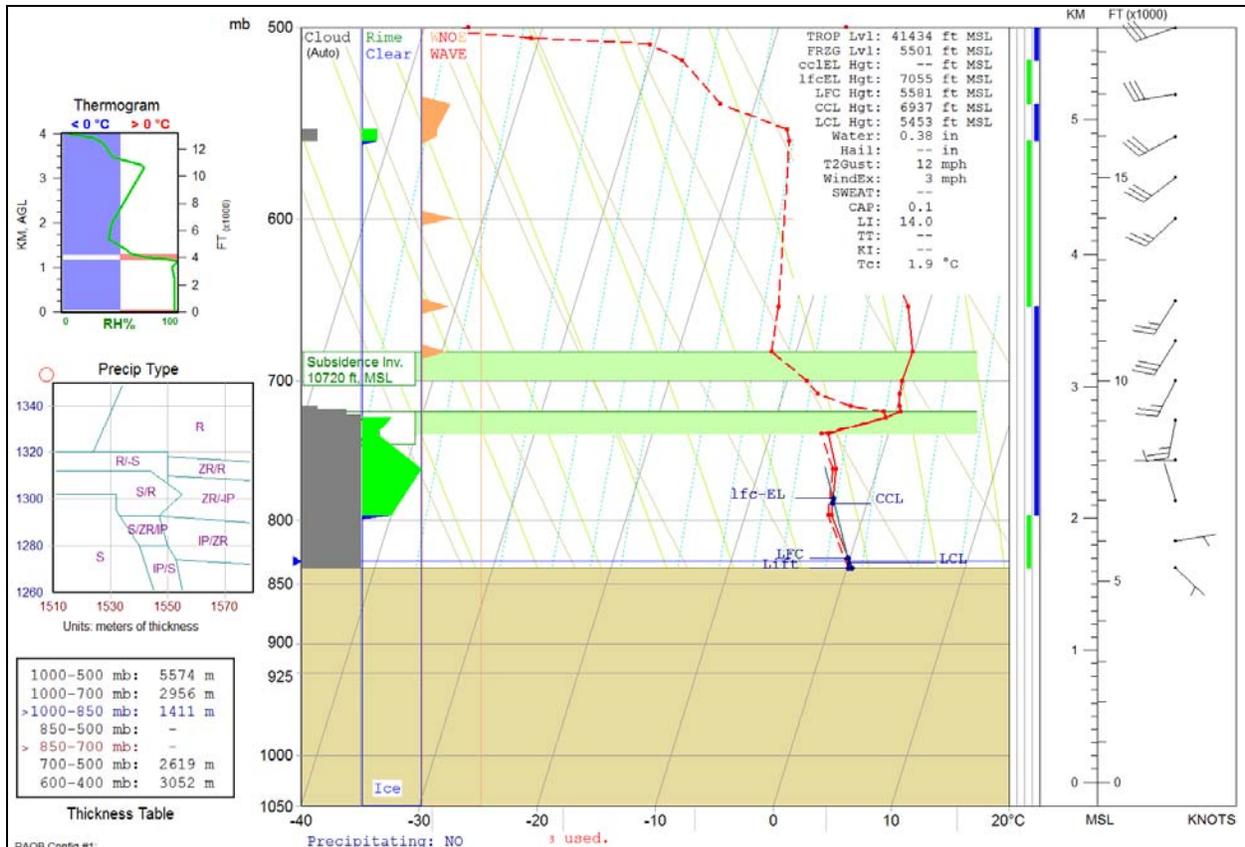


Figure 4 - Denver upper air sounding for 1800 MDT

The Denver sounding depicted the lifted condensation level (LCL)⁷ at 122 feet agl, the level of free convection (LFC)⁸ at 250 feet agl, and the convective condensation level (CCL)⁹ at 1,600 feet agl. A frontal inversion (horizontal green shaded line) was identified at 9,219 feet, below this level the atmosphere was saturated with a relative humidity greater than 90% from the surface to inversion. A second inversion was also identified at 10,720 feet with dry air above. The stability parameters indicated a Lifted Index (LI)¹⁰ of 14.0 and indicated a stable atmosphere. The freezing level was identified by a horizontal blue line immediately above the surface at 170

⁷ Lifting Condensation Level (LCL) - The height at which a parcel of moist air becomes saturated when it is lifted dry adiabatically.

⁸ 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.

⁹ Convective Condensation Level (CCL) - The height to which a parcel of air, if heated sufficiently from below, will rise adiabatically until condensation starts. This is typically used to identify the base of cumuliform clouds, which are normally produced from surface heating and thermal convection.

¹⁰ Lifted Index (LI) - A common measure of atmospheric instability. Its value is obtained by computing the temperature that air near the ground would have if it were lifted to 500-hPa or approximately 18,000 feet and comparing that temperature to the actual temperature at that level. Negative values indicate instability - the more negative, the more unstable the air is, and the stronger the updrafts are likely to be with any developing thunderstorms.

feet agl (5,501 feet msl), with the sounding remaining at or below freezing through the depth of the atmosphere.

On the left side of the sounding in gray was the expected cloud cover with a base near 200 feet and tops near 9,200 feet. An icing analysis indicated an area of potential icing conditions between immediately above the surface through 9,200 feet with an 85% probability of severe rime type icing centered near 7,800 feet.

The wind profile indicated light winds below the frontal inversion, with winds from the south-southwest veering to the west through height with increasing speeds. The mean 0 to 6 kilometer or 18,000 feet wind was from 239° at 23 knots. The level of maximum wind was identified immediately above the tropopause at 46,900 feet with a wind from 245° at 87 knots. The wind profile also supported potential mountain wave activity over and downstream of the higher terrain.

The figure 5 is a table of the observed and derived Denver sounding parameters, with the potential for clear air turbulence (CAT), low-level wind shear (LLWS), icing, and mountain wave activity.

Height (ft-MSL)	Pres (mb)	T (C)	Td (C)	RH (%)	DD/FF (deg/kts)	CAT (AF)	LLWS	Icing - Type (S-F clouds)	Wave/x-W-Turb nm fpm max
5331	837	0.4	0.1	98	135/4				
6000	816				80/7				
6647	796	-2.7	-3.0	98				LGT Clear	
7000	785				345/1				
7782	762	-3.5	-3.8	98				SVR Rime	
8000	756				270/6				
8646	737	-5.1	-5.7	96		MDT		TRC Rime	
9073	725	-0.7	-0.7	100	190/23			LGT Rime	
9219	721	0.4	-1.0	90					
9366	717	0.2	-4.0	73					
9661	709	-0.1	-7.1	59		LGT			
9997	700	-0.3	-8.3	55	205/25				
10720	681	-0.1	-12.1	40		LGT			2.58 626 LT-MD
11000	674				210/29				
11860	652	-1.7	-12.7	43		LGT			4.26 839 LT-MD
12000	648				210/25	LGT			
14000	600				225/24	LGT			8.52 1167 MD-SV
15000	577				230/29				
15896	557	-11.9	-16.1	71		LGT		TRC Clear	
16000	555				240/28				3.25 476 LIGHT
16168	551	-12.1	-16.6	69				TRC Rime	4.49 544 LIGHT
16767	538	-12.9	-22.9	43		L-M			7.66 1066 LT-MD
17000	533				260/28				
17807	516	-15.3	-27.3	35					
18194	508	-15.5	-30.5	26					
18341	505	-14.7	-40.7	9					

Figure 5 - Denver sounding parameters

4.0 Aircraft Sounding

In addition to the balloon sounding, a search of the NOAA aircraft meteorological data reports (AMDAR) of specially instrumented air carrier aircraft was also reviewed for additional high resolution data in the Denver area. An aircraft identified as #11220 had a moisture sensor and descended into Denver International Airport (KDEN) and landed at 1855 MDT (0055Z) immediately prior to the accident. Figure 6 is a composite of the skew T plot on the left with the reported parameters on the right. The sounding indicated a saturated environment from 9,200 feet msl to the surface or 5,370 feet msl, with an average temperature of -3°C in the layer. The layer was capped by the frontal inversion at 9,200 feet which extended to 10,000 feet with a warm layer above the lower freezing layer, with temperatures warming to 4.6°C . The wind profile also identified light easterly winds at approximately 8 knots below the inversion, with a significant shift to the south and increase in speed to 29 knots above the inversion at 9,200 feet, with a gradual veering of the wind to the southwest with height.

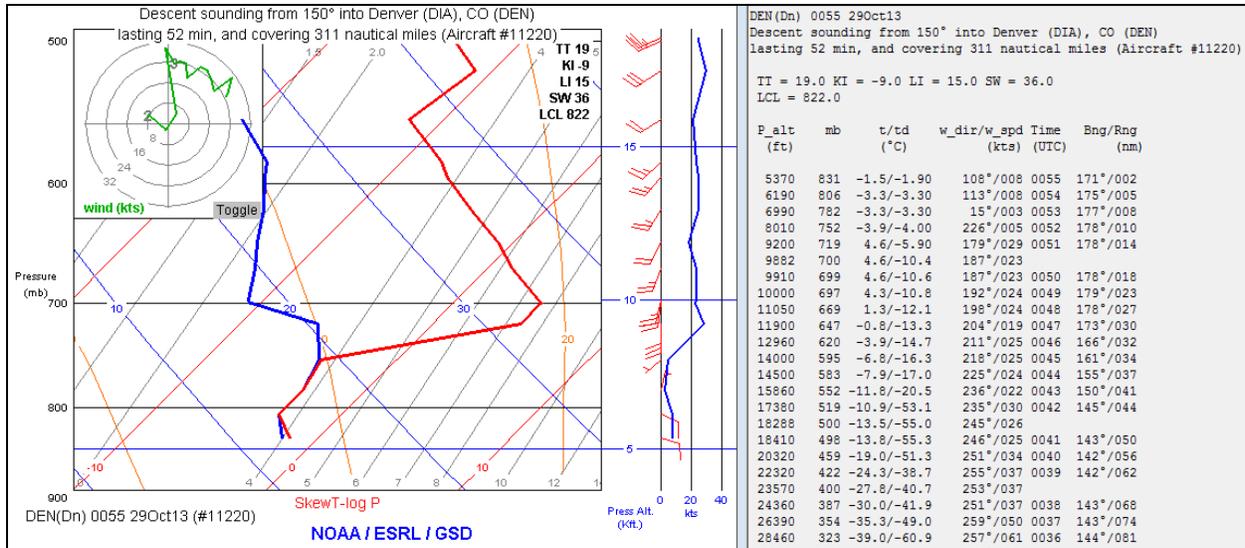


Figure 6 - Aircraft descent sounding into KDEN at 1855 MDT

5.0 Satellite Data

The Geostationary Operational Environmental Satellite number 13 (GOES-13) data was obtained from an archive at the Space Science Engineering Center (SSEC) at the University of Wisconsin-Madison (UW) in Madison, Wisconsin, and processed using the Safety Board's Man-computer Interactive Data Access System (McIDAS) software. The infrared long wave satellite imagery was obtained surrounding the time of the accident. The infrared long wave imagery (band 4) at a wavelength of 10.7 microns (μm) provided a standard satellite image with radiative cloud top temperatures with a resolution of 4 km.

Figure 7 is the GOES-13 infrared image at 1902 MDT at 4X magnification over the area with the accident site added, the frontal positions as of 1800 MDT was also overlaid. The image depicted an area of low stratiform clouds extending over the Denver area and most of northeast Colorado, with the boundary of the clouds in the Colorado Springs area immediately south of the

accident site. The radiative cloud top temperature over the accident site was 269° kelvin or -4.16° C, which corresponded to clouds near 8,600 feet msl.

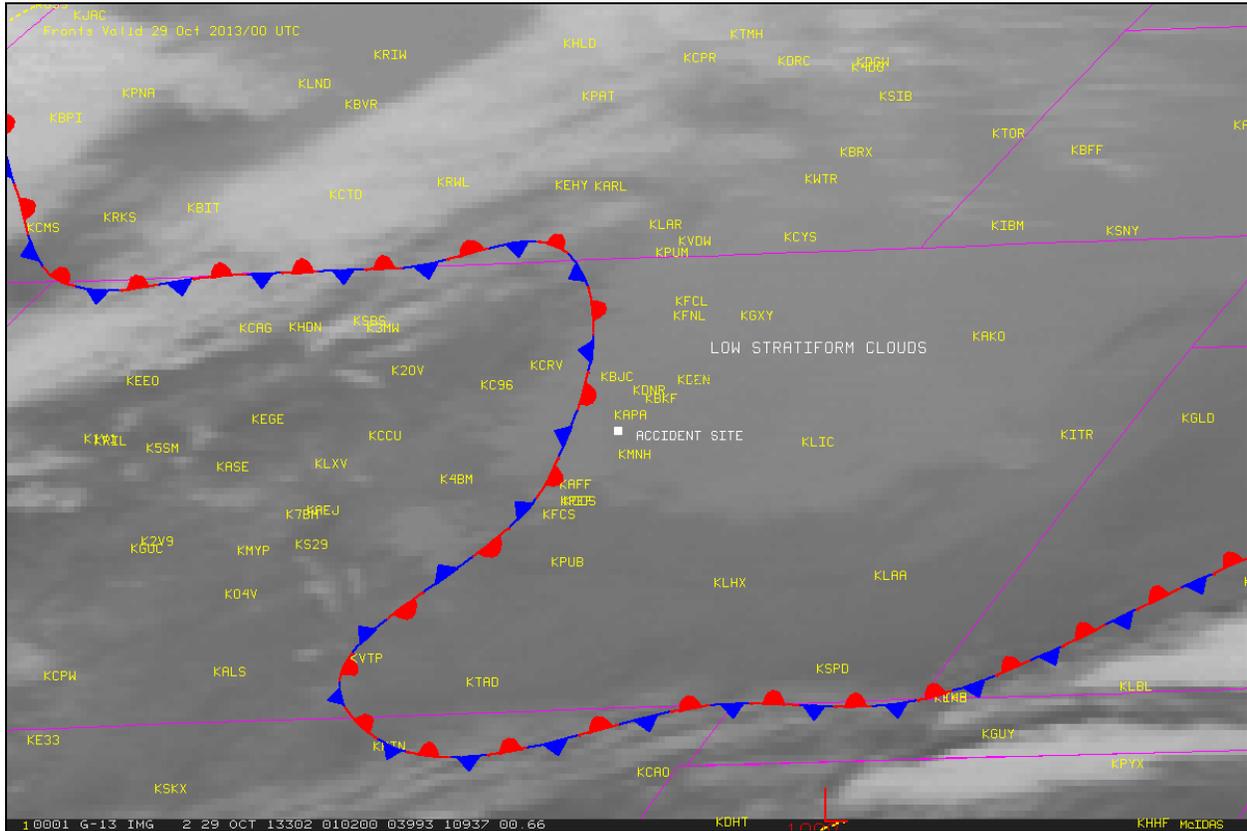


Figure 7 - GOES-13 infrared satellite image at 1902 MDT with frontal position

6.0 Weather Radar Information

The NWS Denver (KFTG) Weather Surveillance Radar-1988, Doppler (WSR-88D) antenna was located approximately 25 miles northeast of the accident site at the Front Range Airport. The level II archive data was obtained from the NCDC utilizing the Hierarchical Data Storage System (HDSS) and displayed using the NWS NEXRAD Interactive Viewer and Data Exporter software.

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

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 six 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 multiple different scanning strategies depending on the type and severity of the expected precipitation over the area. 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 KFTG WSR-88D radar was operating in the clear air mode VCP-32. In this mode the radar has a slow rotation, which increases the sensitivity and is typically used in winter weather situations. Figure 8 is a depiction of the different elevation angles in this VCP, and the approximate height and width of the radar beam with distance from the radar site.

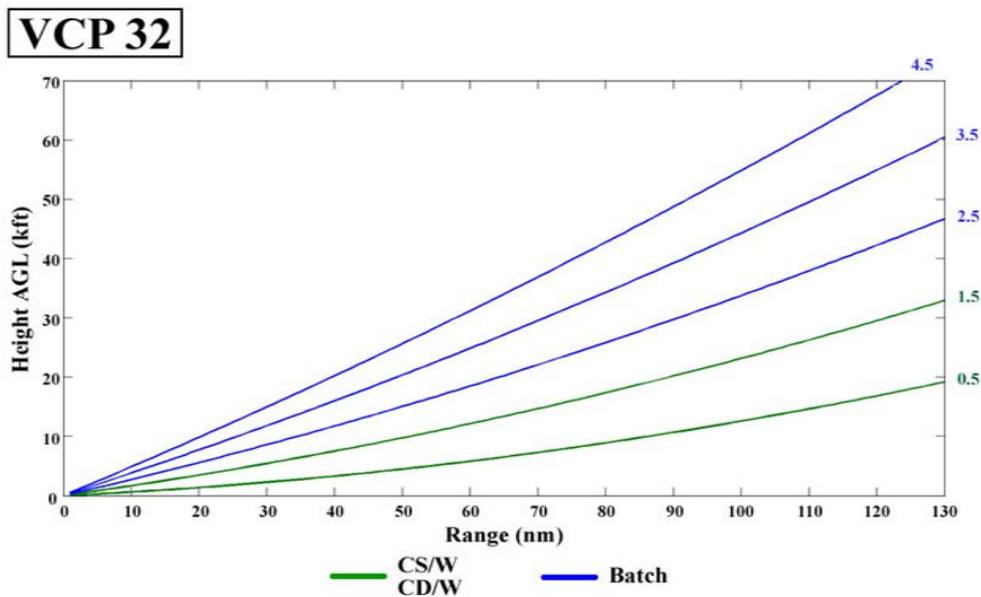


Figure 8- VCP-32 scanning mode

6.2 Beam Height Calculation

Assuming standard refraction¹¹ of the 0.95° radar beam of the KFTG WSR-88D with an antenna height of 5,611 feet and a distance of 25 miles and an azimuth of 212° from the radar, the following table shows the approximate beam height and width information of the radar display over the site of the accident. The heights have been rounded to the nearest 10 feet.

ANTENNA ELEVATION	BEAM CENTER	BEAM BASE	BEAM TOP	BEAM WIDTH
0.5°	7,350 feet	6,090 feet	8,610 feet	2,520 feet

Based on the radar height calculations, the 0.5° elevation scan depicts the conditions encompassing the altitude between 6,090 and 8,610 feet over the accident site.

¹¹ Standard Refraction in the atmosphere is when the temperature and humidity distributions are approximately average, and values set at the standard atmosphere.

6.3 Reflectivity

Reflectivity is the measure of the efficiency of a target in intercepting and returning radio energy. With hydrometeors¹² 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 (dBZ¹³), and is a general measure of echo intensity. The chart below relates the older NWS video integrator and processor (VIP) intensity levels versus the WSR-88D's display levels, precipitation mode reflectivity in decibels, and rainfall rates.

NWS VIP/DBZ CONVERSION TABLE

NWS VIP	WSR-88D LEVEL	PREC MODE DBZ	RAINFALL
0	0	< 5	
	1	5 to 9	
	2	10 to 14	
1 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	

Air traffic control (ATC) weather display systems also use radar weather processors with the ability to determine precipitation intensity, with controllers instructed to describe the intensity to pilots based on the following scale:

¹² Hydrometeors are any product of condensation or sublimation of atmospheric water vapor, whether formed in the free atmosphere or at the earth's surface; also, any water particles blown by the wind from the earth's surface. Hydrometeors are classified as; (a) Liquid or solid water particles suspended in the air: cloud, water droplets, mist or fog. (b) Liquid precipitation: drizzle and rain. (c) Freezing precipitation: freezing drizzle and freezing rain. (d) Solid (frozen) precipitation: ice pellets, hail, snow, snow pellets, and ice crystals. (e) Falling particles that evaporate before reaching the ground: virga. (f) Liquid or solid water particles lifted by the wind from the earth's surface: drifting snow, blowing snow, blowing spray. (g) Liquid or solid deposits on exposed objects: dew, frost, rime, and glaze ice.

¹³ dBZ - $10 \log Z_e$

- (a) "Light" (< 30 dBZ, NWS VIP level 1)
- (b) "Moderate" (30 to 40 dBZ, NWS VIP level 2)
- (c) "Heavy" (> 40 to 50 dBZ, NWS VIP level 3 and 4)
- (d) "Extreme" (> 50 dBZ, NWS VIP level 5 and 6)

6.4 Base Reflectivity

Figure 9 is the Denver WSR-88D 0.5° base reflectivity image at 1859 MDT (0059Z) with the flight track of N535SP overlaid. The images depicted a large area of very light reflectivity's from -15 to 15 dBZ over the region and intermittently along the flight track. The radar image indicated that no significant precipitation was encountered by the flight; however, the radar does not typically detect drizzle droplets. No significant echoes were identified at higher elevation scans over the flight track or accident site.

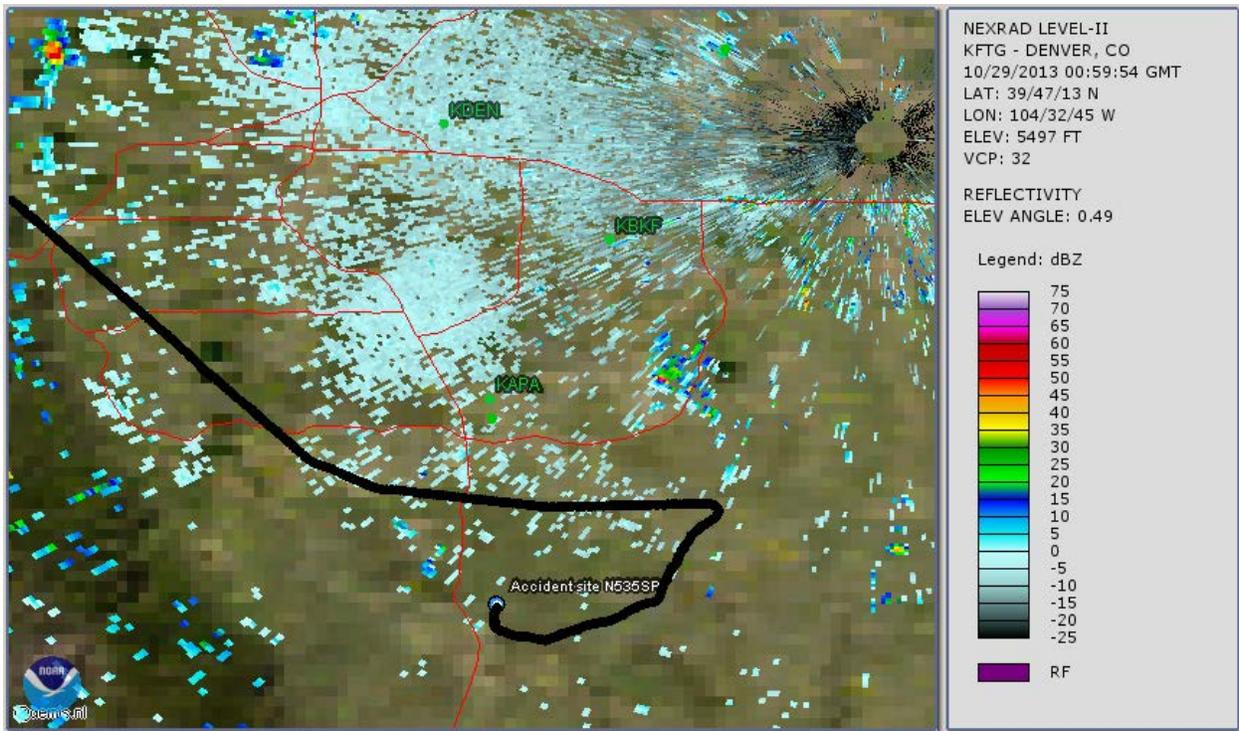


Figure 9 - NWS Denver WSR-88D 0.5° base reflectivity image at 1859 MDT

A review of the radial velocity data indicated no significant echoes over the area to depict any significant wind speeds at low level over the area.

7.0 Pilot Reports

The following pilot reports (PIREPs) were recorded over Colorado below 18,000 feet surrounding the period between 1200 and 2100 MDT. The following reports have been decoded from standard code and use the three-letter identifiers, have been converted to local time, and reported heights are msl. The reports were as follows:

Rocky Mountain Airport (BJC) routine pilot report (UA); Over – BJC; Time – 1245 MDT; Flight level – unknown; Type aircraft – Piaggio (P180) Avanti II twin-engine turboprop business airplane; Temperature – 2° C; Icing – light rime encountered between 9,000 and 5,800 feet; Remarks – during descent to runway 29 at BJC.

Centennial Airport (APA) routine pilot report; Over – 6 miles southwest of APA; Time – 1336 MDT; Flight level – unknown; Type aircraft – Beechcraft Super King Air (BE20) multiengine turboprop; Sky cover – overcast bases unknown tops 9,200 feet.

Centennial Airport (APA) routine pilot report; Over – 15 miles south of Denver International Airport (DEN); Time – 1337 MDT; Flight level – 8,000 feet; Type aircraft – Boeing 757 air carrier jet; Temperature – minus 4° C; Icing – light mixed icing.

Rocky Mountain Airport (BJC) routine pilot report; Over – 2 miles east of BJC; Time – 1345 MDT; Flight level – 8,000 feet; Type aircraft – Cirrus (SR22) single engine airplane; Temperature – minus 4° C; Icing – light rime type icing between 8,000 and 9,000 feet.

Fort Collins-Loveland Airport (FNL) routine pilot report; Over – 5 miles southeast of FNL; Time – 1401 MDT; Flight level – 5,500 feet; Type aircraft – Cessna Citation (C525) light business jet; Sky cover – overcast bases at 5,500 feet msl; Temperature – minus 2° C; Icing – light rime type icing between 7,300 and 5,500 feet.

Centennial Airport (APA) routine pilot report; Over – APA; Time – 1412 MDT; Flight level – unknown; Type aircraft – Canadair Challenger (CL60) business jet; Sky cover – overcast at 6,200 feet.

Pueblo Airport (PUB) routine pilot report; Over – route between Gunnison (GUC) and PUB; Time – 1425 MDT; Flight level – 13,500 feet; Type aircraft – Diamond (DA42) Twin Star multiengine airplane; Wind – 220 at 26 knots; Turbulence – moderate chop with 1,200 feet per minute (fpm) downdrafts and occasional haze, mountains obscured.

Buckley Air Force Base (BKF) routine pilot report; Over – 7 miles south of DEN; Time – 1434 MDT; Flight level – 7,000 feet; Type aircraft – Canadair Regional Jet (CRJ2); Temperature – minus 2° C; Icing – light rime type icing.

Pueblo Airport (PUB) routine pilot report; Over – route between Double Eagle II Airport, Albuquerque, NM (AEG) and PUB; Time – 1446 MDT; Flight level – 9,500 feet; Type aircraft – Piper Cherokee (PA28A) single engine airplane; Turbulence – occasional moderate.

Buckley Air Force Base (BKF) routine pilot report; Over – 4 miles south of DEN; Time – 1453 MDT; Flight level – unknown; Type aircraft – Boeing 737 air carrier jet; Sky cover – bases 300 agl with tops 8,500 feet; Temperature – 0° C; Icing – light mixed icing below 8,500 feet.

Rocky Mountain Airport (BJC) routine pilot report; Over – 5 miles northwest to 5 miles east of BJC to ; Time – 1603 MDT; Flight level – 9,000 feet; Type aircraft – Beechcraft Super King

Air (BE20) multiengine turboprop Temperature – unknown; Icing – light mixed icing below 9,000 feet; Remarks – during descent.

Denver International Airport (DEN) routine pilot report; Over – 10 miles west of DEN; Time – 1609 MDT; Flight level – 8,600 feet; Type aircraft - Canadair Regional Jet (CRJ2); Sky cover – cloud tops 8,600 feet; Temperature – minus 9° C; Icing – light rime type icing.

San Luis Valley Regional Airport, Alamosa (ALS) routine pilot report; Over – 40 miles northwest of ALS; Time – 1631 MDT; Flight level – 15,500 feet; Type aircraft – Piper Cherokee (PA28) single engine airplane; Remarks – very rough, pilot stated that aircraft almost went inverted, forwarded from Denver Center (ZDV).

Rocky Mountain Airport (BJC) routine pilot report; Over – 6 miles west of BJC; Time – 1644 MDT; Flight level – unknown; Type aircraft – Pilatus (PC12) high performance single engine turboprop; Temperature – minus 3° C; Icing – light mixed icing below 9,300 feet.

Centennial Airport (APA) routine pilot report; Over – 5 miles south-southeast of APA; Time – 1913 MDT; Flight level – 8,000 feet; Type aircraft – Glasair (GLSP) high performance single engine airplane; Temperature – minus 4° C; Icing – light to moderate rime type icing.

Denver International Airport (DEN) routine pilot report; Over – 30 miles south-southeast of DEN; Time – 1913 MDT; Flight level – 8,000 feet; Type aircraft – Cirrus (SR22) high performance single engine airplane; Temperature – minus 4° C; Icing – light to moderate rime type icing.

Buckley Air Force Base (BKF) routine pilot report; Over – 5 miles south of DEN; Time – 2105 MDT; Flight level – 6,500 feet; Type aircraft – McDonald Douglas MD90 air carrier jet; Temperature – minus 1° C; Icing – light rime type icing.

The raw pilot reports in standard format and code were as follows:

*BJC UA /OV BJC /TM 1845 /FLUNKN /TP P180 /TA 02 /IC LGT RIME 090-058 /RM DURD RY29R BJC=
APA UA /OV APA245006 /TM 1936 /FLUNKN /TP BE20 /SK OVCUNKN-TOP092=
APA UA /OV DEN180015 /TM 1937 /FL080 /TP B752 /TA M04 /IC LGT MX=
BJC UA /OV BJC090002 /TM 1945 /FL080 /TP SR22 /TA M04 /IC LGT RIME 080-090=
FNL UA /OV FNL145005 /TM 2001 /FL055 /TP C525 /SK OVC055 /TA M02 /IC LGT RIME 073-055=
APA UA /OV APA /TM 2012 /FLUNKN /TP CL60 /SK OVC062=
PUB UA /OV GUC-PUB /TM 2025 /FL135 /TP DA42 /WV 22026KT /TB MOD CHOP /RM 1200 FPM DDFS
OCNL HAZE MTNS OBSCD=
BKF UA /OV DEN180007 /TM 2034 /FL070 /TP CRJ2 /TA M02 /IC LGT RIME=
PUB UA /OV AEG-PUB /TM 2046 /FL095 /TP P28A /TB NEG OCNL MOD=
BKF UA /OV DEN180004 /TM 2053 /FLUNKN /TP B737 /SK UNKN003-TOP085
/TA 00 /IC LGT MX 085-BLO=
BJC UA /OV BJC315005-BJC090005 /TM 2203 /FL090 /TP BE20 /TA UNKN /IC LGT MX BLO 090 /RM
DURD=
DEN UA /OV DEN270010 /TM 2209 /FL086 /TP CRJ2 /SK TOP086 /TA M09 /IC LGT RIME=
ALS UA /OV ALS300040 /TM 2231 /FL155 /TP PA28 /RM VERY ROUGH. PILOT STATED THAT ACFT
ALMSOT WENT INVERTED. FROM ZDV=
BJC UA /OV BJC090006 /TM 2244 /FLUNKN /TP PC12 /TA M03 /IC LGT MX 093-BLO=
APA UA /OV APA150005 /TM 0113 /FL080 /TP GLSP /TA M04 /IC LGT-MOD RIME=*

DEN UA /OV DEN150030 /TM 0113 /FL080 /TP SR22 /TA M04 /IC LGT-MOD RIME=
BKF UA /OV DEN180005 /TM 0305 /FL065 /TP MD90 /TA M01 /IC LGT RIME=

8.0 Area Forecast

The Area Forecast (FA) is a forecast of visual Flight Rules (VFR) clouds and weather conditions over an area as large as the size of several states. It must be used in conjunction with the AIRMET Sierra (IFR) bulletin for the same area in order to get a complete picture of the weather. The area forecast together with the AIRMET Sierra bulletin are used to forecast enroute weather and to interpolate conditions at airports which do not have a terminal forecast (TAF) issued. The NWS Aviation Weather Center (AWC) located in Kansas City, Missouri, issues the FA at regular intervals and issues special reports as necessary usually in the form of an AIRMET. The Salt Lake City (KSLC) regional forecast that was current at the time of the accident was issued at 1548 MDT and valid through 0200 MDT on October 29, 2013. The forecast was as follows:

FAUS45 KKCI 282148 AAA 2013301 2148
FA5W
-SLCC FA 282148 AMD
SYNOPSIS AND VFR CLDS/WX
SYNOPSIS VALID UNTIL 291400
CLDS/WX VALID UNTIL 290800...OTLK VALID 290800-291400
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...NONE DUE TO PRODUCT LENGTH.
.
CO
PLAINS
NRN..OVC055 TOP 080. OTLK..IFR DZ BR.
SRN..SCT150. WND SE G25KT. BECMG 0406 ERN SXNS BKN045 TOP 080. VIS 3SM BR. OTLK..VFR
WRN SXNS..IFR CIG BR ERN SXNS.
FOOTHILLS
N PUB..OVC060 TOP 080. OTLK..IFR CIG BR.
PUB SWD..SCT140 SCT CI. OTLK..VFR.
MTNS..SCT150 BKN CI. WND S 20G30KT. 01Z BKN150 TOP FL220. OTLK..VFR.
.

The forecast for the northern Plains of Colorado expected overcast clouds from 5,500 feet msl (or at the surface) with tops to 8,000 feet msl. The outlook from 0200 through 0800 MDT expected IFR conditions with drizzle and mist to prevail. The forecast was amended by AIRMET Sierra which is included in the next section.

9.0 In-Flight Weather Advisories

The NWS issues in-flight weather advisories designated as Severe Weather Forecast Alerts (AWW's), Convective SIGMET's (WST's), SIGMET's (WS's), Center Weather Advisories

FROM 60SW YQL TO SHR TO CYS TO 40SW DEN TO 20WNW LAR TO 30NNW OCS TO 50E SLC TO 40NNE SLC TO 50NW ELY TO 50NE OAL TO 40SSW FMG TO 40SE LKV TO 50SE REO TO 40SW DNJ TO 30N LKT TO 60SW YQL
MTNS OBSC BY CLDS/PCPN/BR. CONDS CONTG BYD 03Z THRU 09Z.

.
OTLK VALID 0300-0900Z

AREA 1...IFR ID MT WY UT CO

BOUNDED BY 30S YQL-50NNW ISN-50SSW BFF-50ESE SNY-50W LBL-30SW DEN-20S DDY-60SSW BOY-40SSW MTU-50ENE DTA-20W JAC-50S HLN-30S YQL
CIG BLW 010/VIS BLW 3SM PCPN/BR. CONDS CONTG THRU 09Z.

.
AREA 2...MTN OBSCN ID MT WY NV UT CO AZ

BOUNDED BY 60SW YQL-SHR-CYS-20WSW DEN-20WNW LAR-60SSW BOY-30W INW-20NE PGS-20NE SLC-30SE MLD-60SSE TWF-20ESE ELY-60NE OAL-ba40SSW FMG-40SE LKV-50SE REO-40WNW BOI-50WSW LKT-60NW DLN-60SW YQL
MTNS OBSC BY CLDS/PCPN/BR. CONDS CONTG THRU 09Z.

WAUS45 KKCI 282045

2013301 2042

WA5Z

-SLCZ WA 282045

AIRMET ZULU UPDT 3 FOR ICE AND FRZLVL VALID UNTIL 290300

.
AIRMET ICE...MT

FROM 60SSW YXH TO 50NNW ISN TO 60WSW DIK TO 20ESE MLS TO 60SSW YXH
MOD ICE BLW 160. CONDS CONTG BYD 03Z THRU 09Z.

.
AIRMET ICE...ID MT WY NV UT AZ WA OR CA

FROM 20SSE YXC TO 60SSW YXH TO 20ESE MLS TO 60WSW DIK TO 70SW RAP TO 30N BOY TO 40SW MTU TO 40N PGS TO 20WNW ILC TO 20NNW OAL TO 30NNE ENI TO 20SSE OED TO 20W PDT TO 50SE MLP TO 20SSE YXC
MOD ICE BTN FRZLVL AND FL200. FRZLVL SFC-080. CONDS CONTG BYD 03Z THRU 09Z.

.
FRZLVL...RANGING FROM SFC-145 ACRS AREA

MULT FRZLVL BLW 100 BOUNDED BY YDC-50NE GEG-30S MLP-50NNE DNJ-50SSW BKE-60NNE LKV-50ENE OED-20N EUG-30WNW HUH-YDC

MULT FRZLVL BLW 110 BOUNDED BY 80SW DIK-50WNW RAP-40ESE CYS- 40ESE SNY-30NNW GLD-50WSW GLD-20ESE DEN-60SSE BOY-30W CZI-30N SHR-80SW DIK

SFC ALG 70SSE GEG-40N DNJ-40SW LKT-30NE BPI-40SSE DDY-60NNW BFF

080 ALG 50S LAS-20WNW PGS-30NNW SLC-50WSW BPI-80SW DDY-20WNWAKO-40E AKO

120 ALG 80ESE BZA-30NW SSO-50NNW TCS-60WNW FTI-20NNW CIM-50SE LAA

....

WAUS45 KKCI 282101 AAA

2013301 2102

WA5T

SLCT WA 282101 AMD

AIRMET TANGO UPDT 5 FOR TURB STG WINDS AND LLWS VALID UNTIL 290300

.
...SEE SIGMET WHISKEY SERIES...

.
AIRMET TURB...ID MT WY NV UT CO AZ NM CA AND CSTL WTRS

FROM 50SW YQL TO 50SSE BIL TO 50E OCS TO 20NNW HBU TO 40S DMN TO 50S TUS TO BZA TO 20S MZB TO 220SW MZB TO 130SW PYE TO 60W EHF TO 50N LAS TO 20NW BVL TO 20NW BOI TO 30SE GEG TO 50SW YQL

MOD TURB BLW FL180. CONDS CONTG BYD 03Z THRU 09Z.

*AIRMET TURB...ID MT WY NV UT CO AZ NM WA OR CA AND CSTL WTRS...UPDT
FROM YDC TO 50WSW YXC TO 40NW HVR TO 70SW RAP TO 50SSW BFF TO 50ESE SNY TO 20SSW
GLD TO 50W LBL TO 30ESE TBE TO 50S TUS TO BZA TO 20S MZB TO 220SW MZB TO 140WSW FOT
TO 60WNW TOU TO YDC
MOD TURB BTN FL180 AND FL450. CONDS CONTG BYD 03Z THRU 09Z.*

*AIRMET STG SFC WINDS...UT CO AZ
FROM 40E SLC TO 50S OCS TO 30SSW DVC TO 40SE INW TO 20W DRK TO 20S EED TO 30ESE LAS
TO 30WSW BCE TO 50SW SLC TO 40E SLC
SUSTAINED SURFACE WINDS GTR THAN 30KT EXP. CONDS ENDG 00-03Z.*

*LLWS POTENTIAL...WY UT CO AZ
BOUNDED BY 20NE BPI-50SSW BOY-50E OCS-40ESE DBL-30N TBC-40WSW BCE-50ENE DTA-
20NE BPI
LLWS EXP. CONDS DVLPG 00-03Z. CONDS CONTG BYD 03Z THRU 09Z.*

*OTLK VALID 0300-0900Z
AREA 1...TURB WY NV UT CO AZ NM CA AND CSTL WTRS
BOUNDED BY 50ESE BOY-50ESE CIM-40E ELP-50S TUS-BZA-20S MZB-220SW MZB-150SW RZS-
30E LAX-70S ILC-50SSE MLD-50ESE BOY
MOD TURB BLW FL180. CONDS CONTG THRU 09Z.*

*AREA 2...TURB ID MT WY NV UT CO AZ NM WA OR CA AND CSTL WTRS
BOUNDED BY YDC-50WSW YXC-50NE GGW-80SW DIK-70SW RAP-40ESE CYS-40E SNY-50W LBL-
30ESE TBE-50S TUS-BZA-20S MZB-220SW MZB-140WSW FOT-110WNW ONP-60WNW TOU-YDC
MOD TURB BTN FL180 AND FL410. CONDS CONTG THRU 09Z.*

....

A plot of the AIRMETs over the GOES-13 satellite image at 1445 MDT or the time of the issuance of the advisories is included as figure 10 with the accident site marked. AIRMET Sierra for IFR and mountain obscuration conditions was current over the route of flight. No advisories for turbulence or icing conditions were forecast for the destination or route of flight.

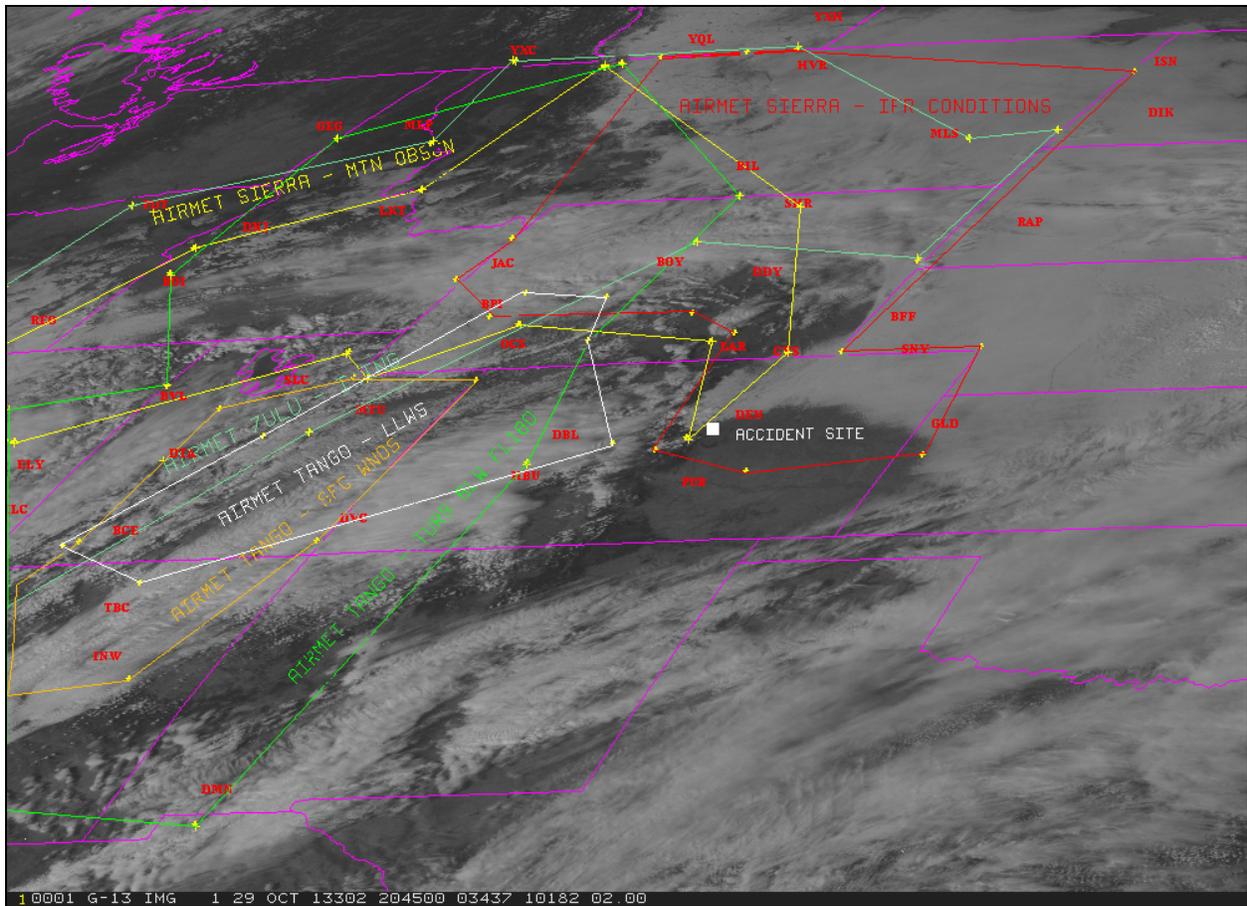


Figure 10 – AIRMET advisories on satellite image

10.0 Current Icing Products

The following Current Icing Products (CIP) were recreated by the National Center for Atmosphere Research (NCAR) and were available to the NWS Aviation Weather Center and available to users from their website (<http://aviationweather.gov/adds/icing/>) at the approximate time of the accident. The CIP products combines sensor and Numerical Weather Prediction model output to provide an hourly, three-dimensional diagnosis of the icing environment. Also available, but not reproduced in this case is the Forecast Icing Product (FIP), which is similar to CIP except that it does not include the sensor inputs. CIP/FIP outputs include calibrated icing probability, icing severity, and potential for supercooled large droplets (SLD), which includes freezing drizzle and freezing rain. The probabilities do not reach 100% because the data available to diagnose icing do not allow for a diagnosis with absolute certainty at any given location in space. Icing severity encompasses five categories: none, trace, light, moderate, and heavy.

Figures 11 through 16 are the CIP icing probability, severity, and SLD potential valid at 1900 MDT on October 28, 2013, provided for 7,000 feet and 8,000 feet respectively. The approximate accident site is indicated by the black circle in Douglas County, Colorado. The charts depicted the accident site on the extreme southern edge of a large area of potential icing conditions which extended over northern Colorado, eastern Wyoming, western Nebraska, and extreme

southwestern South Dakota. The severity over the accident site however, was a trace to light intensity of icing only, while moderate icing conditions existed further north. A high probability of SLD conditions existed within the area, which is considered the most hazardous case for airframe icing and typically beyond normal aircraft certification standards and protection. No NWS advisories for icing were issued prior to the accident in the areas indicated potentially due to the lack of pilot reports of moderate icing prior to 1900 MDT.

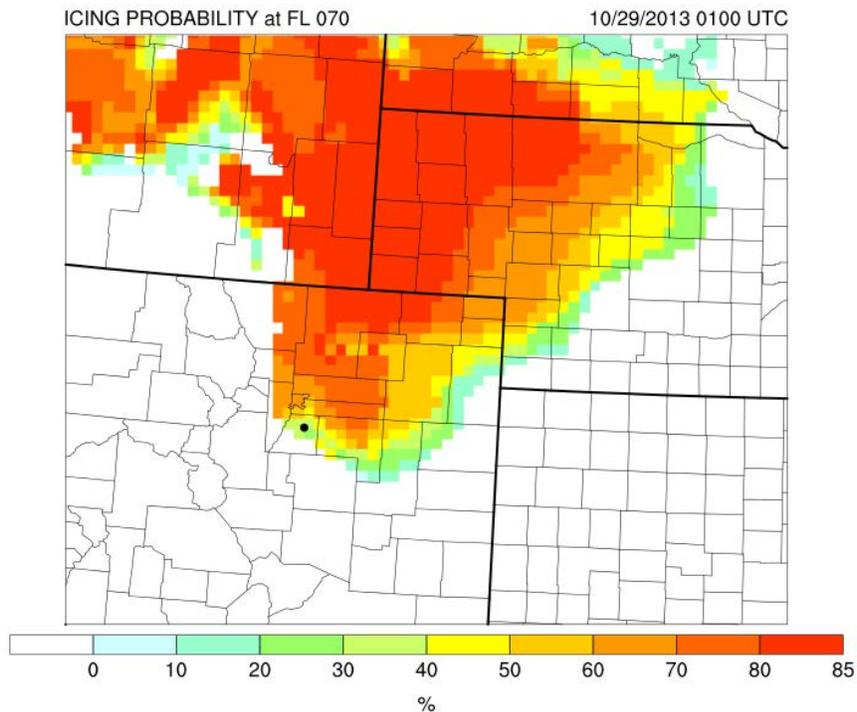


Figure 11 - Icing probability for 7,000 feet

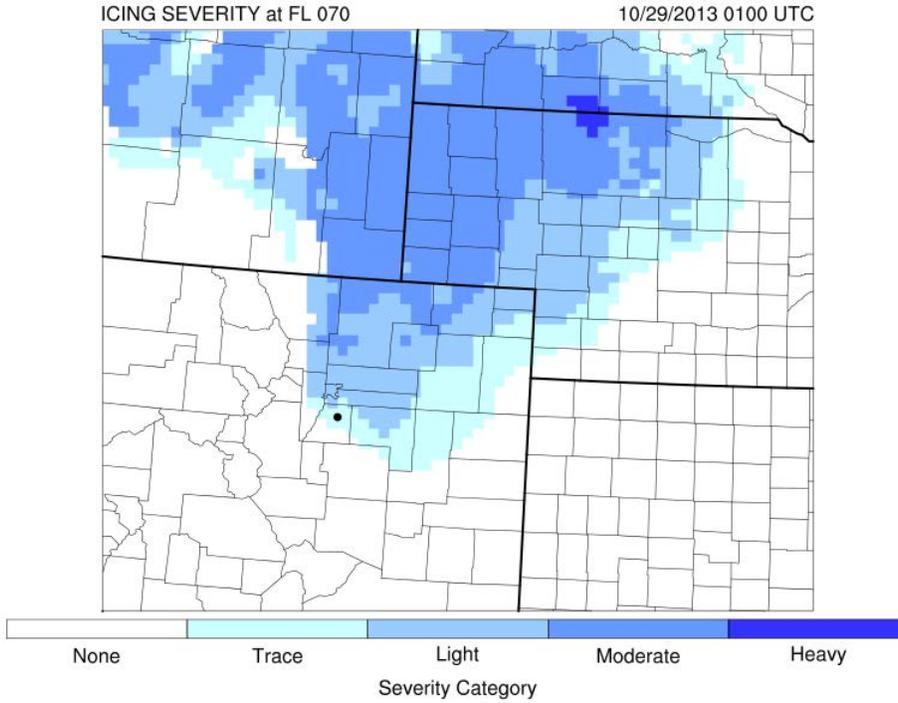


Figure 12 - Icing Severity for 7,000 feet

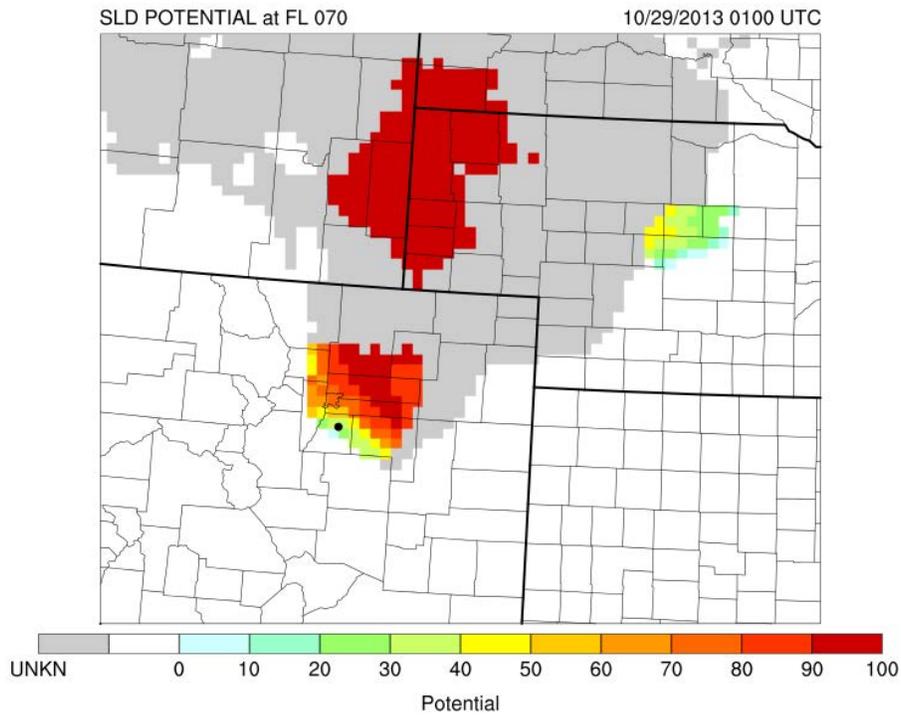


Figure 13 -SLD potential for 7,000 feet

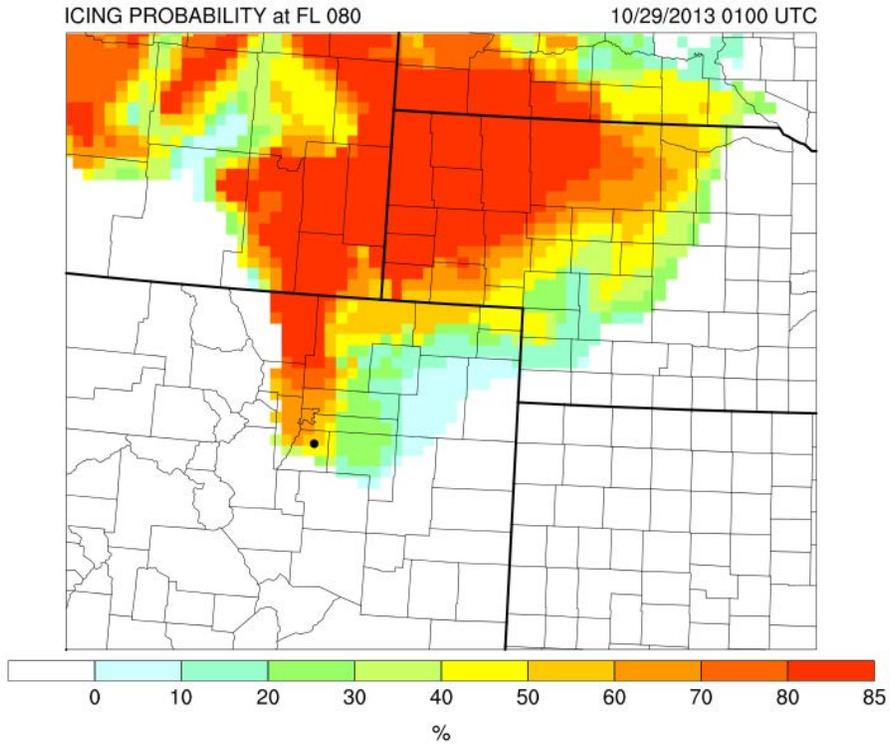


Figure 14 – Icing probability for 8,000 feet

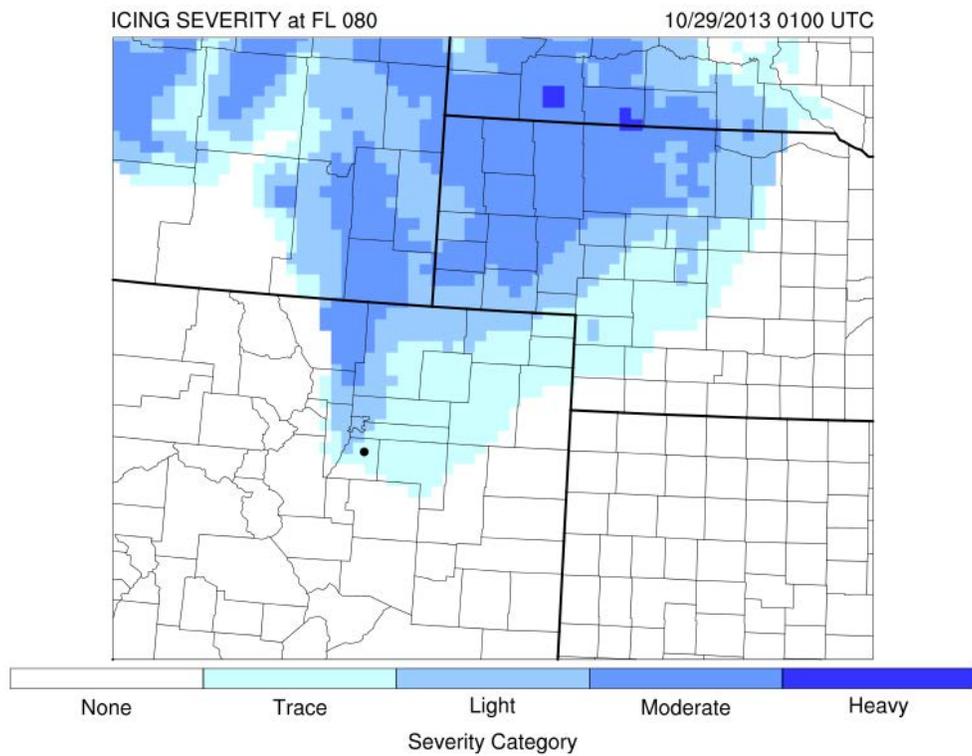


Figure 15 - Icing severity for 8,000 feet

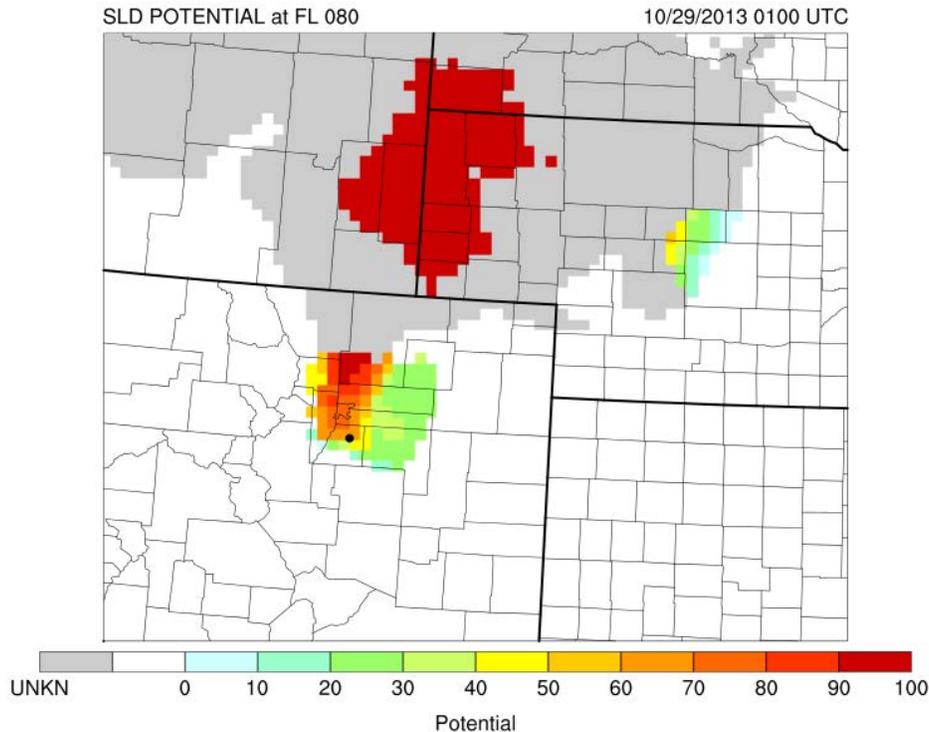


Figure 16 - SLD potential for 8,000 feet

11.0 NWS Area Forecast Discussion

The NWS Denver/Boulder Weather Forecast Office issued the Area Forecast Discussion (AFD) at 1600 MDT discussing their reasoning behind their forecast. While not a typical aviation weather briefing product, it can provide useful information on the TAF and indicate other weather considerations in the forecast. The discussion was as follows:

*FXUS65 KBOU 282301
AFDBOU*

*AREA FORECAST DISCUSSION
NATIONAL WEATHER SERVICE DENVER/BOULDER CO
501 PM MDT MON OCT 28 2013*

.UPDATE...FOG IS VERY THICK IN THE FRONT RANGE FOOTHILLS AND AFFECTING THE EVENING COMMUTE...WORST CONDITIONS APPEAR TO BE I-70 FROM GOLDEN TO FLOYD HILL. AREAS OF FREEZING DRIZZLE ALSO NOTED SO OPTED FOR A WINTER WEATHER ADVISORY TO ADDRESS BOTH HAZARDS. BRIDGES/OVERPASSES MAY BECOME ICY OVERNIGHT AS TEMPERATURES CONTINUE TO SLOWLY FALL. SHOULD SEE SLIGHT IMPROVEMENT LATE TONIGHT OR EARLY TUESDAY MORNING WITH DEPTH OF UPSLOPE DECREASING.

.PREV DISCUSSION... /ISSUED 339 PM MDT MON OCT 28 2013/

SHORT TERM...SOUTHWEST FLOW ALOFT ACROSS CWA AT THIS TIME AS UPPER TROUGH STILL OVER GREAT BASIN. UPSLOPE AND LOW STRATUS STILL IN PLACE ACROSS PLAINS...EVEN INTO THE FOOTHILLS WITH AREAS OF DRIZZLE. ALSO SOME FREEZING DRIZZLE BEING REPORTED...MAINLY ALONG FOOTHILLS. ACROSS MOUNTAINS...CONVECTIVE CLOUD HAD DEVELOPED WITH RADAR SHOWING SOME ECHOES ALONG THE CONTINENTAL DIVIDE. FOR TONIGHT...LITTLE CHANGE IN OVERALL PATTERN EXPECTED AS MODELS KEEP UPPER TROUGH OVER GREAT BASIN. SOME INCREASE IN MOISTURE AND MID LEVEL ASCENT ACROSS

MOUNTAINS...WILL INCREASE POPS A BIT THERE AFTER MIDNIGHT. WITH SOUTHWEST FLOW ALOFT...SNOW ACCUMULATIONS TO BE MINIMAL. AS FOR FOOTHILLS AND PLAINS...MODELS SHOW UPSLOPE CONTINUING WITH EASTERLY SURFACE WINDS. THIS SHOULD KEEP STRATUS AND AREAS OF FOG IN PLACE. IN ADDITION...FORECAST SOUNDINGS SUGGEST SOME THREAT OF FREEZING DRIZZLE. LATEST MODELS NOW SHOWING THIS LOW STUFF PERSISTING OVERNIGHT. WENT AHEAD AND KEPT THE LOW CLOUDS AND AREAS OF FOG ALONG WITH THE POTENTIAL FOR FREEZING DRIZZLE. WITH THE MOISTURE FAIRLY SHALLOW...DOES NOT APPEAR SNOW SHOWERS WILL DEVELOP ACROSS THE PLAINS. ON TUESDAY...MODELS KEEP UPPER LOW AND MOST OF THE MID LEVEL ASCENT ACROSS THE GREAT BASIN WITH SOUTHWEST FLOW ALOFT ACROSS COLORADO. MOISTURE AND MID LEVEL ASCENT TO CONTINUE TO INCREASE ACROSS MOUNTAINS...SHOULD SEE SHOWERS INCREASE AS A RESULT. ACROSS FOOTHILLS AND PLAINS...CROSS SECTIONS STILL KEEP UPSLOPE IN PLACE THROUGH MUCH OF THE MORNING WITH SOME WEAKENING BY THE AFTERNOON. SOME THREAT OF A DENVER CYCLONE THROUGH THE MORNING IF SOUTHEAST WINDS DEVELOP WHICH COULD KEEP THE STRATUS AND FOG IN PLACE IN AND NEAR FOOTHILLS. WILL KEEP THE STRATUS AND AREAS OF FOG IN PLACE AND KEEP A THREAT OF FREEZING DRIZZLE. BY AFTERNOON...STILL EXPECTING SOME IMPROVEMENT WITH SOME MIXING WHICH WILL ALLOW FOR TEMPERATURES TO WARM TO NEAR 50 DEGREES. WITH MID LEVEL ASCENT IN PLACE...WILL KEEP THE SLIGHT CHANCE OF RAIN SHOWERS.

LONG TERM...SLOW NORTHEASTWARD PROGRESSION OF THE UPPER WAVE OVER THE CENTRAL GREAT BASIN MEANS A GRADUAL CHANGE IN PERCEIVABLE WEATHER CONDITIONS ACROSS THE FORECAST AREA THROUGH WEDNESDAY NIGHT. THE 500MB LOW IS NOW PROGGED TO SLOWLY MIGRATE OVER UTAH TUESDAY NIGHT...WHERE IT SPLITS INTO TWO CENTERS. ONE CENTER FORMS OVER WRN WYOMING AND THE OTHER NEAR LAS VEGAS NV LATE TUESDAY NIGHT. FURTHERMORE MODELS SHOW A PERTURBATION IN SWLY MID-LEVEL FLOW AHEAD OF THE TROUGH PASSING OVER WEST-CENTRAL AND NORTH-CENTRAL COLORADO TUESDAY NIGHT. WEAK QG ASCENT AND WARM ADVECTION ASSOCIATED WITH THIS FEATURE WILL LIKELY RAMP UP SNOWFALL IN THE MOUNTAINS AND HIGH VALLEYS WITH LIGHT TO MODERATE ACCUMULATIONS OVER THE HIGHER SLOPES. SOUTHWEST FLOW NOT ALL THAT FAVORABLE FOR HEAVY SNOWFALL. SO NO HIGHLIGHTS AT THIS TIME. EAST OF THE MTNS SHALLOW CYCLONIC UPSLOPE FLOW WILL LIKELY CONTINUE TO PRODUCE LOW CLOUDS AND AREAS OF LIGHT PCPN...EITHER DRIZZLE AND/OR SNOW FLURRIES ALONG THE FOOTHILLS AND ACROSS THE NORTHERN PLAINS COUNTIES THROUGH WEDNESDAY MORNING. MEANWHILE DRY SLOTTING AND GUSTY SOUTH-SOUTHEASTERLY BNDRY LAYER FLOW SHOULD KEEP THINGS DRY AND SKIES LESS CLOUDY ACROSS SOUTHEAST SECTIONS OF THE FORECAST AREA TUESDAY NIGHT AND WEDNESDAY.

WEDNESDAY NIGHT THROUGH THURSDAY NIGHT...THE WESTERN ELONGATED TROUGH IS PROGGED TO SWING ACROSS COLORADO AND WYOMING AS AN OPEN WAVE WITH PRECIPITATION BECOMING POORLY ORGANIZED AND LARGELY CONFINED TO HIGHER ELEVATIONS. COULD SEE A FEW MORE INCHES OF SNOW ACCUMULATING ON HIGHER WEST SLOPES...OTHERWISE ONLY A CHANCE OF SNOW IN THE MTN VALLEYS AND A SLIGHT CHANCE OF RAIN AND SNOW ON THE PLAINS. AS THE MAIN PART OF THE UPPER TROUGH PASSES TO OUR NORTH ON THURSDAY...WIND FIELDS SHOW GUSTY WEST-NORTHWEST WINDS DEVELOPING OVER THE FRONT RANGE AND ALONG THE NORTHERN FOOTHILLS THURSDAY AFTERNOON AND EVENING. SPEEDS ARE EXPECTED TO REMAIN WELL BELOW HIGH WIND CRITERIA. BY FRIDAY...COLD ADVECTION AND NORTHWEST FLOW ON THE BACK SIDE OF THE EXITING TROUGH COULD CONTINUE TO PRODUCE SCATTERED SNOW SHOWERS IN THE NORTHERN MTNS FOR ONE MORE DAY. FRIDAY NIGHT AND BEYOND...AIRMASS OVER THE REGION DRIES AND GRADUALLY WARMS AS A HIGH PRESSURE RIDGE BUILDS IN FROM THE WEST. COULD SEE SHOWERS RETURNING THE NRN MTNS AND A DIP IN TEMPERATURES BY EARLY NEXT WEEK WITH ANOTHER DISTURBANCE DROPPING DOWN FROM IDAHO.

.AVIATION...EASTERLY UPSLOPE FLOW TO CONTINUE ACROSS THE AREA AIRPORTS THROUGH AT LEAST 15Z WITH IFR CONDITIONS PREVAILING ALONG WITH PERIODS OF LIFR/VLIFR CONDITIONS. THERE IS ALSO A THREAT OF FREEZING DRIZZLE...MAINLY THROUGH 12Z. BY 18Z...WINDS TO SHIFT TO THE NORTHWEST AS UPSLOPE WEAKENS. SHOULD SEE CONDITIONS GRADUALLY IMPROVE TO VFR...THOUGH CEILINGS OF AROUND 5000-6000 FEET AGL WILL PREVAIL THROUGH THE AFTERNOON.

.BOU WATCHES/WARNINGS/ADVISORIES...

WINTER WEATHER ADVISORY UNTIL 9 AM MDT TUESDAY FOR COZ035-036.

&&

SHORT TERM...BARJENBRUCH

LONG TERM....BAKER

12.0 Winter Weather Advisory

The NWS Denver/Boulder Weather Forecast Office issued a Winter Weather Advisory to the general public for most of the Denver area for dense fog and freezing drizzle, which were expected to cause hazardous driving conditions for the region. The advisory was as follows:

*WWUS45 KBOU 282252
WSWBOU
URGENT - WINTER WEATHER MESSAGE
NATIONAL WEATHER SERVICE DENVER/BOULDER CO
452 PM MDT MON OCT 28 2013
COZ035-036-290700-
/O.NEW.KBOU.WW.Y.0025.131028T2252Z-131029T1500Z/
LARIMER AND BOULDER COUNTIES BETWEEN 6000 AND 9000 FEET-JEFFERSON AND WEST DOUGLAS
COUNTIES ABOVE 6000 FEET/GILPIN/CLEAR CREEK/NORTHEAST PARK COUNTIES BELOW 9000 FEET-
INCLUDING THE CITIES OF...ESTES PARK...GLENDEVER...NEDERLAND...RED FEATHER
LAKES...BAILEY...CENTRAL CITY...EVERGREEN...GEORGETOWN...IDAHO SPRINGS...WEST CREEK
452 PM MDT MON OCT 28 2013
...WINTER WEATHER ADVISORY IN EFFECT UNTIL 9 AM MDT TUESDAY...
THE NATIONAL WEATHER SERVICE IN DENVER HAS ISSUED A WINTER WEATHER ADVISORY FOR DENSE FOG
AND AREAS OF FREEZING DRIZZLE...WHICH IS IN EFFECT UNTIL 9 AM MDT TUESDAY.
* TIMING...THROUGH TONIGHT. SOME GRADUAL IMPROVEMENT IS EXPECTED EARLY TUESDAY MORNING.
* PRECIPITATION...AREAS OF FREEZING DRIZZLE.
* VISIBILITY...LESS THAN ONE QUARTER MILE IN SPOTS DUE TO DENSE FOG.
* IMPACTS...VERY POOR VISIBILITIES WILL CREATE HAZARDOUS DRIVING CONDITIONS IN THE FOOTHILLS.
IN ADDITION...AREAS OF FREEZING DRIZZLE WILL LIKELY CONTINUE INTO THE OVERNIGHT HOURS. AS
TEMPERATURES DROP SLIGHTLY AND WITH NIGHTFALL...SOME BRIDGES AND OVERPASSES MAY BECOME
ICY AND HAZARDOUS.

PRECAUTIONARY/PREPAREDNESS ACTIONS...
A WINTER WEATHER ADVISORY MEANS THAT FOG AND AREAS OF FREEZING DRIZZLE WILL CAUSE
PRIMARILY TRAVEL DIFFICULTIES. BE PREPARED FOR VERY POOR VISIBILITIES IN SOME FOOTHILL
LOCATIONS...SLOW TRAVEL...POSSIBLE ICY BRIDGES AND OVERPASSES...AND USE CAUTION WHILE DRIVING.
&&
BARJENBRUCH*

13.0 Preflight Weather Briefing

The pilot of N535SP obtained several weather briefings prior to the flight utilizing a computerized data base called Direct User Access Terminal Service (DUATS) in accordance to Code of Federal Regulations (CFR) Part 91.103 - Preflight Action. The last two weather briefings occurred at 1348 and 1738 MDT respectively, and contained 57 to 60 pages of data respectively. Both briefings indicated that IFR to LIFR conditions were reported and forecast to continue at the destination airport and in the immediate vicinity. The briefing included the AIRMETs for IFR and mountain obscuration conditions over the area. Several pilot reports were included in the middle of the briefing on pages 26 and 30 respectively, of light rime to mixed icing in the area. The briefings are included as attachments 1 and 2 respectively.

14.0 Astronomical Data

The United States Naval Observatory website provided the following astronomical data for the departure airport at Hayden, Routte County, Colorado on October 28, 2013:

Moonset	1454 MDT
Sunset	1810 MDT
End of civil twilight	1838 MDT

At the time of the accident both the Sun and Moon were more than 12° below the horizon and provided no illumination.

F. LIST OF ATTACHMENTS

Attachment 1: Weather briefing documentation issued at 1348 MDT (1948Z)

Attachment 2: Weather briefing documentation issued at 1738 MDT (2338Z)

Submitted by:

Donald Eick
NTSB Senior Meteorologist