



NATIONAL TRANSPORTATION SAFETY BOARD

Office of Aviation Safety
Washington, D.C. 20594

August 23, 2018

Weather Study

METEOROLOGY

CEN17FA132

Table Of Contents

A. ACCIDENT	3
B. METEOROLOGIST	3
C. DETAILS OF THE INVESTIGATION	3
D. WEATHER INFORMATION	3
1.0 Synoptic Conditions.....	3
2.0 Surface Observations	5
3.0 Pilot Reports.....	7
4.0 Upper Air Data.....	7
5.0 Weather Radar	12
6.0 Satellite Imagery	13
7.0 Terminal Aerodrome Forecasts.....	13
8.0 Area Forecast	13
9.0 Area Forecast Discussion.....	14
10.0 AIRMETs for Turbulence and Low Level Windshear	15
11.0 SIGMETs	15
12.0 Center Weather Service Unit products	15
E. LIST OF ATTACHMENTS	16

A. ACCIDENT

Location: Opal, South Dakota
Date: March 16, 2017
Time: 1630 mountain daylight time (2230 UTC)¹
Airplane: Type: Cessna 210B; Registration: N9581X

B. METEOROLOGIST

Mike Richards
Senior Meteorologist
Operational Factors Division (AS-30)
National Transportation Safety Board

C. DETAILS OF THE INVESTIGATION

The National Transportation Safety Board's meteorological specialist did not travel in support of this accident investigation and gathered all weather data remotely. Unless otherwise noted, all times are in mountain daylight time (MDT) for March 16, 2017 (based upon the 24-hour clock), directions are referenced to true north, distances are in nautical miles and heights are above mean sea level (msl).

Coordinates used for the accident location: 44.874167° north latitude, 102.416667° west longitude, at an elevation of about 2,550 feet.

D. WEATHER INFORMATION

1.0 Synoptic Conditions

The National Weather Service (NWS) Surface Analysis Charts for 1500 and 1800 MDT are presented in figures 1 and 2. The surface analysis at 1500 MDT chart identified a low pressure center of 1005 hectopascals (hPa) in extreme southcentral South Dakota, with a dissipating cold front extending from the low pressure center westward through northwest Nebraska and into eastern Wyoming. A warm front also extended from this low pressure center eastward through southeastern South Dakota and into Iowa. A northeast-to-southwest-oriented cold front extended from western North Dakota through southeastern Montana and into northern Wyoming and was depicted as advancing southeast toward the accident location. Surface winds near the accident location were depicted as north to northwest at 20 knots.

¹ UTC – abbreviation for Coordinated Universal Time

The surface analysis at 1800 MDT indicated the northeast-to-southwest-oriented cold front had advanced past the accident location and into central South Dakota. Station models in western South Dakota indicated that the surface wind remained from the north to northwest across the area but varied in magnitude from 5 knots to 25 knots.

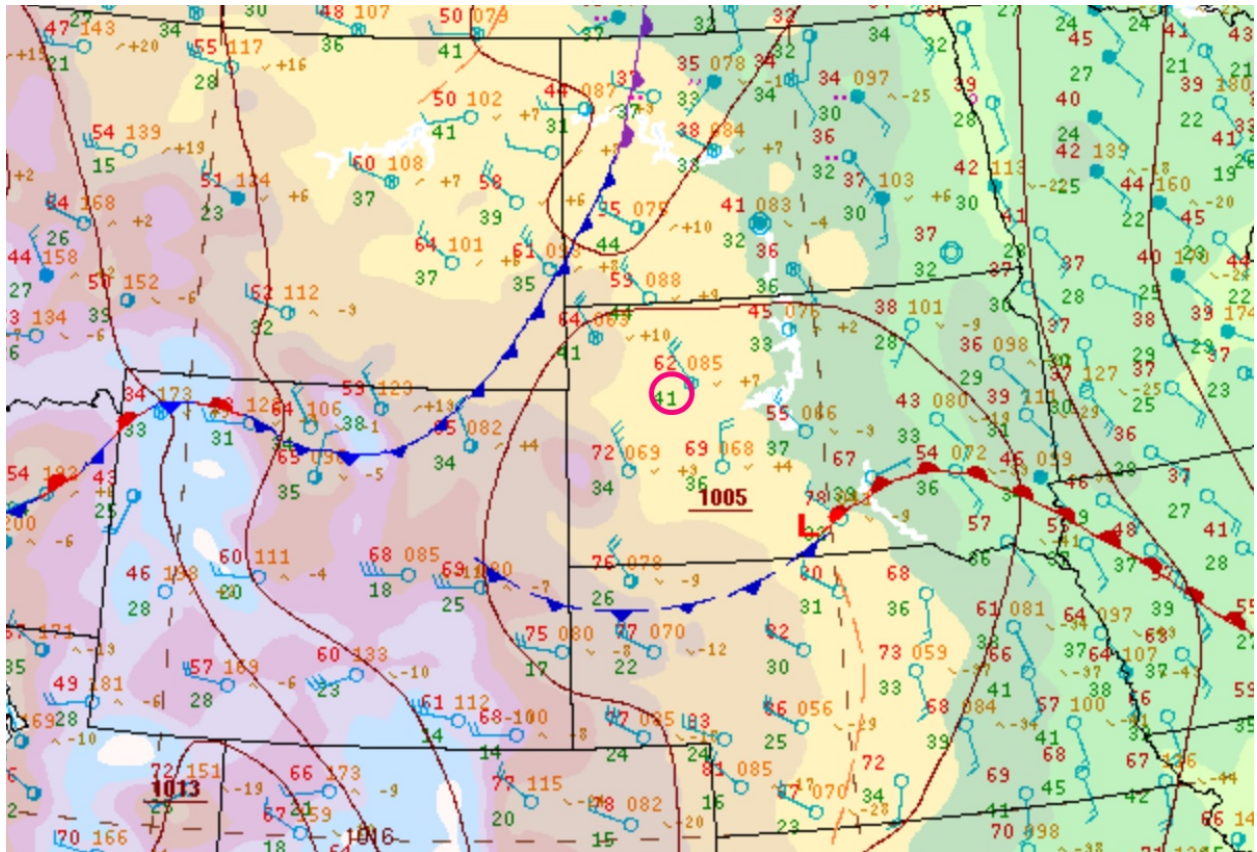


Figure 1 - NWS Surface Analysis Chart for 1500 MDT. Pink circle denotes accident location.

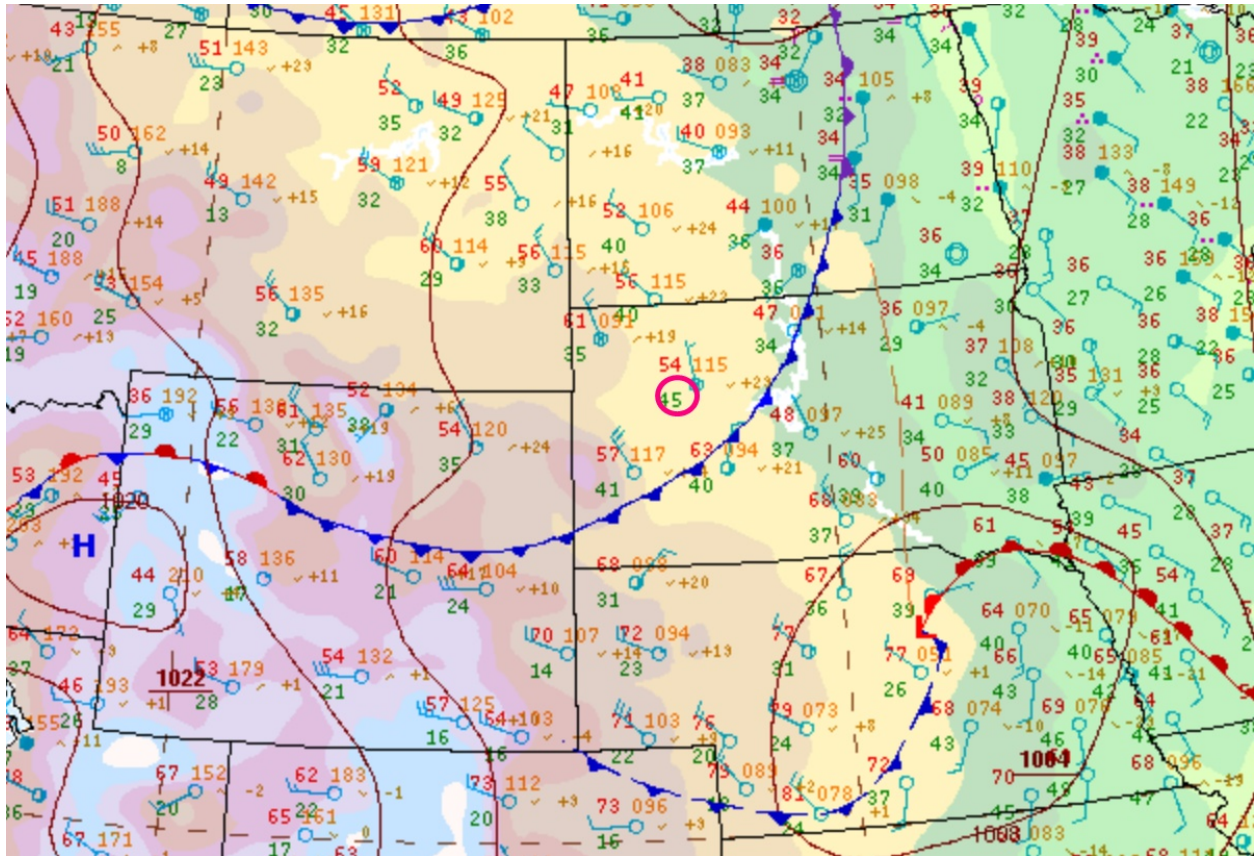


Figure 2 - NWS Surface Analysis Chart for 1800 MDT. Pink circle denotes accident location.

2.0 Surface Observations

An Automated Weather Observing System (AWOS) was located at Faith Municipal Airport (D07)² in Faith, South Dakota, which was located about 19 miles northeast of the accident location at an elevation of about 2,585 feet. Automated reports from D07 during the times surrounding the accident time are presented here. This AWOS was not equipped with visibility, cloud condition or precipitation observing equipment.

[1356 MDT] KD07 161956Z AUTO 33013KT 17/06 A2973 RMK AO1 PK WND 31034/1917 SLP076 T01670056

[1456 MDT] KD07 162056Z AUTO 33020G26KT 17/05 A2975 RMK AO1 PK WND 33027/2007 SLP085 T01670050 53007

[1556 MDT] KD07 162156Z AUTO 34015KT 17/07 A2977 RMK AO1 PK WND 33026/2105 SLP092 T01670072

² The National Weather Service uses the 4-digit International Civil Aviation Organization (ICAO) format for station identifiers (as seen in the body of some formatted weather observations). This report uses the 3-digit International Air Transport Association format for station identification, which does not use the geographic designating digit ("K" for stations in the continental U.S. and "P" for U.S. stations in Alaska and the Pacific region) as found in the ICAO format.

[1656 MDT] KD07 162256Z AUTO 36016KT 16/07 A2979 RMK AO1 SLP100 T01560072

[1756 MDT] KD07 162356Z AUTO 35004KT 12/07 A2983 RMK AO1 SLP115 T01220072 10172 20111 53023

[1856 MDT] KD07 170056Z AUTO 31010KT 11/05 A2985 RMK AO1 SLP123 T01060050

[1956 MDT] KD07 170156Z AUTO 34009KT 08/03 A2986 RMK AO1 SLP131 T00830028

At 1156 MDT, D07 reported a wind from 340° at 15 knots, temperature of 17° Celsius (C) and a dew point temperature of 7° C, altimeter setting of 29.77 inches of mercury; remarks included: station without a precipitation discriminator, peak wind of 26 knots from 330° at 1505 MDT.

At 1656 MDT, D07 reported a wind from 360° at 16 knots, temperature of 16° C and a dew point temperature of 7° C, altimeter setting of 29.79 inches of mercury; remarks included: station without a precipitation discriminator.

A weather reporting station was located at Ellsworth Air Force Base (RCA) in Rapid City, South Dakota, which was located about 53 miles southwest of the accident location at an elevation of about 3,275 feet. Automated and human-augmented reports from RCA during the times surrounding the accident time are presented here.

[1458 MDT] KRCA 162058Z AUTO 35020G31KT 10SM CLR 21/01 A2977 RMK AO2 PK WND 36037/34 SLP076 T02080012 53003 \$

[1558 MDT] KRCA 162158Z AUTO 33023G30KT 10SM CLR 21/01 A2978 RMK AO2 PK WND 32036/28 SLP079 T02090012 \$

[1649 MDT] KRCA 162249Z 32034G40KT 10SM -DZ BKN110 18/02 A2982 RMK AO2A LTG DSNT W DZB49 \$

[1658 MDT] KRCA 162258Z 32028G40KT 10SM -RA FEW013 SCT027 BKN110 17/08 A2985 RMK AO2A PK WND 32041/48 LTG DSNT W DZB49E51RAB51 CIG 055 RWY13 PRESRR SLP112 P0000 T01650075 \$

[1706 MDT] KRCA 162306Z 32021G36KT 10SM FEW025 OVC120 13/08 A2986 RMK AO2A LTG DSNT W RAE06 CIG 055 RWY13 \$

[1724 MDT] KRCA 162324Z AUTO 33026G35KT 10SM FEW021 BKN110 BKN140 14/07 A2986 RMK AO2 RAE06RAB08E09RAB11E24 CIG 085 RWY13 \$=

[1730 MDT] KRCA 162330Z AUTO 33023G35KT 10SM -RA FEW085 SCT110 BKN140 14/07 A2986 RMK AO2 RAE06RAB08E09RAB11E24RAB30 CIG 110 RWY13 \$=

[1743 MDT] KRCA 162343Z AUTO 34017KT 10SM FEW110 13/07 A2987 RMK AO2 RAE06RAB08E09RAB11E24RAB30E43 \$=

[1758 MDT] KRCA 162358Z AUTO 33018KT 10SM CLR 13/07 A2987 RMK AO2 PK WND 33035/21 RAE06RAB08E09RAB11E24RAB30E43 SLP119 P0000 60000 T01290070 10228 20126 52033 \$=

[1858 MDT] KRCA 170058Z AUTO 32012KT 10SM CLR 10/07 A2988 RMK AO2 SLP128 T01040066 \$=

At 1558 MDT, RCA reported a wind from 330° at 23 knots with gusts to 30 knots, visibility 10 statute miles or greater, sky clear below 12,000 feet agl, temperature of 21° C and a dew point temperature of 1° C, altimeter setting of 29.78 inches of mercury; remarks included: observation taken by standard equipment with a full complement of sensors, peak wind of 36 knots from 320° at 1528 MDT, maintenance needed on the system.

At 1649 MDT, RCA reported a wind from 320° at 34 knots with gusts to 40 knots, visibility 10 statute miles or greater, light drizzle, ceiling broken at 11,000 feet agl, temperature of 18° C and a dew point temperature of 2° C, altimeter setting of 29.82 inches of mercury; remarks included: automated observation augmented by a human observer, lightning more than 10 miles away to the west, drizzle began at 1649 MDT, maintenance needed on the system.

3.0 Pilot Reports

There were no publicly disseminated pilot reports³ from South Dakota within an hour of the accident time below FL300⁴.

4.0 Upper Air Data

High-Resolution Rapid Refresh (HRRR) model⁵ soundings (figures 3 and 4) valid for the accident location at 1600 and 1700 MDT were retrieved from the NOAA Air Resources Laboratory. At 1600 MDT, the wind near the surface was from the north-northwest at 15 knots. Above this level the wind *backed*⁶ and increased in magnitude with height to a west-northwest wind of 40 knots at about 9,000 feet. Analysis by the RAwinsonde OBservation program (RAOB) identified the potential for moderate low level windshear (LLWS) within about 100 feet of the surface, and the potential for light LLWS between 100 feet agl and about 500 feet agl.

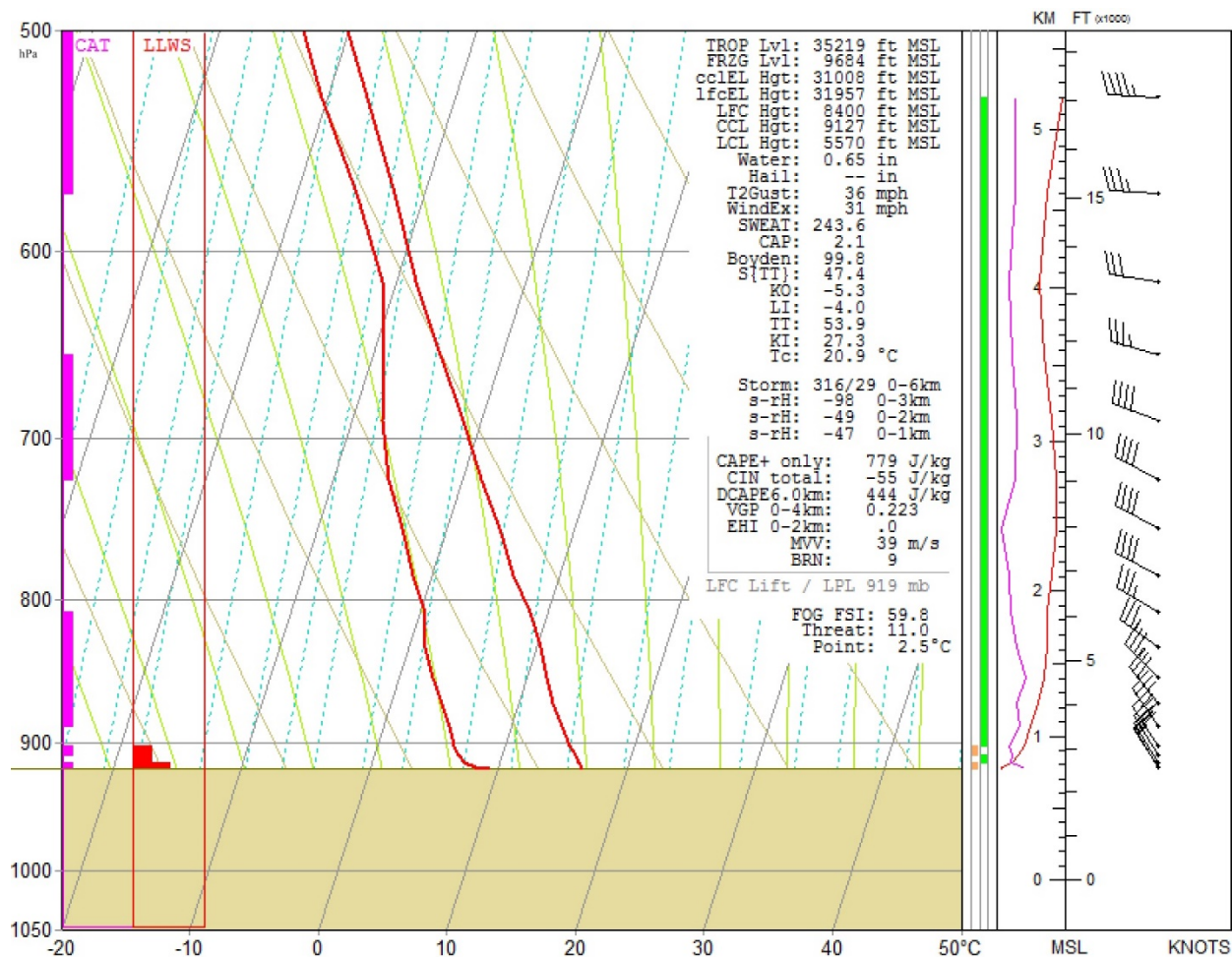
³ Only pilot reports with the World Meteorological Organization header UBSD** were considered. Pilot reports only publicly-disseminated via radio were also not considered.

⁴ Flight Level (FL) - a standard nominal altitude of an aircraft, in hundreds of feet. This altitude is calculated from the international standard pressure datum of 1013.25 hPa (29.92 inches of mercury), the average sea-level pressure, and therefore is not necessarily the same as the aircraft's true altitude either above msl or agl.

⁵ The HRRR is a National Oceanic and Atmospheric Administration (NOAA) real-time three-kilometer resolution, hourly-updated, cloud-resolving, convection-allowing atmospheric model, initialized by three-kilometer grids with three-kilometer radar assimilation. Radar data is assimilated in the HRRR every 15 minutes over a one-hour period.

⁶ A backing wind's wind barbs turn counter-clockwise with increasing height

At 1700 MDT, the wind near the surface was from the north-northwest at 14 knots. Above this level the wind backed and increased in magnitude with height to a west-northwest wind of 38 knots at about 9,000 feet. Analysis by RAOB identified the potential for moderate LLWS and moderate clear air turbulence (CAT; as a function of windshear only) within about 100 feet of the surface, and the potential for light LLWS between 100 feet agl and about 500 feet agl.



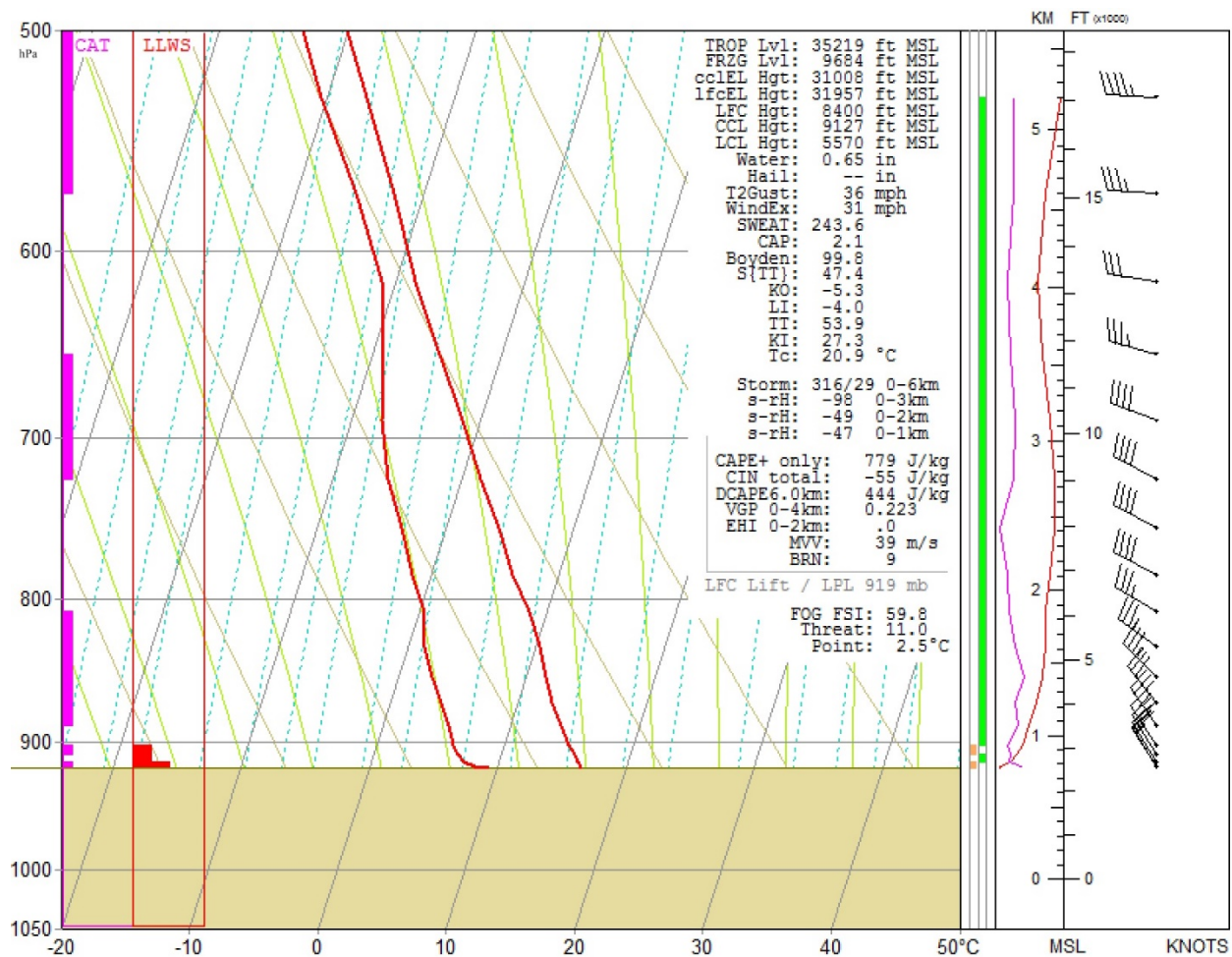


Figure 4 – HRRR model sounding data in SkewT/LogP format for 1700 MDT at the accident site, surface to 500 hPa.

HRRR model soundings were also retrieved for the accident location at 1800 and 1900 MDT (figures 5 and 6, respectively). RAOB's analysis of LLWS for the 1800 MDT sounding was similar to its analysis of LLWS for the 1700 MDT sounding, however at 1800 MDT RAOB identified areas of potential moderate CAT in the lowest 500 feet agl. At 1900 MDT, RAOB identified the potential for strong LLWS and severe CAT within about 100 feet of the surface, and the potential for light LLWS and moderate CAT between 100 feet agl and about 500 feet agl.

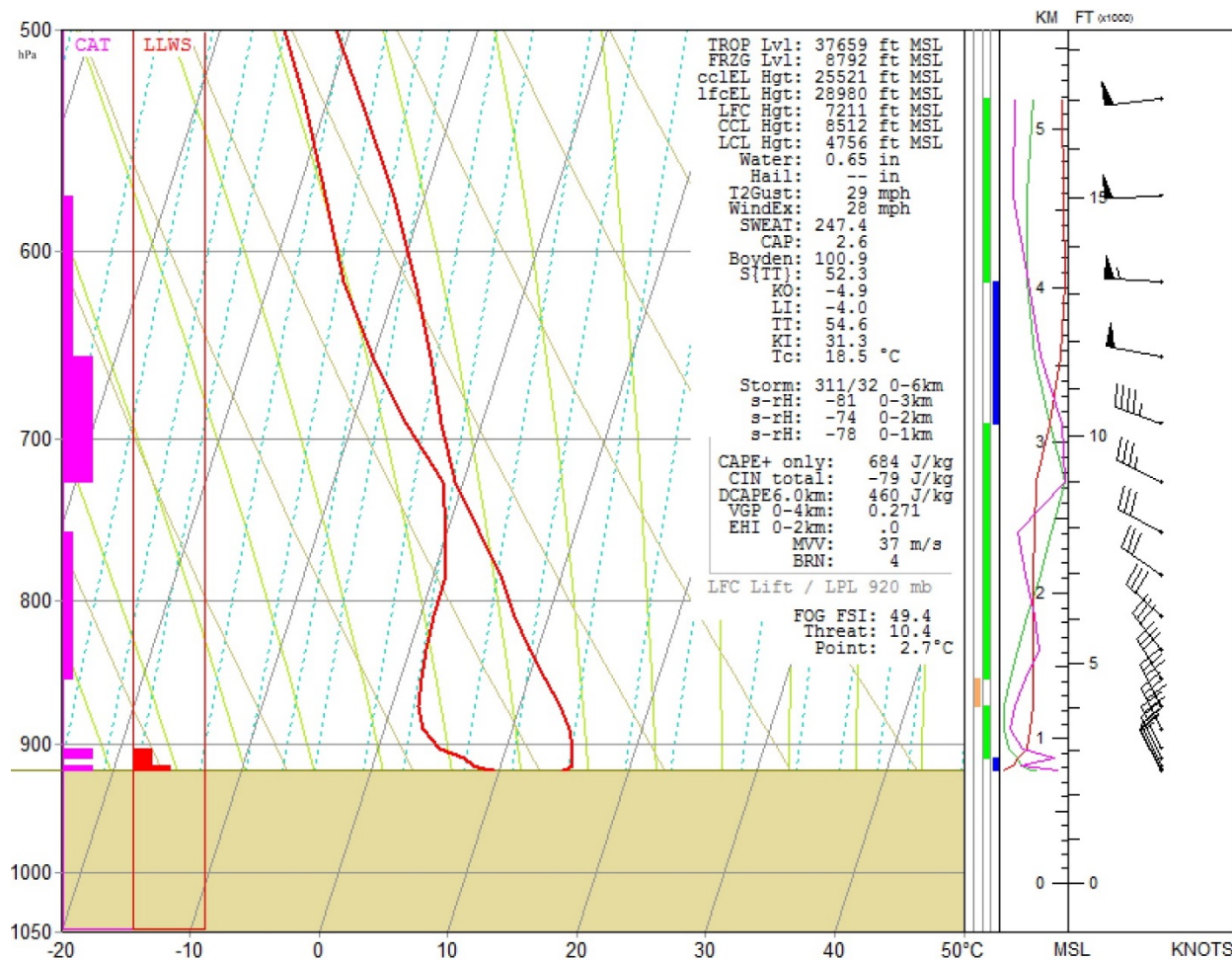


Figure 5 – HRRR model sounding data in SkewT/LogP format for 1800 MDT at the accident site, surface to 500 hPa.

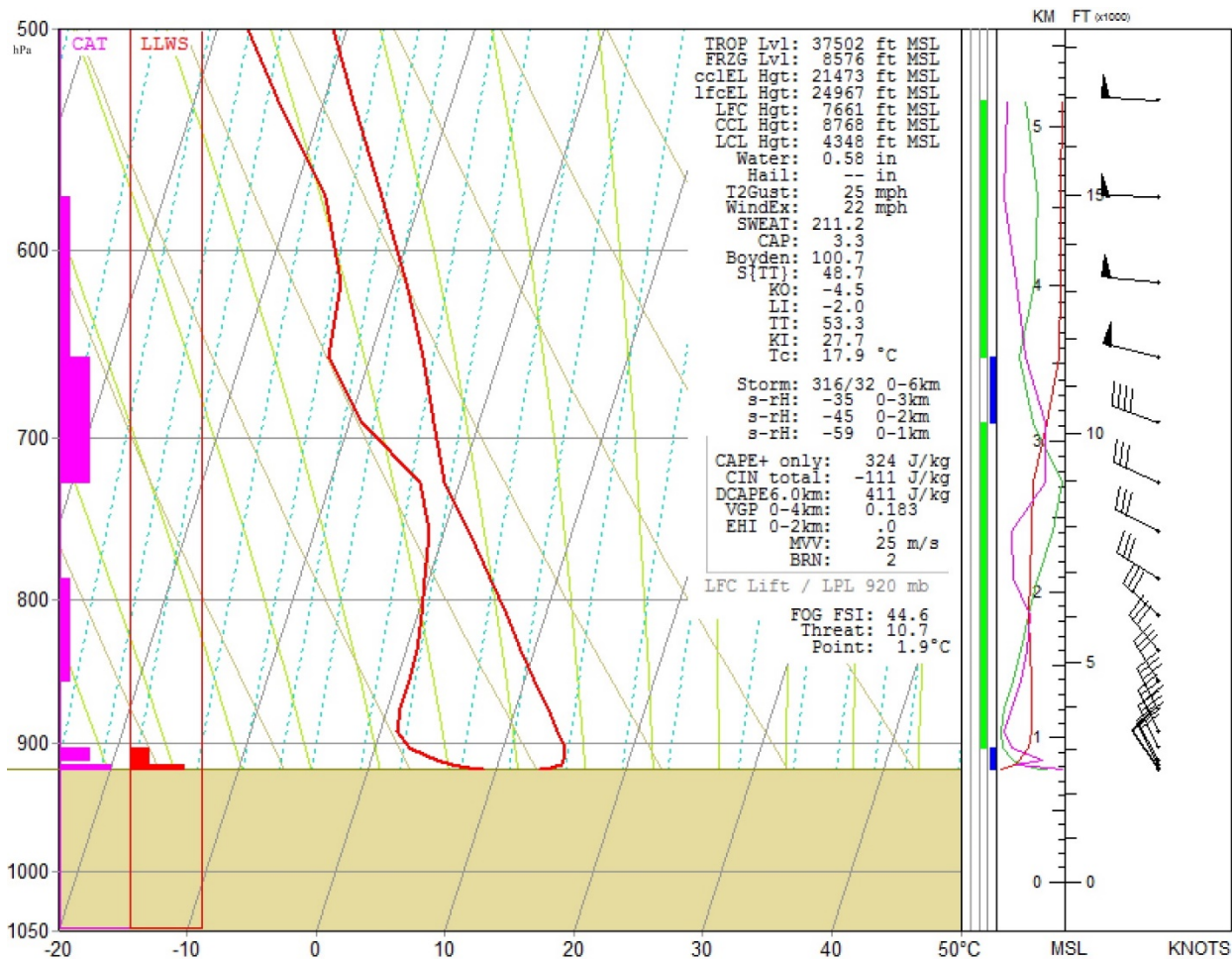


Figure 6 – HRRR model sounding data in SkewT/LogP format for 1900 MDT at the accident site, surface to 500 hPa.

5.0 Weather Radar

WSR-88D Level-II weather radar imagery from Rapid City, South Dakota (KUDX), is presented in figure 7. KUDX was located approximately 49 miles south-southwest of the accident site at an elevation of about 3,025 feet. Assuming standard refraction and considering the 0.95° beam width for the WSR-88D radar beam, the KUDX 0.464° tilt would have “seen” altitudes above the accident location of between about 4,500 and 9,500 feet msl. The KUDX imagery identified widely scattered very light reflectivity values within about 40-50 miles of the accident location. A review of the KUDX weather radar imagery until about 1830 MDT did not reveal more than very light reflectivity targets moving through the accident area.

Attachment 1 presents a Velocity-Azimuth Display (VAD) wind profile⁷ for KUDX around the accident time. The VAD wind profile indicated that the wind was from the north-northwest at 4,000 at 30 knots above KUDX at the accident time, with the 4,000-foot wind measurement showing a root mean square of between 4 and 8. Above these levels and below 9,000 feet the wind varied slightly in magnitude and direction. Attachment 1 also presents the KUDX VAD wind profiles for the (approximately) two hours following the accident time. Between 1754 and 1759 MDT an increase in directional shear in the lowest three to four thousand feet agl is noted.

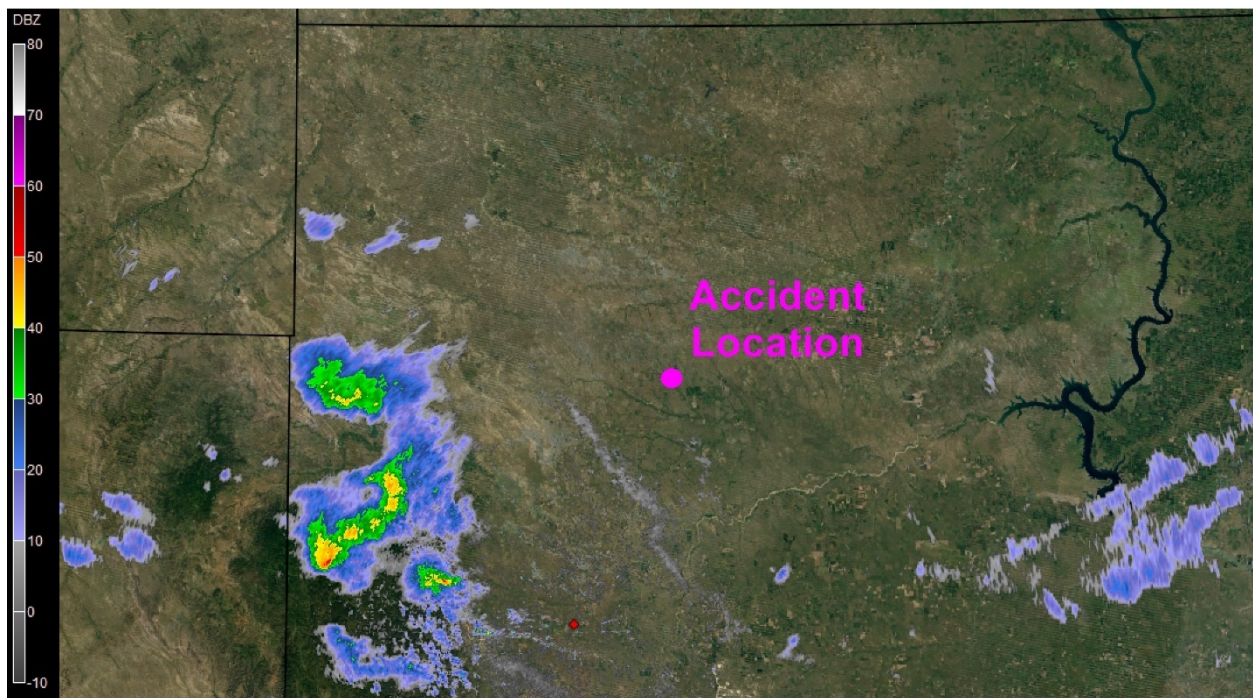


Figure 7 – KUDX 0.464° Level-II reflectivity product from a sweep initiated at 1630:32 MDT.

⁷ VAD wind profile - A plot of horizontal winds as a function of height above a Doppler Radar. The display is plotted with height as the vertical axis and time as the horizontal axis which then depicts the change in wind with time at various heights.

6.0 Satellite Imagery

Geostationary Operational Environmental Satellite (GOES)-13 “visible” (0.63 μ m) data were obtained from an archive at the Space Science Engineering Center at the University of Wisconsin-Madison. Imagery from 1630 MDT is presented in figure 11 and depicts partly cloudy conditions over the accident region.

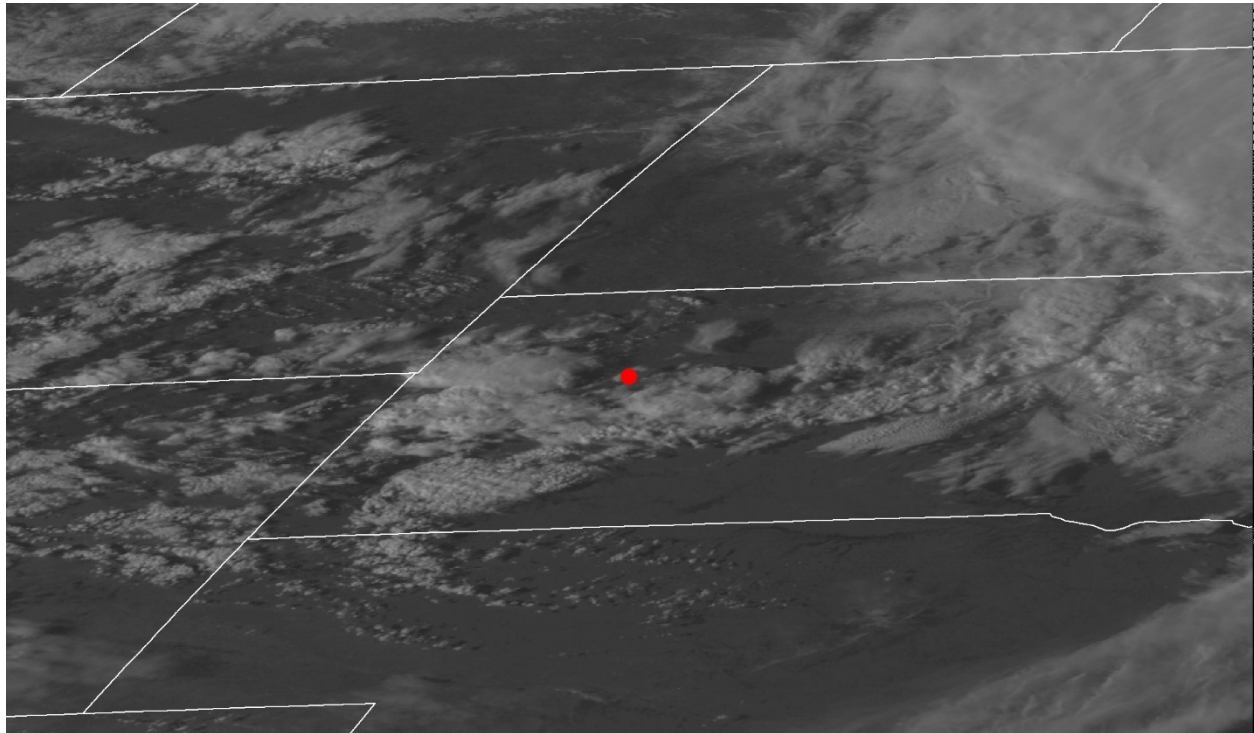


Figure 11 – GOES-13 visible imagery from 1630 MDT. Red dot denotes accident location. Image is not corrected for any parallax error.

7.0 Terminal Aerodrome Forecasts

The closest Terminal Aerodrome Forecast (TAF) site to the accident location was RCA and are not applicable. Both US Air Force and NWS TAFs generally apply to an area within five statute miles of the aerodrome.

8.0 Area Forecast

An Area Forecast that included the state of South Dakota was issued at 1245 MDT by the Aviation Weather Center in Kansas City, Missouri. Cloud heights are above msl. The portion of the Area Forecast directed toward the western half of South Dakota forecasted for the accident time: scattered to broken clouds at 15,000 feet with tops to FL250 and a northwest surface wind of 25 knots with gusts to 35 knots.

FAUS43 KKCI 161845

FA3W

-CHIC FA 161845

SYNOPSIS AND VFR CLDS/WX

SYNOPSIS VALID UNTIL 171300

CLDS/WX VALID UNTIL 170700...OTLK VALID 170700-171300

ND SD NE KS MN IA MO WI LM LS MI LH IL IN KY

.

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.

.

SD

WRN HLF...SCT-BKN150 TOP FL250. WND NW 25G35KT. 23Z BKN100. TIL 04Z WND NW 20G30KT. WDLY SCT -SHRA. OTLK...VFR.

9.0 Area Forecast Discussion

An Area Forecast Discussion (AFD) was issued at 1414 MDT by the NWS Weather Forecast Office in Rapid City, South Dakota. The Short Term and Aviation sections of that AFD are presented here.

FXUS63 KUNR 162014

AFDUNR

Area Forecast Discussion For Western SD and Northeastern WY
National Weather Service Rapid City SD

214 PM MDT Thu Mar 16 2017

.SHORT TERM...(This Evening Through Friday Night)

Issued at 211 PM MDT Thu Mar 16 2017

20z surface analysis had low near KICR with trough into central WY and cold front into southwest SD into northeast WY. Shortwave noted on water vapour across eastern MT into central WY. Post frontal virga and perhaps a light -SHRA indicated on regional radar loop under steep 850-700mb lapse rate regime. Activity will shift east this evening with isolated to scattered PoPs warranted. Gusty winds will subside this evening as boundary layer decouples and pressure rise bubble heads south of CWA. Temperatures tonight will be near guidance as surface high slides into the CWA.

Friday, much cooler day expected. Upper ridge will build over the Rockies and head toward the CWA Friday night. Surface high shifts east with return flow starting in earnest Friday night.

.AVIATION...(For the 18Z TAFS Through 18Z Friday)

Issued At 211 PM MDT Thu Mar 16 2017

VFR conditions will continue through the period. Behind a cold front, gusty northwest winds are expected through this evening. Isolated to scattered showers are possible, especially from northeast WY to southwest SD through early this evening.

10.0 AIRMETs for Turbulence and Low Level Windshear

The following Airmen's Meteorological Information (AIRMET) TANGO advisories, which advised of moderate turbulence and future LLWS conditions⁸ were issued at 1506 MDT and were active for the accident location below 10,000 feet at the accident time.

WAUS43 KPCI 162106 CCA
WA3T
-CHIT WA 162106 COR
AIRMET TANGO UPDT 3 FOR TURB AND LLWS VALID UNTIL 170300
.
AIRMET TURB...ND SD NE KS IA
FROM 30NW BIS TO 60NNW ABR TO 60ESE PIR TO 80S FSD TO 60E HLC TO
40ENE LAA TO GLD TO BFF TO 70SW RAP TO 50W DIK TO 30NW BIS
MOD TURB BLW 100. CONDS CONTG BYD 03Z THRU 09Z.
.
LLWS POTENTIAL...ND SD NE...UPDT
BOUNDED BY 70NNW ISN-70NW MOT-40NNE MOT-80SW GFK-70S FAR-
20NNW FSD-20NNW ONL-50NW ANW-40SW DPR-80SW DIK-70NNW ISN
LLWS EXP. CONDS DVLPG 00-03Z. CONDS CONTG BYD 03Z THRU 09Z.
...CORRECTED AIRMET...

11.0 SIGMETs

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

12.0 Center Weather Service Unit products

There were no Center Weather Advisories or Meteorological Impact Statements issued by the Center Weather Service Unit at the Minneapolis Air Route Traffic Control Center that were active for the accident location at the accident time.

⁸ The LLWS conditions were not expected to develop until 1800-2100 MDT.

E. LIST OF ATTACHMENTS

Attachment 1 - KUDX VAD wind profiles.

Submitted by:

Mike Richards
Senior Meteorologist

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