



National Transportation Safety Board

Office of Aviation Safety
Washington, D.C. 20594-2000

June 3, 2014

WEATHER STUDY
CEN14FA224

A. Accident

Location: Highmore, SD

Date: April 27, 2014

Time: 2116 central daylight time (0216 UTC¹ on April 28, 2014)

Aircraft: Piper PA 32R-300, registration: N8700E

B. Meteorological Specialist

Mike Richards

Senior Meteorologist

National Transportation Safety Board

Operational Factors Division, AS-30

Washington, DC 20594-2000

C. Details of the Investigation

The National Transportation Safety Board's (NTSB) meteorological specialist was not on scene and gathered weather data for this investigation from the NTSB's Washington D.C. office. All times are in central daylight time (CDT) on April 27, 2014 - 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), unless otherwise noted.

Coordinates used for the accident location: 44.36908° North latitude, 99.46292° West longitude.

¹ UTC – abbreviation for Coordinated Universal Time

Synoptic Conditions

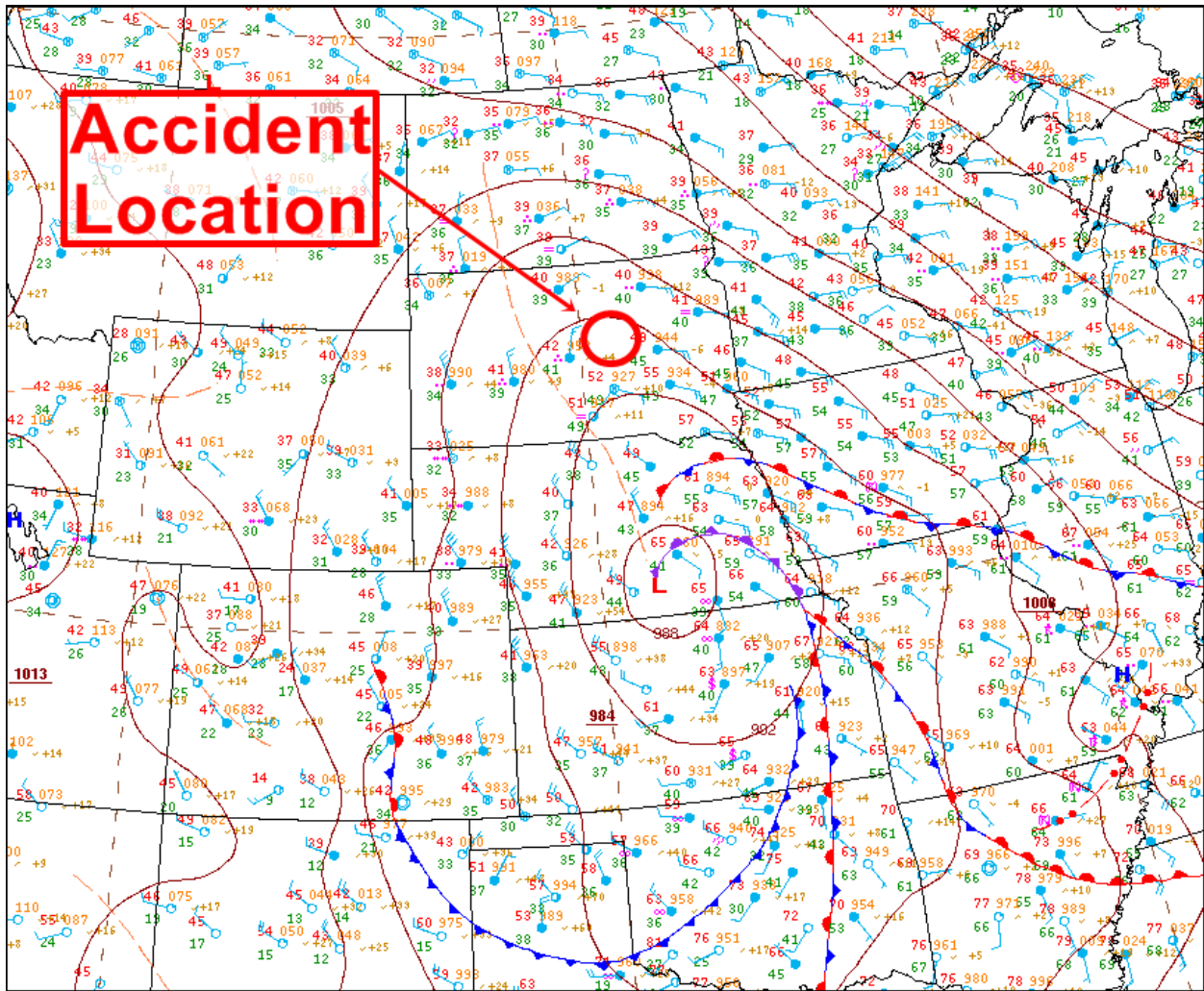


Figure 1 – NWS Surface Analysis Chart for 2200 CDT.

The National Weather Service (NWS) Surface Analysis Chart for 2200 CDT (figure 1) depicted a low-pressure center in southern Nebraska, with an occluded front extending into northeastern Kansas. A stationary front extended from northeastern Nebraska southeast through southern Iowa. Surface wind east of the accident location was generally easterly, with surface wind to the west of the accident location generally northerly. Station models across the state of South Dakota depicted overcast skies, with temperatures ranging from the high 30's° Fahrenheit (F) to the mid-50's°F. Rain and haze were depicted across the state.

A regional Next-Generation Radar (NEXRAD) mosaic (figure 2) obtained from the National Climatic Data Center (NCDC) for 2115 EST identified a large amount of South Dakota under light to moderate values of reflectivity, including the region surrounding the accident site.

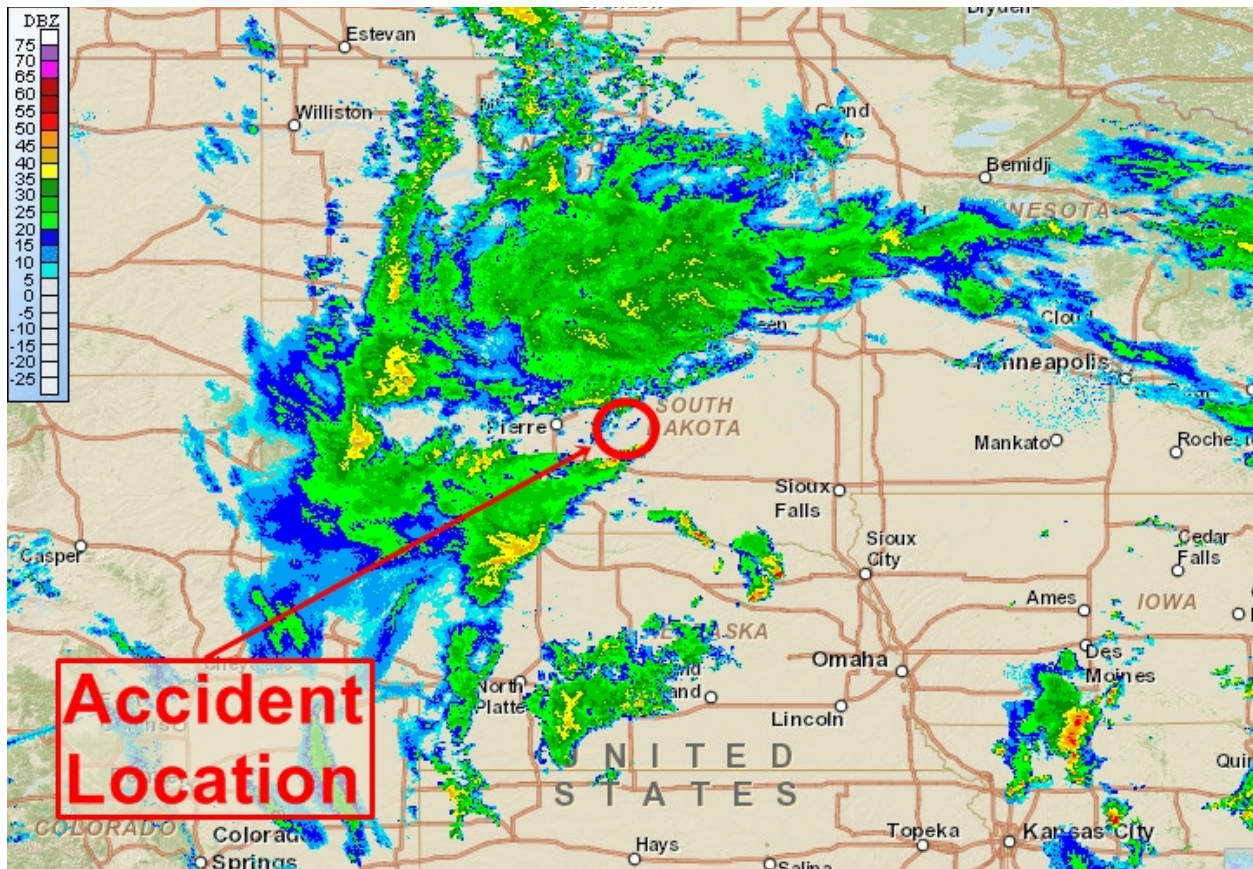


Figure 2 – NCDL NEXRAD mosaic from 2115 CDT.

Surface Observations

Pierre Regional Airport (KPIR) in Pierre, South Dakota, was located 35 miles to the west of the accident site at an elevation of 1,744 feet. The following automated reports were issued from KPIR during the time period surrounding the accident time:

- [2053 CDT] METAR KPIR 280153Z AUTO 02016KT 9SM -RA FEW006 BKN021 OVC025 06/05 A2938 RMK AO2 SLP953 P0011 T00610050=
- [2124 CDT] **SPECI KPIR 280224Z AUTO 01019KT 10SM -RA BKN010 OVC016 06/05 A2937 RMK AO2 CIG 008V012 P0001 T00610050=**
- [2139 CDT] **SPECI KPIR 280239Z AUTO 01019KT 4SM RA BR OVC008 06/05 A2937 RMK AO2 CIG 006V013 P0003 T00610050=**
- [2148 CDT] SPECI KPIR 280248Z AUTO 01016KT 4SM RA BR OVC010 06/05 A2937 RMK AO2 P0005=
- [2153 CDT] METAR KPIR 280253Z AUTO 01016KT 4SM RA BR BKN010 OVC013 06/05 A2938 RMK AO2 LTG DSNT SE SLP952 P0006 60020 T00560050 51004=

At 2124 CDT, KPIR reported a wind from 010° at 19 knots, visibility of 10 statute miles or greater, light rain, ceiling broken at 1,000 feet above ground level (agl), overcast cloud base at 1,600 feet agl, temperature of 6° Celsius (C) and dew point temperature of 5°C, altimeter setting

29.37 inches of mercury. Remarks: station with a precipitation discriminator, ceiling variable between 800 and 1,200 feet agl, 0.01 inches of precipitation since 2053 CDT, hourly temperature of 6.1°C and hourly dew point temperature of 5.0°C.

At 2139 CDT, KPIR reported a wind from 010° at 19 knots, visibility of 4 statute miles, rain, mist, ceiling overcast at 800 feet agl, temperature of 6°C and dew point temperature of 5°C, altimeter setting 29.37 inches of mercury. Remarks: station with a precipitation discriminator, ceiling variable between 600 and 1,300 feet agl, 0.03 inches of precipitation since 2053 CDT, hourly temperature of 6.1°C and hourly dew point temperature of 5.0°C.

Huron Regional Airport (Huron) in Huron, South Dakota, was located 53 miles to the east of the accident site at an elevation of 1,289 feet. The following automated reports were issued from KPIR during the time period surrounding the accident time:

[1955 CDT] METAR KHON 280055Z AUTO 10016G24KT 10SM OVC010 09/07 A2938 RMK AO2 PK WND 11026/0029 RAE32 SLP952 P0000 T00940072=

[2055 CDT] METAR KHON 280155Z AUTO 10020G27KT 10SM OVC010 09/07 A2936 RMK AO2 PK WND 09029/0115 RAB0056E06 SLP946 P0000 T00940072=

[2152 CDT] SPECI KHON 280252Z AUTO 10020G29KT 10SM VCTS OVC010 09/07 A2936 RMK AO2 PK WND 11029/0159 LTG DSNT W=

[2155 CDT] METAR KHON 280255Z AUTO 10018G29KT 10SM VCTS OVC010 09/07 A2936 RMK AO2 PK WND 11029/0159 LTG DSNT W SLP944 60000 T00940072 56006=

At 2055 CDT, KHON reported a wind from 100° at 20 knots with gusts to 27 knots, visibility of 10 statute miles or greater, ceiling overcast at 1,000 feet agl, temperature of 9°C and dew point temperature of 7°C, altimeter setting 29.36 inches of mercury. Remarks: station with a precipitation discriminator, peak wind of 29 knots from 090° observed at 2015 CDT, rain began at 1956 CDT and ended at 2006 CDT, sea-level pressure of 994.6 hectopascals (hPa), trace precipitation since 1955 CDT, hourly temperature of 9.4°C and hourly dew point temperature of 7.2°C.

Data was retrieved² from the SuperAWOS at Miller Municipal Airport in Miller, South Dakota, which was located about 24 miles east-northeast of the accident site. Quality of the data is unknown. Temperatures are in °F, wind magnitudes are in knots and visibility is in statute miles.

| <u>Time</u> | <u>Temp</u> | <u>D Temp</u> | <u>W Dir</u> | <u>W Mag</u> | <u>W-Gust Mag</u> | <u>Vis</u> |
|-------------|-------------|---------------|--------------|--------------|-------------------|------------|
| 1855 | 47 | 44 | 090° | 14 | 21 | 10 |
| 1955 | 45 | 43 | 080° | 14 | 20 | 7 |
| 2055 | 46 | 44 | 080° | 11 | 15 | 15 |
| 2155 | 47 | 45 | 080° | 15 | 20 | 10 |

² Retrieved at: <http://www.superawos.com/>

Sounding Data

Atmospheric data were retrieved from a rawinsonde launch at 1900 CDT from Aberdeen, South Dakota (rawinsonde station: ABR), which was located approximately 77 miles north-northeast of the accident site. These data are presented in figure 3.

The ABR sounding indicated the majority of the troposphere was stable. A strong temperature inversion was evident between about 2,900 and 4,100 feet. The relative humidity was greater than 90 percent below about 16,300 feet, and was greater than 96 percent between about 1,800 and 6,300 feet. The freezing level was approximately 10,000 feet.

The ABR sounding identified an easterly wind of 19 knots near the surface (~1,300 feet), with an easterly wind of 44 knots at about 3,000 feet. Above this level the wind *veered*³ slightly to the southeast and decreased in magnitude to 19 knots through 5,000 feet. Calculations by the Universal RAwinsonde OBServation program (RAOB) for this sounding indicated the potential for significant turbulence and “light” low-level wind shear below 4,000 feet.

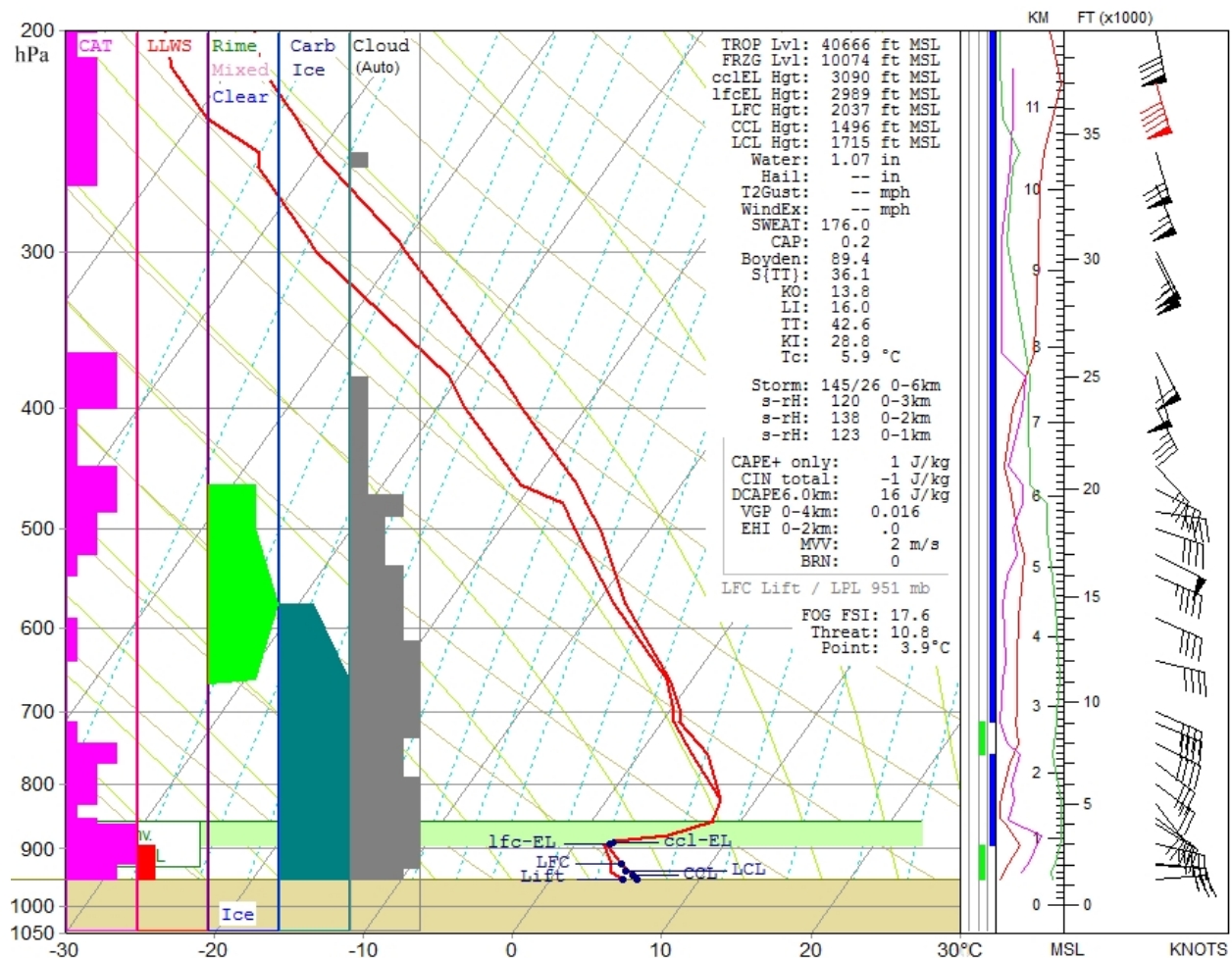


Figure 3 – Rawinsonde sounding from ABR in SkewT/LogP format for 1900 CDT, surface to 200 hPa.

³ A veering wind is a wind that turns clockwise with increasing height.

Pilot Reports

There were no publically disseminated pilot reports within the state of South Dakota⁴ made within two hours of the accident time:

Radar Data

WSR-88D Level-II 0.50° base reflectivity imagery at 2114 CDT from Aberdeen, South Dakota (KABR), located approximately 77 miles to the north-northeast of the accident site, is presented in figure 4. Assuming standard refraction and considering the WSR-88D 0.95° beamwidth⁵, at this tilt the radar would have “seen” altitudes between about 5,460 and 13,200 feet msl at the accident site. The KABR data identified an area of light reflectivity coincident with the accident location approximately two minutes prior to the accident time.

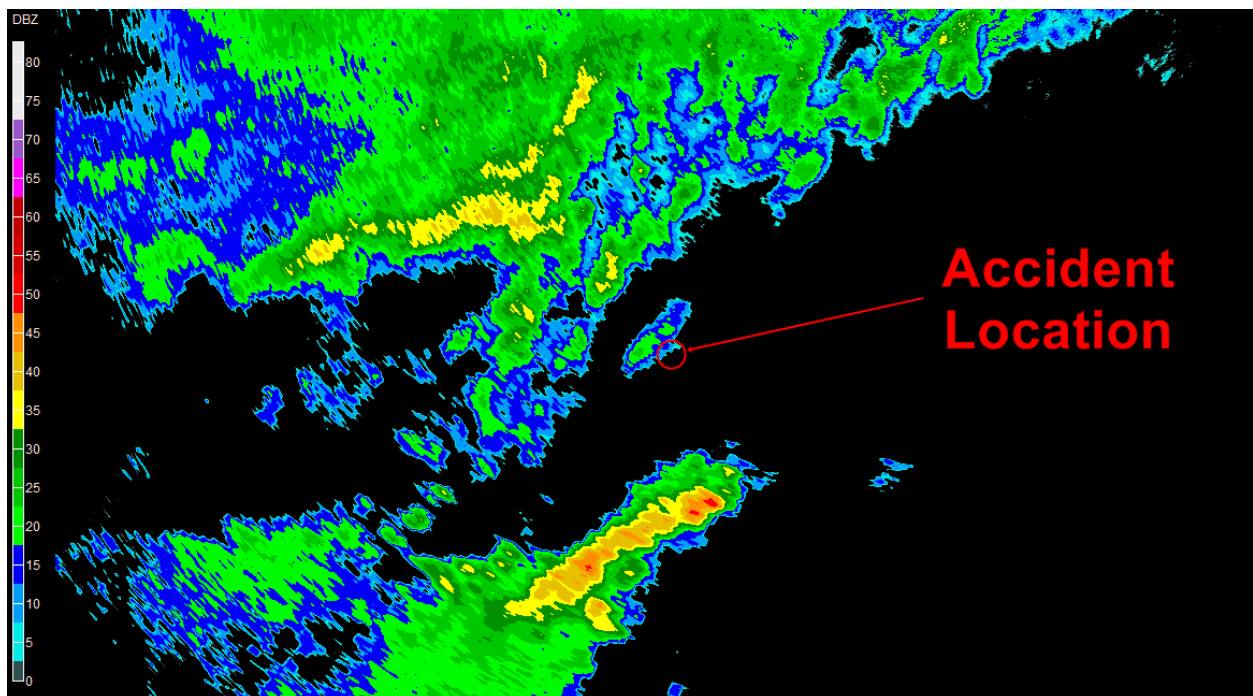


Figure 4 – KABR 0.50° base reflectivity imagery from 2114 CDT.

⁴ Only pilot reports distributed with the UBSD** header were considered.

⁵ Beam width - the angular separation between the half power points on the antenna radiation pattern, where the gain is one half the maximum value.

Lightning

Total lightning data for the accident region between 2100 and 2116 CDT were retrieved from the Earth Networks Total Lightning Network (ENTLN). This data is presented in figure 5.

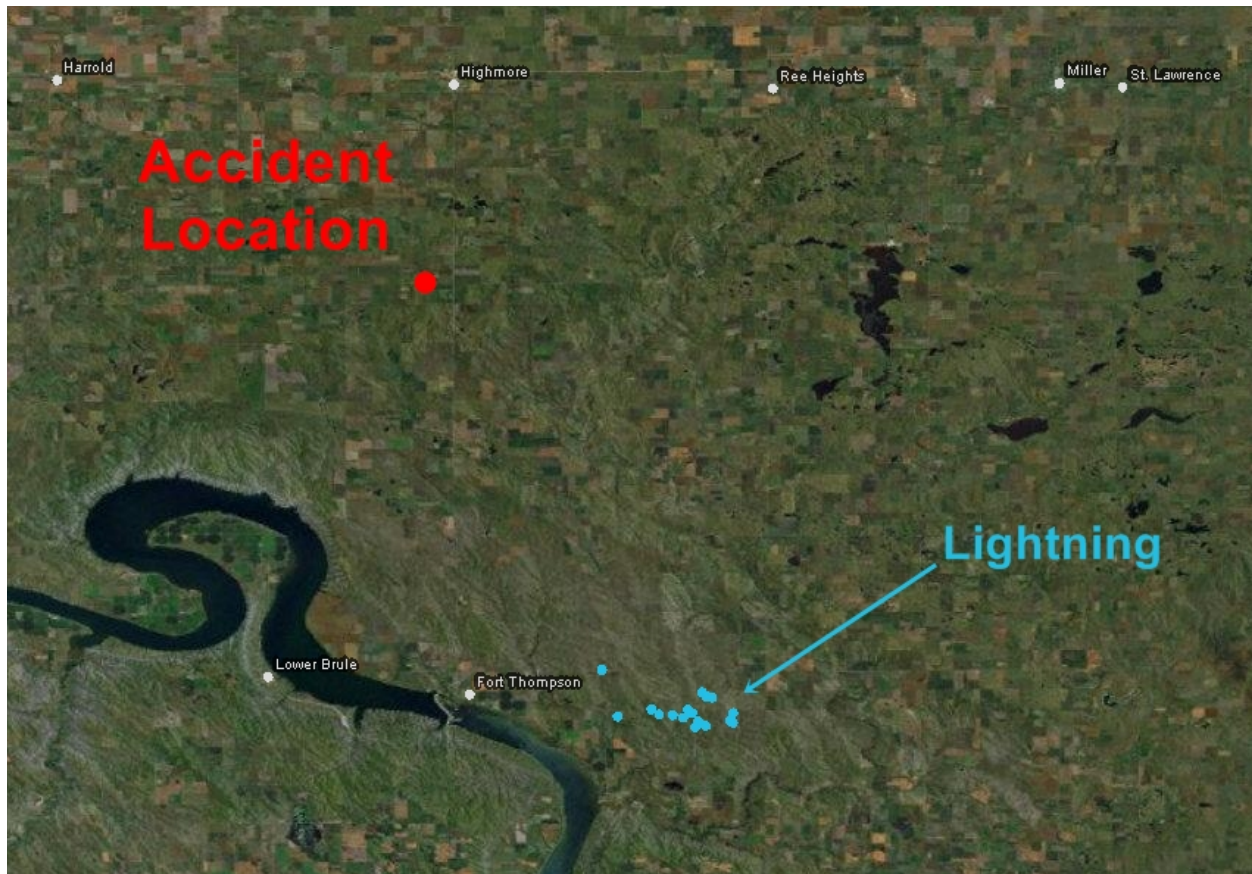


Figure 5 – Plots of ENTLN total lightning strokes between 2100 and 2116 CDT.

Satellite Imagery

Advanced Very High Resolution Radiometer (AVHRR) data from the NOAA-16 satellite data were obtained from the National Oceanic and Atmospheric Administration and processed using the Man computer Interactive Data Access System (McIDAS). AVHRR 10.8 μ m imagery from 2124 CDT is presented in figure 6, and identified cloudy conditions at or near the accident site. Cloud-top temperatures in the region varied between -53°C and 6°C, which, when considering the ABR sounding, the former corresponded to heights of approximately 35,000 feet. Due to a temperature inversion in the ABR sounding near 4,000 feet, the temperature of 6°C may correspond to various heights: at/very near the surface or somewhere between 3,500 and 6,500 feet (this range is due to temperatures between 3,500 and 6,500 being close to 6°C).

Figure 7 presents color-enhanced imagery from the 2124 CDT AVHRR dataset resulting from a band differencing technique that subtracts the 3.64 μ m brightness temperatures from the 10.8 μ m brightness temperatures. Blue areas indicate high cloud while yellow areas indicate possible low cloud (e.g. fog). This technique does not identify low cloud when mid- or high-level cloud exists

above it. Figure 7 indicates low cloud was likely present close to the accident site near the accident time. Low cloud was not identified at the accident location, however low cloud may have existed but was obscured from the satellite's view by higher cloud.

It should be noted that all satellite data presented here have not been corrected for any parallax error.

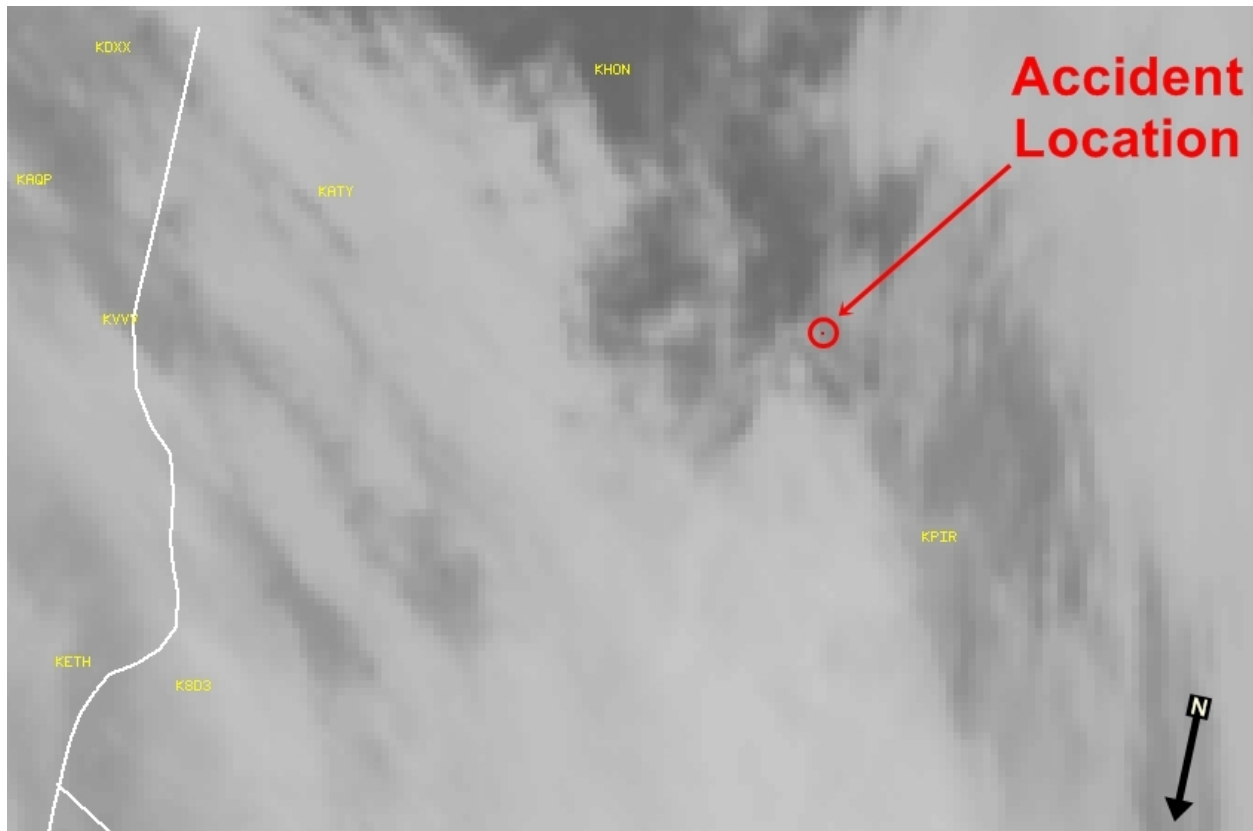


Figure 6 – NOAA-16 AVHRR 10.8µm (infrared) imagery from 2124 CDT.

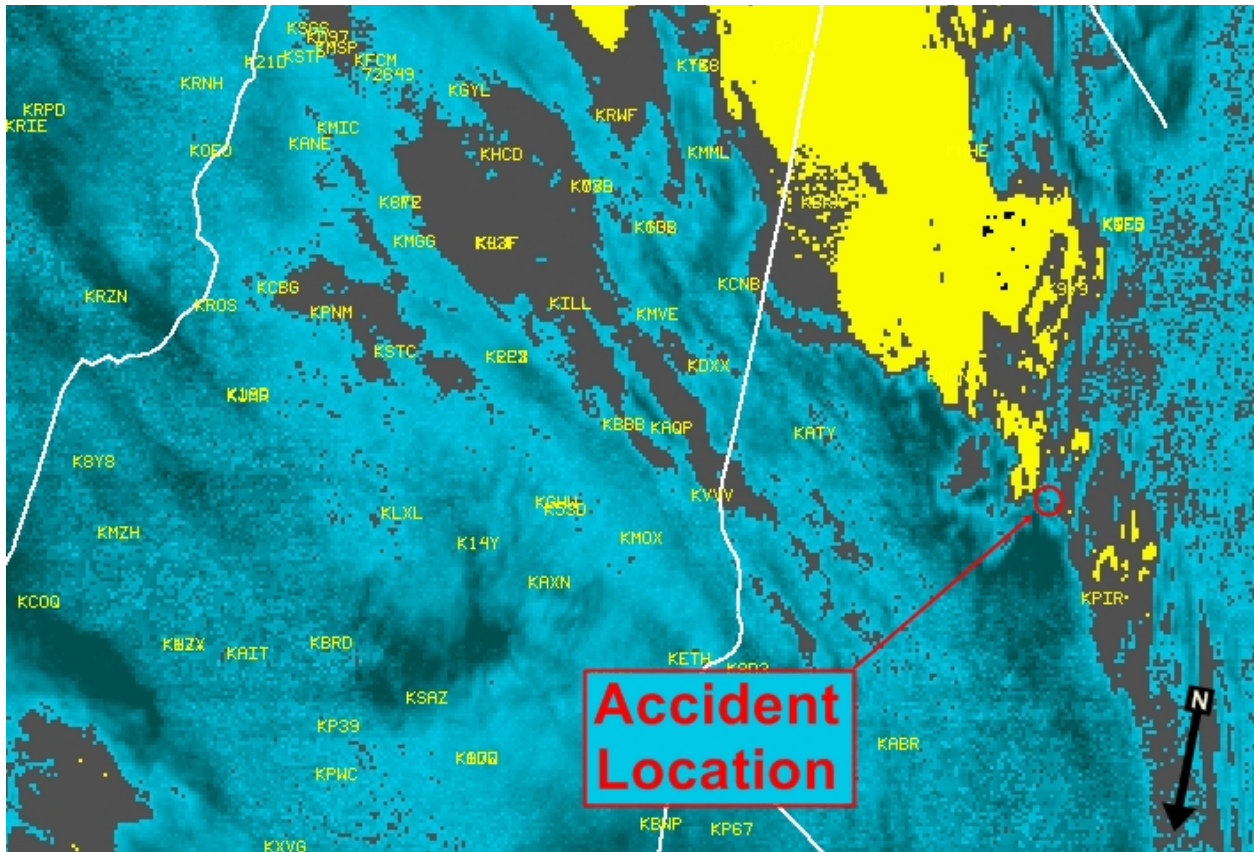


Figure 7 – NOAA-16 AVHRR 10.8µm-3.64µm imagery from 2124 CDT. Yellow areas indicate possible areas of low cloud.

Area Forecast

An Area Forecast that included South Dakota was issued at 2045 CDT. The portion of the Area Forecast directed toward the eastern two-thirds of South Dakota forecasted for the accident time: ceiling overcast at 3,000 feet msl with cloud tops to FL180⁶, widely scattered light rain showers, wind from the east at 20 knots with gusts to 30 knots.

FAUS43 K KCI 280145

FA3W

_CHIC FA 280145

SYNOPSIS AND VFR CLDS/WX

SYNOPSIS VALID UNTIL 282000

CLDS/WX VALID UNTIL 281400...OTLK VALID 281400-282000

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.

.

⁶ Flight Level (FL) - standard nominal altitude of an aircraft, in hundreds of feet. This altitude is calculated from the International standard atmosphere using 1013.25 hPa (29.92 in Hg) for surface pressure.

SYNOPSIS...02Z DEEP LOW OVR S CNTRL NEB. WRMFNT FM LOW EWD THRU S CNTRL IA-SRN IL-ERN KY. CDFNT FM LOW SWD THRU WRN MO-ERN OK. TROF FM LOW NWWD THRU WRN SD. BY 20Z LOW MOVS SLOWLY EWD TO WRN IA. WRMFNT EWD FM LOW THRU CNTRL IL-SRN IN-ERN KY. CDFNT FM LOW THRU CNTRL MO-CNTRL AR. TROF FM LOW SWWD THRU CNTRL KS. TROF FM LOW NWWD THRU CNTRL SD.

.
SD

W 1/3...OVC060 TOP FL320. VIS 4SM -RA BR. ISOL -TSRA. CB TOP FL360. WND NW 25G40KT. 12Z OVC060 TOP FL280. WDLY SCT -SHRA. WND NW 30G45KT. OTLK...MVFR CIG SHRA WND.

E 2/3...OVC030 TOP FL180. WDLY SCT -SHRA. WND E 20G30KT. 07Z
OVC030 TOP FL300. VIS 4SM -RA BR. WND E G25KT. OTLK...MVFR CIG RA BR WND.

Prior to the 2045 CDT Area Forecast, another Area Forecast that included South Dakota was issued at 1345 CDT. The portion of the Area Forecast directed toward the central and eastern portions of South Dakota forecasted for the accident time: ceiling overcast at 3,000 feet msl with clouds layered up to FL300, scattered thunderstorms with light rain, cumulonimbus cloud tops to FL400, wind from the southeast at 20 knots with gusts to 35 knots.

FAUS43 KPCI 271845

FA3W

_CHIC FA 271845

SYNOPSIS AND VFR CLDS/WX

SYNOPSIS VALID UNTIL 281300

CLDS/WX VALID UNTIL 280700...OTLK VALID 280700-281300

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.

.
SYNOPSIS...19Z LOW 30N LBF. CDFNT ALG A 30N LBF-OBH-20W OSW-ADM LN. WRMFNT ALG A 30N LBF-30N OVR-DEC-HMV LN. 13Z LOW 30SW FSD. CDFNT ALG A 30SW FSD-BUM-FSM LN. STNR FNT ALG A 50SW DSM-DEC040S CVG-20E HMV LN.

.
SD

W THIRD...OVC050 LYRD FL300. WDLY SCT -TSRA. CB TOPS FL400. WND NW 25G35KT. 01Z VIS 4SM -RA. WND NW 25G35KT. OTLK...IFR CIG RASN.
CNTRL-ERN...OVC030 LYRD FL300. LYRD FL300. SCT -TSRA. CB TOPS FL400. WND SE 20G35KT. OTLK...IFR CIG RA WND.

Aviation Section of the Area Forecast Discussion

An Area Forecast Discussion (AFD) was issued at 1903 CDT by the NWS Weather Forecast Office in Aberdeen, South Dakota. The aviation portion of the AFD is presented here.

FXUS63 KABR 280003 AAA
AFDABR
AREA FORECAST DISCUSSION...UPDATED
NATIONAL WEATHER SERVICE ABERDEEN SD
703 PM CDT SUN APR 27 2014

.AVIATION...

00Z TAFS FOR THE KABR...KATY...KPIR AND KMBG TERMINALS CURRENT THINKING IS SOME FORM OF SUB-VFR FLYING WEATHER CONDITIONS WILL BE PREVAILING OVER THE NEXT 24 HOURS...WITH RAIN SHOWER CHANCES PERSISTING FOR A FEW MORE HOURS INTO THIS EVENING AT KABR/KMBG/KPIR BEFORE PRECIPITATION EVOLVES INTO AREAS OF FOG/DRIZZLE. BY LATE TONIGHT/EARLY MONDAY...LIGHT RAIN MAY BE BACKING UP INTO THE KMBG/KPIR TERMINALS. ALSO LOOKING AT A GRADUAL STEP DOWN IN THE STRONG EAST-NORTHEAST WINDS. KPIR/KMBG SHOULD SWITCH AROUND TO MORE OF A NORTHERLY WIND DIRECTION BY MONDAY MORNING AS WELL.

AIRMETS

Airmen's Meteorological Information (AIRMET) advisories active for South Dakota below 15,000 feet at the accident time are presented here (also see Figure 8).

An AIRMET for IFR⁷ conditions was issued at 1959 CDT for a region that included the accident location.

WAUS43 KKCI 280059 AAA
WA3S
_CHIS WA 280059 AMD
AIRMET SIERRA UPDT 5 FOR IFR VALID UNTIL 280300

.
...SEE SIGMET WHISKEY SERIES...UPDT

.
AIRMET IFR...ND SD NE MN IA WI
FROM 50NNW MOT TO 20NNW GFK TO 40W BJI TO 50S DLH TO 30SW EAU
TO DBQ TO 20SE DSM TO 40SSW FOD TO 20NW ONL TO SNY TO 20NNW
BFF TO 70SW RAP TO 50NNW ISN TO 50NNW MOT
CIG BLW 010/VIS BLW 3SM PCPN/BR. CONDS CONTG BYD 03Z THRU 09Z.

⁷ Instrument Flight Rules (IFR) – ceiling 500 feet agl to below 1,000 feet agl and/or visibility 1 statute miles to less than 3 statute miles

An AIRMET for moderate turbulence for altitudes below 15,000 feet was issued at 1545 CDT for a region that included the accident location. An AIRMET for strong surface winds was issued at 1545 CDT for a region that did not include the accident location.

WAUS43 KPCI 272045

WA3T

_CHIT WA 272045

AIRMET TANGO UPDT 3 FOR TURB STG WINDS AND LLWS VALID UNTIL 280300

.
AIRMET TURB...ND SD NE KS MN IA MO WI LM LS MI IL IN KY OK TX AR
TN LA MS AL AND CSTL WTRS
FROM 70NNW ISN TO 40NNE INL TO PMM TO 20SE IJU TO 40NNW SJI TO
20ESE HRV TO PSX TO 20SE DLF TO 90S MRF TO 20NW ELP TO INK TO
30ESE TBE TO 50W LBL TO GLD TO BFF TO 70SW RAP TO 70NNW ISN
MOD TURB BLW 150. CONDS CONTG BYD 03Z THRU 09Z.

.
AIRMET STG SFC WINDS...SD NE KS OK TX
FROM 70SW RAP TO 20ESE LBF TO SLN TO CDS TO 20E FST TO 50W MRF
TO ELP TO INK TO 30ESE TBE TO 50W LBL TO GLD TO BFF TO 70SW RAP
SUSTAINED SURFACE WINDS GTR THAN 30KT EXP. CONDS CONTG BYD
03Z ENDG 06-09Z.

An AIRMET for moderate ice for altitudes between the freezing level and FL200 was issued at 1545 CDT for a region that included the accident location.

WAUS43 KPCI 272045

WA3Z

_CHIZ WA 272045

AIRMET ZULU UPDT 3 FOR ICE AND FRZLVL VALID UNTIL 280300

.
AIRMET ICE...ND SD NE KS MN WI LS
FROM 30N INL TO 80WSW YQT TO 50SSW DLH TO 70ESE BIS TO 30WSW
OBH TO 20SE MCK TO GLD TO BFF TO 70SW RAP TO 50NNW ISN TO 30N
INL
MOD ICE BTN FRZLVL AND FL200. FRZLVL 030-100. CONDS CONTG BYD
03Z THRU 09Z.

.
FRZLVL...RANGING FROM 025-125 ACRS AREA
MULT FRZLVL 030-100 BOUNDED BY 40NNW INL-YQT-SSM-YVV-20E
ECK-
50NNW TVC-70E DLH-20E BRD-30SE GFK-40NE DPR-PIR-70WNW ANW-
70NW RAP-50NNW ISN-40NNW INL
040 ALG 60SSW ISN-30NNE DIK-20NNW GFK-50S INL-50SE YQT-SSM
080 ALG 60SE LAA-30SSW GCK-30NE GCK-50WSW ABR-30W ABR-
40WNW RHI-30SSE ECK
120 ALG 40WNW ARG-30S FAM-20NNW DYR

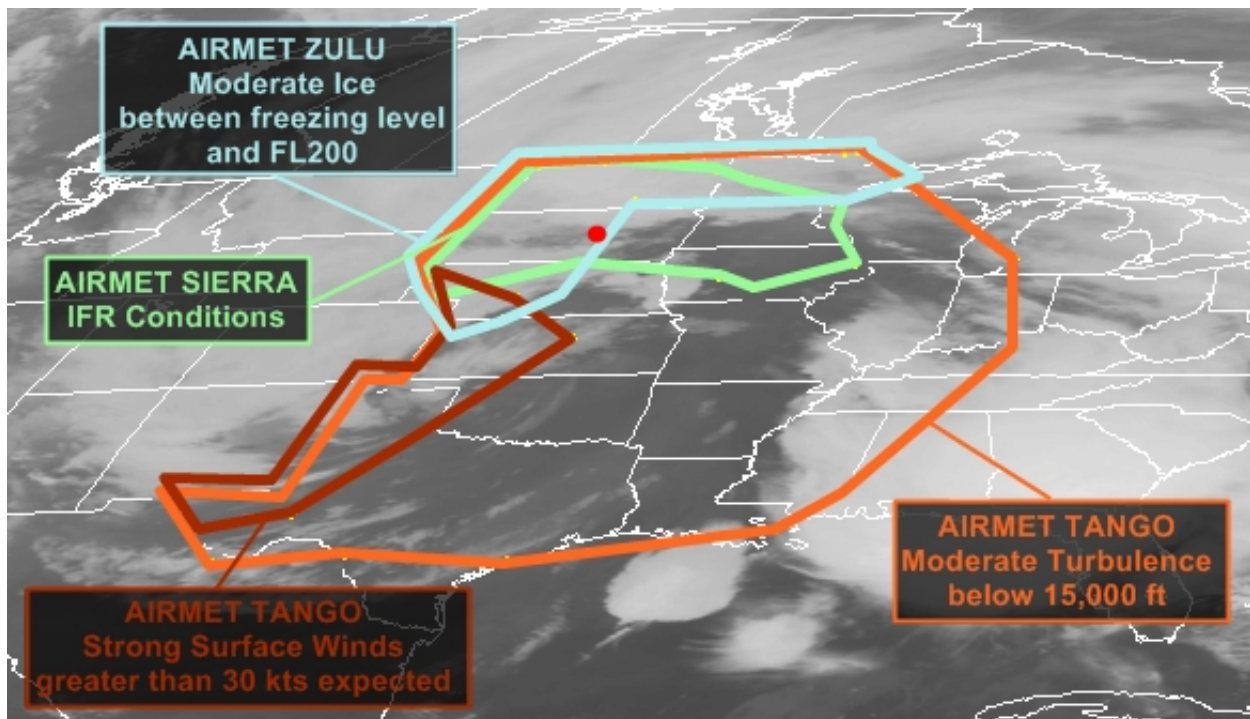


Figure 8 – Graphical depiction of AIRMET boundaries presented in this section. Products overlaid onto GOES-13 10.7µm image from 2115 CDT. Red dot denotes accident location.

SIGMETs

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

There were two Convective SIGMETs (figure 9) issued for convection close to the accident location in the two hours prior to the accident time:

(issued at 1955 CDT)

CONVECTIVE SIGMET 9C

VALID UNTIL 0255Z

NE SD

FROM 50NNW ANW-20NE ONL

LINE TS 40 NM WIDE MOV FROM 13030KT. TOPS TO FL380.

(issued at 2055 CDT)

CONVECTIVE SIGMET 18C

VALID UNTIL 0355Z

NE SD

FROM 50ESE PIR-50SSE PIR-60ESE ONL

LINE SEV TS 40 NM WIDE MOV FROM 15020KT. TOPS TO FL400.

HAIL TO 1 IN...WIND GUSTS TO 50KT POSS.

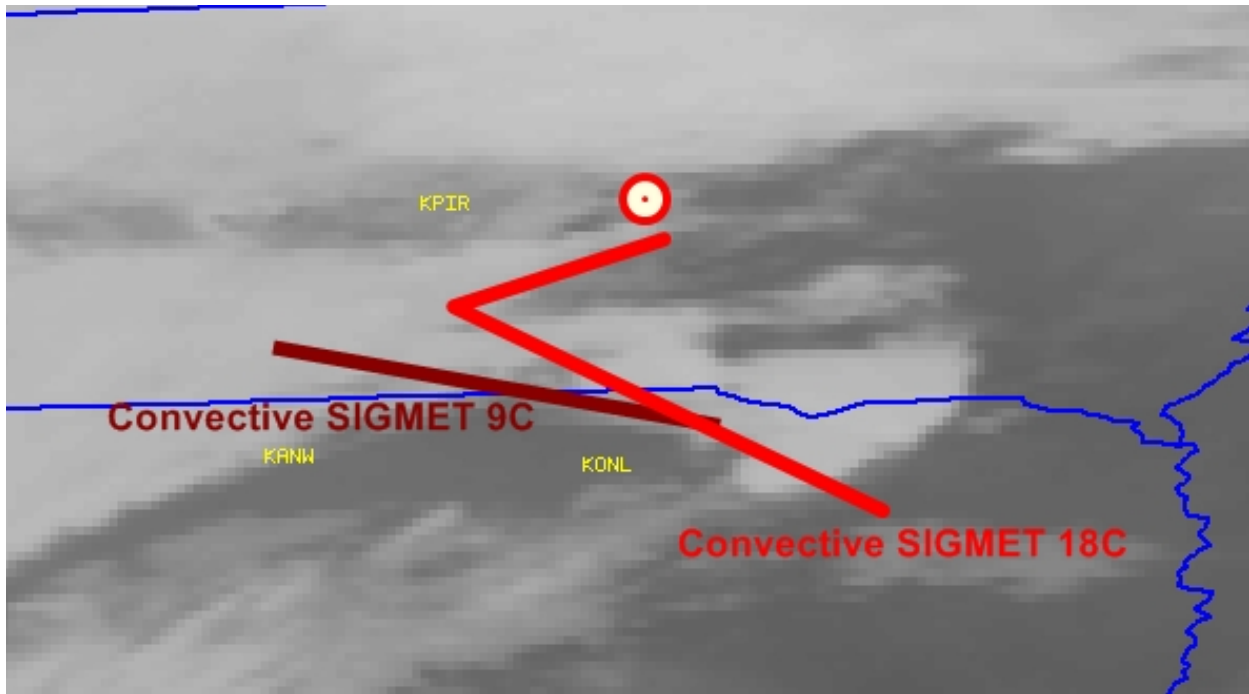


Figure 9 – Plots of Convection SIGMETs overlaid onto GOES-13 infrared satellite imagery from 2115 CDT. Accident location depicted by red/white circle.

CWSU Products

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

*Submitted by: Mike Richards
NTSB, AS-30*