

National Transportation Safety Board

Office of Aviation Safety

Washington, DC 20594



CEN25FA047

METEOROLOGY

Specialist's Factual Report

January 8, 2025

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A. ACCIDENT

Location: Drake, Colorado

Date: 23 November 2024

Time: 1115 mountain standard time (1815 UTC¹)

Aircraft: Type - Cessna 182T; Registration - N434CP

B. METEOROLOGY INVESTIGATOR

Mike Richards

Senior Meteorologist

Office of Aviation Safety

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 standard time for 23 November 2024 (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). The accident site was located at about: 40.441487° north latitude; 105.30918° west longitude; at an elevation of about 7,840 feet.

This report provides information on the weather conditions and forecasts applicable to the accident region at the accident time.

D. WEATHER INFORMATION

1.0 Surface Observations

Meteorological reporting station RSOC2 (data courtesy of MesoWest²) was located about 9 miles northeast of the accident site at an elevation of about 6,160 feet. Type, calibration, maintenance, and siting standards of this station, as well as the overall quality of its data, are not known. Reporting of wind, moisture and temperature parameters³ from RSOC2 during the times surrounding the accident time are presented here:

¹ UTC - abbreviation for Coordinated Universal Time

² <https://mesowest.utah.edu>

³ Temp=temperature (Celsius); D_Temp=dewpoint temperature (Celsius); RH=relative humidity

<u>Time</u>	<u>Temp</u>	<u>D Temp</u>	<u>RH</u>	<u>W Mag</u>	<u>W Dir</u>	<u>G Mag</u>
0757	11.7°	-21.5°	8	0.9	003	7.0
0857	15.0°	-19.0°	8	2.6	007	8.7
0957	17.2°	-20.6°	6	3.5	153	7.8
1057	18.9°	-21.4°	5	7.0	172	11.3
1157	18.3°	-19.8°	6	8.7	143	17.4
1257	16.7°	-19.3°	7	4.3	159	16.4

Meteorological reporting station ESPC2 (data courtesy of MesoWest⁴) was located about 12 miles west-southwest of the accident site at an elevation of about 7,890 feet. Type, calibration, maintenance, and siting standards of this station, as well as the overall quality of its data, are not known. Reporting of wind, moisture and temperature parameters from ESPC2 during the times surrounding the accident time are presented here:

<u>Time</u>	<u>Temp</u>	<u>D Temp</u>	<u>RH</u>	<u>W Mag</u>	<u>W Dir</u>	<u>G Mag</u>
0824	9.4°	-26.3°	6	5.2	235	17.4
0924	10.6°	-25.5°	6	5.2	239	20.0
1024	11.1°	-25.1°	6	6.1	250	21.7
1124	12.8°	-23.8°	6	10.4	250	23.5
1224	13.9°	-25.0°	5	14.8	250	33.0
1324	13.9°	-23.0°	6	12.2	269	42.6

An Automated Weather Observing System (AWOS) was located at Northern Colorado Regional Airport (FNL⁵) in Fort Collins, Colorado, which was located about 14 miles east of the accident site at an elevation of 5,020 feet. Augmented longline⁶ reports from the FNL AWOS during the times surrounding the accident time are presented here.

(percent); W_Mag=average wind magnitude (knots); W_Dir=average wind direction (true); G_Mag=gust wind magnitude (knots).

⁴ <https://mesowest.utah.edu>

⁵ This report uses the 3-digit International Air Transport Association format for airport identification, which does not use the geographic designating digit (e.g., "K" for stations in the continental U.S. and "P" for U.S. stations in Alaska and the Pacific region) as found in the 4-digit International Civil Aviation Organization (ICAO) identifier format. Weather observations from airports in this report are referenced by their reporting station's identifier (using ICAO format that includes the geographic designating digit), not by the airport at which the reporting station is located.

⁶ "Longline" refers to the dissemination of weather observations with the intent that they are available in near-real time to national databases (effectively, the whole world) and accessible to the general global public from a large number of vendors. This does not include public accessibility to observations from a reporting station's Very High Frequency (VHF; line-of-site) or telephone broadcast, where applicable. Longline-dissemination of weather observations is the primary vehicle through which the general global public has access to surface weather observations, particularly outside of the aviation community.

[0856] KFNL 231556Z 00000KT 10SM CLR 03/M03 A2989 RMK AO2 SLP122
T00281028

[0956] KFNL 231656Z 00000KT 10SM CLR 07/M06 A2986 RMK AO2 SLP102
T00721061

**[1056] KFNL 231756Z 01006KT 10SM CLR 09/M06 A2983 RMK AO2
SLP086 T00941061 10100 21011 58020**

[1156] KFNL 231856Z 00000KT 10SM CLR 11/M08 A2978 RMK AO2 SLP063
T01111078

At 1056, the FNL AWOS reported a wind from 010° at 6 knots, visibility of 10 statute miles or greater, sky clear, temperature of 9°C and dew point temperature of -6°C, altimeter setting of 29.83 inches of mercury; Remarks: automated station with a precipitation discriminator, sea level pressure of 1008.6 hectopascals (hPa), temperature of 9.4°C and dew point temperature of -6.1°C, a 6-hour maximum temperature of 10.0°C, a 6-hour minimum temperature of -1.1°C, pressure decrease of 2.0 hPa in last 3 hours.

2.0 Model Data

A High-Resolution Rapid Refresh (HRRR) model⁷ sounding (Figure 1) for near the accident site⁸ at 1100 was retrieved from the National Oceanic and Atmospheric Administration's (NOAA) Air Resources Laboratory and analyzed by the RAwinsonde OBservation (RAOB) program. No clouds were identified below 30,000 feet. The freezing level was at about 12,100 feet. Moderate turbulence was identified around 12,000-13,000 feet. A table⁹ of HRRR-derived wind vectors every 250 feet between 7,000 and 10,000 feet is presented below. Within this layer the wind remained relatively consistent with directions from the southwest at magnitudes between 10 and 16 knots.

<u>Height</u>	<u>W Mag</u>	<u>W Dir</u>
7000	10	227°
7250	11	228°
7500	11	229°
7750	12	229°

⁷ The HRRR is a 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.

⁸ Coordinates used for the model were latitude: 40.44; longitude: -105.31.

⁹ Height=height above msl (feet); W_Mag= wind magnitude (knots); W_Dir= wind direction (true).

8000	12	229°
8250	12	230°
8500	12	231°
8750	13	232°
9000	13	232°
9250	13	233°
9500	14	233°
9750	15	234°
10000	16	236°

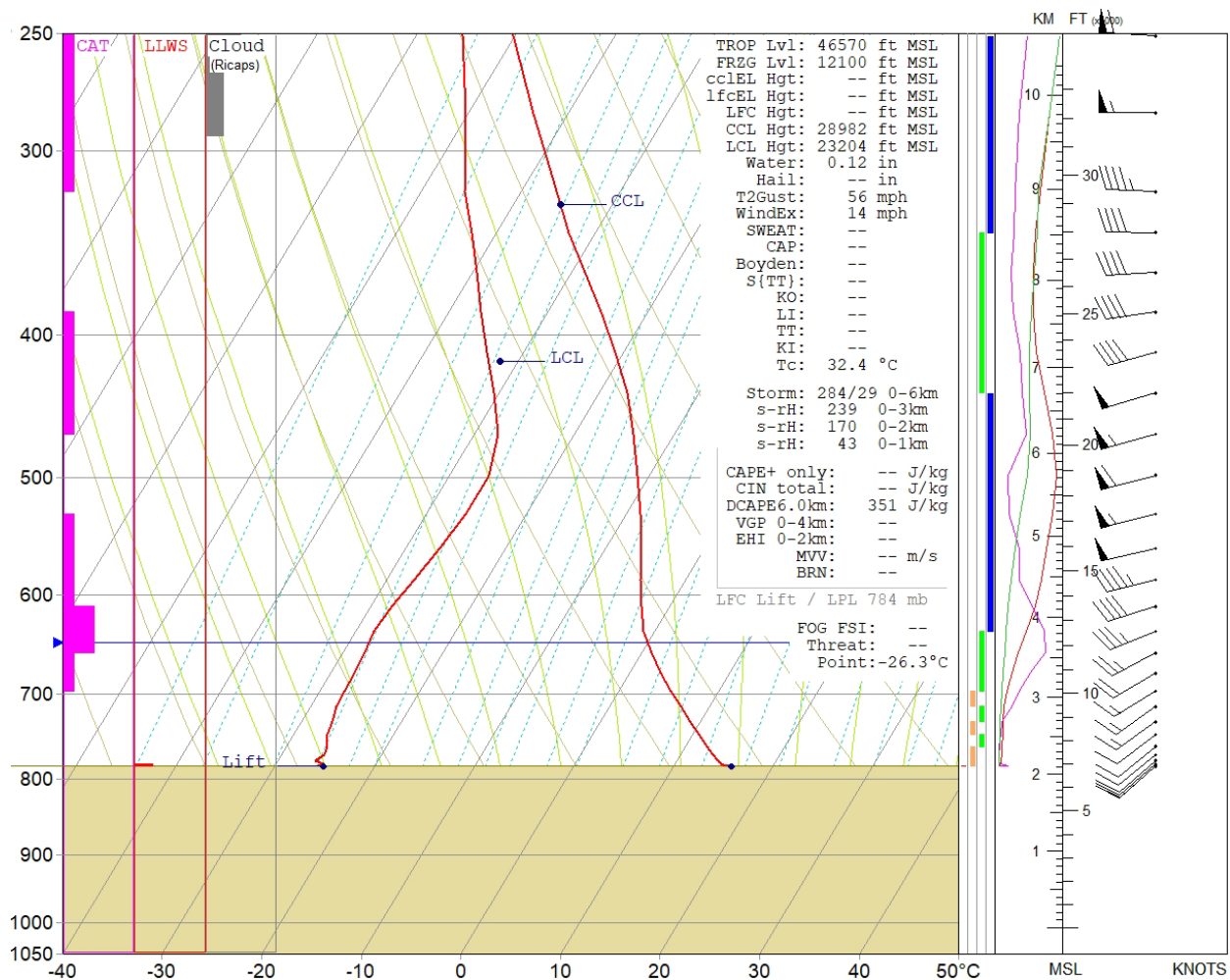


Figure 1 - HRRR model sounding data in SkewT/LogP format for 1100 near the accident site, surface to 250 hPa.

A Weather Research and Forecasting Model (WRF) simulation was run to model the weather conditions surrounding the time of the accident using initialization data from

the GFS4.¹⁰ WRF ARW (Advanced Research WRF core) version 4.1.2 was run with 3 domains with horizontal grid spacing of 8 kilometers, 1.6 kilometers, and 320 meters over the accident site. Other WRF simulation parameters included: 60 vertical levels, the multi-scale Kain-Fritsch cumulus parameterization scheme used on the outer domain, a Lin et al. microphysics scheme, a Yonsei University boundary layer scheme, Noah land surface physics, the Dudhia scheme used for short wave radiation and the RRTM scheme for the long wave radiation.

WRF output (Figures 2-7) indicate variable horizontal and vertical wind speeds around the accident time and location.

¹⁰ <https://www.ncei.noaa.gov/products/weather-climate-models/global-forecast>

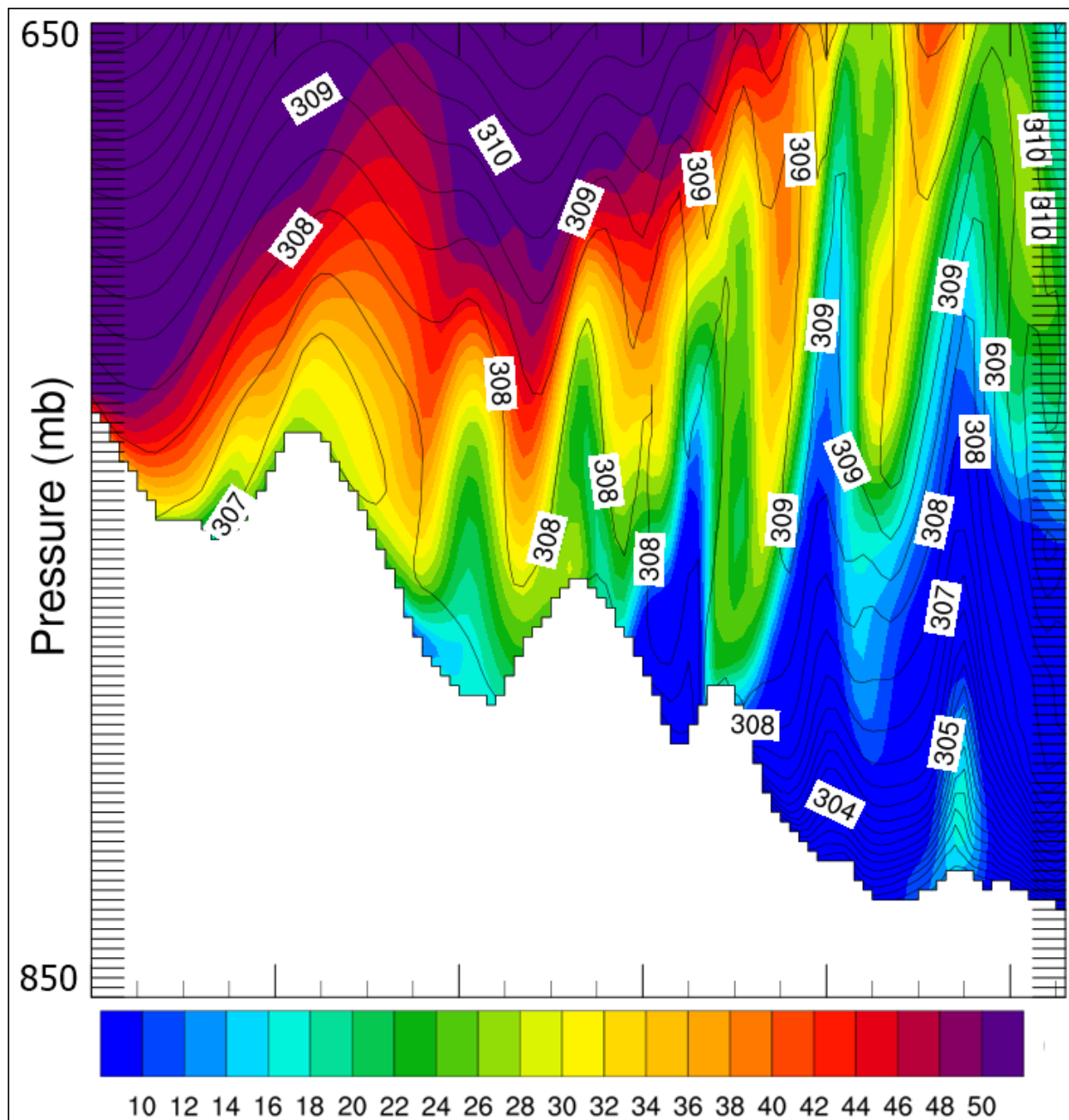


Figure 2 - WRF west-to-east vertical cross-section of the horizontal wind magnitude (color-filled contours; in knots) overlaid with lines of constant potential temperature (in Kelvin) valid at 1110 between 850 hPa (about 5,000 feet) and 650 hPa (about 12,000 feet) with boundary coordinates of: 40.4415°N, 105.5092°W (left-side) to 40.4415°N, 106.1092°W (right-side).

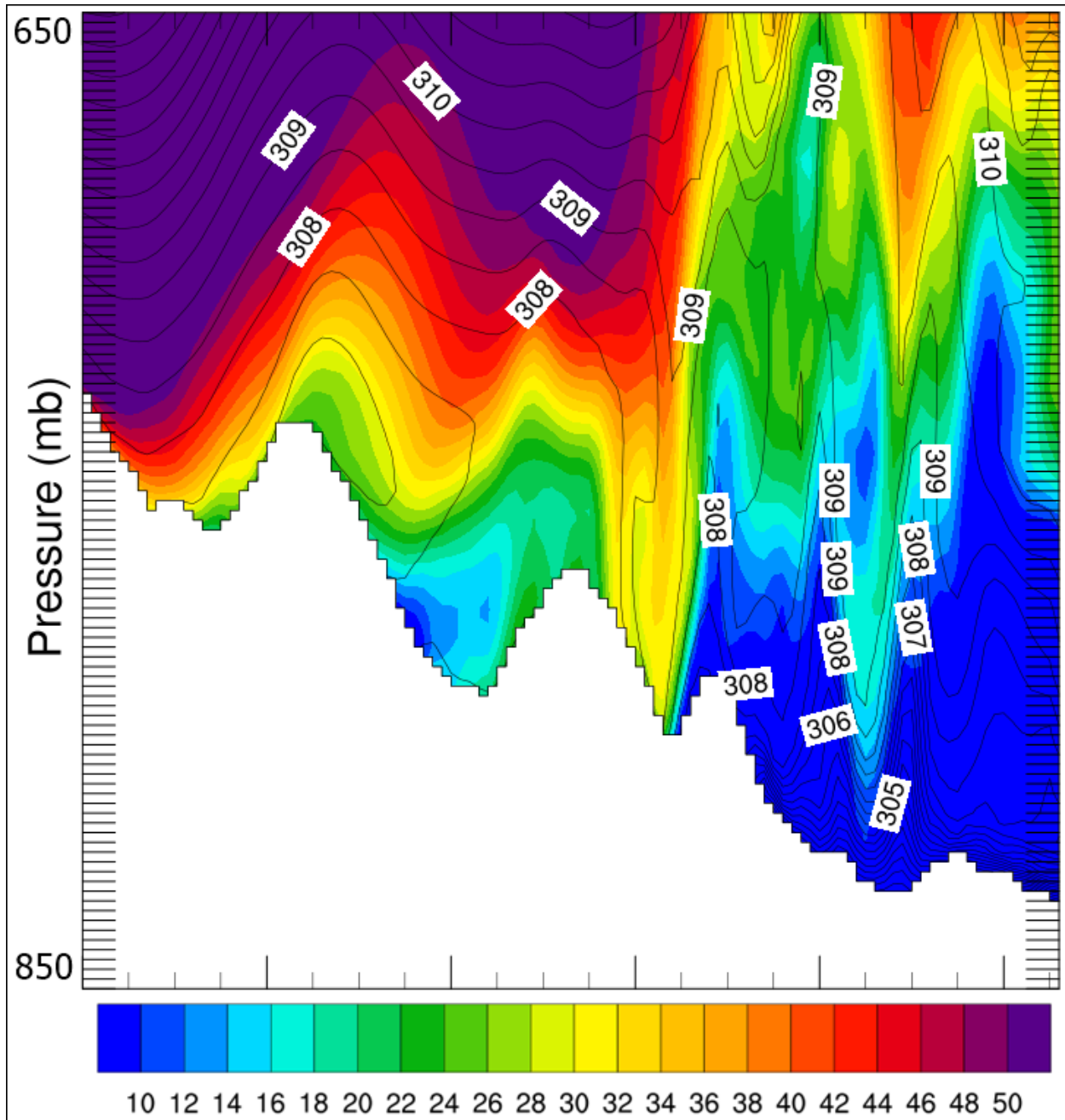


Figure 3 - WRF west-to-east vertical cross-section of the horizontal wind magnitude (color-filled contours; in knots) overlaid with lines of constant potential temperature (in Kelvin) valid at 1120 between 850 hPa (about 5,000 feet) and 650 hPa (about 12,000 feet) with boundary coordinates of: 40.4415°N, 105.5092°W (left-side) to 40.4415°N, 106.1092°W (right-side).

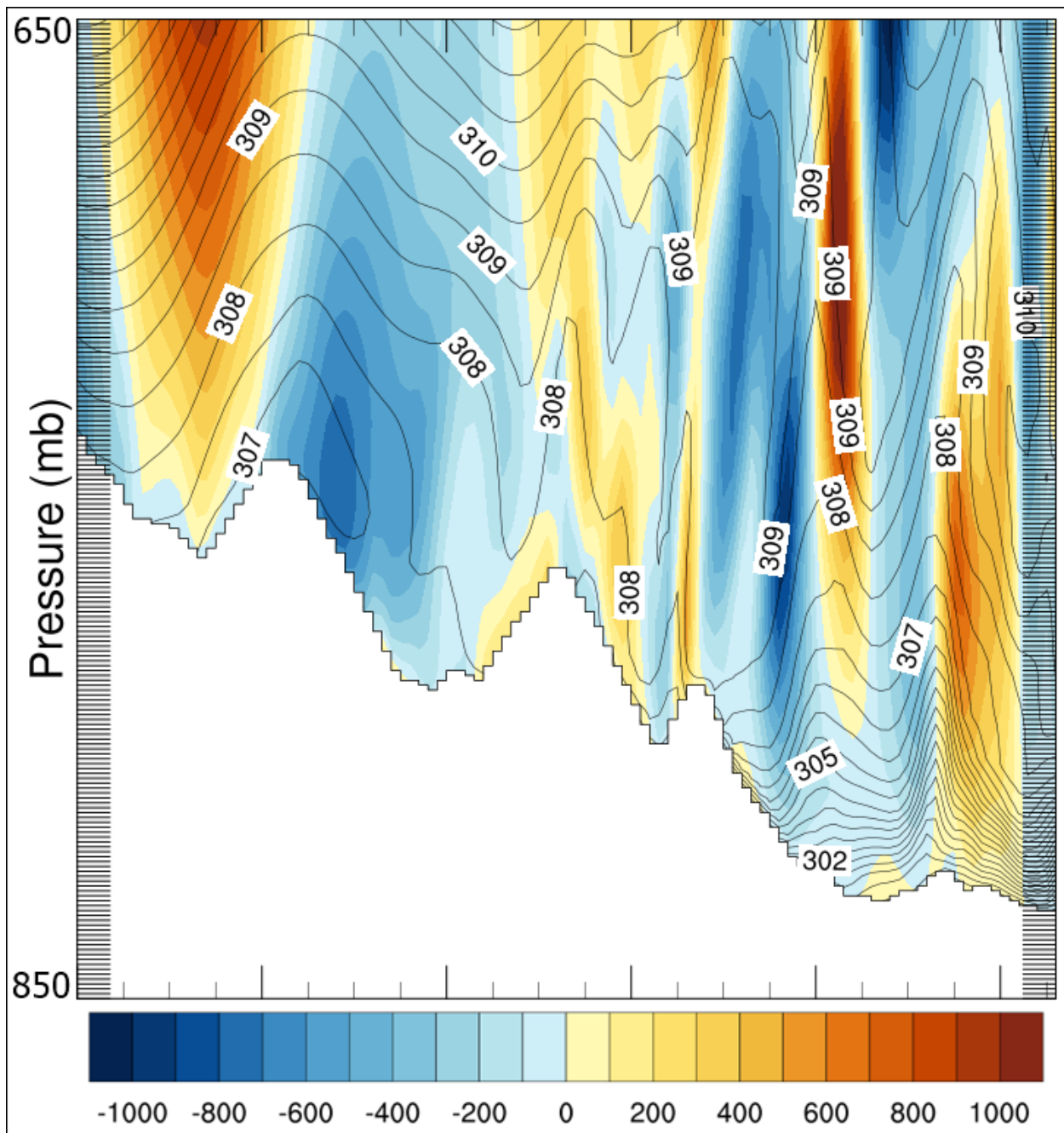


Figure 4 - WRF west-to-east vertical cross-section of the vertical wind magnitude (color-filled contours; in feet-per-minute [fpm]) overlaid with lines of constant potential temperature (in Kelvin) valid at 1110 between 850 hPa (about 5,000 feet) and 650 hPa (about 12,000 feet) with boundary coordinates of: 40.4415°N, 105.5092°W (left-side) to 40.4415°N, 106.1092°W (right-side).

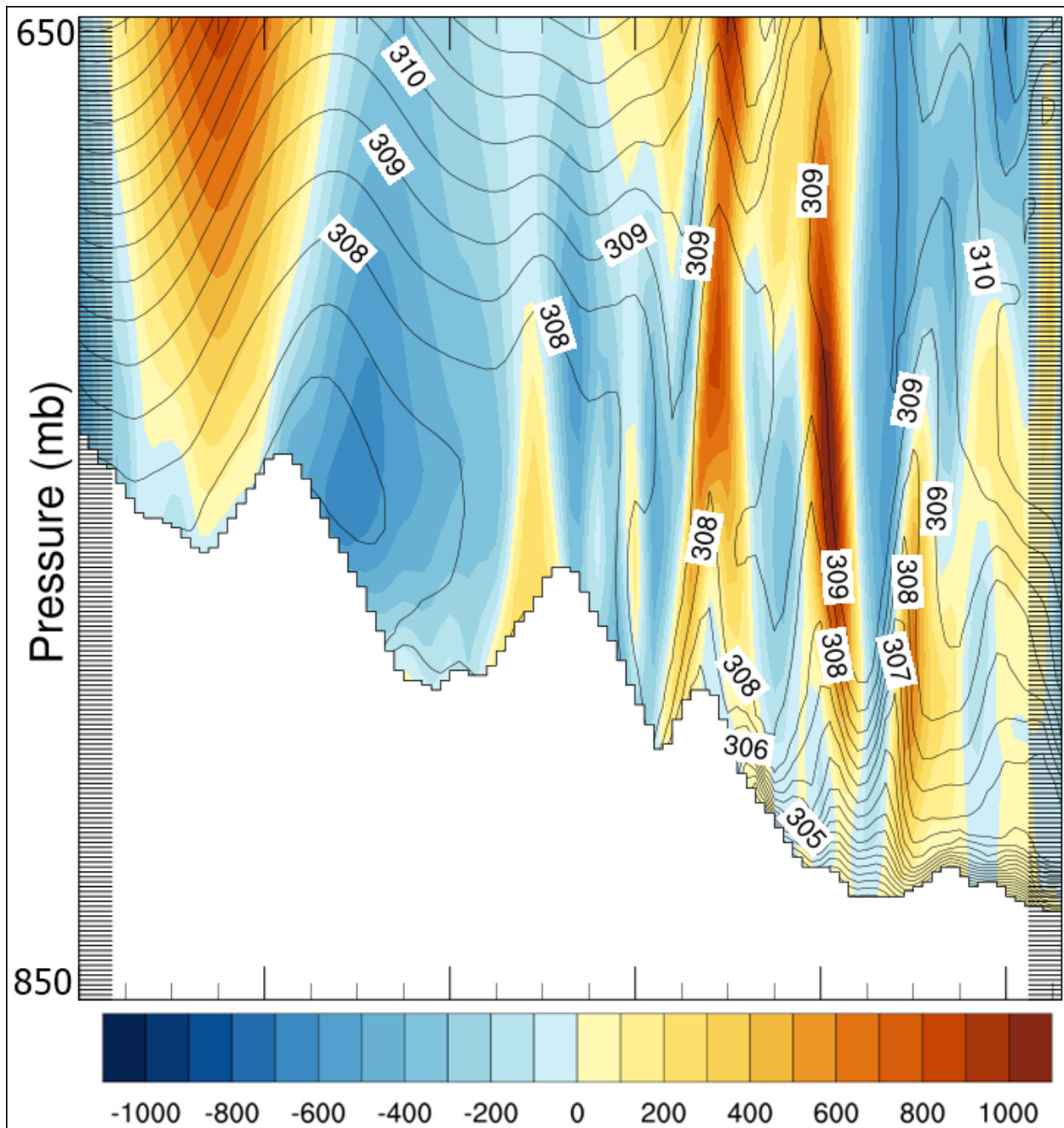


Figure 5 - WRF west-to-east vertical cross-section of the vertical wind magnitude (color-filled contours; in fpm) overlaid with lines of constant potential temperature (in Kelvin) valid at 1120 between 850 hPa (about 5,000 feet) and 650 hPa (about 12,000 feet) with boundary coordinates of: 40.4415°N, 105.5092°W (left-side) to 40.4415°N, 106.1092°W (right-side).

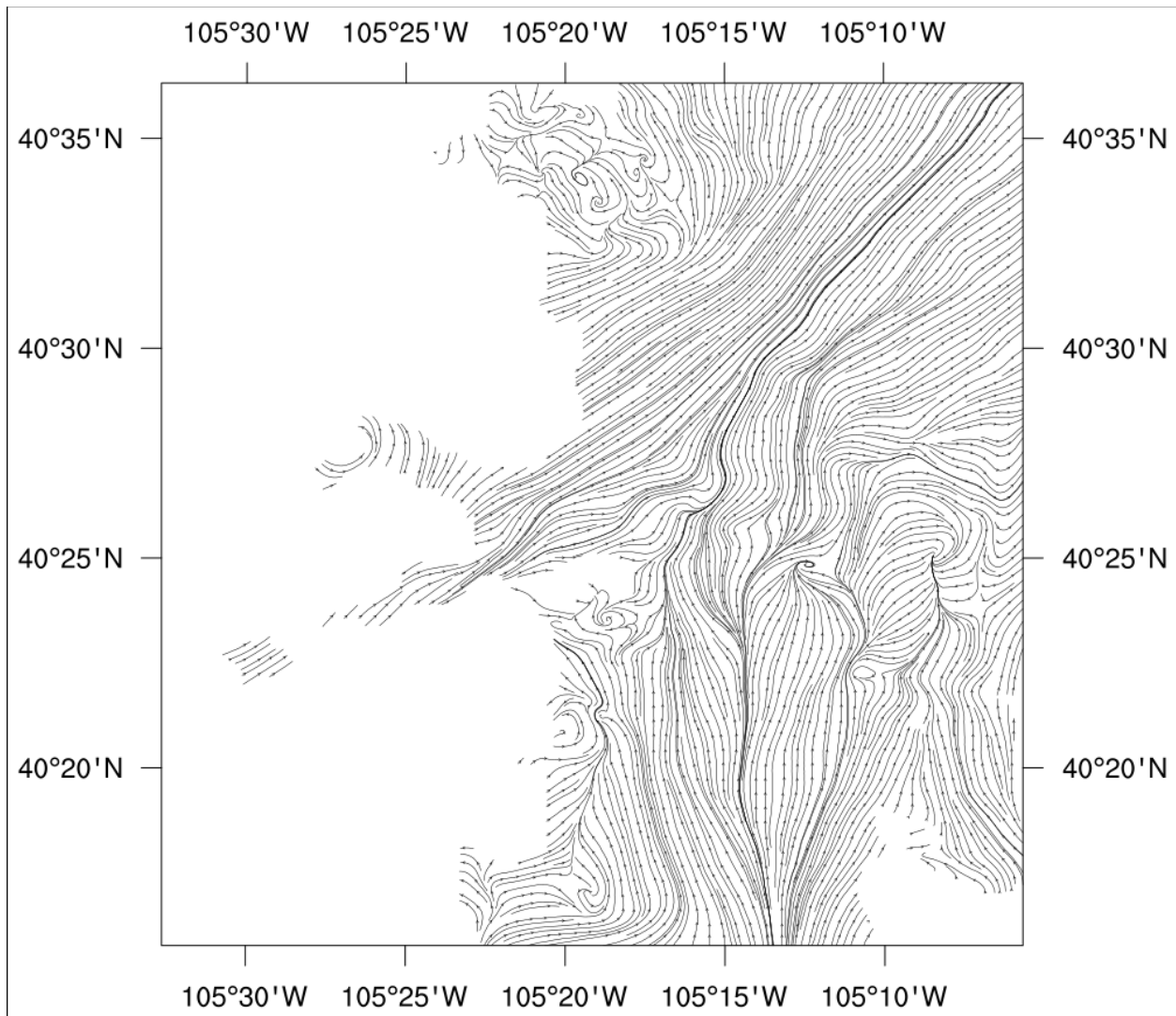


Figure 6 – Planview of wind streamlines at 760 hPa (about 7,700 feet) valid for 1110.

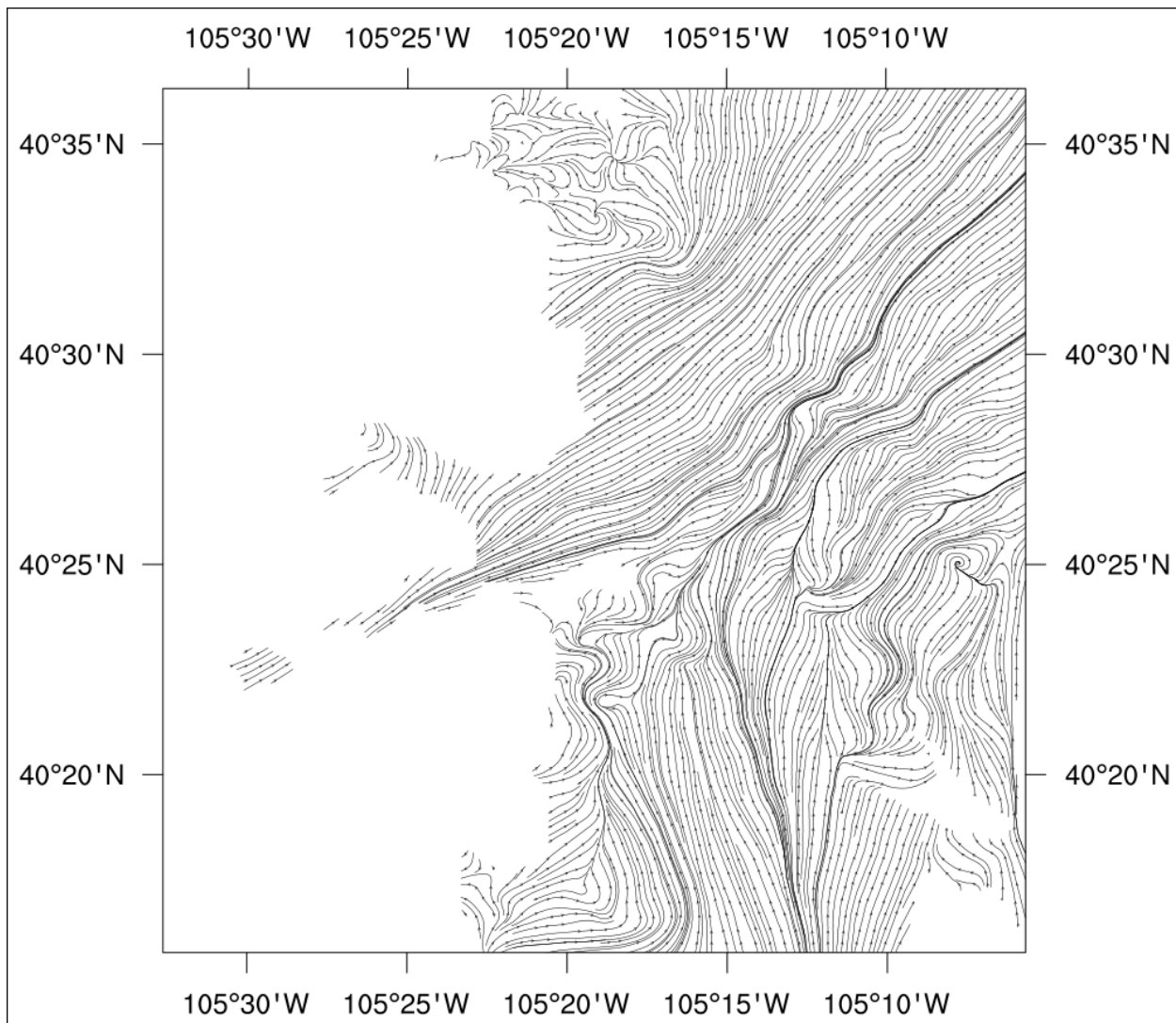


Figure 7 - Planview of wind streamlines at 760 hPa (about 7,700 feet) valid for 1120.

3.0 Pilot Reports

Longline-disseminated pilot reports¹¹ (PIREP) reported between 0900 and 1300 below FL200¹² feet and within 35 miles of the accident location are presented here.

DEN UA /OV DEN310060/TM 1609/FL150/TP B738/TB MOD

DEN UA /OV DEN320020/TM 1737/FL110/TP BE36/TB MOD 100-140

*DEN UA /OV DEN310030/TM 1840/FL160/TP B737/TB MOD 160-110/RM
DURD*

*DEN UA /OV DEN310045/TM 1900/FL160/TP CRJ2/TB MOD 160-100/RM
DURD*

*DEN UA /OV DEN310045/TM 1901/FL160/TP CRJ/TB MOD CAT 160-100/RM
DURD*

DEN UA /OV DEN360020/TM 1910/FL115/TP E75L/RM +/- 30KTS 115-095

*DEN UA /OV DEN330015/TM 1935/FL160/TP A321/TB LGT OCNL MOD 100-
160*

4.0 Satellite Imagery

Geostationary Operational Environmental Satellite (GOES)-16 visible (0.64 μ m) data were obtained from an archive at the Space Science Engineering Center at the University of Wisconsin-Madison. Imagery from these data is presented in Figure 8.

¹¹ These do not include pilot reports only broadcast via radio.

¹² 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.

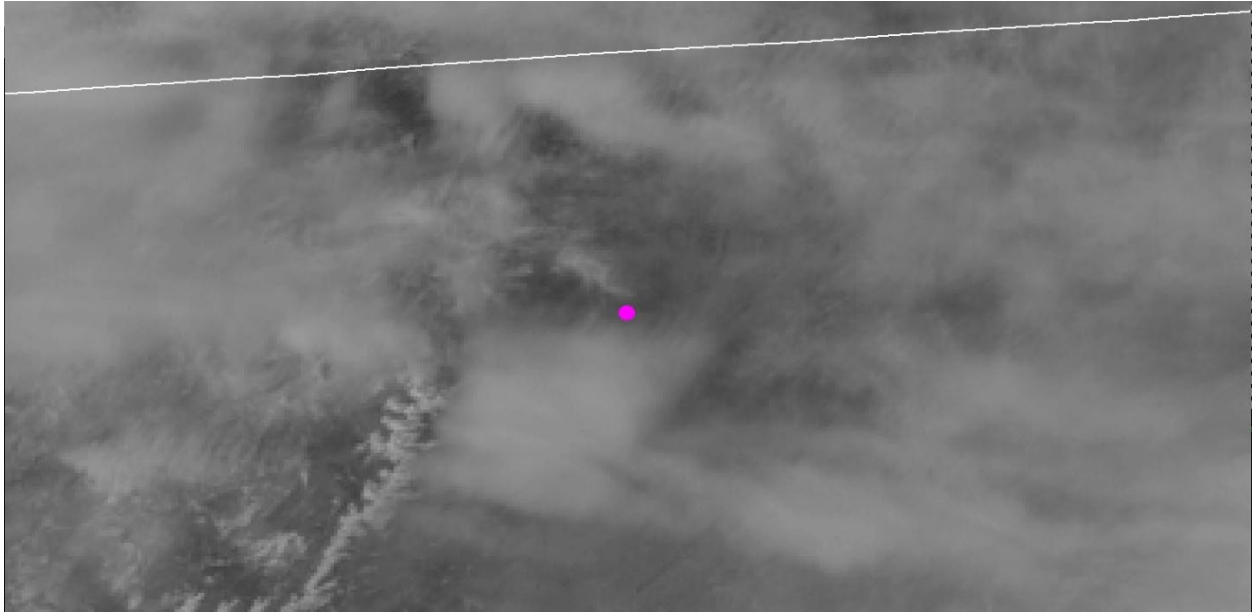


Figure 8 - GOES-16 visible imagery from 1116. The accident location is denoted by the purple dot. Image is not corrected for parallax error.

5.0 Weather Radar

WSR-88D¹³ Level-II base reflectivity weather radar imagery from Denver, Colorado, (site KFTG) is presented in Figure 9. KFTG was located approximately 53 miles south-southeast of the accident location with an antenna elevation of about 5,610 feet. Assuming standard refraction and considering the 0.95° beam width¹⁴ for the WSR-88D radar beam, the KFTG 0.879° tilt would have “seen” altitudes above the accident location of between about 9,700 and 15,100 feet. Areas of mostly light reflectivity¹⁵ were seen in the region, coincident with locally higher terrain. A loop of KFTG radar imagery surrounding the time of the accident indicated that this reflectivity appeared in the same location at various times (the reflectivity was “standing”).

¹³ Weather Surveillance Radar 88 Doppler (WSR-88D)

¹⁴ Here we define the angular width of the radar beam as the region of transmitted energy that is bounded by one-half the maximum power. The maximum power lies along the beam centerline and decreases outward from the radar antenna.

¹⁵

https://www.faa.gov/sites/faa.gov/files/other_visit/aviation_industry/airline_operators/airline_safety/in_FO07008.pdf

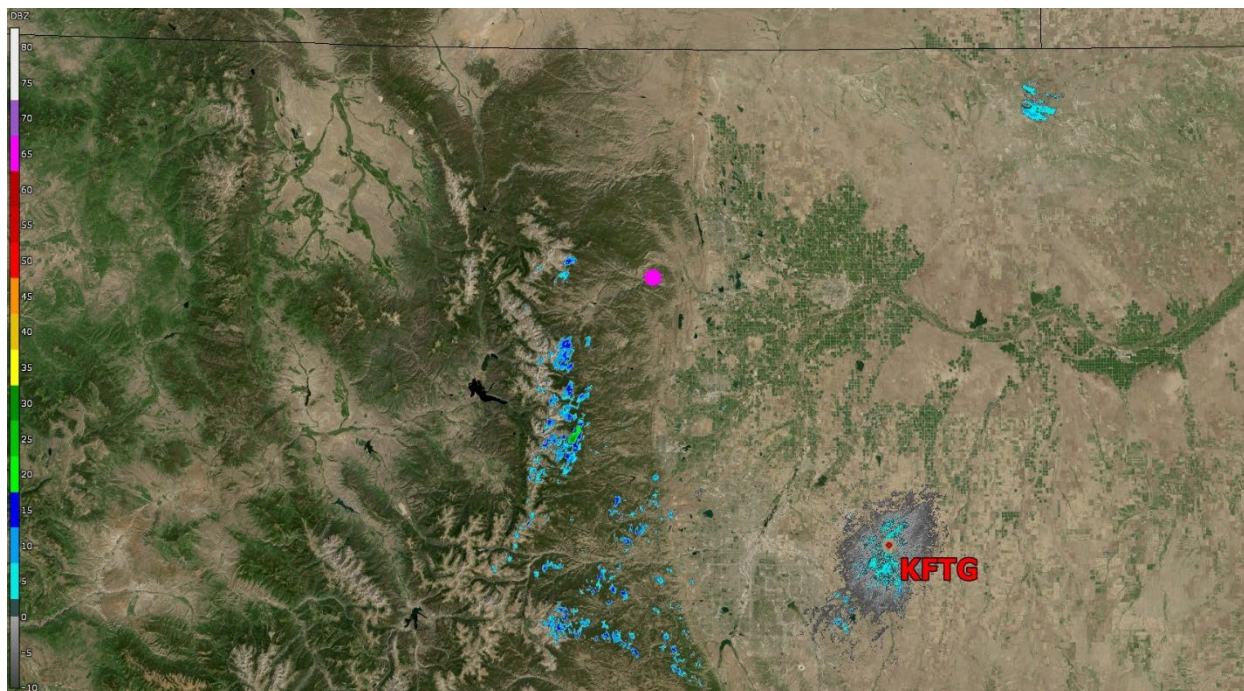


Figure 9 – KFTG WSR-88D 0.879° Level-II base reflectivity product from a sweep initiated at 1117:42. The accident location is denoted by the purple dot.

6.0 Area Forecast Discussion

The National Weather Service's (NWS) Denver, Colorado, Weather Forecast Office issued the following Short Term and Aviation sections of an Area Forecast Discussion at 1054, applicable for a region that included the accident location.

*FXUS65 KBOU 231754
AFDBOU
Area Forecast Discussion
National Weather Service Denver/Boulder CO
1054 AM MST Sat Nov 23 2024
.SHORT TERM /Through Tonight/...
Issued at 342 AM MST Sat Nov 23 2024*

Water vapor imagery shows ample high level moisture over Colorado coming from the Pacific as a jet streak moves over the Intermountain West. Our forecast area will be under the right exit region of this jet which will provide subsident flow and will keep conditions dry. This setup will also lead to well above normal temperatures. With that being said, it will be tricky to forecast high temperatures today since there will be high levels clouds that persist throughout the daylight hours. The thinking is that highs will be close to yesterday's highs if not a couple of degrees warmer. That means the low 60s

are expected in Denver again while Greeley, Longmont, and Erie will have temperatures in the 50s. Areas that have snowpack will also see cooler temperatures. Across the higher terrain, the approaching jet streak will increase wind gusts and since there will be low humidity in the foothills, there will be pockets of elevated fire weather conditions.

A shortwave trough will continue to move closer to Colorado by the overnight hours tonight. Mid level Pacific moisture will make its way to the Park Range mountains and a few light snow showers may begin before sunrise. Since this initial snowfall will likely be very light, a Winter Weather Advisory for the Park Range mountains was not started until 6AM Sunday morning. Otherwise, tonight will be quite mild as clouds and winds keep temperatures elevated.

&&

.AVIATION /18Z TAFS through 18Z Sunday/...
Issued at 1054 AM MST Sat Nov 23 2024

VFR conditions will occur through the TAF period. This afternoon, cyclone development is possible for all terminals through 01Z. Southerly winds increase this evening for KAPA and KDEN. There is some uncertainty in wind direction late Sunday morning due to the next incoming system which may lead to a westerly wind before noon Sunday. By Sunday afternoon, a front will sweep through all sites shifting wind northwest closer to 21-23Z.

7.0 SIGMETs

There were no Convective Significant Meteorological Information (SIGMET) advisories active for the accident flight.

At 1216, about one hour after the accident time, a SIGMET for occasional severe turbulence below FL180 due to strong low-level winds, strong updrafts and low-level wind shear was issued by the NWS Aviation Weather Center for a region that included the accident location.

WSUS05 KPCI 231916

WS5R

-SLCR WS 231916

SIGMET ROMEO 1 VALID UNTIL 232316

WY CO

FROM 50NW BFF TO 20SSE PUB TO 40SSW HBU TO 70SW DDY TO 50NW
BFF

OCNL SEV TURB BLW FL180. DUE TO STG LOW LVL WNDS AND STG UDDFS
AND LLWS. RPTD BY ACFT. CONDS CONTG BYD 2316Z.

8.0 CWSU Products

There were no Center Weather Advisories or Meteorological Impact Statements issued by the Center Weather Service Unit (CWSU) at the Denver Air Route Traffic Control Center that were active for the accident flight.

9.0 G-AIRMETs

A Graphical-Airmen's Meteorological Information (G-AIRMET) is a graphical advisory of weather that may be hazardous to aircraft but are less severe than what would be advised by a SIGMET. G-AIRMETs are only valid at discrete time "snapshots" that are three hours apart for a period of up to 12 hours into the future (i.e., 00-, 03-, 06-, 09- and 12-hour forecasts). They are issued at 0300 UTC, 0900 UTC, 1500 UTC and 2100 UTC (with updates issued as necessary).

At about 0800, a G-AIRMET was issued for moderate turbulence below FL180 that was valid at 1100 for a region that included the accident location.

Submitted by:

Mike Richards
Senior Meteorologist