NATIONAL TRANSPORTATION SAFETY BOARD

Office of Aviation Safety
Washington, D.C. 20594

March 12, 2018

Weather Study

METEOROLOGY

RRD18MR003

A. ACCIDENT

Location: Cayce, South Carolina
Date: February 4, 2018
Time: about 0230 eastern standard time
0730 universal coordinated time (UTC)
Train: Amtrak train collision with CSX freight train

B. METEOROLOGIST

Don Eick
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C. SUMMARY

On February 4, 2018, about 0230 eastern standard time, an Amtrak train P 091 (P91) unexpectedly entered a siding near Cayce, SC and collided with a stationary CSX freight train. The freight train, a local CSX crew (train F 777 03) had just finished some work, entered and cleared the siding, and released their authority back to the dispatcher; however, the switch to the main line was left open to the siding. A signal suspension was in place through this area. The Amtrak train was traveling at 53 mph when it struck the CSX train; the Amtrak engineer and conductor were killed, and the locomotive and four cars derailed.

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 Weather Prediction Center and the National Center for Environmental Information. All times are eastern standard time (EST) based upon the 24-hour clock, local time is +5 hours to UTC, and UTC=Z. Directions are referenced to true north and distances in nautical miles. Visibility is in statute miles and fractions of statute miles.

The accident site is based on the coordinates 33.9657° North and 81.0740° West, at an elevation of about 185 feet.

E. WEATHER INFORMATION

1.0 Synoptic Conditions

Southeast portion of the NWS Surface Analysis Chart for 0100 EST on February 4, 2018 is included as figure 1 with the approximate accident site located within the red circle. The chart depicted a stationary front off the North Carolina and South Carolina coasts, and across eastern Georgia, and northern Florida. The front then became a warm front as it extended northwestward into Alabama and Mississippi, where a low-pressure center at 1010-hectopascals (hPa)[1] was located. The accident site was located on the cool air side of the front and ahead of the developing frontal wave over Mississippi. The station models in the area of the accident site depicted a weak pressure gradient, with an easterly wind of 5 knots or less, overcast clouds, with a temperature of 40° Fahrenheit (F), a dew point temperature of 22° F, and a sea level pressure of 1025.9-hPa. No significant weather was reported by the station models over South Carolina at the time.

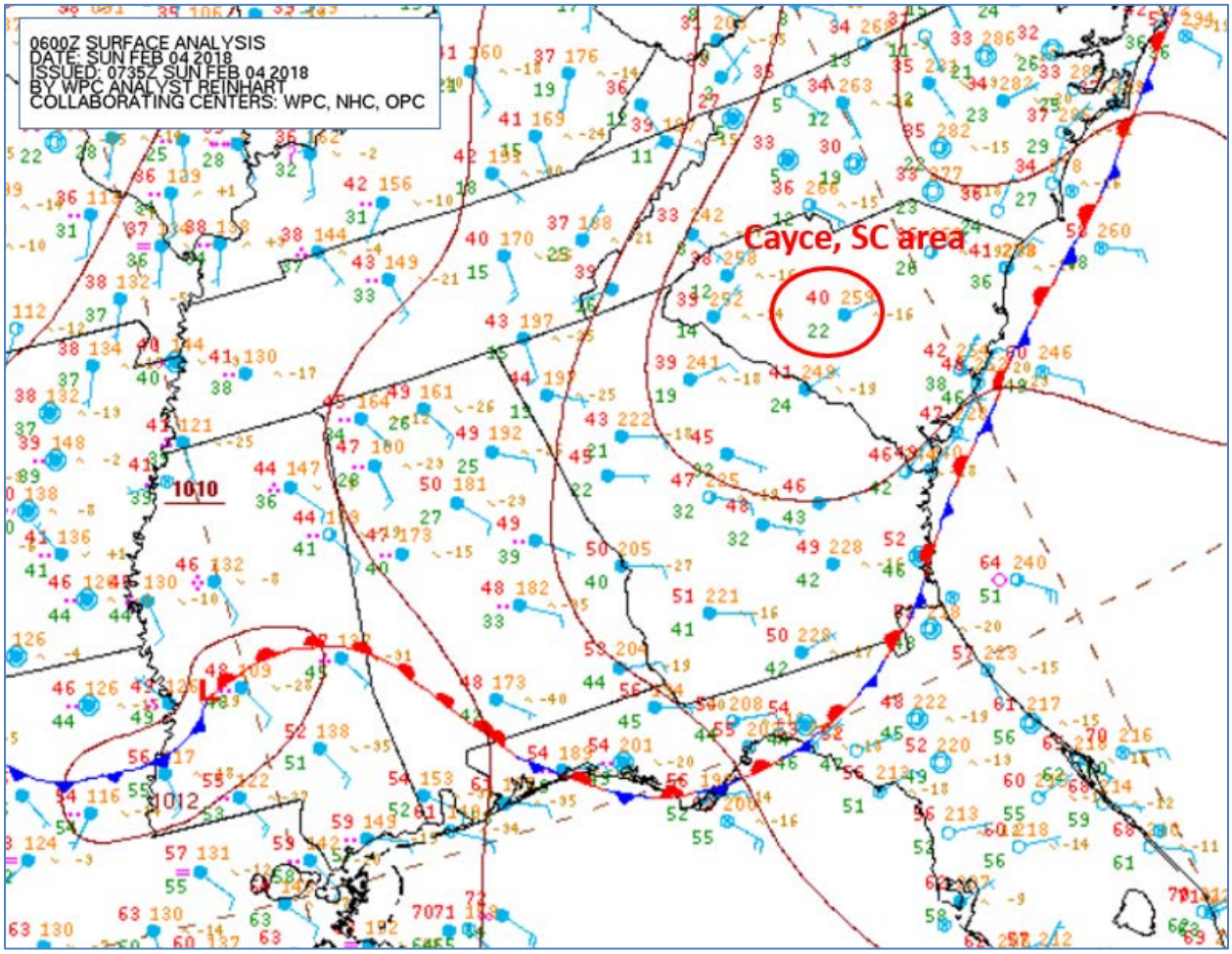

Figure 1 - Southeast section of the NWS Surface Analysis Chart for 0100 EST

[1] Hectopascals (hPa) is the new standard term for reporting sea level pressure and is interchangeable with the former term millibar (mb), with the same units. Standard sea level pressure is 1013.25-hPa.

A review of the National Composite Radar Reflectivity image for the time of the accident is included in figure 2. No significant weather echoes were noted over South Carolina at the time of the accident associated with any organized rain, snow, or thunderstorms over the region. A large area of echoes associated with rain was located west extending from Mississippi, Alabama, Georgia, into Tennessee, and Kentucky. This area of echoes was moving northeastward with time.

Figure 2 - National Composite Reflectivity image for 0230 EST

2.0 Observations

The closest official weather observations to the accident site were from Columbia Metropolitan Airport (KCAE), Columbia, South Carolina, located about 4 miles west-southwest of the accident site at an elevation of 236 feet. The airport had an Automated Surface Observation System (ASOS), which was also augmented by a certified weather observer. The airport lists a magnetic variation of 7° West. At the approximate time of the accident, the KCAE ASOS reported the following conditions, with cloud heights reported above ground level (agl):

Columbia weather observation at 0156 EST, wind from 090° at 7 knots, visibility 10 miles or more, broken clouds at 5,000 feet, and overcast clouds at 6,000 feet, temperature 39° F (4° Celsius (C)), dew point 19° F (-7° C), a relative humidity of 45%, with a sea level pressure of 1024.7-hPa.

Columbia weather observation at 0256 EST, wind from 090° at 7 knots, visibility 10 miles or more, overcast clouds at 6,000 feet, temperature 39° F (4° C), dew point 21° F (-6° C), a relative humidity of 48%, with a sea level pressure of 1023.3-hPa.

A review of the conditions at KCAE during the 24-hours prior to the accident indicated no precipitation and a maximum temperature of 47° F and a low temperature of 38° F. A table of the

decoded observations from KCAE from 2356 EST on February 3rd through 1000 EST is included below. The includes temperature (T), dew point temperature (Td), relative humidity (RH) in percent, wind direction and speed, visibility (VIS), cloud cover (CLD), weather (WX), and sea level pressure (SLP).

Time (EST)	T (°F)	Td (°F)	RH (%)	Wind (true/KT)	VIS (SM)	CLD	WX	SLP
2356	39	22	50	090° 6	10	55 BKN		1026.8
0056	40	22	48	090° 6	10	50 OVC		1025.9
0156	**40**	**20**	**44**	**090° 7**	**10**	**50 OVC**		**1024.7**
0256	**40**	**21**	**46**	**090° 7**	**10**	**60 OVC**		**1023.3**
0356	40	24	53	090° 6	10	12 OVC		1021.6
0456	40	26	57	090° 5	10	11 OVC		1021.6
0556	40	30	67	100° 7	10	10 OVC		1018.9
0656	41	39	93	090° 6	10	9 OVC	R-	1017.8
0756	41	39	93	070° 6	9	9 OVC	R-	1016.8
0856	42	41	96	050° 5	5	8 OVC	R-	1015.9
0956	44	43	96	000° 4	3	5 OVC	R+	1015.2
1000	44	43	96	300° 6	1.5	4 OVC	R+	

Notes: The following abbreviations are used in the table above.
Cloud (CLD) codes; CLR – clear, FEW – few, SCT - scattered, BKN-broken, OVC- overcast
Weather (WX) codes; R (rain) with intensity (-) light, ( ) moderate, (+) heavy

A further review of the observations from KCAE indicated that rain began at 0641 EST after the accident and continued through the day and ended at 1709 EST with 0.92 inches of rainfall.

3.0 Area Forecast Discussion

The NWS Columbia, South Carolina Weather Forecast Office issued the following forecast discussion at 0149 EST on February 4, 2018, discussing the weather conditions over the region:

FXUS62 KCAE 040619
AFDCAE
Area Forecast Discussion
National Weather Service Columbia SC
119 AM EST Sun Feb 4 2018

.SYNOPSIS...
High pressure will be shifting farther off the East Coast tonight. A low pressure system and associated cold front will cross the region Sunday bringing widespread rain. High pressure will return for Monday and Tuesday with another low pressure system crossing the region Tuesday night through Wednesday night.

.NEAR TERM /UNTIL 6 AM THIS MORNING/...
Moisture will be on the increase tonight in an onshore flow on the backside of high pressure shifting farther off the East Coast and ahead of low pressure in the Lower Mississippi River Valley. The high-resolution models display rain moving into the area from the west during the early morning hours and reaching the central Midlands around daybreak.

The main concern continues to be potential for a little freezing rain or sleet to mix with the rain during the predawn hours over the extreme north part. We expect minimum temperatures in the lower 30s north to around 40 south to occur around midnight. Temperatures should begin rising prior to sunrise in a strong low-level southernly flow. So with rising temperatures at the onset of precipitation...the window for frozen precipitation is narrow. The models were consistent showing wet bulb temperatures just above freezing in the north part at the onset time of precipitation. There was also consistency with h85 temperatures above freezing during that time. We continued a forecast of just a slight chance for a brief period of mixed precipitation in northern Lancaster County between 400 am and 700 am because it is possible the models are a little too warm with lingering wedge ridging.

.SHORT TERM /6 AM THIS MORNING THROUGH MONDAY NIGHT/...
the cold front will push across the forecast area on Sunday along with widespread rain as the parent low pressure moves through the eastern Great Lakes. Expect rain to diminish during the late afternoon and early evening hours as the upper-level trough cross the region. Rainfall amounts around three quarters of an inch at most locations with locally higher amounts are forecast. High pressure will build into the region Monday and be centered over the region Monday night. High temperatures Sunday and Monday will be in the low to mid 50s north to around 60 in the CSRA with overnight lows in the mid 30s to around 40 Sunday night, and in the low to mid 30s Monday night.

4.0 Astronomical Conditions

The United States Naval Observatory's website provided the following astronomical conditions for Cayce, Lexington County, South Carolina on February 3-4, 2018:

Sunset	1757 EST on February 3rd
End civil twilight	1823 EST
Moonrise	2138 EST
Accident	0230 EST on February 4th
Moon transit	0356 EST
Begin civil twilight	0653 EST
Sunrise	0719 EST
Moonset	1008 EST
Sun transit	1238 EST
Sunset	1758 EST
End civil twilight	1824 EST

Submitted by:

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Don Eick
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