



NATIONAL TRANSPORTATION SAFETY BOARD

Office of Aviation Safety
Washington, D.C. 20594

October 13, 2021

Specialist's Factual Report

METEOROLOGY

ANC21LA043

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A. ACCIDENT

Location: Cordova, Alaska
Date: May 29, 2021
Time: 1312 Alaska daylight time
2112 Coordinated Universal Time (UTC)
Aircraft: Cessna 182K; Registration: N2761Q

B. METEOROLOGIST

Paul Suffern
Senior Meteorologist
Operational Factors Division (AS-30)
National Transportation Safety Board

C. DETAILS OF THE INVESTIGATION

The National Transportation Safety Board's (NTSB) Meteorologist did not travel for this investigation and gathered the weather data for this investigation from official National Oceanic and Atmospheric Administration (NOAA) National Weather Service (NWS) sources and also from the National Centers for Environmental Information (NCEI). This specialist factual contains the meteorological factors pertinent to the weather surrounding the accident time. All times are Alaska daylight time (AKDT) on May 29, 2021, and are based upon the 24-hour clock, where local time is -8 hours from 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. NWS station identifiers use the standard International Civil Aviation Organization 4-letter station identifiers versus the International Air Transport Association 3-letter identifiers, which deletes the initial country code designator "K" for U.S. airports and "P" for OCONUS¹ airports.

The accident site was located at approximate latitude 60.7025° N, Longitude 143.5103° W, with an approximate elevation of 6,250 feet (ft).

¹ OCONUS - Outside Continental United States or Overseas, refers to any country of place beyond CONUS. Alaska, Hawaii and the U.S. territories are considered overseas.

D. 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 and the Weather Prediction Center, located in College Park, Maryland. These are the base products used in describing synoptic weather features and in the creation of forecasts and warnings for the NWS. Reference to these charts can be found in the joint NWS and Federal Aviation Administration (FAA) Advisory Circular “Aviation Weather Services”, AC 00-45H.²

1.1 Surface Analysis Chart

The NWS Surface Analysis Chart centered over Alaska for 1300 AKDT is provided as figure 1 with the approximate location of the accident site within the red circle. The chart depicted a low-pressure center over northern Canada with a pressure of 1009-hectopascals (hPa), and a high-pressure center located in northern Alaska with a pressure of 1021-hPa. A stationary frontal boundary stretched from southwestern Alaska eastward into northwestern Canada. Another occluded frontal boundary was located in the northeastern Pacific Ocean. A surface ridge³ was located in the northern Gulf of Alaska stretching from the Alaskan Panhandle west into the Anchorage Bowl region.

The station models around the accident site depicted air temperatures in the mid 40’s degrees Fahrenheit (°F), dew point temperatures in the low 40’s °F with temperature-dew point spreads of 5°F or less, an east wind at 5 knots or less, and overcast skies with light rain reported at Cordova, Alaska (PACV), and moderate rain reported at Yakutat, Alaska (PAYA).

²

https://www.faa.gov/regulations_policies/advisory_circulars/index.cfm/go/document.information/documentID/1030235

³ Ridge – An elongated area of relatively high atmospheric pressure or heights.

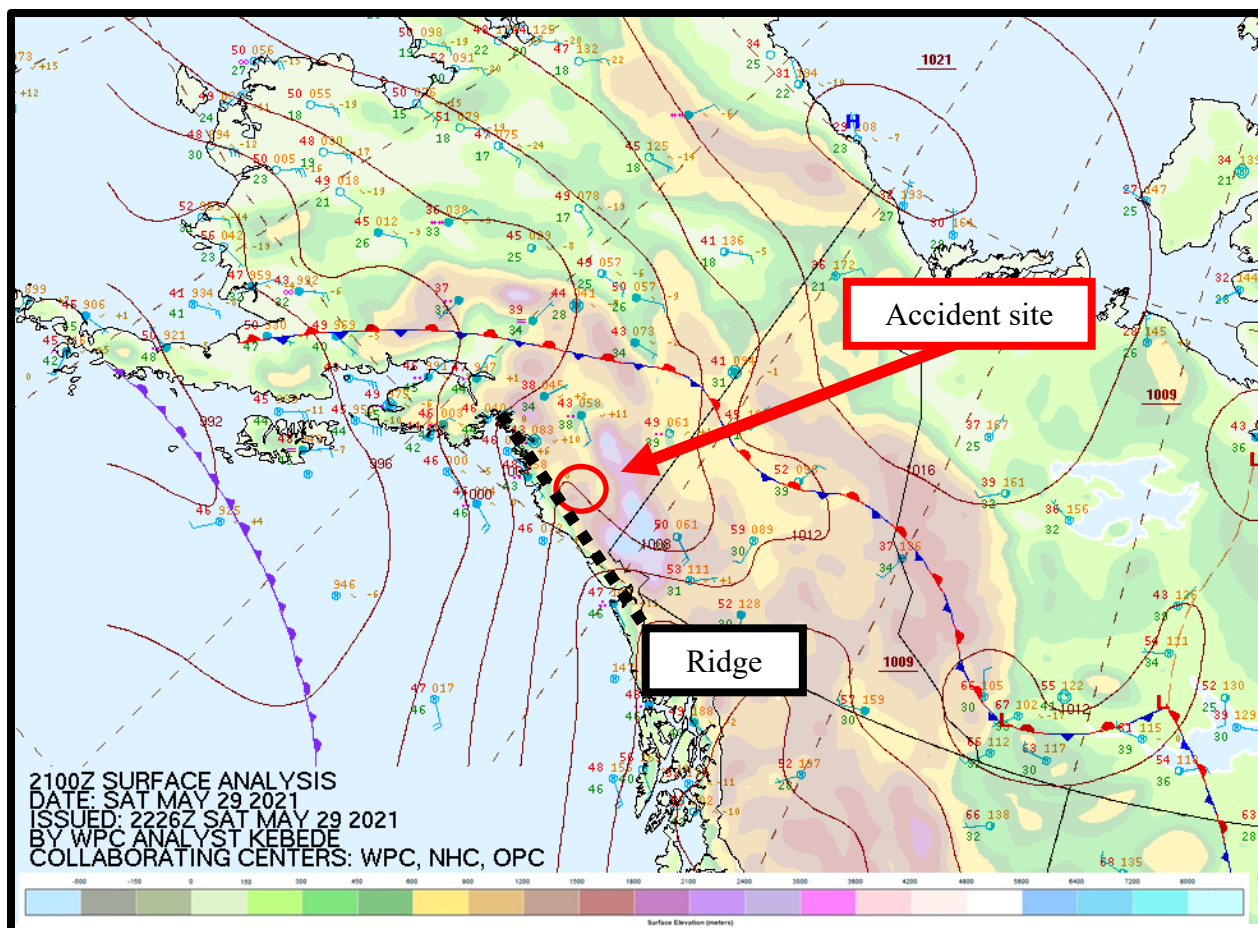


Figure 1 – NWS Surface Analysis Chart for 1300 AKDT.

2.0 Surface Observations

The area surrounding the accident site was documented using official Aviation Routine Weather Reports (METARs) and Specials (SPECIs). The following observations were taken from standard code and are provided in plain language. Figure 2 is a local sectional chart with the accident site and the closest weather reporting location marked.

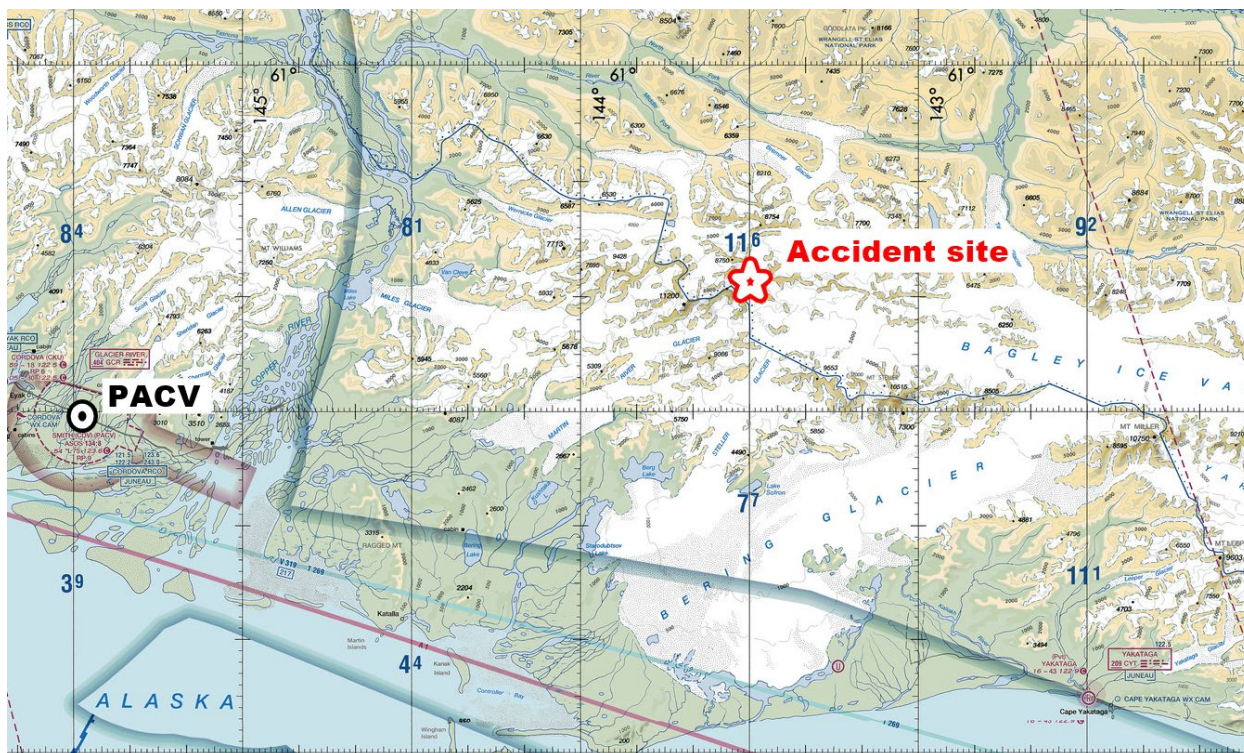


Figure 2 – Sectional map of the accident area with the location of the accident site and surface observation site.

PACV had the closest official airport weather station to the accident site. PACV had an Automated Surface Observing System (ASOS⁴) who's longline⁵ reports were not supplemented. PACV ASOS was located 59 miles west-southwest of the accident site, at an elevation of 54 ft, and had a 18° easterly magnetic variation⁶ (figure 2). The following automated longline observations were disseminated during the times surrounding the accident:⁷

[0853 AKDT] PACV 291653Z 09006KT 10SM -RA FEW034 BKN042 OVC050 08/05 A2967
RMK AO2 SLP046 P0005 T00780050

⁴ ASOS – Automated Surface Observing System is equipped with meteorological instruments to observe and report wind, visibility, weather phenomena, ceiling, temperature, dewpoint, altimeter, and barometric pressure.

⁵ “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.

⁶ Magnetic variation – The angle (at a particular location) between magnetic north and true north. Latest measurement taken from <https://skyvector.com/>

⁷ The bold sections in this NWS product and the rest of the products in this report are intended to highlight the text that directly reference the weather conditions that affected the accident location around the accident time. The local times in this section next to the METARs are provided for quick reference between UTC and local times around the accident time.

[0953 AKDT] PACV 291753Z AUTO 09007KT 9SM -RA FEW033 BKN046 OVC055 08/05
A2968 RMK AO2 SLP050 P0003 60008 T00830050 10089 20072 53007 TSNO

[1053 AKDT] PACV 291853Z 07007KT 7SM -RA BKN047 OVC055 08/05 A2969 RMK AO2
SLP055 P0004 T00830050

[1153 AKDT] PACV 291953Z 07006KT 8SM -RA BKN049 OVC055 08/06 A2970 RMK AO2
SLP056 P0006 T00830056

***[1253 AKDT] PACV 292053Z 10006KT 8SM -RA OVC050 09/06 A2970 RMK AO2 SLP058
P0003 60013 T00890061 51008***

ACCIDENT TIME 1312 AKDT

***[1353 AKDT] PACV 292153Z 10010KT 5SM RA FEW035 BKN044 OVC050 09/06 A2971
RMK AO2 SLP061 P0005 T00940061***

[1453 AKDT] PACV 292253Z 10011G19KT 5SM -RA OVC055 09/06 A2972 RMK AO2 PK
WND 11026/2219 SLP063 P0005 T00940061

The bold type observations decoded in plain language were as follows:

PACV weather at 1253 AKDT, wind from 100° at 6 knots, visibility 8 miles, light rain, overcast ceiling at 5,000 ft above ground level (agl), temperature of 9°Celsius (C), dew point temperature of 6°C, and an altimeter setting of 29.70 inches of mercury (inHg). Remarks: automated station with a precipitation discriminator, sea level pressure 1005.8 hPa, 0.03 inches of precipitation since 1153 AKDT, 6-hourly precipitation of 0.13 inches, temperature 8.9°C, dew point temperature 6.1°C, 3-hourly pressure increase of 0.8 hPa.

PACV weather at 1353 AKDT, wind from 100° at 10 knots, visibility 5 miles, moderate rain, few clouds at 3,500 ft agl, broken ceiling at 4,400 ft agl, overcast skies at 5,000 ft agl, temperature of 9°C, dew point temperature of 6°C, and an altimeter setting of 29.71 inHg. Remarks: automated station with a precipitation discriminator, sea level pressure 1006.1 hPa, 0.05 inches of precipitation since 1253 AKDT, temperature 9.4°C, dew point temperature 6.1°C.

Talkeetna Airport (PATK) was the departure airport and an ASOS whose longline reports were not supplemented. PATK ASOS was located 212 miles northwest of the accident site at an elevation of 365 ft. The following automated longline observations were disseminated during the times surrounding the accident and the departure:

[0853 AKDT] PATK 291653Z 03007KT 10SM FEW028 OVC037 05/02 A2958 RMK AO2
RAE21 SLP021 P0000 T00500022

[0953 AKDT] PATK 291753Z 02005KT 10SM -RA OVC036 06/03 A2958 RMK AO2 RAB33
SLP021 P0000 60002 T00560033 10056 20033 50001

***[1053 AKDT] PATK 291853Z 01004KT 10SM -RA FEW036 SCT049 OVC060 06/03 A2958
RMK AO2 SLP020 P0001 T00610033***

DEPARTURE TIME 1055 AKDT

***[1153 AKDT] PATK 291953Z 34005KT 10SM OVC065 08/03 A2958 RMK AO2 RAE29
SLP019 P0000 T00780033***

[1253 AKDT] PATK 292053Z 36004KT 10SM OVC065 08/03 A2958 RMK AO2 SLP019 60001
T00780028 56001

ACCIDENT TIME 1312 AKDT

[1353 AKDT] PATK 292153Z 33005KT 10SM BKN050 OVC065 08/03 A2958 RMK AO2
RAB20E44 SLP020 P0000 T00780033

[1453 AKDT] PATK 292253Z VRB04KT 9SM -RA BKN045 OVC060 07/04 A2959 RMK AO2
RAB01 SLP023 P0001 T00720044

The bold type observations decoded in plain language were as follows:

PATK weather at 1053 AKDT, wind from 010° at 4 knots, visibility 10 miles or greater, light rain, few clouds at 3,600 ft agl, scattered clouds at 4,900 ft agl, overcast ceiling at 6,000 ft agl, temperature of 6°C, dew point temperature of 3°C, and an altimeter setting of 29.58 inHg. Remarks: automated station with a precipitation discriminator, sea level pressure 1002.0 hPa, 0.01 inches of precipitation since 0953 AKDT, temperature 6.1°C, dew point temperature 3.3°C.

PATK weather at 1153 AKDT, wind from 340° at 5 knots, visibility 10 miles or greater, overcast ceiling at 6,500 ft agl, temperature of 8°C, dew point temperature of 3°C, and an altimeter setting of 29.58 inHg. Remarks: automated station with a precipitation discriminator, rain ended at 1129 AKDT, sea level pressure 1001.9 hPa, a trace of precipitation since 1053 AKDT, temperature 7.8°C, dew point temperature 3.3°C.

PAYA was the intended destination airport and had an ASOS whose longline reports were not supplemented. PAYA ASOS was located 136 miles southeast of the accident site at an elevation of 40 ft. The following automated longline observations were disseminated during the times surrounding the accident:

[0953 AKDT] PAYA 291753Z AUTO 12016G30KT 2SM RA BR OVC009 08/08 A2992 RMK
AO2 PK WND 11031/1735 SLP133 P0008 60062 T00830078 10083 20078 53013
TSNO

[1053 AKDT] PAYA 291853Z AUTO 12016G27KT 2 1/2SM -RA BR OVC008 08/08 A2993
RMK AO2 PK WND 11029/1755 SLP135 P0008 T00830078 TSNO

[1153 AKDT] PAYA 291953Z AUTO 11018G28KT 2 1/2SM RA BR OVC010 08/07 A2994
RMK AO2 PK WND 11031/1856 SLP140 P0010 T00830072 TSNO

[1205 AKDT] PAYA 292005Z AUTO 11015G27KT 3SM -RA BR BKN010 OVC014 08/07
A2994 RMK AO2 PK WND 11027/1958 P0000 T00830072 TSNO

***[1253 AKDT] PAYA 292053Z AUTO 12016G30KT 3SM RA BR OVC010 08/08 A2996 RMK
AO2 PK WND 11030/2051 SLP144 P0008 60026 T00830078 53011 TSNO***

ACCIDENT TIME 1312 AKDT

***[1353 AKDT] PAYA 292153Z AUTO 11014G26KT 2 1/2SM RA BR BKN010 OVC018 08/08
A2998 RMK AO2 PK WND 11030/2105 SLP151 P0012 T00830078 TSNO***

[1432 AKDT] PAYA 292232Z AUTO 11011G25KT 3SM -RA BR BKN011 OVC018 08/08
A2999 RMK AO2 PK WND 13028/2157 CIG 008V014 P0005 T00830078 TSNO

[1453 AKDT] PAYA 292253Z AUTO 10014G21KT 4SM -RA BR OVC011 08/08 A2999 RMK
AO2 PK WND 13028/2157 SLP156 P0009 T00830078 TSNO

[1553 AKDT] PAYA 292353Z AUTO 12012G22KT 4SM -RA BR BKN011 OVC031 08/08
A2999 RMK AO2 SLP157 P0008 60055 T00830078 10083 20083 51013 TSNO

[1653 AKDT] PAYA 300053Z AUTO 10011G20KT 7SM -RA BKN013 OVC023 08/08 A2999
RMK AO2 SLP156 P0005 T00830078 TSNO

The bold type observations decoded in plain language were as follows:

PAYA weather at 1253 AKDT, automated, wind from 120° at 16 knots with gusts to 30 knots, visibility 3 miles, moderate rain, mist, overcast ceiling at 1,000 ft agl, temperature of 8°C, dew point temperature of 8°C, and an altimeter setting of 29.96 inHg. Remarks: automated station with a precipitation discriminator, peak wind from 110° at 30 knots at 1251 AKDT, sea level pressure 1014.4 hPa, 0.08 inches of precipitation since 1153 AKDT, 6-hourly precipitation of 0.26 inches, temperature 8.3°C, dew point temperature 7.8°C, 3-hourly pressure increase of 1.1 hPa, thunderstorm (lightning detection) sensor not operating.

PAYA weather at 1353 AKDT, automated, wind from 110° at 14 knots with gusts to 26 knots, visibility 2 1/2 miles, moderate rain, mist, broken ceiling at 1,000 ft agl, overcast skies at 1,800 ft agl, temperature of 8°C, dew point temperature of 8°C, and an altimeter setting of 29.98 inHg. Remarks: automated station with a precipitation discriminator, peak wind from 110° at 30 knots at 1305 AKDT, sea level pressure 1015.1 hPa, 0.12 inches of precipitation since 1253 AKDT, temperature 8.3°C, dew point temperature 7.8°C, thunderstorm (lightning detection) sensor not operating.

The observations from PACV surrounding the accident time indicated MVFR⁸ conditions with light to moderate rain. VFR conditions prevailed at the departure location at the departure time with light rain and IFR conditions prevailed at the intended destination location during departure and accident time with wind gust to 30 knots at PAYA.

3.0 Upper Air Sounding

Anchorage, Alaska, (PANC) had an upper air sounding that was 192 miles west-northwest of the accident site with a site elevation of 131 ft and had a station ID of 70273. PANC was the closest upper air sounding to the departure airport of PATK. The 0400 AKDT PANC sounding was plotted on a standard Skew-T Log P diagram⁹ with the derived stability parameters included in figure 3 with data from the surface to 400-hPa (or approximately 23,000 ft msl). These data were analyzed using the RAOB¹⁰ software package. The sounding depicted the lifted condensation level (LCL)¹¹ at 299 ft msl and the convective condensation level (CCL)¹² at 3,270 ft msl. The freezing level was located at 3,436 ft msl. The precipitable water value was 0.57 inches.

⁸ As defined by the NWS and the FAA Aeronautical Information Manual (AIM) section 7-1-7 defines the following general flight categories:

- Low Instrument Flight Rules (LIFR*) – ceiling below 500 ft above ground level (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 ft agl and/or visibility 3 to 5 miles.

- Visual Flight Rules (VFR) – ceiling greater 3,000 ft agl and visibility greater than 5 miles.

* By definition, IFR is a ceiling less than 1,000 ft 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 ft agl and visibility greater than 5 miles while MVFR is a sub-category of VFR.

⁹ 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.

¹⁰ RAOB – (The complete Rawinsonde Observation program) is an interactive sounding analysis program developed by Eosonde Research Services, The Villages, Florida.

¹¹ LCL - The height at which a parcel of moist air becomes saturated when it is lifted dry adiabatically.

¹² CCL – The level in the atmosphere to which an air parcel, if heated from below, will rise dry adiabatically, without becoming colder than its environment just before the parcel becomes saturated.

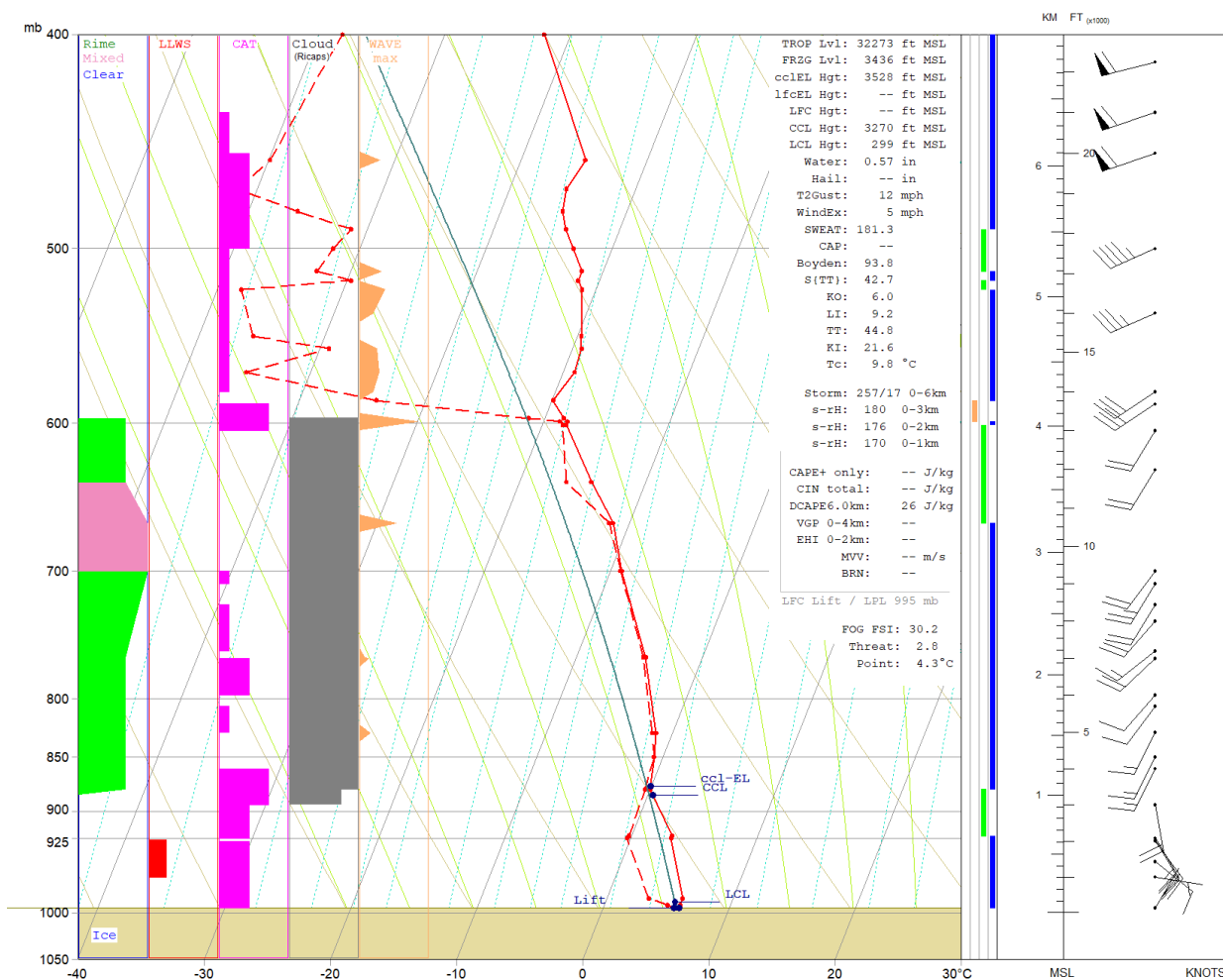


Figure 3 – 0400 AKDT PANC sounding.

The 0400 AKDT PANC sounding indicated layers of conditional unstable and stable environment from the surface through 23,000 ft msl with a conditionally unstable environment between 10,500 and 13,000 ft msl with the aircraft's altitude¹³ near 12,000 ft msl before descent. Clouds and moderate rime icing were indicated by RAOB between 4,000 and 13,000 ft msl.

The 0400 AKDT PANC sounding wind profile indicated a surface wind from 030° at 1 knot with the wind increasing in speed to 30 knots from the southwest by 13,500 ft. RAOB indicated the possibility of light low-level wind shear (LLWS) between the surface and 2,000 ft msl. RAOB indicated the possibility of light to severe clear-air turbulence in several layers between the surface and 20,000 ft msl. RAOB also indicated the possibility of severe mountain wave conditions¹⁴ in between 9,000 and 14,000 ft with updraft and downdraft speeds as high as 2,767 ft per minute (figure 4). Near the aircraft's altitude before descent the wind was from 210° at 21 knots with a temperature near -16°C and a dewpoint temperature near -17°C. Mountain wave conditions will be further discussed in section 16.0.

¹³ For more information please the docket of this accident.

¹⁴ Default RAOB mountain range parameters were used.

Level	Height (ft-MSL)	Pres (mb)	T (C)	Td (C)	RH (%)	DD / FF (deg / kts)	CAT (FAA)	LLWS	Icing - Type (AFGWC method)	Wave/x---W---Turb nm fpm max
1	131	995	6.0	5.6	97	30 / 1				
2	212	992	6.0	5.0	93	n/a				
3	403	985	6.0	3.3	83	n/a	MDT			
4	1000	963				100 / 7	MDT	LIGHT		
5	1428	948				130 / 12	MDT	LIGHT		
6	2000	928				145 / 21		LIGHT		
7	2027	927				150 / 23				
8	2085	925	3.2	-0.3	78	150 / 22				
9	2143	923	3.2	-0.2	78	n/a	MDT			
10	3000	894				170 / 18				
11	3436	879	0.0	-0.4	97	n/a	SVR		LGT Rime	
12	4000	860				205 / 14				
13	4318	850	-0.7	-0.7	100	205 / 16			LGT Rime	
14	4974	829	-1.3	-1.6	98	n/a			LGT Rime	2.01 251 LIGHT
15	5000	828				205 / 14	LGT			
16	5706	806				215 / 12				
17	6000	797				220 / 12	MDT			
18	7000	767				225 / 18				2.33 228 LIGHT
19	7031	766	-4.5	-4.7	99	n/a			LGT Rime	2.80 140 LIGHT
20	7199	761				230 / 17	LGT			
21	8000	738				220 / 20	LGT			
22	8442	725				210 / 22				
23	9000	709				210 / 23	LGT			
24	9342	700	-9.1	-9.2	99	215 / 20			MDT Rime	
25	10602	666	-11.3	-11.6	98	n/a			MDT Mixed	3.78 968 MD-SV
26	11678	638	-14.3	-16.3	85	n/a			LGT Mixed	
27	12000	630				210 / 21				
28	13000	605				210 / 21				
29	13155	601	-18.1	-18.4	97	n/a			LGT Rime	
30	13237	599	-18.1	-18.7	95	n/a			LGT Rime	6.55 2767 SEVERE
31	13319	597	-18.5	-21.3	79	n/a	SVR		LGT Rime	
32	13690	588				235 / 30				
33	13773	586	-19.9	-33.9	28	n/a				
34	14000	581				235 / 31				2.49 354 LIGHT
35	14491	569	-19.1	-45.1	8	n/a				2.81 505 LT-MD
36	15099	555	-19.3	-39.3	15	n/a				3.60 518 LT-MD
37	15408	548	-19.7	-45.7	8	n/a	LGT			
38	16000	535				245 / 36				4.43 428 LIGHT
39	16589	522	-21.1	-48.1	7	n/a				5.96 806 LT-MD
40	16822	517	-21.7	-39.7	18	n/a				
41	17057	512	-21.7	-42.7	13	n/a	LGT			4.16 647 LT-MD
42	17629	500	-23.1	-42.1	16	245 / 44				
43	18113	490	-24.3	-41.3	19	n/a				
44	18556	481	-25.1	-46.1	12	n/a				
45	19107	470	-25.5	-51.5	7	n/a				
46	19828	456	-24.9	-49.9	8	n/a	MDT			4.61 628 LT-MD
47	20000	453				250 / 58	LGT			
48	21000	434				250 / 61				
49	22909	400	-32.1	-48.1	19	255 / 61				
50	25000	365				250 / 62				

Figure 4 – 0400 AKDT PANC sounding text data.

The 1600 AKDT PANC upper air sounding is shown in figure 5. The 1600 AKDT PANC sounding depicted the LCL at 257 ft msl, the level of free convection (LFC)¹⁵ at 406 ft msl, and the CCL at 2,022 ft msl. The freezing level was located at 3,992 ft msl. The precipitable water value was 0.77 inches.

¹⁵ 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.

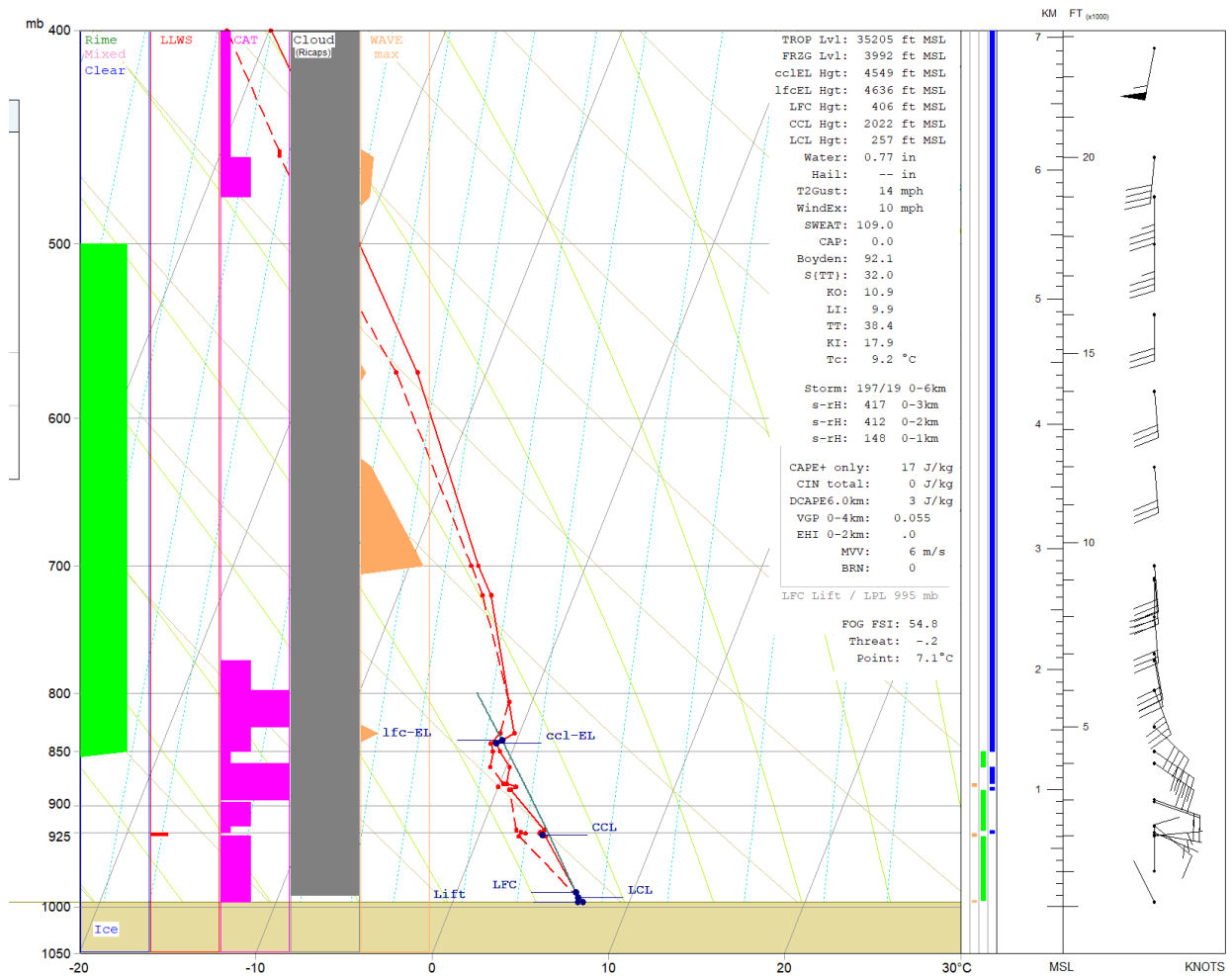


Figure 5 – 1600 AKDT PANC sounding.

The 1600 AKDT PANC sounding indicated a stable environment from 4,500 ft msl through 23,000 ft msl. Clouds were indicated from near the surface through 23,000 ft msl by RAOB with rime icing were indicated by RAOB between 5,000 and 18,000 ft msl.

The 1600 AKDT PANC sounding wind profile indicated a surface wind from 335° at 2 knots with the wind increasing in speed to 50 knots from the south by 5,000 ft. The wind speed increased to over 50 knots by 23,000 ft msl. RAOB indicated the possibility of light to extreme clear-air turbulence in several layers between the surface and 23,000 ft msl with the worst clear-air turbulence noted between 3,500 and 7,000 ft msl. RAOB also indicated the possibility of severe mountain wave conditions¹⁶ in between 9,000 and 14,000 ft with updraft and downdraft speeds as high as 2,044 ft per minute (figure 6). Near the aircraft altitude before descent the wind was from 175° at 28 knots with a temperature near -9.8°C and a dewpoint temperature near -11°C.

¹⁶ Default RAOB mountain range parameters were used.

Level	Height (ft-MSL)	Pres (mb)	T (C)	Td (C)	RH (%)	DD / FF (deg / kts)	CAT (FAA)	LLWS	Icing - Type (AFGW/C method)	Wave/x--w---Turb nm fpm max
1	131	995	7.4	7.1	98	335 / 2				
2	185	993	7.2	7.2	100	n/a	MDT			
3	1000	963				360 / 9				
4	1975	929	3.8	2.3	90	n/a	MDT			
5	2000	928				85 / 5		LIGHT		
6	2032	927				100 / 5				
7	2061	926	3.4	2.6	94	n/a		LIGHT		
8	2090	925	3.4	2.3	92	115 / 6				
9	2148	923	3.6	2.0	89	n/a	LGT			
10	2263	919				130 / 10	MDT			
11	2936	896				110 / 18				
12	3000	894				110 / 17				
13	3264	885	0.8	0.7	99	n/a				
14	3354	882	1.0	0.0	93	n/a				
15	3444	879	0.4	0.2	99	n/a				
16	3897	864	0.2	-0.9	92	n/a	XTR			
17	4000	861				125 / 35	LGT			
18	4326	850	-0.7	-1.1	97	125 / 38			LGT Rime	
19	4543	843	-1.1	-1.4	98	n/a			LGT Rime	
20	4825	834	-0.3	-1.1	94	n/a	MDT		LGT Rime	5.23 580 LIGHT
21	5000	828				135 / 40				
22	5689	807	-1.3	-1.3	100	n/a	XTR		LGT Rime	
23	6000	797				160 / 36	MDT			
24	6809	773				170 / 30				
25	7000	767				170 / 29				
26	8000	738				175 / 29				
27	8585	722	-4.7	-5.2	96	n/a			LGT Rime	
28	9000	710				180 / 28				
29	9054	709				175 / 27				
30	9383	700	-6.1	-6.5	97	175 / 28			LGT Rime	2.07 2044 SEVERE
31	12000	631				175 / 28				3.83 325 LIGHT
32	14000	583				175 / 31				
33	14498	572	-13.9	-15.1	91	n/a			LGT Rime	4.51 170 LIGHT
34	16000	538				180 / 30				
35	17813	500	-20.1	-22.2	83	180 / 33			LGT Rime	
36	19000	476				180 / 33	MDT			4.87 294 LIGHT
37	20000	457				185 / 42				5.81 454 LIGHT
38	20039	456	-23.7	-26.6	77	n/a				
39	20144	454	-23.9	-26.7	78	n/a	LGT			
40	23142	400	-29.9	-32.4	79	190 / 54				8.97 280 LIGHT
41	25000	369				190 / 58				
42	25138	367	-34.1	-36.6	78	n/a	LGT			12.56 366 LIGHT
43	26000	353				195 / 60				
44	27144	336	-39.1	-42.9	67	n/a				
45	27821	326	-41.1	-44.8	67	n/a				
46	28724	313	-43.5	-44.4	91	n/a				
47	29222	306	-44.9	-47.2	78	n/a				
48	29655	300	-46.1	-47.9	82	200 / 57				
49	29947	296	-46.9	-48.9	80	n/a				
50	30000	295				200 / 56				

Figure 6 – 1600 AKDT PANC sounding text data.

4.0 Satellite Data

The Geostationary Operational Environmental Satellite number 17 (GOES-17) visible and infrared data were obtained from an archive at the Space Science Engineering Center at the University of Wisconsin-Madison in Madison, Wisconsin, and processed using the Man-computer Interactive Data Access System software. Visible and infrared imagery (GOES-17 bands 2 and 13) at wavelengths of 0.64 microns (μm) and 10.3 μm , respectively, were retrieved for the period from 1100 AKDT through 1600 AKDT and reviewed, and the closest images to the time of the accident were documented.

Figure 7 presents the GOES-17 visible imagery from 1300 AKDT at 2X magnification with the accident site highlighted with a red square. There was broken cloud cover above the accident site with less cloud cover further north of the accident site at the accident time. The cloud cover had a transverse wave pattern or transverse band¹⁷ (attachment 1). Figure 8 presents the GOES-17 infrared imagery from 1300 AKDT at 6X magnification with the accident site highlighted with a red square. The lower brightness temperatures (green colors; higher cloud tops) were located northwest and south of the accident site. The brightness temperature of about 251 Kelvin would have been between 14,000 and 20,000 ft msl based on the vertical temperature profile provided by the 0400 and 1600 AKDT PANC soundings. It should be noted these figures have not been corrected for any parallax error.

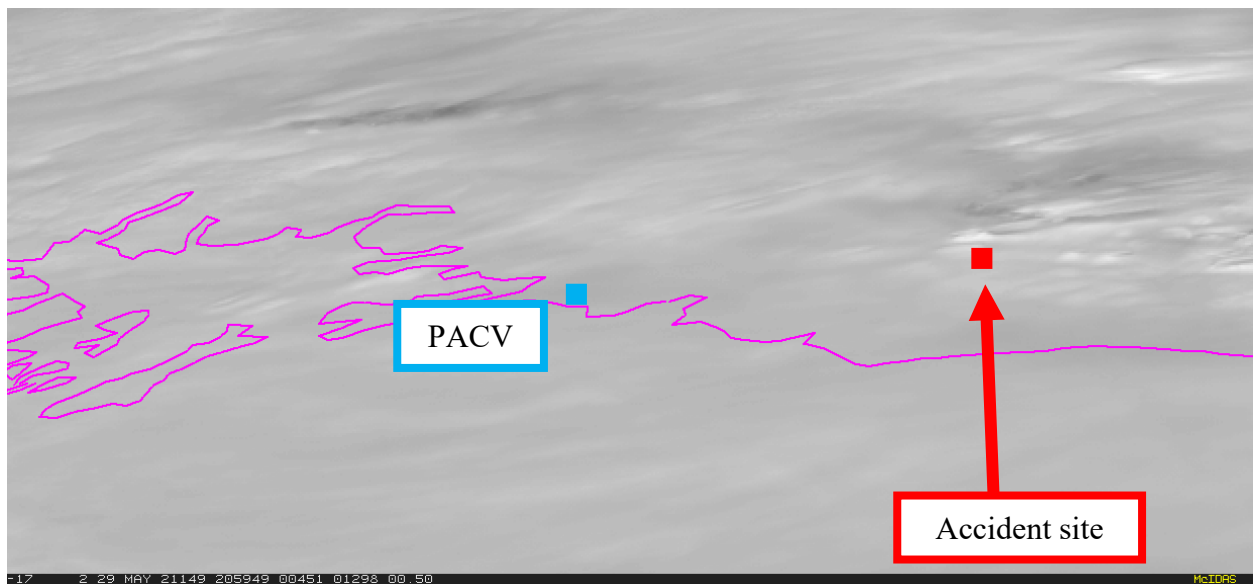


Figure 7 – GOES-17 visible image at 1300 AKDT.

¹⁷ Transverse Bands - Bands of clouds oriented perpendicular to the flow in which they are embedded. They often are seen best on satellite photographs. When observed at high levels (i.e., in cirrus formations), they may indicate turbulence.

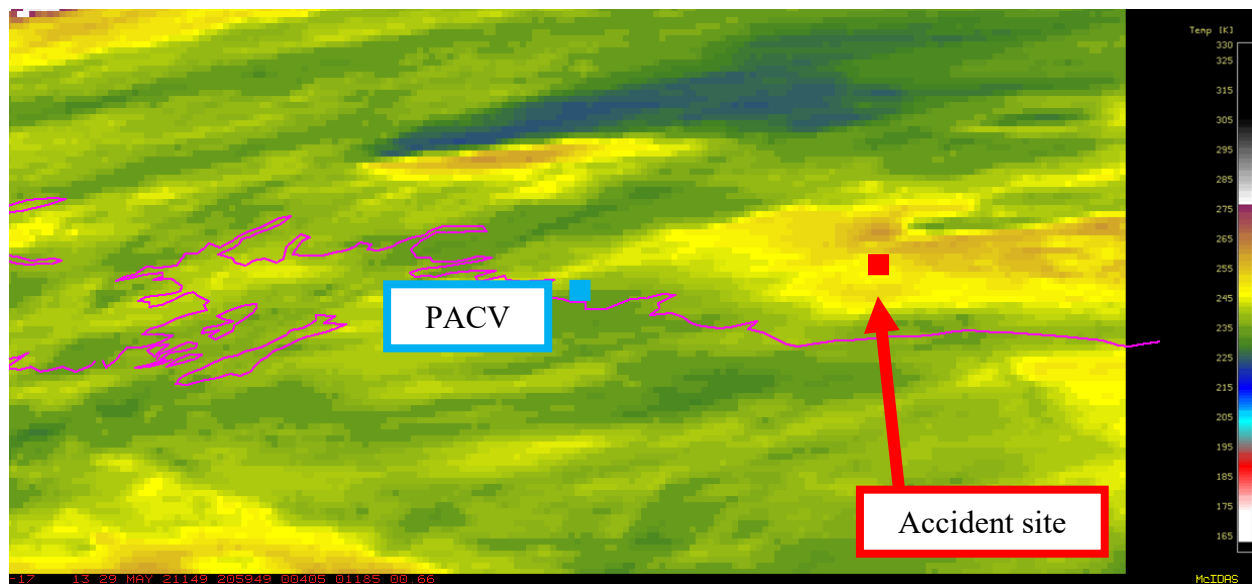


Figure 8– GOES-17 infrared image at 1300 AKDT.

Additional satellite imagery was obtained from the Geographic Information Network of Alaska (GINA) and is provided in figures 9, 10, and attachment 2¹⁸. Imagery from the Polar Operational Environmental Satellites (POES)¹⁹ was available around the accident time. The imagery from 1337 AKDT (figure 9) continued to highlight the transverse wave cloud cover above the accident site with the cloud tops near 15,000 ft msl (attachment 2).

¹⁸ Additional information and imagery from the Joint Polar Satellite System (JPSS), Cooperative Institute for Research in the Atmosphere (CIRA), and Center for Satellite Applications and Research (STAR) can be found at: [AV Cloud Product Evaluation \(alaska.edu\)](http://AVCloudProductEvaluation.alaska.edu) and [RAMMB: RAMSDIS Online - Experimantal Aviation Cross-section Product \(colostate.edu\)](http://RAMMB.RAMSDISOnline.ExperimantalAviationCross-sectionProduct.colostate.edu)

¹⁹ [Office of Satellite and Product Operations - POES \(noaa.gov\)](http://OfficeofSatelliteandProductOperations-POES.noaa.gov) and [Suomi-NPP Operational Status - Office of Satellite and Product Operations \(noaa.gov\)](http://Suomi-NPPOperationalStatus-OfficeofSatelliteandProductOperations.noaa.gov)

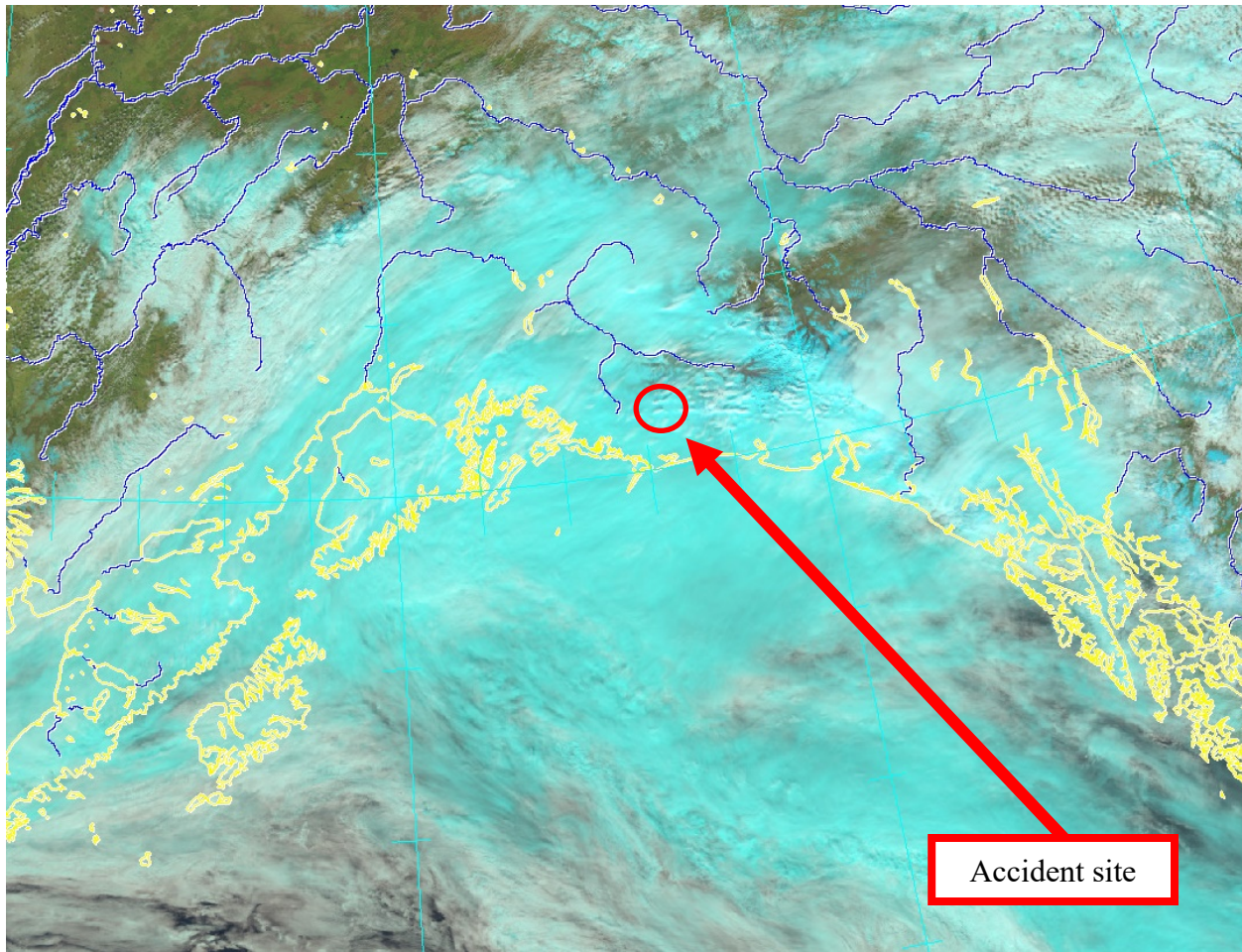


Figure 9 – POES imagery at 1337 AKDT.

Experimental aviation cross-section imagery was made using POES satellite information²⁰ with the Anchorage to Juneau cross-section location noted in the exemplar imagery of figure 10. Figure 11 shows the Anchorage to Juneau Experimental Aviation Cross-section Product valid at 1337 to 1350 AKDT with altitudes above 5,000 ft msl with cloud cover having possibly mixed phase icing conditions. For more information on the cross-section imagery please see attachment 3.

²⁰ [RAMMB: RAMSDIS Online - Experimental Aviation Cross-section Product \(colostate.edu\)](http://RAMMB.RAMSDISOnline.com/ExperimentalAviationCross-sectionProduct)

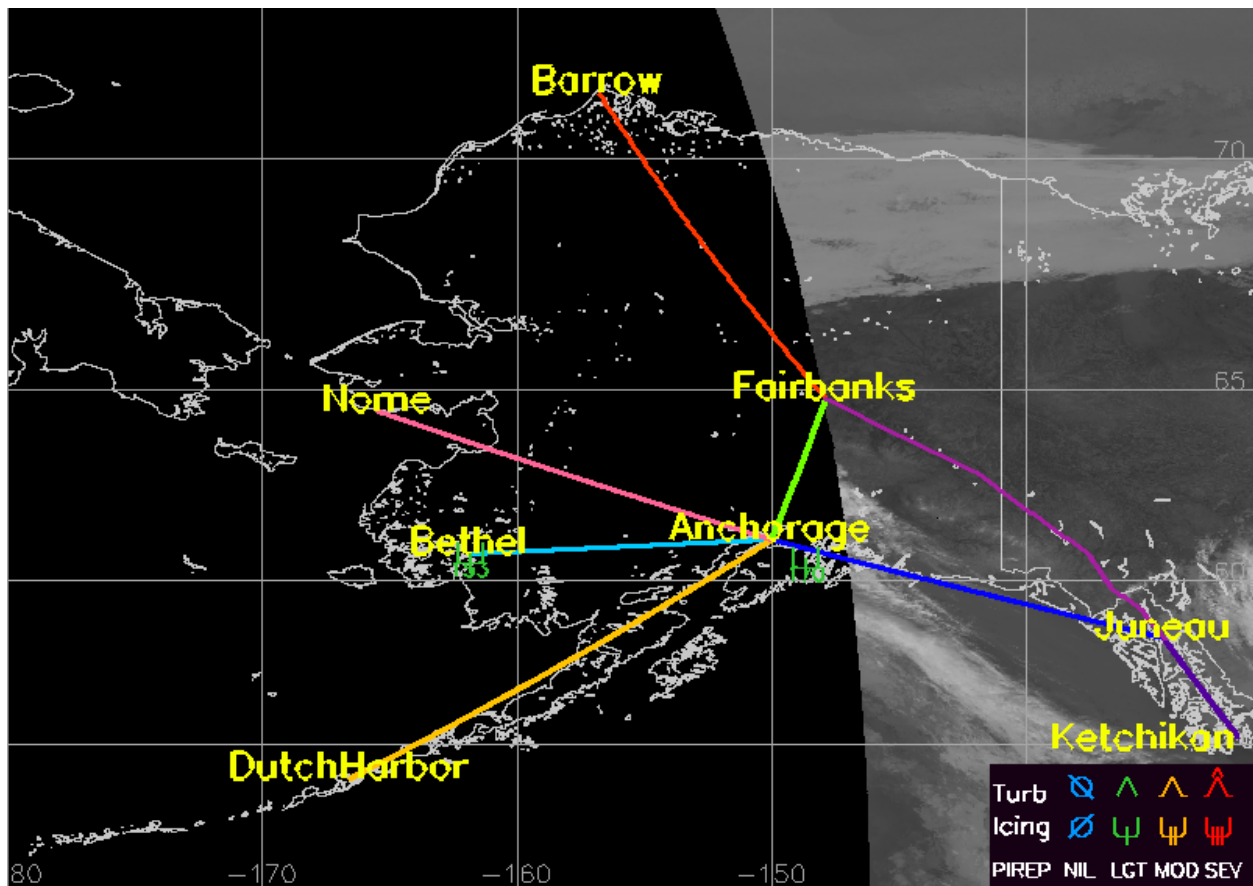


Figure 10 – Exemplar Experimental Aviation Cross-section Product cross-section locations.

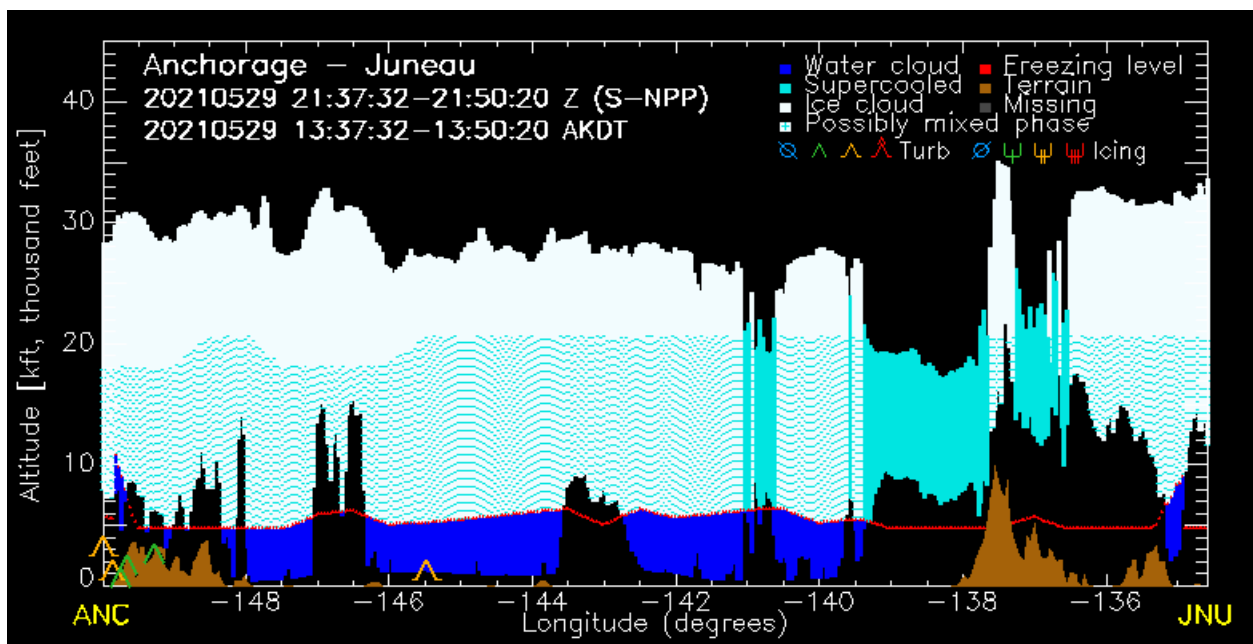


Figure 11 – Anchorage to Juneau Experimental Aviation Cross-section Product valid at 1337 to 1350 AKDT.

5.0 Regional Radar Imagery Information

The closest weather radar was near Middleton Island (PAIH), Alaska, 112 miles west-southwest of the accident site. Level II archive radar data were obtained from the NCEI utilizing the NEXRAD Data Inventory Search and displayed using the NOAA's Weather and Climate Toolkit software.

5.1 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. Products that require data from multiple elevation scans are not available until the end of the four-to-ten-minute volume scan.

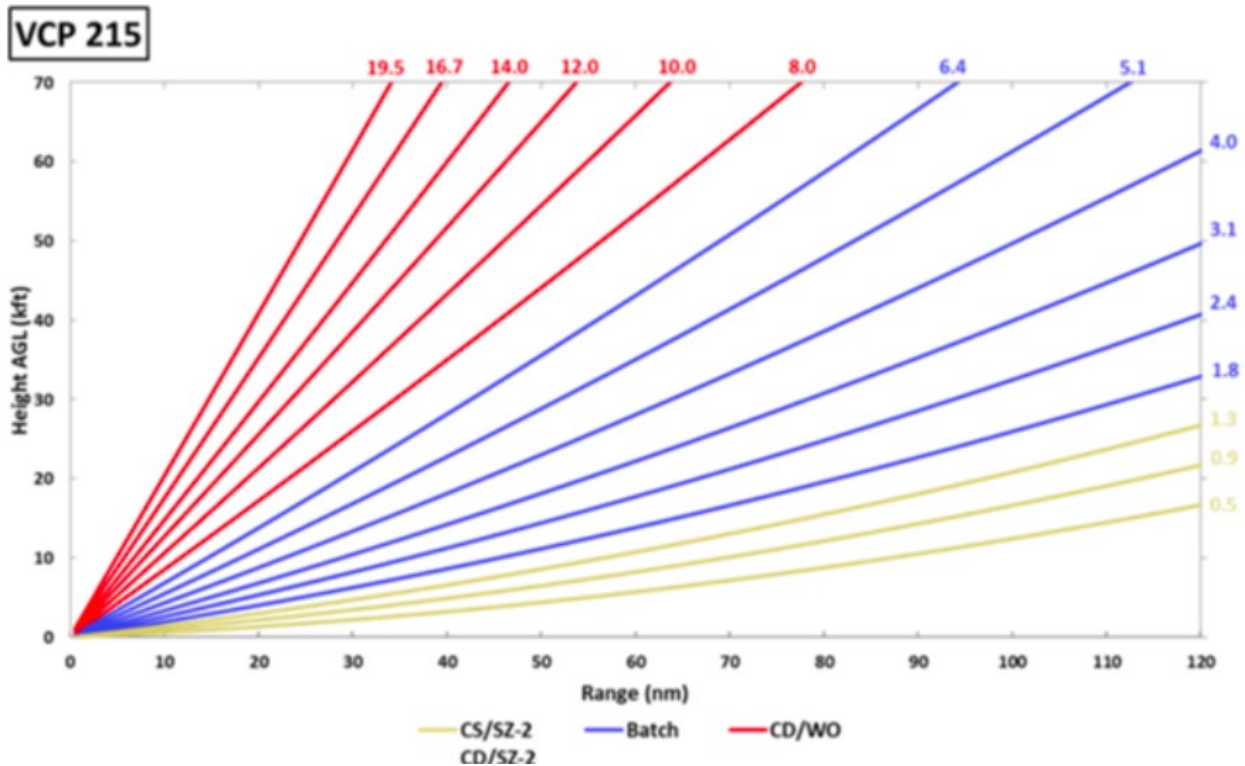
The WSR-88D operates in two main scanning modes, identified as Mode A and Mode B. Mode A is the precipitation scan and has several scanning strategies²¹. The most common is where the radar makes 15 elevation scans from 0.5° to 19.5° every six minutes. This scanning strategy is documented as volume coverage pattern 215 (VCP-215), which the radar was operating at during the period of the accident. The following chart provides an indication of the different elevation angles in this VCP, and the approximate height and width of the radar beam with distance from the radar site.

²¹ Contiguous Surveillance (CS)--The low Pulse Repetition Frequency (PRF) scan of the split cut. Gives a high $R_{\max}$ value to determine proper target location and intensity, but a low $V_{\max}$ value limits the velocities that can be measured. Contiguous Doppler (CD)--The high PRF scan of the split cut. Gives a low $R_{\max}$ value causing more range folded (multiple trip) echoes, but a high $V_{\max}$ value to get higher, more accurate velocity values.

Batch Mode – Uses alternating low and high PRFs on each radial for one full rotation at each elevation angle. The two resulting data sets (low PRF and high PRF) are combined to resolve range ambiguity. Used in the middle elevation angles.

W – With range unfolding (W)

WO – Without range unfolding (WO)



VCP-215 Precipitation Mode Scan Strategy.

5.2 Beam Height Calculation

Assuming standard refraction²² of the PAIH WSR-88D radar beam with the antenna elevation at 132 ft, and considering a beamwidth²³ of 0.95°, the following table shows the approximate heights for the radar beam center, base, and top for an antenna elevation over the accident site. These heights have been rounded to the nearest 10 ft.

ANTENNA ELEVATION	BEAM CENTER	BEAM BASE	BEAM TOP
PAIH 0.5°	15,170 ft	9,650 ft	20,690 ft

Based on the radar height calculations, the elevation scan from PAIH listed in the above table depicted the conditions between 9,650 ft and 20,690 ft msl and these scans “saw” the closest altitudes to the aircraft’s altitude before descent.

²² Standard Refraction in the atmosphere is when the temperature and humidity distributions are approximately average, and values set at the standard atmosphere.

²³ Beamwidth - the angular separation between the half power points on the antenna radiation pattern, where the gain is one half the maximum value.

5.3 Reflectivity

Reflectivity is the measure of the efficiency of a target in intercepting and returning radio energy. With hydrometeors²⁴ 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 (dBZ²⁵) and is a general measure of echo intensity. FAA Advisory Circular AC 00-24C²⁶, “Thunderstorms,” dated February 19, 2013, also defines the echo intensity levels and weather radar echo intensity terminology associated with those levels (figure 12). For dBZ values less than 30 the weather radar echo intensity terminology should be “light”. For dBZ values between 30 and 40, the terminology should be “moderate.” “Heavy” terminology is used for dBZ values greater than 40 dBZ but less than 50 dBZ, inclusive. Finally, any dBZ values above 50 dBZ shall be described as “extreme.”

Reflectivity (dBZ) Ranges	Weather Radar Echo Intensity Terminology
< 30 dBZ	Light
30 – 40 dBZ	Moderate
>40 – 50 dBZ	Heavy
>50 dBZ	Extreme

Figure 12 - Reflectivity values and precipitation intensity terminology.

5.4 Base Reflectivity and Lightning Data

Figure 13 presents the PAIH WSR-88D base reflectivity image for the 0.5° elevation scan initiated at 1313:32 AKDT with a resolution of 0.5° X 250 m. The accident site was located on the edge of reflectivity values between 0 and 15 dBZ at the accident time.

A separate review of Earth Networks Total Lightning archive indicated that there were no lightning flashes²⁷ near the accident site during the period.

²⁴ 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 glazed ice.

²⁵ dBZ – A non-dimensional “unit” of radar reflectivity which represents a logarithmic power ratio (in decibels , or dB) with respect to radar reflectivity factor, Z.

²⁶

https://www.faa.gov/regulations_policies/advisory_circulars/index.cfm/go/document.information/documentID/1020774

²⁷ Lightning Flash – This is one contiguous conducting channel and all the current strokes/pulses that flow through it. There are two types of flashes: ground flashes and cloud flashes. A review of Earth Networks Total Lightning network was done.

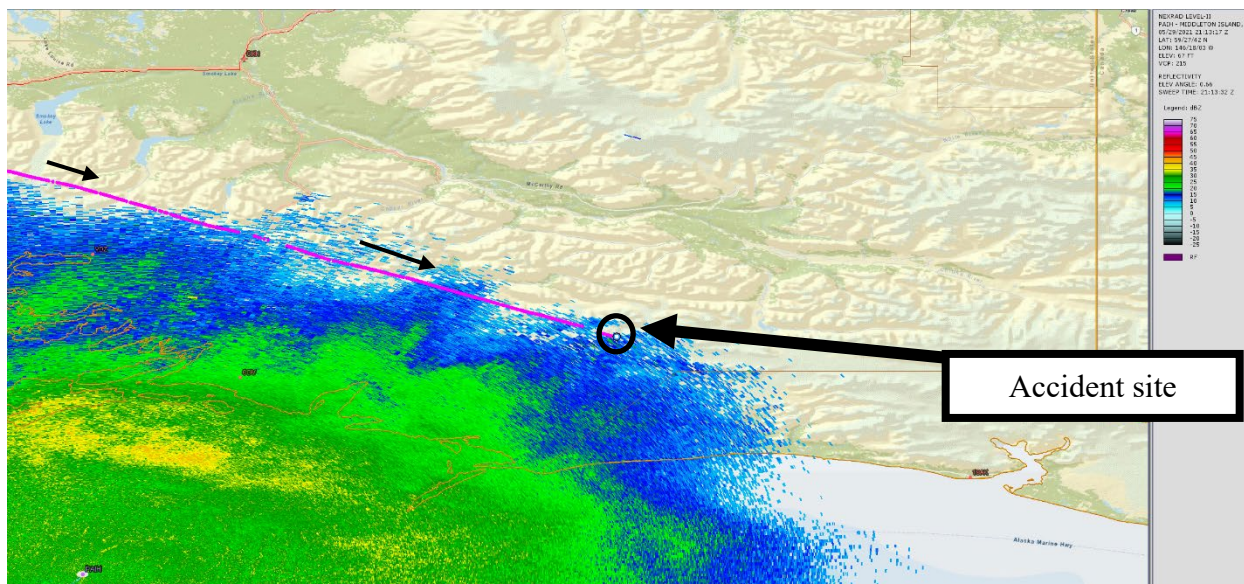


Figure 13 – PAIH WSR-88D 0.5° base reflectivity image for 1313:32 EDT with the total flight track with arrows pointing in the direction of travel.

6.0 Pilot Reports

The longline-disseminated pilot reports²⁸ (PIREPs) distributed into the national airspace (NAS) were reviewed from about three hours prior to the accident time to three hours after the accident time for around 150 miles of the accident site for below 20,000 ft and those PIREPs are shown below:

CDV UA /OV CDV/TM 2100/FL015/TP PA32/WX RA/TB CONS LGT-MOD 015-030/RM /AKFSS/

GKN UUA /OV 15Z-CXC /TM 2300 /FL050 /TP C180 /WV 09030KT /TB MOD/OCNL SEV /RM AKFSS

GKN UA /OV CXC-GKN /TM 2315 /FL050 /TP C180 /WV 09030KT /TB LGT /RM AKFSS

AZK UA /OV GKN-SMU-PAQ /TM 0034 /FL050-040 /TP C180 /WX FV10SM -RA /WV 09020G30KT /TB OCNL
LGT /RM VIA TAHNETA PASS AKFSS

7.0 Significant Meteorological Information

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

²⁸ Only pilot reports with the World Meteorological Organization headers UBAK** were considered. These do not include pilot reports only broadcast via radio.

8.0 Center Weather Service Unit Advisories

The Anchorage (ZAN) Air Route Traffic Control Center (ARTCC) Center Weather Service Unit (CWSU) was responsible for the accident region. ZAN CWSU did not issue a Meteorological Impact Statement (MIS) or a Center Weather Advisory (CWA) for the accident site at the accident time.

9.0 Airmen's Meteorological Information

There were Airmen's Meteorological Information (AIRMET) advisories valid for the accident site at the accident time with the AIRMET forecast shown below issued around 0400 and 1200 AKDT, respectively. The accident site was located near both the Copper River Basin and Central Gulf Coast forecast areas and the intended destination was located in the Eastern Gulf Coast forecast area. AIRMETs Sierra and Zulu for mountain obscuration and moderate icing between 8,000 and 14,000 ft msl were forecast for the accident site at the accident time.

WAAK48 PAWU 291204

WA80

ANCS WA 291215

AIRMET SIERRA FOR IFR AND MT OBSC VALID UNTIL 292015

.

COPPER RIVER BASIN AC

VCY MTS OCNL CIGS BLW 010/VIS BLW 3SM -SHRASN. IMPR.

.

COPPER RIVER BASIN AC

MTS OBSC IN CLDS/PCPN. NC.

.

CNTRL GLF CST AD

OCNL CIGS BLW 010/VIS BLW 3SM -RA BR/+RA. NC.

.

CNTRL GLF CST AD

MTS OBSC IN CLDS/PCPN. NC.

.

=ANCT WA 291215

AIRMET TANGO FOR TURB/STG SFC WINDS VALID UNTIL 292015

.

COPPER RIVER BASIN AC

OCNL MOD TURB FL290-FL380. NC.

.

CNTRL GLF CST AD

JOHNSTONE PT SE SUSTAINED SFC WND 30KT OR GTR. INTSF.

.

CNTRL GLF CST AD

N BLIGH ISLAND OCNL MOD TURB FL290-FL380. NC.

.

=ANCZ WA 291215

AIRMET ZULU FOR ICING VALID UNTIL 292015

.

COPPER RIVER BASIN AC

SE PAGK OCNL MOD ICEIC 060-140.

FZLVL 035. SPRDG TO ALL SXNS AFT 20Z. INTSF.

.

CNTRL GLF CST AD

**OCNL MOD ICEIC 100-FL180.
FZLVL 040 INLAND TO 070 SW. NC.**

.

WAAK48 PAWU 292004
WA8O
ANCS WA 292015
AIRMET SIERRA FOR IFR AND MT OBSC VALID UNTIL 300415

.

**COPPER RIVER BASIN AC
MTS OBSC IN CLDS/PCPN. NC.**

.

**CNTRL GLF CST AD
OCNL CIGS BLW 010/VIS BLW 3SM -RA BR/+RA. NC.**

.

**CNTRL GLF CST AD
MTS OBSC IN CLDS/PCPN. NC.**

.

=ANCT WA 292015
AIRMET TANGO FOR TURB/STG SFC WINDS VALID UNTIL 300415

.

**COPPER RIVER BASIN AC
TIL 02Z N PAGK OCNL MOD TURB FL260-FL330. WKN.**

.

**COPPER RIVER BASIN AC
TIL 23Z PAGK S OCNL MOD TURB FL290-FL380. WKN.**

.

**CNTRL GLF CST AD
PAWR-PACV LN S SUSTAINED SFC WND 30KT OR GTR. INTSF.**

.

**CNTRL GLF CST AD
23Z TO 02Z OFSHR E PAMD OCNL MOD TURB FL290-FL380. WKN.**

.

**CNTRL GLF CST AD
AFT 23Z NE PAWD-PAMD LN OCNL MOD TURB BLW 060. INTSF.**

.

**CNTRL GLF CST AD
AREAS LLWS. INTSF.**

.

=ANCZ WA 292015
AIRMET ZULU FOR ICING VALID UNTIL 300415

.

**COPPER RIVER BASIN AC
PAGK S OCNL MOD ICEIC 080-140.
FZLVL 040. NC.**

.

**CNTRL GLF CST AD
NW MONTAGUE IS OCNL MOD ICEIC 080-140.
FZLVL 050 INLAND TO 070 SW. NC.**

.

**CNTRL GLF CST AD
SW PAWR-PACV LN OCNL MOD ICEIC 120-FL180. FZLVL 050 INLAND TO 070 SW. NC.**

.

WAAK47 PAWU 291216
WA7O

JNUS WA 291215
 AIRMET SIERRA FOR IFR AND MT OBSC VALID UNTIL 292015
 .
ERN GLF CST JE
OCNL CIGS BLW 010/VIS BLW 3SM -RA BR/+RA. NC.
 .
ERN GLF CST JE
MTS OBSC IN CLDS/PCPN. NC.
 .
 =JNUT WA 291215
 AIRMET TANGO FOR TURB/STG SFC WINDS VALID UNTIL 292015
 .
ERN GLF CST JE
OFSHR SUSTAINED SFC WND 30KT OR GTR. INTSF.
 .
ERN GLF CST JE
SE PAYA OCNL MOD TURB BLW 060. SPRDG TO ALL SXNS AFT
20Z. INTSF.
 .
ERN GLF CST JE
LLWS COND. NC.
 .
 =JNUZ WA 291215
 AIRMET ZULU FOR ICING VALID UNTIL 292015
 .
ERN GLF CST JE
OCNL MOD ICEIC 100-FL180.
FZLVL 070 EXC 045 INLAND. NC.
 .
 .
 WAAK47 PAWU 292006
 WA70
 JNUS WA 292015
 AIRMET SIERRA FOR IFR AND MT OBSC VALID UNTIL 300415
 .
ERN GLF CST JE
OCNL CIGS BLW 010/VIS BLW 3SM -RA BR/+RA. NC.
 .
ERN GLF CST JE
MTS OBSC IN CLDS/PCPN. NC.
 .
 =JNUT WA 292015
 AIRMET TANGO FOR TURB/STG SFC WINDS VALID UNTIL 300415
 .
ERN GLF CST JE
OFSHR SUSTAINED SFC WND 30KT OR GTR. NC.
 .
ERN GLF CST JE
23Z TO 02Z ICY BAY W OCNL MOD TURB FL290-FL380. WKN.
 .
ERN GLF CST JE
OCNL MOD TURB BLW 060. NC.
 .
ERN GLF CST JE
LLWS COND. NC.
 .
 .

=JNUZ WA 292015
AIRMET ZULU FOR ICING VALID UNTIL 300415

.
ERN GLF CST JE
PAYA W OCNL MOD ICEIC 120-FL180.
FZLVL 060. NC.

.
ERN GLF CST JE
AFT 23Z ALG CST OCNL MOD ICEIC 080-140. FZLVL 060. INTSF.

10.0 Area Forecast

The Area Forecast valid for the accident site from the Copper River Basin and Central Gulf Coast forecast areas issued around 0400 and 1200 AKDT, respectively, are shown below as well as the Area Forecast valid for the intended destination:

FAAK48 PAWU 291204
FA8H
ANCH FA 291215
AK SRN HLF EXCP SE AK...

.
AIRMETS VALID UNTIL 292015
CB IMPLY POSSIBLE SEV OR GREATER TURB SEV ICE LLWS AND IFR CONDS.
NON MSL HEIGHTS NOTED BY AGL OR CIG.

.
SYNOPSIS VALID UNTIL 300600
A 974 MB LOW 150NM S PADU WL CONTINUE MOVING S INTO THE PAC OCEAN THRU 06Z. ASSOC OCFNT LOW-PASD-400NM SE PAKH WL DSIPT FM PASD W OTRW TRACK TO 50NM N PAKH-100NM S PAMD-250NM SW CWJU LN BY END OF FCST PD. A 995 MB LOW FORMING ALG THE OCFNT 110NM SE PAJC WL MV TO 50NM NW PAKH AT 995 MB BY 06Z. A SERIES OF NRLY STNRY SFC TROFS OVER THE SOUTHCENTRAL AK MAINLAND AND NRN GULF OF AK WL SLOWLY WKN THRU THE FCST PD.

.
COPPER RIVER BASIN AC...VALID UNTIL 300000
...CLOUDS/WX...
*****AIRMET IFR***VCY MTS OCNL CIGS BLW 010/VIS BLW 3SM -SHRASN. IMPR...**
*****AIRMET MT OBSC***MTS OBSC IN CLDS/PCPN. NC...**
SCT020 BKN050 TOP 120 W/DECR LYRS ABV TO FL200. ISOL BKN020/-SHRA. OTRW VCY MTS
SCT005 OVC020 TOP FL200. VIS 3SM -SHRASN. VCY MTS E PAGK SFC WND SE-SW 20G30KT.
OTLK VALID 300000-300600...VCY MTS MVFR CIG SHRASN. ELSW VFR SHRA.
PASS...
TAHNETA...IFR CIG SHSN.
...TURB...
*****AIRMET TURB***OCNL MOD TURB FL290-FL380. NC...**
MTS E PAGK ISOL MOD TURB BLW 080.
...ICE AND FZLVL...
*****AIRMET ICE***SE PAGK OCNL MOD ICEIC 060-140.**
FZLVL 035. SPRDG TO ALL SXNS AFT 20Z. INTSF...
ELSW/OTRW ISOL MOD ICEIC 060-140.

.
CNTRL GLF CST AD...VALID UNTIL 300000
...CLOUDS/WX...

*****AIRMET STG SFC WND***JOHNSTONE PT SE SUSTAINED SFC WND 30KT OR GTR. INTSF...**
*****AIRMET IFR***OCNL CIGS BLW 010/VIS BLW 3SM -RA BR/+RA. NC...**
*****AIRMET MT OBSC***MTS OBSC IN CLDS/PCPN. NC...**
OTRW SCT005 OVC020 TOP FL200. VIS 3SM -RA BR/RA. JOHNSTONE PT SE SFC WND E-SE
30KT INCR AFT 21Z TO E-SE 40G50KT.
OTLK VALID 300000-300600...IFR CIG RA. BLIGH ISLAND S WND.
...TURB...
*****AIRMET TURB***N BLIGH ISLAND OCNL MOD TURB FL290-FL380. NC...**
JOHNSTONE PT SE ISOL MOD TURB BLW 060.
AFT 21Z JOHNSTONE PT SE OCNL MOD TURB BLW 060.
...ICE AND FZLVL...
*****AIRMET ICE***OCNL MOD ICEIC 100-FL180.**
FZLVL 040 INLAND TO 070 SW. NC...

FAAK48 PAWU 292004
 FA8H
 ANCH FA 292015
 AK SRN HLF EXCP SE AK...

.
 AIRMETS VALID UNTIL 300415
 CB IMPLY POSSIBLE SEV OR GREATER TURB SEV ICE LLWS AND IFR CONDS.
 NON MSL HEIGHTS NOTED BY AGL OR CIG.

.
 SYNOPSIS VALID UNTIL 301400
 A 977 MB LOW 200NM S PADK WL CONTINUE MOVING S INTO THE PAC OCEAN
 THRU 12Z AS ITS ASSOC OCFNT DSIPTS. A 991 MB LOW FORMING ALG THE OCFNT
 50NM E PADQ WL WKN TO 993MB IN BRISTOL BAY.

.
COPPER RIVER BASIN AC...VALID UNTIL 300800
...CLOUDS/WX...
*****AIRMET MT OBSC***MTS OBSC IN CLDS/PCPN. NC...**
SCT020 BKN050 TOP 120 W/DECR LYRS ABV TO FL200. ISOL BKN020/-SHRA.
OTRW VCY MTS SCT005 OVC020 TOP FL200. VIS 3SM -SHRASN. ISOL CIG BLW 010.
VCY MTS E PAGK SFC WND SE-SW 25G35KT.
OTLK VALID 300800-301400...VCY MTS MVFR CIG SHRASN. ELSW VFR SHRA.
PASS...
TAHNETA...IFR CIG SHSN.
...TURB...
*****AIRMET TURB***TIL 02Z N PAGK OCNL MOD TURB FL260-FL330. WKN...**
*****AIRMET TURB***TIL 23Z PAGK S OCNL MOD TURB FL290-FL380. WKN...**
...ICE AND FZLVL...
*****AIRMET ICE***PAGK S OCNL MOD ICEIC 080-140.**
FZLVL 040. NC...
S AK RANGE ISOL MOD ICEIC 050-140.

.
CNTRL GLF CST AD...VALID UNTIL 300800
...CLOUDS/WX...
*****AIRMET STG SFC WND***PAWR-PACV LN S SUSTAINED SFC WND 30KT OR GTR. INTSF...**
*****AIRMET IFR***OCNL CIGS BLW 010/VIS BLW 3SM -RA BR/+RA. NC...**
*****AIRMET MT OBSC***MTS OBSC IN CLDS/PCPN. NC...**
OTRW SCT005 OVC020 TOP FL200. VIS 3SM -RA BR/RA.
PAWR-PACV LN S SFC WND E-SE 40G50KT. ELSW SFC WND E 20G35KT.
OTLK VALID 300800-301400...IFR CIG RA. BLIGH ISLAND S WND.
...TURB...
*****AIRMET TURB***23Z TO 02Z OFSHR E PAMD OCNL MOD TURB FL290-FL380. WKN...**
*****AIRMET TURB***AFT 23Z NE PAWD-PAMD LN OCNL MOD TURB BLW 060. INTSF...**

OTRW NE PAWD-PAMD LN ISOL MOD TURB BLW 060.
AIRMET LLWSAREAS LLWS. INTSF...
...ICE AND FZLVL...
AIRMET ICENW MONTAGUE IS OCNL MOD ICEIC 080-140.
FZLVL 050 INLAND TO 070 SW. NC...
AIRMET ICESW PAWR-PACV LN OCNL MOD ICEIC 120-FL180. FZLVL 050 INLAND TO 070 SW. NC...

FAAK57 PAWU 291216
FA7W
JNUC FA 291215
ERN GLF COAST AND SE AK CONTINUED...

.
AIRMETS VALID UNTIL 292015
CB IMPLY POSSIBLE SEV OR GREATER TURB SEV ICE LLWS AND IFR CONDS.
NON MSL HEIGHTS NOTED BY AGL OR CIG.

.
ERN GLF CST JE...VALID UNTIL 300000
...CLOUDS/WX...
AIRMET STG SFC WNDOFSHR SUSTAINED SFC WND 30KT OR GTR. INTSF...
AIRMET IFROCNL CIGS BLW 010/VIS BLW 3SM -RA BR/+RA. NC...
AIRMET MT OBSCMTS OBSC IN CLDS/PCPN. NC...
OTRW SCT005 OVC020 TOP FL200. VIS 3SM -RA BR/RA. OFSHR SFC WND E-SE 30KT INCR AFT 21Z TO E-SE 40G50KT. ELSW SFC WND E 20G30KT.
OTLK VALID 300000-300600...IFR CIG RA. OFSHR WND.
...TURB...
AIRMET TURBSE PAYA OCNL MOD TURB BLW 060. SPRDG TO ALL SXNS AFT 20Z. INTSF...
ELSW/OTRW TIL 20Z ISOL MOD TURB BLW 060.
AIRMET LLWSLLWS COND. NC...
...ICE AND FZLVL...
AIRMET ICEOCNL MOD ICEIC 100-FL180.
FZLVL 070 EXC 045 INLAND. NC...

.
FAAK57 PAWU 292006
FA7W
JNUC FA 292015
ERN GLF COAST AND SE AK CONTINUED...

.
AIRMETS VALID UNTIL 300415
CB IMPLY POSSIBLE SEV OR GREATER TURB SEV ICE LLWS AND IFR CONDS.
NON MSL HEIGHTS NOTED BY AGL OR CIG.

.
ERN GLF CST JE...VALID UNTIL 300800
...CLOUDS/WX...
AIRMET STG SFC WNDOFSHR SUSTAINED SFC WND 30KT OR GTR. NC...
AIRMET IFROCNL CIGS BLW 010/VIS BLW 3SM -RA BR/+RA. NC...
AIRMET MT OBSCMTS OBSC IN CLDS/PCPN. NC...
OTRW SCT008 OVC020 TOP FL200. VIS 3SM -RA BR/RA.
OFSHR SFC WND E-SE 40G50KT. ELSW SFC WND E 20G35KT.
OTLK VALID 300800-301400...IFR CIG RA. OFSHR WND.
...TURB...
AIRMET TURB23Z TO 02Z ICY BAY W OCNL MOD TURB FL290-FL380. WKN...
AIRMET TURBOCNL MOD TURB BLW 060. NC...
AIRMET LLWSLLWS COND. NC...

...ICE AND FZLVL...

AIRMET ICEPAYA W OCNL MOD ICEIC 120-FL180.

FZLVL 060. NC...

AIRMET ICEAFT 23Z ALG CST OCNL MOD ICEIC 080-140. FZLVL 060. INTSF...

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11.0 Alaska Aviation Weather Unit Graphics

The Alaska Aviation Weather Unit (AAWU) produce graphical forecast information valid at the accident time and that information can be found in attachment 4. Isolated moderate turbulence conditions between the surface and 8,000 ft were forecast for the accident site for 1200 AKDT.

12.0 Terminal Aerodrome Forecast

There was no NWS Terminal Aerodrome Forecast (TAF)²⁹ valid within 40 miles of the accident site.

13.0 NWS Area Forecast Discussion

The NWS office in Anchorage, Alaska, (WFO AFC) issued the following Area Forecast Discussion (AFD) at 0528 AKDT and this was the AFD valid at the accident time:

FXAK68 PAFC 291328

AFDAFC

Southcentral and Southwest Alaska Forecast Discussion

National Weather Service Anchorage AK

528 AM AKDT Sat May 29 2021

.ANALYSIS AND UPPER LEVELS...

A strong upper level low centered near the Middle Kuskokwim Valley is bringing cooler temperatures and overcast skies across much of the mainland. Water vapor imagery indicates a deep, southerly fetch of moisture advecting from the Central Pacific into the Gulf as a surface front lifts northward. As such, widespread rain/showers are seen across Southcentral and will continue through the day, although downsloping is expected in the lee of the Chugach Mountains by this evening. Southeasterly winds are also observed in Prince William Sound and thus winds will likewise increase through Passage Canal and Turnagain Arm today. Farther west, rare clearing is shown on current satellite imagery over the northern and central Bering in a drier, northeasterly flow. Mostly cloudy skies are seen across much of the Aleutians associated with a broad, North Pacific low tracking south of the Chain. Heaviest precipitation is occurring near the AKPEN, closer to the aforementioned Gulf front.

²⁹ According to NWS Instruction 10-813: "An NWS TAF consists of the expected meteorological conditions significant to aviation at an airport for a specified time period. For the U.S., this is the area within five (5) statute miles (SM) of the center of an airport's runway complex." www.nws.noaa.gov/directives/sym/pd01008013curr.pdf

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.MODEL DISCUSSION...

Model agreement remains good in the short term. The GFS continues to indicate the strongest winds along the coast, with the current forecast even slightly stronger. The will subsequently determine how much downsloping will occur in the Anchorage area. In any case, widespread precipitation is expected through the day.

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.AVIATION...

PANC...MVFR conditions will generally persist through the day, with IFR ceilings most likely this afternoon when the heaviest rain is expected to occur. Precipitation will gradually taper off this evening into Sunday morning, bringing slightly higher CIGs. Gusty southeasterly winds are expected along Turnagain Arm, but should remain light over the terminal.

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.SHORT TERM FORECAST SOUTHCENTRAL ALASKA (Days 1 through 3: Saturday through Monday)...

Slow moving low pressure continues to send periods of rain into Southcentral AK and Kodiak. This system is dropping more rain than initially forecast and specific bands of precipitation are proving difficult to predict. One such band moved over Anchorage tonight and dropped .15 inches of rain, with 0.44 inches of rain over the last 24 hours. Though some aspects of this system have been difficult to predict, we still have confidence in the overall weather picture. We know that due to the slow moving nature of this system means weather won't change much in the short term. Rain and rain showers will continue through the day, with the next round of more steady rain arriving tonight into earlier tomorrow morning. This next shot of precipitation is due to a shortwave trough moving northeast out of the Gulf of Alaska. Continued strong winds can also be expected along the coast with a barrier jet set up.

After the passage of this trough Sunday, weather will begin to calm. The pressure gradient will weaken some allowing winds to slacken. Precipitation will be less widespread, though coastal areas can still expect to see rain. Low pressure will also maintain its presence in the Western Gulf of Alaska into next week, with on shore flow ahead of this system. This means though weather will quiet, we will still be under this influence of this system. So, continued cool and cloudy conditions for Southcentral into next week and the possibility of rain, depending on your location.

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.SHORT TERM FORECAST SOUTHWEST ALASKA (Days 1 through 3: Today through Monday)...

Strong, northeasterly and offshore flow generated by the pressure gradient between a large North Pacific low and a ridge centered over the Chukchi Sea will continue through this evening. These winds will be strongest over land across the Lower Kuskokwim Valley where gusts to 40 mph will be possible during the early afternoon. The northeast winds will also transport a smoke plume moving off from a wildfire near Scammon Bay towards the far northern Kuskokwim Delta Coast at times today, particularly near Hooper Bay. Even though relative humidity will be fairly low along with the gusty winds, temperatures will be on the cool side with a seasonably cold air mass moving in from the interior today.

By this evening, a potent upper level low moving west across the western mainland will combine with the remnants of front moving north across the AKPen and western Alaska Range. This will help spread a band of rain into the Middle Kuskokwim Valley and Bristol Bay through tonight. As the upper low moves offshore into the Bering, northeast winds will completely shut off, becoming weak and southerly on Sunday. Little, if any, precipitation will make it across the Kuskokwim Mountains as the front shears out by Sunday evening. While cloud cover will persist over most of the Southwest on Monday, most can expect a dry and warmer day to close out the holiday weekend.

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.SHORT TERM FORECAST BERING SEA/ALEUTIANS (Days 1 through 3: Today through Monday)...

Much of the region will continue to feel the influence of a large low centered south of the Aleutian Chain as it continues to spread a wide swath of northeasterly winds across the Bering. These winds will generally be just lower than gale force, and they will gradually weaken over the next 24 hours as the low drifts farther into the North Pacific. The dry, offshore winds will provide an unusual break from the fog and stratus over the Pribilofs, with generally clear skies expected to last through at least Sunday morning. Farther south, a weakening front will bring cooler and showery conditions to the Eastern Aleutians as it stalls out over the Southern Bering and weakens through Sunday. By Monday, the same low previously discussed will pivot back north towards the Eastern Aleutians, bringing the potential for stronger easterly gales to approach from the south on the Pacific side yet again.

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.MARINE (Days 3 through 5: Monday through Wednesday)...

Low pressure passing south of the Alaska Peninsula brings local gale force winds to the Pacific side of the Alaska Peninsula on Monday. A trough across the Bering brings gusty easterly winds to the Northern Bering through Wednesday. A front moves across the

Gulf to the north Gulf coast for Tuesday. Gale force winds ahead of the front with possible storm force winds near the capes on Monday, diminishing. A low approaches the western Gulf spreading gusty winds from the Shumagin Islands east for Tuesday and Wednesday.

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.LONG TERM (Days 4 through 7: Tuesday through Friday)...

A broad longwave trough is expected to persist over the Aleutian Chain with stout ridging extending from British Columbia into the Interior. Throughout the week the upper level pattern will transition to zonal flow with the jet centered over the 50 N parallel. However, slight troughing is expected to persist over the mainland, meaning active, or at least cloudy weather is possible. Sensible weather wise multiple lows are expected underneath the broad trough, which means generally overcast and wet weather throughout the AOR. Midweek storms will be more likely to move into the southern mainland due to southerly flow aloft. As the week progresses the storm track will be increasingly likely to move into Southeast Alaska as the jet shifts into the southern Gulf. Late week troughing will be the most pronounced over the Bering, meaning active weather is possible along the Aleutian Chain and Southwest Alaska. Southcentral may see a break in the weather by the weekend but at this time there is a lot of uncertainty.

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.AFC WATCHES/WARNINGS/ADVISORIES...

PUBLIC...NONE.

MARINE...Storm Warning: 119.

Gale Warning: 125 174 176 181.

FIRE WEATHER...NONE.

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14.0 Pilot Weather Briefing and Pilot Statements

The accident pilot did not request nor receive weather information³⁰ from Alaskan Flight Services³¹. The accident pilot stated that during the morning of the accident he reviewed weather reports at the departure and destination airports. He reviewed weather before the flight using FltPlan.com³² which provided the METARs and winds aloft data. The accident pilot had access to ADS-B weather in the cockpit and could and did review weather for the destination airports while enroute. The weather conditions were smooth and clear at 12,500 ft until about 2 hours and 15 minutes into the flight when they encountered severe turbulence, windshear, and a severe downdraft. The accident pilot stated the flight encountered a 2,000 ft per minute or greater downdraft. Cloud ceilings were around 7,000 ft msl at the accident site during the accident time.

The pilot rated passenger stated he reviewed the weather conditions for the accident flight using ForeFlight. The pilot rated passenger stated the clouds were broken to scattered departing from PATK and they worked their way up to 12,500 ft and the flight, until the accident sequence, was uneventful with calm and variable winds and cloud tops between 10,000 and 11,000 ft msl. During the accident sequence, the pilot rated passenger said the flight got caught in windshear or a rotor from the surrounding terrain. For more information, please see the interview transcripts located in the docket of this accident.

15.0 Global Graphical Turbulence Guidance information

The NWS Aviation Weather Center (AWC) provided the global Graphical Turbulence Guidance³³ (GTG) plots used for the World Area Forecast System (WAFS)³⁴. The global GTG indicated light to moderate turbulence for “light” aircraft at the accident site at 1300 AKDT between 10,000 and 14,000 ft msl. For more information, including the GTG turbulence scale for “light” aircraft, please see attachment 5.

16.0 Mountain Waves and Hazardous Mountain Winds

In FAA Advisory Circular (AC) 00-6B³⁵ published on August 23, 2016, section 17.2.2.1 describes mountain wave conditions and the associated aviation hazards therein (figure 14). Additional information on the hazardous weather and wind conditions in mountainous terrain is published in the FAA’s Advisory Circular 00-57 (AC-00-57)³⁶ published on September 10, 1997.

³⁰ https://www.faa.gov/documentLibrary/media/Advisory_Circular/AC_91-92.pdf

³¹ https://www.faa.gov/about/office_org/headquarters_offices/ato/service_units/systemops/fs/alaskan/alaska/

³² [FltPlan.com](https://www.fltplan.com)

³³ For more information on GTG please see: <https://aviationweather.gov/turbulence>

³⁴ [AWC - WAFS Data \(aviationweather.gov\)](https://www.faa.gov/documentLibrary/media/Advisory_Circular/00-57.pdf)

³⁵

https://www.faa.gov/documentLibrary/media/Advisory_Circular/AC_00-6B.pdf

³⁶

https://www.faa.gov/documentLibrary/media/Advisory_Circular/00-57.pdf

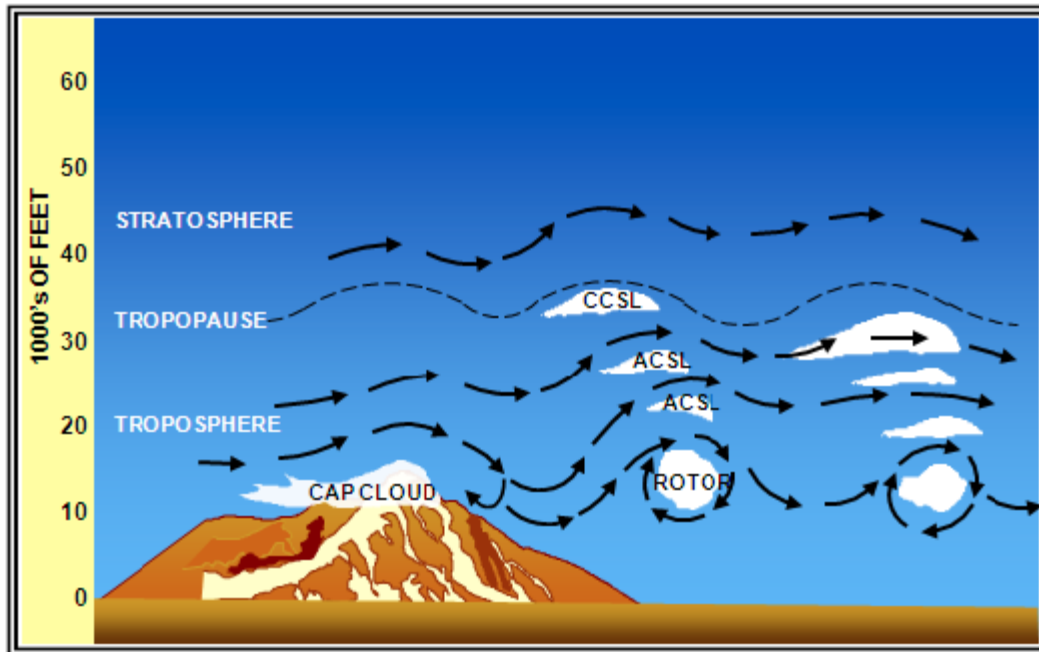


Figure 14 – AC 00-06B mountain wave conditions.

17.0 Astronomical Data

The astronomical data obtained for the accident site on May 29, 2021, indicated the following:

SUN	
Begin civil twilight	0252 AKDT
Sunrise	0419 AKDT
Accident time	1312 AKDT³⁷
Sun transit	1332 AKDT
Sunset	2245 AKDT

At the time of the accident the Sun was located at an altitude of 50.91° and azimuth of 172.79°.

³⁷ Inserted accident time for reference and context.

E. LIST OF ATTACHMENTS

Attachment 1 – GOES-17 satellite animation from 1200 to 1400 AKDT

Attachment 2 – Additional satellite imagery for the accident time

Attachment 3 – Satellite Cloud Vertical Cross-section Quick Guide

Attachment 4 – AAWU graphical forecast information valid at the accident time

Attachment 5 – Global GTG information valid for 1300 AKDT for North America

Submitted by:

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