



NATIONAL TRANSPORTATION SAFETY BOARD

**Office of Aviation Safety
Washington, D.C. 20594**

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WEATHER STUDY

METEOROLOGY

ANC17FA004

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A. ACCIDENT

Location: Port Alsworth, Alaska
Date: October 28, 2016
Time: 1828 Alaska daylight time (0228 UTC¹ on October 29, 2016)
Airplane: Fairchild Heli-Porter Pilatus PC-6; Registration: N5308F

B. METEOROLOGY GROUP

Donald Eick
Senior Meteorologist
Operational Factors Division (AS-30)
National Transportation Safety Board
Washington, D.C.

C. SUMMARY

On October 28, 2016, about 1828 Alaska daylight time, a turbine-powered tailwheel-equipped Fairchild Pilatus Porter PC-6, N5308F, sustained substantial damage after impacting mountainous terrain about 57 miles north-northeast of Port Alsworth, Alaska, in the Neacola Mountains of Lake Clark National Park and Preserve. The airplane was being operated as a visual flight rules (VFR) cross-country personal flight under the provisions of Title 14 *Code of Federal Regulations* (CFR) Part 91. The commercial rated pilot, the sole occupant, sustained fatal injuries. Visual meteorological conditions prevailed at the departure and destination, with areas of reduced visibility and lower cloud ceilings along the route of flight. No flight plan had been filed. The flight departed Lake Hood Seaplane Base, Anchorage, Alaska, at 1711, destined for a private airstrip near Port Alsworth.

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 (WPC) and the National Center for Environmental Information (NCEI). All times are Alaska daylight time (AKDT) based upon the 24-hour clock, local time is +8 hours to 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 uses the International Civil Aviation Organization (ICAO) airport and station codes in their products which are documented in this report.

¹ UTC – is an abbreviation for Coordinated Universal Time. All NWS products are issued with date and times referenced to UTC.

The accident site was located at latitude 61°05.69' N and longitude 153°26.81' W at an elevation of 6,249 feet on the south side of a ridge line. Terrain reached 8,336 feet in the immediate vicinity of the accident site.

E. 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 (NCEP) located in Camp Springs, Maryland, and the Alaska Aviation Weather Unit (AAWU) in Anchorage, Alaska. These are the base products used in describing weather features and in the creation of forecasts and warnings. Reference to these charts can be found in the latest version of the joint NWS and Federal Aviation Administration (FAA) Advisory Circular “Aviation Weather Services”, AC 00-45H.

1.1 Surface Analysis Chart

The NWS Alaska Surface Analysis Chart for 1600 AKDT (0000Z October 29, 2016) depicting the conditions prior to the accident, showed two deep low pressure systems at 960- and 957-hectopascals (hPa)² in the Bearing Sea along an occluded frontal system with the cold front extending southward across the Aleutian Island chain to the southwest of the accident site. A high pressure system at 1025-hPa was located over eastern Alaska. The approximate accident site is noted by a red star and was located well east of the occluded and cold frontal systems. A strong pressure gradient was indicated by the spacing of the isobars³ ahead of the cold front across southwest Alaska and indicated strong southeast to southerly surface winds across the area, including in the vicinity of the accident site.

² Hectopascal (hPa) is the new standard terminology in reporting pressure and is interchangeable with millibars (mb) and has the same units. The International Standard Atmosphere (ISA) is defined as a sea level pressure of 1013.25-hPa at 15° Celsius (C), with a lapse rate of 2° C per 1,000 feet.

³ Isobar – is a line of equal pressure usually depicted every 4-hPa on the surface analysis chart and helps depict wind direction and wind speed by the gradient or rate of change in pressure with distance.

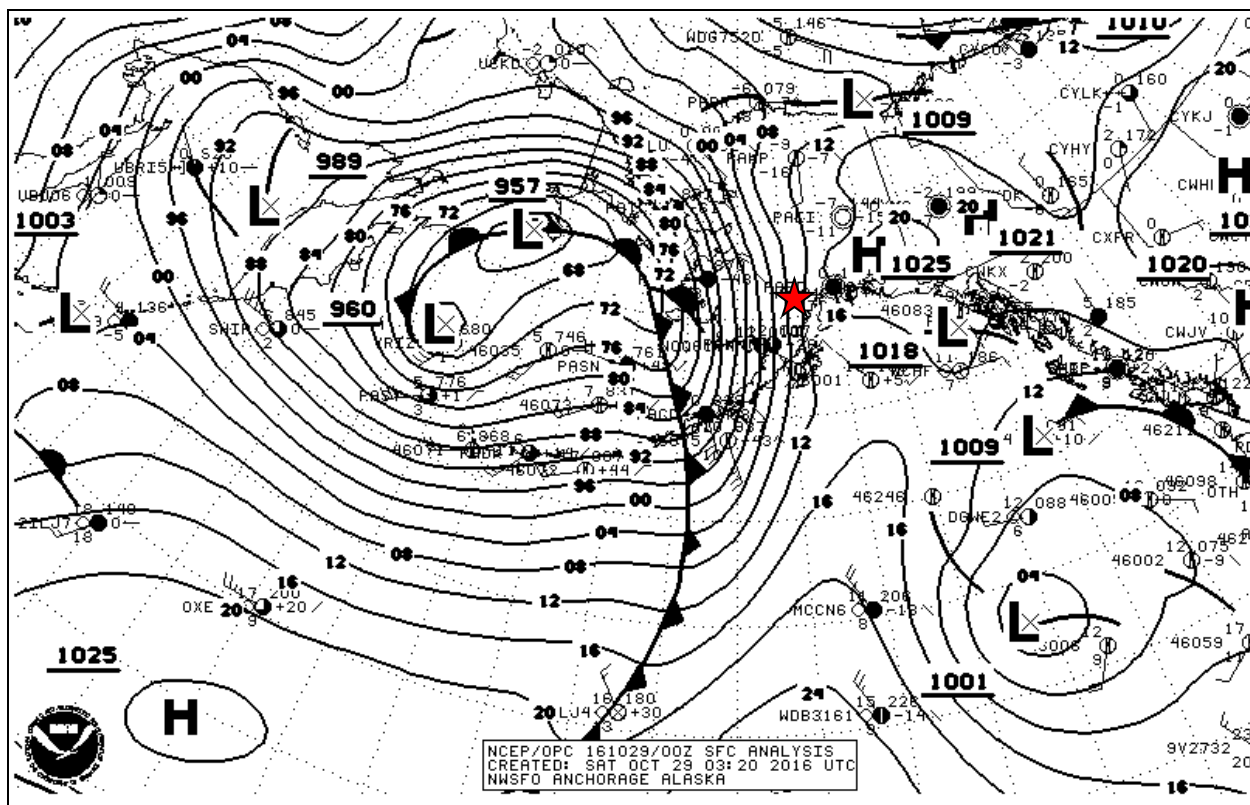


Figure 1 - NWS Alaska Surface Analysis Chart for 1600 AKDT

Figure 2 is the NWS Alaska Aviation Weather Unit's (AAWU) Alaska Surface Forecast Chart issued at 1200 AKDT (2000Z) and valid for 1600 AKDT (0000Z on October 29, 2016), which depicted multiple low pressure centers associated and along the occluded front which extended across the Bearing Sea and across the Aleutian Islands west of the accident site, and a high pressure system at 1021-hPa over Canada with a high pressure ridge extending westward into the Anchorage area. The chart included a large area of expected light continuous rain along the frontal system over southwestern Aleutian Islands and western Alaska during the period. The chart also depicted an increasing pressure gradient with the tight packing of the isobars over western and southwest Alaska. The accident site was depicted ahead of the expected precipitation area and with potential increasing southeasterly winds over the region.

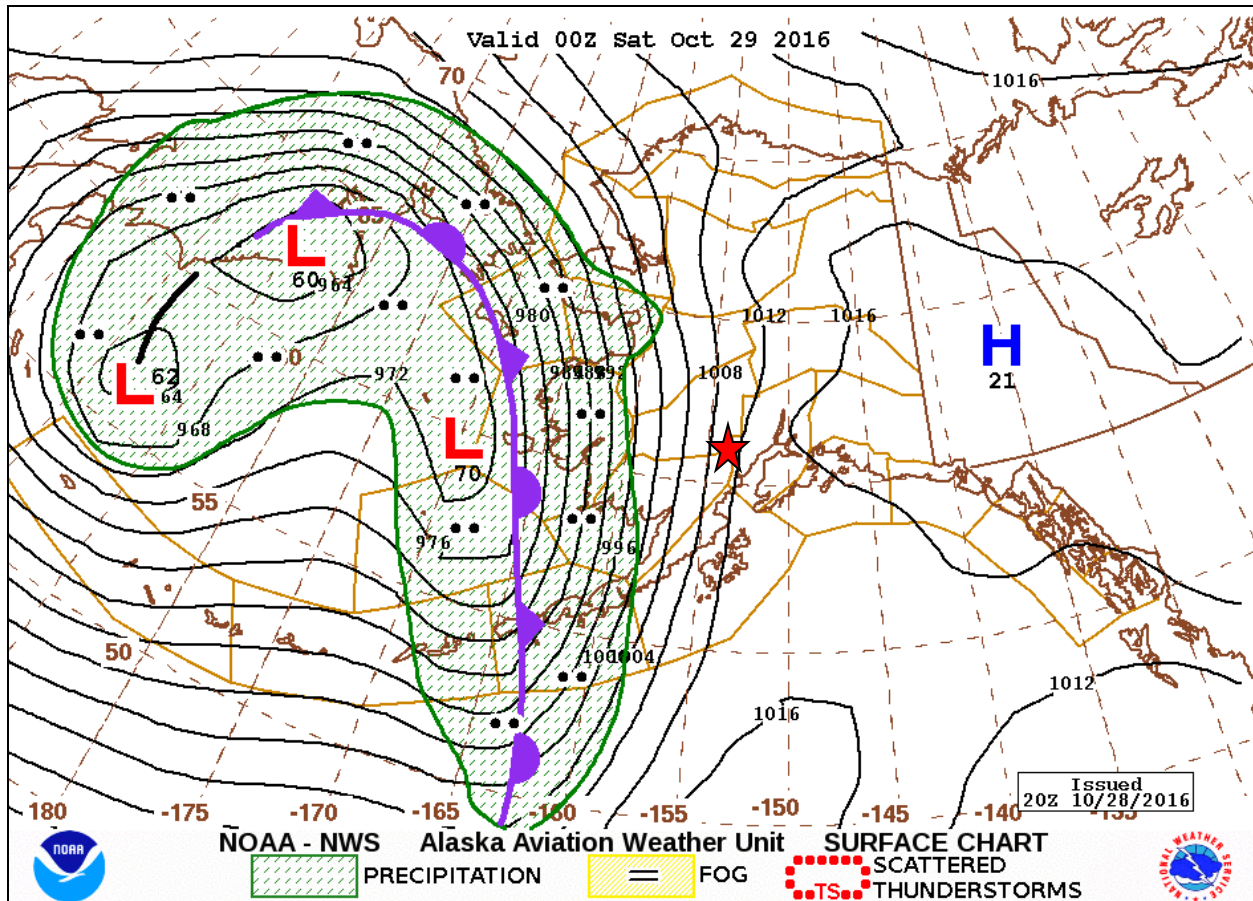


Figure 2 - NWS Alaska Surface Forecast Chart for 1600 AKDT

Figure 3 is the next NWS Alaska Surface Forecast Chart issued prior to the accident at 1400 AKDT (2000Z) and valid for 2200 AKDT (0600Z on October 29, 2016) which continued depicting the approaching occluded front with a large area of mixed precipitation area with rain, snow in higher elevations over northern Alaska, and fog expected to impact western Alaska during the period. The chart continued to depict no significant weather over the route between Lake Hood and Port Alsworth Airports, and indicated an increasing pressure gradient over southwestern Alaska and implying strong and gusty winds southeast to easterly winds at the surface.

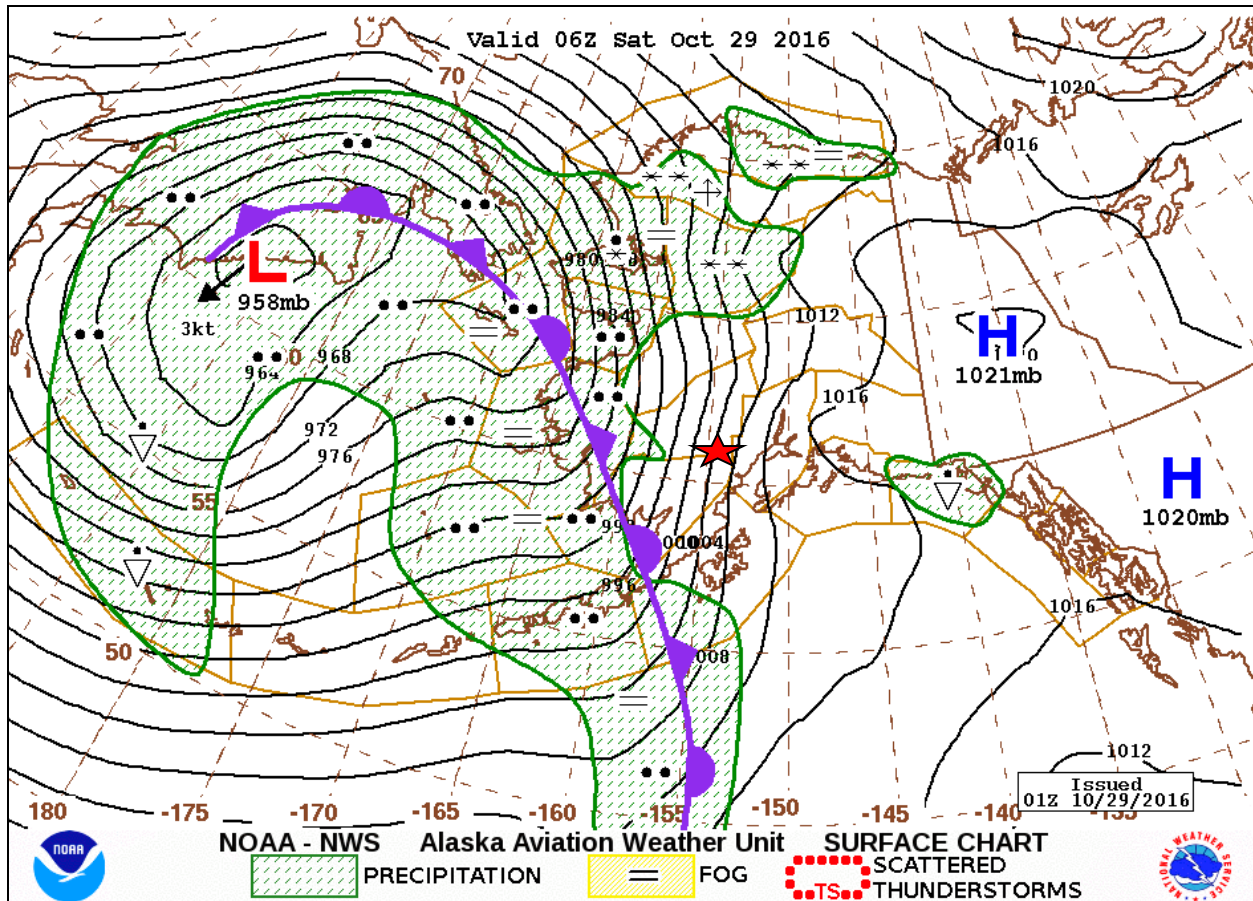


Figure 3 - NWS Alaska Surface Forecast Chart valid for 2200 AKDT

2.0 Surface Observations

The official NWS Meteorological Aerodrome Reports (METARs) and special reports (SPECIs) and Remote Automated Weather Stations (RAWS) sites surrounding the period were documented for the surrounding area. The cloud heights are reported above ground level (agl) in the following section. The magnetic variation was approximately 18° East based on the sectional chart for the area.

2.1 Port Alsworth, Alaska

The planned destination of Port Alsworth Airport (PALJ), Port Alsworth, Alaska was located approximately 57 miles south or on a 205° azimuth from the accident site at an elevation of 280 feet. The airport does not list any specific weather reporting capability at the airport; however, some weather observations were being transmitted from an Aviation Paid Weather Observer (A-Paid) at approximately 2 hour intervals prior to the accident. The airport lists a single dirt/gravel runway 6L/24R at 3,000 feet long and 100 feet wide. The airport remarks indicated that another 4,200 feet runway owned by a separate operator is located ¼ mile south of and parallel to the runway 6L/24R, and that strong downdrafts can be expected on runway 6L during period of east winds. The following weather conditions were reported prior to the accident:

Port Alsworth weather at 1650 AKDT (0050Z), wind from 060° at 10 knots, visibility 30 miles, ceiling overcast at 10,000 feet, temperature 10° Celsius (C), dew point temperature 4° C, altimeter 29.70 inches of mercury (Hg). Remarks: last observation for the day, 24-hour maximum temperature 10.0° C, 24-hour minimum temperature -1.7° C, estimate pass open, no special observations.

The raw observations surrounding the period were as follows:

METAR PALJ 282058Z 09005KT 30SM OVC100 09/06 A2980 RMK EST PASS OPEN

METAR PALJ 282257Z 08018KT 30SM OVC100 09/06 A2972 RMK EST PASS OPEN

*METAR PALJ 290050Z 06010KT 30SM OVC100 10/04 A2970 RMK LAST 401001017 EST PASS OPEN
NOSPECI*

Accident 0230Z

....

METAR PALJ 291658Z 06005KT 20SM OVC060 08/06 A2963 RMK FIRST NOSPECI

The observations indicated that VFR conditions prevailed through the period with easterly winds, with a ceiling overcast at 10,000 feet which had lowered to 6,000 feet when the station first reported at 0858 AKDT on October 29, 2016.

2.2 Sparrevohn LRRS Airport, Alaska

Sparrevohn LRRS⁴ Airport (PASV) was located approximately 60 miles west or on a 272° azimuth from the accident site at an elevation of 1,565 feet. The airport is a military air strip and closed to the public, but has limited weather reporting capability with an Automated Weather Observation System (AWOS). The airport is surrounded by mountains, and has a single runway located on the slope of a 3,302-foot mountain. The airport remarks advise that all approved flights to approach and land from the south on runway 34, and during daylight hours only. The airport also warns that winds in excess of 20 knots may produce severe turbulence. The following conditions were reported at the approximate time of the accident:

Sparrevohn Airport (PASV) weather at 1755 AKDT, automated, wind from 140° at 20 knots gusting to 41 knots, visibility 10 miles, ceiling overcast at 8,500 feet agl, temperature 9° C, dew point 1° C, altimeter 29.57 inches of Hg. Remarks: automated observation system with a precipitation discriminator, sea level pressure 1002.3-hPa, temperature 8.2° C, dew point 0.7° C.

The raw observations reported surrounding the period were as follows:

*METAR PASV 282155Z AUTO 16022G28KT 10SM -SHRA FEW029 BKN048 07/00 A2968 RMK AO2
RAB2110E2136SHRAB2136 SLP065 P0000 T00721002*

METAR PASV 282255Z AUTO 14014G22KT 10SM BKN048 07/01 A2965 RMK AO2 LTG DSNT NE

⁴ LRRS – Long Range Radar Site.

SHRAB2136E2242 SLP054 T00670006

METAR PASV 282355Z AUTO 13012G18KT 10SM OVC100 08/00 A2963 RMK AO2 SLP046 T00750003
10046 20002 57025

METAR PASV 290055Z AUTO 15018G25KT 10SM OVC095 08/01 A2959 RMK AO2 SLP029 T00820007

METAR PASV 290155Z AUTO 14020G41KT 10SM OVC085 09/01 A2957 RMK AO2 SLP023 T00850006

Accident 0230Z

METAR PASV 290255Z AUTO 12021G35KT 10SM FEW070 BKN120 09/00 A2952 RMK AO2 SLP007
T00900001 58035

METAR PASV 290355Z AUTO 15018G29KT 10SM BKN180 09/00 A2950 RMK AO2 PK WND 13036/0330
SLP998 T00891001

METAR PASV 290455Z AUTO 15029G42KT 120V180 10SM BKN190 09/M01 A2947 RMK AO2 SLP987
T00901006

The observations surrounding the period indicated VFR conditions prevailing with east to southeast winds from 18 to 29 knots with gusts to 42 knots, with high broken to overcast conditions. Light rain showers were also reported prior to the accident. Based on the airport remarks the risk of low-level moderate to severe turbulence could be expected based on the reported winds.

2.3 Iliamna, Alaska

Iliamna Airport (PAIL), Iliamna, Alaska at an elevation of 192 feet was located approximately 92 miles south or on a 209° azimuth from the accident site and south of the planned destination. The airport had an Automated Surface Observation System (ASOS) and reported the following conditions at the time of the accident:

Iliamna Airport weather at 1753 AKDT, wind from 090° at 18 knots gusting to 27 knots, visibility 10 miles, scattered clouds at 3,200 feet agl, scattered clouds at 7,000 feet, ceiling overcast at 13,000 feet, temperature 9° C, dew point 5° C, altimeter 29.70 inches of Hg. Remarks: automated observation system with a precipitation discriminator, peak wind from 100° at 38 knots occurred at 1703 AKDT, sea level pressure 1005.9-hPa, temperature 8.9° C, dew point 5.0° C.

The raw observations surrounding the period were as follows:

METAR PAIL 282153Z 09020G30KT 10SM BKN070 BKN085 OVC130 08/04 A2979 RMK AO2 PK WND
10033/2120 RAE14 SLP090 P0000 T00830039

METAR PAIL 282253Z 09022G38KT 10SM BKN070 BKN080 OVC130 09/04 A2976 RMK AO2 PK WND
09038/2244 SLP081 T00890039

METAR PAIL 282353Z 08021G33KT 10SM SCT070 BKN080 OVC130 09/04 A2975 RMK AO2 PK WND
09038/2318 SLP077 60000 T00890039 10089 20022 56016

*METAR PAIL 290053Z 09024G38KT 10SM SCT035 SCT070 OVC130 09/04 A2973 RMK AO2 PK WND
09038/0051 SLP068 T00890044*

*METAR PAIL 290153Z 09018G27KT 10SM SCT032 SCT070 OVC130 09/05 A2970 RMK AO2 PK WND
10038/0103 SLP059 T00890050*

Accident 0230Z

*METAR PAIL 290253Z 09027G38KT 10SM SCT032 BKN130 09/05 A2968 RMK AO2 PK WND 10038/0253
SLP053 T00890050 56024*

*METAR PAIL 290353Z 10026G41KT 10SM SCT035 BKN130 09/05 A2967 RMK AO2 PK WND 10041/0349
SLP048 T00890050*

*METAR PAIL 290453Z 10023G37KT 10SM SCT033 BKN130 09/05 A2966 RMK AO2 PK WND 11038/0425
SLP047 T00890050*

A review of the observations indicated VFR conditions prevailing during the period with easterly winds from 20 to 40 knots, with multiple layers of clouds with broken to overcast sky coverage. A period of light rain was also reported prior to the accident.

2.4 Kenai Municipal Airport, Kenai

Kenai Municipal Airport (PAEN), located in Kenai, Alaska was located approximately 30 miles southeast of the track of N5308F at approximately 1750 AKDT as it climbed southwestward to 14,500 feet to the west of Cook Inlet before flying over the mountainous terrain. The airport was located approximately 72 miles east-southeast or on a 115° azimuth from the accident site. The airport lists an elevation of 100 feet and had an ASOS system and reported the following conditions surrounding the period:

Kenai Municipal Airport weather at 1753 AKDT, wind from 360° at 7 knots, visibility 10 miles, ceiling broken at 6,500 feet agl, broken at 12,000 feet, temperature 2° C, dew point -4° C, altimeter 29.96 inches of Hg. Remarks: automated observation system with a precipitation discriminator, sea level pressure 1014.7-hPa, temperature 2.2° C, dewpoint -3.9° C.

Kenai Municipal Airport weather at 1853 AKDT, wind from 010° at 7 knots, visibility 10 miles in light rain, ceiling overcast at 4,700 feet agl, temperature 1° C, dew point -2° C, altimeter 29.85 inches of Hg. Remarks: automated observation system with a precipitation discriminator, unknown precipitation began at 1832 and ended at 1841 AKDT, rain began at 1841 AKDT, sea level pressure 1014.4-hPa, hourly precipitation less than 0.01 of an inch, 6-hour precipitation less than 0.01 inch, temperature 1.1° C, dew point -1.7° C, 3-hour pressure tendency fallen 1.0-hPa.

Unknown precipitation⁵ was intermittently reported between 1832 through 2049 AKDT, suggesting mixed and/or light freezing precipitation and potential icing conditions aloft over the region. The raw observations were as follows:

⁵ The ASOS employs a precipitation identification sensor also known as a Light Emitting Diode Weather Identifier (LEDWI) which attempts to differentiate between rain and snow and determines the intensity of the precipitation. In most circumstances, it does quite well; however, in mixed rain and snow events, light drizzle or snow, including

METAR PAEN 282353Z 03010KT 10SM OVC050 03/M04 A2998 RMK AO2 SLP154 T00281039 10028 21017 58002

METAR PAEN 290053Z 03009KT 10SM SCT065 BKN110 03/M04 A2996 RMK AO2 SLP148 T00281039

METAR PAEN 290153Z 36007KT 10SM BKN065 BKN120 02/M04 A2996 RMK AO2 SLP147 T00221039

Accident 0230Z

METAR PAEN 290253Z 01007KT 10SM -RA OVC047 01/M02 A2995 RMK AO2 UPB32E41RAB41 SLP144 P0000 60000 T00111017 56010

METAR PAEN 290353Z 04008KT 10SM UP FEW041 OVC065 01/M01 A2993 RMK AO2 RAE46UPB46 SLP138 P0001 T00111006

METAR PAEN 290453Z AUTO 04013KT 10SM UP OVC060 01/M01 A2991 RMK AO2 UPE18B49RAB18E51 SLP129 P0001 T00061011 TSNO

METAR PAEN 290553Z AUTO 04008KT 10SM OVC050 01/M01 A2990 RMK AO2 UPE0458RAB0458E0459 SLP125 P0000 60002 T00061011 10028 20006 56018 TSNO

2.5 Lake Hood Seaplane Base, Anchorage

The accident airplane departed from Lake Hood Seaplane Base (PALH), Anchorage at approximately 1711 AKDT. The airport lists an ASOS system and reported the following conditions at the time of departure:

Lake Hood weather at 1653 AKDT automated report, wind from 030° at 4 knots, visibility 10 miles, ceiling overcast at 8,500 feet agl, temperature 1° C, dew point -6° C, altimeter 30.00 inches of Hg. Remarks; automated observation system with a precipitation discriminator, sea level pressure 1015.8-hPa, temperature 0.6° C, dew point -6.1° C, thunderstorm sensor inoperative.

The raw observations surrounding the period were as follows:

METAR PALH 290053Z AUTO 03004KT 10SM OVC085 01/M06 A3000 RMK AO2 SLP158 T00061061 TSNO

METAR PALH 290153Z AUTO 05004KT 10SM BKN085 OVC110 00/M06 A2998 RMK AO2 SLP151 T00001056 TSNO

METAR PALH 290253Z AUTO 02003KT 10SM FEW095 BKN120 00/M05 A2996 RMK AO2 SLP146 T00001050 58013 TSNO

METAR PALH 290353Z AUTO 03006KT 10SM OVC100 00/M06 A2995 RMK AO2 SLP143

freezing drizzle, ice pellets, and snow grains the system can't differentiate or report accurately and requires human augmentation and as a result will report unknown precipitation conditions.

3.0 MesoWest Plot of Observations

The MesoWest database maintained from the University of Utah was examined to identify any Remote Automated Weather System (RAWS) or other observation site reporting any significant weather over the region. Figure 4 is a plot of wind and temperature reported in degrees Fahrenheit (°F) over the area at the approximate time of the accident at 1830 AKDT (0230Z). The wind plot is referenced to true north and wind speeds in miles per hour (mph) in this plot.

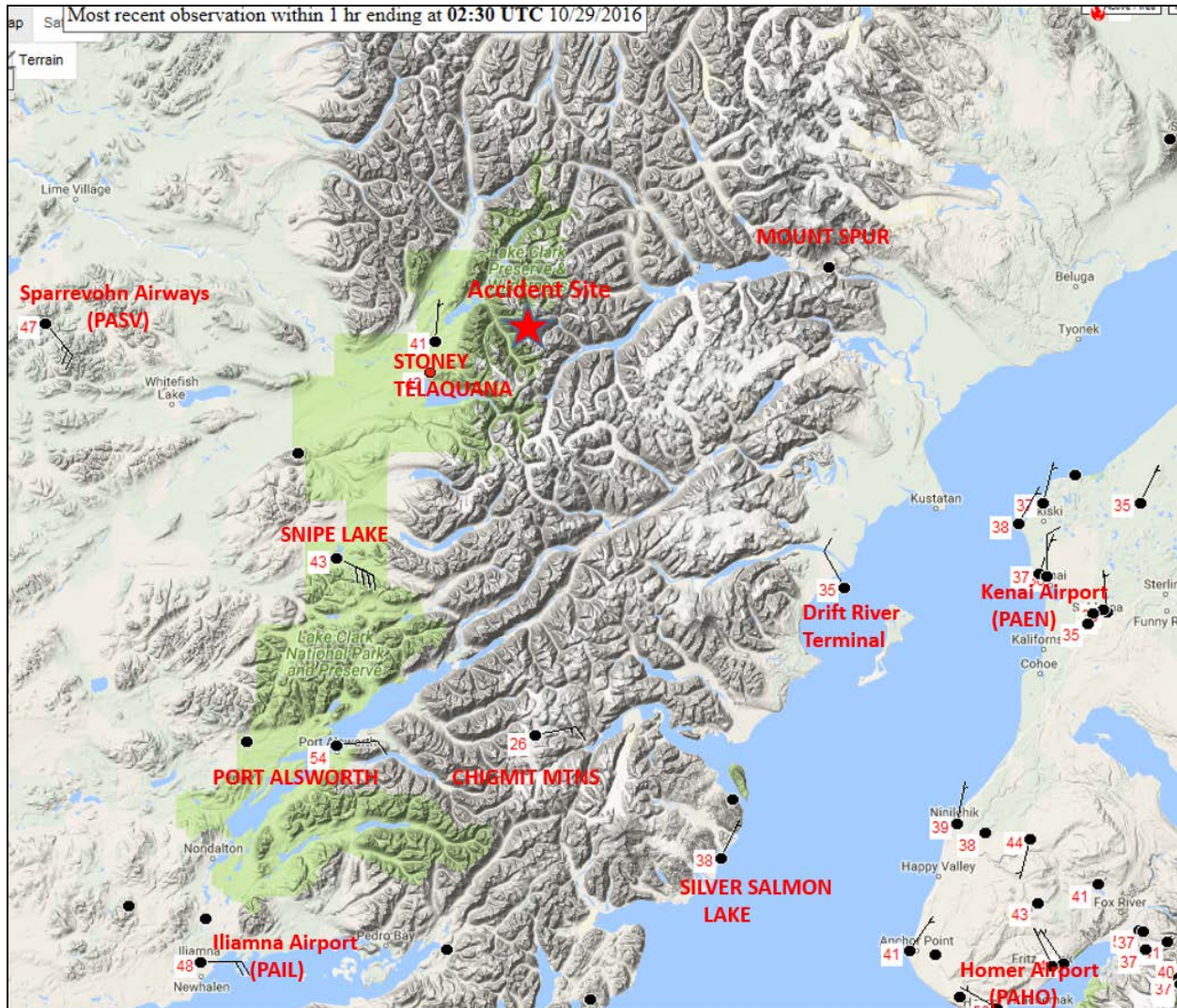


Figure 4 - Remote observations surrounding the accident site

MesoWest identified Stations

Station Name	Elevation (MSL)	T (°F)	Td (°F)	RH (%)	Wind (°true/mph)
Stoney	1,226 ft	41	36	83	N 7G20
Telaquana Lake	1,550 ft	42	-	-	-
Snipe Lake	2,315 ft	43	31	70	ESE 40G51
Drift River Terminal	52 ft	35	30	82	NNW 10G11
Port Alsworth	321 ft	54	34	47	E 8G17

Sparrevohn Airways ⁶	1,588 ft	47	33	58	SE 23G47
Chigmit MTNS	4,658 ft	26	26	99	E 17G29
Silver Salmon Lake	23 ft	38	36	94	NNE 5G9
Iliamna Airport (PAIL)	187 ft	48	41	76	E 21

The closest reporting site to the accident site was from Stoney (STNA2) located approximately 13 miles west-southwest of the accident site along the Stoney River Valley near the southern end of the Two Lakes and north of Telaquana Lake, at an elevation of 1,226 feet. The station reported a north wind at 6 knots or (7 mph) with a peak gust of 17 knots (20 mph), temperature of 41° F, with a temperature-dew point spread of 5° F, and with the relative humidity 83% suggesting a high probability of low clouds and restricted visibility. The station also recorded 0.04 inches of precipitation during the past 24 hours.

The RAWs data also depicted a band of high winds between the accident site and Port Alsworth from the Chigmit Mountain (CGMA2) to Snipe Lake (SNIA2)⁷ to Sparrevohn Airways (PASV) with a band of winds gusting from 25 to 44 knots (29 to 51 mph).

4.0 Upper Air Data

The closest upper air sounding or rawinsonde observation (RAOB) was from the NWS Anchorage (PANC) Forecast Office, Anchorage, Alaska, site number 70273, location approximately 105 miles east of the accident site and near the departure airport at an elevation of 131 feet. The 1600 AKDT Sounding (0000Z on October 29, 2016) was plotted on a standard Skew-T log P diagram⁸ from the surface to 500-hPa or 18,000 feet utilizing RAOB software⁹, and is included as figure 5.

The Anchorage 1600 AKDT sounding depicted a surface temperature of 0.4° C, a dew point of -4.6° C, with a relative humidity of 69%. Several low-level temperature inversions were noted with temperature increasing with height (indicated as a green layer on the diagram) with the tops near 2,100 feet, with the primary freezing level aloft at 4,880 feet which remained below freezing above that level. The lifted condensation level (LCL)¹⁰ was identified at 2,079 feet agl,

⁶ Same as Sparrevohn LRRS Airport (PASV) from section 2.2 above.

⁷ Snipe Lake (SNIA2) RAWs was located at coordinates 60.6102° N and -154.32° W at an elevation of 2,315 feet located on a ridge south of the lake and was operated by the Alaska Bureau of Land Management.

⁸ Skew T log P diagram – is a standard meteorological plot or thermodynamic diagram 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.

⁹ RAOB – (The complete Rawinsonde Observation program) is an interactive sounding analysis program developed by Environmental Research Services, Matamoras, Pennsylvania.

¹⁰ Lifting Condensation Level (LCL) - The height at which a parcel of moist air becomes saturated when it is lifted dry adiabatically.

with the convective condensation level (CCL)¹¹ at 9,076 feet agl. The sounding depicted 3 potential cloud layers, the first at 5,000 feet, the second at 9,000 feet or at the CCL where the sounding indicated a relative humidity of 93% at this level and supported a broken layer of altostratus type clouds based on the stability of the layer, which also was noted by another series of inversions, and a third cloud layer above 16,500 feet. The tropopause height was identified at 39,950 feet. The sounding supported a mixture of light rain and snow, with a precipitable water value of 0.48 inches.

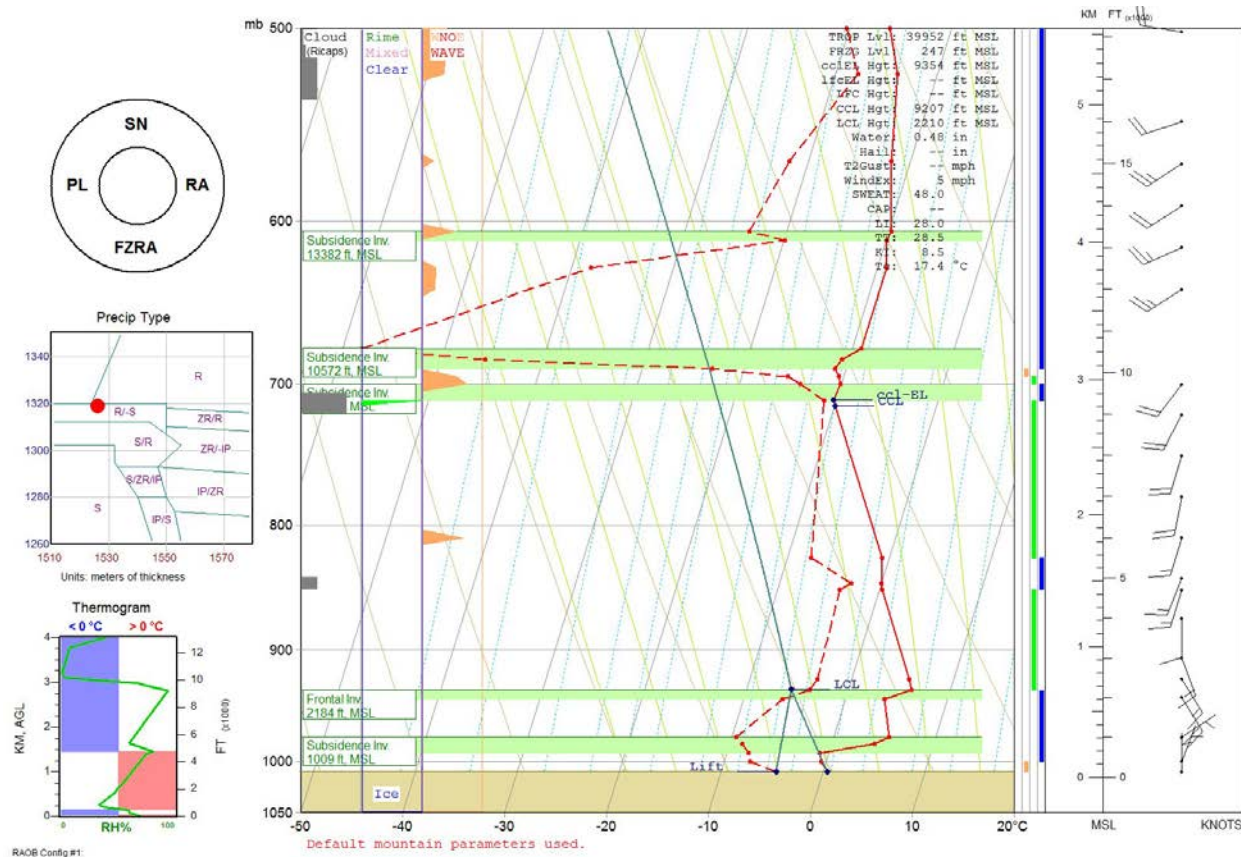


Figure 5 - Anchorage 1600 AKDT sounding

The sounding wind profile indicated a surface wind from the north or from 360° at 3 knots, with the wind veering clockwise to the south immediately above the low-level temperature inversion and then to the southwest and west with increasing height through 18,000 feet. The mean 0 to 6 kilometer or 18,000 feet wind was from 230° at 14 knots. The level of maximum wind was identified from 320° at 75 knots immediately below the tropopause at 36,000 feet. At the accident airplanes cruising level between 9,500 and 10,500 feet the wind was from 210° at 20 knots, with a temperature of -10° C. At 14,500 feet the highest altitude the aircraft was observed to have climbed to and then descended were from 235° at 23 knots with a temperature of -11° C. With regards to clear air turbulence potential, the greatest threat of turbulence was identified near

¹¹ Convective Condensation Level (CCL) - The height to which a parcel of air, if heated sufficiently from below, will rise adiabatically until condensation starts. This is typically used to identify the base of cumuliform clouds, which are normally produced from surface heating and thermal convection.

1,000 feet where the wind was veering from the north to the south, and wind speeds increased rapidly to 18 knots. Above that level only light turbulence potential was indicated over the Anchorage area. The sounding wind and temperature profile did support the formation of mountain wave activity with a predominate wave near 10,000 feet (shown in orange on the left side of the diagram) with the potential for moderate to severe turbulence downwind or northeast from higher terrain based on the wind profile.

A review of the sounding for icing conditions indicated a high potential for moderate rime type icing conditions at 9,330 feet or at the CCL within the shallow layer of broken altostratus type clouds. In this layer the temperature was -10° C with a water content of 0.283 cm¹², and an estimated liquid water content of approximately 0.25 g/m³.

The observed sounding height, pressure, temperature (T), dew point (Td), relative humidity (RH%), wind direction and speed, and derived clear air turbulence (CAT), low-level wind shear (LLWS), icing, and mountain wave potential are provided in figure 6 below.

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
131	1010	0.4	-4.6	69	360/3				
393	1000	-0.5	-7.5	59	20/3				
604	992	-0.9	-7.9	59					
818	984	4.2	-8.8	38					
1009	977	5.4	-9.6	33	55/3	XTR	LIGHT		
1956	943	3.8	-6.2	48	150/18				
2184	935	6.2	-3.8	49					
2473	925	5.6	-3.4	52	150/16	LGT			
3000	907				160/14	LGT			
4000	873				180/12	LGT			
4721	850	0.2	-3.9	74	195/13				
4876	845	0.0	-3.0	80		LGT			
5000	841				200/16				
5505	825	-0.7	-7.7	59					
6000	809				195/17				2.89 1258 MD-SV
7000	778				190/18				
8000	749				195/19	LGT			
9000	720				205/19				
9335	711	-10.3	-11.2	93		LGT		MDT Rime	
9729	700	-10.1	-14.0	73	215/19				2.93 1430 MD-SV
9910	695	-10.5	-15.5	67					5.62 1294 MD-SV
10092	690	-11.1	-23.1	36					
10312	684	-10.7	-45.7	4					
10572	677	-9.1	-58.1	1		LGT			
12000	640				235/23				2.01 328 LIGHT
12519	627	-9.1	-38.1	7		LGT			2.40 392 LIGHT
13000	615				245/24				
13174	611	-9.9	-19.9	44					
13382	606	-9.7	-23.7	31		LGT			2.55 902 MD-SV
14000	591				235/22				
15060	567	-11.9	-21.9	43	235/24	MDT			2.72 326 LIGHT
16000	546				250/19				
17130	522	-13.9	-17.8	72		LGT			2.63 592 LT-MD
18199	500	-16.1	-20.3	70	280/22	MDT			4.65 801 LT-MD

Figure 6 - Anchorage sounding data and derived turbulence, icing, and mountain wave potential

¹² Centimeters (cm) of liquid water.

4.1 Aircraft Derived Sounding

A search of the NOAA Earth System Research Laboratory/Global Systems Division (ESRL/GSD) website (<http://amdar.noaa.gov/>) for Aircraft Meteorological Data Reports (AMDAR) provided another upper air observation immediately after the accident. An aircraft identified as aircraft #10474 arrived from the west and descending into Anchorage and landing at 2149 AKDT (0549Z on October 29, 2016) is included as figure 7. The sounding showed a similar structure in temperature with a low-level temperature inversion near 2,000 feet with light winds below that level and shifting to the southwest and west with height. The wind at 10,000 feet was from approximately 200° at 29 knots, with a mid-level speed maximum of 35 knots at 12,875 feet. The aircraft did not have a moisture sensor to verify the icing potential and did not report any turbulence information.

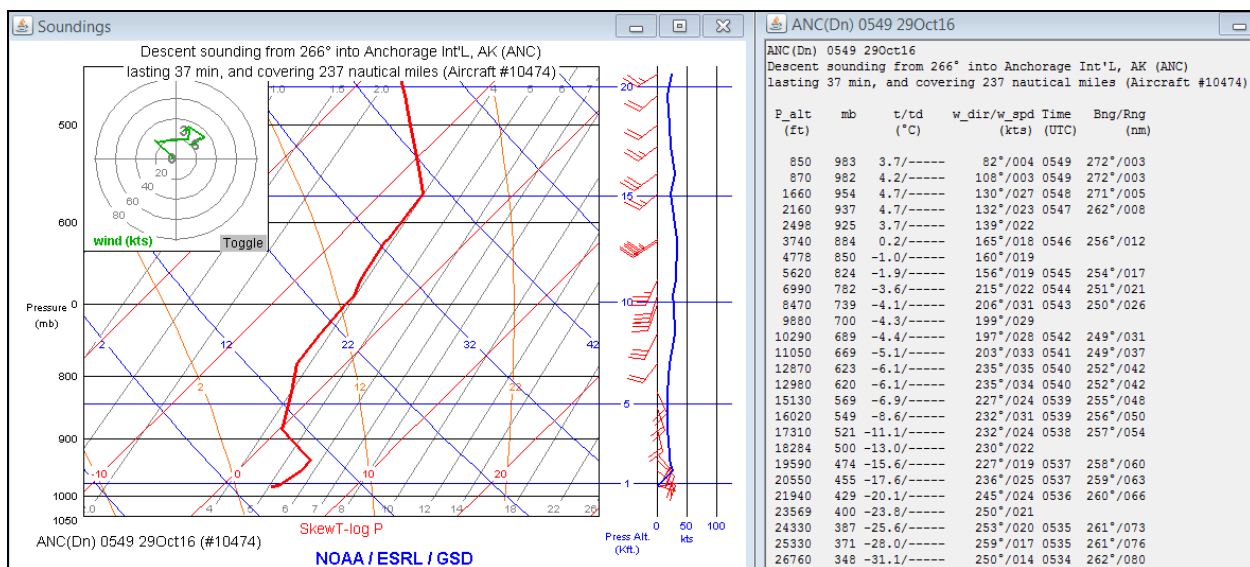


Figure 7 - Aircraft descent sounding into Anchorage at 2049 AKDT

5.0 Satellite Imagery

The Geostationary Operational Environmental Satellite number 15 (GOES-15) data was obtained from an archive at the Space Science Engineering Center (SSEC) at the University of Wisconsin-Madison in Madison, Wisconsin, and processed using the Man-computer Interactive Data Access System (McIDAS) software. Both the infrared long wave and visible band imagery were obtained surrounding the time of the accident. The infrared long wave imagery (band 4) at a wavelength of 10.7 microns (μm) provided standard satellite image with radiative cloud top temperatures with a resolution of 4 km. The visible imagery (band 1) at a wavelength of 0.65 μm provided a resolution of 1 km; however, due to the time of the accident was at a low light condition and unavailable at the time of the accident.

The GOES-15 infrared image for 1830 AKDT at 4X magnification is included as figure 8 and depicted the accident site under multiple layers of clouds, with the radiative cloud top temperature of 233° Kelvin or -40.16° C over the accident site, which corresponded to cloud tops near 30,000 feet or high cirrostratus type clouds.

Figure 9 is the GOES-15 visible image at 1800 AKDT at 2X magnification, when more visible light was available over the region. The image depicts some clouds over the mountainous terrain with more scattered clouds over the valley to the west and southwest. Several bands of clouds are also observed in the visible imagery in the vicinity of Port Alsworth and further to the south.

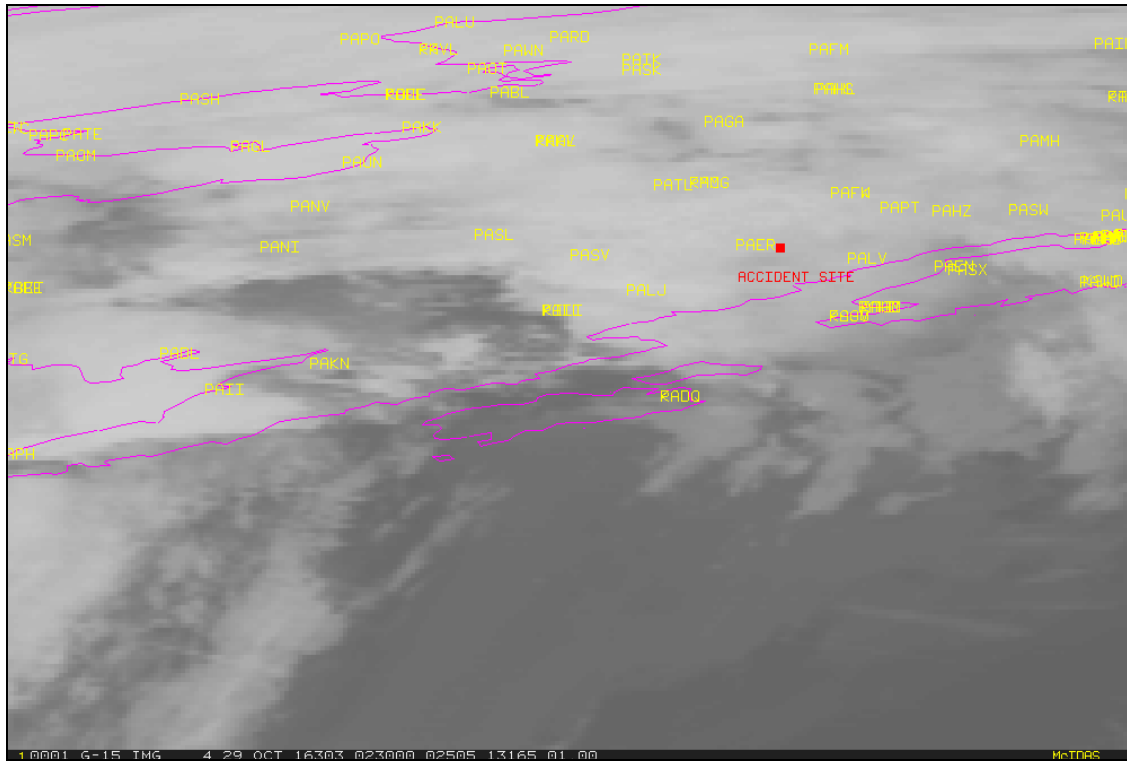
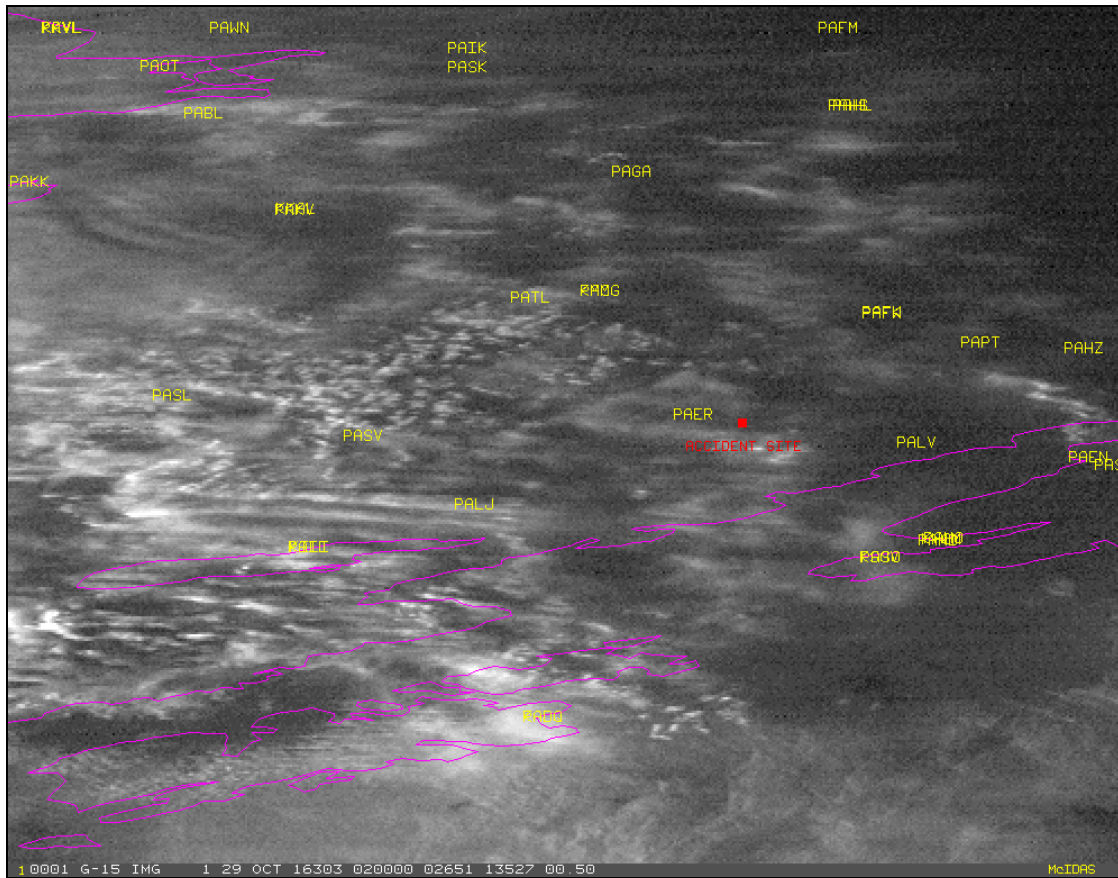


Figure 8 - GOES-15 infrared image at 1830 AKDT



6.0 Weather Radar Information

The closest Weather Surveillance Radar-1988, Doppler (WSR-88D) to the accident site was from the NWS Anchorage/Kenai (PAHG) location 65 miles east from the accident site. The level II and III archive data was obtained from the National Climatic Data Center (NCDC) utilizing the Hierarchical Data Storage System (HDSS) and displayed using the NWS NEXRAD Interactive Viewer and Data Exporter software.

The WSR-88D is a S-band 10 centimeter wavelength radar with a power output of 750,000 watts, with a 28-foot parabolic antenna concentrating the energy into a 0.95° beam width. The radar produces three basic types of products reflectivity, radial velocity, and spectral width.

6.1 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 on the WSR-88D's Principle Users Processor (PUP). Products that require data from multiple elevation scans are not available until the end of the volume scan, which can range from 4 to 10-minutes depending on the scan being utilized.

The WSR-88D operates in several different scanning modes, identified as Mode A and Mode B. Mode A is the precipitation scan and has multiple scanning strategies, which are used when significant weather echoes are present or severe weather is occurring or is anticipated. The most common is the non-severe convective mode where the radar makes 9 elevation scans from 0.50° to 19.5° every six minutes. This particular scanning strategy is documented as volume coverage pattern 21 (VCP-21) and was the mode the PAHG WSR-88D radar was operating in at the time of the accident and this precipitation mode as illustrated in figure 10.

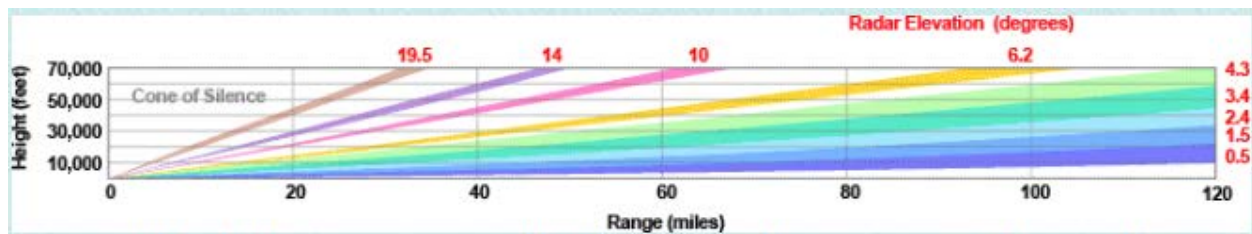


Figure 10- VCP-21 scanning mode

6.2 Beam Height Calculation

Assuming standard refraction¹³ of the 0.95° radar beam of the PAHG WSR-88D with an antenna height of 356 feet and a distance of 65 miles from the radar, the center of the radar beam would have been at approximately 6,600 feet, with the base of the beam at 3,330 feet and the top at 9,880 feet.

6.3 Reflectivity

Reflectivity is the measure of the efficiency of a target in intercepting and returning radio energy. With hydrometeors¹⁴, 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 (dBZ¹⁵), and is a general measure of echo intensity. The chart below relates the NWS video integrator and processor (VIP) intensity levels versus the WSR-88D's display levels, precipitation mode reflectivity in decibels, and rainfall rates.

¹³ Standard Refraction in the atmosphere is when the temperature and humidity distributions are approximately average, and values set at the standard atmosphere.

¹⁴ 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 glaze ice.

¹⁵ dBZ - 10 log Ze

NWS VIP/DBZ CONVERSION TABLE

NWS VIP	WSR-88D LEVEL	PREC MODE DBZ	RAINFALL
0	0	< 5	
	1	5 to 9	
	2	10 to 14	
1 Very Light	3	15 to 19	.01 in/hr
	4	20 to 24	.02 in/hr
	5	25 to 29	.04 in/hr
2 Light to Moderate	6	30 to 34	.09 in/hr
	7	35 to 39	.21 in/hr
3 Strong	8	40 to 44	.48 in/hr
4 Very Strong	9	45 to 49	1.10 in/hr
5 Intense	10	50 to 54	2.49 in/hr
6 Extreme	11	55 to 59	>5.67 in/hr
	12	60 to 64	
	13	65 to 69	
	14	70 to 74	
	15	> 75	

Air traffic control (ATC) weather display systems also use radar weather processors with the ability to determine precipitation intensity, with controllers instructed to describe the intensity to pilots based on the following scale:

- (a) "Light" (< 30 dBZ, NWS VIP level 1 – not displayed)
- (b) "Moderate" (30 to 40 dBZ, NWS VIP level 2)
- (c) "Heavy" (> 40 to 50 dBZ, NWS VIP level 3 and 4)
- (d) "Extreme" (> 50 dBZ, NWS VIP level 5 and 6)

6.4 Base and Composite Radar Reflectivity Images

Figure 11 is the NWS PAHG WSR-88D 0.5° base reflectivity image at 1829 AKDT which depicted a large area of very light echoes over Cook Inlet and over the Alaska Range Mountains, with several spikes of bands of light intensity echoes near the accident site indicated by the red star. The spikes are indicative of beam blockage from high terrain over the area, thus low-level conditions over the accident site cannot be determined.

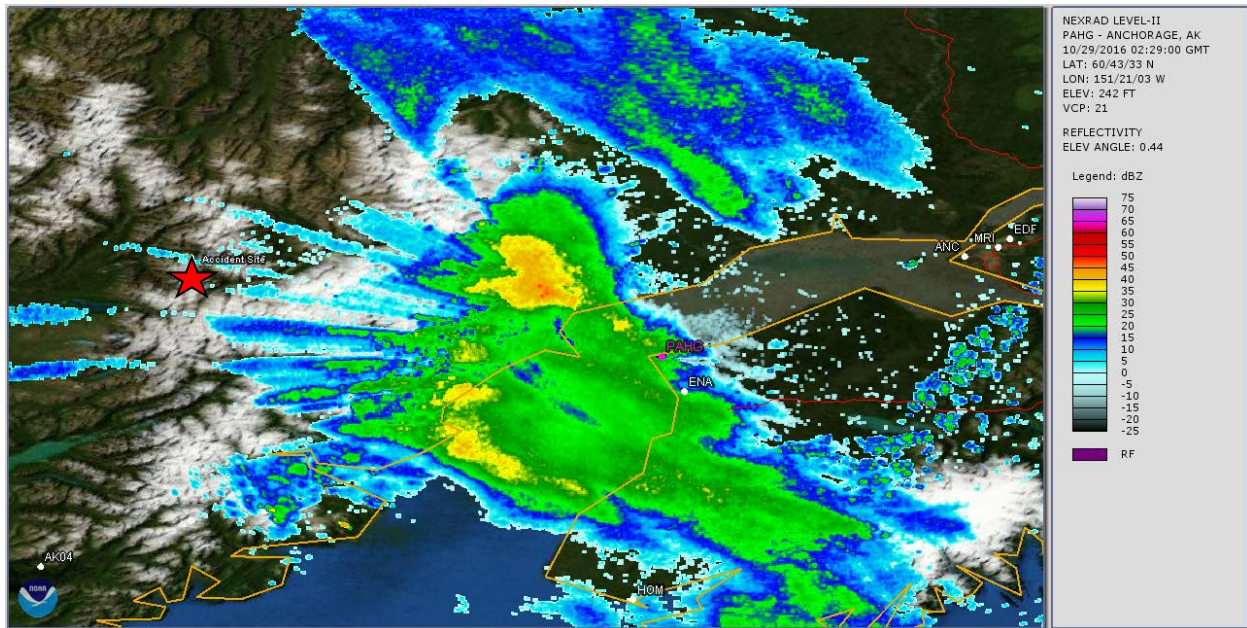


Figure 11 - NWS PAHG WSR-88D 0.5° Base reflectivity image at 1829 AKDT

Figure 12 is the NWS PAHG WSR-88D composite reflectivity image completed at approximately 1829 AKDT (1828:58) created from the maximum echoes detected in all of the 9 echo scans. The image shows echoes of 20 dBZ overhead of the accident site at the time of the accident. The echoes were consistent of those associated with snow showers based on the temperature profiles, and correlation coefficient dual polarization product. Several higher reflectivity areas are identified in the precipitation band near Kenai Municipal Airport (PAEN) and over Cook Inlet, likely associated with some mixed freezing precipitation.

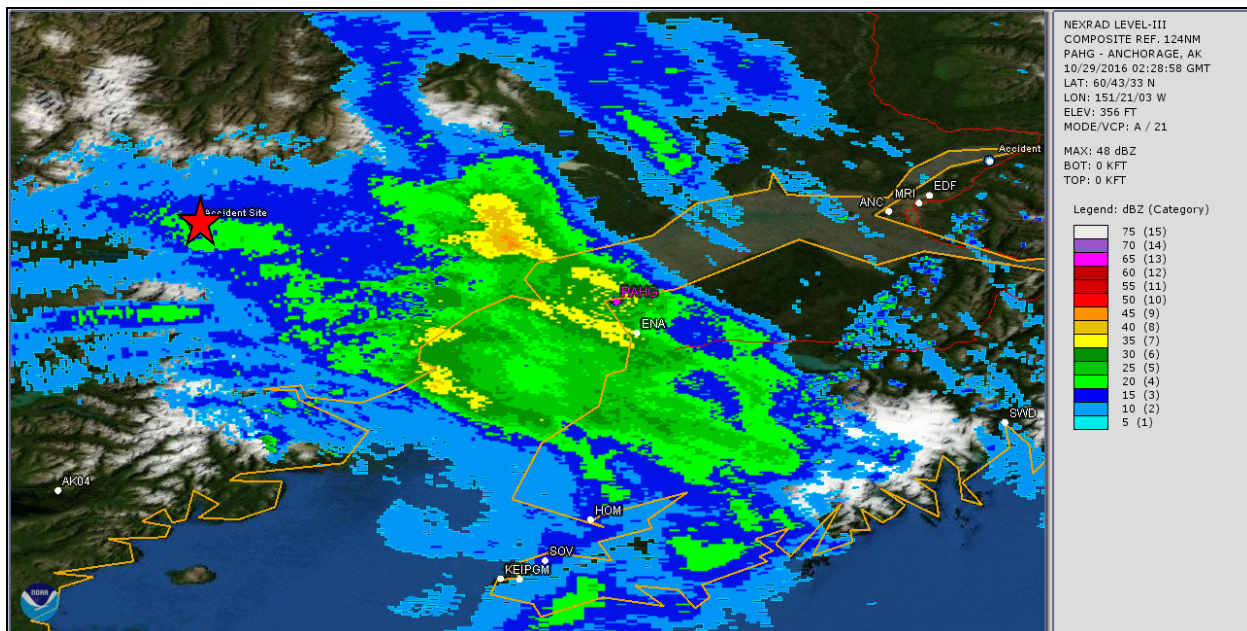


Figure 12 - NWS PAHG WSR-88D composite reflectivity image at approximately 1829 AKDT

The WSR-88D radar products depiction of the large area of echoes and the satellite imagery confirm that a layer of altostratus to nimbostratus type clouds were over the route and over the accident site during the period, with likely snow showers which would have lower ceilings and visibilities over the route of flight.

7.0 Pilot Reports

The following pilot reports or PIREPs were reported over the region surrounding the period from 0900 through 2300 AKDT on October 28, 2016. The reports are included below in plain language, taken from standard code and abbreviations, and converted to local time. The International Air Transportation Association (IATA) three letter airport identifiers are used in PIREPs versus standard NWS ICAO codes. The reports were as follows:

Anchorage (ANC) routine pilot report; Over – southwest or on 235° and 10 miles from TED VORTAC¹⁶, Anchorage; Time – 0905 AKDT; Flight level – during climb; Type aircraft – Cessna 441 multiengine turboprop aircraft; Temperature – minus 5° C; Icing – light rime type icing between 6,500 and 8,500 feet.

Kenai Airport (ENA) routine pilot report; Over – between Merrill Field (MRI) to 21 miles south or 183° of TED VORTAC; Time – 1158 AKDT; Flight level – 2,500 feet, Type aircraft – Cessna 172 Skyhawk single engine airplane; Remarks – occasional light turbulence north side of Turnagain Arm to Barabara Lake.

Anchorage (ANC) routine pilot report; Over –northwest or 310° and 25 miles of TED VORTAC; Time – 1320 AKDT; Flight level – 5,000 feet; Type aircraft – Cessna 208 Caravan single engine turboprop aircraft; Temperature – minus 12° C; Icing – between 9,000 and 8,000 feet light mixed icing and between 7,000 and 5,500 feet light rime type icing; Remarks – during descent into ANC.

Talkeetna Airport (TKA) routine pilot report; Over – south or 180° and 10 miles of TKA VORTAC; Time – 1839 AKDT; Flight level – 3,500 feet; Type aircraft - Cessna 172 Skyhawk single engine airplane; Turbulence – light to moderate chop.

Kenai Airport (ENA) routine pilot report; Over – southwest or 225° and 85 miles of TED VORTAC; Time – 2015 AKDT; Flight level – 21,000 feet; Type aircraft – Saab 340 multiengine turboprop commuter; Temperature – minus 16° C; Icing – moderate rime type icing between 22,000 and 21,000 feet; Remarks – from ANC Center.

Kenai Airport (ENA) routine pilot report; Over – west-southwest or 248° and 71 miles from ENA VORTAC; Time – 2140 AKDT; Flight level – 25,000 feet; Type aircraft – Beechcraft King Air multiengine turboprop aircraft; Sky cover – tops 25,000 feet; Temperature – minus 20° C; Icing – light rime type icing; Remarks – from ANC Center.

¹⁶ VORTAC – is a navigational aid consisting of a co-located VHF omnidirectional range (VOR) beacon and a tactical air navigation system (TACAN) beacon for distance measuring or DME.

The reports were located from southwest, west, and northwest of Anchorage with two reports of light to moderate turbulence or chop between 2,500 and 3,500 feet, and four reports of icing conditions over the region. Two of the icing reports were from aircraft operating at higher altitudes between 21,000 and 25,000 feet and reporting light to moderate rime type icing and the other two reports at low altitude reporting light rime to mixed icing between 5,500 and 9,000 feet.

The reports in their original code were as follows:

ANC UA /OV TED235015/TM 1705/FLDURC/TP C441/TA M5/IC LGT RIME 065-085=

*ENA UA /OV MRI-TED183021 /TM 1958 /FL025 /TP C172 /RM OCNL LGT TURBC N SIDE TURNAGAIN
ARM TO BARABARA LAKE=*

*ANC UA /OV TED 310025/TM 2120/FL050/TP C208/TA M12/IC 090-080 LGT MIX 070-055 LGT RIME/RM
DURD=*

TKA UA /OV TKA180010 /TM 0239 /FL035 /TP C172 /TB LGT-MOD CHOP=

ENA UA /OV TED225085/TM 0415/FL210/TP SF34/TA M16/IC MOD RIME 220-210/RM ZAN=

ENA UA /OV ENA248071/TM 0540/FL250/TP B190/SK TOP250/TA M20/IC LGT RIME/RM ZAN=

8.0 Graphic Area Forecast Charts

The NWS AAWU issues the Flying Weather Graphic Forecast in two, six hour charts for a total of twelve hours into the future and issued shortly after the regular Area Forecasts (FA). These charts are graphic representations of the clouds and visibility included in the FA, but with greater spatial detail. The charts include areas of expected IFR¹⁷ and MVFR conditions¹⁸, areas of surface winds at least 30 knots, and for any known volcanic activity that have recently sent ash into the atmosphere. The IFR and MVFR areas depict the worst occasional or continuous conditions expected during the valid period of the graphic and are expected to occur at least half of the time.

The following Flying Weather Charts were issued during the period:

¹⁷ Instrument Flight Rule (IFR) conditions – as depicted on this chart are defined as a ceiling or lowest layer of broken or overcast clouds below 1,000 feet agl and/or visibility less than 3 statute miles.

¹⁸ Marginal Visual Flight Rule (MVFR) conditions – are defined as a ceiling between 1,000 and 3,000 feet agl inclusive and/or visibility 3 to 5 miles inclusive.

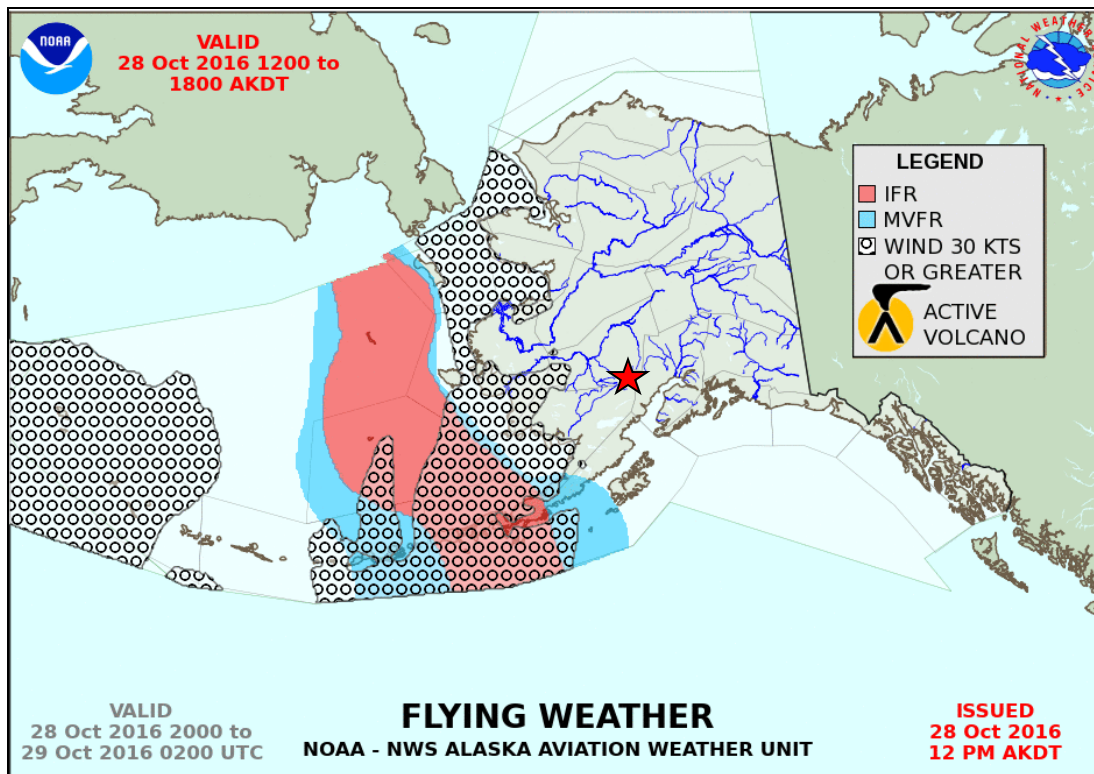


Figure 13 - Flying Weather Forecast valid for 1200 to 1800 AKDT

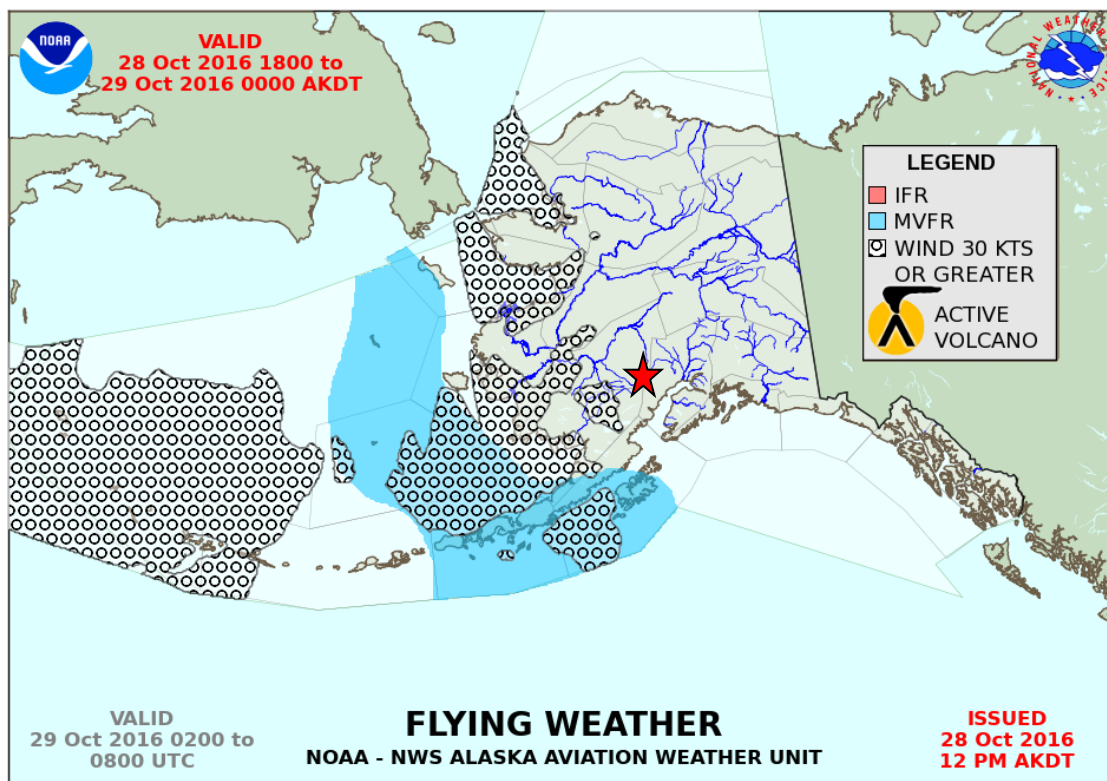


Figure 14 - Flying Weather Forecast valid for 1800 to 2400 AKDT

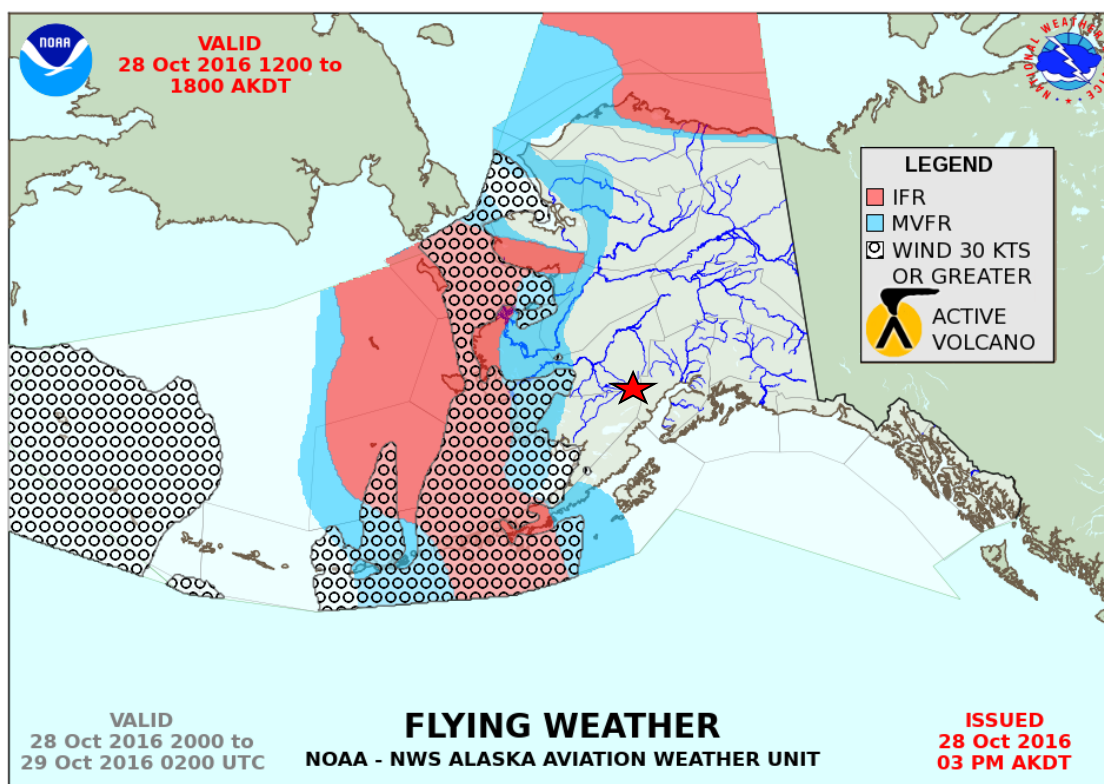


Figure 15 - Updated Flying Weather Forecast valid for 1200 to 1800 AKDT

An additional four charts are issued for low-level and high-level turbulence, icing, and convection for a three hour period, out to 12 hours in the future. The Convective Outlook charts are issued from May through September only, and were not being issued during the period. The high-level turbulence charts are for operations above 18,000 feet and are not documented for this case. The charts are color coded with isolated moderate turbulence/icing in yellow, and occasional or continuous moderate in orange, and red for moderate or isolated severe. Forecasts for severe turbulence or icing would also be covered in a separate significant meteorological information (SIGMET) advisory with a valid period of 4 hours.

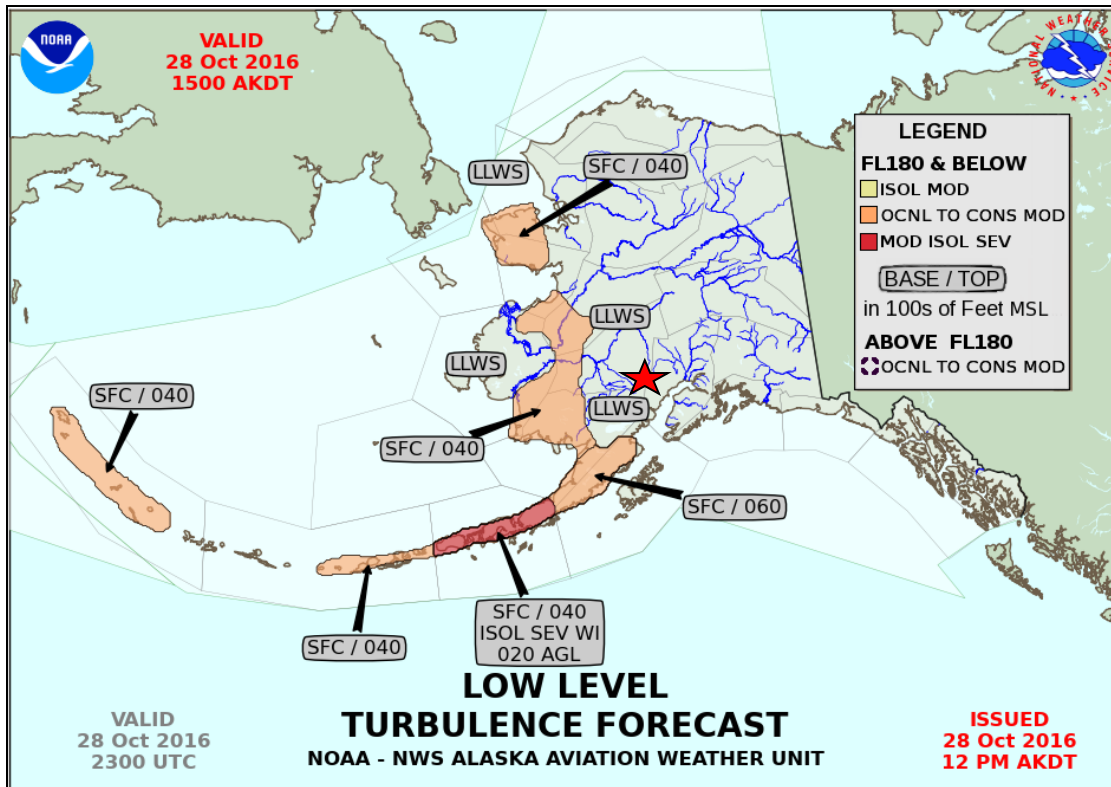


Figure 16 - Low-Level Turbulence Forecast for 1500 AKDT

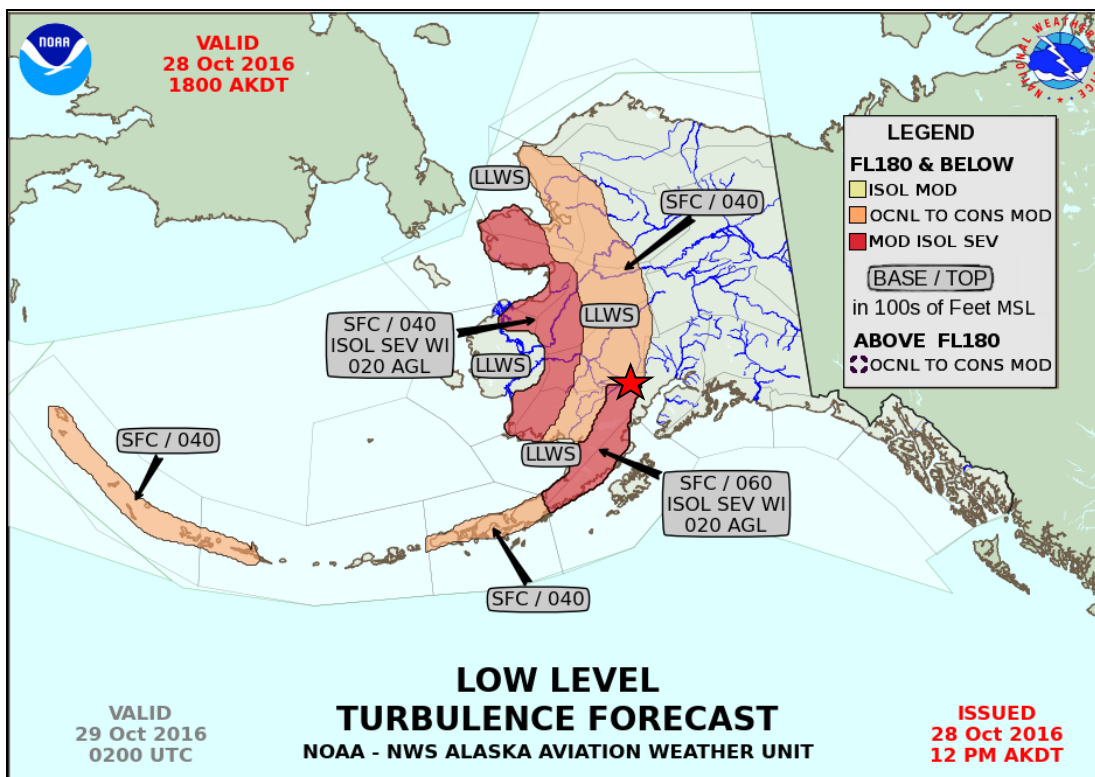
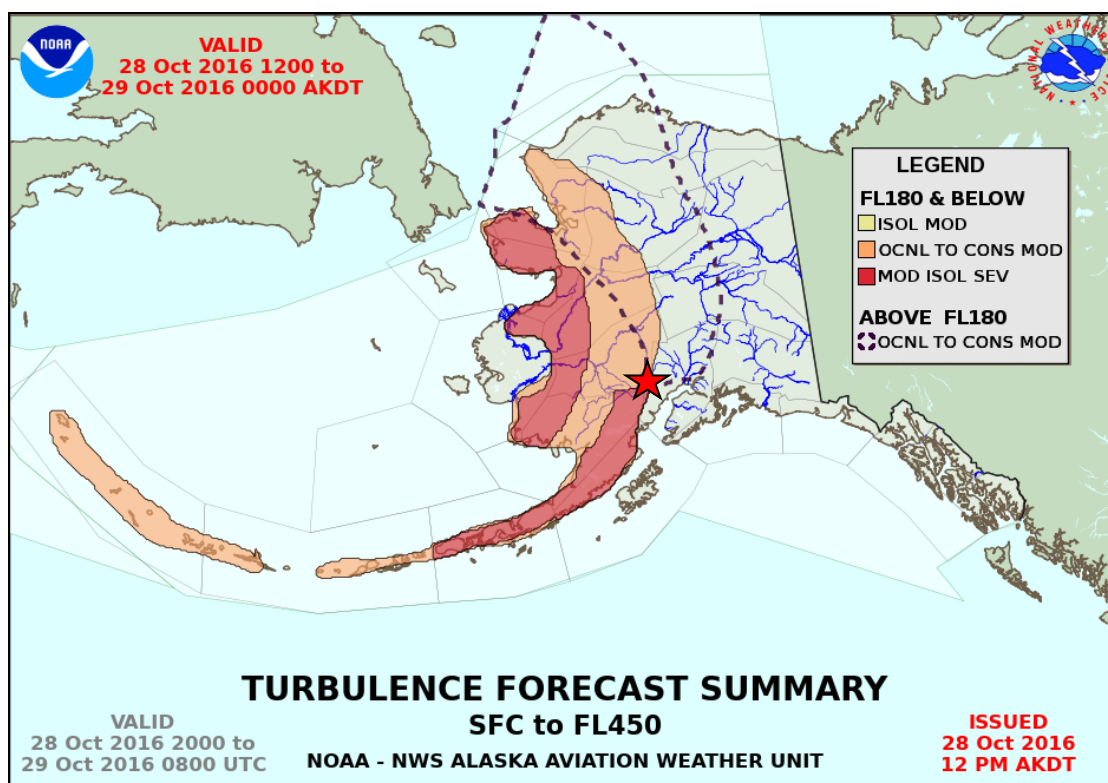
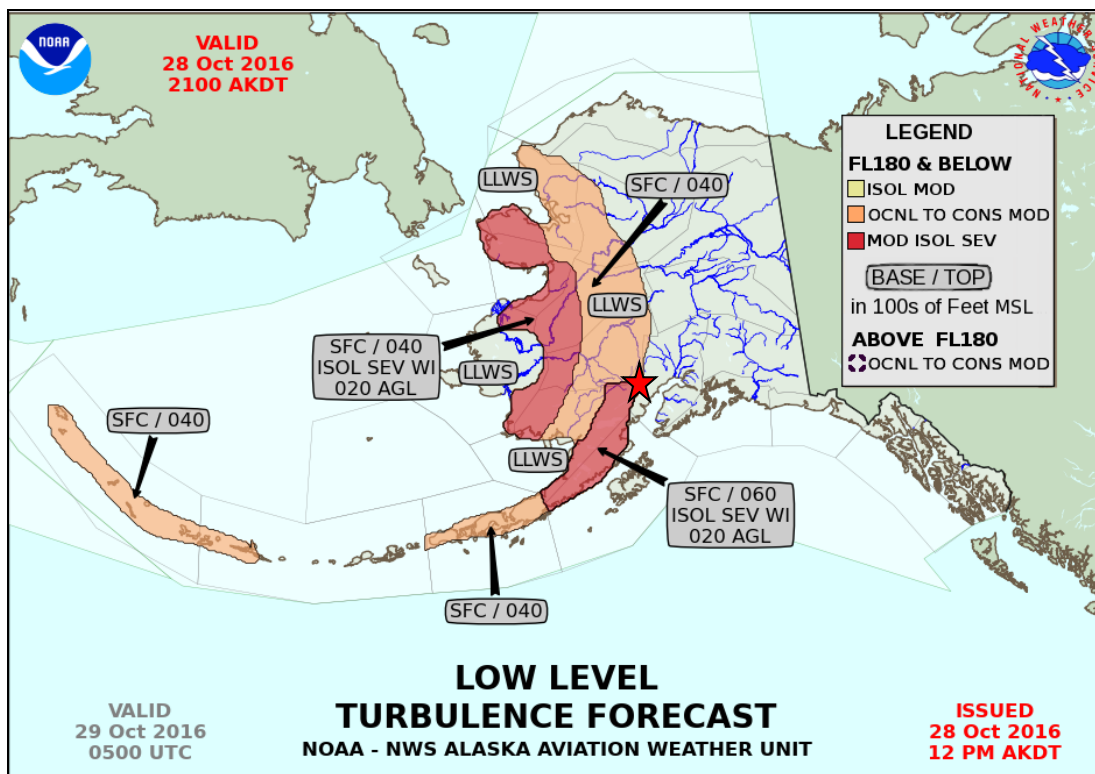


Figure 17 - Low-Level Turbulence Forecast for 1800 AKDT



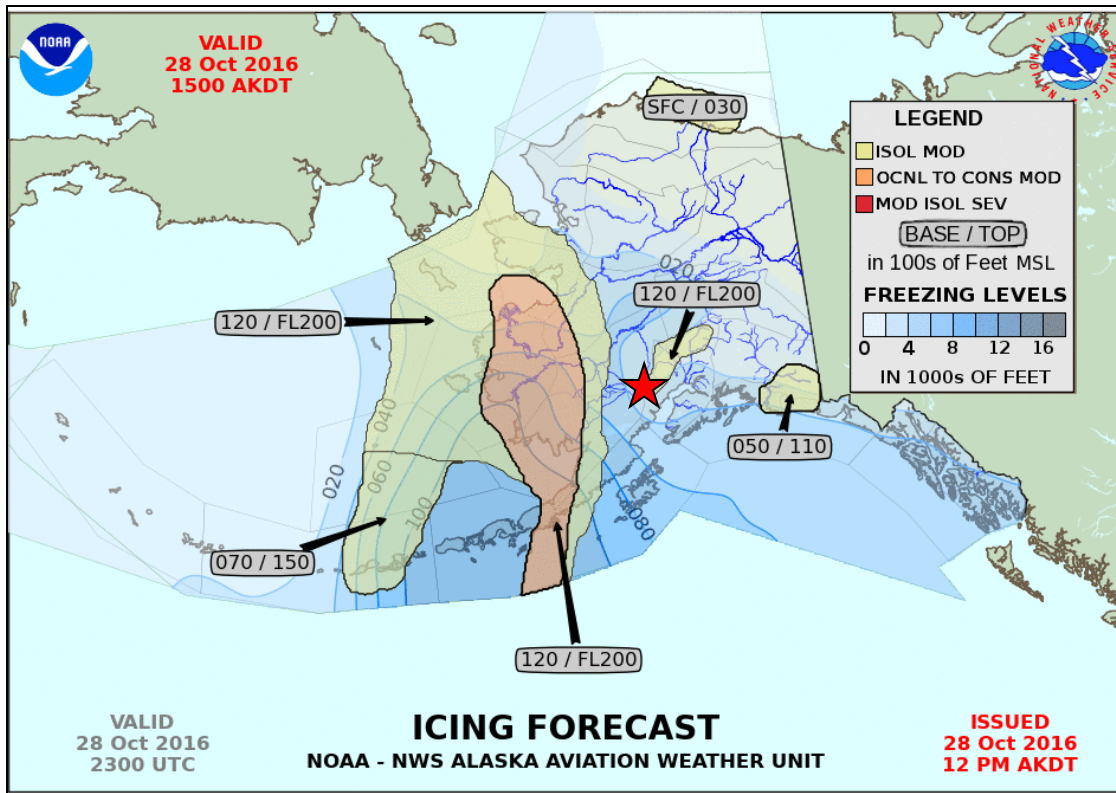


Figure 20 - Icing Forecast for 1500 AKDT

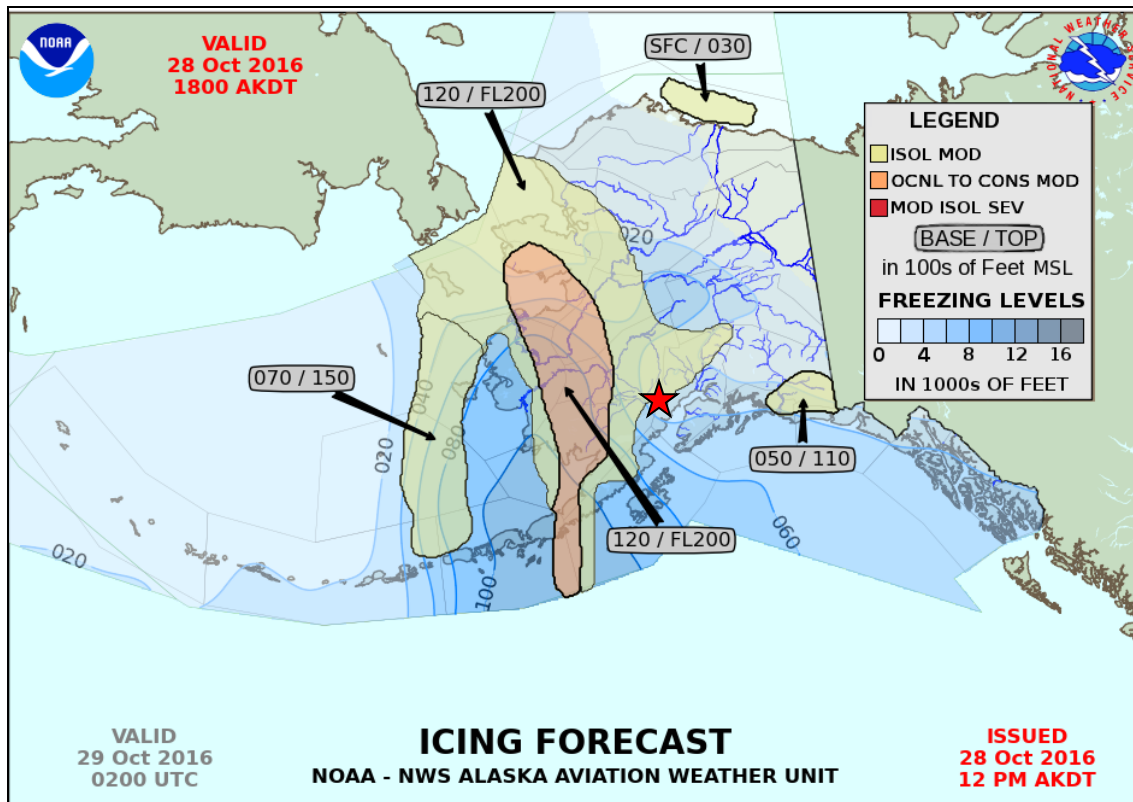


Figure 21 - Icing Forecast for 1800 AKDT

9.0 Alaska Area Forecasts

Area Forecasts are 12-hour aviation forecasts plus an 18-hour categorical outlook giving general descriptions of cloud cover, weather conditions, and potentially hazardous weather which could impact aircraft operations. Alaskan Area Forecasts, each covering a broad geographical area are issued four times a day at 0000, 0600, 1200, and 1800 local. The proposed route of flight crossed 3 different forecast regions; Cook Inlet and the Susitna Valley, Kuskokwim Valley, and the destination bordering the Bristol Bay region. Figure 22 is a map of the various Alaska regions from the FAA Flight Service Station reference material with a yellow circle placed over the general accident site, which bordered 3 regions.

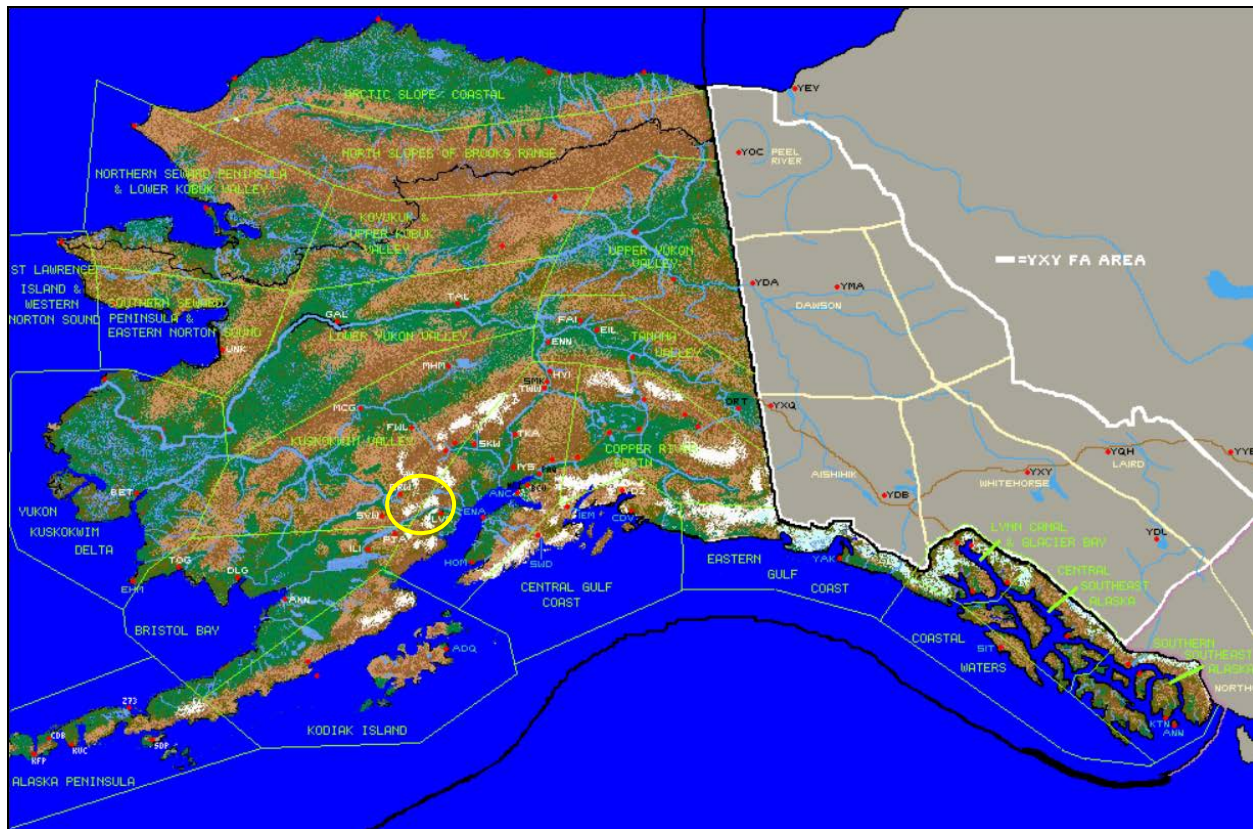


Figure 22 - FSS Area Forecast Regions for Alaska

The Area Forecasts (FA) text forecasts issued by the NWS AAWU for the regions for the route of flight and surrounding areas were as follows:

FAAK48 PAWU 282010

FA8H

ANCH FA 282015

AK SRN HLF EXCP SE AK...

.

AIRMETS VALID UNTIL 290415

CB IMPLY POSSIBLE SEV OR GREATER TURB SEV ICE LLWS AND IFR CONDS.

NON MSL HEIGHTS NOTED BY AGL OR CIG.

.
SYNOPSIS VALID UNTIL 291400
SFC OCFNT FM PAGM...PAMY...PACD WL MOV E TO PASH...PAMC...120 SW
PADQ AT END OF PD. SFC RDG OVR ERN INTERIOR AK/WRN CANADA/SE AK
QSTNRY THRU THE PD.

.
COOK INLET AND SUSITNA VLY AB...VALID UNTIL 290800
...CLOUDS/WX...
BKN-OVC080 INCRG LYRS ABV TO FL250.
OTLK VALID 290800-291400...VFR.
PASSES...LK CLARK...MERRILL...RAINY...WINDY...PORTAGE...VFR.

...TURB...
AIRMET TURBTIL 02Z N PANC OCNL MOD TURB FL300-FL380. WKN...

...ICE AND FZLVL...
AFT 23Z N PANC ISOL MOD ICEIC 120-FL200. FZLVL 045.

.
KODIAK IS AE...VALID UNTIL 290800
...CLOUDS/WX...
SCT045 SCT-BKN080 LYRD ABV TO FL250.
AFT 00Z OFFSHORE SW KODIAK I OVC025 LYRD ABV TO FL250.
OCNL VIS 3-5SM -RA BR.
SFC WND SE 20G30 KTS INCRG TO SE 30G40 KTS AFT 04Z.
OTLK VALID 290800-291400...MVFR CIG RA.

...TURB...
AIRMET TURBAFT 02Z ALUTN RANGE MOD TURB BLW 060.
ISOL SEV TURB WI 020 AGL. INTSF...
AIRMET TURBTIL 02Z ALUTN RANGE OCNL MOD TURB BLW 060. WKN...

...ICE AND FZLVL...
23Z TO 05Z SW PAKH ISOL MOD ICEIC 120-FL200.
AFT 05Z SW PAKH OCNL MOD ICEIC 120-FL200.
FZLVL 060 N TO 100 W.

.
FAAK58 PAWU 282010
FA8W
ANCC FA 282015
AK SRN HLF EXCP SE AK...

.
AIRMETS VALID UNTIL 290415
CB IMPLY POSSIBLE SEV OR GREATER TURB SEV ICE LLWS AND IFR CONDS.
NON MSL HEIGHTS NOTED BY AGL OR CIG.

.
KUSKOKWIM VLY AF...VALID UNTIL 290800
...CLOUDS/WX...
AIRMET MT OBSCAFT 03Z W PASL MTS OBSC CLDS/PCPN. DTRT...
AIRMET STG SFC WNDAFT 00Z W PASL SUSTAINED SFC WND 30KT OR GTR. INTSF...
FEW025 SCT045 BKN-OVC100 TOP 120 INCRG MEGG LYRS ABV TO FL260.
ISOL BKN045 -SHRA. TIL 03Z RISK ISOL -FZRA.
AFT 03Z W PASL SPRDG TO W PAMC-PASV LN BY 08Z SCT015 BKN-OVC025
TOP 120 MEGG LYRS ABV TO FL260. ISOL BKN015 VIS 5SM -RA BR.
W PASL VCY HYR/CHNLD TRRN SFC WND SE 20G30KT INCRG BY 03Z TO SE 30G40KT.
VCY GAPS AK RANGE SFC WND E-SE G25KT INCRG BY 06Z TO 30G40KT.
OTLK VALID 290800-291400...MVFR CIG RA BR.

...TURB...
AIRMET TURBTIL 02Z E PAMC OCNL MOD TURB FL300-FL380. WKN...
AIRMET TURBAFT 02Z W PASL MOD TURB BLW 040. ISOL SEV TURB WI 020 AGL. INTSF...
AIRMET LLWSAREAS OF LLWS. INTSF...

...ICE AND FZLVL...
AIRMET ICEAFT 23Z PASL W OCNL MOD ICEIC 120-FL200.
FZLVL 060. INTSF...
OTRW W PASL SPRDG TO ALL SXNS BY 03Z ISOL MOD ICEIC 120-FL200.

.

BRISTOL BAY AH...VALID UNTIL 290800

...CLOUDS/WX...
AIRMET STG SFC WNDOFSHR AREAS AND VCY CHNLD TRRN SUSTAINED SFC WND
30KT OR GTR. WKN...
AIRMET MT OBSCW PADL SPRDG TO PAJZ-PAPN LN W BY 04Z MTS OBSC
IN CLDS/PCPN. DTRT...
W PADL SCT015 BKN025 OVC045 MEGG LYRS ABV TO FL250 -RA.
OCNL BKN015/VIS 3-5SM -RA BR. ISOL CIG BLW 010.
ELSW/OTRW FEW025 SCT045 BKN-OVC080 TOP 150 INCRG LYRS ABV TO FL240.
ISOL BKN045 -SHRA.
OFSHR AND VCY GAPS ALEUTIAN RANGE SFC WND SE 35G45KT. GAPS ALEUTIAN
RANGE ISOL G55KT. AFT 06Z OFSHR W PAEH SFC WND SHIFTING TO W 30G40KT.
ELSW SFC WND SE 20G30KT ISOL G40KT VCY CHNLD TRRN.
OTLK VALID 290800-291400...MVFR SHRA. GAPS ALEUTIAN CHAIN WND.

...TURB...
AIRMET TURBAFT 02Z KILBUCK MTS MOD TURB BLW 040.
ISOL SEV TURB WI 020 AGL. WKN...
AIRMET TURBAFT 02Z ALG ALUTN RANGE MOD TURB BLW 060.
ISOL SEV TURB WI 020 AGL. WKN...
AIRMET LLWSAREAS OF LLWS. WKN...

...ICE AND FZLVL...
AIRMET ICENW PADL-PAJZ LN OCNL MOD ICEIC 120-FL200.
FZLVL 070 N AND NE TO 100 S AND SE. NC...
TIL 05Z ISOL MOD ICEIC 120-FL200.

The forecast for the Cook Inlet and Sustna Valley expected ceiling of broken to overcast clouds at 8,000 feet layered with tops above 25,000 feet with rainy and windy conditions in the passes for Lake Clark and Merrill. No significant turbulence below 18,000 feet was expected and the freezing level was identified at 4,500 feet, with the potential for isolated moderate icing in clouds between 12,000 and 25,000 feet.

The forecast for the Kuskokwim Valley to the west of the accident site warned of AIRMET for mountain obscuration in clouds and precipitation. The forecast expected a few clouds at 2,500 feet, scattered clouds at 4,500 feet, with a ceiling broken to overcast at 10,000 feet with tops to 12,000 feet, with increasing merging layers above to 26,000 feet. The forecast included a risk of isolated broken clouds at 4,500 feet with light rain showers and isolated light freezing rain. The forecast also included a warning for an AIRMET for strong surface winds in excess of 30 knots in the vicinity of higher terrain and gaps in the Alaska Range, and for locations west of Sleetmute (PASL), AK.

10.0 In-Flight Weather Advisories

A review of the NWS data base for any additional Airman Meteorological Advisories (AIRMETs) or Significant Meteorological Advisories (SIGMETs) issued by the AAWU. The following advisories were issued:

WAAK48 PAWU 282010
WA80
ANCS WA 282015
AIRMET SIERRA FOR IFR AND MT OBSC VALID UNTIL 290415
.
KUSKOKWIM VLY AF
AFT 03Z W PASL MTS OBSC CLDS/PCPN. DTRT.
.
YKN-KUSKOKWIM DELTA AG
ALG CST/OFSHR OCNL CIGS BLW 010/ISOL VIS BLW 3SM -RA BR. NC.
.
YKN-KUSKOKWIM DELTA AG
NE PABE MTS OBSC IN CLDS/PCPN. NC.
.
BRISTOL BAY AH
W PADL SPRDG TO PAJZ-PAPN LN W BY 04Z MTS OBSC IN CLDS/PCPN. DTRT.
.
AK PEN AI
OCNL CIG BLW 010/VIS BLW 3SM -RA BR. WKN.
.
AK PEN AI
MTS OCNL OBSC BY CLDS. NC.
.
UNIMAK PASS TO ADAK AJ
TIL 02Z PAKO E MTS OCNL OBSC BY CLDS. WKN.
.
PRIBILOF ISLANDS AND SOUTHEAST BERING SEA AL
TIL 02Z OCNL CIGS BLW 010/VIS BLW 3SM -RA BR. WKN.
.
=ANCT WA 282015
AIRMET TANGO FOR TURB/STG SFC WINDS VALID UNTIL 290415
.
COOK INLET AND SUSITNA VLY AB
TIL 02Z N PANC OCNL MOD TURB FL300-FL380. WKN.
.
KODIAK IS AE
AFT 02Z ALUTN RANGE MOD TURB BLW 060. ISOL SEV TURB WI 020 AGL. INTSF.
.
KODIAK IS AE
TIL 02Z ALUTN RANGE OCNL MOD TURB BLW 060. WKN.
.
KUSKOKWIM VLY AF
AFT 00Z W PASL SUSTAINED SFC WND 30KT OR GTR. INTSF.
.
KUSKOKWIM VLY AF

TIL 02Z E PAMC OCNL MOD TURB FL300-FL380. WKN.

.
KUSKOKWIM VLY AF
AFT 02Z W PASL MOD TURB BLW 040. ISOL SEV TURB WI 020 AGL. INTSF.

.
KUSKOKWIM VLY AF
AREAS OF LLWS. INTSF.

.
YKN-KUSKOKWIM DELTA AG
SUSTAINED SFC WND 30KT OR GTR. WKN FROM W.

.
YKN-KUSKOKWIM DELTA AG
TIL 02Z VCY MTS OCNL MOD TURB BLW 040. INTSF.

.
YKN-KUSKOKWIM DELTA AG
AFT 02Z VCY MTS MOD TURB BLW 040. ISOL SEV TURB WI 020 AGL. WKN.

.
YKN-KUSKOKWIM DELTA AG
AREAS OF LLWS. WKN FROM W.

.
BRISTOL BAY AH
OFSHR AREAS AND VCY CHNLD TRRN SUSTAINED SFC WND
30KT OR GTR. WKN.

.
BRISTOL BAY AH
AFT 02Z KILBUCK MTS MOD TURB BLW 040. ISOL SEV TURB WI 020 AGL. WKN.

.
BRISTOL BAY AH
AFT 02Z ALG ALUTN RANGE MOD TURB BLW 060. ISOL SEV TURB WI 020 AGL. WKN.

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BRISTOL BAY AH
AREAS OF LLWS. WKN.

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AK PEN AI
SUSTAINED SFC WND 30 KTS OR GTR. NC.

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AK PEN AI
TIL 02Z MOD TURB BLW 040. ISOL SEV TURB WI 020 AGL. WKN.

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AK PEN AI
AFT 02Z OCNL MOD TURB BLW 040. NC.

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UNIMAK PASS TO ADAK AJ
PAKO E SUSTAINED SFC WND 30 KTS. WKN.

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UNIMAK PASS TO ADAK AJ
TIL 02Z OCNL MOD TURB BLW 040. WKN.

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ADAK TO ATTU AK
SUSTAINED SFC WND 30 KTS OR GTR. NC.

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ADAK TO ATTU AK
PASY OCNL MOD TURB BLW 040. NC.

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PRIBILOF ISLANDS AND SOUTHEAST BERING SEA AL
E PRIBLOFS SUSTAINED SFC WND 30 KTS. WKN.

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AIRMET ZULU FOR ICING VALID UNTIL 290415

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KUSKOKWIM VLY AF
AFT 23Z PASL W OCNL MOD ICEIC 120-FL200.
FZLVL 060. INTSF.

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YKN-KUSKOKWIM DELTA AG
TIL 05Z INLAND OCNL MOD ICEIC 120-FL200.
FZLVL 060 EXC 090 SE. WKN.

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BRISTOL BAY AH
NW PADL-PAJZ LN OCNL MOD ICEIC 120-FL200.
FZLVL 070 N AND NE TO 100 S AND SE. NC.

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AK PEN AI
TIL 05Z E PASD OCNL MOD ICEIC 120-FL200.
FZLVL 100. WKN.

The review indicated no SIGMETs were issued during the period. The Anchorage (KZAN) Center Weather Service Unit (CWSU) was also reviewed for any Center Weather Advisories (CWA's) or Meteorological Impact Statements (MIS) issued surrounding the period the accident airplane was operating and no advisories were issued during the period.

11.0 Weather Camera Images

The FAA operated and maintained several weather cameras across the region which were also reviewed and documented in this case. Figure 23 is a map of the weather cameras over the region of interest and the accident site plotted by a red star. A review of the flight track indicated that the accident airplane flew past both Lake Clark Pass cameras and turned north towards Merrill Pass High when the aircraft went down. The accident site was located 6 ½ miles south-southwest or an azimuth of 213° from the Merrill Pass High camera location.

Attachment 1 through 6 are time lapse weather camera views from the related sites with images at approximately every 10 minutes from approximately 1538 through 1910 AKDT surrounding the period of the accident on October 28, 2016.

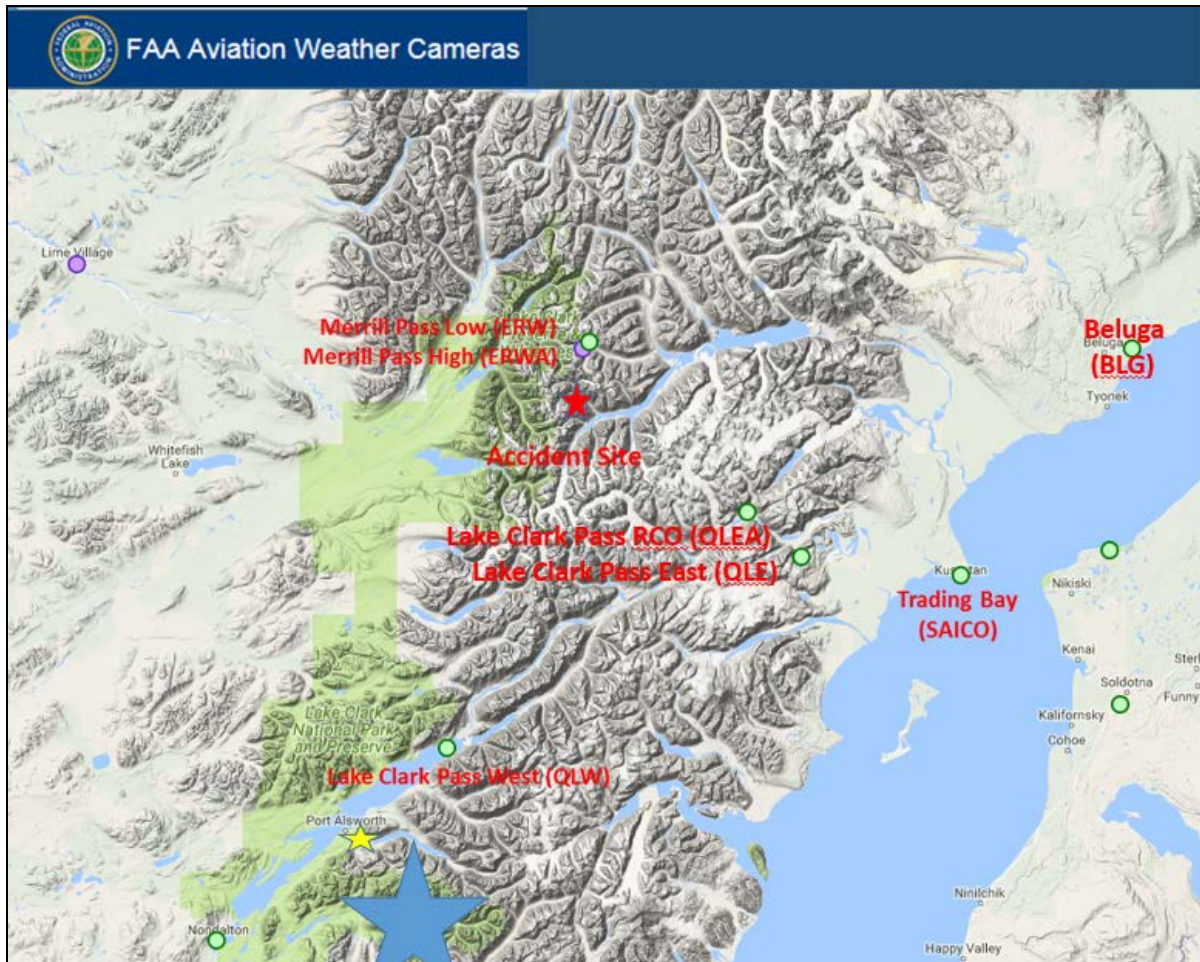


Figure 23 - FAA Weather Camera's over the region

11.1 Merrill Pass High

Merrill Pass High (ERWA) weather camera was located at $61^{\circ} 11' 10.68''$ north latitude and $153^{\circ} 19' 33.96''$ west longitude at an elevation of 4,524 feet. Figure 24 is a picture of the Merrill Pass High camera view looking east or centered on a 103° azimuth on a clear day with visibility references marked on a clear day.

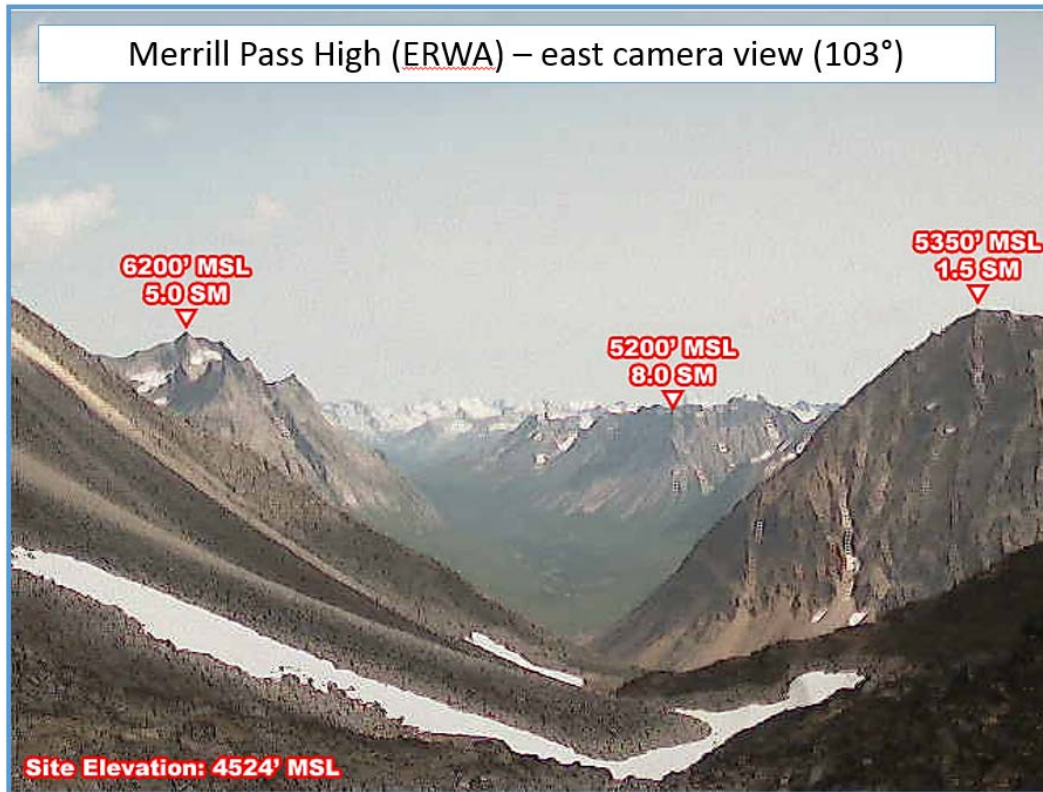


Figure 24 - Merrill Pass High Weather camera looking east with visibility markers

Figure 25 is the Merrill Pass High East view at 1542 AKDT on October 28, 2016 prior to the accident airplanes departure, and shows high overcast sky cover with visibility of at least 10 miles. The ground surrounding the camera and the neighboring mountain peaks already have some snow on the ground at this time. Figure 26 is an image at 1553 AKDT or approximately 10 minutes later and shows a significant decrease in ceiling height and visibility to less than 1 mile. Figure 27 is an image at 1634 AKDT continuing to observe decreasing sky conditions and visibility to less than 1/2 mile, which continues through the period of the accident. Figure 28 is the Merrill Pass High East camera image at the approximate time of the accident at 1834 AKDT with visibility near zero or a complete obscuration at the site.

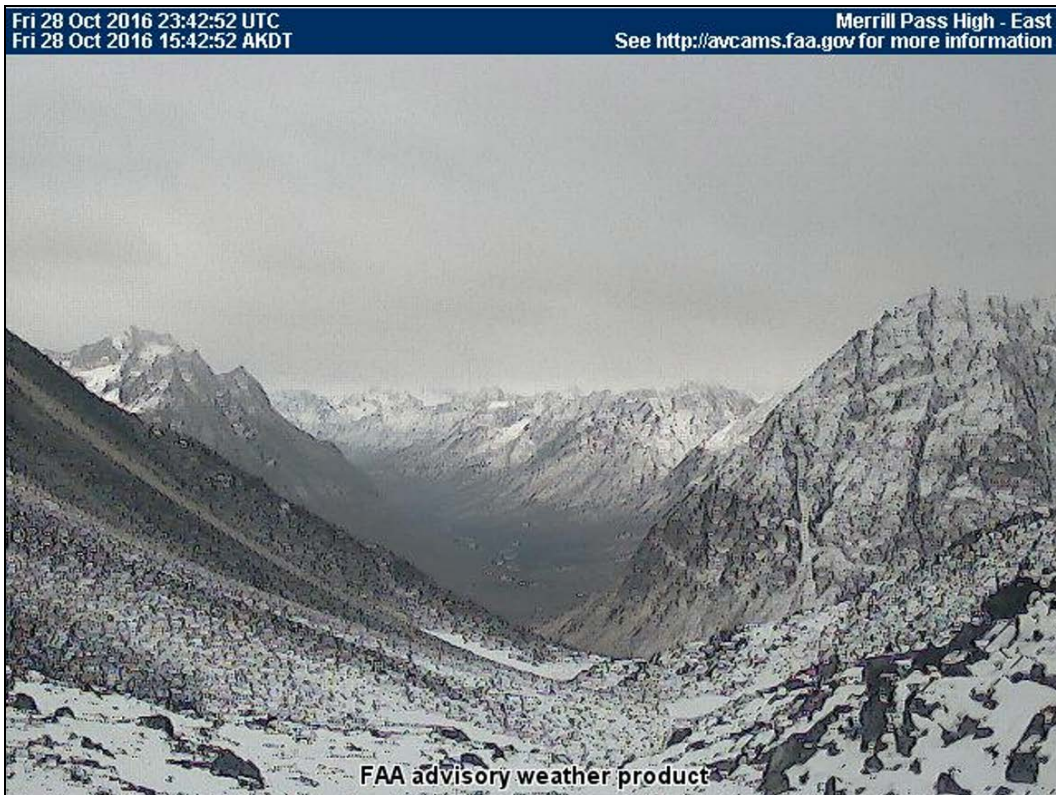


Figure 25 - Merrill Pass High East camera view at 1542 AKDT



Figure 26 - Merrill Pass High East camera view at 1553 AKDT

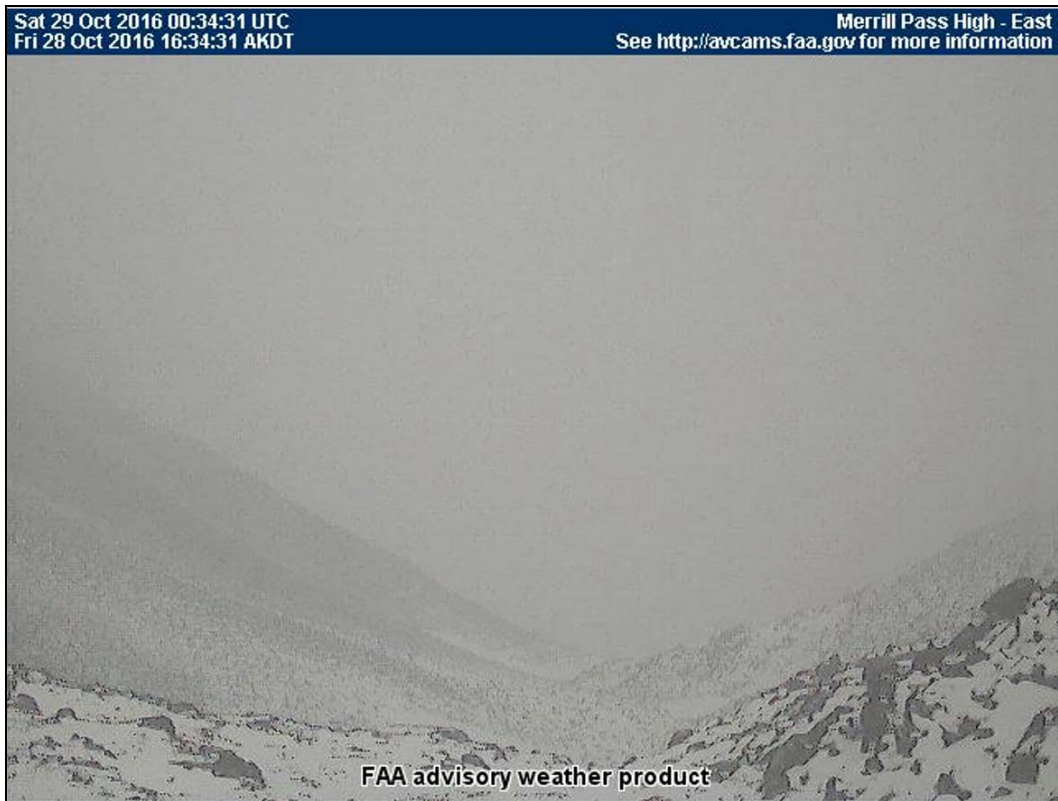


Figure 27 - Merrill Pass High East camera view at 1634 AKDT

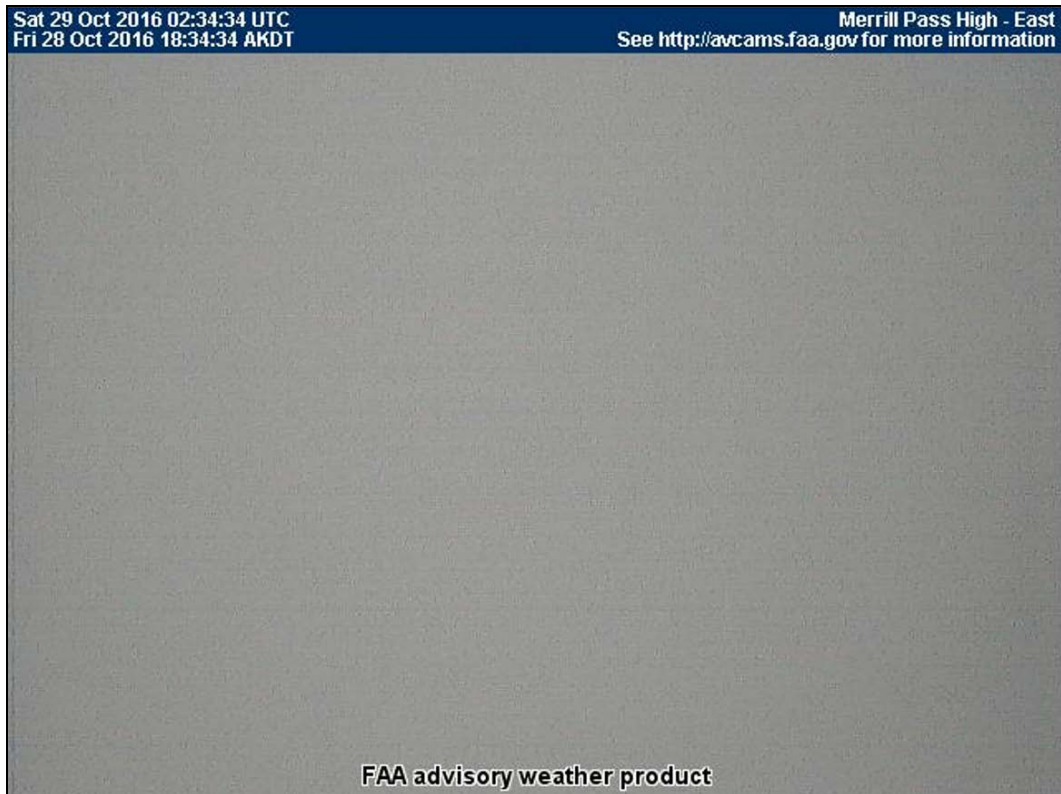


Figure 28 - Merrill Pass High East camera view at 1834 AKDT at the time of the accident

Figure 29 is the Merrill Pass High West camera view centered on a 280° azimuth on a clear day with the visibility reference markers indicated.

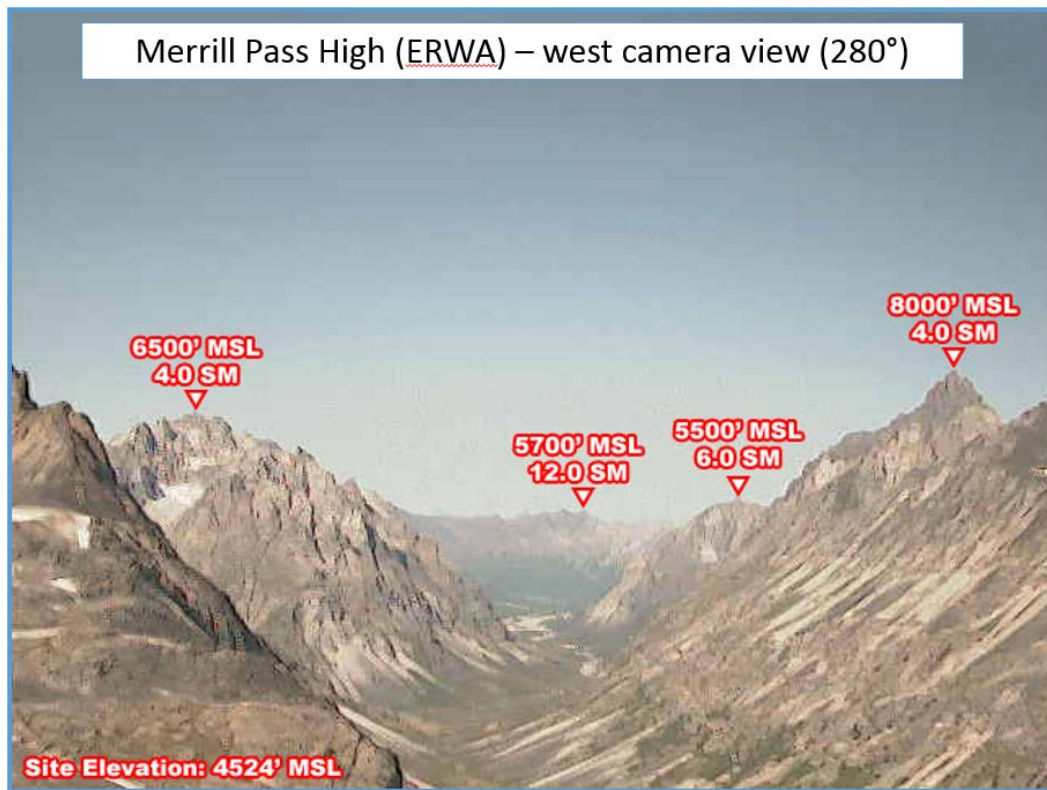


Figure 29 - Merrill Pass High West camera view with visibility references

Figure 30 is the Merrill Pass High West camera view at 1536 AKDT with overcast sky cover and visibility at less than 6 miles, with the distant mountains already hidden from view in precipitation and/or clouds and the higher peaks beginning to be obscured in clouds. Figure 31 is the image at 1546 AKDT continuing to show decreasing sky cover and visibility to less than 4 miles as the closest mountain tops used for reference begin to be obscured in the clouds.

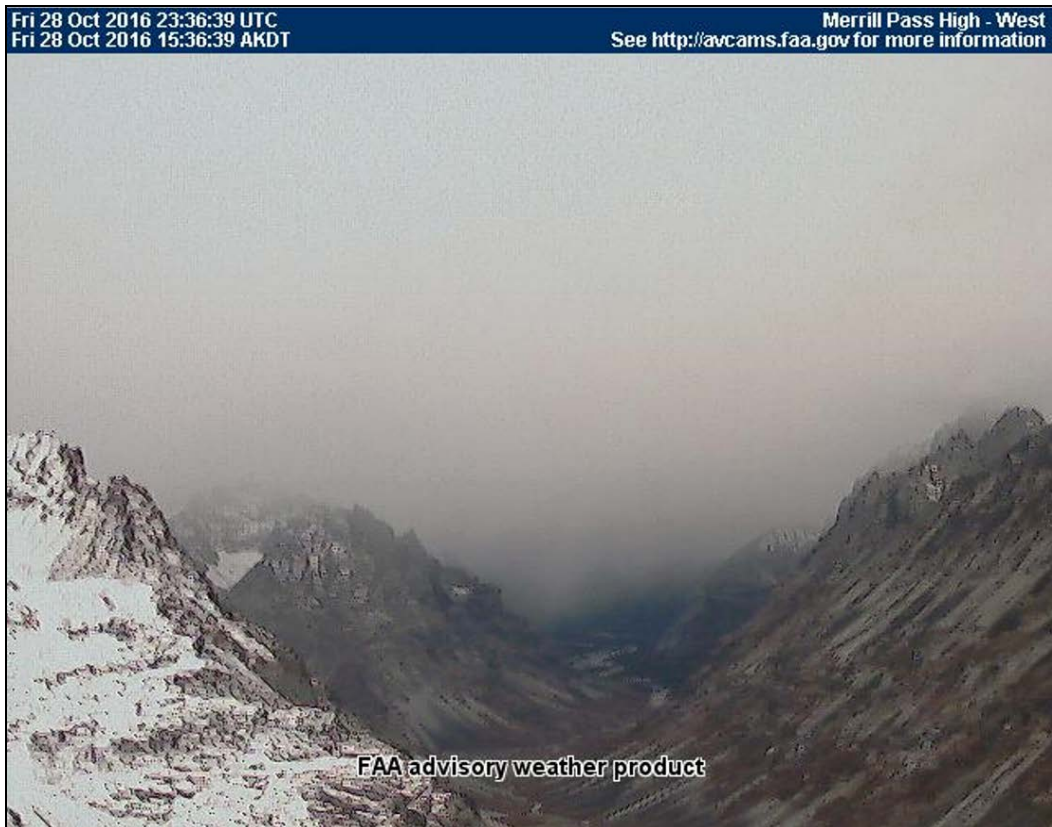


Figure 30 - Merrill Pass High West camera view at 1536 AKDT



Figure 31 - Merrill Pass High West camera view at 1546 AKDT



Figure 32 - Merrill Pass High west camera view at 1556 AKDT



Figure 33 - Merrill Pass High west camera view at 1625 AKDT



Figure 34 - Merrill Pass High west camera view at 1835 AKDT

11.2 Merrill Pass Low

The next closest FAA weather camera site to the accident site was from Merrill Pass Low (ERW) located approximately 7 1/2 miles north-northeast of the accident site at latitude 61°12'0" N and longitude 153° 17'52.08" West at an elevation of 3,045 feet. The site provided two camera views; one towards the southeast camera towards 124° and a west towards 248°.

Figure 35 is the Merrill Pass Low southeast camera view reference showing multiple peaks in the vicinity for visibility references on a clear day, followed by figures 36 through 38 with images surrounding the time of the accident at 1558, 1608, and 1838 AKDT. The images show initial overcast skies with the highest peaks above 5,400 feet already obscured by the clouds and with visibility beginning to restricted and rapidly lowering with time by 1608 AKDT, and completely obscured with visibility less than ½ mile at the time of the accident. The images also suggest that snow was falling during the period with the terrain being covered in snow by the time of the accident.

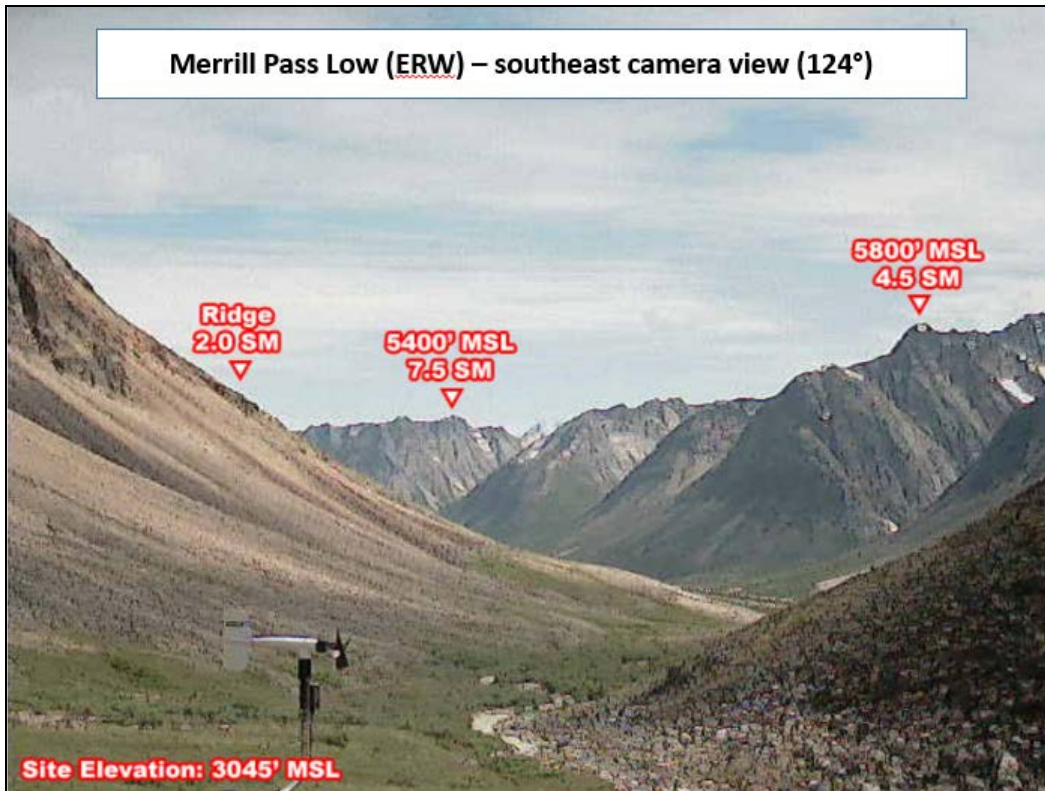


Figure 35 - Merrill Pass Low southeast camera view reference on a clear day



Figure 36 - Merrill Pass Low southeast camera view at 1558 AKDT



Figure 37 - Merrill Pass Low southeast camera view at 1608 AKDT



Figure 38 - Merrill Pass Low southeast camera view at the time of the accident at 1838 AKDT

Figure 39 is the Merrill Pass Low west camera view reference on a clear day showing the high peaks and visibility references on a clear day, follow figures 40 through 43 with images at 1537, 1557, 1627, and 1837 AKDT and shows similar rapidly deteriorating conditions surrounding the period with snow.

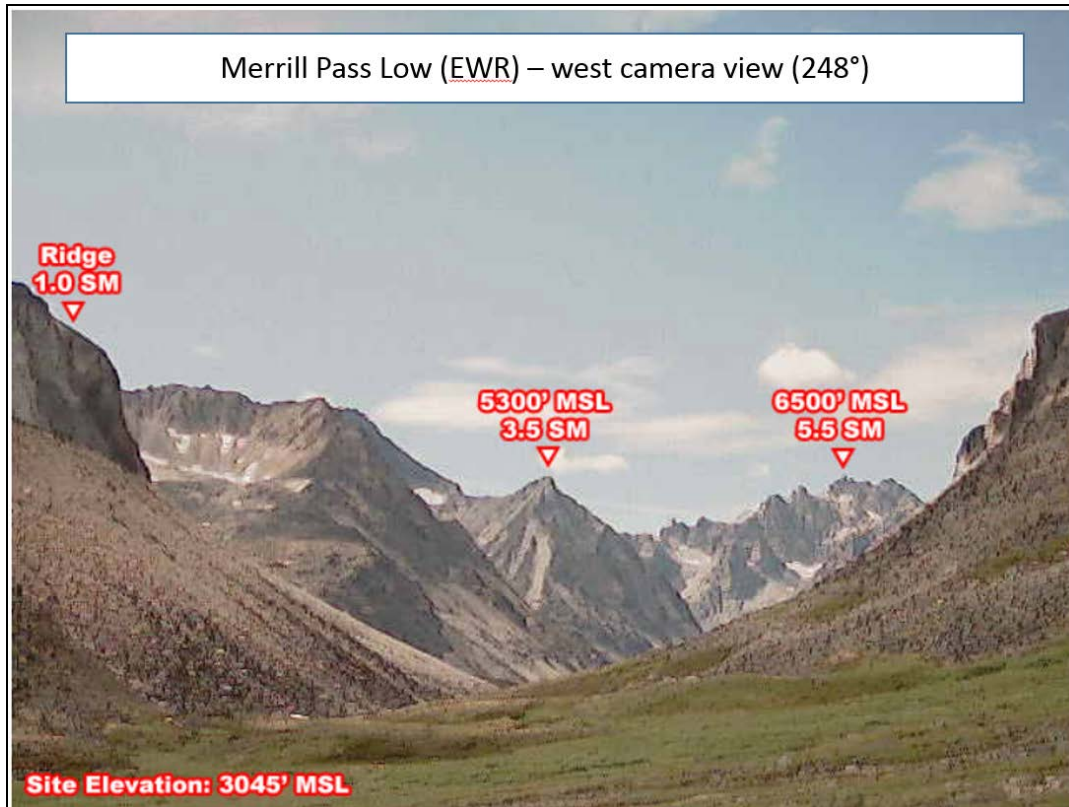


Figure 39 - Merrill Pass Low west camera reference markers on a clear day

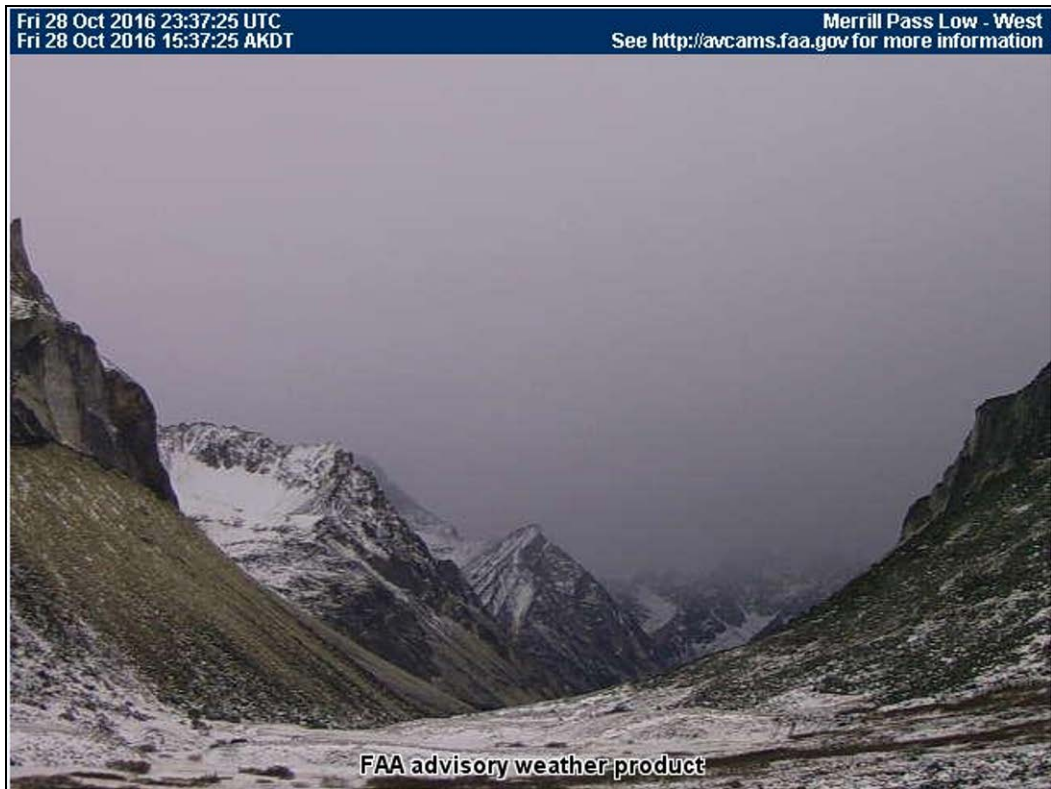


Figure 40 - Merrill Pass Low west camera image at 1537 AKDT



Figure 41 - Merrill Pass Low west camera image at 1557 AKDT



Figure 42 - Merrill Pass Low west camera views at 1627 AKDT



Figure 43 - Merrill Pass Low west camera view at 1837 AKDT

11.3 Beluga

The first camera along the route was Beluga (BLG) located at 61°11'7.775" north latitude and 151° 2'4.438" west longitude, at an elevation of 75 feet. The Beluga northeast or 062° camera view on a clear day is included as figure 44, followed by figure 45 which is the image on the day of the accident at 1730 AKDT when the accident airplane overflew the location at an altitude of approximately 4,800 feet. The image depicted a broken layer of altostratus type clouds with unrestricted visibility under the cloud layer with Cook Inlet and the snowcapped mountains observed on the horizon.

Figures 46 and 47 are the Beluga southwest or 244° camera view on a clear day following by the image at 1729 AKDT on the day of the accident. The image depicted a broken layer of altostratus type clouds over the route of flight with general visibility good below the clouds; however, the mountains approximately 40 miles away are not clearly identifiable in the distance. The accident airplane was likely operating in visual meteorological conditions (VMC) below the layer of clouds during this segment of the flight, but as the flight continued southwest began to climb to approximately 14,500 feet. The broken sky covered continued through the time of the accident with several bands of precipitation falling from the clouds but no reaching the ground or virga and can be seen in figure 48 taken at 1759 AKDT. Figure 49 is the southwest image at 1829 AKDT looking towards the higher terrain and continued mid-level cloud cover and the distant mountain range no longer visible or identifiable in the gray distant cloud cover.

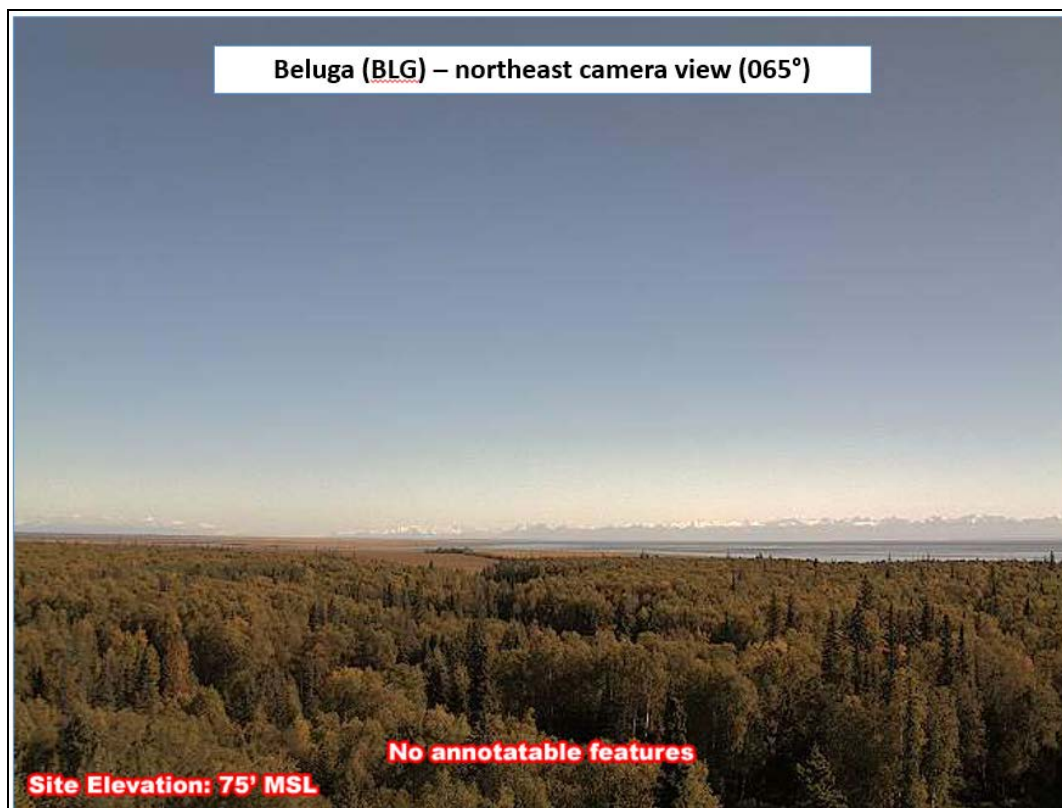


Figure 44 – Beluga northeast camera view on a clear day



Figure 45 - Beluga northeast camera view at 1730 AKDT when accident airplane overflow the area

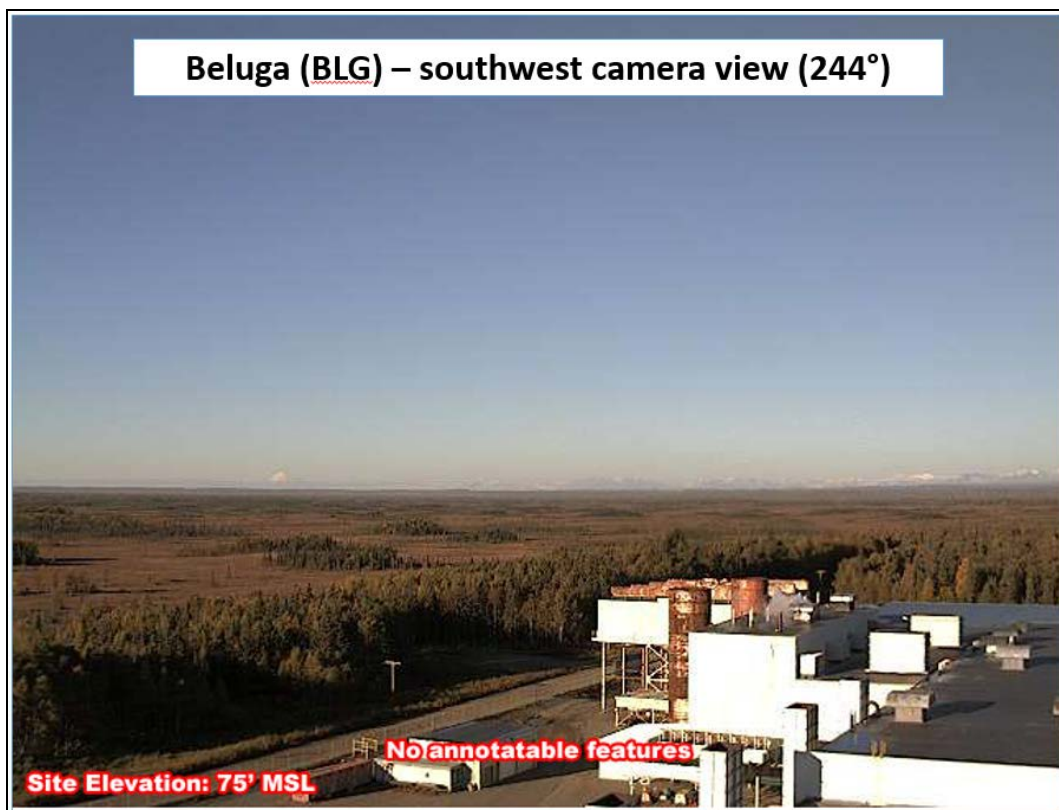


Figure 46 - Beluga southwest camera view on a clear day

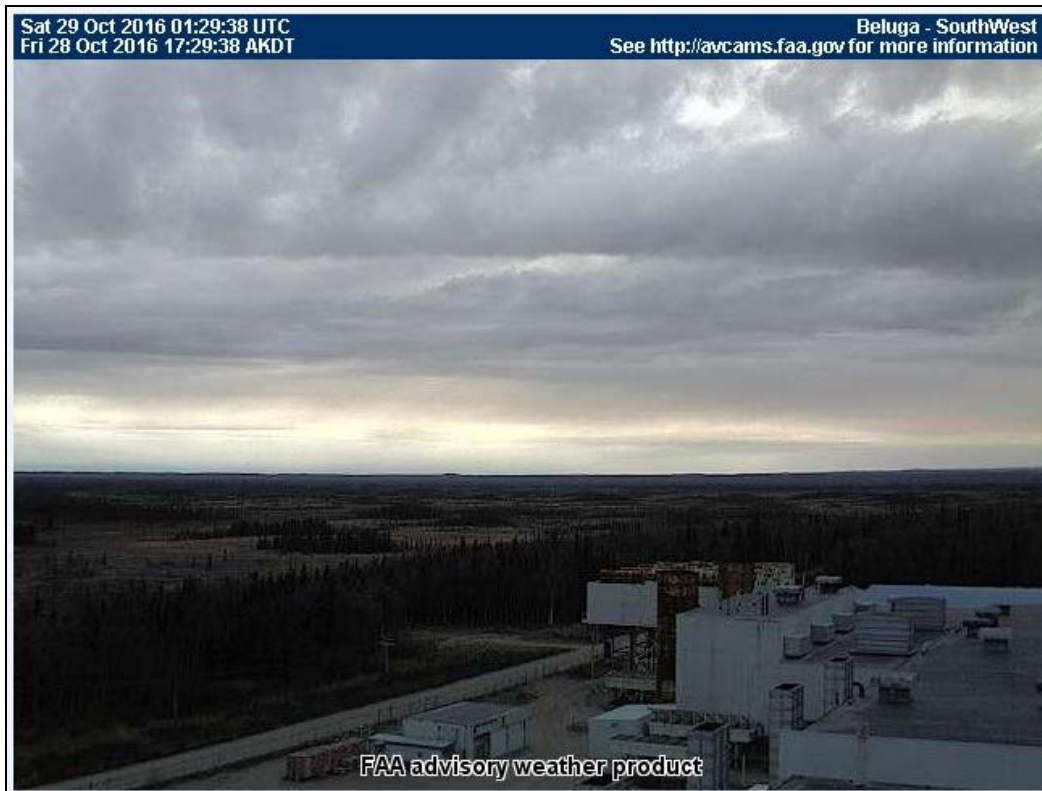


Figure 47 - Beluga southwest view at 1729 AKDT when aircraft overflow the area



Figure 48 - Beluga southwest camera view at 1759 AKDT

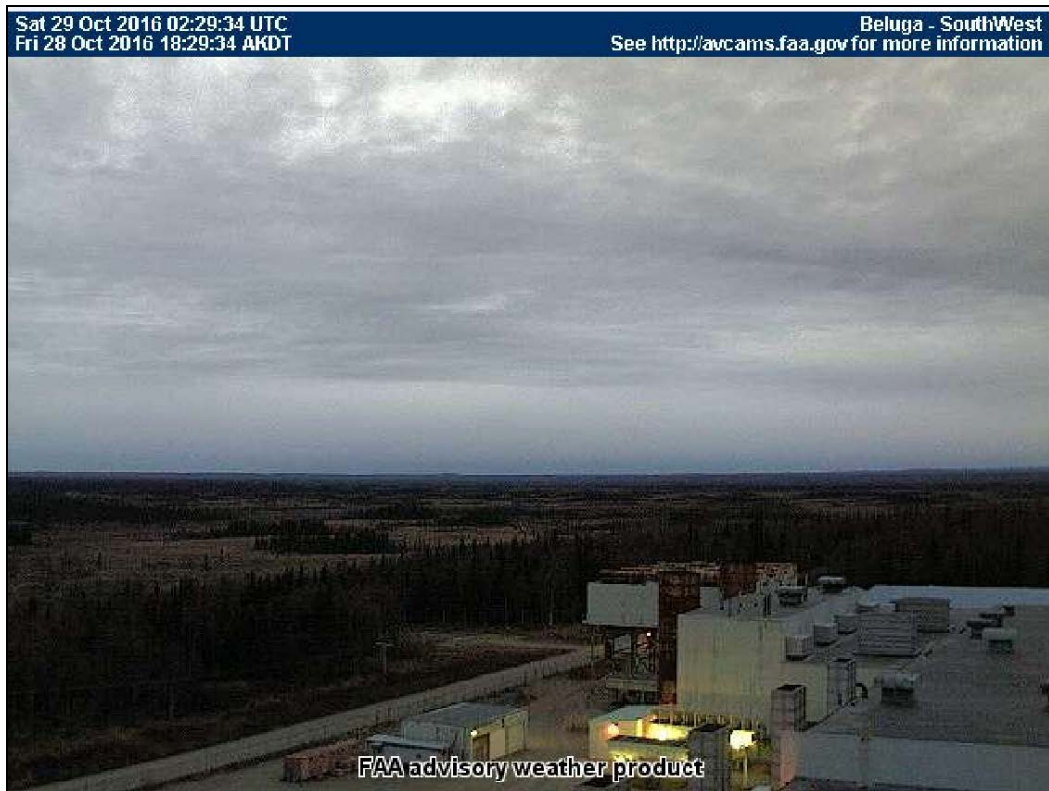


Figure 49 - Beluga southwest camera view at 1829 AKDT or at the time of the accident

11.4 Lake Clark Pass East

As the accident airplane flew towards the weather camera at Lake Clark Pass East (QLE) and flew within 5 miles of the site at approximately 1802 AKDT at an altitude above 14,000 feet. Figure 50 is the Lake Clark Pass East northeast or 062° camera view on a clear day, and at an elevation of 2,559 feet, and figure 51 is the image at 1757 AKDT which shows the view totally obscured by clouds with visibility near zero. The images from 1547 through 1907 AKDT were similar with a completed obscuration conditions.

Figures 51 and 52 are the Lake Clark Pass East northwest or 315° camera view on a clear day for reference with terrain in excess of 5,000 feet used for reference and at 1758 AKDT on the day of the accident with completed obscured conditions over the site as the aircraft flew near the station similar to the northeast camera view.

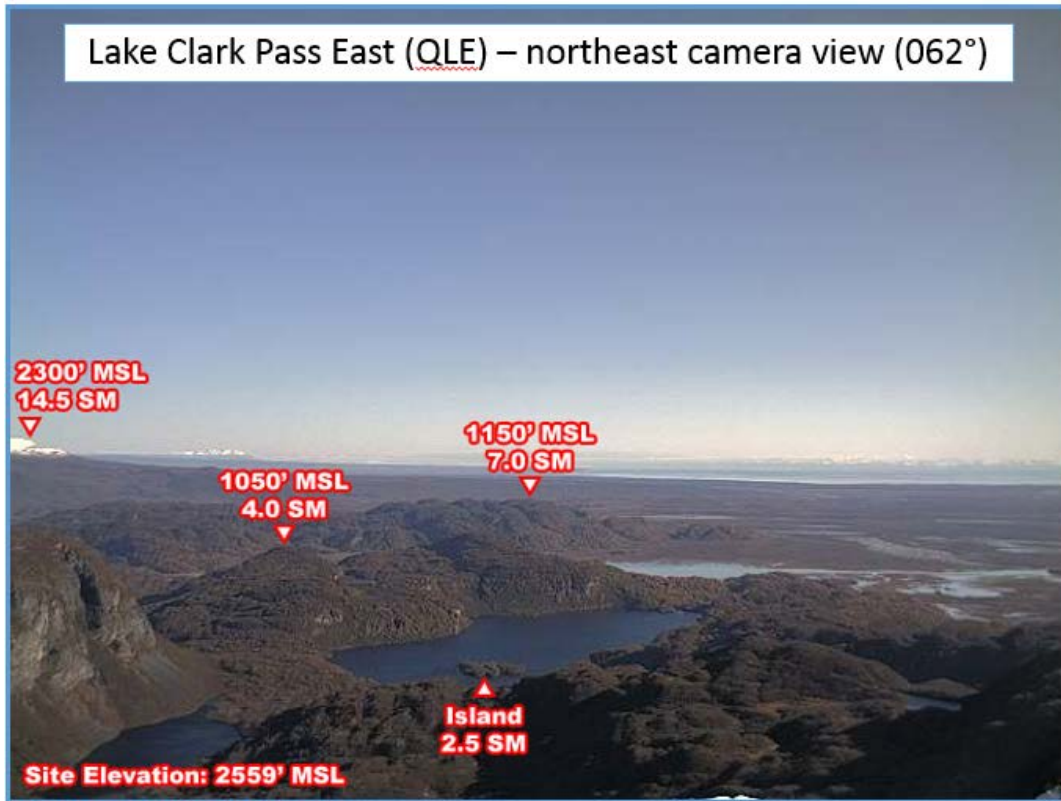


Figure 50 - Lake Clark Pass East northeast camera view on a clear day



Figure 51 - Lake Clark Pass East northeast camera view at 1757 AKDT

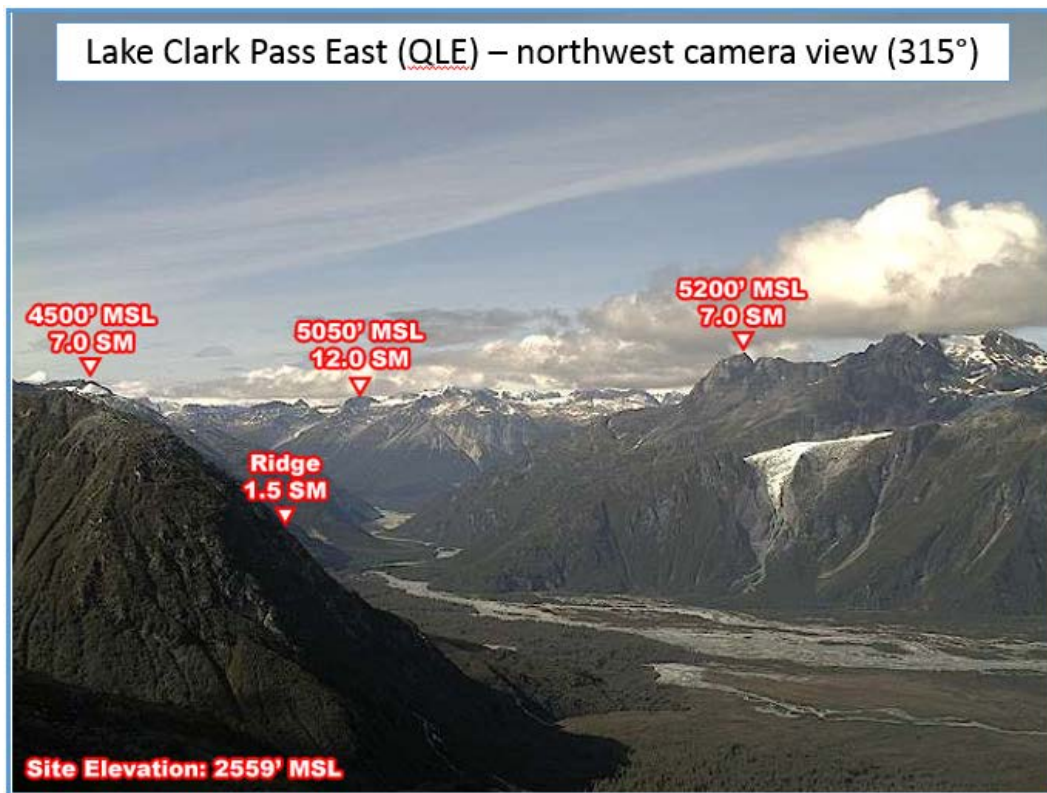


Figure 52 - Lake Clark East northwest camera view on a clear day



Figure 53 - Lake Clark Pass East northeast camera view at 1758 AKDT

11.5 Lake Clark Pass RCO

The accident airplane flew within a mile of Lake Clark Pass (RCO) located at 60°51'19.919" N latitude and 153°38'21.12" W longitude at 1807 AKDT at an altitude of approximately 14,000 feet. The site elevation was 973 feet and had a southeast or 131° and southwest 238° camera views.

Figures 54 and 55 are the Lake Clark Pass southeast view on a clear day and at 1809 AKDT as when the aircraft was passing over the region, with the higher terrain obscured and visibility under a mile. Figures 56 and 57 are the southwest view on a clear day and at 1806 AKDT with the higher terrain obscured and visibility significantly reduced.

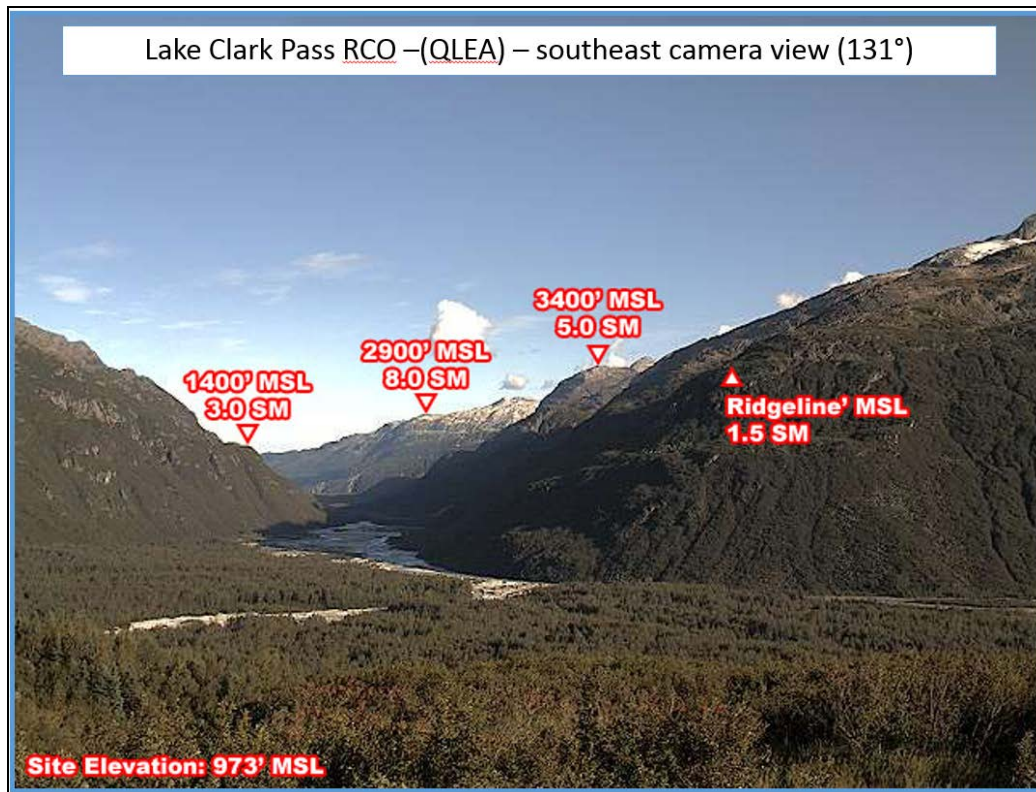


Figure 54 - Lake Clark Pass RCO southeast camera view reference

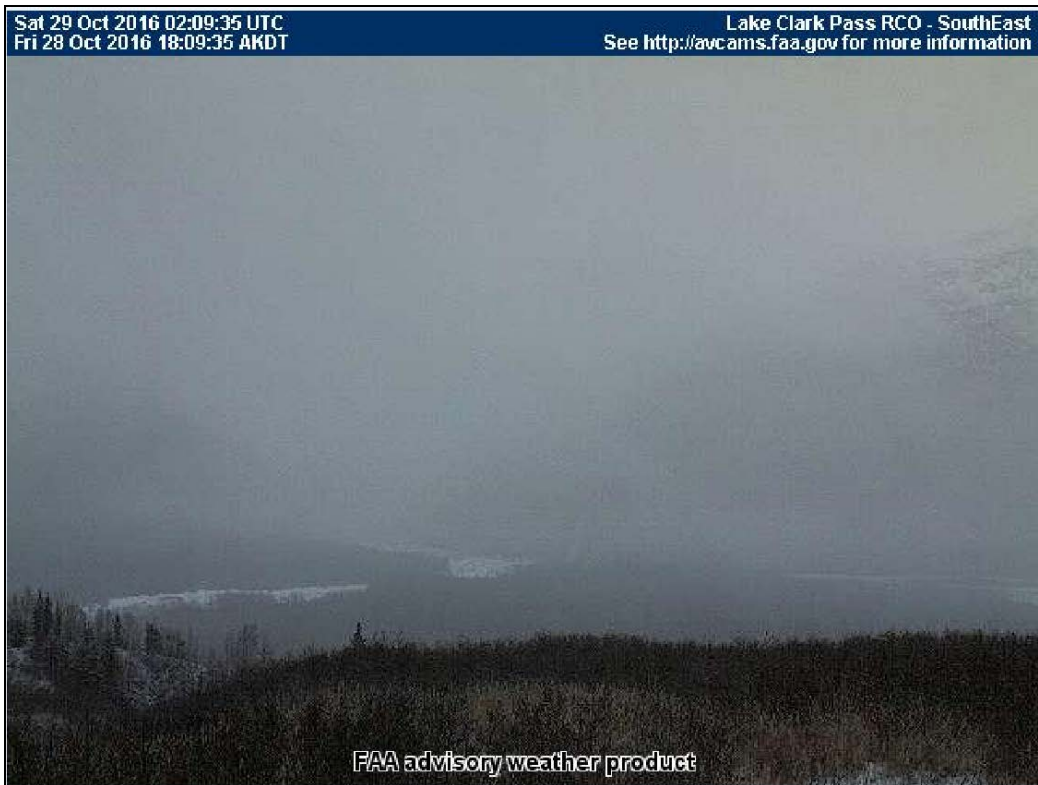


Figure 55 - Lake Clark Pass RCO southeast view at 1809 AKDT

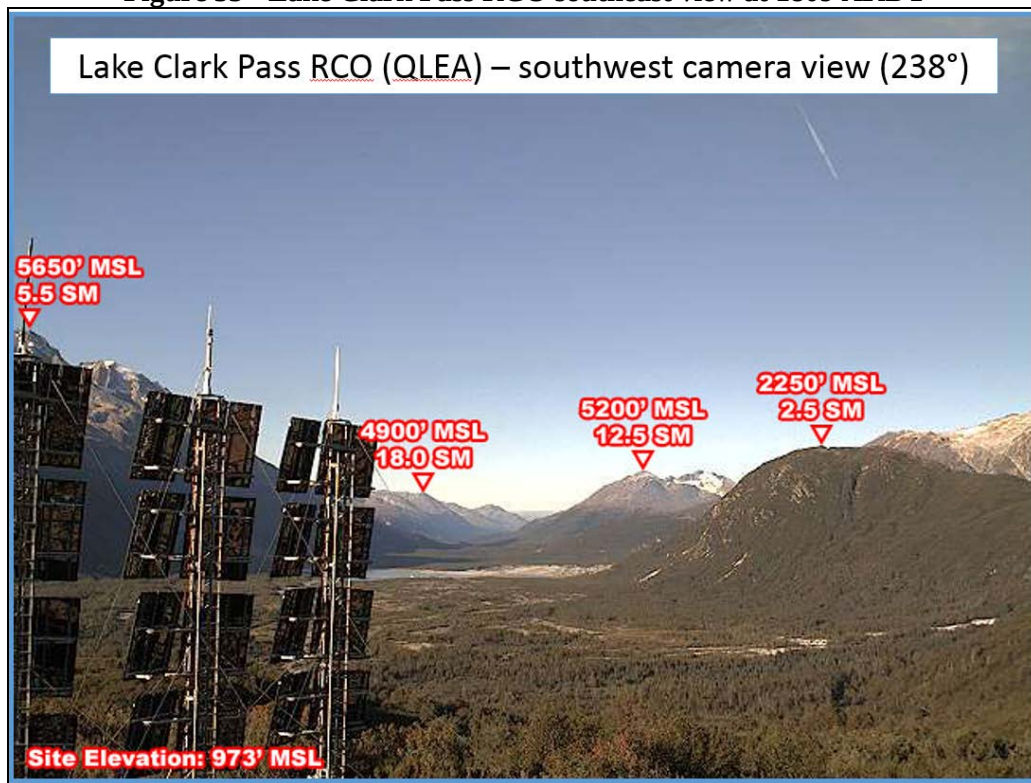


Figure 56 - Lake Clark Pass RCO southwest camera view



Figure 57 - Lake Clark Pass southwest view at 1806 AKDT

11.6 Lake Clark Pass West

Lake Clark Pass West (QLW) was located near the northeast tip of the Lake Clark at coordinates 60° 22'25.32" N latitude and 153° 53'24" W longitude, at an elevation of 261 feet. The accident site was located approximately 45 miles north-northeast or 017° from the camera. Figures 58 and 59 are the lake Clark Pass West northeast or 033° camera view on a clear day and at 1838 AKDT or the approximate time of the accident, with clouds above the higher elevation and visibility unrestricted below the clouds. The animation of the images (attachment 6) shows the trees swaying in relatively strong easterly winds with white caps on Lake Clark during the period. The band of clouds also show little motion with time and show signs of orographic clouds associated with mountain wave activity.

Figures 60 and 61 are the Lake Clark Pass West east or 069° azimuth camera view on a clear day and at the approximate time of the accident, showing again multiple layers of clouds with visibility unrestricted below the clouds. High winds again are indicated on Lake Clark and several bands of clouds move little during the period.

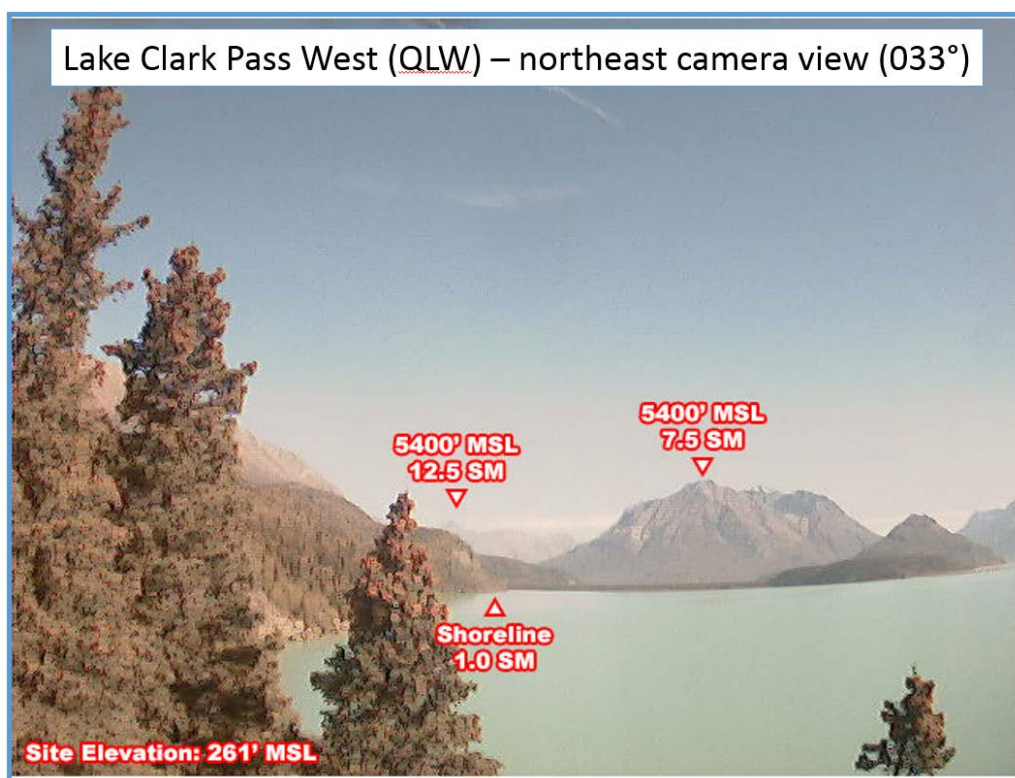


Figure 58 - Lake Clark Pass West northeast camera view on a clear day



Figure 59 - Lake Clark Pass West northeast camera view at 1838 AKDT

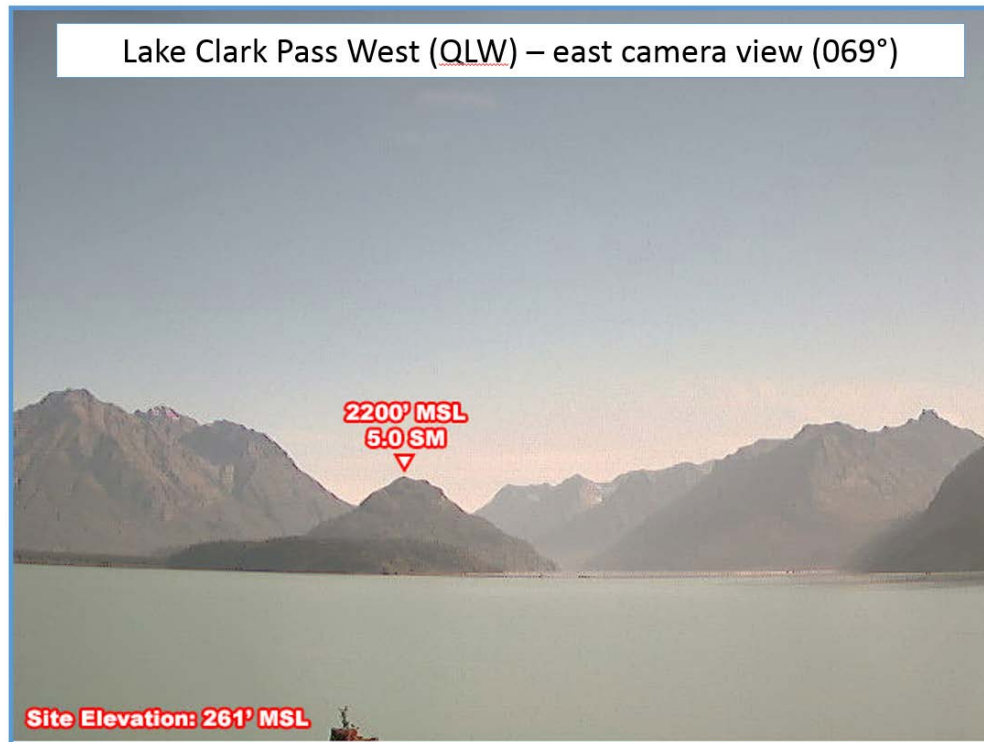


Figure 60 - Lake Clark Pass West east camera view on a clear day

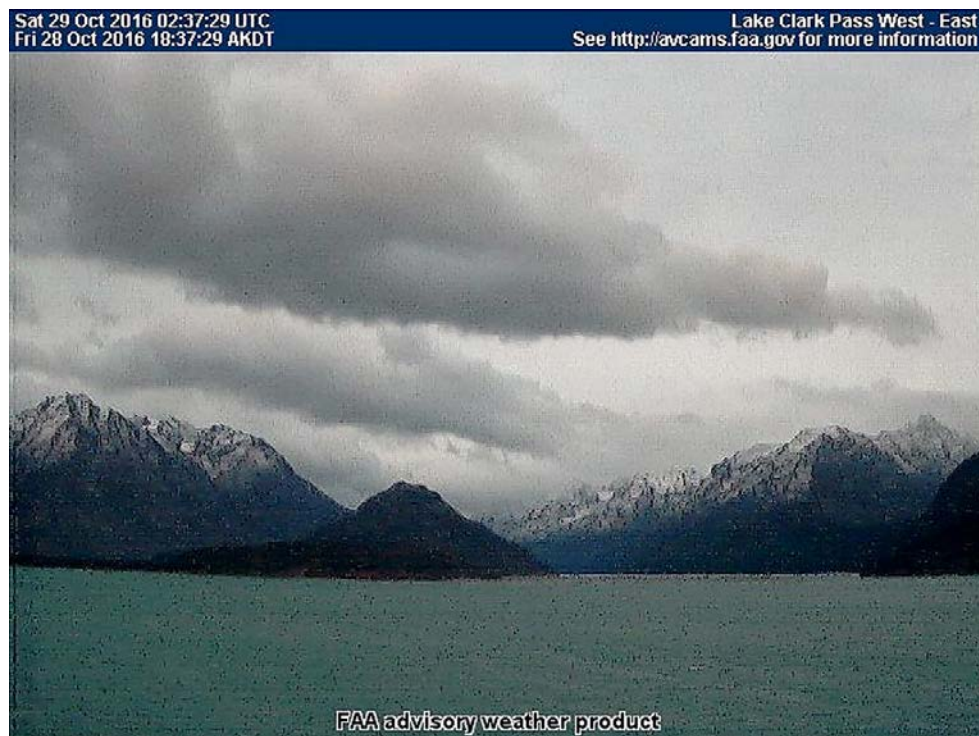


Figure 61 - Lake Clark Pass West east camera view at 1837 AKDT

12.0 Astronomical Data

The United States Naval Observatory website provided the following astronomical data for Anchorage, Anchorage Borough, Alaska to represent the conditions at the departure airport on October 28, 2016.

SUN

Beginning of civil twilight	0832 AKDT
Sunrise	0918 AKDT
Sun transit	1343 AKDT
Sunset	1807 AKDT
Accident	1830 AKDT
End of civil twilight	1853 AKDT

MOON

Moonrise	0639 AKDT
Moonrise	1807 AKDT

At the time of the accident the sun was -3.5° below the horizon at an azimuth of 248° , with official nighttime starting at 1853 AKDT. The accident occurred after official sunset, but during the period of civil twilight and prior to official nighttime.

13.0 Weather Briefing

The FAA Flight Service Station (FSS) indicated that they had no contact with the pilot of N5308F during the period, and there was no record of any Direct Users Access Terminal (DUAT) briefing. It is unknown what information the pilot utilized in his preflight weather evaluation and planning.

F. LIST OF ATTACHMENTS

- Attachment 1: FAA Weather Camera - Beluga animation
- Attachment 2: FAA Weather Camera - Lake Clark Pass East animation
- Attachment 3: FAA Weather Camera - Lake Clark Pass animation
- Attachment 4: FAA Weather Camera - Merrill Pass High animation
- Attachment 5: FAA Weather Camera - Merrill Pass Low animation
- Attachment 6: FAA Weather Camera - Lake Clark Pass West animation

Submitted by:

Donald Eick
NTSB Senior Meteorologist