NATIONAL TRANSPORTATION SAFETY BOARD

Office of Aviation Safety
Washington, D.C. 20594

August 19, 2019

Weather Study

METEOROLOGY

ANC19FA038

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A. ACCIDENT

Location: Vicinity of Skwentna, Alaska
Date: March 6, 2019
Time: 1730 Alaska standard time
0230 Coordinated Universal Time (UTC) on March 7, 2019
Aircraft: Cessna 172, Registration: N7469A

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 including the National Centers for Environmental Information (NCEI). All times are Alaska standard time (AKST) on March 6, 2019, and are based upon the 24-hour clock, where local time is -9 hours from UTC, and UTC=Z (unless otherwise noted). 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 miles. NWS airport and 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 ("P" for Alaska airports).

The accident site was located at 62.1102°N, 152.1679°W, at 3,241 feet (ft).

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.[1]

[1] https://www.faa.gov/regulations_policies/advisory_circulars/index.cfm/go/document.information/documentID/1030

1.1 Surface Analysis Chart

The Alaska United States section of the NWS Surface Analysis Chart for 1800 AKST is provided as figure 1 with the location of the accident site within the red circle. The chart indicated a surface low pressure system over Kodiak Island with a surface pressure of 1010-hectopascals (hPa). A surface high pressure system was located over eastern Alaska with a surface pressure of 1018-hPa. There were no large frontal systems or surface pressure centers near the accident site.

The station models around the accident site depicted air temperatures in the low 30's degrees Fahrenheit (°F), dew point temperatures in the low to upper 20's °F with a temperature-dew point spread of 8° or less, a variable surface wind or 5 knots or less, and mostly cloudy skies.

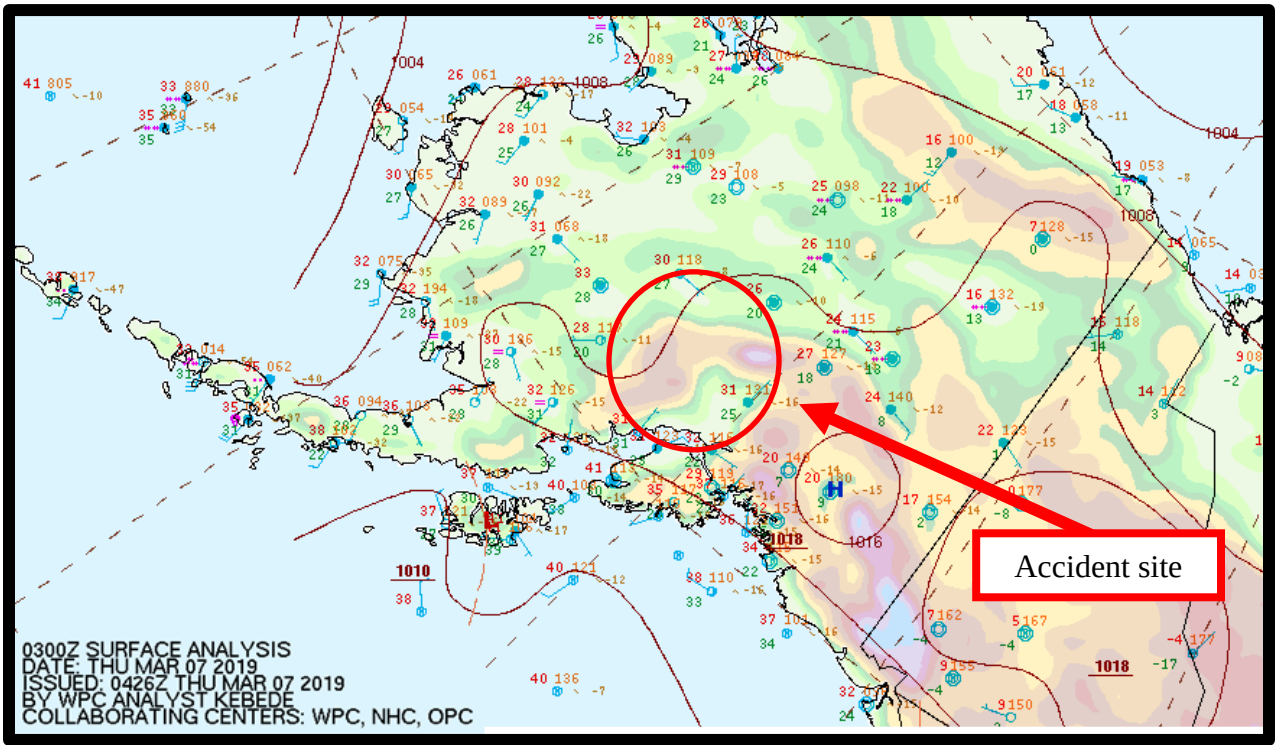

Figure 1 – NWS Surface Analysis Chart for 1800 AKST

1.2 Upper Air Charts

The NWS Ocean Prediction Center (OPC) issued a Constant Pressure Chart for 1500 AKST at 500-hPa and it is presented in figure 2. The OPC 500-hPa chart depicted a mid-level ridge[2] located above the accident site. Ridges can act to help suppress clouds and precipitation at certain levels of the atmosphere. The wind was from the southwest at 30 to 35 knots (figure 2).

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[2] Ridge – An elongated area of relatively high atmospheric pressure or heights.

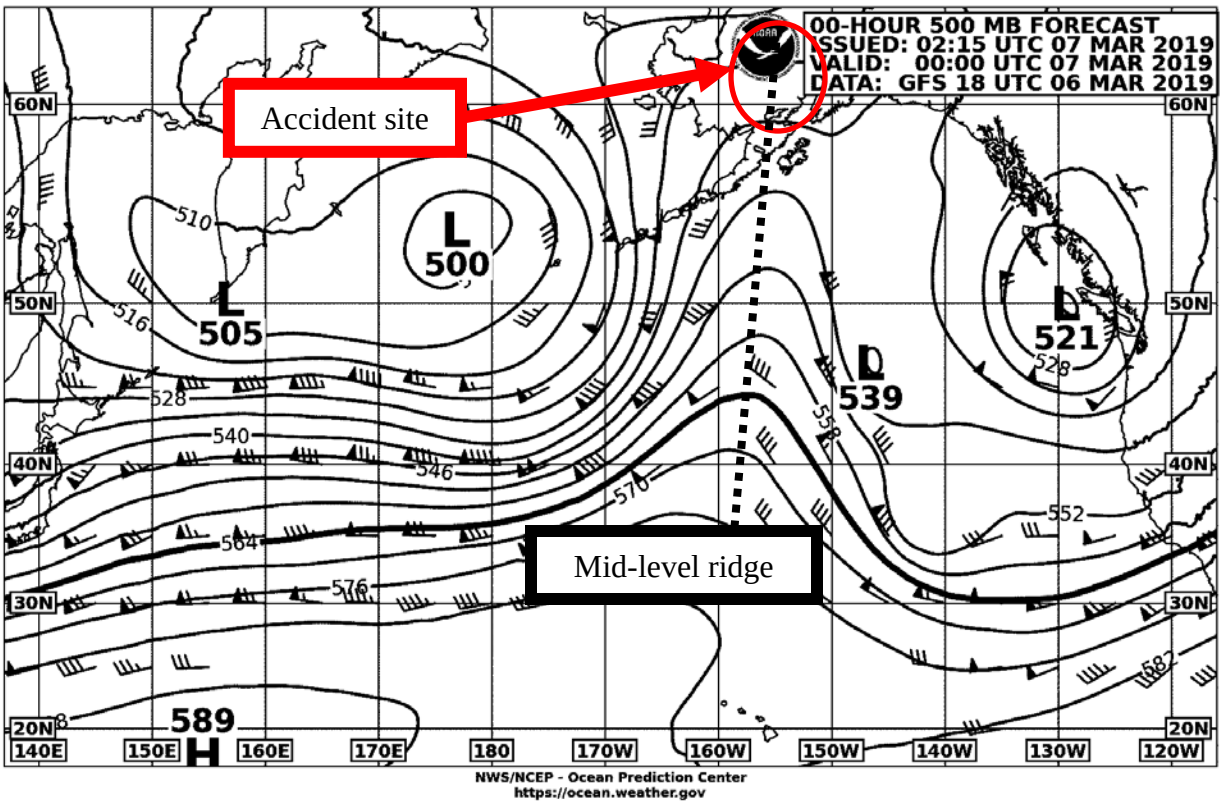


Figure 2 – 500-hPa Constant Pressure Chart for 1500 AKST

2.0 Surface Observations

The area surrounding the accident site was documented using official Meteorological Aerodrome Reports (METARs) and Specials (SPECIs). Figure 3 is a sectional chart with the accident site and the closest weather reporting locations to the accident site marked.

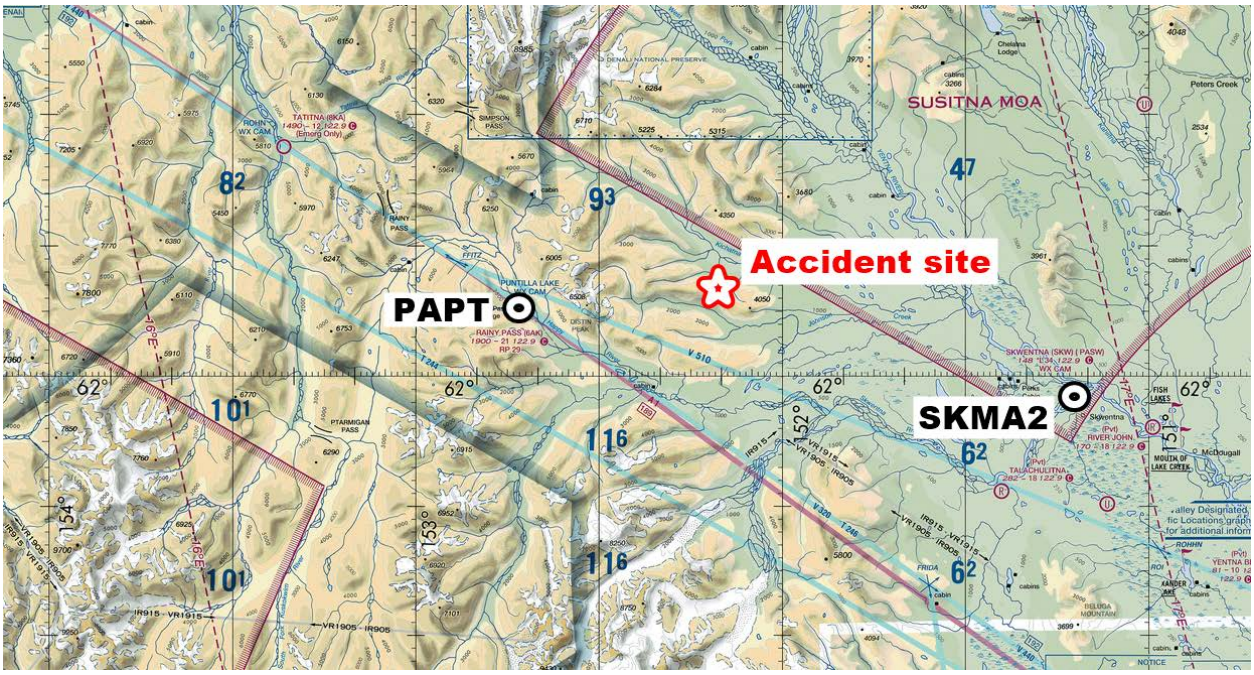


Figure 3 – Sectional chart of accident area with the location of the accident site and the closest surface observation site

The closest official weather reporting facility to the accident site was from Puntilla, Alaska, (PAPT) at an elevation of 1,837 ft, which was 16 miles west of the accident site. PAPT had an Aviation Paid Weather Observer (A-Paid) that provided weather observations on the accident day (attachment 1). PAPT had a 16° easterly magnetic variation[3] (figure 3). The following observations were taken and disseminated during the times surrounding the accident:[4]

[0910 AKST] METAR PAPT 061810Z 00000KT 3SM -SN OVC040 M06/M07 A2989 RMK NO SPECI FIRST=

[1515 AKST] METAR PAPT 070015Z 17005KT 15SM BKN050 M01/M01 A2981 RMK NO SPECI 4100061061 70000 931000 4/025=

[1648 AKST] METAR PAPT 070148Z 25004KT 20SM BKN027 M02/M02 A2980 RMK NO SPECI LAST=

ACCIDENT TIME 1730 AKST

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

[4] Bolded sections in this report highlight information that directly reference the weather conditions that affected the accident location around the accident time.

PAPT weather at 1515 AKST, wind from 170° at 5 knots, 15 miles visibility, a broken ceiling at 5,000 ft above ground level (agl), temperature of -1° Celsius (C), dew point temperature of -1°C, and an altimeter setting of 29.81 inches of mercury (inHg). Remarks: no specials, 24-hour maximum temperature of 0.6°C, 24-hour minimum temperature of -6.1°C, a trace of precipitation and snow accumulation over past 24 hours, snow depth of 25 inches.

PAPT weather at 1648 AKST, wind from 250° at 4 knots, 20 miles visibility, a broken ceiling at 2,700 ft agl, temperature of -2°C, dew point temperature of -2°C, and an altimeter setting of 29.80 inHg. Remarks: no specials, last observation.

The next closest weather reporting facility to the accident site was from near Skwentna, Alaska, (SKMA2) at an elevation of 152 ft, which was 29 miles east-southeast of the accident site (figure 3). SKMA2 was a Hydrometeorological Automated Data System (HADS) site that provided weather observations on the accident day (figure 4). The following observations were taken and disseminated during the times surrounding the accident:

STATION: SKMA2
STATION NAME: SKEWTNA
LATITUDE: 61.97028
LONGITUDE: -151.19472
ELEVATION [ft]: 152
STATE: AK

Station_ID	Date_Time	altimeter_set_1	air_temp_set_1	wind_speed_set_1	wind_gust_set_1	cloud_layer_1_code_set_1	cloud_layer_2_code_set_1	visibility_set_1	weather_	ceiling_set_1	pressure_	weather_condition_set_1d
		INHG	Fahrenheit	Miles/hour	Miles/hour	code	code	Statute miles	code	Feet	INHG	Code
SKMA2	03/06/2019 22:53 UTC	29.97	30	0	4.61	194		4	57	1900	29.81	Light Ice Pellets
SKMA2	03/07/2019 02:53 UTC	29.91	30.99	0	4.61	126	144	12		1400	29.75	Overcast
SKMA2	03/07/2019 03:08 UTC	29.91	30.99	0	4.61	144		12		1400	29.75	Overcast
SKMA2	03/07/2019 03:23 UTC	29.91	30.99	0	2.3	154		9		1500	29.75	Overcast
SKMA2	03/07/2019 03:38 UTC	29.91	30	0		194		7	20	1900	29.75	Light Snow
SKMA2	03/07/2019 03:53 UTC	29.91	30	0	2.3	194		11		1900	29.75	Overcast
SKMA2	03/07/2019 04:08 UTC	29.91	30	0	2.3	146	244	12		2400	29.75	Overcast
SKMA2	03/07/2019 04:23 UTC	29.91	30	0	4.61	154		7		1500	29.75	Overcast
SKMA2	03/07/2019 04:38 UTC	29.91	30	0	4.61	144		4	31	1400	29.75	Mist
SKMA2	03/07/2019 04:53 UTC	29.91	30	0	4.61	144		6	31	1400	29.75	Mist
SKMA2	03/07/2019 05:08 UTC	29.88	30	0	2.3	154		12		1500	29.72	Overcast
SKMA2	03/07/2019 05:23 UTC	29.88	30	0	2.3	154		12		1500	29.72	Overcast
SKMA2	03/07/2019 05:38 UTC	29.88	30	0	2.3	154		12	20	1500	29.72	Light Snow
SKMA2	03/07/2019 05:53 UTC	29.88	30	0	2.3	144		3	20	1400	29.72	Light Snow
SKMA2	03/07/2019 06:08 UTC	29.88	28.99	0		124		1	20	1200	29.72	Light Snow
SKMA2	03/07/2019 06:23 UTC	29.88	28.99	0		114		1	20	1100	29.72	Light Snow
SKMA2	03/07/2019 06:38 UTC	29.88	28.99	0		114		2	20	1100	29.72	Light Snow
SKMA2	03/07/2019 06:53 UTC	29.88	28.99	0		94		2	49	900	29.72	Light Frz Rain
SKMA2	03/07/2019 07:08 UTC	29.88	28.99	0		64		2	20	600	29.72	Light Snow
SKMA2	03/07/2019 07:23 UTC	29.88	28.99	0	2.3	104		3	49	1000	29.72	Light Frz Rain
SKMA2	03/07/2019 07:38 UTC	29.85	30	0	2.3	124		1	53	1200	29.69	Light Frz Drizzle
SKMA2	03/07/2019 07:53 UTC	29.85	30	0	2.3	114		2	53	1100	29.69	Light Frz Drizzle
SKMA2	03/07/2019 08:08 UTC	29.85	30	0	2.3	76	104	2	53	1000	29.69	Light Frz Drizzle
SKMA2	03/07/2019 08:38 UTC	29.85	30	0		84		1	20	800	29.69	Light Snow

Figure 4 – SKMA2 observations

SKMA2 weather at 1753 AKST, wind gusting to 4.61 miles per hour (mph) from unknown direction, 12 miles visibility, an overcast ceiling at 1,400 ft agl, temperature of -30.99°F, and an altimeter setting of 29.91 inHg.

SKMA2 weather at 1808 AKST, wind gusting to 4.61 mph from unknown direction, 12 miles visibility, an overcast ceiling at 1,400 ft agl, temperature of -30.99°F, and an altimeter setting of 29.91 inHg.

The observations from PAPT and SKMA2 surrounding the accident time indicated MVFR[5] to VFR ceiling conditions with the surface wind remaining variable under 6 knots and no precipitation reported at the surface.

[5] As defined by the NWS and the FAA Aeronautical Information Manual (AIM) section 7-1-7 defines the following

3.0 Upper Air Data

A Global Data Assimilation System (GDAS) model sounding was created for the accident site for 1800 AKST with station elevation of 1,864 ft.[6] The 1800 AKST GDAS sounding was plotted on a standard Skew-T Log P diagram[7] with the derived stability parameters included in figure 5 with data from the surface to 600-hPa (or approximately 14,000 ft msl). This data was analyzed using the RAOB[8] software package. The sounding depicted the lifted condensation level (LCL)[9] at 368 ft agl (2,232 ft msl) and the convective condensation level (CCL)[10] at 4,028 ft agl (5,892 ft msl). The sounding had a greater than 80% relative humidity from the surface through 10,000 ft msl. The entire sounding was below freezing. The precipitable water value was 0.24 inches.

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.

[6] HRRR sounding was created using NOAA Air Resource Laboratory: https://ready.arl.noaa.gov/READYamet.php

[7] 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.

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

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

[10] 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.

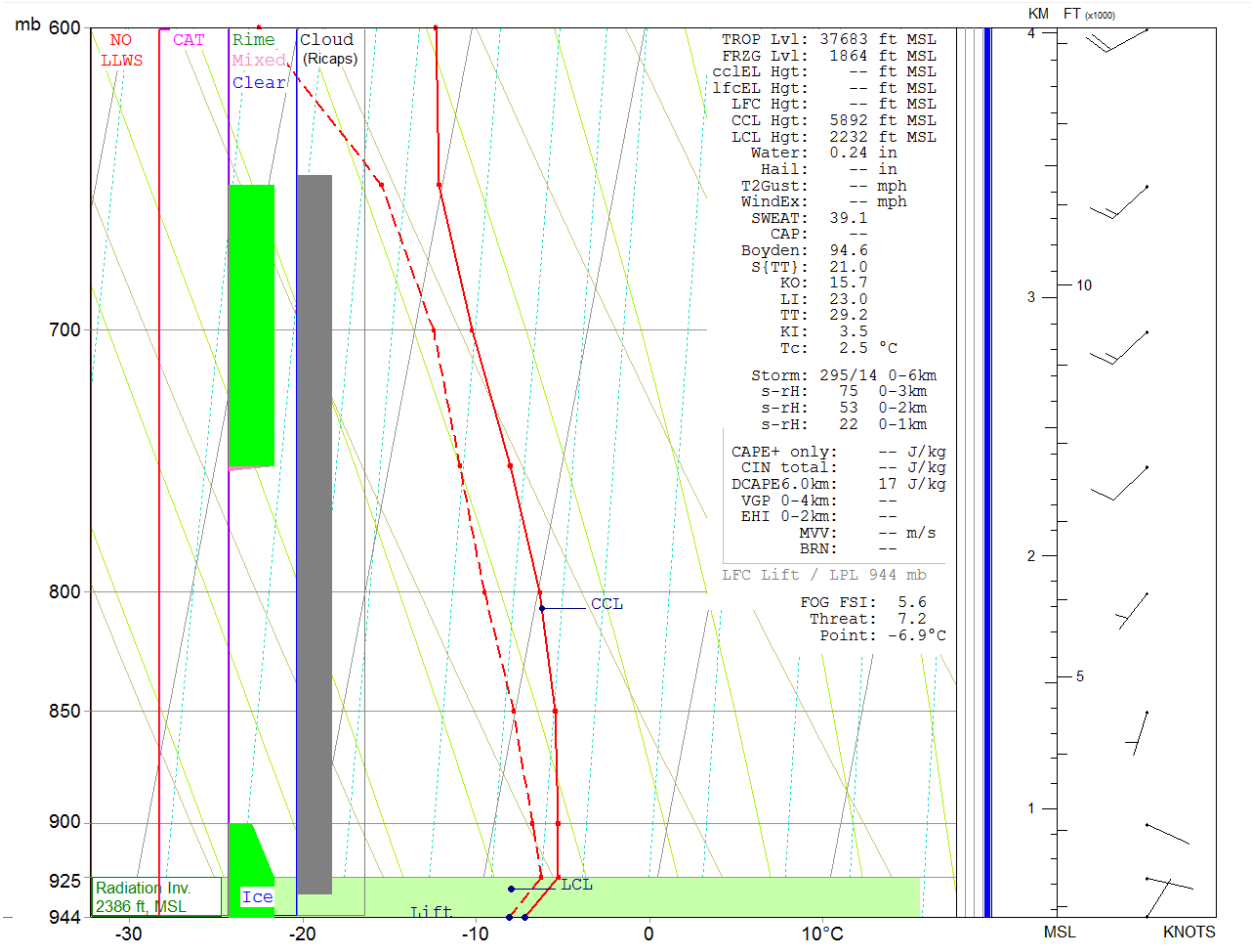


Figure 5 – 1800 AKST GDAS sounding for the accident site

The 1800 AKST GDAS sounding for the accident site indicated a stable layer from the surface through 14,000 ft. RAOB identified the possibility of clouds from ~400 ft agl (~2,250 ft msl) through 11,000 ft msl with moderate rime icing conditions likely in clouds between the surface and 2,000 ft msl. Light to moderate rime icing was indicated by RAOB above 2,000 ft msl to 3,000 ft msl and above 8,000 ft msl. An inversion[11] was located at ~500 ft agl (~2,400 ft msl) consistent with the stable atmosphere indicated by RAOB below 14,000 ft msl.

The 1800 AKST GDAS sounding wind profile indicated a surface wind from 031° at 2 knots with the wind becoming southwesterly by 7,000 ft msl at 10 knots. The wind continued to veer[12] to the west by 14,000 ft msl and the wind speed increased to 20 knots. RAOB did not indicate the possibility of low-level wind shear (LLWS) or clear-air turbulence below 10,000 ft msl.

[11] Inversion – A departure from the usual decrease of the value of an atmospheric property with increasing altitude; also, the layer through which this departure occurs (the "inversion layer"), or the lowest altitude at which the departure is found (the "base of the inversion").
[12] A clockwise turning of the wind with height in the northern hemisphere.

4.0 Satellite Data

Data from the Geostationary Operational Environmental Satellite number 17 (GOES-17) 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 (bands 2 and 13) imagery at wavelengths of 0.64 microns (μm) and 10.3 μm were retrieved for the period. Satellite imagery surrounding the time of the accident, from 1500 AKST through 2200 AKST at approximately 5-minute intervals were reviewed, and the closest images to the time of the accident are documented here.

Figures 6 and 7 present the GOES-17 visible imagery from 1715 and 1730 AKST at 2X magnification with the accident site highlighted with a red square. The GOES-17 imagery indicated overcast cloud cover above the accident site above PAPT and above SKMA2 at the accident time with scattered to broken cloud cover west and northwest of PAPT. The cloud cover was moving from southwest to northeast.

Figure 8 presents the GOES-17 infrared imagery from 1730 AKST at 6X magnification and with a temperature enhance curve applied with the accident site highlighted with a red square. Inspection of the infrared imagery indicated abundant cloud cover over the accident site at the accident time with the lowest brightness temperatures (green colors, higher clouds) located in southwestern Alaska. Based on the brightness temperatures above the accident site (248 Kelvin) and the vertical temperature profile provided by the 1800 AKST GDAS sounding, the approximate cloud-top heights over the accident site were 20,000 ft at 1730 AKST. It should be noted these figures have not been corrected for any parallax error.

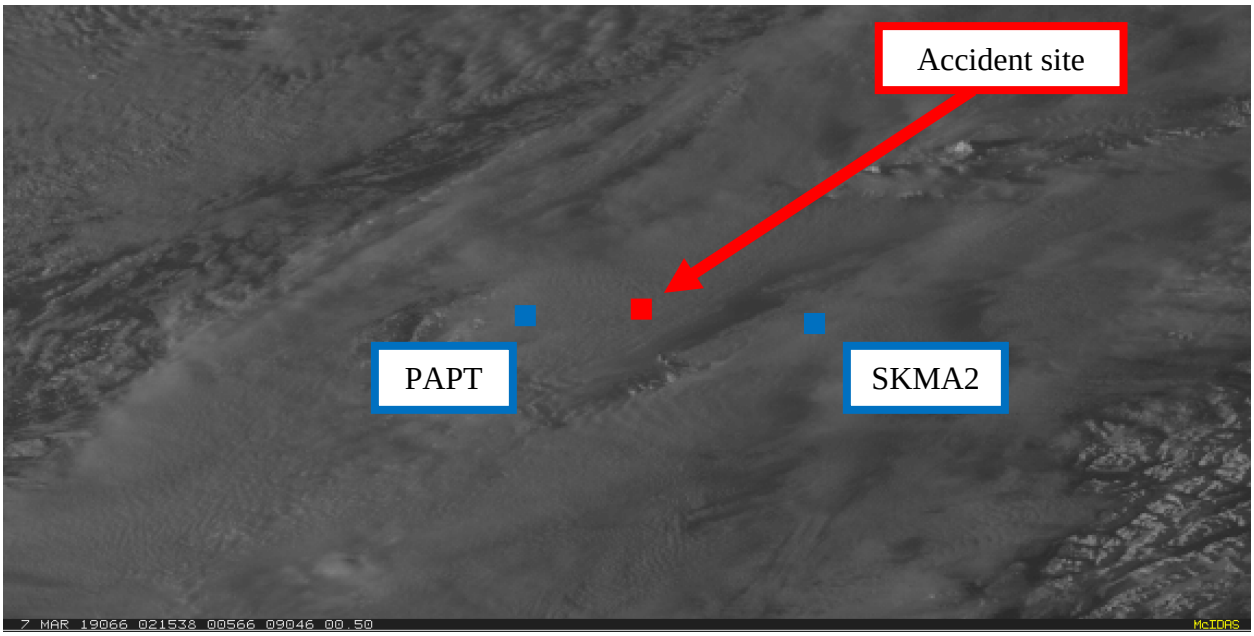


Figure 6 – GOES-17 visible image at 1715 AKST

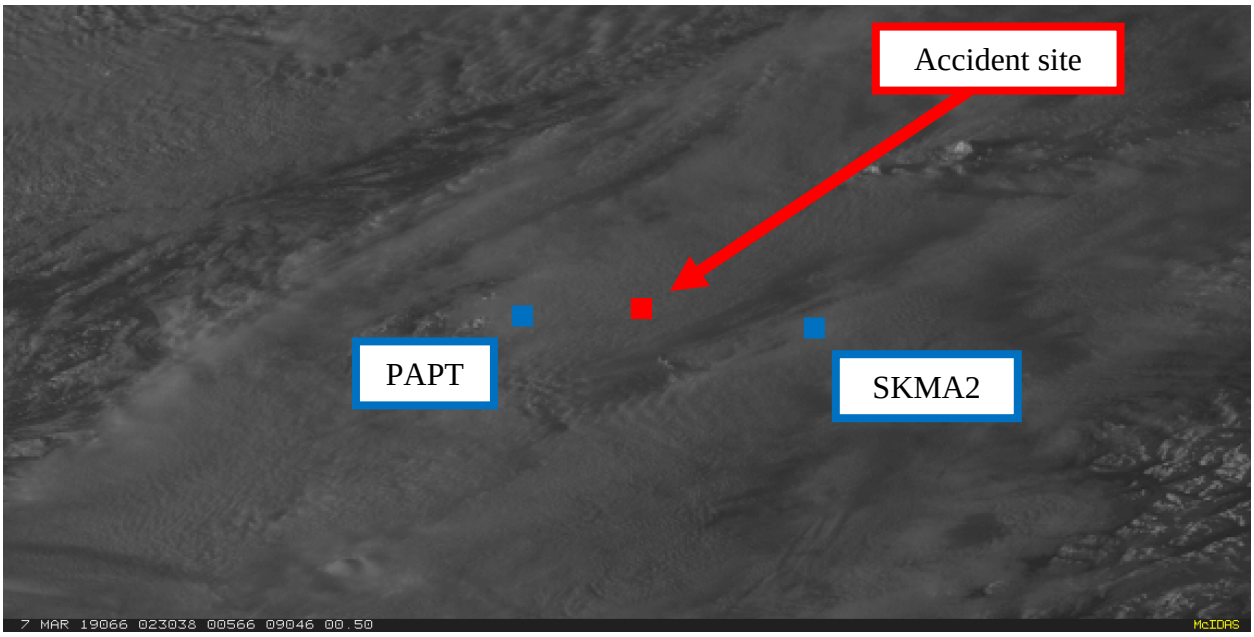


Figure 7 – GOES-17 visible image at 1730 AKST

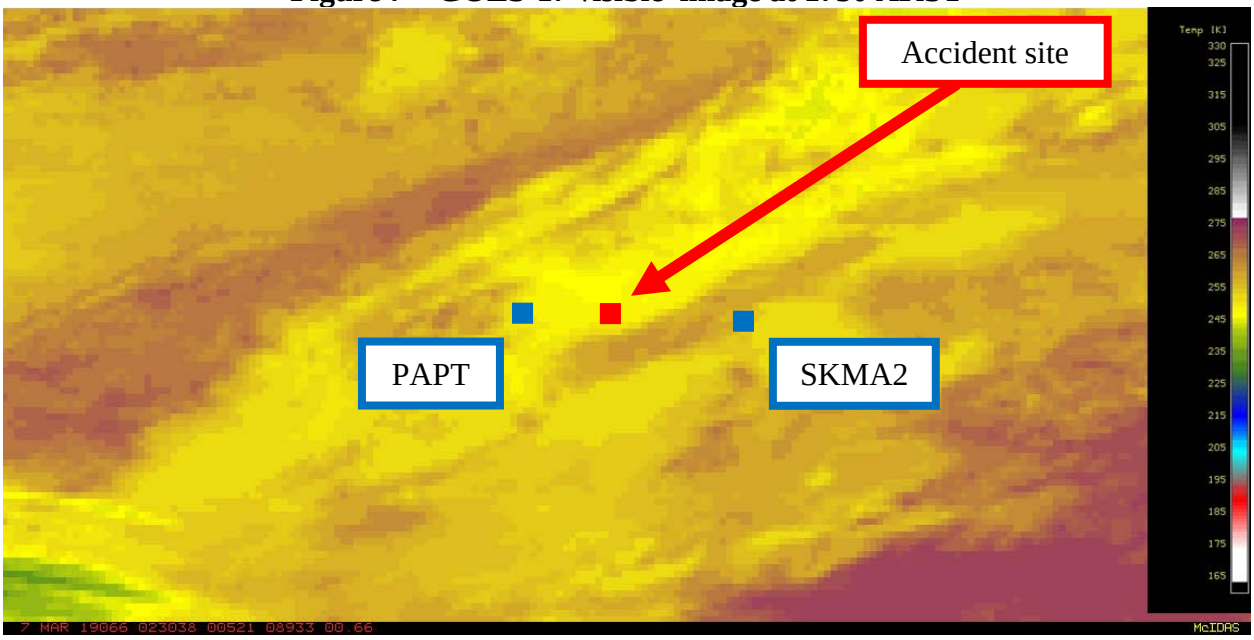


Figure 8 – GOES-17 infrared image at 1730 AKST

5.0 Radar Imagery Information

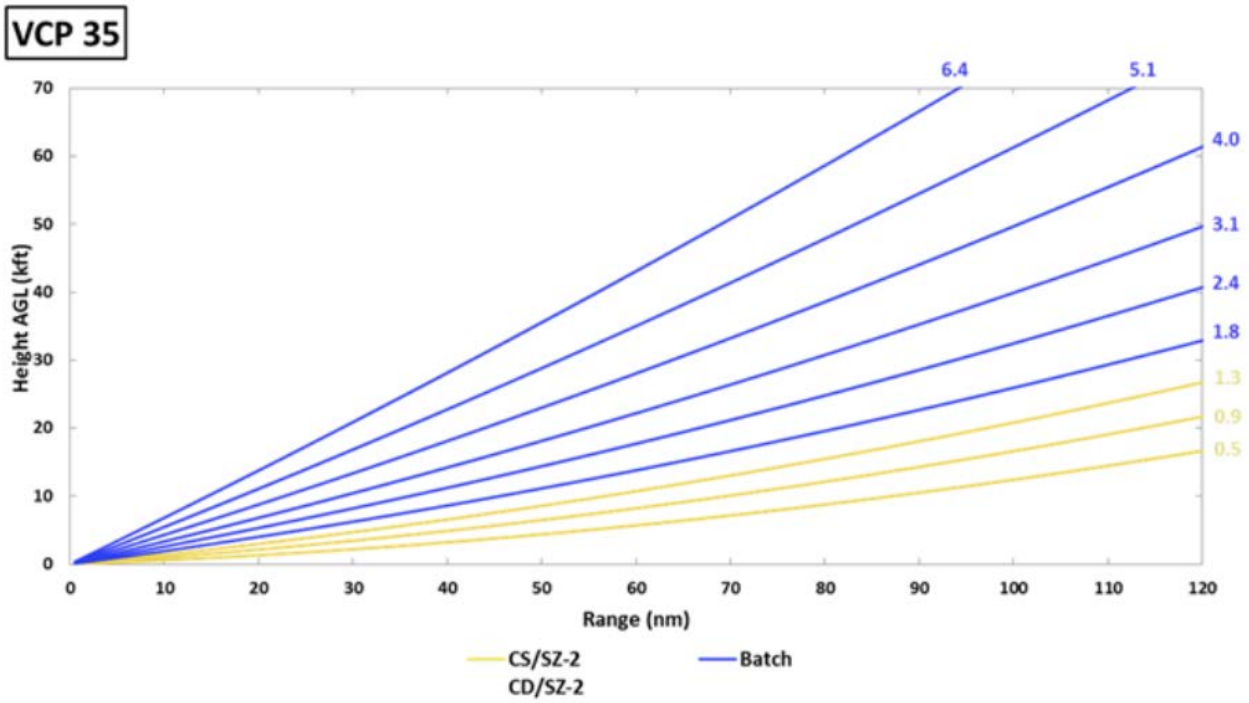
The closest NWS Weather Surveillance Radar-1988, Doppler (WSR-88D)[13] to the accident site was Kenai, Alaska, (PAHG), which had an antenna elevation of 356 ft and was located 86 miles southeast of the accident site. Level II archive radar data were obtained from the NCEI utilizing the NEXRAD Data Inventory 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 five to ten-minute volume scan.

The WSR-88D operates in several different scanning modes, identified as Mode A and Mode B. Mode A is the precipitation scan and has three common scanning strategies. The most common is where the radar makes 15 elevation scans from 0.5° to 19.5° every six minutes. This particular scanning strategy is documented as volume coverage pattern 215 (VCP-215). Mode B is the clear-air mode, where the radar makes 9 elevation scans during a seven-minute period. During the period surrounding the accident, the PAHG WSR-88D radar was operating in the clear-air mode VCP-35. 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.

[13] The WSR-88D is an S-band 10-centimeter wavelength radar with a power output of 750,000 watts, and with a 28-foot parabolic antenna that concentrates the energy between a 0.87° and 0.96° beam width. The radar produces three basic types of products: base reflectivity, base radial velocity, and base spectral width.



VCP-35 Clear-air Mode Scan Strategy[14]

5.2 Beam Height Calculation

Assuming standard refraction[15] of the WSR-88D radar beam with the antenna elevation at 356 ft (PAHG), and considering a beamwidth[16] of 0.95°, the following table shows the approximate heights for the radar beam center, top and base for antenna elevations over the accident site. These heights have been rounded to the nearest 10 ft.

ANTENNA ELEVATION	BEAM CENTER	BEAM BASE	BEAM TOP
KOKX 0.5°	10,280 ft	6,040 ft	14,520 ft

[14] 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)

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

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

Based on the radar height calculations, the elevation scan from PAHG listed in the above table depicted the conditions between 6,040 ft and 14,520 ft over the accident site and "saw" the closest altitudes to the ground and the accident aircraft's flight level before the accident.[17]

5.3 Reflectivity

Reflectivity is the measure of the efficiency of a target in intercepting and returning radio energy. With hydrometeors[18] 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 dBZ and is a general measure of echo intensity. FAA Advisory Circular AC 00-24C[19], "Thunderstorms," dated February 19, 2013, also defines the echo intensity levels and weather radar echo intensity terminology associated with those levels. 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." From the NWS, precipitation conditions at the surface can be inferred from VIP Levels described in the chart below:

- VIP 1 (Level 1, 18-30 dBZ) - Light precipitation
- VIP 2 (Level 2, 30-38 dBZ) - Light to moderate rain
- VIP 3 (Level 3, 38-44 dBZ) - Moderate to heavy rain
- VIP 4 (Level 4, 44-50 dBZ) - Heavy rain
- VIP 5 (Level 5, 50-57 dBZ) - Very heavy rain; hail possible
- VIP 6 (Level 6, >57 dBZ) - Very heavy rain and hail; large hail possible

5.4 Base Reflectivity and Lightning Data

Figure 9 presents the PAHG WSR-88D base reflectivity images for the 0.5° elevation scan initiated at 1727:11 AKST, with a resolution of 0.5° X 250 m. Reflectivity values between 0 and 15 dBZ were located above the accident site at the accident time, which was indicative of very light precipitation (section 5.3). The reflectivity bands were moving from southwest to northeast (attachment 2).

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[17] Flight Level – A Flight Level (FL) is a standard nominal altitude of an aircraft, in hundreds of ft. This altitude is calculated from the International standard pressure datum of 1013.25 hPa (29.92 inHg), the standard sea-level pressure, and therefore is not necessarily the same as the aircraft's true altitude either above mean sea level or above ground level.

[18] 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.

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

There were no lightning flashes[20] recorded around the accident site at the accident time.[21]

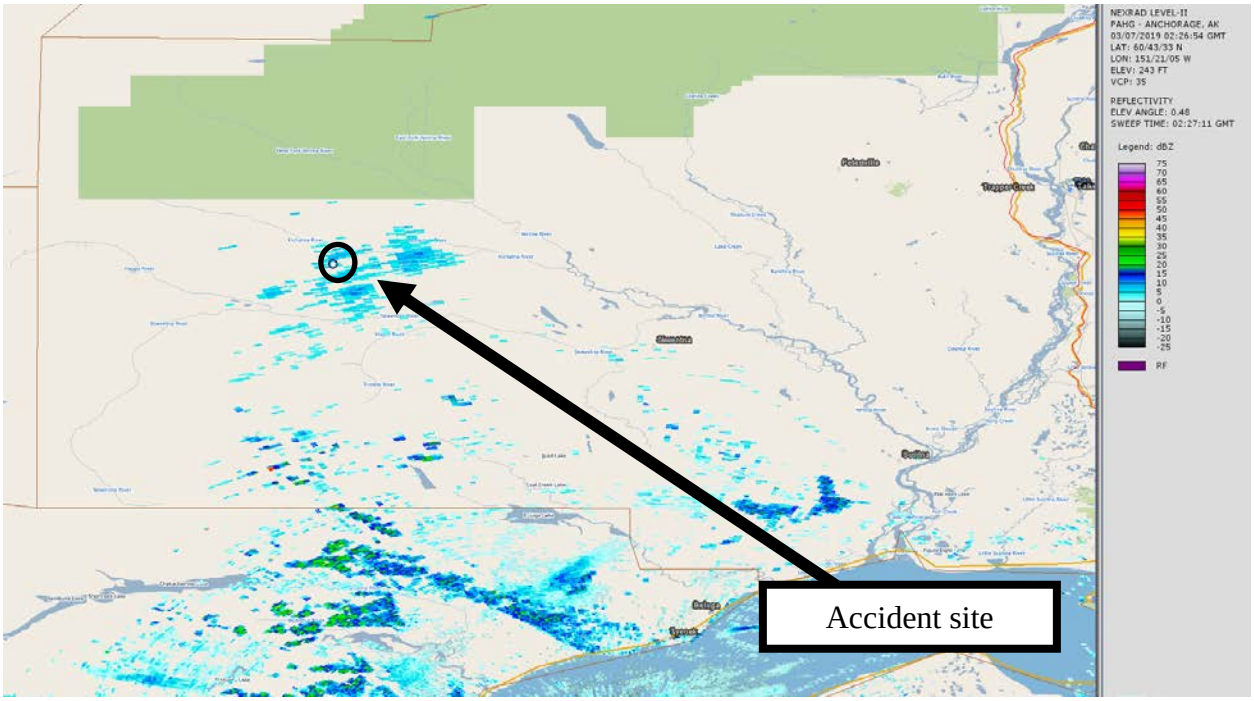

Figure 9 – PAHG WSR-88D reflectivity for the 0.5° elevation scan initiated at 1727:11 AKST with the accident site marked with a black circle

6.0 Pilot Reports

Only one pilot report (PIREP) was reported[22] within 80 miles of the accident site from about three hours prior to the accident time to about one hour after the accident time for FL200[23] and below.

SKW UA /OV LHD-SKW180010 /TM 0042 /FL010 /TP PA20 /SK BKN015 /WX FV10SM /TB NEG /RM PTCHY FG ALONG RVR..APPEARS LWR IN YENLO HILLS...BETTER TOWARD ALASKA RANGE

The report in plain language taken from standard code and abbreviations, with cloud heights in msl, was as follows:

[20] 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.
[21] A review of Earth Networks Total Lightning network was done.
[22] Only pilot reports with the World Meteorological Organization (WMO) header UBAK** were considered.
[23] Flight Level – A Flight Level (FL) is a standard nominal altitude of an aircraft, in hundreds of ft. This altitude is calculated from the International standard pressure datum of 1013.25-hPa (29.92 inHg), the average sea-level pressure, and therefore is not necessarily the same as the aircraft's true altitude either above mean sea level or above ground level.

Skwentna Airport, Alaska (SKW), routine pilot report (UA); Over – Lake Hood Airport (LHD) to 10 miles from SKW on the 180° radial; Time – 1542 AKST (0042Z); Altitude – 1,000 ft; Type aircraft – Piper PA-20 Pacer; Sky – Broken cloud cover at 1,500 ft; Weather – Flight visibility of 10 miles; Turbulence – Negative; Remarks – Patchy fog along river…appears lowers in Yenlo Hills… better toward Alaska Range.

7.0 SIGMET

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

8.0 CWSU Advisories

There were no Center Weather Service Unit (CWSU) Center Weather Advisories (CWA) or Meteorological Impact Statements (MIS) valid for the accident site at the accident time.

9.0 Area Forecast

The NWS Alaska Aviation Weather Unit (AAWU) issued the following Area Forecast for the accident site at 1202 AKST. The Area Forecast warned of Airmen's Meteorological Information (AIRMET) advisories for mountain obscuration and icing conditions (section 10.0) and the forecast was for broken ceiling to overcast clouds at 2,000 ft msl with overcast clouds at 3,500 ft and clouds tops to 12,000 ft with clouds above. Visibilities were forecast to be between 3 to 5 miles in light snow and mist. Isolated moderate icing conditions were forecast between 3,000 and 12,000 ft:

FAAK48 PAWU 062102
FA8H
ANCH FA 062115
AK SRN HLF EXCP SE AK...
.
AIRMETS VALID UNTIL 070515
CB IMPLY POSSIBLE SEV OR GREATER TURB SEV ICE LLWS AND IFR CONDS.
NON MSL HEIGHTS NOTED BY AGL OR CIG.
.
SYNOPSIS VALID UNTIL 071500
A 956 MB LOW VCY AMCHITKA WL MOV TO 250 N AMCHITKA BY 15Z. ASSOCD OCFNT ARCING FM LOW THRU THE CNTRL ALUTNS WL MOV INTO THE CNTRL BERING SEA TO VCY PADU BY END OF PD. A SFC TROF ALG THE AK RNG XTDG TO NEAR PADQ WL DSIPT.
.
COOK INLET AND SUSITNA VLY AB...VALID UNTIL 070900
...CLOUDS/WX...
*****AIRMET IFR***AK RANGE MERRILL PASS S SPRDG N OCNL CIG BLW 010 VIS BLW 3SM -SN BR. NC...**
*****AIRMET MT OBSC***AK RNG OCNL OBSC CLDS/PCPN. NC...**
SCT035 BKN-OVC060 TOP 120 LYRS ABV. ISOL BKN035.
N AND W PATK-PAHO LN BKN-OVC020 OVC035 TOPS 120 LYRS ABV VIS 3-5SM -SN BR.
OTLK VALID 070900-071500...ALG/VCY AK RANGE MVFR CIG SN.
PASSES...LAKE CLARK...MERRILL...IFR CIG SN BR.

RAINY...MVFR CIG SN ISOL IFR CIG SN. WINDY...VFR. OCNL MVFR CIG SHSN.
PORTAGE...MVFR CIG. OCNL VFR.
...TURB...
*****AIRMET TURB***OCNL MOD TURB FL300-FL400. NC...**
...ICE AND FZLVL...
*****AIRMET ICE***AFT 03Z SW PANC OCNL MOD ICEIC 030-100.**
FZLVL 010. INTSF...
W PANC ISOL MOD ICEIC 030-120.
.
COPPER RIVER BASIN AC...VALID UNTIL 070900
...CLOUDS/WX...
SCT200. VLY AREAS TIL 22Z ISOL CIG BLW 010 VIS BLW 3SM BR.
ST/FOG TOPS EST 010 AGL.
OTLK VALID 070900-071500...VFR.
PASS...TAHNETA...VFR.
...TURB...
AIRMET TURBAFT 03Z MTS PAGK W OCNL MOD TURB FL300-FL400. INTSF...
...ICE AND FZLVL...
NIL SIG. FZLVL SFC.
.
CNTRL GLF CST AD...VALID UNTIL 070900
...CLOUDS/WX...
AIRMET MT OBSCKENAI MTS OCNL OBSC CLDS/PCPN. IMPR...
KENAI PEN/OFSHR SCT025 BKN-OVC045 TOPS 120 FEW CI ABV.
MAINLY ALG COAST AND OFSHR OCNL BKN025 VIS 5SM -RASN/SN.
ELSW FEW025 SCT045.
OTLK VALID 070900-071500...PAWD-PAMD LN S MVFR CIG SHRASN. ELSW VFR.
...TURB...
AIRMET TURBAFT 00Z NW MONTAGUE IS OCNL MOD TURB FL300-FL400. INTSF...
...ICE AND FZLVL...
PAWD-PAMD LN SW ISOL MOD ICEIC 030-080.
TIL 03Z KENAI PEN S PAWD ISOL MOD ICEIC 030-120.
FZLVL 010.
.
KODIAK IS AE...VALID UNTIL 070900
...CLOUDS/WX...
AIRMET MT OBSCMTS OCNL OBSC IN CLDS/PCPN. IMPR FM SW...
NE PAKH BKN015 OVC025 TOP 080 FEW LYRS ABV OCNL -RA.
PAKH SW SPRDG SLOWLY NE SCT025. ISOL BKN025 TOP 080.
OTLK VALID 070900-071500...PAKH SW MVFR CIG. CHIFIKOF IS SW IFR CIG RASN.
ELSW VFR.
...TURB...
AIRMET TURBOCNL MOD TURB FL300-FL400. NC...
...ICE AND FZLVL...
AIRMET ICETIL 03Z NE PAKH OCNL MOD ICEIC 030-100.
FZLVL 010. WKN...
TIL 06Z NE PAKH ISOL MOD ICEIC 030-080.
.

10.0 AIRMETs

The AIRMETs valid at the accident time were issued at 1204 AKST and warned of mountain obscuration conditions due to clouds and precipitation and occasional moderate icing conditions between 3,000 and 10,000 ft with the freezing level at 1,000 ft msl:

WAAK48 PAWU 062104
WA8O
ANCS WA 062115
AIRMET SIERRA FOR IFR AND MT OBSC VALID UNTIL 070515
.
COOK INLET AND SUSITNA VLY AB
AK RANGE MERRILL PASS S SPRDG N OCNL CIG BLW 010 VIS
BLW 3SM -SN BR. NC.
.
COOK INLET AND SUSITNA VLY AB
AK RNG OCNL OBSC CLDS/PCPN. NC.
.
CNTRL GLF CST AD
KENAI MTS OCNL OBSC CLDS/PCPN. IMPR.
.
KODIAK IS AE
MTS OCNL OBSC IN CLDS/PCPN. IMPR FM SW.
.
KUSKOKWIM VLY AF
TIL 04Z PAMC-PASV LN E OCNL VIS BLW 3SM -SN BR. IMPR.
.
KUSKOKWIM VLY AF
MTS OCNL OBSC CLDS/PCPN. NC.
.
YKN-KUSKOKWIM DELTA AG
TIL 03Z PAHP-PASM LN N OCNL CIG BLW 010/VIS BLW 3SM BR. IMPR.
.
YKN-KUSKOKWIM DELTA AG
MTS OBSC BY CLDS/PCPN. IMPR FM S.
.
BRISTOL BAY AH
TIL 03Z OCNL CIG BLW 010/VIS BLW 3SM -SN BR/BR. IMPR.
.
BRISTOL BAY AH
MTS OBSC BY CLDS/PCPN. IMPR FM SE.
.
AK PEN AI
SPRDG E MTS OCNL OBSC IN CLDS/PCPN. DTRT.
.
AK PEN AI
SPRDG E AFT 03Z OCNL CIG BLW 010 VIS BLW 3SM -SN/RASN BR.
DTRT.
.
UNIMAK PASS TO ADAK AJ
PAKO E OCNL CIG BLW 010/VIS BLW 3SM -SN/-RASN BR.
IMPR FM W.
.
UNIMAK PASS TO ADAK AJ
MTS OCNL OBSC IN CLDS/PCPN. NC.
.
ADAK TO ATTU AK
OCNL CIG BLW 010 VIS BLW 3SM -RA BR. NC.
.
ADAK TO ATTU AK
MTS OCNL OBSC IN CLDS/PCPN. NC.

.
PRIBILOF ISLANDS AND SOUTHEAST BERING SEA AL
SPRDG NE TO PRIBILOFS BY 00Z OCNL CIG BLW 010 VIS BLW
3SM -SN/RA BR. DTRT.
.
=ANCT WA 062115
AIRMET TANGO FOR TURB/STG SFC WINDS VALID UNTIL 070515
.
COOK INLET AND SUSITNA VLY AB
OCNL MOD TURB FL300-FL400. NC.
.
COPPER RIVER BASIN AC
AFT 03Z MTS PAGK W OCNL MOD TURB FL300-FL400. INTSF.
.
CNTRL GLF CST AD
AFT 00Z NW MONTAGUE IS OCNL MOD TURB FL300-FL400. INTSF.
.
KODIAK IS AE
OCNL MOD TURB FL300-FL400. NC.
.
KUSKOKWIM VLY AF
OCNL MOD TURB FL300-FL400. NC.
.
YKN-KUSKOKWIM DELTA AG
OCNL MOD TURB FL300-FL400. WKN.
.
BRISTOL BAY AH
OCNL MOD TURB FL300-FL400. WKN FM SW.
.
AK PEN AI
TIL 00Z E PASD OCNL MOD TURB FL300-FL400. WKN.
.
AK PEN AI
AFT 03Z W PACD OCNL MOD TURB BLW 040. INTSF.
.
UNIMAK PASS TO ADAK AJ
W SEGUAM IS SUSTAINED SFC WND 30KT OR GTR. NC.
.
UNIMAK PASS TO ADAK AJ
TIL 00Z PAAK TO PADU OCNL MOD TURB FL300-FL400. WKN.
.
UNIMAK PASS TO ADAK AJ
PAKO E MOD TURB BLW 040.
ISOL SEV TURB WI 020 AGL. NC.
.
UNIMAK PASS TO ADAK AJ
PAAK W OCNL MOD TURB BLW 040. NC.
.
ADAK TO ATTU AK
AMCHITKA E SUSTAINED SFC WND 30KT OR GTR. NC.
.
ADAK TO ATTU AK
AFT 00Z TANAGA E MOD TURB BLW 040.
ISOL SEV TURB WI 020 AGL. INTSF.
.
ADAK TO ATTU AK

AFT 00Z AMCHITKA PASS OCNL MOD TURB BLW 040. INTSF.
.
PRIBILOF ISLANDS AND SOUTHEAST BERING SEA AL
PRIBILOFS NE SUSTAINED SFC WND 30KT OR GTR. WKN FM SW.
.
PRIBILOF ISLANDS AND SOUTHEAST BERING SEA AL
TIL 03Z OCNL MOD TURB FL300-FL400. WKN.
.
=ANCZ WA 062115
AIRMET ZULU FOR ICING VALID UNTIL 070515
.
COOK INLET AND SUSITNA VLY AB
AFT 03Z SW PANC OCNL MOD ICEIC 030-100.
FZLVL 010. INTSF.
.
KODIAK IS AE
TIL 03Z NE PAKH OCNL MOD ICEIC 030-100.
FZLVL 010. WKN.
.
YKN-KUSKOKWIM DELTA AG
OCNL MOD ICEIC 020-060. FZLVL SFC. NC.
.
AK PEN AI
00Z TO 06Z W PACD OCNL MOD ICEIC 040-160.
FZLVL BLW 010. WKN.
.
UNIMAK PASS TO ADAK AJ
TIL 00Z PAKO E OCNL MOD ICEIC 040-160.
FZLVL 010. WKN.
.

11.0 AAWU Graphics

The AAWU icing forecast, flying weather, low-level turbulence, and surface chart forecast graphics valid around the accident time are provided in figures 10 through 13. The AAWU graphics indicated that no turbulence conditions were forecast for the accident site, but isolated to constant moderate icing and MVFR to IFR conditions were forecast around the accident time for the accident site with precipitation in the form of snow and fog. For more information please see attachment 3.

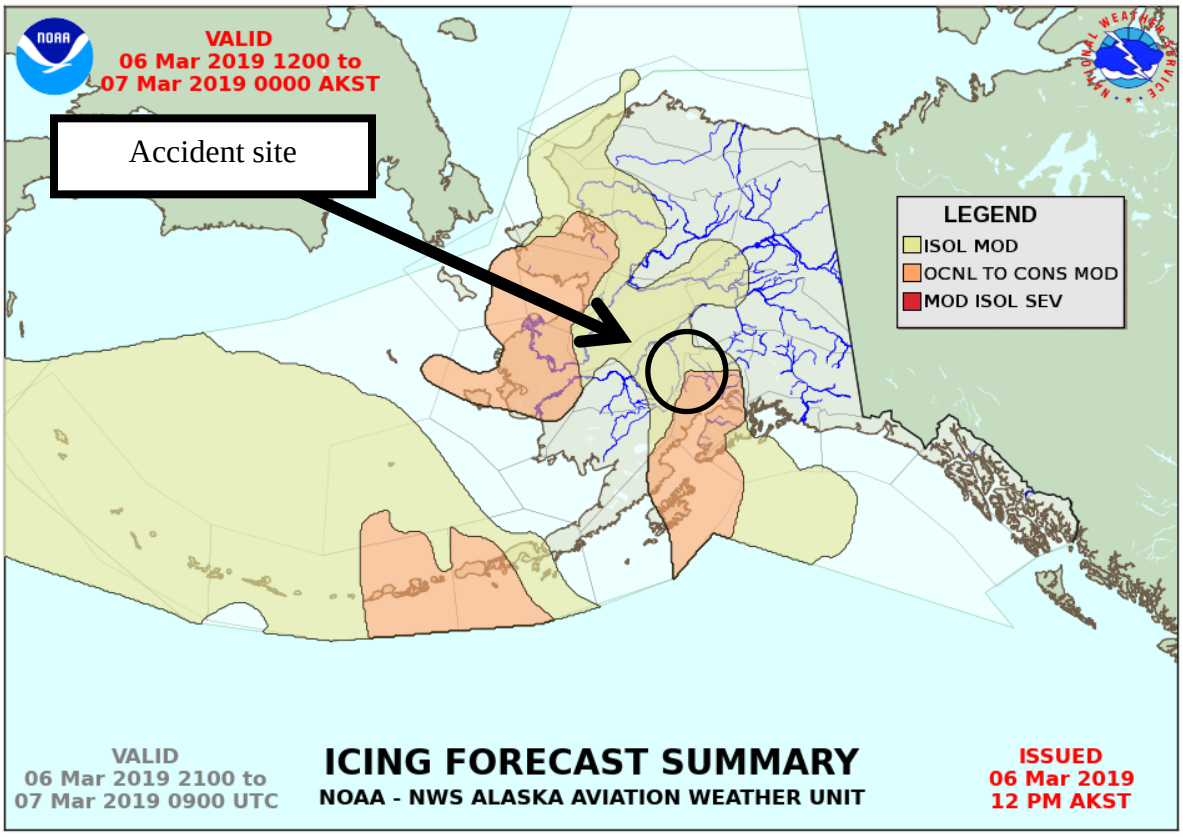

Figure 10 – Icing Forecast Summary graphic from the AAWU valid between 1200 AKST on March 6 and 0000 AKST on March 7 was issued at 1200 AKST on March 6

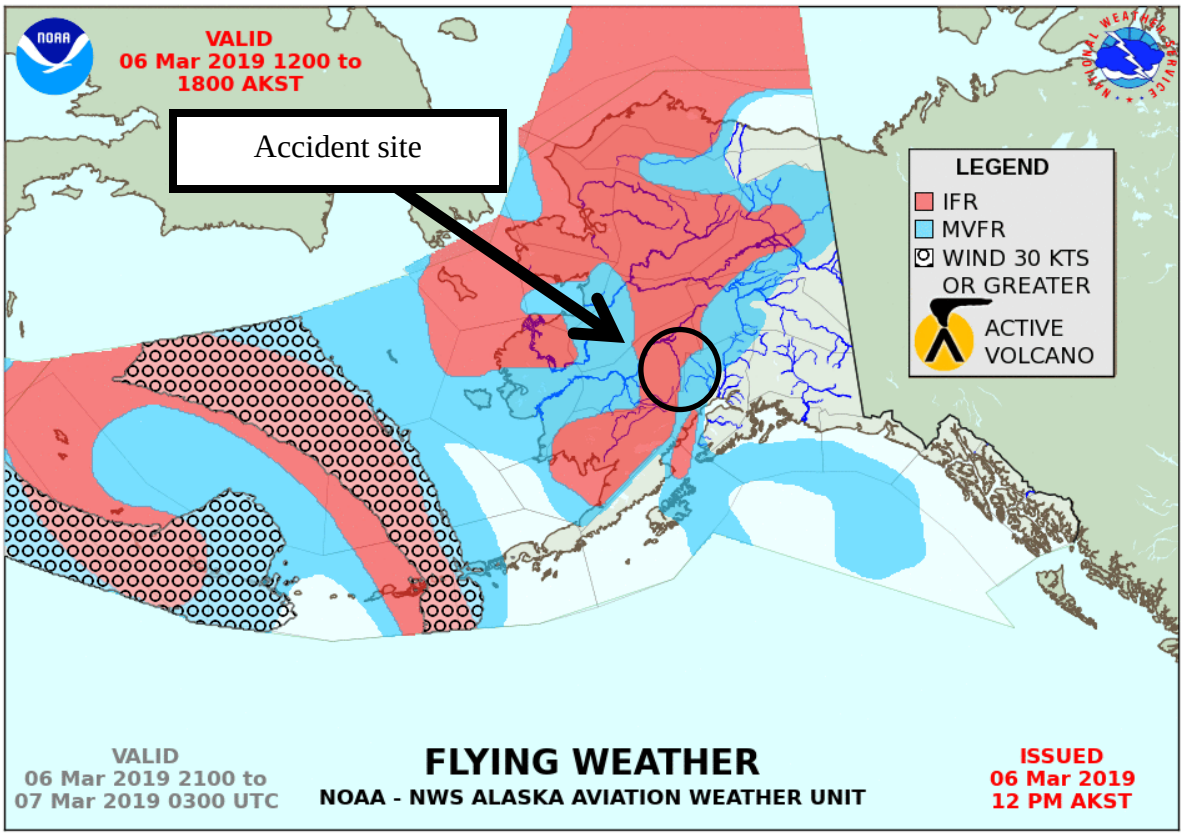

Figure 11 – Flying Weather graphic from the AAWU valid between 1200 and 1800 AKST was issued at 1200 AKST

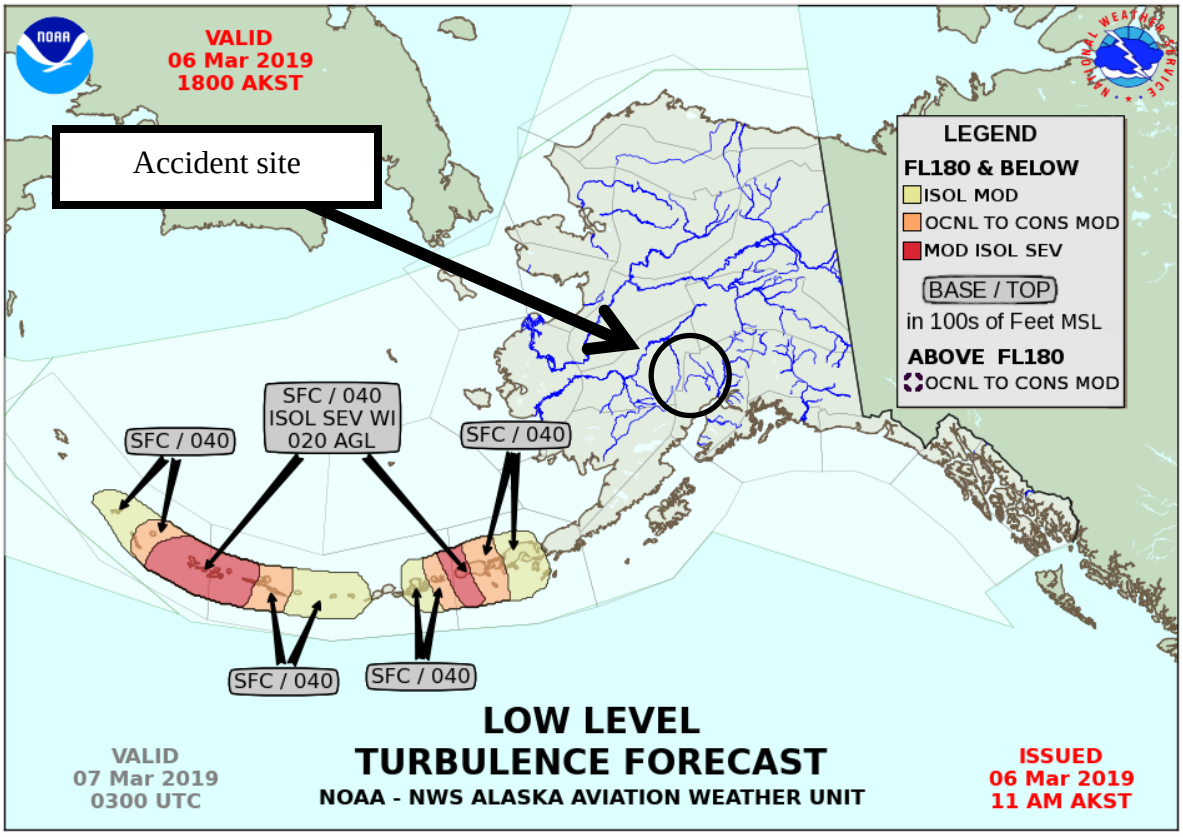

Figure 12 – Low-Level Turbulence Forecast graphic from the AAWU valid at 1800 AKST was issued at 1100 AKST

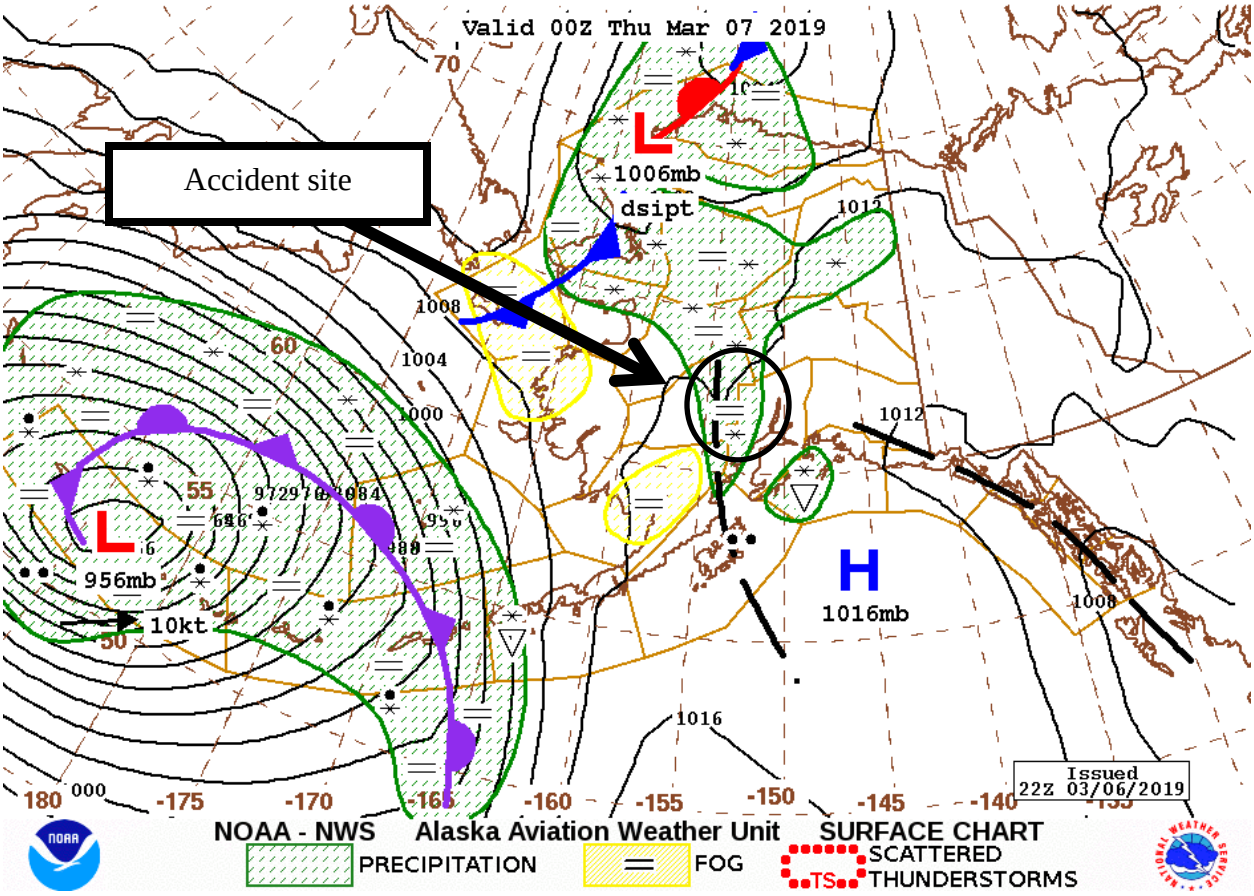

Figure 13 – AAWU Surface Chart valid at 1400 AKST was issued at 1300 AKST

12.0 Terminal Aerodrome Forecast

There were no NWS Terminal Aerodrome Forecast (TAF) valid within 50 miles of the accident site.

13.0 NWS Area Forecast Discussion

The NWS Office in Anchorage, Alaska, issued the following Area Forecast Discussion (AFD) at 1706 AKST (closest AFD to the accident time with an aviation section). The aviation section of the AFD discussed aviation weather conditions surrounding Anchorage, Alaska:

600
FXAK68 PAFC 070206
AFDAFC

Southcentral and Southwest Alaska Forecast Discussion
National Weather Service Anchorage AK
506 PM AKST Wed Mar 6 2019

.ANALYSIS AND UPPER LEVELS...
The upper level ridge that has been over Southcentral has moved

eastward into the Yukon Territory with another upper level ridge over Bristol Bay into the Southwest mainland. A large areas of mostly mid-to-high level clouds is between these ridges and is the remnants of the front that had been over the Bering Sea a few days ago. The IR satellite in particular shows these clouds well. The ridge has also caused subsidence over the Southwest mainland bringing some fog to the Bristol Bay coastline.

Going west we run into the big weather system that will be with us for the second half of the week. Visible satellite shows this low near Kiska this afternoon with the front extending over the majority of the Bering Seas and into the Eastern Aleutians. This low is in the upper 950s and the Shemya observation dropped under 960 mb this morning as the low tracked south of there.

&&

.MODEL DISCUSSION...
Models remain in overall good agreement the next few days. One area where they have all shifted is in the Alaska Peninsula through Kodiak region Friday into Saturday night. Models are now all picking up on a strengthening front in that AkPen and Kodiak region which will increase winds to Gale or Storm force which is a bit of an increase from previous forecasts.

&&

.AVIATION...
PANC...VFR conditions and light winds will persist. Some may be some light snow showers in the vicinity after midnight in to tomorrow morning. Even so, ceilings should remain above marginal conditions though they may drop below 5000 ft.

&&

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

Areas of snow showers stretching from western Cook Inlet north into the Susitna Valley will diminish this evening as a shortwave trough advances east over the Copper River Basin. Overnight, a second shortwave will move toward the AKPEN and western Gulf. The southeasterly flow ahead of this trough will bring another shot of rain for Kodiak beginning Thursday morning. As this feature lifts north, a surface low will develop over Shelikof Strait. This feature will track northeast, pushing gusty winds and a mix of rain and snow across portions of Southcentral by late Thursday. The strong southerly winds allow for some downsloping, limiting precipitation along the lee of the mountains. This feature will advance slowly north and east before stalling along the coast, keeping a mix of rain and snow going across the Southcentral coast through Friday. The trailing shortwave finally lifts north through the region late Friday as a third, more potent shortwave follows on its heels. This trough and its associated frontal system will push more moisture in the form of rain across Kodiak Island by early Saturday. Storm-force winds will also be possible along the surface front on Saturday as it tracks into across the

western Gulf. This feature moves then lifts toward Southcentral by late Saturday with more rain and higher elevation snow. Much like the previous systems, the wind flow aloft should keep precipitation along the lee of the mountains to a minimum.

Gap winds will also be a concern with each of these systems. The first uptick in winds will occur Thursday through Passage Canal and Turnagain Arm where winds could gust as high as 30 to 40 mph. The second, and most significant increase in gap winds, will come Saturday. A stronger pressure gradient with this weekend system could ratchet gusts as high as 45 to 55 mph across Turnagain Arm and the Anchorage Hillside. In addition, expect temperatures to steadily increase as the southerly flow ushers in warmer air from the Gulf. One area of uncertainty in the forecast does deal with the Turnagain Arm wind on Saturday. Models differ as to whether or not this wind will fully mix down to the surface and bend north across all of Anchorage. If it does, temperatures on Saturday could warm into the lower 40s allowing for decent snowmelt. Stay tuned...

&&

.SHORT TERM FORECAST SOUTHWEST ALASKA (Days 1 and 2...Tonight through Friday afternoon)...

An occluded front in the eastern Bering is quickly approaching Southwest. The front will move inland overnight and weaken as it continues to travel away from its parent low. However, for a brief period tonight, gusty southeast winds will kick in along the coastal areas of Southwest and will last through the early morning hours on Thursday. This may cause snow on the ground to be lofted, creating brief periods of blowing snow along the Kuskokwim Delta Coast through the overnight hours. Precipitation will initially fall as snow, though a change to a rain/snow mix and eventually rain will occur along the AKPEN for Thursday afternoon. Upper level support over this surface front dissipates quickly, leaving a mostly disorganized and weaker front stalling over Southwest through Friday. As colder air wraps around the fading parent low, any lingering precipitation will likely change back to snow Friday morning, especially over the Kuskokwim Valley. Showers are expected to last through Friday afternoon, ahead of another front that arrives over Southwest for the weekend.

&&

.SHORT TERM FORECAST BERING SEA/ALEUTIANS (Days 1 and 2...Tonight through Friday afternoon)...

A storm force low centered east of Attu Island continues to slowly move into the Bering. Its leading front moves into the eastern Bering this evening with gale force winds diminishing from west to east as the occluded front weakens and nears landfall over Southwest. Meanwhile, cold air wrapping around the backside of the low will produce an area of westerly storm force winds south of the Rat Islands before diminishing to gales Thursday morning. Precipitation associated with the front will start as snow,

however as warm air is advected northward, a change to rain/snow mix and eventually rain is expected. Behind the front, a showery regime will fill in across the Bering for Thursday. By Thursday afternoon, the low is centered west of the Pribilof Islands and weakens rapidly as it becomes vertically stacked. On the south side of the low, gale force westerlies are still expected to persist across the central Aleutians, however they will quickly diminish early Friday morning. This persistently active pattern will allow for another storm force low to arrive over the western Aleutians Friday afternoon.

&&

.MARINE (Days 3 through 5)...
(Saturday through Monday)

...Bering Sea and coastal waters of the Aleutians/AKPEN...

More of the same looks to be in store for the region, as the overall pattern remains relatively unchanged through the period. In general, look for another strong (~955 mb) low to pass roughly 250 nm south of Shemya Friday evening, reaching the Bristol Bay area late Sunday morning while weakening somewhat.

The associated front will swing north across the Aleutians late Friday evening. Given the track of the low, winds will increase to sustained gales along and ahead of the front for most of the Bering. South of the chain, the gales will develop following frontal passage by early Saturday morning, with seas building in excess of 30 feet.

A brief respite will then follow for Sunday across western portions of the area, as high pressure builds across the region, with decreasing winds and seas. However, another system (albeit significantly weaker) will then enter the western Bering/Aleutians for Monday.

...Gulf of Alaska...
(Sunday and Monday)

Following Saturday's frontal passage and strong winds, look for a decrease in wind speeds and wave heights to commence across the Gulf for Sunday and Monday. Southwesterly to westerly winds in the cyclonic flow will allow good fetch length to be maintained. However, a gradual decrease in the pressure gradient will result in coastal areas still seeing small craft conditions on Sunday, before improving for Monday.

Forecast Confidence: High

&&

.LONG TERM FORECAST (Days 3 through 7)...
(Saturday through Wednesday)

The models remain in pretty good agreement through Monday, before

a few wrinkles in the forecast develop. Overall, the pattern will feature a fairly strong area of low pressure located near the Kuskokwim Coast of Southwest Alaska on Saturday. The associated surface front will bisect the Gulf from northwest to southeast, with short-wave riding developing across the western Bering and Aleutians. Another low (albeit weaker than its predecessor) will quickly move into the area on the heels of the ridge, with the surface low tracking generally along the chain for Sunday into Monday, before turning more northeast towards southwest Alaska Tuesday morning.

It's after this point where a possible pattern change develops, making the forecast a bit more murky. Typically during these transitional phases, the models struggle to agree and this situation is now different. The overall theme is for an area of low pressure to lift northward into the Gulf from the Pacific sometime Wednesday. Here, the GFS portrays a 960 mb low approaching the Gulf, with its European counterpart (the ECMWF) almost 20 mb weaker, and the Canadian Global just showing a trough entering the region. Looking at the ensemble means would lend more support towards the European Solution. The thing is, the GFS was the only model showing a series of strong lows developing for the Bering a week or two ago, with the other models playing catch-up as the time approached. Will we see a repeat scenario...?...stay tuned.

&&

.AFC WATCHES/WARNINGS/ADVISORIES...
PUBLIC...NONE.
MARINE...Gale 155 165 170 172-176 178-181 185 411-414.
Storm 177.
FIRE WEATHER...NONE.

&&

$$

14.0 Winds and Temperature Aloft Forecast

The NWS 1658 AKST Winds and Temperature Aloft forecast valid for 2100 AKST for the closest point to the accident site is included below:

```
FBAK31 KWNO 070158
FD1AK1
DATA BASED ON 070000Z
VALID 070600Z   FOR USE 0200-0900Z. TEMPS NEG ABV 24000

FT  3000    6000    9000   12000   18000   24000  30000  34000  39000
TKA 9900 2210-10 2310-15 2416-21 2834-22 2846-33 295848 296657 275565
```

The accident site was closest to the Talkeetna, Alaska, (TKA) forecast point. The TKA forecast for use between 1700 AKST and 0000 AKST (March 7) indicated a calm wind at 3,000 ft, at 6,000 ft a wind from 220° at 10 knots with a temperature of -10 °C, at 9,000 ft a wind from 230° at 10 knots with a temperature of -15 °C, and at 12,000 ft a wind from 240° at 16 knots with a temperature of -21 °C.

15.0 Pilot Weather Briefing

The accident pilot did not request nor receive a weather briefing through Alaska Flight Services or Leidos. A check of ForeFlight was done and revealed that the accident pilot did not request weather information through ForeFlight. It is unknown if the accident pilot checked or received any weather information before or during the accident flight.

16.0 Web Camera Images

Images from the FAA's Aviation Weather Cameras are shown in figures 16 through 23 and provide pictures of the weather conditions surrounding the accident site at the accident time. Figure 14 indicates the web camera locations included in attachment 4.

The weather cameras (figures 15 through 23) from Puntilla Lake, located 16 miles west of the accident site at an elevation of 1,930 ft, showed the weather conditions surrounding the accident time with the north-facing camera images provided in figures 15 through 19 with times at 1718, 1728, and 1738 AKST. The north-facing camera images from Puntilla Lake depicted a large amount of cloud cover with bases below mountain tops (5,900 ft msl). In addition, the visibility below the cloud cover was less than 9.5 miles but greater than 4.5 miles. The southeast-facing camera images are provided in figures 21 through 23 with times at 1717, 1727, and 1737 AKST. The southeast-facing camera images from Puntilla Lake also depicted a large amount of cloud cover with cloud bases below mountain tops (6,300 ft msl) but above a 2,800 ft msl-high hill. In addition, the visibility was greater than 5.5 miles below the cloud cover in the southeast-facing direction. No precipitation was visible below the cloud cover. For more information, images, and camera locations please see attachment 4.

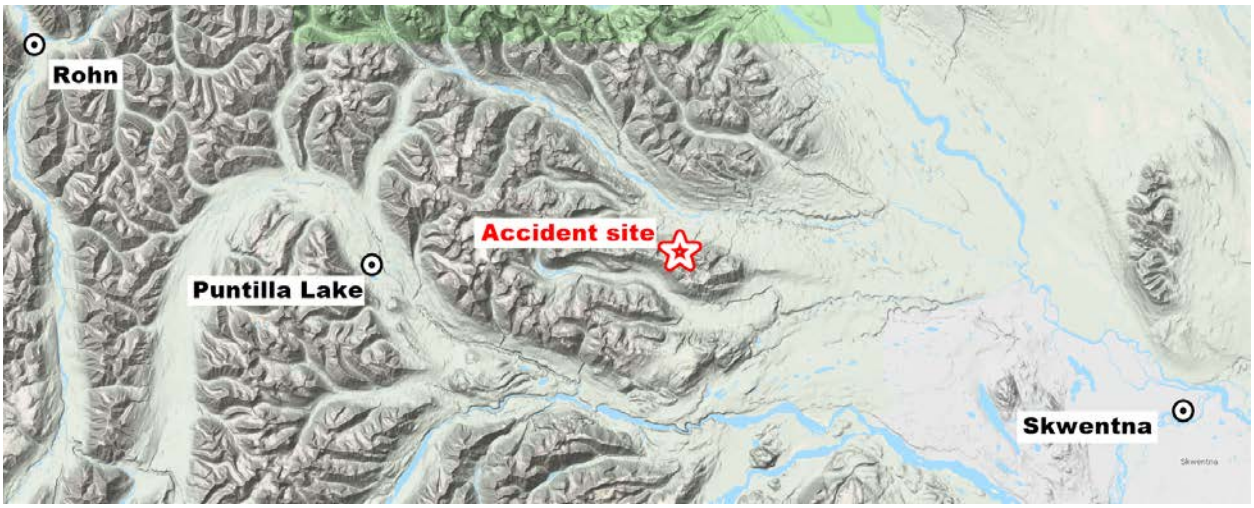

Figure 14 – Map of the closest FAA weather camera sites and the accident site

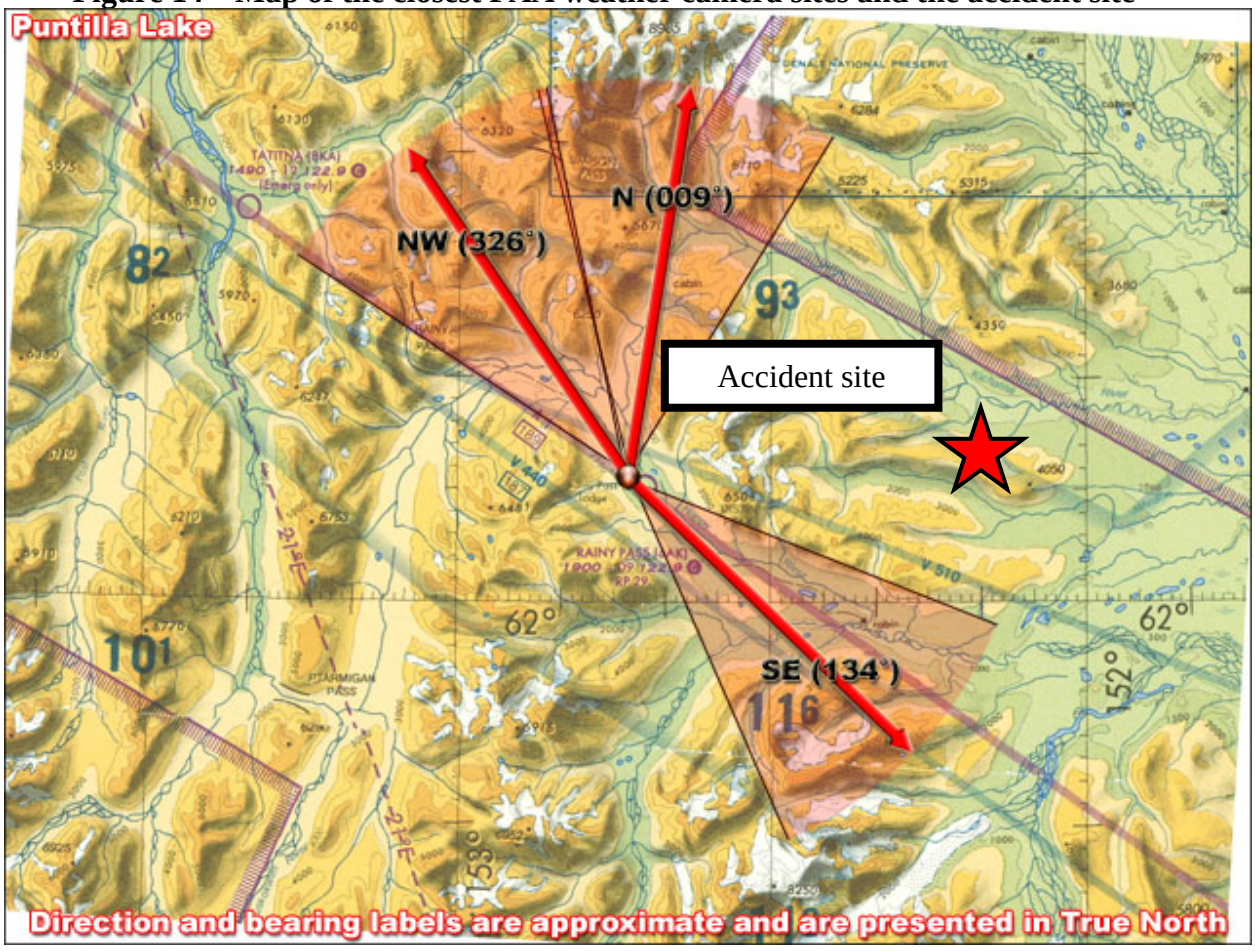

Figure 15 – FAA weather camera Puntilla Lake location on sectional chart with the direction the different camera angles face with the accident site marked

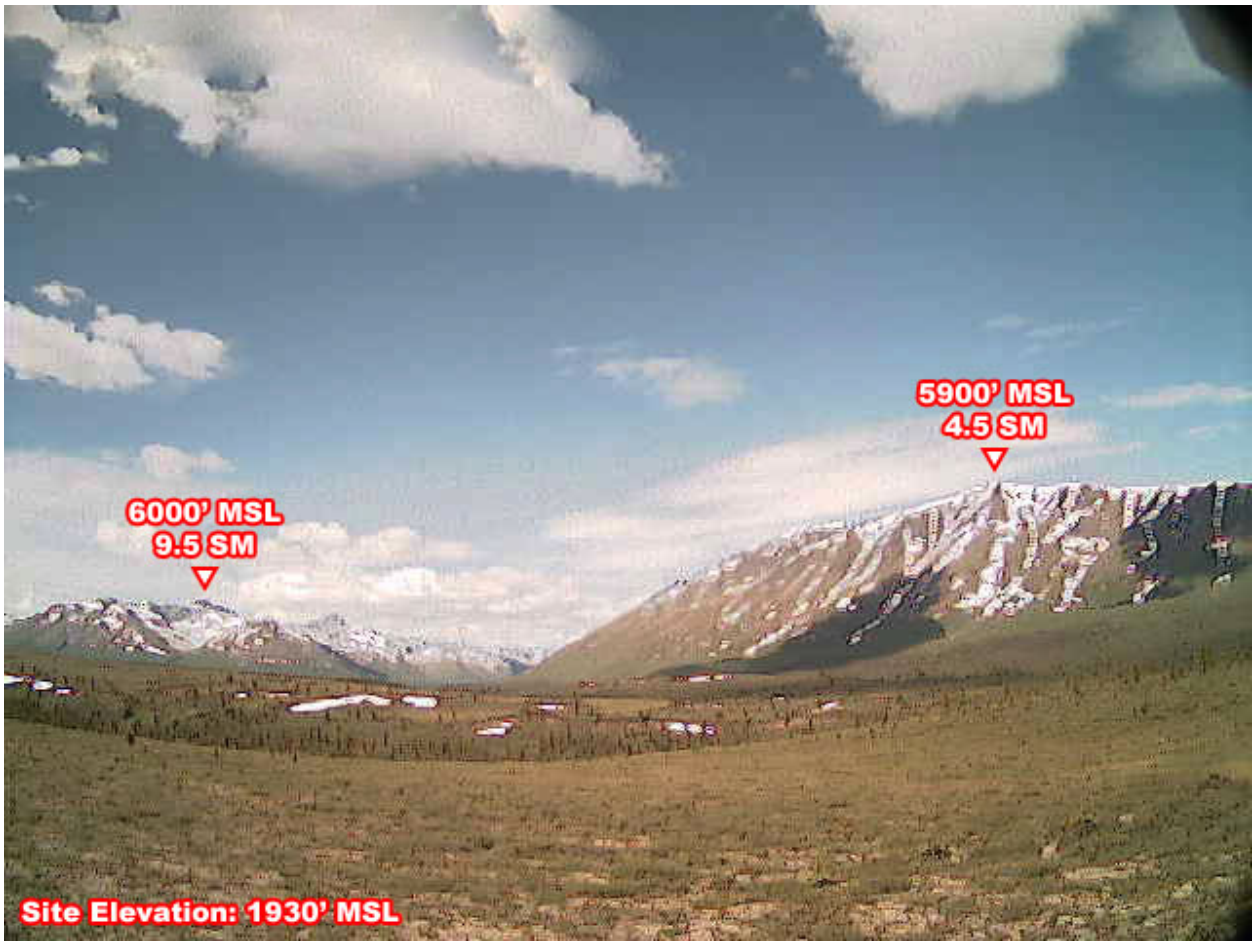

Figure 16 – FAA weather camera from Puntilla Lake north view from a standard clear sky weather day

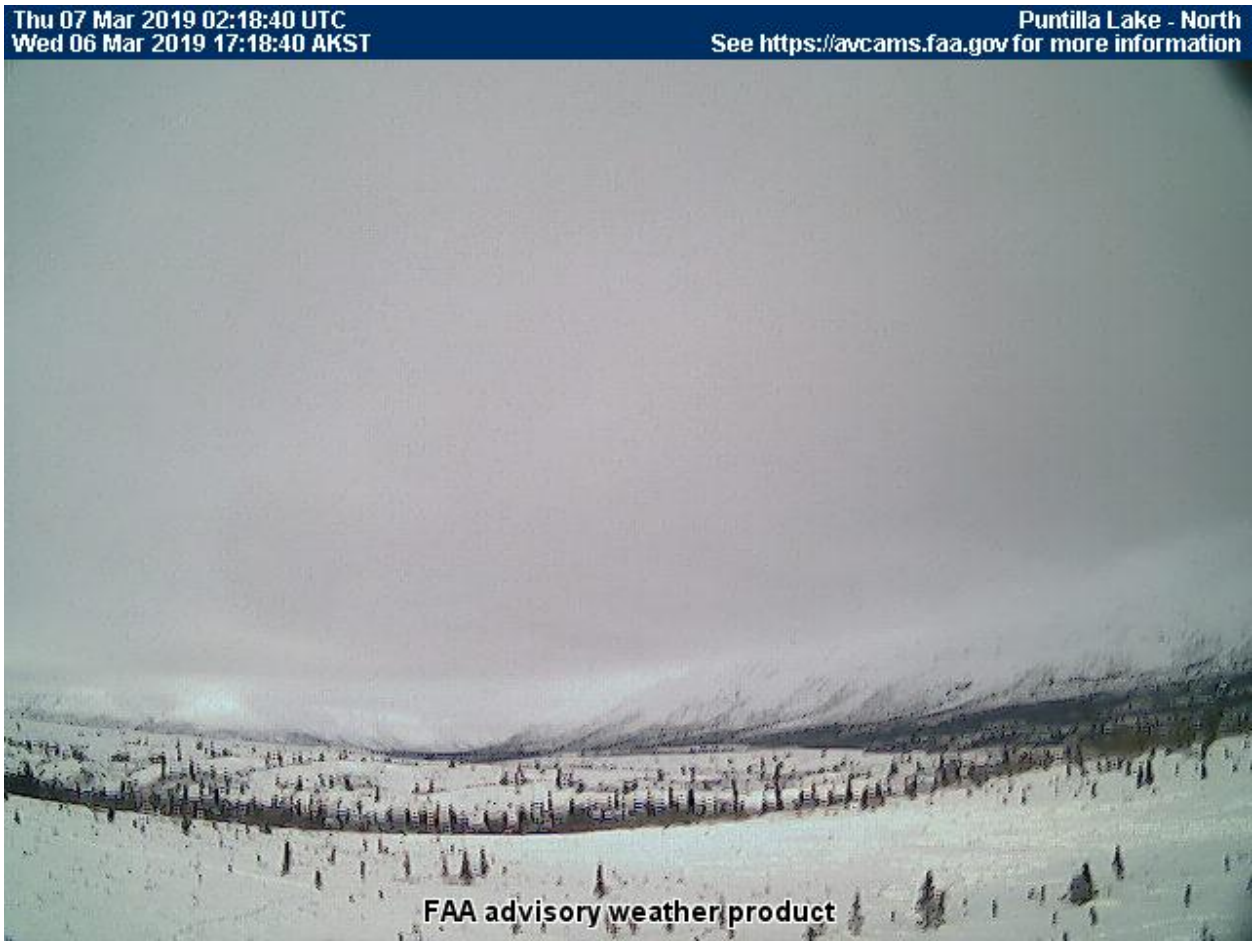

Figure 17 – FAA weather camera from Puntilla Lake north view from 1718 AKST

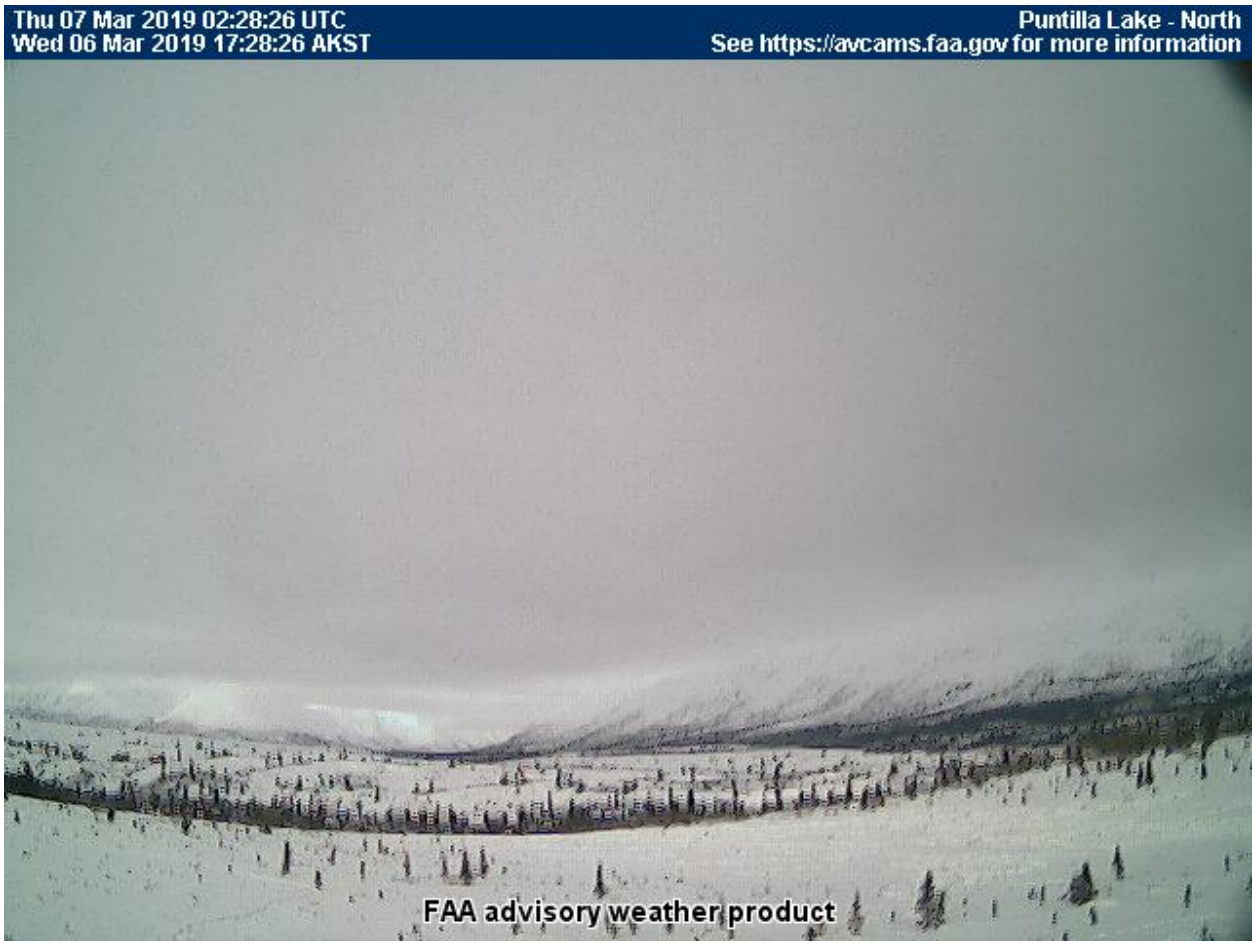

Figure 18 – FAA weather camera from Puntilla Lake north view from 1728 AKST

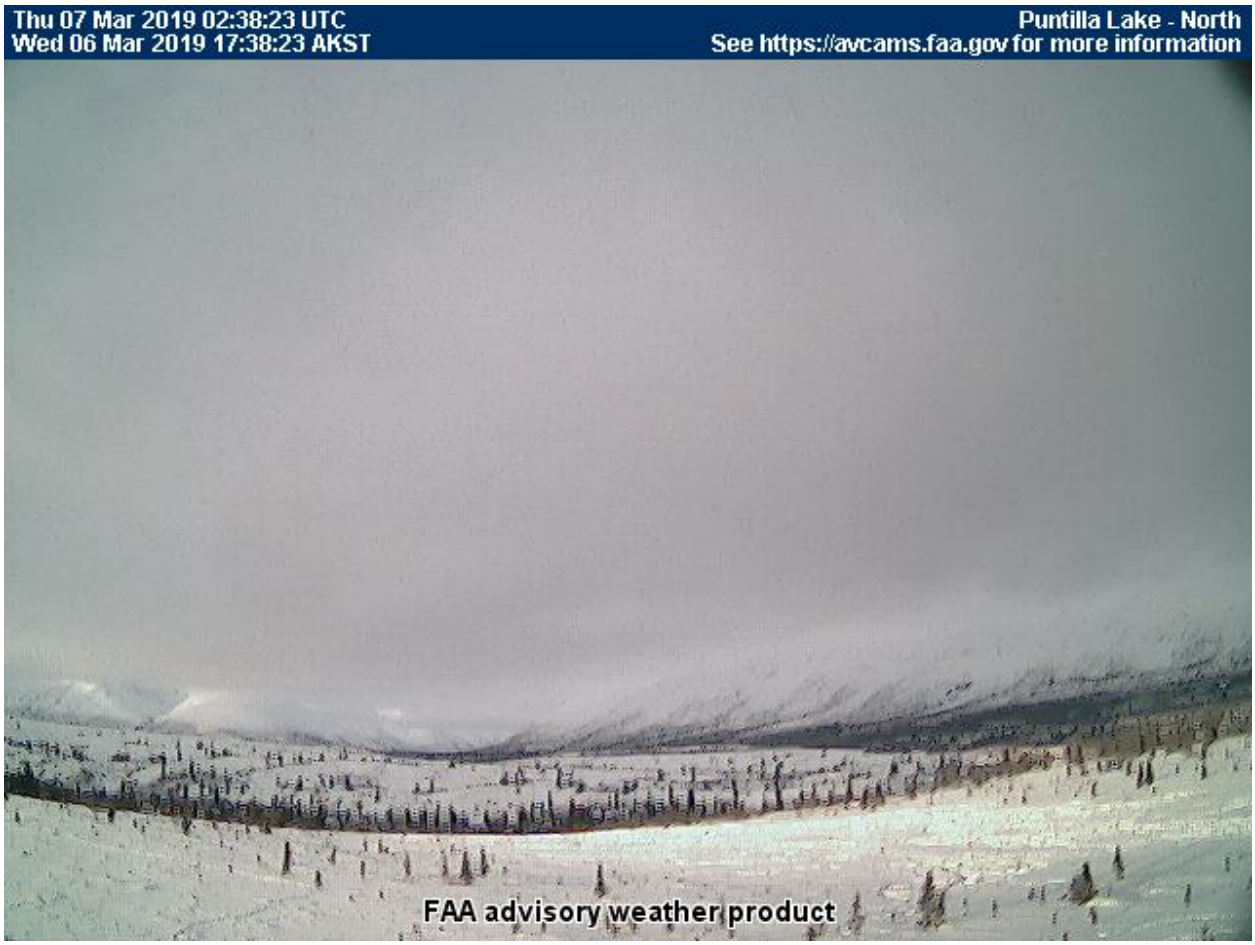

Figure 19 – FAA weather camera from Puntilla Lake north view from 1738 AKST

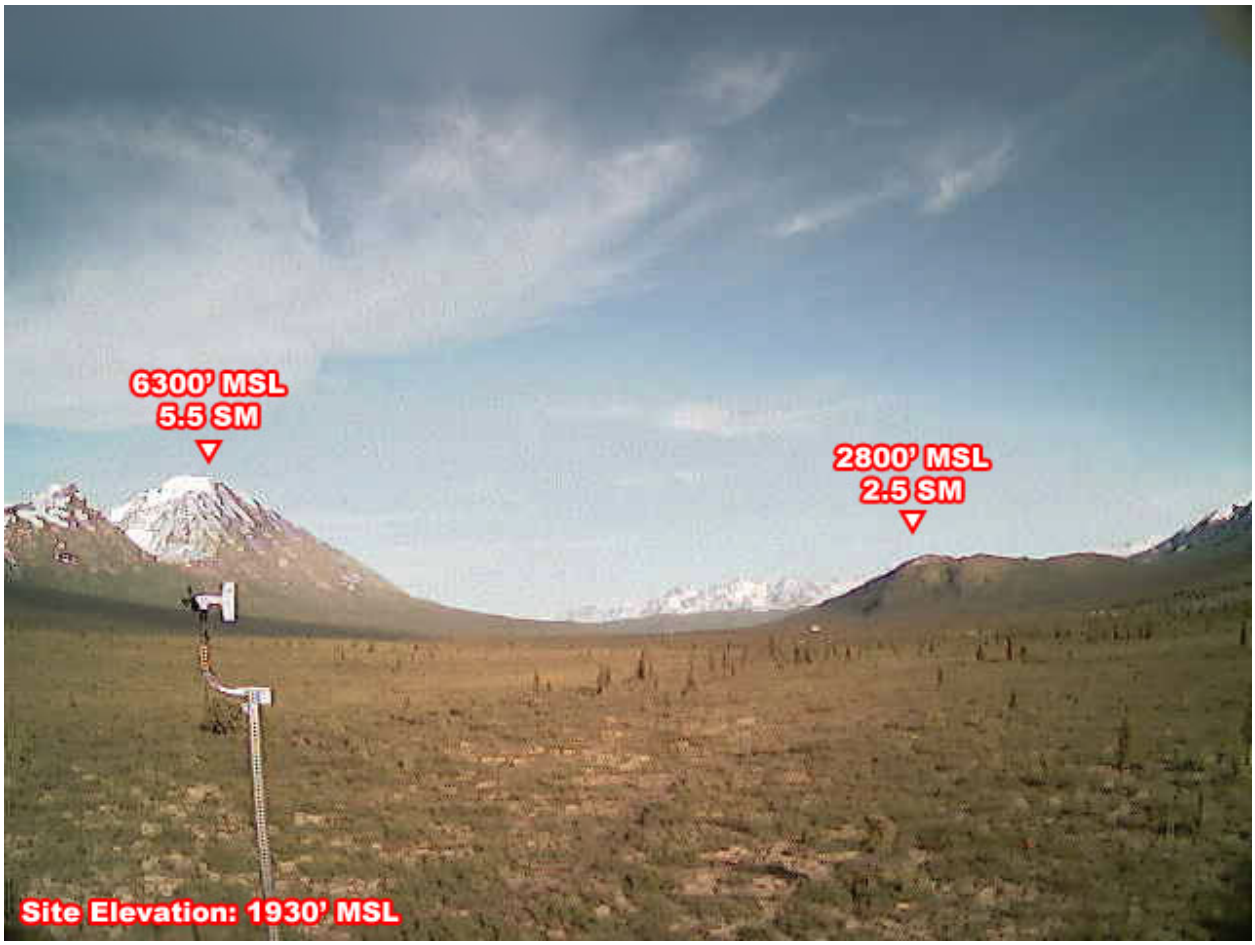

Figure 20 – FAA weather camera from Puntilla Lake southeast view from a standard clear sky weather day

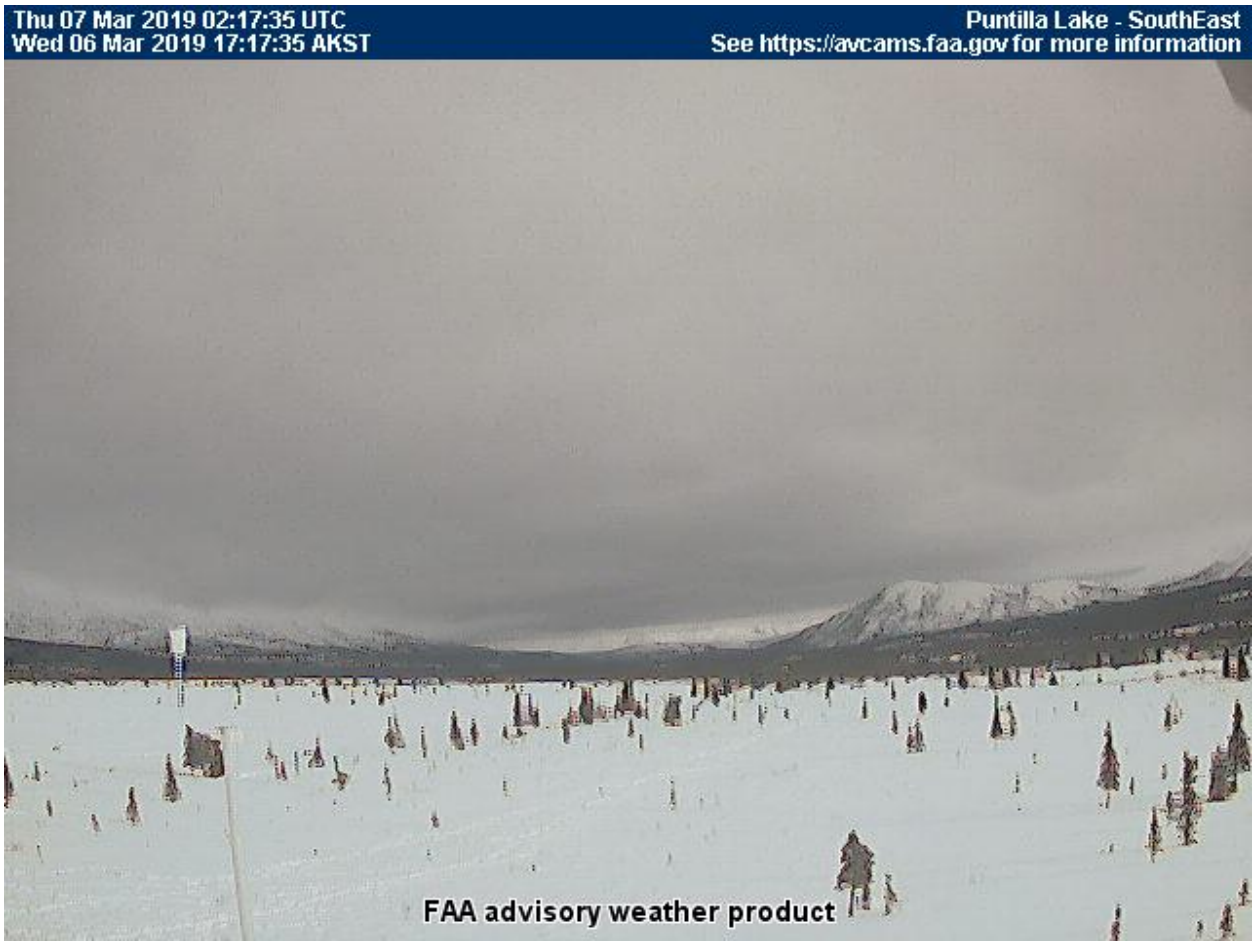

Figure 21 – FAA weather camera from Puntilla Lake southeast view from 1717 AKST

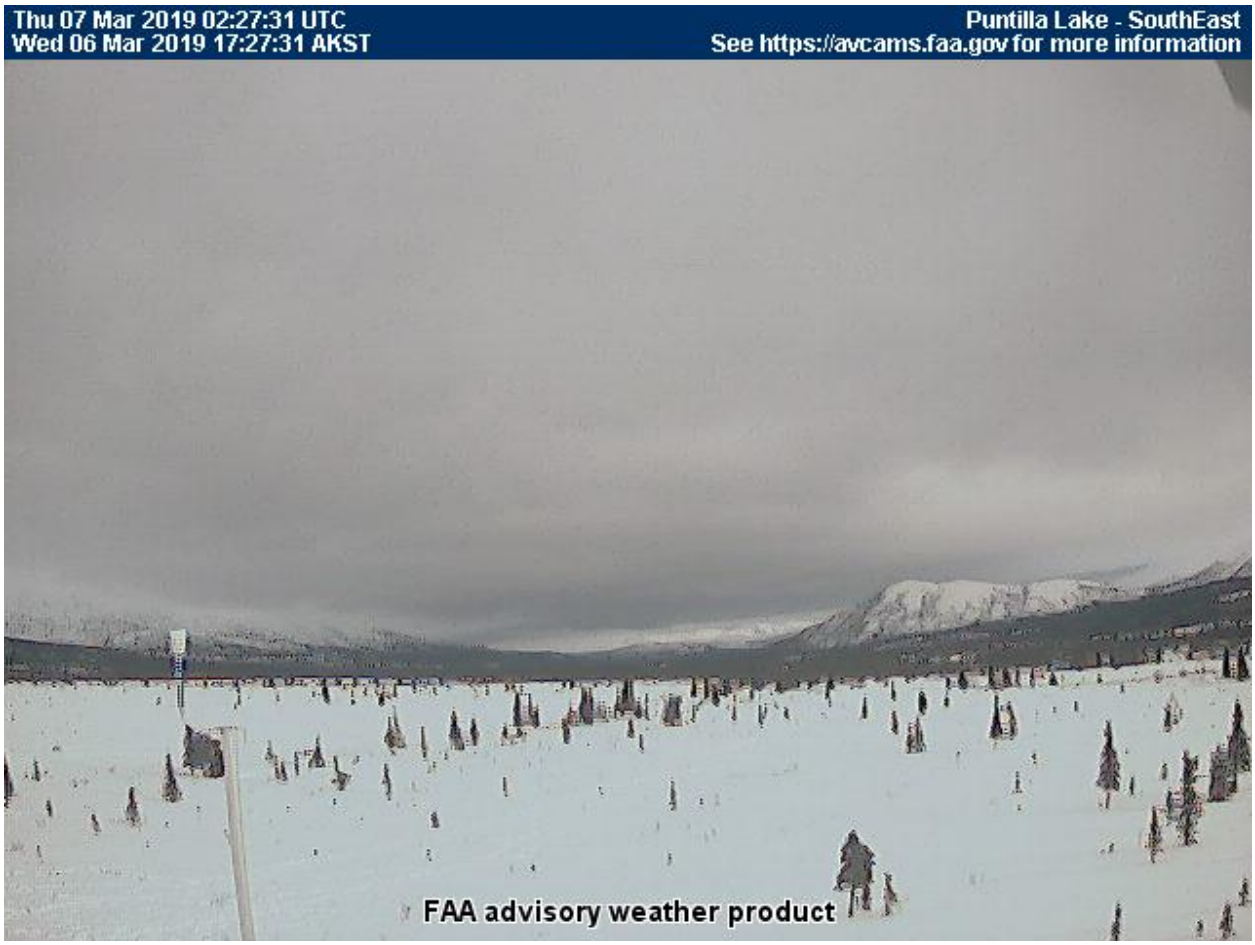

Figure 22 – FAA weather camera from Puntilla Lake southeast view from 1727 AKST

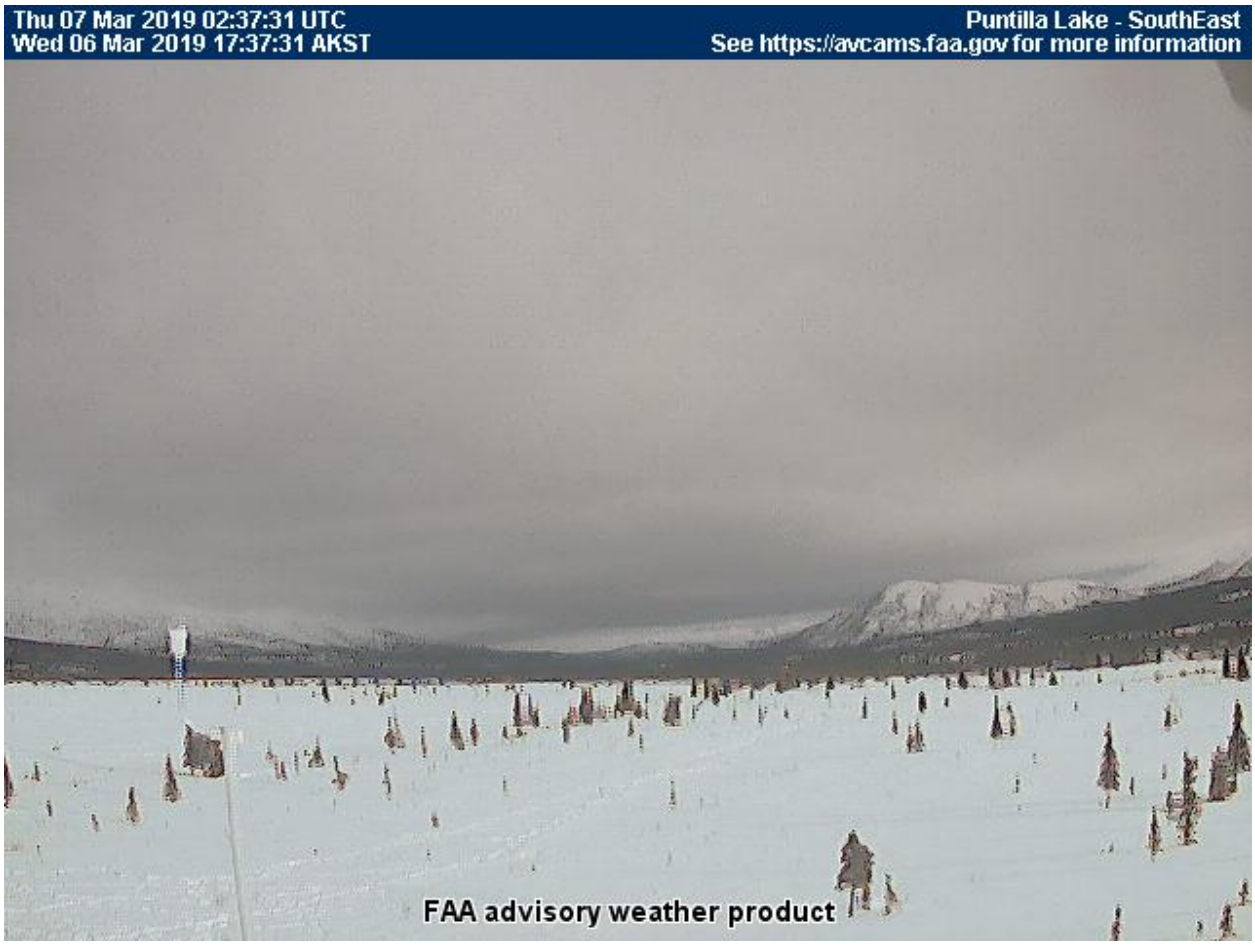

Figure 23 – FAA weather camera from Puntilla Lake southeast view from 1737 AKST

17.0 Witness Information

Please see witness statements located in the docket of this accident for more weather information surrounding the accident day.

18.0 Astronomical Data

The astronomical data obtained for the accident site on March 6, 2019, indicated the following:

SUN	
Begin civil twilight	0711 AKST
Sunrise	0755 AKST
Sun transit	1320 AKST
Accident	**1730 AKST**[24]
Sunset	1846 AKST
End civil twilight	1930 AKST

[24] Inserted accident time for reference and context.

E. LIST OF ATTACHMENTS

Attachment 1 – A-Paid observations at PAPT

Attachment 2 – PAHG base reflectivity animation from 1700 to 1753 AKST

Attachment 3 – AAWU forecast weather images from March 5 to March 7

Attachment 4 – Additional FAA Aviation Weather Camera information

Submitted by:

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Paul Suffern
Senior Meteorologist

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