



## **NATIONAL TRANSPORTATION SAFETY BOARD**

Office of Aviation Safety  
Washington, D.C. 20594

June 10, 2021

### **Specialist's Factual Report**

# **METEOROLOGY**

WPR21FA143

**Table Of Contents**

A. ACCIDENT ..... 3

B. METEOROLOGIST ..... 3

C. SUMMARY ..... 3

D. DETAILS OF THE INVESTIGATION ..... 3

E. WEATHER INFORMATION ..... 3

    1.0 Synoptic Conditions ..... 3

        1.1 Surface Analysis Chart ..... 4

        1.2 Forecast Weather ..... 5

        1.3 General Flight Categories ..... 5

        1.4 Low-Level Turbulence Forecast ..... 6

        1.5 Icing Forecast ..... 7

    2.0 Observations ..... 8

        2.1 Palmer, Alaska ..... 8

        2.2 Wasilla Airport ..... 10

        2.3 METAR Display ..... 10

    3.0 Sounding ..... 11

    4.0 Satellite Imagery ..... 13

    5.0 FAA Weather Camera Images ..... 15

    6.0 Pilot Reports ..... 19

    7.0 NWS Forecasts ..... 20

        7.1 Terminal Aerodrome Forecast ..... 20

        7.2 Area Forecast Discussion ..... 20

        7.3 Area Forecast ..... 22

        7.4 Winds Aloft Forecast ..... 23

        7.5 Inflight Weather Advisories ..... 23

    8.0 Astronomical Conditions ..... 23

F. LIST OF ATTACHMENTS ..... 25

## **A. ACCIDENT**

Location: Palmer, Alaska  
Date: March 27, 2021  
Time: about 1835 Alaska daylight time (AKDT)  
0235 Coordinated Universal Time (UTC)  
Airplane: Eurocopter AS350-B3; Registration: N351SH

## **B. METEOROLOGIST**

Don Eick  
Senior Meteorologist  
Operational Factors Division (AS-30)  
National Transportation Safety Board

## **C. SUMMARY**

On March 27, 2021, about 1835 Alaska daylight time, an Airbus Helicopters AS350-B3, 351SH, was destroyed when it was involved in an accident near Palmer, Alaska. The pilot and four passengers were fatally injured, and one passenger was seriously injured. The helicopter was operated as a *Title 14 Code of Federal Aviation Regulations* Part 135 on-demand charter flight.

## **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 saving 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 in feet (ft) above mean sea level (msl) unless otherwise noted. Visibility is in statute miles and fractions of statute miles.

This report provides a meteorological review on the weather conditions and NWS aviation weather products applicable to the region around the accident time. The accident site was based on the coordinates at latitude 61.449522° N and longitude 148.387886° W, where the helicopter rotor blades were documented striking the ridge at an elevation of approximately 6,266 ft.

## **E. WEATHER INFORMATION**

### **1.0 Synoptic Conditions**

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 College Park, Maryland, and the Alaska Aviation Weather Unit (AAWU) located 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 and other weather products documented in this report can be found in the joint NWS and Federal Aviation Administration (FAA) Advisory Circular “Aviation Weather Services”, AC 00-45H change 2.

### 1.1 Surface Analysis Chart

The NWS Surface Analysis Chart centered over southcentral Alaska for 1900 AKDT (0300Z on March 28, 2021) is included as figure 1 with the approximate accident site marked by a red star. The chart depicted a low-pressure system at 1003-hectopascals (hPa)<sup>1</sup> about 120 miles southeast of the accident site in the northern Gulf of Alaska with a trough of low pressure extending eastward along the Alaska coast and northwestward from the low into Prince William Sound and over the Palmer and Wasilla area, and immediately west of the accident site. Troughs are often marked by a wind shift and can act as a lifting source for clouds and precipitation if sufficient moisture is present. A general cyclonic or counterclockwise wind flow existed around the low with winds generally from the northwest at 10 knots over the accident site.

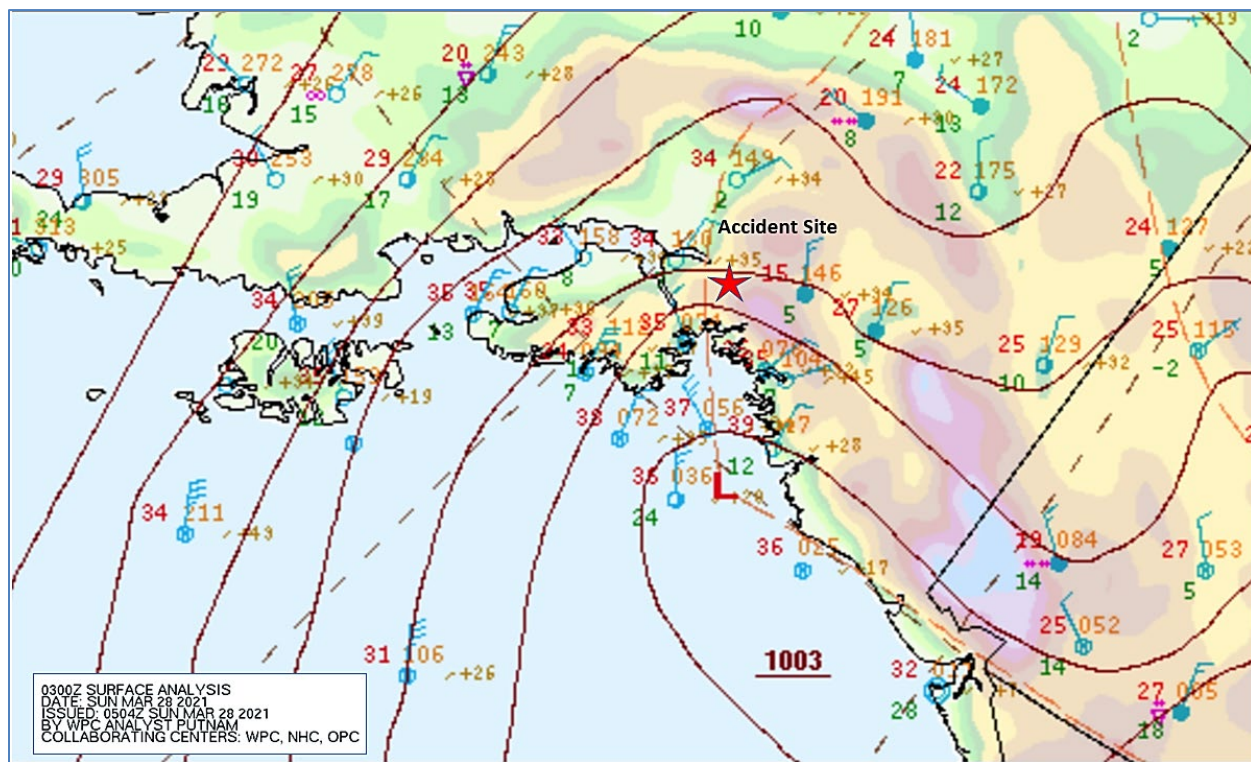


Figure 1 - NWS Surface Analysis Chart centered over southcentral Alaska for 1900 AKDT with the approximate accident site marked by a red star.

<sup>1</sup> Hectopascals (hPa) is the international standard for reporting sea-level pressure and is interchangeable with the term millibar (mb) with the same units. Standard sea-level pressure is 1013.25-hPa at a temperature of 59° Fahrenheit (F) or 15° Celsius (C).

The closest depicted station models on the chart to the west of the accident site<sup>2</sup> depicted northerly winds of 10 knots, clear skies, a temperature of 34° F and a dew point temperature of 11° F. The station model to the east-northeast of the accident site at Eureka (PAZK) depicted northerly winds at 15 knots, overcast clouds, a temperature of 15° F, with a dew point temperature of 5° F, and a sea-level pressure of 1014.6-hPa.

## 1.2 Forecast Weather

The NWS Anchorage Weather Forecast Office (WFO) Forecast Weather Chart issued for the period is included as figure 2. The chart depicted the low-pressure system in the northern Gulf of Mexico at 1000-hPa and moving eastward along the Alaska coast, with another low at 993-hPa over the Yukon Territory of Canada associated with an occluded frontal system. The chart depicted an area of mixed freezing precipitation along the southcentral Alaska coastal section, with light continuous snow inland over the Chugach Mountains in southcentral Alaska in the vicinity of the accident site.

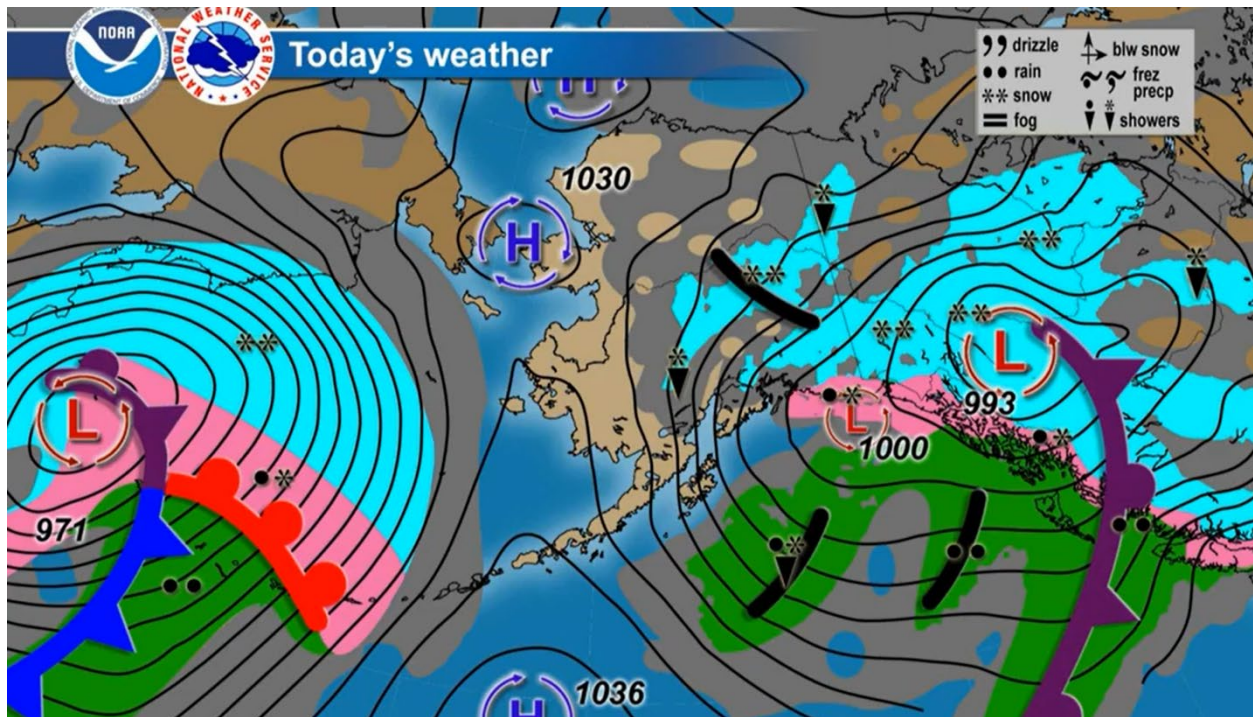


Figure 2 - Forecast Weather Chart issued for the period.

## 1.3 General Flight Categories

The NWS AAWU issued the Flying Weather Chart at 1325 AKDT on March 27, 2021 which was valid from 1800 through 0000 AKDT on March 28th depicting the general flight categories<sup>3</sup>

<sup>2</sup> Anchorage (PANC/ANC) is believed to be the station depicted.

<sup>3</sup> As defined by the NWS and the FAA Aeronautical Information Manual (AIM) section 7-1-7, which defines the following general flight categories based on weather conditions reported:

- Low Instrument Flight Rules (LIFR\*) – ceiling below 500 ft above ground level (agl) and/or visibility less than 1 statute mile.



expected during the period is included as figure 3. The chart depicted general VFR conditions prevailing over the Palmer and Knik Glacier areas with MVFR conditions to the east over the Chugach Mountain range. Further to the north, over the Alaska Range, MVFR to IFR conditions were depicted. An area of winds greater than 30 knots were also depicted south of Prince William Sound between Montague and Hinchinbrook Islands in the Gulf of Alaska and generally south of the accident site.

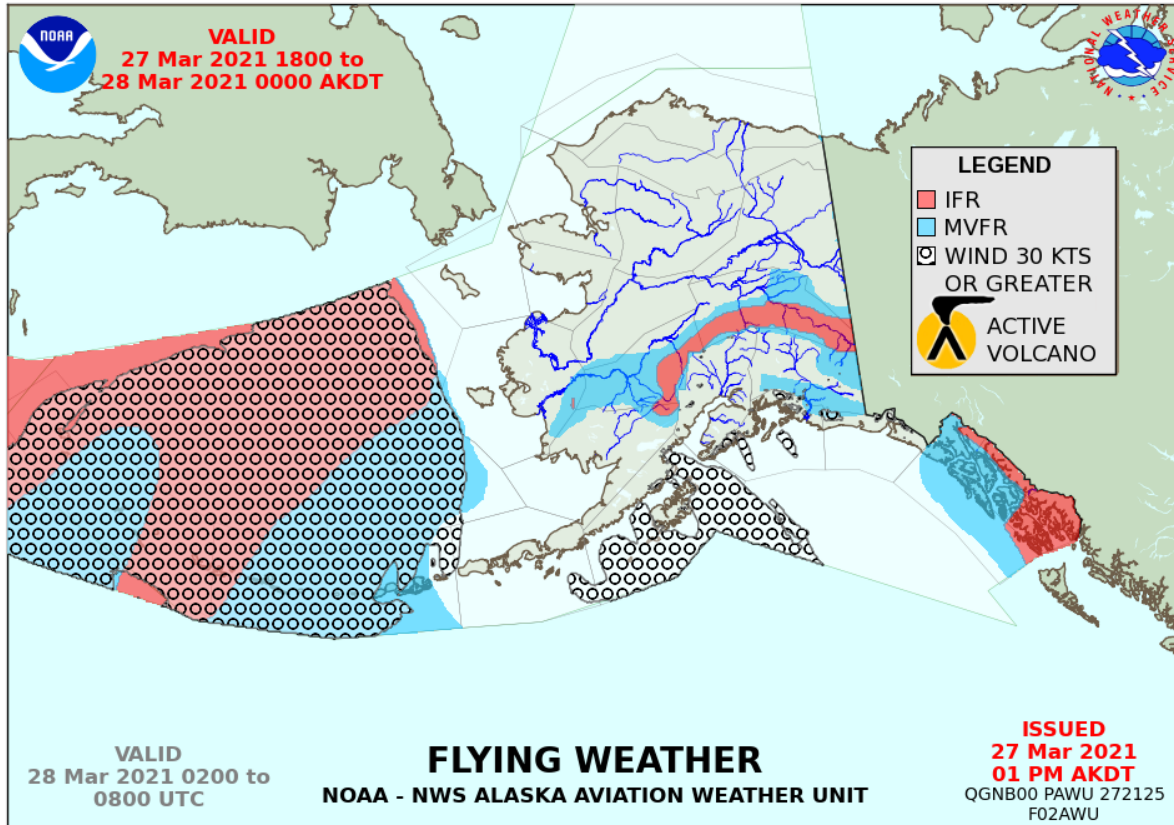


Figure 3 - NWS AAWU Flying Weather Chart depicting the general flight categories expected during the period between 1800 through 2400 AKDT.

#### 1.4 Low-Level Turbulence Forecast

The NWS AAWU issued the Low-Level Turbulence Forecast at approximately 1200 AKDT which was valid for the period between 1800 and 0200 AKDT and is included as figure 4. The

- 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.

chart depicted occasional to continuous moderate turbulence from the surface to 8,000 ft and a threat of low-level wind shear over the area.

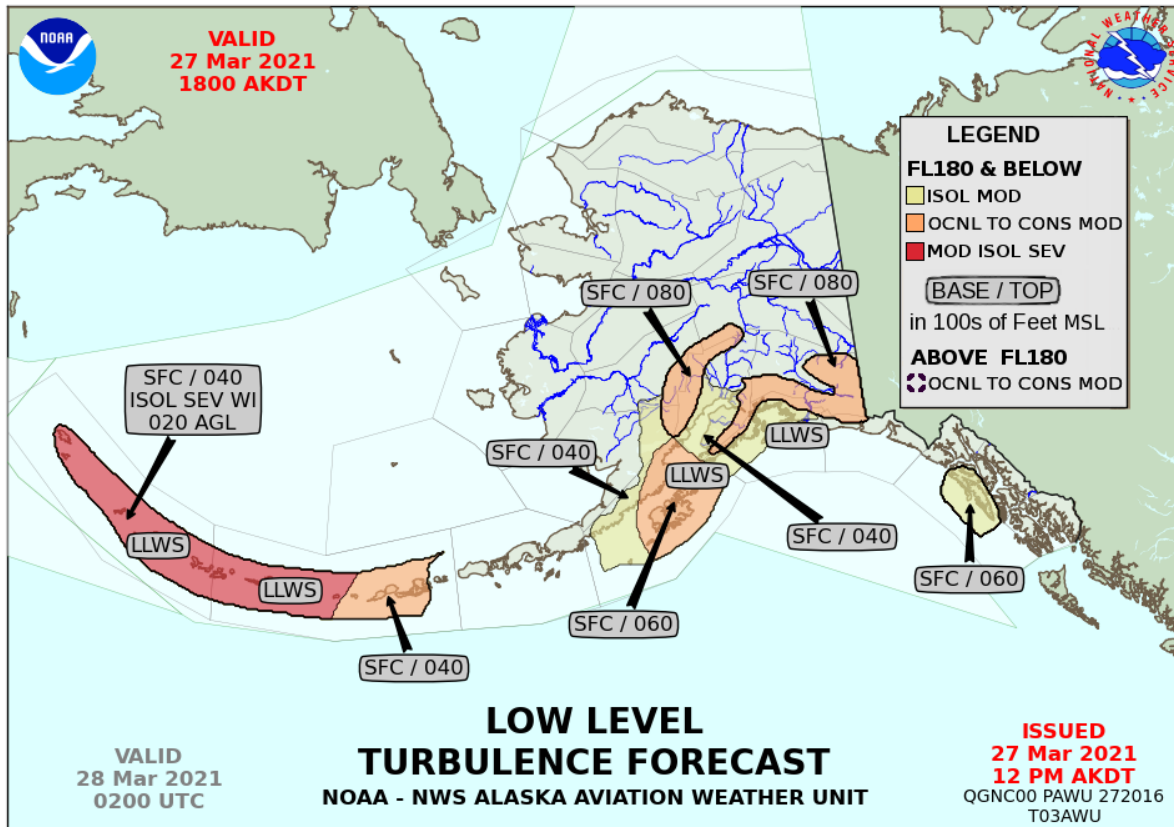


Figure 4 - NWS AAWU Low-Level Turbulence Forecast depicting the potential for turbulence and low-level wind shear over the area during the period between 1800 through 0200 AKDT.

### 1.5 Icing Forecast

The NWS AAWU Icing Forecast Chart issued at approximately 1300 AKDT and valid for the period from 1800 through 0200 AKDT is included as figure 5. The chart depicted no significant icing expected over southcentral Alaska in the vicinity of the accident site.

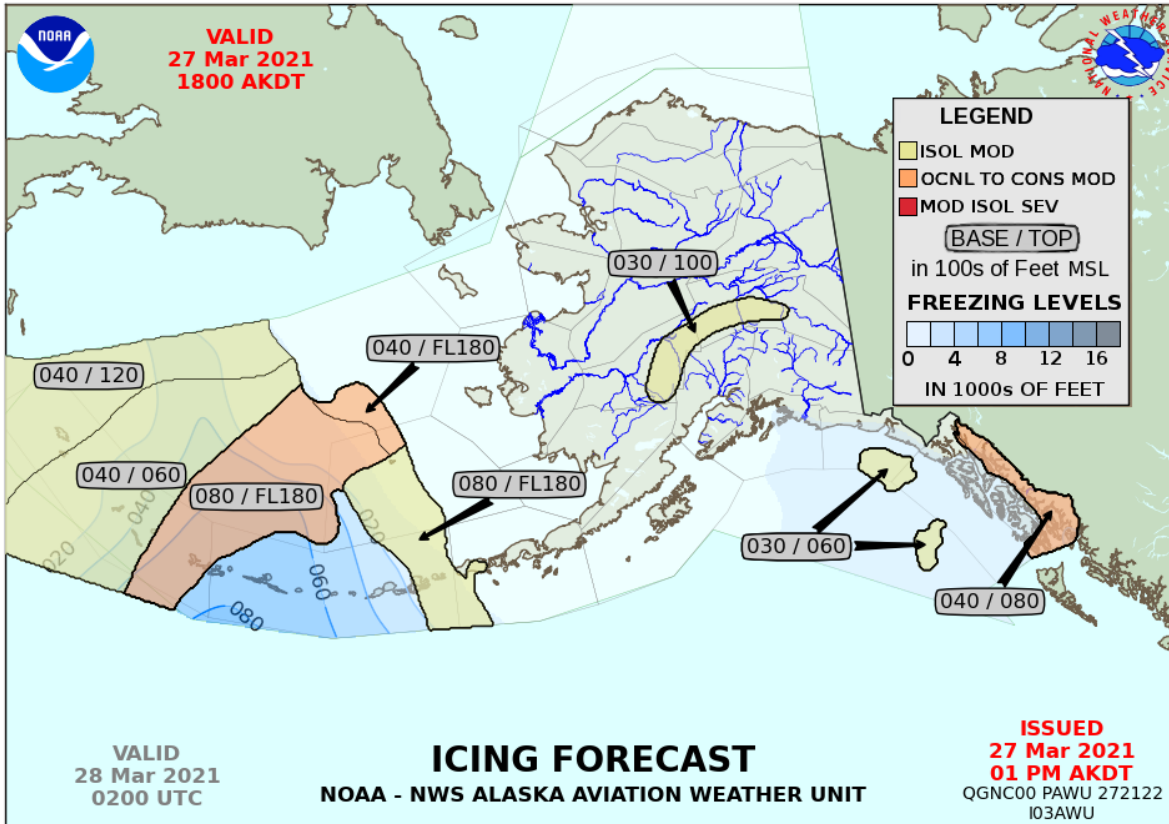


Figure 5 - NWS AAWU Icing Forecast valid for the period from 1800 through 0200 AKDT.

## 2.0 Observations

The area was documented using standard Aviation Routine Weather Reports and Special Reports (METAR<sup>4</sup>/SPECI) issued surrounding the period over the region. Cloud heights are reported above ground level (agl) in the following section, and the magnetic variation was estimated as 16° E over the area based on the latest sectional chart.

### 2.1 Palmer, Alaska

The closest weather reporting site was from Warren “Bud” Woods Palmer Municipal Airport (PAAQ/PAQ), Palmer, Alaska, located approximately 23 miles west-northwest (293°) of the accident site at an elevation 249 ft. The airport had an Automated Surface Observation System (ASOS) which was augmented by Flight Service Station (FSS) personnel during normal business hours. The following conditions were reported surrounding the time of the accident.

<sup>4</sup> METAR – METeoro logical Aerodrome Report.



*PAAQ weather observation at 1653 AKDT, wind from 230° at 6 knots, visibility 10 miles or more, a few clouds at 4,000 ft agl, scattered clouds at 8,000 ft, temperature 1° Celsius (C), dew point temperature -10° C, altimeter 29.82 inches of mercury (inHg). Remarks: automated station with a precipitation discriminator, sea-level pressure 1012.2-hPa, altocumulus standing lenticular clouds southeast through southwest of the station, temperature 0.6° C, dew point temperature -10.0° C.*

*PAAQ weather observation at 1753 AKDT, wind from 260° at 3 knots, visibility 10 miles or more, scattered clouds at 6,500 ft agl, temperature 2° C, dew point temperature -11° C, altimeter 29.85 inHg. Remarks: automated station with a precipitation discriminator, sea-level pressure 1011.3-hPa, temperature 1.7° C, dew point temperature -10.6° C.*

*Accident 1835 AKDT*

*PAAQ weather observation at 1853 AKDT, automated, wind from 330° at 5 knots, visibility 10 miles or more, ceiling<sup>5</sup> broken at 6,500 ft agl, temperature 1° C, dew point temperature -12° C, altimeter 29.89 inHg. Remarks: automated station with a precipitation discriminator, sea-level pressure 1012.7-hPa, temperature 1.1° C, dew point temperature -11.7° C, 3-hour pressure tendency risen 3.1-hPa, thunderstorm sensor inoperative.*

The observations immediately surrounding the time of the accident reported VFR conditions prevailing with scattered to broken clouds at 6,500 ft agl, with a temperature of 35° F, a dew point temperature of 13° F, with a relative humidity of 40%. The density altitude was calculated at 21 ft. The raw METAR and SPECI reports issued between 1453 through 1953 AKDT were as follows with local time added in brackets.

*[1453] METAR PAAQ 272253Z 22005KT 10SM FEW025 SCT055 M01/M08 A2977 RMK AO2 SLP086 T10111078=*

*[1553] METAR PAAQ 272353Z 23004KT 10SM FEW025 SCT050 01/M09 A2980 RMK AO2 SLP095 ACSL S-SW 4/009 T00061094 10006 21044 53029=*

*[1653] METAR PAAQ 280053Z 23006KT 10SM FEW040 SCT080 01/M10 A2982 RMK AO2 SLP102 ACSL SE-SW T00061100=*

*[1753] METAR PAAQ 280153Z 26003KT 10SM SCT065 02/M11 A2985 RMK AO2 SLP113 T00171106=*

*[1835] Accident 0230Z*

*[1853] METAR PAAQ 280253Z AUTO 33005KT 10SM BKN065 01/M12 A2989 RMK AO2 SLP127 T00111117 53031 TSNO=*

*[1953] METAR PAAQ 280353Z AUTO 01007KT 10SM CLR 00/M13 A2994 RMK AO2 SLP142 T00001133 TSNO=*

On the 1653 and 1753 AKDT observations, the remark section included altocumulus standing lenticular clouds (ACSL) southeast through southwest, which are visible indicators of the existence of mountain wave activity.

---

<sup>5</sup> A ceiling is defined as the lowest layer of clouds reported as broken or overcast, or the vertical visibility into a surface-based obscuration.

## 2.2 Wasilla Airport

The accident helicopter departed Wasilla Airport (PAWS/IYS), Wasilla, Alaska, at approximately 1437 AKDT. The airport was located approximately 13 miles west of PAAQ and 34 miles west of the accident site at an elevation of 354 ft. The airport had an Automated Weather Observation System (AWOS), which was not augmented by any human observer. At the approximate time of the accident the following conditions were reported.

*PAWS weather observation at 1856 AKDT, automated, wind from 340° at 13 knots gusting to 19 knots, visibility 10 miles or more, sky clear below 12,000 ft agl, temperature 1° C, dew point temperature -14° C, altimeter 29.92 inHg. Remarks: automated station with a precipitation discriminator, sea-level pressure 1013.9-hPa, temperature 0.6° C, dew point temperature -13.9° C, 3-hour pressure tendency risen 3.7-hPa, freezing rain sensor inoperative.*

The raw observations issued between 1453 through 1953 AKDT were as follows with local time added in brackets.

[1456] METAR PAWS 272256Z AUTO 17005KT 10SM CLR M01/M08 A2978 RMK AO2 SLP093 T10061078  
FZRANO=

[1556] METAR PAWS 272356Z AUTO 15005KT 10SM SCT065 01/M11 A2981 RMK AO2 SLP102 T00061106 10017  
21061 53025 FZRANO=

[1656] METAR PAWS 280056Z AUTO 00000KT 10SM CLR 01/M11 A2984 RMK AO2 SLP111 T00111106  
FZRANO=

[1756] METAR PAWS 280156Z AUTO 34012G18KT 10SM CLR 01/M14 A2988 RMK AO2 SLP124 T00111139  
FZRANO=

### **[1835] 0235Z Accident**

[1856] METAR PAWS 280256Z AUTO 34013G19KT 10SM CLR 01/M14 A2992 RMK AO2 SLP139 T00061139  
53037 FZRANO=

[1956] METAR PAWS 280356Z AUTO 34011KT 10SM CLR M01/M13 A2997 RMK AO2 SLP157 T10061133  
FZRANO=

The observations from PAWS indicated slightly higher northwest winds gusting between 18 and to 19 knots at the time of the accident, with clear skies, and similar temperature and dew point temperatures as reported at PAAQ. Since there was no augmentation of the observations it is unknown if any lenticular clouds were observed in the distance.

## 2.3 METAR Display

A display of the conditions from the NWS Aviation Weather Centers (AWC) METAR display from the Helicopter Emergency Medical Services (HEMS) Weather Tool<sup>6</sup> for 1835 AKDT is

---

<sup>6</sup> <https://aviationweather.gov/hemst>

included as figure 6, with the general topography of the area and the approximate accident site marked by a red star. The highest peak in the vicinity of the accident site was 6,608 ft.

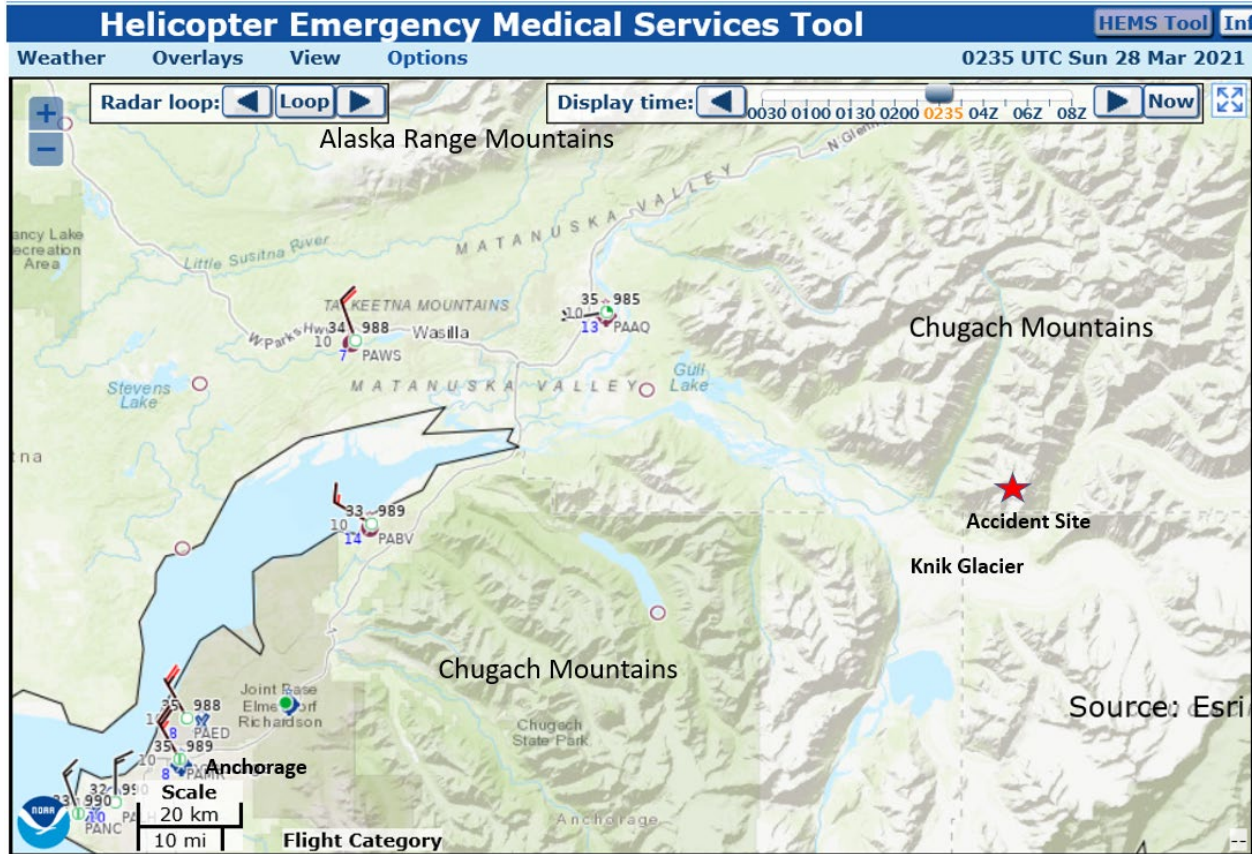


Figure 6 - NWS HEMS Weather Tool depiction of conditions at 1835 AKDT with the accident site marked.

### 3.0 Sounding

The closest NWS upper air sounding was obtained from Anchorage (PANC) approximately 49 miles west of the accident site. The 1600 AKDT<sup>7</sup> PANC sounding plotted on a standard Skew T log P diagram<sup>8</sup> using the Universal RAwinsonde OBservation (RAOB) program software<sup>9</sup> is included as figure 7, from the surface through 400-hPa or approximately 22,000 ft.

<sup>7</sup> The actual time of the launch of the rawinsonde was near 1530 AKDT or 2330Z on March 27, 2021.

<sup>8</sup> 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.

<sup>9</sup> RAOB – (The Universal RAwinsonde OBservation program) is an interactive sounding analysis program developed by Eosonde Research Services (ERS) previously known as Environmental Research Services, The Villages, Florida.

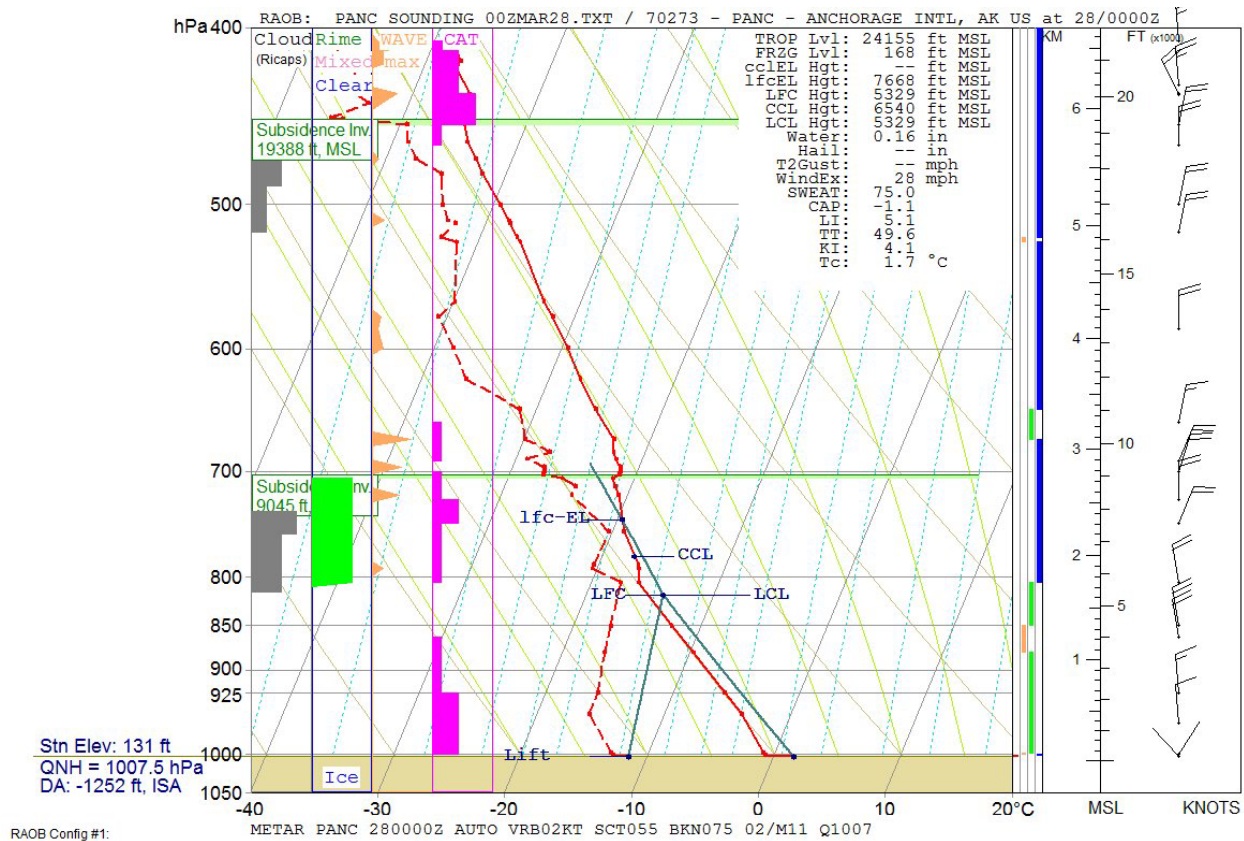


Figure 7 - NWS Anchorage 1600 AKDT sounding

The PANC sounding listed an elevation of 131 ft, and reported a surface temperature of 2° C, and a dew point temperature of -11° C at the time of the observation. The freezing level was identified immediately above the surface at 168 ft msl, with the lifted condensation level (LCL)<sup>10</sup> and level of free convection (LFC)<sup>11</sup> at 5,198 ft agl (5,329 ft msl), with the RAOB analysis program indicated supported for a scattered to broken layer of clouds with tops near 8,000 ft. A shallow temperature inversion was noted at 9,000 ft. The RAOB software indicated the potential for light to moderate icing in clouds between approximately 5,000 ft through 8,000 ft.

The PANC 1600 AKDT sounding wind profile indicated light surface wind, with wind from the north above the surface with little directional variation with height and with increasing wind speeds. At approximately 6,000 ft the wind was from 350° at 21 knots with a temperature of -17° C. The sounding was characterized as conditionally unstable below 6,000 ft and stable above that level. The RAOB analysis program sounding supported light turbulence below 8,000 ft and mountain wave activity. Based on the accident location south of the ridge line, the northerly winds would have resulted in general downslope wind flow south of the mountain ridges and in the vicinity of the accident site.

<sup>10</sup> Lifting Condensation Level (LCL) - the level at which a lifted parcel becomes saturated. The LCL height corresponds to cloud base height for forced ascent.

<sup>11</sup> Level of free convection (LFC) - is the altitude in the atmosphere where the temperature of the environment decreases faster than the moist adiabatic lapse rate of a saturated air parcel at the same level.

A table of the observed sounding data of height, pressure (Pres), temperature (T), dew point temperature (Td), relative humidity (RH%), wind direction and speed (DD/FF), and derived RAOB parameters for Clear Air Turbulence (CAT) potential, Low-Level Wind Shear (LLWS), Icing type and intensity, and mountain wave potential.

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	1003	1.6	-11.4	37	320 / 2				
184	1001	-0.7	-12.7	40			LIGHT		
210	1000	-0.7	-12.7	40	30 / 2				
262	998	-0.9	-12.9	40		MDT			
1245	961				355 / 10				
1545	950	-3.9	-15.9	39		MDT			
2233	925	-5.9	-15.9	45	355 / 16				
3535	879	-9.7	-16.7	57		LGT			
3998	863				350 / 22				
4381	850	-12.3	-17.1	67	350 / 22				
5735	805	-16.3	-17.7	89	350 / 21			LGT Rime	
6168	791	-16.7	-20.4	73				LGT Rime	2.65 309 LIGHT
6293	787	-16.9	-20.4	74				LGT Rime	
7311	755	-19.1	-20.3	90		LGT		LGT Rime	
7570	747				20 / 19	MDT			
8298	725				360 / 19				
8433	721	-20.7	-24.4	72				LGT Rime	3.03 752 LT-MD
8703	713	-21.3	-24.4	76				LGT Rime	
8942	706	-21.7	-25.7	70				LGT Rime	
9045	703	-21.3	-27.3	58					

Figure 8 - Table of PANC sounding parameters for 1600 AKDT from the surface through 9,000 ft.

For 6,168 ft the sounding indicated a temperature of -16.7° C, a dew-point temperature of -20.4° C, with a 73% relative humidity, with winds from 350° at 21 knots, with light rime possible. Conditions were also favorable for wave with a wavelength of 2.65 miles an amplitude of 412 ft, and with a maximum vertical velocity of the downdrafts of 309 fpm with possible light turbulence.

#### 4.0 Satellite Imagery

The Geostationary Operational Environmental Satellite number 17 (GOES-17) data were 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. The infrared and visible imagery were reviewed surrounding the period, and the closest images to the accident time were documented. The infrared long wave imagery (band 15) at a wavelength of 12.3 microns (µm) provided radiative cloud top temperatures with a nominal spatial resolution of 2 km. The visible (band 2) at a wavelength of 0.64 µm provided images at a resolution of 0.5 km.

Figures 9 and 10 are the GOES-17 infrared and visible images at 1830 AKDT at 4X magnification respectively. The infrared image depicted a radiative cloud top temperature of 258 Kelvin or -15° C over the approximate accident site, which corresponded to near surface temperatures. The ground was covered by snow over the area, making it the imagery difficult to differentiate any clouds from the snow-covered surface.



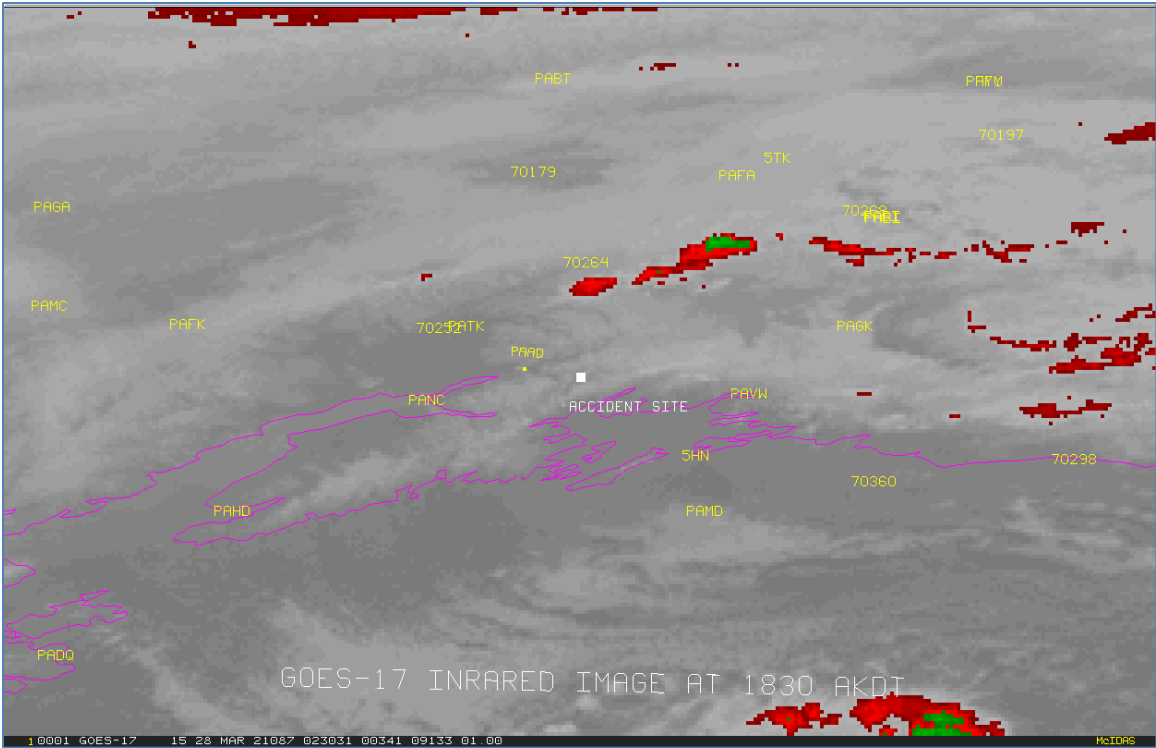


Figure 9 - GOES-17 infrared image at 1830 AKDT at 4X magnification

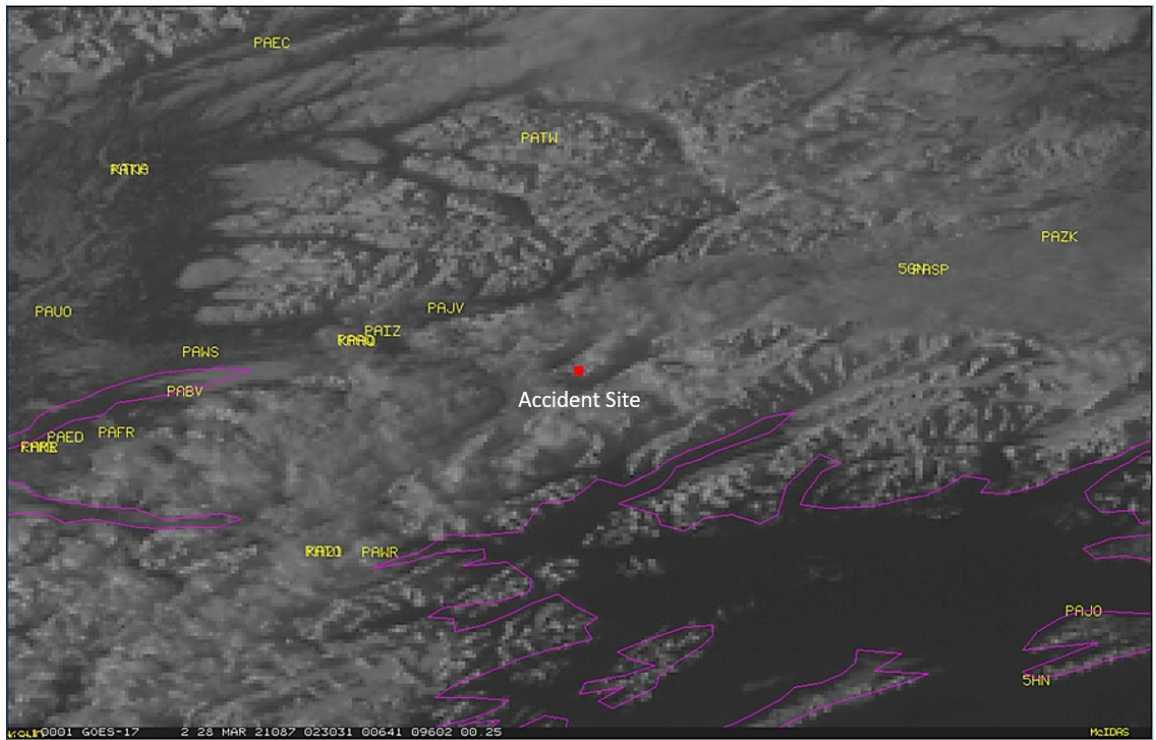


Figure 10 - GOES-17 visible image at 1830 AKDT at 2X magnification

## 5.0 FAA Weather Camera Images

The FAA Weather Camera images from the Palmer, Alaska, southeast camera view were also obtained for the period surrounding the time of the accident. The sectional chart with the Palmer camera views is included as figure 11 highlighting the southeast (135°) camera's view looking down the Knik River Valley towards the Knik Glacier with the approximate accident site marked by the red star. Figure 12 is an image of the FAA Palmer southeast camera view on a clear day with landmarks identified. The accident site was located at an azimuth of 112° and 23 miles from the PAQQ camera site and would have been blocked by the mountains on the extreme left side of the image.

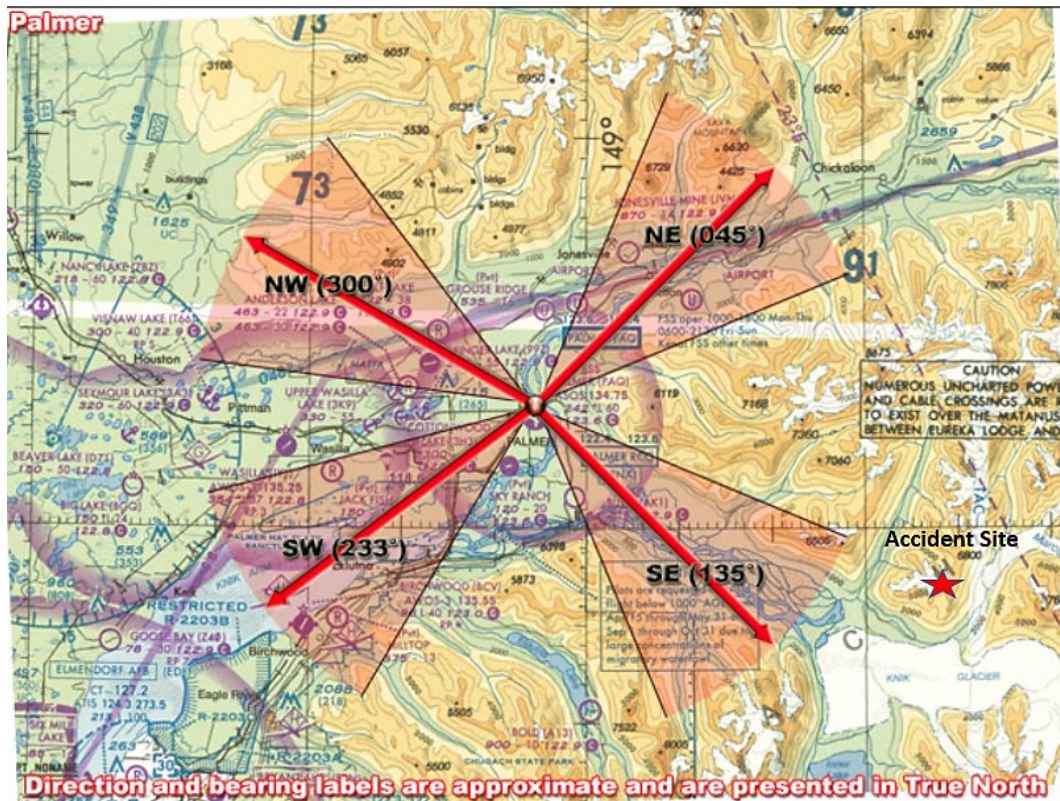


Figure 11 - FAA Palmer Cameras on a sectional chart with the approximate accident site marked

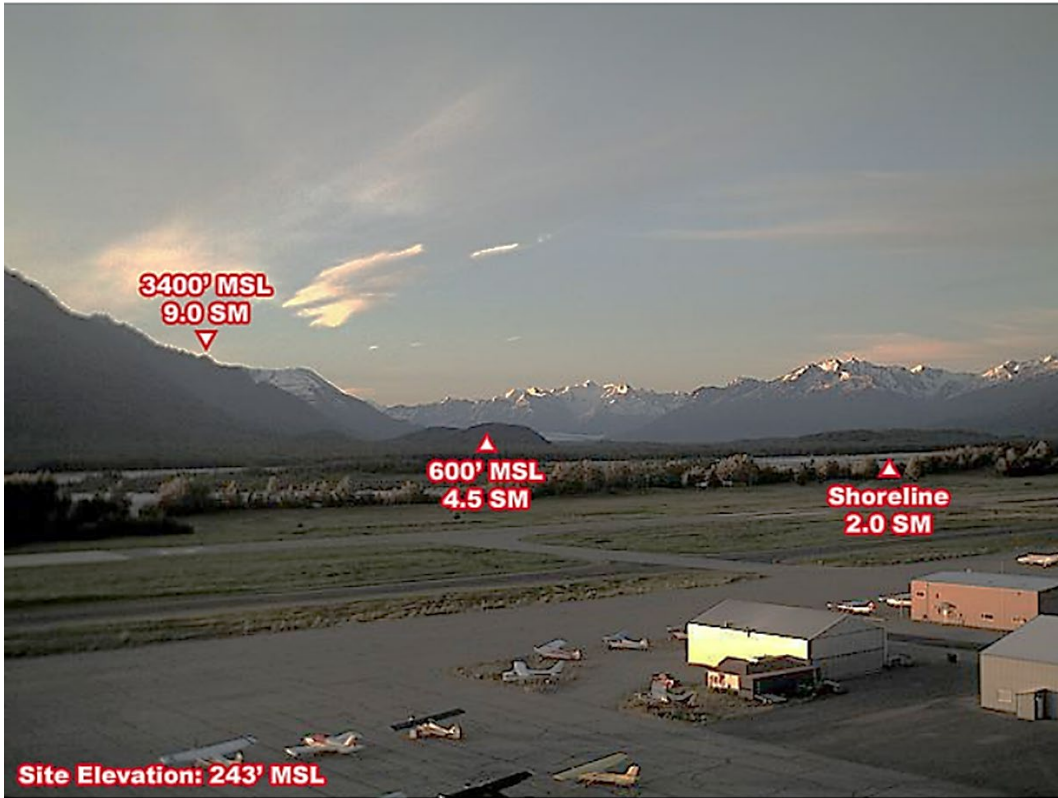
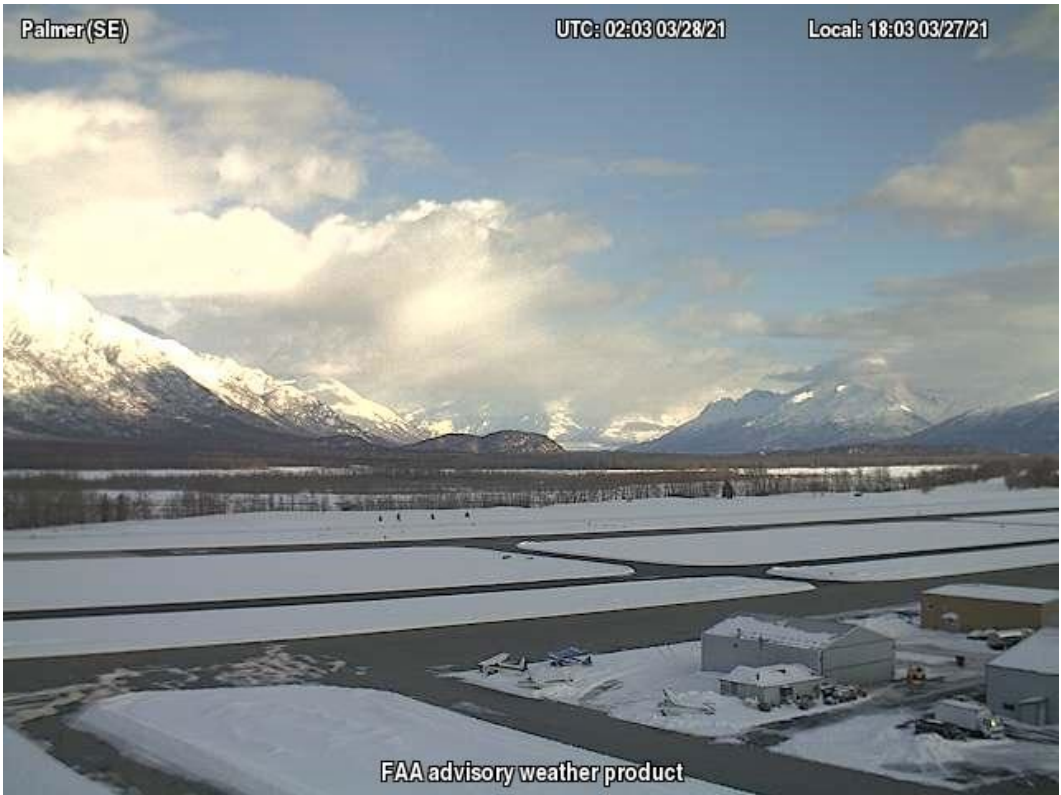


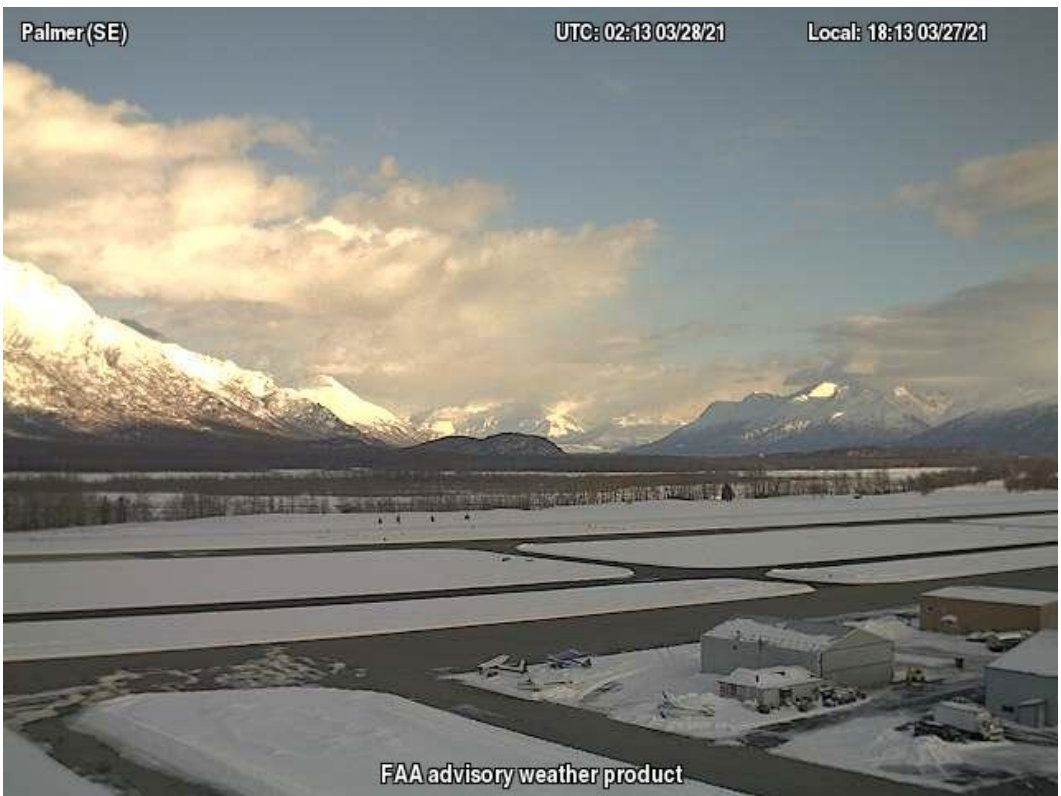
Figure 12 - FAA Weather Camera for Palmer southeast view on a clear day

Figures 13 through 17 are the Palmer southeast camera pictures from 1803 through 1843 AKDT at 10-minute intervals surrounding the time of the accident. A 6-hour animation of the Palmer southeast camera view is included as Attachment 1.





**Figure 13 - FAA Weather Camera from Palmer looking southeast at 1803 AKDT**



**Figure 14 - FAA Weather Camera from Palmer looking southeast at 1813 AKDT**



Figure 15 - FAA Weather Camera from Palmer looking southeast at 1823 AKDT

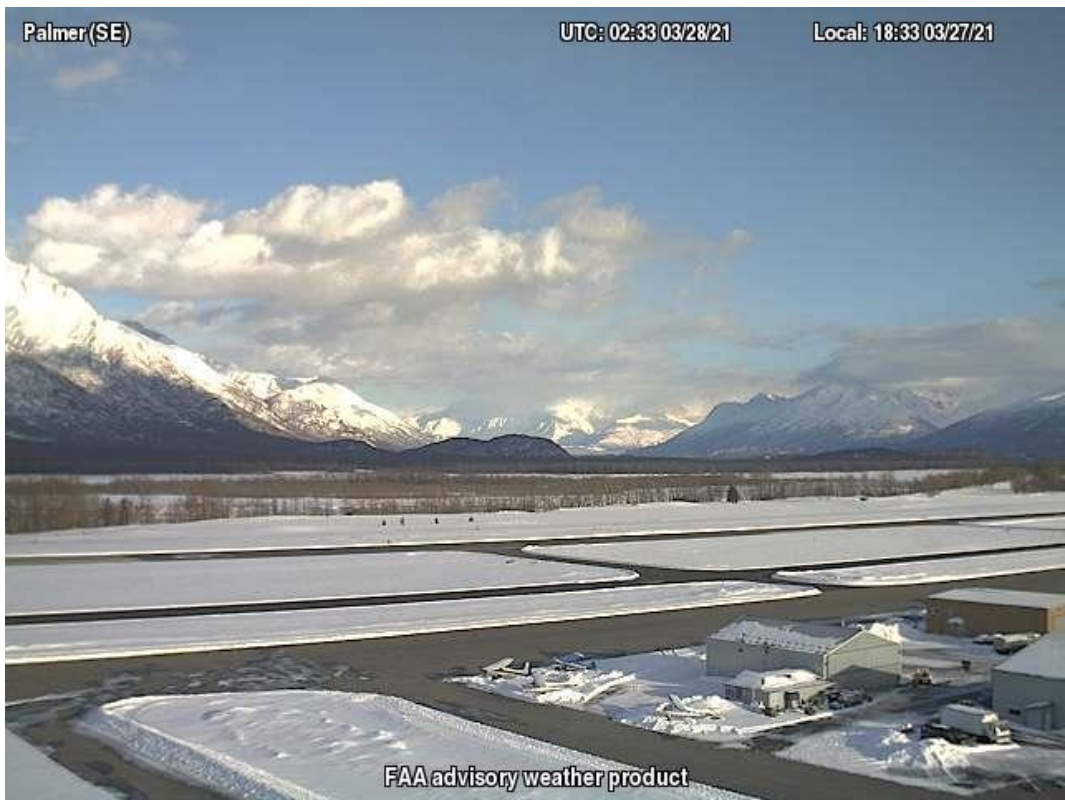


Figure 16 - FAA Weather Camera from Palmer looking southeast at 1833 AKDT prior to the accident



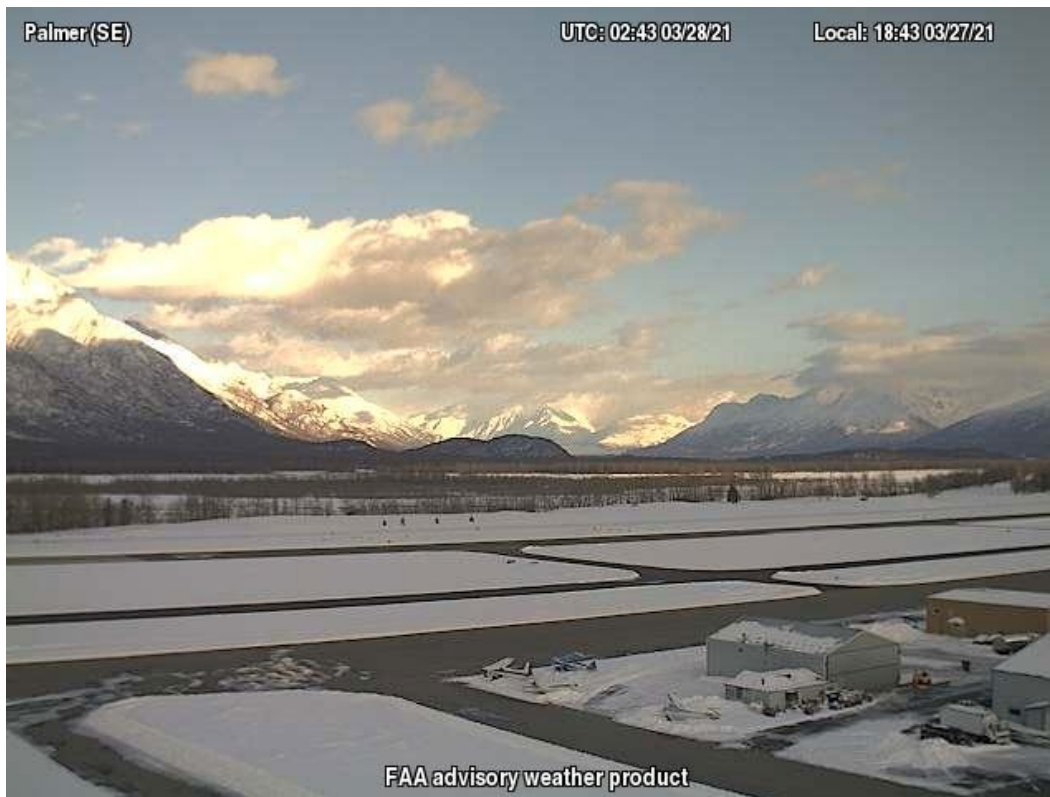


Figure 17 - FAA Weather Camera from Palmer looking southeast at 1843 AKDT after the accident

## 6.0 Pilot Reports

A search of pilot reports (PIREPs) over the area between 1400 through 2200 AKDT provided the following reports over southwestern Alaska. The reports are in raw format with abbreviations, with time referenced to UTC, followed by a plain language version with time in ADKT.

*PANC UA /OV BGQ 180007/TM 2226/FL025/TP C172/TB LGT 025/RM AOB 025 =*

*Ted Stevens Anchorage International Airport (PANC/ANC), Anchorage routine pilot report; Over – 180° azimuth and 7 miles from Big Lake VORTAC<sup>12</sup> (BGO), Time – 1426 AKDT; Altitude – 2,500 ft msl; Type aircraft – Cessna Skyhawk; Turbulence light turbulence at 2,500 ft; Remarks – at or below 2,500 ft.*

*PAQ UA /OV PAQ100006 /TM 2329 /FL020 /TP C172 /WV 310030KT /TB VLGT /RM OVR SWAN LAKE (AKFSS=*

*Palmer Municipal Airport (PAAQ/PAQ) routine pilot report; Over – 100° azimuth and 6 miles from PAAQ; Time – 1529 AKDT; Altitude – 2,000 ft msl; Type aircraft – Cessna Skyhawk; Wind – 310° 30 knots; Turbulence – very light; Remarks – over Swan Lake (entered from Alaska Flight Service Station).*

<sup>12</sup> A VORTAC is a radio-based navigational aid for aircraft pilots consisting of a co-located VHF omnidirectional range (VOR) beacon and a tactical air navigation system (TACAN) beacon for distance information. Unless otherwise noted the name of the VORTAC is collocated with the city.

*MRI UA /OV MRI/TM 0023/FL020/TP C172/TB LGT CHOP=*

*Merrill Field Airport (PAMR/MRI), Anchorage, route report; Over – MRI; Time – 1623 AKDT; Altitude – 2,000 ft msl; Type aircraft – Cessna Skyhawk; Turbulence – light chop.*

*MRI UA /OV MRI070004/TM 0059/FL015/TP C172/TB MOD=*

*Merrill route report; Over – 070° azimuth and 4 miles from MRI; Time – 1659 AKDT; Altitude – 1,500 ft msl; Type aircraft – Cessna Skyhawk; Turbulence – moderate.*

*MRI UA /OV MRI170010/TM 0155/FL015/TP R44/TB LGT=*

*Merrill route report; Over – 170° azimuth and 10 miles from MRI; Time – 1755 AKDT; Altitude – 1,500 ft msl; Type aircraft – Robinson R44 Helicopter; Turbulence – light.*

## **7.0 NWS Forecasts**

A review of the basic NWS aviation forecasts issued during the period and applicable for the flight were as follows.

### **7.1 Terminal Aerodrome Forecast**

A Terminal Aerodrome Forecast (TAF) is a concise statement of the expected meteorological conditions at an airport during a specified period, usually 24 hours. TAFs are valid for a 5-mile radius around an airport's center point. The TAF current for PAAQ at the time of the accident was as follows:

*TAF PAAQ 272341Z 2800/2824 22005KT P6SM SCT050=*

The forecast for PAAQ expected a wind from 220° at 5 knots, visibility 6 miles or more, with scattered clouds at 5,000 ft agl.

### **7.2 Area Forecast Discussion**

The NWS Area Forecast Discussions (AFD) are issued by each WFO to describe the short-term weather conditions within their region with an aviation section that includes the general conditions as they relate to the creation of the TAF. These are useful for additional aviation-related issues that cannot be encoded into the TAF. The discussion also gives some reasoning behind the forecast. These are generated roughly every 6 hours and corresponds to the release of the latest TAFs for that office. The Anchorage WFO issued the AFD at 1621 AKDT, with the long-term forecast, marine, and southwest Alaska discussion sections excluded was as follows:

*FXAK68 PAFC 280021  
AFDAFC*

*Southcentral and Southwest Alaska Forecast Discussion  
National Weather Service Anchorage AK  
421 PM AKDT Sat Mar 27 2021*

*.ANALYSIS AND UPPER LEVELS...*

***An elongated surface low north of Middleton Island sits underneath an upper-level over the northern Gulf. These features are producing a mix of rain and snow showers from the Copper River Delta west across Prince William Sound this afternoon. Scattered snow showers are also moving south along the western side of the Kenai Mountains in response to the upper-level trough lifting across the region.***

*A second upper-level low is weakening as it slides southeast over the AKPEN today. A north-northwesterly flow behind this system is advecting colder air across Southwest Alaska and is also helping to produce a few scattered snow showers, mainly along the western, upslope areas of the Alaska and Aleutian Ranges. Temperatures across interior Southwest are struggling to climb out of the teens as colder air settles in and areas of low cloud cover linger.*

*Farther west, a ridge axis extends from the North Pacific to the Pribilofs with rather tranquil conditions from Saint Paul south to Unalaska. For the western Bering and Aleutians, a storm-force sub 970mb low is lifting north from the North Pacific toward the western Bering. A surface warm front is draped across the Western Bering with a trailing cold front moving east toward Shemya.*

*.MODEL DISCUSSION...*

*Guidance continues to be in very good agreement with the timing and placement of the aforementioned Bering low and its associated fronts as it tracks toward the west coast of Alaska. Models are also in good agreement with the evolution of a series of shortwaves ejecting from the parent upper-level low moving across Southwest and Southcentral Alaska late Sunday through early Tuesday. Thus, forecast confidence remains high that the Southern Mainland will move into an active weather pattern with periods of snow for interior locations and mixed rain/snow for coastal locations across Bristol Bay and Southcentral over the next couple of days.*

*.AVIATION...*

***PANC...VFR conditions and northerly winds will persist through Sunday morning. Northerly winds are expected to be gusty through late this afternoon before diminishing this evening. On Sunday afternoon the next round of snow will move in, though should be light enough to only drop conditions to MVFR.***

*.SHORT TERM FORECAST SOUTHCENTRAL ALASKA (Days 1 through 3:tonight through Tuesday night)...*

*Active weather returns Sunday evening to much of the Southcentral region as a series of shortwaves pass through. This looks to be a similar pattern as the previous one, with a more zonal flow and a strong upper level jet streak passing over. Additionally, this will be another long duration snowfall event, with relatively persistent snowfall beginning Sunday evening lasting through Tuesday evening. The Anchorage area is expected to see accumulations from 1-3 inches. Areas north of Wasilla, including Sutton and Chickaloon, may see snowfall accumulations of 4-8 inches through Tuesday evening. There is still some uncertainty with regards to the intensity of the snowfall, with higher intensity resulting in potentially higher accumulations. Hatcher Pass and higher elevations are expected to receive the highest accumulations, with up to 2 ft possible Sunday night through Tuesday evening. The North Gulf Coast and PWS will see periods of light snowfall through Tuesday evening as well, although significant accumulations are not expected.*

*Outflow winds will persist through tonight, diminishing by tomorrow afternoon. Flow transitions to southerly late Monday night as a highly amplified trough moves across the Southwest Mainland towards Southcentral, advecting warmer air into the region. Thus, expect temperatures to gradually warm over the next few days.*

*.AFC WATCHES/WARNINGS/ADVISORIES...*

*PUBLIC...Blizzard Warning: 155.*

*MARINE...Storm: 177 178 411 413.*

*Gale: 120 121 130-136 150 155 165 170 172-176 179-352 412 414.*

*Heavy Freezing Spray: 180 185 414.*

### **7.3 Area Forecast**

The NWS Anchorage Cool Inlet and Susitna Valley section of the Area Forecast (FA) was as follows:

*FAAK48 PAWU 272010*

*FA8H*

*ANCH FA 272015*

*AK SRN HLF EXCP SE AK...*

*AIRMETS VALID UNTIL 280415*

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

*NON MSL HEIGHTS NOTED BY AGL OR CIG.*

*SYNOPSIS VALID UNTIL 281400*

*999 MB LOW 90 NM ENE PAMD WITH TROF SE TO VCY PAJN. LOW WILL DSIPT  
EARLY IN PD AS NEW LOW DVLPS VCY PAGS BY 06Z AND MOVES S TO VCY  
PAKT BY END OF PD. LATE IN PD 1031 MB HI WILL DVLP COPPER RVR BASIN  
WITH RIDGE SE BO VCY PAGY. N-S RIDGE ST LAWRENCE IS TO VCY PADU AND  
S WILL MOVE TO PAMH-PADQ AND S BY END OF PD. LARGE 972 MB LOW 250  
NM W PASY WILL MOVE TO 280 NM N PASY BY 15Z. ASSOCD OCFNT WILL SWEEP  
E WARD ACROSS CNTRL-ERN ALEUTIANS AND BERING SEA.*

*COOK INLET AND SUSITNA VLY AB... VALID UNTIL 280800*

*...CLOUDS/WX...*

*FEW025 SCT045. VCY MTS ISOL BKN045 TOP 100 VIS 3-5SM -SHSN. VCY CHNLD TRRN AK RANGE  
SFC WND NW-N 20G30KT. ELSW SFC WND NW G25KT.*

*OTLK VALID 280800-281400...VFR.*

*PASSES...LAKE CLARK...MERRILL...RAINY...WINDY...PORTAGE...VFR ISOL SHSN TURB.*

*...TURB...*

*\*\*\*AIRMET TURB\*\*\*AFT 23Z SW PANC MOD TURB FL280-FL400. INTSF...*

*\*\*\*AIRMET TURB\*\*\*AFT 02Z MOD TURB FL200-FL400. INTSF...*

*\*\*\*AIRMET TURB\*\*\*AFT 23Z AK RANGE OCNL MOD TURB BLW 080. INTSF...*

***OTRW AFT 23Z PATK S ISOL MOD TURB BLW 040.***

*...ICE AND FZLVL...*

*TIL 02Z NW PASW ISOL MOD ICEIC 030-100. FZLVL SFC.*

The Area Forecast indicated that an AIRMET for occasional moderate turbulence below 8,000 ft was expected after 1500 AKDT for the Alaska Range Mountains north of the accident site with turbulence expected to intensify with time. Otherwise, south of Talkeetna (PATK) isolated moderate turbulence was expected below 8,000 ft over the region.

## 7.4 Winds Aloft Forecast

The NWS Winds and Temperatures Aloft Forecast<sup>13</sup> for the Anchorage area valid for 1600 AKDT and for use between 1300 and 2200 AKDT was as follows.

*FBAK33 KWNO 271356  
FD3AK3  
DATA BASED ON 271200Z  
VALID 280000Z FOR USE 2100-0600Z. TEMPS NEG ABV 24000*

*FT 3000 6000 9000 12000 18000 24000 30000 34000 39000  
ANC 3314 3621-15 3620-21 3619-27 3620-39 3422-49 323752 324853 315054*

The winds aloft forecast for Anchorage (ANC) for 3,000 ft expected a wind from 330° at 14 knots, at 6,000 ft a wind from 360° at 21 knots with a temperature of -15° C, and at 9,000 ft from 360° at 20 knots with a temperature of -21° C.

## 7.5 Inflight Weather Advisories

Inflight Aviation Weather Advisories are forecasts to advise en route aircraft of the development of potentially hazardous weather. Inflight aviation weather advisories in Alaska are issued by the NWS AAWU and from the Anchorage Center Weather Service Units (CWSU) associated with the FAA Anchorage ARTCCs. There are four basic types of inflight aviation weather advisories: the Significant Meteorological Information (SIGMET), the Convective SIGMET, the Airmen's Meteorological Information (AIRMET), and the Center Weather Advisory (CWA). Inflight advisories serve to notify en route pilots of the possibility of encountering hazardous flying conditions which may not have been forecast at the time of the preflight briefing. Whether or not the condition described is potentially hazardous to a particular flight is for the pilot to evaluate on the basis of experience and the operational limits of the aircraft.

During the period of the accident the AAWU and CWSU had no advisories current for any IFR or mountain obscuration conditions, turbulence, or icing conditions over the accident site other than the AIRMET for turbulence in the Area forecast (section 7.3) above for isolated moderate turbulence below 8,000 ft.

## 8.0 Astronomical Conditions

The astronomical conditions were obtained from the United States Naval Observatory's Multiyear Interactive Computer Almanac (MICA) software program<sup>14</sup> for PAAQ on March 27, 2021. The times are referenced to AKDT and the time of the accident has been added in bold italic print for reference.

---

<sup>13</sup> NWS bulletin FBAK33 KWNO.

<sup>14</sup> The MICA software computes many of the astronomical quantities that are tabulated in *The Astronomical Almanac* and the *Air Almanac*, an annual publication prepared by the Nautical Almanac Office of the U.S. Naval Observatory.



<u>Sun</u>	<u>Time</u>
Begin civil twilight	0649
Sunrise	0733
Culmination	1402
<b><i>Accident</i></b>	<b><i>1835</i></b>
Sunset	2031
End civil twilight	2116

At the time of the accident the Sun estimated to be 12.9° above the horizon at an azimuth of 251°.

## 9.0 Weather Briefing

A search of Federal Aviation Administration (FAA) Flight Service Station (FSS) noted that they had no contact with the pilot for any weather briefing, flight plans, or any inflight contacts on the day of the accident. It is therefore unknown what information the pilot specifically used for familiarization purposes prior to the flight.

According to the NTSB Portable Electronic Devices Report in the docket, a review of the pilot's personal electronic devices indicated that the pilot's browser contained bookmarks for several aviation weather information websites. The browser history indicated that prior to departure on the accident flight, the pilot searched airport conditions for Talkeetna Airport and Wolverine Creek Airport and visited the aeronautical planning site Sky Vector. The accident pilot also had the Windy app<sup>15</sup> on his iPhone which provides weather radar and surface wind forecasts similar to a streamline<sup>16</sup> analysis. The pilot also had access to the FAA Alaska Weather Camera site on his device, but it was unknown if he had accessed the site on the day of the accident.

## 10.0 Witness Statements

A pilot operating in the vicinity a few hours prior to accident in a Citabria on skis indicated that they were flying down Marcus Baker glacier and onto the Knik glacier and reported light surface winds with stronger winds at altitude. His statement indicated that it "was windy as heck at altitude but dead calm on the valley floor". Other pilots flying that day in the vicinity indicated varying winds across the region with gusts over 20 knots.

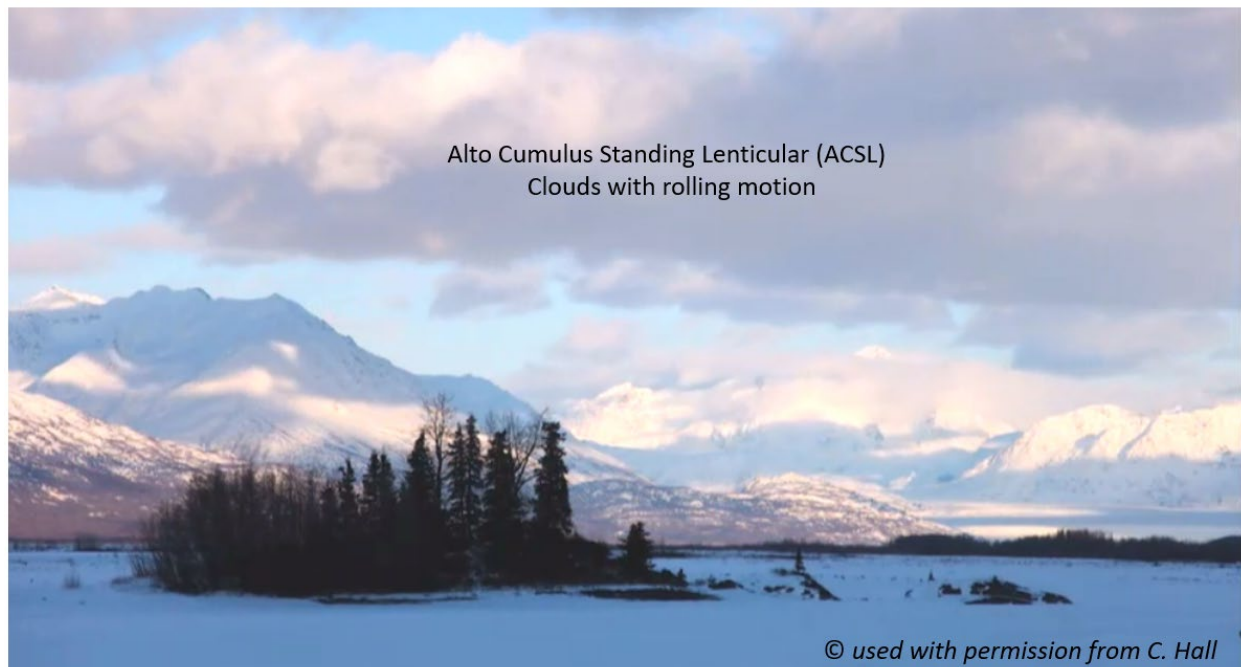
A snowmobile tour operator on Knik Glacier that day indicated that he observed the top of the mountain ridges above the Knit Glacier Lake area for signs of potential avalanche conditions. He further stated on the day of the accident during his morning and afternoon tours he noticed large plumes of snow being blown off the nearby mountain peaks, and he estimated the wind to be between 30 to 40 miles per hour from the west.

---

<sup>15</sup> Windy.com is a software program that displays weather radar and forecast model of the winds over a region.

<sup>16</sup> In meteorology, streamlines are gradient flow lines that can be drawn for any instant on a synoptic chart, thus representing winds blowing parallel to the horizontal isobars and normal to the pressure gradient.

Another individual located in the Knik Valley looking north of the Glacier took time lapse photographs<sup>17</sup> approximately 45 minutes after the accident. His time lapse imagery caught several images of ACSL clouds. Figure 18 is a still image of the ACSL clouds which in the animation are observed to develop or form on the northern side (left), dissipate on the southern side (right), and remain relatively stationary with time and not move with the upper-level winds at their altitude. A defined rolling or overturning motion could be seen in the animation about the cloud's main horizontal axis. Based on the PANC sounding and the observations from PAAQ the base of the scattered to broken cloud layer was approximately 6,500 ft.



**Figure 18 - Still photograph of lenticular clouds over the Chugach Mountains north of Knik Glacier**

## **F. LIST OF ATTACHMENTS**

Attachment 1 – FAA Weather Camera imagery from PAAQ Southeast weather camera imagery animation surrounding the period.

Submitted by:

Don Eick  
Senior Meteorologist

---

<sup>17</sup> Due to copy right and the individuals not wanting the photography to be used in litigation the animation is not available for public dissemination.