



NATIONAL TRANSPORTATION SAFETY BOARD

Office of Aviation Safety
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Weather Study

METEOROLOGY

ANC20FA017

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A. ACCIDENT

Location: 12 miles west of Tuntutuliak, Alaska
Date: February 6, 2020
Time: About 1110 Alaska standard time
2010 Universal Coordinated Time (UTC)
Airplane: Paklook Air Piper PA-32R-300; Registration: N7632C

B. METEOROLOGIST

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Operational Factors Division (AS-30)
National Transportation Safety Board

C. SUMMARY

On February 6, 2020, about 1110 Alaska standard time, a Piper PA-32R-300 airplane, 7632C, sustained substantial damage during impact with terrain about 12 miles west of Tuntutuliak Airport (A61), Tuntutuliak, Alaska. The commercial pilot and four passengers were fatally injured. The airplane was operated by Paklook Air Inc., doing business as Yute Commuter Service, under the provisions of Title 14 *Code of Federal Regulations* Part 135 as a scheduled visual flight rules (VFR) commuter flight. Instrument meteorological conditions prevailed at the departure and arrival airports at the time of the accident, and a company flight plan was filed. The flight originated from Bethel Airport (PABE), Bethel, Alaska, about 1040, and was destined for Kipnuk Airport (PAKI), Kipnuk, Alaska.

D. DETAILS OF THE INVESTIGATION

The National Transportation Safety Board's 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 standard time (AKST) based upon the 24-hour clock, local time is -9 hours from UTC, and UTC=Z. 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. continental airports or the "PA" for Alaska airports. 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.

The accident site was located at latitude 60.35172° N and longitude 163.02301° W, at an elevation of approximately 37 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) and the Weather Prediction Center (WPC) located in College Park, Maryland. These are the base products used in describing weather features and in the creation of forecasts and warnings. Reference to these charts can be found in the joint NWS and Federal Aviation Administration (FAA) Advisory Circular “Aviation Weather Services”, AC 00-45H change 2.

1.1 Surface Analysis Chart

The NWS Alaska Surface Analysis Chart for 0900 AKST is included as figure 1 with the approximate accident site marked by a red star. The chart depicted a low pressure system at 1001-hectopascals (hPa)¹ over the interior of Alaska along a stationary front which extended southwest across interior Alaska to the Bering Sea. The station models depicted a counterclockwise or cyclonic circulation in the wind field near the southern end of the stationary front in the Bering Sea north of the Aleutian Islands indicating the presentence of a low pressure system over the Aleutian Islands just off the analyzed section of the chart. The accident site was located west of the stationary front and north-northeast of the low pressure wind circulation feature in the Bering Sea.

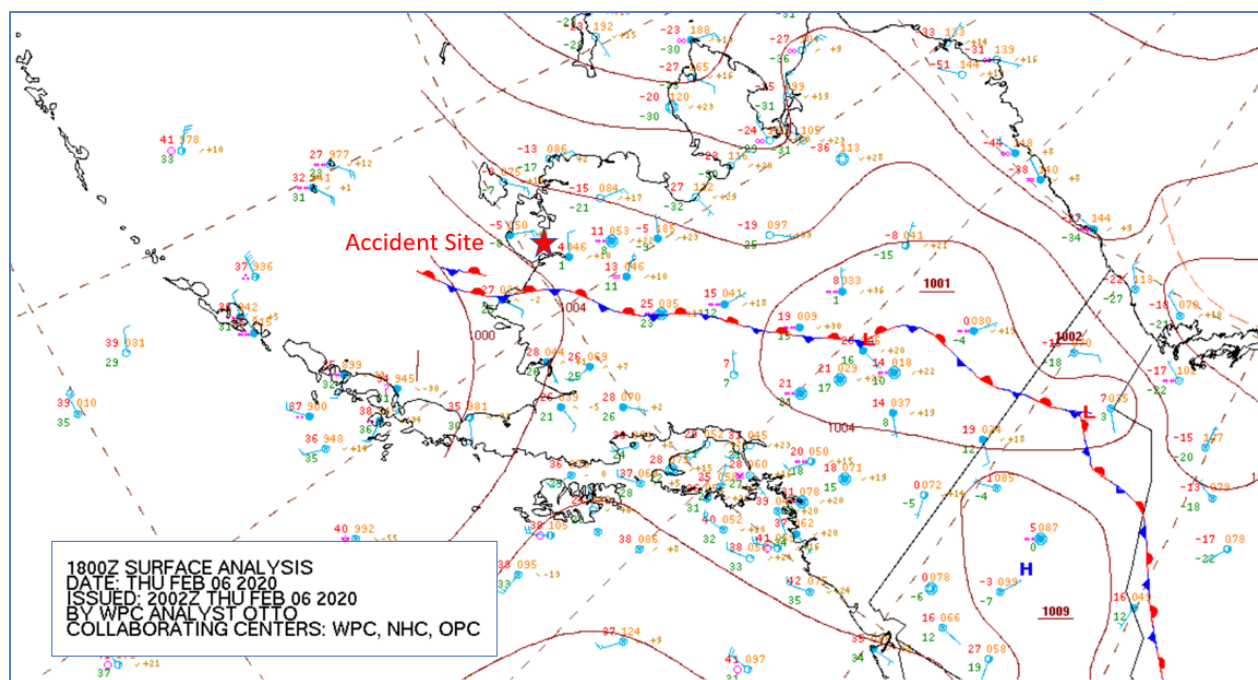


Figure 1 - NWS Alaska Surface Analysis Chart for 0900 AKST

¹ Hectopascals is the new NWS reference for reporting sea level pressure and is interchangeable with the former term millibar (mb) with the same units. Standard sea-level pressure is 1013.25-hPa at 59° Fahrenheit (F) or 15° Celsius (C).

The station models in the vicinity of the accident site depicted light northwest to northerly winds at approximately 10 to 20 knots, overcast sky cover, with temperatures ranging from 4° F in the Bethel area to -5° F along the southwest Alaska coast near Kipnuk, with the temperature-dew point spreads less than 3° F.

1.2 Surface Streamline Analysis

A surface streamline analysis for 1100 AKST is included as figure 2 and further defined a low pressure circulation center south-southwest of Kipnuk and the accident site in the Bering Sea, with a general confluence zone associated with the stationary front east of the accident site. Winds from the north are depicted over the accident site.

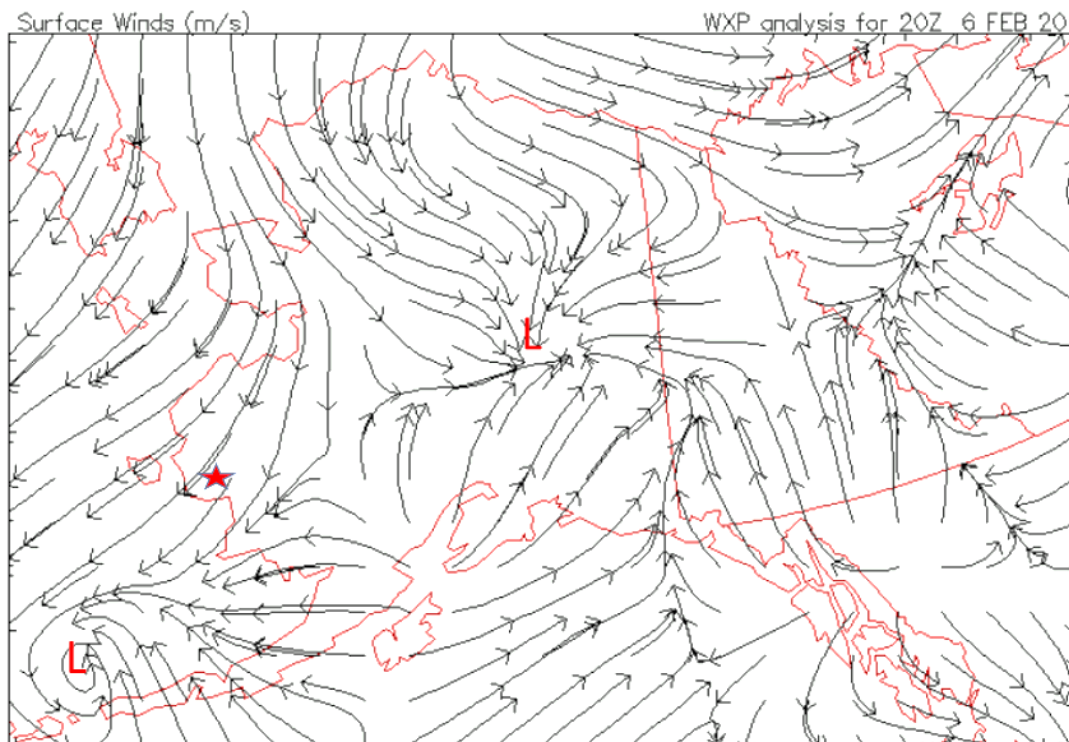


Figure 2 - Surface streamline analysis for 1100 AKST

1.3 Surface Prognostic Chart

The NWS Alaska Aviation Weather Unit (AAWU) Surface Prognostic Chart issued at 0300 AKST and valid for 0900 AKST and available to the pilot for preflight planning is included as figure 3. The chart depicted the main low pressure system at 1000-hPa over interior Alaska with the stationary front extending southwestward across Alaska to the east of the accident site into the Bering Sea. A low pressure system at 990-hPa was depicted in the vicinity of the Aleutian Islands south of the accident site, with a trough of low pressure extending east and west of the low. The chart depicted an area of precipitation in the form of snow along the front generally to the east of the accident site, with visibilities restricted in mist over most of southwest Alaska.

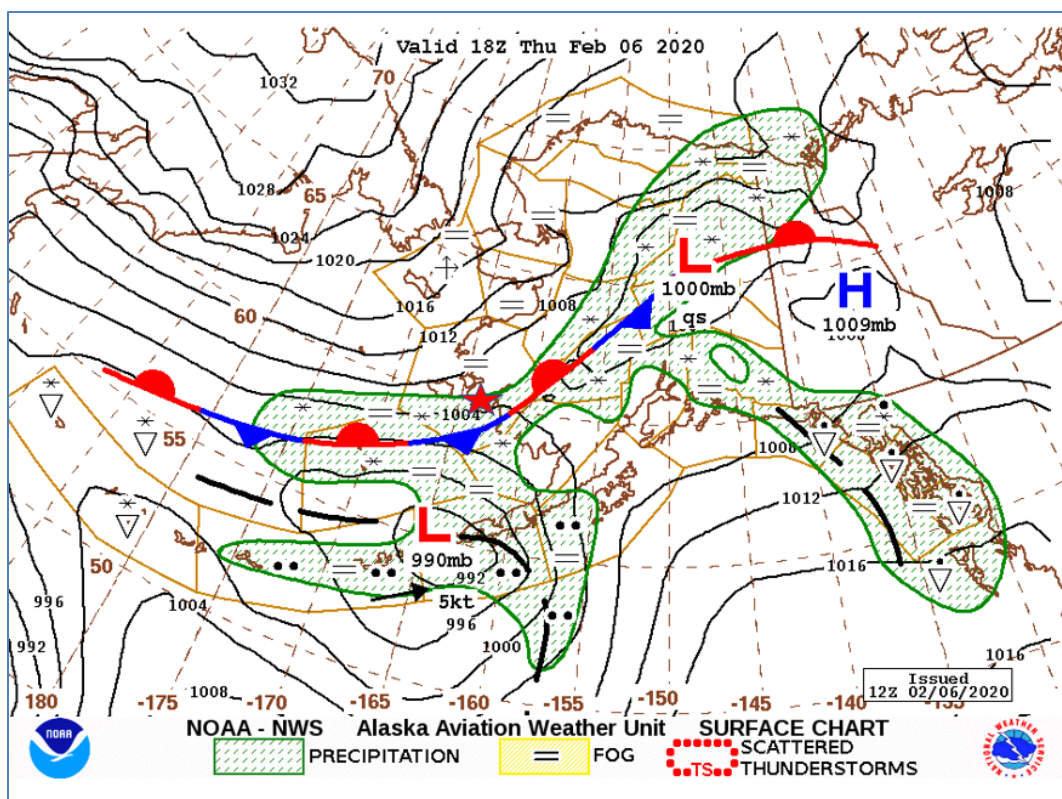


Figure 3 - Alaska Surface Prognostic Chart valid for 0900 AKST

2.0 Observations

The official observations issued surrounding the accident site were documented using standard meteorological aerodrome reports (METARs) and specials (SPECI). Cloud heights are reported above ground level (agl) in the following section, and the magnetic variation was estimated at 12.5° east based on the latest sectional chart.

2.1 Bethel, Alaska

The accident airplane departed from Bethel Airport (PABE), Bethel, Alaska, at approximately 1042 AST. The airport lists an elevation of 129 ft and had an Automated Surface Observation System (ASOS), which was augmented by FAA personnel. Immediately surrounding the time the accident airplane departed the following conditions were being reported.

Special weather observation for PABE at 1030 AKST, wind from 300 at 3 knots, visibility 4 miles, runway 19R visual range 5,000 ft variable to better than 6,000 ft, mist, ceiling overcast at 600 ft agl, temperature -16° Celsius (C), dew point temperature -18° C, altimeter 29.68 inches of mercury (Hg). Remarks: automated station with a precipitation discriminator, temperature -16.1° C, dew point -17.3° C, maintenance indicator on.

Special weather observation for PABE at 1043 AKST, wind calm, visibility 1 1/4 miles, runway 19R visual range 2,200 ft variable to better than 6,000 ft, unknown precipitation

and mist, ceiling overcast at 600 ft agl, temperature -16° C, dew point temperature -17° C, altimeter 29.68 inches of Hg. Remarks: automated station with a precipitation discriminator, unknown precipitation began at 1039 AKST, hourly precipitation less than 0.1 inches, temperature -16.1° C, dew point -17.2° C, maintenance indicator on.

Special weather observation for PABE at 1045 AKST, wind calm, visibility 5 miles, runway 19R visual range 2,200 ft variable to better than 6,000 ft, mist, ceiling overcast at 800 ft agl, temperature -16° C, dew point temperature -17 C, altimeter 29.68 inches of Hg. Remarks: automated station with a precipitation discriminator, unknown precipitation began at 1039 AKST and ended at 1045 AKST, hourly precipitation less than 0.1 inches, temperature -15.6° C, dew point -17.2° C, maintenance required on system.

The accident site was located approximately 43 miles southwest of PABE and at the time of the accident was reporting the following conditions.

Special weather observation for PABE at 1105 AKST, wind from 010° at 7 knots, visibility 3 miles in mist, ceiling overcast at 500 ft agl, temperature -14° C, dew point -15° C, altimeter 29.69 inches of Hg. Remarks; automated station with a precipitation discriminator, temperature -14.4 C, dew point -15.0° C, maintenance indicator on.

The general flight categories² and raw observations from approximately 0600 through 1500 AST were as follows:

MVFR METAR PABE 061453Z AUTO 27006KT 10SM OVC014 M15/M17 A2963 RMK AO2 UPE33 SLP037 P0000 60000 T11501172 51014 TSNO \$

MVFR METAR PABE 061553Z 30003KT 10SM BKN013 OVC042 M16/M17 A2965 RMK AO2 SLP044 T11561172 \$

MVFR METAR PABE 061653Z 26003KT 10SM OVC010 M16/M17 A2965 RMK AO2 SLP045 T11561172 \$

MVFR METAR PABE 061753Z 30008KT 10SM OVC011 M16/M17 A2966 RMK AO2 UPB23E32 SLP046 P0000 60000 T11561172 11144 21156 51010 \$=

MVFR METAR PABE 061853Z 32004KT 8SM OVC010 M16/M18 A2967 RMK AO2 SLP050 T11611178 \$=

IFR SPECI PABE 061930Z 30003KT 4SM R19R/5000VP6000FT BR OVC006 M16/M18 A2968 RMK AO2 T11611183\$=

Departed 1942Z

IFR SPECI PABE 061943Z 00000KT 1 1/4SM R19R/2200VP6000FT UP BR OVC006 M16/M17 A2968 RMK AO2 UPB39 P0000 T11611172 \$=

² As defined by the NWS and the FAA Aeronautical Information Manual (AIM) section 7-1-7 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.
- 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.

IFR SPECI PABE 061945Z 0000KT 5SM R19R/2200VP6000FT BR OVC008 M16/M17 A2968 RMK AO2 UPB39E45 P0000 T11561172 \$=

IFR METAR PABE 061953Z 32004KT 5SM R19R/4500VP6000FT BR OVC008 M16/M17 A2968 RMK AO2 UPB39E4 5 SLP054 P0000 T11561172 \$=

LIFR SPECI PABE 062046Z 36005KT 5SM BR OVC004 M15/M17 A2969 RMK AO2 T11501167 \$=

LIFR METAR PABE 062053Z 36004KT 5SM BR OVC004 M14/M16 A2969 RMK AO2 SLP058 60000 T11441161 52011 \$=

IFR SPECI PABE 062105Z 01007KT 3SM BR OVC005 M14/M15 A2969 RMK AO2 T11441150 \$=

Accident 2010Z

IFR METAR PABE 062153Z 01008KT 5SM BR OVC007 M14/M15 A2970 RMK AO2 SLP062 T11391150 \$=

IFR METAR PABE 062253Z 01014KT 7SM OVC007 M12/M14 A2969 RMK AO2 SLP057 T11221139 \$=

MVFR SPECI PABE 062320Z 01016KT 10SM BKN010 OVC023 M12/M14 A2969 RMK AO2 T11221139 \$=

IFR SPECI PABE 062335Z 02017KT 1SM R19R/P6000FT -SN BR OVC010 M12/M14 A2969 RMK AO2 SNB31 P0000 T11221144 \$=

IFR METAR PABE 062353Z 02017KT 1SM R19R/P6000FT -SN BR OVC008 M12/M14 A2969 RMK AO2 SNB31 SLP056 P0000 60000 T11221139 11122 21161 56005 \$=

The observations from PABE surrounding the period indicated that MVFR conditions were reported during the morning hours due to overcast ceilings, with IFR to LIFR conditions due to low ceilings and visibility restrictions in mist, with snow and unknown freezing precipitation prevailing at the station immediately prior to the accident airplanes departure through the time of the accident.

2.2 Kipnuk, Alaska

The planned destination was Kipnuk Airport (PAKI), Kipnuk, Alaska, located 39 miles southwest of the accident site at an elevation of 20 ft. The airport had an Automated Weather Observation System, which was not augmented by any human observers. The following conditions were reported at the approximate time of the accident.

Weather observation for PAKI at 1056 AKST, automated, wind from 020° at 17 knots, visibility 9 miles in light snow, ceiling overcast at 600 ft agl, temperature -22° C, dew point -24° C, altimeter 29.70 inches of Hg. Remarks: automated station with a precipitation discriminator, snow began at 1048 AST, sea level pressure 1005.9-hPa, hourly precipitation less than 0.01 inches, temperature -22.2° C, dew point -24.4° C, freezing rain sensor inoperative.

The general flight category and raw observations from 0740 to 1500 AKST were as follows.

MVFR SPECI PAKI 061641Z AUTO 01019KT 9SM -SN BKN029 OVC040 M19/M21 A2966 RMK AO2 SNB32 P0000 FZRANO=

MVFR METAR PAKI 061656Z AUTO 02018KT 10SM BKN029 OVC047 M19/M22 A2966 RMK AO2 SNB32E42
SLP047 P0000 T11941217 FZRANO=

VFR SPECI PAKI 061706Z AUTO 02019KT 8SM -SN SCT029 OVC047 M19/M22 A2966 RMK AO2 SNB1658
P0000 FZRANO=

VFR SPECI PAKI 061752Z AUTO 02017KT 10SM SCT008 SCT030 OVC047 M20/M22 A2967 RMK AO2
SNB1658E23 P0000 FZRANO=

VFR METAR PAKI 061756Z AUTO 02019KT 10SM SCT008 SCT030 OVC047 M21/M22 A2967 RMK AO2
SNB1658E23 SLP050 P0000 60000 T12061222 11161 21206 52004 FZRANO=

IFR SPECI PAKI 061805Z AUTO 02019KT 10SM BKN008 OVC047 M21/M23 A2967 RMK AO2 FZRANO=

IFR METAR PAKI 061856Z AUTO 02019KT 6SM BR OVC006 M21/M23 A2968 RMK AO2 SNB36E46 SLP053
P0000 T12111228 FZRANO=

IFR METAR PAKI 061956Z AUTO 02017KT 9SM -SN OVC006 M22/M24 A2970 RMK AO2 SNB48 SLP059
P0000 T12221244 FZRANO=

Accident 2010Z

IFR METAR PAKI 062056Z AUTO 01019KT 4SM -SN OVC006 M22/M24 A2969 RMK AO2 SNE1958B34
SLP059 P0000 60000 T12171244 50008 FZRANO=

IFR SPECI PAKI 062117Z AUTO 01021KT 1 3/4SM -SN BR OVC006 M22/M24 A2969 RMK AO2 VIS 3/4V4
P0000 FZRANO=

LIFR SPECI PAKI 062121Z AUTO 01022G27KT 3/4SM -SN BR OVC006 M22/M24 A2969 RMK AO2 PK WND
01027/2118 VIS 1/2V3 P0000 FZRANO=

LIFR SPECI PAKI 062131Z AUTO 01021KT 1/2SM -SN FZFG OVC004 M21/M23 A2969 RMK AO2 PK WND
01027/2118 P0000 FZRANO=

LIFR SPECI PAKI 062147Z AUTO 01020KT 3/4SM -SN BR OVC006 M21/M23 A2969 RMK AO2 PK WND
01027/2118 CIG 003V007 P0000 FZRANO=

LIFR METAR PAKI 062156Z AUTO 01019KT 3/4SM -SN BR OVC006 M21/M23 A2969 RMK AO2 PK WND
01027/2118 CIG 004V008 SLP058 P0000 T12061228 FZRANO=

LIFR SPECI PAKI 062209Z AUTO 01021KT 1/2SM -SN FZFG OVC006 M21/M23 A2969 RMK AO2 PK WND
01026/2205 CIG 004V008 P0000 FZRANO=

LIFR SPECI PAKI 062218Z AUTO 01021KT 3/4SM -SN BR OVC006 M21/M23 A2969 RMK AO2 PK WND
01026/2214 P0000 FZRANO=

LIFR SPECI PAKI 062244Z AUTO 01021G27KT 1/2SM -SN FZFG OVC006 M20/M22 A2969 RMK AO2 PK
WND 01027/2237 P0000 FZRANO=

LIFR SPECI PAKI 062251Z AUTO 01023KT 1/2SM FZFG OVC004 M20/M22 A2968 RMK AO2 PK WND
01027/2237 SNE47 P0000 FZRANO=

LIFR METAR PAKI 062256Z AUTO 01025G28KT 1/2SM FZFG OVC004 M20/M22 A2968 RMK AO2 PK WND
01028/2256 SNE47 SLP055 P0000 T12001222 FZRANO=

LIFR SPECI PAKI 062305Z AUTO 01021G27KT 3/4SM BR OVC004 M20/M22 A2969 RMK AO2 PK WND 01028/2257 FZRANO=

LIFR SPECI PAKI 062336Z AUTO 01021KT 1/2SM -SN FZFG OVC006 M19/M22 A2968 RMK AO2 PK WND 01028/2311 SNB35 P0000 FZRANO=

LIFR METAR PAKI 062356Z AUTO 01024KT 1/2SM -SN FZFG OVC006 M19/M22 A2967 RMK AO2 PK WND 01028/2356 SNB35 SLP052 P0000 60000 T11941217 11194 21222 56006 FZRANO=

A review of the observations for PAKI indicated that VFR to MVFR conditions were reported during the early morning, with IFR conditions developing over the area prior to the accident airplanes departure and continue to LIFR conditions due to low ceilings and visibility restricted in snow and mist through the afternoon and into the evening hours.

2.3 METAR Display

A display of the conditions from the NWS Aviation Weather Center's website³ for 1120 AKST taken after the accident is included as figure 4, with the estimated route of flight and the accident site marked as a red star. At the time of the image both PABE and PAKI were reporting IFR conditions due to low ceilings and visibility restricted in mist at PABE and light snow at PAKI. No other official METAR sites are shown between the 85 miles between PABE and PAKI on the image; however, the FAA has a weather camera at Tuntutuliak Airport (A61) approximately 12 miles east of the accident site (see section 8.0 for additional details).

³ <https://aviationweather.gov/metar>



Figure 4 - NWS METAR display after the accident at 1020 AKST with the approximate accident site marked by a red star and the general route of flight

3.0 Sounding

The NWS PABE upper air sounding for 1500 AKST (0000Z on February 7, 2020) plotted on a standard Skew T log P diagram⁴ using the complete Rawinsonde Observation RAOB program software⁵ from the surface through 450-hPa or approximately 20,000 ft is included as figure 5. The sounding depicted a surface temperature of -11° C (12° F), a dew point temperature of -13° C (9° F), with a relative humidity of 87%. The lifted condensation level (LCL)⁶ and level of free convection (LFC)⁷ were both identified at 684 ft agl and indicated the approximate base of the clouds. A defined frontal inversion was collocated between the LCL and 3,000 ft where temperature increased with altitude but remained below freezing through the depth of the

⁴ 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.

⁵ RAOB software – The complete RAWinsonde OBservation program is an interactive sounding analysis program developed by Environmental Research Services, Matamoras, Pennsylvania, for plotting and analyzing upper air data

⁶ Lifted Condensation Level (LCL) - the level at which a lifted parcel becomes saturated. The LCL height corresponds to cloud base height for forced ascent.

⁷ Level of Free Convection (LFC) - the last level where a parcel becomes buoyant, or "warmer" than the environmental temperature at the same level. The LFC represents the bottom of the layer containing CAPE.

sounding. The layer between 700 ft and 6,500 ft had a relative humidity in excess of 95% and supported a layer of nimbostratus type clouds capable of producing precipitation in the form of snow. The atmosphere was characterized as stable based on the Lifted Index⁸ of 20.0 and had a precipitable water content of 0.22 inches.

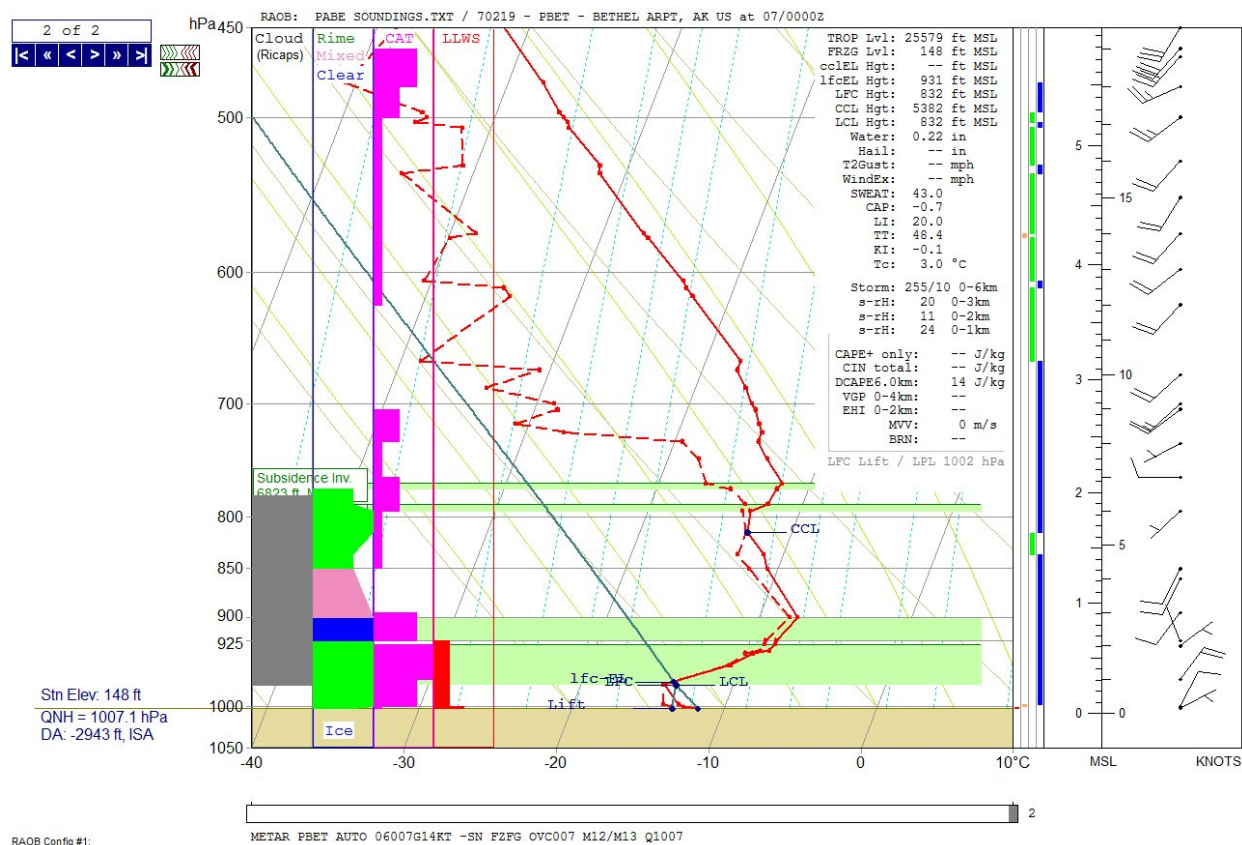


Figure 5 - PABE sounding for 1500 AKST from surface through 20,000 ft

The PABE sounding wind profile indicated a surface wind from 060° at 7 knots with a low-level wind maximum near the base of the inversion at 850 ft agl from 035° at 18 knots, the wind shifted to the southwest above the inversion with wind speeds slowly increasing with height. The mean 0 to 6 kilometer or 18,000 ft wind was from 225° at 13 knots.

Figure 6 is a table of the observed sounding parameters of height, pressure (Pres), temperature (T), dew point (Td), relative humidity (RH), wind direction and speed (DD/FF), and RAOB derived clear air turbulence (CAT), low-level wind shear (LLWS), and icing potential.

⁸ Lifted Index (LI) - the difference between the lifted parcel temperature at 500 hPa and the 500 hPa temperature in the sounding. Negative values denote parcels that are warmer than the background 500 hPa temperatures and are thus buoyant or "unstable".

Height (ft-AGL)	Pres (hPa)	T (C)	Td (C)	RH (%)	DD / FF (deg / kts)	CAT (FAA)	LLWS	Icing - Type (AFGWC method)
0	1002	-11.7	-13.4	87	60 / 7	LGT	MODRT	LGT Rime
50	1000	-12.7	-13.5	94	25 / 8			MDT Rime
125	997	-13.1	-14.1	92				MDT Rime
707	974	-14.5	-14.6	99		SVR	LIGHT	MDT Rime
852	968				35 / 18			
1280	952	-10.7	-10.8	99				MDT Rime
1628	939	-9.5	-10.0	96				MDT Rime
1709	936	-8.5	-9.1	95		XTR	LIGHT	MDT Rime
1900	929	-8.3	-9.0	95	50 / 3		LIGHT	MDT Rime
2010	925	-8.3	-9.0	95	340 / 1			MDT Rime
2709	900	-7.5	-8.0	96		SVR		MDT Clear
2852	895				215 / 10			
3852	860				205 / 11			
4161	850	-10.7	-11.9	91	205 / 10			LGT Mixed
4580	836	-11.3	-13.0	87				LGT Rime
5219	815	-12.9	-13.0	99		LGT		MDT Rime
5872	794	-13.3	-13.8	96	225 / 5			MDT Rime
6062	788	-12.3	-13.8	89				LGT Rime
6512	774	-12.1	-15.1	78				LGT Rime
6675	769	-11.9	-16.9	66		MDT		
6852	764				270 / 10			
7402	747	-13.5	-18.0	69		LGT		
7908	732	-14.5	-19.5	66	240 / 7			
8181	724	-14.5	-27.5	32				

Figure 6 – PABE Observed sounding parameters and derived turbulence, low-level wind shear, and icing potential

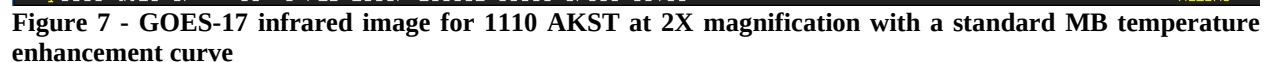
Based on the sounding the estimated cloud base was at 700 ft agl. The wind profile suggested the potential for low-level turbulence based on the low-level wind maximum and the strong vertical shear near the inversion. The RAOB algorithm indicated a 77% probability of moderate to severe turbulence at 700 ft agl due to the strong vertical wind shear. The table also indicated that light to moderate rime icing conditions were likely in clouds and in precipitation due to the inversion and the relative warm low-level airmass with temperature in the range of -7.5° to -10.7° C, which increased the likelihood of icing conditions in the low nimbostratus type clouds.

4.0 Satellite Imagery

The Geostationary Operational Environmental Satellite number 17 (GOES-17) data was 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 (McIDAS) software. The infrared long wave and visible imagery were obtained surrounding the time of the accident, with the images closest to the time of the accident documented below. The infrared long wave imagery (band 13) at a wavelength of 10.3 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.

Figure 7 is the GOES-17 infrared image for 1110 AKST at 4X magnification with a standard MB temperature enhancement curve applied to highlight the higher and colder cloud tops associated with deep convection and/or high cirriform type clouds. The image depicted an extensive area of low stratiform type clouds over southwest Alaska which extended over the

Figure 8 is the GOES-17 visible image for the same period of 1110 AKST at 2X magnification and the approximate frontal positions at 1200 AKST overlaid. The image depicted an overcast layer of stratiform to nimbostratus type clouds extending over the accident site.



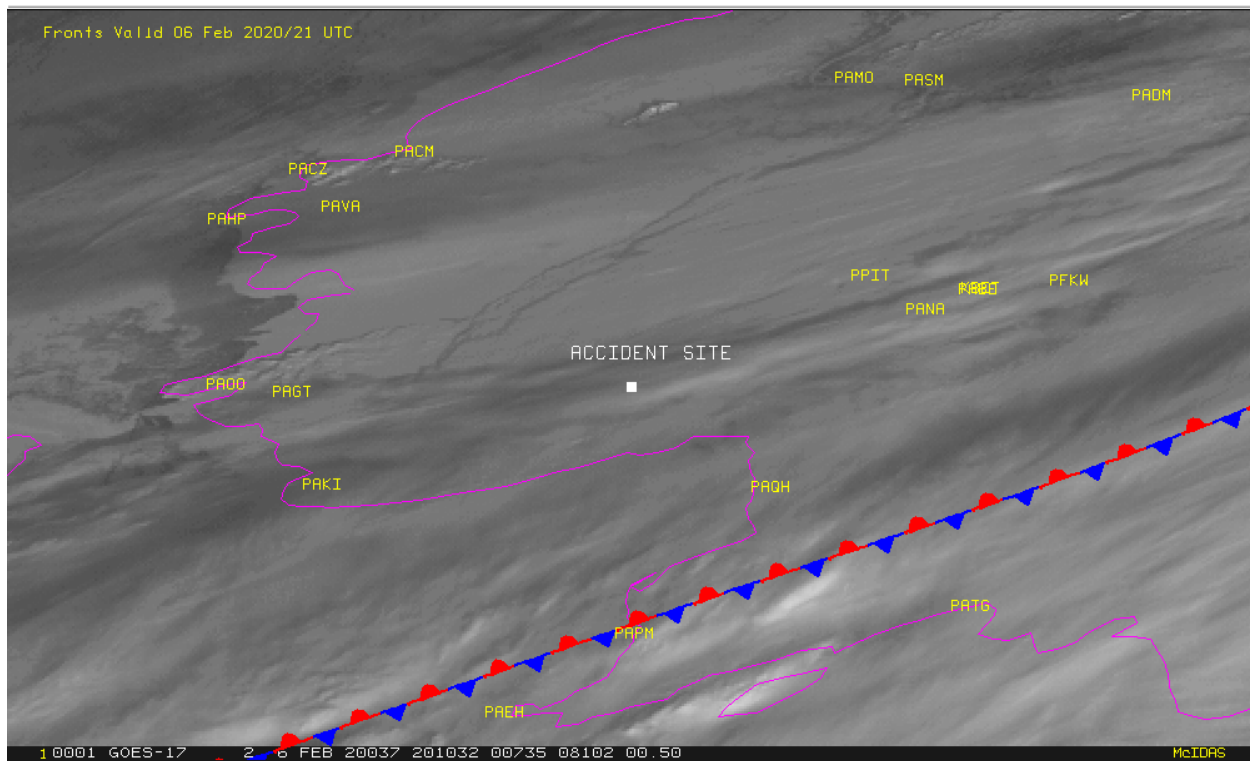


Figure 8 - GOES-17 visible image at 1110 AKST at 2X magnification with fronts overlaid

5.0 Weather Surveillance Radar Imagery

The closest Weather Surveillance Radar 1988 Doppler (WSR-88D) was located approximately 43 miles northeast of the accident site in Bethel, Alaska, with the site identified as PABC⁹. The level II archive data was obtained from the NCEI using the Hierarchical Data Storage System and displayed using the NWS NEXRAD Interactive Viewer and Data Exporter software.

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

5.1 Volume Scanning Strategies

During the period the PABC WSR-88D was operating in the clear air mode volume scan pattern 31 (VCP-31), where the radar makes 5 different elevation scans in 10 minutes. This scan is typically used in helping to identify snow and light stratiform precipitation at low altitudes. The following chart provides the beam height for the lowest 0.5° elevation scan based on the distance and the antenna height of 193 ft. The heights have been rounded to the nearest 10 ft.

Elevation	Center Beam	Base	Top	Width
0.5°	3,700 ft	1,530 ft	5,860 ft	4,330 ft

⁹ The Bethel WSR-88D station PABC is located approximately 1.5 miles west of the PABE airport and is part of the FAA radar network in Alaska.

5.1 Reflectivity

Reflectivity is the measure of the efficiency of a target in intercepting and returning radio energy. With hydrometeors, it is a function of the drop size distribution, number of particles per unit volume, physical state (ice or water), shape, and aspect. Reflectivity is normally displayed in decibels (dBZ¹⁰) and is a general measure of echo intensity. Figure 9 relates the NWS former video integrator and processor (VIP) intensity levels (1-6) versus the WSR-88D's display levels (0-15), precipitation mode reflectivity in decibels (DBZ), and rainfall rates.

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

Figure 9 – NWS VIP levels, WSR-88D levels, dBZ, and rainfall intensities

The FAA has taken the NWS previous VIP levels 1 to 6 intensity levels and has redefined the intensity levels for pilots in Advisory Circular AC 00-24C – “Thunderstorm”. That AC further defines echoes less than 30 dBZ as “light” in intensity and are not generally depicted by air traffic control weather displays.

5.2 Base reflectivity Image

Figure 10 is the PABC WSR-88D 0.5° base reflectivity image for 1106 AKST with the accident site marked. The image depicted very light intensity echoes of 10 dBZ or less over and around PABE associated with false returns associated with the temperature inversion over the area. The only significant echoes were noted well to the east of the accident site over Quinhagak Airport (AQH), which were likely associated with snow. With another area of very light intensity echoes in the vicinity of the destination of Kipnuk identified as IIK on the image, with the echoes south through east of the station. No significant echoes were identified over the accident site.

¹⁰ dBZ - $10 \log Z_e$

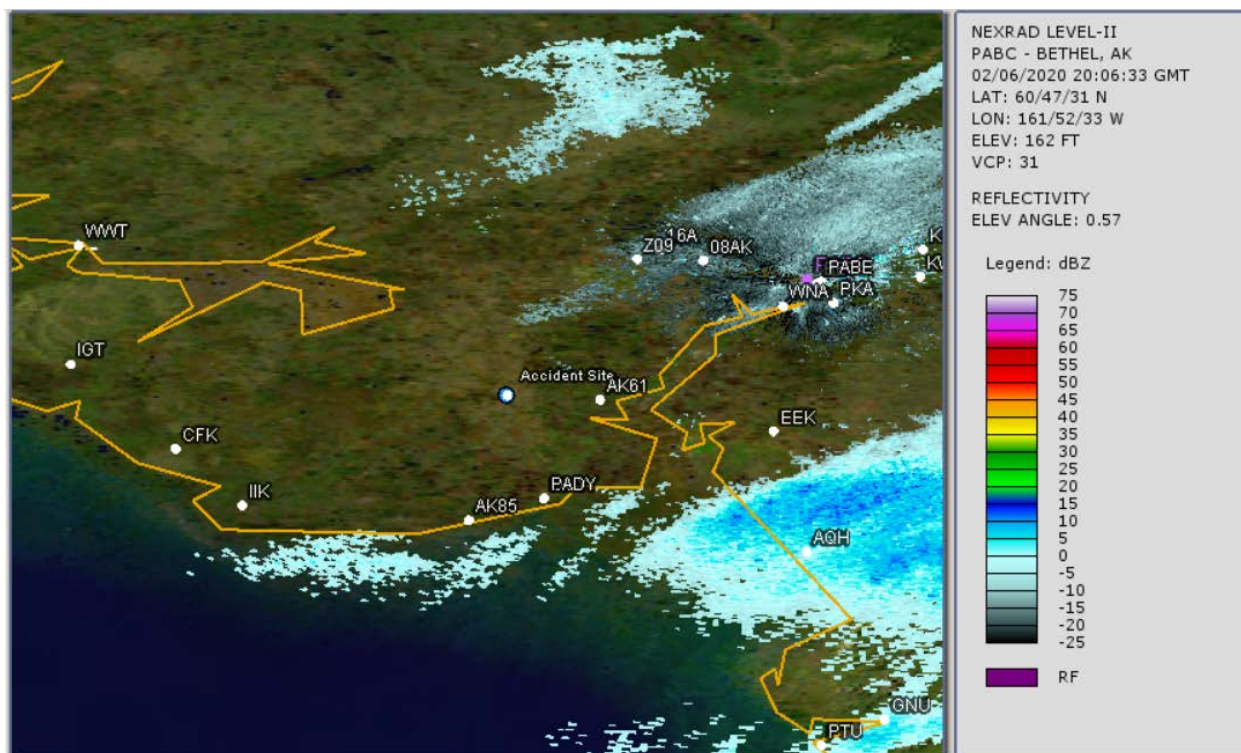


Figure 10 - PABC WSR-88D 0.5° base reflectivity image at 1106 AKST

6.0 Pilot Reports

There were no recorded pilot reports (PIREPs) of relevance within 100 miles of the area surrounding the period below 12,000 ft.

7.0 NWS Forecasts

The NWS standard aviation forecasts, discussions, and graphics were documented over the region.

7.1 Terminal Aerodrome Forecasts

The NWS Anchorage Weather Forecast Office (WFO) was responsible for the issuance of the Terminal Aerodrome Forecast (TAF) for PABE, no TAFs are issued for the planned destination of PAKI. A 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 forecasts issued surrounding the period relevant to the preflight planning and the time of the accident were as follows.

TAF PABE 061730Z 0618/0718 30003KT P6SM BKN010 OVC040
FM070000 36015KT P6SM SCT010 BKN050
FM070300 36020G30KT P6SM SCT050 OVC100=

The forecast issued at 0830 AST for PABE expected from 0900 through 1500 AST, a wind from 300° at 3 knots, visibility 6 miles or more, with a ceiling broken at 1,000 ft agl, overcast at 4,000 ft.

AMD TAF PABE 062100Z 0621/0718 36011KT P6SM SCT005 OVC010
TEMPO 0621/0624 5SM BR OVC004
FM070200 36015KT P6SM SCT010 BKN050
FM070300 36020G30KT P6SM SCT050 OVC100=

The forecast for PABE was amended after the accident at 1200 AKST and expected wind from 360 at 11 knots, visibility better than 6 miles, scattered clouds at 500 ft agl, ceiling overcast at 1,000 ft, with a temporary period between 1200 through 1500 AKST of visibility 5 miles in mist, ceiling overcast at 400 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 it relates 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 long term and marine sections have been excluded. The forecast discussion issued at 0530 AKST was as follows.

FXAK68 PAFC 061430
AFDAFC

Southcentral and Southwest Alaska Forecast Discussion
National Weather Service Anchorage AK
530 AM AKST Thu Feb 6 2020

.ANALYSIS AND UPPER LEVELS...

An upper-level trough and associated weak surface low over Prince William Sound is producing areas of light snow and low stratus over the Copper River Basin. Along the immediate coast, a low-level southerly flow has advected enough warmer, marine air to push temperatures a couple of degrees above freezing. This has led to a mix of rain and snow for areas like Cordova and Valdez overnight. Elsewhere across Southcentral, light snow and low cloud cover persists from Anchorage north to Talkeetna and Skwentna. This is due to an upper-level trough lifting northeast across Cook Inlet this morning. Weak ridging behind the trough has ushered in clearer and drier conditions for the southern half of the Kenai Peninsula, Kodiak Island, and portions of the Alaska Peninsula.

A surface front draped across the interior of Alaska is separating milder air across Bristol Bay from arctic air moving south across the Y-K Delta this morning. Temperatures from Bethel north and west are in the single digits to below zero while south and east temperatures are in the upper teens to near 30 degrees. Light snow is also falling across the Kuskowim Delta along the front.

For the Bering and Aleutians, an upper-level low is situated over the central Bering. At the surface, a complex low with multiple centers of circulation is centered just north of Atka this morning. One center of circulation is southwest of the Pribilofs and is bringing occasional snow and easterly wind gusts to the islands. A second is east of Atka and a third is north of Adak. The low near Adak is producing northwesterly gales and snow across portions of the western Aleutians. Yet another low is south of Dutch Harbor and is producing some rain and southerly winds across the eastern half of the Chain and far southern AKPEN.

.MODEL DISCUSSION...

The numerical models are in fairly good agreement with the overall synoptic-scale pattern into the weekend. The larger differences are with the placement and strength of the various lows forming the complex low system currently over the central Aleutians and AKPEN through early Friday. However, given the model spread, the resultant weather impacts remain fairly similar. Thus, the forecast confidence is above average. The NAM and NAMnest were favored, especially for winds over the Southern Mainland, given the higher resolution.

.AVIATION...

PANC...General MVFR conditions are expected through Thursday morning, mainly for lower ceilings. Some light snow is still possible early this morning, but is not expected to significantly reduce visibility. Southerly winds have developed across the terminal overnight and are expected to continue through Thursday evening. MVFR ceilings are expected to return Thursday night with the potential for fog in the vicinity of the airport complex. IFR visibility is possible for a time Thursday night if fog does move over the terminal.

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

A weakening low over Southwest mainland will keep snow showers in the forecast this morning across the Y-K Delta and Kuskokwim Valley, which will taper off through late morning. A shortwave ridge building in over interior Bristol Bay this morning will keep low stratus and dry conditions early today. The next round of precipitation moves in near Dillingham this afternoon and shifting northeastward tonight associated with a surface low moving over the AKPEN throughout the day. There is still uncertainty in the exact track of this low as it moves eastward through Friday afternoon. Dry conditions will persist across the Kuskokwim Delta tonight as gusty winds and colder air move into the area. A Wind Chill Advisory remains in effect from Hooper Bay to Kipnuk, where there will be the coldest advection.

The pattern will then shift Friday evening when a warm front moves across the AKPEN into Southwest Alaska. The biggest forecast challenge is how far north this system will travel. However, widespread precipitation is expected as it moves farther inland overnight Friday into Saturday. With gusty conditions still in place across the Y-K Delta, blowing snow is a forecast concern as precipitation begins to move inland Friday night and through Saturday.

7.3 Area Forecast

The NWS Area Forecast (FA) issued for the Yukon-Kuskokwim Delta region which cover the Bethel and Kipnuk regions issued at 0404 AKST and current through 1600 AKST was as follows. Cloud heights are reported in msl heights unless otherwise noted in this section.

FAAK58 PAWU 061304

FA8W

ANCC FA 061315

AK SRN HLF EXCP SE AK...

.

AIRMETS VALID UNTIL 062115

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

NON MSL HEIGHTS NOTED BY AGL OR CIG.

.

YKN-KUSKOKWIM DELTA AG...VALID UNTIL 070100

...CLOUDS/WX...

AIRMET IFRPAMY-PARS LN SE OCNL VIS BLW 3SM -SN BR. IMPR...

AIRMET MT OBSCMTS OCNL OBSC CLDS/PCPN. IMPR...

PAMY-PARS LN SE SCT009 BKN015 OVC035 TOP FL180/VIS 3-5SM -SN BR.

ABV CONDS BECM SLOLY BECM ISOL THRU PD.

ELSW FEW005 SCT015 SCT-BKN045 TOP FL180. ISOL BKN015/VIS 3-5SM -SN BR.

ISOL CIG BLW 010/VIS BLW 3SM -SN BR. ALG CST/OFSHR SFC WND NE G25KT.

OTLK VALID 070100-070700...PABE SE MVFR CIG BR. ELWS VFR. CST/OFSHR WND.

...TURB...

NIL SIG.

...ICE AND FZLVL...

NIL SIG. FZLVL SFC.

.

DH FEB 2020 AAWU

The forecast included an AIRMET for IFR conditions for occasional visibility below 3 miles in light snow and mist, and an AIRMET for mountain obscuration conditions in clouds and precipitation was current for the region, with conditions expected to improve with time.

The clouds and weather section indicated that from a line southeast of Mekoryuk (PAMY) to Russian Mission (PARS) expected scattered clouds at 900 ft, ceiling broken at 1,500 ft, overcast at 3,500 ft with tops layered to 18,000 ft, visibilities 3 to 5 miles in light snow and mist, with conditions slowly becoming isolated through the period. The outlook section from 1600 through 2200 AKST expected from PABE to the southeast, MVFR conditions due to ceiling and visibility restricted in mist, with VFR conditions elsewhere. No significant turbulence or icing conditions were expected for the region. The freezing level was at the surface.

7.4 NWS Alaska Aviation Weather Unit Graphics

The NWS AAWU is responsible for the entire Anchorage flight information region (FIR) and issued Airman's Meteorological Information (AIRMETs), Significant Meteorological Information (SIGMETs), Graphic Area Forecasts, Significant Weather Prognostic Charts, and volcanic advisories for Alaska. The following AAWU graphic charts were issued during the period.

Figure 11 is the AAWU Flying Weather issued at 0400 AKST and valid for the period from 1000 through 1600 AKST with the accident site within the circle. The chart depicted MVFR conditions prevailing over the region. Figures 12-15 are the Low Level Turbulence Forecast and Icing Forecasts valid for 0900 and 1200 AKST, which indicated no significant turbulence or icing over the route of flight.

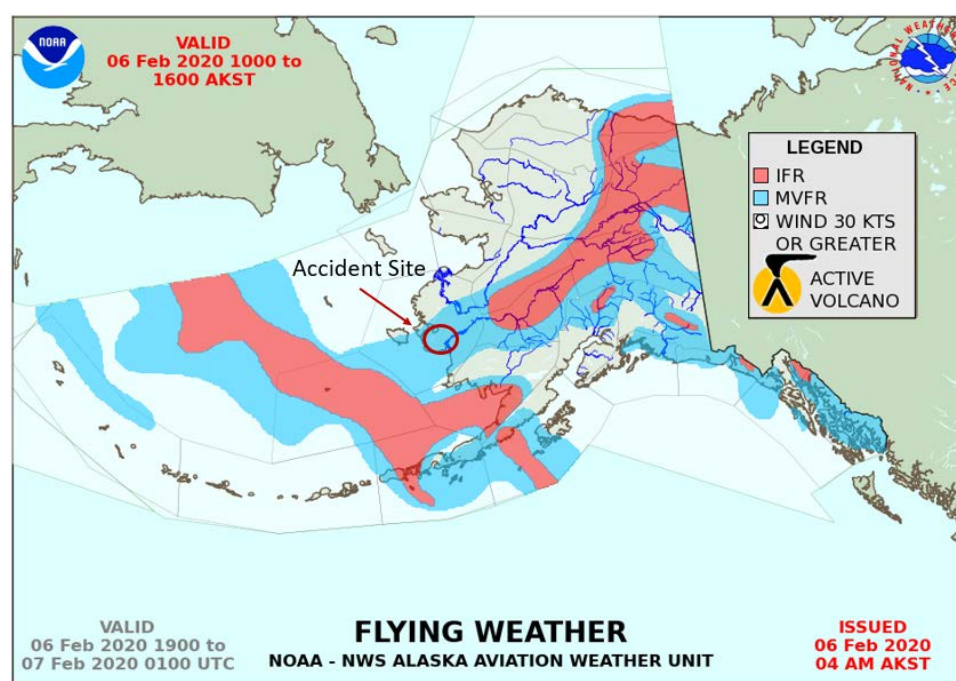


Figure 11 - AAWU Flying Weather valid between 1000 and 1600 AKST

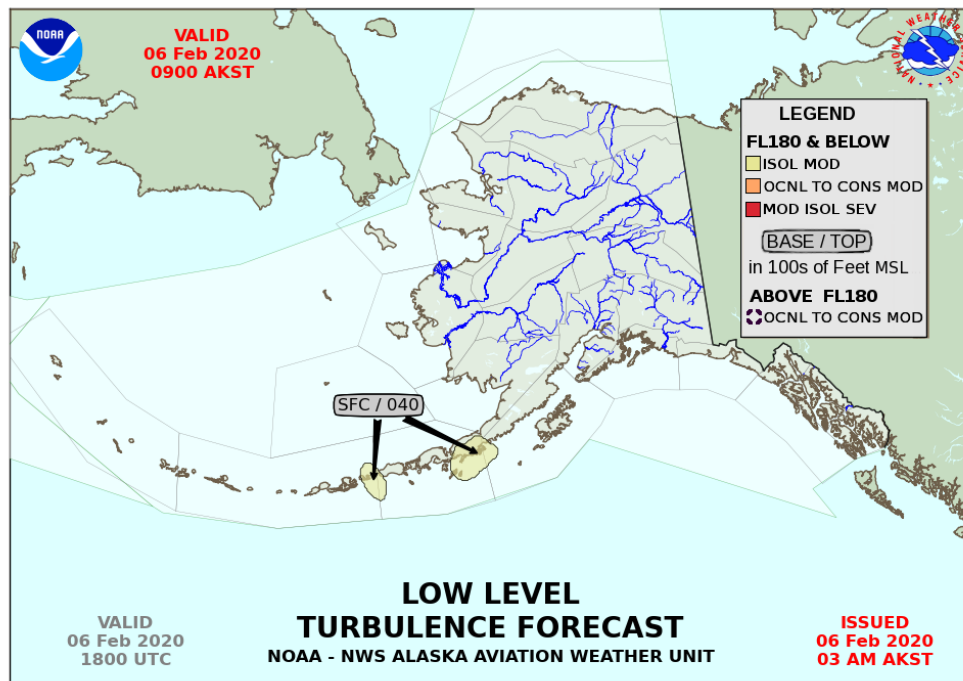


Figure 12 - AAWU Low Level Turbulence Forecast valid for 0900 AKST

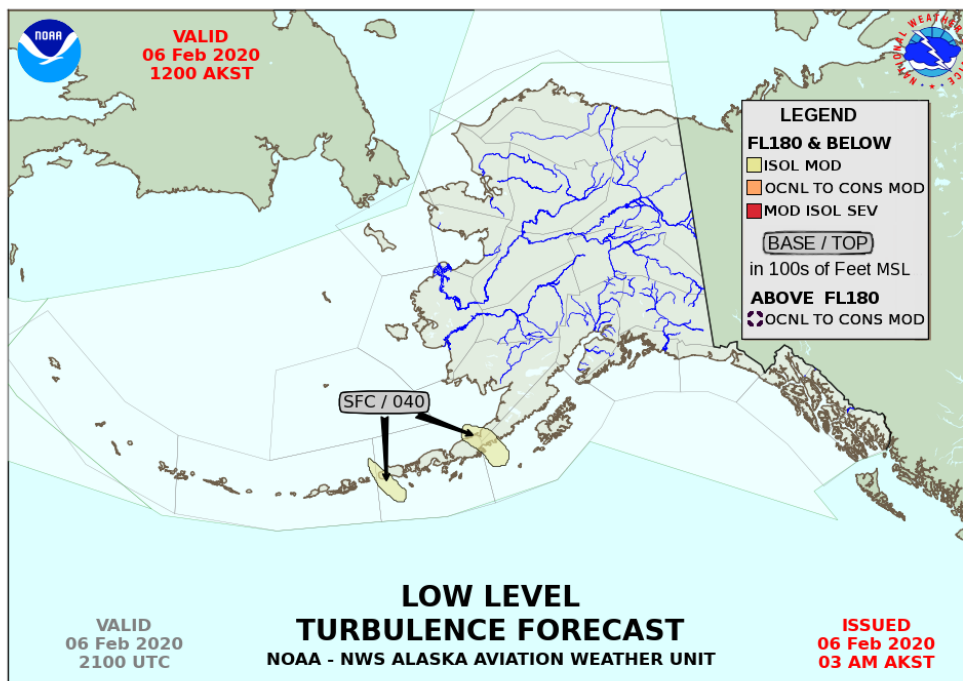


Figure 13 - AAWU Low Level Turbulence Forecast valid for 1200 AKST

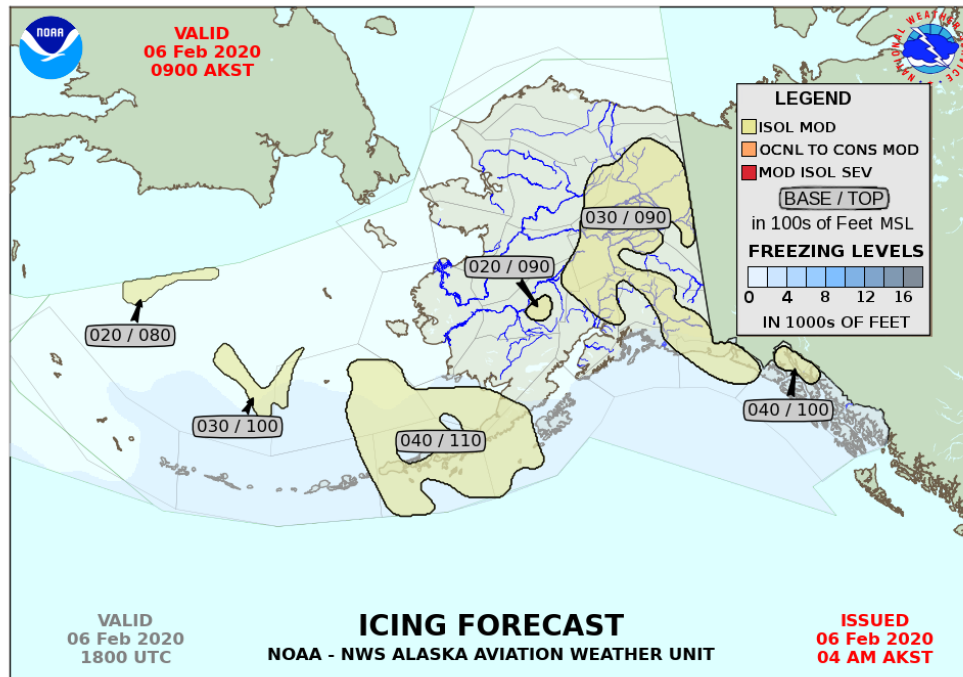


Figure 14 - AAWU Icing Forecast valid for 0900 AKST

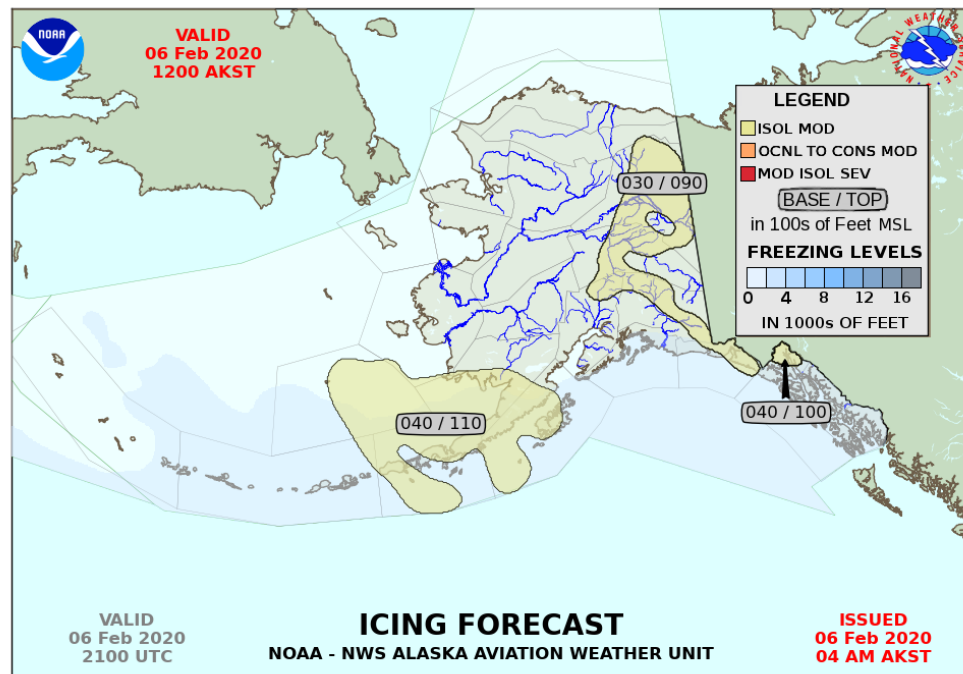


Figure 15 - AAWU Icing Forecast valid for 1200 AKST

7.5 NWS Public Weather Advisories

The NWS issued an Urgent Winter Weather Message at 0413 AKST for the Bethel area for dangerous wind chill temperatures. The advisory was as follows.

WWAK42 PAFC 061313
WSWALU

URGENT - WINTER WEATHER MESSAGE
National Weather Service Anchorage AK
413 AM AKST Thu Feb 6 2020

AKZ155-070200-
/O.CON.PAFC.WC.Y.0009.200207T0400Z-200208T1200Z/
Kuskokwim Delta-
Including the cities of Bethel, Hooper Bay, and Nunivak Island
413 AM AKST Thu Feb 6 2020

...WIND CHILL ADVISORY REMAINS IN EFFECT FROM 7 PM THIS EVENING TO 3 AM AKST SATURDAY...

* WHAT...Very cold wind chills expected. Wind chills as low as 45 below zero.

* WHERE...Kuskokwim Delta Coast from Hooper Bay to Kipnuk, including Nunivak Island.

* WHEN...From 7 PM Thursday to 3 AM AKST Saturday.

* IMPACTS...The dangerously cold wind chills could cause frostbite on exposed skin in as little as 10 minutes.

PRECAUTIONARY/PREPAREDNESS ACTIONS...

Use caution while traveling outside. Wear appropriate clothing, a hat, and gloves.

8.0 FAA Weather Camera Imagery

The FAA has deployed 230 weather cameras across Alaska. The FAA weather camera program is intended as a supplementary product used to improve situational awareness and are not intended to be used to comply with regulatory requirements to determine weather minimums. The camera images are updated every 10 minutes and are designed to assist pilots in making critical weather evaluations and to help pilots make better safety decisions. Each of the weather cameras is identified by a point on the map¹¹, with several camera angle views are available for most of the cameras.

The FAA Weather Cameras at Tuntutuliak west (255°) viewing weather cameras surrounding the period were obtained and are documented below. Figure 16 is a depiction from the FAA website indicating the approximate viewing area of the cameras with the approximate accident site marked 12 miles east of the station.

¹¹ <https://avcams.faa.gov/>

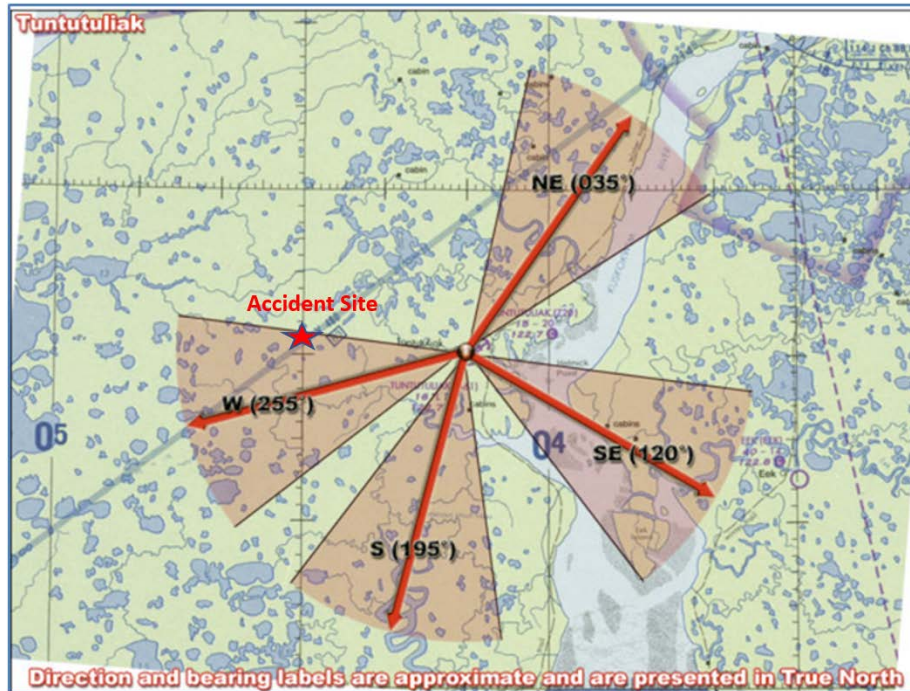


Figure 16 - Tuntutuliak Weather Camera viewing sectors

Figure 17 is the Tuntutuliak west camera view on a clear day with the various landmarks and elevations noted. Only a single visibility marker or buildings was identified at less than 1 mile from the camera, which is set at 13 ft elevation.



Figure 17 - Tuntutuliak West Weather Camera view on a clear day

Weather observers are taught that visibility is the greatest horizontal distance at which selected objects can clearly be seen and identified, and to base the visibility estimate on the sharpness with

which the most distant markers can be seen. If the markers can be seen clearly, with little loss of color, and with the sharp outlines, it means that the visibility is much greater than the distance to the markers. If the object is not clearly identified, visibility is less than that distance.

Figures 18-22 are the Tuntutuliak west camera views for 1048, 1058, 1108, 1118, and 1128 AKST. The images depict an overcast layer of clouds with no appreciable changes in visibility in the limited range of the camera.



Figure 18 - Tuntutuliak West camera view at 1048 AKST



Figure 19 - Tuntutuliak West camera view at 1058 AKST



Figure 20 - Tuntutuliak West camera view at 1108 AKST



Figure 21 - Tuntutuliak West camera view at 1118 AKST



Figure 22 - Tuntutuliak West camera view at 1128 AKST

The Tuntutuliak Northeast and Southeast camera views depicted similar conditions of overcast clouds with no appreciable changes in visibility noted in the limited mile reference locations, with the South camera not useable due to some obstruction or snow on the camera.

9.0 Preflight Weather Briefing

A search of FAA Flight Service Station (FSS) indicated that they had no contact with the pilot of N7632C for any weather briefing, flight plans, or other contacts. A search of 3rd party vendors ForeFlight indicated that they did not provide any weather briefing to N763C; however, the accident pilot did have an account with them. While he did not request a weather briefing or file any flight plans, the accident pilot did enter several route strings which provided METAR and TAF, NOTAMs, and general airport data. The route strings were as follows:

0814:29 AKST (1714Z)	PABE – A61
0814:51 AKST (1715Z)	PABE – PAKI
0816:24 AKST (1716Z)	PABE – PAKI – PACK ¹²
0934:11 AKST (1834Z)	PABE – PAKI - PACK – PABE

The ForeFlight indicated that the pilot did not view any static weather images during the period and no formal weather briefings were generated. Based on this information, the data available from the route strings entered would have shown the METARs for PABE and PAKI current up to 0934 AKST, and the PABE TAF current during the period which indicated MVFR conditions prevailing. The METARs for PAKI would have indicated VFR conditions prevailing with the latest observation reported IFR conditions with a broken ceiling at 800 ft agl.

There was no record of the pilot obtaining the Area Forecast, or the AAWU weather graphic images, or viewing the FAA weather camera's prior to his departure.

10.0 Astronomical Conditions

The following astronomical data was calculated over the accident site on February 6, 2020, with the accident time added in bold italic print for reference.

<u>Sun</u>	
Begin civil twilight	0909 AKST
Sunrise	0955 AKST
<i>Accident</i>	<i>1110 AKST</i>
Sun transit	1406 AKST
Sunset	1818 AKST
End civil twilight	1904 AKST

¹² Chefnak Airport (PACK), Chefnak, Alaska, located about 82 miles west-southwest of KABE, and 14 miles northwest of PAKI. The airport has a gravel runway with no weather reporting capability.

At the approximate time of the accident, the Sun was 6.4° above the horizon at an azimuth of 137°. Total duration of daylight was 8:23:07.

11.0 Flat Light and White Out Conditions

The FAA defines “Flat Light” conditions as an optical illusion and is also known as “sector or partial white out”. It is not as severe as “white out” conditions but the condition causes pilots to lose their depth-of-field and contrast in vision. Flat light conditions are usually accompanied by overcast clouds inhibiting any good visual clues and are most common over snow covered areas or over regions with little contrast such as deserts or glassy water. Flat light can completely obscure features of the terrain, creating an inability to distinguish distance and closure rates. As a result of this reflected light, it can give pilots the illusion of ascending or descending when they are actual flying in level flight.

White out conditions in meteorological terms, is when a person becomes engulfed in a uniform white glow. The white glow may be as a result of blowing snow, dust, sand, mud, or water. There are no shadows, no horizon or clouds and all depth-of-field and orientation is lost. A white out situation is severe in that there aren’t any visual references, and VFR flight in complete white out conditions is not recommended, according to the FAA Safety Bulletin “Flying in Flat Light & White Out Conditions”, dated 2002.

Submitted by:

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