



NATIONAL TRANSPORTATION SAFETY BOARD

Office of Aviation Safety
Washington, D.C. 20594

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Specialist's Factual Report

METEOROLOGY

ANC21LA007

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A. ACCIDENT

Location: Colton, Oregon
Date: November 16, 2020
Time: 0604 Pacific standard time
1404 coordinated universal time (UTC)
Airplane: Cessna 150L; Registration: N18666

B. METEOROLOGIST

Don Eick
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C. SUMMARY

On November 16, 2020, about 0604 Pacific standard time (PST), a Cessna 150L, N18666, was destroyed when it was involved in an accident near Colton, Oregon. The pilot and one passenger were fatally injured. The airplane was operated as a Title 14 *Code of Federal Regulations* Part 91 personal flight.

This report provides a meteorological review on the weather conditions and NWS aviation weather products applicable to the accident region around the accident time.

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 Pacific standard time (PST) based upon the 24-hour clock, local time is -8 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. 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.

According to the Clackamas County Sheriff's office the accident site was located within the Fish Creek drainage, within the Mt. Hood National Forest at or near latitude 45.049998° N and longitude 122.15604° W, and at an elevation of approximately 2,610 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 northwest section of the NWS Surface Analysis Chart for 0700 PST issued is included as figure 1, with the approximate accident site marked by a red star. The chart depicted a low-pressure system at 999-hectopascals (hPa)¹ off the Oregon coast associated with a frontal wave with a warm front and a trough of low pressure extending east-to-west across central Oregon immediately south of the accident site. Another low-pressure system was located over eastern Oregon at 1023-hPa. The accident site was located between the warm front and the trough in an area of a col², which resulted in a relatively weak pressure gradient over the area. The station models in the vicinity of the accident site indicated variable winds of 5 knots, light rain, overcast clouds, with a temperature of 47° F, with dew point temperatures of 45° F. Multiple station models across Oregon reported visibility restrictions in light to moderate rain, and or mist.

¹ Hectopascal (hPa) is the new international standard 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).

² A col, also called a saddle back or neutral point, is the point of intersection of a trough and a ridge. It is the point of relatively lowest pressure between the two highs and the point of relatively highest pressure between the two lows.

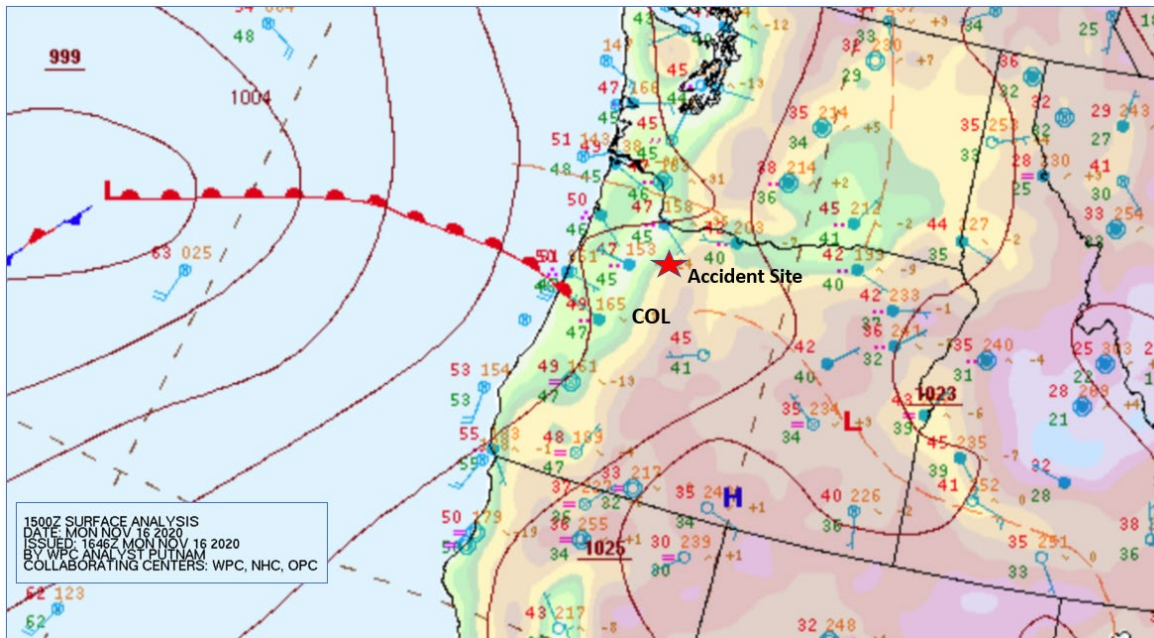


Figure 1 - Northwest section of the Surface Analysis Chart for 0700 PST

1.2 National Composite Radar Mosaic

The regional view of the National Composite Radar Mosaic for 0605 PST is included as figure 2 with the approximate accident site marked by a red star. The image depicted scattered echoes with reflectivities near 30 decibels (dBZ³) or light intensity scattered echoes over the region from near the departure location to the destination airport, with very light intensity echoes less than 20 dBZ surrounding the accident site. Based on the potential for echoes along the flight path and in the vicinity of the accident site the closest NWS weather surveillance radar will be further documented in section 5.0 of this report.

³ dBZ stands for decibel relative to Z. It is a logarithmic dimensionless technical unit used in weather radar to compare the equivalent reflectivity factor (Z) of a target to the return of a droplet of rain with a diameter of 1 mm. It is proportional to the number of drops per unit volume and the sixth power of drop diameter and is used to estimate the rain or snow intensity. Values above 20 dBZ usually indicate falling precipitation.

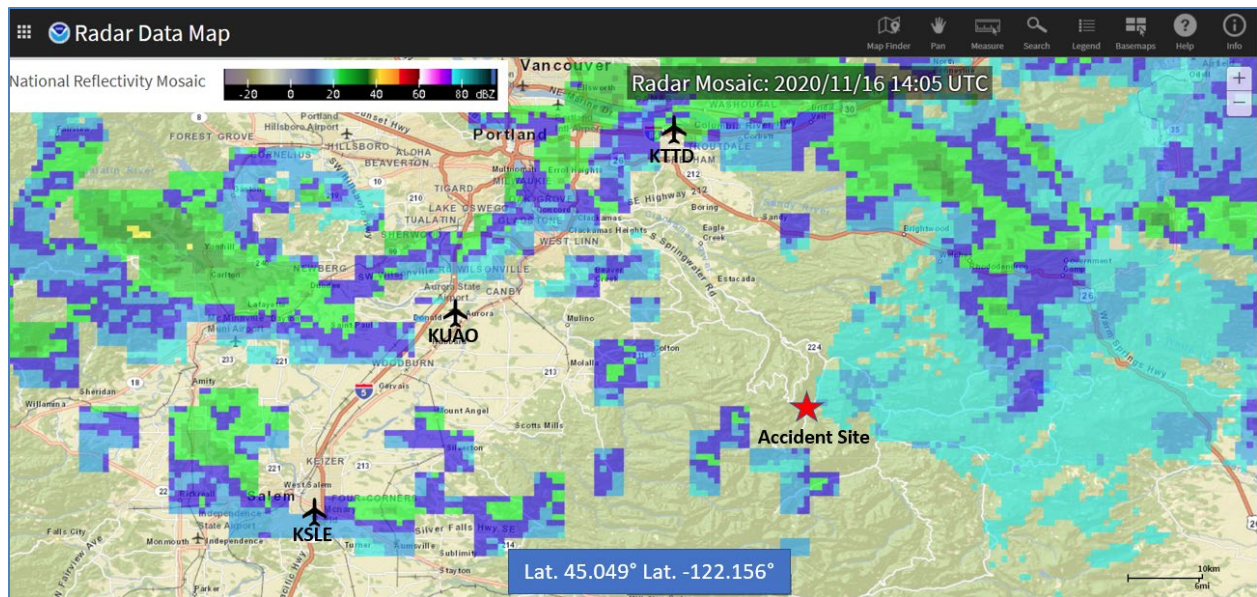


Figure 2 - Regional view of the National Composite radar Mosaic for 0605 PST

1.3 12-hour Surface Prognostic Chart

The NWS 12-hour Surface Prognostic Chart valid for 1000 PST is included as figure 3. The chart depicted the low-pressure system off the Oregon coast with the warm front extending eastward across northern Oregon with a 30 to 60% chance of rain over the region, with rain and mixed precipitation and snow likely (or greater than a 60% probability) further to the north over extreme northern Oregon into Washington.

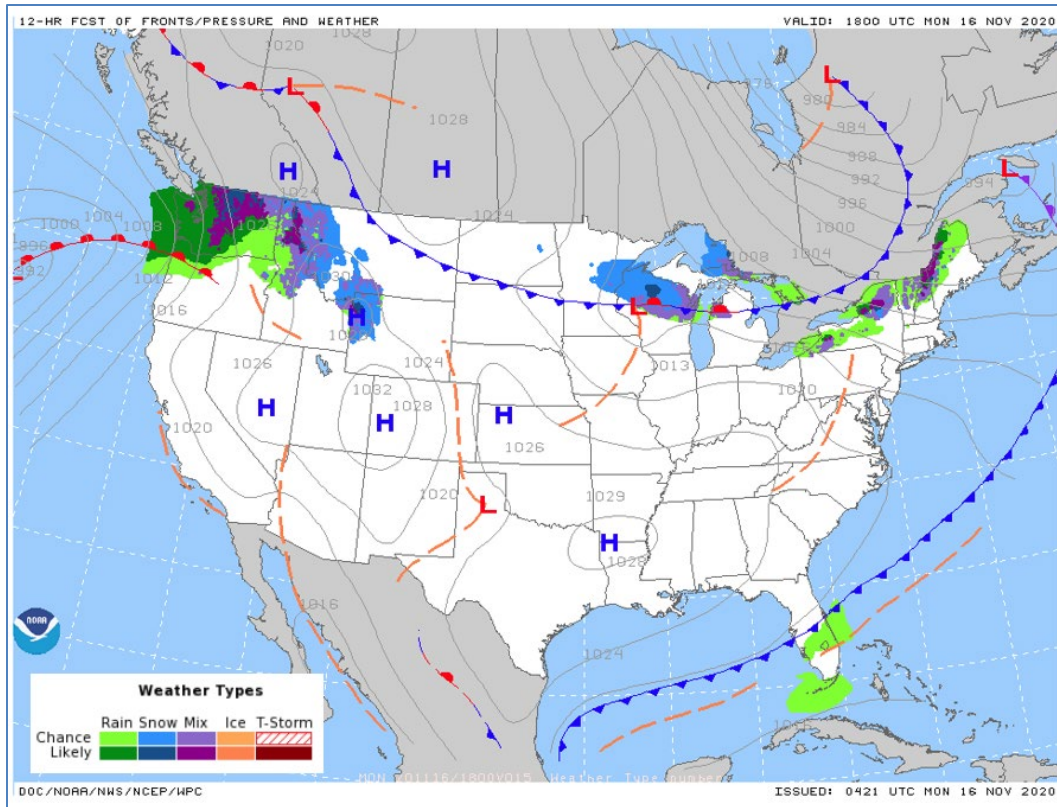


Figure 3 - 12-hour Surface Prognostic Chart for 1000 PST

2.0 Surface 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 15° east based on the latest sectional chart for the area. The location of the airports documented below are depicted in figure 2 and 4.

2.1 Departure Conditions from Salem, Oregon

The accident airplane departed from McNary Field Airport (KSLE), Salem, Oregon, at approximately 0515 PST. The airport had an Automated Surface Observation System (ASOS) and was augmented by air traffic control personnel during normal operating hours (0600 thru 2200 local). The airport listed an elevation of 213 ft. At the time of departure and the time of the accident the following conditions were being reported:

Weather observation for KSLE at 0456 PST, automated, wind calm, visibility 5 miles in light rain and mist, ceiling⁴ overcast at 200 ft agl, temperature 8° C, dew point 7° C, altimeter 30.04 inches of mercury ("Hg). Remarks; automated station with a precipitation

⁴ Ceiling is defined as the lowest layer of clouds reported as broken or overcast, or the vertical visibility into a surface based obscuration.

discriminator, sea-level pressure 1017.3-hPa, hourly precipitation 0.04 inches, temperature 8.3° C, dew point 7.2° C.

Weather observation for KSLE at 0556 PST, automated, wind calm, visibility 5 miles in light rain and mist, ceiling broken at 300 ft agl, overcast at 4,300 ft, temperature 8° C, dew point 7° C, altimeter 30.004 "Hg. Remarks; automated station with a precipitation discriminator, sea-level pressure 1016.0-hPa, hourly precipitation 0.03 inches, temperature 8.3° C, dew point 7.2° C.

The general flight categories⁵ and raw METAR observations in standard code and abbreviations issued during the period from approximately 0400 through 0800 PST were as follows. The observations in bold italic print are decoded above.

MVFR METAR KSLE 161156Z AUTO 03003KT 4SM -RA BR FEW003 SCT015 OVC060 08/07 A3005 RMK AO2 SLP178 P0004 60009 70019 T00830072 10094 20078 58014=

LIFR SPECI KSLE 161219Z AUTO 05004KT 4SM -RA BR BKN002 OVC055 08/07 A3005 RMK AO2 P0000 T00830072=

LIFR METAR KSLE 161256Z AUTO 00000KT 5SM -RA BR OVC002 08/07 A3004 RMK AO2 SLP173 P0004 T00830072=

Departed 1315Z

LIFR METAR KSLE 161356Z AUTO 00000KT 5SM -RA BR BKN003 OVC043 08/07 A3000 RMK AO2 SLP160 P0003 T00830072=

Accident 1404Z

LIFR METAR KSLE 161456Z 28003KT 4SM -RA BR BKN004 OVC017 08/07 A2998 RMK AO2 SLP153 P0002 60009 T00830072 58024=

IFR KSLE 161543Z 00000KT 5SM -RA BR OVC006 08/07 A2997 RMK AO2 CIG 003V008 P0001 T00830072=

IFR METAR KSLE 161556Z 12003KT 5SM -RA BR OVC006 08/07 A2997 RMK AO2 SLP149 P0002 T00830072=

⁵ The general flight categories based on the weather conditions reported are defined by the NWS and the FAA in the Aeronautical Information Manual (AIM) section 7-1-7 as follows:

- 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 METAR KSLE 161656Z 10003KT 9SM -RA OVC005 09/07 A2996 RMK AO2 SLP145 P0001 T00890072=

2.2 Condition west of accident site - Aurora, Oregon

The closest weather reporting facility to the accident site was Aurora State Airport (KUAO), Aurora, Oregon, located approximately 29 miles west of the accident site at an elevation of 200 ft. The airport had an ASOS which was augmented by tower personnel during normal operating hours. At the time of the accident the following conditions were reported.

Weather observation for KUAO at 0553 PST, automated, wind from 360° at 6 knots, visibility 10 miles or more, ceiling broken at 5,500 ft agl, overcast at 8,000 ft, temperature 8°C, dew point 7°C, altimeter 30.02 "Hg. Remarks: automated station with a precipitation discriminator, rain ended at 0511 PST, sea-level pressure 1016.6-hPa, hourly precipitation less than 0.01 inches, temperature 8.3° C, dew point 6.7° C.

The general flight categories and raw observations issued between 0300 and 0900 PST were as follows.

MVFR SPECI KUAO 161101Z AUTO 01004KT 5SM -RA BR FEW006 BKN030 OVC041 09/07 A3011 RMK AO2 P0001 T00890072=

VFR METAR KUAO 161153Z AUTO 04004KT 9SM -RA OVC065 08/07 A3009 RMK AO2 SLP189 P0006 60012 70018 T00830072 10089 20078 58011

VFR METAR KUAO 161253Z AUTO 07004KT 7SM -RA BKN065 OVC080 08/07 A3006 RMK AO2 SLP179 P0003 T00830067

VFR METAR KUAO 161353Z AUTO 36006KT 10SM BKN055 OVC080 08/07 A3002 RMK AO2 RAE11 SLP166 P0000 T00830067

Accident 1404Z

VFR METAR KUAO 161453Z 04004KT 10SM SCT039 BKN048 OVC070 09/07 A3000 RMK AO2 RAB28E47 SLP157 P0001 60004 T00890067 56032

MVFR SPECI KUAO 161541Z 00000KT 8SM BKN024 BKN028 OVC034 09/07 A2999 RMK AO2 T00890072

MVFR METAR KUAO 161553Z 00000KT 5SM -RA BR OVC020 09/08 A2998 RMK AO2 RAB46 SLP153 P0000 T00890078

IFR SPECI KUAO 161646Z 04003KT 2SM -RA BR BKN015 OVC022 09/07 A2997 RMK AO2 P0003 T00890072=

IFR METAR KUAO 161653Z 00000KT 2 1/2SM -RA BR SCT014 BKN019 OVC025 09/07 A2997 RMK AO2 SLP149 P0004 T00890072

2.3 Destination Conditions - Portland, Oregon

The planned destination was Portland-Troutdale Airport (KTTD), Portland, Oregon, located approximately 46 miles northeast of the departure airport and 31 miles north-northwest of the

accident site, at an elevation of 39 ft. The airport had an ASOS and was also augmented by tower personnel during operating hours. The following conditions were reported at the time of the accident.

Weather observation for KTTD at 0553 PST, automated, wind from 090° at 18 knots gusting to 23 knots, visibility 10 miles or more, ceiling overcast at 8,000 ft agl, temperature 9° C, dew point 8° C, altimeter 30.03 "Hg. Remarks: automated station with a precipitation discriminator, rain began at 0502 and ended at 0550 PST, pressure falling rapidly, sea-level pressure 1017.0-hPa, hourly precipitation 0.01 inches, temperature 8.9° C, dew point 7.8° C.

The general flight categories and raw observations were reported between approximately 0400 through 0900 PST.

VFR METAR KTTD 161153Z AUTO 11008KT 10SM -RA OVC055 09/08 A3010 RMK AO2 SLP192 P0001 60001 70017 T00940078 10100 20083 55011=

VFR METAR KTTD 161253Z AUTO 08016G22KT 10SM OVC080 09/08 A3008 RMK AO2 RAE49 SLP184 P0000 T00940078=

VFR METAR KTTD 161353Z AUTO 09018G23KT 10SM OVC080 09/08 A3003 RMK AO2 RAB02E50 PRESFR SLP170 P0001 T00890078=

Accident 1404Z

VFR METAR KTTD 161453Z 09016KT 10SM -RA SCT060 OVC075 09/07 A2999 RMK AO2 RAB1354 SLP156 P0001 60002 T00940072 58036=

VFR METAR KTTD 161553Z 08020G29KT 9SM -RA SCT029 BKN047 OVC065 10/08 A2998 RMK AO2 PK WND 08029/1548 RAE03B38 SLP151 P0000 T01000078=

MVFR SPECI KTTD 161613Z 08017G24KT 6SM -RA BR BKN026 OVC034 10/08 A2998 RMK AO2 PK WND 08028/1559 P0000 T01000083=

MVFR METAR KTTD 161653Z 08016G23KT 9SM -RA OVC026 09/08 A2996 RMK AO2 PK WND 08028/1559 SLP146 P0000 T00940078=

2.4 METAR Depiction

A depiction of the observations from the NWS Aviation Weather Center's METAR display⁶ for 0600 PST with the approximate accident site marked by a red star is included as figure 4, with temperatures and dew point temperatures in °F. The chart depicted several stations reporting LIFR conditions to the southwest, west, and northeast of the accident site, with the closest airport and the destination airports reporting VFR conditions. All the stations reported overcast sky conditions with temperature-dew point spreads of 3° F or less, with most of the stations reporting light rain.

⁶ <https://aviationweather.gov/metar>

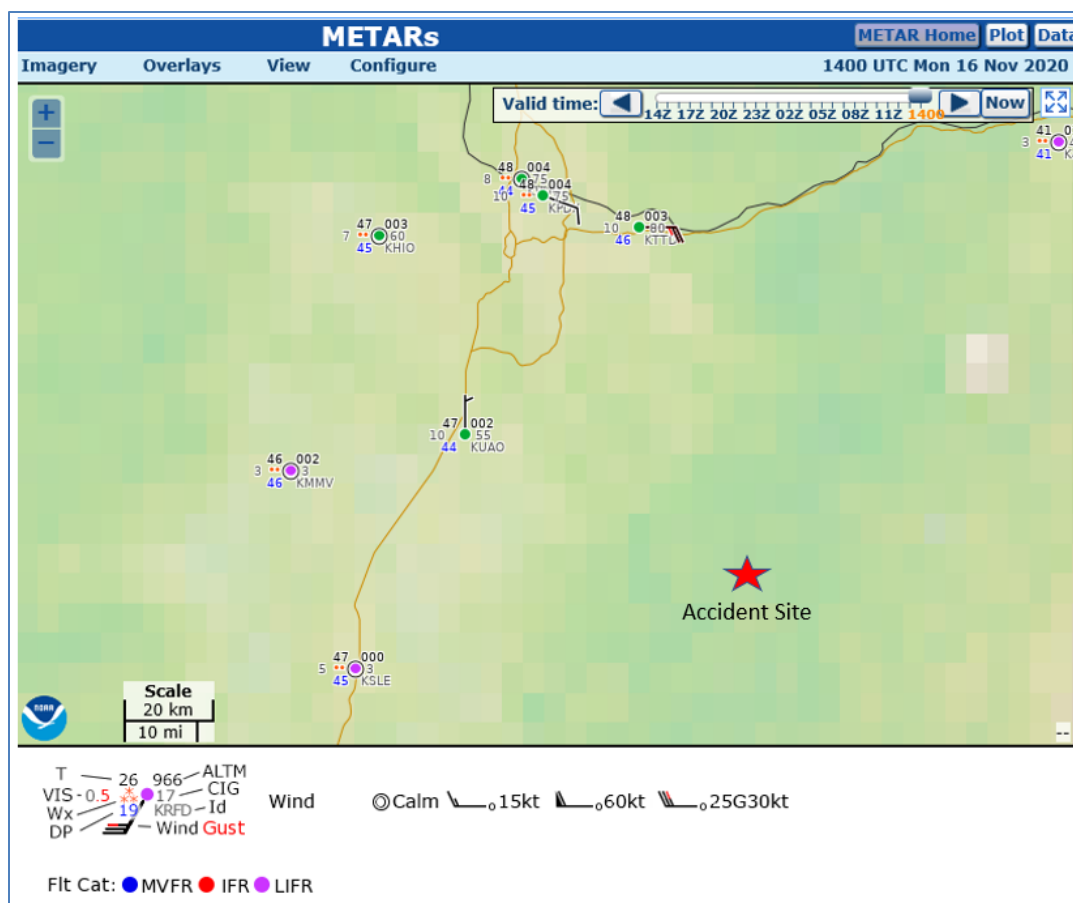


Figure 4 - NWS Aviation Weather Center's METAR display for 0600 PST

3.0 Sounding

To determine the vertical structure and state of the atmosphere over the region and the accident site the closest NWS sounding from Salem (KSLE), Oregon, site number 72694, and a High-Resolution Rapid Refresh (HRRR)⁷ numerical model sounding were retrieved from the NOAA Air Resources Laboratory and plotted on a standard Skew T log P diagram⁸ using the complete Rawinsonde Observation RAOB program software⁹. Figure 5 is the KSLE observed sounding for 0400 PST from the surface through 500-hPa or approximately 18,000 ft. The KSLE sounding depicted several temperature inversions below 3,000 ft due to subsidence and a frontal inversion between 8,000 and 9,944 ft. The lifted condensation level (LCL)¹⁰ was at 327 ft msl (127 ft agl),

⁷ The HRRR is a National Oceanic and Atmospheric Administration (NOAA) real-time three-kilometer resolution, hourly-updated, cloud-resolving, convection-allowing atmospheric model, initialized by three-kilometer grids with three-kilometer radar assimilation. Radar data is assimilated in the HRRR every 15 minutes over a one-hour period.

⁸ Skew T log P diagram – is a standard meteorological plot or thermodynamic diagram using temperature and the logarithmic of pressure as coordinates, used to display winds, temperature, dew point, and various indices used to define the vertical structure of the atmosphere.

⁹ RAOB – (The 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.

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

with the convective condensation level (CCL)¹¹ at 3,600 ft. Multiple cloud layers were supported. The freezing level was identified at 7,170 ft and supported structural icing in clouds above that level through 13,500 ft, which was the indicated cloud tops for that layer. The precipitable water¹² content was 0.95 inches, and the sounding was characterized as stable and supported nimbostratus type clouds with rain.

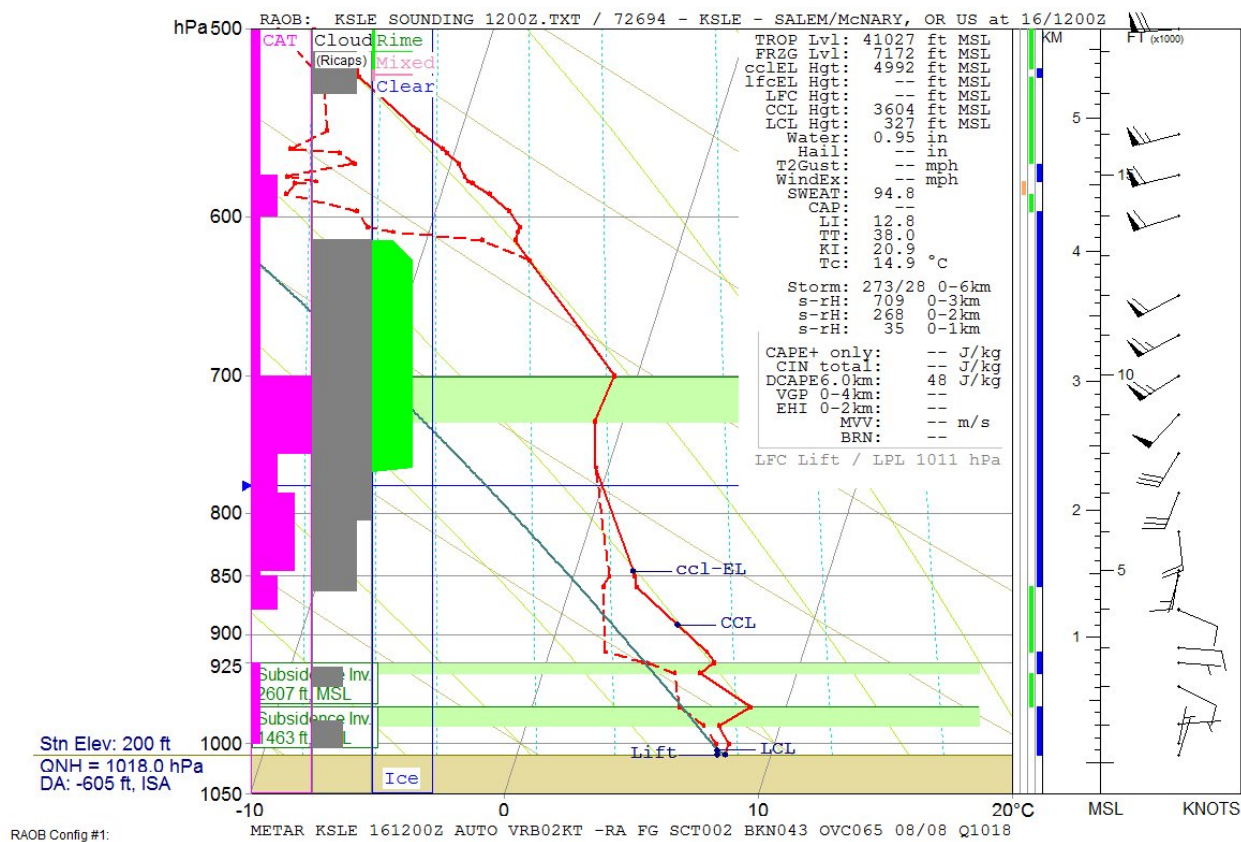


Figure 5 - KSLE observed sounding for 0400 PST

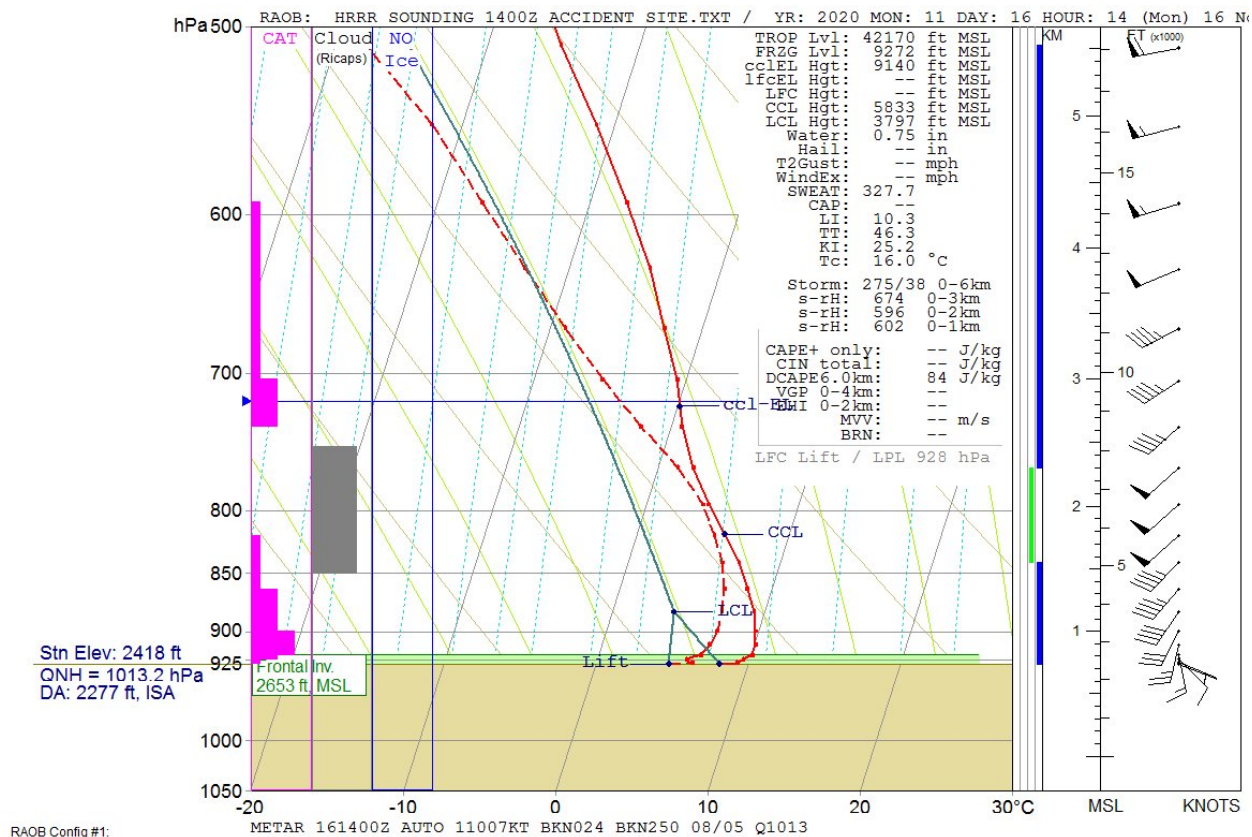
The KSLE sounding wind profile indicated light surface winds, with winds above 4,000 ft from the south and veering to the west with height, with wind speeds above 50 knots above 9,000 ft. At approximately 7,000 ft the wind was from 210° at 30 knots with a temperature of 0.5° C. The sounding supported a high probability of moderate and greater turbulence between 5,000 ft to 10,000 ft and supported mountain wave formation downwind of higher terrain.

The HRRR numerical model sounding over the accident site coordinates for 0600 PST is included as figure 6. The HRRR sounding depicted an elevation of 2,418 ft, with a near surface temperature of 8° C, and a dew point of 5° C. The LCL was identified at 3,797 ft msl, with the CCL at 5,833 ft, with the sounding supporting a broken layer of clouds between 5,000 ft (base near 2,400 ft agl) through 8,000 ft msl, where the relative humidity exceeded 80%. The freezing level

¹¹ Convective Condensation Level (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.

¹² Precipitable Water (PW) - The total amount of (condensed) water available within the lowest 400 mb of the sounding.

was at 9,270 ft. The wind profile indicated a wind at the accident airplanes altitude of 7,000 ft from 240° at 50 knots with a temperature near 4° C.



A comparison of the two soundings is included as figure 7. The wind profiles generally agreed in the general direction with a veering wind with height; however, the HRRR sounding depicted stronger winds at the accident airplanes cruising altitude of 7,000 ft at 50 knots. A significant difference in the temperature and dew point temperatures were noted below 10,000 ft in the soundings between 0400 and 0600 PST, and as a result cloud layers differed. The freezing level also varied from 7,172 ft in the KSLE sounding and increased to 9,272 ft in the HRRR sounding; however, in both soundings the freezing level was above the accident airplane's cruising altitude.

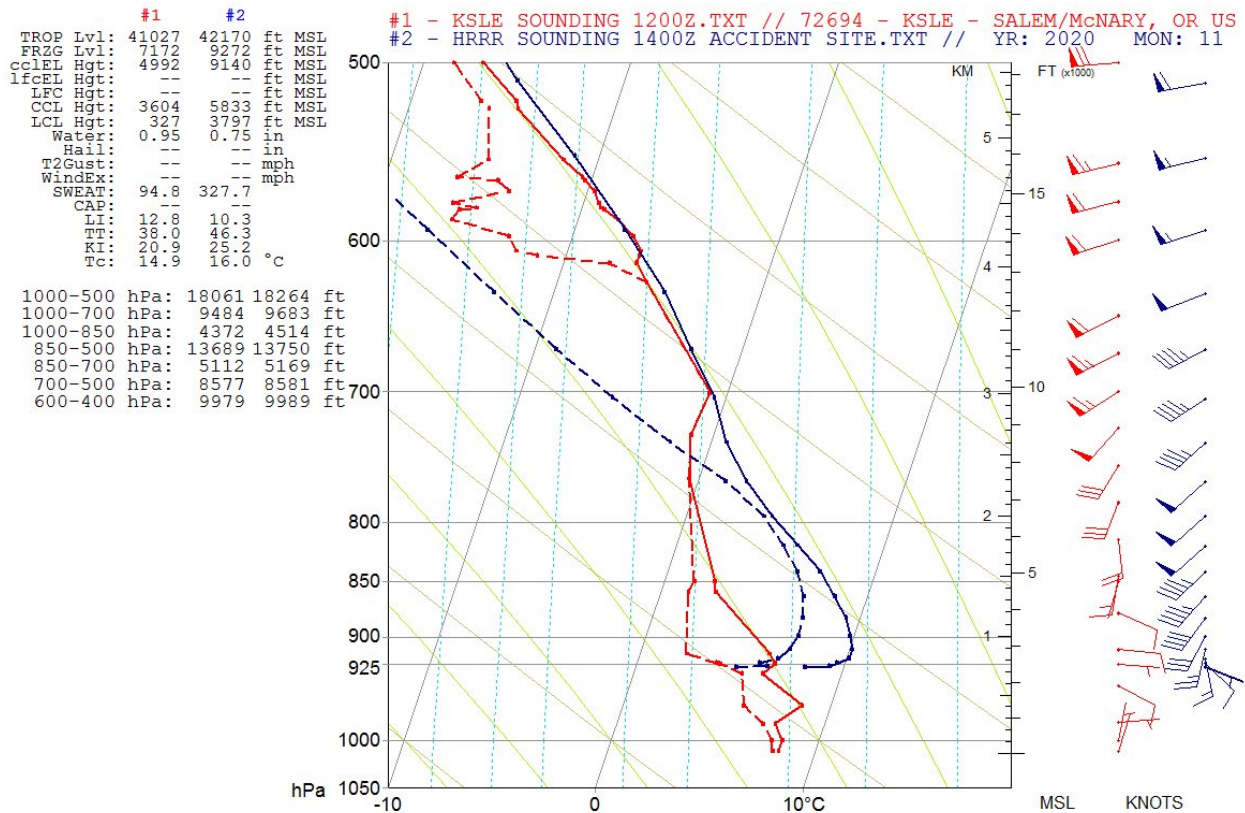


Figure 7 - KSLE and HRRR sounding comparison

4.0 Satellite Imagery

The Geostationary Operational Environmental Satellite number 17 (GOES-17) imagery 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 (McIDAS) software. The infrared long wave band 13 imagery at a wavelength of 10.3 microns (μm) and a resolution of 1.24 nm were obtained surrounding the time of the accident. The infrared imagery provided a standard satellite image with radiative cloud top or brightness temperatures. The low sun angle resulted in too dark conditions to display any cloud cover over the area and making the visible imagery usable at the time of the accident.

The GOES-17 infrared imagery for 0606 PST at 4X magnification and a standard GMB temperature enhancement curve applied to highlight the higher and colder cloud tops is included as figure 8 with the accident site marked by the white square. The fronts and troughs from 0700 PST are also overlaid on the image for reference. The image depicted an area of low to mid-level stratiform clouds over the accident site. The radiative cloud top temperature was 262 Kelvin or -11°C , which corresponded to cloud tops near 15,000 ft based on the HRRR sounding.

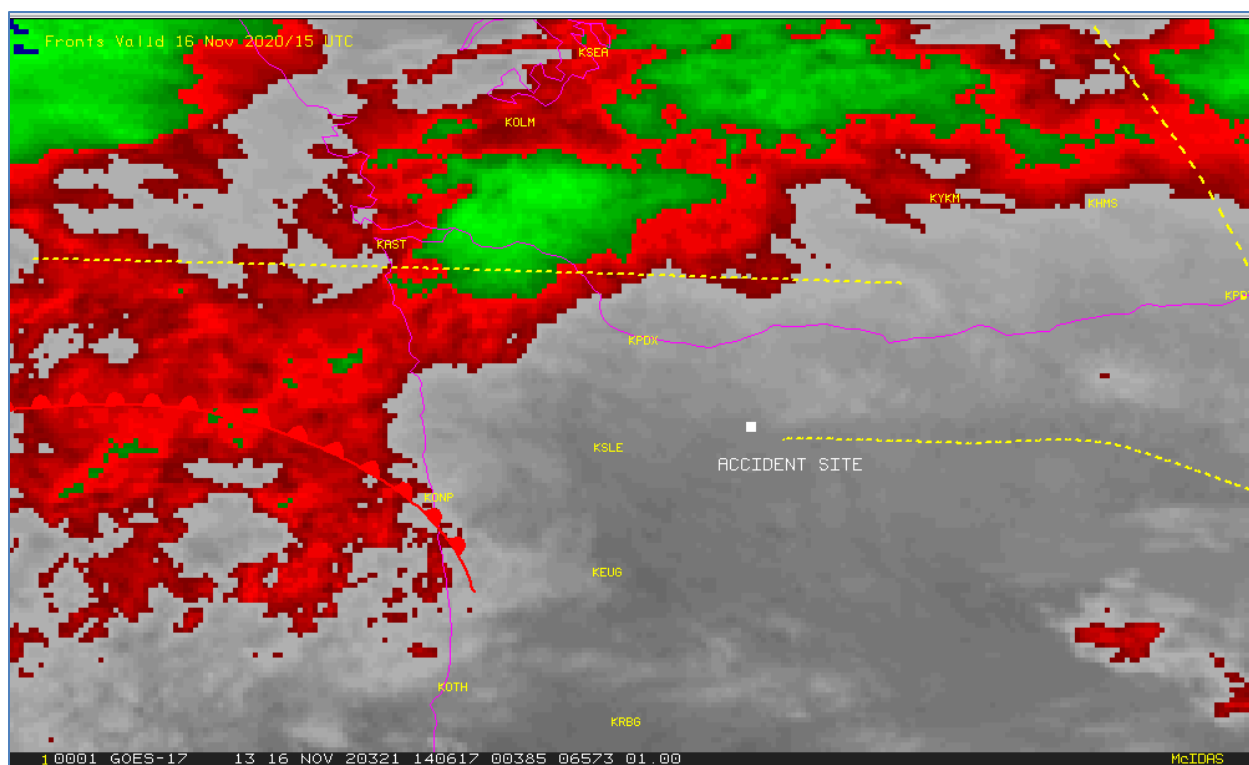


Figure 8 - GOES-17 infrared image for 0606 PST at 4X magnification with fronts overlaid

5.0 Weather Radar Imagery

The closest weather surveillance Radar – 1988 Doppler (WSR-88D)¹³ to the accident site was from the NWS Portland Weather Forecast Office (WFO) with the radar antenna located in Scappoose (KRTX)¹⁴, Oregon, located approximately 52 miles northwest of the accident site. The level II and III archive data were obtained from the NCEI archive data and displayed using the NWS NEXRAD Interactive Viewer and Data Exporter software¹⁵.

During the period the KRTX WSR-88D was operating in the precipitation mode volume scan pattern 215 (VCP-215), where the radar makes 15 different elevation scans in 6 minutes. This scanning strategy is often used during periods of precipitation. Assuming a standard refraction¹⁶ of the WSR-88D 0.95° radar beam with an antenna height of 1,728 ft and at a distance of 52 miles the lowest 0.53° antenna elevation was scanning the altitudes between approximately 3,820 ft to 9,060 ft, with the center of the beam near 6,440 ft over the accident site.

¹³ 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.

¹⁴ The radar antenna or Radar Data Acquisition (RDA) was located about 17 miles northwest of the NWS Portland Weather Forecast Office (KPQR), in Scappoose, OR.

¹⁵ NOAA's Weather and Climate Toolkit (WCT) is free, platform independent software distributed from NOAA's National Centers for Environmental Information (NCEI). The WCT allows the visualization and data export of weather and climate data, including Radar, Satellite and Model data.

¹⁶ Standard Refraction in the atmosphere is when the temperature and humidity distributions are approximately average, and values set at the standard atmosphere.

5.1 Reflectivity

Reflectivity is the measure of the efficiency of a target in intercepting and returning radio energy. With hydrometeors¹⁷, reflectivity is a function of the drop size distribution, number of particles per unit volume, physical state (ice or water), shape, and aspect. As described in section 1.2 above, reflectivity is normally displayed in decibels (dBZ) 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 reflectivity levels, reflectivity in dBZ, and rainfall rates

The FAA identifies and defines the radar reflectivity values in Advisory Circular AC 00-24C – “Thunderstorms”, which reidentifies the former NWS six VIP levels to four basic levels of intensity for aviation and are used by air traffic control¹⁸ to communicate precipitation intensity. The reflectivity ranges and weather echo intensities are provided in the following table in figure 10.

¹⁷ Hydrometeors are any product of condensation or sublimation of atmospheric water vapor, whether formed in the free atmosphere or at the earth's surface. Hydrometeors are classified as; (a) Liquid or solid water particles suspended in the air: cloud, water droplets, mist or fog. (b) Liquid precipitation: drizzle and rain. (c) Freezing precipitation: freezing drizzle and freezing rain. (d) Solid (frozen) precipitation: ice pellets, hail, snow, snow pellets, and ice crystals. (e) Falling particles that evaporate before reaching the ground: virga. (f) Liquid or solid water particles lifted by the wind from the earth's surface: drifting snow, blowing snow, blowing spray. (g) Liquid or solid deposits on exposed objects: dew, frost, rime, and glaze ice.

¹⁸ Echoes less than 30 dBZ are not typically depicted in air traffic control weather displays or communicated to pilots.

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

Figure 10 - FAA reflectivity and precipitation intensity levels

5.2 Composite Reflectivity Imagery

Composite reflectivity images utilize all elevation scans during each volume scan to create the image. It is composed of the greatest echo intensity (reflectivity) from any elevation angle seen from the radar, and it is used to reveal the highest reflectivity value in the column. The short range composite reflectivity product (NCR) provides a resolution of 0.54 nm x 0.54 nm to 124 miles radius.

Figure 9 is the KRTX WSR-88D composite reflectivity image for 0605 PST with the flight track overlaid in violet. The flight track circumnavigated the stronger echoes of 30 dBZ but did not transverse through echoes of 10 to 25 dBZ or very light intensity echoes based on a review of all the composite images during the period.

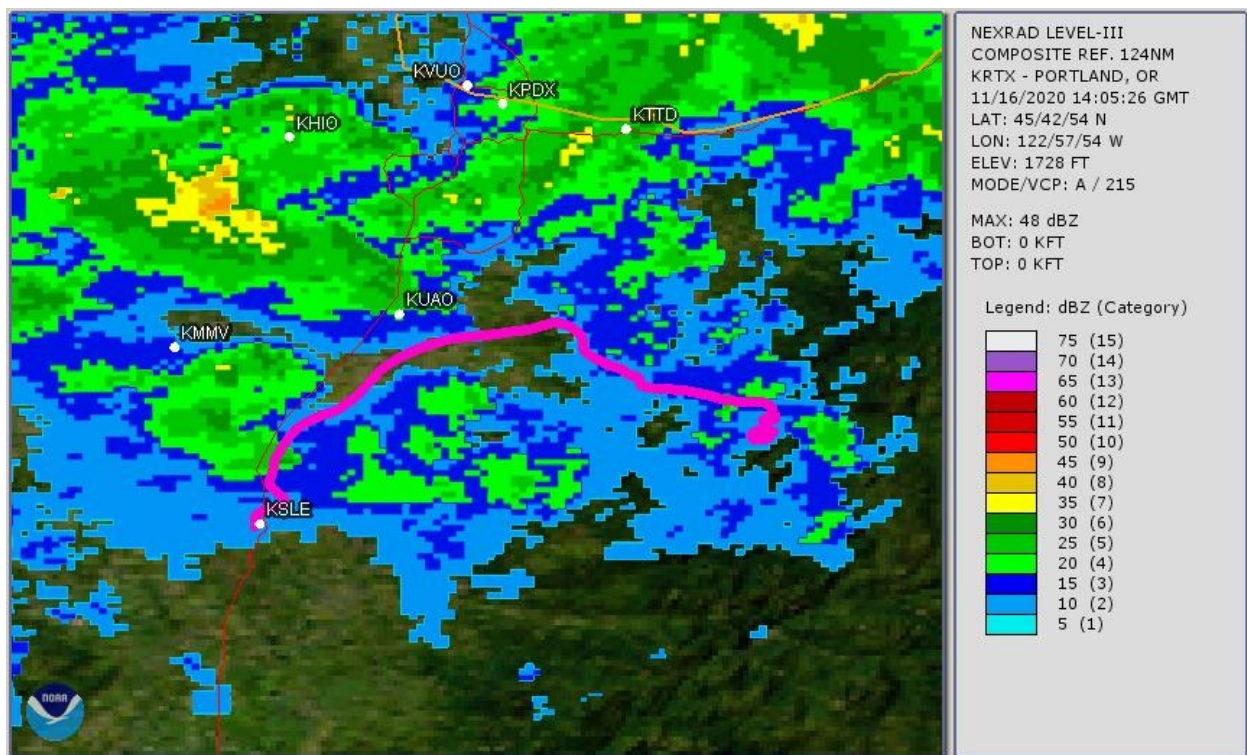


Figure 11 - KRTX WSR-88D Composite Reflectivity image for 0605 PST with flight track

5.3 Base Reflectivity Imagery

The WSR-88D base reflectivity images are the individual elevation scan images for the VCP being operated with a resolution of 0.25 km (0.13 nm) x 0.5°. Figure 12 is the KRTX WSR-88D 0.53° base reflectivity image for 0605 PST with the flight track overlaid and depicted the echoes at the accident airplane's altitude. The base reflectivity image depicts echoes of 15 to 25 dBZ or very light intensity echoes over the flight path and supported light precipitation and clouds being encountered at the accident airplane's cruising altitude of 7,000 ft.



Figure 12 - NWS KRTX WSR-88D 0.53° base reflectivity scan for 0605 PST with flight track

6.0 Pilot Reports

There were no pilot reports (PIREPs) found in the NWS database that were issued over Oregon between 0300 and 0900 PST.

7.0 NWS Forecasts

7.1 Terminal Aerodrome Forecast

The NWS Terminal Aerodrome Forecasts (TAFs) issued by the Portland WFO for the airports documented in section 2.0 are documented below. 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, with cloud heights in hundreds of ft agl. The forecast period applicable to the accident time is identified in bold italic print.

Departure Airport KSLE

TAF KSLE 161147Z 1612/1712 33004KT 5SM -RA BR OVC070

FM161230 VRB05KT 4SM -RA BKN007 BKN015 OVC035 WS020/20035KT

FM161700 17005KT P6SM -RA SCT010 BKN025 OVC040

FM162000 19004KT P6SM SCT040 BKN100=

AMD TAF KSLE 161409Z 1614/1712 00000KT 5SM -RA BR BKN003 OVC045 WS020/20035KT

FM161700 17005KT P6SM -RA SCT010 BKN025 OVC040

FM162000 19004KT P6SM SCT040 BKN100

FM170600 VRB03KT P6SM OVC250=

The TAF issued at 0347 PST and valid for the period between 0430 through 0900 PST expected IFR conditions to prevail and expected a surface wind from 170° at 5 knots, visibility 6 miles or more in light rain, ceiling broken at 700 ft, broken clouds at 1,500 ft, and overcast clouds at 3,500 ft, with low-level wind shear at 2,000 ft with wind from 200° at 35 knots.

The forecast was amended at 0609 PST or immediately after the accident for LIFR conditions and became winds calm, visibility 5 miles in light rain and mist, ceiling broken at 300 ft agl, overcast clouds at 4,500 ft, with wind shear at 2,000 ft from 200° at 35 knots.

Forecast for KUAO

TAF KUAO 161147Z 1612/1712 01004KT 5SM -RA BR FEW006 BKN030 OVC040 WS020/20040KT

FM161800 16005KT P6SM -RA SCT010 BKN025 OVC040

FM162100 19004KT P6SM SCT040 BKN100=

AMD TAF KUAO 161409Z 1614/1712 36006KT P6SM BKN060 OVC080 WS020/20040KT

FM161800 16005KT P6SM -RA SCT010 BKN025 OVC040

FM162100 19004KT P6SM SCT040 BKN100

FM170600 03005KT P6SM OVC250=

The TAF for KUAO current at the time of departure expected MVFR conditions to prevail. The forecast expected a wind from 010° at 4 knots, visibility 5 miles in light rain and mist, with a few clouds at 600 ft, ceiling broken at 3,000 ft, and overcast clouds at 4,000 ft. The forecast also included wind shear at 2,000 ft with winds from 200° at 40 knots. The forecast was also amended after the accident at 0609 PST to VFR conditions, with visibility unrestricted and a ceiling broken at 6,000 ft, and overcast clouds at 8,000 ft, with wind shear conditions continuing.

Destination Airport KTTD

TAF KTTD 161147Z 1612/1712 09014KT P6SM -RA OVC060

FM161500 09012G20KT P6SM -RA SCT025 OVC040 WS020/20040KT

FM162100 10010G20KT P6SM SCT040 BKN100=

AMD TAF KTTD 161409Z 1614/1712 09018G23KT P6SM OVC080

FM161500 09012G20KT P6SM -RA SCT025 OVC040 WS020/20040KT

FM162100 10010G20KT P6SM SCT040 BKN100

FM170600 08024G34KT P6SM OVC250=

The forecast for the planned destination of KTTD expected VFR conditions to prevail with winds from 090 at 14 knots, visibility better than 6 miles in light rain, with ceiling overcast at 6,000 ft agl. The forecast was also amended at 0609 PST with minor changes to the wind and ceiling height and continued to expect VFR conditions to prevail.

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. The discussions are also useful for additional aviation-related issues that cannot be encoded into the TAF and in providing some reasoning behind the forecast. These are generated roughly every 6 hours and correspond to the release of the latest TAFs for that office. The long term and marine sections have been excluded below. The forecast discussion issued at 0357 PST from the Portland WFO was as follows.

*FXUS66 KPQR 161157
AFDPQR*

*Area Forecast Discussion
National Weather Service Portland OR
357 AM PST Mon Nov 16 2020*

*.SYNOPSIS...Active November weather will persist for much of the upcoming work week. **Rain is spreading northward across the forecast area early this morning. The warm front responsible for this rain will lift north of our forecast area today, leading to a mild and dry afternoon for most.** Meanwhile, strong low pressure is developing offshore. This low is expected to brush the coast Tuesday, bringing angry seas and strong winds to the coast. Rain spreads onshore with this system later Tuesday, tapering to showers and isolated thunderstorms for Wednesday and Thursday. Despite a mild start, expect more snow to pile up in the Cascades during the mid to late week period. Drier weather returns towards next weekend, but could be rather short-lived. After all, it is November.*

.SHORT TERM...Today through Wednesday...Stormy November weather continues for the Pacific Northwest. GOES-West water vapor and infrared imagery reveal a deep upper level trough over the NE Pacific, the base of which is beginning to press south of 30N. The area near and just east of 35N/145W is responding to an impressive 150 kt jet core digging from the N-NW with what appears to be rapid surface low development, suggested by the numerous lightning strikes and increasingly cyclonic low-level flow in that area. This system will strengthen further while approaching the Pac NW coast, and will be a major factor in Tuesday's weather.

Calmer weather, albeit wet, prevails for the time being. The above mentioned developing low is likely aiding in the amplification of an upper level ridge over the western United States. As such, the baroclinic zone which remained to our south much of Sunday is now moving northward as a warm front, spreading mostly light rain north across the district. Snow levels started off fairly high at around 5000 feet Sunday evening, and are only expected to rise further with the warm front. Therefore snow is not expected to be an issue for the Cascade passes, though a few pockets of freezing rain are possible near the passes and/or in our highest elevation valleys.

The 00z NAM Nest, along with other high resolution models, lift most of this morning's rain into Washington by midday. This should leave most of our Oregon zones with a mild and mostly dry afternoon. There may even be some sunbreaks, which could push temperatures into the 60s for valleys Salem southward. With a couple spots such as Salem and McMinnville showing record highs in the mid 60s for today, it is not unfathomable that a high temperature record or two could fall today. Somewhat cooler easterly flow

persisting through the Columbia Gorge should keep Hood River and the Portland metro area a little cloudier and cooler with highs in the 50s.

Now, back to Tuesday, and the strong developing low offshore. Models have generally depicted this system as the secondary of two low pressure systems expected to develop over the NE Pacific today, with the primary low developing closer to 40N/135W. This is a bit concerning, as satellite analysis and lightning detection seem to favor the more southern low as the dominant low...and this is the one expected to brush closest to our coastline as it curls toward the Washington coast or Vancouver Island Tuesday. Confidence has increased enough in the wind threat with this system that we will be upgrading our High Wind Watch to High Wind Warning shortly for 65-75 mph gusts along the S WA/N OR coast, and will be including Oregon's Central Coast as well. With most models remaining offshore with the low track, there will be some easterly component to the MSLP gradients, which may keep the strongest winds out of most of our coastal communities. However, if the low ends up tracking onshore before moving north of Willapa Bay, the coastal communities and perhaps even inland areas could end up under threat of strong winds as well. On top of all this, increasing easterly MSLP gradients will drive fairly strong easterly winds through the Columbia Gorge, with gusts 45-55 mph west of Cascade Locks, and gusts up to 40 mph reaching eastern portions of the Portland metro area. Overall – Will need to watch satellite trends closely today to determine how well models are handling the initialization of the developing situation offshore.

The strong winds will coincide with some of our highest tides of the year, so there is concern for coastal flooding. Fortunately, seas associated with this system will be fairly fresh and short in period, which will limit some of the surf energy arriving on the shoreline. However, with the developing low there will be concern for tidal anomaly and surge effects, which could add a couple feet to the already very high high tides. For now, our Coastal Flood Advisories for tidal overflow look good for the afternoon high tides Monday and Tuesday.

Aside from the wind and angry seas, this system will spread rain onshore Tuesday. It may take a while for rain to spread completely across the forecast area, as easterly winds ahead of the system will dry out the low level air mass. This should keep QPF fairly low with this system, with most areas receiving less than an inch. Post-frontal showers will continue through Wednesday, along with lowering snow levels. With 500 mb temps potentially dipping below -30 deg C, thunder is a good bet along the coast, and inland areas will have a slight chance of afternoon and evening thunderstorms Tuesday and Wednesday. Given the dynamic nature of this system and decent instability/shear by our standards, some of these storms could be fairly strong and produce small hail/gusty winds. Weagle

.AVIATION...06Z TAFS: A warm front and broad shield of light to moderate rain currently over southwest Oregon will lift northward overnight and lead to flight conditions deteriorating into a mix of MVFR and IFR conditions across the area between 09-18z Monday. South to southeasterly winds will then spread into the region behind the front between 15-21z Monday and result in VFR conditions returning to all taf sites. Conditions should then remain VFR through 06z Tuesday. Expect a period of LLWS near the mouth of the Columbia River Gorge Monday morning as southerly winds increase above low level easterly winds flowing out of the Columbia River Gorge.

For detailed regional Pac NW weather information, go online to: <http://weather.gov/zse>

KPDZ AND APPROACHES...A warm front and broad shield of light to moderate rain currently over southwest Oregon will lift northward overnight and lead to flight conditions deteriorating into a mix of VFR and MVFR conditions between 12-18z Monday. A temporary period of IFR conditions cannot be ruled out during this time, but it also does not appear likely at the terminal. Expect the area to dry out as the warm front lifts north of the area and VFR conditions to then return and remain through 06z Tuesday.
/Neuman

7.3 Graphic Forecast for Aviation

The NWS Graphic Forecast for Aviation (GFA) product provides a graphical depiction of surface wind, weather, visibility, with color coded general flight categories, and cloud cover, with the graphic Airman's Meteorological Information (G-AIRMET) for IFR, mountain obscuration, and icing conditions overlaid. The GFA is available at the NWS AWC website and through other weather briefing services.

Figure 13 is the northwest section of the GFA Surface Weather issued at 0501 PST and valid for 0700 PST. The image depicted expected surface winds from the south at 10 to 15 knots with light continuous rain over the area. Visibility greater than 5 miles was depicted over the accident site. A G-AIRMET for IFR conditions (depicted in pink shade) extended over the region and enclosed the accident site.

Figure 14 is the northwest section of the GFA Cloud Cover product issued at 0502 PST which was also valid for 0700 PST, with the cloud heights provided with reference to msl heights. The image depicted an extensive area of overcast clouds over Oregon with bases near 1,900 ft (about 900 ft agl) with tops to 39,000 ft. A G-AIRMET for mountain obscuration (pink shade) conditions was depicted over the region with a G-AIRMET for icing (blue shade) to the north of the accident site which extended over northwest, extreme northern, and northeast Oregon, Washington, and Idaho.

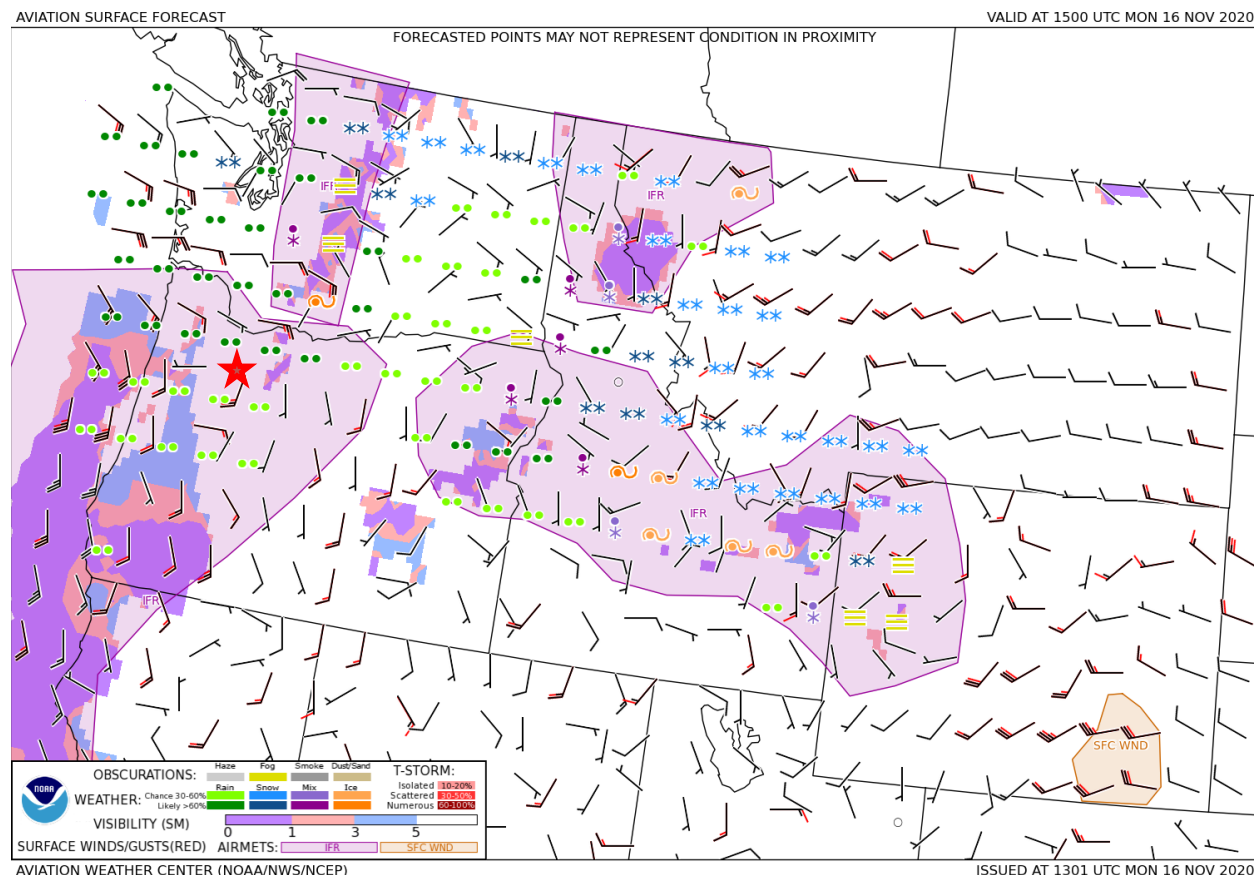


Figure 13 - Graphic Forecast for Aviation for Surface Weather valid for 0700 PST

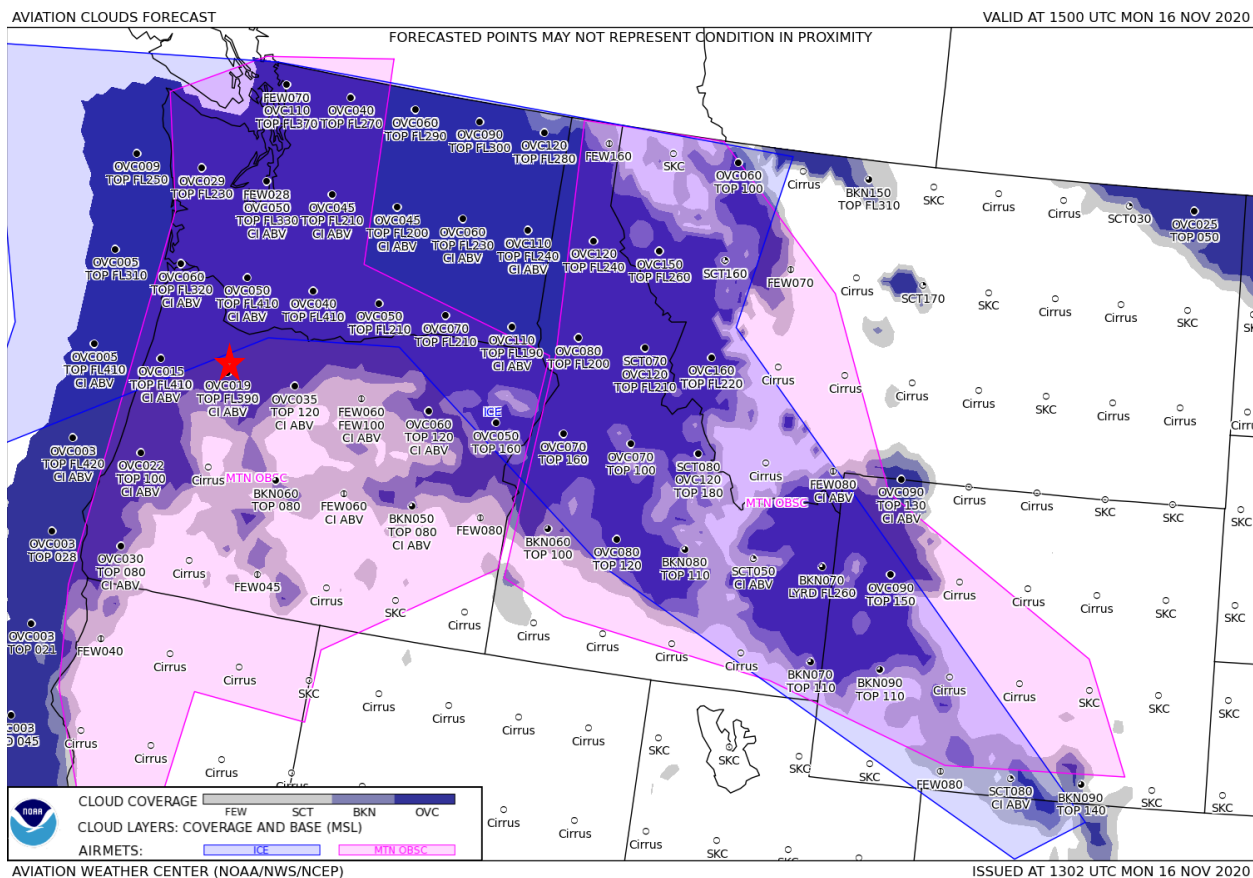


Figure 14 - Graphic Forecast for Aviation Cloud Forecast valid for 0700 PST

8.0 Winds and Temperature Aloft Forecast

The NWS Winds and Temperature Aloft Forecast¹⁹ for the general route of flight valid for use between 0600 through 1300 PST was as follows.

WINDS ALOFT FORECASTS

DATA BASED ON 161200Z

VALID 161800Z FOR USE 1400-2100Z. TEMPS NEG ABV 24000

FT	3000	6000	9000	12000	18000	24000	30000	34000	39000
PDX	2037	2247+05	2340+00	2452-03	2554-16	2567-28	258144	258552	258663
AST	2051	2257+06	2353+00	2460-04	2462-16	2566-28	247744	248953	259062
RDM		2332+07	2328+05	2439-02	2548-15	2661-27	256943	256852	256963
YKM	1114	1821+00	2348-01	2453-05	2656-16	2667-28	268244	258752	268964

The forecast for Portland (PDX) for 3,000 ft expected a wind from 200° at 37 knots, at 6,000 ft wind from 220° at 47 knots with a temperature of 5° C, and at 9,000 ft wind from 230° at 40 knots with a temperature of 0° C.

¹⁹ Based on the NWS FBUS3 KWNO bulletin.

9.0 NWS 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 the conterminous U.S. are issued by the NWS AWC, as well as from the Center Weather Service Units (CWSU) associated with FAA Air Route Traffic Control Centers (ARTCCs). There are four basic types of inflight aviation weather advisories: the Significant Meteorological Information (SIGMET), the Convective SIGMET, the AIRMET, and the Center Weather Advisory (CWA).

Surrounding the period of the accident the NWS had no SIGMETs, Convective SIGMETs, or CWA's current over the region. The NWS did have a full series of G-AIRMETs current during the period for IFR and mountain obscuration, moderate turbulence below 15,000 ft, and low-level wind shear (LLWS) conditions. A G-AIRMET for icing conditions was also current for the area immediately north over extreme northern Oregon, Washington, and Idaho. The G-AIRMETs Sierra for IFR and mountain obscuration, Tango for low-level wind shear and moderate turbulence below 15,000 ft, and Zulu for icing conditions are included as figures 15-17.

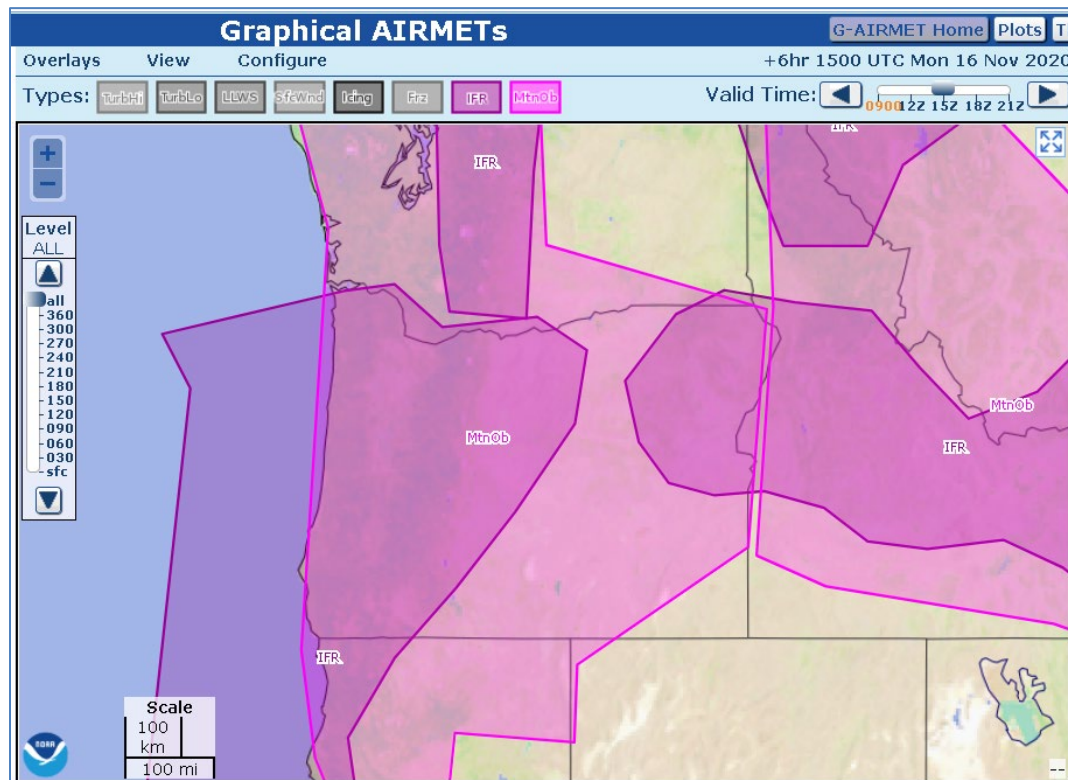


Figure 15 - G-AIRMET Sierra for IFR and mountain obscuration conditions valid for the period

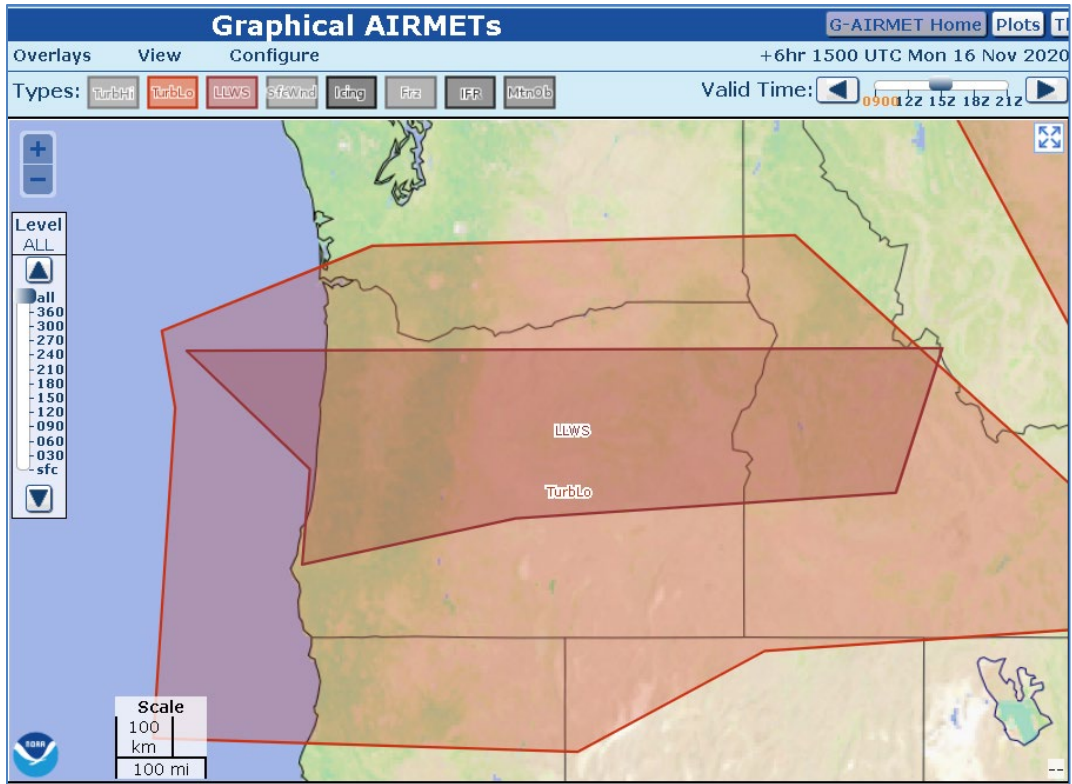


Figure 16 - G-AIRMET Tango for turbulence and low-level wind shear valid for the period

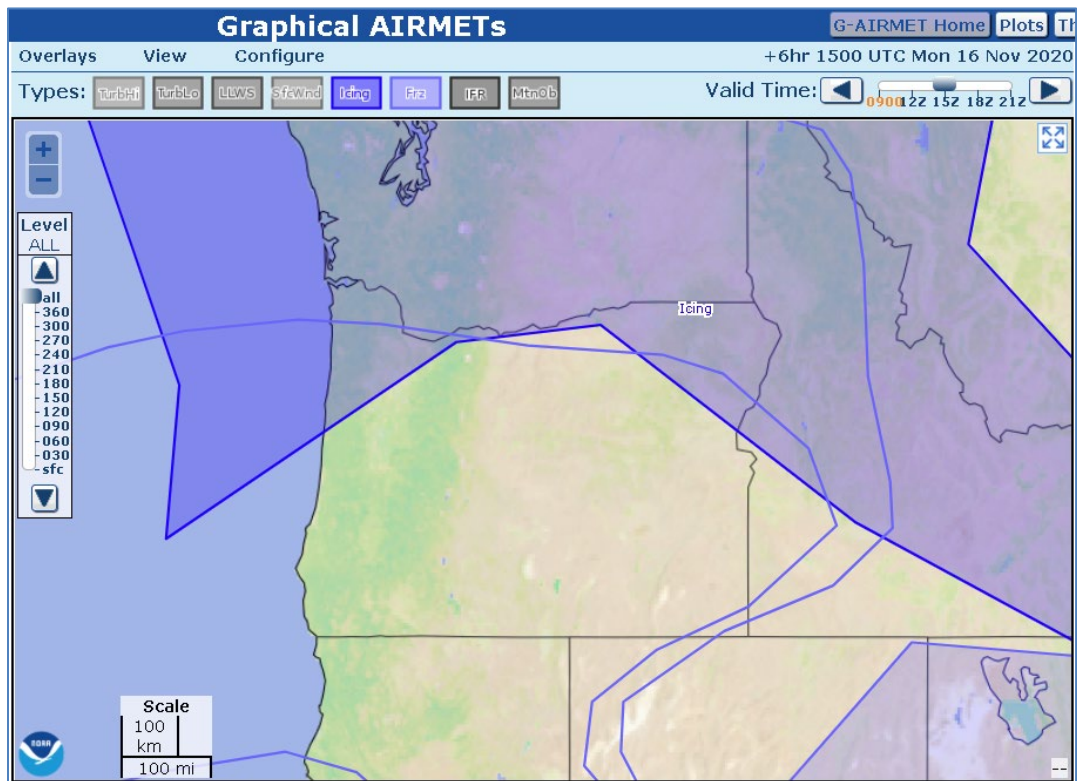


Figure 17 - G-AIRMET Zulu for icing conditions valid for the period

10.0 Preflight Weather Briefing

A search of the FAA contract Flight Service Station (FSS) provider Leidos indicated that they had no contact with the accident pilot for any preflight weather briefings but were contacted at 0506 PST through the McMinnville²⁰ inflight position to pick up his IFR clearance. At that time the McMinnville FSS pulled up an abbreviated weather briefing and advised the pilot of several AIRMET advisories current for the route for IFR, mountain obscuration, icing, turbulence, and low-level wind shear conditions, and advised that the current radar depicted several scattered moderate rain showers across the region. The IFR flight plan clearance was readback as accepted between KSLE to KTTD with a planned cruising altitude of 7,000 ft.

The accident pilot had filed the IFR flight plan through ForeFlight at approximately 0502 PST for an estimated departure time of 0510 PST. The ForeFlight flight plan was filed from KSLE to KTTD direct with a requested cruising altitude of 7,000 ft, with an estimated time enroute of 26 minutes. Filing the flight plan automatically generated a weather briefing with ForeFlight for the route of flight, which is included as Attachment 1. The accident pilot also viewed weather imagery through the ForeFlight app that included the forecast charts from the current conditions through 30-hours clouds and fronts, precipitation, and the 12/24-hour Low-Level Significant Weather Prognostic Chart.

11.0 Astronomical Conditions

The astronomical conditions calculated over the accident site coordinates from the United States naval Observatory Multiyear Interactive Computer Almanac (MICA) software program were as follows.

Sun

<i>Accident</i>	<i>0604 PST</i>
Beginning civil twilight	0636 PST
Sunrise	0708 PST
Culmination	1153 PST
Sunset	1638 PST
End civil twilight	1709 PST

Moon

<i>Accident</i>	<i>0604 PST</i>
Moonrise	0859 PST
Moon culmination	1332 PST
Moonset	1801 PST

At the time of the accident the Sun was 11° below the horizon at an azimuth of 105°, and official nighttime prevailed²¹. The Moon was 28° below the horizon at an azimuth of 94°, and the phase was a waxing crescent with 3% of the moon's disk illuminated.

²⁰ McMinnville radio frequency 122.6 MHz provides access to FSS on the ground at KSLE and inflight.

²¹ Night is defined under 14 *Code of Federal Regulations* Part 1 as the time between the end of evening civil twilight

F. LIST OF ATTACHMENTS

Attachment 1 – ForeFlight Weather Briefing generated at 0501 PST

Submitted by:

Don Eick
Senior Meteorologist

and the beginning of morning civil twilight, as published in the Air Almanac, converted to local time.