



NATIONAL TRANSPORTATION SAFETY BOARD

Office of Aviation Safety
Washington, D.C. 20594

January 30, 2020

Weather Study

METEOROLOGY

CEN20LA028

Table Of Contents

A. ACCIDENT	3
B. METEOROLOGIST	3
C. DETAILS OF THE INVESTIGATION	3
D. WEATHER INFORMATION	3
1.0 Synoptic Conditions.....	3
1.1 Surface Analysis Chart	4
1.2 National Composite Radar Mosaic	5
1.3 12-hour Prognostic Charts	6
2.0 Observations	8
2.1 Coleman A. Young Municipal Airport, Detroit, Michigan	8
2.2 Willow Run Airport, Detroit, Michigan	9
2.3 Detroit Metropolitan Wayne County Airport, Detroit, Michigan.....	10
2.4 METAR Display	11
3.0 Sounding	12
4.0 Satellite Imagery	14
5.0 Pilot Reports.....	15
6.0 NWS Forecasts.....	17
6.1 Terminal Aerodrome Forecasts.....	17
6.2 Area Forecast Discussion.....	17
6.3 Current Icing Product.....	19
6.4 Winds and Temperature Aloft Forecast	26
7.0 NWS Inflight Weather Advisories.....	26
8.0 Preflight Weather Briefing.....	29
9.0 Hawker Icing Encounter Prior to Accident.....	30
10.0 Accident Airplane Photographs of Ice	30
11.0 Astronomical Conditions	33

A. ACCIDENT

Location: Detroit, Michigan
Date: December 3, 2019
Time: 0833 eastern standard time
1333 Coordinated Universal Time (UTC)
Airplane: BAE 125-800A; Registration: N469RJ

B. METEOROLOGIST

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

C. 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 eastern standard time (EST) based upon the 24-hour clock, local time is -5 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.

The accident site was located at latitude 42.4093271° N and longitude 83.0101821° W, at an elevation of approximately 626 ft.

D. 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 Surface Analysis Chart for 0700 CST is included as figure 1 with the approximate accident site marked by a red star. The chart depicted a low pressure system at 978-hectopascals (hPa)¹ to the east of the New England coast associated with an occluded frontal system. A high pressure system at 1021-hPa was located over Louisiana and Mississippi with a ridge of high pressure extending northeastward into eastern Ohio. A trough of low pressure extended from Wisconsin to Kansas where another low pressure system at 1014-hPa was located. The accident site was located in the cold air sector behind the front in an area of a weak pressure gradient, with light southwesterly winds.

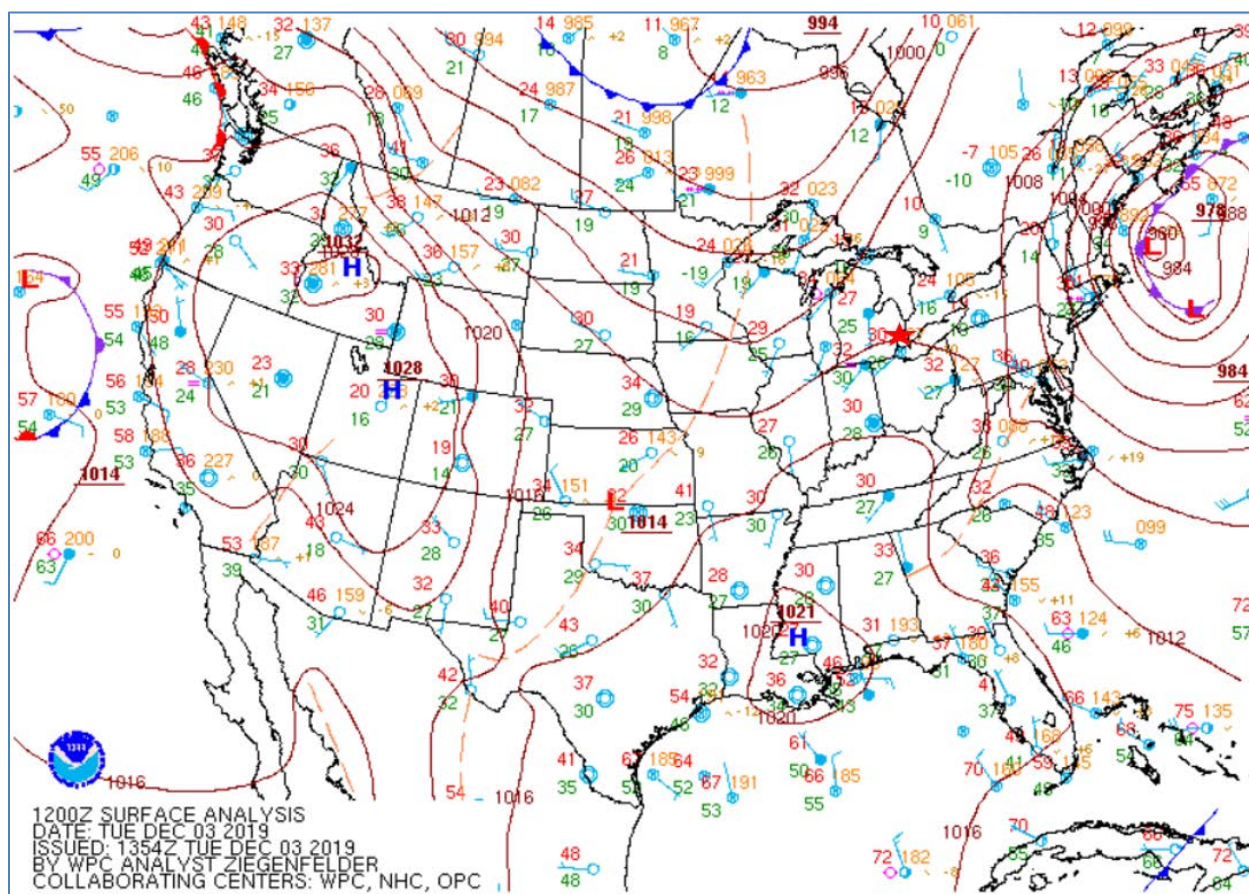


Figure 1 - NWS Surface Analysis Chart for 0700 CST with the accident site marked by a red star

Figure 2 is a close-up of the NWS high-resolution surface analysis chart with the station models for 0700 CST centered over Michigan and the approximate accident site marked by the red star. The station plots depicted an extensive area of clouds over the state with winds from the south to southwest at 10 knots or less, with temperatures near 30° F and dew-point temperatures in the mid to low 20's °F. No precipitation or other significant weather phenomena was depicted over Michigan during the period.

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).

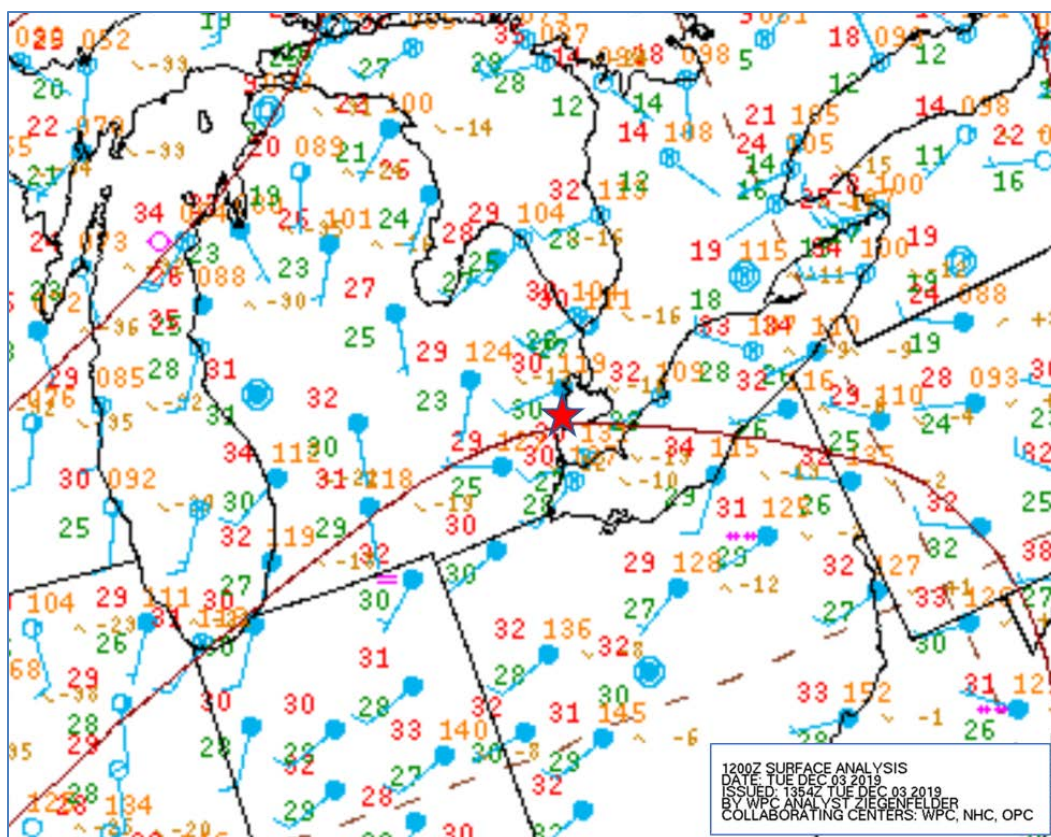


Figure 2 - High-Resolution Surface Analysis Chart for 0700 CST with the accident site marked

1.2 National Composite Radar Mosaic

The NWS National Composite Radar Mosaic centered over Michigan for 0830 EST is included as figure 3 with the accident site marked by the red star. The radar mosaic depicted a large area of light echoes over northern Indiana and western Michigan, which were associated with snow showers. No echoes were identified over the accident airplanes route of flight in the Detroit area.

Data from the closest NWS Weather Surveillance Radar 1988 Doppler (WSR-88D), located approximately 27 miles northwest of the accident site in White Lake (KDTX), Michigan, was also reviewed and did not depict any significant echoes within 50 miles of the accident site.



Figure 3 - National Composite Radar Mosaic for 0830 EST

1.3 12-hour Prognostic Charts

The NWS 12-hour Surface Prognostic Chart valid for 1300 EST is included as figure 4. The chart continued to depict the deep low pressure and associated occluded frontal system off the New England coast with snow over Maine, Vermont, and Massachusetts, with the trough to the west continuing to move eastward into the Upper Peninsula of Michigan, into Wisconsin and Iowa. An area of snow was depicted over the Detroit area north over northern Michigan.

Figure 5 is the 12-hour Low-Level Significant Weather Prognostic Chart also valid for 1300 EST depicting the general flight categories² of IFR, MVFR, and VFR conditions, freezing level,

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.

and areas of expected low-level turbulence below 24,000 ft. The chart depicted a red contour line defining IFR conditions over northern Michigan, with a blue scalloped line depicting MVFR conditions over most of lower Michigan, Ohio, eastern Kentucky, West Virginia, and western Pennsylvania. The freezing level was below 4,000 ft over Michigan and moderate turbulence below 12,000 ft was expected.

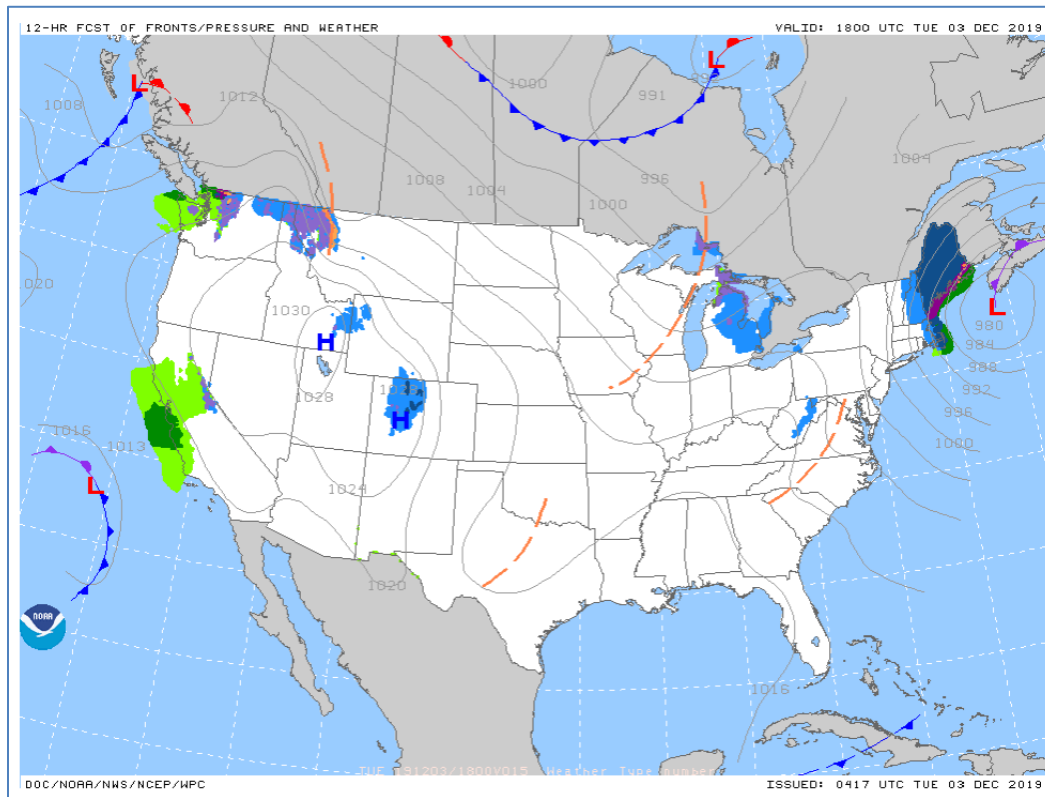


Figure 4 – 12-hour Surface Prognostic Chart valid for 1300 EST

**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.

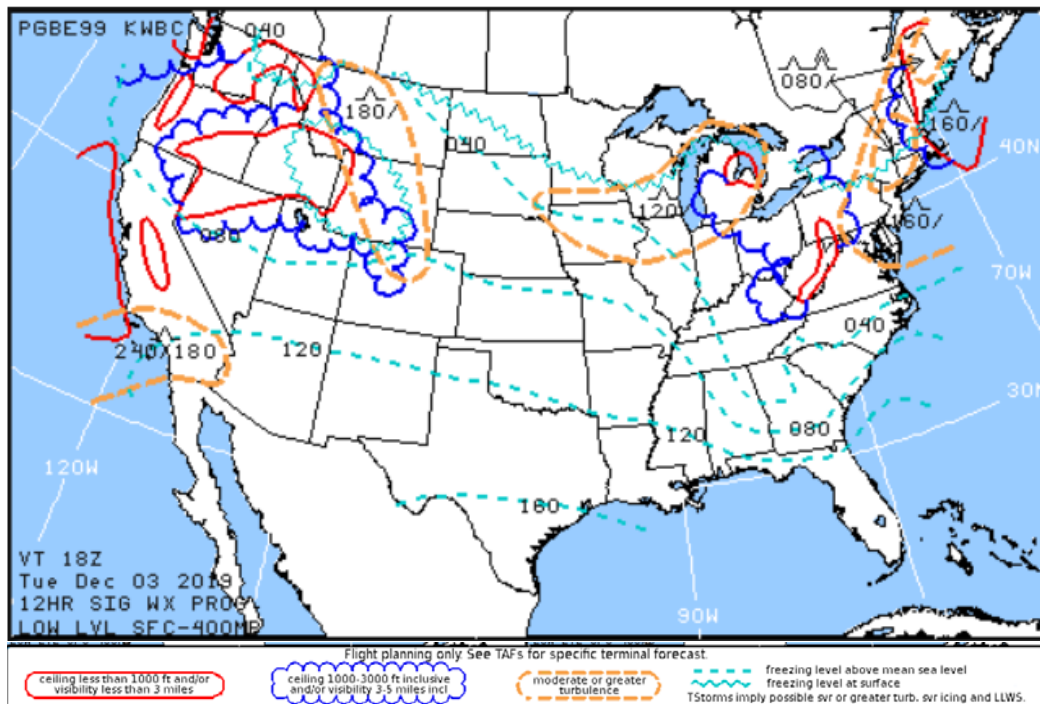


Figure 5 - 12-hour Low-Level Significant Weather Prognostic Chart valid for 1300 EST

2.0 Observations

The official observations issued surrounding the accident site were documented using standard meteorological aerodrome reports (METARs) and specials (SPECIs). Cloud heights are reported above ground level (agl) in the following section, and the magnetic variation was estimated at 7° west based on the latest sectional chart for the area.

2.1 Coleman A. Young Municipal Airport, Detroit, Michigan

The accident occurred as the airplane was landing at Coleman A. Young Municipal Airport (KDET), Detroit, Michigan, at an elevation of 626 ft. The airport had an Automated Surface Observation System (ASOS) which was augmented by air traffic controllers as necessary. The weather conditions reported immediately surrounding the time of the accident were as follows:

Weather observation for KDET at 0753 EST, wind from 260° at 8 knots, visibility 10 miles or more, ceiling overcast at 1,100 ft agl, temperature -1° Celsius (C), dew point temperature -3° C, altimeter 29.87 inches of mercury (Hg). Remarks: automated station with a precipitation discriminator, sea level pressure 1012.1-hPa, temperature -1.1° C, dew point -2.8° C.

Special weather observation for KDET at 0844 EST, wind from 280° at 8 knots, visibility 10 miles or more, ceiling overcast at 1,000 ft agl, temperature -2° C, dew point temperature -3° C, altimeter 29.86 inches of Hg. Remarks: automated station with a precipitation discriminator, temperature -1.7° C, dew point -2.8° C.

Based on landing on runway 33 the wind resulted in a left crosswind component of 5 to 7 knots, with a 4 to 6 knot headwind component. No wind gusts were reported during the period. The general flight categories and raw observations from approximately 0553 through 1300 EST were as follows:

MVFR METAR KDET 031053Z 24007KT 10SM OVC013 M01/M03 A2987 RMK AO2 SLP123 T10111028=

MVFR METAR KDET 031153Z 27007KT 10SM OVC012 M02/M03 A2988 RMK AO2 SLP125 T10171033 10000
21017 55015=

MVFR METAR KDET 031253Z 26008KT 10SM OVC011 M01/M03 A2987 RMK AO2 SLP121 T10111028=

Accident 1333Z

MVFR SPECI KDET 031344Z 28008KT 10SM OVC010 M02/M03 A2986 RMK AO2 T10171028=

MVFR SPECI KDET 031346Z 27007KT 10SM OVC010 M02/M03 A2986 RMK AO2 T10171028=

MVFR METAR KDET 031353Z 26009G15KT 10SM OVC010 M02/M03 A2986 RMK AO2 SLP117 T10171028=

MVFR SPECI KDET 031440Z 20005KT 10SM FEW010 OVC023 M01/M02 A2983 RMK AO2 T10111022=

MVFR METAR KDET 031453Z 19005KT 10SM OVC025 M01/M03 A2983 RMK AO2 SLP108 T10061028 58017

MVFR METAR KDET 031553Z 20006KT 10SM OVC023 00/M03 A2980 RMK AO2 SLP099 T00001028

MVFR METAR KDET 031653Z 21009KT 10SM OVC015 01/M03 A2977 RMK AO2 SLP087 T00061028

MVFR SPECI KDET 031722Z 23009KT 10SM OVC014 01/M02 A2975 RMK AO2 T00061022

IFR SPECI KDET 031744Z 22009G18KT 2SM -SN BR OVC012 01/M01 A2973 RMK AO2 SNB33 P0000
T00061011

2.2 Willow Run Airport, Detroit, Michigan

The accident airplane departed from Willow Run Airport (KYIP), Detroit, Michigan, at approximately 0819 EST. KYIP was located approximately 25 miles southwest of KDET, at an elevation of 716 ft. The airport also had an ASOS and was also augmented by air traffic control personnel. The following conditions were reported at the time of departure.

Special weather observation for KYIP at 0802 EST, wind from 220° at 5 knots, visibility 9 miles, scattered clouds at 1,000 ft agl, ceiling overcast at 2,000 ft, temperature 0° C, dew point temperature -3° C, altimeter 29.87 inches of Hg. Remarks: automated station with a precipitation discriminator, temperature 0.0° C, dew point -2.8° C.

The general flight categories and raw observations reported surrounding the period from 0553 through 1214 EST were as follows:

IFR METAR KYIP 031053Z 24007KT 10SM OVC008 M01/M03 A2988 RMK AO2 SLP124 T10061033

IFR METAR KYIP 031153Z 25009KT 10SM OVC007 M01/M03 A2989 RMK AO2 SLP126 T10061033 10000

21006 55015

IFR METAR KYIP 031253Z 24004KT 10SM BKN009 OVC018 M01/M03 A2987 RMK AO2 SLP120 T10061033

MVFR SPECI KYIP 031302Z 22005KT 9SM SCT010 OVC020 00/M03 A2987 RMK AO2 T00001028

Departure 1319Z

MVFR METAR KYIP 031353Z 20005KT 10SM OVC021 00/M03 A2984 RMK AO2 SLP109 T00001028

MVFR METAR KYIP 031453Z 21008KT 10SM OVC021 01/M03 A2983 RMK AO2 SLP105 T00061028 56021

MVFR SPECI KYIP 031528Z 21009KT 10SM BKN012 OVC021 01/M03 A2982 RMK AO2 T00061028

MVFR METAR KYIP 031553Z 22009KT 10SM BKN011 OVC021 01/M02 A2980 RMK AO2 SLP095 T00111022

IFR SPECI KYIP 031616Z 22009KT 8SM OVC009 01/M02 A2979 RMK AO2 CIG 008V013 T00111017

IFR METAR KYIP 031653Z 21012KT 7SM OVC007 01/M02 A2976 RMK AO2 SLP084 T00111017

IFR SPECI KYIP 031714Z 21012KT 1 3/4SM -SN BR OVC007 01/M01 A2975 RMK AO2 SNB02 P0000
T00111011

2.3 Detroit Metropolitan Wayne County Airport, Detroit, Michigan

The next closest weather reporting location to the accident site was from Detroit Metropolitan Wayne County Airport (KDTW), Detroit, Michigan, located approximately 19 miles southwest, at an elevation of 645 ft. The airport also had an ASOS and was augmented by air traffic control personnel. The following conditions were being reported at the time of the accident.

Weather observation for KDTW at 0853 EST, wind from 260° at 10 knots, visibility 8 miles, ceiling overcast at 800 ft agl, temperature -1° C, dew point temperature -3° C, altimeter 29.88 inches of Hg. Remarks: automated station with a precipitation discriminator, sea level pressure 1012.5-hPa, temperature -1.1° C, dew point -3.3° C.

The general flight categories and observations surrounding the period were as follows:

IFR METAR KDTW 030953Z 26005KT 7SM -SN BKN009 OVC014 M01/M04 A2991 RMK AO2 SLP134 P0000
T10111039

IFR METAR KDTW 031053Z 23007KT 8SM OVC008 M02/M04 A2988 RMK AO2 SNE38 SLP125 P0000
T10171039

IFR METAR KDTW 031153Z 25013KT 8SM OVC008 M02/M04 A2990 RMK AO2 SLP131 60000 70001
T10171039 11006 21017 55013

IFR METAR KDTW 031253Z 26010KT 8SM OVC008 M01/M03 A2988 RMK AO2 SLP125 T10111033

Accident 1333Z

IFR METAR KDTW 031353Z 21006KT 7SM BKN008 OVC020 M01/M03 A2985 RMK AO2 SLP115
T10061028

MVFR SPECI KDTW 031420Z 18006KT 5SM BR SCT008 OVC020 M01/M03 A2984 RMK AO2 T10061028

MVFR METAR KDTW 031453Z 18007KT 7SM SCT008 OVC020 M01/M03 A2983 RMK AO2 SLP107
T10061028 58023

MVFR METAR KDTW 031553Z 20009KT 8SM FEW010 OVC020 00/M03 A2981 RMK AO2 SLP100

MVFR METAR KDTW 031653Z 20009KT 6SM HZ BKN010 OVC020 01/M02 A2977 RMK AO2 SLP089
T00061022

IFR SPECI KDTW 031729Z 21014KT 1 1/2SM -SN BR OVC010 01/M02 A2975 RMK AO2 TWR VIS 2 SNB22
P0000 T00061017

IFR METAR KDTW 031753Z 21012KT 2SM R03R/6000VP6000FT -SN BR OVC010 01/M01 A2973 RMK
AO2 SFC VIS 2 1/2 SNB22 SLP074 P0000 60000 T00061011 10006 21017 58032

2.4 METAR Display

A display of the observations over Michigan at 0830 EST from the NWS Aviation Weather Center's METAR display is included as figure 6. The display indicated MVFR to IFR conditions prevailing over Michigan during the period with ceilings overcast from 700 ft to 2,000 ft.

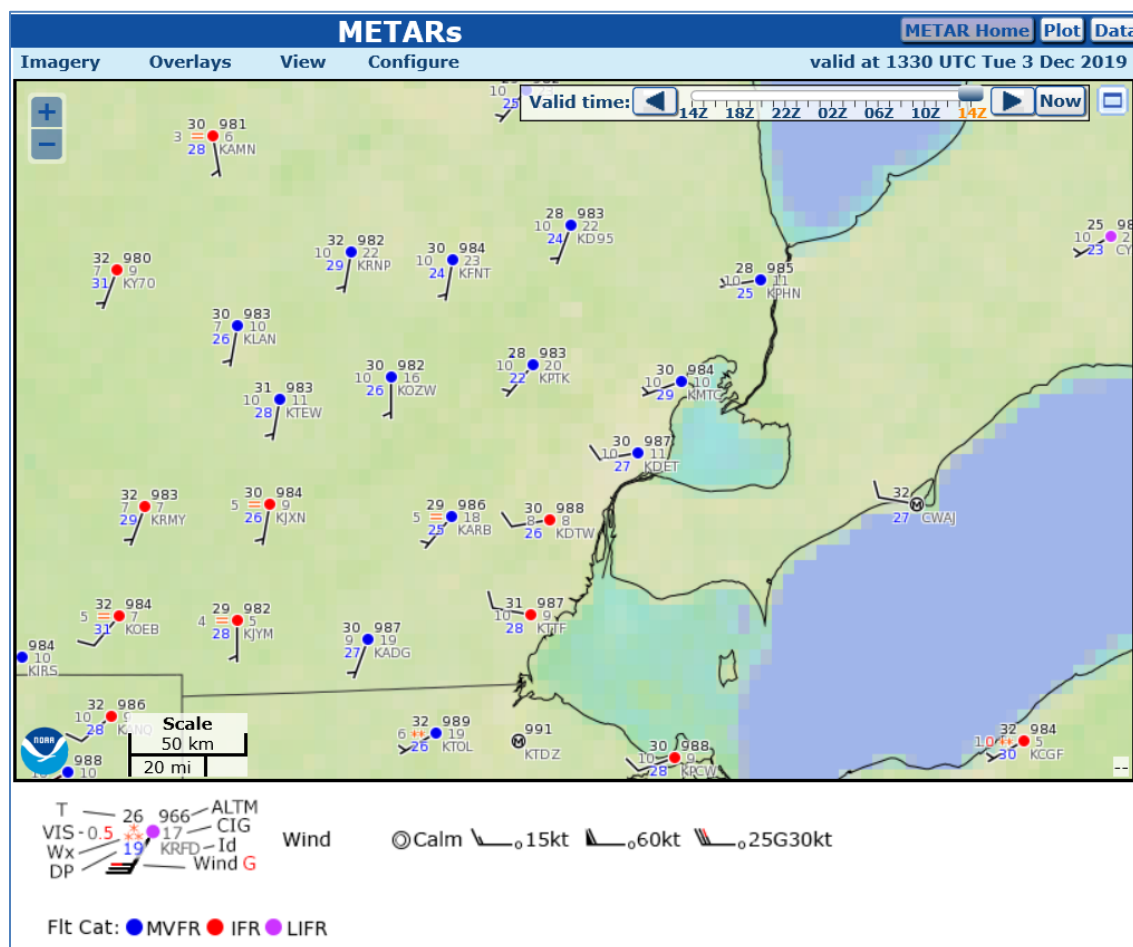


Figure 6 - NWS Aviation Weather Center's METAR display at 0830 EST

3.0 Sounding

The closest NWS upper air sounding for White Lake (KDTW), site number 72632, was not available during the period for unknown reasons. So to determine the vertical structure and state of the atmosphere during the period over the accident site a High-Resolution Rapid Refresh (HRRR)³ numerical model data was retrieved from the NOAA Air Resources Laboratory and plotted on a standard Skew T log P diagram⁴ using the complete Rawinsonde Observation RAOB program software⁵. Figure 7 is the HRRR sounding for 0800 EST over KDET from the surface to approximately 21,000 ft.

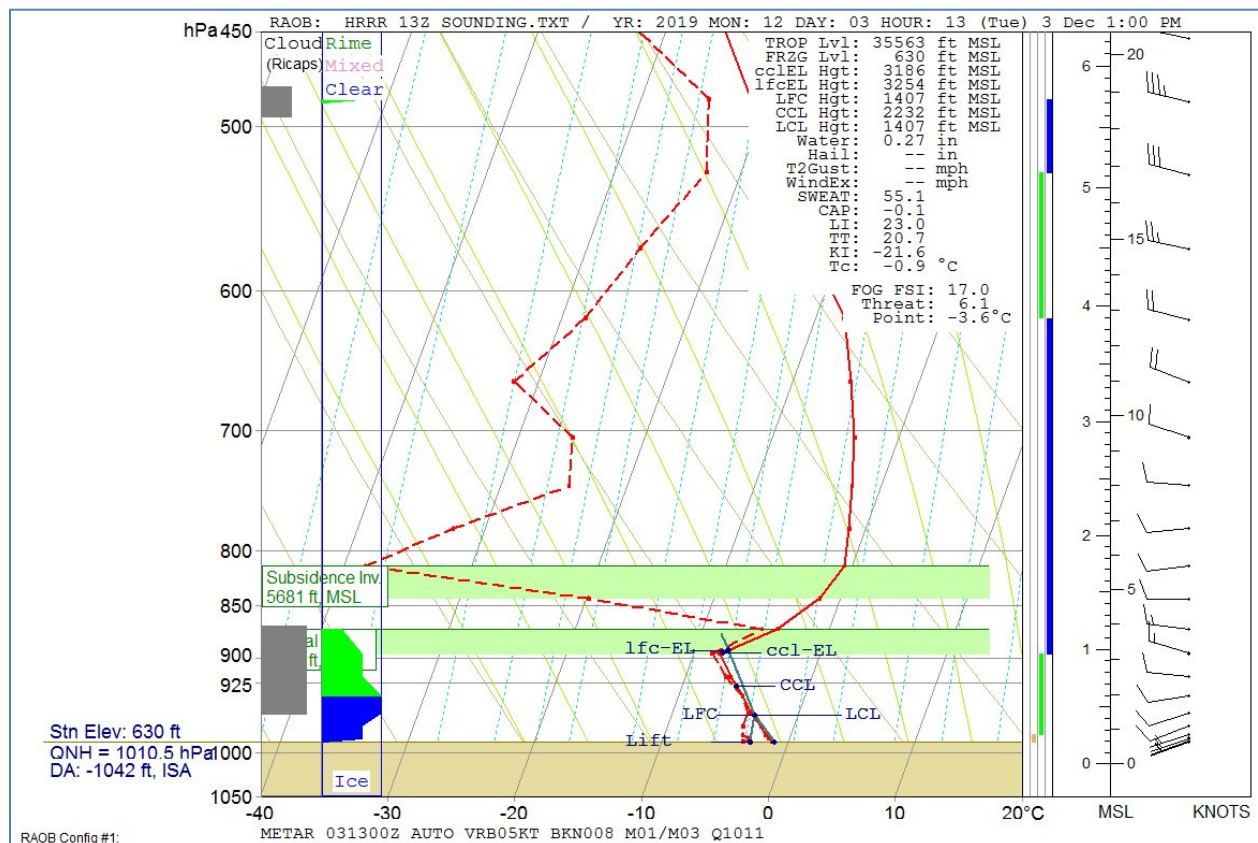


Figure 7 - HRRR numerical model sounding for 0800 EST over KDET

The HRRR 0800 EST sounding depicted a near surface temperature of -1.1°C (30°F), a dew point of -3.0°C (26.6°F), with a relative humidity of 87%. The lifted condensation level (LCL)⁶

³ 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.

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.

and the level of free convection (LFC)⁷ were identified at 777 ft agl, with the convective condensation level (CCL)⁸ at 1,602 ft agl. The sounding supported clouds with bases from the LCL and LFC near 800 ft agl with tops to 4,000 ft given that the relative humidity was greater than 90% in that layer, with another high layer of clouds between 18,000 and 20,000 ft. The low cloud layer's cloud top temperature was near -4° C⁹, and implied supercooled droplets within the layer. A defined temperature inversion was identified between 3,000 ft through 5,681 ft, where temperatures increased with altitude, but remained below freezing. Dry air was indicated above 4,000 ft through 15,000 ft. The precipitable water content was 0.27 inches. The atmosphere was characterized as stable based on the Lifted Index¹⁰ of 22, with the layer from the surface through 3,000 ft as conditional unstable.

The HRRR wind profile indicated a surface wind from 250° at 8 knots, with wind veering to the west with height and gradually increasing wind speeds with height. The mean 0 to 6 km or 18,000 ft wind was from 280° at 19 knots. At the accident airplane's cruising latitude of 3,000 ft the wind was from 285° at 15 knots with a temperature of -7.5° C.

Figure 8 is a table of the HRRR sounding parameters of height, pressure (Pres), temperature (T), dew point (Td), relative humidity (RH), wind direction and speed, and RAOB derived clear air turbulence (CAT), low-level wind shear (LLWS), and icing potential.

Height (ft-MSL)	Pres (hPa)	T (C)	Td (C)	RH (%)	DD / FF (deg / kts)	CAT (FAA)	LLWS	Icing - Type (AFGWC method)
630	988	-1.1	-3.0	87	248 / 5			LGT Clear
657	987	-1.3	-3.6	84	248 / 4	LGT	LIGHT	
737	984	-1.6	-3.2	89	249 / 7			LGT Clear
843	980	-2.0	-3.8	87	250 / 7			LGT Clear
1084	971	-2.6	-4.0	90	248 / 8			LGT Clear
1461	957	-3.7	-4.0	98	250 / 9			MDT Clear
1952	939	-4.9	-4.9	100	260 / 11	LGT		MDT Clear
2506	919	-6.4	-6.8	97	277 / 12	LGT		LGT Rime
3155	896	-7.9	-8.5	95	288 / 16	LGT		LGT Rime
3853	872	-4.1	-5.3	91	278 / 14	LGT		TRC Rime
4733	843	-1.6	-19.8	23	270 / 10			
5681	813	-0.6	-38.3	4	262 / 9			

Figure 8 - HRRR sounding parameters

As seen on the left side of the HRRR sounding profile (figure 7) and the above parameters, light to moderate clear to rime type icing where likely below 4,000 ft in the clouds. This layer was

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.

⁸ 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.

⁹ Cloud top temperatures below -10° C typically imply that any precipitation is likely to be in the form of snow. Cloud top temperatures warmer than -10° C prevent ice crystals formed and imply more supercooled liquid droplets are present. Supercooled droplets grow by the collision-coalescence process mechanism and are often associated with freezing drizzle formation.

¹⁰ 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".

below freezing with temperatures ranging between -1° to -8° C and supported the development of supercooled cloud droplet formation.

4.0 Satellite Imagery

The Geostationary Operational Environmental Satellite number 16 (GOES-16) imagery 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 images at a resolution of 0.5 km.

The GOES-16 infrared image for 0831 EST at 2X magnification with a standard MB temperature enhancement curve applied is included as figure 9. The image depicted an extensive area of low and high clouds over the area, with a radiative cloud top temperature of 248 Kelvin or -25.16° C over KDET, which corresponded to tops near 20,000 ft based on the HRRR model sounding.

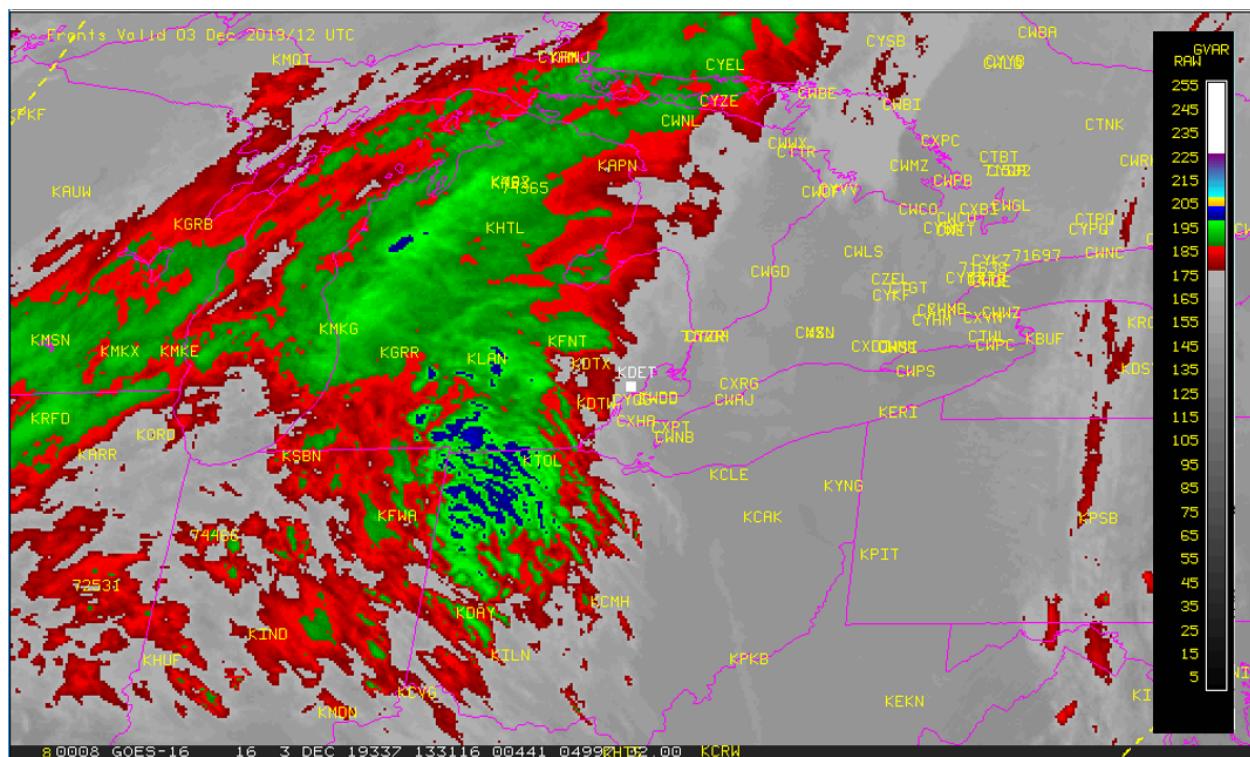


Figure 9 - GOES-16 infrared image for 0831 EST with a standard MB temperature enhancement curve

The GOES-16 visible band 2 image for 0831 EST at 2X magnification is included as figure 10 and identified an extensive overcast layer of low stratiform clouds extending over the area with high thin cirriform clouds also over the Detroit area.

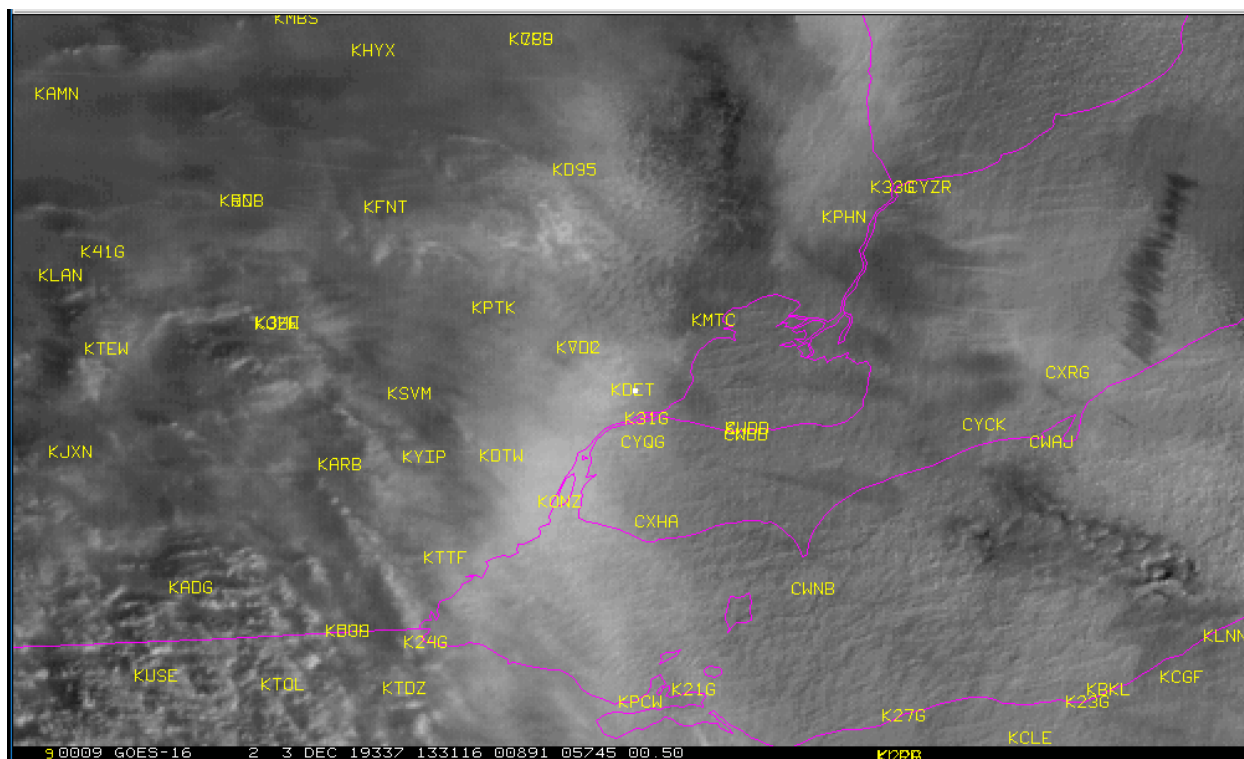


Figure 10 - GOES-16 visible satellite image for 0831 EST at 2X magnification

5.0 Pilot Reports

A search of pilot reports (PIREPs) surrounding the period and within 100 miles of Detroit between 0500 and 1200 EST, and below 12,000 ft are included below. The reports are provided in standard code and abbreviations, with time in UTC. Heights are in msl unless otherwise noted.

YIP UA /OV YIP/TM 1005/FL032/TP CL30/IC MOD/RM TOPS/032. BASES/016. MODERATE ICING.

YZ UA /OV CYQG /TM 1007 /FLDURD /TP TBM9 /IC LGT-MDT MXD 016-036 /RM ON APCH RWY 25

PTK UA /OV 4W/TM 1106/FLDURC/TP C510/SK BASES OVC016 TOPS033/TA +1 033/IC LIGHT RIME

PTK UA /OV 6E/TM 1124/FLDURC/TP BE20/SK TOPS OVC037 BASES 017/TA -4 025/IC MOD MIXED /RM PICKED UP ICING IN THE TOPS AND INTENSIFIED TO BASES

DTW UA /OV DXO035010/TM 1159/FL030/TP A319/TA M07/IC LGHT RIME 030-037

DTW UA /OV 5NM FINAL 21L/TM 1218/FL023/TP A319/SK OVC023/TA -06/IC LT RIME

DTW UA /OV 8 S DTW/TM 1223/FLDURC/TP CRJ9/SK BASES 020 TOPS 038/TA -2/IC LGHT RIME 020/038

DTW UA /OV PTK045005/TM 1238/FL120/TP H25B/SK BASES 030 TOPS 036 OVC/IC NEG

PTK UA /OV PTK315005/TM 1241/FL030/TP H25B/SK OVC030-TOP036/IC NEG/RM DURC

DTW UA /OV 5NM FINAL 21L/TM 1246/FL030/TP CRJ9/TA M07/IC MOD MIXED

PTK UA /OV PTK225010/TM 1310/FL031/TP GALX/SK OVC031-TOPUNKN/TA M06/IC TRACE/RM DURD

Accident 1333Z

DTW UA /OV DTW225010/TM 1342/FLDURGC/TP A321/SK B026 T036/TA MINUS 6/IC LGT CLR

YZ UA /OV CYQG /TM 1344 /FLDURD /TP B190 /IC LGT-MDT MXD /RM IGCIC ON APCH RWY 25

DTW UA /OV 5 SO. DTW/TM 1345/FL50/TP A321/SK B018 OVC T037/TA MINUS 2/IC LT RIME/RM CLR
ABV

DTW UA /OV DET090005/TM 1439/FLDURGC/TP B350/SK T036 MULTI LAYERS/IC NEG

DTW UA /OV YQG090010/TM 1443/FLDURGD/TP DH8D/SK B030 OVC T036/TA MINUS 1/IC MOD RIME
036-020

YZ UA /OV CYQG /TM 1445 /FLDURD /TP DH8D /IC MDT RIME 020-036

DTW UA /OV 10 SO. DXO/TM 1452/FL055/TP A319/SK B029 T038/TA 7/IC LT RIME DURING CLIMB

DTW UA /OV SVM030010/TM 1530/FL030/TP SR22/TA MINUS 4/IC TRACE MX

DTW UA /OV DXO3330010/TM 1532/FL041/TP BCS1/IC LT RM DURD/RM TOP041

YIP UA /OV DXO333010 /TM 1532 /FL041 /TP BCS1 /SK TOP041 /TA UNKN /IC LGT RIME /RM DURD

PTK UA /OV PTK150020/TM 1536/FLDURGC/TP H25B/IC NEG

DTW UA /OV SVM250010/TM 1543/FL110/TP B350/TA 00/IC LGT MX/RM DURC

DTW UA /OV DXO22008/TM 1544/FLDURC/TP A321/TA 0/IC LT RM 020-040

YIP UA /OV DXO220008 /TM 1544 /FLUNKN /TP A321 /TA 00 /IC LGT RIME 020-040 /RM DURC

PTK UA /OV PTK/TM 1555/FL012/TP SR22/SK OVC012/IC NEG/RM BASES 012 TOPS 035

DTW UA /OV DX0180080/TM 1604/FLDURC/TP E75S/TA M2/IC LT RM 025-038

PTK UA /OV 5W/TM 1622/FLDURC/TP LJ55/SK B 021 T 036 OVC/IC NEG

PTK UA /OV 3E/TM 1654/FLDURD/TP F2TH/SK B 010 OVC/TA 4/IC LGT RIME

A review of the 29 reports during the 7 hours surrounding the period indicated 23 reports of icing between 1,600 ft and 4,000 ft. Most of the reports indicated light rime type icing being encountered with moderate rime to mixed icing encounters the second highest number of reports. There was a strong aircraft type bias in the reports with the majority of the light icing intensity reports being made by air carrier aircraft, and all the moderate icing from turboprop, business to smaller regional jet aircraft. The reports of no icing were also most common with departing jet aircraft rapidly climbing through the clouds, versus aircraft on a gradual descent. The reports of moderate icing were noted between 0500 and 0945 EST or immediately surrounding the time of the accident, with the light intensity icing reports dominating after 0945 EST. No urgent PIREPs or severe icing were reported during the period. Cloud bases were reported near 1,600 ft with cloud tops ranging from 3,800 to 4,000 ft.

One pilot report at 0624 EST from a pilot operating a Beechcraft 200 Super King Air (BE20) turboprop located approximately 24 miles northwest of the accident site reported cloud tops at 3,700 ft and bases near 1,700 ft with moderate icing in the clouds and noted that they picked up icing in the cloud tops, which intensified to the base bases. Another report from another Beechcraft 1900 turboprop landing 8 miles north of the accident site at 0845 EST reported light-to-moderate mixed icing in clouds.

For reference the following icing intensity is taken from the Airmen's Information Manual (AIM), Safety of Flight, section 7-1-21 PIREPs relating to airframe icing.

1. **Trace.** *Ice becomes perceptible. Rate of accumulation slightly greater than sublimation. Deicing/anti-icing equipment is not utilized unless encountered for an extended period of time (over 1 hour).*
2. **Light.** *The rate of accumulation may create a problem if flight is prolonged in this environment (over 1 hour). Occasional use of deicing/anti-icing equipment removes/prevents accumulation. It does not present a problem if the deicing/anti-icing equipment is used.*
3. **Moderate.** *The rate of accumulation is such that even short encounters become potentially hazardous and use of deicing/anti-icing equipment or flight diversion is necessary.*
4. **Severe.** *The rate of accumulation is such that deicing/anti-icing equipment fails to reduce or control the hazard. Immediate flight diversion is necessary.*

6.0 NWS Forecasts

6.1 Terminal Aerodrome Forecasts

The NWS Detroit/Pontiac (KDTX) Weather Forecast Office (WFO) was responsible for the issuance of the Terminal Aerodrome Forecast (TAF) for KDET. 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 was as follows.

TAF KDET 031138Z 0312/0412 24008KT P6SM OVC010
FM031700 21012KT P6SM -SHSN OVC015
FM032100 20011KT P6SM BKN025 OVC040
FM040800 22009KT P6SM OVC015=

The forecast for KDET from 0700 through 1200 EST expected wind from 240° at 8 knots, visibility better than 6 miles, with ceiling overcast at 1,000 ft agl. After 1200 through 1600 EST, light snow showers were expected at the station.

6.2 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 0612 EST was as follows.

FXUS63 KDTX 031131 CCA
AFDDTX

Area Forecast Discussion...corrected
National Weather Service Detroit/Pontiac MI
612 AM EST Tue Dec 3 2019

.AVIATION...

Stratus remains locked in across SE Michigan this morning and is already developing back northward along the Lake Michigan shoreline as the wind turns SW there. This adds confidence to the **expectation of borderline IFR/MVFR clouds persisting across the region through the day**. Light southwest wind starts the day at all terminals and then increases toward 15 knots during the afternoon. The stronger low level wind then has a chance to push the western fringe of clouds observed over Illinois into SE Michigan by late afternoon before the next front moves into the region. Dry air in the 5-10,000 ft layer likely prevents any precipitation from the initial round of frontal moisture arriving late in the day and Tuesday evening.

For DTW...Precipitation may be evident late in the day or evening but is not expected to be anything more than flurries or a brief snow shower.

DTW THRESHOLD PROBABILITIES...

* High for ceiling at or below 5000 feet.

.PREV DISCUSSION...
Issued at 303 AM EST Tue Dec 3 2019

DISCUSSION...

Although clearing overspread much of northern Lower Mi overnight, southern Michigan remained entrenched in stratus. Ongoing subsidence has done nothing but lower the cloud base. The low level flow has backed to the southwest over Lake Michigan. Recent satellite data suggests additional moisture flux off the lake will sustain a solid stratus through the day. The lack of decent nocturnal cooling overnight as a result of the low clouds has largely held temps in the upper 20s/low 30s. Limited thermal advection today and persistent cloud cover will only boost daytime highs into the low to mid 30s. Last evening, some light snow and drizzle blossomed within the northerly flow off Lake Huron and affected a good portion of the forecast area. Returns off Lake Mi this morning are much weaker and suggest very light flurries or drizzle at best. A mid level short wave impulse now rotating across the Dakotas will advance into the western Great Lakes this afternoon, spreading decent mid level height falls across Lower Mi. Upstream satellite data confirms model solutions in depicting a narrow axis of higher mid level moisture traversing Se Mi this afternoon ahead of this wave. This moisture may be enough to seed the stratus layer and support a brief window for a few light snow showers this afternoon.

The mid level short wave impulse will cross Se Mi this evening, while a broad mid level trough axis then expands across Lower Mi into the eastern Great Lakes overnight into Wednesday in its wake. A slightly deeper pool of colder air will advance across the region, allowing convective cloud depths to increase. This and indications in the model solutions that there will be at least some intervals of increased mid level moisture will support scattered snow showers. The expected persistence of low clouds will support a continuation of low diurnal temperatures swings Wednesday and through the end of the week.

The split flow regime across NOAM will persist into the first part of the weekend. Another northern stream impulse is forecast to advance across the Great Lakes Thurs night into Friday, bringing a slightly better surge of colder air, albeit brief. The medium range model suite continue to indicate a long wave pattern change late in the weekend into early next week, featuring ridge amplification across the west coast and an amplification of long wave troughing over the central US. This will place Se Mi within the strengthening southwest flow and will allow a warming trend Sun into Monday. This warm spell is likely to be brief as there is indications that the polar low will sink into northern Ontario by the middle of next week, driving arctic air into the Great Lakes. This may also set up a period of active weather along the arctic front, affecting Se Mi late in the forecast period.

.DTX WATCHES/WARNINGS/ADVISORIES...

MI...NONE.

Lake Huron...NONE.

Lake St Clair...NONE.

Michigan waters of Lake Erie...NONE.

AVIATION.....KK

DISCUSSION...SC

MARINE.....KDK

6.3 Current Icing Product

The NWS AWC Current and Forecast Icing Products (CIP/FIP) probability of icing and icing severity for 1000 ft, 3000 ft, and 6000 ft issued during the period were documented. The supercooled large droplet (SLD) product was reviewed but did not depict any large areas over Michigan and thus was not documented. The CIP and FIP graphics are computer-generated three-dimensional analyses of information related to the likelihood of encountering icing conditions. This information is available for the 48 contiguous United States, much of Canada and Mexico, and their respective coastal waters.

The CIP/FIP graphics suite is automatically produced with no human modifications. Information on the graphics is determined from observational data including WSR-88D radar, satellite, pilot weather reports, surface weather reports, lightning and computer model output. The CIP represents the latest analysis of potential icing regions. Besides the most-recent analyses, a forecast of anticipated icing conditions is available in the FIP product.

Figures 11-16 are the CIP Icing Probability for 1000 ft, 3000 ft, and 6000 ft for 0700 EST and 0800 EST, where the probabilities range from 0% (or no icing expected) to 85% or greater (nearly certain icing). Figures 17-20 are the CIP Icing Severity for 1000 ft and 3000 ft for 0700 EST and 0800 EST. No icing was expected at 6,000 ft. The icing intensity is displayed using the intensity categories: trace, light, moderate, and heavy (severe). The charts depicted a greater than 65% probability of light icing conditions at 1,000 ft and 3,000 ft over eastern Michigan in the vicinity of the accident site during the period.

A review of the earlier issued 3-hour Forecast icing Potential (FIP) Icing Probability and Icing Severity Products issued at 0500 EST are included as figures 21-22.

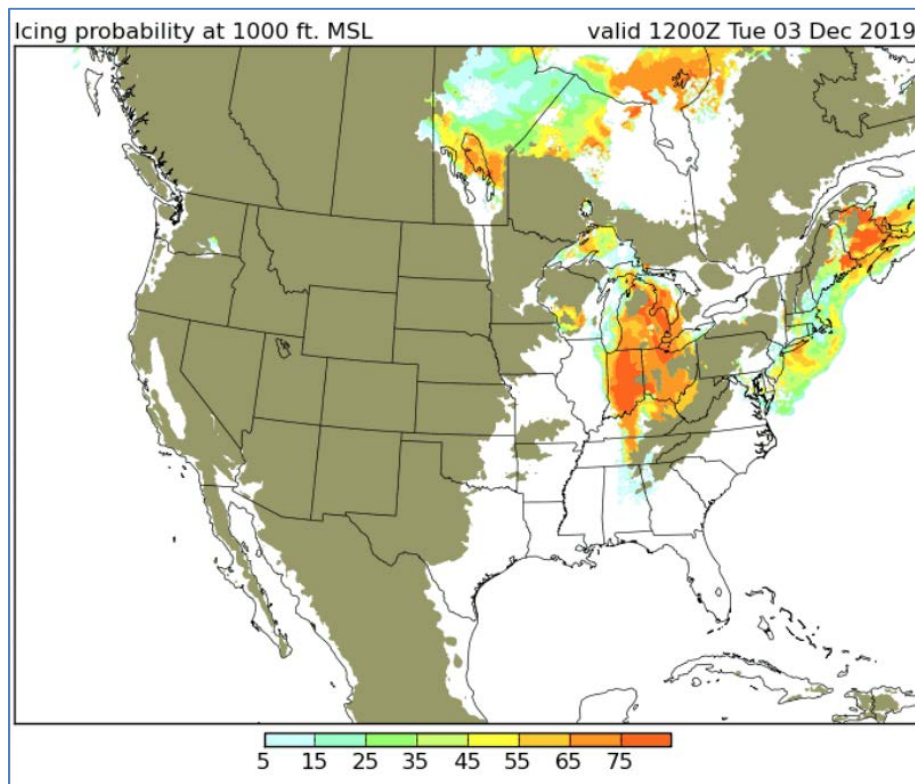


Figure 11 - CIP Icing Probability for 1,000 ft at 0700 EST

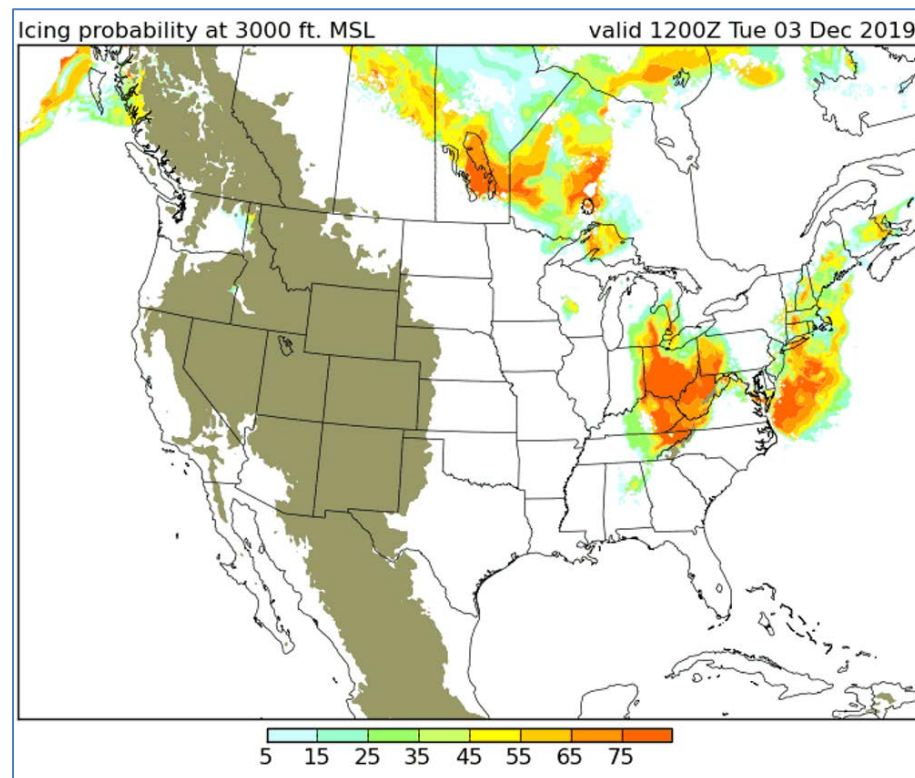


Figure 12 - CIP Icing Probability for 3,000 ft at 0700 EST

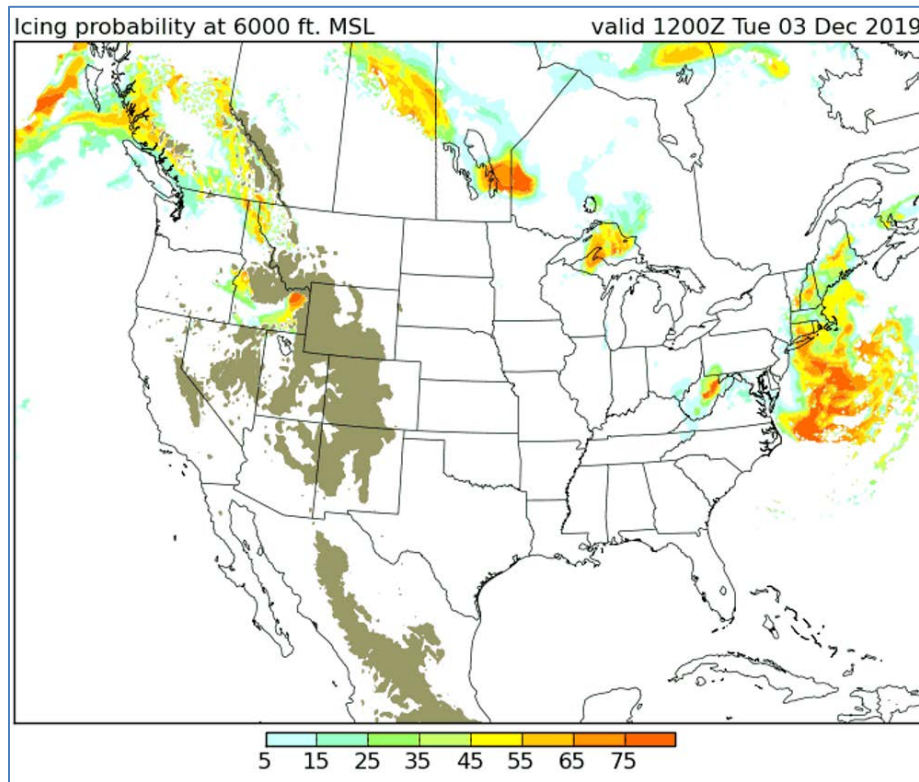


Figure 13 - CIP Icing Probability for 6,000 ft at 0700 EST

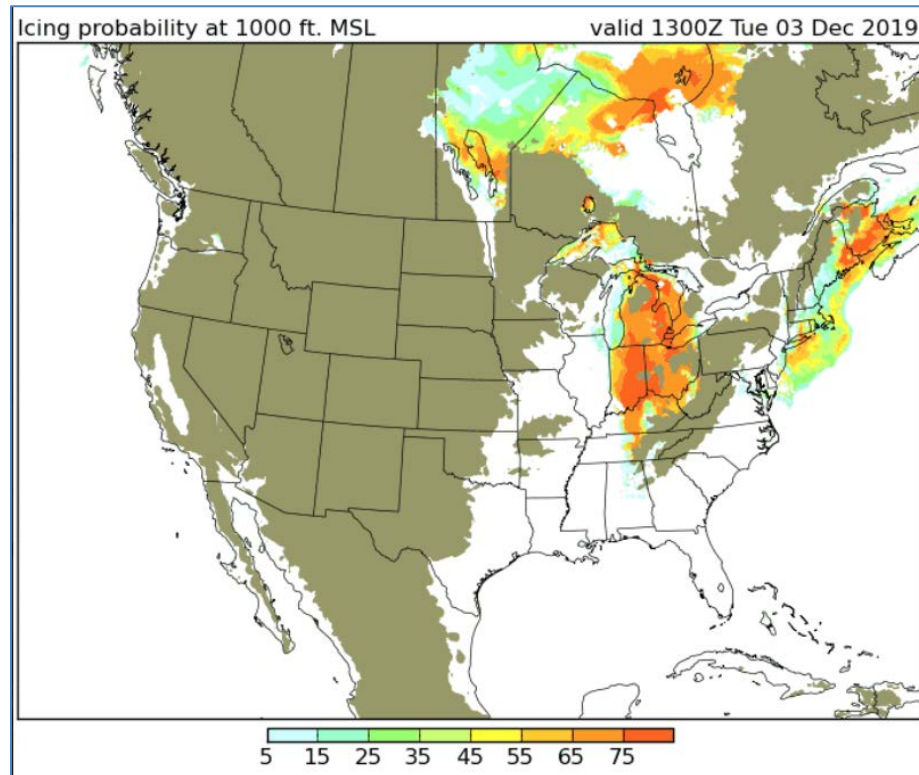


Figure 14 - CIP Icing Probability for 1,000 ft at 0800 EST

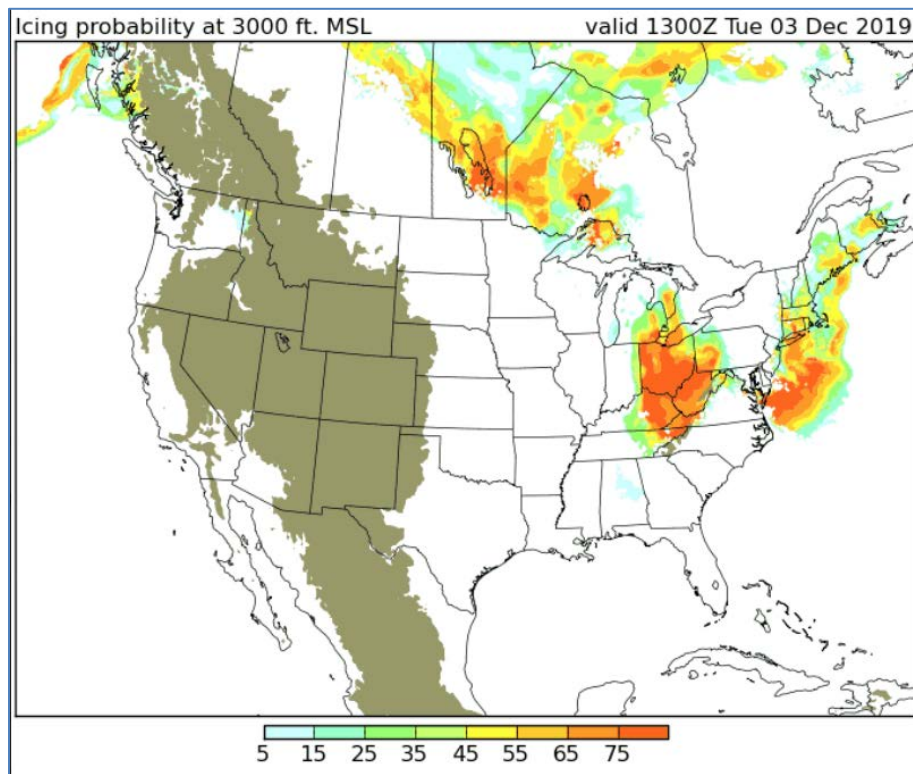


Figure 15 - CIP Icing Probability for 3,000 ft at 0800 EST

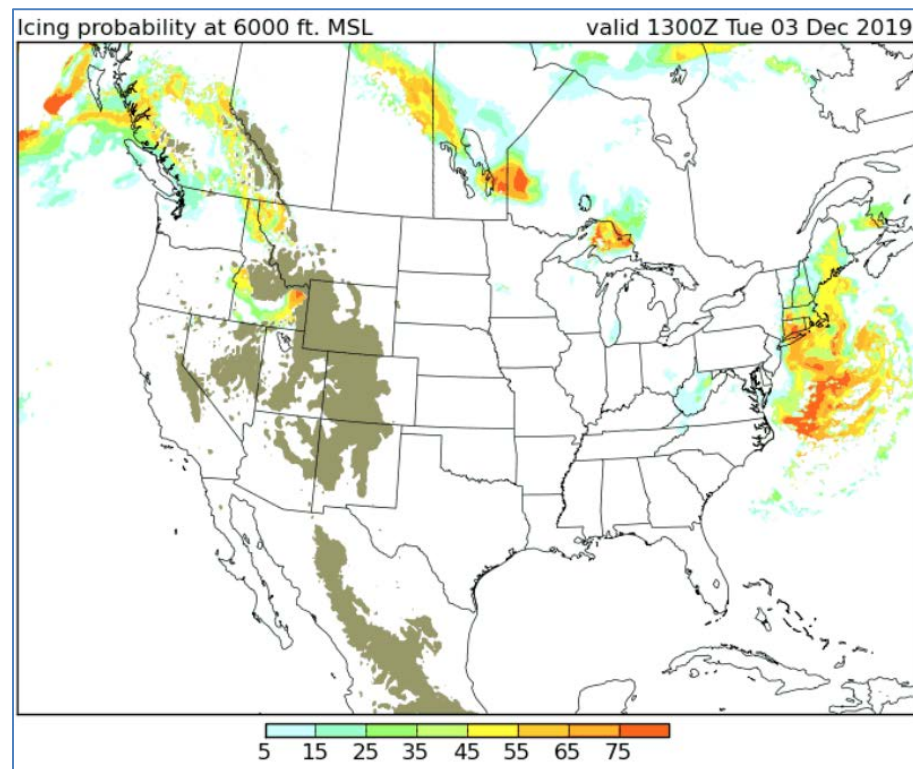


Figure 16 - CIP Icing Probability for 6,000 ft at 0800 EST

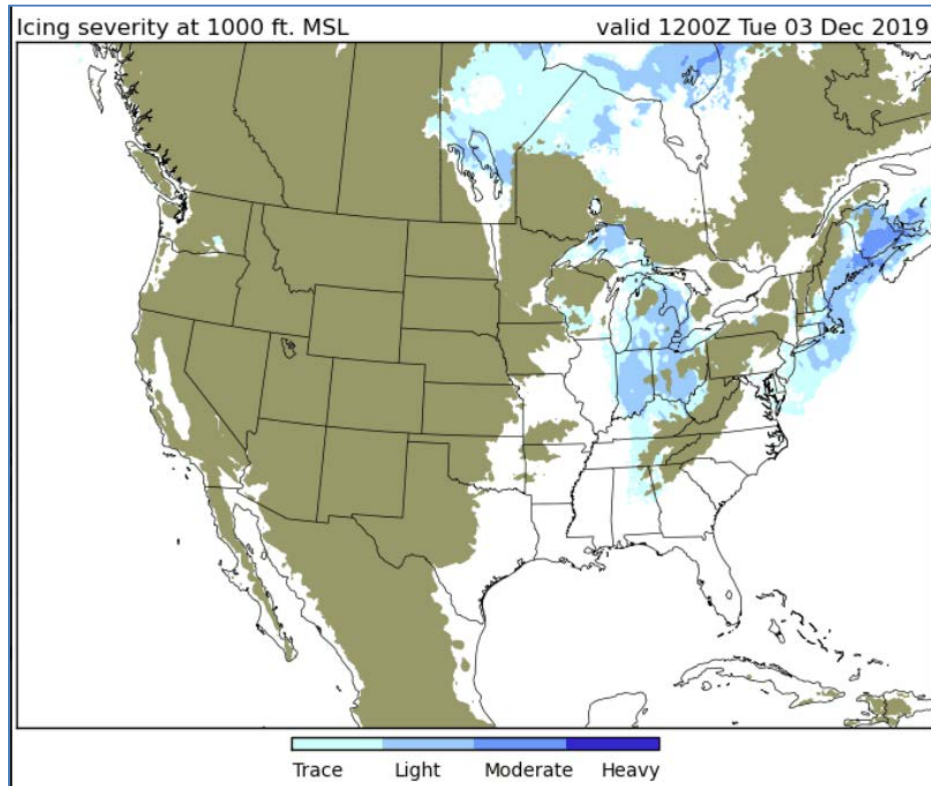


Figure 17 - CIP Icing Severity for 1,000 ft at 0700 EST

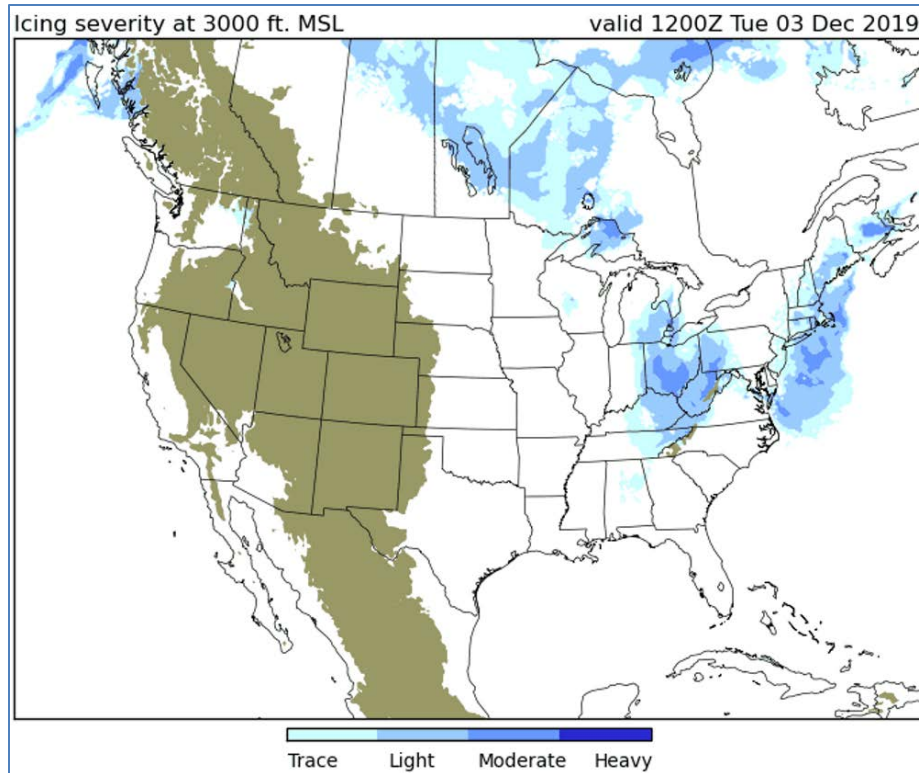


Figure 18 - CIP Icing Severity for 3,000 ft at 0700 EST

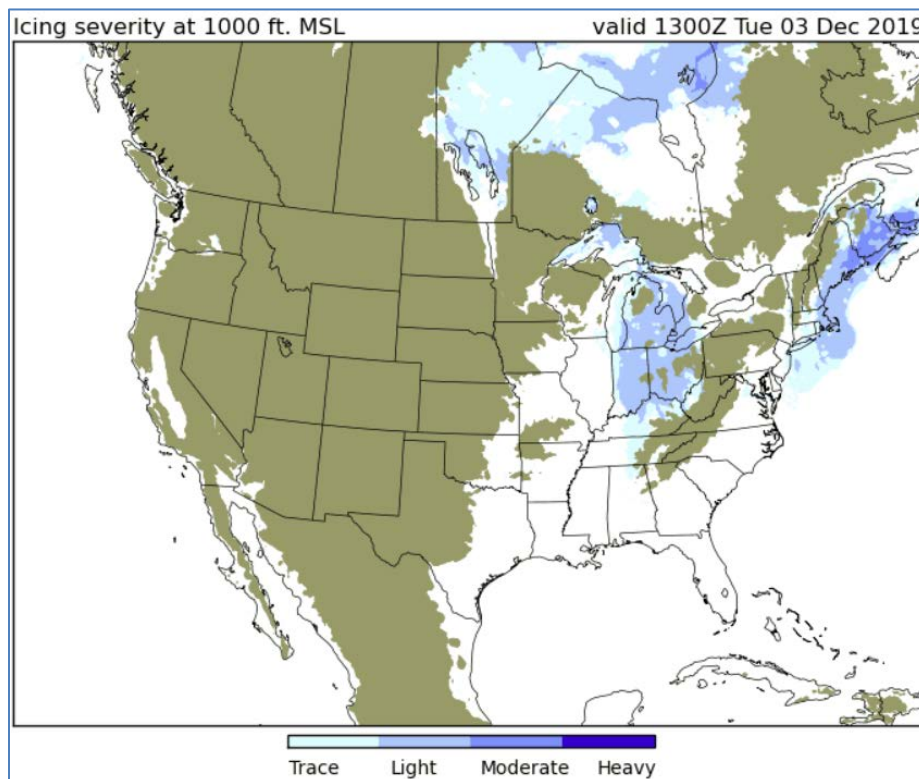


Figure 19 - CIP Icing Severity for 1,000 ft at 0800 EST

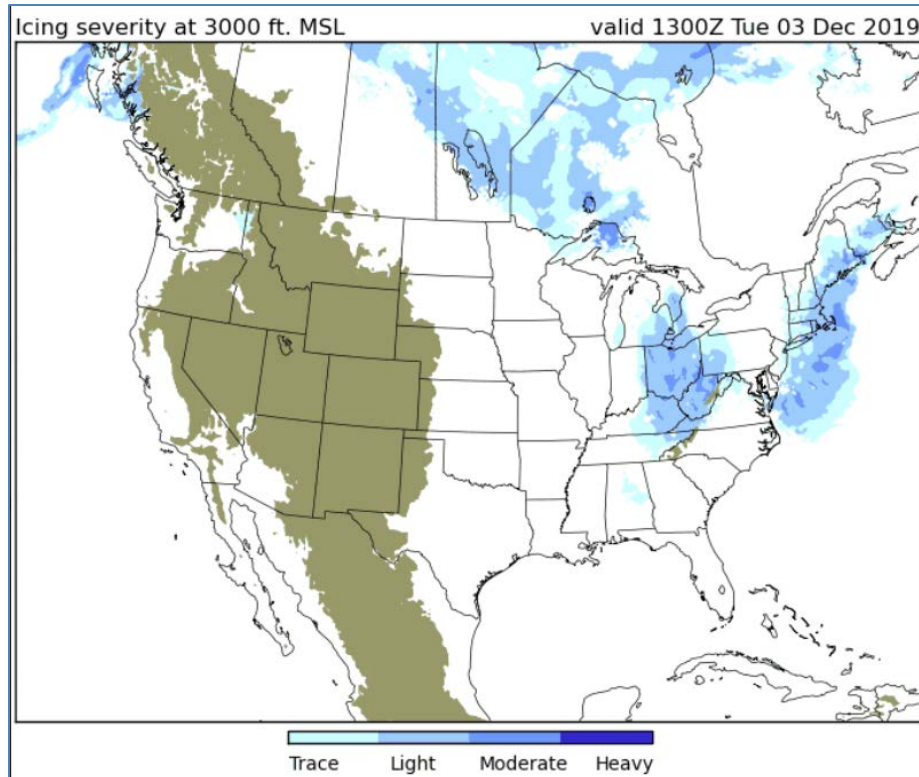


Figure 20 - CIP Icing Severity for 3,000 ft at 0800 EST

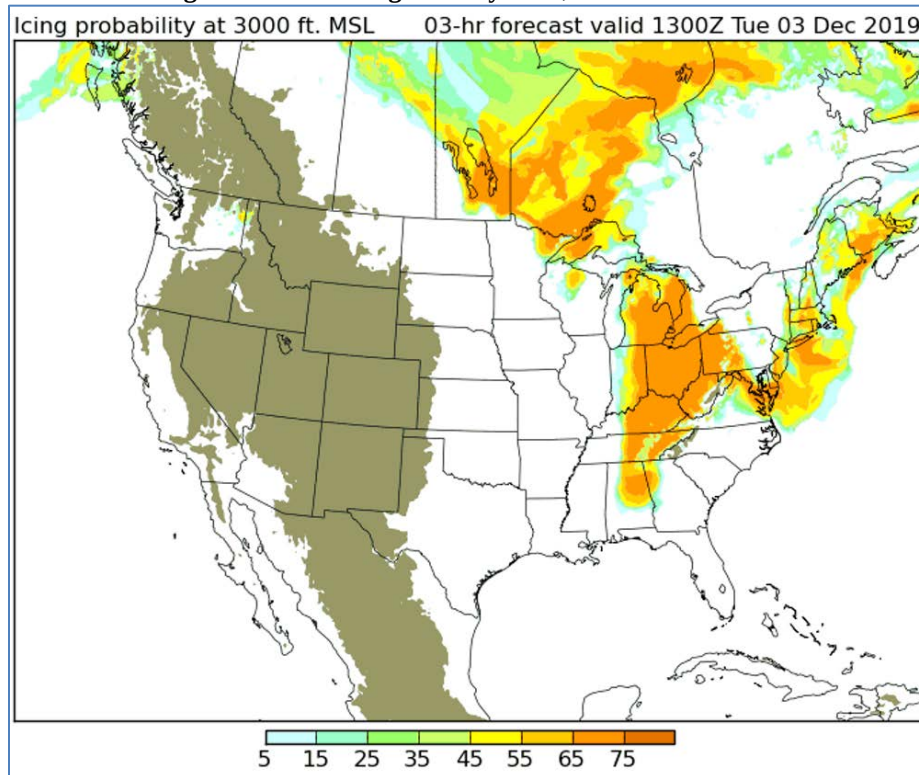


Figure 21 - 3-hour FIP Icing Probability for 3000 ft valid for 0800 EST

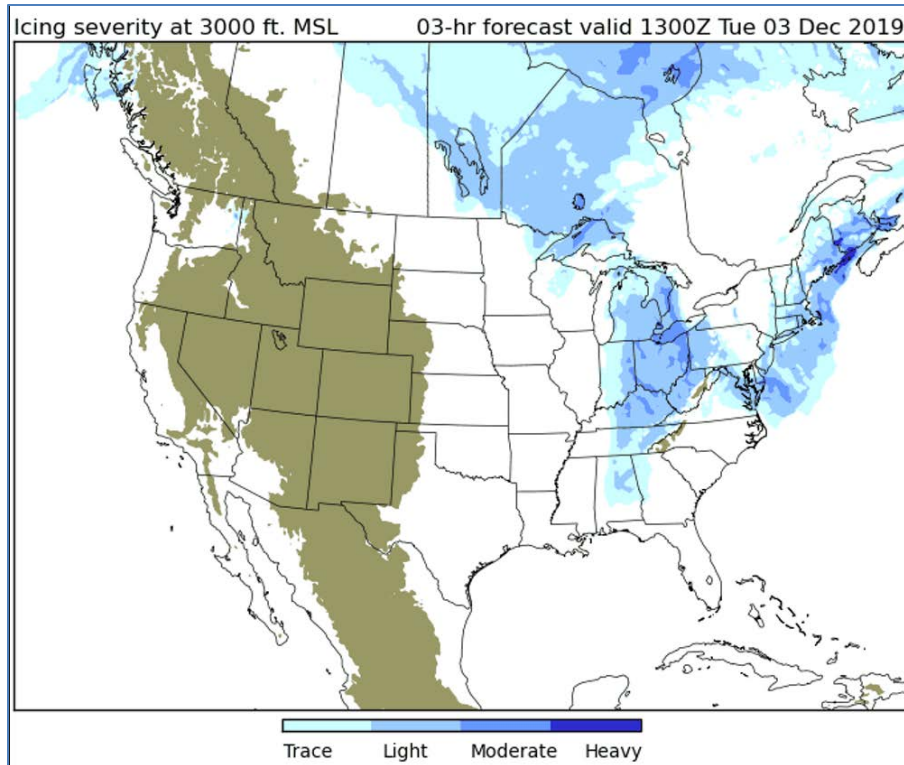


Figure 22 - 3-hour FIP Icing Severity for 3000 ft valid for 0800 EST

6.4 Winds and Temperature Aloft Forecast

The NWS NCEP Winds and Temperature Aloft Forecast¹¹ issued during the period was valid for 0700 EST and were for use between 0900 EST through 1600 EST. The winds and temperature data for Cleveland (KCLE) were as follows:

WINDS ALOFT FORECASTS

DATA BASED ON 031200Z

VALID 031800Z FOR USE 1400-2100Z. TEMPS NEG ABV 24000

FT	3000	6000	9000	12000	18000	24000	30000	34000	39000	45000	53000
CLE	2620	2723+00	2726-05	2636-09	2738-20	2642-32	264649	264657	285255	284153	282453

The forecast for 3,000 ft expected a wind from 260° at 20 knots, and for 6,000 ft from 270° at 23 knots with a temperature of 0° C.

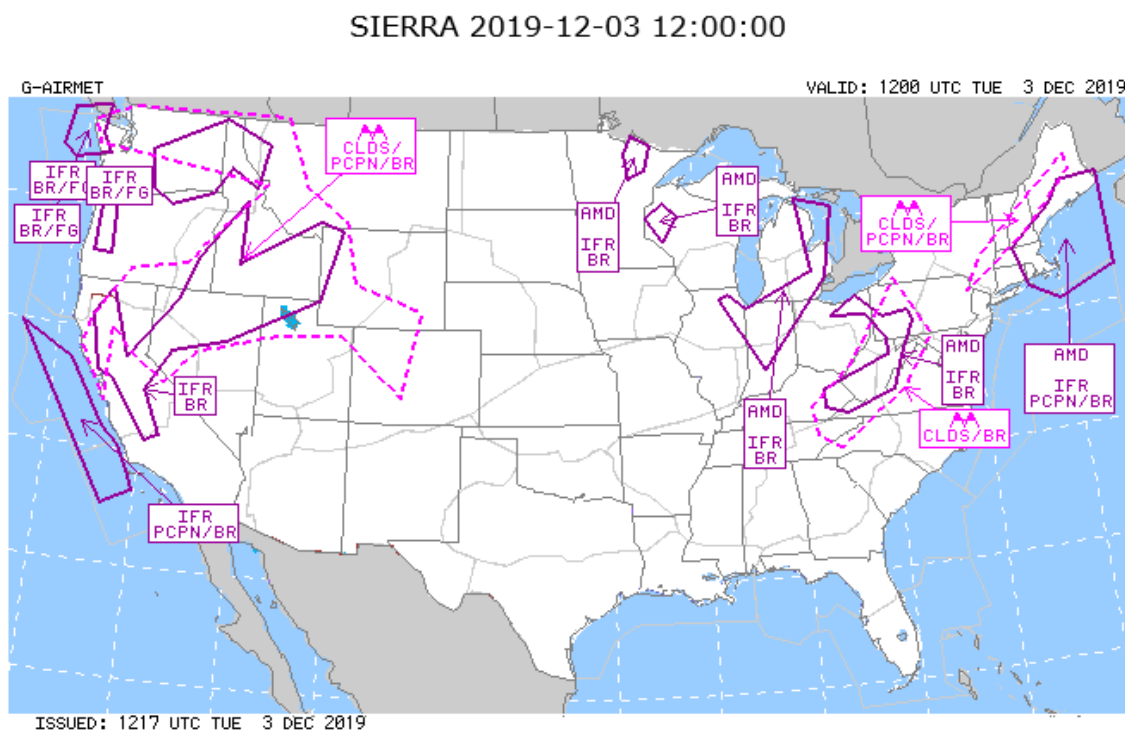
7.0 NWS Inflight Weather Advisories

Inflight Aviation Weather Advisories are forecasts to advise en route aircraft of 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 ARTCCs. There are four basic types of inflight aviation weather advisories: the Significant Meteorological Information (SIGMET), the Convective SIGMET, the AIRMET, and

¹¹ Bulletin FBUS31 KWN0 documented.

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. The following advisories were current during the period.

The NWS AWC had a full series of AIRMETs current for IFR conditions, high altitude moderate turbulence between FL240-FL410, and moderate icing from the surface to 7,000 ft. Figures 23-26 are the Graphic AIRMETs (G-AIRMETs) Sierra, Tango, and Zulu current during the period. G-AIRMET Zulu was the most relevant advisory regarding this event and warned of known and forecast moderate icing conditions over the area below 7,000 ft. No SIGMETs, Convective SIGMETs, or CWA's were issued for the Detroit area surrounding the period.



TANGO 2019-12-03 12:00:00

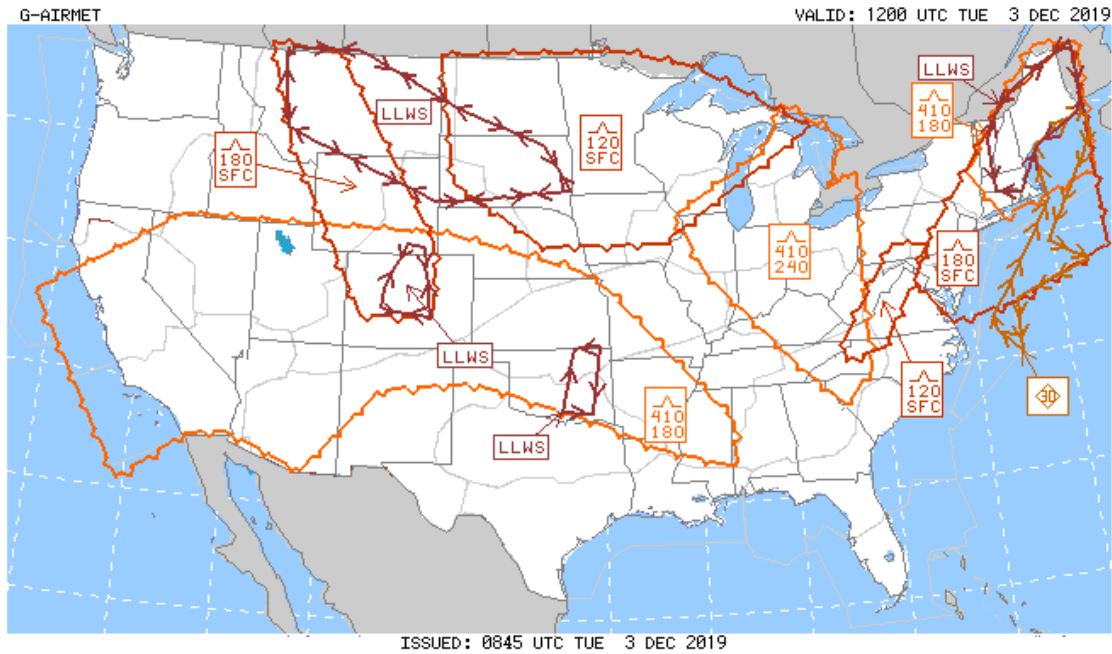


Figure 24 - G-AIRMET Tango for moderate turbulence valid at 0700 EST

ZULU 2019-12-03 12:00:00

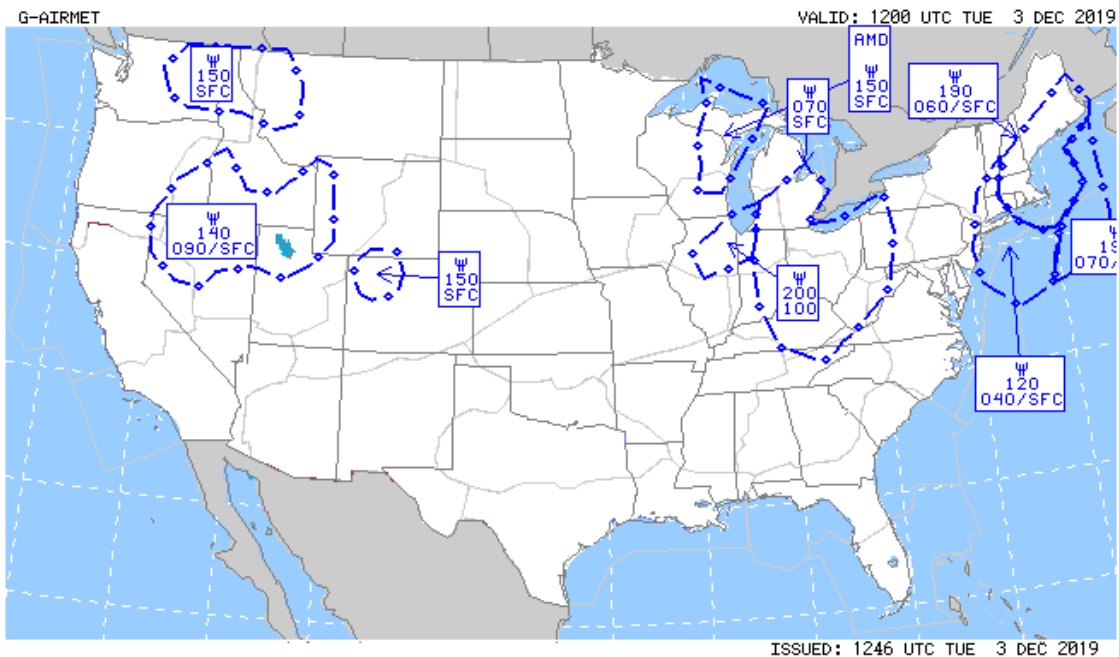


Figure 25 - G-AIRMET Zulu for moderate icing conditions from the surface to 7,000 ft valid for 0700 EST

FREEZING LEVEL 2019-12-03 12:00:00

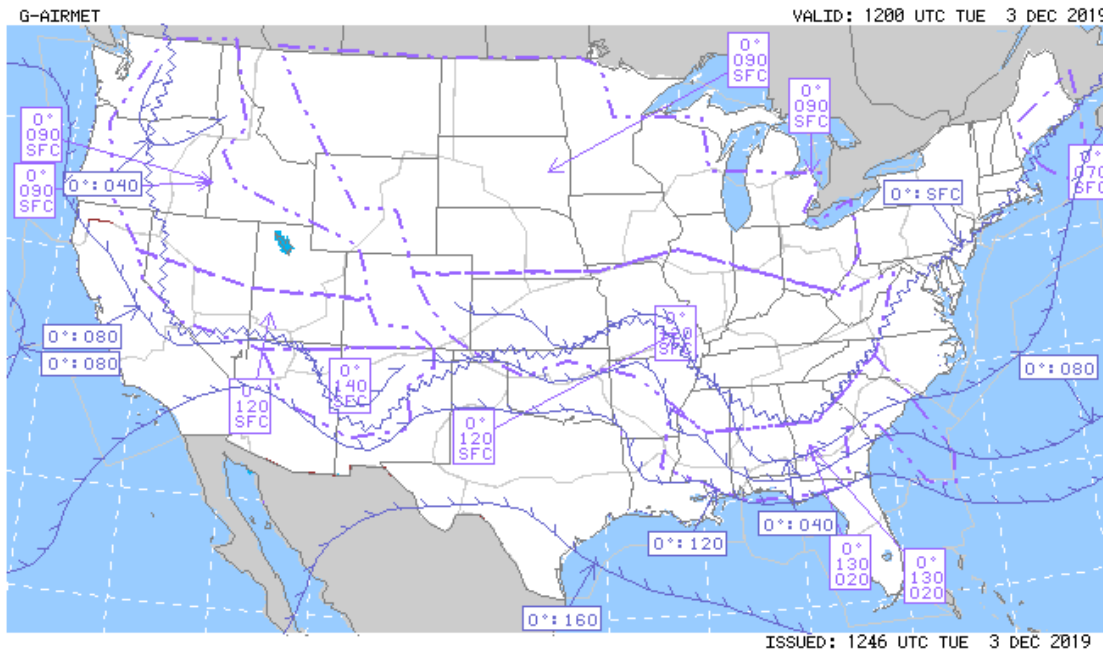


Figure 26 - G-AIRMET Zulu freezing levels at 0700 EST

8.0 Preflight Weather Briefing

A search of the FAA Automated Flight Service Station (AFSS) provider Leidos indicated that the pilot of N469RJ did not contact them for any weather briefing information on December 3, 2019; however, they did have an instrument flight plan's filed through a third party vender of Fltplan.com. A similar search of ForeFlight also indicated that the pilot did not access their system for any weather briefing information or static weather images. According to the pilot's statement they used internet sources of fltplan.com and ForeFlight to obtain weather and NOTAM information, and listened to the KYIP and KDET Automated Terminal Information Service (ATIS) radio broadcasts. The accident pilot also advised that ForeFlight is installed on his electronic flight bag (EFB) but is not available inflight until the aircraft's WIFI is available typically above 10,000 ft. The pilot did not recall seeing the AIRMET for icing over the area. But was advised of a PIREP of light to moderate rime ice reported by recently arriving aircraft prior to his departure from KYIP.

The pilot filed an IFR flight plan at 1332 CST on December 3, 2019 through fltplan.com departing KDET to KYIP, with an estimated departure time of 1530 CST, with a requested altitude of 4,000 ft and an estimated time enroute of 14 minutes, no alternate airport was designated. The flight was then filed to Samuel Field Airport (KBRY), Bardstown, Kentucky, then back to KDET, and terminating at KYIP.

9.0 Hawker Icing Encounter Prior to Accident

A pilot of another Hawker 125, N122LJ that landed at KDET at 0810 EST and witnessed the accident airplane's landing sequence and runway excursion provided a statement regarding the conditions of his approach. On their flight from Pontiac (KPTK), Michigan to KDET the pilot indicated that on their descent into KDET they entered the clouds at about 3,000 ft. Prior to entering the clouds, they had turned on their TKS¹², engine heat, and engine ignition prior to entering the clouds. While in the clouds their ice detection light illuminated, and they reported encountering light icing with a temperature of -9° C. They broke out of the clouds at 1,000 ft agl and landed visually on runway 33.

The pilot also stated that exiting their aircraft, he observed some minor ice on the wing leading edges of the wing, with the temperature probe having an umbrella shaped ice formation, and the outboard ends of the horizontal stabilizer had a typical "T" shape ice formation on about the outer 9-inches of both horizontal stabilizers.

10.0 Accident Airplane Photographs of Ice

The accident pilot noted after they evacuated the airplane, they observed visual signs of ice on the left wing near the wing tip and in the seams between the TKS panels. Photographs of the ice buildup on the left outer section of the wing and on the ground are included in figures 27-29.

¹² The TKS Ice Protection System, manufactured by CAV Ice Protection, is a fluid-based ice protection system used to help aircraft safely exit in-flight icing conditions. The system uses a glycol-based fluid to cover the critical surfaces of an aircraft and prevent the risk of any ice forming on the leading edges of the wings. The system can also break the ice that has accumulated (chemically). Developed by Tecalemit-Kilfrost-Sheepbridge Stokes (TKS), the system was primarily used during World War II by the British.



Figure 27 - Left wing tip with ice



Figure 28 - Left wing with ice on tip and between TKS seems



Figure 29 - Pieces of ice that fell from left wing between TKS seams

11.0 Astronomical Conditions

The following astronomical conditions for Detroit were calculated for December 3, 2019. The time of the accident has been added in italic bold print for reference.

<u>Sun</u>	
Begin civil twilight	0712 EST
Sunrise	0743 EST
<i>Accident</i>	<i>0833 EST</i>
Sun transition	1222 EST
Sunset	1700 EST
End civil twilight	1731 EST

At 0833 EST the Sun was at an altitude of 6.86° above the horizon and at an azimuth of 128°.

Submitted by:

Don Eick
Senior Meteorologist