NATIONAL TRANSPORTATION SAFETY BOARD

Office of Aviation Safety
Washington, D.C. 20594

May 26, 2020

Weather Study

METEOROLOGY

ANC20MA010

Table Of Contents

A. ACCIDENT

Location: Lihue, Hawaii
Date: December 26, 2019
Time: 1657 Hawaii standard time (0257 UTC[1] on December 27, 2019)
Airplane: Type - AS-350B2; Registration - N985SA

B. METEOROLOGIST

Mike Richards
Senior Meteorologist
Operational Factors Division (AS-30)
National Transportation Safety Board

C. DETAILS OF THE INVESTIGATION

The National Transportation Safety Board's meteorological specialist did not travel in support of this accident investigation and gathered weather data remotely. Unless otherwise noted, all times are in Hawaii standard time (HST) for December 26, 2019 (based upon the 24-hour clock), directions are referenced to true north, distances are in nautical miles and heights are above mean sea level (msl).

Coordinates used for the accident location: 22.135431° north latitude, 159.681672° west longitude, at an elevation of about 2,950 feet.

D. WEATHER INFORMATION

1.0 Synoptic Conditions

A section of the Ocean Prediction Center's preliminary North Pacific Surface Analysis Chart valid for 1400 HST is presented in figure 1. This chart depicted a low pressure center of 1002 hectopascals (hPa) north of the Hawaiian islands and the accident site, and a high pressure center of 1021 hPa west-northwest of the accident site. Two cold fronts are depicted extending south from the low pressure center. The easternmost cold front stretches toward the eastern end of the Hawaiian Islands, where a trough is then depicted extending over the "Big Island." The westernmost cold front extends northwest of the accident location and is depicted advancing toward the accident site. A station model along but slightly behind the cold front identified the surface wind to be from the northwest at 15 knots, while a station model located on the eastern side of Kauai presented an easterly surface wind of 10 knots.

[1] UTC – abbreviation for Coordinated Universal Time

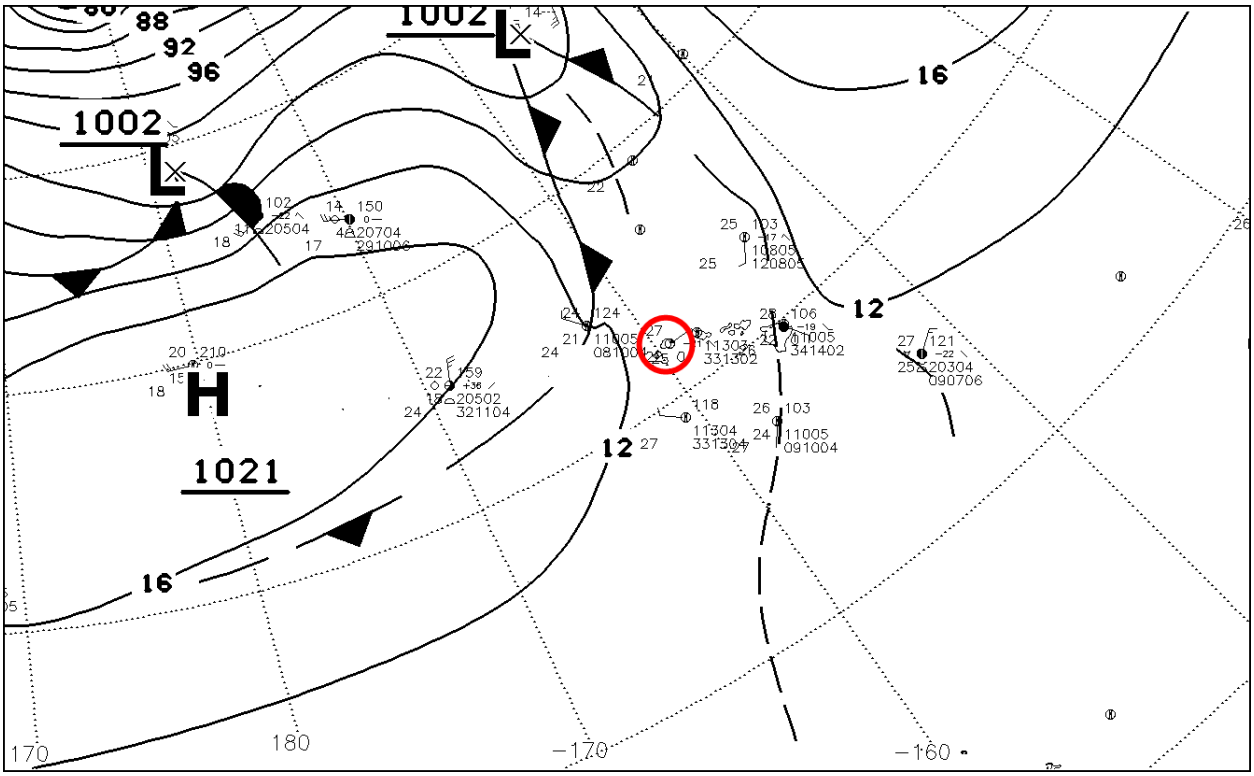

Figure 1 - A section of the Ocean Prediction Center's preliminary North Pacific Surface Analysis Chart valid for 1400 HST. The accident location is denoted by the red circle.

2.0 Weather Radar

The WSR-88D[2] Level-II base reflectivity weather radar imagery from the South Kauai, Hawaii, site (PHKI) is presented in figures 2-4. PHKI was located approximately 16 miles south-southeast of the accident location at an elevation of about 340 feet. Assuming standard refraction and considering the 0.95° beam width[3] for the WSR-88D radar beam, the PHKI 1.317°, 1.801° and 2.415° tilts would have "seen" altitudes above the accident location of between about 1,900 and 3,500 feet, between about 2,800 and 4,400 feet and between about 3,800 and 5,400 feet. Around the time of the accident, light values of reflectivity were seen over the accident location.

Figure 5 presents the PHKI lowest center beam coverage below 5,000 feet and indicates the lowest center beam coverage for the accident location was about 4,700 feet. This corresponds more closely with the 2.415° PHKI tilt than the 1.317° or 1.801° tilts, suggesting the 1.317° or 1.801° tilts did not fully "see" conditions over the accident location.

[2] Weather Surveillance Radar 88 Doppler (WSR-88D)

[3] Here we define the angular width of the radar beam as the region of transmitted energy that is bounded by one-half the maximum power. The maximum power lies along the beam centerline and decreases outward from the radar antenna.

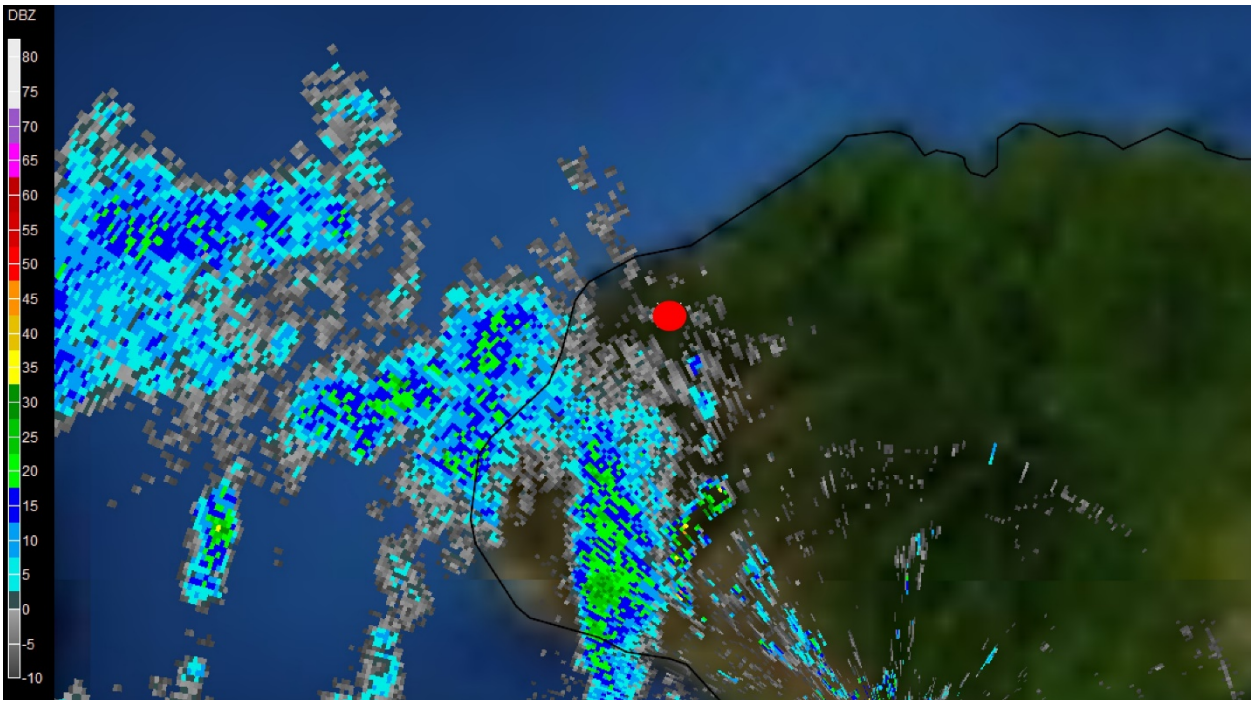

Figure 2 – PHKI 1.317° Level-II base reflectivity product from a sweep initiated at 1655:08 HST. Accident location marked by red circle.

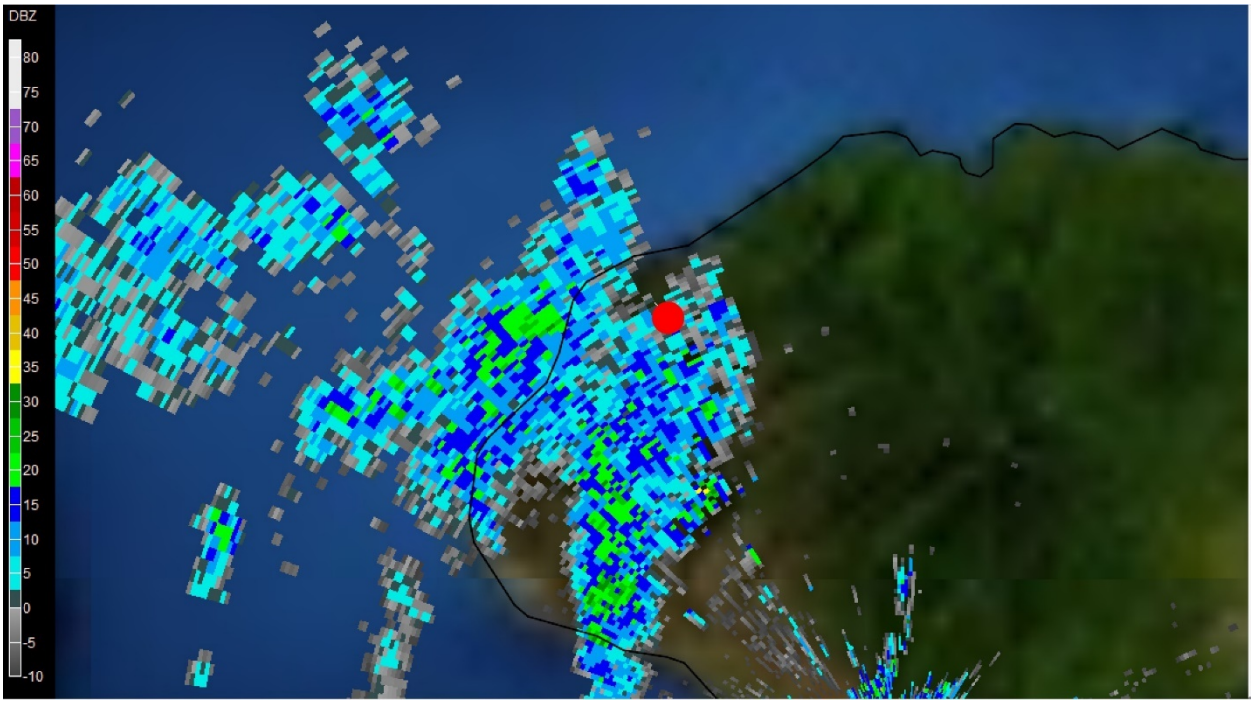

Figure 3 – PHKI 1.801° Level-II base reflectivity product from a sweep initiated at 1655:58 HST. Accident location marked by red circle.

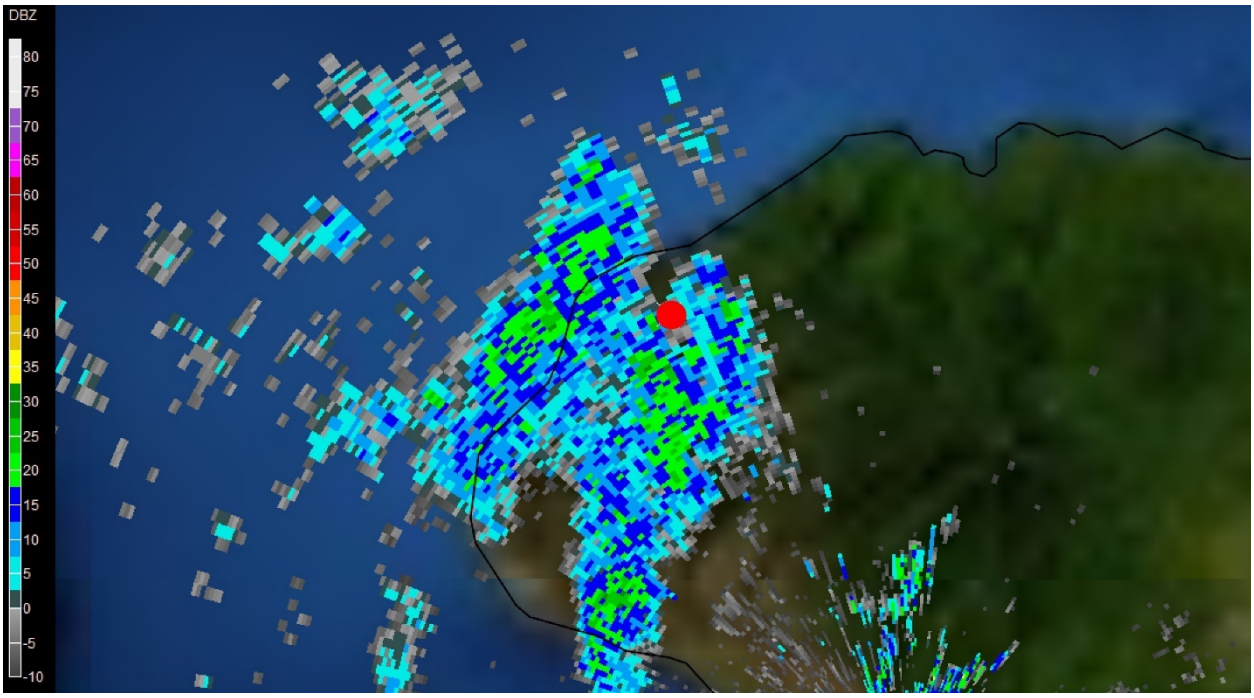

Figure 4 – PHKI 2.415° Level-II base reflectivity product from a sweep initiated at 1656:20 HST. Accident location marked by red circle.

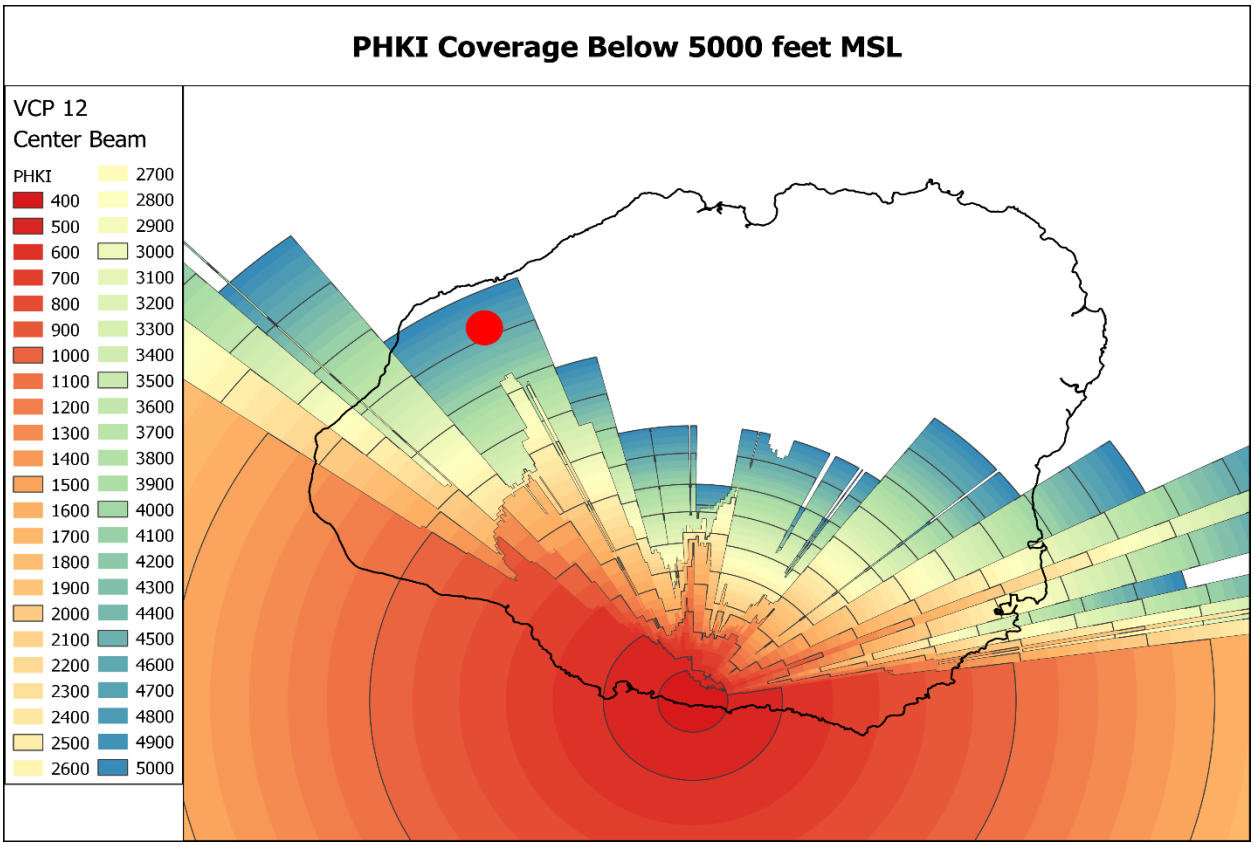

Figure 5 – PHKI center beam coverage map. Accident location marked by red circle.

3.0 Surface Observations

Unofficial meteorological reporting station MKAH1 (data courtesy of MesoWest[4]) was located about 2 miles west of the accident site at an elevation of about 1,800 feet. Type, calibration, maintenance, and siting standards of this instrument, as well as the overall quality of the data, are not known. Reporting of certain parameters[5] from MKAH1 (rounded to nearest whole numbers except for liquid precipitation accumulation) during the times surrounding the accident time are presented here (time in HST):

Time	Temp	D_Temp	RH	W_Mag	W_Dir	G_Mag	P_Acc
1311	73	67	81	4	253°	8	41.91
1411	73	68	85	3	267°	8	41.91
1511	73	68	83	2	292°	7	41.91
1611	72	66	81	1	335°	6	41.91
1711	68	67	97	2	308°	9	41.98

An automated weather reporting station of unknown type was located at Barking Sands Pacific Missile Range Facility Airport (PHBK) in Kekaha, Hawaii, which was located about 8 miles southwest of the accident location at an elevation of 18 feet. Automated reports from PHBK during the times surrounding the accident time are presented here.

[1456 HST] METAR PHBK 270056Z AUTO 32010KT 10SM SCT022 27/21 A2986 RMK AO2 SLP113 T02670211=

[1556 HST] METAR PHBK 270156Z AUTO 32008KT 10SM SCT022 26/21 A2987 RMK AO2 SLP117 T02610206=

[1606 HST] SPECI PHBK 270206Z AUTO 32010KT 10SM FEW022 SCT036 BKN044 26/21 A2987 RMK AO2 T02610206=

[1618 HST] SPECI PHBK 270218Z AUTO 33012KT 10SM SCT019 BKN024 OVC070 25/22 A2987 RMK AO2 T02500217=

[1626 HST] SPECI PHBK 270226Z AUTO 32014KT 2SM +RA SCT013 BKN022 OVC044 25/22 A2988 RMK AO2 RAB23 P0000 T02500217=

[1636 HST] SPECI PHBK 270236Z AUTO 31012KT 6SM -RA BR SCT013 BKN021 OVC033 24/22 A2989 RMK AO2 RAB23 P0000 T02390217=

[1656 HST] METAR PHBK 270256Z AUTO 31012KT 10SM FEW012 BKN034 BKN047 23/22 A2990 RMK AO2 RAB23E40 SLP126 P0000 60000 T02330217 53012=

[1718 HST] SPECI PHBK 270318Z AUTO 35010KT 2 1/2SM RA BR OVC030 23/22 A2991 RMK AO2 RAB05 P0000 T02330217 $=

[4] https://mesowest.utah.edu

[5] Temp=temperature (°Fahrenheit[F]); D_Temp=dew point temperature (°F); RH=relative humidity (%); W_Mag=average wind magnitude (miles-per-hour[mph]); W_Dir=average wind direction (true); G_Mag=gust wind magnitude (mph); P_Acc=liquid precipitation accumulation (inches)

[1723 HST] SPECI PHBK 270323Z AUTO 35009KT 1 3/4SM RA BR BKN028 OVC033 23/22 A2991 RMK AO2 RAB05 P0000 T02330222=

At 1656 HST, PHBK reported a wind from 310° at 12 knots, visibility of 10 statute miles or greater, few clouds at 1,200 feet above ground level (agl), ceiling broken at 3,400 feet agl, broken clouds at 4,700 feet agl, temperature of 23° Celsius (C) and a dew point temperature of 22°C, altimeter setting of 29.90 inches of mercury; remarks: station with a precipitation discriminator, rain began at 1623 HST and ended at 1640 HST, sea level pressure of 1012.6 hPa, trace amount of liquid equivalent precipitation since 1556 HST, trace amount of liquid equivalent precipitation since 1356 HST, temperature of 23.3°C and dew point temperature of 21.7°C, 1.2 hPa pressure increase since 1356 HST.

4.0 GDAS Sounding

A Global Data Assimilation System (GDAS) model sounding (Figure 6) for the accident location at 1700 HST was retrieved from the National Oceanic and Atmospheric Administration's Air Resources Laboratory. The wind in the lowest 5,000 foot layer was from the northwest between 12 and 15 knots. The relative humidity was 80 percent or below for the entire atmosphere below 10,000 feet. Calculations made by the Rawinsonde OBservation Program (RAOB) did not yield any significant areas of non-convective turbulence or low-level wind shear. The freezing level was at about 16,000 feet.

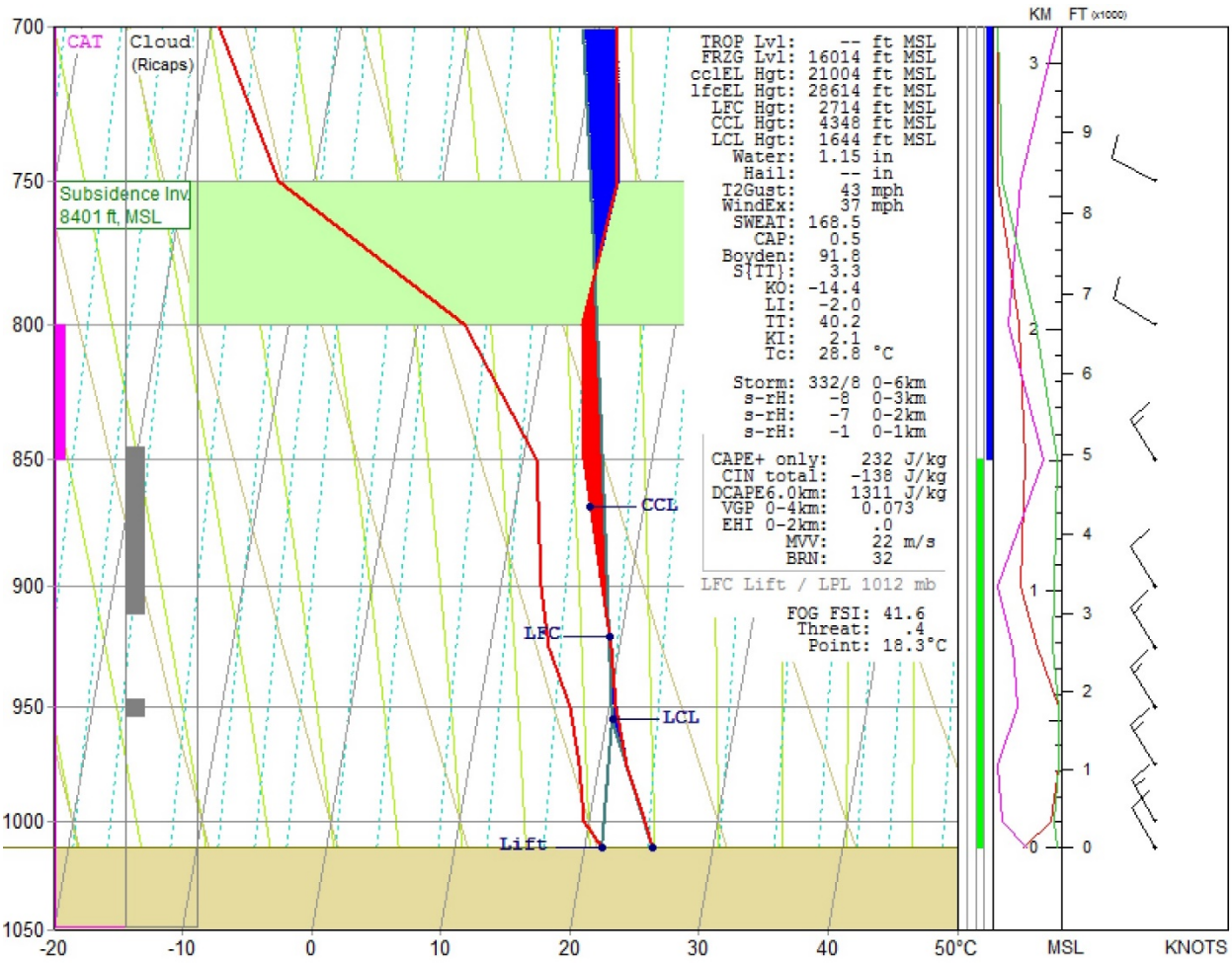

Figure 6 – GDAS model sounding data in SkewT/LogP format for 1700 HST at the accident site, surface to 700 hPa.

5.0 WRF Data

A Weather Research and Forecasting Model (WRF) simulation was run to model the weather conditions surrounding the time of the accident using initialization data from the GFS4.[6] WRF ARW (Advanced Research WRF core) version 4.1.2 was run with 3 domains with horizontal grid spacing of 8 kilometers, 1.6 kilometers, and 320 meters over the accident site. Other WRF simulation parameters included: 60 vertical levels, the multi-scale Kain-Fritsch cumulus parameterization scheme used on the outer domain, a Lin et al. microphysics scheme, a Yonsei University boundary layer scheme, Noah land surface physics, the Dudhia scheme used for short wave radiation and the RRTM scheme for the long wave radiation.

Attachment 2 contains imagery created from the simulation results. Figures 7 and 8 present imagery depicting relative humidity from 1700 HST.

[6] https://nomads.ncdc.noaa.gov/data/gfs4/

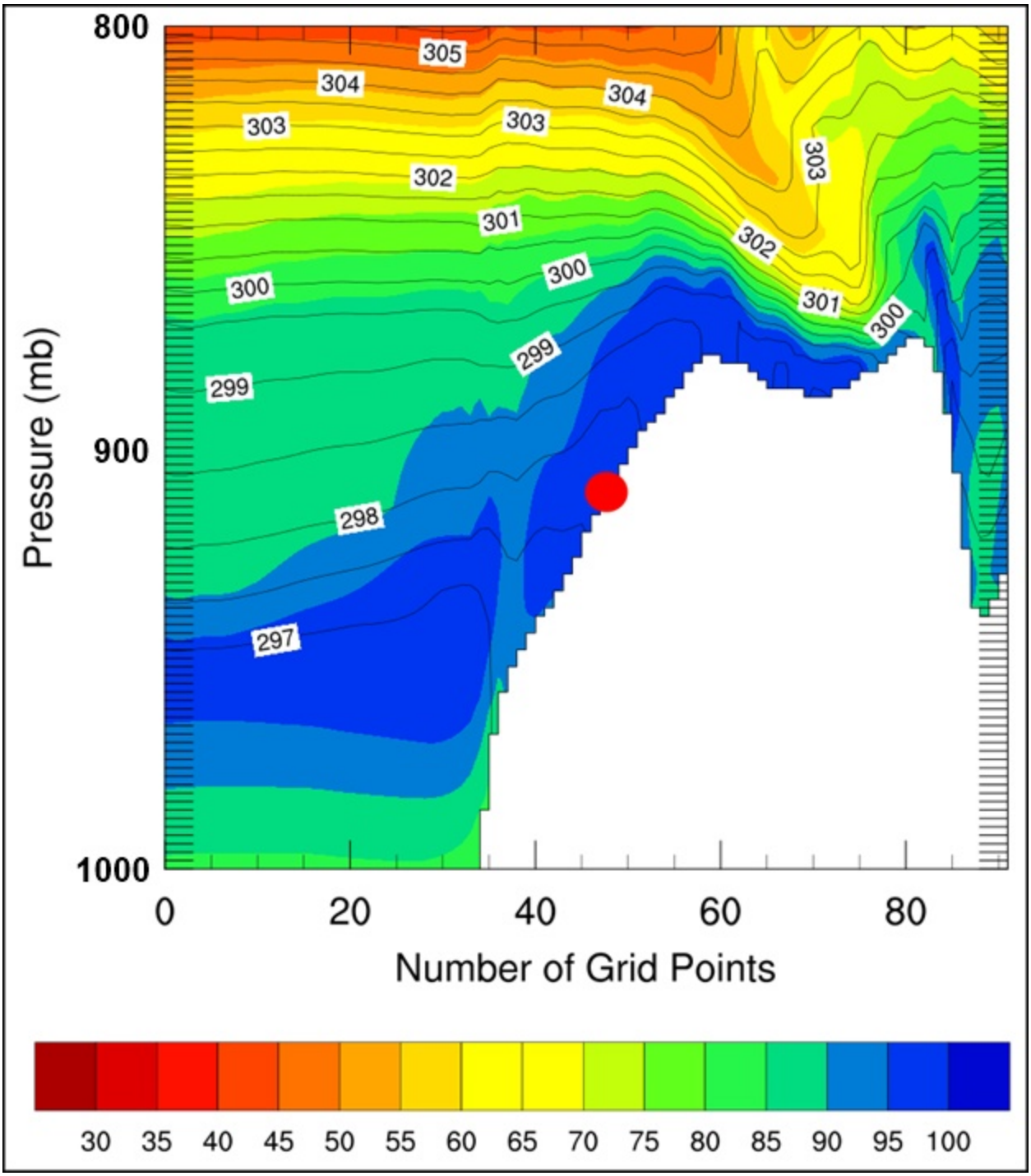

Figure 7 – WRF west-to-east (left-to-right) vertical cross-section of relative humidity (in percentage points) at 1700 HST along the 22.135431° North parallel. Accident location denoted by the red dot. West and east plot boundaries are on the 159.833° West and 159.550° West meridians, respectively.

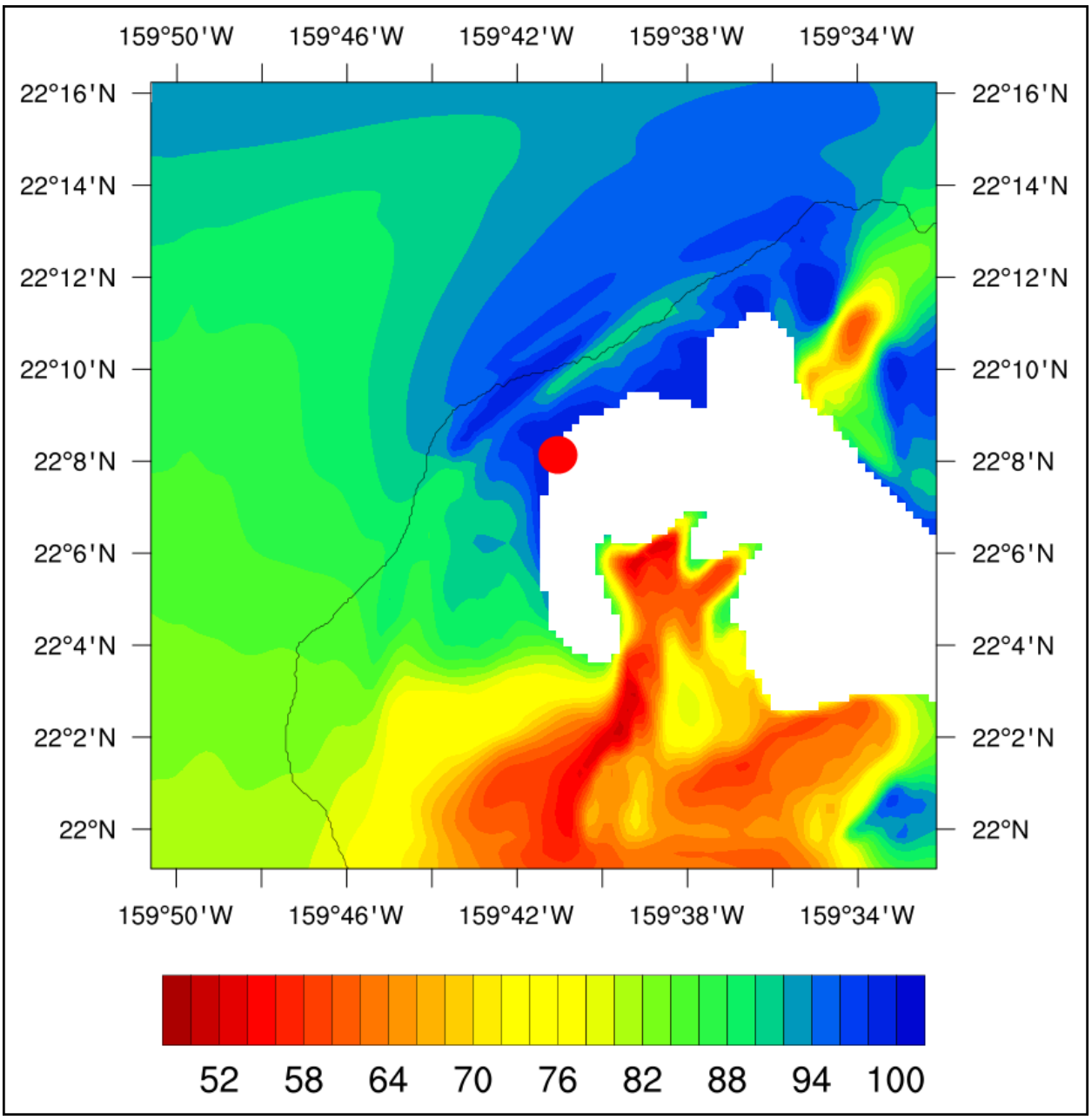

Figure 8 – WRF plan view plot of relative humidity (in percentage points) on the 910 hPa pressure surface at 1700 HST. Accident location is denoted by the red circle.

6.0 Satellite Imagery

Geostationary Operational Environmental Satellite (GOES)-17 visible (0.64µm) and infrared (10.3µm) data were obtained from an archive at the Space Science Engineering Center at the University of Wisconsin-Madison. Imagery from 1700 HST are presented in Figures 9 and 10. The GOES-17 visible imagery depicted cloudy conditions over the majority of Kauai including the accident site. Infrared cloud-top temperatures over the accident site were about 12°C, which, when considering the 1700 PST HRRR sounding, corresponded to cloud top heights of about 10,000 feet.[7]

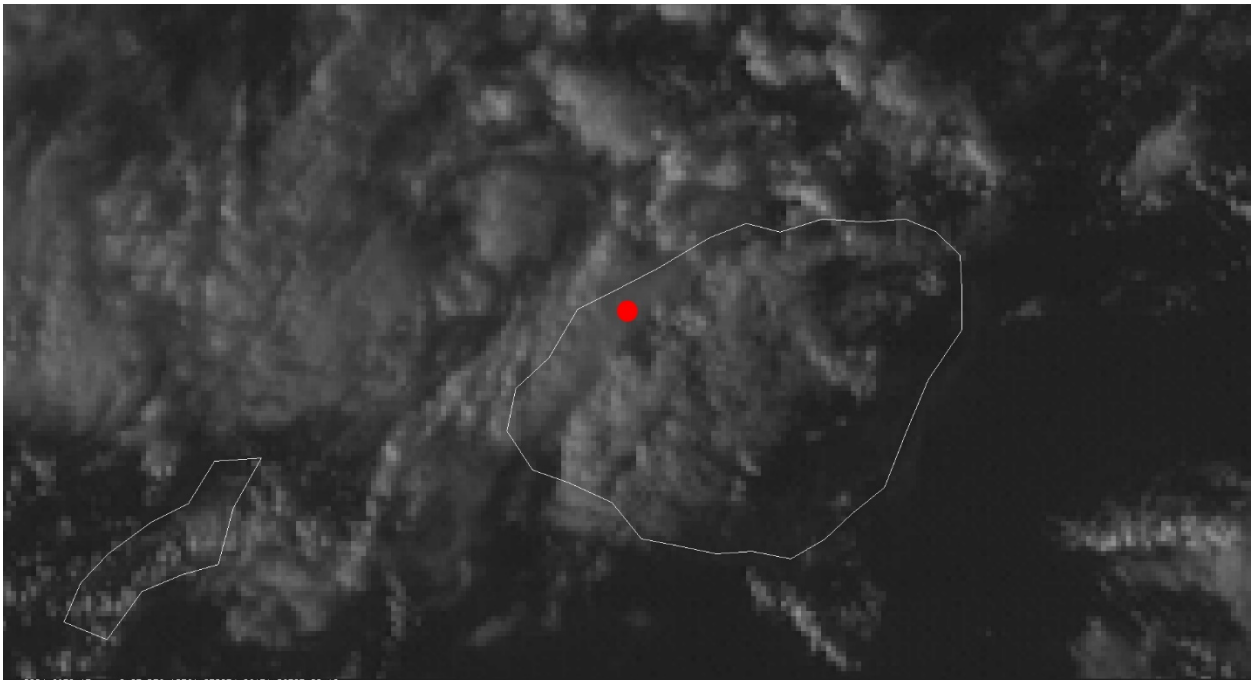

Figure 9 – GOES-17 visible imagery from 1700 HST. Accident location denoted by red dot. This image has not been corrected for any parallax error.

[7] Because the temperature profile was near-isothermal temperature profile near this level, the cloud top temperature may have corresponded to heights as low as near 7,000 feet,

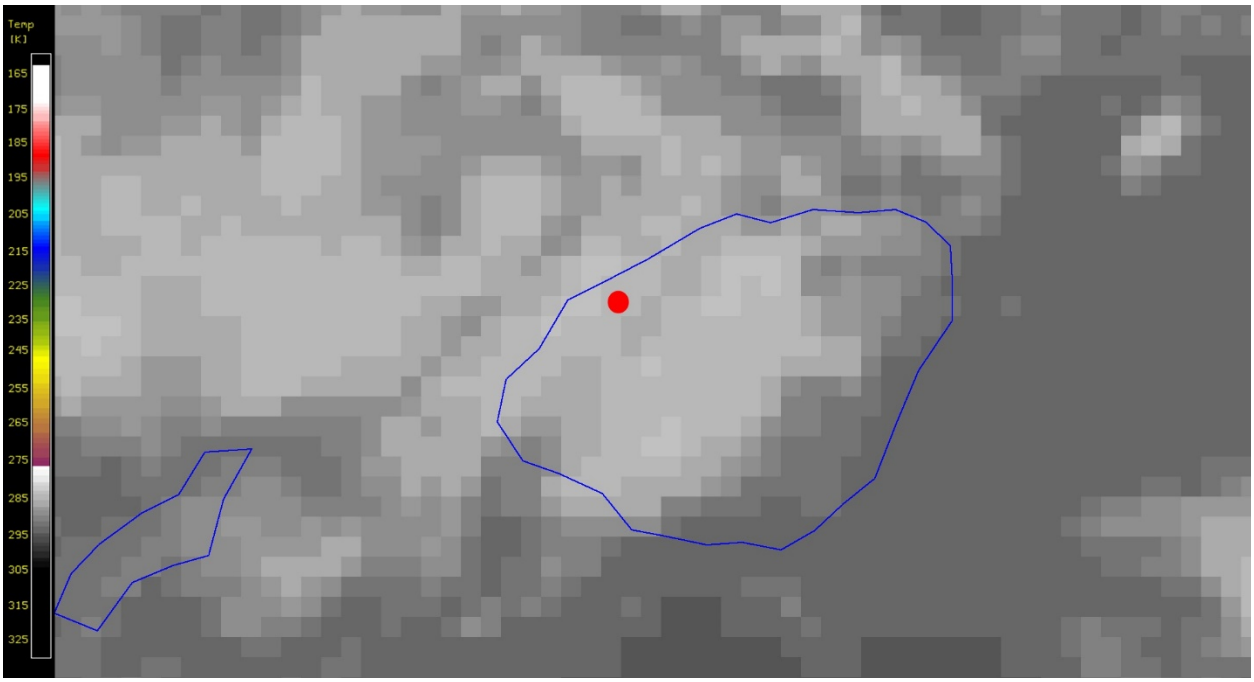

Figure 10 – GOES-17 infrared imagery from 1700 HST. Accident location denoted by red dot. This image has not been corrected for any parallax error.

7.0 Pilot Reports

There were no longline-disseminated pilot reports[8] made within 50 miles of the accident location between 1500 and 1800 HST below 10,000 feet.

8.0 Area Forecast

The Area Forecast issued by the Honolulu NWS Weather Forecast Office (WFO) at 1125 HST and current at the time of the accident is presented below. For the island of Kauai it forecasted: few to scattered clouds at 2,500 feet, scattered to broken clouds at 4,500 feet, cloud tops at 8,000 feet, isolated broken clouds at 3,000 feet and tops at 9,000 feet, visibility 5 statute miles, light rain showers and mist.

FAHW31 PHFO 262125
FA0HI

HNLC FA 262135
SYNOPSIS AND VFR CLD/WX
SYNOPSIS VALID UNTIL 271600
CLD/WX VALID UNTIL 271000...OUTLOOK VALID 271000-271600

[8] "Longline" refers to the dissemination of a product with the intent that it is available in near-real time to national databases (effectively, the whole world) and accessible to the general global public from a large number of vendors. These do not include pilot reports only broadcast via radio.

.
SEE AIRMET SIERRA FOR IFR CLD AND MT OBSC.
TS IMPLY SEV OR GREATER TURB SEV ICE LOW LEVEL WS AND IFR COND.
NON MSL HGT INDICATED BY AGL OR CEILING.
.
SYNOPSIS...CLD AND SHRA REMAIN OVER THE BIG ISLAND.
SCT TO ISOL SHRA REST OF AREA. WINDS TO BECOME NORTH OVERNIGHT BEFORE TRADES RETURN FRIDAY.
.
WATERS WITHIN 40 NM NE OF THE BIG ISLAND OF HAWAII
SFC WINDS S 20 TO 25 KT.
.
AREA S OF THE BIG ISLAND.
SCT-BKN150 TOPS FL350. LOWER CLD AND WX FOLLOW.
.
BIG ISLAND INTERIOR ABV 070.
BKN-OVC090 TOPS 140 TEMPO 5SM DZ. 06Z SCT-FEW090. OUTLOOK...VFR.
.
BIG ISLAND COAST AND LOWER SLOPES FROM UPOLU POINT TO CAPE KUMUKAHI AND WATERS WITHIN 40 NM.
SCT025 BKN-OVC050 TOPS 080 ISOL BKN025 TOPS 090 VIS 5SM SHRA BR.
OUTLOOK...VFR.
.
BIG ISLAND COAST AND LOWER SLOPES FROM CAPE KUMUKAHI TO SOUTH CAPE AND WATERS WITHIN 40 NM.
SCT025 BKN-OVC035 TOPS 100 TEMPO BKN025 VIS 3-5SM SHRA ISOL VIS BLW 3SM +SHRA BR. 04Z SCT-FEW025 SCT-BKN045 ISOL BKN025 VIS 5SM -SHRA.
OUTLOOK...VFR.
.
BIG ISLAND COAST AND LOWER SLOPES FROM SOUTH CAPE TO PHKO TO UPOLU POINT AND WATERS WITHIN 40 NM.
SCT025 BKN-SCT050 TOPS 080 ISOL BKN025 TOPS 090 VIS 5SM SHRA BR. 04Z SCT-FEW030 SCT-BKN050 ISOL BKN030 -SHRA. OUTLOOK...VFR.
.
MOLOKAI AND LANAI.
SCT-BKN015 TOPS 060...OVER THE INTERIOR TEMPO 3SM DZ.
OUTLOOK...VFR.
.
MAUI OAHU AND KAUAI AND ADJ WATERS.
FEW-SCT025 SCT-BKN045 TOPS 080 ISOL BKN030 TOPS 090 VIS 5SM -SHRA BR.
OUTLOOK...VFR.
.
REST OF AREA.
SCT025 BKN-SCT050 TOPS 080 ISOL BKN025 TOPS 090 VIS 5SM SHRA BR.
OUTLOOK...VFR.

9.0 Area Forecast Discussion

The "Aviation" section of the Area Forecast Discussion issued by the Honolulu NWS WFO at 1600 HST and current at the time of the accident is presented below.

FXHW60 PHFO 270200
AFDHFO

Area Forecast Discussion
National Weather Service Honolulu HI
400 PM HST Thu Dec 26 2019

.AVIATION...
Showers remain persistent in the Kau district of the Big Island this afternoon as a weakening front stalls near the state. AIRMET Sierra remains in effect from Cape Kumukahi to South Point. Behind the front, scattered showers are pushing eastward down the island chain. The movement of these showers has taken on a more easterly trajectory from this morning's northerly direction as winds begin to shift around behind the front. There is a somewhat organized line impacting Molokai as of 3 pm moving to the east at about 10 kt. This has brought tempo MVFR conditions to PHMK, so expect brief periods of MVFR with these heavier showers.

Light winds are continuing to switch around from the south to the west and will eventually become more northerly by tonight across the island chain. High pressure will continue to build to the northwest of the state, which will bring the return of the trades by Friday.

10.0 AIRMETs

There were no Airmen's Meteorological Information (AIRMET) advisories active for Kauai at the accident time.

11.0 SIGMETs

There were no Significant Meteorological Information (SIGMET) advisories active for Kauai at the accident time.

E. LIST OF ATTACHMENTS

Attachment 1 - Interview with Honolulu National Weather Service employees

Attachment 2 - WRF simulation imagery

Submitted by:

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Mike Richards
Senior Meteorologist

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