NATIONAL TRANSPORTATION SAFETY BOARD

Office of Aviation Safety
Washington, D.C. 20594

May 1, 2013

Group Chairman's Factual Report

METEOROLOGY

WPR12MA034

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A. ACCIDENT

Location: Pukoo, Hawaii
Date: November 10, 2011
Time: About 1214 Hawaiian standard time (2214 UTC[1])
Aircraft: EUROCOPTER EC 130 B4, registration: N11QV

B. METEOROLOGY GROUP

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C. SUMMARY

On November 10, 2011, about 1214 Hawaiian standard time, a Eurocopter EC 130 B4, N11QV, collided with mountainous terrain near Pukoo (Island of Molokai) Hawaii. The commercial pilot and four passengers were fatally injured. The helicopter was registered to Nevada Helicopters Leasing, Henderson, Nevada, and operated by Blue Hawaiian Helicopters, Maui, Hawaii. The flight was operated under the provisions of 14 Code of Federal Regulations Part 135. Visual meteorological conditions prevailed and a company flight plan was filed for the local air tour flight. The flight originated from the Kahului Airport (PHOG), Kahului, Hawaii, about 1144.

D. DETAILS OF THE INVESTIGATION

The National Transportation Safety Board's (NTSB) meteorological specialist was dispatched to this accident and gathered weather data for this investigation from Maui, Moloka'i, and O'ahu, Hawaii, and the NTSB's Washington D.C. office. All times are reported in Hawaiian standard time (HST) for November 10, 2011, except where noted, and are based upon the 24-hour clock. Local time is -10 hours from UTC, and UTC=Z. Directions are referenced to true north (except where noted) and distances are in nautical miles. Heights are above mean sea level (msl) unless otherwise noted. Visibility is in statute miles (sm) and fractions of sm. Distances along surface of the earth are calculated using the "Great Circle" formula.

Coordinates used for the accident location: 21.0675° North latitude, 156.843° West longitude.

[1] UTC – abbreviation for Coordinated Universal Time

E. FACTUAL INFORMATION

1. Synoptic Conditions

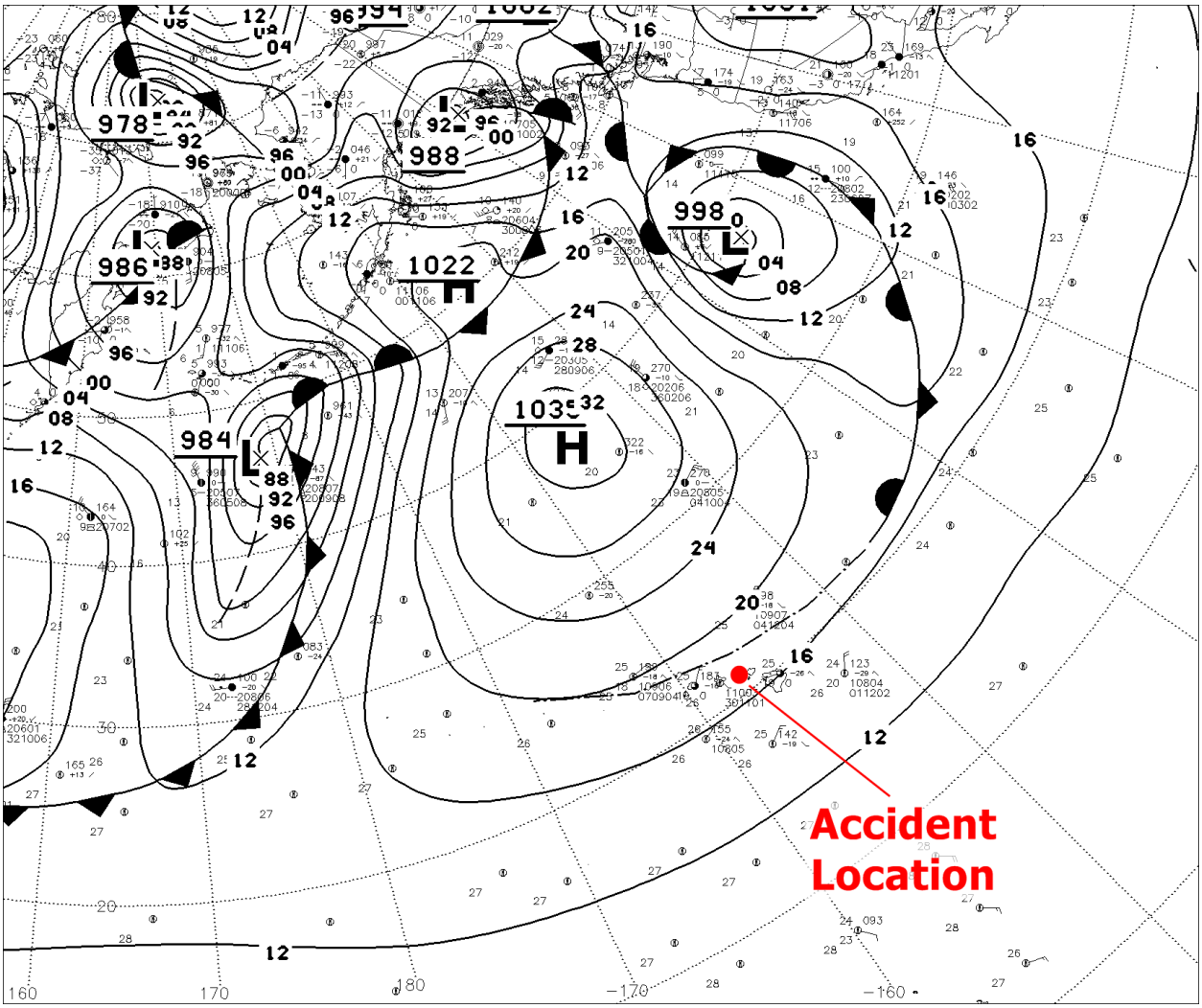

Figure 1 – NCEP/OPC preliminary surface analysis valid 1400 HST.

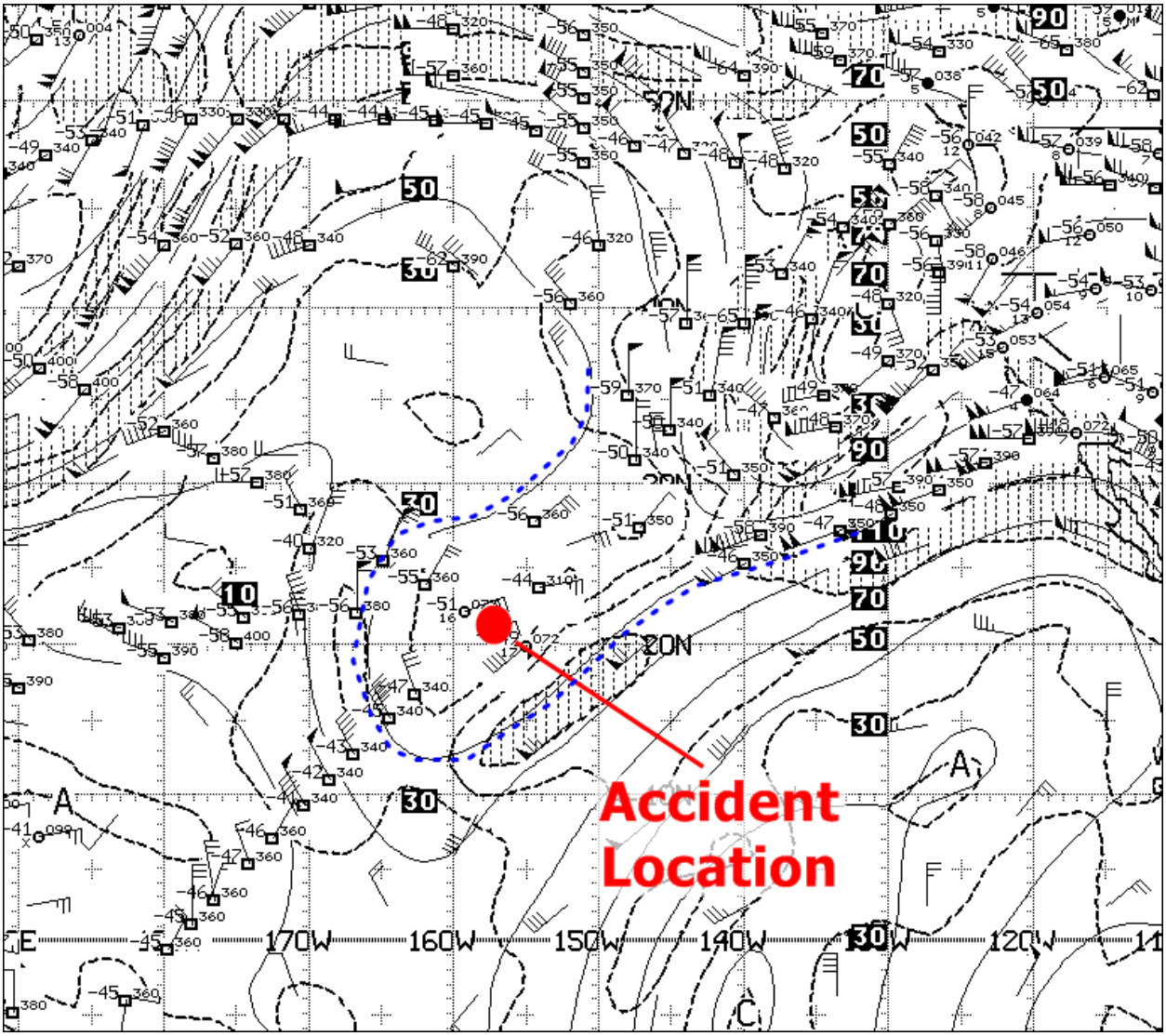

Figure 2 – NCEP 250 hPa analysis valid 1400 HST. The dashed blue line highlights the upper level trough.

The National Center for Environmental Prediction (NCEP)/Ocean Prediction Center's (OPC) preliminary surface analysis for 1400 HST is included as figure 1. The chart depicted a high pressure center about 1,000 miles due north of the Hawaiian Islands with a central pressure of 1035 hectopascals (hPa). A trough is depicted stretching west-to-east immediately north of the Hawaiian Islands. An NCEP 250 hPa analysis depicting geopotential height and wind valid at 1400 HST (figure 2) identified an upper level trough extending southwest over the Hawaiian region.

2. Aviation Routine Weather Reports

Surface observations from the accident region, which included meteorological aerodrome reports (METARs) and special reports (SPECI), as well as information obtained from weather observing systems maintained by government agencies other than the National Weather Service (NWS) or Federal Aviation Administration, were documented for the period surrounding the accident time. Locations of these stations are presented in figures 3 and 4. Cloud heights in this section are reported above ground level (agl).

2.1 Kapalua Airport Observations

Kapalua Airport (PHJH) in Lahaina, Hawaii, was located about 11 miles to the southeast-east of the accident site at an elevation of 256 feet, and was equipped with an Automated Weather Observing System (AWOS). According to the supervisor at the JHM UNICOM facility located at PHJH, hourly weather observations were made by certified weather observers during open hours (0600-1800 HST), who utilized the AWOS as well as other local standalone sensors and their own human observations of local conditions to create the reports. Reports are then relayed to Lockheed Martin Flight Service Station personnel for dissemination. Presented here are some of the publically disseminated surface observations from PHJH from November 10, 2011.

[0602 HST] PHJH 101602Z 04015KT 15SM -SHRA SCT020 SCT040 22/18 A3006=

[0650 HST] PHJH 101650Z 05015KT 15SM -SHRA SCT020 SCT040 22/19 A3008=

[0750 HST] PHJH 101750Z 04015KT 15SM VCSH FEW020 SCT040 22/18 A3009 RMK VCSH E=

[0850 HST] PHJH 101850Z 05012G20KT 15SM VCSH FEW020 SCT040 22/19 A3011 RMK VCSH NW=

[0950 HST] PHJH 101950Z 04010G22KT 15SM VCSH SCT025 SCT040 23/19 A3011 RMK VCSH N AND E=

[1050 HST] PHJH 102050Z 06012G20KT 15SM VCSH SCT025 SCT040 24/19 A3009 RMK VCSH N-E=

[1150 HST] PHJH 102150Z 07012G20KT 7SM -SHRA SCT025 BKN040 23/19 A3000 RMK VIS LWR N=

[1250 HST] PHJH 102250Z 05017G23KT 12SM VCSH FEW012 SCT025 BKN040 23/19 A3004 RMK VCSH N SE W=

[1350 HST] PHJH 102350Z 07012G22KT 12SM VCSH FEW012 SCT025 BKN040 23/20 A3003 RMK VCSH ALQDS=

At 1150 HST, PHJH reported wind from 070° at 12 knots gusting to 20 knots, visibility of 7 miles, light rain showers, scattered clouds at 2,500 feet, ceiling broken at 4,000 feet, temperature 23° Celcius(C), dew point temperature 19°C, altimeter setting 30.00 inches of Mercury. Remarks: visibility lower to the north.

At 1250 HST, PHJH reported wind from 050° at 17 knots gusting to 23 knots, visibility of 12 miles, showers in the vicinity[2], few clouds at 1,200 feet, scattered clouds at 2,500 feet, ceiling broken at 4,000 feet, temperature 23°C, dew point temperature 19°C, altimeter setting 30.04 inches of Mercury. Remarks: showers in the vicinity to the north, southeast and west.

2.2 Kahului Airport Observations

Kahului Airport (PHOG) in Kahului, Hawaii, was located about 25 miles to the east-southeast of the accident site at an elevation of 54 feet, and was equipped with an Automated Surface Observing System (ASOS). These reports were issued while a weather observer was logged into the reporting system. The "$" symbol at the end of each report indicated that maintenance was needed on the system. Presented here are some of the publically disseminated surface observations from PHOG from November 10, 2011.

[0854 HST] METAR PHOG 101854Z COR 07012KT 10SM -RA SCT020 SCT050 23/20 A3012 RMK AO2 RAB49 SLP204 T02300200 PNO $

[0954 HST] METAR PHOG 101954Z 05015G21KT 10SM -RA SCT020 SCT045 24/21 A3012 RMK AO2 RAE16B51 SLP203 T02400210 PNO $

[1054 HST] METAR PHOG 102054Z 04018G25KT 10SM RA SCT020 SCT045 23/22 A3010 RMK AO2 RAE1956B54 SLP196 6//// T02300220 58001 PNO $

[2154 HST] METAR PHOG 102154Z 07015G20KT 10SM FEW020 SCT045 25/20 A3007 RMK AO2 PK WND 06029/2102 RAE07 SLP187 T02500200 PNO $

[2254 HST] METAR PHOG 102254Z 07018G27KT 10SM FEW035 SCT050 26/20 A3004 RMK AO2 PK WND 05027/2252 SLP177 T02600200 PNO $

[1354 HST] METAR PHOG 102354Z 06017G22KT 10SM FEW035 SCT050 26/20 A3002 RMK AO2 PK WND 06026/2256 RAB22E42 SLP170 6//// T02600200 10261 20228 56026 PNO $

At 1154 HST, PHOG reported wind from 070° at 15 knots gusting to 20 knots, visibility of 10 miles, few clouds at 2,000 feet, scattered clouds at 4,500 feet, temperature 25°C, dew point temperature 20°C, altimeter setting 30.07 inches of Mercury. Remarks: automated station with a precipitation discriminator, peak wind from 060° at 29 knots at 1102 HST, rain ended at 1107 HST, sea-level pressure of 1018.7 hPa, hourly temperature 25.0°C and hourly dew point temperature of 20.0°C, precipitation amount not available, maintenance needed on the system.

At 1254 HST, PHOG reported wind from 070° at 18 knots gusting to 27 knots, visibility of 10 miles, few clouds at 3,500 feet, scattered clouds at 5,000 feet, temperature 26°C, dew point temperature 20°C, altimeter setting 30.04 inches of Mercury. Remarks: automated station with a precipitation discriminator, peak wind from 050° at 27 knots at 1252 HST, sea-level pressure of

[2] Phenomena located between 5 and 10 statute miles from the reporting point are coded as being "in the vicinity."

1017.7 hPa, hourly temperature 26.0°C and hourly dew point temperature of 20.0°C, precipitation amount not available, maintenance needed on the system.

One-minute resolution wind data was retrieved from the PHOG ASOS and data from 1200-1220 HST is presented here in raw format. The string of four numerals underlined in each report represents the time of the report in HST. Peak wind gust values (maximum of the 5-second averaged winds) in knots are indicated by the final number in each report and are bolded here. Wind directions are referenced to magnetic north.

The ASOS report from 1214 HST (italicized below) should be translated as follows: *[22516PHOG OGG201111101214*2214*]* on November 10, 2011, at 1214 HST (2211 UTC) PHOG reported *[M]* visible extinction coefficient missing from first sensor, *[M]* visible extinction coefficient missing from second sensor, *[64]* direction of 2-minute average wind is from 064°, *[15]* speed of 2-minute average wind is 15 knots, *[66]* direction of maximum of the 5-second average wind is from 066°, *[18]* speed of maximum of the 5-second average wind is 18 knots.

22516PHOG OGG201111012002200	M	M	65	15	71	**24**
22516PHOG OGG201111012012201	M	M	61	16	57	**19**
22516PHOG OGG201111012022202	M	M	59	15	56	**19**
22516PHOG OGG201111012032203	M	M	61	16	52	**23**
22516PHOG OGG201111012042204	M	M	61	16	41	**20**
22516PHOG OGG201111012052205	M	M	58	15	42	**21**
22516PHOG OGG201111012062206	M	M	57	16	66	**20**
22516PHOG OGG201111012072207	M	M	56	16	45	**20**
22516PHOG OGG201111012082208	M	M	58	16	70	**25**
22516PHOG OGG201111012092209	M	M	58	15	46	**18**
22516PHOG OGG201111012102210	M	M	48	15	41	**21**
22516PHOG OGG201111012112211	M	M	46	18	54	**21**
22516PHOG OGG201111012122212	M	M	53	16	47	**18**
22516PHOG OGG201111012132213	M	M	63	17	63	**22**
22516PHOG OGG201111012142214	*M*	*M*	*64*	*15*	*66*	***18***
22516PHOG OGG201111012152215	M	M	57	14	49	**18**
22516PHOG OGG201111012162216	M	M	51	14	46	**16**
22516PHOG OGG201111012172217	M	M	55	15	57	**20**
22516PHOG OGG201111012182218	M	M	59	16	60	**18**
22516PHOG OGG201111012192219	M	M	58	16	52	**22**
22516PHOG OGG201111012202220	M	M	58	17	68	**20**

2.3 Molokai Airport Observations

Molokai Airport (PHMK) in Kaunakakai, Hawaii, was located about 15 miles to the west-northwest of the accident site at an elevation of 454 feet, and was equipped with an ASOS. These reports were issued while a weather observer was logged into the reporting system. Presented here are some of the publically disseminated surface observations from PHMK from November 10, 2011.

[0954 HST] METAR PHMK 101954Z 04014G23KT 360V060 10SM SCT020 SCT037 24/18 A3012 RMK AO2 SLP200 T02440183

[1021 HST] METAR PHMK 102021Z 05016G24KT 5SM HZ FEW019 BKN026 BKN032 24/19 A3011 RMK AO2 PK WND 05027/2002

[1042 HST] METAR PHMK 102042Z 04017G29KT 10SM SCT022 24/19 A3010 RMK AO2 PK WND 05029/2037 P0002

[1054 HST] METAR PHMK 102054Z 05017G29KT 10SM SCT022 24/19 A3010 RMK AO2 PK WND 06029/2050 SLP194 P0002 60002 T02440189 50003

[1154 HST] METAR PHMK 102154Z 04017G27KT 8SM SCT026 SCT031 BKN045 24/19 A3008 RMK AO2 PK WND 05029/2118 SLP187 T02390189

[1232 HST] METAR PHMK 102232Z 03012G24KT 4SM HZ SCT024 BKN029 BKN050 23/20 A3007 RMK AO2 PK WND 05028/2213 P0001

[1254 HST] METAR PHMK 102254Z 05011G21KT 10SM FEW014 BKN023 OVC048 24/21 A3006 RMK AO2 PK WND 05028/2213 SLP182 P0002 T02390211

At 1154 HST, PHMK reported wind from 040° at 17 knots gusting to 27 knots, visibility of 8 miles, scattered clouds at 2,600 feet, scattered clouds at 3,100 feet, ceiling broken at 4,500 feet, temperature 24°C, dew point temperature 19°C, altimeter setting 30.08 inches of Mercury. Remarks: automated station with a precipitation discriminator, peak wind from 050° at 29 knots at 1118 HST, sea-level pressure of 1018.7 hPa, hourly temperature 23.9°C and hourly dew point temperature of 18.9°C.

At 1232 HST, PHMK reported wind from 030° at 12 knots gusting to 24 knots, visibility of 4 miles with haze, scattered clouds at 2,400 feet, ceiling broken at 2,900 feet, broken clouds at 5,000 feet, temperature 23°C, dew point temperature 20°C, altimeter setting 30.07 inches of Mercury. Remarks: automated station with a precipitation discriminator, peak wind from 050° at 28 knots at 1213 HST, hourly precipitation 0.01 inches.

2.4 Lanai Airport Observations

Lanai Airport (PHNY) in Lanai City, Hawaii, was located about 18 miles to the south-southwest of the accident site at an elevation of 1,308 feet, and was equipped with an ASOS. These automated reports were issued while a weather observer was not logged into the reporting system. The "$" symbol at the end of each report indicated that maintenance was needed on the

system. Presented here are some of the publically disseminated surface observations from PHNY from November 10, 2011.

[0956 HST] PHNY 101956Z AUTO 05021KT 10SM CLR 24/17 A3013 RMK AO2 PWINO TSNO T02380172 PK WND 04033/1904 SLP183 $

[1056 HST] PHNY 102056Z AUTO 04018KT 10SM SCT032 23/17 A3012 RMK AO2 PWINO TSNO 50001 T02330172 PK WND 04026/2005 SLP180 $

[1156 HST] PHNY 102156Z AUTO 04018KT 10SM SCT033 BKN044 23/18 A3009 RMK AO2 PWINO TSNO T02330177 SLP171 $

[1256 HST] PHNY 102256Z AUTO 03013KT 10SM FEW027 BKN036 BKN043 25/17 A3008 RMK AO2 PWINO TSNO T02500172 SLP165 $

At 1156 HST, PHNY reported wind from 040° at 18 knots, visibility of 10 miles or greater, scattered clouds at 3,300 feet, ceiling broken at 4,400 feet, temperature 23°C, dew point temperature 18°C, altimeter setting 30.09 inches of Mercury. Remarks: automated station with a precipitation discriminator, precipitation discriminator information not available, thunderstorm information not available, hourly temperature 23.3°C and hourly dew point temperature of 17.7°C, sea-level pressure 1017.1 hPa, maintenance needed on the system.

At 1256 HST, PHNY reported wind from 030° at 13 knots, visibility of 10 miles or greater, few clouds at 2,700 feet, ceiling broken at 3,600 feet, broken clouds at 4,300 feet, temperature 25°C, dew point temperature 17°C, altimeter setting 30.08 inches of Mercury. Remarks: automated station with a precipitation discriminator, precipitation discriminator information not available, thunderstorm information not available, hourly temperature 25.0°C and hourly dew point temperature of 17.2°C, sea-level pressure 1016.5 hPa, maintenance needed on the system.

2.5 Other Land-Based Surface Observations

Unofficial weather observations were retrieved from observing stations sponsored by several federal and state agencies. Maintenance, calibration and reporting quality are unknown for these stations.

Data from the Bureau of Land Management and the Hawaii Division of Forestry and Wildlife station MLKH1, which was located about 7 miles to the west-northwest of the accident site at an elevation of approximately 2,730 feet, is presented in table 1. The MKPH1 observation closet to the accident time is presented in bold.

Time	Temp(°C)	D Temp(°C)	RH(%)	W Sp(kts)	W Gust(kts)	W Dir.(true)
0837	17.8	15.5	83	3	17	357°
0937	20.6	15.4	66	5	19	064°
1037	19.4	17.0	82	4	21	065°
1137	18.9	16.6	83	3	22	092°

1237	**20.0**	**17.4**	**81**	**4**	**14**	**090°**
1337	20.0	17.7	83	4	16	061°

Table 1 – Data collected from MLKH1. Temp = temperature; D_Temp = dew point temperature; RH = relative humidity; W_Sp = wind speed; W_Gust = wind gust; W_Dir = wind direction.

Data from the Bureau of Land Management and the Hawaii Division of Forestry and Wildlife station MKPH1, which was located about 11 miles to the northwest of the accident site at an elevation of approximately 75 feet, is presented in table 2. The MKPH1 observation closet to the accident time is presented in bold.

Time	Temp(°C)	D Temp(°C)	RH(%)	W Sp(kts)	W Gust(kts)	W Dir.(true)
0814	23.3	19.4	74	19	28	086°
0914	23.3	20.3	79	20	30	068°
1014	22.2	18.6	75	21	28	077°
1114	25.0	21.1	74	17	30	083°
1214	**25.0**	**20.7**	**72**	**16**	**28**	**089°**
1314	23.3	21.1	84	17	30	078°

Table 2 – Data collected from MKPH1 on November 10, 2011. Temp = temperature; D_Temp = dew point temperature; RH = relative humidity; W_Sp = wind speed; W_Gust = wind gust; W_Dir = wind direction.

Data from the Bureau of Land Management and the Hawaii Division of Forestry and Wildlife station LNIH1, which was located about 15 miles to the southwest-south of the accident site at an elevation of approximately 1,270 feet, is presented in table 3. The LNIH1 observation closet to the accident time is presented in bold.

Time	Temp(°C)	D Temp(°C)	RH(%)	W Sp(kts)	W Gust(kts)	W Dir.(true)
0837	21.7	18.1	75	23	37	051°
0937	21.7	18.3	77	23	39	048°
1037	21.7	18.3	77	25	39	052°
1137	22.8	18.8	73	24	38	050°
1237	**24.4**	**19.3**	**67**	**22**	**36**	**054°**
1337	23.9	18.7	67	21	37	061°

Table 3 – Data collected from LNIH1 on November 10, 2011. Temp = temperature; D_Temp = dew point temperature; RH = relative humidity; W_Sp = wind speed; W_Gust = wind gust; W_Dir = wind direction.

Data from the National Ocean Service's National Water Level Program station KLIH1, which was located about 23 miles to the east-southeast of the accident site at sea-level, is presented in table 4. The KLIH1 observations closet to the accident time is presented in bold.

Time	Temp(°C)	W Sp(kts)	W Gust(kts)	W Dir.(true)	Alt (in Hg)
1100	23.3	15	21	031°	30.10
1106	23.3	14	21	059°	30.10
1112	22.2	12	18	069°	30.09
1118	22.8	13	20	067°	30.09
1124	22.8	12	18	055°	30.09
1130	22.8	14	23	055°	30.09
1136	22.8	15	23	054°	30.08
1142	23.3	11	17	052°	30.08
1148	23.3	12	18	046°	30.08
1154	23.9	12	16	051°	30.07
1200	24.4	11	16	048°	30.07
1206	**23.9**	**12**	**16**	**048°**	**30.07**
1212	**24.4**	**12**	**16**	**046°**	**30.06**
1218	**24.4**	**10**	**17**	**038°**	**30.06**
1224	24.4	13	18	043°	30.06
1230	23.3	13	18	029°	30.05
1236	23.9	13	17	045°	30.05
1242	24.4	15	18	047°	30.04
1248	24.4	13	21	054°	30.04
1254	24.4	17	21	052°	30.04
1300	25.0	16	23	050°	30.04

Table 4 – Data collected from KLIH1 on November 10, 2011. Temp = temperature; W_Sp = wind speed; W_Gust = wind gust; W_Dir = wind direction; Alt = altimeter setting.

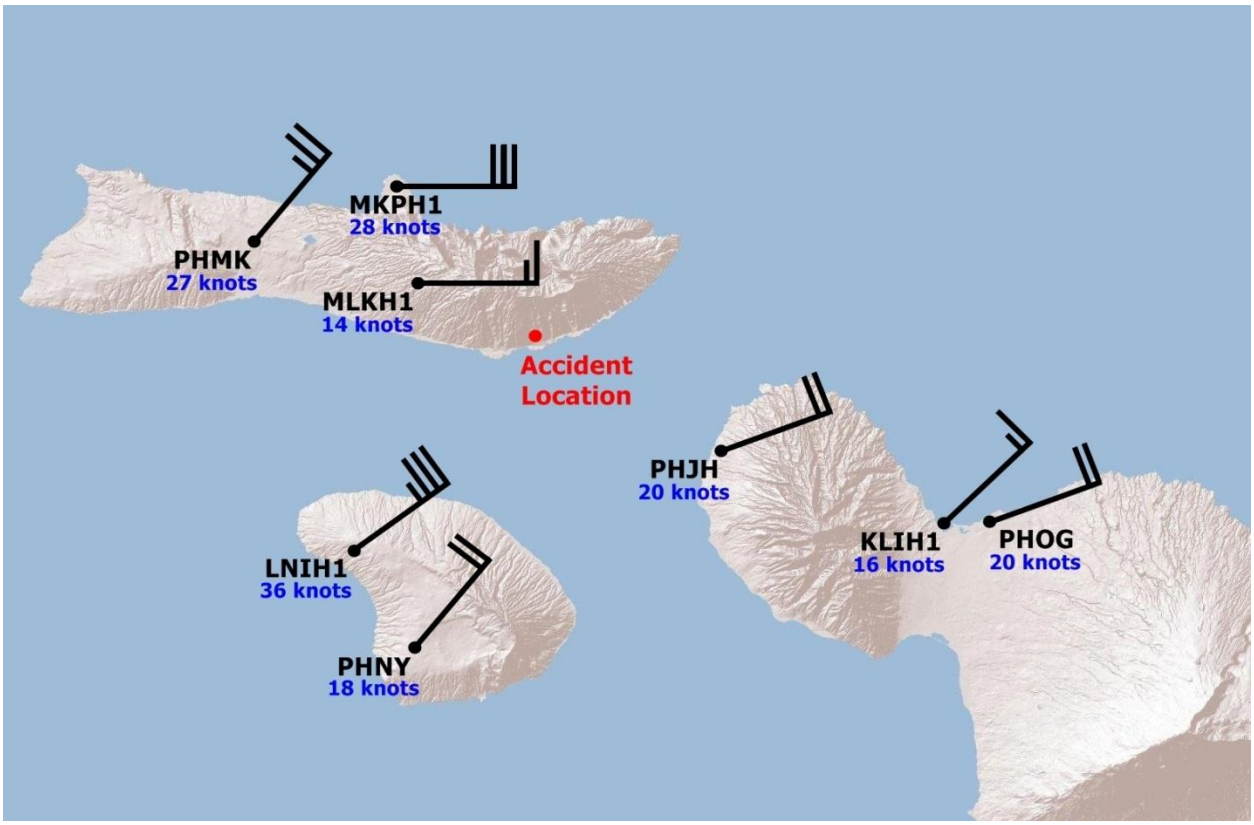

Figure 3 – Plot of land-based surface stations presented in this section. Wind information represents wind retrieved closest to the accident time by each station. One-minute PHOG data was not considered for this image.

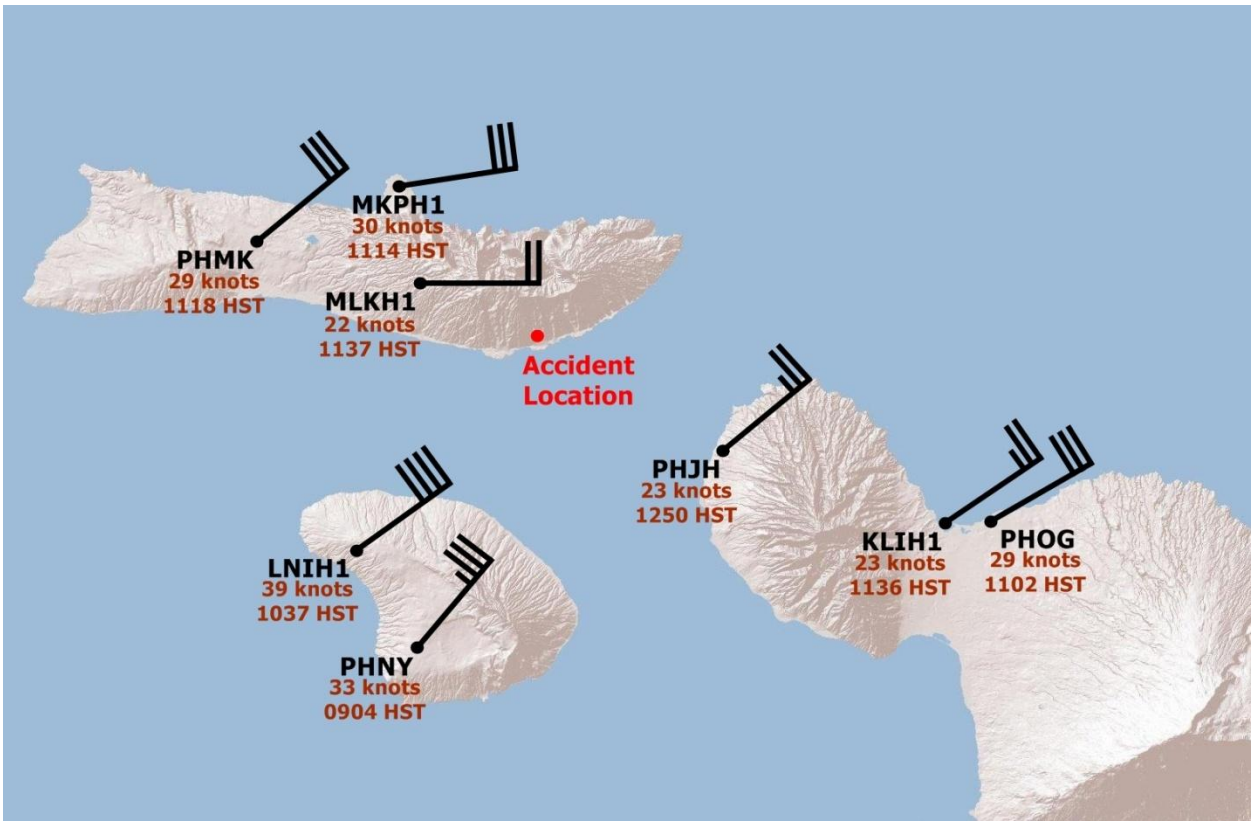

Figure 4 – Plot of land-based surface stations presented in this section. Wind information represents the maximum wind (sustained or gust) retrieved by each station considering only the data presented in this section. Retrieval times are also noted. Note: the definition of what constitutes a "gust" may differ by instrument.

2.6 Sea-Based Surface Observations

Data from the National Data Buoy Center buoy 51000, which was located about 215 miles to the northeast of the accident site at sea-level, is presented in table 5. Although relatively far away, data from buoy 51000, provided information on wind speeds in the oceanic region in the absence of terrain.

Time	Temp(°C)	W Sp(kts)	W Gust(kts)	W Dir.(true)
0850	22.5	21	27	070°
0950	23.4	21	27	050°
1050	23.3	21	27	050°
1150	23.2	21	27	050°
1250	23.3	19	25	050°
1350	23.1	19	25	060°

Table 5 – Data collected from bouy 51000 on November 10, 2011. Temp = temperature; W_Sp = wind speed; W_Gust = wind gust; W_Dir = wind direction.

Data from the National Data Buoy Center buoy 51100, which was located about 222 miles to the northeast of the accident site at sea-level, is presented in table 6. Although relatively far away, data from buoy 51100, provided information on wind speeds in the oceanic region in the absence of terrain.

Time	Temp(°C)	W Sp(kts)	W Gust(kts)	W Dir.(true)
0850	23.1	21	25	040°
0950	23.3	21	25	050°
1050	23.2	21	27	050°
1150	23.1	21	25	050°
1250	23.2	19	23	050°
1350	23.0	19	23	060°

Table 6 – Data collected from bouy 51100 on November 10, 2011. Temp = temperature; W_Sp = wind speed; W_Gust = wind gust; W_Dir = wind direction.

3. Upper Air Data

3.1 Rawinsondes

Atmospheric data was retrieved from rawinsonde launches at 1400 HST from Hilo, Hawaii (PHTO), and Lihue, Hawaii (PHLI).

PHTO was located approximately 129 miles southeast of the accident site. The PHTO sounding indicated the lifted condensation level (LCL) was at about 1,800 feet, and the lowest 8,500 feet of the atmosphere was, for the most part, conditionally unstable. The relative humidity (RH) near the surface was 77 percent, and the RH remained below 90 percent below 9,000 feet. "Most unstable" CAPE[3] for this atmosphere was 1,059 Joules/kilogram (J/kg). The freezing level was identified at about 12,900 feet. Calculations made by the Universal RAwinsonde OBservation program yielded the potential for scattered clouds as low as 2,000 feet. The PHTO wind profile indicated a light surface wind from the north at 4 knots. Above the surface at about 1,000 feet the wind *veered*[4] to the northeast and increased in magnitude to 21 knots at 5,000 feet. Calculations by RAOB identified a layer of significant turbulence just below 3,000 feet but no areas of significant low-level wind shear (LLWS).

[3] Convective Available Potential Energy (CAPE). A measure of the amount of energy available for convection.
[4] A "veering" wind is a wind that turns clockwise with increasing height.

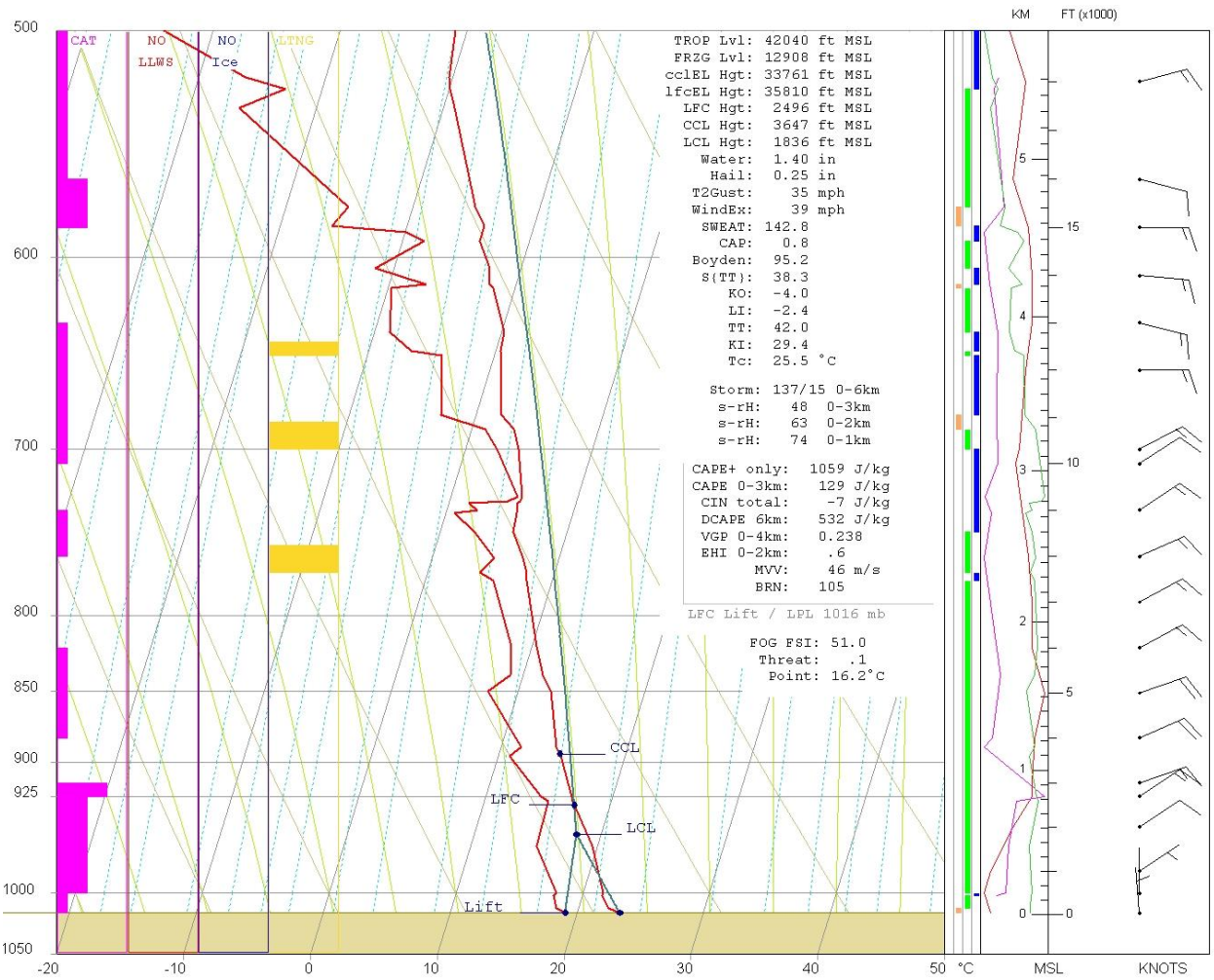

Figure 5 – Rawinsonde sounding from PHTO in SkewT/LogP format for 1400 HST, surface to 500 hPa.

PHLI was located approximately 150 miles west-northwest of the accident site. The PHLI sounding indicated the LCL was at about 3,000 feet, and the lowest 5,000 feet of the atmosphere was, for the most part, conditionally unstable. The RH near the surface was 65 percent, however the RH increased to 94 percent at about 3,600 feet. Above this level, the RH decreased with increasing height. "Most unstable" CAPE for this atmosphere was 725 J/kg. The freezing level was identified as about 13,800 feet. Calculations made by RAOB yielded the potential for scattered clouds as low as 2,000 feet. The PHLI wind profile indicated a surface wind from 055° at 15 knots and the wind magnitudes increased slightly with height. At about 2,800 feet, the wind was from 070° at 22 knots. About this level, the wind veered slightly to a more easterly direction and increased in magnitude with height to 28 knots at about 6,800 feet. Calculations by RAOB indicated no significant turbulence in the lower part of the atmosphere and no areas of significant LLWS were identified.

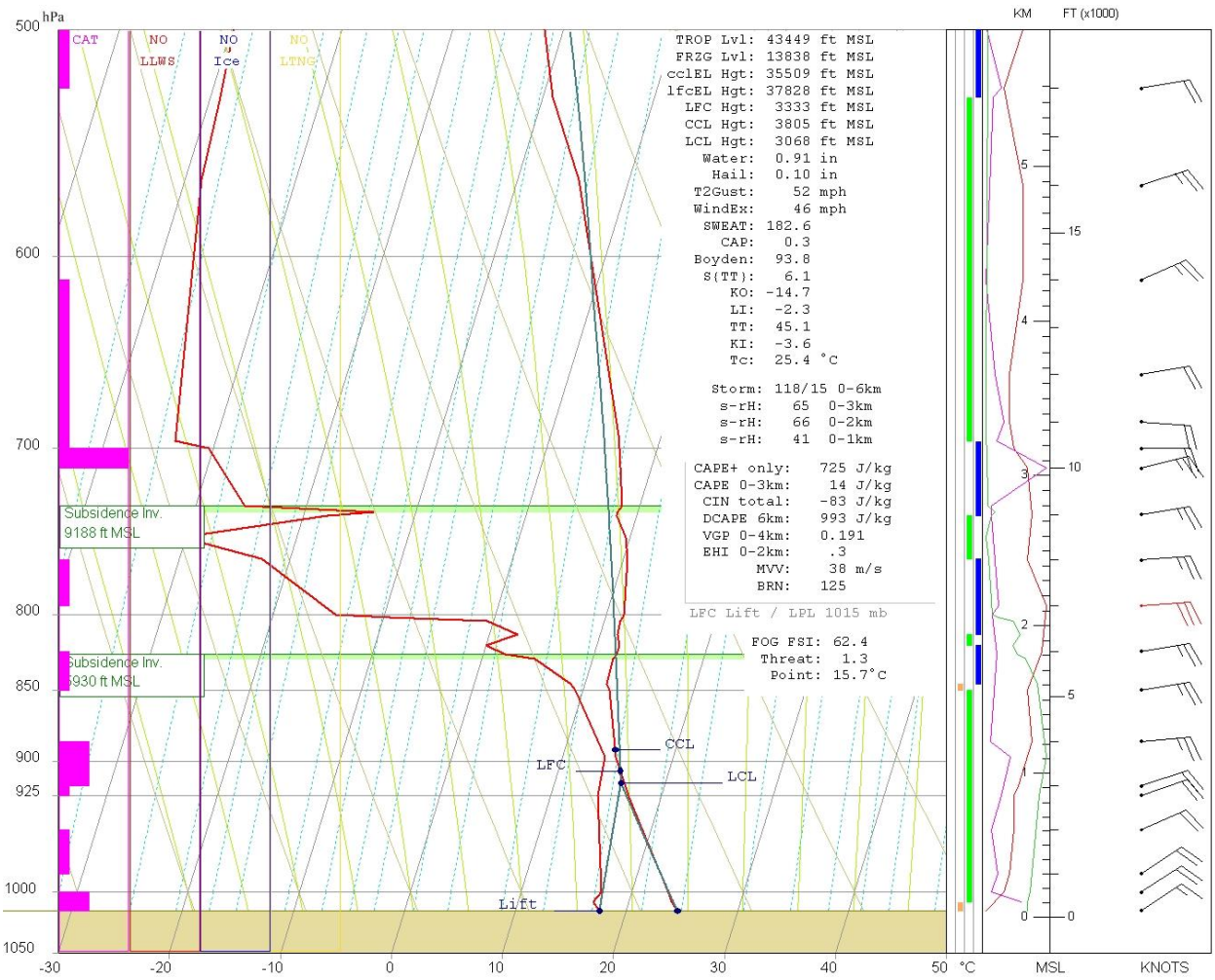

Figure 6 – Rawinsonde sounding from PHLI in SkewT/LogP[5] format for 1400 HST, surface to 500 hPa.

3.2 Model Data

Computer modeling of the wind around the time and location of the accident was provided courtesy of Dr. Yi-Leng Chen, Professor of Meteorology at the University of Hawaii at Manoa. His report is presented as Attachment 1 to this report.

In addition, Dr. Chen provided the following comments with reference to figures found in his report:

[5] SkewT/LogP – A thermodynamic diagram, using the temperature and the logarithm of pressure as coordinates, which allows the plotting of the vertical profile of the temperature, humidity, and atmosphere above a particular point on the earth's surface.

The horizontal winds have large spatial variations (Fig. 1) with gusty winds.

There might be localized updrafts on the order of 1 m/s associated with rains (Fig. 3).

A Weather Research and Forecasting Model (WRF) simulation was run to estimate wind magnitudes (knots), vertical velocities (Pascals [Pa] per second) and turbulence (Richardson number [Ri]) in the area of the accident. These data are presented in figures 7-9. WRF ARW (Advanced Research WRF core) version 3.2.1.5 was run with 3 domains with horizontal grid spacing of 10 kilometers (km), 2 km, and 400 meters over the accident site. Other WRF simulation parameters included: 45 vertical levels, a Lin et al. microphysics scheme, a Yonsei University boundary layer scheme, Noah land surface physics, and the Dudhia scheme used for long and short wave radiation. A Kain-Fritsch cumulus parameterization scheme was used on the 10-km domain.

Figure 7 presents WRF simulated vertical velocities at 930 hPa for the accident region. According to the International Standard Atmosphere, 930 hPa is located at approximately 2,350 feet above msl. At the accident location, vertical velocities were seen to be about 5 Pascals (Pa) per second (88 feet per minute)[6].

Figure 8 presents WRF simulated horizontal wind component at 930 hPa. In the area of the accident site, the horizontal wind component was from the northeast at 32-34 knots.

Figure 9 presents a north-south vertical cross-section of Ri through a point close to the accident site. In general, values of Ri over the southern portion of the island were relatively large (>5.0), however values of Ri were seen to decrease to less than 0.5 when close to terrain. While specific values of Ri cannot be equated with certain severities of aircraft-scale turbulence and scientific literature does suggest varying thresholds of Ri for onset of turbulence, it is generally accepted that values of Ri less than 1.0 indicate a potential for turbulence while values less than 0.25 suggest a likelihood for turbulence.

[6] According to the International Standard Atmosphere, 3,400 Pa separates 2,000 feet above msl from 3,000 feet above msl, which equates to an average change of 3.4 Pa per foot increase of altitude in this layer.

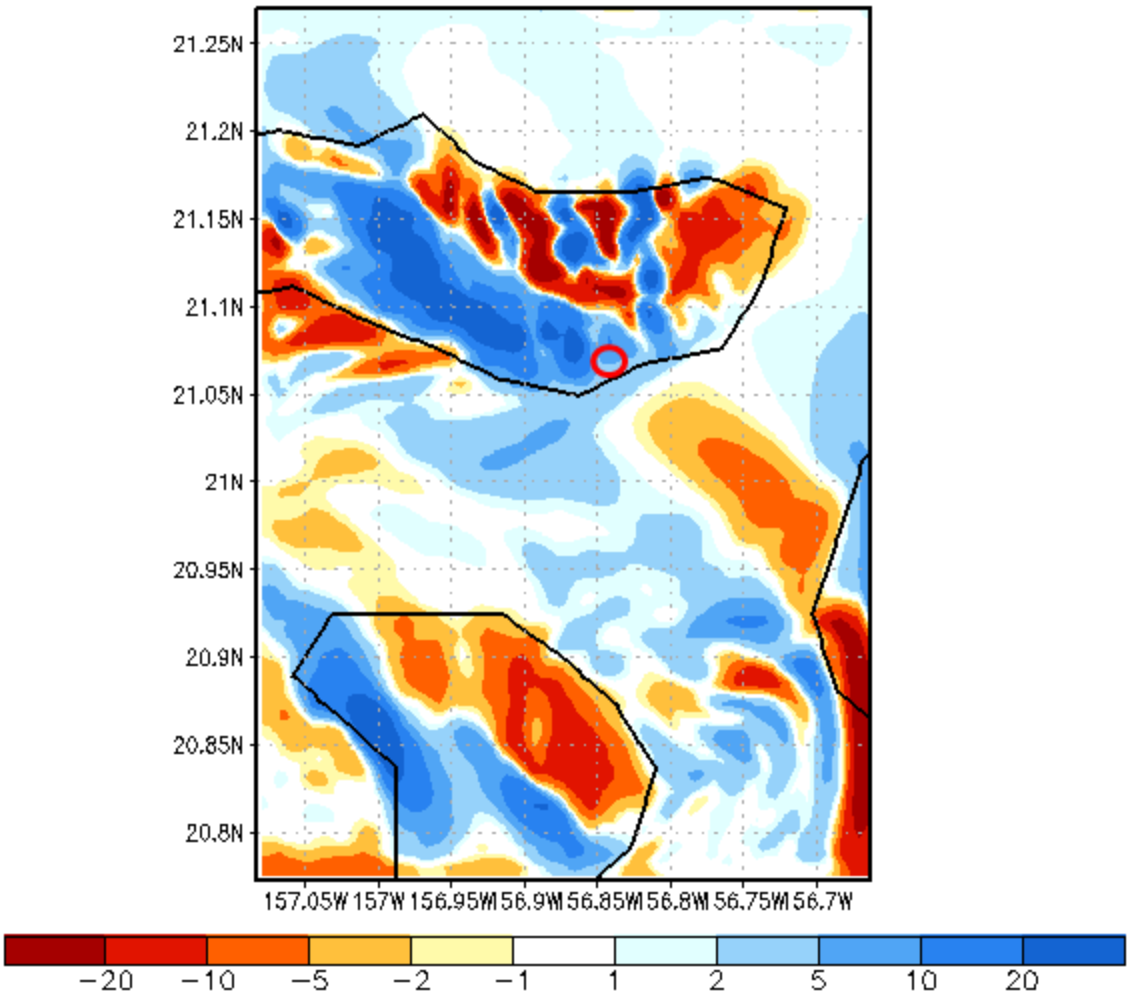

Figure 7 – WRF ARW simulation of vertical velocities (Pa/s) at 930 hPa at 1215 HST. Accident location is circled in red.

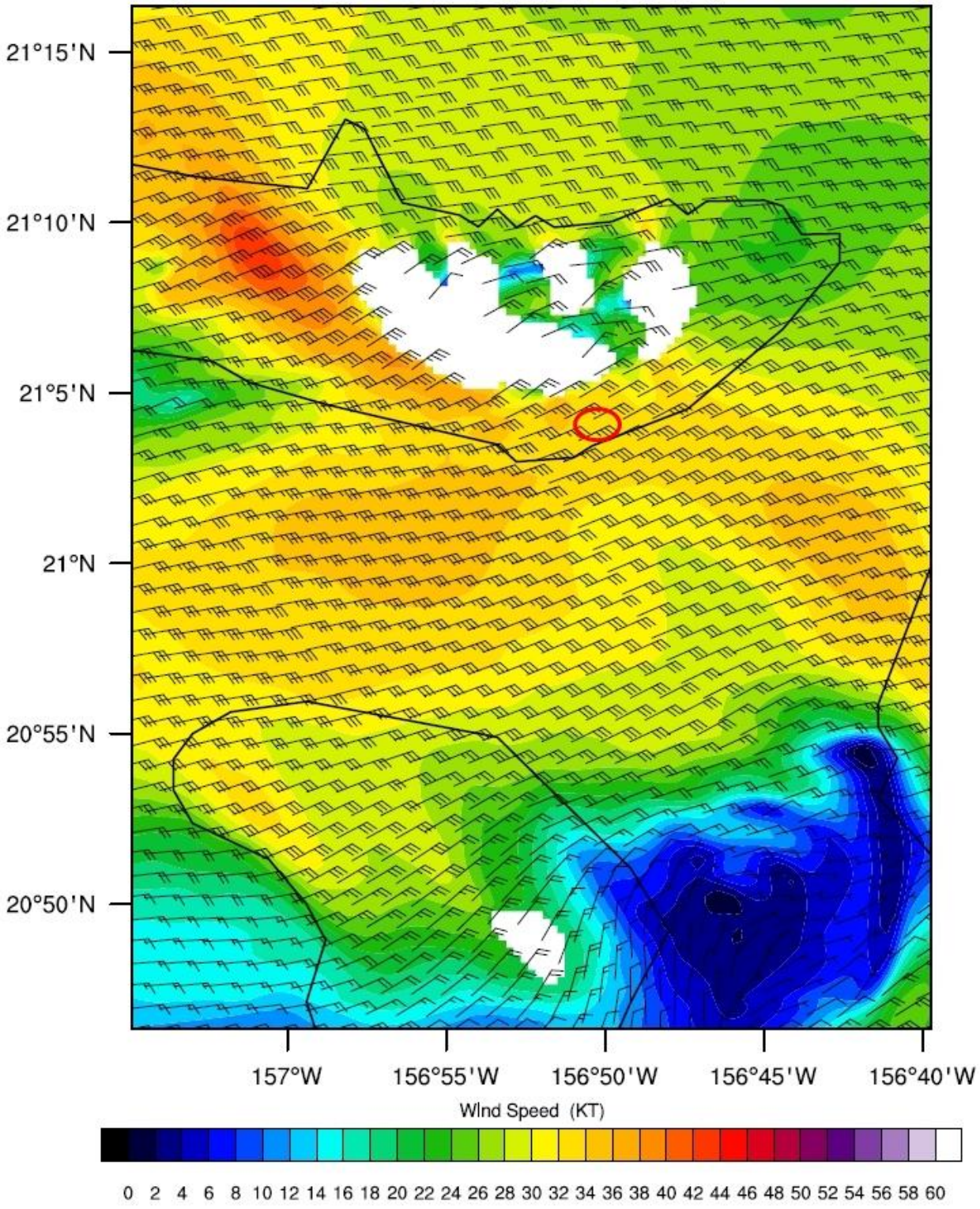

Figure 8 – WRF ARW simulation of the horizontal wind at 930 hPa at 1215 HST. Accident location is circled in red.

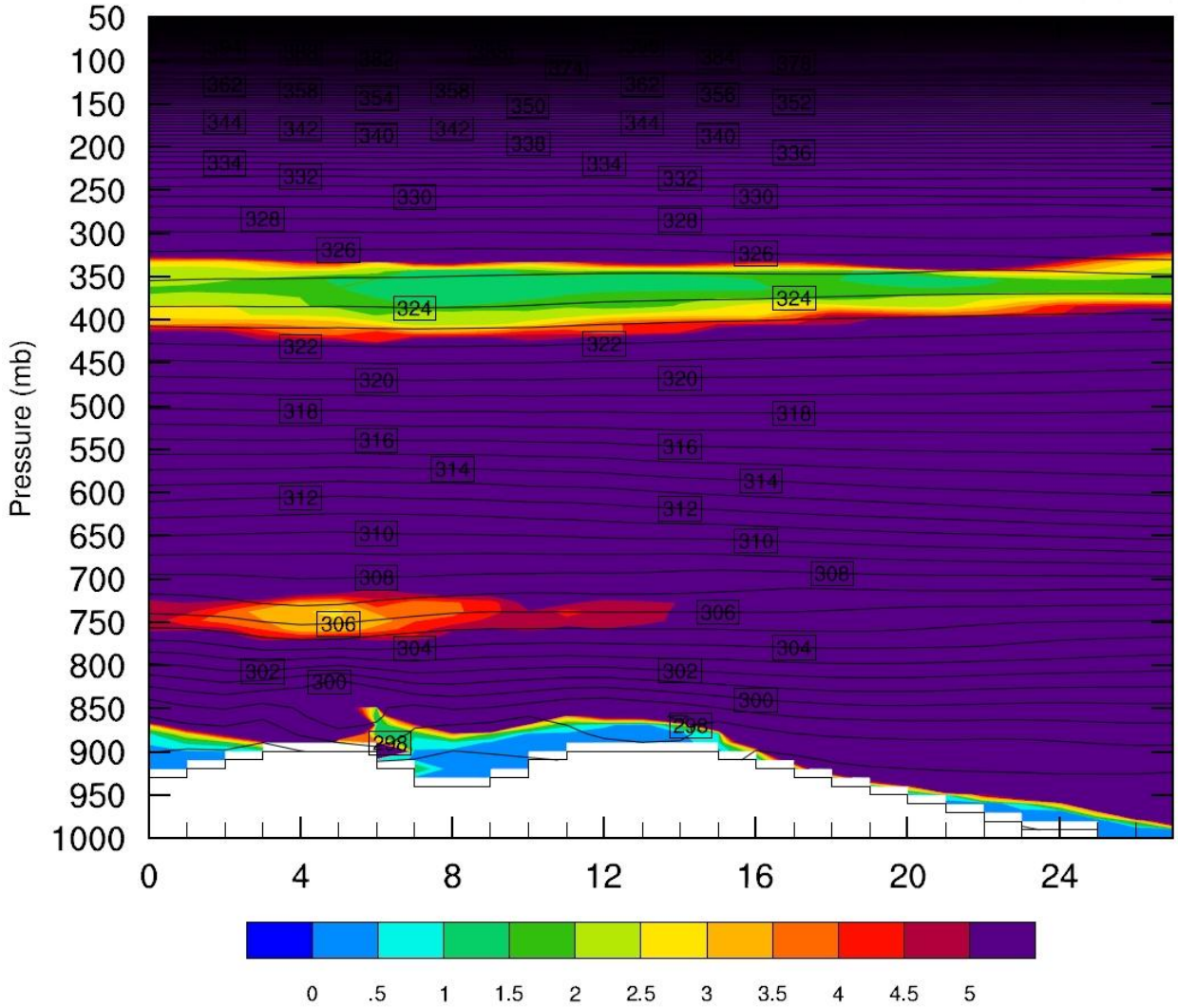

Figure 9 – WRF ARW north(left side)-to-south(right side) vertical cross-section of Richardson number through a point near the accident site at 1215 HST.

3.3 Airborne Aircraft

AMDAR data[7] below about 10,000 feet from commercial aircraft flying in and out of the Hawaiian Islands within about one hour of the accident time on November 10, 2011, are presented in tables 7-14. Flight paths for these aircraft are presented in figure 10.

Time(Z)	Latitude	Longitude	Altitude(ft.)	Wind Dir.	Wind Speed(kts)	Temp(°C)
1209	22.027	-159.500	2160	064°	21	17.6
1210	22.027	-159.490	2280	066°	19	17.2
1210	22.037	-159.480	2380	067°	21	16.7

[7] AMDAR is the generally-accepted worldwide term for automated weather reports from commercial aircraft.

1210	22.047	-159.470	2530	067°	19	16.2
1210	22.047	-159.470	2640	070°	17	16.2
1210	22.047	-159.470	2760	062°	18	16.1
1210	22.057	-159.460	3010	074°	19	15.7
1210	22.067	-159.440	3480	080°	18	14.6
1210	22.087	-159.410	4050	087°	17	13.2
1211	22.117	-159.380	4780	089°	19	12.7
1211	22.137	-159.350	5840	101°	27	12.1
1211	22.137	-159.310	6790	099°	21	11.6
1211	22.137	-159.300	6920	096°	20	11.6
1212	22.117	-159.170	9440	083°	18	6.7
1212	22.127	-159.220	8650	083°	20	8.2
1212	22.137	-159.260	7590	101°	19	10.7
1213	22.117	-159.130	10270	071°	17	5.6

Table 7 – AMDAR data collected from Aircraft 1.

Time(Z)	Latitude	Longitude	Altitude(ft.)	Wind Dir.	Wind Speed(kts)	Temp(°C)
1213	21.764	-158.682	10000	088°	16	6.3
1215	21.747	-158.912	7970	096°	20	9.8
1216	21.749	-159.010	5980	087°	25	12.0
1217	21.744	-159.120	4000	090°	24	13.3
1220	21.841	-159.320	2000	072°	23	18.3
1223	21.968	-159.333	0	044°	16	25.0

Table 8 – AMDAR data collected from Aircraft 2.

Time(Z)	Latitude	Longitude	Altitude(ft.)	Wind Dir.	Wind Speed(kts)	Temp(°C)
1215	21.419	-157.482	10020	080°	18	5.2
1216	21.359	-157.562	9760	088°	15	4.7
1217	21.319	-157.632	8370	079°	18	7.6
1218	21.279	-157.712	7860	082°	21	9.6
1219	21.249	-157.782	7870	082°	22	10.1
1220	21.249	-157.782	7870	079°	21	9.6
1221	21.229	-157.862	7860	085°	24	8.2
1222	21.219	-157.932	6770	087°	26	10.7
1223	21.209	-158.012	5680	079°	28	11.7
1224	21.209	-158.092	4700	075°	28	12.6
1225	21.239	-158.152	3490	078°	19	14.7
1226	21.289	-158.182	2850	092°	25	16.2
1227	21.319	-158.142	2860	083°	22	16.6
1228	21.319	-158.092	2860	073°	20	16.2
1229	21.319	-158.042	2140	073°	22	18.1

Table 9 – AMDAR data collected from Aircraft 3.

Time(Z)	Latitude	Longitude	Altitude(ft.)	Wind Dir.	Wind Speed(kts)	Temp(°C)
1108	21.302	-157.934	-110	---	---	25.2
1108	21.298	-157.936	50	073°	7	25.0
1108	21.294	-157.938	310	047°	11	24.0
1108	21.290	-157.940	520	046°	6	23.5
1108	21.286	-157.942	750	087°	2	22.7
1108	21.282	-157.944	970	108°	4	22.2
1108	21.278	-157.946	1180	049°	5	21.5
1108	21.274	-157.948	1420	064°	8	21.2
1109	21.270	-157.950	1800	054°	17	19.5
1109	21.266	-157.952	1980	049°	23	19.2
1109	21.262	-157.954	2170	052°	24	18.5
1109	21.258	-157.956	2450	055°	22	18.2
1109	21.254	-157.958	2660	056°	24	17.5
1109	21.250	-157.960	2860	061°	26	17.7
1109	21.246	-157.962	3040	062°	31	17.2
1110	21.242	-157.964	3190	063°	29	16.5
1110	21.238	-157.966	3770	066°	27	14.5
1110	21.215	-157.999	4370	066°	28	13.2
1111	21.190	-158.036	5760	078°	30	13.2
1111	21.178	-158.079	7190	084°	34	9.7
1112	21.176	-158.127	8770	083°	28	8.2
1112	21.178	-158.175	10200	071°	24	7.0

Table 10 – AMDAR data collected from Aircraft 4.

Time(Z)	Latitude	Longitude	Altitude(ft.)	Wind Dir.	Wind Speed(kts)	Temp(°C)
1118	21.308	-157.934	-150	---	---	26.1
1118	21.303	-157.929	0	066°	15	25.4
1118	21.298	-157.924	390	050°	19	24.6
1118	21.293	-157.919	760	063°	14	23.5
1119	21.288	-157.914	910	050°	3	22.5
1119	21.283	-157.909	1010	046°	10	22.0
1119	21.278	-157.904	1270	059°	19	21.6
1119	21.273	-157.899	1570	069°	20	20.8
1120	21.268	-157.894	2030	062°	29	19.4
1120	21.263	-157.889	2370	059°	19	18.5
1120	21.258	-157.884	2730	067°	17	17.3
1120	21.253	-157.879	3010	066°	35	16.8
1120	21.248	-157.874	3150	067°	24	16.1
1120	21.243	-157.869	3190	064°	29	15.5
1120	21.238	-157.864	3240	058°	43	16.0
1120	21.233	-157.859	3390	054°	41	15.8

1121	21.228	-157.854	4390	062°	27	15.3
1121	21.221	-157.829	5780	083°	27	13.1
1121	21.216	-157.804	7110	076°	29	11.1
1121	21.211	-157.777	8260	067°	26	9.6
1122	21.208	-157.750	9290	063°	22	8.0
1122	21.205	-157.722	10130	063°	25	5.7

Table 11 – AMDAR data collected from Aircraft 5.

Time(Z)	Latitude	Longitude	Altitude(ft.)	Wind Dir.	Wind Speed(kts)	Temp(°C)
1252	21.099	-156.527	6810	087°	20	10.6
1253	21.139	-156.507	7710	089°	20	9.2
1253	21.179	-156.487	8560	087°	17	8.2
1253	21.219	-156.467	9410	087°	17	7.2
1254	21.249	-156.447	10260	084°	19	5.7

Table 12 – AMDAR data collected from Aircraft 6.

Time(Z)	Latitude	Longitude	Altitude(ft.)	Wind Dir.	Wind Speed(kts)	Temp(°C)
1113	21.661	-156.198	9930	076°	20	5.7
1114	21.531	-156.278	9400	080°	16	6.6
1115	21.401	-156.348	7960	088°	14	8.1
1116	21.281	-156.418	6410	085°	21	9.7
1117	21.171	-156.488	4910	080°	25	11.7
1118	21.051	-156.558	3830	081°	24	14.1

Table 13 – AMDAR data collected from Aircraft 7.

Time(Z)	Latitude	Longitude	Altitude(ft.)	Wind Dir.	Wind Speed(kts)	Temp(°C)
1235	20.706	-156.013	9990	064°	21	5.8
1237	20.539	-156.018	7990	061°	26	7.3
1240	20.347	-156.020	6000	072°	31	11.0
1243	20.097	-156.023	4000	070°	9	16.8
1247	19.854	-156.035	2000	039°	7	21.3
1249	19.751	-156.045	10	226°	4	26.8

Table 14 – AMDAR data collected from Aircraft 8.

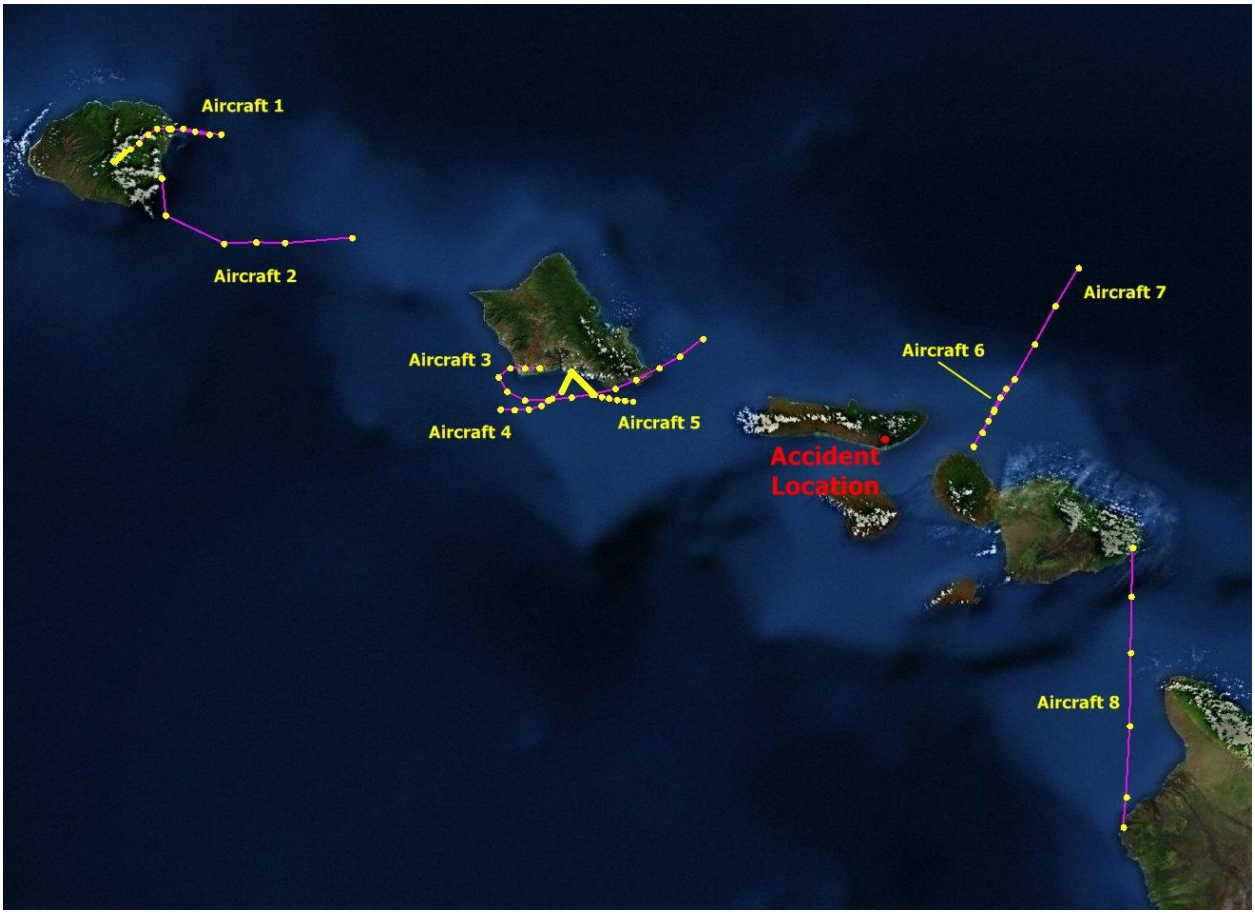

Figure 10 – Flight paths (pink lines) below about 10,000 feet for AMDAR-reporting aircraft. Yellow dots indicate reporting points.

3.4 Pilot Reports

One publically disseminated pilot report was made over the Hawaiian Islands within about three hours of the accident time below 10,000 feet.

> HNL UA /OV LIH-HNL /TM 1911 /FL070 /TP C182 /SK SCT070/TOP080 /WV 04526KT=

A pilot report at 0911 HST from a pilot operating a Cessna C182 between Lihue, Hawaii, and Honolulu, Hawaii, reported scattered clouds at 7,000 feet with cloud tops at 8,000 feet, with a wind from 045° at 26 knots at 7,000 feet.

4. Weather Radar

WSR-88D Level-II 0.54° tilt base reflectivity imagery from Moloka'i, Hawaii (PHMO), located approximately 19 miles west-northwest of the accident site, is presented in figures 11-19. Reflectivity values below 0 dBZ have been masked out. Assuming standard refraction and considering the 0.95° beam width[8], at the 0.54° tilt PHMO would have "seen" altitudes between about 1,700 and 3,600 feet msl over the accident site.

PHMO 0.54° base reflectivity imagery between 1155 and 1213 HST identified areas of light to strong values of reflectivity[9] in the region of eastern Moloka'i and adjacent waters. A table relating reflectivity value to precipitation intensity is provided as table 15. At 1201 HST (figure 12), a "cell" characterized by strong reflectivity values was identified immediately to the east of the accident site. At 1207 HST (figure 13), a cell characterized by strong reflectivity values was identified coincident with the accident location. At 1213 HST (figure 14), PHMO identified several smaller areas characterized by moderate values of reflectivity near the accident location. One was located immediately south of the accident site along the coast of Moloka'i, another was located further west along the coast of Moloka'i, and a third was identified further inland but west of the accident location. At this time only light values of reflectivity were coincident with the accident location.

Vertical cross-sections of the reflectivities were taken for the PHMO radar data at 1207 and 1213 HST are presented in figures 16 and 17, and the boundaries of these cross-sections can be found in figures 13 and 14, respectively. The vertical cross-sections indicate that the stronger values of reflectivity were limited in depth to below about 5,000 feet, and the lightest of reflectivity values (~ 0 dBZ) did not extend far above 9,000 feet msl.

WSR-88D Level III 0.54° base velocity imagery from PHMO is presented in figures 18 and 19. The base velocity product utilizes the Doppler Effect to determine the magnitude of the radial component of the velocity of airborne particles pointed either directly toward (negative values) or directly away (positive values) from the radar antenna. The base velocity product at 1207 HST indicated that the radial component for airborne particles in the airspace above the accident site was between -23 and -32 knots. At 1213 HST, the base velocity product indicated that the radial component for airborne particles in the airspace above the accident site was between -25 and -31 knots.

[8] Beam width - the angular separation between the half power points on the antenna radiation pattern, where the gain is one half the maximum value.

[9] Reflectivity - The sum of all backscattering cross-sections (eg, precipitation particles) in a pulse resolution volume divided by that volume. In order for the radar to calculate the reflectivity, it sends out a small burst of energy. This energy strikes the particles located in the volume. For simplification sake, it is assumed that these particles are evenly spread throughout the volume. The more of these particles located in the volume, the greater the return of energy returned back to the radar. One will see a greater reflectivity return from heavy rain than light rain.

NWS VIP	WSR-88D LEVEL	PREC MODE DBZ	RAINFALL
0	0 1 2	< 5 5 to 9 10 to 14	
1 Very Light	3 4 5	15 to 19 20 to 24 25 to 29	.01 in/hr .02 in/hr .04 in/hr
2 Light to Moderate	6 7	30 to 34 35 to 39	.09 in/hr .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 12 13 14 15	55 to 59 60 to 64 65 to 69 70 to 74 > 75	>5.67 in/hr

Table 15 – Table relating NWS/VIP level, WSR-88D level, reflectivity intensity and rainfall rate.

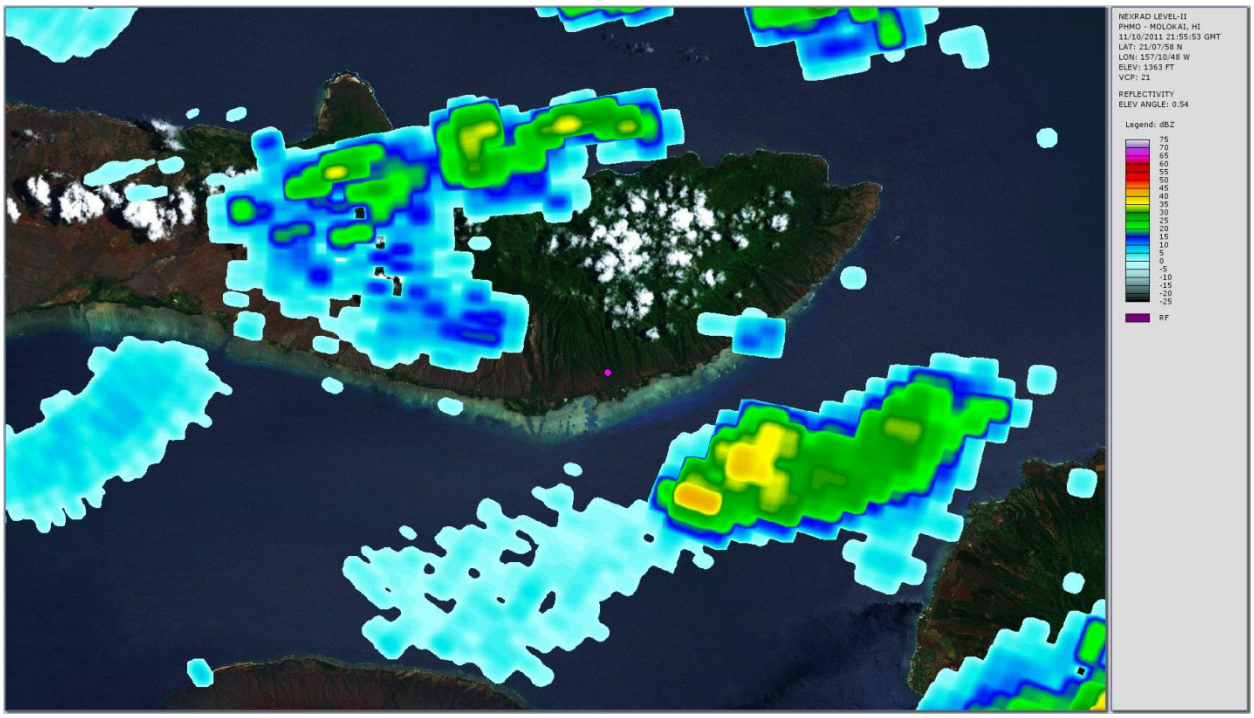

Figure 11 – PHMO 0.54° elevation base reflectivity image from 1155 HST. Pink dot denotes accident location.

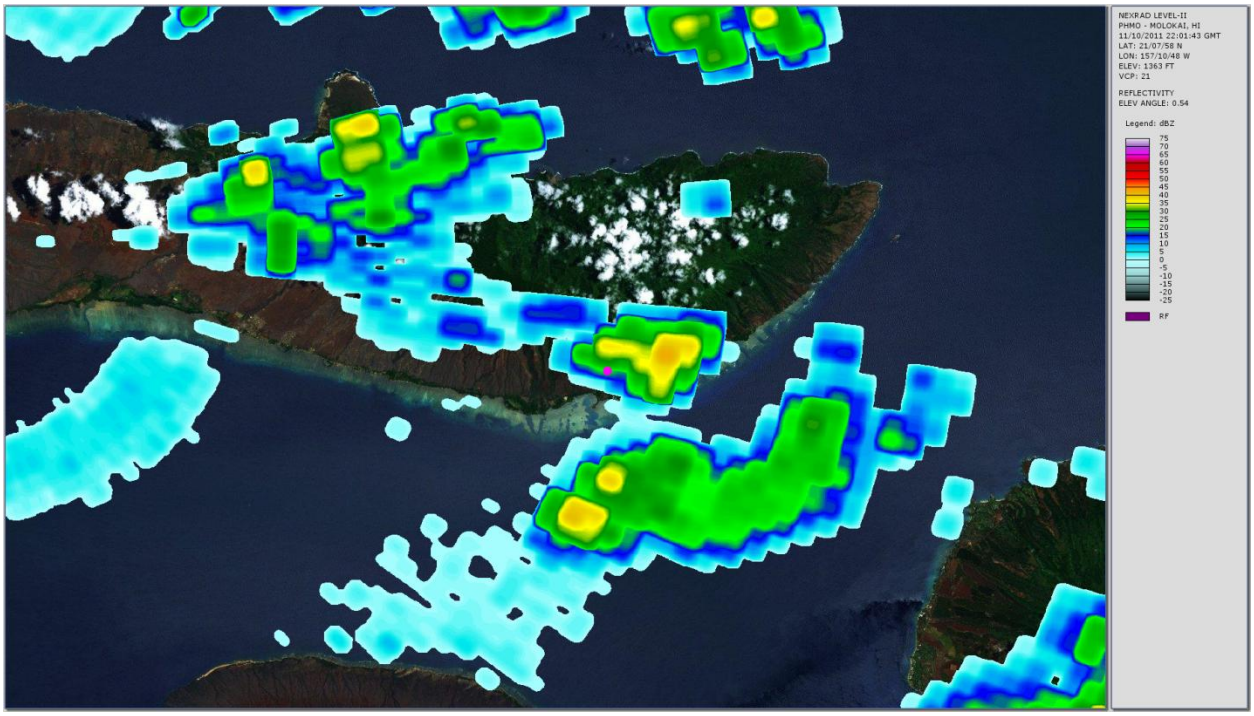

Figure 12 – PHMO 0.54° elevation base reflectivity image from 1201 HST. Pink dot denotes accident location.

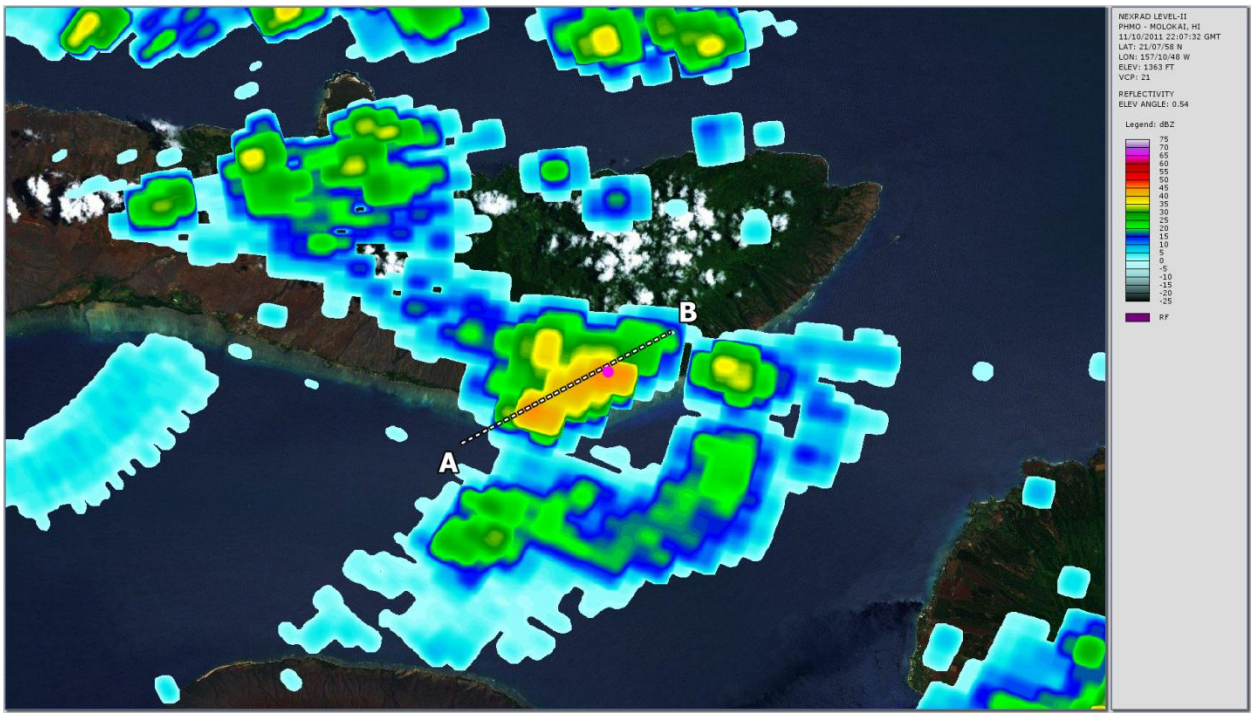

Figure 13 – PHMO 0.54° elevation base reflectivity image from 1207 HST. Pink dot denotes accident location. Dotted line corresponds to section taken for vertical slice in figure 16.

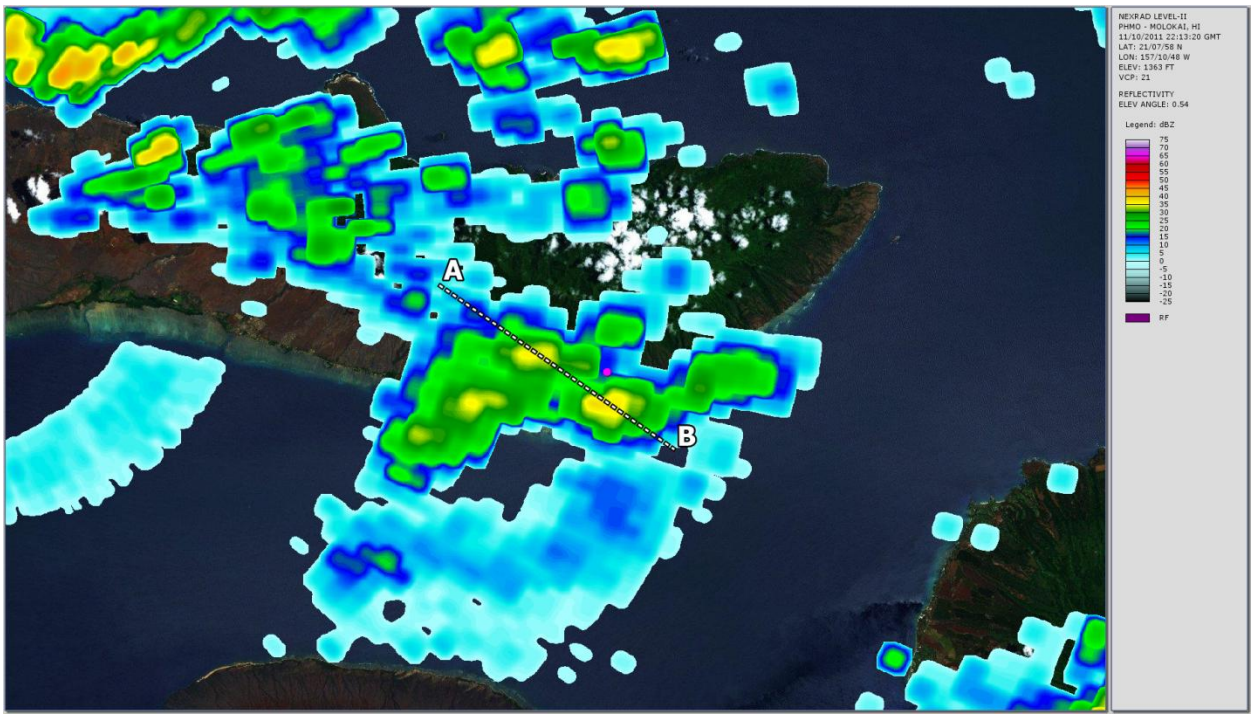

Figure 14 – PHMO 0.54° elevation base reflectivity image from 1213 HST. Pink dot denotes accident location. Dotted line corresponds to section taken for vertical slice in figure 17.

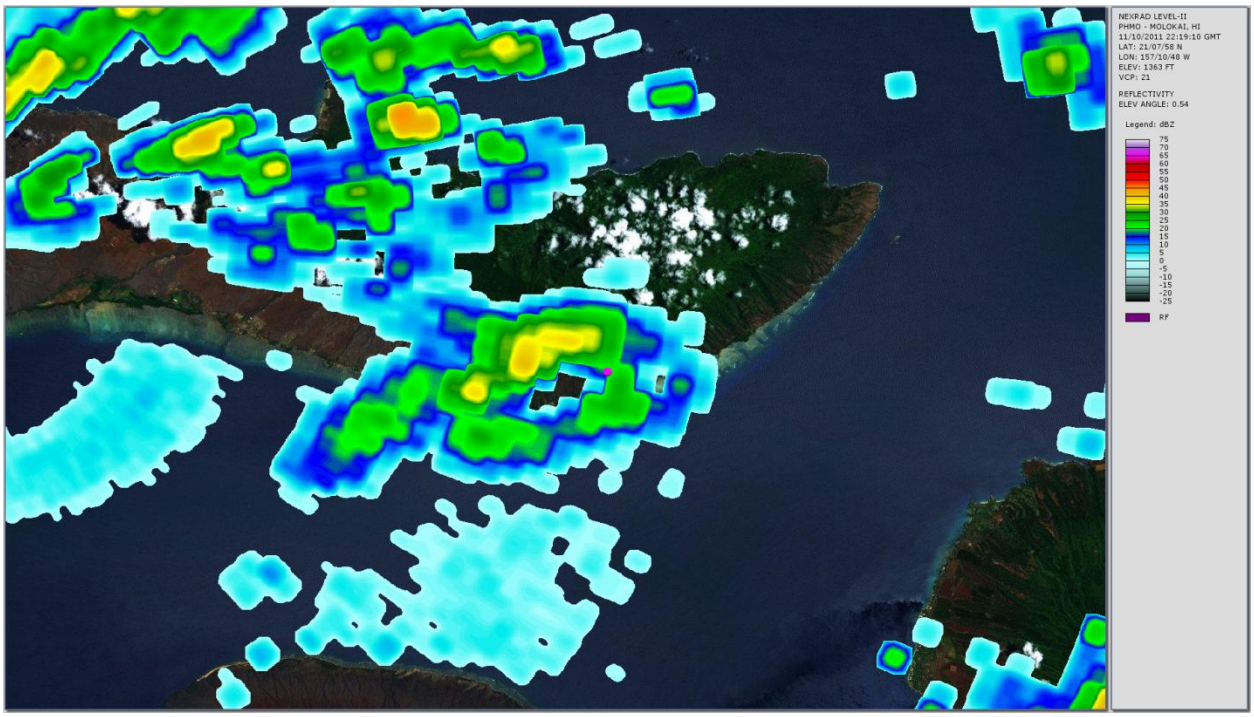

Figure 15 – PHMO 0.54° elevation base reflectivity image from 1219 HST. Pink dot denotes accident location.

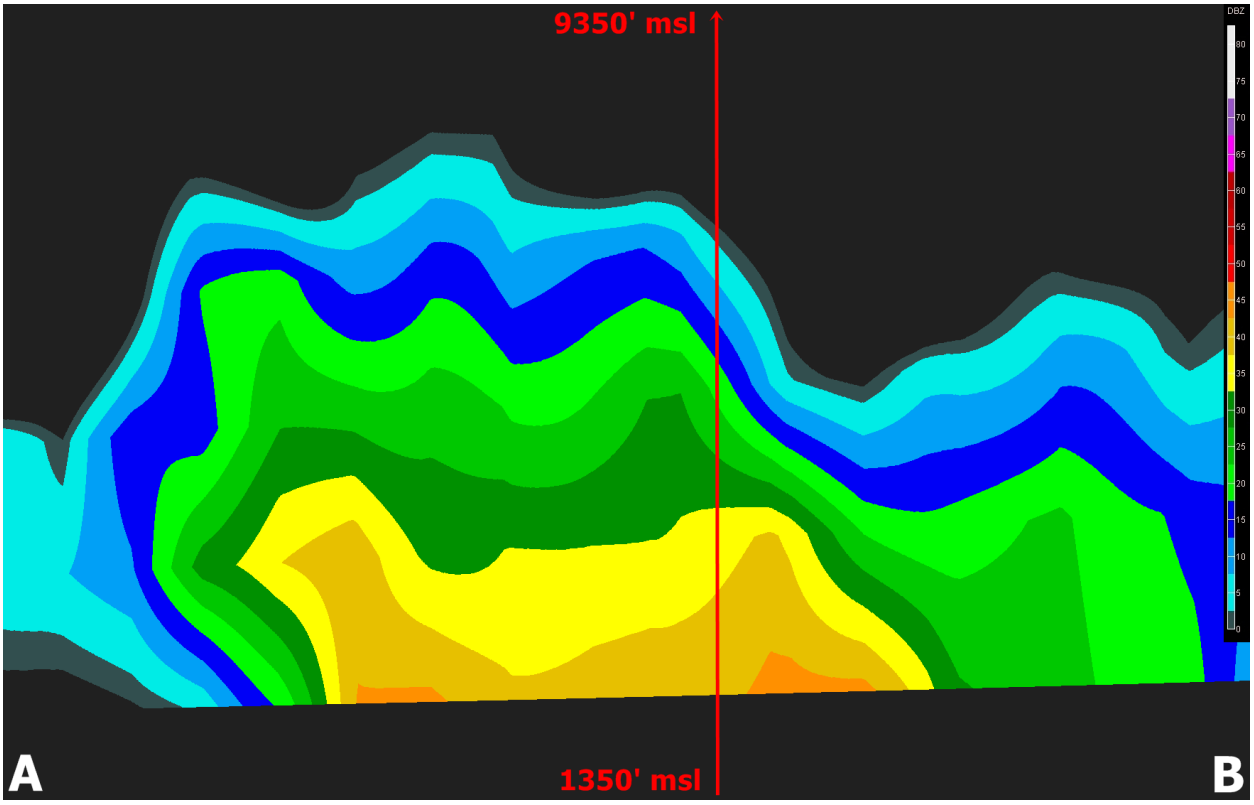

Figure 16 – Vertical cross-section of PHMO base reflectivity beginning at 1207 HST. Cross section end-points A and B defined in figure 13.

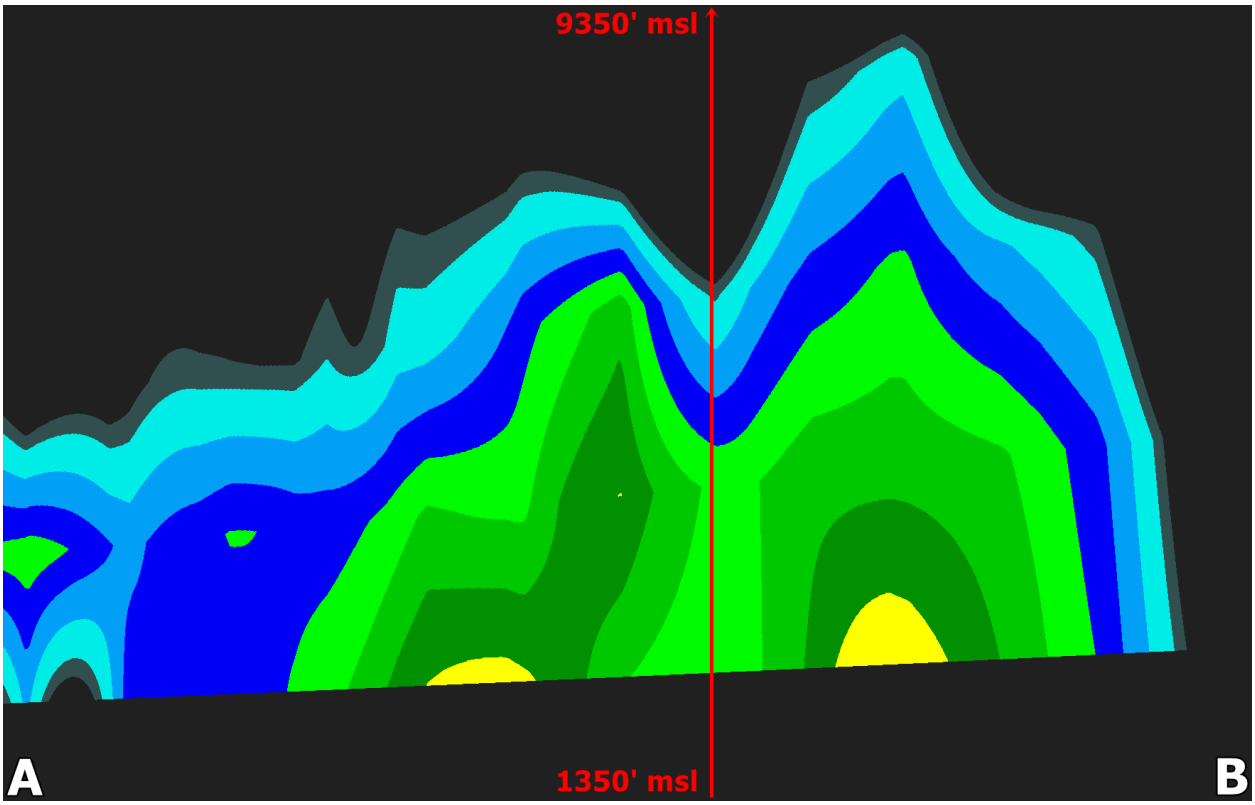

Figure 17 – Vertical cross-section of PHMO base reflectivity beginning at 1213 HST. Cross section end-points A and B defined in figure 14.

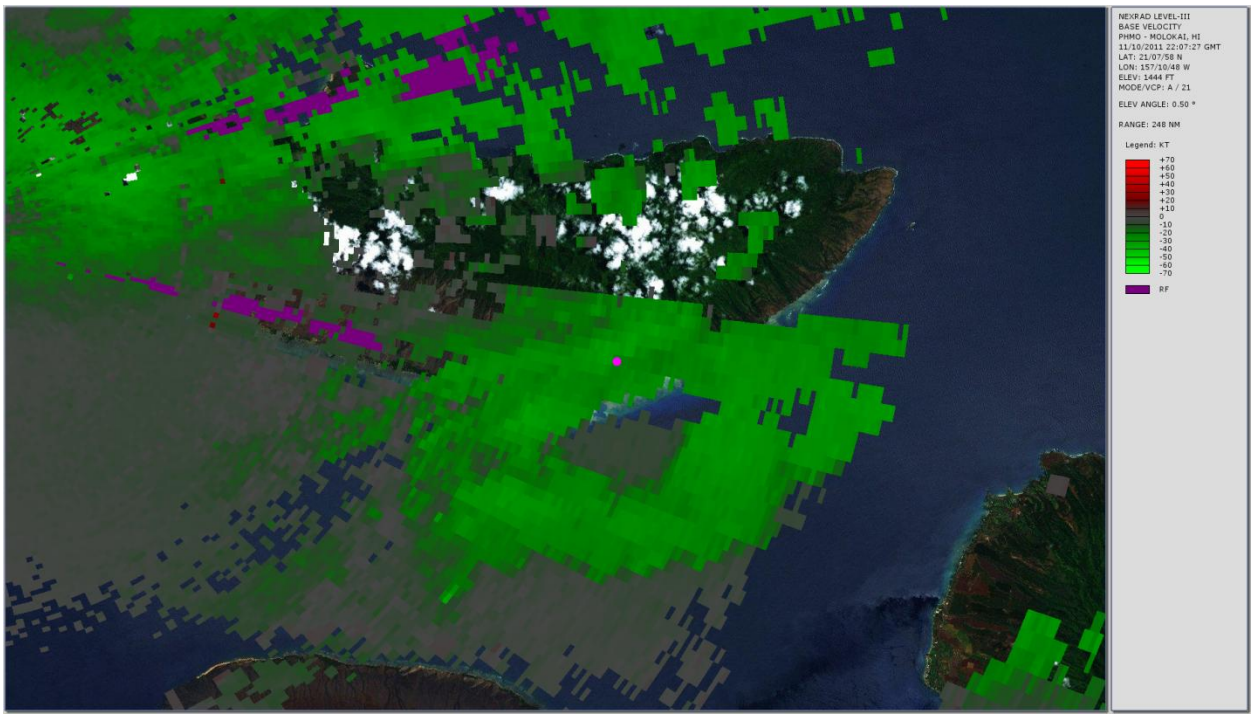

Figure 18 – PHMO 0.50° elevation base velocity image from 1207 HST. Pink dot denotes accident location.

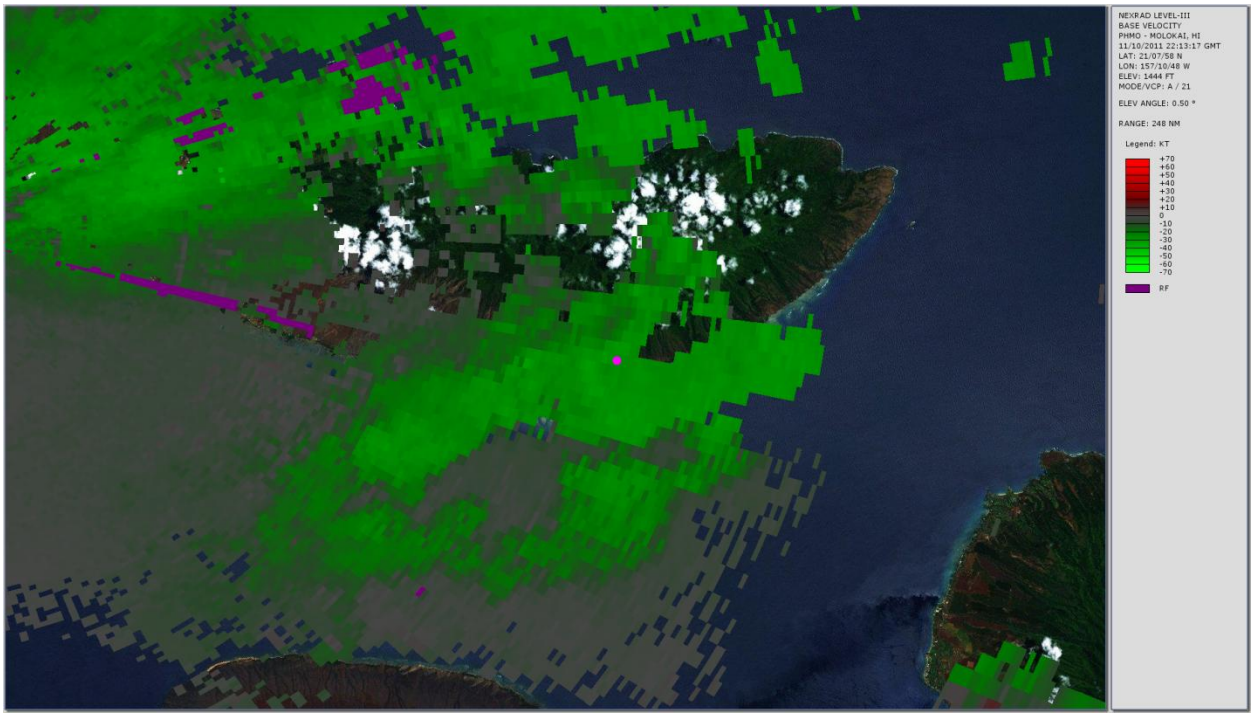

Figure 19 – PHMO 0.50° elevation base velocity image from 1213 HST. Pink dot denotes accident location.

5. Satellite Imagery

Geostationary Operational Environmental Satellite (GOES)-11 visible (0.65µm) and infrared (10.7µm) data were obtained from an archive at the Space Science Engineering Center (SSEC) at the University of Wisconsin-Madison (UW) in Madison, Wisconsin, and processed using the Man computer Interactive Data Access System (McIDAS). Imagery from 1215 HST is presented in figure 20. The GOES-11 visible imagery (figure 20; panel A) indicated cloudy conditions over some of Maui County, with mostly cloudy conditions over the eastern portion of Moloka'i. Cloud-top temperatures from the GOES-11 infrared data in the immediate vicinity of the accident site were retrieved from the GOES-11 infrared data (figure 20; panel B) and varied between approximately 9°C and 15°C. Based on the PHTO sounding, these temperatures corresponded to cloud-top heights of approximately 6,800 and 3,500 feet, respectively. It should be noted that these images are not corrected for any parallax error.

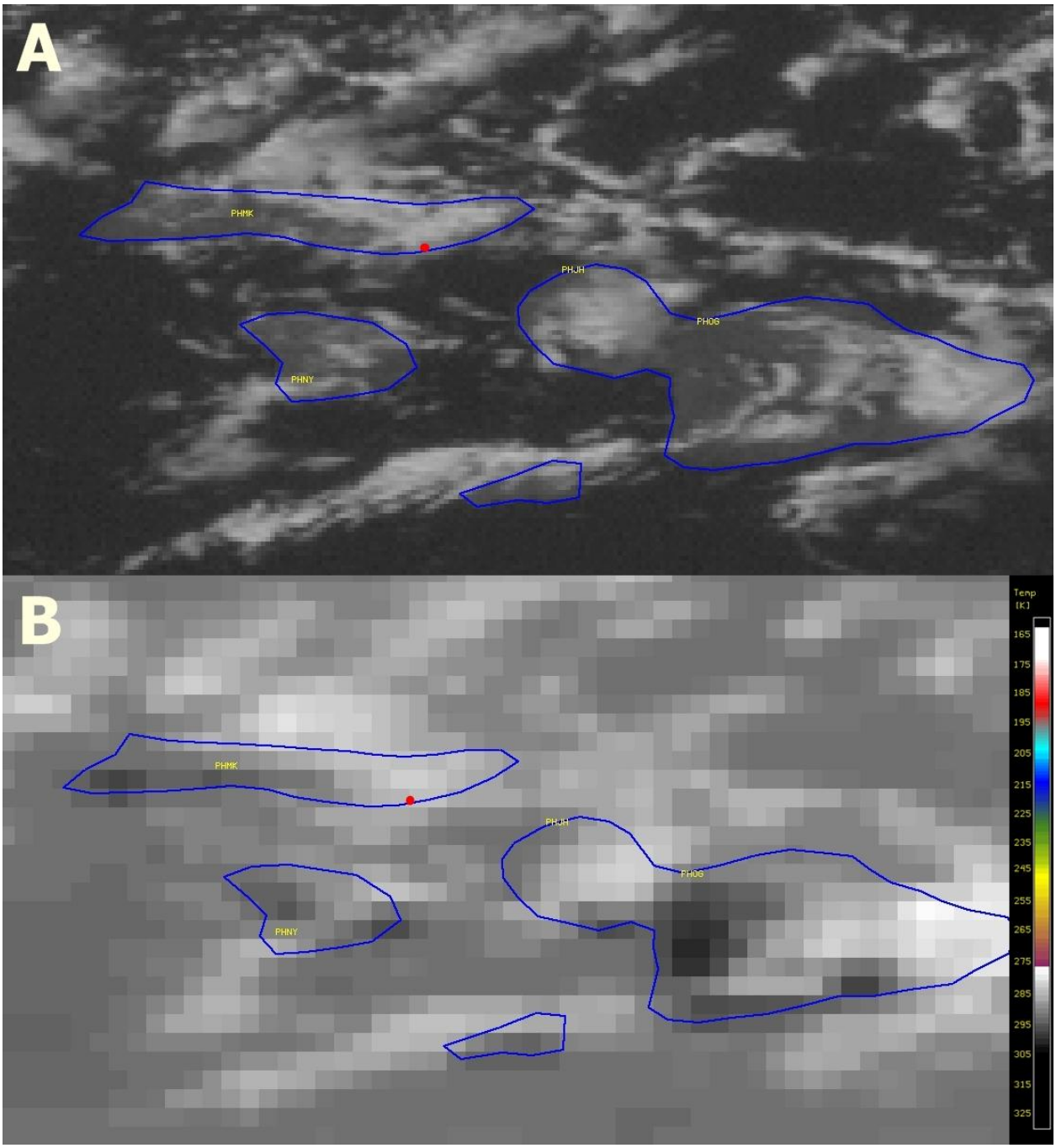

Figure 20 – GOES-11 imagery from 1215 HST. Panel A: 0.65µm (visible). Panel B: 10.7µm.

6. Helicopter Cameras

Video and transcripts of audio recorded by tour helicopters operating in the area of the accident near the accident time are described in the On Board Video Recorder Specialist's Factual Report.

7. Witness Interviews

On scene interviews with ground-based witnesses and pilots operating in the area were conducted by the NTSB Operations Group and summaries of these interviews can be found in their entirety in the Operations/Witness Group Chairman's Factual Report. Presented here are portions of these interviews relating to the meteorological conditions observed around the time of the accident near/at the accident location. Ground-based witness locations are presented in figure 21. Positions of the pilots operating in the area may be found in the Operations/Witness Group Chairman's Factual Report.

Ground-based witness John Austin - *Mr. Austin…stated he was outside his home under a covered patio when a squall of heavy rain, which consisted of large raindrops, and heavy wind entered the area. Mr. Austin stated that the wind was stronger than normal because it shook his house, doesn't normally happen; he estimated the wind to be about 45 knots out of the northeast.*

Ground-based witness Jay Duquette - *Mr. Duquette reported that he was working outside of his home when it started to rain abnormally hard for the area. After a squall had passed, his attention was drawn toward the helicopter…Mr. Duquette reported that it was not raining at his home at the time of the accident, although, in the mountains, it was very dark and rainy with limited visibility.*

Ground-based witness Shannon Lopez – *(Mr. Lopez) mentioned that he was unsure if the object was falling from the helicopter or not because the area was obscured by fog, heavy rain and weather.*

Ground-based witness Floyd Kapuni - *Mr. Kapuni reported that the weather in the area was raining hard with "big rain;" The squall was all dark and the rain was dark; he couldn't see the mountains.*

Ground-based witness Walter Paleka - *Mr. Paleka…reported that at the time of the accident, the weather was ok and not raining, although it was cloudy back in the valley. He further stated that right after the accident it started to rain with winds a little stronger than normal.*

Ground-based witness (unknown) Kaiula - *Mr. Kaiula noted that the clouds were very low.*

Figure 21 – Location of ground-based witnesses at the time of the accident.

Pilot witness Dave Schneider - *(Mr. Schneider) reported that throughout the morning, the weather conditions were continually decreasing with the wind out of the northeast. Mr. Schneider stated that earlier that day he had flown in the area where the accident occurred; he had experienced many updrafts, downdrafts, and microbursts, to the point where it "scared the crap out of me." He further reported that the visibility was "great" below the clouds and out of the heavy rain. Mr. Schneider reported that he departed the Island of Maui at 1130-1135 and was conducting a tour flight around the Island of Molokai at the time of the accident. He estimated that during the flight, the clouds around the island were about 2,000 to 2,100 feet high…Mr. Schneider continued southbound along the eastern side of the island and crossed over to the southern shore where he was experiencing a "little bit of a bumpy ride." While flying across the south side of the island, he briefly observed the accident helicopter flying along the south side of the mountain ridges just below the clouds. Mr. Schneider stated that he could not see the main rotor of the helicopter, just the silhouette. From Mr. Schneider's perspective, he stated that the accident helicopter appeared to be straight and level and did not appear to be in any form of distress…Mr. Schneider gave the NTSB a cut out picture from a newspaper of the accident scene right after the accident occurred (Figure 22) and stated that the clouds looked very similar during the flight as they do in the picture.*

Figure 22 – Newspaper picture referenced by Dave Schneider.

Pilot witness Fred Adler - *Mr. Adler reported that he observed large moderate/heavy rain showers along the shoreline at the time of the accident.*

Pilot witness Cliff Cates - *Mr. Cates reported that…at the time of the accident, his coworker was flying on the east side of the Island of Maui. Mr. Cates explained that the weather on the east side of the Island of Maui is generally the same as the weather on the South side of the Island of Molokai due to the northeast trade winds. His coworker told Mr. Cates that the rain was so heavy at the time that he had to set the helicopter down on the mountainside for about seven minutes, which is an abnormal action for his coworker. Right after Mr. Cates got the call about the accident, he noted that the weather was "crappy" in between the Island of Maui and the Island of Molokai. He arrived in the vicinity of the accident about 20-26 minutes after the initial call. At that time, it was raining pretty heavily and, as a whole, the weather was really poor. He set the helicopter down in a school yard; about 5 to 6 minutes later, the weather lifted and he flew up to survey the accident scene….(afterward) as he waited at the school yard, he noticed that the weather was changing about every 15 minutes or so. The weather would be VFR weather and suddenly change to very "heavy crappy weather." Mr. Cates reported that these squalls were similar to normal; they were just very quick, small and condensed. When asked, Mr. Cates reported that the wind was a constant 25-30 knots; the wind would pick up "a little bit" as the squalls approached. When asked about the best sources for information about the*

weather around the Island of Molokai Mr. Cates reported that the best source of weather was through reading PIREPs and looking at radar. There are not enough weather stations around the islands; the weather can change dramatically from where the stations are to the weather on the other side of the island.

Pilot witness Chris Currier - *Mr. Currier reported that…as he crossed the (Pailolo) channel, the ceilings were about 1,000 feet high. When asked what the weather conditions were like on the southern mountain ridge, Mr. Currier stated that the clouds were at about 1,500 feet with descending ceilings. He further stated that when he says descending, he is referring to the fact that the ceilings were descending parallel along the mountain ridge. As a whole, the weather was VFR with rain showers coming from the northeast. The wind was about 20-25 knots.*

Pilot witness Al Ruiz - *Mr. Ruiz reported that he was flying around the Island of Molokai at the same time of the accident pilot. He reported that, at the time, the clouds were about 2,000 feet high with light rain; the wind over the water was believed to be about 10-15 knots. Mr. Ruiz mentioned that there were a lot of little cells moving through the area constantly, which is nothing out of the ordinary. When asked about common areas of turbulence on the island, Mr. Ruiz stated that with a southeast wind, the Wailau Valley can be very turbulent. With a northeast wind, the southern side of the island, where the accident occurred, can also have some turbulence.*

Pilot interview Erick Hamp - *Mr. Hamp reported that the only real weather issues associated with tour flying around that area are speedy descents through clouds with heavy updrafts. So far, there has never been an issue getting down, it just makes the descent more difficult because the pilot is fighting air going in the opposite direction. Another potential weather issue is when clouds of rain showers happen to cross the flight path. This also normally does not cause an issue, it just takes away from the tour. In terms of weather extremes, Mr. Hamp reported that the heaviest wind he has seen in the area was 40 knots, and that he has only seen severe turbulence on the islands once since he moved to Hawaii about 1.5 years ago. Mr. Hamp stated that he normally avoids the rain because the purpose of the flight is for touring and, when flying in the rain, the passengers cannot see anything. He also reported that he has not experienced any microbursts while flying in Hawaii.*

8. Terminal Aerodrome Forecasts

The closest Terminal Aerodrome Forecast (TAF)[10] location to the accident site was PHJH. The TAF issued for PHJH at 0731 HST forecasted between 0900 and 2200 HST: wind from 050° at 20 knots with gusts to 30 knots, visibility greater than 6 miles, rain showers in the vicinity, scattered clouds at 2,000 feet agl, scattered clouds at 4,000 feet agl.

[10] TAFs are only official and valid for a radius of 5 statute miles from the airport or forecasted point.

PHJH 101731Z 1018/1118 05015KT P6SM VCSH SCT020 SCT040
FM101900 05020G30KT P6SM VCSH SCT020 SCT040
FM110800 05015KT P6SM VCSH SCT020 BKN040
AMD NOT SKED AFT 110400=

A TAF issued for PHMK at 0731 HST forecasted for the accident time: wind from 050° at 15 knots with gusts to 25 knots, visibility greater than 6 miles, rain showers in the vicinity, scattered clouds at 2,500 feet agl, ceiling broken at 4,500 feet agl.

PHMK 101731Z 1018/1118 **05015G25KT P6SM VCSH SCT025 BKN045**
FM110400 05012G20KT P6SM VCSH SCT022 BKN035=

Prior to the 0731 HST PHMK TAF, a TAF was issued for PHMK at 0120 HST that forecasted for the accident time: wind from 050° at 15 knots with gusts to 25 knots, visibility greater than 6 miles, rain showers in the vicinity, scattered clouds at 2,500 feet agl, ceiling broken at 4,500 feet agl.

PHMK 101120Z 1012/1112 05012G20KT P6SM VCSH FEW022 SCT045
FM102000 05015G25KT P6SM VCSH SCT025 BKN045
FM110400 05012G20KT P6SM VCSH SCT023 BKN040=

A TAF issued for PHOG at 0731 HST forecasted for the accident time: wind from 050° at 18 knots with gusts to 28 knots, visibility greater than 6 miles, rain showers in the vicinity, scattered clouds at 2,500 feet agl, ceiling broken at 5,000 feet agl.

PHOG 101731Z 1018/1118 05010KT P6SM VCSH FEW025 BKN050
FM101900 05018G28KT P6SM VCSH SCT025 BKN050
FM110400 05012KT P6SM VCSH SCT020 BKN040
FM111000 05005KT P6SM VCSH SCT020 BKN040=

Prior to the 0731 HST PHOG TAF, a TAF was issued for PHOG at 0120 HST that forecasted for the accident time: wind from 050° at 21 knots with gusts to 30 knots, visibility greater than 6 miles, rain showers in the vicinity, scattered clouds at 2,500 feet agl, ceiling broken at 5,000 feet agl.

PHOG 101120Z 1012/1112 05007KT P6SM VCSH FEW025 BKN050
FM101900 05021G30KT P6SM VCSH SCT025 BKN050
FM110400 04015KT P6SM VCSH SCT023 BKN040=

9. AIRMETs

An AIRMET TANGO for temporary moderate turbulence below 10,000 feet was issued at 1145 HST for areas over and immediately south through west of mountains on all Hawaiian Islands.

WAHW31 PHFO 102145
WA0HI
HNLS WA 102200
AIRMET SIERRA UPDATE 3 FOR IFR VALID UNTIL 110400
.
NO SIGNIFICANT IFR EXP.
=HNLT WA 102200
AIRMET TANGO UPDATE 3 FOR TURB VALID UNTIL 110400
.
AIRMET TURB...HI
OVER AND IMT S THRU W OF MT ALL ISLANDS.
TEMPO MOD TURB EXP BLW 100. COND CONT BEYOND 0400Z.
=HNLZ WA 102200
AIRMET ZULU UPDATE 3 FOR ICE AND FZLVL VALID UNTIL 110400
.
NO SIGNIFICANT ICE EXP.
.
FZLVL...128 PHLI.

Prior to the 1145 AIRMET TANGO, an AIRMET TANGO for temporary moderate turbulence below 10,000 feet was issued at 0530 HST for areas over and immediately south through west of mountains on all Hawaiian islands.

WAHW31 PHFO 101530
WA0HI
HNLS WA 101600
AIRMET SIERRA UPDATE 2 FOR IFR VALID UNTIL 102200
.
NO SIGNIFICANT IFR EXP.
=HNLT WA 101600
AIRMET TANGO UPDATE 2 FOR TURB VALID UNTIL 102200
.
AIRMET TURB...HI
OVER AND IMT S THRU W OF MT ALL ISLANDS.
TEMPO MOD TURB EXP BLW 100. COND CONT BEYOND 2200Z.
=HNLZ WA 101600
AIRMET ZULU UPDATE 2 FOR ICE AND FZLVL VALID UNTIL 102200
.
NO SIGNIFICANT ICE EXP.
.

FZLVL...130.

10. SIGMETs

No SIGMETs were in effect for the times surrounding the accident near the accident location.

11. Area Forecast

An Area Forecast that included the Moloka'i area that was issued at 1140 HST and was valid until 0000 HST on November 11, 2011, advised of a surface wind from the east-northeast with a magnitude of 25-30 knots over mountain ridges and through valleys. In addition, for the north through east sections of mountainous areas, as well as the waters adjacent to Moloka'i, the following conditions were forecasted: scattered clouds at 2,500 feet, ceiling broken at 4,500 feet, cloud tops to 9,000 feet; temporary conditions of ceiling broken at 2,000 feet and visibility 3 to 5 miles with rain showers and mist; isolated conditions of ceiling broken at 1,500 feet with cloud tops to 12,000 feet, visibility at or below 3 miles, heavy rain showers and mist.

FAHW31 PHFO 102140
FA0HI
HNLC FA 102140
SYNOPSIS AND VFR CLD/WX
SYNOPSIS VALID UNTIL 111600
CLD/WX VALID UNTIL 111000...OUTLOOK VALID 111000-111600
.
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 DENOTED BY AGL OR CEILING.
.
SYNOPSIS...SFC HIGH FAR N OF THE ISLANDS SUPPORTING STRONG AND GUSTY ENE WINDS. AN UPR LVL TROUGH OVER THE ISLANDS WILL KEEP THE ATMOSPHERE MODERATELY UNSTABLE.
.
ENTIRE AREA.
SFC WIND OVR MT RIDGES AND THRU VALLEYS ENE 25-30 KT.
..
MT...N THRU E SECTIONS AND ADJ WATERS OF KAUAI OAHU MOLOKAI AND MAUI.
SCT025 BKN045 TOPS 090 TEMPO BKN020 VIS 3-5SM SHRA BR ISOL BKN015 TOPS 120 VIS AOB 3SM +SHRA BR. OUTLOOK...MVFR SHRA.

Prior to the 1140 HST Area Forecast, an Area Forecast that included the Moloka'i area was issued at 0535 HST and was valid until 1800. This Area Forecast advised of a surface wind from the east-northeast with a magnitude of 25-30 knots over mountain ridges and through valleys. In addition, for the north through east sections of mountainous areas, as well as the waters adjacent to Moloka'i, the following conditions were forecasted: scattered clouds at 2,500 feet, ceiling broken at 4,500 feet, cloud tops to 9,000 feet; temporary conditions: ceiling broken at 2,000 feet and visibility 3 to 5 miles with rain showers and mist; isolated conditions: ceiling broken at 1,500 feet with cloud tops to 12,000 feet, visibility at or below 3 miles, heavy rain showers and mist.

FAHW31 PHFO 101535
FA0HI
HNLC FA 101540
SYNOPSIS AND VFR CLD/WX
SYNOPSIS VALID UNTIL 111000
CLD/WX VALID UNTIL 110400...OUTLOOK VALID 110400-111000
.
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 DENOTED BY AGL OR CEILING.
.
SYNOPSIS...SFC HIGH FAR N OF THE ISLANDS SUPPORTING STRONG AND GUSTY ENE WINDS. AN UPR LVL TROUGH OVER THE ISLANDS WILL KEEP
THE ATMOSPHERE MODERATELY UNSTABLE.
.
SFC WIND OVR MT RIDGES AND THRU VALLEYS ENE 25-30 KT.
.
MT...N THRU E SECTIONS AND ADJ WATERS OF KAUAI OAHU MOLOKAI AND MAUI.
SCT025 BKN045 TOPS 090 TEMPO BKN020 VIS 3-5SM SHRA BR ISOL BKN015 TOPS 120 VIS AOB 3SM +SHRA BR. OUTLOOK...MVFR SHRA.

12. Gale Warning

A Marine Weather Message from the NWS in Honolulu was issued at 0334 HST that advised of a Gale Warning currently in effect for the Pailolo Channel (see figure 23) with northeast winds up to 35 knots and gusts up to 45 knots. The advisory also indicated that a Gale Warning means winds of 34 to 47 knots are imminent or occurring.

WHHW70 PHFO 101334
MWWHFO
URGENT - MARINE WEATHER MESSAGE

NATIONAL WEATHER SERVICE HONOLULU HI
334 AM HST THU NOV 10 2011
...ELEVATED WINDS AND SEAS GENERATING ROUGH...HAZARDOUS OCEAN CONDITIONS OVER THE NEXT COUPLE OF DAYS...
.HIGH PRESSURE NORTH OF THE STATE WILL PRODUCE MODERATE TO STRONG TRADE WINDS OVER THE NEXT COUPLE OF DAYS.
PHZ120-121-124-110245-
/O.CON.PHFO.GL.W.0003.000000T0000Z-111111T0400Z/
PAILOLO CHANNEL-ALENUIHAHA CHANNEL-BIG ISLAND SOUTHEAST WATERS-
334 AM HST THU NOV 10 2011
...GALE WARNING REMAINS IN EFFECT UNTIL 6 PM HST THIS EVENING...
A GALE WARNING REMAINS IN EFFECT UNTIL 6 PM HST THIS EVENING.
* **WINDS AND SEAS...THROUGH EARLY THURSDAY EVENING...NORTHEAST WINDS UP TO 35 KNOTS...WITH GUSTS UP TO 45 KNOTS.** ROUGH SEAS 13 TO 15 FEET.

PRECAUTIONARY/PREPAREDNESS ACTIONS...
A GALE WARNING MEANS WINDS OF 34 TO 47 KNOTS ARE IMMINENT OR OCCURRING. OPERATING A VESSEL IN GALE CONDITIONS REQUIRES EXPERIENCE AND PROPERLY EQUIPPED VESSELS. MARINERS WITHOUT THE PROPER VESSEL AND EXPERIENCE SHOULD REMAIN IN PORT UNTIL THE GALE CONDITIONS END.

Figure 23 – Map of the Hawaiian Islands immediately surrounding the accident location that identifies the marine channels by name.

13. Wind Advisory

A Wind Advisory (presented below) from the NWS in Honolulu was issued at 0400 HST that advised of a northeast wind at 15 to 30 miles per hour (mph) (13 to 26 knots) with gusts up to 45 mph (39 knots) for a region that included portions of Maui County and Moloka'i. The advisory also indicated that a Wind Advisory means that sustained winds of 30 mph (26 knots), with gusts to 50 mph (43 knots), are expected.

WWHW70 PHFO 101400
NPWHFO
URGENT - WEATHER MESSAGE
NATIONAL WEATHER SERVICE HONOLULU HI
400 AM HST THU NOV 10 2011
...WIND ADVISORY FOR **PORTIONS OF MAUI COUNTY** AND THE BIG ISLAND...

.STRONG HIGH PRESSURE FAR NORTH OF THE ISLANDS IS DRIVING STRONG AND GUSTY TRADE WINDS. THESE WINDS ARE ACCELERATING AROUND THE HIGH MOUNTAINS OF MAUI AND THE BIG ISLAND...RESULTING IN STRONG SUSTAINED WINDS OVER PORTIONS OF MOLOKAI...MAUI...LANAI AND THE BIG ISLAND.
HIZ012-014-015-017>019-021-024>026-110200-
/O.CON.PHFO.WI.Y.0023.000000T0000Z-111111T0400Z/
MOLOKAI WINDWARD-LANAI MAKAI-LANAI MAUKA-MAUI WINDWARD WEST-MAUI LEEWARD WEST-MAUI CENTRAL VALLEY-LEEWARD HALEAKALA-SOUTH BIG ISLAND-BIG ISLAND NORTH AND EAST-KOHALA-
INCLUDING THE CITIES OF...KALAUPAPA...MANELE...LANAI CITY...WAILUKU...LAHAINA...KAANAPALI...KAHULUI...KIHEI...MAKENA... SOUTH POINT...PAHALA...HILO...VOLCANO...HONOKAA...KAMUELA... WAIKOLOA
400 AM HST THU NOV 10 2011
...WIND ADVISORY REMAINS IN EFFECT UNTIL 6 PM HST THIS EVENING...
A WIND ADVISORY REMAINS IN EFFECT UNTIL 6 PM HST THIS EVENING.
*** WINDS...NORTHEAST 15 TO 30 MPH WITH GUSTS UP TO 45 MPH.**
* TIMING...WINDS WILL REMAIN AT ADVISORY LEVELS TODAY THEN FALL BELOW ADVISORY LEVELS OVERNIGHT.
* IMPACTS...THE STRONG WINDS MAY RESULT IN DOWNED BRANCHES AND TREE LIMBS...AND WILL MAKE FOR DIFFICULT DRIVING CONDITIONS.
PRECAUTIONARY/PREPAREDNESS ACTIONS...
A WIND ADVISORY MEANS THAT SUSTAINED WINDS OF 30 MPH...WITH GUSTS TO 50 MPH...ARE EXPECTED. SECURE ANY LOOSE OBJECTS THAT MAY BECOME AIRBORNE...OR MOVE THEM INDOORS. MOTORISTS...ESPECIALLY THOSE IN VANS AND IN LARGE TRUCKS...SHOULD SLOW DOWN WHEN ENCOUNTERING STRONG WINDS.
&&
$$

14. Area Forecast Discussion

An Area Forecast Discussion was issued at 1027 HST for Hawaii that discussed “strong and gusty” trade winds and the need for a wind advisory and gale warning to remain in place through the afternoon, the potential for heavy showers, and aviation-specific ceiling and visibility forecasts.

FXHW60 PHFO 102027
AFDHFO

AREA FORECAST DISCUSSION
NATIONAL WEATHER SERVICE HONOLULU HI
1000 AM HST THU NOV 10 2011
.SYNOPSIS...
A STRONG HIGH NORTH OF THE AREA WILL MAINTAIN **LOCALLY STRONG AND GUSTY TRADE WINDS**. THE WINDS WILL GRADUALLY WEAKEN STARTING TOMORROW AS THE HIGH MOVES EAST AND WEAKENS. MEANWHILE...A LOW ALOFT WILL REMAIN NEAR THE ISLANDS AND KEEP THE WEATHER UNSETTLED. THE TRAILING END OF A FRONTAL BAND WILL MOVE OVER THE ISLANDS TONIGHT AND PRODUCE INCREASING SHOWERS AND POSSIBLE THUNDERSTORMS THROUGH FRIDAY. THE THREAT OF HEAVY SHOWERS WILL DECREASE STARTING SATURDAY.
&&
.DISCUSSION...
A STRONG 1035MB HIGH LIES ABOUT 1150 MILES NORTH OF KAUAI NEAR 38N156W. THE GLOBAL MODELS ARE IN GOOD AGREEMENT SHOWING THE HIGH REMAINING NEARLY STATIONARY AND WEAKENING SLIGHTLY THROUGH FRIDAY NIGHT...THEN MOVING AWAY SLOWLY TO THE EAST. **A WIND ADVISORY FOR WINDY AREAS OF MAUI COUNTY AND THE BIG ISLAND AND A GALE WARNING FOR THE PAILOLO AND ALENUIHAHA CHANNELS WILL REMAIN UP THROUGH THIS AFTERNOON.** AS THE HIGH WEAKENS A BIT AND THE WINDS WEAKEN NOCTURNALLY WE EXPECT TO BE ABLE TO CANCEL THE WIND ADVISORY AND GALE WARNING...BUT IT WILL REMAIN QUITE BREEZY AND THE SMALL CRAFT ADVISORY WILL REMAIN UP.
MEANWHILE...WATER VAPOR IMAGERY AND UPPER AIR ANALYSES SHOW A BLOCKING PATTERN ALOFT WITH A HIGH ABOUT 700 MILES NORTH OF KAUAI NEAR 33N160W AND A LOW ABOUT 275 MILES SOUTH OF OAHU NEAR 17N159W. THE LOW IS FORECAST TO MOVE SLOWLY NORTH NORTHEAST OVER THE NEXT SEVERAL DAYS. COLD AIR ALOFT ASSOCIATED WITH THE LOW IS MAKING THE ATMOSPHERE UNSTABLE OVER THE MAIN HAWAIIAN ISLANDS. THE 12Z SOUNDING FROM HILO SHOWED A LIFTED INDEX OF -4.3 WHILE THE LIHUE SOUNDING HAD A -5.4 LI.
THE INSTABILITY OVER THE ISLANDS HAS BEEN MAKING THE WEATHER RATHER SHOWERY...SINCE CLOUDS RIDING IN ON THE STRONG TRADES CAN BUILT UP HIGH ENOUGH TO PRODUCE LOCALLY HEAVY SHOWERS. THERE ARE CURRENTLY NO WELL ORGANIZED LOW LEVEL FEATURES OVER THE ISLANDS TO FOCUS SHOWER ACTIVITY...BUT THAT WILL CHANGE TONIGHT. A BAND OF SHOWERY LOW CLOUDS AND TOWERING CUMULUS CLOUDS ASSOCIATED WITH A SHEAR LINE IS NORTH OF A LINE FROM 22N150W TO 225 MILES NORTH OF HILO TO 60 MILES NORTH OF KAUAI. THIS CLOUD BAND WILL REACH THE ISLANDS LATE TONIGHT BRINGING MORE AND HEAVIER SHOWERS. THE INCREASED LOW LEVEL

MOISTURE WILL ALSO BRING A SLIGHT CHANCE FOR THUNDERSTORMS TONIGHT AND FRIDAY AND AN INCREASED CHANCE OF SNOW ON THE SUMMITS OF MAUNA KEA AND MAUNA LOA. WE HAVE ISSUED A WINTER WEATHER ADVISORY FOR THE SUMMITS. AS THE LOW ALOFT MOVES NORTHEAST AND WEAKENS...TEMPERATURES ALOFT WILL BECOME LESS COLD AND THE ATMOSPHERE WILL BECOME MORE STABLE. AS THE SHEAR LINE BREAKS UP AND MOVES OFF TO THE SOUTHWEST LOW LEVEL MOISTURE WILL DECREASE. AND AS THE STRONG SURFACE HIGH MOVES EAST THE TRADE WINDS WILL GRADUALLY WEAKEN. MODERATE TRADE WINDS AND A MORE TYPICAL TRADE-WIND WEATHER PATTERN WILL PREVAIL FOR THE FIRST HALF OF NEXT WEEK.

&&

.AVIATION...

AIRMET TANGO REMAINS UP FOR TURBULENCE BLW 100 S AND W OF MT...DUE TO BRISK TRADE WINDS OVER ROUGH TERRAIN. SHRA MOVG IN WITH THE TRADE WNDS WILL PRODUCE BRIEF MVFR CEILINGS AND VIS...MAINLY FOR WINDWARD TERMINALS. A CLOUD BAND REACHING THE ISLANDS TONIGHT BRING AN INCREASE IN CLOUDS AND SHOWERS AND MAY REQUIRE AN AIRMET FOR MT OBSC.

&&

.MARINE...

GALE WARNINGS REMAIN IN EFFECT FOR THE PAILOLO AND ALENUIHAHA CHANNELS AND SOUTHEAST BIG ISLAND WATERS. THE WINDS WILL CONTINUE TO BE FUNNELED AND ACCELERATED AROUND THE TERRAIN OF THE ISLANDS TODAY. A SMALL CRAFT ADVISORY IS IN EFFECT FOR THE REMAINING COASTAL WATERS DUE TO THE STRONG WINDS OF 25 KNOTS OR GREATER AND COMBINED SEAS OF 10 FT OR GREATER. THESE CONDITIONS WILL PERSIST TODAY BEFORE STARTING TO SLOWLY DIMINISH.

THE HIGH SURF ADVISORY FOR EAST FACING SHORES WILL CONTINUE THROUGH SUNDAY. ROUGH...WIND-DRIVEN SURF AND AN INCOMING NORTH NORTHEAST SWELL WILL CREATE HAZARDOUS CONDITIONS ALONG EXPOSED EAST FACING SHORES.

&&

.HFO WATCHES/WARNINGS/ADVISORIES...

WINTER WEATHER ADVISORY FROM THIS EVENING THROUGH FRIDAY MORNING FOR THE SUMMITS OF MAUNA KEA AND MAUNA LOA.

HIGH SURF ADVISORY THROUGH SUNDAY AFTERNOON FOR EAST FACING SHORES OF KAUAI...OAHU...MOLOKAI...MAUI..AND THE BIG ISLAND.

WIND ADVISORY THROUGH THIS AFTERNOON FOR MOLOKAI WINDWARD-LANAI- MAUI WINDWARD WEST-MAUI LEEWARD WEST-

MAUI CENTRAL VALLEY-LEEWARD HALEAKALA-SOUTH BIG ISLAND-BIG ISLAND NORTH AND EAST-KOHALA.
GALE WARNING THROUGH THIS AFTERNOON FOR PAILOLO AND ALENUIHAHA CHANNELS AND BIG ISLAND SOUTHEAST WATERS.
SMALL CRAFT ADVISORY THROUGH FRIDAY AFTERNOON FOR ALL REMAINING COASTAL WATERS.
&&
$$
DONALDSON

15. Pilot Weather Briefing

At 1036 HST, a weather briefing was provided to "Blue 42" by Lockheed Martin Flight Service. Lockheed Martin identified Blue 42 as the accident aircraft. A transcript of the weather briefing and associated memo is presented in Attachment 2 to this report.

It should be noted that neither the Wind Advisory nor the Gale Warning was part of the weather briefing. FAA Order JO 7110.10V[11], which prescribes air traffic control procedures, did not identify these advisories in its relevant pilot briefing sections. In addition, communication between the NTSB and Lockheed Martin Flight Service revealed that these non-aviation-specific advisories would not have been available to their weather briefers as part of their normal suite of briefing data.

16. Astronomical Data

The astronomical data obtained from the United States Naval Observatory for 21.1°N and 156.8°W on Thursday, November 10, 2011, indicated the following for HST:

SUN	
Sunrise	0635
Sun transit	1211
Sunset	1748

MOON	
Moonset	0632
Moonrise	1751

[11] effective February 9, 2012

F. LIST OF ATTACHMENTS

Attachment 1: Report by Dr. Yi-Leng Chen, Professor of Meteorology at the University of Hawaii at Manoa

Attachment 2: A transcript of the Lockheed Martin Flight Service weather briefing to "Blue 42" and associated memo:

Submitted by: Mike Richards
NTSB, AS-30