APPENDIX

Upper Air and Surface Wind Observations[1,2]

1. Introduction

During the period of "Project Shower", special observations were made of upper winds over the Hilo coast and surface winds at selected points on the windward slopes of Mauna Loa and Mauna Kea on the Island of Hawaii. The purpose of the observations was to obtain data from which estimates could be made of air flow through the saddle during "budget" operations and to supplement regular upper wind observations taken at Hilo by the U.S. Weather Bureau.

2. Upper Winds

The upper winds observations were obtained with a mobile unit equipped for taking single theodolite pilot balloon measurements. The objective was to obtain, in as short a time as possible, a series of upper wind measurements along a line approximately normal to the direction of trade-wind flow. Six stations were established between Mountain View, located 12 miles south of Hilo, and Hakalau, about 15 miles to the north (see Location Map). The first release of each series was made at Mountain View, followed by subsequent releases at successive stations north-

[1] Prepaered by L. E. Eber, present affiliation: U.S. Fish and Wildlife Service. Stanford University, PALO ALTO, CALIFORNIA.

[2] Published with the approval of the Director as Technical Paper No. 247 of the Pineapple Research Institute of Hawaii.

Table 1. Upper Winds (Pibal)

25 October 1954

Altitude feet above sea level	Olaa 1442 HST		Wainaku 1527 HST		Pepeekeo 1610 HST		Honomu 1628 HSS		Hakalau 1647 HST	
	Dir. degs.	Speed m.p.h.	Dir. degs.	Speed m.p.h.	Dir. degs.	Speed m.p.h.	Dir. degs.	Speed m.p.h.	Dir. degs.	Speed m.p.h.
500	70	11	80	10	—	—	100	8	105	13
1,000	75	11	85	9	110	9	100	13	105	14
1,500	85	11	95	8	110	8	95	14	110	14
2,000	95	10	105	8	110	8	105	10	105	12
2,500	100	9	120	8					115	12
3,000	95	7	125	7						
3,500	95	6	130	6						
4,000	100	4	155	5						
4,500	115	4	170	6						
5,000	110	4	175	6						
5,500	100	5	165	7						
6,000	100	5	155	7						
6,500	105	6	140	9						
7,000	115	8	130	13						
7,500			125	15						
8,000			125	14						

6 November 1954

Altitude feet above sea level	Mtn. View 1520 HST		Olaa 1543 HST		Wainaku 1617 HST		Pepeekeo 1643 HST		Hakalau 1702 HST	
	Dir. degs.	Speed m.p.h.	Dir. degs.	Speed m.p.h.	Dir. degs.	Speed m.p.h.	Dir. degs.	Speed m.p.h.	Dir. degs.	Speed m.p.h.
500	—	—	—	—	65	5	—	—	155	7
1,000	—	—	45	5	110	4	160	7	140	9
1,500	—	—	50	7	100	6	130	8	140	10
2,000	35	8	50	7	100	6	120	9	145	10
2,500	50	9	55	6	100	5	130	5	140	11
3,000	50	9	65	7	110	8	125	5		
3,500	40	7	65	7						
4,000	30	8	70	4						

7 November 1954

Altitude feet above sea level	Mtn. View 1131 HST		Olaa 1205 HST		Pepeekeo 1400 HST		Hakalau 1339 HST	
	Dir. degs.	Speed m.p.h.	Dir. degs.	Speed m.p.h.	Dir. degs.	Speed m.p.h.	Dir. degs	Speed m.p.h.
500	—	—	—	—	—	—	90	8
1,000	—	—	60	18	65	7	70	10
1,500	—	—	65	16	45	6	65	8
2,000	60	15	70	11	55	11	65	8
2,500	60	15	60	12	55	15		
3,000	60	14	55	11	45	14		
3 500	50	13			40	13		
4,000	45	10						

25 November 1954

Altitude feet above sea level	Mtn. View 1525 HST		Olaa 1548 HST		Wainaku 1630 HST		Pepeekeo 1700 HST	
	Dir. degs.	Speed m.p.h.	Dir. degs.	Speed m.p.h.	Dir. degs.	Speed m.p.h.	Dir. degs.	Speed m.p.h.
500	—	—	—	—	80	3	—	—
1,000	—	—	65	8	80	4	140	4
1,500	—	—	65	10	90	5	110	6
2,000	40	10	65	11	95	7	105	8
2,500	40	10	70	10	95	10	105	9
3,000	35	10	65	12	95	11	100	11
3,500	30	12	60	11	90	10	95	10
4,000			50	10	85	8	90	8
4,500			40	9	75	5	85	7
5,000			30	11			90	6
5,500			25	11			90	7
6,000			35	10			90	11
6,500							85	16
7,000							90	20
7,500							90	23
8,000							85	25
8,500							80	26
9,000							75	27
9,500							75	27
10,000							70	25

26 November 1954

Altitude feet above sea level	Mtn. View 1525 HST		Olaa 1603 HST		Wainaku 1742 HST		Pepeekeo 1709 HST	
	Dir. degs.	Speed m.p.h.	Dir. degs.	Speed m.p.h.	Dir. degs.	Speed m.p.h.	Dir. degs.	Speed m.p.h.
500	—	—	—	—	190	9	—	—
1,000	—	—	105	12	170	10	155	11
1,500	—	—	110	12	160	11	160	12
2,000	65	7	115	11	160	12	160	14
2,500	65	8	115	10	160	12	155	16
3,000	75	8	125	9	165	12	155	17
3,500	70	7	130	8	170	12	150	17
4,000	55	6	135	7	175	14	150	16
4,500	30	5	125	6			145	16
5,000	25	6	120	6			135	17
5,500	45	9	115	7			120	20
6,000	65	12	120	8			120	21
6,500	70	14	105	10			120	21
7,000	70	11	95	13			120	18
7,500	90	7	95	14			125	15
8,000	115	7	100	11			130	12
8,500	115	7	115	9			135	11
9,000	110	8	130	8			125	9
9,500	100	9	135	7			110	8
10,000	80	12	120	7			80	9
11,000	65	13	70	12			45	10
12,000			55	12			55	10
13,000			45	12				
14,000			25	14				

30 November 1954

Altitude feet above sea level	Mtn. View 1428 HST		Olaa 1500 HST		Pepeekeo 1556 HST		Hakalau 1628 HST	
	Dir. degs.	Speed m.p.h.	Dir. degs.	Speed m.p.h.	Dir. degs.	Speed m.p.h.	Dir. degs.	Speed m.p.h.
500	—	—	—	—	—	—	180	12
1,000	—	—	20	8	195	3	170	13
1,500	—	—	40	8	150	5	155	13
2,000	25	10	55	10	135	9	150	13
2,500	50	12	65	12			145	11
3,000	70	14	70	13				
3,500	70	16	75	15				
4,000			80	18				

ward. The entire series could be completed in about two hours. The data obtained from these observations, made on nine days during the project period, are given in table 1. Most runs were short due to the presence of low clouds.

3. Surface Winds

Standard three-cup anemometers with recorders were installed along the Saddle Road at three sites designated SR2100, SR4500 and C77 on the Location Map. The recorders indicated each mile of wind passage against time. The total miles of wind passing the anemometers were also read daily direct from the counter on each instrument. The anemometers at SR2100 and SR4500 were each mounted on pipes extending 7 feet above the roofs of shacks situated in forest clearings about 100 feet across. The instrument

1 December 1954

Altitude feet above sea level	Mtn. View 1422 HST		Olaa 1447 HST		Wainaku 1523 HST		Pepeekeo 1554 HST		Hakalau 1618 HST	
	Dir. degs.	Speed m.p.h.	Dir. degs.	Speed m.p.h.	Dir. degs.	Speed m.p.h.	Dir. degs.	Speed m.p.h.	Dir. degs.	Speed m.p.h.
500	—	—	—	—	60	4	—	—	130	4
1,000	—	—	30	13	75	6	125	5	130	9
1,500	—	—	35	12	80	7	120	6	125	10
2,000	20	9	35	11	80	8	115	6	125	11
2,500	25	11	35	10	80	9	115	7	125	11
3,000	30	13	35	9	85	9	110	8	125	11
3,500	35	14			85	9	110	9	120	11
4,000	35	15			90	10	110	10	115	12
4,500	35	17			95	10	105	10		
5,000	40	17			95	11	100	12		
5,500	50	18			95	13	95	14		
6,000	60	18			95	16				
6,500	70	20								
7,000	70	20								
7,500	70	20								

2 December 1954

Altitude feet above sea level	Mtn. View 1409 HST		Olaa 1428 HST		Wainaku 1502 HST		Pepeekeo 1527 HST		Honomu 1612 HST		Hakalau 1547 HST	
	Dir. degs.	Speed m.p.h.	Dir. degs.	Speed m.p.h.	Dir. degs.	Speed m.p.h.	Dir. degs.	Speed m.p.h.	Dir. degs.	Speed m.p.h.	Dir. degs.	Speed m.p.h.
500	—	—	—	—	90	17	—	—	90	14	80	15
1,000	—	—	55	15	90	16	80	16	90	15	85	15
1,500	—	—	60	16	90	14	85	18	90	16	90	16
2,000	75	17	65	16			85	19	90	16	90	17
2,500	75	17	65	15			85	18	90	15		
3,000	70	14					85	16	90	15		

3 December 1954

Altitude feet above sea level	Mtn. View 1405 HST		Olaa 1340 HST		Wainaku 1440 HST		Pepeekeo 1512 HST		Honomu 1603 HST		Hakalau 1537 HST	
	Dir. degs.	Speed m.p.h.	Dir. degs.	Speed m.p.h.	Dir. degs.	Speed m.p.h.	Dir. degs.	Speed m.p.h.	Dir. degs.	Speed m.p.h.	Dir. degs.	Speed m.p.h.
500	—	—	—	—	Calm		—	—	Calm		180	8
1,000	—	—	360	7	Calm		90	2	125	2	145	8
1,500	—	—	40	8	70	4	90	7	100	5	105	10
2,000	25	8	70	10	85	7	85	9	85	8	95	12
2,500	35	8			90	10	80	10	75	10	90	13
3,000	45	7			85	10	75	10	70	10	90	13
3,500					75	9	70	8	70	8	85	11
4,000					70	9	65	7			75	9
4,500											70	8

at C77 was installed on a pipe about 7 feet above the ground atop a small cinder cone which rose to a height of about 150 feet above the surrounding lava fields.

Table 2. Daily Surface Wind Speeds at Saddle Road Station C 50

(Average Speeds for 24 Hours Preceding Indicated Times, in Miles per Hour).

Date	C 50 Time	C 50 Speed
Oct 20	1550	M
Oct 21	1215	9.8
Oct 22	1125	9.3
Oct 23	1124	7.7
Oct 24	1024	10.0
Oct 25	1029	9.0
Oct 26	1035	7.1
Oct 27	1040	5.8
Oct 28	1107	4.2
Oct 29	1023	4.0
Oct 30	0958	4.5
Oct 31	1049	6.8
Nov 1	1103	7.0
Nov 2	1034	5.6
Nov 3	1125	6.0
Nov 4	1125	6.0
Nov 5	1043	5.6
Nov 6	1004	5.6
Nov 7	M	M
Nov 8	M	M
Nov 9	1057	7.3
Nov 10	1044	6.2
Nov 11	1047	6.7
Nov 12	1030	5.5
Nov 13	1050	6.9
Nov 14	1029	6.4
Nov 15	1030	10.0
Nov 16	M	M
Nov 20	1040	5.6
Nov 21	M	M
Nov 23	M	M
Nov 24	M	M
Nov 28	1044	6.6
Nov 29	1147	6.1
Nov 30	1027	5.8
Dec 1	1605	11.6
Dec 2	1543	9.8
Dec 3	1450	7.1
Dec 4	1511	2.4

M indicates missing data.

A non-recording anemometer, located at C50 about 6 feet above the ground over open pasture land, was read daily.

Average daily wind speeds from this instrument are given in table 2. Wind speeds at four hour intervals given by the recording anemometers appear in table 3.

At Keaau Orchard (Station 98) wind speed and direction were obtained with a recording anemometer and wind vane. These data, tabulated for four hour intervals, are given in table 4. While the recorder gave the wind direction to four cardinal points of the compass only, intermediate directions were assumed when uniform fluctuations between any two points occurred. The anemometer and vane were mounted about 16 feet above the roof of a quonset building situated in a large clearing in a macadamia nut orchard.

Wind speed and direction indicators were installed at Kulani Camp (Station 79) and read hourly. Data from these instruments, tabulated for four hour intervals, are given in table 5. The anemometer was a three-cup generator type instrument which did not work well at low wind speeds, cutting off below 4 mph. The anemometer and vane were mounted on a pipe extending 7 feet above the roof of a one-story building in a large forest clearing.

Four-hourly values of surface wind speed and direction at Hilo Airport, provided by the U.S. Weather Bureau, are given in table 6.

4. Diurnal Variation of Surface Vind

The surface wind data contain evidence of a diurnal wind regime. Graphs of hourly wind direction frequency and average wind speed for Hilo Airport, Keaau Orchard and Kulani Camp are shown in figs. 1 to 3. Graphs of average hourly wind speed for the three recording anemometers located along the Saddle Road appear in fig. 4.

The principal features of the diurnal wind system, as demonstrated by figs. 1 to 4, are a westerly (downslope) flow occurring at night, and an easterly (upslope) flow during the day time. The speed of the downslope wind appears to be fairly uniform and smaller in magnitude than the upslope flow. The latter increases during the morning and reaches a mixamum at midday. The morning transition from westerly to easterly flow appears to take place earlier at Kulani Camp, at 5,000 feet above sea level, than at Keaau Orchard or Hilo which are near the coast. Westerly winds prevail from 1900 to 0700 or 0800 HST.[2] The frequency of southerly winds (not shown on the graphs) at Kulani and Hilo reach a maximum, amounting to 20—25 percent of all observations, between 0800 and 1100 HST, suggesting that the morning shift in direction is counterclockwise through south.

[2] Hawaiian Standard Time, 150th meridian civil time, is abbreviated HST.

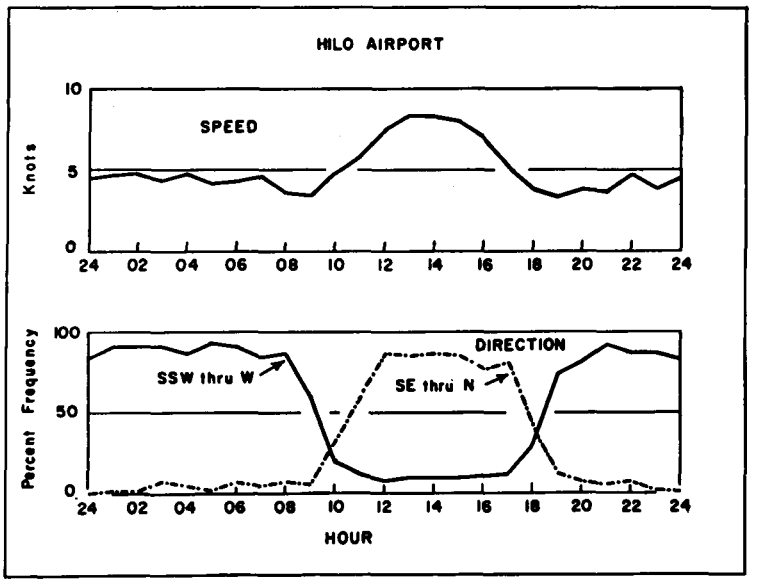

Fig. 1.

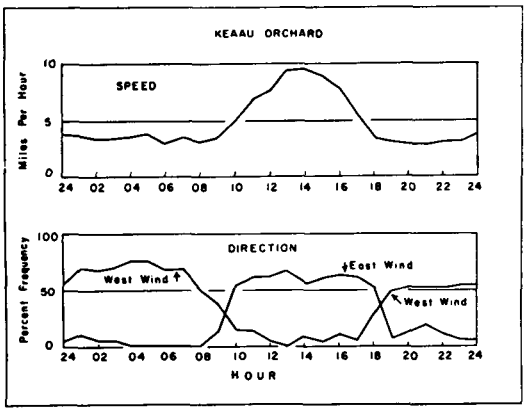

Fig. 2.

Fig. 1. Surface winds at Hilo Airport for the period 20 October to 5 December 1954. *Upper graph*—average hourly wind speed. *Lower graph*—average frequency of occurrence of winds from south-southwest through west (solid line) and of winds from north through southeast (broken line).

Fig. 2. Surface winds at Keaau Orchard for the periods 20 to 22 October and 8 November to 4 December 1954. *Upper graph*—average hourly wind speed. *Lower graph*—average frequency of occurrence of west and east winds.

Fig. 3. Surface winds at Kulani Camp for the period 28 October to 4 December 1954. *Upper graph*—average hourly wind speed. *Lower graph*—average frequency of occurrence of winds from west northwest through north (solid line) and winds from north-northeast through south-southeast (broken line).

Fig. 4. Average hourly wind speeds for Saddle Road anemometers at SR2100, SR4500 and C77 for the period 20 October to 4 December 1954.

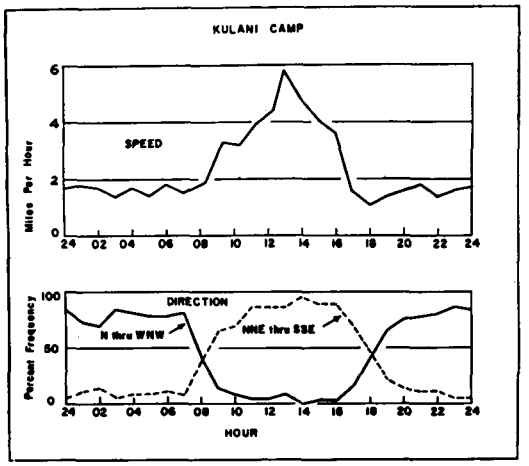

Fig. 3.

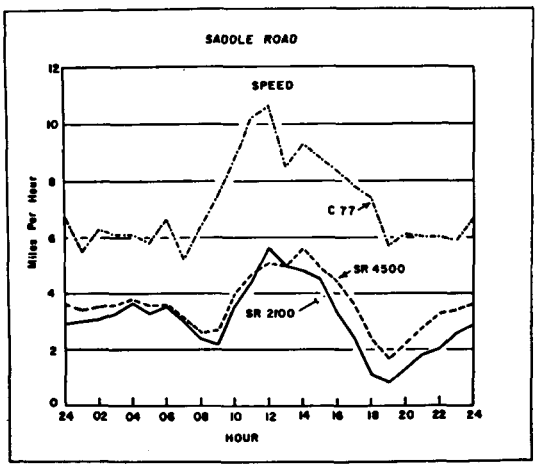

Fig. 4.

Table 3. Four-Hourly Surface Wind Speeds at Saddle Road Stations
(Miles per Hour).

Date	SR 2,100						SR 4,500						C 77					
	Time						Time						Time					
	04	08	12	16	20	24	04	08	12	16	20	24	04	08	12	16	20	24
Oct 20	6	0	2	1	2	0	6	2	4	5	1	4	8	8	13	12	10	10
Oct 21	4	1	0	0	4	4	4	2	4	4	2	4	8	8	15	10	10	13
Oct 22	0	4	8	8	2	4	4	1	5	5	2	4	12	7	M	M	M	M
Oct 23	1	1	4	4	2	2	0	1	M	M	M	M	M	M	12	9	8	10
Oct 24	4	2	6	6	0	2	M	M	M	M	M	M	6	10	M	12	6	7
Oct 25	5	4	5	5	0	4	M	M	M	M	M	M	5	10	12	10	7	M
Oct 26	2	2	1	1	1	2	M	M	M	M	M	M	M	M	10	8	7	4
Oct 27	1	4	6	2	0	0	M	M	M	5	1	1	5	4	9	8	5	8
Oct 28	2	0	6	2	0	2	0	2	6	5	0	2	7	5	6	5	2	4
Oct 29	4	0	5	1	M	M	2	2	6	4	1	2	4	7	7	6	4	0
Oct 30	M	M	M	M	M	M	5	2	6	4	2	4	4	5	12	5	5	5
Oct 31	M	M	6	5	1	5	5	2	6	5	M	M	5	6	9	6	6	6
Nov 1	5	2	5	4	1	4	M	M	6	6	1	5	5	6	13	9	5	5
Nov 2	M	M	M	2	0	2	4	4	6	4	1	5	5	1	9	6	1	6
Nov 3	5	5	7	2	1	6	5	4	M	M	M	M	1	4	M	M	M	1
Nov 4	5	M	6	4	0	1	M	M	1	2	5	6	M	M	7	6	2	2
Nov 5	4	1	8	1	M	M	M	M	6	4	2	5	1	4	12	8	7	6
Nov 6	M	M	4	4	0	1	6	4	6	4	1	1	9	10	13	8	8	5
Nov 7	1	0	M	1	0	4	2	2	M	6	2	4	6	2	8	8	6	9
Nov 8	2	2	6	M	M	M	5	1	4	4	2	5	7	8	13	14	12	7
Nov 9	M	M	7	1	2	0	4	1	6	5	4	4	9	6	13	12	8	9
Nov 10	M	M	6	6	4	6	4	2	5	5	1	4	6	6	10	8	6	2
Nov 11	7	5	8	6	0	5	4	4	6	5	2	4	M	M	10	6	5	4
Nov 12	5	4	7	4	0	5	5	4	5	5	1	5	2	1	10	9	5	7
Nov 13	6	4	7	5	1	6	5	2	6	4	5	6	8	6	12	10	7	6
Nov 14	5	2	5	4	0	1	4	2	6	4	2	2	7	7	13	8	7	10
Nov 15	4	2	7	2	4	2	4	2	6	4	4	5	6	8	13	12	7	9
Nov 16	5	M	M	M	M	M	5	5	7	M	M	M	7	7	10	M	M	M
Nov 19	M	M	7	4	0	4	M	M	7	4	1	5	M	M	8	6	2	5
Nov 20	5	2	7	5	4	6	5	1	6	5	2	6	4	5	9	6	5	5
Nov 21	6	5	8	M	M	M	5	5	4	6	M	M	5	5	8	M	M	M
Nov 22	M	M	7	2	0	5	M	M	6	2	0	6	M	M	8	6	1	2
Nov 23	6	4	6	5	1	5	7	2	6	6	2	6	1	4	8	7	6	6
Nov 24	5	2	7	M	M	M	5	2	6	M	M	M	5	7	10	M	M	M
Nov 27	M	M	6	5	2	2	M	M	6	9	1	2	M	M	13	15	8	12
Nov 28	4	5	7	7	2	4	1	2	9	10	2	4	9	9	17	7	10	9
Nov 29	4	2	M	M	M	M	4	2	2	4	4	2	10	9	M	8	5	7
Nov 30	M	M	M	M	2	0	2	2	2	4	4	4	6	6	10	12	7	14
Dec 1	2	1	M	4	2	4	5	2	4	4	2	1	9	12	12	M	7	9
Dec 2	4	1	M	2	5	0	5	2	5	5	4	2	10	10	12	M	9	8
Dec 3	1	1	M	1	0	0	2	2	5	6	2	2	7	7	8	7	M	M
Dec 4	4	5	4	M	M	M	5	6	4	M	M	M	M	M	M	M	M	M

Notes: Tabulated values are averages for one hour preceding indicated times.
Times are Hawaiian Standard Time.
M indicates missing data.

Table 4. Surface Winds at Keaau Orchard
(Speeds in Miles per Hour).

Date	Time											
	0400		0800		1200		1600		2000		2400	
	Dir.	Speed	Dir.	Speed	Dir.	Speed	Dir.	Speed	Dir.	Speed	Dir.	Speed
Oct 20	W	3	Calm		E	2	W	3	W	2	W	1
Oct 21	M	M	M	M	M	M	E	4	E	6	E	4
Oct 22	Calm		M	2	M	M	M	M	M	M	M	M
Nov 8	M	M	M	M	M	M	NE	7	W	3	E	4
Nov 9	S	3	SW	4	E	10	E	8	Vrbl	2	S	2
Nov 10	W	4	S	3	E	10	E	11	S	2	S	3
Nov 11	SW	4	S	3	E	M	E	12	S	3	S	4
Nov 12	W	6	Vrbl	2	E	10	M	M	M	M	M	M
Nov 15	M	M	S	1	E	8	E	8	SW	2	W	3
Nov 16	W	3	S	2	E	9	E	8	W	2	W	2
Nov 17	W	2	S	2	E	9	E	11	W	3	W	2
Nov 18	W	3	S	4	E	10	E	11	S	2	S	3
Nov 19	S	4	S	3	E	M	M	M	M	M	M	M
Nov 22	M	M	Calm		E	M	E	9	S	2	W	2
Nov 23	W	1	W	3	E	10	E	9	W	1	W	3
Nov 24	W	2	W	4	NE	7	M	M	M	M	M	M
Nov 26	M	M	M	M	NE	6	M	M	M	M	M	M
Nov 29	M	M	M	M	SE	2	E	4	Vrbl	1	W	3
Nov 30	W	5	W	3	W	4	N	2	W	3	NE	10
Dec 1	W	3	W	4	M	M	N	7	W	3	W	4
Dec 2	N	8	N	10	NE	13	N	13	E	9	NE	9
Dec 3	W	5	W	4	NW	5	W	5	W	4	W	5
Dec 4	W	6	W	7	N	6	M	M	M	M	M	M

Notes: Tabulated values are average speeds and prevailing directions for one hour preceding indicated times.
Times are Hawaiian Standard Time.
M indicates missing data.
Vrbl stands for variable.

Table 5. Surface Winds and

(Miles

Date	Time of Observation					
	0400		0800		1200	
	Wind	Weather	Wind	Weather	Wind	Weather
Oct 28						
Oct 29	SE C	M	NE C	M	E C	M
Oct 30	N C	M	N C	M	NE 12	M
Oct 31	N C	M	NNE 9	M	NE C	M
Nov 1	NNW 5	Clear	N 10	Clear	SE C	Clear
Nov 2	NW C	Clear	SW C	Clear	ESE 9	Clear
Nov 3	NW C	Clear	SE C	Clear	SE C	Clear
Nov 4	NW C	Clear	NE C	Clear	NE C	Clear
Nov 5	NW C	Clear	NE C	Clear	SE C	Clear
Nov 6	NW C	Clear	WSW C	Rain	ENE 6	Cldy
Nov 7	WNW C	Clear	N 5	Clear	NE 9	Clear
Nov 8	N 12	Pt Cldy	NNE 8	Rain	ENE C	Clear
Nov 9	WNW C	Clear	NW C	Clear	E C	Rain
Nov 10	NW C	Lt Rain	ENE C	Clear	NE C	Clear
Nov 11	W C	Clear	NW C	Clear	SE C	Clear
Nov 12	NW C	Clear	ENE C	Clear	ENE C	Clear
Nov 13	NNW C	Clear	NNE C	Clear	NE C	Clear
Nov 14	NW 4	Clear	NE C	Clear	NE 8	Clear
Nov 15	NNW C	Clear	NW C	Clear	SE C	Clear
Nov 16	NNW C	Clear	NNW C	Clear	E 5	Clear
Nov 17	WNW 5	Clear	E C	Clear	NE C	Clear
Nov 18	NW C	Clear	WSW C	Clear	E 7	Clear
Nov 19	WNW C	Clear	SW C	Clear	SE 7	Clear
Nov 20	NW C	Clear	NE C	Clear	S C	Clear
Nov 21	WNW C	Clear	SE C	Clear	SE 10	Clear
Nov 22	NW C	Clear	WSW C	Clear	SE C	Clear
Nov 23	NW C	Clear	N C	Clear	NE 6	Clear
Nov 24	NW 7	Clear	N 8	Clear	NE 10	Clear
Nov 25	N C	Clear	NE C	Clear	NE 5	Clear
Nov 26	N C	Clear	ENE C	Clear	NE 7	Clear
Nov 27	SW C	Rain	SW 10	Drzl	SW 16	Rain
Nov 28	SW 10	Th Rain	SW 10	Rain	SSW 15	Rain
Nov 29	W C	Clear	NNW C	Lt Rain	WNW C	Drzl
Nov 30	NNE 4	Rain	N 4	Rain	NNE 8	Clear
Dec 1	NNW 5	Clear	N 6	Rain	N 7	Lt Rain
Dec 2	N 10	Lt Drzl	NNE C	Lt Rain	ENE 5	Lt Rain
Dec 3	NNE C	Drzl	N C	Drzl	NNE C	Clear
Dec 4	NNW C	Clear	N C	Clear	ENE 12	Lt Drzl

Notes: Data in this table pertain to conditions at times of observation.
C indicates wind speeds from 0—3 mph, inclusive.
M indicates missing data.
The following abbreviations are used: Pt = Partly; Cldy = Cloudy; Lt = Light; Th = Thunder; Drzl = Drizzle.
Times are Hawaiian Standard Time.

Weather at Kulani Camp

per Hour).

Date	Time of Observation					
	1600		2000		2400	
	Wind	Weather	Wind	Weather	Wind	Weather
Oct 28			NW C	M	NW C	M
Oct 29	E C	M	NE C	M	NW C	M
Oct 30	NE C	M	N 4	M	NNW 5	M
Oct 31	NNE 7	M	NNW 6	M	NW C	M
Nov 1	SE C	Clear	NW C	Lt Rain	NW C	Lt Drzl
Nov 2	NNE C	Clear	WNW C	Clear	NNW 6	Clear
Nov 3	E 6	Clear	NW C	Clear	NW C	Cldy
Nov 4	ENE C	Clear	NW C	Clear	NNW C	Fog
Nov 5	E C	Clear	NE C	Pt Cldy	W C	Pt Cldy
Nov 6	ENE C	Clear	NW C	Lt Rain	WNW C	Drzl
Nov 7	NE 5	Drzl	N 9	Clear	N 10	Clear
Nov 8	ENE 13	Clear	WNW C	Clear	NNW C	Clear
Nov 9	E 6	Clear	W C	Clear	NW C	Clear
Nov 10	ENE C	Clear	NW C	Clear	W C	Clear
Nov 11	NE 6	Clear	NW C	Clear	WNW C	Cldy
Nov 12	NE C	Clear	NW C	Clear	N C	Clear
Nov 13	NE 5	Clear	NW 6	Clear	N C	Lt Drzl
Nov 14	ENE 10	Clear	N 5	Clear	N C	Clear
Nov 15	NE 5	Clear	NW 5	Clear	NW 5	Clear
Nov 16	NE 6	Clear	NW C	Clear	NNW 5	Clear
Nov 17	E 5	Clear	NW C	Clear	NW C	Clear
Nov 18	E C	Clear	NW C	Clear	WNW C	Clear
Nov 19	SE C	Clear	W C	Clear	NW C	Fog
Nov 20	E 5	Clear	WNW C	Clear	NW 5	Clear
Nov 21	NE C	Clear	NW C	Pt Cldy	NW C	Clear
Nov 22	NE C	Clear	NW 6	Clear	NW C	Clear
Nov 23	S C	Clear	NW C	Clear	NW 5	Clear
Nov 24	NE 5	Clear	NW 7	Clear	N C	Clear
Nov 25	NE 10	Drzl	N C	Cldy	NW C	Clear
Nov 26	SE C	Cldy	SW C	Cldy	NNW C	Cldy
Nov 27	SW 14	Rain	SW C	Cldy	SW 10	Cldy
Nov 28	SSW 6	Cldy	SSE C	Cldy	W C	Cldy
Nov 29	ENE C	Cldy	N C	Clear	NNE 4	Cldy
Nov 30	NNE 5	Drzl	NNW 6	Clear	NNE 5	Clear
Dec 1	N 6	Lt Rain	NNW 5	Rain	N C	Rain
Dec 2	NNE C	Drzl	NNE C	Fog	N C	Drzl
Dec 3	NNE C	Clear	NNE C	Clear	N 4	Clear
Dec 4	ENE 8	Lt Drzl				

Table 6. Surface Winds at Hilo Airport

(Speeds in Miles Per Hour).

Date	Time of Observation											
	0400		0800		1200		1600		2000		2400	
	Dir.	Speed	Dir.	Speed	Dir.	Speed	Dir	Speed	Dir.	Speed	Dir.	Speed
Oct 20	WSW	4	SE	1	N	6	W	4	SW	4	Calm	
Oct 21	WSW	4	SW	4	W	2	NNW	5	SE	5	S	2
Oct 22	W	2	S	2	SE	7	SE	11	SW	2	SW	5
Oct 23	S	3	W	6	N	4	ENE	6	W	5	SW	5
Oct 24	SW	5	SE	3	NE	6	SE	1	SSW	6	SW	6
Oct 25	WSW	4	SSW	3	E	4	E	9	E	5	NW	4
Oct 26	SSW	5	SW	2	SW	4	W	4	W	7	WSW	3
Oct 27	SW	4	SW	2	E	10	ESE	8	SW	3	SW	4
Oct 28	W	4	W	3	Calm		W	7	SW	3	SW	4
Oct 29	WSW	5	SW	3	E	7	SE	8	SW	2	SW	5
Oct 30	SW	5	W	2	E	10	ENE	6	SW	5	SW	5
Oct 31	SW	5	WSW	4	S	5	E	6	SW	4	W	4
Nov 1	WSW	5	WSW	4	ENE	9	E	7	SW	3	SW	4
Nov 2	W	4	WSW	4	ESE	10	SE	7	W	4	SW	5
Nov 3	WSW	4	SSW	4	ESE	5	ESE	9	S	3	SW	4
Nov 4	WSW	4	WSW	4	E	9	E	8	WSW	3	WSW	6
Nov 5	WSW	5	W	7	E	10	ESE	5	WSW	2	WSW	3
Nov 6	WSW	2	W	3	N	5	E	3	WSW	3	Calm	
Nov 7	W	3	WSW	4	NE	6	NNW	3	WNW	3	WSW	4
Nov 8	WSW	4	WNW	4	E	7	ENE	8	W	4	S	12
Nov 9	S	7	SW	5	ESE	9	SSE	5	SSW	3	SW	4
Nov 10	SSW	4	SW	4	ESE	12	SE	12	S	6	S	4
Nov 11	WSW	5	SW	4	E	12	ESE	11	SW	4	SW	5
Nov 12	SW	6	WSW	5	ESE	11	ESE	7	SW	4	SW	4
Nov 13	SW	5	WSW	4	ENE	8	E	5	WSW	1	WSW	5
Nov 14	WSW	4	Calm		NNE	3	NW	3	SSE	4	W	2
Nov 15	SSW	3	SW	4	ESE	10	ESE	8	SW	4	SW	4
Nov 16	SW	3	SSW	3	ESE	9	ESE	7	SE	6	W	5
Nov 17	W	4	SW	4	SE	6	ESE	10	SSW	4	WSW	7
Nov 18	S	5	W	4	SE	6	ESE	8	SW	4	SW	4
Nov 19	SW	4	SW	3	SE	12	SE	14	SSW	3	SSW	5
Nov 20	SW	6	WSW	3	NE	5	SE	11	S	2	SW	6
Nov 21	SW	6	SW	5	SE	15	ESE	10	SSW	3	SW	4
Nov 22	SW	4	SSW	2	E	9	ESE	7	SSW	4	SW	6
Nov 23	SW	5	SSW	4	ESE	9	ENE	4	SSW	4	WSW	6
Nov 24	WSW	7	SW	4	ESE	8	SE	6	SW	3	WSW	6
Nov 25	WSW	4	SSW	3	E	4	E	5	W	3	W	4
Nov 26	WSW	1	Calm		ENE	8	ESE	9	SW	6	S	5
Nov 27	ESE	4	SW	7	SW	12	SW	8	SW	5	SW	6
Nov 28	SSW	7	SSW	4	SSE	11	SSE	17	SSW	5	S	12
Nov 29	SSW	6	SSW	3	S	4	Calm		SW	4	Calm	
Nov 30	W	5	Calm		NNE	4	Calm		W	2	S	3
Dec 1	W	4	SW	3	N	6	NE	4	W	4	WSW	4
Dec 2	E	8	E	11	ESE	14	ESE	9	W	5	WSW	2
Dec 3	WNW	9	WNW	4	N	6	W	4	WSW	2	W	4
Dec 4	WSW	7	WSW	4	N	4	NE	7	WSW	3	WSW	4

Notes: Data in this table pertain to conditions at times of observations.
Times are Hawaiian Standard Time.