this instant that the terrestrial (not solar) radiation is most absorbed, therefore all the conditions favor an excessive generation of ions and a change in the electric potential gradient. The fact that this element follows strictly the two type periods seen in the humidity and the barometric pressure makes it necessary that the absorption of energy and the ionization should be resultant functions occurring together in one general process. I believe that all the complex details observed regarding atmospheric electricity will be explained along these lines. Finally, in fig. 2, it is indicated that the diurnal deflecting wind components and the magnetic deflecting vectors of the earth's field are in close synchronism throughout the twenty-four hours, but by comparing them with the diurnal radiation of the sun and the temperature it is seen that they are simply parts of the single period system which is common to all strata of the atmosphere, except the lowest, in the three elements described, namely, the barometric pressure, vapor tension, and electric potential gradients. We infer, then, that since the double period depends strictly on the convectional rise and fall of the vapor sheet, the magnetic field is primarily more closely connected with the effects of the solar direct radiation throughout the atmosphere. What we lack in this connection is a series of observations to determine the variation of the magnetic components in the higher strata, which I doubt not will be found to be similar to those at the surface. In all respects it is evident that observation in the lower cloud region is as much demanded by the magnetician as by the meteorologist, to determine the subtle cross connections between the gaseous contents of the atmosphere and the electrical and the magnetical variations. But it seems to me very probable that the magnetic diurnal variations are due to a set of physical processes induced by the terrestrial radiation in the lower atmosphere. This may explain the fact that the incoming solar radiation does not seem to be the cause of the ionization which apparently precedes the generation of the electric and the magnetic disturbing forces. If this problem can be solved in the free air, it will probably also contribute important facts regarding our general knowledge of the relations between matter and ether. It is especially desirable to note that the facts which are now known indicate that the diurnal variation of the magnetic field of the earth is strictly a meteorological effect in the atmosphere, caused by the solar-terrestrial radiation, and that the order of production is (1) temperature, (2) electric potential, (3) magnetic deflection, somewhat as explained in Bulletin I, Eclipse Meteorology and Allied Problems.

HAWAIIAN CLIMATOLOGICAL DATA.

By CURTIS J. LYONS, Territorial Meteorologist.

GENERAL SUMMARY FOR DECEMBER, 1902.

Honolulu.—Temperature mean for the month, 70.8°; normal, 71.8°; average daily maximum, 75.9°; average daily minimum, 66.0°; mean daily range, 9.9°; greatest daily range, 18°; least daily range, 6°; highest temperature, 80°; lowest, 61°.

Barometer average, 29.938; normal, 29.970; highest, 30.11, 29th; lowest, 29.73, 10th; greatest 24-hour change, that is, from any given hour on one day to the same hour on the next, 0.10; lows passed this point on the 2d, 10th, and 21st; highs on the 5th, 14th, and 29th.

Relative humidity average, 77.7 per cent; normal, 75.7 per cent; mean dew-point, 63.1°; normal, 63.1°; mean absolute moisture, 6.39 grains per cubic foot; normal, 6.32 grains. There was an unusual period of low dew-point during the last ten days of the month.

Rainfall, 10.20 inches; normal, 3.92 inches; rain record days, 18; normal, 16; greatest rainfall in one day, 3.20, on the 22d; total at Luakaha, 26.50 inches; normal, 10.24 inches; total at Kapiolani Park, 7.81 inches; normal, 3.55 inches.

The artesian well level rose during the month from 33.90 to 34.57 feet above mean sea level. December 31, 1901, it stood at 34.05. The average daily mean sea level for the month was 9.87 feet, the assumed annual mean being 10.00 feet above datum. For December, 1901, it was 10.26. For the year 1902, 9.85. For the previous year, 10.17.

Rainfall data for December, 1902.

Stations.	Elevation.	Amount.	Stations.	Elevation.	Amount.
HAWAII.			**OAHU.**		
HILO, e. and ne.	*Feet.*	*Inches.*		*Feet.*	*Inches.*
Waiakea	50	15.40	Punahou (W. B.), sw.	47	10.20
Hilo (town)	100	15.48	Kulaokahua (Castle), sw.	50	8.94
Kaumana	1,250	.....	Makiki Reservoir	120	9.17
Pepeekeo	100	19.15	U. S. Naval Station, sw.	6	11.56
Hakalau	200	19.00	Kapiolani Park, sw.	10	7.81
Honohina	300	19.74	Manoa (Woodlawn Dairy), c.	285	15.75
Puuohua	1,050	34.84	Manoa (Rhodes Gardens)	300	21.02
Laupahoehoe	500	.....	School street (Bishop), sw.	175	.....
Ookala	400	23.48	College Hills	175	9.76
HAMAKUA, ne.			Insane Asylum, sw.	30	10.43
Kukaiau	250	24.99	Kamehameha School	75	10.94
Paauilo	750	29.25	Kalihi-Uka, sw.	450	21.35
Paauhau (Mill)	300	19.00	Nuuanu (W. W. Hall), sw.	50	10.38
Honokaa (Muir)	425	19.64	Nuuanu (Wyllie street)	250	13.28
Honokaa (Meinicke)	1,100	24.90	Nuuanu (Elec. Station), sw.	405	13.50
Kukuihaele	700	17.92	Nuuanu (Luakaha), c.	850	26.50
KOHALA, n.			Waimanalo, ne.	25	13.02
Niulii	200	14.87	Maunawili, ne.	300	19.45
Kohala (Mission)	521	13.62	Kaneohe	100	12.51
Kohala (Sugar Co.)	235	15.04	Ahuimanu, ne.	350	22.43
Puakea Ranch	600	10.43	Kahuku, n	25	11.85
Hawi	600	.....	Waialua	20	8.63
Puuhue Ranch	1,847	13.29	Wahiawa	900	.....
Waimea	2,720	16.84	Ewa Plantation, s.	60	5.14
KONA, w.			Waipahu	200	5.43
Kailua	950	.....	Moanalua	15	11.68
Holualoa	1,350	5.01	Laniakea (Nahuina)	1,150	15.00
Kealakekua	1,580	6.83	Tantalus Heights	1,360	17.04
Napoopoo	25	3.50	U. S. Experiment Station	350	10.69
Hoopuloa	1,650	3.78	Upper U. S. Exp. Sta. (Castle)	1,150	.....
KAU, se.			U. S. Magnetic Station	45	.....
Kahuku Ranch	1,680	4.69	**KAUAI.**		
Honuapo	15	5.38	Lihue (Grove Farm), e.	200	12.81
Naalehu	650	5.47	Lihue (Molokoa), e.	300	13.87
Hilea	310	8.20	Lihue (Kukaua), e.	1,000	19.17
Pahala	850	5.08	Vealia	15	.....
Moaula	1,700	.....	Kealia, e.	15	14.36
PUNA, e.			Kilauea, ne.	325	14.14
Volcano House	4,000	10.79	Hanalei, n.	10	27.64
Olaa, Mountain View (Russel)	1,690	20.95	Waioli	10	22.04
Kapoho	110	.....	Haena	15	.....
Pahoa	700	17.00	Waiawa	32	1.79
MAUI.			Eleele	200	3.83
Lahaina	200	5.37	Wahiawa	2,100	14.15
Waiopae Ranch	700	.....	Wahiawa (Mountain)	3,000	.....
Kaupo (Mokulau), s.	285	10.18	Lawai	200	5.18
Kipahulu, s	300	14.26	Lawai	450	7.97
Nahiku, ne	850	33.83	Lawai	800	7.37
Nahiku	1,600	.....	McBryde (Residence)	850	6.85
Haiku, n	700	14.70	*Delayed November reports.*		
Kula (Erehwon), n	4,500	9.93	Wahiawa Mountain	3,000	26.70
Kula (Waiakoa), n	2,700	5.31	Kealia	.....	7.33
Puuomalei, n	1,400	18.59	Kilauea, Kauai	.....	10.70
Haleakala Ranch	2,000	21.82	Grove Farm (Lihue)	.....	9.00
Wailuku, ne	200	7.96			

NOTE.—The letters n, s, e, w, and c show the exposure of the station relative to the winds.

Trade wind days, 17 (4 of north-northeast); normal, 16. Average force of wind during daylight, Beaufort scale, 2.3. Average cloudiness, tenths of sky, 5.2; normal, 4.4.

Approximate percentages of district rainfall as compared with normal: South Hilo, 160 per cent; North Hilo, 250 per cent; Hamakua, 400 per cent; Kohala, 330 per cent; Waimea (Hawaii), 380 per cent; Kona, 300 to 400 per cent; Kau, 140 to 300 per cent; Puna, 175 per cent; Maui, 150 to 500 per cent; Oahu, 220 per cent, except Kahuka, 420 per cent; Kauai, 320 per cent.

The month was a rainy one, and the whole year's rainfall, when published, will show surprising records. The heaviest rainfall for the month was at Puuohua, 34.84 inches; the heaviest 24-hour, 10.55, at Hanalei, Kauai, on the 11th; Nahiku (850 feet), 8.90, on the 18th.

Mean temperatures: Pepeekeo, Hilo district, 100 feet elevation, mean maximum, 75.0°; mean minimum, 68.2°; Waimea, Hawaii, 2730 elevation, 74.3° and 58.2°; Kohala, 521 elevation, 75.8° and 65.1°; Waiakoa, Kula, Maui, 2700 elevation, 73.3° and 56.6°; Puunene Mill, Maui, 200 (?) elevation, 77.0° and 65.1°; mean temperature, 69.8°; Ewa Plantation, 50 elevation,

79° and 63°; United States Experiment Station, 350 elevation, 76.3° and 65.9°; W. R. Castle, 60 elevation, highest, 79°; lowest, 61°; mean, 70.0°; United States Magnetic Station, 50 elevation, mean, 71.1°.

Ewa Mill, mean dew-point, 61°; mean relative humidity, 71 per cent; Kohala, Bond, dew-point, 64.5°; relative humidity, 82 per cent; Puunene, 66.4° and 86 per cent; Puunene, pressure 29.91; United States Magnetic Station, dew-point, 63°; relative humidity, 77 per cent.

The month was characterized by four storms, which were no doubt general. One that came in on the 1st from the previous month; then on the 11th, 22d, and finally the heavy blow which characterized the last week of the year, and which was attended by an unusual spell of low dew-point, showing winds from the far north.

Mauna Kea and Mauna Loa were heavily covered with snow at the close of the month; the storm of the 11–13th being especially marked.

Heavy surf, 1st, 12th, 28th, as centers of surf periods.

OBSERVATIONS AT HONOLULU.

The station is at 21° 18′ N., 157° 50′ W. It is the Hawaiian Weather Bureau station Punahou. (See fig. 2, No. 1, in the MONTHLY WEATHER REVIEW for July, 1902, page 365.)
Hawaiian standard time is 10h 30m slow of Greenwich time. Honolulu local mean time is 10h 31m slow of Greenwich.
The pressure is corrected for temperature and reduced to sea level, and the gravity correction, —0.06, has been applied.
The average direction and force of the wind and the average cloudiness for the whole day are given unless they have varied more than usual, in which case the extremes are given. The scale of wind force is 0 to 12, or Beaufort scale. Two directions of wind, or values of wind force, or amounts of cloudiness, connected by a dash, indicate change from one to the other.
The rainfall for twenty-four hours is measured at 9 a. m. local, or 7.31 p. m., Greenwich time, on the respective dates.
The rain gage, 8 inches in diameter, is 1 foot above ground. Thermometer, 9 feet above ground. Ground is 43 feet and the barometer 50 feet above sea level.

Meteorological Observations at Honolulu, December, 1902.

Date.	Pressure at sea level.	Temperature.		During twenty-four hours preceding 1 p. m. Greenwich time, or 1:30 a. m. Honolulu time.									Total rainfall at 9 a. m., local time.
				Temperature.		Means.		Wind.		Average cloudiness.	Sea-level pressures.		
		Dry bulb.	Wet bulb.	Maximum.	Minimum.	Dew-point.	Relative humidity.	Prevailing direction.	Force.		Maximum.	Minimum.	
	*	†	†			‡	‡		§				
1	29.91	70	69	80	66	68.3	87	ssw.	1-0	5-10	29.96	29.89	0.25
2	29.85	68	67.3	76	69	70.7	96	sw.	1-2	10	29.95	29.86	1.80
3	29.85	62	60.7	77	67	67.0	89	w-sw.	2-0	10	29.90	29.80	0.01
4	29.91	67	65	77	61	63.3	84	sw.	1-0	3	29.93	29.85	0.00
5	29.94	62	60	77	65	64.0	80	sw-w.	1-0	2	29.97	29.88	0.00
6	29.92	69	67	79	61	62.5	78	sw.	0	1-9	29.98	29.88	0.00
7	29.89	69	66	77	67	64.3	78	n-ne.	3	4	29.93	29.83	0.00
8	29.89	70	65.5	75	67	61.0	72	n-ne.	3-4	9	29.93	29.85	0.00
9	29.89	70	66	76	69	64.0	77	ne.	3	3	29.95	29.86	0.07
10	29.82	64	63.7	76	68	64.7	78	ne.	4-0	3-1	29.92	29.81	1.00
11	29.76	65	62.3	76	64	65.3	89	w-n.	1-0	2-8	29.85	29.73	0.80
12	29.89	67	65	73	64	59.7	73	n-nne.	6	9	29.94	29.78	1.40
13	29.94	69	66.5	72	65	64.5	82	ne.	4-1	7	29.96	29.87	0.15
14	30.02	70	64	76	67	65.7	84	ne.	3	6	30.05	29.92	0.84
15	30.07	71	66	75	68	58.7	64	ne.	3	3	30.09	29.99	0.00
16	30.04	67	66.3	76	70	65.3	77	ne.	3	4-10	30.09	30.00	0.05
17	30.00	66	65	80	66	66.7	84	ne-se.	1-0	4-10	30.06	29.97	0.00
18	29.94	73	68.5	78	65	66.7	82	s-n.	1-0	9	30.04	29.92	0.03
19	29.94	71	67	75	69	66.7	80	n-e.	1-0	10-8	29.98	29.90	0.14
20	29.89	65	64.3	79	69	65.7	80	s-n.	1-0	2-9	29.97	29.87	0.13
21	29.84	71	68	78	64	65.3	85	n-sw.	0	3-0	29.93	29.83	0.00
22	29.82	66	65.7	76	64	66.5	87	s-ne.	0	10	29.86	29.74	3.20
23	29.89	62	61	77	66	67.3	90	sw.	1-0	5-0	29.90	29.79	0.00
24	29.97	68	61.5	77	61	63.0	78	nne.	1-4	5-0	29.98	29.88	0.00
25	30.02	67	62	73	66	57.7	67	nne.	4	1-4	30.04	29.94	0.00
26	30.03	65	61	72	64	58.7	73	ne.	4	4	30.07	29.98	0.05
27	30.03	69	61	72	63	57.7	71	ne.	4-6	5	30.06	29.95	0.05
28	30.02	70	61.5	73	67	56.7	64	ne.	5-3	2-5	30.06	29.97	0.06
29	30.07	68	60.7	73	66	57.3	64	ne.	5-4	6	30.09	30.00	0.16
30	30.02	71	64.5	75	67	58.7	67	ne.	5-4	5	30.11	29.99	0.01
31	29.98	69	63.5	75	69	60.7	69	ne.	5-4	5	30.09	29.96	0.00
Sums													10.20
Means	29.937	67.8	64.4	75.9	66.0	63.1	77.7			2.3	5.2	29.988	29.890	
Departure	—.032					0.0	+2.0			+0.8			+6.28

Mean temperature for December, 1902, (6 + 2 + 9) + 3 = 70.8; normal is 71.8. Mean pressure for December, 1902, (9 + 3) + 2 = 29.938; normal is 29.970.
*This pressure is as recorded at 1 p. m., Greenwich time. †These temperatures are observed at 6 a. m., local, or 4.31 p. m., Greenwich time. ‡These values are the means of (6 + 9 + 2 + 9) + 4. §Beaufort scale.

Mr. Lyons also communicates Table No. 1 showing the rainfall at stations in the district of Hamakua, on the island of Hawaii. These stations are on a line from the north coast south southwestward toward the mountain of Mauna Kea, being on its lower slopes and at increasing elevations up to 5000 feet. They extend from the lowest station Kukaiau, at an elevation of 250 feet, southwestward toward the mountain top. The highest rainfall station is at an elevation of 5000 feet, but the summit of Mauna Kea is several miles farther on and at an elevation of 13,825 feet. We understand that the observations were originally communicated by Mr. J. M. Horner, of Kukaiau, to the Pacific Commercial Advertiser. Mr. Lyons notes that the rainfall is probably greatest at about 2000 feet elevation.

TABLE 1.—*Rainfall on the lower northeast slope of Mauna Kea.*

1902.	Kukaiau Mill.		Kainehe.		
	250 feet.	900 feet.	1450 feet.	3300 feet.	5000 feet.
	Inches.	*Inches.*	*Inches.*	*Inches.*	*Inches.*
January	3.29	4.31	4.14	2.77	.....
February	3.52	4.72	13.09	2.55	.....
March	62.76	79.41	93.39	78.30	27.01
April	8.23	12.32	14.74	22.77	4.96
May	17.51	22.15	29.88	7.08	9.60
June	5.99	5.68	12.65	4.88	2.75
July	2.69	2.02	2.48	0.06	0.60
August	14.66	18.44	32.62	9.88	0.60
September	8.34	5.90	8.06	2.52	0.92
October	6.95	6.61	9.96	5.68	0.34
November	13.45	15.87	19.56	10.86	6.50
December	24.99	27.18	34.89	33.24	1.50
Total	172.38	204.61	275.46	180.59	*54.78

*For 10 months only.

The complete record for the above-mentioned station Kainehe, at the elevation of 1450 feet, and for nine years, is as in Table 2:

TABLE 2.—*Monthly rainfalls at Kainehe.*

Month.	Year.								
	1894.	1895.	1896.	1897.	1898.	1899.	1900.	1901.	1902.
January	3.00	6.31	12.84	6.67	28.42	.49	5.32	9.49	4.14
February	11.69	10.32	14.46	5.72	5.35	.74	10.14	8.60	13.09
March	21.49	28.21	20.43	4.41	30.35	19.70	4.85	25.66	93.39
April	6.90	39.48	12.84	4.32	8.05	15.84	11.62	3.57	14.74
May	.34	5.86	10.56	1.57	4.12	3.54	16.14	.46	29.88
June	2.35	1.25	6.26	2.03	2.05	2.81	3.48	.21	12.65
July	3.98	9.65	3.93	1.67	5.58	5.96	2.62	1.07	2.48
August	4.66	7.77	9.37	6.70	4.59	7.22	4.17	.26	32.62
September	.35	6.92	1.50	1.44	1.03	1.60	1.15	.70	8.06
October	2.84	3.67	6.41	.89	3.19	23.35	7.59	5.03	9.96
November	20.25	11.54	1.15	9.60	3.47	8.00	18.14	17.56	19.56
December	17.84	.57	11.17	7.60	10.99	.09	5.71	14.75	34.89
Totals	95.69	131.55	110.92	52.62	107.19	89.34	90.93	87.36	275.46

CLOUD BURSTS.

By H. H. TEN BROECK, Braidentown, Fla., dated September 26, 1902.

In the MONTHLY WEATHER REVIEW for May, 1902, page 265, there is an article on a tornado in which the writer mentions as one of the results the formation of hollows in the ground. Such facts are sometimes doubted. I have seen several such excavations, a dozen or more. They all occurred during storms of unprecedented precipitation; the excavations were about 15 to 20 feet in diameter and about 5 feet deep. On the hillside above them there was no more than the ordinary disturbance of the surface made by a heavy rain. The excavations were all well defined and at a short distance looked as though they were cellars dug for houses; those that I saw first I mistook for such cellars, and asked "Who is going to build?" but was told, "No one that we know of." I went to the spot and found two excavations, about 6 or 8 yards apart, on the side of a bluff. The evidence was conclusive that they were made by columns or spouts of water falling from the clouds on a slant; on one side the roots of the vegetation were turned over, as with a plow; on the other side they were undermined and hung over the hole. The earth, rocks, trees, etc., were