In his twenty-five years of service he had been on duty on nearly twenty different stations, scattered from coast to coast and from arctic seas to the Gulf of Mexico. His labors from 1883 to 1886 at St. Micheals, Alaska, the farthest north of the weather stations, were particularly appreciated and valued.

He was a polished gentleman, genial, cheerful, and generous, and easily won his way in the esteem of the communities to which the service called him. He was industrious and efficient, and was frequently commended for the accuracy of his meteorological work.

EARTHQUAKES OF JUNE 25 AND 26, 1904.

By Prof. C. F. MARVIN.

The seismograph at the Weather Bureau recorded an earthquake on June 25, beginning at 4 hours, 12 minutes, 31 seconds, p. m., and another on June 26, beginning at 7 hours, 21 minutes, 3 seconds, p. m. The record in both cases indicated a very slight displacement of the earth at Washington, but the character of the records is such that we believe the origins were at very great distances and seemingly nearly the same for both earthquakes. The disturbances of themselves were probably of considerable violence.

In the record of the first earthquake, especially, the amplitude of the movement at Washington was very small, and exact measurements of the record can not be made The different phases ordinarily characteristic of earthquake records from instruments of this class are more clearly defined in the second than in the first earthquake.

The Omori seismograph, by which these records were made, was fully described and illustrated in the MONTHLY WEATHER REVIEW for June, 1903, page 271.

The following table gives the times of the principal features of both records. The north and south component of horizontal motion only is recorded.

Earthquakes of June 25 and 26, 1904, p. m., seventy-fifth meridian time.

	June 25.			June 26.		
	h.	*m.*	*s.*	*h.*	*m.*	*s.*
First preliminary tremors	4	12	31 p. m.	7	21	03 p. m.
Second preliminary tremors	—	—	— p. m.	7	46	56 p. m.
Principal portion began	4	44	59 p. m.	7	55	26 p. m.
Principal portion ended	4	55	46 p. m.	7	57	01 p. m.
Maximum waves at	4	50	36 p. m.	7	55	56 p. m.
	4	53	24 p. m.			
End of earthquake	5	29	04 p. m.	8	25	09 p. m.
Duration of first preliminary tremor		32	28		34	23
Average period of complete waves in principal portion			20			20
Period of pendulum			26			26
Maximum double amplitude of actual displacement of earth at seismograph				0.26 mm.		
Magnification of record				10		

STUDIES ON THE CIRCULATION OF THE ATMOSPHERES OF THE SUN AND OF THE EARTH.

VII.—THE AVERAGE MONTHLY VECTORS OF THE GENERAL CIRCULATION IN THE UNITED STATES.

By Prof. FRANK H. BIGELOW.

In Table 9, page 144, Annual Report of the Chief of the Weather Bureau, 1898–1899, may be found the data resulting from the nephoscope observations taken in the international cloud year, 1896–1897, which were made to determine the general motions of the atmosphere over the United States. In Table 33, page 409, of the same volume, is given a summary of the resulting general velocities as annual normals. It remains to compute the mean monthly normal vectors of the circulation, and it has been done by the methods used in computing similar vectors for the West Indies, so that but few preliminary remarks are needed in this connection. The method now in use in the Weather Bureau of determining the monthly direction of the wind at a station is really inadequate to the requirements of modern science, which demands an accurate knowledge of the azimuth direction and velocity of the wind. The method referred to consists in counting the number of times the wind was reported on each of the eight cardinal points, N., NE., E., etc., and assigning as the monthly direction that which has the plurality of numbers. This gives no true resultant direction and takes no account of the velocity of the wind prevailing at each observation. A second method of reducing wind observations, which is somewhat more accurate than the former, consists in assuming an equal velocity for each wind and combining the frequency numbers by using Lambert's formula or its equivalent. This system gives a true resultant direction for winds of uniform velocity, but where the winds are variable in force, as well as in direction, this is also insufficient. Many examples of inaccurate resultants can be given when the individual velocities are not constantly the same.

The vectors of Table 16, and figs. 77 to 88, Charts XI, XII, and XIII, "Average monthly vectors of the general circulation," have been computed accurately by resolving each vector $V_1\ \varphi$, as observed, into its north to south and west to east components, taking the algebraic sum of each, and thence computing the mean component for the series, in this case for each month of the year. Then the resultant vectors in velocity and azimuth were constructed, and appear in Table 16 under the columns $V,\ \varphi$. Since the resultant vectors in the lower cloud level and at the surface are very small, I have also computed the mean motion of the wind for each month without regard to the azimuth direction, and this is given under V_1. In the middle and the upper cloud strata the azimuth directions are not so variable as nearer the surface, and hence, there is less difference between the values of V_1 and V. The resultant vectors $V,\ \varphi$ have been plotted in two arrangements, the first giving the vectors of the month for each cloud system terminating on the same vertical lines, which permits a ready inspection of the relative motion in the different levels for each month of the year. The second arrangement gives the vectors for June ending on one vertical line, while those for the other months follow in a broken line, which shows at a glance the trend of the circulation throughout the year in the several cloud groups. It has been convenient to divide the clouds into three groups, (1) the lower clouds (stratus, cumulus, stratocumulus), (2) the middle clouds (alto-stratus, alto-cumulus), and (3) the upper clouds (cirro-cumulus, cirro-stratus, cirrus), which do not differ greatly among themselves in velocity. The average height of group (1), lower clouds, is 2000 meters; of group (2), middle clouds, 5000 meters, and of group (3), upper clouds, 9000 meters, as determined by the theodolite observations at Washington, in 1896–1897.

We make the following remarks on the vectors of Charts XI to XIII. The northern group of stations, St. Paul, Detroit, Cleveland, Buffalo, Louisville, Blue Hill, Washington, Waynesville, and Ocean City, all lie in the strong eastward drift to the north of the high pressure belt of the general circulation; Kansas City, Abilene, and Vicksburg, lie in the midst of this belt, while Key West is on the southern border of it and has some of the characteristics of the West Indian group of stations. The northern stations in the upper levels have strong eastward components, and in the lower levels a turbulent circulation with small resultant vectors. Louisville seems to have something like a personal equation, which has magnified the vectors a little above the apparent average that the entire set would suggest, while Cleveland, on the other hand, seems to have a diminished set of vectors. It is not possible to show from the observations what change, if any, ought to be introduced by means of a modifying factor. Besides the relative lengths of the vectors in the different levels it is interesting to note the north and south components at the several stations. Thus, at St. Paul and also at Kansas City, there is a northward component in the cirrus levels; this component prevails at all levels at Abilene. At Vicksburg the vectors are generally small, and they are westward during certain months

in the lower strata. At Key West the westward component prevails in the lower levels, but the eastward in the cirrus level, as in the Cuban stations generally.

It is desirable to extend such vector computations to various portions of the earth in order to obtain the data needed in dynamic meteorology.

TABLE 16.—*Average monthly vectors of the general circulation in the United States at four levels.*

1. ST. PAUL, MINN.

1896-97.	Velocity in meters per second.											
	Wind.			St., Cu., S. Cu.			A. S., A. Cu.			Ci. Cu., Ci. S., Ci.		
	V_1	V	φ	V_1	V	φ	V_1	V	φ	V_1	V	φ
			°			°			°			°
January	3.9	1.7	48	27.6	16.8	80	52.5	38.0	90	72.9	36.9	95
February	4.1	1.5	37	27.4	14.4	78	54.5	29.5	91	72.9	16.2	117
March	4.1	1.1	27	26.4	12.2	81	54.0	20.5	97	72.0	10.8	158
April	4.1	0.5	7	25.2	10.0	87	52.5	14.5	109	66.6	14.5	150
May	4.0	0.0	180	23.6	8.2	92	50.0	12.0	122	71.1	23.4	128
June	3.7	0.5	174	22.4	7.6	102	48.5	12.5	122	55.8	39.6	113
July	3.6	0.8	163	21.8	8.0	103	46.0	18.5	113	54.0	48.6	106
August	3.6	1.0	142	21.4	9.0	102	45.0	26.0	106	52.2	54.9	102
September	3.5	1.2	126	22.0	11.4	96	45.0	35.0	100	53.1	58.5	98
October	3.5	1.4	107	22.8	14.2	91	46.0	40.0	96	55.8	57.6	93
November	3.6	1.5	91	24.0	17.2	86	49.0	42.0	92	63.0	54.0	91
December	3.7	1.4	69	25.6	18.0	82	50.5	41.5	90	70.2	46.8	90
2. KANSAS CITY, MO.												
January	4.1	1.1	79	22.0	12.0	74	27.0	23.5	76	40.5	36.9	95
February	4.1	0.9	86	21.6	11.0	75	27.5	23.5	75	42.3	35.1	94
March	3.9	0.5	117	19.8	9.6	79	25.0	20.5	77	36.0	28.8	94
April	3.6	0.6	168	17.6	8.0	83	20.0	16.0	82	27.0	24.6	104
May	3.4	0.9	193	15.6	6.2	76	15.0	12.0	92	18.9	18.9	117
June	3.3	1.1	207	14.0	5.2	91	12.0	9.0	111	15.3	18.0	133
July	3.1	1.2	211	14.0	5.4	90	11.0	7.5	121	13.5	18.0	139
August	3.1	1.1	212	14.0	5.6	90	11.0	6.5	122	15.3	18.0	142
September	3.3	0.9	206	15.0	6.6	85	13.0	7.5	97	18.0	18.0	136
October	3.4	0.5	180	16.0	8.0	83	15.5	10.0	82	24.3	18.0	125
November	3.6	0.5	120	18.0	9.8	80	20.0	15.5	76	30.6	22.5	109
December	3.8	0.9	85	20.0	11.0	75	23.5	20.0	76	36.0	29.7	98
3. ABILENE, TEX.												
January	4.5	1.2	128	14.6	12.0	116	24.5	23.5	134	41.4	36.0	125
February	4.8	1.1	130	15.2	5.6	120	25.0	25.0	132	44.1	42.3	126
March	4.8	1.1	164	14.2	5.4	147	24.0	22.0	131	41.4	39.6	125
April	4.5	1.5	182	12.6	5.4	165	20.0	18.0	128	34.2	32.4	124
May	4.3	2.1	192	10.8	5.2	180	15.0	13.0	129	25.2	20.7	129
June	4.0	2.6	196	9.0	4.8	193	11.0	8.0	132	18.0	9.0	135
July	3.9	2.7	197	8.0	4.0	206	10.0	3.0	129	13.5	2.7	180
August	3.7	2.5	195	8.0	3.6	213	10.0	1.5	135	10.8	2.7	161
September	3.7	2.0	193	8.8	4.0	203	11.0	3.5	135	14.4	3.6	166
October	3.9	1.5	173	10.0	4.2	182	15.0	8.5	126	18.9	16.2	124
November	4.1	1.2	147	11.4	5.2	159	18.5	15.0	132	27.0	19.8	118
December	4.4	1.3	128	13.4	5.8	137	22.5	21.0	133	34.2	28.8	118
4. VICKSBURG, MISS.												
January	2.9	0.5	270	8.2	3.0	98	12.0	13.5	96	18.9	25.2	94
February	3.2	0.2	248	9.0	4.4	101	15.0	14.0	98	25.2	26.1	87
March	3.5	0.4	113	9.0	4.8	112	15.0	12.5	97	27.0	25.2	85
April	3.3	0.9	90	8.0	3.2	120	14.0	11.0	92	25.2	18.0	90
May	3.1	1.2	84	6.8	2.0	126	10.5	8.5	90	20.1	12.6	94
June	2.8	1.3	78	5.6	0.4	90	8.0	5.0	84	16.2	7.2	114
July	2.6	1.1	70	4.8	0.4	0	6.0	2.5	78	12.6	3.6	180
August	2.3	0.8	63	4.4	0.2	313	5.0	1.0	60	9.9	4.5	206
September	2.3	0.3	26	4.4	0.4	245	5.5	1.0	130	9.0	1.8	180
October	2.4	0.4	276	4.8	1.0	201	6.5	3.0	149	9.0	4.5	90
November	2.6	0.8	267	5.6	2.0	173	9.0	6.0	121	10.8	11.7	72
December	2.7	0.8	263	6.2	2.2	146	11.0	8.5	104	15.3	16.2	71

TABLE 16.—*Average monthly vectors of the general circulation, etc.*—Continued.

5. LOUISVILLE, KY.

1896–97.	Velocity in meters per second.											
	Wind.			St., Cu., St. Cu.			A. S., A. Cu.			Ci. Cu., C. S., Ci.		
	V_1	V	φ	V_1	V	φ	V_1	V	φ	V_1	V	φ
			°			°			°			°
January	4.0	2.4	130	25.4	23.6	87	49.0	43.5	105	63.0	59.4	90
February	4.1	2.2	128	25.2	22.6	84	48.5	40.5	104	60.3	54.0	94
March	4.1	1.9	131	24.0	20.6	82	42.5	33.0	97	52.2	45.0	96
April	4.0	1.4	132	22.0	18.0	79	35.0	26.0	88	41.4	37.8	87
May	3.7	0.9	124	18.0	15.0	80	27.0	20.5	78	34.2	30.6	76
June	3.5	0.6	108	15.4	12.6	81	24.0	18.5	73	28.8	28.8	71
July	3.2	0.6	104	14.4	11.6	86	24.0	19.5	77	29.7	27.0	67
August	3.0	0.6	104	14.4	12.0	93	25.5	21.5	81	34.2	30.6	75
September	2.9	0.8	114	15.6	13.8	100	30.0	26.0	90	39.2	36.0	84
October	3.1	0.9	141	17.6	16.8	101	35.5	31.5	97	52.2	43.2	95
November	3.3	1.7	128	20.4	20.4	100	41.5	38.0	103	58.5	49.5	104
December	3.6	2.0	132	23.2	22.0	95	46.5	43.0	105	61.2	55.8	103

6. DETROIT, MICH.

January	5.0	3.1	117	40.6	33.2	93	41.5	30.5	100	55.8	52.2	91
February	5.1	2.8	111	38.8	31.2	92	42.0	35.5	98	54.0	52.2	91
March	5.0	2.4	105	35.0	28.0	90	40.0	33.5	97	50.4	48.6	88
April	4.6	2.0	101	29.2	23.2	84	37.5	30.0	94	45.9	45.0	83
May	4.1	1.5	98	23.4	19.0	80	34.0	26.0	91	43.2	41.4	74
June	3.6	0.9	96	20.2	16.2	75	31.5	24.0	88	42.3	40.5	63
July	3.4	0.8	103	19.0	14.4	75	31.5	22.5	86	42.3	39.6	61
August	3.4	0.9	119	19.6	13.6	81	32.0	21.0	87	43.2	40.5	63
September	3.6	1.5	122	22.0	13.8	90	34.5	23.0	92	46.8	40.5	70
October	4.1	2.0	122	26.8	15.8	97	37.0	25.0	95	54.0	44.1	80
November	4.4	2.6	121	34.0	20.4	96	40.0	29.0	99	56.7	48.9	88
December	4.8	3.0	119	40.0	27.6	95	42.0	32.0	99	58.5	49.5	89

7. CLEVELAND, OHIO.

January	5.3	3.3	106	22.6	17.4	103	22.5	22.5	119	41.4	33.3	93
February	5.4	3.2	103	22.4	17.0	104	23.5	21.0	116	39.6	34.2	91
March	5.1	2.8	99	21.0	15.0	102	22.5	17.5	106	36.0	32.4	90
April	4.6	2.4	90	17.6	12.0	101	20.0	15.0	98	27.0	27.0	86
May	4.1	2.0	79	14.0	9.4	94	18.5	13.5	91	23.4	20.7	82
June	3.7	1.8	70	12.2	8.0	86	16.0	12.5	85	18.9	16.2	71
July	3.6	1.5	61	11.4	7.8	72	15.5	13.0	83	18.0	14.4	68
August	3.7	1.4	60	12.0	8.2	63	16.0	14.5	80	18.0	14.4	68
September	4.2	1.5	72	14.0	9.0	63	17.5	16.0	82	19.8	17.1	75
October	4.6	1.8	90	16.4	10.2	70	19.5	18.5	86	25.2	19.8	76
November	5.0	2.3	102	18.4	12.0	82	21.0	19.5	90	32.4	25.2	83
December	5.2	2.8	109	20.4	14.4	93	23.0	20.0	94	37.8	30.7	85

8. BUFFALO, N. Y.

January	5.7	4.2	84	27.4	17.0	86	59.0	44.5	89	51.3	51.3	75
February	5.7	4.1	87	26.4	16.4	84	58.5	43.0	88	53.2	47.7	72
March	5.7	3.7	93	24.0	15.0	87	54.0	36.0	88	36.0	38.7	73
April	5.4	3.2	104	20.6	12.8	91	45.0	30.5	89	33.0	32.4	80
May	5.3	2.9	112	16.8	10.2	96	31.5	23.5	92	33.3	29.7	90
June	5.0	2.6	121	14.0	9.6	102	25.0	18.0	97	35.1	29.7	98
July	4.9	2.3	126	12.0	9.8	104	20.0	15.5	105	36.9	30.6	102
August	4.7	2.3	127	13.2	10.0	105	19.5	16.5	108	41.4	33.3	104
September	4.8	2.3	126	17.0	10.8	102	17.0	19.5	104	45.9	38.7	100
October	5.0	2.2	119	22.0	12.2	96	27.0	23.5	96	52.2	45.0	95
November	5.1	2.4	110	25.4	14.4	91	36.0	30.5	94	54.0	51.3	90
December	5.4	3.2	105	27.2	16.4	87	48.0	39.0	91	55.8	52.2	84

TABLE 16.—*Average monthly vectors of the general circulation, etc.*—Continued.

9. BLUE HILL, MASS.

1896–97.	Velocity in meters per second.											
	Wind.			St., Cu., S. Cu.			A. S., A. Cu.			Ci. Cu., Ci. S., Ci.		
	V_1	V	φ	V_1	V	φ	V_1	V	φ	V_1	V	φ
			°			°			°			°
January	7.6	4.6	68	24.2	12.4	73	38.5	32.0	97	54.0	46.8	87
February	7.2	4.5	62	23.6	12.2	75	35.5	30.5	92	49.5	45.0	83
March	6.8	3.7	61	22.0	11.4	76	32.0	26.5	89	41.4	38.7	80
April	6.4	2.6	88	20.4	10.6	80	28.0	22.0	87	35.1	32.4	83
May	6.2	2.4	116	19.2	9.6	84	24.0	19.0	85	28.8	26.1	87
June	6.1	2.3	126	18.0	8.4	89	22.0	17.5	88	27.0	23.4	94
July	6.2	2.3	129	17.6	8.4	101	19.0	16.5	93	27.0	22.5	98
August	6.3	2.3	130	17.6	9.4	117	20.0	18.5	103	27.9	22.5	99
September	6.8	2.3	125	18.6	10.2	124	25.0	22.0	109	31.5	27.0	101
October	7.0	2.5	114	20.2	10.0	120	31.0	27.0	113	38.7	33.0	99
November	7.3	2.8	98	22.0	9.4	90	36.0	32.0	111	45.0	40.5	96
December	7.6	3.6	80	23.4	10.8	74	38.5	32.5	106	52.2	46.8	93
10. WASHINGTON, D. C.												
January	4.1	2.0	34	14.0	8.6	101	27.5	25.0	90	47.7	45.9	91
February	3.9	1.7	23	14.0	8.4	106	28.5	24.0	97	50.4	45.9	92
March	3.6	1.4	39	13.4	8.0	108	26.5	22.5	101	45.0	43.2	92
April	3.2	1.0	49	12.0	7.4	111	22.5	19.5	104	36.0	35.1	91
May	2.8	0.6	73	11.0	6.0	111	18.5	16.0	107	27.0	26.1	90
June	2.5	0.5	110	10.0	5.2	104	15.0	12.0	100	23.4	19.8	90
July	2.3	0.5	117	8.8	4.6	95	13.5	10.5	95	19.8	17.1	90
August	2.3	0.5	117	8.2	4.8	81	13.5	10.0	90	19.8	18.0	88
September	2.5	0.5	90	8.8	5.8	72	15.0	11.5	85	21.6	20.7	87
October	2.9	0.7	65	10.2	7.4	73	18.0	15.0	81	27.0	24.3	87
November	3.2	1.2	50	12.2	8.4	76	21.0	14.5	79	31.5	31.5	90
December	3.6	1.7	40	14.0	8.0	85	25.0	17.5	82	37.8	38.7	90
11. WAYNESVILLE, N. C. 12. OCEAN CITY, MD.												
January	2.9	1.6	62	15.8	11.6	91	36.0	35.0	108	53.1	51.3	94
February	2.7	1.4	59	15.2	11.2	92	35.5	35.0	107	54.0	51.3	94
March	2.3	0.9	57	13.2	10.0	90	34.0	31.5	109	45.0	45.0	92
April	1.9	0.5	56	12.6	8.0	88	30.0	26.5	108	36.0	35.1	91
May	1.6	0.1	107	8.4	6.0	80	25.0	19.0	103	27.0	25.2	91
June	1.4	0.3	180	6.8	4.8	70	18.5	15.0	95	18.0	14.4	90
July	1.3	0.5	180	6.0	4.6	63	13.0	10.0	91	10.8	9.0	84
August	1.3	0.4	167	6.0	4.8	68	11.0	10.5	90	9.0	9.0	84
September	1.4	0.4	120	8.0	6.4	67	14.0	14.0	94	11.7	14.4	86
October	2.0	0.6	78	10.4	8.0	85	20.0	20.5	98	18.9	26.1	88
November	2.6	1.1	68	13.6	9.8	87	26.5	27.5	102	28.8	36.0	90
December	2.9	1.5	63	15.6	11.2	91	34.0	32.0	105	39.6	45.0	92
13. KEY WEST, FLA.												
January	4.6	2.3	318	14.4	2.4	215	20.0	8.0	97	28.8	26.1	90
February	4.5	1.8	294	15.2	4.6	193	20.0	9.5	106	27.9	24.3	91
March	4.3	1.9	265	14.8	6.4	197	17.0	7.5	106	25.2	19.8	86
April	4.1	2.4	251	13.6	8.0	210	13.5	4.0	104	18.0	14.4	69
May	4.2	2.7	249	12.0	9.0	221	10.0	0.5	135	11.7	10.8	49
June	4.1	2.9	248	10.4	8.8	228	8.5	2.0	270	17.1	7.2	7
July	4.0	2.9	253	9.4	11.0	244	7.5	5.0	259	15.3	5.4	321
August	3.8	2.9	261	8.4	10.0	254	7.5	5.5	255	15.3	4.5	308
September	3.8	2.8	274	8.4	8.0	262	8.5	7.0	249	9.0	1.8	227
October	4.1	2.7	289	9.2	4.8	267	10.5	5.5	246	12.6	7.2	120
November	4.5	2.7	306	10.2	2.4	260	14.5	4.0	235	18.0	15.3	107
December	4.6	2.7	318	12.2	1.8	229	17.0	3.0	211	23.4	19.8	100