

SECTION I.—AEROLOGY.

SOLAR AND SKY RADIATION MEASURED AT WASHINGTON, D. C., DURING DECEMBER, 1915.

By HERBERT H. KIMBALL, Professor of Meteorology.

[Dated: Washington, D. C., Jan. 17, 1916.]

In Table 1 are summarized the measurements of the intensity of direct solar radiation made by the Weather Bureau at the American University,<sup>1</sup> Washington, D. C., during December, 1915. The means for the month are somewhat lower than the five-year means for December published in the Bulletin of the Mount Weather Observatory, 5:182, Table 3, and markedly lower than those for December, 1914, published in the REVIEW for December, 1914, 42:648.

Skylight polarization, measured at solar distance 90° and in his vertical, with the sun at zenith distance 60°, averaged 60 per cent, with a maximum of 66 per cent, which is 3 per cent higher than the average monthly maximum for December published in the Bulletin of the Mount Weather Observatory, 3:114, Table 16.

TABLE 1.—Solar radiation intensities at Washington, D. C., during December, 1915.

[Gram-calories per minute per square centimeter of normal surface.]

Date.	Sun's zenith distance.										
	0.0°	48.3°	60.0°	66.5°	70.7°	73.6°	75.7°	77.4°	78.7°	79.8°	80.7°
	Air mass.										
	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0
1915.											
A. M.	Gr.-cal.	Gr.-cal.	Gr.-cal.	Gr.-cal.	Gr.-cal.	Gr.-cal.	Gr.-cal.	Gr.-cal.	Gr.-cal.	Gr.-cal.	Gr.-cal.
Dec. 1			1.14	1.17	1.11	1.05					
2											
3											
4			0.89	0.77	0.67	0.60	0.52	0.44	0.38	0.35	0.30
5			1.31	1.25							
6				1.16	1.09	1.03	0.96	0.90	0.83	0.77	0.72
7					1.16	1.08	0.99	0.93	0.88	0.83	0.78
15			1.18								
16			1.12								
19			1.03	0.95	0.82	0.70	0.63	0.56	0.49	0.44	0.40
21							0.78	0.73	0.67	0.62	0.56
23			1.28				0.98	0.92			
24			1.31	1.24	1.17						
26			1.31	0.96	0.89						
30			1.11								
Means.....			1.15	1.07	0.99	0.89	0.81	0.75	0.66	0.60	0.55
P. M.											
Dec. 7				1.10	1.02	0.95	0.88	0.81	0.74	0.68	0.63
15				1.24	1.18	1.12	1.05	0.99	0.93		
21				1.04	1.01	0.86	0.77	0.72	0.67	0.62	0.57
22							0.89	0.81	0.74	0.68	
30				0.94	0.77	0.59					
Means.....				1.08	1.00	0.88	0.80	0.82	0.77	0.66	(0.60)

In Table 2, column 2 gives the daily totals of solar and sky radiation received on a horizontal surface at the American University during December, 1915. The measurements were made with a Calendar recording pyr heliometer, as described in the REVIEW for March, 1915, 43:100. Table 2, column 3, gives the daily departures from the normals published in the same number of the REVIEW, page 111, Table 4. A deficiency of radiation is shown for every decade of the month.

<sup>1</sup> For a description of exposures of instruments and details of methods of observation, see this REVIEW, December, 1914, 42:648.

The "Percentage of possible sunshine" and the "Average cloudiness," given in columns 5 and 6 of Table 2, have been taken from the records of the observatory at the central office of the Weather Bureau. The monthly mean percentage of possible sunshine is 51, which is also the normal for Washington for December. The deficiency in the total radiation for the month is therefore to be attributed to low radiation intensities, as indicated by Table 1, rather than to excessive cloudiness.

TABLE 2.—Daily totals and departures of solar and sky radiation at Washington, D. C., during December, 1915.

[Gram-calories per square centimeter of horizontal surface.]

Date.	Daily totals.	Departure from normal.	Excess or deficiency since first of month.	Percentage of possible sunshine.	Average cloudiness.
	Gr.-cal.	Gr.-cal.	Gr.-cal.	Per cent.	0-10.
December 1	188	10	10	54	7
2	126	-50	-40	23	8
3	163	-12	-52	55	6
4	174	1	-51	76	3
5	187	15	-36	70	5
6	182	11	-25	54	6
7	223	52	27	100	0
8	64	-106	-79	17	8
9	116	-54	-133	36	7
10	302	33	-100	79	2
11	184	15	-85	63	6
12	94	-74	-159	4	10
13	103	-65	-224	6	9
14	159	-8	-232	55	6
15	234	67	-165	100	0
16	177	11	-154	46	8
17	41	-125	-279	0	10
18	78	-88	-367	45	7
19	209	44	-323	100	1
20	193	28	-295	55	7
Decade departure.....			-195		
21	206	41	-254	100	0
22	173	8	-246	60	3
23	154	-10	-256	60	5
24	187	23	-233	71	4
25	127	-37	-270	30	9
26	256	92	-178	100	1
27	189	25	-153	83	6
28	61	-102	-255	0	9
29	39	-124	-379	7	8
30	193	30	-349	76	3
31	112	-52	-401	4	10
Decade departure.....			-106		
Total excess or deficiency since first of year.....			-1882		

SOLAR RADIATION INTENSITIES AT SANTA FE, N. MEX., DURING SEPTEMBER, NOVEMBER, AND DECEMBER, 1915.

By HERBERT H. KIMBALL, Professor of Meteorology.

[Dated: Washington, Jan. 18, 1916.]

The measurements summarized in Table 1 are in continuation of those published in the REVIEW for September, 1915, 43: 439-443, except that on November 1, 1915, Mr. Lee R. Grabill, jr., was detailed as an additional assistant at Santa Fe, and since that date has made all the pyr heliometric readings.

It will be noted that in all three months the readings average higher than the means for the corresponding months published in the September REVIEW above referred to. Also, those for September 27, with the sun at zenith distance 48.3° or more, those for November 12, with the sun at zenith distance 60° or more, and all those for December 24, are higher than any previous corresponding readings at Santa Fe in a month with the same name.

TABLE 1.—Solar radiation intensities at Santa Fe, N. Mex., during September, November, and December, 1915.

[Gram-calories per minute per square centimeter of normal surface.]

Date.	Sun's zenith distance.										
	0.0°	48.3°	60.0°	66.5°	70.7°	73.6°	75.7°	77.4°	78.7°	79.8°	80.7°
	Air mass.										
	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0
A. M.	Gr-cal.	Gr-cal.	Gr-cal.	Gr-cal.	Gr-cal.	Gr-cal.	Gr-cal.	Gr-cal.	Gr-cal.	Gr-cal.	Gr-cal.
September 27...	1.48	1.48	1.37	1.29	1.21						
A. M.											
November 4...	1.52	1.47									
5...	1.53	1.48									
8...		1.51	1.42	1.33	1.25	1.18					
11...	1.63	1.56	1.49	1.42	1.36	1.30					
12...	1.66	1.61	1.55	1.48	1.42	1.36	1.32				
13...	1.58	1.49	1.39	1.26	1.17	1.13					
15...		1.53	1.43								
17...	1.63	1.55	1.47	1.35	1.30	1.22					
18...	1.63	1.54	1.46	1.38	1.31	1.29	1.25	1.21			
20...	1.57	1.52	1.43	1.38	1.33	1.26	1.22	1.17			
23...		1.47									
26...		1.53	1.46	1.39	1.33	1.27					
29...		1.51	1.44	1.38							
30...		1.46									
Means...	1.59	1.52	1.45	1.37	1.31	1.25	1.26	(1.19)			
A. M.											
December 1...		1.51	1.43	1.34	1.27	1.22	1.17	1.12			
3...		1.53	1.44								
7...		1.52	1.44	1.35	1.27	1.20	1.12				
8...		1.52	1.44	1.40							
9...						1.31	1.19	1.16	1.13		
11...		1.47		1.29							
17...		1.50	1.48	1.40	1.33						
21...			1.43	1.36	1.27	1.23					
22...		1.49	1.42	1.36	1.31	1.21	1.13				
23...				1.38							
25...		1.59	1.53	1.43	1.35	1.30	1.20				
Means...		1.52	1.44	1.37	1.30	1.24	1.16	(1.12)			

A HALO IN THE MAKING.

By J. R. WEEKS, Local Forecaster.

[Dated: Binghamton, N. Y., June 23, 1915.]

At Binghamton, N. Y., on December 18, 1914, occurred one of those peculiar mornings when the cold air settles in the Susquehanna and Chenango River Valleys, which here run north and south, and abnormal cold is experienced, accompanied by a deposit of hoarfrost. The temperature on this occasion fell to -7°F. at 8 a. m., while neighboring cities in New York and New England at the same hour had much higher temperatures, as shown in Table 1.

TABLE 1.—Temperatures, December 18, 1914, to nearest whole even degrees at New York and New England stations.

	Lowest.		At 8 a. m.			Lowest.		At 8 a. m.	
	°F.	°F.	°F.	°F.		°F.	°F.	°F.	°F.
Binghamton, N. Y....	-8	-7			Canton, N. Y.....	14	18		
Ithaca, N. Y.....	4	4			Scranton, Pa.....	4	4		
Syracuse, N. Y....	8	8			New York, N. Y....	18	18		
Rochester, N. Y....	10	10			Albany, N. Y.....	10	10		
Buffalo, N. Y.....	12	12			Northfield, Vt....	-6	-4		
Oswego, N. Y.....	14	14			Boston, Mass.....	16	18		

Usually such a condition does not occur unless the center of high barometer, which brings the clear sky and increased nocturnal radiation, is located over or north of this locality. But in this instance the center of high pressure was on the North Atlantic coast.

The hoarfrost began to gather on the trees and exposed objects before sunrise and remained until about 11 a. m., being heaviest just after sunrise. The temperature did not begin to rise until about 10:15 a. m. The rivers

were covered over much of their course with ice, but there were numerous open spaces where the swiftness of the current prevented ice formation. In such localities mist wreaths rose from the water to a height of 4 to 15 feet and then disappeared in the air. Only a portion of the hoarfrost and fog is believed to have reached the air from this source, the remainder being condensed from the air itself. The mist ceased rising from the water at about 11 a. m. The average depth of snow on the ground was 8 inches.

The light fog began to form before sunrise, probably when the temperature reached the neighborhood of 0°F., and continued in the air all day, though it was not very noticeable after noon. It reached a maximum density at about 8:30 a. m. At that time objects a thousand feet distant were visible, but the landscape beyond merged into a white obscurity. The hills, distant a half mile, were invisible and the white fog rose from the horizon to an elevation of 20° to 25°, gradually blending into the milky blue that covered the remainder of the heavens. The fog was composed of snow and ice crystals that were just at the limit of visibility to the naked eye. The general appearance of these was not that of spicules, but rather of 6-pointed star shapes of very small size. At 10:30 a. m. the fine deposit that gathered on the sidewalks was examined with a microscope and found to consist of minute 6-pointed stars.

Although hoarfrost and fog are not infrequent at this station, solar halos in connection therewith are of rare occurrence. The halo on this occasion was noticed as soon as the sun rose above the horizon, the north and south sides of the arc of 22° being bright, while the highest part of the curve was very faint. The whole circle of 22° radius was visible at 8:30 a. m. The sun itself was lost in a somewhat diamond-shaped yellowish white glare of light occupying the center of the circle. The bright portions of the halo extended below and in front of the hills about 1 mile distant, but the hills themselves were invisible. The halo had the appearance of being situated about three-fourths of a mile distant from the observer. At 8:15 a. m., the sun then being well above the horizon, the writer took position on a bridge that extended east and west and had at its southeast side a four-storied building. It was thus possible by moving along the bridge to place the building between the apparent position of the northern half of the halo and the observer, while the sun remained visible. In this position an arc of halo light remained visible against the dark background of the building and this arc corresponded with the remaining portion of the 22°-circle of the halo. By moving back and forth on the bridge this was repeatedly verified. Thus the halo was not formed on any one plane of the fog, but through a stratum of perhaps 2 or 3 miles thickness. Again, on facing the sun and looking at an angle downward toward the ground from the bridge, a vertical pillar of light was seen, somewhat faint but plainly visible. This was only noticeable against the dark background, being obscured in the sky by the general glare of light. The ice crystals in the air were visible to the eye as dancing particles of light moving in all directions, up, down, and sideways. No predominant direction of motion could be observed and it was evident that if they were spicules or prisms their planes must lie in all directions. No traces of the halo could be seen at 9:20 a. m., though fog was still present near the surface and did not entirely disappear all day. The appearance of the sky during the day was such as to apparently favor halo formation, but a close watch disclosed none.