SOLAR AND SKY RADIATION MEASUREMENTS DURING MARCH, 1919.

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[Dated: Solar Radiation Investigations Section, Washington, Apr. 29, 1919.]

For a description of instrumental exposures, and an account of the methods of obtaining and reducing the measurements, the reader is referred to the REVIEW for January, 1919, **47**:4.

The monthly means and departures from normal in Table 1 show that solar radiation intensities averaged above the normal at Washington, close to normal at Lincoln, and below normal at Madison.

Table 3 shows deficiencies in the total radiation for the month as compared with the March normals, amounting to about 7 per cent at Washington and Lincoln, and 10 per cent at Madison.

Skylight polarization measurements obtained on 6 days at Washington give a mean of 63 per cent, with a maximum of 66 per cent on the 12th. These are average values for Washington in March. At Madison the ground was covered with snow until the 12th. Skylight polarization measurements obtained on five days during the last half of the month give a mean of 60 per cent, with a maximum of 65 per cent on the 18th. These are low values for Madison in March.

TABLE 1.—*Solar radiation intensities during March, 1919.*

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

Washington, D. C.

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°
	Air mass.									
	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5
A. M.	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*
Mar 1	.....	.....	1.26	1.18	1.11	1.04	0.98	.....	.....	.....
7	.....	1.11	.....	0.89	0.80	0.77	.....	.....	.....	.....
10	.....	.....	1.27	1.22	.....	.....	0.84	.....	.....	.....
12	.....	1.34	1.16	1.02	0.89	0.77	0.70	0.68	0.66	.....
18	.....	1.27	1.22	1.18	.....	.....	.....	.....	.....	.....
20	.....	1.26	.....	.....	.....	.....	.....	.....	.....	.....
21	.....	1.32	.....	.....	.....	.....	.....	.....	.....	.....
25	.....	1.27	1.21	1.09	1.00	0.92	.....	.....	.....	.....
28	.....	.....	1.36	.....	.....	1.04	.....	.....	.....	.....
29	.....	.....	1.14	1.04	0.96	.....	0.79	0.73	0.71	.....
31	.....	1.25	.....	1.01	0.93	.....	.....	.....	.....	.....
Monthly means	.....	**1.26**	**1.23**	**1.08**	**0.95**	**0.91**	**0.83**	**(0.70)**	**(0.68)**	.....
Departures from 11-year normal	.....	**−0.02**	**+0.07**	**+0.02**	**±0.00**	**+0.04**	**+0.03**	**−0.04**	**−0.03**	.....
P. M.										
Mar. 6	(*1.49)	1.37	1.24	1.13	1.02	0.92	0.84	0.77	0.71	0.65
7	.....	1.10	0.89	.....	.....	.....	.....	.....	.....	.....
12	(*1.51)	1.41	1.29	1.17	1.05	0.95	0.88	0.82	0.77	0.72
21	.....	1.34	1.17	1.10	1.05	1.00	0.94	.....	.....	.....
22	.....	1.32	1.27	1.20	1.15	1.10	1.05	1.02	.....	.....
24	.....	1.37	1.26	1.17	1.07	0.98	0.94	0.88	0.82	.....
25	.....	1.00	0.87	.....	.....	.....	.....	.....	.....	.....
29	.....	1.35	1.24	1.16	1.06	0.97	0.96	0.93	0.90	.....
Monthly means	.....	**1.28**	**1.15**	**1.16**	**1.07**	**0.99**	**0.94**	**0.88**	**0.80**	**(0.68)**
Departures from 11-year normal	.....	**−0.01**	**+0.02**	**+0.13**	**+0.13**	**+0.13**	**+0.13**	**+0.12**	**+0.10**	**+0.03**

* Extrapolated, and reduced to mean solar distance.

Madison, Wis.

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°
	Air mass.									
	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5
A. M.	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*
Mar. 5	.....	1.43	1.38	1.33	1.25	1.19	1.12	1.03	.....	.....
11	.....	1.51	.....	.....	.....	.....	.....	.....	.....	.....
12	.....	.....	1.26	1.18	1.12	1.05	.....	.....	.....	.....
18	(*1.49)	.....	1.31	1.22	1.15	1.07	1.00	0.94	.....	.....
19	.....	1.31	1.16	.....	.....	.....	.....	.....	.....	.....
21	.....	1.46	1.36	1.28	1.17	.....	.....	.....	.....	.....
22	.....	1.38	.....	.....	.....	.....	.....	.....	.....	.....
28	.....	.....	1.17	.....	.....	.....	.....	.....	.....	.....
Monthly means	.....	**1.42**	**1.27**	**1.25**	**1.17**	**1.10**	**(1.06)**	**(0.98)**	.....	.....
Departures from 9-year normal	.....	**−0.02**	**−0.06**	**−0.02**	**−0.03**	**−0.04**	**±0.00**	**−0.07**	.....	.....
P. M.										
Mar. 5	.....	1.43	1.33	1.23	1.13	.....	.....	.....	.....	.....
19	.....	1.32	1.21	1.07	0.94	.....	.....	.....	.....	.....
21	.....	1.45	1.28	.....	1.07	1.01	0.94	.....	.....	.....
27	.....	.....	.....	1.25	1.20	.....	.....	.....	.....	.....
Monthly means	.....	**1.40**	**1.27**	**1.18**	**1.08**	**(1.01)**	**(0.94)**	.....	.....	.....
Departures from 9-year normal	.....	**−0.03**	**−0.08**	**−0.08**	**−0.11**	**−0.18**	**−0.13**	.....	.....	.....

Lincoln, Nebr.

A. M.										
Mar. 1	.....	1.42	1.26	1.12	.....	.....	.....	.....	.....	.....
10	.....	1.48	1.30	1.10	.....	.....	.....	.....	.....	.....
11	(*1.56)	1.45	1.35	1.25	1.16	1.07	.....	.....	.....	.....
16	.....	1.43	.....	.....	.....	.....	.....	.....	.....	.....
17	.....	1.46	.....	.....	.....	.....	.....	.....	.....	.....
18	.....	1.37	.....	.....	.....	.....	.....	.....	.....	.....
19	.....	.....	.....	.....	0.98	0.87	0.82	.....	.....	.....
21	.....	1.22	.....	.....	.....	.....	.....	.....	.....	.....
28	.....	1.27	1.17	1.08	.....	.....	.....	.....	.....	.....
31	(*1.48)	1.35	1.24	1.13	1.06	0.95	0.87	.....	.....	.....
Monthly means	.....	**1.38**	**1.26**	**1.14**	**1.07**	**0.96**	**(0.84)**	.....	.....	.....
Departures from 4-year normal	.....	**−0.01**	**−0.06**	**−0.08**	**−0.04**	**−0.05**	**−0.07**	.....	.....	.....
P. M.										
Mar. 10	.....	1.51	1.42	1.28	1.21	1.14	1.08	1.02	0.96	0.90
11	.....	.....	1.33	1.28	1.17	1.11	1.05	0.99	0.94	0.89
12	.....	.....	.....	.....	.....	.....	.....	0.86	0.81	.....
17	.....	1.40	1.28	1.16	1.13	1.05	1.00	0.92	0.85	0.78
18	(*1.48)	1.36	1.23	1.12	1.01	0.92	0.83	0.75	0.70	0.65
29	.....	.....	.....	.....	0.82	0.73	.....	.....	.....	.....
31	.....	1.37	1.27	1.16	1.07	0.98	0.91	.....	.....	.....
Monthly means	.....	**1.41**	**1.31**	**1.20**	**1.07**	**0.99**	**0.97**	**0.91**	**0.85**	**0.80**
Departures from 4-year normal	.....	**+0.02**	**+0.03**	**+0.01**	**−0.02**	**−0.02**	**+0.01**	**+0.02**	**+0.02**	**−0.01**

* Extrapolated, and reduced to mean solar distance.

TABLE 2.—*Vapor pressures at pyrheliometric stations on days when solar radiation intensities were measured.*

Washington, D. C.			Madison, Wis.			Lincoln, Nebr.		
Date.	8 a. m.	8 p. m.	Date.	8 a. m.	8 p. m.	Date.	8 a. m.	8 p. m.
1919.	*mm.*	*mm.*	1919.	*mm.*	*mm.*	1919.	*mm.*	*mm.*
Mar. 1	4.75	3.30	Mar. 5	0.71	1.07	Mar. 1	1.02	1.60
6	3.30	3.30	11	2.36	3.81	10	3.63	3.45
7	3.81	4.57	12	4.37	5.16	11	3.30	5.56
10	3.63	3.99	18	3.15	4.17	12	4.17	5.36
12	3.63	3.45	19	4.17	6.50	16	3.81	4.17
18	5.56	4.75	21	2.06	3.15	17	4.37	4.17
20	6.76	5.56	22	3.00	2.62	18	3.99	6.02
21	5.56	7.29	27	2.36	2.62	19	4.37	7.29
22	3.99	3.00	28	2.62	3.30	21	2.16	5.16
24	3.15	3.30	.....	.....	.....	28	4.37	7.87
25	3.30	4.37	.....	.....	.....	29	6.50	9.14
28	2.49	1.88	.....	.....	.....	31	3.63	3.00
29	2.26	1.88	.....	.....	.....	.....	.....	.....
31	2.36	3.00	.....	.....	.....	.....	.....	.....

TABLE 3.—*Daily totals and departures of solar and sky radiation during March, 1919.*

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

Day of month.	Daily totals.			Departures from normal.			Excess or deficiency since first of month.		
	Washington.	Madison.	Lincoln.	Washington.	Madison.	Lincoln.	Washington.	Madison.	Lincoln.
	cal.	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*
Mar. 1	368	308	314	76	21	− 28	76	21	− 28
2	372	385	413	77	94	67	153	115	39
3	362	252	351	64	− 42	1	217	73	40
4	357	88	237	56	−210	−117	273	−137	− 77
5	63	445	443	−241	143	85	32	6	8
6	441	329	221	134	23	−141	166	29	−133
7	397	275	196	86	− 35	−170	252	− 6	−303
8	292	265	356	− 22	− 49	− 14	230	−55	−317
9	208	387	123	−109	69	−251	121	14	−568
10	426	234	528	106	− 88	150	227	−74	−418
11	276	462	532	− 48	136	150	179	62	−268
12	466	400	430	139	70	44	318	132	−224
13	320	49	218	− 10	−285	−172	308	−153	−396
14	77	89	110	−256	−249	−284	52	−402	−680
15	53	73	208	−283	−269	−190	−231	−671	−870
16	71	226	509	−267	−120	108	−498	−791	−762
17	278	144	552	− 62	−206	149	−560	−997	−613
18	475	478	554	132	124	148	−428	−873	−465
19	233	475	499	−112	117	91	−540	−756	−374
20	435	389	295	88	27	−115	−452	−729	−489
Decade departure							−679	−655	− 71
21	454	537	489	105	171	77	−347	−558	−412
22	226	505	332	−125	135	− 82	−472	−423	−494
23	492	442	524	139	68	108	−333	−355	−386
24	45	418	145	−310	40	−273	−643	−315	−659
25	480	190	112	123	−192	−308	−520	−507	−967
26	160	157	433	−200	−228	12	−720	−735	−955
27	140	526	458	−222	137	36	−942	−598	−919
28	460	515	502	95	122	79	−847	−476	−840
29	480	251	500	113	−145	76	−734	−621	−764
30	360	97	217	− 10	−303	−208	−744	−924	−972
31	400	348	635	28	− 56	209	−716	−980	−763
Decade departure							−264	−251	−274
Excess or deficiency since first of year {gr.-cal							−512	−2,344	−1,349
Excess or deficiency since first of year {per cent							− 2.3	− 10.7	− 5.1

MEASUREMENTS OF THE SOLAR CONSTANT OF RADIATION AT CALAMA, CHILE.

By DR. C. G. ABBOT.

[Dated: Washington, D. C., Apr. 17, 1919.]

In continuation of the publication begun last month, I communicate the following results of the measurements of the solar constant of radiation which were made by the Smithsonian observers, Messrs. A. F. Moore and L. H. Abbot, at Calama, Chile, in the month of February, 1919.

The arrangement of the observations in the table is the same as that employed in the preceding communication, and is fully explained in the MONTHLY WEATHER REVIEW for February, 1919, 47:85–87.

Since my last communication, I have received from the observers notes covering their observations of the cloudiness on every day since they have been in Calama. They are disappointed by the unexpected amount of cloudiness encountered, since daily reports of cloudiness at Calama as furnished in manuscript by Dr. Walter Knoche for the years 1913 and 1914 had indicated that more than 200 days in the year would be found absolutely cloudless there. This is very far from being the case in the years 1918 and 1919. I am inclined to think, however, that these years are exceptional over a large portion of the earth. For instance, at Mount Wilson in 1918 the number of suitable observing days for solar constant purposes was very much less than usual, and reports of the same general tendency have come from other regions.

The following table summarizes the results of observations of cloudiness at Calama. The observers reached the station June 19, and began solar constant observations July 27, 1918.

Cloudiness and observing at Calama.

Month.	Number of days.						
	Total.	Observed.	Available.	All cloudless.	Half day cloudless.	Few clouds.	Generally cloudy.
1918.							
June	12	.....	.....	1	.....	2	9
July	31	5	5	18	.....	5	8
August	31	27	31	10	9	10	2
September	30	18	30	3	2	12	13
October	31	24	31	5	4	11	11
November	30	23	30	3	6	11	10
December	31	19	31	3	7	10	11
1919.							
January	31	19	31	1	5	12	13
February	28	20	28	1	6	13	8
Total	255	155	217	45	39	86	85

$\frac{\text{Observed}}{\text{Available}} = 0.715.$ $\frac{\text{Cloudless+half days cloudless+few clouds}}{\text{Total number of days}} = 0.667.$

Solar radiation observations.

Date.	Solar Const.	Grade.	Transmission coefficient at 0.5 microns.	Humidity, air mass 3.			Remarks.
				ρ/ρ_{sc}	V. P.	Rel. Hum.	
P. M.	*cal.*				*cm.*	%	
Feb. 3	1.949	VG	0.861	0.358	0.53	24	Considerable cirrus and cumulus in east, south and north.
A. M.							
6	1.946	E−	.852	.327	.39	32	Cloudless except cirri along eastern horizon.
7	1.931	E−	.863	.452	.36	32	
8	1.976	VG	.861	.512	.31	30	
9	1.971	E−	.856	.473	.37	46	
10	1.908	E−	.852	.482	.48	53	
11	1.909	VG	.850	.446	.37	39	Thin cirri scattered over sky.
12	1.961	VG−	.846	.351	.58	56	Cirri in west and east.
13	1.957	VG+	.831	.323	.60	57	Few cumuli in south and west.
14	1.952	VG−	.841	.373	.66	66	
15	1.915	VG−	.830	.328	.74	70	Long bank of cirrus in east.
16	1.944	VG−	.831	.357	.64	66	Cirri in north and west, disappearing in east.
17	1.973	E−	.857	.394	.49	52	Cloudless except small cumuli disappearing in west.
18	1.938	VG	.857	.452	.49	46	
19	1.961	VG+	.837	.511	.35	31	Thin cirri on northern and eastern horizon.
22	1.933	VG+	.862	.500	.35	32	Cirrus in west early in morning.
P. M.							
24	1.974	VG	.851	.441	.49	19	Cirri and some cumuli in north, east, and south.
A. M.							
25	1.936	VG+	.861	.449	.36	29	Thin cirri scattered about north and west, and moving east.
P. M.							
26	1.915	E	.865	.427	.32	29	
27	1.891	G−	.844	.317	.75	37	Bank of cumulus in east. Cumuli scattered in other quarters.