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SOLAR OBSERVATIONS.

SOLAR AND SKY RADIATION MEASUREMENTS DURING DECEMBER, 1921.

By HERBERT H. KIMBALL, Meteorologist.

[Solar Radiation Investigations, Weather Bureau, Washington, January 27, 1922.]

For a description of instruments and exposures, and an account of the method of obtaining and reducing the measurements, the reader is referred to this REVIEW for April, 1920, 48:225.

Table 1 indicates that solar radiation intensities averaged slightly above the December normal at Madison, Wis., and Santa Fe, N. Mex., and very close to normal at Washington, D. C., and Lincoln, Nebr. At the first two named stations there were few days on which measurements could be obtained, however.

Table 2 shows that the total radiation received on a horizontal surface was below the normal for December at both Washington and Madison, the deficiency at each station being more marked during the first half than during the second half of the month.

For the year 1921, the last two columns of Table 2 show that at Washington the accumulated excess of radiation was 1.4 per cent of the annual normal, and at Madison the accumulated deficiency was 3.7 per cent. Practically all this latter was accumulated before the end of April, however.

Skylight polarization measurements made on four days at Washington give a mean of 55 per cent and a maximum of 65 per cent on the 28th. These are slightly below the average December values for Washington. At Madison snow covered the ground during most of the month. A measurement made on the 10th, when the ground was free from snow, gave a percentage of polarization of 72, or about the average for December for that station.

TABLE 1.—*Solar radiation intensities during December, 1921.*

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

Washington, D. C.

Date.	Sun's zenith distance.										
	8 a.m.	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	Noon.
	75th meridian time.	Air mass.									Local mean solar time.
		A. M.					P. M.				
	e.	5.0	4.0	3.0	2.0	*1.0	2.0	3.0	4.0	5.0	e.
	mm.	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*mm.*
Dec. 1	5.56	0.68	0.78	0.89	1.17	.....	.....	.....	.....	.....	5.36
3	4.57	0.66	0.87	1.09	1.19	.....	.....	0.92	0.84	.....	3.45
6	2.62	.....	0.94	.....	1.32	.....	.....	.....	.....	.....	3.00
7	2.74	.....	0.59	.....	1.22	.....	.....	.....	.....	.....	3.15
10	3.63	.....	0.66	0.86	1.14	.....	.....	.....	.....	.....	4.95
15	2.16	.....	0.85	1.04	.....	.....	.....	1.04	0.80	0.62	2.62
17	4.95	.....	.....	0.91	.....	.....	.....	.....	.....	.....	6.02
20	3.63	.....	.....	0.72	.....	.....	.....	.....	.....	.....	3.99
22	0.96	1.05	1.16	1.27	.....	.....	.....	.....	.....	.....	1.19
27	3.45	.....	0.86	1.02	1.27	.....	.....	1.07	0.86	0.74	3.99
28	2.49	1.01	1.13	1.23	1.29	.....	.....	.....	.....	.....	2.74
Means	.....	0.85	0.87	1.00	1.23	.....	.....	1.01	0.83	(0.68)	.....
Departures	.....	+0.08	−0.01	−0.04	+0.01	.....	.....	−0.02	−0.05	−0.09	.....
Madison, Wis.											
Dec. 10	3.99	0.98	1.09	.....	.....	.....	.....	.....	.....	.....	4.17
27	0.74	1.06	1.20	1.32	.....	1.59	.....	.....	.....	.....	1.37
29	1.24	1.11	1.21	1.33	.....	1.59	.....	.....	.....	.....	1.37
Means	.....	1.05	1.17	(1.32)	.....	.....	.....	.....	.....	.....	.....
Departures	.....	+0.10	+0.03	+0.10	.....	.....	.....	.....	.....	.....	.....

* Extrapolated.

TABLE 1.—*Solar radiation intensities during December, 1921*—Con.

Lincoln, Nebr.

Date.	Sun's zenith distance.										
	8 a.m.	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	Noon.
	75th meridian time.	Air mass.									Local mean solar time.
		A. M.					P. M.				
	e.	5.0	4.0	3.0	2.0	*1.0	2.0	3.0	4.0	5.0	e.
	mm.	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*mm.*
Dec. 5	3.81	.....	.....	1.22	.....	.....	.....	1.25	1.12	1.04	3.81
6	2.87	.....	0.84	1.06	.....	.....	.....	.....	.....	.....	3.45
8	2.36	.....	1.07	1.27	.....	.....	.....	1.21	1.07	0.95	4.75
9	3.30	0.97	1.10	1.26	.....	.....	.....	.....	.....	.....	2.16
16	3.99	.....	.....	1.31	.....	.....	.....	.....	.....	.....	4.57
13	4.75	.....	.....	.....	.....	.....	.....	1.19	1.04	0.90	4.17
17	2.26	.....	.....	1.26	.....	.....	.....	.....	.....	.....	2.06
19	2.26	.....	.....	.....	.....	.....	.....	0.99	0.71	0.62	3.63
24	0.46	.....	1.12	1.26	.....	.....	.....	1.28	1.14	1.00	0.91
28	3.45	.....	.....	.....	.....	.....	.....	1.23	1.05	0.89	3.63
Means	.....	(0.97)	1.03	1.23	.....	.....	.....	1.19	1.02	0.90	.....
Departures	.....	+0.06	−0.02	+0.01	.....	.....	.....	−0.01	−0.04	−0.05	.....
Santa Fe, N. Mex.											
Dec. 12	2.62	.....	.....	1.36	.....	.....	.....	.....	.....	.....	3.15
13	3.81	.....	1.24	1.35	1.48	1.61	.....	1.43	.....	.....	3.63
17	1.45	1.25	1.35	1.46	1.55	1.65	.....	1.43	1.21	.....	1.96
Means	.....	(1.25)	(1.30)	1.39	(1.52)	.....	.....	(1.43)	(1.21)	.....	.....
Departures	.....	+0.09	+0.04	+0.03	+0.02	.....	.....	+0.12	±0.00	.....	.....

TABLE 2.—*Solar and sky radiation received on a horizontal surface.*

Week beginning.	Average daily radiation.			Average daily departure for the week.			Excess or deficiency since first of year.		
	Washington.	Madison.	Lincoln.	Washington.	Madison.	Lincoln.	Washington.	Madison.	Lincoln.
	cal.	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*
Dec. 3	142	118	.....	−15	− 5	.....	+1826	−4326	.....
10	137	84	.....	−16	−41	.....	+1714	−4611	.....
17	161	124	.....	+ 8	− 4	.....	+1772	−4642	.....
24*	152	162	.....	− 3	+31	.....	+1750	−4427	.....

* For eight days.

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

By C. G. ABBOT, Assistant Secretary.

[Smithsonian Institution, Washington, Jan. 25, 1922.]

In continuation of preceding publications, in the following table are given the results for the solar constant of radiation obtained at Montezuma, near Calama, Chile, in August, September, October, November, and for the first half of December, 1921. The values for the remainder of December will be given with the January values when they shall have been received.

From now on, we give $\rho/\rho sc$ at air mass 2. The reader is referred for further statements regarding the arrangement and meaning of the table to the REVIEW for February, August and September, 1919.

For an account of the circumstances surrounding the recent delay in the publication of these data, see pp. 651–652 of this REVIEW.

Date.	Solar constant.	Method.	Grade.	Transmission coefficient at 0.5 micron.	Humidity.			Remarks.
					p/ps. c.	V. P.	Relative humidity.	
1921								
A. M.	cal.					cm.	Per cent.	
Aug. 2...	1.912	E_0	VG..	0.879	0.633	0.30	33	Cloudless. Evidence of increasing water vapor.
	1.942	$M_{2\cdot5}$						
	1.914	M_2						
	1.949	$M_{1\cdot5}$						
	1.935	W. M						
P. M.								
Sept. 24...	1.937	E_0	VG−	.875	.627	.21	18	Clear around sun. Very heavy west wind.
A. M.								
25...	1.963	E_0	VG+	.876	.696	.27	26	Good sky.
	1.968	$M_{1\cdot5}$						
	1.965	W. M						
P. M.								
27...	1.970	E_0	VG+	.876	.644	.10	8	Good sky early, but cirri forming near sun during last observations.
	1.929	M_2						
	1.946	$M_{2\cdot5}$						
	1.954	W. M						
A. M.								
28...	1.972	E_0	E−	.880	.657	.32	41	Distant cirri all morning. Cirri interfered with 4th bolograph.
	1.929	M_2						
	1.945	$M_{1\cdot5}$						
	1.953	W. M						
30...	1.956	E_0	VG..	.882	.681	.10	10	Good sky.
	1.976	M_2						
	1.953	$M_{2\cdot5}$						
	1.951	M_2						
	1.939	$M_{1\cdot5}$						
	1.955	W. M						
P. M.								
Oct. 3...	1.933	E_0	VG..	.876	.594	.09	4	Good sky. Strong west wind.
	1.924	M_2						
	1.934	$M_{2\cdot5}$						
	1.972	$M_{1\cdot5}$						
	1.930	W. M						
4...	1.966	E_0	E...	.875	.599	.17	9	Do.
	1.950	$M_{2\cdot5}$						
	1.957	M_2						
	1.963	$M_{1\cdot5}$						
	1.959	W. M						
A. M.								
5...	1.939	E_0	E...	.879	.649	.21	19	Do.
	1.931	$M_{2\cdot5}$						
	1.935	M_2						
	1.945	$M_{1\cdot5}$						
	1.938	W. M						
P. M.								
6...	1.983	E_0	VG+	.877	.597	.16	8	Do.
	1.949	$M_{1\cdot5}$						
	1.960	W. M						
A. M.								
7...	1.967	E_0	E−..	.876	.622	.15	16	Cloudless. Much low haze.
	1.925	$M_{2\cdot5}$						
	1.945	M_2						
	1.959	$M_{1\cdot5}$						
	1.952	W. M						
P. M.								
8...	1.937	E_0	VG..	.875	.589	.19	9	Cloudless in west. Strong west wind
	1.949	$M_{2\cdot5}$						
	1.911	$M_{1\cdot5}$						
	1.932	W. M						
A. M.								
9...	1.931	E_0	VG+	.865	.537	.16	15	Distant cirri in east. Low haze.
	1.927	M_2						
	1.929	W. M						
P. M.								
10...	2.023	E_0	VG..	.829	.471	.19	12	Sky hazy and streaky. Strong wind from west.
13...	1.957	$M_{1\cdot33}$	S−...	.878	.653	.13	6	Some distant cirri. Stong west wind.
	1.931	$M_{1\cdot5}$						
	1.944	W. M						
16...	1.962	$M_{2\cdot33}$	S−...	.869	.505	.19	14	Scattered cirro-cumulus. Heavy west wind.
18...	2.001	E_0	VG..	.874	.629	.18	11	Poor sky. Scattered cirri, interfering with last observation.
22...	1.938	E_0	VG..	.875	.671	.17	11	Cirri in east. Strong west wind.
A. M.								
23...	1.975	E_0	E−..	.871	.604	.16	18	Distant cirri. Quite hazy.
	1.953	$M_{2\cdot5}$						
	1.958	M_2						
	1.962	W. M						
Nov. 4...	1.948	$M_{1\cdot33}$	S...	.871	.628	.17	12	Distant cirri around sky. Bright around sun.
	1.952	$M_{1\cdot01}$						
	1.957	$M_{1\cdot01}$						
	1.952	W. M						
P. M.								
15...	1.907	$M_{2\cdot94}$	U...	.867	.543	.21	11	Scattered cirri. Strong west wind.
A. M.								
16...	1.950	$M_{1\cdot5}$	S...	.863	.486	.20	13	Earlier cirri, but sky very good during observations.
	1.941	$M_{1\cdot33}$						
	1.940	$M_{1\cdot33}$						
	1.944	W. M						
17...	1.950	E_0	E...	.874	.649	.17	16	Good sky.
	1.974	$M_{2\cdot5}$						
	1.939	M_2						
	1.962	$M_{1\cdot5}$						
	1.962	W. M						
18...	1.936	E_0	E...	0.881	0.665	0.25	29	Very good sky.
	1.934	$M_{2\cdot5}$						
	1.945	M_2						
	1.915	$M_{1\cdot5}$						
	1.940	W. M						
19...	1.891	E_0	VG+.	.872	.690	.15	14	Cloudless. Little haze.
	1.945	$M_{2\cdot5}$						
	1.952	M_2						
	1.938	$M_{1\cdot5}$						
	1.937	W. M						
20...	1.955	$M_{2\cdot5}$	S...	.875	.678	.21	16	Good sky.
	1.963	M_2						
	1.955	$M_{1\cdot5}$						
	1.958	W. M						
21...	1.950	E_0	E...	.872	.675	.28	24	Much low haze. Cirr in west at end.
	1.963	$M_{2\cdot5}$						
	1.957	M_2						
	1.950	$M_{1\cdot5}$						
	1.955	W. M						
23...	1.900	E_0	VG+.	.880	.775	.19	13	Cirri delayed start, and may have affected early bolographs.
	1.934	M_2						
	1.946	$M_{1\cdot5}$						
	1.932	W. M						
P. M.								
24...	1.956	$M_{2\cdot5}$	S−...	.871	.744	.17	9	Considerable scattered cirrus.
	1.973	$M_{2\cdot33}$						
	1.962	W. M						
A. M.								
25...	1.954	E_0	E...	.879	.770	.17	18	Good sky.
	1.921	$M_{2\cdot5}$						
	1.945	M_2						
	1.944	$M_{1\cdot5}$						
	1.944	W. M						
26...	1.943	E_0	E...	.872	.607	.24	27	Good sky, but some haze and distant cirrus.
	1.951	$M_{2\cdot5}$						
	1.948	M_2						
	1.950	$M_{1\cdot5}$						
	1.948	W. M						
27...	1.949	M_2	S...	.874	.669	.28	23	Some cirri, but none near sun.
	1.961	$M_{2\cdot13}$						
	1.957	$M_{1\cdot5}$						
	1.956	W. M						
28...	1.967	$M_{1\cdot46}$	S...	.866	.664	.29	19	Considerable cirrus, but none near sun during observations.
	1.960	$M_{1\cdot23}$						
	1.963	W. M						
29...	1.951	$M_{1\cdot72}$	S...	.855	.631	.27	21	Considerable thin cirrus but not interfering. Sky rather mottled.
	1.941	$M_{1\cdot69}$						
	1.946	W. M						
Dec. 1...	1.977	$M_{1\cdot86}$	S...	.869	.639	.33	26	No clouds near. Rather hazy.
	1.958	$M_{1\cdot46}$						
	1.962	W. M						
2...	1.952	E_0	E...	.872	.660	.40	48	Good sky.
	1.940	$M_{2\cdot5}$						
	1.941	M_2						
	1.945	$M_{1\cdot5}$						
	1.944	W. M						
3...	1.935	$M_{2\cdot33}$	S...	.873	.684	.24	22	Good sky. Rather hazy.
	1.949	$M_{1\cdot46}$						
	1.953	$M_{1\cdot5}$						
	1.946	W. M						
4...	1.950	$M_{2\cdot33}$	S...	.873	.647	.23	22	Good sky.
	1.957	M_2						
	1.952	$M_{1\cdot5}$						
	1.953	W. M						
5...	1.946	$M_{2\cdot5}$	S...	.880	.812	.17	14	Do.
	1.951	M_2						
	1.964	$M_{1\cdot5}$						
	1.953	W. M						
6...	1.929	$M_{2\cdot5}$	S...	.878	.896	.20	16	Do.
	1.946	M_2						
	1.952	$M_{1\cdot5}$						
	1.945	W. M						
7...	1.964	$M_{1\cdot42}$	S...	.873	.725	.23	16	Scattered cirri delayed start.
	1.972	$M_{1\cdot81}$						
	1.958	W. M						
8...	1.980	$M_{1\cdot19}$	S−...	.863	.587	.36	20	Considerable scattered cirrus. Rather hazy.
	1.960	$M_{1\cdot13}$						
	1.970	W. M						
9...	1.975	E_0	E...	.874	.674	.23	24	Good sky; some haze.
	1.945	$M_{2\cdot5}$						
	1.958	M_2						
	1.961	$M_{1\cdot5}$						
	1.960	W. M						
10...	1.961	$M_{2\cdot5}$	U+..	.870	.651	.32	27	Cirri in east early, and forming near sun at end. Rather hazy.
	1.936	M_2						
	1.956	$M_{1\cdot5}$						
	1.947	W. M						
11...	1.940	$M_{2\cdot22}$	S...	.859	.594	.44	31	Cirri around horizon but none near sun. Hazy.
	1.949	$M_{1\cdot22}$						
	1.953	$M_{1\cdot5}$						
	1.947	W. M						
14...	1.913	$M_{2\cdot5}$	S...	.860	.522	.27	21	Cirri all around horizon; also appearing near sun at end.
	1.928	M_2						
	1.938	$M_{1\cdot5}$						
	1.926	W. M						