I have preferred to determine the water vapor content of the atmosphere from the amount of depletion it produces in the intensity of the radiation in the entire spectrum. On the day under consideration, February 27, 1937, β, computed from $I_m - I_r$, is 0.015, and computed from $I_y - I_r$ is 0.033, giving a mean value of 0.024. With this value of β the value of I_m(dry) is 0.800, as compared with 0.711 determined from I_m reduced to mean solar distance and divided by 1.94; the difference, $0.800 - 0.711 = 0.089$, represents the absorption of solar radiation in passing over a path $m = 1.900$.

The length of the path over which the solar rays pass before reaching the place of observation is a factor in determining the depletion. In plotting the sums of the absorption in individual bands as determined by Fowle, it was found that on an average this depletion (the absorption when $m=1$) was represented by the total measured absorption divided by $m^{1/2}$; i. e., in the case under consideration, the depletion for $m=1.900$ is given by $0.089/1.38 = 0.064$, or 6.4 percent of the solar constant. This is principally absorbed by water vapor, but 0.2 percent to 0.4 percent is attributed by Fowle to absorption by ozone, leaving 6.0 percent to absorption by water vapor.

An equation on page lxxxiii, *Smithsonian Meteorological Tables*, 5th revised edition, 1931, which is there attributed to Fowle, is repudiated by him. He casually mentioned it in the MONTHLY WEATHER REVIEW, Vol. 42, pp. 2–4, 1914, as an approximation formula that might be used when a better method was not available; but Hann appears to have been the originator of this equation (see *Smithsonian Meteorological Tables*, p. lxxii), which served a useful purpose in earlier days before elaborate studies of the great water vapor absorption bands in the infra-red section of the solar spectrum by modern spectroscopic methods were available.

Date and hour angle	Solar altitude	Air mass	I_m	I_y	I_r	β_{m-r}	β_{y-r}	β_{mean}	$\frac{I_{w=0}}{1.94}$	$\frac{I_{w=0}-I_m}{1.94}$	w
1937											
February 27:	° ′	m	gr. cal.	gr. cal.	gr. cal.						mm
(1) 2:14 p. m.	30 55	1.94	1.405	0.933	0.756						
(2)			1.380	.916	.742						
(3)			0.711	1.083	.878	0.015	0.033	0.024	80.0	8.9	6.4

SOLAR RADIATION MEASUREMENTS DURING FEBRUARY 1937

By CHARLES M. LENNAHAN

For a description of the instruments and their exposures, the reader is referred to the January 1935 REVIEW, page 24.

Table 1 shows that solar radiation intensities averaged below normal for the morning observations at Washington. The average intensities were above normal for Blue Hill and for the afternoon observations at Washington. Madison and Lincoln intensities are scattered about the normal values, with no definite positive or negative tendencies.

Table 2 shows that the values of the total solar (direct and diffuse) radiation received on a horizontal surface were below normal at half (7) of the stations for which normals are used, and were above normal at the others.

The turbidity values for Washington, as shown in table 3, are relatively low. It should also be noted that the variation in water-vapor is very slight.

No polarization observations were made during February because of the presence of a snow cover on the days which were otherwise favorable for such observations.

TABLE 1.—*Solar radiation intensities during February 1937*

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

WASHINGTON, D. C.

Date	Sun's zenith distance										
	7:30 a. m.	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	87.7°	Noon
	75th mer. time	Air mass									Local mean solar time
		A. M.				*1.0	P. M.				
	e	5.0	4.0	3.0	2.0		2.0	3.0	4.0	5.0	e
	mm.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	mm.
Feb. 2	1.78	0.43	0.67	0.96	1.13		1.15				1.45
Feb. 3	1.68	.70	.88	1.08	1.38		1.29	1.12	1.00	0.83	1.52
Feb. 6	2.36	.41	.52	.76	.97						2.87
Feb. 10	3.00	.48	.56	.76	1.08						2.49
Feb. 11	1.37	.49	.64	.86	1.27		1.25	1.10	.90	.84	1.24
Feb. 12	2.74			.90	1.18						2.74
Feb. 14	8.18						1.24	.79			2.49
Feb. 15	3.81	.72	.86	.98	1.29						3.30
Feb. 17	1.88		1.16	1.30	1.52		1.39	1.21			2.26
Means		.54	.76	.92	1.19		1.26	1.06	(.95)	(.84)	
Departures		−.17	−.07	−.09	−.01		+.65	+.06	+.09	+.07	

TABLE 1.—*Solar radiation intensities during February 1937*—Con.

MADISON, WIS.

Date	Sun's zenith distance										
	7:30 a. m.	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	87.7°	Noon
	75th mer. time	Air mass									Local mean solar time
		A. M.				*1.0	P. M.				
	e	5.0	4.0	3.0	2.0		2.0	3.0	4.0	5.0	e
	mm.	cal.	cal.	cal.	cal.	cal.	cal.	al.	al.	cal.	mm.
Feb. 2	0.53	0.98	1.10								1.37
Feb. 6	1.68	1.08	1.14	1.32							1.02
Feb. 9	.66	.79	.76	1.29	1.40						1.07
Feb. 10	.51	.60	1.00	1.18	1.38						.79
Feb. 16	2.16	.85	.94	1.14	1.54		1.54				2.06
Feb. 18	3.81	.82	1.00	1.17	1.38		1.30				3.63
Feb. 23	1.37	.85	1.00	1.11							1.45
Feb. 25	1.24				1.35						1.96
Means		.85	.99	1.20	1.41		(1.42)				
Departures		−.07	−.07	.00	+.05		−.03				

LINCOLN, NEBR.

Feb. 2	1.45	1.07	1.23	1.35	1.50		1.48	1.32	1.16	1.01	1.45
Feb. 4	.81				1.47		1.46				1.12
Feb. 9	.91						1.49	1.30	1.13	1.05	.96
Feb. 10	1.07		1.07	1.26	1.44		1.31	1.15	.95		2.62
Feb. 13	4.37			1.33	1.45						2.74
Feb. 16	2.06	1.01	1.14	1.29	1.47		1.46	1.12			2.74
Feb. 18	2.87			.78	.21			.10	.30		3.45
Feb. 23	2.62						1.44				1.60
Feb. 24	1.68		1.28								1.85
Feb. 25	1.12	.90	1.03	1.16	1.39						1.37
Means		.99	1.15	1.08	1.30		1.44	1.00	.82	(1.03)	
Departures		+.06	+.13	+.03	−.07		+.08	−.15	−.19	+.11	

BLUE HILL, MASS.

Feb. 1	3.5				1.38		1.38	1.10			2.5
Feb. 2	2.0				1.20						1.0
Feb. 3	1.5				1.23		1.35	1.25	1.15	1.05	1.7
Feb. 4	1.5	1.12	1.18	1.25	1.32		1.35	1.25			1.7
Feb. 7	2.1			1.00	1.30		1.30	1.23			1.6
Feb. 10	3.3						1.34	1.23	1.13		3.2
Feb. 11	2.0				1.28		1.43	1.33	1.19	1.08	1.2
Feb. 12	2.1						1.13	1.10	.85		2.4
Feb. 16	2.5			1.20							2.6
Feb. 17	1.4						1.37	1.26	1.15	1.06	.6
Feb. 19	2.9		.84	1.10	1.27		1.14	1.07	1.02	.96	1.9
Feb. 23	2.3			1.05	1.10		1.10	.97	.86	.79	2.0
Feb. 24	3.0						1.03				3.5
Feb. 26	2.8						1.03				2.0
Feb. 27	2.1				1.40		1.40	1.30	1.21	1.13	1.2
Feb. 28	1.3			1.24	1.36		1.40	1.31	1.20	1.14	1.5
Means		(1.12)	(1.01)	1.16	1.28		1.27	1.20	1.08	1.03	
Departures		+.24	+.02	+.09	+.02		+.01	+.04	+.01	+.02	

*Extrapolated.

TABLE 2.—*Average daily totals of solar radiation (direct+diffuse) received on a horizontal surface*

Week beginning—	Washington	Madison	Lincoln	Chicago	New York	Fresno	Fairbanks	Twin Falls	La Jolla	Miami	New Orleans	Riverside	Blue Hill	San Juan	Friday Harbor	Ithaca
	Gram-calories per square centimeter															
	cal.	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*
Jan. 29	196	192	234	133	211	238	49	193	340	283	185	290	237	466	118	115
Feb. 5	169	216	268	176	182	245	36	231	270	342	290	260	180	436	102	140
Feb. 12	215	239	255	172	193	247	70	266	216	335	295	272	210	448	169	176
Feb. 19	174	231	281	180	185	371	90	287	356	333	274	373	216	415	166	208
	Departures from weekly normals															
Jan. 29	−7	+4	+10	+13	+57	+37	+6	−9	--------	−60	−24	+30	+8	--------	+16	−63
Feb. 5	−42	+9	+5	+45	+20	−44	−18	+13	--------	−5	+74	−18	−64	--------	−12	−45
Feb. 12	−7	+23	−17	+29	+23	−45	−2	−18	--------	−12	+54	−20	−49	--------	+40	−12
Feb. 19	−83	−13	−16	−3	−14	+32	−27	+33	--------	−36	+13	+51	−66	--------	+39	+1
	Accumulated departures on Feb. 25, 1937															
	−3,339	−294	+294	+406	+147	+1,148	−189	−273	--------	−938	+399	−441	−2,324	--------	+777	−1,617

ON THE METHOD EMPLOYED FOR COMPUTING β AND W, SEE P. 430 OF THE DECEMBER 1936 REVIEW.—ED.

TABLE 3.—*Total, I_m, and screened, I_y, I_r, solar radiation intensity measurements, obtained during February 1937 and determinations of the atmospheric turbidity factor, β, and water-vapor content, w=depth in millimeters, if precipitated*

[American University, Washington, D. C.]

Date and hour angle	Solar altitude	Air mass	I_m	I_y	I_r	(*) $\frac{I_y}{.851+C}$	(*) $\frac{I_r}{.840+C}$	(*) $\beta_{I_{y-r}}$	(*) $\frac{I_{w=0}}{1.94}$ (Percentage of solar constant)	(*) $\frac{I_{w=0}-I_m}{1.94}$ (Percentage of solar constant)	w	Air mass type
	° ′	*m*	*gr. cal.*	*gr. cal.*	*gr. cal.*	*gr. cal.*	*gr. cal.*				*mm*	
Feb. 2:												
1:07 p. m.	32 08	1.88	1.326	1.074	0.872	1.220	1.002	0.021	81.4	13.3	10.9	Pc.
1:04 p. m.	32 26	1.87	1.366	1.075	.873	1.221	1.003	.021	81.4	14.8	11.5	
Feb. 11:												
2:27 a. m.	26 45	2.22	1.222	.962	.782	1.097	.902	.036	75.2	14.1	11.4	Pc.
2:21 a. m.	27 32	2.16	1.251	.965	.782	1.100	.902	.034	75.5	13.0	11.1	
Feb. 17:												
0:49 p. m.	37 44	1.63	1.498	1.069	.849	1.190	.958	.014	84.5	10.5	10.5	Pc.
0:53 p. m.	37 56	1.62	1.477	1.068	.848	1.191	.957	.014	84.5	11.3	10.9	

*Values reduced to mean solar distance.

TABLE 3.—*Total, I_m, and screened, I_y, I_r, solar radiation intensity measurements, obtained during February, 1937, and determinations of the atmospheric turbidity factor, β, and water-vapor content, w=depth in millimeters, if precipitated. Blue Hill Meteorological Observatory of Harvard University.*

Date and hour angle	Solar altitude	Air mass	I_m	I_y	I_r	(*) $\frac{I_y}{0.851+C}$	(*) $\frac{I_r}{0.840+C}$	(*) β mean	(*) $\frac{I_{w=0}}{1.94}$ (Percentage of solar constant)	(*) $\frac{I_{w=0}-I_m}{1.94}$ (Percentage of solar constant)	w	Air-mass type
1937	° ′	*m*	*gr. cal.*	*gr. cal.*	*gr. cal.*	*gr. cal.*	*gr. cal.*				*mm.*	
Feb. 1:												
1:07 a. m.	31 17	1.92	1.231	0.806	0.711	0.916	0.818	0.060	73.1	11.5	8.4	Pc
Feb. 2:												
1:00 a. m.	30 12	1.98	1.072	.695	.611	.788	700	.078	69.0	15.3	11.0	Pc
Feb. 3:												
1:08 a. m.	31 41	1.90	1.334	.834	.693	.946	.796	.088	66.8	5.0	3.7	Pc
1:05 p. m.	29 49	2.01	1.350	.834	.703	.947	.809	.055	73.0	5.4	3.9	
Feb. 4:												
3:48 a. m.	11 41	4.83	1.190	.764	.642	.867	.735	--------	--------	--------	--------	Pc
0:20 p. m.	31 24	1.92	1.318	.796	.693	.856	.796	.062	72.4	6.4	4.7	
Feb. 7:												
1:42 a. m.	27 45	2.14	1.251	.810	.675	.922	.777	.072	73.6	10.9	7.5	Pc
Feb. 10:												
1:35 p. m.	29 36	1.81	1.302	.873	.712	.903	.820	.049	71.3	2.9	2.2	Pc
3:10 p. m.	18 01	3.21	1.219	.822	.667	.937	.769	.023	71.1	9.9	5.5	
Feb. 11:												
1:02 a. m.	32 00	1.88	1.290	.850	--------	.968	--------	--------	--------	--------	--------	
0:58 p. m.	32 12	1.87	1.449	.941	.772	1.072	.889	.041	77.1	4.4	3.2	Pc
3:22 p. m.	17 38	3.28	1.302	.889	.730	1.013	.890	.009	77.9	12.5	7.0	
Feb. 12:												
0:52 p. m.	33 49	1.79	1.131	.762	.615	.868	.711	.082	67.4	10.6	8.0	Pc→NPc
4:02 p. m.	14 41	3.89	.873	.611	.500	.697	.578	.049	49.8	6.0	3.1	
Feb. 16:												
3:08 a. m.	20 29	2.84	.885	.653	.546	.744	.631	.106	56.0	11.5	6.5	Pc
Feb. 17:												
2:55 p. m.	29 38	2.02	1.370	.889	.723	1.028	.836	.030	78.4	9.6	6.8	Pc
4:08 p. m.	11 34	4.87	1.072	.738	.611	.842	.704	--------	--------	--------	--------	

*Corrected for transmission of screens and reduced to mean solar distance.

TABLE 3.—*Total. I_m, and screened, I_y, I_r, solar radiation intensity measurements, obtained during February, 1937, and determinations of the atmospheric turbity factor, β, and water-vapor content, w—depth in millimeters, if precipitated. Blue Hill Meteorological Observatory of Harvard University*—Continued.

Date and hour angle	Solar altitude	Air mass	I_m	I_y	I_r	(*) $\frac{I_y}{0.851+C}$	(*) $\frac{I_r}{0.840+C}$	(*) β mean	(*) $\frac{I_{w-o}}{1.94}$ Percentage of solar constant	(*) $\frac{I_{w-o}-I_m}{1.94}$ Percentage of solar constant	w	Air-mass type
1937	° ′	m	gr. cal.	gr. cal.	gr. cal.	gr. cal.	gr. cal.				mm.	
Feb. 19:												
3:13 a. m.	20 54	2.78	1.084	.740	.623	.846	.721	.049	69.2	14.6	8.5	NP
0:00 m.	36 31	1.61	1.314	.774	.667	.885	.763	.086	68.4	2.2	1.8	
1:45 p. m.	35 33	1.72	1.159	.766	.631	.873	.786	.059	69.0	10.6	8.2	
4:04 p. m.	12 47	4.44	.842	.595	.498	.683	.572	.056	54.6	12.2	9.2	
Feb. 23:												
1:36 a. m.	33 26	1.81	1.286	.844	.701	.967	.812	.076	69.8	11.6	8.7	NPC
2:06 p. m.	30 32	1.96	1.215	.786	.655	.897	.761	.096	65.7	4.4	3.2	
4:15 p. m.	12 02	4.78	.881	.635	.518	.729	.600	.042	----	----	----	
Feb. 25:												
0:02 a. m.	39 41	1.60	1.032	.703	.586	.807	.679	.169	59.2	7.0	5.6	NPC
Feb. 26:												
1:27 p. m.	34 12	1.78	1.060	.730	.600	.876	.699	.137	62.3	8.7	6.6	PA
Feb. 27:												
0:05 a. m.	39 26	1.57	1.437	.953	.754	1.095	.876	.026	79.8	7.1	5.7	PC
2:14 p. m.	30 55	1.94	1.405	.933	.756	1.083	.878	.024	80.2	9.1	6.6	
4:34 p. m.	10 54	5.16	1.131	.794	.651	.912	.755	----	----	----	----	
Feb. 28:												
1:54 a. m.	33 26	1.81	1.382	.891	.730	.987	.846	.084	71.0	1.1	0.8	PC
0:25 a. m.	39 34	1.57	1.429	.921	.762	1.044	.883	.042	80.6	7.4	6.0	
2:01 p. m.	32 43	1.85	1.251	.832	.677	.953	.786	.062	72.9	10.6	7.9	

*Corrected for transmission of screens and reduced to mean solar distance.

Atmospheric conditions during solar observations February 1937

Date	Time from local noon	Temperature ° C.	Wind, Beaufort	Sky blue	Visibility	Cloudiness and remarks
Feb. 3	1:38 a. m.	−6.4	NW 4	8	9	Few Cu; light haze.
3 [1]	1:31 a. m.	−5.2	NW 4	8	9	Few Cu; light haze; instrument indoors.
3	0:22 p. m.	−1.7	NW 2	8	9	Zero clouds; light haze.
4	3:21 a. m.	−10.5	NW 2	9	9	Few Acu; light haze.
7	2:16 a. m.	−2.8	W 4	8	8	Few Ci; few Frcu; light haze.
10	1:02 p. m.	+2.7	NW 3	8	8	Few Cu; light haze.
10	2:26½ p. m.	+3.6	NNW 3	8	8	Do.
11	1:34 a. m.	−5.5	NW 4	8	8	2 Cu; few Ci; light haze.
11	0:16 p. m.	−4.2	NW 4	8	9	1 Cu; light haze.
11	2:50 p. m.	−4.1	NW 5	8	10	2 Cu.
12	0:10 p. m.	+4.4	SW 5	6	8	4 Ci; moderate haze; prob. Ci. over sun.
12	3:30 p. m.	+6.1	SW 5	6	8	1 Ci; light haze.
16	3:39 a. m.	−3.1	NW 3	6	7	2 Ci; moderate haze.
17	2:37 a. m.	−3.3	NNW 6	7	9	Few Cu; few Ci; light haze to north.
17	0:54 a. m.	−3.3	NNW 6	7	10	Few Cu; few Ci.
17 [1]	0:43 a. m.	−3.3	NNW 6	7	10	Do.
17	2:24 p. m.	−0.2	NNW 5	7	10	Few Ci; light haze to north.
17	3:37 p. m.	+1.1	NNW 5	7	10	Do.
19	3:38 a. m.	−1.9	NW 2	7	6	Zero clouds; moderate haze.
19	0:41 a. m.	+3.6	NNW 1	7	6	Do.
19	1:14 p. m.	+6.6	NW 1	7	6	Do.
19	3:33 p. m.	+7.3	NNW 1	7	6	Do.
23	2:05 a. m.	+0.3	W 5	8	8	2 Cu; moderate haze to north.
23 [1]	1:54 a. m.	+.3	W 5	8	8	2 Cu; moderate haze; instrument indoors.
23	1:35 p. m.	+1.6	W 5	8	8	Few Cu; moderate haze to north.
23	3:45½ p. m.	+3.4	W 4	8	8	Few Cu; light haze.
25	0:51 a. m.	−1.1	W 2	8	6	Few Ci; few Cu; moderate haze.
26	0:58 p. m.	+0.6	NW 4	7	8	5 Ci; 3 Cu; light haze.
27	0:37 a. m.	+0.6	W 6	8	10	1 Ci; few Cu; light haze to north.
27	1:45 p. m.	0.0	W 6	8	10	Few Ci; few Cu; light haze to north.
27	4:05 p. m.	−0.6	W 6	8	10	Do.
28	2:32 a. m.	−6.6	NNW 3	8	9	Few Ci.
28	0.58 a. m.	−4.7	NW 3	8	9	Do.
28 [1]	0:42 a. m.	−4.7	NW 3	8	9	Few Ci; light haze to north.
28	1.43 p. m.	−2.2	E 2	8	9	1 Ci; light haze to north.

[1] Indicates Smithsonian observation.

POSITIONS AND AREAS OF SUN SPOTS

[Communicated by Capt. J. F. Hellweg, U. S. Navy (Ret.), Superintendent, U. S. Naval Observatory. Data furnished by the U. S. Naval Observatory in cooperation with Harvard and Mount Wilson Observatories. The difference in longitude is measured from the central meridian, positive west. The north latitude is positive. Areas are corrected for foreshortening and are expressed in millionths of the sun's visible hemisphere. The total area for each day includes spots and groups]

Date	Eastern standard time	Heliographic: Diff. in longitude	Heliographic: Longitude	Heliographic: Latitude	Area: Spot	Area: Group	Total area for each day	Observatory
1937	h m							
Jan. 4	13 14	−7.0	175.7	−34.0	----	242	----	U. S. Naval.
		+17.5	200.2	+28.0	48	----	----	
		+19.0	201.7	−9.0	218	----	----	
		+24.0	206.7	+28.0	388	----	896	
Jan. 6	11 8	−31.0	126.5	−27.0	----	121	----	Do.
		−3.0	154.5	−17.5	----	145	----	
		+18.5	176.0	−36.0	----	145	----	
		+43.5	201.0	−10.0	291	----	----	
		+49.5	207.0	+26.0	436	----	1,138	
Jan. 8	13 26	−3.0	126.9	−26.5	----	194	----	Do.
		+25.0	154.9	−18.0	----	436	----	
		+46.0	175.9	−36.0	----	145	----	
		+47.0	176.9	+12.5	----	97	----	
		+71.0	200.9	−10.0	242	----	----	
		+80.0	209.9	+26.5	582	----	1,696	
Jan. 9	11 16	−77.0	40.9	−12.5	48	----	----	Do.
		−19.5	98.4	+10.0	----	48	----	
		+8.0	125.9	−26.5	----	170	----	
		+37.0	154.9	−18.5	----	485	----	
		+56.0	173.9	−34.0	----	97	----	
		+61.5	179.4	+12.0	73	----	921	
Jan. 10	13 5	−85.0	18.8	−10.0	371	----	----	Mt. Wilson.
		−82.0	21.8	−16.0	----	93	----	
		−64.0	39.8	−15.0	----	51	----	
		−5.0	98.8	+10.0	----	85	----	
		+6.0	109.8	−34.0	----	6	----	
		+12.0	115.8	−24.0	----	18	----	
		+23.0	126.8	−25.0	----	31	----	
		+52.0	155.8	−15.0	----	445	----	
		+62.0	165.8	+11.0	8	----	----	
		+72.0	175.8	−30.5	28	----	----	
		+80.0	183.8	+15.0	26	----	1,162	
Jan. 11	13 0	−80.0	10.6	−12.0	----	203	----	Do.
		−69.0	21.6	−8.0	297	----	----	
		−50.0	40.6	−13.0	----	32	----	
		+8.0	98.6	+10.5	----	64	----	
		+20.0	110.6	−24.0	----	11	----	
		+35.0	125.6	−25.0	----	12	----	
		+65.0	155.6	−15.0	----	491	----	
		+78.0	168.6	+10.0	4	----	----	
		+80.0	170.6	−32.0	----	21	1,135	