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SOLAR OBSERVATIONS

SOLAR RADIATION MEASUREMENTS DURING FEBRUARY, 1936

By IRVING F. HAND, *Asssitant in Solar Radiation Investigations*

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

Table 1 shows that solar radiation intensities averaged close to normal at all three Weather Bureau stations.

TABLE 1.—*Solar radiation intensities during February 1936*

[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 mer. 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*
Feb. 5	1.60	0.63	0.80	0.96	1.30	------	1.43	1.37	------	------	1.60
Feb. 8	1.02	.81	.88	1.13	1.40	------	------	------	------	------	1.78
Feb. 10	1.32	.67	.75	.99	1.21	------	------	------	------	------	1.19
Feb. 28	2.74	.70	.90	1.11	1.31	------	------	------	------	------	2.49
Feb. 29	3.81	------	------	------	1.05	------	------	------	------	------	3.45
Means	------	.70	.83	1.05	1.25	------	(1.43)	(1.37)	------	------	------
Departures	------	−.03	.00	+.04	+.05	------	+.02	+.37	------	------	------

MADISON, WIS.

Feb. 4	1.24	------	------	------	------	------	1.50	------	------	------	1.07
Feb. 5	.28	.76	.86	1.11	1.36	------	------	------	------	------	.43
Feb. 11	.51	.96	1.11	------	------	------	------	------	------	------	.81
Feb. 14	1.68	------	------	------	1.45	------	------	------	------	------	.74
Feb. 18	1.02	------	1.13	1.28	1.44	------	------	------	------	------	.48
Feb. 19	.51	------	.74	------	1.45	------	------	------	------	------	.64
Feb. 21	.79	------	1.09	1.25	1.43	------	1.42	------	------	------	.86
Feb. 27	1.96	------	------	------	1.37	------	------	------	------	------	1.78
Feb. 29	2.16	------	------	------	1.36	------	------	------	------	------	1.88
Means	------	(0.86)	.99	1.21	1.41	------	(1.46)	------	------	------	------
Departures	------	−.07	−.08	+.01	+.06	------	+.19	------	------	------	------

LINCOLN, NEBR.

Feb. 4	0.43	------	------	1.20	1.53	------	1.57	1.38	1.27	1.14	0.91
Feb. 5	.36	------	------	1.18	1.44	------	------	------	------	------	1.19
Feb. 6	.71	------	------	------	------	------	1.15	.90	.71	.57	.89
Feb. 7	.74	------	------	.84	1.10	------	------	------	------	------	1.68
Feb. 10	.46	------	.94	1.22	1.46	------	------	------	------	------	.74
Feb. 14	.30	------	1.28	1.38	1.53	------	------	------	------	------	.41
Feb. 17	.46	------	------	------	------	------	------	1.30	1.18	1.01	.56
Feb. 20	.81	------	------	.99	------	------	------	------	------	------	1.32
Feb. 26	2.87	------	1.16	1.30	1.48	1.67	------	------	------	------	2.36
Feb. 27	1.37	------	------	1.30	1.36	1.60	1.29	1.14	.94	.77	1.96
Feb. 28	3.45	------	------	.95	1.25	------	------	------	------	------	4.57
Means	------	------	1.13	1.15	1.39	(1.64)	1.34	1.18	1.02	.87	------
Departures	------	------	+.11	−.02	+.02	+.10	−.01	+.02	.00	−.03	------

TABLE 1.—*Solar radiation intensities during February 1936*—Con.

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

BLUE HILL METEOROLOGICAL OBSERVATORY OF HARVARD UNIVERSITY

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 mer. 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*
Feb. 1	1.0	------	------	0.63	0.78	------	0.78	0.64	------	------	1.5
Feb. 2	1.2	.96	1.07	1.19	1.45	------	1.45	1.27	1.16	1.07	1.2
Feb. 3	.7	.88	1.02	1.19	1.36	------	------	------	------	------	1.0
Feb. 5	1.9	------	------	------	------	------	1.29	1.24	1.11	.99	1.7
Feb. 6	.7	------	------	1.15	1.26	------	1.32	1.24	1.14	1.04	.9
Feb. 7	1.1	------	------	1.14	1.27	------	1.37	------	------	------	1.1
Feb. 8	.9	.85	.98	1.14	1.27	------	1.37	1.25	1.16	1.07	1.1
Feb. 10	1.1	------	------	.56	.81	------	.84	.76	------	------	1.0
Feb. 11	1.1	------	------	.90	1.09	------	1.21	------	------	------	1.3
Feb. 12	1.3	------	------	1.20	1.40	------	1.42	1.32	------	------	1.0
Feb. 19	.7	------	------	------	1.33	------	1.32	1.21	.98	.80	.8
Feb. 20	1.0	------	------	.92	1.08	------	------	------	------	------	1.3
Feb. 21	1.1	------	.68	.87	1.14	------	1.09	------	------	------	1.3
Feb. 22	1.1	------	------	------	1.26	------	1.33	1.25	1.16	1.07	1.4
Feb. 23	1.0	------	------	1.15	1.40	------	1.45	1.33	1.24	1.16	1.0
Feb. 24	1.9	------	------	1.02	1.33	------	------	------	------	------	2.3
Feb. 28	1.9	------	------	------	1.30	------	1.39	1.25	1.10	1.00	2.0
Feb. 29	1.8	------	------	1.08	1.27	------	1.23	1.07	.98	.92	2.3
Means	------	.90	.94	1.01	1.22	------	1.26	1.15	1.11	1.01	------

LATE DATA

Jan. 4	3.4	1.09	1.15	1.22	1.29	------	------	------	------	------	4.0
Jan. 6	3.2	------	.82	1.03	------	------	------	------	------	------	4.2
Jan. 8	2.5	.87	1.03	1.24	1.33	------	------	------	------	------	2.0
Jan. 10	5.0	------	------	1.15	------	------	------	------	------	------	5.7
Jan. 12	4.0	------	------	------	------	------	1.13	.97	.90	------	3.2
Jan. 14	1.5	.91	1.04	1.18	1.35	------	1.36	1.18	1.03	------	2.1
Jan. 16	3.8	------	------	.79	------	------	1.39	1.29	1.14	.87	2.2
Jan. 17	1.0	.92	1.04	1.18	1.39	------	1.41	1.27	1.15	1.03	1.6
Jan. 20	1.5	------	------	1.04	1.45	------	------	1.27	1.15	1.07	1.5
Jan. 21	1.4	.86	.90	1.07	1.31	------	------	------	------	------	1.7
Jan. 22	2.4	------	------	1.07	1.27	------	------	------	------	------	4.4
Jan. 23	1.0	------	------	------	------	------	------	------	------	.78	.7
Jan. 24	1.0	------	------	------	.98	------	1.00	------	------	------	1.0
Jan. 25	1.0	.90	1.00	1.10	1.36	------	1.37	1.27	------	------	1.1
Jan. 26	1.0	------	------	1.15	1.38	------	1.38	1.32	1.26	1.10	1.3
Jan. 28	1.3	------	------	1.10	1.50	------	------	------	------	------	1.1
Jan. 29	1.1	.85	1.00	1.19	1.45	------	1.43	1.36	1.29	1.22	1.2
Jan. 30	.9	.66	.99	1.10	1.46	------	1.46	1.16	1.02	------	.7
Jan. 31	.9	------	------	.77	.95	------	------	------	------	------	1.2
Means	------	.88	1.00	1.09	1.32	------	1.33	1.23	1.12	1.01	------

* Extrapolated.

Table 2 shows an excess in the amount of total solar and sky radiation at all stations, with the exception of Washington, Fresno, Twin Falls, Miami, and Riverside.

No polarization measurements were taken at either Washington or Madison, because of the presence of snow during observational days.

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

Week beginning—	Washington	Madison	Lincoln	Chicago	New York	Fresno	Pittsburgh	Fairbanks	Twin Falls	La Jolla	Miami	New Orleans	Riverside	Blue Hill	Friday Harbor	Ithaca
	Gram-calories per square centimeter															
1936	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*
Jan. 29	177	229	229	157	152	228	178	49	217	202	351	174	221	272	166	232
Feb. 5	261	236	277	189	210	292	267	75	254	320	272	166	297	260	150	267
Feb. 12	168	256	269	116	125	221	148	80	246	221	246	282	210	145	212	191
Feb. 19	248	294	294	187	258	262	216	80	210	338	348	320	278	338	151	269
	Departures from weekly normals															
Jan. 29	−27	+41	+5	+38	+3	+32	--------	+13	+14	--------	0	−39	−46	+34	+16	+24
Feb. 5	+38	+29	+15	+53	+49	+44	--------	+26	+38	--------	−76	−35	+18	+10	+38	+61
Feb. 12	−54	+31	−3	−25	−43	−77	--------	+10	−41	--------	−103	+52	−87	−116	+93	−4
Feb. 19	−13	+40	−4	+4	+58	−72	--------	−24	−40	--------	−26	+62	−18	+47	+15	+61
	Accumulated departures on Feb. 25															
	−525	+1,092	−602	+175	+665	+378	--------	+231	−1,204	--------	−1,407	+938	−1,134	+693	+1,442	+952

TABLE 3.—*Total, I_m, and screened, I_y, I_r, solar radiation intensity measurements, obtained during February 1936, 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	$\beta_{I_{m-r}}$	$\beta_{I_{y-r}}$	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
Feb. 5, 1936	° ′	*m*	*gr. cal.*	*gr. cal.*	*gr. cal.*						*mm*	
1:20 a. m.	31 53	1.89	1.250	0.899	0.749	0.088	0.098	0.093	66.9	3.2	0.1	N_{yr} above.
1:04 a. m.	33 00	1.83	1.269	.900	.751	.098	.112	.095	67.4	3.7	.1	
Feb. 8, 1936												
2:32 a. m.	25 17	2.33	1.103	.867	.766	.170	.174	.172	48.7	--------	--------	P_c.
2:28 a. m.	25 48	2.29	1.114	.868	.766	.168	.181	.174	49.4	--------	--------	

Meteorological conditions during turbity measurements

Feb. 5. Temperature, —3° C.; wind, NW. 12; visibility, 50 miles; blueness of sky, 6.
Feb. 8. Temperature, —6° C.; wind NE. 9; visibility, 12 miles; blueness of sky, 4.

BLUE HILL METEOROLOGICAL OBSERVATORY OF HARVARD UNIVERSITY

Feb. 1, 1936												
3:00 a. m.	17 26	3.31	0.587	0.441	0.403	0.190	--------	0.190	42.9	3.5	1.8	P_c
0:12 a. m.	30 32	1.97	.781	.548	.470	.201	--------	.201	50.6	1.5	.8	
3:00 p. m.	17 26	3.31	.601	.446	.383	.154	0.178	.166	39.3	9.1	5.3	
Feb. 2, 1936												
2:21 a. m.	22 16	2.62	1.240	.869	.725	.041	.065	.053	70.3	8.2	4.9	P_c
0:48 a.m.	29 34	2.03	1.449	.974	.802	.020	.068	.044	75.3	2.8	1.8	
3:01 p. m.	17 25	3.31	1.325	.926	.767	.056	.027	.042	69.5	3.2	.9	
4:20 p. m.	--------	--------	1.036	.767	.667	--------	--------	--------	--------	--------	--------	
Feb. 3, 1936												
2:05 a. m.	24 14	2.45	1.288	.872	.738	.035	.100	.068	66.2	1.7	1.1	P_c
0:21 p. m.	30 42	1.95	1.370	.910	.745	.014	.074	.044	70.6	1.8	1.0	
Feb. 5, 1936												
0:28 p. m.	30 04	1.98	1.293	.883	.732	.036	.098	.067	71.0	6.3	3.1	P_c
3:00 p. m.	18 50	3.08	1.235	.875	.734	.029	.060	.044	66.8	4.9	2.8	
4:35 p. m.	--------	--------	.770	.586	.533	--------	--------	--------	--------	--------	--------	
Feb. 6, 1936												
1:33 a. m.	27 56	2.13	1.240	.867	.723	.064	.093	.078	67.3	5.2	2.2	P_c
0:50 p. m.	30 38	1.96	1.328	.907	.751	.047	.089	.068	69.2	2.7	1.7	
3:00 p. m.	18 35	3.11	1.225	.852	.716	.027	.066	.046	67.0	5.6	3.0	
4:35 p. m.	--------	--------	.756	.605	.499	--------	--------	--------	--------	--------	--------	
Feb. 8, 1936												
2:58 a. m.	19 18	3.00	1.143	.815	.711	.124	.110	.117	43.6	--------	--------	P_c
1:33 a. m.	31 50	1.89	1.283	.888	.742	.078	.104	.091	66.0	1.8	1.1	
0:14 p. m.	32 17	1.87	1.391	.942	.776	.037	.075	.056	72.1	2.4	1.6	
2:04 p. m.	25 40	2.30	1.313	.898	.761	.038	.066	.052	71.6	4.7	2.9	
4:08 p. m.	--------	--------	1.020	.730	.649	--------	--------	--------	--------	--------	--------	
Feb. 10, 1936												
2:50 a. m.	20 52	2.78	.596	.431	.399	.198	--------	.198	42.1	12.1	7.1	N_{ye}
0:11 p. m.	32 56	1.84	.886	.610	.530	.172	--------	.172	56.6	12.1	8.8	
3:00 p. m.	19 33	2.98	.764	.563	.488	.069	.020	.044	67.5	19.1	10.1	
Feb. 11, 1936												
3:05 a. m.	18 49	3.08	.808	.606	.530	.128	.138	.133	47.0	6.4	3.5	P_c
0:02 a. m.	33 19	1.82	1.129	.780	.677	.128	.125	.126	63.4	6.7	4.8	
Feb. 12, 1936												
3:08 a. m.	18 25	3.14	1.086	.776	.674	.062	.110	.086	55.5	1.0	0.4	P_c
0:17 a. m.	33 49	1.79	1.444	.953	.793	.027	.081	.054	75.2	2.7	1.8	
2:58 p. m.	20 43	2.81	1.342	.919	.769	.060	.090	.075	70.0	2.6	1.4	

TABLE 3.—*Total, I_m, and screened, I_y, I_r, solar radiation intensity measurements, obtained during February 1936, and determinations of the atmospheric turbidity factor, β, and water-vapor content, w=depth in millimeters, if precipitated*—Continued

BLUE HILL METEOROLOGICAL OBSERVATORY OF HARVARD UNIVERSITY—Continued

Date and hour angle	Solar altitude	Air mass	I_m	I_y	I_r	$\beta_{I_{m-r}}$	$\beta_{I_{y-r}}$	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
Feb. 19, 1936												
1:45 a. m.	30 55	1.94	1.336	0.908	0.760	0.050	0.104	0.077	69.5	2.2	1.7	P_c
0:28 p. m.	35 46	1.71	1.367	.918	.765	.027	.029	.028	81.4	12.2	9.2	
3:31 p. m.	17 11	3.35	1.152	.803	.688	.036	.072	.054	62.0	4.0	2.0	
Feb. 20, 1936												
3:06 a. m.	21 22	2.72	.980	.731	.621	.101	.142	.122	55.0	5.6	3.4	P_c
Feb. 21, 1936												
2:56 a. m.	23 12	2.52	.989	.724	.615	.148	.137	.142	58.9	6.4	4.7	N_{rc}
0:28 a. m.	36 21	1.69	1.238	.870	.725	.100	.068	.084	69.9	8.1	6.0	
0:13 p. m.	36 39	1.67	1.271	.796	.735	.093	----------	.093	70.3	7.2	5.4	
1:52 p. m.	30 52	1.94	1,127	.786	.674	.108	.183	.146	58.6	3.6	2.4	
Feb. 22, 1936												
0:06 a. m.	36 46	1.67	1.228	.870	.715	.100	.100	.100	67.2	5.2	3.8	P_c
2:53 p. m.	23 25	2.51	1.311	.934	.759	.033	.024	.028	75.2	9.1	5.6	
Feb. 23, 1936												
2:45 a. m.	25 18	2.33	1.295	.922	.778	.062	.082	.072	66.0	.6	.2	P_c
0:48 a. m.	36 18	1.69	1.495	1.033	.828	.027	.025	.026	81.8	6.3	4.7	
3:27 p. m.	19 19	3.00	1.333	.952	.775	.016	.020	.018	75.2	7.9	4.4	
Feb. 24, 1936												
2:54 a. m.	23 35	2.50	1.300	.942	.778	.046	.050	.048	70.6	5.0	3.0	P_c
Feb. 28, 1936												
1:38 a. m.	34 34	1.76	1.326	.941	.772	.024	.076	.050	76.1	9.0	6.4	P_c
0:16 p. m.	39 10	1.58	1.419	.979	.794	.059	.045	.052	77.3	5.5	4.7	
2:04 p. m.	31 55	1.89	1.402	.939	.762	.018	.055	.036	74.0	2.6	2.4	
4:23 p. m.	11 38	4.87	1.113	.805	.683	.025	.025	.025	----------	----------	----------	
Feb. 29, 1936												
1:44 a. m.	34 22	1.77	1.291	.877	.728	.071	.119	.095	68.6	3.2	2.1	N_{rc}
0:44 p. m.	38 43	1.60	1.384	.934	.752	.034	.049	.042	79.6	9.5	6.6	
2:12 p. m.	31 22	1.92	1.245	.867	.702	.061	.061	.061	73.8	10.8	7.7	
4:31 p. m.	10 32	5.35	.899	.662	.573	----------	----------	----------	----------	----------	----------	

Atmospheric conditions during solar radiation measurements, Blue Hill Observatory of Harvard University, Milton, Mass.

Date and time from apparent noon	Air temperature	Wind, Beaufort scale	Visibility (scale 0-10)	Sky blueness	Cloudiness and remarks
February 1936	°C.				
1; 0:38 a. m.	−9.7	W 4	7	7	T Ci, mod. dense haze.
2; 0:18 a. m.	−10.6	W 5	9	6	T Cu, light haze NE, wind gusty.
3; 2:11 a. m.	−13.6	W 3	8	7	1 Ci, light haze.
3; 0:29 a. m.	−9.9	W 3	9	8	T Ci, light haze.
5; 0:05 p. m.	−3.6	WSW 5	8	6	1 Ci, mod. haze, wind gusty.
6; 1:40 a. m.	−12.8	W 4	8	4	1 Ci, mod. haze, wind gusty, Ci too near sun.
6; 0:02 p. m.	−11.1	W 4	8	4	1 Ci, mod. haze, wind gusty.
8; 2:21 a. m.	−12.7	NNW 5	9	7	No clouds, light haze.
8; 0:35 a. m.	−9.3	NNW 5	9	7	No clouds, light haze, wind gusty.
10; 0:39 a. m.	−11.1	W 5	7	7	No clouds, mod. haze.
11; 1:38 a. m.	−10.6	W 4	8	7	No clouds, light-mod. haze.
12; 0:41 a. m.	−7.2	WNW 4	9	8	No clouds, light haze NE.
19; 0:05 p. m.	−13.2	WSW 4	8	8	T Acu, light haze.
20; 3:18 a. m.	−13.3	W 3	7	7	T Ci, mod. haze, Ci increasing rapidly and obscuring sun during test.
21; 2:15 a. m.	−8.3	WNW 4	6	7	3 Ci, mod. dense haze.
21; 0:49 a. m.	−5.7	NNW 4	6	7	3 Ci, mod. dense haze.
22; 0:23 a. m.	−7.0	N 4	8	6	6 Ci, mod. haze, Ci clouds nearing sun at end of observation.
23; 1:01 a. m.	−6.7	NW 4	9	7	T Ci, light haze NE.
28; 2:24 a. m.	−2.8	W 6	9	7	T Cu, light mod. haze.
28; 0:31 a. m.	−2.2	W 5	9	8	T Ci, T Cu, light mod. haze.
29; 2:44 a. m.	−4.7	E 2	8	7	T Ci, mod. heavy haze.
29; 0:01 a. m.	−0.8	ESE 3	8	7	T Ci, T Acu, mod. haze.

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
1936	*h m*	°	°	°				
Feb. 1	11 17	−55.0	270.8	+33.0	247	--------	--------	U. S. Naval.
		−42.0	283.8	+30.0	62	--------	--------	
		+29.0	354.8	−12.0	123	--------	--------	
		+70.0	35.8	+14.5	62	--------	494	
Feb. 2	11 17	−42.0	270.6	+32.5	247	--------	--------	Do.
		−36.0	276.6	+23.0	--------	108	--------	
		−30.0	282.6	+30.0	31	--------	--------	
		+41.0	353.6	−13.0	123	--------	509	
Feb. 3	13 15	−27.0	271.4	+34.0	--------	240	--------	Mt. Wilson.
		−24.0	274.4	−18.0	6	--------	--------	
		−19.0	279.4	+24.0	--------	98	--------	
		−14.0	284.4	+30.0	31	--------	--------	
		+41.0	339.4	−14.0	--------	9	--------	
		+56.0	354.4	−14.0	131	--------	515	
Feb. 4	13 10	−85.0	200.2	−19.0	73	--------	--------	Do.
		−16.0	269.2	+32.0	--------	209	--------	
		−9.0	276.2	−18.5	3	--------	--------	
		−8.0	277.2	+22.0	--------	170	--------	
		−3.0	282.2	+29.0	8	--------	--------	
		+53.0	338.2	−11.0	--------	82	--------	
		+68.0	353.2	−12.0	102	--------	647	