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SOLOR OBSERVATIONS

[Meteorological Research Division, EDGAR W. WOOLARD in charge]

SOLAR RADIATION OBSERVATIONS, OCTOBER 1938

BY IRVING F. HAND

Measurements of solar radiant energy received at the surface of the earth are made at eight stations maintained by the Weather Bureau, and at nine cooperating stations maintained by other institutions. The intensity of the total radiation from sun and sky on a horizontal surface is continuously recorded (from sunrise to sunset) at all these stations by self-registering instruments; pyrheliometric measurements of the intensity of direct solar radiation at normal incidence are made at frequent intervals on clear days at three Weather Bureau stations (Washington, D. C., Madison, Wis., Lincoln, Nebr.) and at the Blue Hill Observatory of Harvard University. Occasional observations of sky polarization are taken at the Weather Bureau stations at Washington and Madison.

The geographic coordinates of the stations, and descriptions of the instrumental equipment, station exposures, and methods of observation, together with summaries of the data, obtained up to the end of 1936, will be found in the MONTHLY WEATHER REVIEW, December 1937, pp. 415 to 441; further descriptions of instruments and methods are given in Weather Bureau Circular Q.

Table 1 contains the measurements of the intensity of direct solar radiation at normal incidence, with means and their departures from normal (means based on less than 3 values are in parenthesis). At Madison and Lincoln the observations are made with the Marvin pyrheliometer; at Washington and Blue Hill they are obtained with a recording thermopile, checked by observations with a Marvin pyrheliometer at Washington and with a Smithsonian silver disk pyrheliometer at Blue Hill. The table also gives vapor pressures at 8 a. m. (75th meridian time) and at noon (local mean solar time).

Table 2 contains the average amounts of radiation received daily on a horizontal surface from both sun and sky during each week, their departures from normal, and the accumulated departures since the beginning of the year. The values at most of the stations are obtained from the records of the Eppley pyrheliometer recording on either a microammeter or a potentiometer.

Direct radiation intensities averaged below normal for October at Washington and Madison; above normal at Lincoln. The Blue Hill data for October will be included in the November REVIEW.

Total solar and sky radiation was above normal at all stations for which normals have been completed with the exception of Fresno, Twin Falls, Miami, Riverside, and Friday Harbor.

Polarization measurements made on 7 days at Madison give a mean of 53 percent with a maximum of 64 percent on the 10th. Both of these values are below the corresponding normals for the month.

TABLE 1.—*Solar radiation intensities during October, 1938*

[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.*
Oct. 1	8.81				0.96						5.79
Oct. 3	5.79			0.96	1.18						5.16
Oct. 4	6.50			.74	1.06		1.08				4.17
Oct. 5	6.76			.74	1.01		.94				8.81
Oct. 8	4.95			1.08	1.24		1.18				8.81
Oct. 10	6.50				1.11		1.10				6.76
Oct. 11	7.87			.74	.89						8.18
Oct. 14	11.38				1.06						11.38
Oct. 17	9.47		0.85	.99	1.13		1.07				9.83
Oct. 18	9.47		.67	.83	.99		.83				9.47
Oct. 19	13.13				.90		1.04				12.68
Oct. 21	5.36	0.58	.63	.76	1.08						5.36
Oct. 22	6.50	.73	.82	.92	1.05						5.79
Oct. 25	4.17	.85	.96	1.06	1.22						3.81
Oct. 26	5.56	.92	1.00	1.10	1.22						6.02
Oct. 27	5.36	.72	.80	.96	1.06						6.02
Oct. 31	5.79	.65	.75	.88	1.14						4.95
Means		.74	.81	.91	1.08		1.03				
Departures		−.01	−.04	−.06	−.05		−.10				

MADISON, WIS.

Oct. 8	10.97	0.29	0.32								10.21
Oct. 10	9.83	.61	.76	0.89	1.02						11.81
Oct. 13	6.02	1.09	1.19	1.31	1.43						5.56
Oct. 14	5.79	.90	.96	1.08							9.47
Oct. 17	8.81				1.15						9.47
Oct. 25	4.95				1.27						6.02
Oct. 26	5.56				1.22						5.56
Oct. 27	5.56				1.11						5.56
Oct. 28	7.32			.88	1.08						7.32
Means		.72	.81	1.04	1.18						
Departures		−.07	−.11	−.01	−.02						

LINCOLN, NEBR.

Oct. 1	9.14	0.33	0.45	0.62	0.87						7.87
Oct. 3	9.14	.58	.72	.90	1.11	1.42	1.04	0.77			7.04
Oct. 4	9.14				.95						8.48
Oct. 5	8.81				.97						9.47
Oct. 7	11.38				1.03	1.29					8.18
Oct. 8	8.81	.53	.63	.78							10.97
Oct. 11	12.24		.72	.92							13.13
Oct. 12	11.81				1.26		1.25	1.09	0.96	0.86	8.18
Oct. 13	7.04	.70	.90	1.12	1.29		1.28	1.09	.90	.70	7.87
Oct. 14	9.83			.98							7.57
Oct. 17	7.29	.68	.83	−.99	1.18	1.47	1.16	.95	.82	.69	7.29
Oct. 18	8.18						1.24	1.06	.90	.77	7.29
Oct. 19	3.99	.95	1.08	1.22	1.37						4.37
Oct. 20	3.15	.99	1.08	1.27	1.40		1.31	1.11	.99	.89	5.56
Oct. 21	3.99	.96	1.14	1.23	1.40	1.65	1.44	1.22	1.12	1.00	3.99
Oct. 22	4.37	1.01	1.11	1.20	1.39						3.81
Oct. 24	1.96	.94	1.06	1.28	1.44	1.65	1.44	1.26	1.12	1.01	2.26
Oct. 25	2.74	.96	1.11	1.22	1.44		1.41	1.21	1.01	.86	3.15
Oct. 26	4.37	.94	1.06	1.10	1.40		1.41	1.24	1.07	.97	3.48
Oct. 27	4.17	.95	1.07	1.23	1.40		1.34	1.16	1.00	.89	4.57
Oct. 31	5.79			.78	1.04						6.76
Means		.81	.93	1.06	1.23	1.50	1.30	1.11	.99	.86	
Departures		−.02	.00	−.03	+.05	+.02	+.04	+.03	+.04	+.03	

TABLE 1.—*Solar radiation intensities during October, 1938*—Contd.

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

BLUE HILL, MASS.

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.*
Oct. 2	5.2				1.25	1.48	1.14	.89	0.70	0.55	5.6
Oct. 3	7.4					1.50	1.21	1.04			5.6
Oct. 4	6.1		0.90			1.41	1.12	.89			5.2
Oct. 5	6.1		.90	1.01	1.20	1.40	1.00	.61			6.3
Oct. 7	4.6					1.37	1.20	1.04			4.6
Oct. 8	4.4		1.06	1.19	1.33	1.48	1.24	1.00	.80		5.6
Oct. 9	4.8		.80	1.02							6.1
Oct. 10	5.8		.89	1.04	1.22	1.42					5.8
Oct. 11	6.1	0.94	1.00	1.07	1.14	1.21	.96	.65			7.4
Oct. 12	9.2			.75	1.00	1.29	1.00				11.5
Oct. 13	10.7	.41	.68	.78	.94	1.13					9.6
Oct. 16	11.5		.69	.94	1.11	1.32					11.9
Oct. 17	8.5			1.10	1.16	1.15					10.3
Oct. 18	6.5		.79	.94	1.11	1.12	1.00				7.6
Oct. 19	9.6						.94				11.9
Oct. 22	5.6				1.15						5.0
Oct. 23	6.2	.76			1.22						5.6
Oct. 26	5.0			1.06	1.26						5.8
Means		.70	.86	.99	1.16	1.33	1.08	.88	.75	.55	
Departures		−.24	−.14	−.12	−.08	−.05	−.12	−.14	−.16	−.21	

LATE DATA—LINCOLN, NEBR.

Sept. 1	12.68			0.96	1.18						11.38
Sept. 2	14.60				1.14						15.11
Sept. 8	16.20			1.05	1.24	1.48	1.20	1.01	0.85	0.73	13.61
Sept. 9	15.11	0.79	0.90	1.01	1.20	1.45			.76	.59	13.61
Sept. 10	16.79		.90	1.02	1.19	1.40					16.79
Sept. 14	11.38							1.01	.91	.81	13.13
Sept. 15	8.81		1.02	1.20							9.47
Sept. 16	7.29		.82	.96			1.24				7.04
Sept. 19	4.57	1.07	1.16	1.27	1.42	1.60	1.40	1.21	1.09	.98	3.99
Sept. 20	4.75	.80	.87	1.09	1.22	1.55	1.27	1.05	.92	.79	5.16
Sept. 21	6.50	.71	.84	1.02	1.20	1.42	1.12	.91	.75	.61	6.76
Sept. 22	7.87	.72	.83	.95	1.22		1.23	1.00	.86	.69	8.81
Sept. 23	8.48		.91	1.08	1.23		1.20	.99	.82	.73	7.29
Sept. 26	11.81	.58	.71								10.21
Sept. 27	8.18			.72	.78						6.76
Sept. 28	6.76	.44	.54	.67	.92		.98	.78	.62	.47	6.76
Sept. 29	6.76			.72	.95		1.03	.87	.69	.58	8.48
Sept. 30	8.81	.72	.85	.96	1.22		.87	.76	.60	.49	10.59
Means		.73	.86	.98	1.15	1.48	1.15	.96	.81	.68	
Departures		.00	+.02	+.01	+.02	+.06	−.01	−.02	−.03	+.05	

*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	Newport
	Gram-calories per square centimeter																
	cal.	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*
Oct. 1	369	276	406	293	394	388	166	279	448	365	444	402	374	559	209	328	380
Oct. 8	336	306	339	324	314	362	92	258	361	332	336	324	336	517	186	264	366
Oct. 15	308	223	385	277	274	382	92	214	425	397	343	365	282	508	278	221	284
Oct. 22	216	240	333	252	189	303	60	280	309	372	443	358	216	526	150	156	251
	Departures of daily totals from normals																
Oct. 1	+36	+1	+65	+48	+107	−45	+49	−97	+54	−38	+95	+22	+47	+55	−56	+57	
Oct. 8	+31	+60	+33	+105	+48	−39	+5	−101	−2	−37	−6	−42	+11	+32	−48	+5	
Oct. 15	+25	+4	+88	+81	+55	+8	+22	−113	+65	+34	+32	+20	−10	+51	+77	−10	
Oct. 22	−40	+33	+52	+79	−3	−58	−1	−15	−46	−20	+116	−1	−5	+74	−5	+30	
	Accumulated departures since Jan. 1																
	−11,260	−1,309	+1,652	+19,926	+4,291	−2,842	+4,844	−8,729	−2,128	−5,534	+7,644	−5,997	−2,581	+12,992	+7,084	+1,470	