# SOLAR OBSERVATIONS

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

## SOLAR RADIATION OBSERVATIONS, FEBRUARY 1939

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, 65: 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 parentheses). 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 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 averaged close to normal for February at Madison and above normal at the other three stations.

Total solar and sky radiation was above normal at all stations for which normals have been computed with the exception of Fresno, Fairbanks, Twin Falls, Ithaca, Blue Hill, and Newport.

No polarization measurements were made at Madison owing to continual snow or ice cover.

### LATE DATA

The weekly means of total solar and sky radiation, expressed in gram-calories, for the weeks beginning January 1, 8, 15, and 22, 1939, at Miami, Fla., are as follows: 317, 324, 326, and 335, respectively, with corresponding departures of +25, +27, +40, and +5.

TABLE 1.—*Solar radiation intensities during February 1939*

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

| 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] 1.0 | 2.0 | 3.0 | 4.0 | 5.0 | e |
| | *mm.* | *cal.* | *cal.* | *cal.* | *cal.* | *cal.* | *cal.* | *cal.* | *cal.* | *cal.* | *mm.* |
| **WASHINGTON, D. C.** | | | | | | | | | | | |
| Feb. 1 | 3.99 | 0.78 | 0.88 | 1.10 | | | | | | | 3.63 |
| Feb. 7 | 2.62 | | | .63 | | | | | | | 2.26 |
| Feb. 8 | 1.68 | .58 | .64 | .71 | 1.01 | | | | | | 1.68 |
| Feb. 12 | 4.75 | | 1.05 | 1.17 | 1.33 | | | 1.20 | | | 5.56 |
| Feb. 13 | 4.17 | 1.00 | 1.14 | 1.30 | 1.48 | | | 1.26 | | | 3.81 |
| Feb. 16 | 3.81 | | | | 1.30 | | | | | | 3.15 |
| Feb. 18 | 2.16 | | | | 1.18 | | | | | | 1.78 |
| Feb. 23 | 4.95 | | .74 | .98 | 1.27 | | | | | | 3.99 |
| Means | | .79 | .89 | .98 | 1.26 | | | (1.23) | | | |
| Departures | | +.07 | +.06 | −.02 | +.06 | | | +.22 | | | |
| **MADISON, WIS.** | | | | | | | | | | | |
| Feb. 2 | 1.45 | 0.52 | 0.69 | | | | | | | | 1.60 |
| Feb. 3 | .86 | 1.00 | | | 1.50 | | | | | | 1.24 |
| Feb. 8 | 3.99 | | | | 1.20 | | | | | | 1.19 |
| Feb. 11 | .56 | .84 | .99 | 1.36 | 1.38 | | | | | | .66 |
| Feb. 13 | 3.30 | | | .85 | | | | | | | 3.63 |
| Feb. 15 | .86 | 1.10 | 1.21 | 1.38 | 1.52 | | | | | | .71 |
| Feb. 17 | 1.19 | .69 | | | | | | | | | 1.60 |
| Feb. 18 | 3.30 | .92 | | | | | | | | | 3.81 |
| Feb. 24 | 1.02 | 1.02 | 1.17 | | 1.43 | | | | | | 1.32 |
| Feb. 25 | .91 | | 1.00 | | 1.37 | | | | | | 1.19 |
| Means | | .87 | 1.01 | 1.20 | 1.40 | | | | | | |
| Departures | | −.05 | −.05 | 0 | +.03 | | | | | | |
| **LINCOLN, NEBR.** | | | | | | | | | | | |
| Feb. 1 | 3.45 | | | 0.77 | | | | 0.93 | 0.84 | 0.72 | 1.96 |
| Feb. 2 | 1.32 | 1.10 | 1.25 | 1.37 | 1.56 | | 1.53 | 1.38 | | 1.12 | 1.02 |
| Feb. 3 | 1.24 | | | | | | | 1.24 | 1.06 | | 1.24 |
| Feb. 5 | 2.49 | | | | | | 1.40 | 1.24 | 1.12 | 1.00 | 2.62 |
| Feb. 6 | 2.26 | | 1.18 | 1.31 | 1.44 | | | 1.34 | 1.19 | 1.07 | 2.26 |
| Feb. 10 | .56 | | | 1.40 | 1.55 | | 1.56 | 1.34 | 1.14 | .96 | .64 |
| Feb. 11 | .58 | .82 | 1.04 | 1.22 | 1.42 | | 1.41 | 1.18 | | | .94 |
| Feb. 13 | 3.66 | .78 | .84 | 1.18 | 1.40 | | | | | | 4.17 |
| Feb. 14 | 1.78 | 1.02 | 1.11 | 1.30 | 1.46 | | | | | | 3.15 |
| Feb. 17 | 2.95 | .93 | 1.12 | 1.26 | 1.51 | | 1.52 | 1.33 | 1.18 | 1.06 | 2.62 |
| Feb. 21 | .79 | 1.00 | | 1.14 | 1.39 | | | | | | 1.02 |
| Feb. 22 | .74 | | | | 1.50 | | | | | | 1.02 |
| Feb. 25 | 1.78 | 1.00 | 1.14 | 1.30 | 1.48 | | | 1.24 | 1.10 | .96 | .86 |
| Feb. 28 | 3.00 | | | | | | | 1.36 | 1.23 | 1.15 | 2.26 |
| Means | | .95 | 1.10 | 1.22 | 1.47 | | 1.48 | 1.26 | 1.11 | 1.00 | |
| Departures | | +.02 | +.07 | +.05 | +.10 | | +.12 | +.10 | +.09 | +.08 | |
| **BLUE HILL, MASS.** | | | | | | | | | | | |
| Feb. 1 | 1.1 | 1.14 | 1.23 | 1.34 | 1.45 | | 1.42 | 1.27 | 1.14 | | 1.7 |
| Feb. 4 | 3.3 | | | | | | | 1.18 | 1.12 | 1.05 | |
| Feb. 9 | 3.3 | .74 | .88 | 1.04 | 1.31 | | | 1.18 | 1.12 | 1.05 | 2.5 |
| Feb. 11 | | | | | | | | 1.12 | 1.04 | .90 | 1.8 |
| Feb. 12 | 1.4 | 1.01 | 1.10 | 1.21 | 1.40 | | 1.38 | | | | 1.4 |
| Feb. 16 | 1.1 | 1.06 | 1.15 | 1.30 | 1.46 | | 1.41 | 1.28 | 1.12 | 1.06 | .5 |
| Feb. 23 | 1.2 | 1.02 | 1.12 | 1.21 | 1.41 | | 1.30 | 1.12 | .99 | .85 | 1.4 |
| Feb. 25 | 1.4 | 1.20 | | 1.20 | 1.37 | | | | | | 1.4 |
| Feb. 27 | 4.4 | .68 | .83 | 1.02 | 1.28 | 1.40 | | | | | 3.6 |
| Means | | .98 | 1.05 | 1.19 | 1.38 | (1.40) | 1.36 | 1.19 | 1.08 | .96 | |
| Departures | | +.06 | +.04 | +.10 | +.09 | −.06 | +.08 | +.02 | +.01 | −.04 | |

[1] 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.* |
| Jan. 29 | 134 | 199 | 205 | 136 | 103 | 130 | 54 | 186 | 282 | 359 | 257 | 210 | 147 | 463 | -------- | 91 | 141 |
| Feb. 5 | 239 | 196 | 279 | 190 | 159 | 219 | 96 | 169 | 334 | 372 | 232 | 302 | 194 | 516 | -------- | 143 | 200 |
| Feb. 12 | 302 | 282 | 306 | 233 | 222 | 297 | 69 | 221 | 414 | 339 | 295 | 392 | 251 | 558 | -------- | 183 | 272 |
| Feb. 19 | 294 | 283 | 302 | 160 | 224 | 393 | 21 | 309 | 410 | 348 | 302 | 372 | 250 | 560 | -------- | 170 | 264 |
| | Departures of daily totals from normals | | | | | | | | | | | | | | | | |
| Jan. 29 | −66 | +13 | −19 | +17 | −48 | −82 | +2 | −4 | −2 | +22 | +36 | −29 | −64 | −8 | -------- | −57 | −52 |
| Feb. 5 | +28 | −7 | +19 | +51 | −4 | −68 | +23 | −36 | +48 | +28 | +4 | +25 | −41 | +23 | -------- | −28 | −26 |
| Feb. 12 | +77 | +58 | +36 | +86 | +48 | −20 | −20 | −47 | +101 | −5 | +42 | +85 | +19 | +46 | -------- | +25 | +18 |
| Feb. 19 | +40 | +31 | +4 | −16 | +28 | +115 | −95 | +52 | +50 | −13 | +18 | +27 | −16 | +38 | -------- | −34 | +4 |
| | Accumulated departures since Jan. 1 | | | | | | | | | | | | | | | | |
| | +1,043 | +21 | +112 | +596 | +427 | −588 | −707 | −1,190 | +1,701 | +903 | +1,981 | −231 | −546 | +2,352 | -------- | −693 | −427 |

## POSITIONS AND AREAS OF SUN SPOTS

[Communicated by Capt. J. F. Hellweg, U. S. Navy (Ret.) Superintendent, U. S. Naval Observatory. Data from measurements at the U. S. Naval Observatory from plates obtained at the observatories indicated. Difference in longitude is measured from the central meridian, positive toward the west. Latitude is positive toward the north. Areas are corrected for foreshortening and expressed in millionths of Sun's visible hemisphere. For each day, below longitude, latitude, area of spot or group, and spot count, are given respectively the assumed longitude of the center of the disk, assumed latitude of the center of the disk, total area of spots and groups, and total spot count]

| Date | Eastern standard time | Mount Wilson group No. | Heliographic: Difference in longitude | Heliographic: Longitude | Heliographic: Latitude | Heliographic: Distance from center of disk | Area of spot or group | Spot count | Plate quality [1] | Observatory |
|---|---|---|---|---|---|---|---|---|---|---|
| *1939* | *h. m.* | | ° | ° | ° | ° | | | | |
| Feb. 1 | 11 25 | 6298 | −55 | 205 | −18 | 56 | 97 | 1 | F | U. S. Naval. |
| | | 6297 | −30 | 230 | +18 | 38 | 73 | 6 | | |
| | | 6293 | −2 | 258 | −10 | 4 | 73 | 7 | | |
| | | 6293 | +7 | 267 | −11 | 8 | 679 | 50 | | |
| | | 6291 | +28 | 288 | +15 | 35 | 48 | 1 | | |
| | | 6291 | +37 | 297 | +16 | 43 | 73 | 1 | | |
| | | 6299 | +52 | 312 | −7 | 52 | 6 | 2 | | |
| | | 6292 | +62 | 322 | −15 | 62 | 24 | 1 | | |
| | | 6290 | +75 | 335 | −8 | 75 | 218 | 3 | | |
| | | | | (260) | (−6) | | 1,291 | 72 | | |
| Feb. 2 | 11 19 | 6304 | −75 | 172 | +7 | 77 | 24 | 4 | G | Mt. Wilson. |
| | | 6303 | −75 | 172 | −12 | 75 | 12 | 2 | | |
| | | 6298 | −41 | 206 | −18 | 43 | 85 | 1 | | |
| | | 6297 | −17 | 230 | +18 | 30 | 61 | 4 | | |
| | | 6302 | −9 | 238 | −8 | 10 | 48 | 8 | | |
| | | 6293 | +9 | 256 | −11 | 11 | 73 | 15 | | |
| | | 6293 | +17 | 264 | −11 | 18 | 315 | 8 | | |
| | | 6293 | +23 | 270 | −12 | 25 | 291 | 10 | | |
| | | 6291 | +42 | 289 | +15 | 47 | 24 | 4 | | |
| | | 6291 | +51 | 298 | +16 | 56 | 73 | 2 | | |
| | | 6299 | +67 | 314 | −8 | 67 | 24 | 4 | | |
| | | 6300 | +75 | 322 | +13 | 78 | 24 | 2 | | |
| | | | | (247) | (−6) | | 1,054 | 64 | | |
| Feb. 4 | 10 54 | 6306 | −61 | 160 | +6 | 62 | 97 | 6 | P | U. S. Naval. |
| | | 6306 | −53 | 168 | +6 | 55 | 48 | 5 | | |
| | | 6298 | −15 | 206 | −18 | 20 | 48 | 2 | | |
| | | 6302 | +19 | 240 | −8 | 19 | 339 | 12 | | |
| | | (*) | +49 | 270 | −10 | 49 | 145 | 9 | | |
| | | 6291 | +79 | 300 | +16 | 81 | 109 | 2 | | |
| | | | | (221) | (−6) | | 786 | 36 | | |
| Feb. 5 | 11 25 | 6306 | −45 | 162 | +6 | 47 | 170 | 8 | F | Do. |
| | | 6298 | −3 | 204 | −17 | 12 | 61 | 1 | | |
| | | 6302 | +31 | 238 | −9 | 32 | 436 | 20 | | |
| | | 6293 | +63 | 270 | −10 | 63 | 145 | 6 | | |
| | | | | (207) | (−6) | | 812 | 35 | | |
| Feb. 6 | 11 20 | 6306 | −31 | 163 | +7 | 34 | 97 | 5 | F | Mt. Wilson. |
| | | 6304 | −23 | 171 | +7 | 26 | 73 | 3 | | |
| | | 6298 | +10 | 204 | −18 | 16 | 73 | 1 | | |
| | | 6306 | +25 | 219 | +8 | 29 | 97 | 12 | | |
| | | 6302 | +45 | 239 | −9 | 46 | 436 | 15 | | |
| | | 6293 | +76 | 270 | −10 | 76 | 97 | 3 | | |
| | | 6307 | +79 | 273 | −16 | 79 | 97 | 2 | | |
| | | | | (194) | (−6) | | 970 | 41 | | |

See footnotes at end of table.

## POSITIONS AND AREAS OF SUN SPOTS—Continued

| Date | Eastern standard time | Mount Wilson group No. | Heliographic: Difference in longitude | Heliographic: Longitude | Heliographic: Latitude | Heliographic: Distance from center of disk | Area of spot or group | Spot count | Plate quality [1] | Observatory |
|---|---|---|---|---|---|---|---|---|---|---|
| *1939* | | | ° | ° | ° | ° | | | | |
| Feb. 7 | 10 22 | 6306 | −17 | 164 | +7 | 21 | 194 | 40 | G | U. S. Naval. |
| | | 6305 | −12 | 169 | +13 | 23 | 12 | 2 | | |
| | | 6298 | +23 | 204 | −18 | 26 | 36 | 2 | | |
| | | 6308 | +38 | 219 | +7 | 41 | 97 | 11 | | |
| | | 6302 | +58 | 239 | −9 | 58 | 218 | 15 | | |
| | | | | (181) | (−6) | | 557 | 70 | | |
| Feb. 8 | 11 35 | 6306 | −4 | 164 | +7 | 14 | 194 | 32 | P | Do. |
| | | 6298 | +37 | 205 | −18 | 39 | 12 | 2 | | |
| | | 6308 | +52 | 220 | +7 | 55 | 73 | 6 | | |
| | | 6302 | +71 | 239 | −9 | 71 | 145 | 10 | | |
| | | | | (168) | (−6) | | 424 | 50 | | |
| Feb. 9 | 10 57 | 6311 | −58 | 97 | +27 | 66 | 61 | 3 | G | Do. |
| | | 6306 | +11 | 166 | +7 | 16 | 242 | 30 | | |
| | | 6298 | +50 | 205 | −19 | 51 | 12 | 1 | | |
| | | (*) | +67 | 222 | +5 | 69 | 12 | 1 | | |
| | | | | (155) | (−7) | | 327 | 35 | | |
| Feb. 11 | 11 30 | 6313 | −74 | 54 | −17 | 74 | 582 | 8 | G | Do. |
| | | 6312 | −68 | 60 | +8 | 70 | 242 | 2 | | |
| | | 6311 | −31 | 97 | +27 | 45 | 61 | 1 | | |
| | | 6310 | −7 | 121 | +18 | 25 | 48 | 5 | | |
| | | 6309 | +15 | 143 | +25 | 35 | 121 | 8 | | |
| | | | | (128) | (−7) | | 1,054 | 24 | | |
| Feb. 12 | 11 7 | 6313 | −70 | 45 | −19 | 70 | 242 | 3 | F | Do. |
| | | 6313 | −61 | 54 | −17 | 61 | 339 | 4 | | |
| | | 6312 | −54 | 61 | +8 | 56 | 242 | 2 | | |
| | | 6311 | −18 | 97 | +27 | 38 | 61 | 2 | | |
| | | 6310 | +6 | 121 | +18 | 26 | 61 | 3 | | |
| | | 6309 | +28 | 143 | +25 | 42 | 291 | 18 | | |
| | | 6314 | +39 | 154 | −22 | 41 | 48 | 3 | | |
| | | | | (115) | (−7) | | 1,284 | 35 | | |
| Feb. 13 | 10 45 | 6313 | −58 | 44 | −19 | 59 | 145 | 6 | P | Do. |
| | | 6313 | −49 | 53 | −17 | 50 | 436 | 8 | | |
| | | 6312 | −40 | 62 | +7 | 42 | 194 | 3 | | |
| | | 6311 | −5 | 97 | +27 | 34 | 48 | 2 | | |
| | | 6310 | +19 | 121 | +18 | 31 | 48 | 5 | | |
| | | 6309 | +42 | 144 | +25 | 52 | 242 | 20 | | |
| | | 6314 | +53 | 155 | −22 | 55 | 48 | 3 | | |
| | | | | (102) | (−7) | | 1,161 | 47 | | |
| Feb. 14 | 11 6 | 6313 | −46 | 43 | −19 | 47 | 145 | 5 | G | Mt. Wilson. |
| | | 6313 | −37 | 52 | −18 | 39 | 533 | 15 | | |
| | | 6312 | −27 | 62 | +7 | 30 | 121 | 10 | | |
| | | 6311 | +7 | 96 | +26 | 34 | 48 | 2 | | |
| | | 6310 | +31 | 120 | +18 | 39 | 61 | 9 | | |
| | | 6309 | +54 | 143 | +25 | 61 | 242 | 15 | | |
| | | 6314 | +67 | 156 | −23 | 68 | 12 | 3 | | |
| | | | | (89) | (−7) | | 1,162 | 59 | | |