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Solar Radiation at Geneva, New York—Variations in Intensity and Duration 1964—1973

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The intensity and duration of energy received from the sun, as incident direct solar radiation and as diffuse sky radiation, has a large influence, either directly or indirectly, on growth, development, initiation of reproduction, maturation, and yield of plants. Plant responses (13), evapotranspiration (8), evaporation of water (5), air temperature (9), and soil temperature (7) are influenced by solar and sky radiation. Physical characteristics of energy from the sun and its effects on earth are described by Robinson (11), Gates (6), and Baker (2).

Variations in incident solar and sky radiation occur in both short time intervals of minutes or hours as well as in long time intervals of days and sequences of days. Solar radiation data have been statistically analyzed to measure variability (12, 3).

The intensity and duration of solar radiation intercepted on a horizontal plane was measured, over a 10-year period, at the climatological reference weather station at the Vegetable Research Farm of the New York State Agricultural Experiment Station, Geneva, New York. The station is number 3031840 in the U. S. Department of Commerce, National Oceanic and Atmospheric Administration network. The location is latitude 42°53′N, longitude 77°02′W, and the elevation is 718 feet above sea level. The solar radiation data presented here may be related to past physical and biological processes and may be used to estimate solar radiation and the resulting physical and biological responses in the future.

INSTRUMENTATION

A pyranometer intercepts direct solar radiation as well as diffuse sky radiation. A pyrheliometer intercepts direct solar radiation only. Solar and sky radiation are generally referred to herein as solar radiation.

The interceptors of solar and sky radiation used at Geneva from 1961 to 1971 have been described previously (10). In September 1971, a new Eppley Model 2 pyranometer was installed. According to the manufacturer[1], this pyranometer has a receiver coated with Parsons' black lacquer (nonwavelength—selective absorption). The inner and outer concentric hemispheres over the sensing elements are clear glass transparent from a wavelength of about 285 to 2,800 millimicrons.

The 1971 pyranometer was tested by the U. S. Department of Commerce, Environmental Science Services Administration, Weather Bureau, Silver Spring, Maryland on March 1 and 4, 1971. They reported: "This pyranometer has been compared with the Weather Bureau reference standard. The derived value of the constant for this instrument is 4.89 millivolts per langley per minute at 85 F on the 1956 International Pyrheliometric Scale" (1 langley/minute=1 g cal/cm^2/minute).

Another Eppley pyranometer Model 2, with a calibration of 4.82 millivolts per langley per minute at 86 F, is used as an alternate at the climatological reference station. Solar and sky radiation intercepted by the pyranometer sensing element generates an electromotive force (emf) proportional to the intensity of the radiation. The emf is recorded on a strip chart recorder with a chart speed of 2 inches/hour. Intensity and duration of solar and sky radiation is computed as g cal/cm^2. For every 20-minute time interval on the strip chart records, a reference line is drawn parallel to the direction of movement of the chart and perpendicular to the time lines on the chart in such a manner that the reference lines intersect the radiation curve at a point where two equal areas (above and below the reference line) are delineated by the reference line, the radiation curve, and the two time lines that identify the 20-minute time period. Summations of radiation in g cal/cm^2 per 20 minutes give g cal/cm^2 per hour and per day.

Solar radiation was recorded on true solar time. The daily solar radiation data were punched on cards, were analyzed

[1]Eppley Laboratory, Inc., Newport, Rhode Island

by an IBM 1800 computer, and were graphed by a Honeywell 530 X-Y plotter. Curves representing solar radiation were smoothed by a 15-day moving average technique (4).

DAILY SOLAR RADIATION

The average daily solar radiation over the 10-year period varied from approximately 100 g cal/cm^2 per day in December to 500 in June-July (Fig. 1). On any given calendar day, there were large variations in the amount of solar radiation. Line 1H represents the highest daily value, and line 1L represents the lowest daily value observed on each calendar day during the 10 years. For example, for each calendar day in June, radiation exceeded 700 g cal/cm^2/day at least 1 year in 10 and was less than 200 g cal/cm^2/day at least 1 year in 10, based on the smoothed curves.

Lines 2H, 3H, 4H, and lines 2L, 3L, 4L represent the second, third, and fourth highest (H) and lowest (L) daily values, respectively, for each calendar date.

SEQUENCE OF DAYS: AVERAGE DAILY VALUE

The average daily intensity of solar radiation for durations of 3 (Fig. 2) and 5 (Fig. 3) consecutive days ranged from about 100 g cal/cm^2 per day in November-December to 500 in June-July. These curves may be used to estimate solar radiation over a sequence of days when the total radiation over the sequence influences physical processes such as heating soil and buildings or drying crops. Also, they may be used to estimate biological processes resulting from the cumulative effect of heat such as growth, development, flower initiation, and maturity of plants.

SEQUENCE OF DAYS: MINIMUM DAILY VALUE

Data were analyzed to determine minimum daily value of solar radiation within a sequence of days. This was done for both 3-day (Fig. 4) and 5-day (Fig. 5) sequences. These curves demonstrate the occurrence of durations of days with a minimum daily value. They may be related to physical characteristics such as the quantity and duration of storage of energy from the sun used for heating. Also, they may be related to certain biological processes such as the metabolization of nitrate to nitrogen compounds in plants during a sequence of days containing 1 day with low solar radiation.

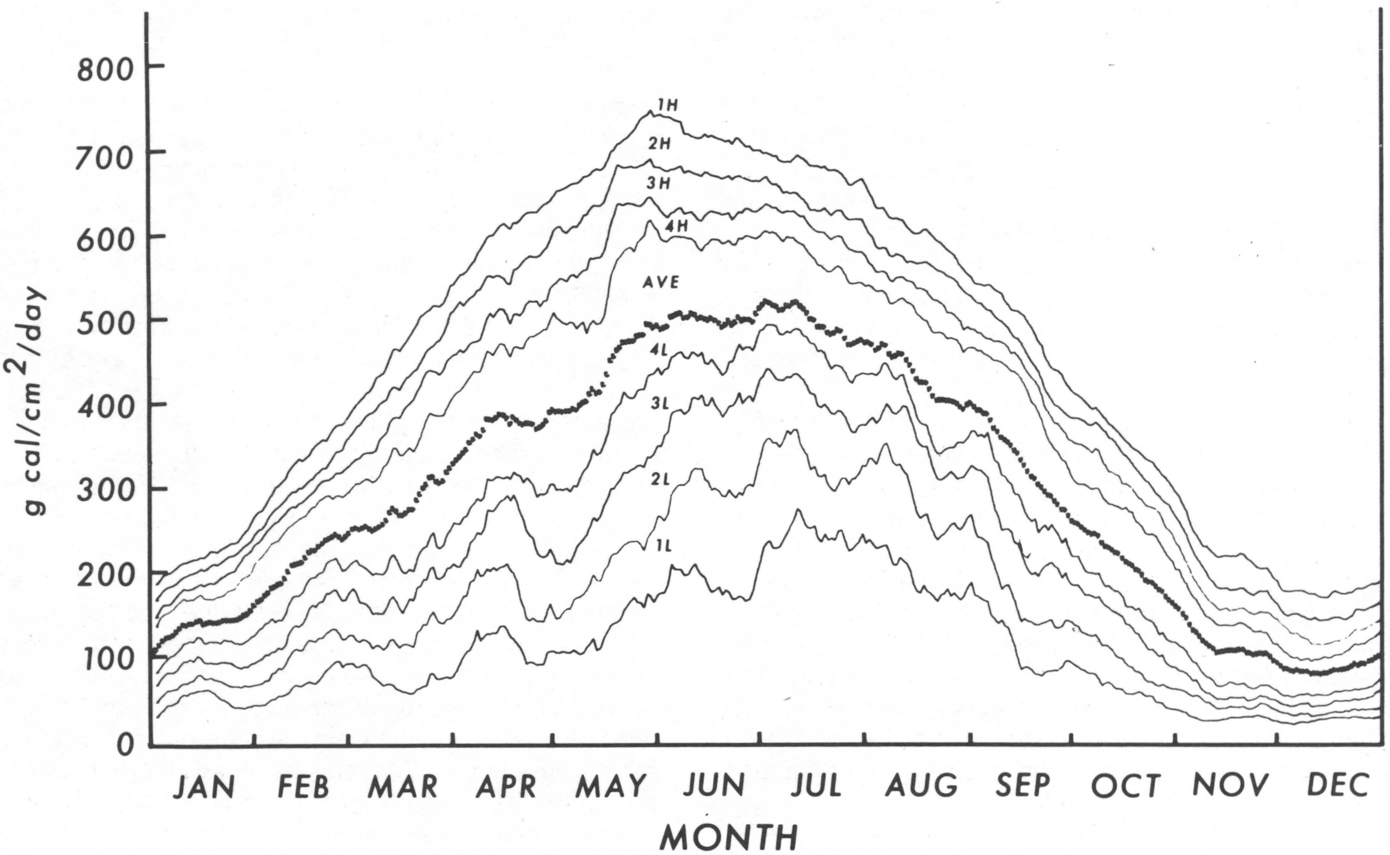

Figure 1.—Average daily solar radiation.

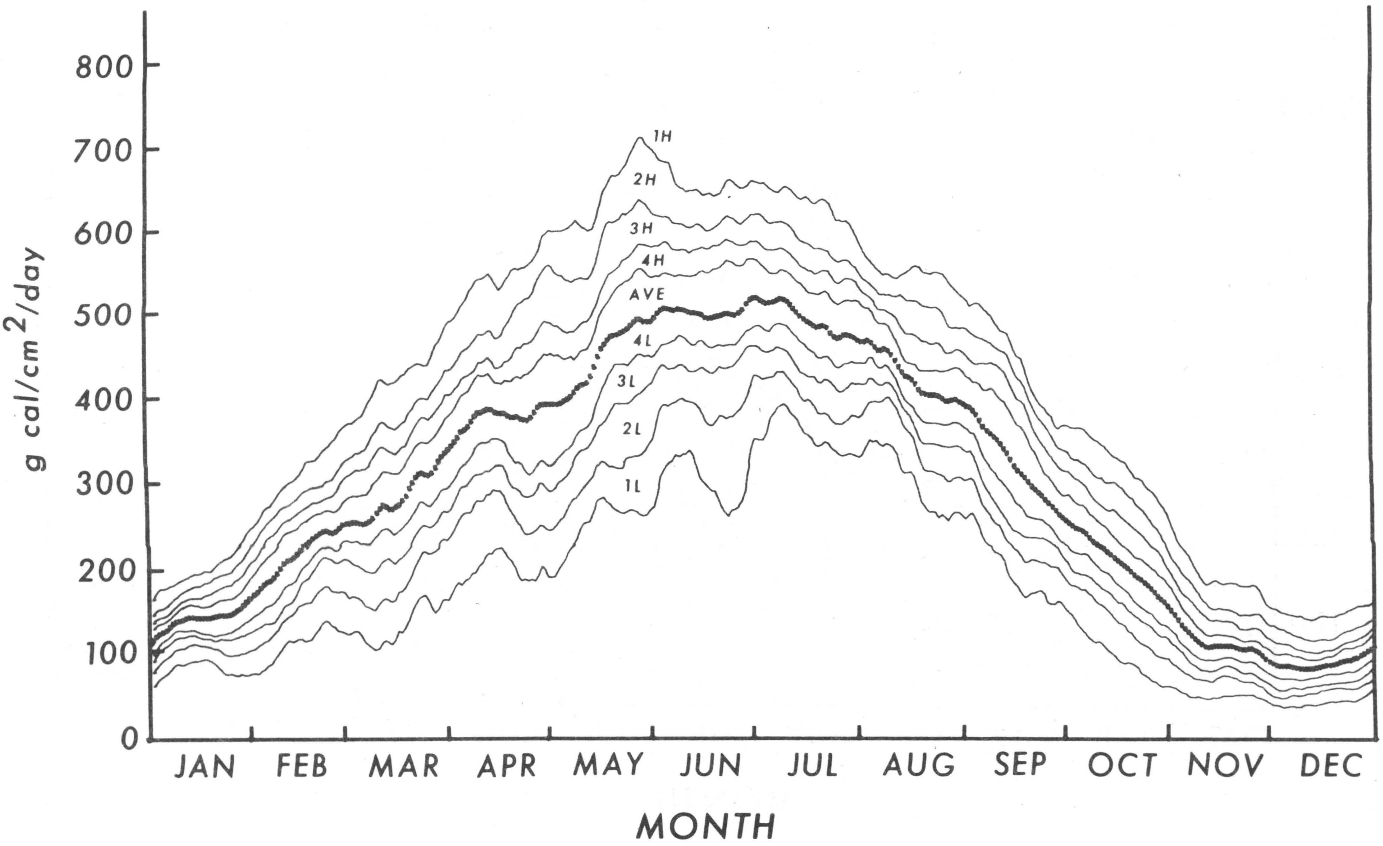

Figure 2.—Average daily solar radiation for sequences of 3 days.

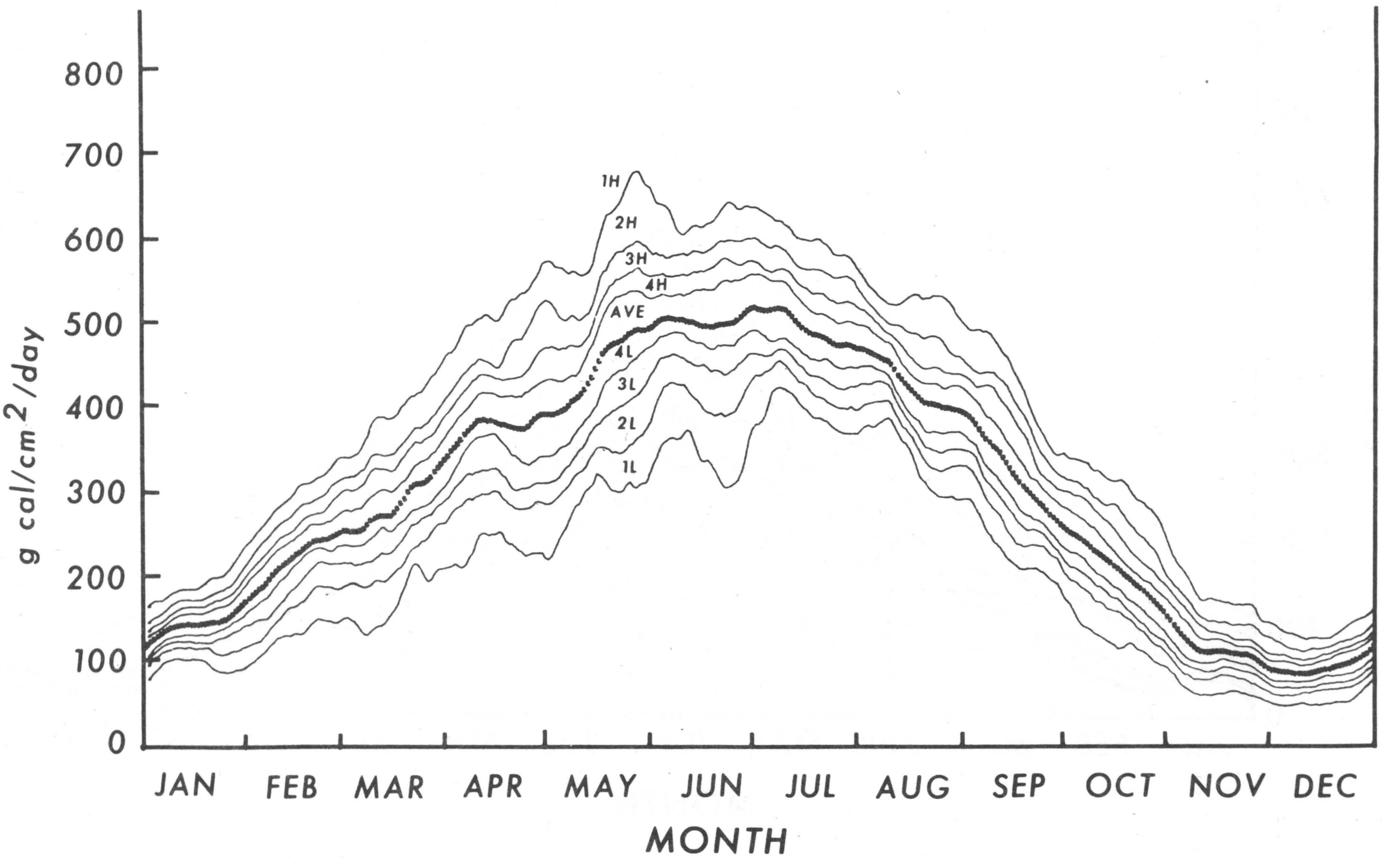

Figure 3.—Average daily solar radiation for sequences of 5 days.

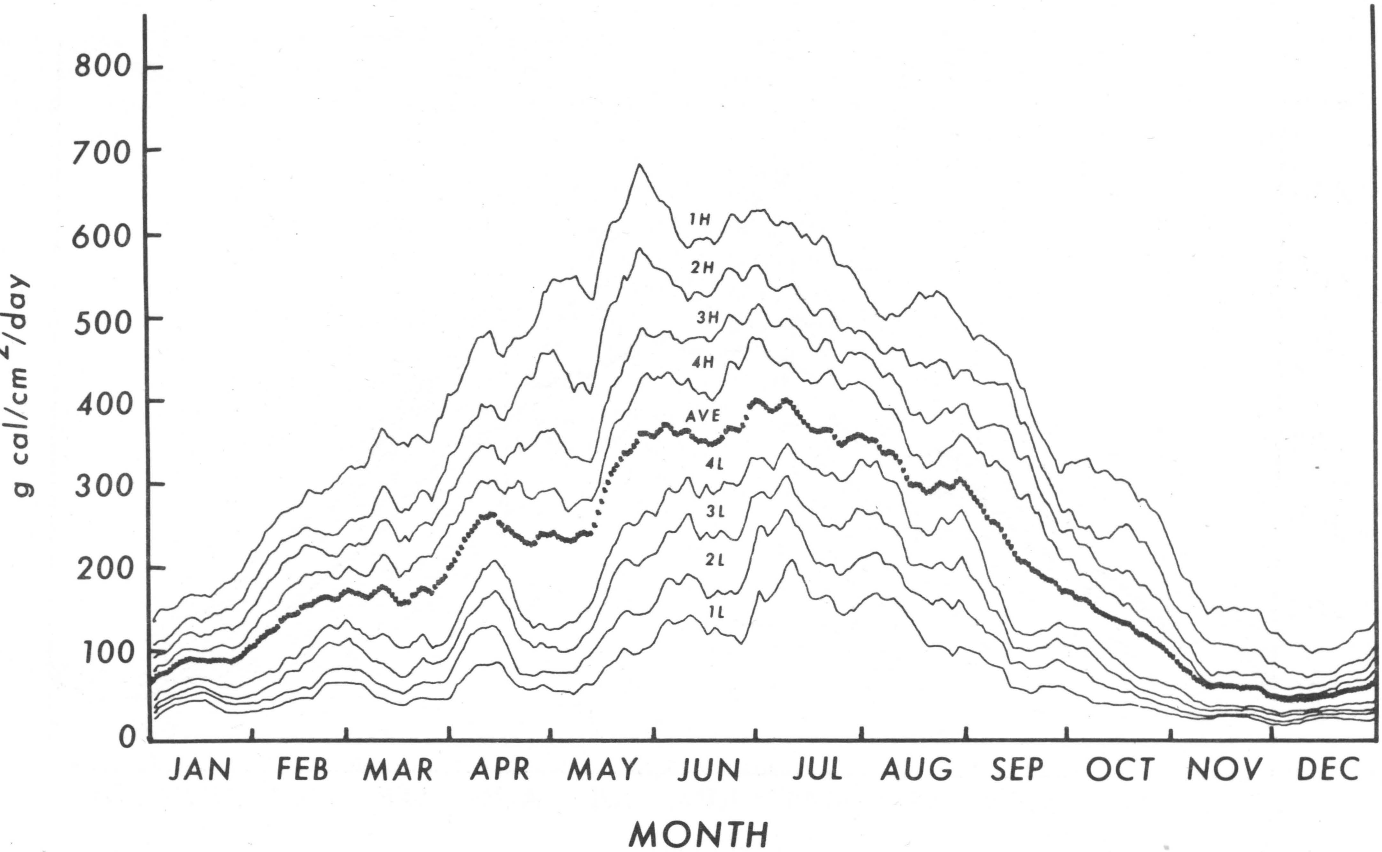

Figure 4.—Average minimum daily solar radiation for sequences of 3 days.

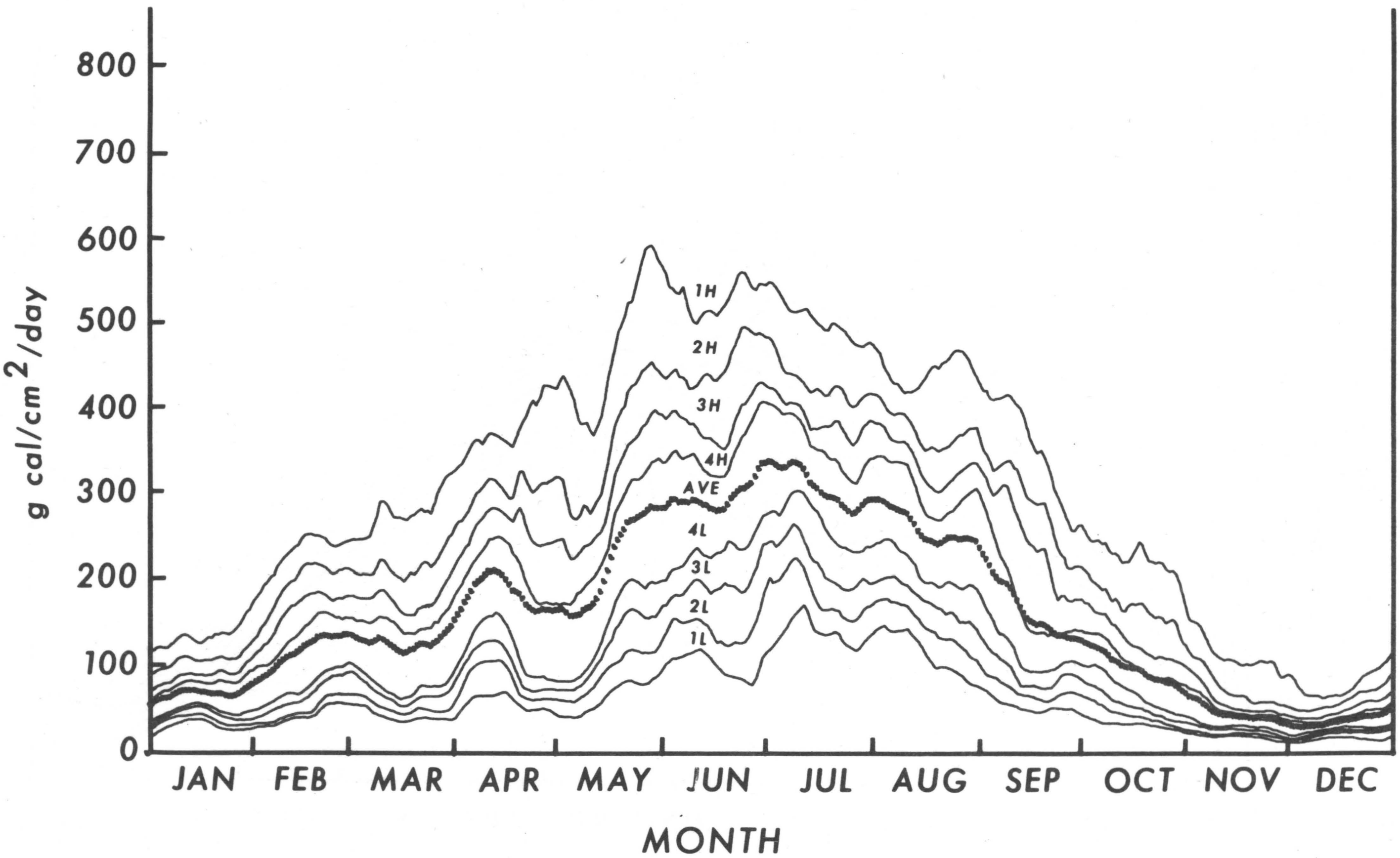

Figure 5.—Average minimum daily solar radiation for sequences of 5 days.

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