State Water Survey Division
CLIMATOLOGY SECTION
AT THE
UNIVERSITY OF ILLINOIS

Illinois Institute of Natural Resources

SWS Contract Report 276

ILLINOIS SOLAR WEATHER PROGRAM

by
L Keith Hendrie, Climatologist

Final Report to Illinois Institute of Natural Resources

Contract: STIL—INR80.210
September 1, 1980 - August 31, 1981

Richard G. Semonin
Principal Investigator

Champaign, Illinois
October 1981

TABLE OF CONTENTS

ILLINOIS SOLAR WEATHER PROGRAM

L. Keith Hendrie
Climatologist
Illinois State Water Survey

Introduction

Pressures to develop alternative energy technologies have increased with the rapid depletion of sources of readily accessible fossil fuels of acceptable quality under present environmental guidelines, and the increased need to at least reduce our dependence upon foreign-controlled oil supplies. While all possible avenues are being considered, solar and wind energy conversion systems have been widely proposed as potential buffers for the national energy crisis.

The solar and wind energy resources are attractive alternatives because they are adaptable for both large and small-scale users. They also have the advantage of having been utilized in the past for a number of small-scale applications, and so are more readily acceptable to the population at large. However, both of these energy sources are quite sensitive to variations in weather and climate. Changes in cloudiness and atmospheric turbidity, along with other parameters, directly influence the receipt of solar energy at the surface, and the associated passage of weather systems and diurnal heating and cooling play a large part in causing the observed variations in surface wind speed. Consequently, to have a good understanding of the magnitude of these potential energy resources and their spatial distribution over Illinois, we need long-term meteorological data, including measurements of wind speed and solar radiation. Reliable and comparable long-term data on the necessary spatial scale are not currently available. Also there is little useful information on the impact of climatic variability upon solar and wind energy availability, even on the short time scale. As a result, climate-induced variations and often even differences due to changes in day-to-day weather have been ignored as variables in the determinatinon of cost-benefit analyses used to evaluate many proposed technological developments related to alternative energy systems.

This program was initiated to establish an observational network to provide a high quality solar radiation data-base on the temporal and spatial scales critical to the appropriate evaluation of solar energy systems. With time and continued monitoring, these data will provide planners with information on climatological trends and variations in receipt of solar radiation at the surface for meso scale regions in Illinois. This is a spatial scale in keeping with that used in previous atmospheric experiments that have revealed variations in cloudiness and precipitation, often with a persistence of months to years. Other previously collected comparable solar radiation data have been considered to provide an initial examination of historical trends and variability in solar radiation received over this region of the mid-west.

Background

Prior to the initiation of this project, solar radiation was being monitored independently at a few places in Illinois, but direction of operations at these sites lacked coordination, and the data are not of sufficiently compatible form to incorporate into one picture for a number of reasons. Often these measurements were made for only a relatively short period of time and with widely different objectives which bore strongly on the methodology adopted. In most cases the acquisition of data had commenced very recently, meaning that little value could be attributed to them as being representative of any mean value. Additionally, the type of instrumentation employed varied widely, resulting in a variety of differences in the sensor outputs related to the instrument characteristics, spectral response, mounting and exposure, and leading to incompatible data in many cases. The types of factors involved here caa cause wide variations in calibrated output, often of the order of 10-20%, and under certain conditions much greater. These factors include differences in instrument response time, varying instrument sensitivity to temperature, spectral composition of the incoming radiation, azimuth, orientation and zenith angle, and also changing sensitivities when instruments are mounted in non-horizontal positions. The procedures adopted for instrument calibration (if performed) and maintenance also varied widely, and the nature of the exposure, particularly in the case of tilted sensors lacked consistency.

In view of the potentially large uncertainties in this presently available data, it was decided not to consider them for the purpose of development of mean values, and to ensure that the network to be developed under this project should be governed by a consistent policy of site selection criteria, instrumentation type, calibration, maintenance, and methodology, and to supplement the data obtained only with other measurements obtained under compatible conditions elsewhere.

Project Aims

The primary aims of the project are:

(1) to collect high-quality solar radiation data in order to develop an understanding of the mesoscale solar climatology for Illinois;

(2) to use these data to interpret the spatial and temporal variability in the solar energy potential for the state;

(3) to publish the collected data and make it available to interested agencies, research organizations and members of the public; and

(4) to incorporate these measurements with other historic data and related information such as sunshine records to extend the usable records back in time.

To ensure the best possible data set, it was necessary to use high quality sensors and recorders, to install these instruments at good data collection sites determined according to a consistent set of criteria, and to use a consistent methodology throughout. Additionally, these sites should be maintained for a long-term program of monitoring.

Selection of Measurement Sites

The criteria developed during the site selection process are listed below in their order of importance.

(1) The sites should provide a reasonably homogeneous spatial coverage of the State, although this is difficult with only 6 sites to be established in the first year of the project. Consequently consideration was also given to probable site locations for the anticipated additional sites to be established during the second year. It was determined that data from the Argonne National Laboratory at Lemont would be compatible with the network data, and permission was obtained for us to receive it, hence giving a seventh site in the first year. It was also decided that no attempt should be made to monitor solar radiation within Chicago since due to large local variations in cloudiness, atmospheric moisture and aerosol concentrations it is likely to be highly variable. Rather this should be studied independently in a future project.

(2) The pyranometers were to be mounted with their sensing surfaces positioned in a horizontal plane as is conventional in meteorological practice. Solar fluxes on surfaces of other orientation can be estimated from this data using appropriate empirical models. The instruments should be positioned at a height of at least 1 meter above the surface, but still be convenient for servicing.

(3) The pyranometers should be located preferably in an open space in a relatively flat area, and fairly unobstructed by buildings, trees and all other tall objects, particularly from the east through south to west. It is important that there be no shading of the sensor surface, and best if there is also little horizon obstruction. The limits imposed were that the top of any obstructions located from the east through south to west should have an angle of elevation from the sensor surface of less than 5° (2.5 meters above instrument at 30 meters distance), and that the location would be definitely unsuitable if the angle of elevation of any obstruction exceeded 10° (5 meters above instrument at 30 meters distance).

(4) The site locations should be relatively accessible at all times of the year to facilitate Water Survey personnel in the initial installation of the delicate equipment, and in their routine visits for maintenance, calibration and checking of the instrumentation. However, the site should not be directly adjacent to high-use areas or traffic corridors where it may become subject to theft, vandalism and/or tampering.

(5) It would be beneficial to have experienced and sympathetic personnel living and/or working near the site. This would greatly enhance the security of the instrumentation and provide an "on-site" observer who could notify Water Survey personnel promptly in the event of such abnormalities as equipment malfunction, damage or theft, thereby reducing periods of data loss.

(6) It would be preferable to have a 115 V AC power source nearby to reduce distances through which cabling would have to be installed.

(7) It was also considered preferable to locate these sites at places where the data could be utilized to assist with on-going operations or research.

It was decided to co-locate these sites with those for a wind energy study also initiated by the Water Survey, and in addition to include equipment to monitor temperature, humidity, precipitation, soil temperature and soil moisture at the same location.

After much discussion and searching it was determined that the most appropriate places to locate the equipment would be at the University of Illinois College of Agriculture Research Centers. It was felt that they could provide a reasonable well-spaced network of sites giving a good state-wide coverage during the first year; having good instrument exposure, accessibility and long-term availabiltiy; offer good security against the threats of vandalism and theft; have experienced staff on location; and the data would be useful to agricultural researchers.

A proposal was submitted to the College of Agriculture and approval given to establish sites at 5 of their Research Centers. In addition to the Water Survey site at Bondville, about 5 miles SW of Champaign, this provided the necessary 6 sites for the first year. The location of these sites is shown in Figure 1, and Table 1 provides detailed information of their exact longitude, latitude and height above sea-level. Initially the Bondville site was not instrumented, the pyranometer instead being installed on the Water Survey building in Champaign in order to recalibrate an actinograph used previously to provide estimates of solar radiation for Champaign, but now in need of considerable maintenance. The Champaign actinograph has been in continuous operation since July 1966, providing a relatively long-term record for evaluation. The simultaneous operation of the pyranometer and actinograph for a period of months at this location will allow an assessment of the quality of the long-term actinograph data.

Description of Instrumented Sites

The following is a general description of the actual instrumented sites which shall for the remainder of the report be referred to as DeKalb, Monmouth, Perry, Champaign, Brownstown, Dixon Springs, and Lemont.

(1) DeKalb:

This site is located in DeKalb County at the University of Illinois Northern Agricultural Research Center between Shabbona and DeKalb and has a resident farm manager. The site has a slight east-facing slope (<3°) and is open in all directions except for a coniferous windbreak of about 12 m height at about 100 m to the NW and the farm manager's residence of about 10 m height at about 100 m distance to the WNW. The immediate surroundings are grassed verges and agricultural experiment plots planted in corn in 1981.

(2) Monmouth:

This site is located in Warren County on the newly acquired University of Illinois Northwestern Agricultural Research and Development Center about 4 miles

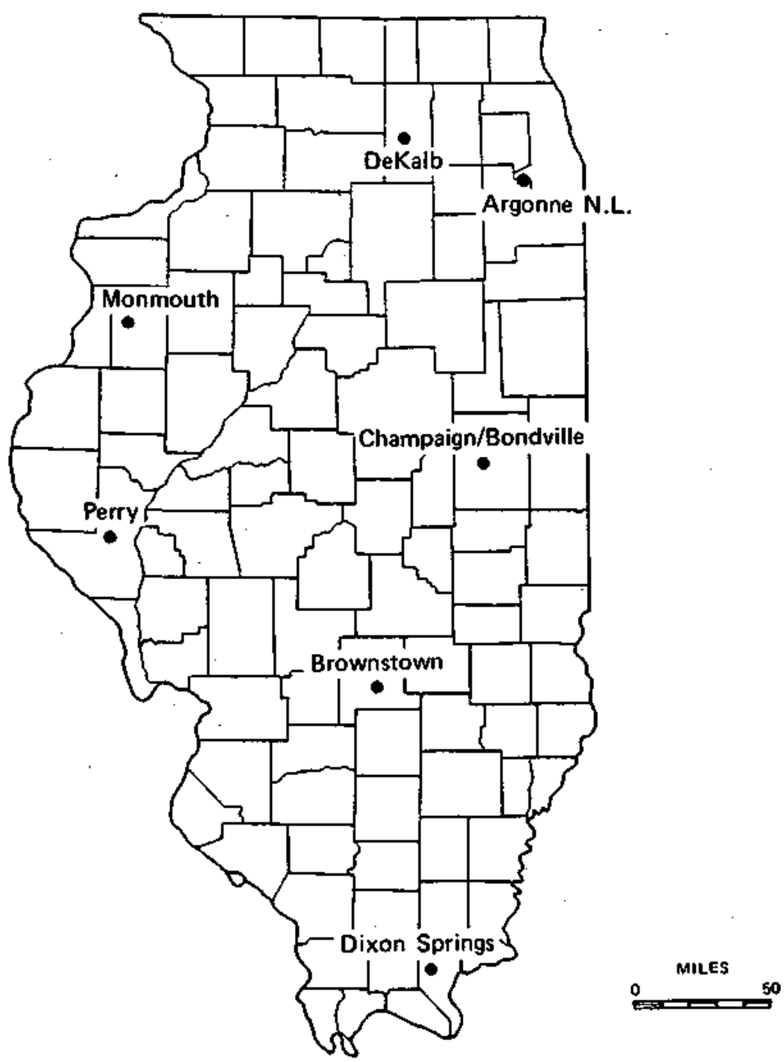


Figure 1: Location of solar radiation sites, 1901.

Table 1 Sites selected for year 1 of the Illinois solar radiation monitoring network.[1]

Site Name	Latitude	Longitude	Height Above MSL (m)
DeKalb	41° 51'N	88° 51'W	265
Monmouth	40° 65'N	90° 45'W	229
Perry	39° 4.8'N	90° 50'W	206
Champaign2	40° 03'N	88° 57'W	219
Brownstown	38° 57'N	88° 57'W	177
Dixon Springs	37° 27'N	88° 40'W	165
Lemont[3]	41° 42'N	87° 58'W	221

[1]It is anticipated that a more spatially homogeneous network will result from additional sites to be initiated in year 2 of the project.

[2]This site is anticipated to be relocated slightly SW to Bondville (40° 03'N, 88° 22'W, 213 m above MSL) during year 2 of the project.

[3]This site is at the Argonne National Laboratory and has not been instrumented by the Water Survey. It was established in 1950 with equipment compatible with that used in the network. It has obvious benefits of a long-term record.

west of Monmouth. At present there is no resident worker, but a farm manager is to be appointed shortly, and will reside on the property. There is no detectable slope at the instrumented site, although there is a shallow SW to NE oriented gully about 100 m to the SE. The only obstruction within 600 m is an unused cattle-shed of about 6 m height at about 50 m to the NE. The surrounding land is cropped in soybeans this year.

(3) Perry:

This site is located in Pike County at the University of Illinois Orr Agricultural Research Center between Perry and Fishook, and has a resident farm manager whose home is adjacent to the site. The instruments are located on an upland area dissected by a NE to SW oriented gully of about 10 m depth to the NW of the site, and with an east-facing slope of about 5° (see Figure 2). The site is open in all directions, with the only obstructions being the farm manager's residence of about 7 m height at 100 m distance to the NW and the Center's office, implement shed and new classroom/laboratory complex over 250 m to the ENE, with a pond lying between them and the site. The immdediately adjacent area serves as the Center's meteorological site and an experimental plot planted in corn.

(4) Champaign:

At the moment the pyranometer is situated on a stand on the penthouse on the eastern end of the Water Resources Building occupied by the Water Survey on the corner of Springfield and Sixth Streets, Champaign (see Figure 3). The exposure is excellent with only a few buildings and odd trees any higher than the sensor, and these are all at considerable distances. The instrument has been placed here temporarily to permit calibration of the previously installed actinograph for which some years of uncalibrated data are available. The instrument is to be reestablished at Bondville on flat land cropped in soybeans as soon as a satisfactory calibration has been completed.

(5) Brownstown:

This site is located in Fayette County on the University of Illinois Brownstown Agricultural Research Center, about 5 miles south of Brownstown. There is a very slight S facing slope (<2°), and apart from a wooded area from the ESE to the SSW and at 300 m there is no obstruction. A large pond lies well to the south and between the wooded area and instrument site. The adjacent area is used as experimental crop land; wheat and irrigated corn and soybeans this year.

(6) Dixon Springs:

This site has been incorporated in the meteorological enclosure of the University of Illinois Dixon Springs Agricultural Research Experimental Station, between Glendale and Dixon Springs, Pope County in an undulating, partially wooded area typical of southern Illinois (see Figure 4). The instrument site is located near the top of a knoll with a shallow-west-facing slope. The nearest obstructions are a timbered area and house to the east and a house and isolated trees to the north. The area is quite open from the SW through W to the N.

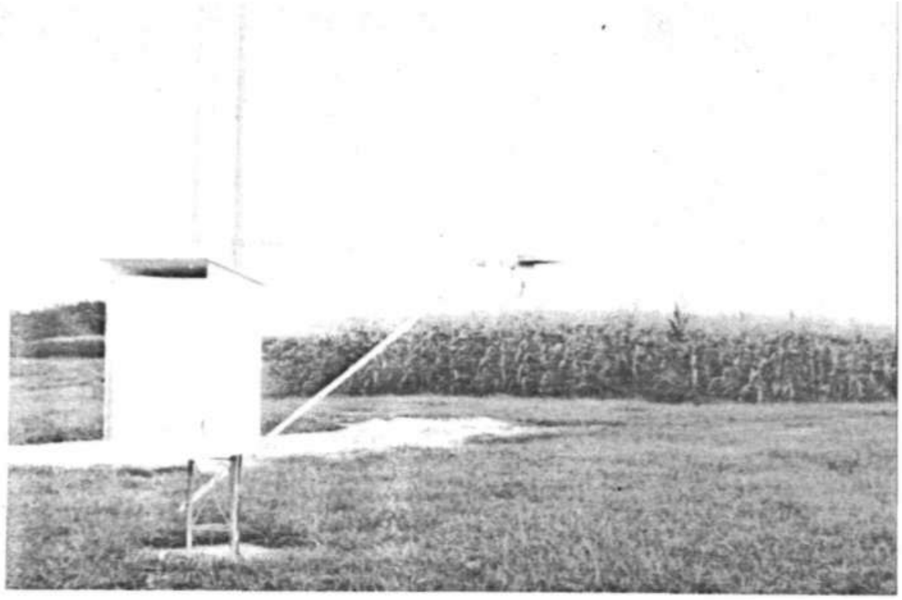


Figure 2. Perry site, August 1981. Eppley 8-48 pyranometer on horizontal boom attached to anemometer tower. Integrator-printer system in insulated white box on tower. View towards SE.

Figure 3. Champaign site, August 1981. Eppley 8-48 pyranometer on left-hand stand and actinograph on right-hand stand. View from top of penthouse on east-end of Water Resources Building, looking NE.

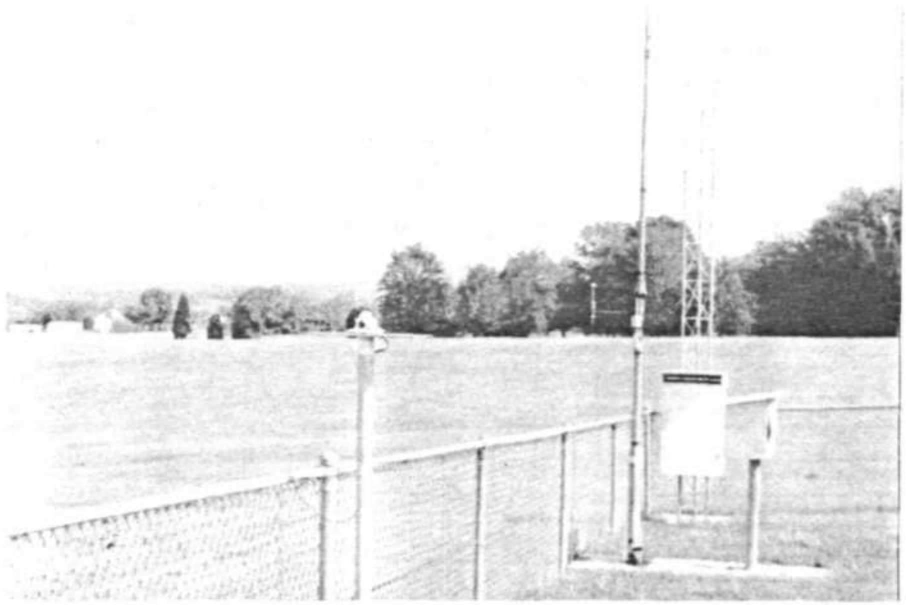


Figure 4. Dixon Springs site, August 1981. Eppley 8-48 pyranometer on near stand, recording system in white box attached to far tower which serves as support for anemometer. View looking towards north.

(7) Lemont:

This site is operated by the Argonne National Laboratory just north of Lemont and the Illinois and Michigan Canal, in western Cook County. The pyranometer monitoring solar radiation is located on the top of a tower of about 8-10 m height, and has an unobstructed exposure.

Instrumentation: Purchase and Calibration

Six Eppley 8-48 or black and white pyranometers (illustrated in Figure 5) and six matched Eppley electronic integrators and digital printers (shown in Figure 6) were purchased from Science Associates Inc., N.J. to serve as the data acquisition systems at each of the sites. This instrumentation was received in March 1981, and given a variety of laboratory tests to ensure operating compatibility, to check calibration values, and to check for any inherent problems. During April, 1981, the six pyranometers were transported to Boulder, Colorado to be calibrated over a 2-3 week period at the national calibration laboratory maintained at the National Oceanic and Atmospheric Administration Environmental Research Laboratory.

This calibration phase at Boulder proved very beneficial, and a number of fine-tuning adjustments were able to be performed on the sensors to make them respond more accurately to the incoming solar flux, or to provide correction factors to modify their signals to give more appropriate solar radiation values. In particular, it was found that 5 of the 6 sensors required at least a slight alignment of their sensor surfaces to make them exactly horizontal when the pyranometer body was exactly horizontal. In the worst case a 5-7% error in the output signal was occurring before the alignment was made. A cosine response curve for the instruments was able to be developed from the data collected, and a measure of the impact of rotation of the black and white sensor surface upon the output signal was determined. This led to a consistent method of exposure of the sensors so that at least their output signals were comparable under similar conditions. Finally, variable calibra-tion values for these sensors were developed to permit their signals to be equated with those from high precision pyranometers.

The net result of these tests and adjustments, is that given no other malfunctioning, the output signals will provide solar radiation values within ±3% of actual values under most circumstances. Only at fairly low intensities is the signal error likely to exceed this value, and fluxes of this order are of little value as an energy source. Consequently we can have high confidence in the data being provided by the network.

The integrator-recorder systems were pre-calibrated at the Eppley Laboratory, and were checked using constant millivolt input sources at the Water Survey. They were found to have been adjusted precisely, and no further preliminary adjustments were effected.

Instrumentation: Installation and Performance

The actual installation of equipment at the various sites commenced in May, 1981, following a period of final site selection, fabrication of support structures and recorder shelters, and cable preparations. In all cases, signal cables were kept as short as possible (maximum of 10 meters) to keep resistance

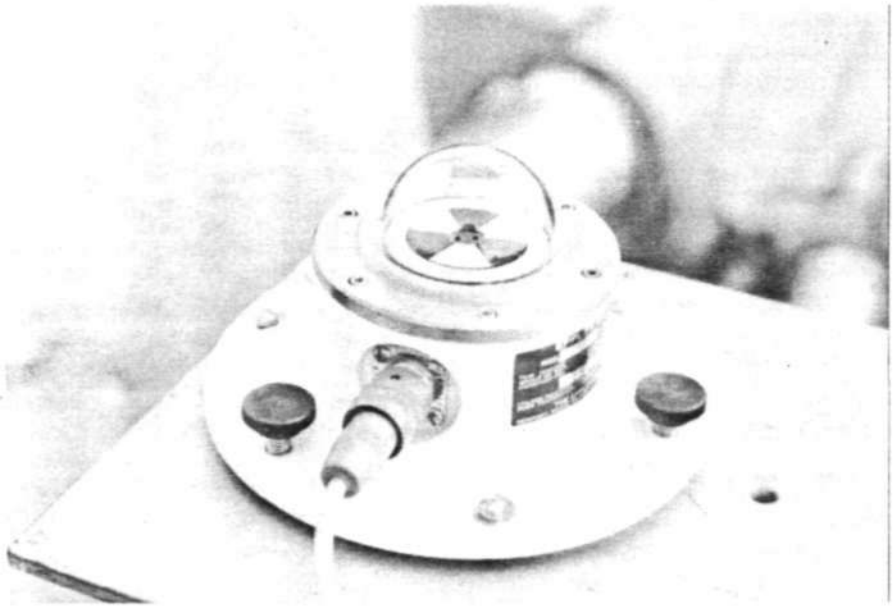


Figure 5. Epply 8-48 (black and white) pyranometer mounted on horizontal steel plate, Champaign site.

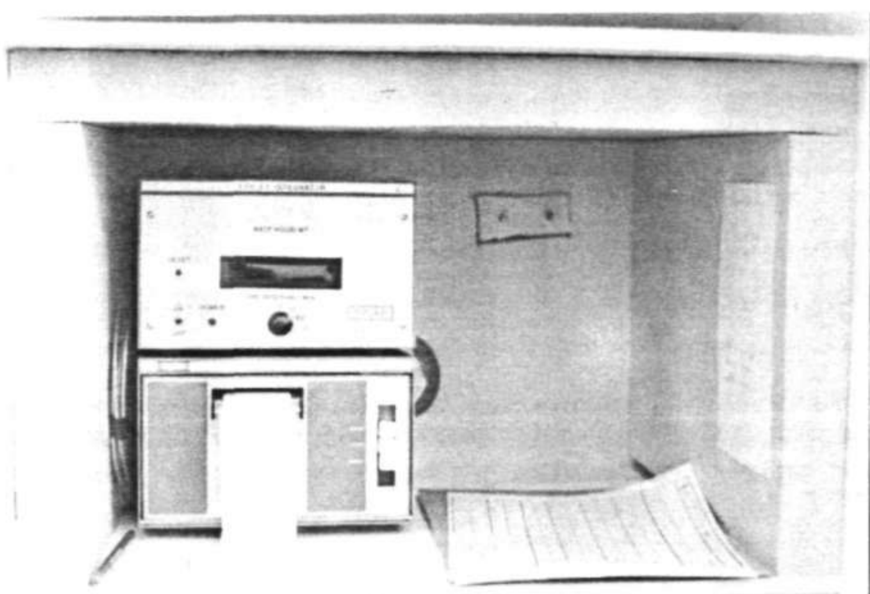


Figure 6. Eppley integrator (top) and digital printer (bottom) housed in insulated recorder box attached to a tower, Perry site.

at a minimum, and shielded cable used to avoid interference to the signal by other electromagnetic fluxes. Power cables installed were trenched, with 12 gage cable used if less than 15 meters long or 10 gage if longer. Circuit breakers were installed at each site.

Two systems were devised for the support of the pyranometers. The first method utilized a horizontal steel plate attached to the top of a pole and positioned at a height of 1.75 meters. This was used at Dixon Springs and Champaign where it was beneficial to locate the pyranometer away from the anemometer tower to improve the conditions of instrument exposure to achieve the necessary standards adopted (see Figures 3 and 4). The second method utilized a horizontal steel plate attached to the end of a 3 meter horizontal boom which was bolted at a height of 1.75 meters on the anemometer tower with necessary support struts. The horizontal boom was pointed towards the south from the tower (see Figure 2). This system was adopted at Bondville, Brownstown, DeKalb, Monmouth and Perry. Both systems have functioned well, and will be adopted for further sites in year 2.

A standard insulated recorder shelter was developed (see Figures 2, 4, and 6) and consisted of a 1 m × 0.6 m × 0.5 m painted box lined with R11 styrafoam insulation and equipped with ventilation ports and thermally controlled fans and light bulbs to maintain internal temperatures well within the operating range of the recording systems. These shelters have proved themselves at all sites under spring and summer conditions.

The first site completed was Champaign, with the first set of usable data being recorded on May 8. All sites had been completed and were providing usable data by June 24, 1981. Table 2 provides a summary of the performance of the equipment at each site. Overall performance has been satisfactory to good, with a total of 7380 hours of usable data recorded for the six sites to mid-August (90.3% of the possible hours).

In general the Eppley 8-48 pyranometers have performed quite well, requiring only that their glass dome be cleaned regularly with methyl alcohol, and that their silica gel be refurbished occasionally. However, two of the sensors, those at Monmouth and Champaign, had a faulty seal that permitted moisture that had condensed on the external body of the instrument to be ingested to the interior. This moisture rapidly expended the silica gel, saturated the air inside the instrument, and then as the air in the dome cooled due to radiative loss at night, condensed on the inside of the dome and ran down onto the sensor surface, staining, it and thereby changing its sensitivity to the incoming solar flux. This condition occurred at Monmouth in early July and at Champaign in late July. These damaged instruments were still under guarantee, and so were returned to the Eppley Laboratory, R.I. for correction of the fault, repainting of the sensor surface, and recalibration. One pyranometer was sent to us on loan while repairs were being effected. The Monmouth sensor has been returned, but we are still awaiting the Champaign instrument.

The Eppley integrator-printer systems have also performed quite well with only one annoying internal feature: that being, that whenever there is a power failure or disruption (even for a few seconds), they turn off, resetting their clocks and integrators, and requiring manual resetting before they will again print data. This one poor feature has resulted in at least half of the data loss that has occurred to date. The other large data losses have resulted from

Table 2. Record of period of monitoring of solar radiation at each of the six sites instrumented and problems encountered.

Site Name	Date of final Installation	Time (CST), Date of First Good Record	# of days of recording/% of hours of data acceptable				Problems Encountered
			May	June	July	August	
DeKalb	June 15	19 hrs, June 15	-/-	16/ 93.4	31/ 71.6	13/100.0	power outage during electrical storms coupled with lack of daily inspection of recorder
Monmouth	June 24	15 hrs, June 24	-/-	2/100.0	0/-	0/-	recorder: failure of electronic component - repaired sensor: internal damage due to moisture - repaired & recalibration (under warranty)
Perry	June 18	17 hrs, June 18	-/-	13/ 93.9	31/ 75.0	16/ 82.0	frequent power interruption due to power outage during electrical storms; frequent power shutdown during construction of major new facility
Champaign	May 8	17 hrs, May 8	24/100.0	30/100.0	31/100.0	19/100.0	internal damage to sensor due to moisture - repair & recalibration in progress (under warranty)
Brownstown	June 4	18 hrs, June 23	-/-	8/100.0	31/ 89.7	12/100.0	faulty cable permitting electrical interference to signal occasional power outage due to electrical storms
Dixon Springs	June 3	19 hrs, June 3	-/-	28/ 90.5	31/ 80.8	11/100.0	extensive damage to electronic components of integrator & recorder resulting from nearby lightning strike occasional power outage due to electrical storms

two sources; frequent power shut-downs at Perry during the construction of a new classroom/laboratory facility; and the impact of a nearby lightning strike at Dixon Springs, leading to extensive damage to the electronic components of both the integrator and printer. This has now been repaired at the Water Survey laboratories, and has been returned to operation. Two other minor electronic component malfunctions have led to minor data losses at Perry and Brownstown respectively, but these were able to be rectified quickly.

Personnel on the Agricultural Research Center farms have been very cooperative in their response to the project, and willing to assist whenever requested, and the support of the University of Illinois College of Agriculture administrative personnel involved has been solid throughout.

Data Collection and Evaluation

The integrator-printer systems have been set to provide integrated hourly data at each of the sites, with accumulated hourly solar radiation data in W/m^2 being printed on paper tape, and values being reset to zero after the midnight printing. These data have been entered onto disc files (one per site) on the University of Illinois CYBER 175 computer in Champaign. A FORTRAN program has been developed to appropriately calibrate and process these data and provide tabular listings of hourly data by days for each month. Daily and monthly totals and maxima and minima values are also calculated and printed. The output can be in any one or more of 3 sets of units; W/m^2 and MJ/m^2, cal/cm^2 and $kcal/cm^2$, or BTU/ft , thus being immediately useful to a wide range of potential users without the need for unit conversions.

Examples of the output provided by this program are listed in Appendices A and B. Appendix A provides the Champaign record from May to August in each of the 3 types of output, while Appendix B provides the Perry data in W/m^2 and MJ/m^2 only. The complete data listing will appear in a separate report.

Distribution and Variation of Solar Radiation Over Illinois

Insufficient data have yet been received from the network stations to provide any useful insight into the spatial and temporal variation of solar radiation over the State, but estimated data presented in Knapp et al.(1980)[1] have been combined with records from Lemont, Columbia (MO), Indianapolis (IN), and Madison (WI) to provide tentative spatial patterns of mean monthly solar radiation received on a horizontal surface over Illinois (Figures 7A and 7B), and Figure 8 provides comparable annual mean data. Once data from the Illinois solar monitoring network becomes available these relatively simple patterns will become modified, and with the more reliable data some changes could become quite significant.

[1]Knapp, C. L., T. L. Stoffel, and S. D. Whitaker, 1980: *Insolation Data Manual. Long-term Monthly Averages of Solar Radiation, Degree Days and Global K_T for 248 National Weather Service Stations.* Solar Energy Research Institute, Golden, CO, SERI/SP-755-789, 282pp.

Figure 7A

MONTHLY MEANS OF DAILY SOLAR RADIATION (BTU ft^{-2} d^{-1})

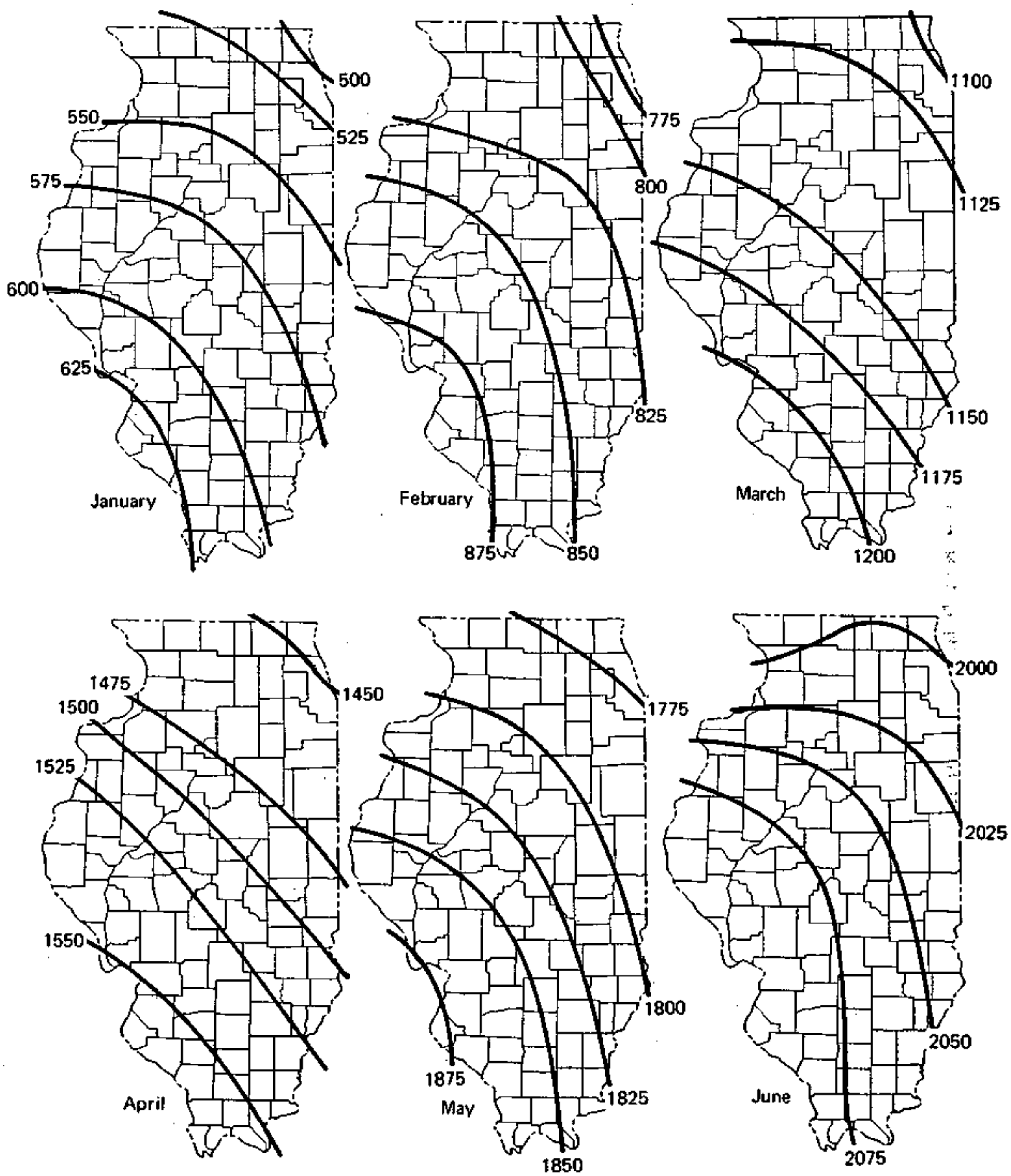


Figure 7B

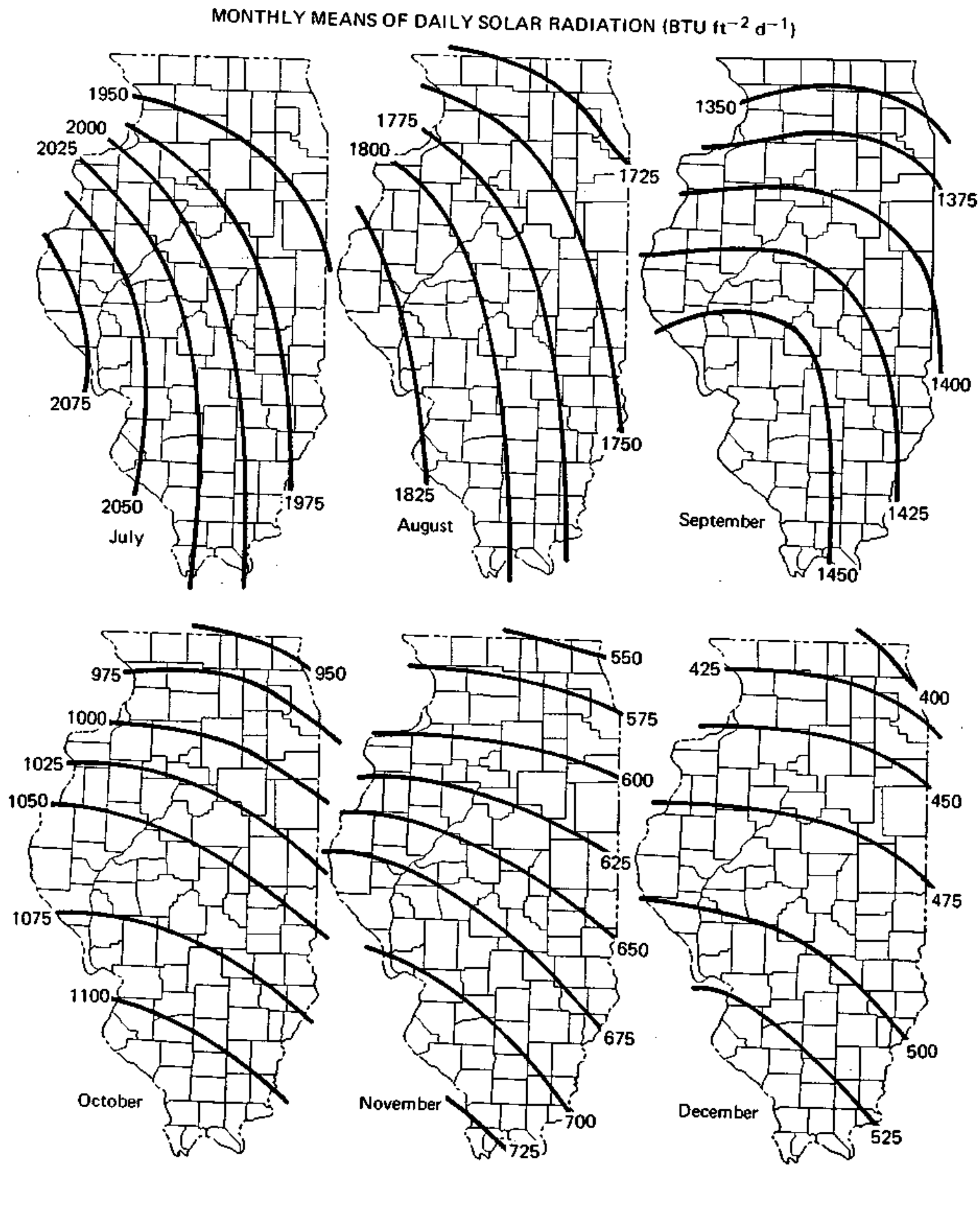
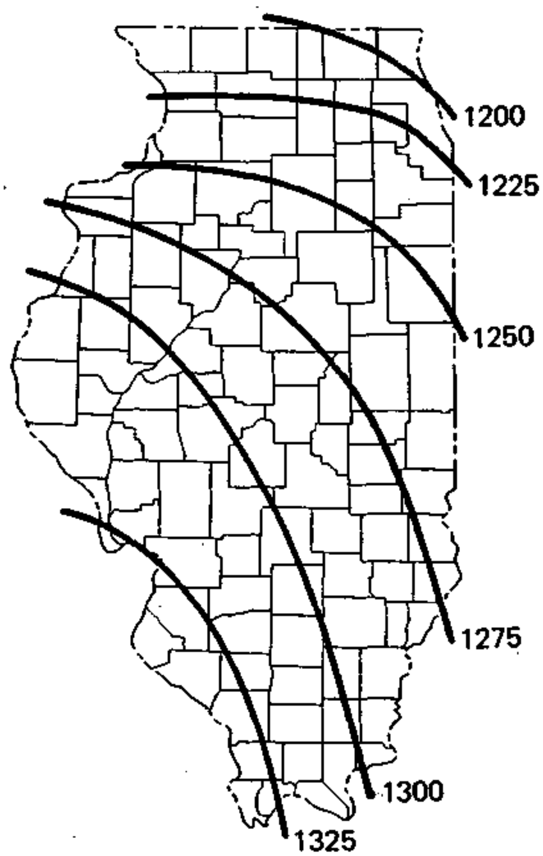

MONTHLY MEANS OF DAILY SOLAR RADIATION (BTU ft−2 d−1)
1950
2000
2025
2075
2050
1975
July
1775
1800
1725
1825
1750
August
1350
1375
1400
1425
1450
September
975
950
1000
1025
1050
1075
1100
October
550
575
600
625
650
675
700
725
November
425
400
450
475
500
525
December

Figure 8

ANNUAL MEAN OF DAILY SOLAR RADIATION

(BTU ft^{-2} d^{-1})



A latitudinal gradient in solar radiation exists for all months, with the lowest values in the north. Additionally, all months, and particularly January through September, exhibit a west to east decrease in solar input in response to the increase in cloudiness over the region as you move eastwards away from the Mississippi River. Also in the northeast there is. a distinct minimum in solar energy related to increased cloudiness associated with Lake Michigan and the urban and industrial influence of the greater Chicago area.

Assuming these mean data to be fairly close, the network data collected to the present give some indication of a reduction in solar radiation below normal during the months of June and July at most sites (see Table 3), and indicate a similar trend for August, although the full month of data has not yet been collected. These data fit expectations in view of the cloudy and wet summer months most of Illinois has experienced this year.

Figure 9 provides monthly mean, extreme and percentile values of solar radiation received on a horizontal surface at Lemont. While these data cannot yet be provided for other areas of the State, it does give an estimate of the likely variability in monthly means of daily values.

In the absence of available measurements of solar radiation, daily or monthly estimates can be made by using simple empirical equations of the type:

$$Q = Q_A (a + b\ n/N)$$

where Q = solar radiation on horizontal surfaces;

Q_A - extraterrestrial radiation impinging on the top of the atmosphere (in same units as Q);

n = hours of bright sunshine;

N = maximum possible hours of bright sunshine;

a,b = regression coefficients - vary with site and season, but approximate values for Illinois are:

$$a = 0.18 \text{ to } 0.20;\ b = 0.50 \text{ to } 0.55$$

These values of regression coefficients a and b were evaluated using data for Columbia, MO and Indianapolis, IN, and should provide reasonable values for solar radiation estimates over Illinois where sunshine data are available.

Long-Term Trends in Solar Radiation

The only data set which can be used to provide long term trends of solar radiation received on a horizontal surface for Illinois is that for Lemont. Table 4 presents monthly means of this data for three periods; namely the whole period of 1950-1978, and two subsections of the whole period, 1950-1964 and 1966-1978. Data for 1965 have not been included as they were not available in a validated form at the time. This clearly indicates that there has been a downturn in the annual mean between the two subsections of 7.2%, and also in all monthly means except those for January and February, and with a maximum decrease

Table 3: Comparison of solar radiation measured during June and July, 1981 to the estimated mean values used in Figures 7A and 7B.

	% difference of measured value from estimated mean value	
	June, 1981	July, 1981
DeKalb	+3	-17
Perry	-4	-15
Champaign	-11	-15
Browns town	-6	-13
Dixon Springs	-9	-11

Table 4: Monthly and annual means of daily total solar radiation received on a horizontal surface at Lemont, IL (Argonne National Laboratory) for the periods 1950-1978, 1950-1964, and 1966-1978 in BTU/ft^2.

	J	F	M	A	M	J	J	A	S	O	N	D	Year
1950-1978	596	854	1145	1440	1790	2010	1944	1729	1396	996	588	460	1244
1950-1964	601	856	1163	1470	1858	2104	1973	1785	1500	1049	635	498	1289
1966-1978	585	852	1125	1408	1716	1910	1914	1668	1275	935	534	416	1196

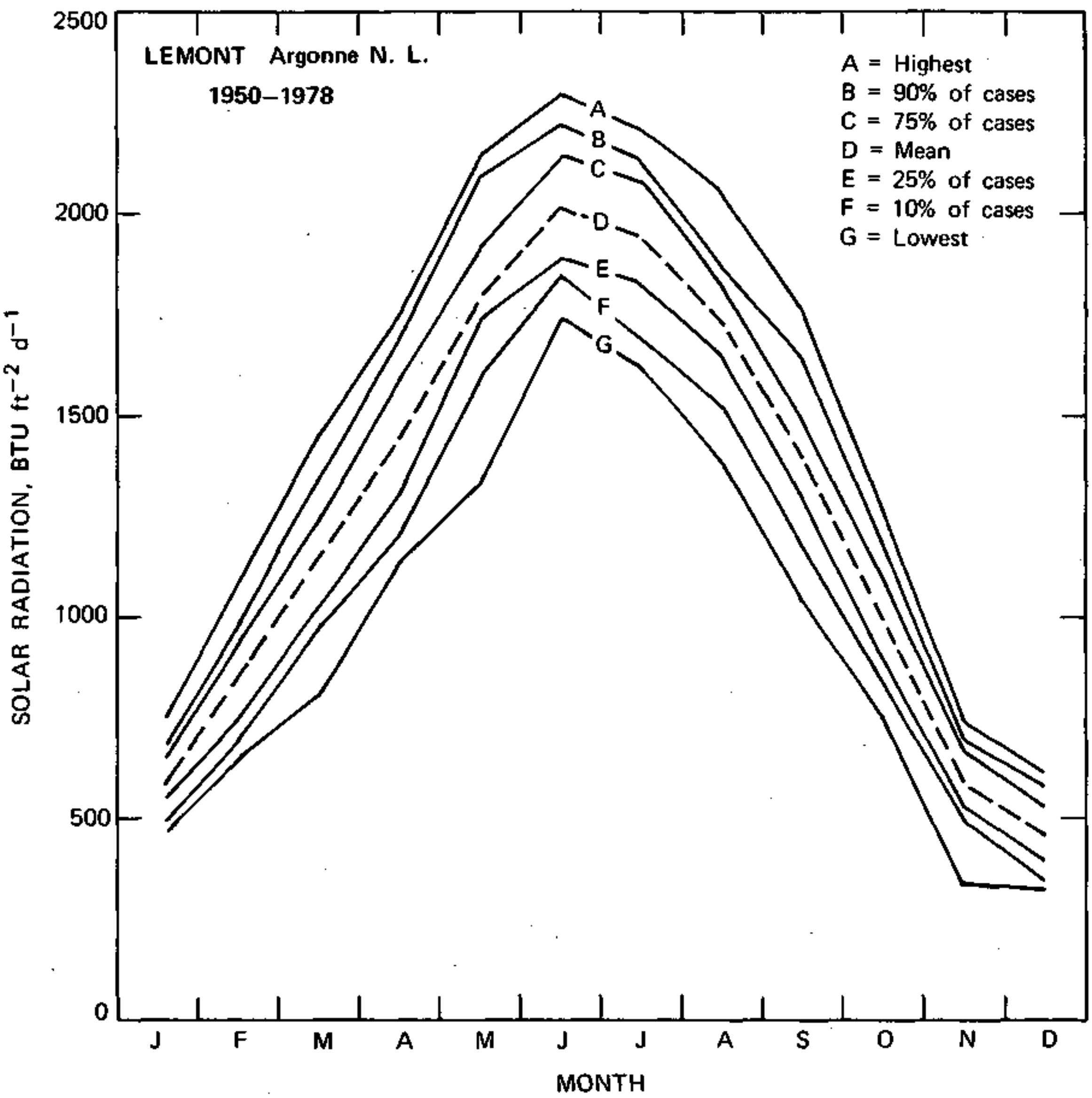


Figure 9: Monthly mean, extremes and percentile (10th, 25th, 75th, 90th) values of daily total solar radiation received on a horizontal surface at Argonne National Laboratory, Lemont.

of 15.0% for September. Figure 10 displays annual and some monthly mean data for each year of record at Lemont from 1950 to 1978 and it is obvious that for some months, although there is considerable interannual variation, a continued and significant reduction in solar radiation received at the surface is apparent. Lines of best fit were computed for each month and the annual case using a least squares analysis, and coefficients for the regression equation determined. These lines have been plotted for the months displayed using dashes. There has been no change for January or February, and only small decreases evident for both March and April which are not statistically significant since they are swamped by the wide scatter in the data. However, in each of the months from May through December, there has been a significant decrease with $r^2 > 0.20$ in each case, and having a maximum value of 0.50 for September.

A closer scrutiny of the monthly and annual data reveals that for years in which one month is significantly different from the line of best fit, there is a tendency for succeeding months to have the same type of variation. Thus, for annual means that are significant peaks or lows, there tends to be 9 or more of its constituent months that vary in the same way.

This general downward trend for Lemont probably results from the interplay of at least two factors. The urban/industrial effect of the Chicago region as it has expanded towards the Lemont area has resulted in an increase of aerosols in the local atmosphere, thereby reducing its transparency to the solar beam, and also leading to an increase in cloudiness and precipitation. The increase in contrails over the same period has resulted in an increase in cirrus cloud and hence greater reflection of the solar beam before it reaches the surface. Shifting weather patterns leading to changes in the patterns of cloudiness and atmospheric water vapor, and possibilities of undetected calibration drift in the instrumentation may also be contributing factors. A review of available data for Columbia, MO and Indianapolis, IN revealed similar trends in the case of Indianapolis, but no significant changes for Columbia.

Thus if solar technology is to be implemented as a major strategy, it is imperative that we investigate these urban/industrial effects and long-term changes in incoming solar radiation in more detail. This is very important in the case of Illinois since such a large proportion of its population lives in an urbanized environment that may be subject to such reductions in incoming solar energy, thus making it potentially less cost-effective, or requiring different technology to achieve the necessary energy levels.

Acknowledgements

This project was conducted under the general direction of Stanley A. Changnon, Jr., Chief of the Illinois State Water Survey, and under the guidance of Richard G. Semonin, Assistant Chief, to whom thanks are given. The following are also acknowledged for their contribution to this research program, both in the establishment of the measurement sites and the continuation of the monitoring process: Doug Jones and Ebe Brieschke who assisted in the establishment of the sites and in the subsequent regular vists to collect data and maintain the instrumentation; and, the staff of the University of Illinois College of Agriculture who have been so supportive of the program, both in providing permission to use their research forms as location for measurement sites, and in having on-site staff assist with additional checks of the

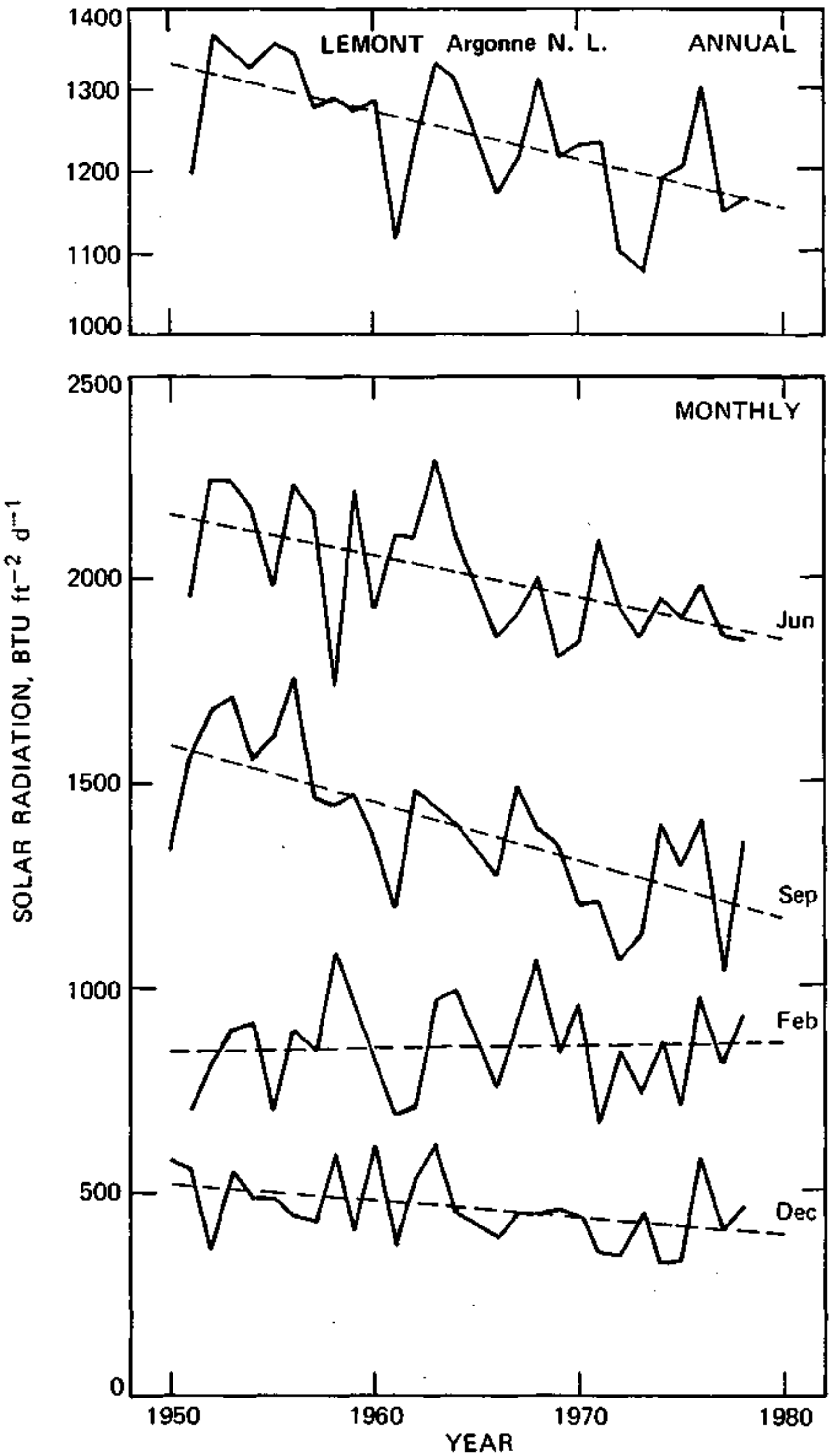


Figure 10: Annual and monthly (February, June, September, December) means of incoming total solar radiation "received on a horizontal surface at Lemont, 1950-1973.

instrumentation. Special thanks are due to Benjamin A. Jones, Jr. and Lester V. Boone of the Champaign campus; C. James Kaiser, Lester E. Arnold and Paul E. Quertermous of the Dixon Springs Agricultural Center; Frank E. Zajicek of the Brownstown Agronomy Research Center; Glenn A. Raines and Tom Halleck of the Orr Research Center, Perry; Michael Mainz of the Northwestern Agricultural Research and Demonstration Center, Monmonth, and local farmer Richard F. Gillen; and, Derreld L. Mulvaney and Richard R. Bell of the Northern Illinois Agronomy Center, Shabbona. Thanks are also extended to Ed Flowers and William Morrison of NOAA ERL, Boulder, CO, for their generous assistance in the calibration and assessment of the Eppley 8-48 pyranometers.

APPENDIX A

The hourly solar radiation record for the Champaign site, May to August, 1981.

The following tables provide the hourly record of total solar radiation received on a horizontal surface at the Champaign site from the commencement of measurement on May 8, 1981 to the end of August, 1981. Daily and monthly totals, means, and extreme values are also included, and the data are presented in three unit formats so as to be immediately useful to a wide spectrum of users. The tables on pages 26 to 29 have the data in W/m^2 and MJ/m^2, those on pages 30 to 33 provide the data in cal/cm and $kcal/cm^2$, and the tables on pages 34 to 37 use units of BTU/ft^2.

The general format is the same in all cases, with each page providing the data for one month. The body of each table provides hourly data for each day of the month in units of W/m^2, cal/cm^2 or BTU/ft^2. The right hand columns list daily totals (TOTD) in MJ/m^2, cal/cm^2 or BTU/ft^2, and the number of hours of acceptable data for each day (#H). The rows across below the hourly data matrix provide monthly mean, maximum and minimum values of solar radiation received for each hour period, labeled as AV, MAX, MIN, respectively and each in W/m , cal/cm or BTU/ft , and the number of days in the month (#D) for which there was acceptable data for that hour period. The row entitled TOT provides the total solar radiation received through the whole month for the hour period in MJ/m^2, cal/cm^2 or BTU/ft^2. The small table at the bottom provides corresponding values for the whole month, using only days with a full 24 hours of acceptable data, and in the units specified within the table.

The Champaign record provides a good example of uninterrupted data, allowing the highest confidence in daily and monthly totals and monthly means and extremes. The maximum daily values for each month are typical of a clear day solar energy receipt on a horizontal surface, while the monthly average value tends to be representative of the energy receipt on most days of the month.

A full listing of the data for all sites will be presented in separate reports expected to be issued on a regular basis.

LKH 5/31

ILLINOIS STATE WATER SURVEY
ILLINOIS SOLAR ENERGY PROGRAM

CHAMPAIGN, ILLINOIS
88 57'W, 40 03'N
219 M ABOVE MSL

GLOBAL SHORTWAVE RADIATION
ON A HORIZONTAL SURFACE
SENSOR: EPPLEY 8-48 PYRANOMETER

MAY, 1981

UNITS: HOURLY = WM-2, DAILY (TOTD & TOT) AND MONTHLY = MJM-2

HOUR (CST) ENDING AT

DAY	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTD	#H
1	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	0
2	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	0
3	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	0
4	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	0
5	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	0
6	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	0
7	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	0
8	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	66	14	2	0	0	0	0	0	.30	8
9	0	0	0	0	2	34	123	139	46	375	464	396	198	61	34	87	54	17	4	0	0	0	0	0	7.32	24
10	0	0	0	0	0	4	10	27	26	31	71	69	62	62	67	42	36	17	4	1	0	0	0	0	1.90	24
11	0	0	0	0	0	13	34	53	67	50	66	97	76	111	214	312	169	99	42	0	0	0	0	0	5.05	24
12	0	0	0	0	6	107	309	485	711	838	896	335	565	603	437	193	111	83	15	0	0	0	0	0	22.30	24
13	0	0	0	0	1	16	47	119	249	230	364	390	204	119	157	57	45	19	3	0	0	0	0	0	7.27	24
14	0	0	0	0	0	3	13	21	30	56	78	53	98	69	98	28	19	21	5	0	0	0	0	0	2.13	24
15	0	0	0	0	4	37	152	449	689	856	962	979	924	817	573	517	431	207	47	0	0	0	0	0	27.52	24
16	0	0	0	0	3	103	295	507	676	760	815	749	776	805	711	535	344	173	48	0	0	0	0	0	20.30	24
17	0	0	0	0	0	39	125	136	227	505	492	218	146	175	141	80	47	17	5	0	0	0	0	0	8.47	24
18	0	0	0	0	0	4	16	62	89	114	123	190	104	73	83	74	42	29	18	2	0	0	0	0	3.69	24
19	0	0	0	0	3	14	52	269	379	799	826	797	852	920	805	612	409	216	57	0	0	0	0	0	25.24	24
20	0	0	0	0	8	113	302	593	690	824	917	952	944	892	758	611	423	227	59	0	0	0	0	0	29.57	24
21	0	0	0	0	9	108	295	497	670	910	903	945	942	880	766	610	424	226	57	0	0	0	0	0	29.31	24
22	0	0	0	0	9	112	296	489	602	797	911	851	651	582	528	473	297	138	44	0	0	0	0	0	24.41	24
23	0	0	0	0	1	32	124	204	267	179	190	625	867	822	704	141	60	215	21	0	0	0	0	0	16.33	24
24	0	0	0	0	8	33	184	456	392	774	723	145	128	604	349	239	102	56	32	2	0	0	0	0	15.39	24
25	0	0	0	0	8	111	296	504	668	911	672	846	678	608	472	425	292	166	42	0	0	0	0	0	23.76	24
26	0	0	0	0	7	53	77	114	210	255	343	394	387	315	316	194	83	52	32	0	0	0	0	0	10.20	24
27	0	0	0	0	6	63	166	361	297	592	497	598	659	585	559	506	371	204	57	3	0	0	0	0	19.89	24
28	0	0	0	0	11	111	290	482	654	738	793	874	919	797	524	456	387	186	48	0	0	0	0	0	26.35	24
29	0	0	0	0	9	48	125	361	587	693	642	728	879	723	609	519	350	98	17	0	0	0	0	0	23.91	24
30	0	0	0	0	2	25	48	156	270	476	380	320	437	457	348	230	136	91	23	0	0	0	0	0	12.36	24
31	0	0	0	0	12	123	313	515	691	824	912	952	939	879	767	617	303	204	59	2	0	0	0	0	29.20	24
AV	0	0	0	0	4	58	160	300	399	538	566	565	540	519	436	328	208	115	30	0	0	0	0	0		
MAX	0	0	0	0	12	123	313	515	711	856	962	979	944	920	805	617	431	227	59	3	0	0	0	0		
MIN	0	0	0	0	0	3	10	21	26	31	65	53	62	61	34	20	19	14	2	0	0	0	0	0		
#D	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	24	24	24	24	24	24	24	24		
TOT	0.0	0.0	0.0	0.0	.4	4.9	13.3	24.9	33.0	44.6	46.9	46.8	44.8	43.0	36.1	27.2	18.0	10.0	2.7	.0	0.0	0.0	0.0	0.0		

MONTHLY VALUES (FOR DAYS OF COMPLETE DATA ONLY)

TOTAL FOR MONTH	396.4 MJM-2	DAILY AVER	17.23 MJM-2
		DAILY MAX	29.57 MJM-2
# COMPLETE DAYS	23	DAILY MIN	1.90 MJM-2

LKH 5/81

ILLINOIS STATE WATER SURVEY
ILLINOIS SOLAR ENERGY PROGRAM

CHAMPAIGN, ILLINOIS
88 57'W, 40 03'N
219 M ABOVE MSL

GLOBAL SHORTWAVE RADIATION ON A HORIZONTAL SURFACE

JUNE, 1981

UNITS: HOURLY = L/HR = CAL/SQ CM/HR, DAILY (TOTD & TOT) = L = CAL/SQ CM, MONTHLY = KL = KCAL/SQ CM

HOUR (CST) ENDING AT

DAY	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTD	#H
1	0.0	0.0	0.0	0.0	.7	5.2	12.0	27.0	44.2	35.9	12.6	13.1	35.9	22.9	29.9	21.5	14.4	5.3	2.6	.2	0.0	0.0	0.0	0.0	298.5	24
2	0.0	0.0	0.0	0.0	.3	2.4	7.1	16.3	45.1	37.8	33.4	59.7	64.6	33.4	40.4	18.9	19.8	9.8	2.2	0.0	0.0	0.0	0.0	0.0	399.1	24
3	0.0	0.0	0.0	0.0	.4	3.0	8.6	24.8	50.1	61.7	55.0	48.7	46.7	41.1	35.3	37.8	26.7	13.6	3.5	.3	0.0	0.0	0.0	0.0	456.9	24
4	0.0	0.0	0.0	0.0	.5	9.7	26.0	41.5	59.5	62.5	76.9	81.3	80.3	74.5	63.4	48.1	31.2	19.1	5.3	.3	0.0	0.0	0.0	0.0	671.2	24
5	0.0	0.0	0.0	0.0	.4	7.7	8.3	13.5	23.9	37.1	46.7	42.1	45.6	58.8	54.1	24.1	25.9	18.1	5.8	.3	0.0	0.0	0.0	0.0	412.4	24
6	0.0	0.0	0.0	0.0	1.0	9.5	22.6	39.8	56.8	61.1	65.0	66.3	56.5	53.2	40.8	40.9	36.0	22.4	6.7	.6	0.0	0.0	0.0	0.0	579.4	24
7	0.0	0.0	0.0	0.0	.9	9.8	26.2	44.8	59.1	70.6	78.3	80.8	90.3	78.3	66.7	46.4	39.3	21.2	4.8	.3	0.0	0.0	0.0	0.0	707.8	24
8	0.0	0.0	0.0	0.0	.9	7.6	23.9	40.6	54.3	52.9	74.5	73.2	72.6	31.7	12.0	27.8	28.0	16.9	.9	0.0	0.0	0.0	0.0	0.0	517.7	24
9	0.0	0.0	0.0	0.0	1.5	10.8	24.9	41.3	53.9	59.5	78.3	47.6	57.3	70.0	63.7	40.2	12.8	4.4	.9	.3	.2	0.0	0.0	0.0	577.3	24
10	0.0	0.0	0.0	0.0	.9	7.0	6.7	9.2	9.8	21.9	35.6	78.8	58.3	68.3	61.6	54.2	31.0	15.7	6.5	.6	0.0	0.0	0.0	0.0	485.8	24
11	0.0	0.0	0.0	0.0	.9	6.8	10.8	17.3	27.3	32.7	16.2	16.1	12.7	21.7	23.4	6.2	3.6	6.9	2.0	.3	0.0	0.0	0.0	0.0	204.8	24
12	0.0	0.0	0.0	0.0	.3	2.2	5.2	.9	.7	7.6	7.2	4.8	43.8	59.9	56.8	51.6	21.6	18.1	5.8	.4	0.0	0.0	0.0	0.0	286.9	24
13	0.0	0.0	0.0	0.0	.3	2.2	12.6	9.7	17.1	21.6	22.2	29.8	29.2	39.3	20.0	20.8	2.5	3.4	3.8	.5	0.0	0.0	0.0	0.0	242.0	24
14	0.0	0.0	0.0	0.0	.5	8.6	13.1	13.4	36.4	48.1	73.5	67.1	61.8	58.1	43.8	45.2	33.5	17.7	4.6	.4	0.0	0.0	0.0	0.0	525.8	24
15	0.0	0.0	0.0	.1	.9	9.5	24.1	35.6	43.0	65.7	71.0	56.2	32.3	56.2	56.8	52.9	30.4	20.0	2.5	.1	.2	0.0	0.0	0.0	557.5	24
16	0.0	0.0	0.0	0.0	.3	1.9	5.3	9.9	16.3	16.9	33.7	34.2	23.0	41.4	52.4	38.1	28.0	23.0	7.2	.5	0.0	0.0	0.0	0.0	332.1	24
17	0.0	0.0	0.0	0.0	1.4	11.7	28.6	45.6	61.6	66.6	72.9	77.8	77.7	72.7	68.4	56.1	40.7	24.6	8.8	.5	0.0	0.0	0.0	0.0	715.6	24
18	0.0	0.0	0.0	0.0	1.2	11.5	27.9	44.6	59.1	70.9	78.5	82.4	81.3	75.9	62.0	53.4	38.1	22.0	7.6	.5	0.0	0.0	0.0	0.0	716.9	24
19	0.0	0.0	0.0	0.0	.3	2.3	7.5	11.1	10.0	14.2	16.3	33.5	7.3	19.4	10.6	22.6	33.2	18.3	5.8	.3	0.0	0.0	0.0	0.0	212.6	24
20	0.0	0.0	0.0	0.0	.7	8.5	23.0	39.7	55.2	60.8	74.6	73.4	63.3	55.5	43.3	47.9	29.3	3.4	.9	.3	0.0	0.0	0.0	0.0	585.2	24
21	0.0	0.0	0.0	0.0	.1	3.1	9.4	8.1	7.4	20.6	13.4	0.9	11.4	21.9	32.7	41.3	30.9	20.3	7.4	.3	0.0	0.0	0.0	0.0	240.2	24
22	0.0	0.0	0.0	0.0	.3	10.3	24.1	37.8	57.7	79.6	76.4	72.8	72.3	65.1	60.4	41.0	23.7	20.5	4.7	.7	0.0	0.0	0.0	0.0	638.5	24
23	0.0	0.0	0.0	0.0	1.7	11.5	27.5	43.9	57.9	69.3	77.0	80.6	79.8	75.2	66.1	53.2	38.9	23.5	8.6	.5	0.0	0.0	0.0	0.0	714.5	24
24	0.0	0.0	0.0	0.0	.2	.2	1.5	19.0	44.0	62.5	70.2	73.2	56.6	39.4	48.9	47.7	35.3	6.5	.3	0.0	0.0	0.0	0.0	0.0	505.7	24
25	0.0	0.0	0.0	0.0	.7	4.7	15.7	28.4	23.7	57.5	76.3	72.8	79.6	74.8	67.3	56.2	39.6	22.1	8.7	.5	0.0	0.0	0.0	0.0	620.5	24
26	0.0	0.0	0.0	0.0	1.1	10.7	26.7	42.8	57.0	68.3	75.0	76.5	80.3	75.1	56.3	43.0	20.6	22.2	8.4	.5	.1	0.0	0.0	0.0	664.6	24
27	0.0	0.0	0.0	0.0	1.0	10.2	25.8	42.2	56.6	67.9	77.7	70.2	54.8	63.7	58.9	45.7	36.8	21.9	7.4	.5	0.0	0.0	0.0	0.0	641.3	24
28	0.0	0.0	0.0	0.0	.3	2.8	7.0	16.3	15.9	16.4	14.1	43.7	75.2	71.1	62.0	50.1	35.6	20.0	7.1	.5	0.0	0.0	0.0	0.0	438.0	24
29	0.0	0.0	0.0	0.0	.8	8.2	20.1	37.2	51.6	64.3	70.5	74.9	74.9	70.7	62.1	43.7	34.6	18.9	3.2	.3	0.0	0.0	0.0	0.0	535.1	24
30	0.0	0.0	0.0	0.0	.5	2.9	5.2	6.6	8.9	20.2	25.0	29.3	39.0	19.6	23.0	34.1	27.7	15.1	4.3	.5	.1	0.0	0.0	0.0	262.2	24
AV	0.0	0.0	0.0	.0	.7	6.7	16.2	27.0	38.5	47.7	53.9	55.8	55.5	53.6	48.4	40.5	28.3	16.5	4.9	.4	.0	0.0	0.0	0.0		
MAX	0.0	0.0	0.0	.1	1.5	11.7	28.6	45.6	61.6	70.9	78.5	82.4	81.3	78.3	68.4	56.2	40.7	24.6	8.8	.7	.2	0.0	0.0	0.0		
MIN	0.0	0.0	0.0	0.0	.1	.2	1.5	.9	.7	7.6	7.2	4.8	7.3	19.4	10.6	6.2	2.5	3.4	.3	0.0	0.0	0.0	0.0	0.0		
#D	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30		
TOT	0	0	0	0	20	201	486	808	1154	1429	1617	1672	1664	1608	1450	1213	848	494	148	11	0	0	0	0		

MONTHLY VALUES (FOR DAYS OF COMPLETE DATA ONLY)

TOTAL FOR MONTH	14.84 KCAL/SQ CM	DAILY AVER	494.5 CAL/SQ CM
		DAILY MAX	716.9 CAL/SQ CM
# COMPLETE DAYS	30	DAILY MIN	204.8 CAL/SQ CM

CKH 5/81

ILLINOIS STATE WATER SURVEY
ILLINOIS SOLAR ENERGY PROGRAM

CHAMPAIGN, ILLINOIS
88 57'W, 40 03'N
219 M ABOVE MSL

GLOBAL SHORTWAVE RADIATION
ON A HORIZONTAL SURFACE

JULY, 1981

UNITS: HOURLY = L/HR = CAL/SQ CM/HR, DAILY (TOTD & TOT) = L = CAL/SQ CM, MONTHLY = KL = KCAL/SQ CM

HOUR (CST) ENDING AT

DAY	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTD	#H
1	0.0	0.0	0.0	0.0	.3	5.9	19.6	29.6	41.4	56.0	33.5	53.7	37.0	40.2	49.5	39.2	24.8	16.0	5.5	.5	0.0	0.0	0.0	0.0	452.7	24
2	0.0	0.0	0.0	0.0	.5	6.6	17.9	24.4	34.7	59.8	62.3	68.4	81.2	70.3	47.6	46.1	27.9	7.0	5.9	.5	0.0	0.0	0.0	0.0	560.9	24
3	0.0	0.0	0.0	0.0	.8	7.8	22.0	28.1	52.5	61.7	67.2	66.4	55.0	36.0	32.5	28.2	28.4	14.4	3.7	.3	0.0	0.0	0.0	0.0	505.1	24
4	0.0	0.0	0.0	0.0	.1	1.7	3.6	5.5	7.3	12.0	25.4	15.4	22.0	16.1	5.6	3.1	.9	.5	.3	.1	0.0	0.0	0.0	0.0	119.6	24
5	0.0	0.0	0.0	0.0	.4	1.6	2.5	11.9	13.8	20.0	17.5	25.7	22.1	25.5	49.6	37.7	17.1	8.6	4.3	.5	0.0	0.0	0.0	0.0	258.9	24
6	0.0	0.0	0.0	0.0	.8	8.3	23.0	38.7	52.4	63.3	71.1	71.1	62.4	71.3	57.5	42.3	35.1	19.6	6.6	.5	0.0	0.0	0.0	0.0	624.0	24
7	0.0	0.0	0.0	0.0	.7	7.5	20.7	33.5	50.3	62.3	68.4	62.5	53.2	57.8	50.6	43.7	38.9	16.9	5.2	.5	0.0	0.0	0.0	0.0	572.6	24
8	0.0	0.0	0.0	0.0	.7	8.4	23.6	37.3	48.9	61.1	70.4	75.4	75.2	71.7	63.5	48.6	33.8	20.6	7.0	.5	0.0	0.0	0.0	0.0	646.6	24
9	0.0	0.0	0.0	0.0	.6	7.4	21.4	37.8	52.6	64.1	69.0	74.4	70.4	70.4	60.5	49.9	35.3	23.3	2.2	.2	.1	0.0	0.0	0.0	539.7	24
10	0.0	0.0	0.0	0.0	.7	8.9	25.0	42.1	57.3	69.1	77.0	80.4	80.3	74.6	67.1	54.5	39.6	23.5	8.3	.5	0.0	0.0	0.0	0.0	708.8	24
11	0.0	0.0	0.0	0.0	.7	9.1	24.8	41.3	56.0	67.9	77.2	79.2	76.7	76.8	63.3	39.5	26.3	20.7	6.2	.6	0.0	0.0	0.0	0.0	666.4	24
12	0.0	0.0	0.0	0.0	.4	5.9	17.6	29.5	46.6	55.8	53.8	76.3	64.1	47.3	38.6	43.9	32.9	19.0	7.9	.5	0.0	0.0	0.0	0.0	540.3	24
13	0.0	0.0	0.0	0.0	.3	4.7	18.6	34.7	49.5	55.8	67.1	74.9	72.2	69.9	58.5	45.5	35.8	11.6	3.2	.1	0.0	0.0	0.0	0.0	607.5	24
14	0.0	0.0	0.0	0.0	.2	1.2	12.0	26.9	29.5	33.0	56.8	67.9	47.6	52.0	42.4	44.7	32.4	18.0	2.8	.2	0.0	0.0	0.0	0.0	467.7	24
15	0.0	0.0	0.0	0.0	0.0	.9	4.0	1.6	13.2	22.4	26.5	24.7	21.5	31.4	21.6	41.6	26.3	13.8	6.0	.3	0.0	0.0	0.0	0.0	255.9	24
16	0.0	0.0	0.0	0.0	.4	5.2	9.9	14.5	17.2	19.8	16.6	15.6	8.8	12.5	15.9	11.6	8.8	7.8	3.8	.3	0.0	0.0	0.0	0.0	168.7	24
17	0.0	0.0	0.0	0.0	.3	6.2	20.6	35.3	47.5	52.7	72.4	75.9	74.0	67.6	61.8	43.3	30.0	17.6	4.4	.3	0.0	0.0	0.0	0.0	609.9	24
18	0.0	0.0	0.0	0.0	.3	5.4	16.9	30.5	44.9	54.4	46.5	51.9	48.6	37.1	50.4	35.3	21.2	7.6	1.5	.1	0.0	0.0	0.0	0.0	452.5	24
19	0.0	0.0	0.0	0.0	.1	.3	.7	8.0	6.5	7.7	3.5	18.6	24.7	39.6	37.2	38.9	7.0	9.1	2.1	.3	0.0	0.0	0.0	0.0	204.2	24
20	0.0	0.0	0.0	0.0	.2	2.4	6.7	25.2	30.5	49.8	62.9	66.4	69.0	51.3	49.4	33.9	13.0	6.6	6.7	.8	0.0	0.0	0.0	0.0	474.7	24
21	0.0	0.0	0.0	0.0	.4	4.7	7.3	8.6	20.5	21.7	19.5	30.5	55.7	47.3	46.0	37.2	34.7	17.2	4.7	.3	0.0	0.0	0.0	0.0	362.7	24
22	0.0	0.0	0.0	0.0	.3	6.3	20.5	37.2	50.9	63.7	71.0	75.2	73.9	70.6	56.8	46.4	33.2	18.3	3.4	.3	0.0	0.0	0.0	0.0	627.9	24
23	0.0	0.0	0.0	0.0	.5	4.6	10.1	14.6	17.5	16.7	32.6	58.3	55.7	69.2	40.3	14.9	11.2	7.1	2.7	.2	0.0	0.0	0.0	0.0	356.1	24
24	0.0	0.0	0.0	0.0	.3	3.9	11.9	27.5	50.1	58.1	58.6	54.5	65.2	49.8	27.5	31.0	13.8	11.4	2.7	.6	0.0	0.0	0.0	0.0	466.8	24
25	0.0	0.0	0.0	0.0	.4	3.7	12.0	14.2	14.3	16.5	27.0	20.6	51.1	42.1	37.8	34.4	29.3	12.4	2.8	.1	0.0	0.0	0.0	0.0	326.6	24
26	0.0	0.0	0.0	0.0	.1	.9	3.4	5.7	2.2	5.7	29.1	36.6	16.2	21.0	18.0	15.7	14.1	14.9	5.2	.2	0.0	0.0	0.0	0.0	189.9	24
27	0.0	0.0	0.0	0.0	.3	.6	.7	3.6	23.7	31.2	36.1	59.6	53.4	41.5	31.6	19.3	4.6	.9	.1	0.0	0.0	0.0	0.0	0.0	306.9	24
28	0.0	0.0	0.0	0.0	0.0	1.5	2.7	3.1	12.1	22.3	46.0	39.7	14.2	10.8	12.6	7.7	4.0	3.7	1.3	0.0	0.0	0.0	0.0	0.0	181.8	24
29	0.0	0.0	0.0	0.0	.3	7.1	21.9	40.0	51.3	58.8	48.3	57.6	57.0	55.4	44.0	39.4	29.0	19.8	5.9	0.0	0.0	0.0	0.0	0.0	535.9	24
30	0.0	0.0	0.0	0.0	.3	6.7	21.0	37.9	53.2	62.0	69.2	73.9	73.6	71.6	62.2	51.9	35.9	19.9	5.3	.2	0.0	0.0	0.0	0.0	644.9	24
31	0.0	0.0	0.0	0.0	.3	6.2	20.9	37.5	51.9	61.7	68.5	72.2	71.5	67.9	61.8	49.4	33.8	18.1	4.0	.1	0.0	0.0	0.0	0.0	626.6	24
AV	0.0	0.0	0.0	0.0	.4	4.9	14.3	24.7	35.5	44.1	50.0	56.0	53.4	50.5	43.9	36.1	24.5	13.7	4.3	.3	.0	0.0	0.0	0.0		
MAX	0.0	0.0	0.0	0.0	.8	9.1	25.0	42.1	57.3	69.1	77.2	80.4	81.2	76.8	67.1	54.5	39.6	23.5	8.3	.8	.1	0.0	0.0	0.0		
MIN	0.0	0.0	0.0	0.0	0.0	.3	.7	1.6	2.2	5.7	3.5	15.4	8.8	10.8	5.6	3.1	.9	.5	.1	0.0	0.0	0.0	0.0	0.0		
#D	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31		
TOT	0	0	0	0	11	151	442	765	1100	1367	1550	1737	1655	1566	1361	1118	758	425	132	9	0	0	0	0		

MONTHLY VALUES (FOR DAYS OF COMPLETE DATA ONLY)

TOTAL FOR MONTH 14.16 KCAL/SQ CM
COMPLETE DAYS 31

DAILY AVER 456.7 CAL/SQ CM
DAILY MAX 708.8 CAL/SQ CM
DAILY MIN 119.6 CAL/SQ CM

LKH 5/81

ILLINOIS STATE WATER SURVEY
ILLINOIS SOLAR ENERGY PROGRAM

CHAMPAIGN, ILLINOIS
88 57'W, 40 03'N
217 M ABOVE MSL

GLOBAL SHORTWAVE RADIATION
ON A HORIZONTAL SURFACE

AUGUST, 1981

UNITS: HOURLY = L/HR = CAL/SQ CM/HR, DAILY (TOTD & TOT) = L = CAL/SQ CM, MONTHLY = KL = KCAL/SQ CM

HOUR (CST) ENDING AT

DAY	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTD	#H
1	0.0	0.0	0.0	0.0	.1	5.3	13.6	34.5	47.7	62.0	60.7	72.2	62.1	63.3	54.4	45.4	32.6	10.1	3.9	.1	0.0	0.0	0.0	0.0	575.8	24
2	0.0	0.0	0.0	0.0	.2	3.4	16.7	32.9	43.6	56.7	48.2	65.8	63.1	60.0	48.0	26.5	15.8	10.4	1.0	0.0	0.0	0.0	0.0	0.0	493.1	24
3	0.0	0.0	0.0	0.0	0.0	2.2	5.5	5.2	6.9	16.9	20.5	39.1	37.8	54.3	30.1	20.5	12.6	8.9	5.1	0.0	0.0	0.0	0.0	0.0	265.5	24
4	0.0	0.0	0.0	0.0	0.0	3.7	16.9	39.3	32.9	43.8	60.7	57.9	52.8	57.0	46.4	43.4	28.6	15.3	2.9	.1	0.0	0.0	0.0	0.0	501.7	24
5	0.0	0.0	0.0	0.0	.2	4.0	9.7	15.6	21.0	5.6	2.1	.3	4.3	11.1	3.6	11.4	3.4	2.8	.9	.1	0.0	0.0	0.0	0.0	96.2	24
6	0.0	0.0	0.0	0.0	.1	2.0	9.1	10.1	17.5	25.1	32.7	24.6	48.9	53.5	50.7	40.3	27.8	8.4	2.8	.1	0.0	0.0	0.0	0.0	353.7	24
7	0.0	0.0	0.0	0.0	.1	3.1	14.2	34.3	44.3	57.3	63.3	72.4	72.2	42.7	51.0	35.8	33.1	13.8	3.8	0.0	0.0	0.0	0.0	0.0	541.6	24
8	0.0	0.0	0.0	0.0	.2	3.5	15.7	13.2	20.0	40.2	43.7	35.0	49.8	38.2	43.9	21.3	13.6	14.8	2.3	.1	0.0	0.0	0.0	0.0	355.4	24
9	0.0	0.0	0.0	0.0	.1	4.2	18.2	35.7	52.7	59.9	64.3	43.0	58.4	57.8	41.5	30.2	22.4	.7	.6	0.0	0.0	0.0	0.0	0.0	490.5	24
10	0.0	0.0	0.0	0.0	.1	3.6	17.2	37.5	39.5	21.3	27.7	19.2	25.4	20.4	10.2	30.9	10.6	7.3	2.1	0.0	0.0	0.0	0.0	0.0	271.9	24
11	0.0	0.0	0.0	0.0	.1	3.2	12.9	34.8	52.1	63.8	69.8	77.9	65.0	69.8	59.0	33.1	21.4	15.5	2.8	.1	0.0	0.0	0.0	0.0	581.5	24
12	0.0	0.0	0.0	0.0	0.0	2.9	12.0	27.3	46.3	59.9	68.5	71.7	70.0	58.0	45.5	35.5	24.3	12.6	2.3	.1	0.0	0.0	0.0	0.0	536.9	24
13	0.0	0.0	0.0	0.0	0.0	2.8	13.6	29.3	45.3	55.0	63.8	60.5	55.7	46.1	48.9	23.5	17.9	8.8	1.3	.1	0.0	0.0	0.0	0.0	472.8	24
14	0.0	0.0	0.0	0.0	.1	.9	7.0	12.0	13.3	12.8	15.4	21.8	43.4	27.2	4.5	34.8	29.0	13.1	2.2	0.0	0.0	0.0	0.0	0.0	237.5	24
15	0.0	0.0	0.0	0.0	0.0	1.3	2.6	4.7	10.9	9.5	9.8	22.4	44.9	55.7	60.1	38.3	31.6	14.3	2.4	.1	0.0	0.0	0.0	0.0	338.6	24
16	0.0	0.0	0.0	0.0	0.0	1.5	9.0	8.8	21.1	43.4	56.0	53.0	48.8	62.0	51.2	42.2	24.7	12.0	2.8	0.0	0.0	0.0	0.0	0.0	438.1	24
17	0.0	0.0	0.0	0.0	0.0	3.2	18.5	36.6	51.9	65.2	68.6	73.4	70.4	73.2	63.4	47.7	32.9	15.2	2.3	0.0	0.0	0.0	0.0	0.0	622.5	24
18	0.0	0.0	0.0	0.0	.1	3.7	19.0	35.3	46.4	64.3	70.0	79.2	77.9	72.8	64.0	41.0	32.3	14.9	2.2	0.0	0.0	0.0	0.0	0.0	623.2	24
19	0.0	0.0	0.0	0.0	0.0	3.5	17.3	35.6	50.1	64.7	67.3	77.3	79.7	73.0	67.6	40.8	21.8	7.1	2.1	0.0	0.0	0.0	0.0	0.0	603.9	24
20	0.0	0.0	0.0	0.0	0.0	3.8	18.2	35.4	51.2	63.0	71.7	76.0	76.5	71.2	57.2	45.0	29.0	12.5	1.1	0.0	0.0	0.0	0.0	0.0	611.7	24
21	0.0	0.0	0.0	0.0	.1	3.0	15.3	33.0	49.3	61.8	69.1	74.3	71.5	51.1	51.3	41.0	26.1	11.6	1.5	0.0	0.0	0.0	0.0	0.0	560.7	24
22	0.0	0.0	0.0	0.0	0.0	2.0	10.2	27.4	34.9	60.5	64.8	71.6	72.2	66.7	58.3	39.1	27.9	10.1	1.3	0.0	0.0	0.0	0.0	0.0	547.1	24
23	0.0	0.0	0.0	0.0	0.0	2.1	12.7	28.9	44.4	57.5	55.2	67.5	67.4	60.6	51.9	40.3	23.5	9.3	.9	0.0	0.0	0.0	0.0	0.0	522.3	24
24	0.0	0.0	0.0	0.0	0.0	2.0	11.9	26.2	43.2	57.8	59.6	52.0	76.5	49.4	48.1	35.6	25.9	11.3	.9	0.0	0.0	0.0	0.0	0.0	510.3	24
25	0.0	0.0	0.0	0.0	0.0	4.1	10.4	5.4	13.8	37.7	67.7	77.2	69.3	57.9	50.2	37.2	23.2	6.1	.5	0.0	0.0	0.0	0.0	0.0	463.7	24
26	0.0	0.0	0.0	0.0	0.0	.9	7.2	23.2	41.3	49.4	52.1	52.6	14.6	2.8	14.8	10.8	11.6	4.0	.3	0.0	0.0	0.0	0.0	0.0	293.6	24
27	0.0	0.0	0.0	0.0	0.0	.3	2.0	5.6	9.9	19.8	48.1	60.3	41.1	45.1	4.8	2.4	1.8	.2	0.0	0.0	0.0	0.0	0.0	0.0	241.8	24
28	0.0	0.0	0.0	0.0	0.0	.4	2.7	6.4	7.1	12.2	14.8	50.9	52.7	31.9	39.3	22.8	13.9	6.7	.5	0.0	0.0	0.0	0.0	0.0	262.4	24
29	0.0	0.0	0.0	0.0	0.0	.7	12.5	27.4	48.9	43.6	58.5	67.3	66.1	46.3	33.0	33.1	17.1	5.7	.8	0.0	0.0	0.0	0.0	0.0	469.8	24
30	0.0	0.0	0.0	0.0	0.0	.9	11.1	23.9	43.3	43.6	42.3	54.2	64.6	55.0	47.1	27.4	13.6	4.3	.2	0.0	0.0	0.0	0.0	0.0	431.5	24
31	0.0	0.0	0.0	0.0	0.0	1.1	7.6	26.7	42.2	37.1	63.2	62.7	49.4	57.5	52.5	36.9	8.1	2.8	.3	.1	0.0	0.0	0.0	0.0	448.2	24
AV	0.0	0.0	0.0	0.0	.0	2.6	12.1	24.3	35.1	44.4	51.0	56.4	56.5	51.4	43.6	33.2	21.2	9.6	1.7	.0	0.0	0.0	0.0	0.0		
MAX	0.0	0.0	0.0	0.0	.3	5.3	19.0	39.3	52.7	65.2	71.7	79.2	79.7	73.2	67.6	47.7	33.1	16.1	5.1	.1	0.0	0.0	0.0	0.0		
MIN	0.0	0.0	0.0	0.0	0.0	.3	2.0	4.7	6.9	5.6	2.1	.3	4.3	2.8	3.6	2.4	1.8	.2	0.0	0.0	0.0	0.0	0.0	0.0		
#D	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31		
TOT	0	0	0	0	1	79	375	752	1088	1376	1580	1747	1752	1592	1352	1028	658	296	53	0	0	0	0	0		

MONTHLY VALUES (FOR DAYS OF COMPLETE DATA ONLY)

TOTAL FOR MONTH 13.74 KCAL/SQ CM

\# COMPLETE DAYS 31

DAILY AVER 443.2 CAL/SQ CM
DAILY MAX 623.2 CAL/SQ CM
DAILY MIN 96.2 CAL/SQ CM

LKH 5781

ILLINOIS STATE WATER SURVEY
ILLINOIS SOLAR ENERGY PROGRAM

CHAMPAIGN, ILLINOIS
88 57'W, 40 03'N
219 M ABOVE MSL

GLOBAL SHORTWAVE RADIATION
ON A HORIZONTAL SURFACE

MAY, 1981

UNITS: HOURLY = BTU FT-2 H-1, DAILY (TOTD & TOT) AND MONTHLY = BTU FT-2

DAY	HOUR (CST) ENDING AT 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTD	#H
1	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	0
2	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	0
3	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	0
4	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	0
5	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	0
6	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	0
7	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	0
8	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	20	4	0	0	0	0	0	0	25	8
9	0	0	0	0	0	10	39	44	14	118	147	125	62	19	10	27	17	5	1	0	0	0	0	0	644	24
10	0	0	0	0	0	1	3	8	8	9	22	21	19	19	21	13	11	5	1	0	0	0	0	0	167	24
11	0	0	0	0	0	4	10	16	21	15	20	30	24	35	67	98	53	31	13	0	0	0	0	0	444	24
12	0	0	0	0	1	33	97	153	225	265	284	264	179	191	138	61	35	26	4	0	0	0	0	0	1963	24
13	0	0	0	0	0	5	14	37	78	72	115	123	64	37	49	18	14	6	0	0	0	0	0	0	640	24
14	0	0	0	0	0	0	4	6	9	17	24	16	31	21	31	8	6	6	1	0	0	0	0	0	197	24
15	0	0	0	0	1	11	48	142	213	271	305	310	292	259	181	163	136	65	14	0	0	0	0	0	2423	24
16	0	0	0	0	2	32	93	160	214	240	258	237	246	255	225	169	109	54	15	0	0	0	0	0	2315	24
17	0	0	0	0	0	17	39	43	71	160	156	67	46	55	44	25	14	5	1	0	0	0	0	0	745	24
18	0	0	0	0	0	1	5	19	28	36	39	60	32	23	26	23	13	9	5	0	0	0	0	0	324	24
19	0	0	0	0	0	4	16	85	120	253	261	252	270	291	255	194	129	68	18	0	0	0	0	0	2222	24
20	0	0	0	0	2	35	95	159	215	261	290	301	299	279	243	193	134	71	18	0	0	0	0	0	2603	24
21	0	0	0	0	2	34	93	157	212	255	286	299	298	279	242	193	134	71	18	0	0	0	0	0	2581	24
22	0	0	0	0	2	35	93	155	190	252	288	269	206	184	167	149	94	43	13	0	0	0	0	0	2149	24
23	0	0	0	0	0	10	39	54	84	56	60	198	274	260	223	44	19	68	6	0	0	0	0	0	1411	24
24	0	0	0	0	2	26	54	144	124	243	229	45	40	191	110	75	32	17	10	0	0	0	0	0	1355	24
25	0	0	0	0	2	35	93	159	211	257	213	268	214	192	149	134	92	52	13	0	0	0	0	0	2091	24
26	0	0	0	0	2	16	24	36	66	80	108	124	122	99	100	61	26	16	10	0	0	0	0	0	997	24
27	0	0	0	0	1	19	52	114	94	187	157	189	208	185	177	160	117	64	18	0	0	0	0	0	1751	24
28	0	0	0	0	3	35	91	152	207	249	251	277	291	252	166	144	122	58	15	0	0	0	0	0	2320	24
29	0	0	0	0	2	15	39	114	185	219	203	230	278	230	193	164	110	31	5	0	0	0	0	0	2026	24
30	0	0	0	0	0	7	15	49	85	135	120	101	138	144	110	72	43	28	7	0	0	0	0	0	1061	24
31	0	0	0	0	3	39	99	163	219	261	289	301	297	278	243	195	96	64	18	0	0	0	0	0	2571	24
AV	0	0	0	0	1	18	50	95	126	170	179	177	171	164	138	104	66	36	9	0	0	0	0	0		
MAX	0	0	0	0	3	39	99	163	225	271	305	319	299	291	255	195	136	71	18	0	0	0	0	0		
MIN	0	0	0	0	0	0	3	6	8	9	20	16	19	19	10	8	6	4	0	0	0	0	0	0		
#D	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	24	24	24	24	24	24	24	24		
TOT	0	0	0	0	36	429	1170	2190	2909	3926	4133	4122	3942	3789	3179	2395	1585	879	234	3	0	0	0	0		

MONTHLY VALUES (FOR DAYS OF COMPLETE DATA ONLY)

TOTAL FOR MONTH 34902 BTU/SQ FT
COMPLETE DAYS 23

DAILY AVER 1517 BTU/SQ FT
DAILY MAX 2603 BTU/SQ FT
DAILY MIN 167 BTU/SQ FT

LKH 5/81

ILLINOIS STATE WATER SURVEY
ILLINOIS SOLAR ENERGY PROGRAM

CHAMPAIGN, ILLINOIS
88 57'W, 40 03'N
219 M ABOVE MSL

GLOBAL SHORTWAVE RADIATION
ON A HORIZONTAL SURFACE

JUNE, 1981

UNITS: HOURLY = BTU FT-2 H-1, DAILY (TOTD & TOT) AND MONTHLY = BTU FT-2

HOUR (CST) ENDING AT

DAY	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTD	#H
1	0	0	0	0	2	19	44	97	162	132	46	66	132	84	110	79	53	19	9	0	0	0	0	0	1063	24
2	0	0	0	0	1	8	26	59	166	139	123	216	238	123	149	69	72	36	7	0	0	0	0	0	1437	24
3	0	0	0	0	1	11	31	91	184	227	202	179	172	151	130	139	98	50	13	0	0	0	0	0	1634	24
4	0	0	0	0	1	35	95	153	186	230	283	299	296	274	233	177	115	70	19	0	0	0	0	0	2473	24
5	0	0	0	0	1	28	30	49	87	136	172	135	169	216	199	88	95	66	21	1	0	0	0	0	1520	24
6	0	0	0	0	3	31	83	146	209	225	239	244	208	196	150	150	132	82	24	2	0	0	0	0	2131	24
7	0	0	0	0	3	35	96	165	217	260	288	298	296	299	246	170	144	78	17	0	0	0	0	0	2609	24
8	0	0	0	0	3	27	89	149	200	195	274	269	267	117	44	102	103	62	3	0	0	0	0	0	1908	24
9	0	0	0	0	5	39	91	152	193	219	288	175	247	253	234	149	47	16	3	0	0	0	0	0	2129	24
10	0	0	0	0	3	25	22	33	36	90	205	290	214	251	227	199	114	58	24	2	0	0	0	0	1790	24
11	0	0	0	0	3	25	39	63	100	120	59	59	46	79	86	22	13	25	7	0	0	0	0	0	754	24
12	0	0	0	0	1	8	19	3	2	27	26	17	161	220	209	190	79	66	21	1	0	0	0	0	1057	24
13	0	0	0	0	0	8	46	35	63	79	91	105	107	144	103	76	9	12	13	1	0	0	0	0	892	24
14	0	0	0	0	1	31	49	49	134	177	271	247	227	214	161	166	123	65	16	1	0	0	0	0	1938	24
15	0	0	0	0	3	34	88	131	153	242	261	207	119	207	209	195	111	73	9	0	0	0	0	0	2054	24
16	0	0	0	0	0	6	19	36	57	62	124	126	84	152	193	140	103	84	26	1	0	0	0	0	1223	24
17	0	0	0	0	5	43	105	168	227	245	258	286	286	267	252	206	149	90	32	1	0	0	0	0	2537	24
18	0	0	0	0	4	42	102	164	217	261	289	303	299	279	228	196	140	81	27	1	0	0	0	0	2642	24
19	0	0	0	0	0	3	27	40	36	52	59	123	26	71	39	83	122	67	21	1	0	0	0	0	793	24
20	0	0	0	0	2	31	94	146	203	246	274	273	233	205	159	176	104	12	3	1	0	0	0	0	2156	24
21	0	0	0	0	0	11	34	29	27	76	49	32	41	80	120	163	113	74	27	1	0	0	0	0	995	24
22	0	0	0	0	1	38	93	139	212	260	281	268	266	240	222	151	97	75	17	2	0	0	0	0	2351	24
23	0	0	0	0	4	42	101	161	213	255	283	297	294	277	243	196	143	86	31	1	0	0	0	0	2633	24
24	0	0	0	0	0	0	5	70	162	230	258	269	208	145	180	175	130	24	1	0	0	0	0	0	1964	24
25	0	0	0	0	2	17	57	104	87	211	281	268	293	275	248	207	145	81	32	2	0	0	0	0	2316	24
26	0	0	0	0	4	39	98	157	210	251	276	281	296	276	207	158	76	81	31	1	0	0	0	0	2449	24
27	0	0	0	0	3	37	95	155	208	250	286	258	201	234	217	168	135	80	27	1	0	0	0	0	2363	24
28	0	0	0	0	1	10	25	60	58	60	52	161	277	262	220	184	131	73	26	1	0	0	0	0	1614	24
29	0	0	0	0	2	30	74	137	190	237	260	276	276	260	228	161	127	67	11	1	0	0	0	0	2344	24
30	0	0	0	0	1	10	19	24	32	74	92	108	143	72	84	125	102	55	15	1	0	0	0	0	966	24
AV	0	0	0	0	2	24	59	99	141	175	198	205	204	197	178	149	104	60	18	1	0	0	0	0		
MAX	0	0	0	0	5	43	105	168	227	261	289	303	299	288	252	207	149	90	32	2	0	0	0	0		
MIN	0	0	0	0	0	0	5	3	2	27	26	17	26	71	39	22	9	12	1	0	0	0	0	0		
#D	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30		
TOT	0	0	0	0	76	742	1793	2981	4257	5269	5963	6166	6135	5930	5348	4473	3128	1824	546	41	1	0	0	0		

MONTHLY VALUES (FOR DAYS OF COMPLETE DATA ONLY)

TOTAL FOR MONTH 54682 BTU/SQ FT
DAILY AVER 1822 BTU/SQ FT
DAILY MAX 2642 BTU/SQ FT
COMPLETE DAYS 30
DAILY MIN 754 BTU/SQ FT

LKH 5781

ILLINOIS STATE WATER SURVEY
ILLINOIS SOLAR ENERGY PROGRAM

CHAMPAIGN, ILLINOIS
88 57'W, 40 03'N
219 M ABOVE MSL

GLOBAL SHORTWAVE RADIATION
ON A HORIZONTAL SURFACE

JULY, 1981

UNITS: HOURLY = BTU FT-2 H-1, DAILY (TOTD & TOT) AND MONTHLY = BTU FT-2

HOUR (CST) ENDING AT

DAY	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTD	#H
1	0	0	0	0	1	21	68	105	157	206	123	197	143	148	182	144	91	58	20	1	0	0	0	0	1568	24
2	0	0	0	0	1	24	65	90	127	220	229	252	299	259	175	169	102	25	21	1	0	0	0	0	2067	24
3	0	0	0	0	2	28	81	103	193	227	247	244	202	132	119	104	104	53	13	1	0	0	0	0	1861	24
4	0	0	0	0	0	5	13	20	26	44	93	56	81	59	20	11	3	1	0	0	0	0	0	0	440	24
5	0	0	0	0	1	5	9	43	53	73	64	94	81	74	182	138	63	31	15	1	0	0	0	0	954	24
6	0	0	0	0	2	30	84	142	193	233	262	262	230	262	211	156	129	72	24	1	0	0	0	0	2299	24
7	0	0	0	0	2	27	76	123	185	229	252	230	196	213	186	161	143	62	19	1	0	0	0	0	2110	24
8	0	0	0	0	2	31	86	137	190	225	259	278	277	264	234	179	124	76	25	1	0	0	0	0	2383	24
9	0	0	0	0	2	27	79	139	174	230	254	274	259	257	223	183	130	85	7	0	0	0	0	0	2357	24
10	0	0	0	0	2	32	92	155	211	254	283	296	296	274	247	201	145	86	30	1	0	0	0	0	2612	24
11	0	0	0	0	2	33	91	152	206	250	284	292	282	283	233	145	97	76	22	2	0	0	0	0	2456	24
12	0	0	0	0	1	21	65	108	171	205	198	291	236	174	142	162	121	70	29	1	0	0	0	0	1991	24
13	0	0	0	0	0	17	63	128	132	205	247	276	266	257	215	167	131	42	11	0	0	0	0	0	2220	24
14	0	0	0	0	0	4	44	99	108	121	209	250	175	191	156	164	119	66	10	0	0	0	0	0	1723	24
15	0	0	0	0	0	3	14	6	48	82	97	91	79	115	79	153	97	51	22	1	0	0	0	0	943	24
16	0	0	0	0	1	19	36	53	63	72	61	57	32	45	58	42	32	28	13	1	0	0	0	0	621	24
17	0	0	0	0	1	22	75	130	175	194	266	279	273	249	227	159	110	65	16	0	0	0	0	0	2243	24
18	0	0	0	0	1	19	61	112	165	200	171	191	179	136	185	130	78	27	5	0	0	0	0	0	1667	24
19	0	0	0	0	0	1	2	29	23	28	13	60	91	145	137	143	25	33	7	0	0	0	0	0	752	24
20	0	0	0	0	0	8	24	92	112	183	231	244	254	189	182	124	47	24	24	2	0	0	0	0	1749	24
21	0	0	0	0	1	17	25	31	75	80	71	134	205	174	159	137	127	63	17	1	0	0	0	0	1336	24
22	0	0	0	0	1	23	75	136	187	234	261	277	272	250	209	171	122	67	12	1	0	0	0	0	2314	24
23	0	0	0	0	1	17	37	53	64	61	120	214	205	255	148	54	41	26	9	0	0	0	0	0	1312	24
24	0	0	0	0	1	14	43	101	194	214	215	201	240	183	101	114	51	41	9	2	0	0	0	0	1720	24
25	0	0	0	0	1	13	44	52	52	50	99	105	188	155	139	126	109	45	10	0	0	0	0	0	1203	24
26	0	0	0	0	0	3	12	20	8	20	107	135	59	77	66	57	52	54	19	0	0	0	0	0	696	24
27	0	0	0	0	0	2	2	13	87	115	133	219	196	152	116	71	16	3	0	0	0	0	0	0	1131	24
28	0	0	0	0	0	5	9	11	44	82	169	146	62	39	46	28	14	13	4	0	0	0	0	0	670	24
29	0	0	0	0	0	26	80	147	188	216	178	212	210	204	162	145	106	72	21	0	0	0	0	0	1975	24
30	0	0	0	0	0	24	77	139	196	228	255	272	271	264	229	191	132	73	19	0	0	0	0	0	2377	24
31	0	0	0	0	0	22	77	138	191	227	252	266	263	250	227	182	124	66	17	0	0	0	0	0	2109	24
AV	0	0	0	0	1	18	52	91	130	152	184	206	196	186	161	133	90	50	15	1	0	0	0	0		
MAX	0	0	0	0	2	33	92	155	211	254	284	296	299	283	247	201	145	86	30	2	0	0	0	0		
MIN	0	0	0	0	0	1	2	6	8	20	13	56	32	39	20	11	3	1	0	0	0	0	0	0		
#D	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31		
TOT	0	0	0	0	43	560	1629	2821	4055	5040	5716	6404	6102	5774	5018	4123	2797	1569	488	35	0	0	0	0		

MONTHLY VALUES (FOR DAYS OF COMPLETE DATA ONLY)

TOTAL FOR MONTH	52182 BTU/SQ FT	DAILY AVER	1683 BTU/SQ FT
		DAILY MAX	2612 BTU/SQ FT
# COMPLETE DAYS	31	DAILY MIN	440 BTU/SQ FT

LKH 5731

ILLINOIS STATE WATER SURVEY
ILLINOIS SOLAR ENERGY PROGRAM

CHAMPAIGN, ILLINOIS
88 57'W, 40 03'N
219 M ABOVE MSL

GLOBAL SHORTWAVE RADIATION
ON A HORIZONTAL SURFACE

AUGUST, 1981

UNITS: HOURLY = BTU FT-2 H-1, DAILY (TOTD & TOT) AND MONTHLY = BTU FT-2

HOUR (CST) ENDING AT

DAY	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTD	#H
1	0	0	0	0	0	19	63	127	175	228	223	260	278	234	200	167	120	59	12	0	0	0	0	0	2133	24
2	0	0	0	0	0	12	61	121	160	208	177	242	232	224	176	97	58	38	3	0	0	0	0	0	1817	24
3	0	0	0	0	0	7	20	19	25	62	75	144	139	200	110	75	46	32	18	0	0	0	0	0	978	24
4	0	0	0	0	0	13	62	144	120	161	223	213	194	210	171	160	105	56	10	0	0	0	0	0	1849	24
5	0	0	0	0	0	14	35	57	77	20	7	0	15	40	13	42	12	10	3	0	0	0	0	0	354	24
6	0	0	0	0	0	7	33	37	64	92	120	90	180	197	187	148	102	31	10	0	0	0	0	0	1303	24
7	0	0	0	0	0	11	52	126	163	211	233	266	266	157	188	131	122	51	13	0	0	0	0	0	1796	24
8	0	0	0	0	0	13	57	48	73	148	161	129	183	140	161	78	50	54	8	0	0	0	0	0	1309	24
9	0	0	0	0	0	15	67	131	194	221	237	160	215	213	153	111	82	2	2	0	0	0	0	0	1307	24
10	0	0	0	0	0	13	63	138	142	78	102	70	93	75	37	113	39	26	7	0	0	0	0	0	1002	24
11	0	0	0	0	0	11	47	129	192	235	257	287	239	257	217	122	78	57	10	0	0	0	0	0	2143	24
12	0	0	0	0	0	10	44	100	170	221	252	264	258	213	167	130	89	46	8	0	0	0	0	0	1979	24
13	0	0	0	0	0	10	46	109	167	202	235	223	205	169	180	90	65	32	4	0	0	0	0	0	1742	24
14	0	0	0	0	0	3	25	44	49	47	56	80	160	100	16	128	106	48	8	0	0	0	0	0	875	24
15	0	0	0	0	0	4	9	17	40	35	36	82	165	205	221	141	116	52	8	0	0	0	0	0	1137	24
16	0	0	0	0	0	5	33	32	77	160	209	198	179	229	188	155	91	44	10	0	0	0	0	0	1614	24
17	0	0	0	0	0	11	63	134	171	240	253	270	259	269	233	175	121	56	8	0	0	0	0	0	2294	24
18	0	0	0	0	0	13	70	130	171	237	258	292	286	268	235	151	119	54	7	0	0	0	0	0	2297	24
19	0	0	0	0	0	13	63	131	184	238	247	285	293	269	249	150	80	26	7	0	0	0	0	0	2210	24
20	0	0	0	0	0	13	67	130	189	232	264	290	281	262	210	165	106	45	4	0	0	0	0	0	2254	24
21	0	0	0	0	0	11	69	121	181	227	254	273	253	188	138	151	96	42	5	0	0	0	0	0	2057	24
22	0	0	0	0	0	7	37	101	128	222	238	264	266	246	214	144	102	37	4	0	0	0	0	0	2016	24
23	0	0	0	0	0	7	46	106	163	211	203	248	248	223	191	148	86	34	3	0	0	0	0	0	1925	24
24	0	0	0	0	0	7	43	96	159	213	219	228	282	182	177	131	95	41	3	0	0	0	0	0	1891	24
25	0	0	0	0	0	15	38	19	50	138	249	294	255	213	185	137	85	22	1	0	0	0	0	0	1693	24
26	0	0	0	0	0	3	26	85	152	182	132	194	53	10	54	69	42	14	1	0	0	0	0	0	1092	24
27	0	0	0	0	0	1	7	20	36	72	177	224	151	166	17	8	6	0	0	0	0	0	0	0	891	24
28	0	0	0	0	0	1	9	23	25	45	54	187	194	117	144	84	51	24	1	0	0	0	0	0	957	24
29	0	0	0	0	0	3	46	101	165	179	215	255	243	172	121	140	63	20	2	0	0	0	0	0	1731	24
30	0	0	0	0	0	3	40	88	157	160	156	197	238	202	173	101	50	15	0	0	0	0	0	0	1590	24
31	0	0	0	0	0	4	27	98	155	136	233	231	182	211	193	136	29	10	0	0	0	0	0	0	1651	24
AV	0	0	0	0	0	9	44	89	129	163	187	207	208	189	160	122	78	35	6	0	0	0	0	0		
MAX	0	0	0	0	0	19	73	144	194	240	264	292	293	269	249	175	122	59	18	0	0	0	0	0		
MIN	0	0	0	0	0	1	7	17	25	20	7	0	15	10	13	8	6	0	0	0	0	0	0	0		
#D	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31		
TOT	0	0	0	0	5	292	1384	2772	4010	5073	5827	6441	6460	5871	4986	3791	2426	1093	197	3	0	0	0	0		

MONTHLY VALUES (FOR DAYS OF COMPLETE DATA ONLY)

TOTAL FOR MONTH	50637 BTU/SQ FT	DAILY AVER	1633 BTU/SQ FT
		DAILY MAX	2297 BTU/SQ FT
# COMPLETE DAYS	31	DAILY MIN	354 BTU/SQ FT

APPENDIX B

The hourly solar radiation record for the Perry site, June to August, 1981.

The following tables provide the hourly record of total solar radiation received on a horizontal surface at the Perry site from the commencement of acceptable data on June 18, 1981 to the end of August, 1981. The format of the tables is identical to that for the Champaign data (see Appendix A), but the data are presented in units of W/m^2 and MJ/m^2 only.

The Perry record provides an example of a record with very frequent interruptions, in this instance resulting from power outages due to a combination of a building project at the site and electrical storms. In the case of the July data, 15 days were omitted from the monthly computations because of at least one hour of missing record, while 12 days were excluded from the August computations. Consequently, the monthly values are more questionable than those for Champaign. In the future, if situations of this type arise it may prove desirable to develop estimates based upon the partial daily records. It is expected that in the near future, with the completion of the building project at Perry, that data losses will be much reduced.

LKH 5781

ILLINOIS STATE WATER SURVEY
ILLINOIS SOLAR ENERGY PROGRAM

PERRY, ILLINOIS
90 50'W, 39 49'N
206 M ABOVE MSL

GLOBAL SHORTWAVE RADIATION
ON A HORIZONTAL SURFACE
SENSOR: EPPLEY 8-48 PYRANOMETER

JUNE, 1981

UNITS: HOURLY = WM-2, DAILY (TOTD & TOT) AND MONTHLY = MJM-2

HOUR (CST) ENDING AT

DAY	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTD	#H
1	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	0
2	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	0
3	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	0
4	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	0
5	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	0
6	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	0
7	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	0
8	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	0
9	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	0
10	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	0
11	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	0
12	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	0
13	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	0
14	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	0
15	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	0
16	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	0
17	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	0
18	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	473	277	95	2	0	0	0	0	3.35	8
19	0	0	0	0	0	15	44	107	245	158	743	576	640	701	578	431	416	192	76	6	0	0	0	0	17.30	24
20	0	0	0	0	3	73	210	190	295	426	542	657	244	271	352	304	202	61	73	4	0	0	0	0	14.04	24
21	0	0	0	0	M	M	M	M	M	M	70	38	149	474	620	593	335	83	20	0	0	0	0	0	8.60	19
22	0	0	0	0	0	110	277	479	652	737	712	731	M	M	M	M	M	M	M	M	M	M	M	M	13.34	12
23	0	0	0	0	2	26	259	472	623	761	858	897	891	853	764	632	462	270	101	7	0	0	0	0	28.42	24
24	0	0	0	0	2	23	201	294	339	494	637	730	797	835	741	586	64	1	7	0	0	0	0	0	20.15	24
25	0	0	0	0	1	9	57	220	577	756	882	916	919	872	782	649	477	290	110	7	0	0	0	0	27.08	24
26	0	0	0	0	4	93	275	458	635	768	866	916	914	870	771	643	475	289	109	6	0	0	0	0	29.17	24
27	0	0	0	0	6	101	253	441	609	714	671	617	514	662	459	243	81	98	93	5	0	0	0	0	20.03	24
28	0	0	0	0	1	74	183	392	592	734	832	904	897	841	742	603	439	257	93	5	0	0	0	0	27.21	24
29	0	0	0	0	3	79	242	430	585	712	810	861	857	780	650	562	362	112	12	0	0	0	0	0	25.41	24
30	0	0	0	0	0	10	80	131	390	495	614	585	711	452	296	329	367	247	81	7	0	0	0	0	17.41	24
AV.	0	0	0	0	2	55	190	333	503	606	686	700	683	692	615	506	346	181	73	4	0	0	0	0		
MAX	0	0	0	0	6	110	277	479	652	768	882	916	919	872	782	649	477	290	110	7	0	0	0	0		
MIN	0	0	0	0	0	9	44	107	245	158	70	38	149	271	296	243	64	1	7	0	0	0	0	0		
#D	12	12	12	12	11	11	11	11	11	11	12	12	11	11	11	11	12	12	12	12	12	12	12	12		
TOT	0.0	0.0	0.0	0.0	.1	2.2	7.5	13.2	19.9	24.0	29.7	30.3	27.1	27.4	24.4	20.1	14.9	7.8	3.2	.2	0.0	0.0	0.0	0.0		

MONTHLY VALUES (FOR DAYS OF COMPLETE DATA ONLY)

TOTAL FOR MONTH	227.0 MJM-2	DAILY AVER	22.70 MJM-2
		DAILY MAX	29.17 MJM-2
# COMPLETE DAYS	10	DAILY MIN	14.04 MJM-2

LKH 5/81

ILLINOIS STATE WATER SURVEY
ILLINOIS SOLAR ENERGY PROGRAM

PERRY, ILLINOIS
90.50'W, 39.49'N
206 M ABOVE MSL

GLOBAL SHORTWAVE RADIATION
ON A HORIZONTAL SURFACE
SENSOR: EPPLEY 8-48 PYRANOMETER

JULY, 1981

UNITS: HOURLY = WM-2, DAILY (TOTD & TOT) AND MONTHLY = MJM-2

HOUR (CST) ENDING AT

DAY	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTD	#H
1	0	0	0	0	1	24	112	357	536	661	596	323	449	356	541	511	299	202	71	5	0	0	0	0	18.16	24
2	0	0	0	0	1	46	177	348	476	626	734	647	473	765	313	281	229	182	39	2	0	0	0	0	19.22	24
3	0	0	0	0	2	53	185	284	403	380	708	545	723	662	669	465	216	88	16	0	0	0	0	0	19.47	24
4	0	0	0	0	0	M	M	M	4	10	41	72	341	294	141	41	22	53	71	6	0	0	0	0	3.95	21
5	0	0	0	0	0	3	28	54	115	201	139	103	308	220	232	341	297	240	70	5	0	0	0	0	8.48	24
6	0	0	0	0	2	59	209	425	580	701	803	850	852	810	718	593	437	266	103	7	0	0	0	0	26.69	24
7	0	0	0	0	2	45	171	400	571	626	773	815	658	725	519	561	274	196	77	7	0	0	0	0	23.12	24
8	0	0	0	0	1	62	227	417	586	701	645	577	914	852	665	581	431	266	96	5	0	0	0	0	25.29	24
9	0	0	0	0	1	57	210	332	563	654	M	M	M	M	M	M	M	M	M	M	M	M	M	M	6.54	10
10	M	M	M	M	M	M	M	344	550	694	798	854	854	807	718	584	427	254	70	1	0	0	0	0	25.04	17
11	0	0	0	0	2	54	70	67	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	.69	8
12	M	M	M	M	M	M	M	363	508	706	815	850	898	704	754	577	295	147	60	7	0	0	0	0	24.06	17
13	0	0	0	0	0	59	213	397	572	710	808	855	861	816	725	585	424	244	83	4	0	0	0	0	26.47	24
14	0	0	0	0	0	38	141	321	537	676	685	502	835	627	575	M	M	M	M	M	M	M	M	M	17.77	15
15	M	M	M	M	M	M	M	M	90	230	391	377	138	220	173	162	252	113	86	14	7	0	0	0	3.11	16
16	0	0	0	0	0	0	14	136	157	272	372	713	762	742	669	609	530	405	260	94	5	0	0	0	20.46	24
17	M	M	M	M	M	M	M	M	535	703	776	854	843	832	739	593	396	120	27	1	0	0	0	0	23.11	16
18	0	0	0	0	0	29	151	148	146	32	37	247	401	446	469	263	M	M	M	M	M	M	M	M	8.53	16
19	M	M	M	M	M	M	M	M	M	M	M	351	665	620	380	245	356	M	M	M	M	M	M	M	9.42	6
20	M	M	M	M	M	M	M	342	564	714	792	641	575	642	192	140	480	M	M	M	M	M	M	M	18.30	10
21	M	M	M	M	M	M	M	407	580	713	819	804	633	700	646	399	222	95	68	3	0	0	0	0	21.92	17
22	0	0	0	0	0	37	116	138	168	299	397	362	557	500	241	273	357	210	76	3	0	0	0	0	13.41	24
23	0	0	0	0	0	0	0	2	38	370	780	579	445	416	467	294	419	244	85	3	0	0	0	0	14.98	24
24	0	0	0	0	0	20	75	156	213	454	524	507	655	345	7	71	139	131	68	4	0	0	0	0	12.33	24
25	0	0	0	0	0	0	7	29	26	209	537	401	735	771	679	446	337	202	49	3	0	0	0	0	15.95	24
26	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	0
27	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	0
28	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	5	0	0	0	0	.32	5
29	0	0	0	0	0	37	197	406	597	668	717	786	532	646	647	552	393	249	75	1	0	0	0	0	23.41	24
30	0	0	0	0	0	22	162	370	559	709	776	841	809	834	739	603	438	250	76	1	0	0	0	0	26.10	24
31	0	0	0	0	0	37	187	384	560	712	814	865	857	760	716	598	429	235	66	1	0	0	0	0	25.92	24
AV	0	0	0	0	0	34	132	275	394	516	611	589	647	619	512	414	337	201	76	7	0	0	0	0		
MAX	0	0	0	0	2	62	227	425	597	714	819	865	914	852	754	609	530	405	260	94	7	0	0	0		
MIN	0	0	0	0	0	0	0	2	4	10	37	72	138	220	7	41	22	53	16	0	0	0	0	0		
#D	21	21	21	21	21	20	20	24	26	26	25	26	26	26	26	25	24	22	22	23	23	23	23	23		
TOT	0.0	0.0	0.0	0.0	.0	2.5	9.5	23.8	36.9	48.3	55.0	55.2	60.6	58.0	48.0	37.3	29.2	16.0	6.1	.7	.0	0.0	0.0	0.0		

MONTHLY VALUES (FOR DAYS OF COMPLETE DATA ONLY)

TOTAL FOR MONTH	319.6 MJM-2	DAILY AVER	19.97 MJM-2
		DAILY MAX	26.69 MJM-2
# COMPLETE DAYS	16	DAILY MIN	8.48 MJM-2

LKH 5/81

ILLINOIS STATE WATER SURVEY
ILLINOIS SOLAR ENERGY PROGRAM

PERRY, ILLINOIS
90 50'W, 39 49'N
206 M ABOVE MSL

GLOBAL SHORTWAVE RADIATION
ON A HORIZONTAL SURFACE
SENSOR: EPPLEY B-48 PYRANOMETER

AUGUST, 1981

UNITS: HOURLY = WM-2, DAILY (TOTD & TOT) AND MONTHLY = MJM-2

HOUR (CST) ENDING AT

DAY	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	TOTD	#H
1	0	0	0	0	0	19	152	358	545	698	799	856	789	777	711	571	387	208	56	1	0	0	0	0	24.97	24
2	0	0	0	0	0	54	157	265	M	M	M	498	347	404	314	309	198	138	86	10	0	0	0	0	10.01	21
3	0	0	0	0	0	19	40	68	119	188	237	243	257	338	423	540	423	231	62	1	0	0	0	0	11.49	24
4	0	0	0	0	0	24	137	324	516	622	694	694	655	776	668	584	394	200	51	0	0	0	0	0	22.82	24
5	0	0	0	0	0	12	95	199	262	333	591	279	360	474	449	500	396	196	48	0	0	0	0	0	15.10	24
6	0	0	0	0	0	25	135	384	325	340	459	496	535	657	638	299	239	35	42	0	0	0	0	0	16.74	24
7	0	0	0	0	0	19	174	371	541	704	738	900	677	434	311	427	406	219	55	0	0	0	0	0	21.51	24
8	0	0	0	0	0	23	124	221	335	450	526	M	M	M	M	M	M	M	51	0	0	0	0	0	6.23	17
9	0	0	0	0	0	3	116	313	521	675	777	752	726	813	384	469	388	140	43	0	0	0	0	0	22.03	24
10	0	0	0	0	0	1	8	51	169	240	249	195	305	326	245	266	368	211	39	0	0	0	0	0	9.62	24
11	0	0	0	0	0	23	165	333	558	692	M	M	M	M	M	M	M	M	M	M	M	M	M	M	6.39	10
12	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	25	0	0	0	0	0	.09	6
13	0	0	0	0	0	19	128	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	.53	7
14	M	M	M	M	M	M	M	M	M	M	556	633	830	751	652	478	276	136	50	0	0	0	0	0	15.70	14
15	0	0	0	0	0	0	0	0	0	185	511	556	603	764	540	435	352	181	33	0	0	0	0	0	14.99	24
16	0	0	0	0	0	6	27	36	63	188	152	329	400	175	179	117	156	157	36	0	0	0	0	0	7.28	24
17	0	0	0	0	0	9	79	234	328	641	715	759	856	810	595	420	258	205	31	0	0	0	0	0	21.64	24
18	0	0	0	0	0	21	M	286	529	681	787	838	840	792	691	547	372	139	33	0	0	0	0	0	23.67	23
19	0	0	0	0	0	9	156	273	486	624	350	619	834	743	640	530	363	179	29	0	0	0	0	0	21.01	24
20	0	0	0	0	0	11	129	342	513	669	772	821	829	780	671	537	365	177	29	0	0	0	0	0	23.94	24
21	0	0	0	0	0	13	120	294	500	656	759	772	831	770	697	524	327	140	23	0	0	0	0	0	23.10	24
22	0	0	0	0	0	10	87	258	485	634	742	670	801	727	530	494	325	150	20	0	0	0	0	0	21.36	24
23	0	0	0	0	0	8	M	M	453	606	723	734	737	649	361	475	307	118	12	0	0	0	0	0	13.66	22
24	0	0	0	0	0	8	149	245	280	250	233	678	760	641	470	426	103	51	3	0	0	0	0	0	15.10	24
25	0	0	0	0	0	5	97	266	412	630	703	716	695	598	569	480	252	76	11	0	0	0	0	0	19.84	24
26	0	0	0	0	0	5	73	251	469	253	136	269	338	339	601	446	153	13	12	0	0	0	0	0	12.11	24
27	0	0	0	0	0	1	29	M	134	229	237	120	156	456	570	290	109	76	15	0	0	0	0	M	8.72	22
28	0	0	0	0	0	3	37	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	.14	7
29	0	0	0	0	0	3	48	212	454	528	614	512	746	657	547	448	307	139	14	0	0	0	0	0	18.82	24
30	0	0	0	0	0	3	46	M	M	M	125	44	M	M	410	327	92	3	0	0	0	0	0	0	3.78	19
31	M	M	M	M	M	M	M	396	468	620	724	716	667	584	520	221	M	M	M	M	M	M	M	M	17.70	9
AV	0	0	0	0	0	12	98	249	378	493	534	560	622	609	517	429	293	141	33	0	0	0	0	0		
MAX	0	0	0	0	0	54	195	396	558	704	799	900	856	813	711	584	423	231	86	10	0	0	0	0		
MIN	0	0	0	0	0	0	0	0	0	185	125	44	156	175	179	117	92	3	0	0	0	0	0	0		
#D	29	29	29	29	29	29	26	24	25	25	26	26	25	25	26	26	25	25	27	27	27	27	27	26		
TOT	0.0	0.0	0.0	0.0	0.0	1.3	9.2	21.6	34.1	44.4	50.1	52.5	56.1	54.8	48.5	40.2	26.4	12.7	3.3	.3	0.0	0.0	0.0	0.0		

MONTHLY VALUES (FOR DAYS OF COMPLETE DATA ONLY)

TOTAL FOR MONTH	343.5 MJM-2	DAILY AVER	18.08 MJM-2
		DAILY MAX	24.97 MJM-2
# COMPLETE DAYS	19	DAILY MIN	7.28 MJM-2