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Solar Energy Information and Data for Illinois

by STANLEY A. CHANGNON, JR.

ILLINOIS STATE WATER SURVEY

URBANA

1978

CONTENTS

CONVERSION FACTORS

To convert	to	Multiply by
Btu ft^{-2}	Langleys (ly)	2.713×10^{-1}
Btu ft^{-2}	kWh m^{-2}	3.160×10^{-3}
Btu ft^{-2} h^{-1}	ly min^{-1}	4.522×10^{-3}
Btu ft^{-2} h^{-1}	W m^{-2}	3.155
Btu ft^{-2} h^{-1}	ly s^{-1}	7.537×10^{-5}
Btu	cal	2.520×10^{2}
Btu	Joule (J)	1.055×10^{3}
Btu	kWh	2.931×10^{-4}
Btu h^{-1}	W	2.931×10^{-1}
ly (langley)	J m^{-2}	4.186×10^{4}
ly min^{-1}	kWh m^{-2} min^{-1}	1.162×10^{-2}
ly min^{-1}	erg cm^{-2} s^{-1}	6.974×10^{5}
ly s^{-1}	W m^{-2}	4.186×10^{4}
W m^{-2}	kWh m^{-2} s^{-1}	2.778×10^{-7}
kWh	M joules	3.600
kWh	therms	3.413×10^{-2}
kWh	Btu	3.413×10^{3}
W ft^{-2}	W m^{-2}	1.0763×10
ton (refrig.)	kW	3.51685
ton (refrig.)	Btu h^{-1}	1.2×10^{4}
therm	kWh	2.931×10
therm	Btu	1×10^{5}
hp	W	7.46×10^{2}
hp	Btu h^{-1}	2.545×10^{3}
To derive	**from**	**Divide by**

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SOLAR ENERGY INFORMATION AND DATA FOR ILLINOIS

by Stanley A. Changnon, Jr.

INTRODUCTION

The number of words written about the energy crises and energy issues in the United States since 1970 could easily fill a large library. One of the newly sought alternatives to fossil fuels and nuclear sources of power is solar energy. Solar energy appears to have great promise if economically feasible technologies can be developed. Predictions are that solar power, by the year 2000, could provide 2 percent of the national consumption (Stalhakis, 1977). Solar energy is envisioned for use in space heating and cooling, electrical applications (solar thermal power plants and photovoltaic power), and special purposes (agricultural drying, biomass conversion, solar ponds, ocean thermal, etc.).

Solar energy as a workable technology depends on the radiation received. Weather conditions are the major hour-by-hour, day-by-day, and month-to-month factors determining the amount of radiation received and hence weather determines the suitability of an area for solar systems, the type of technology needed (including standby energy sources), and the demand. For instance, clear summer days mean ample solar energy is received, but the energy demands for air conditioning are large. Weather conditions in Illinois also vary latitudinally (north-to-south), particularly in colder seasons, and conditions vary greatly between seasons. Illinois, with a continental-type climate, has many extremes, many of which impact on the planning and designs for solar energy, as well as its usage.

The State of Illinois has been very concerned about the energy crisis and has moved forward with alacrity to develop energy technologies and resources, as well as to establish its own energy related agencies. Illinois is one of the first states to develop a comprehensive solar energy program (Nodiff, 1977). In the spirit of the State's solar energy focus, and to serve the needs of the public and those involved in the design and implementation of solar energy systems, we decided to present the readily available weather and climatic data relating to 1) solar energy and 2) the demands for energy. This report is essentially a solar data compendium for Illinois. It contains a minimum of text and consists mainly of tables and graphs, largely assembled from a wide variety of publications (many not easily found).

It should be recognized that the designers and planners of solar energy systems will likely desire more data or some other form of solar information than presented here. Available radiation data are considered inadequate to describe the time-space variations in radiation and more measurements are needed. However, all available quality data in and around Illinois have been used in the results shown here, and users desiring different presentations or analyses of the data can, from this publication, be aware of where to procure available data on radiation, sunshine, temperature, and winds for different analyses.

The information presented is largely based on averages for various records and periods (daily, weekly, monthly, and annually). Some extremes are presented where available. Also, where available, various probabilities of events (such as runs of days with sunshine or radiation) are given. The radiation data and information are presented first, followed by sections on sunshine and sky cover; then one on temperature, humidity, and winds; and finally one on weather hazards to solar energy systems.

Acknowledgments. The author appreciates the efforts of Mrs. J. Loreena Ivens and Mrs. Patricia A. Motherway in editing this report. Marilyn J. Innes prepared the camera copy. Vidyadhar S. Patil and Kurt Peterson under the supervision of John Brother, Jr., prepared the illustrations.

DATA

The tabular data and charts used herein came from three sources: the Environmental Data and Information Service (EDIS, formerly EDS) of NOAA, the Argonne National Laboratory at Lemont, Illinois, and the Illinois State Water Survey. Most of this information relates to:

- Radiation (largely solar, but some net)
- Sunshine (actual and percent possible)
- Cloud cover (percent and amount)
- Pollution (as it affects radiation)
- Temperature and humidity
- Winds
- Weather conditions that would detrimentally affect solar units (hail, snowfall, ice, etc.)

The design of solar energy systems should be based on detailed data from solar radiation measurements. Unfortunately, there have been only two radiation stations operated in Illinois (at Lemont in the north for 15 years, and at Urbana in central Illinois for 17 years). A variety of radiation results from both are presented, including daily values (Changnon, 1959). Many of the available detailed analyses of the radiation data at Lemont are presented, including radiation relationships with wind, temperatures, and humidity (Moses and Bogner, 1967). Available radiation data from Indianapolis, Indiana, and Columbia, Missouri (Baker and Klink, 1975) are presented to furnish estimates of conditions in south-central and southern Illinois, respectively.

The first-order weather stations operated since about 1900 by the National Weather Service at Chicago, Indianapolis, Moline, Peoria, Springfield, St. Louis, Evansville, and Cairo have recorded sunshine and cloud (sky) cover data. These data from various EDS publications are presented to help provide more spatial detail on solar related conditions. Machta (1976) shows that radiation data at one point explains only 65 percent of the variations found in received radiation 125 miles (200 km) away. Therefore, the Indianapolis and Columbia data are not terribly good at estimating conditions in western and southern Illinois; hence the importance of the sunshine data at Cairo, Evansville, and St. Louis.

Selected data on basic weather factors that lead to energy demands are also presented. Average monthly values of temperatures (and extremes of temperature), relative humidity, and winds are offered for various state locales.

Various weather conditions that will create problems for solar collectors are reviewed. Included are average and extreme values of hail, thunderstorms, pollution, snow, and ice, all presented to reveal the dimensions of these hazards.

RADIATION INFORMATION

Factors Influencing Solar Energy

Circumstances that reduce solar energy between what is intercepted by the earth and what is actually received at the surface of the earth include: 1) the rotation of the earth about its axis; 2) the revolution of the earth around the sun; and 3) the scattering, absorption, and reflection of the incoming solar radiation by the atmosphere.

The earth rotating on its axis makes a complete rotation each day, creating the day-night effect. Thus, the solar radiation received is a discontinuous source of energy. Even if no other reason existed for storage of energy, it is necessary to store energy captured during the day if it is to be available at a later time (night).

The earth revolving about the sun creates the seasonal effect. Thus, the angle of the sun's rays to the earth's surface varies appreciably in the course of a year, as does the day length.

The most efficient absorbing surface of the sun's rays for the Illinois area would be one which changes its orientation during the course of a year because the angle of the sun's rays to the earth's surface varies. In the summer, the angle above the horizon is about 60 degrees in Illinois, and in midwinter, it decreases to about 20 degrees. Hence, most absorbing surfaces should be constructed with a permanent tilt from the horizontal and always facing south.

A surface with a fixed slope does not always have an advantage in radiation reception, compared with that received on a horizontal surface, because of the continually changing position of the earth relative to the sun. The variations in the total clear-day reception on a horizontal surface, on vertical surfaces of different orientations, and on a surface that tracks the sun (such that it is always perpendicular or normal to the sun's rays) are illustrated in figure 1.

The second effect of the earth's annual revolution about the sun is the changing length of day. At 40° N latitude, or central Illinois, the difference between the longest and shortest day is 6 hours 2 minutes, and this difference increases as the latitude increases. The short days occur in the winter, the very time when energy needs for heating are high.

Radiation received at the outer limit of the earth's atmosphere, called extraterrestrial radiation, varies throughout the year, as shown in figure 2. The variation is a result of the seasonal effects, the earth's revolution about the sun combined with the constant tilt of the earth from the vertical of about 23°. Upon entering the earth's atmosphere, the radiation is depleted by absorption and scattering. Atmospheric constituents responsible for this include oxygen molecules, ozone, and water vapor. More or less transient materials in the atmosphere, such as dust and smoke, cause additional scattering and absorption. Some of the scattered radiation is lost to outer space and some reaches the earth's surface.

This relates to another important aspect of solar radiation within the earth's atmosphere. Figure 3 illustrates that direct beam radiation arrives in a *direct path* from the sun, but scattered or diffuse radiation arrives at the earth's surface in an *indirect path.* The concentrator type of solar energy collector can make very little use of the diffuse radiation, whereas the flat plate collector makes use of both the diffuse and direct beam.

On a clear day relatively free of smoke and dust, the proportion of the diffuse radiation to the total amount measured in Illinois ranges from about 20 percent with the high sun period of the summer solstice (June 22) to about 35 percent at the winter solstice (December 22). The higher proportion of diffuse radiation in winter is due to the longer path length, and thus, a greater scattering of the sun's rays as they pass through the atmosphere.

Cloud cover also reduces radiation received at the earth's surface. This is an important factor because it is unpredictable, except on a short-term basis, and it often severely restricts the

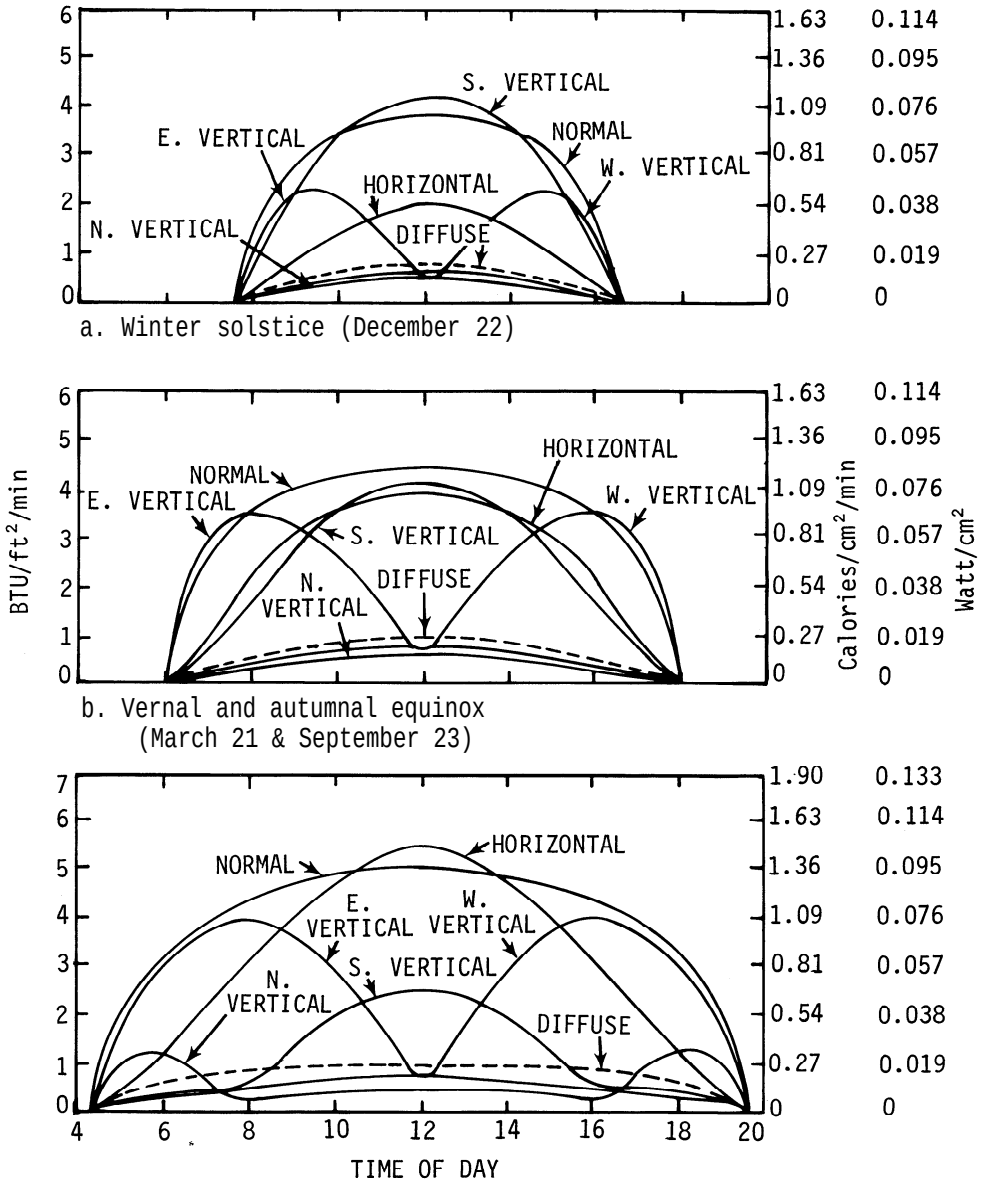

Figure 1. Relative amounts of clear-day radiation received on a horizontal surface, on vertical surfaces of different facing directions (north, south, east, and west), and on a surface always kept normal to the sun's rays

radiation received. A large proportion of incoming solar radiation is reflected off the top of the clouds to outer space while the absorption within the cloud is relatively minor. The radiation which penetrates the cloud is diffuse radiation, as shown in figure 3, and is essentially unuseable by the concentrator type of solar energy collector.

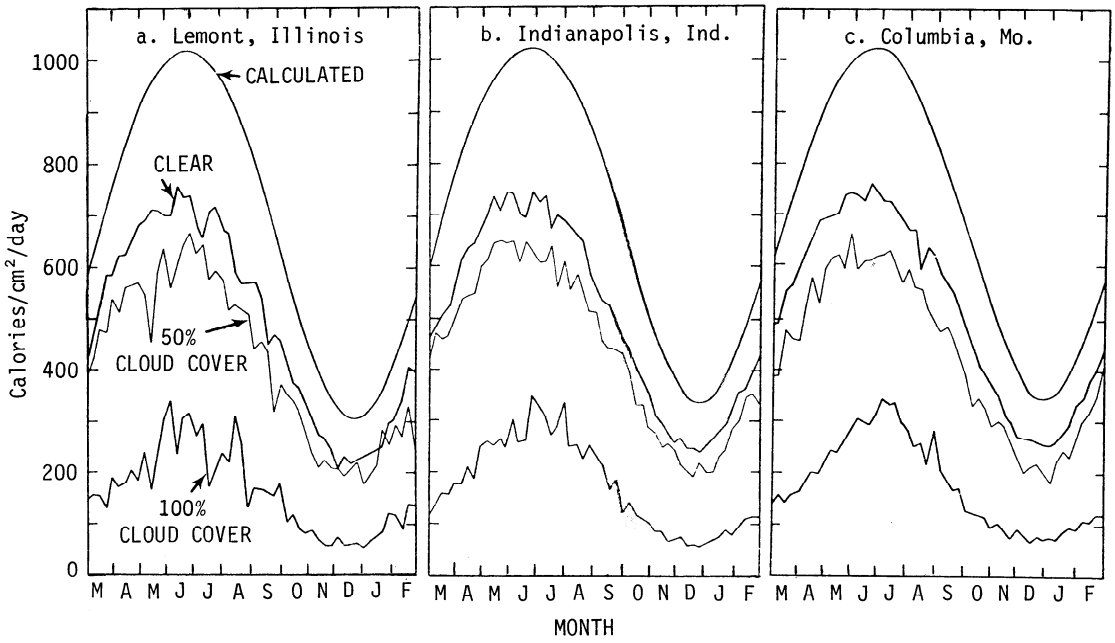

Figure 2. Calculated total daily extraterrestrial radiation and the average measured radiation under three sky conditions (*From Baker and Klink, 1975)*

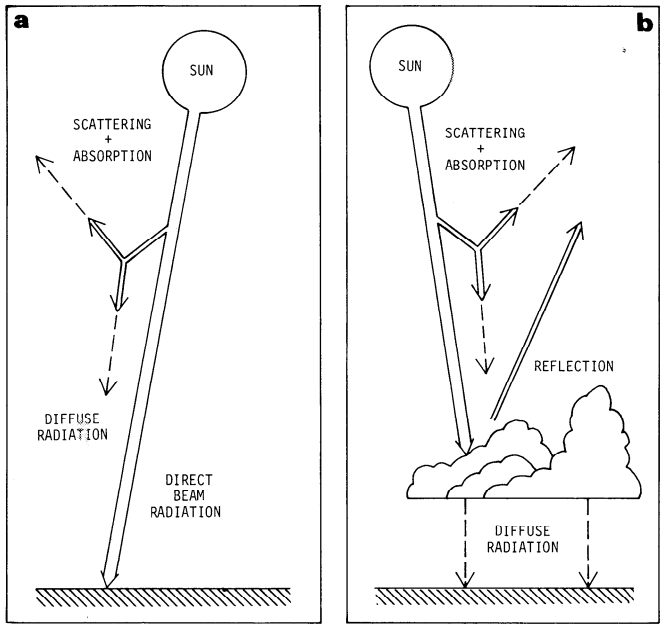

Figure 3. Total radiation received at the earth's surface is depleted a) by scattering and absorption within the atmosphere and b) by clouds because of reflection off the top and absorption within the clouds

Daily Values of Solar Radiation

Assorted curves of average daily solar radiation values for four stations are presented in figures 2 and 4. The curves for Lemont, Indianapolis, and Columbia shown in figure 2 are taken from Baker and Klink (1975). The uppermost curve on figure 2 shows the calculated total daily extraterrestrial radiation.values. The lower three curves of each graph show the average *measured* radiation under three sky conditions including clear, under 50 percent cloud cover, and with 100 percent cloud cover.

One Langley of radiation is equal to a radiation intensity such that 1 calorie of energy falls on a surface that is 1 square centimeter in area. This is equal to 3.69 Btu per square foot. Figure 4 (Changnon, 1959) presents the average daily solar radiation values at Urbana, based on 10-day periods. Also presented in figure 4 are the extremes, the highest 10 days on record and the lowest on record for this 7-year sampling period.

Tables 1, 2, and 3 present the average daily radiation values, sorted according to weekly periods for Lemont, Indianapolis, and Columbia. The mean daily radiation values are shown in the row near the middle of the tables, ranging at Lemont from a low of 113.2 per day during early December to a maximum of 556.9 Langleys in late June. Also shown on these three tables are the minimum daily and maximum daily values obtained during the period of record at each station. The period of record for each is shown on the tables. They also contain the standard deviation of the mean and the number of observations. Another major feature (of tables 1, 2, and 3) relating to daily values are the columns showing the probability, in various 10 percent intervals, of receiving varying amounts of radiation per day. For example, at Lemont (table 1), during the first week in March, there is a 90 percent chance of getting 75.5 Langleys or more per day and a 20 percent chance of getting 411.3 Langleys or more.

Patterns based on the daily total radiation expected at three probability levels (20, 50, 80 percent probability of receiving *at least* the indicated amounts) for various seasons of the year are presented in figures 5, 6, and 7. Baker and Haines (1969) separated the probability maps for

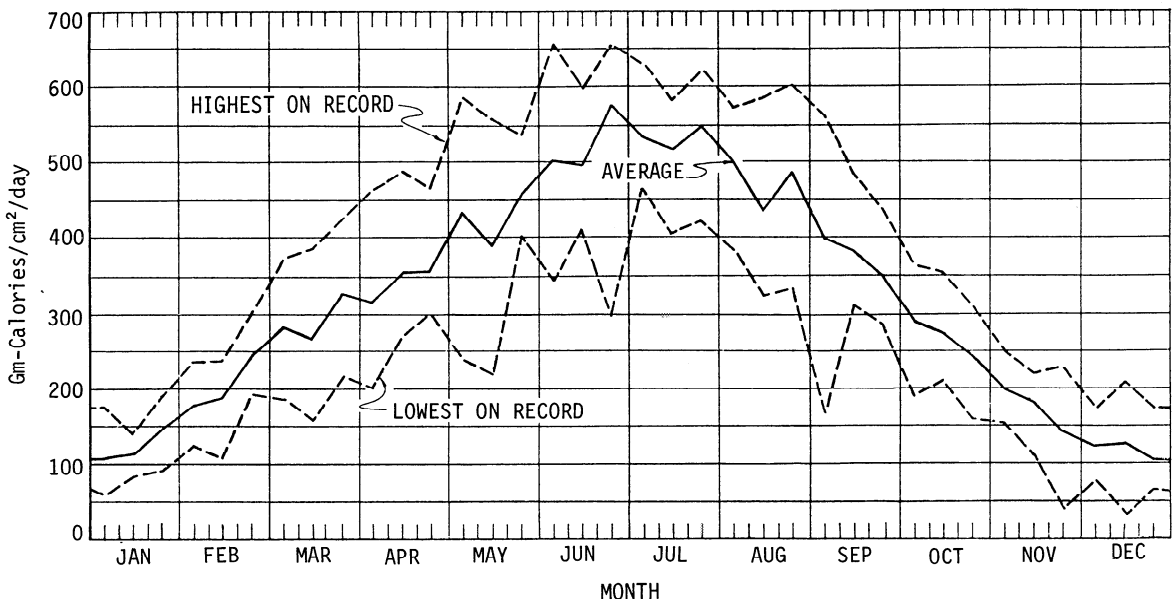

Figure 4. Daily average and extremes of solar radiation at Urbana, 1950-1956, with data smoothed by 10-day averages

Table 1. Solar Radiation in Langleys Per Day at Lemont, Illinois

Week No.	Week	Obser-vations	Radiation			SD of mean	Probability in percent of receiving at least the indicated amount								
			Min	Max	Mean		90	80	70	60	50	40	30	20	10
1	03/01 - 03/07	87	31.2	517.0	272.2	14.9	75.5	117.9	168.9	223.2	285.1	335.6	376.5	411.3	453.6
2	03/08 - 03/14	91	15.4	522.7	279.7	14.1	88.7	132.0	181.0	252.1	307.6	342.3	372.5	404.1	436.8
3	03/15 - 03/21	91	26.2	578.0	333.2	16.4	80.7	166.1	233.9	299.5	366.2	404.5	450.5	480.7	515.4
4	03/22 - 03/28	91	25.0	605.6	349.6	16.6	100.4	174.5	252.9	314.1	382.4	419.5	452.0	495.3	555.0
5	03/29 - 04/04	95	46.2	635.9	353.1	17.0	98.3	170.5	250.3	326.4	365.1	402.8	473.2	523.8	553.2
6	04/05 - 04/11	98	9.7	633.0	376.0	18.0	128.9	193.3	253.1	295.8	374.7	447.2	538.9	576.3	599.0
7	04/12 - 04/18	98	19.4	697.8	394.6	18.3	113.6	188.6	280.7	373.6	431.4	468.6	519.6	580.1	605.1
8	04/19 - 04/25	98	42.8	697.4	416.1	17.9	177.9	251.3	300.6	366.8	412.6	492.3	546.1	607.9	638.1
9	04/26 - 05/02	93	47.8	723.4	433.7	22.0	120.6	171.1	280.0	362.5	477.5	567.9	616.7	643.4	669.4
10	05/03 - 05/09	84	52.1	765.2	491.8	19.6	248.6	322.5	368.4	463.9	528.7	567.1	613.1	654.0	698.3
11	05/10 - 05/16	83	43.1	750.2	464.5	22.3	132.7	256.6	344.6	421.0	524.9	580.1	627.2	652.2	675.0
12	05/17 - 05/23	84	103.4	727.0	477.6	20.6	163.2	258.4	375.3	462.1	534.8	581.1	618.1	648.5	683.9
13	05/24 - 05/30	84	96.9	771.7	520.9	18.4	231.6	357.6	468.4	510.8	535.8	592.6	639.1	670.9	708.2
14	05/31 - 06/06	95	106.7	801.1	533.0	17.1	287.0	346.6	432.5	520.8	563.8	602.9	656.5	681.6	731.7
15	06/07 - 06/13	98	73.9	774.6	528.8	16.8	263.2	378.7	462.4	520.3	562.5	601.3	636.7	660.8	707.4
16	06/14 - 36/20	98	113.0	783.0	554.9	16.3	309.1	418.7	486.2	537.0	589.0	635.1	675.4	697.5	720.9
17	06/21 - 06/27	98	108.3	799.3	556.2	16.9	281.2	426.7	493.4	536.0	601.2	637.7	684.4	700.5	724.2
18	06/28 - 07/04	94	80.0	802.0	556.9	16.1	331.6	413.0	503.5	551.2	585.2	622.1	654.4	691.1	732.1
19	07/05 - 07/11	86	89.6	777.6	533.1	20.0	252.9	346.4	442.8	527.2	593.4	636.3	658.0	689.3	735.0
20	07/12 - 07/18	84	55.1	753.0	517.0	18.2	258.9	331.2	466.6	508.0	582.4	606.1	637.2	652.8	673.4
21	07/19 - 07/25	90	131.2	763.8	546.6	14.5	293.4	457.2	521.4	556.6	590.4	610.4	625.6	647.2	674.6
22	07/26 - 08/01	91	102.8	703.2	486.4	16.3	244.1	334.4	414.7	478.2	535.6	559.8	594.2	612.8	656.7
23	08/02 - 08/08	91	141.0	700.8	501.4	14.1	308.3	378.9	455.6	501.6	526.4	548.9	600.2	610.6	642.0
24	08/09 - 08/15	90	81.4	690.8	484.8	13.6	276.1	383.8	435.1	479.2	533.0	544.6	566.4	580.4	615.6
25	08/16 - 08/22	91	95.1	648.1	470.6	12.9	282.7	340.0	436.4	474.9	501.1	535.8	556.5	569.8	590.2
26	38/23 - 08/29	91	49.0	634.6	452.7	12.8	279.8	376.1	421.6	452.9	476.9	502.7	519.0	549.7	573.7
27	08/30 - 09/05	91	105.4	600.7	423.6	13.6	201.5	310.1	376.9	418.0	455.7	486.6	512.5	522.9	565.4
28	09/06 - 09/12	90	85.8	578.6	426.6	13.2	207.3	338.0	397.6	438.0	463.5	484.8	503.0	523.2	542.0
29	09/13 - 09/19	91	52.2	559.0	348.5	14.5	125.6	218.9	299.7	329.6	351.7	404.3	451.6	477.0	508.5
30	09/20 - 09/26	91	12.3	527.1	319.9	13.7	108.3	202.3	261.2	286.2	327.6	365.6	408.7	441.5	480.4
31	09/27 - 10/03	91	78.4	497.0	362.9	10.5	211.7	269.2	323.2	354.9	397.4	418.7	434.4	449.9	464.0
32	10/04 - 10/10	90	55.6	444.6	296.6	12.5	92.4	184.5	248.1	290.8	331.8	364.1	378.9	401.0	419.2
33	10/11 - 10/17	91	24.6	441.0	289.6	11.6	82.3	185.4	256.6	298.2	333.8	346.7	359.5	376.6	400.4
34	10/18 - 10/24	91	3.6	402.8	241.3	12.2	49.4	124.9	177.0	221.6	275.7	304.4	328.1	347.6	365.8
35	10/25 - 10/31	91	16.8	371.9	211.2	10.8	57.3	96.6	152.8	187.6	212.7	282.0	297,0	309.3	324.9
36	11/01 - 11/07	90	19.1	331.3	174.6	10.1	47.4	62.7	95.7	131.8	176.7	214.8	254.4	269.8	302.8
37	11/08 - 11/14	91	0.5	308.0	171.1	9.2	37.5	72.8	114.6	158.4	189.9	209.8	239.4	257.1	272.3
38	11/15 - 11/21	90	6.4	281.0	128.8	8.4	27.2	45.3	68.4	93.6	120.0	157.6	169.2	203.6	250.6
39	11/22 - 11/28	91	0.2	257.4	147.9	8.3	22.2	53.6	93.7	139.9	164.8	188.8	209.5	223.0	241.8
40	11/29 - 12/05	91	0.8	246.3	135.3	7.2	42.5	63.6	89.2	109.6	134.0	152.5	185.2	210.6	227.9
41	12/06 - 12/12	89	3.2	255.4	113.2	7.7	25.3	35.2	56.2	82.8	105.5	128.5	155.9	191.7	219.9
42	12/13 - 12/19	91	4.6	245.7	136.0	7.6	31.1	50.2	79.7	123.0	143.0	168.0	185.7	212.1	228.0
43	12/20 - 12/26	90	1.4	255.6	127.4	7.7	31.8	46.6	73.4	92.2	117.7	154.6	185.0	205.0	221.4
44	12/27 - 01/02	91	11.2	257.8	132.6	7.3	34.1	55.7	87.6	108.9	140.8	160.2	175.4	209.2	224.9
45	01/03 - 01/09	94	7.0	269.6	158.1	7.6	43.8	79.0	117.6	136.7	159.4	200.6	214.3	226.7	242.4
46	01/10 - 01/16	96	4.2	289.9	159.6	7.8	47.6	69.7	113.2	153.1	177.6	202.0	213.5	232.1	246.7
47	01/17 - 01/23	98	9.4	327.7	178.9	9.2	41.8	81.6	104.0	174.1	207.1	226.1	249.6	259.7	276.7
48	01/24 - 01/30	95	18.4	322.7	175.3	9.0	45.9	74.6	125.1	162.0	181.4	202.8	228.5	264.3	280.9
49	01/31 - 02/06	85	18.8	363.4	201.8	10.3	63.2	97.9	132.8	174.8	194.7	243.0	271.0	290.2	321.5
50	02/07 - 02/13	83	18.8	382.0	214.7	12.4	57.1	86.2	131.4	178.1	218.7	257.9	298.9	335.4	358.9
51	02/14 - 02/20	84	32.8	432.0	278.1	12.1	112.4	167.5	201.5	258.1	298.5	333.0	367.8	383.3	404.6
52	02/21 - 02/27	84	42.6	432.2	244.0	13.1	77.4	120.3	158.6	203.2	228.1	281.4	335.3	382.3	407.8

Table 2. Solar Radiation in Langleys Per Day at Indianapolis, Indiana

	Obser	Radiation			SD of	Probability in percent of receiving at least the indicated amount								
Week	vations	Min	Max	Mean	mean	90	80	70	60	50	40	30	20	10
03/01 - 03/07	128	27.6	541.7	273.7	13.4	57.0	111.5	149.2	203.4	309.0	357.9	382.4	423.8	456.6
03/08 - 03/14	129	34.3	558.9	288.3	13.4	70.0	112.2	159.0	253.7	296.2	344.5	395.1	443.1	474.9
03/15 - 03/21	132	27.6	590.5	332.8	14.4	79.5	155.6	230.1	288.1	363.8	420.7	467.7	496.8	521.9
03/22 - 03/28	131	29.7	606.7	336.2	14.9	107.9	154.7	208.1	267.0	350.1	392.9	477.0	521.5	548.6
03/29 - 04/04	131	22.5	648.9	363.6	14.8	83.3	169.5	271.9	353.2	394.2	426.3	482.1	524.9	553.5
04/05 - 04/11	123	37.5	687.9	397.2	16.5	125.1	172.6	263.2	356.0	448.9	498.0	528.8	573.0	609.2
04/12 - 04/18	128	59.3	698.2	414.3	16.2	162.1	212.2	296.7	372.7	422.0	505.5	548.7	591.5	638.1
04/19 - 04/25	130	52.9	721.7	439.9	16.3	148.0	217.9	356.8	439.0	483.6	528.2	575.8	614.1	649.3
04/26 - 05/02	120	71.2	772.7	462.5	18.1	164.9	247.2	321.4	400.4	493.0	581.4	626.2	657.1	685.6
05/03 - 05/09	126	73.5	748.7	515.2	16.0	214.3	346.0	427.8	498.4	573.7	612.0	646.2	678.0	703.1
05/10 - 05/16	125	63.8	794.4	445.6	17.4	169.2	246.4	318.3	383.7	470.3	521.4	583.1	641.7	679.6
05/17 - 05/23	125	65.7	806.8	519.4	16.9	248.4	318.8	409.6	460.7	573.5	615.4	657.4	697.8	730.2
05/24 - 05/30	131	100.6	820.7	524.8	16.5	208.7	351.1	436.0	500.2	561.2	617.7	654.3	695.6	730.9
05/31 - 06/06	132	148.2	812.0	540.4	14.5	281.7	384.0	464.0	510.2	567.5	624.1	665.9	688.4	731.3
06/07 - 06/13	128	61.8	798.3	523.0	14.2	291.5	373.7	462.0	503.3	550.3	601.8	637.1	659.0	691.2
06/14 - 06/20	127	118.7	776.6	571.8	13.1	343.3	476.9	526.1	576.4	613.6	637.9	668.5	683.0	713.7
06/21 - 06/27	138	134.1	806.8	573.9	13.5	314.7	440.2	509.5	569.2	621.3	651.5	669.6	701.8	748.7
06/28 - 07/04	133	146.4	825.2	573.7	11.9	382.4	465.4	513.5	569.3	606.0	630.0	660.8	683.7	718.8
07/05 - 07/11	132	141.9	765.3	560.8	13.7	362.2	424.7	481.0	546.5	597.6	635.1	673.2	707.6	728.1
07/12 - 07/18	131	100.4	768.5	531.2	13.0	280.6	410.8	465.6	520.1	579.1	614.7	636.5	657.3	683.4
07/19 - 07/25	132	93.9	751.6	527.5	12.7	322.4	404.5	458.2	502.8	551.6	602.5	631.9	653.0	686.4
07/26 - 08/01	122	165.9	738.7	545.0	11.3	354.1	423.4	513.6	545.3	584.7	608.0	629.9	646.1	663.3
08/02 - 08/08	128	107.5	742.1	507.5	12.3	278.8	372.2	455.2	517.0	558.5	580.5	592.1	610.0	652.0
08/09 - 08/15	122	75.4	728.2	500.9	13.0	265.7	361.1	449.6	489.6	545.9	575.0	559.9	614.3	641.7
08/16 - 08/22	120	94.0	681.9	490.6	11.0	330.3	394.0	445.0	491.3	522.4	542.8	565.5	596.0	609.0
08/23 - 08/29	123	61.5	652.7	492.9	10.5	314.4	416.5	468.7	502.4	520.0	544.2	559.5	582.3	612.1
08/30 - 09/05	131	80.3	646.1	448.6	11.3	249.9	322.4	425.3	453.6	488.9	512.1	525.6	548.0	575.0
09/06 - 09/12	128	91.5	599.4	443.5	10.2	255.5	367.9	409.3	445.8	473.9	495.7	514.5	532.9	565.4
09/13 - 09/19	132	46.4	618.3	396.6	12.2	144.6	270.4	351.6	416.9	449.4	469.0	484.3	507.9	535.6
09/20 - 09/26	125	19.9	575.3	379.6	11.3	178.7	272.0	343.0	394.8	414.7	440.6	454.8	475.3	503.3
09/27 - 10/03	121	8.7	530.2	361.3	12.3	133.1	214.6	336.0	383.7	407.7	431.9	453.5	470.2	488.1
10/04 - 10/10	129	32.6	500.8	338.3	10.7	126.8	214.6	278.9	341.0	385.8	409.3	424.8	442.0	459.3
10/11 - 10/17	127	27.4	484.3	303.5	10.0	122.8	196.3	251.3	309.3	345.7	361.2	382.3	394.6	411.8
10/18 - 10/24	133	23.6	418.5	280.4	9.3	98.4	182.0	232.1	269.1	312.2	339.3	358.1	377.6	394.6
10/25 - 10/31	129	24.4	444.4	238.3	9.4	68.5	135.1	172.3	221.2	260.4	289.4	315.3	339.4	360.5
11/10 - 11/07	127	14.7	372.9	205.1	9.2	46.5	90.8	125.0	172.1	223.7	267.3	288.1	304.1	321.7
11/08 - 11/14	125	3.9	346.5	193.4	8.3	55.2	99.8	121.7	170.0	208.6	231.5	272.9	287.2	300.2
11/15 - 11/21	122	12.8	372.4	167.0	8.4	32.0	57.5	108.3	132.6	177.6	209.7	236.3	250.8	275.6
11/22 - 11/28	120	11.1	312.3	145.3	7.7	30.7	57.1	80.8	104.2	142.6	163.0	207.7	236.3	259.1
11/29 - 12/05	130	16.8	305.1	149.3	6.8	36.8	62.4	94.5	126.4	152.7	173.8	198.4	226.9	249.9
12/06 - 12/12	127	12.2	280.6	124.1	6.9	24.1	36.3	62.2	91.6	121.3	141.8	179.6	203.4	233.9
12/13 - 12/19	125	8.6	272.9	140.3	7.1	33.1	49.0	74.0	112.4	150.2	174.1	203.8	220.5	233.6
12/20 - 12/26	128	4.1	282.9	123.7	7.2	20.4	35.4	59.1	87.8	113.7	137.1	183.2	214.7	231.6
12/27 - 01/02	125	13.0	296.0	135.8	7.1	26.3	43.0	71.7	106.4	150.6	164.2	189.8	214.6	234.3
01/03 - 01/09	119	7.0	309.0	153.9	7.6	42.7	63.2	91.4	117.2	158.6	192.3	214.9	238.3	257.5
0l/10 - 01/16	128	12.4	314.6	164.8	8.1	33.2	62.5	96.8	126.8	179.0	216.0	237.9	256.8	275.2
01/17 - 01/23	124	7.6	328.8	161.1	8.3	38.2	67.7	88.2	115.1	164.5	200.7	220.1	257.7	286.1
01/24 - 01/30	125	2.0	368.4	181.4	9.6	34.7	60.6	104.5	137.6	185.3	216.8	260.2	292.3	316.6
01/31 - 02/06	124	2.0	406.2	190.0	9.6	42.5	71.6	118.1	161.1	192.5	222.3	267.0	297.7	330.2
02/07 - 02/13	126	20.4	402.8	213.3	10.1	41.6	88.4	145.9	174.4	217.6	258.5	300.7	328.4	359.7
02/14 - 02/20	132	24.3	445.0	255.7	10.7	70.0	118.0	168.2	238.4	283.8	316.4	354.9	370.3	400.7
02/21 - 02/27	129	27.7	510.5	277.4	12.1	70.2	118.5	198.5	238.5	299.9	348.8	383.8	404.9	431.4

Table 3. Solar Radiation in Langleys Per Day at Columbia, Missouri

Week	Obser-vations	Radiation			SD of mean	Probability in percent of receiving at least the indicated amount								
		Min	Max	Mean		90	80	70	60	50	40	30	20	10
03/01 - 03/07	184	17.6	551.5	312.0	11.2	59.4	134.4	228.5	292.3	354.0	398.3	427.7	446.3	481.1
03/08 - 03/14	188	1.7	583.3	310.4	11.8	74.1	139.3	19 0 .5	264.2	326.7	376.1	445.8	479.2	502.7
03/15 - 03/21	186	16.1	619.4	327.0	12.9	57.6	124.0	197.6	288.5	343.6	409.7	472.7	498.0	537.7
03/22 - 03/28	182	11.1	619.4	387.6	13.0	107.2	204.6	270.7	362.5	437.0	487.1	523.2	544.1	567.2
03/29 - 04/04	182	9.0	674.3	364.4	14.0	102.3	160.6	206.4	303.8	400.9	459.5	511.2	560.4	599.9
04/05 - 04/11	180	22.1	707.1	430.9	14.1	143.7	234.6	318.0	402.1	490.7	544.6	581.0	608.3	628.3
04/12 - 04/18	179	44.8	714.9	430.8	15.3	93 8	226.4	273.0	383.1	489.1	554.9	599.0	636.0	662.8
04/10 - 04/25	180	36.9	725.0	451.7	14.3	152.8	240.0	358.3	426.1	437.9	521.9	604.8	643.5	678.0
04/26 - 05/02	181	62.8	777.3	476.3	14.9	180.7	282.0	349.4	437.9	507.1	594.8	640.3	672.5	696.5
05/03 - 05/09	182	85.6	774.6	502.3	14.0	208.8	279.8	413.0	494.2	552.2	606.7	634.1	672.9	712.0
05/10 - 05/16	182	50.4	802.5	503.7	14.5	175.7	308.9	415.1	479.9	565.9	607.6	660.8	687.0	710.2
05/17 - 05/23	189	34.6	808.3	531.6	13.7	237.2	347.4	448.5	519.8	569.8	623.5	667.0	707.1	735.2
05/24 - 05/30	185	97.1	810.8	534.7	14.0	242.8	349.1	424.9	512.1	578.0	647.1	685.9	708.0	745.1
05/31 - 06/06	182	82.2	800.3	529.3	13.9	219 0	346.3	445.1	519.0	569.6	623.2	663.2	704.0	724.8
06/07 - 06/13	180	101.6	794.4	569.9	12.5	318.3	412.0	507.0	558.0	625.4	657.9	695.3	711.1	739.0
06/14 - 06/20	186	67.2	796.5	556.2	13.2	271.1	380.8	476.3	560.0	599.1	650.7	687.3	717.0	751.1
06/21 - 06/27	181	127.1	835.5	583.1	12.0	318.6	453.5	518.5	577.8	632.7	665.8	694.5	723.2	745.1
06/28 - 07/04	180	122.3	832.6	595.2	10.7	393.7	443.4	538.3	595.7	632.5	667.3	696.5	716.3	749.7
07/05 - 07/11	180	131.4	787.3	589.1	11.3	373.4	471.8	543.2	595.2	635.3	664.5	690.6	714.5	739.4.
07/12 - 07/18	176	151.6	849.1	561.4	11.8	271.9	419.7	526.1	568.6	605.5	637.8	664.1	689.2	719.7
07/19 - 07/25	173	74.6	872.9	569.2	11.7	349.7	443.6	527.3	576.1	610.1	647.4	669.8	691.1	710.5
07/26 - 08/01	177	52.3	814.2	572.4	10.5	346.7	476.5	553.6	594.8	624.9	637.5	651.7	673.5	697.3
08/02 - 08/08	175	113.4	716.9	551.4	10.3	334.7	460.6	521.0	573.6	604.0	622.6	639.2	656.5	679.0
08/09 - 08/15	176	85.8	715.1	507.5	11.4	255.7	377.7	445.9	512.7	548.0	585.5	615.8	636.4	661.5
08/16 - 08/22	177	112.3	692.1	513.3	10.6	271.4	399.0	480.6	532.5	563.5	581.6	601.6	625.1	646.0
08/23 - 08/29	180	52.3	676.1	502.8	10.3	281.8	429.7	485.5	518.4	540.9	566.3	586.8	601.0	621.8
08/30 - 09/05	175	19.7	687.1	466.7	11.5	206.6	330.1	409.0	476.9	524.7	551.0	567.8	590.5	612.8
09/06 - 09/12	178	37.0	657.6	460.4	10.9	197.3	348.8	444.8	475.4	504.7	533.2	557.6	575.4	588.3
09/13 - 09/19	180	21.8	610.1	426.8	10.5	192.9	330.0	395.c	435.4	470.1	498.3	517.5	543.0	562.7
09/20 - 09/26	182	30.4	601.6	389.4	11.0	147.7	230.9	316.9	360.9	442.5	478.1	501.7	520.3	538.9
09/27 - 10/03	181	27.2	552.5	384.1	9.8	165.1	264.1	356.9	399.7	431.4	455.3	472.8	489.5	511.6
10/04 - 10/10	181	12.8	523.2	345.1	10.3	93.5	198.8	285.5	363.5	409.2	429.6	444.0	460.3	470.7
10/11 - 10/17	182	9.8	476.7	333.9	8.5	131.9	245.8	302.3	351.2	377.4	391.7	411.4	426.5	437.8
10/18 - 10/24	179	33.4	484.5	311.1	8.2	130.3	206.2	282.1	324.0	349.2	365.1	383.9	401.1	417.3
10/25 - 10/31	171	28.8	419.1	260.1	9.0	67.4	128.6	194.6	255.1	310.0	329.5	350.6	363.8	382.6
11/01 - 11/07	174	22.6	394.1	219.0	8.3	59.5	101.9	128.0	183.8	221.6	275.1	301.3	330.1	357.2
11/08 - 11/14	170	11.3	365.1	223.3	7.6	70.3	115.8	159.7	209.3	255.6	281.3	298.7	312.8	330.1
11/15 - 11/21	167	10.4	346.0	185.8	7.8	43.8	69.2	95.2	147.1	193.5	247.8	271.3	291.5	306.6
11/22 - 11/28	175	17.0	304.1	188.9	6.4	52.8	91.7	130.3	186.1	211.3	235.9	253.9	270.4	282.4
11/29 - 12/05	173	3.8	304.4	174.0	6.6	48.5	78.7	115.4	153.9	193.4	219.2	240.0	260.1	272.1
12/06 - 12/12	171	8.9	318.8	157.9	6.7	38.8	64.0	85.1	125.8	168.4	205.2	232.0	246.0	267.6
12/13 - 12/19	174	6.8	307.4	169.5	6.2	47.9	76.5	110.3	156.4	183.3	219.6	235.1	246.0	260.8
12/20 - 12/26	172	11.5	306.8	155.9	6.2	40.2	63.6	95.4	134.3	174.0	198.7	211.2	229.4	251.5
12/27 - 01/02	174	0.6	286.8	150.2	6.4	39.0	54.4	87.4	118.2	145.7	178.8	217.6	244.9	260.9
01/03 - 01/09	176	12.6	298.7	178.5	6.6	41.7	67.7	130.1	175.6	210.4	231.8	243.6	262.0	272.4
01/10 - 01/16	178	17.2	330.6	169.4	6.8	44.2	69.3	100.0	132.5	173.5	218.2	245.6	262.5	278.7
01/17 - 01/28	176	16.2	361.9	180.6	7.2	40.0	75.7	112.4	156.3	193.3	223.3	252.4	272.0	299.5
01/24 - 01/40	179	13.2	391.6	199.1	8.2	51.9	79.7	99.8	154.3	192.1	261.0	290.7	309.5	337.7
01/31 - 02/06	187	17.5	406.8	221.8	8.2	54.1	83.6	138.5	204.6	240.0	284.7	30 9.0	328.7	349.4
02/07 - 02/18	188	17.2	428.5	240.9	9.1	50.9	97.1	171.2	207.2	265.8	313.5	341.4	366.4	383.5
02/14 - 02/20	187	13.5	457.9	276.5	9.2	72.4	138.7	209.3	259.3	314.3	353.0	368.6	388.7	412.6
02/21 - 02/27	185	21.0	501.5	270.8	10.6	70.9	100.5	153.8	229.4	295.1	359.9	391.5	410.1	439.0

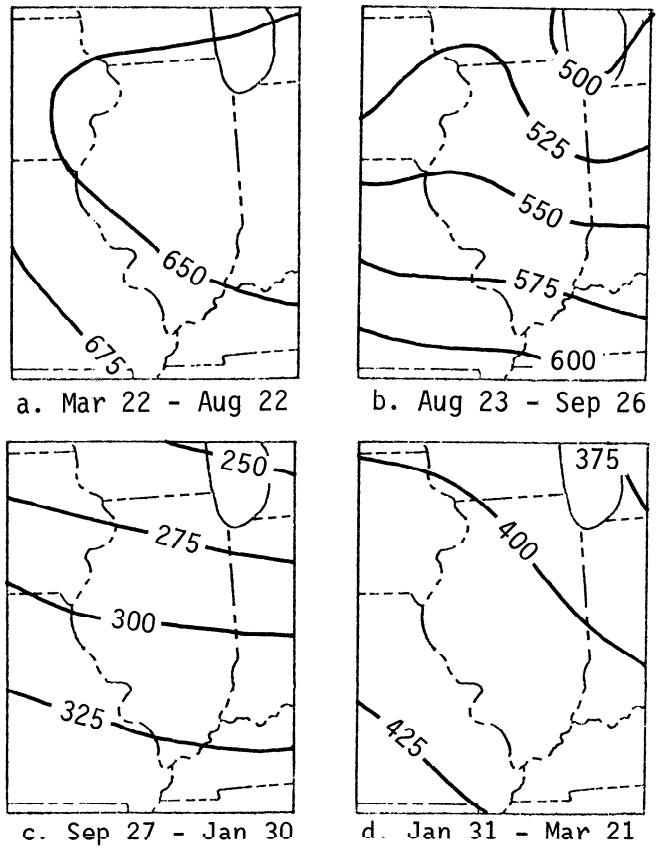

Figure 5. Average daily radiation in Langleys received at the 20 percent level of probability for various seasons

the Midwest into sets of periods that displayed similar regions of patterns of radiation. For example, at the 20 percent level, there were four periods of the year, as based on a study of individual weekly patterns, that had similar patterns. That is, throughout the March 22 through August 22 period (figure 5a), the weekly patterns of radiation expected at the 20 percent level were similar. Figure 5a reveals that the average daily radiation received at the 20 percent level (80 percent of the time the radiation will be less than, or 20 percent of the time greater than, the indicated values) shows that locales in eastern Illinois will receive slightly less than 650 Langleys to slightly more than 650 in southern Illinois.

Figure 5b displays the probability (20 percent) pattern for the August 23 through September 26 period. It is vastly different from the spring and early summer period (figure 5a) with a distinct latitudinal variation ranging from 520 Langleys per day in northern Illinois to over 600 in the south. The latitudinal distribution of Langleys per day continues in the fall-winter season (figure 5c) and the spring season (figure 5d).

Figure 6 presents the probabilities for daily radiation values at the 50 percent level. Here, the Baker and Haines analysis suggested the presence of five periods, or radiation seasons, of unique distributions of the daily probability patterns. Figure 7 based on the 80 percent probability, or likelihood, of daily radiation being received presents six patterns for six distinct seasons of the year.

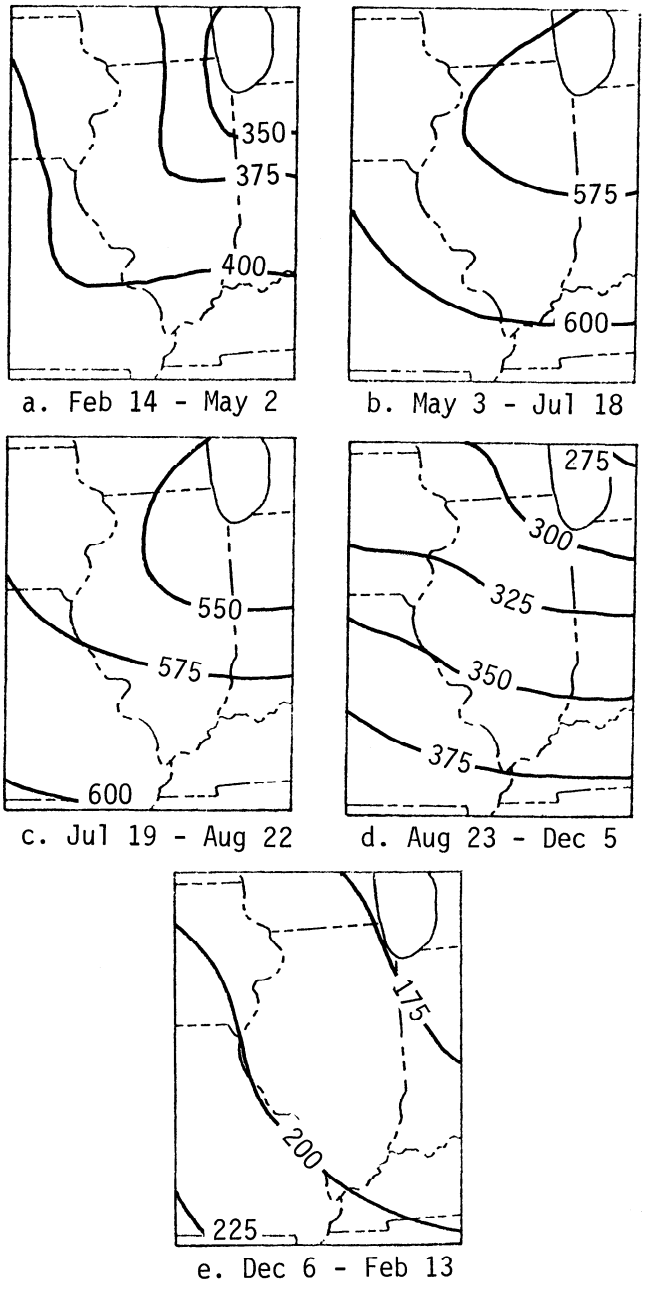

Figure 6. Average daily radiation in Langleys received at the 50 percent level of probability for various seasons

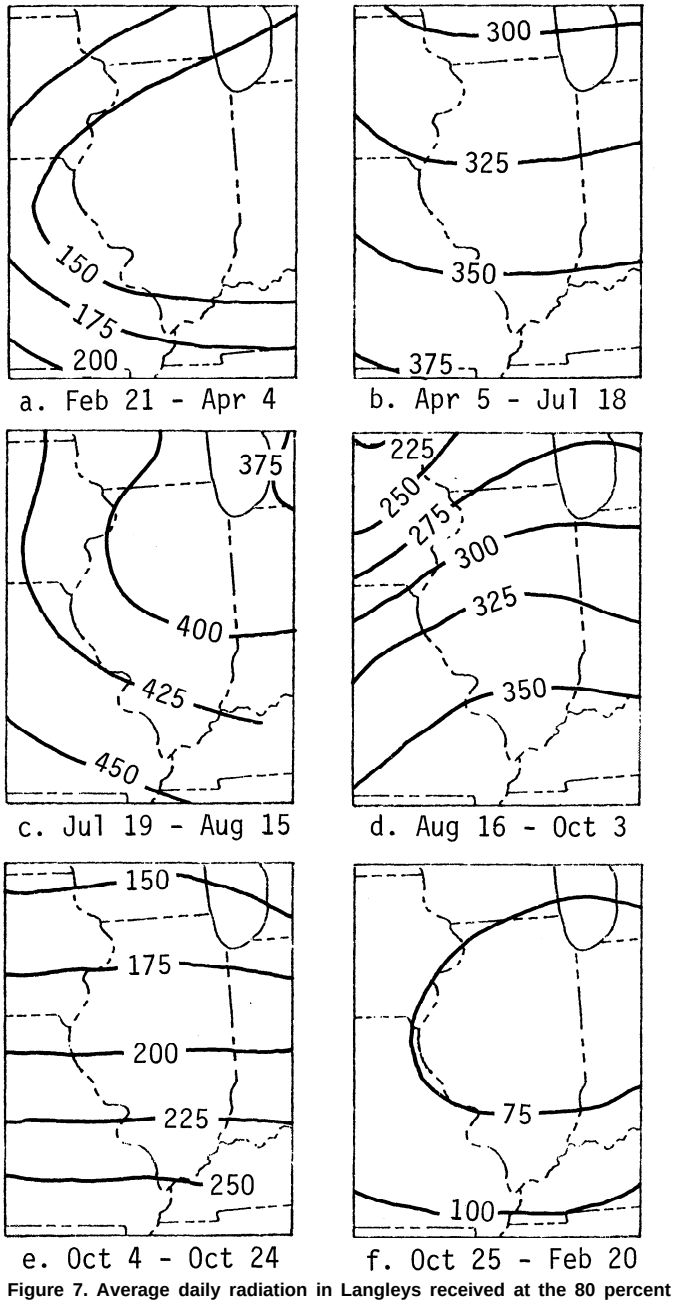

Figure 7. Average daily radiation in Langleys received at the 80 percent level of probability for various seasons

The extensive data obtained on solar radiation at the Argonne National Laboratories in Lemont, Illinois, have been analyzed and presented in a variety of ways. Certain of these presentations are reproduced in this report. The solar data presented are based on observations between 0400 and 2000 CST. Table 4 gives the mean monthly values of daily totals of direct and diffuse solar radiation in Langleys. The average daily total of the 15-year period is 348 Langleys per day.

Table 4 also presents the maximum daily total solar radiation, as determined for each month and year. Blanks in the table indicate that no data were available for the month. An example of the use of these data is that the single day with the greatest solar radiation during June 1951 had a value of 789 Langleys, whereas during June 1952 the maximum daily value was 815. Also, the opposite values are given, the lowest daily solar radiation values received in each month for the period of record. Here we see that in June 1951 the lowest received radiation on one day was 131 Langleys.

Measurements of daily solar radiation were collected in Urbana, Illinois, during two periods, 1950-1956 and 1967-1976. Figures 8 and 9 present the percent of days, by months, sorted according to various 100-Langleys-per-day-distributions. For example, nearly 50 percent of the January daily values in the 1950-1956 period had solar radiation values of 0 to 100 Langleys. Similar winter distributions are found in February and December. The spring season months, April and May, show rather even distributions. Noticeable peaks in the daily distributions occur at the higher values in the summer (June-August) and fall (September-November) distributions.

Hourly Solar Radiation Values

The 15-year record at Lemont also included data on the average hourly solar radiation values. Table 5 presents the mean of the direct and diffuse solar and sky radiation, as measured for each hour of each month. As expected, the maximum values occur at 1200 CST in most months except February and July when comparable values occur at 1300 CST. Figure 10 presents the hourly data, which have been analyzed for probabilities, or precentile distributions, for each month. The comparison of the monthly curves shows the annual march of the hourly solar radiation pattern. The 10-, 25-, 50-, 75-, and 90-percentile curves can be used to determine, for each month, the likelihood of solar radiation values for a given hour.

Monthly Solar Radiation Data

The monthly average total solar radiation values for Urbana appear in table 6. Shown are the values for the early 7-year period, 1950–1956, and the later 10-year period, 1967–1976. The The differences between the monthly averages may relate to sampling differences, indicating that 7- to 10-year periods are not adequate to develop a reliable or stable average value. However, they may also relate to some systematic changes in the weather conditions that would alter radiation between these two sampling periods.

The differences between the monthly averages, expressed as a percent change with regard to the 1950–1956 values, appear in table 6. One notes a relative increase in radiation in the winter months, which could be the result of a decrease in cloudiness in the winter period. The small differences in the spring season, March–May, may reflect very little temporal change in cloudiness. The 10 to 15 percent decreases in radiation in the recent period for the summer and fall months could indicate an increase in cloudiness. Although cloudiness is not routinely observed at Urbana to support this possible explanation of these changes, cloud (sky) cover data from nearby first order

Table 4. Monthly Values of Solar Radiation at Lemont, Illinois*

Year	*J*	*F*	*M*	*A*	*M*	*J*	*J*	*A*	*S*	*O*	*N*	*D*	*Annual*
Monthly mean of daily totals													
1950									362	288	171	157	
1951	150	190	299	326		530	543	444	426	293	196	151	325
1952	148	219	330	472	463	609	599	509	455	337	201	99	370
1953	130	243	295	365	503	608	589	540	462	315	186	150	364
1954	151	247	355	409	538	588	589	480	422	232	173	133	360
1955	169	188	378	449	526	538	565	556	439	281	185	132	368
1956	170	244	328	393	511	605	509	495	477	342	179	120	364
1957	201	230	354	353	476	584	557	490	397	265	132	116	347
1958	174	295	275	414	581	471	446	487	392	319	182	160	350
1959	186	259	332	394	489	600	525	465	399	225	149	109	345
1960	128	222	392	423	449	521	592	442	372	271	178	167	348
1961	181	186	220	307	474	571	463	432	324	222	131	102	303
1962	174	192	259	462	472	570	449	487	403	262	159	142	336
1963	157	264	270	463	514	621	560	449	391	309	173	166	361
1964	165	270	329	353	555	573	507	503	381	308	187	124	355
MEAN	163	232	316	400	503	571	535	485	407	284	172	135	348
Monthly maximum of daily totals													
1950									620	443	290	279	
1951	265	391	590	689		789	785	688	628	484	378	276	789
1952	315	435	586	712	816	815	802	724	616	476	361	261	816
1953	314	460	594	736	777	794	752	675	615	459	328	265	794
1954	317	389	566	681	773	796	755	677	612	477	352	259	796
1955	345	406	639	731	775	804	716	706	646	464	338	234	804
1956	314	468	611	709	802	795	745	679	632	495	286	267	802
1957	334	430	560	713	787	818	778	701	580	447	314	225	818
1958	290	409	510	712	727	733	674	642	576	444	322	299	733
1959	319	432	578	697	695	753	748	613	593	441	303	217	753
1960	283	478	587	653	750	775	744	668	557	467	302	277	775
1961	341	349	502	630	732	735	723	591	493	384	259	223	735
1962	265	424	483	680	730	756	723	630	552	380	277	253	756
1963	317	452	537	636	739	790	741	689	540	458	331	247	790
1964	278	449	555	640	748	738	759	681	577	456	312	286	759
HIGH	345	478	639	736	816	818	802	724	646	495	378	299	818
Monthly minimum of daily totals													
1950									127	20	11	16	
1951	5	23	46	57		131	96	167	100	29	10	33	5
1952	29	39	32	42	98	211	326	156	76	79	8	11	8
1953	15	38	28	55	81	315	178	311	233	3	48	16	3
1954	22	34	23	66	165	131	273	134	82	25	4	5	5
1955	18	1	25	41	95	79	280	178	112	35	55	20	1
1956	15	22	12	56	73	261	140	154	294	73	25	27	12
1957	10	58	39	76	110	123	131	152	86	22	6	1	1
1958	19	52	81	43	168	119	116	112	52	48	9	31	9
1959	23	33	25	84	184	416	217	215	67	44	4	11	4
1960	4	19	71	63	112	113	194	76	98	36	12	31	4
1961	37	33	13	47	52	276	80	49	13	4	12	3	3
1962	7	34	23	88	91	246	101	99	120	38	31	42	7
1963	22	92	24	182	122	421	55	141	87	45	19	39	19
1964	31	86	44	13	168	325	138	276	51	95	33	19	13
LOW	4	1	12	13	52	79	55	49	13	3	4	1	1

** In Langleys, as measured on a horizontal surface during the hours 0400-2000 CST for September 1950-December 1964*

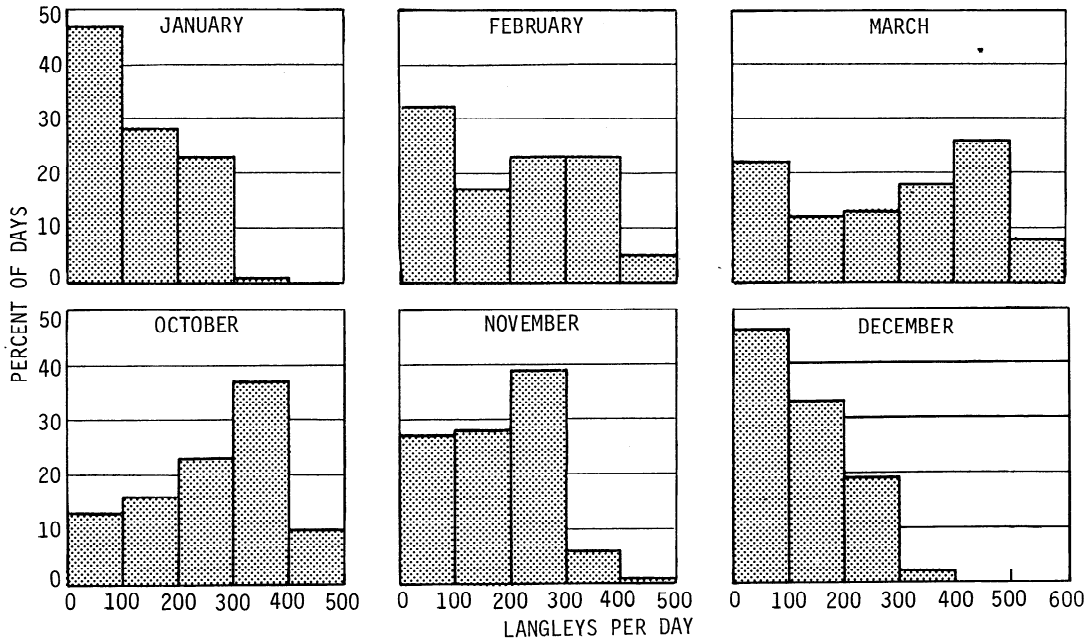

Figure 8. Monthly distribution of daily solar radiation values for colder half-year, 1950-1956

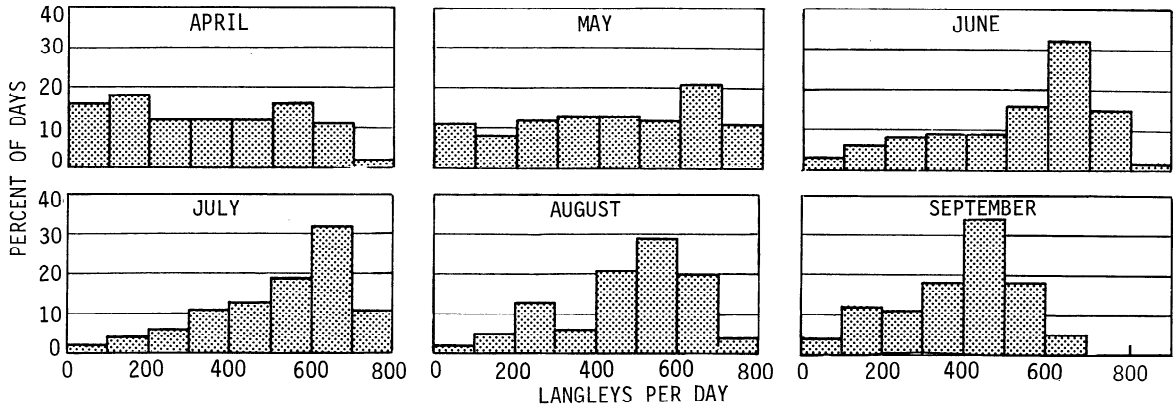

Figure 9. Monthly distribution of daily solar radiation values for warmer half-year, 1950-1956

Table 5. Average Hourly Solar Radiation at Lemont, Illinois*

Hour	*J*	*F*	*M*	*A*	*M*	*J*	*J*	*A*	*S*	*O*	*N*	*D*
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.2	0.6	0.2	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	1.2	5.3	7.2	5.2	2.0	0.4	0.0	0.0	0.0
7	0.1	0.1	2.5	9.0	17.6	20.0	17.5	12.0	7.1	2.3	0.3	0.1
8	1.5	4.1	12.2	20.6	30.8	33.7	30.9	25.7	20.2	12.5	4.6	1.5
9	8.8	14.1	24.4	32.9	42.9	47.0	43.3	39.4	34.3	24.9	13.3	8.2
10	17.6	24.3	35.7	42.5	52.3	57.4	54.4	51.0	45.3	35.3	21.7	16.1
11	24.9	32.7	43.7	49.8	58.0	64.0	60.5	57.9	52.5	41.5	27.7	22.2
12	29.2	37.3	45.9	53.2	60.5	67.1	63.0	60.8	56.1	44.3	30.0	25.1
13	29.0	37.5	45.4	52.0	59.4	65.5	63.0	59.9	55.2	41.8	28.2	23.9
14	24.6	33.7	39.8	48.0	54.1	60.4	58.8	56.2	49.4	35.7	23.2	19.5
15	17.5	26.0	32.0	39.8	47.6	53.0	51.3	47.6	40.2	26.6	15.2	12.6
16	8.8	16.2	22.1	28.7	36.3	42.4	41.0	37.0	27.9	14.9	6.3	4.8
17	1.7	5.7	11.0	17.2	24.2	29.4	29.0	23.6	14.3	4.4	0.7	0.5
18	0.1	0.4	2.3	6.3	12.2	16.4	15.9	10.5	3.3	0.3	0.0	0.1
19	0.0	0.0	0.0	0.6	2.6	5.3	4.7	1.6	0.1	0.0	0.0	0.0
20	0.0	0.0	0.0	0.0	0.0	0.3	0.2	0.0	0.0	0.0	0.0	0.0

**In Langleys, as measured on a horizontal surface for June 1956-December 1964*

Table 6. Average Monthly Total Solar Radiation at Urbana

(In calories per square centimeter)

	1950-1956	*1967-1976*	*1976 % change*
January	3,816	5,136	+34.6
February	5,667	6,363	+12.3
March	9,037	8,684	- 3.9
April	10,134	10,690	+ 5.5
May	12,769	12,687	- 0.7
June	15,743	13,469	-14.4
July	16,441	14,035	-14.6
August	14,674	12,539	-14.4
September	11,357	9,589	-15.6
October	8,498	7,611	-10.4
November	5,251	4,713	-10.2
December	3,625	3,861	+ 6.5
Annual	117,012	109,377	- 6.5

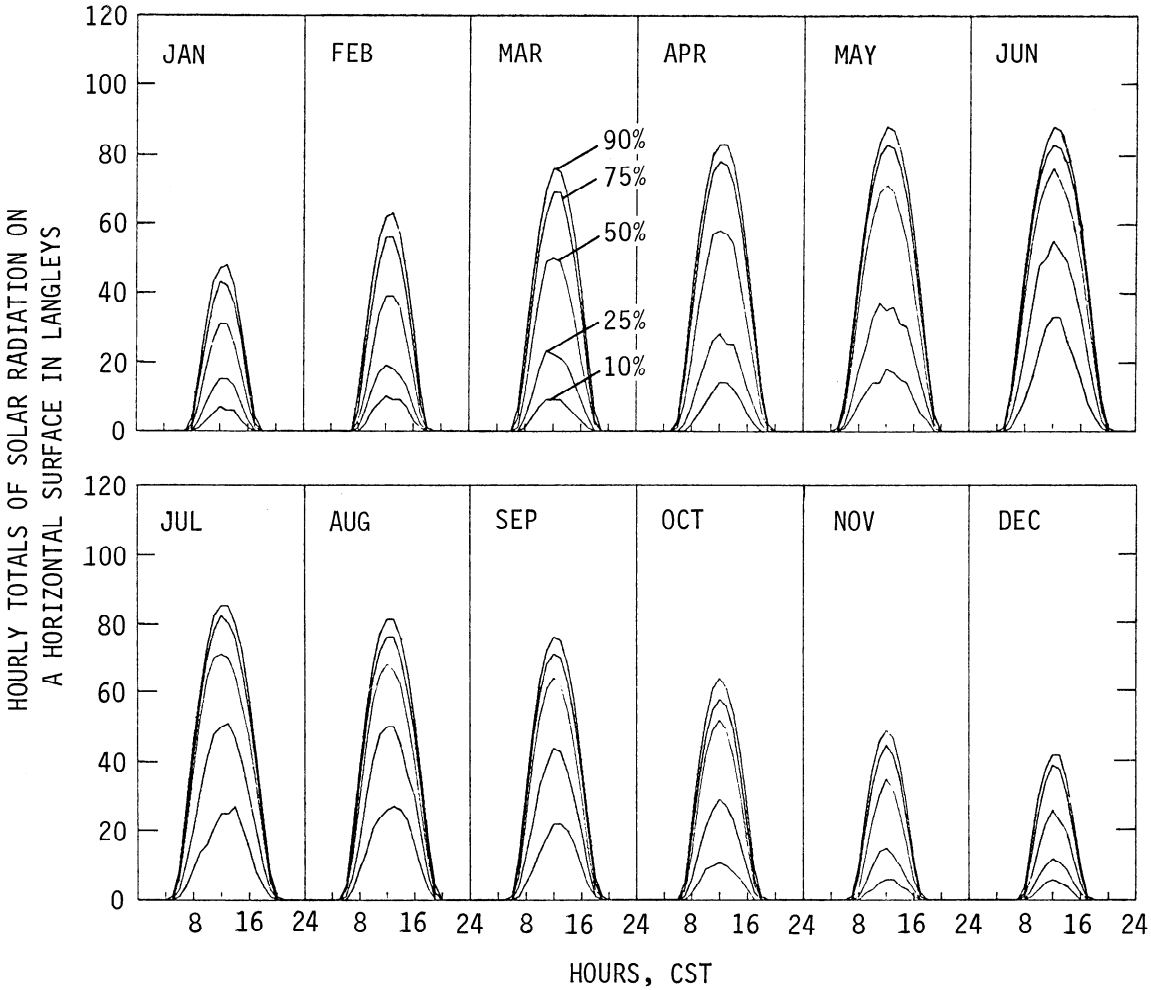

Figure 10. Percentile distribution of hourly amounts of solar radiation at Lemont, Illinois, September 1950-December 1964

stations at Peoria and Springfield offer support for the changing sky cover hypothesis. Figure 11 shows the decreasing number of cloudy days in winter, the lack of any systematic change in cloudy days in spring, and an increase in cloudy days in summer and fall. The important point here is that radiation values based on data of the type presented here may change by 10 to 20 percent as a result of changing atmospheric conditions.

The average monthly values at Lemont in northern Illinois appear in table 4. As expected, these are less than those found in central Illinois at Urbana (table 6). Figure 12 presents the monthly annual cycle of solar radiation at Lemont for the 1950-1964 period. Shown are the mean daily values (the dots), and the maximum and minimum daily totals of solar radiation.

Comparison of the mean values on figure 12 with those for Urbana on figure 4 provides interesting information. For example, both distributions show relative depressions, or reductions in incoming values in mid-May, as compared with early May. Another relative decrease exists in mid-July. These both are periods that have been shown by other research to frequently be periods of stormy and rainy weather, at least relative to other times of these months (Changnon, 1962). These radiation decreases are real climatological features known as singularities. Other such singularities appear in the average and record high curve shown on figures 4 and 12. Figure 13 presents the 10-, 25-, 50-, 75-, and 95-percentile values and the mean of the daily totals of solar radiation at Lemont. These curves help reveal the expected trends in radiation.

Net Radiation

The extensive collection of radiation data at Lemont included collection of net radiation data from 1956 through 1964 (Moses and Bogner, 1967). Net radiation represents the net flux of solar, sky, and terrestrial radiation near the surface and is shown in the data presented. The magnitude of the net radiation flux directed downward is a measure of the amount of heat available in an area to 1) heat the earth's surface and air in contact with the surface, 2) evaporate soil and surface moisture (such as dew), and 3) support photosynthesis. The magnitude of net radiation flux directed upward is a measure of the heat loss by the earth's surface. Thus, during the sunlit portion of a day, the net radiation is primarily positive, that is, the net amount of radiation is directed toward the earth. However, during the dark hours, the radiation flux typically is directed away from the earth and provides negative radiation values.

Table 7 presents the average of the daily totals of net radiation measured within the daylight hours and in the nocturnal hours. During the daylight hours, generally between 0400 and 2000 CST, the values are positive with the exception of a few in December and January (see January 1958, 1959, and 1962). Typically, the highest values of incoming net radiation occur in June and the lowest occur in December. In the dark hours of 2100 to 0300 CST, the mean values are negative indicating net outgoing radiation from the surface. The differences between the winter months is very small.

Table 8 shows the maximum daily totals of net radiation for the daytime and nighttime hours, as sampled during each month of each year. Table 9 presents the minimum daily totals found in each month and each year.

The average hourly net radiation values presented for each month are given in table 10. Examination of the monthly totals reveals the diurnal variation. The maximum average hourly value occurs at near noon in all seasons, and the minimum occurs generally just after sunset.

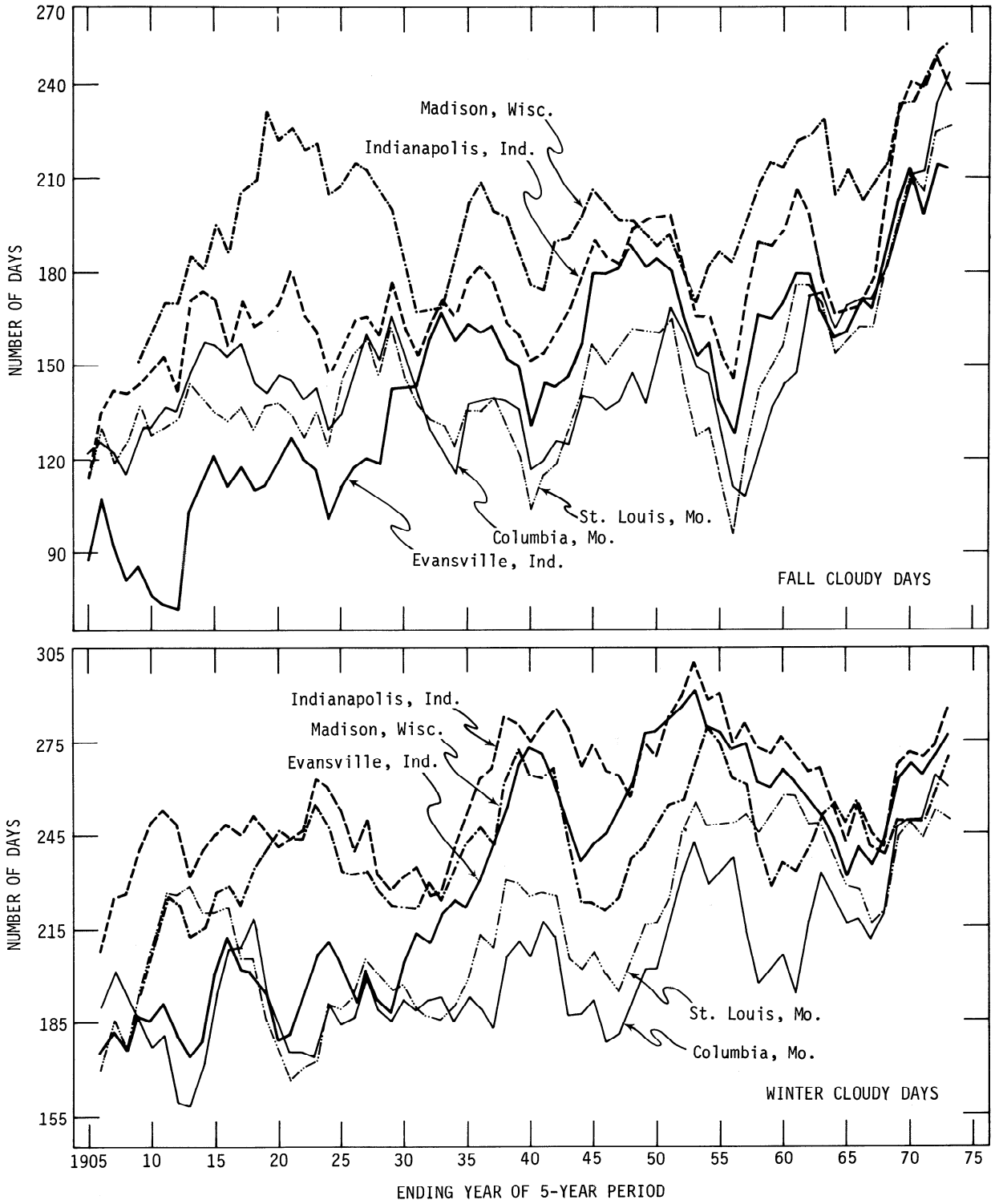

Figure 11. Number of cloudy days per season in 5 years

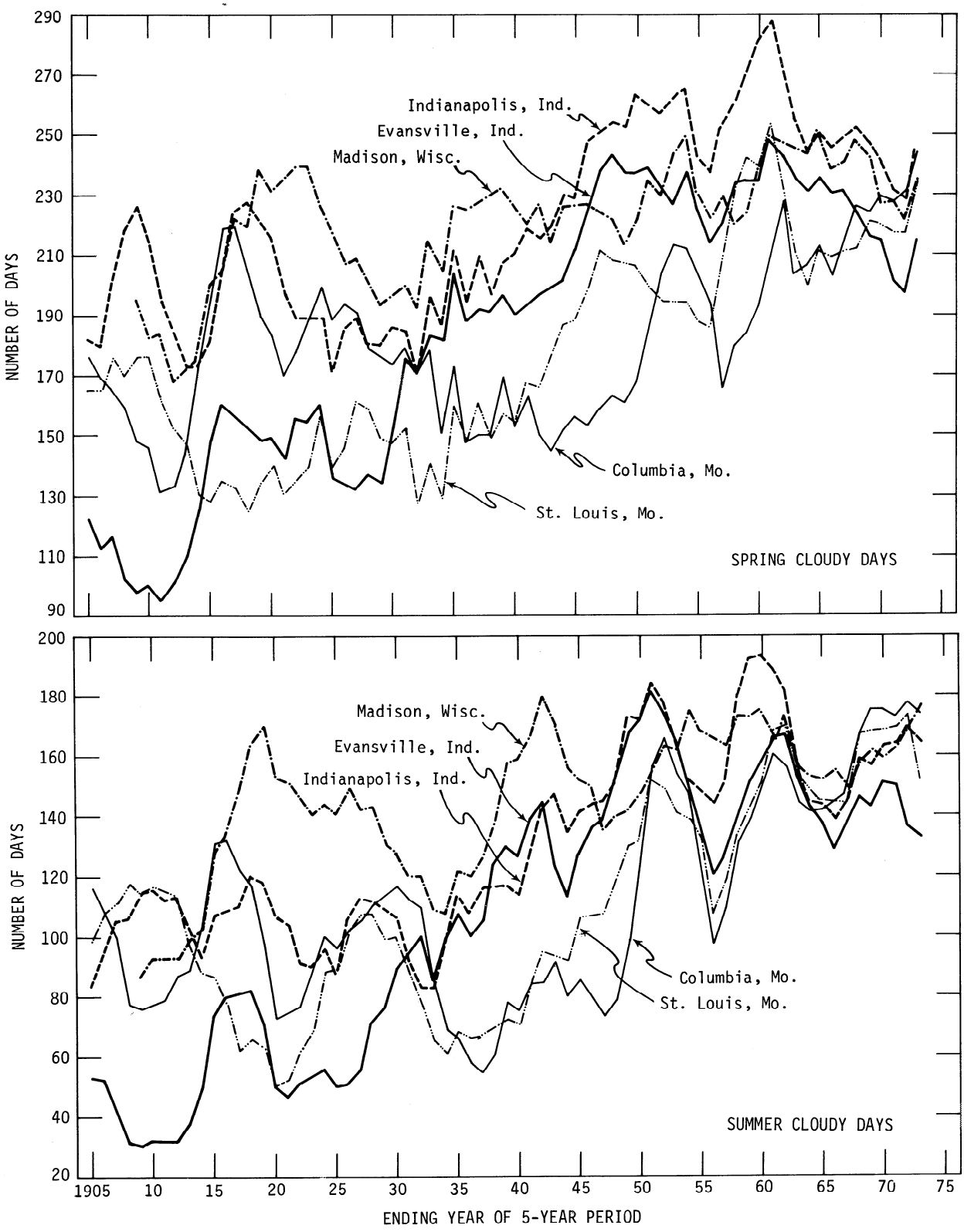

Figure 11. Concluded

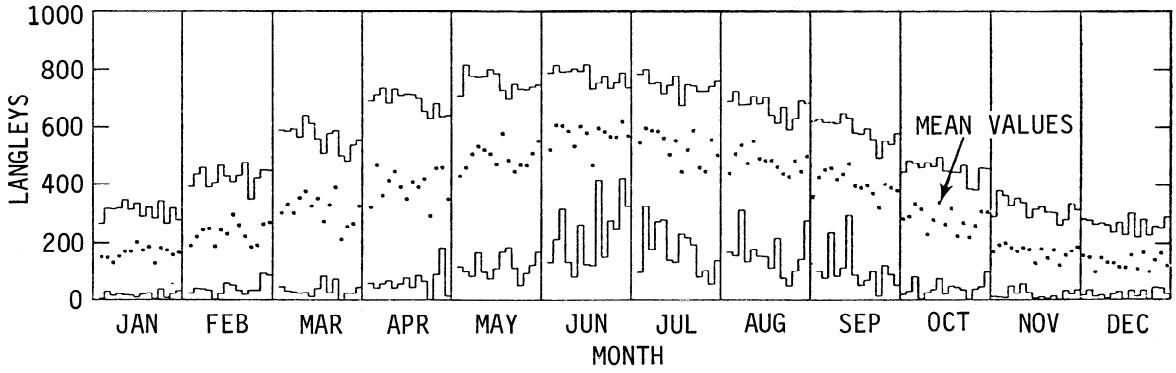

Figure 12. Monthly-annual cycle of solar radiation at Lemont, Illinois for 1950-1964

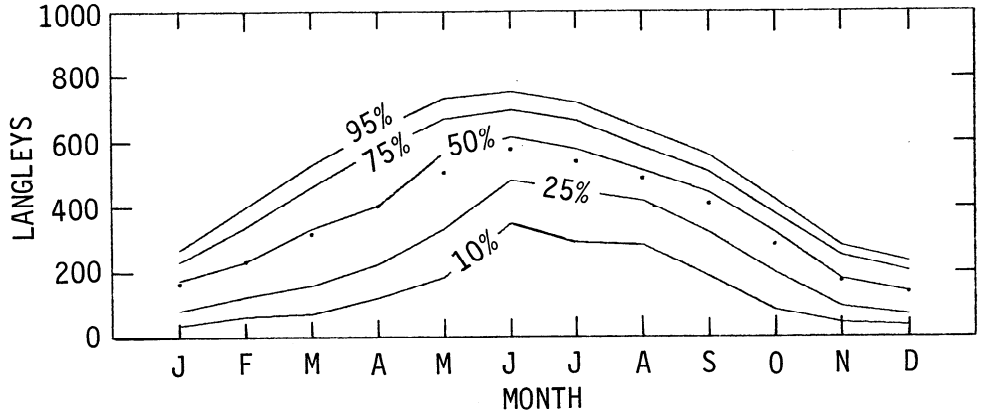

Figure 13. Mean daily totals (dots) and percentile values of solar radiation at Lemont, Illinois

SUNSHINE DATA AND INFORMATION

The first-order stations of the National Weather Service (previously U. S. Weather Bureau) have collected sunshine data with a recording device, generally since most stations in the Illinois area began operation at the turn of the century. The values of sunshine are typically expressed in two ways: 1) the actual time in hours or minutes and 2) the percentage of possible sunshine, that is, the percent of the time that the sun shone as a function of the time the sun could have shone.

Daily and monthly values of sunshine collected at eight first-order stations in and around Illinois are presented. Indianapolis is the only one of these stations with solar radiation data. The intent in providing the sunshine information is to offer relevant information on the time and space variations apt to occur in radiation values, particularly since the available radiation data for Lemont, Urbana, Indianapolis, and Columbia do not adequately describe the regional radiation differences, especially those existing between large urban areas and nearby rural areas. Urban areas are known to produce large quantities of atmospheric pollutants and to increase cloudiness and rainfall (Changnon et al., 1977). Hence, urban-rural differences in net radiation, sunshine, and incoming radiation can be expected. Results at St. Louis show that large urban areas receive 3 to 10 percent less sunshine per year than do the upwind rural areas, defined as those west of the cities.

Table 7. Mean Daily Totals of Net Radiation at Lemont, Illinois*

Year	*J*	*F*	*M*	*A*	*M*	*J*	*J*	*A*	*S*	*O*	*N*	*D*	*Annual*
Daylight hours, ~0400-2000 CST													
1957	4.1	77.5	158.6	235.8	309.7	386.2	358.7	336.2	224.7	123.6	37.0	3.6	202.5
1958	-0.2	35.7	154.3	301.7	386.5	418.3	375.7	346.9	248.8	151.1	46.3	7.0	182.6
1959	-2.7	56.3	167.7	329.3	351.0	448.9	450.6	313.4	234.2	126.4	37.4	16.1	199.5
1960	6.5	18.6	69.1	294.7	384.4	441.3	407.1	311.7	208.2	126.6	50.9	10.1	153.5
1961	24.0	73.6	168.7	279.3	363.7	431.1	386.4	332.3	243.8	146.6	57.9	8.3	189.4
1962	-2.6	57.0	146.5	306.8	351.9	400.3	368.6	330.0	240.8	129.8	49.7	21.2	195.2
1963	5.5	55.3	168.1	301.6	372.0	429.2	375.7	280.4	229.5	138.2	51.7	-25.5	195.7
1964	20.3	69.0	169.9	260.3	369.4	355.3	333.5	284.2	159.4	103.2	38.2	4.7	201.1
Night hours, ~2100-0300 CST													
1957	-19.7	-21.2	-27.5	-24.0	-26.4	-28.0	-21.4	-35.1	-34.6	-37.3	-26.8	-32.6	-27.9
1958	-21.7	-34.6	-28.5	-36.8	-41.2	-36.9	-26.0	-28.3	-33.5	-37.9	-33.1	-27.6	-31.7
1959	-23.5	-30.9	-33.9	-37.0	-28.4	-30.5	-35.6	-28.9	-32.4	-28.9	-28.7	-23.2	-29.8
1960	-24.4	-24.7	-29.6	-39.8	-30.0	-34.4	-34.5	-23.1	-19.2	-29.7	-27.3	-28.4	-28.2
1961	-28.7	-21.5	-35.0	-37.9	-36.9	-30.4	-27.5	-30.9	-33.6	-32.8	-26.9	-21.8	-29.8
1962	-21.7	-19.0	-24.1	-34.2	-25.1	-26.1	-26.1	-26.4	-33.4	-27.0	-29.4	-24.9	-26.5
1963	-20.6	-28.7	-29.7	-31.7	-29.3	-30.0	-29.8	-30.3	-29.4	-32.8	-30.4	-30.7	-29.5
1964	-37.5	-41.0	-31.8	-37.3	-32.2	-28.8	-26.7	-27.0	-29.8	-29.3	-25.2	-28.5	-29.9

**In Langleys, as measured on a horizontal surface for June 1956-December 1964*

Table 8. Maximum Daily Totals of Net Radiation at Lemont, Illinois*

Year	*J*	*F*	*M*	*A*	*M*	*J*	*J*	*A*	*S*	*O*	*N*	*D*	*Annual*
Daylight hours, ~0400-2000 CST													
1957	48.0	138.9	237.1	361.6	406.8	447.7	443.2	399.5	329.7	184.2	67.1	18.0	447.7
1958	69.9	197.7	256.6	397.6	441.0	487.9	490.2	443.5	325.5	204.9	86.6	68.1	490.2
1959	45.3	176.9	306.8	422.9	516.6	550.2	525.8	480.3	322.5	172.4	99.4	50.9	550.2
1960	78.1	75.3	231.5	384.7	474.1	510.0	495.0	404.9	324.6	220.8	114.0	48.8	510.0
1961	56.2	155.6	281.8	391.9	446.8	492.9	466.4	377.4	318.2	194.2	106.1	34.9	492.9
1962	33.4	135.8	273.2	396.5	456.4	501.0	477.0	414.9	316.3	185.8	84.8	66.5	501.0
1963	50.9	147.8	260.5	350.7	453.4	495.5	455.3	425.7	297.6	206.2	82.8	38.5	495.5
1964	57.2	168.7	236.6	333.2	435.4	451.8	430.0	430.4	294.0	230.3	97.9	42.4	451.8
Night hours, ~2100-0300 CST													
1957	0.0	4.2	-1.2	-4.5	0.0	-1.8	-2.4	-11.5	-13.1	-13.3	-8.6	-4.9	4.2
1958	2.4	-6.9	-8.3	-4.9	-19.7	-9.1	-4.8	-8.0	-18.3	-6.6	-3.0	-4.4	2.4
1959	9.0	-2.6	-3.2	-5.4	-7.3	-14.2	-20.7	-7.2	1.2	-6.1	-2.6	3.8	9.0
1960	-1.8	1.8	-7.9	-10.3	-4.9	-20.9	-17.6	-14.4	-1.8	-1.8	-0.6	0.0	1.8
1961	-1.2	-2.1	-1.2	-18.0	-13.7	-1.8	-10.3	-13.2	-6.3	-0.6	0.0	0.0	0.0
1962	3.5	0.0	1.4	-8.0	-6.8	-3.6	-1.8	-6.0	-11.8	-1.8	-7.0	2.8	3.5
1963	0.9	-1.3	-4.3	-7.3	-3.2	-12.0	-2.4	-3.6	-7.9	-6.7	-4.2	-4.4	0.9
1964	-12.2	-12.9	0.0	-3.6	-7.3	-8.4	-3.6	-6.6	0.0	-4.4	10.2	6.3	10.2

**In Langleys, as measured on a horizontal surface for June 1956-December 1964*

Table 9. Minimum Daily Totals of Net Radiation at Lemont, Illinois*

Year	*J*	*F*	*M*	*A*	*M*	*J*	*J*	*A*	*S*	*O*	*N*	*D*	*Annual*
Daylight hours,~0400-2000 CST													
1957	-40.2	12.9	79.3	86.2	56.4	302.6	213.2	215.3	112.8	51.5	10.9	-27.9	-40.2
1958	-59.6	-43.9	41.7	174.4	241.0	279.6	209.6	246.0	135.0	101.5	-3.0	-59.8	-59.8
1959	-63.8	-35.5	30.2	255.8	155.2	276.2	352.3	158.9	54.9	44.9	-39.3	-10.2	-63.8
1960	-41.3	-41.2	6.7	53.4	216.2	291.0	223.8	202.4	52.5	11.7	5.2	-70.1	-70.1
1961	-8.4	-30.9	67.7	115.6	130.6	342.5	287.3	173.2	104.7	39.0	9.6	-32.5	-32.5
1962	-39.0	8.2	13.5	130.8	182.6	145.2	119.0	216.1	75.5	67.6	14.1	-17.5	-39.0
1963	-56.4	-1.0	7.6	203.8	94.0	360.2	257.6	136.9	145.5	68.3	23.0	-83.1	-83.1
1964	-9.7	-17.9	38.1	95.7	144.0	176.7	179.0	145.4	47.1	6.1	-28.3	-61.2	-61.2
Night hours, ~2100-0300 CST													
1957	-42.7	-49.5	-51.3	-45.4	-47.6	-47.4	-40.4	-47.6	-49.5	-55.3	-56.7	-62.7	-52.7
1958	-51.4	-56.0	-56.2	-52.7	-55.2	-52.5	-40.2	-44.7	-53.3	-54.8	-56.0	-56.3	-56.3
1959	-57.3	-60.8	-63.7	-57.7	-46.5	-50.8	-50.6	-43.3	-73.3	-58.1	-53.2	-50.4	-73.3
1960	-55.7	-56.0	-55.5	-62.2	-52.1	-50.6	-47.0	-43.4	-39.8	-59.6	-62.6	-55.6	-62.6
1961	-52.5	-46.6	-63.3	-60.6	-58.0	-47.4	-50.0	-53.5	-58.1	-49.9	-52.7	-55.7	-63.3
1962	-53.1	-52.5	-49.1	-60.2	-40.9	-45.3	-50.4	-41.6	-56.6	-54.2	-50.3	-57.2	-60.2
1963	-45.2	-53.2	-56.5	-55.6	-51.9	-59.8	-52.6	-48.7	-52.5	-56.7	-62.3	-49.7	-62.3
1964	-62.0	-60.2	-61.7	-60.6	-54.7	-56.6	-53.7	-52.2	-60.6	-54.6	-63.1	-61.6	-63.1

**In Langleys, as measured on a horizontal surface for June 1956-December 1964*

Table 10. Average Hourly Net Radiation at Lemont, Illinois*

Hour	*J*	*F*	*M*	*A*	*M*	*J*	*J*	*A*	*S*	*O*	*N*	*D*
1	-3.4	-3.6	-3.9	-4.4	-4.5	-4.1	-3.8	-3.9	-3.9	-4.4	-4.1	-3.7
2	-3.4	-3.7	-4.0	-4.4	-4.4	-4.2	-3.8	-3.8	-3.9	-4.3	-4.1	-3.6
3	-3.5	-3.8	-4.1	-4.3	-4.4	-4.0	-3.8	-3.9	-3.9	-4.3	-4.2	-3.6
4	-3.4	-3.5	-4.0	-4.3	-4.4	-3.9	-3.8	-3.8	-3.8	-4.3	-3.9	-3.6
5	-3.4	-3.4	-4.0	-4.3	-4.0	-3.1	-3.2	-3.7	-3.7	-4.2	-4.6	-3.6
6	-3.5	-3.3	-3.9	-3.2	0.4	2.1	0.6	-1.7	-3.4	-4.2	-3.9	-3.4
7	-3.5	-3.1	-2.1	3.4	8.9	11.4	9.0	5.1	0-8	-2.3	-3.7	-3.5
8	-2.7	-1.2	3.8	13.0	18.9	22.2	19.5	14.9	10.3	4.1	-0.8	-2.6
9	0.0	3.6	11.9	23.9	30.4	33.2	29.3	26.6	20.3	12.5	4.9	0.8
10	3.8	8.8	19.6	33.5	39.6	42.9	39.3	35.6	29.1	20.8	11.1	5.0
11	7.1	13.1	25.4	40.0	44.2	49.4	44.7	42.1	34.7	25.7	15.1	8.3
12	9.0	15.8	27.9	41.8	48.0	51.6	46.3	44.4	37.5	27.7	16.6	10.2
13	9.1	16.1	28.0	40.2	46.2	49.7	46.8	43.2	36.0	25.6	15.0	9.3
14	7.0	14.2	23.9	36.5	41.9	45.5	43.0	39.6	30.9	20.7	11.0	6.5
15	3.4	9.6	18.0	28.6	34.9	38.2	36.1	32.4	23.9	13.0	5.3	2.4
16	-0.6	3.8	10.5	18.3	24.4	28.2	27.0	22.8	14.5	4.4	-0.7	-1.9
17	-3.3	-1.5	2.6	8.2	13.5	17.4	16.9	12.6	4.8	-2.4	-4.0	-3.9
18	-3.9	-4.0	-2.9	-0.2	3.8	7.1	7.0	3.0	-2.2	-4.7	-4.1	-3.9
19	-3.8	-4.1	-4.3	-4.6	-2.9	-0.9	-0.8	-2.9	-4.2	-4.5	-4.1	-3.6
20	-3.6	-3.9	-4.4	-5.0	-4.9	-4.2	-3.9	-4.1	-4.2	-4.5	-3.9	-3.7
21	-3.5	-3.8	-4.1	-4.7	-4.6	-4.3	-4.0	-4.0	-4.1	-4.5	-4.0	-3.8
22	-3.5	-3.8	-4.1	-4.7	-4.5	-4.4	-3.9	-4.0	-4.1	-4.5	-3.9	-3.7
23	-3.5	-3.8	-4.1	-4.6	-4.5	-4.2	-3.9	-3.9	-4.2	-4.6	-3.9	-3.6
24	-3.3	-3.9	-4.0	-4.5	-4.5	-4.1	-3.9	-3.9	-4.0	-4.5	-4.0	-3.6

**In Langleys, as measured on a horizontal surface for June 1956-December 1964*

Tables 11 presents three types of daily average or mean sunshine values. Column 1 for each station presents the daily average minutes of sunshine as compiled on a weekly basis. It should be recognized that week 1 represents 1-7 March, week 2 represents 8-14 March, etc. [The actual weeks can be determined by looking at those in table 1.]

The second column for each station shows the average percent of sunshine per day. For example, at Chicago, during the first week of March, the average duration of sunshine is 300 minutes per day (5 hours), and this represents 44 percent of the time that sunshine could have occurred during days of that week.

Table 12 presents probability distribution of possible daily sunshine for seven first-order stations. The table shows the chance of having at least the indicated percentage of possible daily sunshine in 10 percent increments. For example, at Chicago during week 1 or 1-7 March, there is a 10 percent chance of at least 68 percent possible sunshine on any given day. Conversely, there is a 90 percent or greater chance that possible sunshine will be 19 percent or more.

Monthly values of sunshine data are presented in table 13. The table is based on the monthly values of hours of sunshine at each station for each month in the 1967 through 1976 period. Also shown are the average monthly values and the maximum and minimum of monthly values sampled during this 10-year period. It is important to note the great difference between the maximum and minimum values, which is often more than double during the colder months of the year. These data allow one to determine prolonged periods of relatively low amounts of sunshine. One such period is the winter of December 1974 through February 1975.

Figure 14 presents in graphical form the annual values for percent of sunshine at five first-order stations. These data, basically from the 1901-1976 period, are presented to show the trends in sunshine, as smoothed by 5-year moving averages. Of considerable importance is the gradual decrease in sunshine frequency which in recent years is as low or lower than it has been during any other time in the 20th Century. Figure 15 presents seasonal graphs for three first-order stations to display the decrease.

SKY COVER AND CLOUD DATA

The mean daily values of sky cover, expressed in percentage of cloud cover, and calculated for each week, appear in table 11. For example, in table 11 one finds that in week 1 (l-7 March) the average percentage of cloud cover per day is 71 percent at Indianapolis, 67 percent at Evansville, 66 percent at St. Louis, and 64 percent at Cairo. These are mean daily values based on cloud cover for sunrise to sunset. Data for eight first-order stations appear in table 11.

The average monthly frequency of clear skies (sky cover of 0 to 0.3 or 0 to 30 percent), partly cloudy (0.4 to 0.7 sky cover), and cloudy days (0.8 to 1.0 sky cover) are shown in table 14. The table presents values of clear, partly cloudy, and cloudy days for each month and year. For example, the Chicago data show that in January the average number of clear days is 6, partly cloudy conditions occur on 7 days, and cloudy conditions on 18 days. A shift to more clear days occurs in the summer and fall months, a condition true for all stations in the Illinois area.

Further indications of the temporal shift in solar radiation and sunshine, are presented in figure 11 and 16. These data present the seasonal trends of cloudy days at several first-order stations, and the annual trends of cloudy days and clear days at selected first-order stations. The close agreement of these curves with those shown for percent of possible sunshine (figures 14 and 15) reveals that most decreases in sunshine in the last 20 years have occurred because of an increase

Table 11. Sunshine and Cloud Data for First-Order Stations in and near Illinois

Week No.	Chicago			Moline			Peoria			Springfield		
	Sunshine		Cloud	Sunshine		Cloud	Sunshine		Cloud	Sunshine		Cloud
	Minutes	Percent	Percent	Minutes	Percent	Percent	Minutes	Percent	Percent	Minutes	Percent	Percent
1	300	44	76	329	48	72	312	46	72	355	52	66
2	281	40	79	276	39	79	272	39	79	321	46	70
3	389	54	68	394	55	67	377	52	68	387	53	66
4	401	54	72	397	54	71	385	52	71	401	54	65
5	406	53	72	346	45	75	359	47	75	381	50	72
6	378	48	71	371	48	69	403	52	67	456	59	64
7	480	60	63	474	59	65	470	59	67	447	56	64
8	449	55	68	446	55	66	446	55	69	472	58	67
9	502	60	63	493	59	61	478	57	65	492	59	64
10	571	67	63	504	59	64	513	61	63	560	66	58
11	566	65	60	462	53	63	469	54	65	504	59	67
12	565	64	60	497	56	63	534	61	62	551	63	60
13	625	70	61	556	62	62	577	65	63	584	67	61
14	605	67	64	540	60	70	565	63	72	602	68	64
15	559	62	65	503	56	70	545	60	65	550	61	65
16	646	71	52	627	69	56	626	69	55	656	73	52
17	659	72	51	669	73	54	675	75	53	673	75	58
18	622	67	53	613	67	58	596	66	57	647	72	56
19	630	70	53	639	71	50	607	68	49	677	76	49
20	568	63	60	564	63	64	544	61	66	614	70	59
21	617	70	49	661	75	45	629	72	48	643	74	50
22	546	63	60	585	67	59	558	65	59	680	79	50
23	532	62	59	539	63	58	527	62	56	606	72	57
24	531	63	57	610	73	53	619	74	50	638	77	50
25	547	67	52	565	69	56	530	65	56	594	73	50
26	508	63	57	542	67	53	563	70	51	628	79	42
27	508	65	55	562	72	50	547	70	48	609	78	43
28	498	65	51	531	69	48	518	68	46	600	79	41
29	426	57	58	441	58	58	464	62	49	566	76	42
30	308	42	70	389	53	66	383	53	61	508	70	51
31	523	74	42	480	68	43	513	72	38	557	78	35
32	403	59	53	423	61	52	454	66	48	486	70	43
33	465	69	40	482	72	40	507	75	38	488	72	38
34	313	48	64	365	56	59	367	56	57	435	66	48
35	303	48	63	329	52	58	371	58	54	376	59	55
36	263	43	66	282	46	66	279	45	65	345	55	56
37	293	49	59	323	54	56	329	54	54	391	64	52
38	162	28	80	212	36	75	238	41	71	283	48	64
39	262	46	65	311	54	60	342	58	58	284	49	64
40	252	45	69	263	47	67	285	50	64	269	47	63
41	201	36	70	254	46	66	228	41	67	237	42	69
42	274	50	61	269	49	59	294	53	59	252	45	66
43	189	34	75	267	48	67	230	41	71	231	41	70
44	224	40	68	245	44	70	221	40	69	250	44	67
45	252	45	65	324	57	60	299	53	61	278	49	62
46	280	49	66	303	53	62	284	50	66	250	43	70
47	254	44	67	298	51	65	285	49	66	241	41	72
48	262	44	71	313	53	64	288	48	65	261	44	69
49	262	43	72	304	50	68	280	46	72	254	41	71
50	239	38	70	271	43	69	265	42	72	283	45	72
51	323	50	61	362	56	56	380	59	57	366	57	60
52	220	33	74	282	43	68	284	43	68	346	52	62
53	366	54	53	414	62	51	389	59	48	361	53	53
ANNUAL	412	55	63	425	57	62	425	57	61	453	60	59

(Continued on next page)

Table 11. Concluded

Week No.	Indianapolis			Evansville			St. Louis			Cairo		
	Sunshine		Cloud	Sunshine		Cloud	Sunshine		Cloud	Sunshine		Cloud
	Minutes	Percent	Percent	Minutes	Percent	Percent	Minutes	Percent	Percent	Minutes	Percent	Percent
1	370	54	71	356	52	67	357	52	66	392	57	64
2	342	49	76	314	44	75	316	45	75	348	49	70
3	419	58	68	429	60	62	417	58	65	458	63	56
4	404	55	71	415	56	62	431	59	62	444	60	59
5	434	57	72	434	57	68	391	52	71	448	59	66
6	444	57	72	469	61	65	474	61	59	467	60	61
7	486	61	67	494	62	65	484	61	63	514	65	57
8	471	58	69	489	61	66	456	57	65	528	66	66
9	507	62	66	501	61	62	463	56	63	474	58	61
10	559	66	61	588	70	59	529	63	66	537	64	64
11	473	55	71	482	57	69	512	60	60	508	60	63
12	569	65	63	550	64	62	566	65	60	591	69	61
13	573	65	65	609	70	61	515	59	63	560	64	62
14	582	65	64	608	69	59	529	60	62	580	66	59
15	560	62	69	589	67	64	587	66	60	649	74	58
16	661	74	57	684	77	51	652	73	51	673	76	48
17	688	77	54	674	76	50	730	82	47	699	79	45
18	660	74	56	666	75	55	619	71	57	659	75	55
19	646	73	54	686	78	49	633	73	54	701	80	54
20	599	66	64	600	69	63	547	63	59	661	76	60
21	635	73	55	651	75	57	550	68	53	650	76	59
22	654	76	56	699	82	45	551	70	49	641	76	53
23	595	70	61	656	78	52	547	69	51	661	79	50
24	620	75	54	645	78	51	531	68	52	630	77	50
25	581	71	56	629	78	48	509	67	54	621	77	54
26	611	77	46	632	80	45	533	71	49	623	79	48
27	573	73	51	592	76	44	491	68	47	602	78	45
28	606	79	44	588	77	41	536	72	41	579	76	44
29	541	72	49	556	75	45	454	62	49	543	73	49
30	504	69	54	528	73	48	430	54	50	545	81	47
31	529	75	41	525	74	41	447	65	45	476	68	50
32	477	69	47	529	76	40	454	69	41	515	74	43
33	473	70	42	524	77	37	458	71	40	516	76	38
34	411	63	52	492	75	40	443	68	43	499	75	41
35	364	56	60	361	56	55	408	63	49	391	61	51
36	368	59	61	363	57	55	360	57	58	358	57	55
37	367	60	58	382	62	51	392	64	48	396	64	49
38	273	46	66	279	46	65	310	52	61	317	55	61
39	246	42	72	256	43	68	306	52	63	293	49	68
40	267	46	70	304	52	63	316	53	59	388	67	50
41	234	41	77	225	39	71	228	40	74	293	46	67
42	272	48	68	239	42	67	276	49	64	296	51	62
43	232	41	74	205	36	72	254	45	69	270	47	66
44	254	45	71	222	39	71	283	50	67	253	44	70
45	251	44	69	252	44	68	292	51	62	293	50	61
46	254	44	71	273	47	68	293	50	66	285	48	67
47	253	43	78	245	41	73	301	51	68	300	30	63
48	288	48	70	252	41	71	278	46	66	360	42	69
49	288	46	73	268	43	70	327	53	64	320	51	63
50	299	48	75	277	44	70	316	50	66	333	52	63
51	331	51	69	329	50	65	345	53	60	384	57	58
52	362	54	67	342	51	64	359	54	60	406	60	61
53	365	54	70	239	35	78	294	43	69	246	36	62
ANNUAL	451	60	63	461	61	59	438	60	58	477	64	57

Table 12. Chance of Having at Least the Indicated Percent of Possible Daily Sunshine, for First-Order Stations in and near Illinois

	Chicago										Moline								
Week	*10*	*20*	*30*	*40*	*50*	*60*	*70*	*80*	*90*	*Week*	*10*	*20*	*30*	*40*	*50*	*60*	*70*	*80*	*90*
1	68	64	58	49	47	41	34	27	19	1	69	64	59	54	51	47	36	31	27
2	68	62	59	46	40	35	24	16	6	2	70	62	54	48	38	32	25	17	8
3	81	76	70	65	57	46	40	32	22	3	87	75	75	67	57	51	38	37	21
4	79	75	68	67	59	54	44	32	19	4	75	73	70	67	60	54	43	30	19
5	85	78	72	64	57	49	39	28	15	5	76	72	69	58	48	34	24	16	12
6	84	73	63	57	47	41	33	23	19	6	71	66	61	54	53	40	37	29	19
7	90	86	76	71	63	59	50	36	17	7	86	81	73	67	63	59	54	43	23
8	86	80	73	63	56	49	39	33	26	8	81	77	69	61	60	53	43	30	23
9	82	79	73	66	64	58	54	40	33	9	84	75	70	66	63	57	48	40	33
10	92	90	84	75	71	67	57	49	33	10	89	84	78	73	63	57	46	32	19
11	87	85	81	76	71	65	55	45	37	11	74	74	71	61	58	50	44	35	24
12	84	81	78	76	71	62	54	48	33	12	87	81	78	68	59	52	43	27	17
13	95	94	90	84	79	71	56	44	27	13	95	90	81	73	65	56	41	40	30
14	96	94	85	81	74	63	57	38	28	14	93	90	82	74	62	54	47	35	13
15	93	87	86	76	64	56	43	34	21	15	93	83	73	63	57	47	41	29	20
16	97	96	89	86	80	71	59	49	29	16	99	94	89	80	73	64	59	46	34
17	99	96	94	89	79	70	57	50	36	17	97	96	96	93	86	71	60	50	34
18	94	91	83	74	67	64	56	47	30	18	98	94	88	77	70	59	53	48	33
19	93	92	84	79	75	68	59	52	40	19	94	90	89	86	79	68	62	56	32
20	95	92	87	79	67	62	48	35	21	20	95	92	90	84	71	60	44	33	14
21	97	95	90	83	76	65	60	51	32	21	95	94	94	90	84	75	70	56	40
22	90	84	83	79	68	65	51	37	21	22	92	92	92	86	75	63	54	38	25
23	94	83	81	75	70	56	51	35	30	23	92	90	84	76	70	60	48	38	25
24	98	95	87	74	63	53	48	35	27	24	97	95	90	85	81	74	69	48	35
25	97	94	87	83	75	65	51	41	25	25	98	94	84	83	75	70	59	48	29
26	94	89	84	79	70	62	52	41	22	26	94	92	90	84	79	65	57	38	22
27	89	87	84	78	71	67	56	33	25	27	95	92	87	86	81	70	63	51	38
28	90	89	82	79	74	65	53	40	24	28	90	89	82	77	76	71	60	48	45
29	83	79	68	65	59	56	48	35	27	29	86	79	76	71	62	52	38	33	30
30	75	60	52	51	40	35	30	24	11	30	83	75	71	67	59	51	38	25	17
31	94	94	86	83	78	75	68	57	44	31	83	81	79	76	75	73	68	52	44
32	86	78	73	60	59	52	46	44	37	32	76	75	70	68	67	63	54	48	40
33	89	81	79	76	75	71	65	59	44	33	94	89	84	83	78	70	65	57	43
34	73	70	60	59	54	41	37	29	21	34	86	85	81	62	57	49	40	33	24
35	65	63	56	51	49	46	38	35	27	35	75	70	67	59	49	44	38	37	29
36	65	56	53	47	39	34	34	31	26	36	71	65	56	53	48	42	34	27	18
37	67	67	65	56	51	46	38	33	27	37	73	68	67	65	60	54	44	40	24
38	52	45	39	32	27	19	16	10	6	38	61	52	44	44	37	32	26	19	15
39	71	65	54	52	48	44	38	30	16	39	83	79	78	63	56	49	40	32	17
40	65	62	59	51	46	40	37	24	17	40	78	70	60	51	46	43	33	22	16
41	59	49	41	40	38	30	27	21	17	41	65	62	59	52	43	38	38	35	27
42	68	62	62	59	56	48	38	35	29	42	70	63	59	56	52	46	44	33	24
43	52	44	40	35	33	30	27	24	16	43	71	68	60	56	51	46	40	30	22
44	68	54	51	46	41	35	32	22	14	44	67	63	59	56	48	43	37	29	13
45	71	64	59	30	42	38	32	30	26	45	76	71	68	65	62	58	52	41	32
46	73	69	63	60	54	47	37	24	23	46	73	73	71	66	61	56	44	34	17
47	60	57	56	49	46	44	43	30	17	47	76	70	63	57	51	50	46	37	26
48	76	69	60	48	42	36	30	24	21	48	75	70	67	66	58	54	46	31	19
49	70	61	53	49	46	39	33	26	16	49	79	70	65	60	51	44	35	32	23
50	55	53	49	44	42	33	27	25	20	50	64	60	55	49	44	38	35	29	25
51	73	64	61	59	55	46	41	32	27	51	77	75	66	55	52	52	46	46	39
52	57	52	41	34	30	27	23	18	16	52	66	61	54	48	43	36	36	29	16
53	70	60	60	60	60	60	50	50	30	53	80	80	80	70	60	60	60	50	30

(Continued on next page)

Table 12. Continued

	Peoria										*Springfield*								
Week	*10*	*20*	*30*	*40*	*50*	*60*	*70*	*80*	*90*	*Week*	*10*	*20*	*30*	*40*	*50*	*60*	*70*	*80*	*90*
1	76	63	61	51	44	37	34	27	24	1	73	66	66	62	59	51	39	30	22
2	62	56	51	44	40	37	29	17	11	2	74	62	56	53	51	43	33	27	16
3	76	67	63	60	52	49	43	37	27	3	79	74	68	64	59	46	38	31	24
4	76	73	70	65	57	48	40	30	22	4	83	74	71	63	57	50	41	33	22
5	76	70	67	57	52	42	34	22	13	5	78	72	68	57	52	47	38	27	17
6	79	73	70	60	56	41	40	33	23	6	86	80	73	68	60	54	49	40	24
7	81	76	74	69	67	59	53	41	24	7	82	78	69	65	61	54	44	35	26
8	84	74	71	67	59	51	39	31	26	8	86	79	75	71	66	54	42	36	25
9	82	75	72	66	57	49	46	40	36	9	83	76	72	66	60	58	48	41	36
10	84	78	75	71	70	59	48	43	25	10	89	86	80	77	72	64	58	49	36
11	79	68	63	60	56	52	45	42	32	11	85	76	73	70	64	56	48	38	29
12	87	84	73	67	63	60	49	43	30	12	89	86	82	78	65	58	50	43	32
13	95	94	87	76	70	60	49	41	27	13	97	90	88	84	76	63	50	38	28
14	94	93	84	76	63	53	47	40	25	14	95	92	89	81	72	64	53	43	34
15	91	89	84	76	64	57	40	30	23	15	95	87	81	75	63	54	45	32	24
16	97	91	89	77	70	66	60	50	37	16	98	95	93	90	80	72	64	49	32
17	97	96	89	89	83	71	67	56	43	17	99	97	92	87	84	76	65	50	37
18	97	92	86	79	67	65	53	41	30	18	97	95	91	87	83	75	57	50	36
19	92	86	83	76	75	67	56	49	41	19	98	96	93	88	83	77	66	57	44
20	95	94	89	83	68	54	44	29	16	20	97	96	94	80	75	68	57	45	29
21	94	92	86	83	78	71	68	56	43	21	97	94	89	82	80	73	69	59	41
22	95	90	90	79	73	62	48	35	21	22	98	98	97	92	89	81	70	62	45
23	94	89	83	73	62	51	48	37	29	23	96	96	93	89	80	69	57	46	31
24	98	97	95	89	81	69	61	53	42	24	97	96	92	91	81	74	69	60	46
25	94	92	81	76	68	62	49	46	33	25	95	94	86	83	79	72	68	56	42
26	95	94	94	92	81	65	56	40	29	26	98	97	94	88	86	73	74	63	51
27	96	89	86	76	73	65	65	52	43	27	93	89	87	84	84	83	78	62	51
28	89	82	82	76	69	68	58	50	44	28	98	96	92	91	87	78	73	63	47
29	86	78	71	68	67	60	51	49	35	29	95	93	89	88	80	74	68	60	49
30	78	71	65	62	60	51	41	33	17	30	95	90	89	82	74	65	58	52	38
31	86	84	81	81	75	73	67	62	56	31	94	93	87	86	83	80	73	65	57
32	87	78	75	73	70	68	62	52	41	32	84	84	83	79	71	68	65	52	50
33	94	89	86	83	76	73	71	63	56	33	92	89	86	81	78	74	66	59	46
34	78	73	70	62	56	54	44	38	32	34	84	81	77	70	69	65	62	51	44
35	79	71	67	63	60	57	51	41	40	35	82	77	71	67	59	61	49	44	38
36	69	65	53	52	45	40	31	29	29	36	79	73	70	64	58	55	49	32	26
37	75	70	67	60	54	49	48	40	33	37	81	78	76	75	72	65	59	49	37
38	63	53	50	47	40	40	34	27	19	38	67	59	56	54	51	46	40	35	26
39	83	70	68	63	60	56	51	44	35	39	67	62	58	52	50	47	45	34	24
40	71	70	65	59	52	41	37	32	27	40	69	61	59	52	50	43	37	30	25
41	62	52	49	44	40	37	35	32	17	41	61	54	50	49	45	40	32	27	22
42	75	68	63	63	52	46	41	41	35	42	65	61	55	51	47	39	35	31	22
43	60	52	51	46	44	37	32	32	22	43	56	53	50	45	45	39	37	30	22
44	59	54	49	48	40	38	32	25	19	44	63	57	54	51	44	42	36	30	27
45	71	67	64	62	53	48	44	39	33	45	72	66	62	58	51	43	36	30	24
46	69	63	61	56	51	47	44	34	23	46	62	56	53	50	46	42	36	30	24
47	66	64	61	53	50	47	43	39	30	47	61	54	51	47	41	37	35	27	19
48	67	63	60	55	49	45	40	36	22	48	69	61	51	47	44	39	32	29	21
49	68	63	58	61	47	44	33	26	23	49	67	59	53	45	38	34	31	26	20
50	69	55	51	49	44	36	31	25	20	50	65	64	57	51	46	41	37	27	22
51	80	70	68	66	63	57	52	43	38	51	78	74	68	63	57	53	50	42	35
52	68	57	52	50	41	34	32	27	23	52	74	69	65	61	58	50	44	35	24
53	80	70	70	60	60	60	60	50	40	53	72	72	67	67	56	50	44	39	33

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Table 12. Continued

St. Louis

Week	*10*	*20*	*30*	*40*	*50*	*60*	*70*	*80*	*90*
1	75	68	65	59	52	48	44	36	25
2	69	64	57	55	49	42	36	27	13
3	81	76	73	69	64	58	49	35	26
4	83	80	73	68	64	58	49	38	24
5	75	70	66	61	56	51	41	29	23
6	87	76	75	71	68	59	49	40	33
7	92	89	78	71	62	53	47	38	24
8	87	81	75	72	63	51	43	36	19
9	85	79	68	64	56	50	42	33	32
10	95	89	81	75	68	56	48	40	30
11	83	77	70	67	66	59	53	42	33
12	91	86	83	79	70	61	56	44	33
13	94	86	76	67	56	51	43	37	26
14	91	83	78	71	66	57	45	36	21
15	96	89	82	79	71	63	52	41	30
16	96	94	89	83	78	72	65	56	43
17	98	96	95	95	86	80	77	70	55
18	100	94	91	88	80	74	63	42	31
19	95	91	86	82	75	68	63	57	50
20	94	83	76	75	69	61	51	42	32
21	96	93	87	79	73	64	57	43	32
22	97	95	89	83	76	69	63	45	29
23	96	95	92	88	81	63	56	43	27
24	94	89	84	78	72	68	54	52	35
25	93	91	84	81	78	66	56	41	28
26	100	98	91	82	73	63	58	44	38
27	91	88	86	78	72	66	59	45	36
28	93	90	89	85	82	71	62	56	41
29	91	82	77	73	67	58	47	40	33
30	86	82	78	73	70	61	56	47	34
31	83	78	74	72	69	64	59	53	39
32	87	83	77	74	72	69	64	56	47
33	89	86	83	82	75	71	61	55	43
34	87	80	75	72	69	64	58	56	52
35	79	77	73	68	64	61	59	53	41
36	83	78	73	70	59	54	43	36	27
37	79	79	76	71	66	62	57	50	44
38	70	65	60	59	54	52	48	40	30
39	75	68	63	37	34	49	39	37	26
40	74	69	66	63	33	52	45	40	29
41	70	55	51	45	42	38	25	17	13
42	76	67	62	53	45	42	38	33	22
43	71	60	56	47	44	42	36	31	18
44	71	64	63	54	52	46	43	36	25
45	74	69	61	56	50	45	40	39	31
46	74	70	62	59	32	48	43	33	26
47	75	71	63	58	58	49	37	29	20
48	66	63	52	48	44	40	39	32	29
49	71	70	70	61	57	51	43	33	24
50	70	68	65	61	30	47	36	30	26
51	77	70	61	55	51	49	47	36	32
52	74	72	70	62	57	49	42	34	32
53	58	58	58	50	50	42	42	25	17

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Table 12. Concluded

	Cairo										Evansville									
Week	*10*	*20*	*30*	*40*	*50*	*60*	*70*	*80*	*90*	*Week*	*10*	*20*	*30*	*40*	*50*	*60*	*70*	*80*	*90*
1	82	76	73	66	60	51	44	38	30	1	75	70	62	55	50	46	43	37	28
2	70	66	60	58	53	45	42	34	18	2	72	64	61	50	43	36	32	26	20
3	81	80	76	72	68	66	56	46	33	3	80	79	75	73	64	56	47	39	30
4	81	77	69	67	65	62	51	45	35	4	76	69	67	64	58	54	52	42	28
5	86	84	77	73	65	58	44	34	20	5	83	75	70	68	63	55	48	38	26
6	81	79	76	71	67	57	48	43	28	6	86	84	79	74	69	54	45	39	26
7	88	87	84	83	72	66	53	42	29	7	88	82	76	72	67	60	55	43	31
8	92	89	87	81	72	64	49	40	31	8	91	83	78	72	65	57	49	39	23
9	85	79	72	65	63	57	44	36	28	9	82	79	77	69	64	59	47	42	33
10	92	87	83	78	67	57	52	44	29	10	93	90	85	80	76	72	61	54	37
11	92	84	78	72	64	53	42	36	28	11	86	79	73	65	62	52	42	35	25
12	94	93	89	84	77	67	53	41	29	12	92	84	78	75	69	62	55	45	31
13	93	90	84	74	69	63	51	40	26	13	96	94	90	84	77	67	60	45	33
14	95	93	84	79	74	67	55	38	21	14	95	91	85	82	75	68	60	47	35
15	98	96	96	88	82	73	64	52	32	15	96	92	87	80	71	60	53	39	31
16	94	93	93	89	81	76	69	57	46	16	99	99	97	95	84	77	66	60	41
17	98	95	95	93	89	86	75	61	48	17	98	97	96	89	83	75	67	54	42
18	97	95	94	91	86	78	68	51	35	18	98	98	95	91	88	78	66	50	34
19	100	100	100	92	88	83	70	58	46	19	99	95	91	89	85	78	69	62	47
20	99	99	97	96	88	78	68	50	31	20	95	93	89	85	76	69	56	43	27
21	100	97	96	92	84	79	65	53	33	21	100	99	94	88	86	79	66	50	36
22	99	95	91	89	85	76	67	53	40	22	100	100	97	94	89	86	77	64	53
23	99	99	98	93	87	81	67	57	44	23	99	98	95	92	87	79	69	56	44
24	96	94	92	89	87	76	67	65	44	24	98	97	96	95	85	77	71	58	46
25	100	96	94	91	84	84	67	56	38	25	98	96	93	91	84	78	69	59	48
26	97	94	94	89	85	80	73	64	47	26	97	96	93	92	87	83	74	62	49
27	98	97	95	90	83	79	65	58	44	27	96	93	89	86	80	73	67	61	50
28	94	93	90	84	80	76	70	61	49	28	94	92	89	86	82	76	70	67	52
29	94	93	92	86	78	73	64	51	41	29	96	90	88	86	80	75	66	56	49
30	93	90	86	84	80	74	67	63	48	30	92	90	87	81	76	70	64	58	48
31	89	84	80	79	74	68	58	51	39	31	93	85	82	81	76	71	68	63	34
32	93	93	90	86	81	74	64	53	44	32	92	90	87	84	80	77	71	65	51
33	92	91	89	83	79	73	70	66	52	33	90	90	89	87	83	77	70	65	55
34	91	86	85	78	76	75	71	65	58	34	90	88	84	80	77	73	70	63	55
35	84	78	71	64	63	58	49	47	39	35	75	67	63	62	58	55	50	41	36
36	86	80	70	61	60	53	46	34	27	36	77	74	71	66	63	57	51	39	30
37	80	76	72	71	66	63	60	51	41	37	80	75	70	67	63	59	55	48	42
38	74	72	67	59	52	49	46	37	26	38	63	61	56	51	47	44	36	32	27
39	74	67	64	58	50	44	38	32	23	39	63	60	54	52	41	38	29	25	22
40	87	82	82	81	68	65	58	52	35	40	73	70	64	57	52	50	43	38	26
41	72	68	60	55	49	38	38	28	19	41	61	54	50	46	42	35	27	20	15
42	67	64	62	58	56	53	47	38	29	42	61	56	47	44	42	40	30	28	25
43	67	58	56	53	45	40	40	35	25	43	53	49	44	38	37	35	27	21	20
44	64	55	54	50	45	43	41	30	18	44	62	58	51	47	39	32	26	22	16
45	65	61	58	56	53	50	40	37	29	45	65	58	53	50	42	40	36	29	21
46	67	61	56	56	51	43	38	34	26	46	63	60	56	53	47	41	36	32	28
47	75	66	59	54	51	47	37	32	25	47	62	57	53	46	42	36	32	27	18
48	61	58	55	48	44	35	31	29	21	48	58	52	52	48	44	40	33	26	21
49	69	64	64	61	59	50	40	33	24	49	66	59	53	47	44	40	33	27	20
50	72	62	59	57	55	54	47	36	30	50	66	61	54	52	48	42	31	26	16
51	78	76	70	64	61	57	50	46	31	51	73	66	61	54	50	43	42	36	30
52	79	75	74	70	66	58	53	41	32	52	73	66	62	57	51	48	44	33	26
53	58	50	42	42	42	33	25	17	8	53	56	44	44	44	39	28	22	17	17

Table 13. Hours of Sunshine at Selected Stations

Year	*J*	*F*	*M*	*A*	*M*	*J*	*J*	*A*	*S*	*O*	*N*	*D*	*Annual*
Chicago-Midway Airport													
1967	147	137	141	159	269	280	303	271	253	157	95	104	2316
1968	117	200	237	215	243	257	309	294	224	200	74	68	2439
1969	88	128	242	234	235	219	268	313	218	159	118	59	2283
1970	131	151	175	207	268	279	290	314	205	169	70	97	2356
1971	163	89	181	271	301	334	286	312	221	245	161	96	2661
1972	162	148	210	216	317	365	379	314	224	161	62	82	2640
1973	138	148	178	175	205	321	308	308	240	206	107	73	2406
1974	125	145	184	219	229	289	337	281	244	203	109	64	2427
1975	93	120	217	229	303	320	390	269	225	264	123	55	2608
1976	146	169	215	292	305	317	331	310	257	176	176	163	2857
Average	131.0	143.5	198.0	221.7	267.5	298.1	320.1	298.6	231.1	194.0	109.5	86.1	2499.3
Maximum	163	200	242	292	317	365	390	314	257	264	176	163	2857
Minimum	88	89	141	159	205	219	268	269	205	157	62	55	2283
Moline													
1967	136	156	138	178	249	236	294	282	223	185	123	86	2285
1968	136	220	253	223	215	296	348	308	225	215	107	112	2657
1969	104	151	241	216	267	258	269	326	220	172	143	119	2486
1970	161	197	199	226	278	299	321	283	207	171	130	149	2622
1971	183	140	181	302	257	288	322	334	278	211	122	71	2688
1972	159	164	182	157	286	327	274	272	211	144	60	107	2341
1973	141	158	147	194	238	329	290	273	165	192	110	115	2353
1974	144	169	190	225	207	305	364	245	248	214	123	111	2545
1975	149	124	203	224	205	211	315	253	183	264	114	61	2306
1976	186	196	203	251	294	355	363	265	238	201	210	208	2970
Average	149.9	167.5	193.7	219.6	249.6	290.4	316.0	284.1	229.8	196.9	124.2	113.9	2525.3
Maximum	186	220	253	302	294	355	364	334	278	264	210	208	2970
Minimum	104	124	138	157	205	211	269	245	165	144	60	61	2285
Peoria													
1967	143	153	175	219	256	252	292	285	241	173	122	80	2389
1968	142	210	238	243	197	301	331	304	228	224	89	90	2596
1969	101	133	230	203	233	227	276	320	221	169	139	112	2364
1970	177	206	198	242	304	301	359	302	198	175	100	120	2682
1971	163	141	237	322	302	376	341	298	241	219	126	65	2832
1972	156	169	210	205	331	341	229	246	153	124	52	84	2299
1973	140	150	137	139	187	261	226	224	172	188	111	101	2037
1974	127	170	150	191	108	237	299	195	213	189	101	69	2048
1975	86	106	232	185	254	308	366	262	215	257	114	111	2494
1976	176	206	194	249	256	312	325	272	242	194	231	194	2851
Average	141.1	164.4	200.1	219.8	242.8	291.6	304.4	270.8	212.4	191.2	118.5	102.6	2459.2
Maximum	177	210	238	322	331	376	366	320	242	257	231	194	2851
Minimum	86	106	137	139	108	227	226	195	153	124	52	65	2037
Springfield													
1967	205	162	184	216	253	282	310	334	253	182	142	87	2610
1968	153	205	221	241	234	331	314	301	247	245	90	111	2692
1969	104	132	241	249	283	285	317	321	271	199	154	92	2647
1970	175	176	178	237	300	254	342	269	229	162	136	167	2625
1971	172	149	211	279	278	360	318	327	262	225	156	74	2810
1972	170	161	204	195	300	339	294	269	198	141	60	114	2444
1973	173	169	175	222	247	340	323	277	206	231	125	94	2582
1974	116	162	204	220	172	273	371	247	255	200	137	106	2463
1975	135	96	187	195	324	301	340	235	204	262	130	99	2507
1976	158	192	197	253	291	320	335	292	266	205	220	190	2919
Average	156.1	164.4	200.2	230.7	268.2	308.5	326.4	287.2	239.1	205.2	135.0	113.4	2629.9
Maximum	205	205	241	279	324	360	371	334	271	262	220	190	2919
Minimum	104	96	175	195	172	254	294	235	198	141	60	74	2444

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Table 13. Concluded

Year	*J*	*F*	*M*	*A*	*M*	*J*	*J*	*A*	*S*	*O*	*N*	*D*	*Annual*
Evansville													
1967	162	158	203	243	277	255	288	291	233	194	146	114	2565
1968	133	204	223	232	240	350	318	309	261	238	106	118	2731
1969	114	122	225	214	287	301	300	338	288	199	138	114	2640
1970	124	126	136	204	334	294	324	283	278	184	100	147	2533
1971	135	134	221	295	272	349	357	319	238	245	180	107	2853
1972	161	166	232	197	317	384	306	305	188	173	70	98	2595
1973	114	154	173	145	248	314	337	341	214	228	129	69	2465
1974	95	167	225	242	226	313	378	293	187	259	140	88	2613
1975	126	109	176	278	322	352	386	270	191	220	146	88	2663
1976	165	203	284	322	294	284	352	318	253	193	196	194	3058
Average	132.9	154.3	209.8	237.2	281.7	319.6	334.6	306.7	233.1	213.3	135.1	113.7	2671.6
Maximum	165	204	284	322	334	384	386	341	288	259	196	194	3058
Minimum	95	109	136	145	226	255	288	270	187	173	70	69	2465
Indianapolis													
1967	101	156	159	205	231	245	252	310	236	143	100	82	2220
1968	118	206	195	260	216	319	280	303	239	193	54	58	2441
1969	72	105	204	188	214	224	273	328	226	200	101	55	2189
1970	141	157	141	223	291	286	261	249	215	153	51	128	2297
1971	162	134	184	301	301	339	318	318	216	207	123	56	2657
1972	169	163	211	214	318	280	283	246	165	139	71	88	2347
1973	121	132	144	113	174	279	273	241	197	191	96	88	2048
1974	103	153	198	224	219	288	340	252	212	197	105e	93	2384
1975	115	120	192	225	301	287	318	255	193	227	153	91	2476
1976	132	184	216	287	271	276	317	309	240	189	200	174	2793
Average	123.4	151.0	184.4	224.0	253.6	282.3	291.5	281.1	213.9	183.9	105.4	91.3	23.85
Maximum	169	206	216	301	318	339	340	328	240	227	200	174	2793
Minimum	72	105	141	188	214	224	252	241	165	139	54	55	2048
Cairo													
1967	172	174	216	245	264	261	292	300	224	205	148	120	2617
1968	115	172	228	259	259	339	322	319	277	229	84	144	2774
1969	101	101	243	246	294	296	323	323	254	188	159	122	2650
1970	138	133	147	215	326	295	305	260	241	175	128	130	2492
1971	107	149	228	298	265	287	279	278	224	196	176	93	2581
1972	126	175	220	244	293	335	298	296	164	154	84	94	2483
1973	128	172	172	189	288	321	293	349	190	231	144	79	2556
1974	65	165	166	255	250	328	351	275	201	257	124	97	2534
1975	138	100	189	268	318	326	347	278	195	229	148	90	2624
1976	173	174	224	296	278	298	344	346	264	206	199	198	2999
Average	126.3	151.5	203.3	251.5	283.5	308.6	315.4	302.4	223.4	207.0	139.1	116.4	2631.0
Maximum	173	175	243	298	326	339	351	349	277	257	199	198	2999
Minimum	65	100	147	189	250	261	279	260	164	154	84	79	2483

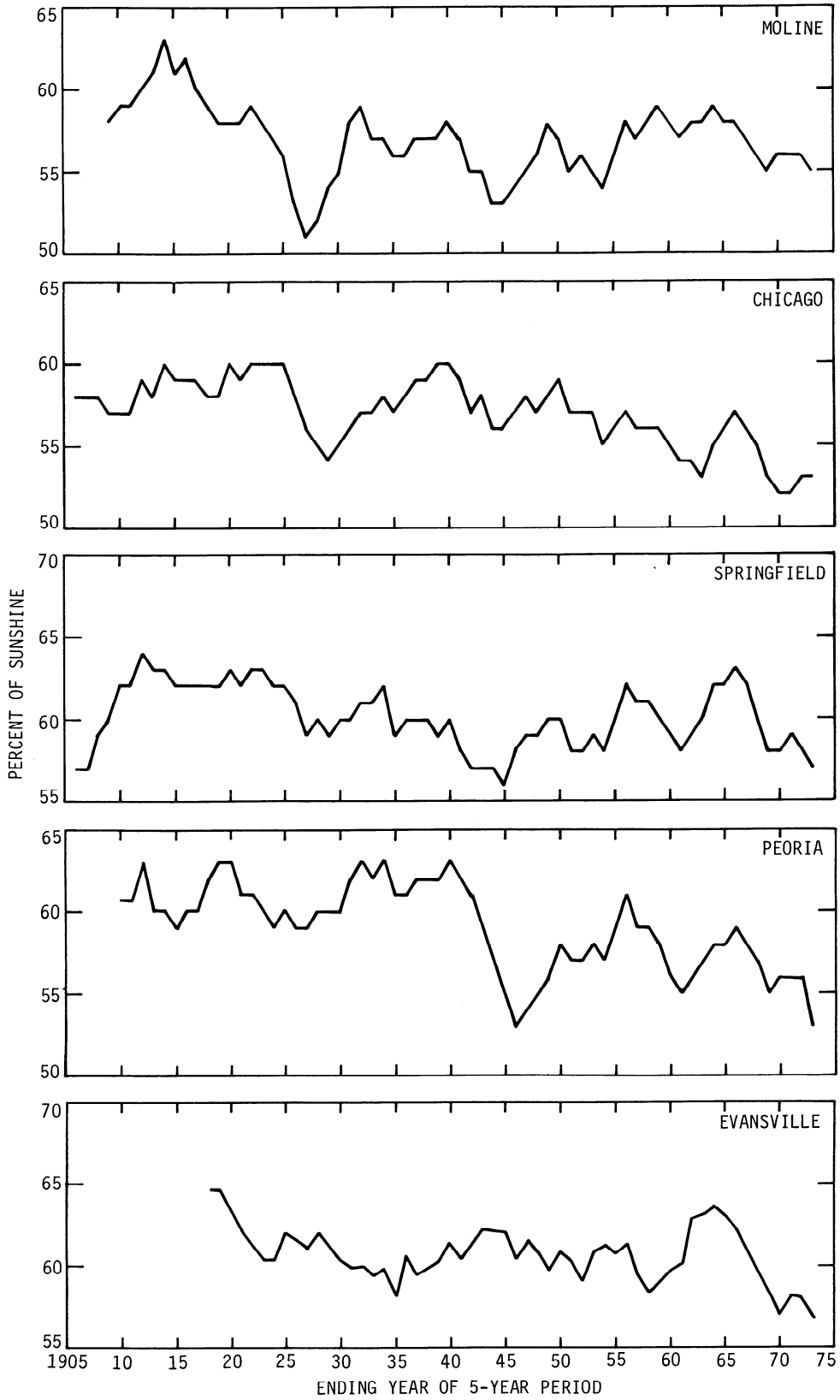

Figure 14. Annual values for percent of sunshine at five first-order stations

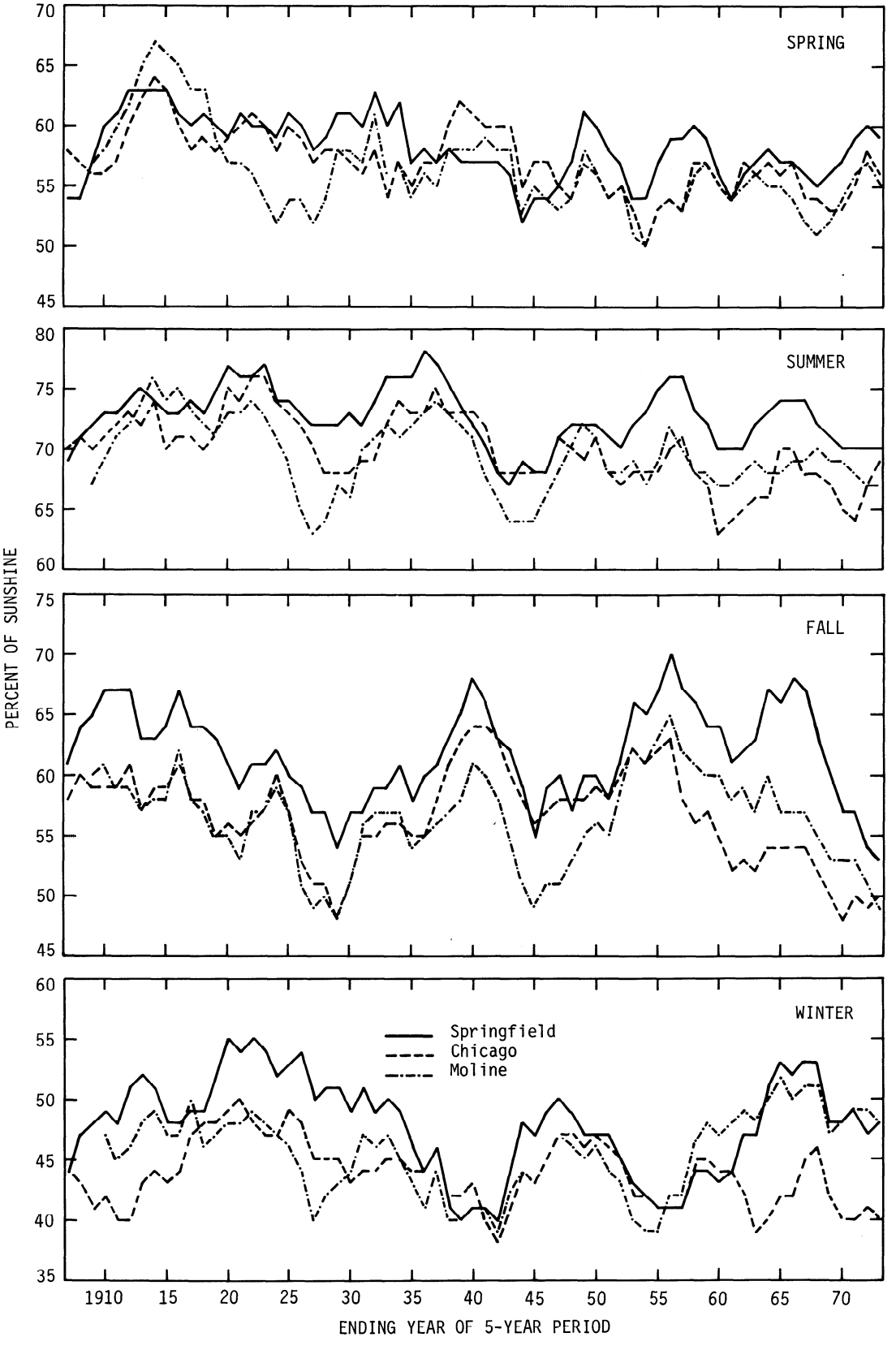

Figure 15. Seasonal trends in sunshine for three first-order stations

Table 14. Normals, Means, and Extremes at Selected Stations

Month	Mean no. of days with: Clear	Partly cloudy	Cloudy	Temperature (°F): Daily max	Daily min	Monthly	Mean no. of days with: Max temp >90°	Max temp <32°	Min temp <32°	Min temp <0°	Relative humidity (percent) for given hour (CST): 00	06	12	18	Wind: Mean hourly speed (mph)	Prevailing direction
Chicago—Midway Airport																
J	6	7	18	33.0	19.0	26.0	0	14	26	3	70	73	64	68	11.3	W
F	7	5	16	34.7	20.6	27.7	0	12	27	2	70	71	60	65	11.4	W
M	5	9	17	43.5	29.0	36.3	0	6	27	0	69	76	64	65	11.7	W
A	6	8	16	57.4	40.5	49.0	0	0	4	0	70	76	62	61	11.6	W
M	7	10	14	69.1	50.9	60.0	2	0	0	0	65	69	52	51	10.2	SSW
J	7	11	12	79.5	61.5	70.5	8	0	0	0	67	74	51	53	9.0	SW
J	10	12	9	84.1	67.1	75.6	8	0	0	0	73	78	57	57	7.9	SW
A	10	12	9	82.4	65.9	74.2	4	0	0	0	74	82	58	60	7.7	SW
S	10	10	10	74.8	57.4	66.1	3	0	0	0	75	81	59	65	8.7	S
O	12	8	11	63.4	46.7	55.1	0	0	4	0	70	78	49	57	9.5	S
N	6	7	17	47.1	32.6	39.9	0	3	14	0	68	75	60	66	11.4	SSW
D	7	6	18	35.7	22.5	29.1	0	10	24	0	76	79	72	75	11.1	W
YR	93	105	167	58.7	42.8	50.8	23	44	123	5	70	76	59	62	10.1	W
Rockford																
J	7	7	17	30.2	13.7	22.0	0	15	29	5	79	79	68	74	9.4	WNW
F	7	6	15	32.7	16.1	24.4	0	14	28	3	76	76	61	69	10.1	WNW
M	6	9	16	42.9	25.1	34.0	0	8	29	0	81	81	66	70	11.3	ENE
A	7	8	15	58.7	36.9	47.8	0	0	7	0	79	83	62	64	11.6	WNW
M	8	9	14	70.5	47.7	59.1	0	0	0	0	76	82	56	56	10.8	ENE
J	7	11	12	80.9	58.4	69.7	4	0	0	0	76	81	53	55	9.1	SSW
J	9	13	9	86.3	62.1	74.2	4	0	0	0	82	85	57	57	7.9	SSW
A	8	12	11	84.2	60.8	72.5	3	0	0	0	86	90	60	64	7.8	SSW
S	10	10	10	75.6	52.0	63.8	1	0	0	0	86	88	63	69	8.7	SSW
O	12	8	11	64.1	40.9	52.5	0	0	8	0	76	82	52	61	8.9	SSW
N	7	7	16	46.1	28.0	37.1	0	3	17	0	80	83	66	74	10.2	WNW
D	7	6	18	33.5	17.7	25.6	0	14	26	2	83	83	74	80	10.0	WNW
YR	95	106	164	58.8	38.3	48.6	12	53	143	10	80	83	61	66	9.6	WNW
Moline																
J	8	7	16	31.6	13.6	22.6	0	18	29	10	73	75	65	69	10.4	WNW
F	7	6	15	34.8	16.6	25.7	0	12	27	3	74	76	65	68	10.8	WNW
M	7	8	16	45.1	25.6	35.4	0	5	23	*	77	80	65	66	12.1	WNW
A	6	9	15	61.7	38.3	50.0	0	0	8	0	75	82	56	56	12.2	NE
M	7	9	15	73.1	49.2	61.2	2	0	*	0	76	82	54	53	10.5	E
J	7	10	13	83.2	59.5	71.4	8	0	0	0	78	82	51	52	9.0	S
J	10	12	9	88.0	63.2	75.6	6	0	0	0	85	87	58	60	7.4	E
A	10	11	10	85.7	61.4	73.6	5	0	0	0	85	89	57	61	7.0	E
S	12	8	10	78.1	52.5	65.3	2	0	*	0	84	87	60	70	8.1	S
O	13	7	11	67.1	42.4	54.8	*	0	5	0	78	84	53	63	8.8	S
N	8	7	15	48.9	29.5	39.2	0	1	17	0	78	82	62	71	10.9	WNW
D	7	6	18	35.4	18.3	26.9	0	15	27	6	77	78	70	74	10.5	WNW
YR	102	100	163	61.1	39.2	50.1	23	51	136	20	78	82	60	64	9.8	WNW

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Table 14. Concluded

Month	Mean no. of days with: Clear	Partly Cloudy	Cloudy	Temperature (° F): Daily max	Daily min.	Monthly	Mean no. of days with: Max temp > 90°	Max temp < 32°	Min temp. < 32°	Min temp. < 0°	Relative humidity (percent) for given hour (CST): 00	06	12	18	Wind: Mean hourly speed (mph	Prevailing direction
Burlington, Iowa																
J	8	7	16	32.7	16.1	24.4	0	14	29	5	78	81	69	74	11.2	NW
F	7	6	15	36.5	19.1	27.8	0	10	25	3	79	81	69	73	11.6	NW
M	6	8	17	46.9	27.6	37.3	0	3	20	*	78	82	63	66	12.5	NW
A	7	8	15	61.4	40.2	50.8	*	*	6	0	74	79	55	57	12.3	NW
M	7	10	14	72.5	51.1	61.8	1	0	*	0	77	81	57	58	10.6	SSW
J	7	11	12	82.7	61.5	72.1	7	0	0	0	81	83	59	60	9.3	S
J	10	13	8	87.6	65.6	76.6	12	0	0	0	83	85	57	60	8.0	S
A	11	11	9	85.2	63.9	74.6	9	0	0	0	83	88	58	63	8.0	S
S	12	8	10	77.3	54.6	66.0	4	0	*	0	80	88	55	64	9.1	S
O	13	8	10	66.6	44.1	55.4	*	*	4	0	75	83	52	63	9.5	S
N	8	7	15	48.8	29.9	39.4	0	2	17	*	77	81	61	69	11.5	NW
D	8	6	17	36.5	20.3	28.4	0	11	27	3	79	81	69	75	11.1	WNW
YR	104	103	158	61.2	41.2	51.2	33	41	128	11	79	83	60	65	10.4	S
Peoria																
J	7	6	18	33.7	17.6	25.7	0	18	29	7	76	78	69	71	11.2	S
F	7	5	16	36.6	20.1	28.4	0	11	27	3	80	81	68	73	11.7	WNW
M	7	8	16	46.7	28.4	37.6	0	7	23	1	81	81	69	71	12.5	WNW
A	6	8	16	61.2	40.3	50.8	0	0	7	0	74	80	59	57	12.5	S
M	7	10	14	72.3	50.7	61.5	*	0	1	0	76	82	59	58	10.7	S
J	7	11	12	82.3	61.1	71.7	6	0	0	0	76	82	56	56	9.2	S
J	9	13	9	87.0	65.0	76.0	5	0	0	0	84	88	60	61	8.2	S
A	11	10	10	85.1	63.5	74.3	5	0	0	0	81	87	59	61	8.1	S
S	13	8	9	77.8	55.0	66.4	3	0	0	0	83	89	61	65	9.0	S
O	13	8	10	66.5	44.1	55.3	*	0	4	0	78	86	57	61	9.6	S
N	8	7	15	48.6	30.7	39.7	0	1	16	0	80	85	66	69	11.6	S
D	7	6	18	36.6	21.3	29.1	0	17	27	4	80	82	71	74	11.0	S
YR	102	100	163	61.2	41.5	51.4	19	54	134	14	79	84	63	65	10.4	S
Springfield																
J	7	6	18	36.3	20.5	28.4	0	14	28	6	75	77	67	71	13.2	NW
F	8	5	15	40.6	22.5	31.6	0	9	26	2	78	80	68	71	13.3	NW
M	7	7	17	50.1	30.3	40.2	0	3	20	*	79	82	67	68	14.5	NW
A	7	8	15	64.8	41.9	53.4	0	0	6	0	71	77	55	54	14.1	S
M	8	9	14	75.6	52.2	63.9	2	0	*	0	73	79	52	53	12.1	SSW
J	8	10	12	85.4	62.5	74.0	9	0	0	0	75	80	52	54	10.0	SSW
J	9	11	11	89.6	66.4	78.0	7	0	0	0	81	85	60	61	8.6	SSW
A	12	10	9	86.8	63.5	75.2	6	0	0	0	82	87	59	63	8.0	SSW
S	14	7	9	80.3	54.9	67.6	3	0	0	0	79	85	53	61	9.5	SSW
O	14	7	10	69.1	44.3	56.7	1	0	3	0	73	81	49	58	10.6	S
N	10	6	14	51.6	32.0	41.8	0	1	14	*	76	80	61	66	13.7	S
D	8	6	17	40.2	23.8	32.0	0	13	26	3	75	78	67	71	13.1	S
YR	112	92	161	64.2	42.9	53.6	28	40	123	11	76	81	59	63	11.7	S

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Table 14. Concluded

Month	Mean no. of days with: Clear	Partly Cloudy	Cloudy	Temperature (° F): Daily max	Daily min.	Monthly	Mean no. of days with: Max temp. > 90°	< 32°	Min temp. < 32°	< 0°	Relative humidity (percent) for given hour (CST): 00	06	12	18	Wind: Mean hourly speed (mph)	Prevailing direction
St. Louis																
J	7	6	18	40. 2	25.5	31.9	0	11	27	5	71	77	60	65	10.2	NW
F	7	6	15	44.0	25.3	34.7	0	6	24	*	70	74	56	60	10.7	NW
M	6	9	16	52.8	32.4	42.6	0	2	15	0	69	76	57	57	11.9	WNW
A	6	9	15	65.9	43.8	54.9	*	0	3	0	64	71	50	49	11.6	WNW
M	7	10	14	75.1	53.3	64.2	2	0	*	0	70	77	54	52	9.7	S
J	7	12	11	85.1	63.1	74.1	6	0	0	0	76	81	56	55	8.3	S
J	9	11	11	89. 2	66.9	78.1	10	0	0	0	78	85	60	57	7.5	S
A	11	11	9	87. 3	66.3	76.8	11	0	0	0	77	85	54	55	7.1	S
S	13	8	9	81. 3	57.6	69.5	5	0	0	0	78	87	55	59	7.8	S
O	14	8	9	70.1	46.6	58.4	1	0	2	0	70	78	48	53	8.1	S
N	10	7	13	53.7	34.5	44.1	0	1	12	0	73	81	57	63	9.9	S
D	8	6	17	43.0	26.5	34.8	0	9	25	2	74	78	65	67	10.2	WNW
YR	105	103	157	65	45.0	55.5	54	28	107	5	75	79	56	58	9.	S
Evansville																
J	7	5	19	42.7	25.6	54.2	0	9	26	4	77	80	66	70	9.7	SSW
F	7	6	15	46.7	28.4	57.6	0	4	25	1	75	78	62	62	10.0	NW
M	7	8	16	55.3	55.2	45.5	0	1	16	0	74	80	65	65	10.7	WNW
A	6	9	15	68.6	46.8	57.7	0	0	2	0	71	73	53	54	10.3	SSW
M	8	9	14	78.4	55.1	66.8	4	0	1	0	79	85	55	56	8.3	SSW
J	8	11	11	87.0	64.6	75.8	10	0	0	0	83	84	55	59	7.5	SW
J	8	13	10	90.3	67.2	78.8	14	0	0	0	87	88	57	59	6.5	SW
A	11	12	8	89.0	65.6	77. 5	15	0	0	0	84	87	53	56	6.1	SW
S	12	8	10	82.9	57.2	70.1	4	0	0	0	88	90	58	67	6.9	SSW
O	14	8	9	72.2	46.0	59.1	1	0	6	0	80	8 3	48	59	7.1	NW
N	9	7	14	55.1	34.4	44.8	0	1	13	0	75	79	57	66	8.9	NW
D	7	6	18	44.6	27.5	36.1	0	7	25	2	76	77	63	69	9.0	NW
YR	104	102	159	67.7	46.1	57.0	48	22	110	7	79	82	57	61	8.4	SSW
Cairo																
J	7	7	17	44.6	50.2	57.4	0	5	20	*		80	67		9.8	SW
F	8	6	14	48.5	52.9	40.7	0	2	14	*		79	64		9.8	NE
M	8	8	15	57.0	59.4	48.2	0	1	8	0		78	59		10.6	SW
A	7	9	14	68.9	49.9	59.4	0	0	*	0		77	54		10.2	SW
M	7	10	14	78.5	59.4	69.0	5	0	0	0		82	57		8.2	SW
J	8	11	11	87.5	68.2	77.9	12	0	0	0		85	57		7.4	SW
J	8	15	10	90.3	71.8	81.1	17	0	0	0		84	59		6.5	SW
A	11	12	8	89.2	70.6	79.9	16	0	0	0		87	59		6.2	NE
S	12	9	9	82.4	62.5	72.5	5	0	0	0		87	57		7.0	NE
0	15	7	9	71.9	51.9	61.9	*	0	*	0		85	53		7.3	S
N	10	7	15	56.3	59.5	47.9	0	*	7	0		80	58		9.1	S
D	9	6	16	46.4	32.6	39.5	0	3	17	*		79	66		9.3	S
YR	110	105	150	68.5	50.7	59.6	53	12	65	*		82	59		8.5	SW

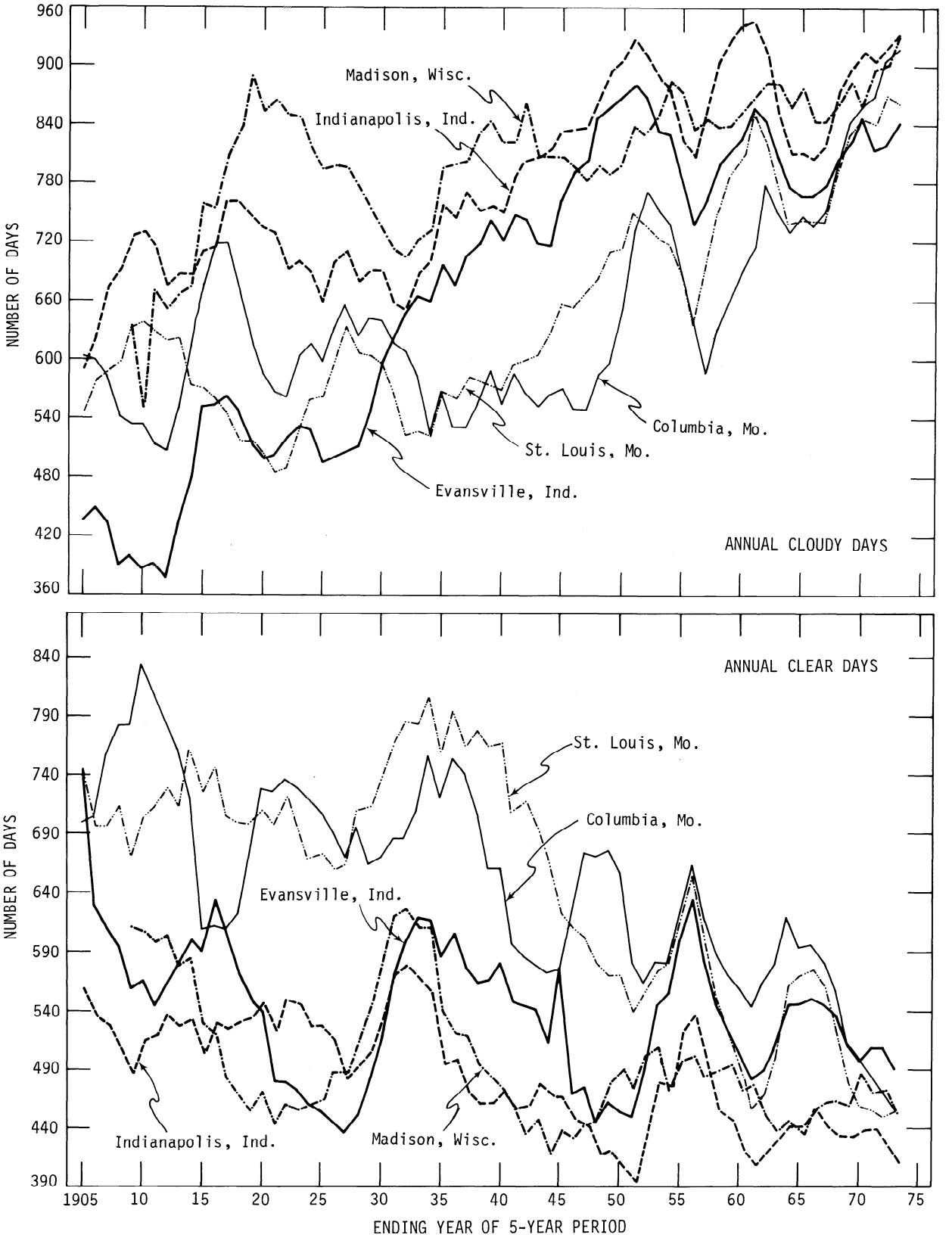


Figure 16. Annual trends of cloudy and clear days at selected first order stations for 5-year periods

in cloudy conditions in the Illinois area. Record numbers of cloudy days have been occurring, principally in the summer and fall seasons. No great changes have existed in the other two seasons.

Table 15 presents sky cover for all hours of the day. Data for six first-order stations are presented for four selected months — January to represent winter, April to represent spring, July to represent summer, and October to represent fall. These hourly data permit examination of the diurnal distributions of clear, partly cloudy, and cloudy conditions. For example, at Chicago the sky conditions at 0100 CST in January are clear 27 percent of the time, partly cloudy 8 percent of the time, and cloudy 65 percent of the time. However, in July, the observations at 0100 show a distinct shift with 55 percent clear skies, 12 percent partly cloudy, and only 33 percent cloudy.

The annual patterns of sky cover over Illinois, for various cloud types, are shown in figure 17. Here, the statewide patterns of cumulus, cumulonimbus, stratocumulus, nimbostratus, alto-cumulus plus altostratus (middle clouds), and cirrus (high clouds) are shown.

Figure 18 presents graphs based on data from Baker and Haines (1969) for three stations with cloud cover and radiation data. These show for selected weeks in each season, the relationship between the amount of cloud caver (in percent) and the average daily radiation. For example, at Indianapolis, no cloud cover in late December occurs with an average daily radiation of 240 Langleys, compared with 500 Langleys on a clear day in late September.

RELATIONSHIP OF SOLAR RADIATION TO OTHER WEATHER CONDITIONS

Available detailed solar radiation records at Lemont (Argonne National Laboratory) were analyzed in relation to occurrence with other relevant weather conditions. The solar radiation data based on 75,000 observations and their associated wind speeds (as measured at a 19-foot height) are shown in table 16. These are based on net radiation values and show joint percentage frequencies. For example, for a wind speed of 8 to 12 miles per hour, 2.216 percent of the observations occurred with a net radiation of 20.0 to 29.9 Langleys. In the table Langleys are shown in tenths. Thus the frequency of any combination of net radiation and wind speed can be obtained from table 16.

Table 17 presents joint percentage frequency distributions of hourly amounts of solar radiation and air temperature, as measured at the standard height of 5.5 feet above the ground, for the hours of 0400 to 2000 CST. These data also are part of the Lemont, Illinois, record. This table gives the monthly distributions for January to represent winter, for April to represent spring, for July to represent summer, and for October to represent fall. Examination of the January data shows that for temperatures of 25 to 29°F, 7.31 percent of the observations had 0 Langleys, and 5.62 percent of the values occurred with 1 to 10 Langleys. Table 17 also presents the temperature-solar radiation joint distributions at Lemont for all years. Examination of the values shows, for example, that for hourly temperatures in the 50 to 54° F range, 1.85 percent occurred with 0 Langleys of radiation.

The relationship of solar radiation and soil temperatures is also available for 12 years of record at Lemont. Shown in table 18 are joint percentage frequency distributions of hourly amounts of solar radiation and soil temperatures during the hours of 0400-2000 CST at two depths, 1 centimeter and 10 centimeters. Examination of the table for the 10-cm depth shows that for temperatures in the range of 31 to 35° F, 9.043 percent of the hourly observations were with 0 Langleys.

Table 19 presents joint percentage frequency distributions of relative humidity and hourly amounts of solar radiation. This is based on hourly data for the period of 0400 through 2000 CST

Table 15. Hourly Distribution of Sky Cover for Selected Stations

	January			*April*			*July*			*October*		
Hr	*0-.3*	*.4-.7*	*.8-1*	*0-.3*	*.4-.7*	*.8-1*	*0-.3*	*.4-.7*	*.8-1*	*0-.3*	*.4-.7*	*.8-1*
Chicago												
00	28	7	65	36	9	55	61	7	32	65	7	28
01	27	8	65	35	7	58	55	12	33	63	11	26
02	26	11	63	31	13	55	54	14	32	60	9	31
03	28	8	64	34	7	59	54	13	34	59	12	29
04	28	8	65	29	11	59	44	21	35	60	8	32
05	23	8	68	27	7	65	43	16	41	55	12	33
06	23	8	68	24	6	70	44	14	43	45	16	39
07	16	11	73	26	4	70	44	15	41	41	17	41
08	16	8	75	25	6	69	42	15	43	42	15	43
09	14	13	74	22	11	67	44	20	36	45	12	43
10	14	10	77	19	13	69	39	22	39	47	13	40
11	16	8	75	19	15	67	30	28	41	46	16	38
12	16	6	77	19	12	69	30	26	45	45	14	42
13	16	8	75	21	14	65	30	26	44	45	17	38
14	19	8	73	21	14	65	26	29	45	47	15	38
15	21	9	70	20	14	66	32	25	43	48	15	37
16	20	10	70	21	15	64	39	23	38	50	14	36
17	26	9	65	19	14	67	45	18	37	50	14	36
18	26	9	65	24	11	65	48	15	37	55	7	38
19	30	6	63	29	9	63	51	18	31	54	13	33
20	32	7	61	32	9	59	57	13	30	57	12	31
21	33	7	60	32	11	57	59	11	30	59	11	30
22	30	9	61	36	10	54	60	12	28	61	10	28
23	31	4	65	39	7	54	60	12	28	61	10	29
AVG	23	8	68	27	10	63	45	18	37	52	13	35
Moline												
00	38	7	55	41	6	53	63	8	29	67	8	25
01	34	5	61	40	7	53	61	7	32	65	6	29
02	32	10	58	39	6	55	59	10	32	68	3	29
03	35	8	57	41	3	56	55	14	32	63	8	30
04	35	8	57	38	8	54	50	18	32	63	8	30
05	34	9	57	35	9	57	45	19	37	61	10	29
06	39	6	55	32	7	61	47	15	38	55	10	35
07	28	10	62	30	11	59	45	16	39	52	10	38
08	21	6	73	31	10	59	43	17	41	54	8	39
09	21	6	74	29	11	60	41	15	45	52	8	39
10	21	8	70	30			43	15	43	48	10	42
11	23	7	70	30	11	59	39	17	45	48	12	40
12	24	10	66	26	12	62	35	21	45	47	15	38
13	29	8	63	26	12	62	33	28	39	50	11	39
14	27	10	63	25	13	62	35	22	43	50	14	36
15	28	8	64	21	17	61	39	21	40	50	14	35
16	23	11	66	22	21	57	39	25	36	54	14	33
17	28	12	60	24	15	61	45	18	37	55	12	33
18	32	9	59	28	13	59	42	21	37	57	11	32
19	35	7	57	32	13	55	52	16	32	62	9	29
20	34	6	59	37	8	55	52	23	25	61	10	29
21	32	8	60	42	9	49	60	15	25	63	6	31
22	37	6	57	39	7	53	65	9	26	62	10	28
23	37	8	54	42	7	51	64	8	28	65	8	27
AVG	30	8	62	33	10	57	48	16	36	57	10	33

(Continued on next page)

Table 15. Continued

	January			April			July			October		
Hr	*0-.3*	*.4-.7*	*.8-1*	*0-.3*	*.4-.7*	*.8-1*	*0-.3*	*.4-.7*	*.8-1*	*0-.3*	*.4-.7*	*.8-1*
Springfield												
00	37	6	57	49	5	46	68	6	26	67	10	23
01	37	5	59	49	7	43	63	7	30	65	8	27
02	35	6	59	47	8	45	63	9	28	68	5	27
03	33	5	63	41	10	49	59	14	28	63	5	32
04	34	4	63	41	9	50	49	17	34	64	6	30
05	34	6	60	33	11	57	39	18	43	61	10	29
06	31	6	63	34	6	60	46	12	43	54	12	34
07	24	8	68	27	8	65	43	12	45	54	8	37
08	20	10	70	33	5	63	43	12	45	54	10	37
09	23	6	71	29	9	61	38	20	42	50	13	37
10	21	9	70	26	13	61	40	18	42	53	10	37
11	23	6	72	26	15	59	34	25	41	53	9	38
12	20	9	71	24	13	63	34	24	42	50	13	37
13	20	11	69	25	11	64	30	28	42	50	10	40
14	23	8	69	24	13	63	31	30	39	52	11	37
15	20	8	72	26	13	61	35	23	42	54	10	37
16	27	5	68	25	13	62	46	19	35	53	10	37
17	26	10	64	26	11	63	46	19	35	56	10	34
18	32	6	62	28	9	63	50	14	35	57	10	32
19	30	7	63	33	12	55	50	15	35	58	12	30
20	35	4	61	38	10	52	53	15	32	65	9	26
21	36	8	56	37	13	50	64	11	25	65	5	30
22	34	11	55	45	6	49	66	12	23	61	11	28
23	33	8	59	46	9	45	69	8	23	68	5	27
AVG	29	7	64	34	10	56	48	16	36	58	9	33
Indianapolis												
00	32	5	64	41	7	51	68	9	23	66	5	28
01	29	5	66	41	5	54	65	6	29	66	6	28
02	26	3	70	39	7	53	63	8	30	65	8	26
03	28	6	66	39	9	52	58	14	28	63	9	28
04	26	5	69	35	7	59	50	19	32	63	7	30
05	27	6	67	27	12	61	47	17	36	57	4	39
06	23	5	72	31	9	60	51	12	37	50	12	38
07	19	3	79	28	7	65	52	12	36	48	14	38
08	21	6	74	28	5	67	50	13	37	47	13	40
09	19	5	76	24	9	67	46	19	35	43	14	43
10	19	8	74	22	10	68	39	23	38	43	19	37
11	18	5	77	24	5	71	30	32	37	44	13	43
12	13	9	78	23	9	68	25	41	34	46	15	39
13	15	6	78	21	13	67	26	34	40	48	15	37
14	15	6	79	17	15	68	26	32	42	47	17	36
15	17	5	79	18	11	71	26	30	44	52	16	32
16	18	5	77	18	14	68	34	26	40	54	15	32
17	19	5	75	20	15	65	44	24	32	54	16	30
18	21	5	74	21	20	59	48	14	38	58	14	28
19	24	6	70	33	15	52	48	16	36	65	8	26
20	23	8	68	38	10	52	53	15	32	64	10	26
21	23	12	66	39	9	53	60	14	26	63	10	26
22	30	5	65	41	8	51	63	8	28	63	10	28
23	30	5	65	42	8	50	65	10	25	64	6	30
AVG	22	6	72	30	10	60	47	19	34	56	12	33

(Continued on next page)

Table 15. Concluded

	January			April			July			October		
Hr	*0-.3*	*.4-.7*	*.8-1*	*0-.3*	*.4-.7*	*.8-1*	*0-.3*	*.4-.7*	*.8-1*	*0-.3*	*.4-.7*	*.8-1*
St.Louis												
00	37	6	57	47	8	45	60	16	24	72	3	25
01	38	7	55	45	13	41	58	13	29	68	7	25
02	34	10	56	48	11	41	59	11	30	66	10	23
03	32	7	61	47	11	43	60	14	26	65	10	25
04	29	10	61	47	10	43	48	23	30	66	10	24
05	32	6	62	35	15	50	45	19	35	64	11	25
06	31	6	63	32	15	53	48	19	33	50	19	31
07	23	12	66	33	11	55	46	17	37	53	12	35
08	24	9	67	35	9	56	50	15	34	50	18	32
09	25	6	69	29	13	57	50	15	35	53	14	33
10	25	10	66	27	12	61	40	23	37	55	12	34
11	25	11	64	26	13	61	39	23	37	51	19	30
12	25	10	65	27	14	59	36	25	39	51	15	34
13	26	11	63	27	15	58	31	31	38	53	14	33
14	23	14	63	26	13	61	28	40	32	52	14	34
15	28	7	65	27	14	59	34	32	34	52	14	35
16	30	9	61	31	15	54	35	30	34	54	13	33
17	31	8	61	34	13	53	46	23	32	57	14	30
18	30	10	60	33	15	53	49	21	30	60	10	30
19	36	8	55	35	15	51	48	24	28	65	7	28
20	31	9	60	39	9	52	52	23	26	66	6	28
21	31	12	57	40	16	44	59	12	29	68	8	25
22	35	12	54	47	7	46	55	16	29	68	8	23
23	35	8	57	47	6	47	64	13	23	69	8	23
AVG	30	9	61	36	12	52	47	21	32	59	12	29
Evansville												
00	28	6	65	46	9	45	68	9	23	65	9	26
01	28	6	65	43	9	48	68	8	24	62	12	26
02	28	6	65	43	7	50	68	9	23	60	13	27
03	27	6	66	45	9	47	57	16	27	62	9	29
04	26	6	68	39	11	49	49	19	32	64	10	26
05	26	6	68	37	9	53	47	13	40	59	10	30
06	26	3	71	33	13	55	46	10	44	55	12	33
07	17	6	76	31	13	56	46	14	40	55	11	34
08	19	4	77	33	10	57	47	13	40	52	14	34
09	17	5	79	29	13	59	47	15	38	53	15	32
10	17	5	78	31	13	56	35	22	43	52	12	35
11	20	5	75	29	15	55	33	23	45	55	11	34
12	22	3	75	28	14	58	32	22	46	57	9	34
13	20	6	74	27	15	59	30	29	41	52	15	33
14	22	6	72	23	20	57	30	29	41	54	12	34
15	24	5	71	23	23	55	32	29	39	53	14	33
16	24	5	71	27	13	59	36	27	37	52	15	33
17	23	6	70	31	11	57	40	24	36	54	15	32
18	24	7	69	27	13	60	44	16	40	58	10	32
19	26	5	68	34	13	53	47	15	37	61	9	30
20	27	3	70	35	15	51	52	21	28	62	10	28
21	26	6	67	39	11	51	57	16	26	65	11	25
22	26	7	66	43	8	49	63	15	23	65	10	25
23	25	7	68	47	8	45	65	12	24	69	6	25
AVG	24	6	71	34	12	53	48	18	35	58	12	30

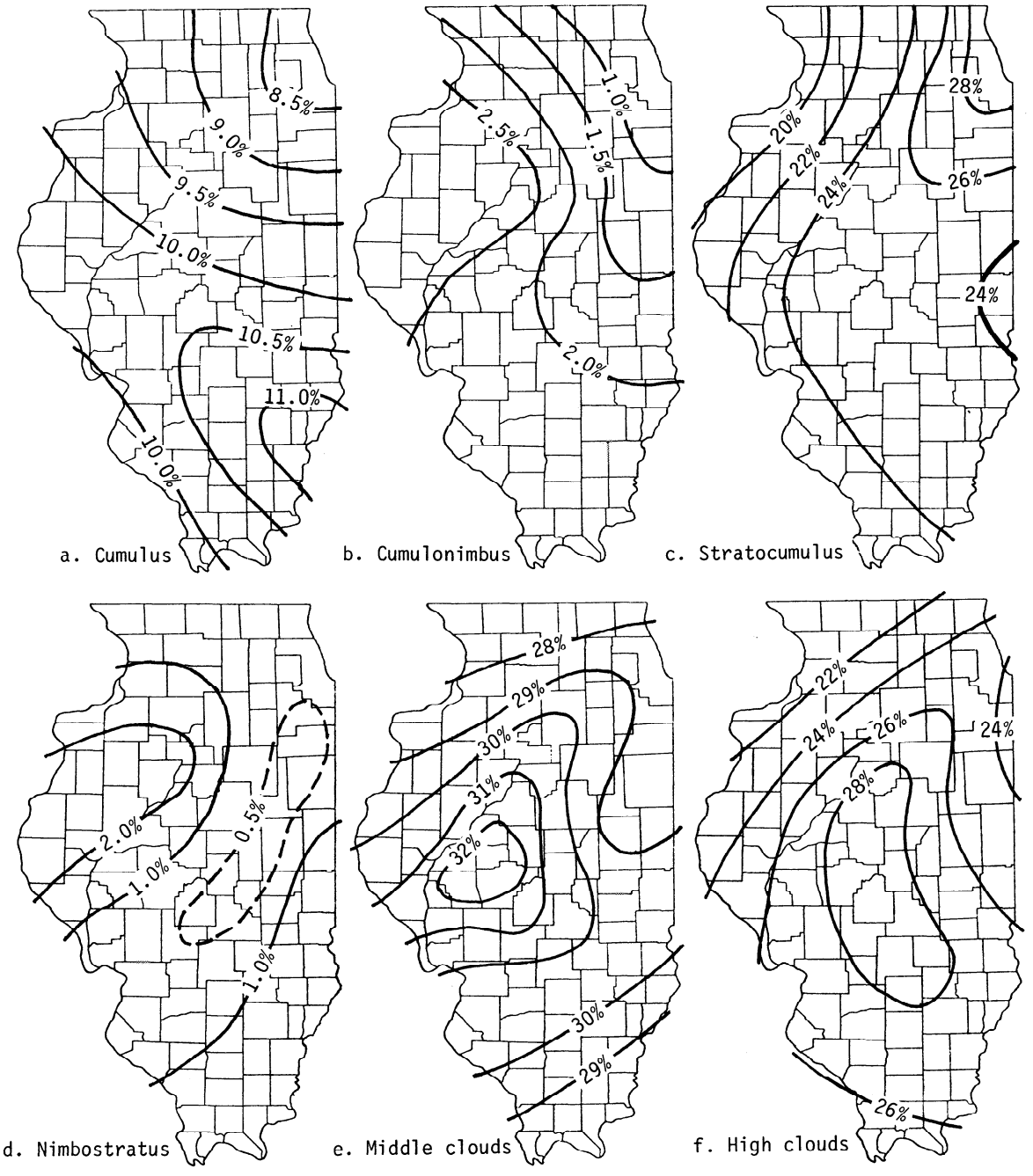


Figure 17. Annual patterns of sky cover over Illinois for various cloud types

Table 16. Joint Percentage Frequency Distribution of 19-foot Wind Speed and Hourly Amounts of Net Radiation atLemont, Illinois*

Net radiation	*Wind speed in miles per hour*												*Cumul total*
	Calm	*1-3*	*4-7*	*8-12*	*13-18*	*19-24*	*25-31*	*32-38*	*39-46*	*>46*	*Missing*	*Total*	
≤-75	0.012	0.149	1.339	1.117	0.302	0.041	0.000	0.000	0.000	0.000	0.000	2.960	2.960
-74- -50	0.477	2 809	7.478	3.344	0.795	0.050	0.005	0.000	0.000	0.000	0.013	14.971	17.932
-49- -25	1-186	4.547	6.574	2.931	0.845	0.112	0.008	0.000	0.000	0.000	0.033	16.236	34.168
-24- 0	0.894	2.987	5.975	4.695	1-783	0.270	0.036	0.000	0.000	0.000	0.035	16.675	50.842
1 -9	0.060	0.243	0.434	0.408	0.159	0.028	0.004	0.000	0.000	0.000	0.004	1.341	52.183
10-19	0.048	0.244	0.659	0.662	0.234	0.040	0.003	0.000	0.000	0.000	0.000	1.889	54.072
20-29	0.028	0.113	0.333	0.375	0.151	0.021	0.001	0.000	0.000	0.000	0.003	1.026	55.098
30-39	0.035	0.214	0.538	0.618	0.247	0.029	0.003	0.000	0.000	0.000	0.004	1.687	56.785
40-49	0.024	0.118	0.429	0.419	0.157	0.016	0.001	0.000	0.000	0.000	0.001	1.165	57.951
50-59	0.019	0.085	0.399	0.474	0.244	0.019	0.005	0.000	0.000	0.000	0.000	1.245	59.196
60-79	0.031	0.256	0.784	0.925	0.343	0.045	0.005	0.000	0.000	0.000	0.001	2.390	61.586
80-99	0.024	0.191	0.695	0.806	0.316	0.036	0.005	0.000	0.000	0.000	0.000	2.074	63.660
100-149	0.036	0.379	1.272	1.653	0.779	0.093	0.007	0.000	0.000	0.000	0.007	4.224	67.884
150-199	0.013	0.227	1.063	1.406	0.644	0.082	0.012	0.000	0.000	0.000	0.003	3.451	71.334
200-299	0.019	0.371	1.580	2.216	0.981	0.130	0.016	0.001	0.000	0.000	0.009	5.323	76.657
300-399	0.007	0.300	1.298	1.755	0.795	0.137	0.020	0.000	0.000	0.000	0.004	4.315	80.972
400-499	0.003	0.225	1.111	1.468	0.644	0.090	0.009	0.000	0.000	0.000	0.005	3.555	84.528
500-599	0.000	0.157	0.729	1.024	0.445	0.048	0.000	0.000	0.000	0.000	0.003	2.406	86.934
600-799	0.000	0.044	0.206	0.271	0.134	0.011	0.000	0.000	0.000	0.000	0.000	0.666	87.600
≥ 800	0.001	0.000	0-000	0.003	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.005	87.605
MISSING	0.298	1.574	4.058	4.116	1.956	0.308	0.028	0.000	0.000	0.000	0.057	12.395	100.000
TOTAL	3.213	15.233	36.954	30.687	11.955	1.606	0.169	0.001	0.000	0.000	0.182	100.000	
CUMUL TOTAL	3.213	18.446	55.400	86.086	98.042	99.648	99.817	99.818	99.818	99.818	100.000		

**Net radiation measured on a horizontal surface in tenths of Langleys for June 1956-December 1964; number of observations = 75,264*

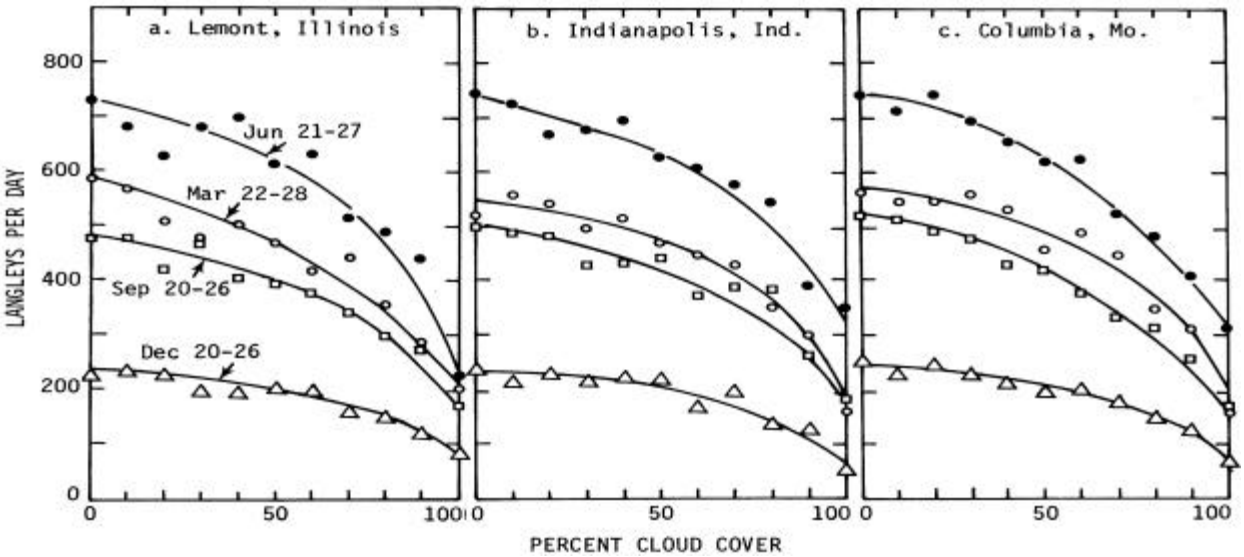


Figure 18. Average measured radiation with increasing cloud cover for selected weeks at three stations

Table 17. Joint Percentage Frequency Distribution of Hourly Amounts of Solar Radiation and Temperature at Lemont, Illinois

Temp. (°F)	Solar radiation in Langleys												Cumul
	0	1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100	Missing	Total	Total
January 1951-1964, observations = 7378														
≤ -16	0.27	0.09	0.00	0.01	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.41	0.41
-15- -11	0.53	0.09	0.04	0.00	0.03	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.72	1.12
-10- -6	0.80	0.37	0.18	0.12	0.08	0.05	0.00	0.00	0.00	0.00	0.00	0.00	1.60	2.72
-5- -1	1.92	0.76	0.37	0.18	0.23	0.27	0.09	0.00	0.00	0.00	0.00	0.00	3.82	6.55
0-4	2.74	1.36	0.39	0.28	0.42	0.38	0.12	0.00	0.00	0.00	0.00	0.01	5.71	12.25
5-9	2.72	1.29	0.95	0.64	0.54	0.73	0.16	0.00	0.00	0.00	0.00	0.03	7.06	19.31
10-14	3.43	1.71	1.00	0.75	0.69	0.72	0.08	0.01	0.00	0.00	0.00	0.01	8.40	27.72
15-19	4.38	2.20	1.11	1.03	0.73	0.58	0.07	0.00	0.00	0.00	0.00	0.04	10.14	37.86
20-24	5.72	3.69	1.64	1.08	0.72	0.47	0.12	0.00	0.00	0.00	0.00	0.00	13.45	51.30
25-29	7.31	5.62	1.99	1.26	0.87	0.76	0.03	0.00	0.00	0.00	0.00	0.00	17.84	69.14
30-34	7.08	7.05	2.10	1.37	0.79	0.46	0.01	0.00	0.00	0.00	0.00	0.01	18.87	88.00
35-39	2.28	2.37	0.72	1.04	0.77	0.19	0.00	0.00	0.00	0.00	0.00	0.01	7.39	95.39
40-44	0.65	0.95	0.30	0.43	0.39	0.19	0.00	0.00	0.00	0.00	0.00	0.00	2.91	98.31
45-49	0.27	0.30	0.07	0.05	0.08	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.83	99.13
50-54	0.26	0.28	0.05	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.64	99.77
55-59	0.07	0.05	0.00	0.03	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.23	100.00
60-64	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00
65-69	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00
70-74	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00
75-79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00
80-84	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00
85-89	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00
90-94	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00
95-99	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00
≥100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00
MISSING	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00
TOTAL	40.42	28.18	10.91	8.31	6.44	4.89	0.72	0.01	0.00	0.00	0.00	0.12	100.00	
CUMUL TOTAL	40.42	68.60	79.51	87.82	94.25	99.15	99.86	99.88	99.88	99.88	99.88	100.00		
April 1951-1964, observations = 7140														
≤ -16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
-15- -11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
-10- -6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
-5- -1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0-4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5-9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10-14	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
15-19	0.13	0.03	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.18	0.20
20-24	0.49	0.10	0.04	0.00	0.01	0.01	0.04	0.00	0.00	0.00	0.00	0.00	0.70	0.90
25-29	1.47	0.74	0.20	0.10	0.04	0.04	0.00	0.01	0.00	0.00	0.00	0.01	2.62	3.52
30-34	3.80	2.72	0.97	0.59	0.27	0.18	0.08	0.04	0.00	0.01	0.00	0.13	8.78	12.30
35-39	3.82	3.92	1.61	0.78	0.84	0.42	0.27	0.24	0.18	0.07	0.00	0.03	12.18	24.48
40-44	3.80	5.00	2.10	1.20	1.01	0.46	0.63	0.45	0.63	0.29	0.00	0.04	15.62	40.10
45-49	2.91	3.85	l.69	1.29	0.85	0.76	0.78	0.66	0.81	0.46	0.01	0.11	14.20	54.30
50-54	2.34	2.96	1.65	1.11	1.09	1.02	0.76	0 81	0.88	0.53	0.00	0.10	13.25	67.55
55-59	1.72	2.18	1.08	1.12	0.76	0.67	0.62	0.83	1.04	0.34	0.00	0.08	10.43	77.98
60-64	1.29	1.60	0.77	0.74	0.69	0.73	0.62	0.74	0.59	0.31	0.00	0.06	8.12	86.11
65-69	0.35	0.76	0.78	0.76	0.70	0.50	0.33	0.73	0.77	0.29	0.00	0.06	6.53	92.63
70-74	0.20	0.53	0.36	0.32	0.42	0.56	0.55	0.43	0.60	0.14	0.00	0.00	4.22	96.85
75-79	0.00	0.11	0.18	0.14	0.18	0.29	0.32	0.39	0.38	0.10	0.00	0.21	2.31	99.16
80-84	0.00	0.00	0.00	0.07	0.03	0.10	0.13	0.18	0.21	0.01	0.00	0.07	0.80	99.96
85-89	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	99.95
90-94	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	99.96
95-99	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	99.96
≥100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	99.96
MISSING	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	100.00
TOTAL	22.35	24.51	11.46	8.22	6.90	5.76	5.62	5.52	6.09	2.56	0.01	0.99	100.00	
CUMUL TOTAL	22.35	46.86	58.32	66.54	73.45	79.20	84.82	90.34	96.43	98.99	99.0l	100.00		

(Continued on next Page)

Table 17. Continued

Temp. (°F)	Solar radiation in Langleys												Total	Cumul total
	0	*1.10*	*11.20*	*21.30*	*31.40*	*41.50*	*51.60*	*61.70*	*71.80*	*81.90*	*91.100*	*Missing*		
July 1951-1964, observations = 7378														
≤ –16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
-15- -11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
-10- -6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
-5- -1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0-4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5-9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10-14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
15-19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
20-24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
25-29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
30-34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
35-39	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
40-44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
45-49	0.07	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.11
50-54	0.54	0.33	0.33	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.89	1.00
55-59	1.94	1.52	0.08	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.66	4.66
60-64	3.10	4.70	0.61	0.65	0.12	0.14	0.01	0.01	0.00	0.00	0.00	0.03	9.38	14.04
65-69	4.15	7.17	2.10	2.21	0.70	0.75	0.47	0.45	0.38	0.11	0.00	0.05	18.54	32.58
70-74	2.60	5.29	2.43	2.49	2.30	1.88	1.38	1.19	1.12	0.85	0.05	0.11	21.71	54.30
75-79	0.62	2.68	2.17	2.20	2.45	2.16	2.90	2.07	2.24	1.42	0.01	0.08	21.01	75.30
80-84	0.14	0.79	1.02	1.22	1.57	1.95	2.52	2.55	2.85	1.14	0.01	0.03	15.78	91.08
85-89	0.03	0.05	0.18	0.33	0.64	0.88	1.31	1.49	1.79	0.72	0.00	0.00	7.41	98.50
90-94	0.00	0.00	0.07	0.07	0.09	0.08	0.22	0.27	0.34	0.15	0.00	0.00	1.29	99.78
95-99	0.00	0.00	0.00	0.00	0.01	0.01	0.04	0.01	0.07	0.05	0.00	0.00	0.20	99.99
≥ 100	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.01	100.00
MISSING	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00
TOTAL	13.19	22.57	8.66	9.30	7.90	7.85	8.88	8.05	8.78	4.45	0.08	0.30	100.00	
CUMUL TOTAL	13.19	35.75	44.42	53.71	61.62	69.46	78.34	86.39	95.17	99.62	99.70	100.00		
October 1950-1964, observations = 7905														
≤ -16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
-15- -11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
-10- -6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
-5- -1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0-4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5-9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10-14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
15-19	0.05	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.09
20-24	0.20	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.22	0.30
25-29	0.71	0.27	0.01	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.02	1.33
30-34	2.29	0.73	0.16	0.08	0.13	0.05	0.00	0.00	0.00	0.00	0.00	0.00	3.44	4.77
35-39	3.63	1.72	0.76	0.22	0.18	0.11	0.06	0.00	0.00	0.00	0.00	0.08	6.76	11.52
40-44	5.19	2.75	0.83	0.70	0.52	0.28	0.25	0.04	0.00	0.00	0.00	0.14	10.69	22.21
45-49	6.19	4.12	1.49	0.86	0.67	0.56	0.47	0.16	0.01	0.00	0.00	0.09	14.62	36.84
50-54	5.02	3.87	1.77	1.04	0.90	1.09	0.89	0.40	0.01	0.00	0.00	0.20	15.19	52.03
55-59	4.62	3.52	1.43	1.09	1.09	0.99	0.96	0.34	0.00	0.00	0.00	0.15	14.18	66.21
60-64	2.61	2.63	1.28	1.10	1.10	1.24	1.52	0.47	0.00	0.00	0.00	0.11	12.06	78.27
65-69	1.81	1.88	1.10	1.04	1.13	1.37	1.44	0.47	0.00	0.00	0.00	0.11	10.35	88.61
70-74	0.47	0.99	0.61	0.78	0.82	1.08	0.99	0.28	0.00	0.00	0.00	0.05	6.06	94.67
75-79	0.09	0.33	0.37	0.30	0.44	0.76	0.85	0.25	0.00	0.00	0.00	0.11	3.50	98.18
80-84	0.03	0.05	0.10	0.20	0.33	0.40	0.35	0.09	0.00	0.00	0.00	0.00	1.56	99.73
85-89	0.00	0.00	0.00	0.03	0.01	0.06	0.06	0.00	0.00	0.00	0.00	0.00	0.16	99.90
90-94	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	99.90
95-99	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	99.90
≥ 100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	99.90
MISSING	0.00	0.00	0.01	0.03	0.00	0.05	0.01	0.00	0.00	0.00	0.00	0.00	0.10	100.00
TOTAL	32.89	22.90	9.94	7.48	7.32	8.03	7.86	2.50	0.03	0.00	0.00	1.05	100.00	
CUMUL TOTAL	32.89	55.79	65.73	73.21	80.53	88.56	96.42	98.92	98.95	98.95	98.95	100.00		

(Concluded on next page)

Table 17. Concluded

Temp. (°F)	Solar radiation in Langleys												Total	Cumul total
	0	*1-10*	*11-20*	*21-30*	*31-40*	*41-50*	*51-60*	*61-70*	*71-80*	*81-90*	*91-100*	*Missing*		
All years 1950-1964, total observations = 89,012														
£ -16	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.04
-15- -11	0.08	0.02	0.00	0.00	0-00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.15
-10- -6	0.17	0.06	0.02	0.02	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.28	0.43
-5- -1	0.36	0.16	0.07	0.04	0.04	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.70	1.14
0-4	0.50	0.26	0.07	0.07	0.08	0.07	0.02	0.00	0.00	0.00	0.00	0.00	1.08	2.21
5-9	0.60	0.29	0.13	0.13	0.11	0.11	0.05	0.01	0.00	0.00	0.00	0.00	1.42	3.64
10-14	0.88	0.45	0.20	0.13	0.12	0.11	0.05	0.02	0.00	0.00	0.00	0.00	1.96	5.60
15-19	1.33	0.68	0.30	0.27	0.20	0.14	0.05	0.03	0.01	0.00	0.00	0.00	3.02	8.62
20-24	2.16	1.19	0.47	0.36	0.24	0.19	0.10	0.05	0.02	0.00	0.00	0.01	4.77	13.39
25-29	2.97	2.11	0.72	0.45	0.32	0.22	0.10	0.08	0.02	0.00	0-00	0.01	7.00	20.39
30-34	3.71	3.07	1.06	0.61	0.41	0.26	0.12	0.09	0.05	0.01	0.00	0.02	9.40	29.79
35-39	2.36	2.04	0.82	0.54	0.47	0.27	0.17	0.10	0.05	0.01	0.00	0.03	6.87	36.66
40-44	1.90	1.74	0.63	0.51	0.43	0.30	0.22	0.12	0.09	0.03	0.00	0.06	6.02	42.68
45-49	1.91	1.73	0.61	0.47	0.40	0.32	0.23	0.15	0.11	0.04	0.01	0.06	6.04	48.72
50-54	1.85	1.88	0.78	0.49	0.40	0.37	0.25	0.18	0.14	0.07	0.01	0.08	6.49	55.20
55-59	1.88	1.86	0.73	0.61	0.47	0.39	0.28	0.24	0.19	0.10	0.01	0.08	6.85	62.05
60-64	1.78	2.18	0.81	0.62	0.51	0.49	0.42	0.36	0.21	0.12	0.01	0.08	7.60	69.65
65-69	1.58	2.30	1.03	0.89	0.69	0.64	0.61	0.48	0.38	0.16	0.01	0.08	8.85	78.50
70-74	0.80	1.54	0.89	0.94	0.86	0.83	0.77	0.66	0.55	0.31	0.02	0.09	8.26	86.76
75-79	0.24	0.72	0.58	0.65	0.74	0.74	0.91	0.81	0.71	0.32	0.01	0.09	6.52	93.28
80-84	0.04	0.24	0.26	0.31	0.42	0.55	0.68	0.73	0.63	0.24	0.00	0.05	4.15	97.??
85-89	0.00	0.02	0.06	0.14	0.18	0.24	0.33	0.42	0.45	0.12	0.00	0.01	1.98	99.41
90-94	0.00	0.00	0.01	0.01	0.03	0.04	0.08	0.11	0.12	0.03	0.00	0.00	0.44	99.85
95-99	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.00	0.00	0.03	99.80
≥100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	99.89
MISSING	0.04	0.02	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.11	100.00
TOTAL	27.16	24.55	10.26	8.28	7.15	6.33	5.47	4.66	3.75	1.58	0.08	0.74	100.00	
CUMUL TOTAL	27.16	51.71	61.97	70.25	77.39	83.72	89.19	93.85	97.60	99.18	99.26	100.00		

for 15 years of record. In general, these tables show a negative correlation between solar radiation and relative humidity; that is, low humidity values are associated with large hourly amounts of solar radiation and vice versa. Several factors enter into such a relationship. First, dry air masses are associated with clear skies and large amounts of solar radiation. Second, relative humidity values are comparatively high at sunrise when the temperature is close to the daily minimum. As the day progresses, sunshine typically causes the air to become warmer, thus, lowering the relative humidity. Table 19 presents the humidity-radiation relationship values for January, for July, and for all years, 1951-1964.

TEMPERATURE, HUMIDITY, AND WIND INFLUENCES

Selected results, generally of monthly average values for air temperatures, humidities, and winds are presented to furnish some general information on these conditions which affect the use of energy for both heating and cooling purposes. These results provide some guidance to those who must consider the use of solar energy.

Presented first are patterns of the mean temperatures (°F) during the mid-winter month of January and the mid-summer month of July (figure 19). In both months, patterns reveal the expected north-to-south latitudinal difference, but the gradation is much sharper in the colder season as shown by the January map. Table 14, based on monthly data from nine first-order stations in the Illinois area, presents other temperature data. Shown for each station is the mean maximum, the mean minimum, and the monthly mean temperatures for each month as well as the annual values. Also shown are the average number of days with maximum temperatures of 90°F or higher, 30°F or lower, and the occurrences of minimum temperatures below 32°F and below 0°F. Also

Table 18. Joint Percentage Frequency Distribution of Hourly Amounts of Solar Radiation and Soil Temperature at Dixon Springs, Illinois*

Soil temp (°F)	Solar radiation in Langleys													
	0	*1-10*	*11-20*	*21-30*	*31-40*	*41-50*	*51-60*	*61-70*	*71-80*	*81-90*	*>90*	*Missing*	*Total*	*Cumul total*
At 1-centimeter soil depth														
< 1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1-5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6-10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11-15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
16-20	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
21-25	0.28	0.14	0.08	0.05	0.05	0.04	0.02	0.00	0.00	0.00	0.00	0.00	0.65	0.66
26-30	1.58	0.98	0.41	0.35	0.28	0.22	0.09	0.03	0.00	0.00	0.00	0.00	3.95	4.61
31-35	9.01	6.41	2.51	1.91	1.51	1.05	0.59	0.32	0.12	0.01	0.00	0.00	23.43	28.04
36-40	2.69	2.01	0.73	0.44	0.37	0.21	0.12	0.12	0.05	0.01	0.00	0.01	6.74	34.81
41-45	2.03	1.75	0.69	0.52	0.45	0.29	0.20	0.15	0.11	0.02	0.00	0.01	6.23	41.03
46-50	1.79	1.60	0.66	0.41	0.40	0.33	0.21	0.15	0.14	0.03	0.00	0.00	5.74	46.77
51-55	1.87	1.67	0.67	0.56	0.43	0.43	0.27	0.17	0.18	0.06	0.00	0.02	6.34	53.10
56-60	1.87	1.79	0.74	0.60	0.46	0.48	0.42	0.25	0.18	0.08	0.01	0.02	6.90	60.01
61-65	1.88	1.95	0.88	0.71	0.56	0.53	0.49	0.41	0.25	0.13	0.01	0.01	7.79	67.80
66-70	2.04	2.47	1.05	0.92	0.72	0.75	0.66	0.56	0.35	0.19	0.02	0.03	9.75	77.55
71-75	1.48	2.06	0.91	0.90	0.84	0.76	0.84	0.78	0.56	0.24	0.01	0.01	9.37	86.92
76-80	0.52	1.11	0.62	0.62	0.69	0.68	0.84	0.90	0.80	0.30	0.01	0.01	7.11	94.04
81-85	0.07	0.31	0.24	0.27	0.34	0.41	0.62	0.65	0.71	0.29	0.01	0.00	3.93	97.97
86-90	0.01	0.02	0.04	0.05	0.10	0.12	0.17	0.25	0.32	0.14	0.00	0.00	1.20	99.17
91-95	0.00	0.00	0.00	0.00	0.01	0.01	0.03	0.05	0.08	0.05	0.00	0.00	0.23	99.40
96-100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.02	99.42
>100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	99.42
MISSING	0.18	0.12	0.07	0.05	0.03	0.03	0.03	0.01	0.03	0.01	0.00	0.02	0.58	100.00
TOTAL	27.32	24.38	10.30	8.37	7.24	6.35	5.59	4.82	3.87	1.56	0.06	0.14	100.00	
CUMUL TOTAL	27.32	51.70	61.99	70.37	77.60	83.95	89.55	94.36	98.24	99.80	99.86	100.00		
At 10-centimeter soil depth														
< 1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1-5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0-000
6-10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
11-15	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
16-20	0.034	0.016	0.009	0.007	0.005	0.003	0.000	0.000	0.000	0.000	0-000	0.000	0.074	0.074
21-25	0.276	0.162	0.093	0.066	0.067	0.075	0.028	0.008	0.000	0.000	0.000	0.000	0.776	0.850
26-30	1.574	0.974	0.451	0.391	0.333	0.268	0.118	0.034	0.000	0.000	0.000	0.000	4.143	4.993
31-35	9.043	6.623	2.567	1.946	1.549	1.037	0.615	0.400	0.146	0.021	0.000	0.000	23.948	28.941
36-40	2.596	1.945	0.741	0.472	0.401	0.256	0.178	0.141	0.098	0.013	0.000	0.020	6.862	35.803
41-45	2.049	1.675	0.703	0.513	0.455	0.327	0.228	0.169	0.157	0.050	0.000	0.007	6.333	42.136
46-50	1.774	1.653	0.644	0.454	0.423	0.370	0.221	0.162	0.201	0.070	0.003	0.015	5.991	48.127
51-55	1.896	1.684	0.668	0.560	0.470	0.478	0.377	0.212	0.164	0.067	0.008	0.016	6.600	54.727
56-60	1.780	1.722	0.785	0.620	0.466	0.483	0.440	0.366	0.212	0.137	0.009	0.011	7.031	61.759
61-65	1.937	2.017	0.898	0.765	0.607	0.637	0.608	0.529	0.346	0.185	0.015	0.027	8.571	70.329
66-70	2.064	2.594	1.114	1.012	0.891	0.824	0.828	0.823	0.558	0.266	0.012	0.009	10.996	81.325
71-75	1.523	1.998	0.876	0.862	0.800	0.776	0.935	0.925	0.862	0.280	0.008	0.011	9.856	91.181
76-80	0.511	0.929	0.498	0.451	0.530	0.530	0.658	0.684	0.670	0.276	0.004	0.008	5.749	96.931
81-85	0.083	0.259	0.161	0.177	0.178	0.213	0.264	0.286	0.338	0.158	0.001	0.003	2.123	99.054
86-90	0.001	0.013	0.020	0.024	0.034	0.039	0.054	0.058	0.083	0.028	0.000	0.000	0.354	99.408
91-95	0.000	0.000	0.000	0.000	0.001	0.003	0.001	0.004	0.003	0.000	0.000	0.000	0.012	99.420
96-100	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	99.420
>100	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	99.420
MISSING	0.174	0.115	0.067	0.052	0.027	0.028	0.039	0.019	0.036	0.005	0.000	0.016	0.580	100.000
TOTAL	27.317	24.382	10.296	8.371	7.237	6.349	5.594	4.819	3.875	1.558	0.060	0.142	100.000	
CUMUL TOTAL	27.317	51.698	61.995	70.365	77.602	83.951	89.545	94.365	98.239	99.797	99.858	100.000		

**Radiation measured on a horizontal surface during 0400-2000 CST for 1953-1964*

Table 19. Joint Percentage Frequency Distribution of Relative Humidity and Hourly Amounts of Solar Radiation at Lemont, Illinois*

Solar radiation (Langleys)	*Relative humidity in percent*											*Total*	*Cumul total*
	1-10	*11-20*	*21-30*	*31-40*	*41-50*	*51-60*	*61-70*	*71-80*	*81-90*	*91-100*	*Missing*		
January, observations = 7378													
0	0.00	0.00	0.00	0.01	0.12	0.81	3.78	8.28	11.33	16.02	0.05	40.42	40.42
1-5	0.00	0.00	0.00	0.03	0.14	0.77	2.09	3.80	4.53	9.45	0.05	20.85	61.26
6-10	0.00	0.00	0.00	0.01	0.09	0.38	1.18	1.63	1.90	2.14	0.00	7.33	68.60
11-15	0.00	0.00	0.01	0.03	0.19	0.45	1.36	1.67	1.34	1.18	0.00	6.22	74.82
16-20	0.00	0.00	0.00	0.04	0.20	0.56	1.03	1.30	0.96	0.57	0.03	4.69	79.51
21-25	0.00	0.00	0.00	0.03	0.12	0.64	1.19	1.12	0.72	0.27	0.00	4.09	83.60
26-30	0.00	0.00	0.01	0.03	0.37	0.79	1.38	0.96	0.41	0.27	0.00	4.22	87.82
31-35	0.00	0.00	0.00	0.05	0.16	0.85	1.00	0.79	0.28	0.16	0.00	3.31	91.12
36-40	0.00	0.00	0.01	0.03	0.30	0.81	1.08	0.61	0.15	0.14	0.00	3.13	94.25
41-45	0.00	0.00	0.00	0.09	0.15	0.88	1.34	0.56	0.18	0.04	0.00	3.24	97.49
46-50	0.00	0.00	0.00	0.03	0.24	0.54	0.61	0.18	0.05	0.00	0.00	1.65	99.15
51-55	0.00	0.00	0.00	0.03	0.03	0.26	0.26	0.04	0.00	0.00	0.00	0.61	99.76
56-60	0.00	0.00	0.00	0.00	0.00	0.07	0.04	0.00	0.00	0.00	0.00	0.11	99.86
61-65	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	99.86
66-70	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.01	99.88
71-75	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	99.88
76-80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	99.88
81-85	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	99.88
86-90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	99.88
91-95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	99.88
96-100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	99.88
> 100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	99.88
MISSING	0.00	0.00	0.00	0.00	0.00	0.01	0.04	0.03	0.00	0.00	0.00	0.12	100.00
TOTAL	0.00	0.00	0.04	0.41	2.11	7.83	16.39	20.95	21.89	30.24	0.14	100.00	
CUMUL TOTAL	0.00	0.00	0.04	0.45	2.56	10.40	26.78	47.74	69.63	99.86	100.00		
July, observations = 7378													
0	0.00	0.00	0.00	0.00	0.05	0.41	0.92	1.50	3.05	7.10	0.15	13.19	13.19
1-5	0.00	0.00	0.00	0.03	0.31	0.91	1.52	2.20	3.09	5.83	0.27	14.15	27.34
6-10	0.00	0.00	0.00	0.03	0.34	0.81	1.23	1.49	2.06	2.39	0.07	8.42	35.75
11-15	0.00	0.00	0.00	0.01	0.11	0.28	0.56	0.61	1.02	0.81	0.09	3.50	39.25
16-20	0.00	0.00	0.00	0.09	0.39	0.87	1.12	1.10	0.96	0.57	0.05	5.16	44.42
21-25	0.00	0.00	0.00	0.23	0.62	0.83	1.38	1.34	0.95	0.23	0.08	5.67	50.08
26-30	0.00	0.00	0.01	0.08	0.37	0.61	0.94	0.92	0.43	0.18	0.09	3.63	53.71
31-35	0.00	0.00	0.00	0.09	0.46	0.70	0.99	0.70	0.37	0.08	0.09	3.50	57.21
36-40	0.00	0.00	0.01	0.20	0.79	1.17	0.99	0.89	0.27	0.05	0.03	4.40	61.62
41-45	0.00	0.00	0.01	0.37	0.73	1.40	1.04	0.73	0.18	0.05	0.08	4.59	66.21
46-50	0.00	0.00	0.00	0.16	0.53	0.99	0.98	0.46	0.11	0.00	0.03	3.25	69.46
51-55	0.00	0.00	0.03	0.19	0.85	1.27	1.12	0.52	0.08	0.01	0.04	4.12	73.58
56-60	0.00	0.00	0.03	0.39	1.23	1.56	1.12	0.34	0.07	0.01	0.00	4.76	78.34
61-65	0.00	0.00	0.03	0.37	1.12	1.49	0.87	0.14	0.05	0.00	0.04	4.11	82.45
66-70	0.00	0.00	0.08	0.34	1.26	1.42	0.64	0.20	0.00	0.00	0.00	3.94	86.39
71-75	0.00	0.00	0.03	0.50	1.88	1.64	0.62	0.09	0.00	0.00	0.00	4.77	91.16
76-80	0.00	0.00	0.07	0.65	1.46	1.37	0.38	0.08	0.00	0.00	0.00	4.01	95.17
81-85	0.00	0.00	0.07	0.62	1.52	0.85	0.31	0.01	0.00	0.00	0.00	3.39	98.56
86-90	0.00	0.00	0.00	0.19	0.61	0.20	0.05	0.00	0.00	0.00	0.00	1.06	99.62
91-95	0.00	0.00	0.00	0.01	0.04	0.03	0.00	0.00	0.00	0.00	0.00	0.08	99.70
96-100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	99.70
> 100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	99.70
MISSING	0.00	0.00	0.00	0.00	0.00	0.07	0.05	0.08	0.03	0.07	0.00	0.30	100.00
TOTAL	0.00	0.00	0.37	4.57	14.69	18.88	16.85	13.42	12.71	17.39	1.12	100.00	
CUMUL TOTAL	0.00	0.00	0.37	4.93	19.63	38.51	55.35	68.77	81.49	98.88	100.00		

(Concluded on next page)

Table 19. Concluded

Solar radiation (Langleys)	*Relative humidity in percent*											*Total*	*Cumul total*
	1-10	*11-20*	*21-30*	*31-40*	*41-50*	*51-60*	*61-70*	*71-80*	*81-90*	*91-100*	*Missing*		
All years, observations = 89,012													
0	0.00	0.00	0.02	0.16	0.57	1.41	3.05	4.74	6.19	10.87	0.15	27.16	27.16
1-5	0.00	0.00	0.02	0.23	0.66	1.24	2.01	2.75	3.32	6.62	0.11	16.97	44.12
6-10	0.00	0.00	0.02	0.13	0.43	0.77	1.13	1.36	1.64	2.07	0.03	7.59	51.71
11-15	0.00	0.00	0.02	0.14	0.38	0.61	0.98	1.13	1.12	0.97	0.03	5.39	57.10
16-20	0.00	0.00	0.03	0.18	0.49	0.76	0.94	1.03	0.88	0.53	0.03	4.87	61.97
21-25	0.00	0.00	0.03	0.20	0.54	0.79	1.00	0.94	0.56	0.28	0.03	4.37	66.34
26-30	0.00	0.00	0.04	0.20	0.52	0.79	0.99	0.81	0.38	0.15	0.01	3.91	70.25
31-35	0.00	0.00	0.06	0.23	0.55	0.86	0.88	0.61	0.27	0.07	0.03	3.57	73.82
36-40	0.00	0.00	0.04	0.29	0.68	0.87	0.86	0.58	0.18	0.06	0.02	3.57	77.39
41-45	0.00	0.00	0.05	0.30	0.68	0.92	0.85	0.46	0.13	0.03	0.03	3.44	80.83
46-50	0.00	0.00	0.06	0.29	0.65	0.86	0.64	0.30	0.07	0.00	0.02	2.89	83.72
51-55	0.00	0.00	0.06	0.34	0.71	0.80	0.56	0.22	0.05	0.01	0.01	2.76	86.48
56-60	0.00	0.00	0.07	0.38	0.79	0.73	0.53	0.16	0.03	0.01	0.01	2.71	89.19
61-65	0.00	0.00	0.07	0.37	0.73	0.70	0.38	0.11	0.01	0.00	0.01	2.40	91.60
66-70	0.00	0.00	0.06	0.41	0.77	0.60	0.31	0.09	0.01	0.00	0.01	2.25	93.85
71-75	0.00	0.00	0.06	0.40	0.79	0.49	0.25	0.05	0.01	0.00	0.01	2.05	95.90
76-80	0.00	0.00	0.08	0.37	0.62	0.43	0.15	0.03	0.01	0.00	0.01	1.70	97.60
81-85	0.00	0.00	0.06	0.30	0.45	0.24	0.08	0.00	0.00	0.00	0.01	1.14	98.74
86-90	0.00	0.00	0.02	0.14	0.18	0.08	0.02	0.00	0.00	0.00	0.00	0.44	99.18
91-95	0.00	0.00	0.00	0.02	0.03	0.02	0.00	0.00	0.00	0.00	0.00	0.08	99.26
96-100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	99.26
>100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	99.26
MISSING	0.00	0.00	0.01	0.07	0.06	0.10	0.08	0.07	0.07	0.10	0.19	0.74	100.00
TOTAL	0.00	0.03	0.88	5.17	11.29	14.07	15.70	15.44	14.92	21.77	0.73	100.00	
CUMUL TOTAL	0.00	0.03	0.91	6.08	17.37	31.43	47.14	62.58	77.50	99.27	100.00		

**Radiation measured on a horizontal surface during 0400-2000 CST for 1951-1964*

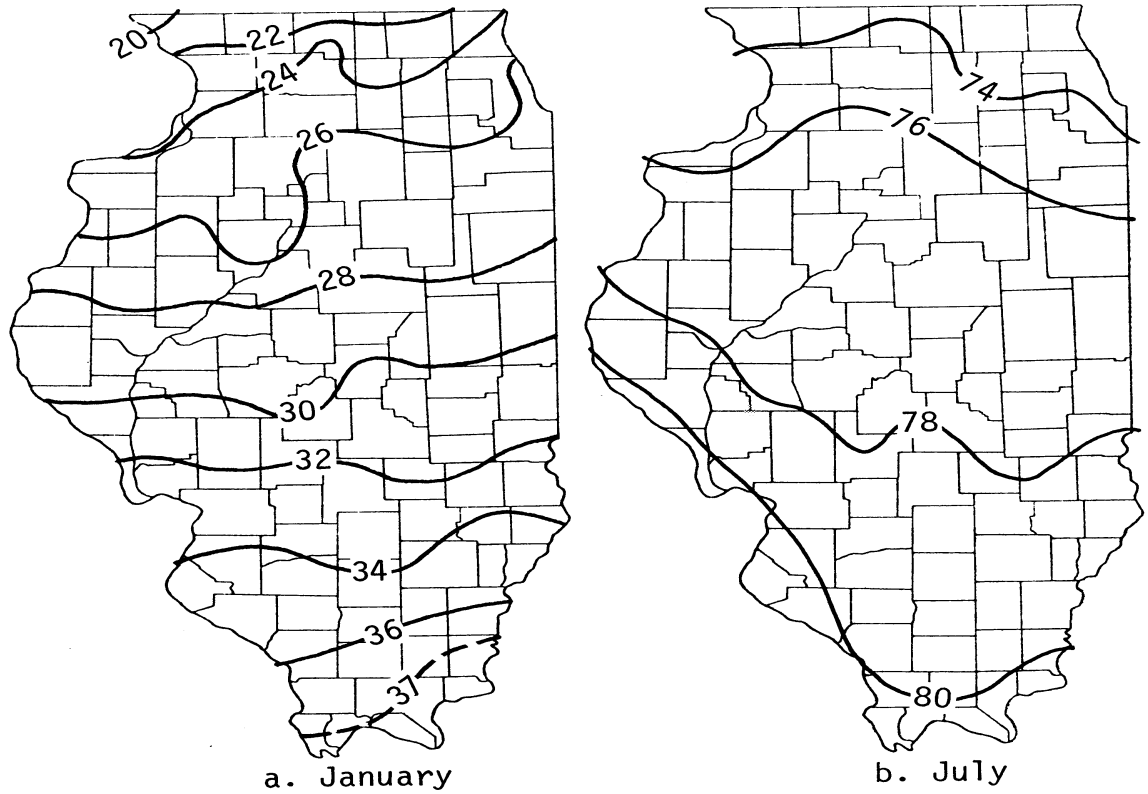


Figure 19. Mean temperature patterns, °F

presented in the table are the monthly average values of relative humidity, typically shown for four different times during the day.

The frequencies of days of 90°F or higher, as determined for four regions of the state, are shown in figure 20a. These are based on runs of five or more consecutive days with such high temperatures (Changnon, 1967). These show that there is a 32 percent chance of a 5-day period with 90°F or higher in northern Illinois in late July, whereas in the southern fourth of Illinois, there is a 70 percent chance of such runs of extremely hot days. Figure 20b presents, for the same four regions, the probability curves for runs of five or more consecutive days each with minimum temperatures below 30°F. Graphs such as these are useful in determining extreme short period demands on energy sources.

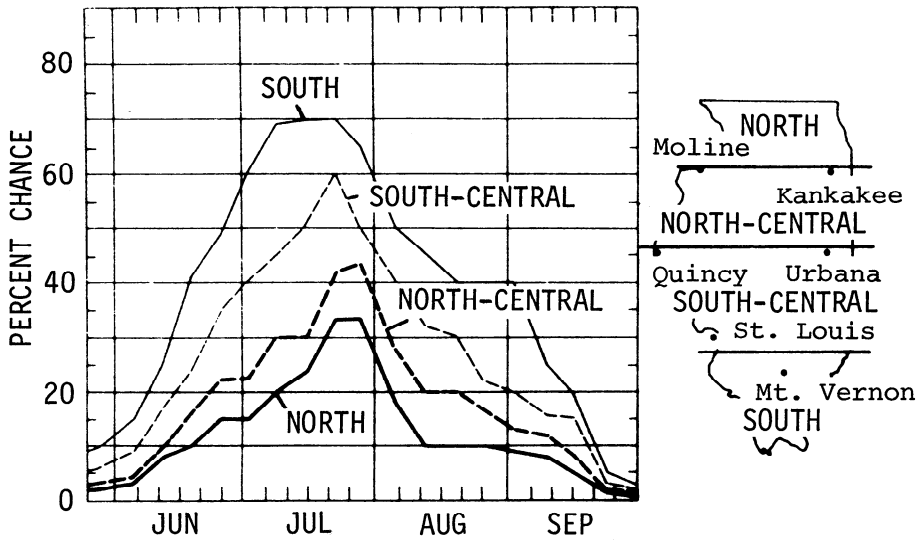
Data on winds are relevant to energy consumption because wind speed affects the use of energy both for heating and cooling. Table 14 presents the average monthly wind speeds and direction at nine first-order stations. More information on the interaction between temperature, winds, and relative humidity is presented in table 20 for Chicago, in table 21 for Springfield, and in table 22 for Evansville. These three stations were chosen to represent typical conditions in northern, central, and southern Illinois, respectively. For each station, the frequency distributions are presented for four months, each chosen to represent the four seasons. In table 20 for Chicago for the month of January, one sees that for temperatures in the range of 35 to 39°F, two observations occurred when the humidity was 50 to 69 percent and when wind speeds were 0 to 4 mph. Data presented in these tables are from the Local Climatological Data publications for first-order stations (Environmental Data Service, 197l-l975). These can be used to determine the likelihood of extreme temperature, wind, and humidity conditions which impact on energy usage.

WEATHER HAZARDS

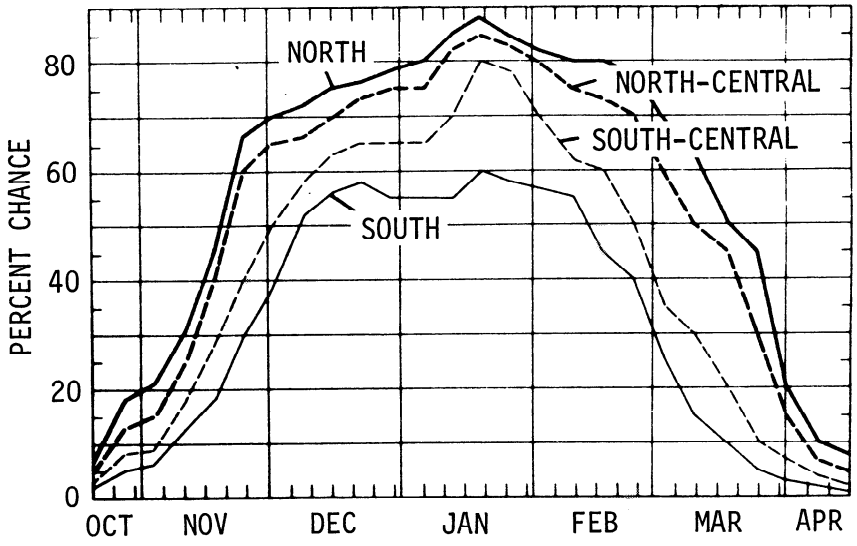
Certain weather conditions influence potential solar systems and devices used to capture, retain, and transfer solar energy to storage units. Among the weather elements which can affect such systems, particularly if they are constructed with glass or other fragile materials, is hail. Figure 21 presents the pattern of the average number of daily hail occurrences at a point. In northeastern Illinois, the typical frequency is 2 hail days per year, whereas in parts of southwestern, northwestern, and southern Illinois, three or more hail falls can be expected in an average year. Record high numbers in most parts of Illinois have been in excess of 12 days of hail, and in many years no hail falls.

Table 23 presents hail information for Illinois (Changnon, 1970). These show the distributions of hail by stone sizes. For example, 22 percent of all hailstones that fall have diameters of 1/8 inch, and 24 percent have diameters of 1/4 inch. Only 7 percent of all hailstones that fall in Illinois have diameters in excess of 1 inch. The average number of hailstones per hail event is 129 stones per square foot. The record largest number of hailstones per square foot from a single storm was 1402. Information on the average impact energy of hailfalls, as calculated from the hailstones and impact on sensors, shows that the average impact energy per hailhall is 0.22 foot-pound per square foot. The largest impact energy measured from a single hailfall in Illinois was 12.66 foot-pounds per square foot. Extensive hail data are available (Changnon and Morgan, 1976).

Another weather hazard closely related to hail is thunderstorms. Incidences of thunderstorms with associated lightning and strong winds represent a potential damage threat to solar collectors. Figure 22 presents the pattern based on the average annual number of thunderstorm



a. Chance of 5 or more consecutive days with maximum temperatures above 90°F



b. Chance for 5 or more consecutive days with minimum temperatures below 30°F

Figure 20. Frequencies of days with temperatures above 90° F and below 30° F determined for four regions in Illinois

Table 20. Temperature and Wind Speed — Relative Humidity Occurrences (Hourly Observations) for Chicago*

Temp range (°F)	Winds 0-4 mpb						Winds 5-14 mpb						Winds 15-24 mpb						Winds >25mpb						Total Obs
	£30	30-49	50-69	70-79	80-89	90-100	£30	30-49	50-69	70-79	80-89	90-100	£30	30-49	50-69	70-79	80-89	90-100	£30	30-49	50-69	70-79	80-89	90-100	
January																									
65/ 69																	2						2		4
60/ 64																	8						3		12
55/ 59											1	1					3	5					1		20
50/ 54									1		4	10			2	1	12	13							55
45/ 49			1		2	2			7	2	9	22		2	10	2	2	6				2			101
40/ 44			7	1		10		2	30	29	31	54		3	11	8	3	10			3		1		198
35/ 39			2	6	19	32		5	70	97	97	49		2	43	38	31	17			1	4	1		623
30/ 34			3	9	51	20		5	91	109	210	158		3	55	52	54	26				4	2		817
25/ 29		2	6	16	18	2		5	79	150	122	123	2	7	46	48	27	3		2	10	3			561
20/ 24			5	22	17	4		9	98	101	79	13	8	23	65	40	11	2			6	4	2		496
15/ 19			4	15	8			14	110	68	25	2	1	14	45	22	4	1		1	5	1			338
10/ 14	2		3	3			5	11	78	34	8	1	1	16	25	16	1								202
05/ 09	1		10	6	2		1	12	67	22	2			11	8	10	1								153
00/ 04			5	1			1	10	33	12				7	9	2	2	1		4					87
-01/-05							1	6	8	2	2			5	2										26
-06/-10							3	7						9											19
-11/-15							4	2	1					1											8
April																									
85/ 89														2											2
80/ 84							3	14	10				1	3	4										35
75/ 79		2					17	21	18				3	11	8	1				2					83
70/ 74		3					7	19	30	7			6	12	16	13					1				114
65/ 69	2	2	3				11	27	26	20	10		1	17	3	10	10								142
60/ 64		2	9	2	1		10	39	35	27	43	16	14	17	19	11	12	2				1	1		261
55/ 59	2	9	14	4	5	5	7	51	49	21	33	24	3	23	15	10	3	3			1				282
50/ 54		4	16	8	18	1	5	99	97	53	58	32	5	33	40	5	10	10	1	6	5	1	1		508
45/ 49		8	10	10	4		3	78	127	75	51	27		30	50	24	18	8		6	9		3		541
40/ 44		2	29	11	20	6		32	152	74	77	62	4	17	63	29	28	15		1	2	8	3	1	636
35/ 39		1	22	13	17	9	1	21	123	79	69	30		7	86	29	54	18			10	9	2	1	601
30/ 34	1		10	20	5	2		14	45	66	31	24		11	35	20	17	4			1	1			307
25/ 29			1	7	2	1	4	6	10	12	9	2		4	4	2	2								66
20/ 24							2	4	1	1	1			3	9										21
15/ 19														1											1
July																									
95/ 99								15	1					11											27
90/ 94		1					4	106	39					25	7										182
85/ 89	3	10	9				4	163	126	4				18	30										367
80/ 84		18	29	2	1		3	209	196	38	4			16	25	6	1				1				549
75/ 79	1	17	45	20	12	3		133	244	108	80	18		5	8	12	6	1							713
70/ 74		10	67	49	31	20		63	197	128	123	86		2	10	4	4	5							799
65/ 69		2	60	82	89	31		11	96	108	96	70		1	7	3	2	5							663
60/ 64			30	34	57	22			35	36	60	44			1	2		3							324
55/ 59			2	16	21	16				17	10	2													84
50/ 54					7	1					4														12
October																									
90/ 94									1																1
85/ 89							19	6	11					5	2										43
80/ 84	1	1	2				13	28	30				1	9	12					1	5				103
75/ 79		1	3	3			27	38	25	9	2		2	6	5						1	2			124
70/ 74		3	4				17	62	49	28	19	1	3	14	3	7	4								214
65/ 69		9	6	4		3	8	102	67	29	50	37	4	8	4	1	4	7							343
60/ 64	1	5	15	3	2	4	1	92	100	57	45	34	7	31	8	8	11	6		3					433
55/ 59		3	18	13	20	12	6	94	144	41	78	34	3	44	11	9	7	7							544
50/ 54		2	42	25	25	34	1	69	210	131	71	52	2	42	41	15	2	3							767
45/ 49		2	31	22	27	11	1	58	114	86	67	11	4	11	27	14	9	12				1			508
40/ 44		2	12	22	24	12		33	71	56	38	14	1	9	15	8	7				3				327
35/ 39			6	11	11	3		26	41	35	36	6		14	23	3	2	1							218
30/ 34			1	8	17				23	14	12	4			1	1	2								83
25/ 29			3		2				5			1						1							12

**Relative humidity in percent*

Table 21. Temperature and Wind Speed–Relative Humidity Occurrences (Hourly Observations) at Springfield *

Temp range (°F)	Winds0-4 mph						Winds5-14 mph						Winds >25 mph						Winds 15-24 mph						Total Obs
	£ 30	30-49	50-69	70-79	80-89	90-100	£ 30	30-49	50-69	70-79	80-89	90-100	£ 30	30-49	50-69	70-79	80-89	90-100	£ 30	30-49	50-69	70-79	80-89	90-100	
January																									
69/ 65																					6	1			7
64/ 60															3		4				5		5		17
59/ 55									1			16		2	6	13	12	2			4	5	6	1	68
54/ 50						13		8	14	3	4	22			17	13	13	16		2	7			2	134
49/ 45		1	2					6	22	5	7	10		5	52	25	5	26			6	4	1	2	159
44/ 40			1	5				4	51	18	17	25		8	59	37	9	31			27	7	1	2	281
39/ 35			1	3	1	8		2	44	43	51	76		1	70	64	27	48			10	8	3	3	467
34/ 30			2	6	5	21		5	45	69	95	225		1	59	92	127	85			17	9	13	4	875
29/ 25			6	1	4	5		2	51	86	86	46		3	65	104	86	31		2	4	10	8	6	612
24/ 20				2	10	10		1	51	58	58	15		10	66	75	36	3		2	10	16	5	1	407
19/ 15			2	10	8	1		4	55	45	42	9		3	50	75	10				3	6			306
14/ 10				2	10			10	55	50	29			3	27	32	6				6	4			185
09/ 05			3	3	3			15	25	14	6			5	26	10	5			2	1				116
04/ 00					3				16	4				6	12	6					2				46
-05/-01			1					1	10	6				7	15										40
April																									
89/ 85							2	5						3											10
84/ 80							4	13	4				5	19	15					1	6				67
79/ 75	1	1					8	16	18	1			1	25	57	5				2	7				122
74/ 70		2	1	1			6	27	24	4	3		1	7	40	16	5		1	3	15	7			161
69/ 65		3	2	2			5	29	30	18	5	2	4	23	28	56	54	2		4	8	7	4		246
64/ 60		5	1	1	1	2	1	28	41	8	17	30	4	45	49	18	29	17		5	8	4	2		316
59/ 55		10	4	4		2		59	41	20	19	34	2	51	41	25	24	23	1	5	6	4	5	4	382
54/ 50		9	4	10	1	4		44	73	58	50	27	4	60	55	25	22	11	1	23	13	5	6	1	486
49/ 45		3	5	3	5	5		20	87	44	32	54	1	30	59	42	54	22		11	29	6	13	2	507
44/ 40		3	4	4	2	10		6	66	62	51	45	2	21	67	49	57	50		1	27	8	7	9	531
59/ 55			4	6	12	2		4	29	58	64	29	1	14	58	46	55	55			20	15	17	19	466
54/ 50			2	4	7	11		3	10	33	50	15		2	27	12	17	14			8	1	2	11	229
29/ 25			2	1	1	2			3	9	19	5			16	2	2	1							63
24/ 20				1	6				2	2	1				2										14
July																									
114/110																									2
109/105							2						2												5
104/100								15					1	2											21
99/ 95		3					1	39	4					6											74
94/ 90	1	2	3				5	77	59	14			1	25	1										206
89/ 85	2	8	16	1	1		13	142	162	95	22		1	29	29										456
84/ 80		12	52	8	2		2	130	210	123	133	36		19	75						3				672
79/ 75		12	48	36	25	3	1	89	199	102	139	152		17	73	30	6				10	3			822
74/ 70		5	28	23	35	38		16	134	59	66	69		9	30	39	23	8				5	3		740
69/ 65			16	22	46	54		1	58	32	60	25		7	17	14	14	13			2	1			418
64/ 60			5	9	27	51			13	2	5	12			10	8	2	6						1	234
59/ 55				5	18	15				1	2	2					8	4							57
54/ 50					7	1																			13
October																									
94/ 90							5													2	1				8
89/ 85							5	4	2				4	11	10						4				40
84/ 80	2		1				18	39	22	2			15	21	34				3	1	1	1			160
79/ 75	2	1	3	2			28	43	28	7	2		12	15	30	4	3			5					185
74/ 70	3	9	2		1	6	22	74	34	19	7	27	9	30	22	22	10	8	2						307
69/ 65		12	4	2	1		7	80	67	10	30	26	15	33	27	17	17	21	3	2		1			375
64/ 60	3	9	10	2	5	6	8	91	78	33	24	28	19	34	36	13	19	17	3	1	2				441
59/ 55		3	15	5	7	8	7	61	112	47	51	44	5	57	45	13	13	10	6	1					510
54/ 50		2	14	5	9	7	8	45	103	58	62	45	14	41	53	11	17	27			1	2	2		527
49/ 45		1	7	12	11	7	5	28	80	58	48	53	5	4	48	22	29	37		1	2	1			449
44/ 40			5	10	13	18	2	19	21	53	74	45	2	17	10	16	15	16			1	1			338
39/ 35		1	4	5	10	15		19	30	20	58	40		12	16		3								233
54/ 50			2	3	5	2		1	20	13	17	11		2	17	4	1								98
29/ 25			3	5	5				6	8	12	1													40
24/ 20			1	1					1	2															5
19/ 15										1	3														4

*Relative humidity in percent

Table 22. Temperature and Wind Speed—Relative Humidity Occurrences (Hourly Observations) for Evansville*

Temp range (°F)	Winds 0-4 mph						Winds 5-14 mph						Winds 15-24 mph						Winds >25 mph						Cumul total
	£ 30	30-49	50-69	70-79	80-89	90-100	£ 30	30-49	50-69	70-79	80-89	90-100	£ 30	30-49	50-69	70-79	80-89	90-100	£ 30	30-49	50-69	70-79	80-89	90-100	
January																									
70/ 74															12	5					3	1			21
65/ 69								1	1		2			1	15	29	19	2				5	4		79
60/ 64							1	3	3	1	9	8		2	7	14	46	20			1				115
55/ 59						1		3	5	27	22	52		14	16	19	24	57			1		2		243
50/ 54			2	1		8		13	23	19	25	84		8	28	21	12	29			3				276
45/ 49			4	1	2	10		18	56	32	21	52		10	31	8	8	15							268
40/ 44		2	4	8	6	14		22	107	32	40	97		14	48	3	19	19			2	1	1	3	442
35/ 39		1	5	10	11	20		3	107	78	70	114		1	40	20	30	44			2	1	1	2	590
30/ 34			5	24	22	40		4	66	109	115	178		2	30	68	63	39				5	3	3	776
25/ 29			2	25	22	19			62	96	81	20			24	71	21	8							451
20/ 24			5	7	13	24			48	49	43	11			17	14	7								238
15/ 19				1	18			5	18	11	18	1			12	8	10								102
10/ 14			3	5	9			1	12	4	4			3	13	6	2								62
05/ 09			1	5	8				4	4					12										34
00/ 04			4	7	1						3				1										16
-01/-05			3	4																					7
April																									
85/ 89								4						7	1										12
80/ 84			3				8	18	24				7	29	21					1	3				114
75/ 79		1	2				12	35	34	5			6	27	29	3				6	5				165
70/ 74	1	2	4	6	2		4	33	48	36	14	3	7	14	42	20	1			4	1	2			244
65/ 69	1	6	10	5	6	4	8	55	35	38	42	7	3	29	35	12	10	6			2	1	1		325
60/ 64	1	7	6	8	6	30	5	66	60	33	52	52	2	28	26	11	18	13		3	2		3		432
55/ 59		3	7	17	21	19		74	64	34	47	74	2	32	32	11	10	9		1	1	1	2	1	462
50/ 54		1	13	9	18	12		52	101	32	49	44		31	49	15	23	15		3	3	1		1	472
45/ 49		5	8	16	23	5		21	88	52	44	45		8	54	33	30	30			7		1	2	472
40/ 44		3	12	17	28	18	1	8	78	53	83	31		8	64	34	25	15		3	9				490
35/ 39		1	3	10	30	25			34	60	48	10		4	15	17	16	17			1	1	4	4	300
30/ 34			1	6	14	22			8	11	8	1		4	3		3	4							85
25/ 29			3		9	7			2	1	3				1										26
20/ 24					1																				1
July																									32
100/104		3					3	16						10											138
95/ 99		12						91	5				1	28	1										303
90/ 94	4	22	9				19	140	87					15	6					1					530
85/ 89	1	22	40	4			15	157	223	9			1	18	37	2					1				685
80/ 84		19	35	34	11		1	135	222	134	30			5	39	14	4				1	1			753
75/ 79		5	28	47	112	41		44	139	110	153	46		6	8	7	4	1				1	1		714
70/ 74			28	57	98	143		5	79	39	122	150		1	5	4	8	2							299
65/ 69			8	28	77	81			27	16	27	27			1	2	3	2							187
60/ 64			5	20	42	80			3	9	15	13													49
55/ 59				1	14	25				1	7	1													3
50/ 54						2						1													
October																									
90/ 94	1	1					2	1	1																6
85/ 89	1	3					15	22	5						11	1									58
80/ 84	5	4	6				19	53	30	1				4	12	22									156
75/ 79	3	17	16	2			20	65	66	10	4			6	13	11	2								235
70/ 74	1	20	20	10	8	2	18	63	49	43	20	11		6	20	9	9	6	1						316
65/ 69	1	24	10	15	18	38	17	73	46	35	38	81		5	23	7	2	15	15						463
60/ 64		25	28	25	31	54	8	64	73	26	18	47		5	17	14	7	4	6						452
55/ 59		8	44	14	36	70	6	42	96	54	42	43		1	9	20	5	12	5						507
50/ 54		1	18	29	68	91	10	27	62	51	34	41		3	6	27	16	16	4				1		505
45/ 49		3	5	24	72	80	4	10	34	41	54	43		4	3	12	12	10	3						414
40/ 44		1	5	15	41	113	1	8	18	26	26	45		1	12	6	7	1		2	1	1			330
35/ 39			5	7	14	70	2	3	7	12	23	23			7	3	1		5		1				183
30/ 34			2	5	5	21		5	14	2	6	5													65
25/ 29				6	5				9	2	1														23
20/ 24				1	5						1														7

**Relative humidity in percent*

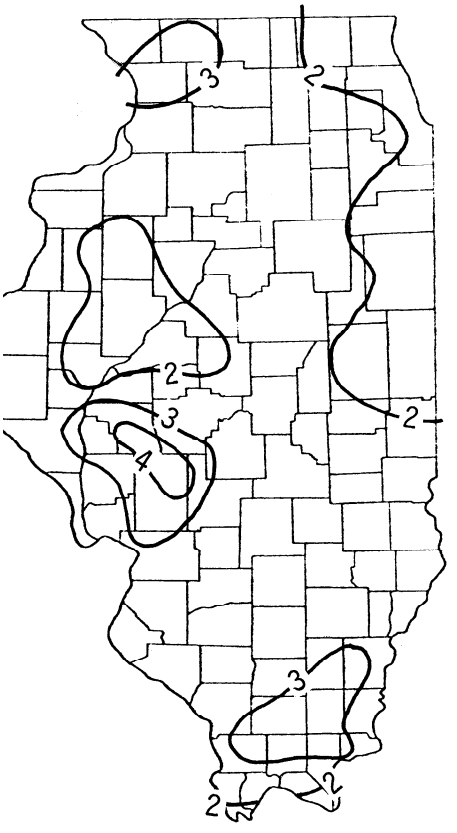


Figure 21. Average annual point hail occurrences

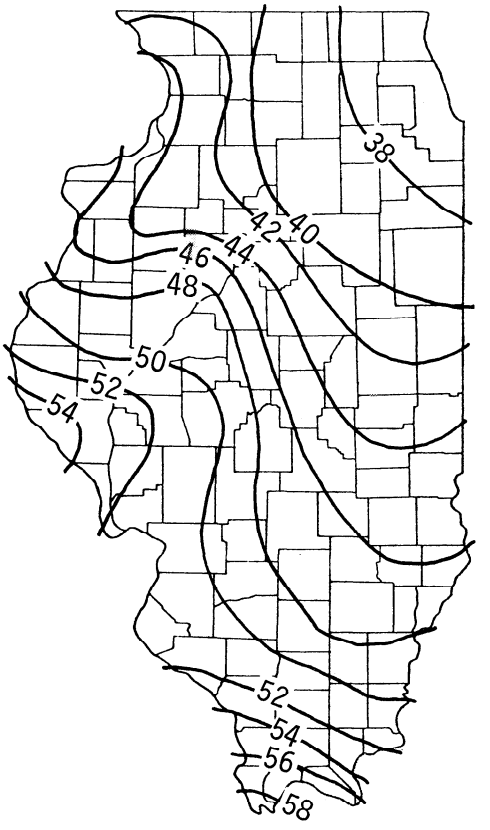


Figure 22. Average annual thunderstorms

Table 23. Point Hail Information for Illinois

	Hailstone diameter, inch					
	1/8	*1/4*	*1/2*	*3/4*	*1*	*>1*
Percent of total hailstones	22	24	30	11	6	7

Average number of hailstones per hailfall = 129 hailstones per square foot
Record number of hailstones = 1402 hailstones per square foot

Average impact energy per hailfall = 0.22 foot-pounds per square foot
Maximum energy in single hailfall = 12.66 foot-pounds per square foot

days in Illinois. These show a range from less than 38 days per year in northeastern Illinois to more than 58 days in extreme southern Illinois. Research on lightning damages supports these results, showing that the greatest number of lightning-induced damages in Illinois have occurred in southwestern and extreme southern Illinois (Changnon, 1964). Thunderstorm-produced winds in excess of 40 mph typically occur at least once each year at most points in Illinois. Tornadoes are another weather hazard. They occur very infrequently at a point and many areas of Illinois have not experienced a tornado in the past 100 years (Wilson and Changnon, 1971).

Another problem for solar radiation instrumentation and efficiency of these systems is air pollution. Figure 23 presents a graph of the annual frequency of smoke and haze days for Peoria since the turn of the century. A notable increase in smoke and haze situations is illustrated. The effect of these atmospheric particulates (and gases) on incoming radiation is not clear, although it is known to produce some reduction through interception of radiation. Another man-made effect on radiation concerns the vapor contrails left in the upper atmosphere by jet aircraft. Figure 24 presents the frequency of jet aircraft traffic across Illinois since the inception of the jet airplane engine in 1950. This shows a clear increase in the number of jet aircraft. This form of pollution apparently leads to more cirrus type clouds and a reduction in solar energy. It is believed to be one reason for the decrease in clear days and the increase in cloudy days (see figures 11 and 16).

Winter snowstorms represent another major hazard to solar collectors, either by producing damages or by covering collectors. Figure 25 is based on the maximum 2-day snowfall total recorded at various points in Illinois over a 61-year period. In most parts of Illinois, heavy snowfalls in excess of 12 inches have occurred with up to 23 inches in some storms. Figure 26a presents the pattern based on the average annual number of days with 1 inch or more snowfall (Changnon, 1969). This shows that the frequency varies considerably in Illinois on a latitudinal basis. A problem resulting from snowfall is the accumulated snow depth. Figure 26c shows the pattern based on the average annual number of days with 3 inches or more snow cover on the ground. The variations range from 5 days in southern Illinois to more than 30 days in extreme northern Illinois when ground is covered by 3 or more inches of snow. Figure 27 shows the maximum depths of snow recorded in Illinois over a 60-year period. This reveals that most areas in Illinois have had accumulations of snow on the ground in excess of 15 inches, at least once during this period.

The other major form of winter condition that is potentially serious for solar collectors is the ice storm. Figures 26d and 26e show the pattern of average patterns of glaze and sleet storms. Glaze storms are most frequent in the central sections of the state. Figure 28a shows the number of times that extremely damaging glaze storms occurred during an average 10-year period in three part parts of the state, again reflecting the greater incidence of glaze events in the central part of this state. Figure 28b shows the pattern based on data when the ice cover was 0.75 inch or thicker on wires. This indicates that the central, and most of the northern part of Illinois, experiences a storm of that magnitude at least once every 3 years. Tables 24 and 25 present additional information on glaze storms, including the thickness of ice and the types of wind speeds associated with them.

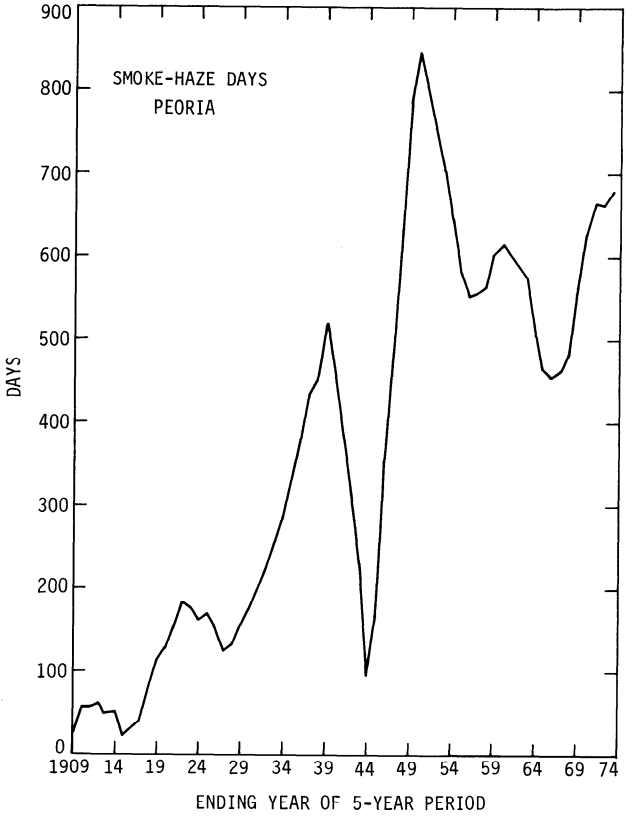


Figure 23. Annual frequency of smoke and haze days for Peoria

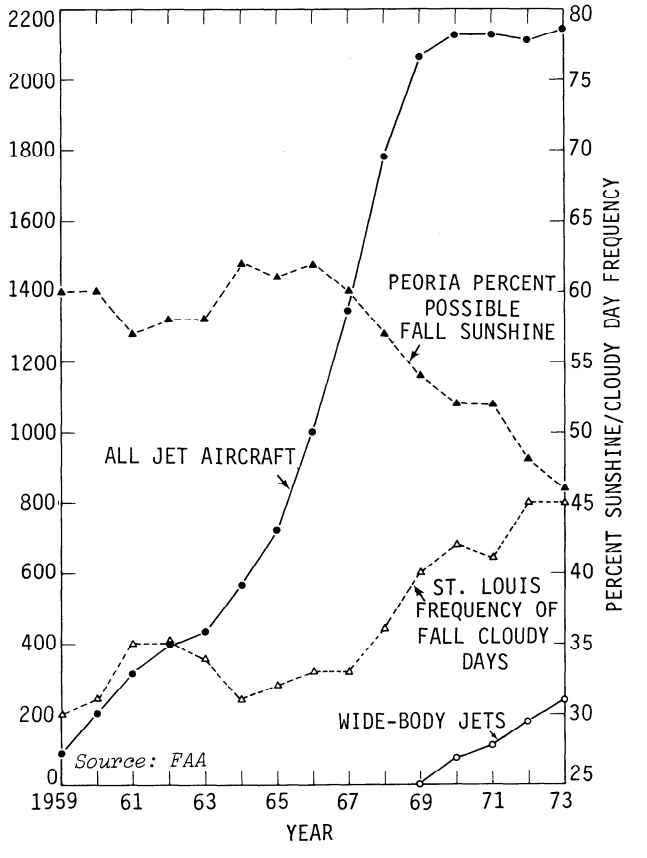


Figure 24. Comparison of growth of national commerical jet aircraft and fall season sunshine and clouds

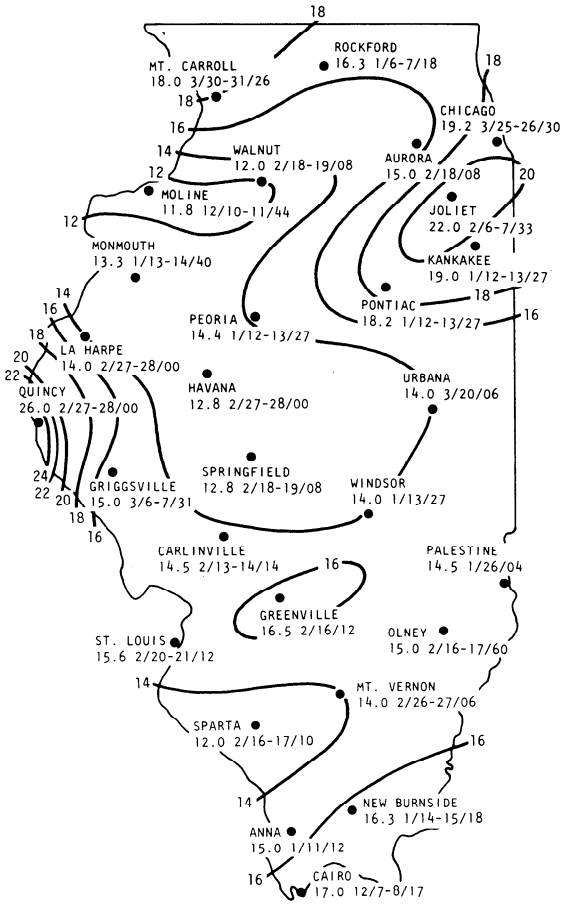


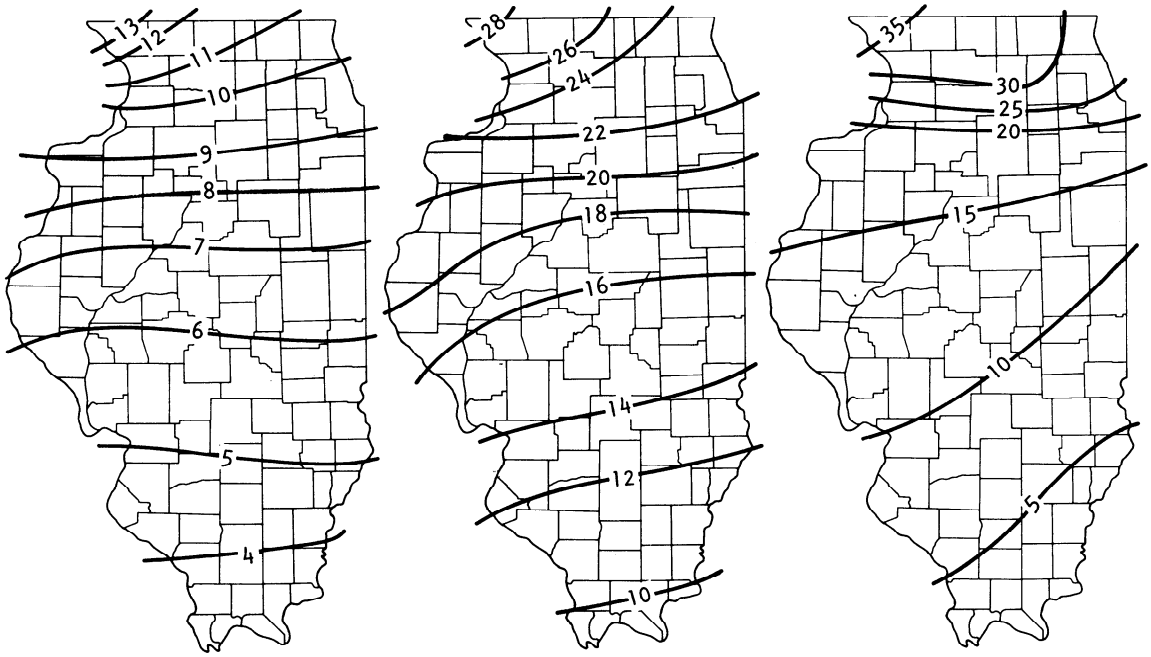
Figure 25. Maximum 2-day snowfall totals, in inches, and dates of occurrence in 1900-1960

Table 24. Summary of Maximum 5-Minute Wind Speeds Occurring after 148 Glaze Storms

Wind speed intervals (mph)	*Number of cases*	*Number of cases when radial thickness of ice was 0.25-inch or more*
0—4	1	0
5—9	17	2
10—14	35	3
15—19	46	15
20—24	27	6
25—29	10	3
30—34	6	1
35—39	2	1
40—44	1	0
45—49	2	1
50—54	1	0
Total	148	32

Table 25. Wind-Glaze Thickness Relations for Five Periods of Greatest Speed and Greatest Thickness

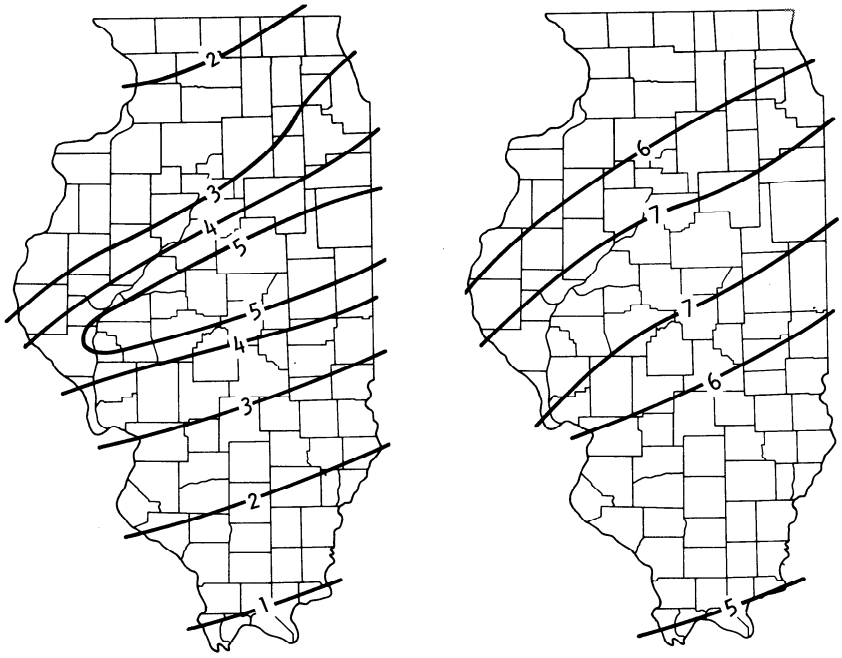
	Five periods when five fastest 5-minute speeds were registered		*Five periods when five greatest ice thicknesses were measured*	
Rank	*Speed (mph)*	*Ice thickness (inches)*	*Ice thickness (inches)*	*Speed (mph)*
1	50	0.19	2.87	30
2	46	0.79	1.71	18
3	45	0.26	1.50	21
4	40	0.30	1.10	28
5	35	0.78	1.00	18



a. Annual number of days with 1 inch or more of snowfall

b. Number of 2-day periods with snowfall of 4 inches or more in an average 10-year period

c. Annual number of days with 3 inches or more of snow on the ground



d. Annual number of days with glaze

e. Annual number of days with sleet

Figure 26. Average patterns of days with snowfall, snow depth, glaze, and sleet, based on point data

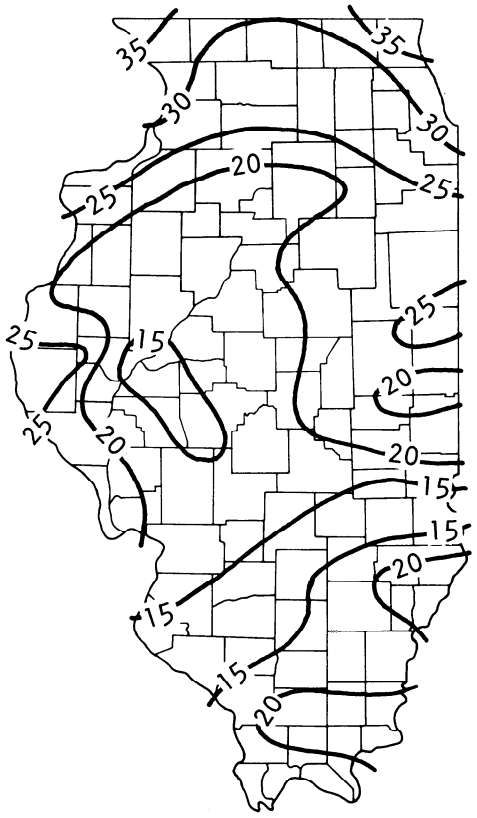
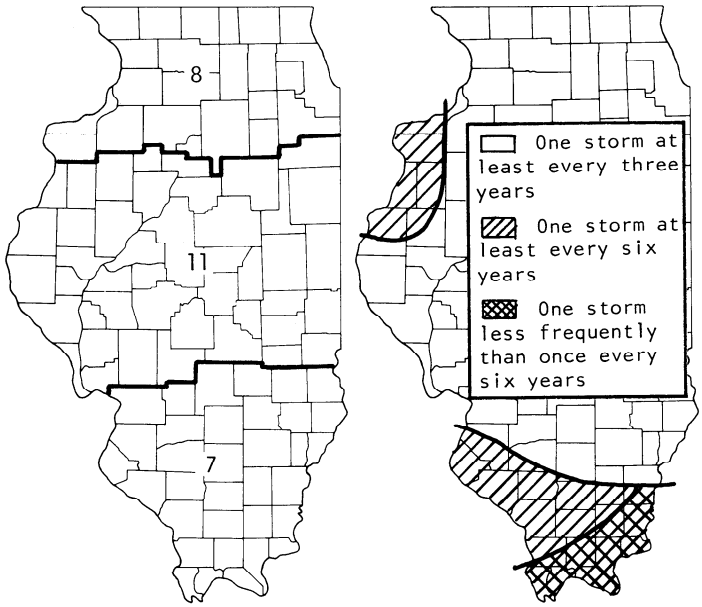


Figure 27. Maximum snow depths, in inches, 1901-1960



a. Number of damaging glaze areas expected in an average 10-year period

b. Areal frequencies of storms with 0.75-inch or thicker ice on wires

Figure 28. Regional frequencies of severe ice storm centers

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