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MEASUREMENTS OF MEAN DAILY SOLAR RADIATION FOR MEMPHIS, TENNESSEE, 1982-1987

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ABSTRACT

This paper presents a summary of solar radiation data that has been collected since 1982 by the Department of Geography and Planning at Memphis State University. Solar radiation data are useful for many environmental studies, but are not collected in many locations. These data are valuable as an index of solar radiation for western Tennessee, northeastern Arkansas and northwestern Mississippi.

INTRODUCTION

Solar radiation data are a valuable resource with applications in several disciplines, including studies in biology, agriculture, climatology and energy (Rosenberg et al., 1983, Muller and Mclaughlin, 1985). Since solar radiation data are not recorded at many locations in the United States, and at only a few in Tennessee, other forms of climatic data, such as air temperature data, are often used as surrogates, but are often inadequate (Mather, 1974, Rosenberg et al., 1983).

Since the summer of 1982 solar radiation data have been collected by the Department of Geography and Planning at Memphis State University. This data set is unique in that it is one of the few solar radiation data collections for Tennessee. This paper presents a summary of these data.

SOLAR RADIATION DATA COLLECTION

The solar radiation data collected at Memphis State University are measured on a daily basis by a Weathertronics Mechanical Pyranograph. The pyranograph has a range from 0 to 2.5 langleys/min. The pyranograph is positioned on top of Johnson Hall, which houses the Department of Geography and Planning. In this location the pyranograph is permitted to measure solar radiation with little interference from horizonal obstructions.

The pyranograph measures both direct beam and scattered solar radiation in the range of .3 to 3 microns. Solar radiation is measured by the temperature difference between four bimetallic strips, two of which are painted black and two are painted white. The white strips reflect incoming solar radiation and only respond to changes of ambient temperature. The two black metallic strips absorb incoming solar radiation and are thus heated. The black strips also respond to changes of ambient temperature. The difference in temperature of the white and black strips results in a difference of curvature of the two types of strips. One end of each black strip is connected to one end of a white strip to cancel curvature due to ambient temperature conditions, while the remaining curvature of the black strips represents the absorbed incoming solar radiation (Weathertronics Manual).

The pyranograph records incoming solar radiation on a seven-day strip chart, with each day represented by a daily curve. Daily totals of solar radiation are determined by digitizing the curves on an electronic digitizer.

RESULTS

Table 1 contains values of mean daily solar radiation by month for Memphis. As expected, the lowest values of solar radiation occur during December and the greatest values during June. In general, mean solar radiation values, at the surface of the earth in Memphis, range from approximately

YEAR	J	F	M	A	M	J	J	A	S	O	N	D
1982								317	317	268	150	129
1983	167	195	264	307	371	402	422					
1984	229	248	267	325	407	431	380	305	306	194	204	137
1985	171	224	255	354	364	386	367	321	305	224	157	166
1986	214	212	340	366	339	346	409	339	309	223	129	153
1987			330	382	392	421	399	384	343	313	195	147
MEAN	195	220	291	347	375	397	395	333	316	244	167	146

Table 1. Mean daily solar radiation in langleys/day for Memphis, Tennessee, 1982-1987.

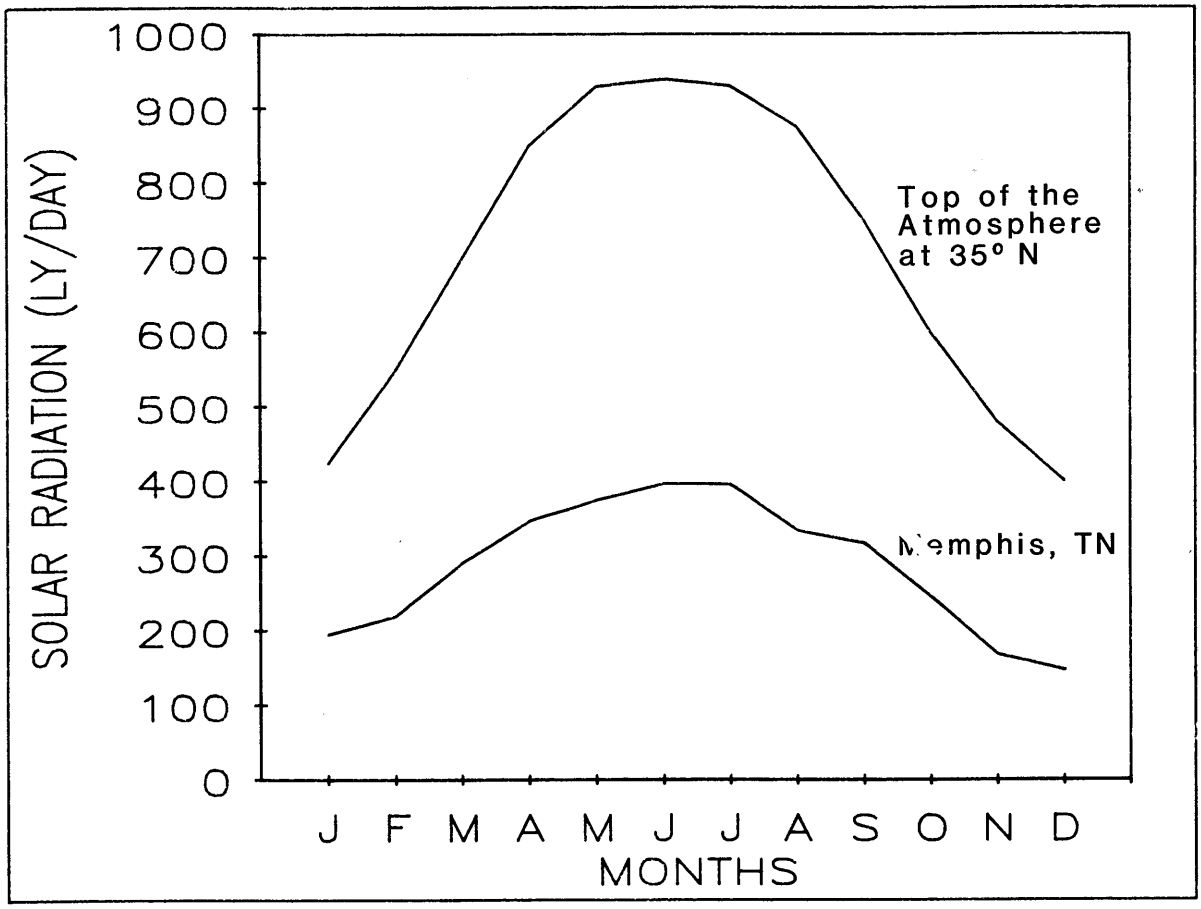

Figure 1. Mean daily solar radiation in langleys/day for Memphis, Tennessee and for the top of the atmosphere at 35 degrees north latitude.

150 to 200 langleys per day during winter, to nearly 400 langleys per day during the summer months.

Figure 1 is a comparison between mean daily solar radiation received at Memphis during the study period, and estimated levels of mean daily solar radiation received at the top of the atmosphere at 35 degrees north, which is the latitude of Memphis. The solar radiation estimates for the top of the atmosphere are based on a solar constant of 1.94 langleys per minute, and are derived from estimates for the fifteenth of each month (List, 1951). This comparison indicates the relative transmissivity of the atmosphere through the year in Memphis. On the average, Memphis only receives 40 percent of the solar radiation available at the top of the atmosphere. Thus, 60 percent of the solar radiation incident upon the outer atmosphere over Memphis never reaches the surface of the earth.

CONCLUSION

This paper has presented a summary of solar radiation data collected at Memphis, Tennessee. Values of mean daily solar radiation for Memphis are useful as an index of solar radiation values in western Tennessee, northeastern Arkansas and northwestern Mississippi, and are more appropriate as estimates of available solar energy for these areas than are surrogates such as air temperature. The relationship between mean daily solar radiation at the surface and at the top of the atmosphere is useful for those interested in modeling solar radiation receipts for the Memphis area. It is hoped that these data will be helpful to others with interests in climatological, biological, agricultural or other environmental studies that are benefited by information regarding solar radiation.

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