NORTH CENTRAL FOREST EXPERIMENT STATION

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INSOLATION AT CARTERVILLE, ILLINOIS

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ABSTRACT.— Insolation measured with a precision spectral pyranometer, was recorded near Carterville, Illinois, for 1 year. The pyranometer was tilted at an angle of 25° in summer, 50° in winter, and 37.5° in spring and fall. The insolation measured in winter was found to be significantly larger than the insolation estimated on a horizontal surface.

KEY WORDS: Pyranometer, tilting, horizontal surface, beam radiation, reflected radiation.

A better understanding of insolation, the total solar radiation, throughout the year is needed to evaluate the efficiencies of the solar collectors and solar kilns used in hardwood drying research. So insolation has been measured daily with a pyranometer at the North Central Forest Experiment Station's Wood Processing Pilot Plant near Carterville, Illinois (37.5° N), since the fall of 1978. This precision spectral pyranometer was considered more sensitive, precise, durable, and rapid in response than other types of instruments that measure total solar radiation. It was mounted on top of a solar collector (fig. 1) that was tilted at an angle of 25° in summer, 50° in winter, and 37.5° in spring and fall to increase the reception of solar radiation. Daily insolation was recorded automatically on strip charts by a dual pen recorder with an electronic integrator. The upper pen traces the instantaneous values of insolation (peaks), while the lower pen produces an oscillatory trace, or integration, on a marginal scale to provide a count of the area under the peaks traced simultaneously by the upper pen.

RESULTS

Mean daily insolation, with standard deviation, was calculated for each month in 1979; maximum and minimum daily insolation was also noted. Insolation peaked during June and reached the lowest level during November (fig. 2). Amplitude, the range between maximum and minimum daily insolation, was greatest in February and the mean daily insolation was low; amplitude was least in July and the mean daily insolation was high. This is contrary to observations in West Virginia over a longer period of time (Patric and Caruso 1979).

The insolation measured in winter was significantly larger than the insolation estimated on a horizontal surface (table 1) (U.S. Department of Commerce 1968). Tilting the pyranometer to a 50° inclination probably caused the measured insolation to increase in winter. The pyranometer received not only more beam radiation (direct from the sun) but also more reflected radiation due to the snow-covered ground, especially during January and February (table 1).

To determine the solar collector size necessary to supply a certain portion of the heating requirement, one should consider the average daily temperatures of different months and seasons as well as the insolation (table 1). The ambient temperature does affect the efficiency of solar collectors.

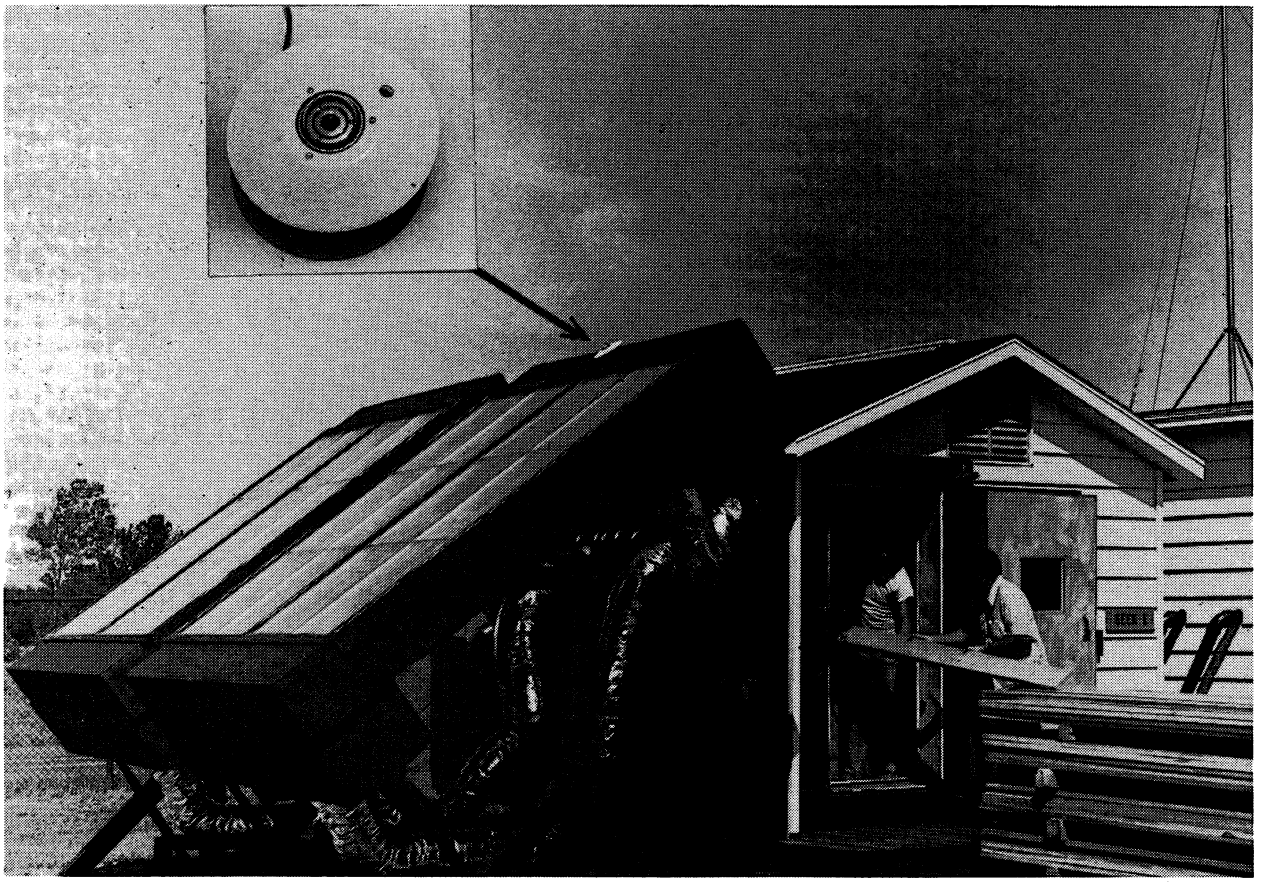

Figure 1.—*The precision spectral pyranometer mounted on top of a solar collector at the Wood Processing Pilot Plant near Carterville, Illinois (37.5° N).*

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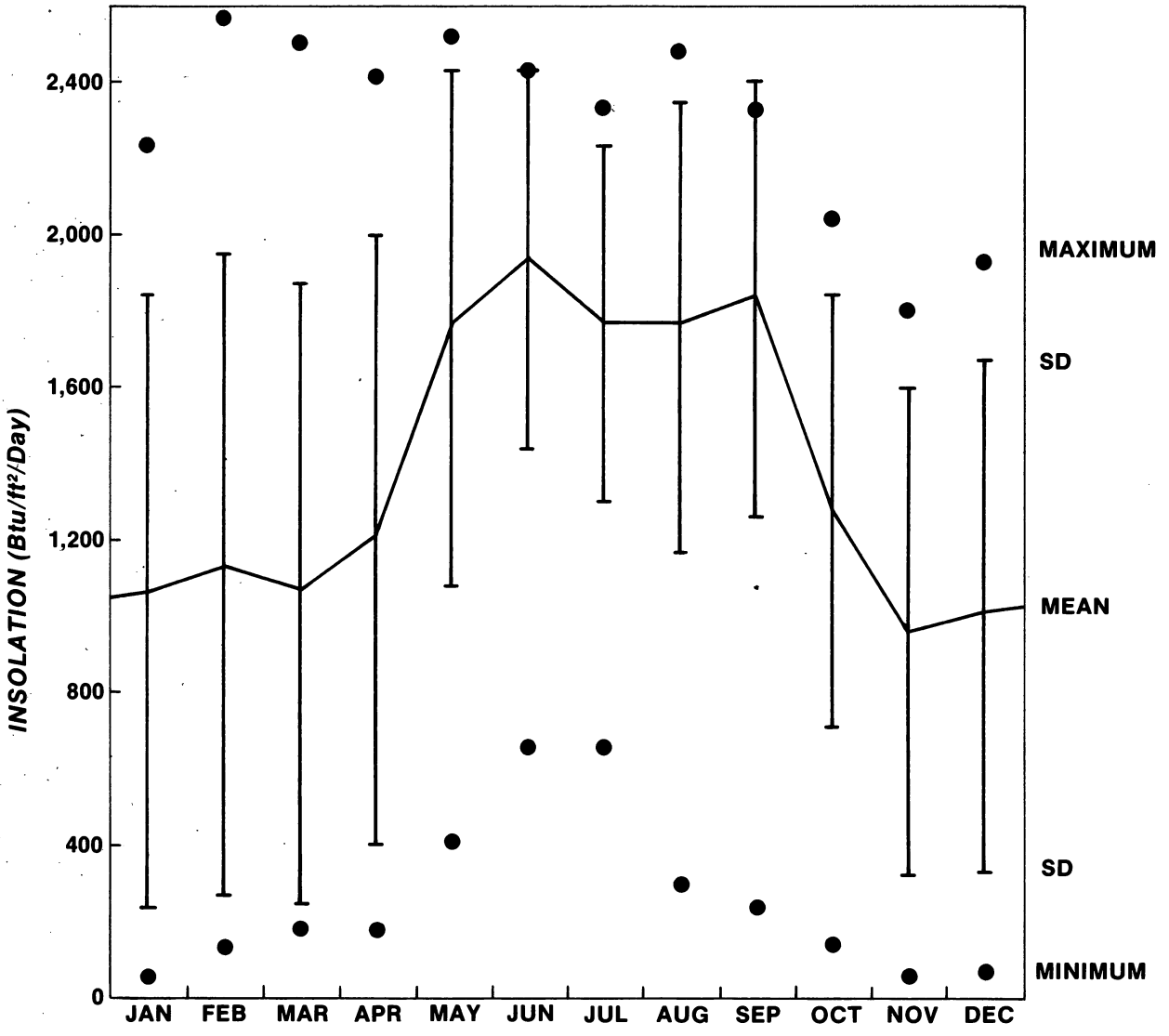

Figure 2.—*The range of measured daily insolation at the Wood Processing Pilot Plant near Carterville, Illinois. Mean daily values are plotted as a curve; standard deviations are plotted as vertical bars. Maximum and minimum values are the most and the least daily insolation observed for each month in 1979.*

Table 1.—*Measured versus estimated average daily insolation, monthly precipitation, and average daily temperatures at Carterville, Illinois*

Month	Insolation		Monthly precipitation		Average daily temperature	
	Measured	Estimated[1]	(snowfall)[2]		Maximum	Minimum
	Btu/ft²/day		*Inches*		*°F*	
January	1,042	701	3.92	(20.6)	28.5	9.8
February	1,108	904	6.30	(15.7)	36.1	12.6
March	1,060	1,255	5.26	(1.0)	53.1	35.4
April	1,201	1,587	8.26	0	63.4	44.7
May	1,756	1,937	3.32	0	73.4	51.4
June	1,933	2,030	4.68	0	84.3	62.4
July	1,767	2,030	6.54	0	85.4	66.7
August	1,759	1,827	5.47	0	84.0	64.1
September	1,831	1,568	1.58	0	80.0	51.0
October	1,276	1,199	1.72	0	70.5	41.1
November	961	812	6.31	0	54.3	30.7
December	1,003	572	2.54	0	45.9	25.0

[1](U.S. Department of Commerce 1968).
[2](U.S. Department of Commerce 1979).

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