PN-AAW-100
ISN 47583
9365716

SOLAR RADIATION MEASUREMENT

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Training in Alternative Energy Technologies
University of Florida
Gainesville, Florida
Session 9

ACKNOWLEDGEMENT

We are very grateful to the Agency for International Development which supported us for this course. We are also very grateful to the TAET staff, headed by Dr. Martin Bush, and the administration and technicians for the high standard of help they gave us in all our training sessions.

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INTRODUCTION

Our group consists of two participants, Mr. Pichai Namprakai, from Thailand, and Omer Musa Osman, from Sudan. We have selected this project to be our course project for a number of reasons, namely:

1. Solar radiation measurement is considered as the base for the design of all appliances to be operated by solar energy.
2. To learn the know-how for measuring, compiling and analysing data.
3. In Sudan there are some stations that belong the University of Khartoum and Research Centre, but these stations are very few and only experimental. They do not cover the whole country and the data available are not processed.
4. In Thailand there are about 30, or more, measuring stations for measuring sunshine duration and four or five stations for measuring global radiation on a horizontal plane. This is carried out by the Meteorological Department of Thailand and the data are now processed by some groups of concerned bodies. The processing can be focused on statistics of the useful data for assessing the possibility of using solar energy in the country.

OBJECTIVES OF THE PROJECT

Measure, compile and process data from solar radiation.

Means

Taking the data already available, measured by a pyronometer placed on the roof of the TREEO Center. We have started our data from the month we came to the training center and ended it a year back (i.e., March 1983 up to February 1984).

How We Processed Our Data

1. Solar radiation constant submitted by the sun is 428 Btu/ft^2 (1353 w/m^2). Some is absorbed by the atmosphere. Only 80%, which is 342 Btu/ft^2, reaches the ground.
2. Other than atmospheric absorption and reflection, there is a factor which affects the solar radiation--that is the availability of clouds. They have two different effects on radiation. The first effect is that they form a barrier, thus decreasing the solar radiation to a range of less than 50% (i.e., 0 - 45%). The second effect is that they reflect solar radiation, thus raising the pyronometer reading, in most cases, to an abnormal figure.

   The process which we used for our project is to take the measured area half-an-hour before and after solar noon (i.e., forming an hour). Then taking a measurement each hour after that.

   We found the area under the curve for each hour and multiplied that by the pyronometer factor, and related the hourly reading to the total number of Btu/day.

i.e., in the form of ratio

$$\text{Ratio} = \frac{\text{Hourly Btu}}{\text{Daily Btu}}$$

That was shown on the Y - Y axis. On the X - X axis we put the time in hours, making the basis of our measurement as the solar noon in hourly divisons.

As a sample we took only four days per each month (i.e., the beginning, the middle two days, 15th and 16th, and the end of it). We made an average for each month (for the four days selected).

What is the Significance of this Graph

As previously mentioned above, what we have taken was only a sample. The readings can be taken for the whole month so the average can be more truthful.

Many conclusions can be taken from the graph, such as:

a) A comparison between a clear day and the actual reading can be found by plotting the clear day data on the same graph.

b) When total radiation is known in a particular day, it can be calculated easily from the graph for any hour during the day.

c) Design for solar energy needs to be done according to the actual average radiation available. By that we mean, when someone wants to design any solar appliance, he should know that there are some environmental effects (such as clouds) in some certain months of the year which should be taken into consideration in design.

The Performance in the Graphs

Locking at some of our graphs, we see that in some cases after sunrise the curve drops down, and in other cases it goes beyond the actual limit. This effect is due to the two phenomena mentioned earlier. The drop is due to the coverage of the clouds (i.e., diffuse) and the second high reading mentioned is due to reflection by clouds.

TABLE OF RATIO $\frac{\text{HOURLY GLOBAL SOLAR RADIATION}}{\text{DAILY GLOBAL SOLAR RADIATION}}$

TIME IN HOURS FROM SOLAR NOON

Date	Sunset 7.5	6.5	5.5	4.5	3.5	2.5	1.5	Solar Noon 0.5	1.5	2.5	3.5	4.5	5.6	6.5	Sunrise 7.5
01/01/84	-	-	.009	.010	.090	.130	.150	.190	.150.	.120	.090	.040	.007	-	-
01/15/84	-	-	-	.030	.070	.130	.120	.150	.180	.170	.080	.040	-	-	-
01/16/84	-	-	.020	.070	.130	.150	.150	.150	.110	.080	.080	.030	.010	-	-
0/31/84	-	-	.010	.030	.090	.120	.120	.170	.170	.140	.080	.050	-	-	-
02/01/84	-	-	.010	.040	.060	.120	.150	.170	.160	.140.	.090	.030	.010	-	-
02/15/84	-	-	.010	.050	.080	.130	.150	.150	.150	.120.	.090	.050	-	-	-
02/29/84	-	.005	.010	.050	.090	.120	.184	.140	.141	.114	.085	.051	.017	-	-
02/16/84	-	-	.010	.090	.100	.070	.150	.140	.150	.150.	.060	.050	.008	.001	-
05/15/83	.002	.008	.040	.040	.090	.080	.110	.120	.150	.130	.100	.070	.040	.010	.002
05/16/83	.005	.007	.002	.006	.020	.050	.070	.050	.230	.240	.130	.100	.060	.010	.005
05/31/83	.005	.005	.020	.040	.050	.130	.150	.100	.170	.120	.080	.060	.050	.010	.001
06/01/83	.009	.020	.060	.110	.130	.150	.110	.130	.110	.080	.030	.040	.010	-	-
06/29/83	.030	.020	.070	.110	.040	.050	.090	.150	.160	.110	.070	.050	.020	.003	-
08/01/83	-	.020	.070	.100	.090	.130	.130	.130	.110	.080	.070	.040	.010	-	-
08/15/83	.002	.010	.050	.080	.110	.120	.120	.120	.110	.090	.060	.030	.005	-	-
08/16/83	.007	.030	.070	.090	.110	.120	.140	.120	.110	.090	.060	.030	.002	-	-
08/31/83	-	.010	.020	.070	.120	.130	.160	.150	.150	.080	.080	.010	-	-	-
09/01/83	-	-	.010	.020	.180	.100	.070	.140	.180	.140	.100	.030	-	-	-
09/15/83	-	.080	.140	.120	.150	.190	.120	.100	.050	.020	.010	-	-	-	-
09/16/83	-	.040	.080	.110	.130	.150	.150	.130	.100	.060	.030	-	-	-	-
09/30/83	-	.010	.050	.090	.090	.150	.140	.150	.130	.090	.050	.010	-	-	-
10/01/83	-	.003	.037	.105	.171	.242	.113	.257	.251	.197	.169	.095	.034	.010	-
10/15/83	-	-	.003	.021	.035	.035	.063	.048	.038	.048	.026	.030	.014	.002	-
10/16/83	-	-	.007	.070	.120	.120	.130	.130	.120	.170	.080	.020	.009	-	-
10/31/83	-	-	.004	.036	.100	.141	.157	.275	.198	.157	.042	.045	.006	-	-
11/01/83	-	-	.013	.033	.115	.138	.133	.139	.124	.142	.114	.045	.004	-	-
11/15/83	-	-	.007	.014	.014	.031	.102	.224	.287	.159	.114	.046	.002	-	-
11/16/83	-	-	.010	.045	.093	.133	.156	.162	.154	.116	.091	.035	.005	-	-
11/30/83	-	-	.002	.039	.102	.141	.142	.153	.167	.148	.073	.025	.007	-	-
12/01/83	-	-	-	-	.100	.140	.170	.180	.140	.130	.100	.020	-	-	-
12/31/83	-	-	-	.040	.100	.140	.160	.170	.140	.130	.080	.040	-	-	-

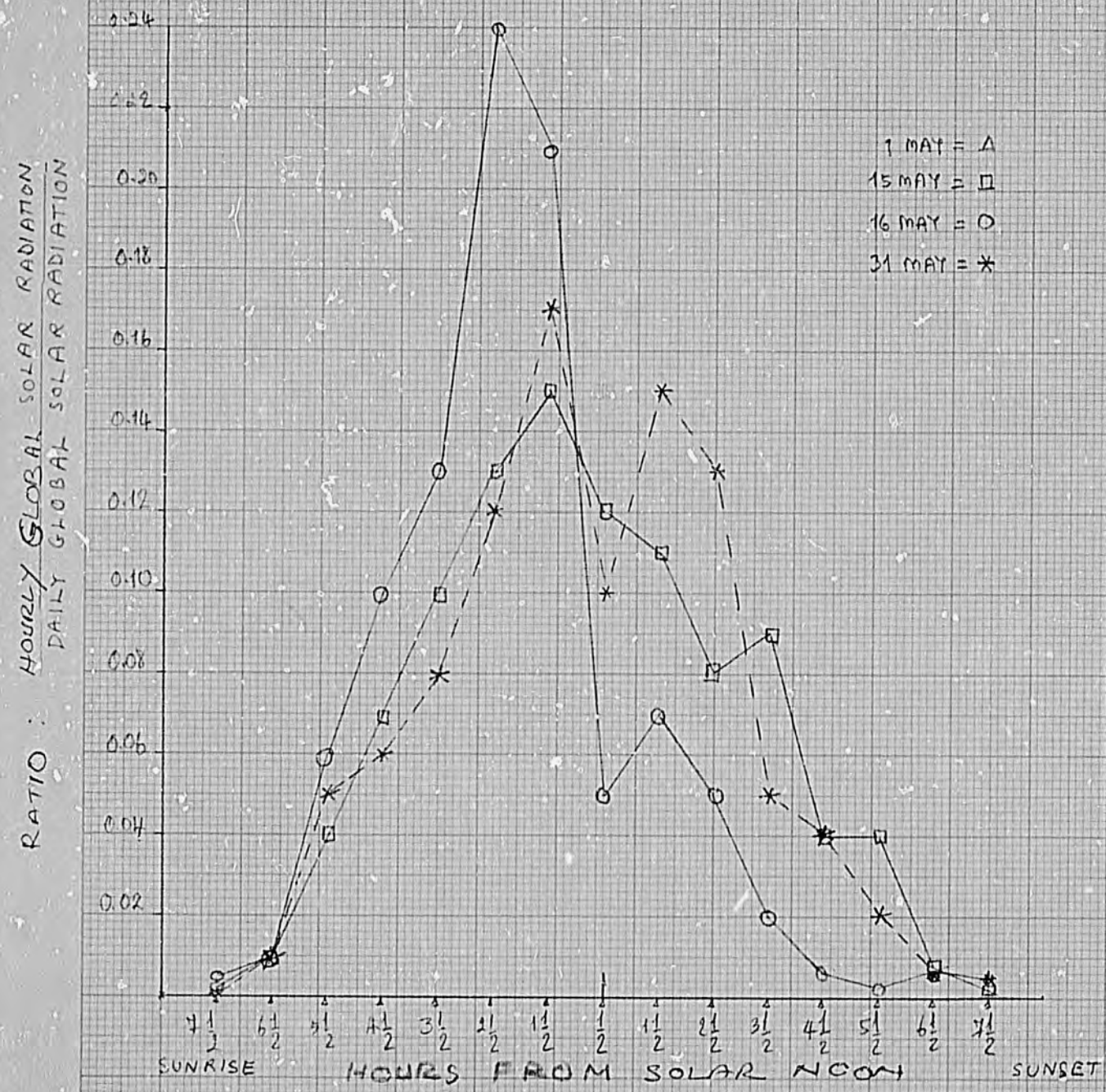

FIG 1 RATIO OF HOURLY TO DAILY GLOBAL SOLAR RADIATION ON MAY 1983

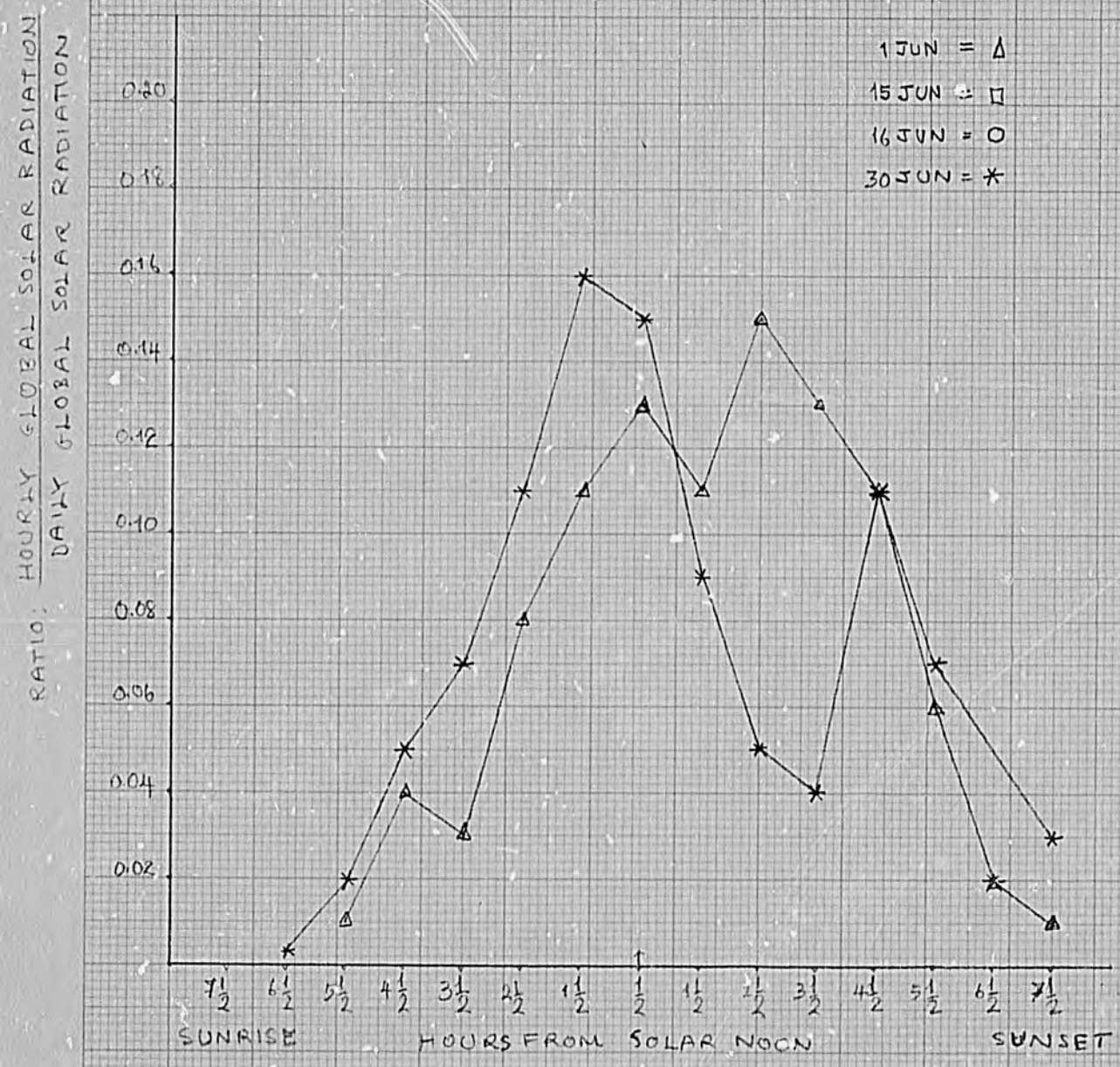

FIG. 2 RATIO OF HOURLY TO DAILY GLOBAL SOLAR RADIATION ON JUNE 1983

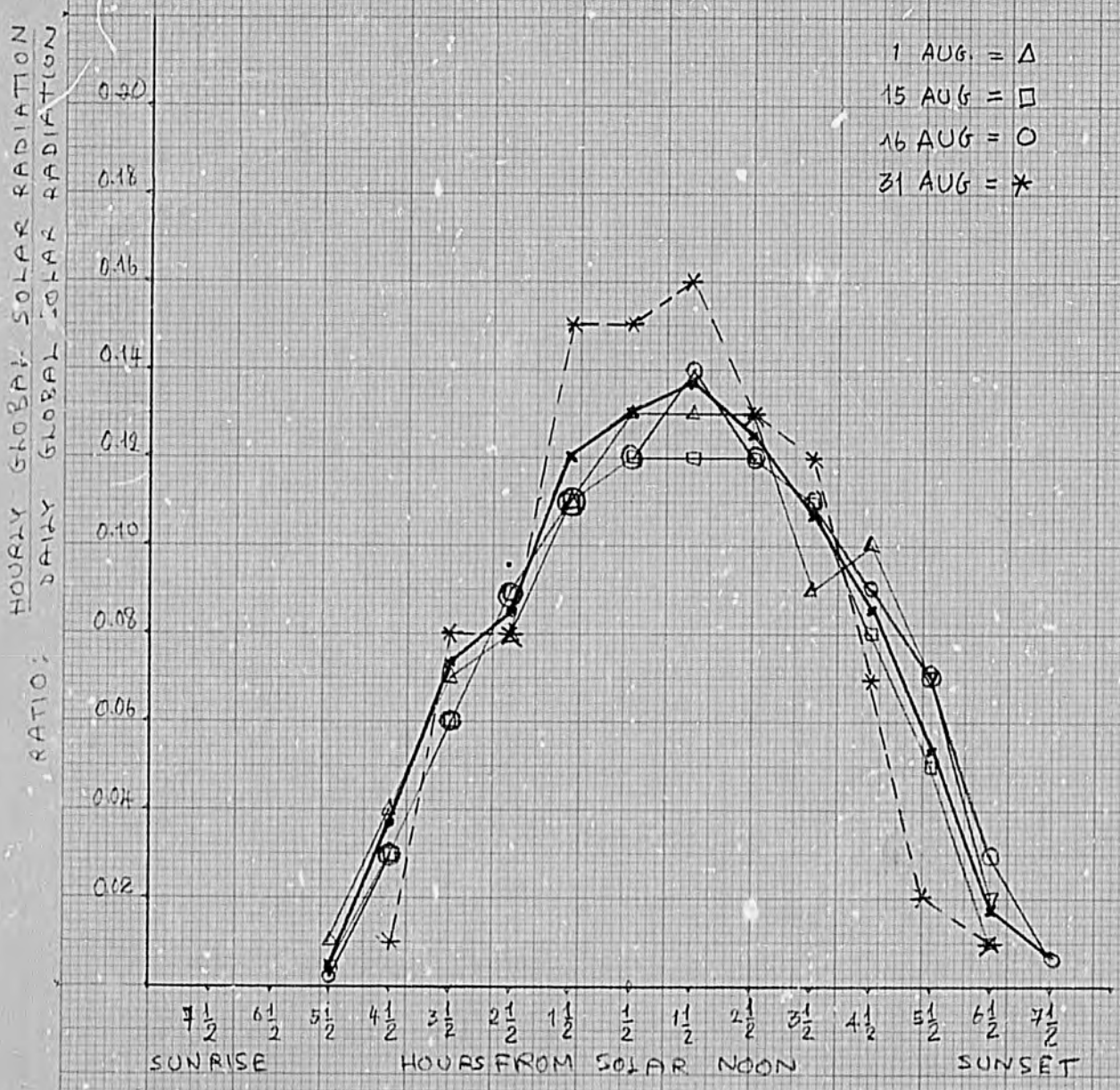

FIG 3 RATIO OF HOURLY TO DAILY GLOBAL SOLAR RADIATION ON AUGUST 1983

20 Squares to the Inch

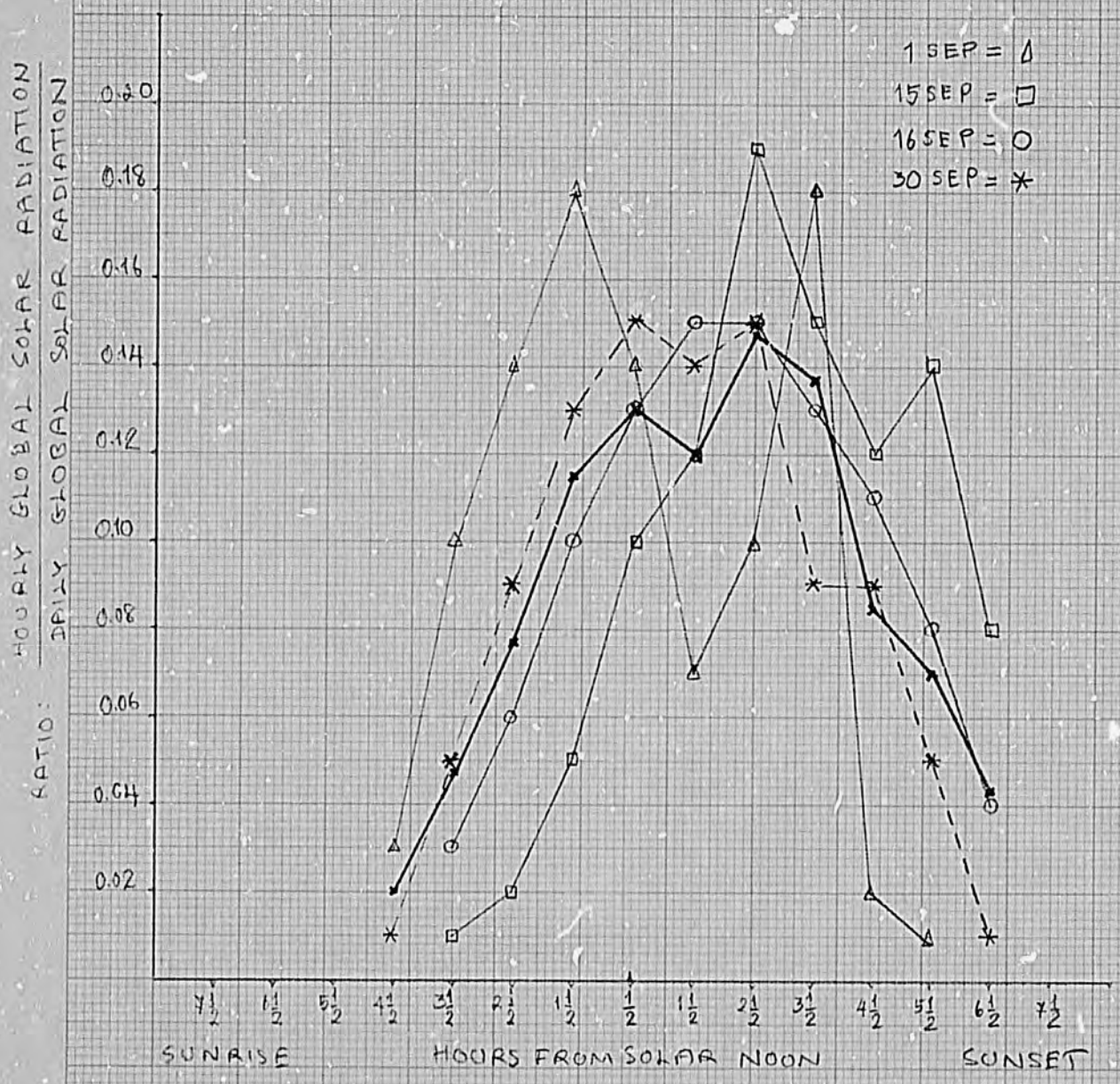

FIG 4 RATIO OF HOURLY TO DAILY GLOBAL SOLAR RADIATION ON SEPTEMBER, 1983

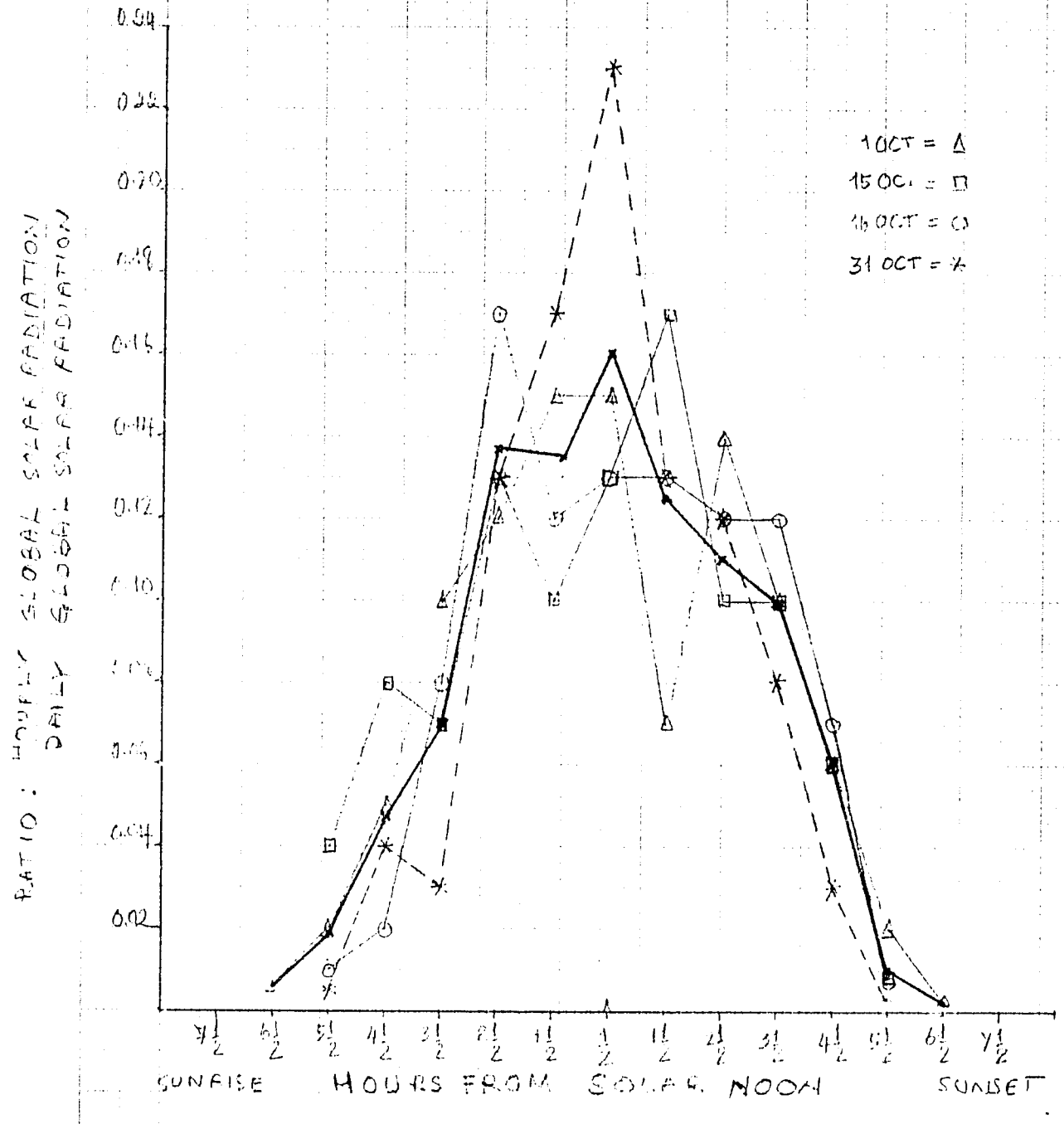

FIG 5 RATIO OF HOURLY TO DAILY GLOBAL SOLAR RADIATION ON OCTOBER 1983

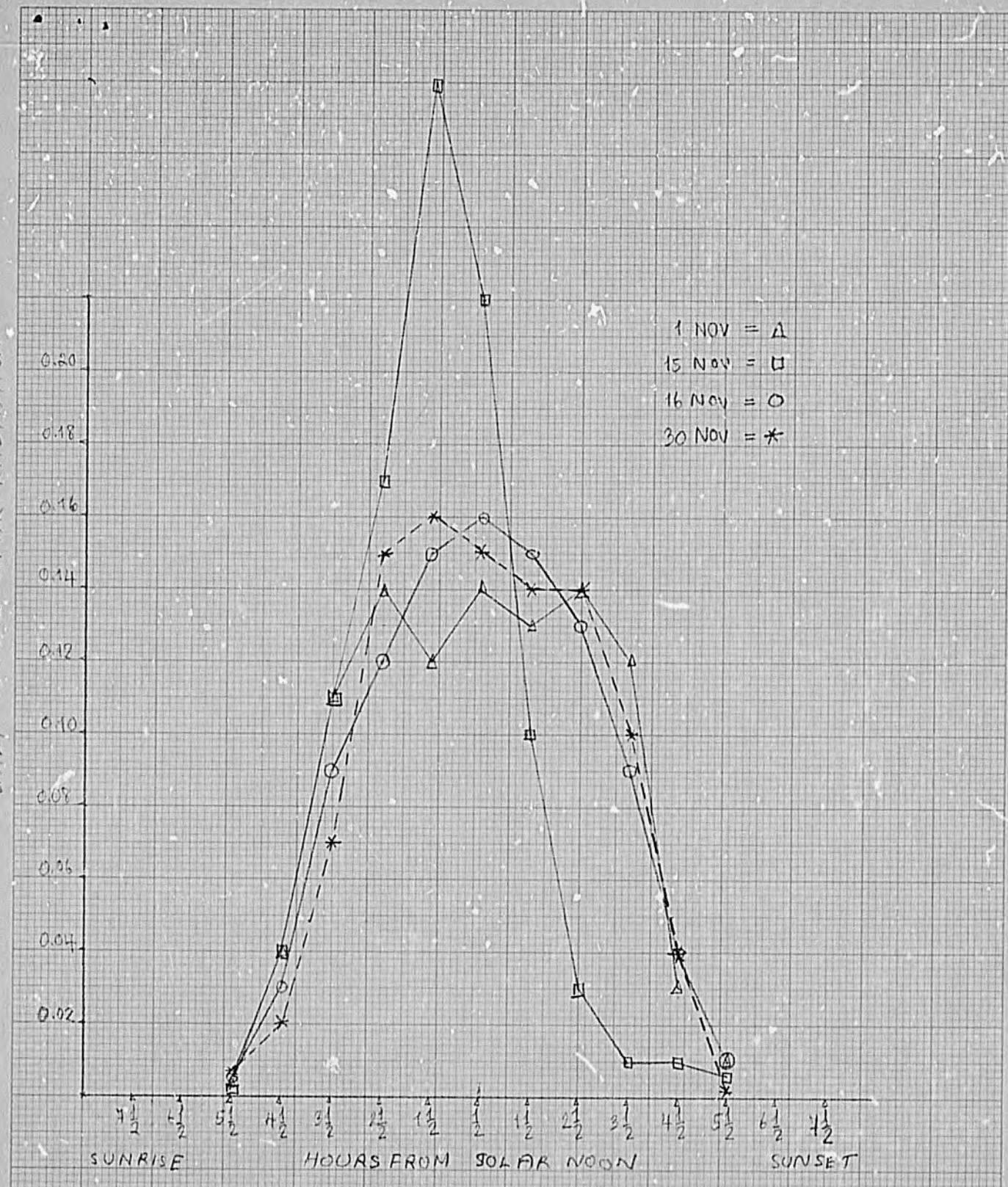

FIG 6 RATIO OF HOURLY TO DAILY GLOBAL SOLAR RADIATION ON NOVEMBER 1983

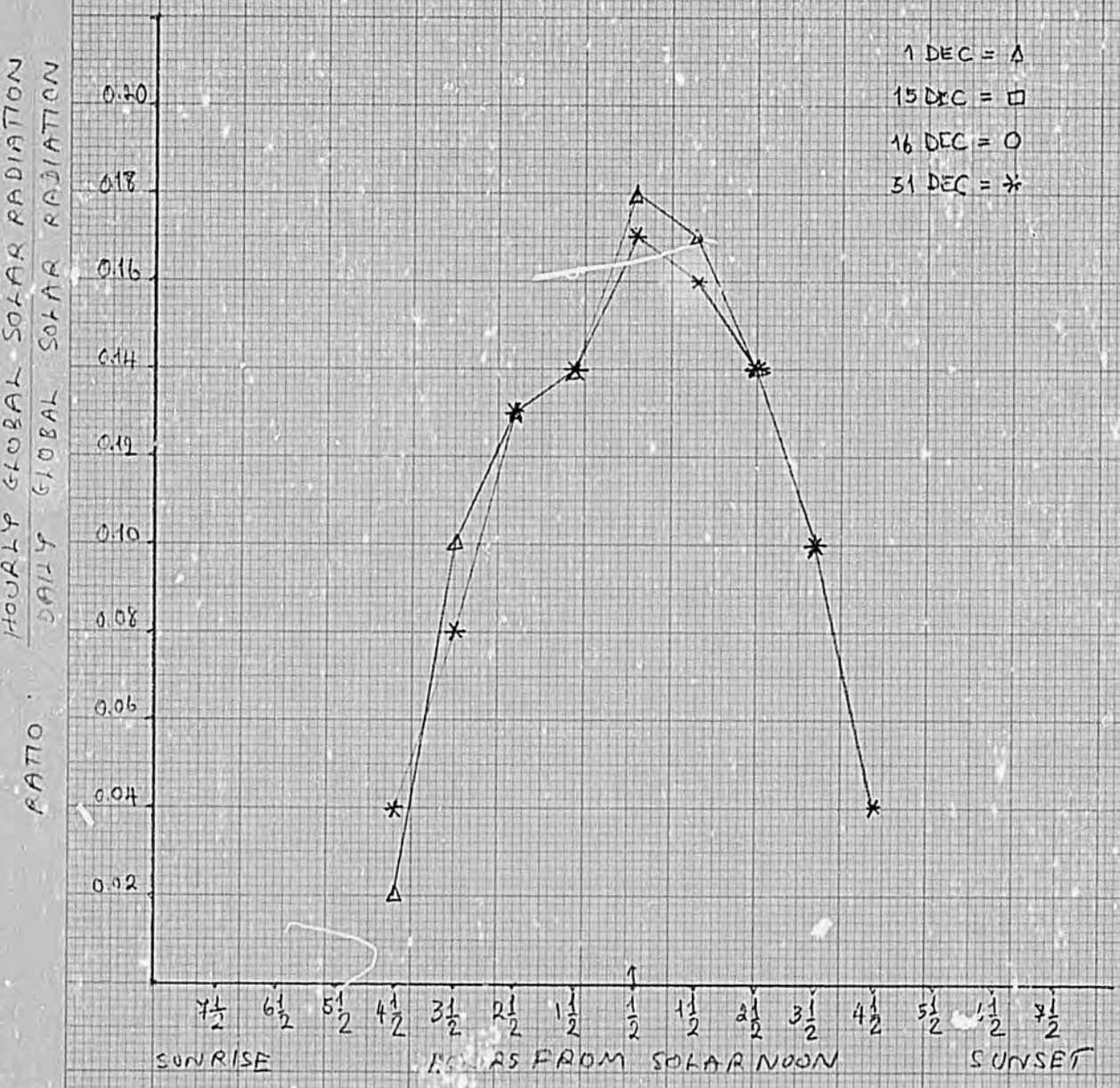

FIG 7 RATIO OF HOURLY TO DAILY GLOBAL SOLAR RADIATION ON DECEMBER 1983

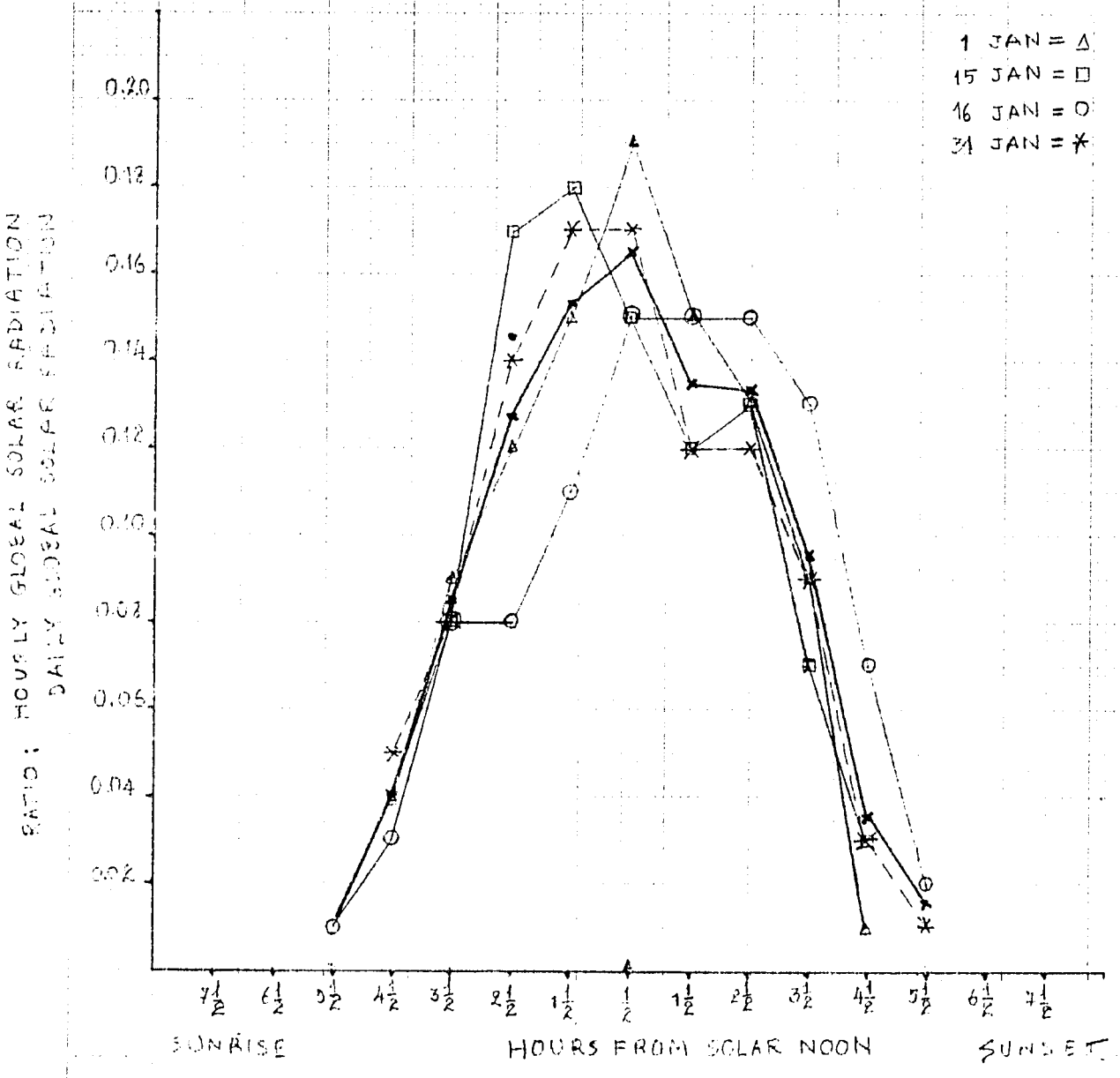

FIG. RATIO OF HOURLY TO DAILY GLOBAL SOLAR RADIATION ON JANUARY 1ST

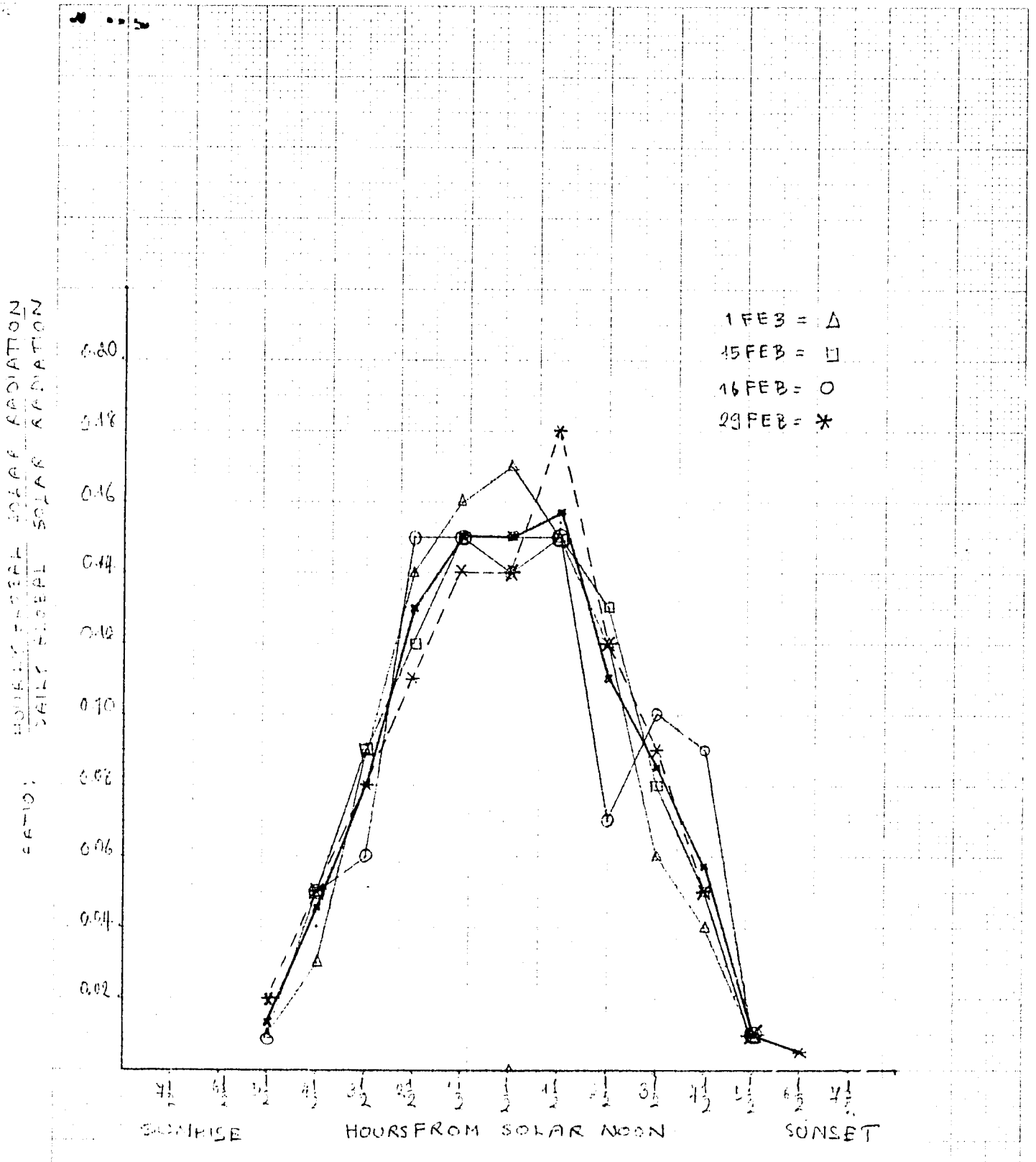

FIG 9 RATIO OF HOURLY TO DAILY GLOBAL SOLAR RADIATION ON FEBRUARY 1984