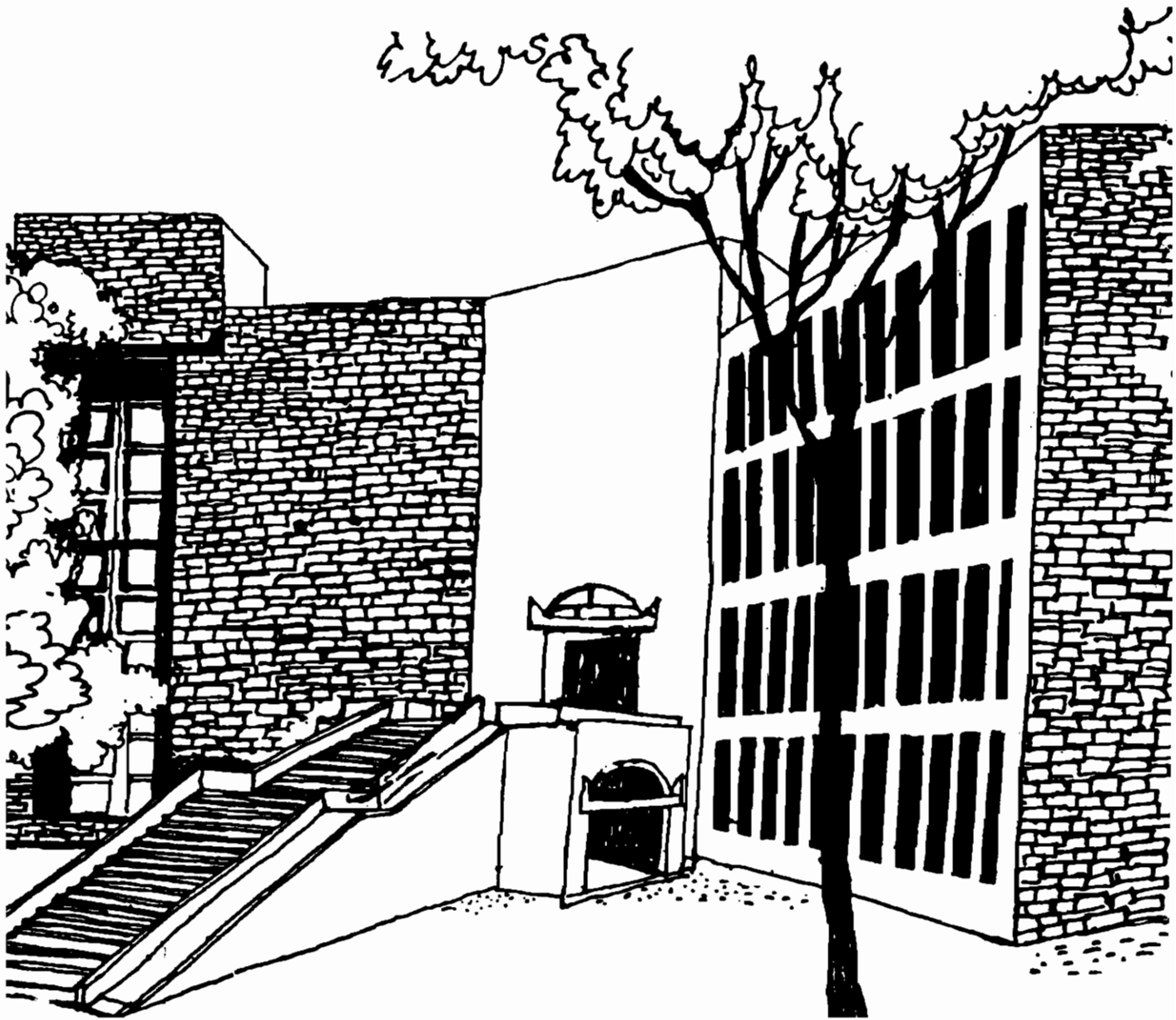




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AHMEDABAD

# Working Paper



# Fourier Representation of Ambient Temperature and Duration of Sunshine

Girja Sharan

Krishna Kumar M.

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## Fourier Representation of Ambient Temperature and Duration of Sunshine

Girja Sharan

Krishna Kumar M.

In the course of constructing a transient simulation model of the box-type solar cooker, a need arose for analytic expressions of ambient temperatures during the day. Mean hourly ambient temperature data for several places is given in the 'Handbook of Solar Radiation Data for India'(1). Locations in and immediate neighbourhood of Gujarat were of interest to us. These include Ahmedabad (23°04'N, 72°38'E), Bhavnagar (21°45'N, 72°11'E) Bombay (19°07'N, 72°51'E) and Jodhpur (26°18'N, 73°01'E). Accordingly, data of Ahmedabad, Bhavnagar, Bombay and Jodhpur (given in Tables 16, 56, 78 and 150 respectively of Handbook) were put through Fourier analysis.

For solar thermal systems, it is useful to know the availability of clear sunshine. Mean duration of sunshine during each one hour span is also available in the Handbook (Tables 13, 54, 76 and 147 for Ahmedabad, Bhavnagar, Bombay and Jodhpur). This data too has been subject to Fourier analysis. Results may be useful to those working on solar thermal appliances, as also some others interested in heat load calculations, moisture loss from plants etc.

### Ambient Air Temperatures

Equation 1 gives the Fourier series representation for ambient temperature.

$$T(t) = A_0 + \sum_1^n \left( A_n \cos \left( n \frac{\pi}{12} t \right) + B_n \sin \left( n \frac{\pi}{12} t \right) \right) \quad \dots(1)$$

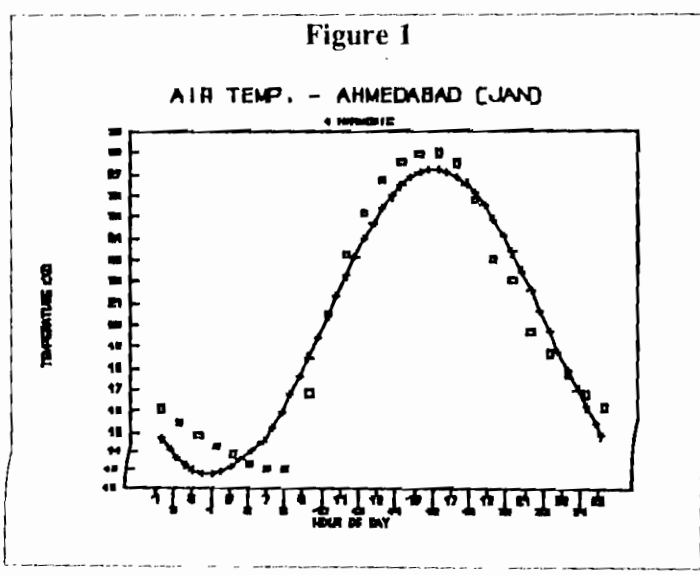
where T                      ambient temperature (°C)  
t                              time in hours, midnight being the origin  
A<sub>n</sub>, B<sub>n</sub>                      Fourier coefficients  
n                              number of harmonics

Table A1 of appendix gives the first six harmonics for Ahmedabad and Tables A2, A3 and A4 for Bhavnagar, Bombay and Jodhpur. For illustration, Figures 1 to 3 show the comparison of data from the Handbook (shown by □), and the computed values (using Equation 1) with one, three and five harmonics respectively for January month at Ahmedabad. Visual examination suggests that the representation with three harmonics is quite good and it gets better with inclusion of more terms. The maximum absolute deviation from the data with three and five harmonics is shown in Table 1.

Graphs of ambient temperature using three harmonics are given in appendix Figures A1 to A12 for May, July and December of the four cities.

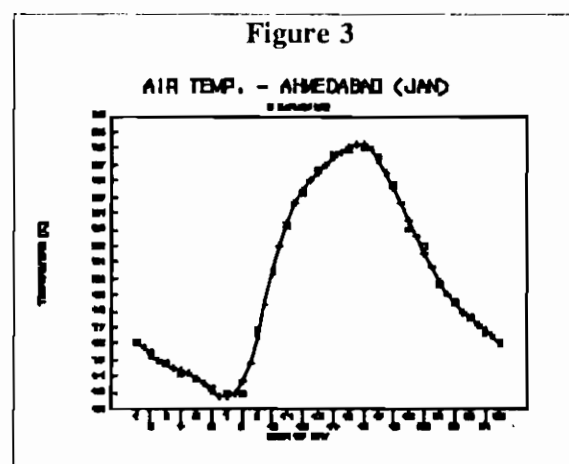
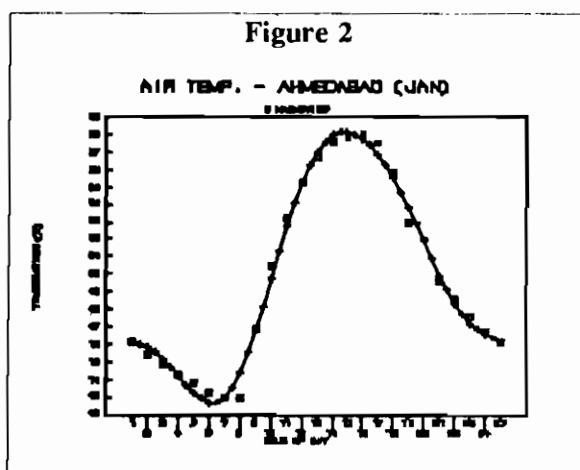
**Table 1**  
**Max. Absolute Deviation (%)**  
**Ambient Air Temperature**

	Ahmedabad		Bhavnagar		Bombay		Jodhpur	
	3 HAR	5 HAR	3 HAR	5 HAR	3 HAR	5 HAR	3 HAR	5 HAR
Jan	10.92	5.30	3.67	1.22	5.86	3.25	3.69	3.07
Feb	9.75	4.53	4.10	1.13	6.09	3.00	5.13	2.18
Mar	4.91	2.36	3.51	1.12	2.68	1.43	4.03	1.83
Apr	2.21	0.87	1.32	1.19	2.87	1.33	2.52	1.10
May	1.33	0.48	1.69	0.77	1.62	0.70	4.02	2.36
Jun	0.85	0.90	2.14	1.71	0.94	0.69	0.49	0.37
Jul	0.71	0.61	1.06	0.57	0.65	0.43	0.49	0.38
Aug	0.66	0.34	0.86	0.75	0.46	0.19	0.50	0.39
Spt	1.21	0.79	1.28	0.65	1.14	0.79	1.15	0.61
Oct	3.86	1.77	2.54	0.71	1.93	1.32	3.31	1.06
Nov	7.31	3.51	3.41	1.42	2.93	1.81	3.38	1.37
Dec	9.28	4.77	3.45	1.10	3.44	1.71	2.53	2.66



**Duration of Sunshine**

The data given in the Handbook is the mean duration of sunshine at the end of hourly span. If plotted against hour of day, a staircase profile will result. When summed (or integrated) over the day length, it will give the effective duration when there was clear sunshine. We have treated the given hourly values as if these were instantaneous values. Fourier representation given by **Equation 1** can again be used with left hand side replaced by sunshine duration,  $S(t)$ , interpreted as just stated.



Appendix Tables A5 to A8 give the first eight harmonics for Ahmedabad, Bhavnagar, Bombay and Jodhpur respectively. Presence of sharp corners near sunrise and sunset necessitates larger number of terms. Greater deviation from data can be expected near the sharp corners. However, the representation during the day say, from 8 am to 4 pm with eight harmonics is quite good. Table 2 shows the maximum absolute deviation for all the four places with 8 harmonics.

Graphs of sunshine using eight harmonics are given in appendix Figures A13 to A24 for May, July and December of the four cities.

	Ahmedabad	Bhavnagar	Bombay	Jodhpur
Jan	8.70	11.32	6.81	7.80
Feb	6.28	3.59	6.81	9.17
Mar	10.13	3.59	4.19	6.12
Apr	8.58	4.99	6.80	1.81
May	4.48	10.32	2.52	4.61
Jun	7.01	3.71	5.63	5.57
Jul	11.12	6.31	17.81	7.39
Aug	8.92	5.12	17.99	4.85
Spt	8.91	7.72	15.22	4.37
Oct	5.30	8.20	4.94	8.41
Nov	8.62	5.44	8.77	9.16
Dec	11.19	11.10	8.37	10.53

A word of caution may be in order. Whereas sunshine and irradiance have a definite diurnal regularity on a clear day, occurrence of clouds and other local factors obscuring sunshine are essentially stochastic. Fourier representation would make the occurrence of obscuring out to be deterministic which it is not. The utility of sunshine representation lies in that it can give a broad idea of the reduction in direct radiation during a typical day in the region to which these expressions belong. Moreover, it may be equally good to use a simple 'staircase' function with size of steps derived from data to represent the sunshine duration. Only advantage the Fourier series would offer over staircase is that it is differentiable and more convenient to use in simulation.

### References

1. Mani Anna. Handbook of Solar Radiation Data for India. Allied, 1980.
2. Hildebrand F.B. Introduction to Numerical Analysis. Mcgraw Hill, 1956.

## **Appendices**



**Table A1**  
**Fourier Coefficients for Air Temperature Series**  
**AHMEDABAD**

	n	0	1	2	3	4	5	6
Jan	A	20.01	-3.92	0.89	-0.44	0.23	0.07	-0.18
	B		-6.07	1.63	0.35	-0.48	0.20	0.08
Feb	A	23.13	-3.97	0.98	-0.36	0.35	0.14	-0.27
	B		-6.70	1.67	0.60	-0.48	0.17	0.15
Mar	A	27.37	-3.54	0.79	-0.40	0.20	0.17	-0.18
	B		-6.42	1.36	0.59	-0.44	-0.05	0.09
Apr	A	31.55	-2.94	0.69	-0.30	0.16	0.13	-0.08
	B		-6.12	1.15	0.55	-0.31	-0.05	0.06
May	A	33.77	-2.53	0.31	-0.08	0.11	0.13	-0.04
	B		-5.90	1.20	0.39	-0.14	-0.09	0.03
Jun	A	31.83	-2.08	0.06	0.11	0.04	0.00	-0.08
	B		-3.74	1.07	0.20	-0.12	-0.08	0.06
Jul	A	28.74	-1.24	0.08	0.04	0.00	0.01	-0.04
	B		-2.07	0.54	0.10	-0.12	-0.03	0.06
Aug	A	28.03	-1.12	0.12	0.02	0.03	0.01	-0.03
	B		-2.07	0.50	0.06	-0.10	-0.03	0.04
Sep	A	28.00	-1.76	0.34	0.00	0.04	0.01	-0.08
	B		-2.60	0.71	0.13	-0.17	-0.03	0.08
Oct	A	27.69	-4.02	1.02	-0.13	0.03	0.07	-0.18
	B		-4.65	1.33	0.55	-0.51	0.01	0.19
Nov	A	24.27	-4.73	1.27	-0.26	0.03	0.07	-0.17
	B		-5.31	1.48	0.48	-0.65	0.11	0.23
Dec	A	21.03	-4.20	0.99	-0.26	0.20	0.00	-0.23
	B		-5.47	1.70	0.31	-0.58	0.08	0.16

Table A2 Fourier Coefficients for Air Temperature Series BHAVNAGAR								
	n	0	1	2	3	4	5	6
Jan	A	20.38	-1.89	0.73	-0.34	0.28	-0.09	-0.13
	B		-5.39	1.43	-0.22	-0.25	0.09	-0.03
Feb	A	23.58	-2.19	0.98	-0.36	0.24	-0.06	-0.11
	B		-5.17	1.06	0.05	-0.44	0.06	0.05
Mar	A	27.99	-2.37	0.98	-0.39	0.22	0.06	-0.11
	B		-5.30	1.07	0.17	-0.34	0.11	-0.04
Apr	A	30.60	-2.22	1.07	-0.18	0.13	0.00	-0.02
	B		-4.37	0.88	0.25	-0.19	-0.05	0.08
May	A	32.14	-2.56	0.96	-0.06	-0.12	0.11	-0.08
	B		-4.52	1.02	-0.15	-0.27	0.00	-0.01
Jun	A	29.74	-2.05	0.50	-0.11	0.10	0.02	-0.05
	B		-2.26	0.67	0.08	-0.09	0.06	-0.05
Jul	A	27.85	-1.52	0.46	-0.23	0.05	0.03	0.03
	B		-1.51	0.40	0.14	-0.11	0.08	0.02
Aug	A	27.31	-1.46	0.42	-0.13	0.01	0.04	0.02
	B		-1.95	0.52	0.06	-0.05	-0.04	0.08
Sep	A	27.38	-2.22	0.84	-0.17	0.05	0.07	-0.08
	B		-2.63	0.70	0.00	-0.14	-0.02	0.04
Oct	A	29.63	-2.65	1.07	-0.32	0.08	-0.05	-0.02
	B		-4.00	0.69	0.25	-0.39	0.17	0.04
Nov	A	26.93	-1.95	0.88	-0.28	0.05	0.06	-0.13
	B		-3.35	0.81	0.16	-0.37	0.09	0.06
Dec	A	22.41	-2.24	1.10	-0.33	0.22	-0.08	-0.08
	B		-4.89	1.08	0.03	-0.35	0.15	-0.02

**Table A3**  
**Fourier Coefficients for Air Temperature Series**  
**BOMBAY**

	n	0	1	2	3	4	5	6
Jan	A	23.40	-3.65	1.38	-0.54	0.03	0.07	-0.12
	B		-3.90	0.83	0.04	-0.38	0.13	0.12
Feb	A	24.55	-3.81	1.38	-0.65	0.05	0.09	-0.16
	B		-4.01	0.74	0.24	-0.48	0.14	0.10
Mar	A	26.44	-3.17	1.18	-0.43	-0.02	0.07	-0.08
	B		-3.10	0.45	0.35	-0.40	0.03	0.12
Apr	A	28.31	-2.58	0.99	-0.15	-0.10	0.07	0.00
	B		-2.34	0.14	0.40	-0.30	-0.03	0.12
May	A	29.75	-1.95	0.70	0.00	-0.11	0.05	0.01
	B		-1.48	0.20	0.25	-0.16	-0.04	0.08
Jun	A	28.71	-1.17	0.36	-0.01	-0.04	0.00	0.02
	B		-1.01	0.23	0.06	-0.04	-0.04	0.08
Jul	A	27.26	-0.68	0.19	-0.02	-0.04	0.03	-0.02
	B		-0.57	0.11	0.01	-0.06	0.00	0.02
Aug	A	26.80	-0.72	0.22	-0.06	0.03	0.01	0.00
	B		-0.59	0.18	0.06	-0.07	0.01	0.01
Spt	A	26.87	-1.18	0.35	-0.07	-0.04	0.03	-0.03
	B		-1.14	0.29	0.05	-0.10	-0.04	0.08
Oct	A	27.58	-2.64	0.84	-0.28	-0.08	0.05	-0.02
	B		-2.41	0.48	0.14	-0.24	0.05	0.13
Nov	A	26.64	-3.55	1.21	-0.27	-0.18	0.05	0.04
	B		-3.21	0.74	0.11	-0.36	0.17	0.11
Dec	A	24.68	-3.51	1.21	-0.39	-0.10	0.09	-0.06
	B		-3.43	0.74	0.00	-0.32	0.14	0.11

**Table A4**  
**Fourier Coefficients for Air Temperature Series**  
**JODHPUR**

	n	0	1	2	3	4	5	6
Jan	A	17.12	-2.53	0.67	-0.29	0.27	-0.08	-0.03
	B		-5.19	1.82	-0.27	-0.06	0.02	-0.06
Feb	A	20.64	-2.67	0.83	-0.40	0.42	-0.08	-0.09
	B		-5.84	1.71	0.05	-0.26	0.02	-0.05
Mar	A	26.29	-2.89	0.98	-0.49	0.23	0.10	-0.12
	B		-5.85	1.38	0.26	-0.28	0.03	0.05
Apr	A	31.37	-2.94	1.02	-0.50	0.09	0.15	-0.04
	B		-5.68	1.03	0.42	-0.25	-0.06	0.05
May	A	34.50	-2.32	0.78	-0.34	-0.03	0.23	-0.03
	B		-5.43	0.90	0.42	-0.22	-0.07	0.15
Jun	A	34.07	-1.08	0.32	-0.11	0.02	0.03	0.01
	B		-4.36	0.87	0.08	-0.05	0.01	0.00
Jul	A	31.06	-1.17	0.15	-0.07	0.01	0.00	-0.03
	B		-2.89	0.65	0.07	-0.05	-0.02	0.01
Aug	A	29.80	-1.21	0.23	-0.10	0.03	0.04	-0.05
	B		-2.66	0.64	0.03	-0.09	0.02	-0.01
Spt	A	29.06	-1.97	0.51	-0.14	0.02	0.05	-0.06
	B		-3.28	0.80	0.11	-0.14	0.00	0.05
Oct	A	27.92	-3.41	1.15	-0.39	0.20	0.02	-0.11
	B		-5.12	1.49	0.26	-0.38	0.07	0.08
Nov	A	22.58	-3.42	1.15	-0.41	0.23	-0.18	-0.05
	B		-5.18	1.80	-0.01	-0.30	0.06	0.07
Dec	A	18.46	-2.81	0.63	-0.24	0.22	-0.20	-0.03
	B		-5.12	1.92	-0.29	-0.14	0.05	0.15

**Table A5**  
**Fourier Coefficients for Sunshine Duration Series - AHMEDABAD**

	n	0	1	2	3	4	5	6	7	8
Jan	A	0.41	-0.60	0.16	0.13	-0.11	-0.02	0.06	-0.01	-0.03
	B		-0.07	0.03	0.06	-0.06	-0.03	0.07	-0.01	-0.06
Feb	A	0.43	-0.61	0.14	0.14	-0.10	-0.03	0.06	0.00	-0.03
	B		-0.08	0.04	0.06	-0.06	-0.02	0.06	-0.01	-0.04
Mar	A	0.40	-0.59	0.18	0.10	-0.12	0.01	0.05	-0.03	-0.01
	B		-0.07	0.04	0.05	-0.06	-0.02	0.06	-0.01	-0.04
Apr	A	0.41	-0.58	0.12	0.13	-0.07	-0.04	0.05	0.00	-0.02
	B		-0.06	0.02	0.06	-0.04	-0.04	0.05	0.00	-0.02
May	A	0.46	-0.62	0.07	0.16	-0.05	-0.06	0.03	0.03	-0.01
	B		-0.08	0.02	0.07	-0.03	-0.05	0.03	0.04	-0.01
Jun	A	0.37	-0.51	0.10	0.10	-0.05	-0.04	0.03	0.01	0.00
	B		-0.09	0.05	0.03	-0.02	-0.04	0.03	0.03	-0.02
Jul	A	0.19	-0.27	0.06	0.05	-0.03	-0.01	0.01	0.00	-0.01
	B		-0.06	0.05	0.01	-0.02	0.00	0.00	0.01	-0.01
Aug	A	0.18	-0.27	0.08	0.03	-0.03	-0.01	0.02	0.00	-0.01
	B		-0.08	0.06	0.01	-0.04	0.01	0.02	-0.01	-0.01
Sep	A	0.23	-0.36	0.13	0.04	-0.06	0.01	0.02	0.00	-0.02
	B		-0.07	0.06	0.00	-0.04	0.01	0.03	-0.03	-0.01
Oct	A	0.38	-0.55	0.13	0.13	-0.10	-0.03	0.06	0.00	-0.03
	B		-0.06	0.03	0.04	-0.05	-0.01	0.05	-0.01	-0.04
Nov	A	0.41	-0.59	0.14	0.13	-0.09	-0.04	0.07	0.00	-0.03
	B		-0.07	0.04	0.04	-0.04	-0.02	0.05	0.00	-0.06
Dec	A	0.40	-0.60	0.16	0.12	-0.11	-0.03	0.07	0.00	-0.04
	B		-0.07	0.04	0.04	-0.06	-0.01	0.06	-0.01	-0.06

<b>Table A6</b>										
<b>Fourier Coefficients for Sunshine Duration Series - BHAVNAGAR</b>										
	n	0	1	2	3	4	5	6	7	8
Jan	A	0.41	-0.60	0.16	0.12	-0.10	-0.03	0.06	0.00	-0.03
	B		-0.08	0.04	0.05	-0.06	-0.02	0.06	0.00	-0.06
Feb	A	0.43	-0.61	0.12	0.15	-0.09	-0.04	0.05	0.00	-0.02
	B		-0.08	0.03	0.06	-0.05	-0.03	0.05	0.00	-0.04
Mar	A	0.43	-0.61	0.12	0.15	-0.09	-0.04	0.05	0.00	-0.02
	B		-0.08	0.03	0.06	-0.05	-0.03	0.05	0.00	-0.04
Apr	A	0.45	-0.61	0.09	0.15	-0.05	-0.07	0.03	0.04	-0.02
	B		-0.06	0.00	0.07	-0.02	-0.05	0.03	0.03	-0.02
May	A	0.47	-0.62	0.05	0.17	-0.02	-0.08	0.00	0.05	0.00
	B		-0.07	0.00	0.07	-0.01	-0.07	0.01	0.06	-0.01
Jun	A	0.27	-0.37	0.05	0.09	-0.03	-0.03	0.01	0.01	0.00
	B		-0.06	0.02	0.05	-0.02	-0.03	0.02	0.02	-0.01
Jul	A	0.13	-0.18	0.04	0.04	-0.03	-0.01	0.02	0.00	0.00
	B		-0.02	0.00	0.01	-0.01	-0.01	0.01	0.01	-0.01
Aug	A	0.13	-0.18	0.04	0.03	-0.03	0.00	0.01	0.00	0.00
	B		-0.02	0.01	0.01	-0.01	0.00	0.01	0.00	0.00
Sep	A	0.27	-0.40	0.12	0.06	-0.05	-0.01	0.03	0.00	-0.02
	B		-0.05	0.02	0.03	-0.04	-0.01	0.03	-0.01	-0.02
Oct	A	0.39	-0.55	0.11	0.13	-0.08	-0.03	0.05	-0.01	-0.02
	B		-0.07	0.02	0.06	-0.04	-0.04	0.05	0.01	-0.04
Nov	A	0.38	-0.55	0.12	0.13	-0.09	-0.03	0.05	0.00	-0.02
	B		-0.07	0.03	0.05	-0.05	-0.02	0.05	0.00	-0.04
Dec	A	0.40	-0.58	0.14	0.12	-0.09	-0.04	0.07	-0.01	-0.03
	B		-0.07	0.02	0.07	-0.07	-0.01	0.06	-0.01	-0.06

<b>TableA7</b>										
<b>Fourier Coefficients for Sunshine Duration Series - BOMBAY</b>										
	<b>n</b>	<b>0</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>	<b>8</b>
<b>Jan</b>	<b>A</b>	0.40	-0.59	0.18	0.10	-0.11	0.00	0.04	-0.02	-0.01
	<b>B</b>		-0.09	0.05	0.06	-0.07	-0.01	0.07	-0.02	-0.04
<b>Feb</b>	<b>A</b>	0.40	-0.60	0.17	0.11	-0.11	-0.01	0.05	-0.01	-0.02
	<b>B</b>		-0.10	0.06	0.06	-0.09	-0.01	0.08	-0.03	-0.04
<b>Mar</b>	<b>A</b>	0.40	-0.59	0.16	0.10	-0.10	0.00	0.03	-0.01	0.00
	<b>B</b>		-0.12	0.07	0.07	-0.09	-0.01	0.08	-0.03	-0.04
<b>Apr</b>	<b>A</b>	0.41	-0.58	0.14	0.10	-0.06	-0.02	0.02	0.01	-0.01
	<b>B</b>		-0.11	0.05	0.08	-0.07	-0.04	0.07	0.00	-0.04
<b>May</b>	<b>A</b>	0.39	-0.54	0.10	0.11	-0.04	-0.03	0.01	0.02	0.00
	<b>B</b>		-0.13	0.06	0.08	-0.07	-0.03	0.05	0.01	-0.03
<b>Jun</b>	<b>A</b>	0.24	-0.34	0.09	0.05	-0.03	-0.02	0.01	0.01	-0.01
	<b>B</b>		-0.06	0.02	0.04	-0.04	-0.02	0.03	0.00	-0.02
<b>Jul</b>	<b>A</b>	0.10	-0.15	0.07	0.01	-0.03	0.02	0.00	0.00	0.00
	<b>B</b>		-0.02	0.02	-0.01	-0.01	0.00	0.01	-0.01	0.01
<b>Aug</b>	<b>A</b>	0.10	-0.16	0.07	0.01	-0.02	0.01	0.00	0.01	0.00
	<b>B</b>		-0.03	0.02	0.01	-0.02	0.01	0.01	-0.01	-0.01
<b>Spt</b>	<b>A</b>	0.21	-0.32	0.11	0.03	-0.05	0.01	0.01	-0.01	0.01
	<b>B</b>		-0.07	0.06	0.00	-0.04	0.01	0.03	-0.03	-0.01
<b>Oct</b>	<b>A</b>	0.34	-0.50	0.13	0.09	-0.08	0.00	0.02	0.00	0.00
	<b>B</b>		-0.10	0.07	0.03	-0.05	-0.01	0.05	-0.02	-0.02
<b>Nov</b>	<b>A</b>	0.36	-0.54	0.15	0.10	-0.10	0.00	0.04	-0.01	-0.01
	<b>B</b>		-0.08	0.04	0.06	-0.06	-0.02	0.07	-0.02	-0.05
<b>Dec</b>	<b>A</b>	0.37	-0.55	0.16	0.10	-0.10	-0.01	0.06	-0.01	-0.03
	<b>B</b>		-0.08	0.04	0.05	-0.08	0.01	0.06	-0.02	-0.05

**Table A8**  
**Fourier Coefficients for Sunshine Duration Series - JODHPUR**

	n	0	1	2	3	4	5	6	7	8
Jan	A	0.38	-0.55	0.15	0.12	-0.11	-0.01	0.06	0.00	-0.04
	B		-0.07	0.04	0.03	-0.05	-0.01	0.06	-0.02	-0.05
Feb	A	0.41	-0.59	0.15	0.11	-0.08	-0.03	0.05	0.00	-0.03
	B		-0.06	0.03	0.05	-0.04	-0.03	0.05	0.00	-0.04
Mar	A	0.36	-0.54	0.15	0.10	-0.10	0.00	0.04	-0.01	-0.01
	B		-0.06	0.03	0.04	-0.05	-0.01	0.05	-0.01	-0.04
Apr	A	0.42	-0.60	0.13	0.13	-0.08	-0.03	0.04	0.01	-0.02
	B		-0.04	0.00	0.05	-0.02	-0.04	0.03	0.01	-0.02
May	A	0.45	-0.61	0.09	0.15	-0.06	-0.05	0.03	0.02	-0.01
	B		-0.06	0.01	0.05	-0.01	-0.05	0.02	0.04	-0.01
Jun	A	0.40	-0.55	0.11	0.12	-0.06	-0.04	0.03	0.01	-0.01
	B		-0.06	0.02	0.05	-0.01	-0.05	0.03	0.02	-0.01
Jul	A	0.29	-0.41	0.09	0.08	-0.04	-0.03	0.02	0.02	-0.02
	B		-0.04	0.02	0.02	-0.01	-0.01	0.00	0.01	0.00
Aug	A	0.25	-0.36	0.09	0.06	-0.04	-0.01	0.00	0.02	-0.01
	B		-0.06	0.04	0.02	-0.02	-0.01	0.02	0.01	-0.02
Spt	A	0.32	-0.47	0.14	0.08	-0.08	-0.01	0.03	0.00	-0.02
	B		-0.05	0.02	0.04	-0.04	-0.02	0.05	-0.02	-0.03
Oct	A	0.39	-0.57	0.15	0.10	-0.08	-0.03	0.06	-0.01	-0.02
	B		-0.08	0.04	0.06	-0.06	-0.02	0.06	-0.01	-0.04
Nov	A	0.42	-0.61	0.15	0.13	-0.10	-0.03	0.06	0.00	-0.03
	B		-0.06	0.03	0.05	-0.05	-0.02	0.06	-0.01	-0.05
Dec	A	0.39	-0.58	0.18	0.09	-0.09	-0.01	0.04	0.00	0.03
	B		-0.09	0.05	0.06	-0.07	-0.01	0.07	-0.02	-0.04



Figure A1

AIR TEMP. - AHMEDABAD (MAY)

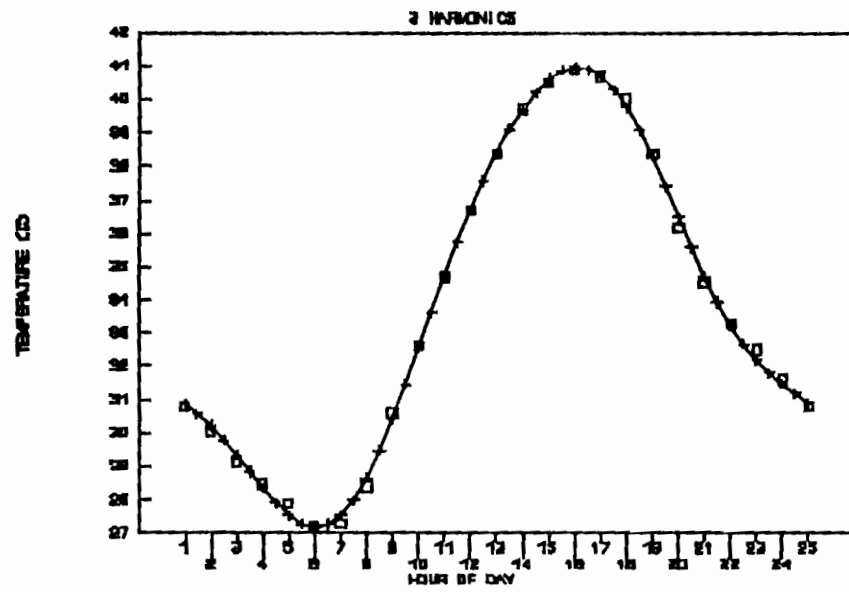


Figure A2

AIR TEMP. - AHMEDABAD (JUL)

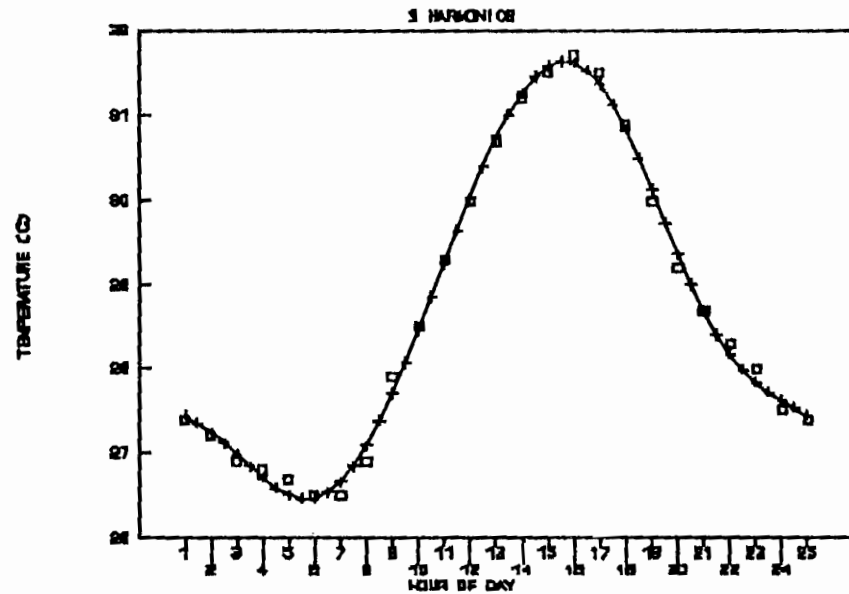


Figure A3

AIR TEMP. - AHMEDABAD (DEC)

3 HARMONICS

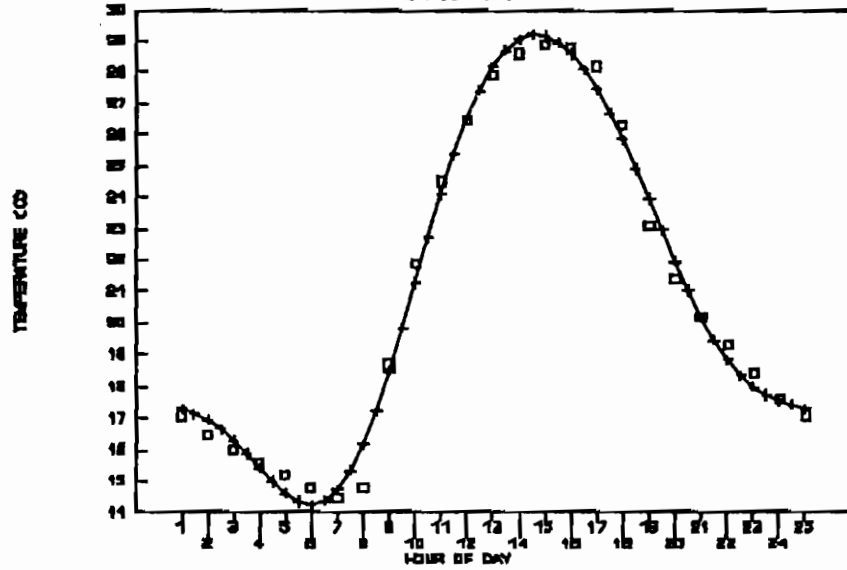


Figure A4

AIR TEMP. - BHAVNAGAR (MAY)

3 HARMONICS

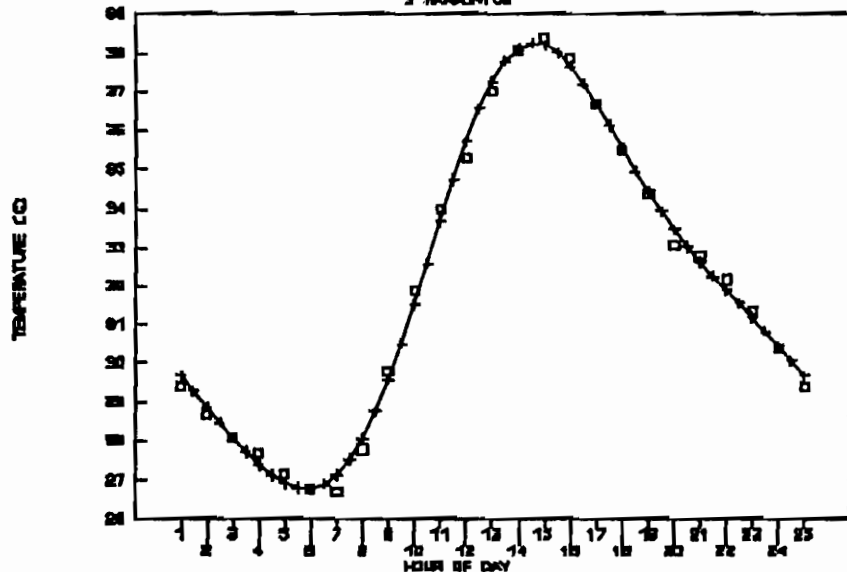


Figure A5

AIR TEMP. - BHAVNAGAR (JUL)

1 HARMONIC

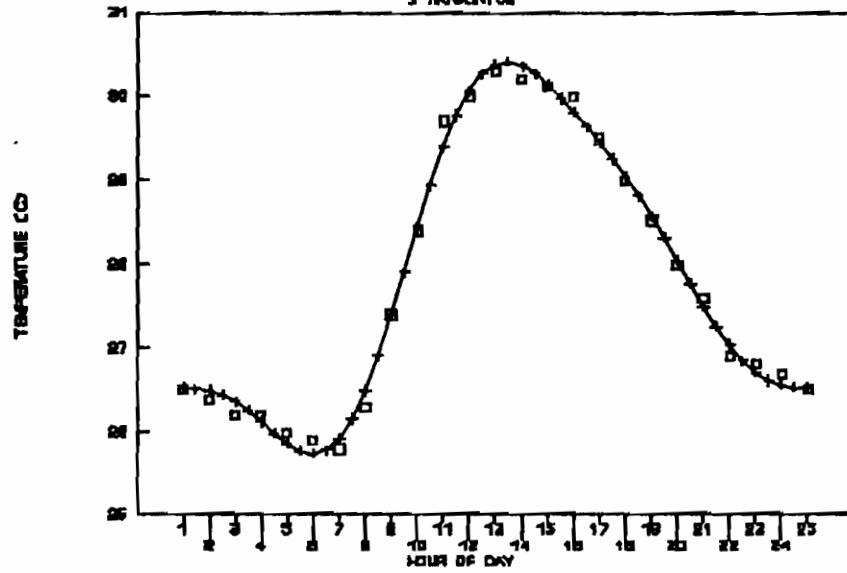


Figure A6

AIR TEMP. - BHAVNAGAR (DEC)

1 HARMONIC

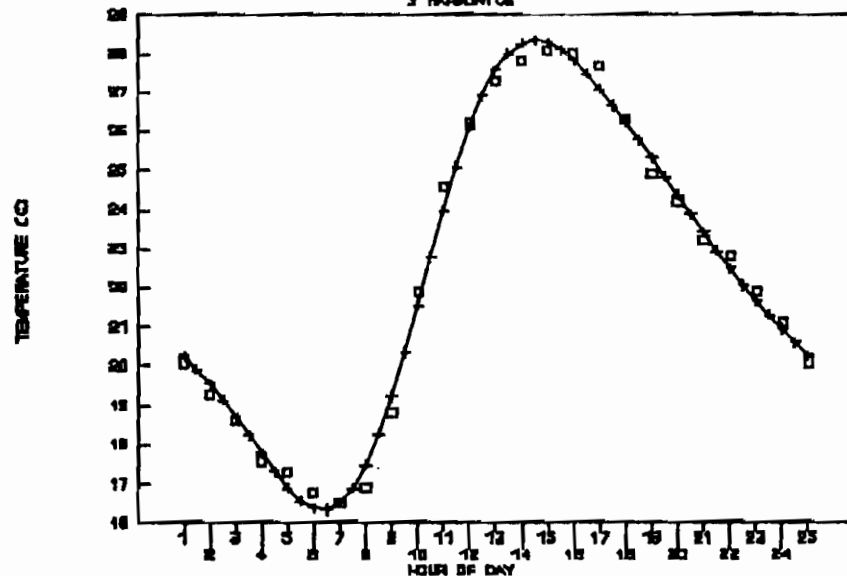


Figure A7

AIR TEMP. - BOMBAY (MAY)

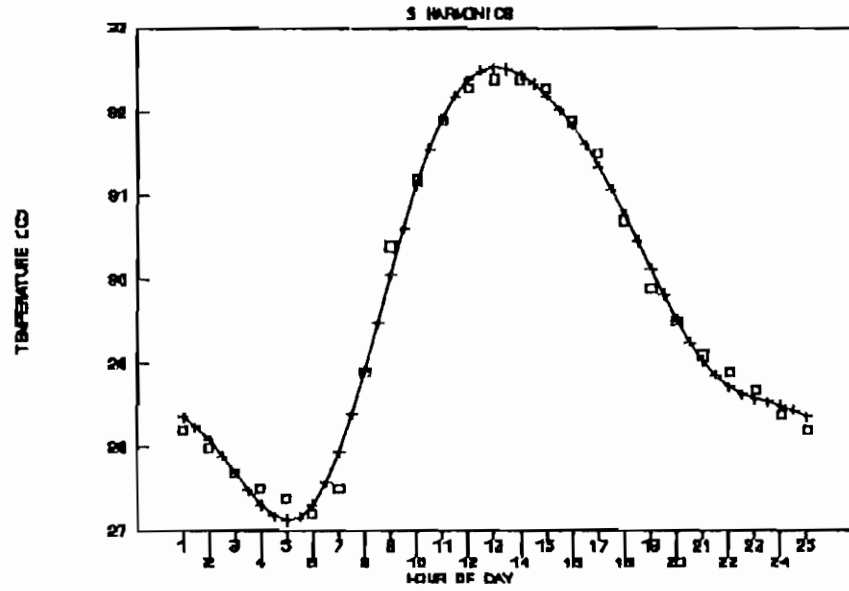


Figure A8

AIR TEMP. - BOMBAY (JUL)

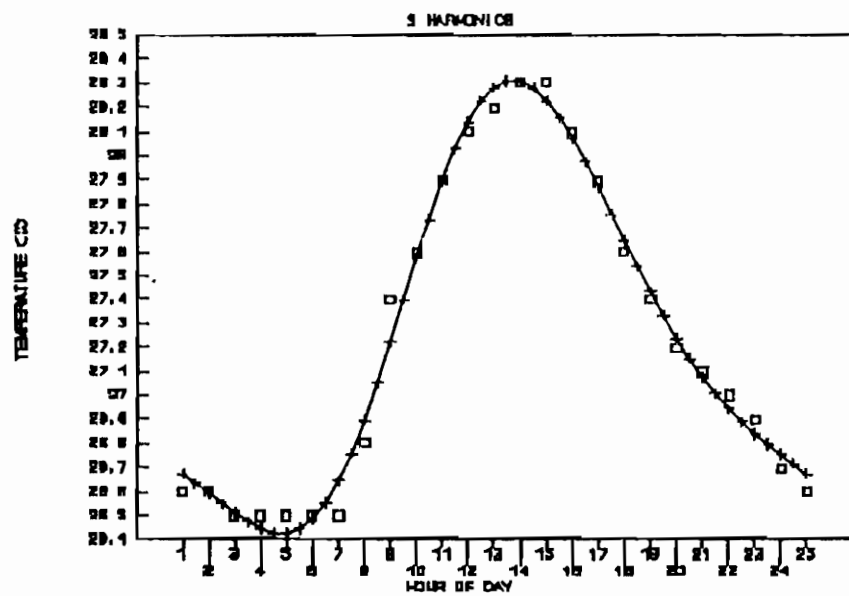


Figure A9

AIR TEMP. - BOMBAY (DEC)

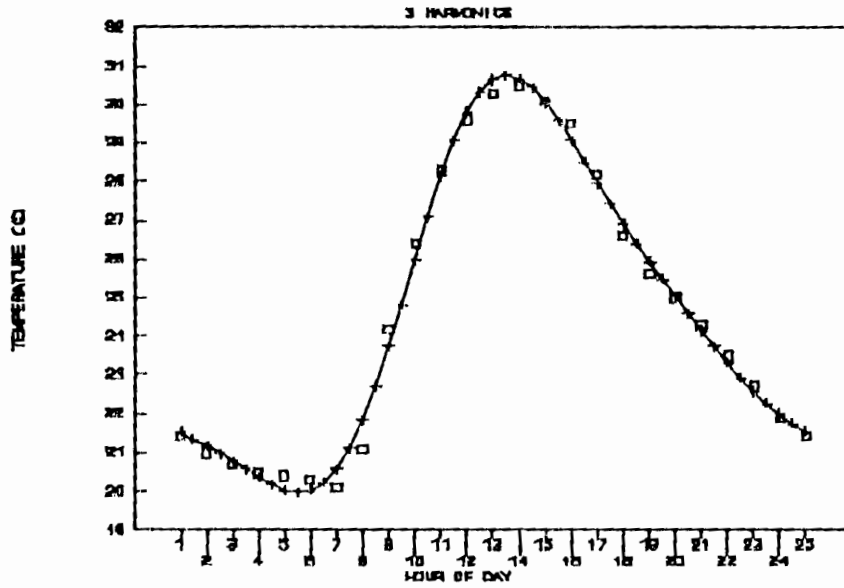


Figure A10

AIR TEMP. - JODHPUR (MAY)

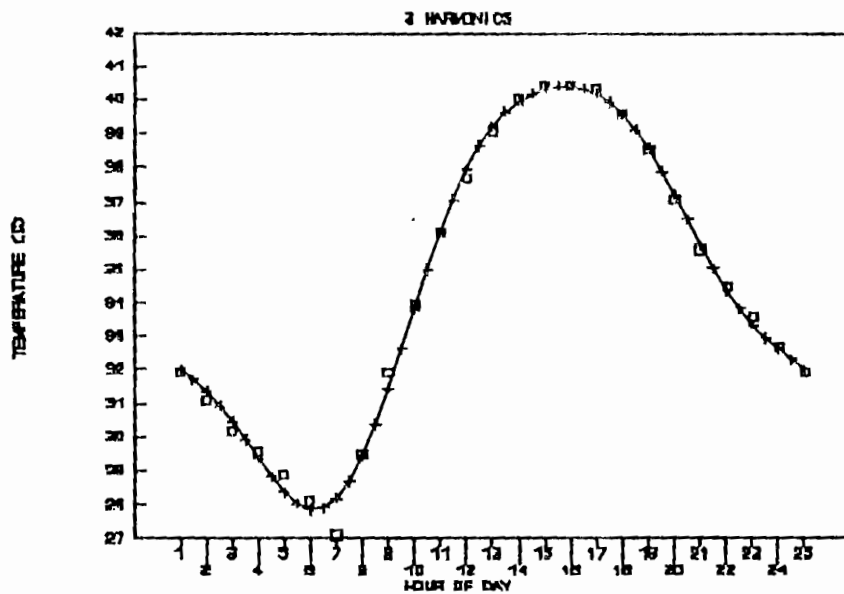


Figure A11

AIR TEMP. - JODHPUR (JUL)

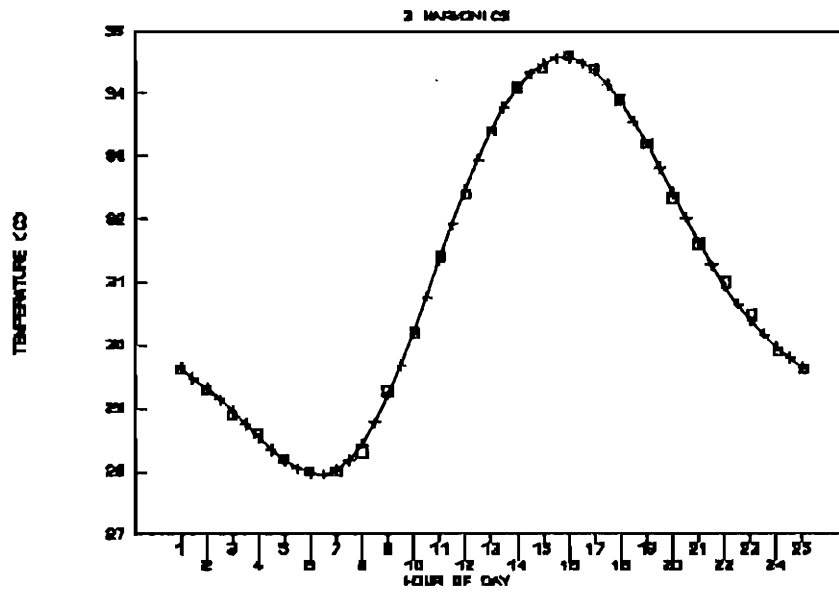


Figure A12

AIR TEMP. - JODHPUR (DEC)

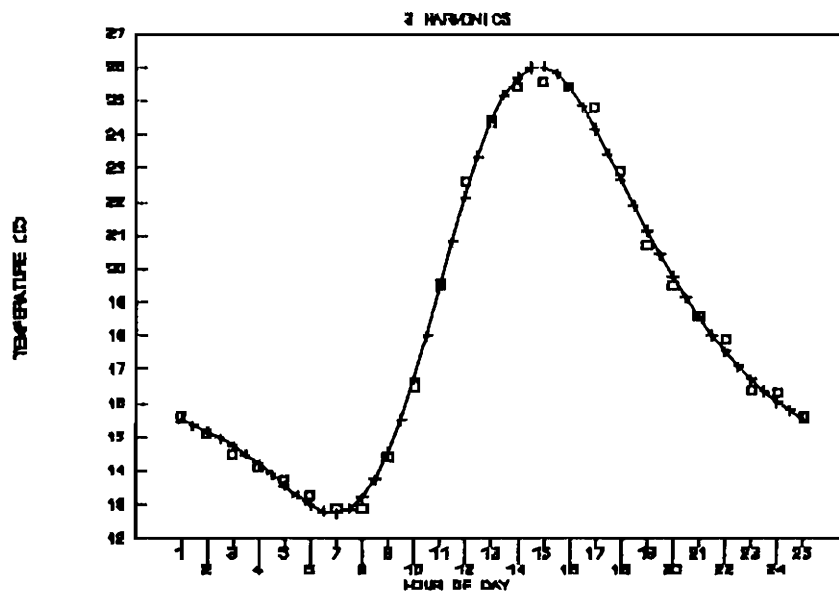


Figure A13

SUNSHINE - AHMEDABAD (MAY)

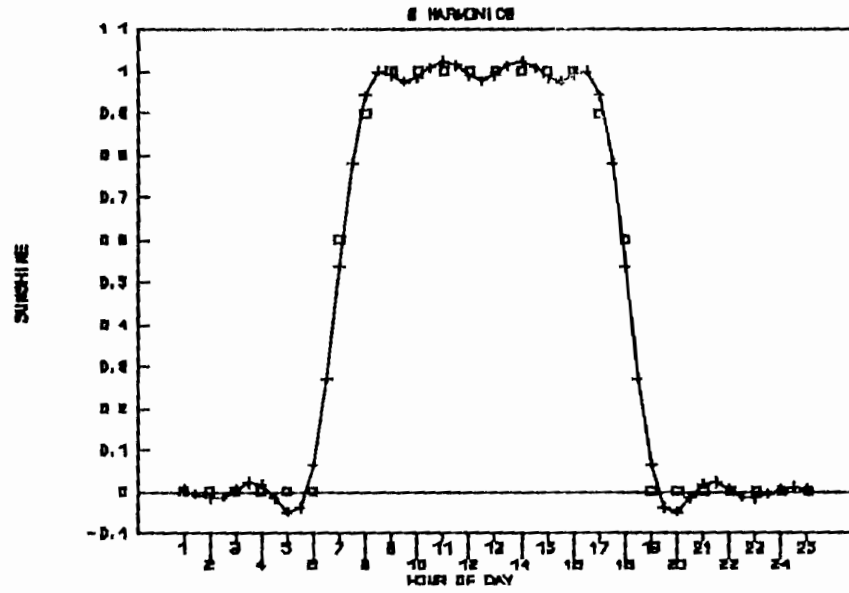
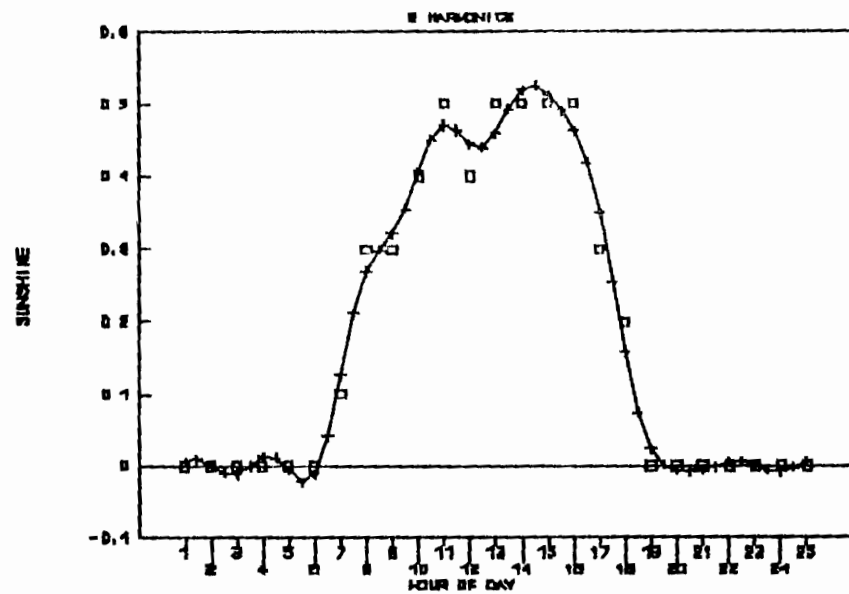
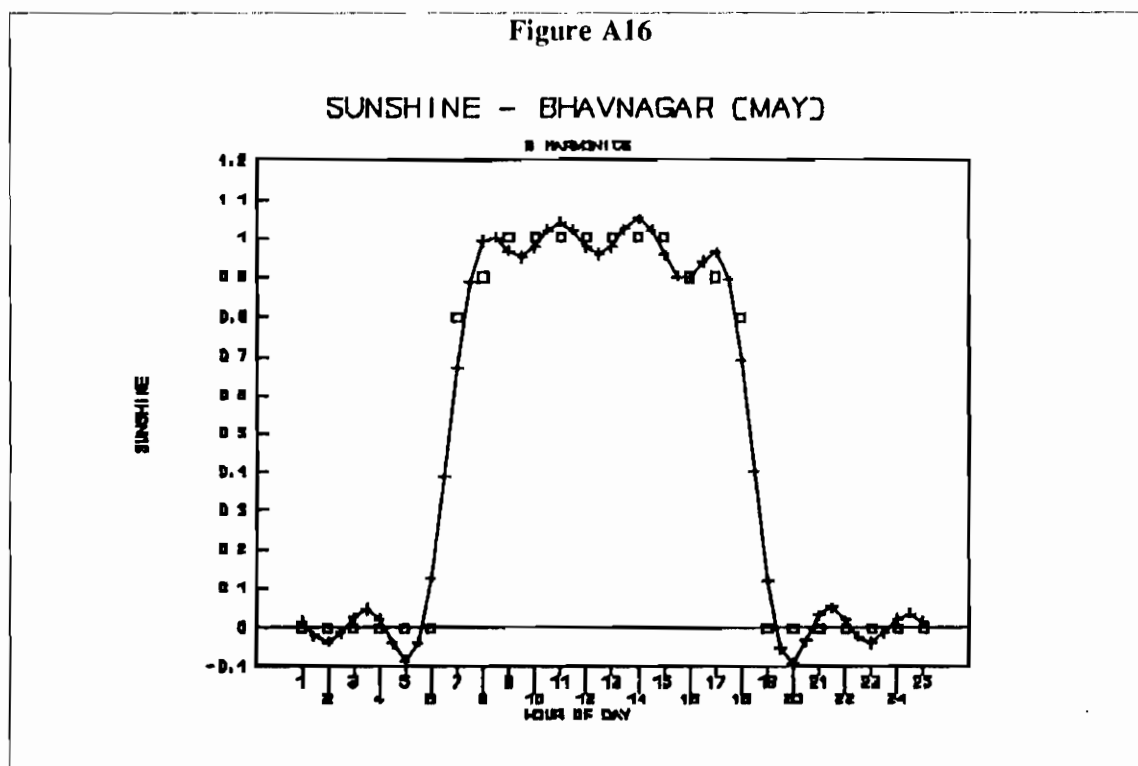
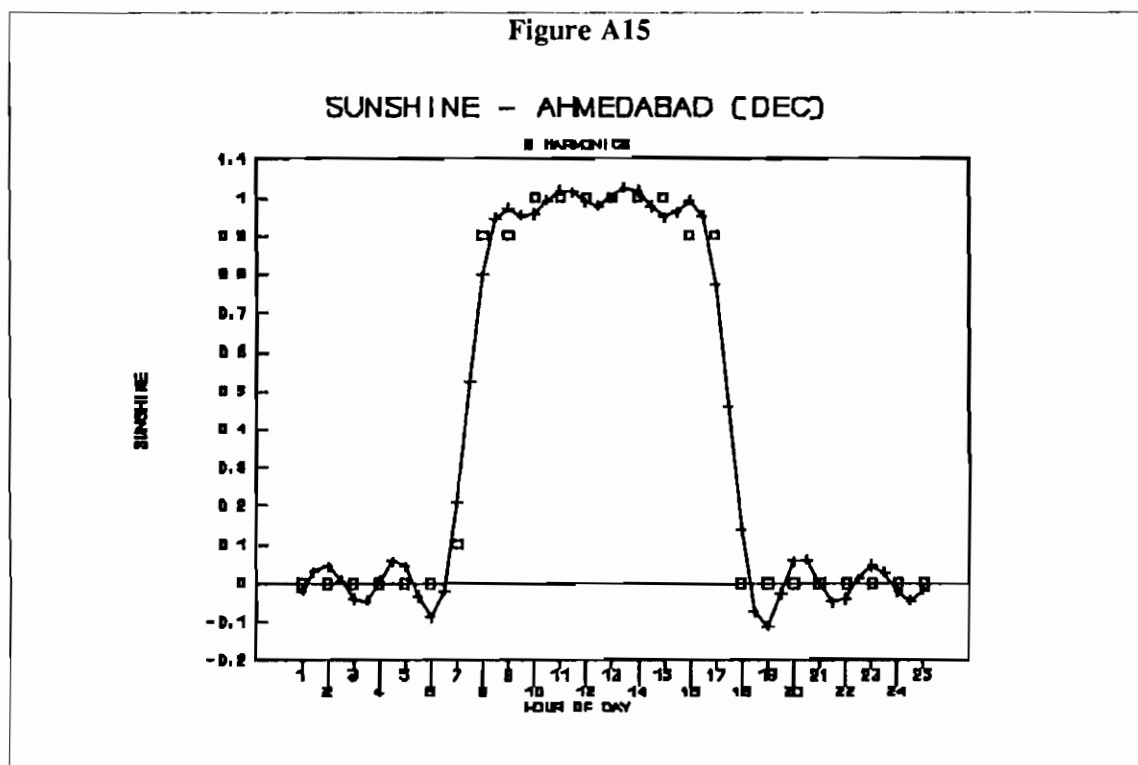


Figure A14

SUNSHINE - AHMEDABAD (JUL)







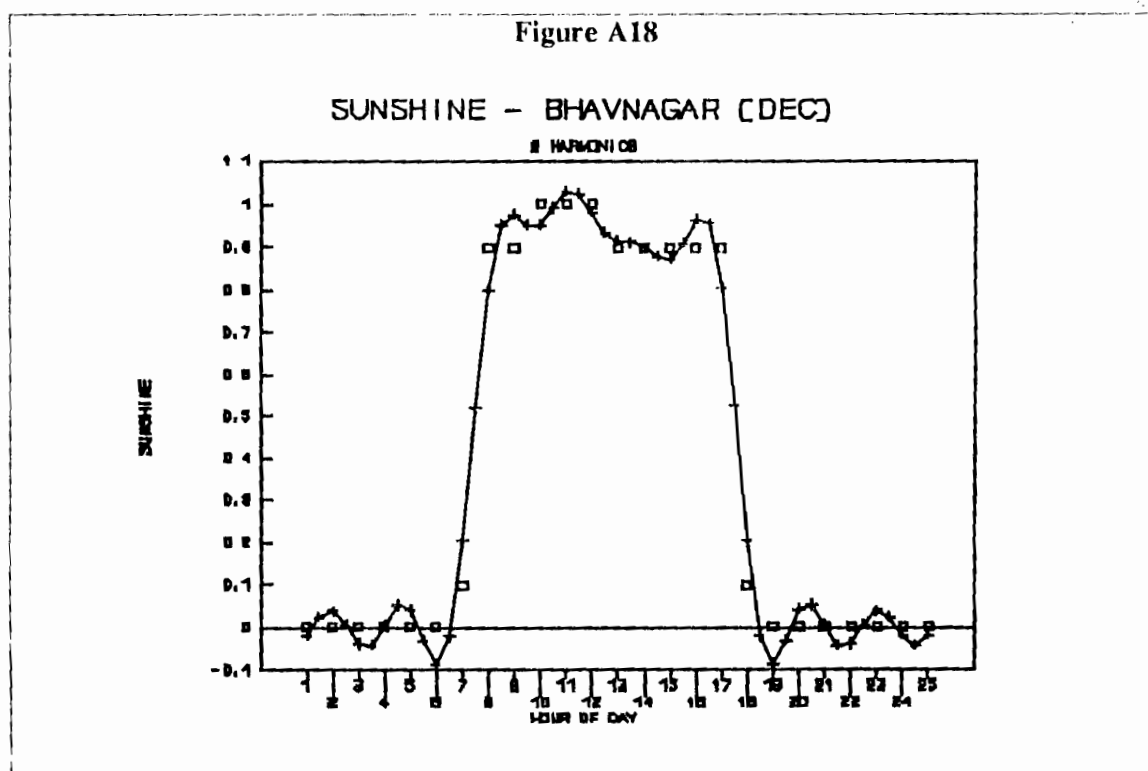
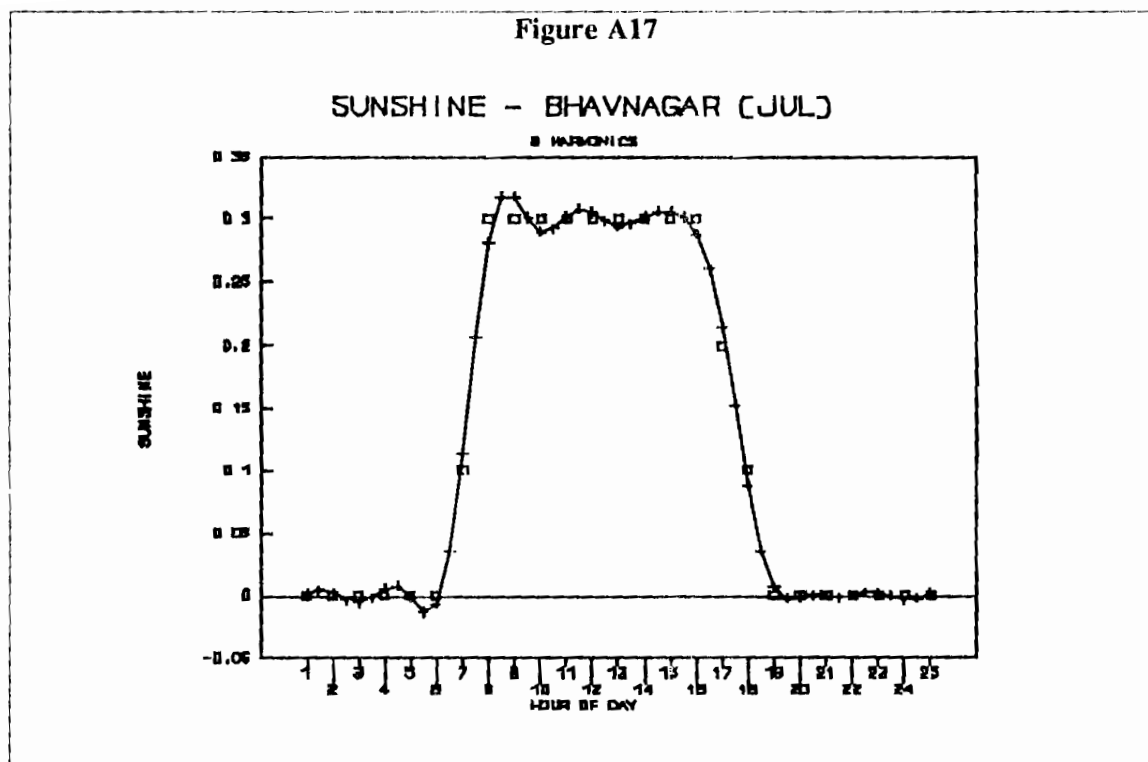


Figure A19

SUNSHINE - BOMBAY (MAY)

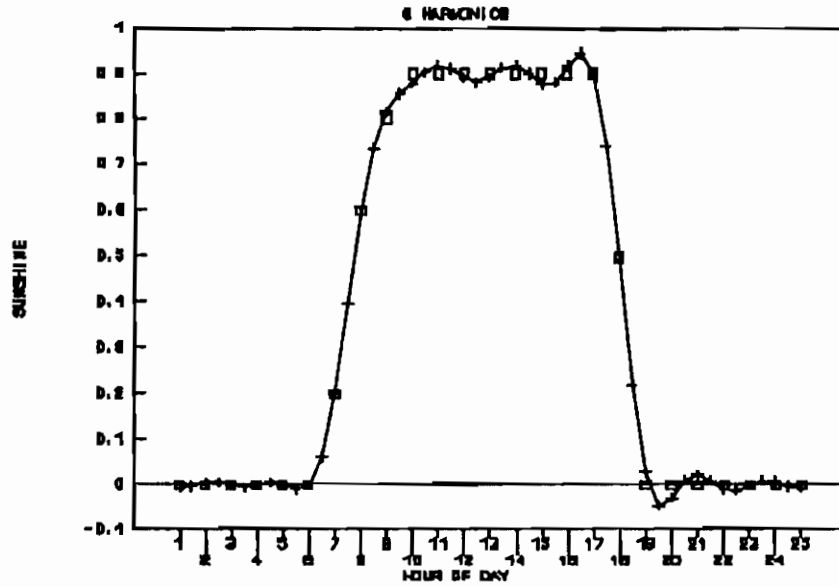


Figure A20

SUNSHINE - BOMBAY (JUL)

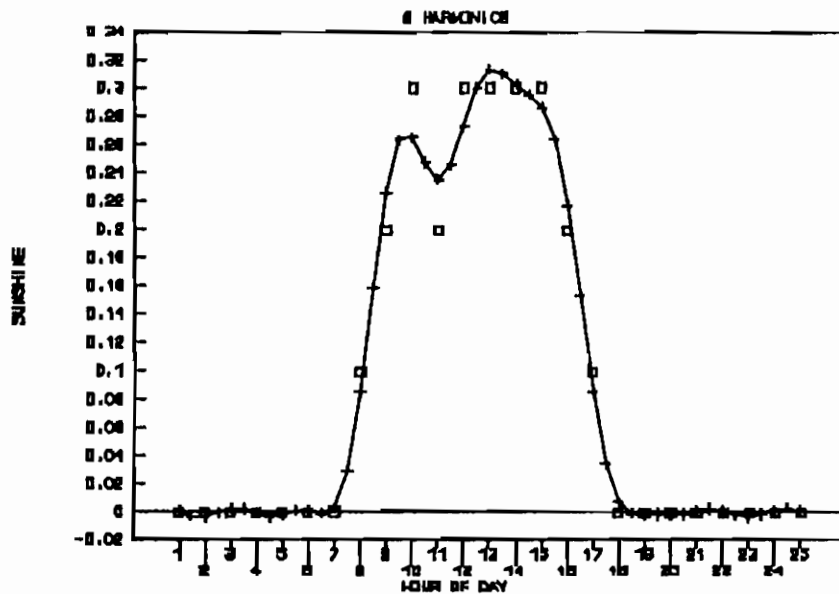


Figure A21

SUNSHINE - BOMBAY (DEC)

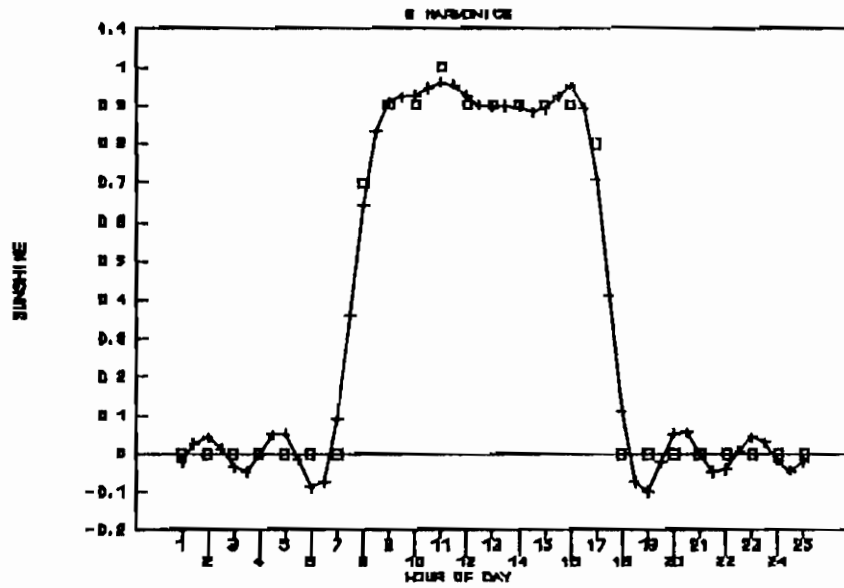


Figure A22

SUNSHINE - JODHPUR (MAY)

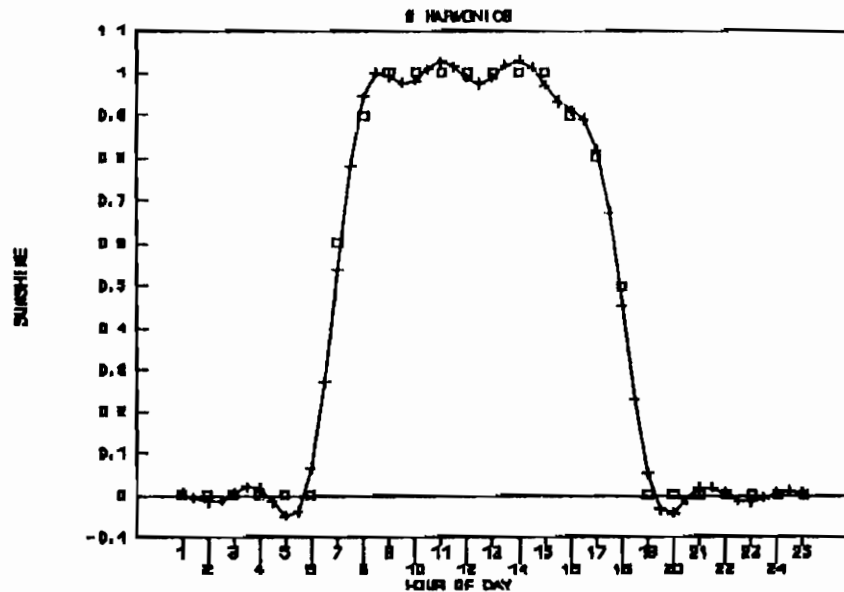


Figure A23

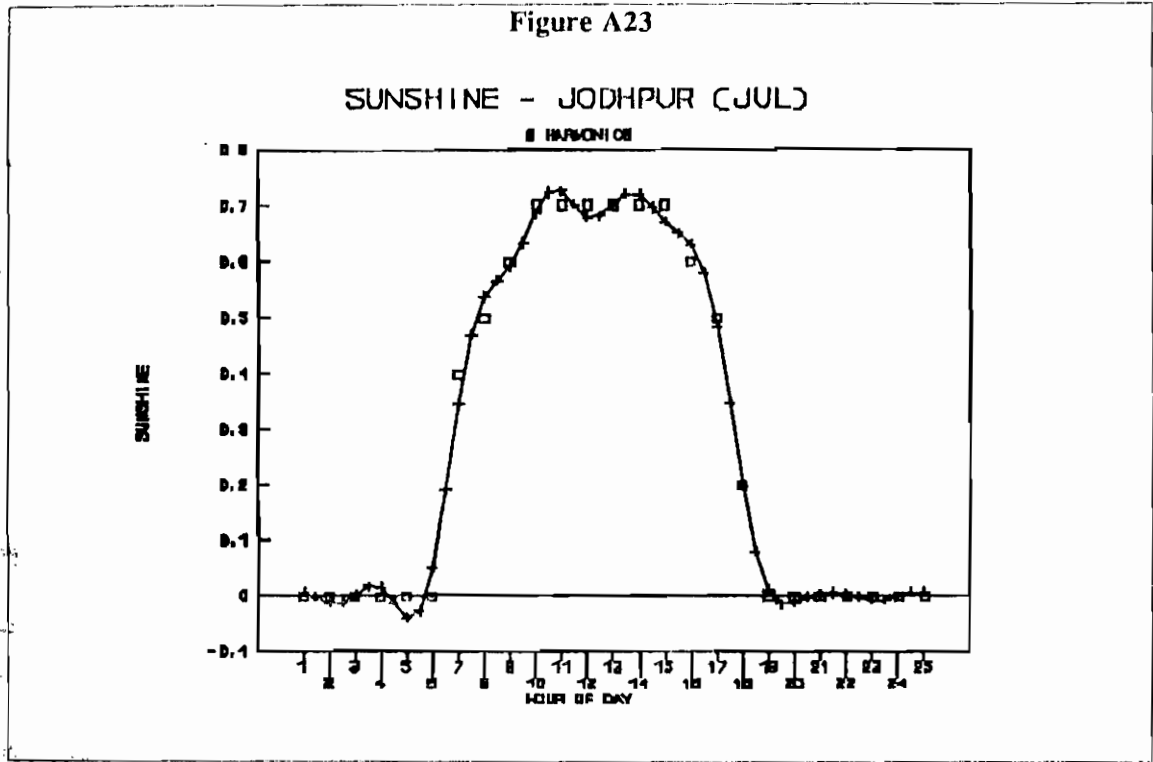
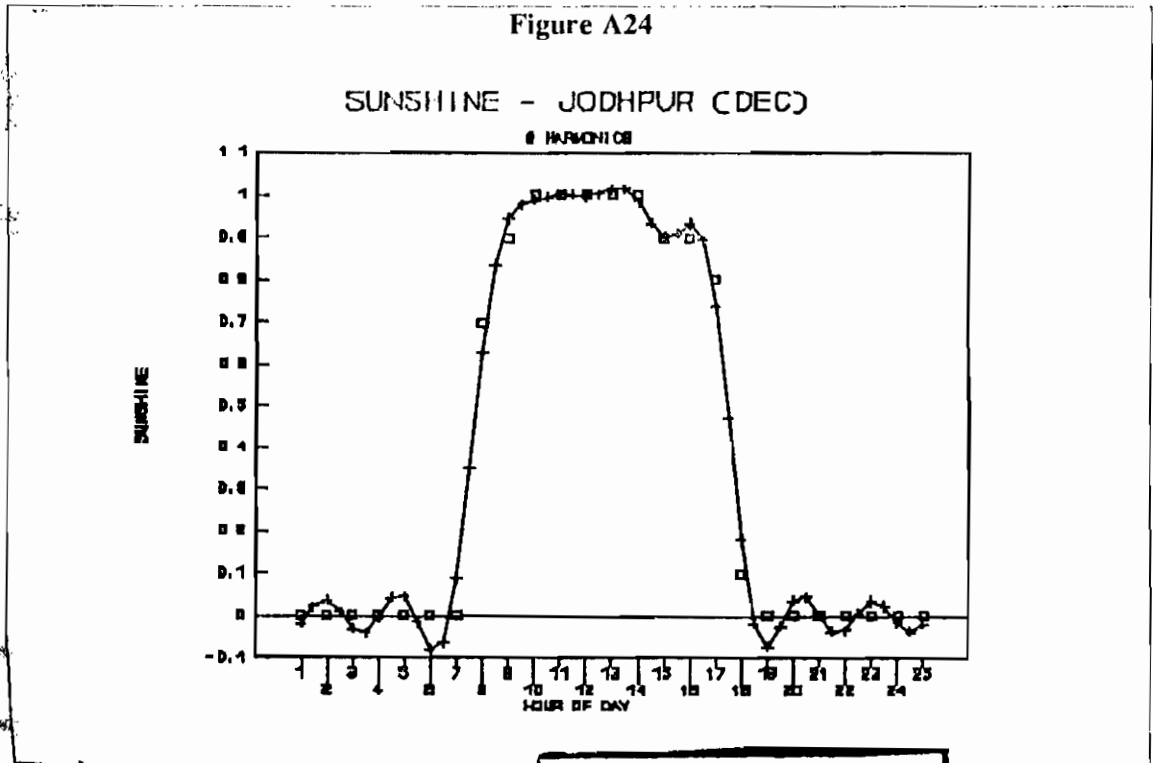


Figure A24



**PURCHASED**  
**APPROVAL**  
**GRATIS/EXCHANGE**

VIKRAM