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APPENDIX

APPENDIX A

Atmospheric Species Concentration Calculations

1. Calculations Using Results From IC Analysis (SO_4^{2-})

These assumptions lead directly to equations for computing atmospheric concentrations from denuder measurements.

1.1 Analytical results are given at SO_4^{2-} in μg/mL.

1.2 The extraction volume was 10 mL (i.e., 0.010L).

1.3 Sulfate concentration convert to equivalent sulfuric acid:

$$CSO_4^{2-} = [\ SO_4^{2-}\ \text{sample} - SO_4^{2-}\ \text{blank}\ ][10\ \text{mL}][98/96]$$

2. Calculations Using results from pH Measurement (H^+)

2.1 A convenient method of expressing concentration of the hydrogen ion was first proposed by Sorensen in 1909 and has been widely adopted by chemists.

$$pH = -\log [H^+]$$
$$[H^+] = 10^{-pH}$$

2.2 For each working standard on a given analytical day, calculate the "apparent net strong acid concentration" as follows:

$$Ci = 10^{-pHWSi} - 10^{-pHEA}$$

where: Ci = apparent net strong acid concentration, molar,
pHWSi = measured mean pH of a working standard, and
pHEA = measured mean pH of the EA solution.

2.3 For each analytical day, utilizing a particular set of freashly prepared daily working standards, develop a standard curve by calculating the linear regression of Ci vs. Ceq, as documented in table A-1. Calculated slope and intercept of the standard curve.

Table A-1 Standard Preparation

Standard H_2SO_4 flask	Volume of 1.000 N H_2SO_4 added to each flask, (μL)	Working standard concentration, 10^{-3}N H_2SO_4	Equivalent strong acid mass collected on filter (Ceq), μg@	Approximate pH
1	0	0	0	4.09
2	25	1	4.90	4.01
3	50	2	9.80	3.95
4	100	4	19.60	3.84
5	200	8	39.20	3.68
6	400	16	78.40	3.48
7	800	32	156.8	3.23

@ Based on 3.1 mL extraction volume.

2.4 Calculate the corresponding "apparent net strong acid concentration" from the sample pH utilizing the following equation:

$$Cs = 10^{-pHS} - 10^{-pHEA}$$

where:

Cs = apparent net strong acid concentration for unknown sample, molar,

pHS = measured pH of the sample (S), and

pHEA = measured pH of the EA solution.

2.5 Utilizing the slope and intercept of the standard curve, calculate equivalent mass of strong acid:

$$Cf = [\text{intercept}] + [Cs][\text{Slope}]$$

where:

Cf = apparent net strong acid mass, μg, as calculated from standard curve,

Intercept = calculated relationship from linear regression analysis of Ci vs. Ceq, and

Slope = calculated relationship from linear regression analysis of Ci vs. Ceq.

2.6 The actual sample air value, V, for each sample is calculated using the data from the Field Test Data Sheet. These data include the initial and final elapsed times, the initial rotameter reading, and the rotameter I.D.No. Use the calibration curve for

the given rotameter to calculate the flow for the sample, in L/min, if applicable. Calculate the value of V as follows:

$$V = [F][T]$$

where: F = flow from the calibration curve, L/min,
T = net elapsed time, min, and
V = total sample volume, L

Convert L to m^3 by:

$$Vs = V \times (10^{-3})$$

where: Vs = total sampling volume, m^3, and
10^{-3} = conversion factor, m^3/L.

3.7 Calculate the air volume sampled, corrected to EPA-reference conditions:

$$Vs(std) = VsY[Tstd/Tm][Pbar/Pstd]$$

where:
Vs(std) = volume of sample at EPA-reference conditions, m^3,
Vs = volume of gas sample through the dry gas meter, or calculated volume sampled as indicated by rotameter, m^3,
Tstd = absolute EPA-reference temperature, 298 ^{0}K,
Tm = average flowmeter or dry gas meter temperature, ^{0}K
Pbar = barometric pressure of flow or volume measurement condition, mm Hg,
Pstd = EPA-reference barometic pressure, 760 mm Hg, and
Y = dry gas meter calibration factor (if applicable), dimensionless

3.8 Calculate the final concentration of apparent net fine particle (<2.5 μm) strong acidity (as H_2SO_4):

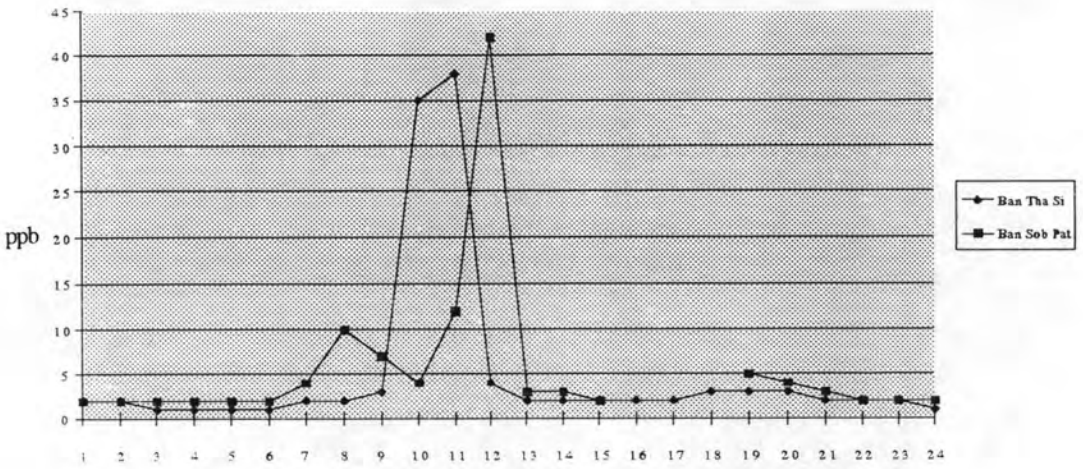
$$C(H^+) = Cf / Vs(std)$$

where:
$C(H^+)$ = apparent net fine particle strong acudity concentration, $\mu g/m^3$,
Cf = apparent net strong acid, μg, as calculated from standard curve,
Vs(std) = volume of sampled gas at EPA-reference conditions, m^3

From : Determination of the Strong Acidity of Atmospheric Fine-Particles (<2.5 μm) Using Annular Denuder Technology - Enhanced Method. Atmospheric Research and Exposure Assessment Laboratory, Office of Research and Development.U.S. Environmental Protection Agency.1992.

APPENDIX B

Diurnal Variations of Sulfur Dioxide



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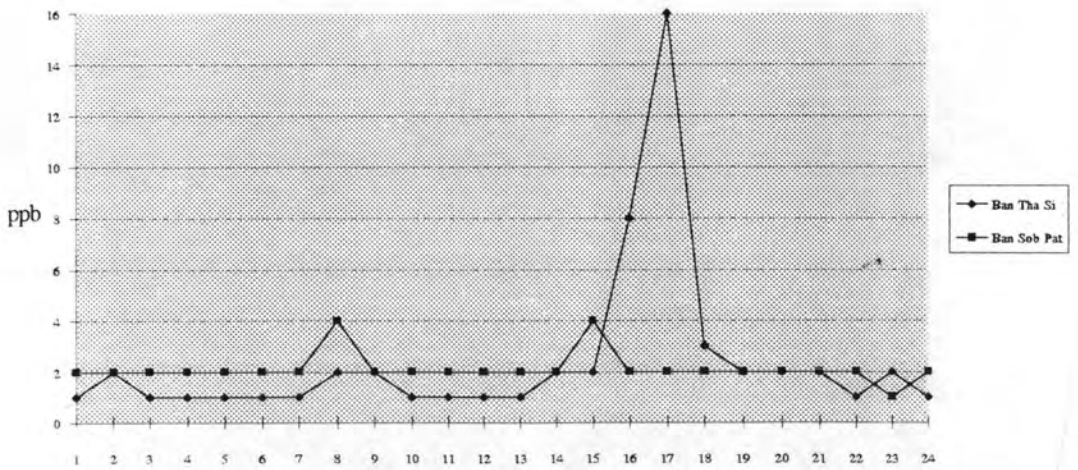

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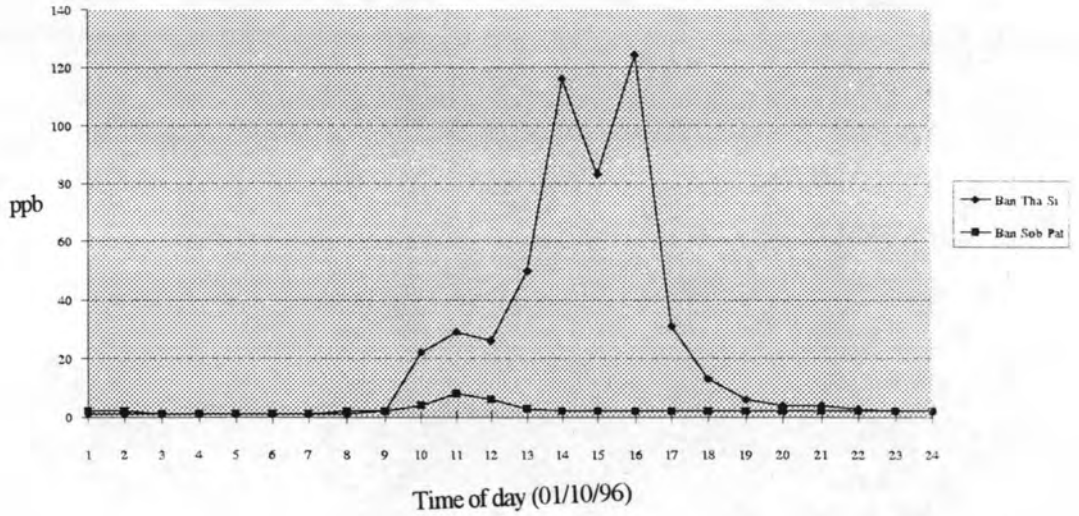
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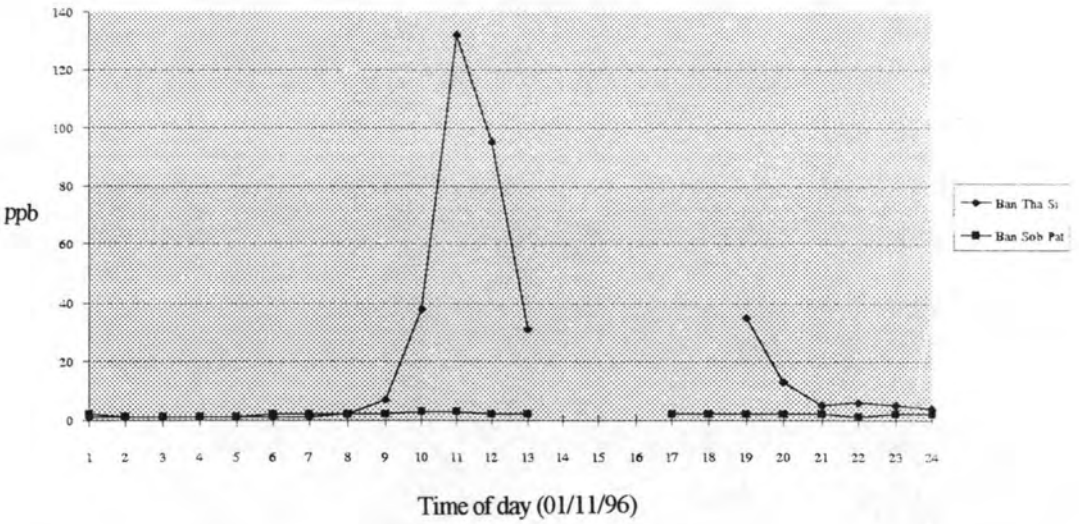
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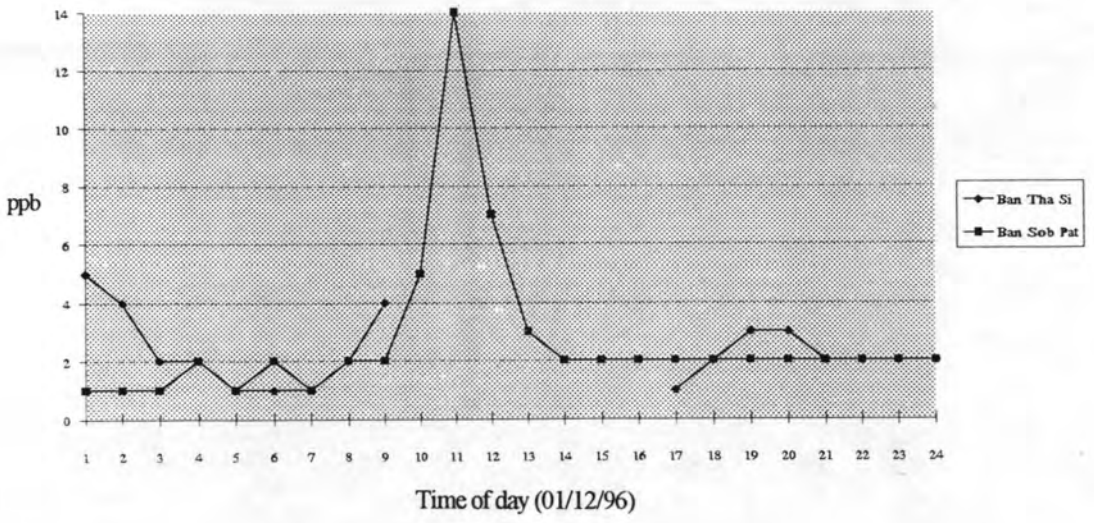
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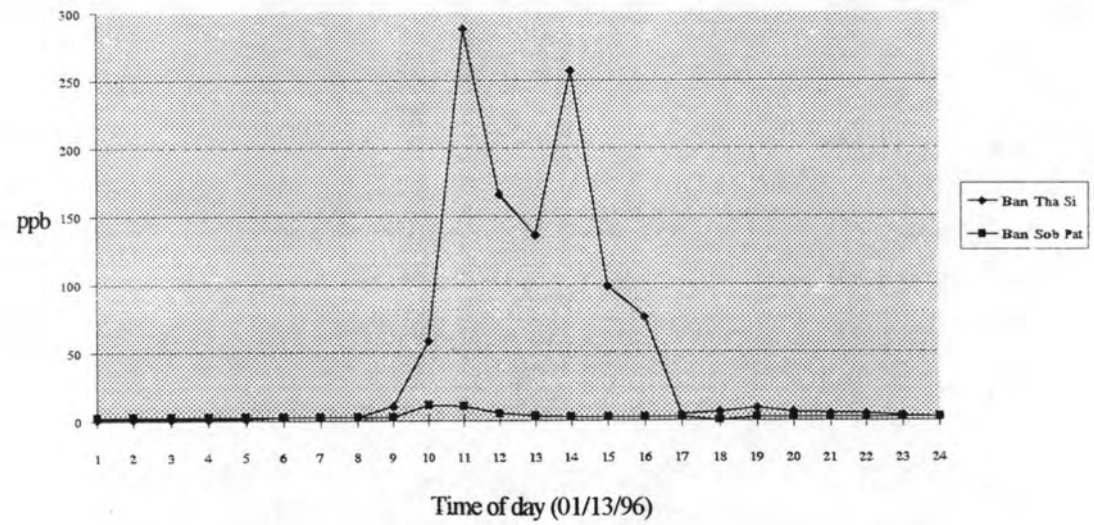
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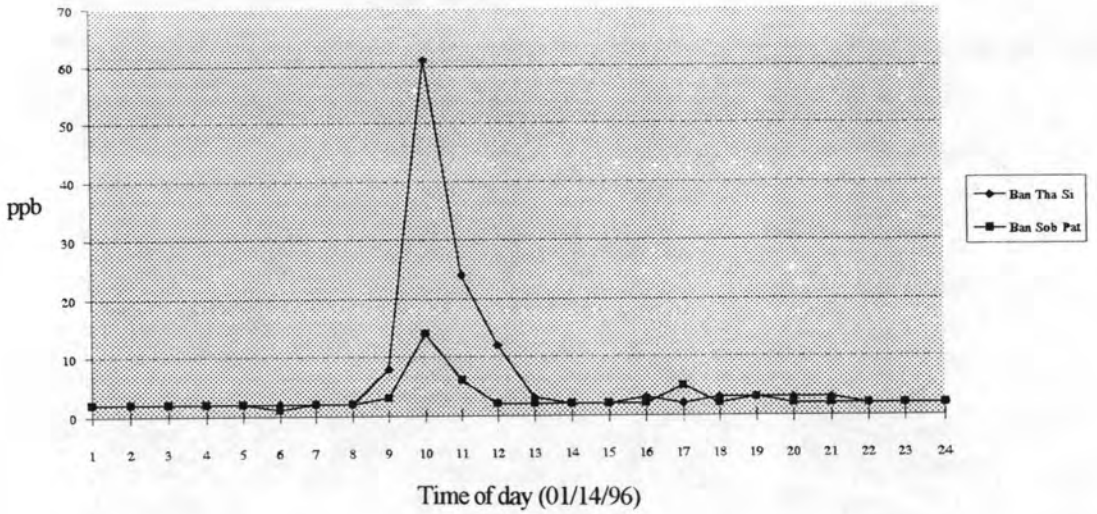
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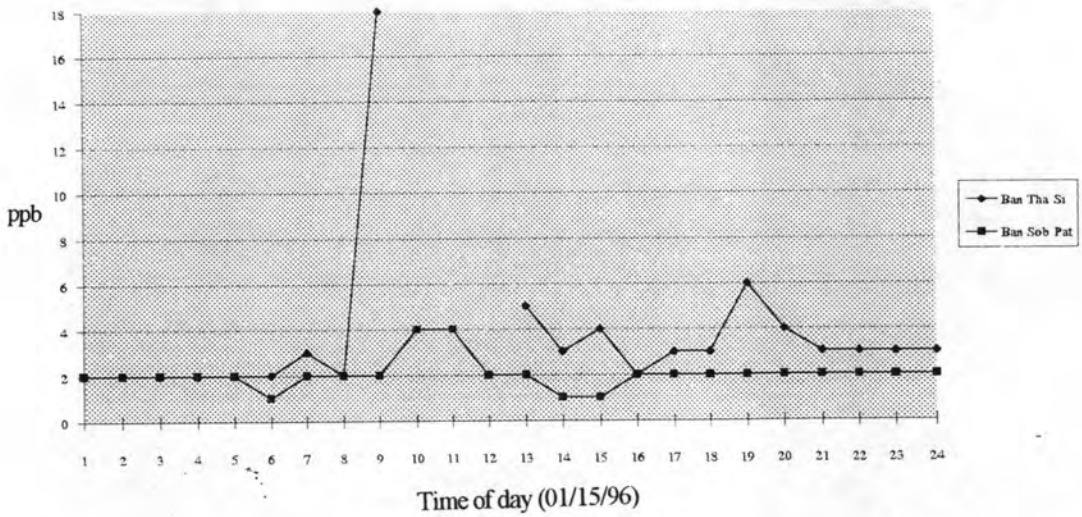
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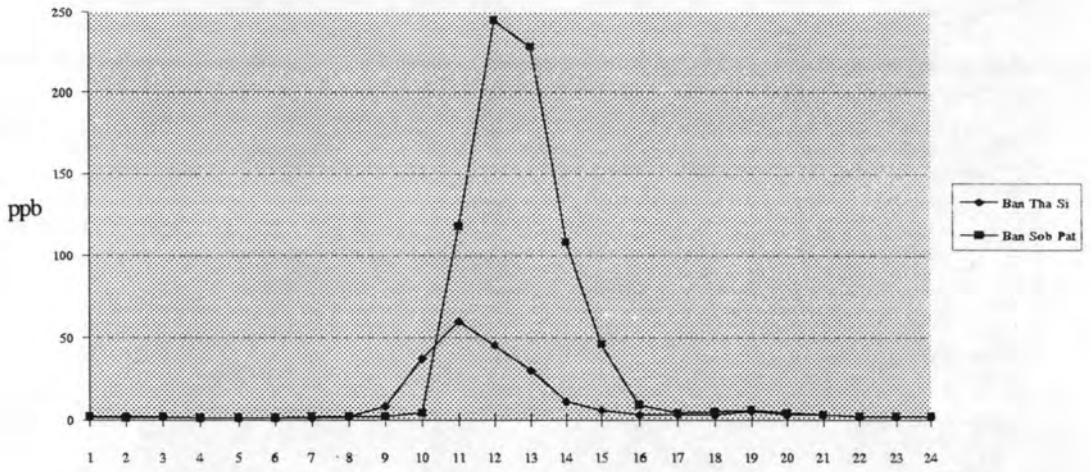
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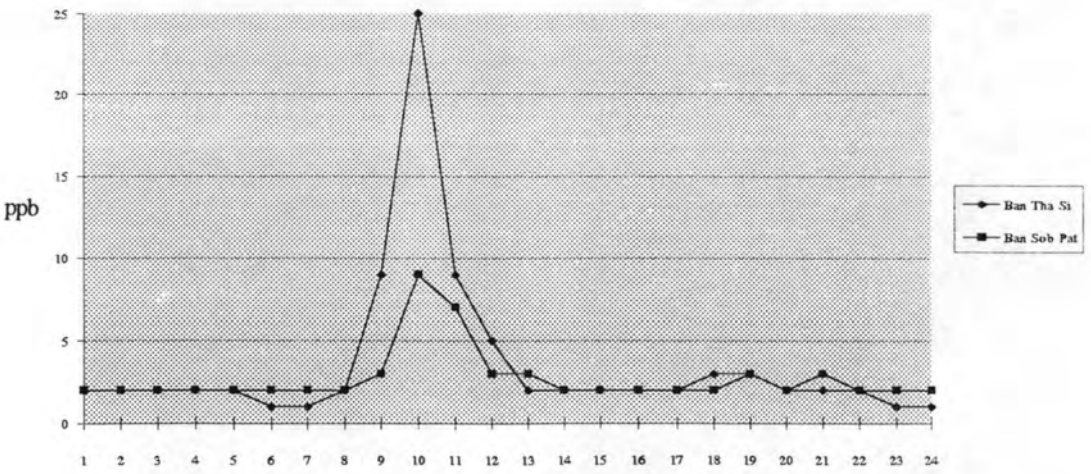
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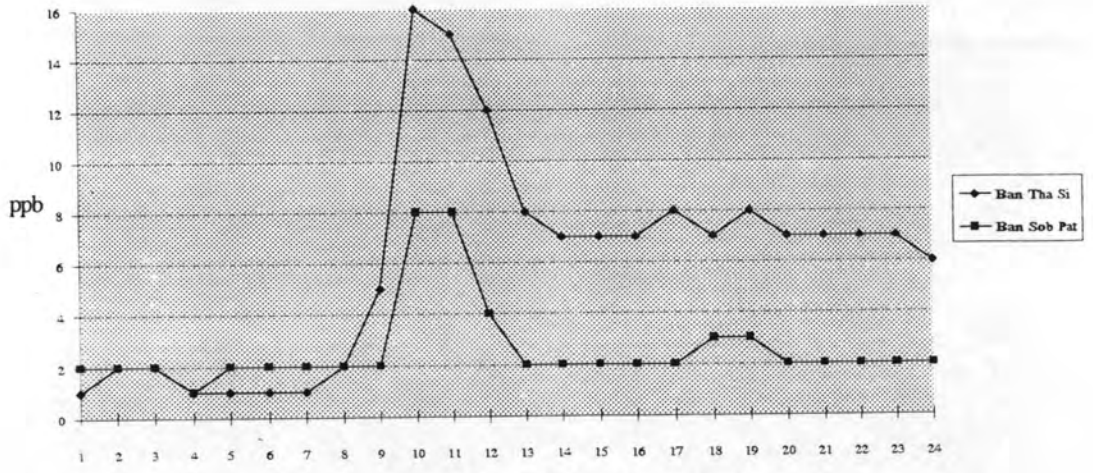

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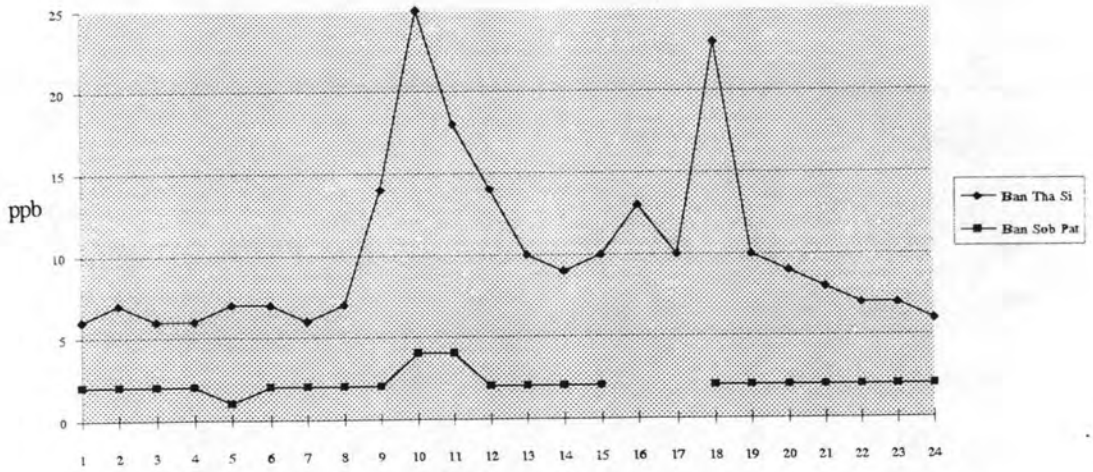

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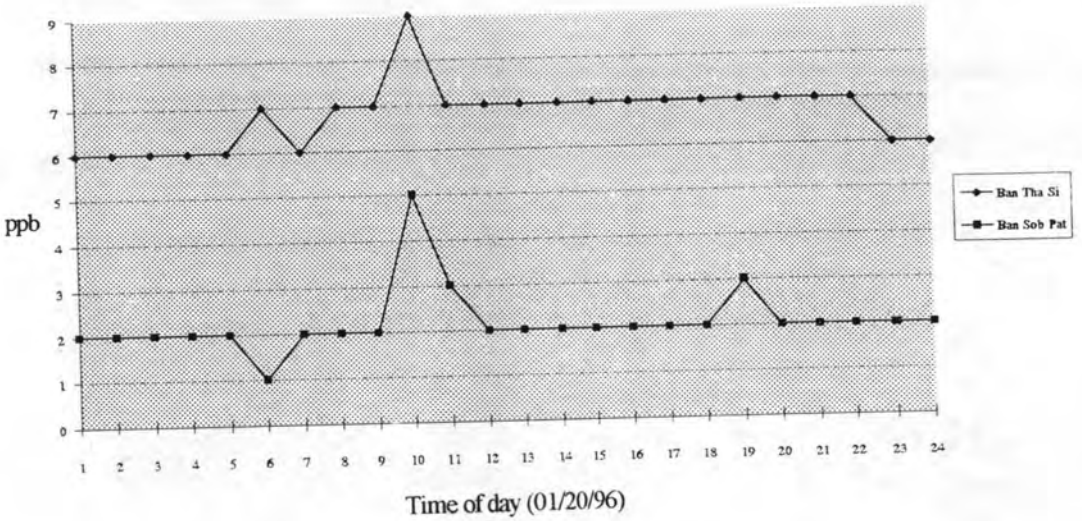
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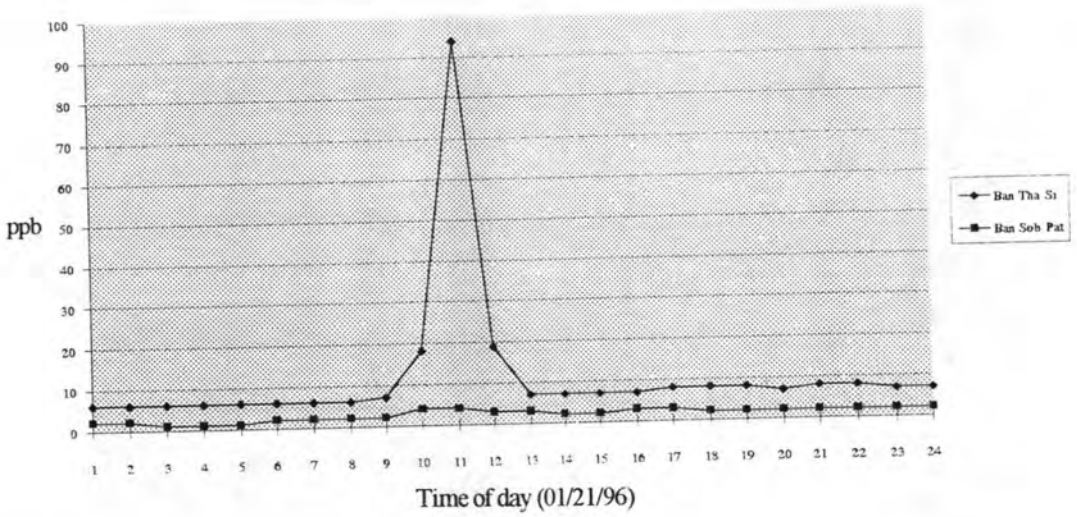
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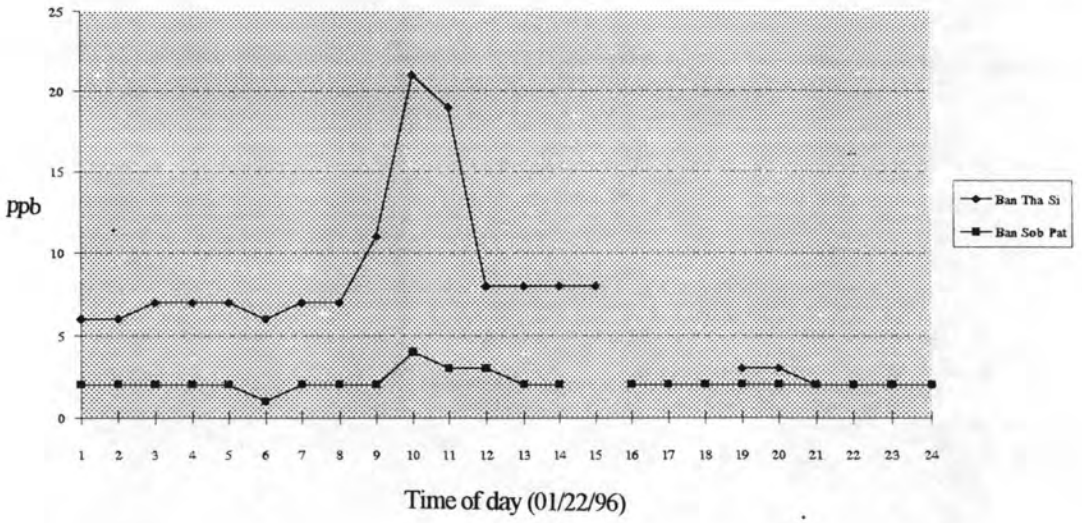
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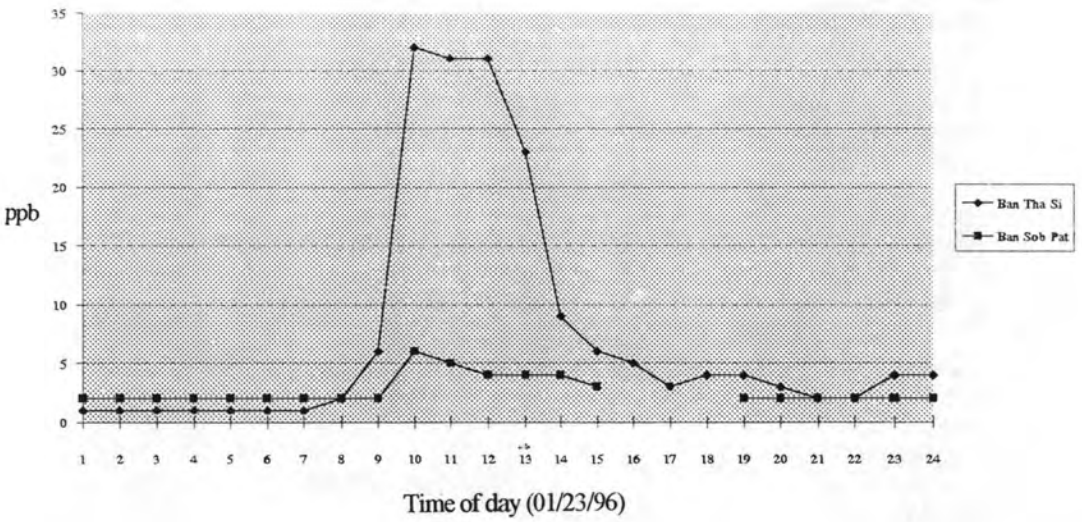
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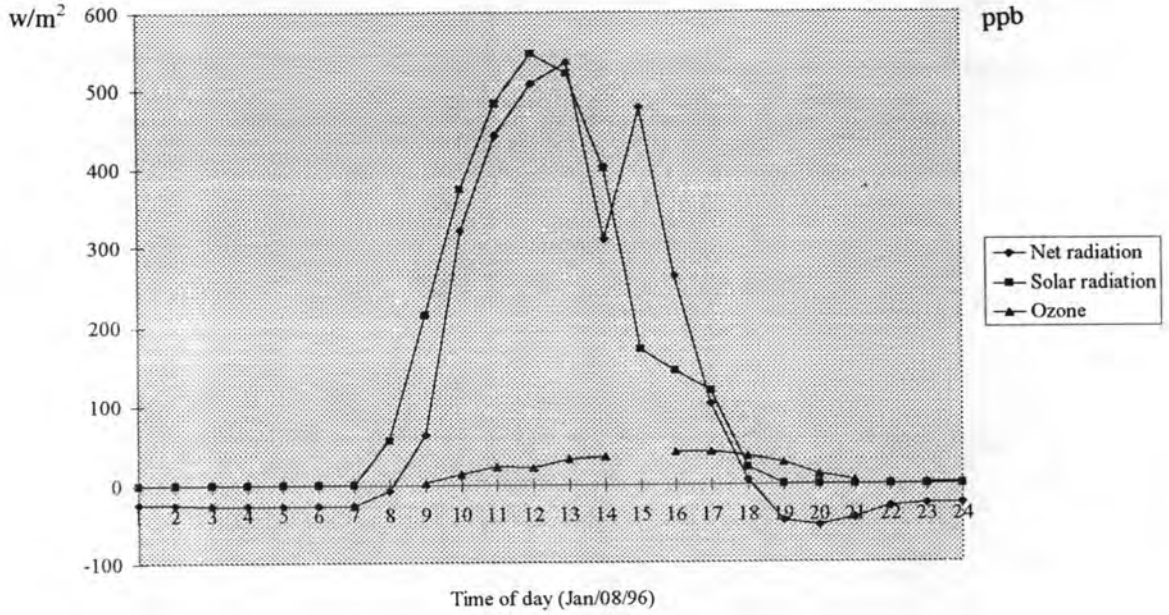
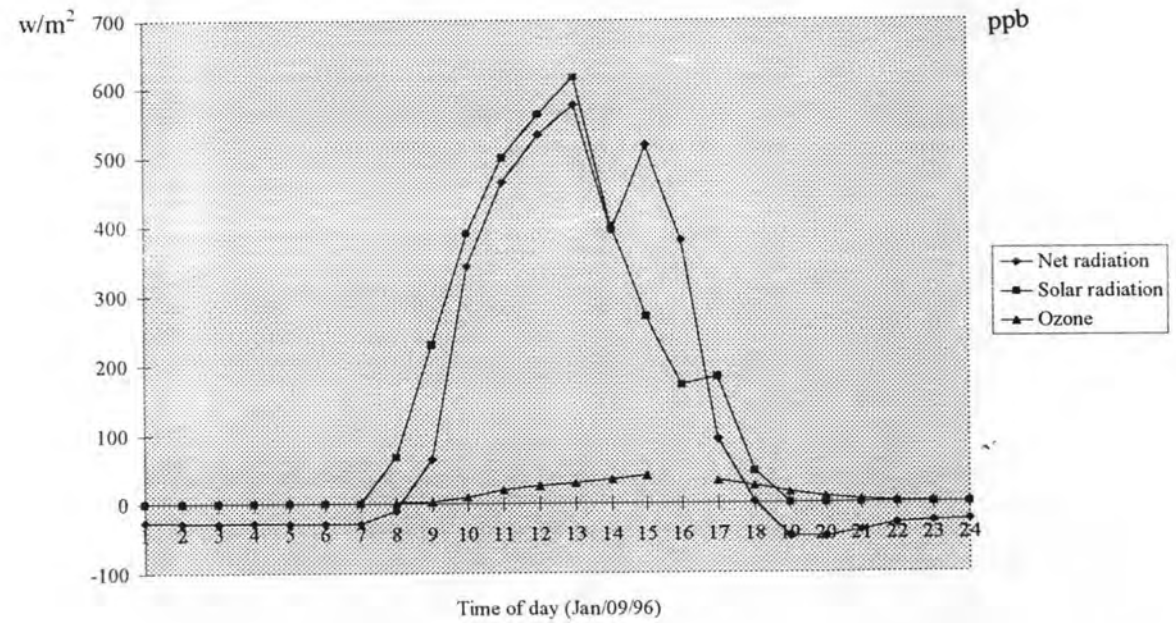
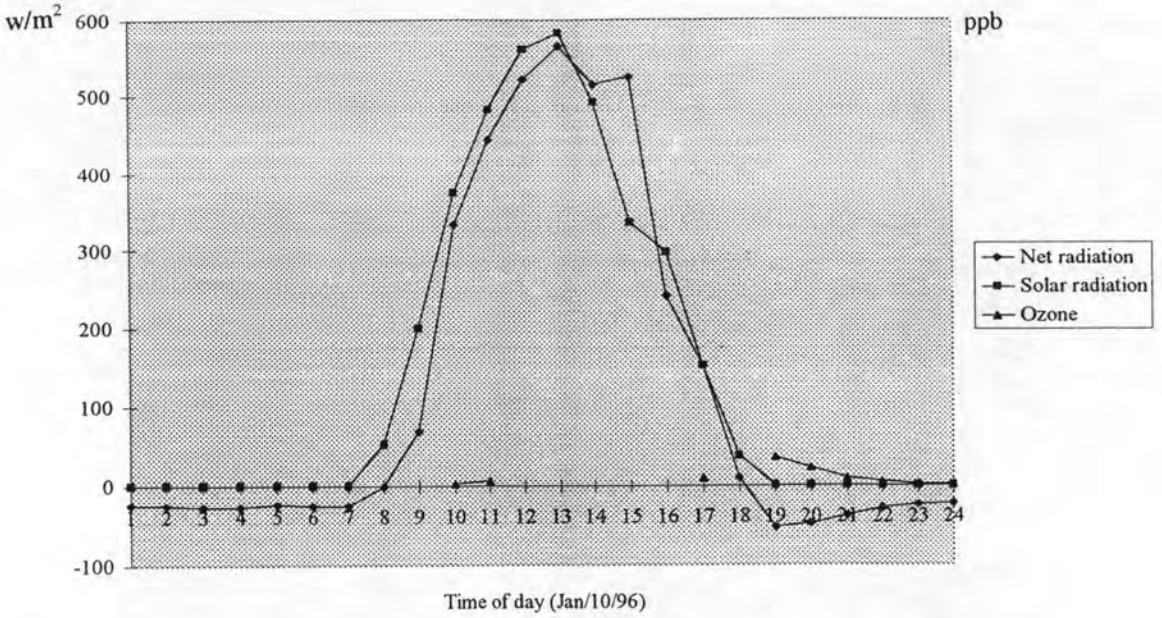
APPENDIX C

Diurnal variations of ozone, solar radiation and net radiation



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Ozone
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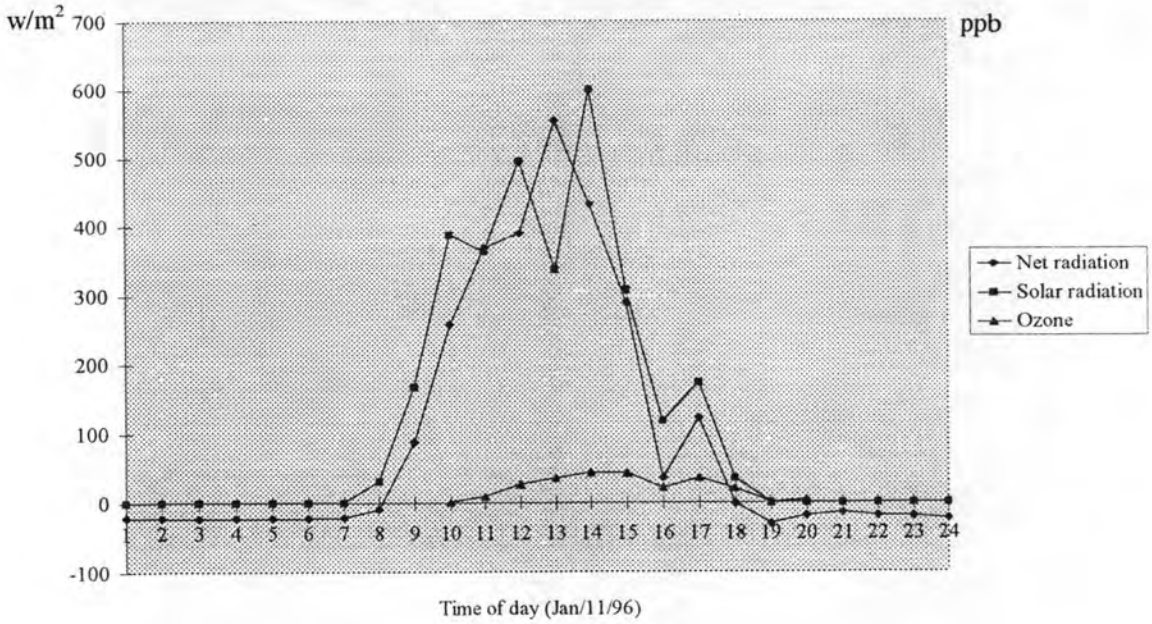
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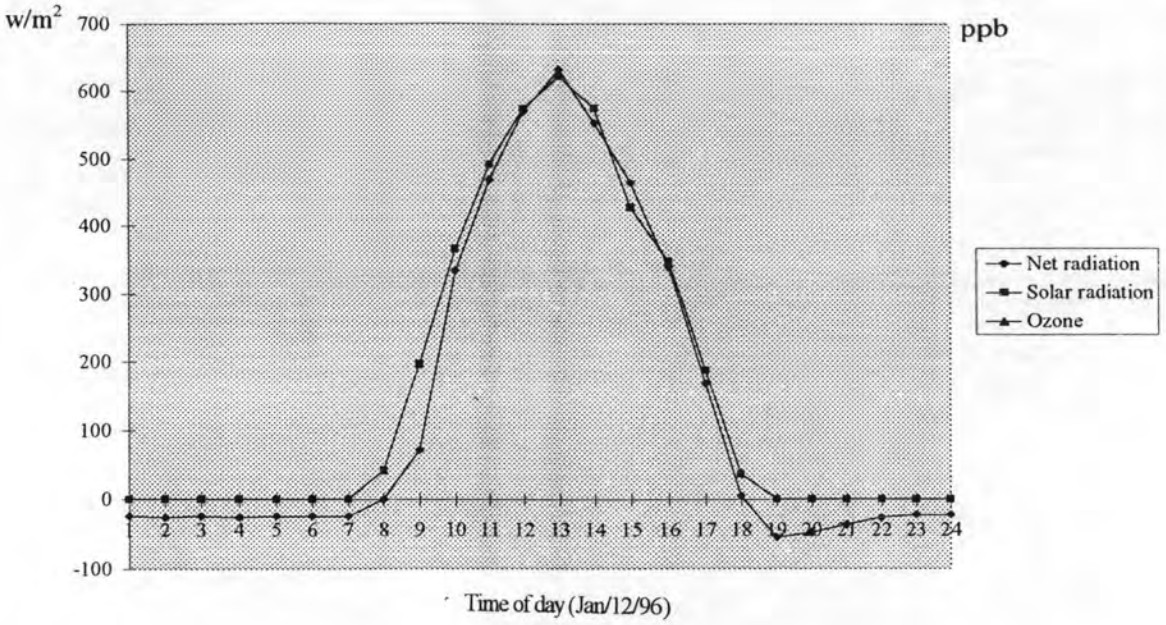
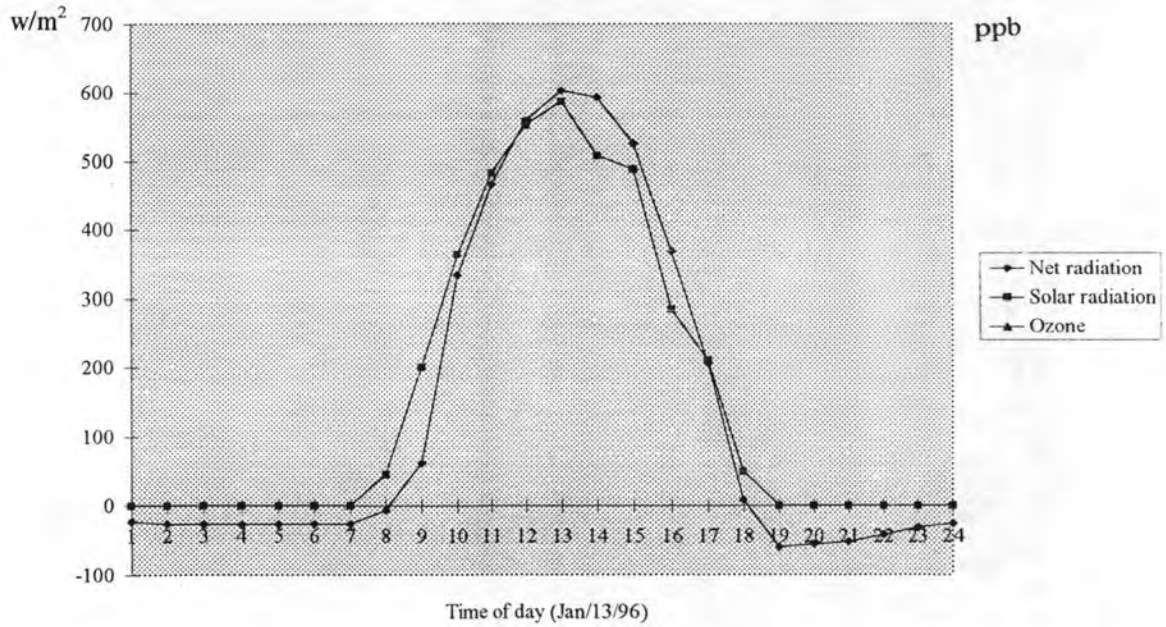
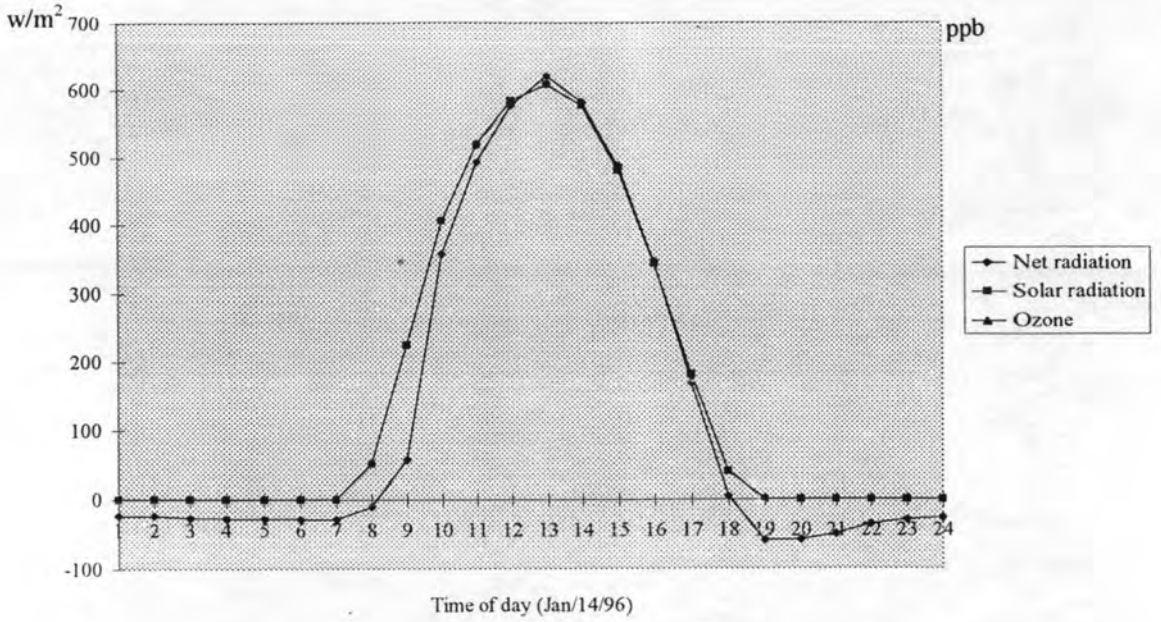
Ozone
Time of day (Jan/11/96)


w/m2
ppb
700
600
500
400
300
200
100
0
-100
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Net radiation
Solar radiation
Ozone
Time of day (Jan/12/96)


w/m2
ppb
700
600
500
400
300
200
100
0
-100
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Net radiation
Solar radiation
Ozone
Time of day (Jan/13/96)


w/m2
ppb
700
600
500
400
300
200
100
0
-100
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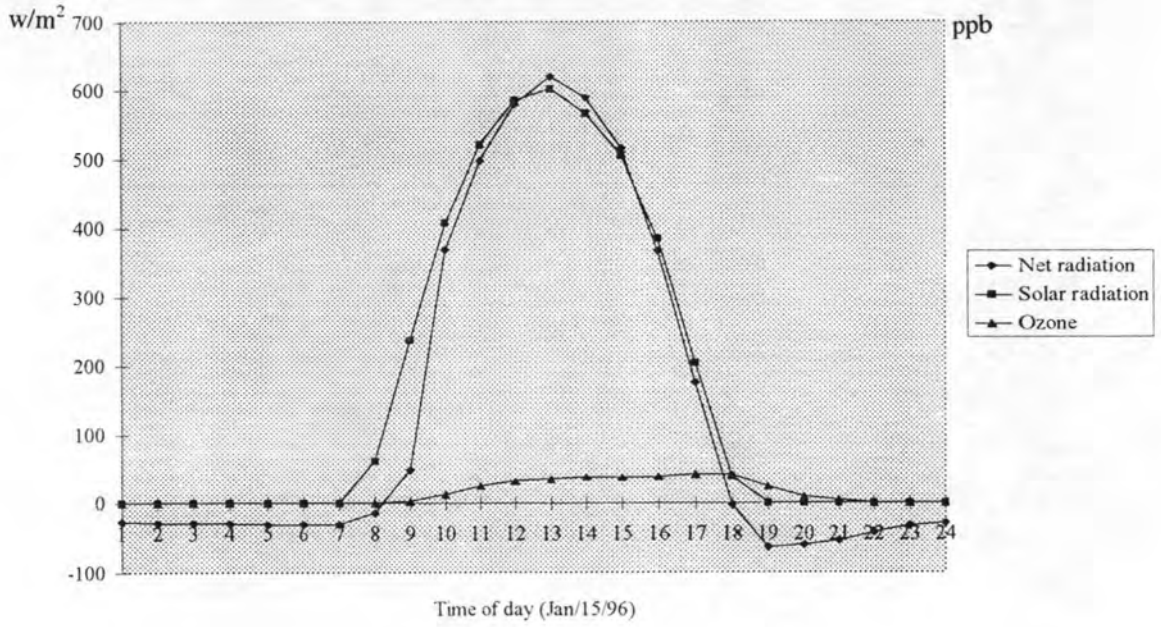
Net radiation
Solar radiation
Ozone
Time of day (Jan/14/96)


w/m2
ppb
700
600
500
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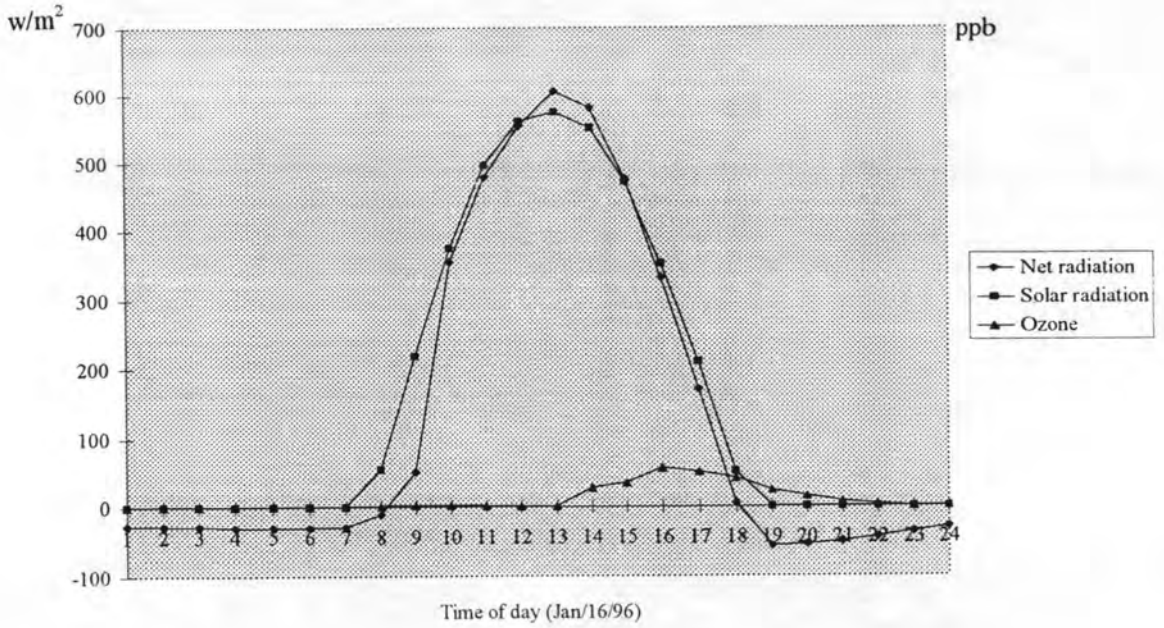
300
200
100
0
-100
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Net radiation
Solar radiation
Ozone
Time of day (Jan/15/96)


w/m2
ppb
700
600
500
400
300
200
100
0
-100
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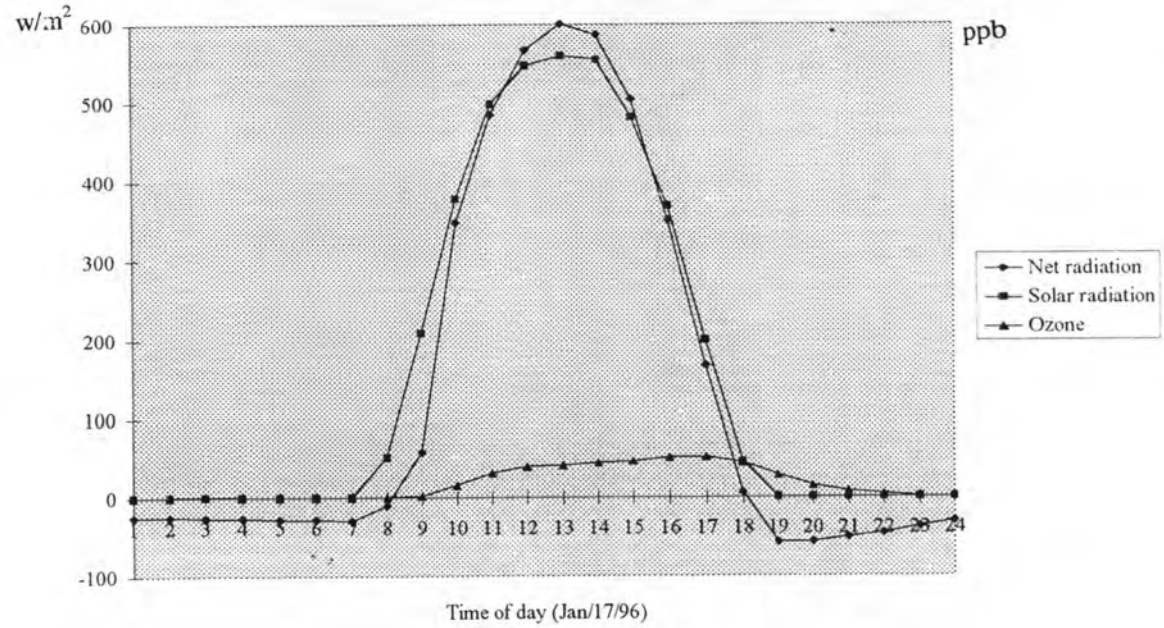
Net radiation
Solar radiation
Ozone
Time of day (Jan/16/96)


w/m2
ppb
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400
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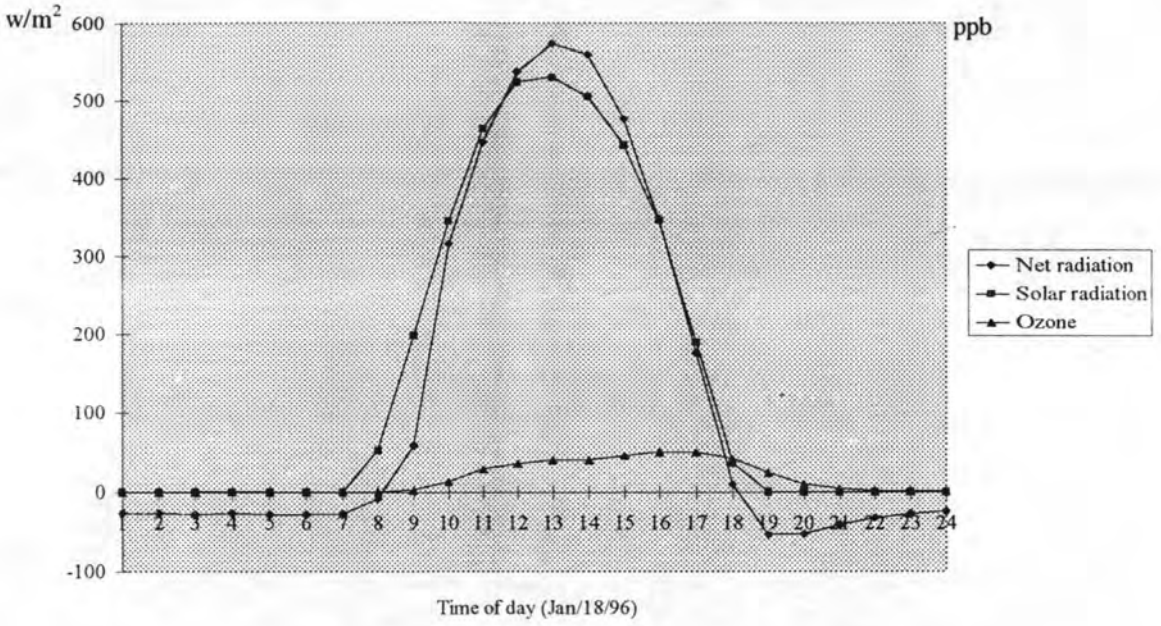
200
100
0
-100
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Net radiation
Solar radiation
Ozone
Time of day (Jan/17/96)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ppb
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500
400
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200
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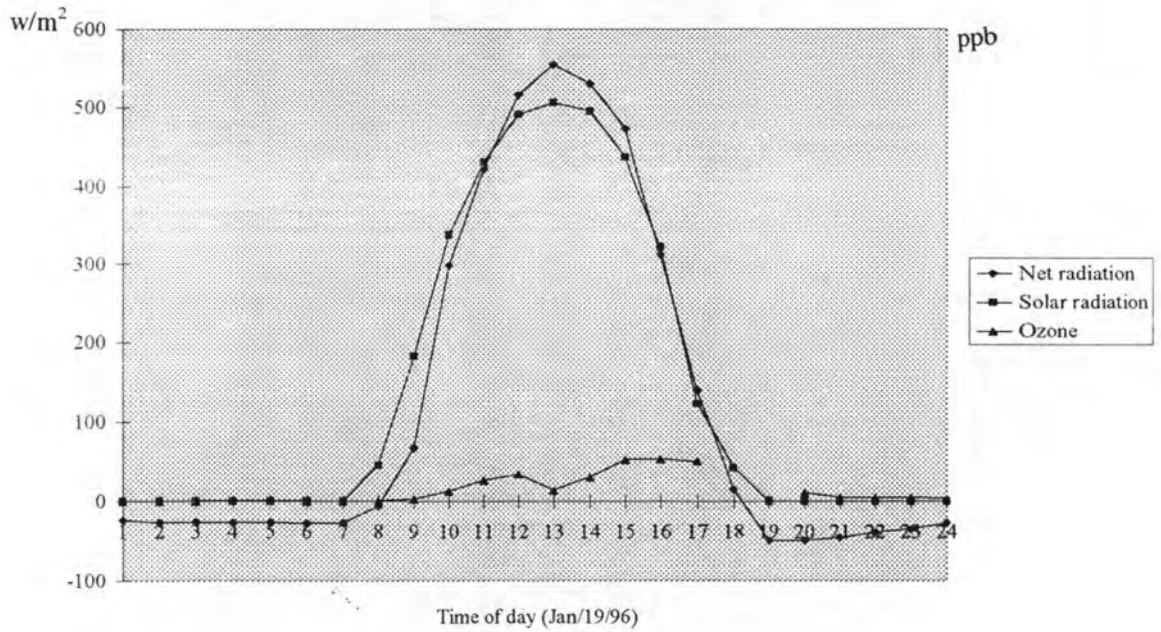
-100
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Net radiation
Solar radiation
Ozone
Time of day (Jan/18/96)


w/m2
ppb
600
500
400
300
200
100
0
-100
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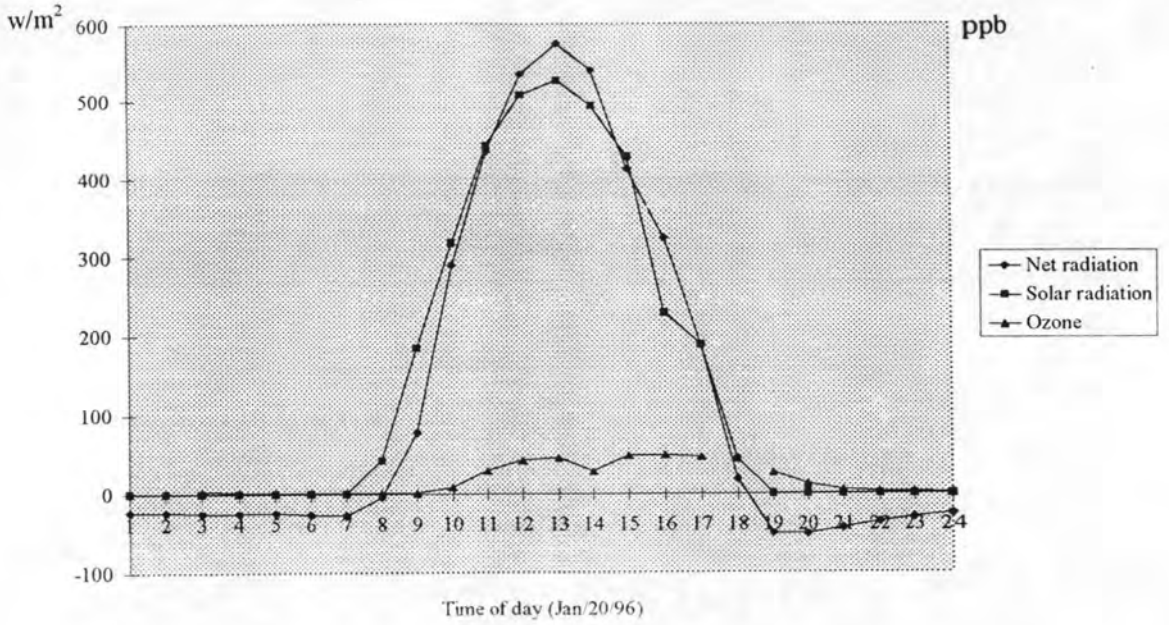
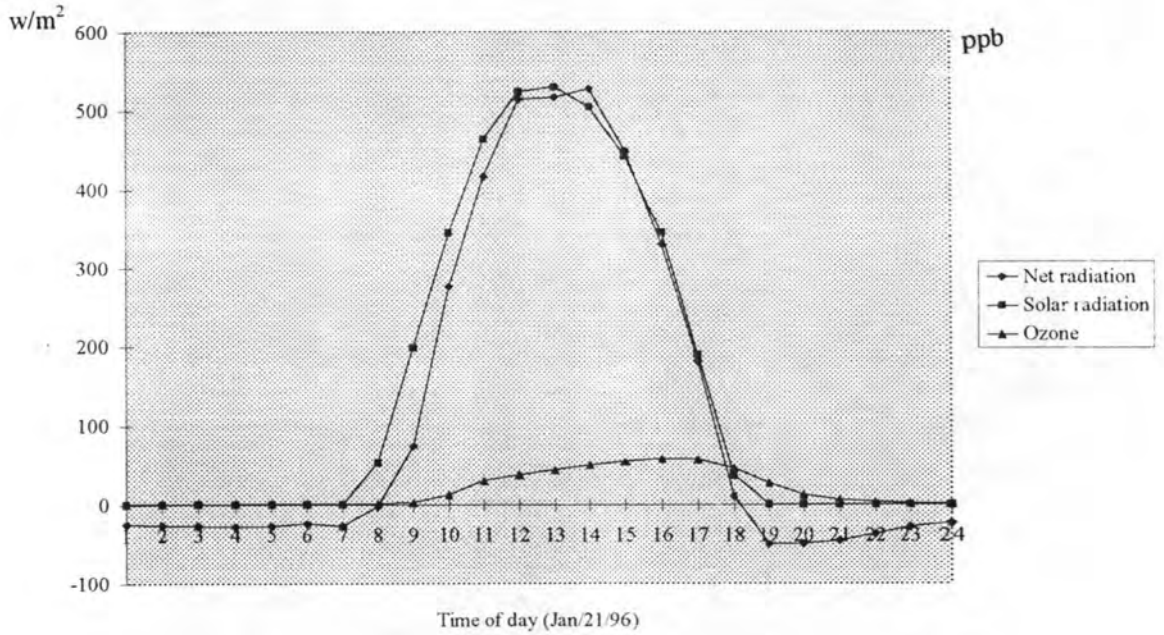
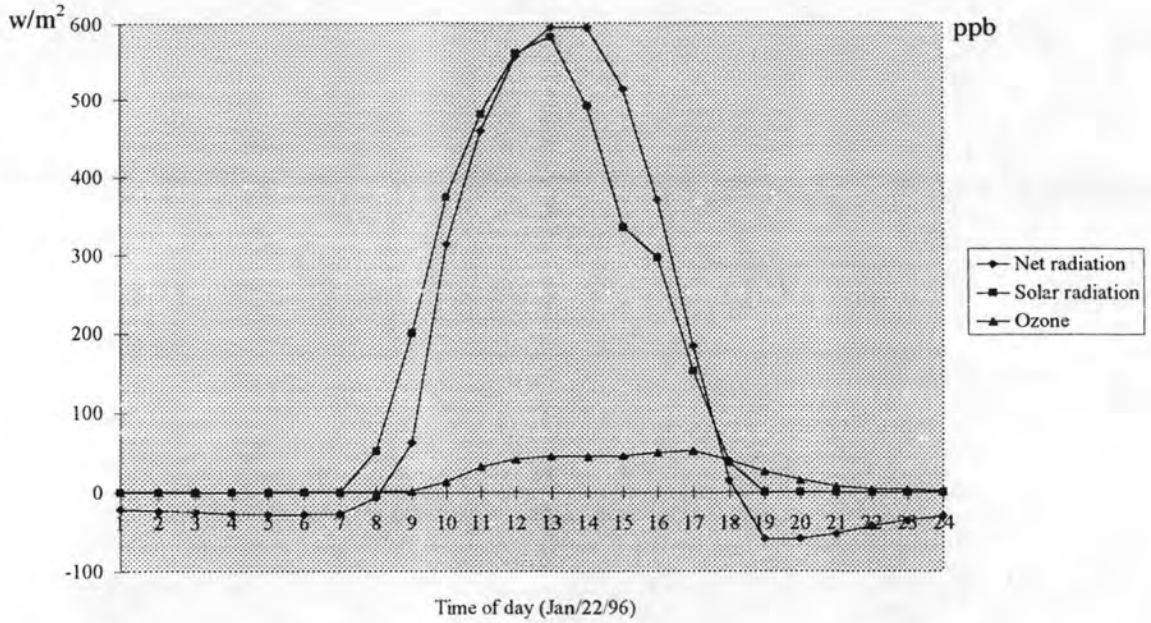
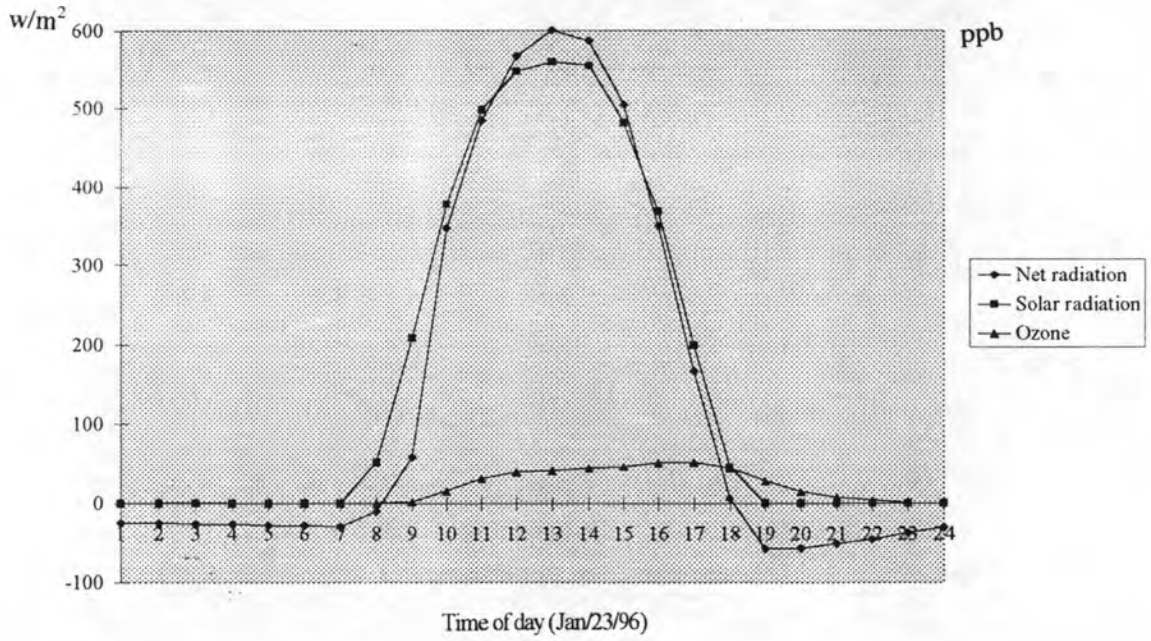
Net radiation
Solar radiation
Ozone
Time of day (Jan/19/96)


w/m2
ppb
600
500
400
300
200
100
0
-100
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Net radiation
Solar radiation
Ozone
Time of day (Jan/20/96)


w/m2
ppb
600
500
400
300
200
100
0
-100
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Net radiation
Solar radiation
Ozone
Time of day (Jan/21/96)


w/m2
ppb
600
500
400
300
200
100
0
-100
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Net radiation
Solar radiation
Ozone
Time of day (Jan/22/96)


w/m2
ppb
600
500
400
300
200
100
0
-100
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Net radiation
Solar radiation
Ozone
Time of day (Jan/23/96)

APPENDIX D

Table D-1 Frequency of occurrence of wind direction grouped in various wind speed intervals (m/s)

Station : Mae Moh Power Plant (Upper Wind)

Duration : January 08-23,1996 (Daytime)

Direction	0-1	1-2	2-3	3-4	4-6	over 6
N	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
NNE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
NE	0.8333	0.0000	0.0000	0.0000	0.0000	0.0000
ENE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
E	1.6667	0.0000	0.0000	0.0000	0.0000	0.0000
ESE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SE	0.0000	0.0000	0.8333	0.0000	0.0000	0.0000
SSE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
S	0.8333	3.3333	2.5000	0.8333	0.0000	0.0000
SSW	4.1667	6.6667	9.1667	2.5000	0.0000	0.0000
SW	3.3333	5.0000	6.6667	2.5000	0.0000	0.0000
WSW	3.3333	1.6667	1.6667	0.8333	0.0000	0.0000
W	4.1667	1.6667	0.8333	0.8333	0.0000	0.0000
WNW	0.0000	1.6667	2.5000	0.8333	0.0000	0.0000
NW	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
NNW	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
CALM	29.1667					

Total hours of non-calm = 85
Total hours of calm = 35

Table D-2 Frequency of occurrence of wind direction grouped in various wind speed intervals (m/s)

Station : Mae Moh Power Plant (Upper Wind)

Duration : January 08-23,1996 (Nighttime)

Direction	0-1	1-2	2-3	3-4	4-6	over 6
N	0.0000	0.0000	0.0000	0.4167	0.0000	0.0000
NNE	0.0000	0.4167	0.0000	0.0000	0.0000	0.0000
NE	0.8333	0.0000	0.0000	0.4167	0.0000	0.0000
ENE	0.0000	0.0000	0.0000	0.4167	0.0000	0.0000
E	0.8333	0.0000	0.0000	0.0000	0.0000	0.0000
ESE	0.8333	0.0000	0.0000	0.0000	0.0000	0.0000
SE	0.8333	0.4167	1.6667	0.0000	0.0000	0.0000
SSE	0.0000	0.4167	0.4167	0.0000	0.8333	0.0000
S	0.4167	0.0000	1.2500	0.8333	0.0000	0.0000
SSW	0.8333	0.0000	0.0000	0.0000	0.0000	0.0000
SW	0.4167	0.0000	0.0000	0.0000	0.0000	0.0000
WSW	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
W	0.4167	0.0000	0.0000	0.0000	0.0000	0.0000
WNW	0.4167	0.0000	0.0000	0.0000	0.0000	0.0000
NW	0.4167	0.0000	0.0000	0.0000	0.0000	0.0000
NNW	0.8333	0.4167	0.8333	0.0000	0.0000	0.0000
CALM	84.1667					

Total hours of non-calm = 38
Total hours of calm = 202

Table D-3 Frequency of occurrence of wind direction grouped in various wind speed intervals (m/s)

Station : Mae Moh Power Plant (Lower Wind)

Duration : January 08-23,1996 (Daytime)

Direction	0-1	1-2	2-3	3-4	4-6	over 6
N	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
NNE	0.8333	0.8333	0.0000	0.0000	0.0000	0.0000
NE	0.8333	6.6667	0.0000	0.0000	0.0000	0.0000
ENE	6.6667	9.1667	0.8333	0.0000	0.0000	0.0000
E	1.6667	8.3333	1.6667	0.0000	0.0000	0.0000
ESE	0.8333	5.0000	0.8333	0.0000	0.0000	0.0000
SE	11.6667	10.0000	1.6667	0.0000	0.0000	0.0000
SSE	7.5000	5.0000	0.8333	0.0000	0.0000	0.0000
S	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SSW	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SW	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
WSW	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
W	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
WNW	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
NW	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
NNW	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
CALM	19.1667					

Total hours of non-calm = 97
Total hours of calm = 23

Table D-4 Frequency of occurrence of wind direction grouped in various wind speed intervals (m/s)

Station : Mae Moh Power Plant (Upper Wind)

Duration : January 08-23,1996 (Nighttime)

Direction	0-1	1-2	2-3	3-4	4-6	over 6
N	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
NNE	0.0000	0.4167	0.0000	0.0000	0.0000	0.0000
NE	0.0000	0.4167	0.0000	0.0000	0.0000	0.0000
ENE	0.4167	0.0000	0.0000	0.0000	0.0000	0.0000
E	1.6667	0.0000	0.0000	0.0000	0.0000	0.0000
ESE	2.0833	0.0000	0.0000	0.0000	0.0000	0.0000
SE	0.8333	0.0000	0.0000	0.0000	0.0000	0.0000
SSE	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
S	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SSW	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
SW	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
WSW	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
W	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
WNW	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
NW	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
NNW	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
CALM	94.1667					

Total hours of non-calm = 14
Total hours of calm = 226

APPENDIX E

Daily Summary Report of Fuel Supply during January 8-23, 1996

Date	Fuel	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00
Jan-8	coal	1825	1565	1565	1565	1565	1325	1325	1325	1325	1325	1385	1385	1425	1600	2025	2025	2025	1905	2010	2000	1840	1905	1725	1725
	oil	-	-	-	-	-	120	120	120	120	120	120	120	120	-	-	-	-	-	-	-	160	100	160	100
Jan-9	coal	1725	1865	1865	1665	1665	1225	1225	1225	1325	1255	1245	1210	1355	1630	1675	1755	1755	1765	1925	2025	2025	2025	2025	2025
	oil	160	-	-	-	-	200	200	200	200	280	280	160	160	160	80	80	80	120	80	-	-	-	-	-
Jan-10	coal	1975	1975	1775	1565	1565	1325	1325	1325	1325	1265	1225	1225	1725	1935	1965	1995	2015	2015	2025	1975	2025	2025	2025	2025
	oil	-	-	-	-	-	160	160	160	160	160	160	160	-	-	-	-	-	-	-	-	-	-	-	-
Jan-11	coal	2025	2025	1825	1785	1545	1325	1305	1305	1080	1035	1035	1035	1405	1405	1405	1405	1405	1405	1485	1655	1655	1805	1875	1875
	oil	-	-	-	-	-	180	180	180	280	280	280	280	160	160	160	160	160	160	160	60	60	40	-	-
Jan-12	coal	1875	1875	1875	1875	1875	1345	1345	1345	1345	1345	1345	1565	1875	1855	1875	1875	1875	1875	1875	1879	1728	1725	1780	1810
	oil	-	-	-	-	-	120	120	120	120	120	120	-	-	-	-	-	-	-	-	40	140	140	100	40
Jan-13	coal	1785	1795	1795	1795	1795	1455	1355	1265	1225	1175	1025	1115	1545	1575	1575	1575	1575	1575	1575	1575	1575	1575	1575	1575
	oil	40	-	-	-	-	80	80	80	80	80	80	-	-	-	-	-	-	-	-	-	-	-	-	-
Jan-14	coal	1575	1575	1545	1545	1545	1225	1045	1025	1035	1035	1035	1115	1275	1275	1275	1275	1275	1275	1275	1275	1275	1275	1275	1275
	oil	-	-	-	-	-	80	80	80	80	80	80	-	-	-	-	-	-	-	-	-	-	-	-	-
Jan-15	coal	1260	1275	1295	1395	1395	1155	1025	1035	955	955	1075	1315	1495	1575	1575	1575	1575	1575	1575	1530	1530	1530	1570	1530
	oil	-	-	60	-	-	-	80	80	240	240	240	-	-	-	-	-	-	-	-	-	-	-	-	-
Jan-16	coal	1530	1530	1530	1340	1340	1045	1045	1045	1035	1035	995	875	875	1085	1475	1575	1575	1575	1575	1575	1575	1565	1565	1565
	oil	-	-	-	-	-	140	140	140	200	200	240	240	240	240	40	-	-	-	-	-	-	-	-	-
Jan-17	coal	1515	1425	1425	1525	1570	1510	975	975	975	1025	1025	1215	1575	1575	1875	1875	1875	1875	1875	1875	1875	1875	1875	1865
	oil	-	-	-	-	-	60	260	260	260	260	260	120	-	-	-	-	-	-	-	-	-	-	-	-
Jan-18	coal	1830	1830	1830	1830	1560	1170	1170	1170	1225	1225	1225	1225	1365	1495	1875	1875	1810	1810	1810	1810	1810	1810	1810	1810
	oil	-	-	-	-	-	140	140	140	140	140	140	140	-	-	-	-	-	-	-	-	-	-	-	-
Jan-19	coal	1810	1810	1610	1610	1430	1220	1170	1170	1180	1180	1180	1320	1590	1875	1875	1875	1800	1800	1800	1800	1800	1800	1600	1725
	oil	-	-	-	-	-	140	140	140	140	140	140	-	-	-	-	-	-	-	-	-	-	-	-	-
Jan-20	coal	1785	1785	1785	1615	1615	1235	1235	1235	1225	1225	1215	1215	1655	1855	1855	1855	1875	1875	1875	1875	1875	1875	1875	1875
	oil	-	-	-	-	-	140	140	140	140	140	200	200	-	-	-	-	-	-	-	-	-	-	-	-
Jan-21	coal	1515	1425	1425	1525	1570	1510	1025	1025	1025	1025	1025	1215	1575	1575	1875	1875	1875	1875	1875	1875	1875	1875	1875	1865
	oil	-	-	-	-	-	140	140	140	140	140	140	140	-	-	-	-	-	-	-	-	-	-	-	-
Jan-22	coal	1875	1875	1875	1875	1875	1345	1345	1345	1345	1345	1345	1565	1875	1855	1875	1875	1875	1875	1875	1879	1728	1725	1780	1810
	oil	-	-	-	-	-	120	140	140	140	140	140	-	-	-	-	-	-	-	-	-	-	-	-	-
Jan-23	coal	1830	1830	1830	1830	1560	1170	1170	1170	1225	1225	1225	1225	1365	1495	1875	1875	1810	1810	1810	1810	1810	1810	1810	1810
	oil	-	-	-	-	-	140	140	140	140	140	140	-	-	-	-	-	-	-	-	-	-	-	-	-

APPENDIX F

THE REPORT OF MULTIPLE REGRESSION ANALYSIS

```
This procedure was completed at  1:11:44
title test multiple reg2.
data list free/so4 fe mn so2 o3 solar.
begin data.
end data.
     60 cases are written to the compressed active file.

This procedure was completed at  1:11:46
corr/variable so4 fe mn so2 o3 solar/option 3 5/stat 1.
```

Page 11 TEST MULTIPLE REG2 9/15/9

Variable	Cases	Mean	Std Dev
SO4	60	468.2945	378.1053
FE	60	2.8377	1.3420
MN	60	.1285	.0891
SO2	60	10.9598	23.0849
O3	60	8.9493	3.8754
SOLAR	60	204.3833	200.4366

Page 12 TEST MULTIPLE REG2 9/15/9

Correlations:	SO4	FE	MN	SO2	O3	SOLAR
SO4	1.0000	-.2274	-.0673	-.0425	-.3815	-.3830
	(60)	(60)	(60)	(60)	(60)	(60)
	P= .	P= .081	P= .610	P= .747	P= .003	P= .003
FE	-.2274	1.0000	.7675	-.0051	.4113	.3785
	(60)	(60)	(60)	(60)	(60)	(60)
	P= .081	P= .	P= .000	P= .969	P= .001	P= .003
MN	-.0673	.7675	1.0000	-.1490	.1697	.1131
	(60)	(60)	(60)	(60)	(60)	(60)
	P= .610	P= .000	P= .	P= .256	P= .195	P= .390
SO2	-.0425	-.0051	-.1490	1.0000	.2293	.2133
	(60)	(60)	(60)	(60)	(60)	(60)
	P= .747	P= .969	P= .256	P= .	P= .078	P= .102

(Coefficient / (Cases) / 2-tailed Significance)

" . " is printed if a coefficient cannot be computed

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Correlations:	SO4	FE	MN	SO2	O3	SOLAR
O3	-.3815	.4113	.1697	.2293	1.0000	.8592
	(60)	(60)	(60)	(60)	(60)	(60)
	P= .003	P= .001	P= .195	P= .078	P= .	P= .000
SOLAR	-.3830	.3785	.1131	.2133	.8592	1.0000
	(60)	(60)	(60)	(60)	(60)	(60)
	P= .003	P= .003	P= .390	P= .102	P= .000	P= .

(Coefficient / (Cases) / 2-tailed Significance)

" . " is printed if a coefficient cannot be computed

Page 14 TEST MULTIPLE REG2 9/15/9

This procedure was completed at 1:11:49
regress/variable all/stat default/dependent so4/method enter.

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* * * * M U L T I P L E R E G R E S S I O N * * * *

Listwise Deletion of Missing Data

Equation Number 1 Dependent Variable.. SO4

Block Number 1. Method: Enter

Page 16 TEST MULTIPLE REG2 9/15/9

* * * * M U L T I P L E R E G R E S S I O N * * * *

Equation Number 1 Dependent Variable.. SO4

Variable(s) Entered on Step Number
1.. SOLAR
2.. MN
3.. SO2
4.. FE
5.. O3

Page 17 TEST MULTIPLE REG2 9/15/9

* * * * M U L T I P L E R E G R E S S I O N * * * *

Equation Number 1 Dependent Variable.. SO4

Multiple R .41349
R Square .17098
Adjusted R Square .09421
Standard Error 359.85324

Analysis of Variance

	DF	Sum of Squares	Mean Square
Regression	5	1442156.89015	288431.37803
Residual	54	6992695.29533	129494.35732

F = 2.22737 Signif F = .0647

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* * * * M U L T I P L E R E G R E S S I O N * * * *

Equation Number 1 Dependent Variable.. SO4

---------- Variables in the Equation ----------

Variable	B	SE B	Beta	T	Sig T
SOLAR	-.337985	.464174	-.179169	-.728	.4697
MN	584.831298	872.219385	.137817	.671	.5054

SO2	.952160	2.130738	.058133	.447	.6568
FE	-53.032404	61.783021	-.188226	-.858	.3945
O3	-18.231874	24.179747	-.186870	-.754	.4541
(Constant)	765.418636	161.193667		4.748	.0000

End Block Number 1 All requested variables entered.

Biography

Mr. Sarawut Thepanondh was born on August 28, 1971 in Bangkok, Thailand. He received his Bachelor of Science Degree in Environmental Science from Faculty of Science and Technology, Thammasat University, Bangkok, Thailand, in 1992. After graduation, he worked as an environmental scientist at Southeast Asia Technology Co. Ltd. from 1992-1994. Then in 1994, he has continue studied in Interdisciplinary Programme in Environmental Science, Graduate school, Chulalongkorn University. He also received postgraduate scholarship from Pollution Control Department, Ministry of Science Technology and Environment. At the present, he works as an environmentalist in the Air Quality and Noise Management Division, Pollution Control Department of Thailand.