7 Questionnaire on the Residential Heating

7-1 Purpose and Method

To investigate the actual state of fuel consumption by type of combustion apparatus in Ankara City, information was gathered by the questionnaire method under cooperation of GDE. 1,000 questionnaires were distributed throughout 14,350 ha of the City. It was definitely printed on the questionnaire papers that the questionnaire would be used solely for the air pollution control study.

The items of the questionnaire are as follows:

1. Usage of Building
2. Number of Floors
3. Area per Floor
4. Number of Residents
5. Height and Diameter of Stacks
6. Kind of Fuels
7. Fuel Consumption in the Winter of 1983/84
8. Fuel Consumption by Month
9. Supply Source of Fuels
10. Operation Pattern of Combustion Apparatus
11. Fuel Use Hours
12. Area of Boiler Room
13. Heating Surface Area of Boilers
14. Temperature of Boiler

7-2 Outline of Investigation

The 737 questionnaires out of 1,000 were retrieved (73.7%) and the ratio of effective answers to the total number of answers varied depending on the items of the questionnaire. The ratio of the effective answers to fuel consumption and kind of fuels was as high as 88%, while the ratio of the effective answers to technical questions such as height of stacks and heating surface was low. For example, the effective answers were 36% to the questions about the heating surface. The area where questionnaires were distributed was divided into 574 elements of the 500 m mesh. After random

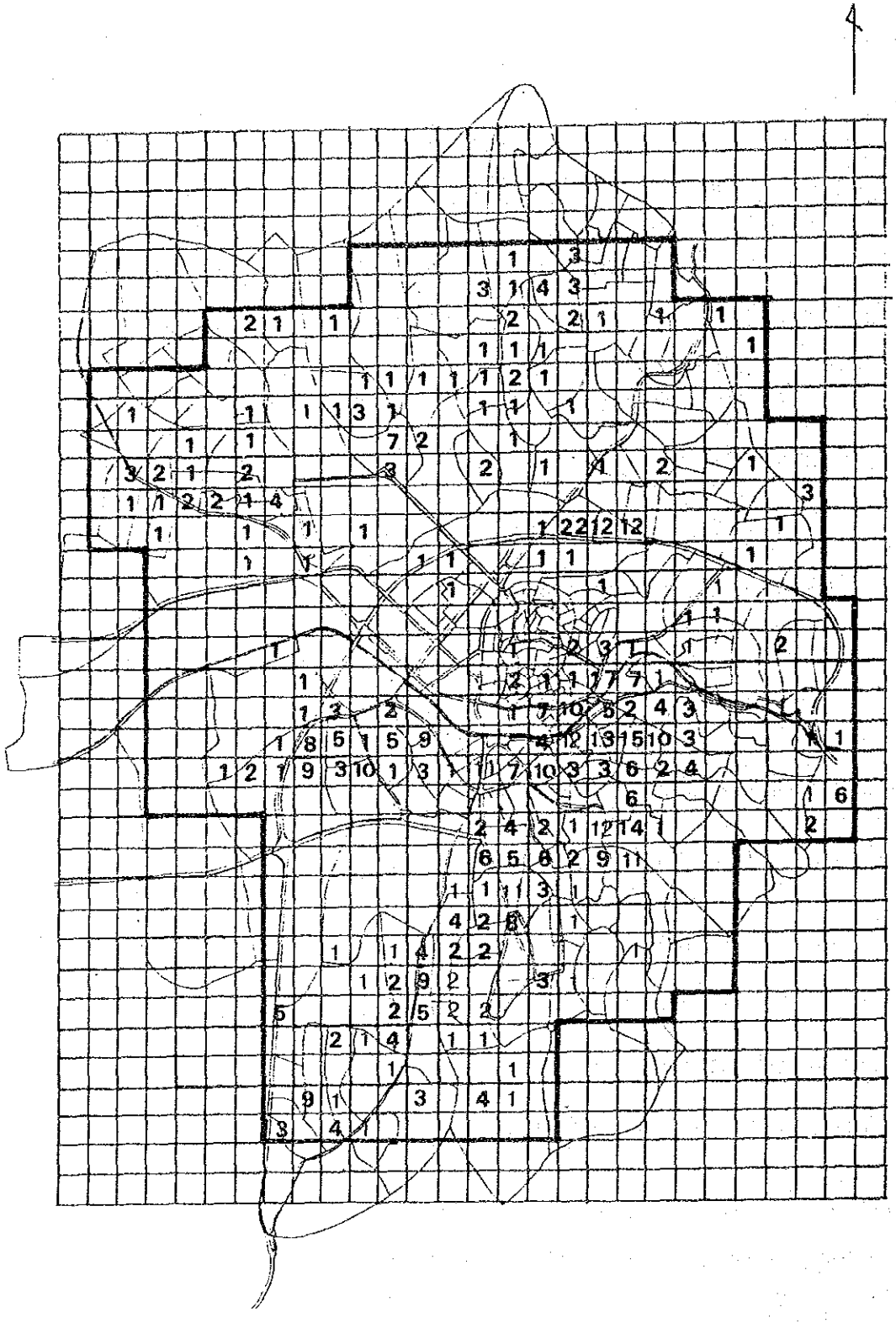


Figure 7-2-1 Distribution of the 737 Samples Retrieved

sampling, the number of samples was aggregated. The result shows that the samples were found in 189 meshes and the ratio to the whole meshes was 33%. The maximum number of the samples per mesh was 22, the minimum was 1, and the average was 3.4. Distribution of the 737 samples retrieved is shown in Figure 7-2-1.

7-3 Fuel Consumption

Table 7-3-1 shows the types of combustion apparatus and kind of fuels. Figure 7-3-1 shows distribution of these apparatus and fuels in the meshs.

Table 7-3-1 Types of Combustion Apparatus and Kinds of Fuels

(%)

Fuel / Apparatus	lignite	coke	fuel-oil	coal	briquette	wood	kerosene	electricity	Total
boiler	72.4	1.8	21.6	4.2	-	-	-	-	100
stove	42.9	46.3	-	4.8	2.2	1.7	1.7	0.5	100

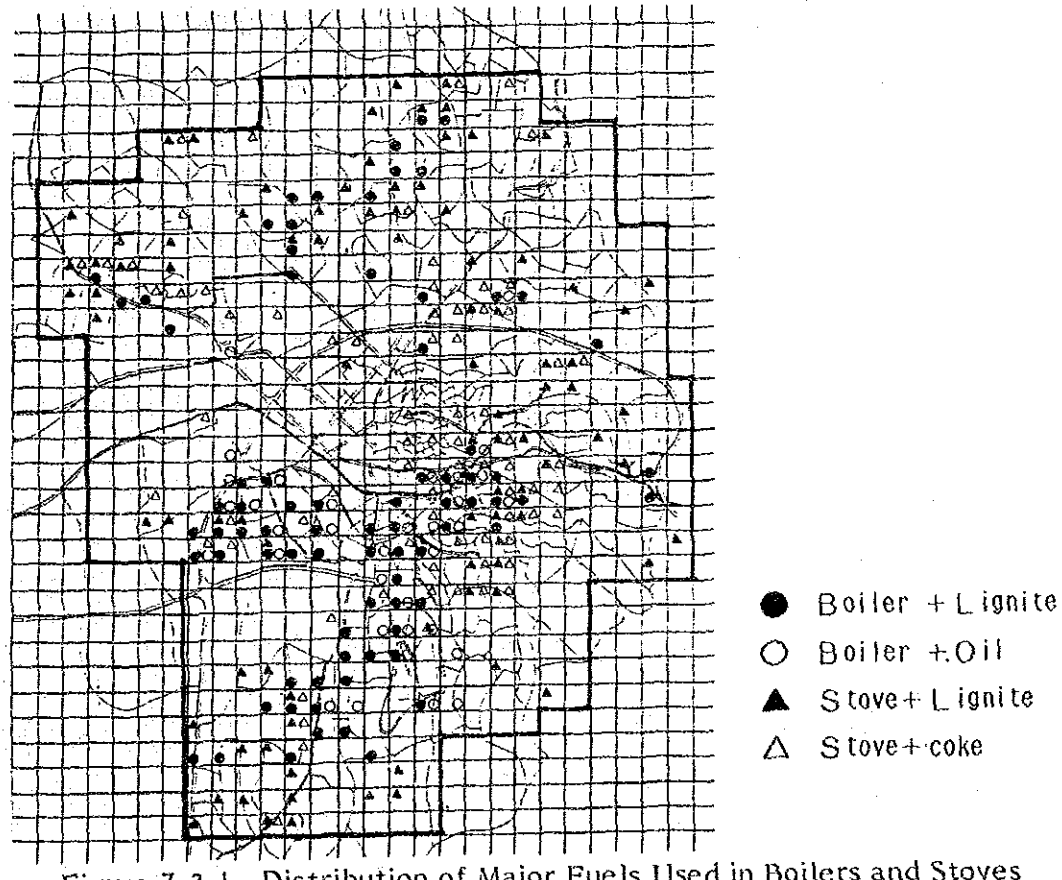


Figure 7-3-1 Distribution of Major Fuels Used in Boilers and Stoves

Table 7-3-1 shows that 74.2% of boilers use lignite, and 21.6% use coke (total: 94%) and that 42.9% of stoves use lignite and 46.3% use coke (total: 89.2%).

Table 7-3-2 shows the fuel consumption per household per one heating season by types of combustion apparatus, kinds of fuels, and usage of buildings, together with floor area and number of persons per household.

Table 7-3-2 Fuel Consumption per Household

Combustion apparatus	Fuel	Building usage	Fuel consumption per household	Floor area	Persons per household
Boiler	Oil	Residence	1.97 kl	113 m^2	3.0
		Residence/Store	1.90 kl	81 m^2	-
	Lignite	Residence	6.03 t	118 m^2	3.8
		Residence/Store	8.69 t	97 m^2	-
Stove	Lignite	Residence	2.31 t*	88 m^2	4.9
	Coke	Residence	1.54 t*	91 m^2	4.1

* Amount of firewood used in each type of stove is:

Lignite	0.99 t
Coke	1.08 t

Table 7-3-3 shows, for reference, fuel consumption per household in the Japanese cities of Kushiro and Muroran, both of which belong to the cold climate zone.

Table 7-3-3 Fuel Consumption per Household in the Cold Climate Zone in Japan

Place	Classification of Household by Type of Fuels	Kind of Fuels		
		Kerosene	Coal	Coke
Kushiro	Kerosene	1.60 kl	-	-
	Coal	0.47 kl	3.08 t	-
Muroran	Kerosene	1.47 kl	-	-
	Coal	1.05 kl	1.22 t	-
	Coke	0.63 kl	-	1.88 t

Note:

1) Calorific Value: Kerosene 10,200 kcal/l
Coal 6,500 kcal/kg
Coke 6,500 kcal/kg

2) Source: "Environmental Assessment of Coal Consuming Area (Kushiro, Muroran)", Hokkaido Gov., 1983.

Based on the previous two tables, the amount of fuel consumed in one season for residential heating was calculated by places and shown in Table 7-3-4.

Table 7-3-4 Fuel Consumption by Places

Place	Kind of Fuels	Heat Consumption of G cal	Apparatus
Ankara (3.2°C)	Oil Lignite	20.7 25.3	Boiler
Kushiro (-2.6°C)	Oil Kerosene + Oil	16.3 21.7	Stove
Kuroran (-0.9°C)	Kerosene Kerosene + Coal Kerosene + Coke	15.0 17.4 18.6	Stove

Note: 1) Mean temperature from November through March is shown in the parentheses under each place

2) Average calorific values of oil and lignite used in Ankara are as follows:

oil	10,500 kcal/l
lignite	4,200 kcal/l

Despite the fact that the mean temperature in Ankara City from November through March is higher than that of Kushiro by 5.8°C and Muroran by 4.1°C, Ankara City consumes more heat than these two cities by 30%. Thermal efficiency of boilers is generally lower than that of stoves because boilers have to use water to transmit heat. Even taking this fact into consideration, it is advisable to further investigate the combustion conditions of boilers and other factors.

7-4 Other Items

(1) Fuel Supply Source

90.1% of boiler fuels and 85.7% of stove fuels are supplied by TKI.

(2) Pattern of Operation (continuous or intermittent)

4.1% of Boilers and 14.9% of stoves were in 24-hour continuous operation. (effective answers: 89%)

(3) Combustion Hours

Two kinds of answers were obtained. One was citing actual combustion hours. And the other was citing time zones of the day. (morning, daytime, evening, and night-time)
The latter is shown in Table 7-4-1, and the former in Table 7-4-2.

Table 7-4-1 Combustion Time Zones

	Morning	Daytime	Evening	Night-time
Boiler	96.4%	23.8%	90.5%	32.1%
Stove	66.2%	42.3%	88.5%	26.2%

Note: The respondent rate was 31% as calculated in the following manner:

$$\frac{\text{Number of Answers in Combustion Hours} \times 100}{\text{Total Number of Answers}}$$

Table 7-4-2 Combustion Hours by the Times of Day

Time of Day	Boilers (%)		Stoves (%)	
	Lignite	Oil	Lignite	Coke
3	0.9	1.0	0.0	0.0
4	0.9	2.1	0.4	0.0
5	10.4	4.1	0.9	0.9
6	20.1	26.8	11.6	4.3
7	5.7	8.2	13.8	21.6
8	0.0	0.0	1.8	6.0
9	1.6	1.0	0.9	5.1
10	0.3	2.1	0.0	0.9
11	0.9	2.1	0.4	0.0
12	2.5	1.0	3.1	2.6
13	2.2	2.1	5.3	5.2
14	6.9	1.0	5.3	3.4
15	4.7	4.1	0.4	0.0
16	9.7	14.4	4.0	1.7
17	11.9	15.5	11.6	7.8
18	6.6	4.1	14.7	7.8
19	2.5	1.0	3.6	5.2
20	1.6	0.0	0.9	1.7
21	2.5	0.0	0.9	0.9
22	2.2	5.2	3.6	3.4
23	3.1	1.0	0.9	0.9
24	1.3	1.0	1.8	0.9
24 hour continuous	2.8	2.1	13.8	19.8

(Respondent rate : 45%)

(4) Boiler Water Temperature

Boiler water temperatures are shown in Table 7-4-3. Most of boilers (75 - 81%) were operated with water temperatures between 50 - 70°C. There was no significant difference in the water temperature between the lignite boilers and the oil boilers.

Table 7-4-3 Boiler Water Temperature

Temperature Range (°C)	Oil (%)	Lignite (%)	Whole (%)
41 - 50	1.7	2.0	1.8
51 - 60	38.3	30.5	30.5
61 - 70	43.3	44.5	46.5
71 - 80	10.0	16.5	14.9
81 - 90	6.7	6.5	7.3

(Respondent rate : 97%)

(5) Stack Height and Building Height

Height of stacks by numbers of building floors is shown in Table 7-4-5. Distribution of buildings in terms of number of floors is shown in Figure 7-4-1. This was made based on the questionnaire and the subsequent site visits.

Table 7-4-5 Average Stack Height by Number of Building Floors

Number of Floors	3	4	5	6	7	8	9	10	11
Stack Height (m)	15.5	15.9	18.3	20.2	23.8	30.0	29.8	31.3	35.0

(Respondent rate : 36%)

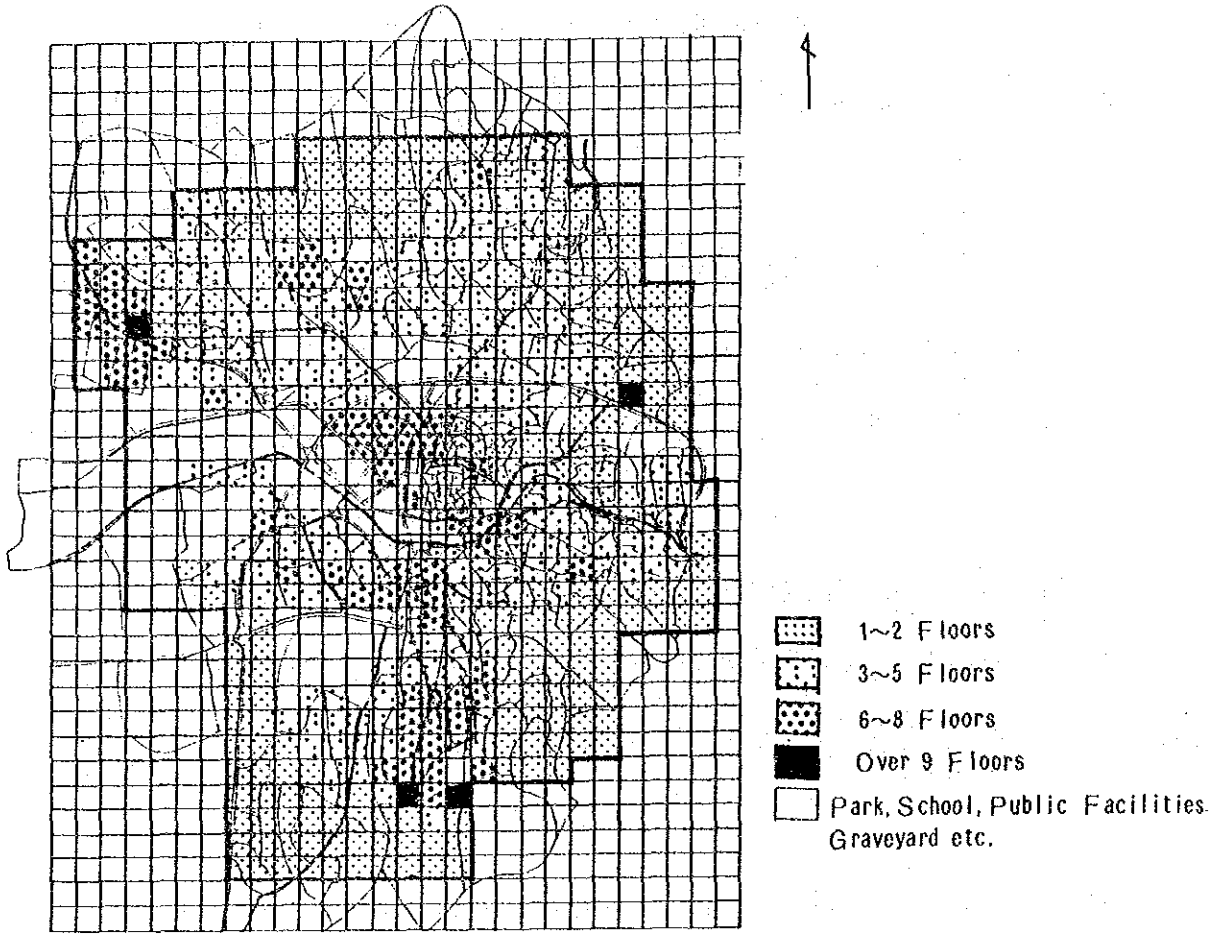


Figure 7-4-1 Distribution of Building Hight in Terms of Floor Number

7-5 Consumption of Lignite in Boilers by Districts

Apart from the questionnaire, a statistics for the consumption of lignite in boilers in apartment buildings and governmental offices in Ankara was obtained from TKI for the one year period of 1982/1983. It gives numbers of buildings and lignite consumption by the ranks of the consumption for each of the three distribution districts (I, II, and III) in the City. They are shown in Table 7-5-1. The district I occupies the central part of the City (see Figure 7-5-1), and constitutes about 67% of the total consumption of lignite.

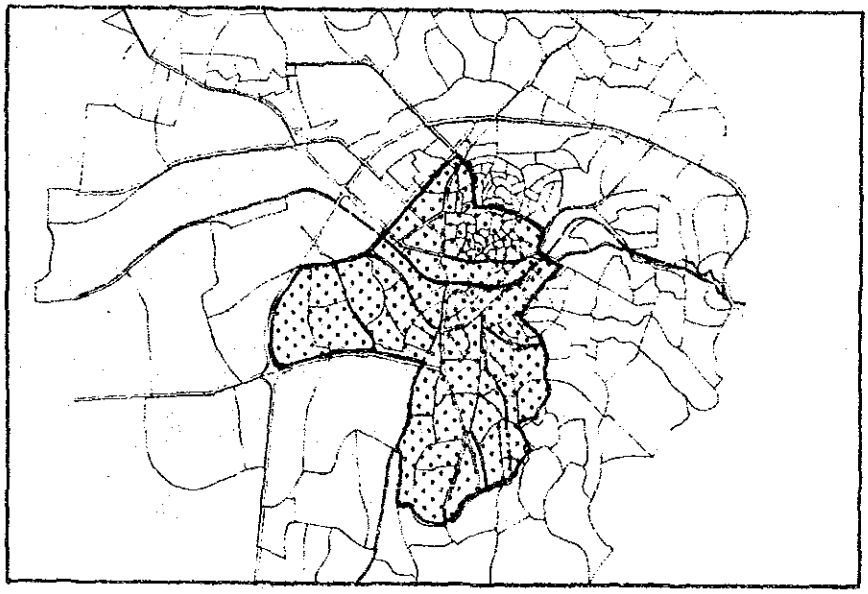


Figure 7-5-1 Location of District I

Table 7-5-1 Lignite Consumption in Boilers by Districts and by Ranks of Consumption

Consumption Rank (ton)	District I				District II				District III				Total	
	Appartment		Gov. Bldg.		Appartment		Gov. Bldg.		Appartment		Gov. Bldg.			
	Number of Bodg.	Consump. (ton)	Number of Bldg.	Consump. (ton)	Number of Bldg.	Consump. (ton)	Number of Bldg.	Consump. (ton)	Number of Bldg.	Consump. (ton)	Number of Bldg.	Consump. (ton)	Number of Bldg.	Consump. (ton)
0 - 50	606	21,274	170	5,190	55	2,035	121	2,689	31	763	306	24,413	1,289	56,364
51 - 100	253	192,554	178	12,548	320	23,312	45	2,732	444	37,817	-	-	1,240	268,963
101 - 150	958	115,492	64	7,429	103	12,422	17	2,075	347	40,683	-	-	1,489	178,101
151 - 200	177	29,946	25	3,484	49	8,299	6	1,033	34	5,612	-	-	291	48,374
201 - 250	22	4,784	7	1,495	19	4,305	3	651	2	469	-	-	53	11,704
251 - 300	2	537	4	1,025	11	2,226	7	1,837	4	1,111	-	-	28	6,736
301 - 350	7	2,243	3	967	3	913	6	1,950	5	1,601	-	-	24	7,674
351 - 400	5	1,875	1	380	6	2,158	2	751	-	-	-	-	14	5,164
401 - 450	-	-	-	-	7	2,950	6	3,761	-	-	-	-	13	6,711
451 - 500	-	-	-	-	3	1,445	-	-	-	-	-	-	3	1,445
501 - 550	-	-	-	-	1	547	-	-	-	-	-	-	1	547
551 - 600	1	558	7	11,314	3	1,639	-	-	-	-	-	-	11	13,511
651 - 700	-	-	-	-	1	671	-	-	-	-	-	-	1	671
751 - 800	-	-	-	-	1	800	-	-	-	-	-	-	1	800
851 - 900	1	878	-	-	-	-	-	-	-	-	-	-	1	878
901 - 950	-	-	-	-	1	947	-	-	-	-	-	-	1	947
1501 -1550	-	-	-	-	1	1,516	-	-	-	-	-	-	1	1,516
1650 -1700	-	-	-	-	-	-	-	-	1	1,693	-	-	1	1,693
2451 -2500	-	-	-	-	-	-	-	-	1	2,477	-	-	1	2,477
Total	2,032	370,141	459	43,832	584	66,185	213	17,479	869	92,226	306	24,413	4,463	614,276

8 Boiler Combustion Test in the Apartments in Ankara

The results are shown in Tables 8-1 through 8-7.

Table 8-1 Measurement Results of Pembe Kösk Boiler
(July 11, 1985)

Measurement Results of Exhaust Gas Flow Volume and Boiler Water Temperature

No.	Sampling Time	Flue Gas				Boiler Water Temp. (°C)		Room Temp (°C)
		Temp (°C)	Velocity (of Flue Gas) (m/s)	Static Pressure (mm Aq)	Flow Rate (m^3_N/h)	Feed Water	Hot Water	
1	(17:05)	(38)	(1.24)	-	(1269)	(45.0)	(59.0)	(23)
2	17:35	96	1.43	-4	1234	49.8	-	23
3	17:45	145	-	-	-	48.6	62.3	23
4	17:54	199	3.95	-5	2665	53.0	-	23
5	18:06	160	3.53	-7	2596	63.0	61.0	23
6	18:15	104	1.12	-4	946	68.3	63.3	23
7	18:40	92	0.78	-4	680	67.2	63.5	23
8	18:54	82	0.63	-4	565	67.0	61.2	23
9	19:10	79	0.62	-3	561	66.7	60.4	23
10	19:32	75	0.44	-3	403	66.2	59.0	23
	Average	115	1.56	-4	1206	61.1	61.5	23

Measurement Results of Composition of Flue Gas (Orsat Method)

No.	Sampling Time	CO_2(%)	O_2(%)	CO(%)	N_2(%)	Air Ratio
1	17:35	1.4	19.7	0.0	78.9	16.5
2	18:14	2.9	15.1	0.1	81.9	3.2
3	19:00	1.8	18.5	0.3	79.4	7.7
	Average	2.0	17.8	0.1	80.1	6.0

Measurement Results of SO_2

No.	Sampling Time	Flue Gas			SO_2	
		Temp. (°C)	Velocity (of Flue Gas) (m/s)	Flow Rate (m^3_N/h)	Concentration (ppm)	Flow Volume (m^3_N/h)
1	17:39 - 18:09	141	2.51	1930	560	1.081
2	18:15 - 18:48	93	0.84	731	170	0.124
3	18:54 - 19:00 19:02 - 19:25	81	0.63	567	161	0.091
	Average	105	1.33	1076	297	0.432

Table 8-2 Measurement Results of Pembe Kösk Boiler (July 12, 1985)

Measurement Results of Exhaust Gas Flow Volume and Boiler Water Temperature

No.	Sampling Time	Flue Gas				Boiler Water Temp. (°C)		Room Temp (°C)
		Temp (°C)	Velocity (of Flue Gas) (m/s)	Static Pressure (mm Aq)	Flow Rate (m^3_N/h)	Feed Water	Hot Water	
1	16:55	78	0.44	-4	399	78.0	52.5	24.7
2	17:48	67	0.43	-4	391	71.5	69.7	25.0
3	18:12	62	0.30	-3	285	66.4	58.8	24.8
4	18:30	60	0.43	-3	411	63.6	55.9	24.8
5	18:45	63	0.44	-3	417	61.0	54.6	25.0
6	19:00	75	0.62	-4	567	59.7	55.1	25.0
7	19:18	67	0.75	-4	702	59.3	53.9	25.0
8	19:53	60	0.61	-4	583	57.0	53.1	25.0
9	20:00	66	0.61	-4	572	56.2	53.0	24.5
	Average	66	0.51	-4	481			

Measurement Results of Composition of Flue Gas (Orsat Method)

No.	Sampling Time	CO_2(%)	O_2(%)	CO(%)	N_2(%)	Air Ratio
1	16:40	1.2	19.5	0.2	79.1	12.9
2	18:40	0.4	20.0	0.2	79.4	17.5
3	18:58	1.0	19.0	0.0	80.0	9.4
4	19:20	0.8	18.2	0.0	81.0	6.5
	Average	0.8	19.2	0.1	79.9	10.2

Measurement Results of SO_2

No.	Sampling Time	Flue Gas			SO_2	
		Temp. (°C)	Velocity (of Flue Gas) (m/s)	Flow Rate (m^3_N/h)	Concentration (ppm)	Flow Volume (m^3_N/h)
1	16:41 - 17:12	78	0.44	399	32.0	0.0128
2	18:18 - 18:40	62	0.39	371	4.3	0.0016
3	18:43 - 18:57 18:58 - 19:12	68	0.60	560	63.4	0.0355
4	19:16 - 19:46	64	0.68	642	43.0	0.0276
5	19:51 - 20:06	63	0.61	578	93.2	0.0539
	Average	67	0.54	510	47.2	0.0263

Table 8-3 Measurement Results of Pembe Köşk Boiler
(July 24, 1985)

Measurement Results of Exhaust Gas Flow Volume and Boiler Water Temperature

No.	Sampling Time	Flue Gas				Boiler Water Temp. (°C)		Room Temp (°C)
		Temp (°C)	Velocity (of Flue Gas) (m/s)	Static Pressure (mm Aq)	Flow Rate (m^3_N/h)	Feed Water	Hot Water	
1	17:15	94	1.27	-4	1102	49.0	52.3	22.3
2	17:30	115	0.46	-5	377	56.5	52.7	22.5
3	17:40	106	0.46	-4	386	60.0	54.0	23.3
4	17:55	94	0.45	-4	390	61.0	54.4	23.4
5	18:09	83	0.44	-4	394	61.8	54.2	23.5
6	18:23	115	0.65	-5	533	63.2	54.0	23.8
7	18:45	95	0.64	-5	554	68.0	55.3	23.0
8	19:02	77	0.44	-4	400	67.0	57.0	22.7
9	19:08	87	0.45	-4	398	66.4	57.0	22.7
10	19:17	89	0.45	-4	396	66.8	56.7	22.7
11	19:34	75	0.44	-4	403	66.4	57.2	22.5
12	19:45	79	0.44	-4	398	65.8	57.6	22.7
13	20:00	73	0.44	-4	405	65.4	57.8	22.0
	Average	91	0.54	-4	472			

Measurement Results of Composition of Flue Gas (Orsat Method)

No.	Sampling Time	CO_2(%)	O_2(%)	CO(%)	N_2(%)	Air Ratio
1	17:17	3.5	16.0	0.0	80.5	4.0
2	17:36	1.4	18.5	0.0	80.1	7.6
3	18:02	1.5	18.1	0.0	80.4	6.5
4	18:19	3.1	16.0	0.0	80.9	3.9
5	18:39	1.0	18.6	0.5	79.9	7.4
6	19:05	1.2	18.4	0.0	80.4	7.2
7	19:22	1.1	18.9	0.0	80.0	9.0
8	19:42	1.1	18.9	0.0	80.0	9.0
	Average	1.7	17.9	0.1	80.3	6.1

SO_2 Concentration and Desultarizating Rate

No.	Sampling Time	Line (kg/h)	Flue Gas Temp. (°C)	Flue Gas Velocity (of Flue Gas) (m/s)	Flue Gas Flow Rate (m^3_N/h)	SO_2 Concentration (ppm)	SO_2 Flow Volume (m^3_N/h)	Flow Rate of Salfur	Desulturizing Rate
1	17:41 - 17:56	1.6	106	0.46	216	168	0.0363	0.0519	39
	18:03 - 18:18	-	99	0.56	267	224	0.0598	0.0854	
2	19:06 - 19:21	-	88	0.45	221	234	0.0517	0.0517	50
	19:25 - 19:40	1.6	81	0.44	224	116	0.0260	0.0260	
Average			94	0.50	244	229	0.0557	0.0686	44
Average			94	0.45	220	142	0.0312	0.0390	

Table 8-4 Measurement Results of Cinnah Cad. Boiler (1)
(July 15, 1985)

Measurement Results of Exhaust Gas Flow Volume and Boiler Water Temperature (1)

Test No. / No.	Sampling Time	Flue Gas				Boiler Water Temp. (°C)		Damper	Room Temp (°C)
		Temp (°C)	Velocity (of Flue Gas) (m/s)	Static Pressure (mm Aq)	Flow Rate (m^3_N/h)	Feed Water	Hot Water		
1	Start 11:28	-	3.08	3.0	348	52.5	49.0	Open	21.7
2	11:35	-	3.08	3.0	348	60.7	49.0	"	
3	11:38	-	3.08	3.4	348	69.0	52.0	"	
4	Stop 11:39	-	3.08	3.4	348	70.9	53.9	"	
5	11:42	-		(1.8)		72.5	59.0		22.5
6	11:51	-		(2.0)		71.6	64.4		
	Average	280	3.08	3.2	348	66.2	54.6		
1	Start 12:02	-	3.09	3.0	346	-	-	Open	
2	12:04	-	3.09	3.0	346	69.4	62.9	"	
3	12:07	-	3.14	3.5	351	71.9	63.3	"	22.8
4	12:09	-	3.14	3.5	351	76.3	64.2	"	
5	12:12	-		(2.5)		80.4	67.1		23.0
6	12:16	-		(2.8)		80.0	71.3		
7	12:20	-		(1.3)		79.7	72.0		
	Average	286	3.12	3.2	348				
1	Start 14:50	-	3.28	3.0	369	49.0	48.0	Open	23.7
2	14:51	-	3.28	3.0	369	50.5	47.7	"	23.7
3	14:55	-	3.04	4.5	341	60.4	48.3	"	
4	14:57	-	3.13	2.8	352	65.6	50.7	"	25.3
5	14:59	-	3.23	3.2	363	69.4	52.8	"	
6	15:01	-	3.09	3.0	347	73.8	56.6	"	
7	15:03	-	3.18	3.4	358	77.1	59.5	"	24.5
8	Stop 15:04	-	3.18	3.4	358	80.0	62.2	"	
9	15:05	-		(1.8)		80.5	64.0		
10	15:12	-		(1.1)		79.8	71.0		
11	15:23	-		(1.5)		78.0	71.4		24.6
12	15:39	-		(1.2)		68.7	65.3		
13	15:49	-		(1.5)		63.6	63.0		
14	16:14	-		(0.7)		61.2	59.9		
	Average	283	3.18	3.3	357				

Table 8-5 Measurement Results of Cinnah Cad. Boiler (2)
(July 15, 1985)

Measurement Results of Exhaust Gas Flow Volume and Boiler Water Temperature (2)

Test No.	No.	Sampling Time	Flue Gas				Boiler Water Temp. (°C)		Damper	Room Temp (°C)
			Temp	Velocity (of Flue Gas)	Static Pressure	Flow Rate	Feed Water	Hot Water		
	1	Start 16:37	-	4.30	3.0	482	57.3	57.3	Open	
	2	16:39	-	4.30	3.0	482	60.7	57.6	"	24.7
	3	16:41	-	4.04	2.8	453	65.5	57.9	"	
	4	16:44	-	4.08	3.0	457	71.7	59.1	"	25.0
	5	16:46	*(261)	-	(1.9)	-	75.0	61.0	1/2	
	6	Stop 16:49	30 sec *(261)	-	(1.9)	-	80.8	66.6	"	
	7	16:51	-		(2.3)		81.1	68.9		
	8	16:54	-		(1.3)		80.8	71.7		24.8
	9	16:59	-		(1.3)		80.2	74.0		
	10	17:08	-		(1.3)		78.7	73.4		25.2
	11	17:17	-		(1.2)		74.6	69.7		
	12	17:43	-		(1.1)		65.2	64.1		24.6
		Average	285	4.18	3.0	468				
	1	Start 17:53	-	3.03	2.8	342	64.4	63.4	Open	24.6
	2	17:55	-	3.03	2.8	342	64.6	63.0	"	
	3	17:57	-	3.03	2.8	342	68.0	63.3	"	
	4	Stop 18:01	30 sec (251)	-	(3.5)	-	78.0	65.8	17:59 1/2	
	5	18:04	-		(2.5)		81.0	69.0		25.0
	6	18:07	-		(1.8)		80.9	73.2		
	7	18:12	-		(1.5)		80.3	75.0		
	8	18:17	-		(1.3)		80.0	75.1		
		Average	281	3.03	2.8	342				

Measurement Results of Exhaust Gas (Average)

Test No.	Sampling Time	Flue Gas				Remarks
		Temp. (°C)	Velocity (of Flue Gas) (m/s)	Static Pressure (mm Aq)	Flow Rate (m^3_N/h)	
1	11:28 - 11:39	280	3.08	-3.2	348	Damper Open
2	12:01 - 12:10 30 sec	286	3.12	-3.2	348	Damper Open
3	14:50 - 15:04	283	3.18	-3.3	357	Damper Open
4	16:37 - 16:48 30 sec	(285)	(4.18)	(-3.0)	(468)	Peeping hole 1/2 16:46 Damper 1/2
5	17:53 - 18:01 30 sec	281	3.03	-2.8	342	17:59 Damper 1/2
	Grand Average	282	3.10	-3.1	349	

Table 8-6 Measurement Results of Cinnah Cad. Boiler (3)
(July 15, 1985)

Measurement Results of Composition of Flue Gas (Orsat Method)

No.	Sampling Time	CO_2(%)	O_2(%)	CO(%)	N_2(%)	Air Ratio	Damper
1	11:31	10.4	7.3	0.0	82.3	1.50	Open
2	14:51	9.9	7.1	0.0	83.0	1.47	Open
3	16:38	8.7	8.3	0.0	83.0	1.60	Open
4	16:47	9.0	8.3	0.0	82.7	1.61	1/2
5	18:00	10.3	6.9	0.0	82.8	1.46	1/2
Average		9.7	7.6	0.0	82.8	1.53	-

Measurement Results of SO_2

No.	Sampling Time	Flue Gas			SO_2	
		Temp. (^oC)	Velocity (of Flue Gas) (m/s)	Flow Rate (m^3_N/h)	Concentration (ppm)	Flow Volume (m^3_N/h)
1	11:32 - 11:39 15 Sec 15 Sec	280	3.08	348	413	0.144
2	12:02 - 12:10 15 Sec	286	3.12	348	412	0.143
3	14:52 - 15:04	283	3.18	357	446	0.159
4	16:38 - 16:46 16:47 - 16:48	(285)	(4.18)	(468)	(347)	(0.162)
5	17:54 - 17:59	281	3.03	342	370	0.127
Average		282	3.10	349	410	0.143

Table 8-7 Measurement Results of Hava Sok. Boiler
(July 17, 1985)

Measurement Results of Exhaust Gas Flow Volume and Boiler Water Temperature

No.	Sampling Time	File Gas				Boiler Water Temp. (°C)		Room Temp (°C)
		Temp (°C)	Velocity (of Flue Gas) (m/s)	Static Pressure (mm Aq)	Flow Rate (m^3_N/h)	Feed Water	Hot Water	
1	13:40	-	-	-	-	21	22.0	19.0
2	13:46	54	1.47	1.0	473	21	22.0	19.0
3	14:05	109	2.79	2.2	769	24	22.0	
4	14:15	120	2.98	2.2	798	35	22.1	20.1
5	14:35	149	3.17	2.9	791	55	27.3	
6	14:45	147	3.23	3.2	809	63	32.6	
7	14:55	160	3.35	3.4	814	70	37.0	22.9
8	15:04	167	3.16	3.2	756	82	41.2	
9	15:12	131	3.20	3.3	834	88	45.8	23.7
10	15:19	112	2.11	2.6	577	90	50.0	
11	15:50	90	2.10	2.5	609	94	60.0	
12	16:10	71	1.90	2.2	581	94	66.2	24.0
13	16:15	68	1.37	1.9	423	94	67.0	23.8
	Average	106	2.37	2.4	633			

Measurement Results of Composition of Flue Gas (Orsat Method)

No.	Sampling Time	CO_2(%)	O_2(%)	CO(%)	N_2(%)	Air Ratio
1	13:50	1.1	18.9	0.4	79.6	8.6
2	14:39	6.3	12.6	0.0	81.1	2.4
3	15:07	8.4	10.9	0.3	80.4	2.0
4	15:43	2.5	17.1	1.2	79.2	4.6
	Average	4.6	14.9	0.5	80.1	3.2

Measurement Results of SO_2

No.	Sampling Time	Flue Gas			SO_2	
		Temp. (°C)	Velocity (of Flue Gas) (m/s)	Flow Rate (m^3_N/h)	Concentration (ppm)	Flow Volume (m^3_N/h)
1	13:51 - 14:26	108	2.55	704	585	0.412
2	14:34 - 15:04	156	3.23	792	1116	0.884
3	15:11 - 15:41	111	2.39	656	566	0.371
4	15:49 - 16:15	76	1.52	459	208	0.095
	Average	113	2.42	653	619	0.440

9 Boiler Combustion Test at MTA

The results are shown in Tables 9-1 through 9-5.

Table 9-1 Measurement Results of MTA Boiler
(July 22, 1985)

Measurement Results of Exhaust Gas Flow Volume and Boiler Water Temperature

No.	Sampling Time	Flue Gas				Boiler Water Temp. (°C)			
		Temp (°C)	Velocity (of Flue Gas) (m/s)	Static Pressure (mm Aq)	Flow Rate (m^3_N/h)	Feed Water	Hot Water	(m^3)	Room Temp (°C)
1	13:30	172	2.22	1.5	372	92.7	64.8	1717.2	24.8
2	13:40	172	2.33	1.9	389	90.7	65.2	1718.1	25.0
3	14:00	177	2.23	1.9	369	92.2	64.8	1720.1	25.4
4	14:10	164	1.97	1.7	335	88.1	65.7	1721.2	25.4
5	14:25	160	2.07	2.0	356	83.2	65.1	1723.2	25.5
6	14:47	148	1.99	1.9	352	79.9	63.9	1726.0	25.6
7	14:58	155	2.00	1.8	348	81.9	63.0	-	25.6
8	15:15	164	1.97	1.6	335	82.3	63.0	1730.0	25.7
9	15:25	158	1.95	1.4	337	80.7	63.2	1731.2	25.9
10	15:40	146	2.04	1.6	362	76.7	62.5	1733.0	26.0
11	15:53	150	1.99	1.5	350	78.6	62.0	1734.6	26.0
12	16:32	150	1.81	1.2	318	77.5	62.1	1740.8	26.3
Average		160	2.05	1.7	352	83.7	63.8	-	

Measurement Results of Composition of Flue Gas (Orsat Method)

No.	Sampling Time	CO_2(%)	O_2(%)	CO(%)	N_2(%)	Air Ratio
1	13:18	12.5	5.7	0.0	81.8	1.36
2	13:48	12.5	6.1	0.0	81.4	1.39
3	14:14	10.8	6.8	0.2	82.3	1.44
4	14:39	11.8	4.3	0.9	83.0	1.21
5	15:04	(12.9)	(3.4)	(1.2)	(82.5)	(1.15)
6	15:35	12.5	4.7	0.8	82.0	1.25
7	15:57	12.4	5.6	0.0	82.0	1.35
8	16:24	12.4	6.6	0.0	81.0	1.44
Average		12.4	5.7	0.3	81.9	1.34

Measurement Results of SO_2

No.	Sampling Time	Flue Gas			SO_2	
		Temp. (°C)	Velocity (of Flue Gas) (m/s)	Flow Rate (m^3_N/h)	Concentration (ppm)	Flow Volume (m^3_N/h)
1	13:27 - 13:47	172	2.27	380	1984	0.754
2	13:52 - 14:12	175	2.11	350	1652	0.578
3	14:17 - 14:37	158	2.07	357	1292	0.461
4	14:42 - 15:03	156	2.01	348	1158	0.403
5	15:11 - 15:31	161	1.96	336	579	0.195
6	15:36 - 15:56	150	2.05	361	773	0.279
7	16:00 - 16:23	150	1.93	340	1019	0.346
8	16:26 - 16:38	150	1.74	307	765	0.235
Average		159	2.02	347	1153	0.406

Table 9-2 Measurement Results of MTA Boiler
(July 23, 1985) - (1)

Measurement Results of Exhaust Gas Flow Volume
and Boiler Water Temperature

No.	Sampling Time	Flue Gas				Boiler Water Temp. (°C)		Flow Rate of Water (m^3)	Room Temp (°C)
		Temp (°C)	Velocity (of Flue Gas) (m/s)	Static Pressure (mm Aq)	Flow Rate (m^3_N/h)	Feed Water	Back Water		
1	12:43	200	2.98	1.8	469	84.9	68.0	1772.6	24.8
2	12:48	215	2.94	1.9	448	85.8	68.3	1773.2	24.8
3	13:00	211	2.53	1.9	389	88.5	69.2	1774.6	24.7
4	13:05	201	2.45	2.0	384	89.0	69.9	1775.4	24.9
5	13:14	201	2.29	2.1	359	87.8	69.4	1776.5	25.0
6	13:27	189	2.14	1.8	345	85.6	68.5	1778.1	25.1
7	13:39	187	2.85	2.1	461	81.7	67.7	1779.5	25.2
8	13:46	194	2.96	2.2	471	82.6	66.6	1780.5	25.5
9	13:52	194	3.25	2.2	518	88.1	63.2	1782.0	25.4
10	14:11	189	3.19	2.4	514	86.4	62.2	1782.7	25.4
11	14:18	184	3.26	2.1	531	83.7	61.2	1783.6	25.4
12	14:28	189	3.11	1.7	501	81.3	61.1	1784.4	25.3
13	14:40	181	2.96	1.8	485	78.4	60.3	1785.4	25.3
14	14:47	209	3.18	1.9	491	79.4	60.3	1786.0	25.5
15	14:56	194	3.09	1.8	508	80.8	59.0	1786.9	25.4
16	15:04	199	2.98	1.8	470	80.7	58.7	1787.5	25.0
17	15:09	194	2.92	1.7	465	81.7	58.7	1788.1	25.0
18	15:27	189	3.07	1.6	494	76.8	58.1	1789.7	25.0
19	15:40	211	3.35	1.8	538	78.8	57.2	1790.8	25.0
20	15:49	194	3.13	1.6	499	78.4	57.1	1791.6	25.1
Average		196	2.93	1.9	467	83.0	63.2	-	

Table 9-3 Measurement Results of MTA Boiler
(July 23, 1985) - (2)

Measurement Results of Composition of
Flue Gas (Orsat Method)

No.	Sampling Time	CO_2(%)	O_2(%)	CO(%)	N_2(%)	Air Ratio
1	11:45	10.5	8.5	0.0	81.0	1.65
2	12:01	8.5	10.5	0.0	81.0	1.95
3	12:33	6.4	12.4	0.0	81.2	2.35
4	12:46	8.7	10.1	0.0	81.2	1.88
5	13:08	8.0	11.4	0.0	80.6	2.14
6	13:25	5.4	14.0	0.0	80.6	2.89
7	13:45	6.8	12.8	0.0	80.4	2.49
8	14:10	7.5	11.7	0.0	80.8	2.20
9	14:28	6.6	12.9	0.1	80.4	2.51
10	14:44	8.7	10.2	0.0	81.1	1.90
11	15:02	9.0	9.6	0.0	81.4	1.80
12	15:26	6.7	13.3	0.0	80.0	2.67
13	15:48	6.0	13.6	0.0	80.4	2.75
Average		7.6	11.6	0.0	80.8	2.17

Measurement Results of SO_2

No.	Sampling Time	Flue Gas			SO_2	
		Temp. (°C)	Velocity (of Flue Gas) (m/s)	Flow Rate (m^3_N/h)	Concentration (ppm)	Flow Volume (m^3_N/h)
1	11:45 - 12:00	185	3.02	490	917	0.449
2	12:02 - 12:17 30 sec 30 sec	188	3.23	521	568	0.296
3	12:20 - 12:32 30 sec	182	3.25	531	640	0.340
4	12:36 - 12:44 30 sec	192	3.12	500	523	0.262
5	12:47 - 13:02	209	2.83	436	616	0.269
6	13:05 - 13:07 13:09 - 13:24	197	2.28	361	402	0.145
7	13:26 - 13:41 30 sec 30 sec	190	2.68	430	419	0.180
8	13:46 - 14:07 30 sec	189	3.11	501	511	0.256
9	14:10 - 14:25 30 sec 30 sec	187	3.19	516	508	0.262
10	14:28 - 14:43	193	3.09	492	367	0.181
11	14:46 - 15:01	201	3.07	482	410	0.198
12	15:04 - 15:24	194	3.00	479	347	0.166
13	15:27 - 15:47	198	3.19	503	350	0.176
Average		193	3.00	480	506	0.245

Table 9-4 Measurement Results of MTA Boiler (August 2, 1985) - (1)

Measurement Results of Exhaust Gas Flow Volume and Boiler Water Temperature

No.	Sampling Time	Flue Gas				Boiler Water Temp. (°C)		Flow Rate of Water (m^3)	Room Temp (°C)
		Temp (°C)	Velocity (of Flue Gas) (m/s)	Static Pressure (mm Aq)	Flow Rate (m^3_N/h)	Feed Water	Back Water		
1	10:35	196	2.83	1.8	449	87.6	63.0	1805.0	28.5
2	10:40	205	2.86	1.7	445	86.2	64.1	1805.5	28.5
3	10:45	220	3.13	1.9	472	89.5	64.8	1806.0	28.5
4	10:50	226	3.28	2.0	489	92.6	65.5	1806.6	29.0
5	10:55	218	2.76	2.0	418	93.2	65.2	1807.5	29.0
6	11:00	208	3.18	1.9	492	91.2	65.0	1808.0	29.0
7	11:05	199	2.75	1.7	433	87.7	65.1	1808.7	29.0
8	11:10	228	2.88	1.6	428	86.9	64.5	1809.5	29.0
9	11:15	221	2.86	1.8	431	87.4	64.8	1810.0	29.1
10	11:20	209	2.78	2.0	429	85.7	64.3	1810.9	29.2
11	11:25	219	2.81	1.7	425	83.2	63.6	1811.4	29.4
12	11:30	214	2.74	1.7	418	82.3	62.9	1812.3	29.4
13	11:35	219	2.71	2.0	410	81.3	62.5	1813.0	29.4
14	11:40	219	2.50	2.0	378	82.2	62.3	1814.0	29.4
15	11:45	228	2.73	2.0	405	84.6	62.4	1814.9	29.4
16	11:50	238	2.38	2.1	346	86.4	62.1	1815.5	29.5
17	11:55	240	2.38	2.2	345	87.2	62.3	1816.0	29.5
18	12:00	236	2.37	2.0	346	86.3	62.7	1816.9	29.5
19	12:05	224	2.40	2.1	359	84.9	62.5	1817.7	29.5
20	12:10	216	2.38	1.8	362	82.8	61.6	1818.3	29.5
21	12:15	202	2.35	1.6	368	80.5	61.5	1819.0	29.8
22	12:20	192	2.27	1.5	363	77.8	61.9	1820.3	29.8
23	12:25	182	2.18	1.5	356	75.4	61.1	1820.8	29.8
24	12:30	212	2.31	1.6	354	75.0	60.8	1821.2	29.8
25	12:35	222	2.34	1.6	352	77.1	60.3	1822.4	30.1
26	12:40	219	-	-	-	79.1	60.0	1823.0	30.1
27	12:45	212	-	-	-	79.2	60.1	1823.6	30.1
28	12:50	214	2.32	1.8	354	77.5	60.2	1824.4	30.1

Table 9-5 Measurement Results of MTA Boiler (August 2, 1985) - (2)

Measurement Results of Exhaust Gas Flow Volume and Boiler Water Temperature

No.	Sampling Time	Flue Gas				Boiler Water Temp. (°C)		Flow Rate of Water (m^3)	Room Temp (°C)
		Temp (°C)	Velocity (of Flue Gas) (m/s)	Static Pressure (mm Aq)	Flow Rate (m^3_N/h)	Feed Water	Back Water		
29	12:55	207	2.24	1.6	347	76.9	59.9	1825.2	30.1
30	13:00	200	-	-	-	76.5	59.2	1825.9	30.1
31	13:05	192	2.21	1.6	354	75.0	59.5	1826.7	30.1
32	13:10	197	2.22	1.6	351	72.9	58.6	1827.4	30.1
33	13:15	200	1.70	1.6	267	72.5	58.2	1828.0	30.1
34	13:20	195	1.69	1.6	269	73.0	57.4	1828.9	30.1
35	13:25	187	1.67	1.4	270	72.3	56.9	1829.8	30.1
36	13:30	190	1.68	1.6	270	70.7	56.5	1830.6	30.1
37	13:35	190	1.75	1.5	281	68.7	56.0	1831.3	30.1
38	13:40	187	1.95	1.5	315	67.7	55.2	1832.1	30.1
39	13:45	175	1.72	1.4	286	66.9	54.5	1832.9	30.1
40	13:50	173	2.53	1.2	422	65.4	53.4	1833.7	30.1
41	13:55	175	2.68	1.3	445	63.9	52.2	1834.5	30.1
42	14:00	165	2.65	1.5	450	62.6	51.3	1835.3	30.1
43	14:05	180	2.74	1.4	450	61.8	50.5	1836.0	30.2
44	14:10	178	2.58	1.2	426	61.6	49.8	1837.0	30.2
45	14:15	170	2.52	1.2	423	61.4	51.5	1838.0	30.2
Average		204	2.45	1.7	382	78.2	59.9	-	

10 Stove Combustion Test at MTA

The results are shown in Tables 10-1 through 10-5.

Table 10-1 Measurement Results of MTA Stove
(July 18, 1985) - (1)

Comburstion Test of Stove

No.	Sampling Time	Flue Gas				Surface Temperature		Weight Reduction of by Combustion (kg)	Room Temp (°C)
		Temp (°C)	Velocity (of Flue Gas) (m/s)	Static Pressure (mm Aq)	Flow Rate (m^3_N/h)	Upper	Lower		
1	14:05	(300)							
2	14:08	240	1.51	0.8	34.6	425	405	34.30	26.0
3	14:15	197	1.14	0.6	28.5				
4	14:20	195	1.25	0.7	31.4	384	416		26.9
5	14:32	195	1.25	0.6	31.4	402	422	32.40	27.8
6	14:40	205	1.36	0.8	33.4	402	426		
7	15:00	200	1.02	0.7	25.3	362	390	31.96	29.0
8	15:11	205	1.03	0.8	25.3	346	437		29.0
9	15:30	205	1.03	0.6	25.3	329	356	31.10	28.8
10	15:40	205	1.03	0.7	25.3	351	383		29.1
11	15:50	210	1.03	0.7	25.0	334	376		29.0
12	16:00	210	1.27	0.7	30.9	346	383	30.58	29.2
13	16:10	215	1.04	0.7	25.0	362	403	30.34	29.2
14	16:20	210	1.15	0.9	28.0	346	398		
15	16:30							30.00	
16	16:40								
17	16:43							29.80	
18	17:00	190	1.13	0.8	28.7	305	396	29.68	29.2
19	17:12	175	1.22	0.8	32.0	270	344		
20	17:20	170	1.11	0.7	29.4	229	298	29.52	
		202	1.16	0.7	28.7	346	389	-	17.9

Table 10-2 Measurement Results of MTA Stove (July 18, 1985) - (2)

Measurement Results of Composition of Flue Gas (Orsat Method)

No.	Sampling Time	CO_2(%)	O_2(%)	CO(%)	N_2(%)	Air Ratio
1	14:06	3.2	16.5	0.1	80.2	4.58
2	14:27	7.0	10.6	0.2	82.2	1.93
3	14:55	7.3	10.9	0.5	81.3	1.97
4	15:20	9.1	10.3	0.1	80.5	1.92
5	15:47	9.6	10.0	0.3	80.1	1.86
6	16:14	9.5	10.6	0.2	79.7	2.00
7	16:54	3.4	12.9	0.4	83.3	2.34
		7.0	11.7	0.3	81.0	2.37

Measurement Results of SO_2

No.	Sampling Time	Flue Gas			SO_2	
		Temp. (°C)	Velocity (of Flue Gas) (m/s)	Flow Rate (m^3_N/h)	Concentration (ppm)	Flow Volume (m^3_N/h)
1	14:05 - 14:25	233	1.40	32.46	2037	0.0661
2	14:31 - 14:54	200	1.25	31.01	2184	0.0677
3	14:58 - 15:18	205	1.03	25.28	1449	0.0366
4	15:23 - 15:43	205	1.03	25.28	1008	0.0255
5	15:49 - 16:12	210	1.15	27.94	1481	0.0414
6	16:18 - 16:48	210	1.15	27.94	1790	0.0500
7	17:00 - 17:20	178	1.12	29.01	1501	0.0435
		206	1.16	28.42	1636	0.0473

Table 10-3 Measurement Results of MTA Stove
(July 19, 1985) - (1)

Comburstion Test of Stove

No.	Sampling Time	Flue Gas				Surface Temperature			Weight Reduction of by Combustion (kg)	Room Temp (°C)
		Temp (°C)	Velocity (of Flue Gas) (m/s)	Static Pressure (mm Aq)	Flow Rate (m^3_N/h)	Upper	Lower			
1	10:15	-	-	0.5	-	317	181	292	-	21.8
2	10:30	170	1.10	0.4	29.1	397	359	424	34.33	24.0
3	10:40	200	1.25	0.6	31.0	444	447	521	-	25.8
4	10:52	200	1.25	0.7	31.0	421	430	500	-	27.0
5	11:00	210	1.27	0.7	30.9	426	431	452	32.73	28.0
6	11:10	200	1.35	0.8	33.5	403	413	432	-	27.0
7	11:23	220	1.28	0.8	30.5	404	404	421	31.65	28.2
8	11:30	215	1.16	0.5	27.9	370	366	382	31.47	28.7
9	11:50	210	1.03	0.5	25.0	312	447	328	-	28.8
10	12:00	215	1.27	0.5	30.6	341	361	355	30.93	28.9
11	12:10	210	1.03	0.7	25.0	414	421	411	-	29.9
12	12:20	200	1.02	0.7	25.3	365	399	415	-	30.0
13	12:30	200	1.02	0.6	25.3	360	404	413	30.40	30.0
14	12:40	190	0.97	0.6	24.6	342	406	413	-	30.0
15	12:55	190	0.97	0.5	24.6	328	404	396	-	30.0
16	13:00	180	0.87	0.5	22.6	325	404	379	29.93	29.8
17	13:10	175	0.86	0.6	22.5	313	394	356	-	29.8
18	13:30	155	0.84	0.4	23.0	270	344	307	29.67	29.0
19	(13:40)	(150)	(0.68)	(0.4)	(18.9)	(254)	(323)	(281)	-	28.0
20	(13:48)	(145)	(0.83)	(0.6)	(23.3)	(234)	(298)	(259)	29.12	28.0
		196	1.09	0.59	27.2	364	390	400	-	-

Table 10-4 Measurement Results of MTA Stove
(July 19, 1985) - (2)

Measurement Results of Composition of
Flue Gas (Orsat Method)

No.	Sampling Time	CO_2(%)	O_2(%)	CO(%)	N_2(%)	Air Ratio
1	10:25	6.6	9.8	1.6	82.0	1.70
2	10:48	9.1	9.8	0.7	80.4	1.79
3	11:13	4.5	10.5	0.2	84.8	1.86
4	11:47	5.1	10.2	0.2	84.5	1.82
5	12:56	4.1	13.0	0.0	82.9	2.44
6	13:19	3.4	12.2	0.0	84.4	2.19
7	14:43	2.1	12.0	0.0	85.9	2.11
		5.0	11.1	0.4	83.6	1.99

Measurement Results of SO_2

No.	Sampling Time	Flue Gas			SO_2	
		Temp. (°C)	Velocity (of Flue Gas) (m/s)	Flow Rate (m^3_N/h)	Concentration (ppm)	Flow Volume (m^3_N/h)
1	10:27 - 10:47	185	1.23	31.50	1980	0.0624
2	10:51 - 11:11	205	1.26	31.26	1170	0.0366
3	11:17 - 11:38	220	1.28	30.47	527	0.0161
4	11:41 - 12:03	215	1.16	27.89	343	0.0096
5	12:07 - 12:27	200	1.02	25.30	527	0.0133
6	12:31 - 12:51	195	0.88	22.06	763	0.0168
7	12:57 - 13:17	5	0.87	22.28	976	0.0217
8	13:27 - 13:43	155	0.84	23.03	722	0.0166
		173	1.07	26.72	876	0.0241

Table 10-5 Measurement Results of MTA Stove
(July 18 - 19, 1985)

Total Emission of Sulfer With and Without Lime Addition

	No.		(min)	(m^3/h)	SO_2 Concentration (ppm)	Flow Rate of Sulfur (g)	Total Amount of Sulfer (g)
Without Lime	1	14:05 - 14:28	23	32.46	2037	36.21	220.1
	2	14:28 - 14:56	28	31.01	2184	45.16	
	3	14:56 - 15:20	24	25.28	1449	20.94	
	4	15:20 - 15:46	26	25.28	1008	15.77	
	5	15:46 - 16:15	29	27.94	1481	28.57	
	6	16:15 - 16:54	39	27.94	1790	46.44	
	7	16:54 - 17:20	26	29.01	1501	26.96	
With Lime	1	10:27 - 10:49	22	31.50	1980	32.69	110.1
	2	10:49 - 11:14	25	31.26	1170	21.54	
	3	11:14 - 11:40	26	30.47	527	9.93	
	4	11:40 - 12:05	25	27.89	343	5.70	
	5	12:05 - 12:29	24	25.30	527	7.61	
	6	12:29 - 12:54	25	22.06	763	10.01	
	7	12:54 - 13:20	26	22.28	976	13.46	
	8	13:20 - 13:43	23	23.03	722	9.11	

11 Stove Combustion Test in Japan

The results are shown in Tables 11-1 through 11-7.

Table 11-1 Measurement Results of Stove Made in Japan (without Lime) - (1)
(August 7, 1985)

No.	Sampling Time	Flue Gas			Surface Temperature (°C)		Room Temp (°C)
		Temp (°C)	Velocity (of Flue Gas) (m/s)	Flow Rate (m^3_N/h)	Combustion Section	Radiator Box	
1	10:15	157	0.69	15.0	161	180	32.0
2	10:40	262	0.94	16.4	323	295	33.0
3	11:06	269	1.09	18.8	553	405	35.0
4	11:31	253	0.93	16.6	483	414	35.4
5	12:00	158	0.69	14.9	394	228	35.6
6	12:24	158	0.69	14.9	511	270	35.7
7	13:12	233	0.92	16.9	591	350	36.4
8	13:46	193	0.72	14.4	576	335	36.6
9	14:20	180	0.87	17.9	514	250	36.0
10	14:54	127	0.66	15.5	265	143	33.5
	Average	183	0.82	16.1	437	287	-

Measurement Results of Composition of
Flue Gas (Orsat Method)

No.	Sampling Time	CO_2(%)	O_2(%)	CO(%)	N_2(%)	Air Ratio
1	(10:10)	4.3	14.5	0.1	81.1	3.03
2	(10:24)	3.2	15.8	0.2	80.8	3.72
3	10:40	5.9	12.9	0.0	81.2	2.49
4	10:55	6.6	11.4	0.1	81.9	2.09
5	11:10	9.8	7.8	0.1	82.3	1.55
6	11:25	8.9	7.5	0.2	83.4	1.50
7	11:40	10.0	7.3	0.1	82.6	1.49
8	11:57	7.4	9.8	0.4	82.4	1.78
9	12:15	11.2	7.8	0.6	80.4	1.54
10	12:35	9.2	10.4	0.0	80.4	1.95
11	12:50	9.7	9.4	0.2	80.7	1.77
12	13:05	8.0	10.7	0.7	80.6	1.93
13	13:20	9.4	10.3	0.0	80.3	1.93
14	13:35	11.4	8.3	0.1	80.2	1.63
15	13:50	11.1	8.7	0.0	80.2	1.69
16	14:05	10.9	9.4	0.0	79.7	1.80
17	14:20	6.7	13.3	0.0	80.0	2.67
18	14:35	4.2	15.7	0.1	80.0	3.79
19	(14:50)	2.4	17.4	0.2	80.0	5.36
	Average	7.9	11.0	0.2	81.5	2.01

Table 11-2 Measurement Results of Stove Made in Japan (without Lime) - (2)
(August 7, 1985)

No.	Sampling Time	Flue Gas			SO_2	
		Temp. (°C)	Velocity (of Flue Gas) (m/s)	Flow Rate (m^3_N/h)	Concentration (ppm)	Flow Volume (m^3_N/h)
1	10:15 - 10:35	157	0.69	15.0	1569	0.0235
2	10:40 - 11:00	262	0.94	16.4	1638	0.0269
3	11:06 - 11:26	269	1.09	18.8	2850	0.0534
4	11:31 - 11:53	253	0.93	16.6	2083	0.0346
5	12:00 - 12:20	158	0.69	14.9	766	0.0114
6	12:24 - 12:57	158	0.69	14.9	2736	0.0407
7	13:12 - 13:42	233	0.92	16.9	1451	0.0245
8	13:46 - 14:16	193	0.72	14.4	2685	0.0387
9	14:20 - 14:50	180	0.87	17.9	1383	0.0241
10	14:54 - 15:10	(127)	0.66	15.5	487	0.0075
	Average	199	0.82	16.1	1764.8	0.0284

Calculation Total of Sulfer

No.		(min)	(m^3_N/h)	SO_2 Concentration (ppm)	Flow Rate of Sulfer (g)	Total Amount of Sulfer (g)
1	10:10 - 10:38	28	15.7	1569	16.4	215.2
2	10:38 - 11:03	25	17.6	1638	17.2	
3	11:03 - 11:28	25	17.7	2850	30.0	
4	11:28 - 11:56	28	15.8	2083	21.9	
5	11:56 - 12:22	26	14.9	766	7.1	
6	12:22 - 13:05	43	15.9	2736	44.5	
7	13:05 - 13:44	39	15.6	1451	21.0	
8	13:44 - 14:18	34	16.2	2685	35.2	
9	14:18 - 14:52	34	16.7	1383	18.7	
10	14:52 - 15:10	18	15.5	487	3.2	

Table 11-3 Measurement Results of Stove Made in Japan (Lime 3%) - (1)
(August 8, 1985)

No.	Sampling Time	Flue Gas			Surface Temperature (°C)		Room Temp (°C)
		Temp (°C)	Velocity (of Flue Gas) (m/s)	Flow Rate (m^3_N/h)	Comburstion Section	Radiator Box	
1	10:05	181	1.00	20.6	231	210	34.2
2	10:30	209	0.89	17.3	449	275	34.8
3	10:57	217	0.90	17.2	506	245	35.1
4	11:23	230	0.75	13.8	547	345	36.0
5	11:50	127	0.47	11.0	474	186	36.0
6	12:15	142	0.68	15.2	444	236	36.7
7	12:41	159	0.69	14.9	496	248	37.0
8	13:06	170	0.70	14.7	568	280	38.0
9	13:31	189	0.71	14.4	660	294	37.3
10	14:05	217	0.74	14.0	661	330	38.1
11	14:39	182	0.71	14.5	450	246	38.0
	Average	202	0.82	16.8	549	290	-

Measurement Results of Composition of Flue Gas (Orsat Method)

No.	Sampling Time	CO_2(%)	O_2(%)	CO(%)	N_2(%)	Air Ratio
1	(10:00)	4.8	14.4	0.3	80.5	2.99
2	(10:20)	3.8	14.7	0.1	81.4	3.10
3	10:30	5.0	13.7	0.0	81.3	1.46
4	10:45	6.0	12.2	0.2	81.6	2.16
5	11:00	6.3	11.9	0.2	81.6	2.19
6	11:15	7.7	10.3	0.0	82.0	1.90
7	11:30	7.8	10.2	0.0	82.0	1.88
8	11:45	6.8	11.2	0.3	81.7	2.06
9	12:00	5.6	12.2	0.4	81.8	2.23
10	12:15	9.8	9.0	0.4	80.8	1.69
11	12:30	9.2	10.3	0.1	80.4	1.92
12	12:45	10.7	9.1	0.0	80.2	1.74
13	13:00	10.0	9.6	0.0	80.4	1.82
14	13:20	12.2	7.0	0.2	80.6	1.48
15	13:40	11.2	8.1	0.1	80.6	1.60
16	14:00	11.9	7.7	0.0	80.4	1.56
17	14:20	9.2	10.6	0.0	80.2	1.99
18	14:40	4.3	15.4	0.2	80.1	3.55
19	(14:50)	3.7	15.8	0.4	80.1	3.74
	Average	39.1	11.2	0.2	80.9	2.07

Table 11-4 Measurement Results of Stove Made in Japan (Lime 3%) - (2)
(August 8, 1985)

No.	Sampling Time	Flue Gas			SO_2	
		Temp. (°C)	Velocity (of Flue Gas) (m/s)	Flow Rate (m^3_N/h)	Concentration (ppm)	Flow Volume (m^3_N/h)
1	10:05 - 10:25	181	1.00	20.6	459	0.0095
2	10:30 - 10:50	209	0.89	17.3	783	0.0135
3	10:57 - 11:17	217	0.90	17.2	938	0.0161
4	11:23 - 11:43	230	0.75	13.8	1448	0.0245
5	11:50 - 12:10	127	0.47	11.0	504	0.0055
6	12:15 - 12:37	142	0.68	15.2	622	0.0095
7	12:41 - 13:01	159	0.69	14.9	877	0.0131
8	13:06 - 13:26	170	0.70	14.7	1479	0.0217
9	13:31 - 14:01	189	0.71	14.4	1950	0.0281
10	14:05 - 14:35	217	0.74	14.0	1774	0.0248
11	14:39 - 15:20	182	0.71	14.5	718	0.0104
	Average	202.3	0.82	16.8	1155	0.0194

Calculation Total of Sulfer

No.		(min)	(m^3_N/h)	SO_2 Concentration (ppm)	Flow Rate of Sulfer (g)	Total Amount of Sulfer (g)
1	10:00 - 10:28	28	19.0	459	5.8	
2	10:28 - 10:54	26	17.2	783	8.3	
3	10:54 - 11:20	26	15.5	938	9.0	
4	11:20 - 11:46	26	12.4	1448	11.1	
5	11:46 - 12:12	26	13.1	504	4.1	
6	12:12 - 12:39	27	15.0	622	6.0	118.8
7	12:39 - 13:03	24	14.8	877	7.4	
8	13:03 - 13:28	25	14.6	1479	12.9	
9	13:28 - 14:03	35	14.2	1950	23.1	
10	14:03 - 14:37	34	14.2	1774	20.4	
11	14:37 - 15:20	43	14.5	718	10.7	

Table 11-5 Measurement Results of Bucket Type Stove (Made in Japan)
(June 20, 1985)

Measurement Results of SO_2 (Lignite and Lime)

No.		Time (h)	Average Volume (m^3_N/h)	Volume Gas Drown (m^3_N)	SO_2 Concentration (ppm)	SO_2 Volume (l)
1	11:04 - 11:48	0.733	25.7	18.84	27.2	0.51
2	11:48 - 12:31	0.716	24.8	17.76	65.7	1.17
3	12:31 - 13:06	0.583	23.7	13.82	65.3	0.90
4	13:06 - 13:34	0.467	24.2	11.30	67.2	0.76
5	13:34 - 13:53	0.317	25.1	7.96	91.0	0.72
6	13:53 - 14:12	0.317	26.0	8.24	115.0	0.95
7	14:12 - 14:33	0.350	28.0	9.80	247.7	2.43
8	14:33 - 14:53	0.333	26.8	8.92	207.5	1.85
9	14:53 - 15:12	0.317	23.8	7.54	222.4	1.68
10	15:12 - 15:30	0.300	23.7	7.11	216.4	1.54
11	15:30 - 16:10	0.667	23.5	15.67	146.1	2.29
12	16:10 - 16:46	0.600	21.9	13.14	181.8	2.39
13	16:46 - 17:20	0.567	22.1	12.53	223.3	2.80
14	17:20 - 17:51	0.517	18.5	9.56	230.8	2.21
15	17:51 - 18:23	0.533	17.3	9.22	181.3	1.67
16	18:23 - 18:55	0.533	15.8	8.42	148.1	1.25
17	18:55 - 19:26	0.517	11.8	6.10	147.7	0.90
	19:26 - 21:00	1.567	(11.8)	18.49	(106.7)	1.97
Total	11:04 - 21:00	9.934	-	204.42	-	27.99

Table 11-6 Measurement Results of Hopper Feed Type Stove (Made in Japan)
(June 21, 1985)

Measurement Results of SO_2 (Lignite and Lime)

No.		Time (h)	Average Volume (m^3_N/h)	Volume Gas Drown (m^3_N)	SO_2 Concentration (ppm)	SO_2 Volume (l)
1	9:43 - 10:26	0.717	20.0	14.34	490.3	7.03
2	10:26 - 10:57	0.517	17.0	8.79	451.8	3.97
3	10:57 - 11:29	0.533	19.4	10.34	292.6	3.03
4	11:29 - 12:00	0.517	20.8	10.75	317.6	3.41
5	12:00 - 12:32	0.533	20.1	10.71	223.6	2.39
6	12:32 - 13:01	0.483	19.2	9.27	236.0	2.19
7	13:01 - 13:33	0.533	18.5	9.86	241.4	2.38
8	13:33 - 14:05	0.533	18.3	9.75	253.2	2.47
9	14:05 - 14:36	0.517	17.4	9.00	175.7	1.58
10	14:36 - 15:09	0.550	18.4	10.12	74.0	0.75
11	15:09 - 16:00	0.850	20.3	17.26	22.3	0.38
Total		6.283	-	120.19	-	29.58

Table 11-7 Measurement Results of Bucket Type Stove (Made in Japan)
(June 24, 1985)

Measurement Results of SO_2 (Briquette and Cement 7%)

No.		Time (h)	Average Volume (m^3_N/h)	Volume Gas Drown (m^3_N)	SO_2 Concentration (ppm)	SO_2 Volume (l)
1	10:15 - 11:01	0.767	19.5	15.0	203.7	3.06
2	11:01 - 11:30	0.483	20.9	10.1	171.7	1.73
3	11:30 - 12:00	0.500	21.0	10.5	208.5	2.19
4	12:00 - 12:30	0.500	21.7	10.8	189.4	2.05
5	12:30 - 13:00	0.500	22.9	11.4	145.6	1.66
6	13:00 - 13:29	0.483	24.8	12.0	219.1	2.63
7	13:29 - 14:02	0.55	27.1	14.9	208.0	3.10
8	14:02 - 14:30	0.467	28.0	13.1	182.8	2.39
9	14:30 - 15:02	0.533	27.4	14.6	70.5	1.03
10	15:02 - 16:00	0.967	24.6	23.8	51.7	1.23
11	16:00 - 17:40	1.667	16.5	27.5	24.3	0.67
Total	10:15 - 17:40	7.417	-	163.7	-	21.74

12 Proximate Analysis of Turkish Lignite

Table 12-1 Results of Proximate Analysis of Lignite (Wet Base)

Table 12-1 Results of Proximate Analysis of Lignite
(Wet Base)

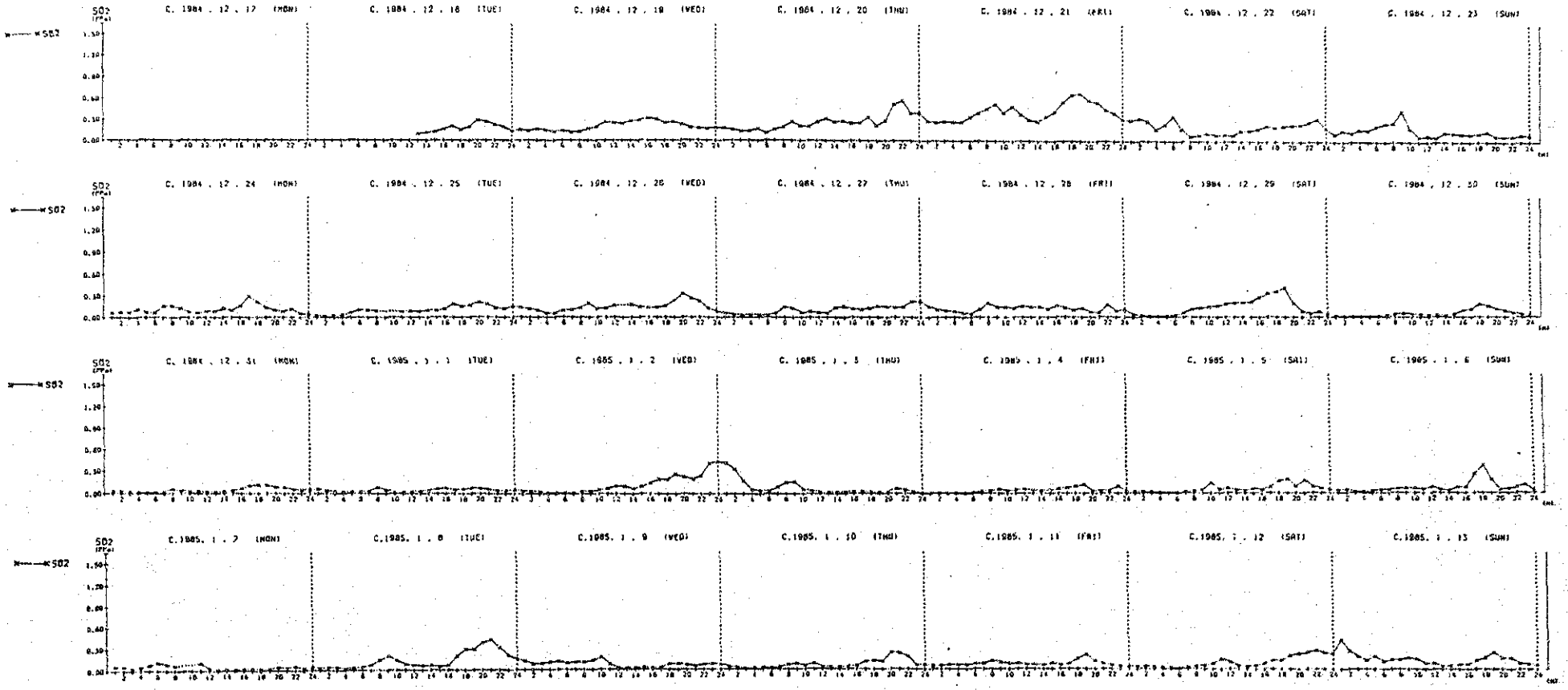
Sample Name			Moisture (%)	Total Sulphur (%)	Calorific Value (Kcal/kg)
Ungraded Lignite	P-I	Vali Dr. Resit Sok.	11.1	2.0	4280
		And Sok. No.3	12.0	3.1	3940
		Y. Ayranci Hasder Sok.	12.1	2.3	4180
		Tireboln Sok.	11.5	2.7	4250
	P-II	Hava So.	8.4	2.7	5460
		MTA Stove	8.5	3.3	5490
		MTA Boiler	6.6	2.3	5590
	Tuncbilek Coal Mine	Screening plant (30 - 400 mm)	8.3	2.3	3720
		Screening plant (below 30mm)	8.2	3.1	4520
		Open mine A (4 samples mixed)	12.8	3.3	5030
		Open mine B (2 samples mixed)	10.2	3.1	5060
		Plant hopper (3 samples mixed)	15.5	3.0	5470
Laved Lignite	P-I	Pembe Kösk	10.4	1.0	4660
	P-II	Pembe Kösk	7.0	1.8	5540
	Tuncbilek Coal Mine	Washing selection (10mm)	6.3	2.1	5270
		Washing selection (10 - 18mm)	4.5	1.9	5540
		Washing selection (18 - 50mm)	4.2	1.8	5620
		Washing selection (50mm)	3.9	1.3	5060
		Separate of under grand (0 - 1.3m)	9.9	0.8	4380
		Separate of under grand (1.3 - 2.6m)	6.9	1.2	4370
		Separate of under grand (2.6 - 3.9m)	4.3	1.5	3680
		Separate of under grand (3.9 - 4.2m)	6.6	0.8	5520
		Separate of under grand (4.2 - 6.5m)	10.1	1.2	5120
Seytomer Coal Mine			13.8	1.1	4420

Note: P-I : Lignite used during the combution test at Phase I
P-II : Lignite used during the combution test at Phase II

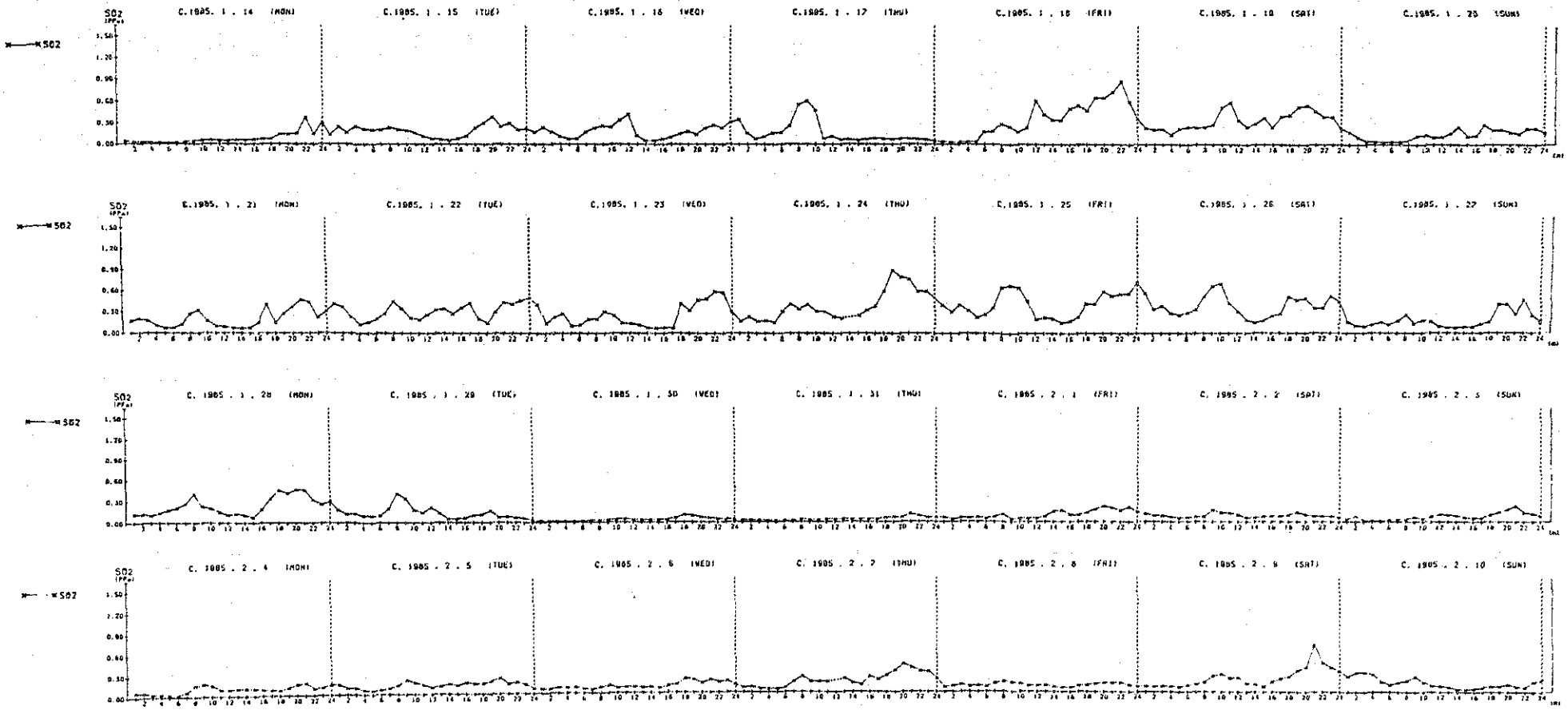
Part III

RESULTS OF METEOROLOGICAL OBSERVATION AND AMBIENT AIR QUALITY MONITORING

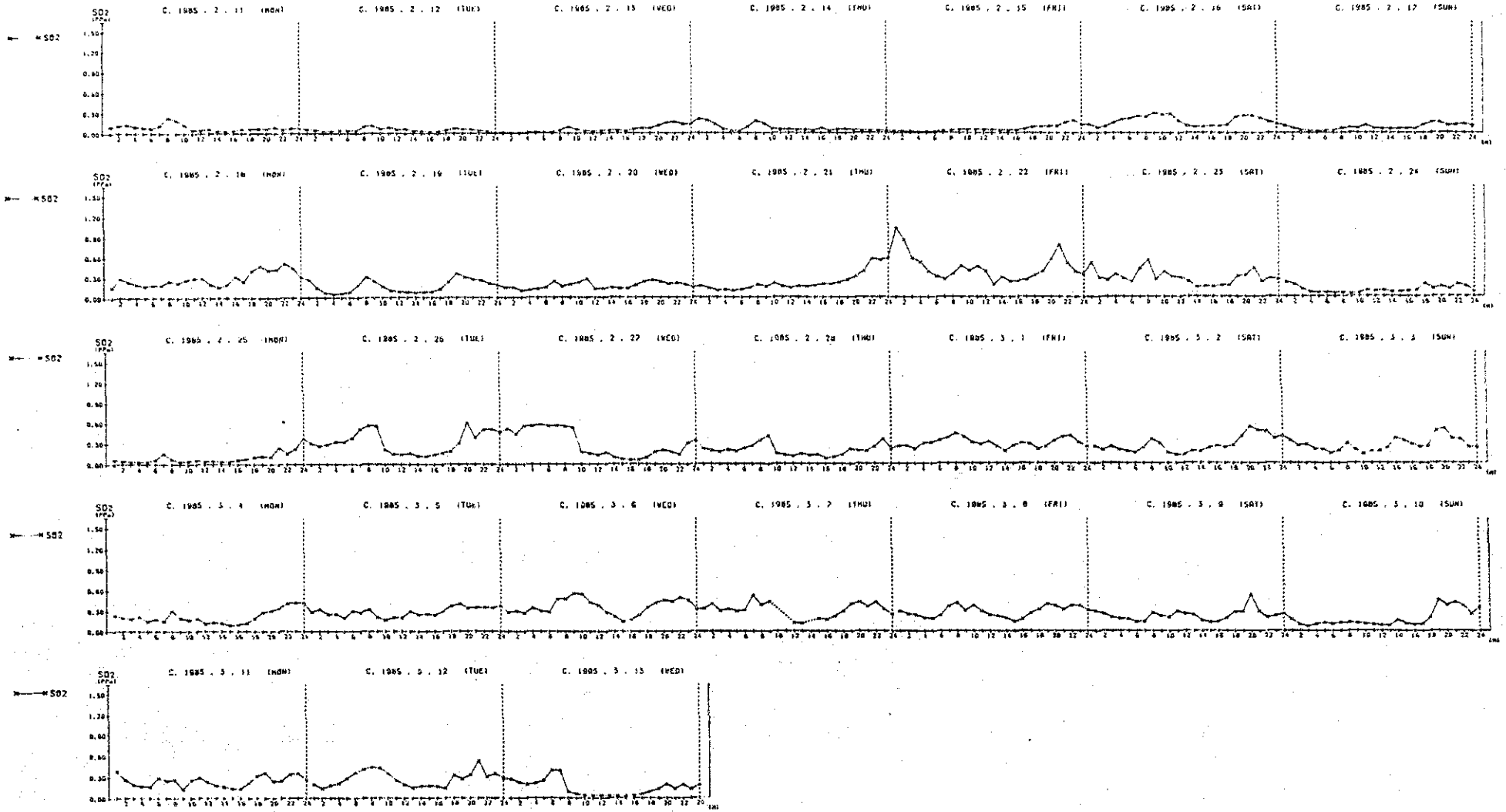
POINT : Yenimahalle



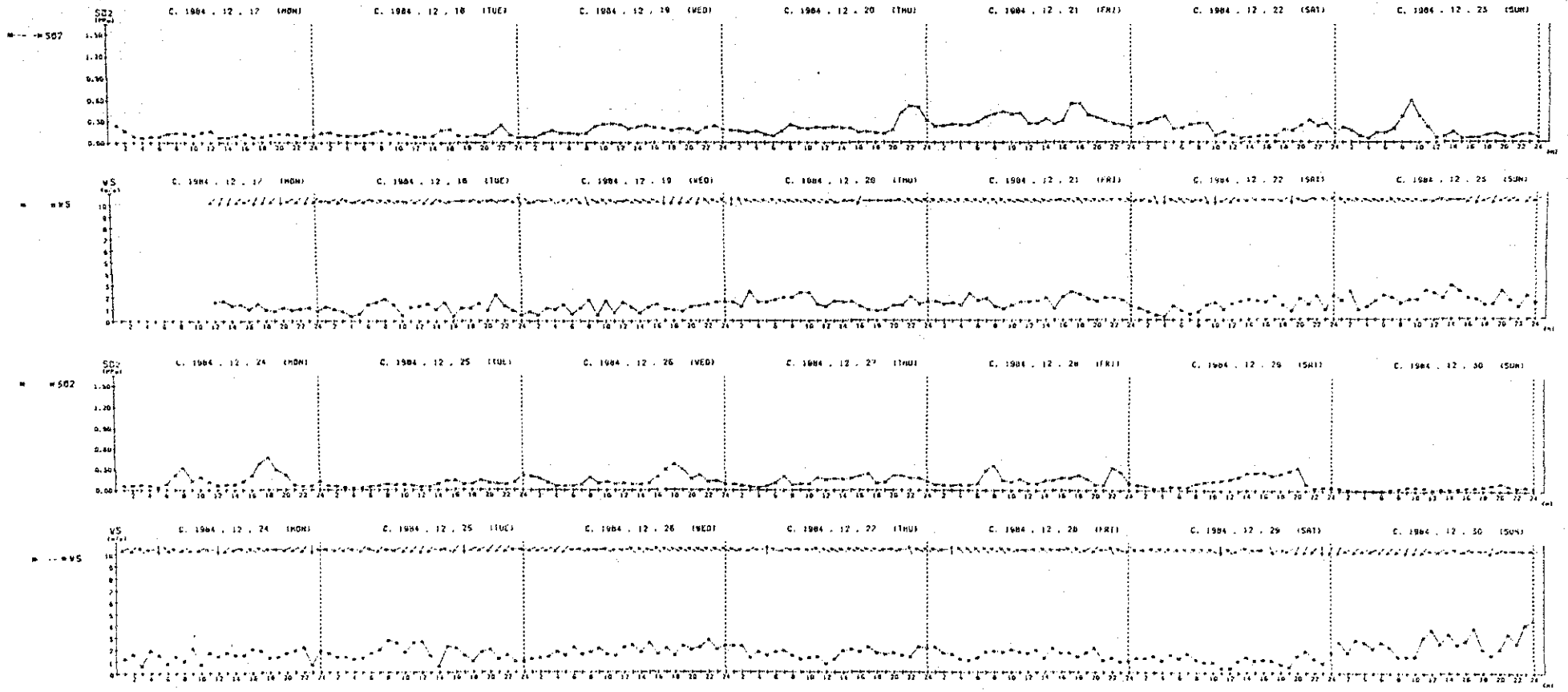
POINT : Yenimahalle



POINT : Yenimahalle



POINT : Tandoğan



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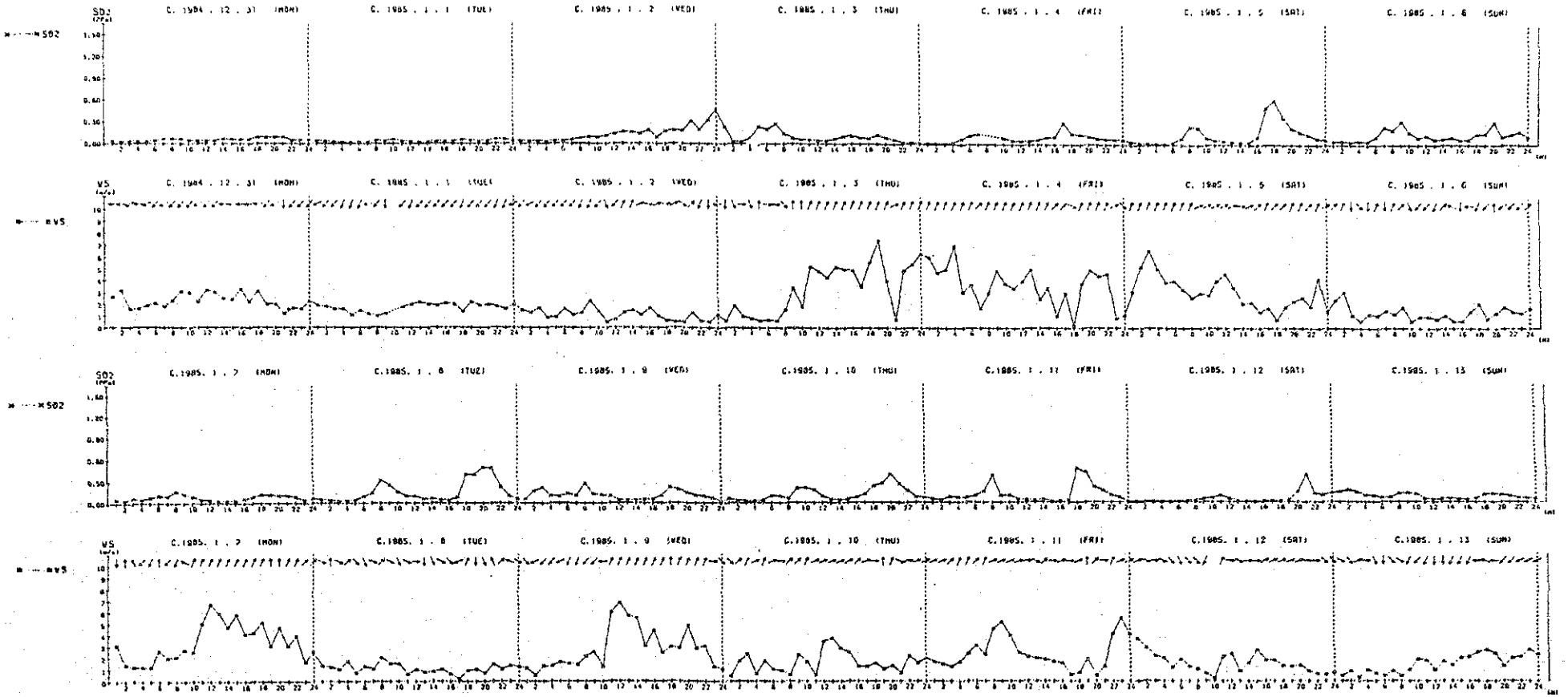

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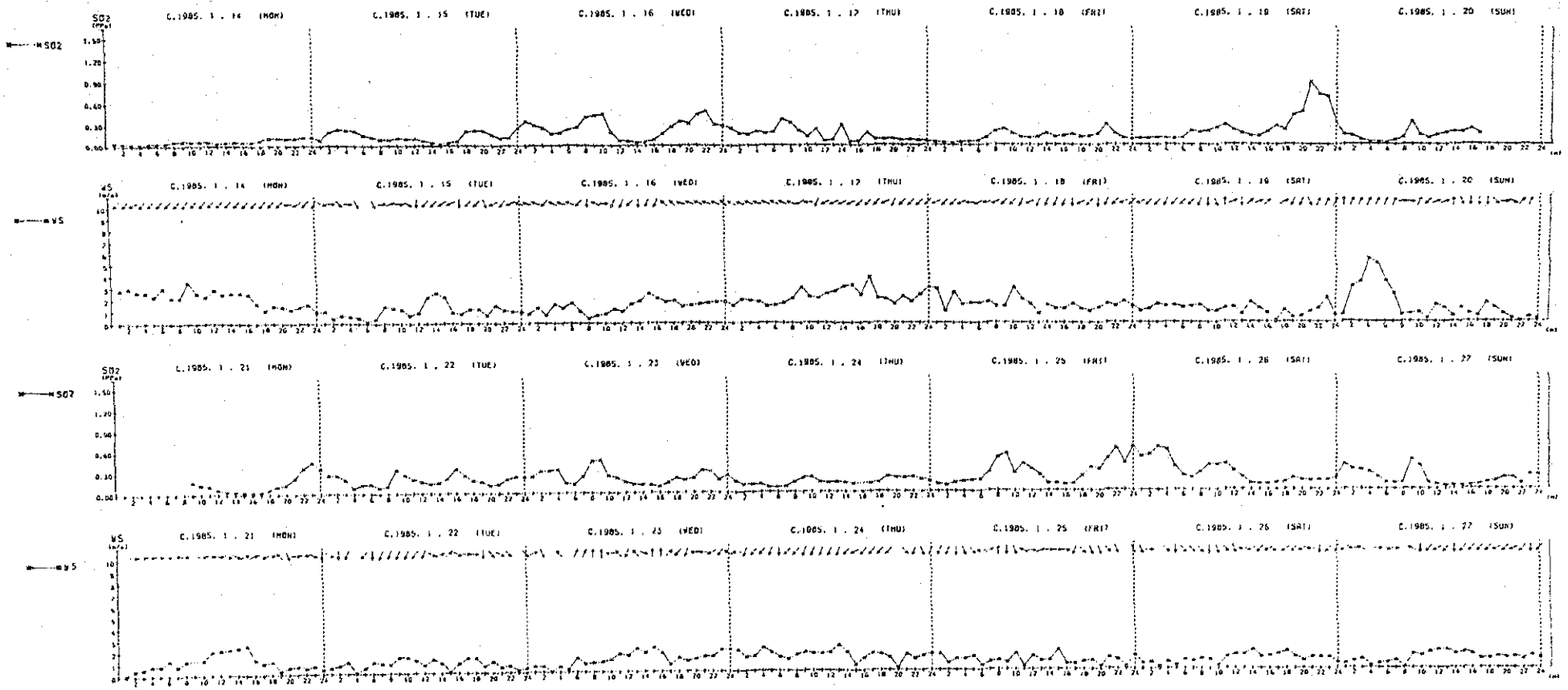

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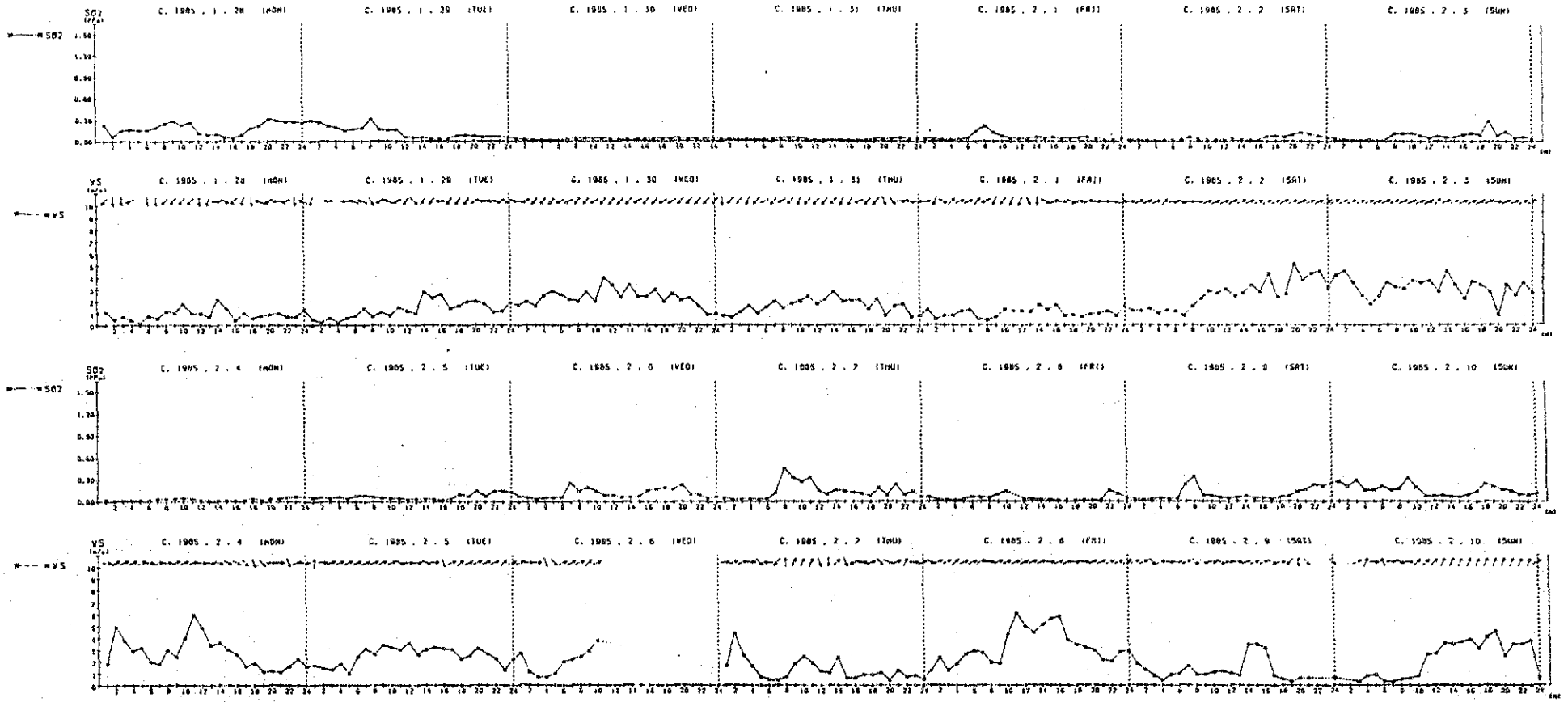

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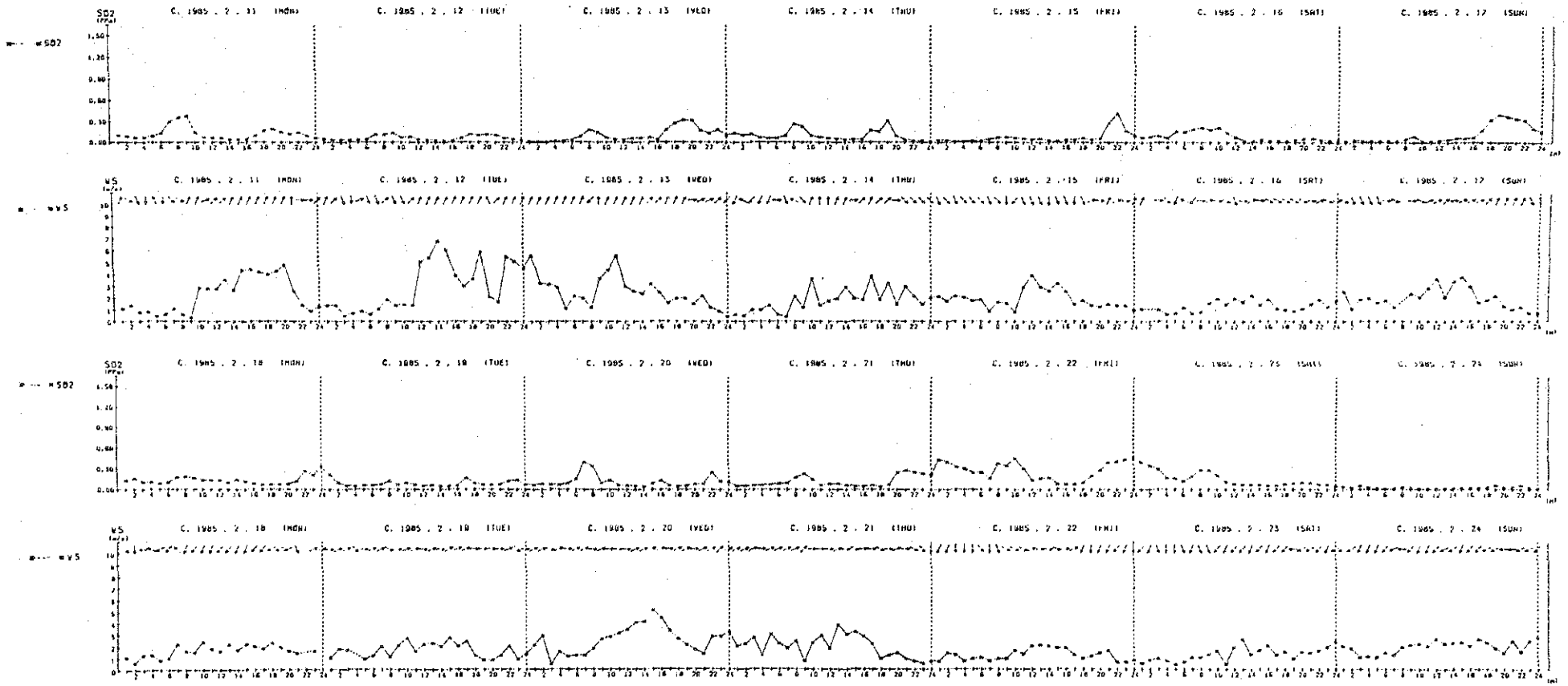

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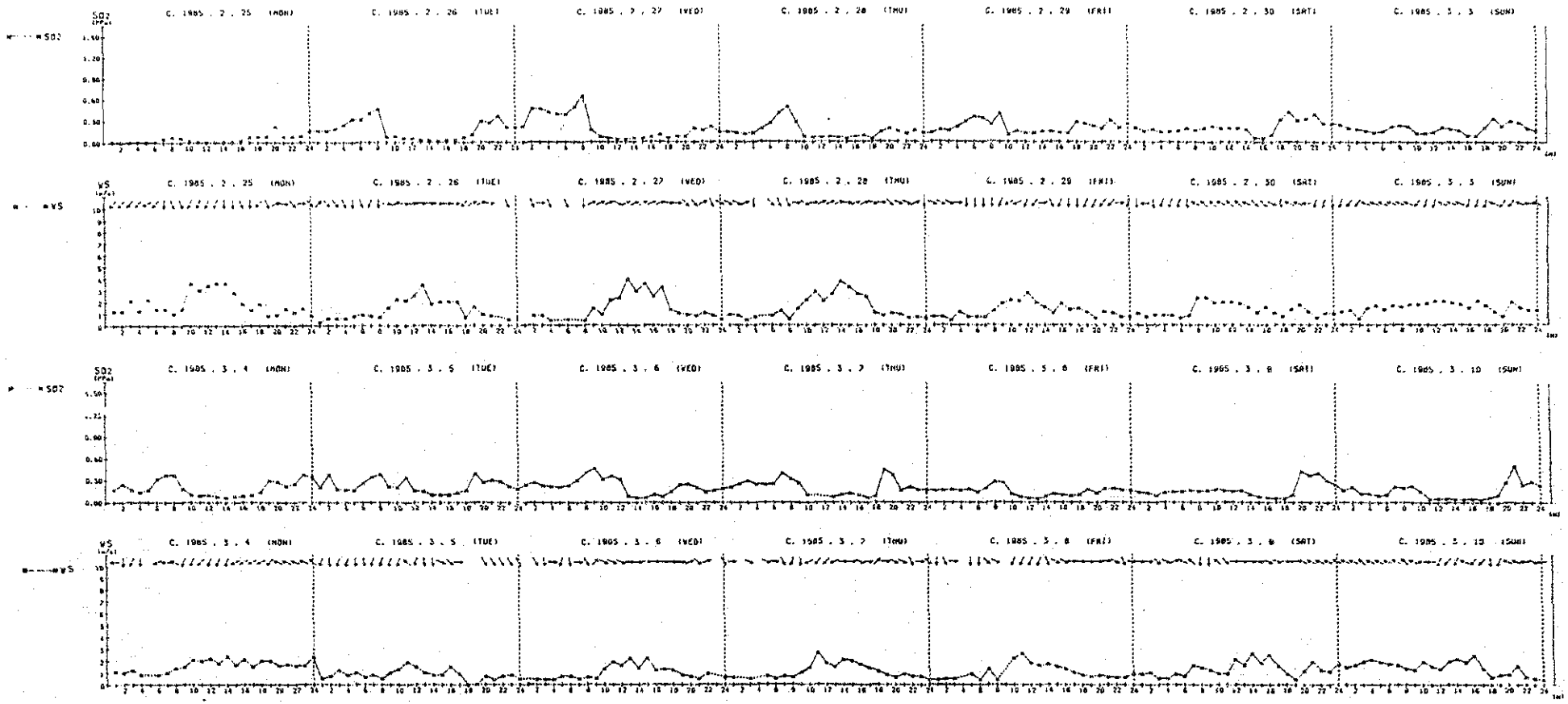

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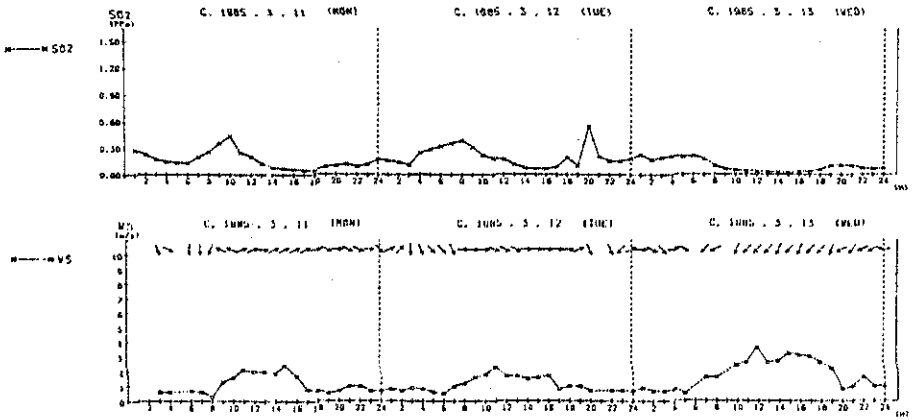
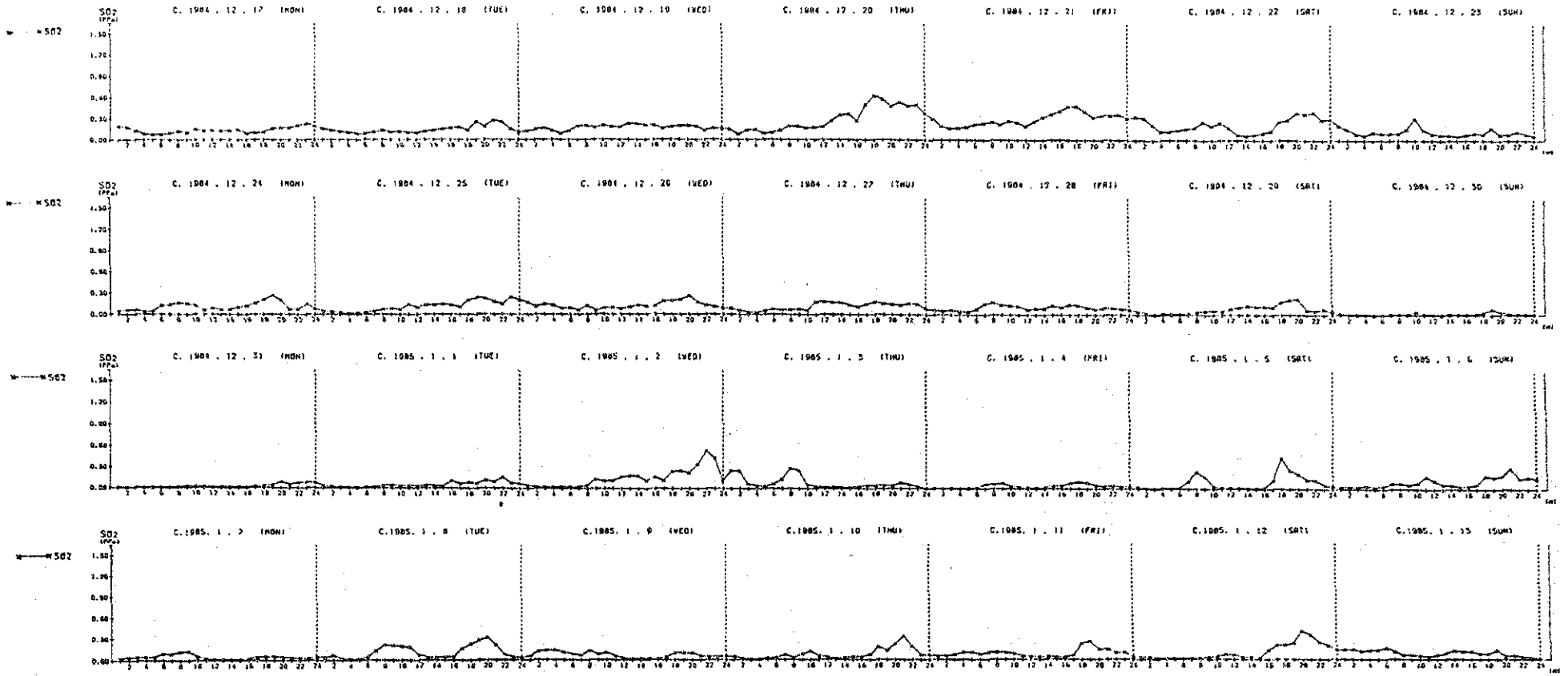
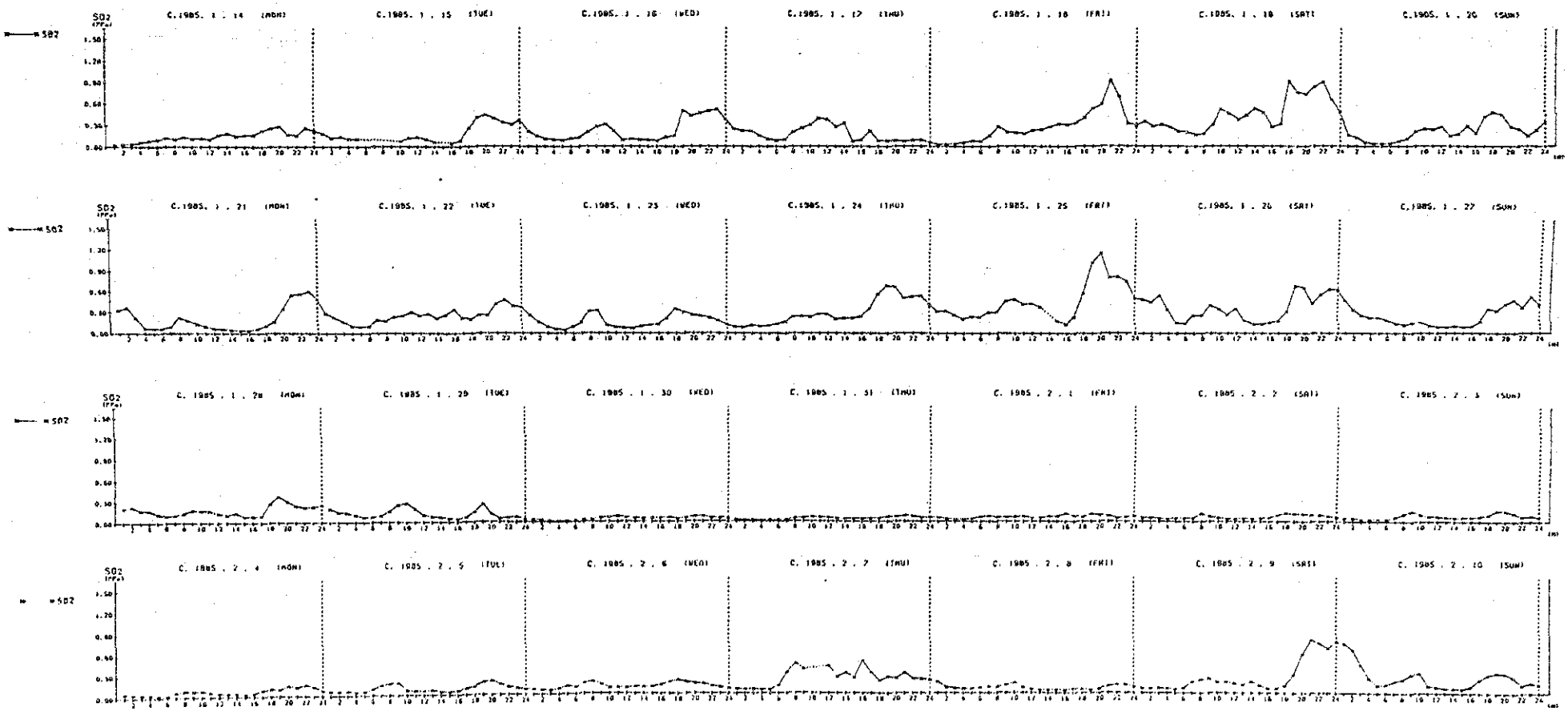


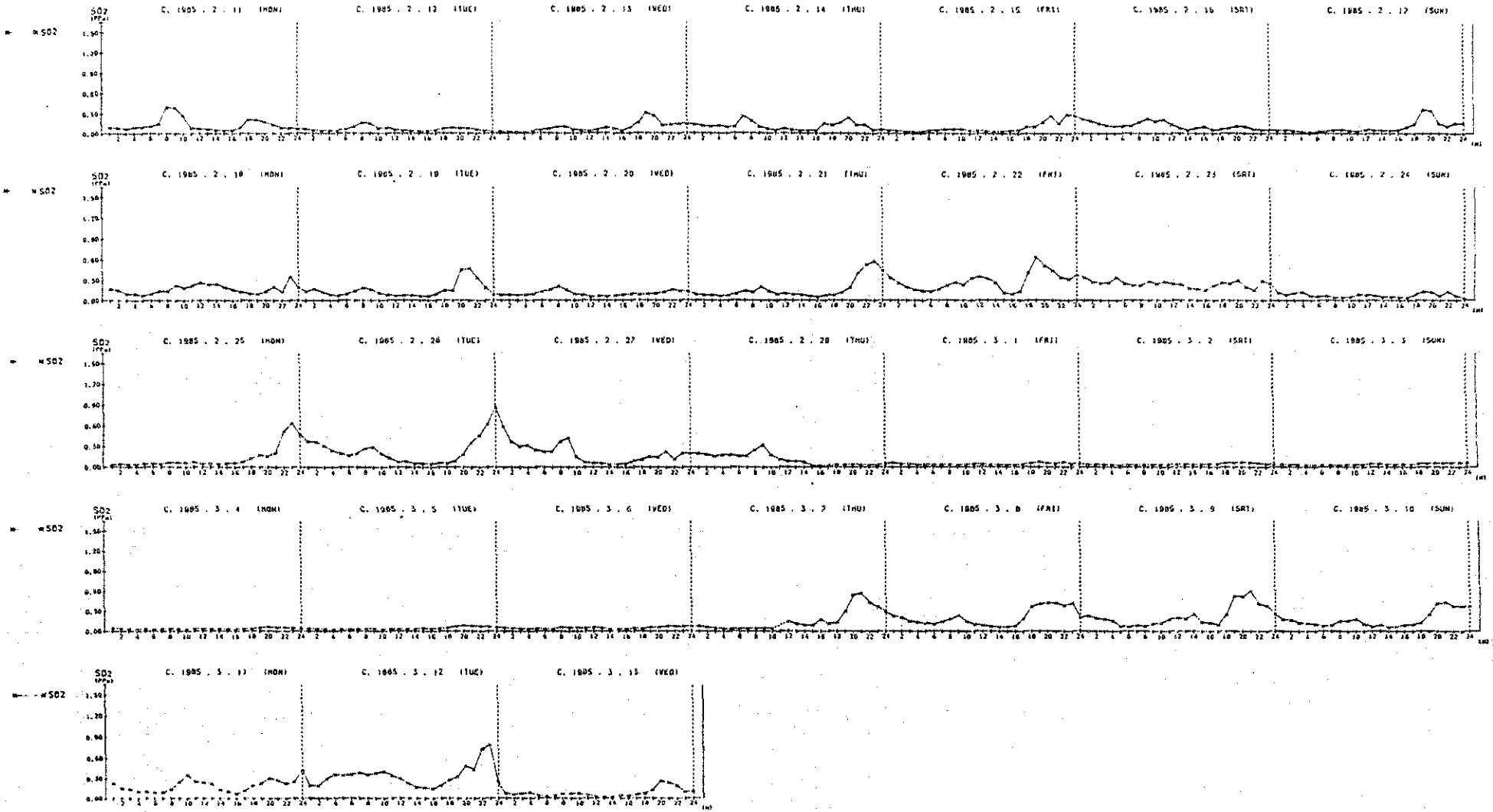
POINT : Cebeci



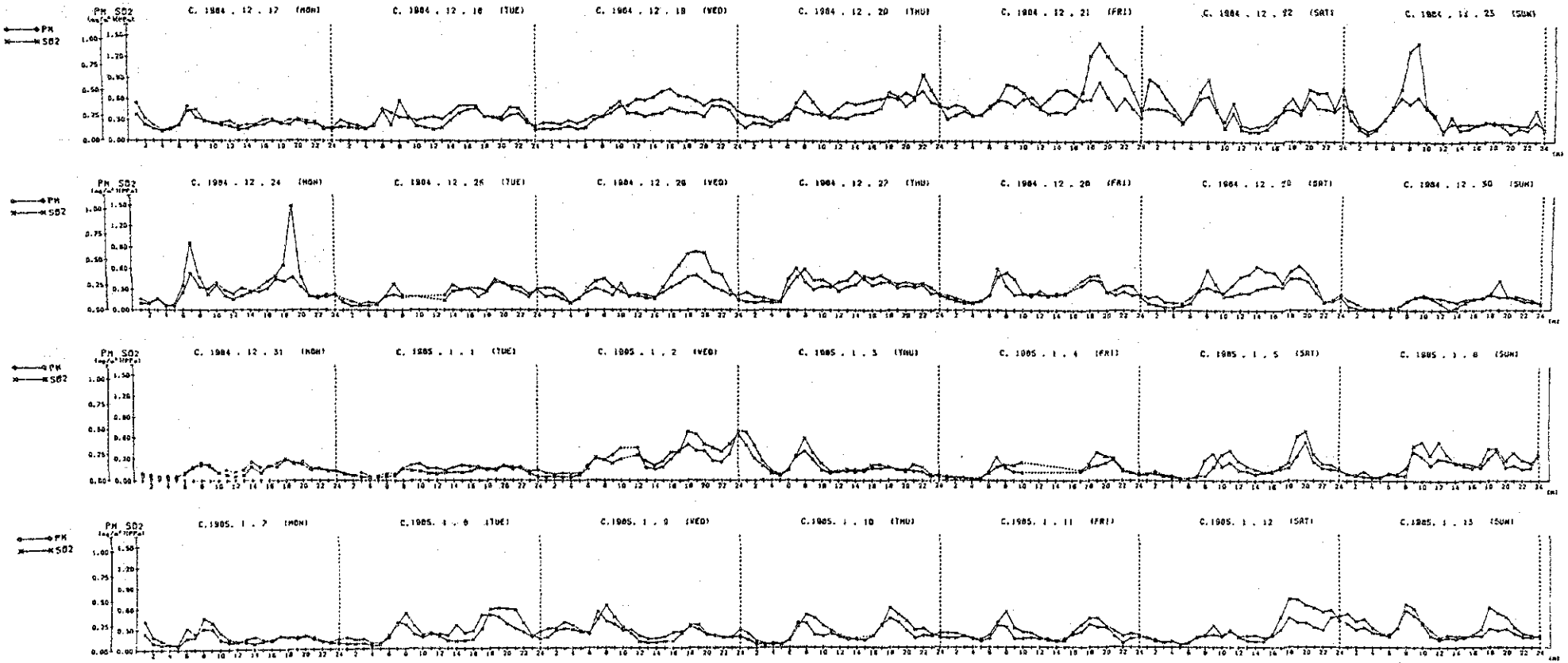
POINT : Cebeci



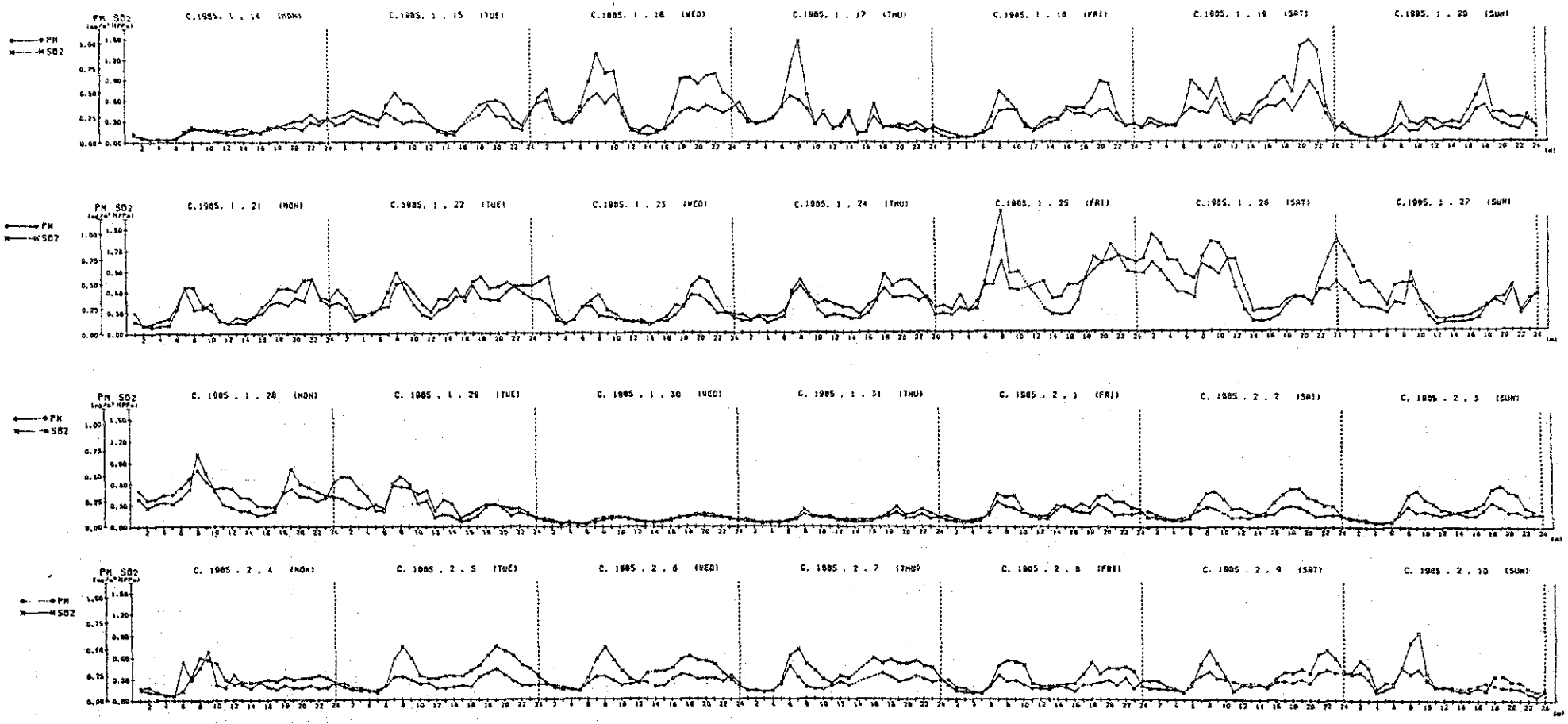
POINT : Cebeci



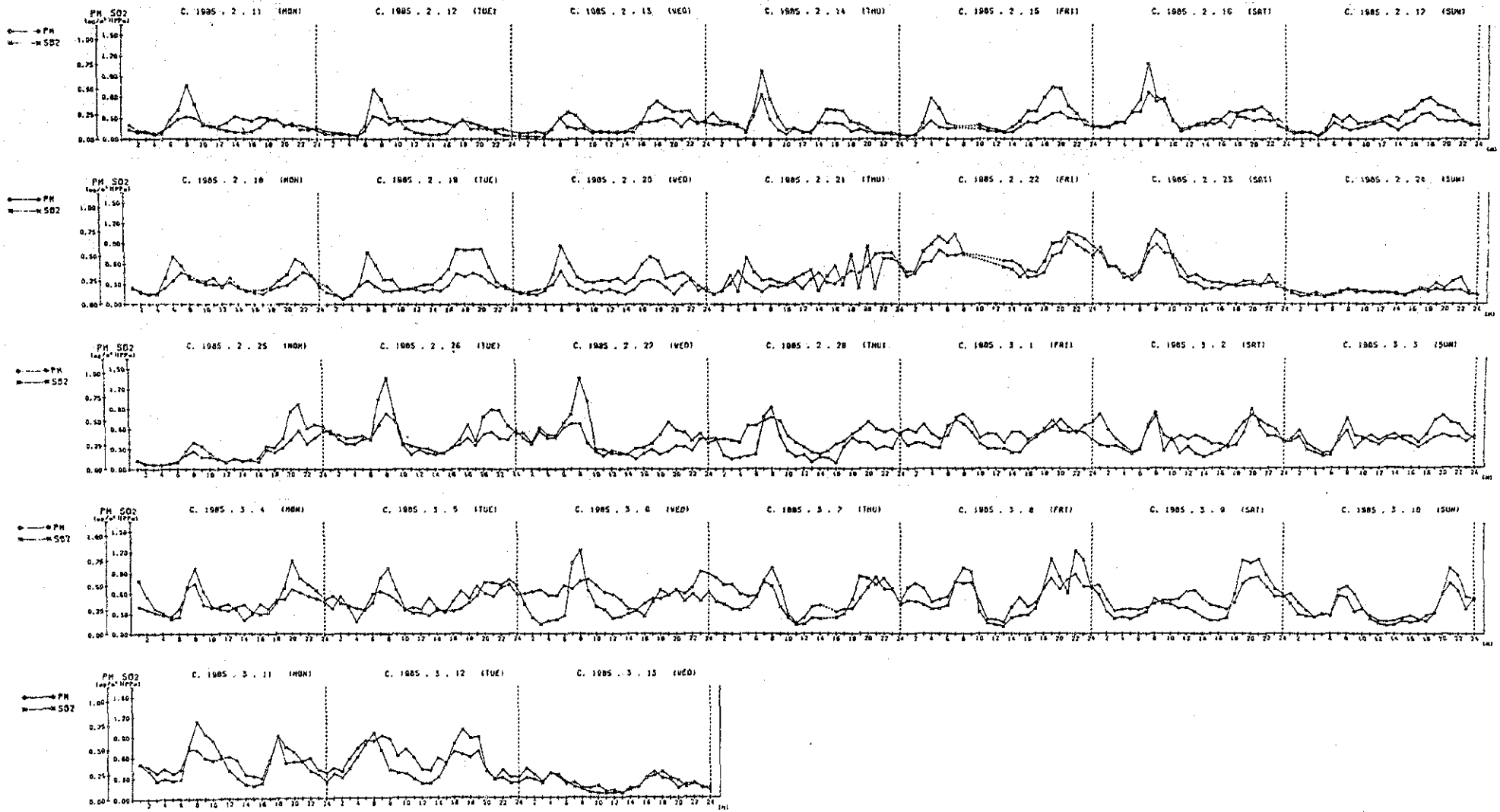
POINT : Bahçelievler



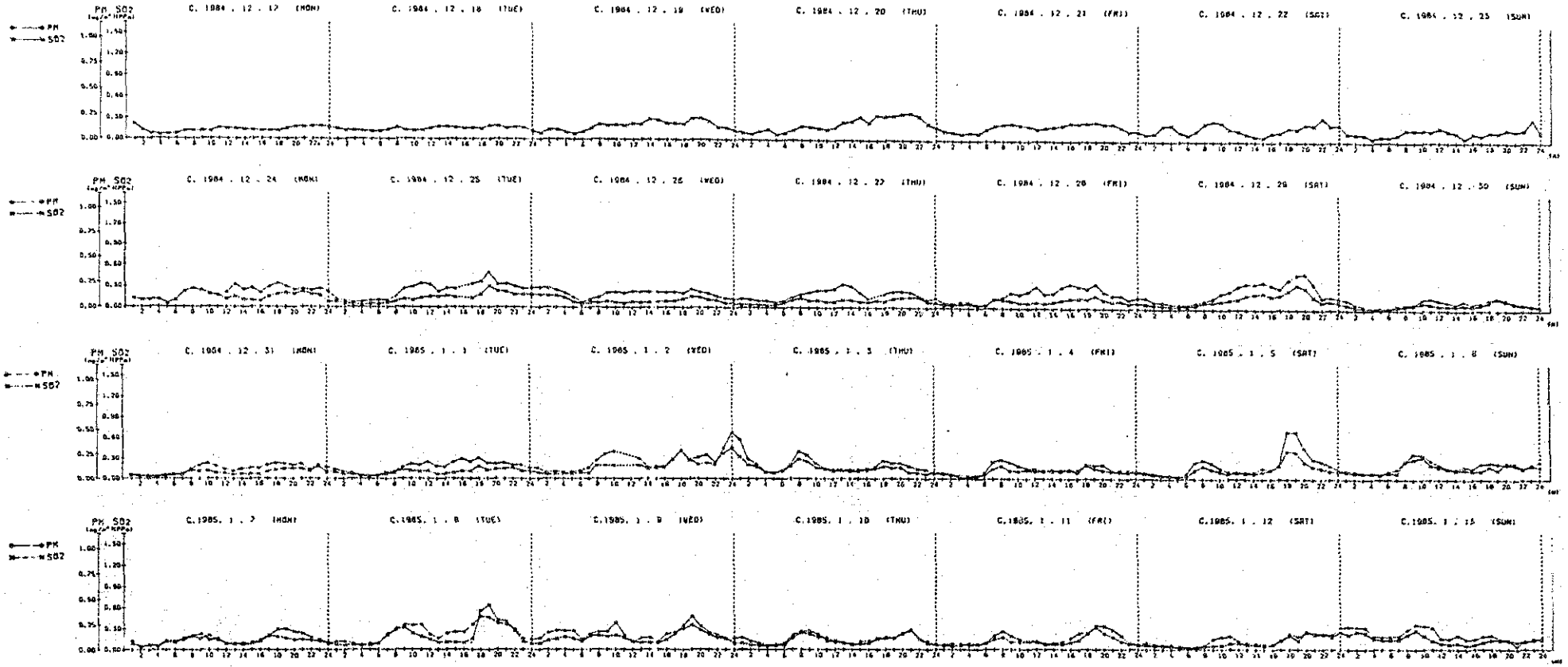
POINT : Bahçelievler



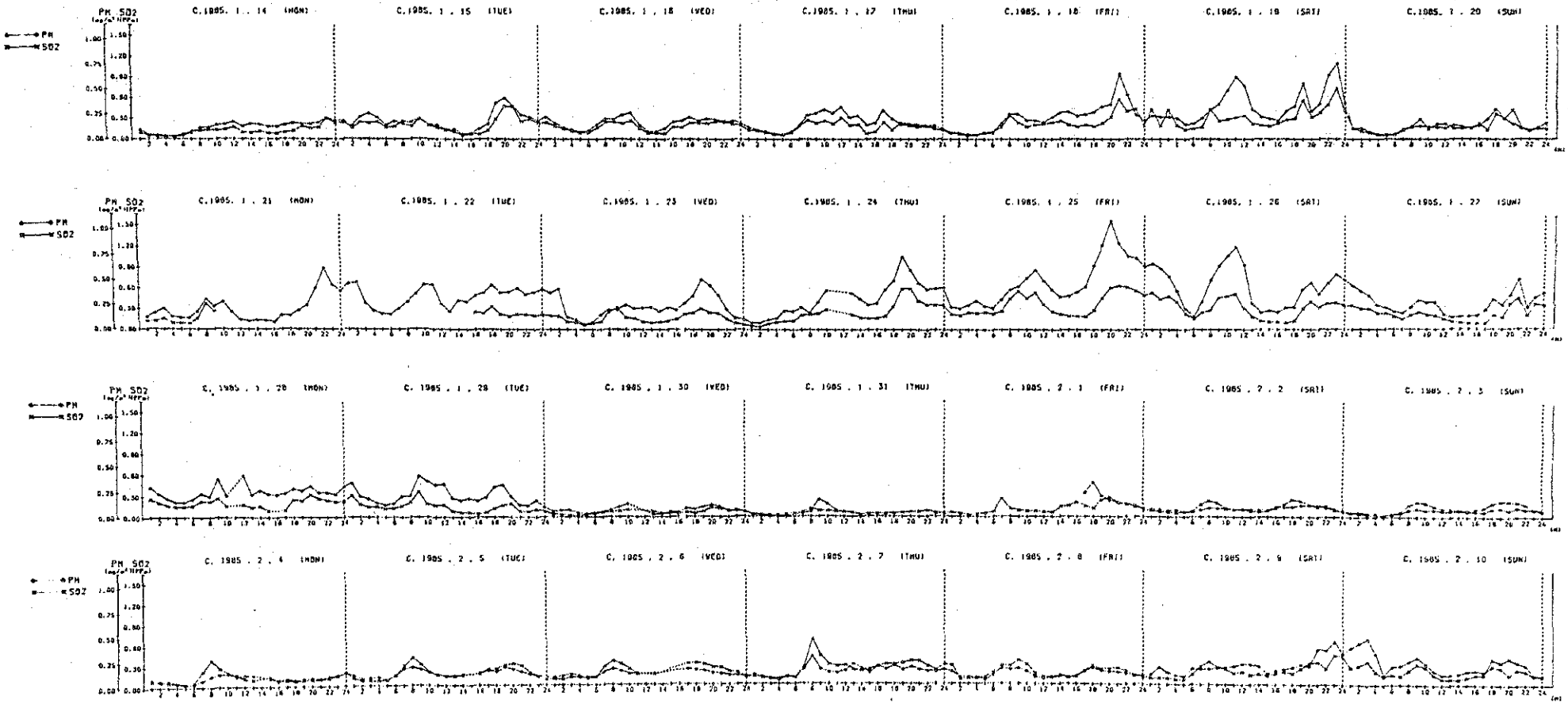
POINT : Bahçelievler



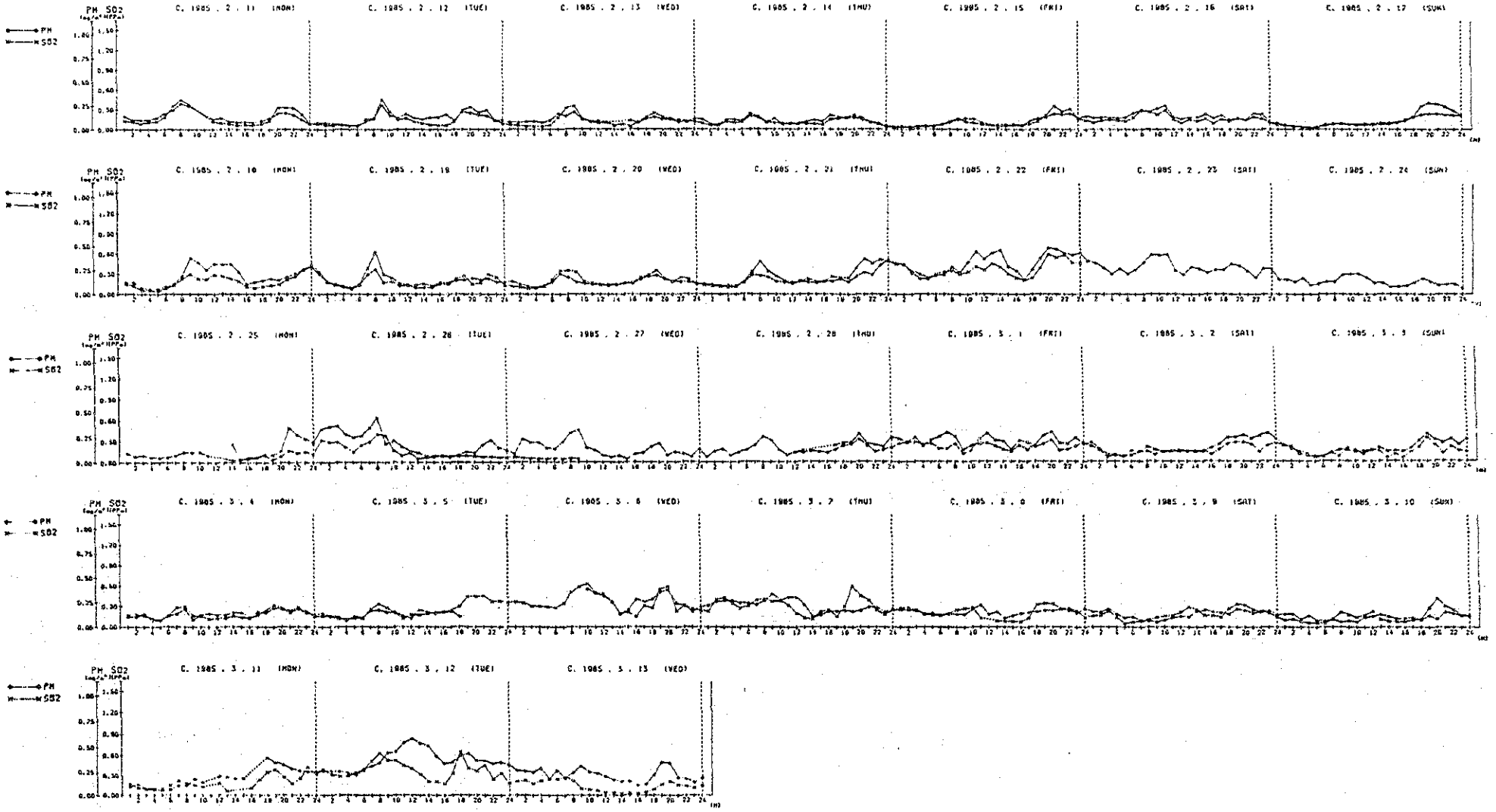
POINT : Sihhiye



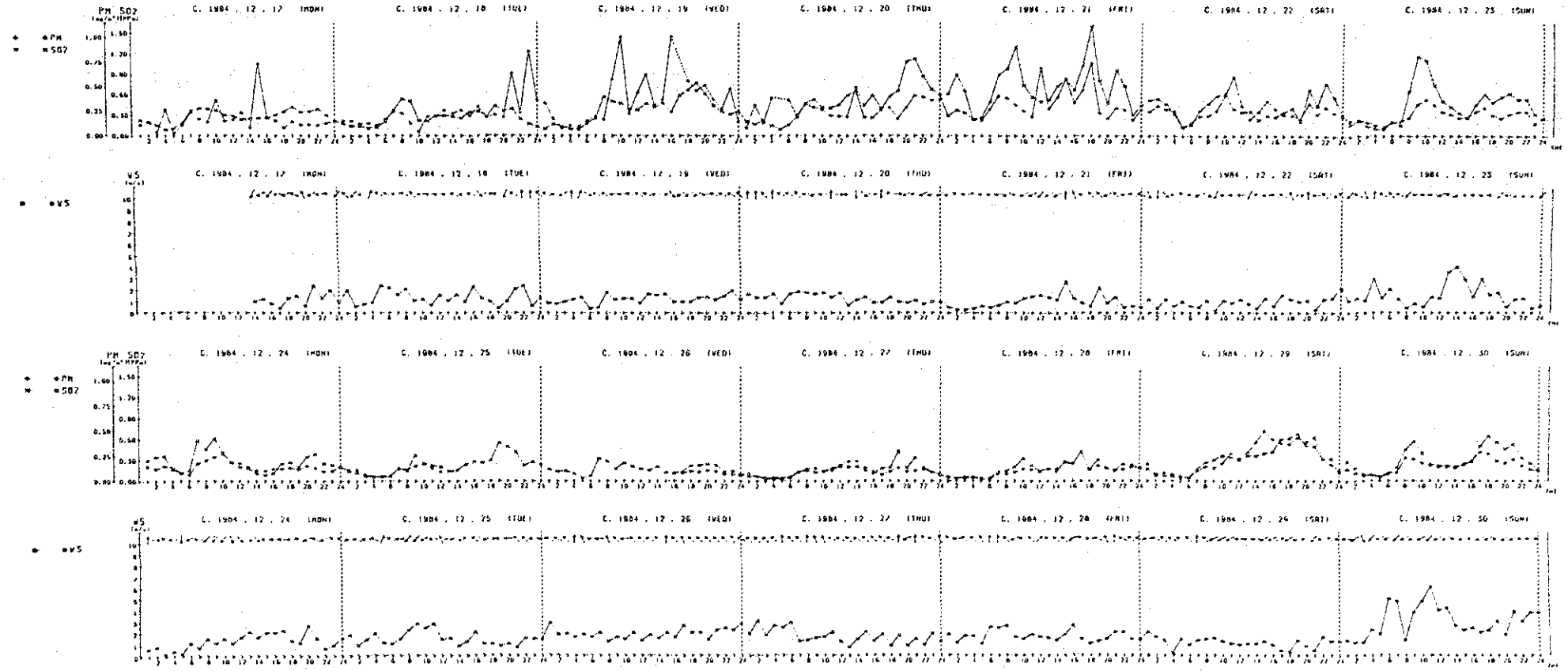
POINT : Shhiye



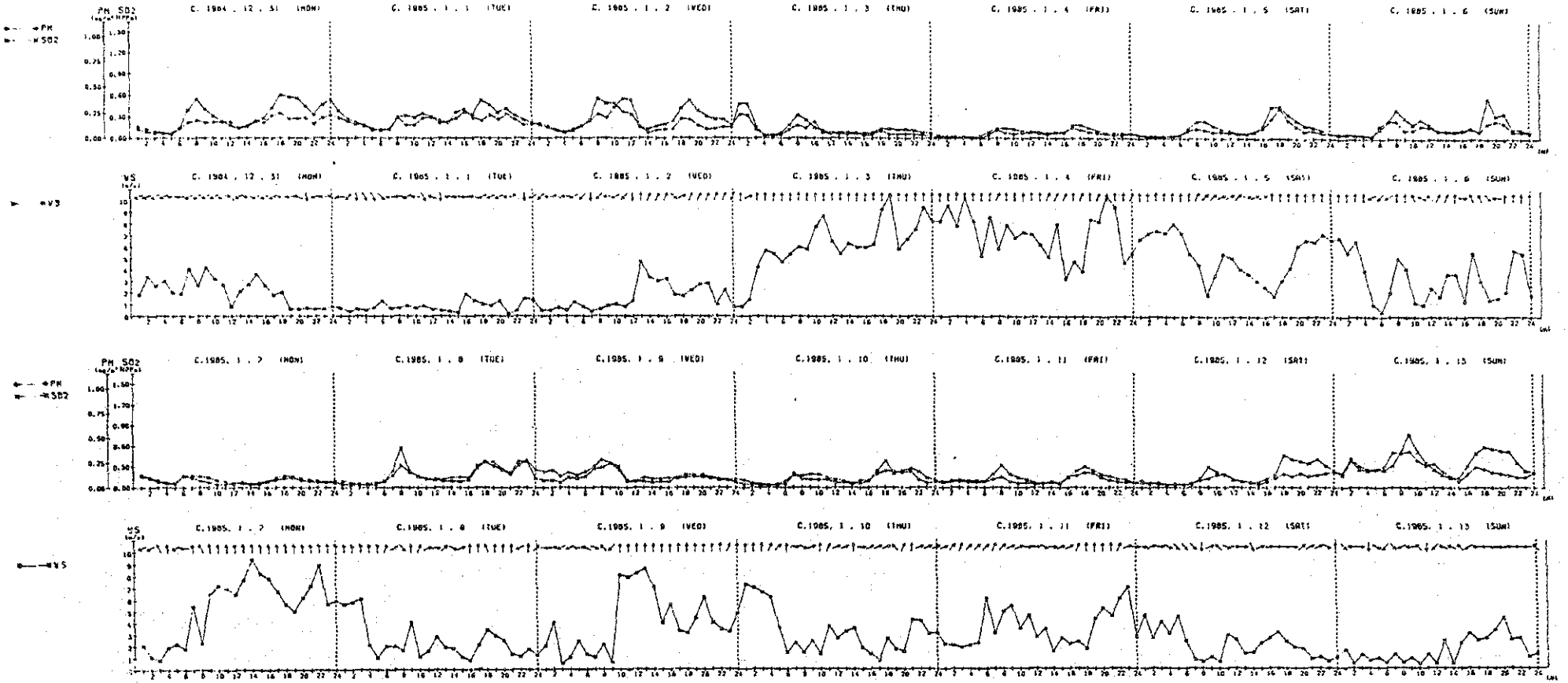
POINT : Sihhiye



POINT : Kavaklidere



POINT : Kavaklıdere



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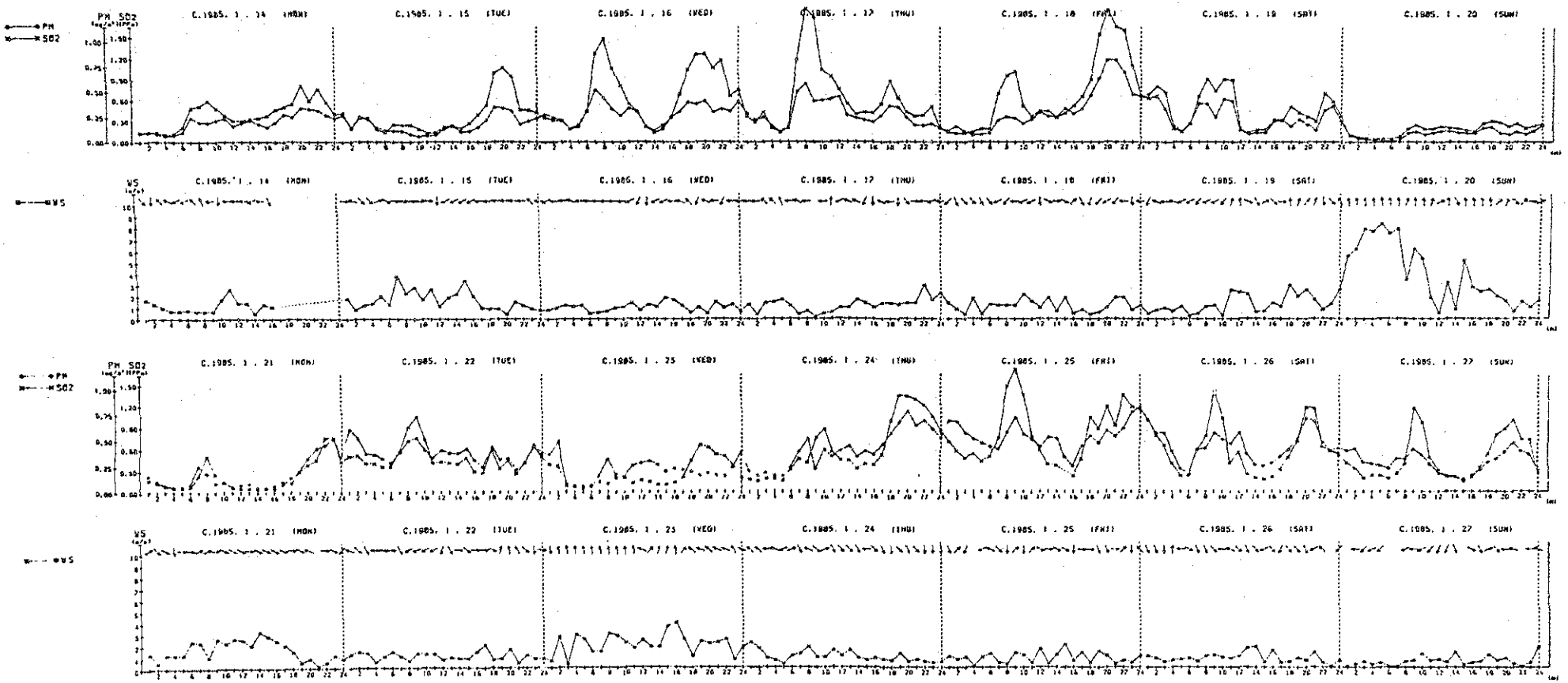

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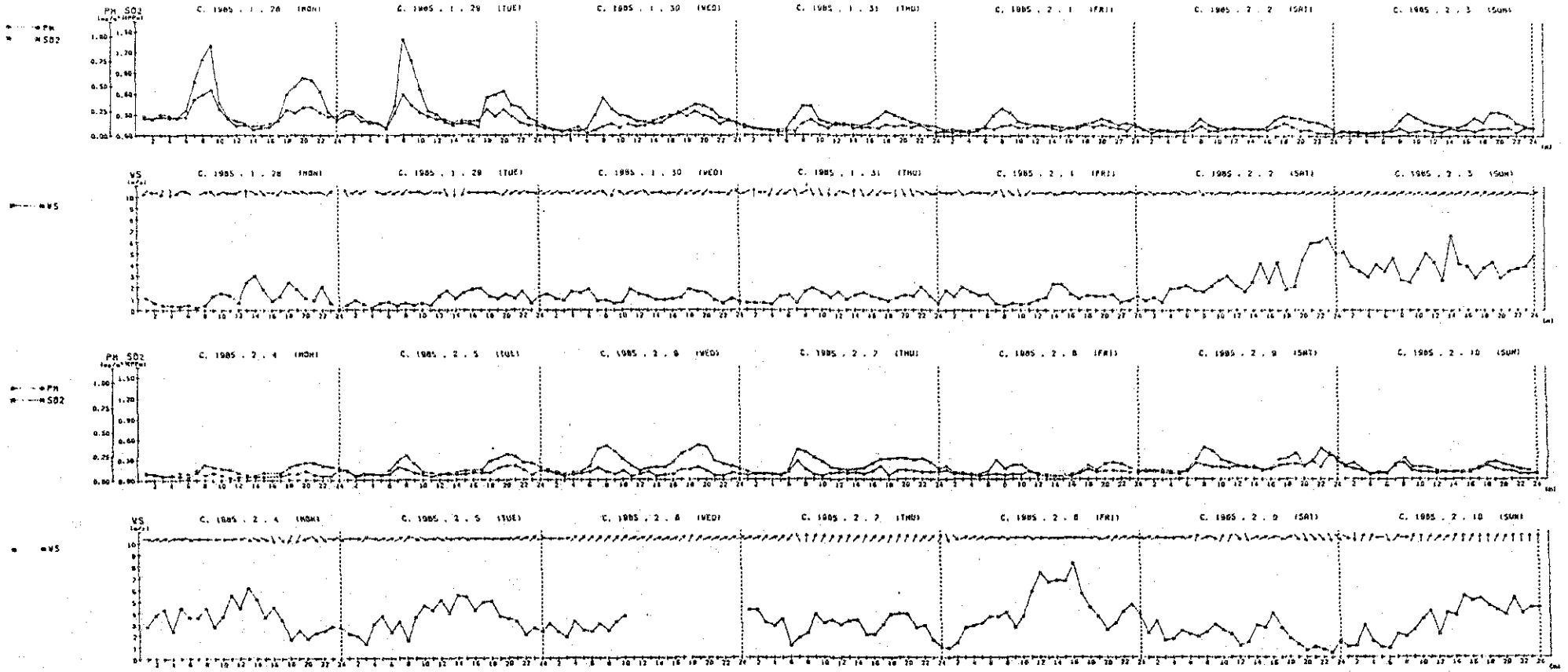

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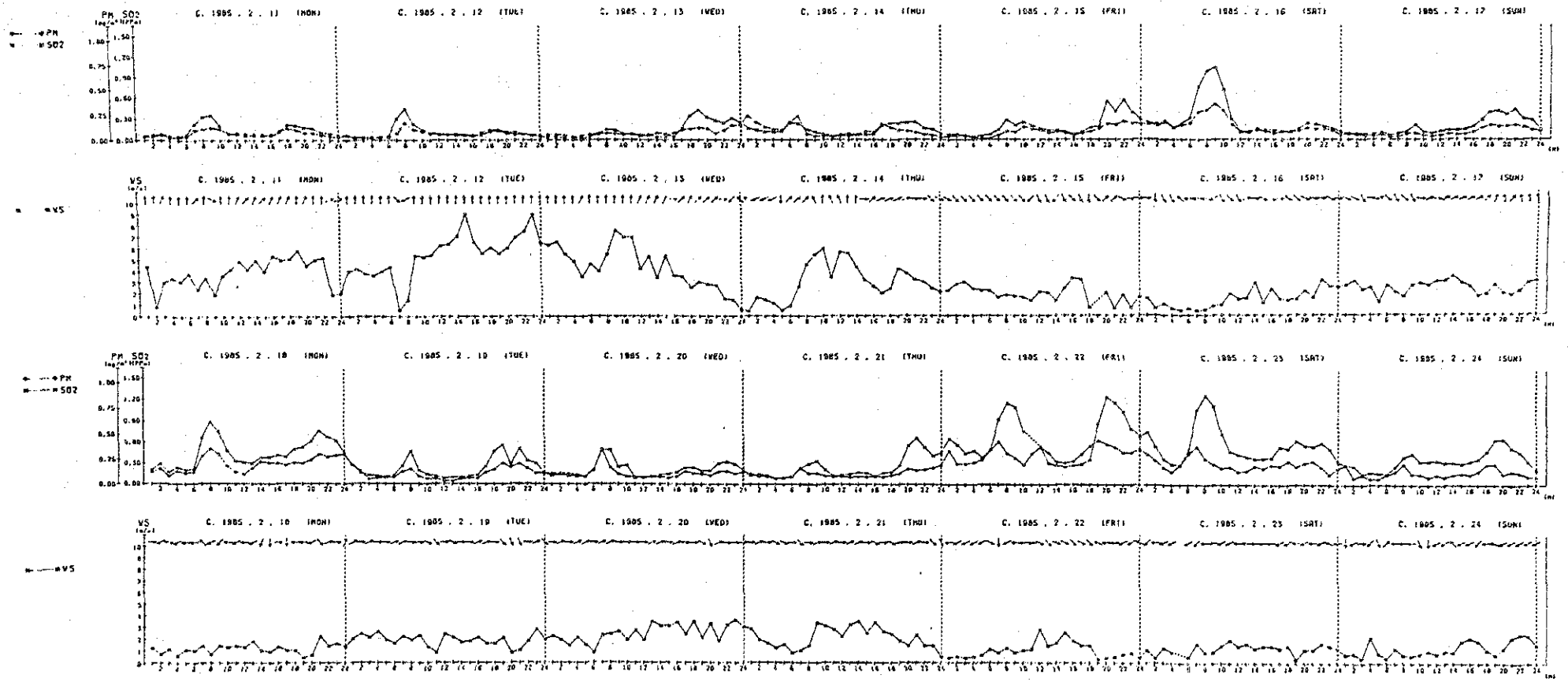

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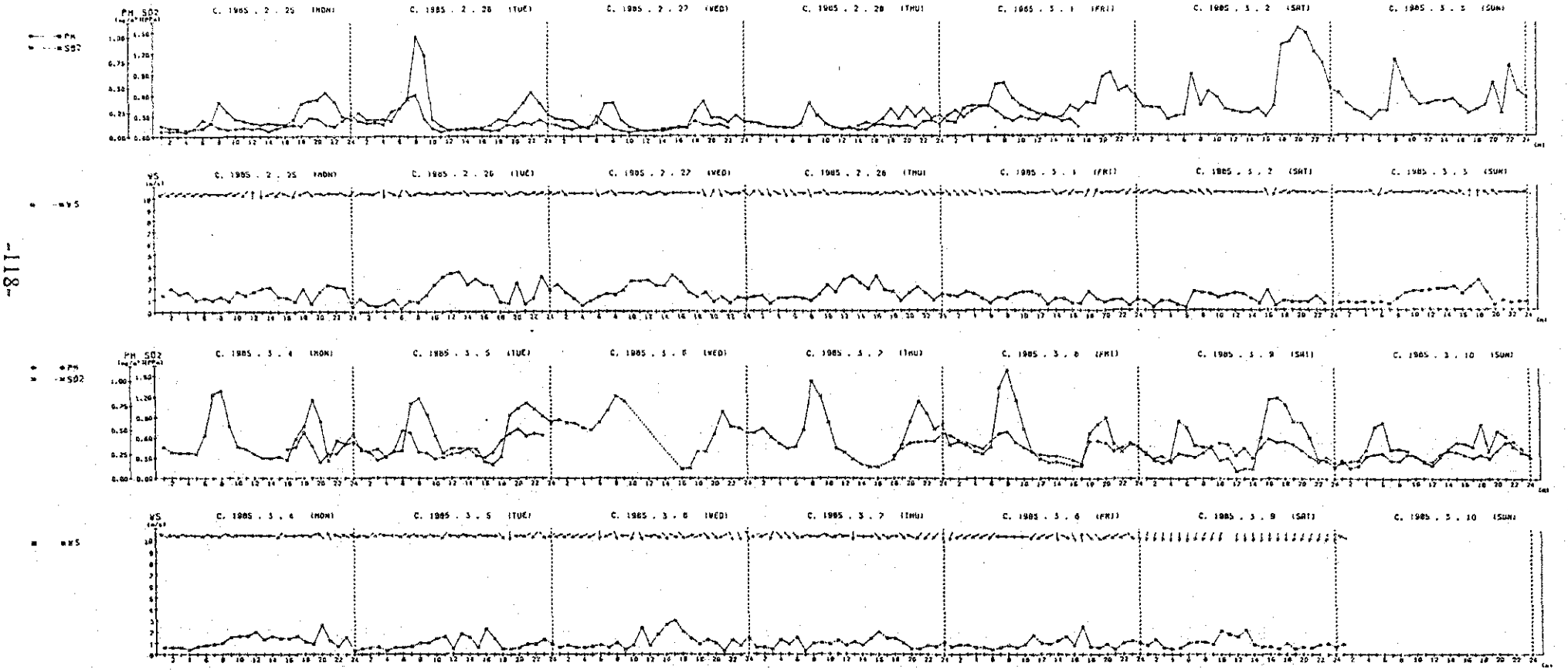
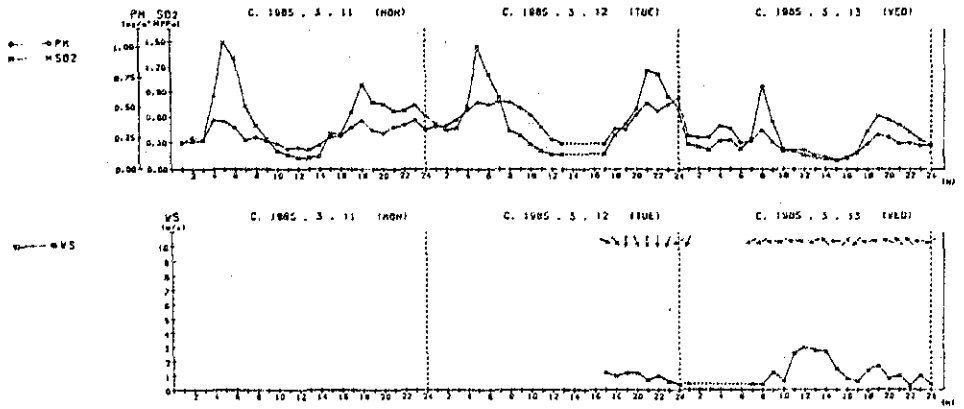
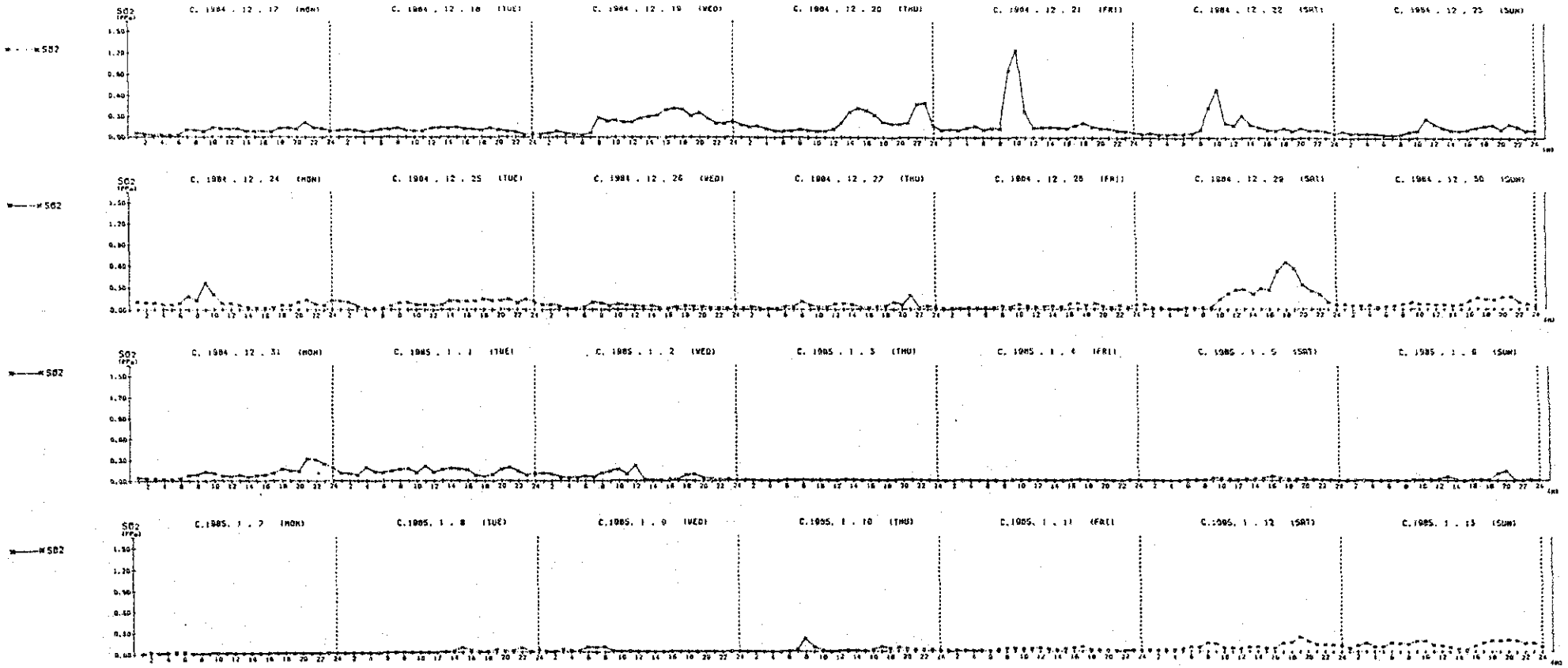


POINT : Kavaklıdere



POINT : Çankaya



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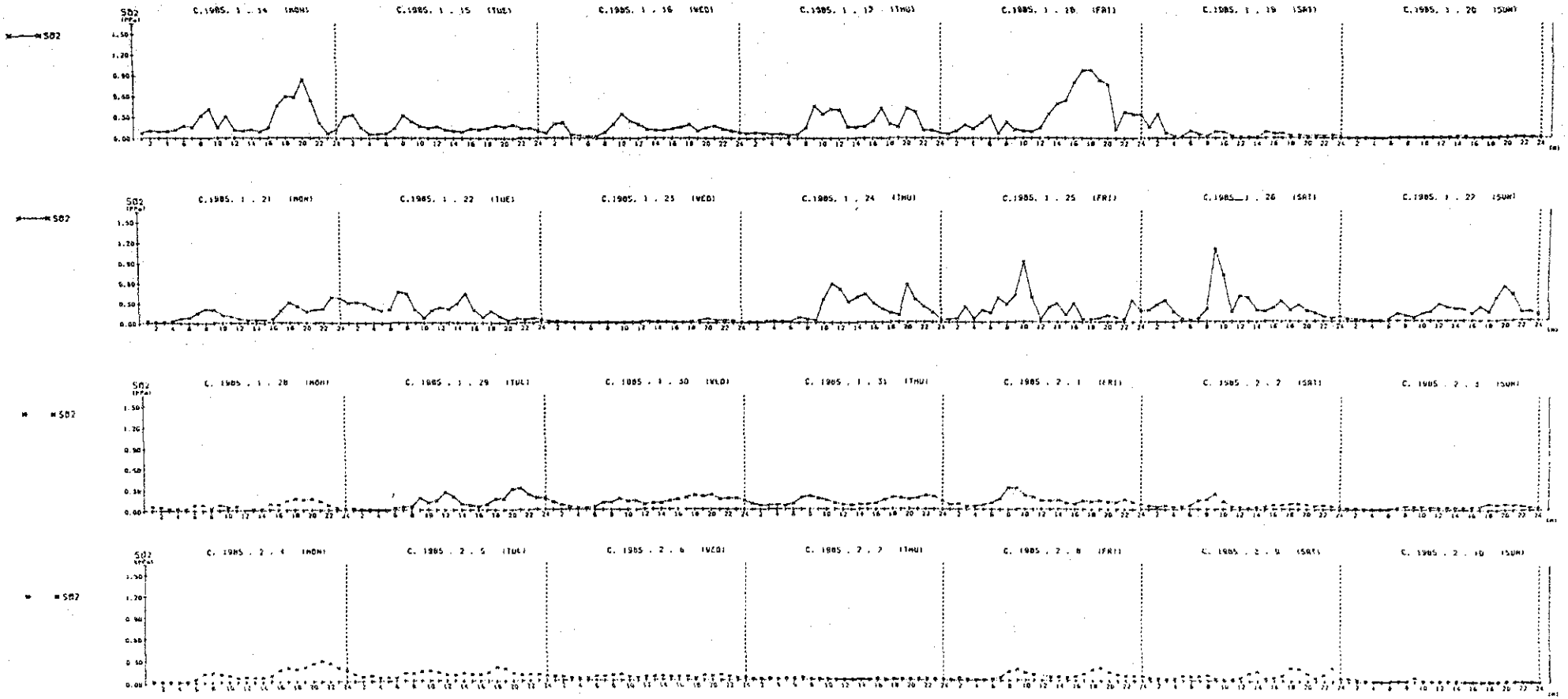

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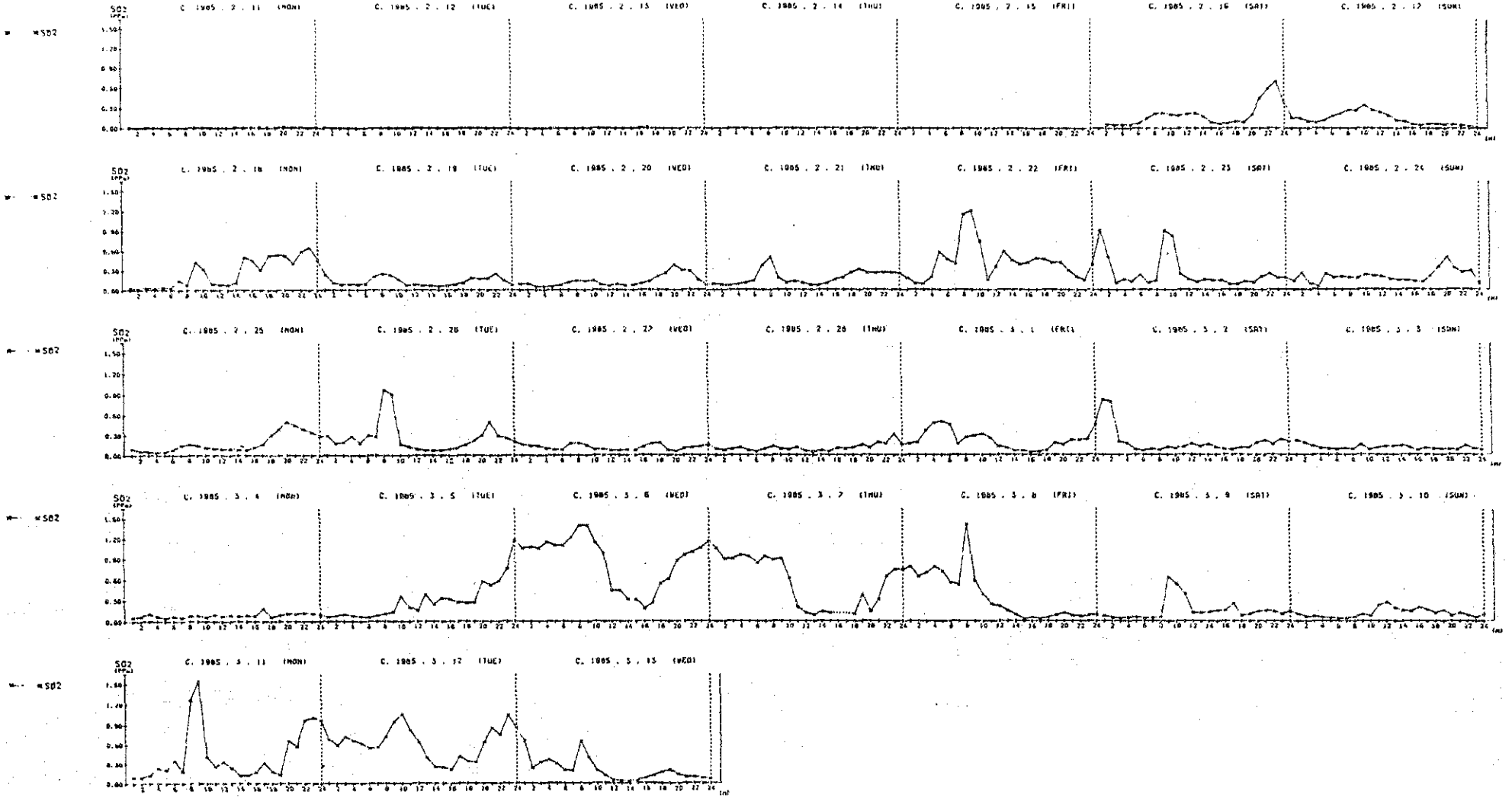
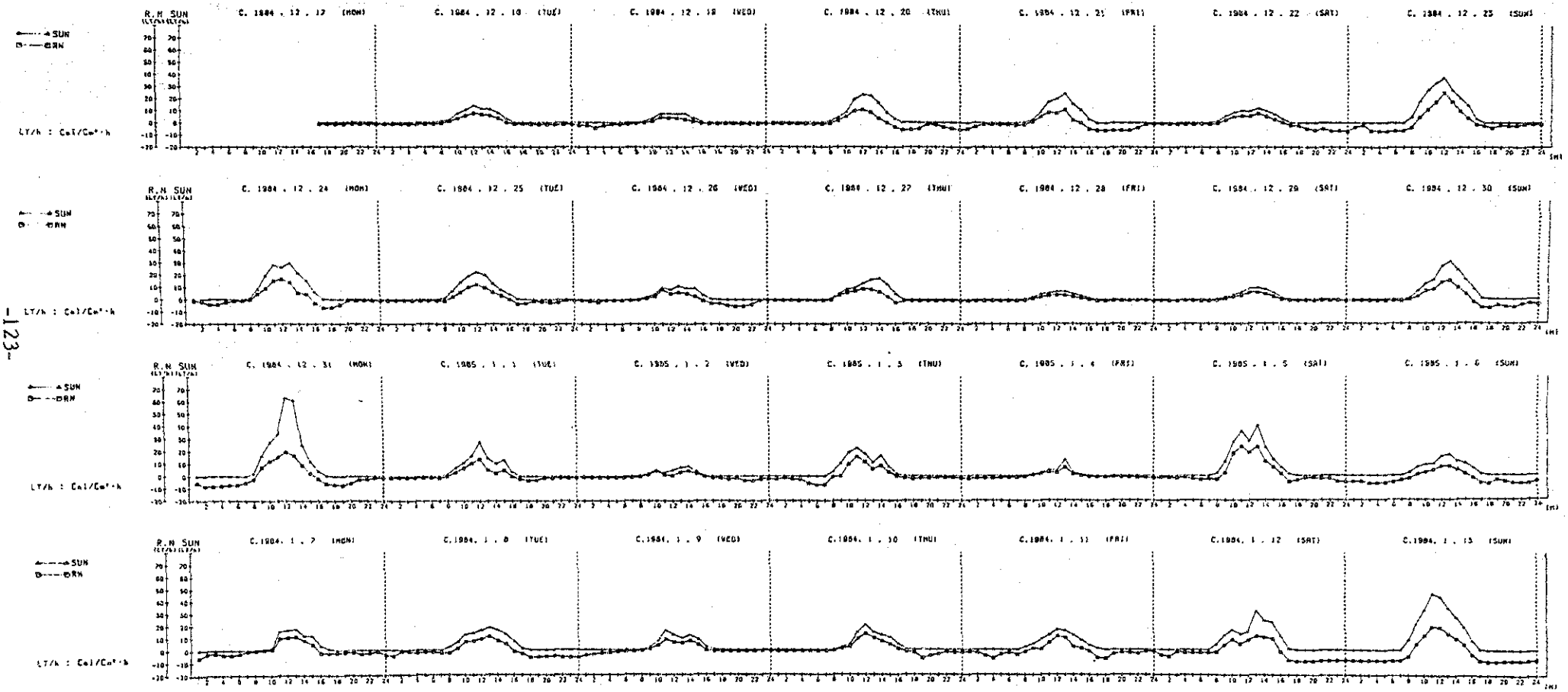
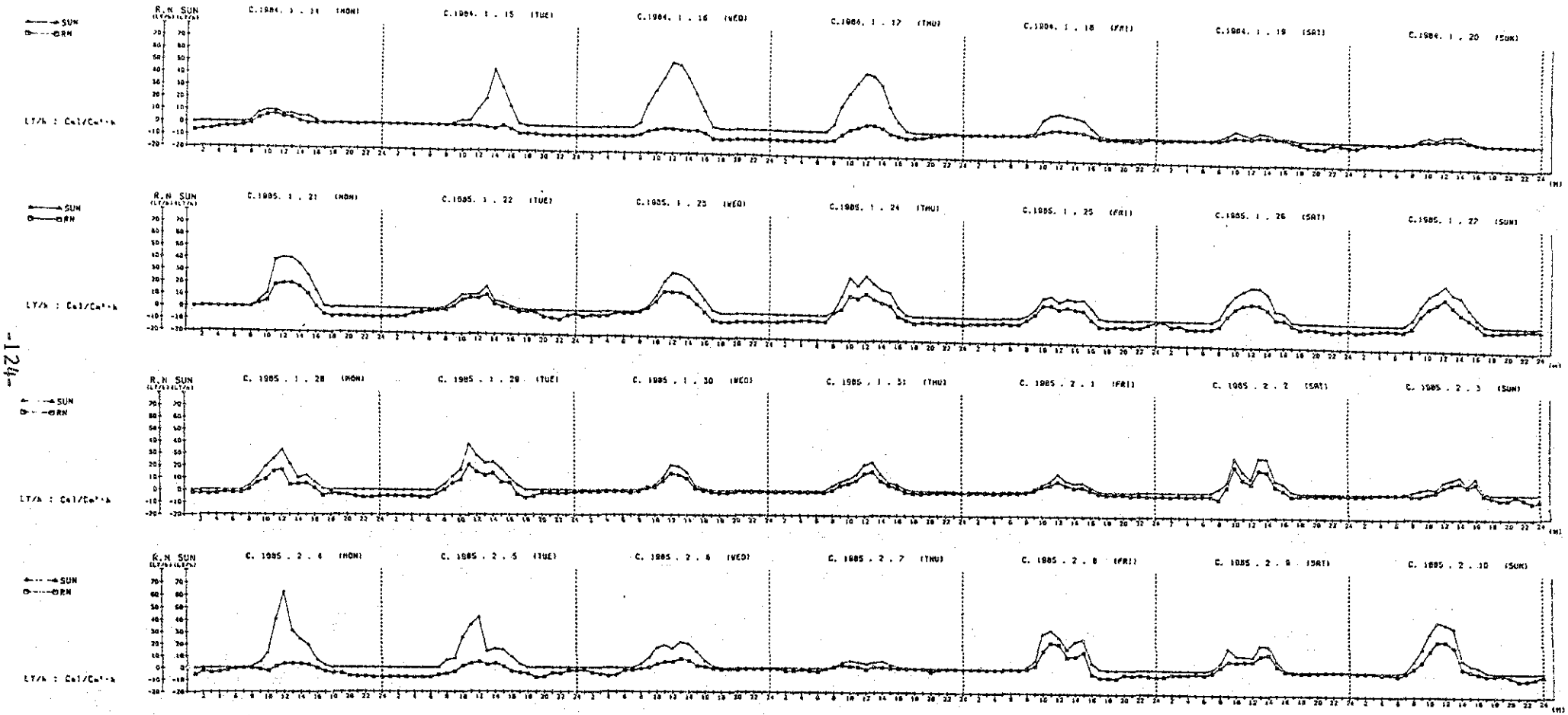


Meteorological Agency



Meteorological Agency



Meteorological Agency