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Air Pollution Condition in Sagamihara, Kanagawa Prefecture in 1996

1996年度の神奈川県相模原市における大気汚染状況について

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Abstract: The environment is becoming diversified and complicated due to urbanization. It is necessary to utilize the results of analysis of various environments in environmental administration. And local residents should be offered environmental information in visual environmental data at the level of local government. The relationship between air pollutants and weather factors was examined on the basis of the data obtained at measuring stations in Sagamihara in 1996, and the following conclusions were obtained:

1. Due to visual expression of air pollution conditions in environmental information provided to local residents, each pollutant showed characteristic seasonal variation at three stations. There was also a similar variation seen in the moving average method to grasp the basic trend.
2. As a result of correlation analysis, it is supposed that it is possible to classify pollutants by differences in the excretion source, that is, differences in the local air environment, and that there is a relationship between air pollutants in the atmosphere.
3. Weather factors linked to air pollutants are representative of conditions in the region, but it is supposed that differences in measured values are affected by the local surroundings. In addition to measurement of emission sources, it is necessary to measure air pollution in the locality.

Key words: Air Pollution, Sagamihara, Weather factor, Correlation analysis, Seasonal variation

Introduction

Environment is diversified and complicated due to urbanization. It is necessary to use the results of analysis of various explained environment synthetically for environmental administration. And local residents should be offered environmental information which is understood easily and visually expressed, showing the results of analysis of environmental data at the level of local government related to civil life, and it is especially necessary to utilize these data actively at the civil administration level[1,2,4-6]. It is the purpose of this study to examine the relationship between air pollutants and weather factors on the basis of the data used in previous papers[3] on continuous observation and measurements at stations in Sagamihara in 1996.

Materials and Methods

1) Materials

Materials are hourly measurements of pollutant density (SO_2/NO/NO_2/O_X/SPM/CO/NMHC/CH_4) and weather factors such as wind velocity, temperature and humidity on 1996 that were measured at continuous observation and measurement stations such as City hall, Sagamidai and Hashimoto in Sagamihara and the calculated monthly averages.

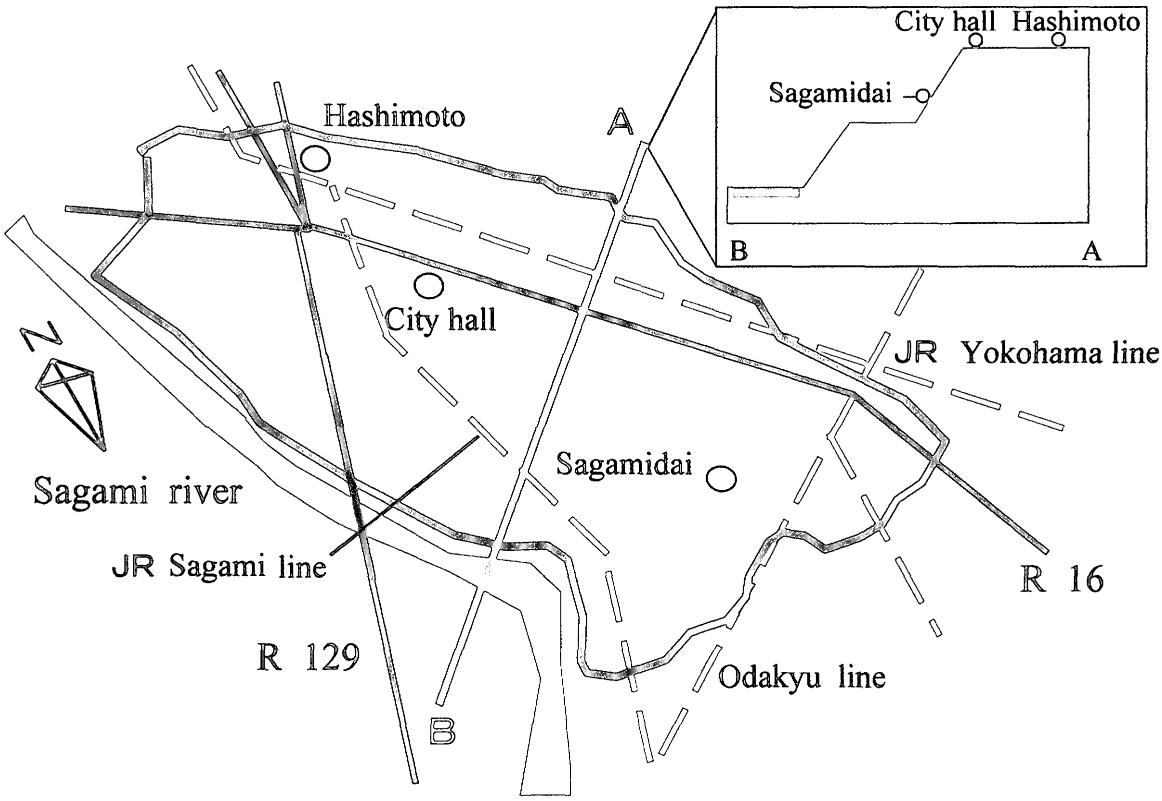

Fig. 1. Sketch map and section of A to B in Sagamihara

2) Methods

1. Observation of seasonal variations in pollutants.

2.Correlation analysis

3) Outline of Sagamihara City and measurement stations

Sagamihara is in middle north of Kanagawa Prefecture. As geographical features (Fig. 1), there are three different levels: two stations in the upper section and one in the middle section. This city is a satellite town of Tokyo and Yokohama for population movement and is adjacent to Atsugi, Zama and Machida, and it has been developed as a housing estate. This city is growing and is now the third largest city in Kanagawa and the population was over 600,000 on 1996. Also a network of roads have been made in response to demand. Routes16 and 129 run through this city.

Results and Discussion

1) Variation of pollutants

1. Observation of seasonal variation (Table 1)

It is found that SO_2 density (Fig. 2) of at City hall is low from May to July, increasing in August, and afterward the level is in the range of 8–10ppb, at Sagamidai, there is a level trend and the lowest values for the three stations. At Hashimoto it peaks in July and varies throughout the year. Also it is seen that similar variation is the trend in the moving average method to grasp the basic trend, and this is the same for other pollutants. It is supposed that the NO density (Fig. 3) reaches a peak in November, with NO_2/CO density (Fig. 4 and Fig. 7) decreasing in summer and increasing in winter because the source of these pollutants is exhaust gas and heating devices[7–9]. The variation in O_X density (Fig. 5) has a trough in December. It is seen that SPM density (Fig. 6) decreases from June and July to September, increases to December, decreases again, and it

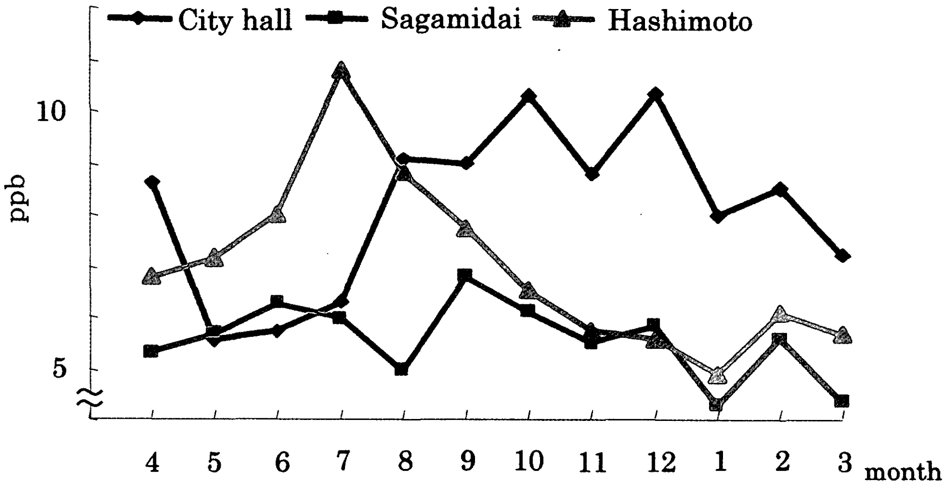

Fig. 2. Seasonal variation of SO_2 density at all stations

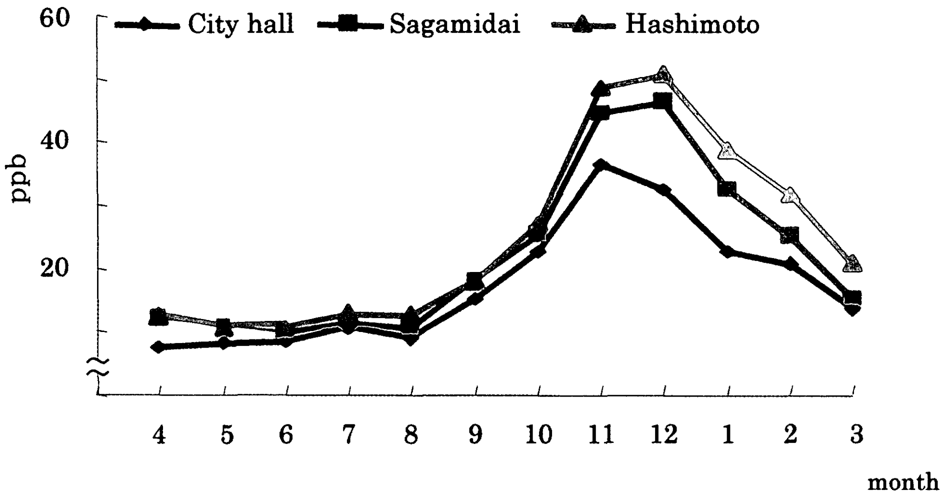

Fig. 3. Seasonal variation of NO density at all stations

is found to be higher in Sagamidai than in the other places. There are two sources of natural origin, for example carried by the wind and volcanic ashe and of artificial origin such as exhaust gas from diesel cars. It is not enough to determine the occurrence and variation because the problem is complex, and involving particles(secondary generation) caused by physical and chemical transformation in the atmosphere, but it reading are higher in Sagamidai than at the other locations because of a lack of atmospheric movement and the existence of sources such as railways and golf courses and relatively more enclosed big buildings[10–15]. NMHC density (Fig. 8) is peaks in November and decreases thereafter. It is seen that, in spite of the low range of values, CH_4 density (Fig. 9) decreases in August and increases in winter, so it is supposed that the source is not changed, and the variation is similar to the background value[16–18].

2. Correlation analysis

The correlation coefficient is calculated by correlation analysis at the level of 5% and 1% for pollutant density. There are distinctive features at each station, so that SO_2

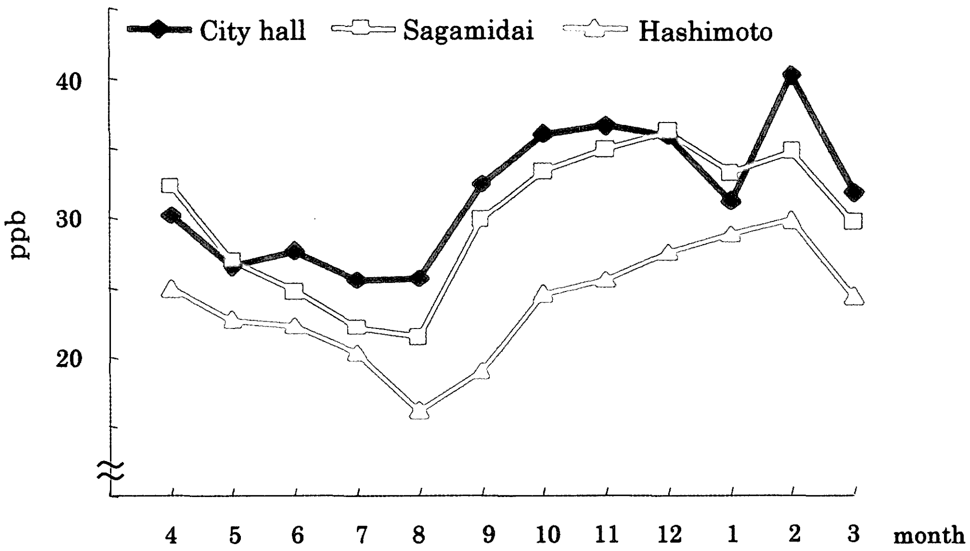

Fig. 4. Seasonal variation NO_2 density at all stations

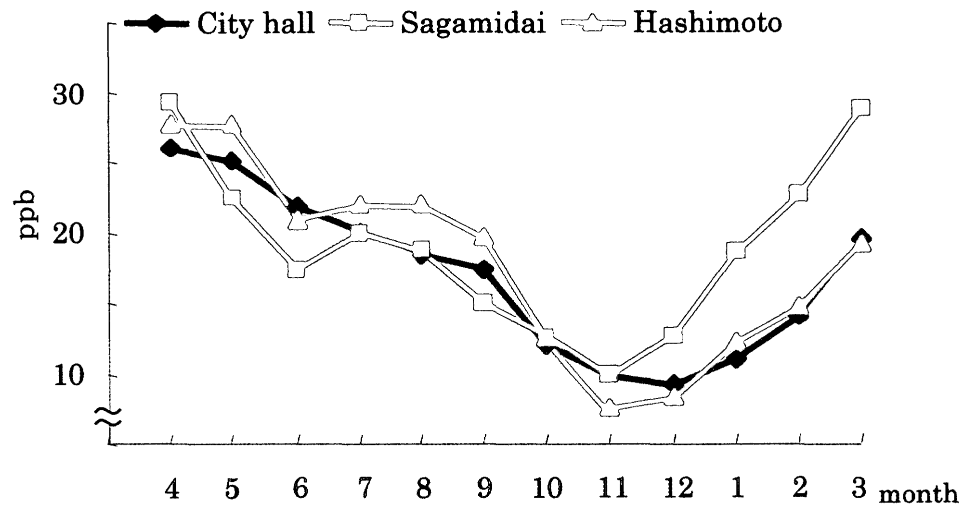

Fig. 5. Seasonal variation Ox density at all stations

density is found to be a positive NO/NO_2 density at City hall, no relation to it at Sagamidai and negative at Hashimoto. The combination of NO-NO_2 is found positive at all three stations. O_X density is found negative at all three stations, negative $SO_2/NO_2/CO$ density at City hall, and SPM density at Sagamidai. A combination of SPM-SO_2 is found positive at Sagamidai and Hashimoto, CO density is found to be a positive NO/NO_2/NMHC density at City hall. Therefore it is supposed that with seasonal variation, photochemical oxidants change with the photochemical reaction to NO_2 and CO_2[19]. Secondly, on analysis of the relationship between the stations for each pollutant, there is found to be a positive $NO/NO_2/O_X$/SPM density. Also on the relationship each month, there is found to be a close relationship at city hall, but no relationship from April to September and from November to January at Sagamidai and Hashimoto. Therefore it is possible to classify pollutants according to the difference in

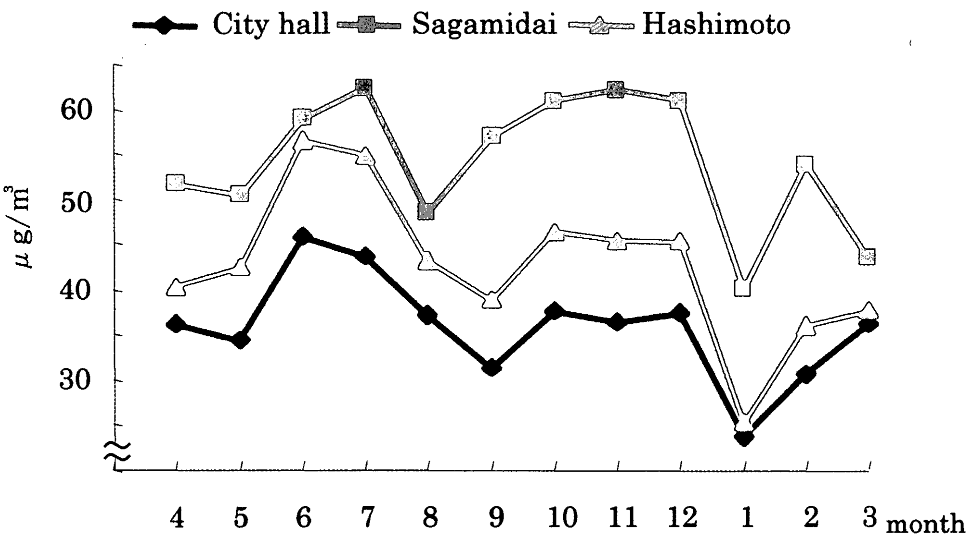

Fig. 6. Seasonal variation SPM density at all stations

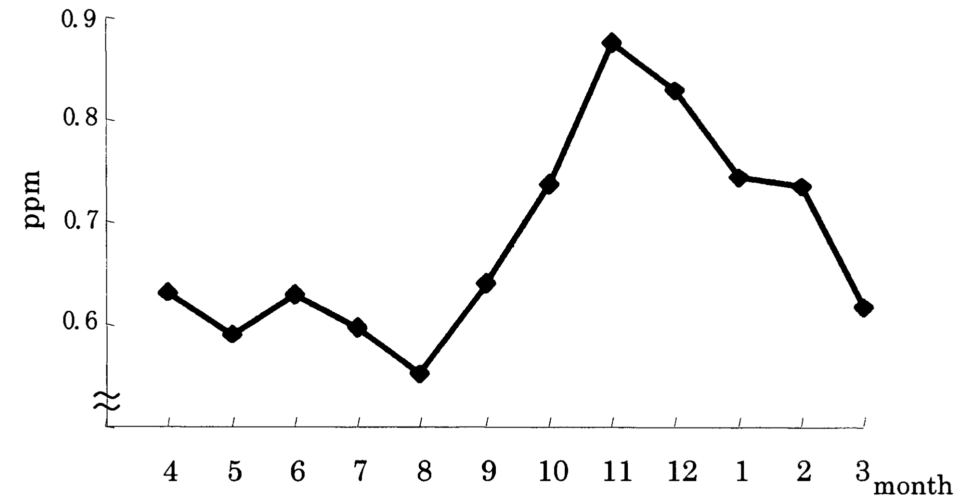

Fig. 7. Seasonal variation CO density at City hall

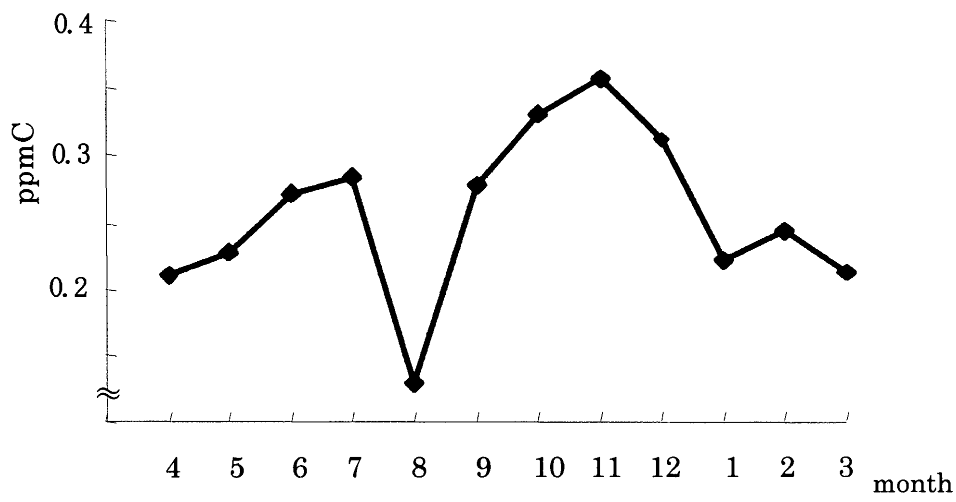

Fig. 8. Seasonal variation NMHC density at City hall

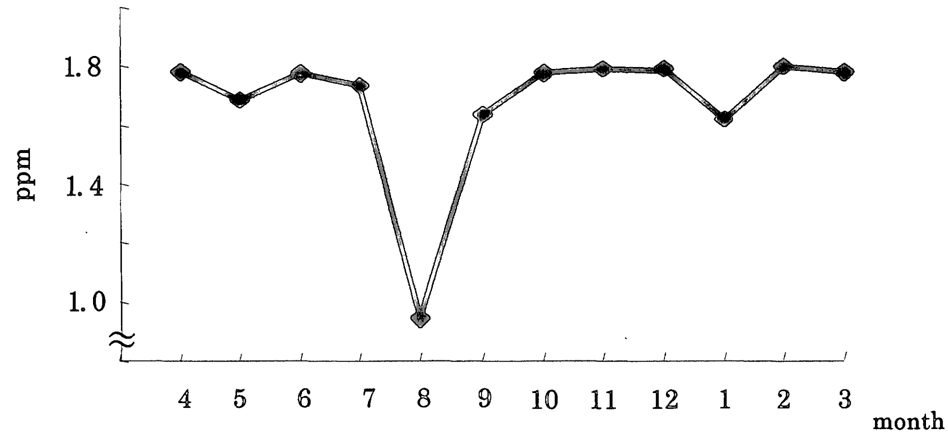

Fig. 9. Seasonal variation CH_4 density at City hall

Table 1. Average and standard deviation of each pollutant in all stations.

	SO_2		NO		NO_2		Ox		SPM		CO		NMHC		CH_4	
	Ave.	S.D.	Ave.	S.D.	Ave.	S.D.	Ave.	S.D.	Ave.	S.D.	Ave.	S.D.	Ave.	S.D.	Ave.	S.D.
City hall	8.10	1.61	17.13	9.81	31.61	4.81	16.97	5.79	35.78	5.77	0.68	0.10	0,26	0,06	1.67	0.24
Sagamidai	5.53	0.75	21.73	13.20	29.95	5.11	18.96	4.00	54.13	6.00						
Hashimoto	6.96	1.67	24.38	0.00	23.78	4.03	17.81	6.12	42.60	7.48						

Table 2. Result of correlation analysis between measurement stations.

NO	City hall	Sagamidai	Hashimoto	NO_2	City hall	Sagamidai	Hashimoto
City hall	1.00			City hall	1.00		
Sagamidai	0.98**	1.00		Sagamidai	0.89**	1.00	
Hashimoto	0.97**	0.99**	1.00	Hashimoto	0.71**	0.83**	1.00

level of significance: *: 5% **: 1%

the excretion source: pollutants emitted from mobile sources and those from stationary sources, and it is clear that local air environments are different. (Table 2)

2)Relationship between air pollution and weather conditions

1. weather conditions in 1996

It is found that the wind blows hard in spring, moderately from August to November (at City hall); and in December (Sagamidai), February (Hashimoto), and afterward blows hard. In order of strength: City hall, Sagamidai and Hashimoto. As to temperature, it is high in summer and low in winter, and in Hashimoto lower than in the other locations in winter. Humidity is high from July to October, and low in winter, and from April to September, it is highest in Sagamidai, and the others are close; and from October to February, it is lowest at city hall, and the others are close.

Next, degrees are 0.5m/s for wind velocity, 5°C for temperature, 5% for humidity, and at various frequencies for every class, wind velocity starting at 1.5–2.0 m/s at city hall, and at 1.0–1.5 m/s at the other locations. The highest frequency is 2.5–3.0 m/s at city hall, 2.0–2.5 m/s at Sagamidai and 1.5–2.0 m/s at Hashimoto. As for temperature, Hashimoto has the frequent reading at 0–5°C, then city hall, Sagamidai and Hashimoto in that high order, there being no difference at 30°C. As for humidity, frequency at city hall is the highest (Table 3). The results of analysis of weather factors at each station show that temperature-humidity is positive at city hall and Hashimoto, and wind velocity-temperature is negative at Sagamidai. Therefore, these figures are representative of

Table 3. Frequency in class on weather factor.

Wind velocity

m/s	City hall	Sagamidai	Hashimoto
0–0.5			
0.5–1.0			
1.0–1.5		5	84
1.5–2.0	4	66	160
2.0–2.5	39	148	77
2.5–3.0	100	68	23
3.0–3.5	89	40	11
3.5–4.0	60	17	5
4.0–4.5	26	7	4
4.5–5.0	15	7	
5.0–5.5	13	3	
5.5–6.0	6	2	
6.0–6.5	6	1	1
6.5–7.0	1		
7.0–7.5	2	1	
7.5–8.0	3		
8.0–8.5			
8.5–9.0			
9.0–9.5			
9.5–10.0			
10.0–10.5	1		

Temperature

°C	City hall	Sagamidai	Hashimoto
0–5	24	33	47
5–10	98	89	85
10–15	60	58	56
15–20	76	70	70
20–25	72	68	67
25–30	33	44	37
30–35	2	3	3

Humidity

%	City hall	Sagamidai	Hashimoto
0–5			
5–10			
10–15			
15–20			
20–25			
25–30			
30–35	1		1
35–40	2	3	1
40–45	4	1	2
45–50	14	3	8
50–55	28	26	18
55–60	25	24	24
60–65	36	30	30
65–70	53	53	61
70–75	47	53	76
75–80	62	56	56
80–85	35	46	36
85–90	31	32	27
90–95	25	23	20
95–100	2	15	5

conditions in this region, but it is supposed that differences in measurements and frequency distribution are due to the local surroundings.

2. High-density days

When average of weather factors in each area are calculated, as to wind velocity, it is clear that at not all pollutants are found to relate to frequency. When wind velocity is high, pollutant density decreases, and when low, density increases[20–21], and inversely, photochemical oxidant density increases. In relation to temperature and $NO/NO_2/CO$ density, it is found that when temperature rises, the frequency is increased and density is at a high level, at from 15 to 20°C and density decreases, and this trend is similar to the seasonal variation. Also at $SO_2/O_X/$ SPM density, the frequency and density increases, from 15 to 20°C. At $NMHC/CH_4$ density, density decreases at 20 to 30°C. In relation to humidity, frequency and density increases, from 75 to 80% and density tends to be level or decrease somewhat.

Conclusion

The relationship between air pollutants and weather factors in Sagamihara City in 1996 was examined, and the following conclusions were drawn.

1) It is seen that the SO_2 density in the city hall vicinity is low from May to July, increasing in August, at Sagamidai tends to be level and the lowest among the three areas; at Hashimoto it reaches a peak in July and hardly varies at all throughout the year. NO density is peaks in December, NO_2/CO density decreases in summer and increases in winter. A variation in the O_X density is a trough in November. SPM density has two peaks in July and December, and it is higher in Sagamidai than at the other places. NMHC density is peaks in November. In spite of the low of range of values, CH_4 density decreases in August and increases in winter. Also it is seen that a similar variation is the trend in the moving average method to find the basic trend.

2) In the results of correlation analysis, SO_2 density is found positive in NO/NO_2 density at city hall, no relation at Sagamidai and negative at Hashimoto. A combination of $NO\text{-}NO_2$ is found positive at all three stations. O_X density is found negative in NO density at three stations, and in negative SO_2/NO_2/CO density at city hall, and SPM density at Sagamidai. A combination of SPM-SO_2 density is found positive at Sagamidai and Hashimoto, and CO density is found positive in the NO/NO_2/NMHC density at city hall. And in the results of analysis of the relationship between stations, it is found positive for pollutants except SO_2 density. Also, it is not found from April to September or from November to January at Sagamidai and Hashimoto.

3) It is found that the wind blows hard in spring, is light from August to November (City hall), in December (Sagamidai), and in February (Hashimoto). In order, City hall (strongest), Sagamidai and Hashimoto. As for temperature, Hashimoto has lower temperatures than the others in winter, as for humidity, it is high from July to October, and from April to September, it is highest in Sagamidai, with the others close; and from October to February, it is lowest at city hall, with the others close. As for variation in frequency according to class, it starts at 1.0–2.0 m/s, and the highest frequency class is 1.5–3.0 m/s. In the results of correlation analysis for weather factors, temperature-humidity is positive at city hall and Hashimoto, and wind velocity-temperature is negative at Sagamidai.

4) Due to easily visualized expression of air pollution conditions providing environmental information to local residents, the density of pollutants emitted from automobiles and heating equipment is high in winter, and it is supposed that the SO_2 density from stationary sources is affected by differences in the surrounding stations, and it is higher in Sagamidai than in the other areas due to non-activity in atmospheric movement because of the surroundings, and the variation in CH_4 density is close to that of the background value. And as for correlation analysis, it is supposed that it is possible to classify pollutants by the difference in the excretion source, and that the difference in the local air environment affects the relationships of air pollutants to each other in the atmosphere. Weather factors linked to air pollutants are representative of conditions in this region, but it is supposed that differences in measurements and frequency distribution are affected by local surroundings. In particular, pollutant density is very closely related to wind velocity. Therefore, in addition to measurements of emission sources, it is necessary to examine measurements related to air pollution taking the locality into consideration.

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