NOTES AND CORRESPONDENCE

Recent Change of Atmospheric Turbidity over Japan

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Secular variation of atmospheric turbidity over Japan has been studied by Yamamoto *et al.* (1971), and the results showed that it began to increase after the World War II not only in large cities but also in rural regions and that its increase stopped in about 1967. However, an accumula-

tion of the latest years' data seemed to be desirable to see the recent change of turbidity exactly. In this sense, the present author attempted to extend the above study with some discussions on its trend.

The turbidity coefficient, β , was evaluated

Fig. 1. Time series of the bimonthly mean values of the turbidity coefficient at Sapporo.

Fig. 2. Same as Fig. 1 but for at Akita.

Fig. 3. Same as Fig. 1 but for at Shionomisaki.

Fig. 4. Same as Fig. 1 but for at Tosa-Shimizu.

Fig. 5. Same as Fig. 1 but for at Fukuoka.

Fig. 6. Same as Fig. 1 but for at Kagoshima.

through the method developed by Yamamoto *et al.* (1968), but the precipitable water was estimated from the surface vapor pressure for the data of the last three years. As the errors due to this approximation are almost within two percent for the average values of β , they are not serious in this study.

The time series of the bimonthly mean values of β for six stations are shown in Figs. 1–6. The bimonthly mean values obtained from the number of data less than three days were omitted, so that the values of winter months are partly lacking in the figures of Sapporo and Akita. As seen from the figures, there has been a noticeable decrease in urban areas, such as Sapporo and Fukuoka, after the maximum period around 1966. On the other hand, the trend of β in nonurban areas did not show so marked change, although a slight decrease appeared at Akita and Tosa-Shimizu. In order to show these changes more clearly, the biennial mean values of β for three periods are listed in Table 1. The values of the

Table 1. Biennial mean values of the turbidity coefficient for three periods and the differences of them between 1966–67 and 1972–73.

Station	β			$\beta_{66-67} - \beta_{72-73}$
	1935–36	1966–67	1972–73	
Sapporo	0.076	0.197	0.145	−0.052
Akita	0.083	0.142	0.126	−0.016
Shionomisaki	0.056	0.113	0.124	+0.011
Tosa-Shimizu	0.047	0.127	0.109	−0.018
Fukuoka	0.092	0.160	0.134	−0.026
Kagoshima	—	0.123	0.131	+0.008

first period (1935–36), which were shown for reference, can be regarded as the levels before 1950, because atmospheric turbidity at each of the stations almost kept the same level for an interval between 1933 and 1950 (Yamamoto *et al.* 1971). As a result of the recent decrease of turbidity especially in large cities, it seems that the difference in β between urban and nonurban stations has decreased. On the whole, the annual mean value of β at each of the stations seems to be converging to a figure of about 0.130.

The recent change of turbidity should be discussed with due consideration for the stratospheric dust effects caused by the eruption of Mt. Agung in March 1963. The values of β in low turbidity

seasons such as autumn and winter may give a useful information about them, because the fluctuation of the average values of β in these seasons is rather small compared with the other seasons. Reviewing the figures from this point of view, a sudden increase of β in early winter can be seen at Shionomisaki just after the eruption. However, the same change did not always appear at the other stations. For instance, a similar increase appeared at Tosa-Shimizu seemingly, but it began in 1962, which is before the eruption. Therefore, it would be rather reasonable to conclude that although the Mt. Agung effects more or less affected the value of β , their contribution to the bimonthly mean values was not so large as exceeding the range of normal fluctuation. Accordingly, the turbidity maximum which appeared in about 1966 especially in urban stations should be ascribed to other sources.

It is then inferred that the change of fuel usage from coal to oil might have contributed to the decrease of turbidity in recent years. Fig. 7 shows

Fig. 7. History of the energy consumptions of coal and oil in Japan. The energies were computed as $7.0 \times 10^6 \text{ cal/kg}$, $7.7 \times 10^6 \text{ cal/kg}$ and $1.0 \times 10^7 \text{ cal/l}$ for domestic coal, imported coal and oil, respectively. (Materials: Japan Statistical Year Book)

the secular variations of consumption of coal and oil in Japan. As seen from the figure, the consumption of oil has exceeded that of coal in 1963 and grew very rapidly thereafter. However, that of coal still kept the same level or slightly increased after 1963. Therefore, the decrease of turbidity in recent years seems to be not depending on the change of fuel usage itself.

The recent trends in the concentrations of

suspended particulate matter and sulfur oxides in densely polluted cities such as Tokyo, Osaka, Kawasaki and so on (Environment Agency, 1974) are shown in Fig. 8. Although the measurements

Fig. 8. Annual average concentrations of suspended particulate matter and sulfur oxides in densely polluted cities in Japan. (Source: Environment Agency of Japan, 1974)

of these substances both at Sapporo and Fukuoka are not included in this figure, the rapid decreases of them in other large cities and industrial regions are very noteworthy. The annual mean concentration of suspended particulate matter at Sapporo also showed a decrease from 0.095 mg/m³ in 1968 to 0.060 mg/m³ in 1971 (Environment Agency, 1973). In consideration of the fact that sulfur oxides and other minor gaseous constituents in

the atmosphere play an important role in forming man-made aerosols (Peterson and Junge, 1971), it is inferred that the recent decrease of atmospheric turbidity in large cities would be attributed to the attempt of controlling the air pollution which dated from 1968 with enforcement of the Air Pollution Control Law.

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最近の日本における大気混濁の変化

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