Measurements of ultrafine particles in the roadside and urban atmospheres

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1. Objective

Long-term measurements of size distribution and number concentration of ultrafine particles in the atmospheres have been carried out using scanning mobility particle sizer to understand the impact of vehicle emission and the behavior of ultrafine particles in the atmosphere.

2. Measurement Sites

Five sites were selected in urban area and suburbs of Tokyo.

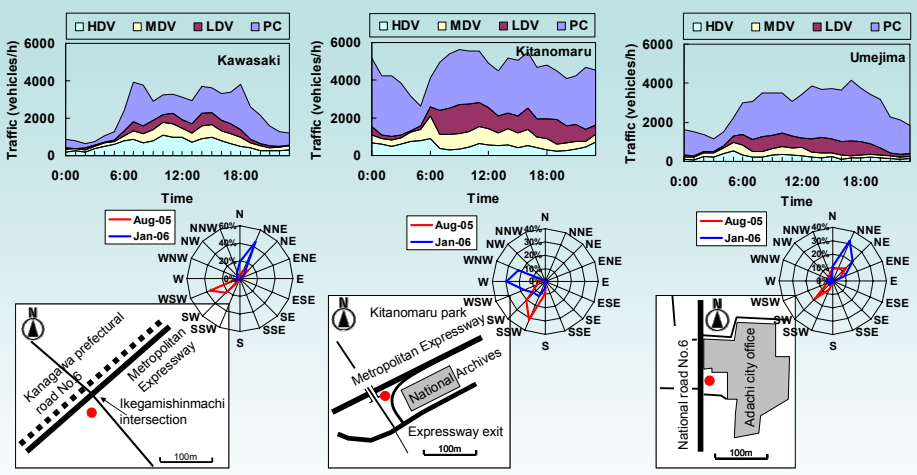
Roadside sites	Urban site
(1)Kawasaki	(4)Ayase
(2)Kitanomaru	Suburban site
(3)Umejima	(5)Tsukuba

Fig.1 Location of five measurement sites

3. Instruments

Particle size and number : SMPS (TSI Model 3034)
NO, NO_2: CLA (Thermo Electron Model 42C)
PM7: b-ray PM analyzer (Horiba APDA-361)
PM2.5 : TEOM (Thermo Electron TEOM-1400)

4. Details of roadside measurement sites



(a) Kawasaki (b) Kitanomaru (c) Umejima

Fig. 2 Traffic and wind rose at the roadside measurement sites

Traffic of heavy duty diesel vehicles : (a)Kawasaki > (b)Kitanomaru > (c)Umejima. Contribution of vehicle emission is large in winter than in summer because measurement sites located in leeward of the road in winter.

5. Monthly variation of particle number and pollutants

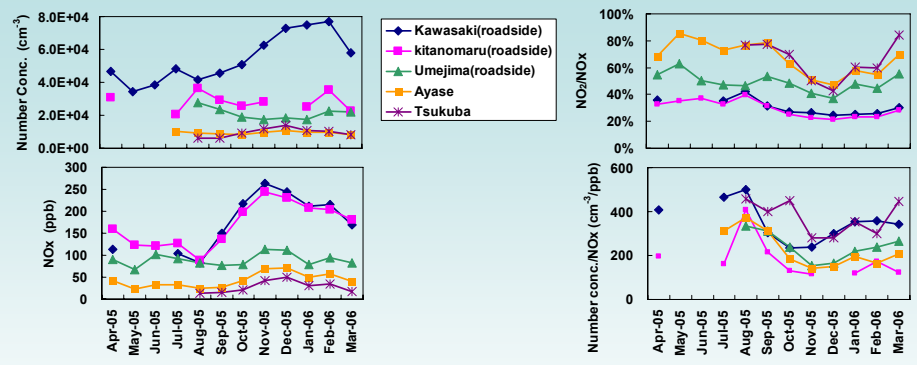
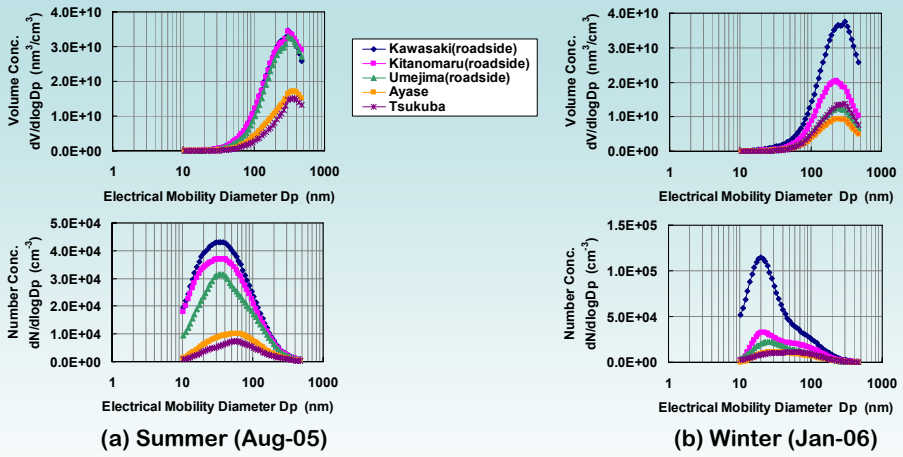


Fig.3 Monthly variation of particle number and NOx, PM mass

Monthly variation of number concentration showed a similar trend at urban and suburban sites, however at roadside sites, showed different trends between measurement sites. It is thought that the reasons of differences between roadside sites are that the number concentration is sensitive to the meteorological conditions, operating conditions and types of vehicles.

6. Monthly averaged size distribution

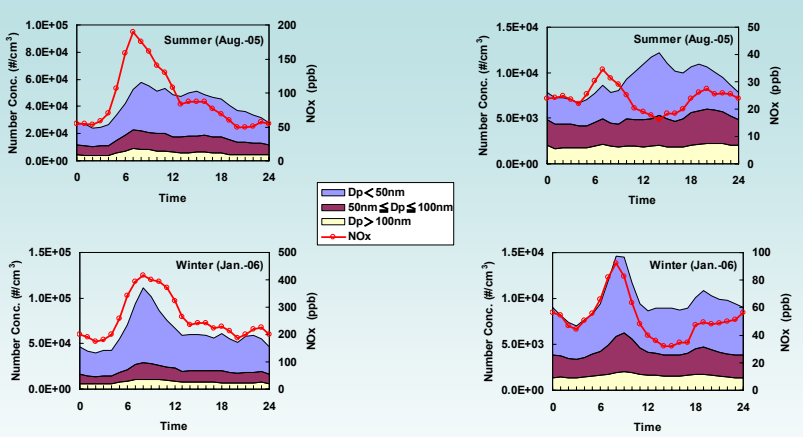


(a) Summer (Aug-05) (b) Winter (Jan-06)

Fig.4 Comparison of monthly averaged size distribution between summer and winter

At roadside sites, bimodal size distribution with peak diameters of around 20 and 60 nm were observed in winter and broad unimodal size distribution with peak diameters of 30-40nm was observed in summer. At urban and suburban sites, number concentration was lower than that of the roadside and broad unimodal size distribution was observed. Similar peak diameter with 50-60nm was observed at both of urban and suburban sites in summer. In winter, peak diameter was 30 nm at urban site and 60nm at suburban site.

7. Diurnal variation of Number and NOx Concentration

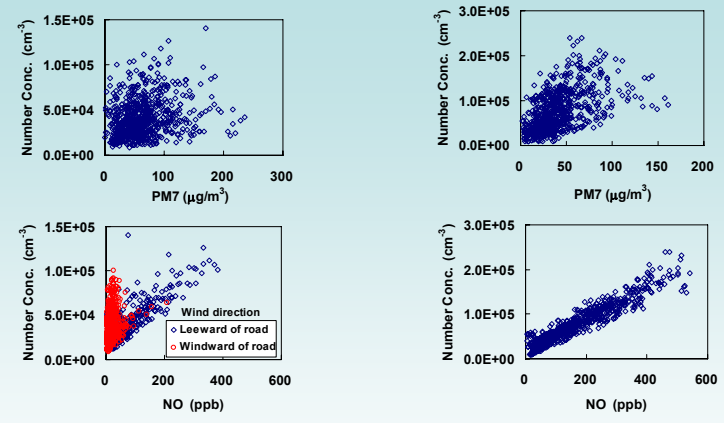


(a) Kawasaki (Roadside site) (b) Ayase (Urban site)

Fig.5 Diurnal variation of number concentration between Roadside and Urban sites

Diurnal variation of number concentration showed similar pattern to NOx concentration at roadside site. At urban site, NOx showed the peak in morning and evening in sync with traffic of the neighboring area. Number concentration showed similar pattern to NOx in winter. In summer, small peaks were also seen in morning and evening, while a large peak observed at early afternoon was dominant.

8. Correlation between pollutants and Number Concentration



(a) Summer(Aug-05) (b) Winter (Jan-06)

Fig.6 Correlation between NO, PM mass and Number Concentration at Kawasaki

Number concentration of particles in roadside atmosphere correlated with NOx rather than PM mass concentration. It indicates that the number concentration in the roadside atmosphere is influenced by diesel exhaust and contribution of diesel exhaust particles for particle mass became small as a result of tighter vehicle emission regulation. When measuring site is windward of road in summer, high concentration fine particles from other emission sources except mobile source were observed.

SUMMARY: Monthly variation of number concentration showed a similar trend at urban and suburban sites, however at roadside sites, showed different trends between measurement sites. At roadside sites, bimodal size distribution with peak diameters of around 20 and 60 nm was observed in winter and concentration of nuclei mode particles (Dp=20nm) showed high level. On the other hand, the concentration of nuclei mode particles decreased and broad unimodal size distribution with peak diameter of 30-40nm was observed in summer.
And the correlation analysis shows a strong correlation between number concentration of particles and NO, NOx rather than PM mass concentration in roadside atmosphere. When measuring site is windward of road in summer, high concentration fine particles from other emission sources except mobile source were observed.
At urban and suburban sites, number concentration was lower than that of the roadside and broad unimodal size distribution was observed. Similar peak diameter with 50-60nm was observed at both of urban and suburban sites in summer. In winter, peak diameter was 30 nm at urban site and 60nm at suburban site.
Diurnal variation of number concentration at roadside site showed similar pattern to NOx concentration that increased in proportion to the traffic of diesel vehicles.
At urban and suburban sites, NOx showed the peak in morning and evening in sync with traffic of the neighboring area and number concentration showed similar pattern to NOx in winter. In summer, small peaks were also seen in morning and evening, while a large peak observed at early afternoon was dominant.

Acknowledgement
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