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SIZE DISTRIBUTION AND NUMBER CONCENTRATION OF THE 10nm-20µm AEROSOL AT AN URBAN BACKGROUND SITE, GENNEVILLIERS, PARIS AREA.

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ABSTRACT

The purpose of this study is to quantify the exposure of people to the submicronic particles, and especially ultrafine/nanoparticules (< 100 nm) at an urban background site in the Paris area.

Since 2003, two particle sizers have been used every year for a winter five weeks campaign.

INTRODUCTION

It is recognised that particles in urban air are responsible for serious health effects. The very small particles – ultrafines particules – are assumed to be important for the adverse health effects of particles [1, 2, 4].

Thus, it is of main importance to characterize the exposure to submicrometer particles, in addition to the regulatory survey measurements (PM₁₀). Size distribution and number concentration should be considered.

France is especially concerned by this issue, due to the high percentage of diesel vehicles in the car fleet.

This paper presents the results of a winter five weeks field campaign which has been carried out at the urban background station of Gennevilliers, Paris area from 2003 [5] to 2006.

In order to characterize the exposure to submicrometer particles, the size distribution and number concentration have been monitored in the 10 to 500 nm range. The statutory air survey parameters, and meteorological parameters have also been considered.

INSTRUMENTATION

A Scanning Mobility Particle Sizer (TSI) equipped with a long DMA and a TSI-3010 Particle Counter has been used. Each quarter of hour measurement was based on four 200 seconds scans, in the 10 to 500 nm range. The measurements were performed at the Gennevilliers urban background station (North-West of Paris). The monitoring site is a fixed station of the Paris Air Monitoring Network (AIRPARIF), and includes quarter of hour measurements of NO_x, O₃, SO₂, PM₁₀ (TEOM) and PM_{2.5} (TEOM).

RESULTS

Figure n°1 shows a view of the continuous measurements of the number of particles versus time.

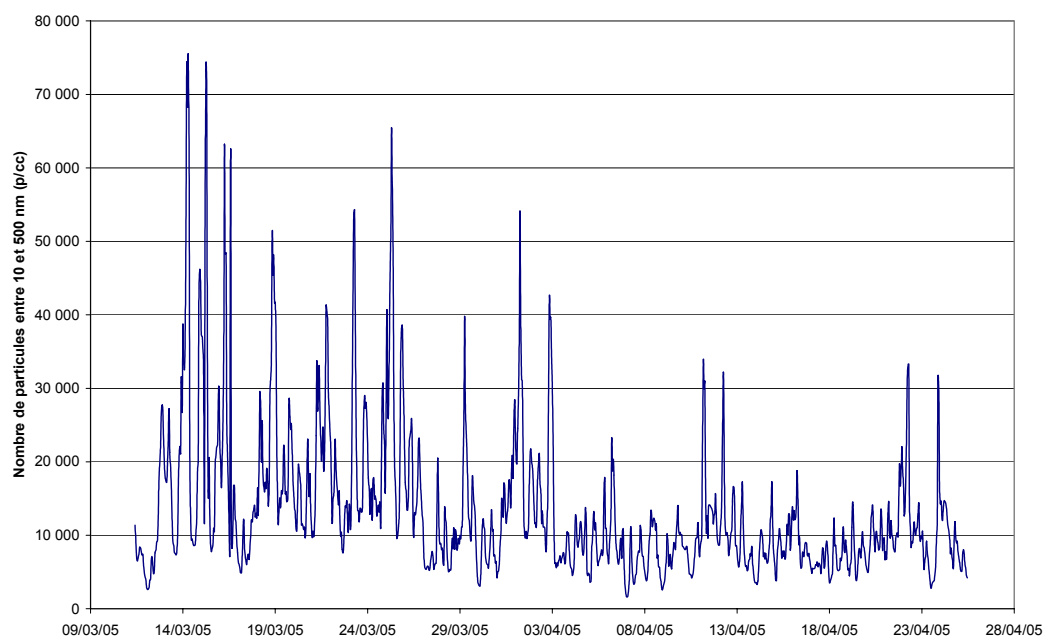


Fig. 1: Total number concentration versus time.

Table 1 gives the total number 5% and 95% percentiles, and average. Table 2 gives the correlation (linear regression) between the total number concentration and other measurements (PM, gas).

Number concentration	Percentile 5%	Percentile 95%	Average
2003 (10-500 nm)	5 000	35 000	15 000
2004 (10 nm – 20 µm)	2 000	20 000	9 000
2005 (10 nm – 20 µm)	4 000	34 000	13 500
Summer 2005	7 200	40 000	20 700

Table 1: Total number concentration.

Correlation R N (10-500 nm) versus ...	10-100 nm	100- 500 nm	PM10 TEOM 50°C	PM2,5 TEOM 50°C	NO	NO ₂	O ₃
2003	0.99	0.87	0.51	0.58	0.73	0.64	-0.50
2004	0.99	0.91	0.41	0.37	0.81	0.88	-0.73
2005	0.99	0.91	0.67	0.66	0.72	0.77	-0.58
Summer 2005			0.64	0.67	0.68	0.84	-0.45

Table 2: Correlation of the 10-500 nm number concentration versus PM and gas measurements.

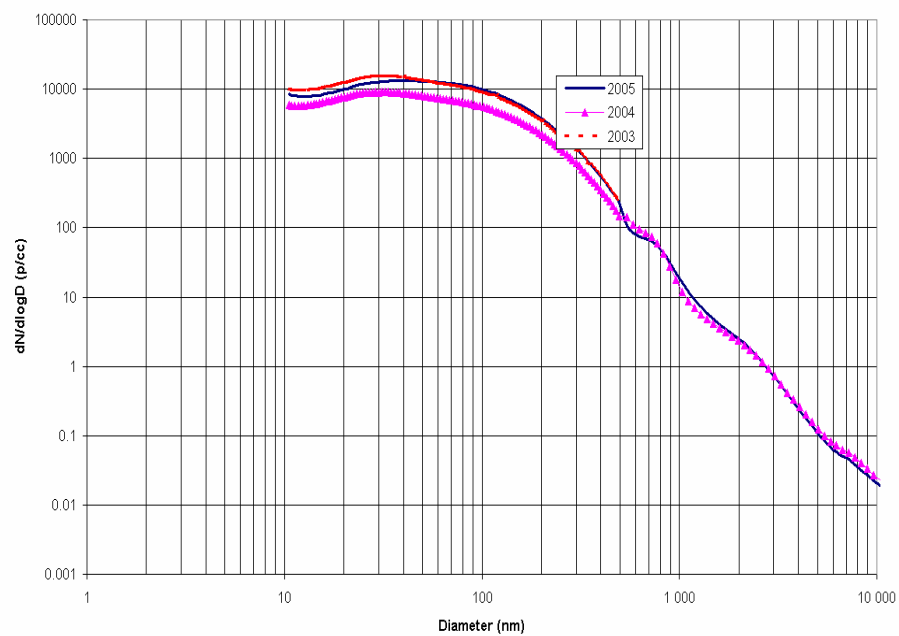


Fig. 2: average size distribution (winter 2003 – 2005). Log scale.

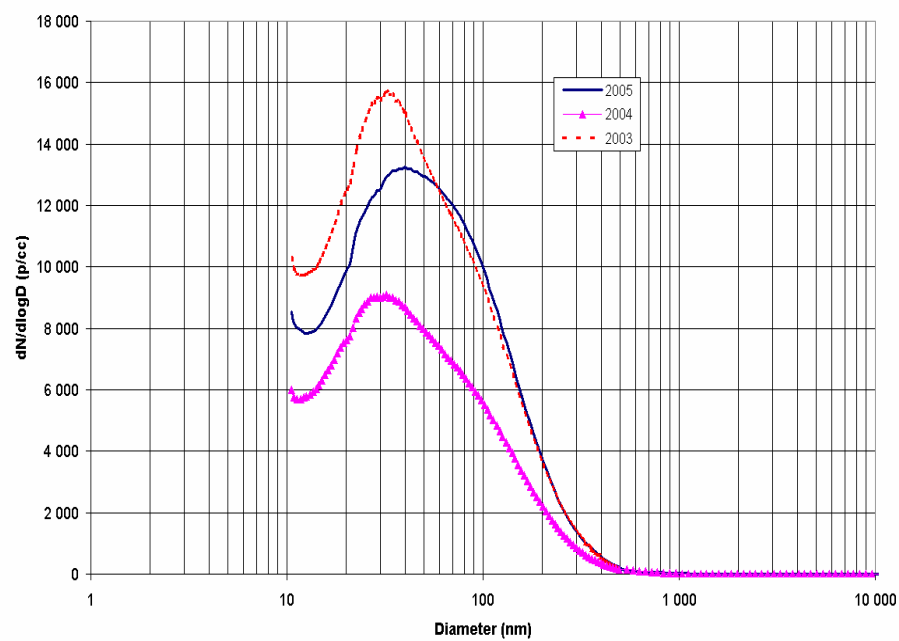


Fig. 3: average size distribution (winter 2003 – 2005).

Ultrafine particles and non-volatile PM₁₀ (TEOM 50°C) present the lowest correlation coefficient R (Table 2). These values (0.51, 0.41, 0.67) indicates a real but moderate correlation between these two parameters. The link would be better between the 100-500 nm range and PM_{2.5} (2005 : 0.83).

The winter average size distributions of the different campaigns (Figures 2 and 3) show quite a similar shape : the dominant mode is centred in the 20-50 nm range that is to say that the ultrafine particles (< 100 nm) dominate the number size distribution and the total number concentration.

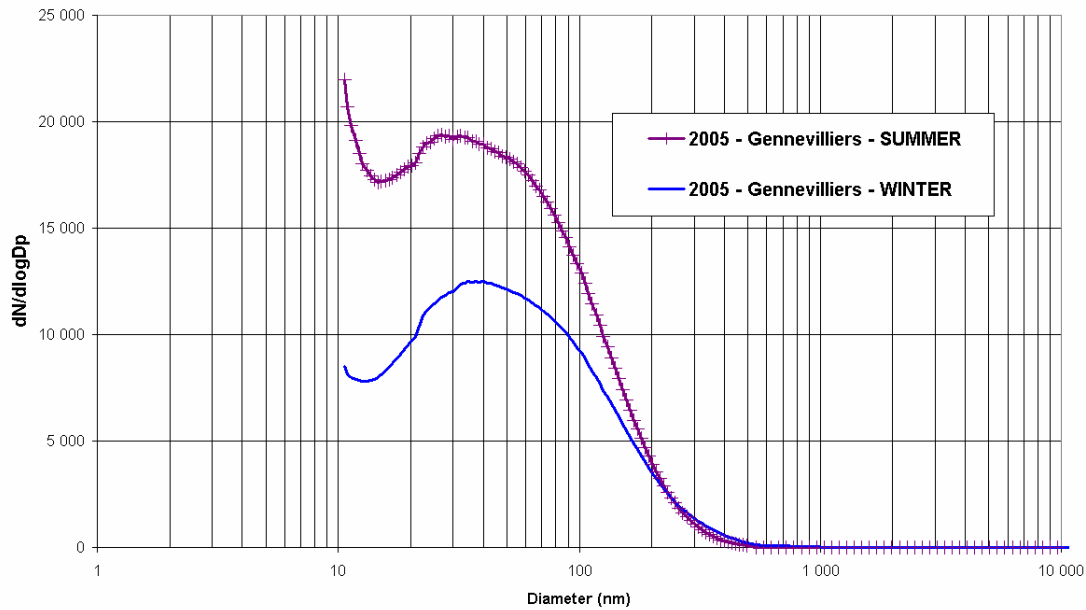
This information confirms the correlation calculation (Table 2).

These results are in accordance to comparable studies [3].

SEASONAL COMPARISON

In figure 4 are compared the 2005 winter and summer average size distributions. As seen in Table 1 and figure 4, the summer average total number concentration is higher than the winter one.

A more noteworthy observation is that the < 20 nm range seems to be characterized by



an important mode, indicating high nucleation production of new particles.

Fig. 4: comparison of the 2005 winter and summer average size distributions

DAILY CYCLE

A systematic daily mode has been observed at the Gennevilliers urban background site with a morning and an evening peaks.

A link should be considered with traffic and heating, but also with the meteorological conditions (mixing layer height).

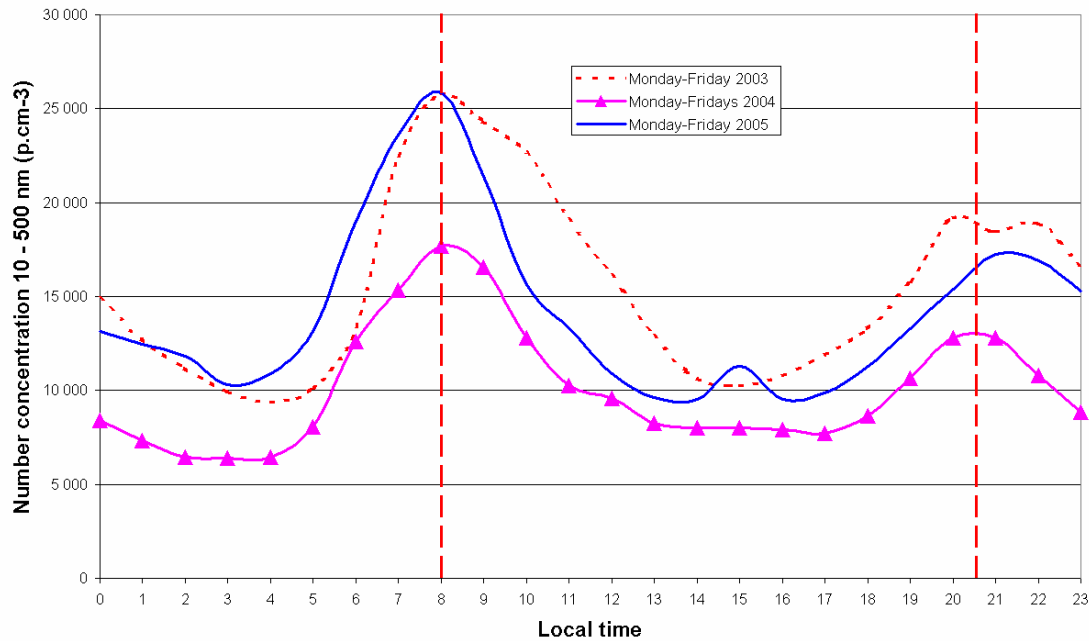


Fig. 5: daily variations of the total number concentration during working days.

SIZE DISTRIBUTION ANALYSIS

A software has been developed in order to replace the multi-mode size distribution by a sum of fragments (unimode size distributions in the form of log-normal functions). An example of results is proposed in Figure 6 and table 3.

	Measurement	Calculated distribution	size
Khi²	-	2	
Number concentration	9 600 p/cc	9 950 p/cc	

	Mean diameter	Concentration (p/cc)
Mode A	8 nm	1 500
Mode B	36 nm	5 150
Mode C	120 nm	3 300

Table 3: fragmentation of the size distribution.

A comparison between the measurements has been carried out for each size distribution obtained thanks to the fragmentation (Khi 2 assessment).

It has been demonstrated that three modes are more or less permanent at the Gennevilliers site.

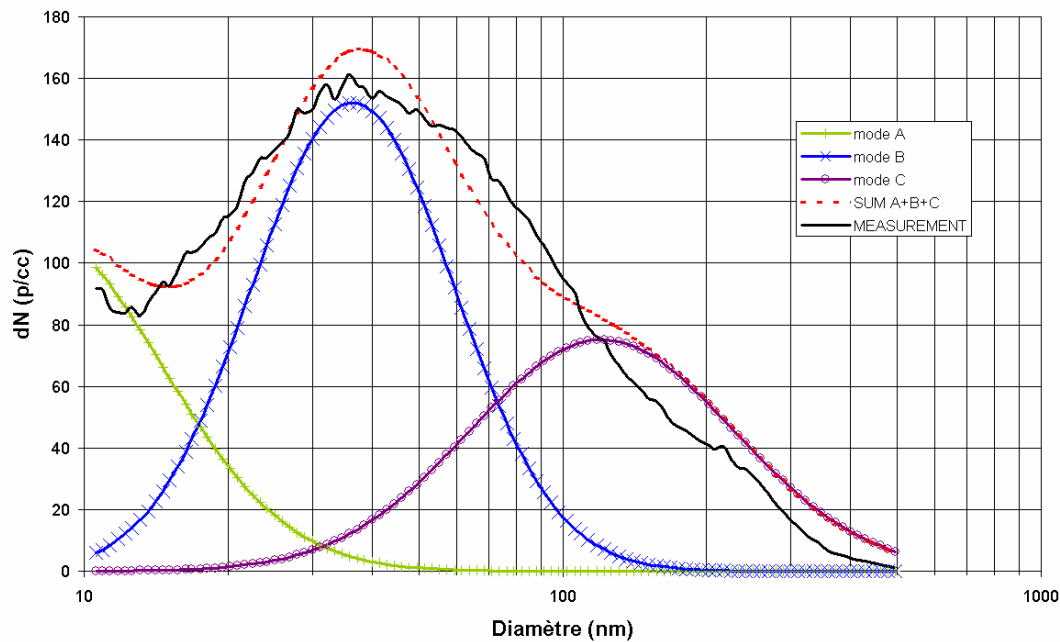


Fig. 6: fragmentation of the size distribution.

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