

Physico-chemical Characterisation of Aerosol particles in Urban Zone (II)

A contribution to subproject SATURN

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Summary

The first results of the measurements realised on a roof building located in Marseille downtown during the last ESCOMPTE campaign are presented. We focus here on concentrations, size distributions and chemical composition of aerosol particles sampled during the high pollution event (IOP 2) which lasts from 20 to 26 June.

Aim of the research

Included in the general scope of the ESCOMPTE program, the specific aim of our research is threefold : (i) to describe the main physico-chemical characteristics (and their evolution according to different meteorological conditions) of the particles at the roof level of a big city, which are necessary as input data for pollution and (or) transport models, (ii) to compare the results obtained in urban and near-urban zones, (iii) to compare measurements realised simultaneously at street and roof level.

Activities during the year

The activity has been first centred on the preparation of the experimental campaign, then devoted to our effective participation during the whole experiment (June, 4 to July, 16) and to the data analyse. During the campaign a quite complete experimental system was set up at 30m above street level on the roof of a public building located in Marseille downtown, close to a heavily trafficked road. Two counters (SMPS and optical system) were used to measure size distributions in the size range 10 nm-15 μ m. Aerosol particles were collected with a low pressure 13 stages cascade impactor. PM 10 and PM 1 mass concentrations were measured with two TEOM equipped with the respective size selective inlets. One aethalometer was installed for BC measurements. Wind velocity and direction, air temperature and photometric information were also available on the experimental site.

Principal results

Concentration and size distributions

We present here an example of concentrations and size distributions of fine particles recorded the June 23. This journey is typical of this IOP: sunny, hot (30-32 °C), low wind in the morning and marine breeze from 14 h T.U.

The concentration all along the journey (fig. 1-a) is characterised by two peaks around 8 h and 10 h T.U., which are likely linked to the morning traffic rush and photochemical effects, respectively. When these last effects disappear the particle concentration begins to diminish and the decrease becomes important when the breeze regime is established, near 14 h T.U..

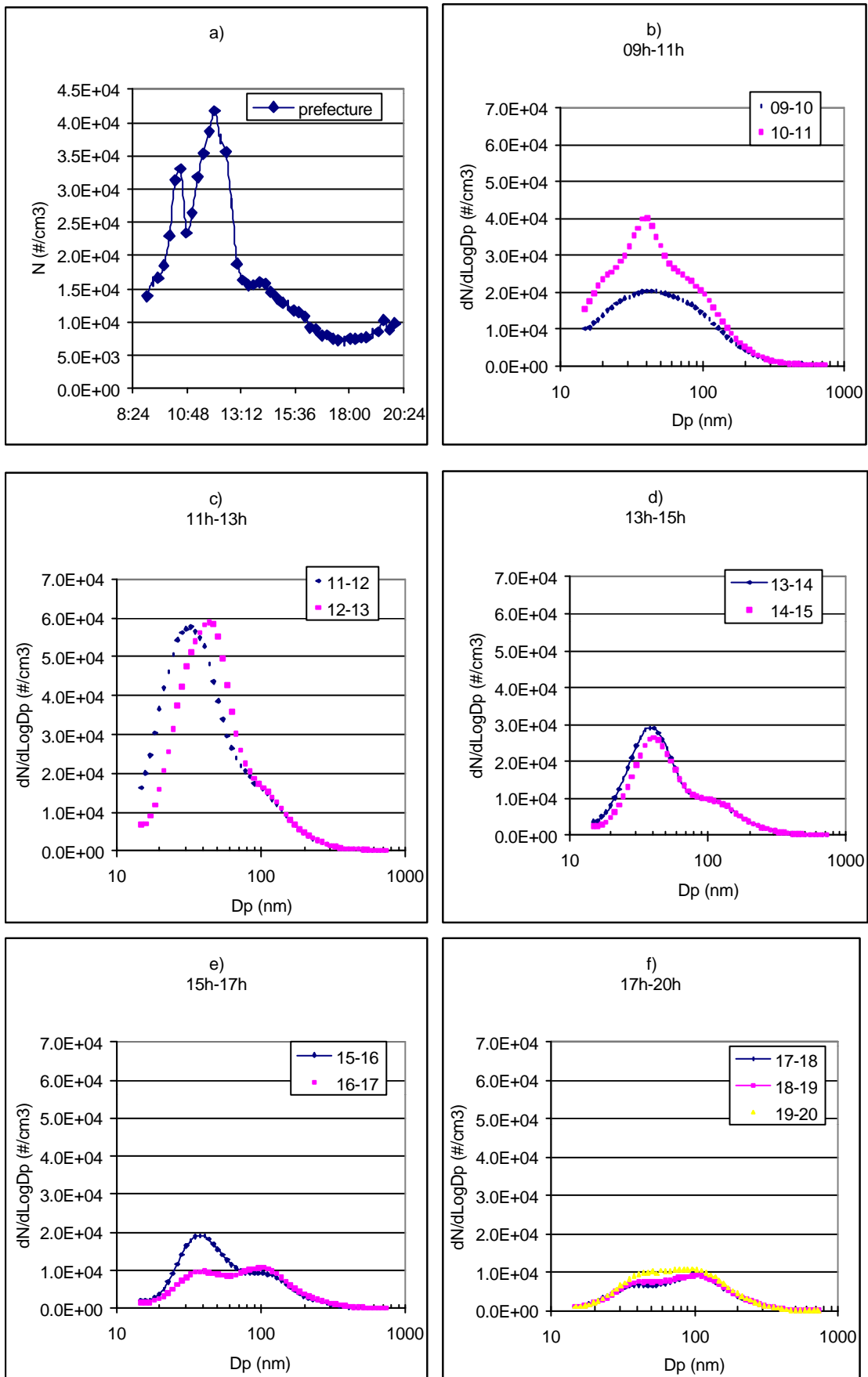


Figure 1. I.O.P. 2, June 23: diurnal evolution (local time) at roof level of the concentration (a) and size distribution (b) to f)) of fine particles.

That characteristic is still more evident looking at the evolution of the size distributions averaged over periods of one hour and represented on fig.1 (b to f). In the morning, the size distribution is largely dominated by the particles of the Aitken peak (30-40 nm), which increases from 10 h local time (L.T.), [8 h T.U.] to 13 h L.T., where it reaches a value 3 times greater than in the morning. Then, the peak value decreases. It is reduced by a factor 2, two hours later and by a factor 6 at 16 h L.T., when the distribution becomes clearly bimodal. After 17h L.T., the size distribution remains bimodal and the corresponding concentrations are low. The evening traffic rush is not detected at roof level, likely because the marine breeze transports the particles away. The morning sequence indicates clearly that efficient photochemical effects lead to the production of secondary particles and these effects last about 2 hours.

Chemical composition

On fig. 2 a-c, are reproduced the ionic composition of fine and coarse particles obtained by ionic chromatography analysis of filters sampled with the Dekati impactor, on 3 different days during the IOP 2.

At the beginning of the IOP (fig.2-a), the mass distribution is dominated by the coarse particles composed essentially of marine elements (Na^+ , Cl^-) and nitrates.

Three days after (fig 2-b), the mass distribution is largely modified and dominated by the particles of the accumulation mode. The particles are composed principally of sulphates (50-60 %) and ammonium (about 30 %), which represent, together, between 80 and 87 % of the total ionic mass of the size ranges of this mode, the 0.4–0.7 μm class being the most loaded. The marine signature disappeared from the coarse particles essentially composed of nitrates. It must be noted that the concentrations of the ranges 1.8 to 4.3 μm , which were maximum 3 days before, are clearly lower (factor 2 to 3 !) than the ionic mass concentrations of the particles 10 times smaller in diameters.

At the end of the IOP (fig. 2-c), the mass concentrations are globally reduced but still dominated by particles of the accumulation mode. The smaller particles of this mode (0.1–0.4 μm) are comparatively less reduced than the other classes. The contribution of sulphates and ammonium is, relatively, still more important since they represent from 86 to 96 % of the total ionic composition. The coarse particles are totally dominated by nitrates and in concentrations still largely lower than those of the accumulation mode.

Main conclusions

All the data are not yet analysed, it is then quite difficult to conclude accurately, even on the first results presented above. Nevertheless, some interesting tendencies may be pointed out. The efficiency of photochemical effects that lead to the generation of secondary particles and last, in our case, about two hours. An important decrease in concentration at roof level when the breeze is installed. Concerning the chemical composition, the coarse mode, composed of sea salts and nitrates, which is the most important at the beginning of the event, decreases strongly when the pollution increases, to become largely lower than the accumulation mode. This mode is totally dominated by sulphates and ammonium and the smaller particles of this mode become progressively more and more important during the event.

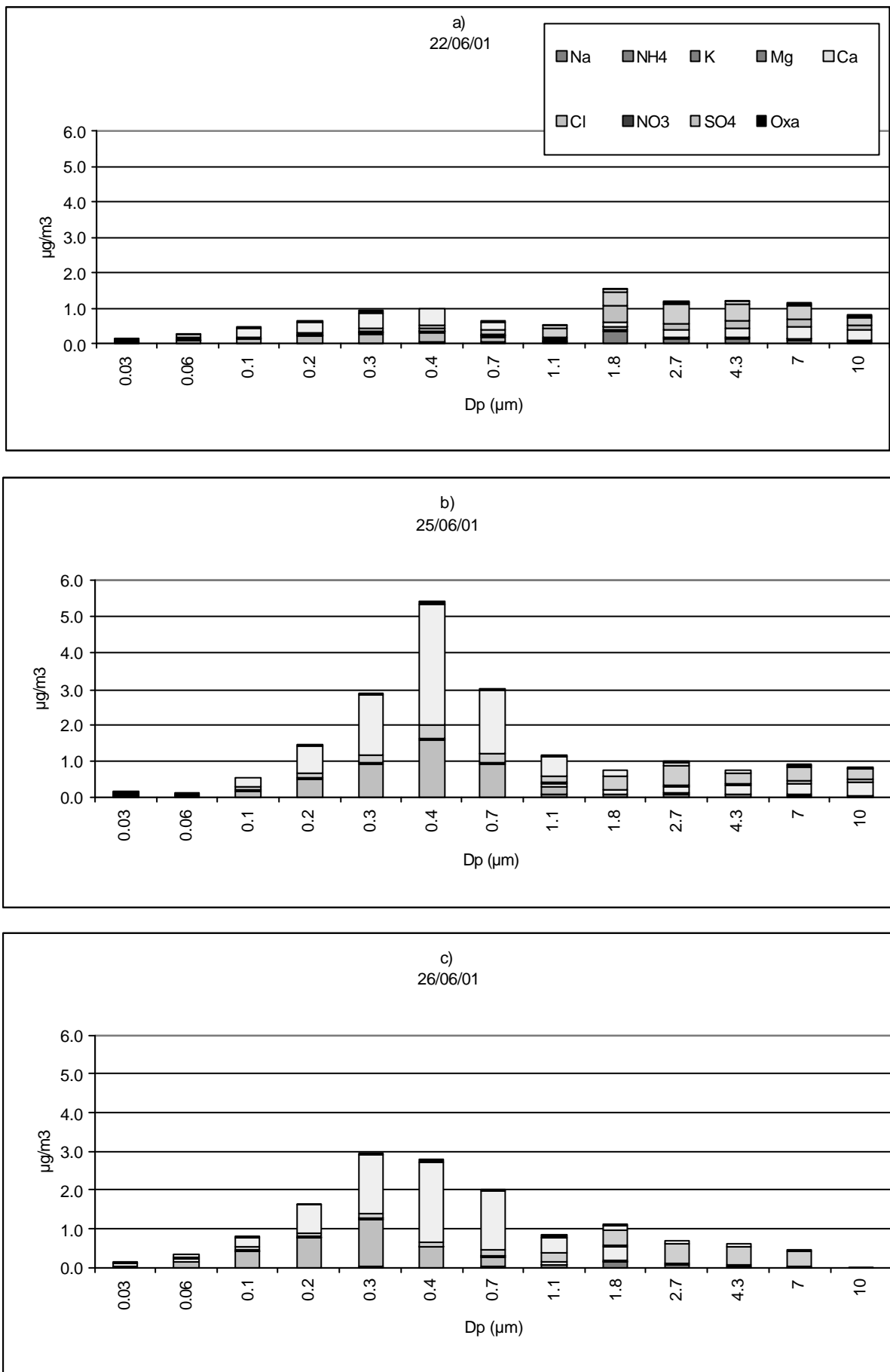


Figure 2. Mass distribution of ionic compounds measured during I.O.P.2 at roof level in Marseille downtown.

Aims for the coming year

The activity will still be focused on ESCOMPTE data analyse with 3 main objectives.

- To precise the “signature” of aerosol particles at roof level in cases of high pollution events that should be took into account as input data in regional models of transport and air pollution.
- To compare the results obtained downtown with those obtained in near-urban zone, in relation with meteorological conditions and source strengths.
- To study the differences between measurements realised simultaneously at street and roof level.

Acknowledgements

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