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SIZE DISTRIBUTION CHARACTERISTICS OF ATMOSPHERIC AEROSOLS OVER AN URBAN SITE, NEW DELHI, INDIA

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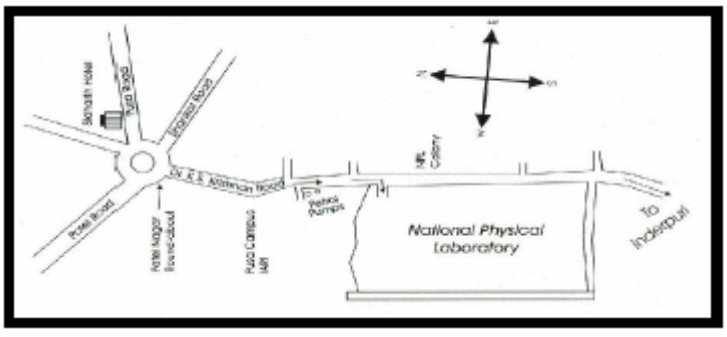
Introduction

Size is probably the most fundamental parameter describing aerosol particles. Particles in the ambient atmosphere have diameters spanning the entire range from few nanometers to 100 µm. The particle sizes are determined by the formation processes and subsequent physical and chemical reactions in the atmosphere. Particle size is a key parameter in the transport and removal of the ambient aerosol (De Reus et al., 2001). The principle effects of aerosol, including the respiratory health hazard (Dockery and Pope, 1994), visibility reduction (Finlayson-Pitts and Pitts, 2000), and deposition to surfaces depend on particle size. Therefore, the measurement and interpretation of particle size distributions in the atmosphere are essential to the overall understanding of the origin and the effects of ambient aerosol (Paul A. Baron and Klaus Willeke, 2005). In big urban areas like Delhi, where wide variety of aerosol compounds released into the atmosphere may enhance stability of aqueous aerosols and these by degrading visibility and also may alter fog and haze forming processes.

In this paper we present the near-surface size distribution characteristics of atmospheric aerosols over an urban site New Delhi and examine their regional synoptic processes associated with winter period. The time evolution of aerosol loading, size distribution and their association with the prevailing meteorological conditions are presented and the implications are discussed.

Observational site and Experimental setup

The observational site, National Physical Laboratory (NPL: 28.65^{o}N, 77.27^{o}E, 220 m amsl), is situated in central part of the Delhi and it is surrounded by green vegetation. The laboratory is inside the PUSA campus. The agricultural fields of Indian Agricultural Research Institute are situated nearly 1 km away from NPL measurement site. At Delhi temperature varies between 47 °C (summer's maximum) to 2 °C (winter's minimum). Dry summer season starts from Second week of February to July, monsoon from late July to October and winter from November to February.



Regular measurements on aerosol number size distribution have been made using GRIMM particle size analyzer (Model: 1.108) since November, 2004 at NPL, New Delhi.

The instrument sucks in the ambient air and segregates the aerosols in accordance with the aerodynamic diameter into one of its 15 size modes.

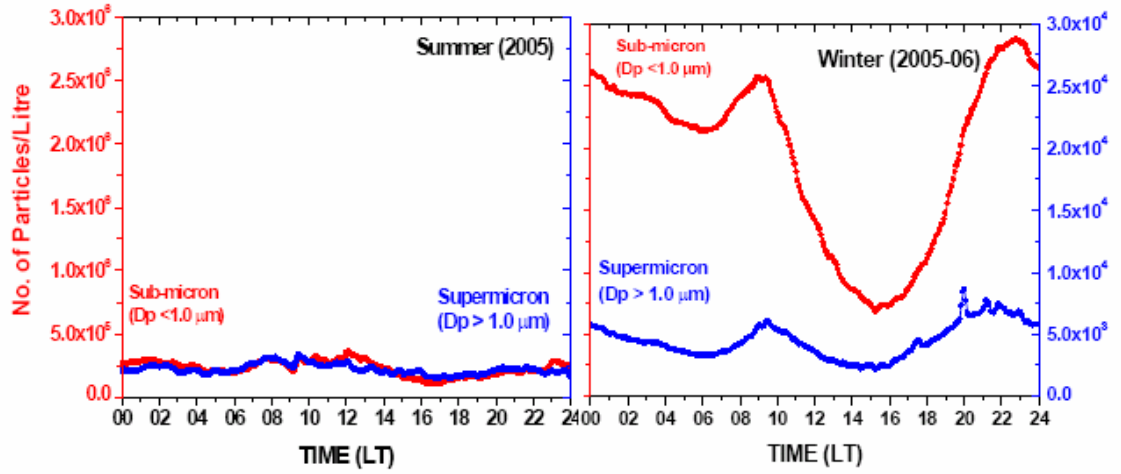
Size Range	:	>0.3 µm to >20.0 µm
Sample flow rate	:	1.2 liters/minute
Particle Range	:	1 to 2,000,000 counts/liter
Sensitivity	:	1 particle/liter
Reproducibility	:	± 2%

This instrument uses a light-scattering principle for single-particle counts, whereby a semiconductor laser serves as the light source. The scattered signal from the particle passing through the laser beam and is collected at approximately 90₀ by a mirror and transferred to a recipient-diode. The signal of the diode passes, after a corresponding reinforcement, a multichannel size classifier. A pulse height analyzer then classifies the signal transmitted in each channel.

Results and discussion

❖ Diurnally, particle number concentration showed close correlations with traffic activities and it has been observed highest number concentrations (both in sub-micron and super micron mode) during traffic peak hours (i.e., 0700–1000 and 1700-2200 hours) at the measurement site.

❖ During the daytime (10:00 – 17:00 hrs), the concentration of particles decreases and attains minimum value. This minimum values may be resulting from dilution of boundary layer during its vertical expansion in spite of additional injection of aerosols during daytime. The increasing trend in evening and nighttime may be due to strong inversion.



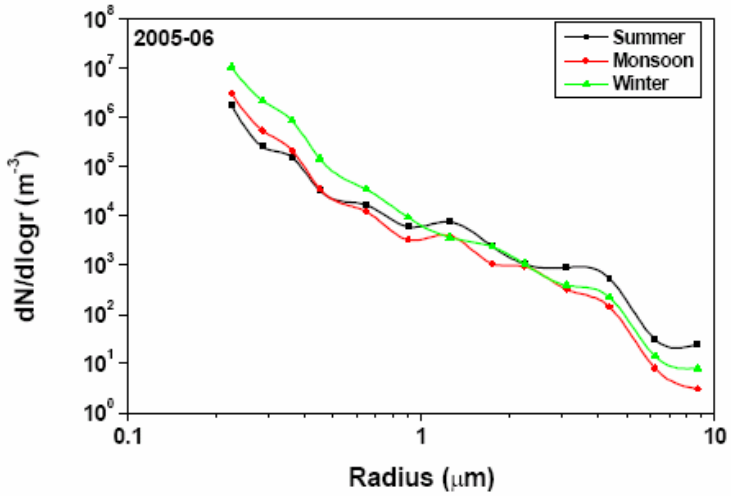
Diurnal variation of sub-micron and super micron mode particles.

❖ In general at NPL, sub-micron mode particles are dominating and are contributing more than 98% for the total number concentration.

❖ Particulates in the sub-micron size regime (aerodynamic diameter < 1.0 µm) contribute dominantly to visibility degradation and radiative interactions.

❖ Seasonally, aerosol number concentration both in sub-micron and super micron size regime has been found highest in winter season than summer and monsoon seasons.

Seasonal variation of aerosol number size distribution at NPL, New Delhi during 2005-2006.



Seasonal variation of aerosol number size distribution at NPL, New Delhi during 2005-2006.

❖ The foggy day aerosol number concentration levels are approximately 3 times higher than non-foggy day values at the particle of radius less than 2 μm.

❖ HYSPLIT4 reanalysis has been carried out for non-foggy and foggy days and 3-day backward trajectories have been plotted. These plots reveals that the air parcel reached at measurement site on 02.02.2006 (ie., non-foggy day) is originated from north-west.

Where as on 10.02.2006 (ie., foggy day) the same is originated from East, which is anthropogenic in nature (fine particles) and enhanced the concentration of aerosols at the measurement site.

Enhanced concentration of aerosols during fog may be due to the small hygroscopic particles (nanometer size) get activated and their size grows in high humidity condition and also may be due to oxidation of dissolved gases to aerosol phase. The fog formation provides the reacting medium, the liquid water, for aqueous phase chemistry.

Acknowledgements

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