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STUDY OF AMBIENT AEROSOL MASS CONCENTRATION OVER RAJKOT

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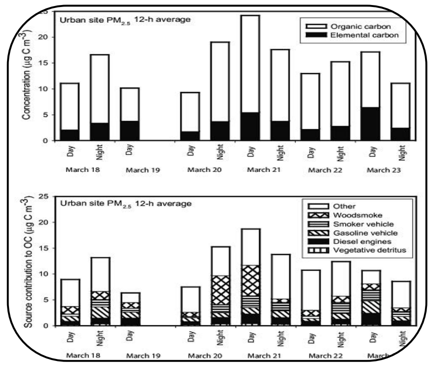
ABSTRACT :

Measurements on mass and size distribution of ambient atmospheric aerosols have been started at Department of Physics, Saurashtra University, Rajkot, using a ten channel Quartz Crystal Microbalance Cascade Impactor (QCM), since May 2008. It is found that the total mass concentration varied from 19.45 ± 1.56 to 44.57 ± 1.84 $\mu g/m^3$. The accumulation mode (ra≈0.05 to 0.4 μm) aerosol mass concentration, Ma is found to be minimum (~7 $\mu g/m^3$) and maximum (~23 $\mu g/m^3$) during the months May–June and November–December, 2008-11 respectively. Coarse mode (rc≈ 0.8 to12.5 μm) aerosol mass concentration Mc is found to be maximum (~ 18 $\mu g/m^3$) during the months of May-June 2008-11.



KEYWORDS : *Measurements , size distribution , mass concentration varied.*

1. INTRODUCTION

Atmospheric aerosols are tiny particles in solid or liquid phase with size extending from 10^{-3} μm to 10^2 μm suspended in the atmosphere. The geographically localized source and sinks, and the relatively short atmospheric life times, gives aerosols high spatial and temporal inhomogeneity in the atmosphere [1]. Characteristics of near-surface aerosols are very important from the Geosphere and Biosphere perspective due to variety of reasons. The different types of aerosols sources (natural and anthropogenic), the wide size spectrum and their short life times result in a spatially and temporally heterogeneous aerosol field, making aerosol characterization a real challenge [2]. The size distribution and mass concentration are important parameters in order to understand their source strength, environmental impact, optical properties, radiative effects and climatic implications [3]. The dynamics of aerosol number density, their production process, the size transformation and lifetime are influenced by Aerosol size distribution. Aerosols modify the macrostructure of clouds [4] since they act as condensation nuclei. The characterization of the size distribution of atmospheric aerosols is important [5]. The micro-scale aerosol mechanisms such as coagulation and condensational growth, larger scale atmospheric processes have significance effects on the size distribution. The changes in prevailing circulation systems, rainfall, land surface heating, air mass types etc., produce distinct signatures in the size distributions [6].

Keeping the above view in the mind, measurements on mass and size distribution of near surface composite aerosols have been started at Rajkot using a ten channel Quartz Crystal Microbalance Cascade Impactor (QCM), since May 2008. The results of this work have been presented in this paper.

2. METHOD OF CALCULATION

When air containing aerosols is sucked by means of a pump and directed towards a collecting substrate, particles in the stream having inertia large enough will impact on the substrate, while those with lesser inertial will be advected with the air flow. This is the principle of inertial impaction. By means of a pump, the aerosol stream is accelerated through a nozzle into a small high speed jet and impinges on the Quartz crystal plate mounted normal to the direction of flow. Its mass sensitivity is 1.4 ng/Hz. During each measurement, the QCM provides direct information on two parameters: (i) the total mass concentration (M_t)which is the mass of aerosols in the size range 0.05 to 25 µm in unit volume of the sampled air and (ii) the mass concentration (m_{ci}) in each of the size bins i=1-10 which gives the mass-size distribution. These constitute the raw data, which in itself is useful. M_t and m_{ci} are related by

$$M_t = \sum_{i=1}^{10} m_{ci}$$

The QCM raw data can be effectively used to retrieve various physically meaningful parameters of aerosols, called derived parameters. These are:

(1) The mass size distribution
(2) Volume Concentration
(3) The effective radius
(4) The number size distribution

3. RESULTS

The monthly averaged submicron (Ma), supermicron (Mc) and total mass concentration (Mt) aerosols during the period have been shown in the Figure-1.

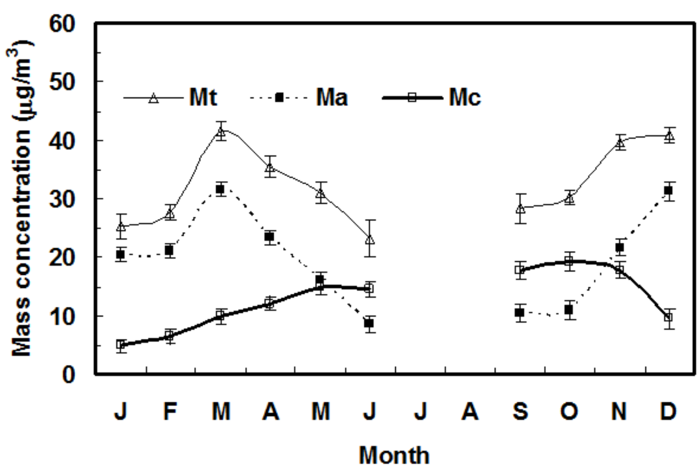


Figure 1. The monthly averaged submicron (Ma), supermicron (Mc) and total mass concentration (Mt) of Ambient aerosols over Rajkot

The standard deviation of the mean is represented by vertical bars over the points. The supermicron range aerosol mass concentration remains low in winter and is high during March. Subsequently it increases to maximum value in July and remains high till September. The coarse mode (super-micron) range mass concentration exhibits high value during summer and monsoon periods. In sharp contrast to the above, the accumulation mode (sub-micron) range mass concentration increases from a low value in January and reaches a peak value in March and from April it decreases and during May to September it remains low. It remains high from October to December. In the case of total mass concentration it reaches a peak value in March and decreases from April onwards. In month of July it remains high, subsequently the concentration increases and remains high from September to December. Examining the above variations, it is known that they exhibit similar behaviour and vary slightly in magnitude and great contribution and influence of Ma is observed towards the total aerosol concentration Mt.

The other aerosol parameters that derived from the mass measurements are the Effective radius R_{eff} , mass mean radius R_m and Number size distribution dn/dr. These are shown in Figure- 2 and Figure- 3 respectively.

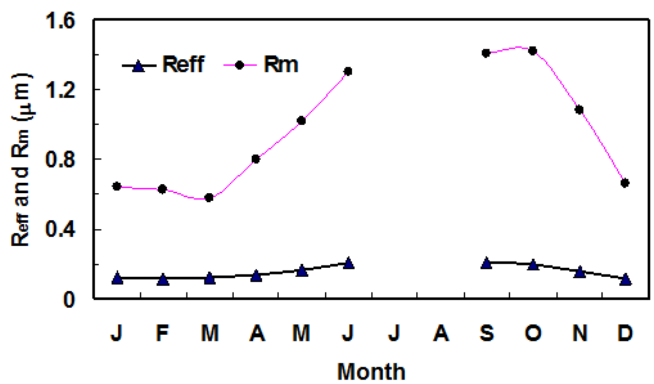


Figure 2. Month to Month variation of the Effective radius R_{eff} and mass mean radius R_m

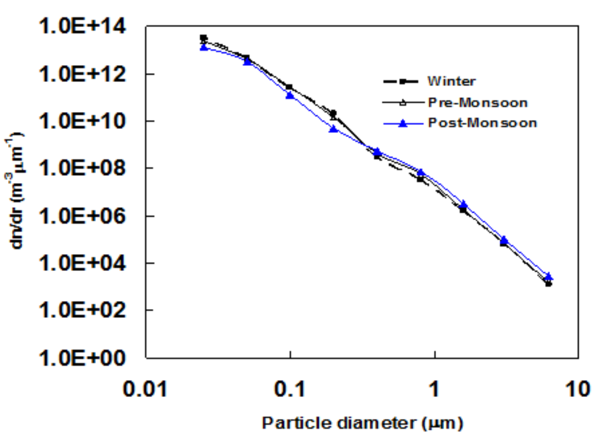


Figure 3. Seasonal variation of Number size distribution dn/dr

The particles with size <1 µm are termed submicron and those with size >1 µm are called supermicron. It is clear that the number of sub micron size particles is orders of magnitude higher than that of supermicron range.

Similar behavior of ambient aerosols has been reported in other regions over India [7]. Mc and Ma also depends on wind speed. It is observed that as wind speed increases particles related to Ma are found to decrease and wind speed decreases particles related to Ma are found to increases during the study period. It indicates that accumulated mode aerosols strongly depend on the wind speed.

4. CONCLUSION

The mass concentrations of M_t and M_a follow almost same variation in all months. Mass concentration of Mc shows high during summer and low during winter. The number of sub-micron size particles is orders of magnitude higher than that of super-micron range.

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