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CHEMICAL CHARACTERIZATION OF AEROSOLS AT A TROPICAL COASTAL SITE, TRIVANDRUM

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Introduction

The role played by aerosols in the radiation budget of the earth-atmosphere system is well understood. Diversity in sources and short residence time displayed by aerosols, make their characterization a challenging task. The source characteristics are largely heterogeneous in space and time depending on the topography and degree of urbanization of the region as well as prevailing meteorology. This necessitates the need for regional modeling of aerosol system. Knowledge on the chemical composition of aerosols is crucial in identifying the prominent sources acting at a particular location. A study on seasonal basis on this can provide information on the relative strength of various sources. Several stations have been set up all over the world for the continuous monitoring of chemical properties of aerosols. Chemical charactersitcs of aerosols, both short-term and long-term, have been reported from different sites over the Indian subcontinent (Kulshrestha et al., 1998; Rastogi and Sarin, 2005; Chinnam et al; 2006). Most of these sites are located in the northern parts of India. Detailed information on the chemical composition of aerosols in the southern parts of India remains unknown even now. This paper presents the results from a similar study on aerosols at a coastal location, Trivandrum along the west coast of peninsular India. The sampling site, situated ~500m away from the Arabian Sea coastal line, is a rural area devoid of any large-scale industrial activity.

Instrumentation

Aerosol samples were collected using a single stage high volume sampler (Model GH2000 of Grasby Anderson, USA), operating at a flow rate of 20 CFM. Preconditioned quartz fibre filters were used as the collection substrate. The typical sampling duration was around 3-4 hours. Gravimetric analysis of these collection substrates prior to and after collection gave the mass of the samples collected. From this mass, knowing the flow rate and duration of sampling, the mass concentration of aerosols (in $\mu g\ m^{-3}$) is estimated. The samples were later subjected to chemical analysis for identifying and quantifying various chemical species present in the aerosols. For this, the collection substrates were dissolved in de-ionized water/ultrapure HNO_3 for the analysis of various anions/cations. Ion Chromatography (Model DX-120 of Dionex) was used for the analysis of various anions viz., F^-, Cl^-, Br^-, NO_2^-, NO_3^-, $PO_4^{3-}$and SO_4^{2-}, and for the water soluble fractions of various cations, viz., NH_4^+, Na^+, K^+, Mg^{2+} and Ca^{2+}. The acid soluble fractions of Na and K were analyzed using Atomic Absorption Spectroscopy (Model Varian Spectr 250 plus) and that of other species, viz., Al, Ca, Cu, Fe, Mg, Mn, Pb, Ti, Zn, etc. were analyzed using Inductively Coupled Plasma – Atomic Emission Spectroscopy (Model Perkin Elmer Optima 4300V). Aerosol samples collected during the period October 2003 – January 2005, form the basis of this study.

Results and Discussion

The mean mass concentration of aerosols (M_L) at Trivandrum during the study period was ~54.4 ± 19 μg m^{-3}. This value is well below the Indian national ambient air quality standard of 60 μg m^{-3} for Respirable Particulate Matter (size <10 microns) in rural/residential areas. Fig. 1 shows the seasonal variation in M_L during the study period, which shows two prominent peaks – one during monsoon and the other during winter period. These peaks could be attributed to the increased production of sea-salt during the monsoon period and to accumulation of aerosols (caused by the shallow boundary layer) during winter.

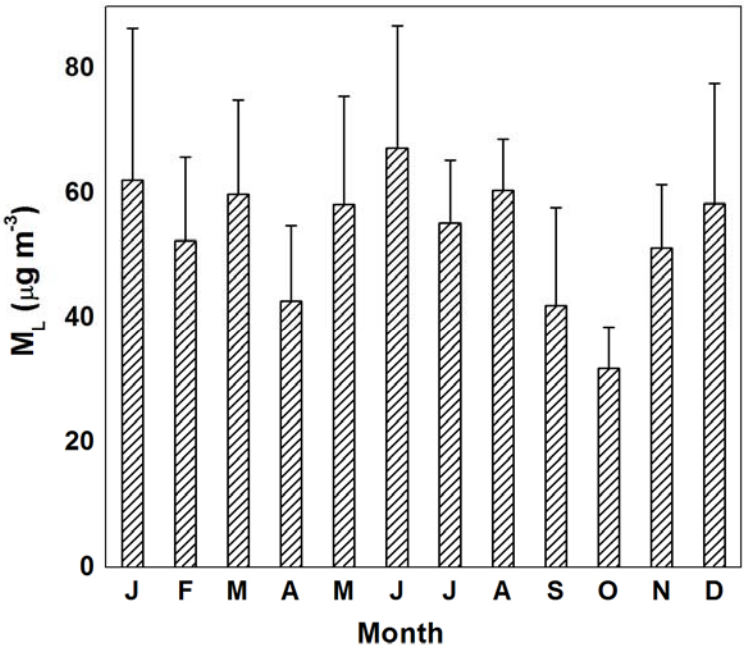

Fig. 1. Seasonal variation in mass loading (M_L) at Trivandrum

The major anionic species at this site is found to be Cl^- followed by SO_4^{2-}. Dominating cation was Na. The major sources of these ions were inferred with the help of correlation analysis. Different tracers used for this purpose were Na for sea-salt, non-sea-salt SO_4^{2-} for anthropogenic sources, Al or Fe for crustal sources and non-sea-salt K for biomass burning. This analysis revealed that sea-spray is the dominant source of aerosols at this location, irrespective of season. The mass fractions of various species exhibited a systematic seasonal pattern. While the species of marine origin (Cl^-, Na, etc.) were found to be abundant during monsoon period, those originating from anthropogenic activity (SO_4^{2-}) contributed more during winter. The crustal components (Fe, Al) dominated during pre-monsoon months. The histograms in fig.2 show the seasonal variation in the mass fractions of some of the species, which were used for inferring the source characteristics in different seasons. This seasonal pattern was made use of in estimating the relative contribution of the various sources during different seasons.

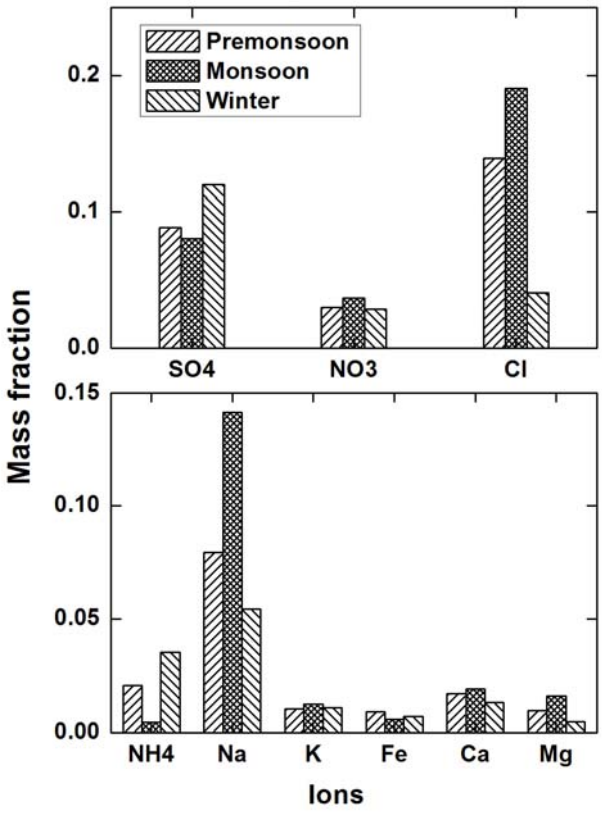

Fig.2. Seasonal variation in the mass fraction of various ions

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