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AEROSOL SIZE DISTRIBUTIONS AND THEIR SEASONAL VARIATIONS OVER TROPICAL SEMI-ARID REGION: RAJKOT

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Abstract

Multi wavelength columnar Aerosol Optical Depth (AOD) measurements have been made at the tropical semi-arid location Rajkot ($22^0$18N, $70^0$44 E, 142 m above mean sea level) for the period March 2005-March 2007 to examine the nature of the Aerosol Size Distributions (ASD). Aerosol loading inferred from angstrom turbidity coefficient, β, showed that it is highest in summer season. Wavelength exponent, α, showed that this site have larger sized particles in the atmosphere in summer rather than winter and monsoon. ASD, retrieved by inversion technique, were mostly unimodal type. This type of size distributions were observed during all three seasons, winter, summer and monsoon. The mean radius in summer month is ~ 0.5 µm and during winter and monsoon it is ~ 0.4 µm. The seasonal variation of ASD showed the influence of meteorological condition as well as source region.

Introduction

The optical properties of the aerosols are effectively characterized by their chemical composition and size distribution, while the physical properties are strong functions of their sources. One of the most important parameters is the Aerosol Size Distribution (ASD) to characterize the atmospheric aerosol system over any location and to study their various effects. There have been many observational results concerning particle size distributions[1] which have been compiled for several typical models and which include multimodal, unimodel, bimodal, Junge and log normal distribution. The processes which are responsible for various size distributions include biomass burning combustion of fossil fuel from urban industrial sources, volcanic eruptions, wind blown soil particles etc[2-3].

With a view to examine the seasonal variations in columnar aerosol size distribution in a typical semiarid urban environment, the Aerosol Optical Depth (AOD) measurements have been made over Rajkot, India, for a period of two years (2005-07). The results of the study will be presented and discussed here.

Methodology

Measurements of columnar AOD have been made with portable hand-held multi-band sun photometers (MICROTOPS-II). The sun photometers give instantaneous AOD values at the six wavelengths of 380, 440, 500, 675, 870 & 1020 nm. The complete details of the sun photometer and measuring technique have been already described by Morys[4] et al. (2001). Meteorological parameters like temperature, relative humidity and wind speed over this location are obtained through the website[5].

The Ångström parameters (wavelength exponent,α, and turbidity coefficient,β) are estimated using Ångström formula[6]. The columnar aerosol number size distributions over this location are estimated from numerically inverting AOD measurements as a function of wavelength by adopting the algorithm of King et al[7]. Effective radius (R_{eff}) for the column of particles is computed from the inverted ASD.

Results

Variation in monthly mean wind speed, temperature and relative humidity (RH) from June 2004 to May 2007 (three years averaged) is shown in Fig. 1(a). The wind speed is maximum (32 km/hr) during May and June, and minimum (12 km /hr) in November and December. Temperature is also high (~42 ^{0}C) in April and May. The secondary peak in temperature (~35 ^{0}C) is found in the month of October. The RH is also high in June, July and August. From Fig-1(b), it is clear that AOD at all wavelengths are the highest during summer months. Meteorological condition could be the cause of relatively higher increase in AOD at higher wavelengths and urban activity could be the main cause of relatively higher optical depth at lower wavelengths. Fig.-1(c) shows the monthly variation in Ångström parameters (α & β) with effective radius in different month averaged over two year's data (March 2005-March 2007). The low value of wavelength exponent (α) and larger value of turbidity coefficient (β) shows the abundance of coarse-mode aerosols (originating from marine air mass and wind blown dust) particles with greater extinction during summer season (April, May and June) due to local meteorology and vice-versa in winter and monsoon[8]. Columnar ASD and effective radii of dominated aerosols are estimated for different months (data has been collected during quite and stable days) are plotted in Fig.-1d. There is a consistency among these parameters, angstrom parameters and effective radii during the whole year. Effective radius is high (~0.50 μm) in summer and low (~0.40 μm) in winter and monsoon.

Conclusions

1. The influence of meteorological parameters on AOD is noticed.
2. Wavelength dependence of AOD in different seasons shows that AOD is comparatively high at longer wavelength in summer and low in winter and monsoon.
3. The aerosol size distributions presented in this study are unimodal and may primarily be representative of semiarid urban aerosols in a city like Rajkot.
4. The effective radius is high (~50 cm) in May - June and lowest in October.

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