Study of Wavelength Dependence of Column Aerosol Optical Depth over Rajkot, Gujarat

NILESH H. MANANI
Department of Physics,M.M. Science College, Morbi, Gujarat, India

Abstract:
Columnar Aerosol Optical Depths (AOD) estimated from two hand held sun photometers [MICROTOPS-II (version 2.43 & 5.5)] over Rajkot were analyzed from March 2005 to March 2006. The AOD shows seasonal variation with high values in summer and low value in winter. The high AOD values in summer (low during winter) is higher for longer wavelengths, which shows that the coarse particles contribute more to the observed variation as compared to sub micron particles. The AOD values decrease in winter and the decrease is more at higher wavelengths indicating that there is a general reduction in the number of bigger particles. Also during the winter months the wind direction changed to southerly and south easterly that brings air that is more rural to the measurement site. The angstrom parameters α and β have also been used to characterize the aerosol optical depths,

Keywords: *Atmospheric Aerosol, Angstrom parameters, Sun photometer*

1. Introduction

Aerosols play an important role in earth's radiation budget, air quality and environmental health effects (Satheesh et al, 2006, Ritweej et al. 2007a, 2007b). Hence the properties of aerosols are studied over the entire globe using different measurement techniques and parameters. One of the most important optical properties is the aerosol optical depth, which is defined as the attenuation of direct solar radiation passing through the atmosphere by scattering and absorption due to aerosols. This paper presents the month-to-month variation of AOD and Angstrom parameters that contribute to understand the regional characteristics of aerosols and helping in aerosol modeling.

2. Site and Instrumentation

Rajkot ($22^{O}18'$ N, $70^{O}44'$ E and 142m above sea level) is a semi-arid suburban region near the Arabian Sea. In this study MICROTOPS-II sun-photometers are used for the estimation of AOD at different wavelengths. The complete details of the sun-photometer and measuring technique have been already described by Morys et. al.,2001. Here 380, 440, 500, 675, 870 and 1020nm wavelengths are selected for the aerosol study.

3. Method of Data analysis

Estimated value of aerosol optical depths at six different wavelengths ranging from 380nm to 1020nm and precipitable water vapour were collected from the MICROTOPS II sun photometer. Monthly values of relative humidity, temperature and wind velocity were downloaded from the Internet site "wunderground.com".

The angstrom parameters were determined using angstrom formula (Angstrom, 1961) given by

$$\tau(\lambda) = \beta\lambda^{-\alpha} \qquad \ldots..(1)$$

Where α is wavelength exponent related to the size distribution of the scattering particles and β is the turbidity coefficient related to the total aerosol content.

For the purpose of determining α and β values by linear regression, the above equation can be further expressed in the form:

$\ln\tau(\lambda) = \ln\beta - \alpha\ln\lambda$ ……..(2)

For spectral analysis this method of linear fitting is the best way of obtaining the Angstrom parameters (Maheshkumar et al, 2001).

4. Results and Discussion

June to September months are the normal rainy months as the rainfall pattern at Rajkot generally follows the southwest monsoon, during the rest of the months throught the year the weather is dry with abundent sunshine but frequently clouds are seen whole of the year. That's why, June to August the measurements are scare and we could not take a significant number of observation during this period. The mean value of AODs at all wavelengths are high during summer, perior to the monsoon. Immediately after the monsoon, the mean AOD values are the lowest.

4.1 Monthly variation of AODs

Variation of AODs for the period March 2005-06 is shown in Fig. (1). The lowest values of mean AODs are obtained from october to december. The fall in AOD from winter is considered to due to cloud scavenging and rain wash out processes. Fig. (1) also reveals a cprrespondence between AOD and PWC which suggests the growth of aerosol particles on the occasions associated with higher PWC values. This is in qualitative agreement with the results at other indian stations (Devara et al. 2005) where in AOD values have been found to be the lowest for October to December and increase thereafter until summer.

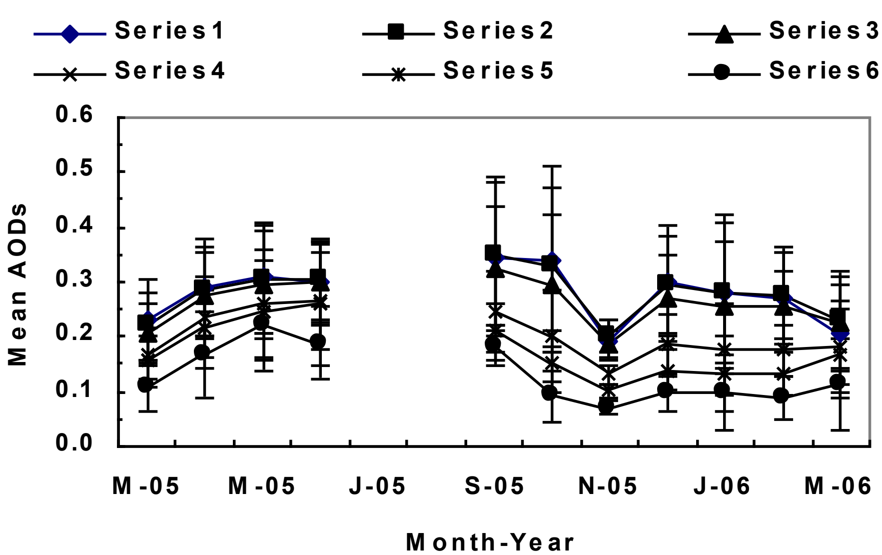

Figure-1 Monthly variation in AOD at different wavelengths.

4.2 Monthly variation of Angstrom parameters, α and β

From the log–log pot of AOD versus wavelength, the Angstrom wavelength exponent and turbidity coefficient have been derived . These aerosol optical and physical parameters computed for each month are plotted in Fig. (2).

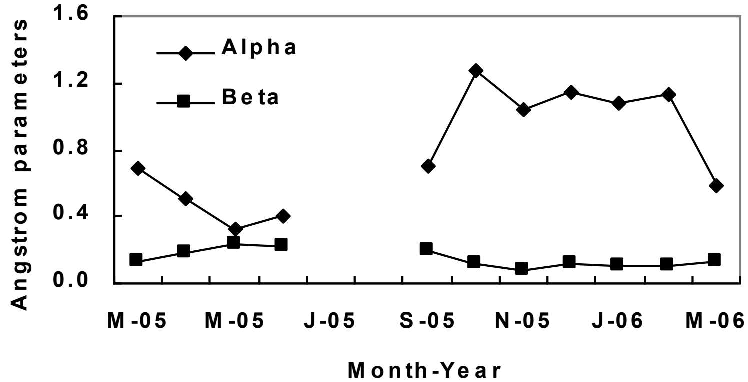

Figure-2: Monthly variation in Angstrom parameters (Wavelength exponent, α & turbidity coefficient,β).

Our data reveal an inverse relationship between α and β values i.e. low exponent α values are associated with high β values and vice-versa. Dani et.al 2003, Devara et al., 2005 and Satheesh et al. 2006 also reported such type of relationship. In examine this feature further, correlation coefficient between α and β is estimated as shown in Fig. (3).

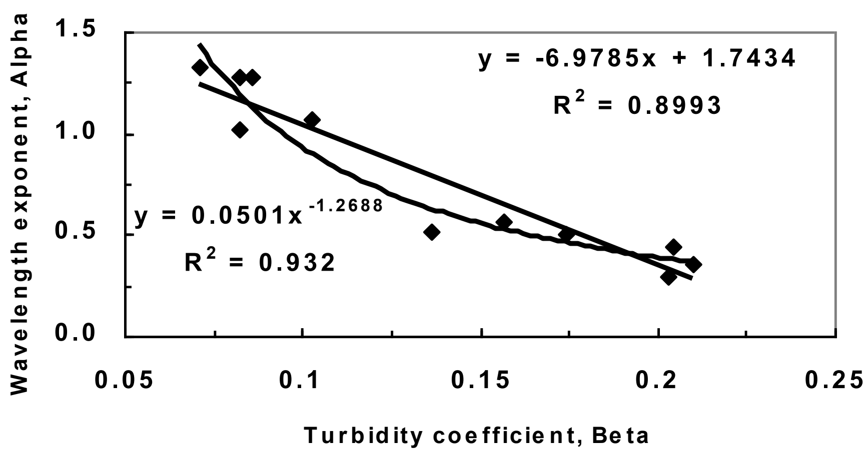

Figure-3: Inverse relation between Wavelength exponent, α & turbidity coefficient,β.

The square of the estimated value of correlation coefficient (R^2=0.899) indicates a very good correlation between α and β. Minimum values of α in summer indicates presence of coarse-mode aerosol particles during this period and high values of α during winter indicates the reduction of coarse mode particles. These features indicate the presence of marine airmass, originating from the Arabian Sea passes over Rajkot and wind blown dust during this period.

5. Conclusions

The results of the analysis of optical and meteorological data for the period March 2005 to March 2006 indicate the following:

1. Spectral dependence of AOD with higher values at smaller wavelengths and vice versa. High value of AOD in summer (pre-monsoon) and low in winter (post-monsoon).
2. Smaller wavelength exponent and larger turbidity coefficient indicating abundance of coarse-mode aerosols (originating from wind blown dust and marine airmass) particles with greater extinction during summer due to local meteorology and vice versa in winter. Sharp fall in AOD from summer to winter period is considered to due to cloud scavenging and rain wash out processes.
3. There is inverse and good correlation relation between wavelength exponent α and turbidity coefficient β.

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