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AEROSOL RADIATIVE PROPERTIES IN THE SEMI-ARID REGION

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INTRODUCTION:

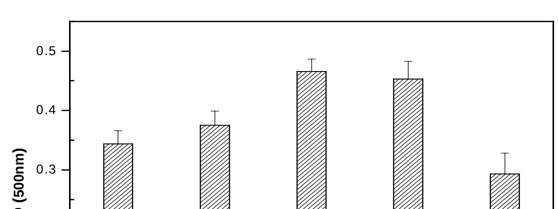
Aerosols play a potentially important role in earth's climate system because of their direct interaction with solar and terrestrial radiation through scattering and absorption, there by modifying sources and are distributed in the atmosphere through transport by air mass of soar and terrestrial radiation due to aerosols depends on their size and number density. Aerosol can also indirectly affect climate by regulating cloudiness. Science they exhibit high degree of spatial and temporal variability, it is very essential to monitor features of aerosols over land and as well as marine environment. Aerosols Optical depth (AOD), the column integrated aerosol extinction coefficient at a given wavelength, is one of the useful parameters to study the effect of aerosols on climate. In the present study spectral, temporal and turbidity coefficient from aerosol optical depths measurements were made over semi-arid region at Anantapur (14.62^0N, 77.65^0E), during January to May, 2007.

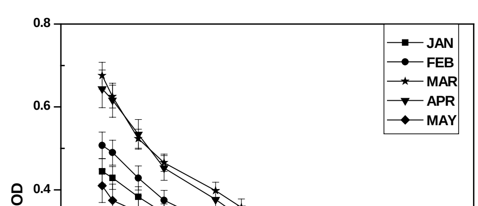
EXPERIMENTAL SETUP AND METHODOLOGY:

Aerosols optical depths were estimated at 10 narrow wavelength bands centered at 380, 400, 450, 500, 600, 650, 750, 850, 935 and 1025 nm (selected using interference filters having full width at half maximum band width in the range of 6-10 nm) using a multiwavelength solar radiometer (MWR) having an overall field of view of 2^0. The MWR makes spectral measurements of ground reaching solar flux as a function of solar zenith angle (χ) during clear sky periods. The data collected during the period January to May 2007 used for the study. The columnar aerosol optical depths are deduced from the MWR measurements following the Langley technique the details are given elsewhere (Shaw et al., 1973). The details of the instrument and data deduction techniques and accuracies involved are described by Moorthy et al., (1999, 2001).

RESULTS AND DISCUSSION:

Monthly averaged values of AOD at 500 nm wavelength are shown in Fig. 2. AOD is minimum in January and moderately high in February to March, and reaches a maximum in April and then decreases in May. Low values in January and May are due to decreased aerosol input due to colder ground surface, low wind and generally absence of any local sources of aerosols. High values of February to March is due to many factors such as conversion of precipitation moisture into haze on cold mornings in winter, confinement of aerosols deriving inversion episodes, influx of aerosols due to upper wind, etc. March and April high levels in normal summer high. It is attributed to increase aerosol input due to surface heating, wind blown dust, local confinement of aerosols. Dispersal due to strong upper winds in May leads to lower AOD.





The spectral variations of aerosol optical depths in different months are shown in Fig.2. The AOD values are averaged for each month of January to May 2007 and the standard deviations and standard errors are calculated. The vertical bars in the figure represent the standard errors. The spectral variation of τ_p is the important and it is indicative of the changes in aerosol size characteristics. The spectral dependence of τ_p remains nearly similar for all the months from January to May 2007. τ_p shows a general decrease as λ increases. At longer wavelengths, the AOD values are less, which indicates the concentration of bigger size particle is less. The larger values of aerosol optical depths around shorter wavelengths indicate the abundance of small sized particles.

Inferences on the size spectra of the aerosols can be obtained readily from the corresponding AOD spectra ($\tau_p(\lambda)$) by estimating the Angstrom parameters in the expression (Angstrom, 1961).

$$\tau_p(\lambda) = \beta\lambda^{-\alpha}$$

where α is the wavelength exponent, indicating the size distribution and β the turbidity parameter, shows the measure of aerosol loading and λ the wavelength. The least square fit between τ and λ in log-log scale gives the value of α and β. These parameters are estimated for each day and the monthly mean values are estimated. Fig. 3 shows day to day variation of Angstrom exponent (α) and Turbidity coefficient (β) during the months January to May for the year 2007. The mean value were found be as 1.03 ± 0.13 and 0.19 ± 0.02 respectively.

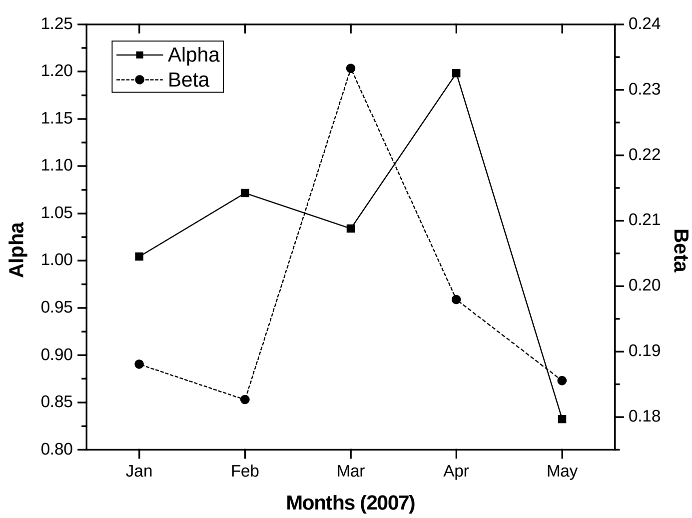


Fig. 3. Monthly variation of α and β during the months of January to May, 2007

Forenoon-Afternoon (FN/AN) asymmetry in AOD and Water vapour:

The special features of the aerosol optical depth (τ_p) data at Anantapur is the presence of forenoon-afternoon asymmetry while such an asymmetry is often seen at other stations also (Prasad et al., 2000), it is more or less a regular feature at Anantapur. Using the data on daily aerosol optical depth (τ_p) considered separated for FN and AN, the monthly mean τ_{fn} and τ_{an} are obtained from which the fractional $(\tau_{fn}-\tau_{an})/\tau_{fn}$ for each month is calculated and shown in Fig. 4. These fractional changes are found to be similar for all the wavelengths. The mean monthly fractional changes $(\tau_{fn}-\tau_{an})/\tau_{fn}$ i.e., the asymmetry value is determined. This asymmetry can be positive or negative depending on τ_{fn} > or <τ_{an}. The asymmetry is also observed in the experimentally determined precipitable water vapour content 'W' and the FN/AN asymmetry in W is calculated as $(W_f-W_a)/W_f$. The FN/AN asymmetry in AOD at the individual wavelengths, the averaged value for all the wavelengths and asymmetry in W are shown in Fig. 4. its is seen that there is almost one to one correspondence between the asymmetry in τ_p and W, and this indicates that the changes in water vapour/RH in the atmosphere is one of the factors controlling the continental/island aerosol characteristics.

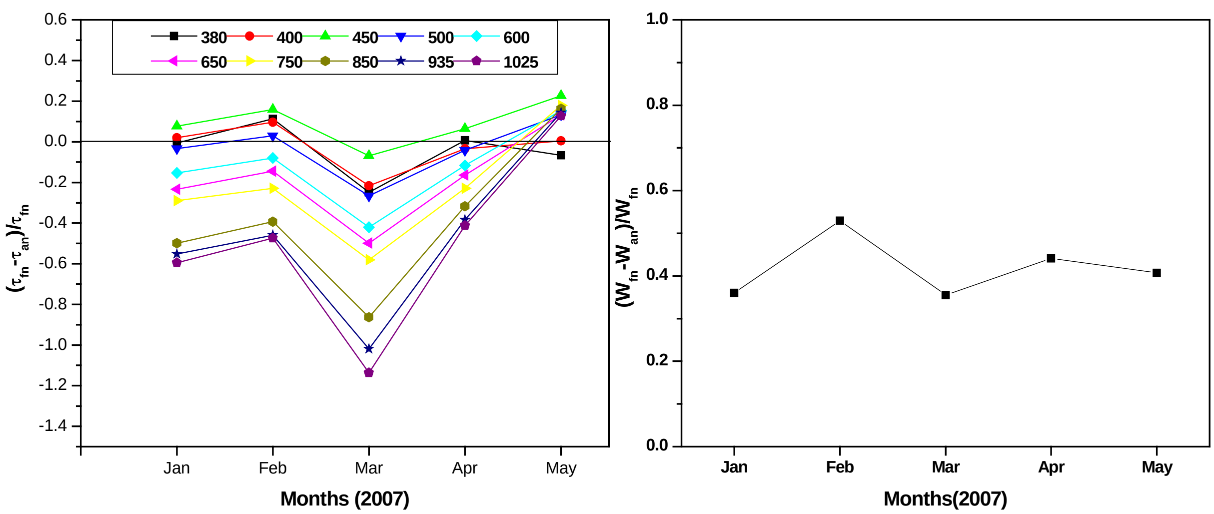


Fig.4. Monthly variation in FN/AN asymmetry in AOD at ten wavelengths and Water vapour.

Variation of Water vapour content FN and AN

Fig.5 shows the monthly mean water vapour content for the period January to May, 2007. The variations are more or less similar for other years also. It can be seen that the FN water vapour is always larger than AN values and in general the difference between the two is much less during rainy months. Due to low temperature in the morning hours, the water vapour is in the condensed form and more over part of it will be condensed on other aerosol particles also. Growth of these particles due to water vapour condensation pushes them into optically active region and thereby increasing the extinction. As the temperature increases in the afternoon, evaporation takes place and thereby water droplets will decrease in concentration. This is one of the reasons for the higher AOD in the forenoon during summer months. Another possible factor for the higher AOD is convective activity associated with the wind.

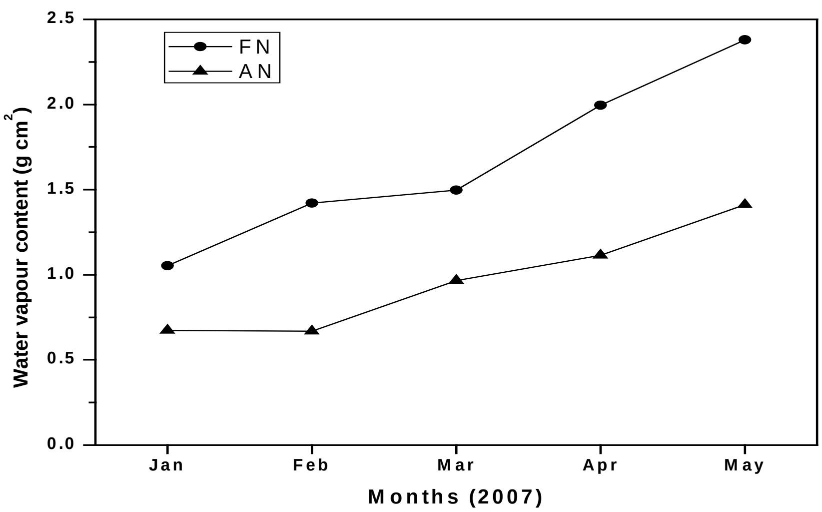


Fig. 5. Variation in water vapour content of the atmosphere.

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