

Study of MODIS Satellite Derived Aerosol Angstrom Exponent and in-situ Measured Values Using the Sun photometer in part of the west coast of Indian Peninsula

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Abstract: The aerosol angstrom exponent (AAE) is often used as a qualitative indicator of aerosol particle size. It is important to understand and quantify the microphysical impact of aerosols which are derived from natural and anthropogenic activities. Aerosols influence variations in clouds and it is possible to predict climate change and their microphysics. The AAE has been evaluated at Malvan, Dona Paula, Murdeshwara and Karwar coastal regions of the west coast of Indian Peninsula. The correlation of satellite derived aerosol angstrom exponent with the in-situ measured values (using Sun photometer) the 440, 500, and 675nm wavelengths were carried out. The error observed in the MODIS derived AAE values may be attributed to the atmospheric correction algorithm used for processing the satellite data over the coastal waters. The MODIS Aqua image and Sunphotometer data of the study area provides the distribution of Aerosol Angstrom exponent onin the west coast of India. In the Malvan the aerosol angstrom exponent is high at 675nm, which is 1.44 and 1.57 and decreases to 1.15 and 1.18 at 440nm, respectively. In the Dona Paula which is 1.44 and 1.57 and decreases to 1.15 and 1.18 at 440nm, respectively. In case of Murdeshwar The value decreases at 440nm in the range of 0.97 and 1.07, respectively. The AAE in Karwar is about 1.54 and 1.63 at 675nm and decreases to 1.26 and 1.32 at 440nm, respectively.

Keywords: MODIS Aqua, Aerosol Angstrom Exponent, Sun photometer, Coastal region.

1. Introduction

Aerosol studies have gained importance during recent time due to their regional and global impact on the climate and environment as compared to the greenhouse gases (Smirnov, et al 2002). However, due to their spatial and temporal variability particularly near the coastal regions and their combination of various sizes, absorption properties and concentrations, computing the contribution due to aerosols in the total path radiance is a difficult task (Suresh, et al. 1999). Aerosols in Malvan, Dona Paula, Murdeshwar and Karwar coastal site, indicate seasonal variations with a high values aerosol load being observed during summer and relatively lower values being observed in winter. Correspondingly, there is a seasonal variation of angstrom exponent; with large particles being observed in summer, (Suresh et al., 2005). The variation observed at Dona Paula, would be valid for the aerosols over the coastal waters of Goa. The ocean colour satellite sensors such as SeaWiFS, IRS-P4 OCM and MODIS are sun synchronous and have an overpass at the site during the day at 12.00-14.00 hrs local time.

Aerosol particles in the 0.1 to 1.0 micron diameter range changes incoming solar radiation due the similarity of particle size and wavelength of interaction. Sulphate aerosols and organic matter are most effective at scattering and absorbing shortwave solar radiation. The atmospheric aerosols may be of natural origin such as the wind-blown mineral dust or of anthropogenic origin such as those from industry, automobiles or other human activities in the urban areas. They may originate from gas-phase reactions of low volatile vapors in the atmosphere (Hoffmann et al., 1997). The tropical Indian atmosphere system acts as a natural experiment for observing the radiative forcing by the anthropogenic aerosols. MODIS aerosol data are useful for detailed studies of local, regional, and global aerosol loading, distribution, and temporal dynamics, as well as for radiative forcing calculations (Ichoku et al., 2004). Aerosols are tiny particles, however they have the potential to influence the climate. These particles influence the net radiation budget of the earth. The rapid temperature change of the earth's surface has been attributed to a balance between absorption of incoming solar radiation and emission of thermal radiation from the earth system. The aerosol plays a major role in this process, by dampening the surface temperature rise (Chauhan et al., 2009, Chakley et al., 1983, Satheesh et al., 2000 and 2001, Suresh et al., 1999 and 2005). The effect of wind on aerosols over the oceans has been studied, but has mostly focused on the aerosol concentration and size distribution (McDonald et al., 1982; O'Dowd and Smith, 1993; Nilsson et al., 2001).

The present study makes use of Aerosol Angstrom exponent estimated from MODIS satellite data and *in-situ* measured Sun photometer data over the parts of western coast line of Indian subcontinent in particular over Malvan, Dona Paula, Murdeshwara and Karwar locations.

2. Data Used

MODIS aerosol products were used during January to March 2009 period for the present study. The *in-situ* measurements obtained from the Microtop II Sun Photometer were used to validate the MODIS AOD products. SeaWiFS Data Analysis System (SeaDAS) was used to process the obtained MODIS AOD products images. A Global Positioning System (GPS) receiver attached with the Sun photometer provided information on the location, altitude and atmospheric pressure.

3. Study Area

The west coast of Indian sub-continent extends over 3050 km between Gujarat and Kanyakumari. The coast line is formed by a sandy beach. The sand grains are almost entirely constituted by quartz grains. Malvan (16° 05', 74°27'), Dona Paula (15° 30', 74° 15'), Murudeshwar (14° 45', 74 33'), and Karwar (14° 45', 74°45') locations are the partial part of this coast line. These places are important for tourism and fishing activities.

4. Methodology

The methodology for data analysis includes seven step approach (Fig.1). Step 1. AAE values are estimated from Sun photometer AOD measurements. Step 2. Cloud free MODIS Aqua satellite data products are downloaded from the <http://oceancolor.gsfc.nasa.gov> web site. Step 3. Analysis of MODIS data using SeaDAS software. Step 4. Atmospheric correction algorithm used for the elimination of errors in the MODIS using the AOD & AAE data. Step 5. Correlation of sun photometer and MODIS data. Step 6. AAE was plotted with respect to wavelength Step 7. Evaluation of AAE distribution.

SeaDAS programme was used to process the downloaded raw MODIS data (level 0). Level 1A files contain radiance counts at each channel received by the MODIS sensors. Errors such as atmospheric scattering, often called haze, clouds and radiance errors were eliminated by the atmospheric correction algorithm at level 1B. Level 1A is processed by Geoprocessing to get geo-location file which contains latitudes and longitudes. Level 1A is processed to get the Level 1B file, it will check for meteorological, ozone,

and other files for necessary data. Level 1B file is processed to get Level 2 file, and finally processed MODIS image.

Microtops II hand held Sunphotometer (Solar Light Ind., USA) was used to collect the ground based AOD further AAE values derived from AOD using algorithm. The data were obtained at different stations in the spectral ranges of 440, 500, 675 nm. Haze and clouds free environment is selected for the data recording. Global Position System (GPS) was used along with the Sunphotometer to get the latitudes and longitudes.

5. Results and Discussions

The MODIS Aqua image and Sunphotometer data of the study area provides the distribution of Aerosol Angstrom exponent on the west coast of India. In the Malvan (Fig. 2a, b), the aerosol angstrom exponent is high at 675nm, which is 1.44 and 1.57 and decreases to 1.15 and 1.18 at 440nm, respectively (AAE values does not have any unit You have written in Figure 2b & 3b AAE(nm), which is wrong, Pl. modify.). In the Dona Paula (Fig. 3a, b), the aerosol angstrom exponent at 675nm is about 1.44 and 1.52. Where as at 440nm the aerosol angstrom exponent varies from 1.26 and 1.32 respectively. In case of Murdeshwar (Fig. 4a, b), the aerosol angstrom exponent is 1.26 and 1.40 in 675nm range. The value decreases at 440nm in the range of 0.97 and 1.07, respectively. The aerosol angstrom exponent distribution in Karwar (Fig. 5a, b), is about 1.54 and 1.63 at 675nm and decreases to 1.26 and 1.32 at 440nm, respectively. Karwar and Dona Paula have comparatively high anthropogenic activities and industrialization. Based on these data aerosol angstrom exponent has been determined at different places, Karwar and Dona Paula have comparatively high AAE with that of Malvan and Murdeshwar (Fig.6a,b) Based on industrial and mining activity.

6. Conclusions

The study of comparing the *in-situ* estimated AAE with that the MODIS Aqua derived AAE has provided an opportunity to learn the method of validating the satellite data with the measured values. The AAE derived from suphotometer measured at Murdeshwar, Karwar, Malvan and NIO coastal locations were correlated with the values derived from MODIS. MODIS derived AAE values were observed to underestimate in comparison with in-situ measured AAE. The error observed in the MODIS derived Angstrom exponent is attributed to atmospheric correction algorithm used for processing the

satellite data. The Aerosol Angstrom Exponent was found to be high at Karwar and Dona Paula due to anthropological activities as compared with that of Murdeshwar and Malvan areas.

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Figure Captions

Fig. 1. The methodology for the AAE analysis.

Fig. 2(a). MODIS image of Malvan coastal region

Fig. 2(b). AAE distribution at different wavelengths in Malvan coastal region

Fig. 3(a). MODIS image of Dona Paula (NIO) coastal region

Fig. 3(b). AAE distribution at different wavelengths in Dona Paula (NIO) coastal region

Fig. 4(a). MODIS image of Murudeshwar coastal region

Fig. 4(b). AAE distribution at different wavelengths in Murudeshwar coastal region

Fig. 5(a). MODIS image of Karwar coastal region

Fig. 5(b). AAE distribution at different wavelengths in Karwar coastal region

Fig. 6. Shows Aerosol Angstrom Exponent Vs Study Area (a) Sun photometer data (b)

MODIS data

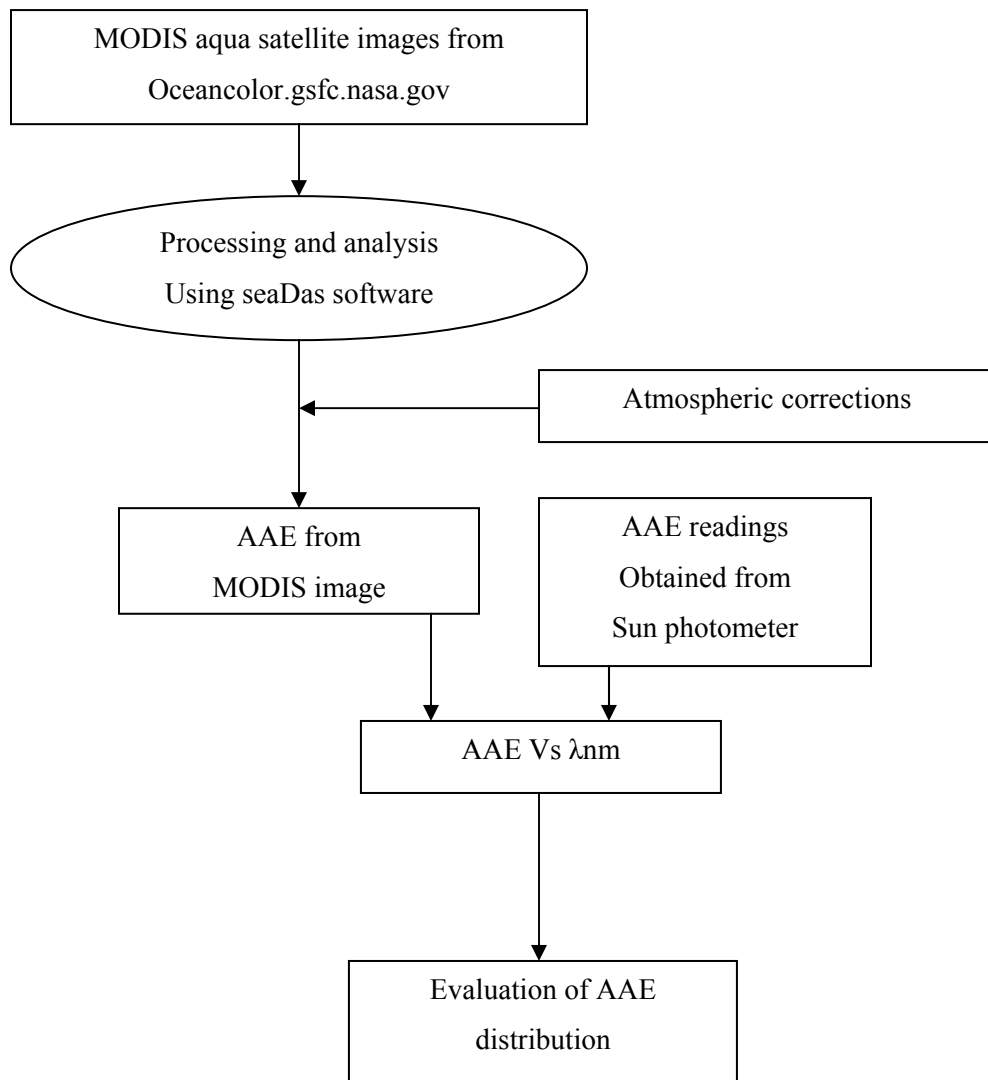


Fig.1.The methodology for the AAE analysis

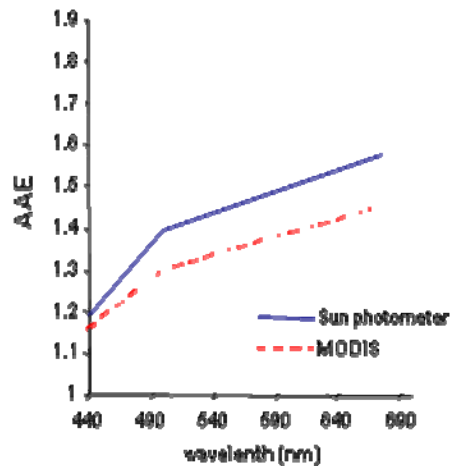
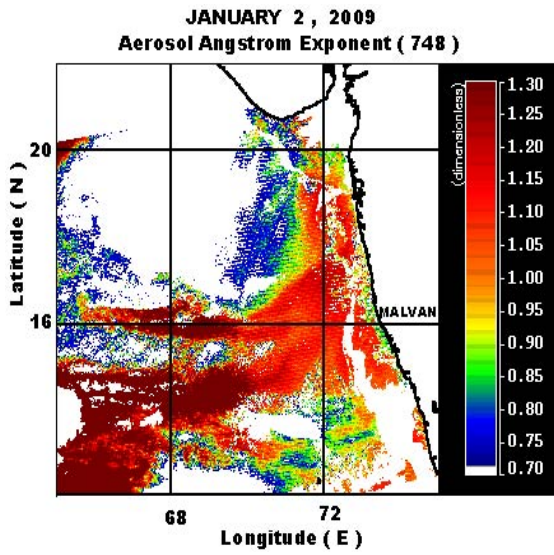


Fig. 2(a).

Fig. 2(b).

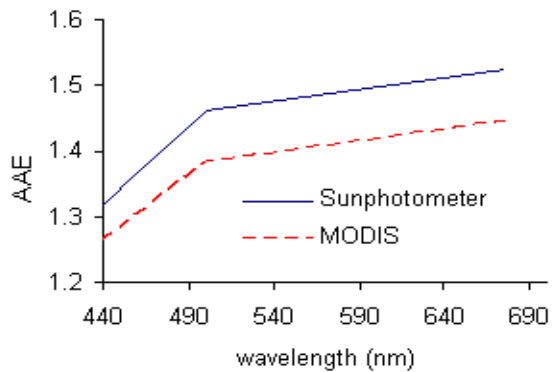
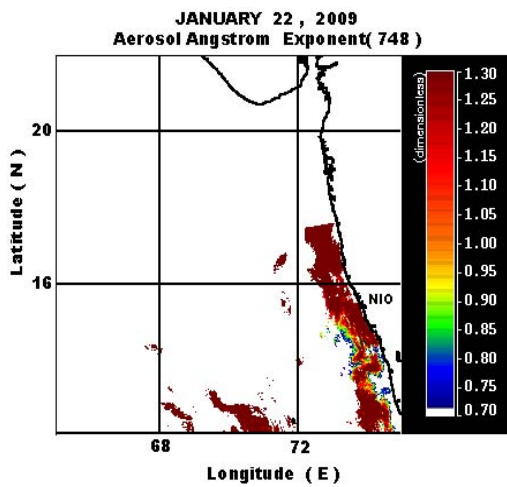


Fig. 3(a).

Fig. 3(b).

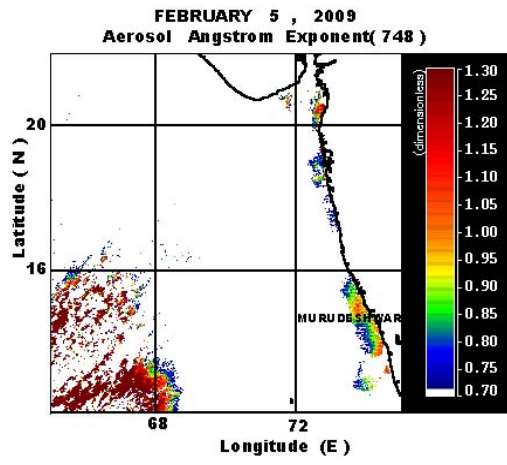


Fig. 4(a).

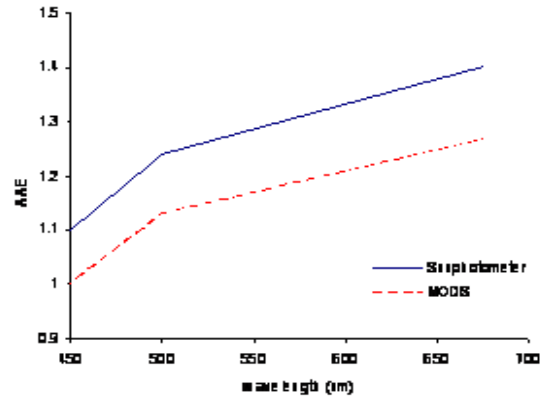


Fig. 4(b).

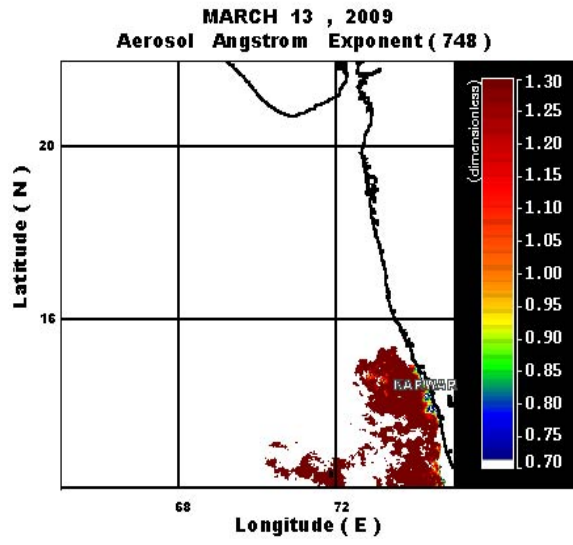


Fig. 5(a).

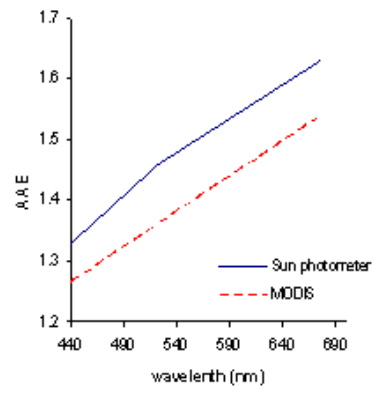


Fig. 5(b).

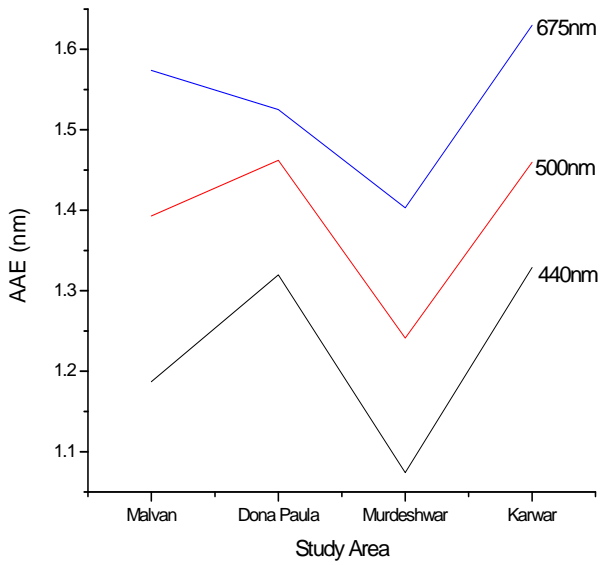


Fig. 6(a).

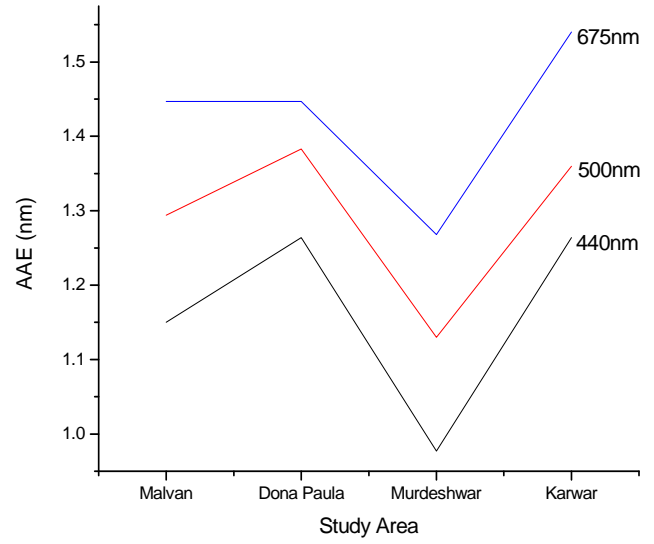


Fig. 6(b).

Fig. 6(a,b). Shows Aerosol Angstrom Exponent Vs Study Area (a) Sun photometer data
(b) MODIS data