

Study of Aerosol Optical Thickness using MODIS Satellite data and Sun Photometer in a part of West coast of India

SUNIL KUMAR R.K, T. SURESH¹, GOVINDARAJU² Jagadish Raje Urs and B. V. SURESH KUMAR[®]

Department of Studies in Earth Science, University of Mysore, Mysore - 570006,

¹Marine Instrumentation Division, National Institute of Oceanography, Goa – 403004

²Department of Studies in Applied Geology, Kuvempu University, Shimoga – 577451

[®]Corresponding author: bvsureshkumar@yahoo.com

Abstract: The knowledge of aerosol optical properties plays an important role in estimation of the direct aerosol forcing. The paper describes the aerosol optical thickness obtained from MODIS and Microtops II Sunphotometer. The data has been collected from the part of west coast line of Indian main land which are economically commercial areas. Due to anthropogenic activities the aerosols optical thickness (AOT) are more fluctuating. AOT values are plotted from MODIS and multispectral Sunphotometer with four spectral channels at 440, 500, 675 and 870 nm. The AOT values derived from MODIS and Sunphotometer are found to correlate well. The error observed in the MODIS derived AOT values is attributed to the atmospheric correction algorithm used for processing the satellite data. The aerosol optical thickness has been evaluated at different places.

Keywords: AOT, Sun Photometer, MODIS, SeaDAS

1. Introduction:

The Indian subcontinent is undergoing a phase of rapid urbanization. Inevitable fallout of this process is a concomitant increase in air pollution much of which can be attributed to the infamous great Indian haze phenomena. Earth atmosphere consists of minute particles in the range of 0.1 to 1.0 micron size aerosols. One observes that the aerosol size distributions vary considerably (Ghanti et al, 2010). Aerosols are only one part in a billion of the mass of the atmosphere and 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 (Prakash Chauhan et al, 2009, Chakley et al, 1983, Satheesh et al, 2000 and 2001, Suresh et al, 1999 and 2005). 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 effect of radiative forcing by anthropogenic aerosols is one of the largest sources of uncertainty in the climate prediction (Bates et al., 1998). 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) The present study consists of Aerosol optical thickness obtained from MODIS satellite data and Sun photometer in the part of west coast line of main land of Indian sub continent. Aerosol Optical Thickness have been determined at Malvan, Dona Paula (NIO), Murdeshwar and Karwar locations.

2. Data Used:

Moderate Resolution Imaging Spectro radiometer (MODIS) was used with Ocean color sensors and cloud free data has been obtained from January to March 2009. The measurements values obtained from the Microtop II Sun Photometer. SeaWiFS Data Analysis System (SeaDAS) was used to process the obtained MODIS images. A Global Positioning System (GPS) receiver attached with the photometer provided information on the location, altitude and 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 (Maharastra), Dona Paula (Goa), Murudeshwar(Karnataka) and Karwar (Karnataka) locations are part of this coast line. These places are important tourist as well as fishing activities.

4. Methodology:

The methodology includes seven step approach (Fig.1). Step 1. AOT readings are obtained from Sunphotometer. Step 2. Cloud free MODIS aqua satellite images are downloaded from the oceancolor.gsfc.nasa.gov. Step 3. Processing and analysis of MODIS data using SeaDAS software. Step 4. Atmospheric correction algorithm used for the elimination of errors in the MODIS data. Step 5. Correlation of sunphotometer and MODIS data. Step. 6. AOT was plotted against wavelength. Step 7. Evaluation of AOT distribution.

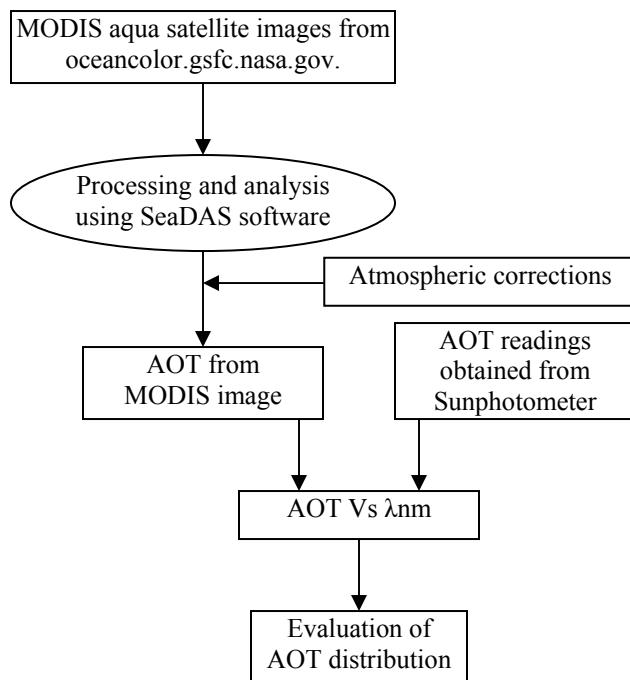


Figure 1.The methodology for the AOT analysis

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 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 AOT. The data were obtained at different stations in the spectral ranges of 440, 500, 675 and 870nm. 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 optical thickness in the west coast of Indian sub-continent. In the Malvan (Fig. 2a,b), the aerosol optical thickness is high at 440nm, which is 0.478 and 0.494 and decreases to 0.206 and 0.22 at 870nm respectively. In the Dona Paula (Fig. 3a,b), the aerosol optical thickness at 440nm is about 0.462 and 0.575nm whereas at 870nm the aerosol optical thickness varies from 0.242 and 0.206nm respectively. In case of Murdeshwar (Fig. 4a,b), the aerosol optical thickness is 0.285 and 0.326nm in 440nm range. The value decreases at 870nm in the range of 0.181 and 0.14nm respectively. The aerosol optical thickness distribution in Karwar (Fig. 5a,b), is about 0.545 and 0.595nm at 440nm and decreases to 0.262 and 0.221nm at 870nm respectively. Based on these data aerosol optical thickness has been determined at different places. Karwar and Dona Paula have comparatively high AOT in comparison to that of Malvan and Murdeshwar (Fig.6a,b).

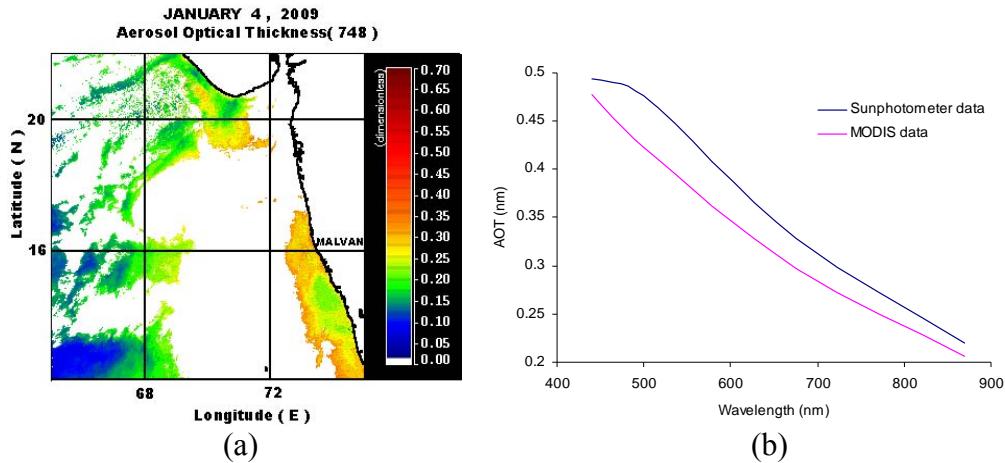


Figure 2. AOT at Malvan region (a) MODIS image, (b) Sunphotometer Vs MODIS data

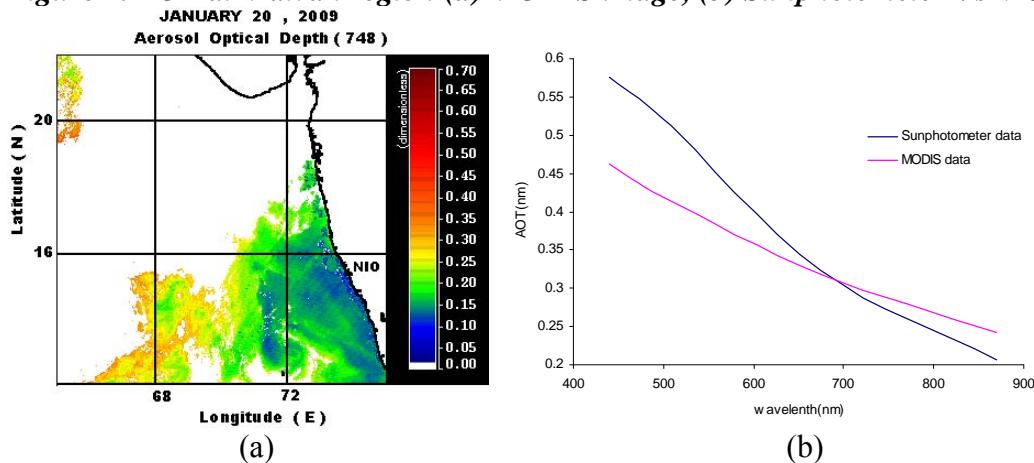


Figure 3. AOT at NIO region (a) MODIS image, (b) Sunphotometer Vs MODIS data

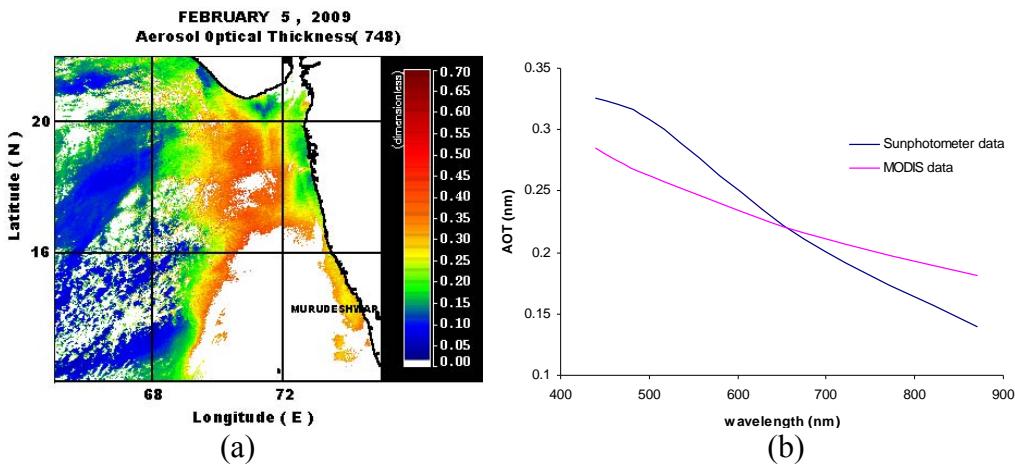


Figure 4. AOT at Murdeshwar region (a) MODIS image, (b) Sunphotometer Vs MODIS data

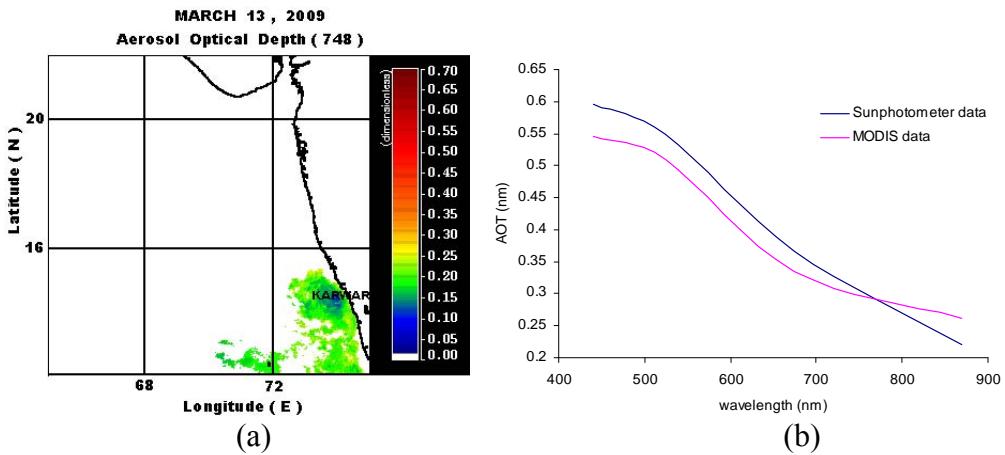


Figure 5. AOT at Karwar region (a) MODIS image, (b) Sunphotometer Vs MODIS data

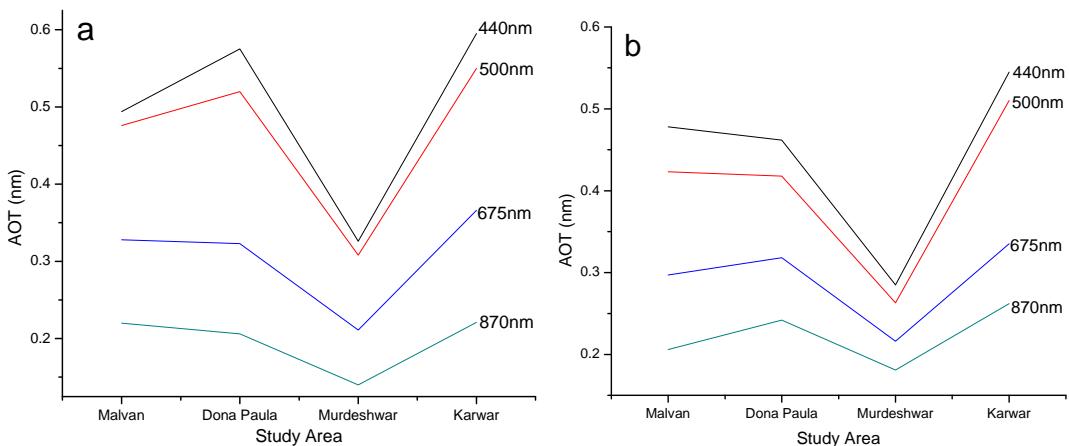


Figure 6. Shows Aerosol Optical Thickness Vs Study Area (a) Sunphotometer data (b) MODIS data

6. Conclusions:

The aerosol optical thickness measured from the Microtop II Sunphotometer has been correlated with that of satellite derived MODIS data in Malvan, Dona Paula (NIO), Murdeshwar and Karwar locations. The measurements were taken at the wavelength intervals of 440, 500, 675 and 870nm spectral regions. There is a slight difference in the sunphotometer data with that of satellite image data. The error observed in the MODIS derived aerosol optical thickness is attributed to the atmospheric correction algorithm used for processing the satellite data. The aerosol optical thickness is high at 440nm and decreases at 870nm spectral regions. Also, AOT is high at Karwar and Dona Paula whereas low at Malvan and Murdeshwar, Because of Anthropogenic activities like Industrialization, Tourism, Exporting of mining material, And Fishing. The variation in the aerosol optical thickness is the result of natural as well as more anthropogenic activities.

7. Acknowledgements:

Authors are thankful to Madubala Talaulikar and Ancy Rodrigues for helping in software processing and instrumentation.

8. Reference:

- [1] Bates, T. S., Huebert, B. J., Gras, J. L., Griffiths, F. B and Durkee, P.A. (1998). International Global Atmospheric Project's first aerosol characterization experiment : Over view. *J.Geophys.Res.* **103**: 16297-16318.
- [2] Chakley, J. A., Cess R.D and Yurevich, F.B. (1983). The effect of tropospheric aerosols on the earth's radiation budget: A parameterization for climate models. *J. Atmos. Sci.* **40**: 116-138.
- [3] Ghanti, R. and Ghosh, S. (2010). The Great Indian haze revisited: Aerosol distribution effects on microphysical and optical properties of warm clouds over peninsular India. *Advances in Geosciences*, **25**: 51-54.
- [4] Hoffmann, T., Odum, J.R., Bowman, F., Collins, D., Klockow, D., Flagan, R.C. and Seinfeld, J.H. (1997). Formation of organic aerosols from the oxidation of biogenic hydrocarbons. *J. Atmos. Chem.* **26**: 189–222.
- [5] Ichoku, C., Kaufman, Y. J., Remer, L.A, Levy, R., (2004). Global aerosol remote sensing from MODIS. *Advances in Space Research*, **34**: 820–827
- [6] Prakash Chauhan, Nivedita Sanwlani and Navalgund, R.R. (2009). Aerosol optical depth variability in the north eastern Arabian sea during winter Monsoon; a study using in –situ and satellite measurements. *Indian Journal of Marine Sciences*, **38(4)**: 390-396.
- [7] Satheesh, S.K and Ramanathan, V. (2000). Large differences in tropical aerosol forcing at the top of the atmosphere and the earth's surface. *Nature*, **405**: 60-63.
- [8] Satheesh, S. K., Krishnamurthy, K and Das, I. (2001). Aerosol optical depths over the Bay of Bengal, Arabian Sea and Indian Oceans. *Current Science*, **81**: 425-435.
- [9] Suresh, T., Dulac, F., Leon, G.F. and Ehrlich Desa. (1999). Aerosol properties over the Arabian Sea during north east monsoon. National Symposium on Tropical Meterology (TROPMET-99), 557-561.
- [10] Suresh, T and Elgar Desa. (2005). Seasonal variations of aerosol over Dona Paula, a coastal site on the west coast of India. *Atmospheric Environment*, **39 (19)**: 3471-3480.