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On Retrieval of Aerosol Asymmetry Parameter over Dehradun

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Abstract—*Aerosol properties influence the radiative budget at global and regional scales. The direct effects include absorption and scattering. On the other hand, indirect effects are evident in the alteration of cloud properties. In addition to the ground based instruments, space-borne sensors are used for the estimation of aerosol parameters. In this study, we have used Simple Model for Atmospheric Radiative Transfer (SMART), an approximate physical model for the estimation of aerosol asymmetry parameter in multiple scattering approximation. The study area chosen lies in Dehradun, Uttarakhand, India. Aerosol Optical Depth (AOD) has been recorded using Sun Photometer. The satellite data is taken from Indian satellite sensor, AWiFS, onboard Resourcesat-2 satellite. Land surface albedo is chosen from MODIS data product. The radiative transfer model is iterated with the choice of aerosol asymmetry parameter till the model retrieves the AOD corresponding to that observed on the ground.*

Keywords*: Asymmetry parameter, AOD, aerosol, AWiFS, SMART.*

1. INTRODUCTION

Aerosols affect the earth's climate system by changing the cloud properties and alteration of radiation budget. Hence, the knowledge of aerosols and their optical properties are crucial in the understanding of global and regional climate effects. The knowledge of land surface parameters along with atmospheric constituents is required in order to understand the radiative transfer process.

This paper is based on one of the many approximate models, i.e. Simple Model for Atmospheric Radiative Transfer (SMART) model. It makes use of approximate analytical equations and parameterizations that enable real-time parameter retrieval (Seidal et al., 2010, Seidal et al., 2012, M.Mehta et al., 2014). In this paper, we attempted to estimate the aerosol asymmetry parameter in multiple scattering mode. The aerosol asymmetry parameter is an important property that indicates the symmetry of scattered radiation.

MODIS Data, AWiFS data, and AOD values using Sun photometer are used as inputs to the model. Iterations for various asymmetry parameters are performed to get AOD values which are then are compared with the field data.

2. STUDY AREA AND DATA USED

Dehradun, the capital city of the Uttarakhand state, is situated in the south central part of Dehradun district. It is located in Doon valley, 230 kilometers north of India's capital, New Delhi. Geographically, the location of Dehradun is in between 29°58′ and 31°2′ N latitudes and 77°35′ and 78°18′ E longitudes. The location of the study area is shown in Fig. 1. The data used for this study is obtained for 3rd April, 2016.

Dehradun's climate is generally temperate, depending upon season and the altitude of the precise location. During summer, temperatures can reach 35°C and in winter temperatures are generally between 3.6° and 19.3°C. During monsoon season, there is heavy and stretched rainfall

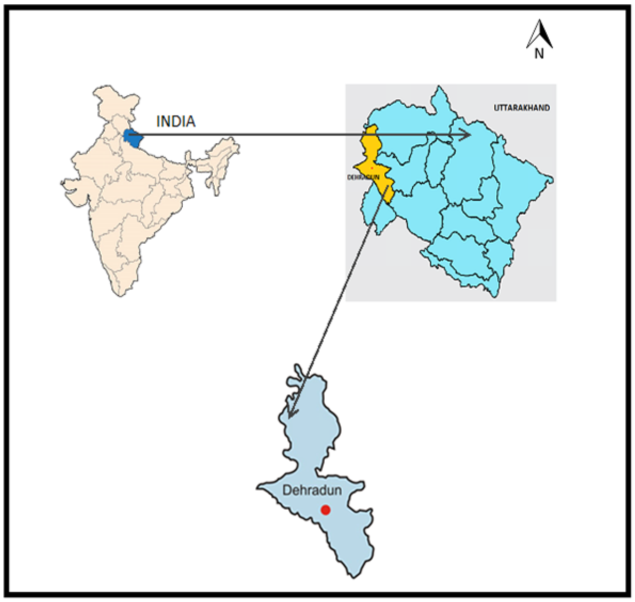

Fig. 1: Study Area

2.1 RESOURCESAT-II AWiFS data

AWiFS (Advanced Wide Field sensor) is a push broom sensor on board Resourcesat satellite which is realized in two electro-optic modules, AWiFS-A and AWiFS-B. The combined swath of the two modules is 740 km. The spatial resolution of the sensor is 56 m with four spectral bands. The radiometric resolution of the sensor is 12 bit with revisit period of 5 days. The data is acquired in four spectral bands, three in the visible-NIR (B2, B3 and B4) and one in the short wave infrared (SWIR B5). For this study, Band 2 data is used.

2.2 MODIS Albedo Product

MODIS is a near-polar satellite in sun synchronous orbit with Terra and Aqua sensors respectively. The swath of the sensor is 2330 km. There are 36 spectral bands with varying spatial resolutions. In this study MODIS land surface albedo product MCD43_A3 (Strahler et al., 1999) has been used which provides both directional and bi-hemispherical reflectance at 500 m resolution as 16-days aggregate. In this study, Band 4 data is used.

2.3 Sun Photometer

It is a hand-held instrument for measuring AOD at multiple wavelengths accurately. It consists of five filters for the determination of the same. The AOD values obtained at 500 nm are used in the study.

2.4 Softwares Used:

ERDAS IMAGINE 2014

MATLAB 2015

ArcGIS 10.2.2

3. METHODOLOGY AND RESULTS

Aerosol asymmetry parameter was estimated using SMART model by iterating the code for its values (Fig. 2). The input to the models were Top of Atmosphere (TOA) radiance obtained from AWiFS data, land surface Albedo obtained from MODIS data, AOD from Sun photometer data. The SMART model was run in the multiple scattering approximations. For details the readers are referred to Seidal et al., 2010, Seidal et al., 2012, A. A. Kokhanovsky et al., 2005, M.Mehta et al., 2014. The calculations were performed for varied Land Surface features, i.e. Water Body, Vegetation, Dry River bed, Forest and Urban Locations.

Table 1 shows the results obtained for the estimated aerosol asymmetry parameter that provided simulated AOD closest to that of sun photometer. The iterations were performed for values ranging from 0.2 to 0.8 for the case study. This technique exemplifies the use of Radiative transfer model which is approximate but simple; to estimate the aerosol asymmetry parameter. Future work will be focused upon estimation and evaluation of aerosol optical properties using similar techniques and involving more number of test cases.

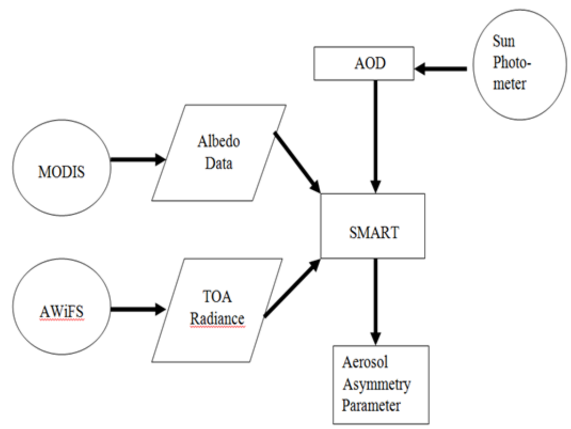

Fig. 2: Flowchart of overall methodology

Table 1: Comparison of the SMART Simulated and Sun photometer AOD values

Feature	AWIFS Estimated AOD	Sun photometer AOD
WATER BODY (N 30°26.234’) (E 077° 39.945’)	0.271	0.594
VEGETATION (N 30° 24.462’) (E 077° 44.487’)	0.426	0.695
DRY RIVERBED (N 30° 20.311’) (E 077° 52.320’)	0.850	0.662
FOREST (N 30° 20.899’) (E 077° 52.993’)	0.565	0.711

URBAN (N 30° 19.478') (E 078° 02.522')	0.581	0.668

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