H-O-6

EFFECT OF ANTHROPOGENIC ACTIVITIES ON UV INDEX VARIATIONS – A STUDY USING GROUND-BASED MEASUREMENTS AND SATELLITE DATA

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INTRODUCTION

The diurnal and annual variability of solar UV radiation reaching the ground is governed by astronomical and geographical parameters as well as by the atmospheric conditions. The most important factors affecting the UV radiation reaching the Earth's surface are atmospheric ozone, solar zenith angle, aerosols, altitude, atmospheric scattering, cloud cover and surface albedo (Meloni et al., 2004). The influence of aerosols on the transmission of UV radiation has important consequences for stratospheric and tropospheric photochemistry, human and plant biology, remote sensing of column ozone, and surface UV mapping. If the amount of UV radiation is sufficiently high, the self-protection ability of some biological species is exhausted and the subject may be severely damaged. The need to reach the public with simple-to-understand information about UV and its possible detrimental effects led scientists to define a parameter that can be used as an indicator of the UV exposures. This parameter is called the UV index(UVI). It is related to the well known erythemal effects of solar UV radiation on human skin and it has been defined and standardized under the umbrella of several international institutions such as World Meteorological organization (WMO), World Health Organization (WHO), United Nations Environment Program (UNEP), etc. In contrast to several of the above UVI, aerosol and ozone monitoring studies conducted all over the world in varied urban environments, relatively few studies have been conducted in the study region of Hyderabad, south India (Figure 1). Hyderabad is the fifth largest city in India, highly urbanized and its population is 5,751,780 inhabitants (Census, 2001). The city is influenced not only by urban pollutants but also by industrial as well as neighboring biomass burning trace gases and aerosols. In this study, we characterized the spatio-temporal variations in UVI and assess the correlations between ozone depletion and the amount of UV radiation that penetrates the atmosphere to reach the earth's surface. We analyzed the effects of dust and anthropogenic aerosols (from biomass burning) on ground reaching UV irradiance using ground based measurements and satellite data analysis.

DATASETS AND METHODOLOGY

The instruments used in this study were Ultra–Violet Multifilter Rotating Shadow band radiometer (UV-MFRSR), Microtops II Sunphotometer and SUV-Meter. The database used for this study was collected between January –May 2006. The UVMFR-SR works under the same principles as the original visible wavelength version described in Harrison et al. (1994) and is detailed in Bigelow et al. (1998). This instrument measures both total and diffuse irradiance for four specified wavelengths (299, 304.7, 310.8, and 317.1 nm) with a 2 nm nominal full width at half maximum (FWHM) bandwidth. Measurements of total and diffuse irradiance were recorded every 2 minute interval. There is filter-to-filter variation in the nominal wavelength center (±0.5nm), and each is characterized to an accuracy of ±0.02 nm as described by Gao et al., (2001). The cosine response and irradiance calibration of the UV-MFRSR were conducted (Yankee Environmental Systems) in spring 1999 before deployment to the field site. MICROTOPS-II sun photometer was used to measure aerosol optical depth (AOD) at different wavelengths viz., 380, 440, 500, 675, 870 and 1020nm (Leckner, 1978) *and total ozone column amount.* UV - meter from Solar Light Co., USA has been used to measure UV in the spectral range of 280-320nm over the study area in units of Minimum Erythema Dose per hour (MED/hr). The effective power of 1 MED/hr is equalent to 0.583 W/m^2 for an MED of 21 mJ/cm^2. This effective power of 1MED was utilized to convert the measured UVB radiation to W/m^2 when calculating the corresponding UV Index(UVI). The cosine response of the instrument is ±5% with a resolution of 0.01MED/hr (Minimal Erythemal Doses per Hour). In addition, to infer the forest fire characteristics over the Indian region, daily data sets of Defense Meteorological Satellite Program – Operational Line Scanner (DMSP-OLS) has been assessed from February–April, 2006 for generating nighttime fire products (Elvidge et al., 1997). In this study, we used the UV index (UVI), which describes the biologically effective solar radiation reaching the Earth's surface at a location. It is determined by weighting the incident solar radiation at the Earth's surface with the erythemal response of human skin at 280–400 nm and then summing over this wavelength range to derive a total effect. It is given as,

$$UVI = 40/Wm^2 \int_{280}^{400} E(\lambda)A(\lambda)d(\lambda)$$

Where, E (λ) is the irradiance at wavelength (λ) and A (λ) is the (dimensionless) CIE (*Commission Internationale de l'\'Eclairage* (*International Commission on Illumination*) action spectrum (McKinlay and Diffey, 1987). One UVI unit is equivalent to biologically effective solar UV radiation of 0.025 W m^{-2} effective (Gies et al., 2004).

RESULTS AND DISSCUSSION

UV radiation can neither be seen nor felt and the index is an important tool to raise awareness of the problem and alert people. Instead, of this we plotted the monthly average hourly UVI values from 09:00 to 16:00 LST are shown in figure – 1 over tropical urban region of Hyderabad, India from January - May, 2006. The UVI values on the ordinates have been separated into four ranges according to the generally accepted classification of the UVI vales, viz. extreme, UVI ≥ 9; high, 7< UVI < 9; moderate, 4< UVI < 7 and low UVI < 4. It is clear from the figure that midday hours during April and May exhibit high

UVI values. The high UVI value over Hyderabad in summer period during noon time is an alarm that may enhance noticeable spurt in skin and eye deceases. We have correlated the aerosol optical depth (AOD) measurements derived from Microtops II sunphotometer with UVI to evaluate the impact of aerosols on UVI. Figure – 2 shows a strong negative correlation in the scatter plots of UV index and AOD at 500 nm suggesting attenuation of UV radiation by aerosols. Reduction of ground reaching solar UV irradiance on 31, March 2006 during the presence of aerosols from biomass burning with AOD_{500} ~ 1.07 is almost 6% higher than on 10th April 2006 with dust aerosols suggesting relatively higher attenuation of UV radiation from aerosols from biomass burning predominantly containing soot particles. Figure – 3 shows the scatter plot of UV index (derived from SUV meter) and ozone measured from Microtops II sunphotometer. An inverse relation between the total ozone column and the UV Index was observed as shown in figure – 3. The negative correlation between UV index and ozone suggested a clear decrease in ground reaching UV–B irradiance during higher ozone conditions. Higher levels of ozone in urban areas of Hyderabad were attributed to photochemical production during the oxidation of trace gases emitted by fossil fuel and biomass burning (Shailesh et al2006; Lelieveld et al., 2000). Satellite data analysis on forest fires over the region showed higher incidence of forest fires on days with increased Ozone concentrations and aerosol loading. The combined analysis of satellite data sets and ground measurements enables to address the observed variations in UV-Index over urban region of Hyderabad.

CONCLUSIONS

In the present study, we characterized the UV radiation characteristics and its controlling factors in the typical urban environment, Hyderabad, India using ground based measurements including UV-MFFRSR, SUV-meter, Microtops II Sunphotometer and satellite data. Results of the study suggested that,

- In addition to urban pollutants, aerosols from biomass burning play a significant role on ground reaching UV-B radiation, in the study region.
- The inverse correlation between UV index and ozone measurements suggested a clear decrease in ground reaching UV–B irradiance during higher ozone conditions.
- Reduction of ground reaching solar UV irradiance on 31, March 2006 (AOD_{500} ~ 1.07) is almost 6% stronger than on 10th April 2006 (AOD_{500} ~ 0.86), suggesting relatively higher attenuation of UV radiation from aerosols from biomass burning predominantly containing soot than dust aerosols.

ACKNOWLEDGEMENTS

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Figure – 1

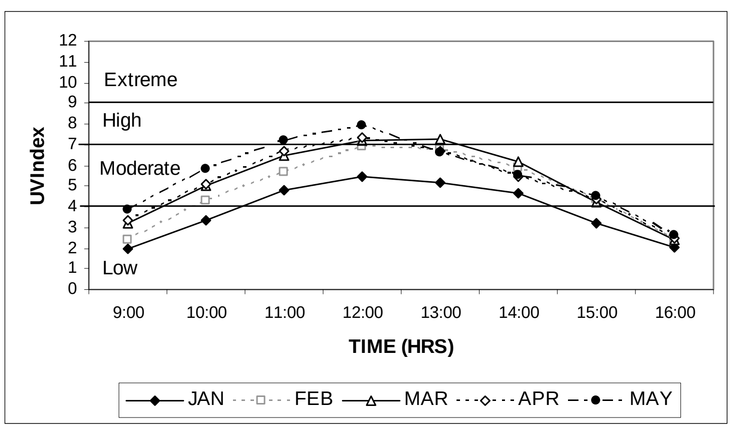

Figure – 2

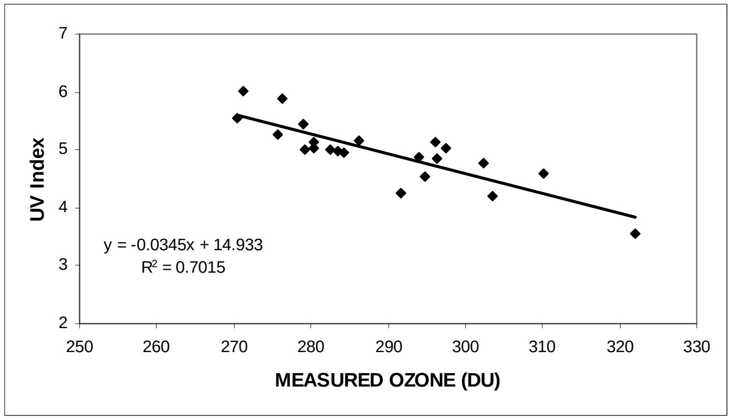

Figure – 3