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MULTI-YEAR ANALYSIS OF COLUMNAR OZONE, UV_{ery} AND UV-A OVER TROPICAL URBAN REGION OF HYDERABAD

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INTRODUCTION

Ozone is one of the major greenhouse gases in the Earth's atmosphere (Goody and Yung, 1989, IPCC,1996). It has been proposed that ozone, especially the lower stratospheric component, can affect the earth's climate significantly (Lacis et al, 1990). Near the surface, ozone can be produced in high concentrations as a result of industrial activities (Fusco and Logan, 2003). With continuous global industrial growth, the near surface ozone has at least doubled during the last century (Mickley et al., 2001). The low concentration of tropospheric ozone beneath the larger concentration of the stratospheric ozone makes it difficult to measure by top of the atmosphere (TOA) based remote sensing techniques. Ground-based measurement therefore becomes a reasonable alternative to TOA ozone profile retrievals. The potential for increased solar ultraviolet (UV) radiation reaching the Earth's surface in response to ozone (O_3) reduction has been a major concern since the first signs of ozone depletion in the early 1980s. Although UV is a small fraction of the total radiant solar energy, it may produce detrimental effects on the ecosystem and degrading effects on materials, and therefore knowledge of its variability in time and space has high priority in scientific research. Monitoring of UV radiation has been a challenging task because of the great difficulties in conducting accurate measurements and proper quality control, and because UV is highly variable both in time and space. In the present study continuous measurements on columnar ozone, UV-B, UV-A and Aerosol Optical Depth (AOD) were carried out over urban area of Hyderabad, India.

DATASETS AND METHODOLOGY

MICROTOPS-II sun photometer was used to measure aerosol optical depth (AOD) at different wavelengths viz., 380, 440, 500, 675, 870 and 1020nm and total ozone column amount. UV - meter from Solar Light Co., USA has been used to measure UV radiation in the spectral range of 280-320nm (UV-B) and 320-400 nm (UV-A) over the study area in units of Minimum Erythema Dose per hour (MED/hr) and mw/cm^2. Global distribution of the Ozone and UV intensity were evaluated with archived data of the Earth Probe (EP)/Total Ozone Mapping Spectrometer (TOMS).

RESULTS AND DISSCUSSION

Figure – 1 (a-c) shows the scatter plots of Total Ozone Mapping Spectrometer (TOMS) total column ozone and ground measured ozone (from MICROTOPS II sun photometer) for the year of 2004, 2005 and 2006. The ground measured ozone data show good agreement with the satellite measured ozone data. The correlation coefficient *r* is

0.82, 0.88 and 0.70 for the year of 2004, 2005 and 2006. The spectral characteristics of the surface UV radiation have great importance in terms of their biological effects. The different aerosol loading and their different properties have a great influence on the amounts of solar radiation reaching the ground. Figure – 2 shows the statistical fit through the average data points of AOD and UV_{ery} during 2006 suggesting negative gradient. The slopes of the figure suggested that every 0.1 increase in AOD causes 0.53 MED/hr reduction in ground reaching UV_{ery}. This is the average direct radiative forcing efficiency at surface by aerosols in the UV_{ery} over tropical urban environments of Hyderabad.

Figure – 3 shows the Julian day variations of UV_{ery} and UV-A radiations over urban region of Hyderabad during 2006. As expected, there is an increasing trend in UV_{ery}, and UV-A values from January to April due to the higher sun elevation, while the largest UV_{ery}, and UV-A values are observed in the middle of March. The low UV_{ery}, and UV-A values on certain days (e.g. around 57^{th}, 85^{th} and 92^{nd} Julian days) seem to correlate well with large forest-fire counts over the region as analysed from satellite data. This is also confirmed by ground measurements of aerosol optical properties.

CONCLUSIONS

Continuous measurements on columnar ozone, UV_{ery}, UV-A and Aerosol Optical Depth (AOD) at different wavelengths were carried out over the urban region of Hyderabad, India, for the period of 2004, 2005 and 2006. The analysis of the results suggested that –

- Measurements of columnar ozone from sun photometer showed significant correlation with TOMS ozone.
- Aerosols from biomass burning play a significant role in attenuating surface reaching UV-B radiation.
- The aerosol radiative forcing estimated from simultaneous measurements of AOD and UV_{ery} suggested that every 0.1 increase in AOD causes ~0.53 MED/hr reduction in ground reaching UV_{ery}.

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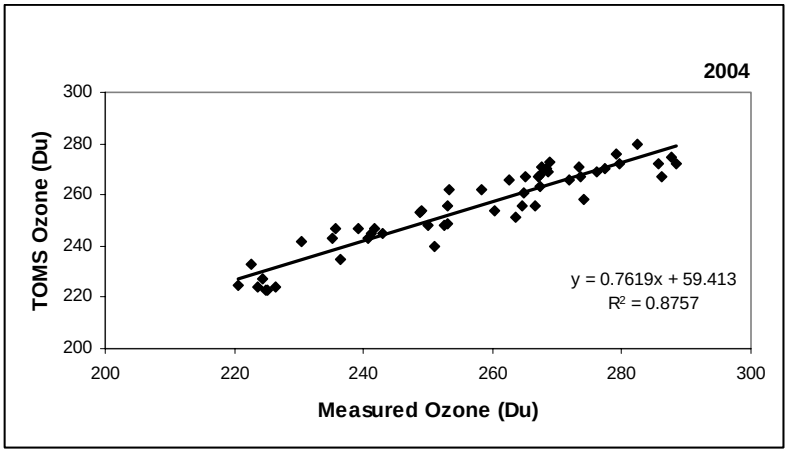
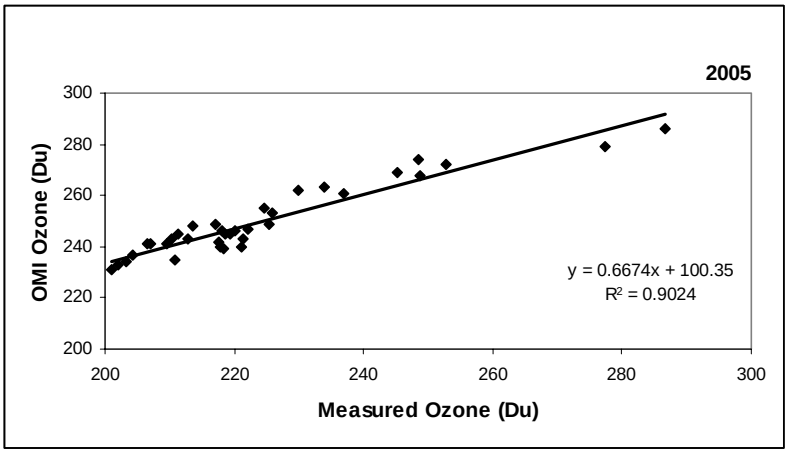
Figure – 1

(a)


2004
TOMS Ozone (Du)
Measured Ozone (Du)
y = 0.7619x + 59.413
R² = 0.8757
300
280
260
240
220
200
200
220
240
260
280
300

(b)


2005
OMI Ozone (Du)
Measured Ozone (Du)
y = 0.6674x + 100.35
R² = 0.9024
300
280
260
240
220
200
200
220
240
260
280
300

(c)

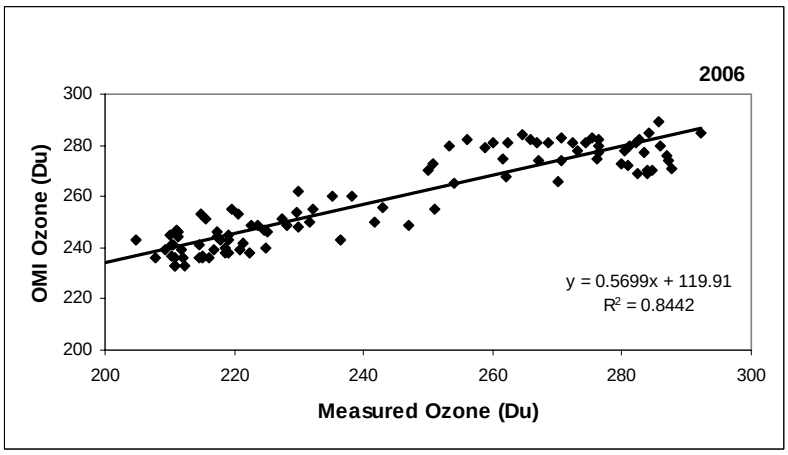

2006
OMI Ozone (Du)
Measured Ozone (Du)
y = 0.5699x + 119.91
R² = 0.8442
300
280
260
240
220
200
200
220
240
260
280
300

Figure – 2

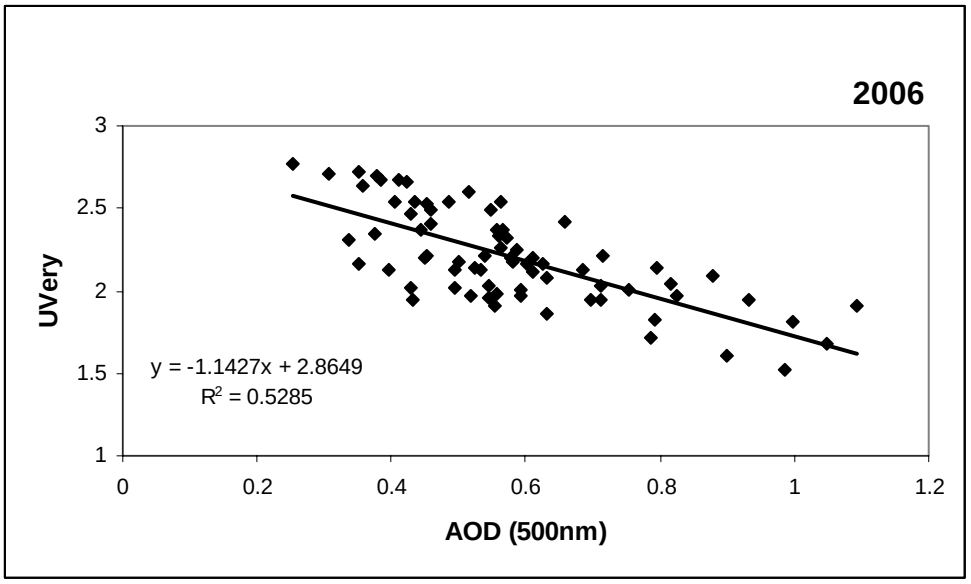


Figure – 3