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Effective UV irradiance & total Ozone column – a case study using data from TOMS and Microtps II sunphotometer

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Ozone plays a particularly significant role in the chemistry of the Earth's atmosphere, though in terms of abundance it is a 'minor species'. Several factors contribute to ozone's importance but perhaps the most important feature is the relationship between the absorption spectrum of ozone and the intensity of solar UV radiation harmful for living beings.

Although the Sun emits a large spectrum of radiation, the UV radiation constitutes a small part of it. Regarding its biological effects, it can be divided in three main ranges UV-A(315-400nm), UV-B(280-315nm) and UV-C(100-280nm)[Madronich et al., 1998]. While the UV-C radiation is completely blocked (absorbed) by atmospheric Oxygen (O_2) and Ozone (O_3) in the middle and upper atmosphere, the UV-B radiation is absorbed efficiently though not completely by the stratospheric ozone. Around 300-320nm wavelength region, the sole agent for absorption of this portion of the solar radiation is the atmospheric Ozone. Therefore, the intensity of solar UV-B radiation on the surface depends on the ozone layer concentration and more Ozone should give less UV-B radiation at ground level. The UV-B radiation has been reported to cause skin cancer and several other effects on human health as well as detrimental effects on animal and plants [Roy et al., 1994].

Total Ozone column is measured by a handheld Microtops II sunphotometer in presence of enough sunlight. The variation of the UV radiation intensity on the earth's surface is dependent on geometrical factors (solar zenith angle, Earth-Sun distance, altitude and latitude) and atmospheric factors. Measurements of the total ozone column density (at 305,312,320nm), columnar water vapor, and AOT(at 1020nm) have been made since May 2003 at Kolkata (22°N, 88°E) and during Dec. 2004 at Kharagpur (22°N, 87°E) as part of ISRO-GBP Land Campaign II.

On examination, reasonable agreement was observed between data obtained from TOMS and Mcrotops II sunphotometer. From the day to day and month to month temporal variation of total columnar Ozone (in DU) and UV-B irradiance (in W/m^2) we find anticorrelation. A study of the temporal variation of AOT with total column ozone shows a negative correlation (-0.567 at KGP; -0.645 at Kolkata). The squared correlation coefficients (R^2) for both the linear and first order exponential fit are determined. The UV-B variations are explained considering only ozone variation at fixed SZA and clear sky conditions. The values for linear fits varied from R^2=0.46 (SZA=55°) to R^2=0.79 (SZA=48°). However, better correlation is obtained for smaller SZA. This is probably because in higher SZA the optical depth that the UV-B radiation crosses is larger than in smaller SZA. For larger optical depth it would be expected an increased aerosol scattering effect and as a consequence a worse anticorrelation with ozone results.