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Characteristics of Erythemal Ultraviolet-B Irradiance Change with Atmospheric Conditions

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1. Introduction

The increase of surface ultraviolet radiation caused by the decrease of the stratospheric ozone gives human damage stimulating to skin cancer, cataract, DNA damage and changes atmospheric environment by photochemical reaction of the atmosphere(Herman et al., 1996). Therefore, although the surface ultraviolet radiation is very few quantity comparing with solar radiation of all wavelength band, it is a very important wavelength band in the biological and environmental point of views. Generally, The surface ultraviolet radiation changes temporally and spatially by extra-terrestrial solar radiation, solar zenith angle, cloud condition, total ozone amount, surface albedo and atmospheric turbidity. Thus, in this study, we wish to analyze characteristics of the surface ultraviolet radiation with atmospheric conditions using the erythemal ultraviolet-B irradiance data for latest several years.

2. Data and Methodology

The erythemal ultraviolet-B irradiance which the wavelength has 280~320nm was known that is specially harmful in human body or a creature. The ultraviolet radiation uses a weighted value of spectral function that has an effects on other wavelength according to kind of a creature because the ultraviolet radiation differs effects on creature with wavelength(Madronich et al., 1991; action spectrum). The erythemal weighted ultraviolet-B(after called EUV-B) radiation that integrated UV-B domain is expressed as following,

$$EUV-B=\int_{280nm}^{320nm} E(\lambda)\,W(\lambda)\,d\lambda \qquad (1)$$

where the $E(\lambda)$ is the ultraviolet radiation intensity by wavelength($Wm^{-2}nm^{-1}$) and the $W(\lambda)$ is CIE (Commision Internationale de L'Eclairage) erythemal action spectrum. Therefore, the intensity of weighted UV-B radiation has a unit of Wm^{-2}(Cho et al., 2001). The EUV-B irradiance data used in this study is from January 1999 to December 2007. The UV-Biometer(Solar Light Co., Model 501) measures automatically every 10 minute. The Minimal Erythemal Dose(MED) (after called MED) is extensively used as a measurement unit of the skin damage by sunlight. 1 MED is the minimal level of the ultraviolet radiation sufficient to produce erythema on skin within 24 hours after exposure to sunlight. 1 MED measured by the UV-Biometer corresponds to 210 Jm^{-2} in the horizontal level(Solar Light, 1993). The data processing to analysis for seasonal and annual variation of the ultraviolet radiation converted 144 MED values observation data measured every 10 minute by the day into the EUV-B irradiance data. The EUV-B irradiance having maximum value was chosen a daily representative value. The clear-sky day for the EUV-B irradiance data selected and used the day that a curved line of the EUV-B irradiance suits well in cosine curved form(Song et al., 2005). The UV-Biometer which measures the EUV-B irradiance was verified every twice year by Solar Light Co.

3. Results and discussion

Fig. 1 shows the variations of the EUV-B irradiance with weather conditions. We selected Case I and Case II in order to analysis for variation of the EUV-B irradiance with weather conditions. The Case I was April, 8, 2002 and 2006 as Asian dust case, and the Case II was April, 24, 2006. Case I was analyzed for variation trends of the EUV-B irradiance with weather conditions of April, 8, from 1999 to 2006. The April, 8, 2005 shows a typical clear-sky day. The EUV-B irradiance was 188 mWm^{-2}. Also, the average cloudiness of cloudy sky day was 5~8 in tenth. The EUV-B irradiance at this time decreased 20 to 30% compared with clear sky day. The Asian Dust Case in the year 2002 and 2006 decreased 41 to 60% compared with clear sky day. The Aerosol Optical Depth(AOD) at this time was 1.2 to 1.95 at 500nm. The Case II is less than Case I viewing from a intensity of the Asian Dust and cloudiness. The rate of the EUV-B irradiance attenuation and AOD was 35% and 0.8 at 500nm, respectively.

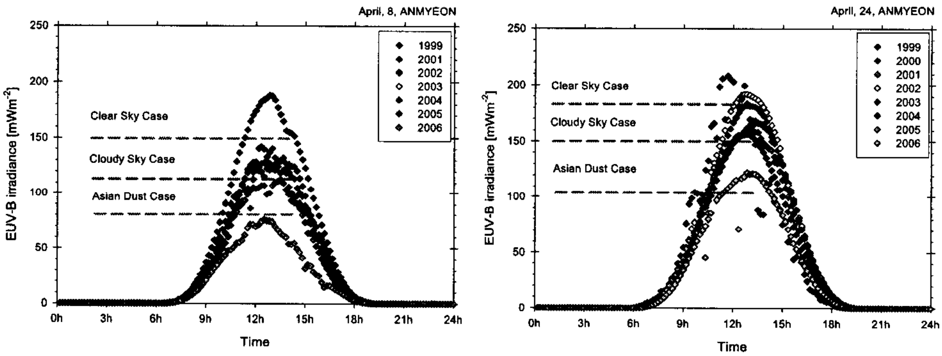

Fig. 1. The variation of the EUV-B irradiance with weather conditions(Clear-sky, cloudy-sky and Asian Dust case).

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