

SOLAR ULTRAVIOLET IRRADIANCE INCIDENT ON A HORIZONTAL SURFACE AT TAEGU IN KOREA DURING 1995-1998: (II) ULTRAVIOLET-B

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Abstract—Solar ultraviolet-B (UV-B) irradiances incident on a horizontal surface at Taegu of Korea during 1995-1998 were calculated with 5 min averages of measurements taken every 30 seconds by a broadband UV-B sensor. The maximum and minimum of monthly averages of daily UV-B dose were 15.89 KJ m⁻² day⁻¹ in April and 3.91 KJ m⁻² day⁻¹ in December for 4 years of the observation period. The maxima of daily UV-B dose and instantaneous UV-B were observed as 32.11 KJ m⁻² day⁻¹ on May 22, 1998 and 1.230 W m⁻² at 12:45, July 13, 1998, respectively. Increasing trend in annual maxima of instantaneous UV-B radiation was averaged to 12.0% per year during 1995-1998 of observation period.

INTRODUCTION

The ozone reduction in the stratosphere over Antarctica¹ has produced public concern about the increase in ultraviolet-B radiation (UV-B, 280-320 nm) reaching the earth surface² because UV-B radiation effects on living organisms at all levels, ranging from molecules, cell organelles and plant organs to the whole plant. The depletion reached 71% during several days in 1993 and 1994 which is the globally most pronounced stratospheric ozone depletion.³ An abrupt 50% reduction in stratospheric ozone could inhibit photosynthesis of Antarctic phytoplankton up to 8.5% by increased near-surface UV-radiation.⁴

However, the ozone loss is not restricted to Antarctica but has also been shown in the Arctic⁵ and at mid-latitudes in both hemispheres.^{6,7} Kerr and McElroy have reported that in Toronto (44°N) UV-B (300 nm) increased by 35% per year in winter and 6.7% per year in summer between 1989 and 1993.⁸ Global UV levels are predicted to peak around the turn of the century in association with peak loading of chlorine in the stratosphere and the concomitant ozone reductions. The recovery to pre-ozone depletion levels is expected to take place gradually over the next 50 years.⁹

Monitoring of UV-B at the specific area is essential to evaluate the effect of increased UV-B at that area because global UV-B reaching the earth surface is also affected by other factors such as cloud, aerosol, gaseous pollutant in the troposphere.¹⁰ Here I report results from solar UV-B measurements on a horizontal surface at Taegu, Korea during 1995-1998.

MATERIALS AND METHODS

Measurements were done at Kyeongsan campus of Taegu university in Korea (35° 53' 45" N, 128° 50' 56", 70m above

sea level) for 1,157 days from Jan. 1, 1995 to December 31, 1998 except the days of raining, snowing and calibration.

Solar UV-B irradiances were measured with a SKU 430 UV-B sensor and a SDL 2500 data-logger from Skye Instruments (U.K.) which has 293 nm of center wavelength and 27 nm of full width half maximum wavelength. The sensor installed horizontally on the roof of Life Science building at Taegu university was inspected and cleaned regularly. Raw signal voltages from the sensor were converted to the units of watt m⁻² by the simple linear relationship. 5 minute averages of instantaneous values taken every 30 seconds were registered and stored in the logger.

Daily UV-B dose was regarded as the sum of instantaneous 5-minute averages from sunrise to sunset time which was calculated everyday with the equation describing the elevation angle of the sun on a day in a year.¹¹

RESULTS AND DISCUSSION

Monthly average of daily UV-B dose

The monthly and annual averages of daily UV-B dose are shown in Table 1. During the period of 1178 days, daily UV-B dose was averaged to 10.40 KJ m⁻² day⁻¹. Annual averages of daily UV-B dose were calculated as 11.96, 11.11, 11.35 and 7.20 (100: 93: 95: 60) KJ m⁻² day⁻¹ for 1995, 1996, 1997 and 1998, respectively.

The maximum and minimum of monthly average of daily UV-B dose were 15.89 KJ m⁻² day⁻¹ in April and 3.91 KJ m⁻² day⁻¹ in December for 4 years of the observation period. Monthly averages of daily UV-B dose ranged from 1.34 KJ m⁻² day⁻¹ in Dec. 1998 to 22.65 KJ m⁻² day⁻¹ in May 1998. The month of maximum UV-B dose was April instead of June which includes summer solstice because the rainy sea-

Table 1. Monthly averages of daily UV-B dose ($\text{KJ m}^{-2} \text{day}^{-1}$) incident on a horizontal surface at Taegu in Korea during 1995-1998

Month	1995	1996	1997	1998	Average
1	11.461	3.658	4.568	6.628	6.579
2	12.228	5.117	5.549	6.428	7.330
3	14.941	n/a	8.902	9.884	11.242
4	16.075	15.488	11.536	20.456	15.889
5	12.188	15.702	12.495	22.647	15.758
6	13.033	18.234	16.177	8.595	14.010
7	19.040	16.195	17.368	6.347	14.738
8	17.574	14.825	15.444	5.545	13.347
9	10.287	11.114	13.858	7.407	10.666
10	8.386	8.181	13.978	3.640	8.546
11	5.138	5.591	9.845	1.450	5.506
12	3.149	3.862	7.286	1.340	3.909
Average	11.959	11.113	11.350	7.197	10.405

son usually starts at the middle of June in Korea.

Monthly maxima of daily UV-B dose

The monthly and annual maxima of daily UV-B dose are shown in Table 2. During the period, the maximum of daily UV-B dose was observed as $33.11 \text{ KJ m}^{-2} \text{day}^{-1}$ on May 22, 1998. Annual maxima of daily UV-B dose were recorded as 29.12, 27.35, 26.58 and 33.11 (100: 94: 91: 114) $\text{KJ m}^{-2} \text{day}^{-1}$ for 1995, 1996, 1997 and 1998, respectively.

Instantaneous UV-B

During the period, the maximum of instantaneous UV-B was observed as 1.230 W m^{-2} at 12:45, July 13, 1998. Annual maxima of instantaneous UV-B were recorded as 0.996, 1.034, 1.081 and 1.230 (100: 104: 109: 124) W m^{-2} for 1995, 1996, 1997 and 1998, respectively (Table 3). Monthly maxima of instantaneous UV-B ranged from 0.224 W m^{-2} on Dec. 04, 1995 to 1.230 W m^{-2} on July 13, 1998. Increasing trend in annual maxima of instantaneous UV-B radiation was averaged

Table 2. Monthly maxima of daily UV-B dose ($\text{KJ m}^{-2} \text{day}^{-1}$) incident on a horizontal surface at Taegu in Korea during 1995-1998

Month	1995	1996	1997	1998
1	15.179	5.201	8.788	7.750
2	15.590	6.015	8.438	9.300
3	18.770	n/a	13.150	14.245
4	29.119	20.493	15.427	30.581
5	18.144	20.961	18.260	33.113
6	17.711	24.939	22.035	21.370
7	27.575	27.352	21.422	16.690
8	27.810	22.254	22.986	16.755
9	16.753	17.918	26.577	17.462
10	10.123	12.095	18.633	11.133
11	7.056	10.356	15.640	5.235
12	4.269	8.146	10.478	3.201

Table 3. Monthly maxima of instantaneous UV-B radiation (W m^{-2}) incident on a horizontal surface at Taegu in Korea during 1995-1998

Month	1995	1996	1997	1998
1	0.497	0.271	0.463	0.462
2	0.533	0.294	0.491	0.512
3	0.694	n/a	0.615	0.845
4	0.827	0.693	0.718	0.941
5	0.780	0.727	0.831	1.055
6	0.858	0.987	1.013	1.126
7	0.992	0.949	0.962	1.230
8	0.996	1.034	1.081	1.204
9	0.785	0.853	0.923	0.952
10	0.539	0.606	0.696	0.724
11	0.363	0.467	0.602	0.386
12	0.224	0.389	0.401	0.327

to 12.0% per year during 1995-1998 of observation period.

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