3.2.4. MLO AND BOULDER UV SPECTRORADIOMETERS

Introduction

UV spectroradiometers were installed at MLO in July 1995 and at the Boulder DSRC in June 1998. The first instrument (UVL) operated at MLO until June 1997. The next instrument (UV3) was installed at MLO in November 1997 and is still in operation. After removal from MLO, the UVL instrument was installed in Boulder and then replaced by a new instrument (UV4) in September 1999. UV data from MLO were described by *Bodhaine et al.* [1996, 1997], and briefly in *CMDL Summary Reports No. 23 and 24* [*Hofmann et al.*, 1996, 1998]. The UV irradiances measured at MLO are much larger than at low-altitude midlatitude locations, primarily because of less Rayleigh scattering, but also because of lower column ozone in the subtropics. The complete data set selected for clear mornings at MLO and clear mornings and afternoons at Boulder is presented in this report. Clear mornings occur at MLO approximately 60% of the time providing an excellent site for solar radiation measurements. All processed spectral data are available from the solar radiation division of the CMDL program.

Instrumentation

The UVL spectroradiometer was described by *McKenzie et al.* [1992] and *Bodhaine et al.* [1997]. Briefly, a diffuser designed to minimize cosine error and machined from Teflon is mounted as a horizontal incidence receptor to view the whole sky. For UVL, stepper-motor driven gratings cover the spectral range of 290-450 nm in a single scan with a bandpass of about 1 nm. The newer instruments (UV3 and UV4) cover the range 285-450 nm with a bandpass of about 0.8 nm and use fiber optic cables to transmit the light from the sensor to the spectrometer. A complete forward scan for UVL requires about 3 minutes. The UV3 and UV4 instruments do a backward scan and then a forward scan centered at the desired solar zenith angle (SZA) and, therefore, require about 6 minutes for a complete measurement. All instruments are programmed to perform scans every 5 degrees of SZA during daytime hours.

Absolute calibrations of the spectroradiometers are performed at approximately 6-mo intervals using 1000-W FEL lamps traceable to NIST standards. Weekly stability calibrations are performed using mercury lamps and 45-W standard lamps as long-term stability checks. The expected long-term accuracy of the spectroradiometer systems is expected to be better than ±5%.

Data Analysis

For the following analyses, UV spectroradiometer data for 45° SZA were chosen for clear mornings at MLO during the July 1995-December 1999 time period. This gives approximately 4.5 years data and includes ozone values in the range of 212-330 Dobson units (DU). For Boulder data, 70° SZA and the period July 1998-December 1999 were used, covering an ozone range of 230-390 DU. Clear mornings at MLO and Boulder were determined in the same manner as in previous studies; that is, a day was accepted as a clear day at MLO if the sky was cloudless from dawn through the time of the desired scan and if Dobson ozone data were available for that morning. At Boulder, generally speaking, the sky had to be clear at the time of the scan. Figure 3.16 shows MLO ozone and UV erythema data for July 1995-December 1999. Figure 3.17 shows similar data for Boulder for July 1998-December 1999. Erythemal radiation data were obtained from the spectroradiometer data for both sites by applying the erythemal weighting function of *McKinlay and Diffey* [1987] and integrating over wavelength for each scan, as discussed by *Bodhaine et al.* [1997]. Figures 3.16 and 3.17 also show the time series of ozone at the two sites. The inverse relationship of UV erythema and ozone is apparent.

Figures 3.18 and 3.19 show the relationships between UV erythema and ozone at MLO and Boulder, respectively, for the time period July 1998-December 1999. The radiative amplification factor (RAF), defined as the percent change of UV (erythemal) irradiance divided by the percent change of total ozone, was calculated for both sites for 70° SZA using the power-law formulation of *Madronich* [1993]: RAF = $-\Delta\ln(I)/\Delta\ln(O_3)$, where I is UV irradiance. The RAF is simply the slope of a straight-line fit on a log-log plot. The data for Boulder are subject to more scatter because of less pristine clear sky conditions than for MLO.

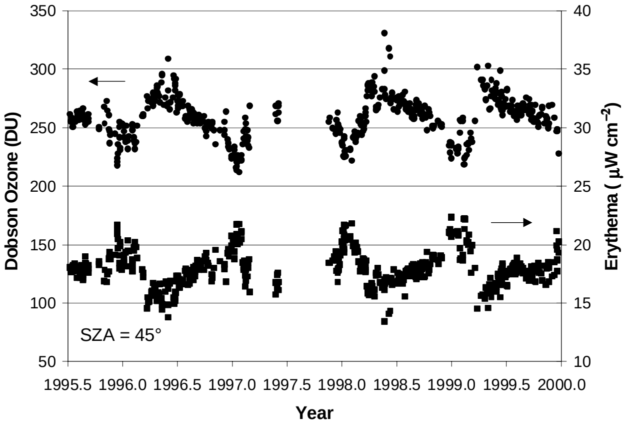

Fig. 3.16. Erythemal irradiance at SZA 45° (bottom, squares) and total ozone (top, circles) for clear-sky mornings at MLO from July 1995-December 1999.

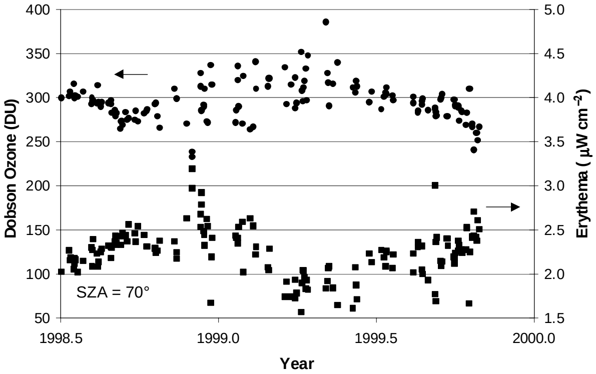

Fig. 3.17. Erythemal irradiance at SZA 70° (bottom, squares) and total ozone (top, circles) for clear-sky mornings and afternoons at Boulder from July 1998-December 1999.

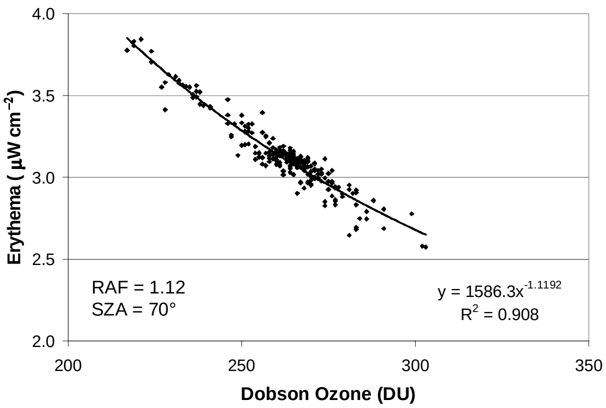

Fig. 3.18. Power law regression between erythemal irradiance at SZA 70° and Dobson total ozone at MLO from July 1998-December 1999. The graph is plotted on a linear scale to facilitate reading the units. The coefficient of the power law function (1.12) gives the RAF.

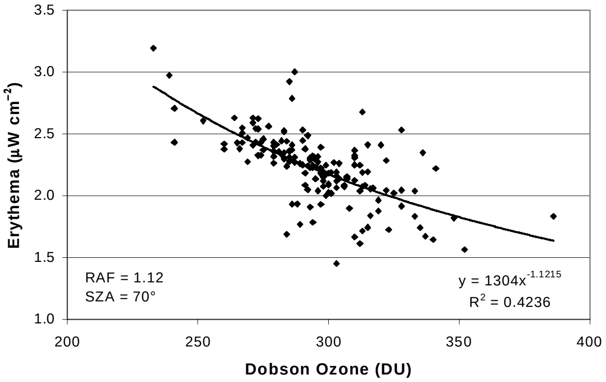

Fig. 3.19. Power law regression between erythemal irradiance at SZA 70° and Dobson total ozone at Boulder from July 1998-December 1999. The graph is plotted on a linear scale to facilitate reading the units. The coefficient of the power law function (1.12) gives the RAF.

Conclusions

1. Erythema irradiance calculated from UV spectra at MLO and Boulder is inversely correlated with Dobson total ozone.
2. The erythema RAF measured at MLO and Boulder for the 1.5-yr period is about 1.12 for both sites, in reasonable agreement with current modeling efforts.
3. No significant trend in UV irradiance may be inferred because of the limited time period.