SOLAR UV-B MEASUREMENTS WITH A DOUBLE MONOCHROMATOR BREWER SPECTROPHOTOMETER

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Recently a new Brewer instrument was developed, equipped with a double monochromator spectrometer in order to further improve the spectral measurements of solar ultraviolet radiation, especially at wavelengths lower than 300 nm. The operational wavelength range of this instrument extends from 285 up to 365 nm, and the scans are normally taken in steps of 0,5 nm. The spectral resolution of the instrument is controlled by the three slits (entrance, middle and exit) and the effective bandwidth at half height is about 0,55 nm, as seen also from figure 1. The slit function of the instrument presented in this figure was obtained from measurements of a mercury lamp in steps of 0,1 nm, and it appears that it has a rather defined triangular shape. Plotting of the same function in logarithmic scale (dashed line, right axis) gives an idea of its shape at the edges, which is very important in the UVB region because each measurement can be strongly affected by the neighboring wavelengths of higher intensity. Unfortunately we cannot draw any safe conclusions because the mercury line used for the measurements is not as fine as it is required, and all details are suppressed.

Another important characteristic of a UVB instrument is the cosine response of the input optics. The Brewer is equipped with a teflon diffuser, shaped at the edges, which is placed under a quartz dome for weather protection. The ratio of the instrument's cosine response over the true cosine is shown in figure 2 for the full range of angles of incidence (-90 to 90 degrees). It appears that the behavior of the instrument is within a few percent for the angles lower than about 60 degrees and almost symmetrical. The deviation from the true cosine becomes larger at the high angles, at which, however, the contribution of the direct component of the sun light is weaker. It should be noted here that the cosine response of the instrument refers only to the direct sun light, because the diffuse light is not affected at all.

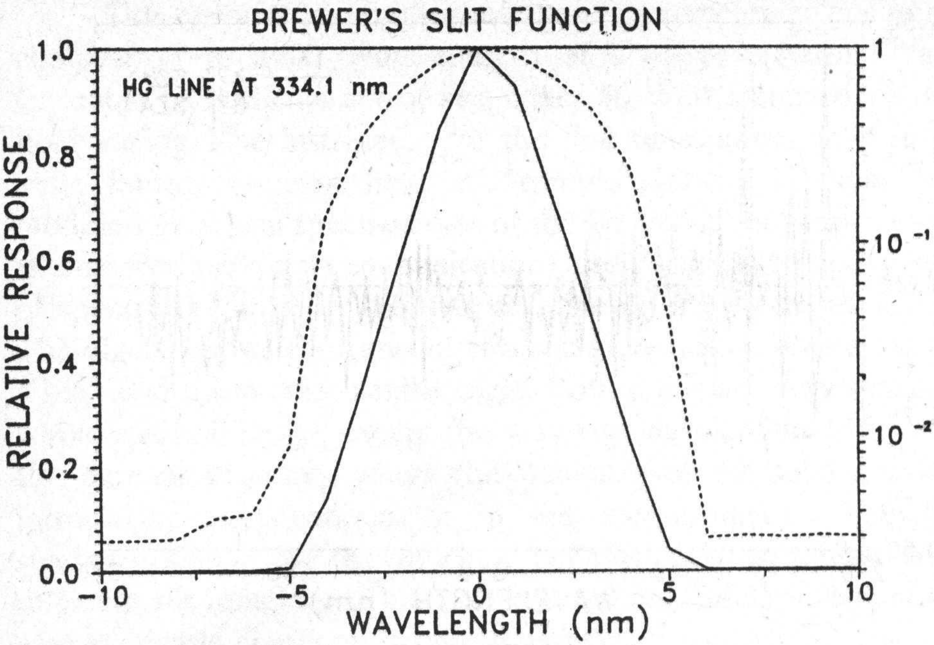

Figure 1: Brewer's slit function, using the mercury line at 334.1 nm, plotted in linear (left axis, solid line) and logarithmic (right axis, dashed line) scales

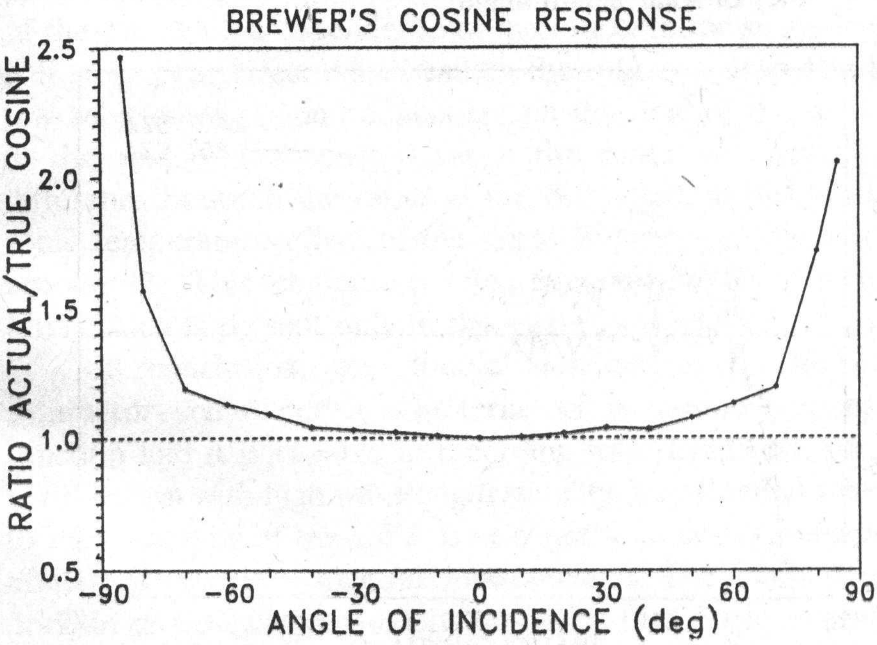

Figure 2: Ratio of the measured intensity of a halogen lamp for various angles of incidence over the cosine of these angles

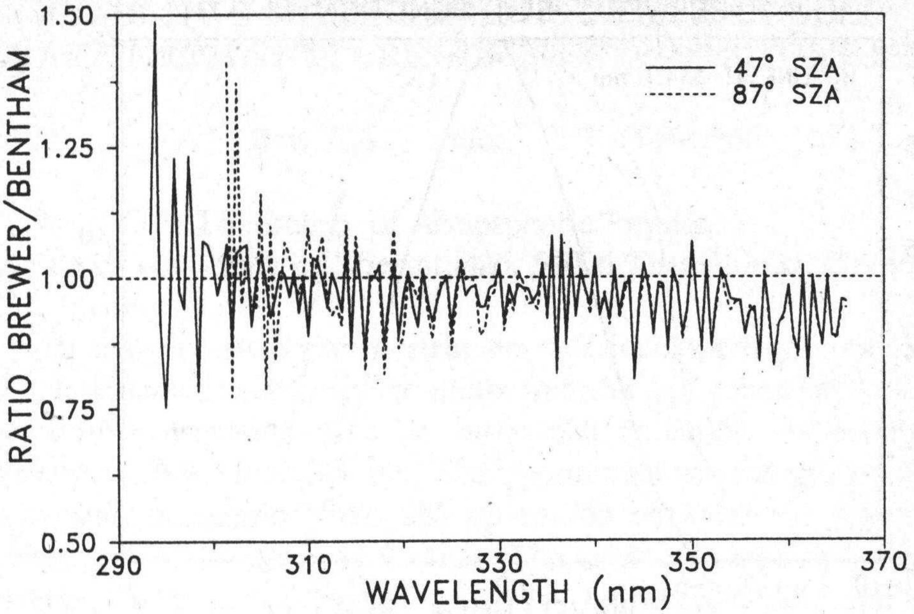

Figure 3. Ratio of spectra obtained by the double monochromators Brewer and Bentham at 47° (solid line) and 87°' (dashed line) of solar zenith angle

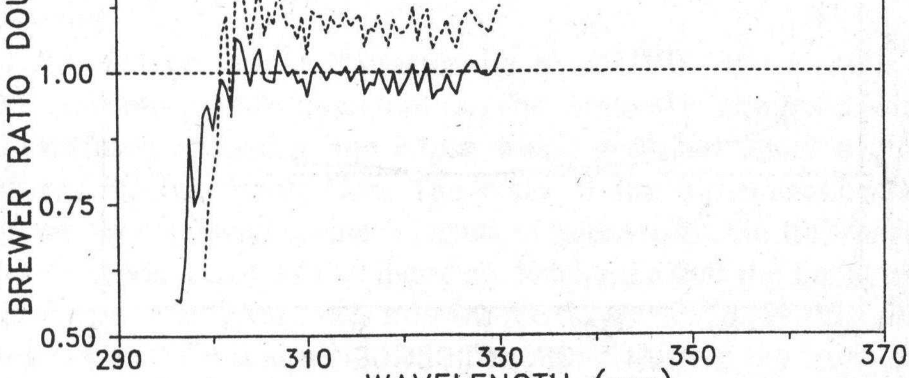

Figure 4. Ratio of spectra obtained by the double and the single monochromator Brewers at 40° (solid line) and 85° (dashed line) of solar zenith angle

The absolute calibration of the spectrometer is maintained by comparison to 1000 Watt sources of absolute spectral irradiance, traceable to NIST. A set of secondary 50 Watt standards is used for field testing. The instrument for the first time participated in a small scale intercomparison held in Tromso, Norway in June 1993. A modified Bentham spectrometer of the University of Innsbruck (Mario Blumthaler, personal communication) also participated and an example of spectra obtained by the two instruments are presented in figure 3. This figure shows the ratio of two simultaneously obtained spectra at a high and a low solar zenith angle. Both ratios are very similar in the whole spectral range, except the very low wavelengths (depending on the time of the day), where the weakness of the solar irradiance is introducing significant noise in the measurements. The peculiar structure shown on the ratios is believed that is caused from the different slit functions of the two instruments (Bentham's bandwidth is almost double compared to the Brewer).

A second example from a comparison with the single monochromator Brewer #005 of the University of Thessaloniki is presented in figure 4. Here the results are different especially in terms of the wavelength dependence of the ratios. In the single Brewer there is a stray light effect which causes the ratios to drop abruptly at the low wavelengths (again dependent on the time of the day). However in the rest of the spectral range the ratios are quite stable. The difference between the ratios at the two zenith angles is attributed to some temperature effect of the single Brewer which is not taken into account yet. This temperature effect is caused mainly by a $NiSO_4$ cutoff filter which is present only in the single Brewer.

In conclusion, the double monochromator Brewer presents satisfactory characteristics in terms of its cosine response and slit function and it is capable in recording solar irradiance spectra in the UVB region with high wavelength stability. Its extended spectral region to the beginning of the UVA is very useful in determining cloud cover effects on the UVB spectral measurements. The comparison with the double monochromator Bentham and the single monochromator Brewer #005 showed that it rejects satisfactory the stray light.