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Brewer direct irradiance measurements: polarization effects and model simulation

EUBREWNET

V. Carreño[1], H. Diémoz [2], S.F. León-Luis[1], López-Solano[1,3], B. Hernández-Cruz[1,3], A. Berjón[1,3], D. Santana-Díaz[1,3], M. Rodríguez Valido[3] and A. Redondas[1]

[1] Regional Brewer Calibration Center – Europe, Izaña Atmospheric Research Center, Agencia Estatal de Meteorología, Tenerife, Spain; [2] ,Regional Agency for Environmental Protection of the Aosta Valley (ARPA), Italy; [3]Departamento de Ingeniería Industrial, Universidad de La Laguna, Tenerife, Spain.

GOBIERNO DE ESPAÑA · MINISTERIO DE AGRICULTURA, ALIMENTACIÓN Y MEDIO AMBIENTE · AEMet Agencia Estatal de Meteorología · ARPA Valle d'Aosta · ULL Universidad de La Laguna · cost EUROPEAN COOPERATION IN SCIENCE AND TECHNOLOGY

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Introduction

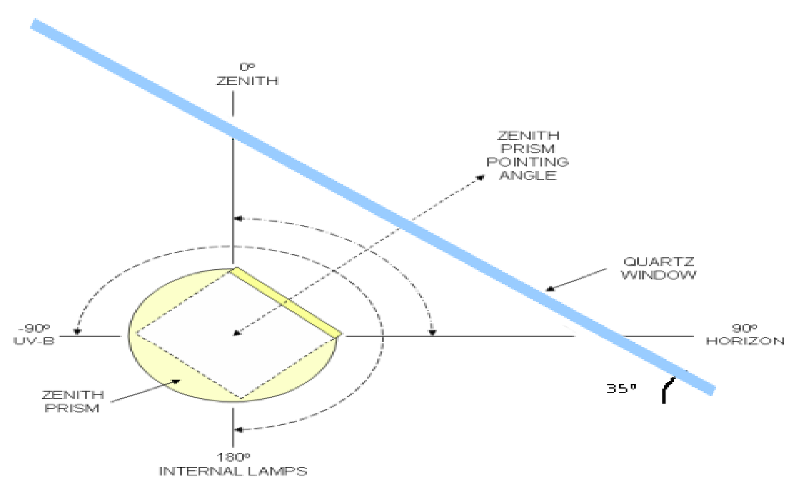
Spectral measurements of the direct component of the UV solar radiation have reached more importance recently in the measurement programs of various Brewer spectrophotometer monitoring stations, and are reaching a wide range of applications, such aerosol optical depth (AOD) retrieval, determination of aerosol properties, measurement of absorbing gases in the atmosphere amount.

The sensitivity of direct-sun measurements from Brewer spectrophotometers changes with the solar zenith angle (SZA) [Cede et al., 2006] due to Fresnel effects on the flat quartz window and polarization by the diffraction grating. To study the effect of the instrument internal polarization with the SZA we have carried out a first group of measurements with a modified brewer case that allowed us to easily measure direct-sun count rates with and without the quartz window during the X Regional Brewer Calibration Center for Europe (RBCC-E) intercomparison that was held at El Arenosillo Atmospheric Sounding Station of the "Instituto Nacional de Técnica Aeroespacial" (INTA) joint with EUBREWNET, with the support of the COST ACTION 1207, and a second set of measurements made at the Izaña Atmospheric Research Center (IARC).

In this work we will try to quantify the effect of the window for the range of angles viewed by the Brewer and propose a correction for absolute spectral irradiances for all Brewer marks (MkII, MkIII and MkIV, i.e. single and double monochromator Brewers). We will also try to determine if a non negligible wavelength dependence in the effect exists.

Problem overview

The sensitivity of direct-sun measurements from Brewer spectrophotometers changes with the solar zenith angle(SZA)



The combination of the effect of the flat quartz window and the effect of the diffraction grating produce a remarkable sensitivity decrease at high SZAs when measuring absolute irradiances by the Brewer.

Measurements and calculations

We measured at different SZAs with/without the window (more resolution in the interest zones), then, calculated the ratios and compared them to the ratio at 35º SZA (beam perpendicular to the window and no Fresnel effects) [Cede et al., 2006]

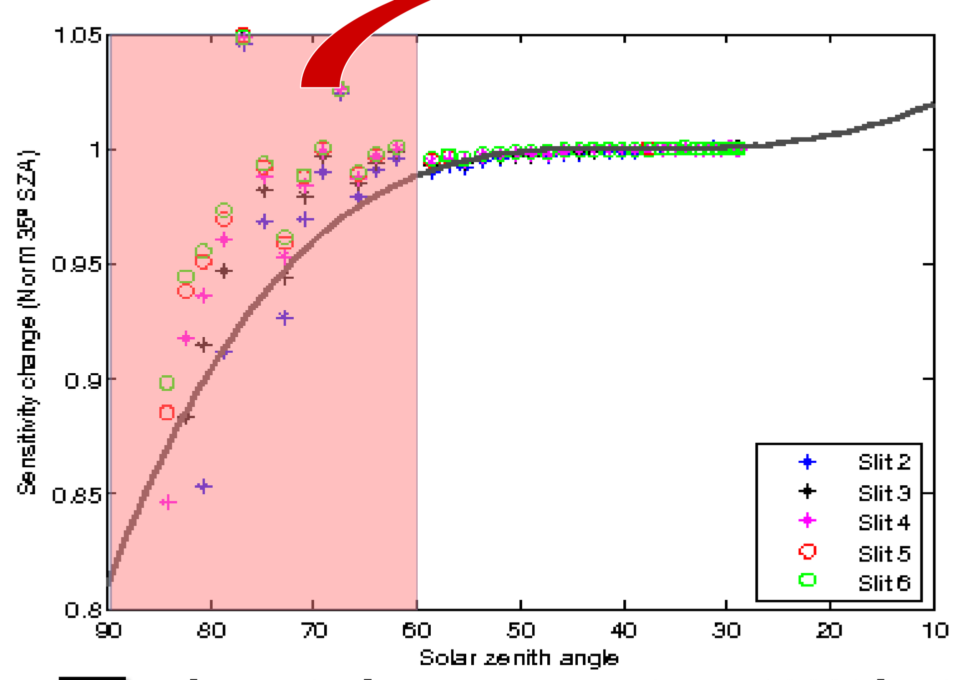
Data reduction

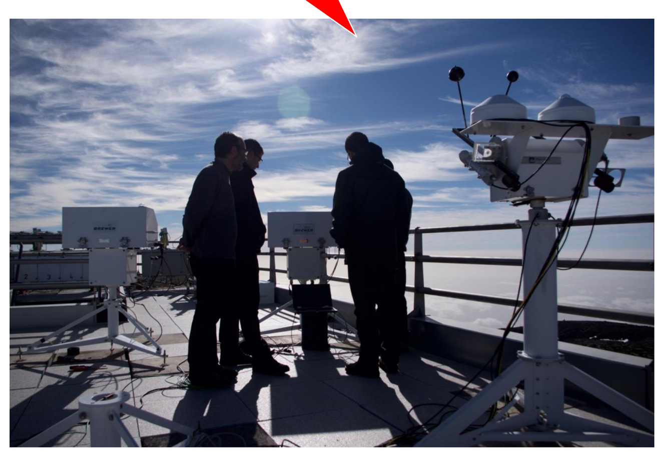
- Calculate the count rates from raw data of the B file, extracting only the experiment data.

$$F_i = \frac{F_i - F_1}{CYxIT} \quad i = 0,2\ldots6$$

-Adjust for Dead time.
-No temperature correction applied.
-Calculate the ratios Window/No window.
-Make sure that there are no measurements with filter change, and discard this measurements in case there is any occurrence.
-We have to interpolate to calculate the ratio with/without window at the same time. A simple time interpolation would introduce spectral dependence (2)
-Better solution: Physical law (i.e., Bouguer-Lambert-Beer law): linear interpolation of log(I) vs ozone airmass, removing the Rayleigh contribution before the regression, then reintroducing it (2)

Measurements



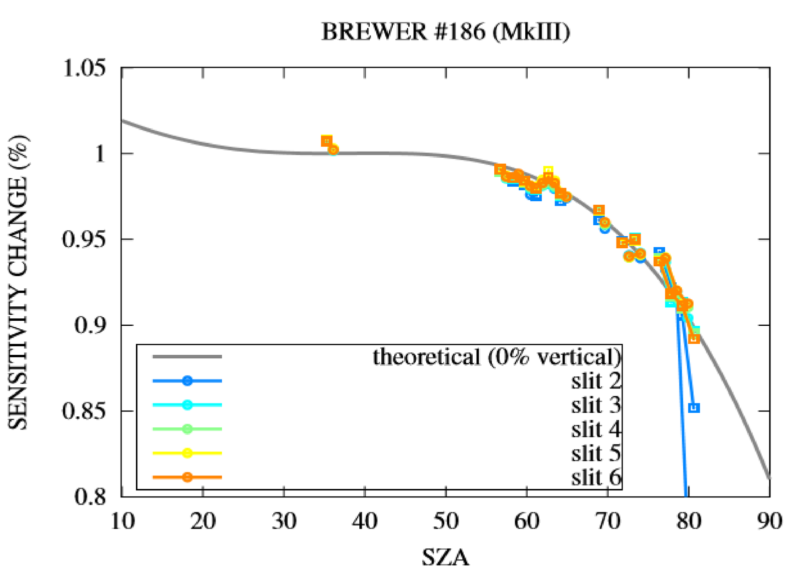


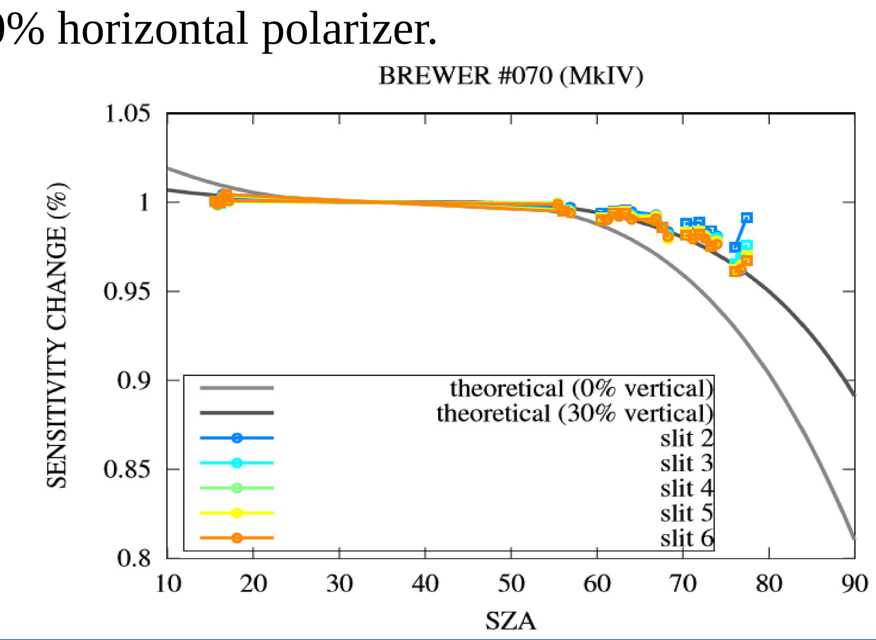
— Theoretical curve, supposing a 100% horizontal polarizer

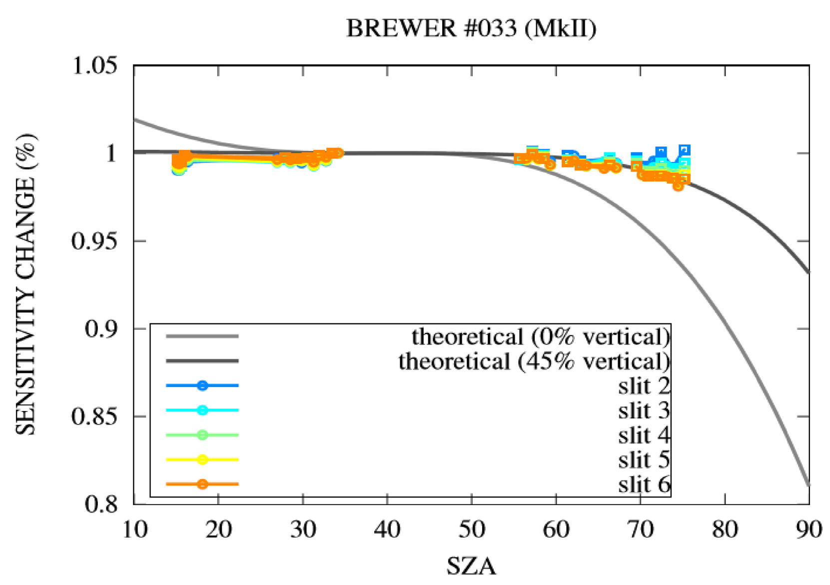
The morning of the experiment dawned with a set of cirrus until the sun reached 60º sza which produced a big spread in the measured data. For the results we will present the set of measurements from the EUBREWNET campaign, and processed by H. Diemoz.

Results and conclusions

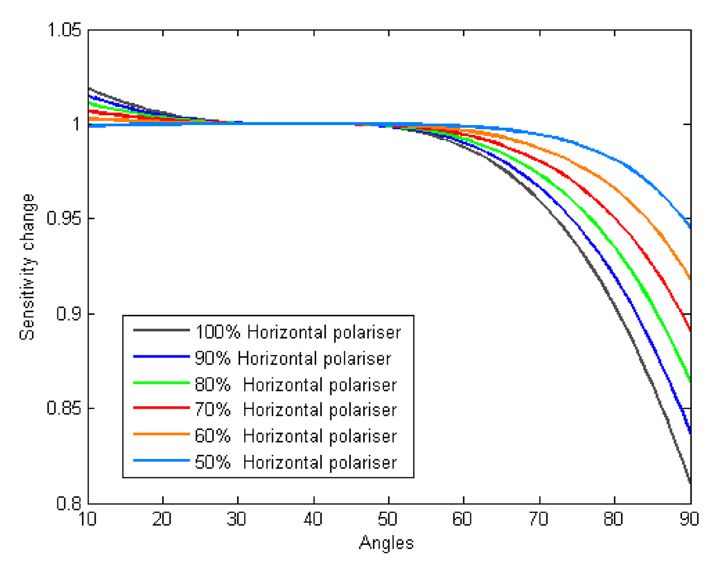
For a Brewer MKIII there is a very good agreement of the measured data with the theoretical curve supposing a 100% horizontal polarizer, for a Brewer MKIV (Single monocromator brewer with extended range) to obtain a good agreement between both curves we have to suppose a 70% horizontal polarizer and finally for a Brewer MKII (single monocromator Brewer) to obtain a good agreement between both curves we have to suppose a 70% horizontal polarizer.







The difference in the curvature from the theoretical curve can be explained by the fact that diffraction gratings are not necessarily linear polarisers



Acknowledgments

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