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A New Calibration Procedure which Accounts for Non-linearity in Single-monochromator Brewer Ozone Spectrophotometer Measurements

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It is now known that Single-Monochromator Brewer Spectrophotometer ozone and sulphur dioxide measurements suffer from non-linearity due to the presence of instrumental stray light caused by scattering from the optics of the instrument. Because of the large gradient in the ozone absorption spectrum in the ultraviolet, the atmospheric spectra measured by the instrument possess a very large gradient in intensity in the 300 to 325 nm wavelength region. This results in a significant sensitivity to stray light when there is more than 1000 Dobson Units (D.U.) of ozone in the light path. As the light path (airmass) increases, the stray light effect on the measurements also increases. The measurements can be on the order of 8% low for an ozone column of 600 D.U. and an airmass factor of 3 (1800 D.U.) causing an underestimation of the ozone column amount.

Primary calibrations for the Brewer instrument are carried out at Mauna Loa Observatory in Hawaii. They are done using the Langley plot method to extrapolate a set of measurements made under a constant ozone value to an extraterrestrial measurement. Since the effects of a small non-linearity at lower ozone paths may still be important, a better calibration procedure should account for the non-linearity of the instrument response. Previous methods involve scanning a laser beam with known wavelength with the Brewer spectrophotometer and observing the out of band signals. This paper presents a much more practical method to correct for stray light effects that includes a mathematical model of the instrument response and a non-linear retrieval approach that calculates the best values for the model parameters. The parameterization used was validated using an instrument physical model simulation. The model can then be used in reverse to provide correct ozone values up to a defined maximum ozone slant path.