**A New Calibration Procedure which Accounts for Non-linearity in Single-Monochromator Brewer Ozone Spectrophotometers**

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**Abstract**

It is now known that Single-Monochromator Brewer Spectrophotometer ozone and sulphur dioxide measurements suffer from a non-linearity due to the presence of instrumental stray light. Because of the large gradient of 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. The measurements can be on the order of 8% low for an ozone column of 600 D.U and an airmass factor of 3 (1800D.U.).

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 a small non-linearity at lower ozone paths may still be affected, a better calibration procedure should account for the non-linearity of the instrument response. This poster presents a mathematical model of the instrument response and a non-linear retrieval approach that calculates the best values for the model parameters. The model can then be used in reverse to provide correct ozone values even at large ozone slant paths.

**Methodology**

A very sensitive way of measuring the instrumental stray light is by using the deviation of Beer's law from linearity at high absorbance. A new model for the instrument is described considering a non-linearity factor as well as accounting for the filter changes in the instrument.

\[
F_m = -\alpha \cdot (x - \mu - \gamma \cdot ((\mu - 1) \cdot x) + b_j \cdot ND_j + F_0
\]

Where:
- \(F_m\): Modeled Absorption Function
- \(\alpha\): Absorption Coefficient
- \(x\): Ozone Column Amount
- \(\mu\): Ozone Airmass
- \(F_0\): Absorption at Zero Airmass
- \(\gamma\): Non-Linearity Factor
- \(b_j\): Filter Change Factor
- \(ND_j\): Filter Number \(j\)

**Results**

- Data set: Single Brewer instrument No.009 and Double Brewer instrument No.119 at sunset at the same time.
- Model correction for the non-linearity factor and filter changes:

  - **Single Brewer No.009**
    - Non-linearity Factor: 1.0164 ± 0.0007
    - Ozone Amount: 273.4270

  - **Double Brewer No.119**
    - Non-linearity Factor: 1.1187 ± 0.0003
    - Ozone Amount: 275.4275

  ➢ Using these corrections in reverse can eliminate the effects of stray light on the data and give the real ozone column amount.

**Conclusion and Future Work**

- Double Brewer suffers less from non-linearity.
- The non-linearity factor for the Double Brewer is an order of magnitude less than the Single Brewer.
- Instrument model agrees very well with the Double Brewer.
- Weighting of the data is needed.
- Transfer calibration from one instrument to another by using these corrections in reverse can eliminate the effects of stray light on the data and give the real ozone column amount.

**References**