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Supplement of

Detecting volcanic sulfur dioxide plumes in the Northern Hemisphere using the Brewer spectrophotometers, other networks, and satellite observations

Christos S. Zerefos et al.

Correspondence to: Christos S. Zerefos (zerefos@geol.uoa.gr)

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SO₂ plume from Nabro Volcano over the Canary Islands (June 2011)

1. SO₂ algorithm improvement

The SO₂ is calculated routinely on the Brewer's ozone retrieval algorithm (Kerr et al., 1988).

$$\text{SO}_2 = \text{MS8} - \text{ETC} / m_3 \text{ A3} * \text{A2} - \text{O}_3 / \text{A2}$$

Where:

MS8 is the linear combination of log count ratios of the SO₂ wavelengths 306.3, 316.8, and 320.1 nm, with weights [-1.00, 4.20, -3.20]; m₃ is the ozone air mass factor; ETC is the extraterrestrial constant; and A3 and A2 are the effective cross sections of SO₂. A3 is the differential O₃ absorption coefficient for the SO₂ wavelength combination whereas A2 is the ratio of the SO₂ absorption coefficient to the O₃ absorption coefficient with SO₂ wavelength combination (A2 is nominally set equal to 2.44). These effective absorption cross section quantities can be measured during the wavelength characterization of the spectrometer using the same methodology as that used for the ozone absorption calculation (Redondas 2014). The SO₂ cross section used by the Brewer network were calculated by Kerr, but certainly this subject needs more investigation as we cannot find the laboratory calibration to which is referenced this cross section.

The only calibration constant is the ETC. There are three methods to derive the ETC: 1) by comparing to a reference instrument, 2) assuming a zero SO₂ during a certain period (this is what most of Brewer stations use to do), and 3) by Langley extrapolation. In this case analysis we show results using the last two methods, so the Langley extrapolation with the RBCC-E (Regional Brewer Calibration Centre for Europe) methodology (Redondas, 2007; Ito et al., 2011), and using the days 6 and 7 of June as zero reference. The estimated error of the Langley is +/- 0.25 DU.

2. Ancillary information

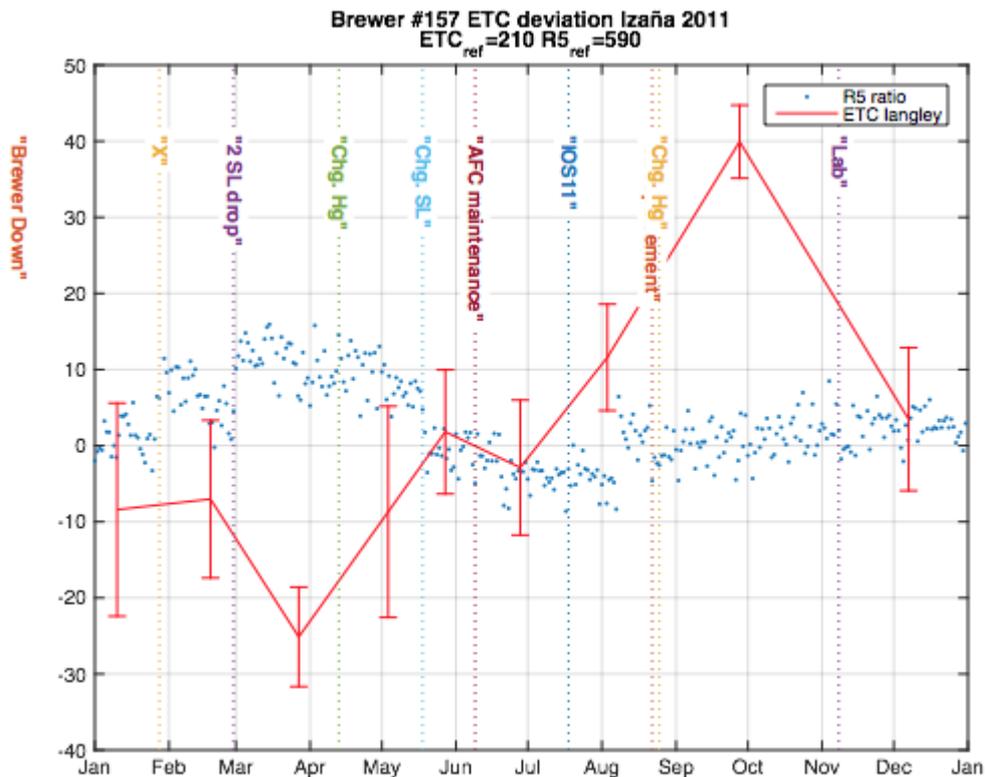


Figure S1: Langley determination of the SO_2 extraterrestrial constant and the internal lamp measurement (R5) used for track the calibration between calibrations. Possible changes on the calibration of the instrument are marked by vertical lines. The error estimation of the ETC is shown on error bars and is in mean ± 10 ETC units (± 0.25 DU).

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