

## ***Interactive comment on “Direct-sun total ozone data from a Bentham spectroradiometer: methodology and comparison with satellite observations” by M. Antón et al.***

**Anonymous Referee #2**

Received and published: 7 January 2013

This paper presents application of the well established differential optical absorption (DOA) technique to Bentham spectroradiometer direct irradiance measurements to retrieve total ozone column (TOC). While DOA has been widely used on data obtained by other instruments, this is the first time it has been used to analyze Bentham direct sun observations. Improved TOC measurements are of interest to the scientific community and therefore I recommend publishing the article after the authors address the questions and comments below.

General comments:

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1. This paper does not explain why a new method is needed to derive TOC from the Bentham spectroradiometer and how the DOA method is more superior to the currently used TOC retrieval techniques.
2. The Bentham instrument is not described sufficiently to understand its capabilities and limitations. No information is provided about the detector used, entrance and intermediate slit sizes, stray light characterization, its fiber optics, and its effect on irradiance measurements as a function of pointing angle, instrument function characterization, and signal to noise ratio at the selected wavelengths per measurement. It would also be beneficial to discuss which atmospheric properties are typically retrieved from the Bentham instruments and how many of the instruments are in service around the world.
3. While comparison of ground-based derived TOC with satellite measurements is important, I would recommend not using the comparison as a validation tool for such ground-based observations. Why not validate the Bentham TOC measurements side by side with a Brewer or a Dobson instrument? Many uncertainties arise from validation of direct sun ground-based TOC measurements that sample a narrow cone of the atmosphere from sunrise to sunset with equal sensitivity to tropospheric and stratospheric optical absorption ( $\text{SZA} < 75^\circ$ ) using satellite observations with large footprints, reduced sensitivity near surface, and at best two overpasses a day. In addition, the DOA method itself does not require validation, while the Bentham instrument measurements do.
4. The authors make an observation that cloud-free days have a “typical” diurnal pattern characterized by a “flat” morning and gradually increasing afternoon TOC, amounting to an unrealistically large column change (up to 40–50 DU) over a few hours. They attribute this large TOC increase in the afternoon hours to  $\text{O}_3$  photochemical production due to anthropogenic emissions in the lower troposphere. The authors need to convenience readers that the observed diurnal pattern is

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real and not the result of instrumental errors.

Specific comments:

Page 8132:

Line 13. Do the authors mean different behavior?

Page 8133:

Line 10. The authors here state that high quality ground-based TOC measurements are necessary for satellite TOC validation. Later, they use satellite measurements to prove the high quality of the Bentham ground-based TOC observations. This is circular logic.

Line 14. "is SO called differential OPTICAL absorption"

Line 27: This instrument CAN record

Page 8135:

Line 4. Is this a scanning system with a 0.5 nm step?

Page 8135:

Line 5. Does 0.48 nm spectral resolution refer to FWHM with the narrowest slit available, and FWHM (Line 5) of 1.05 nm to actual spectral resolution? Please clarify.

Line 8. Reword sentence starting with "The double-monochromator. . .". It is unnecessarily long.

Line 11. In order to perform

Line 12. Accuracy of sun tracker is BETTER than

Page 8135: List overpass times for OMI, GOME and SCIAMACHY.

Page 8138:

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Line 5. I would recommend listing the wavelength pairs as 305.5/325.5 nm (A1/A2) and 317.5/340.0 nm (D1/D2).

Page 8139:

Line 9. "temperature changes with the height..." Do you mean measurement site altitude?

Line 11. Is the ozone effective temperature higher in winter than summer? Explain why fig. 2 is referenced while talking about TOC effective temperature.

Page 8140:

The entire discussion starting from Line 11 is somewhat irrelevant. AMF sensitivity to effective gas height is very low (<1% for an error in effective height of +/- 5 km at SZA 75°) at SZA smaller than 75° which follows directly from the equation 9.

Page 8141:

Line 16. Please specify year/years of the selected 30 days. Are they all from 2005?

Page 8141:

Line 16. Please explain why only morning measurements are considered for the Langley plot analysis.

Page 8142:

Line 22. Marengo et al. 2002 mainly focuses on the effect of the diurnal changes of aerosol OD on the ETC derivation. Since intensity ratio is used in this work, the "random" aerosol effect ("disturbances") should be minimized.

Page 8143:

Line 25. the error bars

Page 8144:

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Line 20. monotonic

Line 21. Consistent change in TOC of up to 40-50 DU is too large for a typical diurnal TOC variability!

Line 25. On most cloud free mornings

Line 29. is the result of

Page 8145:

Line 2. Zbinden et al. 2006 reported mean summer total tropospheric columns over major middle latitude cities ranging from about 30 to 40 DU, with about 6 to 10 DU in the boundary layer. Consistent daily change in TOC of up to 40-50 DU over afternoon hours presented in the current study cannot be explained solely by the O<sub>3</sub> photochemical production near the surface.

Line 28. While satellite measurements agree within a few percent with ground-based measurements, one should realize that a boundary layer ozone column of 10 DU translates into roughly 3% of TOC. The comparison is not consistent. UV ground-based instruments have high sensitivity to gases located in the lower troposphere, while UV satellite instruments have low sensitivity. Ground-based instruments measure along the line of view; satellite instruments average over a large area. Ground-based instruments should be validated by a well established similar ground-based instrument to assure high quality of TOC data.

Page 8146:

Line 4. Why were the Bentham TOC measurements for comparison with the three satellite instruments averaged from 11:00 to 13:00 instead of at the actual satellite overpass times [9:30am (GOME-2), 10:00 am (SCIAMACHY) and 13:30 (OMI)]?

Figure 3. Title: Error bars,

Legend: Please replace "oktas" for "cloud cover", right axes title: cloud cover (okta).

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Interactive comment on Atmos. Meas. Tech. Discuss., 5, 8131, 2012.

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