Atmos. Meas. Tech. Discuss., 4, C589–C595, 2011
www.atmos-meas-tech-discuss.net/4/C589/2011/

Atmospheric
Measurement
Techniques
Discussions

Interactive comment on "Development and characterization of the CU ground MAX-DOAS instrument: lowering RMS noise and first measurements of BrO, IO, and CHOCHO near Pensacola, FL" *by* S. Coburn et al.

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Received and published: 17 May 2011

Dear referee # 1, thank you for taking the time to review our paper and for your helpful comments. Detailed below are our answers.

Manuscript "Development and Characterization of the CU Ground MAX-DOAS Instrument: lowering RMS noise and first measurements of BrO, IO, and CHOCHO near Pensacola, FL" by Coburn et al. provides a detailed description on development of ground-based MAX-DOAS system capable of achieving low RMS values often nec-

essary for detection of trace gases that are present in very low concentrations in the boundary layer. In addition, this paper presents a brief description on measurements of IO, BrO, Glyoxal, HCHO and NO2 at the Florida coast. The topic of the paper fits into the scope of AMT. It is well-written and contains appropriate figures. Presented study on factors affecting the magnitude of RMS of the residual spectrum is very thorough, and definitely of interest for scientific community. However, I was disappointed by the lack of interpretation for measurements also presented in this manuscript.

- The measurements and chemistry background presented in this manuscript were meant to serve as the motivation for the building of the instrument and the following studies, and we feel that any further discussion on these points would be inappropriate for this particular journal. A more robust treatment of the chemistry found in this manuscript is planned for a future publication.

Specific comments:

Section 3.1 shows results of temperature sensitivity test. Why the five test temperatures in the range between 27°C and 40°C were selected? Were other, more extreme temperature values evaluated? Being a field instrument, MAX-DOAS can easily be exposed to a wider temperature range. Have you tested at lower temperatures, for example 5°C, or 15°C or 20°C?

- This temperature range was selected because it encompasses the operating temperature (∼35 °C – 36 °C) of the instrument. Because of the high temperature sensitivity of this instrument field deployments have always been at locations where the instrument could be maintained within this range.

Page 261, line 24-25 – Please clarify if Ring spectrum was calculated for each analyzed spectrum, or single Ring spectrum was used.

- Text in this section has been modified to make more transparent the different operating modes and settings for the different analyses employed.

Page 261, line 19, through Page 262, line 25 - This description is rather lengthily and confusing. I think that this information (or a big part of it) can be much better relayed in a table format.

- This section has been re-worked and some of the information put into a table.

Page 263, line 22 through Page 265, line 27 (Section 4.2): Please provide detection limits for all measured species. Provide wavelength regions used for all trace gas spectral evaluation. What were NOx levels at the times of measurements? What are the highest NOx levels at which BrO and IO were observed? Why elevation viewing angles of 25° and 155° degrees were chosen to estimate trace gas average daytime VCDs? For species located close to the surface, especially one like IO, lower elevation viewing angles would serve better. Can you do better than to use geometric AMF? Based on values and shapes of dSCD curves for different trace gases and O4, please expand discussion on spatial distribution of observed trace gases, especially IO, BrO and CHOCHO.

- Detection limits and wavelength ranges for the different analyses have been added to this section. NOx levels throughout the duration of the measurements varied from <100 ppt to >several ppb. IO was measured at even high levels of NOx while the correlation with BrO tended to be less clear. Measuring BrO at these levels of NOx presented quite the analytical challenge and will be discussed in further detail in a forthcoming publication. The 25° and 155° elevation angles were used so that geometric AMFs could be used to estimate VCDs. Sensitivity studies were performed to assess the potential to model AMFs, but uncertainties in the vertical distributions of these gases led us to conclude that using geometric AMFs was sufficient. Text will be added here to expand the discussion on the spatial distributions of these gases.

Figure 8: Figure 8 captions state that IO analyzed in 425–438 nm spectral range, but IO analysis example in this figure shows range of 415-438 nm.

- The caption text is incorrect and has been updated accordingly.

Figure 9: It is very difficult to see anything on this figure. It might be better to make it into two figures and/or omit some viewing angles.

- This figure has been split into two figures to make points more visible

Show error bars

- We feel that the addition of error bars to the plot will further reduce the visibility of the points, so we have added text to the captions stating averages fit errors for the individual trace gases.

Legend on Figure 9 lists 90° elevation viewing angle. Is this a mistake? Usually 90° is used as a Fraunhofer reference.

- This is not a mistake as the 90° elevation angle spectra are analyzed and included in the plot – although none of these points were found to be significant. The non significant data points in this plot are denoted by smaller dots and those for the 90° spectra can be seen to stay very close to zero (as expected).

Based on the data presented in this figure, BrO was only measured above detection limit at high SZA. Were there other days (not shown in Figure 9) when BrO was detected at lower SZA?

- There are scattered individual events where BrO is detected – this time period was chosen because it contained the most significant BrO detected at one time.

Table 1 is missing two MAX-DOAS instruments which have been used for halogen oxides detection. Below are the references: 1. Pikelnaya et al. (2007), Intercomparison of multi-axis and long-path differential optical absorption spectroscopy measurements in the marine boundary layer, JGR, Vol. 112, Issue D10, doi:10.1029/2006JD007727. 2. Carlson et al. (2010), A low power automated MAX-DOAS instrument for the Arctic and other remote unmanned locations, AMT, Vol. 3 , Issue 2, pp 429 -439.

- Table 1 has been meant to show the range of capabilities of typical MAX-DOAS hardware and has not been intended to be a comprehensive list of all currently used MAX-DOAS instrumentation. As that the instruments described in these references fall within the range already reported in the table they would not add any information content and so have not been included in the revised manuscript.

Technical comments: Page 256, lines 23-26 - Rewrite this sentence.

- Text here has been updated to more clearly convey this information.

Interactive comment on Atmos. Meas. Tech. Discuss., 4, 247, 2011.

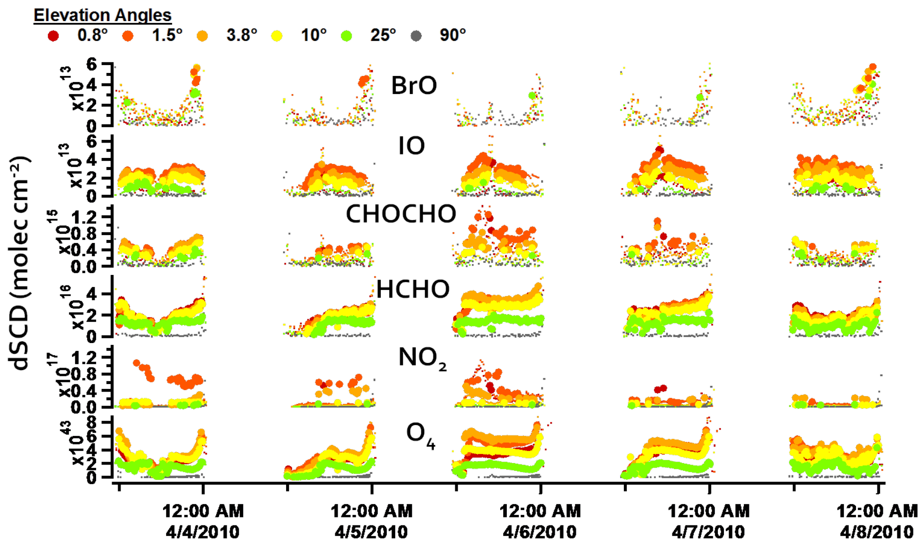

Fig. 1. Figure 9: Split into two figures, this is the first one

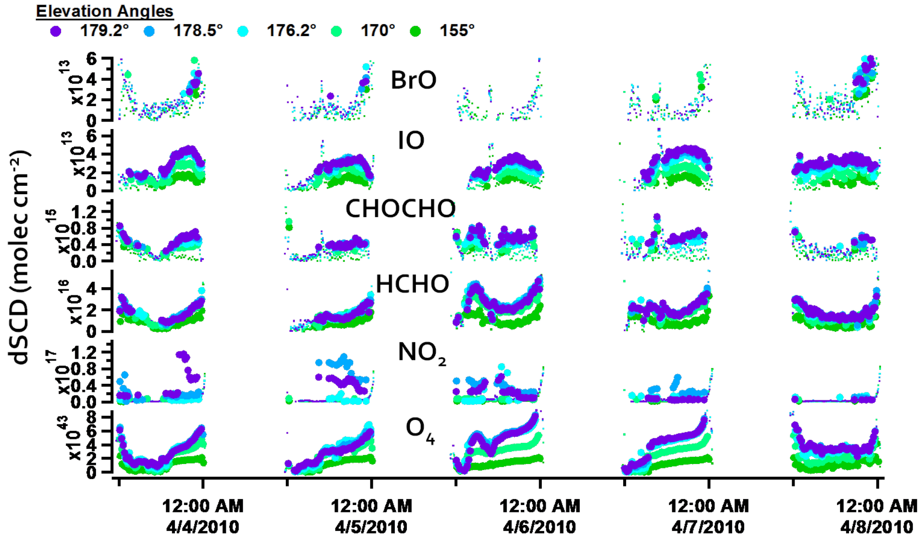

Fig. 2. Figure 10: Second figure after splitting Fig. 9