

## ***Interactive comment on “A low power automated MAX-DOAS instrument for the Arctic and other remote unmanned locations” by D. Carlson et al.***

### **Anonymous Referee #1**

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The paper presents a newly developed MAX-DOAS instrument with the aim to operate in full automation in trickily accessible locations such as polar regions and volcanic sites. This project is innovative and offers promising insights regarding more particularly satellite validation, boundary layer chemistry and stratospheric ozone monitoring issues on long-term timescales. To me, the authors have adequately described the instrument and the technical improvements brought to more “classical” MAX-DOAS systems. The on-site test results presented here, showing the various limits (spectral residuum, biases) of the system, strongly add to the value of the paper and highlight the potential of this new instrument for routine use in the frame of atmospheric studies. This manuscript being concise, well-written and bringing potential further advances in atmospheric observations, I recommend its publication in AMT through the minor revisions described hereafter.

Specific comments:

Abstract. Please specify in the abstract whether the automated MAX-DOAS uses active or passive technique.

Introduction. P2349 line 2: in the UV-vis region OIO can also be detected under high enough abundance conditions and twilight measurements or for active DOAS techniques. Line 10: “spectra. In the case”... P2350 Line 29: the reference Simpson et al. (2007b) about bromine monoxide is not referred as “2007b” in the reference list (“b” missing).

P2351: line 1: “SCIAMACHY” is the correct term.

Line 9: The status “Satellites are limited by their spatial and temporal resolution” is too strong, unless I do not understand the sentence. It is hard to believe that spatial and temporal resolution is a weakness for satellite instruments when compared to ballooning or aircraft observations for example. Please explain, correct or suppress.

Line 25: Galle et al., 2002 is referred as “2003” in the reference list.

P2352 line 10: in the introduction, you mention the temperature-stabilization of the spectrometer. This is hardly discussed in the manuscript but could have some implications on the retrieval of thin spectral lines as those for BrO. Well, I guess that temperature variations on the ground are not those encountered all along a balloon flight from ground to stratospheric conditions but did you manage to plot spectral drift vs temperature? Could you provide somewhere in part 4.4 information about the (expected to be slight all over the experiment) spectral drift of the spectrometer towards temperature variations?

2 instrumental Is “instrument” a better title for chapter 2 ? It would be interesting to give in a few sentences within the various parts of chapter 2 some technical comparisons with current ground-based DOAS systems concerning in particular the scan head, the housing, and the spectrometers typically used so as to emphasize better your work. I

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mean for example: is the scan head original compared to other DOAS systems ? Does it offer a better zenith angle range ? Are the optics better protected inside your housing ?

P2354 line 6: On figure 3 the LED wavelength centre is 398 nm rather than 395 nm as said in the text.

P2355 line 8: as said above, concerning the HR2000 spectrometer, it would be interesting to mention to what extent the HR2000 is used in the remote sensing community. I personally know that this is the case for some balloon observations (see e.g. Weidner et al., ACP, 2005).

Line 13: I do not see why you do not give the same list of species that can be detected in the UV-visible spectral range as in the introduction. OCIO can be observed in the 318-455 nm range. Most of all, BrO is a key species that you particularly focus on at the end of the manuscript.

Line 20: Same comment as above (P2352 line 10) that can be addressed here. Do you have an idea of the spectral drift resulting from temperature or mechanical variations ? Has it been tested in temperature ranges typical of what can be encountered at polar latitudes at ground pressure? It can be of importance for BrO detection objectives since dividing the low zenith angle spectra by the 0° zenith angle spectra (to calculate transmissions) is likely to create artificial spectral structures. I am tending to think that considering the typical temperature variations and the short time of integration to scan all the elevation angles (as described in chapter 3.1) from 2 to 90° this may be not a tricky factor, but I would want to be sure of that.

P2356 line 4: I do not understand why “the tilt meter is turned on only. . .” I thought that precise knowledge of the tilt was necessary. Please explain.

4.2 Polarization effects I see from your tests that the influence of polarization is rather low though 3% could have an impact, at least to some extent, on the retrieval of weak

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absorptions like BrO. Why not having added a depolariser between the scan head and the spectrometer to definitely get rid of polarisation effects as done e.g. in Platt et al., GRL, 1997? Is it because polarization effects consist of low frequency signatures that can be easily distinguished from the spectral thin lines of BrO and NO<sub>2</sub> in the <400 nm domain? If yes, please add it in the text.

4.3 Power budget What are the typical time durations of a campaign to provide the reader indications about the power consumption margins towards the campaign scientific objectives? Unless these margins are large (which will be the case using solar power for example), it would be interesting to provide maximum operational time of the MAX-DOAS instrument according to the various scenarios described in the text (in particular, 2h per day of heating or more).

P2360 line 8: Why not citing some of the references given in the introduction in addition to the Donohoue et al. (2009) manuscript? Please also specify what are the species reference spectra (cross-sections) found in the literature used in your fitting procedure.

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