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Atmospheric Measurement Techniques Discussions

AMTD

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Interactive Comment

Interactive comment on "Novel SO_2 spectral evaluation scheme using the 360–390 nm wavelength range" *by* N. Bobrowski et al.

Anonymous Referee #2

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The paper by Bobrowski et al. describes a novel DOAS retrieval approach to determine SO2 column densities. The paper is clearly written and present interesting results for both ground-based and satellite measurements. However, there remain some questions (see below) that should be resolved. I recommend the paper for publication in AMT after revisions.

Specific Comments

1 Introduction

It would be better to split section 1 into two sections: an introduction and a section with a more detailed description of the current retrieval approach. In the current introduction, the background information about the ground based measurements is rather limited,

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and a general description of atmospheric SO2 (natural and anthropogenic sources, impact on chemistry and climate etc.) and of satellite SO2 measurements is missing completely.

P865, 7-19: It is not fully clear to me with phenomenon is meant here. Does it refer to the I0-effect?

P866-867: The three problems described here are also related to the use of the traditional DOAS approach in the 310-330 nm wavelength range. It would be interesting to know to what extend these problems can be resolved by applying a modified DOAS method (Marquard et al., 2000) in this wavelength region. Issues like the temperature dependence of the SO2 absorption cross-sections and the strong ozone absorption that complicates the satellite retrieval in this wavelength region should be mentioned here as well.

3 Sample measurements and evaluations

P870,10-13: The SO2 spectrum and SO2 Reference in Fig. 1a seem to be a perfect fit. For the very large SO2 column measured here ($\sim$ 600 DU), one would expect significant difference between the SO2 spectrum and SO2 Reference (similar to that in Fig 2a) because of the limitations of the classical DOAS approach in this wavelength region. Please clarify.

P870,15: Why is the estimated error in the slant column density (0.1 molec/cm2) smaller than for the long wave UV window? For the GOME-2 example in section 3.2, the estimated error is larger for the short wave UV window.

P870,24-26: Are there any independent measurements available to validate the SO2 columns from the mini MAX-DOAS system?

P871,1-6: Point 1 and 3 seems to be closely related. Is Point 3 (a wavelength dependent air mass factor) not one of the effects caused by high optical densities?

P872,5-8: What is the theoretical background for including this second ozone cross-

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section in the fit? Is there a reference about this method?

P872,16-17: Can you include a more quantitative comparison of the AMF and vertical column density for the two wavelength regions (in addition to the slant column density comparison)? It should be relatively easy to calculate an AMF for the centre wavelengths of the two fitting windows.

P872,17-20: The unexplained systematic structures in the residual are not only a result of the dependence of the SO_2 AMF on the wavelength. It is likely that the simple treatment of the Ring effect and the strong ozone absorption contribute to the residual structures as well.

P873,3-4: Please indicate in fig 3 the locations of the GOME-2 measurements with the maximum SO_2 columns. Do I understand it correctly that the two DOAS analyses from fig 2 have been done for two different GOME-2 measurements? This should be mentioned in the text.

P873,11-14: The assumption of a decreased sensitivity for high SO_2 columns can be verified by calculating the AMFs for this measurement. One would expect very small values of the AMF in this case.

4 Discussion

As explained here, both the sensitivity/detection limit and the signal to noise ratio play an important role for the DOAS fit in the long wave UV region. Can you provide more quantitative information about the detection limit and the estimated slant column density error? (here it is only mentioned that there is a loss in sensitivity of about an order of magnitude) For example, is it possible to detect moderate SO_2 enhancements (e.g. 5-10 DU) in the long wave UV region? If so, it would be interesting to include another example of a smaller eruption (e.g. Etna) as well.

5 Model studies

P867,5-8: Here, the retrieved slant column densities are compared with the modeled straight column (i.e. without applying an AMF). Is the short wave UV window described as "better" because the AMF for 320 nm is closer to 1? Why is the larger sensitivity of long wave UV window not preferable in this case ?

P877, 19-21: It would be interesting to known the vertical columns that corresponds to the SCDs plotted in fig. 6.

P878,9-10: It is not clear to me what is meant with: "Good agreement for the upper bound of measured SO2 SCDs for 315 nm is found for an assumed aerosol optical depth of about 3"

Minor Comments

P864,17: please correct/add references Noxon, 1975 and Perener et al., 1976

P865, 6-7: Since the DOAS method is also widely applied for ozone retrieval in the UV wavelength range, this sentence should be changed.

P867-868: Please add a reference to fig. 4 in section 2 as well.

P872,24: please add reference Burkholder et al., 1990 and Vandaele, 1997

P873,14-15: Fig 3c only illustrates the large differences between the two wavelength ranges

P884, Fig 1: The quality of this figure could be improved, the lines are not clear (Fig 2 is better)

Interactive comment on Atmos. Meas. Tech. Discuss., 3, 863, 2010.