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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.

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Review of the paper "Novel SO_2 spectral evaluation scheme using the 360-390 nm wavelength range" by N. Bobrowski et al.

In this paper, N. Bobrowski and co-authors propose the use of a shifted wavelength window for Differential Optical Absorption Spectroscopy observations of very large SO_2 amounts in volcanic plumes. The advantages of this approach are reduced effects of scattering in the air column between observer and plume, strongly reduced wavelength dependency of the airmass factor and reduced sensitivity to instrumental straylight. The main disadvantage is a much reduced absorption signal which limits application of this new retrieval window to very large SO_2 amounts. Two examples of the new retrieval are given using ground-based and satellite observations of volcanic plumes and the results are compared to those from a standard fitting window. The results are also compared to radiative transfer calculations highlighting the effects of scattering on the measurements and the importance of aerosols in the plume.

The paper is clearly written and to the point. Although a simple change in wavelength region used for SO_2 retrieval appears straight forward, it has to my knowledge never been done before and has the potential to significantly improve DOAS measurements of volcanic SO_2 plumes in particular from the ground. I therefore recommend publication after minor revisions.

Comments:

* In several places, the authors discuss the non-linearity introduced by insufficient spectral resolution of strong absorptions, making reference to work on IR absorbers. In my opinion, this is not relevant for the SO_2 retrieval as none of the main absorbers (SO_2 and O_3) have line spectra that could lead to saturation effects. This spectral resolution dependent effect is different from the non-linearity induced by changes in light path under strong absorption which is a major issue in volcanic plumes in the UV.

* The discussion of radiation dilution is important for ground-based SO_2 observations where it apparently was detected as late as 2006. It would be worthwhile to point out that the same effect (reduction in sensitivity through radiation scattered into the line of sight between the observer and the plume) was already well known for a long time in the satellite community where it is discussed in the framework of airmass factors and their vertical variation (shape factors, box-AMFs).

* I think it would be good to briefly discuss the work of Yang et al. who in several papers investigated the change in SO_2 absorption as a function of wavelength and how this can be used to estimate plume altitude from satellite observations and also to correct for the above mentioned wavelength dependence of airmass factor. Although the wavelength range used is limited to 330 nm, the basic concept is related to the work in this manuscript.

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* The comparisons of the results from the two fitting windows shown here are in a way unfair as no attempt was made to correct for the non-linearity in the shorter wavelength window. However, such corrections can (and are) applied, e.g. in the papers by Yang et al. and also in some of my own work. With these corrections, both the spectral retrieval and the retrieved SO_2 column should be of much better quality than the “naive” column assumed here.

* It is a pity that the discussion of the satellite data is limited to slant columns. I think that vertical columns should be shown so that readers can compare the values to results from other retrievals and get an idea of the uncertainties involved. It is interesting to note that the region of highest maxima retrieved in the new fitting window appears to be in good agreement with results from a standard fitting window using an iterative approach to correct for the non-linearities (Richter et al., 2009).

* The discussion of the dilution and in particular aerosol effects in the ground-based measurements is in my opinion quite sensitive to the details of the assumptions made for the plume. The balance between light path enhancement through scattering and light path reduction through absorption will depend on plume diameter, aerosol amounts and single scattering albedo, quantities which often are difficult to estimate in the field.

* The use of the ratio between the two retrievals as a means to estimate aerosol effects is promising but it should be kept in mind that the airmass factor varies strongly with wavelength and this also affects the retrieved slant columns in non-trivial ways if not accounted for. Therefore the results shown using single wavelengths can only be an indication but are not quantitative. Neglecting the LOS dependence of the airmass factor potentially also introduces a bias in the calculated ratio as it will be a larger effect at long wavelengths.

* Somewhere in the manuscript it should also be stated that the quality of the reference spectrum for SO_2 in the longer wavelength part of the spectrum introduces some

uncertainty and better reference spectra (including the temperature dependence) are needed.

Corrections:

p 865, l28: for of the => for the

p 880, l6: could be could => could

* Fig. 1: Lines are nearly invisible in my printout change Residuum to residual

* Fig. 2: Mention GOME-2 in the figure caption and give time and location

References:

Richter et al., poster at the EGU2009-7679, AS3.15, XY247 (http://www.doas-bremen.de/posters/egu_2009_richter.pdf)

Yang, K. et al., (2007), Retrieval of large volcanic SO2 columns from the Aura Ozone Monitoring Instrument: Comparison and limitations, J. Geophy. Res., 112, D24S43, doi:10.1029/2007JD008825

Yang, K., X. Liu, N. A. Krotkov, A. J. Krueger, and S. A. Carn (2009), Estimating the altitude of volcanic sulfur dioxide plumes from space borne hyper-spectral UV measurements, Geophys. Res. Lett., 36, L10803, doi:10.1029/2009GL038025

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