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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Averaging kernels for DOAS total-column satellite retrievals" *by* H. J. Eskes and K. F. Boersma

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We thank the referee for her/his useful specific remarks. We will quote the comments of the referee and provide our reply below.

" Abstract, l. 8: the sentence stating 'this paper generalise the AK concept to the total column retrieval' is to my point of view not adequate. This paper is clearly an application of the general Rodgers formalism to a specific case: total column retrieval in optically thin conditions. The relevant part of the abstract should be rephrased accordingly."

Our statement did refer to the book of Rodgers specifically. We fully agree that our statement can (will) be interpreted as asking for too much credit. We have changed these sentences in the updated manuscript without claiming a generalisation of the Rodgers approach.

" Section 3: this section describes in short the principle of the DOAS retrieval. I have

two comments: first, mention that the DOAS equation (eq.6) is a direct application of the Beer-Lambert law.

This suggestion to mention the Beer-Bouguer-Lambert law is incorporated in the updated manuscript.

"Second, concerning the DOAS approximation, there are two main reasons why the retrieval can be simplified in a two-step approach. First the fact that the molecular absorption cross-sections are independent of the pressure and that their temperature dependence can be considered as linear. Second, as a reason of the weak optical density of the atmosphere in a large part of the UV-visible, the mean optical path of the scattered photons is weakly dependent on the wavelength so that one single wavelength can be defined for the AMF calculation, that is representative for the whole fitting interval."

To our opinion these comments discuss details of DOAS, and we feel this is beyond the scope of the present paper. DOAS is in fact not one technique, but many different forms of DOAS have been introduced by different groups. (A paragraph has been added to the updated manuscript to discuss this issue) These modifications to DOAS also address these issues: how the air-mass factor should be computed (one wavelength, a few wavelengths, all wavelengths, or in an empyrical way by performing a DOAS fit on a model-generated spectrum). The temperature and pressure impact on the cross section is also important, and again several approaches exist to describe this. For instance the derivative of the cross section versus temperature can be fitted to the observed spectrum as an additional "tracer" to obtain the effective mean temperature of the tracer.

We are of the opinion that these considerations go in far too much detail: our paper discusses the baseline DOAS technique in terms of the Rodgers retrieval formalism and is meant to introduce DOAS averaging kernels.

" In general, since DOAS relies so much on the optically thin approximation, it would

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be useful to provide some figures that illustrates that this approximation is effectively fulfilled (e.g. give typical NO2 and total optical density at 437 nm, the wavelength used for the calculations shown in Fig.1) "

These numbers are indeed useful, and are provided in the updated manuscript.

" Page 902, l. 23-25: The problem of the temperature dependence of the absorption cross-sections is usually solved in practice (when it cannot be neglected) by using a linear parameterisation. The effective temperature of the measured trace species is then retrieved by the DOAS fit together with its slant column."

As mentioned above, we do not want to go too much into such DOAS considerations, because this is not the focus of our paper. We have mentioned this temperature dependence because it is quite an important effect for e.g. NO_2.

A comment to this remark. Indeed this is one approach to account for the temperature dependence of the cross section by fitting the temperature derivative of the cross section together with the cross section itself. This trick, however, is only meaningful when the cross section and its derivative are largely orthogonal (show other differential structures) on the fitting wavelength interval. Alternatively, one may obtain temperature information from a weather forecast model, together with a climatology of the tracer profile.

Interactive comment on Atmos. Chem. Phys. Discuss., 3, 895, 2003.