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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Alternative polarisation retrieval for SCIAMACHY in the ultraviolet" *by* L. G. Tilstra and P. Stammes

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Author Comment

Response to Anonymous Referee #2:

(1)

This paper presents and discusses a simple method for the correction of the impact of polarization on the Sciamachy spectra. As it stands, the paper brings no new knowledge on the polarization or on the Earth atmosphere. It does warn the interested

community on uncertainties on the current Sciamachy spectra. On the other hand, the method presented in the paper is very specific as it applies only to Sciamachy data. The method may be used in the future for the processing of Sciamachy data, if the science teams chooses to, but a general user has no option but to use the operational method rather than that described in the paper: indeed, additional knowledge on the Sciamachy instrument optical characteristics would be needed if a user would be willing to apply such correction scheme. As a consequence, I feel that the document under review is more a technical note to the Sciamachy science team that a paper to be published in a scientific journal open to a wider community.

We do not share the feelings of the referee for the following reasons:

First, the paper is intended for publication in the SCIAMACHY Special Issue ("Geophysical validation of SCIAMACHY: 2002–2004"). As the validation of SCIAMACHY data, including its polarisation information (L1 product), is the main topic of this special issue, it is unrealistic to want to exclude papers on the basis that they focus only on the validation of SCIAMACHY retrievals.

Secondly, the method that is presented here is applied to SCIAMACHY, but may very well be applicable to other spectrometers. As an example we would like to mention a recent paper by McLinden et al. (2004) in GRL 31 (doi:10.1029/2004GL020825) on polarisation retrieval from Odin/OSIRIS limb spectra. Here a similar use of the polarisation sensitivity of a spectrometer leads to a successful method of ozone retrieval.

Thirdly, the method that is proposed is not the sole goal of this paper. The paper presents a validation study of the polarisation retrieval of SCIAMACHY, and the

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proposed method is used as a validation tool.

Also, the paper does not, at any point, imply or suggest that the presented method should become part of the operational method currently used for SCIAMACHY's polarisation retrieval.

In conclusion, we feel that the reviewer should have focused also on the validation part of the paper, and not only on the introduced method.

We added a reference to the McLinden paper.

(2)

In addition, the method as it is presented seems to be limited to a very small spectral range. From the description of section 4, I understand that the method permits the correction of polarization between two wavelengths lambda1 and lambda2, at which Sciamachy is insensitive to the polarization. There is no information on lambda1 and lambda2, except that they "are no more than 25 nm apart". The method is limited to this spectral range as it assumes a linear variation of radiance, and a constant polarization ratio, for this range. There is no discussion on this crucial fact. In fact, the abstract claims that the method is "able to retrieve the full state of polarization in the wavelength range 330 and 400 nm". This is in contradiction to what is described in the text...

The wavelength range λ_1–λ_2 from which the polarisation Stokes parameters are obtained is indeed small, which benefits the accuracy of the method and the retrieved polarisation. However, the size of this wavelength window does not say anything

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about the wavelength range for which the obtained result is valid. In fact, the Earth polarisation between 330–400 nm is rather stable/flat (see e.g. Schutgens and Stammes, JQSRT 75, 2002, 239–255, Fig. 3) and therefore the retrieved polarisation may serve as valid for the entire interval 330–400 nm. Also in the operational PMD algorithm of SCIAMACHY it is assumed that the polarisation is constant for 330–400 nm.

We agree that the wavelengths λ_1 and λ_2 should be specified.

...Figure 4 indicates that the polarization sensitivity of Sciamachy is quite large for wavelengths close to 400 nm. In addition, at that wavelength, molecular scattering may not dominates as it does for shorter wavelengths so that the approximations may not hold the same way. How does the method applies to this wavelength rang ?

There is no assumption regarding Rayleigh scattering. The method is not related to any atmospheric polarisation assumption, but only to the response of the instrument to incident radiation with arbitrary polarisation properties.

Changes to the manuscript with regard to remark (2): in the paper, we now mention typical values of λ_1 and λ_2, and their ranges, i.e. λ_1 = 335$\pm$5 nm, λ_2 = 365$\pm$5 nm.

(3)

The introduction gives the conclusion, so that we get 4 times the same information in the abstract, in the introduction, in the main body of the paper and in the conclusion. The description of Sciamachy is not needed here, in particular in a special edition on this instrument. Figures 1 and 2 bring very little to the paper.

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The reader should be able to read the paper on its own, and certain parts of information just need to be introduced. Though concisely presented, Figures 1 and 2 explain a lot about the measurement approach of SCIAMACHY.

(4)

Equation (6) and a few lines above describe the polarization ratio for wavelengths below 300 nm, while the paper focuses on longer wavelengths.

We feel that Equation (6), which describes the single scattering degree of polarisation P, which is valid below 300 nm, is a necessary ingredient for the paper. One argument for this is that P is presented on the x-axis of Figures 5 and 6. This was done because P calculated from Equation (6) may serve as a practical upper limit for the atmospheric degree of polarisation (see e.g. Krijger et al., JGR 110, doi:10.1029/2004JD005184) and as such provides a first estimate for polarisation validation.

Changes to the manuscript: we added this reference and mention it in the manuscript.

(5)

Below equation 7, it is said that "clouds tend to descrease the degree of polarization, and hence Q and U. This is not true. Clouds tend to increase I, which decreases the polarization ratio. The impact of clouds on Q and U is very variable, and can in fact be an increase for longer wavelengths of for specific directions such as that of the rainbow.

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The referee is correct. We made a typing error here, we should have written "Q/I and U/I" instead of "Q and U". Sentence has been corrected.

(6)

There is a strong need for further discussion on lambda1 and lambda2. Do such wavelengths always exist? How do they vary ? In the shorter wavelength range, I see that mu_2 is close to zero while mu_3 stays negative. Thus I suspect there may be configuration with xi such that beta does not take null values. The discussions on the assumptions of the method is rather poor. In particular, but not only, the fact that the operational processor uses the same approximation does not help much to assess the validity of the method as one objective of the paper is to criticize the operational method results.

Indeed, beta should be zero but this can be achieved by searching for a suitable λ_1 and λ_2. In response to this remark, we have specified typical values for λ_1 and λ_2, and the typical range within which λ_1 and λ_2 reside. See also our response to remark (2).

The assumption that $\chi = \chi_{\rm ss}$, which is also part of the operational processor, has been checked recently by Schutgens et al., JGR 109, 2004, doi:10.1029/2003JD004081.

As for the last comment, we do not agree that the objective of the paper would be to criticize the operational method. The aim of the paper is to validate the operational polarisation product. Agreement between the new technique and the operational product is found for the latest processor version, and reported in the paper.

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Changes to the manuscript: We mention the typical values of λ_1 and λ_2, and their ranges. We also mention that these λ_1 and λ_2 are determined for every spectrum.

(7)

I do not see the point of section 5.2 as the corrected measurements are "validated" against a very crude model. The model itself uses adjustable parameters

The nice thing of the simple model of section 5.2 is that the number of adjustable parameters is low. This simple model was checked with POLDER polarisation measurements, as described in Tilstra et al. (2003). Only two parameters are varied in Figure 7, namely the surface albedo and the Rayleigh optical thickness, and these parameters are kept fixed to the same value for all the individual measurements presented in Figure 7. In this way, the geometrical dependence of the retrieved degree of polarisation is checked, not the absolute value of the degree of polarisation.

As a result, it appears that the retrieved polarisation depends in a consistent way on the single scattering angle. This gives additional credibility to the results obtained by the operational method and alternative method.

Interactive comment on Atmos. Chem. Phys. Discuss., 5, 1973, 2005.