A new algorithm to estimate polarisation in the UV for SCIAMACHY limb measurements

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Introduction

- New algorithm to estimate polarisation for SCIAMACHY limb measurements in the spectral region below 380 nm
- Basic idea: Replace spectrally smooth function currently used in this context by a model / LUT approach which also reproduces differential structures in the polarisation spectra
- One of the (invalid) assumptions of the current approach (but not of the new one) is that the ratio U/Q or the polarisation angle $\chi = \frac{1}{2} \arctan(U/Q)$ are independent from wavelength
- Current algorithm very often fails
 for limb geometry







Basic Assumptions

- The following is available:
 - The (measured) intensity (reflectance) I as function of wavelength.
 - The single scattering polarisation values Q_0 and U_0 (theoretical values) and the corresponding I_0 (from measured spectrum).
 - TBC:
 - $Q_{ref} = Q(370 \text{ nm})$, possibly derived from PMD data.
 - U_{ref} = U(370 nm)
- To be determined:
 - $q' = Q/I Q_0/I_0$
 - u' = U/I U₀/I₀





General Idea: Polarisation as function of reflectance

- Part 1 (red):
 - Spectral region where q' or u' are below a minimum value q'min or u'min
 - Corresponds to wavelengths below λ_{min}
 - Currently treated specially to avoid problems for low polarisation values.
- Part 2 (green):
 - Contains all data for wavelengths below the wavelength λ_{max} of the maximum of I which have a high enough signal (i.e. which are not contained in part 1).
 - Usually, this is also the region where most spectral structures occur.
 - In this part of the spectra the relation between I and q' or u' is non-ambiguous. -> derive g' and u' from I using a LUT (main idea of the new model)
- Part 3 (blue):
 - Wavelengths larger than λ_{max}
 - Shows a different (and sometime ambiguous) relation between I and q' or u' and therefore needs to be treated separately.
 - However, especially above about 350 nm spectral structures are small.
- Special treatment for higher altitudes needed







TH = 25 km

Polarisation Model: Example Results



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Summary

- New procedure determination of polarisation spectra in the UV for limb geometry
- Does not assume constant scattering angle and reproduces spectral structures
- Depending on actual geophysical conditions (e.g. aerosols) and geometry amplitudes of remaining / new differential structures in the spectra usually do not exceed about 0.01.
- To be compared with the case of not considering the differential structures at all by using a spectrally smooth approximation for the polarisation, which may results in much larger differences to the 'true' polarisation of up to **0.05–0.1**.
- First tests using spectra corrected with the new method for ozone profile retrieval indicate small improvements (esp. for albedo retrieval).





Operational Implementation

- To be provided for operational implementation (by IUP):
 - LUT for relation between I and q' or u' determined by SCIATRAN radiative transfer simulations for different settings (SZA, AZ, TH, albedo)
 -> 1st version available
 - Algorithm description
 -> draft TN distributed
 - Possibly scientific code
- Some details of settings possibly to be discussed, e.g.:
 - use PMD data?
 - u', q' limits
 - reference altitudes
 - size of LUT



