Sensitivity study on glyoxal retrievals from OMI data

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1. Introduction

- Glyoxal (CHOCHO) is the smallest of the alpha-dicarbonyls and the most abundant in the atmosphere. CHOCHO is an intermediate product in the oxidation of most VOCs and an indicator of secondary aerosol formation in the atmosphere. The primary sources of CHOCHO are emission by plants, vegetation fires, and biofuel combustion.
- CHOCHO columns can be determined by remote sensing using the Differential Optical Absorption Spectroscopy (DOAS) method. Glyoxal has been retrieved from SCIAMACHY and GOME-2 data at IUP-Bremen, MPI Mainz, IASB and from OMI spectra at SAO.
- Despite the efforts to improve CHOCHO retrievals, the results still have a large uncertainty.

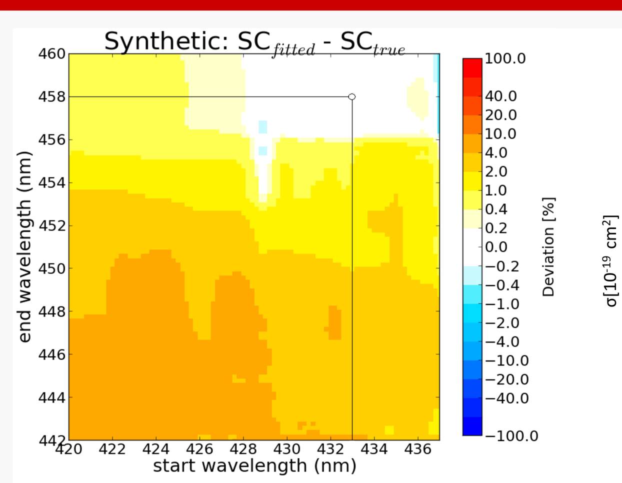
The present study focuses on the results of a new CHOCHO algorithm used on OMI data. Sensitivity tests have been performed aiming at the optimization of the CHOCHO retrieval window, accounting for spectral interferences of the liquid water absorption over oceanic regions and interferences with NO_2 over region with large NO_x emissions.

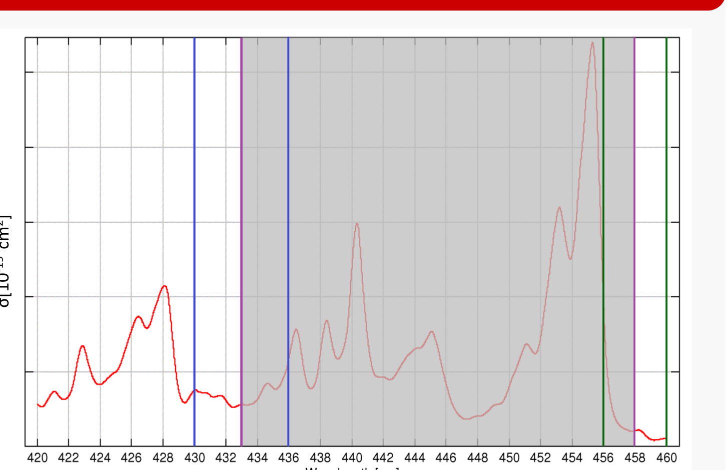
2. Glyoxal retrieval

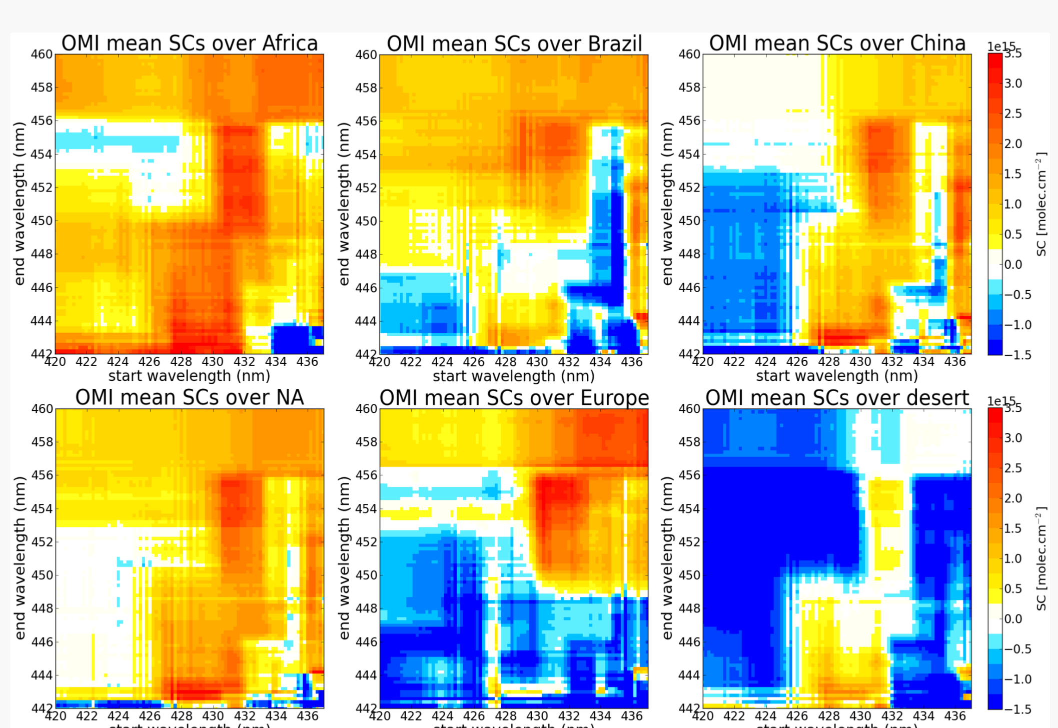
- The DOAS method allows for the determination of atmospheric trace gases with narrow absorption bands in the ultraviolet and visible.
- The retrievals include O_3, NO_2, water vapour, O_4 (O_2-O_2 collision), a pseudo absorber cross-sections for the correction of the Ring effect, and a polynomial of order 3, 4 or 5 for the removal of broad band signatures.
- A normalisation over the Pacific is applied as in Vrekoussis et al., 2009.

3. Optimization of glyoxal retrieval window

- Systematic error can be introduced in the glyoxal retrievals due to possible cross correlation between reference cross-sections, the influence of instrumental features, and shifts in the wavelength calibration.

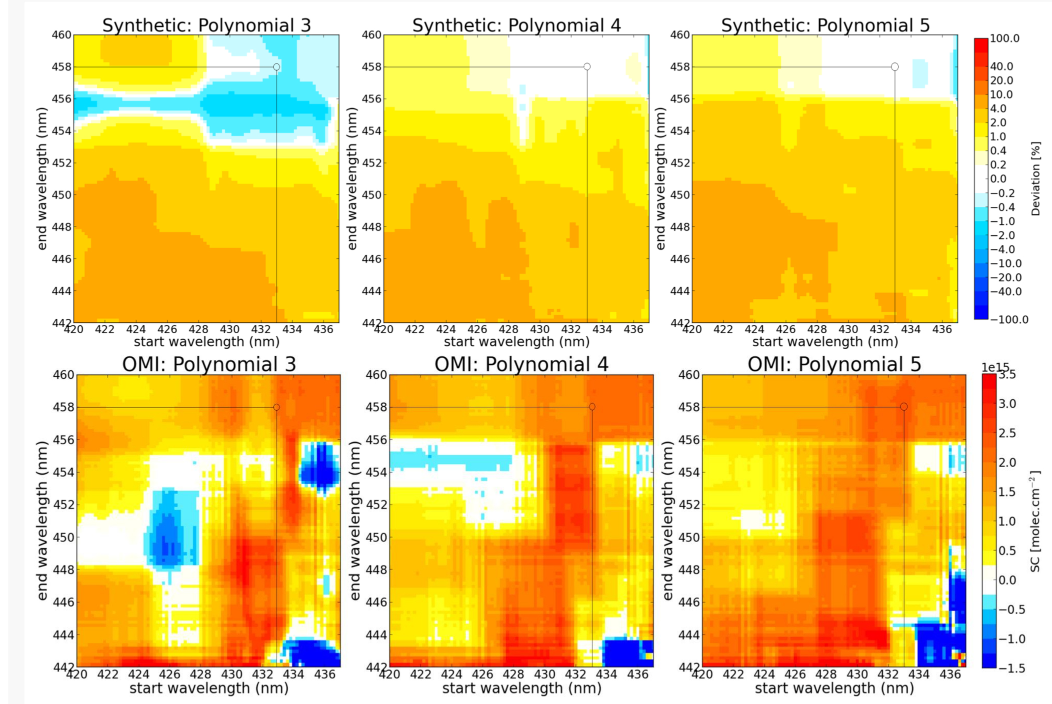






- A synthetic spectrum from SCIATRAN has been computed in the wavelength range 365–500 nm including absorption of NO_2, O_3, O_4, H_2O, and CHOCHO.
- Glyoxal has been retrieved using different wavelength intervals as in Vogel et al. from the synthetic spectrum.
- In order to evaluate the consistency of these results, the same test has been repeated on OMI data over small regions.
- The optimal wavelengths interval was found for start wavelengths of 430-436 nm and end wavelengths of 456-460 nm.

4. Dependence on the polynomial

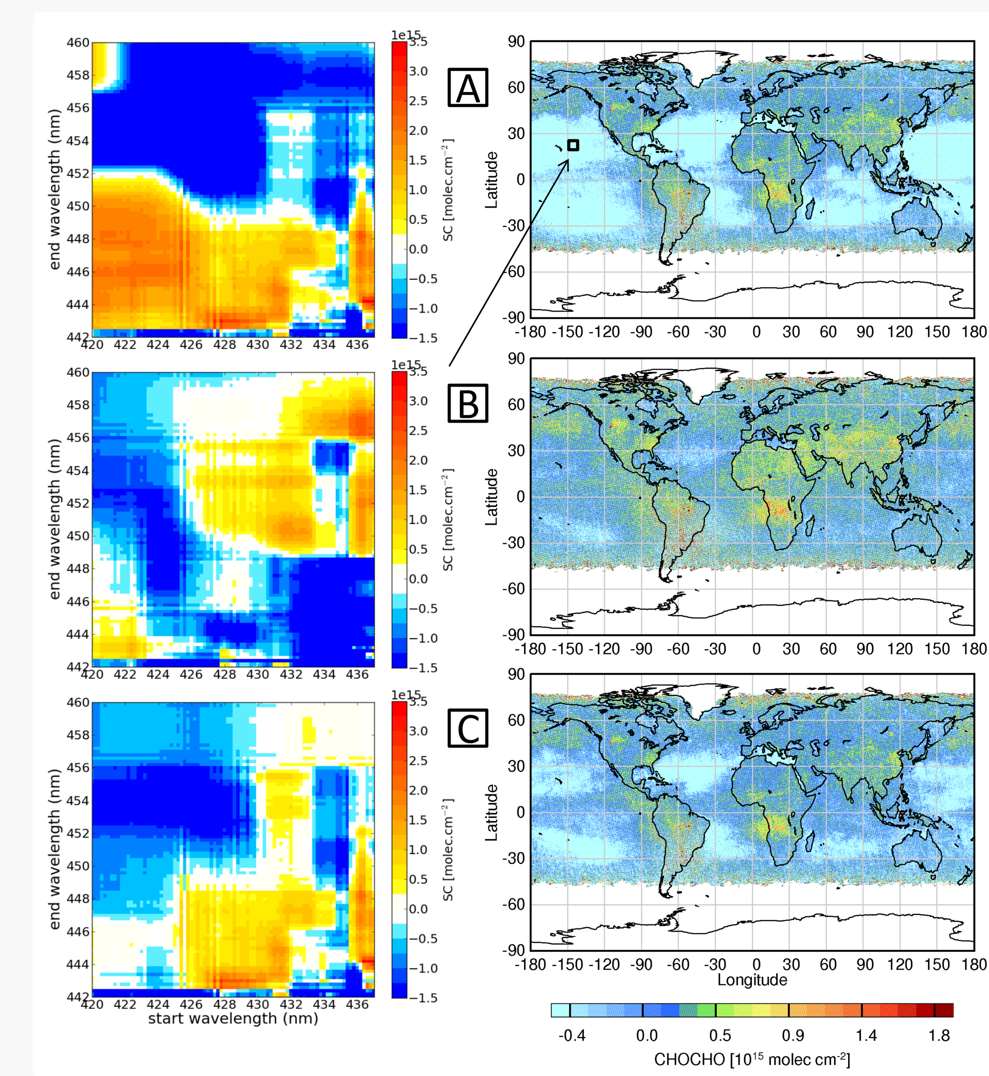


- Another main parameter in the DOAS retrieval is the polynomial order, because this removes the broad band signals in the DOAS fit.
- Glyoxal retrievals were performed for both cases, using the synthetic spectrum and OMI data for polynomial order of 3, 4 and 5 (# of coefficients).
- Color mapping shows a similar pattern for polynomials 4 and 5 from the synthetic spectrum, however for polynomial 3 more dispersion in the deviation from the true value for most wavelength intervals has been found. Moreover, the glyoxal retrievals from real data over Africa show a similar pattern for polynomial 3 and 4, which is not in agreement with the results from the synthetic spectrum. The values for the polynomial 5 are higher than the others. Nevertheless, in the optimal wavelength intervals the polynomial 4 present a more homogeneous SCs pattern.

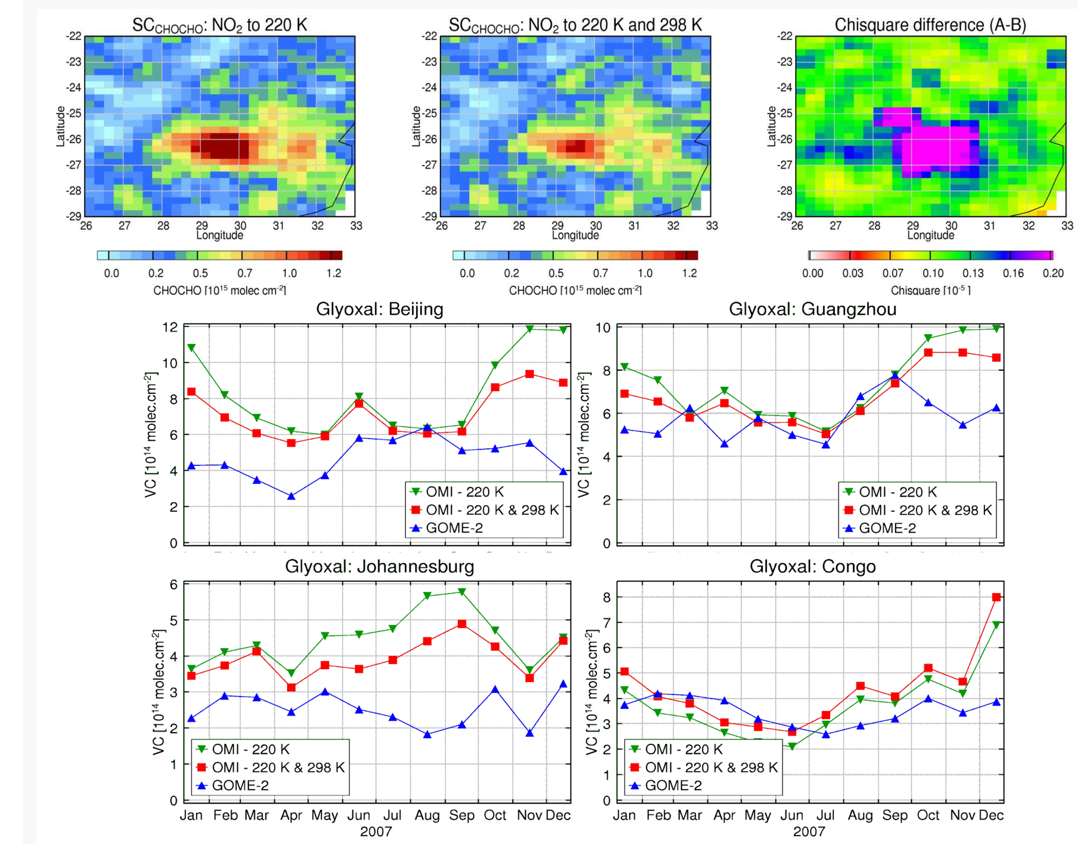
5. Liquid water interference

The figure shows a comparison of monthly global maps of CHOCHO SCs for August 2007 and color mapping of CHOCHO SCs over the ocean. Standard CHOCHO retrieval (A), including the liquid water cross-section (B) and using the two step fit proposed by Lerot et al., 2010 (C).

Clearly the CHOCHO results using the liquid water cross section are improved over the oceans, as the negative values obtained over these regions are less pronounced. Nevertheless, the interference with liquid water is still present to a lesser degree, judging from the fact that some negative CHOCHO SC values still remain.



6. NO_2 interference



Some regions with large anthropogenic emissions (e.g. Johannesburg, Beijing, and Guangzhou) show unexpected high levels of glyoxal in OMI data. A possible reason for these high levels is interference with NO_2 absorption.

As a test, an additional NO_2 high temperature cross-section was included in the glyoxal retrieval.

Monthly maps of glyoxal SC for September 2007 and seasonal variation over some regions are shown in the figure.

The largest differences among products were found in the winter season. Moreover, the OMI glyoxal product has larger values than GOME-2 for most of these regions. In contrast, over the Congo the seasonal variation is similar for all products and no differences were found in the winter season. Probably, because the glyoxal over this region is coming from biogenic emissions.

7. Summary and Outlook

- An improved glyoxal product has been retrieved from OMI data.
- An optimal wavelength interval from 433 nm to 458 nm and a polynomial order 4 for removal of broad band signals for glyoxal retrievals have been found.
- Reduction in the negative values over ocean regions is obtained using a two step retrieval proposed by Lerot et al. and also by including a liquid water cross-section in the standard glyoxal retrieval.
- Using an additional high temperature NO_2 cross section reduces the high glyoxal values over regions with large anthropogenic NO_x emissions, the differences are more significant in the winter season.
- Further work will be performed in order to improve the correction of cloud and aerosol effects, in particular in the case of biomass burning when atmospheric aerosol levels are high.

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