# Intercomparison of global total ozone measurements retrieved from ENVISAT/SCIAMACHY using different state-of-the-art algorithms

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## INTRODUCTION

The SCaning Imaging Absorption spectroMeter for Atmospheric CartograpHY (SCIAMACHY) is an imaging spectrometer launched in March 2002 on the ESA ENVISAT platform. Its primary objective is to achieve global measurements of a number of important atmospheric trace gases, among which ozone. Combined with measurements from ESA's Global Ozone Monitoring Experiment (GOME), SCIAMACHY provides an opportunity to accurately monitor the state of the ozone layer over a period of more than a decade. However, this requires that the accuracy of the SCIAMACHY total ozone retrieval matches the one recently achieved for GOME as a result of algorithmic developments carried out at BIRA-IASB, KNMI and IUP-Bremen.

We compare here the results from three established state-of-the-art total ozone algorithms developed for GOME and applied to nadir backscattered light observations from SCIAMACHY, namely: SDOAS, the SCIAMACHY version of the GDOAS algorithm developed at BIRA-IASB for GOME and currently implemented at DLR in the ESA operational system of both GOME and SCIAMACHY; TOSOMI (version 0.33), an adaptation of the total ozone algorithm developed at KNMI for the Aura/OMI instrument; and WF-DOAS, an advanced modified-DOAS algorithm developed at IFE-Bremen. We focus on assessing the consistency between the aforementioned algorithms including the ESA SCIAMACHY off-line operational processor (SGP L12) and we characterize different dependences of the retrieved ozone columns. It has to be noted that the results issued from WFDOAS are still preliminary. Figure 1 illustrates the total $O_3$ vertical column density retrieved from these algorithms for one orbit of the 29[th] march 2003.

**TABLE 1: MAIN DIFFERENCES IN THE SETTINGS OF THE ALGORITHMS**

| | SDOAS | TOSOMI | WFDOAS | SGPL12 |
|---|---|---|---|---|
| Fitting interval (nm) | 325.0 – 335.0 | 325.0 – 335.0 | 326.6 – 335.0 | 325.0 – 335.0 |
| $O_3$ cross-sections | SFM (Bogumil et al.) Scale factor : +3.0 % Preshift : +0.020 nm | GFM (Burrows et al.) @ 0.45 nm resolution Preshift : +0.017 nm | SFM (Bogumil et al.) Scale factor : +3.7 % Preshift : +0.016 nm | SFM (Bogumil et al.) Scale factor : +3.0 % Preshift : +0.020 nm |
| Additional wavelength re-calibration | Yes | No | Yes | Yes |
| Cloud algorithm | FRESCO | FRESCO | OCRA/SACURA | OCRA/SACURA |

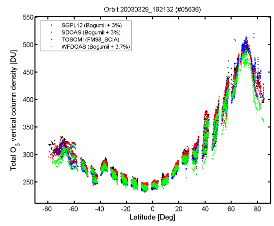


*Fig. 1 : Total ozone vertical column density retrieved from SGPL12, SDOAS, TOSOMI and WFDOAS versus latitude for the orbit #05636 (29/03/2003)*

## Ozone cross-sections

As indicated in table 1, the different algorithms compared in this work are usually set with different $O_3$ absorption cross-sections. In order to minimize the impact of these differences when comparing SCIAMACHY results, the following scale factors have been applied for the SDOAS $O_3$ retrievals:

- +3% for the comparisons with SGPL12
- +3.7% for the comparisons with WFDOAS
- +5.0% for the comparisons with TOSOMI. Fig. 2 shows that the usage of the Bogumil et al. (SFM) data leads to similar $O_3$ columns than the FM98 (GFM) data at the SCIAMACHY resolution for the SDOAS retrievals.

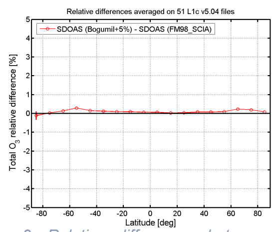


*Fig. 2: Relative differences between the SDOAS total $O_3$ columns derived with the FM98 (GFM) at SCIAMACHY resolution and the Bogumil (SFM) +5% data.*

**SCIAMACHY - GOME differences** | **Differences between the various algorithms for SCIAMACHY measurements**

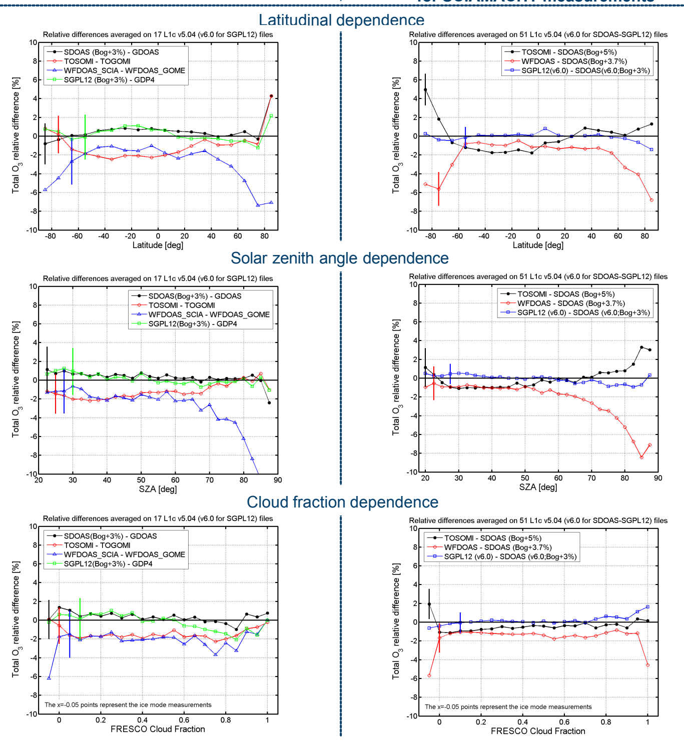


*Fig. 3 : Total ozone relative differences versus latitude, solar zenith angle and FRESCO cloud fraction. Left panels depict the differences averaged on 17 orbits in early 2003 between SCIAMACHY and GOME measurements for the SGPL12, SDOAS, TOSOMI and WFDOAS algorithms. Right panels show the differences averaged on 51 orbits of 2003 between the ozone vertical columns retrieved from the same algorithms using the SCIAMACHY measurements.*

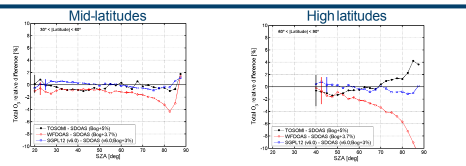


*Fig. 4 : Latitudinal variation of the SZA dependences for the total ozone relative differences*

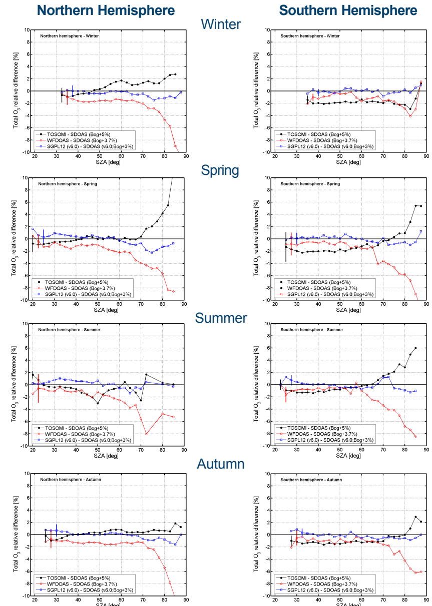


*Fig. 5 : Seasonal variation of the SZA dependences for the total ozone relative differences for the northern (left panel) and southern (right panel) hemispheres*

## CONCLUSIONS

- Very good consistency between GDOAS, SDOAS, GDP4 and SGPL12. No dependence could be observed for the relative differences.
- The differences observed between SGPL12 and GDP4 come obviously from the instrumental differences but also from the change of cloud algorithm and the profile extraction and albedo surface reading procedure improvement.
- SCIAMACHY $O_3$ columns issued from WFDOAS (preliminary) and from TOSOMI (v0.33) are generally low regarding the GOME results (approx. –2%).
- The TOSOMI $O_3$ columns are globally higher in the Northern Hemisphere than in the Southern Hemisphere.
- SDOAS, TOSOMI and WFDOAS $O_3$ column differences show marked SZA dependences mostly significant at high latitudes (Fig. 4).
- The origin of the discrepancies at high latitudes is currently not resolved. Further work is needed to consolidate the SCIAMACHY $O_3$ retrievals.