OVERVIEW OF SCIAMACHY LEVEL 2 DATA QUALITY

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ABSTRACT

SCIAMACHY products are generated at several scientific institutes. The involved institutes have agreed on common quality criteria regarding documentation, availability, and validation of their products. The products are being made available via a central web site. The validation of these SCIAMACHY products is monitored by the SCIAMACHY Validation and Interpretation Group, a subgroup of the SCIAMACHY Science Advisory Group. This paper gives an overview of the quality of the available SCIAMACHY level 2 data products.

1 SCIAMACHY LEVEL 2 PRODUCTS

SCIAMACHY on board Envisat observes the Earth reflectance in a wide spectral range (240-2380 nm), allowing the retrieval of a variety of species. Currently available products are: vertical columns of O_3, NO_2, BrO, H_2O, SO_2, CO, CH_4, CO_2, and HCHO, slant columns of OClO, tropospheric columns of NO_2, stratospheric vertical profiles of O_3, NO_2, BrO, and OClO, absorbing aerosol index (AAI), cloud fraction, cloud top height, and other cloud properties, PSC, UV index and UV dose. The products are generated by ESA/DLR, IFE/IUP Bremen, IUP Heidelberg, KNMI, SAO, BIRA-IASB, SRON, and Dalhousie, in some cases as joint products. The products generated by ESA/DLR are called 'operational' products, the others 'non-operational' products, although some 'non-operational' products are also operationally processed and distributed. All SCIAMACHY level 2 products, their documentation, and their quality status are available through a central web site [1]. The products can be ordered directly from the product generators by filling in a web form.

2 QUALITY CRITERIA

In order to facilitate the use of the non-operational products for research applications the involved institutes have agreed on common quality criteria regarding documentation, availability, and validation of their products. The quality assessment is performed by the SCIAMACHY validation product coordinators, under the responsibility of the SCIAMACHY VALidation and Interpretation Group, subgroup of the SCIAMACHY Science Advisory Group.

3 VALIDATION

Validation of SCIAMACHY products is performed by a large international community. Dedicated campaigns and numerous operational stations have delivered a wealth of correlative measurements over the past four years. The quality assessment presented here is based on validation studies published in the literature and presented at validation workshops. An overview of the validation until 2004 is given in [2] where also the references to the results quoted here can be found. Future funding for SCIAMACHY validation is limited, and validation activities performed within the framework of scientific projects are essential for the assessment of the quality of SCIAMACHY products. These results

Proc. of the First 'Atmospheric Science Conference', ESRIN, Frascati, Italy
8 – 12 May 2006 (ESA SP-628, July 2006)

are closely monitored by the SCIAMACHY Validation and Interpretation Group. Validation results are reported on the validation website [3].

4 DATA QUALITY OPERATIONAL PRODUCTS

The operational SCIAMACHY processor run by ESA/DLR is currently undergoing a major upgrade (version OL 3.0) which is expected to affect the quality of total columns of O_3 and NO_2, slant columns of SO_2, cloud cover and height, AAI, and profiles of O_3 and NO_2. The first operational data from the upgraded processors are expected to become available in the second quarter of 2006. The quality of the total columns of O_3 and NO_2 for the latest operational processors (NRT 5.01/5.04 and OL 2.5) is acceptable for limited periods and geographical domains only. The cloud cover fraction correlates well with scientific retrievals. An overview of the data quality is given in Table 1.

4.1 Operational O_3 and NO_2 columns (NRT 5.01/5.04 and OL 2.5)

The agreement of O_3 columns to ground-based networks and satellite measurements is mostly within 2-10%, SCIAMACHY on average somewhat lower. The bias significantly depends on solar zenith angle, season and viewing angle. Similar behaviour of the O_3 column errors was observed for the GOME processor version 2, on which this SCIAMACHY processor version is based.

Validation of the NO_2 columns indicates good agreement with correlative data over clean areas in the southern winter/spring and northern summer. Large deviations are observed in other cases with a clear correlation with cloud fraction, ghost vertical column and air mass factor values.

4.2 Operational O_3 and NO_2 profiles (OL 2.5)

Validation of O_3 profiles with ground-based instruments and satellites showed that 20% of the profiles have unrealistic values. The other 80% display no systematic deviations above 24 km but are significantly underestimated below 24 km by 15%.

A comparison of NO_2 profiles with collocated and photochemically corrected SAGE II (vs. 6.2) measurements indicate that the quality of the retrievals strongly depends on latitude and/or solar zenith angle.

5 DATA QUALITY NON-OPERATIONAL PRODUCTS

Most of the UV-visible data products - O_3, NO_2, H_2O, BrO total columns; OClO slant columns; O_3, NO_2 profiles, cloud cover fraction - already have acceptable, if not excellent, quality. Provisional short wave infrared column products - CO, CH_4, and CO_2 – have already demonstrated their potential for a variety of applications. An overview of the data quality is given in Table 1.

5.1 Non-operational products from nadir UV/Visible

O_3 columns: Validation of O_3 columns shows a good agreement with ground-based data, with a bias of 1-1.5% (usually a slight underestimation) and an RMS of about 5%.

NO_2 columns: The NO_2 stratospheric columns have good quality, but large differences exist between the different tropospheric NO_2 columns. This is mainly the result of the different assumptions and a priori information used in the retrievals, e.g. for the NO_2 profile shape, aerosol loading and cloud impact. Validation with independent measurements is still sparse as only few comparable data sets exist. Dedicated validation campaigns and detailed algorithm intercomparisons are planned.

BrO columns coincide well with GOME retrievals and with ground-based UV-VIS measurements but have a larger scatter than for GOME data and an interference with HCHO.

Table 1. Overview of the quality of the available SCIAMACHY products. Details can be found in Section 4 for the operational products and Section 5 for the non-operational products.

Operational products

(OL 2.5, ESA/DLR)

nadir		limb
UV/Vis	SWIR	UV/Vis
O_3 (v)	H_2O (v)	O_3 (p)
NO_2 (v)	N_2O (v)	NO_2 (p)
cloud fr	CH_4 (v)	
AAI	CO (v)	

v: vertical column
s: slant column
t: tropospheric column
p: profile
m: mesospheric profile

good to reasonable
issues to be solved
unknown quality
do not use

Non-operational products

(IFE/IUP Bremen, IUP Heidelberg, KNMI, SAO, BIRA-IASB, SRON, Dalhousie)

nadir		limb
UV/Vis	SWIR	UV/Vis
O_3 (v)	CO (v)	O_3 (p)
NO_2 (s/v/t)	CO_2 (v)	NO_2 (p)
BrO (s/v)	CH_4 (v)	BrO (p)
OClO (s)		OClO (p)
H_2O (v)		PSCs
cloud fr		
AAI		
SO_2 (s/v)		
HCHO (v)		
cloud props *		
UV index/dose		

*) cloud top pressure/height, cloud optical thickness, liquid water path, TOA reflectance (443nm), phase index, droplet effective radius

SO_2 columns: Quantitative validation of SO_2 columns is hampered by the lack of independent measurements. The retrieved columns are similar to those observed by GOME and show both anthropogenic and volcanic emissions. Routine measurements and campaigns near SO_2 sources are currently planned.

OClO slant columns are consistent with GOME retrievals and ground-based as well as AMAX-DOAS measurements.

H_2O columns: Validation of H_2O columns shows a systematic bias of -0.05 g/cm^2 and a scatter of 0.5 g/cm^2 with respect to SSM/I measurements and ECMWF model values.

Cloud cover fraction: The different cloud cover fraction algorithms compare well for most of the globe.

Absorbing Aerosol Index compares well with TOMS.

5.2 Non-operational products from nadir SWIR

Correlative studies have been conducted using

- ground- data from a pole-to-pole network of 12 FTIR instruments and from the FTIR operated during two cruises of the Polarstern vessel from Bremerhaven to Africa,
- CO column data from the EOS-Terra MOPITT satellite,
- CO and CH_4 data from the TM3 (KNMI) and TM5 (IMAU) models, and
- ancillary data such as fire maps produced by ERS-2 ATSR and EOS-Aqua MODIS.

The general potential of SCIAMACHY SWIR products is demonstrated, in particular its capabilities to detect source/sink areas of CO, CH_4 and CO_2 and to track their transport. Provisional precision estimates for SCIAMACHY CO (30%) and CH_4 (5%) vertical columns are not far away from the nominal requirements and can already be used in a variety of applications. Even so, inverse modeling analyses seem to indicate that nominal precision requirements are a firm precondition for the potential improvement of existing emission catalogues.

For CO_2, current validation is too limited to give firm conclusions. The tropics need special attention.

5.3 Non-operational products from limb UV/Visible

O_3 profiles (IFE/IUP Bremen version 1.61) were validated for five months spread over 2004 with ground-based and satellite data. The systematic bias, after a downward shift of 1.5 km was applied to account for a pointing offset, is -3% with respect to lidars, averaged between 16 and 40 km, and -6% with respect to SAGE II over the same latitude range.

NO_2 profiles retrieved by IFE/IUP Bremen, SAO Harvard and IUP Heidelberg agree to within 20% with DOAS balloon profiles between 20 and 30 km. NO_2 profiles from IFE/IUP Bremen (version 1) are within 12% of HALOE profiles between 22 and 33 km. Comparisons with SAGE II show a systematic negative bias of 10 to 35% between 20 and 38 km.

BrO profiles: The comparison of BrO profiles with those from balloons, using a photochemical correction along trajectories, shows promising results in the middle stratosphere where the deviation is smaller than 50%. Below 20 km the agreement is worse.

6 LATEST RESULTS

The newest validation results are not yet included in this paper. They are presented at this meeting, a.o. in the following talks and posters:

- Amekudzi et al: Validation of ozone profiles retrieved from SCIAMACHY lunar occultation measurements
- Bojkov et al: SAUNA - Sodankylä Total Ozone Intercomparison and Validation Campaign
- Bracher et al: Global comparisons of total O3 columns from SCIAMACHY retrieved with Weighting Function DOAS (WFDOAS) Algorithm to OMI, GOME WFDOAS and ground-based measurements
- Dils et al: The evaluation of SCIAMACHY CO and CH_4 scientific data products, using ground-based FTIR measurements
- Dorf et al: EnviSat / SCIAMACHY validation with the LPMA / DOAS balloon gondola: Comparison of a) O_3, NO_2 and BrO profiles, b) the solar irradiance spectrum and c) limb radiances.
- Goutail et al: Ten years of NO2 comparisons between ground-based SAOZ and satellite instruments (Gome, Sciamachy, OMI)
- Hendrick et al: BrO Profiling from Ground-based DOAS Observations: New Tool for the ENVISAT/SCIAMACHY Validation
- Lerot et al: Intercomparison of Global Total Ozone Measurements Retrieved from ENVISAT/SCIAMACHY Using Different State-of-the-art Algorithms
- Meijer et al: Long-term validation of GOMOS, MIPAS and Sciamachy ozone and temperature profiles by the Envisat Quality Assessment with Lidar (EQUAL) project
- Pommereau and Borchi: Evaluation of ozonesondes, HALOE, SAGE II, SAGE III, ODIN-OSIRIS and SMR, and ENVISAT-GOMOS, -SCIAMACHY and MIPAS Ozone profiles in the tropics from SAOZ long duration balloon measurements
- Rozanov et al: Retrieval of BrO vertical distributions from SCIAMACHY limb measurements: Data quality assessment and algorithm improvements
- Theys et al: Retrieval of BrO Columns from SCIAMACHY and their Validation Using Ground-based DOAS Measurements

7 REFERENCES

1. http://www.sciamachy.org/products
2. Piters, A.J.M., K. Bramstedt, J.-C. Lambert, and B. Kirchhoff, Overview of SCIAMACHY validation: 2002-2004, *Atmos. Chem. Phys.*, 6, 127-148, 2006, and references therein.
3. http://www.sciamachy.org/validation