

# SCIAMACHY: monitoring instrument and data processing in support to science



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The successful monitoring of the Earth's atmospheric composition and its thorough understanding strongly depend on the availability of adequate sensors performing accurate measurements, as well as on the quality of the information extracted from observations. Quality assessment of instrument performances and data products is therefore essential to provide to the science community the best available information with a well defined level of confidence.

## Basics on SCIAMACHY

SCIAMACHY aboard the ENVISAT ESA platform is an imaging spectrometer provides continuous global measurements of scattered, reflected, and transmitted solar radiation in the spectral region between 240 and 2400 nm, using nadir, limb and sun/moon occultation viewing geometries.

Currently the SCIAMACHY instrument performs nominally. No particular anomalies have been detected since begin of mission; instrument unavailabilities are mainly due to single event upsets (SEU).



Level 1b product format not changed. News: • Stray light correction using a matrix approach in channel 2 • Mesospheric Limb Measurements • Scanner encoding values corrected.

Level 2 product format changed. News: • Additional nadir trace gas total columns (SO<sub>2</sub>, BrO, H<sub>2</sub>O, O<sub>3</sub> and O<sub>2</sub>) • Limb profiles of BrO and O<sub>3</sub> • Limb Cloud indicators for cloud presence and type • Improved Absorbing Aerosol Index.

Product	Processing Stage	Center	Operational processor	Products Dissemination
Level 1b NRT	SCI_NL_1PN	PDHS-EK	IPF 7.04 since 15/06/2010	DDS/FTP ftp://scia1usr@oas-es.esa.int ftp://scia1usr@oas-ks.esa.int
Level 1b OL	SCI_NL_1PU	D-PAC	IPF 7.04 since 24/06/2010	FTP ftp://scia1usr@ftp-ops-dp.esa.int
Level 2 FD	SCI_OL_2PN	D-PAC	SGP 5.01 since Apr. 2010	FTP ftp://scia2dusr@ftp-ops-dp.esa.int
Level 2 OL	SCI_OL_2PU	D-PAC	SGP 5.01 since Feb. 2010	FTP ftp://scia2dusr@ftp-ops-dp.esa.int

SCIAMACHY processing configuration. Please, note that Product Specification for Level 1 and 2 products is version 3L Issue 1.1.

## Data processing overview

### Operational calibration

SCIAMACHY requires suitable calibrations to correct for instrumental effects (e.g. dark current, instrument ageing) and ensure instrument's precision and accuracy throughout the mission lifetime. These calibrations are Static parameters and in-flight measurements translated into Auxiliary Data Files (ADFs) directly used in the Level 0-1b processing step.

Auxiliary Data Files  
Orbital Dark current - SCI\_L01  
Orbital PPG/Beam - SCI\_P01  
Daily Solar Spectrum - SCI\_S01  
Weekly Spectral calibration - SCI\_S01  
Static Key Date - SCI\_K01  
Static Int File - SCI\_I01

Daily M-factor - SCI\_M01

A correction for the radiometric degradation of SCIAMACHY is applied to the L1b-2 operational data processing by usage of the so-called **m-factors**.

<http://www.iap.uni-bremen.de/sciamachy/mfactors>

### User Data calibration

## Level 1c product

Not all possible calibrations are applied to SCIAMACHY Level 1b data in the operational processing.

Science users can transform Level 1b products into fully calibrated Level 1c products with the **SciaLIC** tool selecting calibrations and extracting specific geographic areas, time intervals, spectral regions and type of measurements. The latest SciaLIC version includes also the possibility to correct data for the radiometric degradation applying the m-factor correction.

<http://envsat.esa.int/sciaLIC/>

## Level 0 product

Level 0 data contain instrument source packets and telemetry data as received from the instrument.

NRT

SCIAMACHY Level 0-1b processing is performed Near Real Time (NRT) at ESRIN and Kiruna PDHS by using available NRT auxiliary information.

OL

## Level 1b product

Level 1b data are geo-located and engineering calibrated radiances.

FD

The new operational Fast Delivery (FD) data processing chain at D-PAC provides full SCIAMACHY Level 2 products based on Level 1b NRT data and predicted instead of consolidated auxiliary files within 24 hours from data acquisition.

OL

## Level 2 product

Level 2 consolidated products are processed off-line (OL) at D-PAC using consolidated Level 1b products and the most precise auxiliary data available.

Level 2 data are final geo-located geophysical parameters.

## Mission highlights

On February 2010, **new SCIAMACHY processors** became operational - Level 1 processor IPF 7.03 and Level 2 off-line processor SGP 5.01 - achieving significant improvements w.r.t. data quality (upgraded retrieval schemes) and enhancing products' list (5 new trace gases).

### ENVISAT 2010+ mission extension

The new ENVISAT orbit will be reached through an altitude decrease of 17.4 km with different orbital maneuvers and will have a repeat cycle of 30 days (431 orbits). The new scenario will ensure continuity of SCIAMACHY measurements in a changing climate and to fulfill the high data demand from both the science and operational user communities. The Level 0-1b processing was further upgraded to IPF 7.04 (June 2010) in order to meet the requirements of the lowering of the satellite's orbit foreseen for October 2010.



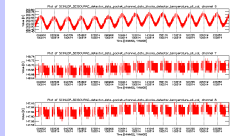
Validation activities of the SCIAMACHY products generated with new processors are on-going. The **validation dataset** covering selected orbits for the complete mission (around 1900 orbits for 2002-2010) was recently made available to the SCIAMACHY Validation and Interpretation Group (SCIAVALIG). A specific validation campaign will be dedicated to SO<sub>2</sub>.

The **SCIAMACHY Level 0-1b full mission re-processing** covering orbits from August 2002 to begin of the off-line forward processing (orbit 41287) using IPF 7.03 is expected to be released by summer 2010.

## Products Quality control

Instrument and products monitoring activities are carried out amongst others (SOST, SRON) by the IDEAS (Instrument Data quality Evaluation and Analysis Service) team in order to assure the reliability of SCIAMACHY disseminated products. QC allows an in-depth characterization of the SCIAMACHY data and to account for short- and long-term variations in the instrument performances and processing conditions.

**Daily monitoring** is implemented for all the levels of SCIAMACHY operational data production (both NRT and OL) and includes content and consistency checks: daily checks for product availability w.r.t. mission planning, format checks of the received products and controls on ADF generation and dissemination. In addition, it permits detection of anomalies in the Flight and Ground Segment. Results are presented by means of Daily Reports published on the web at: <http://earth.esa.int/pcs/envisat/sciamachy/reports/daily/>



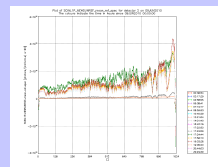
The **Level 0** monitoring provides a first check of the operational processing performance, allowing detection of anomalies in the acquisition and transmission of the instrument source packets.

Level 0 monitoring is important to check the instrument behavior, especially those keeping key parameters like optical bench module and detector temperatures. On the right are reported temperatures for detector channels 6, 7 and 8.

Further monitoring of the SCIAMACHY instrument is regularly performed by SOST and SRON. Results are updated on the respective web-pages:

<http://atmos.col.de/de/projects/scops/>

[http://www.sron.nl/index.php?option=com\\_content&task=view&id=1588&Itemid=1495](http://www.sron.nl/index.php?option=com_content&task=view&id=1588&Itemid=1495)

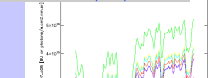


The **Level 1b** monitoring allows the quality check of the measured spectra and to verify the correctness of the spectral and radiometric calibration as well as the leakage current calibration. The measured reference solar spectra are constantly inspected (figure on the right).

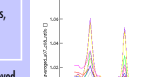
### The new monitoring of the SCIAMACHY Level 1b Source Packets

has been included in the daily inspections performed on consolidated SCIAMACHY Level 1b products, aiming to inspect the spectral ranges where retrievals are actually performed. Average spectra for selected mode-state-cluster combinations are inspected after calibration with the SciaLIC tool. Plots of calibrated averaged radiances vs. pixel number and ratio plot over a reference spectrum for the previous 30 days (scaled by the average pixel intensity) are reported for nadir state 7, cluster 8.

### Level 1b Source Packets inspection: spectral intensities



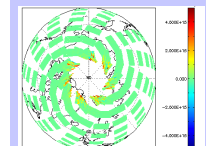
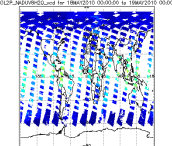
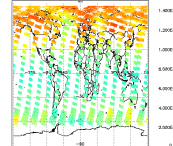
### Level 1b Source Packets inspection: spectral shapes



The **Level 2** monitoring allows to verify the scientific validity of the information extracted from measured limb and nadir radiances, in particular detecting anomalies in the operational retrieval processes.

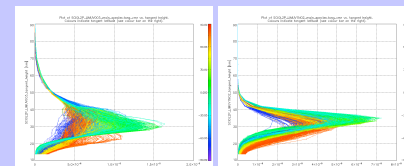
With the new Level 2 processing baseline Version 5.01, newly retrieved trace gases have been introduced besides O<sub>2</sub> and NO<sub>2</sub> monitoring: nadir vertical column densities (VCD) of BrO, SO<sub>2</sub> (volcanic & anthropogenic), OCO, H<sub>2</sub>O, CO and BrO limb profiles. Examples are reported.

SCIA2P\_H2O\_VCD\_Level 1b (2002-01-01 to 2002-01-01) 00:00:00

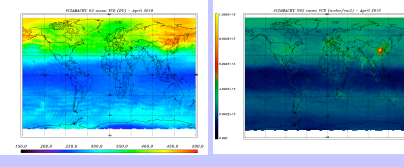


Level 2 monitoring - O<sub>2</sub> (mole/cm<sup>2</sup>) and H<sub>2</sub>O (g/cm<sup>2</sup>) VCD for one day of measurements (May 2010).

Level 2 monitoring - OCO VCD [mole/cm<sup>2</sup>] - northern hemisphere for one day of measurements (Feb. 2010).



Level 2 monitoring - limb profiles of O<sub>2</sub>, NO<sub>2</sub> and BrO VNR (Different colours indicate different tangent latitudes).



Long-term validation of global trace gas: Monthly consistency check - as an example, monthly average VCD of O<sub>3</sub> (DU), NO<sub>2</sub> (mole/cm<sup>2</sup>) and H<sub>2</sub>O (g/cm<sup>2</sup>) for April 2010.

## Your feedback is welcome

The SCIAMACHY monitoring baseline ensures the quality of the products before arriving to scientific users by timely detecting anomalies that could impact the measured spectra and the retrieval parameters. We are continuously evaluating improvements considering processors upgrades and SCIAMACHY Quality Working Group recommendations. Therefore, feedback from the SCIAMACHY data users is essential.

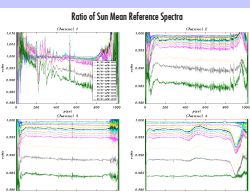
Point of contact: [sciamachy@eo-sppa.org](mailto:sciamachy@eo-sppa.org)

For any questions on SCIAMACHY: [eohelp@esa.int](mailto:eohelp@esa.int)

## ADFs Quality control

Besides the day-to-day data monitoring, long-term monitoring is performed in order to capture trends in the SCIAMACHY data set. Results also with updates on instrument status, data quality and processors updates are included in the SCIAMACHY **Bi-monthly report** available on-line at

<http://earth.esa.int/pcs/envisat/sciamachy/reports/bimonthly/>

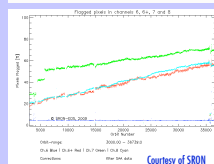
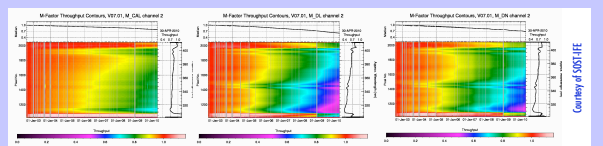


**Leakage Current** variation is monitored for all 8 detector channels building ratios of the leakage constant part of the fixed pattern readout noise (FPN) over a reference leakage dark current.

Fully calibrated **Sun mean spectra** are monitored by means of ratio plots calculated dividing the SMR spectra during each month to a spectrum at the beginning of each month.

Results for April 2010 channels 1-4 are reported.

**M-factor** calculation (ratio between the sun spectrum measured at a certain time to a spectrum obtained for the same optical path at a reference time) is performed by SOST-IFE and provides an end-to-end correction for the absolute radiometric calibration. Figures below report the degradation (=1/m-factor) observed from August 2002 to end April 2010 for channel 2 for SCIAMACHY nadir, limb and calibration light paths.



## Dead and bad pixels of IR detector channels are routinely monitored at SRON.

[http://www.sron.nl/index.php?option=com\\_content&task=view&id=908&Itemid=1009](http://www.sron.nl/index.php?option=com_content&task=view&id=908&Itemid=1009)

The plot shows the increasing rate of pixels flagged as bad/dead for the IR channels 6+, 7 and 8.

Starting from the Level 1b IPF 7.03 baseline, an operational Bad and Dead Pixel Mask is generated on an orbital basis and is enclosed in the Level 1b products. This mask indicates the position of pixels which may not be used for further processing.