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**SCIAMACHY**

**BI-MONTHLY REPORT:**

**NOVEMBER - DECEMBER 2011**

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prepared by/*préparé par* Gabriele Brizzi

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# **SCIAMACHY**

## **BI-MONTHLY REPORT**

### **NOVEMBER - DECEMBER**

### **2011**

## **1 INTRODUCTION**

The SCIAMACHY Bi-Monthly report documents the current status and recent changes to the SCIAMACHY instrument, its data processing chain, and its data products.

The Bi-Monthly Report (hereafter BMR) is composed of analysis results obtained by IDEAS, combined with inputs received from the different groups working on SCIAMACHY operation, calibration, product validation and data quality.

The first part of the report is dedicated to Instrument Configuration and Performance. It is composed of contributions from SOST-DLR, SOST-IFE and SRON. The remainder of the report is dedicated to Level 1b and Level 2 performance assessment and is generated by ESA/ESRIN IDEAS with contributions from ESA/ESTEC PLSO and DLR-IMF.

The structure of the report will be in constant evolution through the ENVISAT mission, as experience with SCIAMACHY data and quality control grows.

### **1.1 Scope**

The main objective of the BMR is to give, on a regular basis, the status of SCIAMACHY instrument performance, data acquisition, results of anomaly investigations, calibration activities and validation campaigns.

The BMR is composed of the following six sections:

- Summary;
- Instrument Configuration and Performance;
- Degradation monitoring and correction;
- Data Availability Statistics;
- Level 1 Product Quality Monitoring;
- Level 2 NRT and OFL Product Quality Monitoring;
- Validation Activities and Results.

## 1.2 References

- [1] ‘Instrument Operation Manual’, MA-SCIA-0000DO/01, Issue F R2, 16 Dec. 2004.
- [2] ‘ENVISAT-1 Products Specifications Volume 15: SCIAMACHY Products Specifications’, PO-RS-MDA-GS-2009, Issue 3L version 1.1, 21 January 2010.
- [3] ‘SCIAMACHY cL0 Statistics’, PO-TN-DLR-SH-0012, Issue 1, Rev. 1, 14 April 2005.
- [4] SCIAMACHY cL0 Statistics 2003, PO-TN-DLR-SH-0013, Issue 1, Rev. 0, 14 April 2005.
- [5] ‘SCIAMACHY Consolidated Level 0: Statistics for the Year 2005’, PO-TN-DLR-SH-0014, Issue 1, Rev. 0, 11 July 2006.
- [6] ‘Final SCIAMACHY Consolidated Level 0 Product Status 2002-2008’, PO-TN-DLR-SH-0025, Issue 1, Rev. 0, 1 June 2010.

### 1.3 *Acronyms and Abbreviations*

ADC	Analogue to Digital Converter
ADF	Auxiliary Data File
ANX	Ascending Node Crossing
AOCS	Attitude and Orbit Control System
APSM	Aperture Stop Mechanism
ASM	Azimuth Scan Mechanism
ATC	Active Thermal Control
BMR	Bi-Monthly Report
CA	Corrective Action
CCA	Communication Area
CTI	Configurable Transfer Item
DAC	Digital Analogue Converter
DLR-IMF	Deutsches Zentrum fuer Luft- und Raumfahrt
EOL	End of Life
ESM	Elevation Scan Mechanism
FAT	Factory Acceptance Test
FPN	Fixed Pattern Noise
HK	Housekeeping
HSM	High Speed Multiplexer
ICE	Instrument Control Electronics
ICU	Instrument Control Unit
IDEAS	Instrument Data quality Evaluation and Analysis Service
IECF	Instrument Engineering and Calibration Facilities
IOM	Instrument Operation Manual
LK1	Leakage Current Auxiliary File (SCI_LK1_AX)
LLI	Life Limited Item
LOS	Line of Sight
MCMD	Macro Command
MPH	Main Product Header
MPS	Mission Planning Schedule
NCWM	Nadir Calibration Window Mechanism
NDFM	Neutral Density Filter Mechanism
NIVR	Netherlands Agency for Aerospace Programmes
NNDEC	Non-nominal Decontamination
NRT	Near Real Time
OAR	Observation Anomaly Report
OBM	Optical Bench Module
OCM	Orbit Control manoeuvre
OCR	Operations Change Request
OFL	Off-line
OSDF	Orbit Sequence Definition File
OSV	Orbit State Vector



PCF	Product Control Facility
PDHS	Payload Data Handling Station (PDS)
PDHS-E	Payload Data Handling Station – ESRIN
PDHS-K	Payload Data Handling Station – Kiruna
PDS	Payload Data Segment
PE1	Pixel to Pixel/ Etalon Auxiliary File (SCI_PE1_AX)
PLSO	Payload Switch OFF
PMD	Polarization Measurement Device
QUADAS	Quality Analysis of Data from Atmospheric Sounders
QWG	Quality Working Group
SAA	South Atlantic Anomaly
SCIAMACHY	Scanning Imaging Absorption Spectrometer for Atmospheric Chartography
SCIAVALIG	SCIAMACHY Validation and Interpretation Group
SCICAL	SCIAMACHY Calibration tool
SEU	Single Event Upset
SLS	Spectral Line Source
SM	Service Module
SMR	Sun Mean Reference
SOST	SCIAMACHY Operations Support Team
SP1	Spectral Calibration Auxiliary File (SCI_SP1_AX)
SU1	Sun Reference Auxiliary File (SCI_SU1_AX)
SZA	Sun Zenith Angle
TC	Thermal Control
TCFoV	Total Clear Field of View
TOA	Top of Atmosphere
TRUE	Tangent height Retrieval by UV-B Exploitation
VCD	Vertical Column Density
WLS	White Light Source
WUR	Wageningen University and Research
YSM	Yaw Steering Mode

## 2 SUMMARY

- For the reporting period (orbits 50577 – 51452) SCIAMACHY measurements were nominal with respect to planning.
- During the reporting period, regular monthly calibration was scheduled between orbits
  - 50716-50719 (10-Nov-2011)  
The 5<sup>th</sup> calibration orbit was omitted for a planning bug.
  - 51133-51137 (09/10-Dec-2011)
- During the reporting period, no occultation measurements with the moon rising on the night side could be executed.
- During the reporting period, no OCR was implemented.
- No TC adjustments were required.
- A subset of SCIAMACHY data products generated between 25 December 2011 and 02 January 2012 from both the Fast Delivery and the Off-line Level 2 processing chains were found affected by an incorrect processing triggered by a hardware failure of the processing platform at D-PAC causing reduced file size and incorrect measurement coverage. 114 anomalous Level 2 consolidated products (off-line processing) for the time period from November 2011 to January 2012 were removed from the D-PAC FTP server and replaced with a correctively reprocessed data set. No quality impact on the retrieved parameters has been identified. A list of products affected is available at <http://earth.eo.esa.int/pcs/envisat/sciamachy/reports/anomalies/>
- SCIAMACHY instrument performances and products' quality are checked on a daily basis, monitoring the operational data processing chains. Results are presented by means of Daily Reports published on-line.

The Level 0 NRT daily reports can be accessed at the following address:

[http://earth.eo.esa.int/pcs/envisat/sciamachy/reports/daily/Level\\_0/](http://earth.eo.esa.int/pcs/envisat/sciamachy/reports/daily/Level_0/)

The NRT and OFL Level 1b daily reports can be accessed at:

[http://earth.eo.esa.int/pcs/envisat/sciamachy/reports/daily/Level\\_1/](http://earth.eo.esa.int/pcs/envisat/sciamachy/reports/daily/Level_1/)

The Fast-Delivery and OFL Level 2 daily reports can be accessed at:

[http://earth.eo.esa.int/pcs/envisat/sciamachy/reports/daily/Level\\_2/](http://earth.eo.esa.int/pcs/envisat/sciamachy/reports/daily/Level_2/)

### 3 INSTRUMENT CONFIGURATION AND PERFORMANCE

#### 3.1 *In-Flight Status and Performance*

Detailed operations, planning and instrument status information can be found on the website of the *SCIAMACHY Operations Support (SOST)* under <http://atmos.caf.dlr.de/projects/scops/>. These pages are maintained on a daily basis and show the history and actual progress of the SCIAMACHY mission.

##### 3.1.1 *Planned Operations and Measurements (SOST-DLR)*

The reporting period covers the orbits 50577 (ANX = 01-Nov-2011, 00:54:29.630) to 51452 (ANX = 31-Dec-2011, 22:37:50.729). Two OSDFs specified the planning baseline.

Orbit		ANX		OSDF
Start	Stop	Start	Stop	
50132	51007	01-OCT-2011 01:30:59.797	30-NOV-2011 23:14:27.143	MPL_OSD_SHVSH_20110823_010101_00000000_36080001_20111001_013101_20111201_005439.N1
51008	51452	01-DEC-2011 00:54:41.086	31-DEC-2011 22:37:50.729	MPL_OSD_SHVSH_20111017_010101_00000000_36090001_20111201_005443_20120101_001802.N1

**Table 3.1: SCIAMACHY OSDF planning file from October/November – December 2011, including the reporting period.**

Measurements were nominal, i.e. timelines executed limb/nadir sequences with wide swath settings on the dayside of the orbit. Each month they were interleaved with 2 blocks of 14-15 orbits each where the limb state was replaced by the *limb\_mesosphere\_thermosphere* state (see below). In-flight calibration and monitoring measurements occurred on daily, weekly and monthly timescales. Regular monthly calibration was scheduled between orbits

- 50716-50719 (10-Nov-2011) – note: due to a planning bug the 5<sup>th</sup> calibration orbit was omitted
- 51133-51137 (09/10-Dec-2011)

The moon was in the limb TCFoV between orbits

- 50635-50735 (05-Nov-2011 until 12-Nov-2011)
- 51061-51158 (04-Dec-2011 until 11-Dec-2011)

No occultation measurements with the moon rising on the night side could be executed.

Four blocks of *limb\_mesosphere\_thermosphere* measurements were scheduled with two orbits from the final October block ending in 01-Nov-2011.

Orbit		UTC		Remark
Start	Stop	Start	Stop	
50563	50578	31-OCT-2011 01:31:14	01-NOV-2011 02:34:43	MIPAS upper atmosphere mode
50778	50793	15-NOV-2011 00:41:13	16-NOV-2011 01:44:42	
50992	51007	29-NOV-2011 22:10:58	30-NOV-2011 23:14:27	MIPAS upper atmosphere mode
51209	51224	15-DEC-2011 00:41:23	16-DEC-2011 01:44:52	
51425	51440	30-DEC-2011 01:31:34	31-DEC-2011 02:35:03	MIPAS upper atmosphere mode

Table 3.2: Scheduled *limb\_mesosphere\_thermosphere* measurements in November – December 2011.

- No OCR was implemented.

### 3.1.2 Instrument Measurement Status (SOST-DLR)

The final flight status as from 10-Jan-2011 remained unchanged.

### 3.1.3 Executed Operations and Measurements (SOST-DLR)

#### *Measurements and instrument availability*

The OSDF planning file has been scheduled as requested. No instrument unavailability had occurred.

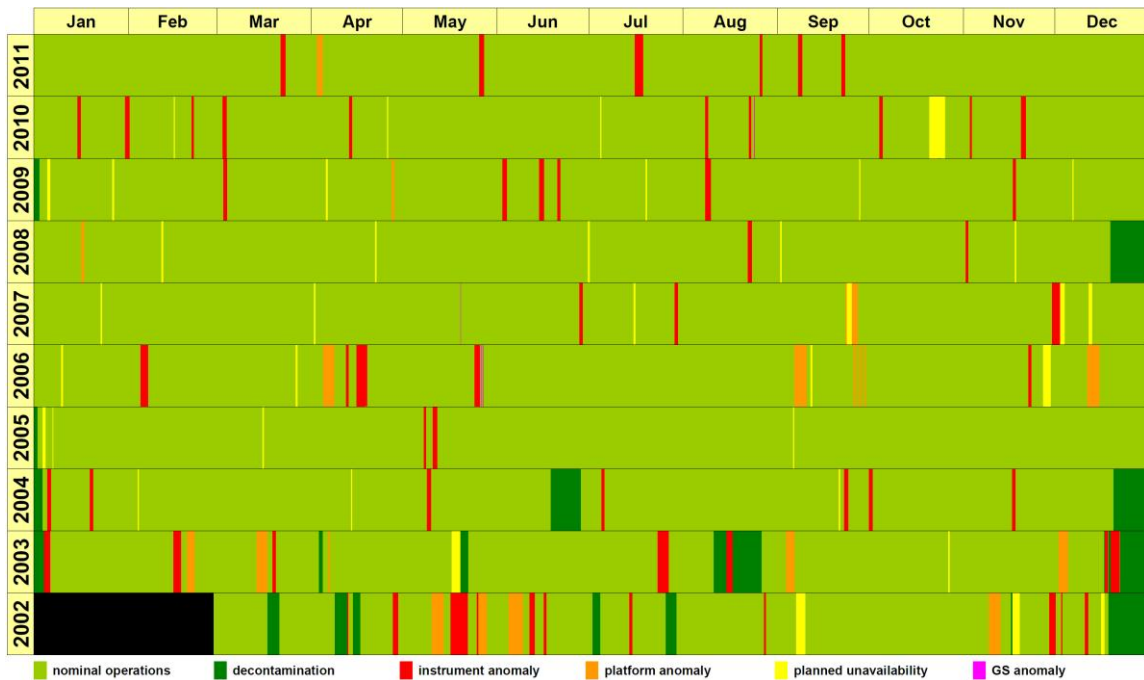


Figure 3.1: Current instrument availability status including the reporting period.

**Detector thermal adjustment (TC)**

No TC adjustment was required. The TC settings remained at

- DAC1 = 0.53 W
- DAC2 = 0.50 W
- DAC3 = 0.00 W

**APSM/NDFM health checks & PMD ADC cal**

In the reporting period 1 APSM/NDFM health check and 2 PMD ADC calibrations were executed. All showed nominal results.

APSM/NDFM			PMD ADC	
Orbit	ANX	Result	Orbit	ANX
n.a.	n.a.	n.a.	50911	24-NOV-2011 08:21:40
51284	20-DEC-2011 07:33:37	ok	51285	20-DEC-2011 09:09:45

Table 3.3: APSM/NDFM health check and PMD ADC calibration.

### *Anomalies*

No instrument or platform anomalies had occurred.

### *Data Quality*

Since no anomalies had occurred and the platform attitude mode had remained unchanged, data quality did not degrade.

#### *3.1.4 Performance Monitoring - System (SOST-DLR)*

Detector and OBM temperatures are monitored according to the requirements of the IOM [1]. It requests to ensure that the average temperature per orbit remains within the specified limits.

#### *Detector temperatures*

For each detector the average temperatures per orbit are determined from HK telemetry parameters. Figure 3.2 displays the temperatures of all 8 detectors. Colour coding is as on the operational monitoring website, i.e. data from orbits with HK telemetry coverage > 90% are shown in red, for < 90% in green. Minimum/maximum values per orbit are indicated as vertical bars.

The temperatures of channels 1-3 and 6-8 were in limits over the entire reporting period. Channels 4 and 5 exceeded their upper limits. This behaviour has been discussed with calibration and retrieval experts and is currently considered uncritical.

#### *OBM temperatures*

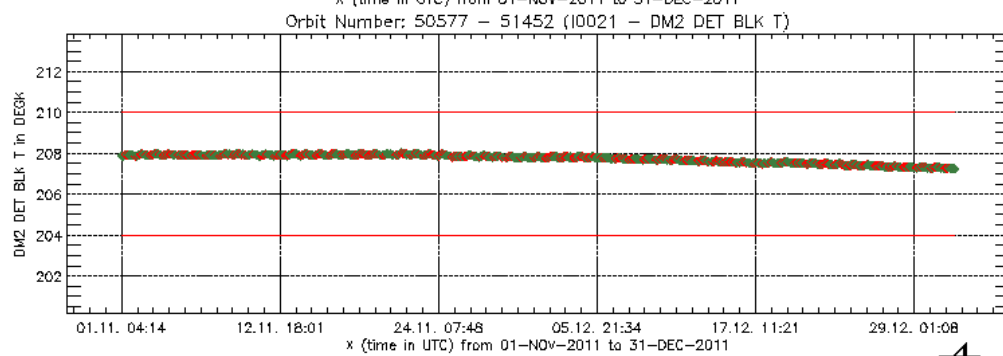
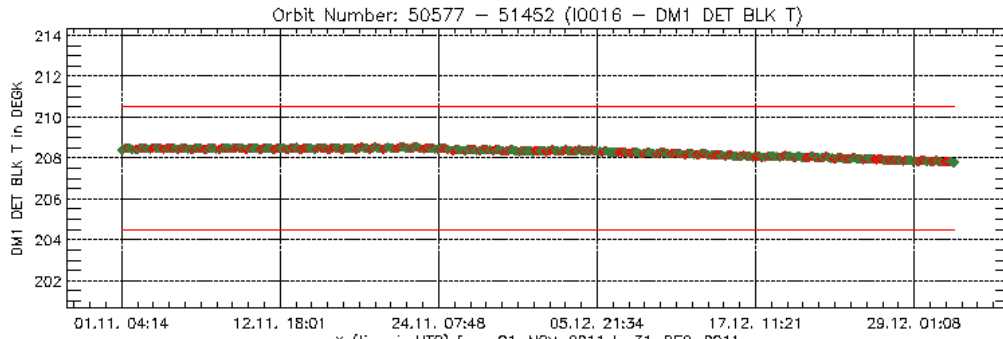
The average OBM temperature per orbit is determined from specific HK telemetry parameters. In addition power readings for the ATC heaters are monitored. Temperatures and ATC heater powers are given in Figures 3.3 and 3.4. Colour coding is as in Figure 3.2.

OBM temperatures and ATC heater powers remained within limits during nominal operations.

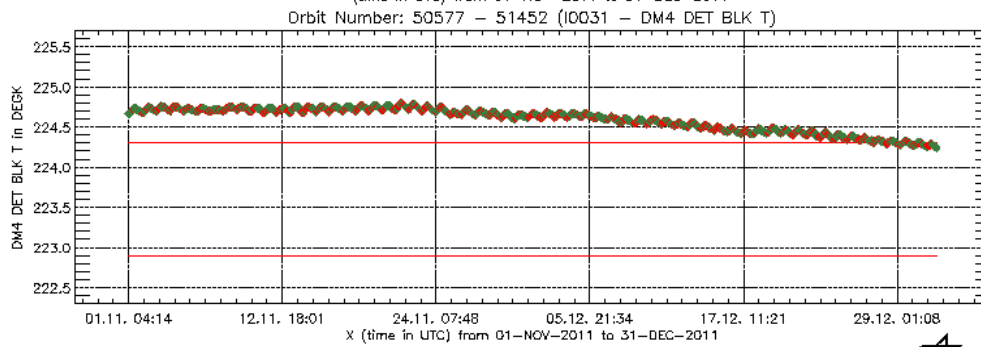
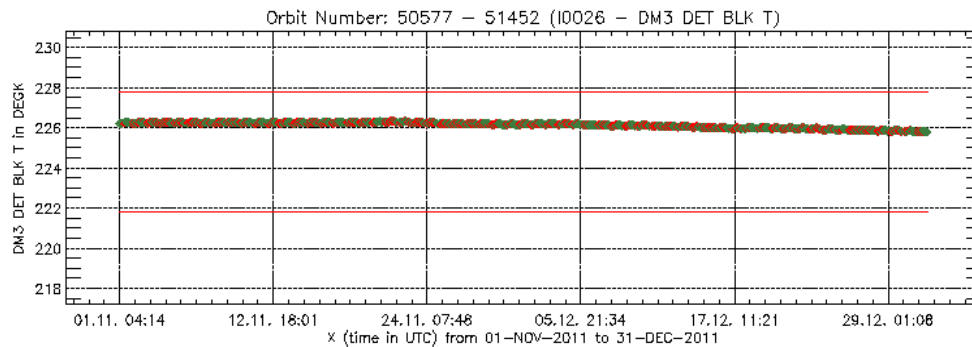
#### *PMD ADC status*

The status of the PMD ADC is monitored according to the requirements of the IOM [1]. It requests to ensure that no glitches occur caused by an SEU.

No PMD ADC glitches have been detected.



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Date : 20-01-2012 Page : 7



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Date : 20-01-2012 Page : 7





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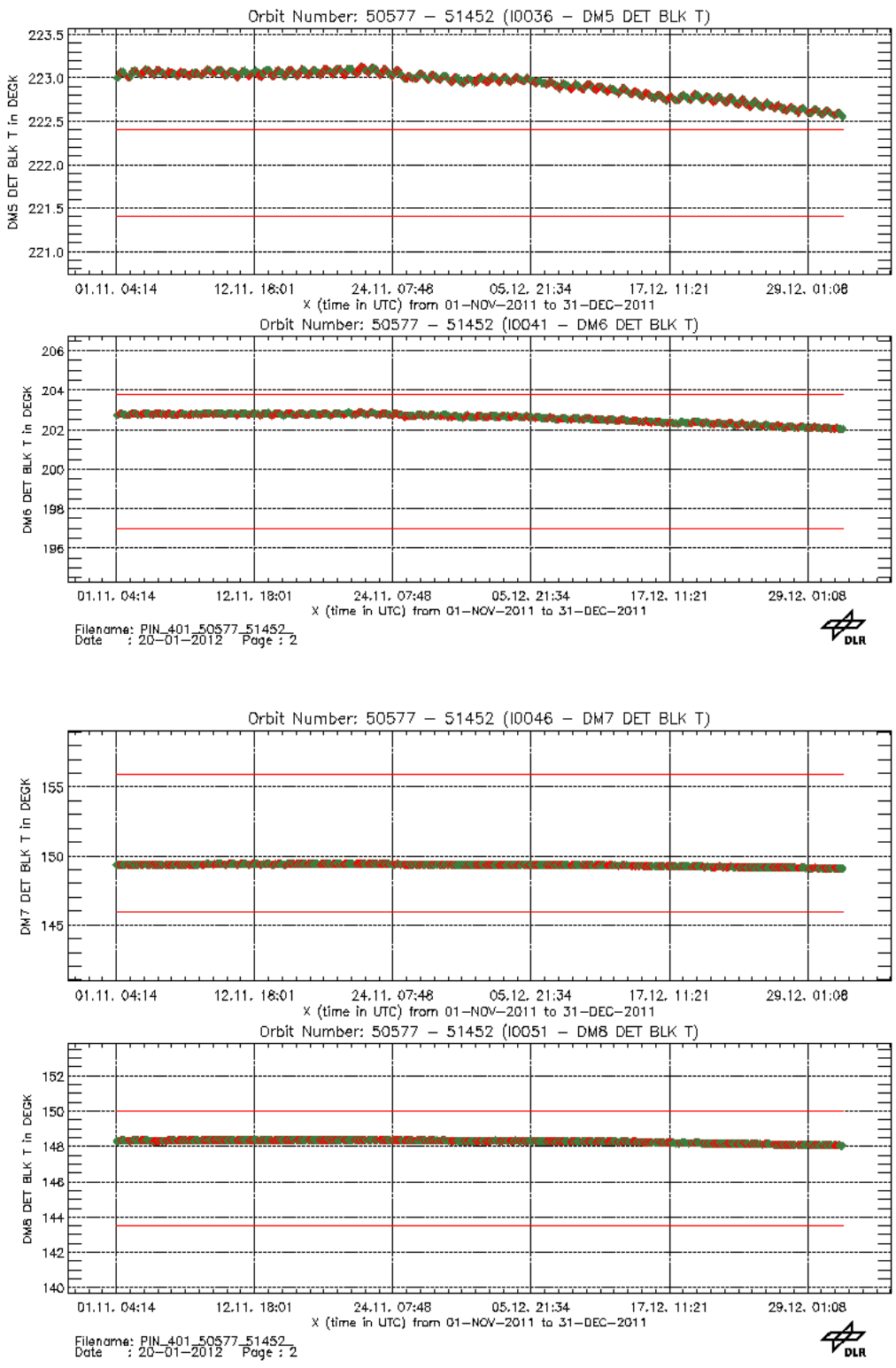


Figure 3.2: Detector temperatures.



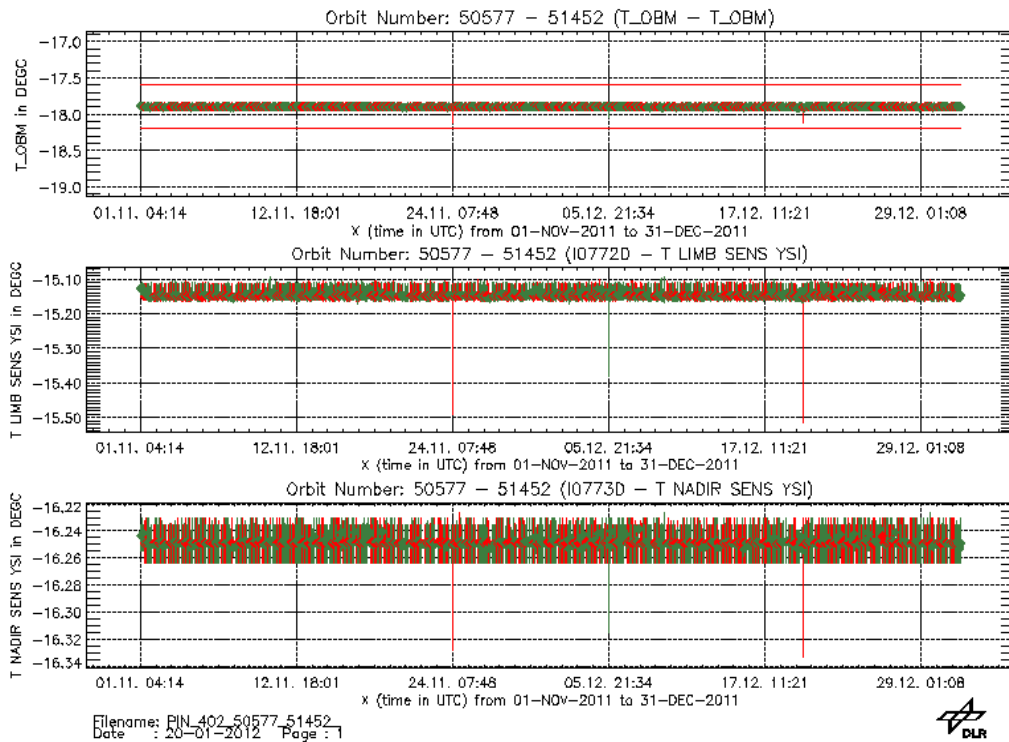


Figure 3.3: OBM temperatures (top: derived OBM, middle: limb sensor, bottom: nadir sensor).

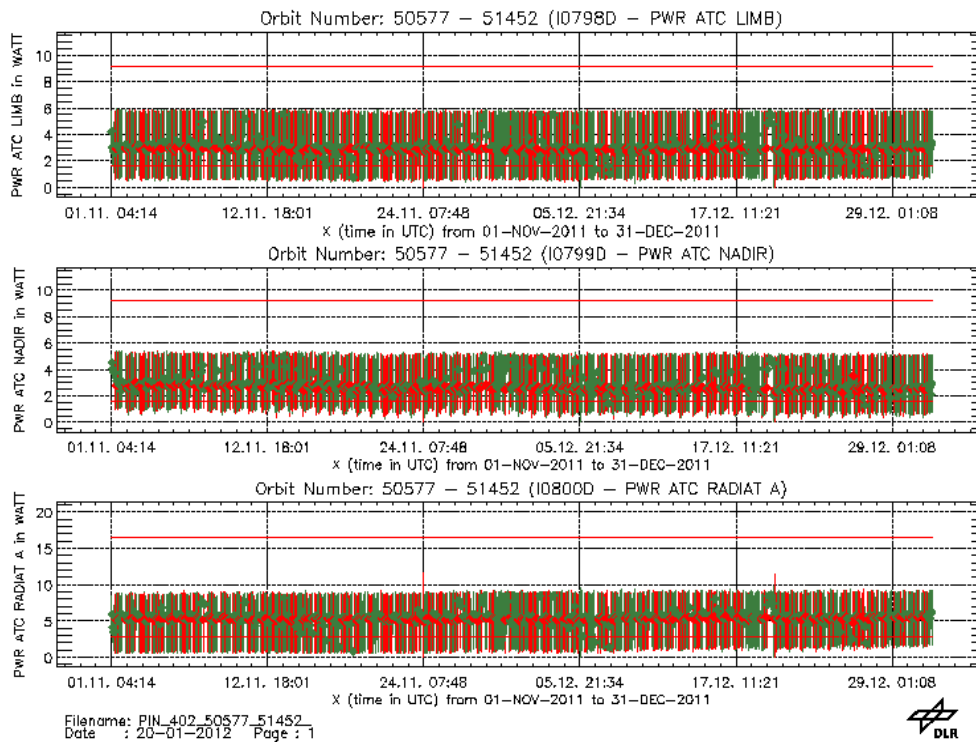


Figure 3.4: ATC heater power (top: ATC limb, middle: ATC nadir, bottom: ATC Rad A).



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### LLI status

Life Limited Items are monitored based on analysis of the

- OSDF: This yields a predicted LLI usage.
- Report format: This counts the actual LLI switches or used LLI cycles. No WLS/SLS burning times can be derived thereof.

In addition, the in-flight usage of the cryogenic heat pipe is recorded. This subsystem has a limited number of cycles. Each decontamination increases the accumulated number of cycles by 1.

At the end of the reporting period the fractional usage of the LLI relative to the allowed in-flight budget was (based on OSDF prediction)

- NDFM: 0.65
- APSM: 0.60
- NCWM (sub-solar port): 0.95
- WLS (switches): 0.19
- WLS (burning time): 0.35
- SLS (switches): 0.09
- SLS (burning time): 0.02

For the NDFM and APSM the safety margin factor of 2 is no longer applied in the calculation of the fractional usage since it had been found acceptable to stay below the figures of the life-tests. How the relative LLI usage has accumulated since launch is illustrated in Figure 3.5. 'EOL' assumes a total mission lifetime until end of 2013.

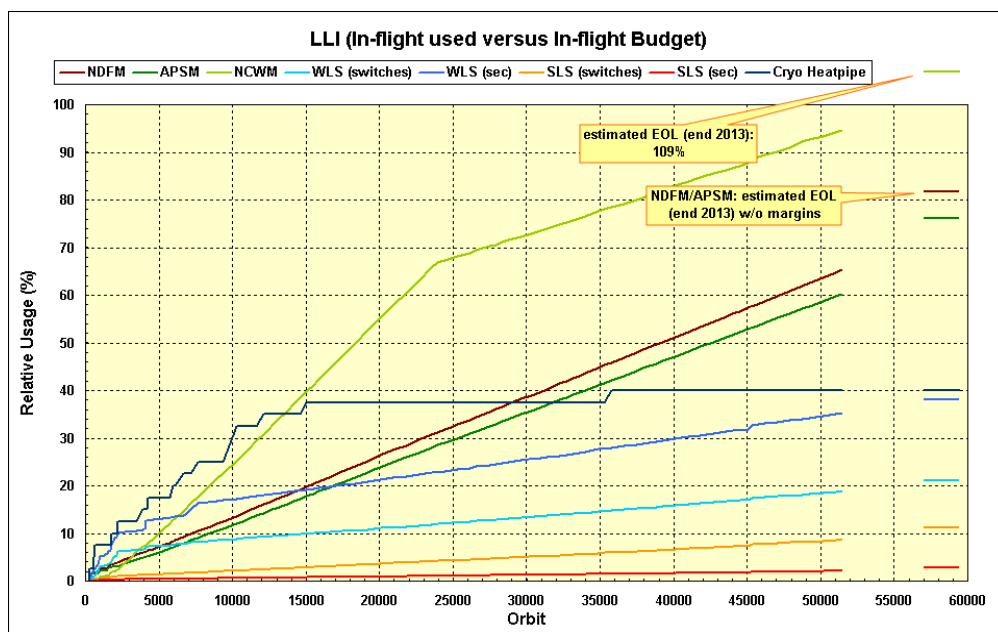


Figure 3.5: Relative usage of LLIs. 'EOL' is derived for a mission lifetime until 2013. For the NDFM and APSM no margin factors have been applied to derive the EOL relative usage.



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Note that the NCWM usage exceeding 100% by the end of 2013 has been discussed with the SSAG and SQWG and is currently considered uncritical. Operations of the subsolar port, i.e. execution rates of subsolar states, remain unchanged.

The number of cryogenic heatpipe cycles did not increase (no decontamination). The budget used remained at 40% of the allowed in-flight budget.

### Time reference

The times quoted in all planning files refer to the reference orbit. Since the actual orbit differs from the reference orbit (e.g. orbit drift), the times given w.r.t. the reference orbit also do not reflect exactly the actual absolute times of events along the orbit (e.g. ANX, sunrise, sub-solar, moonrise, eclipse). The requirements for orbit maintenance may result in time differences of usually  $< \pm 10$  sec. In some cases this value may even reach  $\pm 1$  min, however.

SOST monitors how the reference time deviates from the actual time. This is done by using the predicted time which comes very close to the actual = restituted time. If the predicted times are delayed with respect to the reference orbit, then the difference *predicted* – *reference time* is  $> 0$  sec; in the other case it is  $< 0$  sec.

Figure 3.6 displays the time difference *predicted* – *reference*. Orbit manoeuvres cause distinct discontinuities.

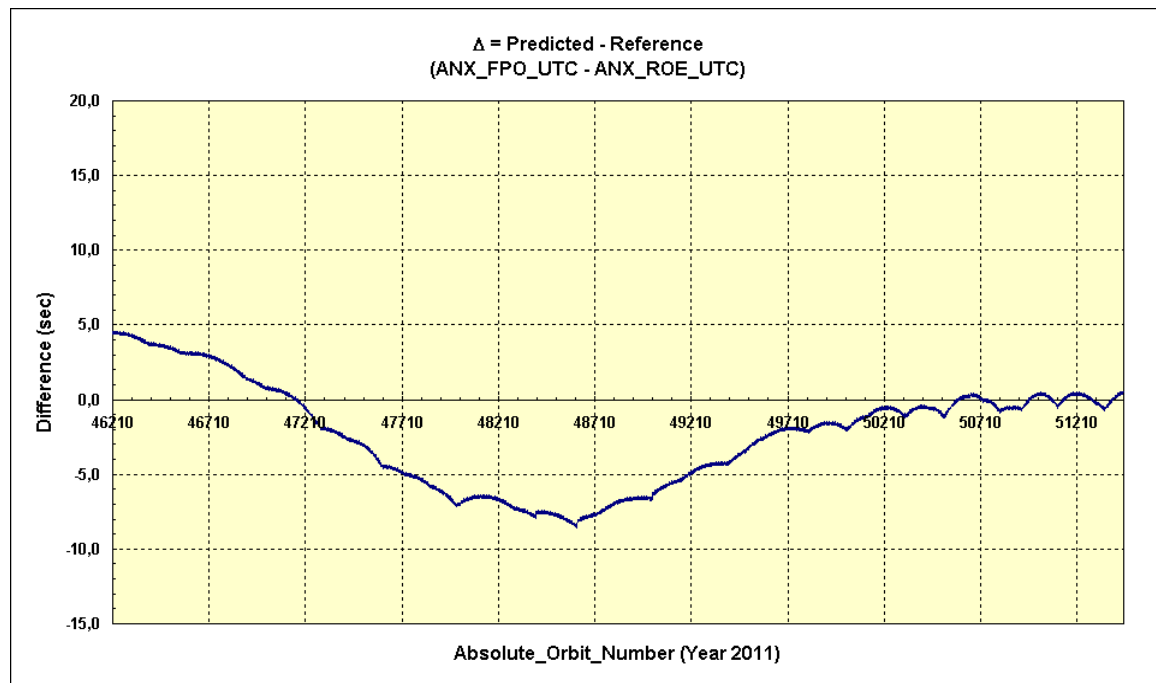


Figure 3.6: Time difference between predicted and reference time.

### 3.1.5 Performance Monitoring - Light Path (SOST-IFE)

This section summarises the performance monitoring results for the two months time interval covered by this report.

A more detailed description of the performance monitoring activities is given in the SCIAMACHY Bi-Monthly Report May-June 2008.

#### 3.1.5.1 Science Channel Averages

One part of the SOST long-term monitoring activities is the trend analysis of measurements with the internal White Light Source (WLS) and of observations of the unobscured Sun above the atmosphere. In order to monitor the different SCIAMACHY light paths, solar measurements are taken in various viewing geometries: In limb/occultation geometry (via ASM and ESM mirrors), in nadir geometry (via the ESM mirror through the sub solar port), and via the so-called calibration light path involving the ASM mirror and the ESM diffuser. SCIAMACHY long-term monitoring comprises a regular analysis of these measurements. The plots displayed in Figure 3.7 show results of these monitoring activities for the time interval November to December 2011.

Note that the reported channel averages are medians. The currently used scan angle correction is based on Version 6 radiometric key data.

The light path monitoring results presented in this section may be regarded as a first step towards spectrally resolved monitoring factors (m-factors) which is produced based on fully calibrated data. Daily updated light path monitoring results can be found on the SOST or IUP web site (<http://www.iup.uni-bremen.de/sciamachy/LTM/LTM.html>).

The following specific features can be identified from the light path monitoring results during the time interval of this report:

- The instrument behaved as expected except that the throughput in the UV-Vis for all light paths involving the ESM mirror is still rapidly increasing. This issue is under investigation.
- The minimum average throughput in channel 1 increased from about 40% to around 58% (for the limb light path) during the two months of this reporting period. The minimum channel 2 throughput also increased from about 63% to 68%.
- The throughput of the calibration light path is still stable for channels 1 to 5 and currently at about 79% in channels 1 and 2 and around 98% for channels 3 to 5.
- The overall degradation of channel 3 is still very small (2 – 5%, depending on light path) compared to channels 1 and 2, but also shows an increase of about 2% during the two months for the limb and nadir light paths.
- Even channel 4 shows a small increase of throughput of about 0.5% in two months.
- Channel 5 remains stable on a sub-percent level.
- In channels 6 to 8 a slight decrease of throughput of about 0.5% per month or less is observed.
- The throughput of channel 8 is currently at about 67%.

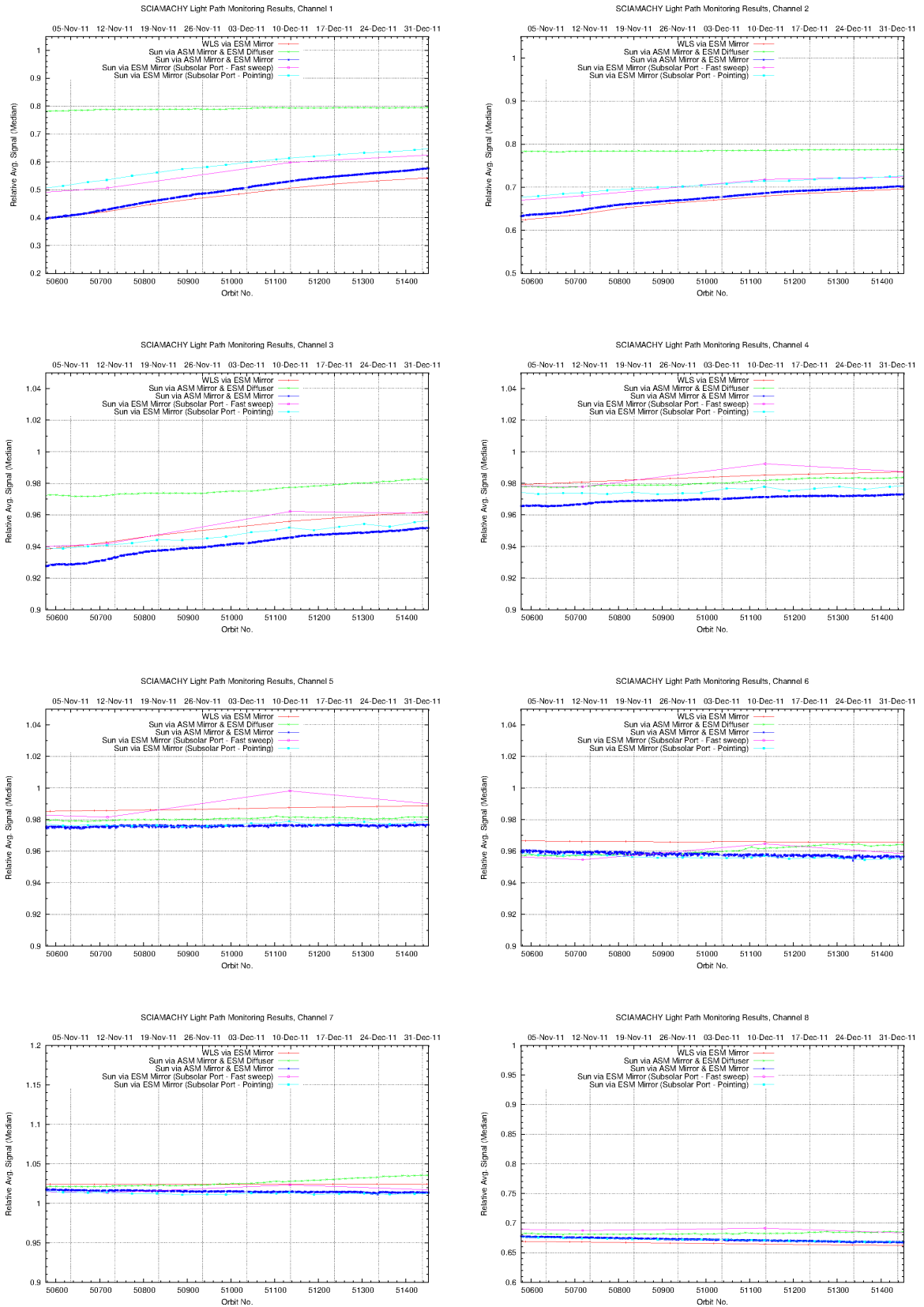


Figure 3.7: Light path monitoring results November to December 2011 (medians).

### 3.1.5.2 Spectral light path monitoring results

Starting from the Bi-Monthly report January-February 2010, spectral light path monitoring results have been replaced by corresponding m-factor results (based on fully calibrated Level 1 data) shown in Section 4. Nevertheless, the Level 0 based spectral monitoring data are still available via the SOST-IFE web site (see [http://www.iup.uni-bremen.de/sciamachy/LTM/LTM\\_spectral/LTM\\_spectral.html](http://www.iup.uni-bremen.de/sciamachy/LTM/LTM_spectral/LTM_spectral.html)).

### 3.1.5.3 PMD monitoring results

The SCIAMACHY PMDs are monitored in a similar way as the science channels, but of course no channel averaging is performed. However, the results presented here are based on the same measurements as the science channel results (but using the PMD low gain signal), and they have been normalized to the same reference times as the spectral results. Figure 3.8 shows the PMD throughput variation for the whole time period between 2 August 2002 and end of December 2011. Note that a constant dark signal for each of the PMDs has been assumed. To verify this assumption, Figure 3.8 also shows the variation of the PMD dark signal over time, which is usually quite low.

Considering the broadband character of the PMDs, the observed PMD throughput changes are (except for PMD 4 and 7) very similar to those of the science channels. The rapid increase of throughput for the limb and nadir light paths is also visible in the UV-Vis PMDs.

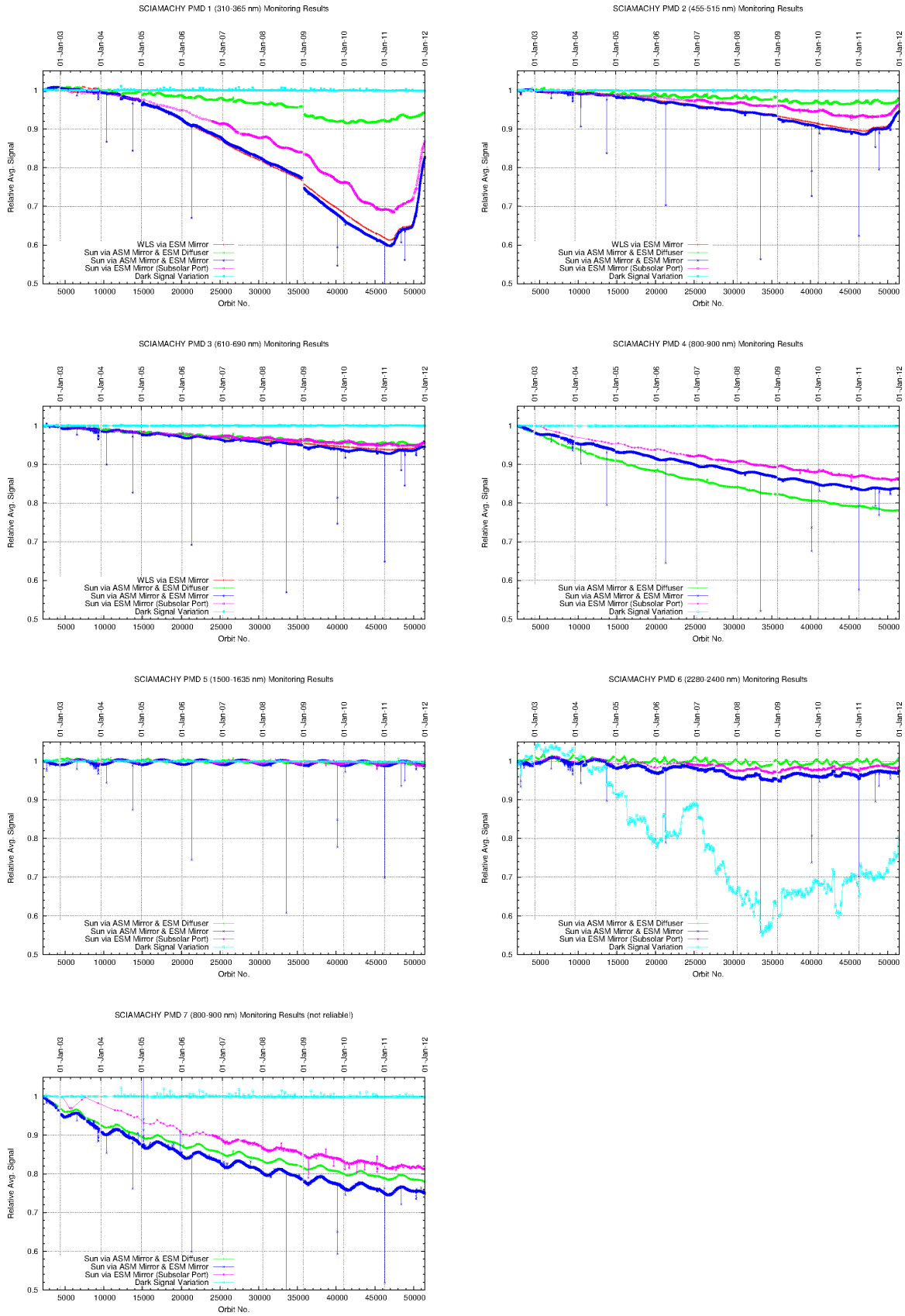


Figure 3.8: PMD monitoring results August 2002 to December 2011.

## 4 DEGRADATION MONITORING AND CORRECTION

Since Level 2 product version 5.01, a correction for the radiometric degradation of SCIAMACHY is included in the operational processing. This degradation correction is performed by so-called m-factors. An m-factor is defined as the ratio between a measured spectrum of a constant light source (typically the sun) at a certain time to a spectrum obtained for the same optical path at a reference time. M-factors therefore provide an end-to-end degradation correction for each individual light path.

In general, m-factors have an impact on the polarization correction and on the absolute radiometric calibration. The m-factors for the science detectors are multiplicative factors to the absolute radiometric calibration of SCIAMACHY. The m-factors for the PMDs influence in a non-linear way the polarization correction of SCIAMACHY. Currently, only the science channel m-factors are used in operational data processing. M-factors are regularly calculated by SOST-IFE and provided to ESA.

More details on m-factors and also the m-factors themselves can be found on the IUP Bremen web site under <http://www.iup.uni-bremen.de/sciamachy/mfactors>.

Figures 4.1 to 4.3 show plots of the science channel degradation ( $=1/m$ -factor) observed for each of the SCIAMACHY light paths (nadir, limb, calibration). The current plots cover the time range 2 August 2002 (reference time) to end of December 2011. For each science channel, the plots consist of three main areas: The central part is the contour plot of the degradation. On top of it is the median of the degradation over the detector pixels plotted, showing the overall behaviour of the channel. Right of the main area, the degradation of the last plotted day is shown. The grey bars in the plot are times of instrument unavailabilities (no data at all or the instrument was not in nominal state).

The current status of the degradation can be summarised as follows:

- The increase of the throughput observed in the level 0 based monitoring data is also visible in the m-factor medians and in the contour plots.
- The throughput is below 40% below about 240 nm for the limb light path in channel 1. In the nadir light path the throughput is now always above 40%.
- The minimum throughput around 350 nm in channel 2 is currently about 60%.
- The minimum throughput in channel 3 is currently about 90% (not considering the overlaps).
- The throughput of channels 4 and 5 is rather stable over the whole spectral range (except for the overlaps).
- Channel 6 shows a small throughput decrease at the lower wavelength edge, which is an indication for ice growth.
- The throughput of channels 7 and 8 remains rather stable (except for dead/bad pixels).



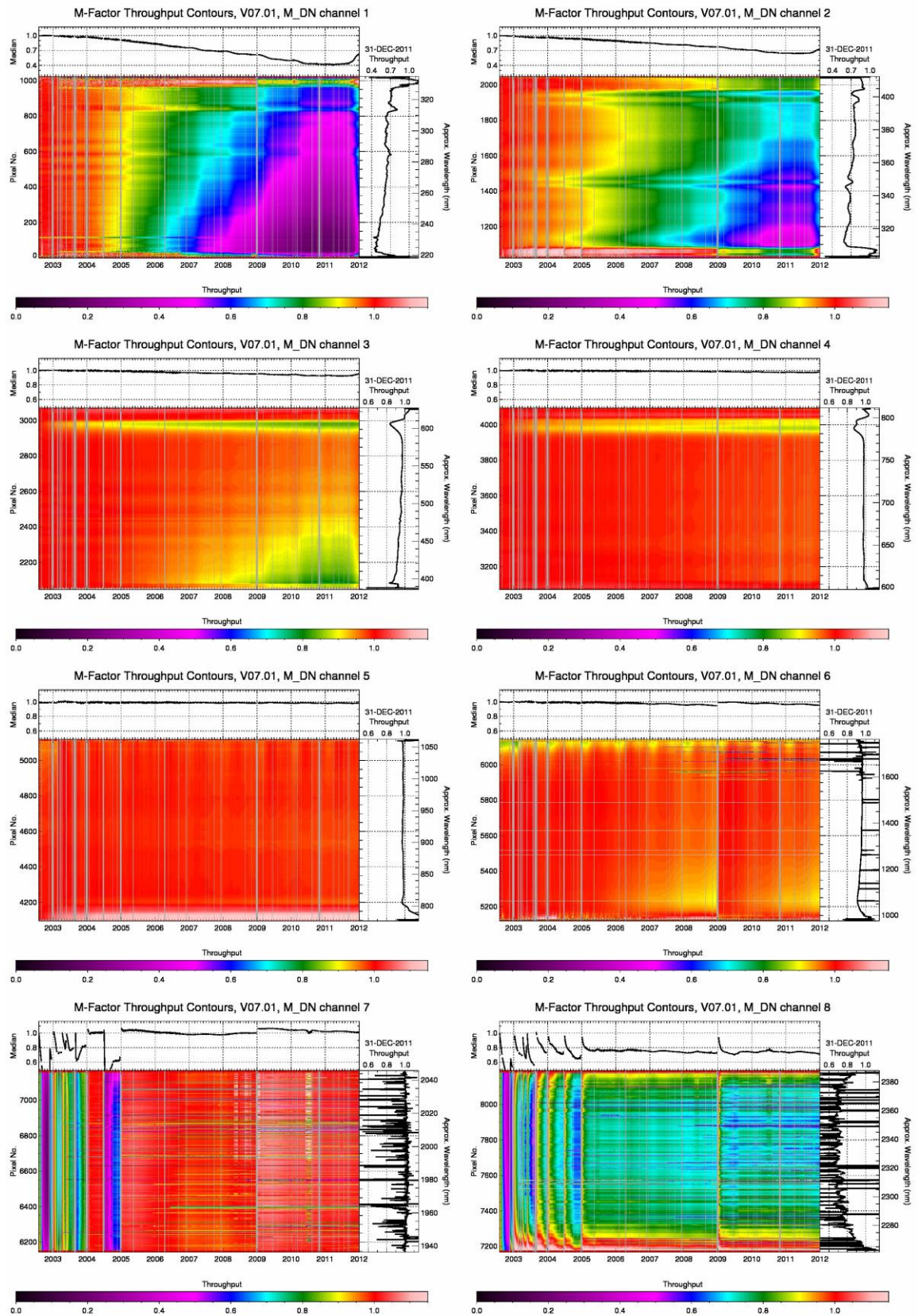


Figure 4.1: Degradation derived from m-factors August 2002 to December 2011 (nadir light path).

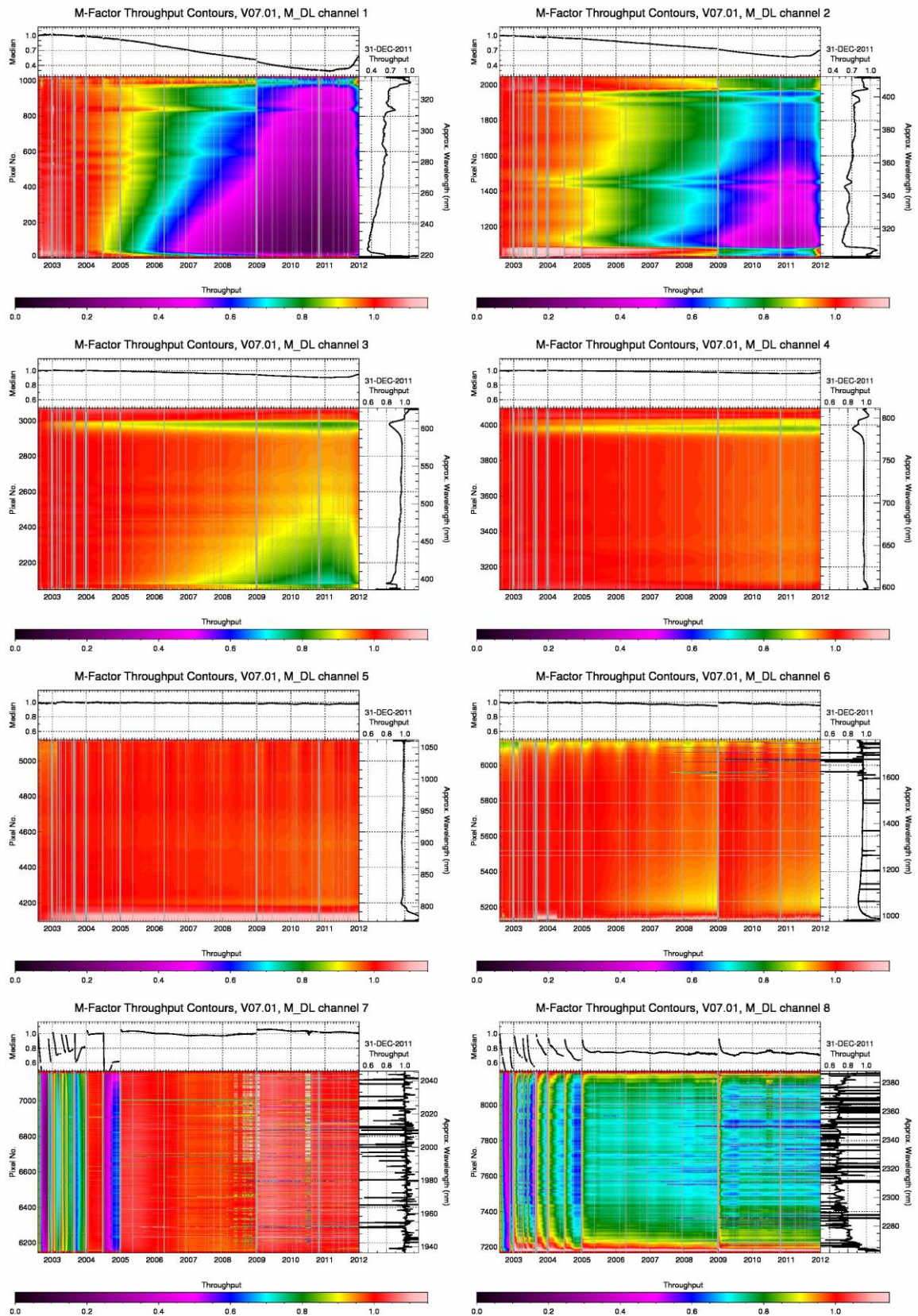


Figure 4.2: Degradation derived from m-factors August 2002 to December 2011 (limb light path).

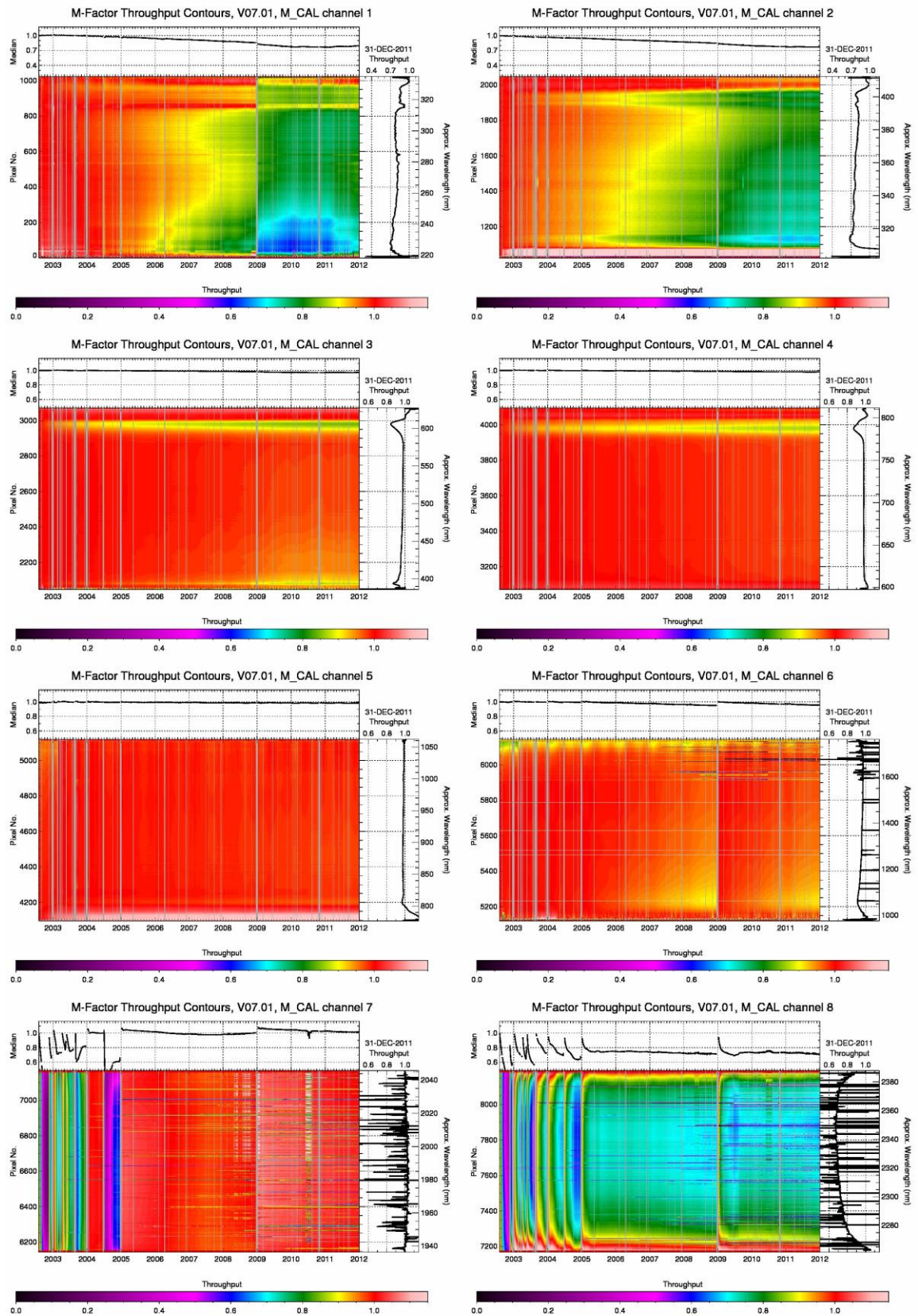


Figure 4.3: Degradation derived from m-factors August 2002 to December 2011 (calibr. light path).

## 5 DATA AVAILABILITY STATISTICS

### 5.1 Downlink/Acquisition Performance

For the reporting period, problems are known for the Level 0 products listed in Table 5.1.

Day	Filename	Description
03-12-2011	SCI_NL__0PNPDE20111203_210604_000063283109_00172_51048_7690.N1	FORMAT ERROR: trying to read beyond the end of the file
	SCI_NL__0PNPDE20111203_210604_000000003109_00172_51048_4385.N1	Duplicate with incorrect file size
	SCI_NL__0PNPDE20111203_210604_000000003109_00172_51048_4386.N1	
	SCI_NL__0PNPDE20111203_210604_000000693109_00172_51048_4390.N1	
	SCI_NL__0PNPDE20111203_210715_000000013109_00172_51048_4391.N1	
	SCI_NL__0PNPDE20111203_210712_000000693109_00172_51048_4392.N1	
	SCI_NL__0PNPDE20111203_210821_000000003109_00172_51048_4396.N1	
	SCI_NL__0PNPDE20111203_210821_000000003109_00172_51048_4398.N1	
	SCI_NL__0PNPDE20111203_210821_000000003109_00172_51048_4399.N1	
	SCI_NL__0PNPDE20111203_210821_000000693109_00172_51048_4401.N1	
	SCI_NL__0PNPDE20111203_210929_000000003109_00172_51048_4406.N1	
	SCI_NL__0PNPDE20111203_210929_000000003109_00172_51048_4413.N1	
	SCI_NL__0PNPDE20111203_210929_000000003109_00172_51048_4416.N1	
	SCI_NL__0PNPDE20111203_210929_000000003109_00172_51048_4417.N1	
	SCI_NL__0PNPDE20111203_210929_000000003109_00172_51048_4418.N1	
	SCI_NL__0PNPDE20111203_210929_000000003109_00172_51048_4419.N1	
	SCI_NL__0PNPDE20111203_210929_000000003109_00172_51048_4423.N1	
SCI_NL__0PNPDE20111203_210929_000000003109_00172_51048_4424.N1		
SCI_NL__0PNPDE20111203_210929_000000693109_00172_51048_4426.N1		
SCI_NL__0PNPDE20111203_211038_000000003109_00172_51048_4429.N1		
05-12-2011	SCI_NL__0PNPDK20111205_103704_000060283109_00195_51071_6571.N1	FORMAT ERROR: trying to read beyond the end of the file
20-12-2011	SCI_NL__0PNPDK20111220_144203_000044343109_00413_51289_6702.N1 SCI_NL__0PNPDK20111220_155556_000015253109_00413_51289_6703.N1 SCI_NL__0PNPDK20111220_144203_000059593109_00413_51289_6707.N1	FORMAT ERROR: trying to read beyond the end of the file
26-12-2011	SCI_NL__0PNPDK20111226_173847_000036873110_00070_51377_6762.N1 SCI_NL__0PNPDK20111226_184014_000020493110_00070_51377_6763.N1	Duplicate with incorrect file size

**Table 5.1: Level 0 products containing format errors or duplicated.**



## 5.2 Statistics on unconsolidated data (SCI\_NL\_\_0P, SCI\_NL\_\_1P)

This paragraph reports the availability of NRT data on a monthly basis. The statistics in Figure 5.1 are based on Level 0 and Level 1 data inventoried in the ground segment. Unavailability periods due to instrument anomalies or satellite switch-offs are excluded. The gaps considered are only interfile gaps. Statistics of Level 1 NRT data production are calculated with respect to Level 0 product availability.

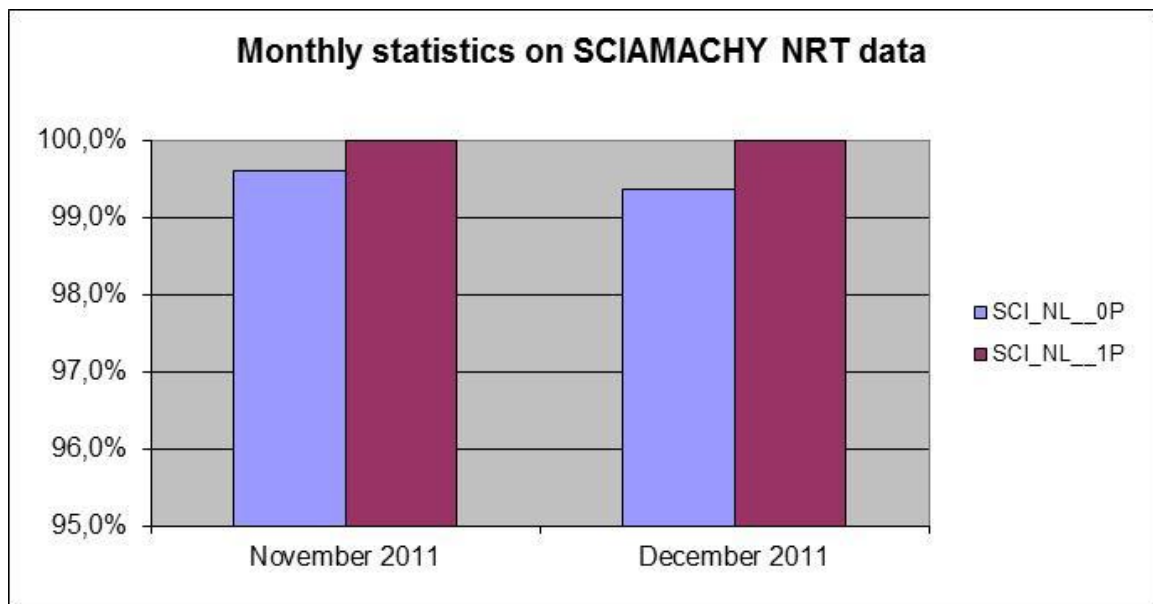


Figure 5.1: Statistics on available unconsolidated Level 0 and Level 1b products.

## 5.3 Statistics on consolidated data

In this Chapter an overview about operational off-line data (consolidated data) is provided.

### 5.3.1 Anomalies on Level 0 consolidated data products

In the past it had been reported by SOST-DLR that the SCIAMACHY consolidated Level 0 data contain errors and are not complete. Specific problems were identified and reported in detail in the technical notes [3], [4], [5], [6].

More details on consolidated Level 0 data can be found on the SOST web page, which contains a catalogue of available Level 0 products and description of errors ([http://atmos.caf.dlr.de/projects/scops/data\\_availability/availability.html](http://atmos.caf.dlr.de/projects/scops/data_availability/availability.html)).

The consolidation activity aimed to reprocess erroneous Level 0 data, has been completed up to year 2010. The overall goal is to achieve a ‘master set’ of Level 0 consolidated data that allows data reprocessing of improved data quality.

### 5.3.2 Availability of consolidated SCI\_NL\_\_1P products

SCIAMACHY Level 1b consolidated data are generated at D-PAC using the consolidated Level 0 products as input for processing. The available Level 1b off-line products on the D-PAC ftp-server are regularly checked for completeness and an overview for the months of November and December 2011 is summarised here, considering flight segment and ground segment anomalies. Note that also interfile gaps are considered, but no data gaps inside the products.

Month/Year	Planned orbit range	Number of products unavailable due to anomalies	Number of unique products available at D-PAC	Expected number of products (considering anomalies)	Availability in percentage during month
November 2011	50577-51007	0	431	431	99.70%
December 2011	51008-51452	0	444	445	99.52%

Table 5.2: Statistics on consolidated Level 1b products.

The operational SCIAMACHY Level 1b off-line data production switched to a new configuration (IPF version 7.04 with processing flag "W") on 04 October 2011. See details [here](#).

The new Level 1b data (SCI\_NL\_\_1PW) is nominally accessible from the D-PAC FTP server (ftp-ops-dp.eo.esa.int, scialusr account). The scialusr account also hosts products generated with prior IPF versions and processing stage flag “U” from the past reprocessing campaign and from the operational forward processing (from 22 January 2010 - orbit 41287 to 21 September 2011 - orbit 49999).

**The SCIAMACHY Level 1b data set stored at D-PAC will be soon reorganized upgrading the current archiving system to a new infrastructure.** The full time series with version 7.04-W, including data from the latest reprocessing campaign, as well as data from the operational off-line forward processing chain will be accessible through a single account at the D-PAC FTP server eoa-dp.eo.esa.int. The data archive structure will be provided in the same way as for the previous server ftp-ops-dp.eo.esa.int, organized per year/month/day. The ftp-ops-dp.eo.esa.int server will remain still active in order to allow all users a timely reconfiguration of the operational data download streams. Users will be notified on the changes. Users are recommended to use the data set processed with the newest processor version: 7.04-W.

Access details can be obtained from the [Earth Observation Helpdesk](#).

The overall status of the SCIAMACHY consolidated Level 1b data set for the full-mission as resulting from the reprocessing campaign and from the operational processing can be viewed at [http://earth.eo.esa.int/pcs/envisat/sciamachy/full\\_mission\\_dataset/](http://earth.eo.esa.int/pcs/envisat/sciamachy/full_mission_dataset/)

### *5.3.3 Availability of consolidated SCI\_OL\_\_2P products*

SCIAMACHY Level 2 consolidated data are generated at D-PAC using the consolidated Level 1b products as input for processing. The available Level 2 off-line products on the D-PAC ftp-server are regularly checked for completeness and an overview for the months of November and December 2011 is reported in Figure 5.2 and Figure 5.3. For the reporting months, 428 and 441 Level 2 products are available respectively.

Orbits missing in the plots indicate

- Instrument unavailability (highlighted in red).
- Level 2 products not generated at D-PAC as a consequence of processing failures or missing inputs (either consolidated Level 0 or Level 1b files). Recovery of the missing products will be performed when possible.
- Orbits sensed during monthly calibrations for which Nadir or Limb measurements were not planned. For the reporting months orbits 50717, 50718 (10/11) and 51134, 51135 (09/12) were not processed up to Level 2 products.

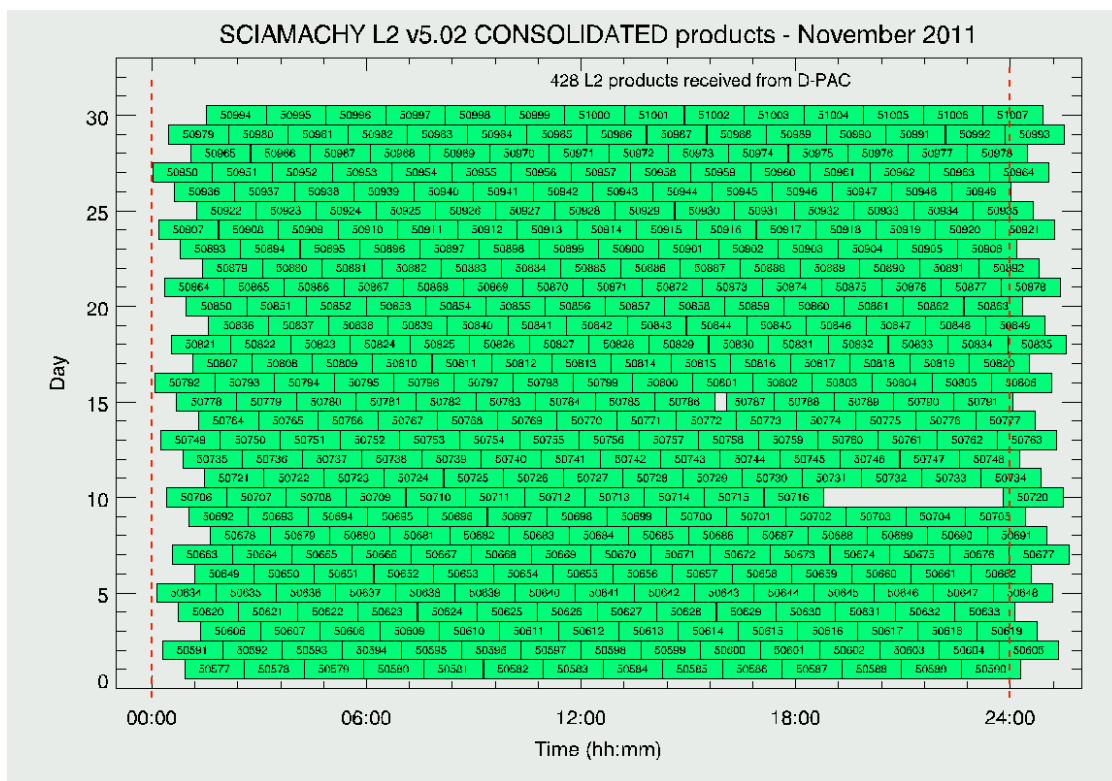


Figure 5.2: SCIAMACHY Level 2 off-line data production at D-PAC for November 2011.

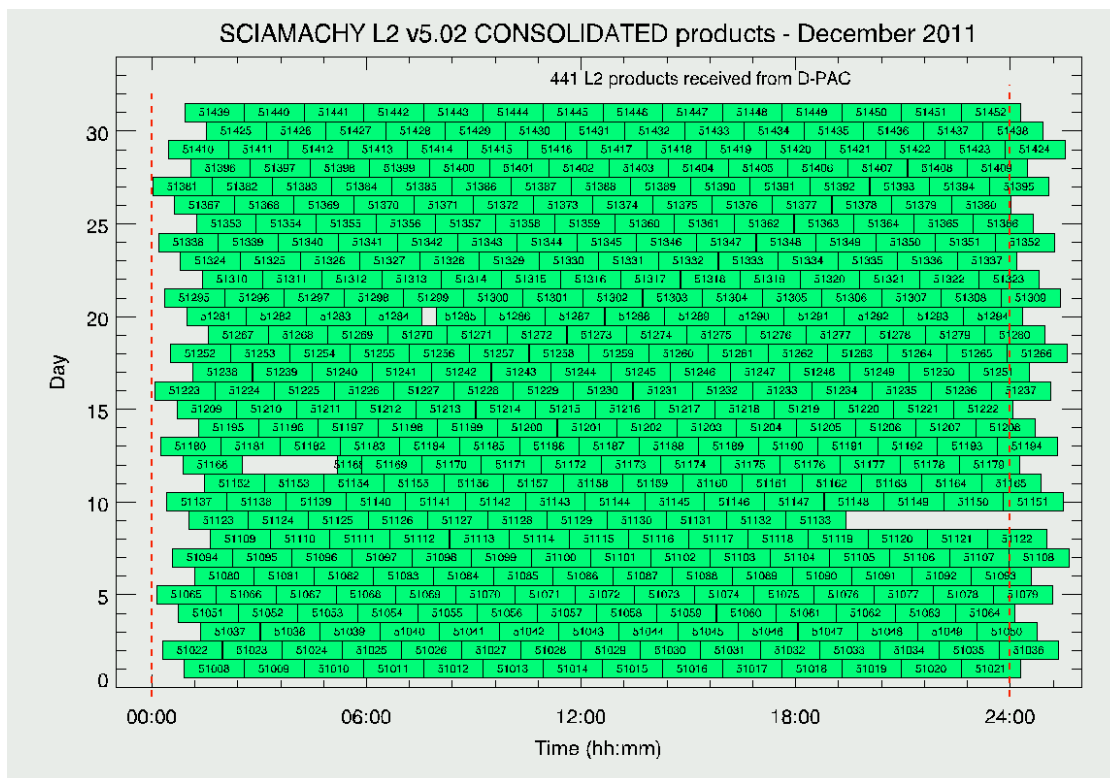


Figure 5.3: SCIAMACHY Level 2 off-line data production at D-PAC for December 2011.



## 5.4 *Statistics on reprocessed data*

### 5.4.1 *Level 1b re-processing*

During 2010, the complete SCIAMACHY Level 1b data set was reprocessed with IPF version 7.03 and provided to the user community; however significant shortcomings were identified in the data set: not up-to-date auxiliary information was integrated into SCIAMACHY Level 1b GADS. In order to provide correct calibrations and assure the best possible data for the subsequent Level 2 reprocessing a new reprocessing campaign was performed using the latest IPF version and an improved set of auxiliary files.

The new reprocessing of SCIAMACHY consolidated Level 1b data for the full-mission was completed in November 2011 at D-PAC adopting the latest operational processor IPF version 7.04 with and an upgraded processing stage flag "W" for MPH and product filenames (SCI\_NL\_\_1PW) replacing previous flag "U".

The Level 1b reprocessing activity covered the time range from 02 August 2002 (orbit 2204) to the activation of the off-line forward processing with new configuration IPF 7.04-W on 21 September 2011 (orbit 49999).

The new reprocessed Level 1b data (7.04-W) bring an overall data quality improvement for the complete mission, fixing out-dated calibration information that was integrated into the previous Level 1b data set version 7.03-U.

The new SCIAMACHY Level 1b version 7.04-W data set will be soon released to the user community on the D-PAC FTP server and will be merged with the operational consolidated Level 1b IPF 7.04-W forward data production started from orbit 50000. Once the new data will be made available, users are recommended to use the new reprocessed SCIAMACHY Level 1b consolidated products, version 7.04-W. Access details can be obtained contacting the Earth Observation Helpdesk.

The overall status of the SCIAMACHY consolidated Level 1b data set version 7.04-W for the full-mission, resulting from the reprocessing campaign and from the operational processing can be accessed at

[http://earth.eo.esa.int/pcs/envisat/sciamachy/full\\_mission\\_dataset/reprocessing/](http://earth.eo.esa.int/pcs/envisat/sciamachy/full_mission_dataset/reprocessing/)

Currently, 46549 unique Level 1b consolidated products (7.04-W) for years 2002-2011 are available, while 2320 products along the entire mission result not recoverable for missing or corrupted Level 0 inputs. The following table summarizes for every year of the mission the number of Level 1b products available, orbits not recoverable for ENVISAT, SCIAMACHY or Ground Segment anomaly, and the number of Level 1b products missing for processing failures or incorrect transfer of input files.

Details on known instrument and processing issues affecting the Level 1b data set are reported on the SCIAMACHY anomaly web-page

<http://earth.eo.esa.int/pcs/envisat/sciamachy/reports/anomalies/> and on the SCIAMACHY Level 1b Product Quality Readme file [http://envisat.esa.int/handbooks/availability/disclaimers/SCI\\_NL\\_1P\\_README.pdf](http://envisat.esa.int/handbooks/availability/disclaimers/SCI_NL_1P_README.pdf)

The new Level 1b version 7.04-W data set represents an improved and coherent data set to be used for the subsequent Level 2 full-mission reprocessing.

Year	Orbits		
	Available	Not recoverable	Failed or Missing
2002	1817	319	40
2003	4720	456	48
2004	4996	168	75
2005	5030	113	83
2006	4797	396	32
2007	4996	191	37
2008	5144	85	11
2009	5021	181	22
2010	4972	249	8
2011	5057	162	24
<b>Total</b>	<b>46549</b>	<b>2320</b>	<b>380</b>

Table 5.3: Statistics on consolidated Level 1b products version 7.04-W for the full-mission.

### 5.4.2 Level 2 re-processing

The full-mission reprocessing of SCIAMACHY consolidated Level 2 data with new processor SGP version 5.02 has commenced at D-PAC. The previous reprocessing campaign with SGP 5.01 was discontinued on the basis of results from the validation activities that highlighted the nadir products of SO<sub>2</sub>, OCIO, and CO being of insufficient quality. Data will be made available at the end of the reprocessing campaign after thorough quality control.

Operational SCIAMACHY Level 2 data products (version 5.02-W) from the off-line forward processing are nominally accessible starting from sensing orbit 50000 on the usual FTP account at D-PAC (sciaol2usr on the ftp-ops-dp.eo.esa.int server).

Access details can be obtained contacting the [Earth Observation Helpdesk](#).

## 6 LEVEL 1 PRODUCT QUALITY MONITORING

### 6.1 Processor Configuration

#### 6.1.1 Version

The IPF currently in use at Kiruna and ESRIN PDHS for the operational processing of near-real-time SCIAMACHY Level 1b data is version 7.04 since 15 June 2010. The same IPF is adopted at D-PAC for the forward processing of Level 1b off-line data and was activated since acquisition data from 17 June 2010, orbit 43375.

The SCIAMACHY processor IPF 7.04 was developed in order to meet the requirements for the ENVISAT 2010+ mission extension project aimed to extend the ENVISAT mission beyond its nominal lifetime of five years. Since 22 October 2010, the ENVISAT satellite has been placed in a new orbit, 17.4 km lower than the original one. With the modified scenario, a new mission phase has started with operations planned up to end of 2013. Products generated from 02 November 2010 onwards for the ENVISAT mission extension orbit scenario report in the mission phase MPH ASCII field flag 3 instead of previous flag 2. More details can be found on the ESA news available at

<http://earth.esa.int/object/index.cfm?fobjectid=6999>

<http://earth.esa.int/object/index.cfm?fobjectid=7024>

<http://earth.esa.int/object/index.cfm?fobjectid=7223>

The SCIAMACHY processor was changed to be compliant with the new orbit scenario. No evolution aspects in the algorithm for the Level 0 to 1b data processing were included into IPF 7.04 - compared to its predecessors of version 7.03, but the CFI software library implemented (i.e. CFI 5.6) was replaced with new CFI routines version 5.8.1 (Linux 32 bit) capable to handle measurements for both the old and the new satellite's orbit. As established during validation, CFI 5.8.1 has no influence on data processing performance, and no impact on the generated SCIAMACHY Level 1b products was detected.

IPF 7.04 has been adopted for the operational processing of SCIAMACHY near-real-time and off-line Level 1b data since June 2010. No format change has been introduced in the Level 1b product version 7.04.

On 04 October 2011, a configuration change was successfully implemented for the off-line Level 1b operational processing at D-PAC. Starting from orbit 50000 (21 September 2011), SCIAMACHY off-line Level 1b products adopt the new Processing Stage Flag "W" replacing flag "U". The filename of SCIAMACHY Level 1b off-line products was changed from "SCI\_NL\_\_1PU\*" to "SCI\_NL\_\_1PW\*". The corresponding MPH fields for product's name and processing stage flag were updated as well.

The processing stage flag was upgraded to “W” to identify unambiguously the SCIAMACHY Level 1b data set for the complete mission obtained from the reprocessing campaign with IPF 7.04.

The corresponding **Product Specification** is Volume 15 issue 3L version 1.1 [2]. This document is available at

[http://earth.eo.esa.int/pub/ESA\\_DOC/ENVISAT/Vol15\\_Sciamachy\\_3L\\_1.1.pdf](http://earth.eo.esa.int/pub/ESA_DOC/ENVISAT/Vol15_Sciamachy_3L_1.1.pdf)

A **Readme file** describing data quality and known instrument and processing issues as well as major improvements with respect to previous IPF versions is regularly maintained by the SCIAMACHY Quality Working Group and provided to the users. The document - updated corresponding to the IPF version 7.04 - applies to the SCIAMACHY Level 1b Near-Real-Time and Off-Line products (SCI\_NL\_\_1P) and is available at [http://envisat.esa.int/handbooks/availability/disclaimers/SCI\\_NL\\_\\_1P\\_README.pdf](http://envisat.esa.int/handbooks/availability/disclaimers/SCI_NL__1P_README.pdf)

Table 6.1 gives a brief overview of changes implemented in the SCIAMACHY Level 0 to Level 1b processing baseline compared to prior processor versions.

Starting from the operational Level 1b data version 7.03, a new type of limb state is available; Mesospheric Limb Measurements (state ID 55) are performed scanning altitudes between 60 and 150 km. The measurements are performed instead of "normal" limb states for 30 orbits every month split on two separate days. The operational Level 2 processor does not process these scientific Mesospheric Limb Measurements.

The radiometric degradation of SCIAMACHY can be compensated using m-factors, calculated from the new NRT Level 1b data. M-factors are not part of the Level 1b product and are not used at present in the Level 0-1b processing itself. They are applied in the Level 2 data processing only. The m-factors are provided by an external database accessible at <http://www.iup.uni-bremen.de/sciamachy/mfactors/>.

IPF Version	Description	Proc Centre	Date	Start Orbit
7.04	In view of the ENVISAT 2010+ mission extension requiring the lowering of the satellite's orbit, the new IPF 7.04 was developed without introducing changes in the algorithm but updating the CFI library to version 5.8.1.	D-PAC	17-JUN-2010	43375
		PDHS-E	15-JUN-2010	43355
		PDHS-K	15-JUN-2010	43347
7.03	Following changes are implemented with IPF 7.03: <ul style="list-style-type: none"> <li>Degradation correction using m-</li> </ul>	D-PAC	22-JAN-2010	41287
		PDHS-E	04-FEB-2010	41479
		PDHS-K	04-FEB-2010	41472

	<p>factors implemented in SciaL1c.</p> <ul style="list-style-type: none"> <li>Improved spectral stray light correction using a matrix approach in channel 2.</li> <li>Mesospheric Limb Measurements included in the Limb MDS.</li> <li>Correction of the Scanner encoding values.</li> </ul>			
6.05	No evolution in the algorithm has been introduced with IPF 6.05 but the processor was ported from AIX to LINUX operating system.	D-PAC	05-OCT-2009	39634
		PDHS-E	29-SEP-2009	39633
		PDHS-K	29-SEP-2009	39639
6.03	<p>The following changes are implemented with IPF 6.03</p> <ul style="list-style-type: none"> <li>New pointing correction (new SCI_LI1_AX)</li> <li>Updated of the ESA CFI (5.6) software</li> <li>Correction of a non-compliance report, impacting the Leakage GADS in the consolidated data processing chain (channels 6-8)</li> </ul>	D-PAC	04-JUL-2007	27937
		PDHS-E	19-JUL-2007	28153
		PDHS-K	19-JUL-2007	28145

**Table 6.1: Processor version and main changes.**

### 6.1.2 Anomalies

During the processing of SCIAMACHY Level 1b products with IPF version 7.04 and processing stage flag “W” the following anomalous processing caused by inadequate ADF usage are known.

- In the SCIAMACHY consolidated Level 1b version 7.04-W data set, a subset of SCIAMACHY consolidated Level 1b products was processed without the expected ENVISAT restituted Attitude Data File (AUX\_FRA\_AX). This file (one for each orbit) is handled automatically by the orbit propagation CFI and contains the AOCS parameters and information about the attitude of the ENVISAT spacecraft (roll, pitch and yaw). If the AUX\_FRA file is available to the Level 0-1b processing the information therein is extracted and provided as AOCS parameters, mis-pointing angles and rate to the target calculation of the geolocation module. On the contrary, the AOCS parameters need to be calculated and the mis-pointing information has to be set to zero with consequent impact on data accuracy. Reprocessing of the affected Level 1b products is not possible as the corresponding restituted Attitude Data Files are currently unavailable at FOS.

A list of consolidated Level 1b products affected by incorrect processing is reported in the SCIAMACHY Readme file for Level 1b products [http://envisat.esa.int/handbooks/availability/disclaimers/SCI\\_NL\\_1P\\_README.pdf](http://envisat.esa.int/handbooks/availability/disclaimers/SCI_NL_1P_README.pdf)

- In the SCIAMACHY consolidated Level 1b version 7.04-W data set, a subset of SCIAMACHY consolidated Level 1b products was processed adopting the predicted orbit state vector (AUX\_FPO) file instead of the expected restituted orbit state vector (AUX\_FRO) file. The orbit state vector is used internally by the PDGS processing chain as an input for the orbit propagation software. For Near-real-time processing the predicted state vector (AUX\_FPO\_AX) reported in the MPH of the level 0 product is applied for the definition of the geolocation of the measurements, because no better orbital information is available by that time. During off-line processing different orbit state vector products are available and provided to the processing environment. Whenever a restituted orbit state vector file (AUX\_FRO) is available, it shall be used instead of the predicted orbit state information. The accuracy of the ENVISAT orbit state vector restitution impacts the obtained spatial accuracy of the measurements. The spatial accuracy obtained adopting the AUX\_FPO file is 920 m along-track and 15 m across-track; while adopting the AUX\_FRO file is 60 m along-track and 15 m across-track. For limb measurements the attitude control system of the satellite is more important for the spatial accuracy. Due to this control system the tangent height may not be calculated better than  $\pm 6$  km according to a viewing stability of  $\pm 0.1^\circ$  into limb direction. Reprocessing of the affected Level 1b products is not possible as the corresponding restituted orbit state vector files (AUX\_FRO) are currently unavailable at FOS. A list of consolidated Level 1b products affected by incorrect processing is reported in the SCIAMACHY Readme file for Level 1b products [http://envisat.esa.int/handbooks/availability/disclaimers/SCI\\_NL\\_1P\\_README.pdf](http://envisat.esa.int/handbooks/availability/disclaimers/SCI_NL_1P_README.pdf)

During the off-line processing of SCIAMACHY Level 1b products, duplicated files might be generated in the D-PAC processing environment. Duplicates are regularly identified in the D-PAC data archive and removed. Users are systematically notified for duplicates via the SCIAMACHY anomaly web-page at

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

## 6.2 Auxiliary Data Files

For operation of the SCIAMACHY Level 1 processor, a set of auxiliary files as input is required. One subset of these auxiliary files usually changes only in correspondence with a new IPF version, namely the Initialisation file (SCI\_LI1\_AX) and the Key Data file (SCI\_KD1\_AX).

Table 6.2 lists the actual Key Data File and Initialisation File used with IPF 7.03.

**Table 6.2: Key Data and Initialisation configuration**

SCI_KD1_AXNIEC20091126_123849_20020301_000000_20991231_235959
SCI_LI1_AXNIEC20091126_125714_20020701_000000_20991231_235959

Another subset of auxiliary files is the in-flight calibration data files, which are generated when calibration measurements are included in the set of Level 0 data to be processed.

Four types of in-flight calibration auxiliary files exist:

- Leakage Current Calibration (SCI\_LK1\_AX - updated on orbital basis)
- Solar Reference Spectrum (SCI\_SU1\_AX - updated on daily basis)
- Spectral Calibration Parameters (SCI\_SP1\_AX - updated on a weekly basis)
- Pixel-to-Pixel Gain and Etalon Parameters (SCI\_PE1\_AX - updated on orbital basis).

Figure 6.1 shows statistics of the SU1, LK1, PE1 and SP1 auxiliary data files (ADFs) generated operationally with SciCal 2.2 for November and December 2011.

Statistics are based on the SciCal ADFs production/distribution to PDGS and are calculated with respect to the number of auxiliary files expected. It has to be noted that unavailability periods are excluded from statistics as well as duplicated products identified on the basis of the start/stop validity time in the filename.

LK1 statistics are calculated dividing the number of LK1 auxiliary files (generated on orbital basis) by the number of available (to SciCal) Level 0 products. These statistics do not exclude dark measurements that cannot be used for ADF generation due to SAA and orbit phase constraints leading to an over-estimation of missing files. SU1, SP1 and PE1 statistics are calculated with respect to the number of ADFs expected for the reporting months.

Before the activation of IPF 7.04, the complete set of these ADFs was regenerated for the full-mission data reprocessing campaign.



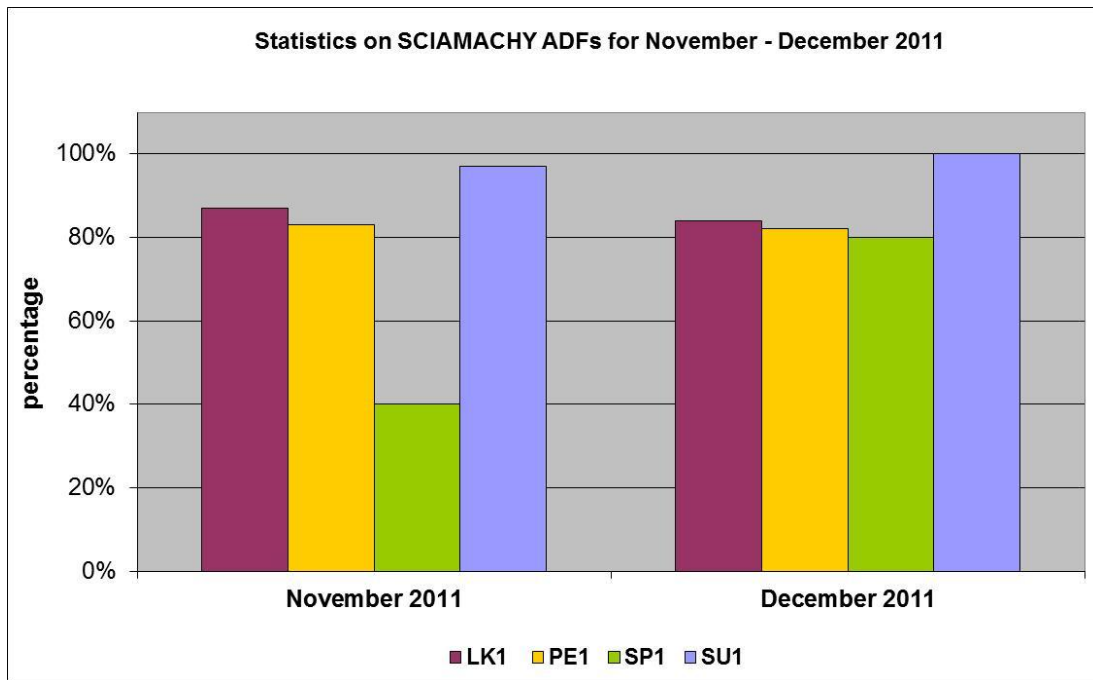


Figure 6.1: Statistics on SU1, LK1, PE1 and SP1 productions.

## 6.2.1 Auxiliary Data File quality analysis

### 6.2.1.1 SMR analysis

SciCal generates daily SU1 Auxiliary Files. Solar spectra obtained from ESM and ASM calibration measurements are provided in two ways:

- fully calibrated
- not radiometrically calibrated.

The different types of spectra can be recognized by the so called identifier in the solar reference global annotation data set record.

Note the following recommendation:

- Use a not radiometrically calibrated ASM diffuser spectrum (A0) for DOAS type applications.
- All retrieval methods requiring absolute calibrated radiance and irradiance are obliged to use the calibrated ESM diffuser spectrum (D0) (see also disclaimer).

From Figure 6.2 to Figure 6.5, plots show the ratios of SMR spectra derived from calibrated SMR/ESM (D0) during the months November - December 2011. The ratios were determined by dividing the spectra of a set of days during each month to a spectrum at the beginning of each month. Ratios are not corrected for variation of distance Earth/Sun.

In detail the spectra used for the ratios of each month are the following:

- **November 2011**  
Reference SMR - 01 November 2011

SMR used for ratios: 01, 02, 03, 05, 06, 07, 08, 09, 10, 11, 14, 21, 30 November 2011.

- **December 2011**

Reference SMR - 01 December 2011

SMR used for ratios: 01, 02, 03, 04, 05, 06, 07, 08, 09, 10, 14, 21, 31 December 2011.

The overall changes lie usually at about 1-2 % during one month for all channels, which is at least partially caused by the decreasing distance between Sun and Earth.

In channel 1, around pixel 550 (at 282 nm), some strong features can be noticed, as well as in channel 2 near pixel 840 (near 393 nm). These strong features coincide with the Mg II and Ca Fraunhofer lines respectively. These lines are partially formed in the solar Chromosphere and are known to change with solar variability.

The weaker spectral features in channel 2 (e.g. near pixels 550, 650, 750), on the other hand, correlate with strong Fraunhofer lines, which are not chromospheric. These features probably arise from small wavelength shifts (order of 1/100 of a pixel).

Generally a spectral feature could have significant impact on the product quality, especially when the affected spectral parts are used for DOAS retrieval.

The large features in the end of channel 6 (channel 6+) and channels 7 and 8 are due to bad pixels. Note that the bad pixel mask used is still from the on-ground calibration.

A regular update of the bad pixel mask is implemented starting with IPF 6.02. However a bad pixel correction will not be applied to the SMR spectra, but only to PMD out-of-band factors, in order to enable the user to apply a different mask from the one provided by the ADF.

Figure 6.6 and Figure 6.7 show SMR ratios as long term trends; plots are obtained dividing the ESM spectra (D0) from day 30 November 2011 and 31 December 2011, respectively with spectra from 30 November 2003 and 31 December 2003. In order to consider the Sun/Earth distance, the ratio was performed with spectra from same calendar days. All SCL\_SU1\_AX files used were generated with SciCal version 2.2.

What can be concluded is that for channels 1 and 2 an average degradation in 8 years of about 10-15% is observed, channels 3 degrades by about 2% and channels 4-5 degrade by less than 1%, channel 6 by about 4-5%. The signal in channel 7 has increased with respect to the SMR of year 2003. This is due to the impact of the icing of the IR detectors. This is consistent with the Light Path monitoring at SOST-IFE and available at [http://www.iup.uni-bremen.de/sciamachy/LTM/LTM\\_spectral/LTM\\_spectral.html](http://www.iup.uni-bremen.de/sciamachy/LTM/LTM_spectral/LTM_spectral.html).

Ratio of SMRs as a function of pixel, November 2011

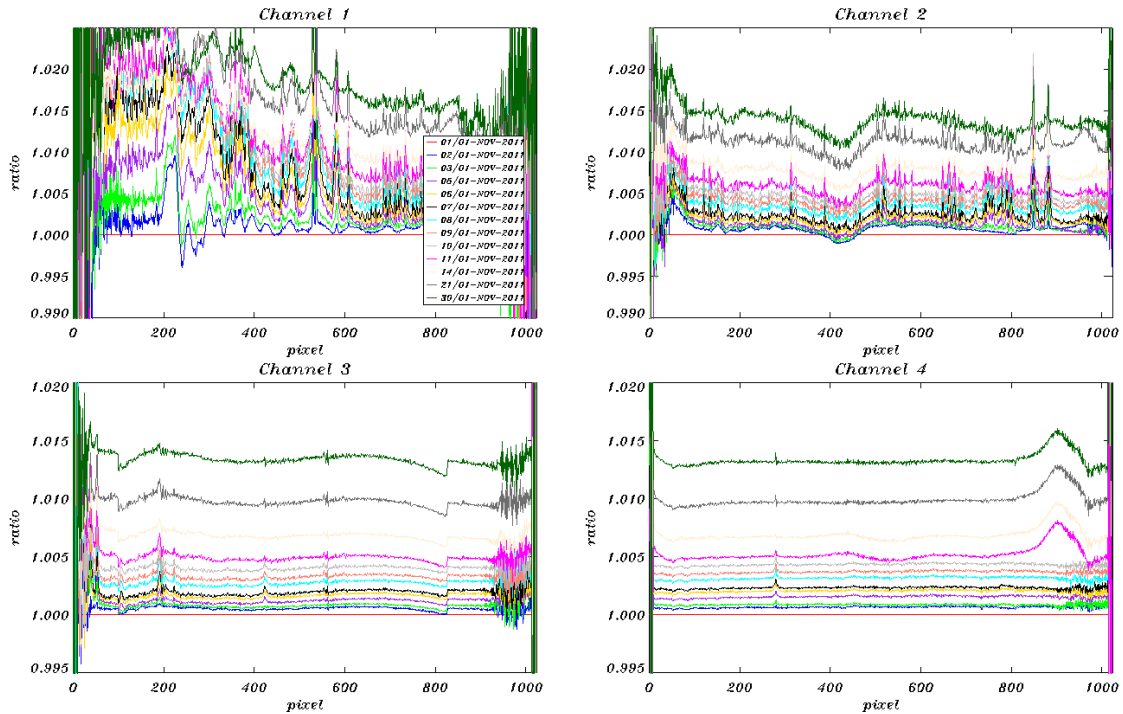


Figure 6.2: SMR ratios per detector channel 1-4 (changes during November 2011).

Ratio of SMRs as a function of pixel, November 2011

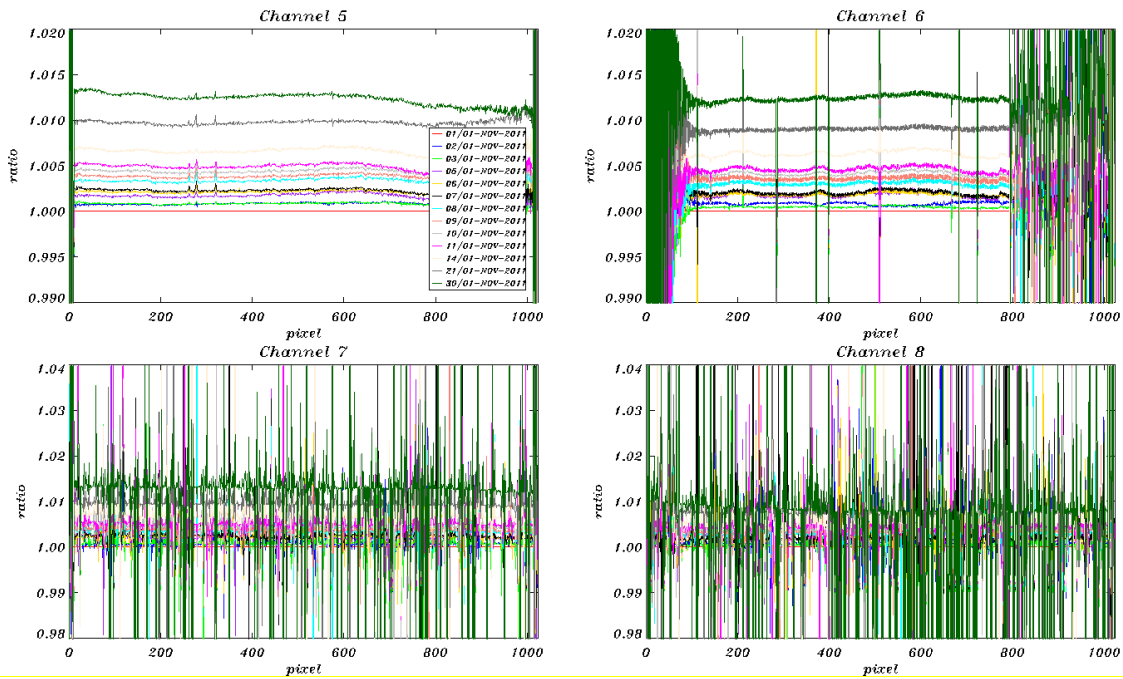


Figure 6.3: SMR ratios per detector channel 5-8 (changes during November 2011).



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Ratio of SMRs as a function of pixel, December 2011

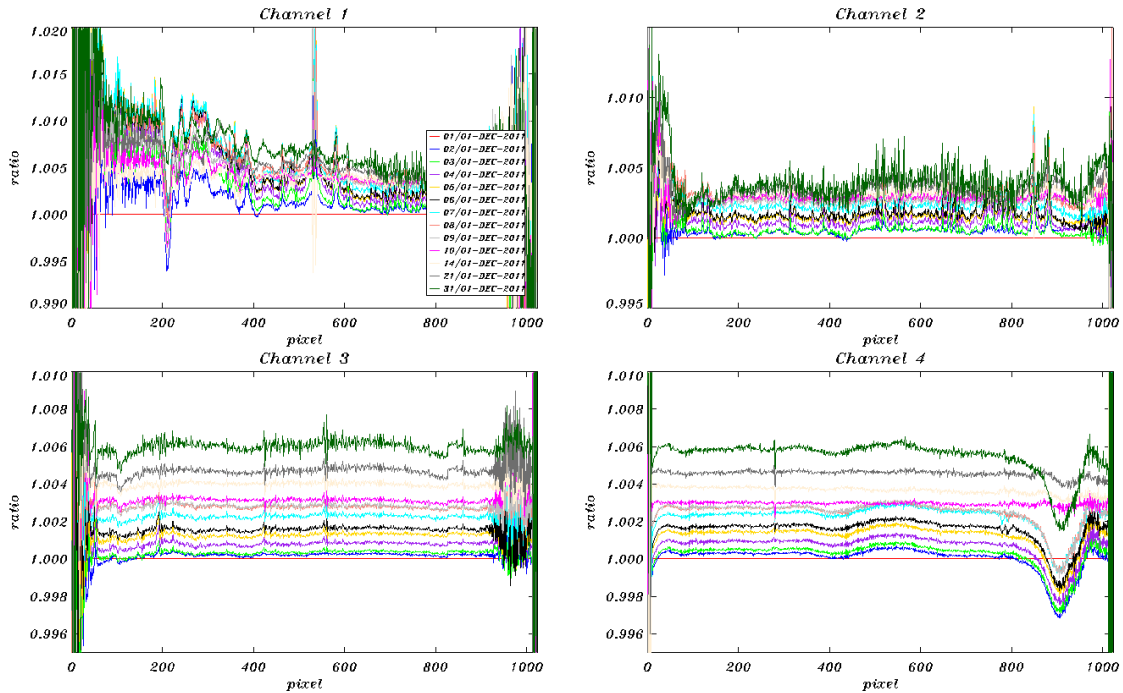


Figure 6.4: SMR ratios per detector channel 1-4 (changes during December 2011).

Ratio of SMRs as a function of pixel, December 2011

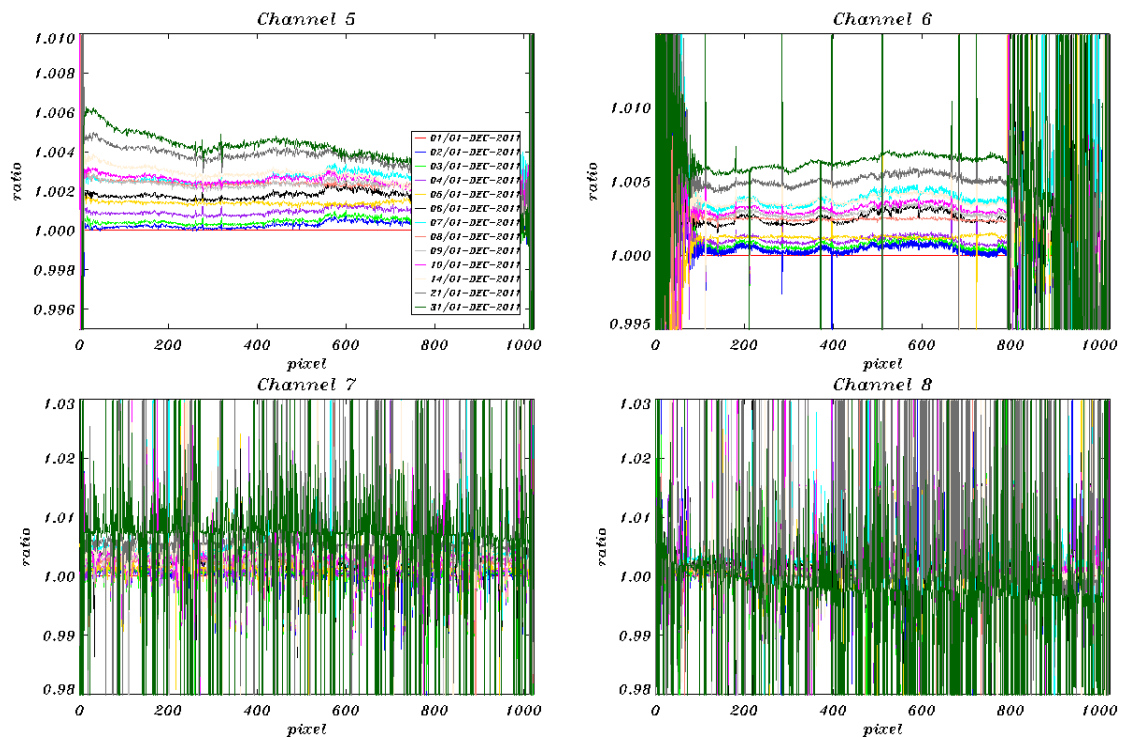


Figure 6.5: SMR ratios per detector channel 5-8 (changes during December 2011).

SMR ratio, D0 30/11/2011 divided by 30/11/2003

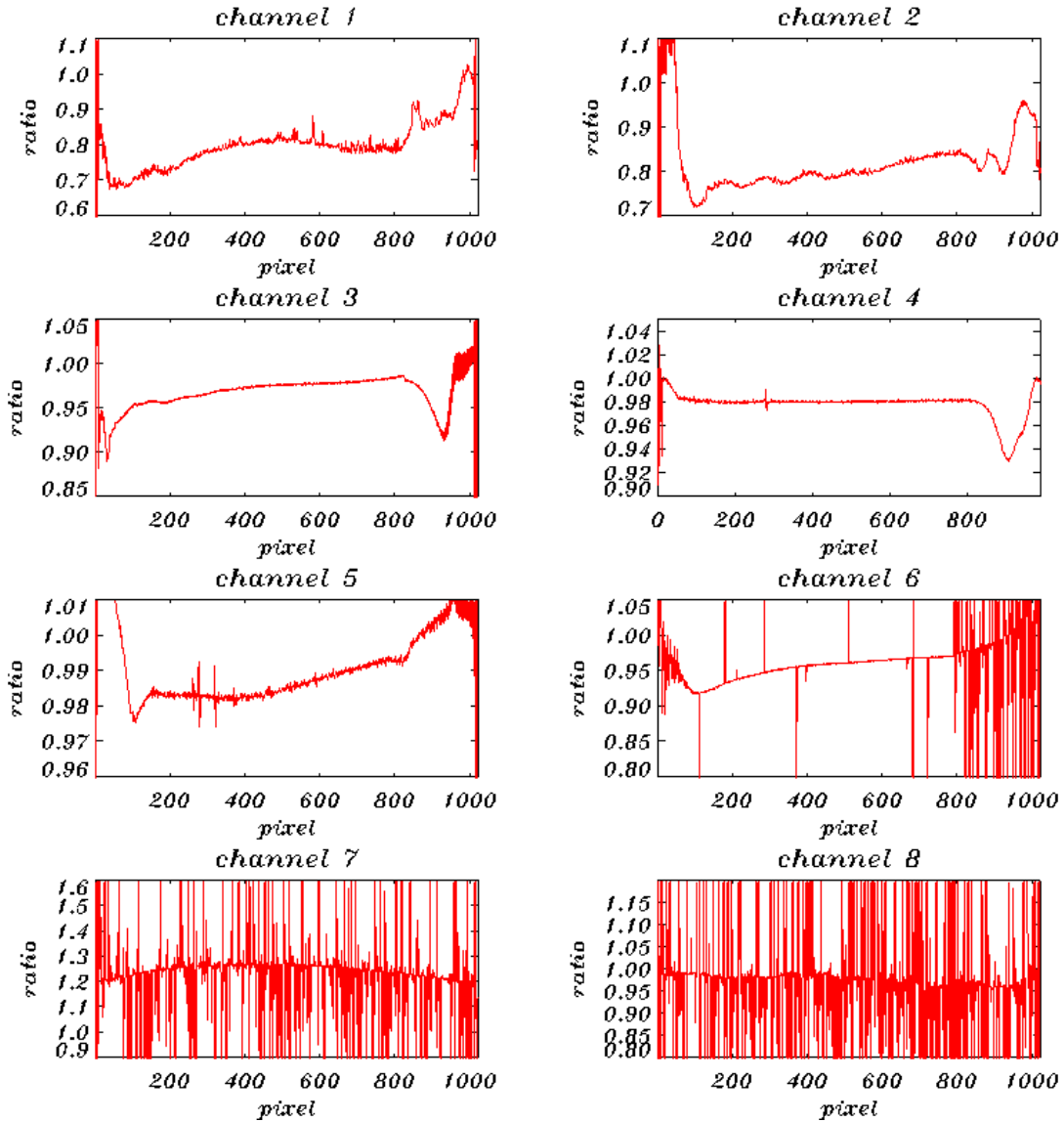


Figure 6.6: SMR ratios per detector channel on Long Term Trend 30/11/2011 divided by 30/11/2003.

SMR ratio, D0 31/12/2011 divided by 31/12/2003

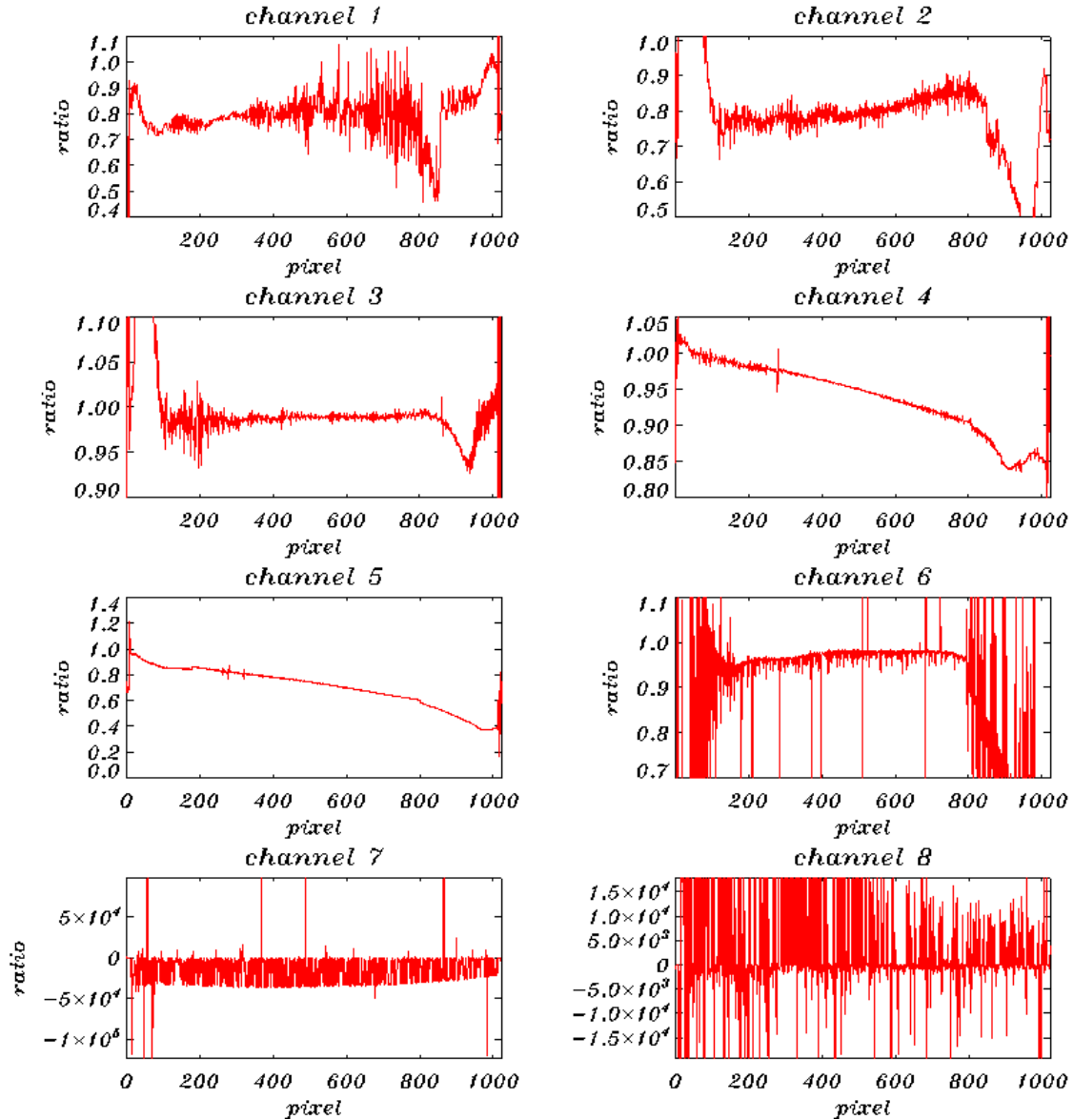


Figure 6.7: SMR ratios per detector channel on Long Term Trend 31/12/2011 divided by 31/12/2003.

## 6.2.1.2 LK1 analysis

### 6.2.1.2.1 Leakage Constant part

On an orbital basis a leakage current calibration is performed, whenever measurement data do not lie in the South Atlantic Anomaly region.

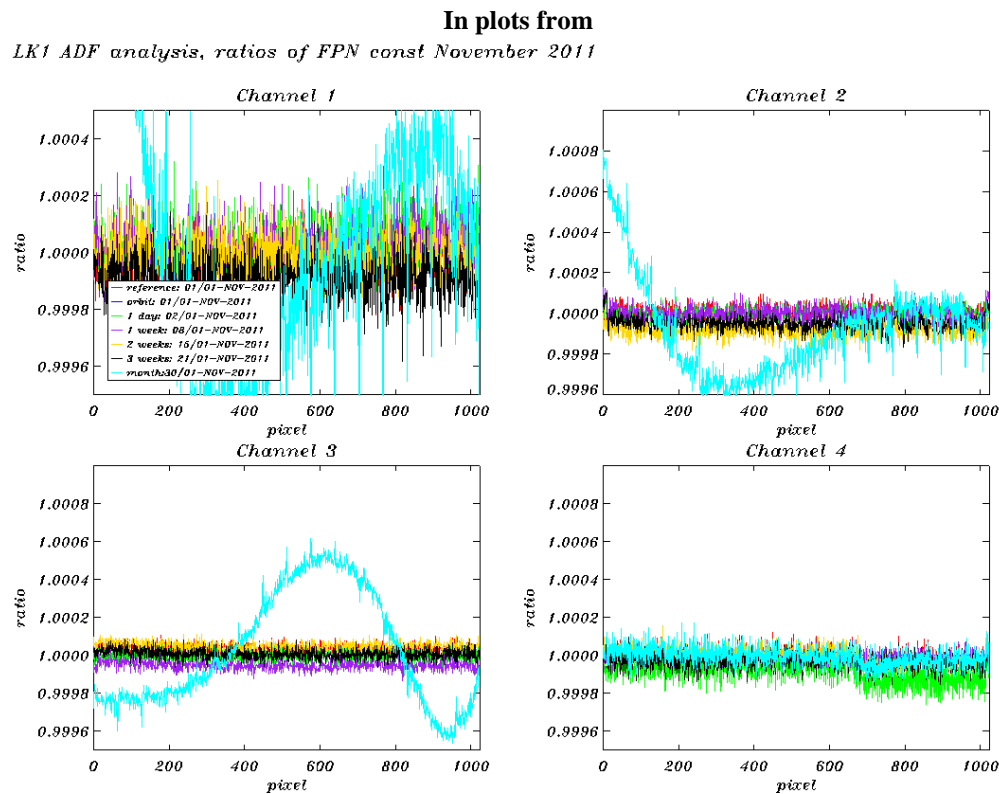


Figure 6.8 to Figure 6.11 the leakage constant part FPN (fixed pattern noise) of the LK1 ADFs is analysed by determining the ratios of the FPN of each month with a time distance of one orbit, one day, one week, two weeks, three weeks and a month.

For channels 1-5 and the first part of channel 6, during up to three weeks nearly no changes can be noticed. Sudden jumps however between the different dark current ratios can be seen for channels 1, 2, 4 and 5 between 4 weeks. They are very small but above the noise level.

The IR channels show a lot of noise.

Note that since the processor version IPF 6.03, the time dependent part of the leakage current is considered as well (see 6.2.1.2.2).

LK1 ADF analysis, ratios of FPN const November 2011

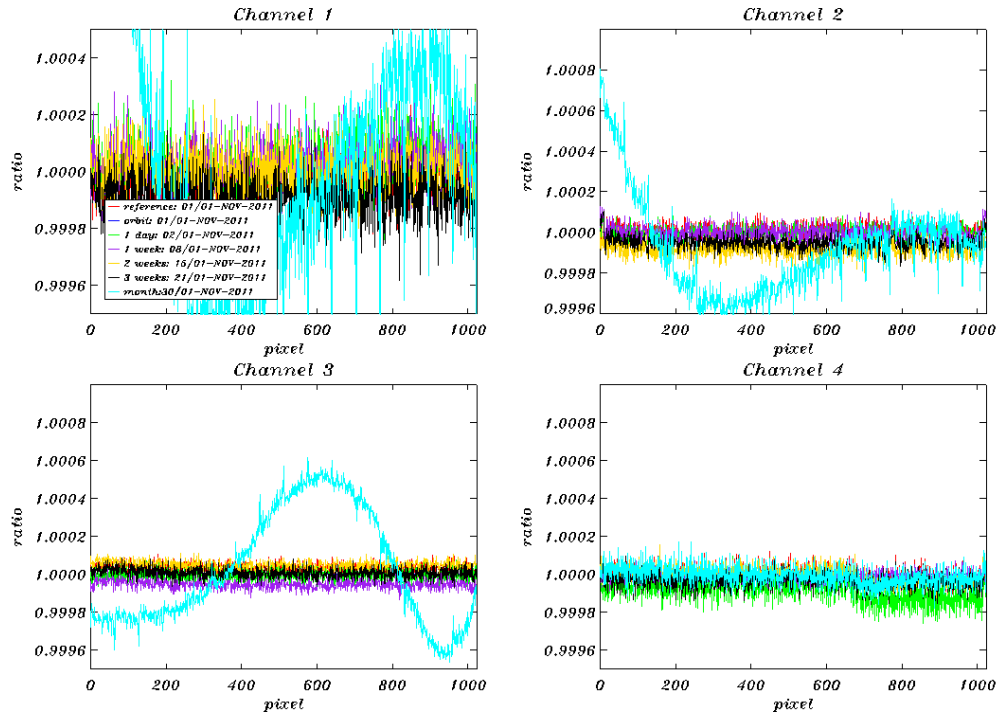


Figure 6.8: Dark current ratios (constant part) channels 1-4 during November 2011.

Reference spectrum used: Orbit 50580, 01 November 2011.

LK1 ADF analysis, ratios of FPN const November 2011

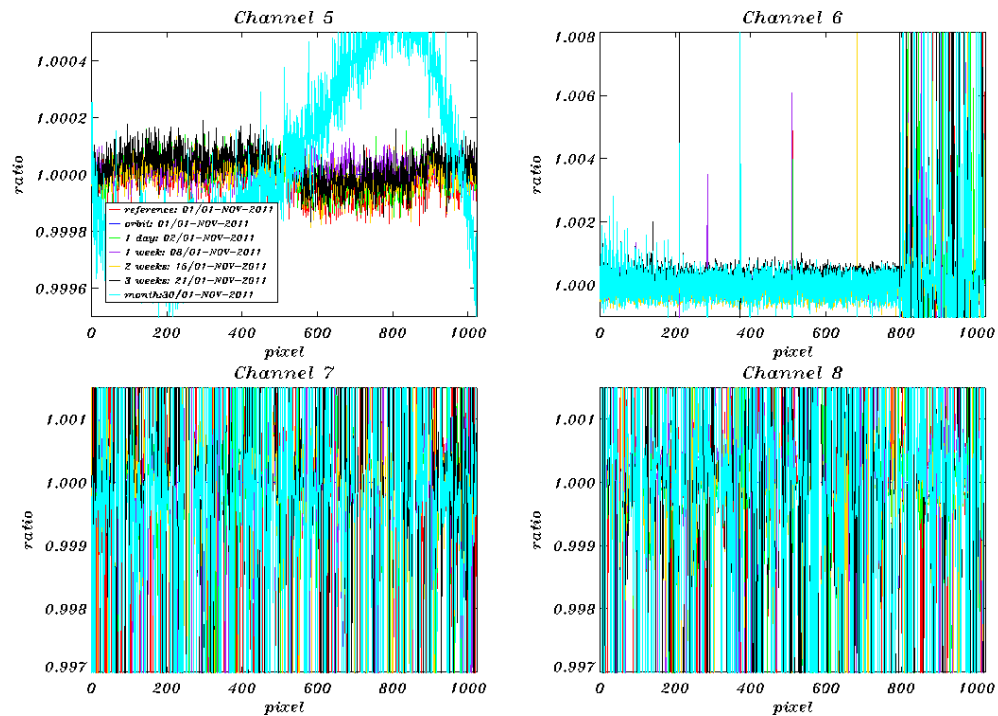


Figure 6.9: Dark current ratios (constant part) channels 5-8 during November 2011.

Reference spectrum used: Orbit 50580, 01 November 2011.



LK1 ADF analysis, ratios of FPN const December 2011

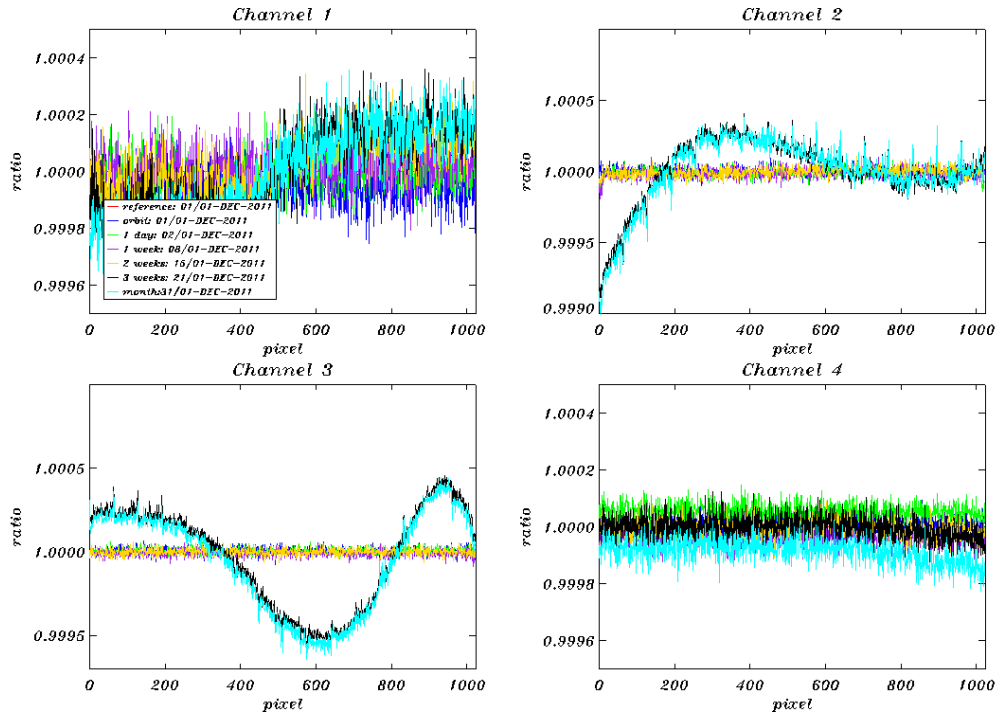


Figure 6.10: Dark current ratios (constant part) channels 1-4 during December 2011.  
Reference spectrum used: Orbit 51012, 01 December 2011.

LK1 ADF analysis, ratios of FPN const December 2011

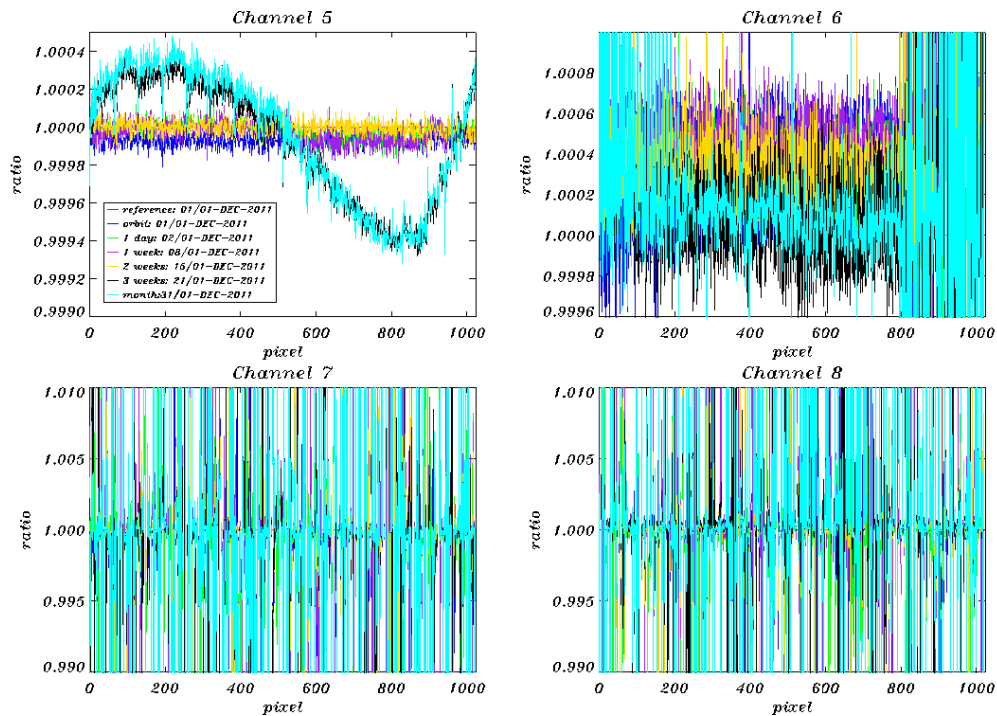


Figure 6.11: Dark current ratios (constant part) channels 5-8 during December 2011.  
Reference spectrum used: Orbit 51012, 01 December 2011.

### 6.2.1.2.2 Leakage Variable part

Starting with IPF 6.03, the orbital dependency of channel 6 to 8 leakage current is considered. SCIAMACHY detector channels 6 - 8 have a time dependent leakage dark signal that consists of two components, the leakage current of the detector pixel and second a component due to thermal background that varies along the orbit. The implementation of the orbital variation of the leakage current is expected to improve retrieval especially in detector channel 8 for infrared products.

Figure 6.12 shows the evolution of the leakage variable part of the SCI\_LK1\_AX ADF during the time span from 01 November 2011 to 31 December 2011. The leakage variation for pixel 222 in channel 7 corresponding to orbit phase 6 is shown.

Updates of the leakage variable values are expected after the processing of the monthly calibration orbits, usually once per month. During the reporting period, monthly calibration sequences were scheduled between orbits:

- 50716-50719 (10-Nov-2011)
- 51133-51137 (09/10-Dec-2011)

The 5<sup>th</sup> calibration orbit on 10 November 2011 was omitted for a planning bug.

For these dates, the change of the Leakage Variable value can be clearly seen in Figure 6.12, demonstrating that calibrations were performed successfully.

SCIAMACHY leakage variable analysis 01/11/2011 – 01/01/2012

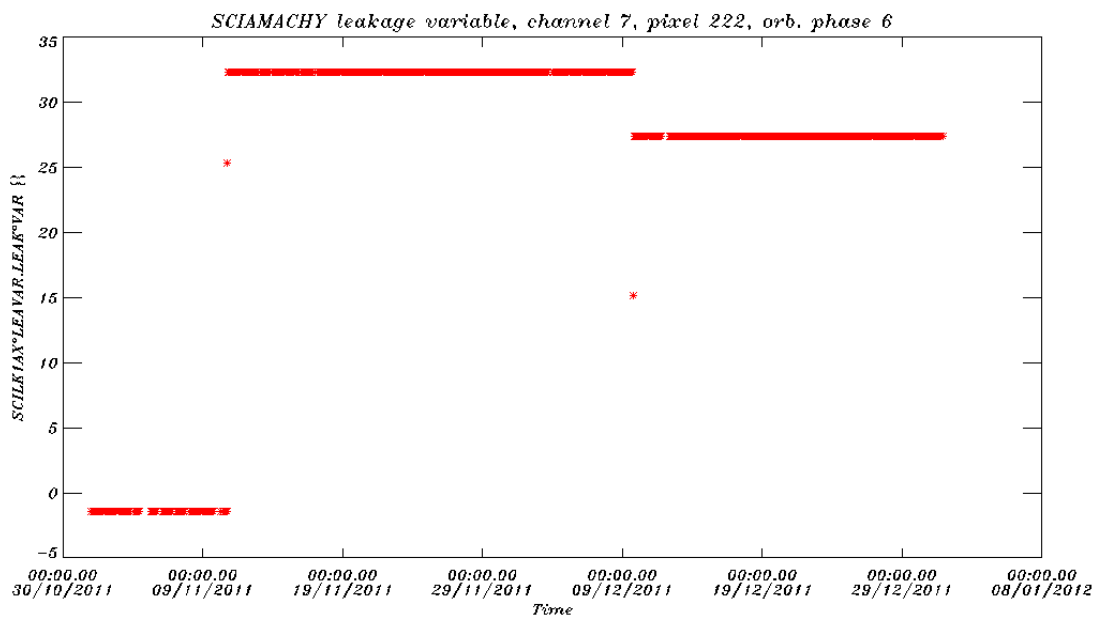


Figure 6.12: Leakage variable part from 01 November 2011 to 31 December 2011, for channel 7, orbit phase 6, pixel 222.

## 6.3 *Bad and Dead Pixel Mask*

The SWIR channels 6-8 suffer from a rising number of bad pixels that are not (or only to a small degree) usable for retrieval. The reason is a lattice constant mismatch between the substrate material and the light detecting material of the detectors. The bad pixels are detected using dark, WLS and sun measurements. The number of bad pixels rises with the life time of the instrument due to proton impact. The mask is calculated on an orbital basis.

### 6.3.1 *Operational Processor Analysis*

Starting from the Level 1b IPF 7.03 baseline, SCIAMACHY bad and dead detector pixel masks are generated on an orbital basis. The PPG/Etalon correction parameters required for the SCIAMACHY Level 0 to 1b processing are calculated by SciCal and enclosed in the SCI\_PE1\_AX auxiliary data files. The set of parameters generated is then written into the Level 1b Pixel-to-Pixel Gain (*PPG*) *ETALON* GADS indicating the position of pixels which may not be used for further processing. In the next BMR, results for the operational Bad and Dead Pixel Mask will be presented. The mask currently provided in the Level 1b products is not identical to the mask generated at SRON. It is planned to align the two masks in future processor versions.

### 6.3.2 *SRON Analysis*

SRON performs routinely analysis on the SCIAMACHY Bad and Dead Pixel Mask identifying bad pixels of the detector arrays with the SCIAMACHY Detector Monitoring Facility (SDMF) using 11 flagging criteria. These criteria are based on the dark signal model, transmission, gain and noise of a pixel. Bad pixel masks are calculated on an orbital basis and combined into a "smoothmask" with masks from about 50 orbits. In Figure 6.13 we show the number/fraction of pixels that is flagged as bad for channels 6, 6+, 7 and 8. Note that channel 6 consists of two parts employing different detector materials. Channel 6+ starts at pixel 794. The rate at which the number of pixels that is flagged is increasing is similar for the IR channels 6+, 7 and 8. The fraction of flagged pixels in channel 6 is much lower and almost constant over the mission, because of the different detector materials used in this part of the channel.



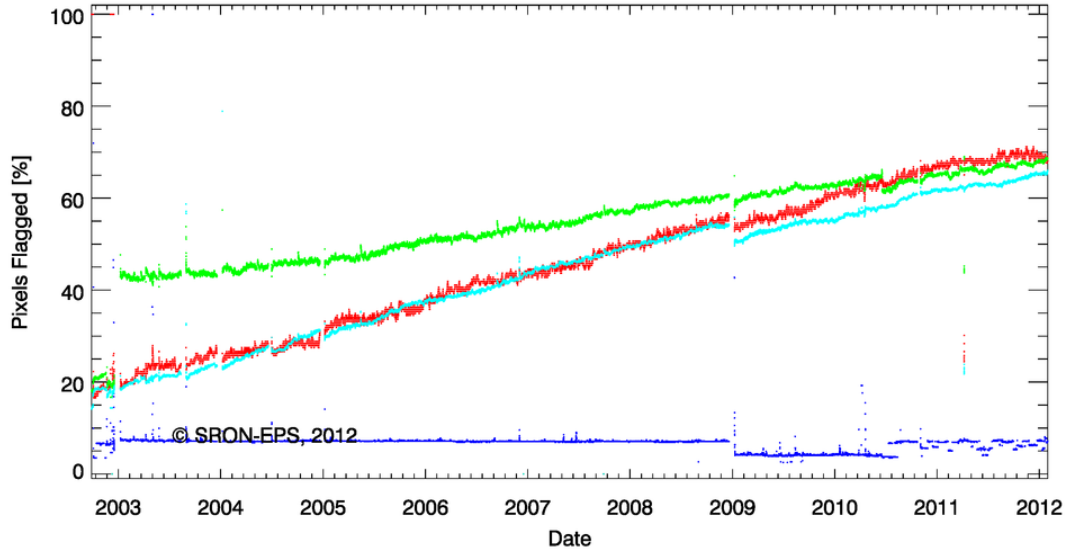
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Orbit-range: 3001 - 51881  
 Ch.6 Blue | Ch.6+ Red | Ch.7 Green | Ch.8 Cyan  
 Corrections: filter SAA data

Generated on Tue Jan 31 01:36:01 2012 by SDMF channel evolution viewer (UTC) by SRON (SDMF-channel-evolution 3.0)

Figure 6.13: Number/Fraction of pixels that is flagged as bad by the SDMF smoothmask for channels 6 (blue), 6+ (red), 7 (green) and 8 (cyan). Orbits during SODAP or decontaminations have been removed. Note the temporary decrease in the number of bad pixels after the last decontamination, for channel 8 about 6%, a few percent more than after the previous decontaminations.

## 6.4 *Pointing Performance*

No updates to present in the reporting period.

## 6.5 *SciaL1c tool*

The SciaL1c tool is an application provided to the users of SCIAMACHY Level 1b products. This application allows selecting specific calibrations to apply to Level 1b data, which are in case of SCIAMACHY defined as not fully calibrated Level 0 channel information in combination with calculated calibration data. The generated Level 1c products are suitable for the user's particular applications.

The SciaL1c Calibration and Extraction Software was upgraded to be compatible with IPF 6.03 data. It is downward compatible, i.e. it can also be used with data from older IPF versions. SciaL1c can be downloaded at: <http://envisat.esa.int/scial1c/>

LINUX, Sun Solaris, LINUX on DEC-Alpha and HP-UX on IA64 versions are available.

The latest updated version 2.1 of the SciaL1c tool was provided to the users end of November 2008.

Please, note that an anomaly in the handling of the m-factor file during the calibration of SCIAMACHY Level 1b data was observed. The m-factor file (SCI\_MF1\_AX) is not correctly reported into the child product restituted from the SciaL1c processing. In particular, the MF1 ADF filename does not fully appear in the DSD descriptor. The quality of the product is not impacted; the anomaly will be fixed in the next delivery of SciaL1c.

## 7 LEVEL 2 NRT PRODUCT QUALITY MONITORING

### 7.1 Processor Configuration

#### 7.1.1 Version

Since 08 May 2006, the near-real-time processing of SCIAMACHY Level 2 data has been suspended, evolution is restricted to the Level 2 off-line processor (see Section 8). The last IPF version used was 5.04. The corresponding product specification is [2]. The Product Quality Disclaimer at [http://envisat.esa.int/dataproducts/availability/disclaimers/SCI\\_NL\\_2P\\_Disclaimers.pdf](http://envisat.esa.int/dataproducts/availability/disclaimers/SCI_NL_2P_Disclaimers.pdf) describes known artefacts.

An overview on the implementation dates of the IPF at the different PDS processing centres and the main modifications implemented can be found in previous BMR (June-May 2007).

An overview of Auxiliary Files being used as input for SCI\_NL\_\_2P products can be found in BMR May-June 2007.

With the activation of the SCIAMACHY Level 2 processor Version 5.01, the Fast Delivery processing of Level 2 products has operationally started at D-PAC. Level 1b near real time products and predicted instead of consolidated Auxiliary Data Files are used as input for the Level 2 off-line processor. With this new service ESA provides to the users within 24 hours from data acquisition the full SCIAMACHY Level 2 products. Data monitoring of the SCIAMACHY Level 2 Fast Delivery processing chain is routinely performed and the corresponding Daily Reports are published on ESA's PCS web-pages at the link: [http://earth.eo.esa.int/pcs/envisat/sciamachy/reports/daily/Level\\_2/](http://earth.eo.esa.int/pcs/envisat/sciamachy/reports/daily/Level_2/)

The main difference between SCIAMACHY off-line and Fast Delivery products is that the Restituted Attitude file cannot be used for processing. It also adopts Level 1b NRT data, which can differ in the used calibration measurements from the consolidated data. However, the difference between off-line processor products and fast delivery products is small in most cases.

## 8 LEVEL 2 OFF-LINE PRODUCT QUALITY MONITORING

### 8.1 *Processor Configuration*

#### 8.1.1 *Version*

On 04 October 2011, the new Level 2 processor SGP version 5.02 was activated both for the Level 2 fast-delivery and off-line forward processing chains replacing processor SGP 5.01. The new Level 2 processor version 5.02 corrects deficiencies identified during the validation campaign of SCIAMACHY Level 2 version 5.01 products. In particular, it optimizes the retrieval settings for several trace gases and implements algorithmic optimizations leading to a significant overall quality improvement.

The new processor version introduces the following changes:

Nadir SO<sub>2</sub> Vertical Column Density:

- Fix for background database;
- Max-SZA cut-off decreased from 89 to 80 deg.;
- Fix quality flag;
- Earthshine stretch implemented;
- Reference Ring spectrum improved;
- Change in eta spectrum reference.

Nadir OCIO Slant Column Density:

- Correction of the polynomial degree used in DOAS fit;
- SZA cut-off changed from 95 to 92 deg.

Nadir CO Vertical Column Density:

- Introduction of a linear wavelength-dependent wavelength shift spectral correction.

No format change was introduced in the new Level 2 product version 5.02.

The new off-line Level 2 products were generated with a modified processing stage flag "W" in alignment with the upgrade of the Level 1b off-line configuration to processing stage flag "W"; for the fast-delivery processing flag "N" was maintained. This new configuration will also be adopted for the Level 2 reprocessing of the full mission data set.

Access to the operational Level 2 data products remains unchanged at the D-PAC archiving centre on the ftp-ops-dp.eo.esa.int server.

The corresponding **Product Specification** is Volume 15 issue 3L version 1.1 [2]. This document is available at [http://earth.eo.esa.int/pub/ESA\\_DOC/ENVISAT/Vol15\\_Sciamachy\\_3L\\_1.1.pdf](http://earth.eo.esa.int/pub/ESA_DOC/ENVISAT/Vol15_Sciamachy_3L_1.1.pdf)

A **Readme file** describing data quality and known instrument and processing issues as well as major improvements with respect to previous processor versions is regularly maintained by the SCIAMACHY Quality Working Group and provided to the users. The document applying to the SCIAMACHY Level 2 Fast-Delivery and Off-Line products (SCI\_OL\_\_2P) - updated corresponding to the SGP version 5.02 - is available at [http://envisat.esa.int/handbooks/availability/disclaimers/SCI\\_OL\\_\\_2P\\_README.pdf](http://envisat.esa.int/handbooks/availability/disclaimers/SCI_OL__2P_README.pdf)

SCI\_OL\_\_2P products contain geo-located vertical column amounts of trace gases retrieved from Nadir measurements, as well as stratospheric Limb profiles of O<sub>3</sub>, NO<sub>2</sub> and BrO. Additionally fractional cloud coverage, cloud-top height, and cloud optical thickness are derived and provided as product to the user. The major upgrades with respect to prior processor versions are summarised in Table 8.1.

Processor Version	Description	Proc. Centre	Date	Start Orbit
5.02	<p>Main processor changes:</p> <p>Nadir SO2 Vertical Column Density:</p> <ul style="list-style-type: none"> <li>• Fix for background database;</li> <li>• Max-SZA cut-off decreased from 89 to 80 deg.;</li> <li>• Fix quality flag;</li> <li>• Earthshine stretch implemented;</li> <li>• Reference Ring spectrum improved;</li> <li>• Change in eta spectrum reference.</li> </ul> <p>Nadir OCIO Slant Column Density:</p> <ul style="list-style-type: none"> <li>• Correction of the polynomial degree used in DOAS fit;</li> <li>• SZA cut-off changed from 95 to 92 deg.</li> </ul>	D-PAC	04-OCT-2011	50000



	<p>Nadir CO Vertical Column Density:</p> <ul style="list-style-type: none"> <li>• Introduction of a linear wavelength-dependent wavelength shift spectral correction.</li> </ul>			
5.01	<p>Main processor changes:</p> <ul style="list-style-type: none"> <li>• Nadir MDS now contain additional trace gas columns: SO<sub>2</sub>, BrO, H<sub>2</sub>O, OCIO and CO.</li> <li>• Limb MDS now contain the trace gas profiles of BrO.</li> <li>• Limb Cloud MDS Contains height resolved indicators for cloud presence and type (water clouds, PSCs and NLCs).</li> </ul>	D-PAC	23-JAN-2010	41295
3.01	<p>Main processor changes:</p> <ul style="list-style-type: none"> <li>• Updated SACURA cloud algorithm</li> <li>• Offset applied in NO<sub>2</sub> slant column processing was removed</li> <li>• Number of retrieved profiles per state was set from one to four (4)</li> <li>• Cloud and Aerosol MDS are filled with the next valid value instead of being set to zero</li> <li>• Molecular Ring correction applied on NADIR O<sub>3</sub> slant column density</li> </ul> <p>Non-compliance corrections:</p> <ul style="list-style-type: none"> <li>• Inter change of Pressure and Temperature values in LIMB MDS</li> <li>• Erroneous Cloud and Aerosol Quality Flags</li> <li>• AAI erroneously set to zero in Cloud and Aerosol MDS</li> <li>• Scaling of too large NO<sub>2</sub> error estimate</li> </ul>	D-PAC	23-SEP-2007	29092

**Table 8.1: Level 2 off-line Processor configuration.**

## 8.1.2 Anomalies

A subset of SCIAMACHY data products generated between 25 December 2011 and 02 January 2012 from both the Fast Delivery and the Off-line Level 2 processing chains were found affected by an incorrect processing triggered by a hardware failure of the processing platform at D-PAC causing reduced file size and incorrect measurement coverage. 114 anomalous Level 2 consolidated products (off-line processing) for the time period from November 2011 to January 2012 were removed from the D-PAC FTP server and replaced with a correctively reprocessed data set. No quality impact on the retrieved parameters has been identified. A list of products affected is available at

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

## 8.1.3 Auxiliary Data Files

Input for Level 2 off-line processing is the so-called Initialization File. This ADF is usually changed only in case of a processor upgrade.

With the activation of processor SGP version 5.02 a new initialization file became active:

```
SCI_IN__AXNPDE20110201_120000_20020301_000000_20991231_235959
```

## 8.2 Monitoring results

### 8.2.1 Nadir: NO<sub>2</sub> consistency checking

The world map plots of Nadir NO<sub>2</sub> vertical column density (VCD) values averaged over one month are generated from the SCI\_OL\_\_2P Nadir products. Figure 8.1 and Figure 8.3 show the monthly world map plots for November and December 2011.

Figure 8.2 and Figure 8.4 show errors for the VCD monthly average plots. The errors are given in absolute values (molec/cm<sup>2</sup>). Generally the equator region has NO<sub>2</sub> values with higher errors.

An overall reduction of the error associated to NO<sub>2</sub> mean VCDs has been obtained with the new processor version 5.02.

High concentration of NO<sub>2</sub> is expected over industrial regions, such as over North America, especially the East coast, over central Europe, China and South Africa, which is reflected in the world maps.



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### 8.2.1.1 Nadir: VCD NO<sub>2</sub> map November 2011

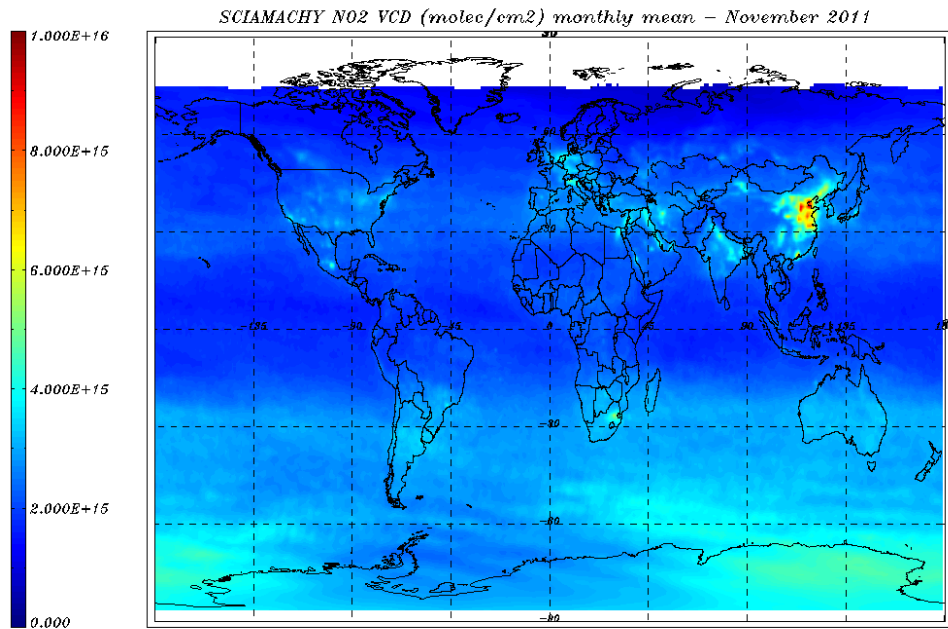


Figure 8.1: NO<sub>2</sub> VCD (molec/cm<sup>2</sup>) world map for 01 - 30 November 2011 – monthly average.

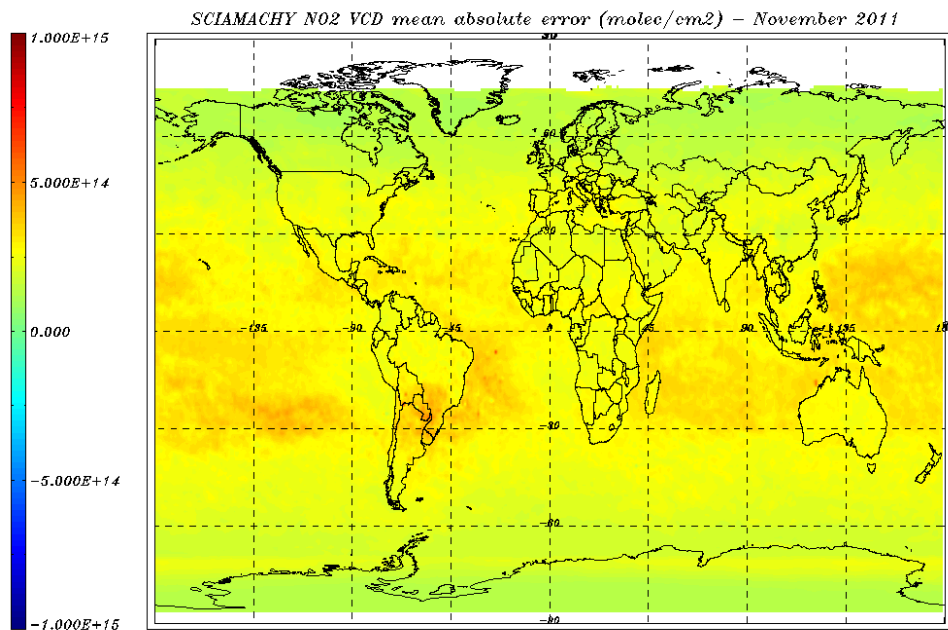


Figure 8.2: NO<sub>2</sub> VCD error (molec/cm<sup>2</sup>) for 01 - 30 November 2011 - monthly average.



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### 8.2.1.2 Nadir: VCD NO<sub>2</sub> map December 2011

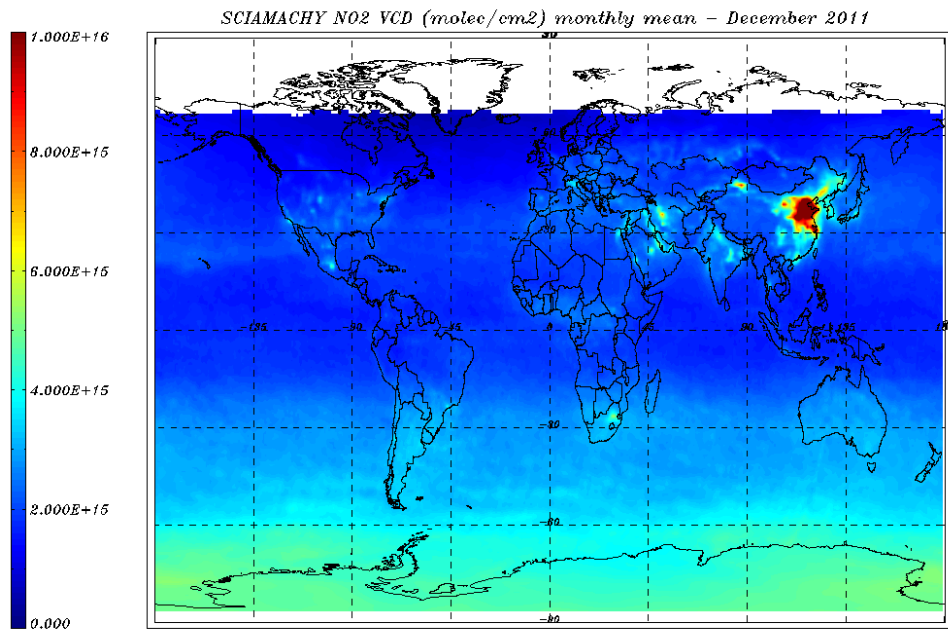


Figure 8.3: NO<sub>2</sub> VCD (molec/cm<sup>2</sup>) world map for 01 – 31 December 2011 – monthly average.

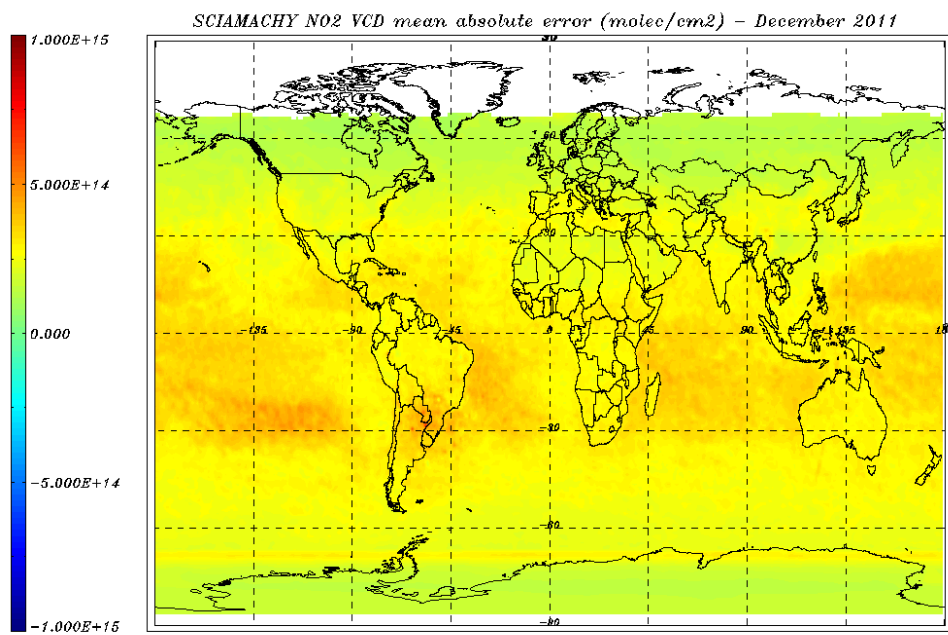


Figure 8.4: NO<sub>2</sub> VCD error (molec/cm<sup>2</sup>) for 01 – 31 December 2011- monthly average.

### 8.2.2 Nadir: O<sub>3</sub> consistency checking

Analogous to the NO<sub>2</sub> world maps, O<sub>3</sub> vertical column density (VCD) values averaged over one month are generated from the SCI\_OL\_\_2P Nadir products and plotted on a world map.

Figure 8.5 and Figure 8.7 show the ozone distribution converted to Dobson units for November and December 2011. The VCD error as monthly average plots is shown in Figure 8.6 and Figure 8.8 as relative fraction.

8.2.2.1 Nadir: VCD O<sub>3</sub> map November 2011

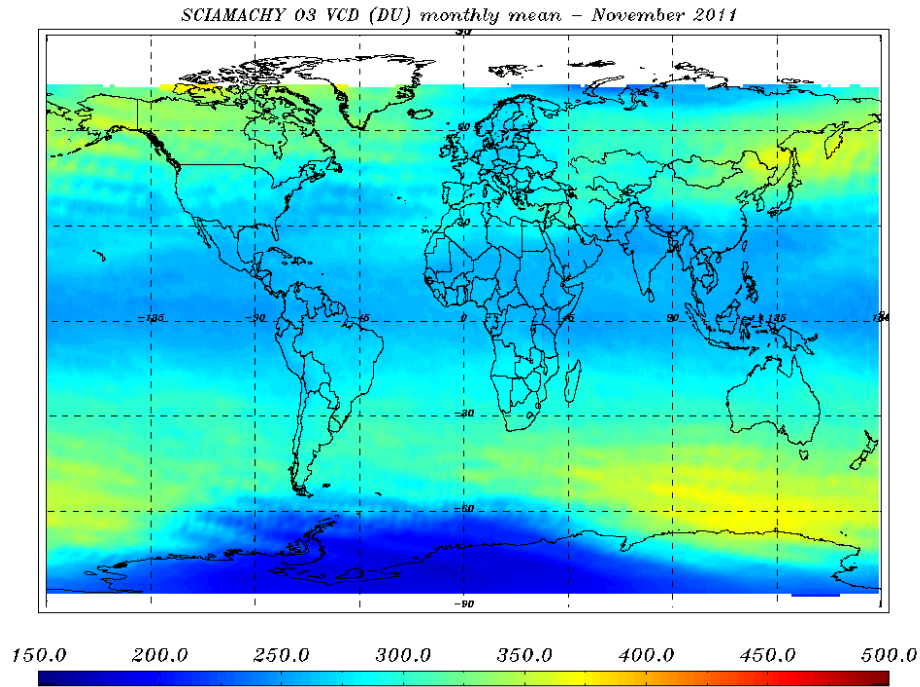


Figure 8.5: O<sub>3</sub> VCD (DU) world map for 01 - 30 November 2011 – monthly average.

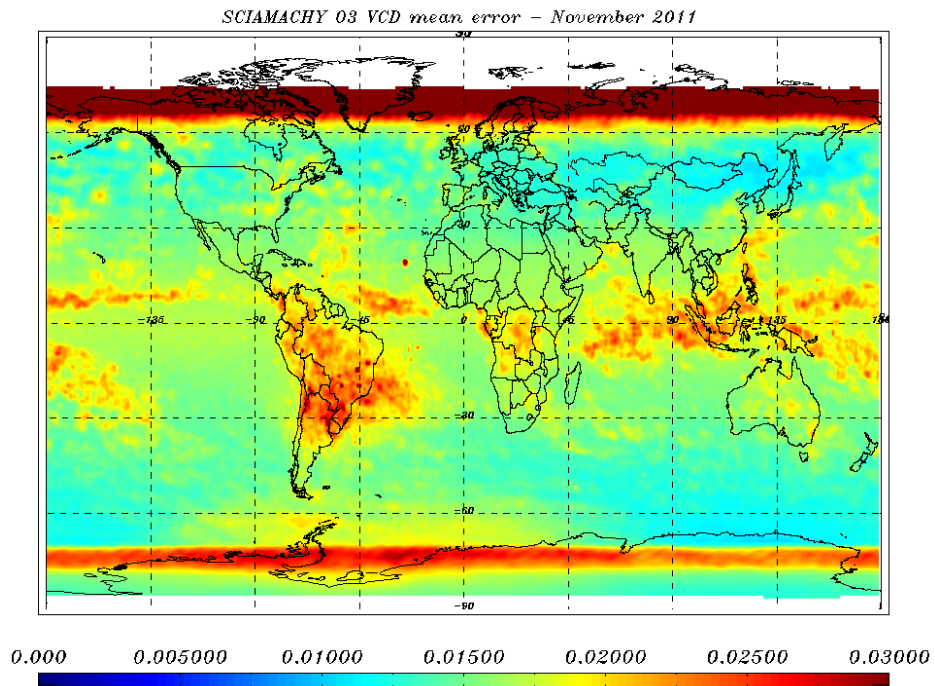


Figure 8.6: O<sub>3</sub> VCD error for 01 - 30 November 2011 - monthly average.

8.2.2.2 Nadir: VCD O<sub>3</sub> map December 2011

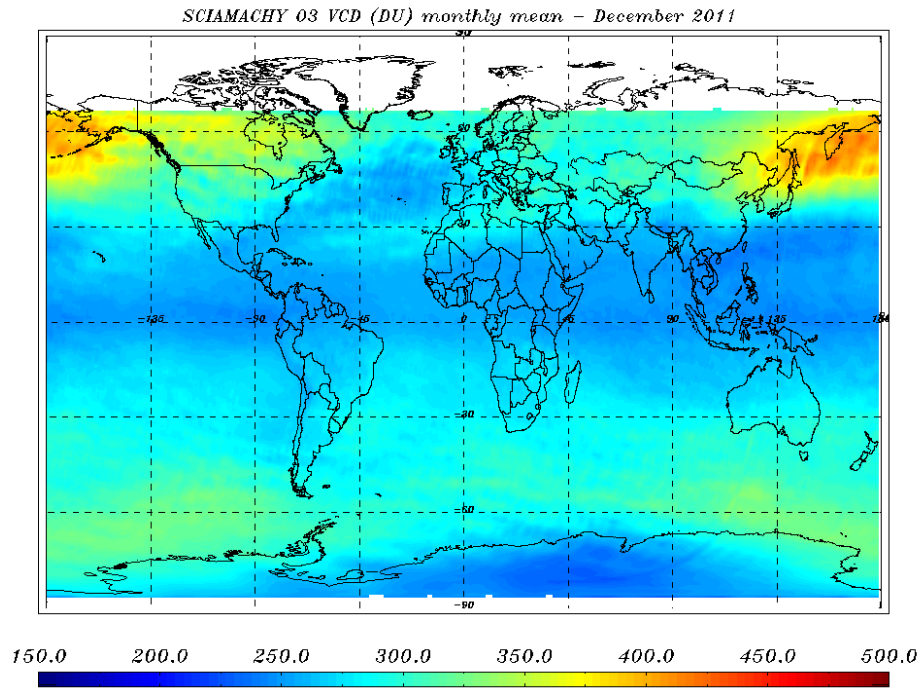


Figure 8.7: O<sub>3</sub> VCD (DU) world map for 01 - 31 December 2011 – monthly average.

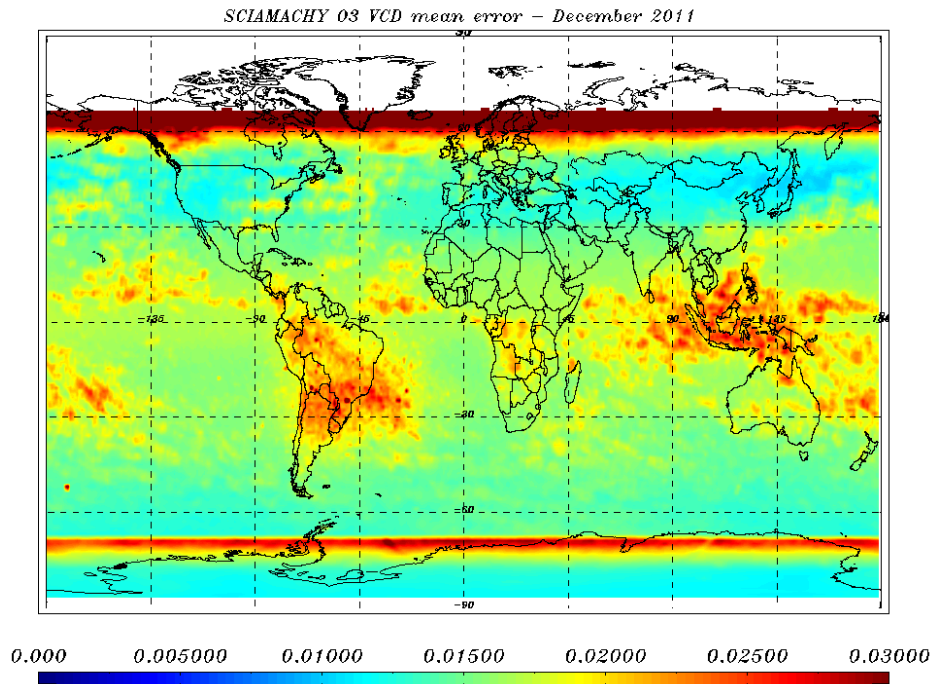


Figure 8.8: O<sub>3</sub> VCD error for 01- 31 December 2011 - monthly average.

### 8.2.3 Nadir: H<sub>2</sub>O consistency checking

The world map plots of Nadir H<sub>2</sub>O vertical column density (VCD) values in g/cm<sup>2</sup> averaged over one month are generated from the SCI\_OL\_\_2P Nadir products version 5.02.

Figure 8.9 and Figure 8.11 show the monthly plots for November and December 2011. Figure 8.10 and Figure 8.12 show the VCD error for the monthly average plot. Errors are absolute values (g/cm<sup>2</sup>).

In the plots, data over high mountain areas (Himalayas and the Andes range) are masked out by the processor's internal quality checks. No correction for surface elevation is performed.

Please note that these plots are preliminary results after the implementation of the new processor version and are still under review.





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### 8.2.3.1 Nadir: VCD H<sub>2</sub>O map November 2011

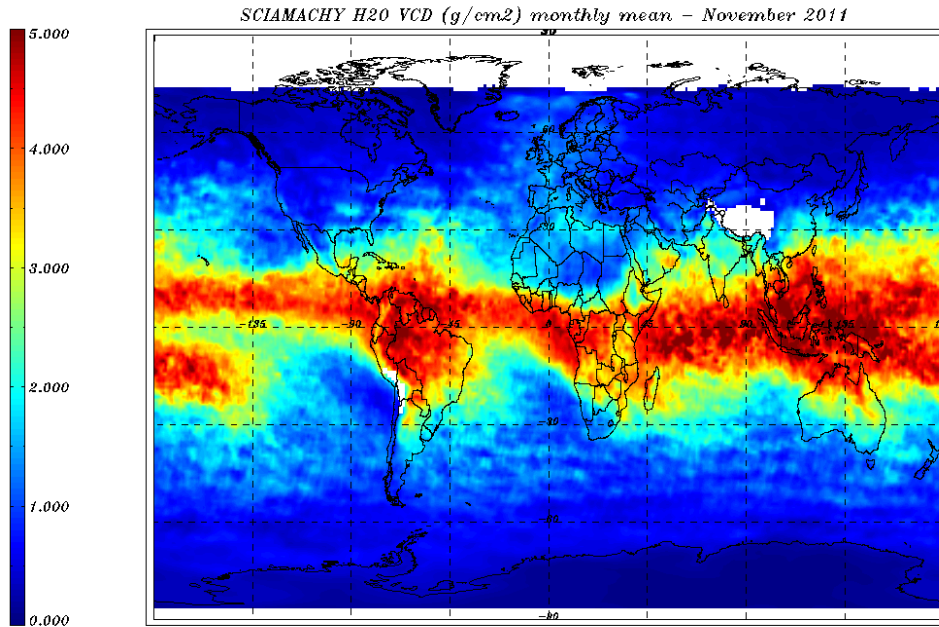


Figure 8.9: H<sub>2</sub>O VCD (g/cm<sup>2</sup>) world map for 01 - 30 November 2011 – monthly average.

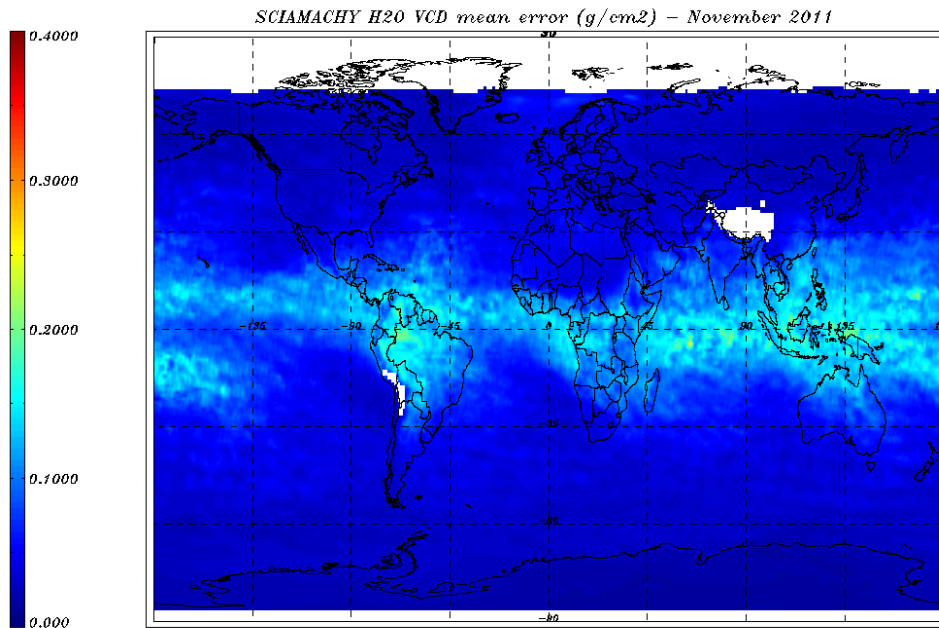


Figure 8.10: H<sub>2</sub>O VCD (g/cm<sup>2</sup>) error for 01 - 30 November 2011 - monthly average.



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### 8.2.3.2 Nadir: VCD H<sub>2</sub>O map December 2011

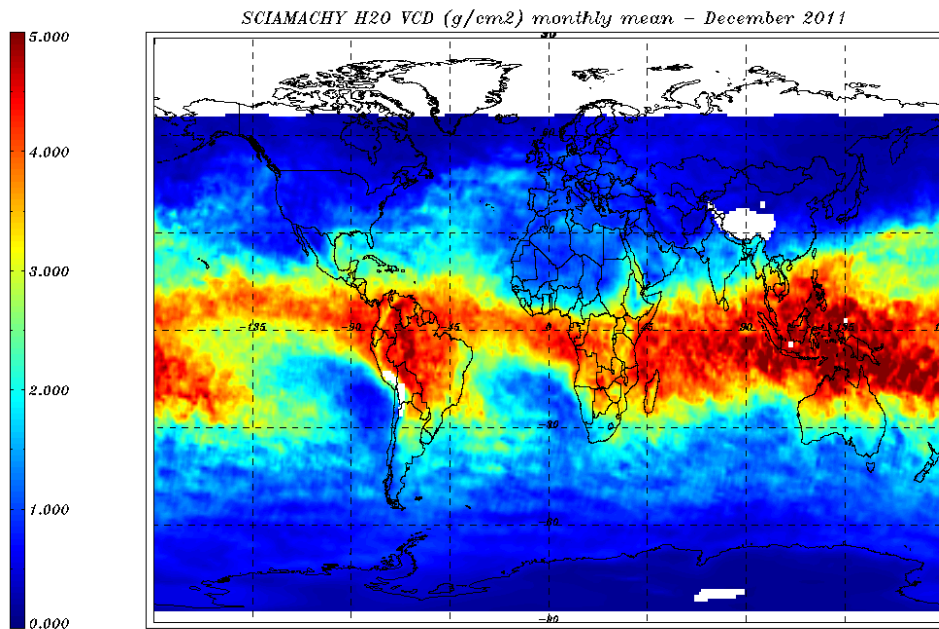


Figure 8.11: H<sub>2</sub>O VCD (g/cm<sup>2</sup>) world map for 01 – 31 December 2011 – monthly average.

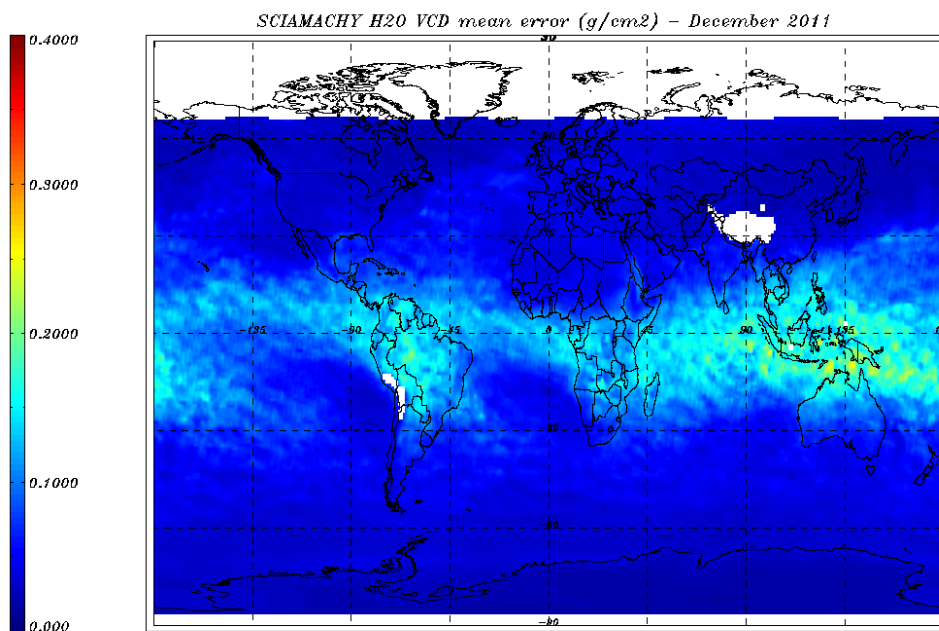


Figure 8.12: H<sub>2</sub>O VCD (g/cm<sup>2</sup>) error for 01 – 31 December 2011- monthly average.

### 8.2.4 Nadir: BrO consistency checking

The world map plots of Nadir BrO vertical column density (VCD) values averaged over one month are generated from the SCI\_OL\_\_2P Nadir products version 5.02. Figure 8.13 and Figure 8.15 show the monthly world map plots for November and December 2011.

Figure 8.14 and Figure 8.16 show the VCD errors for the monthly average plots. Errors are given in absolute values (molec/cm<sup>2</sup>).

Large emissions of inorganic bromine are expected in the Tropospheric Polar Regions at the end of the winter (bromine explosion event) and in the troposphere and possibly in the stratosphere as a consequence of active volcanoes. Low values are present in correspondence with the SAA.

Please note that these plots are preliminary results after the implementation of the new processor version and are still under review.

For year 2002 the BrO column densities are substantially too low with a lot of negative values. We recommend users not to use the 2002 BrO data in the current implementation.



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### 8.2.4.1 Nadir: VCD BrO map November 2011

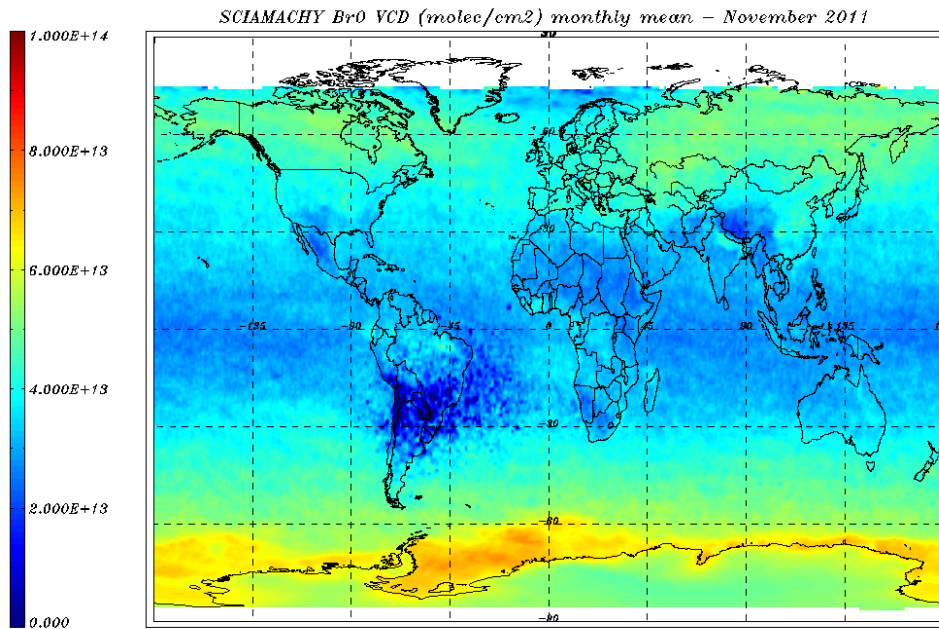


Figure 8.13: BrO VCD (molec/cm<sup>2</sup>) world map for 01 – 30 November 2011 – monthly average.

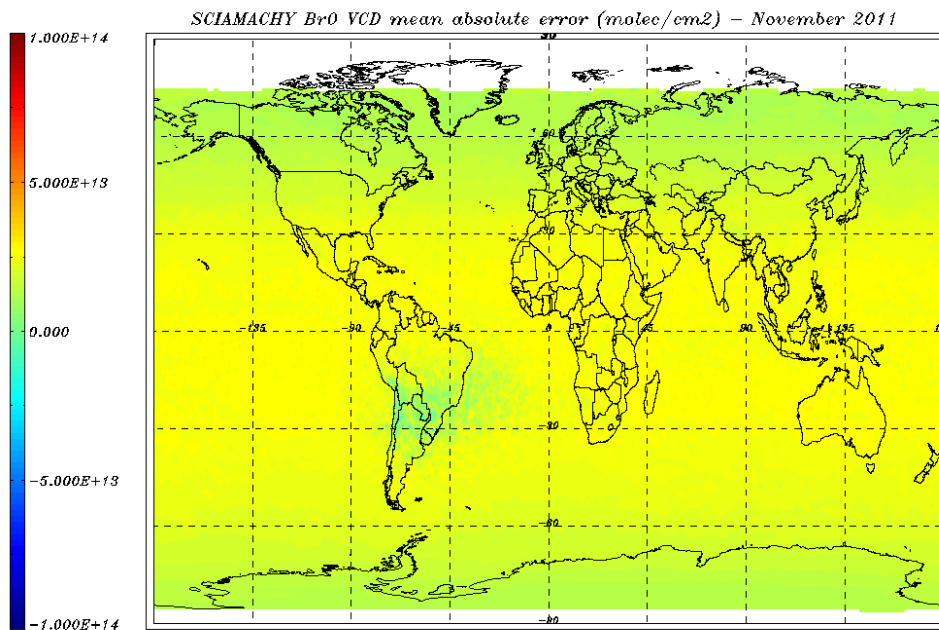


Figure 8.14: BrO VCD error (molec/cm<sup>2</sup>) for 01 – 30 November 2011- monthly average.



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### 8.2.4.2 Nadir: VCD BrO map December 2011

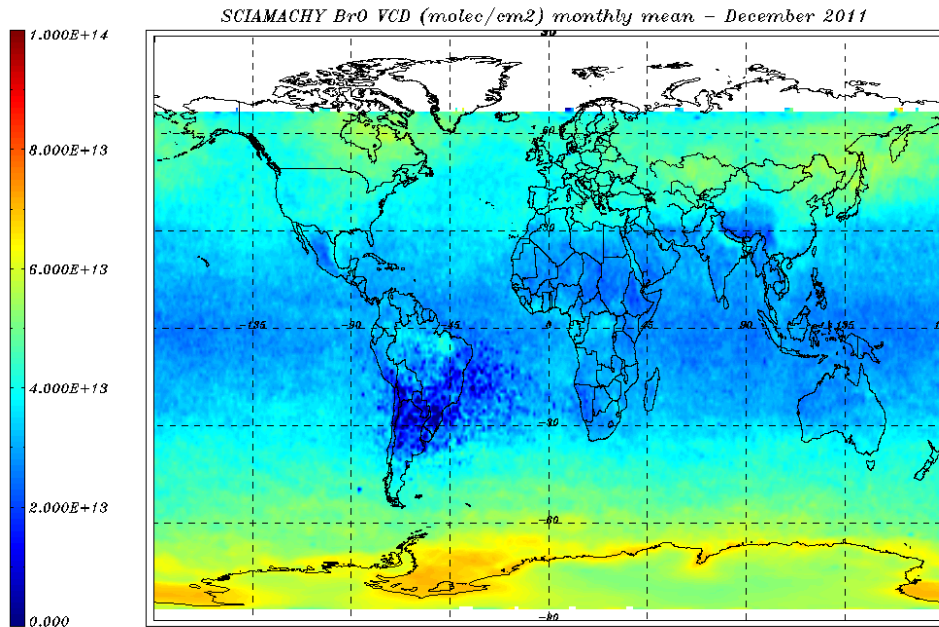


Figure 8.15: BrO VCD (molec/cm<sup>2</sup>) world map for 01 – 31 December 2011 – monthly average.

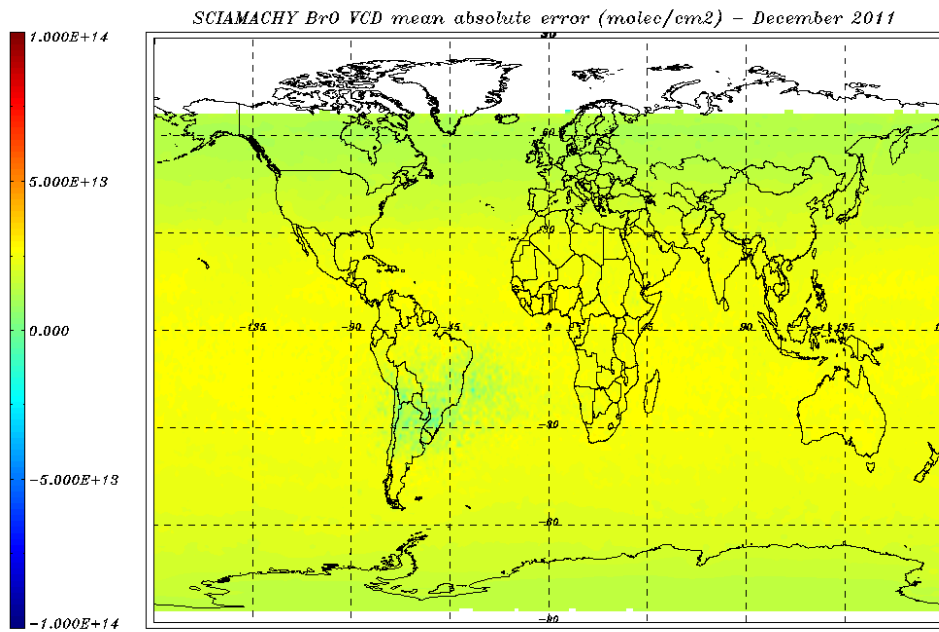


Figure 8.16: BrO VCD error (molec/cm<sup>2</sup>) for 01 – 31 December 2011- monthly average.

### 8.2.5 Nadir: SO<sub>2</sub> consistency checking

The world map plots of Nadir SO<sub>2</sub> vertical column density (VCD) values in molec/cm<sup>2</sup> averaged over one month are generated from the SCI\_OL\_\_2P Nadir products version 5.02. Each Level 2 product now contains one MDS for an anthropogenic scenario (SO<sub>2</sub> present in the boundary layer labelled as NAD\_UV5\_SO2) and one MDS for the volcanic scenario (SO<sub>2</sub> layer between 10 and 11 km with label NAD\_UV7\_SO2).

Since SO<sub>2</sub> distribution varies to a large degree between an anthropogenic scenario (pollution dominated) and a volcanic scenario, the AMF cannot be determined for both with a single climatology. Two types of AMF for the calculation of the “anthropogenic” SO<sub>2</sub> vertical columns and the “volcanic” ones are derived assuming a constant profile shape for two typical scenarios:

- a profile with 1 DU of SO<sub>2</sub> from surface to 1 km height simulating an Anthropogenic Pollution scenario;
- a profile with 10 DU of SO<sub>2</sub> between a 10 and 11 km simulating a volcanic eruption.

Accordingly, two types of SO<sub>2</sub> vertical columns - anthropogenic and volcanic - are computed and written into two different MDSs of the Level 2 products.

Both retrievals use the same background subtracted slant column as input, calculated from a reference sector over the Pacific Ocean as a pollution free correction.

Figure 8.17, 8.19, 8.21 and 8.23 show the monthly world map plots for anthropogenic and volcanic vertical columns for November and December 2011. Figure 8.18, 8.20, 8.22 and 8.24 show the VCD errors for the monthly average plots. Errors are given in absolute value (molec/cm<sup>2</sup>). SO<sub>2</sub> values measured in the ascending node (the satellite moving northwards) have been filtered out.

Please note that these plots are preliminary results after the implementation of the new processor version and are still under review. The operational SO<sub>2</sub> product picks-up the main relevant features, but VCDs are strongly affected by negative values, presumably resulting from problems with the reference sector subtraction. Due to the poor results, it is recommended not to use the current version of the anthropogenic columns for quantitative studies. Usage of the volcanic columns as indicator of volcanic eruptions seems to be feasible.



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8.2.5.1 Nadir: SO<sub>2</sub> Anthropogenic scenario - November 2011

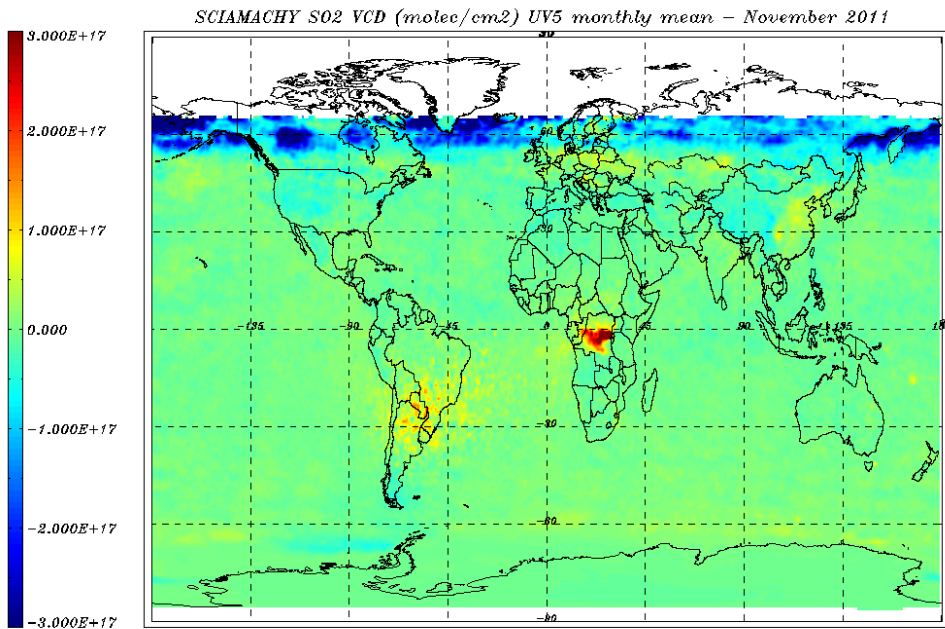


Figure 8.17: SO<sub>2</sub> VCD (molec/cm<sup>2</sup>) world map for 01 –30 November 2011 – monthly average.

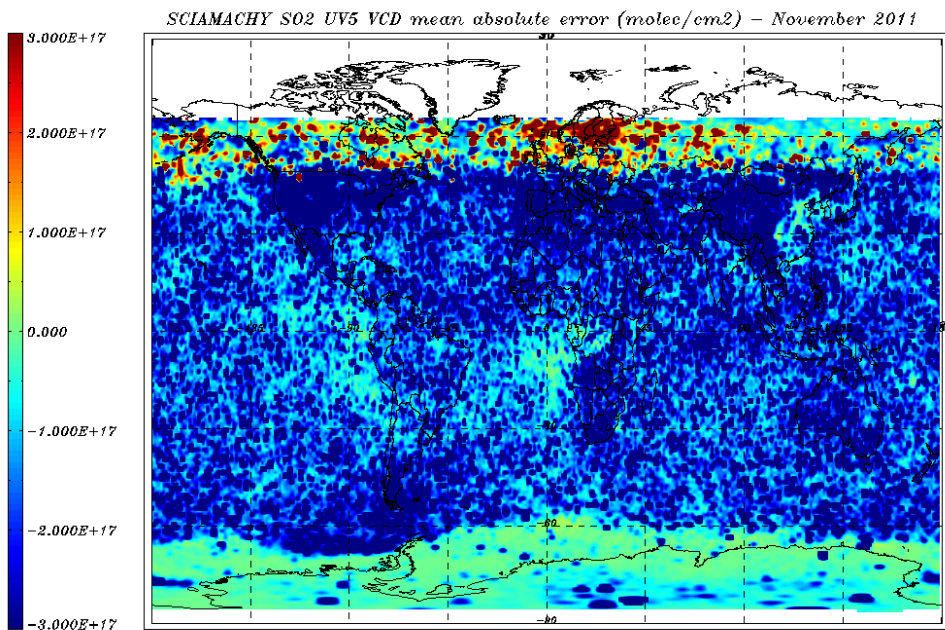


Figure 8.18: SO<sub>2</sub> VCD error (molec/cm<sup>2</sup>) for 01 –30 November 2011- monthly average.



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### 8.2.5.2 Nadir: SO<sub>2</sub> Anthropogenic scenario - December 2011

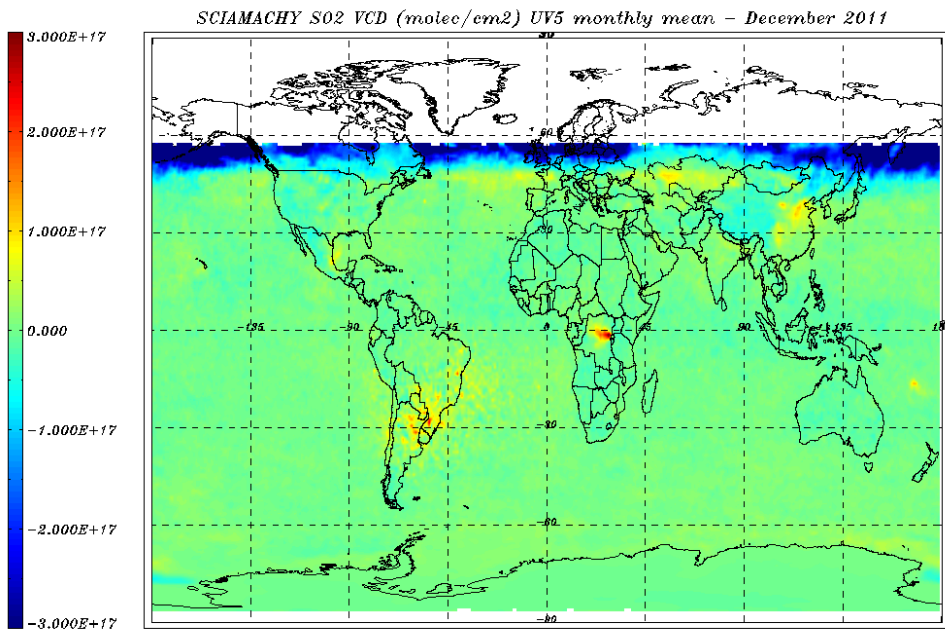


Figure 8.19: SO<sub>2</sub> VCD (molec/cm<sup>2</sup>) world map for 01 – 31 December 2011 – monthly average.

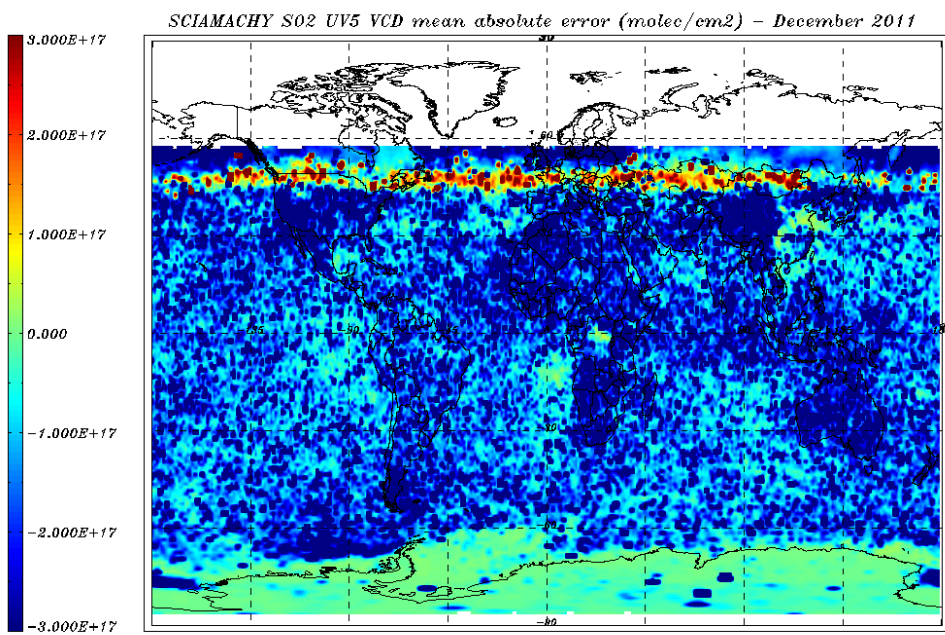


Figure 8.20: SO<sub>2</sub> VCD error (molec/cm<sup>2</sup>) for 01 – 31 December 2011- monthly average.





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### 8.2.5.3 Nadir: SO<sub>2</sub> Volcanic scenario - November 2011

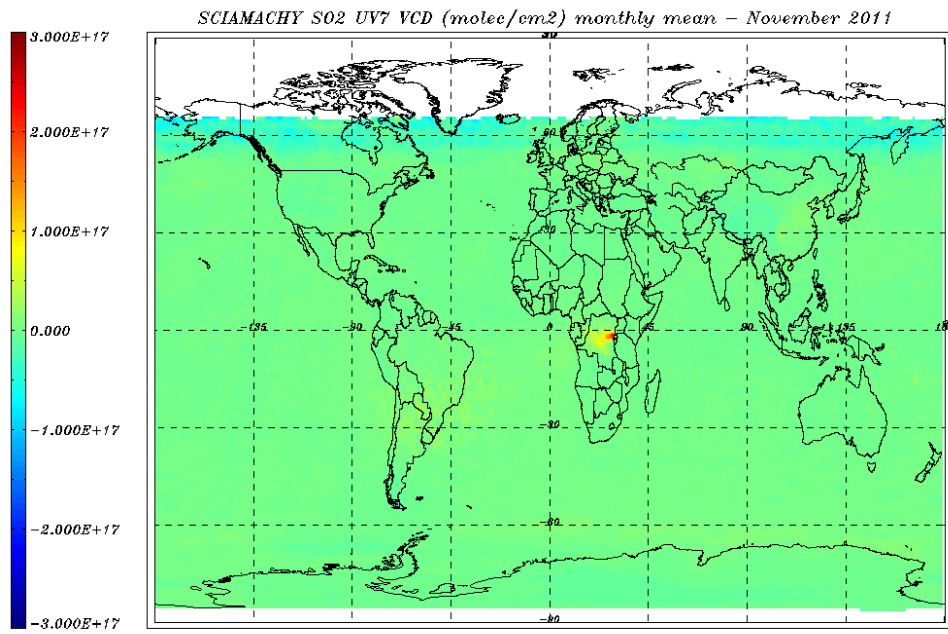


Figure 8.21: SO<sub>2</sub> VCD (molec/cm<sup>2</sup>) world map for 01 –30 November 2011 – monthly average.

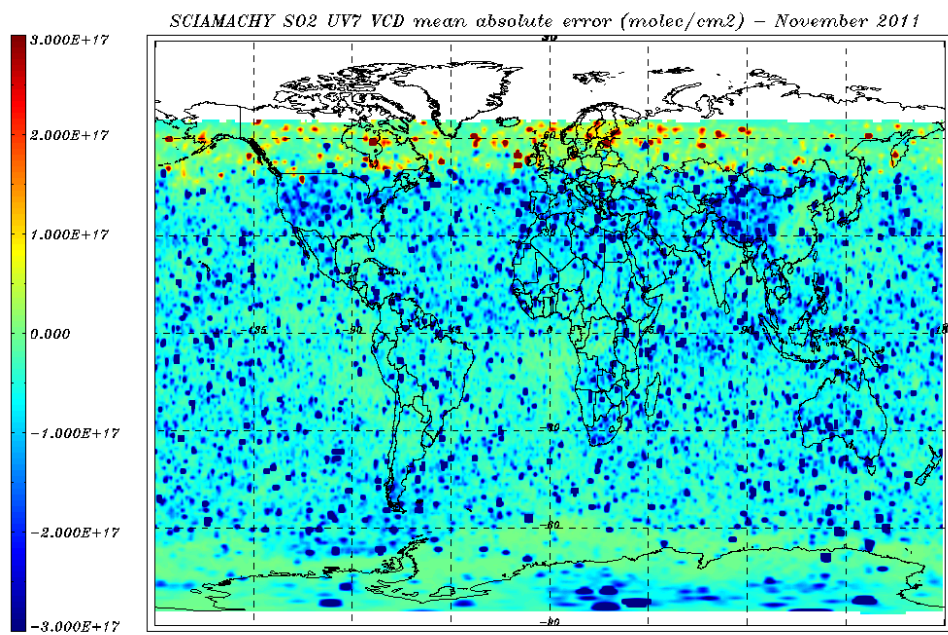


Figure 8.22: SO<sub>2</sub> VCD error (molec/cm<sup>2</sup>) for 01 – 30 November 2011 – monthly average.



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### 8.2.5.4 Nadir: SO<sub>2</sub> Volcanic scenario - December 2011

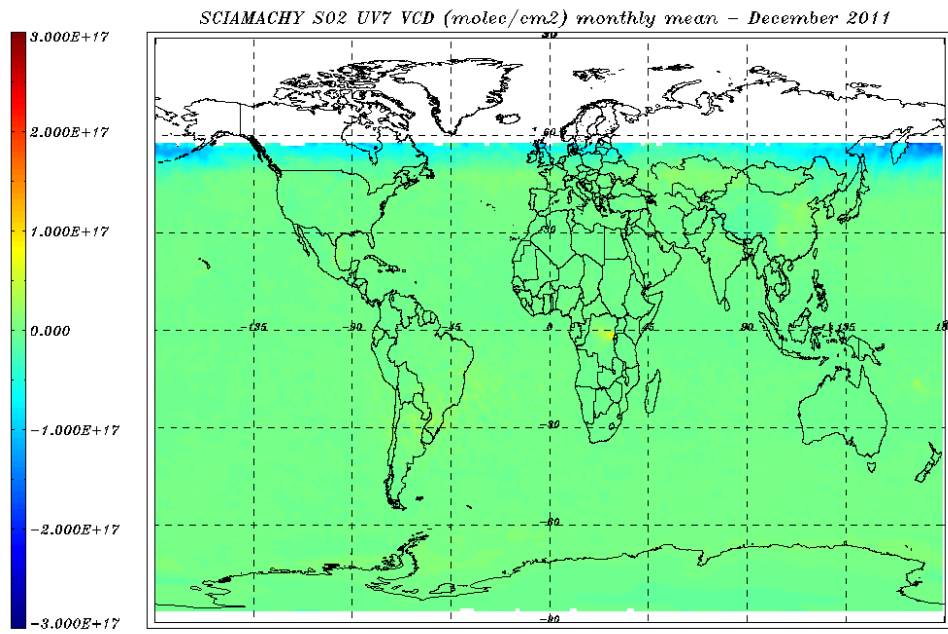


Figure 8.23: SO<sub>2</sub> VCD (molec/cm<sup>2</sup>) world map for 01 – 31 December 2011 – monthly average.

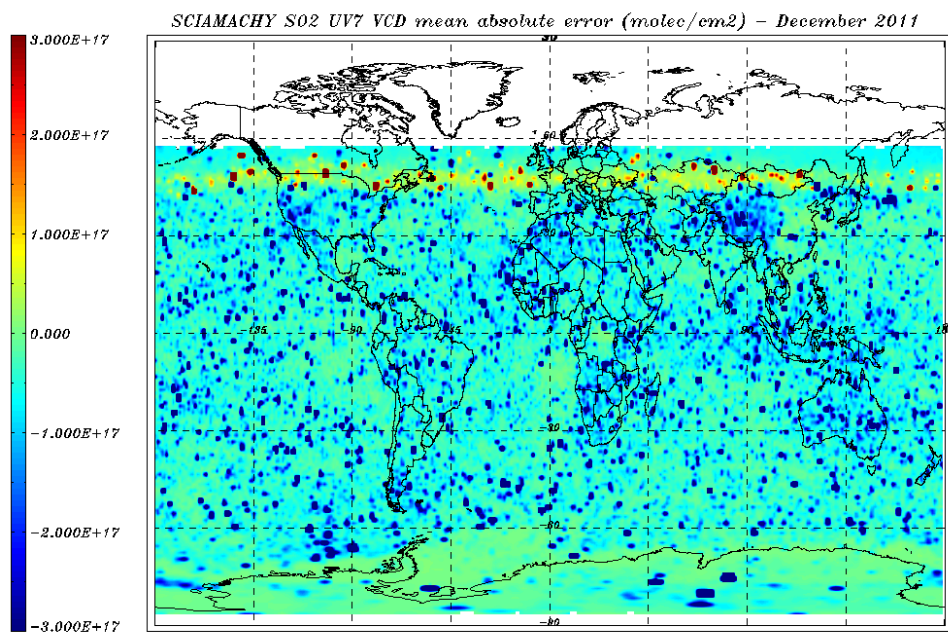


Figure 8.24: SO<sub>2</sub> VCD error (molec/cm<sup>2</sup>) for 01 – 31 December 2011 – monthly average.

### 8.2.6 Nadir: OCIO consistency checking

The polar maps of Nadir OCIO slant column density (SCD) values averaged over one month are generated from the SCI\_OL\_\_2P Nadir products version 5.02.

Figure 8.25 and Figure 8.27 show the monthly SCD values for November 2011 over the Northern and the Southern Hemisphere respectively. Figure 8.26 and Figure 8.28 show the corresponding SCD absolute errors for the monthly average plots.

Figures from 8.29 to 8.32 show the corresponding plots for December 2011.

Computation of VCD is difficult for the rapid photochemistry of OCIO. The vertical column given in the product does not contain any correction for photochemical effects and should thus not be used as given.

Significant amounts of OCIO are expected only in the activated polar vortex. OCIO values measured in the ascending node (the satellite moving northwards) introduce artifacts in the plots (i.e. spurious high OCIO values in the summer hemisphere in the absence of chlorine activation) and have been filtered out from the monthly maps.

Please note that these plots are preliminary results after the implementation of the new processor version and are still under review.

### 8.2.6.1 Nadir: SCD OCIO maps November 2011

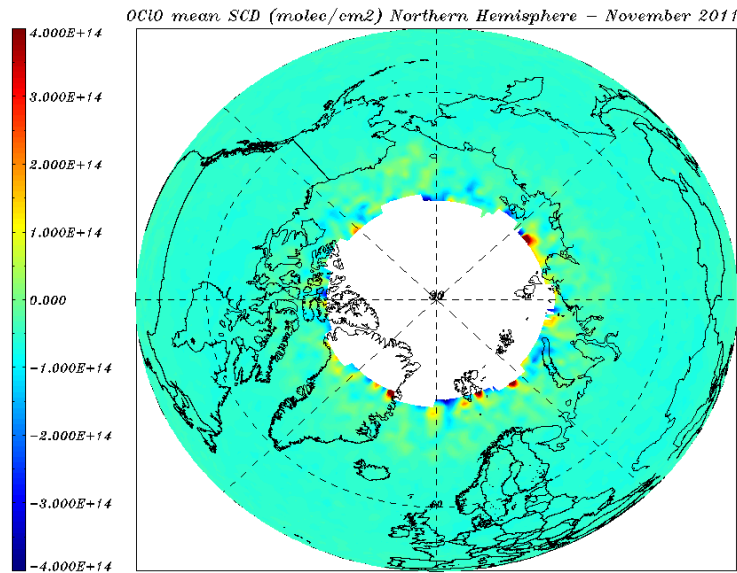


Figure 8.25: OCIO SCD (molec/cm<sup>2</sup>) for 01 – 30 November 2011 – monthly average over the Northern Hemisphere.

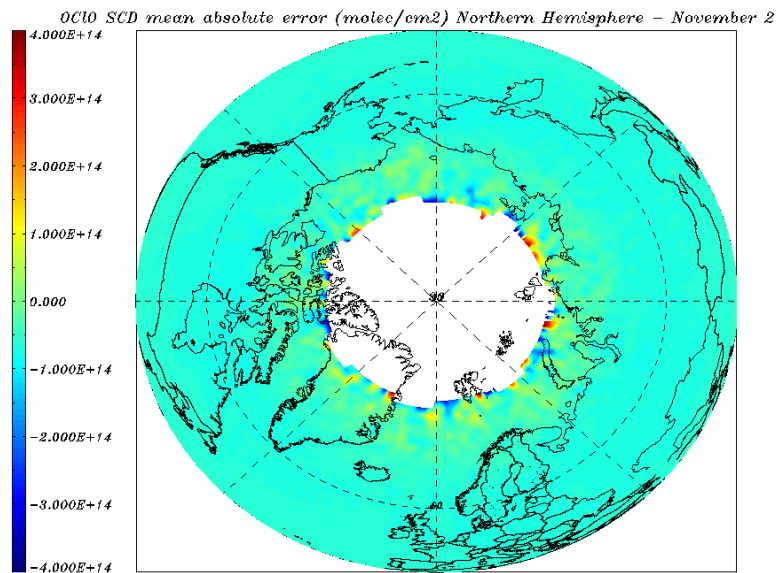


Figure 8.26: OCIO SCD error (molec/cm<sup>2</sup>) for 01 – 30 November 2011- monthly average over the Northern Hemisphere.

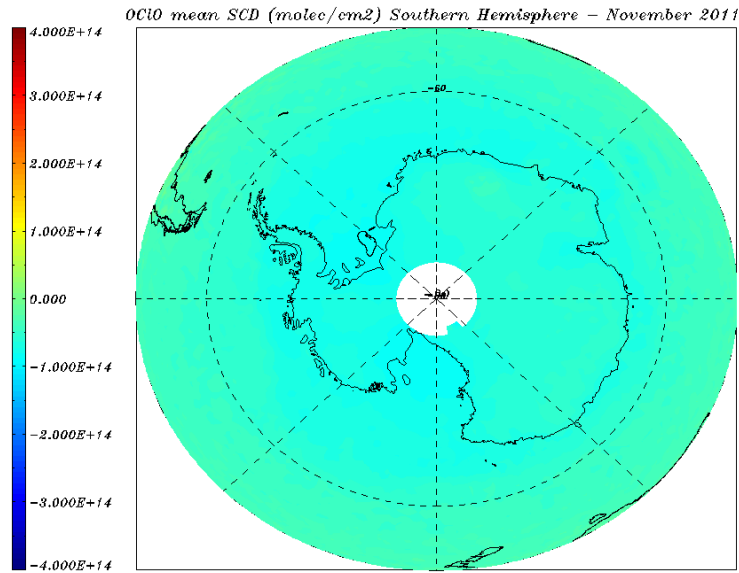


Figure 8.27: OCIO SCD (molec/cm<sup>2</sup>) for 01 – 30 November 2011 – monthly average over the Southern Hemisphere.

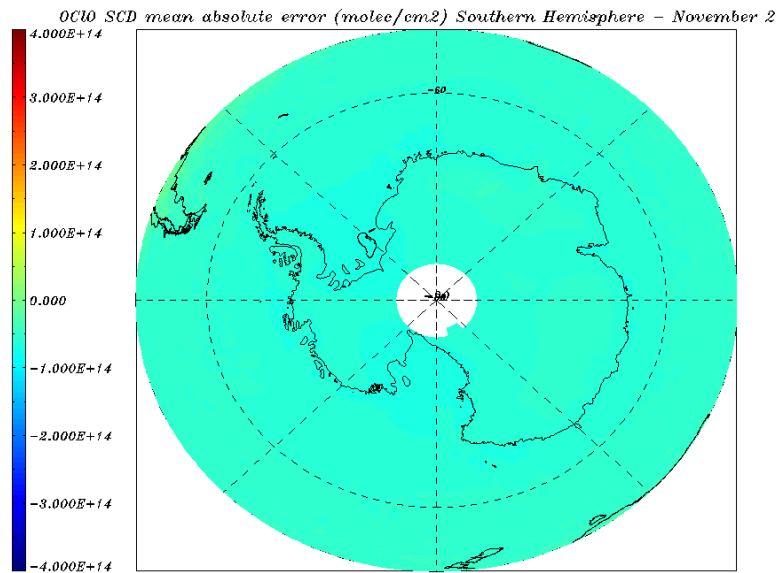


Figure 8.28: OCIO SCD error (molec/cm<sup>2</sup>) for 01 – 30 November 2011- monthly average over the Southern Hemisphere.

### 8.2.6.2 Nadir: SCD OCIO maps December 2011

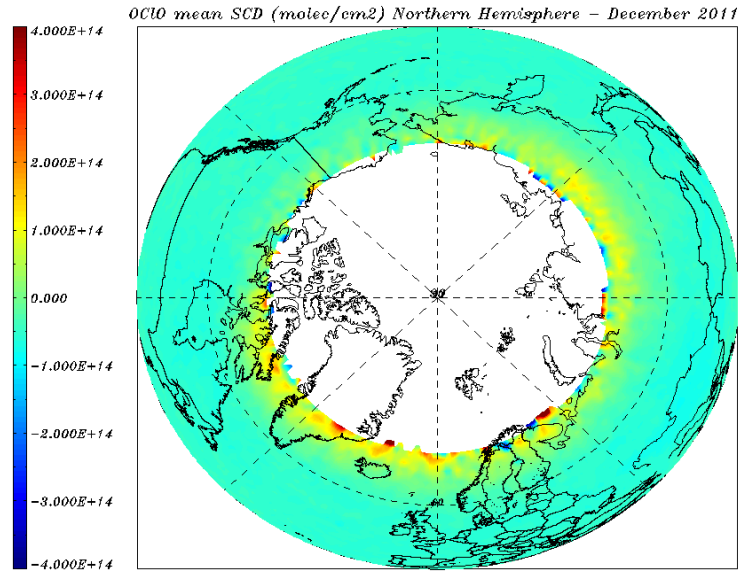


Figure 8.29: OCIO SCD (molec/cm<sup>2</sup>) for 01 – 31 December 2011 – monthly average over the Northern Hemisphere.

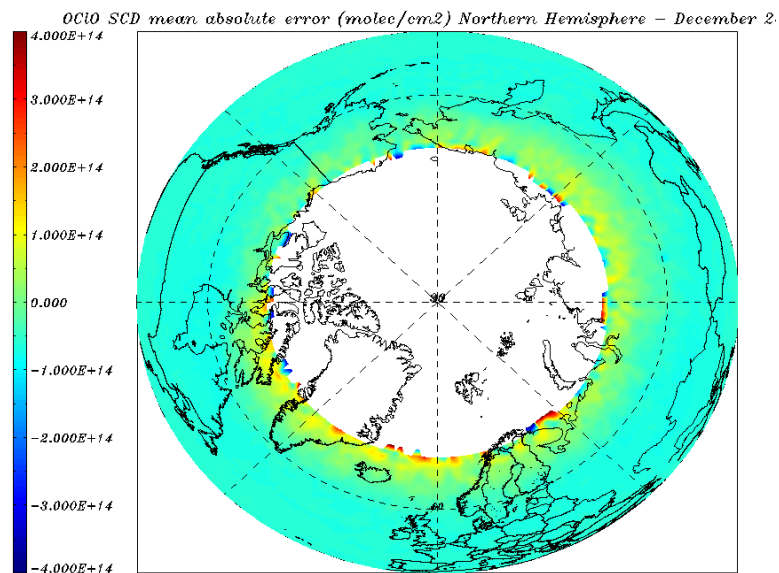


Figure 8.30: OCIO SCD error (molec/cm<sup>2</sup>) for 01 – 31 December 2011- monthly average over the Northern Hemisphere.

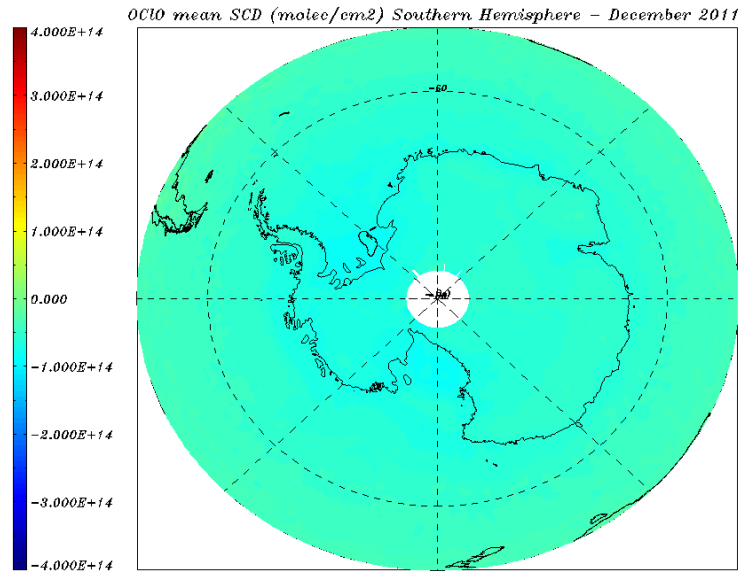


Figure 8.31: OCIO SCD (molec/cm<sup>2</sup>) for 01 – 31 December 2011 – monthly average over the Southern Hemisphere.

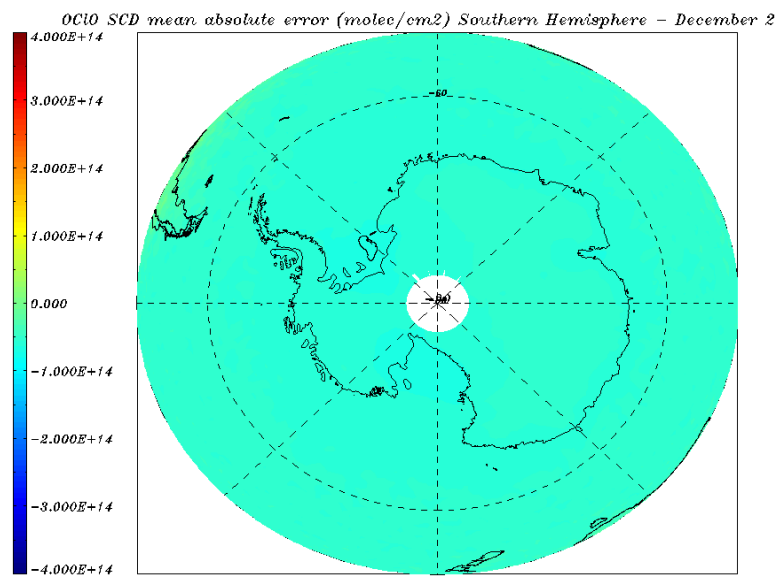


Figure 8.32: OCIO SCD error (molec/cm<sup>2</sup>) for 01 – 31 December 2011- monthly average over the Southern Hemisphere.



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### 8.2.7 Nadir: CO consistency checking

Carbon monoxide vertical column densities (VCD's) are enclosed in the operational Level 2 products since version 5.01. However, SGP version 5.02 incorporates a spectral correction to the SCIAMACHY channel 8 Level 1b spectra which brought a significant improvement in terms of quality of the product.

VCD's are retrieved with the BIRRA (Beer InfraRed Retrieval Algorithm) code developed at DLR-IMF with a non-linear least squares method directly fitting radiances. The Level 2 products contain two VCD entries: the VCD CO corrected with CH<sub>4</sub> scaling (first entry) and the CO value without CH<sub>4</sub> scaling (for details see the ATBD).

The SGP version 5.02 CO products are intended to be used as time-averaged products. Although single observations are provided, they have large errors and should not be used individually.

Retrievals over ocean are expected to have degraded quality due to the low radiance signal. The throughput correction and the dead/bad pixel mask will critically affect the data quality. Filtering of the data is crucial to get a good CO product.



### 8.2.8 Limb: Ozone profile averages

This paragraph reports on the monitoring of SCIAMACHY limb profiles on a monthly basis, showing the results for Ozone limb profiles binned for two tangent height regions.

Starting with processor version 5.01, a new limb retrieval grid of 27 tangent altitudes has been adopted instead of the 19 values grid used by processor 3.01. As a consequence, the limb profile average plots in this section use different altitude bins with different thickness according to the new product's configuration for limb measurements.

In particular, for the O<sub>3</sub> limb VMR profile extracted from Level 2 products version 5.01, the average plots are reported for the following two tangent height bins

- 22.75 – 24.5 km
- 36.75 – 38.5 km.

The data of the first half of each month (calendar days 1 - 15) and the second half (calendar days 16 - 31) are averaged for selected tangent heights into geo-location bins of 10 degrees longitude and 5 degrees latitude. The binning algorithm uses a single longitude and latitude value for the entire profile, being the value for the middle of the integration time as reported in the Geo-location Limb Dataset. The corresponding error is averaged as well.

The world maps of the averaged Ozone values show comparably low errors over the SAA region, which is not as expected. Investigation showed that the low SAA errors result from irregular conditions of the limb retrieval in that region.

Figures from 8.33 to 8.36 show the results for the months of November and December 2011 and for the two different tangent height regions.



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### 8.2.8.1 Ozone limb profiles November 2011

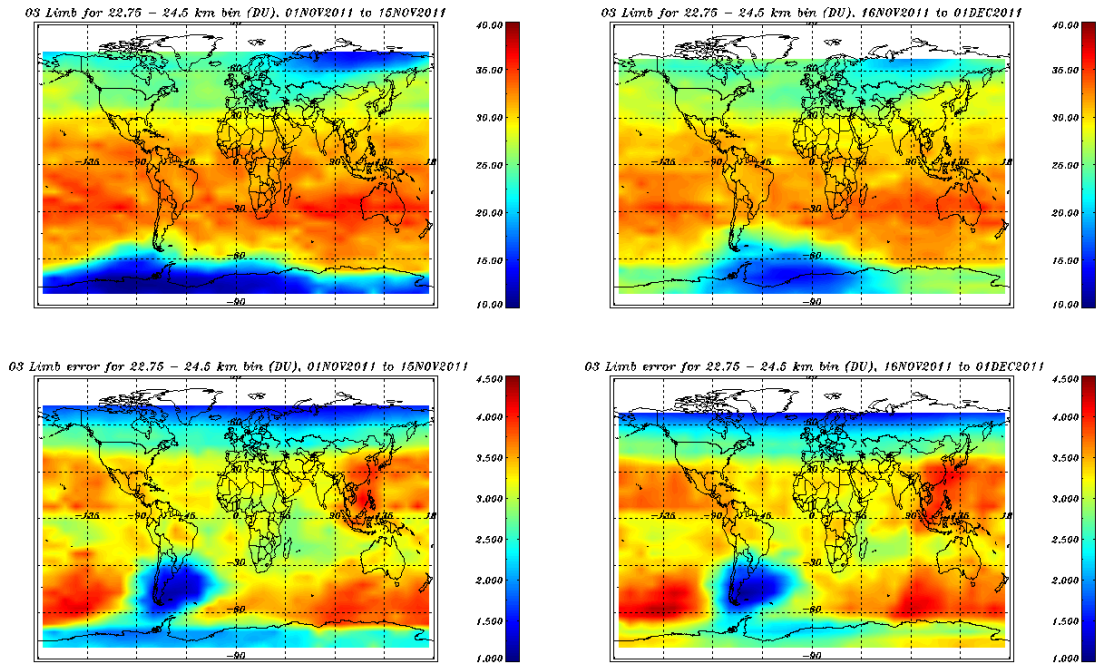


Figure 8.33: Limb Ozone profiles, binned over 22.75 – 24.5 km, November 2011.

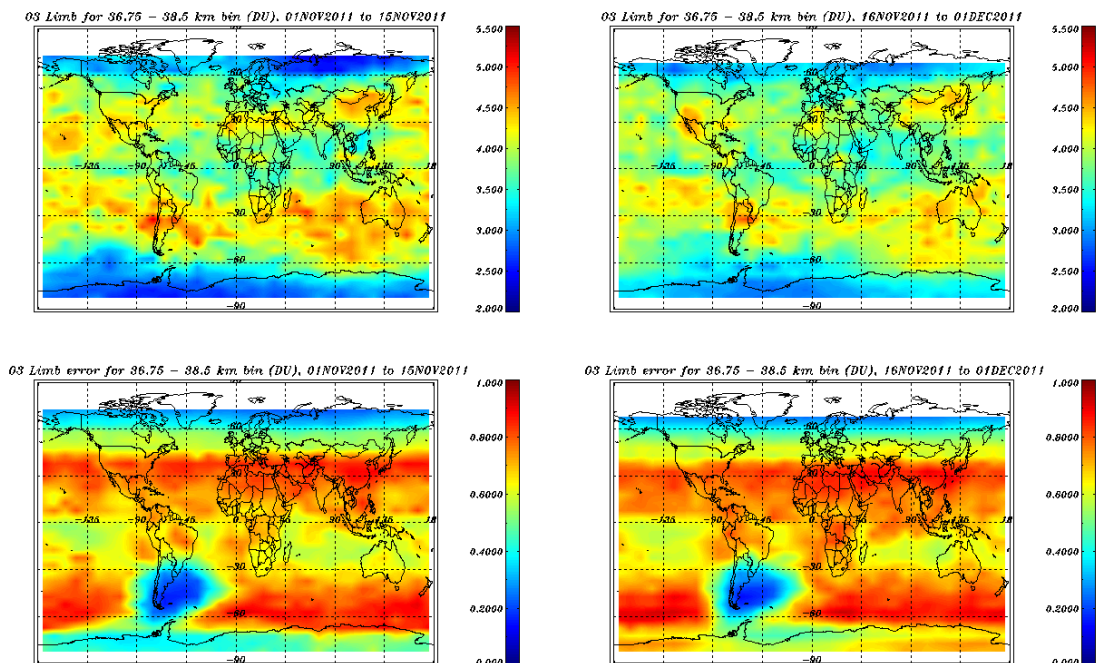


Figure 8.34: Limb Ozone profiles, binned over 36.75 – 38.5 km, November 2011.

### 8.2.8.2 Ozone limb profiles December 2011

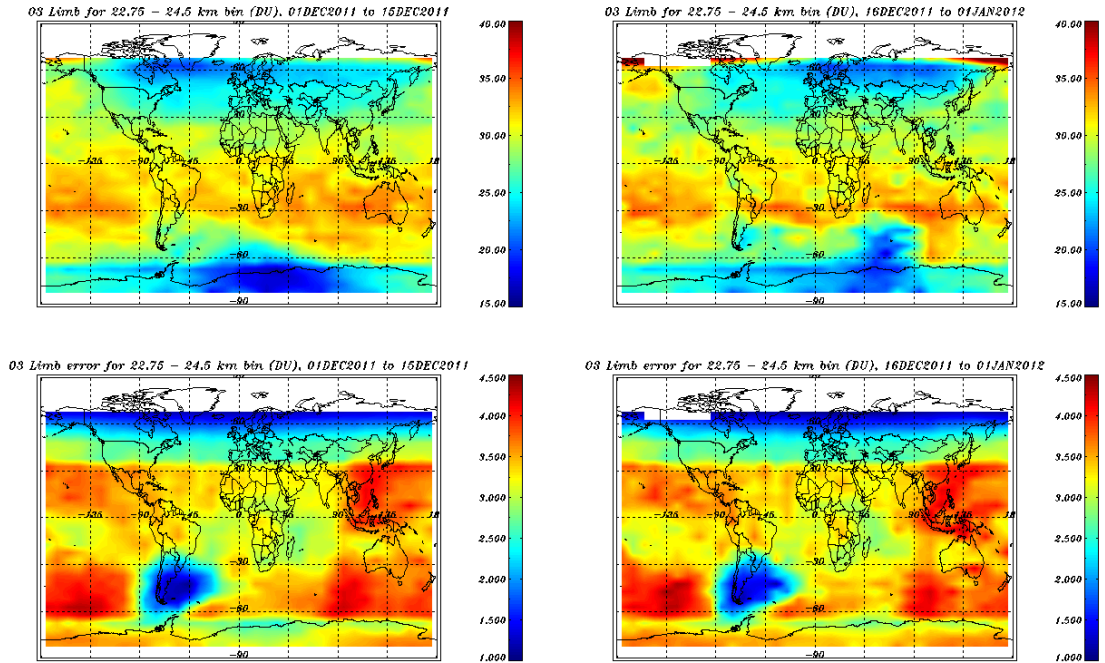


Figure 8.35: Limb Ozone profiles binned over 22.75 – 24.5 km, December 2011.

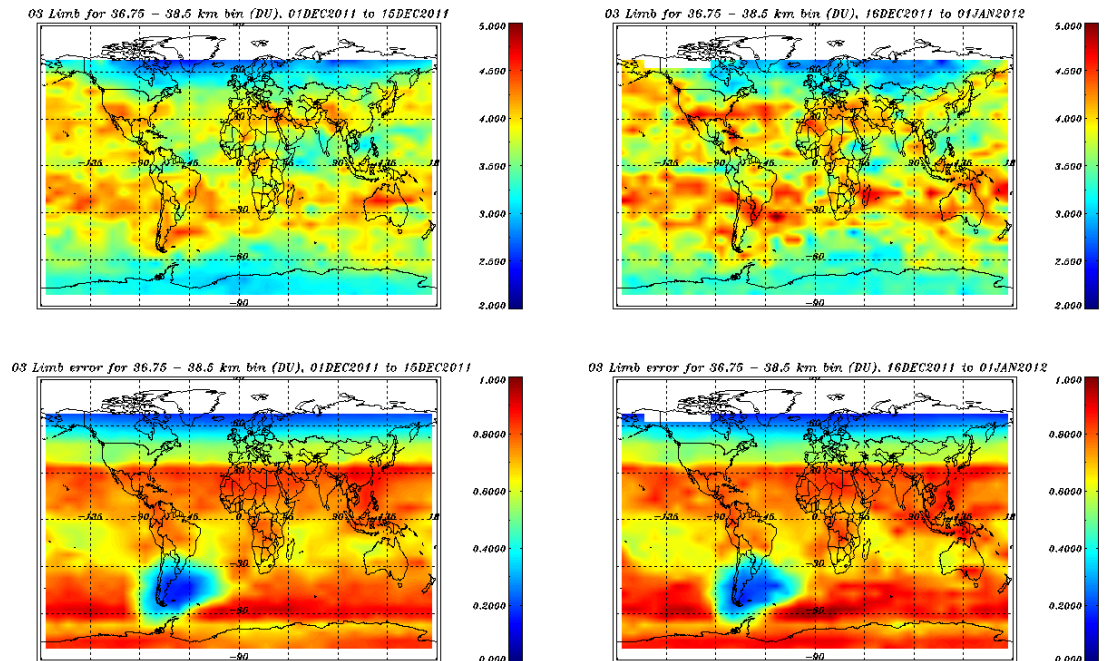


Figure 8.36: Limb Ozone profiles binned over 36.75 – 38.5 km, December 2011.

### 8.2.9 Limb: NO<sub>2</sub> profile averages

Analogous as for the limb Ozone profiles monthly averages for NO<sub>2</sub> limb averages were generated. For the new Level 2 products version 5.01, the tangent height region chosen is:

- 24.5-26.25 km.

As for the ozone averages the data of the first half of each month (calendar days 1 - 15) and the second half (calendar days 16 - 31) are averaged for selected tangent heights into geo-location bins of 10 degrees longitude and 5 degrees latitude. The binning algorithm used is the same as the described in 8.2.8. The corresponding error is averaged as well.

Figures 8.37 and 8.38 show the results for the months of November and December 2011 respectively.



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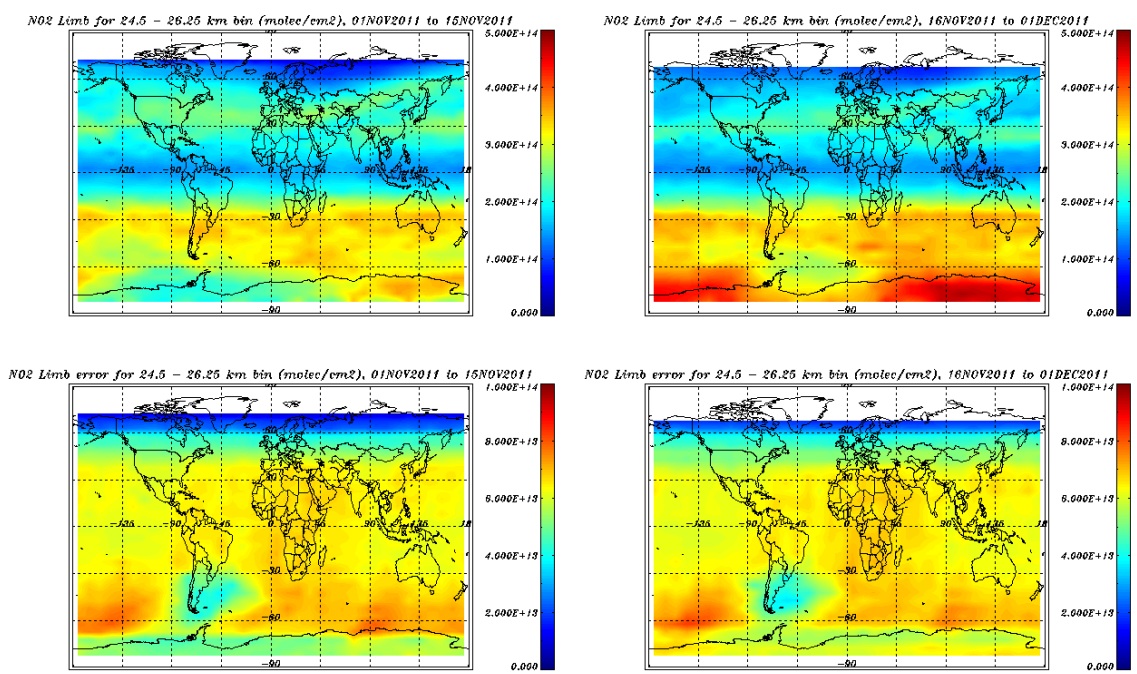


Figure 8.37: Limb NO<sub>2</sub> profiles binned over 24.5 – 26.25 km, November 2011.

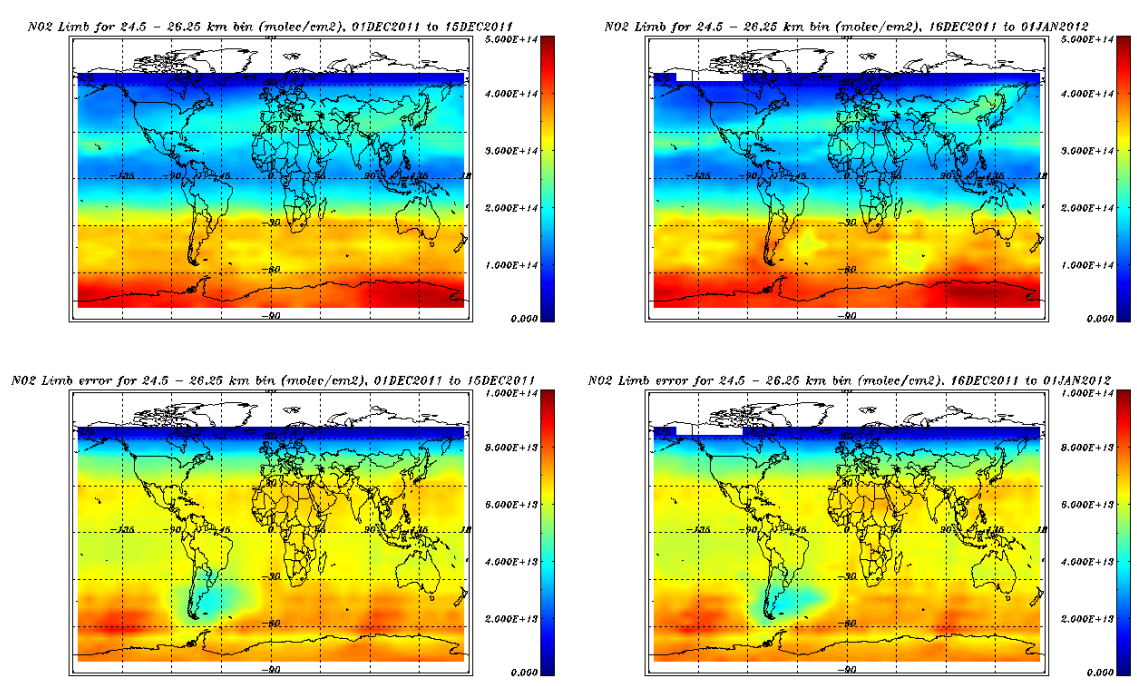


Figure 8.38: Limb NO<sub>2</sub> profiles binned over 24.5 – 26.25 km, December 2011.

### 8.2.10 Limb: BrO profile averages

Analogous as for the limb O<sub>3</sub> and NO<sub>2</sub> profiles, monthly averages of BrO limb profiles were generated. The tangent height region chosen is:

- 24.5-26.25 km.

As for the ozone averages, data of the first half of each month (calendar days 1 - 15) and the second half (calendar days 16 - 31) are averaged for selected tangent heights into geolocation bins of 10 degrees longitude and 5 degrees latitude. The binning algorithm used is the same as the described in Section 8.2.8. The corresponding error is averaged as well.

Figure 8.39 and Figure 8.40 show the results for the months of November and December 2011 respectively.



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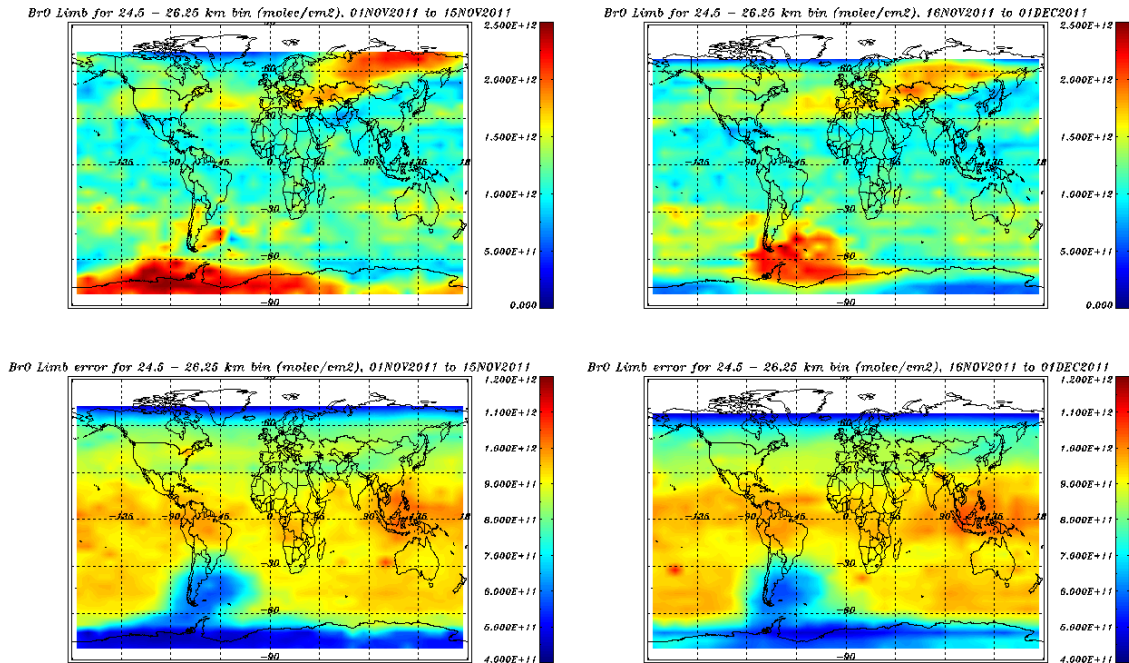


Figure 8.39: Limb BrO profiles binned over 24.5 – 26.25 km, November 2011.

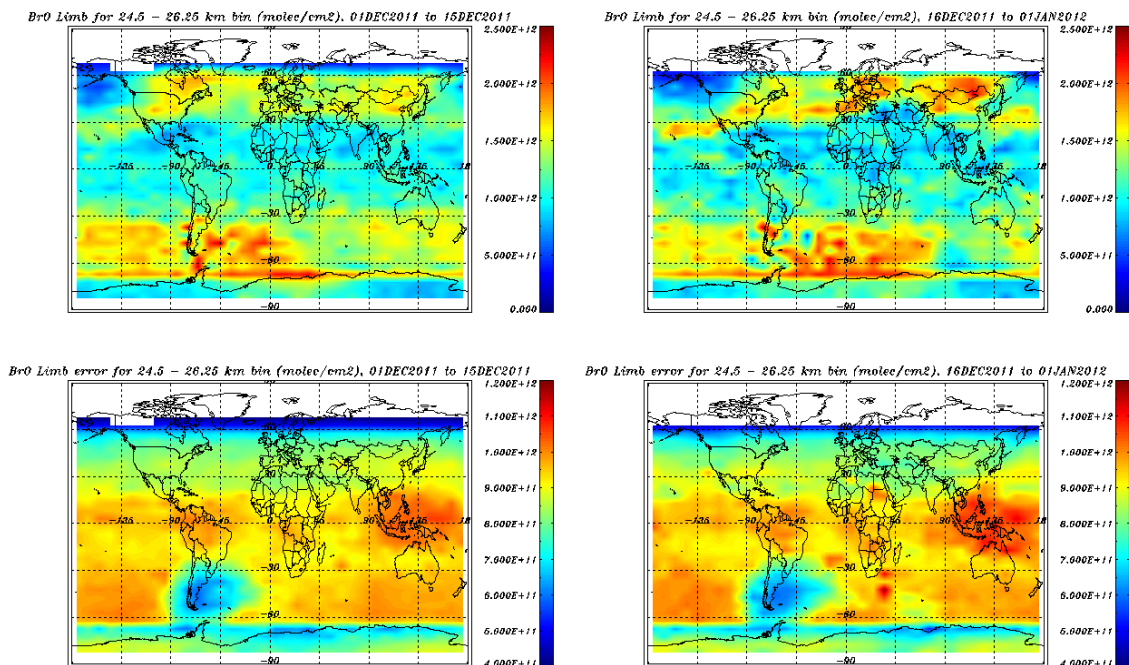


Figure 8.40: Limb BrO profiles binned over 24.5 – 26.25 km, December 2011.

## 9 VALIDATION ACTIVITIES AND RESULTS

Validation activities of Level 1b version 7.04 and Level 2 version 5.02 products are currently on-going.

Validation is performed on the basis of a validation data set covering selected orbits identified by the core validation teams for the complete mission and the forward processed data.

Validation of products from the previous re-processing campaigns was performed by the SCIAMACHY Validation and Interpretation Group (SCIAVALIG).

Results are published

- for Level 1b IPF 6.03 and Level 2 off-line processor 3.01 at

[http://www.sciamachy.org/validation/documentation/technotes/SCIAVALIG/Summary\\_operational\\_product\\_quality\\_20080326.pdf](http://www.sciamachy.org/validation/documentation/technotes/SCIAVALIG/Summary_operational_product_quality_20080326.pdf)

- for Level 1b IPF 7.03 and Level 2 off-line processor 5.01 at

[https://earth.esa.int/c/document\\_library/get\\_file?folderId=42594&name=DLFE-674.pdf](https://earth.esa.int/c/document_library/get_file?folderId=42594&name=DLFE-674.pdf)