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SCIAMACHY Bi-MONTHLY Report: March - April 2009

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SCIAMACHY Bi-monthly Report March - April 2009

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;
- Data Availability Statistics;
- Level 1 Product Quality Monitoring;
- Level 2 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 3, Rev: K, Gianni Sotis, 06 May 2006
[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] 'Summary of the Atmospheric Chemistry Instrument Validation results as presented at the ACVE-3 Workshop', Paul Snoeij, Ankie Piters, Herbert Fischer, Yasjka Meijer, Jean-Christopher Lambert, Thorsten Fehr
[7] 'SCIAMACHY Extra Misalignment Model', PO-TN-DLR-SH-0016 Issue 1, M. Gottwald, E. Krieg, DLR-IMF, C. von Savigny, S. Noël, K. Bramstedt IUP-IFE, 07 March 2007
[8] 'Verification of the extra misalignment correction in the SCIAMACHY IPF 6.03 processor', TN-IUP/IFE-2007-cvs-02, C. von Savigny, A. Dehn, H. Bovensmann, J. Steinwagner IUP-IFE, 05 July 2007
[9] 'SCIAMACHY SciCal Tool Change of Leakage ADF generation' ENV-TN-DLR-SCIA-0094, Issue 1.0, Bernd Aberle, Günter Lichtenberg, 08 November 2007

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
DPQC	Data Processing Quality Control
EOL	End of Life
ESM	Elevation Scan Mechanism
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
MR	Monthly Report
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
OCR	Operations Change Request
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
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

- During the reported period SCIAMACHY measurements were nominal with respect to planning, besides two unavailability period during following orbits:
  - 36647-36664 (04-05 March 2009) SCIAMACHY PMT_Tx buffer overflow
  - 37130-37137 (06-07 April 2009) ENVISAT planned OCM manoeuvre
  - 37438-37451 (28/29 April 2009) ENVISAT HSM Multiplexer anomaly
- An anomaly in the level 0 consolidation caused a wrong assignment of orbit numbers in a subset of about 3-12 products per month, starting from September 2008 until April 2009. The wrong orbits are consequently present as well in higher level products. The anomaly has been solved and corrective re-processing is currently on-going.
- Monthly Calibration was executed during Orbits:
  - 36726-36730 (09/10-Mar-2009)
  - 37141-37145 (07/08-Apr-2009)
- Occultation measurements with the moon rising on night side were executed during:
  - 36656-36735 (04-Mar-2009 until 10-Mar-2009)
  - 37076-37156 (03-Apr-2009 until 08-Apr-2009)
- One OCR_037 was implemented (slit width calibration to test Venus measurements) during orbits
  - 36873- 36876 (20-Mar-2009)
- No TC adjustments was required
- Light Path monitoring:
  - Channel 1&2: degradation in UV for all light paths involving ESM increases with a rate of about 1 % per month. The maximum average throughput loss in channel 1 is currently ca. 42%.
  - Channel 3 small throughput loss (about 4%)
  - Channels 4-7 remained stable

- Channel 8 throughput is decreased and lies now at ca. 70%

- PMD monitoring:
  - UV degradation visible in science channels is also visible in PMD 1 to 3
  - PMD 4 and 7 show a large decrease in throughput
  - PMD 6 results still under investigation

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 36601 (ANX = 01-Mar-2009, 00:43:19.172) to 37473 (ANX = 30-Apr-2009, 22:45:28.513). One OSDF specified the planning baseline.

Orbit		ANX		OSDF
Start	Stop	Start	Stop	
36601	37473	01-Mar-2009 00:43:19.172	30-Apr-2009 22:45:28.513	MPL_OSD_SHVSH_20090121_010101_00000000_35040001_20090301_004321_20090501_002602.N1

Table 3-1: SCIAMACHY OSDF planning files from March – April 2009

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 according to the mission scenarios. Regular monthly calibration was scheduled between orbits

- 36726-36730 (09/10-Mar-2009)
- 37141-37145 (07/08-Apr-2009)

The moon was in the limb TCFoV between orbits

- 36656-36758 (04-Mar-2009 until 11-Mar-2009)
- 37076-37193 (03-Apr-2009 until 11-Apr-2009)

Occultation measurements with the moon rising on the night side could be executed between orbits

- 36656-36735 (04-Mar-2009 until 10-Mar-2009)
- 37076-37156 (03-Apr-2009 until 08-Apr-2009)

Four blocks of *limb_mesosphere_thermosphere* measurements were scheduled.

Orbit		UTC		Remark
Start	Stop	Start	Stop	
36641	36656	03-Mar-2009 19:47:16	04-Mar-2009 20:56:15	
36916	36931	23-Mar-2009 00:51:56	24-Mar-2009 02:00:55	MIPAS upper atmosphere mode
37061	37076	02-Apr-2009 03:58:46	03-Apr-2009 05:07:45	
37345	37360	22-Apr-2009 00:08:49	23-Apr-2009 01:17:48	MIPAS upper atmosphere mode

Table 3-2: Scheduled *limb_mesosphere_thermosphere* measurements in March – April 2009

One OCR was successfully implemented. This was

- OCR_037 *(slit width calibration)*: Between orbits 36873-36876 (20-Mar-2009) Venus was observed prior to sunrise. It was a test run to ensure that Venus measurements are indeed feasible from a pointing/timing point of view and that the selected scanning approach supports the required slit width calibration. Based on the results of the Venus test execution the final slit width measurements are planned for June.

3.1.2 Instrument Measurement Status (SOST-DLR)

The final flight status for states and timelines remained unchanged.

3.1.3 Executed Operations and Measurements (SOST-DLR)

Measurements and instrument availability

The OSDF planning files have been scheduled as requested except for three periods:

- Orbit 36647-36664 (04/05-Mar-2009): Transfer to STANDBY due to a *PMTC_Tx buffer overflow* (likely SEU) followed by a *PMTC driver timeout* anomaly.
- Orbit 37130-37137 (06/07-Apr-2009): A planned orbit control manoeuvre (OCM) required a transfer to MEASUREMENT IDLE.
- Orbit 37438-37451 (28/29-Apr-2009): Due to a High Speed Multiplexer (HSM) anomaly corrupt data have been generated and the recovery included a brief transfer to HEATER.

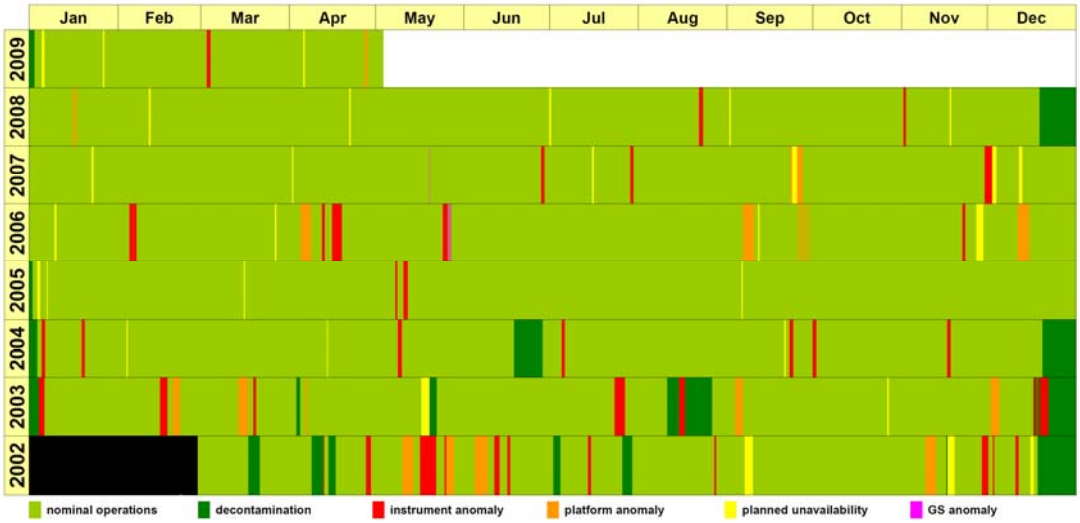


Fig. 3-1: Current instrument availability status including the reporting period

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.	36963	26-Mar-2009 09:02:54
37449	29-Apr-2009 07:53:56	ok	37450	29-Apr-2009 09:30:25

Table 3-3: APSM/NDFM health check and PMD ADC calibration

Anomalies

One major instrument (likely caused by a SEU) and one major platform anomaly (causing corrupt measurement data) had occurred.

- Transfer to STANDBY due to a *PMTC_Tx buffer overflow* (likely SEU) followed by a *PMTC driver timeout* anomaly. This double anomaly was similar to that experienced in August 2008. In total measurement data for orbits 36647-36664

(04-Mar-2009, 07:29:32 UTC to 05-Mar-2009, 11:38:32 UTC) could not be generated as planned.

- High Speed Multiplexer (HSM) anomaly: Similarly to the HSM anomaly in January 2008 measurement data for orbits 37438-37451 (28-Apr-2009, 13:02:00 UTC to 29-Apr-2009, 11:13:21 UTC) were either corrupt or missing (transfer to HEATER required during recovery).

Two short minor instrument anomalies were reported caused by 1 sec detector module latch-ups.

Orbit	Date	Entry - UTC	Level	Entry Type	ID Content/Transition	Mode	Remark
36603	01-MAR-2009	2009.060.05.19.30.910	Instrument	HK PARAMETER LIMIT EXCEEDING	1 (I6000)	MEASUREMENT	DM latchup (1 sec OOL), possible SEU
36647	04-MAR-2009	2009.063.07.29.22.907	INSTRUMENT	AUTONOMOUS SWITCHING	ID454 / goto HEATER/REFUSE	HTR/REF	PMTC_Tx_Buffer_Overflow
36647	04-MAR-2009	2009.063.07.29.29.274	INSTRUMENT	AUTONOMOUS SWITCHING	ID455 / goto STANDBY/REFUSE-I	STDBY/REF-I	PMTC_Driver_Timeout
36648	04-MAR-2009	2009.063.07.43.35.376	INSTRUMENT	MACROCOMMAND EXECUTION ENTRY	START TIMELINE	STDBY/REF-I	Complementary Failure
36648	04-MAR-2009	2009.063.07.43.35.383	INSTRUMENT	COMPLEMENTARY FAILURES	---	STDBY/REF-I	Complementary Failure
36648	04-MAR-2009	2009.063.07.43.35.387	INSTRUMENT	MACROCOMMAND EXECUTION ENTRY	START TIMELINE	STDBY/REF-I	Complementary Failure
36648	04-MAR-2009	2009.063.07.49.37.801	INSTRUMENT	MACROCOMMAND EXECUTION ENTRY	START TIMELINE	STDBY/REF-I	Complementary Failure
36648	04-MAR-2009	2009.063.07.49.37.813	INSTRUMENT	COMPLEMENTARY FAILURES	---	STDBY/REF-I	Complementary Failure
36648	04-MAR-2009	2009.063.07.49.37.813	INSTRUMENT	MACROCOMMAND EXECUTION ENTRY	START TIMELINE	STDBY/REF-I	Complementary Failure
36716	09-MAR-2009	2009.068.02.49.23.719	Instrument	HK PARAMETER LIMIT EXCEEDING	1 (I6000)	MEASUREMENT	DM latchup (1 sec OOL), possible SEU
37438	28-APR-2009	2009.118.13.02.00.000	ENVISAT	---	---	HEATER	HSM anomaly

Table 3-4: Instrument anomalies between March and April 2009

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. Fig. 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 temperature limits of each detector are shown as horizontal lines.

At the end of the reporting period detector 5 temperatures exceeded the upper limit. It was decided to tolerate elevated detector 5 temperatures up to about 0.5 K. This is the expected range until the seasonal maximum in early June.

OBM temperatures

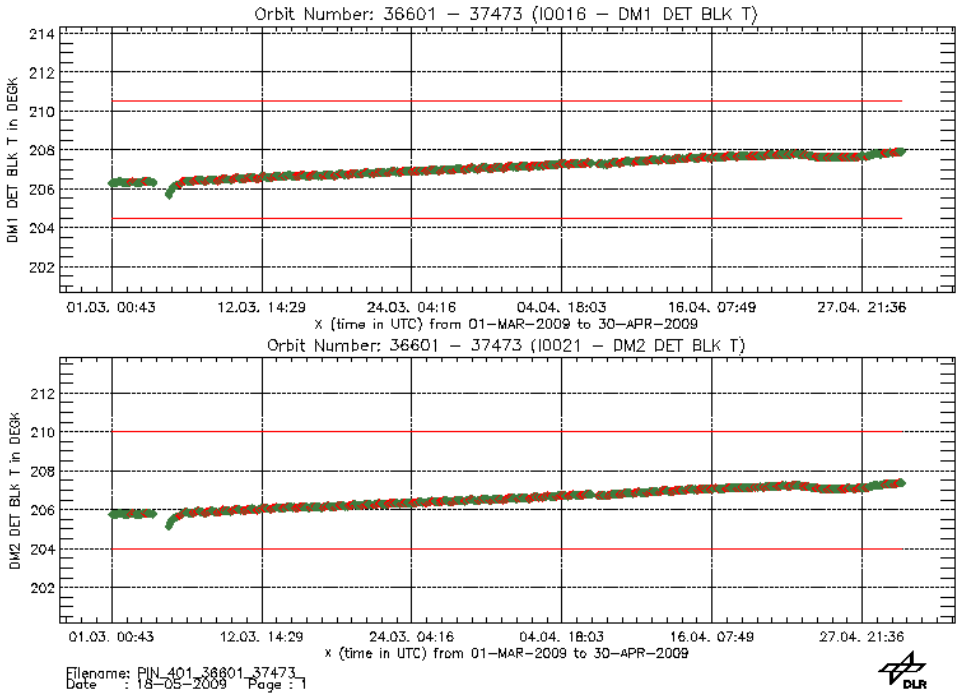
The average OBM temperature per orbit is determined from specific HK telemetry parameters. In addition power readings for the ATC heaters are monitored. Temperatures and ATC heater powers are given in Fig. 3-3 and 3-4. Colour coding is as in Fig. 3-2.

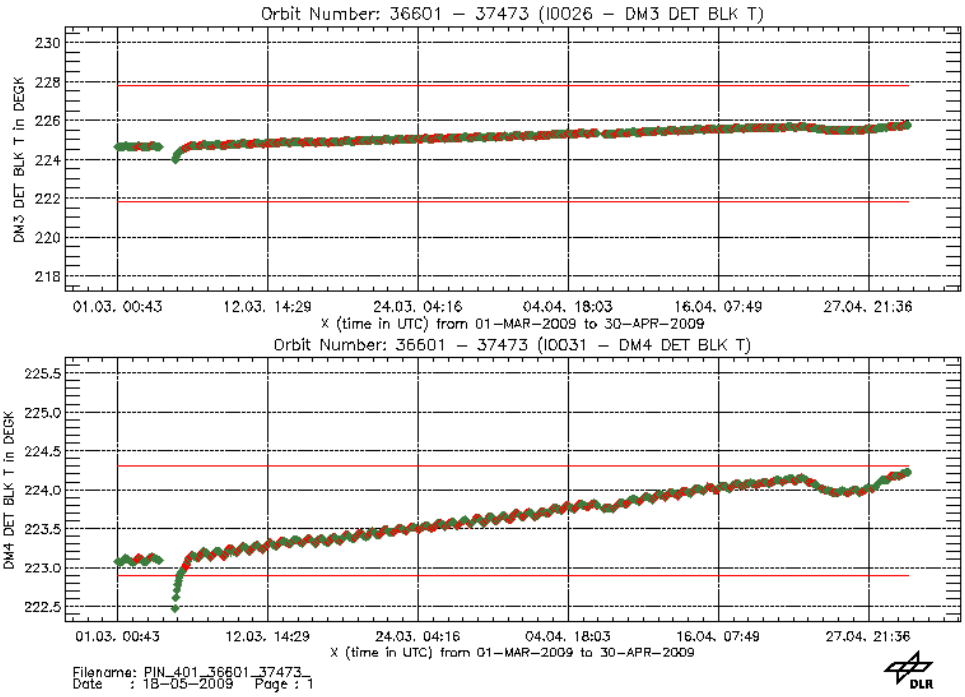
OBM temperatures and ATC heater powers remained within limits. The gap for orbits < 35873 in the OBM temperature graph is caused by the scale of the temperature axes. In the heater power display the maximum commanded power during NNDEC is obvious.

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.


Orbit Number: 36601 – 37473 (I0016 – DM1 DET BLK T)
DM1 DET BLK T in DEGK
214
212
210
208
206
204
202
01.03. 00:43
12.03. 14:29
24.03. 04:16
04.04. 18:03
16.04. 07:49
27.04. 21:36
X (time in UTC) from 01-MAR-2009 to 30-APR-2009
Orbit Number: 36601 – 37473 (I0021 – DM2 DET BLK T)
DM2 DET BLK T in DEGK
212
210
208
206
204
202
01.03. 00:43
12.03. 14:29
24.03. 04:16
04.04. 18:03
16.04. 07:49
27.04. 21:36
X (time in UTC) from 01-MAR-2009 to 30-APR-2009
Filename: PIN_401_36601_37473_
Date : 18-05-2009 Page : 1
DLR


Orbit Number: 36601 – 37473 (I0026 – DM3 DET BLK T)
DM3 DET BLK T in DEGK
230
228
226
224
222
220
218
01.03. 00:43
12.03. 14:29
24.03. 04:16
04.04. 18:03
16.04. 07:49
27.04. 21:36
X (time in UTC) from 01-MAR-2009 to 30-APR-2009
Orbit Number: 36601 – 37473 (I0031 – DM4 DET BLK T)
DM4 DET BLK T in DEGK
225.5
225.0
224.5
224.0
223.5
223.0
222.5
01.03. 00:43
12.03. 14:29
24.03. 04:16
04.04. 18:03
16.04. 07:49
27.04. 21:36
X (time in UTC) from 01-MAR-2009 to 30-APR-2009
Filename: PIN_401_36601_37473_
Date : 18-05-2009 Page : 1
DLR

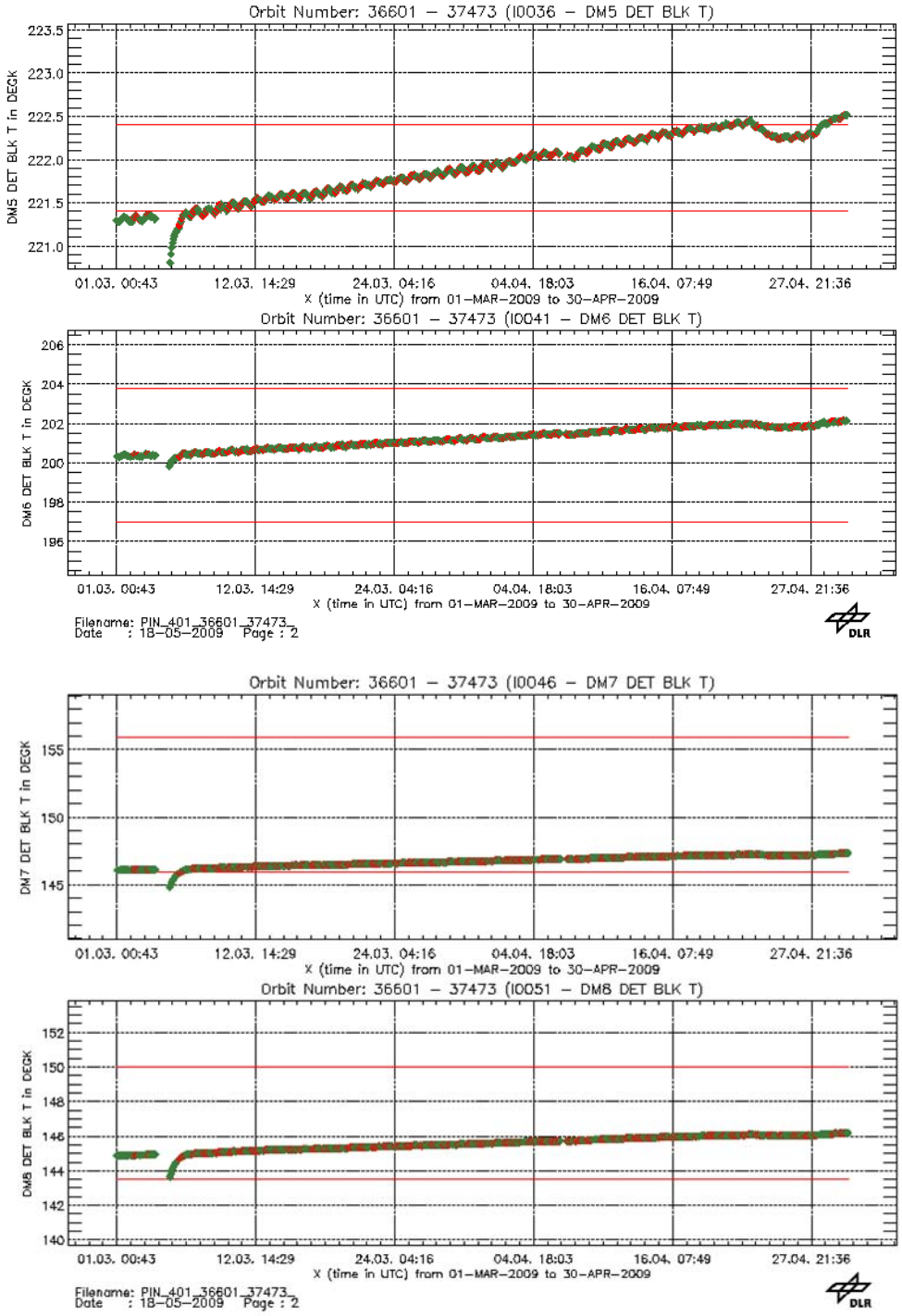


Fig. 3-2: Detector temperatures

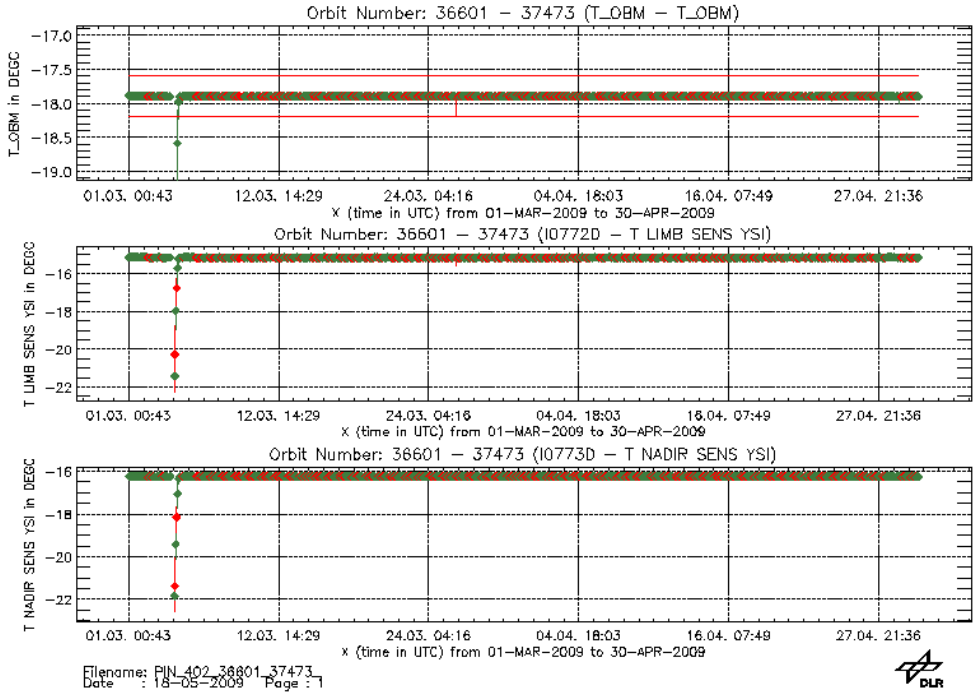


Fig. 3-3: OBM temperatures (top: derived OBM, middle: limb sensor, bottom: nadir sensor)

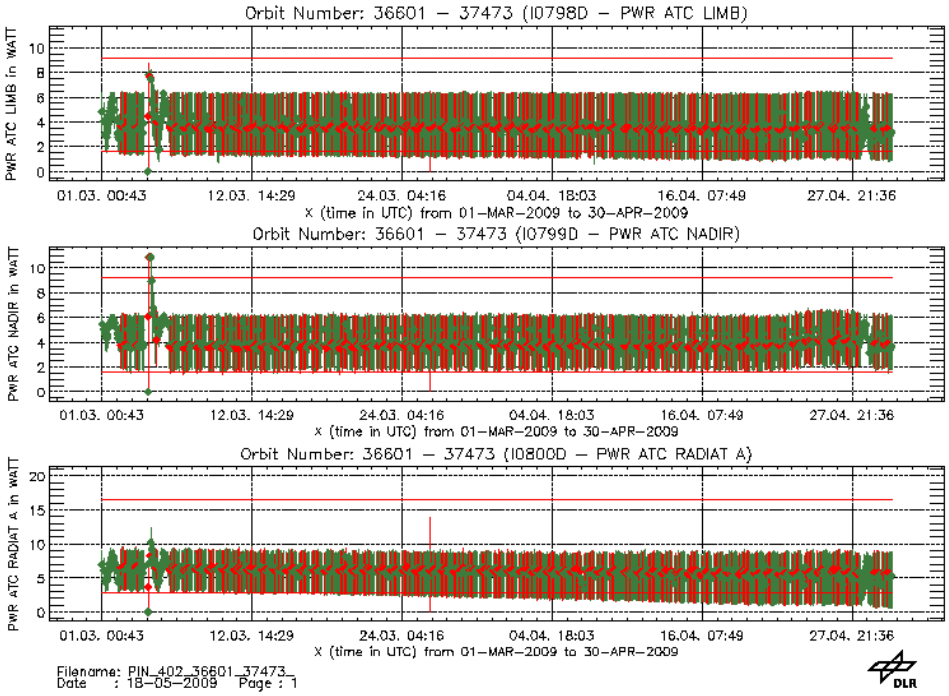


Fig. 3-4: ATC heater power (top: ATC limb, middle: ATC nadir, bottom: ATC Rad A)

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: 0.48
- APSM: 0.44
- NCWM (sub-solar port): 0.80
- WLS (switches): 0.15
- WLS (burning time): 0.29
- SLS (switches): 0.06
- SLS (burning time): 0.02

For the NDFM and APSM the safety margin factor of 2 was no longer applied in the calculation of the fractional usage since it was found acceptable to stay below the figures of the life-tests. How the relative LLI usage has accumulated since launch can be seen in fig. 3-5. 'EOL' assumes a total mission lifetime until end of 2013.

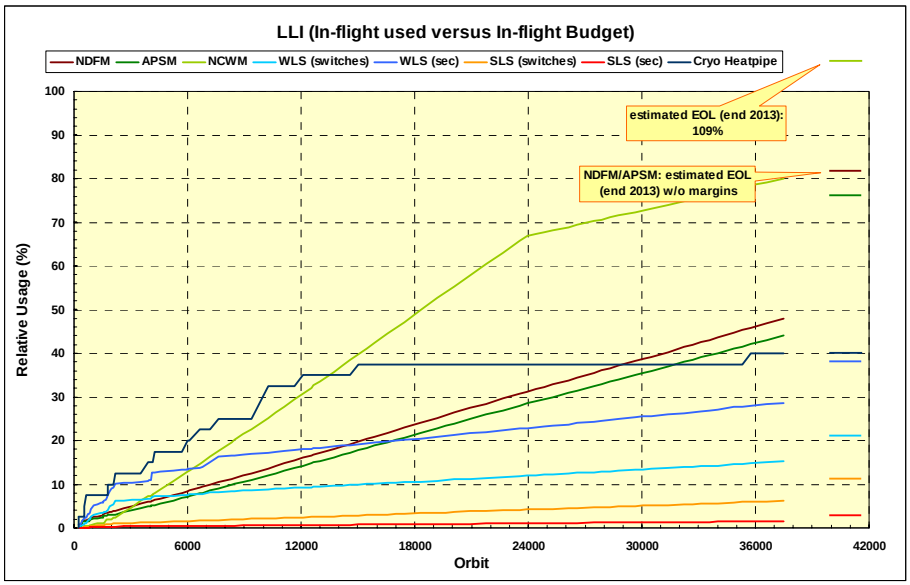


Fig. 3-5: Relative usage of LLIs. 'EOL' is derived for a mission lifetime until 2013. For the NDFM and APSM no margin factors have been applied to derive the EOL relative usage.

Note that the NCWM usage exceeding 100% by the end of 2013 will be adjusted once the second phase of the mission extension has started in 2010.

The number of cryogenic heatpipe cycles did not increase (decontamination was already included in the November-December report). 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 < ±10 sec. In some cases this value may even reach ±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 w.r.t. the reference orbit, then the difference *predicted – reference time* is > 0 sec; in the other case it is < 0 sec.

Fig. 3-6 displays the time difference *predicted – reference*. Orbit manouevres cause distinct discontinuities.

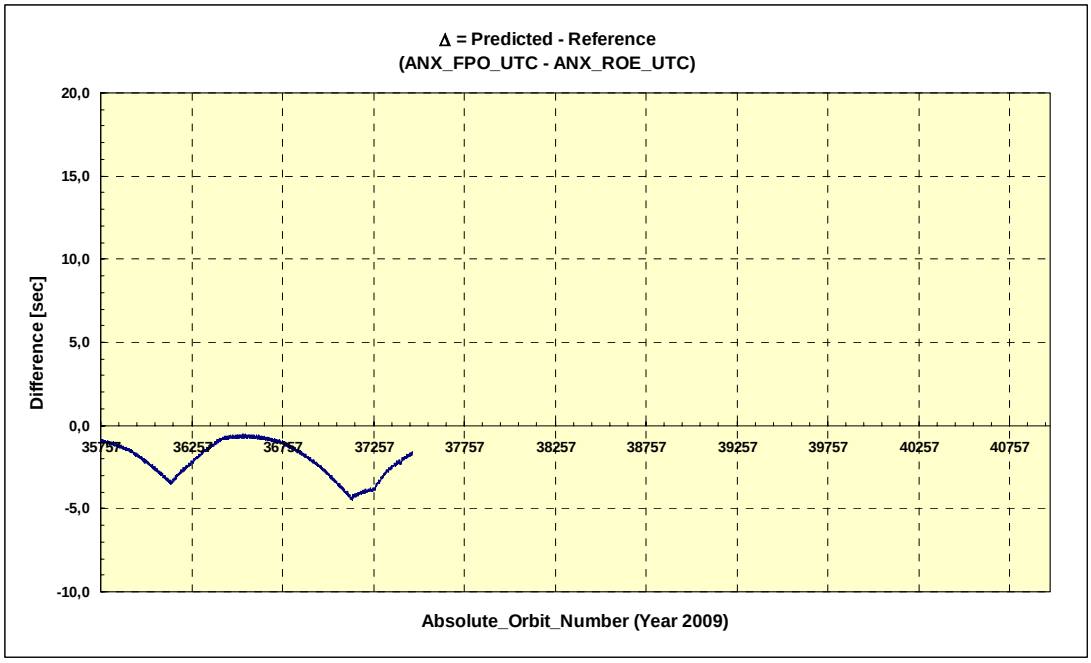


Fig. 3-6: Time difference between predicted and reference time.

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 subsolar 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 Fig. 3.7 show results of these monitoring activities for the time interval March to April 2009.
Note that the reported channel averages are medians. The currently used scan angle correction is based on V6 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 will be 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:

- Overall the instrument behaved as expected.
- Channel 2 shows some slight jumps in throughput end of March and end of April which are currently unexplained.
- The gap on 5/6 March 2009 is due to an instrument anomaly during that time.
- The degradation rate in the UV (channels 1 & 2) remains at about 1% per month, two times the rate before the decontamination December 2008/January 2009.
- The minimum average throughput in channel 1 lies currently around 42% (for the limb light path). The throughput of the calibration light path is currently at about 80% in channel 1 and 83% in channel 2.
- The overall degradation of channel 3 is very small (still about 4%) compared to channels 1 and 2. A small decrease in throughput of about 0.5% is observed within the two months of this report.
- Channel 4 to 7 remained stable except from some remaining seasonal variations, especially visible in the calibration light path.

- The channel 8 throughput is still decreasing (but with a slower rate) and lies currently for all light paths at around 70%.

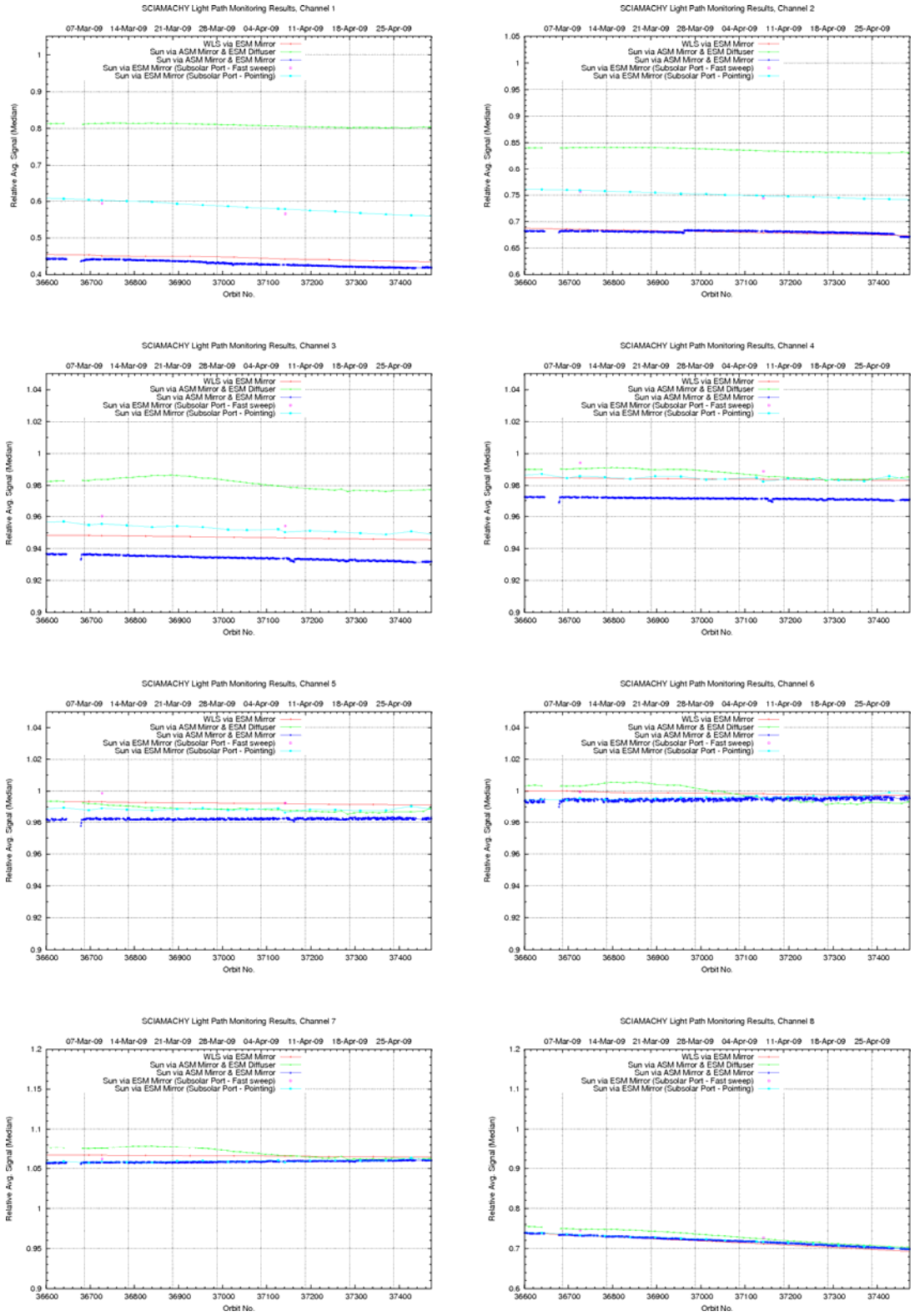


Fig. 3.7: Light path monitoring results March to April 2009 (medians).

3.1.5.2 Spectral light path monitoring results

Fig. 3.8 – 3.11 show results of spectral throughput monitoring performed by SOST-IFE for the different light paths (nadir, limb, calibration, and WLS). These results have been derived from Level 0 data analysed in a similar way as for the channel averaged throughput data (but of course without spectral averaging). Because the variation in spectral direction is very small within two months, Fig. 3.8 – 3.11 show the complete time series from 2 August 2002 to the end of April 2009.
Note that the colour scale of the plots is different from previous reports.

The underlying data for the spectral monitoring are available via the SOST-IFE web site (see http://www.iup.uni-bremen.de/sciamachy/LTM/LTM_spectral/LTM_spectral.html). As for the plotted results, these data are regularly updated (since January 2009 on a daily basis).

The current status of the degradation is as follows:

- The minimum throughput is below 40% for the limb and WLS (nadir) light paths at the short wavelength edge of channel 1 (i.e. below about 260 nm).
- The minimum throughput at the degradation peak around 350 nm in channel 2 is currently about 50%.
- The minimum throughput at the lower wavelength edge of channel 3 is currently about 80% (not considering the overlaps).
- Channels 4 to 7 are still stable over the whole spectral range (except for the overlaps).
- Channel 8 throughput still decreases.

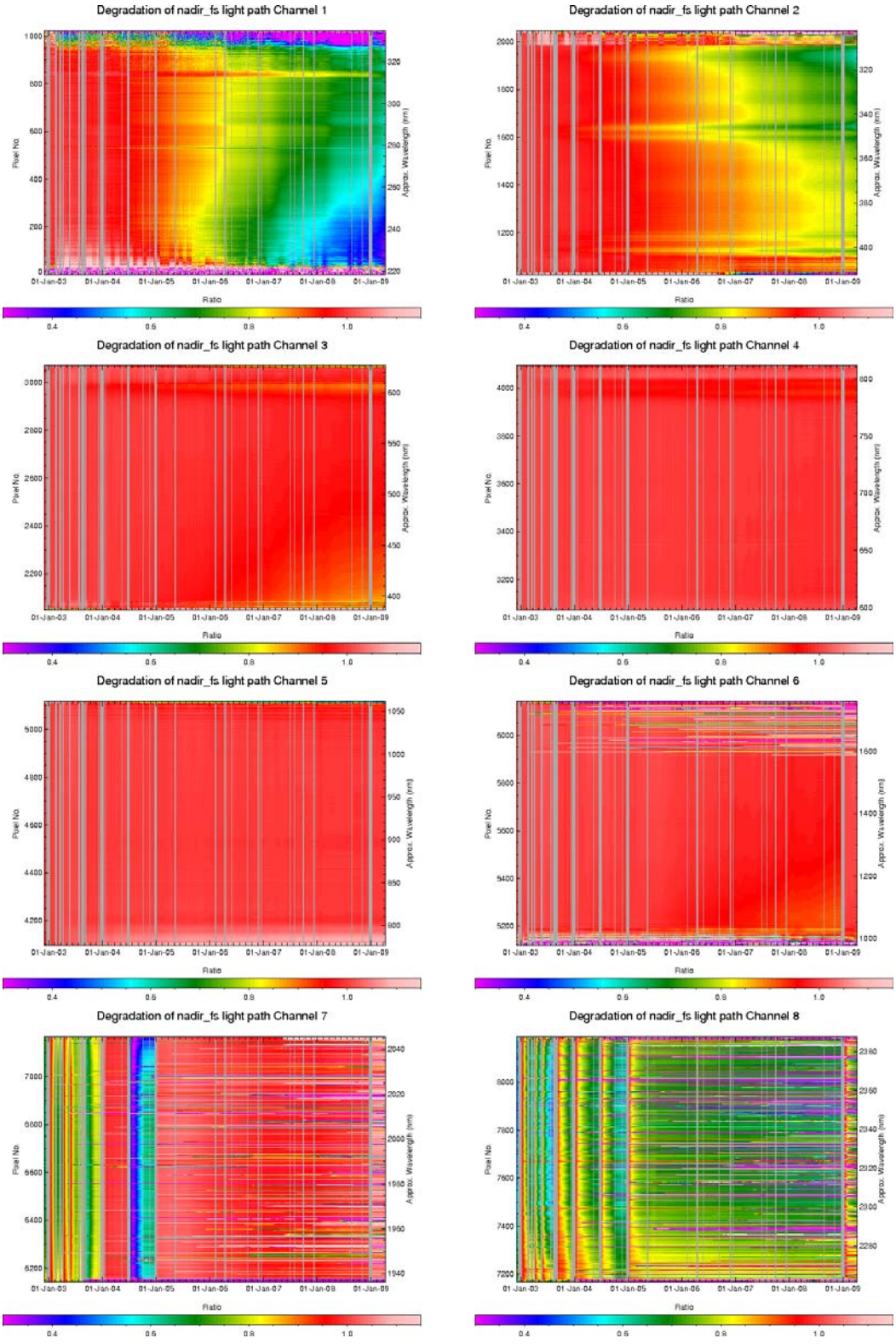


Fig. 3.8: Spectral light path monitoring results August 2002 to April 2009 (nadir light path)

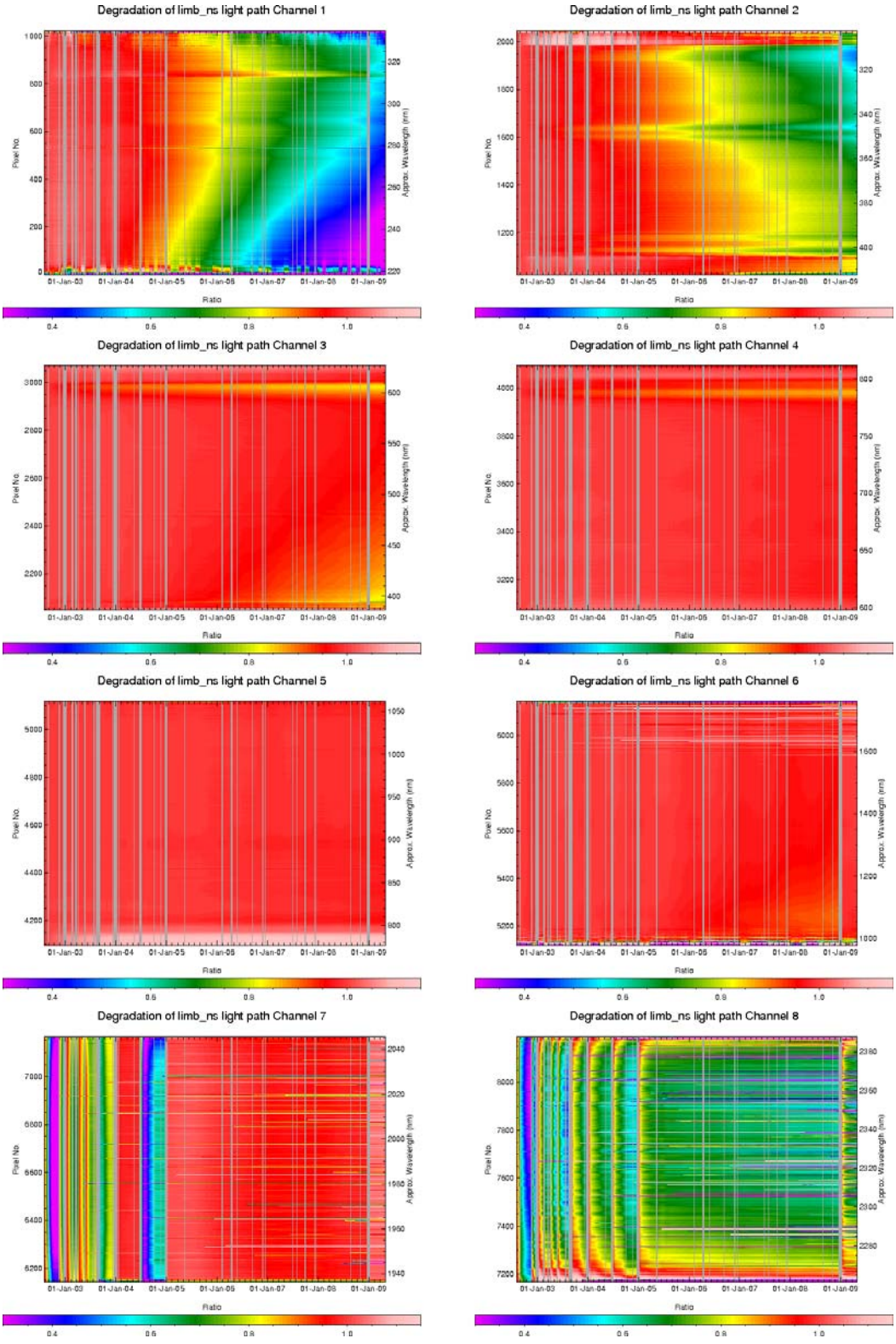


Fig. 3.9: Spectral light path monitoring results August 2002 to April 2009 (limb light path)

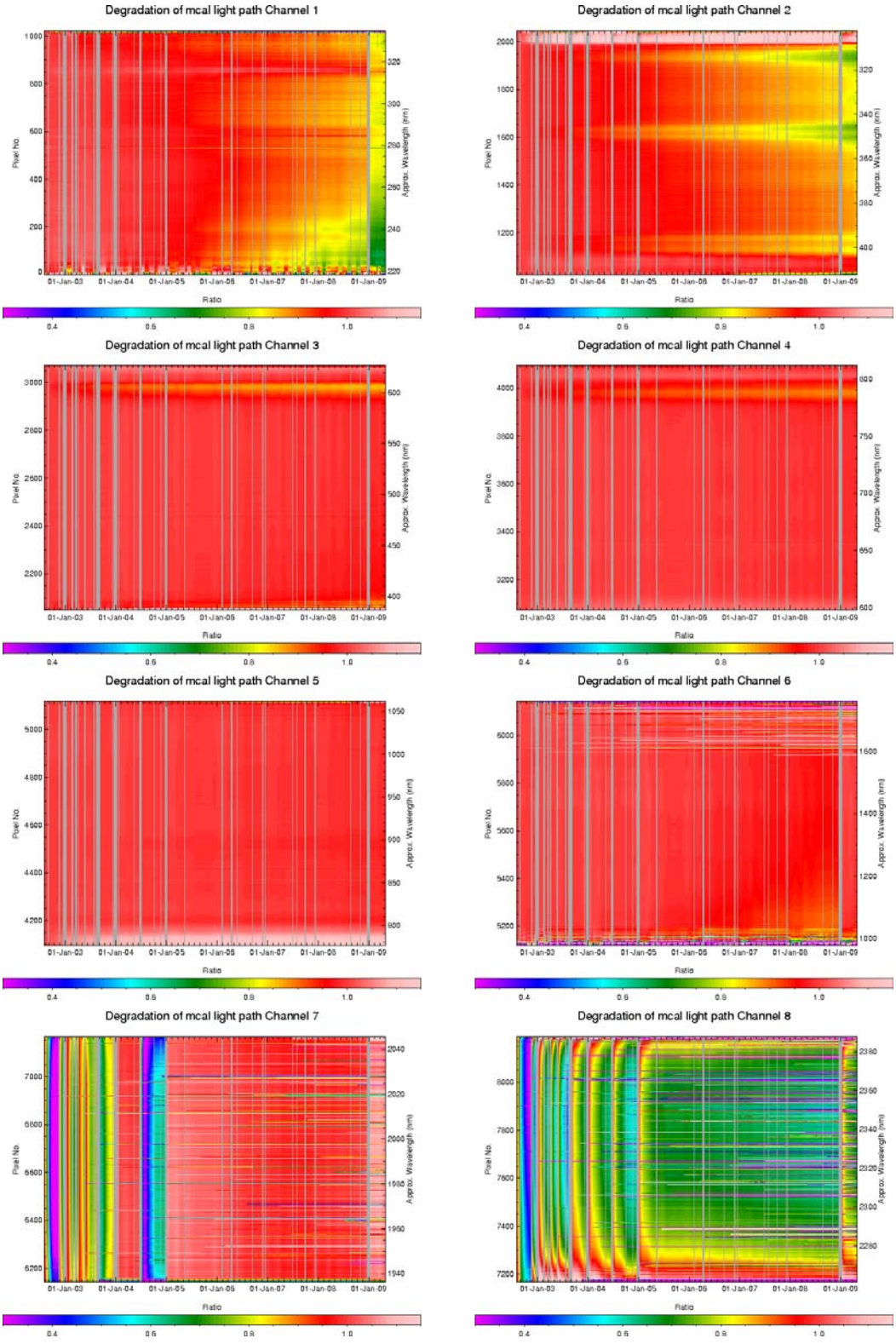


Fig. 3.10: Spectral light path monitoring results August 2002 to April 2009 (calibration light path)

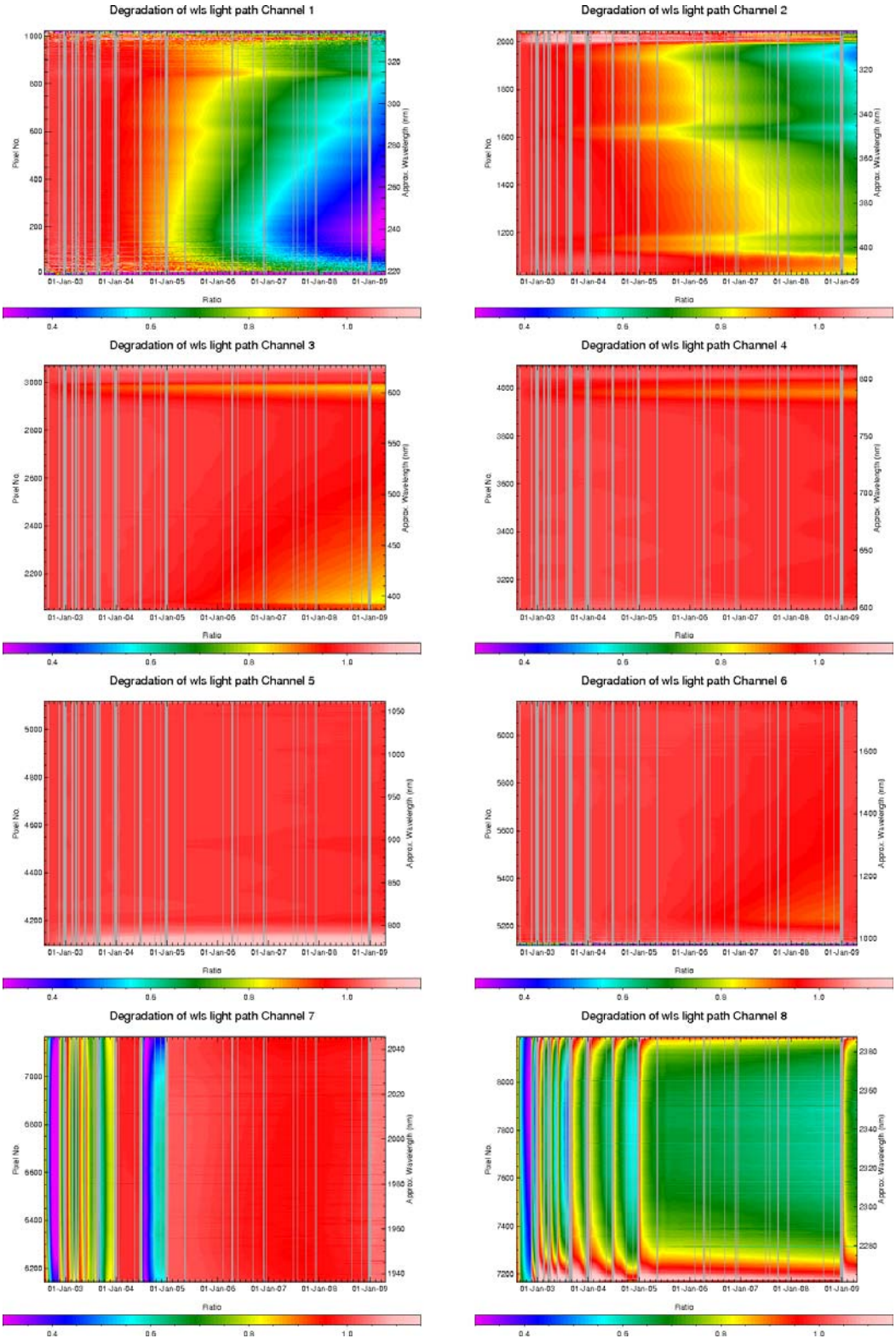


Fig. 3.11: Spectral light path monitoring results August 2002 to April 2009 (WLS light path)

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. Fig. 3.12 shows the PMD throughput variation for the whole time period between 2 August 2002 and 30 April 2009. Note that a constant dark signal for each of the PMDs has been assumed. To verify this assumption, Fig. 3.12 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.

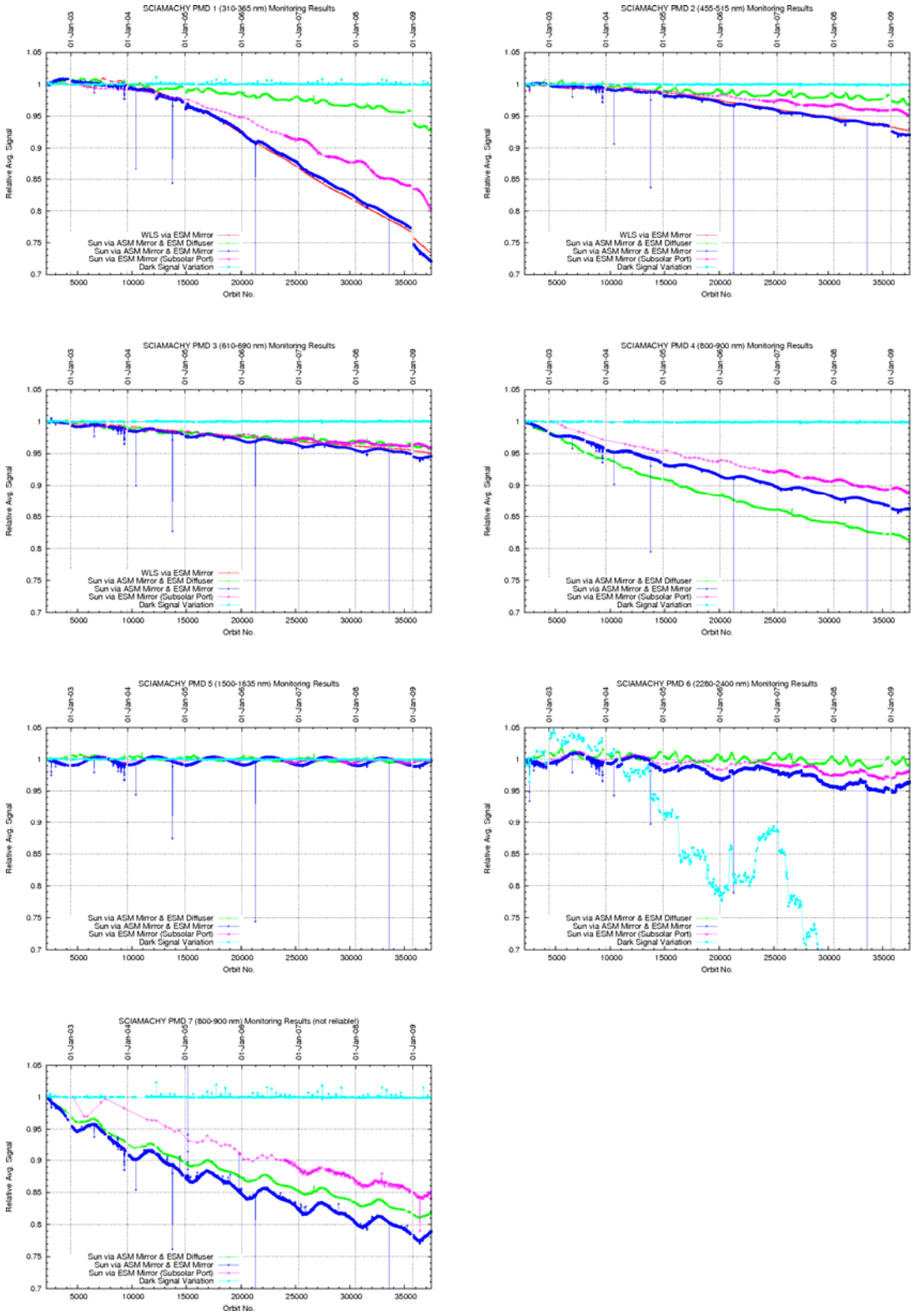


Fig. 3.12: PMD monitoring results August 2002 to April 2009

4 DATA AVAILABILITY STATISTICS

4.1 Downlink/Acquisition Performance

Problems are known for the products listed in Tab. 4.1:

Product	Day	Filename	description
SCI_NL__0P	17-MAR-2009	SCI_NL__0PNPDK20090317_111057_000060232077_00209_36836_0984.N1	sciamachy_source_packets ERROR: incorrect file size
SCI_NL__0P	19-MAR-2009	SCI_NL__0PNPDE20090319_195835_000000002077_00243_36870_8704.N1 SCI_NL__0PNPDE20090319_200405_000000002077_00243_36870_8773.N1	sciamachy_source_packets ERROR: incorrect file size
SCI_NL__0P	20-MAR-2009	SCI_NL__0PNPDK20090320_112018_000057992077_00252_36879_1011.N1	sciamachy_source_packets ERROR: incorrect file size
SCI_NL__0P	22-MAR-2009	SCI_NL__0PNPDK20090322_115330_000060232077_00281_36908_1029.N1	sciamachy_source_packets ERROR: incorrect file size
SCI_NL__0P	29-MAR-2009	SCI_NL__0PNPDK20090329_081224_000062162077_00379_37006_1127.N1 SCI_NL__0PNPDK20090329_085148_000000412077_00379_37006_1099.N1 SCI_NL__0PNPDK20090329_085256_000000242077_00379_37006_1115.N1 SCI_NL__0PNPDK20090329_145145_000057182077_00383_37010_1124.N1	sciamachy_source_packets ERROR: incorrect file size
SCI_NL__0P	01-APR-2009	SCI_NL__0PNPDK20090401_113956_000059802077_00424_37051_1150.N1 SCI_NL__0PNPDK20090401_145658_000059242077_00426_37053_1152.N1	sciamachy_source_packets ERROR: incorrect file size
SCI_NL__0P	07-APR-2009	SCI_NL__0PNPDK20090407_164419_000060572078_00012_37140_1204.N1	sciamachy_source_packets ERROR: incorrect file size
SCI_NL__0P	10-APR-2009	SCI_NL__0PNPDK20090410_164959_000060432078_00055_37183_1233.N1	sciamachy_source_packets ERROR: incorrect file size
SCI_NL__0P	16-APR-2009	SCI_NL__0PNPDK20090416_120715_000060482078_00138_37266_1285.N1	sciamachy_source_packets ERROR: incorrect file size
SCI_NL__0P	26-APR-2009	SCI_NL__0PNPDK20090426_164436_000060532078_00284_37412_1381.N1	sciamachy_source_packets ERROR: incorrect file size
SCI_NL__0P	27-APR-2009	SCI_NL__0PNPDK20090427_130057_000059802078_00296_37424_1387.N1	sciamachy_source_packets ERROR: incorrect file size
SCI_NL__0P	28-APR-2009	SCI_NL__0PNPDK20090428_091009_000059802078_00308_37436_1393.N1	sciamachy_source_packets ERROR: incorrect file size

Table 4-1 Products containing format errors

4.2 Statistics on unconsolidated data (SCI_NL__0P, SCI_NL__1P)

This paragraph reports the availability of NRT data on a monthly basis. The statistics are based on level 0 data 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.

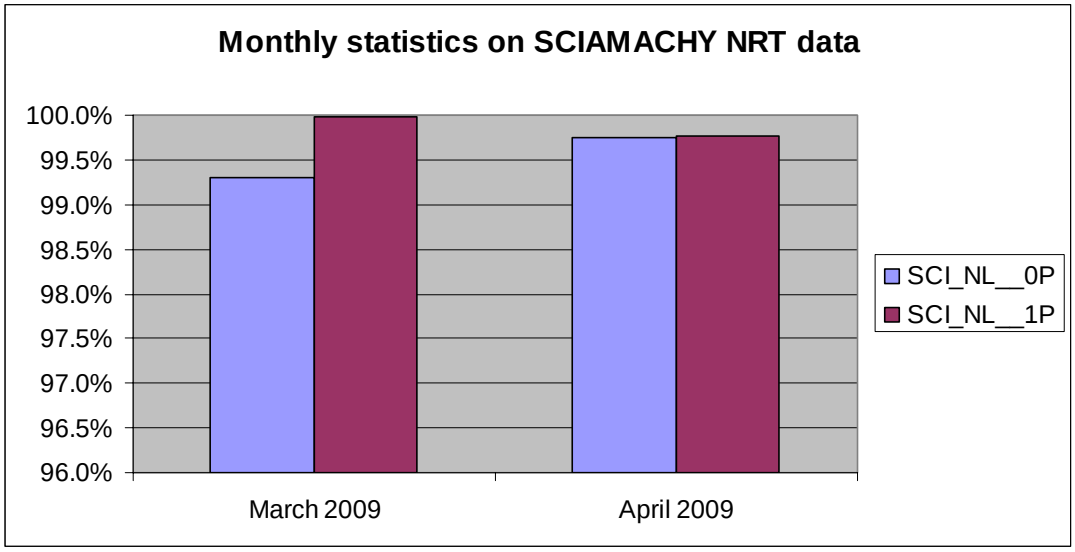


Fig. 4-1: Statistics on available unconsolidated level 0 and level 1b products

4.3 Statistics on consolidated data

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

4.3.1 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. Following specific problems have been identified and are reported in detail in the technical notes *[3]*, *[4]* for years 2003 and 2004 as well as for products of 2005 *[5]*:

- For one orbit there can be more than one consolidated level 0 product. These products may be identical or different in content (disregarding the product type file counter).
- Some orbits are not covered by consolidated level 0 products although SCIAMACHY was operational.
- Some orbits are covered by consolidated level 0 products but the product duration does not comply with the actually planned and executed instrument operations in that particular orbit.
- Some consolidated level 0 products exceed the Reed Solomon correction threshold and are flagged accordingly. The occurrence of Reed Solomon errors is non-uniform.
- Until late October / early November 2003 consolidated level 0 data are hampered by an incorrect orbit number.

More details on consolidated level 0 anomalies can be found on the SOST web page, which contains a catalogue of available level 0 consolidated data and description of errors.
http://atmos.caf.dlr.de/projects/scops/data_availability/availability.html

A recovery plan was initiated in order to reprocess erroneous data 2002 - 2007. This activity has been completed. For the year 2008 the recovery is currently being performed.

The overall goal is to achieve a level 0 consolidated data 'master set' that allows data reprocessing of improved data quality.

4.3.2 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 checked for completeness and an overview for the months March - April 2009 is summarised here, considering flight segment and ground segment anomalies. Note that also interfile gaps are considered, but no data gaps inside the products. Both months show a comparably large number of missing products. In March data products for days 03 and10 are partially missing and for day 31 they are fully missing. For day 31 March the corresponding restituted Attitude file (AUX_FRA) had not been available. In April for day 08 no level 1b were processed, which is under investigation currently as well as the other occasions in March.

Besides the missing orbits an anomaly in the data consolidation process had been detected and corrected. The anomaly occurred in wrong assignment of Orbit numbers in a subset of orbits per month. This anomaly had started in September 2008 until 22 April 2009, when the misbehaviour was corrected. About 3 to 12 orbits per month were impacted. Currently corrective activities related to reprocessing of these products are on-going and the full list of products will be reported in the next BMR.

The FTP address accessing the data server at D-PAC is 195.37.183.37.

Month/Year	Planned orbit range	Number of orbits unavailable due to anomalies	Number of unique orbits available at D-PAC	Expected number of orbits (considering anomalies)	Availability in percentage during month
03/2009	36601 - 37044	16	390	428	90.6 %
04/2009	37045 - 37473	19	393	410	95.8%

Table 4-2 Consolidated level 1b statistics

4.4 Statistics on reprocessed data

4.4.1 Level 1b re-processing

The next re-processing is planned to be started during 2009 with the new IPF 7.00 (LINUX processor).
IPF 7.00 will include the following changes compared to the operational IPF 6.03:

- Straylight Matrix in Channel 2
- Limb mesosphere/thermosphere measurement written to Limb MDS
- Correction of the Scanner encoding values

4.4.2 Level 2 re-processing

The quality of the data reprocessed with off-line processor version 3.01 has been checked and can be viewed via the daily level 2 reports that are made available at http://earth.esa.int/pcs/envisat/sciamachy/reports/daily/Level_2/

The next re-processing cycle is planned to be started during 2009 with the new processor version 5.00 instead of version 4.00, as already significant progress on the new baseline has been made.
The new processor version introduces the following changes compared to the operational processor:

- M-Factors implemented in Level 1b-2 processing step
- Changes in the NO2 retrieval settings
- New AAI algorithm
- Improvements in Limb retrieval
- Nadir SO2 total columns
- Nadir BrO total columns
- Nadir H2O total columns
- Nadir xCO columns
- Nadir OClO slant columns
- Limb BrO profile
- Limb Cloud product

5 LEVEL 1 PRODUCT QUALITY MONITORING

5.1 Processor Configuration

5.1.1 Version

The operational IPF version used for processing of near real-time SCIAMACHY level 1b data is 6.03 at Kiruna and ESRIN. The same IPF is used for level 1b off-line processing at D-PAC for forward processing.

The corresponding product specification is Volume 15 issue 3/k *[2]*. It is available at http://earth.esa.int/pub/ESA_DOC/ENVISAT/Vol15_Sciamachy_3k.pdf

The disclaimer at http://envisat.esa.int/dataproducts/availability/disclaimers/SCI_NL__1P_Disclaimers.pdf describes known artefacts as well as major improvements with respect to the previous IPF version.

The new baseline 7.00 has been implemented by industry and is currently under acceptance testing.
Table 5.1 gives a brief overview of changes implemented with processor versions IPF 6.03, 6.02, 6.01 and 5.04/5.01.

IPF Version	Description	Proc Centre	Date	Start Orbit
6.03	Following changes are implemented with IPF 6.03 • New pointing correction (new SCI_LI1_AX) • Updated of the ESA CFI (5.6) software • Correction of a non compliancy report, impacting the Leakage GADS in the consolidated data processing chain (channels 6-8)	D-PAC	04-JUL-2007	27937
		PDHS-E	19-JUL-2007	28153
		PDHS-K	19-JUL-2007	28145
6.02	No algorithm specification changes were implemented, but following non compliances of version 6.01 have been corrected, to get • Polarisation correction factors different from 0 • Correct order of SMR spectra in Sun Reference ADS	D-PAC	05-MAY-2006	21843
		PDHS-E	07-JUN-2006	22327
		PDHS-K	07-JUN-2006	22318

	• Solar mean reference spectra in New Sun Reference Data set with positive sign (was negative in IPF 6.01)			
6.01	• Improved parameterization of the Memory effect for channels 1 to 5 • New correction for the Non-Linearity effect in the infrared channels • Usage of improved key data for the radiometric calibration of all channels • Each solar spectrum is provided in a calibrated and un-calibrated manner for all channels • Orbital dependency of channel 6 to 8 leakage calculated; currently applied only to channel 8 • Improvement of the pointing accuracy through the usage of the ENVISAT Restituted Attitude auxiliary files for the off-line processing • decontamination flag added to the SPH	D-PAC	No operations activated	-
		PDHS-E	22-MAY-2006	22098
		PDHS-K	22-MAY-2006	22090
		PDHS-E PDHS-K LRAC	24-MAR-2004	

Tab. 5-1: Processor Version and main changes

5.1.2 Anomalies

During analysis of the reprocessed data set Level 1b version IPF 6.03, it was found that for limited data sets

January 2005, orbits15154 – 15166
December 2005, orbits 19752-19762
January 2006, orbits 20224-20235, 20352-20363
April 2006, orbits 21356-21512

The D1 solar reference spectra were not updated in the SCI_SU1_AX files and within in the Level 1b products. Analysis of this problem could confirm that the spectra were measured, though. Detailed analysis of this processing problem is still on-going. Please note, that for operational Level 1b – level 2 offline processing the D1 spectrum is not used. The outcome of further analysis will be reported in the next BMR.

5.2 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), the Key Data File (SCI_KD1_AX).
In addition there is the m-factor file (SCI_MF1_AX), which shall describe the degradation of the instrument during its stay in orbit. Note that the m-factor file has not been changed so far.

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 a weekly basis)

Table 5-2 lists the actual Key Data File and Initialisation File used with IPF 6.02 and IPF 6.03. The SCI_LI1_AX was updated with IPF 6.03 in order to improve the instrument pointing correction.

Table 5-2 Key data and Initialisation configuration

SCI_LI1_AXVIEC20060523_182643_20020701_000000_20991231_235959 (until 18/07/2007)
SCI_LI1_AXVIEC20070628_134108_20020701_000000_20991231_235959 (from 18/07/2007)
SCI_KD1_AXVIEC20060523_182626_20020301_000000_20991231_235959

Fig. 5.1 shows statistics of the SU1 and LK1 ADFs generated operationally with SCICAL. It has to be noted that unavailability periods are excluded from statistics. Generation of SU1 ADFs for March and April 2009 was 100 %.
The LK1 ADF statistic is calculated by dividing the number of all LK1 ADFs by number of all available (to SCICAL) level 0 products. The statistics on available LK1 ADFs during March 2009 (60.0%) and April 2009 (56.2%) are on a nominal level considering seasonal variations.
The statistic does 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.

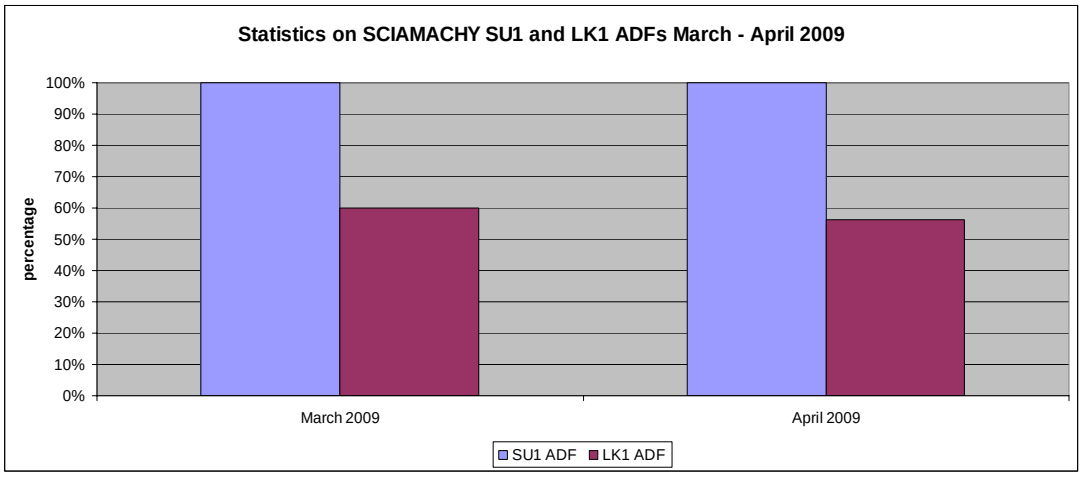


Fig. 5-1: Statistics on SU1 and LK1 processing

5.2.1 Auxiliary Data File quality analysis

5.2.1.1 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).

Fig. 5-2 to Fig. 5-5 show the ratios of SMR spectra derived from calibrated SMR/ESM (D0) during the months March - April 2009. The ratios were determined by dividing the spectra of the beginning of each month to a set of days during 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:

- **March 2009**
  Reference SMR - 01 March 2009
  SMR used for ratios: 02, 03, 05, 06, 07, 08, 09, 10, 11, 14, 21, 31 March 2009
- **April 2009**
  Reference SMR - 01 April 2009

SMR used for ratios: 02, 03, 04, 05, 06, 07, 08, 09, 10, 14, 21, 30 April 2009

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.

Fig. 5-6 and Fig. 5-7 show SMR ratios on a long term trend dividing the ESM spectra from days 31 March 2003 and 31 March 2009, respectively 29 April 2003 and 29 April 2009.
The first spectrum available exists for 18-Jul-2002. However to consider sun/earth distance, the ratio was performed with spectra from same calendar days. All SCI_SU1_AX files used were generated with SCICAL.

What can be concluded is that for channels 1-2 an average degradation in 6 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.

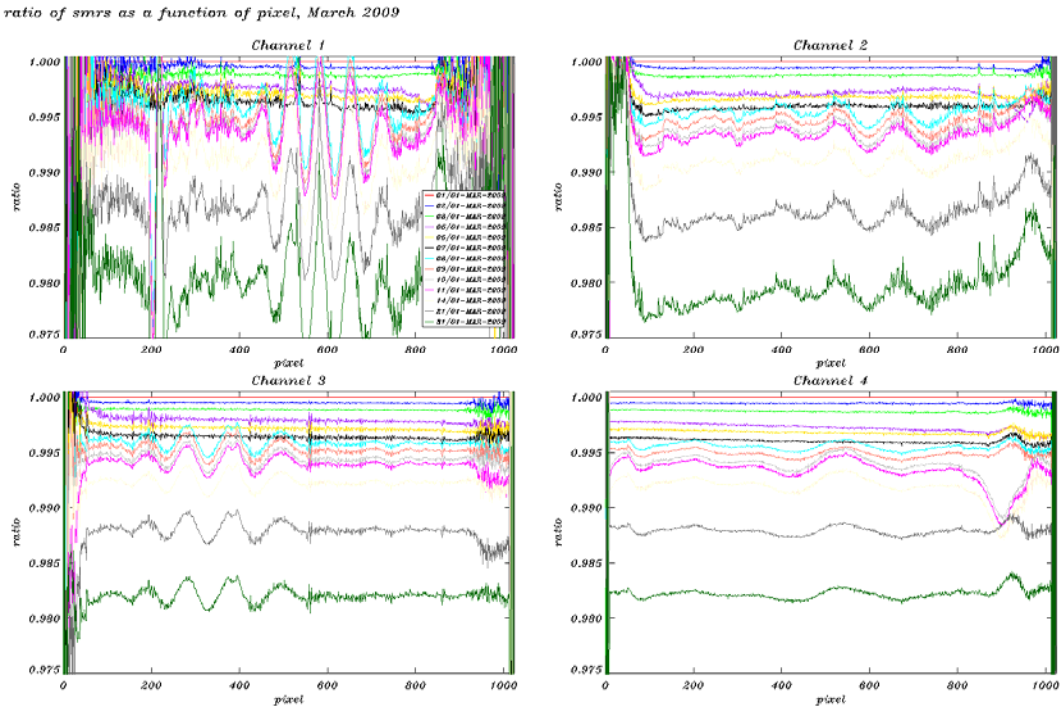


Fig. 5-2: SMR ratios per detector channel 1-4 (changes during March 2009)

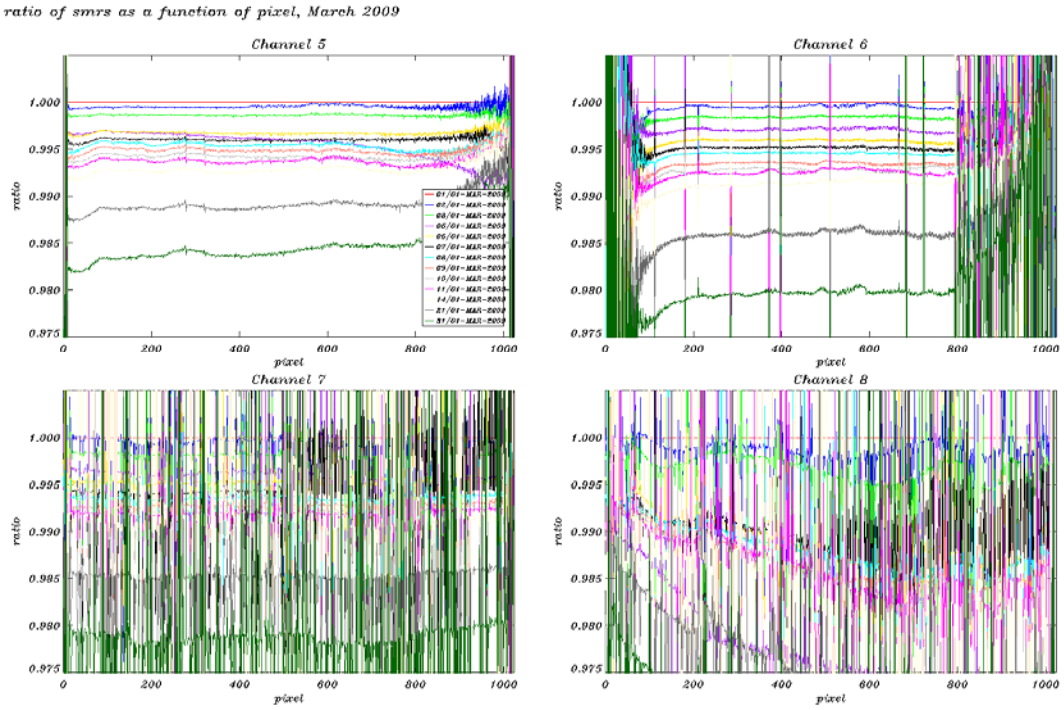


Fig. 5-3: SMR ratios per detector channel 5-8 (changes during March 2009)

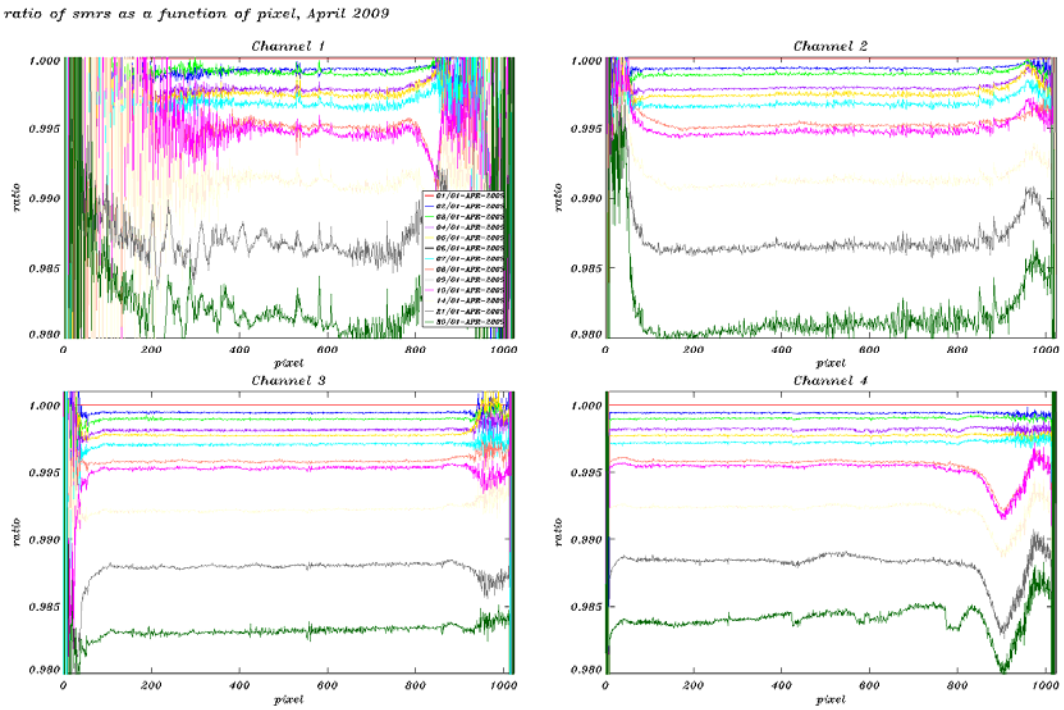


Fig. 5-4: SMR ratios per detector channel 1-4 (changes during April 2009)

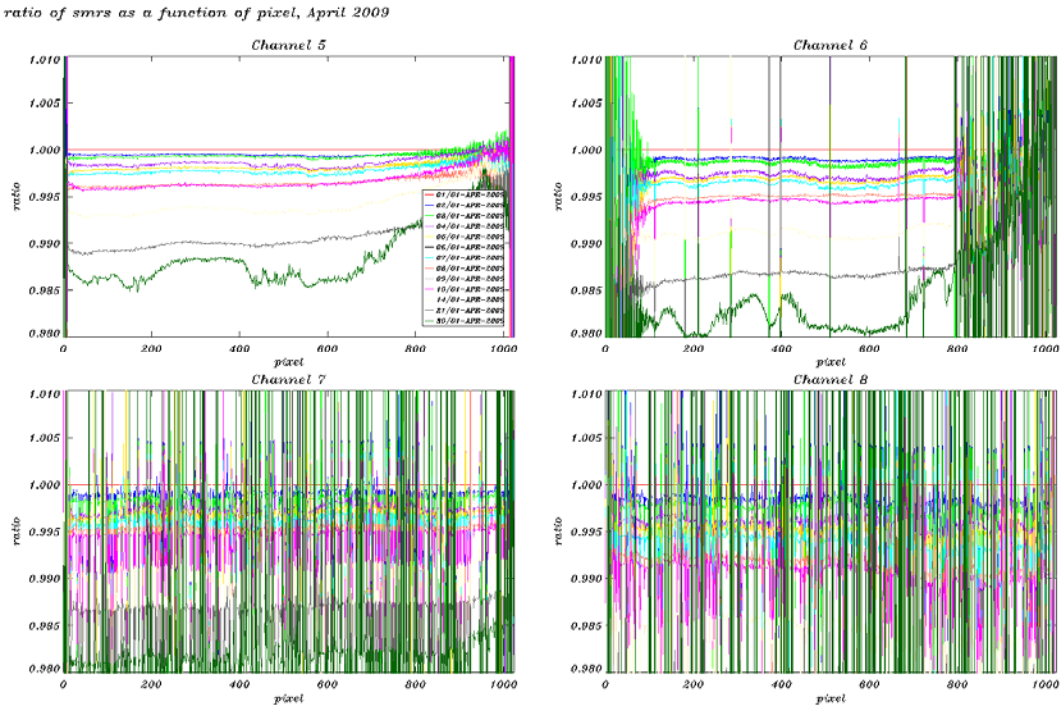


Fig. 5-5: SMR ratios per detector channel 5-8 (changes during April 2009)

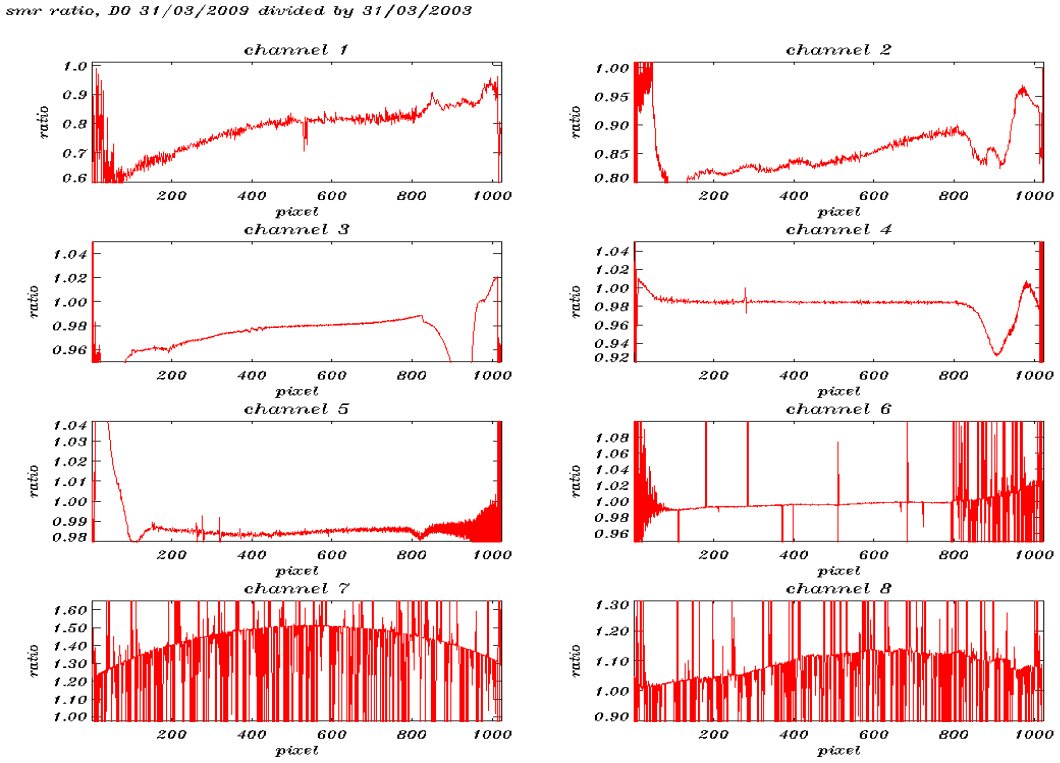


Fig. 5-6: SMR ratios per detector channel on Long Term Trend 31/03/2003 divided by 31/03/2009

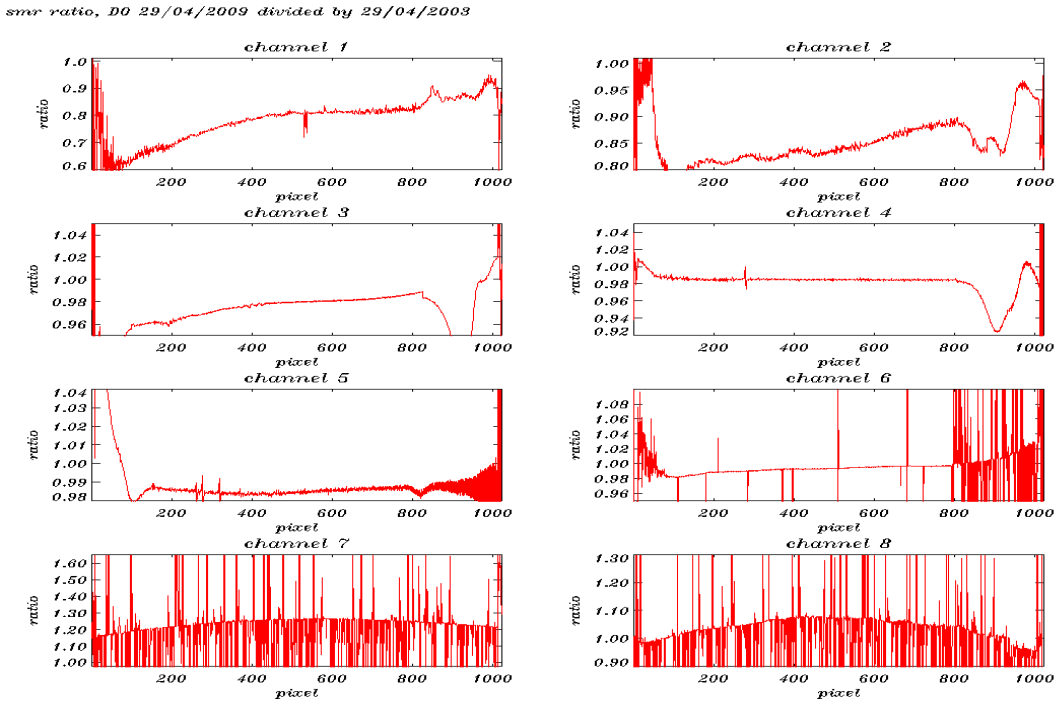


Fig. 5-7: SMR ratios per detector channel on Long Term Trend 29/04/2003 divided by 29/04/2009

5.2.1.2 LK1 analysis

5.2.1.2.1 Leakage Constant part

On an orbital basis a leakage current calibration is performed, if measurement data do not lie in the South Atlantic Anomaly region.
In Fig. 5-8 to Fig. 5-11 the leakage constant part FPN (fixed pattern noise) of the LK1 ADFs are 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. Note that for all channels the noise in January might be higher than usual because of the decontamination and the higher detector temperatures.
The IR channels show a lot of noise. Note that since the processor version IPF 6.02, the time dependent part of the leakage current is considered (see 5.2.3.2.2).

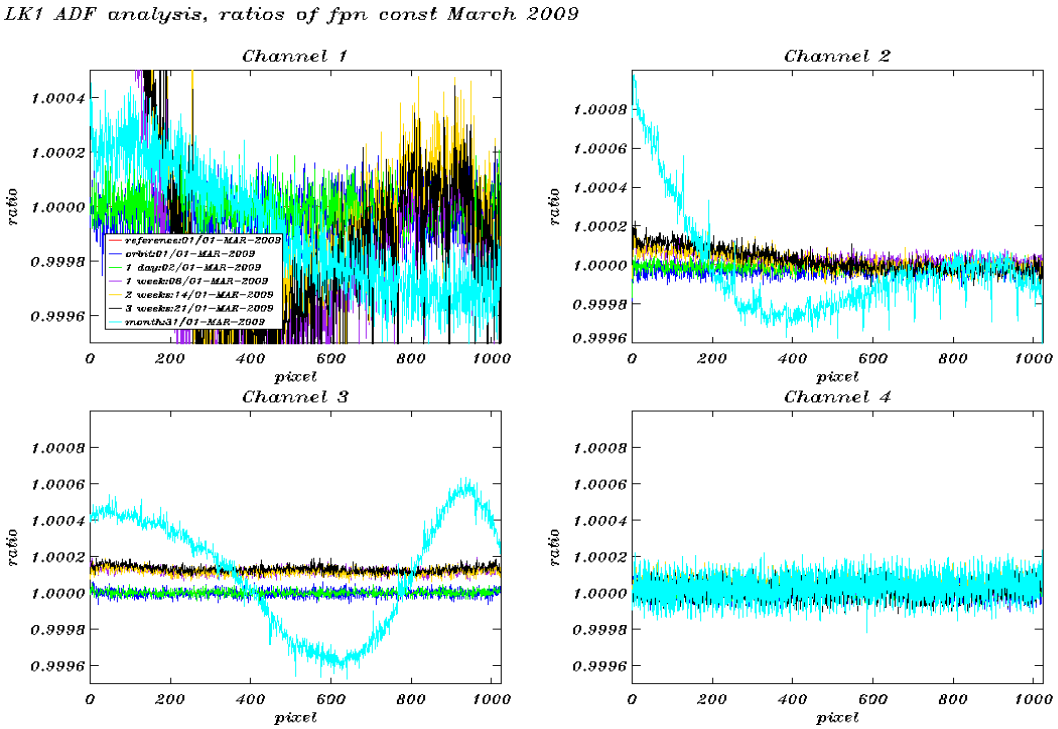


Fig. 5-8: dark current ratios (constant part) channel 1-4 during March 2009, Reference Spectrum used: Orbit 36605, 01-March-2009

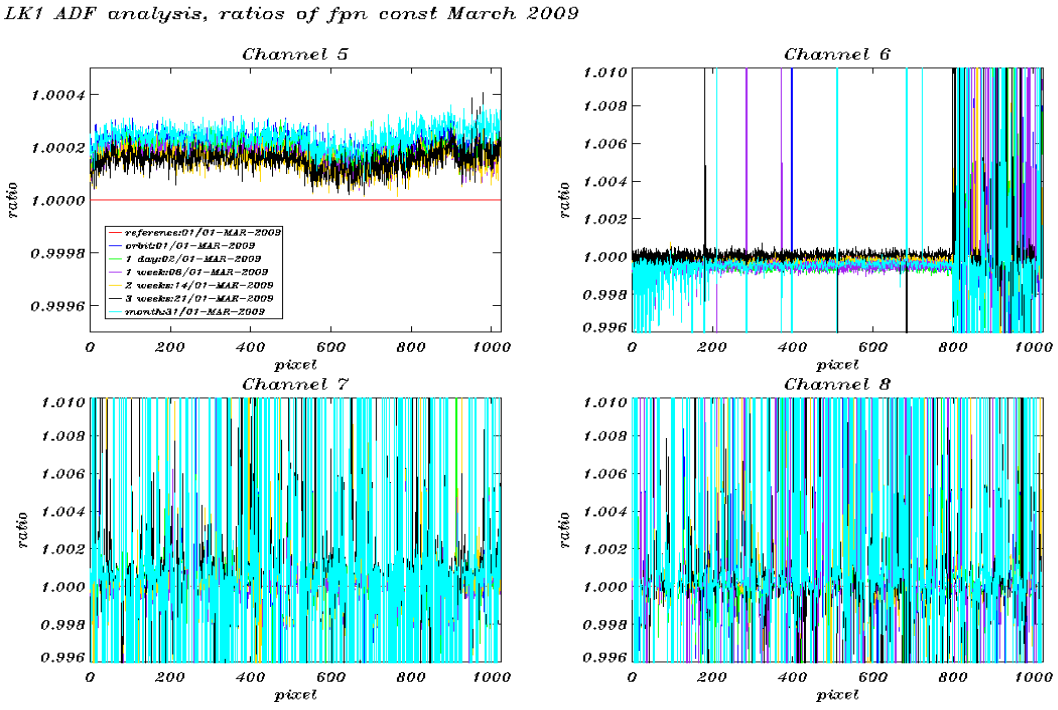


Fig. 5-9: dark current ratios (constant part) channel 5-8 during March 2009, Reference Spectrum used: Orbit 36605, 01-March-2009

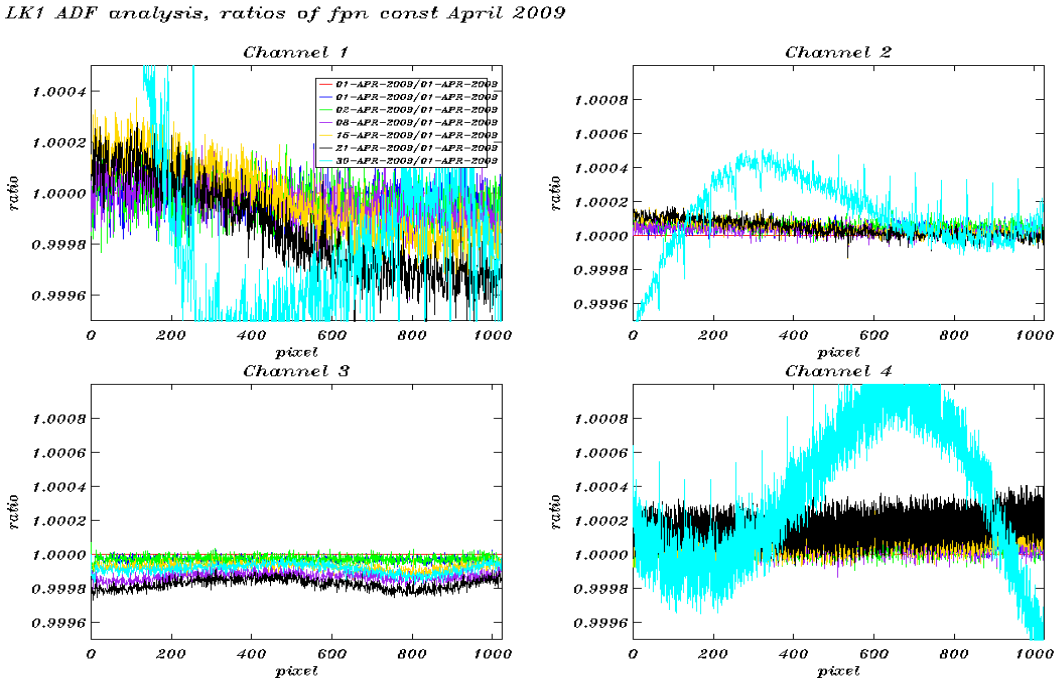


Fig. 5-10: dark current ratios (constant part) channel 1-4 during April 2009, Reference Spectrum used: Orbit 37048, 01-April 2009

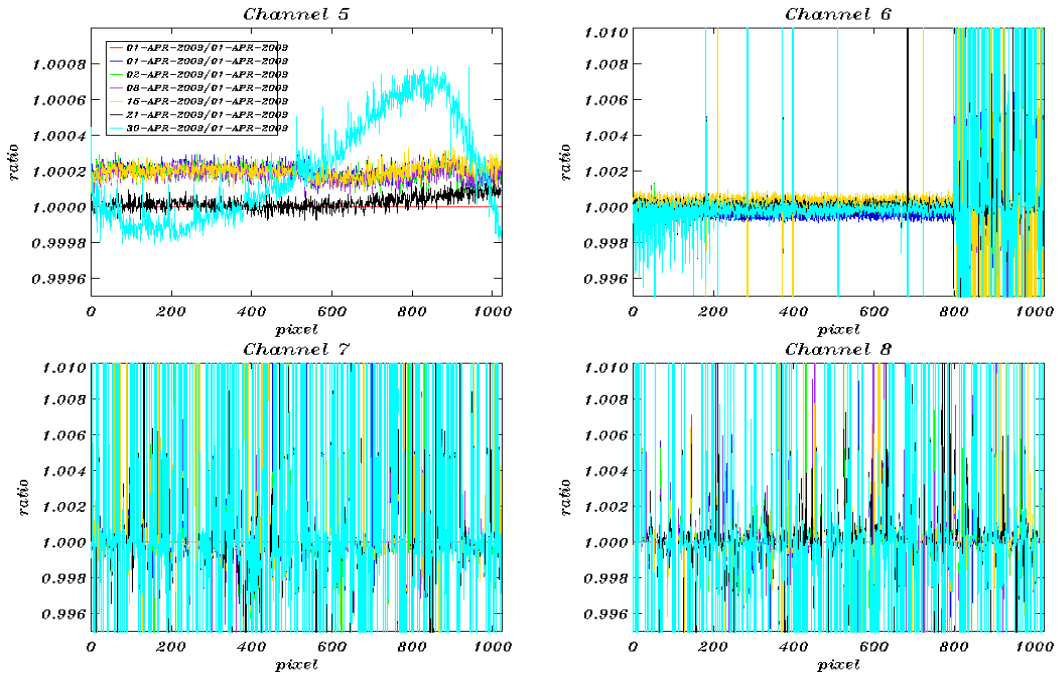


Fig. 5-11: dark current ratios (constant part) channel 5-8 during April 2009, Reference Spectrum used: Orbit 37048, 01-April-2009

5.2.1.2.2 Leakage Variable part

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 5-12 shows the evolution of the leakage variable part of the SCI_LK1_ADF during the time span 01 March 2009 to 30 April 2009. The leakage variation for a selected pixel (222) in channel 7 corresponding to orbit phase 5 is shown.
Updates of the leakage variable are expected after the processing of the monthly calibration orbits, i.e. once per month. During this period Monthly Calibration sequences were scheduled for:

- 09/10 March 2009
- 07/08 April 2009

For both dates the change of the Leakage Variable value can be clearly seen, demonstrating that the calibration was performed successfully.

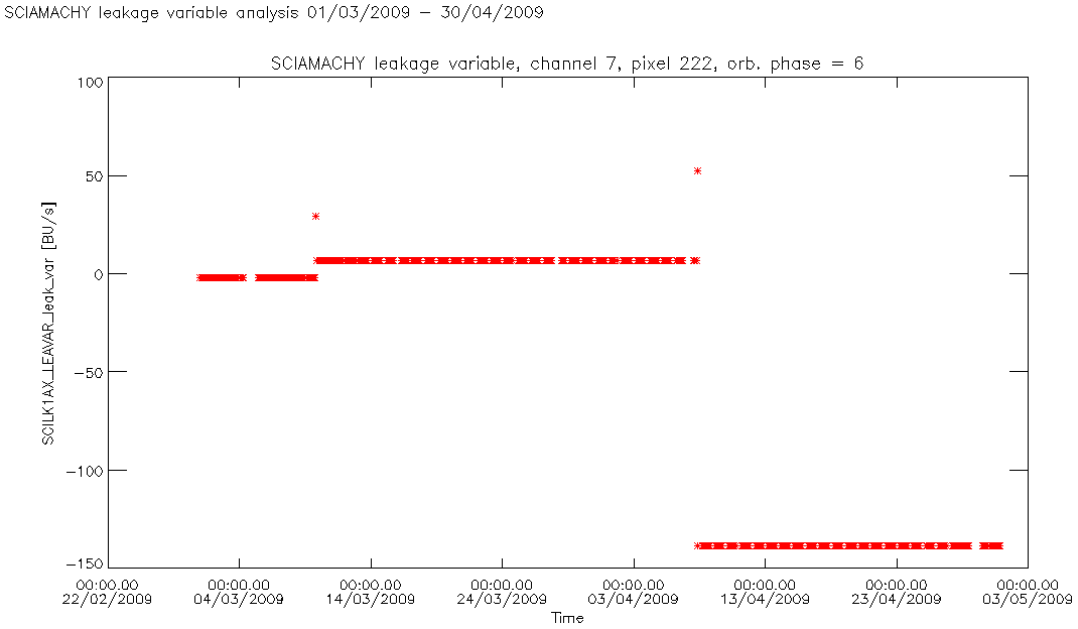


Figure 5-12: Leakage VARIABLE, SCI_LK1_AX, 01 March – 30 April 2009, channel 7, Orbit phase=6 pixel 222

5.3 Bad and Dead Pixel Mask

SRON performs routinely analysis on the SCIAMACHY Bad and Dead Pixel Mask. Within this analysis bad pixels of the detector arrays are identified by 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" that combines the masks of about 50 orbits. In Fig. 5.13 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. The mask currently provided in the level 1b product must be regarded experimental. It uses a different algorithm and is not identical to the mask provided by SRON. It is planned to align the two masks in future processor versions.

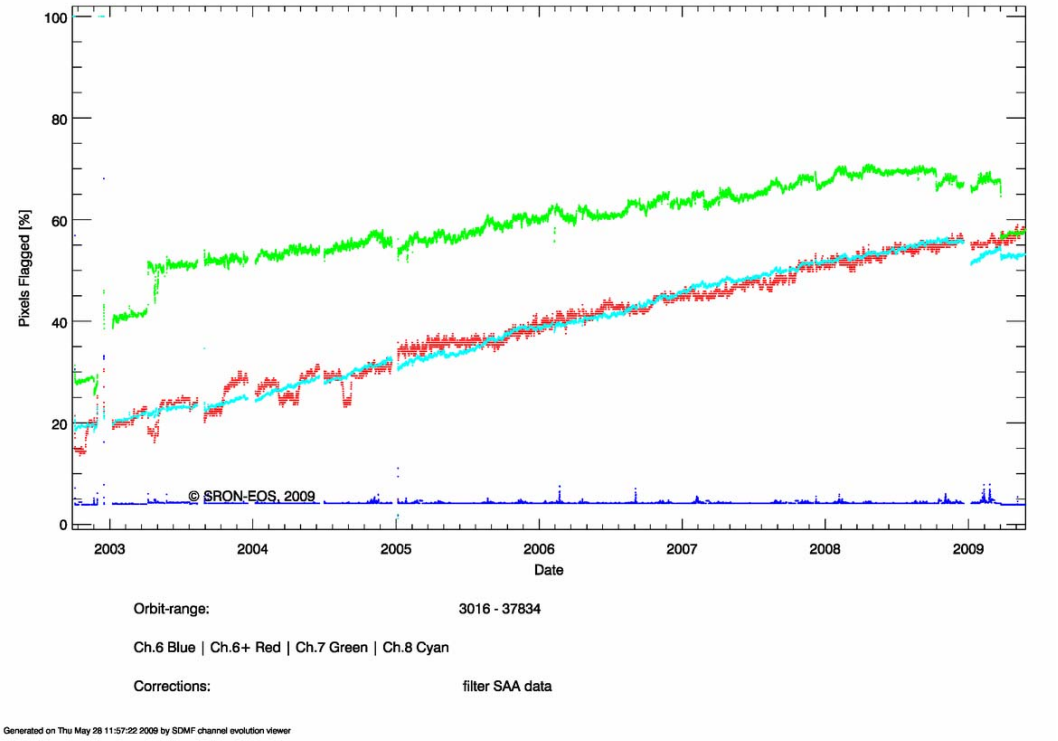


Figure 5-13: Number/Fraction of pixels that is flagged as bad by the SDMF smoothmask for channels 6 (blue), 6+ (red), 7 (green) and 8 (cyan). Orbits during SODAP or decontaminations have been removed. Note the temporary decrease in the number of bad pixels after the last decontamination, for channel 8 about 6%, a few persent more than after the previous decontaminations.

5.4 Pointing Performance

No upgrade with respect to the pointing performance during this reporting period. See BMR September-October 2007 for the last status.

5.5 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. New in this version is the possibility to apply m-factor calibration.

6 LEVEL 2 NRT PRODUCT QUALITY MONITORING

6.1 Processor Configuration

6.1.1 Version

Since 08 May 2006 the near real time processing of SCIAMACHY level 2 data has been suspended, evolution is currently restricted to the level 2 Off-line processor (see chapter 7).
The last IPF version used was 5.04. The corresponding product specification is *[2]*. The disclaimer at
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).

Please note that currently the Fast Delivery processing of level 2 off-line products is in preparation. Level 1b near real time products will be used as input for the level 2 off-line processor with SCI_SU1_AX, SCI_LK1_AX, SCI_SP1_AX and SCI_PE1_AX similar as for near real time processing. The main difference between off-line and Fast Delivery files will be that the Attitude file cannot be used for processing, since it can only be calculated after all orbit datat are available which introduces a larger delay in the data delivery. However the user will be provided with Nadir and Limb data sets with 24 hours after data acquisition.

6.1.2 Auxiliary Data Files

An overview of Auxiliary Files being used as input for SCI_NL__2P products can be found in BMR May-June 2007.

7 LEVEL 2 OFF-LINE PRODUCT QUALITY MONITORING

7.1 Processor Configuration

7.1.1 Version

The Level 2 Off-line processing version is 3.01.
The product specification corresponding to the level 2 off-line processor 3.01 is Volume 15, issue 3/k *[2]* and can be found at
http://earth.esa.int/pub/ESA_DOC/ENVISAT/Vol15_Sciamachy_3k.pdf

The disclaimer at
http://envisat.esa.int/dataproducts/availability/disclaimers/SCI_OL__2P_Disclaimers.pdf
describes known artefacts.

SCI_OL__2P products contain geo-located vertical column amounts of O_3 and NO_2 Nadir measurements, as well as stratospheric Limb profiles of O_3 and NO_2. Additionally the fractional cloud coverage, the cloud-top height, and the cloud optical thickness are derived and provided as product to the user. The major upgrades are summarised in table 7.1.

Processor Version	Description	Proc Centre	Date	Start Orbit
3.01	Main processor changes: • Updated SACURA cloud algorithm • Offset applied in NO_2 slant column processing was removed • Number of retrieved profiles per state was set from one to four (4) • Cloud and Aerosol MDS are filled with the next valid value instead of being set to zero • Molecular Ring correction applied on NADIR O3 slant column density Non-compliance corrections: • Inter change of Pressure and Temperature values in LIMB MDS • Erroneous Cloud and Aerosol Quality Flags • AAI erroneously set to zero in Cloud	D-PAC	23-SEP-2007	29092

	and Aerosol MDS • Scaling of too large NO_2 error estimate			
3.00	• Nadir UV/Visible algorithm for ozone and NO2 is based on the GDP (GOME Data Processor) Version 4.0 • Nadir UV/Visible algorithm for cloud-top height and cloud optical thickness based on the SACURA algorithm • Limb UV/Visible products: Stratospheric Ozone and NO2 profiles • Improved pointing performance through the use of the ENVISAT Restituted Attitude information in the consolidated Level 1b product	D-PAC	03-MAY-2006	21824

Table 7-1: Level 2 off-line Processor Configuration

7.1.2 Anomalies

During this reporting period no anomalies in level 2 offline processing were identified.

7.1.3 Auxiliary Data Files

Input for level 2 Off-line processing is the so-called Initialization File. For processor version 3.01 a new Initialization file became active which is
SCI_IN__AXNPDE20070629_092400_20070720_000000_20991231_235959
This ADF is usually changed only in case of a processor upgrade.

7.2 Monitoring results

7.2.1 Nadir: NO_2 consistency checking

The world map plots of nadir NO_2 vertical column density (VCD) values averaged over one month are generated from the SCI_OL__2P nadir products. Fig 7.1 and 7.3 show the monthly world map plots for March and April 2009.
Figures 7.2 and 7.4 show the VCD errors for the monthly average plots. The errors are given in relative fraction. Generally the equator region has NO_2 values with higher errors.

High concentration of NO_2 is expected over industrial regions, as over North America, especially the East coast, over central Europe, China and South Africa, which is reflected in the world maps.

7.2.1.1 Nadir: VCD NO2 map March 2009

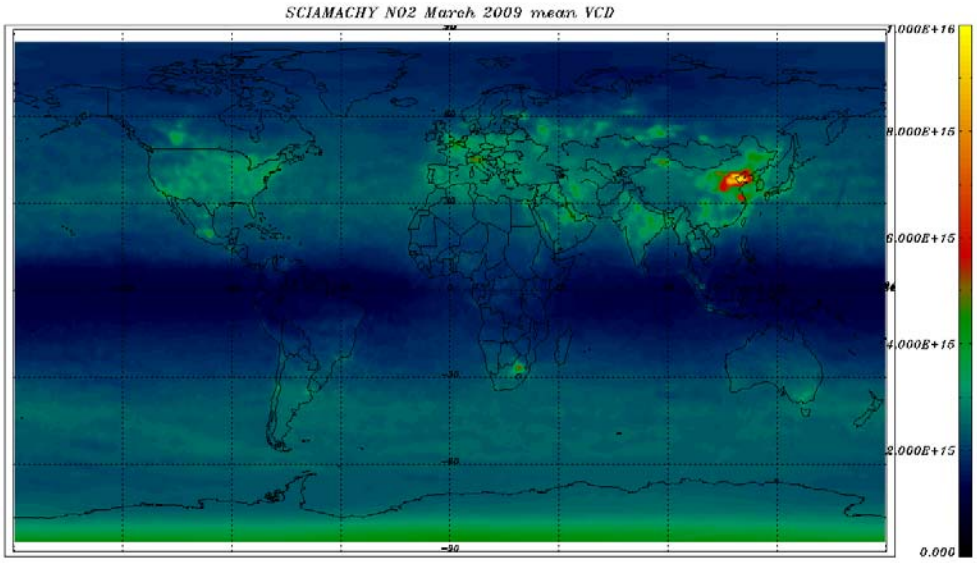


Figure 7-1: NO2 VCD world map 01 - 31 March 2009 – monthly average

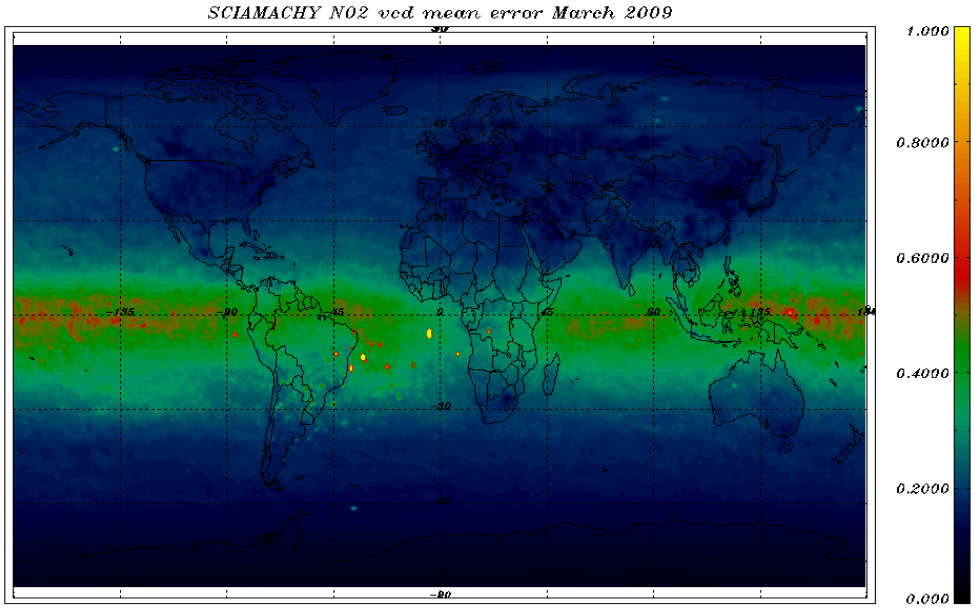


Figure 7-2: NO2 VCD error 01 - 31 March 2009

7.2.1.2 Nadir: VCD NO2 map April 2009

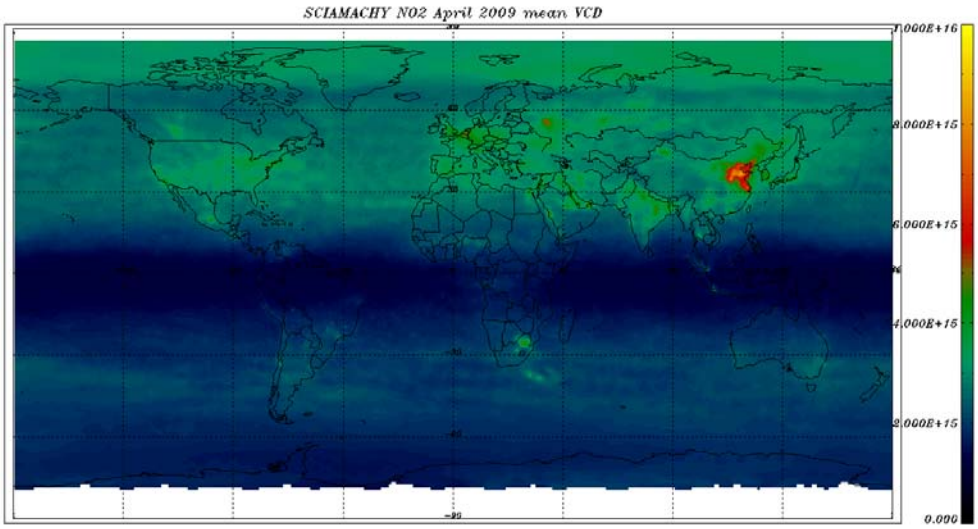


Figure 7-3: NO2 VCD world map 01 – 30 April 2009 – monthly average

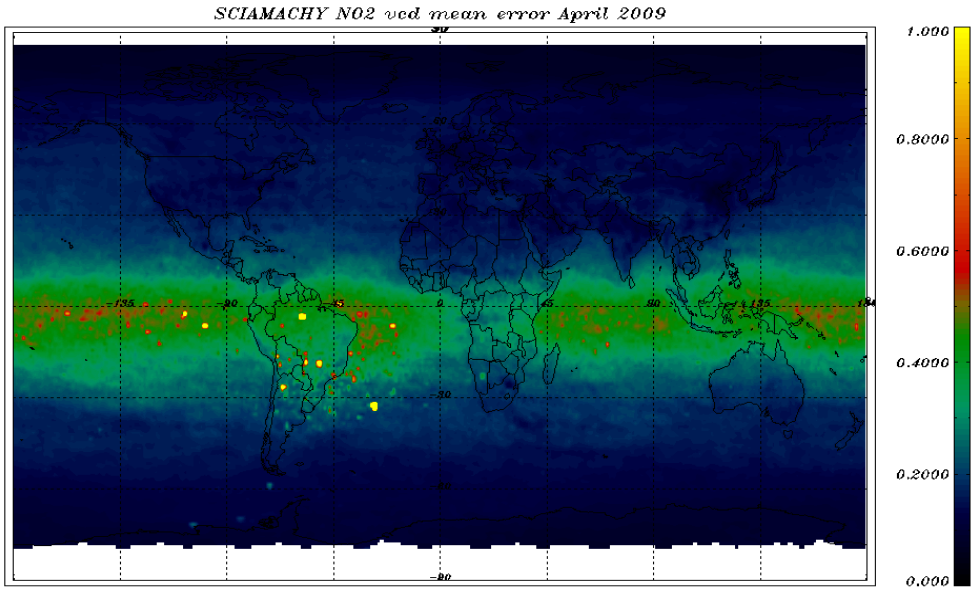


Figure 7-4: NO2 VCD error 01 – 30 April 2009

7.2.2 Nadir: O3 consistency checking

Analogous to the NO_2 world maps, O_3 vertical column density (VCD) values averaged over one month are generated from the SCI_OL__2P nadir products and plotted on a world map. Fig 7.5 and 7.7 show the ozone distribution converted in Dobson units for March and April 2009.
The VCD errors as monthly average plots are shown in Figures 7.6 and 7.8. The errors are given in relative fraction. Systematically higher error values at the North Pole area are visible.

7.2.2.1 Nadir: VCD O3 map March 2009

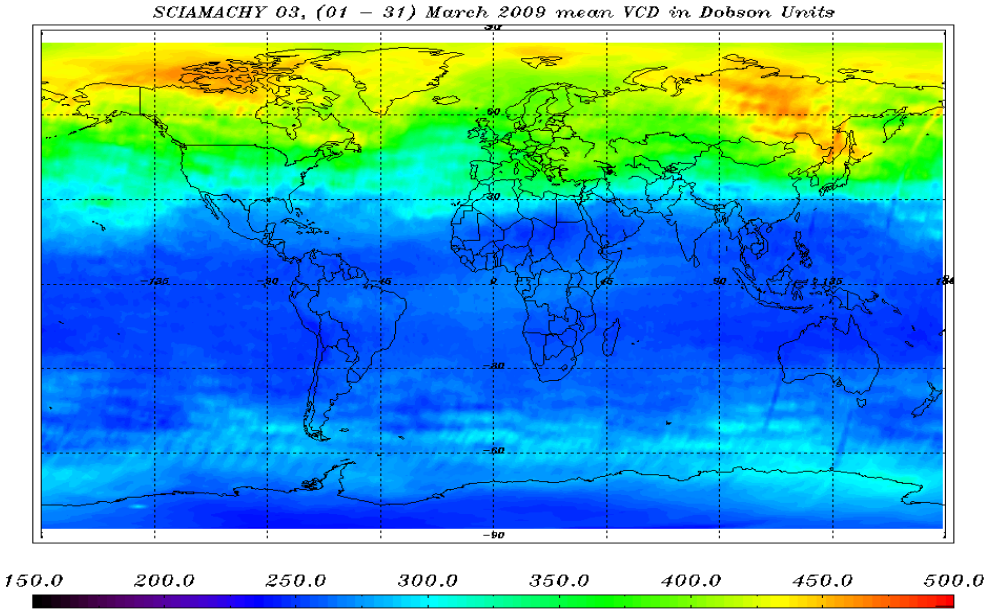


Figure 7-5: O_3 VCD world map 01-31 March 2009 – monthly average

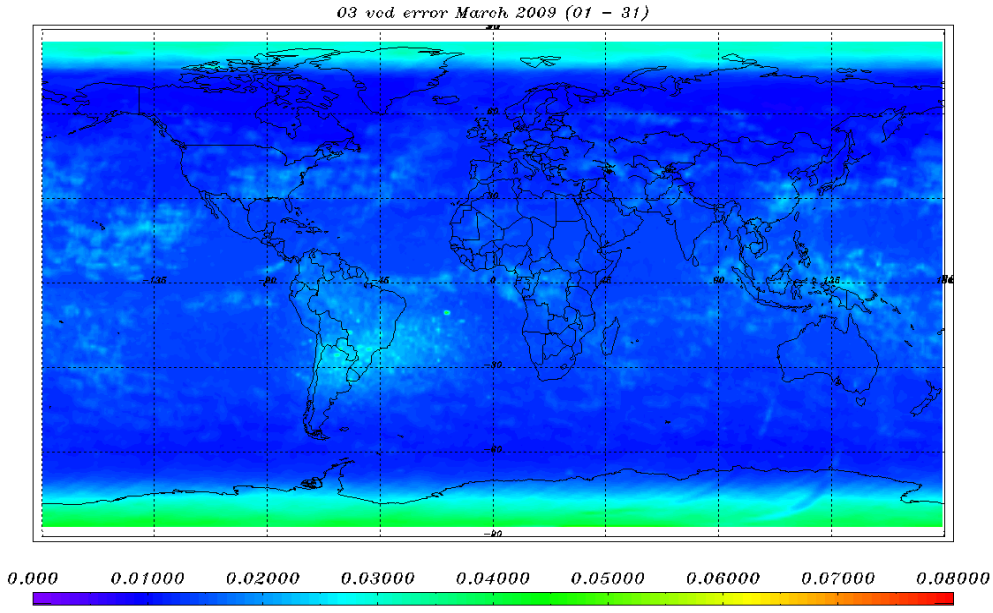


Figure 7-6: O_3 VCD error 01-31 March 2009

7.2.2.2 Nadir: VCD O3 map April 2009

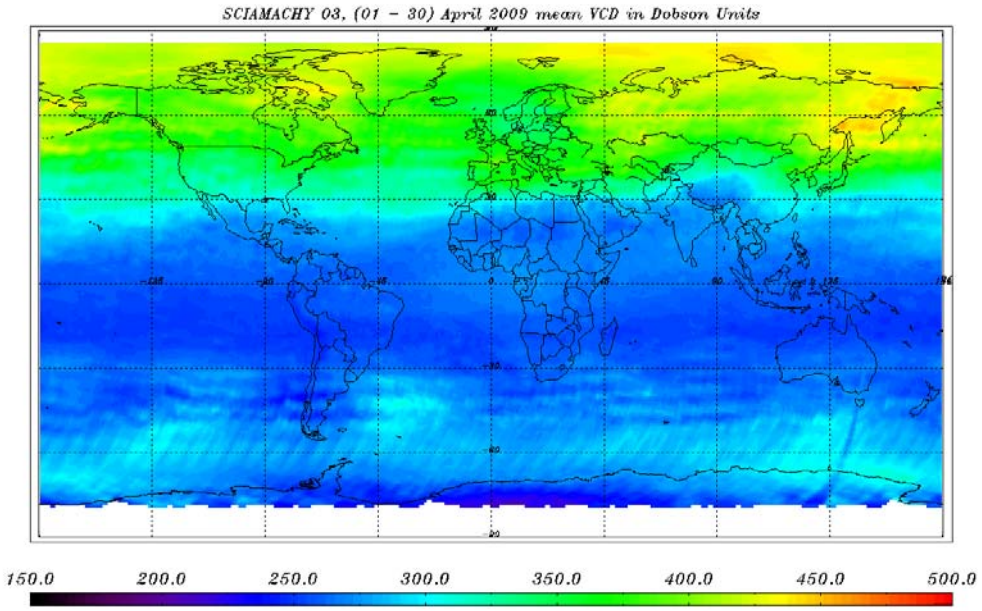


Figure 7-7: O_3 VCD world map 01 - 30 April 2009 – monthly average

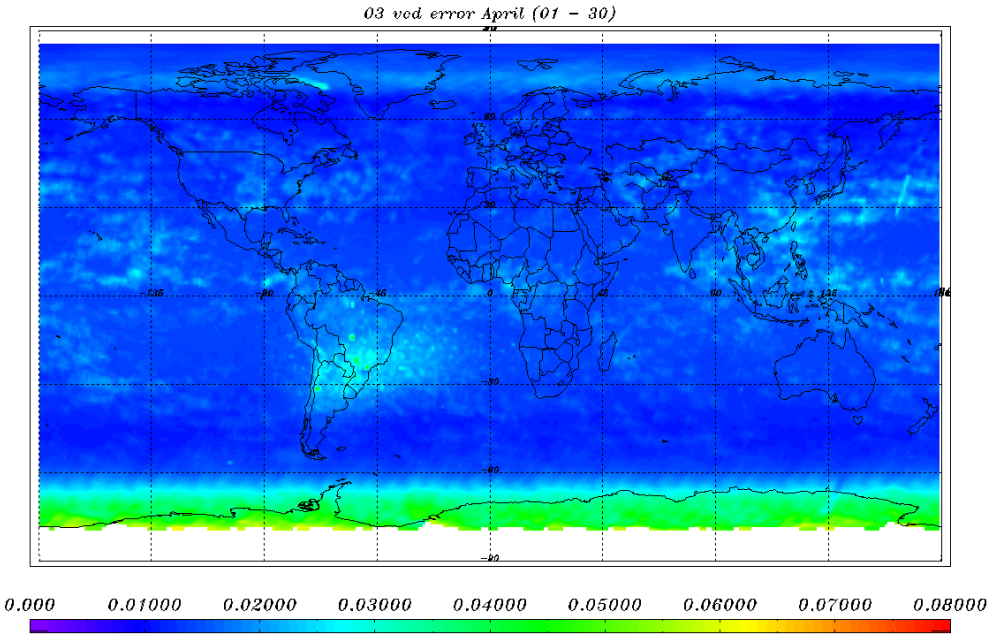


Figure 7-8: O_3 VCD error 01- 30 April 2009

7.2.3 Limb: Ozone profile averages

This paragraph reports on the quality check of SCIAMACHY limb profiles on a monthly basis, showing the results for Ozone limb profiles binned for two tangent height regions bins:

- 21.0 – 24.5 km (17th bin, bin index=16).
- 35.0 – 38.5 km (13th bin, bin index=12).

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 geolocation 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 Geolocation 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. This issue will be included into the level 2 off-line disclaimer.
Figures 7.9 – 7.12 show the results for the months of March and April 2009 and for the two different tangent height regions.

7.2.3.1 Ozone limb profiles March 2009

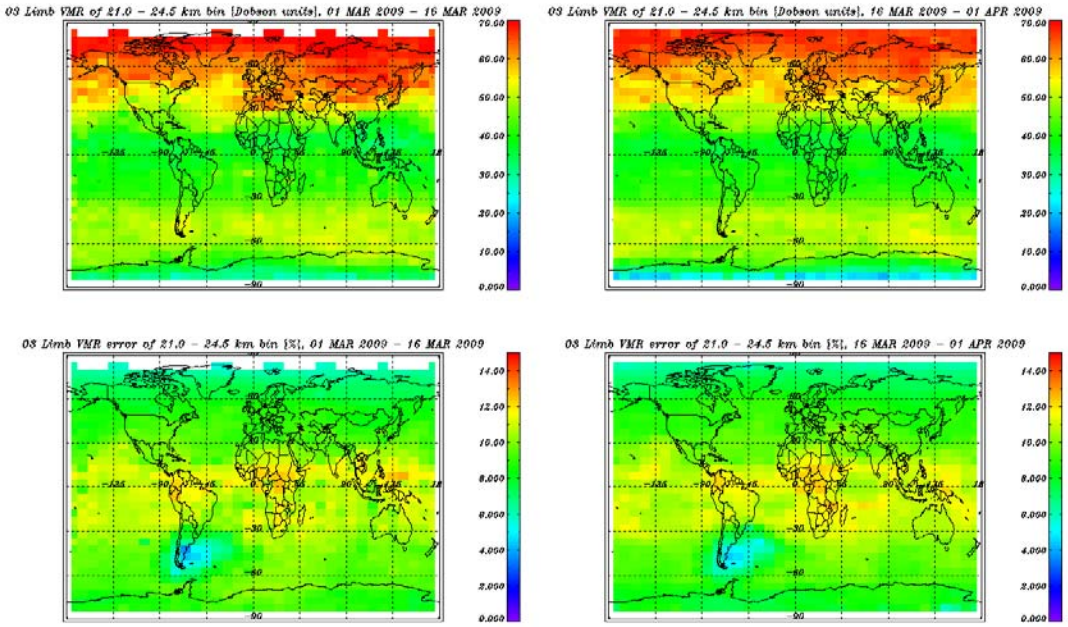


Figure 7-9 Limb Ozone profiles, binned over 21.0 – 24.5 km

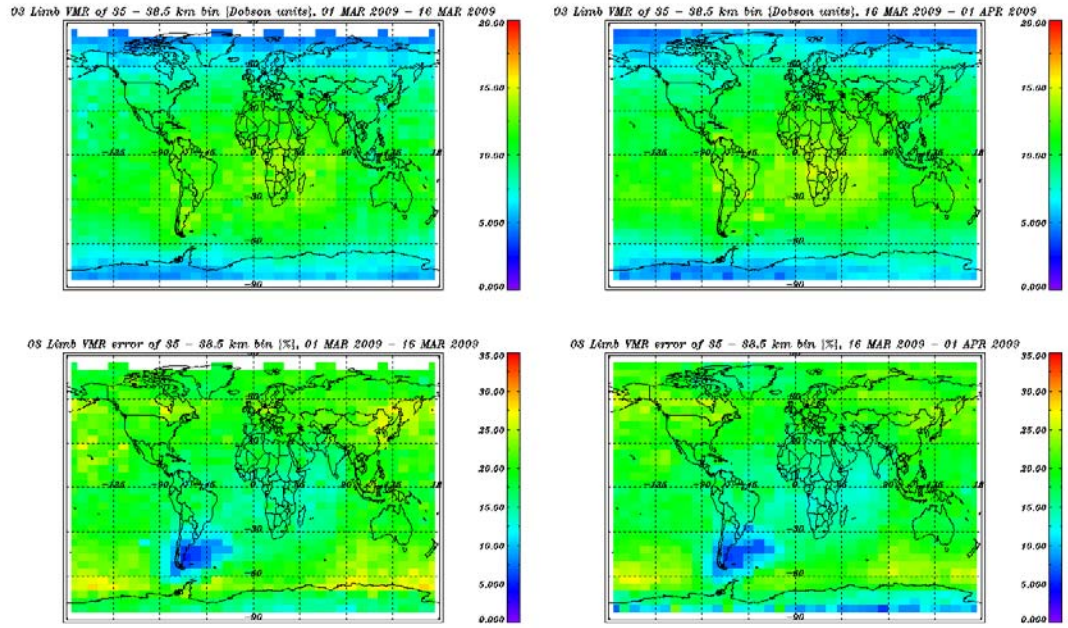


Figure 7-10 Limb Ozone profiles, binned over 35.0 – 38.5 km

7.2.3.2 Ozone limb profiles April 2009

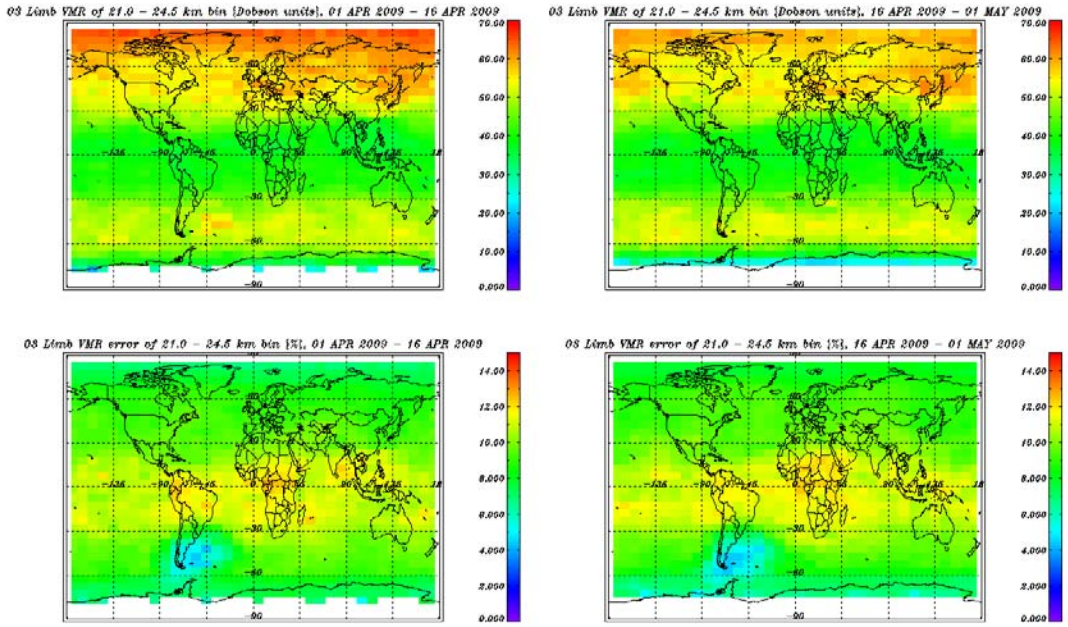


Figure 7-11: Limb Ozone profiles binned over 21.0 – 24.5 km

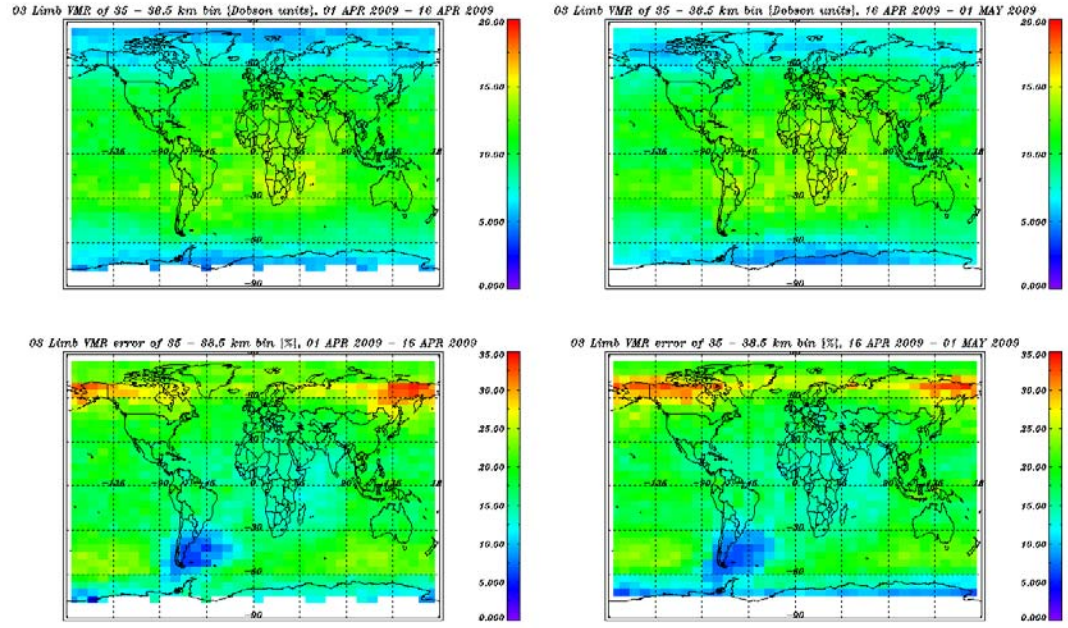


Figure 7-12: Limb Ozone profiles binned over 35.0 – 38.5 km

7.2.4 Limb: NO_2 profile averages

Analogous as for the limb Ozone profiles monthly averages for NO_2 limb averages were generated. The tangent height region chosen is:

- 24.5 – 28.0 km (15th bin, bin index=14).

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 geolocation bins of 10 degrees longitude and 5 degrees latitude. The binning algorithm used is the same as the described in 7.2.3. The corresponding error is averaged as well. Figures 7.13 – 7.14 show the results for the months of March and April 2009.

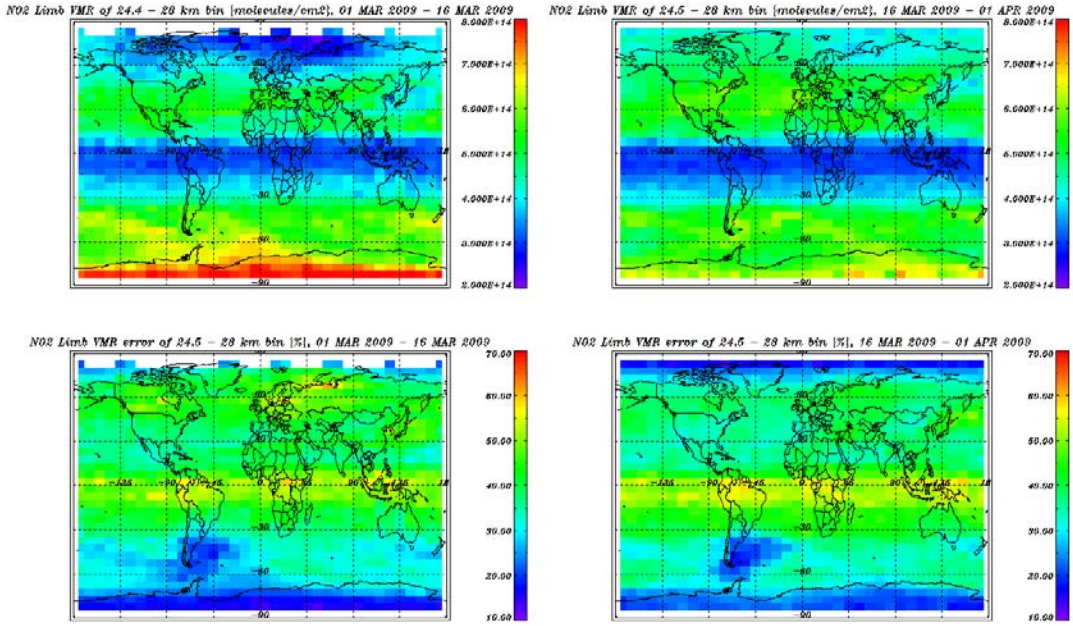


Figure 7-13 Limb NO2 profiles binned over 24.5 – 28 km, March 2009

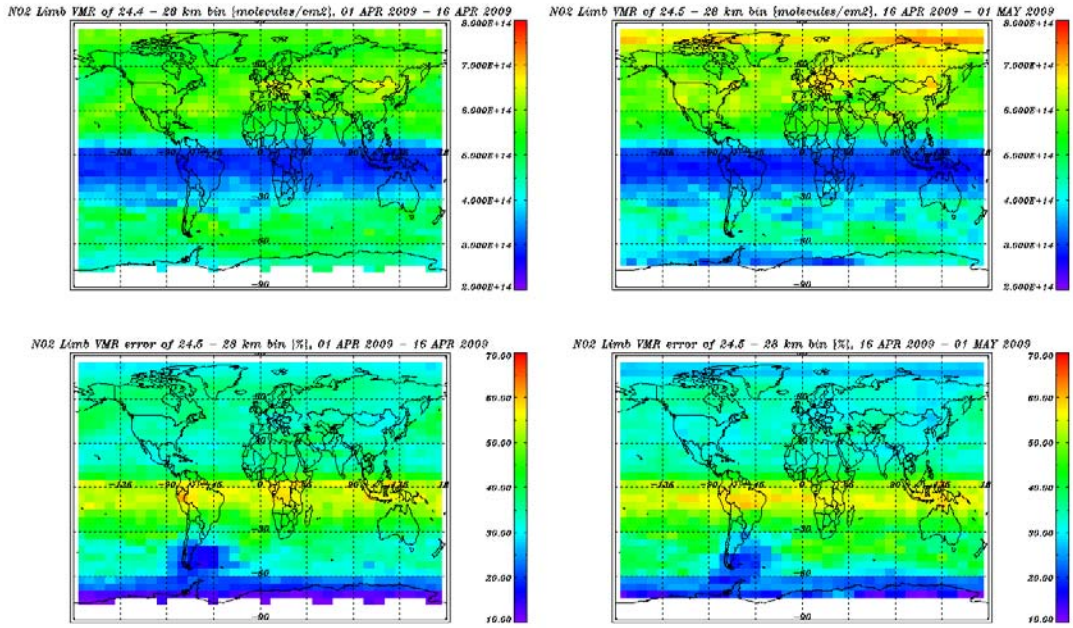


Figure 7-14 Limb NO2 profiles binned over 24.5 – 28 km, April 2009

8 VALIDATION ACTIVITIES AND RESULTS

Validation activities of products from re-processing, level 1 IPF 6.03 and level 2 off-line processor 3.01 have been performed.

The SCIAVALIG group has published the results of the Product Quality at

http://www.sciamachy.org/validation/documentation/technotes/SCIAVALIG/Summary_operational_product_quality_20080326.pdf