SCIAMACHY

Bi-Monthly Report:

January - February 2010

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SCIAMACHY

BI-MONTHLY REPORT

JANUARY - FEBRUARY 2010

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] '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
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

- The SCIAMACHY new processors were successfully activated in February 2010: the SCIAMACHY Level 1b IPF was upgraded from version 6.05 to 7.03 while the Level 2 off-line processor evolved from version 3.01 to version 5.01. Data from the off-line processing chains are available via FTP from D-PAC archive (please contact the ESA Earth Observation Helpdesk to get access). Both off-line Level 1b and Level 2 products adopt the new processing flag "U". The related changes are described in detail at
  http://earth.eo.esa.int/object/index.cfm?fobjectid=6709
  http://earth.eo.esa.int/object/index.cfm?fobjectid=6775

- With the activation of the SCIAMACHY Level 2 processor Version 5.01, the operational Fast Delivery data processing of Level 2 products has started at D-PAC. This new service intends to provide to the users the full SCIAMACHY Level 2 products within 24 hours from data acquisition. The Fast Delivery Level 2 products are based on Level 1b near real-time data and adopt predicted instead of consolidated auxiliary files. Data can be obtained via FTP from D-PAC archive. Access details can be requested from the ESA Earth Observation Helpdesk.

- With the switch of SCIAMACHY Level 1b IPF from version 6.05 to 7.03, the activation of a new set of ADFs was required. New static ADFs (SCI_KD1_AX and SCI_LI1_AX) were put in operation. The SCIAMACHY Calibration tool (SciCal) generating in-orbit calibration ADFs was also updated from version 1.0 to 2.2. Major improvements were introduced in the SCI_PE1_AX auxiliary files considering the DBPM operationally on an orbital basis.

- The instrument degradation correction via the application of so-called m-factor auxiliary files (SCI_MF1_AX) has been operationally introduced in the Level 2 processing chain version 5.01.

- The structure of the Bi-Monthly report has been considerably revised in order to cope with new processors and products newly included into SCIAMACHY Level 1b and Level 2 data.

  The light path monitoring has been replaced by corresponding m-factor results and a new section of the report has been introduced (Section 4)

- For the reported period (orbits 40981 – 41825) SCIAMACHY measurements were nominal with respect to planning, besides four unavailability periods during following orbits:

- Orbit 41186-41201 (15/16-Jan-2010): transfer to STANDBY due to a PMTC_Tx buffer overflow (likely SEU) followed by a PMTC driver timeout anomaly.
- Orbit 41409-41430 (30-Jan-2010/01-Feb-2010): the MCMD Check Error triggered a transfer to R/W WAIT.
- Orbit 41638-41643 (15/16-Feb-2010): a planned orbit control manoeuvre (OCM) required a transfer to MEASUREMENT IDLE. SCIAMACHY measurements started after the OCM with the platform being in yaw steering mode only for a few orbits.
- Orbit 41722-41733 (21/22-Feb-2010): instrument was sent to HTR/RF due to I0105 out-of-limit (latch-up detection) anomaly, likely caused by a SEU.

- Monthly Calibration was regularly performed during orbits:

  - 41378-41382 (28/29-Jan-2010)
  - 41793-41797 (26/27-Feb-2010)

- Occultation measurements with the moon rising on night side were executed between orbits:

  - 41344-41389 (26-Jan-2010 until 29-Jan-2010)
  - 41736-41810 (22-Feb-2010 until 27-Feb-2010)

- During the reporting period no OCR had to be implemented.

- No TC adjustments were required.

- 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/

  The NRT and OFL Level 1b daily reports can be accessed at the following address:
  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/

  A web-page reporting anomalies in the SCIAMACHY data production is available at:
  http://earth.eo.esa.int/pcs/envisat/sciamachy/reports/anomalies/

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 40981 (ANX = 01-Jan-2010, 00:26:04.441) to 41825 (ANX = 28-Feb-2010, 23:31:27.795). One OSDF specified the planning baseline.

Orbit		ANX		OSDF
Start	Stop	Start	Stop	
40981	41825	01-Jan-2010 00:26:04.441	28-Feb-2010 23:31:27.795	MPL_OSD_SHVSH_20091123_010101_00000000_35110001_20100101_002606_20100301_011202.N1

Table 3-1: SCIAMACHY OSDF planning file from January – February 2010.

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

- 41378-41382 (28/29-Jan-2010)
- 41793-41797 (26/27-Feb-2010)

The moon was in the limb TCFoV between orbits

- 40981-40984 (01-Jan-2010)
- 41321-41404 (24-Jan-2010 until 30-Jan-2010)
- 41737-41825 (22-Feb-2010 until 28-Feb-2010)

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

- 41344-41389 (26-Jan-2010 until 29-Jan-2010)
- 41736-41810 (22-Feb-2010 until 27-Feb-2010)

Four blocks of *limb_mesosphere_thermosphere* measurements were scheduled.

Orbit		UTC		Remark
Start	Stop	Start	Stop	
41024	41039	04-Jan-2010 00:31:49	05-Jan-2010 01:40:48	
41239	41254	19-Jan-2010 01:00:33	20-Jan-2010 02:09:32	MIPAS upper atmosphere mode
41454	41469	03-Feb-2010 01:29:18	04-Feb-2010 02:38:17	
41668	41683	18-Feb-2010 00:17:27	19-Feb-2010 01:26:25	MIPAS upper atmosphere mode

Table 3-2: Scheduled *limb_mesosphere_thermosphere* measurements in January – February 2010.

No OCR had to be implemented.

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 file has been scheduled as requested except for four periods:

- Orbit 41186-41201 (15/16-Jan-2010): Transfer to STANDBY due to a *PMTC_Tx buffer overflow* (likely SEU) followed by a *PMTC driver timeout* anomaly.
- Orbit 41409-41430 (30-Jan-2010/01-Feb-2010): The MCMD Check Error triggered a transfer to R/W WAIT.
- Orbit 41638-41643 (15/16-Feb-2010): A planned orbit control manoeuvre (OCM) required a transfer to MEASUREMENT IDLE. SCIAMACHY measurements started after the OCM with the platform being in *yaw steering mode* only for a few orbits.
- Orbit 41722-41733 (21/22-Feb-2010): Transfer to HTR/RF due to a *I0105 Out-of-Limit* (latch-up detection) anomaly, likely caused by a SEU.

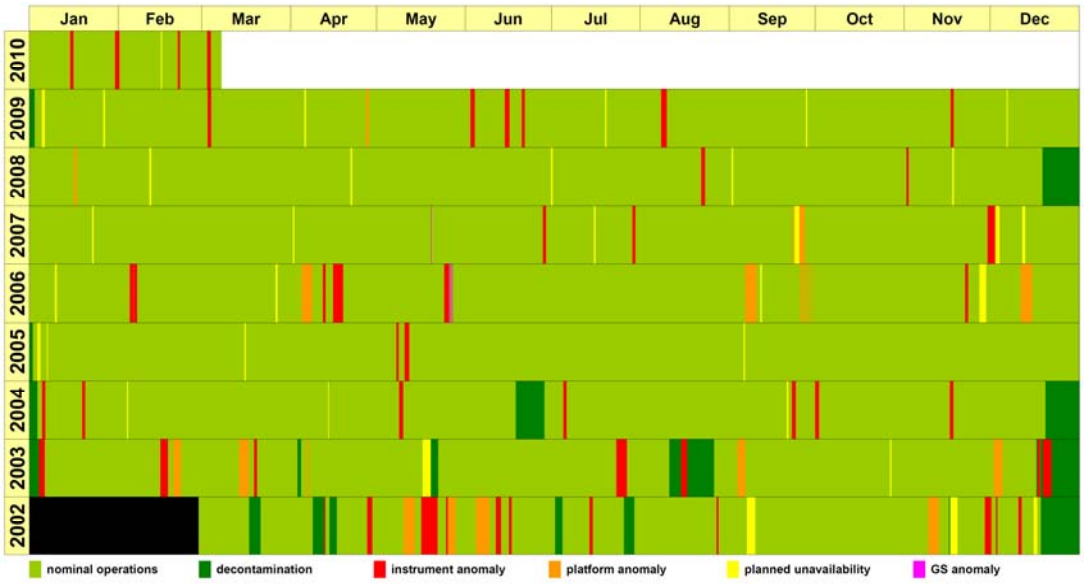


Fig. 3-1: Current instrument availability status including the reporting period.

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.	41357	27-Jan2010 08:21:14
41772	25-Feb-2010 08:10:38	ok	41773	25-Feb-2010 09:47:08

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

Anomalies

Three instrument anomalies and one minor platform anomaly, triggering a minor instrument anomaly, had occurred.

- Between orbits 41130-41135 (11-Jan-2010, 11:34:56-19:05:37 UTC) an anomaly of the platform attitude (bright object in the field-of-view of one of the start

trackers) triggered a switch to *Yaw Steering Mode (YSM)*. At the beginning of this period ancillary data were missing leading to the error I0110 in SCIAMACHY. Note that the Line-of-Sight pointing knowledge could be slightly disturbed during the YSM phase.

- A transfer to STANDBY due to a *PMTC_Tx buffer overflow*, followed by a *PMTC driver timeout* anomaly, was likely caused by a Single Event Upset (SEU). In total measurement data for orbits 41186-41201 (15-Jan-2010, 09:31:18 UTC to 16-Jan-2010, 10:50:52 UTC) could not be generated as planned.
- In orbit 41409 (30-Jan-2010, 22:21:47 UTC) the MCMD Check Error triggered a transfer to R/W WAIT. The MPS schedule was resumed in orbit 41430 (01-Feb-2010, 10:46:51 UTC).
- Due to an I0105 out-of-limit error (latch-up detection), most likely caused by a SEU, the instrument was sent to HTR/RF in orbit 41722 (21-Feb-2010, 20:03:04 UTC). The MPS timeline continued in orbit 41733 (22-Feb-2010, 14:45:52 UTC).

Orbit	Date	Entry - UTC	Level	Entry Type	ID Content/Transition	Mode	Remark
41130	11-JAN-2010	2010.011.11.34.59.354	Instrument	HK PARAMETER LIMIT EXCEEDING	89 (I0110)	MEASUREMENT	Missing ancillary data due to ENVISAT SM switch to YSM
41186	15-JAN-2010	2010.015.09.31.18.243	INSTRUMENT	AUTONOMOUS SWITCHING	ID454 / goto HEATER/REFUSE	HTR/REF	PMTC_Tx_Buffer_Overflow
41186	15-JAN-2010	2010.015.09.31.24.610	INSTRUMENT	AUTONOMOUS SWITCHING	ID455 / goto STANDBY/REFUSE-I	STDBY/REF-I	PMTC_Driver_Timeout
41186	15-JAN-2010	2010.015.09.41.56.755	INSTRUMENT	MACROCOMMAND EXECUTION ENTRY	START TIMELINE	STDBY/REF-I	Complementary Failure
41186	15-JAN-2010	2010.015.09.41.56.767	INSTRUMENT	COMPLEMENTARY FAILURES	---	STDBY/REF-I	Complementary Failure
41186	15-JAN-2010	2010.015.09.41.56.767	INSTRUMENT	MACROCOMMAND EXECUTION ENTRY	START TIMELINE	STDBY/REF-I	Complementary Failure
in total 8 Complementary Failures until 2010.015.11.53.04.111							
41188	15-JAN-2010	2010.015.11.53.04.100	INSTRUMENT	MACROCOMMAND EXECUTION ENTRY	START TIMELINE	STDBY/REF-I	Complementary Failure
41188	15-JAN-2010	2010.015.11.53.04.111	INSTRUMENT	COMPLEMENTARY FAILURES	---	STDBY/REF-I	Complementary Failure
41188	15-JAN-2010	2010.015.11.53.04.111	INSTRUMENT	MACROCOMMAND EXECUTION ENTRY	START TIMELINE	STDBY/REF-I	Complementary Failure
41409	30-JAN-2010	2010.030.22.21.47.402	Instrument	AUTONOMOUS SWITCHING	goto R/W-WAIT	R/W-WAIT	MCMD CCA check error
41722	21-FEB-2010	2010.052.20.03.04.941	Instrument	HK PARAMETER LIMIT EXCEEDING	84 (I0105)	HTR/RF	Single Event Upset (SEU)
41722	21-FEB-2010	2010.052.20.03.04.945	Instrument	AUTONOMOUS SWITCHING	goto HEATER/REFUSE	HTR/RF	Single Event Upset (SEU)
41722	21-FEB-2010	2010.052.20.19.23.515	Instrument	MACROCOMMAND EXECUTION ENTRY	START TIMELINE	HTR/RF	Complementary failure
41722	21-FEB-2010	2010.052.20.19.23.531	Instrument	COMPLEMENTARY FAILURES	---	HTR/RF	Complementary failure
41722	21-FEB-2010	2010.052.20.19.23.535	Instrument	MACROCOMMAND EXECUTION ENTRY	START TIMELINE	HTR/RF	Complementary failure
in total 4 Complementary Failures until 2010.052.20.49.39.555							
41723	21-FEB-2010	2010.052.20.49.39.539	Instrument	MACROCOMMAND EXECUTION ENTRY	START TIMELINE	HTR/RF	Complementary failure
41723	21-FEB-2010	2010.052.20.49.39.551	Instrument	MACROCOMMAND EXECUTION ENTRY	---	HTR/RF	Complementary failure
41723	21-FEB-2010	2010.052.20.49.39.555	Instrument	COMPLEMENTARY FAILURES	START TIMELINE	HTR/RF	Complementary failure

Table 3-4: Instrument anomalies between January and February 2010.

Data Quality

Slightly reduced pointing performance was possible during the platform attitude anomaly and for a few orbits after the OCM period. All transfers to instrument modes lower than MEASUREMENT affected the stability of the ATC/TC system for a short while as listed in table 3-5.

Orbit		UTC		Event	Affected System
Start	Stop	Start	Stop		
41130	41135	11-Jan-2010 11:34:56	11-Jan-2010 19:05:37	platform attitude anomaly	Line-of-Sight (LoS) possible
41201	41212	16-Jan-2010 10:50:52	17-Jan-2010 03:44:23	recovery from STANDBY	ATC/TC
41430	41442	01-Feb-2010 11:12:44	02-Feb-2010 05:22:07	recovery from R/W WAIT	ATC/TC
41643	n.a.	16-Feb-2010 07:52:46	n.a.	end OCM period	Line-of-Sight (LoS) possible
41733	41738	22-Feb-2010 14:45:52	22-Feb-2010 21:29:22	recovery from HTR/RF	ATC/TC

Table 3-5: Periods with reduced data quality between January and February 2010.

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.

During part of the reporting period detector 5 temperatures were below the lower limits. This was tolerated since deviations were less than about 0.5 K.

OBM temperatures

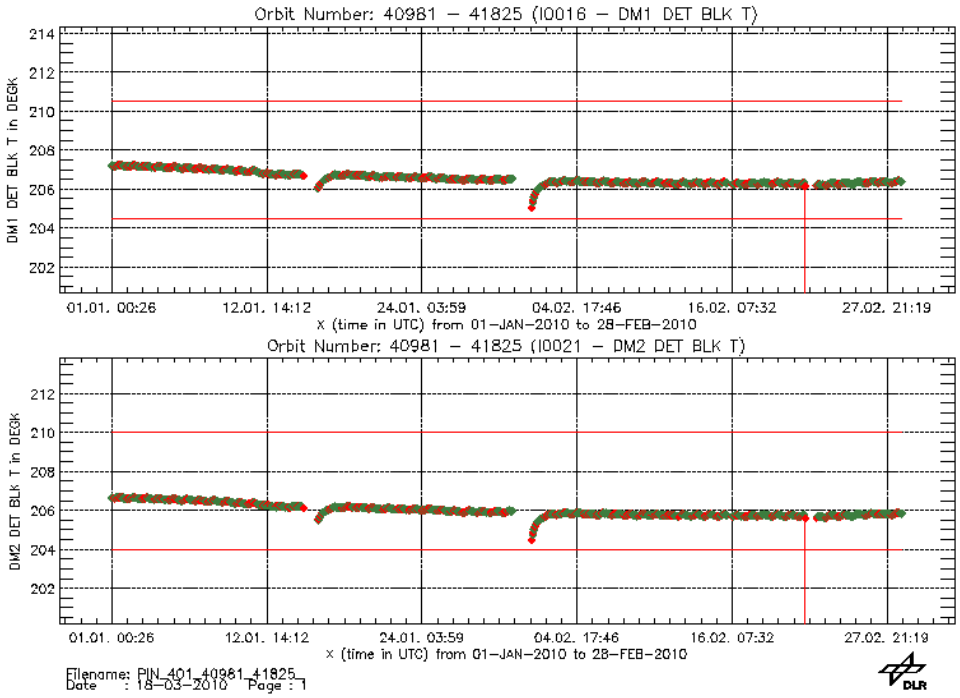
The average OBM temperature per orbit is determined from specific HK telemetry parameters. In addition power readings for the ATC heaters are monitored. Temperatures and ATC heater powers are given in Fig. 3-3 and 3-4. Colour coding is as in Fig. 3-2.

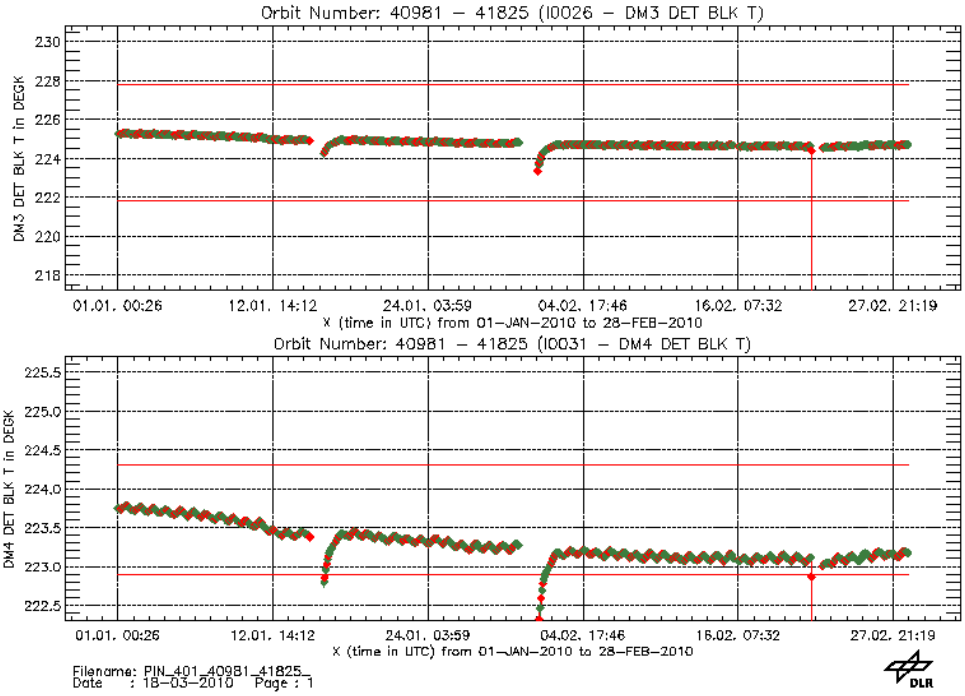
OBM temperatures and ATC heater powers remained within limits during nominal operations.

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.


Orbit Number: 40981 – 41825 (I0016 – DM1 DET BLK T)
DM1 DET BLK T in DEGK
214
212
210
208
206
204
202
01.01. 00:26
12.01. 14:12
24.01. 03:59
04.02. 17:46
16.02. 07:32
27.02. 21:19
X (time in UTC) from 01-JAN-2010 to 28-FEB-2010
Orbit Number: 40981 – 41825 (I0021 – DM2 DET BLK T)
DM2 DET BLK T in DEGK
212
210
208
206
204
202
01.01. 00:26
12.01. 14:12
24.01. 03:59
04.02. 17:46
16.02. 07:32
27.02. 21:19
X (time in UTC) from 01-JAN-2010 to 28-FEB-2010
Filename: PIN_401_40981_41825
Date : 18-03-2010 Page : 1
DLR


Orbit Number: 40981 – 41825 (I0026 – DM3 DET BLK T)
DM3 DET BLK T in DEGK
230
228
226
224
222
220
218
01.01. 00:26
12.01. 14:12
24.01. 03:59
04.02. 17:46
16.02. 07:32
27.02. 21:19
X (time in UTC) from 01-JAN-2010 to 28-FEB-2010
Orbit Number: 40981 – 41825 (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
01.01. 00:26
12.01. 14:12
24.01. 03:59
04.02. 17:46
16.02. 07:32
27.02. 21:19
X (time in UTC) from 01-JAN-2010 to 28-FEB-2010
Filename: PIN_401_40981_41825
Date : 18-03-2010 Page : 1
DLR

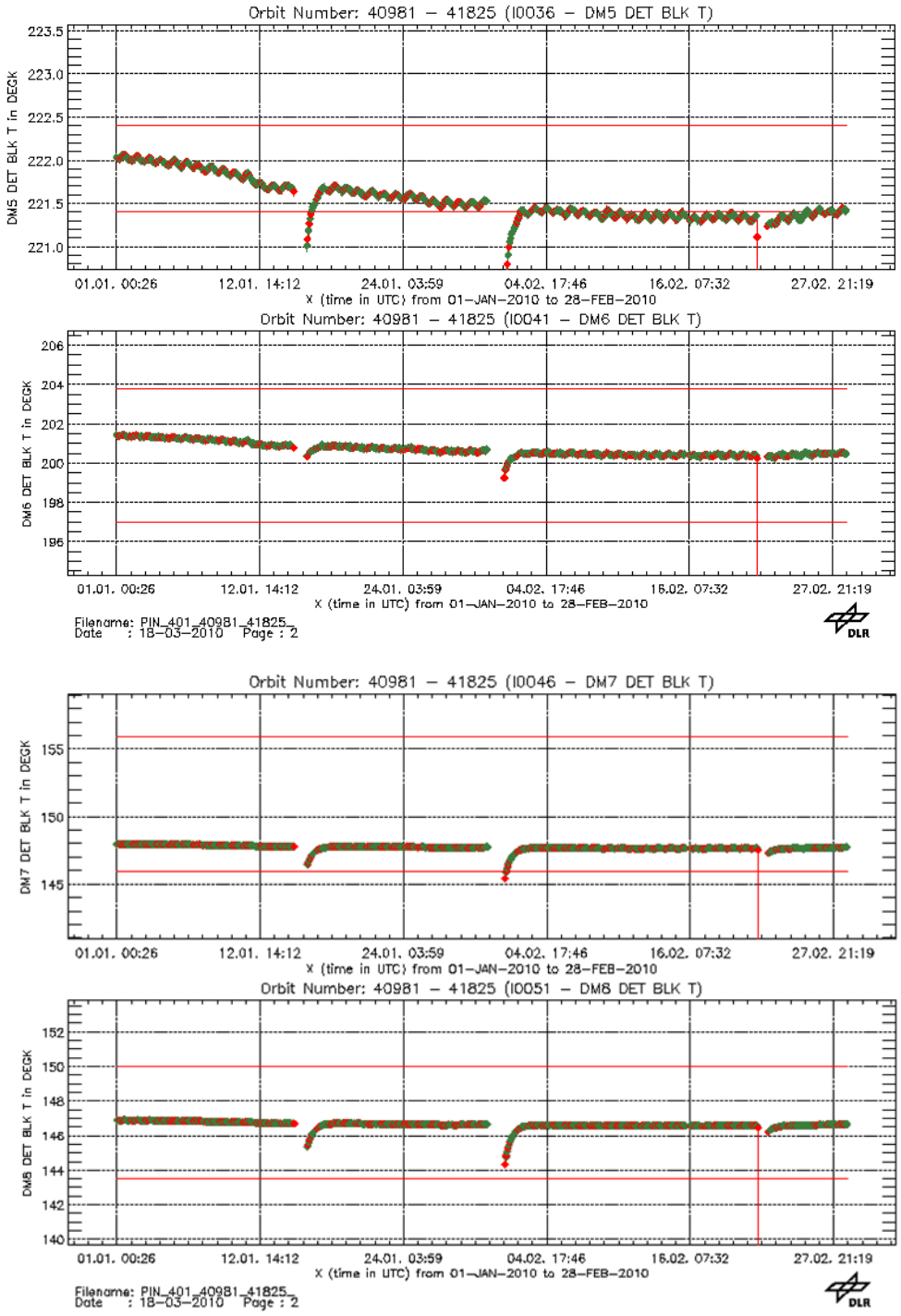


Fig. 3-2: Detector temperatures.

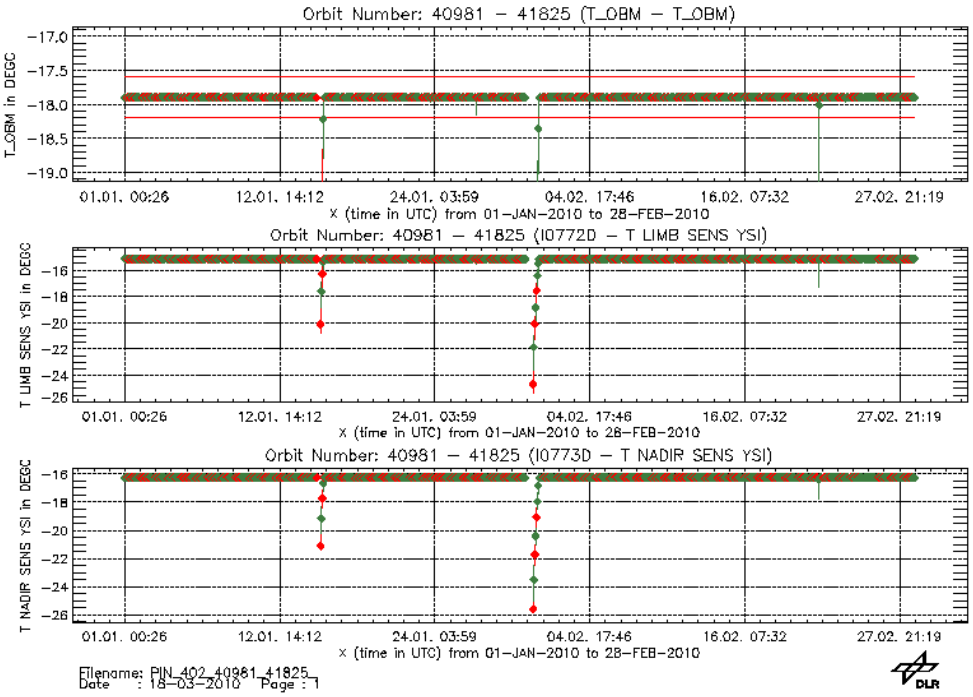


Fig. 3-3: OBM temperatures (top: derived OBM, middle: limb sensor, bottom: nadir sensor).

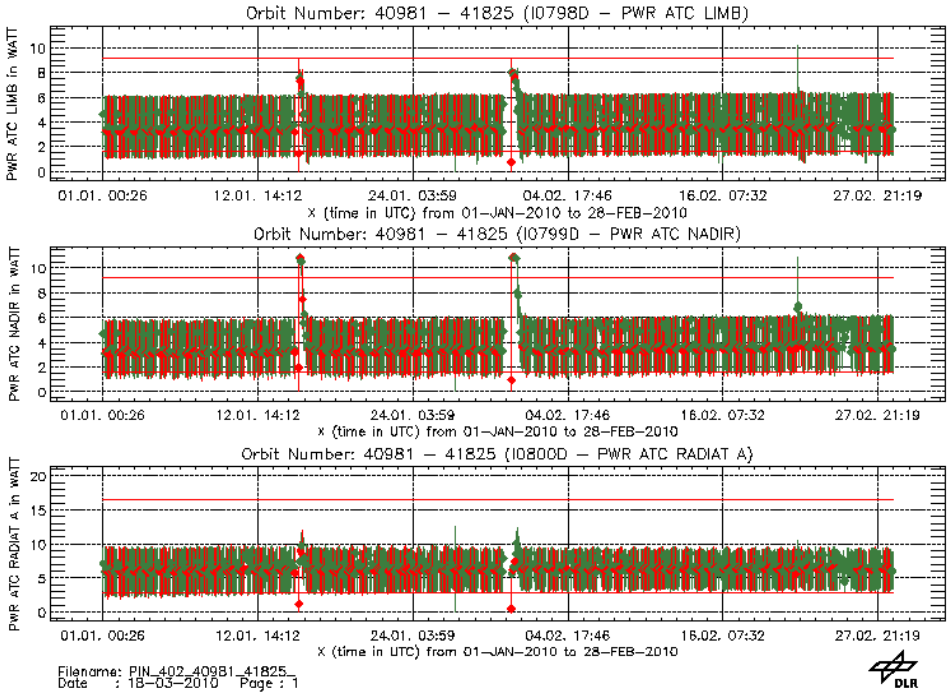


Fig. 3-4: ATC heater power (top: ATC limb, middle: ATC nadir, bottom: ATC Rad A).

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: 0.53
- APSM: 0.49
- NCWM (sub-solar port): 0.85
- WLS (switches): 0.16
- WLS (burning time): 0.31
- SLS (switches): 0.07
- 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 is illustrated in Fig. 3-5. 'EOL' assumes a total mission lifetime until end of 2013.

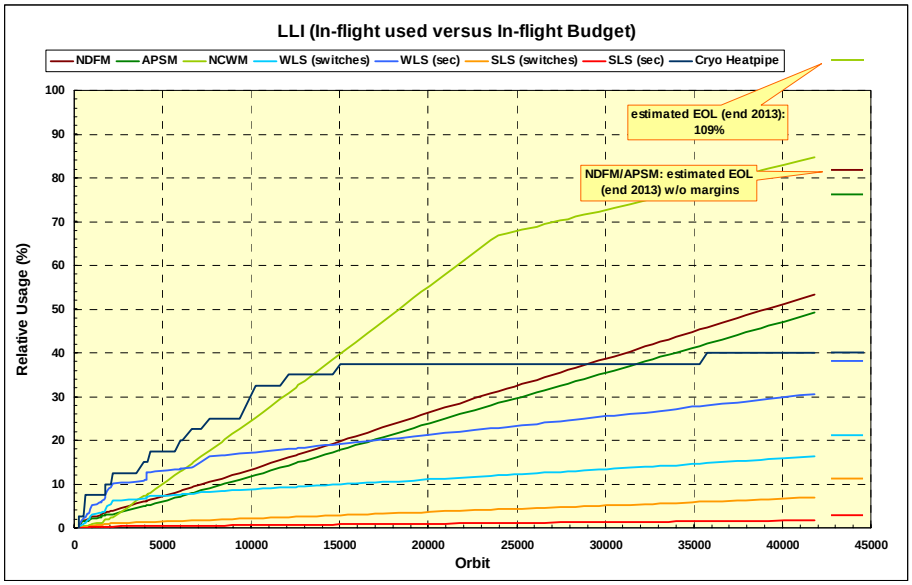


Fig. 3-5: Relative usage of LLIs. 'EOL' is derived for a mission lifetime until 2013. For the NDFM and APSM no margin factors have been applied to derive the EOL relative usage.

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 with respect to 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 manoeuvres cause distinct discontinuities.

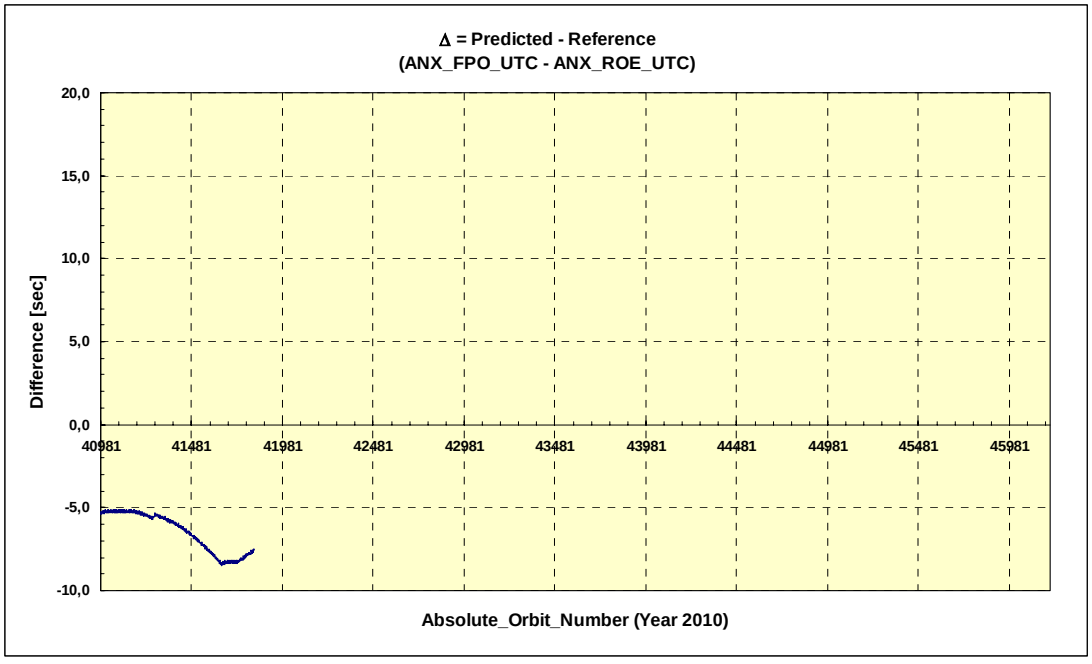


Fig. 3-6: Time difference between predicted and reference time.

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 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 January to February 2010.
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:

- Overall the instrument behaved as expected.
- Three instrument switch-offs occurred in January/February 2010, resulting in data gaps around 16 January, 1 February and 22 February.
- The sharp throughput decrease in the limb light path just before the first gap is due to a solar eclipse occurring at that time.
- The degradation rate in the UV (channels 1 & 2) remains at about 1% per month.
- The minimum average throughput in channel 1 lies currently around 33% (for the limb light path). The throughput of the calibration light path is currently at about 77% in channel 1 and 81% in channel 2.
- The overall degradation of channel 3 is still very small (2 – 8%, depending on light path) compared to channels 1 and 2. A small decrease in throughput of much less than 0.5% is observed within the two months of this report.
- In channels 4 to 8 the throughput remained stable between January and February 2010.
- The throughput in channel 8 is about 70%.

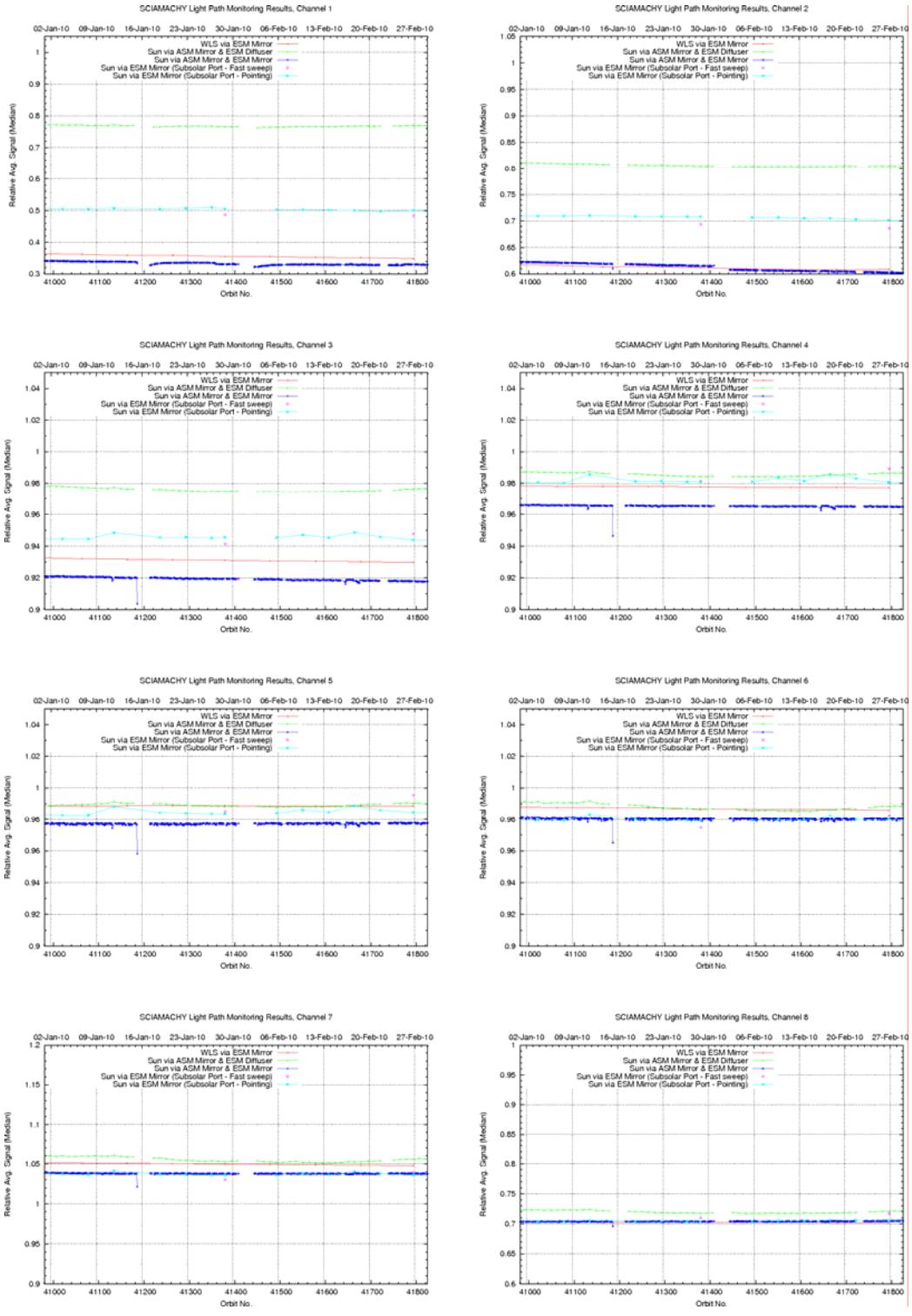


Fig. 3.7: Light path monitoring results January to February 2010 (medians).

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).

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 28 February 2010. Note that a constant dark signal for each of the PMDs has been assumed. To verify this assumption, Fig. 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.

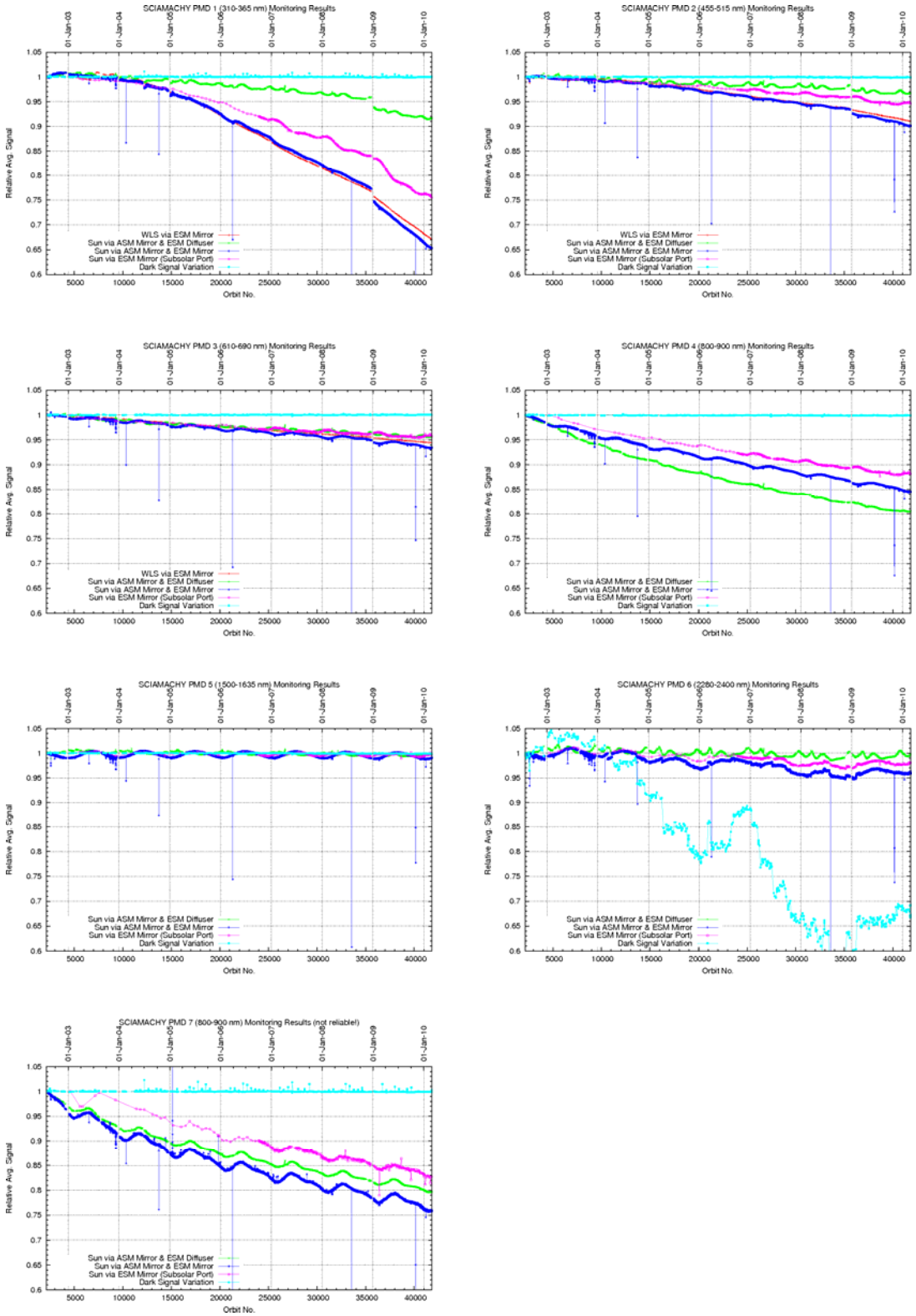


Fig. 3.8: PMD monitoring results August 2002 to February 2010.

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 28 February 2010. 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 minimum throughput is below 40% for the limb and nadir light paths at the short wavelength edge of channel 1 (i.e. below about 300 nm in the nadir light path and 260 nm in limb).
- The minimum throughput 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).
- The throughput of channels 4 to 8 is stable over the whole spectral range (except for the overlaps and dead/bad pixels).

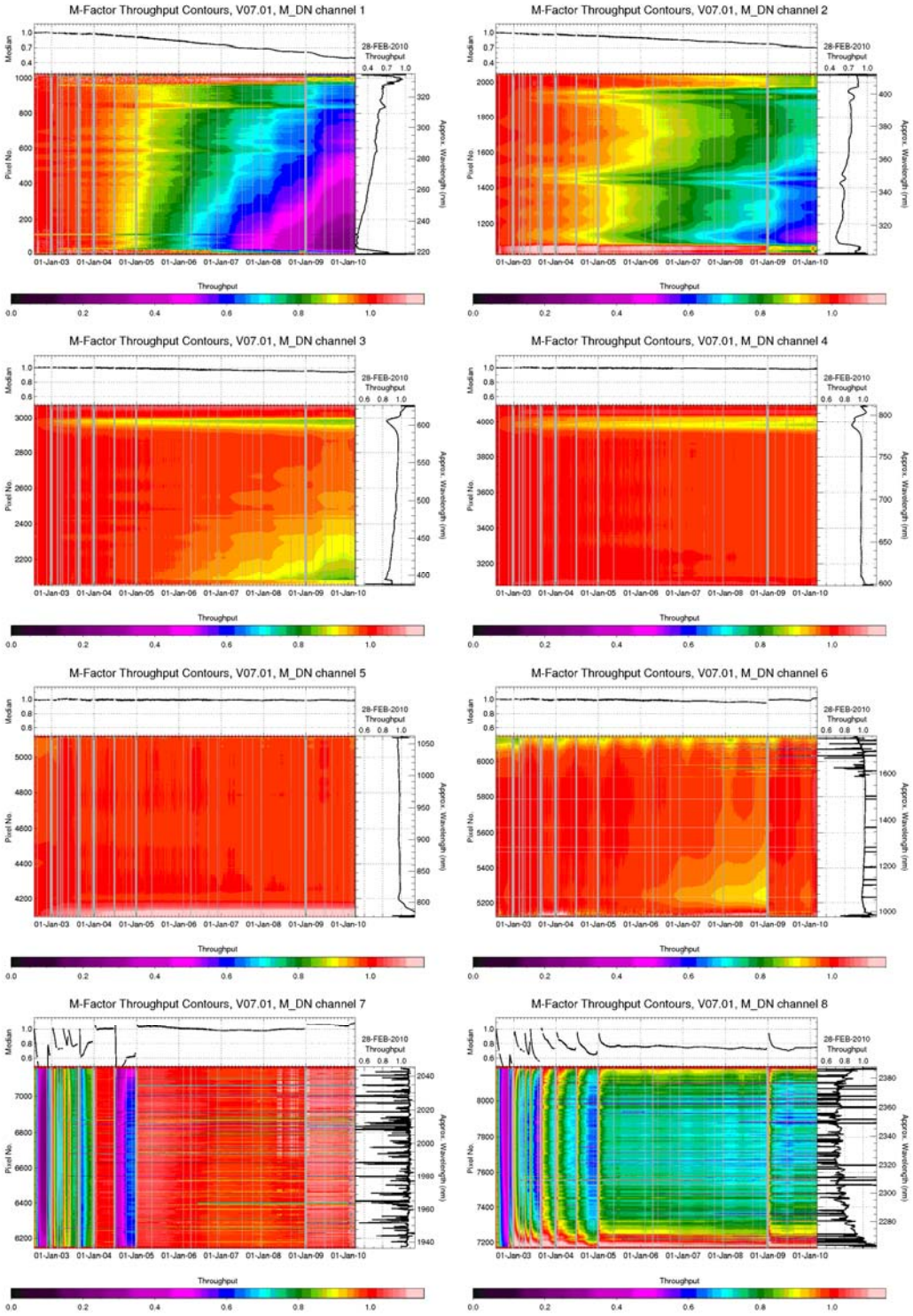


Fig. 4.1: Degradation derived from m-factors August 2002 to February 2010 (nadir light path).

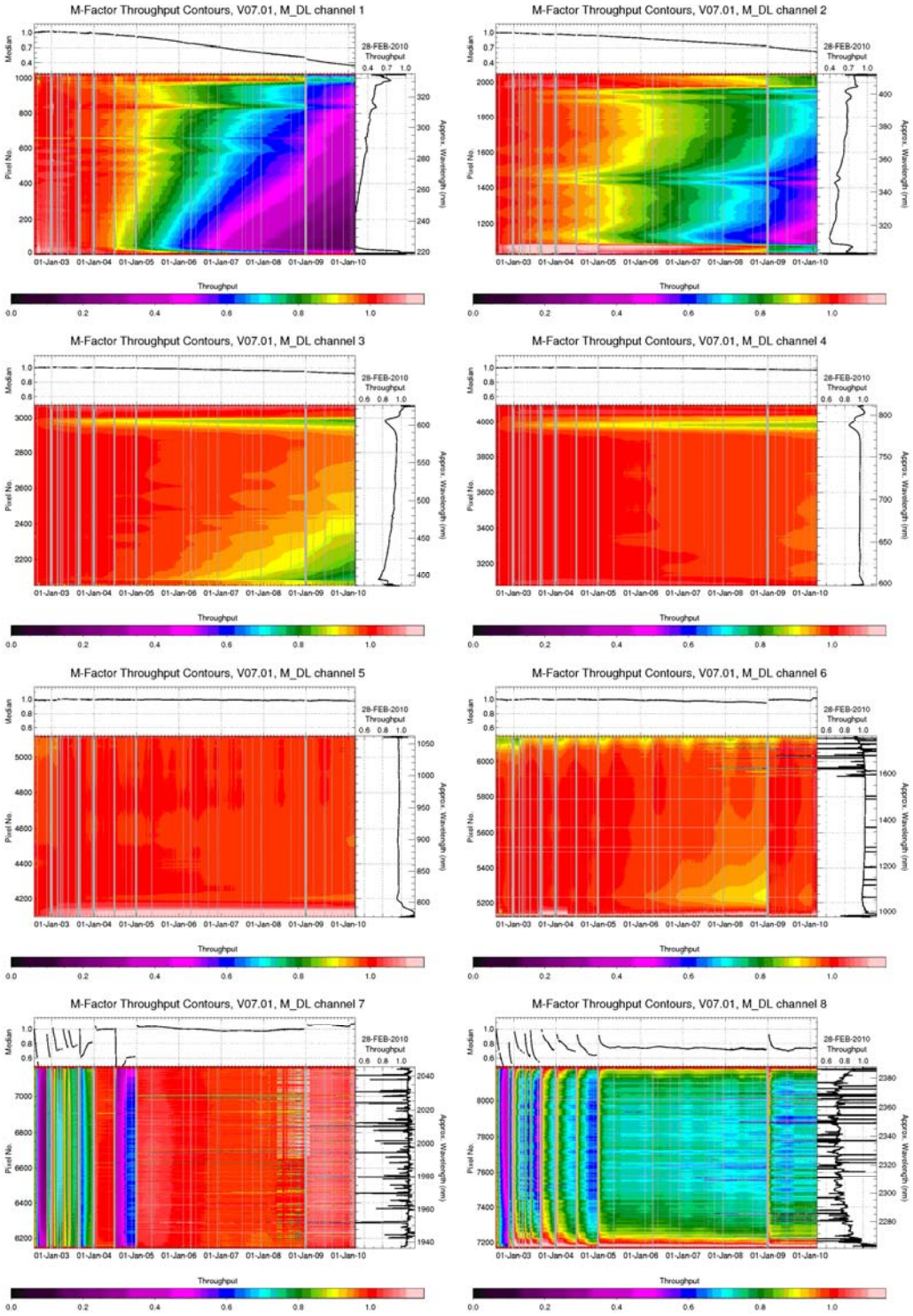


Fig. 4.2: Degradation derived from m-factors August 2002 to February 2010 (limb light path).

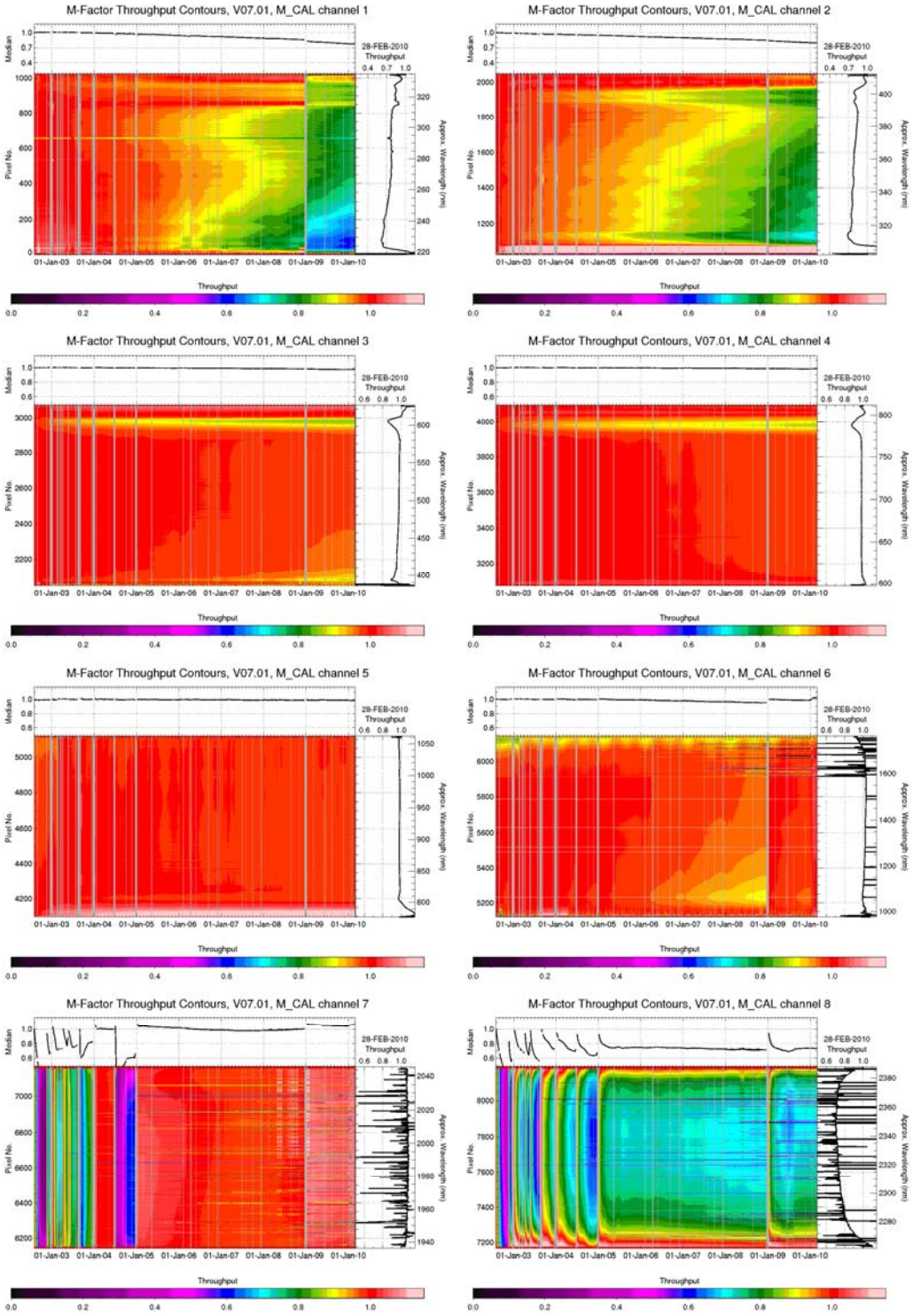


Fig. 4.3: Degradation derived from m-factors August 2002 to February 2010 (calibration light path).

5 DATA AVAILABILITY STATISTICS

5.1 Downlink/Acquisition Performance

Problems are known for the products listed in Table 5.1:

Product	Day	Filename	Description
SCI_NL__0P	26-Feb-10	SCI_NL__0PNPDE20100206_215234_000000022086_00373_41509_0873.N1	sciamachy_source_packets ERROR: incorrect file size

Table 5-1 Products containing format errors.

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 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. Statistics of Level 1 NRT data production are calculated with respect to Level 0 product availability.

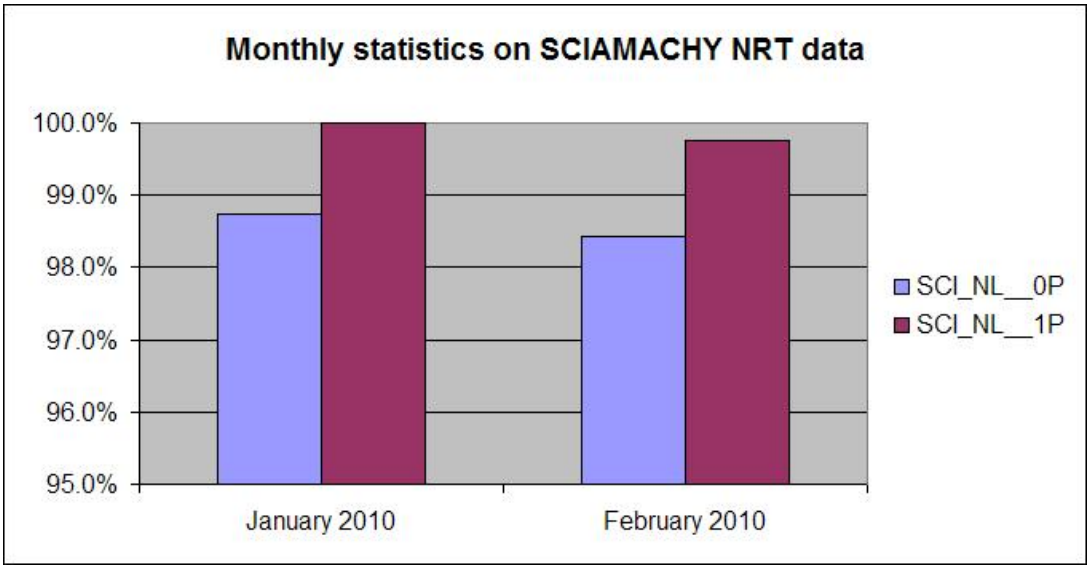


Fig. 5-1: Statistics on available unconsolidated Level 0 and Level 1b products.

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. 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).

The consolidation activity, reprocessing erroneous Level 0 data, has been completed up to year 2008. For year 2009 the recovery will be soon performed.

The overall goal is to achieve a Level 0 consolidated data ‘master set’ 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 checked for completeness and an overview for the months of January and February 2010 is summarised here, considering flight segment and ground segment anomalies. Note that also interfile gaps are considered, but no data gaps inside the products.

The FTP address accessing the data server at D-PAC is ftp-ops-dp.eo.esa.int.

Please, note that with the activation of the new SCIAMACHY Level 1b processor version 7.03, the account to access the off-line consolidated Level 1b product at D-PAC were modified.

The SCIAMACHY historic Level 1b data set from August 2002 to January 2010, processed with the previous processor Version 6 and processing flag "R" (SCI_NL__1PR) has been temporarily migrated to a different user account at DLR (scia1old).

Operational SCIAMACHY Level 1b data products Version 7.03, with the processing flag "U" (SCI_NL__1PU) starting on the sensing orbit 41287 (acquisition day 22/01/2010) are nominally accessible as before (scia1usr account) from the D-PAC FTP server (ftp-ops-dp.eo.esa.int).

Access details for both accounts can be obtained from the Earth Observation Helpdesk.

A new configuration for the data access at D-PAC with a unique account will be set up in the coming months, and users will be informed accordingly.

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
01/2010	40981 – 41424	29	415	415	99.49%
02/2010	41425 – 41825	20	373	381	97.34%

Table 5-2 Consolidated Level 1b statistics.

5.4 Statistics on reprocessed data

5.4.1 Level 1b re-processing

Following the processor switch to IPF 7.03, a re-processing campaign has already started.

The full-mission reprocessing of the SCIAMACHY Level 1 data set with processor version 7.03 covering the time range from August 2002 to the activation of the off-line forward processing (22 January 2010) is expected to be released by summer 2010.

5.4.2 Level 2 re-processing

The beginning of the Level 2 re-processing campaign with the new processor version 5.01 depends on the results from the SCIVALIG and additional validation teams on the validation data set (see Section 9).

6 LEVEL 1 PRODUCT QUALITY MONITORING

6.1 Processor Configuration

6.1.1 Version

The IPF used for the operational processing of near-real-time SCIAMACHY Level 1b data is version 7.03 at Kiruna and ESRIN since 04 February 2010. The same IPF is used for forward processing of Level 1b off-line data at D-PAC and was activated since acquisition data from 22 January 2010, orbit 41287.

IPF 7.03 includes the following changes compared to prior IPF 6.05:

- Stray light Matrix in Channel 2
- Limb mesosphere/thermosphere measurements written to Limb MDS
- Correction of the Scanner encoding values

No format change has been introduced in the new Level 1b product version 7.03.

In 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 on two separate days. The operational Level 2 processor does not process the scientific mesospheric limb measurements.

The radiometric degradation of SCIAMACHY can be compensated using m-factors, calculated from the new NRT Level 1b data Version 7.03. M-factors are not part of the Level 1b product and are not used at present in the L0-1b processing itself. They are applied in the Level 2 data processing. The m–factors are provided by an external database accessible at http://www.iup.uni-bremen.de/sciamachy/mfactors/.

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

The Product Quality Disclaimer at
http://envisat.esa.int/dataproducts/availability/disclaimers/SCI_NL__1P_Disclaimers.pdf
was updated corresponding to the new IPF version 7.03 and describes known artefacts as well as major improvements with respect to the previous IPF version 6.05.

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.

IPF Version	Description	Proc Centre	Date	Start Orbit
7.03	Following changes are implemented with IPF 7.03: • Degradation correction using m-factors implemented in SciaL1c. • Improved spectral stray light correction using a matrix approach in channel 2. • Mesospheric Limb Measurements • Correction of the Scanner encoding values	D-PAC	22-JAN-2010	41287
		PDHS-E	04-FEB-2010	41479
		PDHS-K	04-FEB-2010	41472
6.05	No evolution in the algorithm has been introduced with IPF 6.05 but the processor was ported from AIX to LINUX.	D-PAC	05-OCT-2009	39634
		PDHS-E	29-SEP-2009	39633
		PDHS-K	29-SEP-2009	39639
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

Tab. 6-1: Processor version and main changes.

6.1.2 Anomalies

Details on anomalies affecting SCIAMACHY Level 1b products can be found at http://earth.eo.esa.int/pcs/envisat/sciamachy/reports/anomalies/.

6.1.2.1 Level 1b OFL products 7.03 generated with outdated ADFs

The presence of outdated auxiliary files in the D-PAC archive led to incorrect Level 0 to Level 1b processing with IPF 7.03 during the SCIAMACHY full mission reprocessing campaign. The wrong SCIAMACHY Level 1b off-line products (660 SCI_NL_1PU products with time range 2003 – 2009) had been by mistake available for download on the D-PAC FTP server in the period 10-20 March 2010. Products have been removed

from D-PAC archive and will be generated with correct ADFs. For more details see http://earth.eo.esa.int/pcs/envisat/sciamachy/reports/anomalies/A_05.html

6.1.2.2 SCI_SU1_AX without update of D1 spectra

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

January 2005,	orbits 15154-15166
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 in the Level 1b products. Analysis of this problem could confirm that the spectra were measured. Please note, that for operational Level 1b – Level 2 off-line processing the D1 spectrum is not used.

With the new reprocessing cycle for IPF version 7.03 also with the calibration tool SciCal version 2.2, the Level 1b products will correctly contain the D1 spectra updated also in the above time periods.

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 and LK1 ADFs generated operationally with SciCal. It has to be noted that unavailability periods are excluded from statistics. Generation of SU1 and LK1 ADFs for January and February 2010 was below 100 %. The ADF statistics are calculated by dividing the number of ADFs by the number of available (to SciCal) Level 0 products. 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.

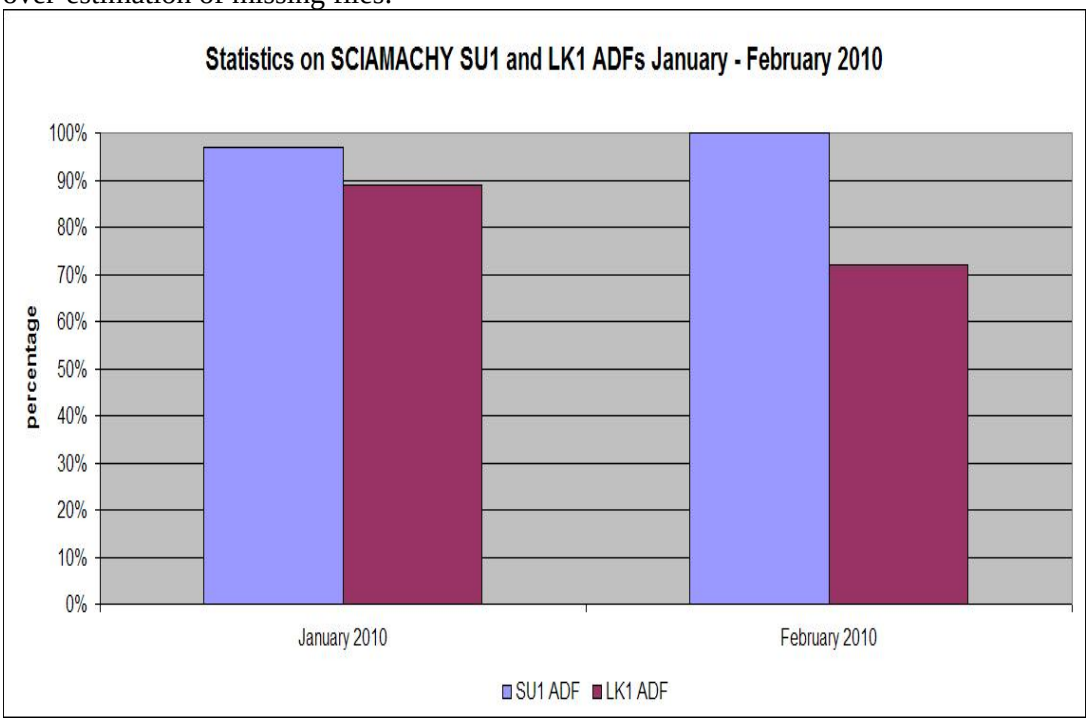


Fig. 6-1: Statistics on SU1 and LK1 processing.

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).

Figures From 6-2 to 6-5 show the ratios of SMR spectra derived from calibrated SMR/ESM (D0) during the months January - February 2010. 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:

- **January 2010**
  Reference SMR - 01 January 2010
  SMR used for ratios: 02, 03, 04, 05, 06, 07, 08, 09, 10, 14, 21, 30 January 2010
- **February 2010**
  Reference SMR - 01 February 2010
  SMR used for ratios: 02, 03, 04, 05, 06, 07, 08, 09, 10, 14, 21, 28 February 2010

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.

Figures 6-6 and 6-7 show SMR ratios on a long term trend dividing the ESM spectra from days 30 January 2003 and 30 January 2010, respectively 28 February 2003 and 28 February 2010.
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 and available at http://www.iup.uni-bremen.de/sciamachy/LTM/LTM_spectral/LTM_spectral.html.

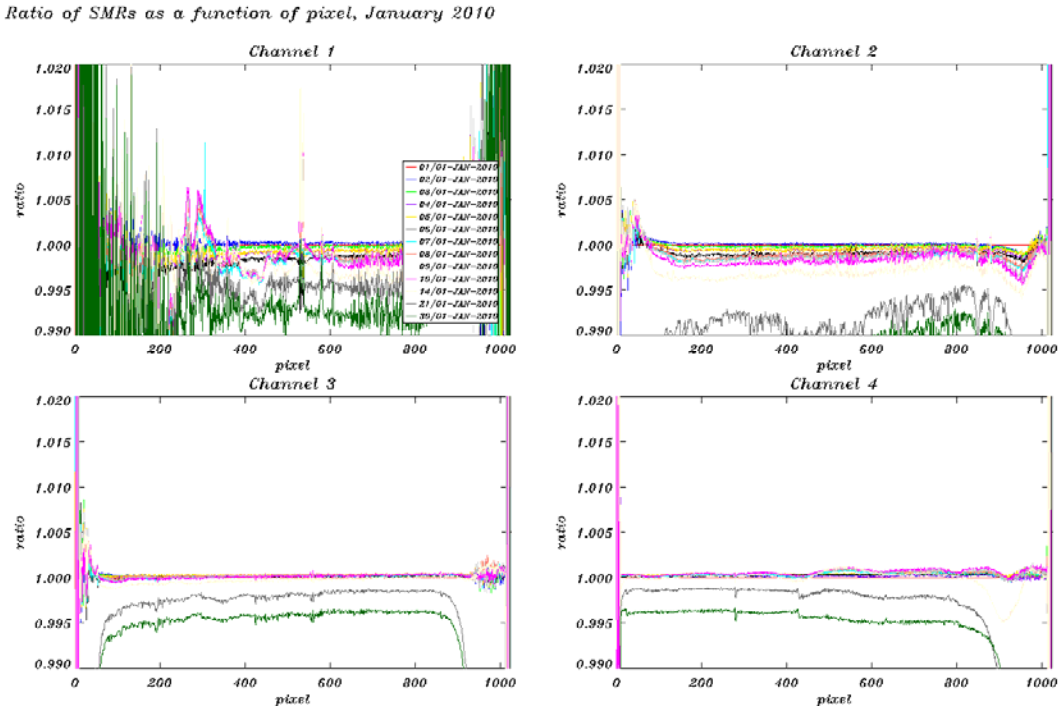


Fig. 6-2: SMR ratios per detector channel 1-4 (changes during January 2010).

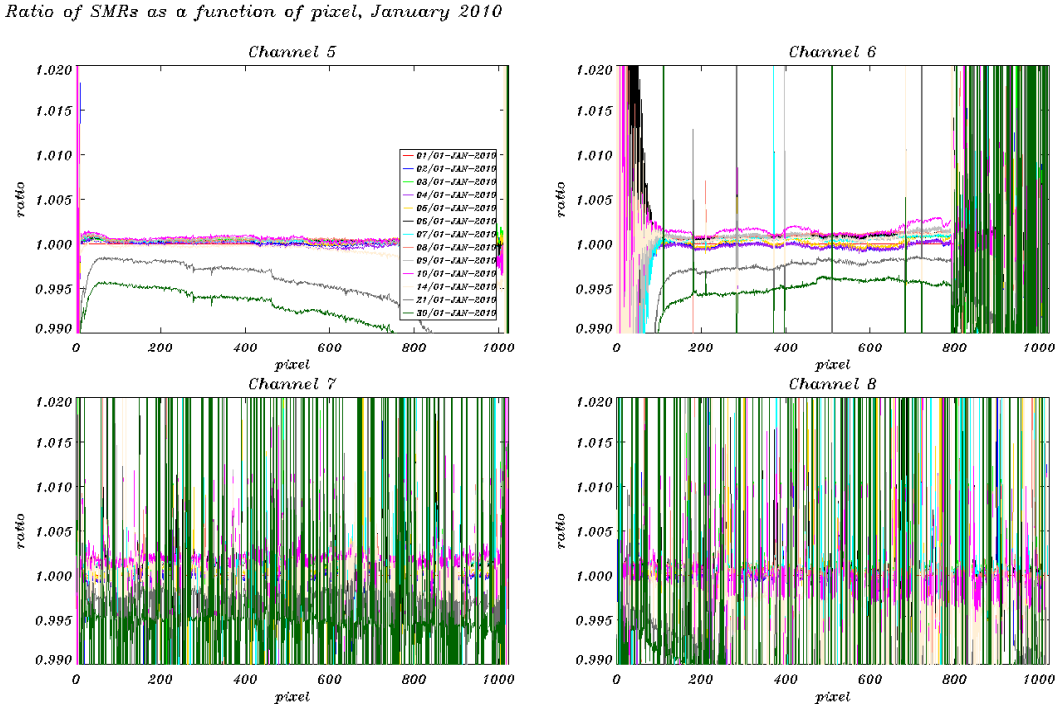


Fig. 6-3: SMR ratios per detector channel 5-8 (changes during January 2010).

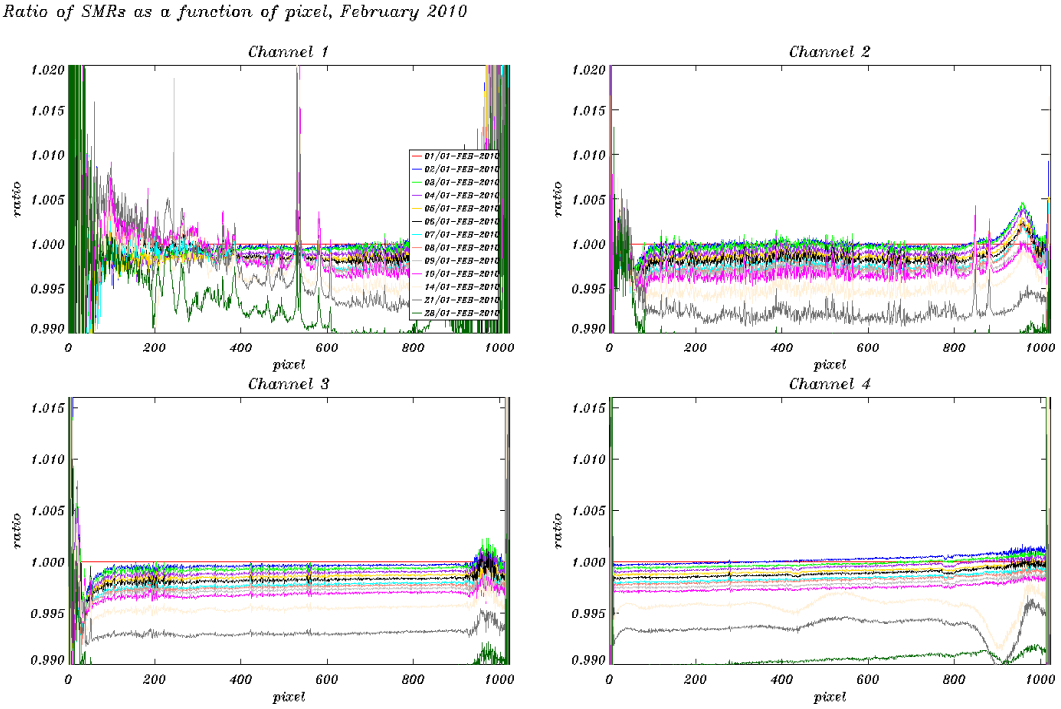


Fig. 6-4: SMR ratios per detector channel 1-4 (changes during February 2010).

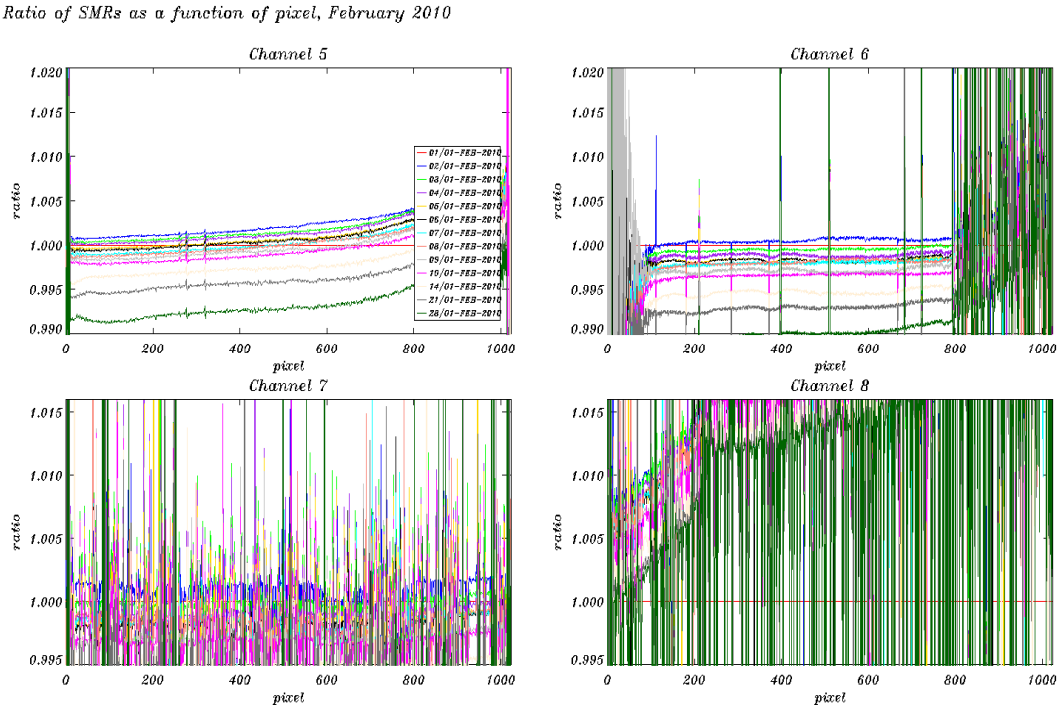


Fig. 6-5: SMR ratios per detector channel 5-8 (changes during February 2010).

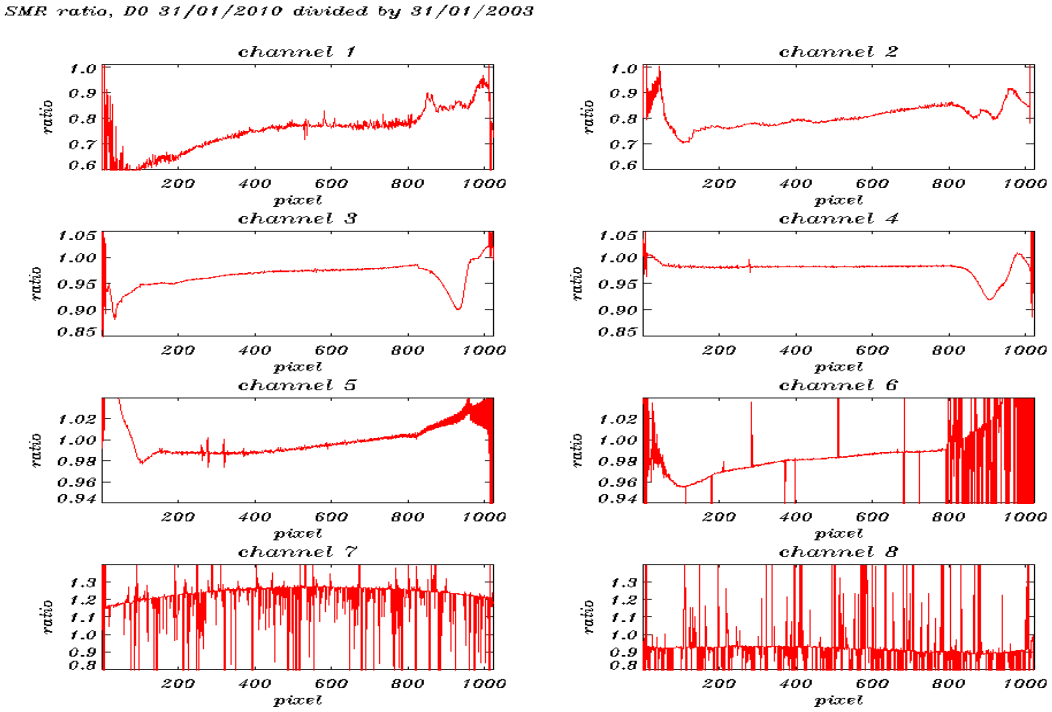


Fig. 6-6: SMR ratios per detector channel on Long Term Trend 30/01/2010 divided by 30/01/2003.

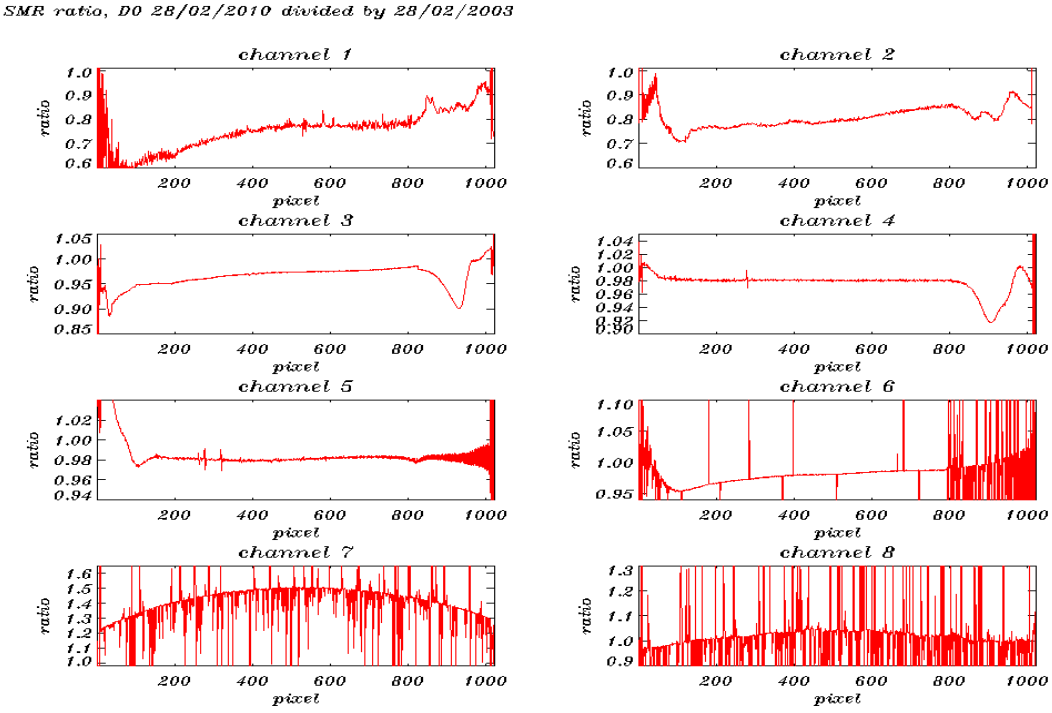


Fig. 6-7: SMR ratios per detector channel on Long Term Trend 28/02/2010 divided by 28/02/2003.

6.2.1.2 LK1 analysis

6.2.1.2.1 Leakage Constant part

On an orbital basis a leakage current calibration is performed, if measurement data do not lie in the South Atlantic Anomaly region.
In Fig. 6-8 to Fig. 6-11 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.
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 6.2.1.2.2).

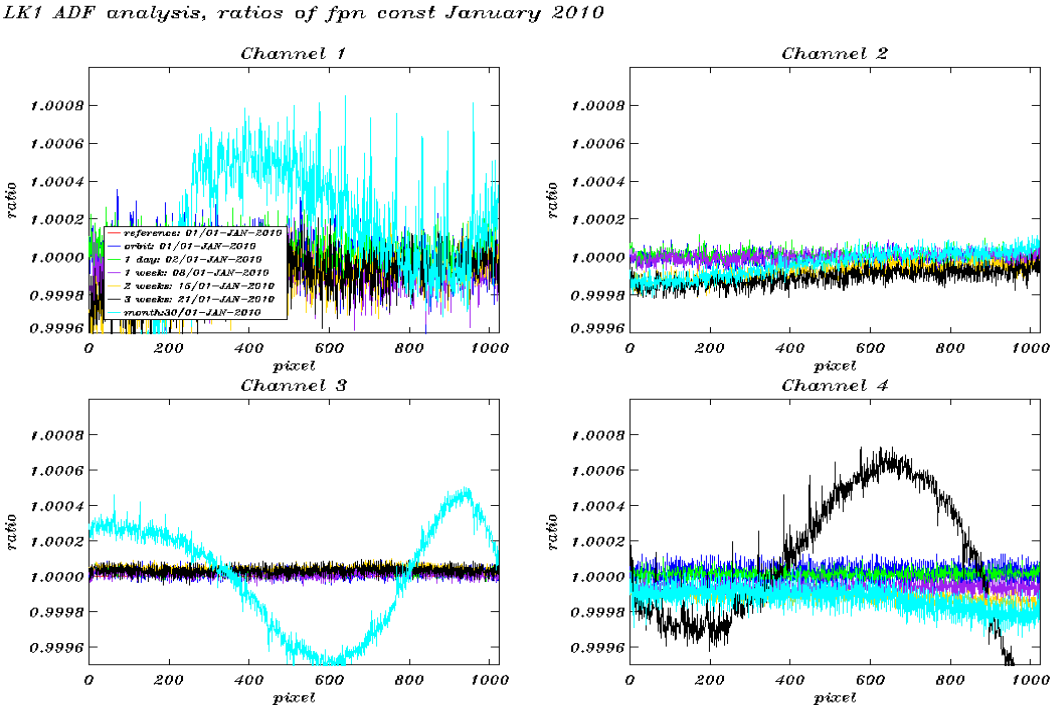


Fig. 6-8: Dark current ratios (constant part) channel 1-4 during January 2010. Reference Spectrum used: Orbit 40984, 01 January 2010.

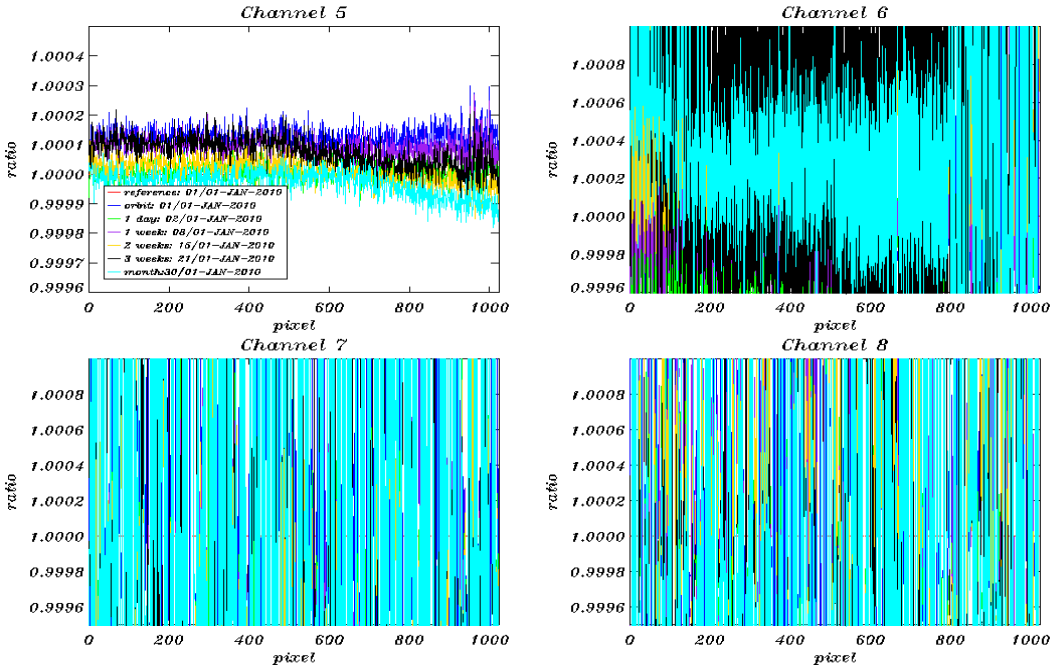


Fig. 6-9: Dark current ratios (constant part) channel 5-8 during January 2010. Reference Spectrum used: Orbit 40984, 01 January 2010.

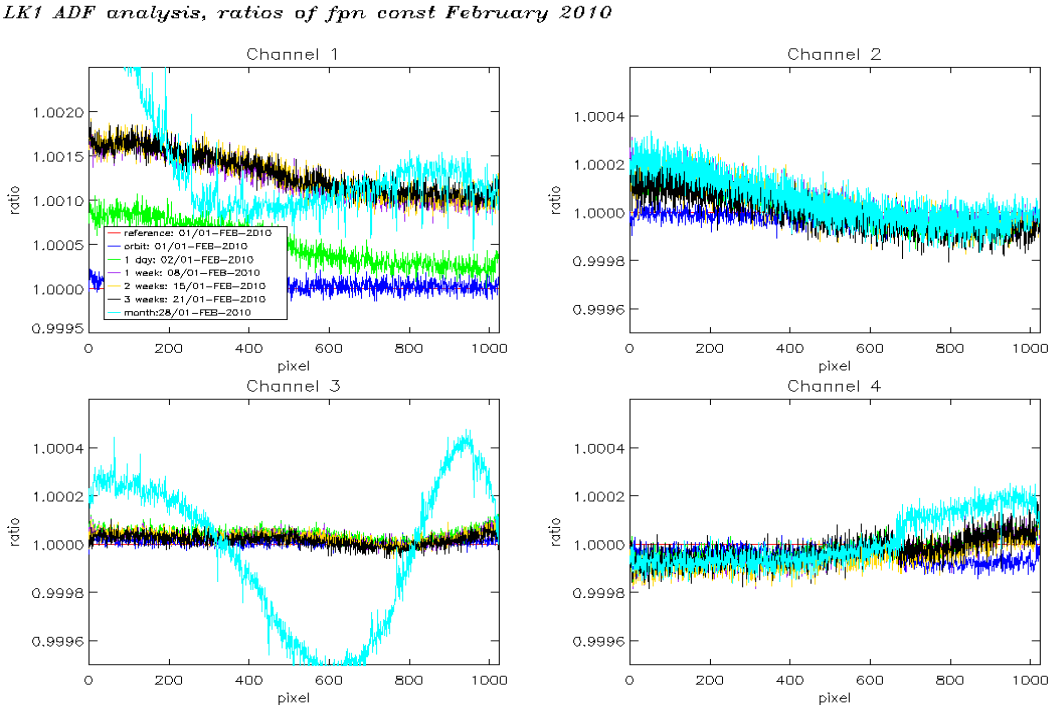


Fig. 6-10: Dark current ratios (constant part) channel 1-4 during February 2010. Reference Spectrum used: Orbit 41430, 01 February 2010

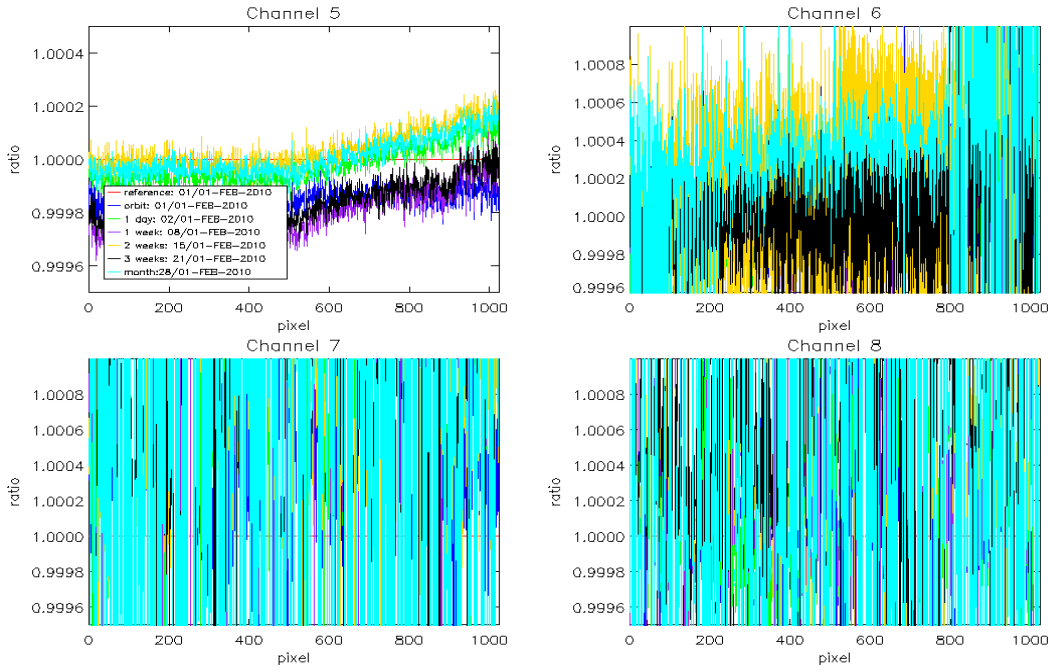


Fig. 6-11: Dark current ratios (constant part) channel 5-8 during February 2010. Reference Spectrum used: Orbit 41430, 01 February 2010.

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_ADF during the time span from 01 January 2010 to 28 February 2010. The leakage variation for a selected pixel (222) in channel 7 corresponding to orbit phase 6 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 between orbits:

- 41378-41382 (28/29-Jan-2010)
- 41793-41797 (26/27-Feb-2010)

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

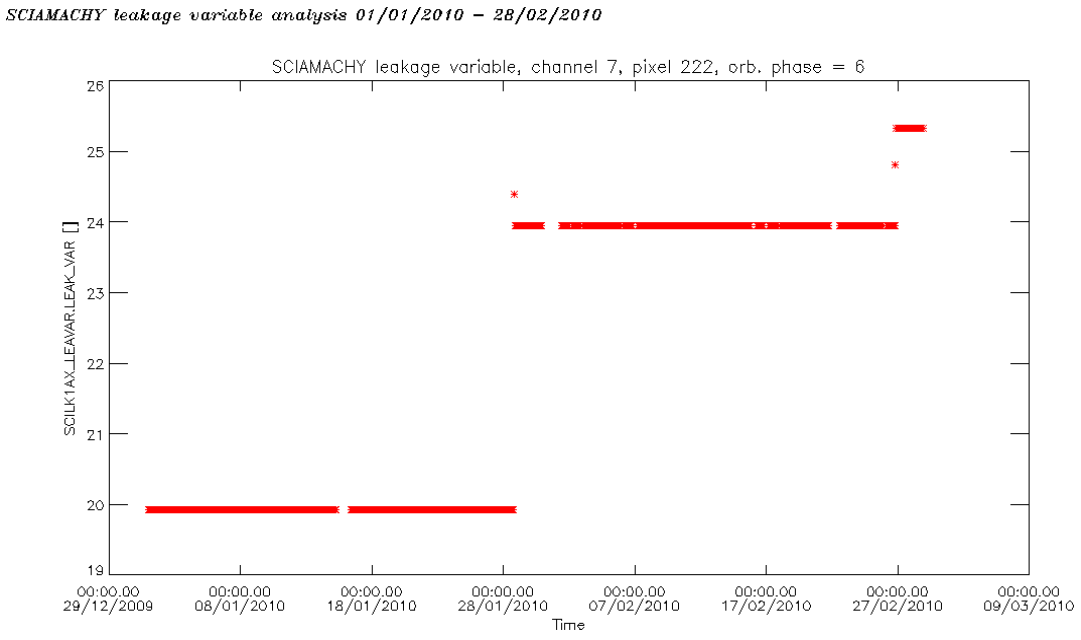


Figure 6-12: Leakage variable part, SCI_LK1_AX, 01 January – 28 February 2010, channel 7, orbit phase 6, pixel 222.

6.3 Bad and Dead Pixel Mask

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 PPG 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 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.

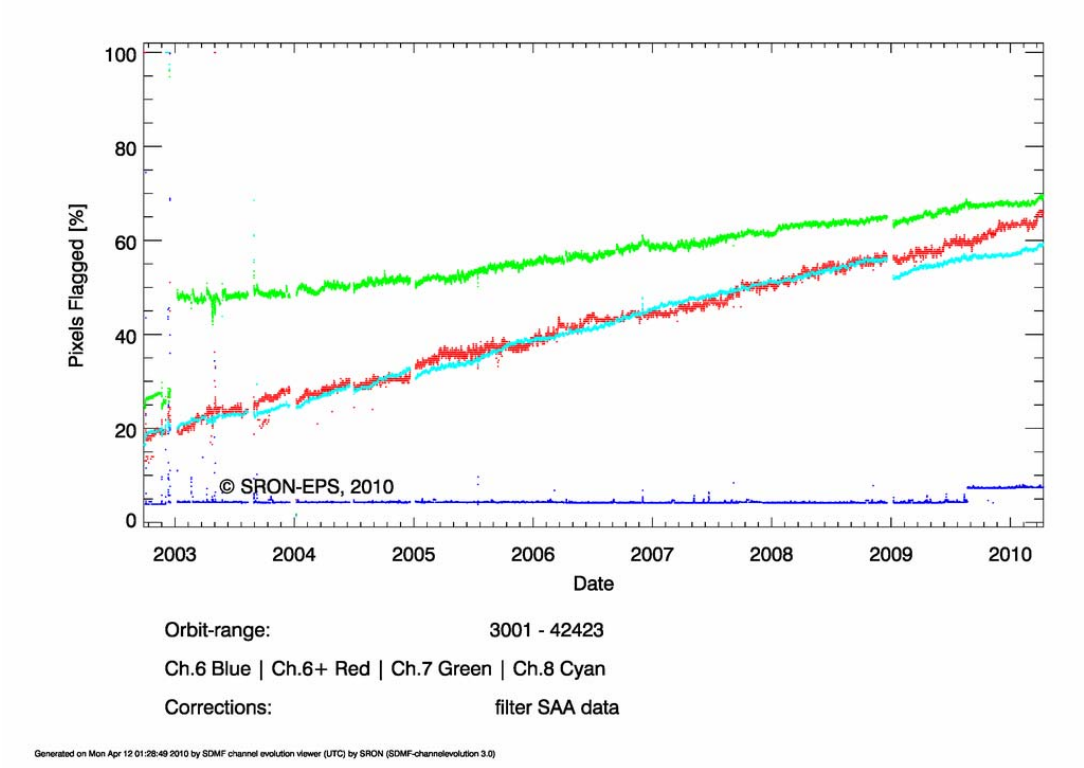


Figure 6-13: Number/Fraction of pixels that is flagged as bad by the SDMF smoothmask for channels 6 (blue), 6+ (red), 7 (green) and 8 (cyan). Orbits during SODAP or decontaminations have been removed. Note the temporary decrease in the number of bad pixels after the last decontamination, for channel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

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

The current Level 2 off-line processing version is 5.01 since 09 February 2010 in alignment with the activation of the Level 1b IPF 7.03 in the off-line processing chain at D-PAC.

The new processor version introduces the following changes:

- M-Factors implemented in Level 1b-2 processing step
- Changes in the NO_2 retrieval settings
- New AAI algorithm
- Improvements in Limb retrieval
- Nadir SO2 total columns for anthropogenic and “volcanic” scenarios
- Nadir BrO total columns
- Nadir H_2O total columns
- Nadir CO columns
- Nadir OClO slant columns
- Limb BrO profile
- Limb Cloud product

Note that the new version includes an update in the Level 2 data format.

The Product Specification corresponding to the Level 2 off-line processor 5.01 is Volume 15, issue 3L, version 1.1 *[2]* and can be found at
http://earth.eo.esa.int/pub/ESA_DOC/ENVISAT/Vol15_Sciamachy_3L_1.1.pdf

The Product Quality Disclaimer at
http://envisat.esa.int/dataproducts/availability/disclaimers/SCI_OL__2P_Disclaimers.pdf
has been updated in relation to the new processor version 5.01 and describes known artefacts.

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_3, NO_2 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
5.01	Main processor changes: • Nadir MDS now contain additional trace gas columns: SO2, BrO, H2O, OClO and CO. • Limb MDS now contain the trace gas profiles of BrO. • Limb Cloud MDS Contains height resolved indicators for cloud presence and type (water clouds, PSCs and NLCs).	D-PAC	23-JAN-2010	41295
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 O_3 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 and Aerosol MDS • Scaling of too large NO_2 error estimate	D-PAC	23-SEP-2007	29092

3.00	• Nadir UV/Visible algorithm for ozone and NO_2 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 NO_2 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 8-1: Level 2 off-line Processor Configuration.

8.1.2 Anomalies

No significant anomalies in this reporting period.

8.1.3 Auxiliary Data Files

Input for Level 2 off-line processing is the so-called Initialization File. For processor version 5.01 a new Initialization file became active which is
SCI_IN__AXNPDE20090615_120000_20090615_000000_20991231_235959
This ADF is usually changed only in case of a processor upgrade.

8.2 Monitoring results

8.2.1 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. Figures 8-1 and 8-3 show the monthly world map plots for January and February 2010.

Please, note that for January 2010 SCIAMACHY Level 2 products version 3.01 are still used while the new products (version 5.01) are adopted for February 2010.

Figures 8-2 and 8-4 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. From the comparison between Figures 8-2 and 8-4 can be noticed the improvement obtained with the new processor with the reduction of the error associated to NO_2 mean VCDs.

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.

8.2.1.1 Nadir: VCD NO_2 map January 2010

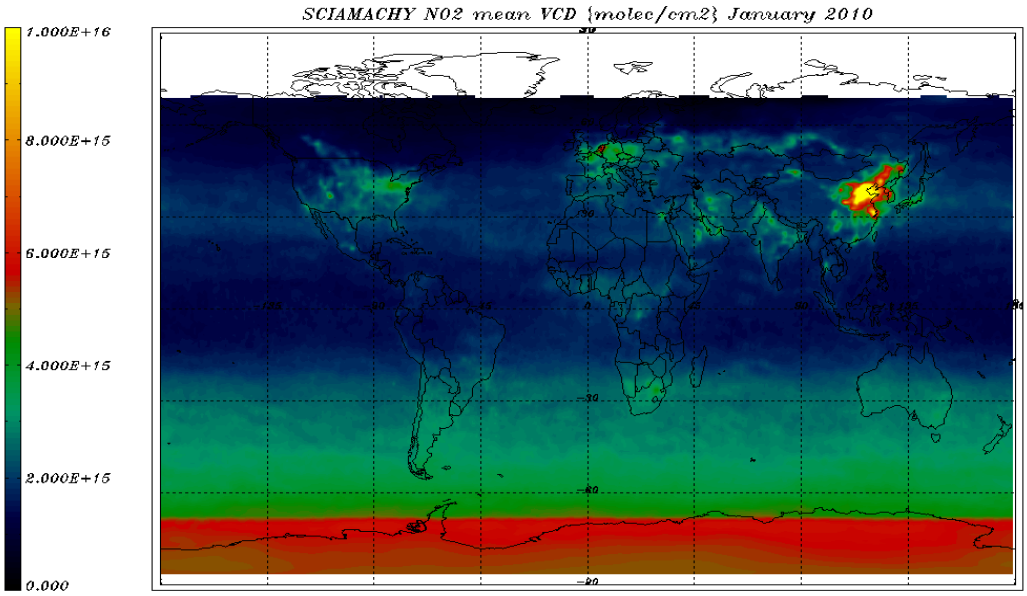


Figure 8-1: NO_2 VCD world map for 01 - 30 January 2010 – monthly average.

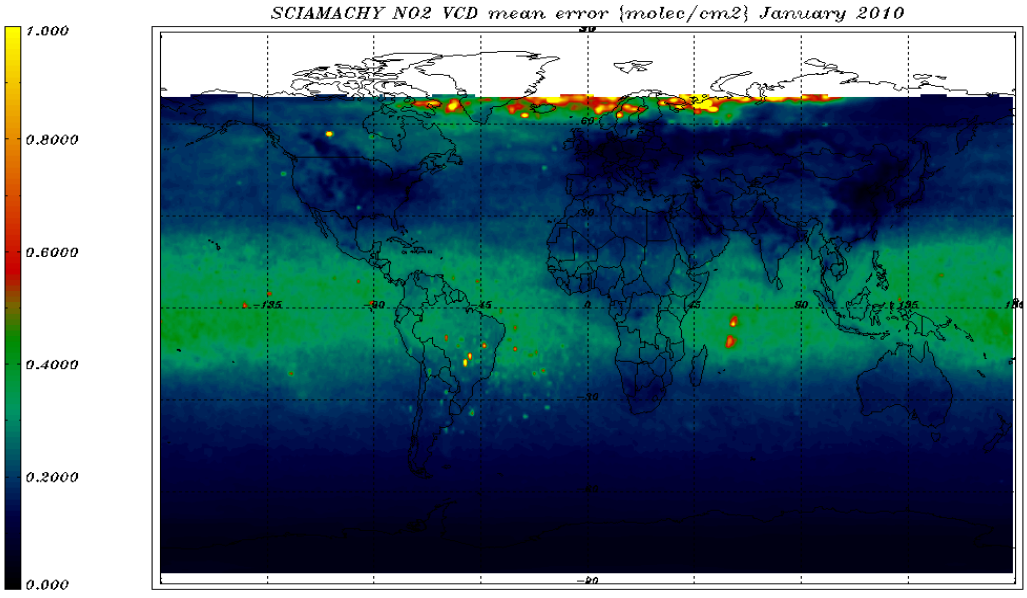


Figure 8-2: NO_2 VCD error for 01 - 30 January 2010 - monthly average.

8.2.1.2 Nadir: VCD NO2 map February 2010

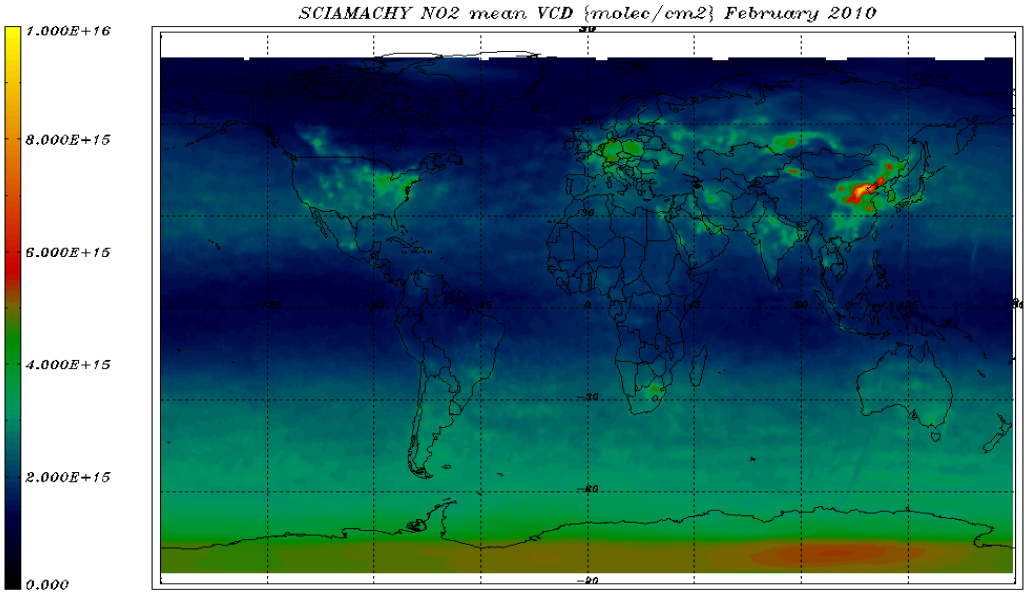


Figure 8-3: NO_2 VCD world map for 01 – 28 February 2010 – monthly average.

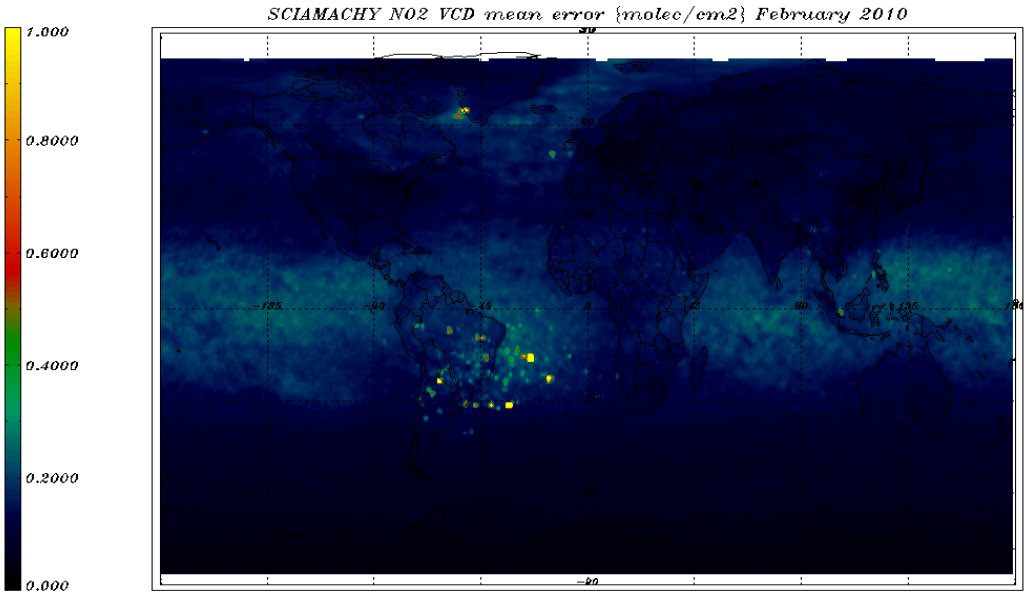


Figure 8-4: NO_2 VCD error for 01 – 28 February 2010- monthly average.

8.2.2 Nadir: O_3 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. Figures 8-5 and 8-7 show the ozone distribution converted in Dobson units for January and February 2010.
The VCD errors as monthly average plots are shown in Figures 8-6 and 8-8. The errors are given in relative fraction. Systematically higher error values at the North Pole area are visible.

Please, note that for January 2010 SCIAMACHY Level 2 products version 3.01 are still used while the new products version 5.01 are adopted for February 2010.

8.2.2.1 Nadir: VCD O_3 map January 2010

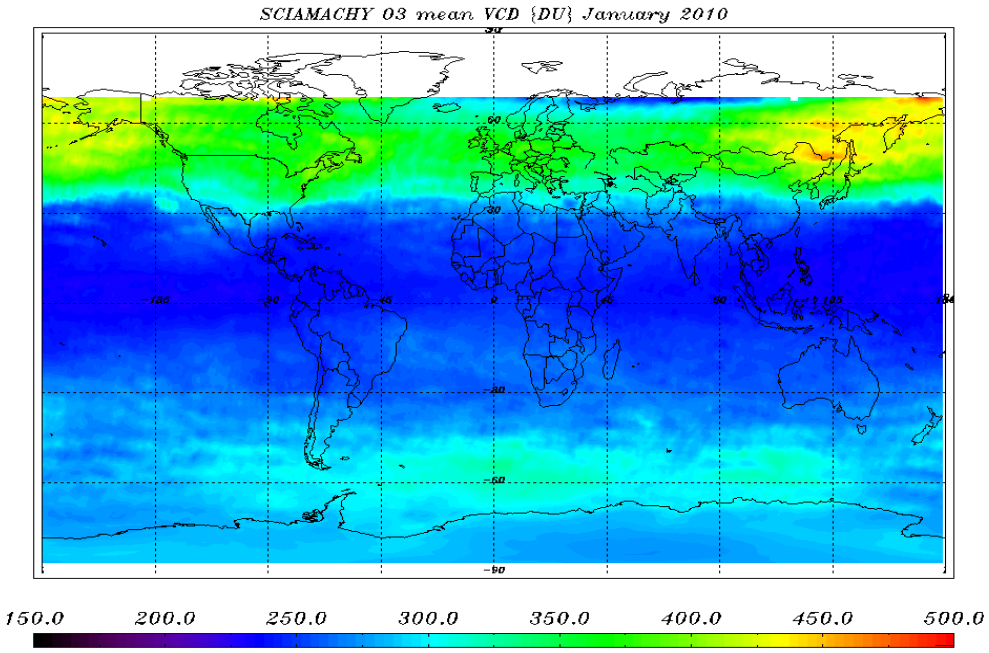


Figure 8-5: O_3 VCD world map for 01 - 30 January 2010 – monthly average.

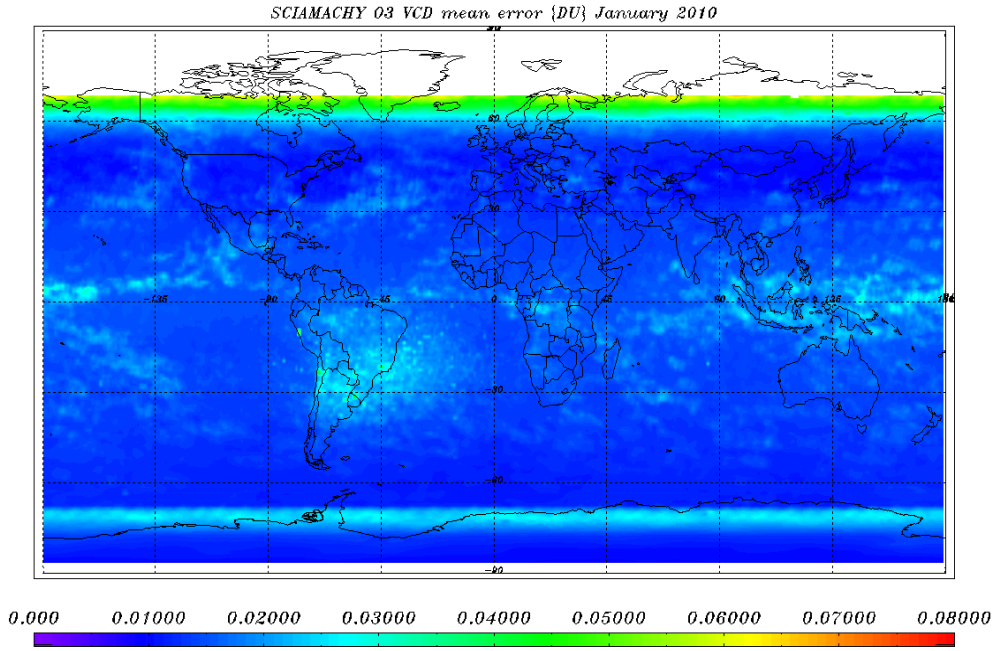


Figure 8-6: O3 VCD error for 01 - 30 January 2010 - monthly average.

8.2.2.2 Nadir: VCD O3 map February 2010

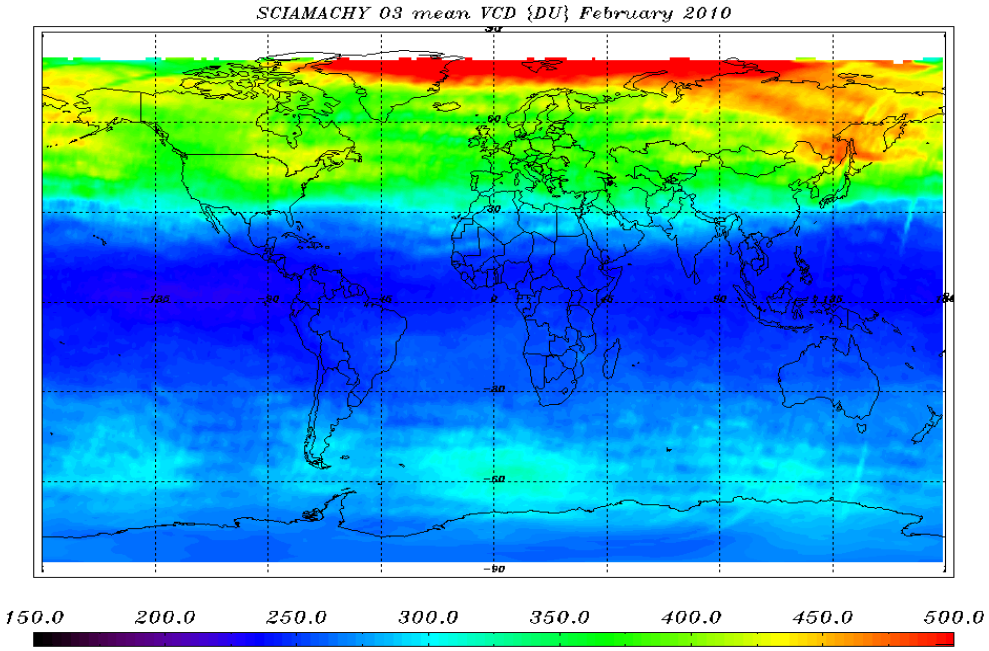


Figure 8-7: O_3 VCD world map for 01 - 28 February 2010 – monthly average.

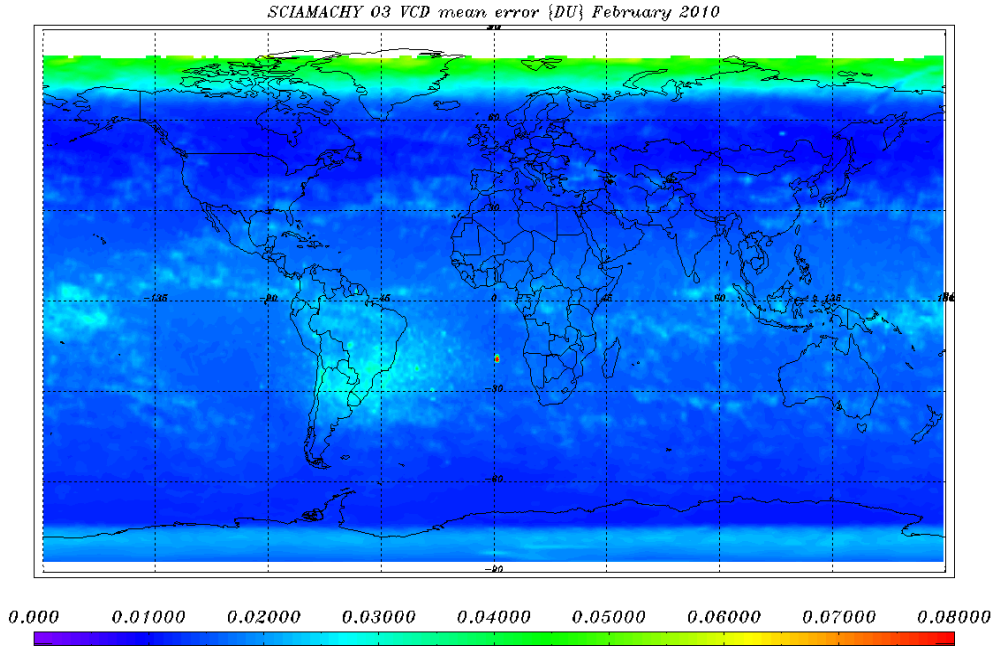


Figure 8-8: O_3 VCD error for 01- 28 February 2010 - monthly average.

8.2.3 Nadir: H_2O consistency checking

The world map plot of Nadir H_2O vertical column density (VCD) values in g/cm^2 averaged over one month is generated from the SCI_OL__2P Nadir products version 5.01. Figure 8-9 shows the monthly world map plot for February 2010.
Figure 8-10 shows the VCD error for the monthly average plot. Errors are absolute values (g/cm^2).

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.

8.2.3.1 Nadir: VCD H_2O map February 2010

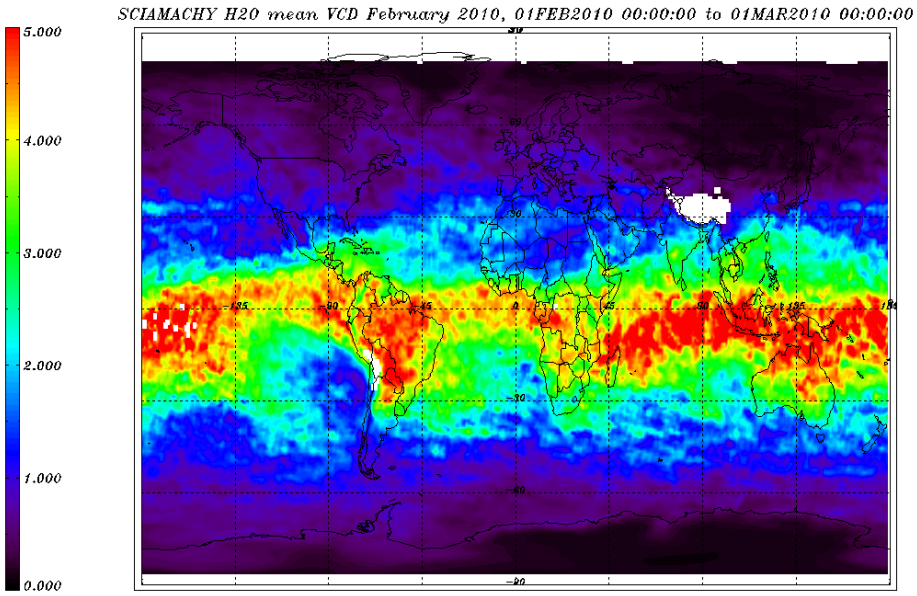


Figure 8-9: H_2O VCD world map for 01 – 28 February 2010 – monthly average.

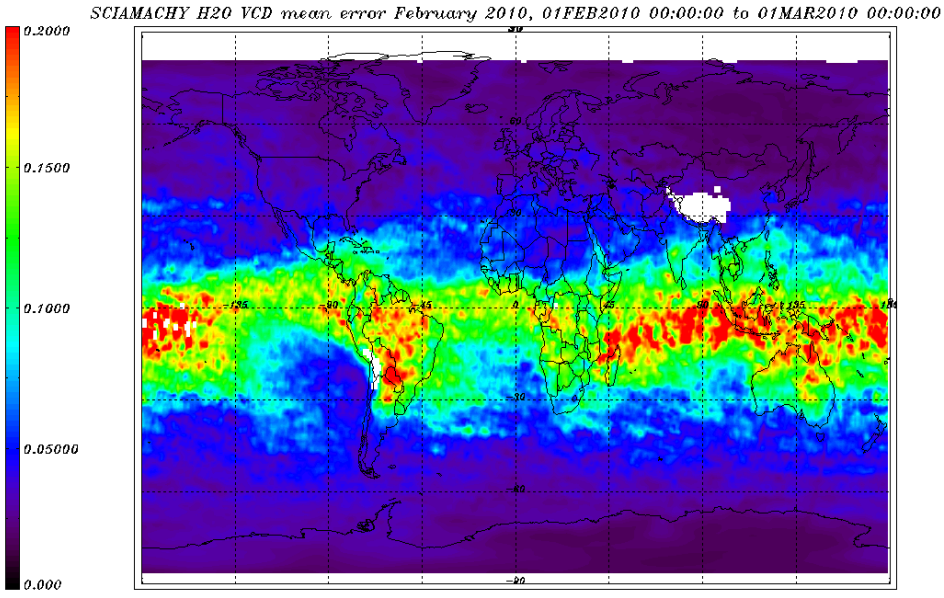


Figure 8-10: H_2O VCD error for 01 – 28 February 2010- monthly average.

8.2.4 Nadir: BrO consistency checking

The world map plot of Nadir BrO vertical column density (VCD) values averaged over one month is generated from the SCI_OL__2P Nadir products version 5.01. Figure 8-11 shows the monthly world map plot for February 2010. Figure 8-12 shows the VCD errors for the monthly average plot. Errors are given in relative fraction.

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.

8.2.4.1 Nadir: VCD BrO map February 2010

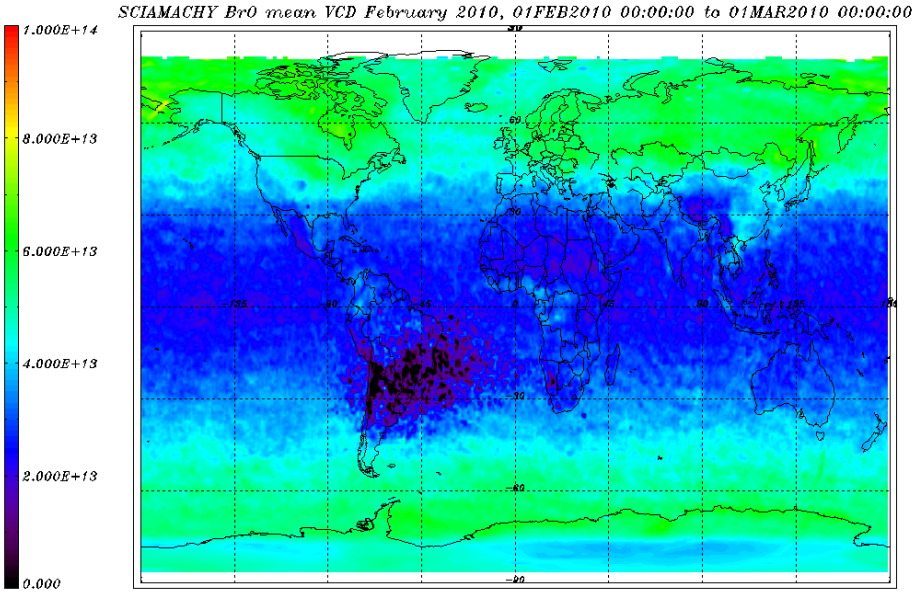


Figure 8-11: BrO VCD world map for 01 – 28 February 2010 – monthly average.

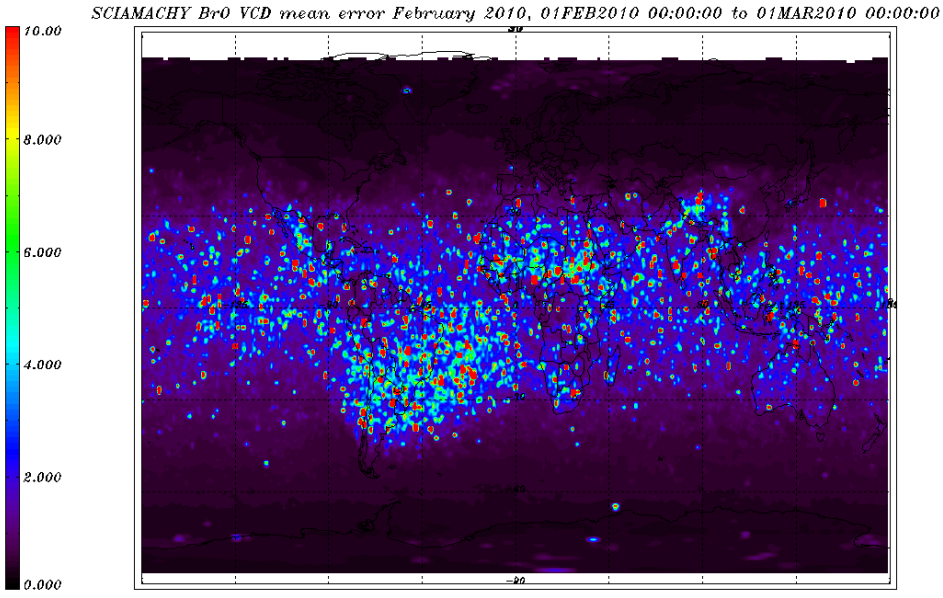


Figure 8-12: BrO VCD error for 01 – 28 February 2010- monthly average.

8.2.5 Nadir: SO_2 consistency checking

The world map plots of Nadir SO_2 vertical column density (VCD) values in molec/cm^2 averaged over one month are generated from the SCI_OL__2P Nadir products version 5.01. Each Level 2 product now contains one MDS for an anthropogenic scenario (SO_2 present in the boundary layer) and one MDS for the volcanic scenario (SO_2 layer between 10 and 11 km).

Since SO_2 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" SO2 vertical columns and the "volcanic" ones are derived assuming a constant profile shape for two typical scenarios:

- a profile with 1 DU of SO_2 from surface to 1 km height simulating an Anthropogenic Pollution scenario;
- a profile with 10 DU of SO_2 between a 10 and 11 km simulating a volcanic eruption.

Accordingly, two types of SO_2 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.

Figures 8-13 and 8-15 show the monthly world map plots for anthropogenic and volcanic vertical columns for February 2010. Figures 8-14 and 8-16 show the VCD errors for the monthly average plots. Errors are given in relative fraction.

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

8.2.5.1 Nadir: SO_2 Anthropogenic scenario - February 2010

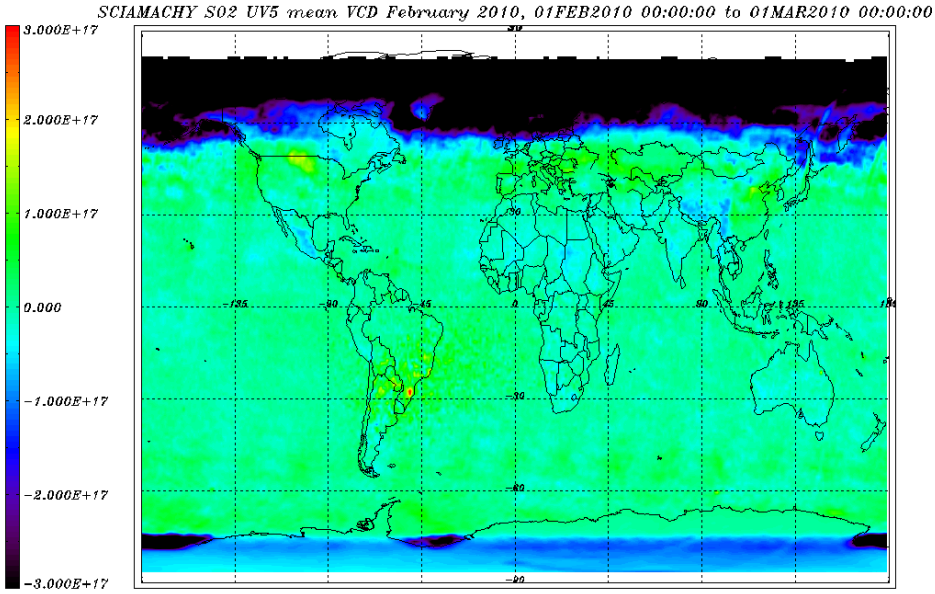


Figure 8-13: SO_2 VCD world map for 01 – 28 February 2010 – monthly average.

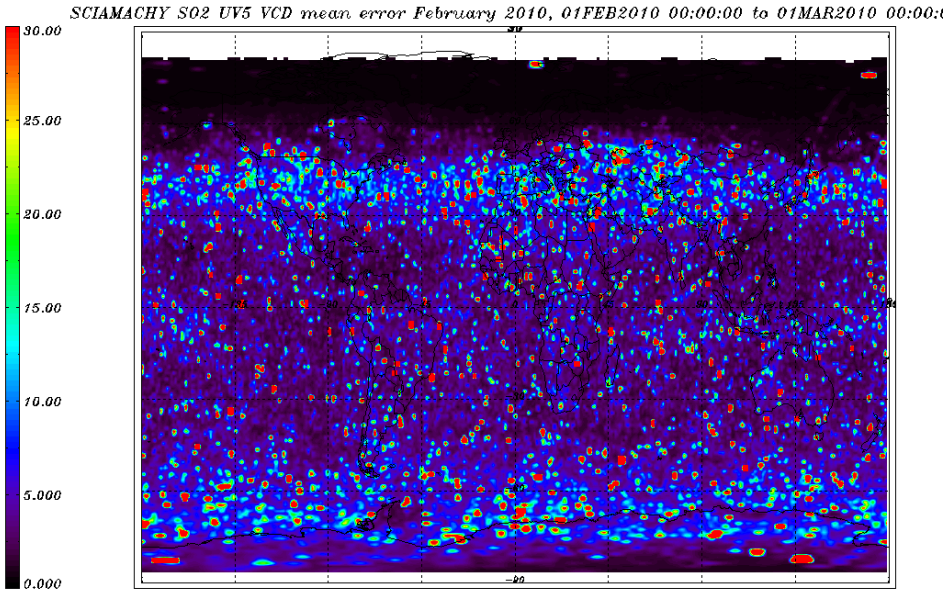


Figure 8-14: SO_2 VCD error for 01 – 28 February 2010- monthly average.

8.2.5.2 Nadir: SO_2 Volcanic scenario - February 2010

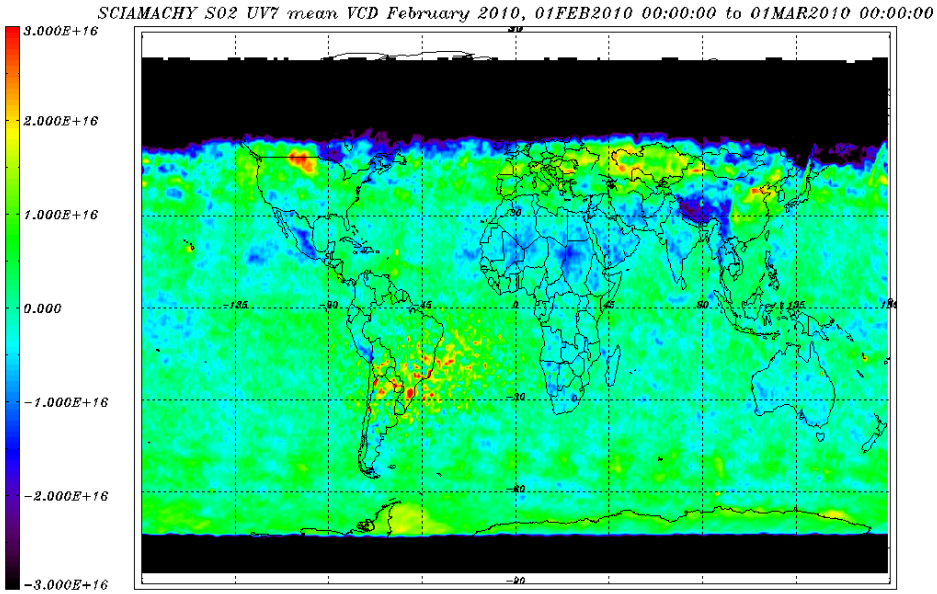


Figure 8-15: SO_2 VCD world map for 01 – 28 February 2010 – monthly average.

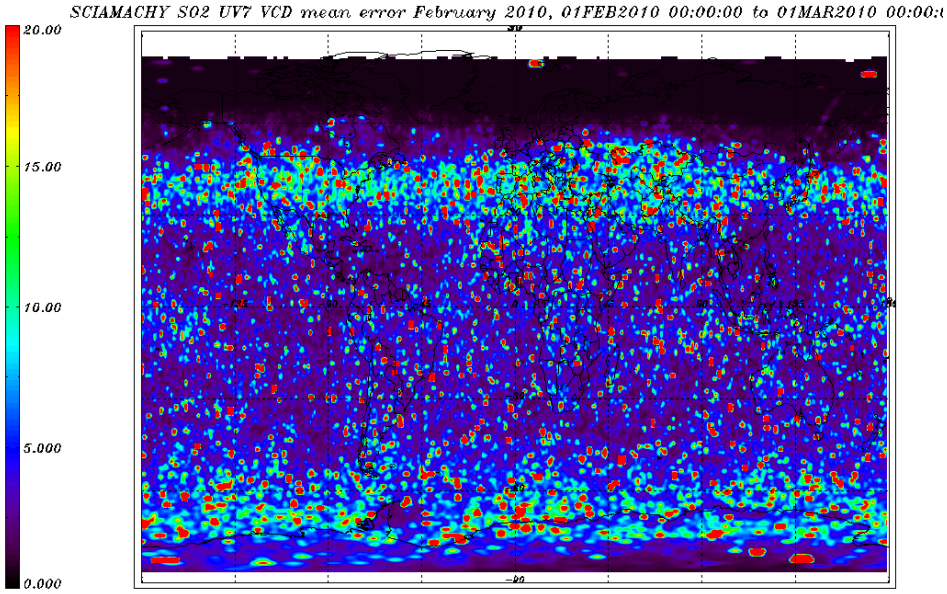


Figure 8-16: SO_2 VCD error for 01 – 28 February 2010 – monthly average.

8.2.6 Nadir: OClO consistency checking

The world map plots of Nadir OClO slant column density (SCD) values averaged over one month are generated from the SCI_OL__2P Nadir products version 5.01. Figure 8-17 shows the monthly world map plots for February 2010.
Figures 8-18 shows the SCD errors for the monthly average plots. Errors are given in relative fraction.

Computation of VCD is difficult for the rapid photochemistry of OClO and only the slant columns are given in the product. Significant amounts of OClO are expected only in the activated polar vortex.

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 OClO map February 2010

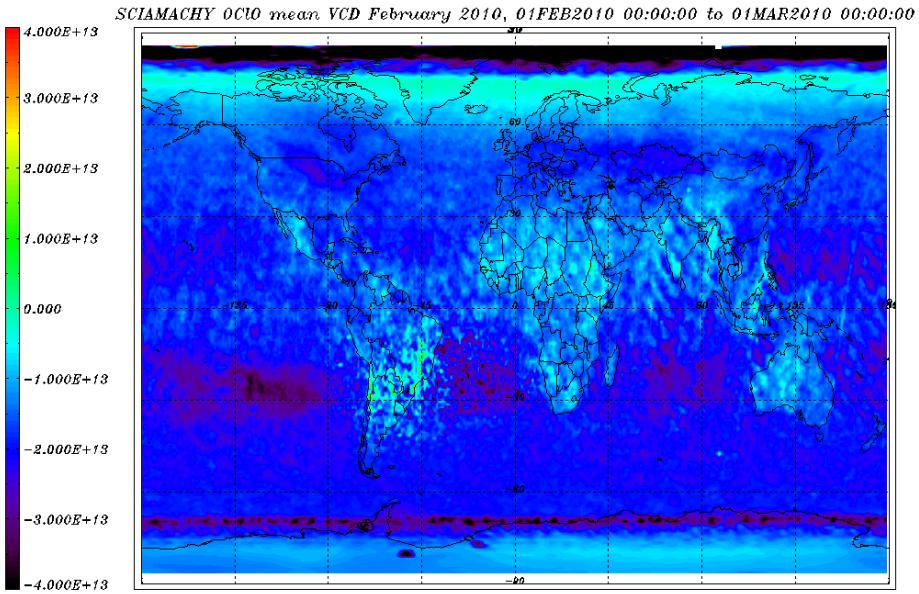


Figure 8-17: OClO SCD world map for 01 – 28 February 2010 – monthly average.

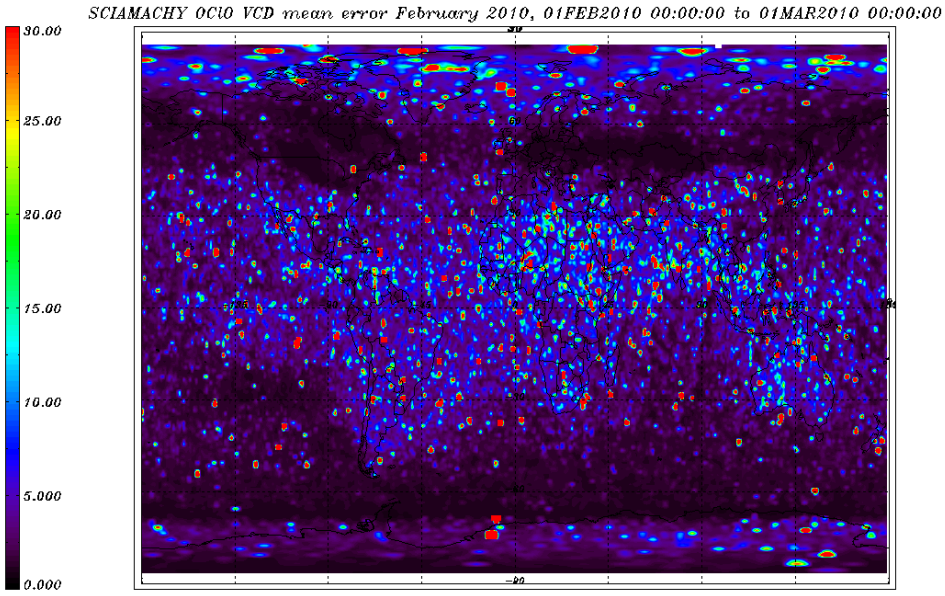


Figure 8-18: OClO SCD error for 01 – 28 February 2010- monthly average.

8.2.7 Nadir: CO consistency checking

The future reports will include plots for the CO VCD.

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 product's configuration for limb measurements.

In particular, for the O_3 limb VMR profile extracted from Level 2 products version 3.01, the average plots are reported for the following two tangent height bins

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

For the new Level 2 products (version 5.01) the selected bins are

- 22.75 – 24.5 km (21th bin, bin index=20)
- 36.75 – 38.5 km (12th bin, bin index=11).

Please, note that for January 2010 SCIAMACHY Level 2 products version 3.01 are still used for the plots while the new version 5.01 products are adopted for February 2010.

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 8-21 to 8-24 show the results for the months of January and February 2010 and for the two different tangent height regions.

8.2.8.1 Ozone limb profiles January 2010

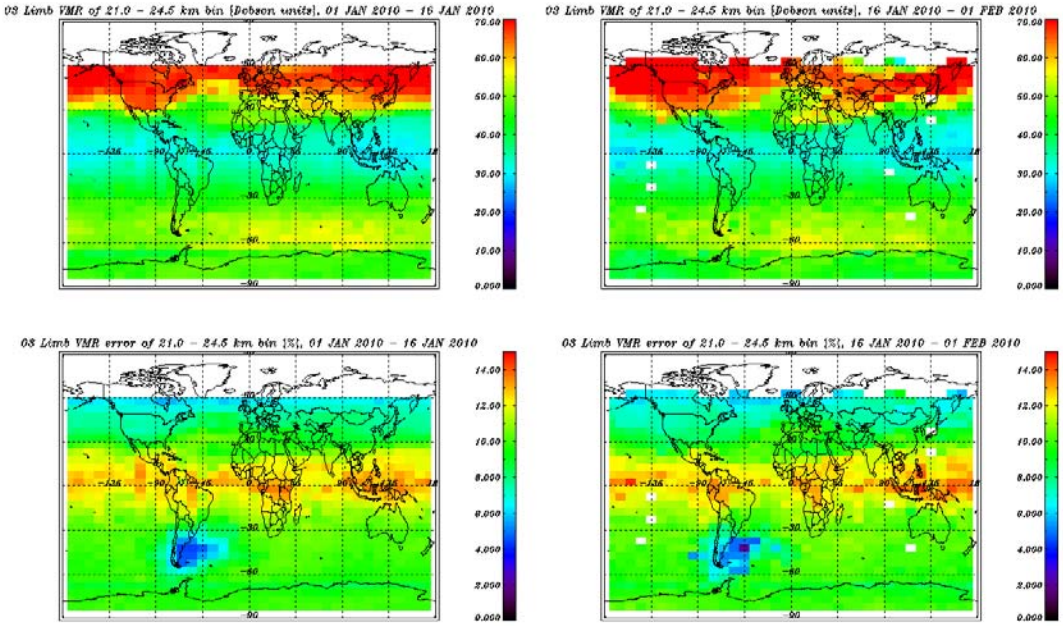


Figure 8-21 Limb Ozone profiles, binned over 21.0 – 24.5 km, January 2010.

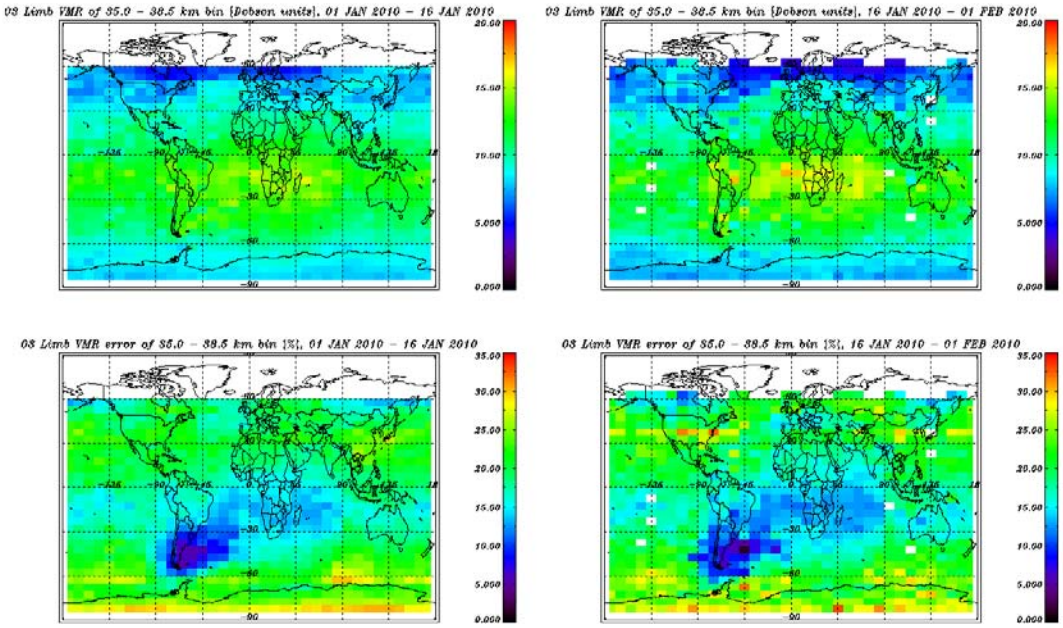


Figure 8-22 Limb Ozone profiles, binned over 35.0 – 38.5 km, January 2010.

Ozone limb profiles February 2010

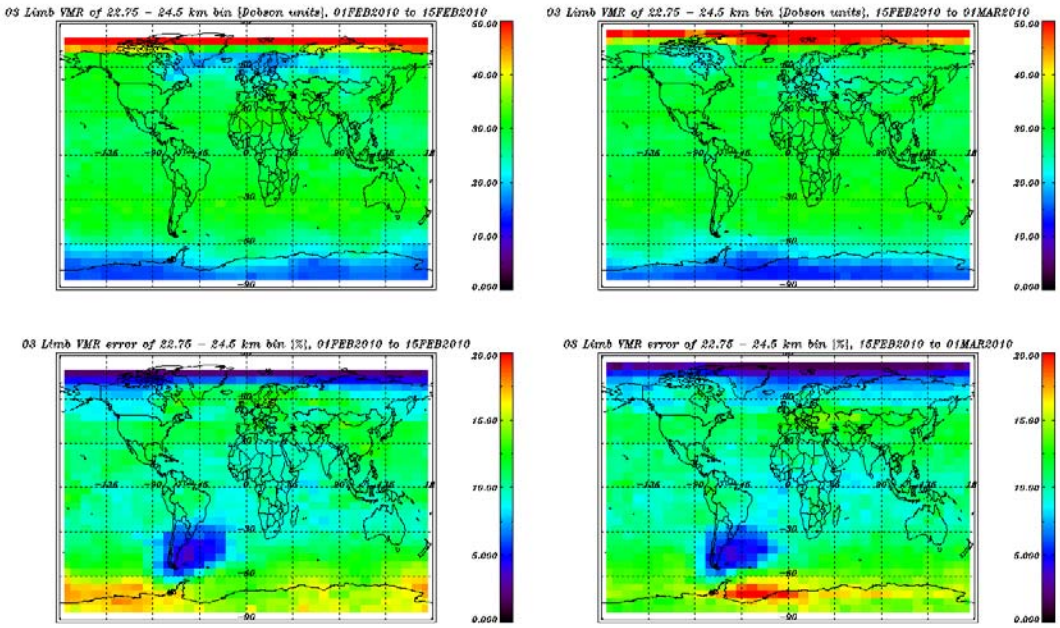


Figure 8-23: Limb Ozone profiles binned over 22.75 – 24.5 km, February 2010.

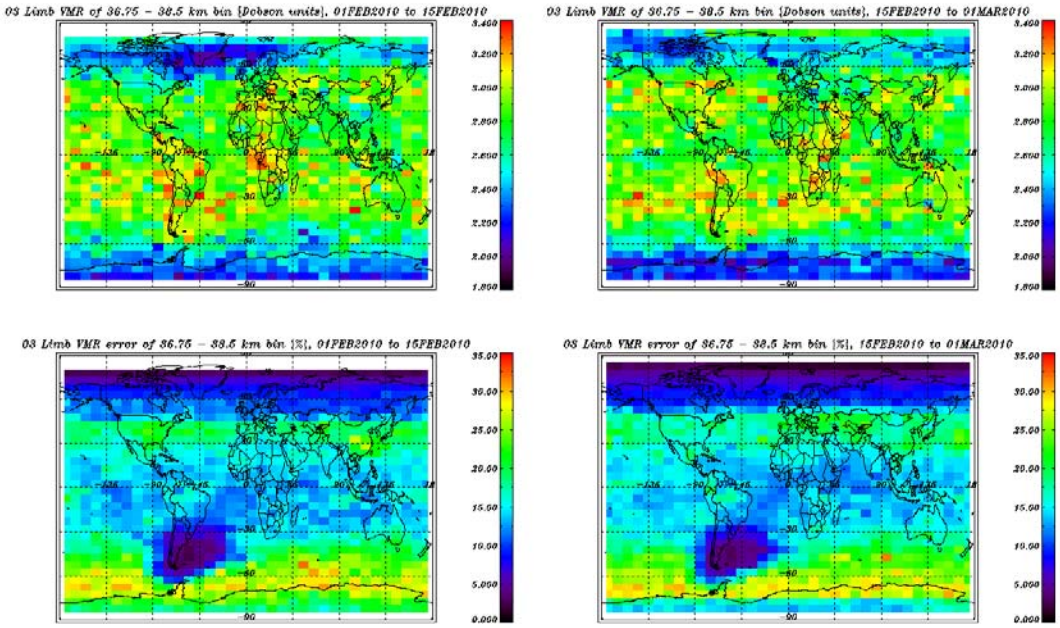


Figure 8-24: Limb Ozone profiles binned over 36.75 – 38.5 km, February 2010.

8.2.9 Limb: NO_2 profile averages

Analogous as for the limb Ozone profiles monthly averages for NO_2 limb averages were generated. For Level 2 products version 3.01, the tangent height region chosen is:

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

For the new Level 2 products (version 5.01) the selected bin is

- 24.5-26.25 (20th bin, bin index=19).

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 8.2.3. The corresponding error is averaged as well. Figures 8-25 and 8-26 show the results for the months of January and February 2010 respectively.

Please, note that for January 2010 SCIAMACHY Level 2 products version 3.01 are still used while the new products version 5.01 are adopted for February 2010.

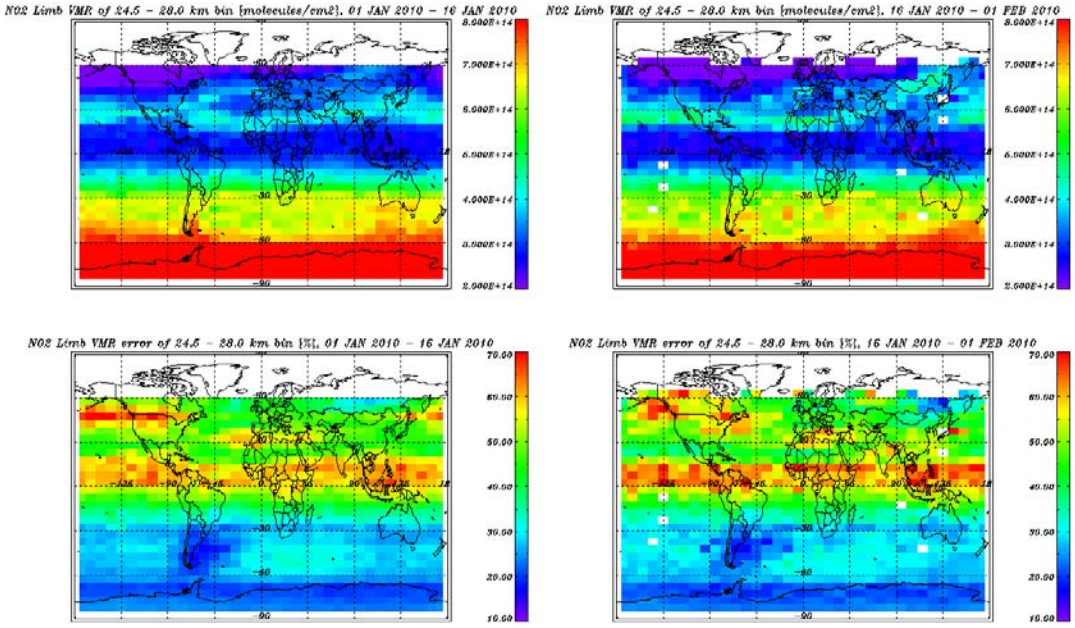


Figure 8-25 Limb NO_2 profiles binned over 24.5 – 28 km, January 2010.

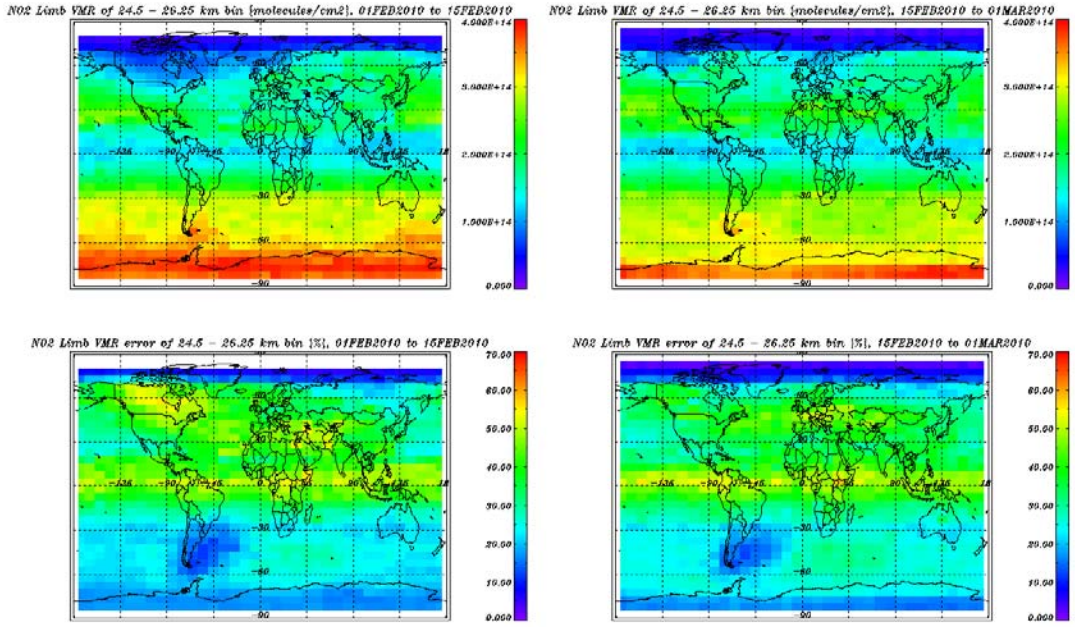


Figure 8-26 Limb NO_2 profiles binned over 24.5 – 26.25 km, February 2010.

8.2.10 Limb: BrO profile averages

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

- 24.5-26.25 (20th bin, bin index=19).

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 8.2.3. The corresponding error is averaged as well. Figure 8-27 shows the results for the months of February 2010.

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

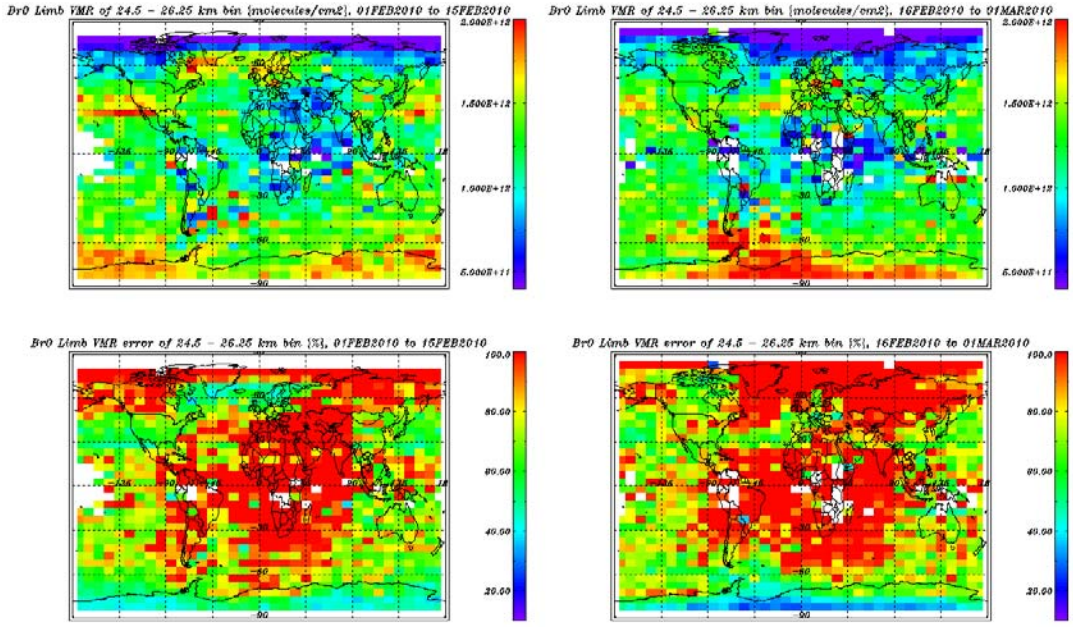


Figure 8-9 Limb BrO profiles binned over 24.5 – 26.25 km, February 2010.

9 VALIDATION ACTIVITIES AND RESULTS

Validation activities of products from re-processing with Level 1b IPF 7.03 and Level 2 off-line processor 5.01 are on-going.

The SCIAMACHY validation dataset for the operational Level 1 processor version 7.03 and Level 2 processor version 5.01 was recently made available to the validation teams. The dataset covers selected orbits identified by the core validation teams for the complete mission until 2010 with around 1900 orbits total.

The quality of the SCI_OL__2PU data re-processed with off-line processor version 5.01 has been checked and can be viewed via the daily Level 2 reports that are available at http://earth.eo.esa.int/pcs/envisat/sciamachy/reports/daily/Level_2/

Validation of products from the previous re-processing campaign (Level 1 IPF 6.03 and Level 2 off-line processor 3.01) were performed by the SCIAMACHY Validation and Interpretation Group (SCIAVALIG). Results are published at

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