

---

/document title/ titre du document

# **SCIAMACHY BI-MONTHLY REPORT: MARCH - APRIL 2008**

---

prepared by/ <i>préparé par</i>	Angelika Dehn
reference/ <i>référence</i>	ENVI-SPPA-EOPG-TN-08-0027
issue/ <i>édition</i>	1
revision/ <i>révision</i>	0
date of issue/ <i>date d'édition</i>	31 May 2008
status/ <i>état</i>	
Document type/ <i>type de document</i>	Technical Note
Distribution/ <i>distribution</i>	

## **APPROVAL**

<b>Title</b> <i>titre</i>	SCIAMACHY Bi-Monthly Report: March - April 2008	<b>issue</b> 1 <i>issue</i>	<b>revision</b> 0 <i>revision</i>
------------------------------	---	--------------------------------	--------------------------------------

<b>author</b> <i>auteur</i>	Angelika Dehn, DPQC-SERCO, Manfred Gottwald, SOST-DLR, Stefan Noël, SOST-IFE, Roald Schnerr, SRON	<b>date</b> 20/05/2008 <i>date</i>
--------------------------------	--	---------------------------------------

<b>approved by</b> <i>approuvé by</i>	T. Fehr ESA/ESRIN, D/EOP-GQ G. Lichtenberg, DPQC-DLR	<b>date</b> 30/05/2008 <i>date</i>
--	---	---------------------------------------

## **CHANGE LOG**

<i>reason for change /raison du changement</i>	<i>issue/issue</i>	<i>revision/revision</i>	<i>date/date</i>

## **CHANGE RECORD**

Issue: 1 Revision: 0

<i>reason for change/raison du changement</i>	<i>page(s)/page(s)</i>	<i>paragraph(s)/paragraph(s)</i>

## **TABLE OF CONTENTS**

<b>1</b>	<b>INTRODUCTION .....</b>	<b>5</b>
1.1	Scope .....	5
1.2	References .....	5
1.3	Acronyms and Abbreviations.....	7
<b>2</b>	<b>SUMMARY .....</b>	<b>9</b>
<b>3</b>	<b>INSTRUMENT CONFIGURATION AND PERFORMANCE .....</b>	<b>11</b>
3.1	In-Flight Status and Performance .....	11
3.1.1	Planned Operations and Measurements (SOST-DLR) .....	11
3.1.2	Instrument Measurement Status (SOST-DLR) .....	12
3.1.3	Executed Operations and Measurements (SOST-DLR) .....	12
3.1.4	Performance Monitoring - System (SOST-DLR) .....	13
3.1.5	Performance Monitoring - Light Path (SOST-IFE) .....	20
3.1.5.1	Science Channel Averages .....	20
3.1.5.2	Spectral light path monitoring results .....	24
3.1.5.3	PMD monitoring results.....	30
<b>4</b>	<b>DATA AVAILABILITY STATISTICS .....</b>	<b>32</b>
4.1	Downlink/Acquisition Performance .....	32
4.2	Statistics on unconsolidated data (SCI_NL__0P, SCI_NL__1P) .....	32
4.3	Statistics on consolidated data .....	33
4.3.1	Anomalies on level 0 consolidated data products .....	33
4.3.2	Availability of consolidated SCI_NL__1P products .....	33
4.4	Statistics on reprocessed data.....	34
4.4.1	Level 1b re-processing IPF 6.03 .....	34
4.4.2	Level 2 re-processing processor version 3.01 .....	34
<b>5</b>	<b>LEVEL 1 PRODUCT QUALITY MONITORING .....</b>	<b>36</b>
5.1	Processor Configuration.....	36
5.1.1	Version .....	36
5.1.2	Anomalies .....	37
5.2	Auxiliary Data Files .....	37
5.2.1	Spectral Performance .....	39
5.2.2	Radiometric Performance .....	39
5.2.3	Other Calibration Results.....	39
5.2.3.1	SMR analysis .....	39
5.2.3.2	LK1 analysis .....	44
5.2.3.2.1	Leakage Constant part.....	44

5.2.3.2.2	Leakage Variable part .....	47
5.3	Bad and Dead Pixel Mask .....	48
5.4	Pointing Performance .....	49
5.5	SciaL1c tool .....	49
<b>6</b>	<b>LEVEL 2 NRT PRODUCT QUALITY MONITORING .....</b>	<b>50</b>
6.1	Processor Configuration .....	50
6.1.1	Version .....	50
6.1.2	Auxiliary Data Files .....	50
<b>7</b>	<b>LEVEL 2 OFF-LINE PRODUCT QUALITY MONITORING .....</b>	<b>51</b>
7.1	Processor Configuration .....	51
7.1.1	Version .....	51
7.1.2	Anomalies .....	52
7.1.2.1	Data 23 September 2007 – 27 October 2007 .....	52
7.1.2.2	Data 13 – 21 April 2008 .....	52
7.1.3	Auxiliary Data Files .....	53
7.2	Monitoring results .....	53
7.2.1	Nadir: NO <sub>2</sub> consistency checking .....	53
7.2.1.1	Nadir: VCD NO <sub>2</sub> map March 2008 .....	54
7.2.1.2	Nadir: VCD NO <sub>2</sub> map April 2008 .....	55
7.2.2	Nadir: O <sub>3</sub> consistency checking .....	56
7.2.2.1	Nadir: VCD O <sub>3</sub> map March 2008 .....	57
7.2.2.2	Nadir: VCD O <sub>3</sub> map April 2008 .....	58
7.2.3	Limb: Ozone profile averages .....	59
7.2.3.1	Ozone limb profiles March 2008 .....	60
7.2.3.2	Ozone limb profiles April 2008 .....	61
<b>8</b>	<b>VALIDATION ACTIVITIES AND RESULTS .....</b>	<b>62</b>
8.1.1	Level 2 Column Products results Off-line .....	62
8.1.2	Level 2 Profile Products results Off-line .....	63

# **SCIAMACHY BI-MONTHLY REPORT MARCH - APRIL 2008**

## **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 the DPQC, 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 DPQC 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 PETERS, 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



esa



DLR



ife

serco

SCIAMACHY BI-MONTHLY



### 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
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)



esa



DLR



ife

serco

SCIAMACHY Bi-MONTHL



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

- The verifications of the next SCIAMACHY level 1b and level 2 off-line baselines were successfully completed.
- The SCIAMACHY reprocessed data (level 1b version 6.03 and level 2 version 3.01) were validated by the SCIAVALIG group and results are included in this report.
- During the reported period SCIAMACHY measurements were nominal with respect to planning, besides one unavailability period during following orbits:
  - 32120 - 32127 (21 - 22 April 2008)      ENVISAT planned OCM manoeuvre
- An ENVISAT platform pointing anomaly occurred during orbits:
  - 31553 – 31559 (13 March 2008)
- A wrong processing flag (P instead of R) occurred for level 1b consolidated products and level 2 off-line products generated at D-PAC due to a wrong processing configuration. Data were in the meantime removed and reprocessed correctly. The following orbits were affected:
  - 32002 – 32119 (13 - 21 April 2008)
- Monthly Calibration was executed during Orbits:
  - 31658-31662 (20 March 2008)
  - 32073-32077 (18 April 2008)
- Following occultation measurements with the moon rising on nightside were executed:
  - 31574-31663 (14 March 2008 until 21 March 2008)
  - 31998-32084 (13 April 2008 until 19 April 2008)
- One OCR was implemented (OCR\_035: Cluster 16 and 18 short integration times):
  - 32092 - 32493 (20 April – 18 May 2008)

- One TC adjustments was required performed in orbit
  - 31968 (11 April 2008).
- 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 average throughput loss in channel 1 is currently ca. 44%.
  - Channel 3 small throughput loss (about 4%)
  - Channels 4-7 small throughput loss (sub percent level)
  - Channel 8 throughput remains stable at about 67%
- 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



esa



DLR



ife

serco

SCIAMACHY Bi-MONTHLY



### 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 31376 (ANX = 01-Mar-2008, 00:14:34.621) to 32249 (ANX = 30-Apr-2008, 23:57:19.891). One OSDF specified the planning baseline.

Orbit		ANX		OSDF
Start	Stop	Start	Stop	
31376	32249	01-Mar-2008 00:14:34.621	30-Apr-2008 23:57:19.891	MPL_OSD_SHVSH_20080129_010101_00000000_34180001_20080301_001436_20080501_013754.N1

Table 3-1: SCIAMACHY OSDF planning file from March – April 2008

Measurements were nominal, i.e. timelines executed limb/nadir sequences with wide swath settings on the dayside of the orbit. 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

- 31658-31662 (20-Mar-2008)
- 32073-32077 (18-Apr-2008)

The moon was in the limb TCFoV between orbits

- 31574-31692 (14-Mar-2008 until 23-Mar-2008)
- 31998-32129 (13-Apr-2008 until 22-Apr-2008)

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

- 31574-31663 (14-Mar-2008 until 21-Mar-2008)
- 31998-32084 (13-Apr-2008 until 19-Apr-2008)

One OCR was successfully implemented. This was OCR\_035 (*Cluster 16 and 18 short integration times*) which started execution in orbit 32092 (20-Apr-2008). The OCR ends in May and return to the final flight configuration will occur in orbit 32493 (18-May-2008).



esa



serco

SCIAMACHY Bi-MONTHLY



### 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 the period:

- Orbit 32120-32127 (21/22-Apr-2008): Due to planned orbit control manoeuvre (OCM) a transfer to MEASUREMENT IDLE occurred.

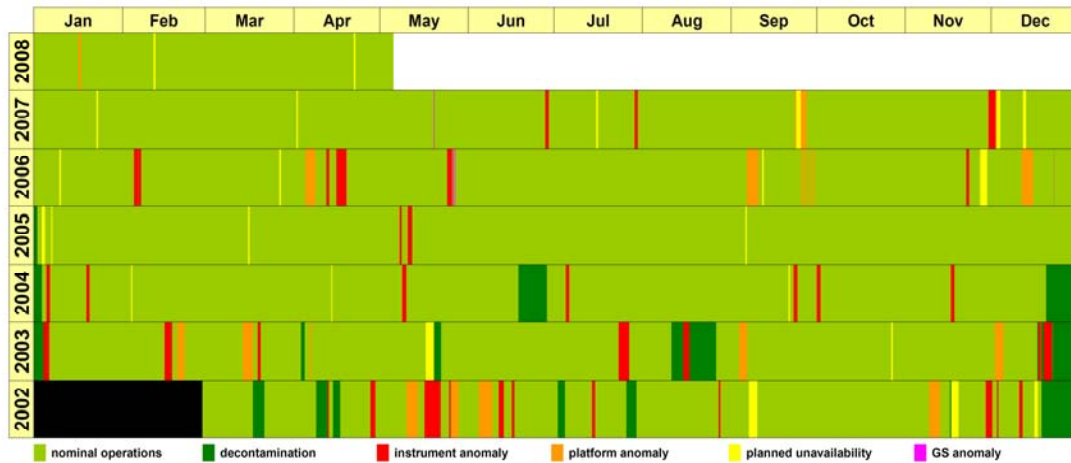


Fig. 3-1: Current instrument availability status including the reporting period

#### Detector thermal adjustment

One TC adjustment was required to decrease the temperatures of detectors 4 and 5. This occurred in orbit 31968 (11-Apr-2008). The new TC settings are

- 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.



esa



serco

SCIAMACHY Bi-MONTHL



APSM/NDFM			PMD ADC	
Orbit	ANX	Result	Orbit	ANX
n.a.	n.a.	n.a.	31752	27-Mar-2008 08:02:27
32224	29-Apr-2008 07:25:12	ok	32225	29-Apr-2008 09:01:41

Table 3-2: APSM/NDFM health check and PMD ADC calibration

### Anomalies

One minor instrument anomaly had occurred. In orbit 31885 (05-Apr-2008, 14:09:05 UTC) a possible SEU caused brief out-of-limit reading. Measurements were not interrupted and continued as scheduled.

Orbit	Date	Entry - UTC	Level	Entry Type	ID Content/Transition	Mode	Remark
31885	05-APR-2008	2008.096.14.09.05.402	Instrument	HK PARAMETER LIMIT EXCEEDING	1 (R000)	MEASUREMENT	ADC latchup (1 sec OOL), possible SEU

Table 3-3: Instrument & platform anomalies between March and April 2008

A platform attitude anomaly occurred between orbits 31559 and 31559 (13-Mar-2008, 09:33:46 – 19:28:44 UTC). The ENVISAT platform was operated in Yaw Steering Mode (YSM) instead of the nominal Stellar Yaw Steering Mode (SYSM) due to a Star Tracker 3 malfunction (caused by a bright object in FoV). SCIAMACHY measurements continued as planned. The only minor impact could be a slightly worse attitude solution during this period.

### 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.

In April the temperatures of detectors 4 and 5 reached their upper limits and a TC adjustment was required.

It has to be noted that the detector temperature curves since 2002 clearly indicate a degrading TC system with constantly rising temperatures (0.2-0.3 K/year for detectors 1-6 and 1 K/year for detectors 7 & 8). This is however a predicted behaviour.



esa



DLR



serco

SCIAMACHY Bi-MONTHL



page 14 of 63

### *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.

### *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.

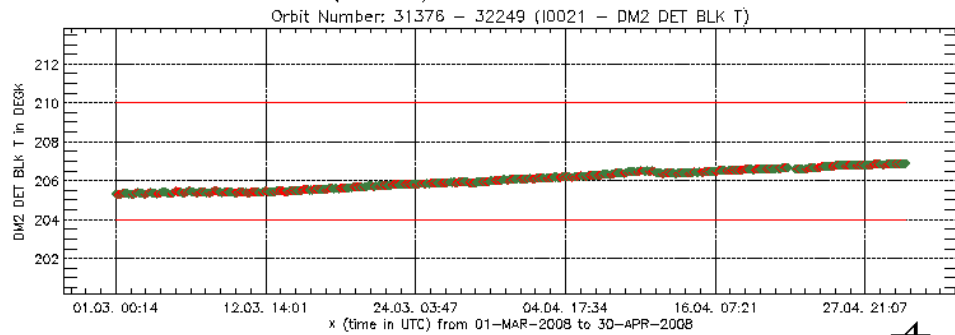
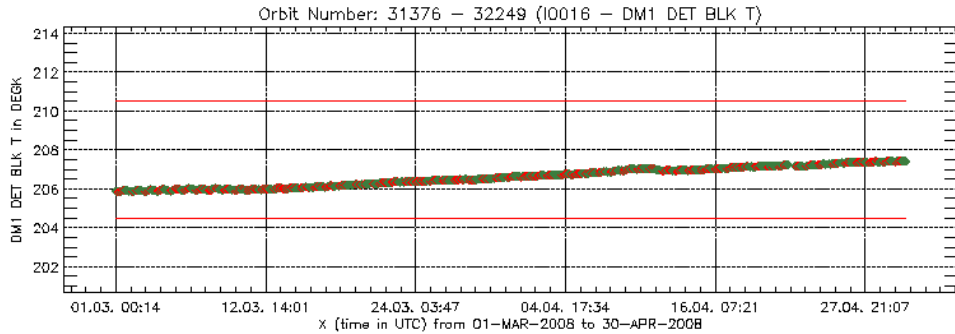


esa

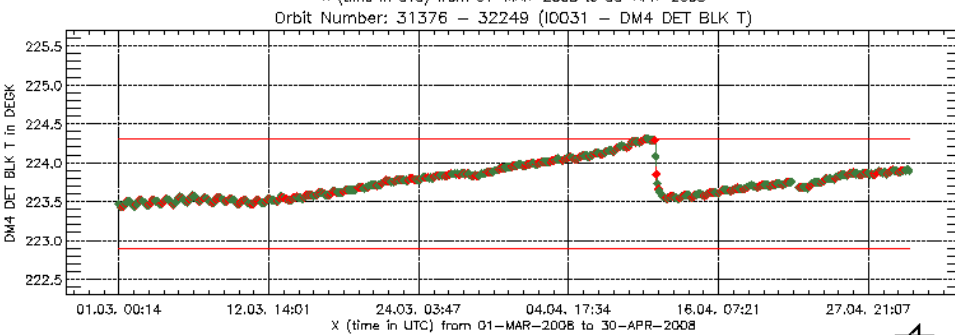
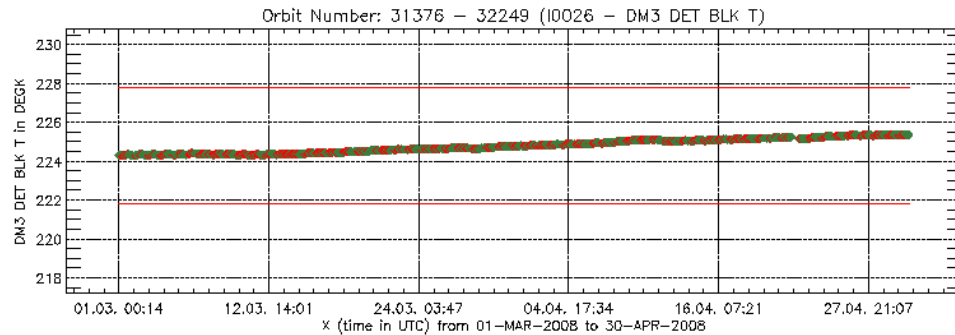


serco

SCIAMACHY Bi-MONTHL



Filename: PIN\_401\_31376\_32249  
Date : 09-05-2008 Page : 1



Filename: PIN\_401\_31376\_32249  
Date : 09-05-2008 Page : 1





esa



serco

SCIAMACHY Bi-MONTHL

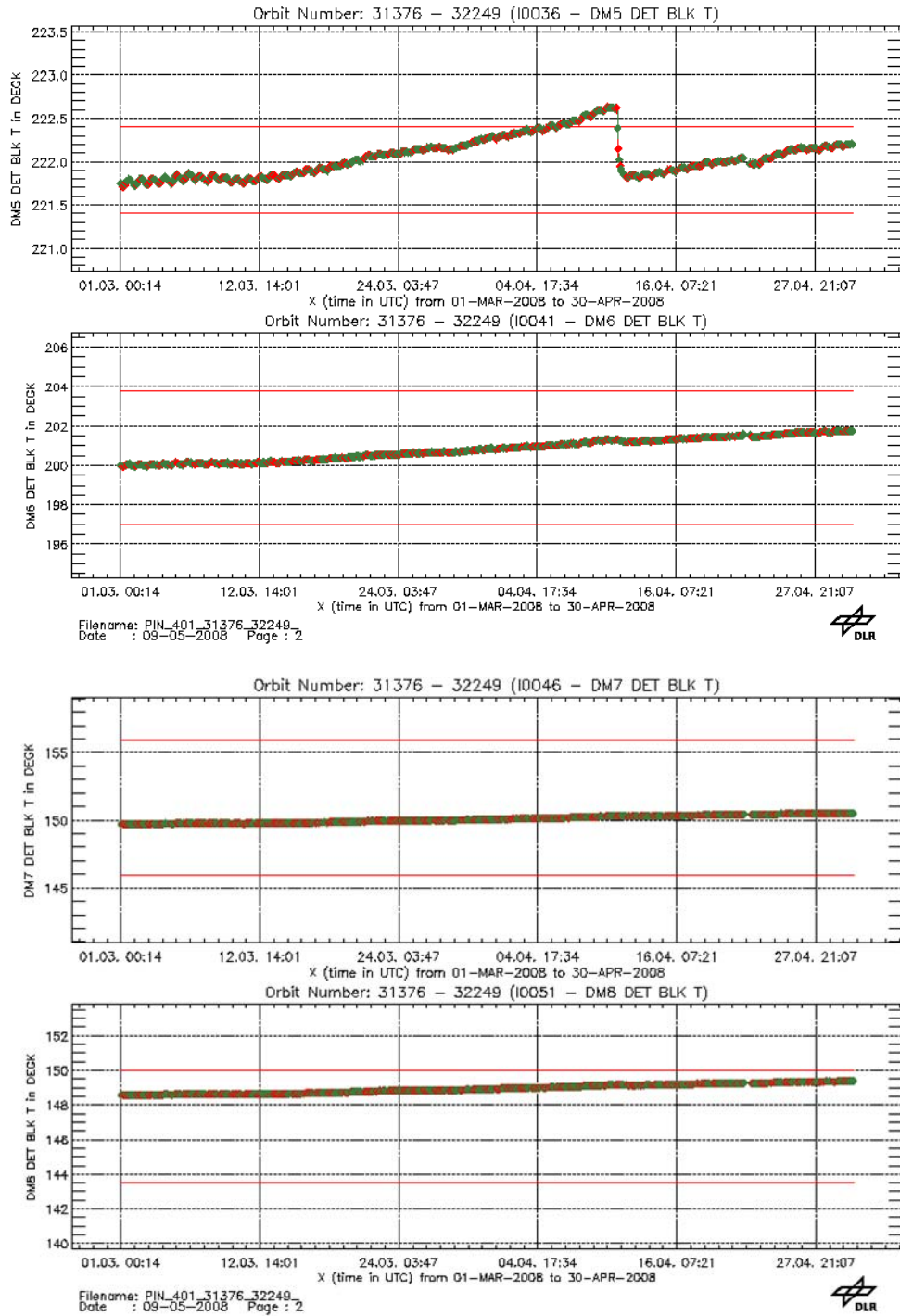


Fig. 3-2: Detector temperatures





esa



serco

SCIAMACHY Bi-MONTHL

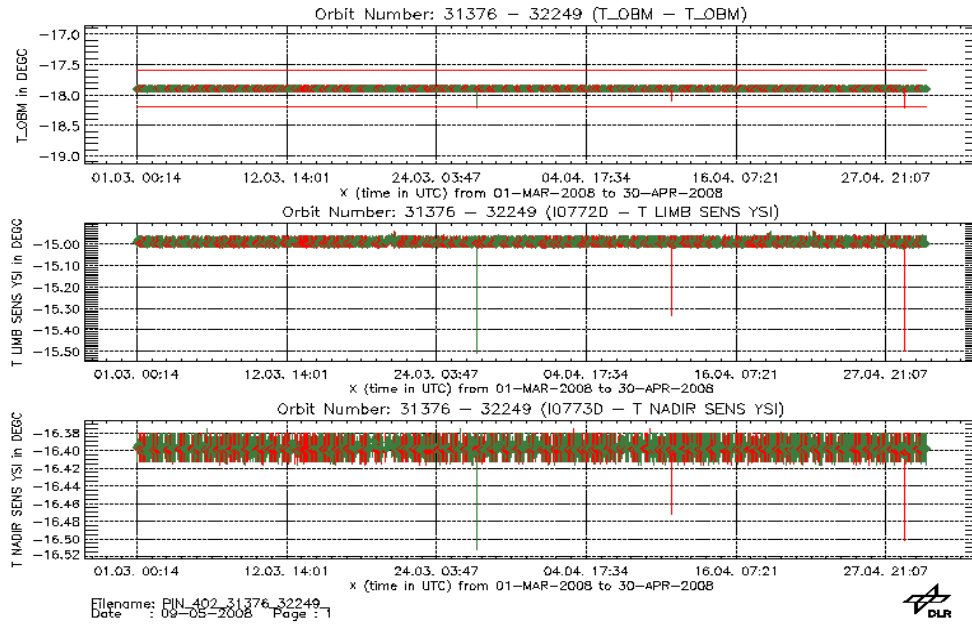


Fig. 3-3: OBM temperatures (top: derived OBM, middle: limb sensor, bottom: nadir sensor)

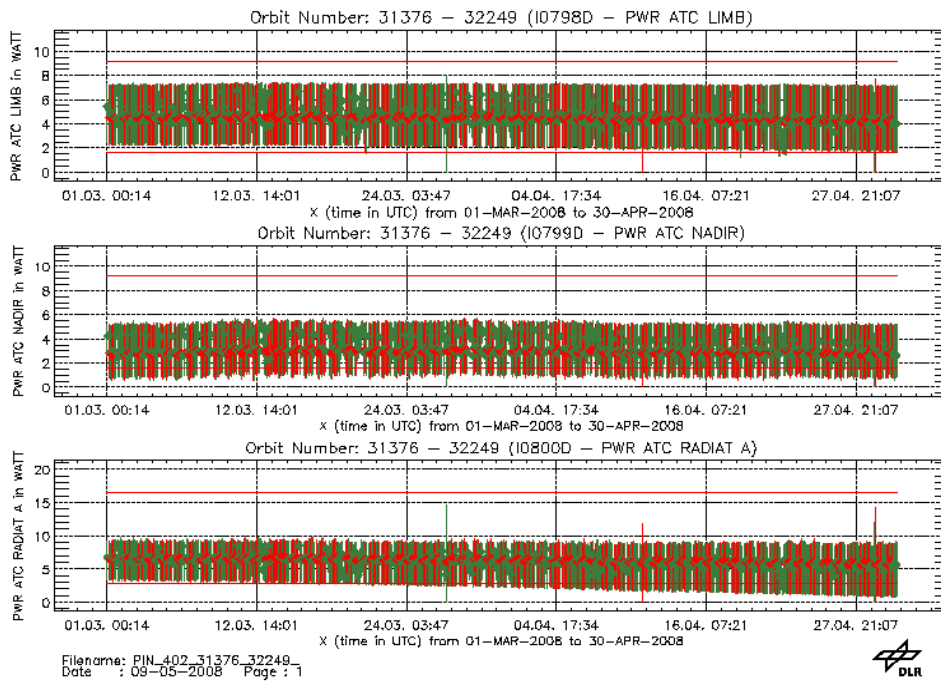


Fig. 3-4: ATC heater power (top: ATC limb, middle: ATC nadir, bottom: ATC Rad A)



esa



DLR



serco

SCIAMACHY Bi-MONTHLY



page 18 of 63

### *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: 0.41
- APSM: 0.38
- NCWM (sub-solar port): 0.75
- WLS (switches): 0.14
- WLS (burning time): 0.26
- SLS (switches): 0.05
- SLS (burning time): 0.01

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 lifetests. 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 2010.



esa



serco

SCIAMACHY Bi-MONTHLY

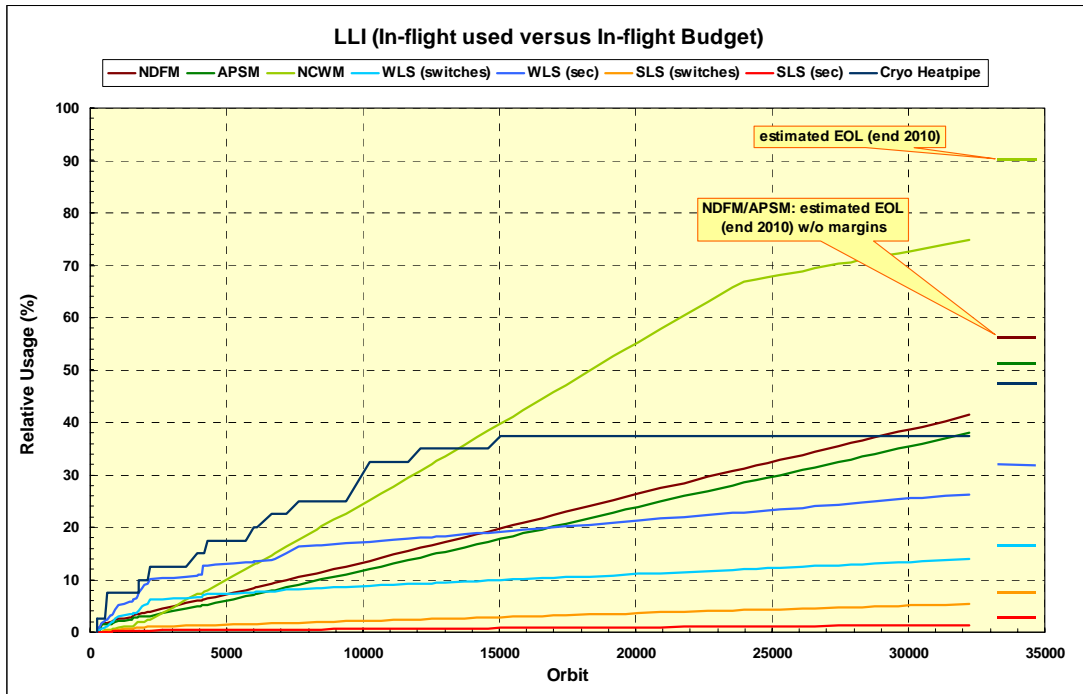


Fig. 3-5: Relative usage of LLIs. 'EOL' is derived for a mission lifetime until 2010. For the NDFM and APSM no margin factors have been applied to derive the EOL relative usage.

The number of cryogenic heatpipe cycles did not increase (no decontamination). The budget used remained at 38% of the allowed in-flight budget.

### Time reference

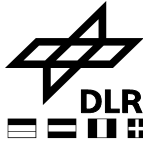
The times quoted in all planning files refer to the reference orbit. Since the actual orbit differs from the reference orbit (e.g. orbit drift), the times given w.r.t. the reference orbit also do not reflect exactly the actual absolute times of events along the orbit (e.g. ANX, sunrise, sub-solar, moonrise,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

SOST monitors how the reference time deviates from the actual time. This is done by using the predicted time which comes very close to the actual = restituted time. If the predicted times are delayed 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 manoeuvres cause distinct discontinuities.



esa



serco

SCIAMACHY Bi-MONTHL

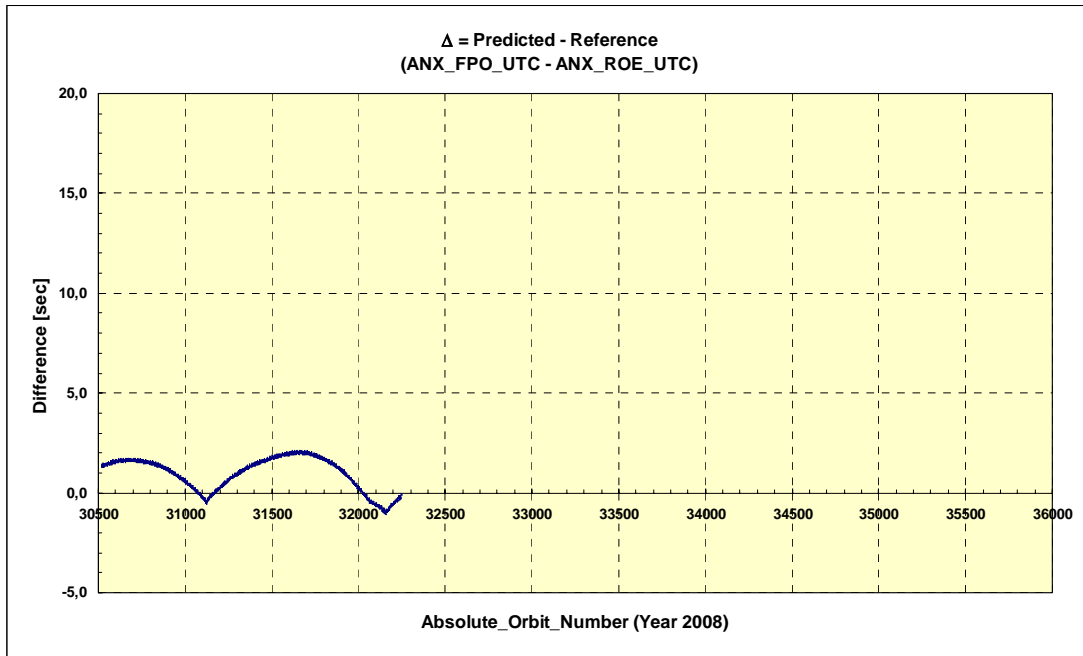


Fig. 3-6: Time difference between predicted and reference time.

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

#### 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 2008.

Note that the reported arithmetical channel averages are medians.

The displayed data have been produced in the following way:

All measured spectra have been divided by the corresponding measurement at a reference time; then for each channel a median of the ratio is computed, yielding an effective instrument throughput for the different light paths.

The reference spectra for all light paths are derived from measurements on 16 January 2003 (the time of the first monthly calibration performed with final flight settings). The resulting medians are then scaled to be 1 just after the first decontamination under



esa



DLR



serco

SCIAMACHY Bi-MONTHLY



page 21 of 63

(quasi-) nominal measurement conditions in August 2002. Therefore, the reference date for all data is in fact 2 August 2002.

Subsolar measurements before 30 November 2002 (about orbit 3922) did not consider the known yaw misalignment of SCIAMACHY on ENVISAT and thus may not be used for monitoring purposes. Therefore there are no subsolar data shown before December 2002. Since no valid subsolar measurements are available for August 2002 the subsolar throughput data have been scaled to 2 August 2002 by using the same factor as for the limb light path.

Note that measurements performed during times of reduced instrument performance (e.g. switch-offs or decontamination periods) have been omitted.

The results presented in Fig. 3.7 are based on the analysis of Level 0 data, which have been corrected for dead/bad pixels, dark current (fixed value from August 2002), scan angle dependencies, quantum efficiency changes, and the seasonally varying distance to the Sun. Additional calibration steps have not been performed, like for example a straylight correction. Therefore, variations smaller than about 1% require careful interpretation. Especially, small variations of the throughput signal may be caused by remaining seasonal effects due to the limited calibration of the data.

Until October 2006 the nadir/subsolar light path was monitored based mainly on fast sweep measurements. However, subsolar pointing measurements are considered to have a better quality for monitoring purposes (especially for PMD monitoring) and thus have become the new baseline.

Since 1 October 2006 subsolar measurements in fast sweep scan mode are only executed once per month (before that time: daily) whereas subsolar measurements in pointing mode are executed twice per week (before: once per month).

The channel average plots in Fig. 3.7 show both data sets for the subsolar light path.

Note that the reference time for the subsolar pointing data is 16 January 2003 (instead of 10 January 2003 for subsolar fast sweep).

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 throughput changes were close to expectation.
- The platform pointing anomaly of 14 March 2008 is clearly visible in all sun light paths.
- The calibration light path throughput shows some small fluctuations in the percentage range, probably due to incomplete correction of seasonal effects. These variations limit the possibilities to derive estimates of the calibration light path degradation rate during the two months of this report.
- For all light paths involving the ESM mirror the degradation in the UV (channels 1 and 2) increases with a rate of about 1% per month. The degradation rate of the nadir light path is slightly higher than for the other light paths. This has not been



esa



DLR



serco

SCIAMACHY Bi-MONTHLY



page 22 of 63

observed before and needs further attention. The maximum average throughput loss in channel 1 lies currently around 44% (for the limb light path; the WLS throughput is considered to be not representative here because a degradation of the lamp may not be excluded). The throughput of the calibration light path is currently still at about 88% in channel 1, but 87% in channel 2. This is probably due to a larger contribution of the spectral features in the degradation (see spectral plots) to the average degradation rate.

- The overall degradation of channel 3 is very small (still about 4%) compared to channels 1 and 2. A small decrease in throughput of less than 0.5% is observed for the limb and WLS light paths within the two months of this report.
- Channel 4 remains stable on a sub-percent level.
- Channels 5 and 6 are also stable on a sub-percent level, but there is a slight throughput increase visible for the nadir and limb light paths.
- The throughput in channel 7 slightly increases by about 0.5%/month, similar as observed during the last reporting period.
- The Channel 8 transmission is rather stable and lies for all light paths at around 66-67%.



esa



serco

SCIAMACHY Bi-MONTHL

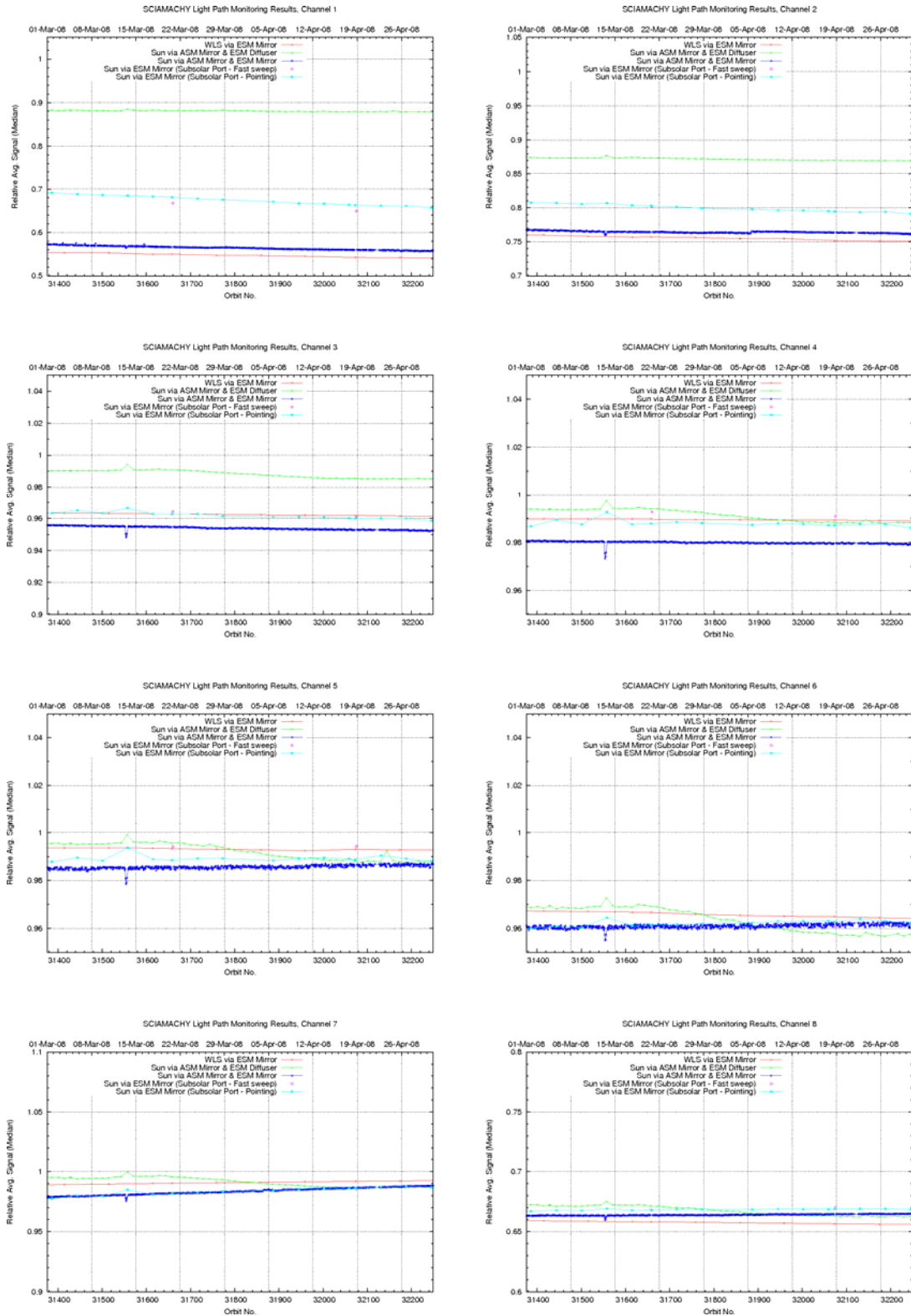


Fig. 3.7: Light path monitoring results March to April 2008 (medians).



esa



serco

SCIAMACHY Bi-MONTHL



### 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 2008.

#### Notes:

- The data (12:00 UTC reference time) have been interpolated over dead/bad pixels (using the on-ground list).
- Data from times of reduced instrument performance (like decontaminations or instrument switch-offs) have not been considered. These times are masked out by grey vertical bars.
- All data have been transformed to a daily grid, involving averaging and interpolation.
- Ratios have been performed on a pixel axis without any spectral interpolations. The wavelength axis is just for illustration and gives only approximate values, assuming a linear relation between pixel number and wavelength.
- Depending on the availability of measurement data, features close to large data gaps (especially before and after a decontamination) may be caused by interpolation.
- WLS data have not been corrected for a potential degradation of the lamp. Only the intensity jump after the extended WLS usage in June 2003 has been removed.
- As mentioned before, the timing of subsolar measurements before 30 November 2002 did not consider the known yaw misalignment of SCIAMACHY on ENVISAT. The timing has been corrected in the final flight settings. To take this change into account, all subsolar measurements have been referred to orbit 4519 (10 January 2003).  
Therefore, subsolar results before 30 November 2002 are not reliable.
- Subsolar pointing data are not considered here yet because of their low measurement frequency before October 2006. Activities to generate a joined consistent subsolar fast sweep/pointing data set are ongoing.
- Subsolar data affected by blocking of the subsolar port (May/June 2007) have been excluded.

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](http://www.iup.uni-bremen.de/sciamachy/LTM/LTM_spectral/LTM_spectral.html)). As for the plotted results, these data are regularly updated one to two times per month.

The following main features can be identified in the spectral monitoring plots:

- As expected, the UV degradation generally decreases with increasing wavelength.
- The SCIAMACHY degradation strongly depends on wavelength and is largest at the channel edges. The prominent degradation peak around 350 nm in channel 2





esa



DLR



serco

SCIAMACHY Bi-MONTHLY



page 25 of 63

coincides with a region of high polarisation sensitivity, although this is probably not directly related.

- The minimum throughput is below 50% for the limb and WLS (nadir) light paths at the short wavelength edge of channel 1 (i.e. below about 255-265 nm).
- Also solar activity variation can be seen in the plots, e.g. the intensity change of the solar Mg II Fraunhofer line at about 280 nm.
- The degradation in channel 3 which was already indicated by the channel integrated results is much better visible in the spectrally resolved plots, where the propagation of this effect in time to higher wavelengths can be clearly identified.
- The difference in degradation between the diffuser light path and the other light paths is also visible in the plots; however, the spectral regions where degradation is strongest coincide quite well.
- The spectral plots also show that the relative stability for channels 4 and 5 observed in the integrated data is not present over the whole spectral range; also these channels show variations, but these are restricted to the overlap regions close to the channel edges.
- The channel 6 degradation is concentrated at the lower wavelength edge, but is still below 10%.
- For channels 7 and 8 the spectral behaviour of the throughput loss is consistent with (broadband) ice absorption features. The effect of the decontaminations is of course also clearly visible in these channels.
- Especially channel 8 shows a large pixel dependence of the throughput variation caused by the different sensitivity of the pixels. This variation is much higher for light paths where the small aperture is involved (i.e. nadir (subsolar) and limb), indicating that the small aperture causes additional effects which need to be considered when applying these results to Earthshine data.
- In general, the WLS data are much smoother than the solar data.



esa



serco

SCIAMACHY BI-MONTHLY

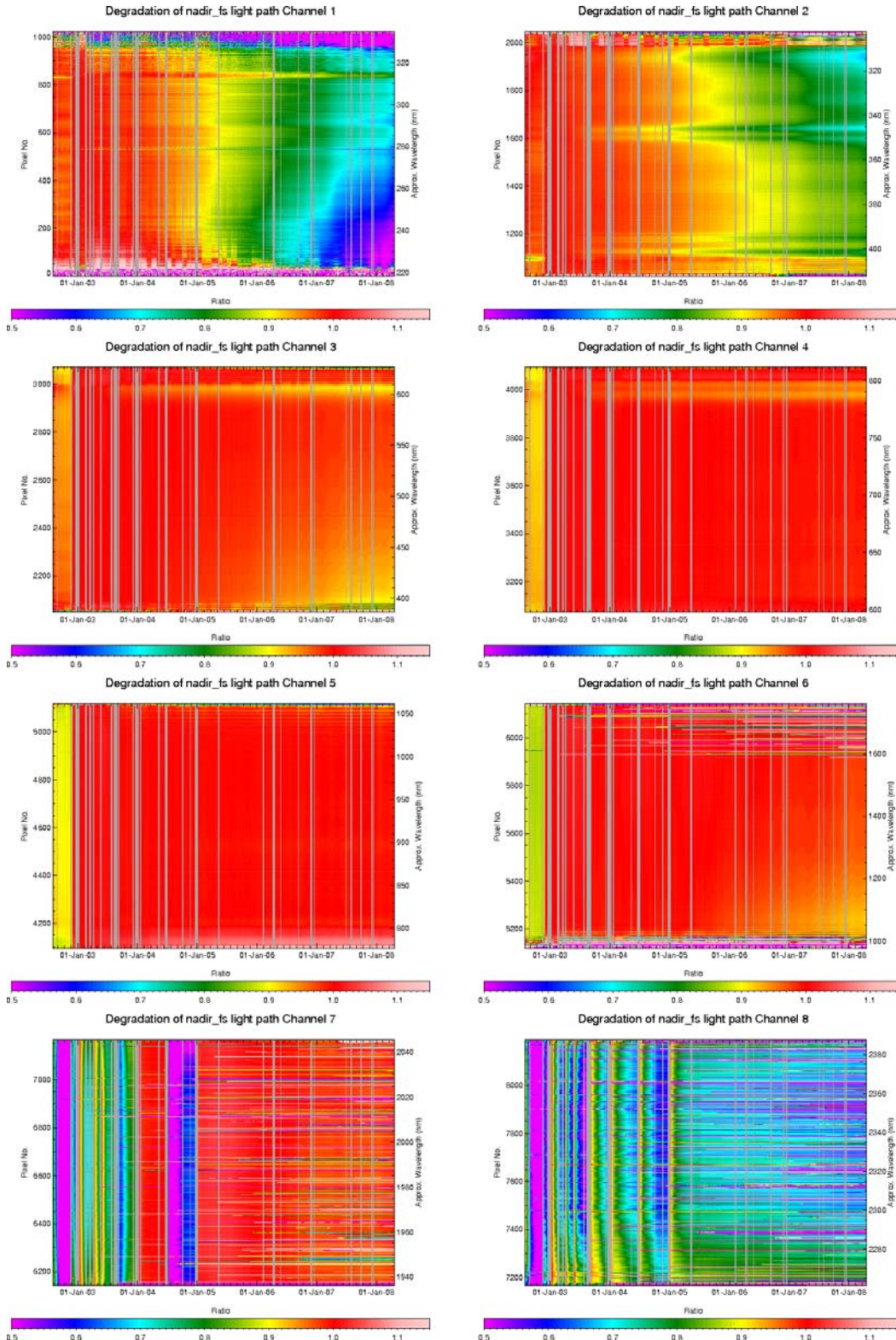


Fig. 3.8: Spectral light path monitoring results August 2002 to April 2008 (nadir light path)



esa



serco

SCIAMACHY BI-MONTHLY

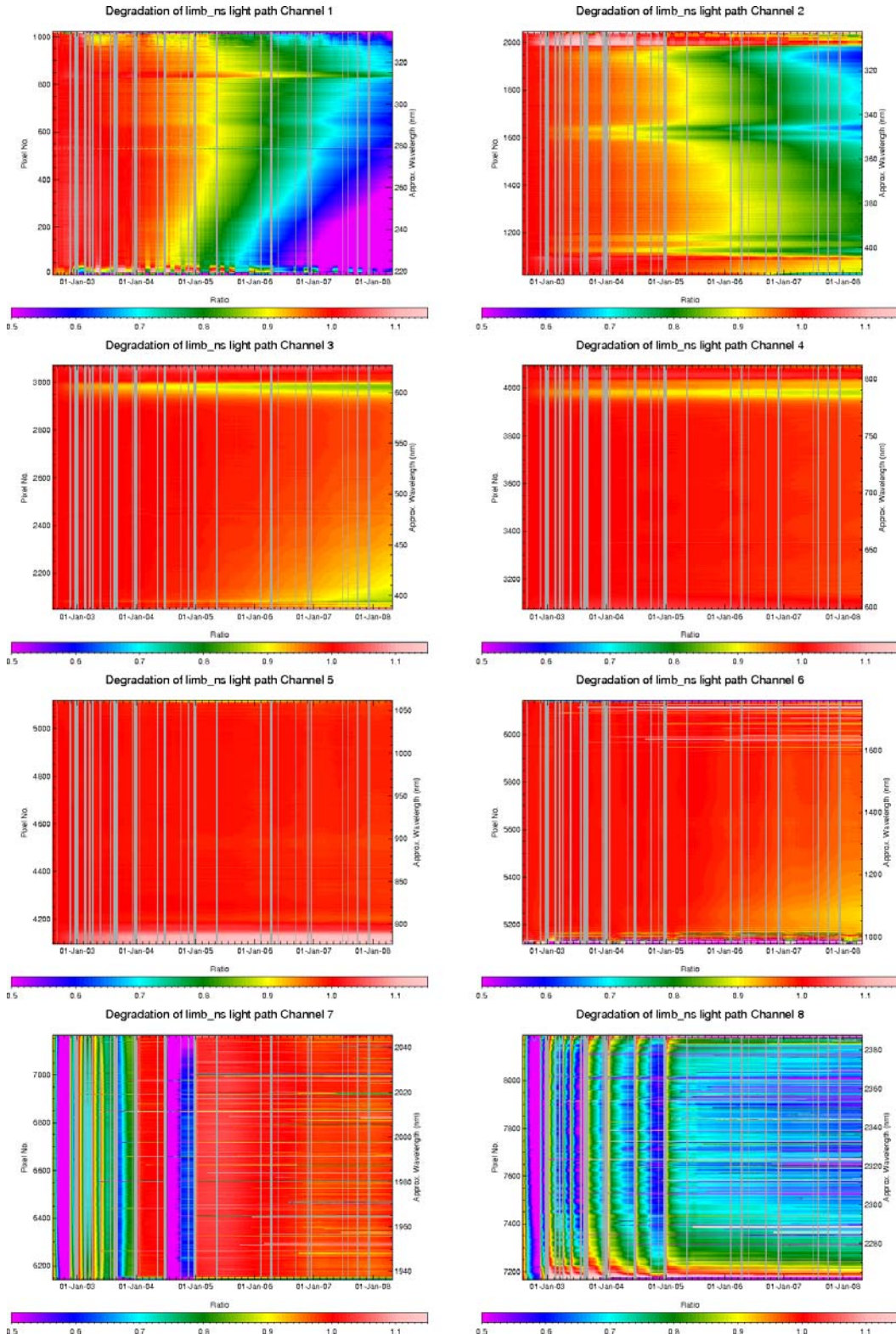


Fig. 3.9: Spectral light path monitoring results August 2002 to April 2008 (limb light path)



esa



serco

SCIAMACHY Bi-MONTHL

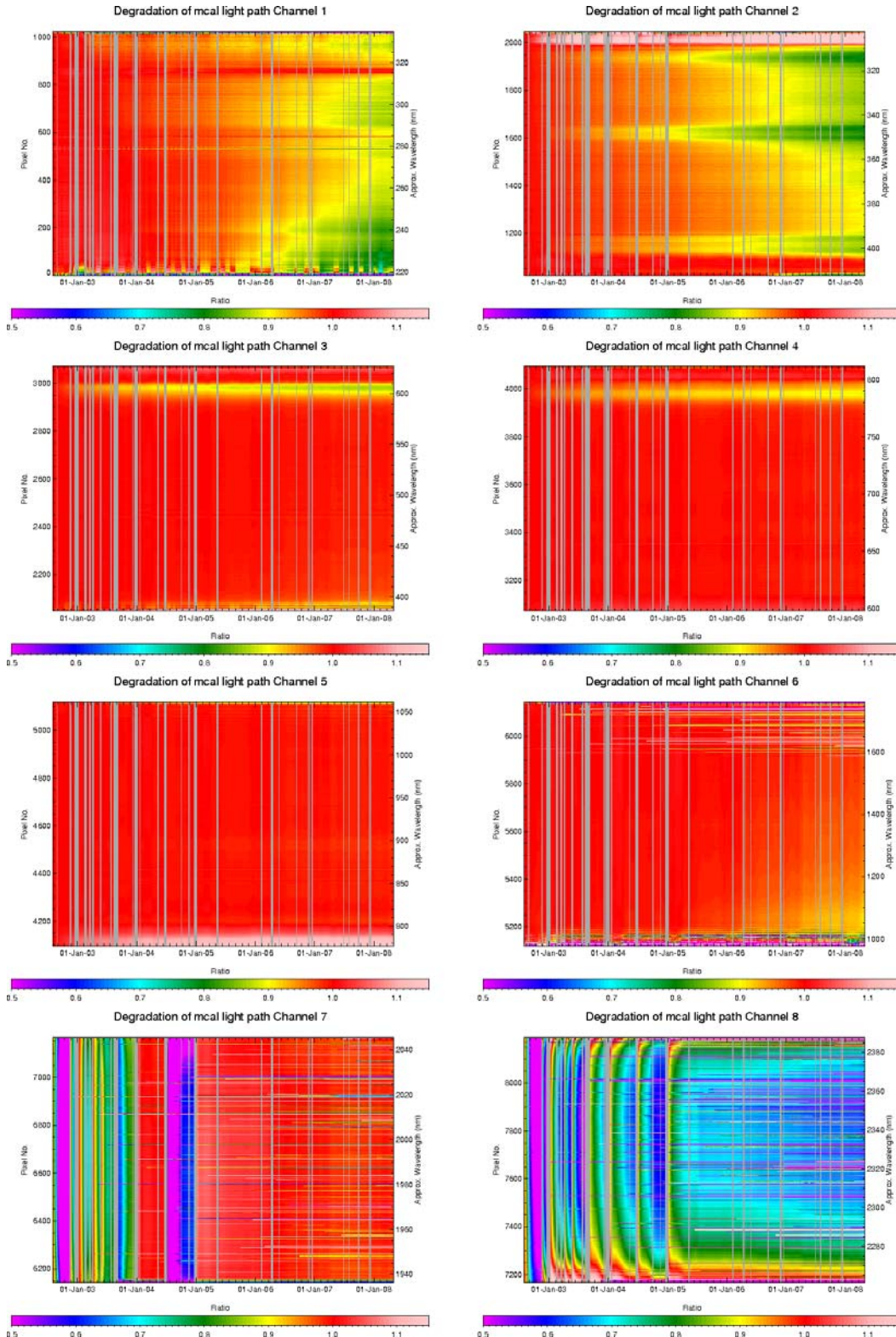


Fig. 3.10: Spectral light path monitoring results August 2002 to April 2008 (calibration light path)



esa



serco

SCIAMACHY BI-MONTHLY

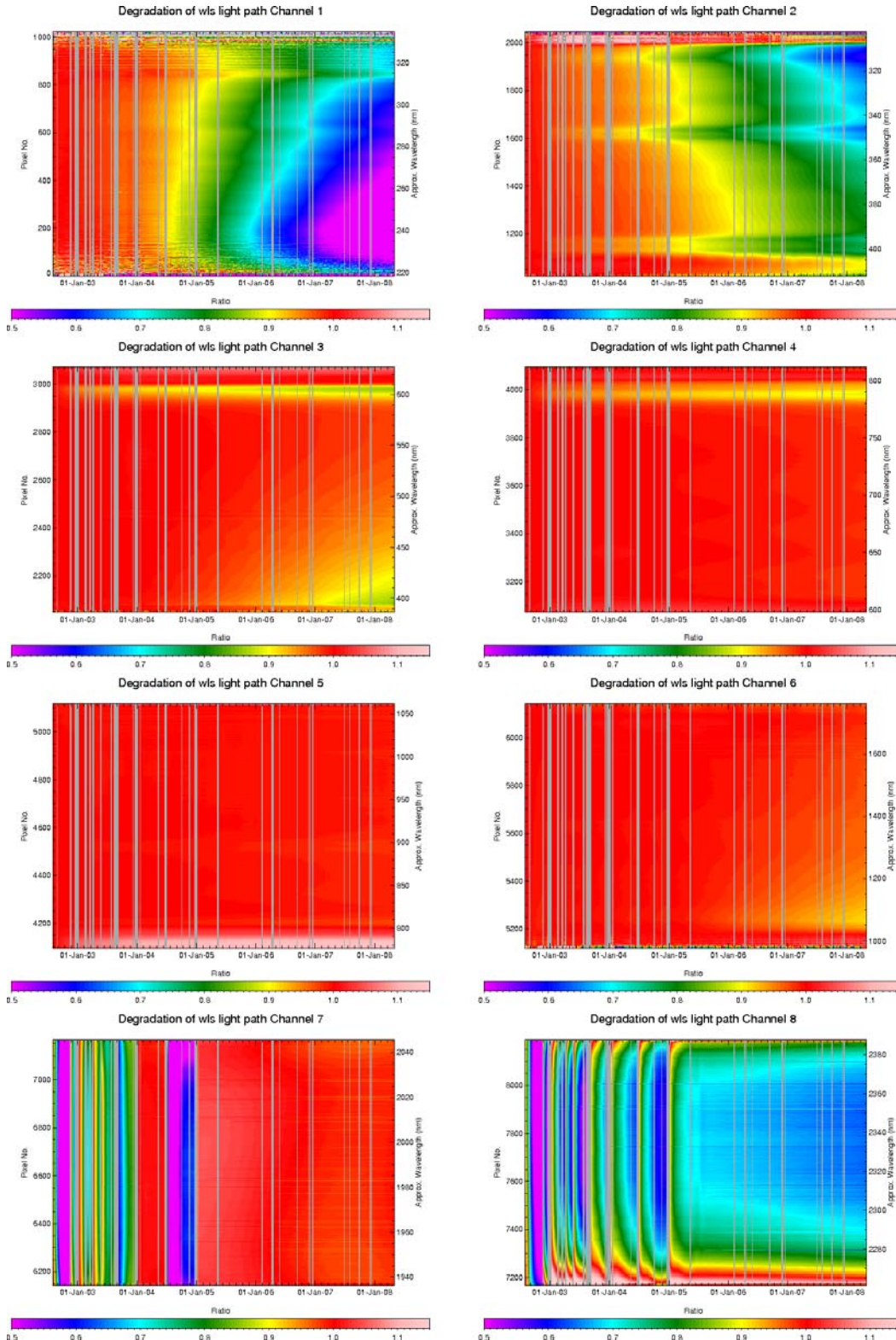


Fig. 3.11: Spectral light path monitoring results August 2002 to April 2008 (WLS light path)



esa



serco

SCIAMACHY Bi-MONTHLY



page 30 of 63

### 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. Thus, the reference time for the subsolar data is January 2003, whereas it is August 2002 for the other data sets.

For the nadir light path it is not possible to use subsolar fast sweep measurements for PMD monitoring, because these show too large scatter. This is probably caused by a combination of the very time-sensitive measurement type and scan mode and the fact that the PMDs measure a sampled signal, not an integrated one. Therefore, subsolar pointing measurements are used for monitoring of the PMD nadir light path, because the pointing signal is much more stable. Until October 2006 subsolar pointing measurements were only performed once per month, therefore the temporal sampling is much less than for the other light paths. Since 1 October 2006 the number of subsolar pointing measurements has been increased (on the cost of subsolar fast sweep data).

Fig. 3.12 shows the PMD throughput variation for the whole time period between 2 August 2002 and 30 April 2008. 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.

Note that PMD 7 results are most likely dominated by straylight and not reliable. They are only shown for completeness. Furthermore, WLS data are only available for PMD 1 to 3 because of saturation in the other PMD channels.

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 with the following features:

- The UV degradation apparent in the science channels is also visible in PMD 1 to 3.
- PMD 4 and 7 (which cover the same wavelength interval) show a considerably large decrease in throughput which is still unexplained (but may be related to the specific detector material).
- There are remaining seasonal variations in the data which could up to now not be corrected out. The amplitude of these seasonal variations increases with the wavelength range covered by the PMD. This issue is still unresolved.
- The PMD 6 dark signal shows a strange variation over time which is still under investigation.

A more detailed investigation of the open issues listed above requires a better calibration of the monitoring data which is currently (in the context of m-factor generation) under development, but will probably take some time.

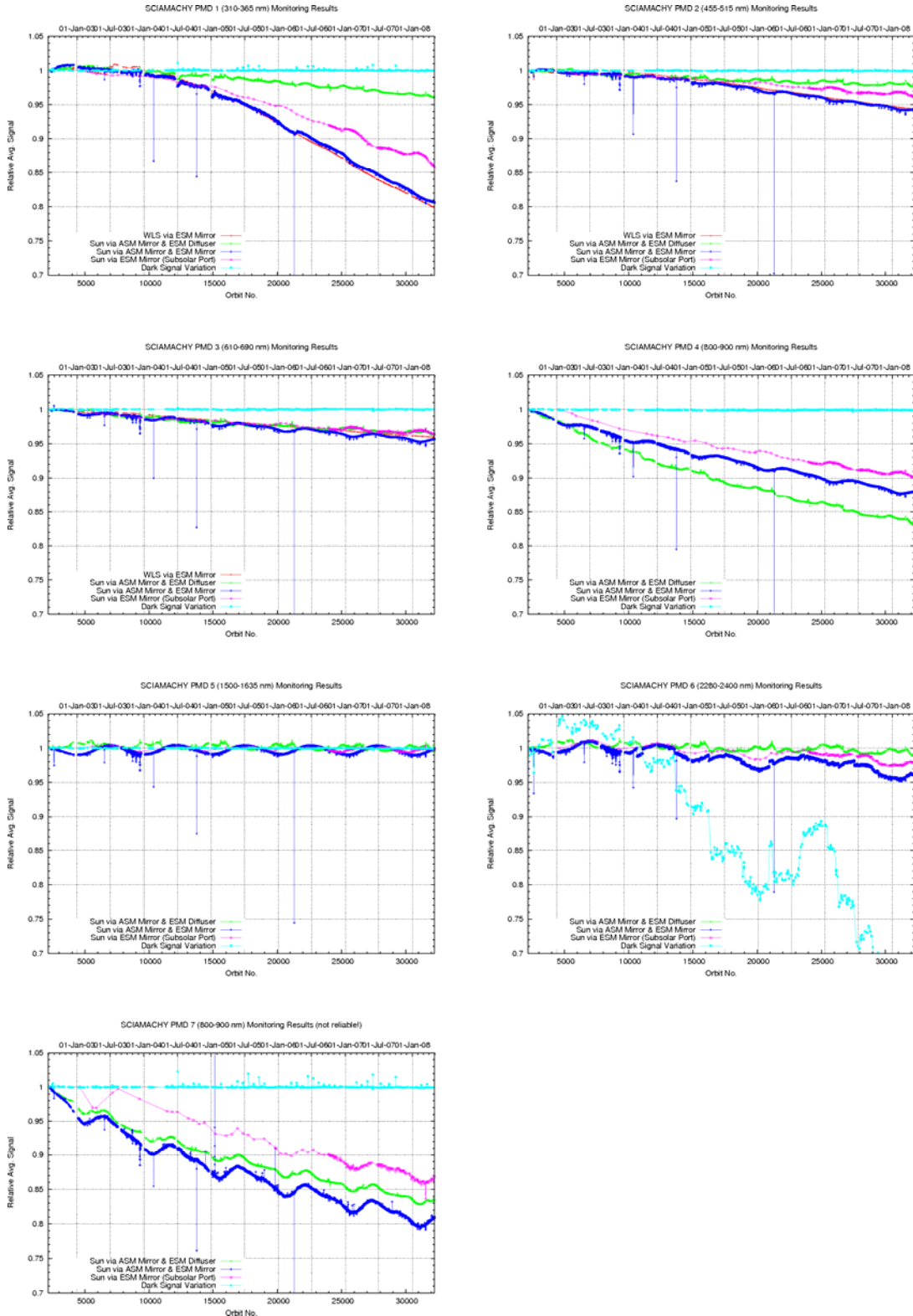


Fig. 3.12: PMD monitoring results August 2002 to April 2008



esa



serco

SCIAMACHY Bi-MONTHL



## 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	07-APR-2008	SCI_NL__0PNPDK20080407_062132_000125692067_00292_31909_7884.N1	sciamachy_source_packets ERROR: incorrect file size
SCI_NL__0P	14-APR-2008	SCI_NL__0PNPDK20080414_074216_000061042067_00393_32010_7944.N1	sciamachy_source_packets ERROR: incorrect file size

Table 4-1 Products containing format errors

These occurrences of data corruptions are currently under investigation.

### 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.

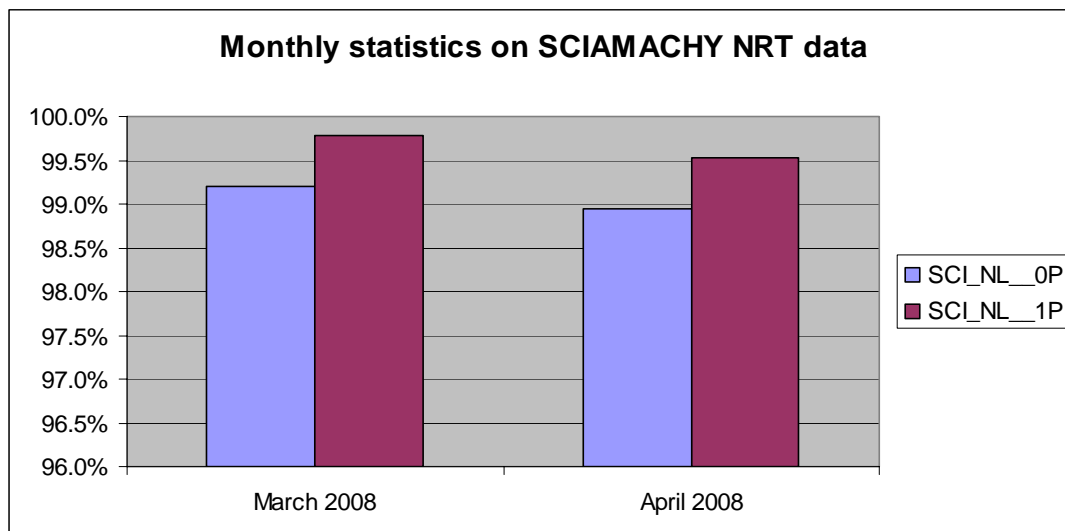
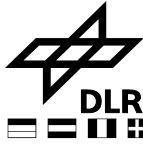


Fig. 4-1: Statistics on available unconsolidated level 0 and level 1b products





esa



serco

SCIAMACHY Bi-MONTHL



page 33 of 63

## 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](http://atmos.caf.dlr.de/projects/scops/data_availability/availability.html)

A recovery plan was initiated in order to reprocess erroneous data 2002 - 2006. This activity has been completed. For the year 2007 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 to April 2008 is summarised here, considering flight segment and ground segment anomalies. Note that also interfile gaps are considered, but no data gaps inside the products. During the period 14-19 April, orbits 32009 – 32090 a tape reading failure



esa



DLR



ife

serco

SCIAMACHY Bi-MONTHLY



caused that corresponding level 0 products could not be processed to consolidated products. Those data are currently being recovered and corresponding level 1b products will be generated once the level 0 consolidated products are available.

Please note, that after a network maintenance in November 2007 at D-PAC, the FTP address accessing the data server was permanently changed to 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
03/2008	31376 – 31819	0	443	444	99.0%
04/2008	31820 - 32249	9	337	421	78.3%

Table 4-2 Consolidated level 1b statistics

#### 4.4 Statistics on reprocessed data

##### 4.4.1 Level 1b re-processing IPF 6.03

The second reprocessing cycle had started on 24 September 2007 using the level 1b IPF version 6.03 at D-PAC and was completed in December 2007 in a first systematic processing round.

A new reprocessing flag was introduced in the filename and MPH, which is the letter “R” replacing the Processing Stage flag “P” for off-line level 1b products that was valid for IPF 5.04 and IPF 6.02 products.

Data is available at the D-PAC server (FTP address 195.37.183.37, ftp-ops-dp.eo.esa.int). Monthly mean availability lies at about 94% and progress on the missing data to be processed is still on-going as well as the quality check on the whole dataset. More details see previous BMR (January - February 2008).

Detailed statistics will be provided in the next BMR considering the reprocessing round filling the data gaps.

In a second step the data contents will be monitored. Preparations for this major monitoring activity are ongoing.

##### 4.4.2 Level 2 re-processing processor version 3.01

Level 2 off-line re-processing has been performed at D-PAC with processor version 3.01.



esa



DLR



serco

SCIAMACHY Bi-MONTHL



page 35 of 63

As for the level 1b, the level 2 off-line reprocessed data set contains the new processing flag “R” in the filename and MPH.

The level 2 off-line products have been successfully validated by the SCIAVALIG team and results have been presented during a validation workshop at the end of March 2008 (see chapter 8). Data are now available to the users at the D-PAC server (FTP address 195.37.183.37, ftp-ops-dp.eo.esa.int).

The first round of reprocessing for level 2 data for the period 02 August 2002 – September 2007 had been completed in January 2008.

As well as for the level 1b, consolidation of the data set is on-going with respect to completeness and duplicates. In a second step the data contents will be monitored.

Besides a few exceptions the mean monthly availability lies at about 91%.

Detailed statistics will be provided in the next BMR.



esa



serco

SCIAMACHY Bi-MONTHLY



## 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 and the second SCIAMACHY full mission re-processing cycle.

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](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](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.

Currently the new baseline 7.00 is in preparation (a verification meeting took place at IFE Bremen 26 March 2008).

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 <ul style="list-style-type: none"> <li>• New pointing correction (new SCI_LI1_AX)</li> <li>• Updated of the ESA CFI (5.6) software</li> <li>• Correction of a non compliancy report, impacting the Leakage GADS in the consolidated data processing chain (channels 6-8)</li> </ul>	D-PAC	04-JUL-2007	27937
		PDHS-E	19-JUL-2007	28153
		PDHS-K	19-JUL-2007	28145
6.02	No algorithm specification changes were implemented, but following non compliances of version 6.01 have been corrected, to get <ul style="list-style-type: none"> <li>• Polarisation correction factors different from 0</li> <li>• Correct order of SMR spectra in</li> </ul>	D-PAC	05-MAY-2006	21843
		PDHS-E	07-JUN-2006	22327
		PDHS-K	07-JUN-2006	22318



esa



serco

SCIAMACHY Bi-MONTHL



	<p>Sun Reference ADS</p> <ul style="list-style-type: none"> <li>Solar mean reference spectra in New Sun Reference Data set with positive sign (was negative in IPF 6.01)</li> </ul>			
6.01	<ul style="list-style-type: none"> <li>Improved parameterization of the Memory effect for channels 1 to 5</li> <li>New correction for the Non-Linearity effect in the infrared channels</li> <li>Usage of improved key data for the radiometric calibration of all channels</li> <li>Each solar spectrum is provided in a calibrated and un-calibrated manner for all channels</li> <li>Orbital dependency of channel 6 to 8 leakage calculated; currently applied only to channel 8</li> <li>Improvement of the pointing accuracy through the usage of the ENVISAT Restituted Attitude auxiliary files for the off-line processing</li> <li>decontamination flag added to the SPH</li> </ul>	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

Due to an erroneously activated processing-configuration, SCIAMACHY off-line Level 1 (IPF Version 6.03) products contained the processing flag "P" instead of the flag "R". Except for the processing flag, the files contained nominal data. The concerned data set covers the measurement dates between 13 April 2008 and 21 April 2008, Orbits 32002 – 32119. The wrong data were already removed from the D-PAC center and corrective reprocessing had been completed.

### 5.2 Auxiliary Data Files

For operation of the SCIAMACHY level 1 processor, a set of auxiliary files as input is required.



esa



DLR



ife

serco

SCIAMACHY Bi-MONTHL



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 2008 was 96.7% and for April 2008 it was 100%. The SU1 ADF for 12 March was not generated.

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 2008 (66.9%) and April 2008 (60%) are on a nominal level.

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.



esa



serco

SCIAMACHY Bi-MONTHLY

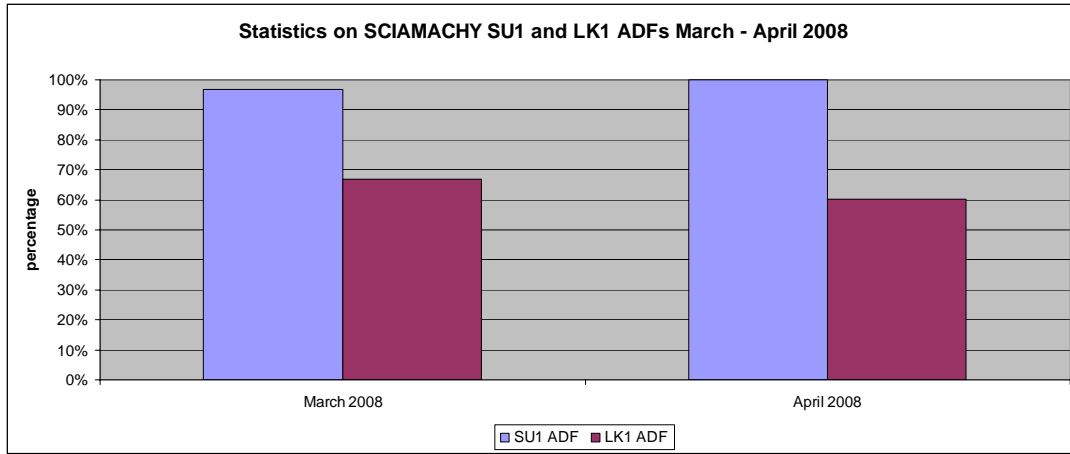


Fig. 5-1: Statistics on SU1 and LK1 processing

### 5.2.1 Spectral Performance

Future reports will contain analyses of spectral performance.

### 5.2.2 Radiometric Performance

Future reports will contain analyses of spectral performance.

### 5.2.3 Other Calibration Results

#### 5.2.3.1 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 2008. The ratios were determined by dividing the



esa



serco

SCIAMACHY Bi-MONTHLY



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 2008**  
Reference SMR - 01 March 2008  
SMR used for ratios: 02, 03, 04, 05, 06, 07, 08, 09, 10, 15, 21, 31 March 2008
- **April 2008**  
Reference SMR - 01 April 2008  
SMR used for ratios: 02, 03, 04, 05, 06, 07, 08, 09, 10, 14, 21, 30 April 2008

The overall changes lie 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 2008, respectively 29 April 2003 and 29 April 2008.

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 5 years of about 7-10% 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.





esa



serco

SCIAMACHY Bi-MONTHLY



ratio of smrs as a function of pixel, March 2008

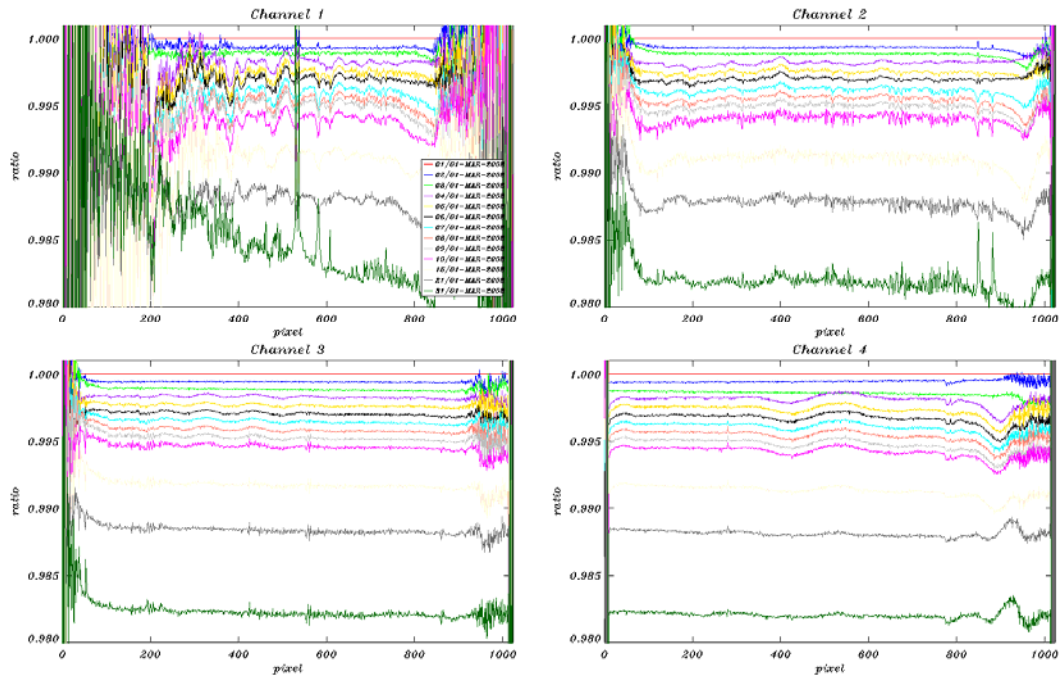


Fig. 5-2: SMR ratios per detector channel 1-4 (changes during March 2008)

ratio of smrs as a function of pixel, March 2008

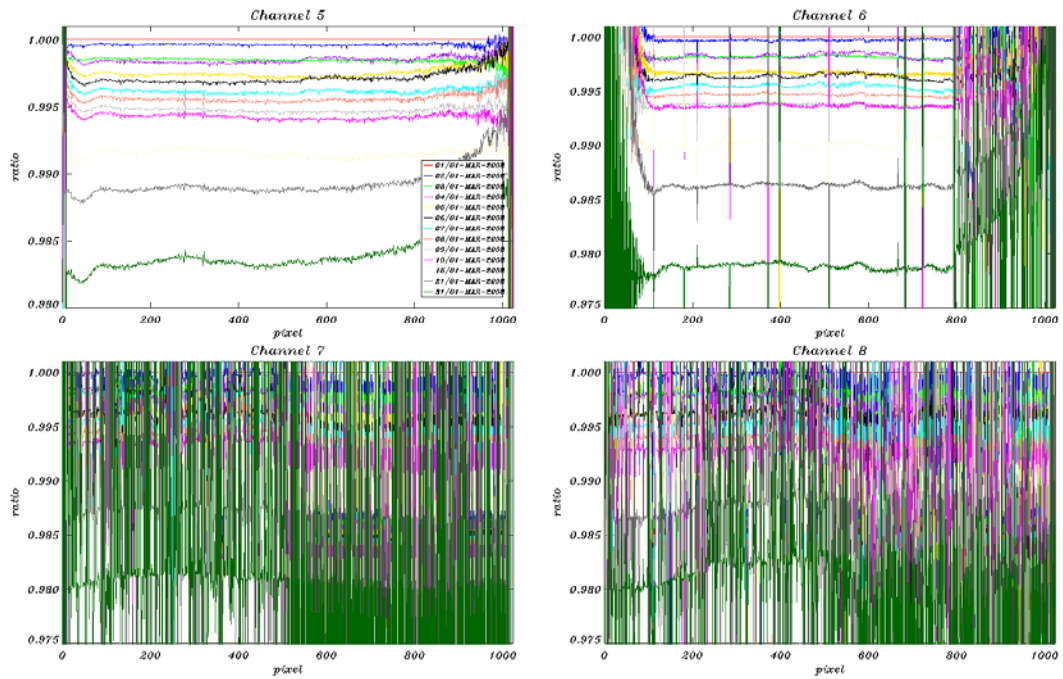


Fig. 5-3: SMR ratios per detector channel 5-8 (changes during March 2008)



esa



serco

SCIAMACHY Bi-MONTHL



ratio of smrs as a function of pixel, April 2008

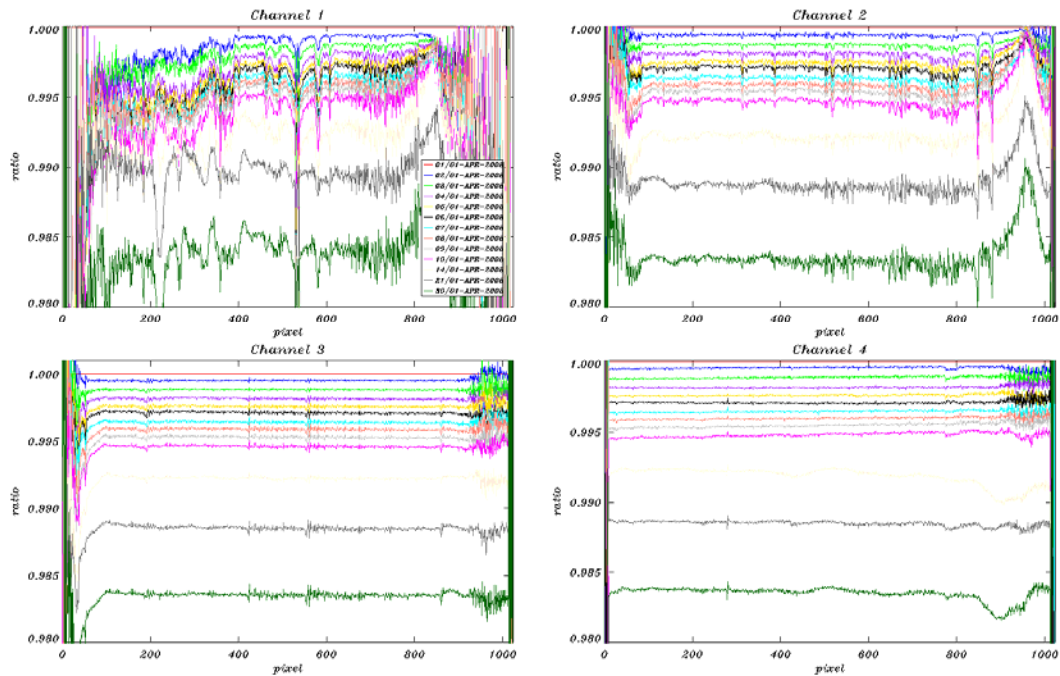


Fig. 5-4: SMR ratios per detector channel 1-4 (changes during April 2008)

ratio of smrs as a function of pixel, April 2008

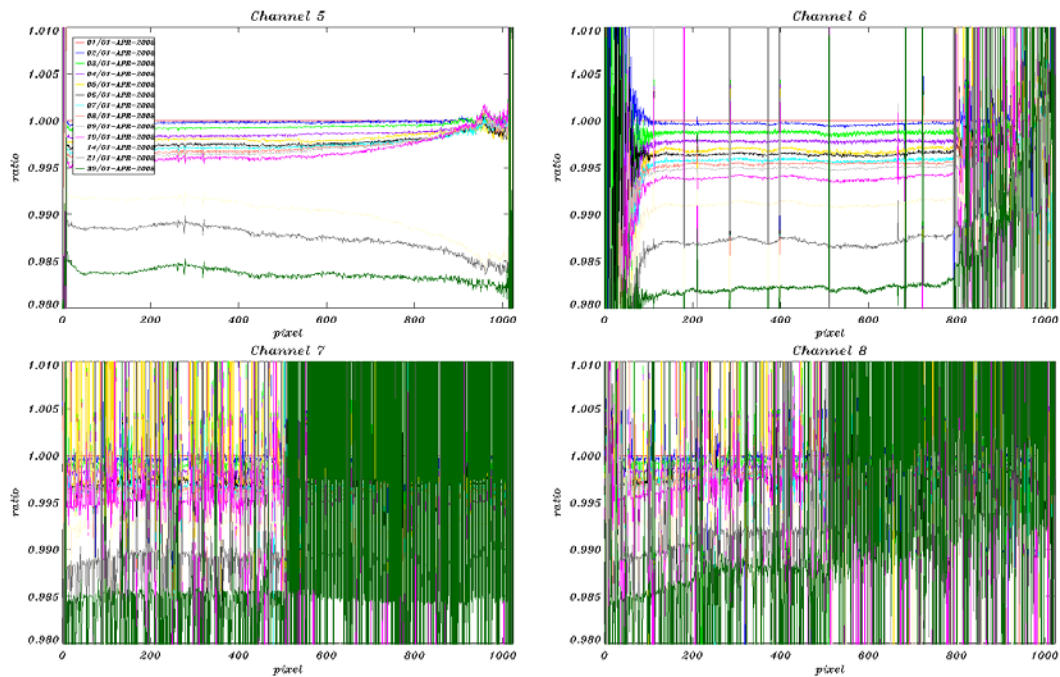


Fig. 5-5: SMR ratios per detector channel 5-8 (changes during April 2008)



smr ratio, D0 31/03/2008 divided by 31/03/2003

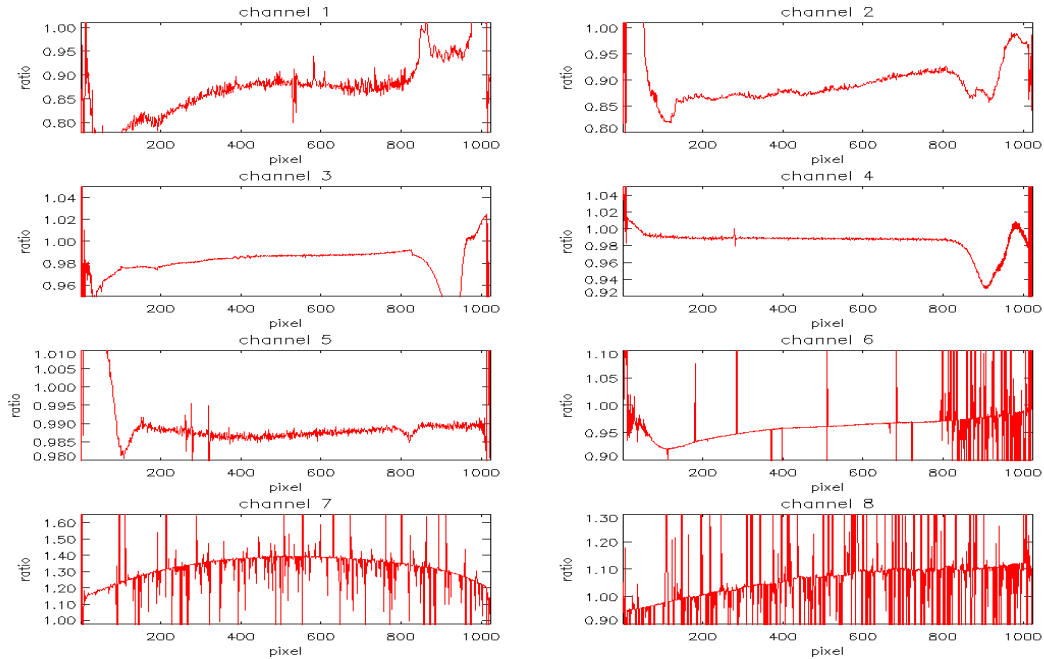


Fig. 5-6: SMR ratios per detector channel on Long Term Trend

smr ratio, D0 29/04/2008 divided by 29/04/2003

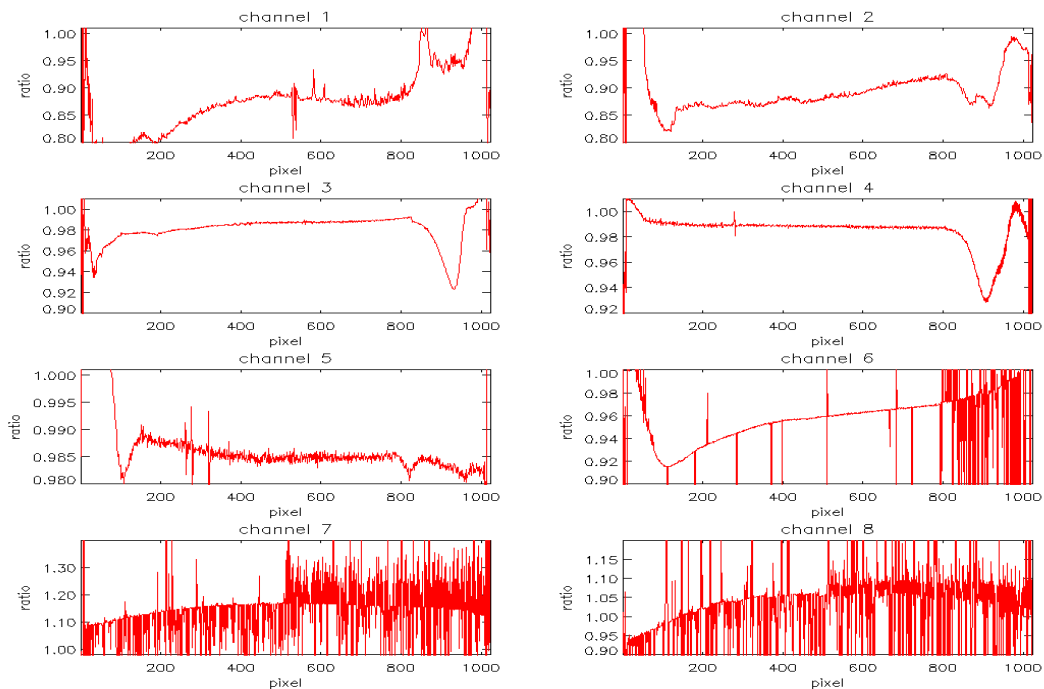


Fig. 5-7: SMR ratios per detector channel on Long Term Trend



esa



DLR



ife

serco

SCIAMACHY Bi-MONTHL



page 44 of 63

### 5.2.3.2 LK1 analysis

#### 5.2.3.2.1 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.

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).



esa



serco

SCIAMACHY Bi-MONTHL



LK1 ADF analysis, ratios of fpn const March 2008

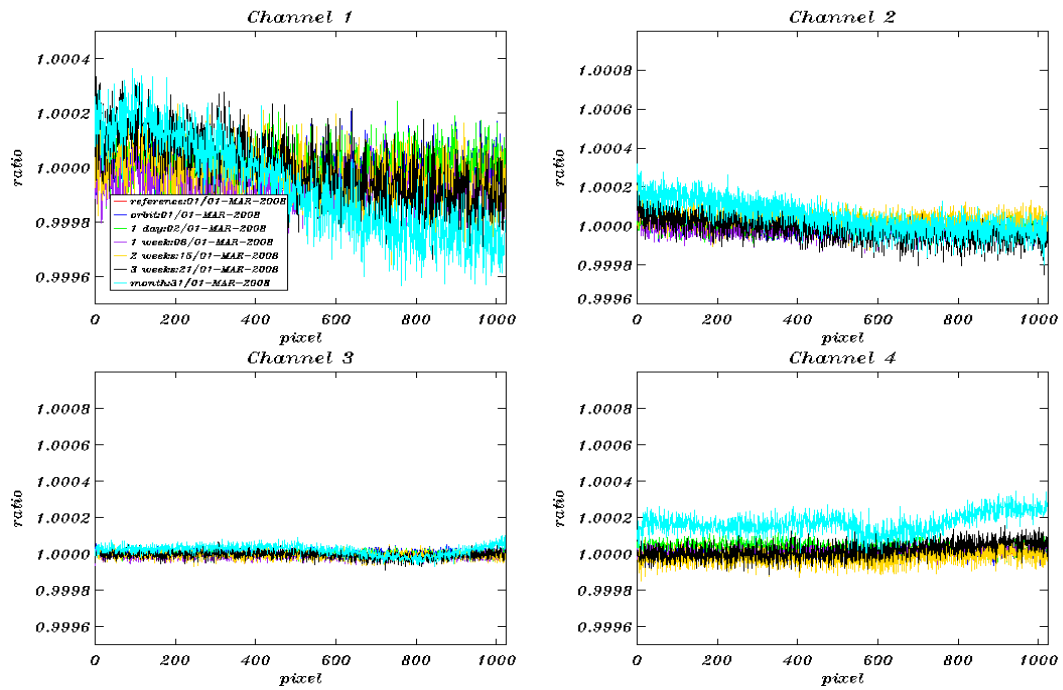


Fig. 5-8: dark current ratios (constant part) channel 1-4 during March 2008, Reference Spectrum used: Orbit 31380, 01-March-2008

LK1 ADF analysis, ratios of fpn const March 2008

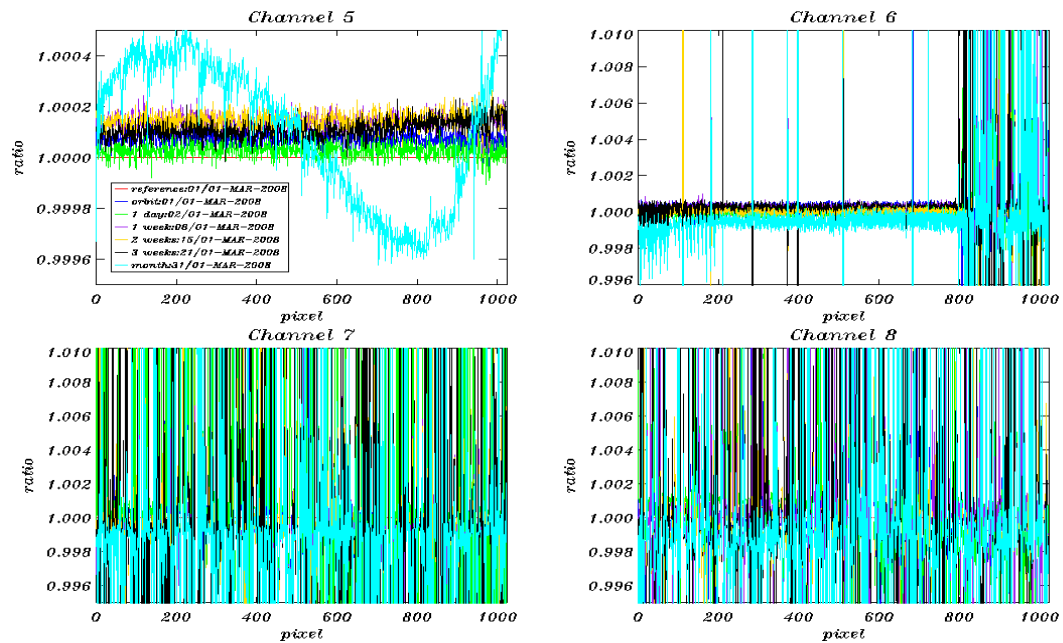


Fig. 5-9: dark current ratios (constant part) channel 5-8 during March 2008, Reference Spectrum used: Orbit 31380, 01-March-2008



esa



serco

SCIAMACHY Bi-MONTHL



LK1 ADF analysis, ratios of fpn const April 2008

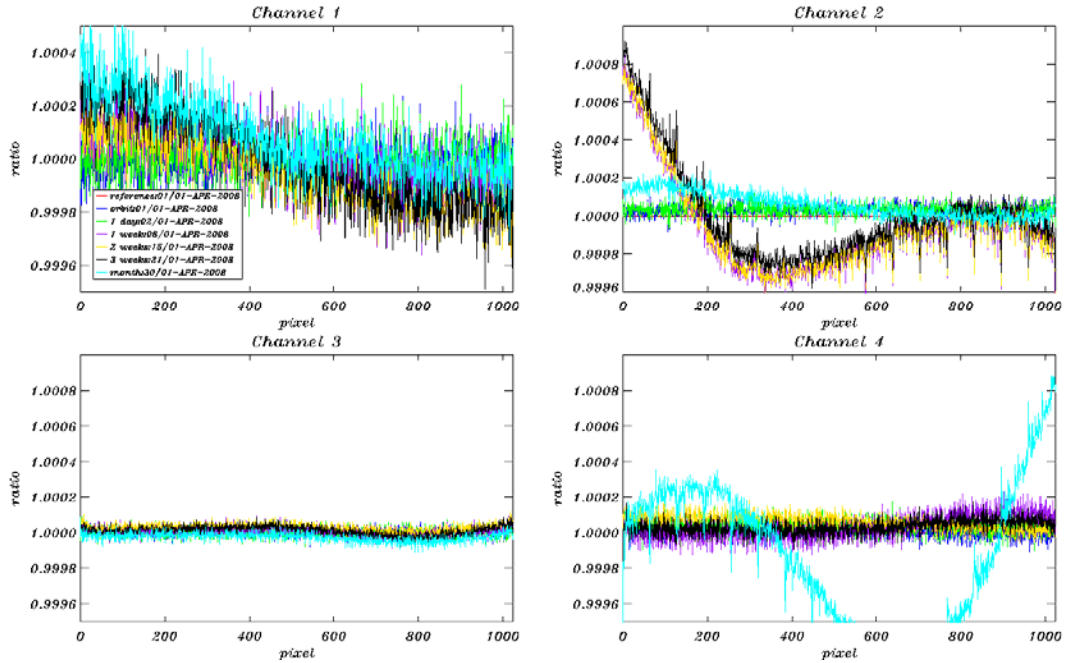


Fig. 5-10: dark current ratios (constant part) channel 1-4 during April 2008, Reference Spectrum used: Orbit 31824, 01-April 2008

LK1 ADF analysis, ratios of fpn const April 2008

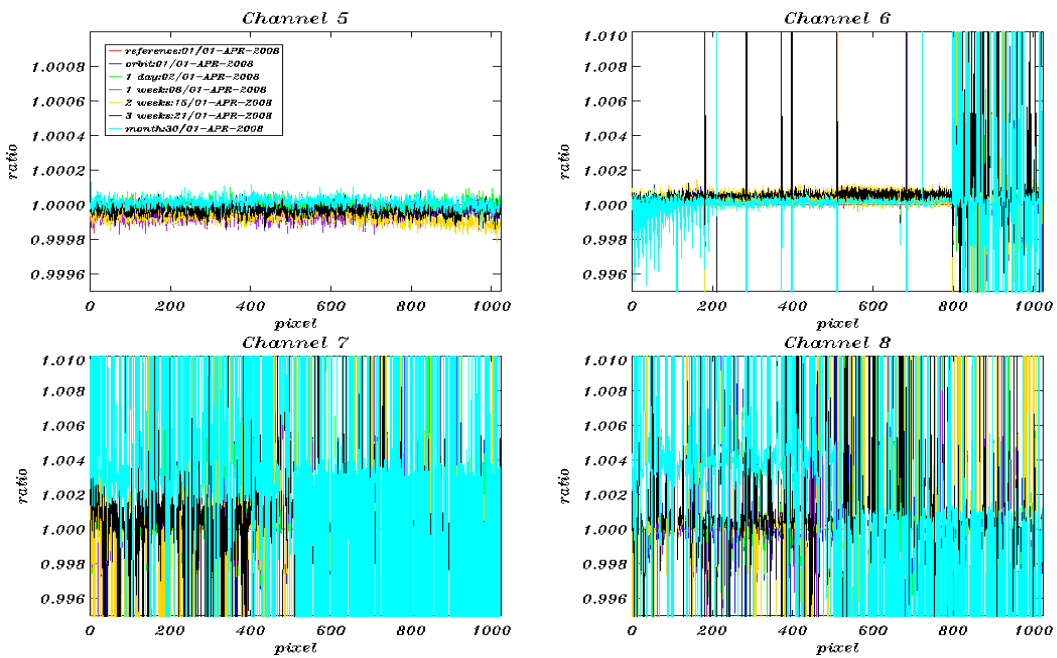


Fig. 5-11: dark current ratios (constant part) channel 5-8 during April 2008, Reference Spectrum used: Orbit 31824, 01-April-2008



esa



serco

SCIAMACHY Bi-MONTHL



### 5.2.3.2.2 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 2008 to 30 April 2008. 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:

- 20 March 2008
- 18 April 2008

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

SCIAMACHY leakage variable analysis 01/03/2008 – 31/04/2008

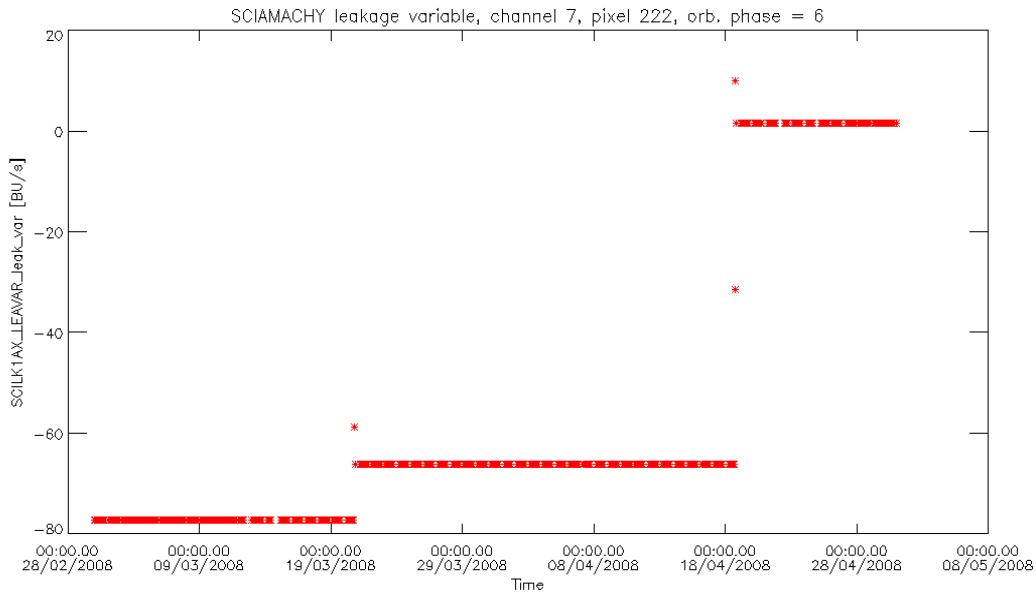
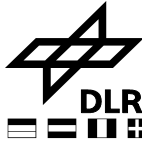


Figure 5-12: Leakage VARIABLE, SCI\_LK1\_AX, 01 March – 30 April 2008, channel 7, Orbit phase=6 pixel 222



esa



serco

SCIAMACHY Bi-MONTHL



### 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.

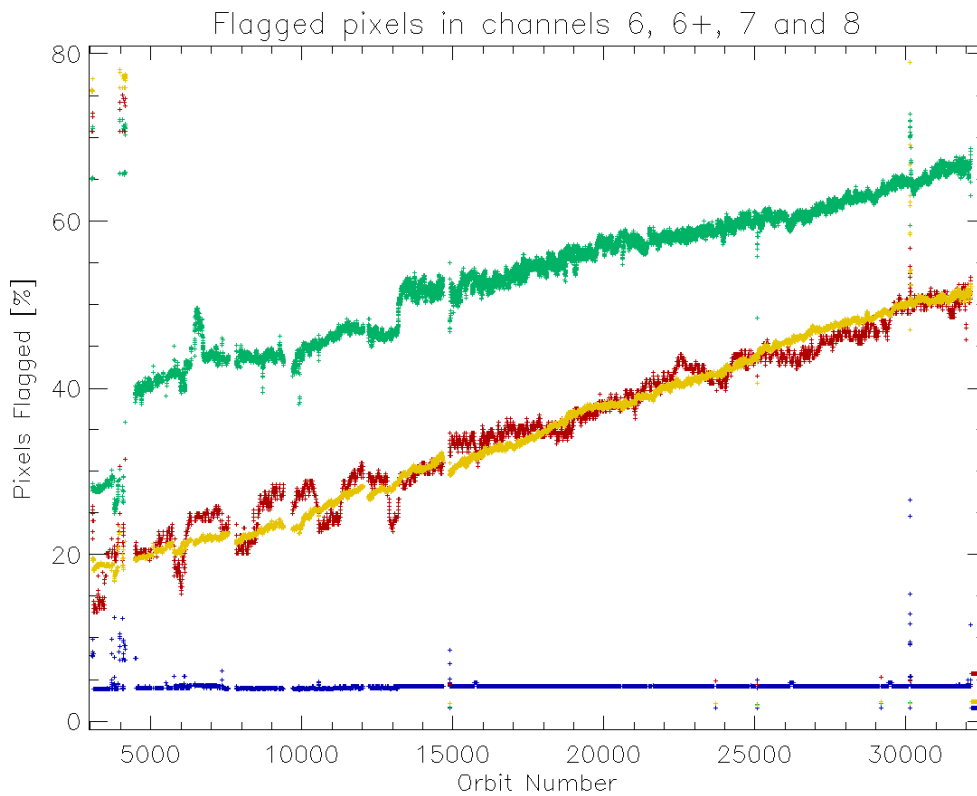


Figure 5-13: Number/Fraction of pixels that is flagged as bad by the SDMF smoothmask for channels 6 (blue), 6+ (red), 7 (green) and 8 (dark yellow). Orbits during SODAP or decontaminations have been removed.





esa



DLR



serco

SCIAMACHY Bi-MONTHL



page 49 of 63

## 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 6.02 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.



esa



DLR



serco

SCIAMACHY Bi-MONTHL



page 50 of 63

## 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](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).

#### 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](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](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<sub>3</sub> and NO<sub>2</sub> Nadir measurements, as well as stratospheric Limb profiles of O<sub>3</sub> and NO<sub>2</sub>. 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.

Currently the new baseline 4.00 is in preparation (a verification meeting took place at IFE Bremen 26 March 2008).

Processor Version	Description	Proc Centre	Date	Start Orbit
3.01	<p>Main processor changes:</p> <ul style="list-style-type: none"> <li>• Updated SACURA cloud algorithm</li> <li>• Offset applied in NO<sub>2</sub> slant column processing was removed</li> <li>• Number of retrieved profiles per state was set from one to four (4)</li> <li>• Cloud and Aerosol MDS are filled with the next valid value instead of being set to zero</li> <li>• Molecular Ring correction applied on NADIR O<sub>3</sub> slant column density</li> </ul> <p>Non-compliance corrections:</p> <ul style="list-style-type: none"> <li>• Inter change of Pressure and Temperature values in LIMB MDS</li> <li>• Erroneous Cloud and Aerosol</li> </ul>	D-PAC	23-SEP-2007	29092



esa



DLR



ife

serco

SCIAMACHY Bi-MONTHLY



	<p>Quality Flags</p> <ul style="list-style-type: none"> <li>• AAI erroneously set to zero in Cloud and Aerosol MDS</li> <li>• Scaling of too large NO<sub>2</sub> error estimate</li> </ul>			
3.00	<ul style="list-style-type: none"> <li>• Nadir UV/Visible algorithm for ozone and NO<sub>2</sub> is based on the GDP (GOME Data Processor) Version 4.0</li> <li>• Nadir UV/Visible algorithm for cloud-top height and cloud optical thickness based on the SACURA algorithm</li> <li>• Limb UV/Visible products: Stratospheric Ozone and NO<sub>2</sub> profiles</li> <li>• Improved pointing performance through the use of the ENVISAT Restituted Attitude information in the consolidated Level 1b product</li> </ul>	D-PAC	03-MAY-2006	21824

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

### 7.1.2 Anomalies

#### 7.1.2.1 Data 23 September 2007 – 27 October 2007

With the operation of the new off-line processor version 3.01 an erroneous processing configuration was activated for the operational processing chain, containing a too short time-out setting. This led to an incomplete Limb MDS processing; only a reduced number of tangent latitude values were processed. Nadir MDS were nominal and not effected by this anomaly. The data set concerned is between 23 September 2007 and 27 October 2007. Data after this period are processed nominally again as the configuration was corrected.

The data of the time span, containing a reduced number of LIMB MDS, have been processed in April 2008.

#### 7.1.2.2 Data 13 – 21 April 2008

Due to an erroneously activated processing-configuration, SCIAMACHY off-line Level 1 (IPF Version 6.03) and Level 2 (Version 3.01) products contained the processing flag "P" instead of the flag "R".

Except for the processing flag, the files contained nominal data.

The concerned data set covers the measurement dates between 13 April 2008 and 21 April 2008, Orbits 32002 – 32119. The wrong data were already removed from the D-PAC center and corrective reprocessing had been completed.

### *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<sub>2</sub> consistency checking*

The world map plots of nadir NO<sub>2</sub> vertical column density (VCD) values averaged over one month are generated from the SCI\_OL\_\_2P nadir products. Fig 7.1 and 7.3 show the monthly world map plots for March and April 2008.

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<sub>2</sub> values with higher errors.

High concentration of NO<sub>2</sub> 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.



esa



serco

SCIAMACHY Bi-MONTHLY



7.2.1.1 Nadir: VCD NO2 map March 2008

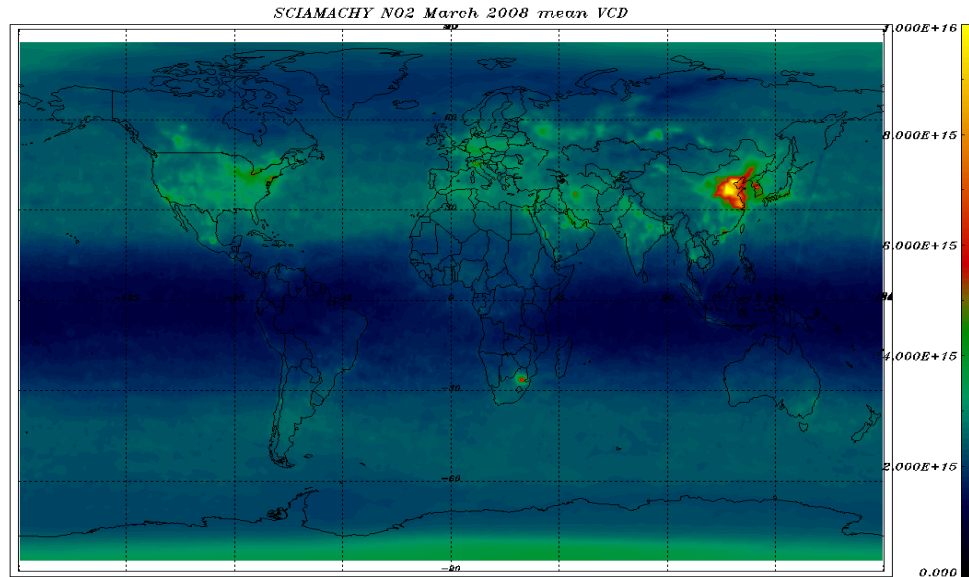


Figure 7-1: NO2 VCD world map 01 - 31 March 2008 – monthly average

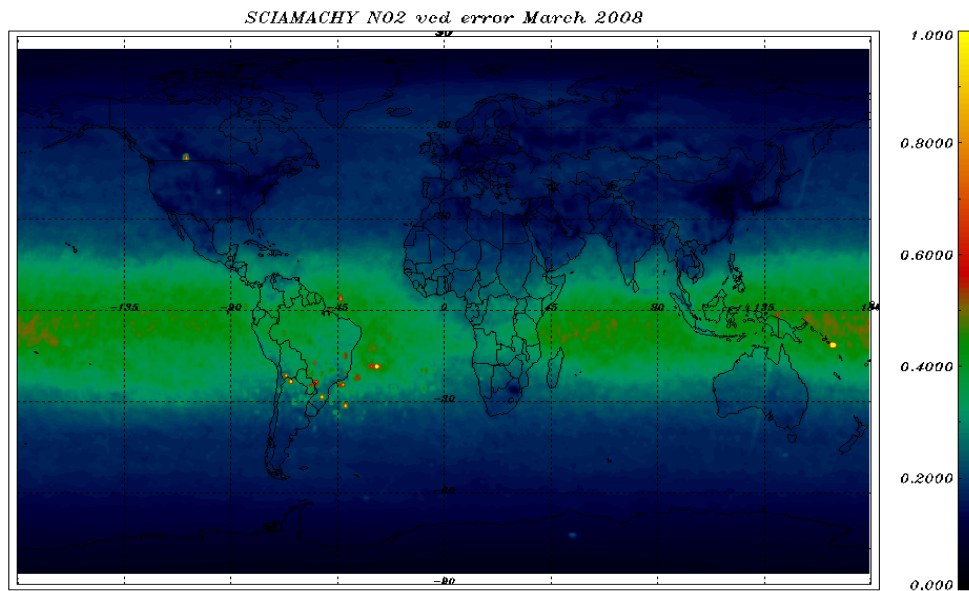


Figure 7-2: NO2 VCD error 01-31 March 2008



esa



serco

SCIAMACHY Bi-MONTHL



### 7.2.1.2 Nadir: VCD NO<sub>2</sub> map April 2008

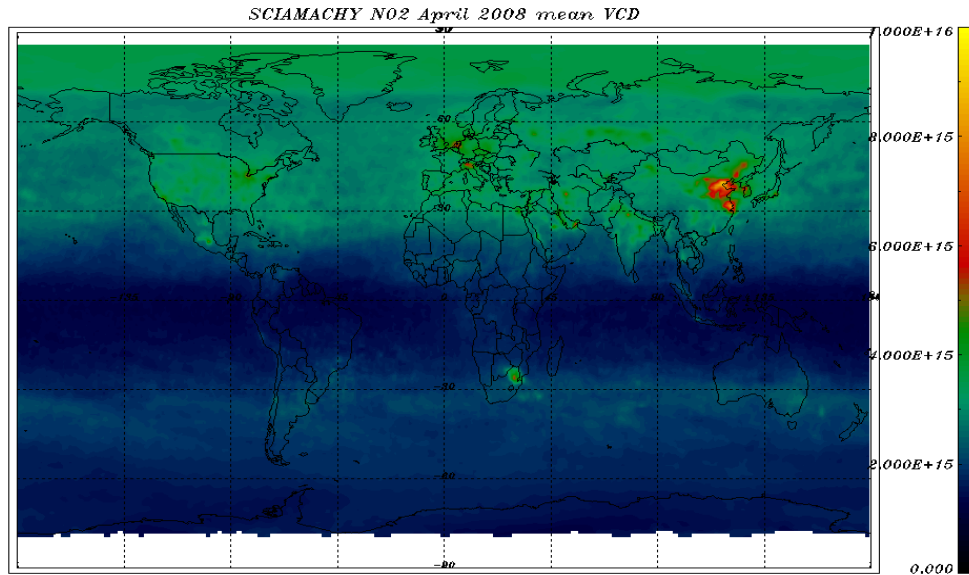


Figure 7-3: NO<sub>2</sub> VCD world map 01 – 30 April 2008 – monthly average

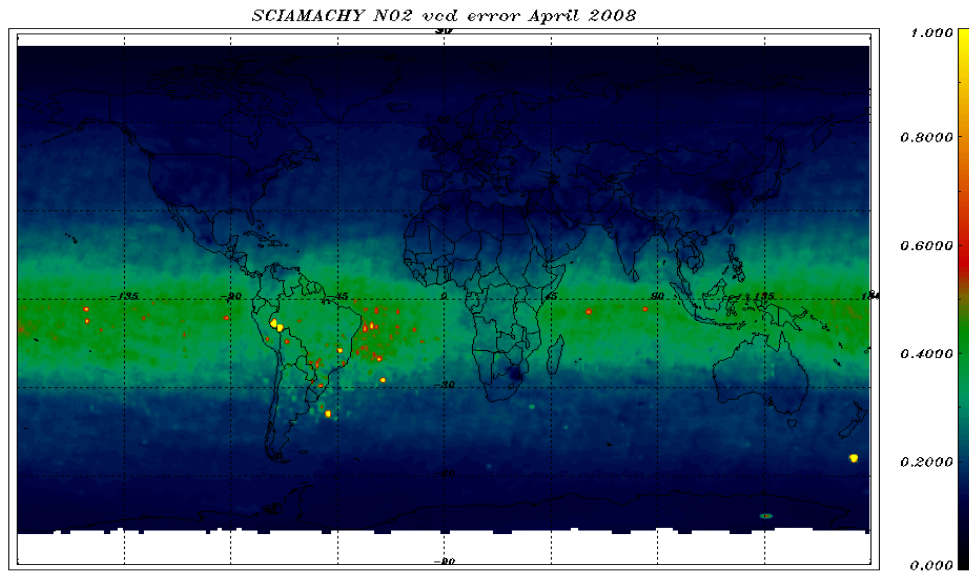


Figure 7-4: NO<sub>2</sub> VCD error 01 – 30 April 2008



esa



DLR



serco

SCIAMACHY Bi-MONTHLY



page 56 of 63

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

Analogous to the NO<sub>2</sub> world maps, O<sub>3</sub> vertical column density (VCD) values averaged over one month are generated from the SCI\_OL\_2P nadir products and plotted on a world map. Fig 7.5 and 7.7 show the ozone distribution converted in Dobson units for March and April 2008. Corresponding to the seasonal evolution the Ozone Hole over the Antarctica is not visible during these two months.

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 O<sub>3</sub> map March 2008

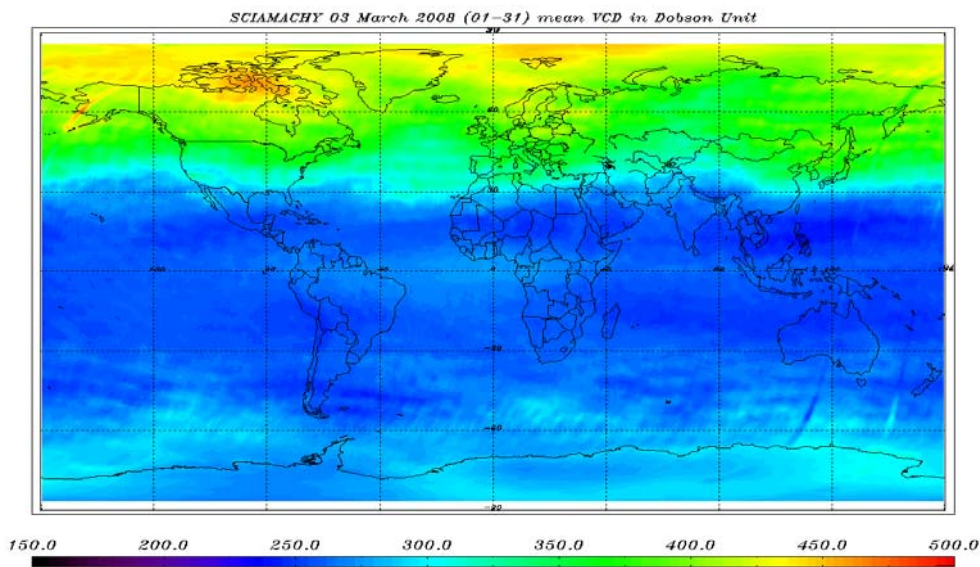


Figure 7-5: O<sub>3</sub> VCD world map 01-31 March 2008 – monthly average

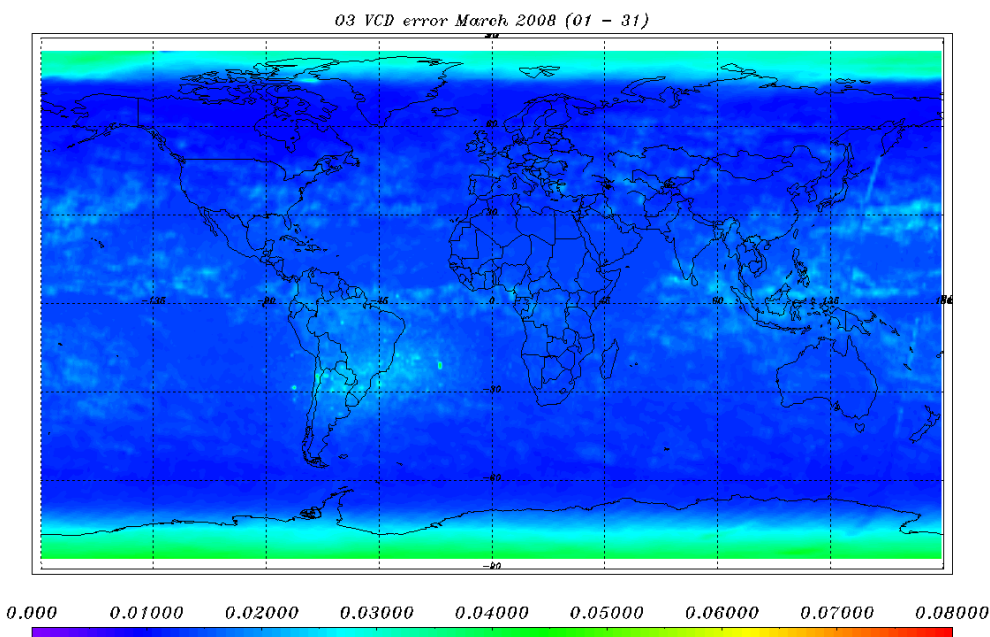


Figure 7-6: O<sub>3</sub> VCD error 01-31 March 2008

7.2.2.2 Nadir: VCD O<sub>3</sub> map April 2008

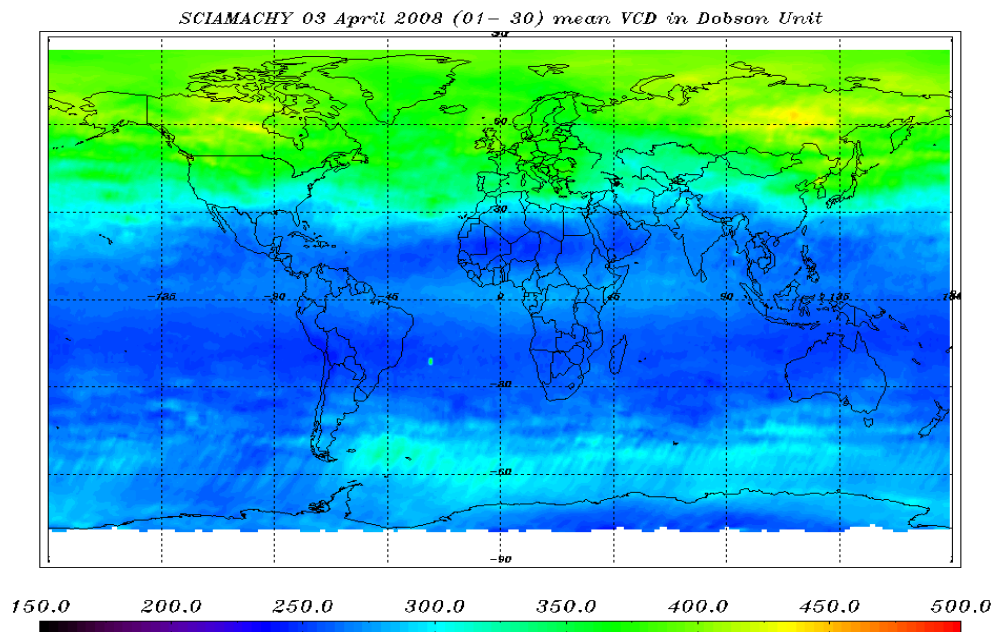


Figure 7-7: O<sub>3</sub> VCD world map 01 - 30 April 2008 – monthly average

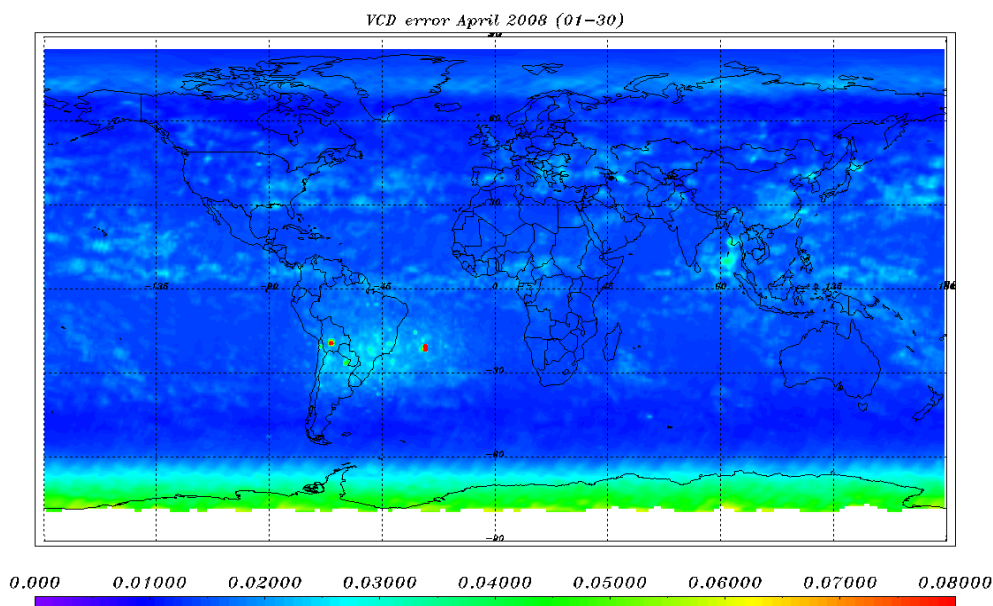


Figure 7-8: O<sub>3</sub> VCD error 01-30 April 2008

### 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.

During the second half of March 2008 some small data gaps over Asia can be seen. This is under investigation, however data products were available and products were not missing.



esa



serco

SCIAMACHY BI-MONTHLY



7.2.3.1 Ozone limb profiles March 2008

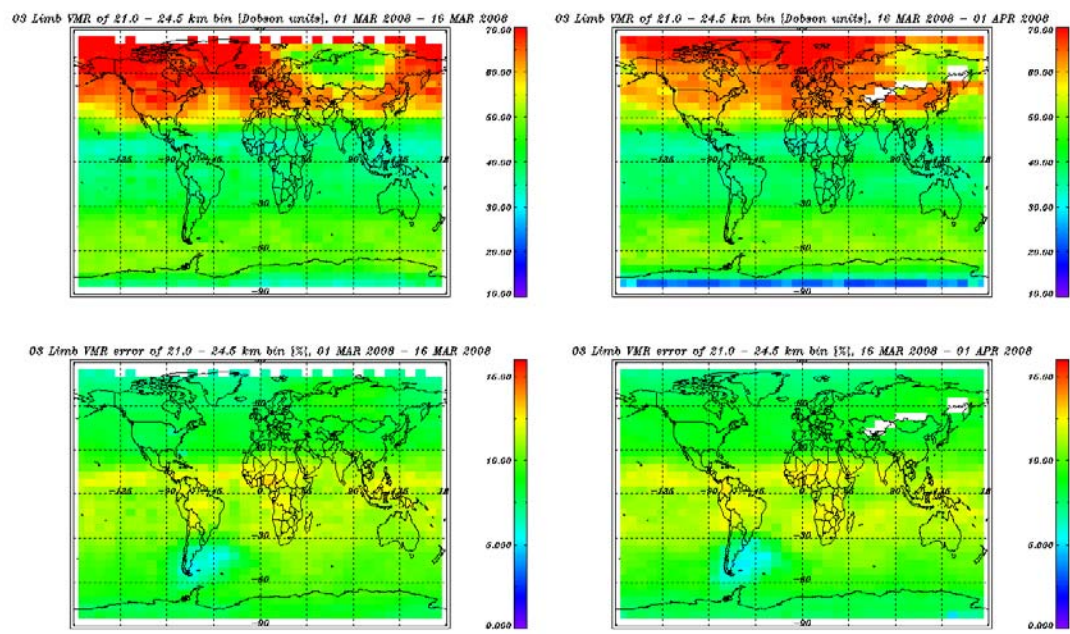


Figure 7-9 Limb Ozone profiles, binned over 21.0 - 24.5 km

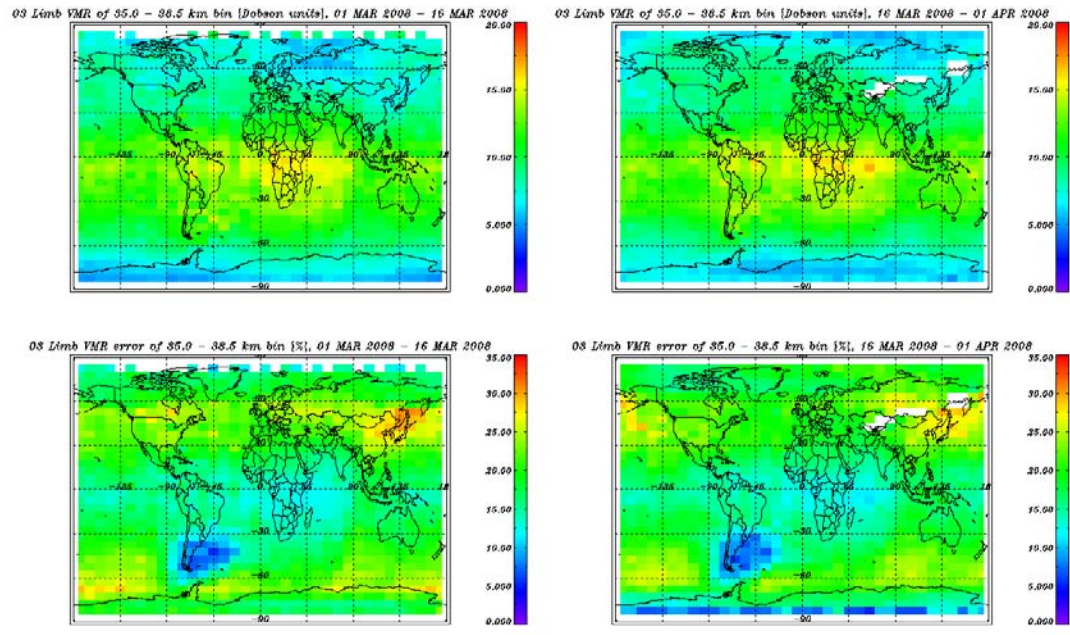


Figure 7-10 Limb Ozone profiles, binned over 35.0 - 38.5 km



esa



serco

SCIAMACHY BI-MONTHLY



### 7.2.3.2 Ozone limb profiles April 2008

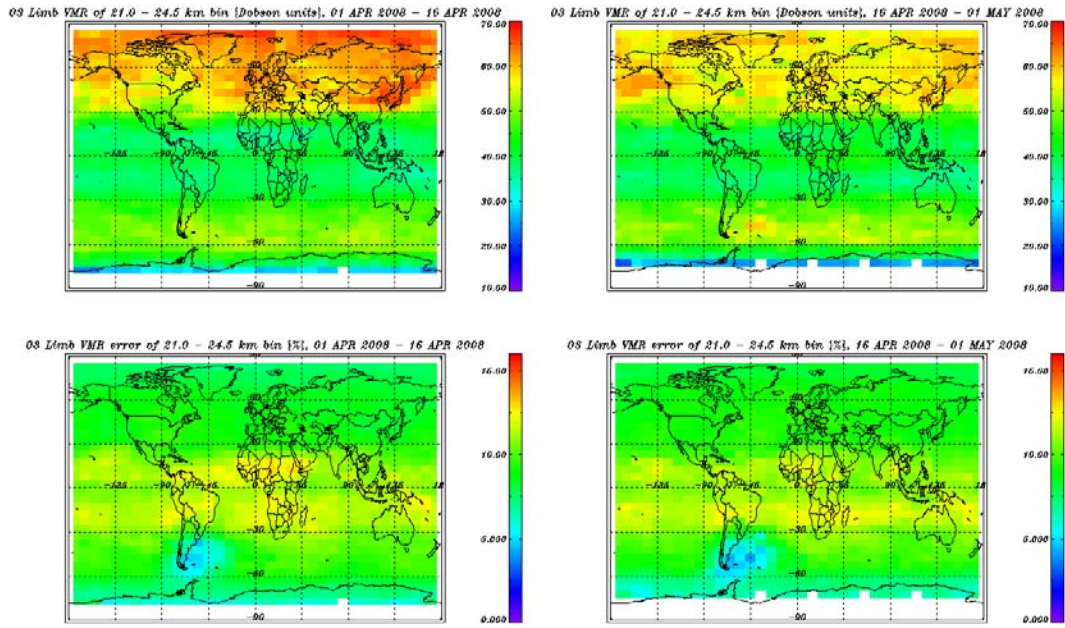


Figure 7-11: Limb Ozone profiles binned over 21.0 – 24.5 km

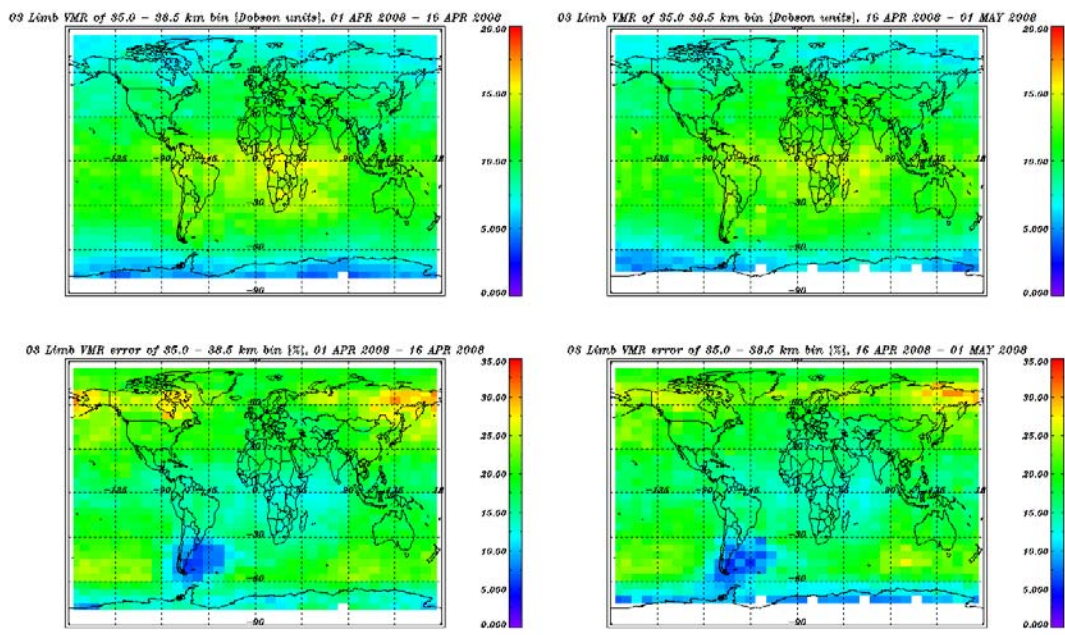


Figure 7-12: Limb Ozone profiles, binned over 35.0 – 38.5 km



esa



serco

SCIAMACHY Bi-MONTHLY



page 62 of 63

## 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. A preliminary validation meeting took place on 22 January 2008 at SRON and a second meeting at 26<sup>th</sup> March 2008 in Bremen.

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

The results of the validation activity on the level 2 column products and level 2 profile products are summarized here as well.

### 8.1.1 Level 2 Column Products results Off-line

Validation results for the following products were published:

- O<sub>3</sub> (operational product)  
SCIAMACHY OL v3.01 O<sub>3</sub> columns are on a global average less than 1% higher than ground-based network measurements and other satellite measurements. The general agreement exhibits no latitudinal dependence. Larger differences have been found for high solar zenith angles and low ozone columns. Differences with ground-based measurements show a small negative trend of approximately 0.3% per year.
- NO<sub>2</sub> (operational product)  
Over areas with low tropospheric NO<sub>2</sub> content, SCIAMACHY OL 3.01 NO<sub>2</sub> columns agree with GOME GDP 4.1 and NDACC/UVVIS measurements to a few 10<sup>14</sup> molec/cm<sup>2</sup>. The estimated accuracy ranges from 5% to 20% at polar latitudes and in the Northern Hemisphere. The NO<sub>2</sub> columns are low biased by about 5·10<sup>14</sup> molec/cm<sup>2</sup> at low and middle latitudes of the Southern Hemisphere. This low bias exhibits a seasonal cycle (larger in summer) and a latitudinal dependence. The NO<sub>2</sub> columns are affected by larger errors over polluted areas (large underestimation) and in the South Atlantic Anomaly (noisier data).
- Clouds (operational product)
  - Cloud fraction  
SCIAMACHY OL 3.01 cloud fraction is an 'effective' cloud fraction. The values on average differ from FRESCO sc-v5 by only 0.02, with a RMS difference of 0.08. Cloud fraction distributions over the globe are very similar between the two retrieval methods. No validation with independent correlative measurements has been reported yet.



esa



DLR



serco

SCIAMACHY Bi-MONTHLY



page 63 of 63

- Cloud top height  
SCIAMACHY OL 3.01 cloud top height correlates well with FRESCO sc-v5 cloud height ( $R=0.87$ ) but is on average 1.2km higher. The spread in the difference is about 1.9km. About 15% of the cloud height data are clipped to the lower limit of 1km. No validation with independent correlative measurements has been reported yet.
- Cloud optical thickness  
SCIAMACHY OL v3.01 cloud optical thickness deviates from MERIS for some collocated states. More investigation is needed.
- AAI  
SCIAMACHY OL v 3.01 AAI quality needs further improvement, since the absolute calibration of the reflectance, including degradation correction, is not properly accounted for yet.

### 8.1.2 Level 2 Profile Products results Off-line

- O<sub>3</sub> (operational product)  
SCIAMACHY OL v3.01 ozone profile concentrations between 20 and 35 km are on average slightly lower (0-15%) than sonde and lidar measurements, SAGE II and HALOE. No seasonal dependence is observed in the differences. Below the ozone maximum the differences increase. The RMS differences are between 10 and 20%. Between 35 and 40km average differences vary between -25 and +25% (RMS values between 20 and 40%). No significant tangent height shifts have been observed.
- NO<sub>2</sub> (operational product)  
SCIAMACHY OL v3.01 NO<sub>2</sub> profile concentrations between 20 and 40km are in good agreement with those derived from HALOE measurements in combination with a photochemical model to account for diurnal changes. On average, the values are within 10-18% with larger uncertainties in the lower stratosphere (based on 2002-2003 data).