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SCIAMACHY Bi-MONTHLY REPORT: NOVEMBER - DECEMBER 2005

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SCIAMACHY Bi-Monthly Report November – December 2005

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 Product Control Facility, 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 and SOST-IFE.
The remainder of the report is dedicated to Level 1 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: J, Alberto Pellegrini
[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

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
D-PAC	Processing and Archiving Centre in Germany
DPQC	Data Processing Quality Control
ESM	Elevation Scan Mechanism
FAT	Factory Acceptance Test
FPN	Fixed Pattern Noise
HK	Housekeeping
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)
LOS	Line of Sight
MCMD	Macro Command
MR	Monthly Report
NCWM	Nadir Calibration Window Mechanism
NDFM	Neutral Density Filter Mechanism
NNDEC	Non-nominal Decontamination
NRT	Near Real Time
OBM	Optical Bench Module
OCR	Operations Change Request
OSDF	Orbit Sequence Definition File
PCF	Product Control Facility
PCR	Processing Change Request
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
SAA	South Atlantic Anomaly
SCIAMACHY	Scanning Imaging Absorption Spectrometer for Atmospheric Chartography
SEU	Single Event Upset
SLS	Spectral Line Source
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

2 SUMMARY

- During the reported period SCIAMACHY measurements were nominal with respect to planning.

- Monthly Calibration was executed during Orbits

  - 19405-19409 (15-Nov-2005)
  - 19820-19824 (14-Dec-2005)

- Moon occultations were executed with the moon rising on the night side between orbits

  - 19413-19420 (16-Nov-2005)
  - 19812-19841 (14-Dec-2005 until 16-Dec-2005)

- No OCR has been implemented during November - December 2005.

- No TC adjustment was required.

- Light Path monitoring:

  - Small degradation in UV continues as before (channel 1 – 2%, channel 2 – 1%); sun over ESM diffuser degradation smaller than for other light paths – indication that ESM diffuser degrades less than ESM mirror
  - Overall degradation in channel 3 continues, but is smaller than for channels 1 and 2
  - Channels 4-5 radiometricly stable
  - Channel 6 throughput loss due to icing
  - Channel 7 throughput rather stable over time interval
  - Channel 8 throughput is reduced by about 20%, the transmission is stable at this level

- Spectral light path monitoring:

  - UV degradation decreases with increasing wavelength
  - Degradation is wavelength dependent (especially at channel edges)
  - Solar activity variation visible (e.g. Mg II Fraunhofer line)
  - Channel degradation results generally are confirmed with spectral light path monitoring

- 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 which is currently unexplained.
    - PMD 6 results still under investigation

- ADF generation was impacted by hardware failures during December

- SCIAMACHY Level 2 NRT ozone and AMF values are impacted by a wrong handling of the seasonal index 3, corresponding to the period 15 October – 31 December 2005. This season index is handled correctly in the L2 offline product.

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 19195 (ANX = 01-November-2005, 01:00:33.903) to 20067 (ANX = 31-December-2005, 23:02:43.244). Two OSDFs specified the planning baseline.

Orbit		ANX		OSDF
Start	Stop	Start	Stop	
19195	19623	01-Nov-2005 01:00:33.903	30-Nov-2005 22:36:51.148	MPL_OSD_SHVSH_20050826_010101_00000000_33120001_20051101_010036_20051201_001725
19624	20067	01-Dec-2005 00:17:27.076	31-Dec-2005 23:02:43.244	MPL_OSD_SHVSH_20051024_010101_00000000_33130001_20051201_001729_20060101_004317

Table 3-1: SCIAMACHY OSDF planning files from November – December 2005

All measurements were nominal, i.e. timelines executed on the dayside of the orbit limb/nadir sequences with wide swath settings. In-flight calibration and monitoring measurements occurred on daily, weekly and monthly timescales according to the mission scenarios. Monthly calibration was scheduled between orbits

- 19405-19409 (15-Nov-2005)
- 19820-19824 (14-Dec-2005)

The moon was in the limb TCFoV between orbits

- 19336-19423 (10-Nov-2005 until 16-Nov-2005)
- 19756-19844 (10-Dec-2005 until 16-Dec-2005)

Occultations with the moon rising on the nightside were executed between orbits

- 19413-19420 (16-Nov-2005)
- 19812-19841 (14-Dec-2005 until 16-Dec-2005)

No OCR has been implemented between November and December.

3.1.2 Instrument Measurement Status (SOST-DLR)

Final flight status for mission scenarios, states and timelines remained unchanged throughout the reporting period.

3.1.3 Executed Operations and Measurements (SOST-DLR)

Measurements

The OSDF planning files have been scheduled as requested.

Detector thermal adjustment

No TC adjustment was required. TC settings throughout the reporting period were

- DAC1 = 0.53 W
- DAC2 = 0.70 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**
19599	*29-NOV-2005 07:57:06*	*ok*	*19600*	*29-NOV-2005 09:33:36*
n.a.	*n.a.*	*n.a.*	*19900*	*20-DEC-2005 08:34:02*

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

Anomalies

No anomalies had occurred.

Instrument unavailability

The instrument was available throughout the reporting period.

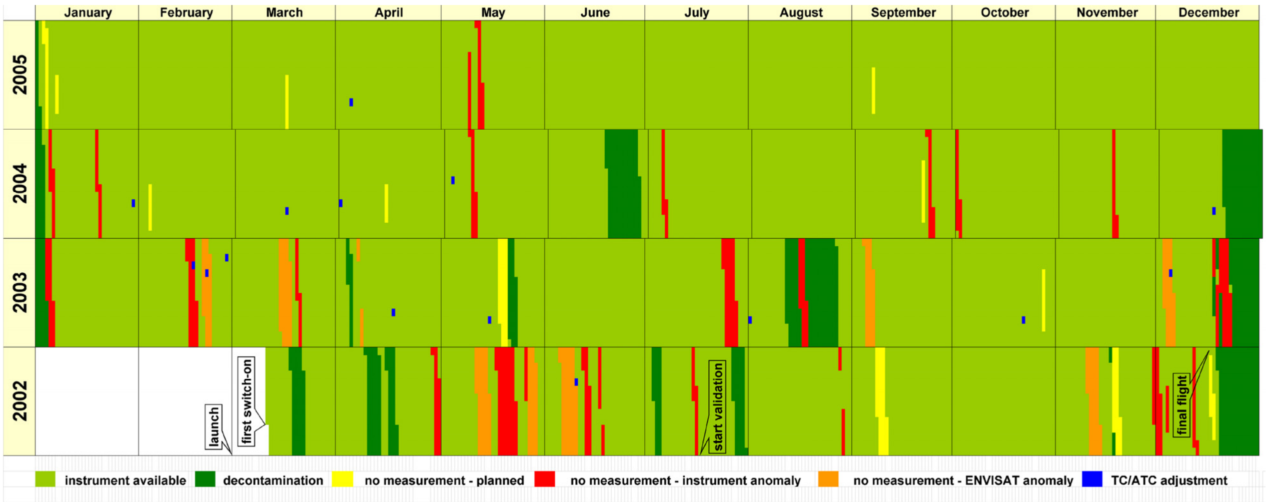


Fig. 3-1: Current instrument availability status including the reporting period

3.1.4 Performance Monitoring - System (SOST-DLR)

Detector temperatures

Detector 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. 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.

No temperature violations occurred.

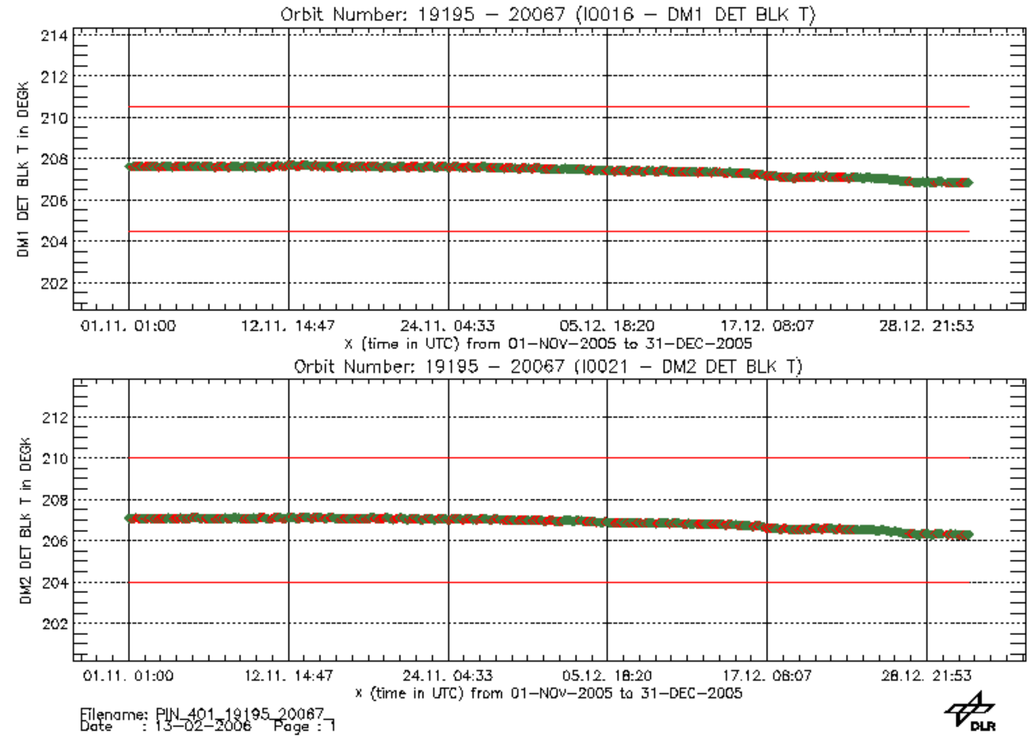
OBM temperatures

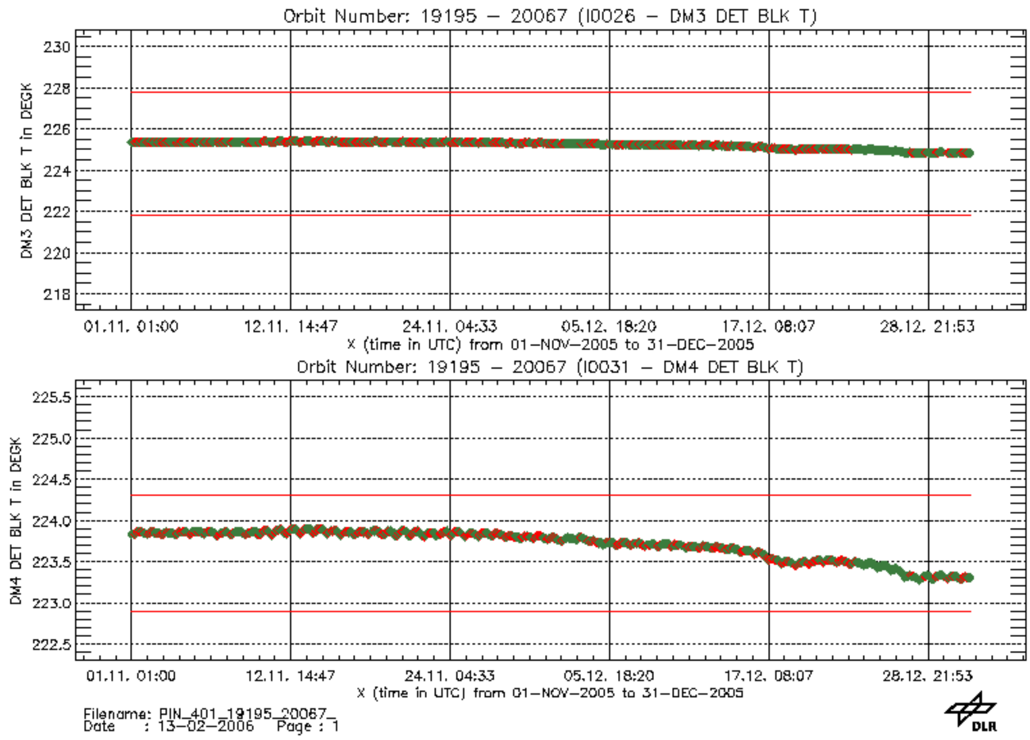
OBM temperatures are monitored according to the requirements of the IOM *[1]*. It requests to ensure that the average temperature per orbit remains within the specified limits. The average OBM temperature per orbit is determined from specific HK telemetry parameters. In addition power readings for the 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.


Orbit Number: 19195 – 20067 (I0016 – DM1 DET BLK T)
DM1 DET BLK T in DEGK
214
212
210
208
206
204
202
01.11. 01:00
12.11. 14:47
24.11. 04:33
05.12. 18:20
17.12. 08:07
28.12. 21:53
X (time in UTC) from 01–NOV–2005 to 31–DEC–2005
Orbit Number: 19195 – 20067 (I0021 – DM2 DET BLK T)
DM2 DET BLK T in DEGK
212
210
208
206
204
202
01.11. 01:00
12.11. 14:47
24.11. 04:33
05.12. 18:20
17.12. 08:07
28.12. 21:53
X (time in UTC) from 01–NOV–2005 to 31–DEC–2005
Filename: PIN_401_19195_20067_
Date : 13–02–2006 Page : 1
DLR


Orbit Number: 19195 – 20067 (I0026 – DM3 DET BLK T)
DM3 DET BLK T in DEGK
230
228
226
224
222
220
218
01.11. 01:00
12.11. 14:47
24.11. 04:33
05.12. 18:20
17.12. 08:07
28.12. 21:53
X (time in UTC) from 01–NOV–2005 to 31–DEC–2005
Orbit Number: 19195 – 20067 (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
01.11. 01:00
12.11. 14:47
24.11. 04:33
05.12. 18:20
17.12. 08:07
28.12. 21:53
X (time in UTC) from 01–NOV–2005 to 31–DEC–2005
Filename: PIN_401_19195_20067_
Date : 13–02–2006 Page : 1
DLR

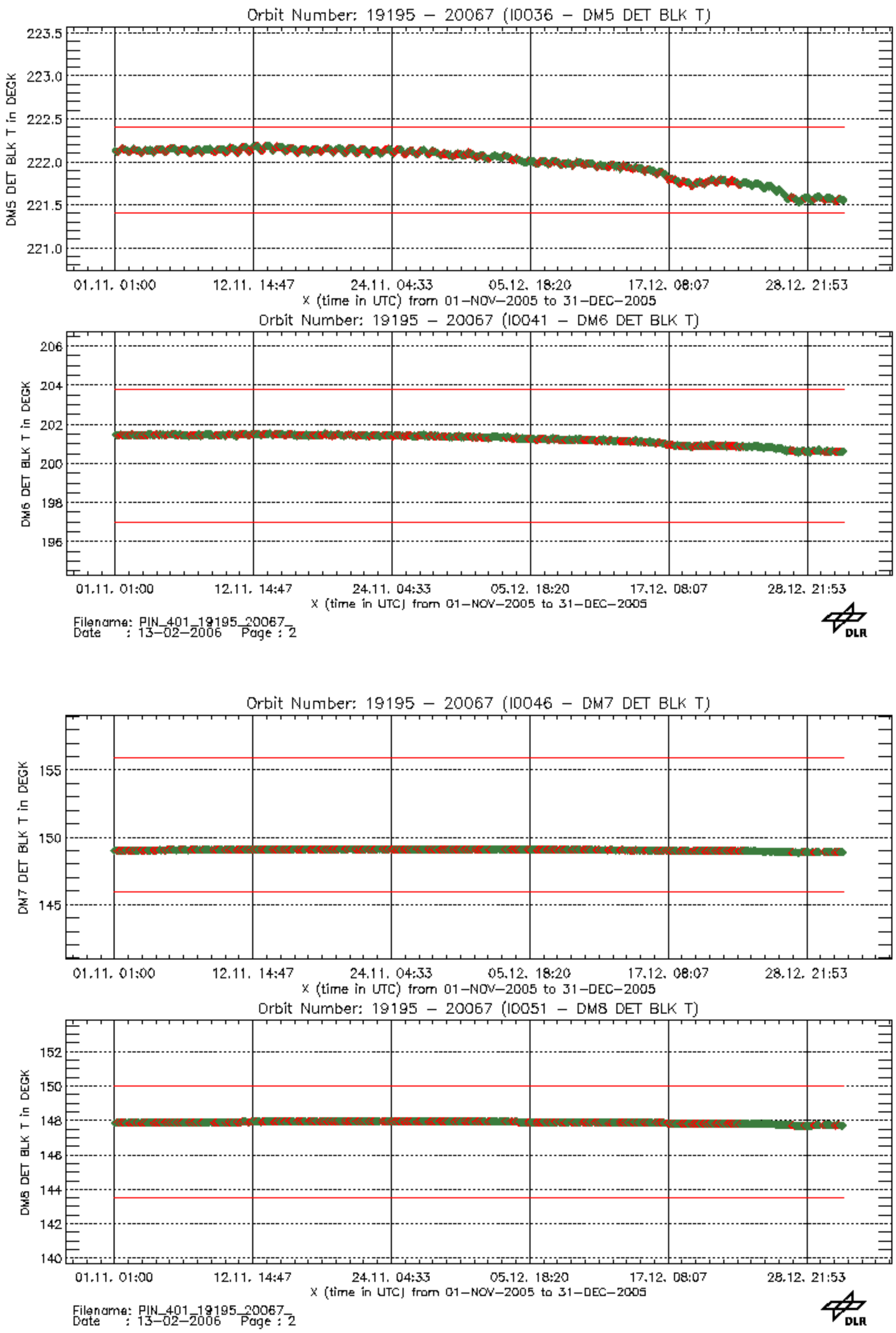


Fig. 3-2: Detector temperatures

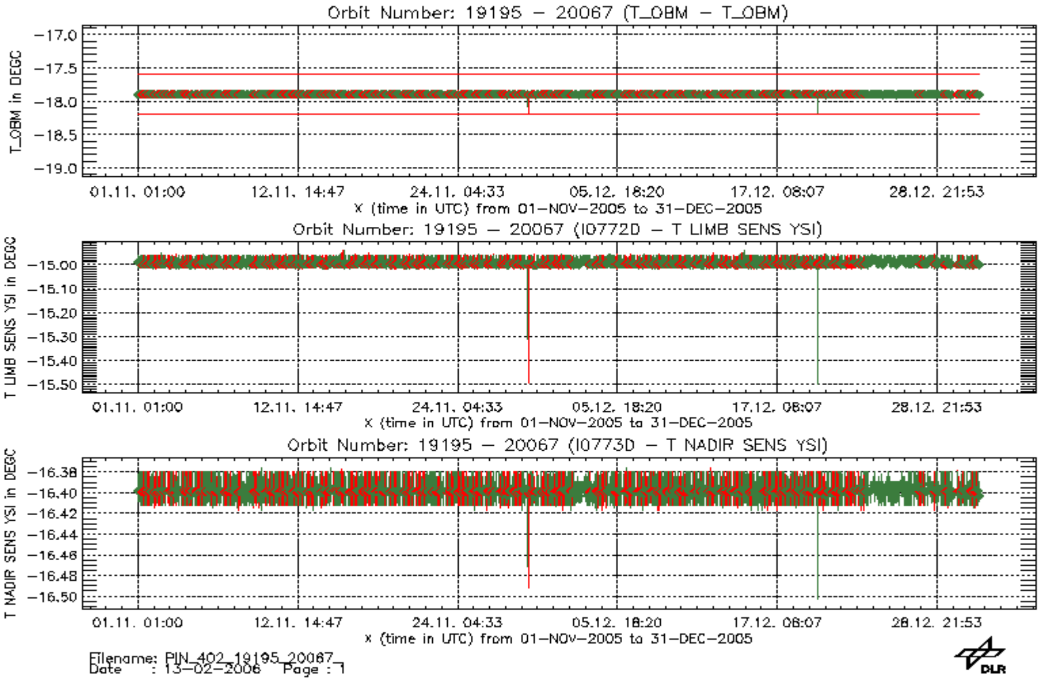


Fig. 3-3: OBM temperatures (top: derived OBM, middle: limb sensor, bottom: nadir sensor)

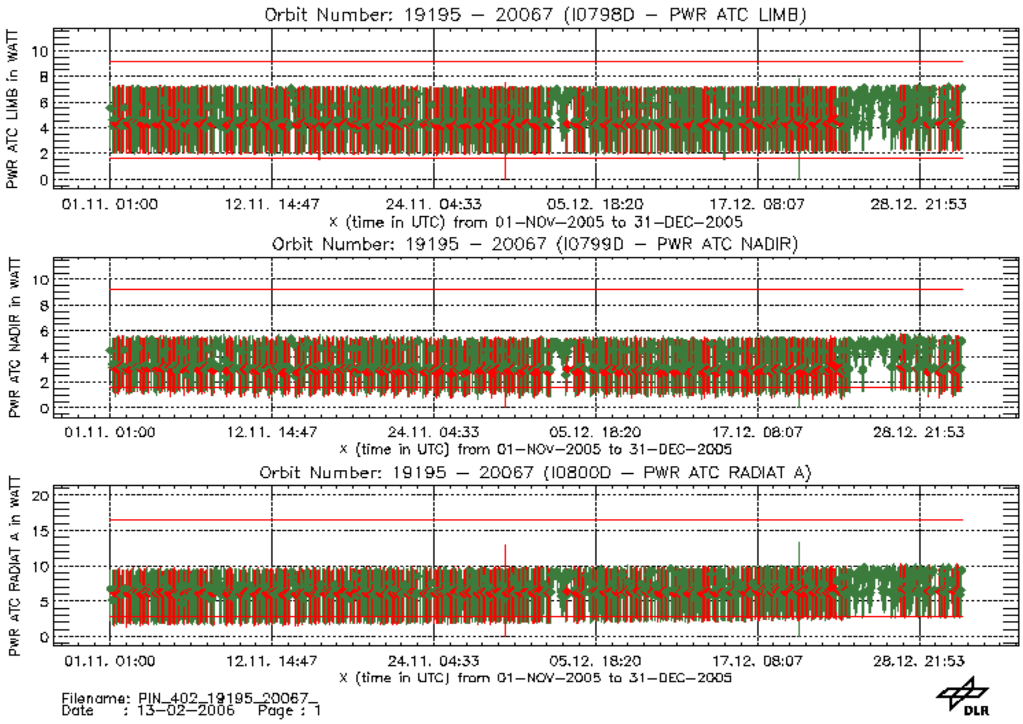


Fig. 3-4: ATC heater power (top: ATC limb, middle: ATC nadir, bottom: ATC Rad A)

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

- NDFM: 0.53
- APSM: 0.48
- NCWM (sub-solar port): 0.55
- WLS (switches): 0.11
- WLS (burning time): 0.21
- SLS (switches): 0.04
- SLS (burning time): 0.01

How the relative LLI usage has accumulated since launch can be seen in fig. 3-5. 'EOL' assumes a total mission lifetime of 0.5 years of Commissioning Phase and 4.5 years of routine operations (note that discussions have started to adapt the LLI usage to the envisaged mission extension).

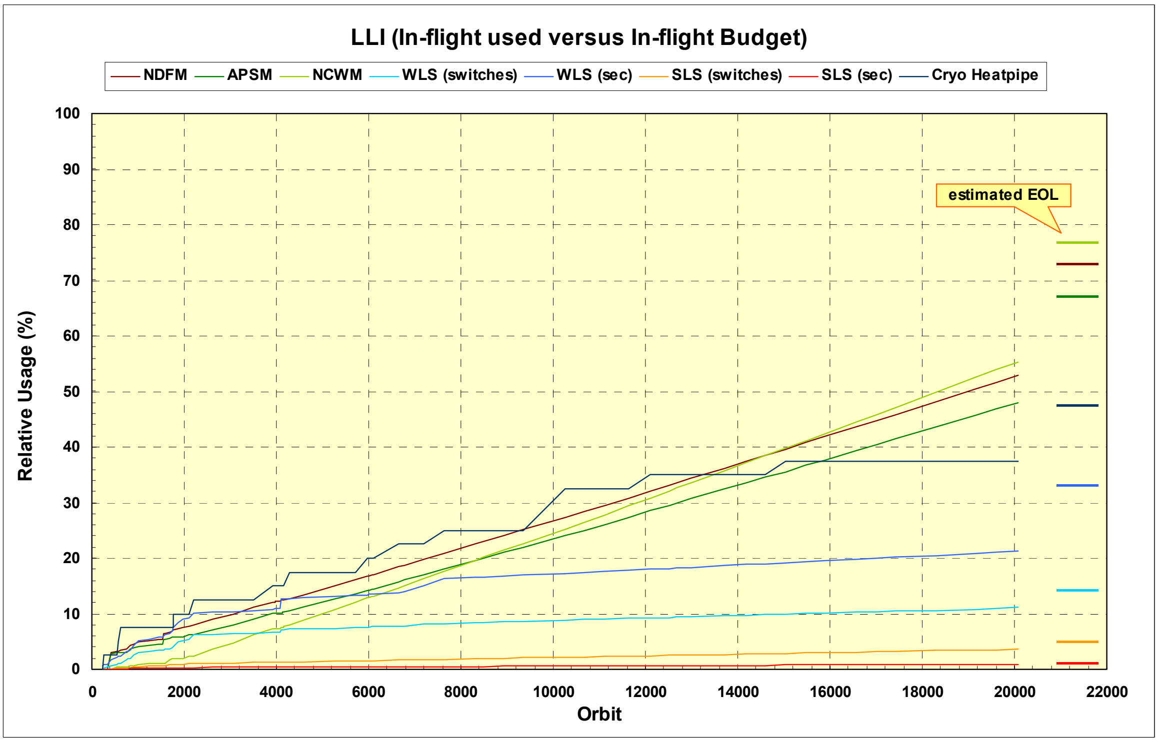


Fig. 3-5: Relative usage of LLIs. 'EOL' is derived for the currently specified mission lifetime.

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 ± 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.

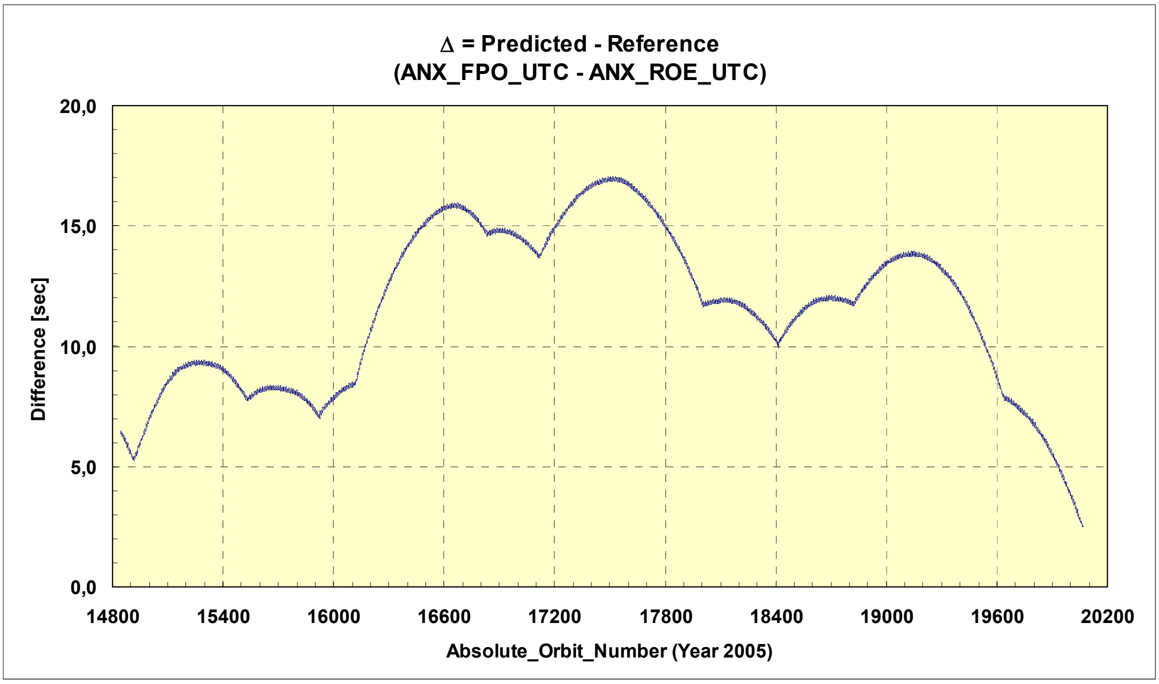


Fig. 3-6: Time difference between predicted and reference time.

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 November to December 2005.
All measured signals have been averaged over the entire channel and then divided by the corresponding measurement at a reference time (currently 2 August 2002, at about orbit 2200), yielding an effective instrument throughput for the different light paths.

The timing of subsolar measurements before 30 November 2002 (about orbit 3922) did not consider the known yaw misalignment of SCIAMACHY on ENVISAT. Therefore all subsolar measurements after 30 November 2002 have been referred to orbit 4519 (10 January 2003, just after a long decontamination phase).
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.

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 Level 1b data.
Daily updated light path monitoring results can be found on the SOST or IUP web site (http://www.iup.physik.uni-bremen.de/sciamachy/LTM/LTM.html).

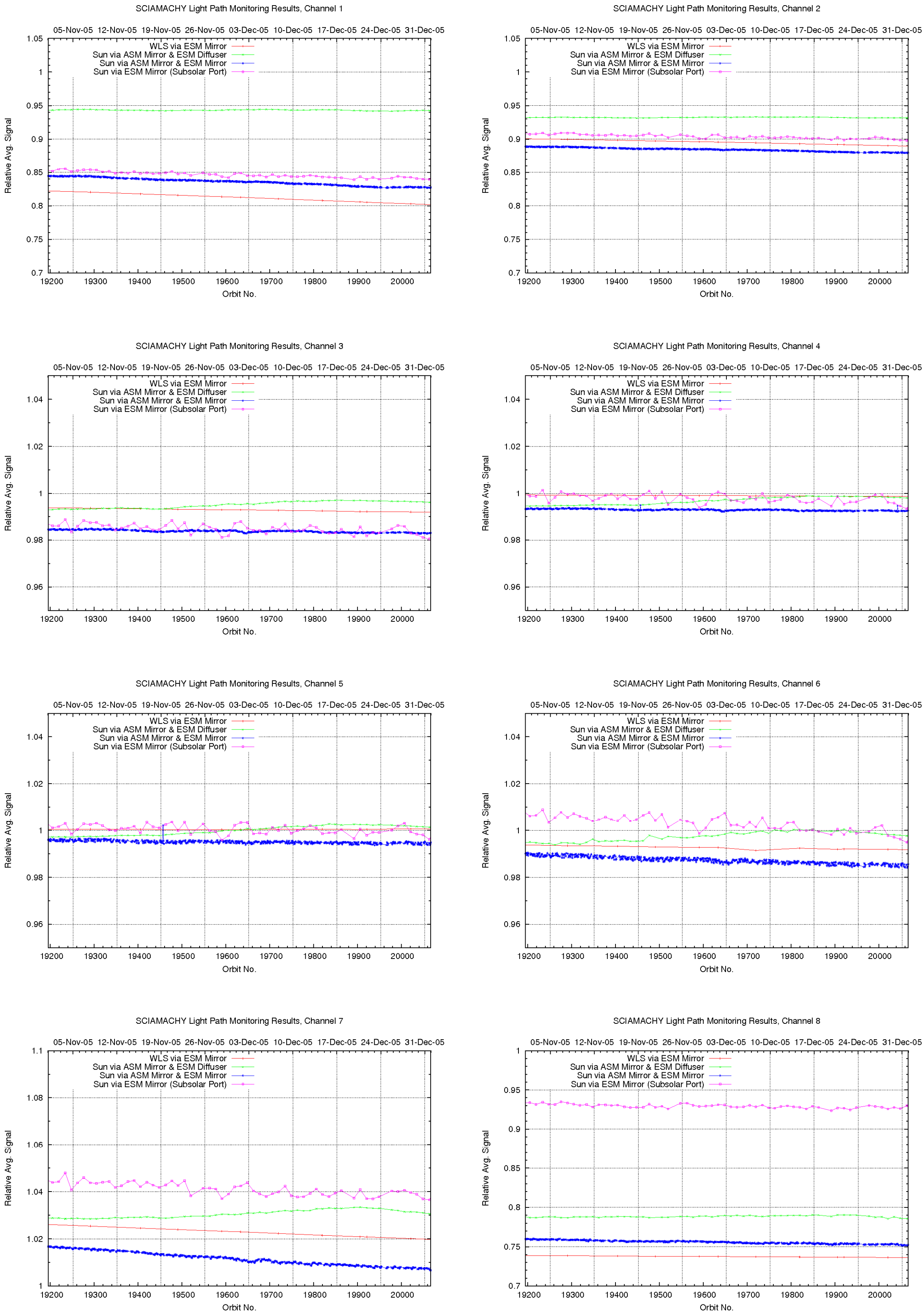


Fig. 3.7: Light path monitoring results November 2005 to December 2005.

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

- The degradation in the UV (channels 1 & 2) increases with the same rate as observed during the previous time intervals. Currently, the throughput loss in channel 1 reaches about 20%. The degradation of the calibration light path which involves the ESM diffuser instead of the ESM mirror is still smaller than for the other light paths, indicating that the ESM diffuser degrades less than the ESM mirror.
- The overall degradation of channel 3 is still very small (well below 2%) compared to channels 1 and 2.
- Channels 4 and 5 remain stable.
  The throughput in channel 6 is still slightly decreasing. This may be partly attributed to degradation/icing, but a quantitative statement is difficult because of the overlaid seasonal component mentioned already in previous reports.
- The throughput of channel 7 still decreases, but this is almost negligible compared to the formerly observed throughput losses. Seasonal effects may also not be excluded here.
- Channel 8 transmission remains quite stable at about 75-80% (depending on light path). For the limb light path a small downward trend is visible which needs to be observed further. The higher throughput for the subsolar light path is most likely caused by the specific scan mode (fast sweep) analysed which causes a systematic offset.

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 month, Fig. 3.8 – 3.11 show the complete time series from 2 August 2002 to the end of December 2005.
Note that the colour scale of the spectral monitoring plots has been modified with respect to the previous reports. Now the same colour scale is used for all channels to facilitate intercomparisons.

Additional notes:

- Dates in the graphs refer to UTC noon (12:00).
- The data 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.

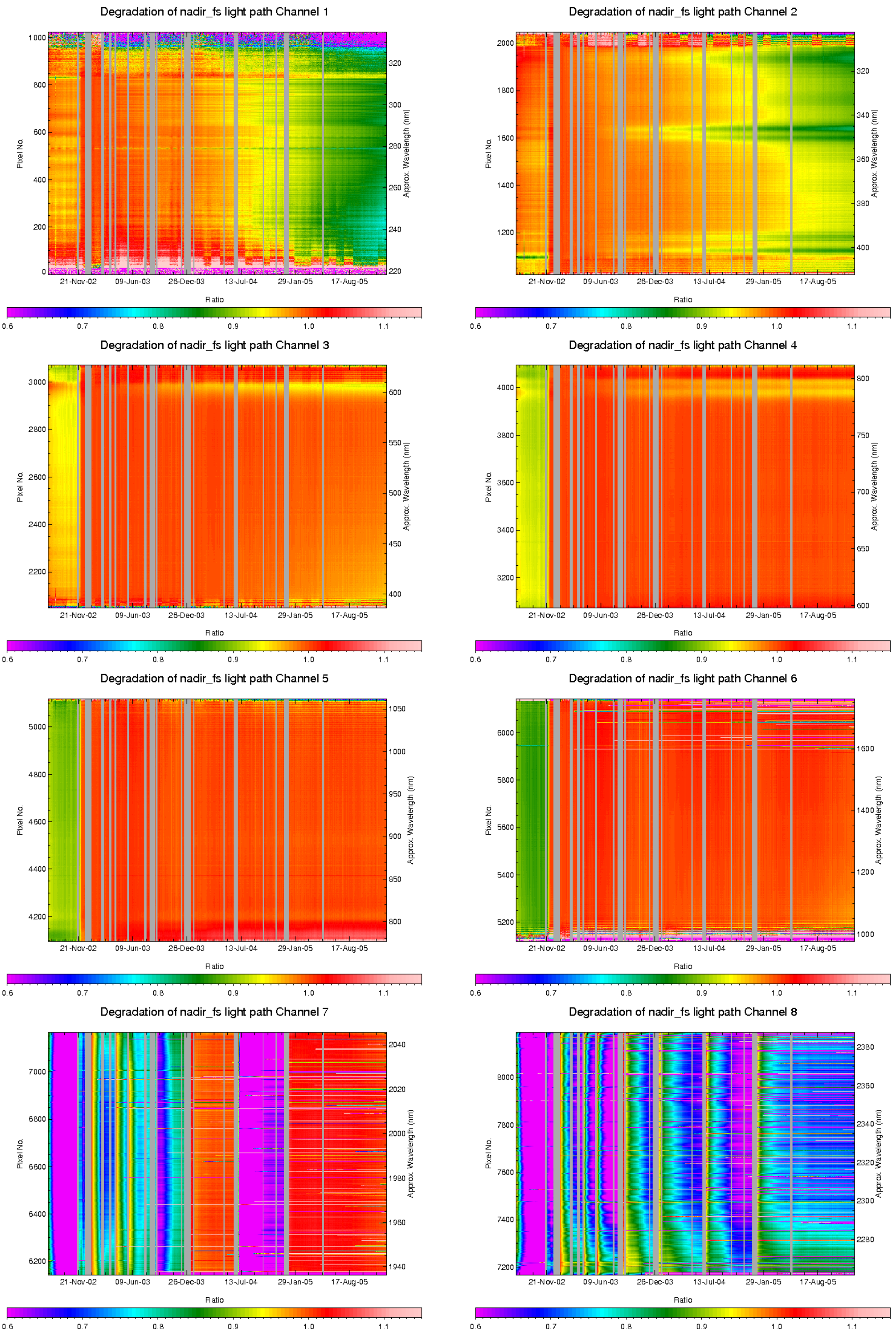


Fig. 3.8: Spectral light path monitoring results August 2002 to December 2005 (nadir light path)

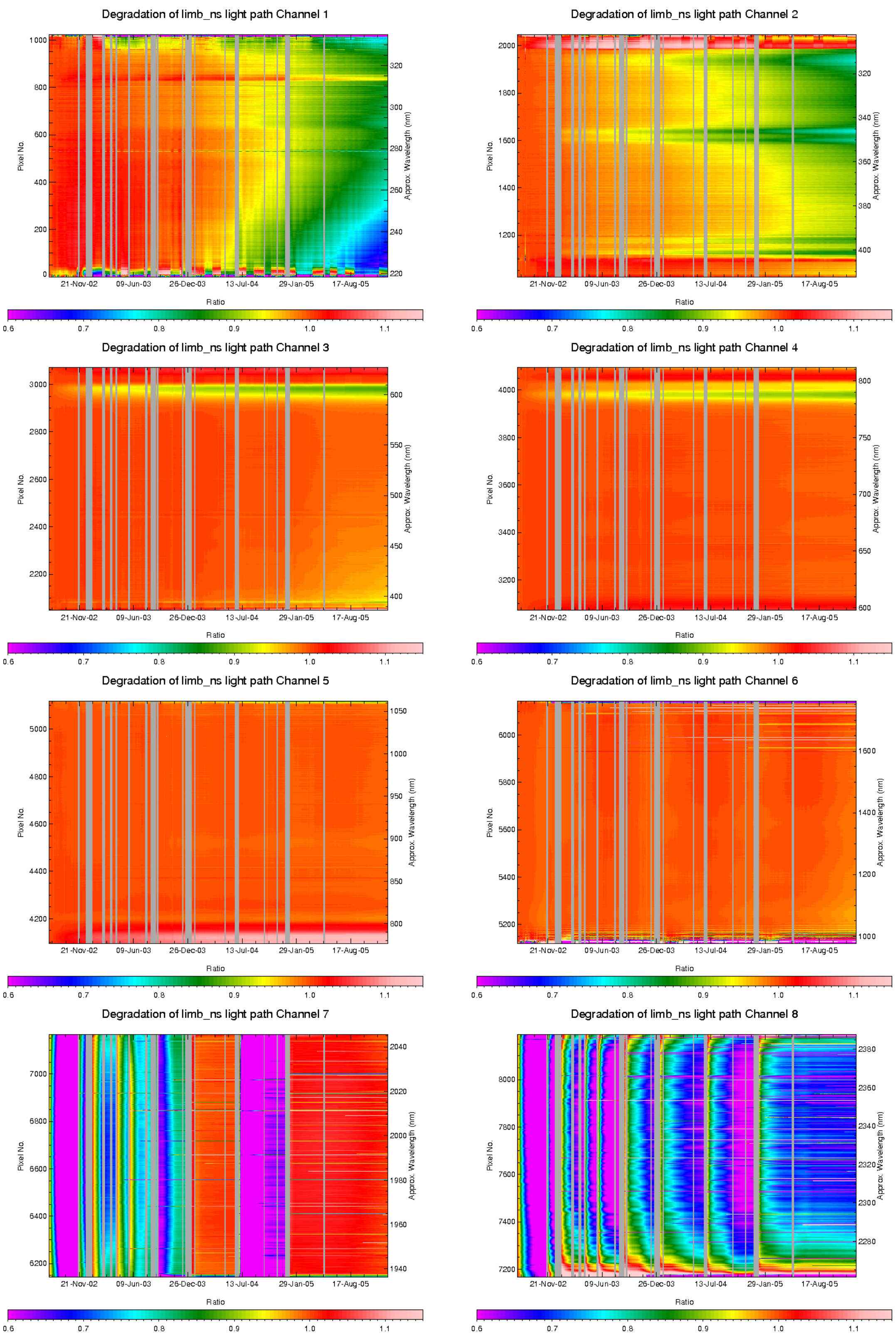


Fig. 3.9: Spectral light path monitoring results August 2002 to December 2005 (limb light path)

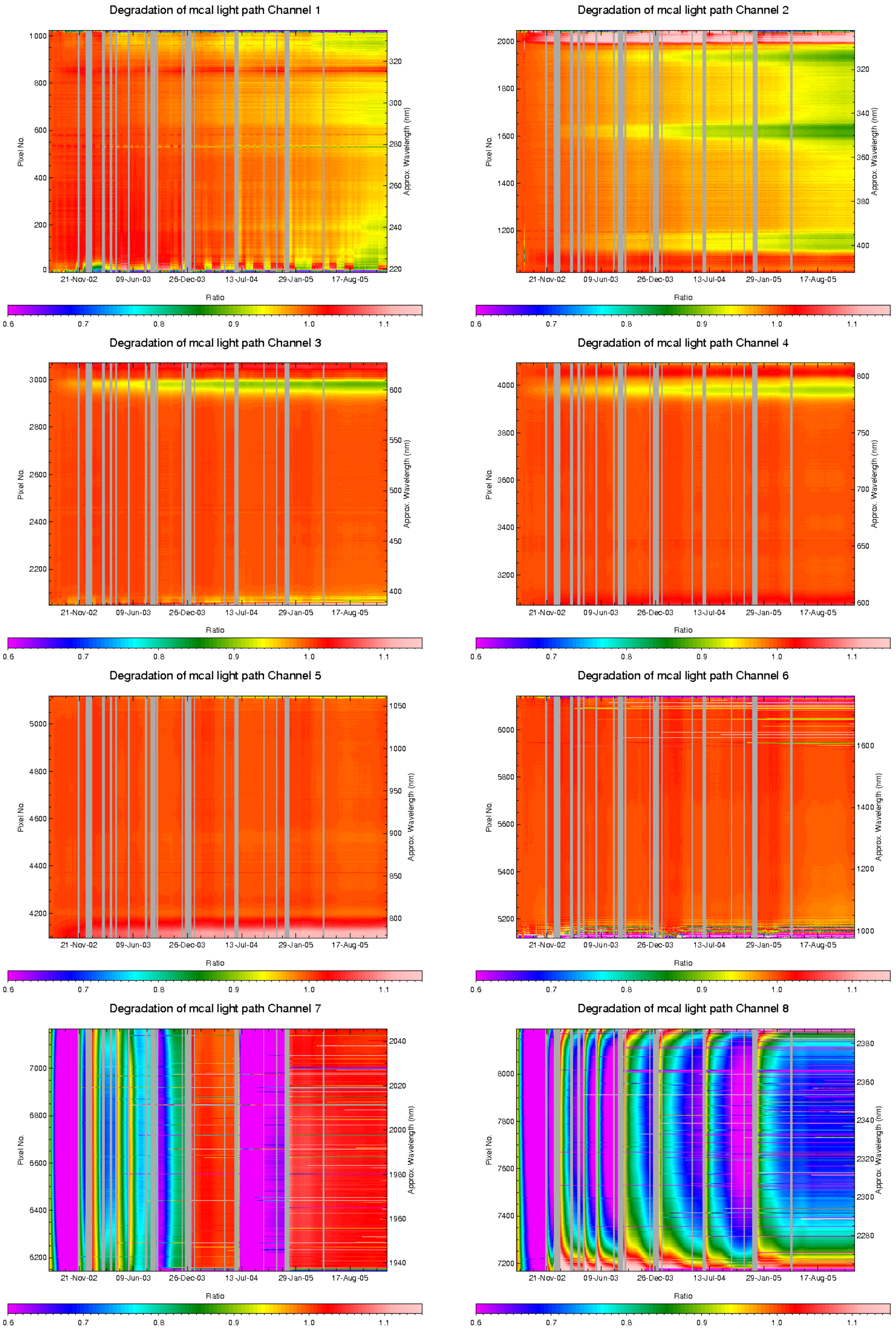


Fig. 3.10: Spectral light path monitoring results August 2002 to December 2005 (calibration light path)

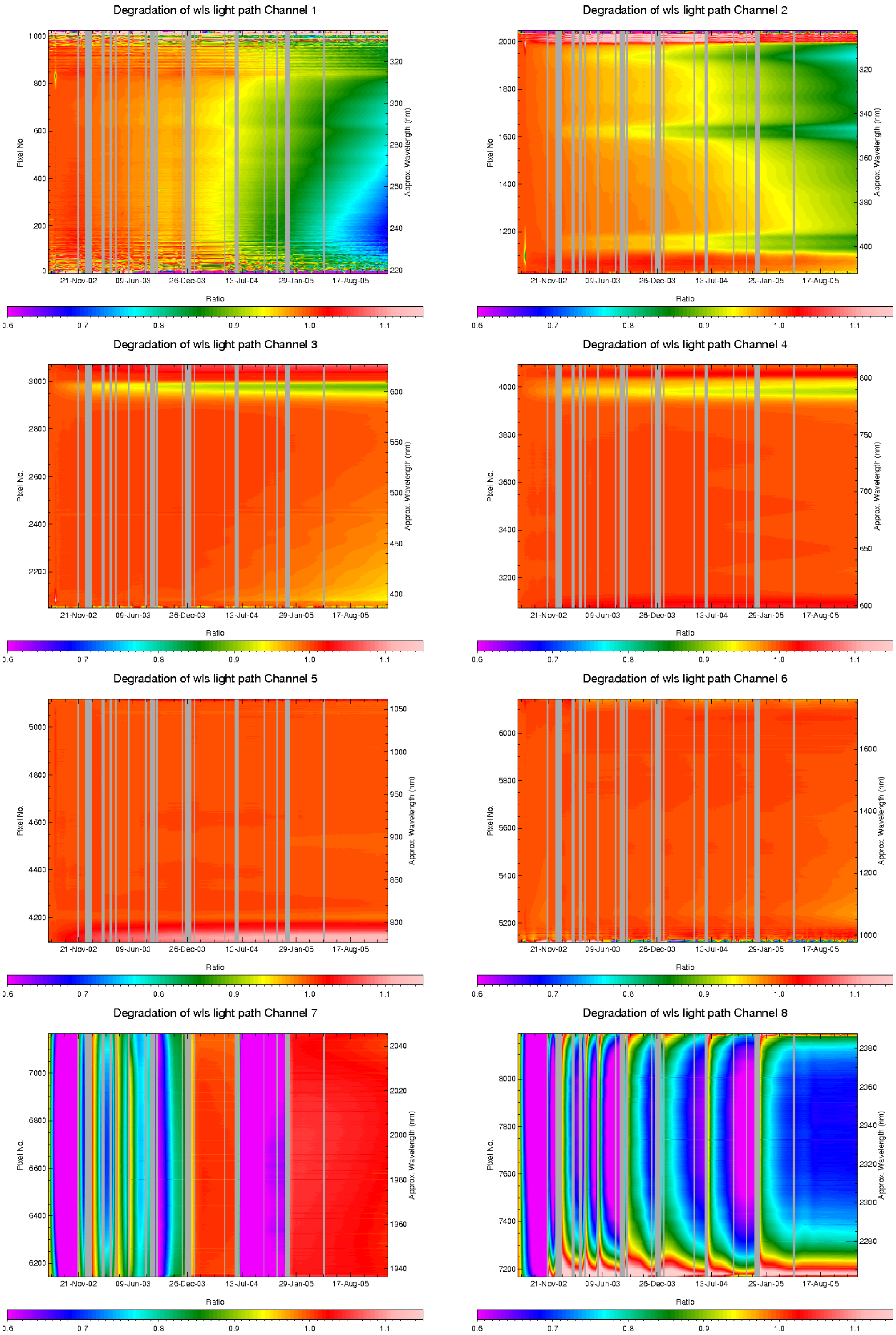


Fig. 3.11: Spectral light path monitoring results August 2002 to December 2005 (WLS light path)

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 and at spectral regions of high polarisation sensitivity (especially visible in channel 2, e.g. the peak around 350 nm).
- The minimum throughput in channel 1 reaches about 70% for the limb and nadir light paths.
- 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 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.
- Channel 6 spectral results confirm the assumption of a slight degradation in this channel which is concentrated at the lower wavelength edge and independent of the overlaid remaining seasonal cycle.
- 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.

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.
For the nadir light path it is not possible to use subsolar fast sweep measurements for PMD monitoring, because these show a 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. Unfortunately, subsolar pointing measurements are only performed once per month, therefore the temporal sampling is much less than for the other light paths.
This reduced temporal sampling is also the reason that Fig. 3.12 shows the PMD throughput variation for the whole time period between 2 August 2002 and 31 December 2005 (instead of only the two month time interval of this report). 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.

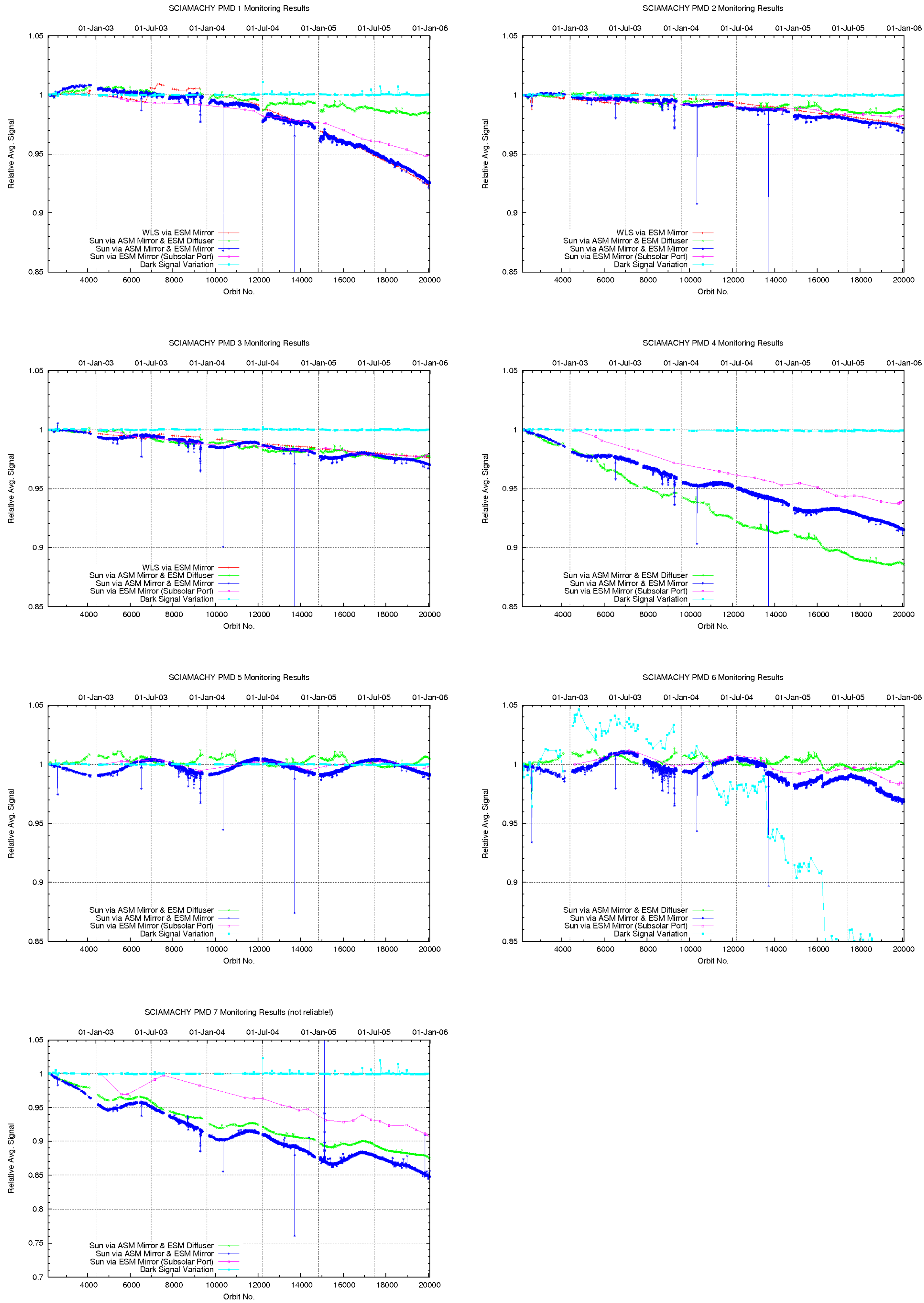


Fig. 3.12: PMD monitoring results August 2002 to December 2005

3.1.6 Problem Report Status (DLR-BO)

The problem report statistics is as follows (same status as during period July-August 2005):

- Total number of problem reports: 43
- Open problem reports: 5
- New problem reports during the reporting period: 0

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	31-Dec-2005	SCI_NL__0PNPDE20051231_061334_000014952043_00463_20056_1419.N1	products have a high number of ISP Errors; the data format is not correct

Tab. 4-1: Products with data 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.

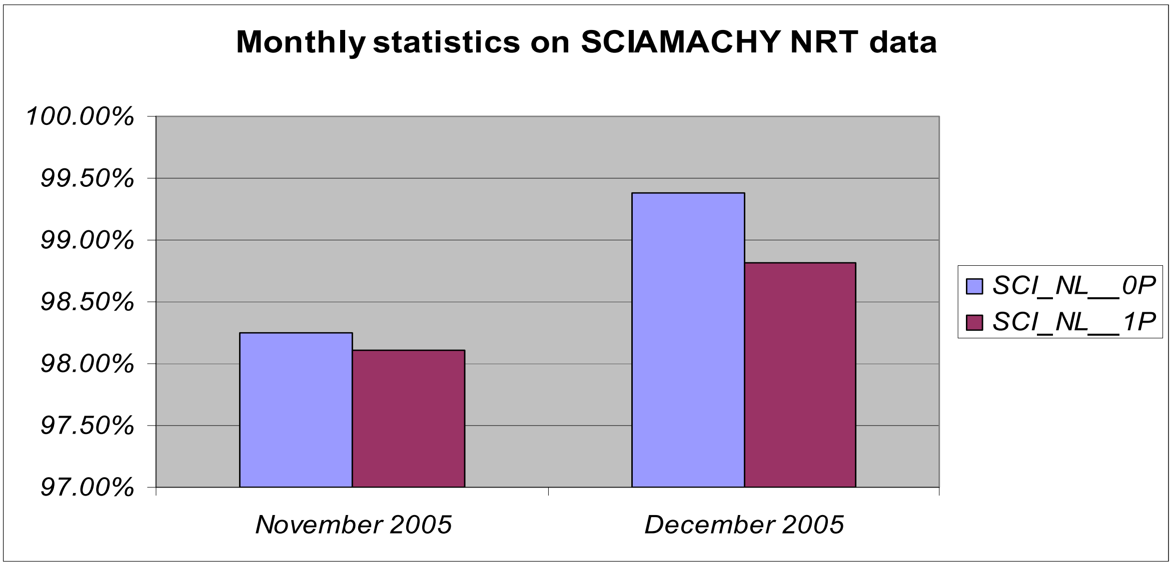


Fig. 4-1: Statistics on available unconsolidated Level 0 and Level 1 products

4.3 Statistics on consolidated data

In Fig. 4-2 statistics on consolidated data products L0 and L1 are presented. The percentage for SCI_NL__1P products are calculated with respect to the available L0 consolidated products of a cycle, which explains that the percent numbers for Level1b can be higher than for L0. The day given next to the cycle number indicates the start day of each cycle.

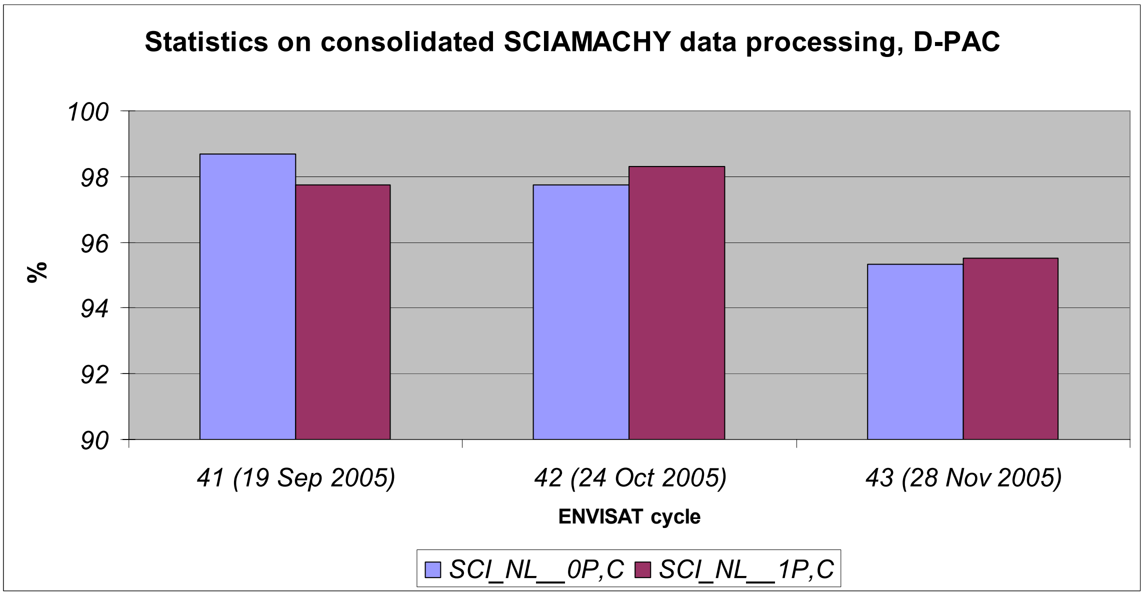


Fig. 4-2: Statistics on consolidated Level 0 and Level 1 products

4.3.1 Anomalies on L0 consolidated data products

In the past it had been reported by SOST-DLR, that the SCIAMACHY consolidated L0 data contain errors and are not complete. Following specific problems have been identified and are reported in detail in the technical notes *[3]* and *[4]*:

- For one orbit there can be more than one cL0 product. These products may be identical or different in content (disregarding the product type file counter).
- Some orbits are not covered by cL0 products although SCIAMACHY was operational.
- Some orbits are covered by cL0 products but the product duration does not comply with the actually planned and executed instrument operations in that particular orbit.
- Some cL0 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 cL0 data are hampered by an incorrect orbit number.

More details on cL0 anomalies can be found on the SOST web page, which contains a catalogue of available L0 consolidated data and description of errors.
http://atmos.caf.dlr.de/projects/scops/data_availability/availability.html

The errors contained in the consolidated L0 data have been formally transferred into Observation Anomaly Reports (OARs) towards the PDS.
As a consequence in the beginning of December 2005 a dedicated meeting was held at ESA to implement a strategy to improve the product quality of cL0 data and to reprocess erroneous products in the historic data set.
A recovery plan is currently being executed and reprocessing of erroneous data has already been started.

4.4 Statistics on reprocessed data

The reprocessing of products from the time interval July 2002 to May 2004 (corresponding to cycles 7 -26, each cycle consisting of 501 orbits) with IPF 5.04 has been completed. See also last BMR (September-October 2005) for details.

5 LEVEL 1 PRODUCT QUALITY MONITORING

5.1 Processor Configuration

5.1.1 Version

The current IPF version used for processing (and re-processing) of SCIAMACHY level 1 data is 5.04. The corresponding product specification is *[2]*. The disclaimer at http://envisat.esa.int/dataproducts/availability/disclaimers/SCI_NL__1P_Disclaimers.pdf describes known artefacts.

Table 5.1 gives an overview of changes implemented with processor versions IPF 5.04 and 5.01.

In addition here is a summary on the definition of the SZA for Limb/Occultation measurements used in previous and actual IPFs.

For IPF versions 4.02, 5.00, 5.01, 5.04 the SZA is defined with respect to Top of Atmosphere (TOA).

Instead for IPF versions 4.03, 4.01 and earlier versions the SZA is defined with respect to Tangent Height. IPF versions 4.02 and 5.00 however were not used operationally but to generate the validation dataset for the ACVT workshop in 2004.

A new upgrade on the IPF to version 6.00 is currently in progress the FAT for the new IPF took place on day 15 December 2005.

IPF Version	Description	Proc Centre	Date	Start Orbit
5.04	No algorithm specification changes were implemented, but two algorithm	PDHS-K	21-AUG-2004	12942
		LRAC	20-AUG-2004	12750
		PDHS-E	16-AUG-2004	12823

	implementation errors have been corrected. In addition, code adaptations have been performed to resolve performance problems encountered during reprocessing. The list of modifications is as follows: • An incorrect polarisation-ratio calculation has been corrected, to remove radiance discrepancies up to 1% between prototype and operational processor. • Memory leaks have been detected and eliminated • Two modifications have been performed to avoid level 1B processing crashes	DPAC	12-AUG-2004	12879
5.01		DPAC	31-MAR-2004	
		PDHS-E PDHS-K LRAC	24-MAR-2004	

Tab. 5-1: Processor Version and main changes

5.1.2 Auxiliary Data Files

For operation of the SCIAMACHY level 1 processor a set of Auxiliary files as input is required.
One subset of these auxiliary files usually changes only in correspondence with a new IPF version, namely the Initialisation file (SCI_LI1_AX), the Key Data File (SCI_KD1_AX).
In addition there is the m-factor file (SCI_MF1_AX), which shall describe the degradation of the instrument during its stay in orbit (note that the m-factor file has not been changed so far).

Another subset of Auxiliary Files are 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 monthly basis)

- Pixel-to-Pixel Gain and Etalon Parameters (SCI_PE1_AX - updated on a monthly basis)

Since 04 May 2004 LK1 Auxiliary Files (Leakage Current Calibration) were processed operationally by the IECF. A SCI_LK1_AX is generated about every orbit (if measurements do not lie in the SAA area or orbit phase constraints occur).
SU1 Auxiliary Files were operationally processed starting from day 08 May 2004, a new SCI_SU1_AX file is generated every day with a validity time of two weeks.
PE1 and SP1 Auxiliary files are generated once per month with measurements of the monthly calibration orbits.
The table in Appendix A gives an overview about the Auxiliary files for the reporting period November - December 2005.
Fig. 5.1 shows statistics of the SU1 and LK1 ADFs generated operationally with the IECF. It has to be noted that unavailability periods are excluded from statistics. Generation of SU1 ADFs for November and December 2005 was 100%.
The LK1 ADF statistic is calculated by dividing the number of all LK1 ADFs by number of all available (to IECF) level 1 orbits. The statistics on available LK1 ADFs during November (64.1%) and December 2005 (75.9%) represent a nominal level of ADFs generated. The statistic does not take into account SAA and orbit phase constraints. Special analysis showed that only 6-8 orbits per day can be used for LK1 ADF processing, and therefore the performance is at 80-100%.
Between mid December 2005 and mid January 2006 hardware problems caused a delay of the generation of in flight SU1 ADFs, which needed to be generated manually with a time delay of up to 2 weeks, due to the Christmas holiday period. This had an impact for processing L1b Near Real Time products being processed with SU1 ADFs older than 1 week.

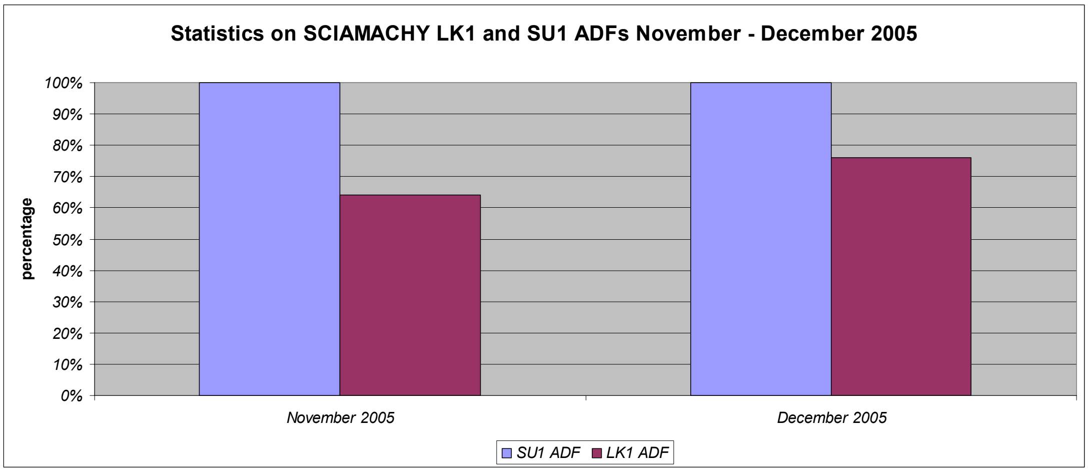


Fig. 5-1: Statistics on LK1 and SU1 processing

5.1.3 Spectral Performance

Future reports will contain analyses of spectral performance.

5.1.4 Radiometric Performance

Future reports will contain analyses of spectral performance.

5.1.5 Other Calibration Results

5.1.5.1 SMR analysis

The IECF generates daily SU1 Auxiliary Files, that contain new sun mean reference spectra for the different possible modes (e.g., subsolar, ESM diffuser, occultation).
Fig. 5-2 to Fig. 5-5 show the ratios of SMR spectra derived from calibrated SMR/ESM during the months November – December 2005. The ratios were determined by dividing the spectra of the beginning of each month to a set of days during each month. All ratios are not corrected for variation of distance earth/sun.
In detail the spectra used for the ratios of each month are the following:

- **November 2005**
  Reference SMR - 01 November 2005
  SMR used for ratios: 02, 03, 04, 05, 06, 07, 14, 21, 28 November 2005
- **December 2005**
  Reference SMR - 01 December 2005
  SMR used for ratios: 02, 03, 04, 05, 06, 07, 14, 21, 28 December 2005

The overall changes lie between 1 - 2 % during one month. 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.

Etalon like patterns occur in the SMR ratio plot for channels 1 and 4 after 4 weeks in November and already after 3 weeks in December. These patterns can be explained with the update of the SCI_PE1_AX ADF on day 22 November and 16 December respectively. Investigation by DLR-SOST confirms that the Level 0 based light path monitoring is not impacted by etalon-like features. Further investigation on the applied Etalon algorithms need to be performed and eventually a PCR needs to be opened.
The large features in the end of channel 6 (channel 6+) and channels 7 and 8 are due to bad pixels (no bad pixel correction applied).
Note that the bad pixel mask used is still from the on ground calibration.

A regular update of the bad pixel mask will be foreseen starting with IPF 6.0. 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 29-Nov-2002 and 29-Nov-2005, respectively 16-Dec-2002 and 16-Dec-2005. 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. For December a day was chosen where data are not impacted by non-nominal decontamination periods (e.g. 19 December 2002 – 08 January 2003).
What can be concluded is that for channels 1-2 an average degradation of about 5% is observed, channels 3-6 degrade by less than 1%. The signal in channels 7 and 8 has increased with respect to the SMR of year 2002. This is consistent with the Light Path monitoring at SOST-IFE. The effect is due to ice contamination for the last two channels.

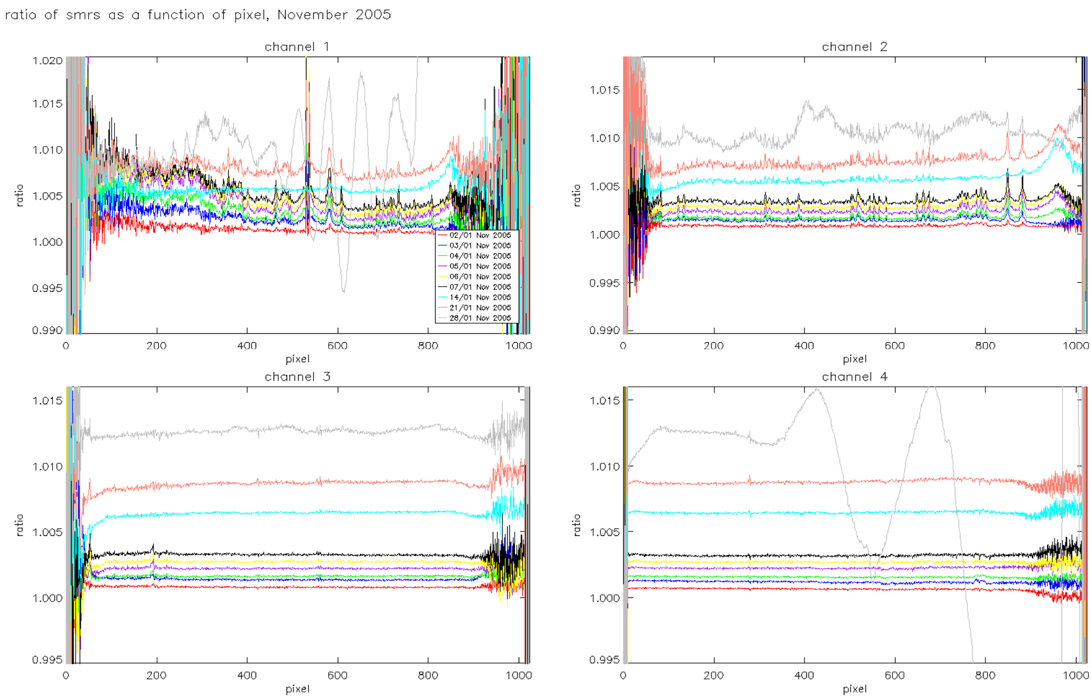


Fig. 5-2: SMR ratios per detector channel 1-4 (changes during November 2005)

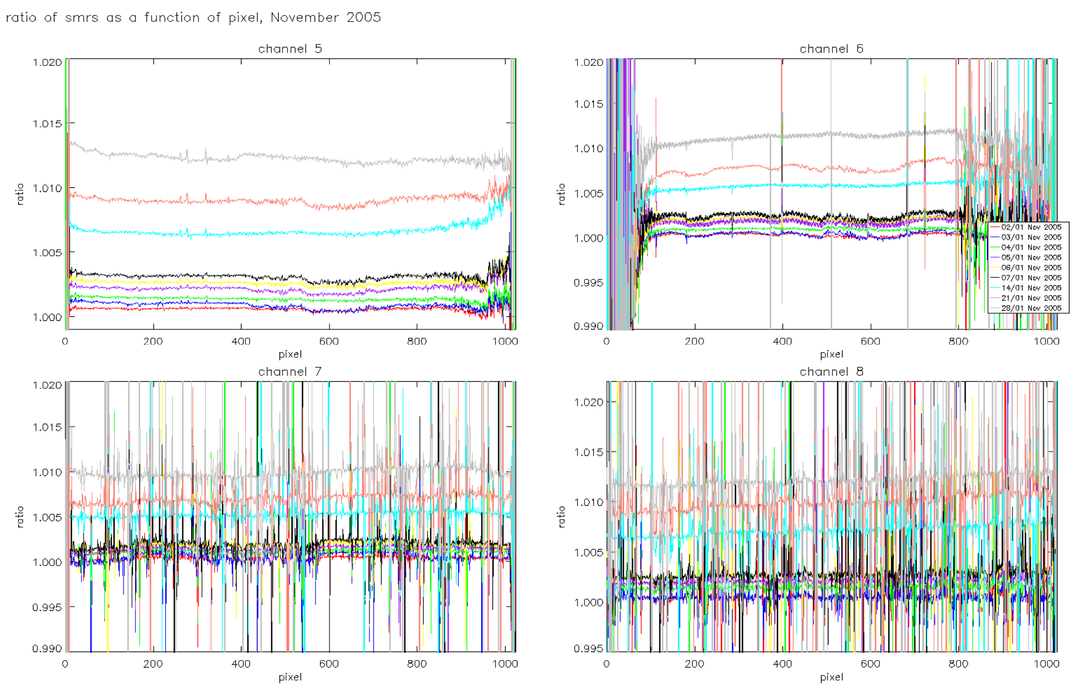


Fig. 5-3: SMR ratios per detector channel 5-8 (changes during November 2005)

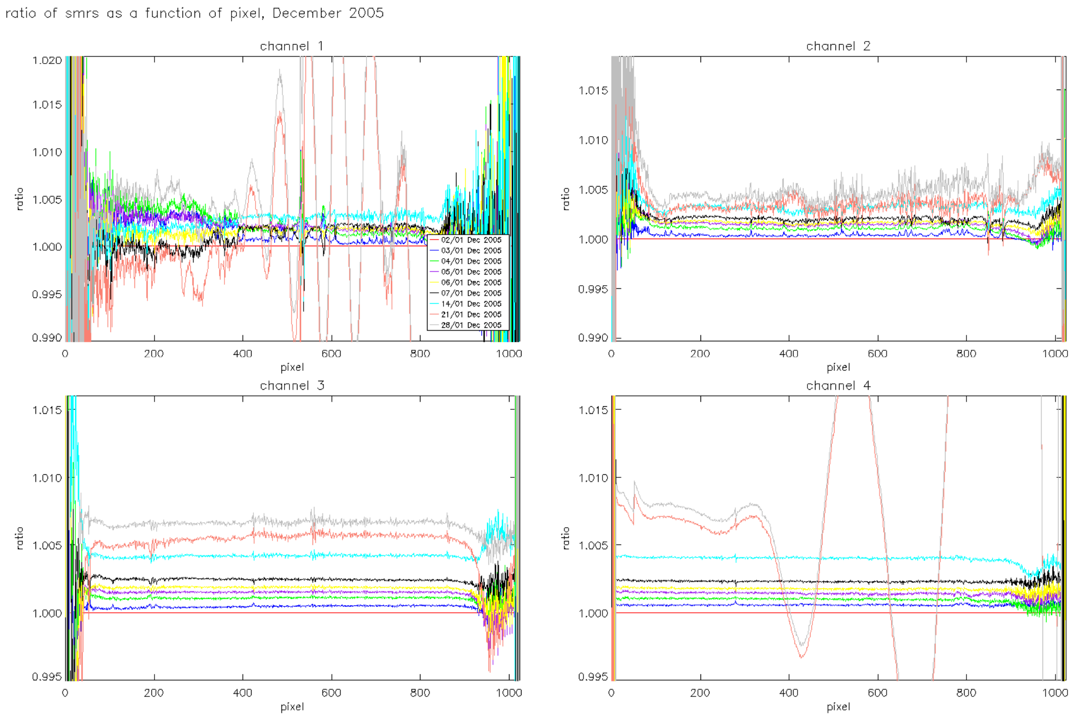


Fig. 5-4: SMR ratios per detector channel 1-4 (changes during December 2005)

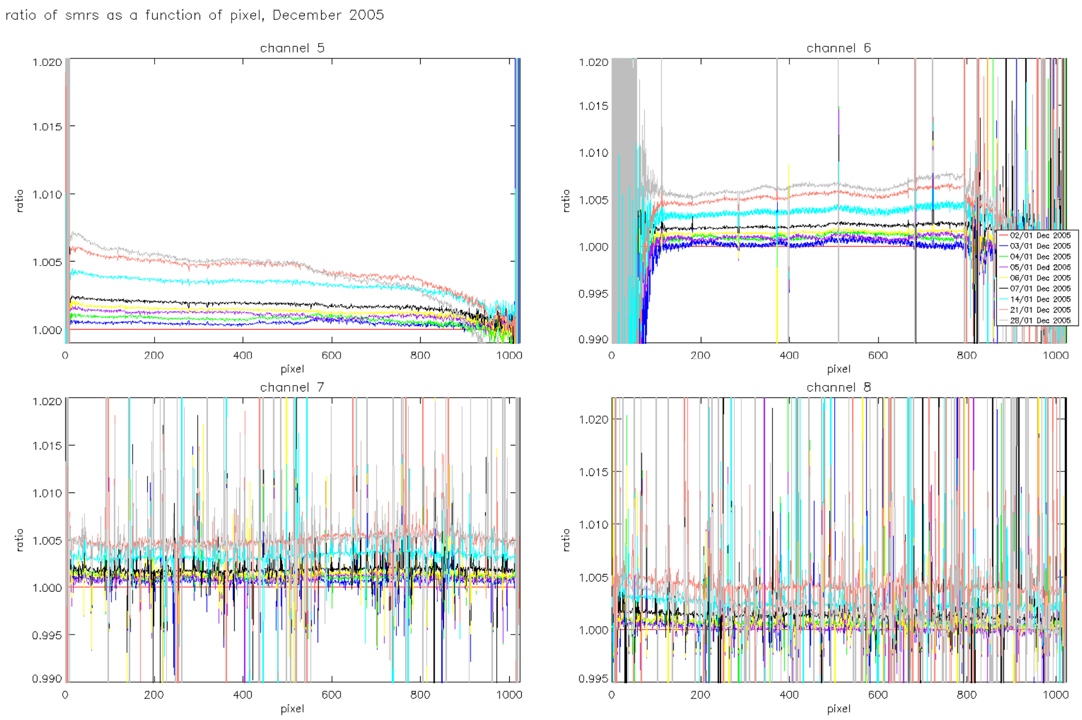


Fig. 5-5: SMR ratios per detector channel 5-8 (changes during December 2005)

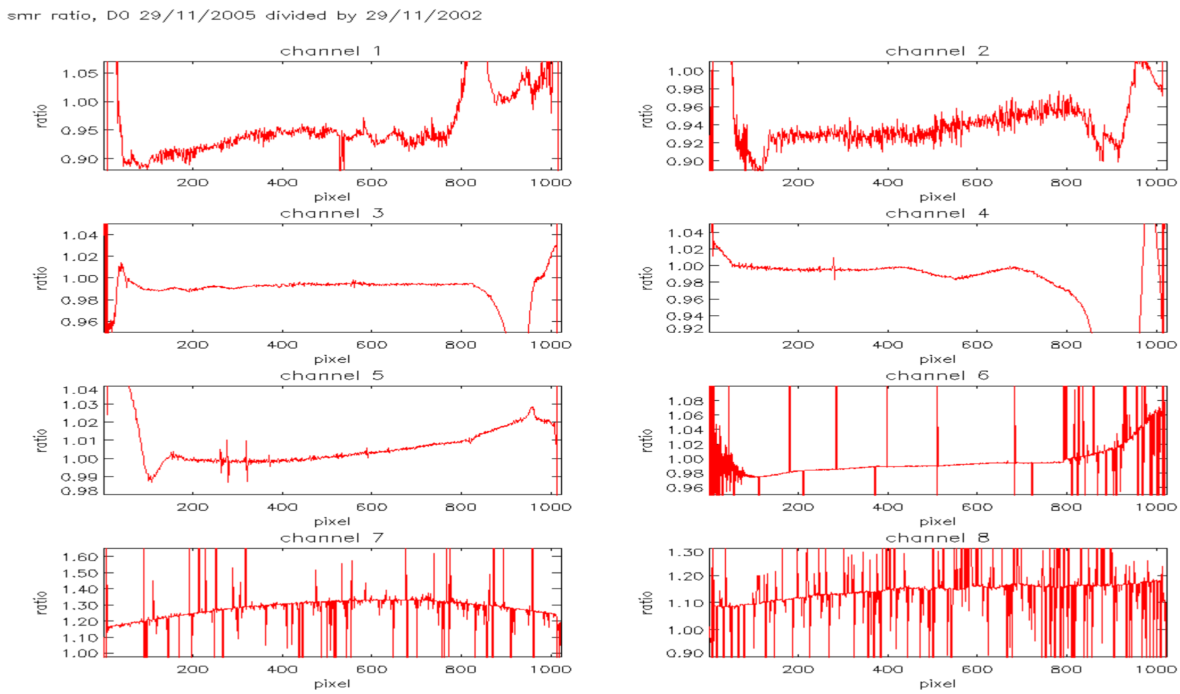


Fig. 5-6: SMR ratios per detector channel on Long Term Trend

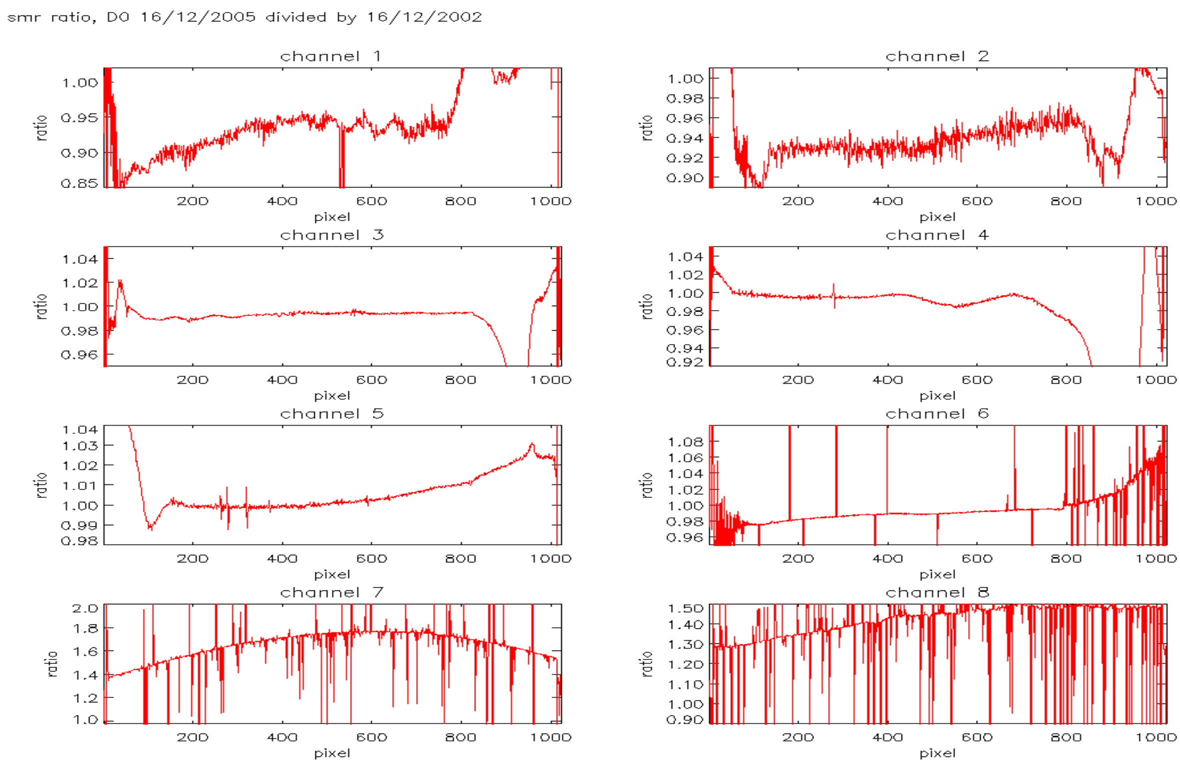


Fig. 5-7: SMR ratios per detector channel on Long Term Trend

5.1.5.2 LK1 analysis

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 2 and 3 weeks. They are very small but above the noise level.

The IR channels show a lot of noise. Here an improvement is foreseen with the new processor version IPF 6.00, where the time dependent part of the leakage current will be considered.

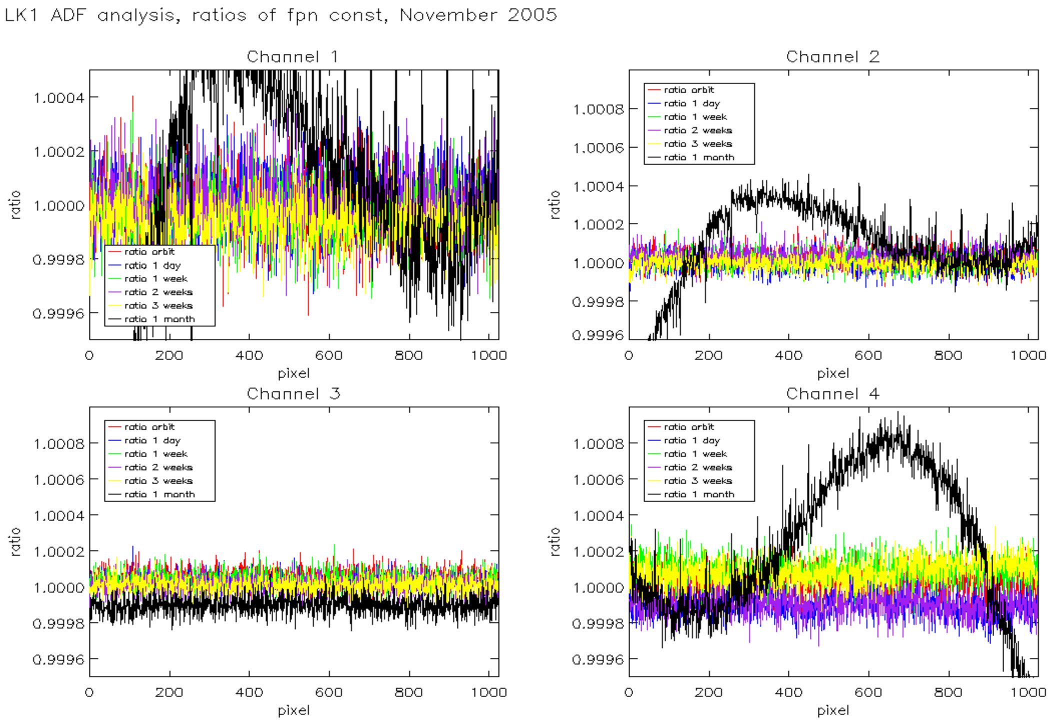


Fig. 5-7: dark current ratios (constant part) channel 1-4 during November 2005, Reference Spectrum used: Orbit 19198, 01-November-2005

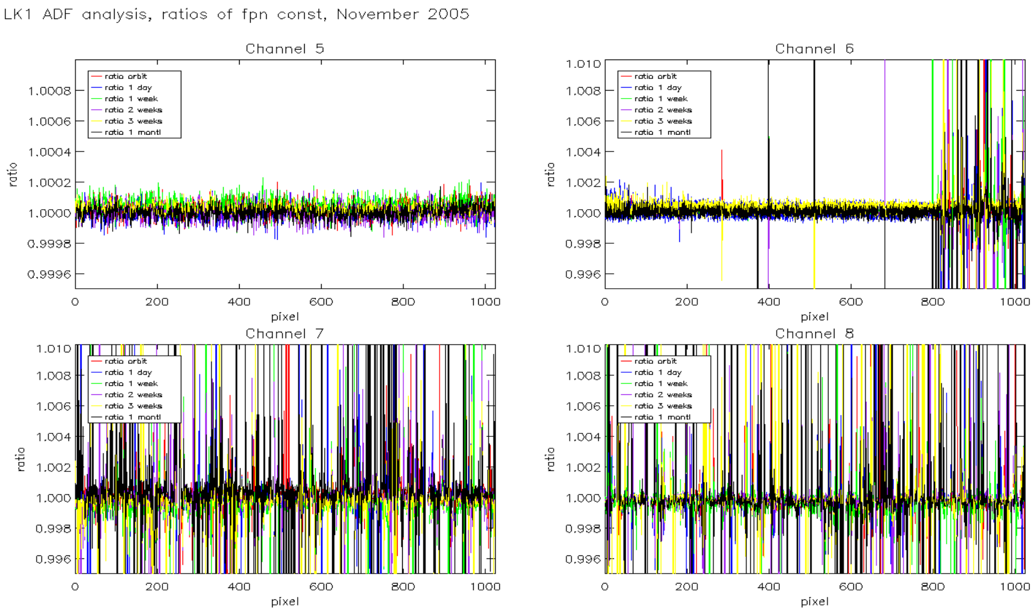


Fig. 5-8: dark current ratios (constant part) channel 5-8 during November 2005, Reference Spectrum used: Orbit 19198, 01-November-2005

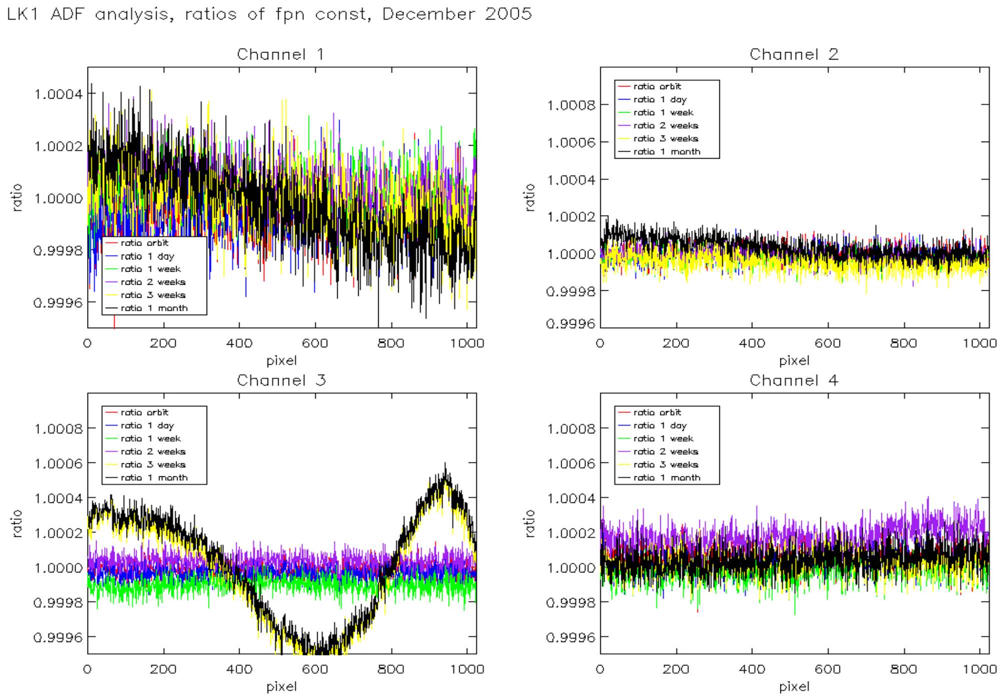


Fig. 5-9: dark current ratios (constant part) channel 1-4 during December 2005, Reference Spectrum used: Orbit 19628, 01-Dec-2005

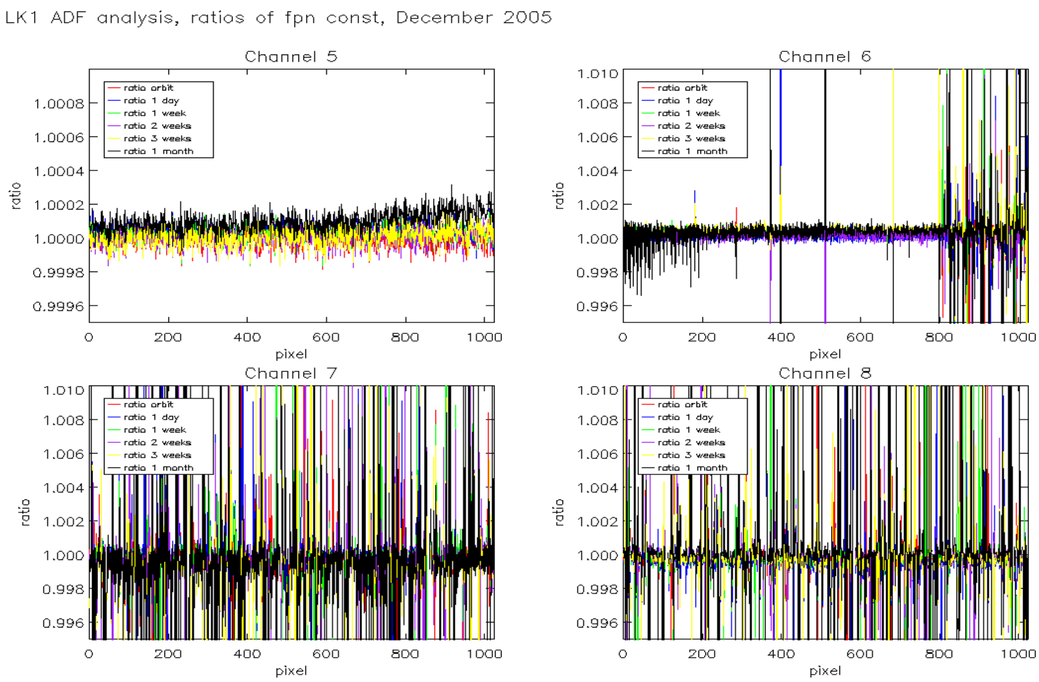


Fig. 5-10: dark current ratios (constant part) channel 5-8 during December 2005, Reference Spectrum used: Orbit 19628, 01-Dec-2005

5.1.5.3 PE1 analysis

During the reporting period monthly calibration measurements were available which were used to generate new SCI_PE1_AX files. These auxiliary files impact directly the SMR spectra (see also 5.1.5.1) as can be seen from Fig. 5-11. Fig. 5-12 shows the analysis results for channel 2 and 3. Further investigation is required to identify if the algorithm generating the etalon correction factor should be adjusted. In that case a PCR might be opened.

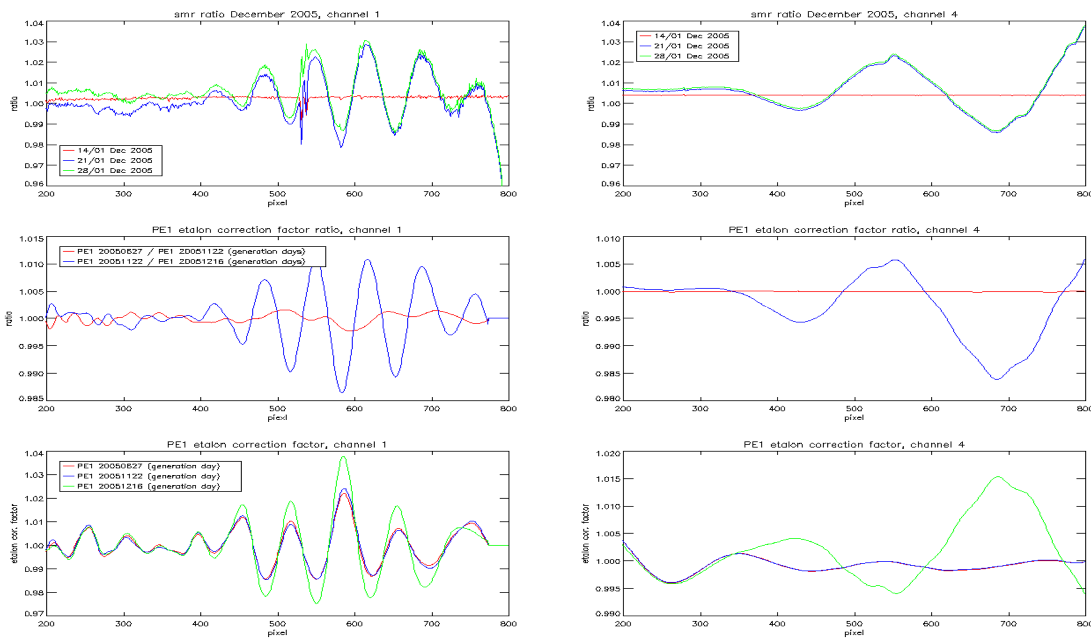


Fig. 5-11: Etalon correction factor – impact on detector data channel 1 and 4

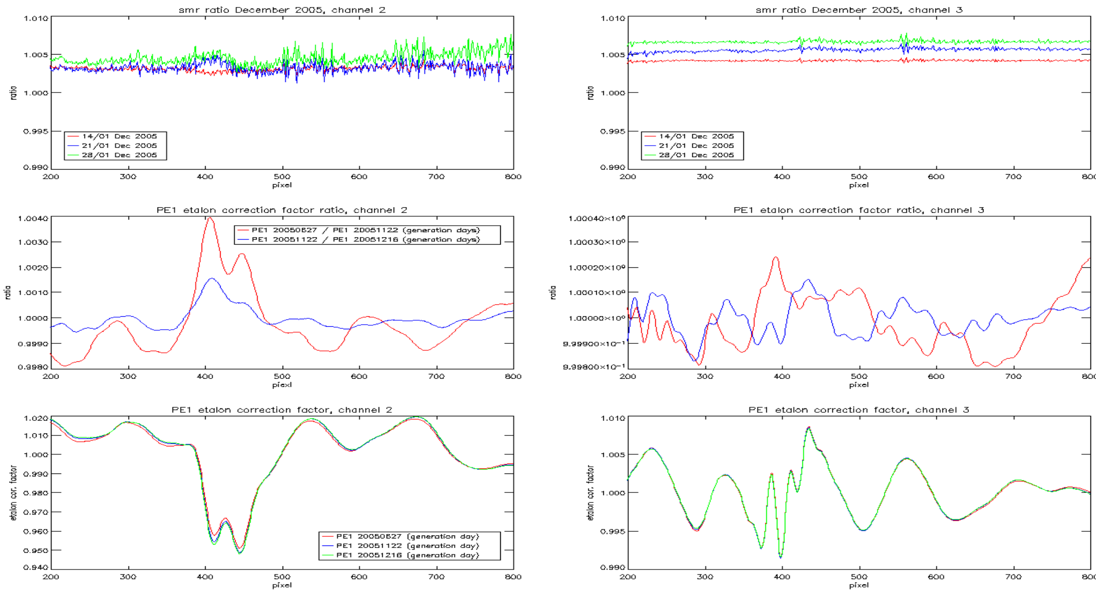


Fig. 5-12: Etalon correction factor – impact on detector data channel 2 and 3

5.1.6 Pointing Performance

The results on the analysis with respect to the Pointing Performance were presented in BMR July - August 2005.
The findings of this study are being implemented in the new SCIAMACHY processor IPF 6.0.

6 LEVEL 2 NRT PRODUCT QUALITY MONITORING

6.1 Processor Configuration

6.1.1 Version

The current IPF version used for processing (and re-processing) of SCIAMACHY level 2 data is 5.04. The according product specification is *[2]*. The disclaimer at http://envisat.esa.int/dataproducts/availability/disclaimers/SCI_NL__2P_Disclaimers.pdf describes known artefacts. SCIAMACHY NRT products generated with IPF 5.04 contain wrong ozone and AMF values due to a wrong handling of the seasonal index 3. This occurs to data starting from day 15 October 2005 until 31 December 2005 (as well as for previous years).

Table 6.1 shows the implementation dates of the IPF at the different PDS processing centres and the main modifications implemented.

IPF Version	Description	Proc Centre	Date	Start Orbit
5.04	No algorithm specification changes were implemented, but two algorithm implementation errors have been corrected. In addition, code adaptations have been performed to resolve performance problems encountered during reprocessing. The list of modifications is as follows: • The incorrect handling of the season index 4 has been corrected. • An incorrect polarisation-ratio calculation has been corrected, to remove radiance discrepancies up to 1% between prototype and operational processor. • Memory leaks have been detected and eliminated • An adaptation has been implemented to allow co-existence with the initialisation file used by the Off-Line processor	PDHS-K	21-AUG-2004	12942
		LRAC	20-AUG-2004	12750
		PDHS-E	16-AUG-2004	12823
		DPAC	12-AUG-2004	12879
5.01	• description for cloud MDS updated • minor changes in MPI and USA climatology description • latitude grids fixed • list of surface types fixed, note about vegetation index added • O_3 FM formula fixed sizes of SCIA FM spectra fixed latitude zones fixed • solar zenith angle grid fixed	DPAC	31-MAR-2004	
		PDHS-E PDHS-K LRAC	24-MAR-2004	

Tab. 6-1: Level 2 Processor Configuration

6.1.2 Auxiliary Data Files

Auxiliary Files being used as input for SCI_NL__2P products are listed in table 6-2. These ADF files are generally not changed.

SCI_FM2_AXVIEC20040309_092553_19990101_000000_20991231_235959
SCI_BL2_AXVIEC20020220_093709_20020101_000000_20200101_000000
SCI_CC2_AXVIEC20020220_094004_20020101_000000_20200101_000000
SCI_CL2_AXVIEC20020220_094214_20020101_000000_20200101_000000
SCI_CS2_AXVIEC20020220_094417_20020101_000000_20200101_000000
SCI_MF2_AXVIEC20040309_093236_19990101_000000_20991231_235959
SCI_PF2_AXVIEC20020220_100450_20020101_000000_20200101_000000
SCI_PR2_AXVIEC20020220_100642_20020101_000000_20200101_000000
SCI_RC2_AXVIEC20020220_100912_20020101_000000_20200101_000000
SCI_UC2_AXVIEC20040309_092027_19990101_000000_20991231_235959
SCI_SF2_AXVIEC20020220_101039_20020101_000000_20200101_000000
SCI_LI2_AXVIEC20040308_170000_20020101_000000_20200101_000000

Tab. 6-2: Level 2 Auxiliary Files

6.2 O_3 consistency checking

Future reports will contain information on this issue.

6.3 NO_2 consistency checking

NO_2 vertical column density (VCD) values of one month were averaged using QUADAS, filtering those data where the VCD flags are 0. Diurnal variations have not been corrected (no model applied). Fig. 6-1 and Fig. 6-2 are aimed at processing consistency checking and are not intended for geophysical interpretation.
Generally, 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.

6.3.1 NO_2 VCD map November 2005

High NO_2 VCD values can be seen over industrial regions.

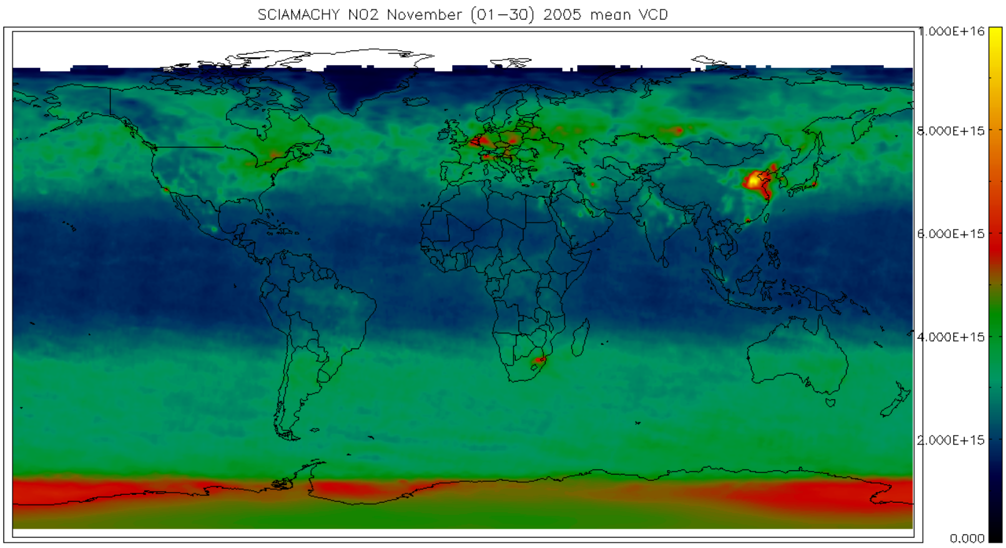


Fig. 6-1: NO_2 VCD world map 01-30 November 2005 – monthly average

6.3.2 NO_2 VCD map December 2005

The world map showing the distribution of mean values of NO_2 VCD values of December 2005 contains unphysical values at low latitudes which need to be investigated.

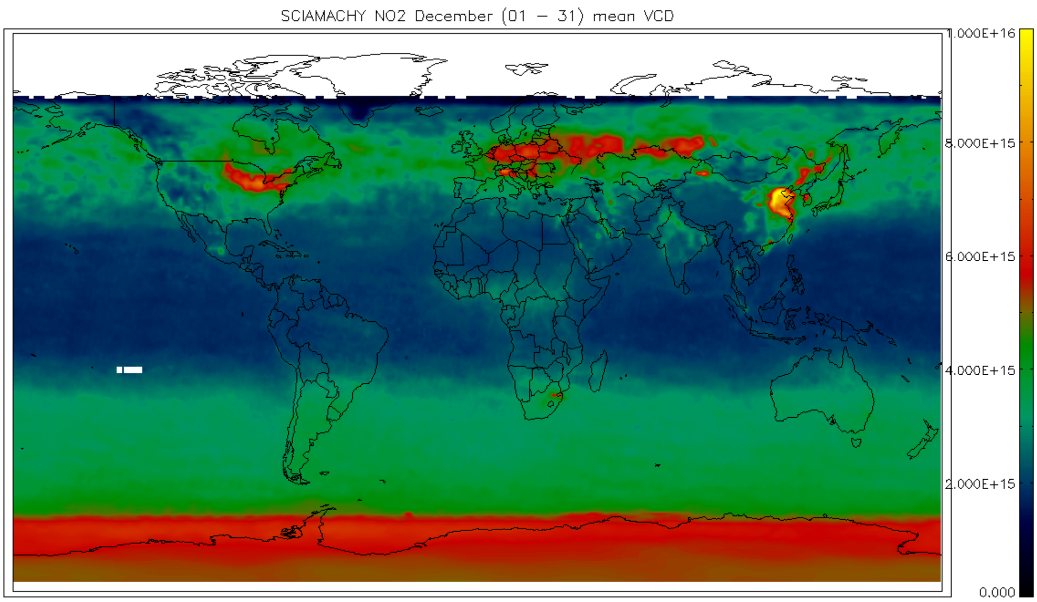


Fig. 6-2: NO_2 VCD world map 01-31 December 2005 – monthly average

7 LEVEL 2 OFFLINE PRODUCT QUALITY MONITORING

7.1 Processor Configuration

7.1.1 Version

In January 2005 the SCIAMACHY Level 2 Offline product SCI_OL__2P was released, data are generated with processor version 2.5.
The according product specification is PO-RS-MDA-GS-2009_15_3H. The disclaimer at http://envisat.esa.int/dataproducts/availability/disclaimers/SCI_OL_2P_Disclaimers.pdf describes known artefacts.
SCI_OL__2P products contain geolocated vertical column amounts of O_3, NO_2 Nadir measurements, as well as stratospheric Limb profiles of O_3, NO_2.

7.1.2 Auxiliary Data Files

Input for Level 2 Offline processing is the Initialization File SCI_IN_AXNPDE20041221_112322_000000000000_000000 _000000_0000.N1, that usually is changed only in case of a processor upgrade.

7.1.3 Monitoring results

In future reports results on Limb and Nadir products will be presented here.

8 VALIDATION ACTIVITIES AND RESULTS

8.1 SCIAMACHY-ECMWF Comparisons using SCI_RV__2P

8.1.1 Summary of the ECMWF SCIAMACHY monthly report for November 2005

- SCIAMACHY data quality stable.
- SCIAMACHY large drift as compared to ECMWF model in the northern extratropics throughout the month
- Large SCIAMACHY data and analysis and first-guess departures standard deviations, in particular at high latitudes
- Unrealistically large ozone values in the latitude band 70_ S-82.5_ S

- Relatively large biases south of 50_ S along about 0_ and 90_ E meridians
- The operational ECMWF model version used was CY29R2.

The full report is available at http://earth.esa.int/pcs/envisat/tmp_calval_res/

Below see the ECMWF plot on SCIAMACHY mean observation in DU.

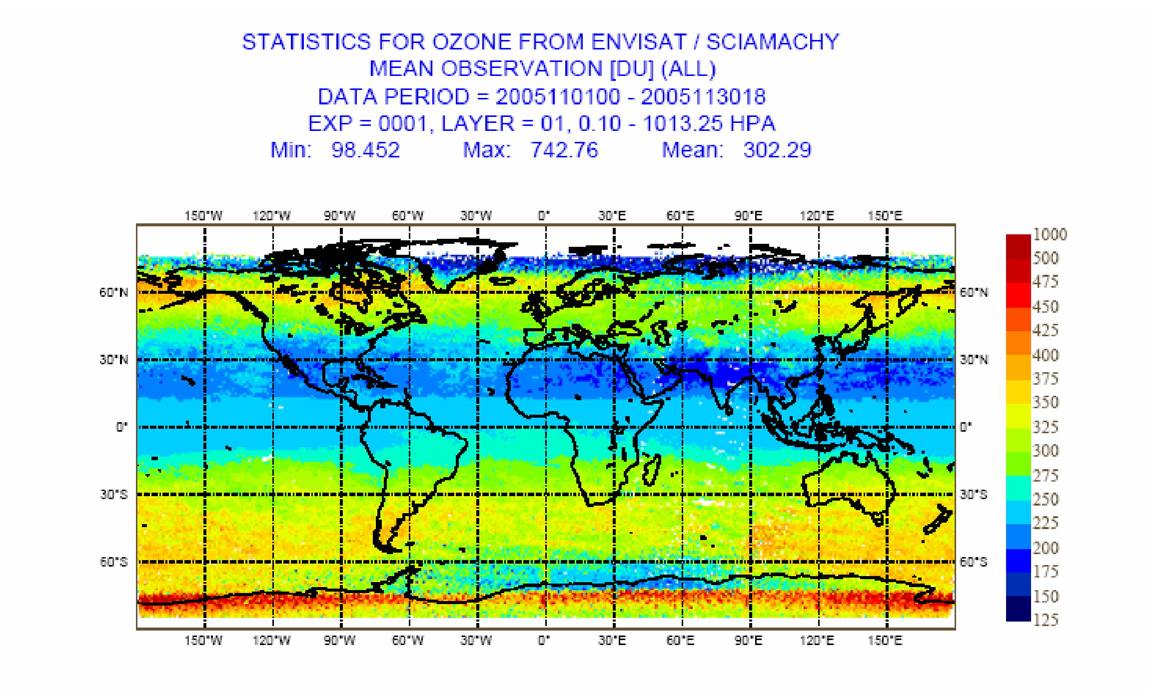


Fig. 8-1: Ozone Mean ECMWF November 2005

8.1.2 *Summary of the ECMWF SCIAMACHY monthly report for December 2005*

- SCIAMACHY data quality not stable.
- Change in SCIAMACHY data on 15 December
- SCIAMACHY data are about 20 DU lower than ECMWF ozone values in the global mean from 15 December onwards
- Decrease of the standard deviations of SCIAMACHY data and of the mean departures in the global mean, on 15 December
- Relatively large ozone values in the latitude band 62.5_ S-67.5_ S
- This monitoring report was produced with the operational ECMWF model, CY29R

The full report is available at **http://earth.esa.int/pcs/envisat/tmp_calval_res/**

Below see the ECMWF plot on SCIAMACHY mean observation in DU.

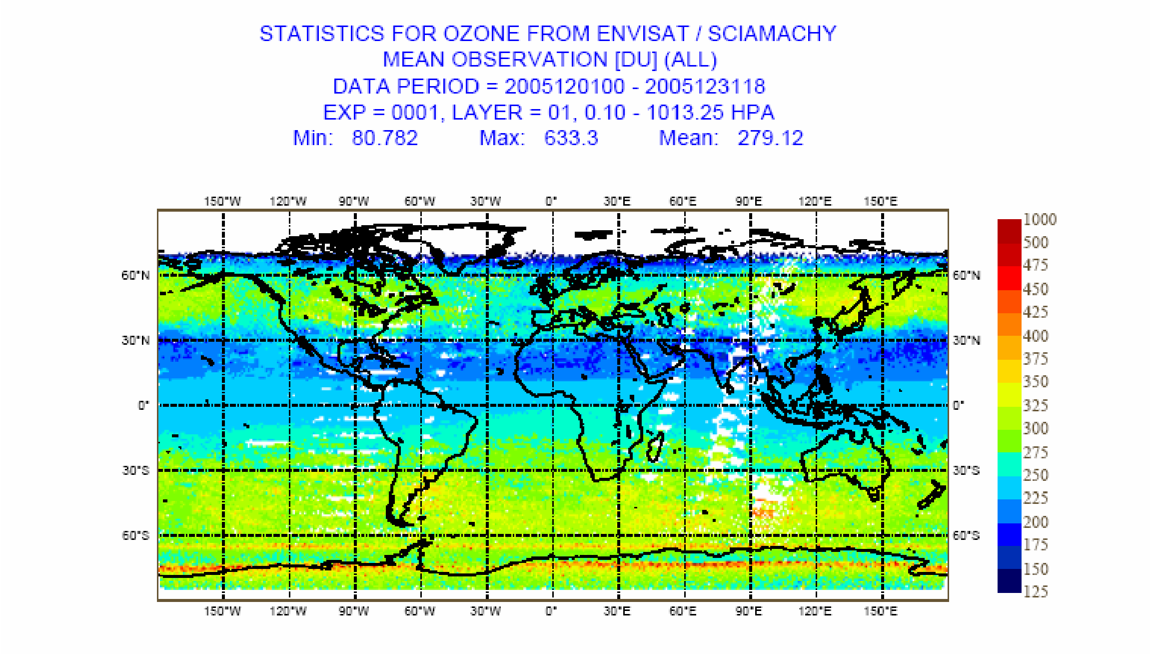


Fig. 8-2: Ozone Mean ECMWF December 2005

8.2 Statistics from Inter comparison with External Data

Future reports will contain information on this issue.

APPENDIX A

Type	ADF Name
PE1_AX	SCI_PE1_AXVIEC20050627_154704_20050621_000000_20900101_000000
	SCI_PE1_AXVIEC20051122_112332_20051115_000000_20900101_000000
	SCI_PE1_AXVIEC20051216_171614_20051214_000000_20900101_000000
SP1_AX	SCI_SP1_AXVIEC20051024_172837_20051016_000000_20060401_000000
	SCI_SP1_AXVIEC20051122_113952_20051115_000000_20060501_000000
	SCI_SP1_AXVIEC20051216_172605_20051214_000000_20060601_000000
SU1_AX	SCI_SU1_AXVIEC20051104_001046_20051101_005040_20051115_022456
	SCI_SU1_AXVIEC20051105_002435_20051102_001909_20051116_015420
	SCI_SU1_AXVIEC20051108_123907_20051105_173658_20051119_220821
	SCI_SU1_AXVIEC20051109_001228_20051106_012829_20051120_213649
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