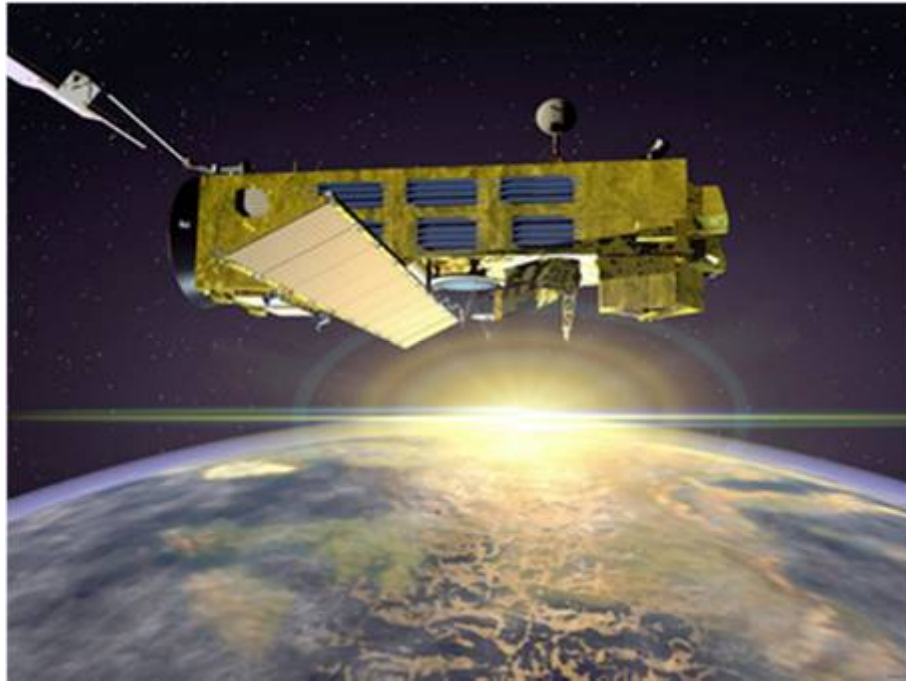


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## ENVISAT GOMOS report: October 2011



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Inputs from:	GOMOS Quality Working Group, ECMWF
Issue:	1.0
Reference:	ENVI-SPPA-EOPG-TN-11-0030
Date of issue:	15 November 2011
Status:	Reviewed
Document type:	Technical Note

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# 1 INTRODUCTION

The GOMOS monthly report documents the current status and recent changes to the GOMOS instrument, its data processing chain, and its data products.

The Monthly Report (hereafter MR) is composed of analysis results obtained by the Data Processing and Quality Control, combined with inputs received from the different entities working on GOMOS operation, calibration, product validation and data quality. These teams participate in the GOMOS Quality Working Group:

- European Space Agency (ESRIN, ESOC, ESTEC-PLSO)
- IDEAS
- ACRI
- Service d'Aeronomie
- Finnish Meteorological Institute
- IASB-Belgian Institute for Space Aeronomy
- Astrium Space
- ECMWF

In addition, the group interfaces with the Atmospheric Chemistry Validation Team.

## 1.1 *Scope*

The main objective of the Monthly Report is to give, on a regular basis, the status of GOMOS instrument performance, data acquisition, results of anomaly investigations, calibration activities and validation campaigns. The following six sections compose the MR:

- Summary
- Unavailability
- Instrument Configuration and Performance
- Level 1 Product Quality Monitoring
- Level 2 Product Quality Monitoring
- Validation Activities and Results

## 1.2 *References*

- [1] ENVISAT Weekly Mission Operations Report #477, #478, #479, #480, , #481
- [2] ECMWF GOMOS Monthly Reports
- [3] Routine update of the wavelength assignment, Gilbert Barrot (ACRI-ST), Issue 1 Revision 1, September 19, 2007

### 1.3 *Acronyms and Abbreviations*

ACVT	Atmospheric Chemistry Validation Team
ADC	Analogue-to-Digital Converter
ADF	Auxiliary Data File
ADS	Auxiliary Data Server
ANX	Ascending Node Crossing
AOCS	Attitude and Orbit Control System
ARB	Anomaly Review Board
ARF	Archiving Facility (PDS)
CCU	Central Communication Unit
CFI	Customer Furnished Item
CFS	CCU Flight Software
CNES	Centre National d'Études Spatiales
CTI	Configuration Table Interface / Configurable Transfer Item
CR	Cyclic Report
DC	Dark Charge
DDS	Data Dissemination System
DMOP	Detailed Mission Operation Plan
DPM	Detailed Processing Model
DS	Data Server
DSA	Dark Sky Area
DSD	Data Set Descriptor
ECMWF	European Centre for Medium Weather Forecast\
EO	Earth Observation
EQSOL	Equipment Switch Off Line
ESA	European Space Agency
ESL	Expert Support Laboratory
ESRIN	European Space Research Institute
ESTEC	European Space Research & Technology Centre
ESOC	European Space Operations Centre
FCM	Fine Control Mode
FinCoPAC	Finnish Products Archiving Center
FMI	Finnish Meteorological Institute
FOCC	Flight Operations Control Centre (ENVISAT)
FP1	Fast Photometer 1
FP2	Fast Photometer 2
GADS	Global Annotations Data Set
GOMOS	Global Ozone Monitoring by Occultation of Stars
GOPR	Gomos Prototype
GS	Ground Segment
HK	Housekeeping
IASB	Institut d'Aeronomie Spatiale de Belgique
IAT	Interactive Analysis Tool
ICU	Instrument Control Unit
IDEAS	Instrument Data quality Evaluation and Analysis
IDL	Interactive Data Language
IECF	Instrument Engineering and Calibration Facilities

IMK	Institute of Meteorology Karlsruhe (Meteorologisch Institut Karlsruhe)
INV	Inventory Facilities (PDS)
IPF	Instrument Processing Facilities (PDS)
JPL	Jet Propulsion Laboratory
LAN	Local Area Network
LMA	Levenberg-Marquardt Algorithm
LPCE	Laboratoire de Physique et Chimie de l'Environnement
LRAC	Low Rate Archiving Center
LUT	Look Up Table
MCMD	Macro Command
MDE	Mechanism Drive Electronics
MIP	Most Illuminated Pixel
MPH	Main Product Header
MPS	Mission Planning System
MR	Monthly Report
NRT	Near Real Time
OBDH	On-Board Data Handling
OBT	On Board Time
OCM	Orbit Control Manoeuvre
OOP	Out-of-plane
OP	Operational Phase of ENVISAT
OS	Operating System
PAC	Processing and Archiving Centre (PDS)
PCF	Product Control Facility
PDCC	Payload Data Control Centre (PDS)
PDHS	Payload Data Handling Station (PDS)
PDHS-E	Payload Data Handling Station – ESRIN
PDHS-K	Payload Data Handling Station – Kiruna
PDS	Payload Data Segment
PEB	Payload Equipment Bay
PLSOL	Payload Switch off Line
PMC	Payload Module Computer
PRNU	Pixel Response Non Uniformity
PSO	On-Orbit Position
QC	Quality Control
QUARC	Quality Analysis and Reporting Computer
QWG	Quality Working Group
RDV	RenDez-Vous
RGT	ROP Generation Tool
RIVM	Rijksinstituut voor Volksgezondheid en Milieu
ROP	Reference Operations Plan
RRM	Rate Reduction Mode
RTS	Random Telegraphic Signal
SA	Service d'Aeronomie
SAA	South Atlantic Anomaly
SATU	Star Acquisition and Tracking Unit
SFA	Steering Front Assembly
SFCM	Stellar Fine Control Mode

SFM	Steering Front Mechanism
SM	Service Module
SMNA	Servicio Meteorológico Nacional de Argentina
SMP	Set Measurement Parameter
SODAP	Switch On and Data Acquisition Phase
SPA1	Spectrometer A CCD 1
SPA2	Spectrometer A CCD 2
SPB1	Spectrometer B CCD 1
SPB2	Spectrometer B CCD 2
SPH	Specific Product Header
SQADS	Summary Quality Annotation Data Set
SSP	Sun Shade Position
STP	Set Thermal Parameter
SYSM	Stellar Yaw Steering Mode
SZA	Solar Zenith Angle
VCCS	Voice Coil Command Saturation

## 2 SUMMARY

### 2.1 *Highlights*

- Several instrument measurement interruptions have been occurring since 24 August; the observed anomalies in the mirror rallying appear to be similar to those which impacted the GOMOS instrument operations in previous years. Due to the persisting instrument anomalies also after a further reduction of the rally Azimuth angle range which has been restricted to the interval [40 - 55] degrees, a new operational scenario aimed at minimizing the number of movements of the SFA is going to be defined along with GOMOS QWG.
- A problem in the wavelength assignments in a GOMOS ADF has been detected: work is on-going to fix it; in addition to it, the wavelength assignment has been also impacted by the annealing of July 2011. As a consequence, all products generated with the version 6.01 (off-line: 25 May 2011; NRT: 7 June 2011) will be reprocessed and the off-line forward production has been stopped, whereas the NRT production is continuing to allow anomaly investigations.
- A full mission reprocessing (3<sup>rd</sup>) is going to start as soon as the GOMOS ADF is corrected, likely in November 2011.

### 2.2 *Main monitoring topics*

**Instrument availability** (section 3.1): There were 11 instrument unavailabilities during the reporting period.

**Instrument operations** (section 4.1.2): Since 13<sup>th</sup> February 2010 the minimum allowed azimuth angle is set to +15 degrees. The azimuth window is still set to 30 degrees (since 30<sup>th</sup> October 2009). The instrument is working with a “soft” patch uploaded for tracking controller tuning (since 29<sup>th</sup> October 2009) and rallying filter gain set to 50% of its original (nominal) value (since 12<sup>th</sup> February 2010). Starting from 16<sup>th</sup> September 2010 the upper value of the azimuth window is set to 55 degrees in order to

avoid “Fine Stage Out Of Range” and VCCS anomalies. A reduced azimuth field of view is being currently set to [+47,+55] and is going to be scheduled starting from the beginning of November 2011.

**Data availability** when instrument was in operation (section 3.4): Level 1 data availability dropped to around 40% in the periods 29 August 04 September and 22 - 28 September 2011 due to GOMOS VCCS anomaly occurrences.

**Data availability for users** (section 3.5): Routine dissemination of Level 1b and Level 2 products produced by the PDS to the users is enabled. Level 1b data are available on request to the EO Helpdesk ([EOHelp@esa.int](mailto:EOHelp@esa.int)), while level 2 data are available for the whole mission on different ftp sites. Level 2 consolidated products are available from D-PAC ftp server. Full mission reprocessing with the latest GOMOS version (6.01) will start as soon as the problem occurring in an ADF file is solved.

**Wavelength monitoring** (section 5.3): the wavelength shifts showed a variation which was not expected after the implementation of the routine calibration on 14<sup>th</sup> December 2007. This change has been investigated by the QWG and an updated calibration law has become operational with the new version of GOMOS (6.01). Nevertheless an erroneous wavelength assignment in the GOM\_CAL\_AX ADF file has recently been found; moreover the wavelength assignment has been found to be impacted by the annealing performed in July 2011. The correct ADF is currently been implemented.

**Pointing performance** (section 4.6.1): the SATU Noise Equivalent Angle is carefully monitored as several anomalies have affected the mirror elevation angle (measured by the SATU ‘Y’) since the beginning of the mission. An increasing trend observed after September 2010 anomaly restart (similar to that observed prior to September 2010 anomaly) has disappeared at operations’ restart after the instrument unavailability of 3-5 April 2011; in the following two months a decrease has been observed yielding to a nominal situation until the occurrence of the anomalies in the period September - October 2011.

**Temperatures** (section 4.3): The CCD temperatures show the expected global increase due to the radiator ageing. Another expected variation of the temperatures, the seasonal one, with amplitude of around 1.5 degree can also be observed.

**Modulation signal** (section 4.5.2): The values of the modulation are daily extracted and plotted; they should not be very different from the ones coded into the processor: 1.40 ADU for SPA1 and 0.76 ADU for SPA2. The modulation signal shows high values during summer time for the ESRIN data, it has been shown that the South Atlantic Anomaly is the cause of these unexpected peaks. The quality of ESRIN data, in particular over the SAA zone, is impacted but the measure of this impact is under investigation. However, in the second half of the months of October of all years (2004-2010) the peaks are smaller because the DSA zone where the data are taken for this analysis is moving towards the Northern Hemisphere. At the end of October the DSA zone is definitely chosen by the planning system in the Northern Hemisphere (to fill the criteria ‘DSA in full dark limb conditions’) and the high peaks disappear.

**Star detection performance** (section 4.6.3): the stars should be detected not far from the SATU center, that is, pixel number 145 in elevation and number 205 in azimuth. The elevation MIP (Most Illuminated Pixel, which is the pixel at the moment of the detection) had a significant variation until 12<sup>th</sup> December 2003 when a new PSO algorithm was activated in order to reduce the deviations of the ENVISAT platform attitude with respect to the nominal one. Afterwards, the MIP position was quite stable around



its nominal pixel values until the occurrence of the VCCS anomaly on January 2005. The reason for the change in trend observed after the anomaly is, at the moment, not understood. This behavior, currently stable at pixel 127 in elevation and 193 in azimuth, does not impact the data quality but may invalidate attitude monitoring by GOMOS and could represent a hidden anomaly.

**Radiometric sensitivity monitoring** (section 5.4.1): for stars 25 and 9, the UV ratio is greater than the threshold 10%. It is clear that there is a global decrease of UV ratios for all the stars. This confirms the expected degradation suffered by the UV optics that is, anyway, very small considering also the small variation for the rest of the stars. For the photometers radiometric sensitivity ratios it is observed that every star has a variation that seems to be seasonally related. The variation is significant for stars 25 and 18. After some investigations performed by the QWG that exclude an inaccurate reflectivity correction LUT, it seems that the PH1/2 radiometric sensitivity variations could come from the fact that the spectrometers and the photometers are not illuminated the same way when the straylight appears.

**Auxiliary Data File** (sections 5.1.2 and 5.3): two GOM\_CAL\_AX files with updated DC maps and new (wrong) wavelength assignment has been disseminated during the reporting period.

### 3 INSTRUMENT AND DATA AVAILABILITY

#### 3.1 GOMOS Unavailability Periods

There were 11 instrument unavailability periods during the reporting month (see Table 3.1-1); 8 due to Heater/Refuse Mode caused by Fine Stage out of Range and 3 due to ICU powered off; anomaly investigations and tests are under way: a reduction of the spanned SFM rally Azimuth angle to overcome the instrument anomalous behaviour is currently being explored.

**Table 3.1-1: List of unavailability periods issued during the reporting month**

Reference of unavailability report	Start time Star orbit	Stop time Stop orbit	Description
EN-UNA-2011/199	30 Sep 2011 11:56:44 Orbit = 50123	02 Oct 2011 11:01:22 Orbit = 50152	ICU off
EN-UNA-2011/200	03 Oct 2011 00:24:29 Orbit = 50160	03 Oct 2011 03:39:23 Orbit = 50162	Fine Stage out of range (Heater/Refuse)
EN-UNA-2011/201	03 Oct 2011 17:54:21 Orbit = 50170	03 Oct 2011 20:22:42 Orbit = 50172	Fine Stage out of range (Heater/Refuse)
EN-UNA-2011/202	03 Oct 2011 23:43:17 Orbit = 50174	04 Oct 2011 03:03:42 Orbit = 50176	Fine Stage out of range (Heater/Refuse)
EN-UNA-2011/204	04 Oct 2011 11:22:36 Orbit = 50181	04 Oct 2011 13:04:43 Orbit = 50182	Fine Stage out of range (Heater/Refuse)
EN-UNA-2011/209	04 Oct 2011 15:38:04 Orbit = 50183	12 Oct 2011 08:25:31 Orbit = 50294	ICU off
EN-UNA-2011/213	12 Oct 2011 16:46:44 Orbit = 50299	12 Oct 2011 21:32:02 Orbit = 50302	Fine Stage out of range (Heater/Refuse)
EN-UNA-2011/214	13 Oct 2011 06:08:39 Orbit = 50307	13 Oct 2011 07:33:49 Orbit = 50308	Fine Stage out of range (Heater/Refuse)
EN-UNA-2011/224	23 Oct 2011 10:21:03 Orbit = 50453	23 Oct 2011 14:50:01 Orbit = 50456	Fine Stage out of range (Heater/Refuse)

EN-UNA-2011/226	26 Oct 2011 11:31:24 Orbit = 50497	26 Oct 2011 13:01:00 Orbit = 50498	Fine Stage out of range (Heater/Refuse)
EN-UNA-2011/227	26 Oct 2011 18:13:32 Orbit = 50501	-- Nov 2011 Orbit =	ICU off

### 3.2 Stars Lost in Centering

The acquisition of a star initiates with a rallying phase where the telescope mechanism is directed towards the expected position of the star. Subsequently the acquisition procedure enters into detection mode, where the SATU star tracker output signal is pre-processed for spot presence survey and for the location of the most illuminated couple of adjacent pixels for two added lines, over the detection field. The Most Illuminated Pixel (MIP) defines the position of the first SATU centering window. The following step in the acquisition sequence is then initiated and consists of a centering phase where the SATU output signal is pre-processed for spot presence survey over the maximum of 10x10 pixel field. This allows the third phase to begin: the tracking phase.

The centering phase has occasionally resulted in loss of the star from the field of view. Figure 3.2-1 reports the percentage of the stars lost in centering in the period: 3 February 2003 – 23 October 2011. It can be seen that only three stars, mainly weak stars (higher star id means higher magnitude) are lost during the centering phase between 4% and 9.5 % of their planned observations. The majority of those are geo-localized over the SAA.

Several instrument anomalies (interruptions) have occurred during the reporting period (section 3.1) that, together with the high amount of VCCS anomaly occurrences (section 3.3) have caused a high reduction of the acquired stars; yet the statistics of the stars lost in centering since 2003 appears to be stable.

### Statistics on stars lost in centering: 03-FEB-2003 until 23-OCT-2011

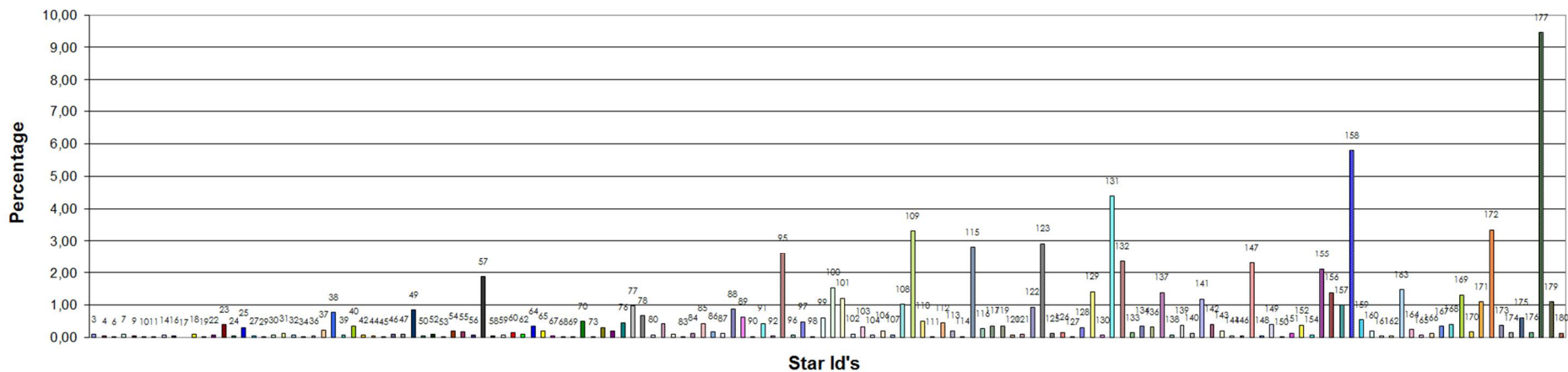


Figure 3.2-1: Statistics on stars that have been lost during the centering phase. The number above the columns corresponds to the Star ID



### 3.3 Stars lost due to VCCS anomaly

Many VCCS in elevation occurred during the reporting period leading to high losses of star acquisitions (see below).

### 3.4 Data Generation Gaps

The trend in percentage of available NRT data within the archives PDHS-K and PDHS-E is depicted in Figure 3.4-1 (when instrument was in measurement mode). It is a good indicator on how the PDS chain is working in terms of generation and dissemination of data to the archives. The percentage is calculated once per week until 21 October 2010 (end of ENVISAT nominal mission). After restart of GOMOS mission on 29 November 2010 the percentages are calculated every 6 days.

Level 0 and 1 data availability “when GOMOS on” is not derived in the period 4-10 October due to the instrument unavailability during the whole period; Level 1 availability dropped to around 10% in the period 10-16 October and 2% in the period 16-22 October due to removal of stars from the nominal planning; product availability was generally low also due to many GOMOS VCCS anomaly occurrences.

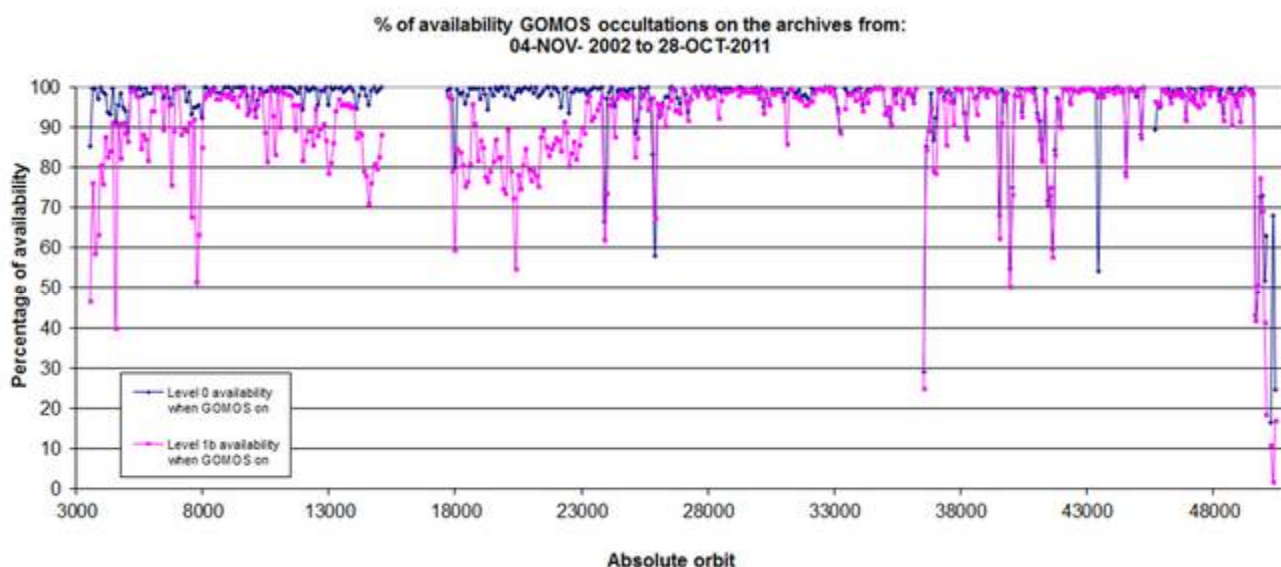


Figure 3.4-1: Percentage of level 0 and level 1b data availability on the archives PDHS-E and PDHS-K

Occultations planned to be acquired but for which no GOM\_NL\_\_0P data product has become available are presented in Figure 3.4-2 for the reporting period: an increase of missing occultations due to GOMOS anomalies can be observed.

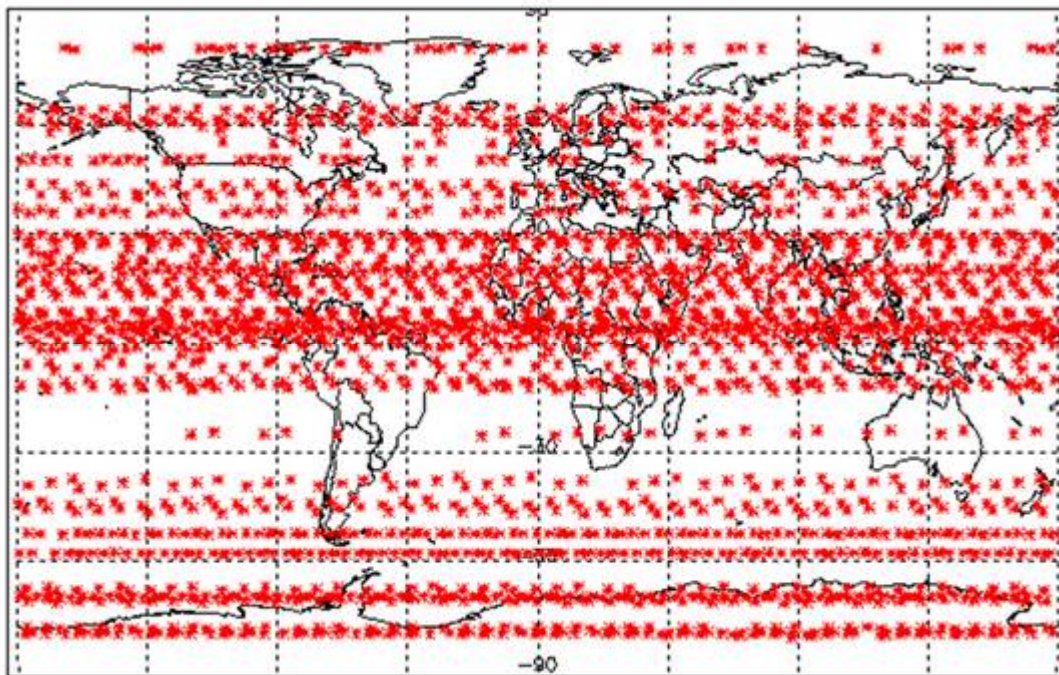


Figure 3.4-2: The red points are the occultation geo-location (starting) corresponding to planned data acquisitions for which no GOMOS level 0 product has become available

### 3.5 Data availability to users

Routine dissemination of higher-level products produced by the PDS to the users is enabled. Level 1b data are available on request to the EO Helpdesk ([EOHelp@esa.int](mailto:EOHelp@esa.int)), while level 2 data are available for the whole mission. For information on the passwords, please, contact the EO Helpdesk ([EOHelp@esa.int](mailto:EOHelp@esa.int)):

- Reprocessed products GOM\_NL\_\_2P are available at **the D-PAC ftp server** (name: **ftp-ops-dp.eo.esa.int**):  
<ftp://gomo2usr@ftp-ops-dp.eo.esa.int> from **August 2002 to 4<sup>th</sup> July 2006**.
- Near Real Time products GOM\_NL\_\_2P (generated three hours after sensing time) are available on the following servers:  
<ftp://gomosusr@oa-es.eo.esa.int> (ESRIN data). **A seven-day rolling archive has been set-up on this server.**  
<ftp://gomosusr@oa-ks.eo.esa.int> (KIRUNA data). **A seven-day rolling archive has been set-up on this server.**
- Consolidated products GOM\_NL\_\_2P (generated three weeks after sensing time) are available at D-PAC ftp server  
<ftp://gomo2usr@ftp-ops-dp.eo.esa.int> **since 23 July 2006**

All data (reprocessed, NRT and consolidated) are processed with the same version of GOMOS processor until 25 May 2011 when consolidated level 2 data started to be processed with GOMOS/6.01.

Full mission reprocessing with the latest version of GOMOS (6.01) will start as soon as the problem occurring in the ADF for wavelength assignment is solved.

## 4 INSTRUMENT CONFIGURATION AND PERFORMANCE

### 4.1 *Instrument Operation and Configuration*

#### 4.1.1 OPERATIONS SINCE BEGINNING OF MISSION

GOMOS has had different operational scenarios during the mission:

- **End of March 2003 to July 2003:** during this period the azimuth range had to be decreased in steps (Table 4.1-1) to avoid an instrument problem (“Voice\_coil\_command\_saturation” anomaly) that caused GOMOS to go into STAND BY/REFUSE mode
- **July 2003:** the driver assembly was switched to the redundant B-side and since that date the full azimuth range (-10.8, +90.8) was again available
- **25<sup>th</sup> January 2005:** A second major anomaly occurred. Between this date and until the instrument was declared operational again (29<sup>th</sup> August 2005), GOMOS has been operated for testing and anomaly investigation purposes in different operation scenarios.
- **29<sup>th</sup> August 2005:** GOMOS operational again with reduced azimuth window of 20 degrees
- **9<sup>th</sup> October 2005:** azimuth window moved from 20 to 25 degrees
- **12<sup>th</sup> March 2006:** the reduced azimuth window of 25 degrees becomes a sliding window
- **2<sup>nd</sup> February 2008:** azimuth window moved from 25 to 30 degrees
- **21<sup>st</sup> August 2008:** minimum allowed azimuth angle set to +2 degrees
- **3<sup>rd</sup> March 2009:** azimuth range fixed to [+30, +50]
- **17<sup>th</sup> July 2009:** azimuth range fixed to [+25, +50]
- **October 2009:** many filter gain changes (in rallying and tracking) with the aim of overcoming the elevation pointing degradation and the VCCS anomalies (Table 4.1-2). On 29<sup>th</sup> October 2009 the configuration was fixed to: “soft” patch for tracking controller tuning remained uploaded and rallying filter gain set to 10 (nominal was 7.64). On 30<sup>th</sup> October 2009 the reduced azimuth window is enlarged to 30 degrees and becomes a sliding window with a minimum allowed azimuth angle set to +5 degrees. Many rallying filter gains were again tested during January/February 2010 in an attempt of avoiding the VCCS anomalies that appeared on 7<sup>th</sup> January 2010 after the azimuth window was moved from [15, 45] to [10, 40].
- **February 2010:** the rallying filter gain is set to 3.8 on 12<sup>th</sup> February. On 13<sup>th</sup> February the minimum allowed azimuth is set to 15 deg.
- **September 2010:** GOMOS azimuth window is restricted from [15°; 90°] to [15°; 55°] on 16 September.
- **October 2010:** end of ENVISAT Phase 2 operations on 21<sup>st</sup> Oct 2010 at 23:59:00, orbit 45190; GOMOS commanded into Heater mode MDE-ON on 22<sup>nd</sup> October at 03:15:20.
- **November 2010:** The planning anomaly that prevented the restart of GOMOS after ENVISAT orbit lowering manoeuvre (22 October 2010) was solved. As a consequence, GOMOS resumed operations on 29 November 2010 at 08:27:36, orbit 45740.

The changes in azimuth configuration during the whole mission until end of reporting period are summarized in Table 4.1-1; in the period 10-23 October September stars with azimuth below 40 degrees were removed from the MPS schedule (stars with azimuth below 22 degrees had been removed starting from 22 September).

**Table 4.1-1: Historical changes in Azimuth configuration when GOMOS is in operations**

Date	Orbit	Minimum Azimuth (°)	Maximum Azimuth (°)	Comment
01-MAR-2002		-10.8	+90.8	Nominal
29-MAR-2003 17:40	5635	0.0	+90.8	Reduced
31-MAY-2003 06:22	6530	+4.0	+90.8	Reduced
16-JUN-2003 16:17	6765	+12.0	+90.8	Reduced
15-JUL-2003 01:39	7200	-10.8	+90.8	Nominal
25-JAN-2005 23:33	15200	tests	tests	Different configurations for testing purposes
29-AUG-2005 02:52	18280	-10	+10	Reduced
26-SEP-2005 01:32	18680	-5	+20	Reduced
03-OCT-2005 01:12	18780	-5	+15	Reduced
09-OCT-2005 21:30	18878	-5	+20	Reduced
12-MAR-2006 17:29	21080	+10	+35	Reduced
09-APR-2006 12:47	21480	+5	+30	Reduced
16-APR-2006 15:48	21580	0	+25	Reduced
30-APR-2006 15:08	21780	-5	+20	Reduced
07-MAY-2006 14:48	21880	0	+25	Reduced
14-MAY-2006 14:28	21980	+15	+40	Reduced
28-MAY-2006 13:47	22180	+20	+45	Reduced
04-JUN-2006 13:27	22280	+15	+40	Reduced
18-JUN-2006 12:47	22480	+20	+45	Reduced
25-JUN-2006 12:27	22580	0	+25	Reduced
02-JUL-2006 12:07	22680	-5	+20	Reduced
16-JUL-2006 11:27	22880	0	+25	Reduced
23-JUL-2006 11:07	22980	+10	+35	Reduced
06-AUG-2006 10:26	23180	0	+25	Reduced
27-AUG-2006 09:26	23480	+5	+30	Reduced
03-SEP-2006 09:06	23580	0	+25	Reduced
10-SEP-2006 08:46	23680	-5	+20	Reduced
01-OCT-2006 07:45	23980	+5	+30	Reduced
15-OCT-2006 07:05	24180	-5	+20	Reduced
22-OCT-2006 06:45	24280	0	+25	Reduced
29-OCT-2006 06:25	24380	-5	+20	Reduced
05-NOV-2006 06.05	24480	10	+35	Reduced
12-NOV-2006 05.45	24580	5	+30	Reduced
03-DEC-2006 04.44	24880	20	+45	Reduced
10-DEC-2006 04.24	24980	10	+35	Reduced
17-DEC-2006 20.50	25090	0	+25	Reduced
24-DEC-2006 03.44	25180	5	+30	Reduced
07-JAN-2007 03.04	25380	0	+25	Reduced
14-JAN-2007 02.44	25480	-5	+20	Reduced
21-JAN-2007 02.23	25580	0	+25	Reduced
28-JAN-2007 02.03	25680	-5	+20	Reduced
04-FEB-2007 01.43	25780	-10	+15	Reduced
11-FEB-2007 01.23	25880	-5	+20	Reduced
18-FEB-2007 01.03	25980	0	+25	Reduced
25-FEB-2007 00.43	26080	+5	+30	Reduced
04-MAR-2007 00.23	26180	+15	+40	Reduced
11-MAR-2007 00.03	26280	+20	+45	Reduced
24-MAR-2007 23.22	26480	0	+45	Reduced
31-MAR-2007 23.02	26580	+5	+30	Reduced
07-APR-2007 22.42	26680	+10	+35	Reduced
14-APR-2007 22.22	26780	+5	+30	Reduced

21-APR-2007 22.02	26880	0	+25	Reduced
28-APR-2007 21.42	26980	-5	+20	Reduced
12-MAY-2007 21.02	27180	20	+45	Reduced
19-MAY-2007 20.41	27280	+10	+35	Reduced
09-JUN-2007 19.41	27580	+15	+40	Reduced
16-JUN-2007 19.21	27680	-5	+20	Reduced
23-JUN-2007 19.01	27780	0	+25	Reduced
07-JUL-2007 18.21	27980	-5	+20	Reduced
04-AUG-2007 17:00	28380	0	+25	Reduced
11-AUG-2007 16.40	28480	5	+30	Reduced
18-AUG-2007 16.20	28580	0	+25	Reduced
26-AUG-2007 16.00	28680	10	+35	Reduced
04-SEP-2007 04.01	28816	+65	+90	Reduced: SATU-Y test
05-SEP-2007 06.51	28832	+10	+35	Reduced
08-SEP-2007 15.19	28880	+15	+40	Reduced
15-SEP-2007 14.59	28980	+20	+45	Reduced
22-SEP-2007 14.39	29080	-5	+15	Reduced
29-SEP-2007 14.19	29180	+5	+30	Reduced
13-OCT-2007 13.39	29378	10	+35	Reduced
20-OCT-2007 13.19	29480	0	+30	Reduced
24-OCT-2007 01.09	29530	0	+25	Reduced
27-OCT-2007 12.59	29580	10	+35	Reduced
10-NOV-2007 12.18	29780	-5	+20	Reduced
17-NOV-2007 11.58	29880	0	+25	Reduced
24-NOV-2007 11.38	29980	+5	+30	Reduced
01-DEC-2007 11.18	30080	+15	+40	Reduced
08-DEC-2007 10.58	30180	+10	+35	Reduced
11-DEC-2007 22.48	30230	+5	+35	Reduced
15-DEC-2007 10.38	30280	+5	+30	Reduced
22-DEC-2007 10.18	30380	0	+25	Reduced
05-JAN-2008 09.37	30580	-1	+24	Reduced
12-JAN-2008 09.17	30680	-2	+23	Reduced
19-JAN-2008 08.57	30780	-7	+18	Reduced
26-JAN-2008 08.37	30880	-2	+23	Reduced
02-FEB-2008 08.17	30980	-6	+24	Reduced
16-FEB-2008 07.37	31180	-8	+22	Reduced
23-FEB-2008 07.17	31280	-2	+28	Reduced
01-MAR-2008 06.56	31380	+5	+35	Reduced
08-MAR-2008 06:36	31480	+13	+43	Reduced
15-MAR-2008 06:16	31580	+10	+40	Reduced
22-MAR-2008 16:00	31686	+14	+44	Reduced
29-MAR-2008 05:36	31780	-1	+29	Reduced
05-APR-2008 05:16	31880	-8	+22	Reduced
12-APR-2008 04:56	31980	-4	+26	Reduced
19-APR-2008 04:36	32080	-10	+20	Reduced
03-MAY-2008 03:55	32280	-5	+25	Reduced
10-MAY-2008 03:35	32380	-6	+24	Reduced
17-MAY-2008 03:15	32480	+9	+39	Reduced
24-MAY-2008 02:55	32580	+14	+44	Reduced
31-MAY-2008 12:39	32686	+16	+46	Reduced
07-JUN-2008 02:15	32780	+18	+48	Reduced
14-JUN-2008 01.55	32880	+5	+35	Reduced
21-JUN-2008 01.35	32980	+6	+36	Reduced
28-JUN-2008 01.14	33080	-2	+28	Reduced
05-JUL-2008 00.54	33180	-10	+20	Reduced
19-JUL-2008 00.14	33380	0	+30	Reduced



25-JUL-2008 23.54	33480	+5	+35	Reduced
01-AUG-2008 23.34	33580	-1	+29	Reduced
08-AUG-2008 23.14	33680	-3	+27	Reduced
15-AUG-2008 22.54	33780	+12	+42	Reduced
23-AUG-2008 08.37	33886	+5	+35	Reduced
29-AUG-2008 22.13	33980	+4	+34	Reduced
05 -SEP- 2008 21.53	34080	+6	+36	Reduced
12 -SEP- 2008 21.33	34180	+15	+45	Reduced
27 -SEP- 2008 06.56	34386	+4	+34	Reduced
03-OCT-2008 20.33	34480	+7	+37	Reduced
10-OCT-2008 20.13	34580	+4	+34	Reduced
17-OCT-2008 19.53	34680	+2	+32	Reduced
01-NOV-2008 05.16	34886	+3	+33	Reduced
07-NOV-2008 18.52	34980	+5	+35	Reduced
14-NOV-2008 18.32	35080	+40	+70	Reduced
28-NOV-2008 17.52	35280	+25	+55	Reduced
06-DEC-2008 03.35	35686	+17	+47	Reduced
12-DEC-2008 17.12	35480	+14	+44	Reduced
19-DEC-2008 16.51	35580	+10	+40	Reduced
26-DEC-2008 16.31	35680	+6	+36	Reduced
02-JAN-2009 16.11	35780	+3	+33	Reduced
10-JAN-2009 01.55	35886	+4	+34	Reduced
16-JAN-2009 15.31	35980	+2	+32	Reduced
12-FEB-2009 04.39	36360	+3	+23	Testing
12-FEB-2009 08.00	36362	+20	+40	Testing
12-FEB-2009 11.21	36364	+35	+55	Testing
12-FEB-2009 14.42	36366	+50	+70	Testing
12-FEB-2009 18.03	36368	+65	+85	Testing
02-MAR-2009 15.17	36624	+10	+20	Testing
02-MAR-2009 21.59	36628	+20	+30	Testing
03-MAR-2009 04.41	36632	+30	+40	Testing
03-MAR-2009 11.24	36636	+40	+50	Testing
03-MAR-2009 18.06	36640	+30	+50	Reduced
19 -JUN- 2009 08.08	38180	+25	+50	Testing
21 -JUN- 2009 10.26	38210	+15	+40	Testing
23 -JUN- 2009 12.44	38240	+5	+30	Testing
25 -JUN- 2009 15.02	38270	+20	+45	Testing
26 -JUN- 2009 07.48	38280	+30	+50	Reduced
17-JUL-2009 06.48	38580	+25	+50	Reduced
30-OCT-2009 01:46	40080	+20	+50	Reduced
06-NOV-2009 01:26	40180	+15	+45	Reduced
27-NOV-2009 00.26	40480	+23	+53	Reduced
04-DEC-2009 00.05	40580	+20	+50	Reduced
10-DEC-2009 23.45	40680	+15	+45	Reduced
07-JAN-2010 22.25	41080	+10	+40	Reduced
14-JAN-2010 22:05	41180	+5	+35	Reduced (but ESOC removed stars below 15° in azimuth between 13-25 February 2010)
25-FEB-2010 20:04	41780	+15	+45	Reduced
11-MAR-2010 19:24	41980	+16	+46	Reduced
25-MAR-2010 18:44	42180	+15	+45	Reduced
29-APR-2010 13:42	42680	+23	+53	Reduced
06-MAY-2010 16:43	42780	+15	+44	Reduced
13-MAY-2010 16:23	42880	+19	+49	Reduced
20-MAY-2010 16:03	42980	+15	+40	Reduced
27-MAY-2010 15:42	43080	+15	+44	Reduced
03-JUN-2010 15:22	43180	+17	+47	Reduced

10-JUN-2010 15:02	43280	+18	+48	Reduced
17-JUN-2010 14:42	43380	+15	+45	Reduced
24-JUN-2010 14:22	43480	+18	+48	Reduced
01-JUL-2010 14:02	43580	+30	+60	Reduced
08-JUL-2010 13:42	43680	+15	+45	Reduced
15-JUL-2010 13:22	43780	+17	+47	Reduced
22-JUL-2010 13:02	43880	+15	+45	Reduced
05-AUG-2010 12:21	44080	+17	+47	Reduced
12-AUG-2010 12:21	44180	+15	+45	Reduced
02-SEP-2010 12:21	44480	+17	+47	Reduced
09-SEP-2010 10:41	44580	+42	+72	Reduced
16-SEP-2010 10:21	44680	+15	+45	Reduced
23-SEP-2010 10:01	44780	+18	+48	Reduced
30-SEP-2010 9:40	44880	+20	+50	Reduced
07-OCT-2010 09:21	44980	+23	+53	Reduced
14-OCT-2010 09:01	45080	+22	+52	Reduced
26-NOV-2010 23:38	45706	+20	+50	Reduced
04-DEC-2010 10:23	45813	+16	+46	Reduced
11-DEC-2010 22:48	45921	+15	+45	Reduced
24-FEB-2011 21:58	46998	+19	+49	Reduced
04-MAR-2011 10:23	47106	+15	+45	Reduced
11-MAR-2011 22:48	47214	+16	+46	Reduced
26-MAR-2011 21:58	47429	+15	+45	Reduced
03-APR-2011 10:22	47429	+18	+48	Reduced
10-APR-2011 22:48	47645	+22	+52	Reduced
18-APR-2011 09:32	47452	+25	+55	Reduced
25-APR-2011 21:58	47860	+23	+53	Reduced
03-MAY-2011 10:23	47968	+17	+47	Reduced
10-MAY-2011 22:48	48076	+16	+46	Reduced
18-May-2011 11:13	48184	+22	+52	Reduced
25-MAY-2011 23:38	48292	+15	+45	Reduced
02-JUN-2011 12:03	48400	+17	+47	Reduced
09-JUN-2011 21:07	48506	+18	+48	Reduced
17-JUN-2011 09:33	48614	+19	+49	Reduced
24-JUN-2011 18:37	48720	+18	+48	Reduced
02-JUL-2011 07:02	48828	+15	+45	Reduced
17-JUL-2011 11:13	49046	+17	+47	Reduced
24-JUL-2011 23:38	49154	+15	+45	Reduced
01-AUG-2011 12:03	49262	+16	+46	Reduced
16-AUG-2011 11:13	49477	+15	+45	Reduced
31-AUG-2011 07:02	49690	+18	+48	Reduced
07-SEP-2011 22:48	49800	+15	+45	Reduced
30-SEP-2011 08:42:26	50122	+21	+51	Reduced
07-OCT-2011 21:07:29	50222	+15	+45	Reduced
22-OCT-2011 18:37:08	50446	+16	+46	Reduced
23-OCT-2011 09:39:13	50453	+40	+55	Reduced
06-NOV-2011 22:47:43	50662	+47	+55	Reduced

#### 4.1.2 CURRENT OPERATIONS AND CONFIGURATION

A reduced azimuth field of view [+47, +55], tested during GOMOS anomalies investigations carried out in October 2011, has been scheduled starting from the 6th of November 2011.

The instrument is working with a “soft” patch uploaded for tracking controller tuning (since 29<sup>th</sup> October 2009) and rallying filter gain set to 3.8 (since 12<sup>th</sup> February 2010).

The planned GOMOS operations for the reporting period are identified in Table 4.1-2. The main operation scenario of GOMOS since 29<sup>th</sup> August 2005 until end of reporting month consists of:

- **Planning 2 orbits per sequence** (nominal were 5): this is done because in case of a VCCS failure with subsequent loss of star observation, the maximum loss of consecutive observations cannot exceed two orbits.
- **Reduced azimuth field of view** (nominal was [-10°, +90°]): as the VCCS anomaly occurs during the rallying of the telescope in the preparation for the star observation, it has been decided to reduce the field of view in order to minimize the failure occurrence probability. Different ranges have been used (Table 4.1-1) in order to optimize the number of occultations per orbit.

**Table 4.1-2: GOMOS planned operations. The planning is built on a 2-orbit sequence basis (2 orbits with the same stars)**

UTC Start	Start Orbit	Stop Orbit	Mode (Asynchronous or Synchronous)	Calibration (CAL) Dark Sky Area (DSA) or Nominal (Nom)
30-SEP-2011 08:42:26	50122	50123	A	Nom
30-SEP-2011 12:02:53	50124	50229	S	Nom
07-OCT-2011 21:07:29	50230	50231	A	Nom
08-OCT--2011 00:27:57	50232	50337	S	Nom
15-OCT-2011 09:32:33	50338	50339	A	Nom
15-OCT-2011 12:53:00	50340	50451	S	Nom
23-OCT-2011 09:39:13	50453	50453	A	Nom
23-OCT-2011 11:19:27	50454	50551	S	Nom
30-OCT-2011 07:02:12	50552	50553	A	Nom
30-OCT-2011 10:22:39	50554	50659	S	Nom

There was no new Configuration Table Interface (CTI) uploaded to the instrument. The files used since the beginning of the mission are in Table 4.1-3. The yellow ones are the current ones in use.

**Table 4.1-3: Historic CTI Tables**

CTI filename		Dissemination to FOCC
SMP	CTI_SMP_GMVIEC20030716_123904_00000000_00000004_20030715_000000_20781231_235959.N1	16-JUL-2003
	CTI_SMP_GMVIEC20021104_075734_00000000_00000003_20021002_000000_20781231_235959.N1	06-NOV-2002
	CTI_SMP_GMVIEC20021002_082339_00000000_00000002_20021002_000000_20781231_235959.N1	07-OCT-2002
	CTI_SMP_GMVIEC20020207_154455_00000000_00000000_20020301_032709_20781231_235959.N1	21-FEB-2002
STP	CTI_STP_GMTIEC20021104_080137_00000000_00000000_20021002_000000_20781231_235959.N1	04-NOV-2002
	CTI_STP_GMVIEC20021002_083222_00000000_00000000_20021002_000000_20781231_235959.N1	02-OCT-2002

## 4.2 Limb, Illumination conditions and instrument gain setting

The **limb** and the **illumination condition** are two parameters that can confuse the user community. In Table 4.2-1 there are specified the product parameter (level 1b and level 2 of processor GOMOS/4.02 operational until 8<sup>th</sup> August 2006) where the flag is located, the meaning and the source. The difference between the limb (SPH/bright\_limb) and the illumination condition (SUMMARY\_QUALITY/limb\_flag) is that the first one is coming from the mission scenario and the second is coming from the processing (defined from the computation of the sun zenith and azimuth

angles at both instrument and tangent point locations). The SPH/bright\_limb is for some occultations set to “dark” in the mission scenario while they are in fact in bright limb illumination conditions. To select the highest quality data for scientific applications, data with SUMMARY\_QUALITY/limb\_flag equal to ‘0’ should be used (see also the disclaimer: <http://envisat.esa.int/dataproducts/availability/disclaimers>). The instrument gain settings are also specified in Table 4.2-1 (they depend on the mission scenario flags) just for completeness of information. The same is valid for the prototype version GOPR\_6.0a\_6.0a and following ones (including the one that was used for the second reprocessing of 2002-2005 years), where the limb is in fields SPH/bright\_limb and SUMMARY\_QUALITY/dark\_bright\_limb and the illumination condition is in field SUMMARY\_QUALITY/obs\_ill\_cond. For these prototypes **and the processor GOMOS/6.01 in operations since 07 June 2011**, the illumination condition can have five values (see Table 4.2-1).

**Table 4.2-1: Relationship between limb, illumination condition flags and instrument gain settings (IPF version GOMOS/4.02 and previous)**

Products parameter	SPH/bright_limb	0 = Dark	1 = Bright	Coming from mission scenario
	SUMMARY_QUALITY/limb_flag	0 = Full Dark 1 = Bright 2 = Twilight	1 = Bright 2 = Twilight	In the geolocation process the sun zenith angle is computed and the occultation then is flagged accordingly
Instrument Gain	SPA Gain	3 (2)	0	Gain setting for spectrometer A. In parenthesis, values valid only for Sirius occultations (starID=1)
	SPB Gain	0	0	Gain setting for spectrometer B

**Table 4.2-2: Relationship between limb, illumination condition flags and instrument gain settings (IPF version GOMOS/5.00 and following ones; prototype version GOPR 6.0a\_6.0a and following ones)**

Products parameter	SPH/bright_limb SUMMARY_QUALITY/dark_bright_limb	0 = Dark	1 = Bright	Coming from mission scenario
	SUMMARY_QUALITY/obs_ill_cond	0 = Full Dark 1 = Bright 2 = Twilight 3 = Straylight 4 = Twi.+Stray		In the geolocation process the sun zenith angle is computed and the occultation is then flagged accordingly
Instrument Gain	SPA Gain	3 (2)	0	Gain setting for spectrometer A. In parenthesis, values valid only for Sirius occultations (starID=1)
	SPB Gain	0	0	Gain setting for spectrometer B

### 4.3 Thermal Performance

Since the beginning of the mission, the hot pixel and RTS phenomena have been producing a continuous increase of the dark charge signal within the CCD detectors (see section 0). In order to minimize this effect, in the past three successive CCD cool down were performed in orbits 800 (25<sup>th</sup> April 2002), 1050 (13<sup>th</sup> May 2002) and 2780 (11<sup>th</sup> September 2002) with a total decrease in temperature of 14 degrees. During July 2011 the temperatures were increased for some time periods in view of obtaining an annealing effect (decrease of hot pixels causing dark charge).

Figure 4.3-1 and Figure 4.3-2 display, respectively, the overall temperature variation and the temperature variation around the Ascending Node Crossing (ANX) time with a resolution of 0.4 degrees (coding accuracy for level 0 data).

Normally CCD temperatures show the expected global increase due to the radiator ageing. Another expected variation of the temperatures, the seasonal one, can be also observed: at the beginning of mission the amplitude was around 0.8 but now it is around 1.5 degrees. The peaks that occur mainly in spectrometer B1 and B2 are also to be noted. They happen a little before the ANX for some consecutive orbits and every 8-10 days. Their origin is not known, as we did not find any correlation between these peaks and other activities carried out by other ENVISAT instruments.

The CCD temperature at almost the same latitude location (Figure 4.3-2) is monitored in order to detect any inter-orbital temperature variation. The abnormal decreases observed sometimes in all detectors are after GOMOS switch off periods, when the instrument did not have enough time to reach the nominal temperature before starting the measurements.

During the reporting period, the orbital temperature variation of the detector SPB2 for ascending and descending passes (Figure 4.3-3 and Figure 4.3-4) is non-nominal (~ 6 degrees) due to the many GOMOS switch off periods. The stability of the temperature during the orbit is important because it affects the position of the interference patterns. The phenomenon of the interference is present mainly in SPB and the Pixel Response Non-Uniformity (PRNU) and the lately discovered intra Pixel Response Non-Uniformity (iPRNU) are corrected during the processing (the iPRNU is corrected since the switch to version GOMOS/6.01)

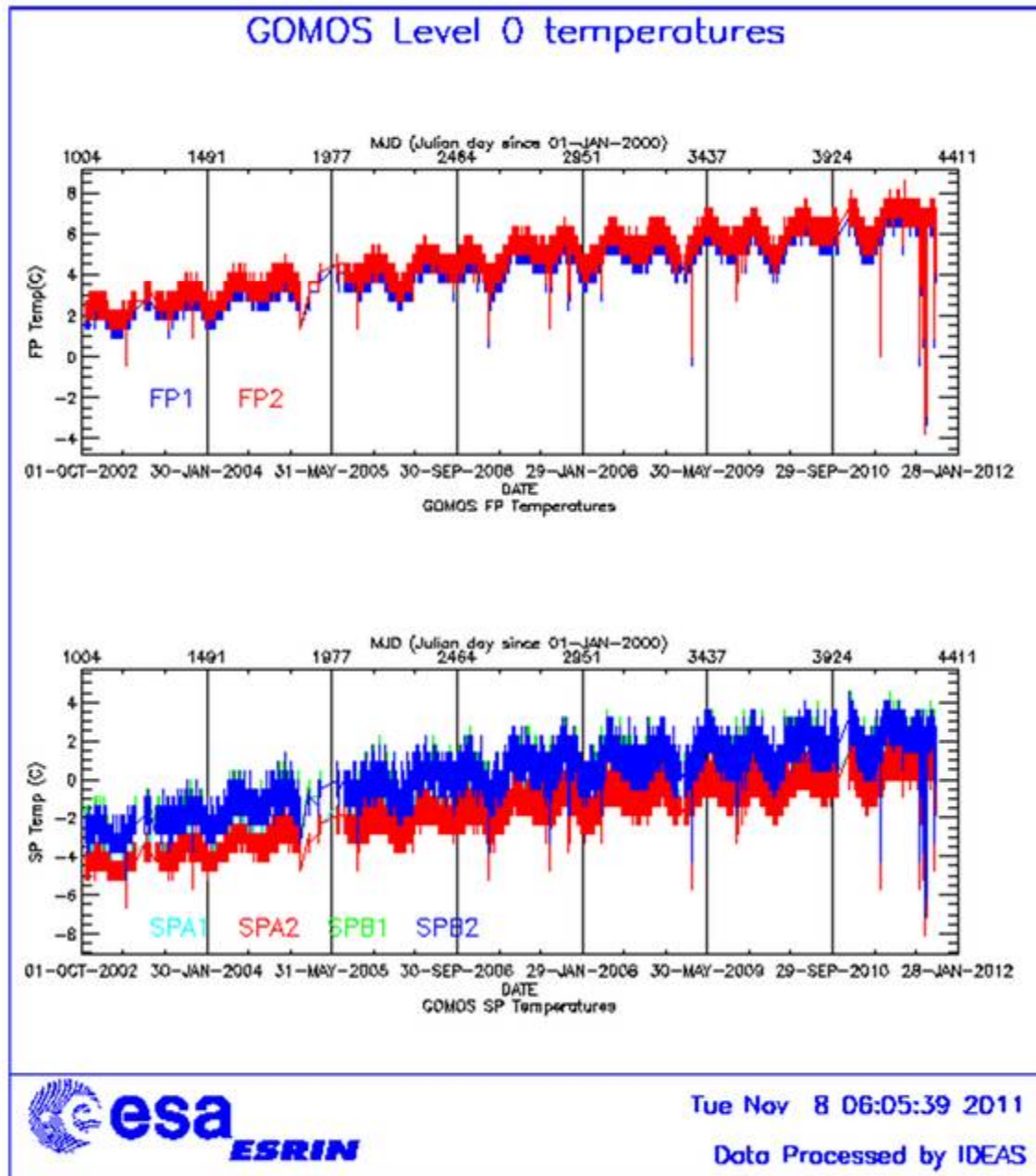


Figure 4.3-1: Level 0 temperature evolution of all GOMOS CCD detectors since October 2002 until the end of the reporting period

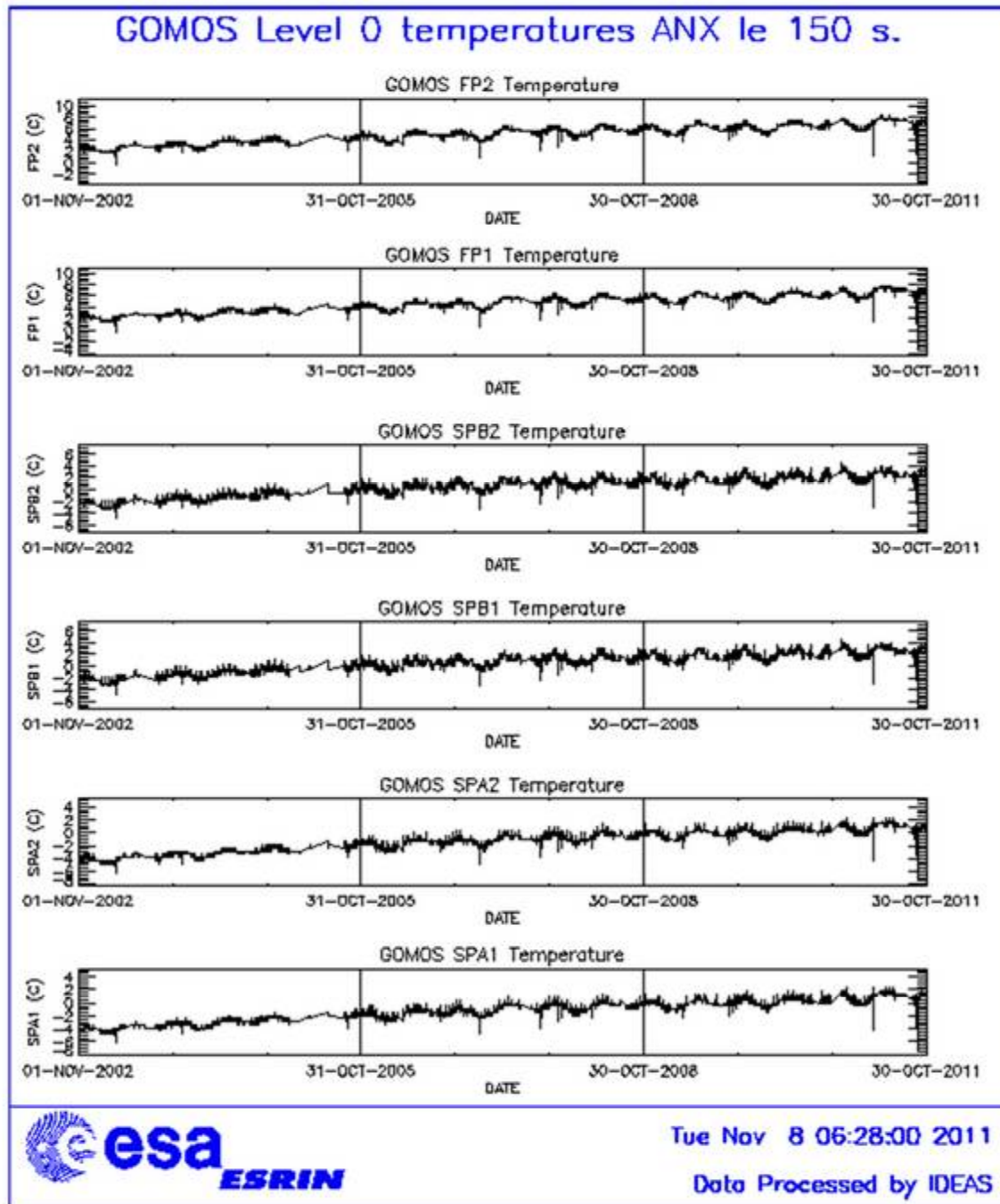


Figure 4.3-2: Level 0 temperature evolution of all GOMOS CCD detectors around ANX since November 2002 until the end of the reporting period

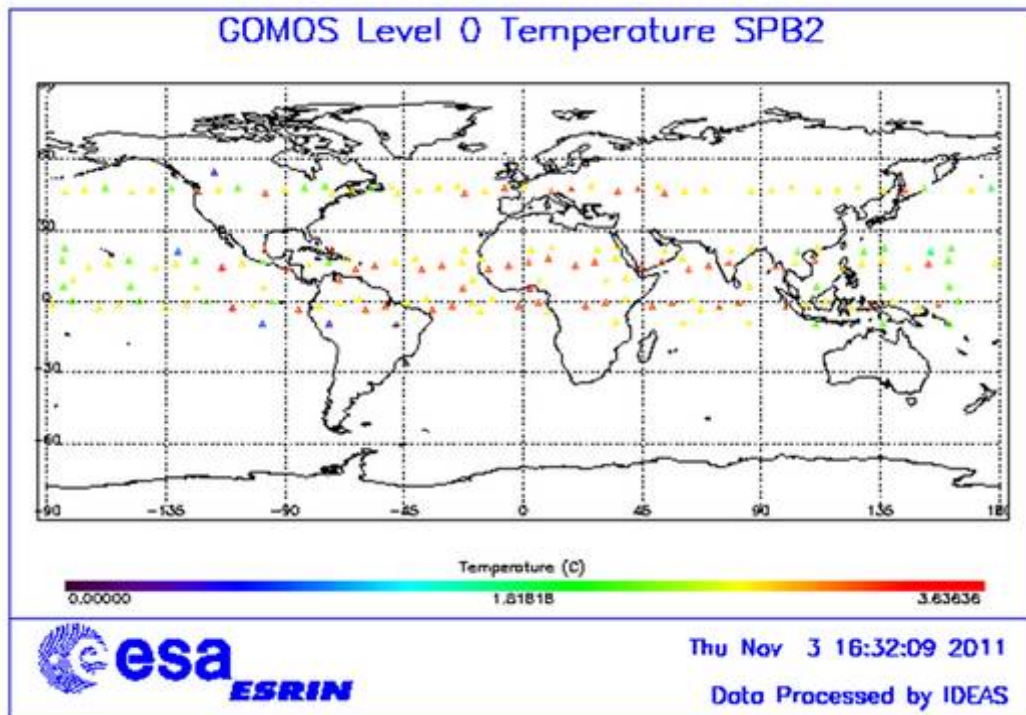


Figure 4.3-3: Ascending orbital variation of SPB2 temperature during reporting period

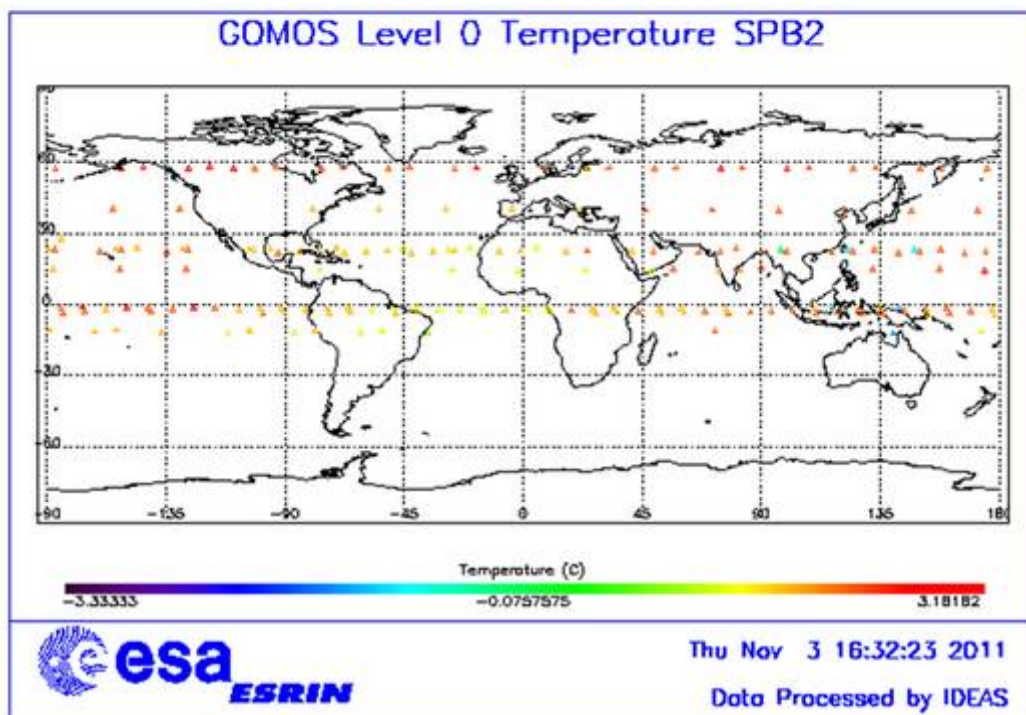


Figure 4.3-4: Descending orbital variation of SPB2 temperature during reporting period



### 4.4 Optomechanical Performance

- Version GOMOS/4.00 and previous ones: in the GOMOS processor versions GOMOS/4.00 and previous ones, the spectra are expected to be aligned along CCD lines, and therefore use only a single average line index per CCD. In Table 4.4-1, the mean values of the location of the star signal for all the calibration analysis done is reported. The ‘left’ and ‘right’ values are calculated (the whole interval is not used) because the spectra shows a slight slope, more pronounced in spectrometer B. In Table 4.4-2, mean values of the location of the star signal are calculated for some specific wavelength intervals. These intervals have been changed between the calibration performed in September 2002 and the ones performed afterwards (until November 2003). Table 4.4-3 reports the average location of the star spot on the photometer 1 and 2 CCD.
- Version GOMOS/4.02: in this processor version operational since 23<sup>rd</sup> March 2004 until 8<sup>th</sup> August 2006, a Look Up Table (LUT) gives the line index of the spectra location as a function of the wavelength. The values obtained during calibration exercises are shown in Table 4.4-4. These values should be similar to the ones of the LUT; otherwise the LUT should be updated. However this characterization curve is not exactly the location of the star spectrum on the CCD but rather a combination of this position and some artefact created by the shape of the instrument optical point spread function (PSF). The exact shape is actually a straight line (especially for SPB) that has been characterised in 2005.
- Version GOMOS/5.00 (8<sup>th</sup> August 2006) and following ones: the exact shape of the CCD spectra location curve (which is a straight line) that has been characterised in 2005 was implemented in the set of GOMOS ADFs valid at that time. The position of the spectra convoluted with the PSF is calculated during the processing.
- Version GOMOS/6.01: The algorithm and the LUT for the star spectra location on the CCD have been updated.

**Table 4.4-1: Mean value of the location of the star signal during the occultation at the edges of every band (mean over 50 values, filtering the outliers)**

	UV (SPA1) left/right	VIS (SPA2) left/right (Inverted spectra)	IR1 (SPB1) left/right	IR2 (SPB2) left/right
11/09/2002	80.7/80.7	79.8/79.5	82.8/81.9	83.1/82.1
01/01/2003	80.7/80.6	79.8/79.5	82.8/82.0	83.2/82.2
17/07/2003 & 02/08/2003	80.7/80.7	79.8/79.5	82.8/81.9	83.1/82.1
08/11/2003	80.7/80.6	79.8/79.5	82.8/81.9	83.1/82.1

**Table 4.4-2: Mean value of the location of the star signal during the occultation (as table 4.4-1) but now within some wavelength intervals**

	UV (SPA1)	VIS (SPA2)	IR1 (SPB1)	IR2 (SPB2)
11/09/2002 wl range (nm)	80.8 [300-330]	79.8 [500-530]	82.6 [760-765]	82.9 [937-942]
01/01/2003 wl range (nm)	80.6 [350-360]	78.6 [650-670]	81.6 [760-765]	80.3 [935-945]
02/08/2003	80.6	79.7	82.5	82.8
08/11/2003	80.6	79.9	82.4	82.8

**Table 4.4-3: Average column and row pixel location of the star spot on the photometer CCD during the occultation**

	FP1 (column/row)	FP2 (column/row)
11/09/2002	11/4	5/5
01/01/2003	10/4	6/4.9

02/08/2003	10/4	6/5
08/11/2003	10/4	6/5

Table 4.4-4: Location of the star signal on the CCD's

Pixel Column	LUT (Pixel line)	Calibration on 10-APR-2004	Calibration on 04-DEC-2004	Calibration on 27-NOV-2005	Calibration on 19-FEB-2006	Calibration on 14-MAY-2006 and 11-JUN-2006
0	80.59	80.80	80.67	80.93	80.67	80.85
20	80.46	80.60	80.44	80.32	80.43	80.49
449	80.42	80.50	80.42	80.40	80.53	80.56
450	79.25	79.39	79.30	79.16	79.30	79.35
900	79.50	79.63	79.57	79.36	79.45	79.61
1415	79.70	79.76	79.76	80.00	79.81	79.93
1416	82.64	82.80	82.88	82.95	82.76	82.81
1500	82.31	82.60	82.66	82.63	82.58	82.55
1600	82.12	82.22	82.30	82.35	82.41	82.20
1700	81.97	82.04	82.08	82.09	82.05	82.06
1750	81.89	81.98	82.03	82.00	81.92	81.97
1800	81.78	81.91	81.96	81.93	81.83	81.98
1835	81.68	81.88	81.94	81.96	81.79	81.91
1836	82.98	83.10	83.10	83.27	83.17	83.08
2000	82.78	82.90	82.94	83.04	82.83	82.93
2100	82.33	82.70	82.73	82.82	82.83	82.67
2150	82.17	82.40	82.54	82.79	82.70	82.49
2350	81.83	82.00	82.00	82.68	81.96	82.11

## 4.5 Electronic Performance

### 4.5.1 DARK CHARGE EVOLUTION AND TREND

The trend of Dark Charge (DC) is of crucial importance for the final quality of the products, and is therefore subject to intense monitoring. As part of the DC there is:

- “Hot pixels”, a pixel is “hot” when its dark charge exceeds its value measured on ground, at the same temperature, by a significant amount.
- RTS phenomenon (Random Telegraphic Signal), it is an abrupt change (positive or negative) of the CCD pixel signal, random in time, affecting only the DC part of the signal and not the photon generated signal.

The temperature dependence of the DC would make this parameter a good indicator of the DC behaviour, but the hot pixels and the RTS are producing a continuous increase of the DC (independently of the temperature). In order to reduce the dark charge caused by hot pixels two annealing periods have been performed in August 2011. Following the annealing an overall dark charge reduction of 8-10 % has been estimated, therefore it has been considered as successful. In order to correct for the above two phenomena (hot pixels and RTS), since version GOMOS/4.00 (the current one is GOMOS/6.01) a DC map per orbit is extracted from a Dark Sky Area (DSA) observation performed around ANX (full dark conditions). For every level 1b product (occultation), the actual thermistor temperature of the CCD is used to convert the DC map measured around ANX into an estimate of the DC at the time (and different temperature) of the actual occultation. When the DSA observation is not available, the DC map inside the calibration product that was measured at a given thermistor reference temperature is used; again, the

actual thermistor temperature of the CCD is used to compute the actual map. Table 4.5-1 reports the list of products that used the DC maps inside the calibration file due to the non-availability of DSA observation. A “CAL DC map with no T dep.” means that, as the temperature information was not available for that occultation, the DC map used is exactly the one inside the Calibration product.

The “quality ranking” of the products depending on DC correction performed is as follows:

- Best quality: products with DC correction using DSA observation inside the orbit
- Less quality than previous ones: products with DC correction using the map inside the calibration product, thermal corrected (‘DC map used’ in Table 4.5-1)
- Less quality than previous ones: products with DC correction using the map inside the calibration product, no thermally corrected (‘DC map with no T dep.’ in Table 4.5-1)

**Table 4.5-1: Table of level 1b products that used the Calibration DC maps instead of the DSA observation. (Complete table in APPENDIX A)**

Product name	DC information
GOM_TRA_IPNPDE20110901_010959_000000523106_00117_49700_1258.N1	DC map used
GOM_TRA_IPNPDE20111002_214039_000000433107_00144_50158_3665.N1	DC map used
GOM_TRA_IPNPDE20111002_223444_000000553107_00144_50158_3697.N1	DC map used
...	...
GOM_TRA_IPNPDE20111026_061530_000000683108_00049_50494_9489.N1	DC map used
GOM_TRA_IPNPDE20111026_062020_000000683108_00049_50494_9490.N1	DC map used
GOM_TRA_IPNPDE20111026_062858_000000623108_00049_50494_9491.N1	DC map used

The average DC inserted by the processor into the level 1b data products for the spectrometers SPA1 and SPB2 (per band: upper, central and lower) is plotted in Figure 4.5-1 and Figure 4.5-2. The abnormal decreases observed sometimes in all detectors are due to the temperature decreases that occur after GOMOS switch off periods. The same DC values are plotted in Figure 4.5-3 but for the ESRIN occultations belonging only to the reporting month: drops linked to the instrument power off during September are observed.

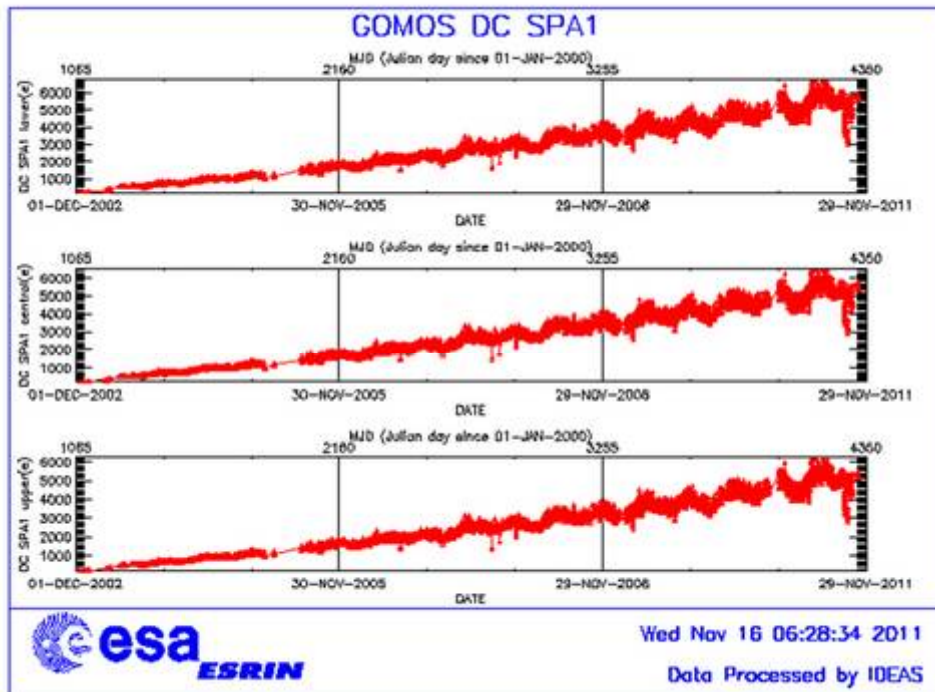


Figure 4.5-1: Mean DC evolution on SPA1 since 15<sup>th</sup> December 2002 until the end of the reporting period

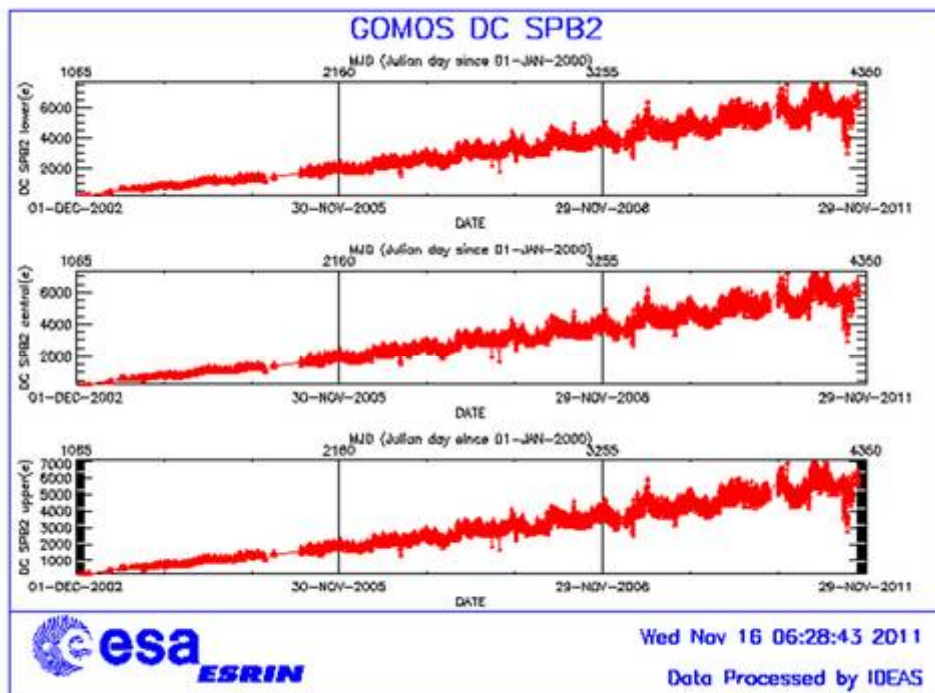


Figure 4.5-2: Mean DC evolution on SPB2 from 15<sup>th</sup> December 2002 until the end of the reporting period

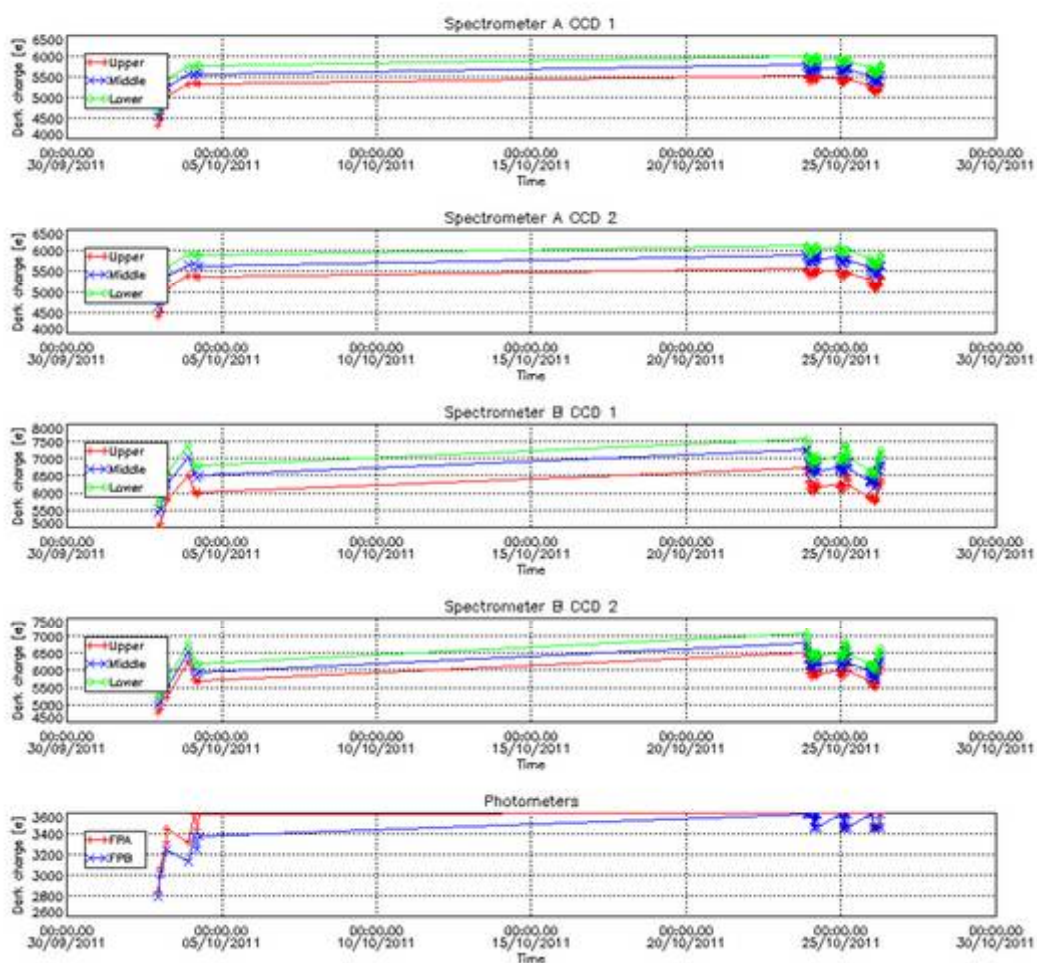


Figure 4.5-3: Mean Dark Charge of spectrometers and photometers during the reporting period

### 4.5.2 SIGNAL MODULATION

A parasitic signal was found to be systematically present, added to the useful signal, for the spectrometers A and B (Figure 4.5-4). The modulation is corrected in the data processing for spectrometers A1 and A2, for spectrometer B it has much smaller amplitude and so it is not corrected.

The values of the modulation (Figure 4.5-4) are daily extracted and plotted; they should not be very different from the ones coded into the processor: 1.40 ADU for SPA1 and 0.76 ADU for SPA2.

Figure 4.5-4 shows high values during summer time, it has been shown that the South Atlantic Anomaly is the cause of these unexpected peaks. The quality of ESRIN data, in particular over the SAA zone, is impacted but the measure of this impact is under investigation. However, in the second half of the months of October for all years (2004-2010) the peaks are smaller because the DSA zone where the data are taken for this analysis is moving towards the Northern Hemisphere. At the end of October the DSA zone is definitely chosen by the planning system in the Northern Hemisphere (to fill the criteria ‘DSA in full dark limb conditions’) and the high peaks disappear.

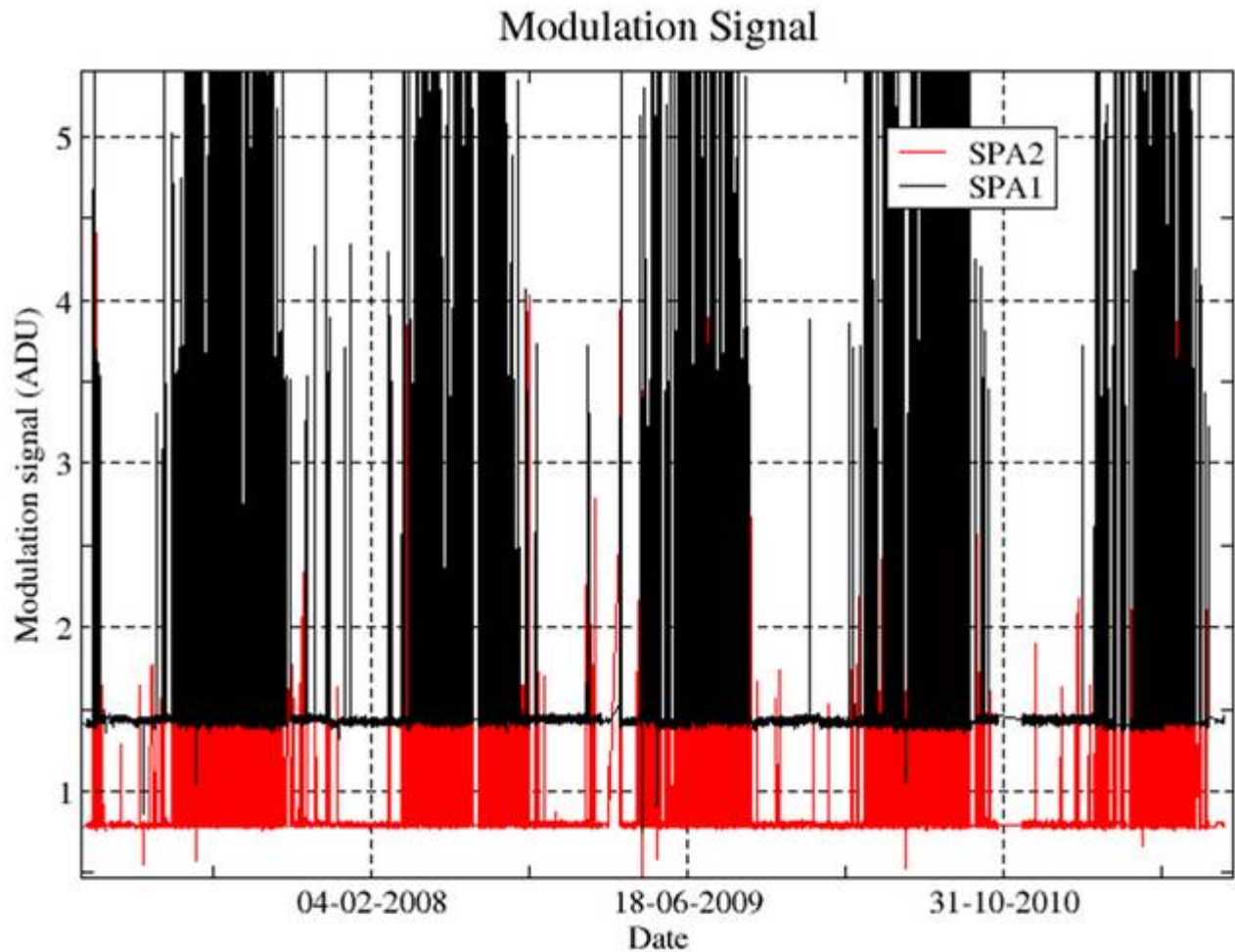
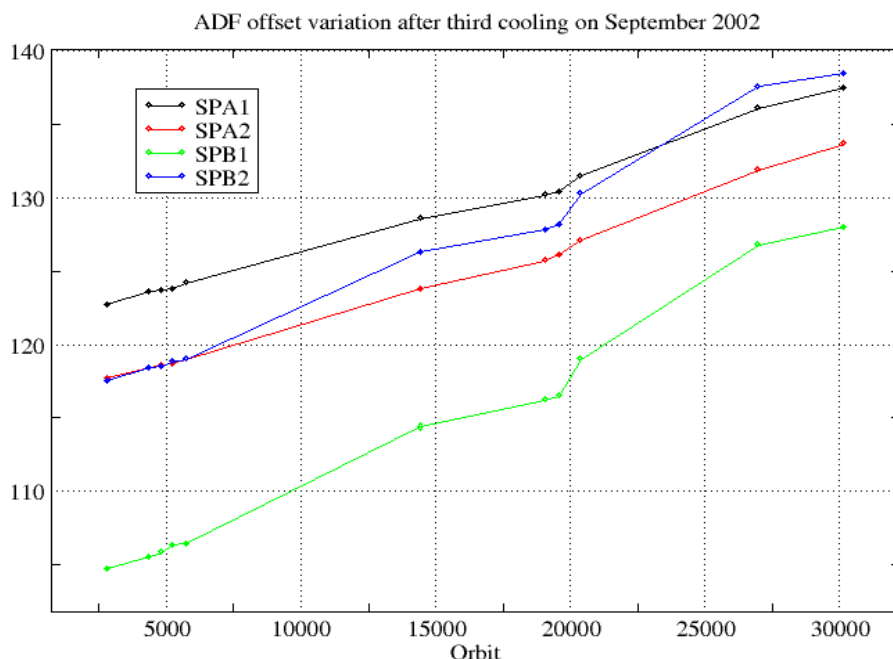


Figure 4.5-4: Modulation signal

### 4.5.3 ELECTRONIC CHAIN GAIN AND OFFSET

No new electronic chain gain and offset calibration has been done during the reporting period. The routine monitoring of the ADC offset is a good indicator of the ageing of the instrument electronics. The Figure 4.5-5 presents the evolution of the calibrated ADC offset for each spectrometer electronic chain.



**Figure 4.5-5: ADC offset evolution for each spectrometer electronic chain**

The unexpected increase of this offset seems to be due to an external contribution. In the ADC offset calibration procedure, linearity observations are used with two integration times of 0.25 and 0.50 seconds to extrapolate to an integration time of 0 seconds that gives the complete chain offset and not only the ADC offset. The complete offset contains any possible offsets, and especially the static dark charge (i.e. the dark charge that does not depend on the spectrometer integration time). The presence of vertical lines visible in the measurement maps in spatial spread monitoring mode confirms that the memory area of the CCD is affected by the generation of hot pixels. These new hot pixels are one contributor to the increase observed in Figure 4.5-5.

A current QWG task consists in completing the analysis to confirm that the offset increase is also due to the expected dark charge increase in the memory area due to ageing. This can be proved by the study of the noise due to the increased dark charge. The increase of ADC offset will be assumed to be equal to the increase of 'static dark charge' and the corresponding noise will be computed and compared to the increase of the residual of the signal variance.

If we keep the ADC offset constant, as it is also used to compute the dark charge at band level (which is used to correct the samples in the level 1b processing), the increase of the static dark charge - not taken into account in the ADC offset - is compensated by an artificial increase of the calibrated dark charge. So, the star and limb spectra are correctly corrected for dark charge. A small bias can be added to the instrument noise due to the incorrect dark charge level. Anyway, this quantity is not large enough to require a modification of the ADC offset value.

## 4.6 Acquisition, Detection and Pointing Performance

### 4.6.1 SATU NOISE EQUIVALENT ANGLE

The Star Acquisition and Tracking Unit (SATU) noise equivalent angle (SATU NEA) consists of the statistical angular variation of the SATU data above the atmosphere. The mean of the standard deviation (STD over the 50 values per measurement) above 105 km are computed for every occultation, giving two values per occultation: one in the ‘X’ direction, one in the ‘Y’ direction. A mean value per day in every direction and limb is calculated and monitored in order to assess instrument performance in terms of star pointing (Figure 4.6-1). Also monthly averages are calculated and plotted (Figure 4.6-2). The thresholds are 2 and 3 micro radians in ‘X’ and ‘Y’ directions respectively. Before May 2003, data above 90 km have been considered (instead of 105 km) but from May 2003 on, data taken in the mesospheric oxygen layer (located around 100 km altitude) have been avoided because they could cause fluctuations on the SATU data. Also the products with errors (error flag set) are discarded from May 2003 onwards.

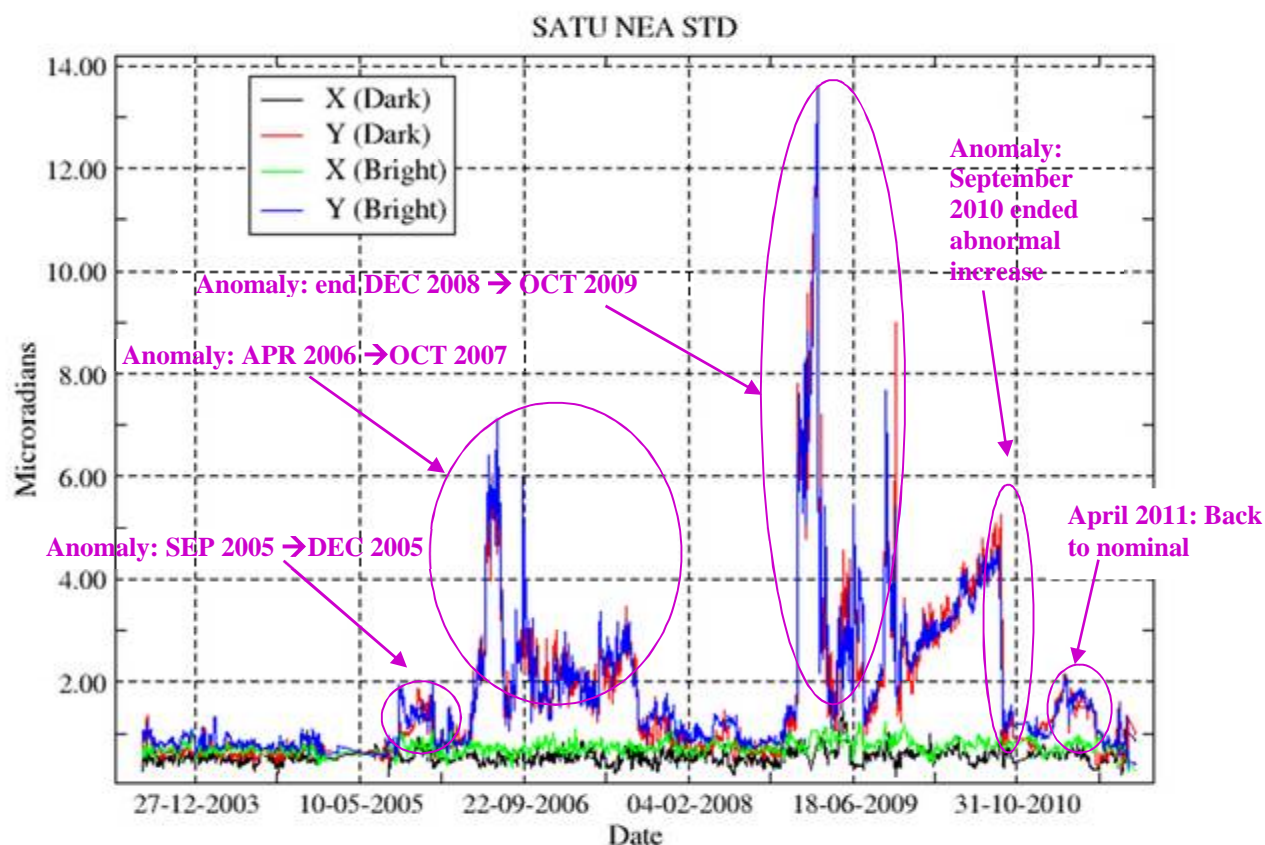


Figure 4.6-1: Average value per day of SATU NEA STD above 105 km

Different anomalies have affected the SATU during the mission:

- **Sudden increase on September 2005:** as can be seen in Figure 4.6-1, the SATU NEA had a sudden increase on 8<sup>th</sup> September 2005 mainly in ‘Y’ axis. These values remained high, fluctuating between 1 and 1.8 microrad until December 2005 when they came back to the values



they used to be before the increase of September. The reason why there was higher noise in the data causing the jump in daily SATU average is not known.

- **Gradual increase on mid April 2006:** a different problem was present since mid April 2006 until October 2007. A gradual increase of the daily SATU ‘Y’ mean was observed. This increase was due to fluctuations of the SATU ‘Y’ data observed at the beginning of nominal occultations (starting at 130 km that corresponds to an elevation angle of around  $65^{\circ}$ ). The decrease of the start elevation angle of the occultation has no impact on the amplitude of the SATU ‘Y’ fluctuations. Investigations carried out by the ESL, ESA and industry pointed to a problem on the SFM (mechanical or electrical) and not to a problem on the SATU itself. Since October 2007 the fluctuations have disappeared and as a consequence the daily SATU ‘Y’ average has come back below the threshold set to 3 micro radians.
- **Sudden increase on December 2008:** similarly to the anomaly happened on April 2006, the SATU NEA had an increase on 29<sup>th</sup> December 2008 due to fluctuations of the SATU ‘Y’ data. The difference with respect to the previous anomaly is that this time, the increase was quite sudden and the fluctuations are present during the whole occultation, not only at the beginning of the occultation. The most critical effect of this anomaly is the loss of the star measurement high in the atmosphere, which means that many times the corresponding ozone profiles do not include the ozone peak present at around 25-30 km. After the increase of the elevation filter from 100 to 150 on 29<sup>th</sup> June 2009, the abortion of the star measurements was deeper in the atmosphere but still premature. Several configurations of the filter gain (tracking and rallying ones) were tested and after some reset/restart of the instrument, GOMOS was measuring without elevation anomaly since 29<sup>th</sup> October 2009 with the “soft” patch uploaded (which represents an increase of the elevation tracking filter gain for low frequencies). The rallying gain has been changed several times (for avoiding VCCS and “Fine Stage out of range” anomalies) and since 12<sup>th</sup> February 2010 it is set to 3.8.
- **Back to nominal in September 2010:** the abnormal increasing trend of the SATU ‘Y’ NEA STD was interrupted when the instrument went back to operations with a reduced upper value of the azimuth, adopted to cure the anomalies of 9-13 September. These anomalies were caused by a mechanical coupling between GOMOS and ENVISAT which seems to have been exacerbated by a more robust SFM mirror controller implemented since October 2009.
- **Back to nominal in April 2011:** An increasing trend, similar to that observed prior to September 2010 anomaly occurred since new mission started on November 2010; such increasing trend has disappeared again at operations’ restart after the instrument unavailability of 3-5 April 2011; in the following two months a decrease has been observed yielding to nominal conditions.

The results for some occultations belonging to previous months (monthly averages) are presented in Figure 4.6-2, where the change in trends in September 2005, May 2006, December 2008 and September 2010, mainly for the ‘Y’ axis is visible.

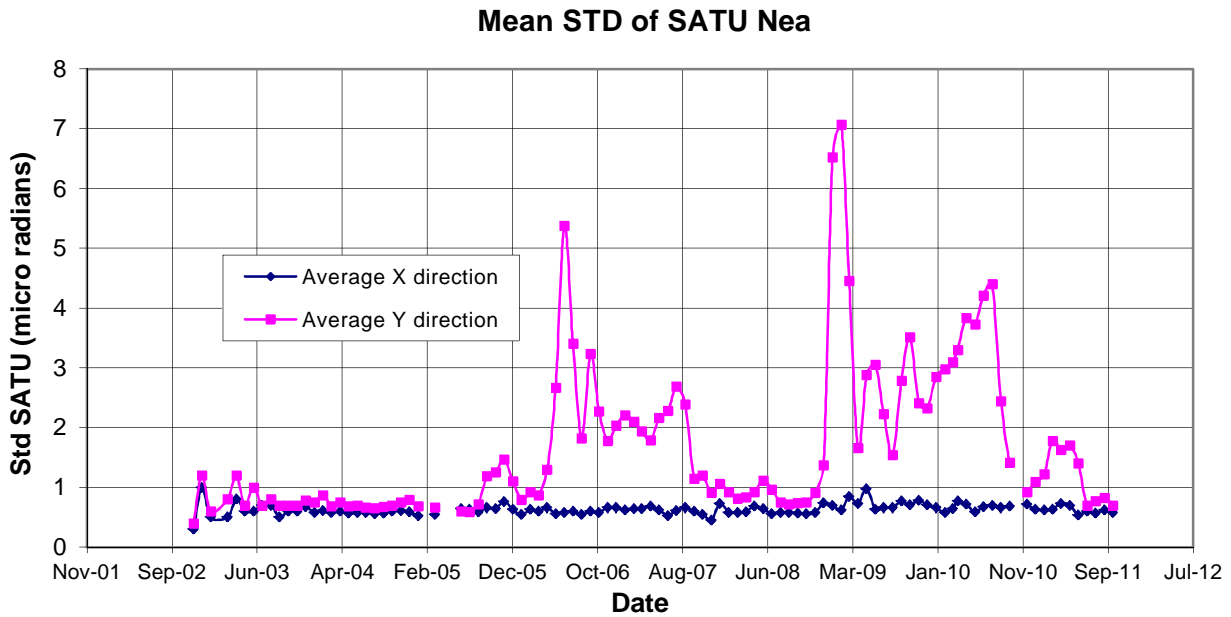


Figure 4.6-2: Average value per month of SATU NEA STD above 105 km

### 4.6.2 TRACKING LOSS INFORMATION

This verification consists of the monitoring of the tangent altitude at which the star is lost. It is an indicator of the pointing performance although it is to be considered that star tracking is also lost due to the presence of clouds and hence not only due to deficiencies in the pointing performance. Therefore, only the detection of any systematic long-term trend is the main purpose of this monitoring. The recent results are presented in Figure 4.6-3 and Figure 4.6-4:

- The dependence of the altitude at which tracking is lost on the magnitude of the star is very small because the tracking is mainly lost due to the refraction and the scintillation that depend on the atmospheric conditions.
- The azimuth of some stars could be very near to the reduced instrument azimuth edges and therefore there could be occultations planned to have a duration very small (2, 6, 10...seconds). To avoid planning this kind of useless occultation, it has been decided to set the minimum occultation duration value to 25 seconds. Figure 4.6-3 shows stars lost at altitudes higher than 20 km which corresponds with durations around 25-30 seconds.
- In bright limb it is not expected that the stars are lost at very low altitudes due to the amount of light arriving to the pointing system mainly when the refraction effects start to be important. We see from Figure 4.6-4 that there are some stars lost at altitudes around 4 km. This occurs when the pointing system is not able to point to the star anymore but, instead of finishing the occultation, it continues to track light until the planned duration is reached.
- Daily statistics are given in Figure 4.6-5 (calculated using all ESRIN products since August 2009). The high peaks in standard deviation before 25<sup>th</sup> January 2005 are due to the long lasting occultations or partial occultations (the entire occultation is included within the following orbit data). The ones during June/July/August 2005 are due to the tests performed for anomaly investigation. On 2009 the peaks are due to the elevation anomaly.
- Monthly statistics are given in Figure 4.6-6 (calculated using all ESRIN products since August 2009) where the change in trend is visible for the period of GOMOS elevation anomaly on 2009.

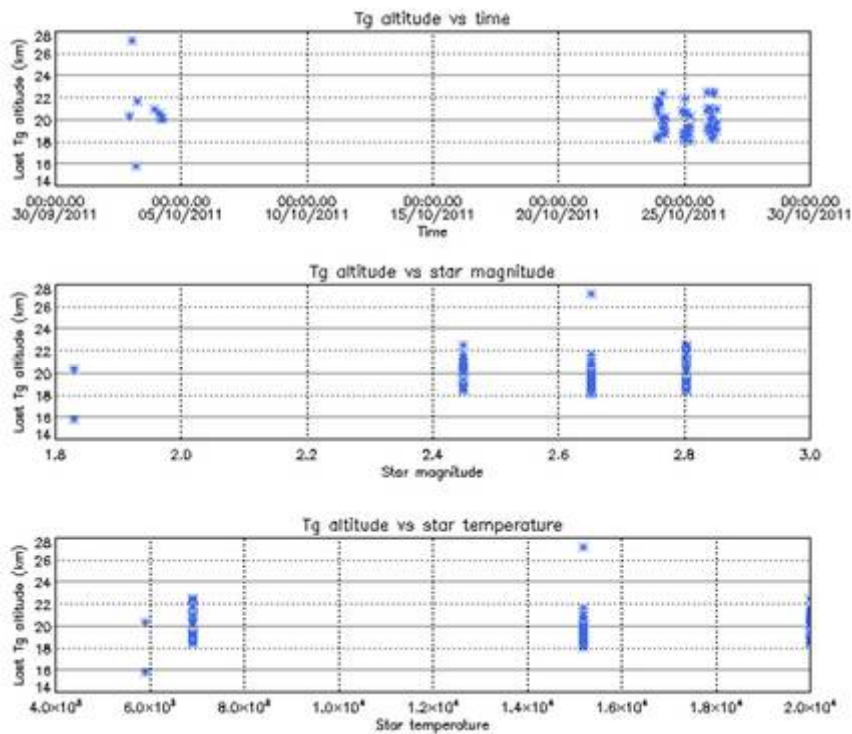


Figure 4.6-3: Last tangent altitude of the occultation (dark limb), point at which the star is lost

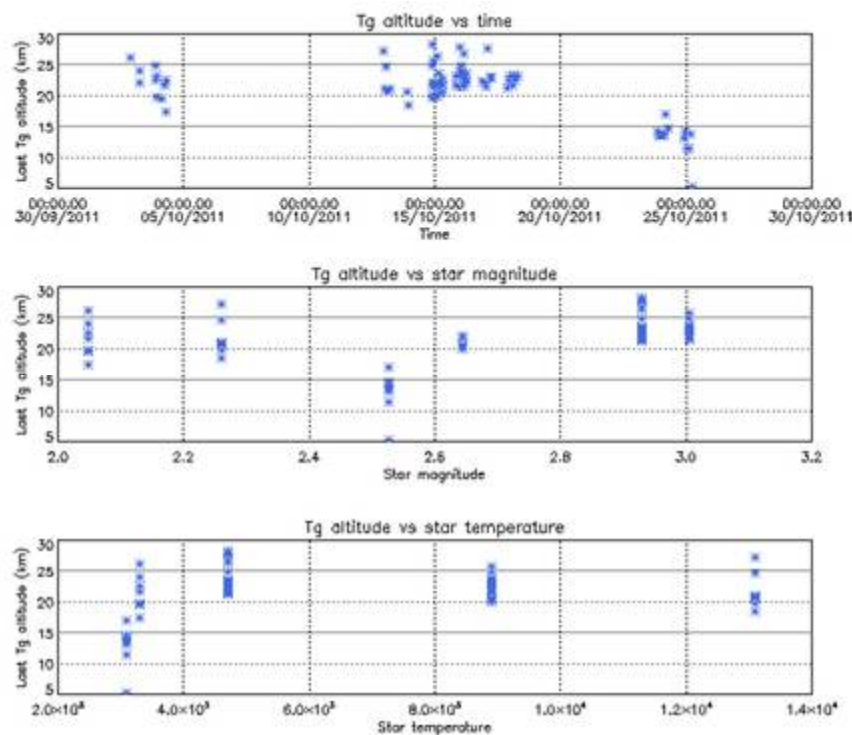


Figure 4.6-4: Last tangent altitude of the occultation (bright limb), point at which the star is lost

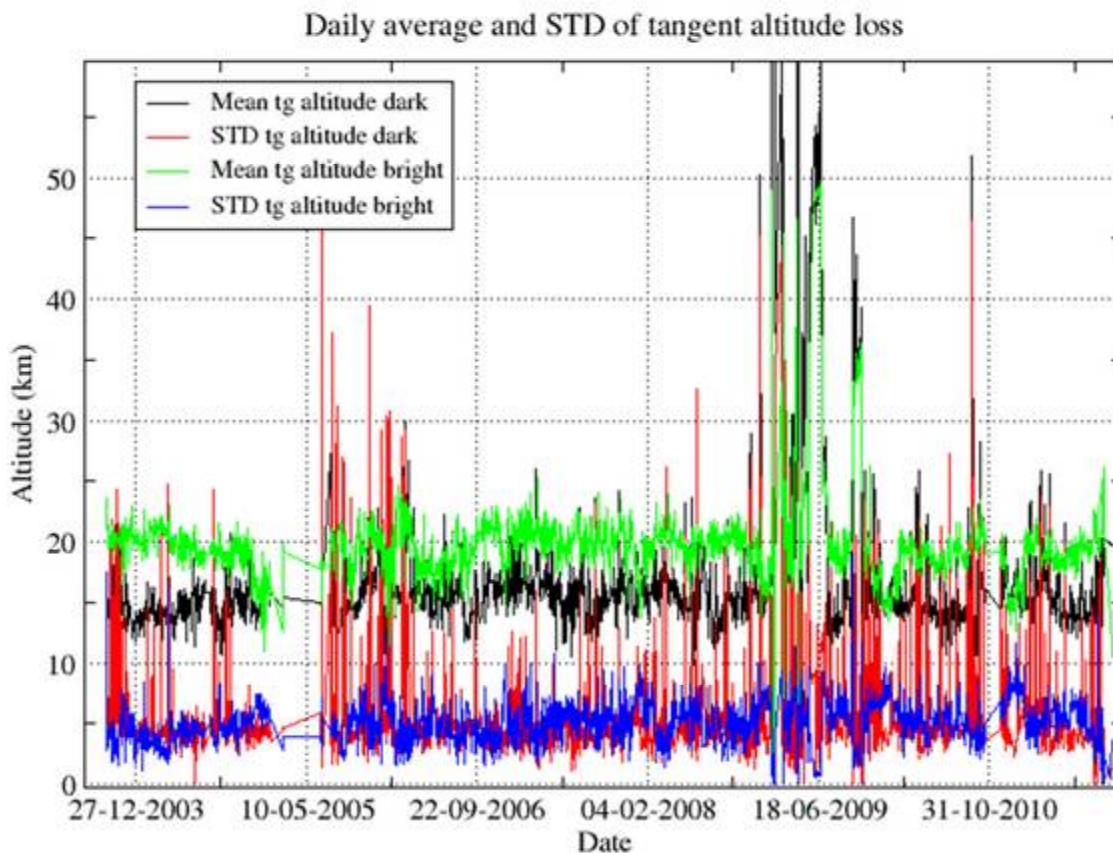


Figure 4.6-5: Daily average and STD of tangent altitude loss since the beginning of the mission

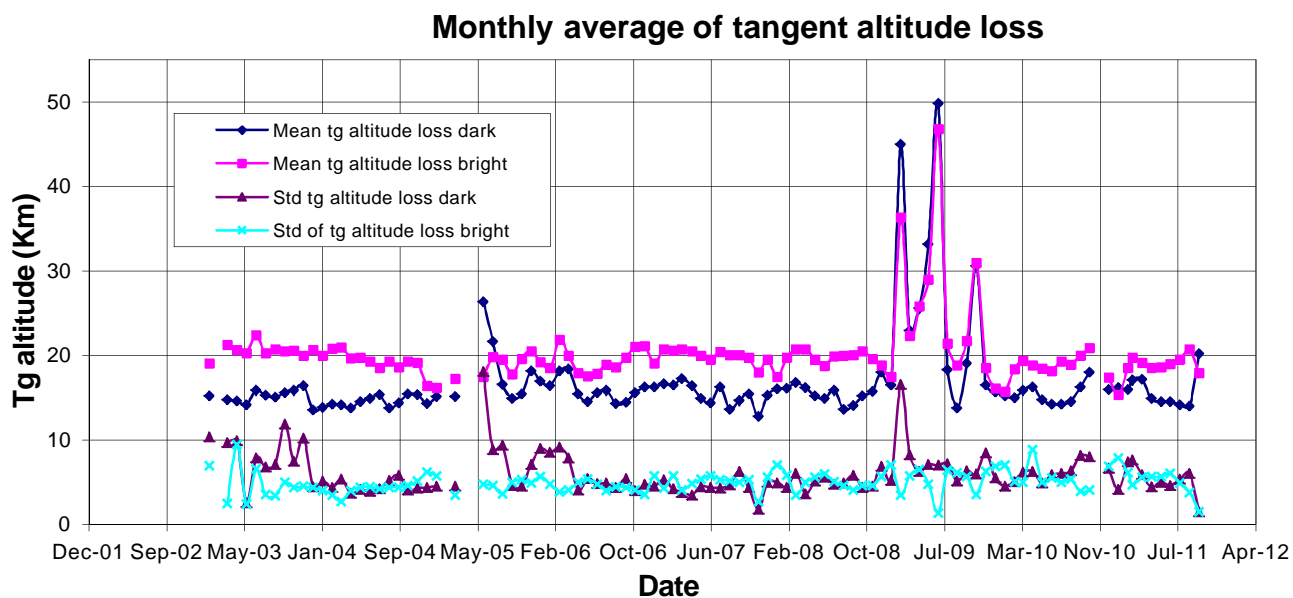


Figure 4.6-6: Monthly mean tangent altitude (and STD) at which the star is lost since January 2003

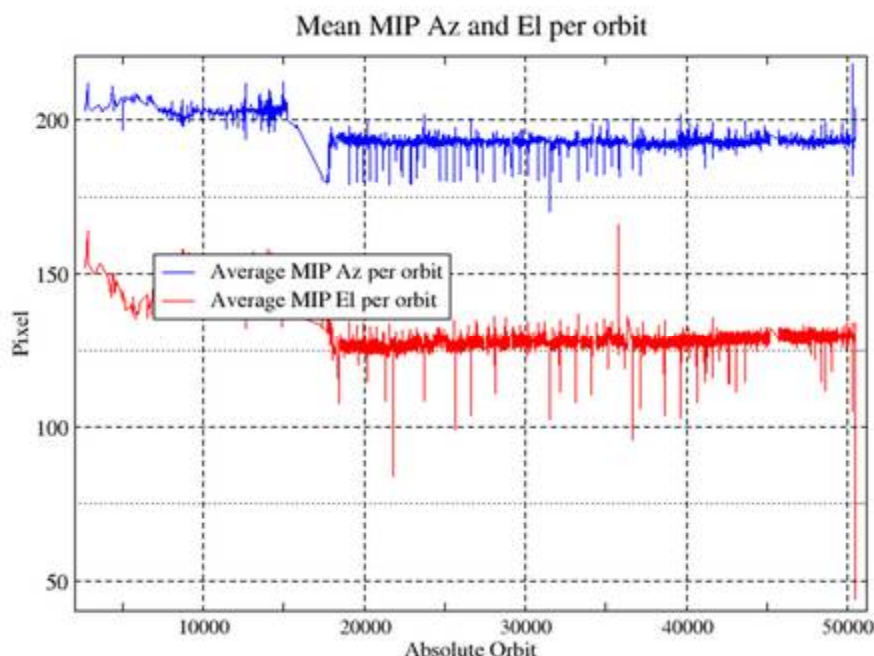
### 4.6.3 MOST ILLUMINATED PIXEL (MIP)

The MIP (Most Illuminated Pixel) is the star position on the SATU CCD in detection mode and it is recorded in the housekeeping data. The nominal centre of the SATU is pixel number **145** in elevation and number **205** in azimuth. The detection of the stars should not be far from this centre. As it can be seen in Figure 4.6-7 the **azimuth MIP** was within the threshold (Table 4.6-1) since September 2002 until the occurrence of the anomaly on January 2005, even if a small variation is present. The reason for the change in trend observed after the anomaly is, at the moment, not understood. The **elevation MIP** had a significant variation (see the *note* below) until 12<sup>th</sup> December 2003 when a new PSO algorithm was activated in order to reduce the deviations of the ENVISAT platform attitude with respect to the nominal one. Similarly to the azimuth, after the anomaly of January 2005 the Elevation MIP has a drift that has no explanation. Although this behavior of the MIP does not impact the data quality or the star location on the CCD array during the measurements, it may invalidate attitude monitoring by GOMOS and could represent a hidden anomaly. During this reporting month some anomalous values have been observed which need further investigation.

*Note:* A MIP variation onto the SATU CCD of 50 pixels corresponds to a de-pointing of 0.1 degrees

**Table 4.6-1: MIP Thresholds**

MIP X	Mean delta Az	[198 - 210]
	Std delta Az	7
MIP Y	Mean delta El	[140 - 150]
	Std delta El	4



**Figure 4.6-7: Mean values of MIP for some orbits since 1<sup>st</sup> September 2002 (see table 4.6-1)**

Figure 4.6-8 shows the standard deviation of azimuth and elevation MIP that should be within the thresholds of Table 4.6-1. The peaks observed mean that one (or more) stars were detected very far from the SATU detection point and, in this case, the stars were lost during the centering phase (see section 3 for stars lost in centering).

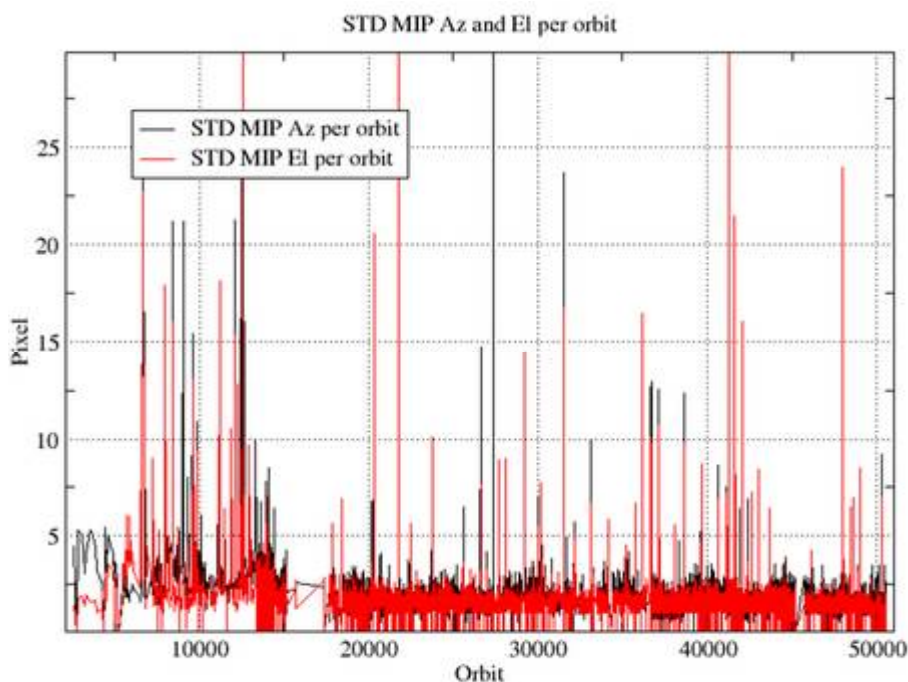


Figure 4.6-8: Standard deviation of MIP Azimuth and Elevation for some orbits since 1<sup>st</sup> September 2002 until end of reporting period (see table 4.6-1)

## 5 LEVEL 1 PRODUCT QUALITY MONITORING

50% of near real time GOM\_TRA\_1P archived products have been analysed by the IDEAS team for routine quality control and long term trend quality monitoring.

### 5.1 Processor Configuration

#### 5.1.1 VERSION

A new version of the processor, **GOMOS/6.01**, is in operations since **7 June 2011** (starting from orbits 48471/48477, respectively, in Kiruna and ESRIN). The main changes introduced by this processor are detailed in Table 5.1-1. The product specification is "PO-RS-MDA-GS-2009\_3/J". An updated disclaimer for level 1 and level 2 products is under way and will be soon available at <http://envisat.esa.int/dataproducts/availability/disclaimers>

Table 5.1-1: PDS level 1b product version and main modifications implemented

Data date	Version	Description of changes
25-MAY-2011 07-JUN-2011	GOMOS/6.01 (FinCoPAC)  GOMOS/6.01 (PDHS-E PDHS-K)	Algorithm baseline level 1b DPM 7.0 <ul style="list-style-type: none"> <li>• New Reflectivity LUT: impact on all species</li> <li>• New Slit width LUT: impact on all species</li> <li>• Intra-pixel PRNU (Pixel Response Non Uniformity): Highly improves H2O retrieval</li> </ul>

		<ul style="list-style-type: none"> <li>• Star spectra location on CCD: impact on all species</li> <li>• New wavelength assignment: impact on all species</li> <li>• Automatic DC bias correction: impacts O3 (cold stars) and all other species</li> <li>• Update of Cosmic Ray detection and correction algorithm (twilight): impact on all species, but mainly O2</li> <li>• SATU missing data correction: impact on all species</li> </ul> <p>Other upgrades:</p> <ul style="list-style-type: none"> <li>• Flag consolidation</li> <li>• Attitude file written to DSD (MPH+SPH consolidation)</li> <li>• Error due to DC included in the error budget of L1b (error on measured transmission)</li> <li>• Threshold level of pixel saturation (bright limb) changed (lowered)</li> <li>• New limb spectra error estimate</li> </ul>
16-JUN-2010	GOMOS/5.01	Identical to previous but with orbit handling software aligned with ENVISAT mission extension scenario
19-NOV-2009	Level 1b version 5.00L04 at PDHS-E and PDHS-K (equivalent to GOMOS/5.00 but running in Linux OS)	Identical to version GOMOS/5.00
29-SEP-2009	Level 1b version 5.00L03 at PDHS-E and PDHS-K (equivalent to GOMOS/5.00 but running in Linux OS)	Identical to previous (GOMOS/5.00). LRAC could not switch to this version as a problem was preventing from processing some Level 0 data. A New version that corrects this problem was put in operations on 19 <sup>th</sup> November 2009
08-AUG-2006	Level 1b version 5.00 at PDHS-E, PDHS-K	<p>Algorithm baseline level 1b DPM 6.3</p> <ul style="list-style-type: none"> <li>• Correction of FP unfolding algorithm</li> <li>• Background correction of SPB in full dark limb</li> <li>• Modification of the computation of the incidence angle</li> <li>• Correction of the flat-field correction equations</li> <li>• Star spectrum location on CCD modified for SPB</li> <li>• Provide SFA and SATU angles in degrees</li> <li>• Elevation angle dependency of the reflectivity LUT added in the algorithms</li> <li>• Ratio upper/star signal added (FLAGUC)</li> <li>• Add Dark Charge used for dark charge correction (per band)</li> <li>• Flag for illumination condition (PCDillum)</li> <li>• Minimum sample value for which the cosmic rays detection processing is applied (Crmin) is a function of gain index</li> <li>• Logic for computation of the flags attached to the reference star spectrum (Flref) modified</li> </ul>
23-JUL-2006	Level 1b version 5.00 at LRAC	<ul style="list-style-type: none"> <li>• Add the computation of the sun direction in the inertial geocentric frame to be written in the level 1b and limb products.</li> <li>• Spectrometer effective sampling time added</li> </ul> <p>Change in configuration at the time of switch over:</p> <ul style="list-style-type: none"> <li>○ Use of new reflectivity LUT (GOM_CAL_AX)</li> <li>○ New wavelength assignment for SPA1, A2, B1 (GOM_CAL_AX)</li> <li>○ Location of star spectrum projection on the CCD arrays (GOM_CAL_AX)</li> <li>○ Spatial PSF of SPB modified (GOM_INS_AX)</li> <li>○ Some universal constants (GOM_PR1_AX)</li> </ul>
23-MAR-2004	Level 1b version 4.02 at PDHS-E and PDHS-K	<p>Algorithm baseline level 1b DPM 6.0</p> <ul style="list-style-type: none"> <li>• Adding a new calibration parameters (these values are hard</li> </ul>

		<p>coded at the moment)</p> <ul style="list-style-type: none"> <li>• Removal of redundancy chain from code</li> <li>• Modifications in the processing to apply new configuration and calibration parameter</li> <li>• New algorithm to determine between dark, twilight and bright limb and to handle data accordingly</li> <li>• Added handling of source packages with invalid packet header</li> <li>• Added enumerations for all configuration flags</li> </ul>
31-MAY-2003	Level 1b version 4.00 at PDHS-E and PDHS-K	<p>Algorithm baseline level 1b DPM 5.4:</p> <ul style="list-style-type: none"> <li>• Modulation correction step added after the cosmic rays detection processing</li> <li>• Inversion of the non-linearity and offset corrections</li> <li>• Modification of the computation of the estimated background signal measured by the photometers: use the spectrometer radiometric sensitivity curve and the photometer transfer function.</li> <li>• Use of the dark charge map at orbit level computed from the DSA (dark sky area) if any in the level 0 product</li> <li>• Implementation of a new unfolding algorithm for the photometer samples</li> </ul>
21-NOV-2002	Level 1b version 3.61 at PDHS-E and PDHS-K	<p>Algorithm baseline DPM 5.3:</p> <ul style="list-style-type: none"> <li>• Review of some default values</li> <li>• New definition of one PCD flag (atmosphere)</li> <li>• Temporal interpolation of ECMWF data</li> </ul>

**Table 5.1-2: GOPR level 1b product version and main modifications implemented**

Date	Version	Description of changes
22-JUL-2005	GOPR_6.0c	<p>Level 1b:</p> <ul style="list-style-type: none"> <li>• Correction of FP unfolding algorithm</li> <li>• Background correction of SPB in full dark limb</li> <li>• Modification of the computation of the incidence angle</li> <li>• Correction of the flat-field correction equations</li> <li>• Star spectrum location on CCD modified for SPB</li> </ul> <p>Configuration for second reprocessing:</p> <ul style="list-style-type: none"> <li>○ Use of new reflectivity LUT</li> <li>○ New wavelength assignment for SPA1, A2, B1</li> <li>○ Spatial PSF of SPB modified</li> </ul>
17-MAR-2004	GOPR 6.0a	<ul style="list-style-type: none"> <li>• Provide SFA and SATU angles in degrees</li> <li>• Elevation angle dependency of the reflectivity LUT added in the algorithms</li> <li>• Ratio upper/star signal added (FLAGUC)</li> <li>• Add Dark Charge used for dark charge correction (per band)</li> <li>• Flag for illumination condition (PCDillum)</li> <li>• Minimum sample value for which the cosmic rays detection processing is applied (Crmin) is a function of gain index</li> <li>• Logic for computation of the flags attached to the reference star spectrum (Flref) modified</li> <li>• Add the computation of the sun direction in the inertial geocentric frame to be written in the level 1b and limb products.</li> <li>• Spectrometer effective sampling time added</li> </ul>
25-JUL-2003	GOPR 5.4f	<ul style="list-style-type: none"> <li>• The demodulation process is applied only in full dark limb and twilight limb conditions.</li> </ul>
17-JUL-2003	GOPR 5.4e	<ul style="list-style-type: none"> <li>• Sun zenith angle is computed in the geolocation process. The occultation is now classified into (0) full dark limb condition, (1) bright limb condition and (2) twilight limb condition.</li> <li>• No background correction applied in full dark limb condition. The location</li> </ul>



		of the image of the star spectrum on the CCD array is no more aligned with the CCD lines.
02-JUL2003	GOPR 5.4d	<ul style="list-style-type: none"> <li>The maximum number of measurements is set to 509 (instead of 510) in the GOPR prototype.</li> </ul>
17-MAR-2003	GOPR 5.4c	<ul style="list-style-type: none"> <li>Modification of the CAL ADFs (update of the limb radiometric LUT). The products are affected only if the limb spectra are converted into physical units</li> <li>Modifications to allow compatibility with ACRI computational cluster (no modifications of the results)</li> <li>Modification of the logic to handle dark charge map refresh at orbit level (DSA data is now directly processed by the level 1b processor if available in the level 0 product). No impact on the results</li> </ul>
21-FEB-2003	GOPR 5.4b	<ul style="list-style-type: none"> <li>DC map values are rounded when written in the level 1b product</li> <li>Modification of the CAL ADFs (update of the wavelength assignment of SPB1 and SPB2)</li> <li>Modify the computation of flag_mod in the modulation correction routine</li> </ul>
17-JAN-2003	GOPR 5.4a	<ul style="list-style-type: none"> <li>use the start and stop dates of the occultation when calling the CFI Interpol instead of start and stop dates of the level 0 product</li> <li>modify the ECMWF filename information in the SPH of the level 1b and limb products</li> </ul>

### 5.1.2 AUXILIARY DATA FILES (ADF)

The ADF's files in Table 5.1-3, Table 5.1-4, Table 5.1-5, Table 5.1-6 and Table 5.1-7 have been disseminated to the PDS during the whole mission. Note that the files outlined in yellow are the set of auxiliary files used during the reporting period. For every type of file, the validity runs from the start validity time until the start validity time of the following one, but if an ADF file has been disseminated after the start validity time, it is obvious that it will be used by the PDHS-E and PDHS-K PDS only after the dissemination time (this happens the majority of the time). Just like the other ADF's, the calibration auxiliary file (GOM\_CAL\_AX) has been updated several times in the past (Table 5.1-7) but the difference is that now it is updated on a weekly basis with new DC maps and new wavelength assignment (routine weekly wavelength calibration was activated on 14<sup>th</sup> December 2007), and that is why the files used during reporting period are reported in a separate table (Table 5.1-8) that changes from report to report. Note that a fault in the wavelength assignment has been detected in these files so they are wrong since the latest IPF6.01 has become operational [NRT: 7 June 2011, orbit 48471; off-line: 25 May 2011, orbit 48277)]; work is under way to correct them; corrected ADFs are expected to be delivered during the forthcoming weeks.

**Table 5.1-3: Historic GOM\_PR1\_AX files used by PDS for level 1b products generation. The GOM\_PR1\_AX is a file containing the configuration parameters used for processing from level 0 to level 1b products**

Used by PDS for Level 1b products generation during	GOM_PR1_AX (GOMOS processing level 1b configuration file)
01-MAR-2002 → 29-MAR-2002	GOM_PR1_AXVIEC20020121_165314_20020101_000000_20200101_000000 <ul style="list-style-type: none"> <li>Pre-launch configuration</li> </ul>
30-MAR-2002 → 14-NOV-2002	GOM_PR1_AXVIEC20020329_115921_20020324_200000_20100101_000000 <ul style="list-style-type: none"> <li>Changed num_grid_upper, thr_conv and max_iter in the atmospheric GADS</li> </ul>
Not used	GOM_PR1_AXVIEC20020729_083756_20020301_000000_20100101_000000 <ul style="list-style-type: none"> <li>Cosmic Ray mode + threshold</li> <li>DC correction based on maps</li> <li>Non-linearity correction disabled</li> </ul>
Not used	GOM_PR1_AXVIEC20021112_170331_20020301_000000_20100101_000000 <ul style="list-style-type: none"> <li>Central background estimation by linear interpolation + associated thresholds</li> </ul>

15-NOV-2002 → 26-MAR-2003	GOM_PR1_AXVIEC20021114_153119_20020324_000000_20100101_000000 <ul style="list-style-type: none"> <li>• Same content as GOM_PR1_AXVIEC20021112_170331_20020301_000000_20100101_000000 but validity start updated so as to supersede according to the PDS file selection rules GOM_PR1_AXVIEC20020329_115921_20020324_200000_20100101_000000</li> </ul>
27-MAR-2003 → 19-MAR-2004	GOM_PR1_AXVIEC20030326_085805_20020324_200000_20100101_000000 <ul style="list-style-type: none"> <li>• Same content as GOM_PR1_AXVIEC20021112_170331_20020301_000000_20100101_000000 but validity start updated so as to supersede according to the PDS file selection rules GOM_PR1_AXVIEC20020329_115921_20020324_200000_20100101_000000</li> </ul>
20-MAR-2004 → 22-MAR-2004	GOM_PR1_AXVIEC20040319_134932_20020324_200000_20100101_000000 Ray tracing parameter changed: convergence criteria set to 0.1 microrad
23-MAR-2004 → 01-APR-2004 <i>Notes:</i> This file was constructed from GOM_PR1_AXVIEC20030326_085805_20020324_200000_20100101_000000 (so without the ray tracing parameter changed) This file was used by the GOMOS/4.02 processors before the IECF dissemination. The dissemination was done on 25 <sup>th</sup> March 2004	GOM_PR1_AXVIEC20040316_144850_20020324_200000_20100101_000000 GOM_PR1 ADF for version GOMOS/4.02, changes: The central band estimation mode Atmosphere thickness Altitude discretisation
02-APR-2004 → 07-AUG-2006	GOM_PR1_AXVIEC20040401_083133_20020324_200000_20100101_000000 Ray tracing parameter changed: convergence criteria set to 0.1 microrad
08-AUG-2006 Used at the time of switching over GOMOS/5.00	GOM_PR1_AXNIEC20050627_151042_20020301_000000_20100101_000000 Change of some universal constants
07-JUN-2011 Used at the time of switching over GOMOS/6.01	GOM_PR1_AXNIEC20110513_081743_20020301_000000_20500101_000000 New saturation low values levels for SPA, gain 1: 3200 and 3600 New minimum number of star spectra used to compute the reference star spectrum: set to 1

**Table 5.1-4: Historic GOM\_INS\_AX files used by PDS for level 1b products generation. The GOM\_INS\_AX is a file containing the characteristics of the instrument and it is used for processing from level 0 to level 1b products and from level 1b to level 2 products**

Used by PDS for Level 1b products generation during	GOM_INS_AX (GOMOS instrument characteristics file)
01-MAR-2002 → 29-JUL-2002	GOM_INS_AXVIEC20020121_165107_20020101_000000_20200101_000000 <ul style="list-style-type: none"> <li>• Pre-launch configuration</li> </ul>
30-JUL-2002 → 12-NOV-2002	GOM_INS_AXVIEC20020729_083625_20020301_000000_20100101_000000 <ul style="list-style-type: none"> <li>• Factors for the conversion of the SFA angles from SFM axes to GOMOS axes</li> </ul>
13-NOV-2002 → 16-JUL-2003	GOM_INS_AXVIEC20021112_170146_20020301_000000_20100101_000000 <ul style="list-style-type: none"> <li>• No more invalid spectral range</li> </ul>
Not used	GOM_INS_AXVIEC20030716_080112_20030711_120000_20100101_000000 <ul style="list-style-type: none"> <li>• New value for SFM elevation zero offset for redundant chain: 10004</li> </ul>
17-JUL-2003 → 07-AUG-2006	GOM_INS_AXVIEC20030716_105425_20030716_120000_20100101_000000 <ul style="list-style-type: none"> <li>• Bias induct azimuth redundant value set to -0.0084 rad (-0.4813 deg)</li> </ul>

08-AUG-2006 → 11-NOV-1009	GOM_INS_AXNIEC20050627_150713_20030716_120000_20100101_000000 The spatial PSF of SPB
12-NOV-2009	GOM_INS_AXVIEC20091111_143220_20030716_120000_20500101_000000 Same content as previous one but with extended validity end time

**Table 5.1-5: Historic GOM\_CAT\_AX files used by PDS for level 1b products generation. The GOM\_CAT\_AX is a file holding the star catalogue used for processing from level 0 to level 1b products**

Used by PDS for Level 1b products generation during	GOM_CAT_AX (GOMOS Stat Catalogue file)
01-MAR-2002	GOM_CAT_AXVIEC20020121_161009_20020101_000000_20200101_000000 <ul style="list-style-type: none"> <li>Pre-launch configuration</li> </ul>

**Table 5.1-6: Historic GOM\_STS\_AX files used by PDS for level 1b products generation. The GOM\_STS\_AX is a file containing star spectra used for processing from level 0 to level 1b products**

Used by PDS for Level 1b products generation during	GOM_STS_AX (GOMOS Star Spectra file)
01-MAR-2002 → 07-AUG-2006	GOM_STS_AXVIEC20020121_165822_20020101_000000_20200101_000000 <ul style="list-style-type: none"> <li>Pre-launch configuration</li> </ul>
08-AUG-2006 → 11-NOV-2009	GOM_STS_AXNIEC20040308_103538_20020101_160000_20100101_000000 Wavelength assignment GADS has been suppressed from the product Wavelength assignment vector has been added to the star spectrum
12-NOV-2009	GOM_STS_AXVIEC20091111_151504_20020101_160000_20500101_000000 Same content as previous one but with extended validity end time

**Table 5.1-7: Historic GOM\_CAL\_AX files used by PDS for level 1b products generation. The GOM\_CAL\_AX is a file containing the calibration parameters used for processing from level 0 to level 1b products**

Used by PDS for Level 1b products generation during	GOM_CAL_AX (GOMOS Calibration file)
01-MAR-2002 → 29-JUL-2002	GOM_CAL_AXVIEC20020121_164808_20020101_000000_20200101_000000 <ul style="list-style-type: none"> <li>Pre-launch configuration</li> </ul>
Not used	GOM_CAL_AXVIEC20020121_142519_20020101_000000_20200101_000000 <ul style="list-style-type: none"> <li>Pre-launch configuration</li> </ul>
30-JUL-2002 → 12-NOV-2002	GOM_CAL_AXVIEC20020729_082426_20020717_193500_20100101_000000 <ul style="list-style-type: none"> <li>Band setting information</li> <li>Wavelength assignment</li> <li>Spectral dispersion LUT</li> <li>ADC offset for Spectrometers</li> <li>PRNU maps</li> <li>Thermistor coding LUT</li> <li>DC maps</li> </ul>
Not used	GOM_CAL_AXVIEC20021112_165603_20020914_000000_20100101_000000 <ul style="list-style-type: none"> <li>Band setting information</li> <li>DC maps</li> <li>PRNU maps</li> <li>Wavelength assignment</li> <li>Spectral dispersion LUT</li> <li>Radiometric sensitivity LUT (star and limb)</li> <li>SP-FP intercalibration LUT</li> <li>Vignetting LUT</li> <li>Reflectivity LUT</li> <li>ADC offset</li> </ul>

13-NOV-2002 → 30-JAN-2003	GOM_CAL_AXVIEC20021112_165948_20021019_000000_20100101_000000 <ul style="list-style-type: none"> <li>Only DC maps updated</li> </ul>
31-JAN-2003 → 11-APR-2003	GOM_CAL_AXVIEC20030130_133032_20030101_000000_20100101_000000 <ul style="list-style-type: none"> <li>Only DC maps updated (using DSA of orbit 04541)</li> </ul>
12-APR-2003 → 02-JUN-2003	GOM_CAL_AXVIEC20030411_065739_20030407_000000_20100101_000000 <ul style="list-style-type: none"> <li>Modification of the radiometric sensitivity curve for the limb spectra. Note that the modification of this LUT has no impact on the GOMOS processing. The LUT is just copied into the level 1b limb product for user conversion purpose.</li> <li>Updated DC map only (using DSA of orbit 05762).</li> </ul>
03-JUN-2003: from this date onwards, mainly updates to DC maps are done. Every month, the table of new GOM_CAL files with <b>only</b> DC maps updated is provided (table 5.1-8). Eventual changes to this file not corresponding only to DC maps updates will be reported in this table.	GOM_CAL_AXVIEC20030602_094748_20030531_000000_20100101_000000 <ul style="list-style-type: none"> <li>Updated DC maps only (using DSA of orbit 06530)</li> </ul>
13-FEB-2004 → 23-FEB-2004	GOM_CAL_AXVIEC20040212_103916_20040209_000000_20100101_000000 Update of the reflectivity LUT Updated DC maps (Orbit 10194, date 11-FEB-2004)
08-AUG-2006 Used at the time of switching over GOMOS/5.00	GOM_CAL_AXNIEC20050704_110915_20050125_224800_20100101_000000 Reflectivity LUT updated Location of the star spectrum projection on the CCD arrays Wavelength assignment of the spectra updated The spatial LSF of SPB updated Updated DC maps (orbit 15200, date 25 JAN 2005)
07-JUN-2011 Used at the time of switching over GOMOS/6.01	GOM_CAL_AXNIEC20110606_150230_20110607_000000_20500101_000000 New Pixel Response Non Uniformity/intraPixel Response Non Uniformity (PRNU/iPRNU) maps Wavelength assignment (WA) updated DC thermal sensitivity Look Up Tables (LUTs) updated Reflectivity LUT updated Slit width variation updated

**Table 5.1-8: Calibration ADF for reporting period. These files are updated (only with new DC maps and wavelength calibrated) in a 8-10 days basis**

Used by PDS for Level 1b products generation during	GOM_CAL_AX (GOMOS Calibration file)
04-OCT-2011 → 23-OCT-2011	GOM_CAL_AXVIEC20111004_085053_20111003_000000_20500101_000000 (orbit 50168, date 03-OCT-2011)
23-OCT-2011 →	GOM_CAL_AXVIEC20111021_144853_20111020_000000_20500101_000000 (orbit 50453, date 23-OCT-2011)

## 5.2 Quality Flags Monitoring

In this section, the results of monitoring some Product Quality information stored in level 1b products that did not have a fatal error (MPH error flag not set) are discussed. The products with fatal errors were around 0.7% of the products received during the reporting month for the quality monitoring.

On the one hand, for every product we have information of the **number of measurements** where a given problem was detected (i.e. number of invalid measurements, number of measurements containing saturated samples, number of measurements with demodulation flag set...). On the other hand, there are **flags** that indicate problems within the product (i.e. flag set to one if the reference spectrum was computed from DB, flag set to zero if SATU data were not used...).

For the information on the number of measurements a plot of percentages with respect to time is provided in Figure 5.2-1. The most relevant part of this information is also plotted in a world map as a function of ENVISAT position: % of cosmic ray hits per profile, % of datation errors per profile, % of star falling outside the central band per profile and % of saturation errors per profile ( Figure 5.2-2).

It can be seen from Figure 5.2-1 that the cosmic rays hits occurred several times for the 99% of the measurements of the products. Looking at Figure 5.2-2 it can be clearly observed that this high percentage occurred when the satellite crossed the South Atlantic Anomaly (SAA) zone. Also the percentage of saturation errors per profile shows an increase over the SAA zone.

Another observation from Figure 5.2-1 is that for several products, 15-20% of the measurements have the star signal falling outside the central band. In Figure 5.2-2 it is observed that this percentage occurred mainly during twilight/dark conditions (roughly ascending) while in bright conditions the percentage is around 10% ( Figure 5.2-2). This is because during the night the stars are lost deeper within the atmosphere and the turbulence phenomena becomes more important, producing the star to be less 'focused' on the spectrometers central band. The other values (% of invalid measurements per product, % of measurements per product with datation errors..) are quite low.

The QWG has requested to perform a different plot of the cosmic rays in order to have a clear picture on the geographical position of the hits: count the cosmic rays detected in every product and when they are more than 100 then consider that cosmic rays have been detected. This plot is in Figure 5.2-3. The products in bright limb have not been considered because the cosmic rays detection is not activated when processing products in bright.

The flag information is given in table Table 5.2-1. The percentage of the products that have at least one measurement with demodulation flag set is also reported.

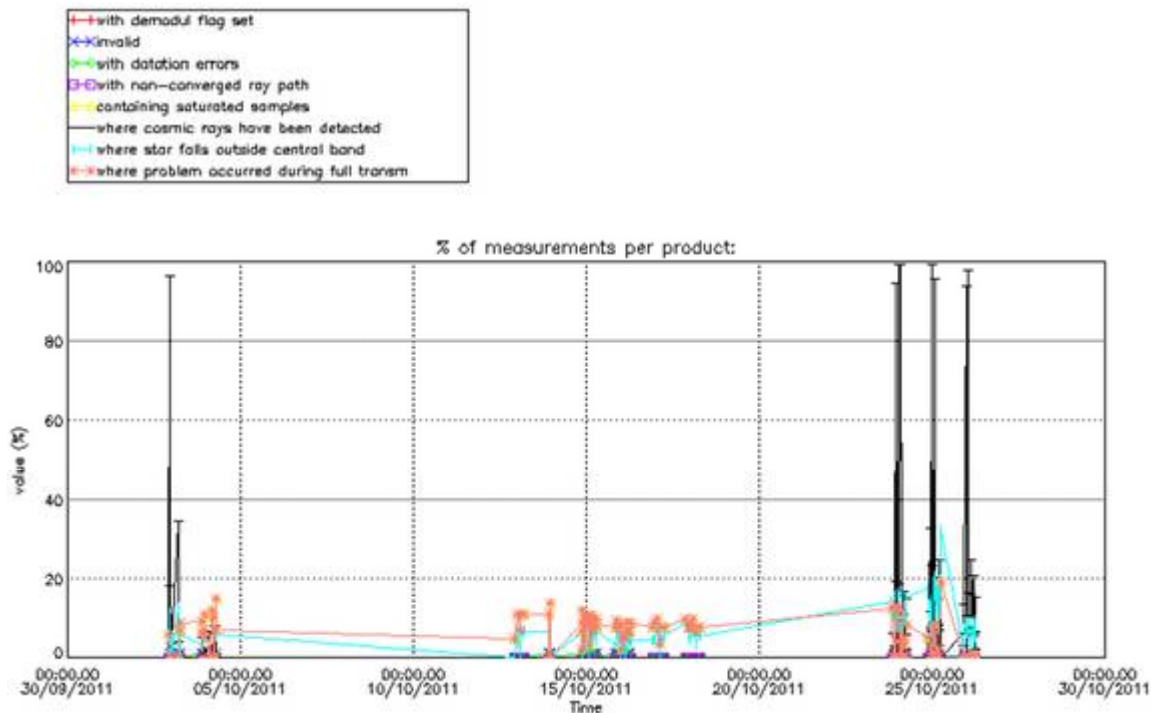


Figure 5.2-1: Level 1b product quality monitoring with respect to time

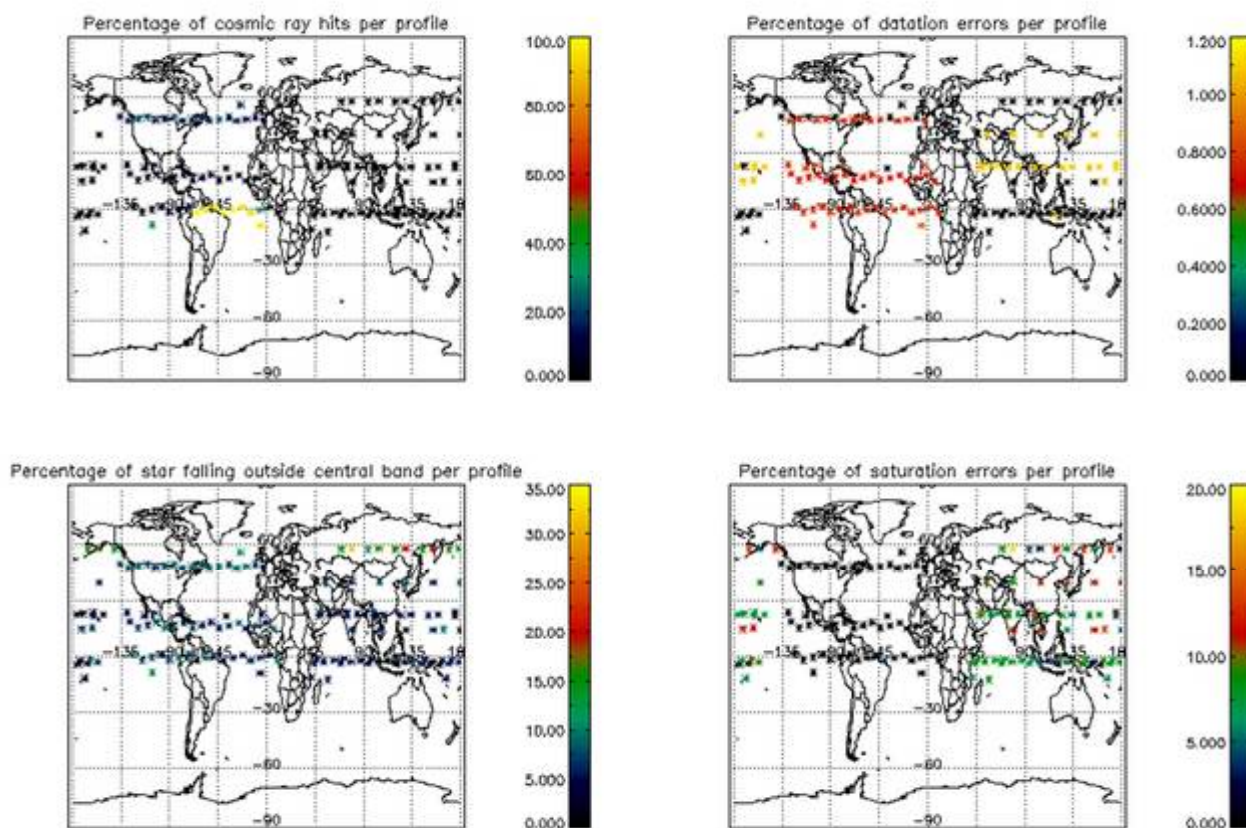


Figure 5.2-2: Level 1b product quality monitoring with respect to geolocation of ENVISAT

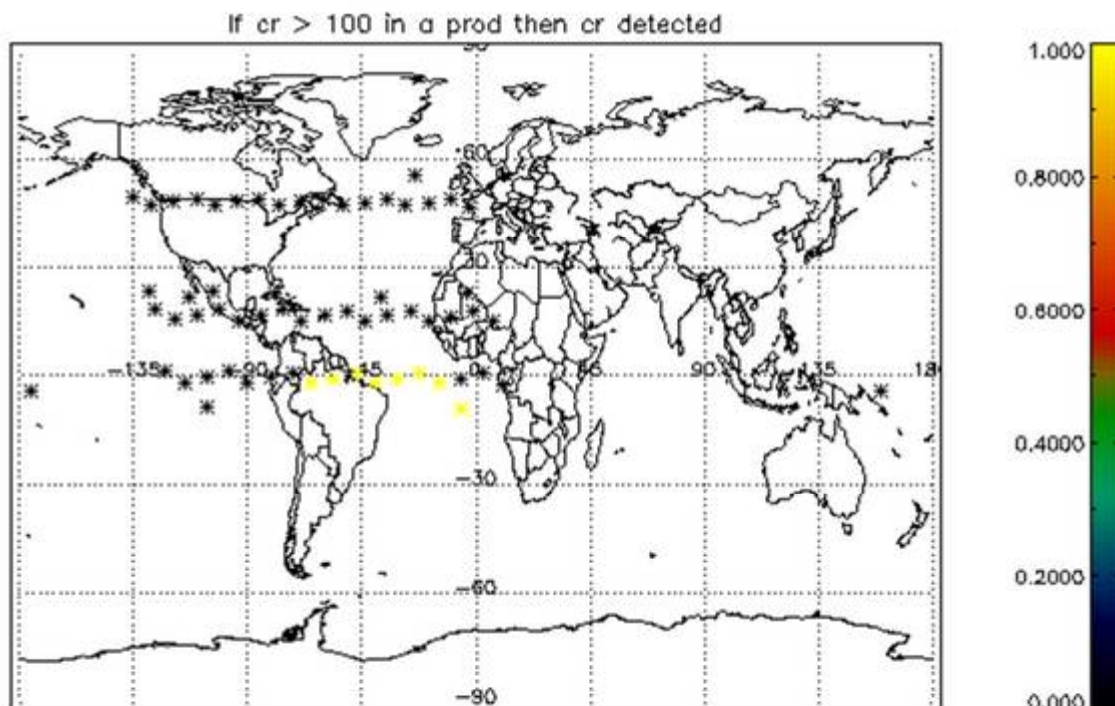


Figure 5.2-3: Count every time a cosmic ray has been detected. When it is > 100, then cosmic rays detected (yellow in the plot)

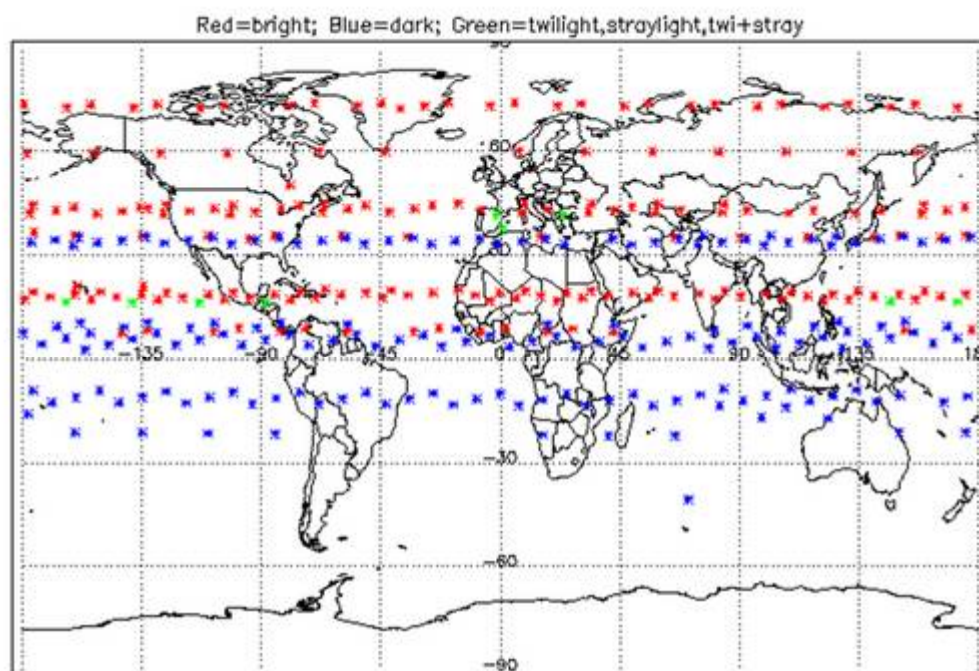
Table 5.2-1: Percentage of products during the reporting period with:

At least one measurement with demodulation flag set:	39 %
Reference spectrum computed from DB:	0.0 %
Reference spectrum with small number of measurements:	0.0 %
SATU data not used:	56 %

### 5.2.1 QUALITY FLAGS MONITORING (EXTRACTED FROM LEVEL 2 PRODUCTS)

In this section, the Product Quality information coming from the level 1 processing that is also stored in the level 2 products is plotted. Only products that did not have a fatal error (MPH error flag not set) are considered. The purpose of using the level 2 data is simply that the percentage of level 2 products arriving to the IDEAS team for the quality monitoring is much higher. For the reporting month, 100% of the archived products have been received. The plots are very similar to Figure 5.2-1 and Figure 5.2-2 (demodulation flag information is not included) but separating ascending from descending passes. Since processor version GOMOS/5.00 there is no correspondence between illumination condition and latitude range when separating the passages (ascending and descending). Now, in the geo-location process, the sun zenith angle is computed and the occultation is then flagged accordingly (dark, bright, twilight, straylight, twilight+straylight). You can see in Figure 5.2-4 the location of the occultations and their limb for the reporting month.

Figure 5.2-5 and Figure 5.2-6 present some quality information as a function of the time whereas in Figure 5.2-7 and Figure 5.2-8 the plot is respect to the satellite position at the beginning of the occultations.



**Figure 5.2-4: Position of the occultations based on illumination conditions**

The percentage of measurements “where a problem occurred during the full transmission” per product ranges between 2 and 35 % (Figure 5.2-5, Figure 5.2-6). The high values are due to the saturation that occurs mainly in bright limb. In dark limb the saturation occurs over the SAA zone but it is quite low elsewhere. From Figure 5.2-5 and Figure 5.2-6 you can see also that there are a variable percentage of the measurements that have the star signal falling outside the central band. This is because in dark the stars are lost deeper within the atmosphere and the turbulence phenomena become more important, resulting in the star being less ‘focused’ on the spectrometers central band.

In ascending (Figure 5.2-7) the SAA is perfectly localized by the high percentage of cosmic ray hits per product (upper left panel). It is not the same if we look at Figure 5.2-8, because in descending most of the occultations in that world region are in bright limb conditions and the cosmic rays detection processing is not activated.



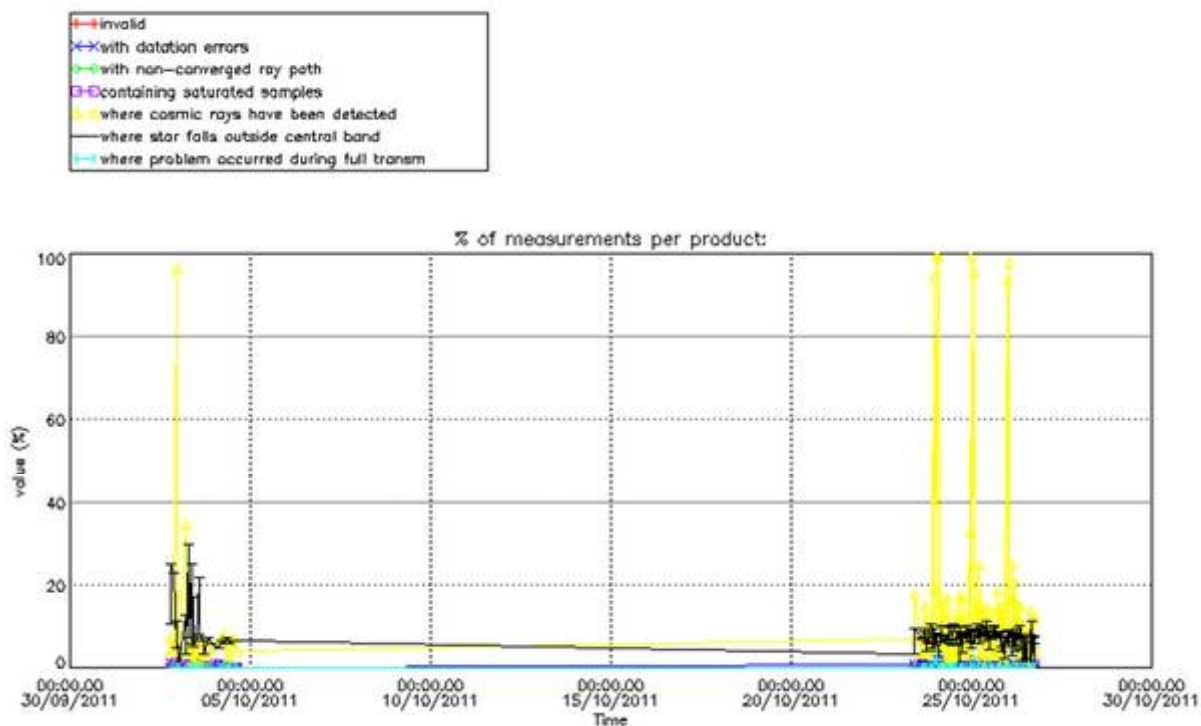


Figure 5.2-5: Level 1b product quality monitoring with respect to time ASCENDING ENVISAT passes

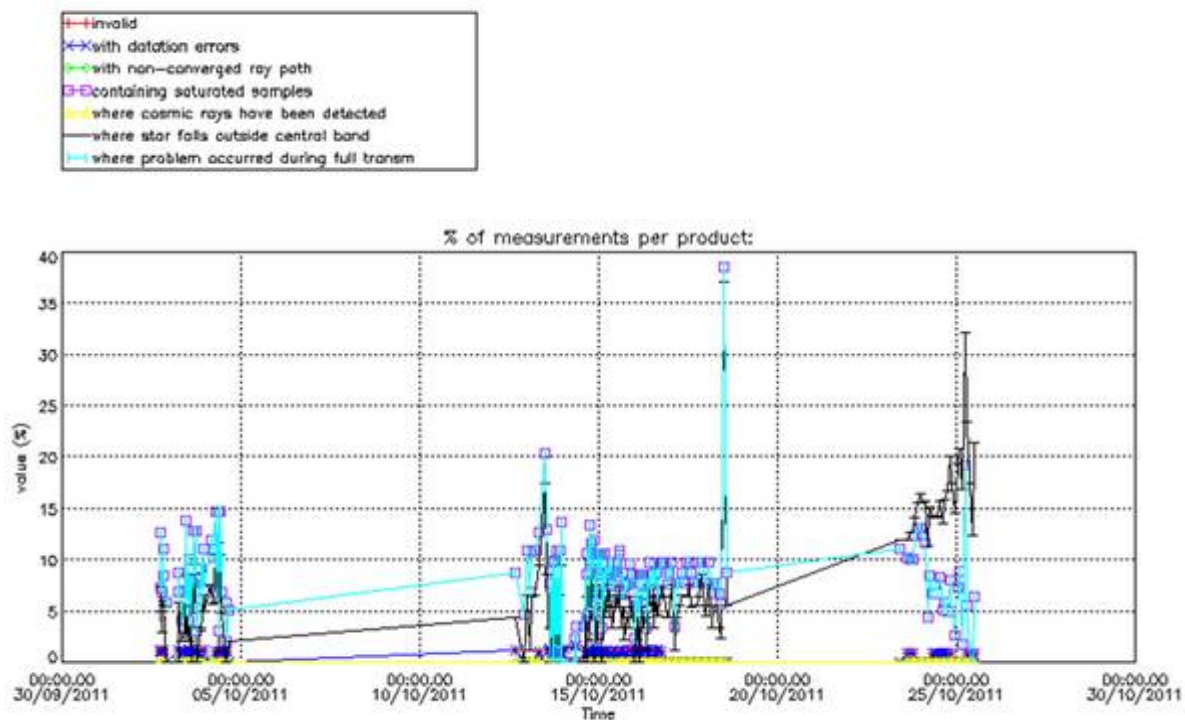


Figure 5.2-6: Level 1b product quality monitoring with respect to time DESCENDING ENVISAT passes

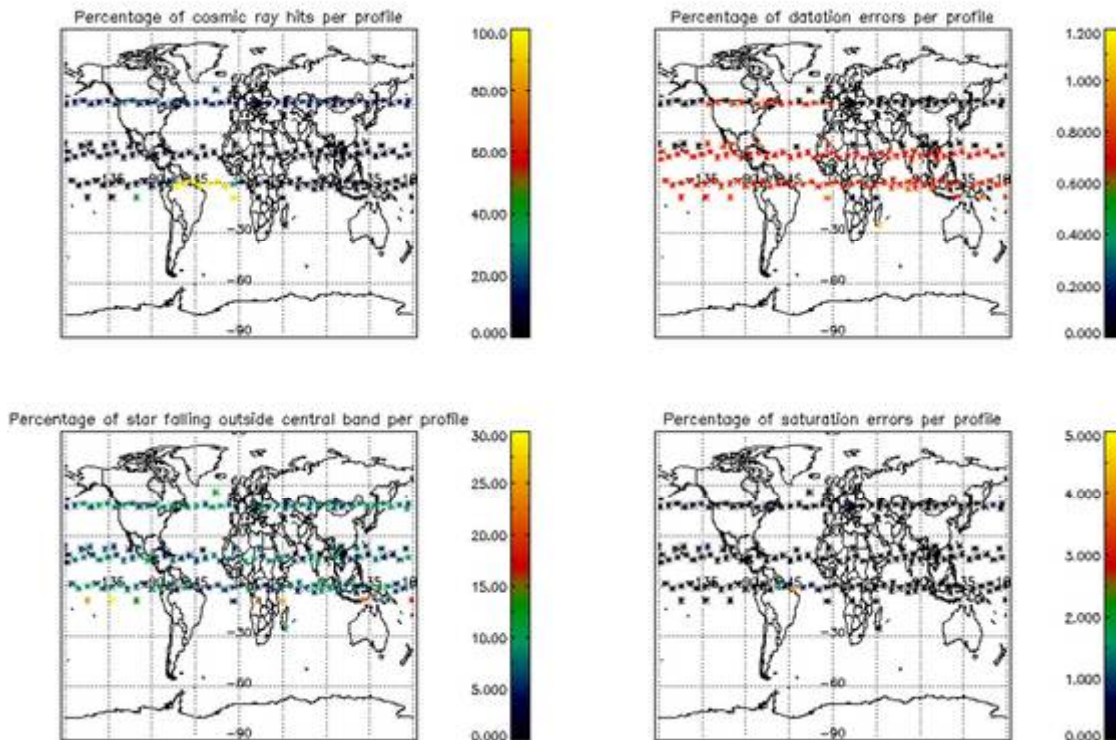


Figure 5.2-7: Level 1b product quality monitoring with respect to satellite geo-location for ASCENDING ENVISAT passes

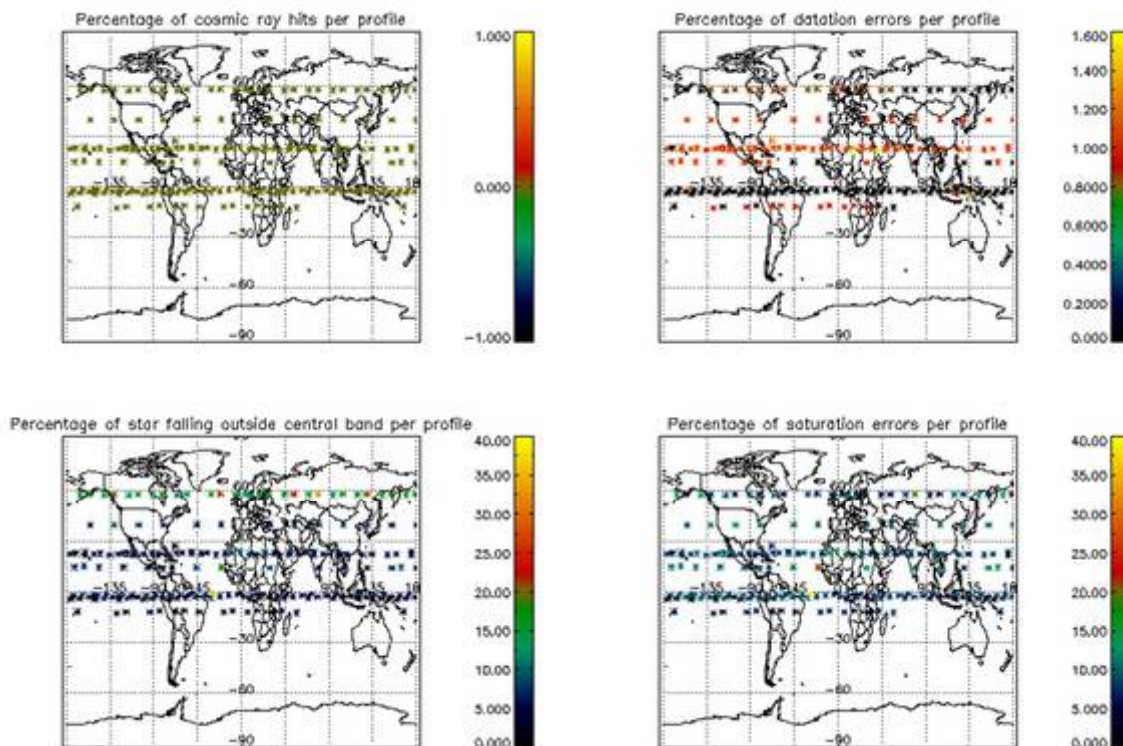


Figure 5.2-8: Level 1b product quality monitoring with respect to satellite geo-location for DESCENDING ENVISAT passes

### 5.3 Spectral Performance

Every pixel of the spectrometers has a wavelength assigned. This assignment has been monitored through the mission by calculating, for given stars, the spectral shift corresponding to a maximum correlation between the reference star spectrum and the one of the occultation.

In order to have the wavelength well calibrated during the second reprocessing activity, the QWG performed a study to correct the spectral shift that was detected during the routine spectral performance monitoring (see Figure 5.3-1). A linear regression using data from stars 1 and 2 has been used to calibrate the wavelength for each needed orbit (one value for each calibration ADF used for the second reprocessing). This linear law took into account the ageing of the instrument. During the QWG #13, it has been decided to perform a wavelength calibration routinely with an extrapolation of this law and introducing also an extension to a second order law taking into account the seasonal variations. This routine calibration has been implemented on 14<sup>th</sup> December 2007 and is performed once a week at the same time of the DC maps calibration.

With this implementation the monitoring curve presented in Figure 5.3-1 should show small wavelength shifts since 14<sup>th</sup> December 2007. At least, the values should be smaller than the warning value set to 0.07 nm but, as it can be seen, the values had an unexpected variation (exceeding the threshold for given periods); this trend has been investigated by the QWG and an updated calibration law has become operational with the new version of GOMOS (6.01), nevertheless the last points of the monitoring shows anomalous values (star 1) which have been found to be due to an erroneous wavelength assignment in the GOM\_CAL\_AX ADF file; moreover the wavelength assignment has been found to be impacted by the annealing performed in July 2011. Once the corrected law will be derived and the ADF generation procedure will be corrected, it will be implemented also in the ADFs for the third reprocessing activity.

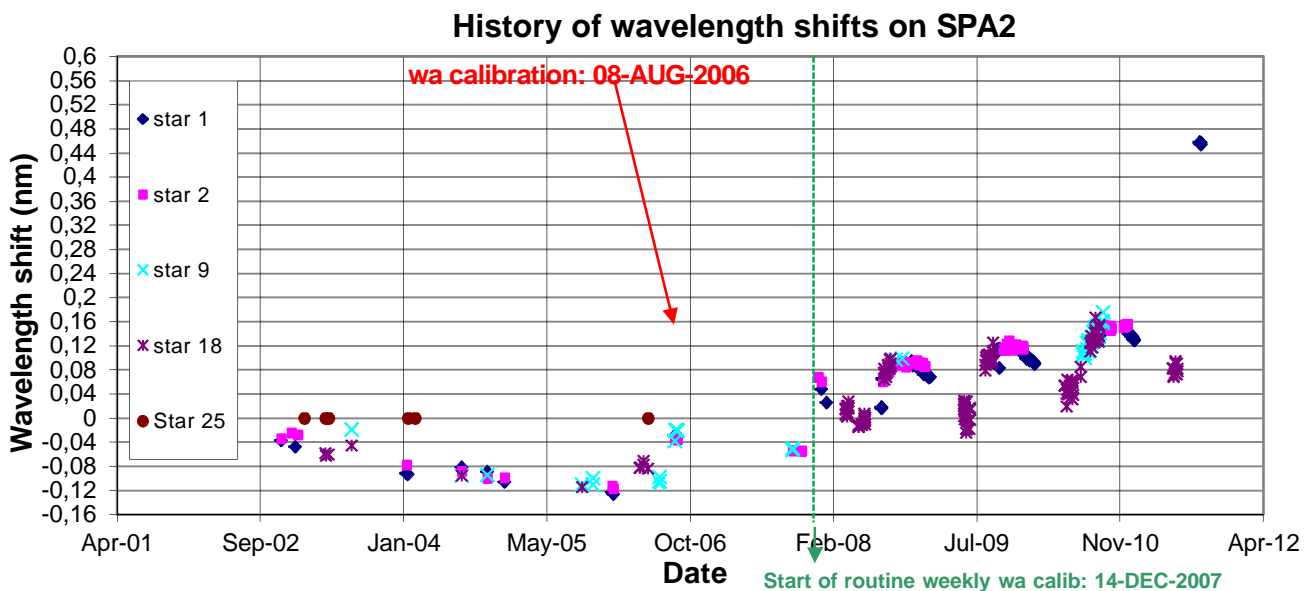


Figure 5.3-1: SPA2 wavelength monitoring since 12<sup>th</sup> November 2002: for every star ID (1, 2, 9, 18, 25) it is plotted the spectral shift for which a maximum correlation has been found between the reference spectrum and the one of the occultation

## 5.4 Spectral Performance

### 5.4.1 RADIOMETRIC SENSITIVITY

The monitoring performed consists of the calculation of the radiometric sensitivity of each CCD by computing the ratio between parts of the reference spectrum using specific stars (Figure 5.4-).

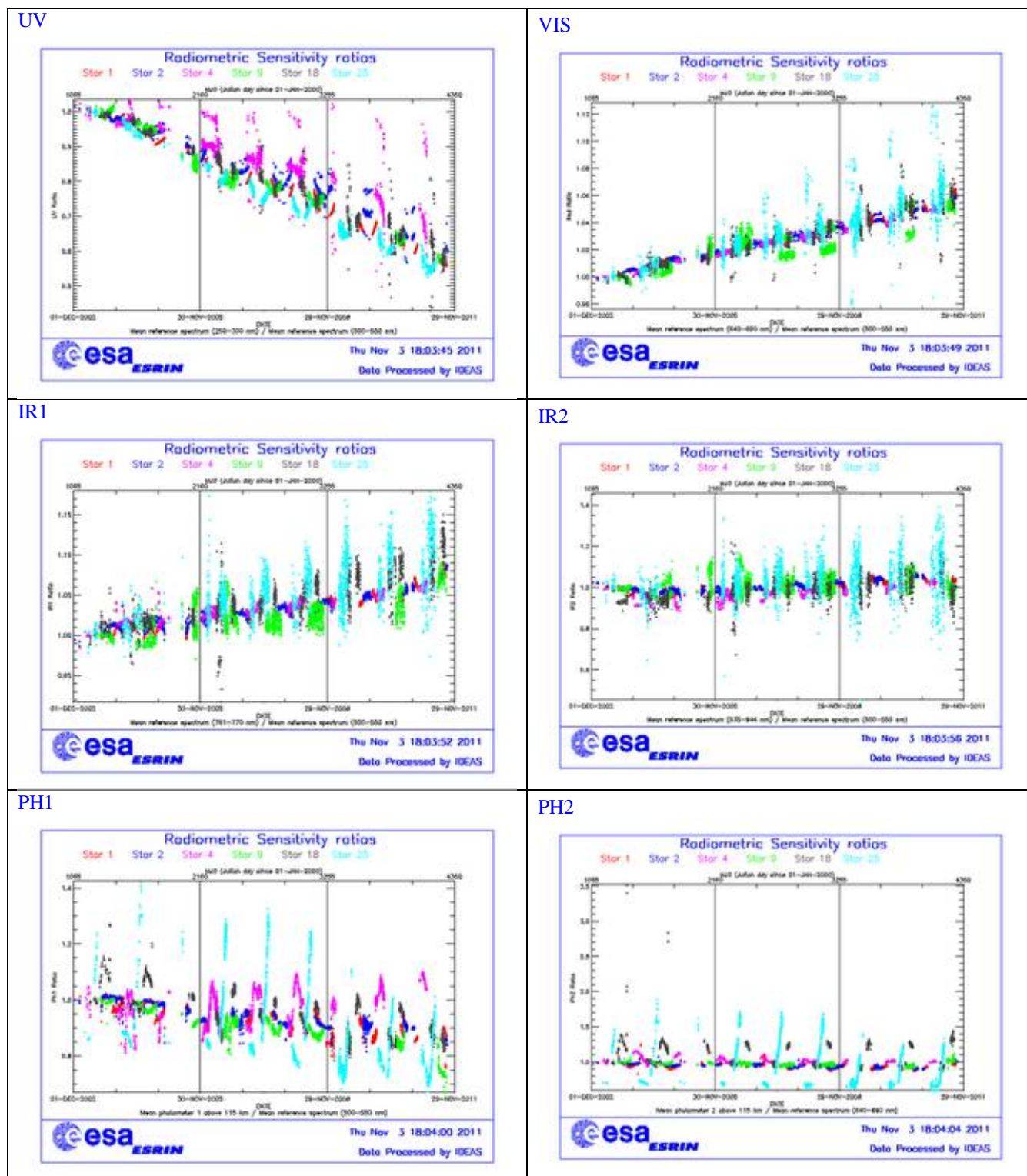


Figure 5.4-1: Radiometric sensitivity ratios since December 2002

The parts of the spectrum used are:

- UV: 250–300 nm
- Yellow: 500–550 nm
- Red: 640–690 nm
- Ir1: 761-770 nm
- Ir2: 935-944 nm

For the spectrometers the ratios are with respect to the ‘yellow’ spectral range. For the photometers, the ratios are calculated by dividing the mean photometer signal above the atmosphere (115 km) by the ‘yellow’ spectral range (for PH1) or by the ‘red’ spectral range (for PH2). The variation of the ratio should be within a given threshold which is set to 10% (see Table 5.4-1 that corresponds to Figure 5.4-).

**Table 5.4-1: Variation of RS for the different ratios (corresponds to fig. 5.4-1). Should be less than 10%**

Star Id	% Variation of UV ratio	% Variation of Red ratio	% Variation of IR1 ratio	% Variation of IR2 ratio	% Variation of Ph1 ratio	% Variation of Ph2 ratio
1	9.6	2.4	1.1	0.4	13.2	30.2
2	2.3	2.6	1.5	0.5	9.9	14.9
4	1.3	3.4	1.9	1.3	8.1	23.5
9	32.6	2.3	1.3	0.6	19.0	13.8
18	8.0	3.7	2.2	1.8	14.8	300.0
25	66.0	4.1	1.9	1.7	28.1	147.4

For every star, this variation is calculated as the difference between the maximum (or minimum) ratio, and the mean over the 15 first values (if there were not 15 values computed yet, all values would be used).

For star 9 and 25 the UV ratio is greater than the threshold 10%. It is clear (Figure 5.4-1) that there is a global decrease of UV ratios for all the stars. This confirms the expected degradation suffered by the UV optics that is, anyway, very small considering also the small variation for the rest of the stars (Table 5.4-1).

By looking at the photometers radiometric sensitivity ratios of Figure 5.4-, it can be seen that every star has a variation that seems to be annual. The variation is significant for stars 25 and 18. After some investigations performed by the QWG that exclude an inaccurate reflectivity correction LUT, it seems that the PH1/2 radiometric sensitivity variations could come from the fact that the spectrometers and the photometers are not illuminated the same way when the straylight appears (seasonal effect).

## 6 LEVEL 2 PRODUCT QUALITY MONITORING

Level 2 products from the operational ground segment have been disseminated during the reporting period to the users. Almost 100% of GOM\_NL\_\_2P products have been received by the IDEAS team for routine quality control and long term trend monitoring

## 6.1 Processor Configuration

### 6.1.1 VERSION

A new version of the processor, **GOMOS/6.01**, is in operations since **7 June 2011** (starting from orbits 48471/48477, respectively, in Kiruna and ESRIN). The main changes introduced by this processor are detailed in Table 6.1-1. The product specification is "PO-RS-MDA-GS-2009\_3/J". An updated disclaimer for level 1 and level 2 products is under way and will be soon available at <http://envisat.esa.int/dataproducts/availability/disclaimers>

**Table 6.1-1: PDS level 2 product version and main modifications implemented**

Date	Version	Description of changes
25-MAY-2011 07-JUN-2011	GOMOS/6.01 (FinCoPAC) GOMOS/6.01 (PDHS-E PDHS-K)	Algorithm baseline level 2 DPM 7.0: <ul style="list-style-type: none"> <li>• Full covariance matrix inversion: impact on error estimates and <math>X^2</math></li> <li>• New H RTP (High Resolution Temperature Profile) algorithm: improves the High Resolution Temperature profiles</li> <li>• New coding of the error bar (absolute value).</li> </ul>
16-JUN-2010	GOMOS/5.01	Identical to previous but with new orbit handling software needed for ENVISAT 2010 mission extension
13-DEC-2010	GOMOS/5.01	Level 2 version at FIN-CoPAC identical to previous (5.00L04) but running in Linux and with new orbit handling software needed for ENVISAT 2010 mission extension
19-NOV-2009	Level 2 version 5.00L04 at PDHS-E and PDHS-K (equivalent to GOMOS/5.00 but running in Linux OS)	Identical to version GOMOS/5.00
29-SEP-2009	Level 2 version 5.00L03 at PDHS-E and PDHS-K (equivalent to GOMOS/5.00 but running in Linux OS)	Identical to previous. LRAC could not switch to this version as a problem was preventing from processing some Level 0 data. A New version that corrects this problem was put in operations on 19th November 2009

<p>08-AUG-2006</p>	<p>Level 2 version 5.00 at PDHS-E and PDHS-K</p>	<p>Algorithm baseline level 2 DPM 6.2:</p> <ul style="list-style-type: none"> <li>• The optimisation of the DOAS iterations</li> <li>• Negative column densities and local densities not flagged anymore</li> <li>• Suppress the setting of maximum error in case of negative local densities</li> <li>• Correction of HRTP discrepancies, and error estimates fixed</li> <li>• Rename Turbulence MDS into High Resolution Temperature MDS (HRTP)</li> <li>• Add vertical resolution per species in local densities MDS</li> <li>• Add Solar zenith angle at tangent point and at satellite level in geolocation ADS</li> <li>• Add "tangent point density from external model" in geolocation ADS</li> <li>• Suppress contribution of "tangent point density from external model" in "local air density from GOMOS atmospheric profile" in geolocation ADS</li> </ul>
<p>23-JUL-2006</p>	<p>Level 2 version 5.00 at FinCoPAC</p>	<p>Change in configuration at the time of the switch over:</p> <ul style="list-style-type: none"> <li>○ 2<sup>nd</sup> order polynomial for aerosol</li> <li>○ Air fixed to ECMWF (local density set to 0 in the L2 products)</li> <li>○ Orphal cross-sections for O<sub>3</sub></li> <li>○ GOMOS cross-sections for other species</li> <li>○ Covariance matrix terms linked to air set to 0</li> <li>○ Air and NO<sub>2</sub> additional errors set to 0</li> </ul>
<p>23-MAR-2003</p>	<p>Level 2 version 4.02 at PDHS-E and PDHS-K</p>	<p>Algorithm baseline level 2 DPM 5.5:</p> <p>Section 3</p> <ul style="list-style-type: none"> <li>• Add references to technical notes on Tikhonov regularization</li> <li>• Change High level breakdown of modules: SMO/PFG</li> <li>• Change parameter: NFS in I2 ADF</li> <li>• Change parameter <math>\sigma_G</math> in I2 ADF (Table 3.4.1.1-II)</li> <li>• Change content of Level 2/res products – GAP</li> <li>• Change time sampling discretisation</li> <li>• Add covariance matrix explanation</li> </ul> <p>Section 5</p> <ul style="list-style-type: none"> <li>• Replace SMO by PFG VER-1/2: Depending on NFS, Apply either a Gaussian filter or a Tikhonov regularization to the vertical inversion matrix</li> <li>• Unit conversion applied on kernel matrix</li> <li>• Suppress VER-3</li> </ul> <p>Section 6</p> <ul style="list-style-type: none"> <li>• GOMOS Atmospheric Profile (GAP): not used in this version</li> <li>• Time sampling in equation (6.5.3.7-73)</li> </ul>

31-MAY-2003	Level 2 version 4.00 at PDHS-E and PDHS-K	<p>Algorithm baseline level 2 DPM 5.4:</p> <ul style="list-style-type: none"> <li>• Revision of some default values</li> <li>• Add a new parameter</li> <li>• Transmission model computation: suppress tests on valid pixels and species</li> <li>• Apply a Gaussian filter to the vertical inversion matrix</li> <li>• Very low signal values are substituted by threshold value</li> </ul>
21-NOV-2002	Level 2 version 3.61 at PDHS-E and PDHS-K	<ul style="list-style-type: none"> <li>• Algorithm baseline level 2 DPM 5.3a:</li> <li>• Revision of some default values</li> <li>• Wording of test T11</li> <li>• Dilution term computation of jend</li> <li>• Covariance computation scaling applied before and after</li> </ul>

**Table 6.1-1: GOPR level 2 product version and main modifications implemented**

Date	Version	Description of changes
14-OCT-2005	GOPR_6.0f	<ul style="list-style-type: none"> <li>• The optimisation of the DOAS iterations</li> <li>• Negative column densities and local densities not flagged anymore</li> <li>• Suppress the setting of maximum error in case of negative local densities</li> <li>• Correction of H RTP discrepancies, and error estimates fixed</li> </ul> <p>Configuration for second reprocessing:</p> <ul style="list-style-type: none"> <li>○ 2<sup>nd</sup> order polynomial for aerosol</li> <li>○ Air fixed to ECMWF (local density set to 0 in the L2 products)</li> <li>○ Orphal cross-sections for O<sub>3</sub></li> <li>○ GOMOS cross-sections for other species</li> <li>○ Covariance matrix terms linked to air set to 0</li> <li>○ Air and NO<sub>2</sub> additional errors set to 0</li> </ul>
17-MAR-2004	GOPR 6.0a	<ul style="list-style-type: none"> <li>• Rename Turbulence MDS into High Resolution Temperature MDS (H RTP)</li> <li>• Add vertical resolution per species in local densities MDS</li> <li>• Add Solar zenith angle at tangent point and at satellite level in geolocation ADS</li> <li>• Add "tangent point density from external model" in geolocation ADS</li> <li>• Suppress contribution of "tangent point density from external model" in "local air density from GOMOS atmospheric profile" in geolocation ADS</li> </ul>
18-AUG-2003	GOPR 5.4d	<ul style="list-style-type: none"> <li>• Tikhonov regularisation is implemented</li> </ul>
18-MAR-2003	GOPR 5.4b	<ul style="list-style-type: none"> <li>• Modification to implement the computation of Tmodel for spectrometer B (in version 5.4b, the Tmodel for SPB is still set to 1)</li> </ul>
30-JAN-2003	GOPR 5.4a	<ul style="list-style-type: none"> <li>• Modifications for ACRI internal use only. No impact on level 2 products.</li> </ul>

### 6.1.2 AUXILIARY DATA FILES (ADF)

The ADF’s files in Table 6.1-2 and Table 6.1-3 are used by the PDS to process the data from level 1 to level 2. For every type of file, the validity runs from the start validity time until the start validity time of the following one, but if an ADF file has been disseminated after the start validity time, it is obvious that it will be used by the PDHS-E and PDHS-K PDS only after the dissemination time (this happens the



majority of the time). Note that the files outlined in yellow are the set of auxiliary files used during the reporting period.

**Table 6.1-2: Historic GOM\_PR2\_AX files used by PDS for level 2 products generation. The GOM\_PR2\_AX is a file containing the configuration parameters used for processing from level 1b to level 2 products**

Used by PDS for Level 2 products generation during	GOM_PR2_AX (GOMOS Processing level 2 configuration file)
01-MAR-2002 → 29-JUL-2002	GOM_PR2_AXVIEC20020121_165624_20020101_000000_20200101_000000 <ul style="list-style-type: none"> <li>Pre-launch configuration</li> </ul>
30-JUL-2002 → 02-SEP-2002	GOM_PR2_AXVIEC20020729_083851_20020301_000000_20100101_000000 <ul style="list-style-type: none"> <li>Maximum value of chi2 before a warning flag is raised (set to 5)</li> <li>Maximum number of iterations for the main loop (set to 1)</li> </ul>
03-SEP-2002 → 12-NOV-2003	GOM_PR2_AXVIEC20020902_151029_20020301_000000_20100101_000000 <ul style="list-style-type: none"> <li>Maximum value of chi2 before a warning flag is raised (set to 100)</li> </ul>
13-NOV-2003 → 22-MAR-2004	GOM_PR2_AXVIEC20021112_170458_20020301_000000_20100101_000000 <ul style="list-style-type: none"> <li>Smoothing mode</li> <li>Hanning filter</li> <li>Number of iterations</li> <li>Spectral windows to suppress the O2 absorption in the high spectral range of SPA2</li> </ul>
23-MAR-2004 <i>Note:</i> this file was used by the GOMOS/4.02 processors before the IECF dissemination. The dissemination was done on 25 <sup>th</sup> March 2004	GOM_PR2_AXVIEC20040316_145613_20020301_000000_20100101_000000 Pressure at the top of the atmosphere Number of GOMOS sources data (used in GAP) Activation flag for GOMOS sources data (GAP) Smoothing mode (after the spectral inversion) Atmosphere thickness
08-AUG-2006 → 11-NOV-2009	GOM_PR2_AXNIEC20051021_081111_20020301_000000_20100101_000000 Several level 2 processing configuration parameters
12-NOV-2009	GOM_PR2_AXVIEC20091111_152718_20020301_000000_20500101_000000 Same content as the previous one but with extended validity end time

**Table 6.1-3: Historic GOM\_CRX\_AX files used by PDS for level 2 products generation. The GOM\_CRX\_AX is a file containing the cross sections used for processing from level 1b to level 2 products**

Used by PDS for Level 2 products generation during	GOM_CRX_AX (GOMOS Cross Sections file)
01-MAR-2002 → 08-MAR-2002	GOM_CRX_AXVIEC20020121_164026_20020101_000000_20200101_000000 <ul style="list-style-type: none"> <li>Pre-launch configuration</li> </ul>
09-MAR-2003 → 29-JUL-2002	GOM_CRX_AXVIEC20020308_185417_20020101_000000_20200101_000000 <ul style="list-style-type: none"> <li>Corrected NUM_DSD in MPH - was 14 and is now 19 - and corrected spare DSD format by replacing last spare by carriage returns in file GOM_CRX_AXVIEC20020121_164026_20020101_000000_20200101_000000</li> </ul>
30-JUL-2002 → 25-MAR-2004	GOM_CRX_AXVIEC20020729_082931_20020301_000000_20100101_000000 <ul style="list-style-type: none"> <li>O3 cross-sections summary description (SPA)</li> <li>NO3 cross-sections summary description</li> <li>O2 transmissions summary description</li> <li>H2O transmissions summary description</li> <li>O3 cross sections (SPA)</li> </ul>
26-MAR-2004 <i>Note:</i> the file was disseminated on 27 Jan 2004 but could not be used by PDS until version GOMOS/4.02 was in operation	GOM_CRX_AXVIEC20040127_150241_20020301_000000_20100101_000000 Update of the O2 and H2O transmissions (S.A input) Extension by continuity of the O3 cross-section for SPB

08-AUG-2006 → 11-NOV-2009	GOM_CRS_AXNIEC20051021_080452_20020301_000000_20100101_000000 Updated O <sub>3</sub> cross-sections
12-NOV-2009	GOM_CRS_AXVIEC20091111_154832_20020301_000000_20500101_000000 Same content as the previous one but with extended validity end time

### 6.1.3 RE-PROCESSING STATUS

The improvement of the GOMOS processing chain is a continuous on-going activity, not only for the processing algorithm but also for the instrument characterization data. In order to provide the best quality products to the users, systematic reprocessing activities are planned when a new processor is ready.

A full mission reprocessing with the current operational version 6.01 will start as soon as the ADF relevant for wavelength assignment is corrected (section 5.1.2).

The second reprocessing activity covering years 2002-2006 (until 4<sup>th</sup> July 2006) using the prototype GOPR\_6.0c\_6.0f (in line with the previous processor GOMOS/5.01) was completed in 2006. This data can be retrieved via web query from <http://www.enviport.org/gomos/index.jsp>. FTP access to bulk reprocessing results (one tar file of GOMOS products per day) is allowed from the D-PAC: <ftp://gomo2usr@ftp-ops.de.envisat.esa.int>

## 6.2 Quality Flags Monitoring

In this section, some information contained in the Quality Summary data set of the level 2 products arrived during reporting period is shown. In particular, the percentage of flagged points per profile for the local species O<sub>3</sub>, H<sub>2</sub>O, NO<sub>2</sub> and NO<sub>3</sub> is depicted (Figure 6.2-1). Only products in dark limb illumination conditions and without fatal errors (error flag in the MPH set to "0") are used.

The flagging strategy for GOMOS version GOMOS/6.01 foresees that a profile point is flagged when

- The local density is greater than a given maximum value
- The line density is not valid. And it occurs when:
  - The acquisition from level 1b is not valid
  - There is no acquisition used for reference star spectrum
  - The line density is greater than a given maximum value

Only for species: air, aerosol, O<sub>3</sub>, NO<sub>2</sub>, NO<sub>3</sub>, OCIO

- No convergence after a given number of LMA iterations
- $\chi^2$  out of LMA is bigger than  $\chi^2$
- Failure of inversion

Only for species: O<sub>2</sub>, H<sub>2</sub>O

- Spectro B only: no convergence
- Spectro B only: data not available
- Spectro B only: covariance not available

There are points mainly between about  $-30^{\circ}$  and  $35^{\circ}$  latitude (Figure 6.2-1) because in this period of the year full dark illumination condition occultations (only those products have been used for these plots) are geo-located on that region. In summer, full dark illumination data are mainly in the Southern Hemisphere while in winter it is the contrary: full dark illumination occultations are found mainly in the Northern Hemisphere.

Looking at Figure 6.2-1, the most relevant feature is the high percentage of flagged points per profile for some H<sub>2</sub>O profiles. Users should be careful in using these data as the quality is only guaranteed for a few stars. As a consequence of the current flagging strategy the percentage of flagged points per profile for O<sub>3</sub>, NO<sub>2</sub> and NO<sub>3</sub> is around 10-15%. It can be seen also that there are latitudinal bands with almost the same color (same percentages) mainly for H<sub>2</sub>O. This means that the percentages of flagged points per profile have a dependence on the stars that have been observed: a given star is always observed at the same latitude but at different longitude.

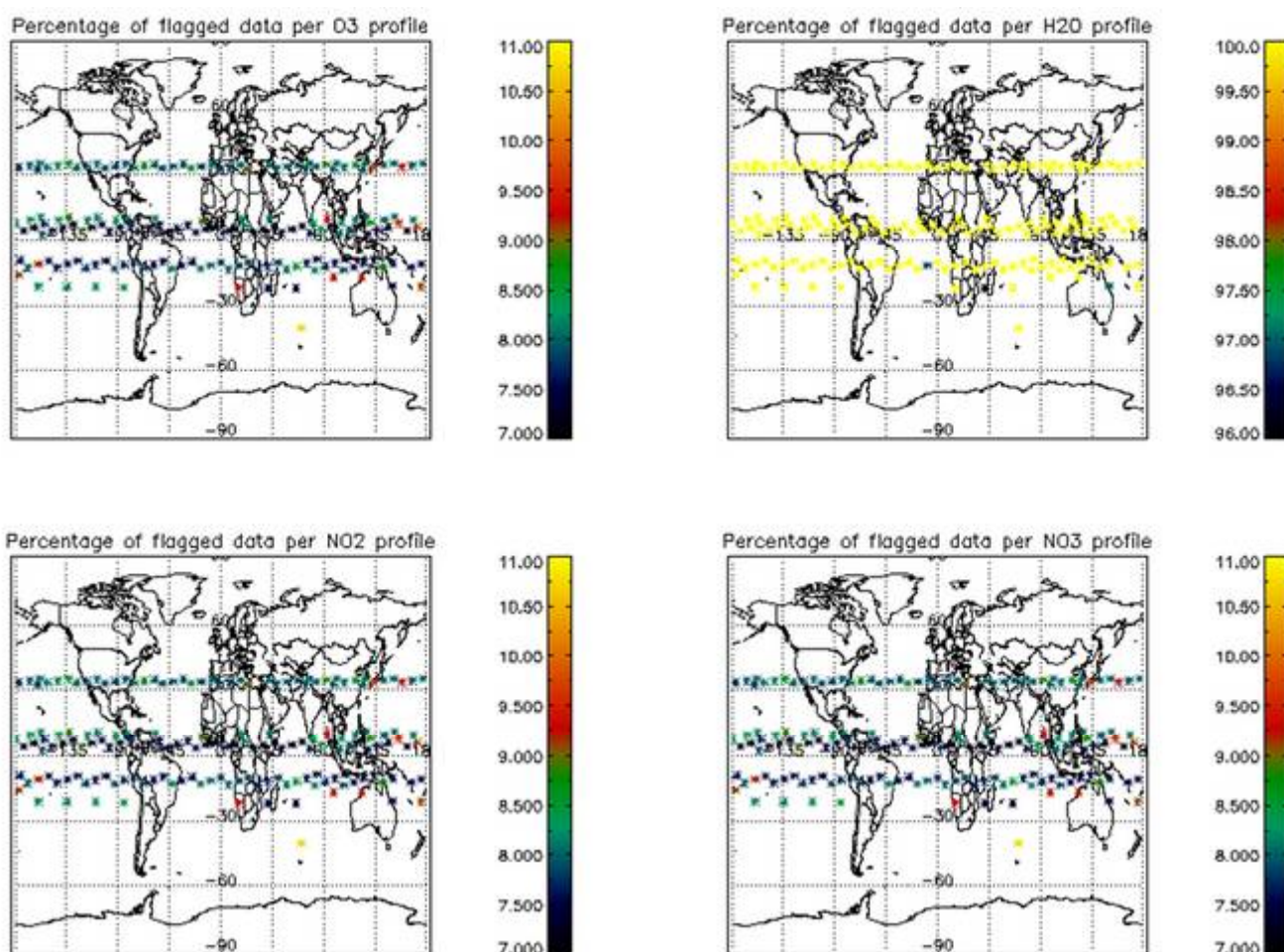


Figure 6.2-1: Percentage of flagged points per profile

### 6.3 Other Level 2 Performance Issues

#### 6.3.1 MONTHLY OZONE AVERAGE

The plot presented in Figure 6.3-1 is the average of the Ozone values during the reporting month in a grid of 0.5 degrees in latitude per 1 km in altitude.

For the current month the amount of data is significantly reduced due to the GOMOS unavailability and so the fig. 6.3-1 does not show any relevant information.

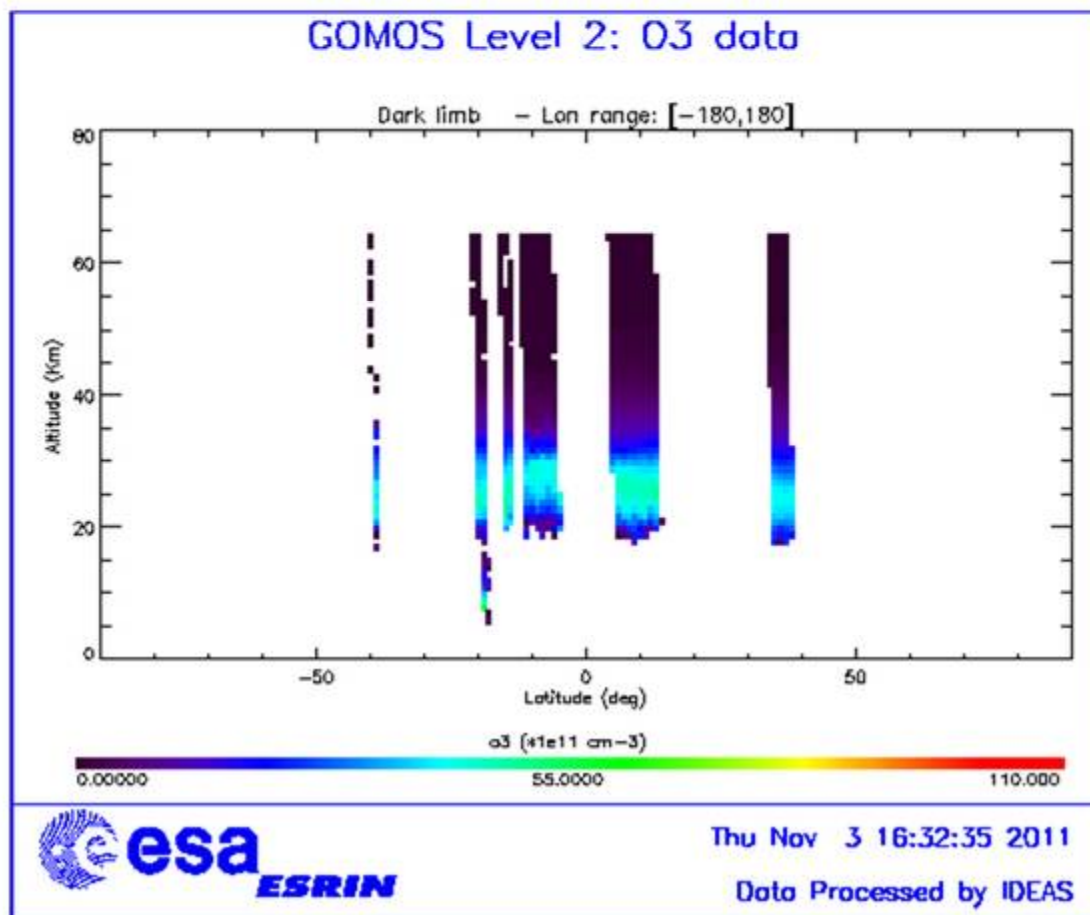


Figure 6.3-1: Average GOMOS O<sub>3</sub> profile during the reporting month: average in a grid of 1° latitude x 1 km altitude

#### 6.3.2 OZONE DISPERSION MONITORING

This section is the output of a QWG request for the monitoring of the dispersion around the equator [-30°, 30°] using the brightest star of the day and with temperature greater or equal than 7000 K. This request includes the plot of daily median ozone, daily averaged  $\chi^2$ , daily averaged estimated errors and daily dispersion (defined as STD/Mean in %). The first step is the interpolation to given altitude layers (20, 25, 30, 40, 50, 60, 70, 80 and 90 km) and afterwards the daily average is performed. More than 5 profiles per day should be used for the average, if for a given day the number of profiles is less than 5

(for the brightest star) then the following star in increasing magnitude is chosen. The data above the SAA have not been used because those data produce unwanted fluctuations in the monitoring curves. The numbers below the lower curve are the star ID of the stars used for the statistics whilst the numbers above the upper curve are the number of profiles used.

Figure 6.3-2 shows the daily ozone median for the reporting month. The daily averaged  $\chi^2$  is shown in Figure 6.3-3 while Figure 6.3-4 and Figure 6.3-5 show the daily average of estimated errors and the dispersion, respectively.

The few available data points show no major changes; a high value of the averaged  $\chi^2$ , as compared to the previous months, is observed at 20 km.

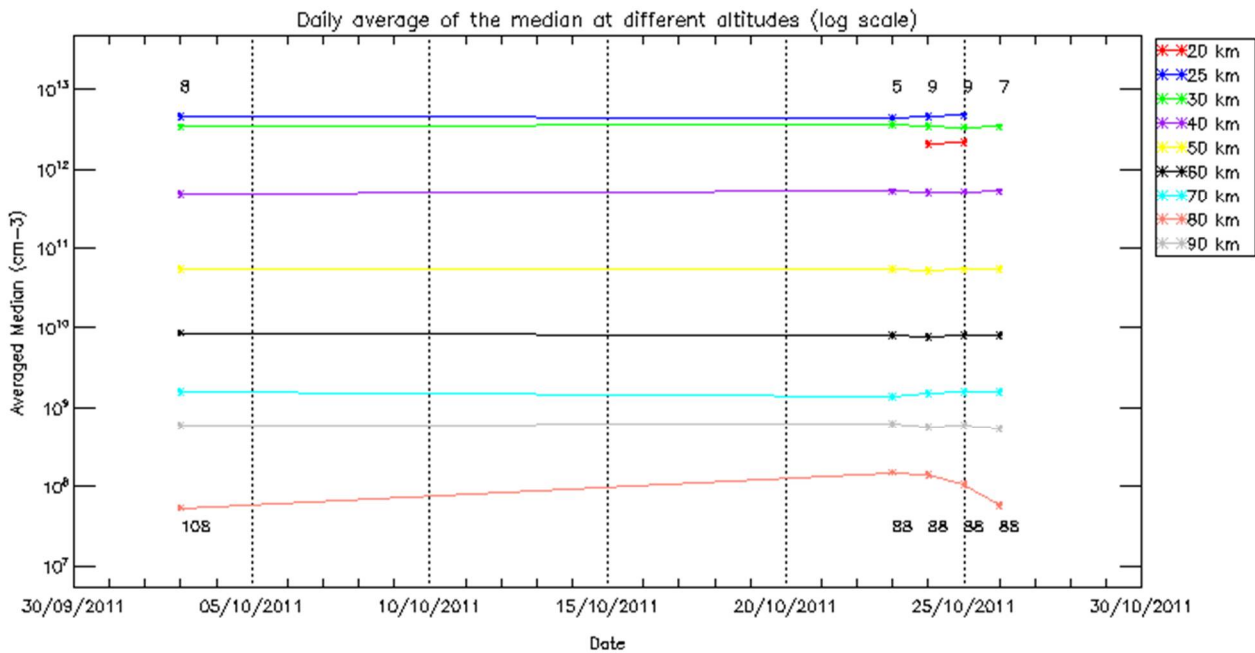


Figure 6.3-2: Daily ozone median at different altitude layers for the reporting month

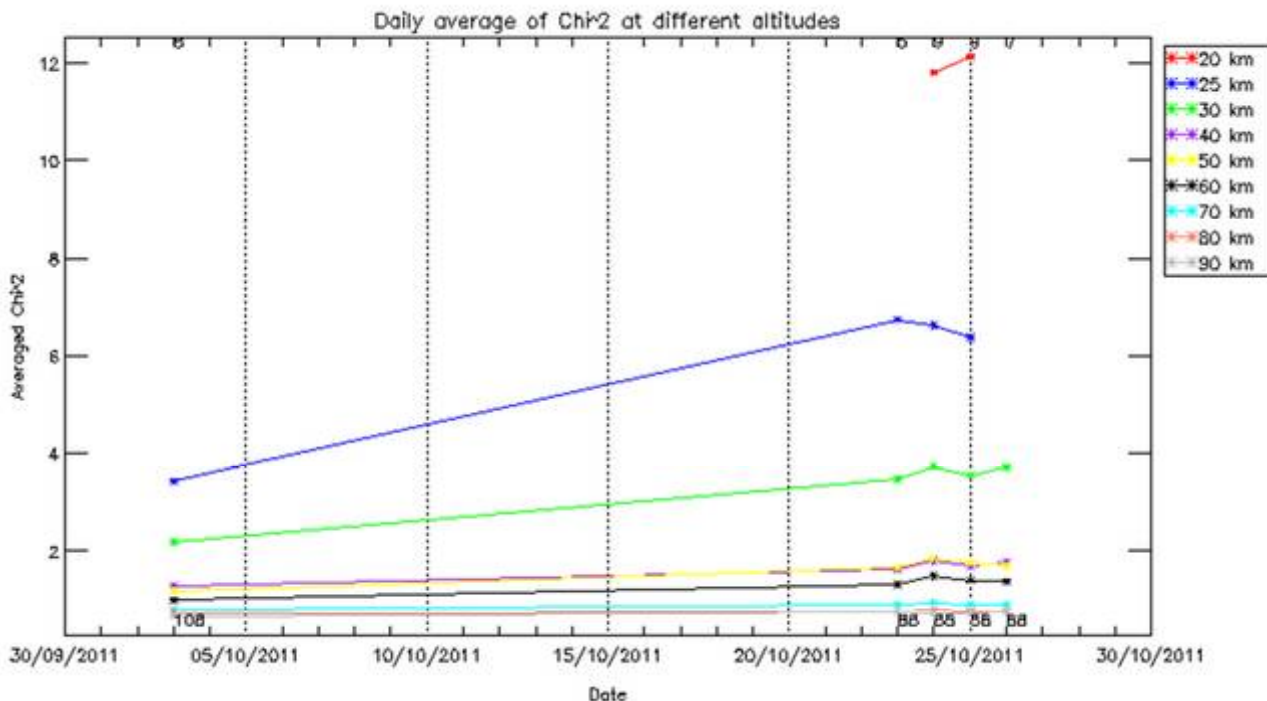


Figure 6.3-3: Daily chi2 average at different altitude layers for the reporting month

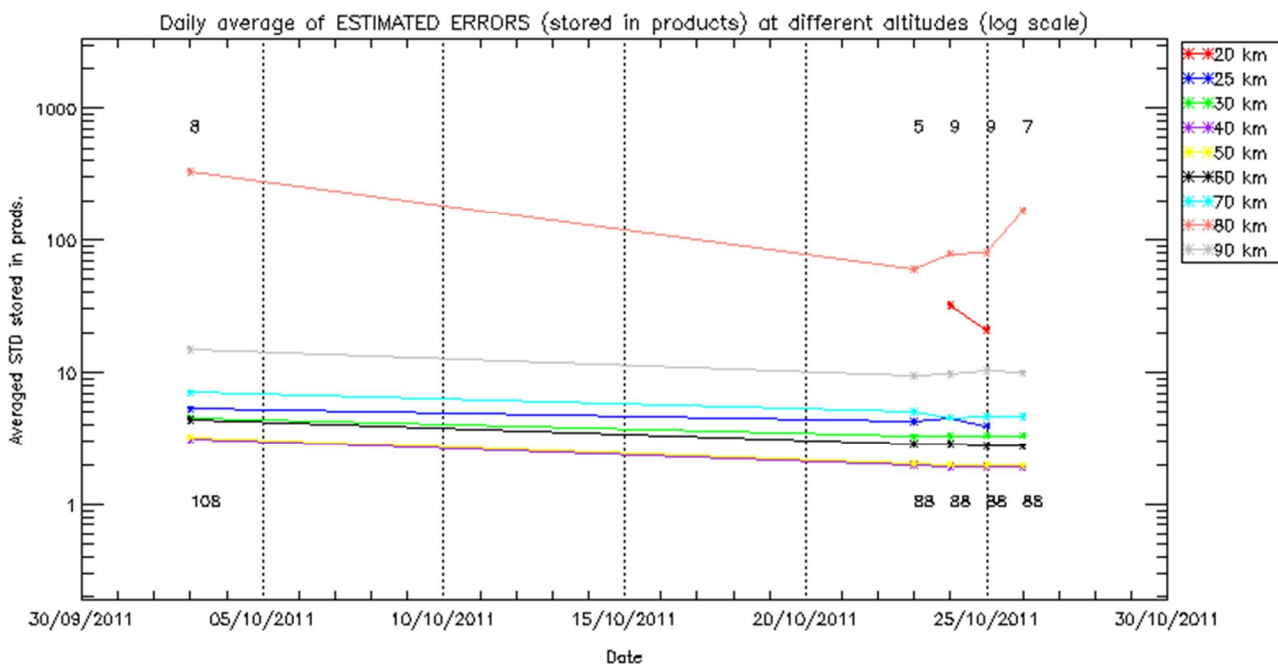


Figure 6.3-4: Daily average of the estimated errors at different altitudes

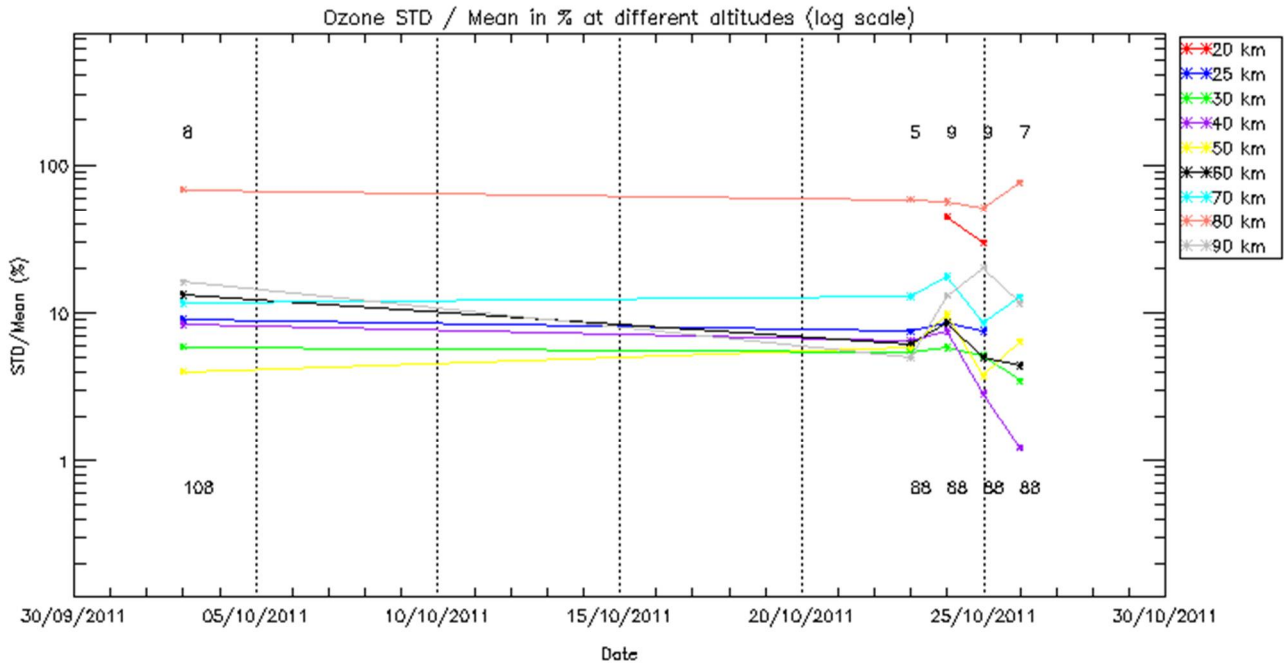


Figure 6.3-5: Daily dispersion defined as STD/Mean in %

### 6.3.3 MERIT FUNCTION

An estimator of the quality of the mission has been built in order to evaluate the scientific return of the mission as a function of time and in particular to survey the impact of the restricted azimuth window on the scientific results. Only dark, twilight, straylight and twilight+straylight ( $pcd\_illum = 0, 2, 3$  or  $4$ ) data are considered, bright limb data are not taken into account by this estimator. The quality estimator is computed with a merit function. We compute one quality estimator for the stratosphere, one for the mesosphere and one global which is a combination of the stratosphere and mesosphere ones ( $global = (2 * strat + meso) / 3$ ).

A merit function value is computed for each day since the beginning of the mission. The parameters taken into account for computing this merit function are the latitude coverage, the altitude coverage and the magnitude of the occulted stars during this day. Once the merit function has been computed for each day since the beginning of the mission, we normalize the curve to 1. The procedure to normalize is to compute a virtual "1 year" merit function normalizer. This normalizer is a smoothed upper envelope made of the highest values for each day considering all the years. As the year 2004 was the best year for GOMOS in term of quantity of observations, this normalization is close to normalizing by the year 2004. The value 1 should not be considered as the expected nominal value but rather as a comparison with the optimal year. The normalization allows also removing the seasonal variations due to availability of stars. The plot is updated until 31 August 2011; due a major inconsistency in the provision of GOMOS auxiliary data (section 5.1.2) the off-line consolidated production of GOMOS data (used for this estimation) has been stopped until the problem is solved.

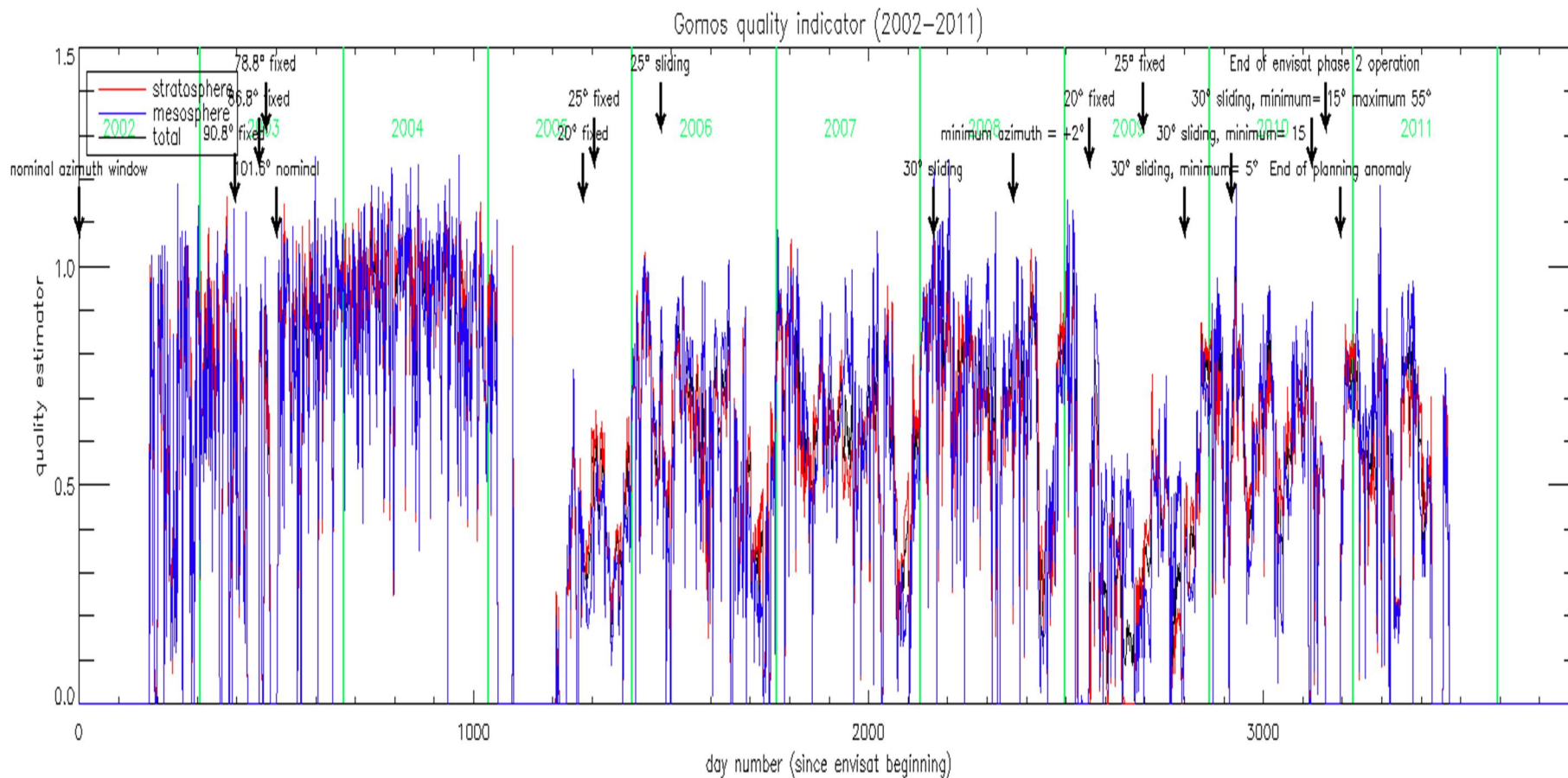


Figure 6.3-6: MERIT Function computed for each day normalized to the year 2004



## 7 VALIDATION ACTIVITIES AND RESULTS

### 7.1 GOMOS-ECMWF Comparisons (*Rossana Dragani, ECMWF input*)

The full ECMWF validation report is available at the following link:

[http://earth.esa.int/pcs/envisat/calval\\_res/2011/ecmwf\\_gomos\\_monthly\\_201110\\_all.pdf](http://earth.esa.int/pcs/envisat/calval_res/2011/ecmwf_gomos_monthly_201110_all.pdf)

A summary of the report is reported in the following paragraph:

- During October, the GOMOS instrument continued experiencing difficulties in performing nominal operations, which resulted in prolonged data unavailability for most of the month. The low data volume is unprecedented for ozone; while practically all water vapour observations were filtered out by the data quality filter implemented in the PDS to BUFR converter.
- Ozone data were only available at mid-latitudes in the NH (around 40 degrees N) and in the tropics, in the ratio of about one third and two third of the received data volume, respectively.
- The ozone first guess and analysis departures from GOMOS observations were typically negative (ozone analyses larger than GOMOS retrievals), with the only exceptions represented by the upper stratosphere at mid-latitudes in the NH and by the lower stratosphere ( $40 < p < 60$  hPa) in the tropics.
- The ozone first guess and analysis departures varied from -20 to +12% at most levels ( $0.2 < p < 60$  hPa) at mid-latitudes in the NH and in the tropical stratosphere. Slightly larger, negative values of the GOMOS-model departures were found (up to -33%) in the tropical mesosphere. The standard deviations of the ozone first-guess and analysis departures were larger than 10% at most levels and at both latitudinal bands.
- The monitoring statistics for October were produced with the operational ECMWF model, CY37R2.

## APPENDIX A

List of level 1b products that used the Calibration DC maps instead of the DSA observation (only ESRIN production):

Product name	DC information
GOM_TRA_IPNPDE20110901_010959_000000523106_00117_49700_1258.N1	DC map used
GOM_TRA_IPNPDE20111002_214039_000000433107_00144_50158_3665.N1	DC map used
GOM_TRA_IPNPDE20111002_223444_000000553107_00144_50158_3697.N1	DC map used
GOM_TRA_IPNPDE20111002_225251_000000503107_00145_50159_3698.N1	DC map used
GOM_TRA_IPNPDE20111003_002332_000000563107_00146_50160_3728.N1	DC map used
GOM_TRA_IPNPDE20111003_051546_000000603107_00148_50162_3799.N1	DC map used
GOM_TRA_IPNPDE20111003_052419_000000603107_00149_50163_3800.N1	DC map used
GOM_TRA_IPNPDE20111003_060145_000000443107_00149_50163_3801.N1	DC map used
GOM_TRA_IPNPDE20111003_061137_000000523107_00149_50163_3802.N1	DC map used
GOM_TRA_IPNPDE20111003_210346_000000443107_00158_50172_4011.N1	DC map used
GOM_TRA_IPNPDE20111003_211335_000000503107_00158_50172_4012.N1	DC map used
GOM_TRA_IPNPDE20111003_220654_000000613107_00159_50173_4038.N1	DC map used
GOM_TRA_IPNPDE20111003_224359_000000463107_00159_50173_4039.N1	DC map used
GOM_TRA_IPNPDE20111003_225347_000000513107_00159_50173_4040.N1	DC map used
GOM_TRA_IPNPDE20111004_044756_000000623107_00163_50177_4149.N1	DC map used
GOM_TRA_IPNPDE20111004_052453_000000453107_00163_50177_4150.N1	DC map used
GOM_TRA_IPNPDE20111004_062811_000000623107_00164_50178_4172.N1	DC map used
GOM_TRA_IPNPDE20111004_070506_000000483107_00164_50178_4173.N1	DC map used
GOM_TRA_IPNPDE20111004_071453_000000513107_00164_50178_4174.N1	DC map used
GOM_TRA_IPNPDE20111013_213942_000000463107_00302_50316_7625.N1	DC map used
GOM_TRA_IPNPDE20111013_214500_000000333107_00302_50316_7626.N1	DC map used
GOM_TRA_IPNPDE20111013_231955_000000483107_00303_50317_7643.N1	DC map used
GOM_TRA_IPNPDE20111013_232513_000000333107_00303_50317_7644.N1	DC map used
GOM_TRA_IPNPDE20111014_205557_000000463107_00316_50330_7771.N1	DC map used
GOM_TRA_IPNPDE20111014_210057_000000453107_00316_50330_7772.N1	DC map used
GOM_TRA_IPNPDE20111014_210249_000000463107_00316_50330_7773.N1	DC map used
GOM_TRA_IPNPDE20111014_210805_000000443107_00316_50330_7774.N1	DC map used
GOM_TRA_IPNPDE20111014_223610_000000473107_00317_50331_7796.N1	DC map used
GOM_TRA_IPNPDE20111014_224111_000000453107_00317_50331_7797.N1	DC map used
GOM_TRA_IPNPDE20111014_224818_000000473107_00317_50331_7798.N1	DC map used
GOM_TRA_IPNPDE20111015_001623_000000473107_00318_50332_7822.N1	DC map used
GOM_TRA_IPNPDE20111015_002124_000000473107_00318_50332_7823.N1	DC map used
GOM_TRA_IPNPDE20111015_002831_000000473107_00318_50332_7824.N1	DC map used
GOM_TRA_IPNPDE20111015_015637_000000473107_00319_50333_7883.N1	DC map used
GOM_TRA_IPNPDE20111015_020137_000000473107_00319_50333_7884.N1	DC map used
GOM_TRA_IPNPDE20111015_020844_000000453107_00319_50333_7885.N1	DC map used
GOM_TRA_IPNPDE20111015_033650_000000473107_00320_50334_7886.N1	DC map used
GOM_TRA_IPNPDE20111015_034150_000000473107_00320_50334_7887.N1	DC map used
GOM_TRA_IPNPDE20111015_034858_000000463107_00320_50334_7888.N1	DC map used
GOM_TRA_IPNPDE20111015_051704_000000463107_00321_50335_7917.N1	DC map used
GOM_TRA_IPNPDE20111015_052204_000000473107_00321_50335_7918.N1	DC map used
GOM_TRA_IPNPDE20111015_052911_000000473107_00321_50335_7919.N1	DC map used
GOM_TRA_IPNPDE20111015_065717_000000473107_00322_50336_7962.N1	DC map used
GOM_TRA_IPNPDE20111015_070217_000000463107_00322_50336_7963.N1	DC map used
GOM_TRA_IPNPDE20111015_070924_000000473107_00322_50336_7964.N1	DC map used
GOM_TRA_IPNPDE20111015_202403_000000463107_00330_50344_8100.N1	DC map used
GOM_TRA_IPNPDE20111015_203110_000000473107_00330_50344_8101.N1	DC map used
GOM_TRA_IPNPDE20111015_220416_000000463107_00331_50345_8129.N1	DC map used
GOM_TRA_IPNPDE20111015_221123_000000473107_00331_50345_8130.N1	DC map used
GOM_TRA_IPNPDE20111015_234430_000000453107_00332_50346_8164.N1	DC map used

GOM_TRA_IPNPDE20111015_235136_000000443107_00332_50346_8165.N1	DC map used
GOM_TRA_IPNPDE20111016_012443_000000453107_00333_50347_8200.N1	DC map used
GOM_TRA_IPNPDE20111016_013149_000000453107_00333_50347_8201.N1	DC map used
GOM_TRA_IPNPDE20111016_030456_000000473107_00334_50348_8226.N1	DC map used
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