GOME-2 Newsletter Archive

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Document Change Record

Issue / Revision	***Date***	***DCN. No***	***Changed Pages / Paragraphs***
v1	25/08/2010		Initial version. Transfer of GOME-2 Newsletter archive from GOME-2 Extranet CalVal pages to HB.
v1A	28/12/2010		Added newsletter 25. Updated Resource link section.
v1B	16/05/2011		Added newsletter 26.
v1C	14/09/2011		Added newsletter 27.
v1D	14/12/2011		Added newsletter 28.
v1J	23/05/2012		Added newsletter 29.
v1K	30/08/2012		Added newsletter 30.
v1L	31/08/2012		Added acronyms to list, Did edits to Metop nomenclature to match official nomenclature Metop
v2	02/11/2012		Added newsletter 31, after launch of Metop-B
v2A	08/01/2013		Added newsletter 32, during commissioning of Metop-B GOME-2 level 1b data
v3	18/04/2013		Added newsletter 33, end of commissioning of Metop-B GOME-2 level 1b and start of tandem operations
v4	06/01/2014		Added newsletter 34. Included report on GOME-2 tandem operations, changes to the 29-day repeat cycle, and announcement of the new product to be released.
v4A	22/05/2014		Added newsletter 35. Update of auxiliary files for FM3, introduction of PPF 6.0.0, PMAp update on PPF and documentation.
v4B	19/04/2015		Corrected issues with newsletter 35. Update of all equations (except the last one) in Section: *Applying PMD cloud fractions to main channel data – spatial aliasing.*
V4C	12/05/2015		Added newsletter 36. Update to processor (PPF) version 6.1.0.
V4D	25/04/2016		Added newsletter 37. Update to PMAp version 2 and degradation matrix version 1.
V4E	04/09/2018		Added newsletter 38. Metop-C launch preparations.

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1 INTRODUCTION

1.1 Purpose and Scope

This document informs about the latest developments concerning the GOME-2 instruments and level 1 product status as part of the EUMETSAT Polar System (EPS).

The EPS programme consists of a series of three Meteorological Operational (Metop) satellites, to be flown successively for more than 14 years from 2006, together with the relevant ground facilities. The first launch, the launch of Metop-2, was on 19 October 2006, from the Baikonur cosmodrome in Kazakhstan, using a Soyuz launcher. Once in orbit, the satellites are alphabetically ordered, so the first satellite that was launched is called Metop-A in operation.

The Global Ozone Monitoring Experiment–2 (GOME-2) is an optical spectrometer, fed by a scan mirror which enables across-track scanning in nadir, as well as sideways viewing for polar coverage and instrument characterisation measurements using the moon. GOME-2 senses the Earth's backscattered radiance and extraterrestrial solar irradiance in the ultraviolet and visible part of the spectrum (240 – 790 nm). The footprint size is 80 x 40 km for main channel data. The instrument also measures the state of linear polarisation of the backscattered earthshine radiances in two perpendicular directions. The polarisation data are down linked in 15 spectral bands covering the region from 312 to 800 nm for both polarisation directions with a footprint of 10 × 40 km. The GOME-2 instrument on board Metop-A is flight-model number 3 (FM3). The GOME-2 instrument on board Metop-B is flight-model number 2 (FM2). The GOME-2 instrument on board Metop-C will be flight-model number 1 (FM1).

For more information on the GOME-2 instrument and the level 0 to 1 processing we refer to the following resource websites.

GOME-2 fact sheet

www.eumetsat.int > Satellites > Metop > Instruments > GOME-2

Essential documentation on instrument and products

www.eumetsat.int > Data & Products > Resources

GOME-2 daily monitoring, essential technical documentation and instrument/processor history:

www.eumetsat.int > Service Status > Product Quality Monitoring > GOME-2 Instrument,

or via the following direct url:

http://gome.eumetsat.int

Meteosat and EPS system status news and service updates

www.eumetsat.int > Service Status

The newsletters also provide a case-by-case summary of status developments on GOME-2 level-2 products. The responsibility for development, operations and (continuous) validation is in the hands of the Ozone and Atmospheric Chemistry Satellite Application Facility (O3MSAF). For more information please consult the O3MSAF webpage at

http://o3msaf.fmi.fi.

The latest version of this newsletter is available from
www.eumetsat.int > Service Status > Product Quality Monitoring > GOME-2 Newsletter,

or via the GOME-2 monitoring pages:

http://gome.eumetsat.int > Metop-A/B -> Newsletter.

1.2 Document Structure

The newsletters are presented in chronological order with the most recent newsletter first. Some of the hyperlinks in the newsletters refer to pages in the EUMETSAT Extranet and require a registered user to have logged in already in order to function.

Note: Open issues or anomalies reported in older newsletters are very likely resolved later or may have been superseded by other issues.

For a list of instrument events and processor updates we refer to
http://gome.eumetsat.int > Metop-A/B -> Documentation > Processor change history

1.3 Applicable Documents

[AD1] GOME-2 Level 1 Product Format Specification, EPS.MIS.SPE.97232
[AD2] GOME-2 L1 Product Generation Specification, EPS.SYS.SPE.990011

1.4 Reference Documents

[RD1] GOME-2 Product Guide, EUM/OPS-EPS/MAN/07/0445

1.5 Acronyms used in this document

Acronym	*Meaning*
AVHRR	Advanced Very High Resolution Radiometer
CGS	Core Ground Segment
ESA	European Space Agency
FPA	Focal Plane Assembly (GOME-2 main channel detectors)
PDU	Product Dissemination Unit (3-minute chunk of EPS data disseminated in near-real time)
PFS	Product Format Specification document
PGS	Product Generation Specification document
PMD	Polarisation Measurement Devices
PPF	Product Processing Facility
SSST	Single Space Segment Team
UTC	Universal Transport Container

2 NEWSLETTER ARCHIVE

2.1 Newsletter #38 September 2018

Preparation for Metop-C launch and SIOV

Preparations for a launch of Metop-C from the “European Space Port” Centre Spatial Guyanais (CSG) in Kourou, French Guiana on 7 November 00:47 UTC are ongoing at EUMETSAT. Three consecutive launch attempts over 4 days can be performed with the Soyuz launcher with Fregat upper stage once fuelled. The preparation of Metop-C is well advanced at the launch site and a 4 weeks Stand-by Period had been introduced before re-start of the launch campaign for the final activities to count-down. The launch is followed by a LEOP phase of three days, after which the satellite is handed over to EUMETSAT for satellite operations. The satellite and instrument and in-orbit verification (SIOV) will start directly after the LEOP phase. The GOME-2 In-Orbit Verification (GIOV) will start with an initial phase of functional tests and performance as well as nominal timeline operations, all carried out with “warm” detectors, to allow for the initial instrument and platform outgassing without attracting contamination at the detector level.
The detector coolers will then be switched on with a gradual decrease of detector temperatures during the first week of December. This is followed by the next major milestone, the opening of the solar port shutter. We expect a first measurement of the sun just before Christmas around the 21st of December.

In the days over Christmas and New Year the instrument will acquire nominal and daily calibration spectra which should gradually lead to a stable nominal measurement conditions.

Commissioning and early data dissemination

The end of GIOV is marked by another throughput test, gradually increasing and then decreasing the detector temperatures (from their nominal un-cooled temperature plateau to their nominal low temperature plateau) to acquire temperature related signal responses as a reference early in the mission. Thereafter, during the course of January and February, the on-ground level-1b processing is brought to a quality level sufficient for early evaluation of level-2 performance. Early dissemination of level-1b data to selected users is therefore planned for mid-February. During the following months further adjustments in data quality are carried out involving the early feedback of level-2 data users, such as the AC SAF who provide most of the operational GOME-2 level-2 products. The commissioning phase is expected to end with the release of the Metop-C GOME-2 level-1b commissioning report and the start of dissemination of level-1b data to all users by May/June 2019. The start of operational dissemination of GOME-2 level-2 products by the AC SAF and the Polar Multi-Sensor Aerosol product (PMAp) is planned to follow with a couple of weeks of the start of 1b operations.

Three Metops

After the launch of Metop-C there will be three Metop platforms operating. Metop-C will be placed in the same orbit (with LT equator crossing at 9:30 UTC as for Metop-A and B) as Metop-A and B at equal distance to both platforms (“tristar” configuration – see Figure 1).

This platform phasing is the favourable phasing for LEOP and SIOV providing the most margin at the data downlink stations. During the course of commissioning and based on early data-user feedback the decision will be made to either remain in a “tristar” phasing configuration or to shift Metop-C 180 degrees opposite to Metop-B (original A/B configuration) with Metop-A in-between (“trident” configuration – see Figure 1).

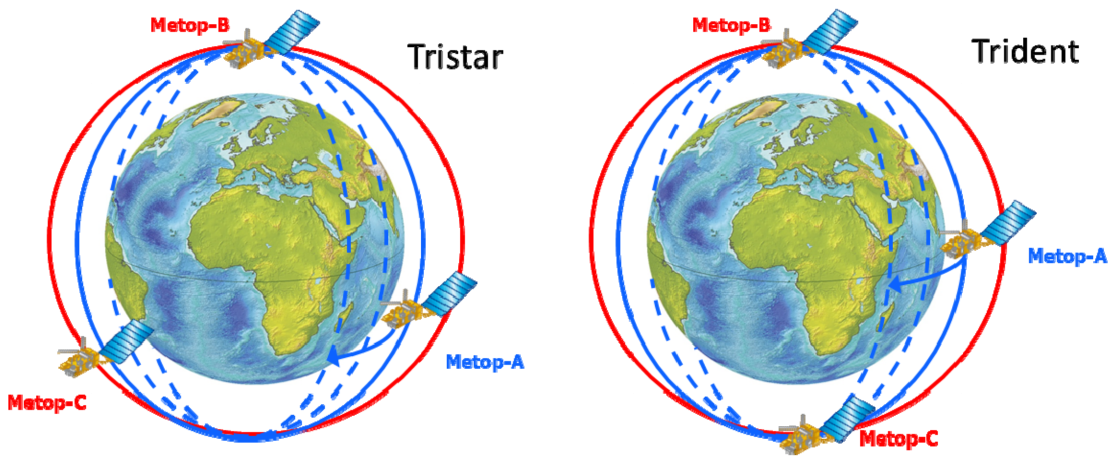

Figure 1: Left panel: Three Metops phasing with 120 degree separation (“Tristar”) adopted for SIOV and commissioning phase. Right panel: “Trident” phasing with 180 degree separation between Metop-B and C (as currently for Metop-A and B) and Metop-A phased at about 90 degrees in-between.

Milestones

7th of November:	Metop-C launch
Launch+3days:	Start of SIOV
~21st December:	GOME_2 solar port opening
11th January:	End of SIOV
Mid-February:	Start of early data-dissemination
May/June:	End of level-1b commissioning and start of dissemination

GOME-2 FM-1 (Metop-C) channel-3 anomaly

During an on-ground satellite test in March 2018 anomalous random “spike” signals have been detected in channel 3 of the GOME-2 flight-model 1 (FM1) to be launched on Metop-C. The spikes appeared in the dark-signal read-outs (see lower inlay Figure 2) at every 64th detector pixel with the direct neighbouring pixels receiving additional signal, too. In total 4% of the detector pixels in channel 3 are affected by the anomalous signals. All other GOME-2 channels are not affected. The spike positions appear to be stable by +- one pixel position since their first appearance in March 2018.

At its most recent meeting in Konstanz in May the Scientific and Technical advisory Group (STG) has endorsed the decision to “fly as is” and to remove the spike signatures by software processing on-ground. The degradation has been confirmed present and stable at the last functional tests with GOME-2 FM-1 on the launch site in July.

A new version of the level-0 to 1b processor (version 6.3) is currently being developed and tested and will be implemented during commissioning of Metop-C, after further tests of a recently developed spike-removal scheme (dead-pixel mask – DPM) prove successful. A prerequisite for a successful and stable removal of the anomalous signatures with minimal to negligible impact on the level-2 products is that the spike positions remain stable over the course of at least one orbit. The spike positions will be detected using the daily white-light-source (WLS) calibration measurement, will be monitored and, if needed, updated using dark-measurements carried out during every orbit.

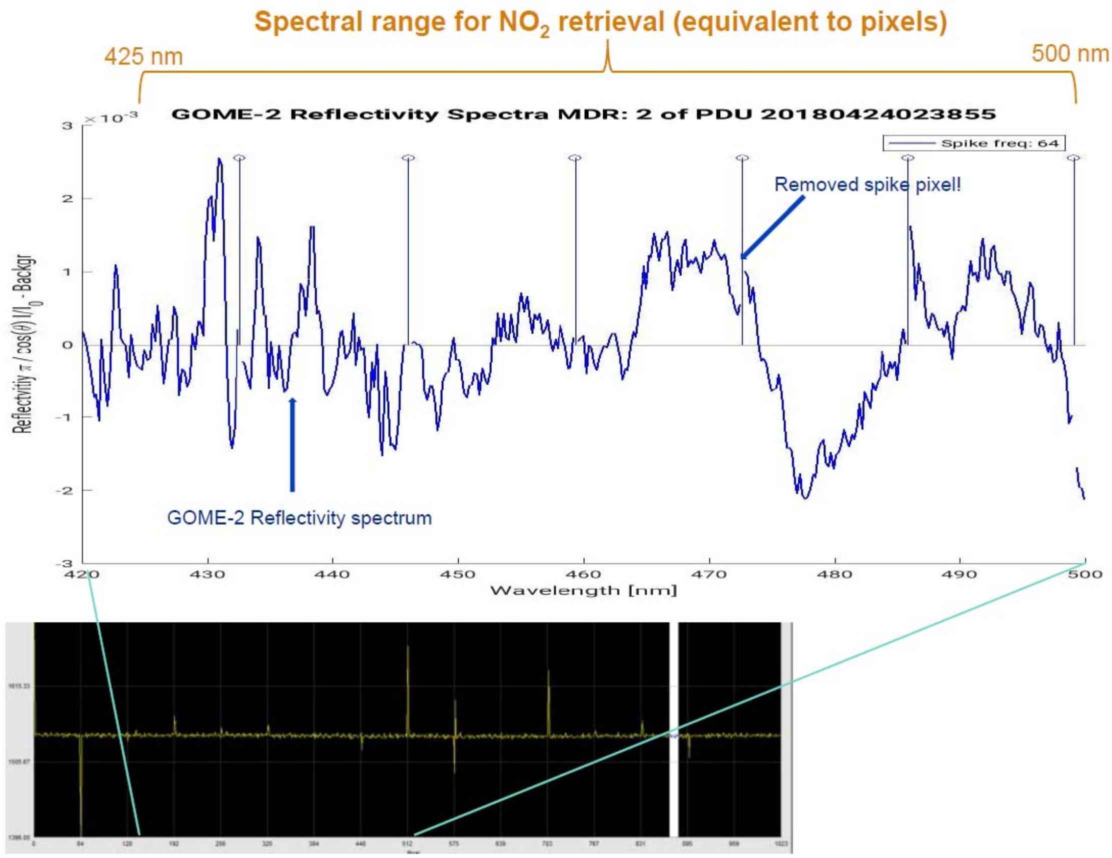

Figure 2: Lower panel: Dark signal readout with every 64th detector pixel exhibiting a Spike (random read-out signal). Upper panel: A GOME-2 reflectivity spectrum in the NO2 spectral region of channel 3 with background removed and every 64th (+-1) detector pixel set to NaN. The vertical lines indicate the position of the removed read-outs.

The upper inlay in Figure 2 shows the NO2 spectral region between 420 and 500 nm with a reflectivity spectrum from GOME-2 for which a broad-band background has been removed and every 64^{th} (+-1) detector pixel read-out has been set to not-a-number (vertical stem lines). Out of the 375 detector pixels covering the region 18 have been removed resulting in a loss of 4% of the nominal information content. As a result of dead-pixel screening, a small increase in retrieval noise but a negligible impact on absolute accuracy is therefore expected, providing the anomaly remains stable in orbit.

2.2 Newsletter #37 May 2015 – April 2016

1. PMAp version 2 – AOD over land update released

EUMETSAT released a major update to the Polar Multi-Sensor Aerosol properties (PMAp) product on 17 March 2016. The new release extends the coverage of the previous Aerosol Optical Depth (AOD) product, which was restricted to water surfaces. Now, this AOD product has global coverage even for solar zenith angles lower than 70 degrees, and includes AOD over almost all land surface types, including desert areas, but excluding surfaces with snow/ice cover. This updated product also contains a realistic AOD error estimate.

The update uses a new netCDF4 data model, which significantly improves the organisation of the data-fields and their structures and also provides additional parameters. The parameter-naming scheme has been changed to allow compatible with future mission-naming conventions used for EPS second-generation missions. Complete details are in the updated PMAp user guide.

The PMAp retrieval algorithm relies on the GOME-2 instrument Polarisation Measurement Device (PMD) observations and makes use of the unique polarisation-sensitive information it provides. This information also includes sub-pixel resolution information from the AVHRR imager, as well as thermal infra-red information from the IASI instrument on the EPS mission.

Changes to the retrieval algorithm with respect to Version 1 of the PMAp product are detailed in the latest version of the ATBD. See also the PMAp Factsheet and an updated PMAp validation report for version 2 together with other relevant documentation on the Technical Documents page:
http://www.eumetsat.int/website/home/Data/TechnicalDocuments/index.html > GDS Metop > PMAp

For instructions on accessing PMAp data, go here:
http://navigator.eumetsat.int/discovery/Start/DirectSearch/DetailResult.do?f%28r0%29=EO:EUM:DAT:METOP:PMAP

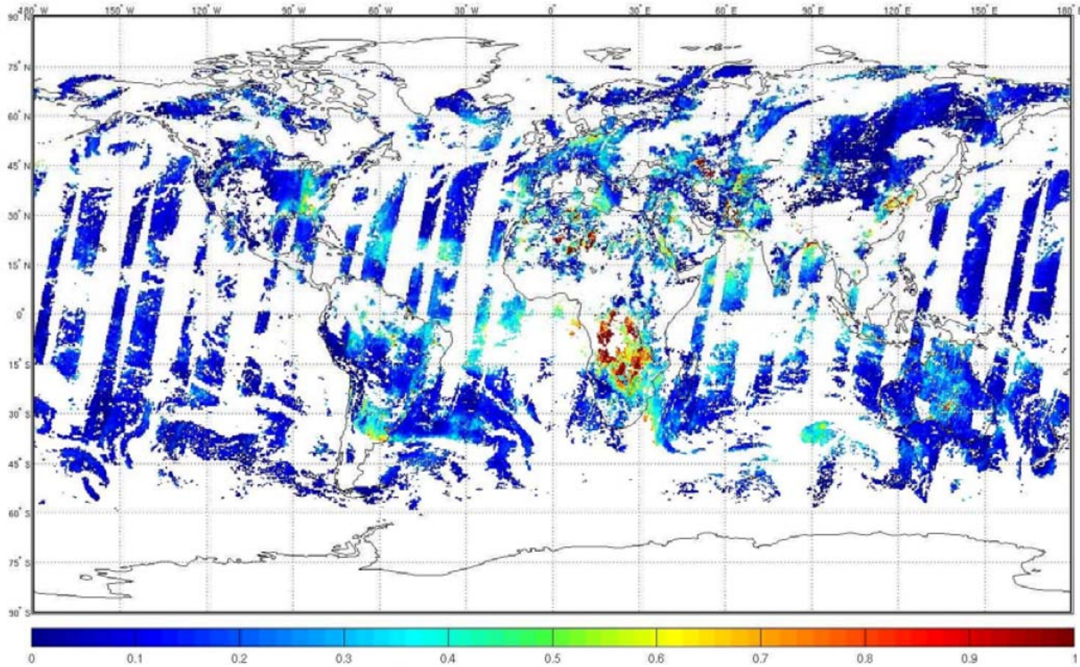

Figure 3: PMAp-derived AOD values from both Metop-A and Metop B platforms using level-1b data from GOME-2 PMD and AVHRR measurements.

2. The GOME-2 degradation model for the preparation of GOME-2 level-1C data

The latest version of the GOME-2 degradation model (v.1.0.C) for both Metop-A (M02) and Metop-B (M01) data is available for testing at this address:

ftp://ftp.eumetsat.int/pub/EPS/out/lang/Level1C/

This version is based on GOME-2 level-1B data generated during the time span of 2007-01-25 to 2015-12-31 for Metop-A. For Metop-B data, the degradation correction coefficients provided by the model are based on the time span 2012-12-01 to 2015-12-31. Both models now include an extended model forecast time span that covers data from 2016-01-01 to 2016-12-31, which is based on one year of forecast base time taken from 2015.

The GOME-2 degradation model (v.1.0.C) coefficients therefore provide the capability to correct GOME-2 data until the end of 2016, removing potential issues originating from differences in the degradation of the solar path and the earthshine path. The model assumes a moderate variation of the amount of radiance degradation in the spectral domain; but it is capable of removing significant spectral structures introduced partly by the changing spectral interference patterns of contamination layers on the entrance scan mirror and partly by the solar diffuser systems. The model provides degradation coefficients for all detector pixels (including the two PMD channels) and for the earthshine and solar paths separately. It also provides a set of coefficients for 24 viewing angles addresses to compensate for the effect of viewing angle differences in the observed differential degradation. Using this technique, the degradation correction can also be carried out for solar or earthshine radiances separately.

a. Application of version 1.0.C GOME-2 degradation coefficients

To apply the model degradation coefficients is a straight-forward process and is detailed in the README file provided with the data on the FTP server. The correction is done by applying this set of equations:

Earthcorr = (Earth – cStray,1,2(v,t,ch=1)) / cEarth (l,v,t)

SMRcorr = SMRNewAIRR / cSMR (l,t)

Where:

v	**is viewing angle**
t	**is Day (Julian date with pivot date 0000-00-00)**
l	**is wavelength (detector pixel)**

Since all three dimensions (v, t, and l) are static reference grids, the coefficients have to be interpolated from their fixed grid domains–both in wavelength and viewing angles–to the grids actually used in the level-1B data and for each application.

Note: The set of SMR degradation coefficients (cSMR (l,t)) apply only to in-flight solar-diffuser (AIRR)-calibrated SMR spectra provided with the data in the FTP repository. (see README).

See the README file for v. 1.0.C for complete specifications and examples instructions for this calculation.

b. Initial validation: a graphic illustration

Figure 4 shows the modelled degradation at one wavelength (at 320 nm) and for one viewing angle (v=17 @ close to nadir). The panels show Solar, Earthshine and Reflectance signals (in red, green and blue plots) over their full model fits (solid black lines) and their temporal degradation coefficients identified as *Fit*, *Trend*, and *Trend I/I* in the plot legends below. The model applies multiple splines to the in-flight AIRR-calibrated solar signal and excludes instrument-anomaly related outliers. It applies a linear combination of trigonometric functions together with various polynomial and step-function fittings for the reflectance data. The reflectance data takes atmospheric seasonal variations into account. The Earthshine model and degradation coefficients are effectively derived by combining the results of the solar model and the reflectance model.

Model input Earthshine data is screened for cloud and collected over the Libyan Desert, where surface albedo-related temporal variations are known to be small. Comparisons with degradation coefficients derived from Pacific data screened for clouds have produced the same results.

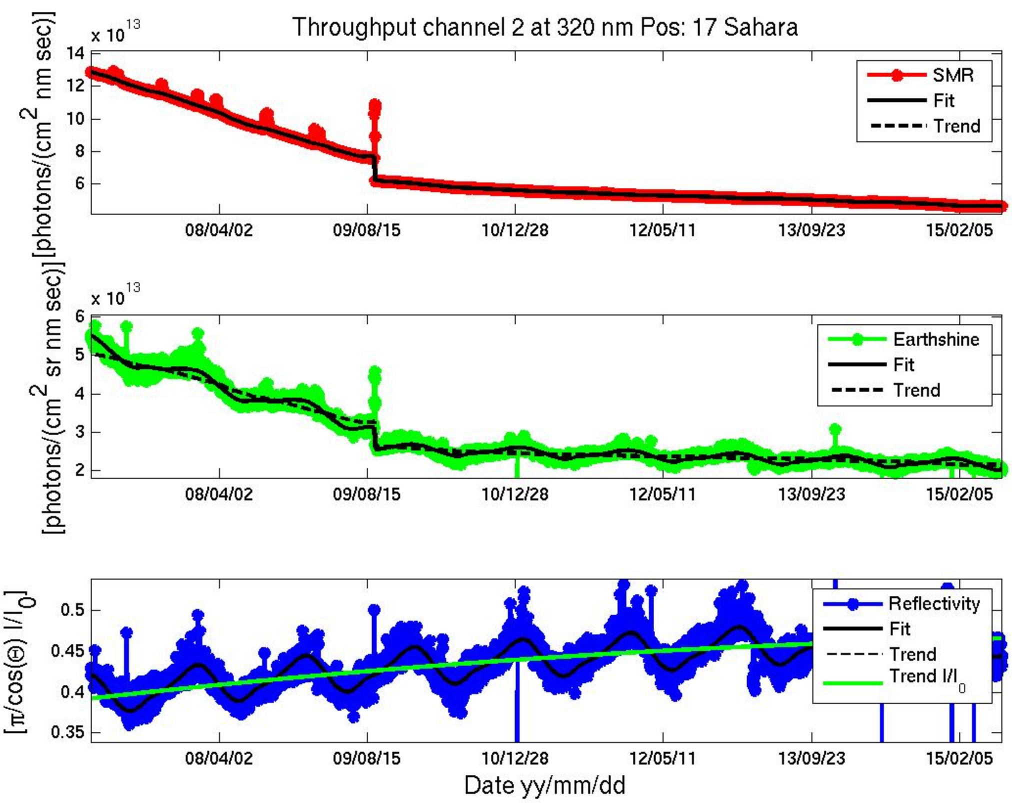

Figure 4: GOME-2 signals for the Sun (top), Earthshine (middle), and Reflectance (bottom panel) values at 320 nm (channel 2). The solid black lines provide the degradation model spline (Sun) and fit (Earthhsine/Reflectance) results. The dashed black lines show the polynomial fit results providing the

degradation correction coefficients. The Trend I/I *line in the bottom panel is the control degradation coefficient result for the main reflectance product produced from Earth- and Sunshine coefficients at 320 nm.*

Figure 5 shows the ratio of Solar path divided by Earthshine path degradation coefficients (cEarth (l,1,t) / cSMR (l,t)) of Metop-A for the most Eastward-looking viewing angle (v=1) and for all wavelengths of at least l.0 up to 31 December 2015, as well as for the extended forecast until end 2016. This ratio effectively corrects GOME-2 level-1B reflectance values to level-1C data.

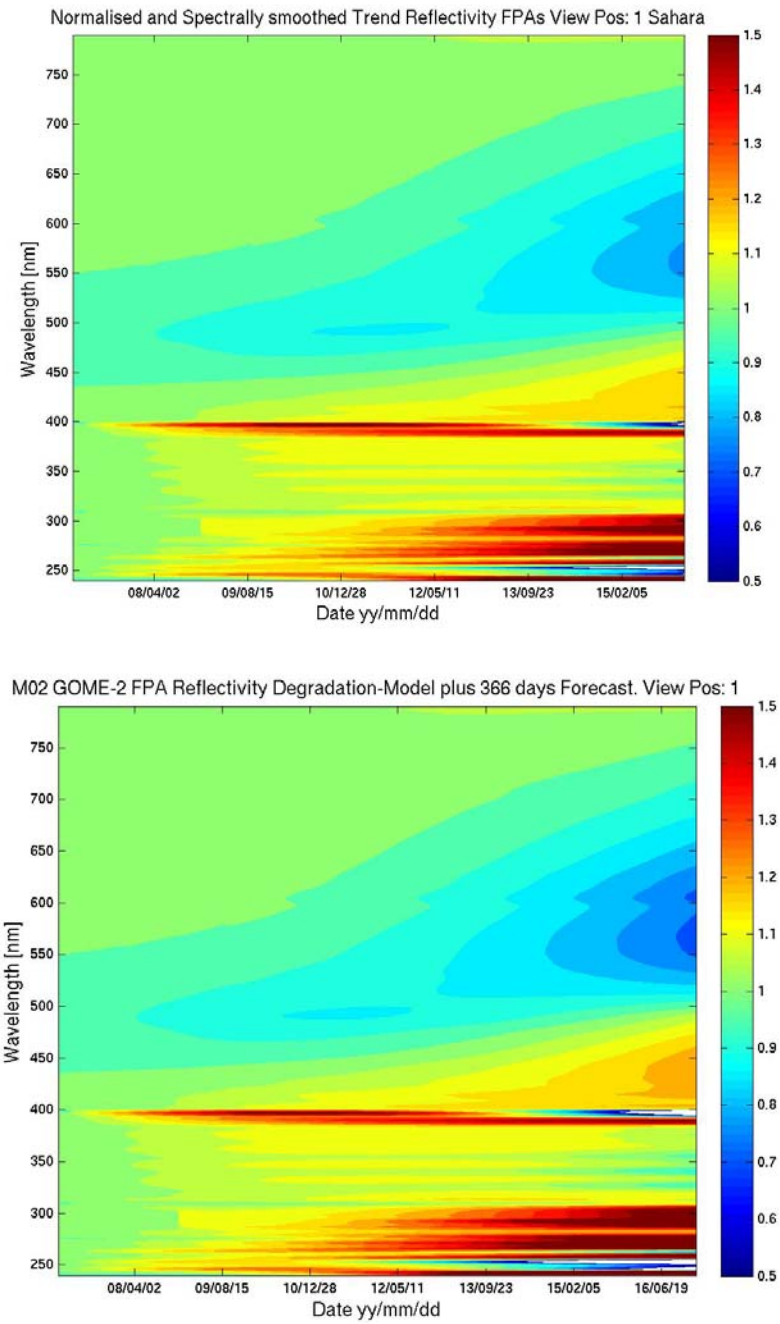

Figure 5: Reflectivity degradation model coefficients 1.0.C for GOME-2 Metop-A normalised to 25 January 2007. The vertical axis covers all wavelengths from 240 to 780 nm. The left panel shows the time-series based

on level-1B data from the Libyan desert region ending 31 December 2015. The rightpanel is the same but extends the model range until end 2016 using polynomial extensions with a forecast base time of one year, 2015.

Note: The model does not correct for the initial degradation condition at the beginning of the time series, which is 25 January 2007 for Metop-A and 1 December 2012 for Metop-B. Therefore, the correction may introduce an offset in the corrected level-1c data. This offset is expected to be static. The impact of this offset on the level-2 retrieval data quality may vary from retrieval to retrieval.

Figure 6 shows a time series of total column ozone (TO3) differences relative to January 2017 and derived for one day per month over the full Metop-A period and based on uncorrected level-1B data and on corrected level-1C data. The retrieval is carried out with the EUMETSAT in-house suite of GDOAS retrieval monitoring tools. The latter are used for the purpose of monitoring of level-1B data quality and do not necessarily providing the most accurate product quality in absolute terms. For high-quality total column retrievals, see the official operational O3MSAF products at http://o3msaf.fmi.fi. However, the GDOAS monitoring tools should provide acceptable relative stability.

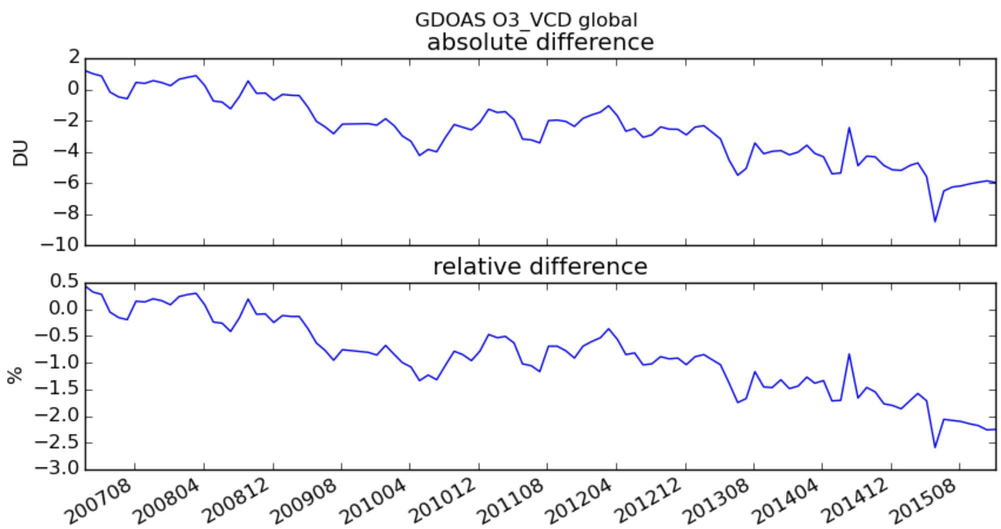

Figure 6: Differences between GOME-2-derived total ozone column (TO3) GDOAS retrievals based on uncorrected level-1B data and degradation corrected level-1C data using the GOME-2 degradation model version 1.0.C (TO3@level-1c – TO3@level-1b). Comparisons are made for one day per month. The top panel shows absolute differences and the bottom panel relative differences.

Figure 7 shows that the TO3 time series becomes significantly more stable when based on level-1C data corrected for degradation. This result is confirmed by comparison to ozone sonde data from the WOUDC (World Ozone and Ultraviolet Radiation Data Centre) network. With respect to the sonde data, the offset may be a result of both the GDOAS (GOME total ozone DOAS product) retrieval accuracy limitations and the impact of the initial degradation as discussed above.

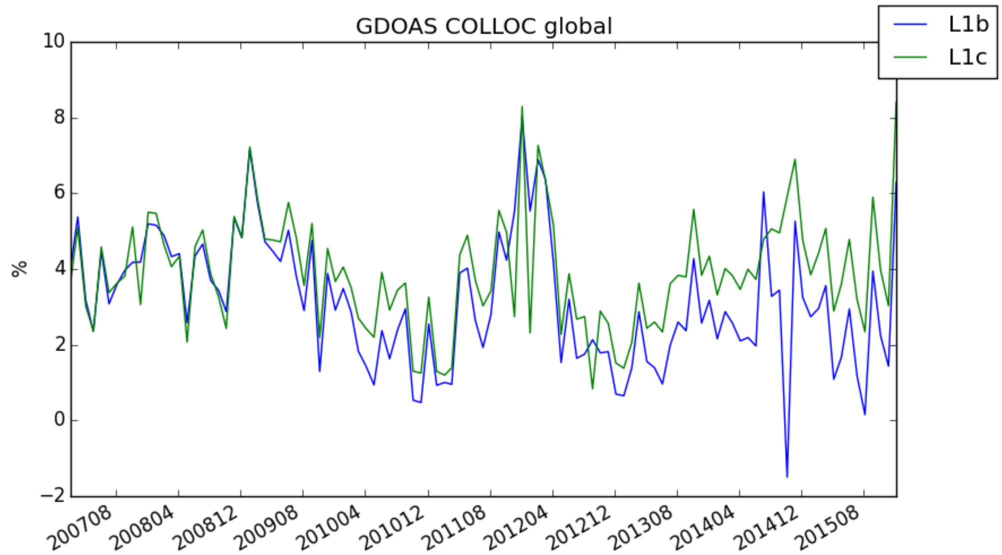

Figure 7: Relative differences between WOUDC ozone-sonde in-situ measurements and GOME-2 derived total ozone columns (TO3) for one day per month. The latter are based on uncorrected level-1B data (blue line) and degradation corrected level-1C data (green line) using the GOME-2 degradation model version 1.0.C.

Disclaimer: EUMETSAT encourages the testing of GOME-2 degradation model v. 1.0.C coefficients by interested users. However, the degradation model data we provide on model data is still only in demonstration status. We welcome feedback on any issues–technical issues as well as quality issues–you have when testing the data. Send an e-mail to EUMETSAT: ops@eumetsat.int.

Known deficiencies: The region between 283 nm and 300 nm is difficult to model because of the very steep gradients introduced by the ozone absorption involved. Use the data in this region only with additional precautions for potential deficiencies in the degradation coefficients provided here.

2.3 Newsletter #36 July 2014 – April 2015

EUMETSAT is planning to install and activate an update to the GOME-2 level 0 to 1b processor on 25 June 2015. The update will replace the current version 6.0 with version 6.1 in our core ground segment. This processor update addresses the following issues:

1. Removal of remaining spectral and angular signatures in instrument key-data due to Xe-line contamination. This issue was described in GOME-2 newsletter #33. See “*Cleaning” of small-scale spectral features from polarisation key-data* for GOME-2 / Metop-B data.
2. Introduction of a characterisation of the angular-dependence of solar irradiance data derived on board the instrument. This resolves some issues in the Solar Mean Reference data (SMR) used for the calculation of reflectances.

1. Removal of remaining spectral and angular key-data Xe-line signatures

Some remaining issues in the quality of GOME-2 / Metop-B radiance data were indentified during a recent study supported by the University of Bremen. These issues are related to small-scale spectral and angular structures introduced in the instrument's on-ground calibration key-data during the on-ground measurement campaign. This is also the result of detailed investigations on the data quality since the last key-data update for GOME-2 / Metop-B on 7 May 2013, at the beginning of the Metop-B operational phase. The latter update has already addressed some of the issues, but not completely resolved them. The study revealed that NO_2 retrieval data quality in particular was still suffering from key-data impurity and could still be improved with a more targeted removal of observed spectral features. We suspect the impurity originates in an on-ground Xe-line source or possibly instrument instability during the calibration campaign.

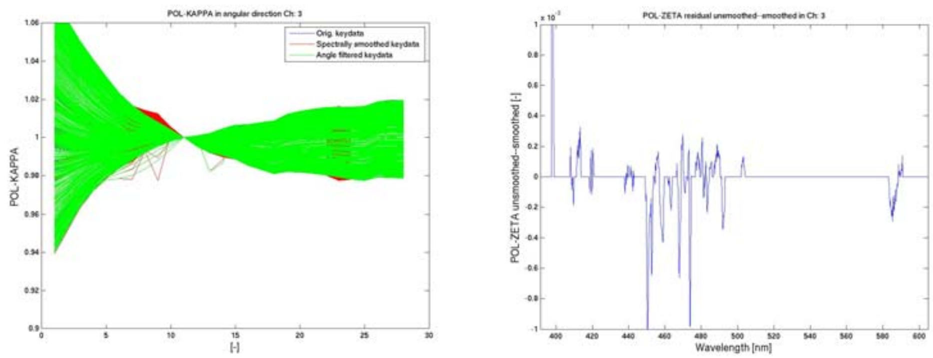

Figure 8: Removal of spurious jumps on the instrument on-ground calibration key-data for GOME-2 Metop-B (FM2) in the viewing angle domain (left panel). Here, the key-data for the angular dependence (scanner viewing angle dependence) of the radiometric response data ("kappa") has been cleaned. The panel at right panel shows the residual after cleaning of the spectral domain in channel 3 of key-data, accounting for the sensitivity of the instrument to 45°- polarised light ("zeta")

This cleaning has been carried out in both the viewing angle and the spectral domain on key-data for which this stimulus has been used. **Figure** 8 shows the original keydata in blue and the cleaned key-data for all wavelengths on channel 3 in the angular domain (left panel) and for the spectral domain (right panel). **Figure** 9 shows reflectivity spectra for main channel data over the complete GOME-2 spectral domain at three different viewing angles. See the details and legends in the top panel. The lower panel of **Figure** 9 shows the residuals for the original key-data used for PPF version 5.3 and 6.0 and for GOME-2 / Metop-B with respect to the new PPF 6.1 key-data. The positions of the removed Xe-lines are clearly visible and, in contrast to the previous key-data version, the cleaning has been limited to only the position of the Xe-lines. GOME-2 newsletter #33 has complete specifications. The impact of the smoothing of the angular domain at specific angles is visible as an offset, as shown by the green line in the lower panel.

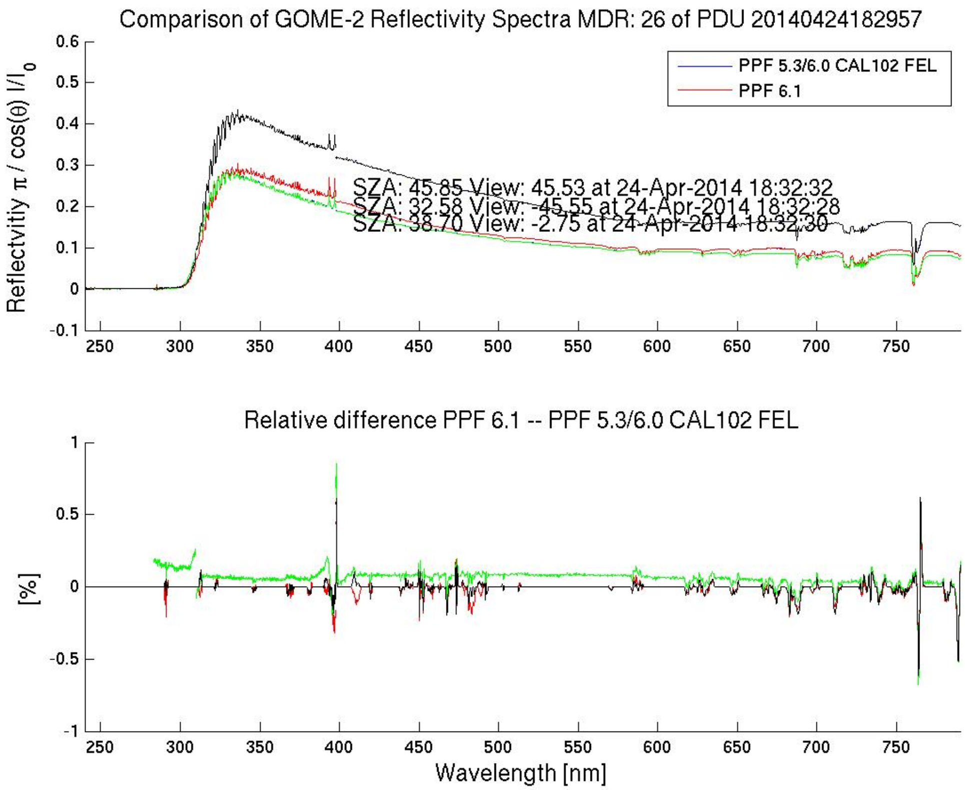

Figure 9: The top panel shows reflectivity spectra for GOME-2 Metop-B for three different observation geometries. The lower panel shows the residuals for these three spectra when processed with PPF version 6.0 and PPF version 6.1. The cleaning of the GOME-2 Metop-B key-data at the position of the Xe-lines, as shown in Figure 8 is clearly visible. The offset of the green residual line is due to the cleaning of spurious jumps in the angular domain.

Figure 10 illustrates the reduction of the NO_2 fit residual in the 420 nm to 450 nm domain compared to the output for level-1b processor versions 5.3 and 6.0. Other trace gas retrievals might be affected, but to a significantly lesser degree.

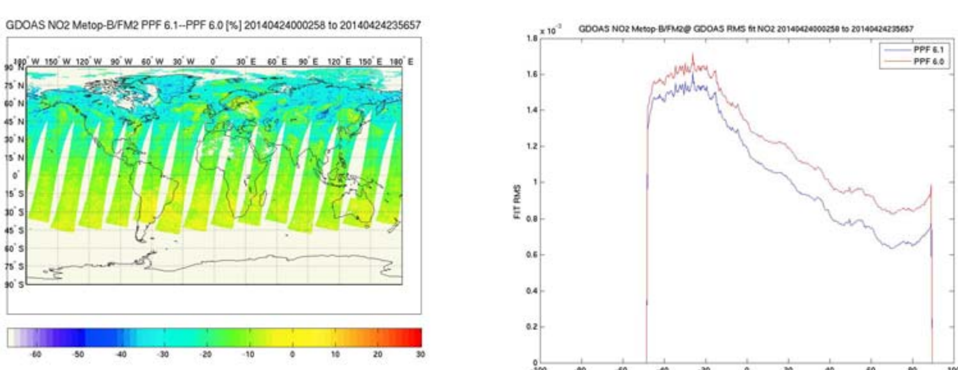

Figure 10: NO2 fit residual (420 nm to 450 nm) of the EUMETSAT UVN tools suite for one day of GOME-2 / Metop-B data on 24 April 2014 retrieved based on level-1b data produced with processor version 6.1 and compared to processor version 6.0. The left panel shows the global decrease of NO_2 fit residuals in percentage

difference applying the GDOAS retrieval technique The right panel shows the zonal mean of the individual GDOAS RMS values.

2. Introduction of the angular-dependence of solar irradiance data derived on board the instrument

We have derived the angular-dependence of solar irradiance data from the solar diffuser on board the instrument during the course of one year of Metop-A data (in 2011). This newly-derived key-data covers changes in solar azimuth during the year and during one daily solar measurement sequence; during which time the solar disc is moving over the diffuser (elevation angle). Exact specifications of the derivation can be found in a recent GSICS newsletter. See Volume 8 Number 2, 2014 **(**doi: 10.7289/V5N29TWP**).**

A comparison with the corresponding on-ground key-data currently used for GOME-2/Metop-A reveals some significant deviations in elevation and azimuth angle for various wavelength domains. The azimuth domain differences cannot be compensated for by averaging, as is partially the case for the elevation domain. Differences in the SAA domain may result in reoccurring variances in the solar signal time-series. This is evident in the blue time series at 745 nm in **Figure** 11. In contrast, when using the diffuser key-data derived on board, these variances are largely removed.
The use of this newly-derived diffuser key-data will also be introduced with the forthcoming processor version 6.1, but this will impact only GOME-2 / Metop-A level-1b data for both the main and the PMD channels along with the corresponding PMD SMR band values therein.

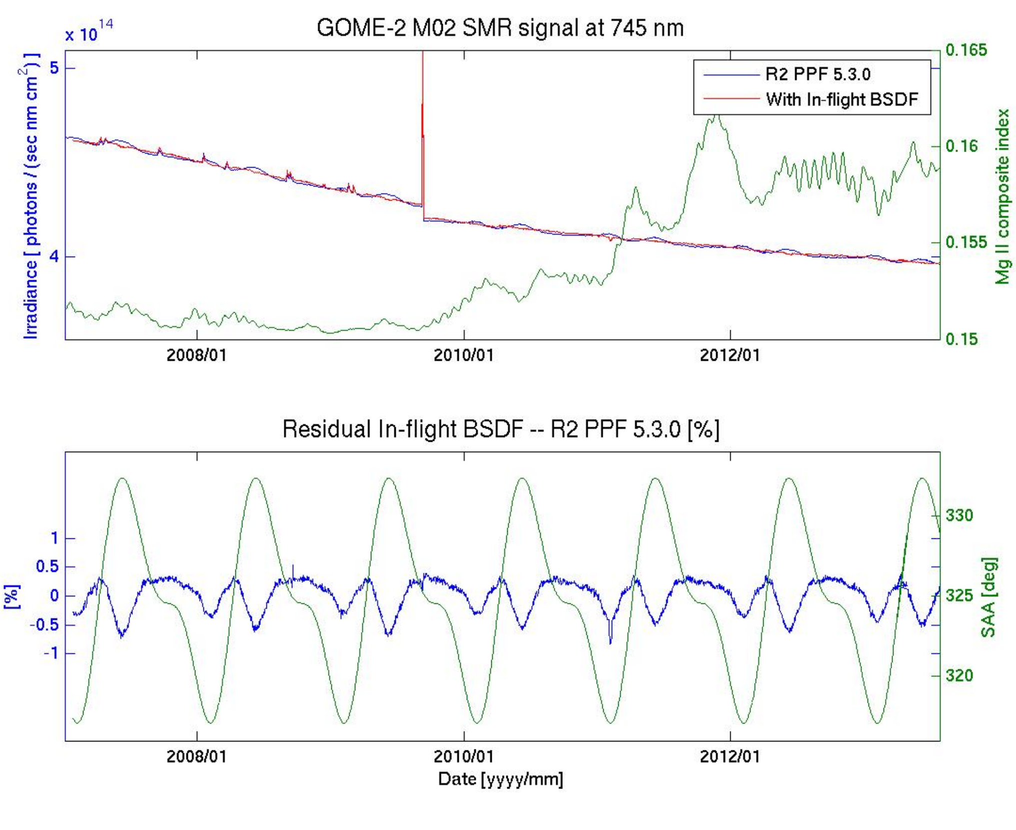

Figure 11: In the top panel, the blue line is a daily GOME-2 / Metop-A Solar Mean Reference (SMR) measurement data in channel 4 at 745 nm using the original instrument key-data for solar diffuser as deployed up to processor version 6.0. The corresponding red-line time series shows SMR data that uses newly derived solar diffuser data introduced with processor version 6.1. The lower panel shows the corresponding residual as a blue line. The observed re-occurring variances in the original solar data are not related to solar activity; the green line in the top panel is for solar Mg-II index, but well correlated with solar azimuth angle (green line in the lower panel) indicating a problem in the azimuth domain of the on-ground derived calibration key-data for the diffuser on board GOME-2 / Metop-A.

Test-data for processor version 6.1

Level-1b test data for the forthcoming processor version 6.1 is now available at:

ftp://ftp.eumetsat.int/pub/OPS/out/test-data/GOME-2_L1b_V6.1_Test-data_May2015/

Please send any feedback about the data quality after the version 6.1 update to: ops@eumetsat.int. The planned release date for processor version 6.1 is 26 June 2015.

PMAp: Operational and preparing a new version

The Polar Multi-Sensor Aerosol product (PMAp) was given operational status in October 2014. Since then, PMAp aerosol optical properties like aerosol optical depth (AOD), aerosol type, and volcanic ash flags have been available for retrieval over water surfaces and in near-real time in netCDF4 format via EUMETCast. The data is also available offline in eps native format.

Since the initial release of the PMAp, we have been working on the new version of PMAp (PMAp v2), which will extend the retrievals to land surfaces. Figure 5 shows AOD from a preliminary test of PMAp v2. It combines retrievals for both Metop-A and Metop-B PMAp products and combines GOME-2 Polarisation Measurement (PMD) reflectance and Stokes-fraction data with AVHRR sub-GOME-2 pixel radiance information for a single day.

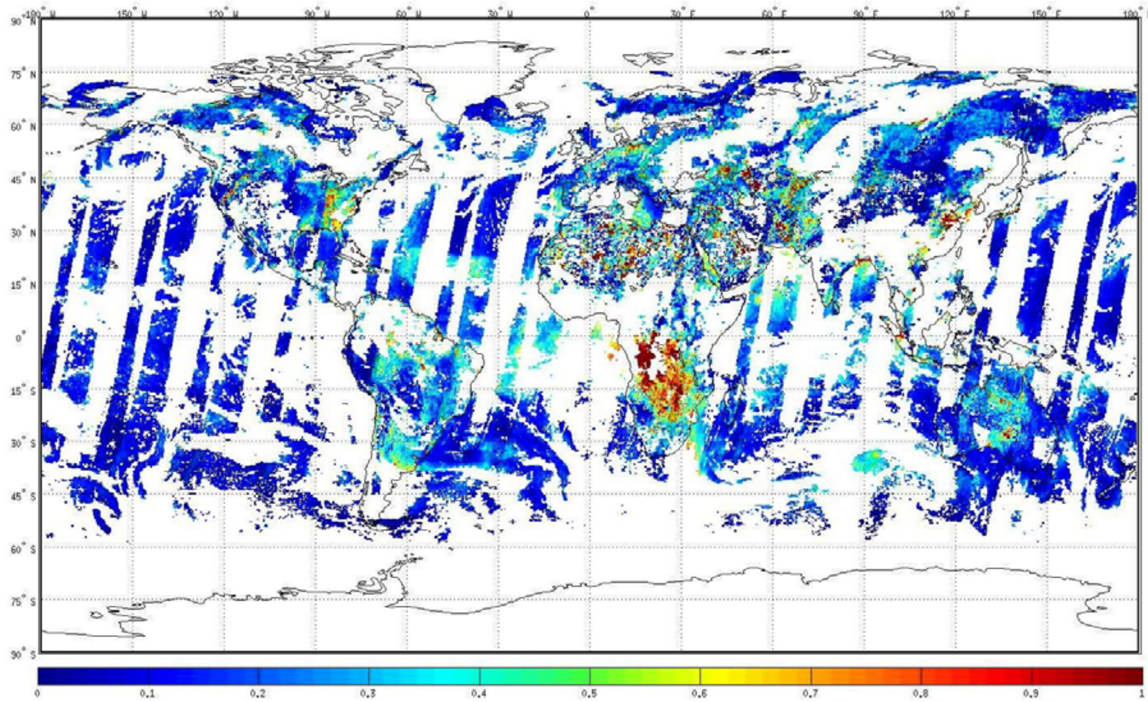

Figure 12: *Example map from PMAp v2 combining AOD from Metop-A and Metop-B. This version will extend the coverage of the current operational version of PMAp to land surfaces.*

For complete details on the retrieval algorithm and the PMAp product, see the ATBD and factsheet in the Technical Documents page. Release of PMAp v2 is planned for Q4 2015.

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2.4 Newsletter #35 January-June 2014

a) New Polar Multi-Sensor Aerosol product (PMAp) is in pre-operational status

Polar Multi-Sensor Aerosol product (PMAp) data is now available with a pre-operational status in near-real time via EUMETCast and offline in eps native and the netcdf4 format. For details on accessing this data, see the entry point of our Product Navigator:

www.eumetsat.int > Products > Atmosphere > Polar Multi-Sensor Aerosol Optical Properties - Metop

This first version provides aerosol optical depth (AOD) over ocean only, but we hope to release a second version to expand the retrievals to land surfaces early in 2015. The product uses co-location of GOME-2 PMD and AVHRR data and defines aerosol types in three modes: no dust/fine, dust, and volcanic ash. Volcanic ash is identified using AVHRR infra-red channels. Later, we plan to include IASI infra-red radiances as well as UV information from GOME-2 to better distinguish between fine and coarse particles. The spatial resolution of the product is the resolution of the GOME-2 PMD pixels—10/5 km × 40 km for both Metop-B and Metop-A. The product also provides cloud-fraction and cloud optical depth information derived from co-located AVHRR radiances.

Note: *The Aerosol Optical Depth results are the only parameters with pre-operational status. The other parameters mentioned are planned for future release.*

We are in the process of producing a full validation of the product involving ground based Aeronet measurements, MODIS Terra morning orbit observations, and model studies. Results of this validation effort, required to grant the product operational status, will be published in Q4 of 2014.

Some preliminary validation results are shown in Figure 13 and Figure **14**. Figure 13 shows an average of PMAp AOD for December 2013 to the end of January 2014. Figure 14 shows the accumulated statistics of comparisons to ground based Aeronet stations between end of January 2014 and end of April 2014. For more details on the status of the current validation we refer to the validation report available in our technical documents section for PMAp. Therein you can also find the Algorithm Theoretical Baseline Document (ATBD) and a user guide describing the usage of the data and the netcdf4 format content.

www.eumetsat.int > Data > Technical Documents > METOP/NOAA Global Data Services (GDS) > Polar Multi-Sensor Aerosol Optical Properties.

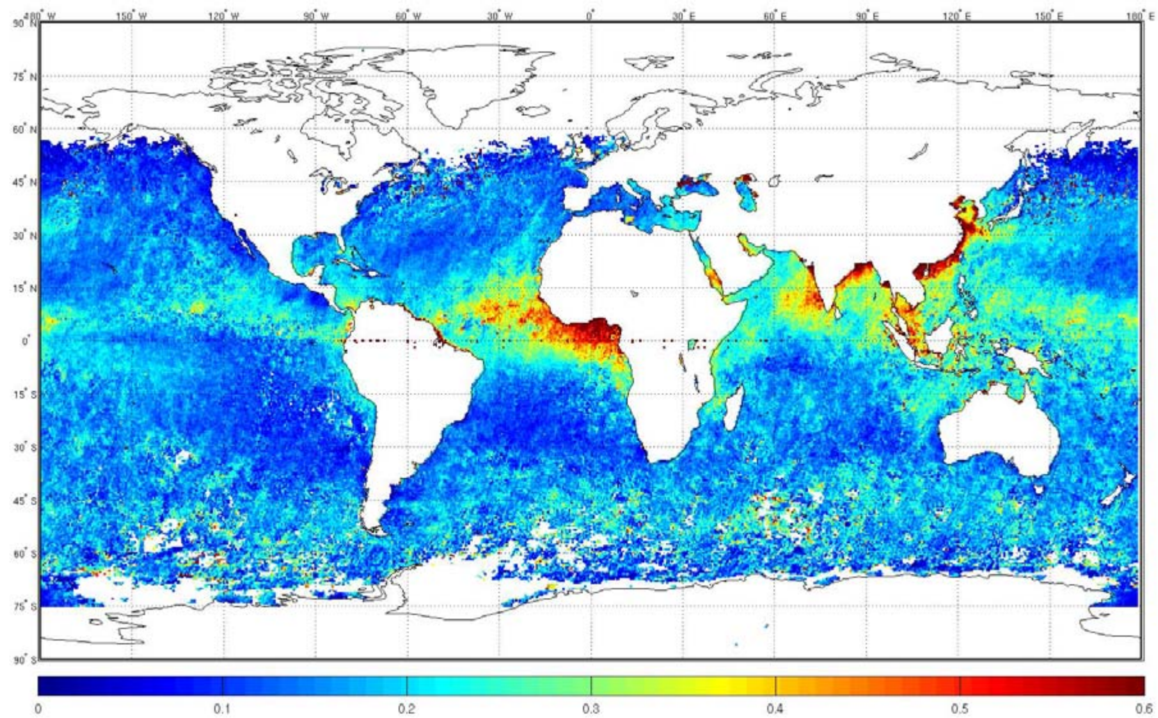


Figure 13: Averaged AOD values for December 2013 and January 2014 derived from both Metop platforms.

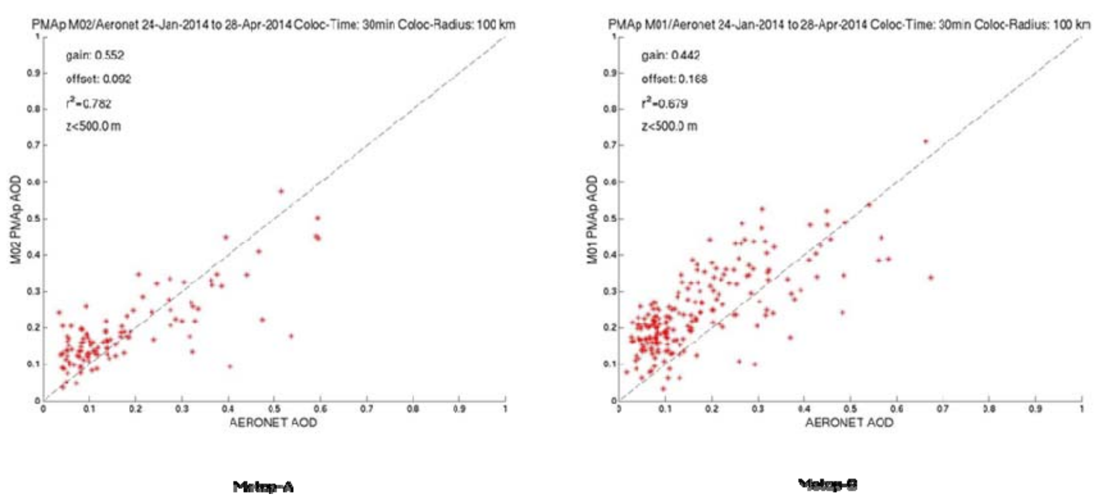


Figure 14: Scatter plots showing overpasses of Metop-A and B over multiple Aeronet stations for which the PMAp-derived AOD values have been accumulated within 100 km distance from the station within 30 minutes of sensing time. Data accumulated for the period 24 January to 28 April 2014.

b) Updated GOME-2 / Metop-A auxiliary data

Auxiliary data for GOME-2 / Metop-A level 0 to 1b data processing was updated on 15 April 2014 in our main ground segment. We made this update to correct a small but recurring degradation of the Stokes fraction quality in the GOME-2 / Metop-A level1b dating from the start of tandem operations in July 2013. After the introduction of the narrow-swath scanning for Metop-A, the online correction of Stokes fractions using special geometry observations for which the polarisation is expected to be zero was not an optimal solution.

In April 2014, the quality of special geometry Stokes fractions was still within specifications but worse than in July 2013. A few days after the update introduced on 15 April 2014, the Stokes fraction quality was back to the same level of accuracy as before the start of tandem operations or comparable to GOME-2 on Metop-B. Figures 3 and Figure 4 provide illustrations.

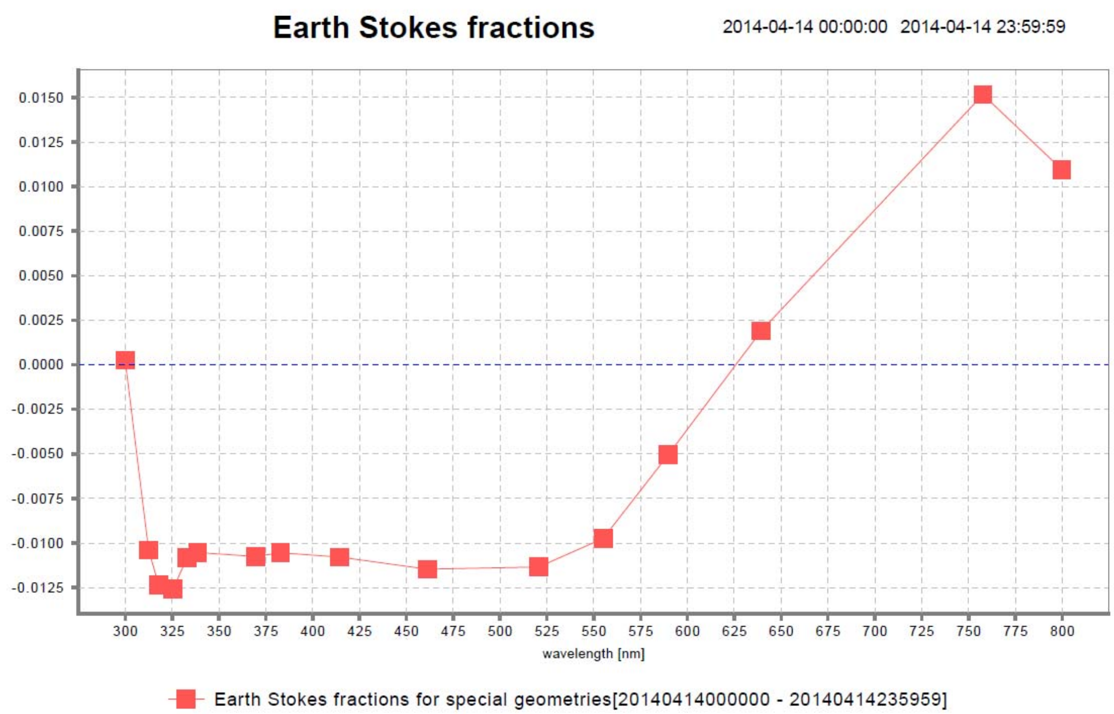


Figure 15: Special geometry Stokes fractions collected 14 April 2014, before the auxiliary file update. Special geometry Stokes fractions are expected to be close to zero. The plots fall below this level. The figure is taken from the daily report for the 14th of April 2014 available at http://gome.eumetsat.int.

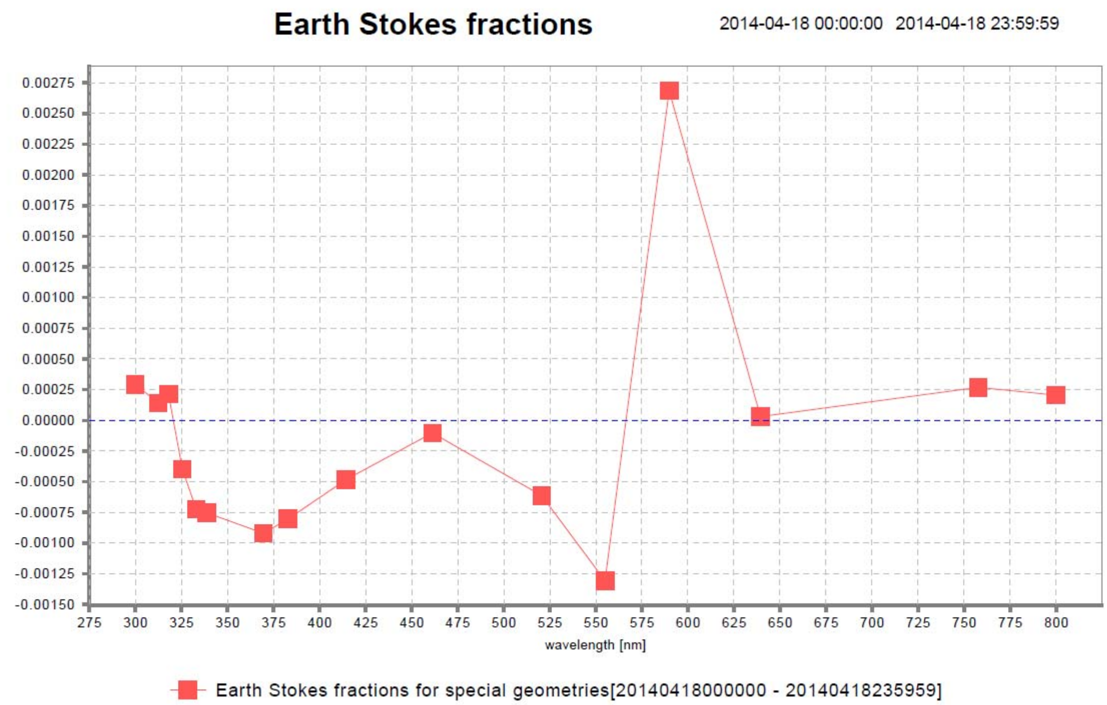


Figure 16: Contains the same plots as Figure 3, but includes plots after the update on 18 April 2014. Note the difference in the y-axis scale.

c) Release of level 0 to 1b processor version 6

The commissioning of Metop-B data caused some delays in development and implementation, but we have now started implementing our new processor (version 6) in our main ground segment. This article details some of the science involved in additional cloud information from the AVHRR cloud mask and spatial aliasing.

Provision of additional cloud information from the AVHRR cloud mask on PMD read-out level (MDR-1b Earthshine:CLOUD:CLOUD)

Radiometric and polarisation information is used in the UV/visible to infrared region for the retrieval and monitoring of geo-physical parameters. This practice often requires the knowledge of several cloud properties within the light path per individual polarisation measurement. Three important properties are the cloud fraction, cloud top height, and the cloud distribution. To improve the usability of radiometric and polarisation measurements from GOME-2 both for the main channels and the polarisation measurement device (PMD) data, we add geometric cloud fraction and scene homogeneity derived from AVHRR cloud information as well as radiance measurements to the cloud properties compound field of the MDR-1b-Earthshine record using a fixed PMD read-out grid of 256 read-outs per scan (MDR).

Currently, the cloud compound provides cloud information from FRESCO+ derived from main channel data at main channel resolution. FRESCO+ Cloud top height in hPa is provided in the ***FIT_1*** parameter and the radiometric cloud fraction of FRESCO+ at main channel ground-pixel resolution. For GOME-2 /Metop-B this is 80 km × 40 km; for GOME-2 /Metop-A: it is 40 km × 40 km. This is provided in the parameter FIT_2. This parameter is detailed in Table 1. For details on FRESCO+ see this link: Support for Upgrade to FRESCO+ in the GOME-2 PPF - Final Report)

In version 6 (PPF 6) we now provide *Scene Homogeneity* values at PMD ground pixel resolution in the variable ***CLOUD_PMD_1.***. This value ranges from 0 (homogenous) to 1 (inhomogeneous. Resolution is 80 km × 40 km for GOME-2/Metop-B, and 40 km × 40 km for GOME-2/Metop**.** Also the geometric cloud fraction derived from the AVHRR cloud tests (see below) is provided in the variable ***CLOUD_PMD_2.*** The calculation for Scene homogeneity is included below.

Scene homogeneity is calculated as the ratio of the standard deviation σ_R over N_R valid collocated radiances AVHRR_RAD within one GOME-2 PMD ground pixel as follows:

$$sh = \frac{\sigma_R}{N_R}$$

Otherwise the *geometrical cloud-fraction from AVHRR* within one GOME-2 PMD pixel is calculated as the ratio of the number of pixels (N_C) identified as cloudy to the total number of valid tests (N_T).

$$cf = \frac{N_C}{N_T}$$

In principle, all available cloud tests defined for the AVHRR level1b cloud product are configurable. However, the default is the use of the “albedo” test. This albedo test uses the visible channels of AVHRR. For the definition of these tests, see the AVHRR Level 1B Product Guide.

In cases where the AVHRR test results are identified as cloud or ice, the output is set to *NaN*.

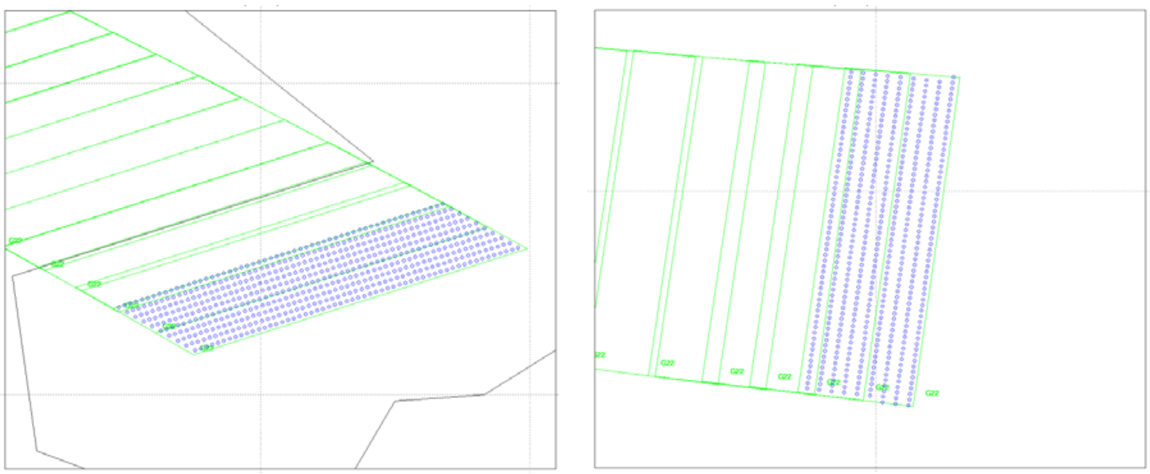


Figure 17: Example of AVHRR collocation on GOME PMD pixels

The release of PPF version 6 is scheduled for 17 June 2014. A separate announcement will offer offline test data for one day of Metop-A and Metop-B measurements will be made available to interested users.

Note: This new version (PPF version 6) implements the new ***CLOUD_PMD_1*** and ***CLOUD_PMD_2*** parameter values–currently filled with *NaN* values–in "demonstrational" status. The status will change to (pre-)operational status only after intensive testing and validation. Any feedback to ops@eumetsat.int on the data-quality of the new geometrical AVHRR-derived cloud parameters is therefore much appreciated. We expect to make this status final by the end of Q3 2014.

Operational Note: The change does not involve any change of the current product format. The two fields ***CLOUD_PMD_1*** and ***CLOUD_PMD_2*** already exist in the cloud compound of the MDR-1b-Earthshine record of product format version 12 (PFS 9A). No other fields or parameters are affected by this update to the new version 6.

CLOUD - Cloud fitting parameters									
FIELD	**DESCRIPTION**	**SF**	**UNITS**	**DIM1**	**DIM2**	**DIM3**	**TYPE**	**TYPE SIZE**	**SIZE**
FIT_MODE	Cloud fitting mode (default or snow/ice)	0		32	1	1	enumerated	1	32
FAIL_FLAG	Fail flag	0		32	1	1	enumerated	1	32
FIT_1	Cloud fitting parameter 1 - depending on FIT_MODE this is either cloud top pressure or lower reflecting surface pressure	3	hPa	32	1	1	integer4	4	128
FIT_2	Cloud fitting parameter 2 - depending on FIT_MODE this is either effective cloud fraction or albedo for lower reflecting surface	6		32	1	1	integer4	4	128
E_FIT_1	Error in Cloud fitting parameter 1	1	hPa	32	1	1	u-integer2	2	64
E_FIT_2	Error in Cloud fitting parameter 2	4		32	1	1	u-integer2	2	64
FINAL_CHI_SQUARE	Final Chi-Square from cloud parameter fitting	5		32	1	1	u-integer4	4	128
CLOUD_ALBEDO	Cloud albedo. This is always greater than or equal to the a priori cloud albedo	6		32	1	1	integer4	4	128
SURFACE_ALBEDO	Surface albedo used in the retrieval (at 758 and 772 nm)	6		32	2	1	integer4	4	256
SURFACE_PRESSURE	Surface pressure	3	hPa	32	1	1	integer4	4	128
CLOUD_PMD_1	Scene Homogeneity derived from AVHRR radiances	0		256	1	1	integer4	4	1024
CLOUD_PMD_2	Geometrical Cloud Fraction derived from AVHRR cloud mask	0		256	1	1	integer4	4	1024
Size of the Compound									**3136**

Table 1: MDR-1b-Earthshine: CLOUD compound from the GOME-2 L1 Product Format Specification (PFS 9A) Product format version 12.

The GOME-2 level-1b product format specification document describes product format version 12. The document is the technical documents section here:

www.eumetsat.int > Data > Technical Documents > METOP/NOAA Global Data Services (GDS) > GOME-2 GDS Level 1B.

Applying PMD cloud fractions to main channel data – spatial aliasing

The effect of *spatial aliasing* has to be accounted for when very accurate geo-referencing is needed for individual measurements, which is often the case when using cloud information data for co-location or masking purposes.

Since the geo-location corner and centre latitude and longitude values, as reported in the GEO_EARTH_ACTUAL section for each channel (FPA and PMDs), are only provided for the first detector pixel readout per channel, and since the satellite is moving at high speed during the integration time of one measurement, every detector pixel of each channel detector-pixel-array sees a slightly different part of the surface than the one seen by the first detector pixel per detector array. The detector arrays are therefore read out in alternating direction in order to make sure that the last and first detector pixels see approximately the same surface where they join in spectral space. Figure 6 illustrates the idea. The readout direction–from first detector pixel to the last (0) or from the last to the first (1) –is given in the GIADR-Channels record available with each product as shown in **Error! Reference source not found.**. **Error! Reference source not found.** also provides the information on the time it takes to read out the full detector array: 1024 pixels for FPA, $t_{FPA, full}$, and 256 pixels for PMDs, $t_{PMD, full}$) as well as for reading one individual detector pixel.

So, after the acquisition of one measurement, the time it takes to readout the content of detector pixel *i* in main channel *j* can be calculated as follows:

$$t_{FPA} = \begin{cases} i \cdot \delta_{rd} & (readout\ sequence\ up) \\ (1023 - i) \cdot \delta_{rd} & (readout\ sequence\ down) \end{cases},$$

While the time it takes to read out the signal stored in detector pixel k of one of the two PMD detectors s or p can be calculated as follows:

$$t_{PMD} = \begin{cases} (k - 768) \cdot \delta_{rd} & (readout\ sequence\ up) \\ (1023 - k) \cdot \delta_{rd} & (readout\ sequence\ down) \end{cases},$$

where $\delta_{rd} = 45.776367 \times 10^{-6}$ seconds is the readout time per single detector and the readout sequence is specified in the field CHANNEL_READOUT_SEQ of GIADR-Channels record. This sequence is as follows: 0 for sequence *up*, from short to long wavelength, and 1 for sequence *down*, from long to short wavelength.

To calculate the relative shift with respect to the geo-location data provided for the first detector pixel of the current measurement (read-out *n*) and the next measurement (read-out n+1) for the actual detector pixel *i* (FPA), k (PMD), you must divide t_{FPA}, t_{PMD} by the time it takes to read-out all 1024/256 detector pixels for the FPA or PMD. This is also illustrated in **Error! Reference source not found.**. The calculation is, simply:

$\Delta_{i,FPA} = t_{FPA} / IT_{band}$, and
$\Delta_{i,PMD} = t_{PMD} / IT_{PMD}$.

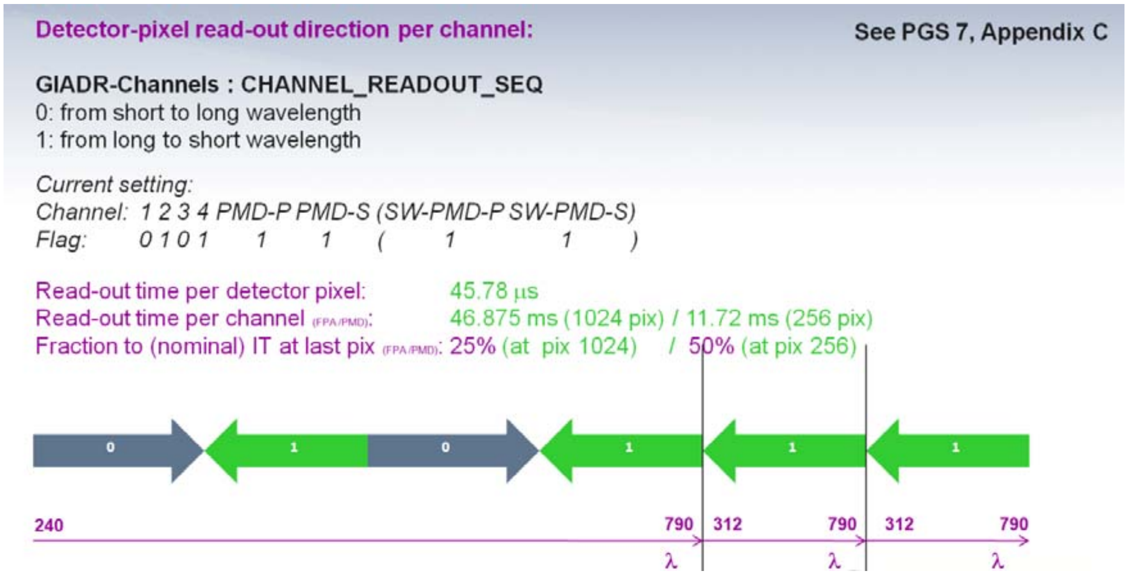


Figure 18: Detector pixel read-out time and read-out direction for main channels (FPA) and for the polarisation measurement device channels PMD p and PMD s and their corresponding spectral coverage. Note that for FPAs all 1024 detector pixels from 0 to 1023 are used, whereas the PMDs actually use only 256 pixels though they consist of 1024 pixels.

d) Accounting for spatial-aliasing between PMD and FPA channels.

We want to apply the cloud properties information from AVHRR provided for the PMD channels at PMD read-out resolution (256 readouts per scan) to results obtained from the main channels (32 readouts per scan). To do this, we use the sub-pixel information provided by the PMDs because there are eight times more measurements. This ensures the spatial aliasing effects outlined above are correctly accounted for.

To do this, we calculate the time offset between FPA and PMD measurements in units of 23.4375 ms, the integration time of a single PMD measurement, as follows:

$$m_{ij}^{r} = \left(t_{FPA} - t_{PMD}\right) / 23.4375 \bullet 10^{-3} + 1,$$

for the i^{th} detector pixel of channel j of the main science channels (FPAs).

If m^{r}_{ij} is split into its integer part and its fractional part using a modulus function, and by packaging the PMD cloud fraction information in $m=0,\ldots,3$, averages of 8 PMD read-outs (c_m) each shifted by one PMD read-out k, the corresponding PMD geometric cloud property $c_{s,ij}$ for detector pixel $\underline{i}$ of channel j of the main science channel can be found by this formula:

$$c_{s,ij} = \left(1 - m_{ij}^{r,frac}\right)\overline{c}_{m} + m_{ij}^{r,frac}\overline{c}_{m+1}, \quad where\ m = m_{ij}^{r,\mathrm{int}}.$$

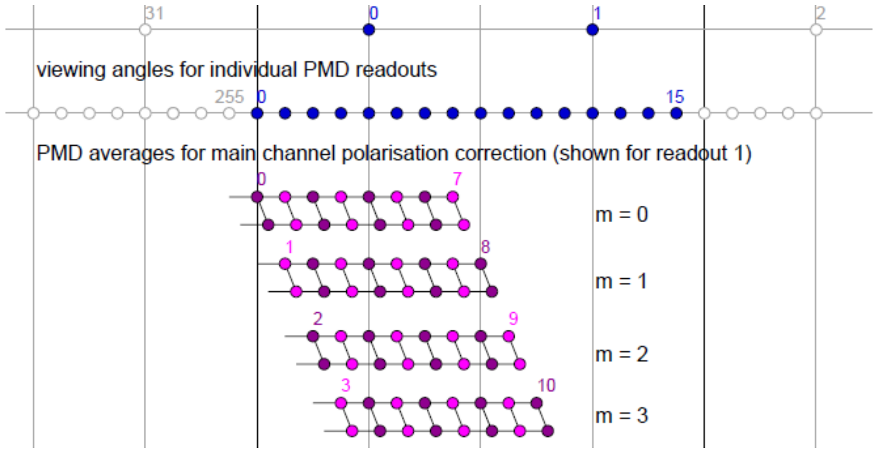


Figure 19: Packaging of 8 PMD cloud properties readouts k into four packages with m=0,...3 for one main channel read-out n (here n=0, top row). These four averages (c_m) can be used to accurately calculate the geometrical cloud properties as seen by a detector pixel i of one main channel j (see text).

These details and solutions for dealing with matters of spatial aliasing are also documented in the GOME-2 fact-sheet available here:

www.eumetsat.int > Data > Technical Documents > METOP/NOAA Global Data Services (GDS) > GOME-2 GDS Level 1B.

2.5 Newsletter #34 May-December 2013

Updated GOME-2 factsheet is now available online

This factsheet contain summaries of instrument budgets, performance tables, and settings. It also includes references to useful documentation, a list of data access and answers to questions frequently asked by level 1b data users. You can find this document on our newly-designed Technical Documents web page:

www.eumetsat.int > Data > Technical Documents > METOP/NOAA Global Data Services (GDS) > GOME-2 GDS Level 1B.

The factsheet also contains a summary of valid spectral regions to be used for level-2 retrievals and includes the latest data-quality improvements that are close to channel-overlap regions. These data quality improvements are also described in Newsletters #32 and #33.

GOME-2 Metop-A and Metrop-B Tandem Operations

Separate GOME-2 instruments on board Metop-A and Metop-B have operated in tandem since 15 July 2013. For this tandem operation, the GOME-2 swath width on Metop-A was changed to 960 km, while GOME-2 on Metop-B used a full-swath width of 1920 km. As a result, the ground pixel footprint of GOME-2 on Metop-A has been reduced to 80 km by 40 km compared to the 40 km by 40 km swath width on GOME-2 on Metop-B. The corresponding Polarisation Measurement Device (PMD) pixel foot-print has been reduced from the 10 km by 40 km on GOME-2 on Metop-B to 5 km by 40 km on GOME-2 on Metop-A. Figure 1 shows a Global NO_2 total column “quick-look” retrieval from this tandem operation. In this figure, the GOME-2/Metop-A swaths with a finer ground pixel resolution of 40 km × 40 km are plotted on top of the GOME-2/Metop-B swath with the previous 40 km × 80 km ground pixel size. Note also that Metop-A scans are made 48 minutes after Metop-B scans.

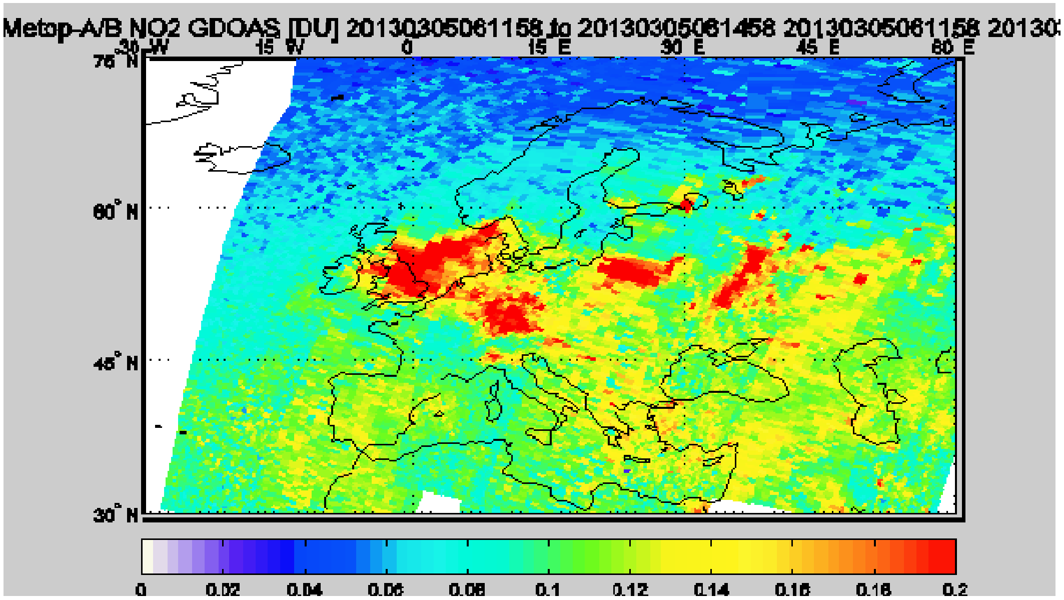


Figure 20: Global NO_2 total column "quick-look" retrievals over Europe from GOME-2 instruments operating in tandem on Metop-A and Metop-B.

For comprehensive information on the day-to-day performance of both instruments, go to the EUMETSAT website: http://gome.eumetsat.int

Change to Cycle of Routine Operations and Viewing Configuration

The 29-day repeat cycle of routine operations and viewing configuration has also changed for both instruments. The monthly calibration sequence is issued for both instruments on the same day. The sequence has two nadir static orbits (no scanning) followed by one orbit during which the PMD data is down-linked at full spectral resolution–256 channels for both PMDs–but at reduced spatial read-out resolution. This resolution is 12 read-outs in the forward-scanning direction and 4 read-outs in backward scanning direction at the same ground spatial resolution for PMDs, with gaps in between the read-outs. The latter configuration is called the monthly PMD RAW read-out figuration.

For the monthly PMD RAW mode configuration, the PMD_READOUT flag in the MDR-1b-Earthshine records is set to three (3). Otherwise the read-out mode flag is set to 0 for nominal earthshine scanning, 1 for solar measurements, or 2 for calibration measurements. See Table 11 in the GOME-2, L1 Product Format Specification (EPS.MIS.SPE.97232) available on the new Technical Documentation web page described above. ***Note:*** During PMD RAW orbits, level-1b data quality is reduced because no polarisation correction is applied to main channel data.

GOME-2 on Metop-A is configured to operate once per month at a reduced swath-width of 320 km. The 29-day operational schedule for Metop-A is summarized in **Error! Reference source not found.**. Figure 3 shows the 29-day operational schedule for Metop-B. See also http://gome.eumetsat.int > Timelines.

GOME-2/Metop-A timeline planning per 412/29 repeat cycle. Version 5.0, July 2013 - Start of Tandem Operations

day	orbit offset	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	0	X	X	X	**M1**	**M2**	**D1**	**D2**	X	X	**S**	**S**	**R**	X	X	X
2	15	X	X	X	X	X	**D1**	**D2**	X	X	X	X	X	X	X	
3	29	X	X	X	X	X	**D1**	**D2**	X	X	X	X	X	X	X	
4	43	X	X	X	X	X	**D1**	**D2**	X	X	X	X	X	X	X	
5	57	X	X	X	X	X	**D1**	**D2**	X	X	X	X	X	X	X	X
6	72	X	X	X	X	X	**D1**	**D2**	X	X	X	X	X	X	X	
7	86	X	X	X	X	X	**D1**	**D2**	X	X	X	X	X	X	X	
8	100	X	X	X	X	X	**D1**	**D2**	X	X	X	X	X	X	X	
9	114	X	X	X	X	X	**D1**	**D2**	X	X	X	X	X	X	X	
10	128	X	X	X	X	X	**D1**	**D2**	X	X	X	X	X	X	X	X
11	143	X	X	X	X	X	**D1**	**D2**	X	X	X	X	X	X	X	
12	157	X	X	X	X	X	**D1**	**D2**	X	X	X	X	X	X	X	
13	171	X	X	X	X	X	**D1**	**D2**	X	X	X	X	X	X	X	
14	185	X	X	X	X	X	**D1**	**D2**	X	X	X	X	X	X	X	
15	199	N3	N3	N3	N3	N3	**D1**	**D2**	N3	N3	N3	N3	N3	N3	N3	N3
16	214	X	X	X	X	X	**D1**	**D2**	X	X	X	X	X	X	X	
17	228	X	X	X	X	X	**D1**	**D2**	X	X	X	X	X	X	X	
18	242	X	X	X	X	X	**D1**	**D2**	X	X	X	X	X	X	X	
19	256	X	X	X	X	X	**D1**	**D2**	X	X	X	X	X	X	X	
20	270	X	X	X	X	X	**D1**	**D2**	X	X	X	X	X	X	X	X
21	285	X	X	X	X	X	**D1**	**D2**	X	X	X	X	X	X	X	
22	299	X	X	X	X	X	**D1**	**D2**	X	X	X	X	X	X	X	
23	313	X	X	X	X	X	**D1**	**D2**	X	X	X	X	X	X	X	
24	327	X	X	X	X	X	**D1**	**D2**	X	X	X	X	X	X	X	
25	341	X	X	X	X	X	**D1**	**D2**	X	X	X	X	X	X	X	X
26	356	X	X	X	X	X	**D1**	**D2**	X	X	X	X	X	X	X	
27	370	X	X	X	X	X	**D1**	**D2**	X	X	X	X	X	X	X	
28	384	X	X	X	X	X	**D1**	**D2**	X	X	X	X	X	X	X	
29	398	X	X	X	X	X	**D1**	**D2**	X	X	X	X	X	X	X	

D1	CALNS6	Daily calibration, part 1 (SLS/WLS) with 960 km swath
D2	CALNS0	Daily calibration, part 2 (Sun) with 960 km swath
M1	CALNS4	Monthly calibration, part 1 (LED, WLS, SLS modes) with 960 km swath
M2	CALNS5	Monthly calibration, part 2 (SLS over diffuser mode) with 960 km swath
N3	NOT320	Narrow swath (320 km)
S	NADIR	Nadir static
R	PMDRAWNS	PMD monitoring (nominal readout/raw transfer mode) with 960 km swath
X	NOT960	Nominal swath (960 km)

Figure 21: The 29-day repeat cycle for instrument operations for GOME-2 on Metop-A. Different colours and ID tags indicate different instrument operations settings as explained in the document key.

GOME-2/Metop-B timeline planning per 412/29 repeat cycle. Version 1.0, July 2013 - Start of Tandem Operations																
day	orbit offset	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	0	X	X	X	M1	M2	D1	D2	X	X	S	S	R	X	X	X
2	15	X	X	X	X	X	D1	D2	X	X	X	X	X	X	X	
3	29	X	X	X	X	X	D1	D2	X	X	X	X	X	X	X	
4	43	X	X	X	X	X	D1	D2	X	X	X	X	X	X	X	
5	57	X	X	X	X	X	D1	D2	X	X	X	X	X	X	X	X
6	72	X	X	X	X	X	D1	D2	X	X	X	X	X	X	X	
7	86	X	X	X	X	X	D1	D2	X	X	X	X	X	X	X	
8	100	X	X	X	X	X	D1	D2	X	X	X	X	X	X	X	
9	114	X	X	X	X	X	D1	D2	X	X	X	X	X	X	X	
10	128	X	X	X	X	X	D1	D2	X	X	X	X	X	X	X	X
11	143	X	X	X	X	X	D1	D2	X	X	X	X	X	X	X	
12	157	X	X	X	X	X	D1	D2	X	X	X	X	X	X	X	
13	171	X	X	X	X	X	D1	D2	X	X	X	X	X	X	X	
14	185	X	X	X	X	X	D1	D2	X	X	X	X	X	X	X	
15	199	X	X	X	X	X	D1	D2	X	X	X	X	X	X	X	X
16	214	X	X	X	X	X	D1	D2	X	X	X	X	X	X	X	
17	228	X	X	X	X	X	D1	D2	X	X	X	X	X	X	X	
18	242	X	X	X	X	X	D1	D2	X	X	X	X	X	X	X	
19	256	X	X	X	X	X	D1	D2	X	X	X	X	X	X	X	
20	270	X	X	X	X	X	D1	D2	X	X	X	X	X	X	X	X
21	285	X	X	X	X	X	D1	D2	X	X	X	X	X	X	X	
22	299	X	X	X	X	X	D1	D2	X	X	X	X	X	X	X	
23	313	X	X	X	X	X	D1	D2	X	X	X	X	X	X	X	
24	327	X	X	X	X	X	D1	D2	X	X	X	X	X	X	X	
25	341	X	X	X	X	X	D1	D2	X	X	X	X	X	X	X	X
26	356	X	X	X	X	X	D1	D2	X	X	X	X	X	X	X	
27	370	X	X	X	X	X	D1	D2	X	X	X	X	X	X	X	
28	384	X	X	X	X	X	D1	D2	X	X	X	X	X	X	X	
29	398	X	X	X	X	X	D1	D2	X	X	X	X	X	X	X	
		D1	CAL6	Daily calibration, part 1 (SLS/WLS) with 1920 km swath												
		D2	CAL0	Daily calibration, part 2 (Sun) with 1920 km swath												
		M1	CAL4	Monthly calibration, part 1 (LED, WLS, SLS modes) with 1920 km swath												
		M2	CAL5	Monthly calibration, part 2 (SLS over diffuser mode) with 1920 km swath												
		S	NADIR	Nadir static												
		R	PMDRAW	PMD monitoring (nominal readout/raw transfer mode) with 1920 km swath												
		X	NOT1920	Nominal swath (1920 km)												

Figure 22: The 29-day repeat cycle for instrument operations of GOME-2 on Metop-B. Different colours and ID tags indicate different instrument operations settings as explained in the document key.

New Product Release: Polar Multi-Sensor Aerosol properties (PMAp)

EUMETSAT is about to release the first version of a new aerosol optical depth (AOD) over ocean product, The product uses the accurate co-location of GOME-2 PMD and AVHRR data and defines aerosol types in three modes: no dust/fine, dust, and volcanic ash. The presence of volcanic ash is identified by making additional use of AVHRR infra-red channels. Later, IASI infra-red radiances as well as UV information from GOME-2 will be added to better distinguish between fine and coarse particles.

The targeted spatial resolution of the product is the resolution of the GOME-2 PMD pixels– 10/5 km by 40 km for both Metop-B and Metop-A. The product also provides cloud-fraction and cloud optical depth information derived from co-located AVHRR radiances. This highly-accurate three-instrument co-location framework will also be applied to AOD retrievals over land and will also be used to distinguish more and different aerosol types in future product versions. Figure 4 is an early look at the

PMAp product, deriving AOD values from both Metop-A and Metop-B platforms using level-1b data from GOME-2 PMD and AVHRR measurements.

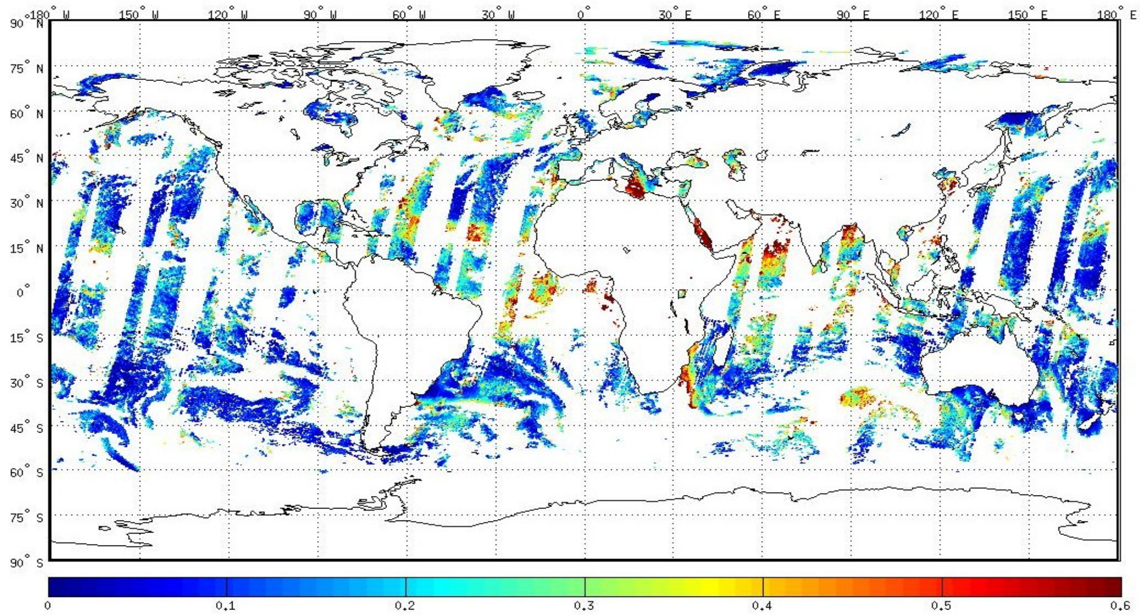


Figure 23: AOD values derived from the PMAp product using both Metop-A and Metop-B platforms using level-1b data from GOME-2 PMD and AVHRR measurements.

Data will be available both in near-real time and offline via EUMETcast and via the EO portal in netcdf 4. Related information on relevant documentation and the start of demonstrational or pre-operational dissemination will be sent to all current users via email and UNS and will be announced in the news section on our web-pages in the coming months.

2.6 Newsletter #33 January-April 2013

Metop-B / GOME-2 FM2 level 1 – start of operational dissemination of data

Dissemination of level 1b data from the GOME-2 FM2 instrument on Metop-B will start as planned the second week of May 2013. This follows a successful SIOV campaign in October–November 2012 and an intensive commissioning phase that produced updates and improvements to level 1b data quality. Dissemination will also depend on review and approval of the final validation report due the first week of May. This report will be on the EUMETSAT webpage. See the technical documentation section (www.eumetsat.int > Data & Products > Resources).

All users will be notified of the exact start date of operations notice will be posted on the service status section of our web-page (www.eumetsat.int > Service Status > Product and Service News) and also via the UNS message service.

Level 1 data from GOME-2 FM2 on Metop-B is already available via EUMETCast or the EUMETSAT data archive (see www.eumetsat.int > Data access). The data has pre-operational status and dates to mid-February 2013. Daily monitoring reports for both Metop-A and B instruments and detailed information on orbit-to-orbit information are available at gome.euemetsat.int.

GOME-2 Metop-A/B Tandem Operation

As a test, Metop-A and B instruments were operated in tandem with either one or both GOME-2 instruments using a reduced swath of 960 km, instead of the nominal 1920 km swath, during the first half of March 2013. This test was configured as shown in Table 2:

GOME-2 Metop-A/B tandem operations test-sequence	***1***	***2***	***3***
Test Mode	G–A 1920 G–B 960	G–A 960 G–B 960	G–A 960 G–B 1920
Impact	Metop-B commissioning affected	Metop-A OPS affected	Metop-A OPS affected
Implemented 960 km swath schedule	**4 March 2013** **Start G-B:** 16:35:58 **Orbit:** 2387	**7 March 2013** **Start G-A:**14:38:57 **Orbit:** 33115	**11-14 March 2013** **Stop G-B:** 11/03/2013 15:50:58, **Orbit**: 2486 **Stop G-A:** 14/03/2013 15:32:54, **Orbit**:33215
Approximate Duration	3 days	4 days	3 days

Table 2: GOME-2 tandem operations test schedule. See also gome.eumetsat.int > Documentation > Processor update history.

Error! Reference source not found. shows the impact of a reduced swath on the ground-pixel spatial resolution and the one-day global coverage for the nominal wide-swath configuration and the double narrow-swath test sequence number 2. Both are NO_2 total column retrievals ("quick-look" retrievals with reduced total column accuracy).

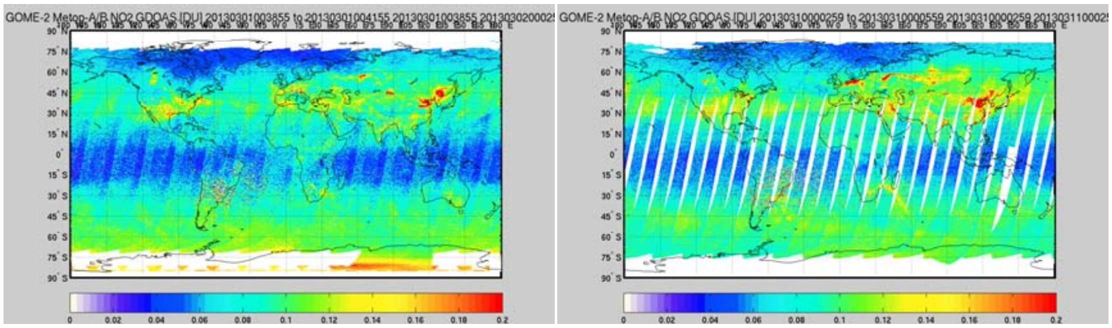


Figure 24: Global NO_2 total column "quick-look" retrievals from both instruments. The left panel uses the current nominal wide-swath configuration–1920 km; 40 km × 80 km ground pixel size over the full swath. The right panel shows one day of the tandem-test sequence for which both instrument were operated in narrow-swath mode at 960 km–40 km × 40 km ground pixel size over the full swath.

Recently, the GOME Scientific Advisory group (GSAG) and the O3MSAF consortium (o3msaf.fmi.fi) made an interim recommendation to EUMETSAT: operate GOME-2 on Metop-A in 960 km swath mode and maintain GOME-2 on Metop-B in 1920 km swath mode for several months. This implementation will gain us experience in the use of the higher spatial resolution data and further improve the consistency of the products from both instruments because it takes advantage of the overlap between the swaths of the two instruments which is still present in this configuration. A more detailed schedule of this implementation of tandem operation will be provided in a separate announcement.

GOME-2 level 1 key-data update: Preparation for Tandem Operations

Metop-B / GOME-2 FM2 level 1

"Cleaning" small-scale spectral features from polarisation key-data

During the pre-operational phase of level 1b commissioning, persistent small-scale structures were identified in the fit residuals of level 2 data. Eventually, these were linked to spectral features introduced by on-ground calibration stimulus sources. These small-scale structures were predominantly in key data related to the polarisation correction of the instrument and their angular response data. To remove these small-scale structures and reduce outliers in key-data in the angular domain, a combination of fourier-transfer high-pass filtering (spectral domain) and spline-interpolation (angular domain) of key-data was applied. The visible effect on the radiometrically-calibrated Earthshine data is quite small–but significant, especially at specific viewing angles. See **Error! Reference source not found.**.

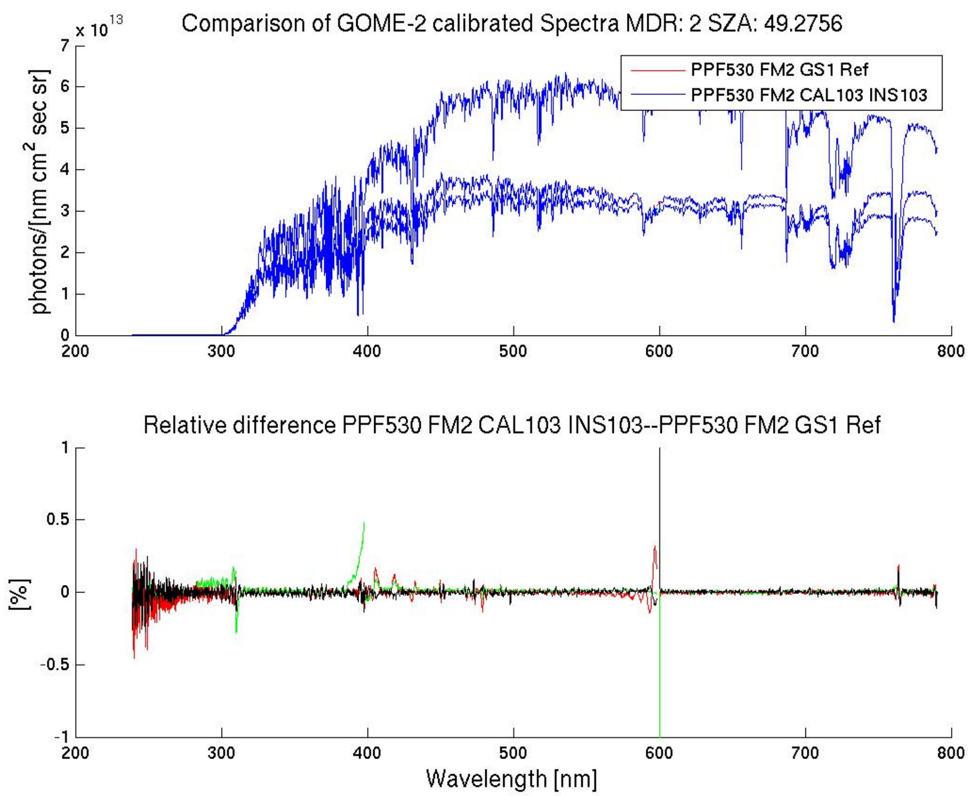


Figure 25: The top panel shows earthshine spectra at three different viewing angles acquired by GOME-2 FM2 on Metop-B on 26 December 2012 for both old and new key-data sets. The bottom panel shows the residuals between the old and new key-data with "cleaned" polarisation key-data updates.

Metop-A / GOME-2 FM3 level 1

a) Radiometric response calibration

During commissioning of GOME-2 Metop-B level 1 data, we implemented an updated procedure for adjusting the radiometric response functions to account for on-board shifts of the channel separation. This procedure allows the exploitation of level 1b data radiances close to the overlap points (see newsletter #32). This procedure has also been applied to the latest version of FM3 Metop-A radiometric key-data as it also extends the "valid" spectral regions to be used for level 2 retrievals close to the overlap points and accounts for a long-term drift of the latter that has occurred since the last adjustment of this key-data set shortly after launch in March, 2007). **Error! Reference source not found.** shows the overlap point of Channels 2 and 3 for GOME-2 Metop-A over the full period of the mission. Notice that it reached a stable state only after 2009. At the start of tandem operations, we readjusted the key-data in order to account for this shift.

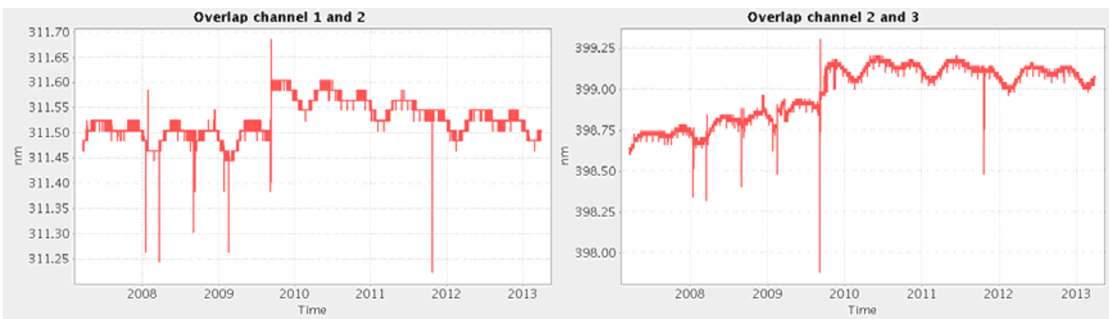


Figure 26: Overlap point between channel 1 and 2 (left panel) and between 2 and 3 (right panel) for GOME-2 FM3 on Metop-A.

Error! Reference source not found. shows a comparison between a solar reference measurement and a solar measurement taken onboard for both the previous and updated IRR-radiometric response key-data.

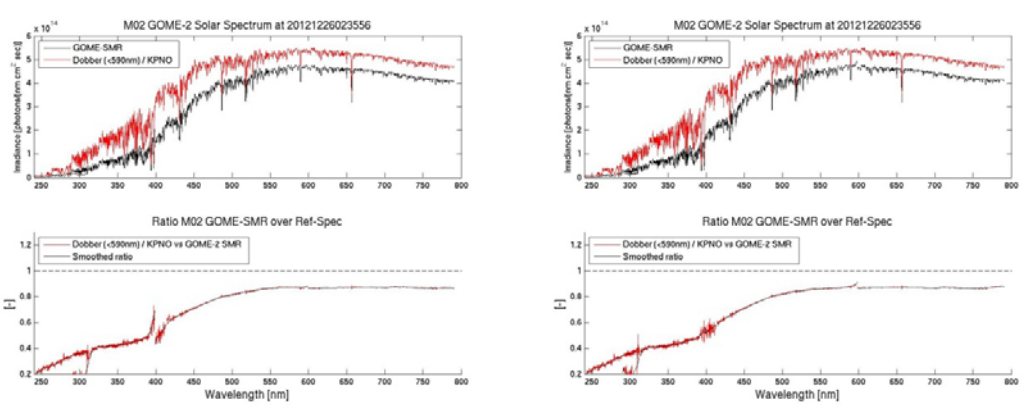


Figure 27: The top two panels show solar mean reference spectrum acquired by GOME-2 FM3 on board Metop-A 26 December 2012 (top panel) compared to a reference spectrum derived by Dobber et al. (<590 nm) and as published by KPNO/AFGL 2004 (>590 nm).The lower two panels show the residual. The left panels show the situation BEFORE the second adjustment of the radiometric response key-data for GOME-2 Metop-A and the right panels show results after this adjustment.

After this second adjustment of GOME-2 Metop-A radiometric response key-data, and when using on-board white-light source spectra from 1April 2013, the overlap region comparisons to the reference data improves significantly. The overall difference to the reference spectrum is due to the instrument signal degradation.

In relation to the previous update on Metop-B key-data (described in newsletter #32), this update will extend the "valid" spectral region of Metop-A GOME-2 level 1b data. Table 3 and **Error! Reference source not found.** detail these changes in terms of wavelength (indication depending on actual spectral calibration) and detector fractional pixel number.

FM3 Channel Transition	*First channel 50% point [pixel]*	*Second channel 50% point [pixel]*	*Wave-length 50% signal point [nm]*
½	920.96 (921.06)	167.99 (167.37)	311.50 (311.46)
2/3	908.72 (904.90)	34.09 (32.62)	399.07 (398.54)
¾	980.23 (980.40)	59.52 (60.16)	597.97 (598.03)

Table 3: GOME-2 Metop-A / FM3 Channel overlap point (50/50 signal). Value for the previous key-data version is in parenthesis.

FM3	*Channel 1*	*Channel 2*	*Channel 3*	*Channel 4*	*PMD-P*	*PMD-S*
Start	310 (310)	168 (210)	34 (120)	60 (85)	750 (750)	750 (750)
Stop	921 (935)	909 (850)	980 (1009)	989 (989)	997 (997)	998 (750)

Table 4: GOME-2 Metop-B / FM2 validity of etalon correction [detector pixel start/stop]. Value for the previous key-data version is in parenthesis.

Error! Reference source not found. summarizes these results in terms of the "valid" regions in wavelength usable for retrievals before (FM3 key-data version CAL 2.01) and after the update (FM3 CAL 2.02).

Note: Wavelength start/stop is approximate, depending on the actual spectral calibration. Also note that the signal-to-noise ration close to the 50 % overlap point (seen in Table 3 is 50 % lower than in the rest of the channel.

FM3 Channel	*Approx. wavelength start/stop [nm] CAL 2.02*	*Approx. wavelength start/stop [nm] CAL 2.01*
1	243/311.5	243/312.8
2	311.5/399.0	316.5/392.1
3	399.0/598.0	417.1/604.1
4	604.1/790.8	603.2/790.8

Table 5: GOME-2 Metop-A / FM3 valid spectral regions per channel for use in level 2 retrievals. The table presents the regions before (FM3 CAL 2.01) and after the key-data update (FM3 CAL 2.02)

b) "Cleaning" small-scale spectral features from polarisation key-data

Like the cleaning of GOME-2 FM2 Metop-B key-data described previously, FM3 polarisation related key-data from Metop-A has been cleaned of small-scale spectral structures introduced by the on-ground calibration sources. The same "cleaning" procedure was used; however, FM3 key-data clearly did not suffer as severely from this problem as FM2 key-data did. The radiometric FM3 key-data upgrade had the biggest impact on the Earthshine reflectivity data, though both the polarisation and radiometric FM3 key-data was updated. **Error! Reference source not found.** shows the combined impact of the cleaned polarisation key-data and the radiometric adjustment on reflectivity data from GOME-2 Metop-A.

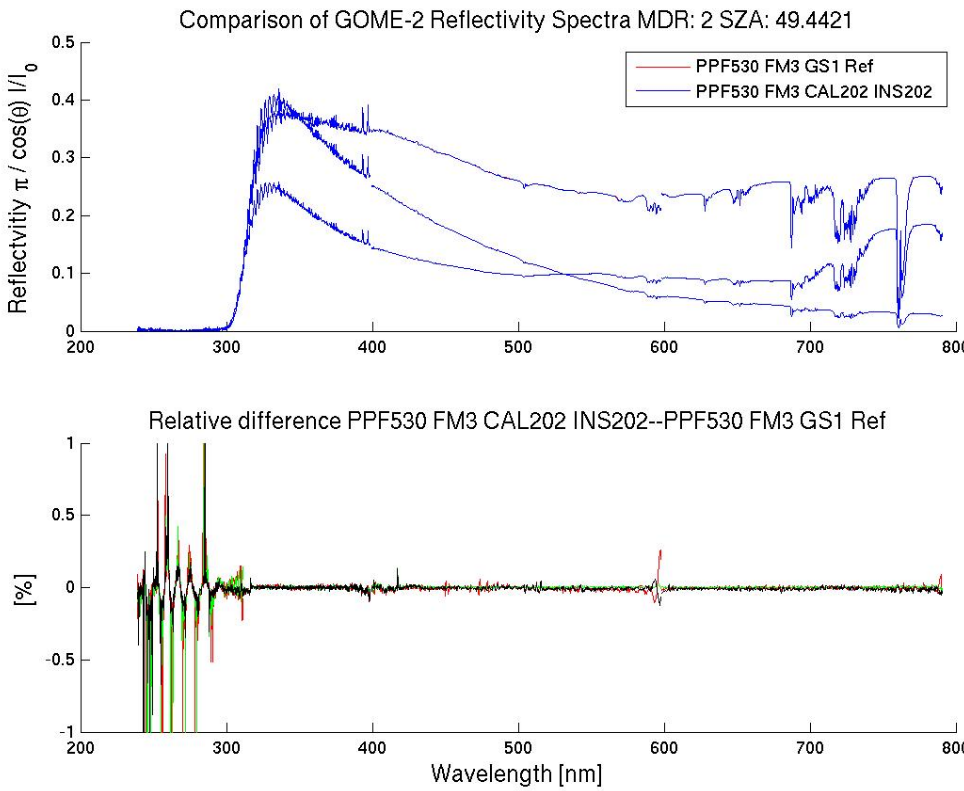


Figure 28: The top panel shows reflectivity spectra at three different viewing angles acquired by GOME-2 FM3 on board Metop-A on 26 December 2012 and for the old and new key-data sets. The lower panel shows the residuals between the old and new key-data, which combines "cleaned" polarisation data and radiometric response data updates.

Note: *Test data for this key-data update, affecting level 1B quality for both Metop-A and B instruments, is available under ftp://ftp.eumetsat.int/pub/EPS/out/lang/G2AG2B/)*

2.7 Newsletter #32 November-December 2012

Metop-B / GOME-2 FM2 level 1 data quality - status

After a successful completion of the instrument in-orbit verification (IOV) phase on 14 November 2012, GOME-2 FM2 level 1b data was given "demonstrational" status on 7 December. Trial dissemination of data to selected users started on 12 December 2012. Several significant improvements to data quality have been implemented. First, updates to instrument key-data now take into account observed changes of the on-ground versus the in-orbit situation (e.g. in the channel overlap), by optimizing essential processing parameters. Second, there is a new method for dealing with the on-ground and in-orbit etalon changes. The continuous improvement in data quality can be followed on the daily Metop-A GOME-2 reports presented on our monitoring web-page. See eumetsat.int/epsreports,

The new method for dealing with the initial etalon change (from on-ground to in-orbit) has yielded significant improvements .By incorporating this change in the radiometric response key-data, which has been adapted to account for the expected shift (on-ground to in-orbit) in the channel separation point (see also Newsletter #31), we can now correct for the continuous in-orbit changes of the etalon effect over the entire valid spectral region of each channel. As a result, no “gaps” (where the applied correction is not optimal) in spectral space are left. When this on-ground to in-orbit initial etalon effect is removed, our applied etalon correction (once per day; see daily reports on gome.eumetsat.int) is now significantly smaller.

Channel Transition	First channel 50% point [pixel]	Second channel 50% point [pixel]	Wave-length 50% signal point [nm]
½	902.05	96.17	309.72
2/3	840.15	28.54	397.76
¾	982.85	62.23	598.43

Table 6: GOME-2 Metop-B / FM2 Channel overlap point (50/50 signal)

	Channel 1	Channel 2	Channel 3	Channel 4	PMD-P	PMD-S
Start	310	85	14	37	751	750
Stop	929	880	1013	991	1000	999

Table 7: GOME-2 Metop-B / FM2 validity of etalon correction [detector pixel start/stop]

Table 1 lists the specifications for the 50/50% signal overlap point to be used as a channel separation guideline Table 2 lists the validity range of the applied etalon correction per channel. From table 2, we can see that the valid etalon correction extends over the 50% overlap point. Thus, the whole spectral region can now be exploited, with the 50% overlap point used as a channel separation guideline

Note that these changes have only been applied to Metop-B FM2 data. If they prove to be successful, they will also be applied to Metop-A FM3 data.

Figure 1 shows the solar mean reference spectrum taken on 30 October after adjustment of the overlap region. The change in the etalon correction procedure mentioned previously is also applied here. The improvement in the data can be seen by comparing this Figure to Figure 1 in Newsletter #31 (see newsletter archive). The spectrum is compared to a reference spectrum by Dobber et al. (Solar Phys (2008) 249: 281–291). Note that the latter is only available up to 590 nm. Above this wavelength, we use the KPNO/AFGL spectrum of 2004.

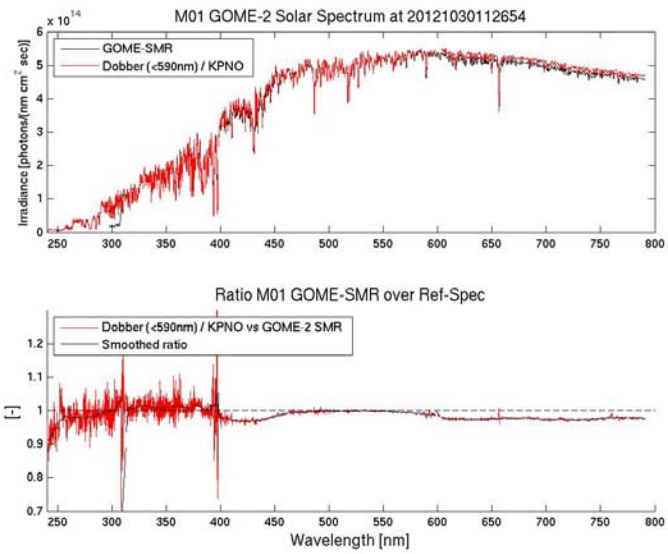


Figure 29: First solar mean reference spectrum acquired by GOME-2 FM2 on board Metop-B on 29 October at 13:20 UTC (top panel) compared to a reference spectrum derived by Dobber et al. (<590 nm) and as published by KPNO/AFGL 2004 (>590 nm).

After successful optimisation of the PMD-P to S co-registration and their spectral calibration, and having acquired sufficient data for the online-correction of Stokes fractions to be applied, the polarisation correction of level 1b data has been of good quality since the beginning of December 2012. The daily reports on gome.eumetsat.int show Stokes fractions for special viewing geometries being very close to 0 over the entire spectral range. Figure 2 below shows a collection of “Limiting Atmosphere”-plots per PMD band 1 to 15 as collected over a complete orbit taken on 28 November 2012.

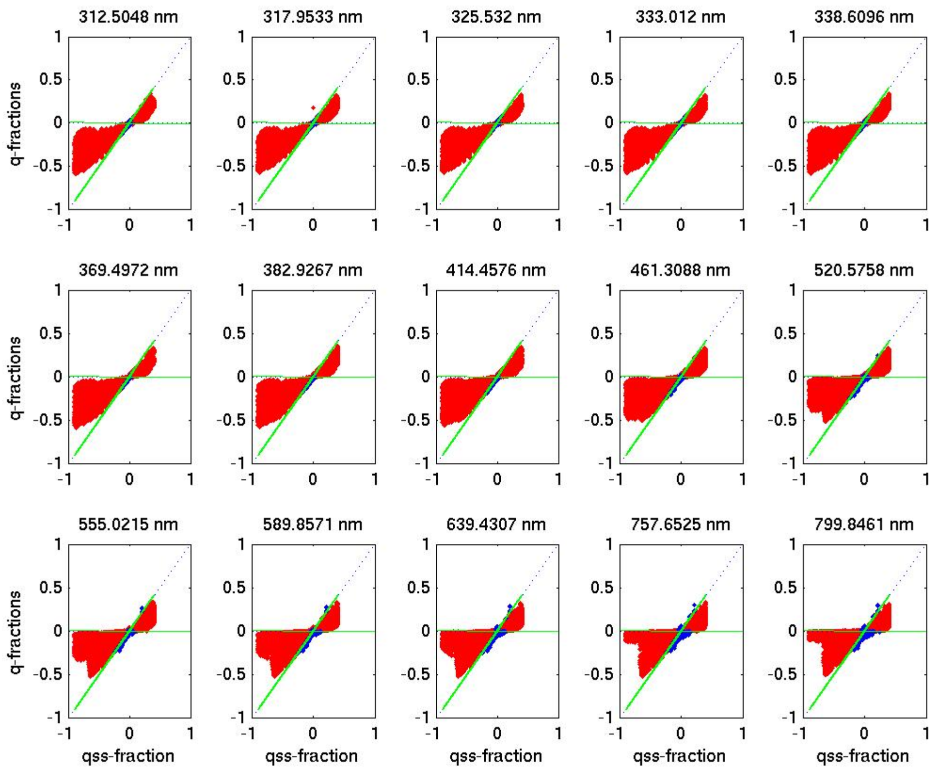


Figure 30: Stokes fractions as collected for one orbit on 28 November 2012 for FM2 /Metop-B data and for all 15 PMD bands (individual panels). Stokes fractions q with nominal quality (in red) are expected to be with the range of indicated by the green lines. Out- of- range Stokes fractions are plotted in blue.

As seen in Figure 2, there are only a very few outliers (indicated in blue) falling outside the targeted region and these are only for small Stokes fraction values. Regarding the Stokes fraction and polarisation correction quality, we believe the FM2 level 1B data has already achieved quality levels equal to FM3 Metop-A data.

The detailed analysis of Metop-B GOME-2 Earthshine level 1b data quality with respect to stable ground targets, different scan-angles with respect to forward model results, and to co-located Metop-A FM3 data is currently ongoing. Results of these analyses will be provided once the product has achieved its pre-operational status level, hopefully by February 2013. After this status change, all interested users will be able to receive data via EUMETCast or via our archive (archive.eumetsat.int). A dedicated announcement on data-dissemination start will be sent out via email and will be placed in the product and service news section under www.eumetsat.int > service status.

Metop-B / GOME-2 FM2 signal levels - status

Significant levels of signal degradation have been observed for the GOME-2 Metop-A FM3 instrument during the first three years in orbit. For a detailed analysis, please see www.eumetsat.int > Data & Products > Resources > EPS Product Validation Reports and the Technical Note section, The technical note section has two studies by the University of Bremen on instrument degradation of FM3 and its impact on level 2. See Newsletter #27. After September 2009, the degradation slowed down significantly.

Since the root cause for the degradation has not yet been identified, we expected similar levels of degradation for FM2 on Metop-B. The signal throughput level is continuously monitored by our operational Mission Performance and Statistical Analysis facility (MPSTAR). Figure 3 shows a comparison of the solar mean reference ratio SMR for FM2/Metop-B during the third month in orbit (December 2012) and FM3/Metop-A reprocessed data during its fourth month in orbit. Monthly degradation rates for Metop-A FM3 were similar for main channel data throughout 2007).

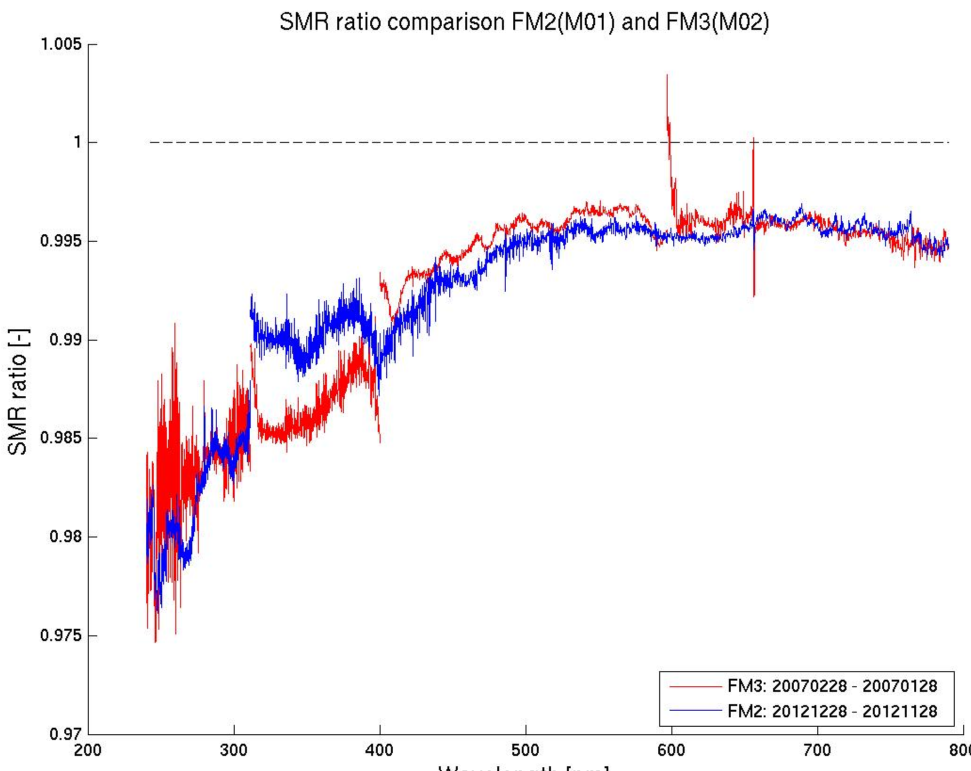


Figure 31: SMR ratio covering one month for December 2012 as measured by FM2 / Metop-B (third month in orbit; blue line) and as measured by FM3/Metop-A in February 2007 (fourth month in orbit; red line).

GOME-2 FM2 on Metop-B appears to degrade at a similar rate to FM3 on Metop-A at approximately the same lifespan in orbit, with some noticeable differences in the spectral signature, especially between channel 1 (240 – 309 nm) and channel 2 (309 – 400 nm).

Metop-B / GOME-2 FM2 slit-function data – final version available

After a successful final review of the FM2 Metop-B slit-function data provided by the Rutherford Appleton Laboratory (RAL) on 19 December 2012 at EUMETSAT, users can now download the data from our ftp site under ftp://ftp.eumetsat.int/pub/EPS/out/GOME/Calibration-Data-Sets/

Note that the essential slit-function key-data has not changed since the version provided on 12 December 2012. The documentation provided on the slit function data is also complete, though further minor updates on the documentation can be expected. These will be uploaded at a later stage.

2.8 Newsletter #31 August-October 2012

Metop-B / GOME-2 FM2 Successful Launch and In-orbit Verification

Metop-B was successfully launched on 17 October at 18:00 UTC. The orbit injection and subsequent manoeuvres brought Metop-B to exactly the same orbit as Metop-A, but with a time separation of 48.93 minutes. After three days in orbit, ESA/ESOC handed control of the satellite over to EUMETSAT. After six days, the GOME-2 instrument on Metop-B (flight model 2: FM2) was switched on for initial function tests. Subsequently, on the seventh day in orbit, the dedicated instrument in-orbit verifications (IOV) process was started. The IOV is an intense 47-day period of instrument testing that involves the activation of many dedicated on-board measurement sequences (timelines). The complete IOV period is broken down into seven phases. The first three were carried out with all instrument detector cooling turned off and lasted until the 30th day in orbit. This period is known as the *out-gassing period*. During this period, cooling was turned off so as not to attract contamination to the cooled instrument detectors from the heavily out-gassing satellite platform.

Phase 4 of the IOV lasted two days. During this phase, the instrument detectors were gradually cooled (in increments of 5 K) to their nominal operating temperature of 235 K, which is approximately 28 K lower than the temperature of the optical bench and the overall platform environment. At this point, the instrument had already performed all nominal measurement sequences and quite a number of non-nominal measurement sequences during the initial phases, with the exception of solar measurements. First Earthshine data was therefore retrieved as early as 24 September after only seven days in orbit.

After Phase 4 of the IOV finished, the detectors were sufficiently cool. At this time, Phases 1 to 3 of the IOV sequence were repeated. When complete, the IOV sequence stood at Phase 6, when the first solar measurements by GOME-2 FM2 were taken. See Figure 1.

Figure 1 shows a comparison of the first solar spectrum taken by GOME-2 Metop-B on 29 October 2012 and a reference spectrum by Dobber et al. (Solar Phys (2008) 249: 281–291). Note that the latter is only available up to 590 nm. Above this wavelength, we use the KPNO/AFGL spectrum of 2004.

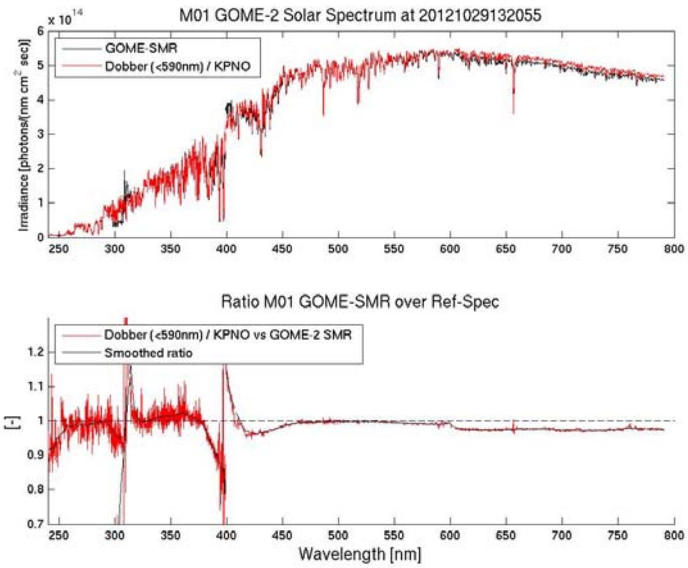


Figure 32: First solar mean reference spectrum acquired by GOME-2 FM2 on board Metop-B on 29 October at 13:20 UTC (top panel) compared to a reference spectrum derived by Dobber et al. (<590 nm) and as published by KPNO/AFGL 2004 (>590 nm).

This comparison shows very good agreement between the two spectra except for these two areas: the overlap regions of Channels 1 and 2 (~309 nm) and Channels 2 and 3 (~398 nm). During the launch of GOME-2 on Metop-A, we learned that the pre-disperser prism separating the beams in the different channels is subject to slight stresses during launch. One of the many tasks to be carried out during the upcoming commissioning phase of level 1 data is to account for these channel-overlap changes.

After the acquisition of the solar mean reference spectrum on 29 October, we were also able to monitor the reflectivity from the earthshine scanning by the instrument, now with cooled instrument detectors. Our monitoring web page details all of the IOV activities starting on 26 October.

http://gome.eumetsat.int -> Metop-B

Please note that missing data, data-gaps and non-nominal instrument signatures or level 1 data quality should be expected during the entire FM2 in-orbit verification and commissioning cycle. Therefore, all Metop-B data on this monitoring site is purely for information. It should not be referenced for validation.

That being said, all IOV data acquired to date confirms a healthy GOME-2 FM2 instrument on board Metop-B. Figure 2 shows the first reflectivity spectra acquired over the Sahara on 30 October, the day after the acquisition of the first solar mean reference spectra.

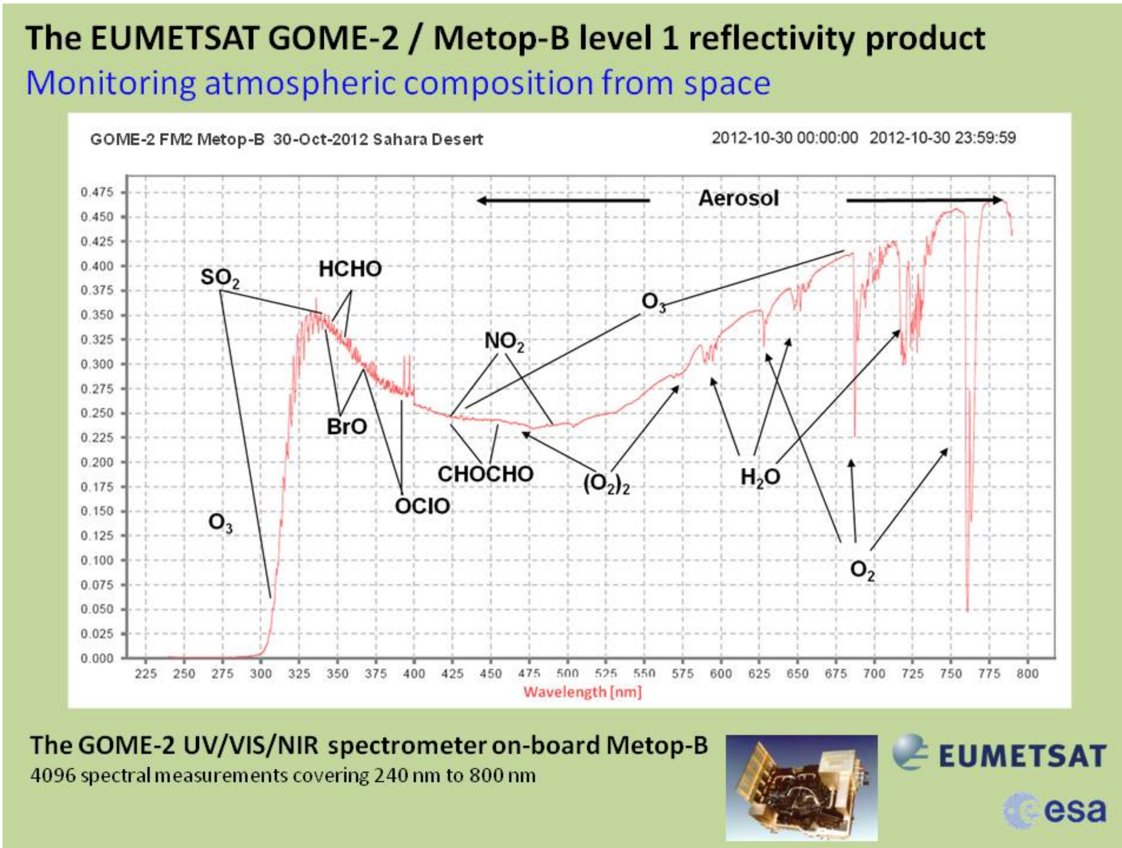


***Figure 33**: Metop L1 reflectivity spectra data plot 30 October over Sahara Desert*

Since then, both the radiometric calibration, as well as the spectral assignment, has been carried out during level 0 to 1b processing–passing all operational processing quality checks. You can see the daily monitoring reports at this site:

http://gome.eumetsat.int -> Metop-B)

Of course, there are many more offline quality checks to be applied and passed during the upcoming commissioning phases before we can release the first level 1b data even in “trial” status. The release is currently planned for mid-December 2012 and will be followed by a release of “pre-operational” data to all interested users. Target date for this release is beginning of February 2013.

Metop-B / GOME-2 level 1 data commissioning – initial steps

The commissioning activities for the GOME-2 FM2 level 1 radiance products start during the second week of November. For a detailed schedule and mission milestones, see newsletter 30. At the beginning of the commissioning phase, we will check and validate the performance of all basic calibration steps applied during level 0 to 1 processing. We will also update, where necessary, the processor settings and instrument key-data definitions with results acquired during the IOV period. Lastly, we will check the quality of the geo-reference data in the product.

In parallel, we will receive the final version of the FM2 instrument slit-function at the beginning of December. This will interest all our users who need to convolve high-resolution reference-spectra (like cross-section data) to the instrument spectral response. The data will be made available by ftp at this site:

ftp://ftp.eumetsat.int/pub/EPS/out/GOME/Calibration-Data-Sets/

This site also contains other dedicated static instrument key-data for the FM2 instrument. Note that some of the key-data files will be subject to changes as a consequence of level 1 commissioning activities. We will make the latest set of key-data available once it has been applied in the “pre-operational” level 0 to 1b processing.

As part of initial commissioning activities, we will also closely monitor the FM2 instrument signal throughput and compare it to the signal throughput of FM3 on Metop-A during a concurrent orbit. Results of this initial assessment of the Metop-B FM2 throughput performance will be available in mid-December.

2.9 Newsletter #30 April-August 2012

Metop-B / GOME-2 FM2 New Launch Schedule and Mission Milestones

The launch of the second Metop satellite platform (Metop-B) with the GOME-2 instrument flight-model number 2 (FM2) on board has been re-scheduled for 17 September 2012. Following the successful launch and the deployment of the space-segment, these milestones have been established with the goal of getting the level 1b data from GOME-2 FM2 declared operational.

1. End November 2012: End of the Satellite and instrument in-orbit verification phase (SIOV).
2. Mid-December 2012: Early dissemination of level 1 data to beta test users for preliminary evaluation of level 1b data quality.
3. Mid-January 2013: Dissemination of pre-operational data to all users using a 1920 km swath (the current nominal swath width on Metop-A) for both satellites.

4. Mid-February 2013: Dissemination of pre-operational data using different swath settings. The swath settings will be decided after analysis of GOME-2 on Metop B performance. The default selection is a 960 km swath on Metop B. Potentially, both Metop A and Metop B will have a 960 km swath.
5. End April 2013: Decision point for the final configuration of GOME-2 Metop-A/Metop-B tandem operations.
6. Early July 2013: Final validation of Metop-B / GOME-2 FM2 level 1 data quality (operational status).

Pre-operational Metop-B/GOME-2 FM2 data will be disseminated on a dedicated channel via EUMETCAST.

Metop-B / GOME-2 FM2 launch preparation - campaign status

Following a reduction in UV-throughput that was observed for GOME-2 FM3 on Metop-A, a review of the satellite-level contamination control policy was carried out. Special emphasis was placed on the period between the calibration campaign and the launch, the latter being by far the most critical for potential contamination issues. A dedicated review of FM3 throughput degradation by the ESA lead team (the Tiger Team) concluded that the provisions in place planned for GOME-2 on Metop-A were sufficient, but the team recommended a more careful monitoring of contamination during the launch campaign. Here is a summary of this report on the status of contamination monitoring of GOME-2 FM2 during the current campaign at Baikonur. The full report was provided by ESA.

To mitigate the threat of contamination, these measures were considered standard operational procedure:

- Storage in class 100.000 standard clean room at all times. Cleanliness level while Metop was stored in Astrium premises was monitored by Astrium. There was no anomaly reported during the AIV phase.

- Transport in nitrogen-filled container between locations, for example, from supplier through to the calibration team.
- FPAs permanently filled with nitrogen. The nitrogen is refreshed every few months and refreshed on the occasion of any test requiring cooling. To allow venting in space, the valve closing the FPAs will be removed at the last possible moment—which will be nine days before the launch.
- Red-tag covers on all optical windows are permanently installed. Like the FPA case, these red-tag covers will be removed nine days before launch.
- GOME 2 is equipped with a QCM measuring molecular contamination. This will also be removed nine days before launch, after the last reading. Any change in measured frequency can indicate deposition of contaminants. Readings have been taken during the AIV phase, throughout the Launch Campaign, as well as during the "baby-sitting" period, when launch countdown was paused. All these readings have been logged and have been around 3500 Hz, which is considered nominal.

Contamination monitoring started on 22 February 2012. Since then, heightened awareness of the contamination potential has been exercised. When the launch countdown was paused for two months (8 June to 19 July) due to external circumstances, the satellite was immediately placed in a closed container. The UTC (Universal Transport Container) volume is about 175 m^3 and it was stored in the clean-room facility and flushed with available nitrogen. The nitrogen-purging system required by some other instruments was also used to moderately purge the container itself; this also helped to reduce the chance of contamination.

During the current launch campaign, the satellite has been cleaned two times. On the launch preparation schedule, the fairing encapsulation takes place one day after the GOME 2 red tags removal. Therefore, at a maximum, the GOME 2 optics will be exposed to the clean room environment for one day.

The continuous contamination monitoring of GOME-2 FM2 during the current Metop-B launch campaign (including the unforeseen "baby-sitting") gives us confidence that the GOME 2 performance will not be affected. At present, there is no reason to worry about contamination of the instrument during launch preparation.

Metop-A / GOME-2 level 1 reprocessing (G2RP-R2) finalized

The second reprocessing campaign of GOME-2 level 1 data (G2RP-R2) was finalised in the last week of May 2012. The result was a successful validation review of the dataset by internal and external reviewers. The full review report is now available on our website:

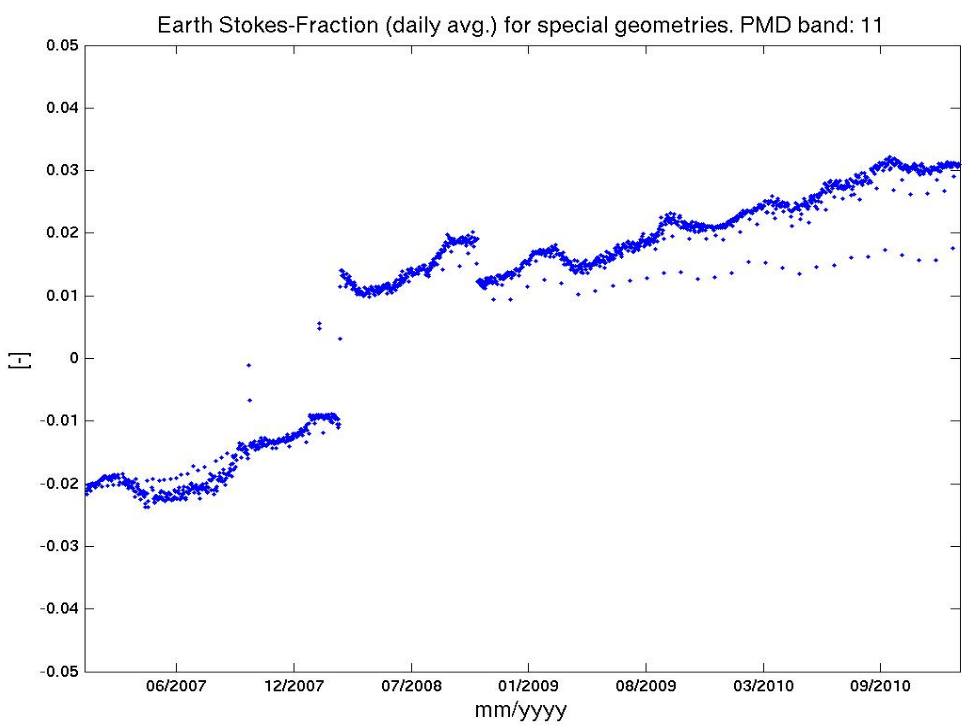
www.eumetsat.int > Data & Products > Resources > EPS Product Validation Reports > GOME-2 / Metop-A Level 1B Product Validation Report No. 5: Status at Reprocessing G2RP-R2 (PDF, 11 MB)

The report is complemented by a dataset user guide that includes basic file statistics, dataset identifiers, and data access details. This document contains a list of any potential future anomalies that are related to the reprocessing campaign. The user guide is available here:

www.eumetsat.int > Data & Products > Resources > EPS Product Validation Reports > GOME-2 / Metop-A Reprocessed L1B-R2 Data-Set User Guide (PDF, 400 KB)

This dataset covers the time period 25 January 2007 to 25 January 2012. The reprocessing is done with our latest processor (Version 5.3.0), which was installed in the operational ground segment on 24 January 2012. For more details, refer to the user-guide, the validation report, or to previous newsletter #29.

As an illustration, Figure 1 below shows Stokes fractions for earthshine special geometries for Polarisation Measurement Device (PMD) band 11 (around 560nm), for which the Stokes fraction values derived should approach zero. The top panel shows special geometry Stokes fractions as derived during the GOME-2 FM3 R1 reprocessing campaign using PPF 4.0 (no online Stokes fraction correction applied). The lower panel shows the same but uses the recent second reprocessing campaign (R2) with PPF version 5.3 and a physical online correction of Stokes fractions. The Stokes fraction quality is important for the overall quality of main channel earthshine data because of the polarisation correction involved during the processing to level 1B data.



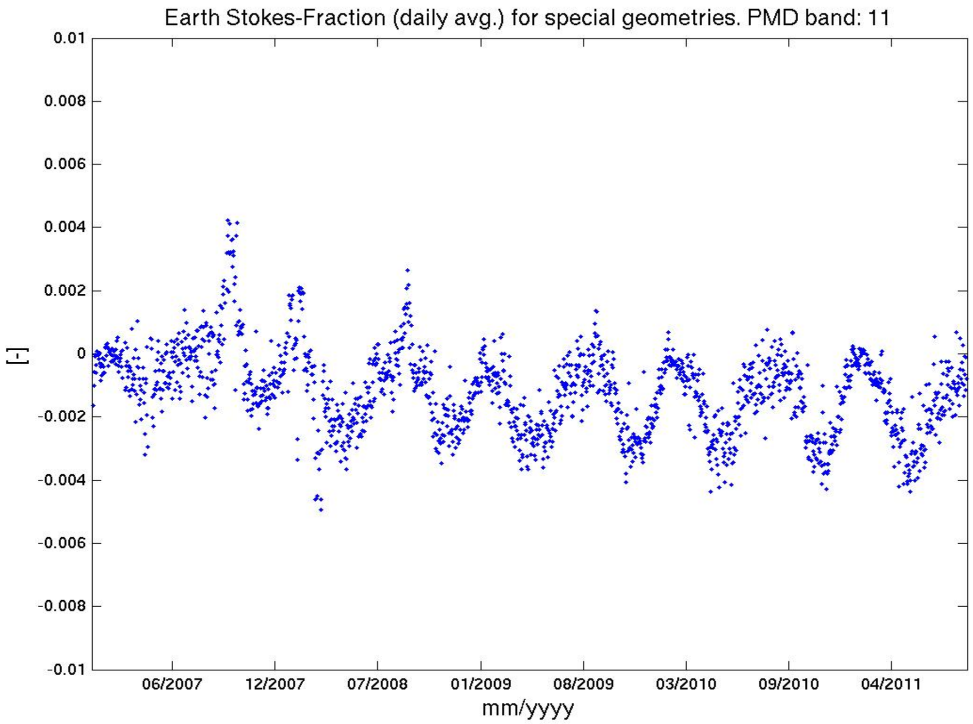


Figure 34: Stokes fractions for earthshine special geometries for Polarisation Measurement Device (PMD) band 11 (around 560nm)

All data from this R2 campaign has been uploaded to the archive. This means that any retrieval of level 1 data from the EUMETSAT data-centre that covers the R2 time period will provide GOME-2 L1B-R2 data only. NRT level 1B data has been processed with the same configuration as for R2. The dates for the NRT level 1B data are 24 January 2012 to 3 July 2012. For an update on FM3 key-data see the next section.

Users who want to order the complete dataset can send an e-mail to ops@eumetsat.int with the reference "*G2RP-R2 complete data-set*" in the subject line. You must provide a contact name and a shipping address. The complete dataset will be shipped on LTO-4 tapes.

Metop-A / GOME-2 level 1 FM3 key-data update

As announced in the previous newsletter #29, we have successfully updated the re-worked FM3 calibration key-data on 3 July in our core ground segment number 1. The update prepared us for optimal GOME-2 FM2/FM3 inter-calibration conditions during the commissioning of Metop-B/FM3 and for any additional GOME-2 flight model inter-calibration activities afterwards. The impact on level 1b radiances is small. Below 290 nm, the maximum change is on the order of 1 %–and only for very high solar zenith and viewing angles. For longer wavelengths, the changes at large viewing and high solar zenith angle should be well below 0.5 %.

For details, please refer to newsletter #29 and to the processor update history document available on http://gome.eumetsat.int > Documentation.

2.10 Newsletter #29 Jan-Mar 2012

Metop-B / GOME-2 FM2 launch schedule and mission milestones

The launch of the second Metop satellite platform (Metop-B) with the GOME-2 instrument flight-model number 2 (FM2) on board is scheduled for the 23 May 2012. Following the successful launch and the deployment of the space-segment, these milestones have been established with the goal of getting the level 1b data from GOME-2 FM2 declared operational.

1. End July 2012: End of the Satellite and instrument in-orbit verification phase (SIOV).
2. Beginning August: Initial verification of level 1 data.
3. End August 2012: Dissemination of pre-operational data using a 1920 km swath (the current nominal swath width on Metop-A) for both satellites.
4. Mid October: Dissemination of pre-operational data using different swath settings. The swath settings will be decided after analysis of GOME-2 on Metop B performance. The default selection is a 960 km swath on Metop B. Potentially, both Metop A and Metop B will have a 960 km swath
5. Beginning January: Decision point for the final configuration of GOME-2 Metop-A/Metop-B tandem operations.
6. End February 2013: Final validation of Metop-B / GOME-2 FM2 level 1 data quality.

Pre-operational Metop-B / GOME-2 FM2 data will be disseminated on a dedicated channel via EUMETCAST.

Forthcoming instrument calibration key-data update for FM3 / Metop-A.

During the delta instrument calibration (key-data) campaign for FM2 (Flight Model Number 2) that will fly on Metop-B, the complete set of key-data for the current flight model FM3 on Metop-A has been reanalysed. See also Newsletter #28. The following issues were identified during analysis of the Metop-A FM3 key-data:

- There were deficiencies in the application of stray-light correction.
- Improvements were needed in the algorithm for the spectral calibration of polarisation measurement device (PMD) data.
- The available full Brewster scan on-ground information for key-data related to the calibration of the polarisation sensitivity of the instrument response has been used for the reanalysed data-set.

At the same time, EUMETSAT has introduced changes during the course of the current Metop-A mission that have improved the instrument key data. These changes are reflected in the new official delivery issue 6 of Metop-A/GOME-2 FM3 key-data from *SELEX/Galileo/TNO*. This key-dataset for FM3 is now available on our restructured calibration data ftp site (see http://gome.eumetsat.int -> Metop-A -> Documentation).

To streamline the contribution of the on-ground key-data analysis to the calibration of GOME-2 level 0 data during level 0 to 1b processing for both Metop-A and Metop-B instruments, we plan to introduce this new set of Metop-A/GOME-2 FMs auxiliary data in our operational ground schedule on 2 July 2012. The impact on level 1b radiances should be small, with a maximum change on the order of 1% below 290 nm and only for very high solar zenith and viewing angles. For longer wavelengths, the changes at large viewing and high solar zenith angle should be well below 0.5%. There is one orbit of test data with the new key-data applied and a reference orbit (for comparison) available on the ftp site. ftp://ftp.eumetsat.int/pub/EPS/out/GOME/PPF530_FM3reanalysis

Please send any feedback on the update to ops@eumetsat.int before 29 June 2012.

Metop-A and B / GOME-2 band 1a/b separation

Band 1a and band 1b have two different integration times: nominally, 1.5 seconds in band 1a and 0.1875 seconds in band 1b. On 10 December 2008, the separation between band 1a and 1b was shifted from 307 nm to 283 nm for Metop-A/GOME-2 FM3., This was done to better separate the stratospheric signal sensitivity (no clouds) from the tropospheric sensitivity (with clouds) of the two bands and to increase the spatial resolution in the UTLS region. The value 283 nm was chosen mainly because it is well inside the "stratospheric regime" and, also, because this separation has also been used for GOME-1. However, due to the unexpectedly large degradation rate of GOME-2 in the UV, we are now in a situation where the signal-to-noise (S/N) ratio in the area between 283 nm and 287 nm approaches 1.0. Figure 1 compares the S/N situation in December 2008 and in February 2012 respectively.

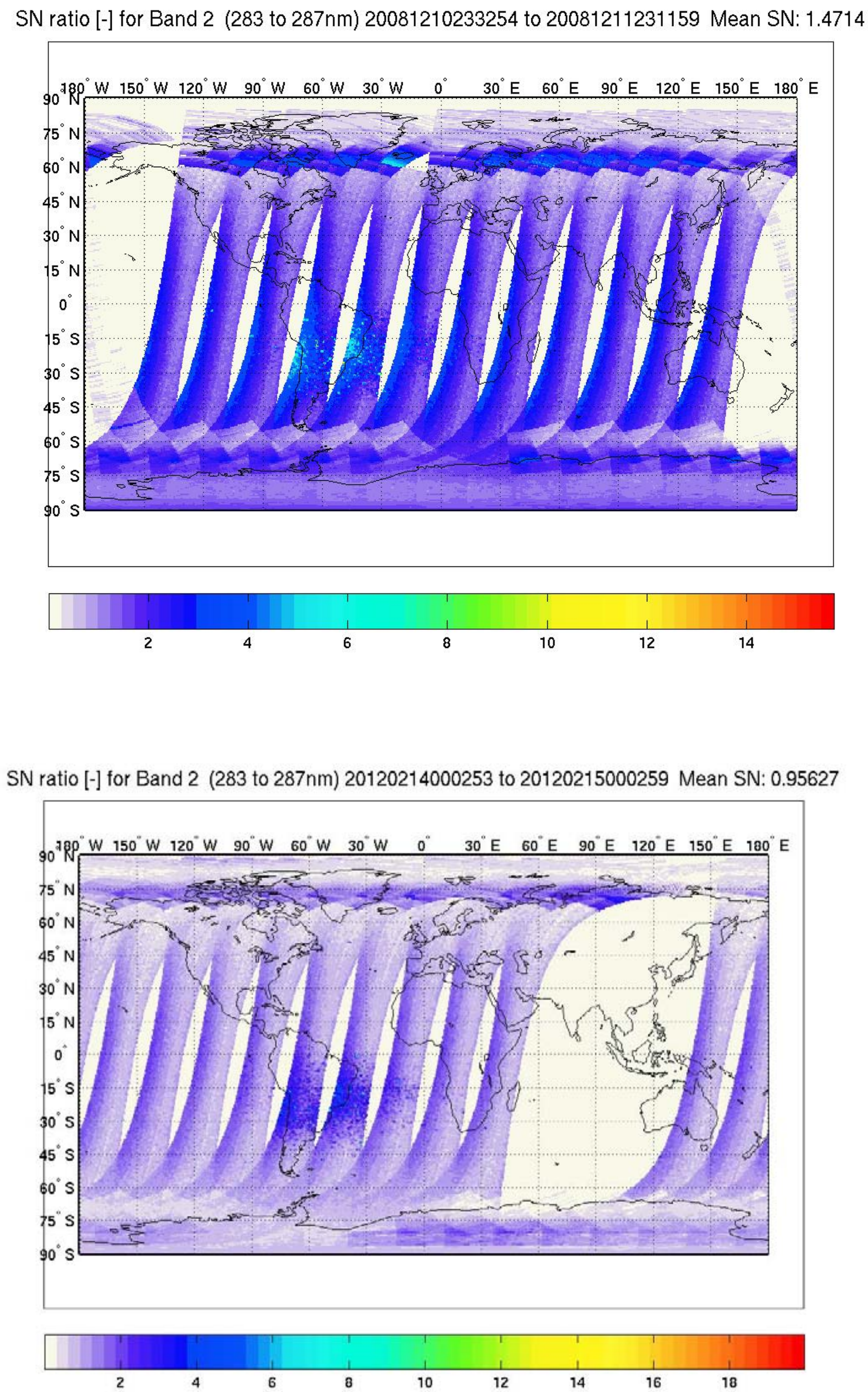


Figure 35: ***The upper panel shows the signal-to-noise ratio averaged over the wavelength region between 283 to 287 nm just after the shift of the band 1a/1b separation to 283 nm in December 2008. The lower panel shows the same but for a recent day of measurements carried out on 14 February 2012***

In a recent survey, we asked users if they favoured shifting the band separation up to 290 nm. Considering that the instrument is much more stable, the S/N situation would be much more favourable, as shown in Figure 2. A study by the KNMI (Olaf Tuinder et al.) has shown that such a shift would not introduce unfavourable interference with clouds in the troposphere when merging the higher spatial resolution band 1b data with the lower resolution band 1a signals. However, other users have pointed out that such a shift would reduce the spatial resolution in parts of the lower stratosphere where higher spatial resolution might be favourable under certain, more dynamic, conditions.

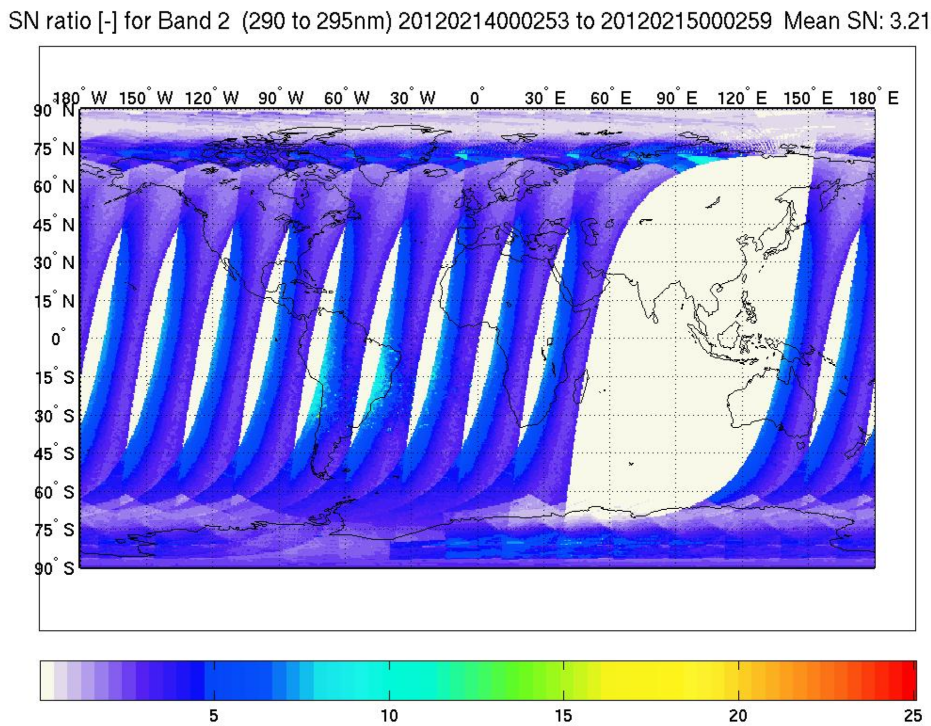


Figure 2: The same as Figure ,1 but the S/N is averaged over the wavelength region between 290 and 295 nm for one day of measurements taken on 14 February 2012.

After evaluation, it has been decided to use the currently operational setting for both Metop-A and Metop-B GOME-2 instruments in the medium-to long-term future. We can point out that Metop-A GOME-2 is much more stable now after completion of the 2nd throughput test in September 2009 in this wavelength regime. For a report on the long-term throughput performance of the instrument, see this link: (gome.eumetsat.int -> Metop-A -> documentation).

For users who experience too-low signal-to-noise conditions in the region between 283 and 290 nm for GOME-2 FM3 on Metop-B, we recommend to co-add level 1b data in the preferred wavelength regime to the band 1a resolution in order to regain signal. This approach will provide more flexibility for the user when dealing with low S/N conditions in band 1b below 290 nm.

Metop-A / GOME-2 reprocessing G2RP-R2 status

We are finalising the ongoing second reprocessing campaign of GOME-2 level 1 data (G2RP-R2). This effort comprises data from the time period January 2007 to January 2012. The reprocessing is done with our latest processor (Version 5.3.0), which was installed in the operational ground segment on 24 January 2012. Here is a summary of changes noted with respect to R1 data using processor Version 4.0 from January 2007 to December 2009.

a. Improved polarisation correction for the full mission
b. Improved geo-referencing, including geo-locations for PMD measurements
c. Random noise contribution instead of absolute errors reported in the product.
d. The product format 12.0.
e. Homogenous data-set, removing the impact of previous processor changes.

For a full list of changes with respect to PPF 4.0, see gome.eumetsat.int -> documentation -> processor change history.)

The full G2RP-R2 data-set will consist of roughly 27000 products (per product type) with a data size of 1200MB (700MB; compressed) in case of one level 1B orbit. This amounts to an overall data-set size of 32 TB (19 TB; compressed). We plan to make the full-data set available during the 2nd and 3rd quarter of 2012.

A dedicated validation report and documentation on the data-set specifications and usage will be delivered together with the release of the data. The older data from R0 (NRT) and R1, covering this period, will be placed in our archives. After this, the data will only be available by special request. After the release of G2RP-R2, individual orbits from the R2 data-set can also be ordered online using the EUMETSAT data-centre ordering tool..

If you want to order the complete data-set, but haven't already done so, you can send an e-mail to ops@eumetsat.int with the reference *G2RP-R2 complete data-se*" in the subject line.

New GOME-2 monitoring and support page for Metop-A/B operations

The EPS monitoring pages for GOME-2 and IASI have been recently updated to accommodate monitoring of two instruments in parallel from Metop-A and B. The EPS monitoring pages can be found under our main pages at this link:

www.eumetsat.int > Service Status > Product Quality Monitoring

The link to this newsletter is there also. If you only interested in GOME-2 data, the following link will take you directly to the GOME-2 monitoring page.:

gome.eumetsat.int

Note: Level-2 support data, (instrument calibration data-sets, instrument slit-function measurements and CATGAS measurements) are provided via a dedicated ftp link in the documentation section on the same page:

http://gome.eumetsat.int > Metop-A/B -> Documentation

The *Product Change and Instrument Event History* document is found in the same section. It is now separated for both instruments on both platforms.

2.11 Newsletter #28 Oct-Dec 2011

Forthcoming level 0 to 1 processor update 5.3.

An updated version of the GOME-2 level 0 to 1B processor is planned to be released in the third week of January 2012. For this update two changes are foreseen with impact on the product content.

1) Change of radiometric key data for PMDs

During the recent delta calibration campaign for FM2 (the flight model of the GOME-2 instrument to be launched with Metop-B in May 2012) systematic deficiencies in the representativeness of the radiometric response functions for the solar path (irradiance path) have been discovered, which partially also affect the previous calibration campaigns of FM3 (Metop-A) and FM1 (Metop-C). Detailed analysis of the calibration key data for FM3 revealed that the radiometric response functions of this campaign, as evaluated for the solar path using calibrated FEL lamps, seem to also suffer from deficiencies due to the non-ideal geometry of the set-up, at least for the PMD detectors. The observed differences between calibrated FM3 PMD-P and S irradiance measurements at beginning of life of Metop-A are a direct consequence of these deficiencies. Figure 1 shows the situation for calibrated solar PMD measurements in 2008 when using the current key data (FEL measurements) and compared to using newly constructed key data for FM3 based in part on sun-simulator measurements (Figure 2). The overall offset is reduced, though the fine structure remains the same. The latter may partially be due to residual polarisation introduced by the optics of the calibration unit (sun-path) which is not adequately corrected for by the instrument key data. This reduction in the overall offset of PMD-S with respect to PMD-P will reduce the systematic error on derived PMD reflectance measurements as already used by some scientific users for the retrieval of ozone, as well as aerosol properties or the routine retrieval of cloud properties.

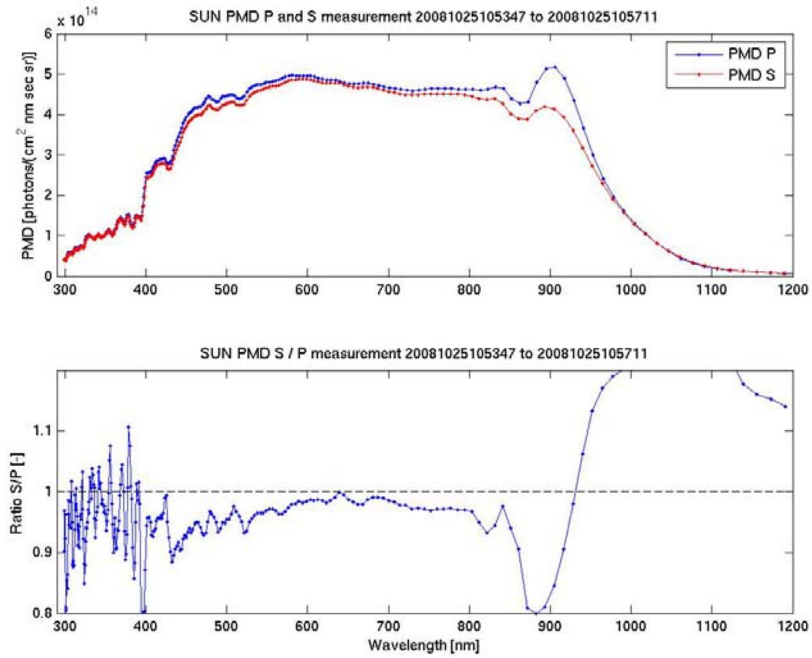


Figure 1: Solar irradiance measurements of the GOME-2 polarisation measurement devices PMD-P and S (sensitive to linear polarisation). The top panel shows the two measurements of calibrated irradiance and the lower panel their ratio.

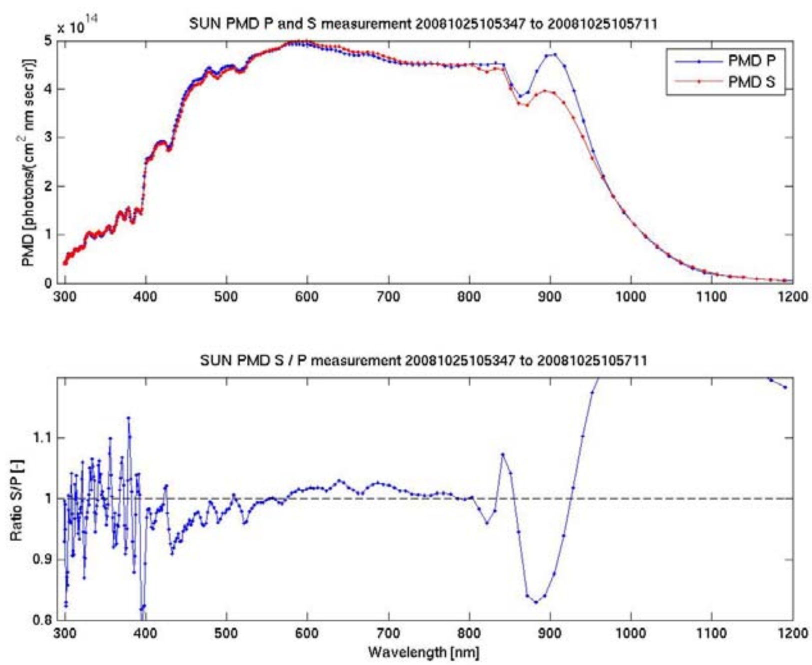


Figure 2: Same as Figure 1 but using sun-simulator key data for the calibration of the individual PMD measurements.

The change will also provide better consistency between Metop-A/FM3 and forthcoming Metop-B/FM2 data, which will become important for the commissioning of Metop-B level 1 data, as well as for the anticipated Metop-A/B future tandem operations.

2) Reporting of random noise contribution instead of absolute accuracies

Currently, the level 1B product provides a rigorous estimate of the absolute radiometric error contribution to the reported radiances in the MDR-1b-Earthshine product class BAND_M and BAND_P compound fields ERR_RAD (see PFS 9 [AD1] (www.eumetsat.int > Data & Products > Resources > EPS Product Generation Specifications, Appendix BAND_M and BAND_P Compounds; www.eumetsat.int > Data & Products > Resources > EPS Product Format Specifications). This estimate includes systematic error components for the application of calibration key data and other static data during the various calibration steps, in addition to the random noise contribution of the detector read-out, photon statistics and dark signal. Various operational users of level 1 data have however been requesting that only the random noise contribution is provided, since this is essential for retrievals using, for example, Bayesian optimisation-based approaches. This request has led to a recommendation by the GOME Scientific Advisory Group (GSAG) to implement such a change with one of the next processor versions.

Up to the current processor version 5.2, the reported absolute error has been derived from Eq. 218 in PGS v7 [AD2] (www.eumetsat.int > Data & Products > Resources > EPS Product Generation Specifications). For PPF 5.3 the random noise contribution is evaluated from the read-out noise and photon noise statistics of the uncalibrated signal S, with

$$E_D^{BU} = \sqrt{S_D^s / e + \sigma_D^2 + \sigma_D^2 / N_{dark}} \ ,$$

where σ is the read-out noise of the detector estimated from N dark signals, and e is the electron-to-binary unit conversion factor of the detectors. For the final random noise contribution in units of *photons/(sr.s.nm.cm²)* the error is normalised to the integration time and to the radiometric response function M at a specific viewing angle Ψ, leading to

$$E_{Cal} = E_D^{BU/s} / M_\Psi^1 \ .$$

3) Test data for processor version 5.3

Test data for one day of data calibrated with processor version 5.3 is now provided at the following anonymous ftp site for all interested users:

ftp://ftp.eumetsat.int/pub/EPS/out/GOME/PPF530

Please provide any feedback on the new products by sending an email to ops@eumetsat.int.

Level 1 data reprocessing campaign R2 – status update

The recent findings on key-data issues and the latest product developments have led to a delay in issuing the final part of the GOME-2 level 1 R2 reprocessing campaign. We are now anticipating to finalise the reprocessing and to start the delivery of data by Q2 of 2012 with processor version 5.3, including all the changes as detailed above.

Future processor developments

With the introduction of product format version 12.0 in January 2011 (see Newsletter #24 and 25) and the delivery of geo-referencing information on PMD read-out resolution (40 x 10 km), two place-holder compound fields for cloud-fraction values on PMD resolution called CLOUD_PMD_1 and CLOUD_PMD_2 were introduced. For the current processors up to 5.3 these fields are filled with NaN values. The GSAG recommended at its recent meeting to fill one of the two fields with a geometric cloud-fraction value as derived from AVHRR. In this way the GOME-2 product would provide radiometrically-derived cloud fraction values and cloud top height information, along with additional information on cloud albedo over ice and snow, on a main channel resolution (of approximately 40 x 80 km) using the FRESCO+ algorithm as in the current products. This would be then complemented by a geometrical cloud fraction product on the higher PMD resolution. The geometrical cloud fraction can then be used either for cloud screening on PMD resolution or for the evaluation of cloud homogeneity values on main channel resolution by making use of all eight collocated PMD read-outs in conjunction with one main channel read-out and taking spatial aliasing into account.

After screening for ice and snow cover the AVHRR level 1B product to be used as input for the new cloud fraction products provides six different tests for cloud flagging:

1. Test for Uniformity (broken cloud test)
2. Test T3-T5
3. Test T4-T3
4. Test T4-T5
5. Albedo Test
6. T4 Test

where Tn denotes the brightness temperature of the AVHRR/3 infrared channel n, n=3...5. For n=3, T3 is the Channel 3b brightness temperature. For the ‘Albedo Test’, the channel selection depends on the surface type and includes those channels which have highest sensitivity to surface type in the visible NIR (channels 1 and 2). A uniformity test will mainly return ‘cloudy’ for the cloud edges or for broken clouds, but can give ‘clear’ for a homogeneous stratus cloud deck.

For the future implementation of an AVHRR-derived geometrical cloud fraction value we propose to collect all threshold values from the albedo test (test 5) within the footprint of one PMD pixel (see Figure 3), since it is radiometrically closest to the GOME-2 situation, and to calculate a cloud fraction from it. The AVHRR/PMD collocated CFR value will then be provided in the CLOUD_PMD_2 field (to be consistent with CFR values from FRESCO+ provided in the FIT_2 compound field). We propose to put the result of calculating the radiance variance for one of the VIS/NIR AVHRR channels (default: channel 1), normalised by the mean signal over the GOME-2 PMD pixel, into the CLOUD_PMD_1 compound field. This provides an estimate of the cloud homogeneity within one PMD ground pixel.

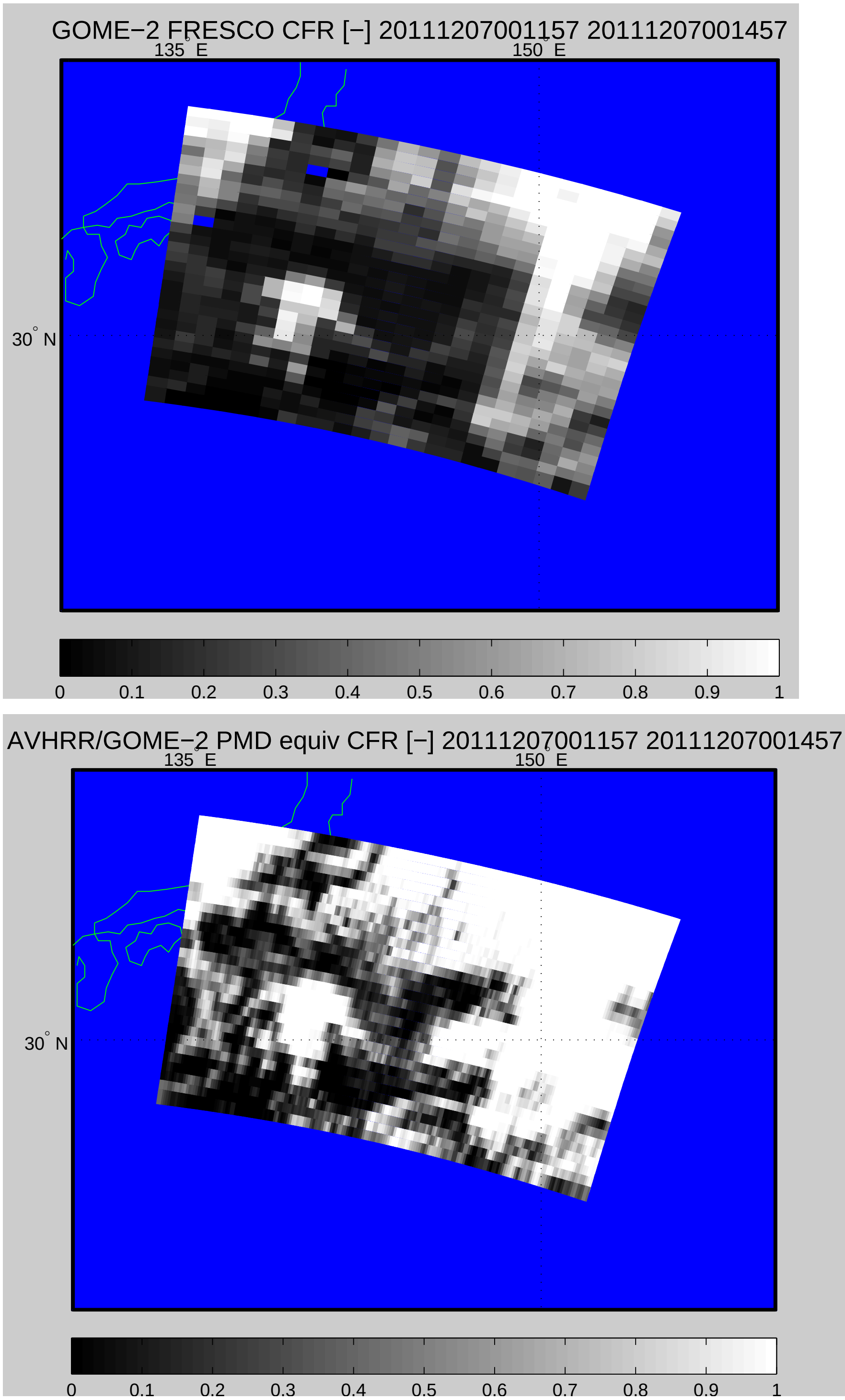


Figure 3: Top panel: Cloud fraction values as provided by FRESCO+ for main channel data (approx. 40 x 80 km^2 at nominal resolution). Lower panel: Offline derived PMD resolution equivalent cloud mask from all AVHRR measurements within the ground pixel size of a GOME-2 PMD measurement and applying the AVHRR albedo test (see text).

2.12 Newsletter #27 May-Sep 2011

PMD absolute radiometric calibration – Level 0 to 1 processor update 5.2

The operational GOME-2 level 0 to 1B processor has been updated to version 5.2 in our main ground segment on 6 September 2011 (for the full processor change history please visit http://gome.eumetsat.int > Documentation > Processor change history). This new processor version employs a new formulation for the radiometric calibration of polarisation measurement device (PMD) data. Instead of the previously-used Eq. 216 in PGS v7 [AD2] (www.eumetsat.int > Data & Products > Resources > EPS Product Generation Specifications), we now use the following equation:

$$S_{Cal}^{corr,MME} = S_{DP}^{p/s} / M_{\Psi}^{1,p,s}\left(\lambda, \kappa^{p,s}\right),$$

where $S_{DP}^{p/s}$ are the dark-signal corrected and normalised PMD-P and PMD-S band-signal values, which are corrected for the polarisation sensitivity of the instrument by

$$S_{DP}^{p/s} = S_{D}^{p/s} / \left(1 + q\mu^2 + u\mu^3\right).$$

Here q and u are the Stokes-fraction values as derived from the ratio of the PMD-S and P signals (see Section 5.2.23 in the PGS [AD2] on the determination of Stokes fraction) and μ^2 and μ^3 are the intensity-normalised Mueller–Matrix elements of the instrument's polarisation response as characterised on ground (instrument key data). In this way, and as already detailed in Newsletter #26 Jan-Apr 2011, the calibrated signals are dependent on the online corrected Stokes fractions q, which include a correction for the changes in the S to P signal ratio due to instrument degradation and key-data deficiency. For the viewing-angle dependency κ of the radiometric response $M_{\Psi}^{1,p/s}\left(\lambda\kappa^{p,s}\right)$ for PMDs and up to processor version 5.1, the κ for main channel signals has been used from the instrument key data set. For processor version 5.2 this κ has now been replaced by the dedicated κ^s and κ^p for PMDs.

The detailed changes to processor 5.2 serve two purposes:

1. Radiometrically calibrated PMD-S and PMD-P data (as provided by the BAND_PS and BAND_PP fields of GOME-2 MDR-1b-Earthshine records in the level 1B product) are now more consistent with main channel data (see also Newsletter #26, Figures 1 and 2).
2. The new formulation enables us to correct for potential systematic deficiencies in the characterisation of κ in the future, as well as for the impact of instrument degradation on the radiometric calibration of the signals directly, in a similar fashion to the current implementation of the q-Stokes fractions correction.

Note that such a radiometric correction as referred to under 2) has *not* been implemented in processor version 5.2! Instead we target an overall correction of the impact of degradation on the absolute radiometric quality of both main channel and PMD signals as an offline level 1B to C processing step to be applied depending on the need of the level 1 data user (see the following section on reprocessing).

Level 1 data reprocessing campaign R2 – status and overall scope

The GOME-2 level 1 reprocessing campaign R2 has started in September 2011. The campaign will cover data from 5 January 2007 to 6 September 2011 processed with processer version 5.2 (for the full processor change history please visit http://gome.eumetsat.int > Documentation > Processor change history; see also previous section). We target a consistent data set covering at least the period of 5 years until the end of 2011 (i.e. including the months after August 2011, which are processed in near-real time with processor version 5.2 in our operational ground segment).

Apart from providing a consistent data set to all level 1B data users, data from R2 will subsequently be used for the evaluation of an anticipated 3D (spectral, temporal, viewing geometry space) correction matrix for the impact of instrument degradation on the absolute radiometric accuracy of main channel and PMD radiance and irradiance data. **Note that the reprocessed level 1B R2 data set will not be instrument-degradation corrected (except for the currently implemented implicit online correction of *q*-Stokes fractions; see also previous section)**.

The delivery of R2 data to the users is currently scheduled to start in January 2012. The exact delivery date of the 3D correction matrix for degradation is still open. Currently we hope to be able to implement this task during the course of 2012. EUMETSAT plans for the provision of this matrix offline to be applied as an additional level 1B to 1C processing step as required by users.

The GOME-2 team at EUMETSAT is happy to receive input from the user community concerning their needs for correction of GOME-2 instrument degradation effects in the radiometrically calibrated level 1B radiance data. Any suggestions or comments may be sent to our user service contact address at ops@eumetsat.int.

Instrument throughput degradation status – impact on level 2 products

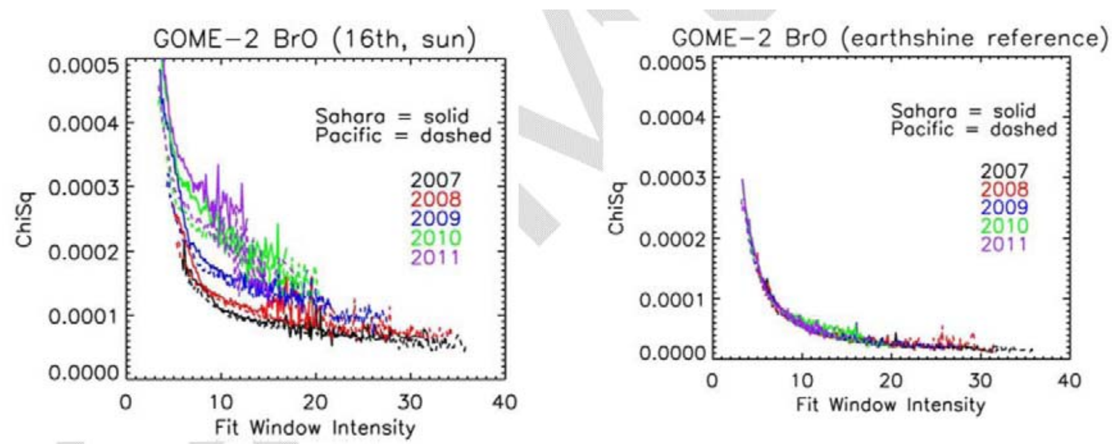
Significant impact on level-2 data quality for sensitive, minor trace-gas products or profile retrievals due to the degradation of the GOME-2 instrument has been reported by several users. Other products, like total ozone, nitrogen dioxide, or products derived from the visible to near-infrared spectral region with very low levels of degradation, are not (or only marginally) affected.

The operational product quality of level-2 data is continuously monitored by the O3MSAF (http://o3msaf.fmi.fi) and its members, e.g. at DLR (http://atmos.caf.dlr.de/gome/) and the University of Thessaloniki (http://lap.physics.auth.gr/eumetsat/index.php).

A detailed analysis of the impact of degradation on level-2 data using similar retrieval techniques for a large variety of trace-gas products has also been carried out by the University of Bremen (http://iup.physik.uni-bremen.de/eng/) for EUMETSAT. A final report from this study will be presented to EUMETSAT by the end of September 2011 and will also be made available to all users by the end of this year.

The report largely confirms the overall observations by the data users as set out before. It provides a detailed quantitative analysis of the increase of fitting and total column errors over time, their relationship to signal intensity decreases, and of the continuous increase of scatter on the absolute vertical columns for sensitive retrievals. In addition, the report also points at other potential issues, like the overall quality of the solar spectrum unrelated to degradation but potentially interfering with its effect on data quality. In this context, (increasing) levels of stray light in channel 1, which are not corrected for by the current instrument key data, may have a significant or even larger effect on level-2 data quality for some species than instrument degradation alone.

Figure 1 shows the dependency of the fit quality expressed in χ^2-values on signal levels, which in principle should not change its functional behaviour over time except that the maximum observed intensities are expected to decrease because of instrument degradation and consequentially the minimum χ^2-value increases. However, when fitting sun-normalised reflectances in the BrO absorption region (here the wavelength region between 336 and 347 nm is used) a step-wise behaviour of the relationship between signal and χ^2-values is observed (see left panel). This "feature" is removed when using earthshine normalised reflectances (using a daily earthshine spectrum from a region with negligible amounts of BrO for normalisation) indicating that this "feature" might be introduced by the daily solar mean reference spectrum (right panel).



Courtesy Dikty and Richter, IUP University Bremen.

Figure 1: Intensity-dependent behaviour of χ2 for GOME-2 BrO fitting results over the Sahara and the Pacific. Data from January 2007 to July 2011 are presented using only measurements from the 16th of each month. The left panel shows results using sun-normalised level 1 spectra, whereas the right panel shows the same results but using earthshine-normalised spectra for which a mean earthshine spectrum has been collected at each point in time over the Pacific between 10°S and 10°N and 180°W to 140°W.

2.13 Newsletter #26 Jan-Apr 2011

Total Column Water Vapour from GOME-2 now operationally available

The clear sky total column water vapour offline product from GOME-2, as produced by the O3MSAF (http://o3msaf.fmi.fi), became operational on 13 April 2011.
For a full set of references and how to order the data please visit:
http://o3msaf.fmi.fi/products/oto.html.
For near-real-time monitoring quick-look results please visit:
http://atmos.caf.dlr.de/gome/product_h2o.html.

New GOME-2 Level 1 Product Generation Specifications available

Since the launch of Metop-A in October 2006 the GOME-2 level-1 product quality has significantly improved from the original PPF launch version 3.2 until the most recent version 5 (for the full processor change history please visit http://gome.eumetsat.int > Documentation > Processor history). All changes up to processor version 5.1 are now covered by the latest release of the Product Generation Specification version 7, which is available on the EUMETSAT resources page (www.eumetsat.int > Data & Products > Resources > EPS Product Generation Specifications). Some of the major improvements are recalled here:

1. Improvement of spectral calibration for PMD by using a full wavelength grid representation; PPF 3.8.
2. Improvement of the Stokes fraction quality used for polarisation correction, especially in regions where q is close to 0 (C-shape problem); PPF 4.1.
3. Improvement of the detection of South Atlantic Anomaly (SAA) signals for product flagging and for the special treatment of dark signals within the SAA; PPF 4.2.1.
4. Online correction of Stokes fraction derived from special geometry situations (where q is expected to be 0) to compensate for deficiencies in the angular dependency of the relative radiometric response between P and S, as well as for different degradation rates in time of the two polarisation detectors; PPF 4.3.
5. Introduction of FRESCO+, providing cloud-fraction and cloud top pressure results based on a Rayleigh scattering atmospheric model; PPF 5.0.
6. Provision of geolocation data for the high spatial resolution PMD measurements in the new product version 12.0 (see also Newsletter #25 Sep-Dec 2010); PPF 5.0.
7. Provision of uncorrected polarisation measurement data; PPF 5.0.

PMD absolute radiometric calibration

Following the release of processor version 5.0 and version 12.0 of the product format which provides significant improvements for the exploitation of polarisation measurement device (PMD) data (including uncorrected PMD data and geolocation information for PMDs), we have turned our attention to the absolute radiometric accuracy of the calibrated individual PMD P and S signals. Note that with previous improvements for processor version 4 (see previous section), the quality of Stokes fraction data (also used for correction of main channel data) has already reached very high accuracy levels. However, for *q* and *u*-Stokes fraction data only the relative response of S and P signals is needed. Here we are concerned with the accuracy of the individual PMD signals as provided in the fields BAND_PP and BAND_PS of the GOME-2 product MDR sub-class records.

Studies carried out by Tilstra et al., KNMI, the Netherlands, comparing polarisation-corrected PMD signals to main channel data show discrepancies depending on signal level (slopes) and individual PMD band number (offsets). Figure 1 shows a series of slopes and offsets for 14 orbits in 2008 depending on PMD band number (i.e. at various wavelengths).

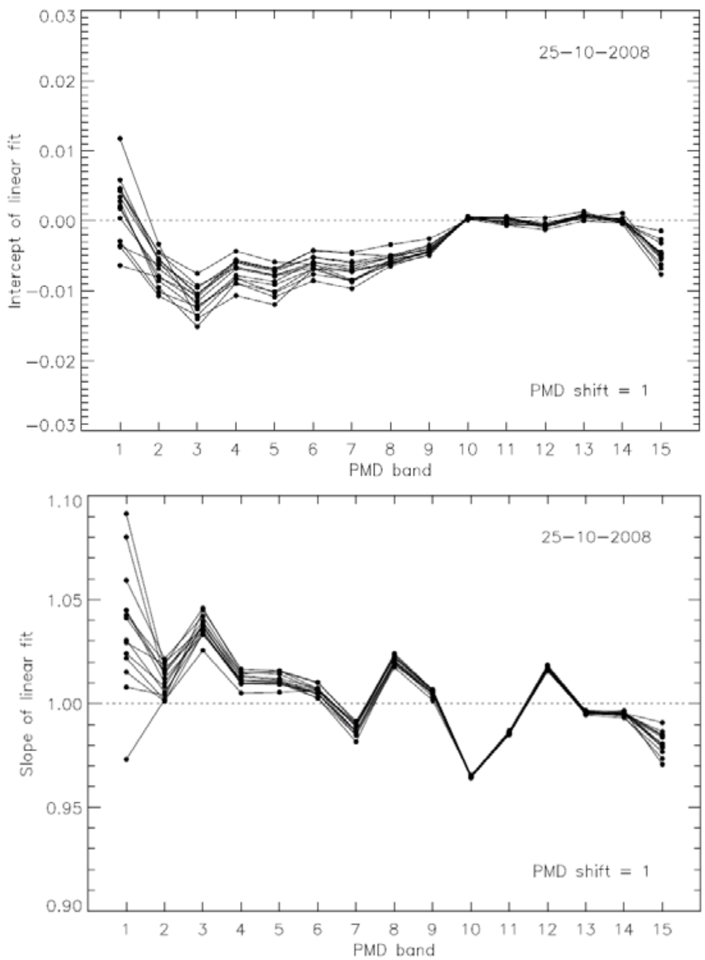


Figure 1: Upper panel: PMD band offsets with respect to main channel reflectivity levels for all 15 PMD wavelength bands and for 14 orbits in October 2008. Lower panel: slopes at various signal levels for correlations between PMD band reflectivity and main channel values and per PMD wavelength band. These results are provided by Tilstra et al., KNMI, the Netherlands.

It has been found, however, that both of these offsets and slopes are very stable in time. Therefore we suspect that the root cause for this behaviour is due to the missing correction of angular and temporal deficiencies in the polarisation key data concerning the sensitivity of the optics of the instrument to the state of the incoming polarised light. The latter has been corrected for in the case of q-Stokes fractions used to correct main channel data (see above) since PPF 4.3. However, this correction is not applied for the PMD signals themselves. Also the angular dependence of the radiometric response function (κ for PMDs, see Eq. 13, PGS 7) turns out to be quite different for the PMD detectors than for the main channel detectors, which so far has not been taken into account.

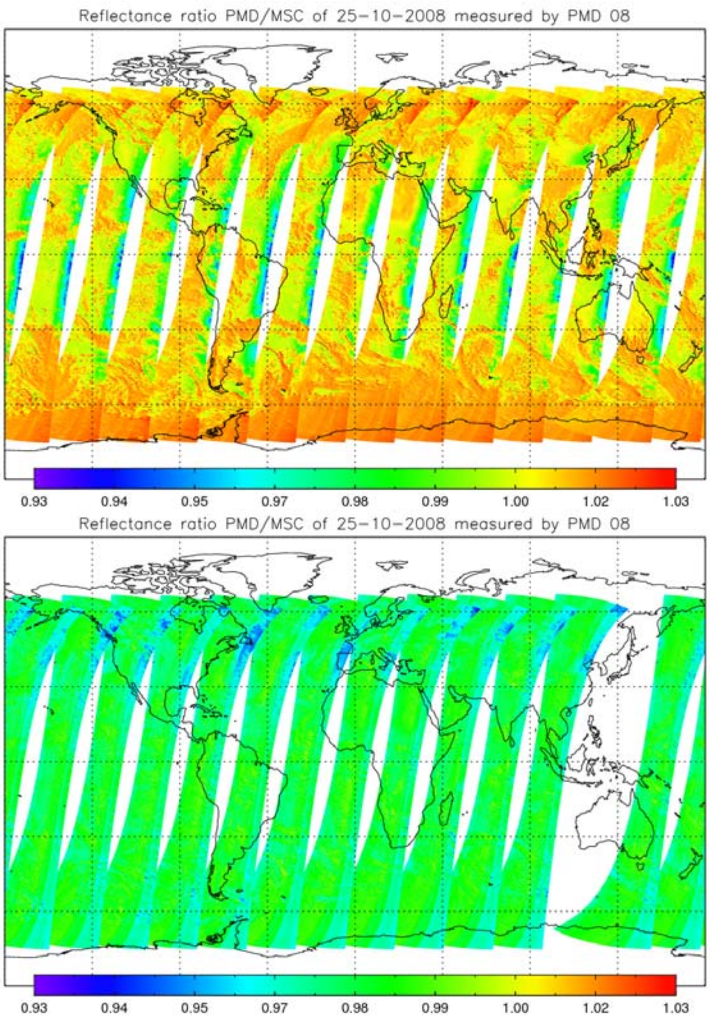


Figure 2: Ratio between PMD-P signal and corresponding main channel data for one day in October 2008 as provided by Tilstra et al., KNMI, the Netherlands. Upper panel: current situation for data from PPF 4 (reprocessed data R1). Lower panel: Results from offline processing using a properly polarisation-corrected PMD-P signal and applying a recent update of key data for the angular dependence of the radiometric response function for PMDs (κ for PMDs, see Eq. 13, PGS 7).

Figure 2 shows the ratio of PMD signals correlated to main channel data for a complete day of measurements in October 2008, taking the effect of spatial aliasing into account. The differences between a properly polarisation-response corrected PMD signal (lower panel) and the current situation (upper panel) are clearly visible. The improvement is partly caused by the disappearance of polarisation-related features, and partly by a reduction of the offsets. The latter points to remaining deficiencies in the newly (offline) applied instrument key data for PMDs. We hope that we will be able to correct for the remaining offsets using similar comparisons to main channel data as the ones presented in Figure 2.

In summary, we could show that we are able to significantly improve on the quality of the PMD signals absolute radiometric calibration by applying an improved correction of the PMD channel optics sensitivity to the state of polarisation and by taking newly available instrument key data into account. We hope that we will resolve the remaining issues identified and will be able to come up with significantly improved radiometric accuracies for individual PMD signals for one of the next updates of the level 0 to 1 processor. Note again that the issues presented in this section do not affect the quality of polarisation correction of main channel data, which remains at a very high level since the changes implemented for processor version 4.3 and later versions.

Instrument throughput degradation status

One and a half years after the 2nd throughput test carried out in September 2009 it is still evident that the rate of degradation has significantly slowed down for all instrument channels following the test (see also Newsletter #23 Jan-May 2010) to the extent that the remaining degradation rate is of the order of what might be expected from a continuous degradation of the scan mirror itself.

Figures 3 and 4 show the normalised throughput at 283 nm and 420 nm in channels 1 and 3 respectively. The spikes in the time series are due to instrument switch-offs or testing periods.

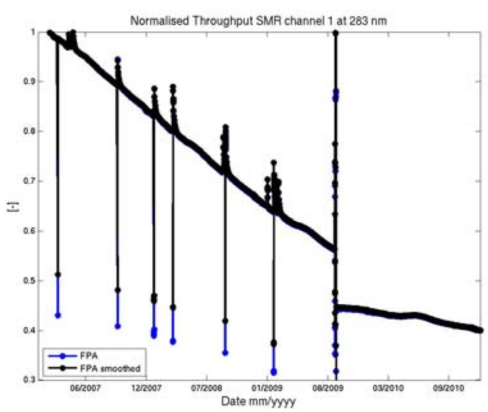


Figure 3: Solar mean reference signal normalised to February 2007 at 283 nm at the very beginning of band 1B (channel 1)

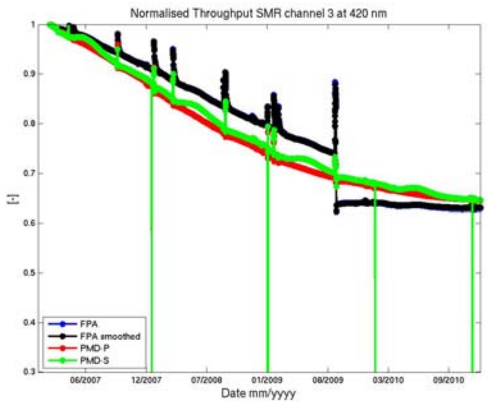


Figure 4: Same as Figure 3 but at 420 nm (channel 2) and adding PMD-P and S data from the polarisation measurement devices. Note, the latter were not part of the 2nd throughput test and therefore did not experience a sudden drop in September 2009.

From Figure 4 it is also evident that PMD signals and main channel signals are now approaching the same throughput levels at the same rate of remaining degradation.

Even though the instrument degradation has significantly slowed down, we are meanwhile approaching signal-to-noise limits for dark surfaces and at high solar zenith angles at the UV end of band 1B (channel 1) between 283 nm and 290 nm. The latter is also due to the fact that the band 1A/1B separation, with short integration times of 0.1875 seconds for band 1B (1.5 seconds for band 1A), is currently at 283 nm (since 10 December 2008). We may be forced to shift the separation back to a longer wavelength around 290 nm in the foreseeable future in order to avoid these situations.

Level 1 data reprocessing campaign R2

The GOME-2 level-1 reprocessing campaign R2 will be carried out starting this summer in the new EUMETSAT EPS reprocessing facility. The GOME-2 data archive will be the first of the Metop instrument data sets to be reprocessed on the new system. The reprocessing will take place with the latest processor version 5 and cover the time between January 2007 and January 2011.

For this new reprocessed data set we will reprocess orbits covering a complete instrument timeline. Currently a Metop orbit file starts and ends at Svalbard, Spitzbergen, i.e. at the place of Metop-data downlink. As a result, and during northern hemispheric summer, the day-side part of the orbit is split in two parts at Svalbard.

The new reprocessing architecture for the R2 campaign will now take advantage of the fact that a GOME-2 instrument timeline always starts at a fixed point with respect to solar zenith angle at the dark side of the orbit, and the full level-1 orbits will be reconstructed accordingly. For the user it will then be easier to skip the part of the data which does not contain any earthshine measurements. Please note that this logic will however be applied to reprocessed data only, which will be made available after the successful validation of the campaign data by the EUMETSAT Data Centre (www.eumetsat.int > Data Access >

EUMETSAT Data Centre). Reconstructed orbits provided by the Data Centre outside the reprocessing campaign period will continue to follow the current logic.

Due to the current planning, we target a release of R2 data by the end of 2011.

Metop-B planning and commissioning

We are in the process of setting up detailed planning for the in-orbit verification and commissioning of data from the next instrument on board Metop-B to be launched in April 2012. The Metop-B satellite will fly together with Metop-A on the same orbit (i.e. the same sun inclination of 98.7° to the equatorial plane at 9:30 local solar time for the descending node) but with a time delay of approximately 48.93 minutes, such that the Metop-B/GOME-2 ground surface track will fall in the gaps of the Metop-A/GOME-2 track.

The instrument in-orbit verification and data commissioning phases will follow the same logic as for Metop-A. We plan for an IOV and initial data verification phase (pre-operational status) of about 4 months. At this point level-1B data will be made available with pre-operational status to interested users. Fully commissioned level 1 data (operational status) are then expected to be disseminated in near-real time to all users by the end of 2012.

2.14 Newsletter #25 Sep-Dec 2010

PPF 5.0 activated on 5 January 2011

The new GOME-2 level 0 to 1 processor PPF 5.0 has been activated on our main ground segment on 5 January starting with sensing time 15:15. The new release will produce GOME-2 level 1 products in the new format version 12.0 based on the updated product format specification document version 9. Details on all changes are summarised in a technical note on the format update and provided together with PFS v9 in the Product Format Specifications on the Eumetsat webpage (www.eumetsat.int > Data & Products > **Resources)**. Note that this early scheduling of the PPF 5.0 in 2011 will enable us to produce a consistent and continuously updated record of products with format 12.0 as produced by processor version 5.0 by reprocessing the complete years of 2007 to 2010. Reprocessing activities of GOME-2 level 1B data with PPF 5.0 will start during the first quarter of 2011 (see also newsletter #23).

Apart from the format change, the new PPF version 5 introduces the following improvement:

FRESCO+ cloud information (cloud top pressure and cloud fraction) now accounting for the contribution of clear-sky Rayleigh scattering in the atmosphere and utilising a new MERIS surface albedo database over land. For details on the new FRESCO+ we refer to the ATBD and the validation report on our resource webpage (www.eumetsat.int > Data & Products > **Resources)**. For details see also newsletter #23.

Additional uncorrected PMD data provided with PPF 5.0

The new products version 12.0 provided with PPF 5.0 provides additional polarisation measurement device (PMD) radiance data which are not corrected for the polarisation sensitivity of the instrument. Whereas in the previous and current products BAND_PP and BAND_PS structure data contain corrected PMD radiance for the polarisation sensitivity of the instrument in the field “RAD”, the newly-added fields “UNCORR_RAD” provide the uncorrected data. Corrected data use PMD-S and P raw data to implicitly correct for the polarisation sensitivity. Therefore both fields BAND_PP.RAD and BAND_PS.RAD contain the same numbers. Fully corrected PMD data can directly be compared with main channel (FPA) data since the information on the state of linear polarisation has been removed (green line in Figure 1). Not so for the new uncorrected fields BAND_PP.UNCORR_RAD and BAND_PS.UNCORR_RAD. For the latter both the state of linear polarisation of the incoming light due to scattering conditions in the atmosphere and surface albedo has been preserved, but also the impact of the instruments optics to the state of polarisation (red lines Figure 1). The newly added PMD data will be useful for increasing the information content of GOME-2 data on atmospheric scattering, e.g. with respect to the retrieval of aerosol optical properties. Note, that the new products also provide geo-records for the very short integration times and thus high spatial resolution (8 times higher than main channel FPA data) of the PMD measurements. For details we refer to the tech-note on the new product format provided in (www.eumetsat.int > Data & Products > **Resources)**.

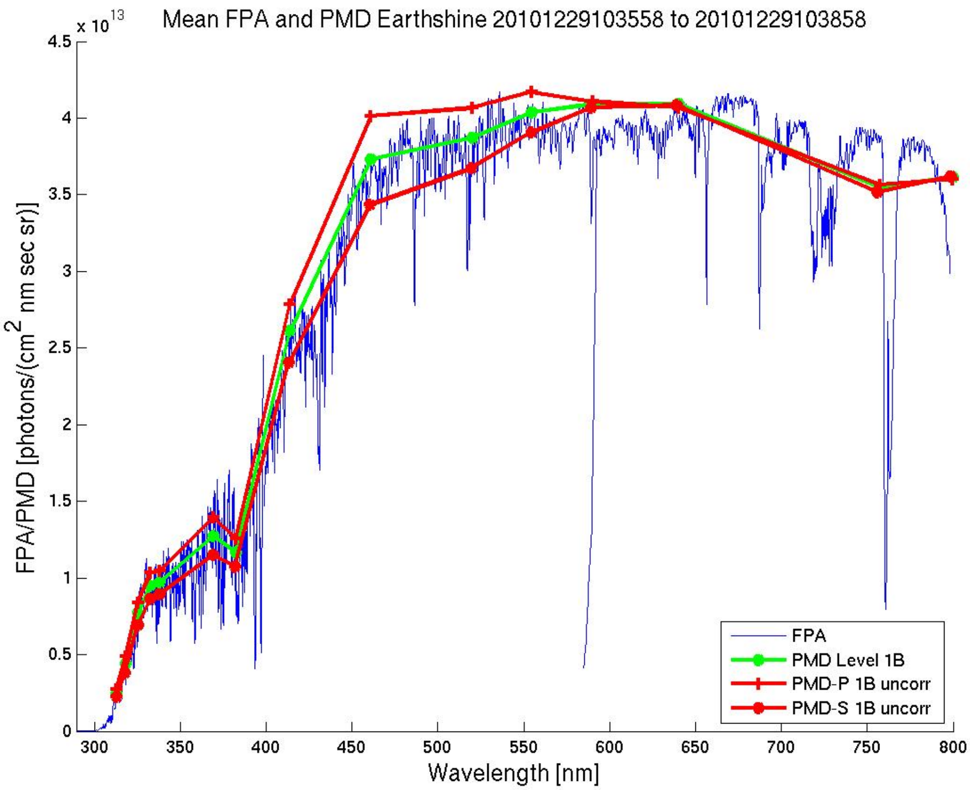


Figure 1: *Averaged radiances for one pdu (3 minute granule) of GOME-2 main channel (blue line) and PMD (red and green lines) data. Corrected PMD data comparable to main channel read-outs is shown with the green line. The newly added "uncorrected" PMD data sensitive to the state of polarisation of the incoming light and thus to atmospheric scattering is shown with the two red lines. Depending on atmospheric scattering conditions and surface albedo, PMD-P and PMD-S data differ significantly for the "uncorrected" case.*

Description usage of geo-actual records with new product format

With the new product format 12.0 the geo-earth actual fields in the individual MDR-1b-Earthshine records (see PPF version 9 and technical note) have been significantly re-organised in order to make room for the significant amount of additional information provided with the new product format. However, the principle structural logic remains the same. The "geo_earth_actual" structure is separated with respect to different integration times. One "geo_earth_actual" structure is provided per unique integration time (frequently valid for multiple bands). So in the case where we have three different unique integration times present for all eight main radiometric bands (main channel band 1a/1b, 2a/2b, 3 and 4, PMD-P and S) as is frequently the case, e.g. where it_{1a}, $it_{1b\ to\ 4}$, $it_{PMD\text{-}P/S}$, are unique integration times, only three non-zero size "geo_earth_actual" structures are provided.

In order to know which of the "geo_earth_actual" structures holds the correct geo-information for a certain band, one needs to read the MDR-1B-Earthshine field "integration-times" as well as the field "unique_int". The former provides one integration time per band, whereas the latter provides the information indicating which "geo_earth_actual" structure number ***n*** refers to which unique integration time. For a certain band with integration time ***it***, the index in the vector of unique integration times for the same ***it*** value is the number ***n*** of the actual geo-earth structure to be read for this radiometric band, i.e. "geo_earth_actual_***n***".

Summary of steps:

1) Find integration time ***it*** for band X (use INTEGRATION_TIMES field).
2) Find appropriate unique integration time index ***n*** (use UNIQUE_INT field).
3) Check if the geo-record size is non-zero (use GEO_REC_LENGTH)
4) Use index ***n*** to access structure geo_earth_actual_***n***.

Description usage of cloud information and the appropriate geo-records

The FRESCO (PPF up to 4.5) and FRESCO+ (PPF 5.0 and later) cloud information is provided in the CLOUD field structure of each MDR-1B_Earthshine record. The cloud parameter fields are provided in turn in a fixed-size vector with one dimension being 32 in order to accommodate a maximum of 32 read-outs. Cloud information is derived by FRESCO/FRESCO+ from the oxygen A-band located in band 4. The provided cloud information is therefore corresponding to the "geo_earth_actual_n" structure geo-information appropriate for the integration time of band 4. There are two issues which need to be taken into account:

1. As for the radiometric data provided for band 4, the first read-out in each MDR always corresponds to the last back-scan pixel. Therefore the first entry in the cloud-fields vectors is also corresponding to the last back-scan, oxygen A-band measurement. This is correctly reflected in the "geo_earth_actual_n" field geo-information for band 4.
2. For band 4 integration times higher than 0.1875 s, i.e. less than 32 read-outs per scan, the fixed cloud vector with dimension 32 is filled from index 0 onwards with the remaining entries set to undefined.

The algorithm technical description and the final validation report for FRESCO+ are provided in the technical notes section on (www.eumetsat.int > Data & Products > **Resources)**.

Missing initial 6 seconds integration time geo-record

For the current version of the PPF (5.0), geo-records corresponding to measurements of 6 seconds integration times (i.e. band 1A at high SZA) are missing in cases where there is no previous earthshine scan available. This may therefore occur only once per orbit for the very first scan after dark calibration measurements. In future versions of the PPF this record will be present (non-zero size) but will be filled with undefined numbers.

BEAT software for format 12.0 is now available

The updated BEAT software 6.4.0 for reading the new GOME-2 format version 12.0 is available since November 2010 under the following link:

www.stcorp.nl/beat

2.15 Newsletter #24 Jun-Aug 2010

Geolocation pointing correction

During a recent evaluation of the geolocation pointing accuracy of the instrument and the accuracy of the reported geolocation parameters in the level-1b products, we found a problem with the determination of the UTC time per scanner position. An accurate determination of the latter is an important prerequisite for an accurate determination of the exact geolocation coordinates per measurement. The problem results in an overall shift of 375 ms of the scanner position time in all products and for the current (4.4.0) and previous processor versions. As a consequence all latitude/longitude geolocation parameters are shifted by 1 to 2 km along the orbit, i.e. by 2.5 to 5% of the along-track pixel size at nadir position. The across-track values are not affected! This issue will be fixed by an update of the operational level 0 to 1 processing system to version 4.5.0, which is planned for 9 September 2010.

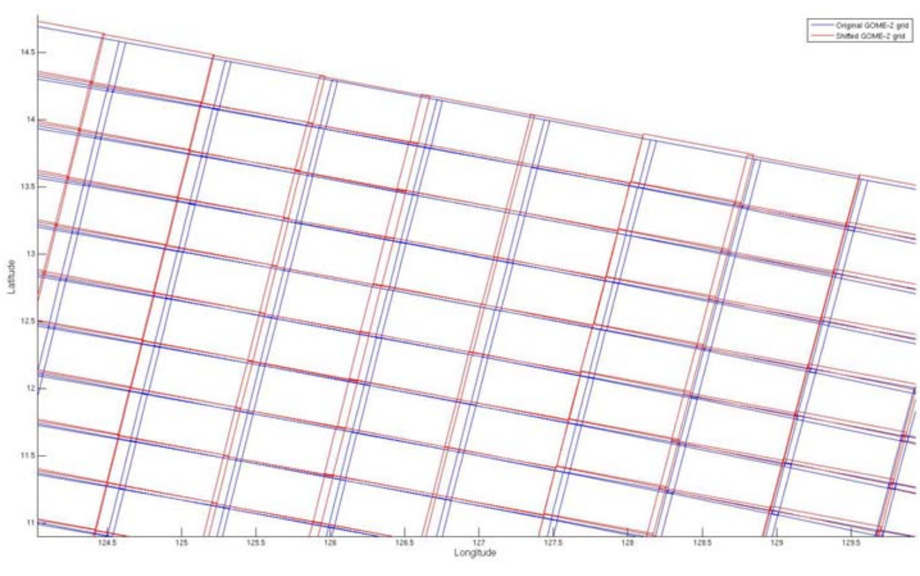


Figure 1: *Shows individual GOME-2 ground pixels per measurement for a main-channel forward scan around nadir at 187.5 ms integration time (blue lines). The red line ground pixel geolocation values are shifted according to the best correlation with averaged AVHRR radiance values covered by a GOME-2 ground pixel. The across-track shift is expected and due to the effect of finite detector pixel read-out time (spatial aliasing). The along-track shift of 2.5% (pixel along-track size) is however due to an error in the calculation of the correct scanner position read-out time.*

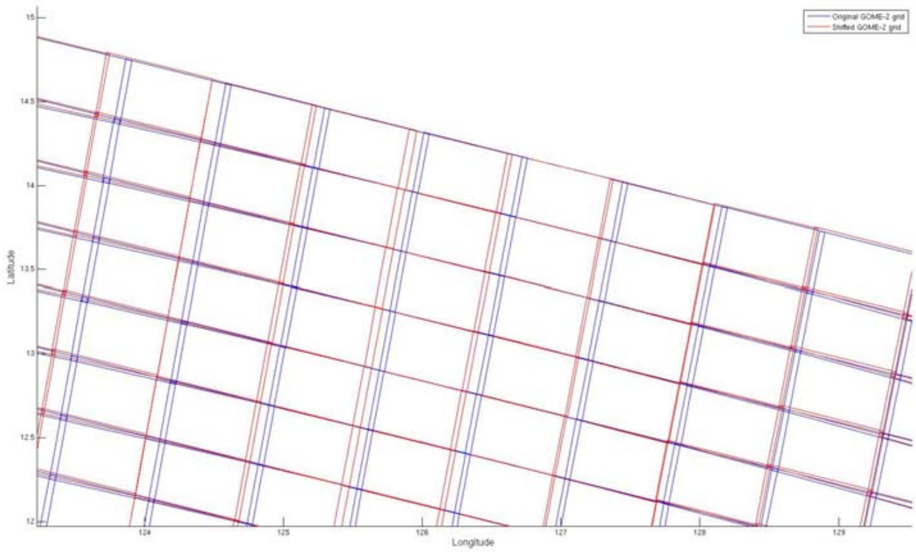


Figure 2: *Shows the same results as Figure 1 but for a fixed scanner-angle position read-out time. The observed along-track shift then basically vanishes.*

Product Format Update – Status

We are currently in the process of validating the new GOME-2 PPF version 5.0, which is planned for installation on our prime ground segment during the first week of 2011. Together with the update to PPF 5.0 the product format will undergo significant changes to facilitate the provision of uncorrected PMD radiances, the provision of PMD geolocation records and improved product confidence flags. As has been announced previously there is a full data pack available comprising all relevant documents, as well as test data (full orbits and pdu/3 minute granules) in the new format with PFS version 9 (Product Format 12.0). The data pack can be downloaded under

ftp://ftp.eumetsat.int/pub/EUM/out/OPS/User/Update_GOME2_Product_Format_PFSV9/

Note that the data format change will require an update of all GOME-2 level-1 readers. An update of the BEAT software to read GOME-2 format version 12.0 is on its way.

2.16 Newsletter #23 Jan-May 2010

NRT Level 1b data developments

A new processor version 4.4.0 was released on 21 January 2010. For this processor version instrument key data for the calibration of the polarisation measurement device (PMD) channels have been updated. For previous processor versions this key data have not accurately been corrected for stray light. In addition, the scan-angle dependence of the polarisation sensitivity of PMD channels to -45/45 degrees polarised light has not been applied correctly. For the latter new key data have been added.

For more details on the update and on changes and upgrades in the calibration of GOME-2 PMD data we refer to the documentation under the following links:

http://gome.eumetsat.int > Documentation > "Processor change history"

www.eumetsat.int > Data & Products > **Resources** > Section: EPS Product Validation Reports > "GOME-2 PMD Band Definitions 3.0 and PMD Calibration"

Geophysical products

On 6 March 2010 the operational dissemination of the offline total formaldehyde (OTO/HCHO) and total water vapour column (OTO/H2O) products was started. For an overview of the available products, and information on how to receive the data, please visit the O3MSAF webpage or refer to the EUMETSAT Product Navigator. GOME-2 geophysical value-added products are also available at a new website by DLR with a lot of useful quick-look imagery. Quick-look imagery of GOME-2 Absorbing Aerosol Index (AAI) contributing to volcanic ash monitoring by the VAAC is also available.

For detailed continuously updated validation reports, product user manuals and algorithm theoretical basis documents for these products we refer to the O3MSAF webpage under the "Documents" section.

Instrument throughput – status summary and expert meeting

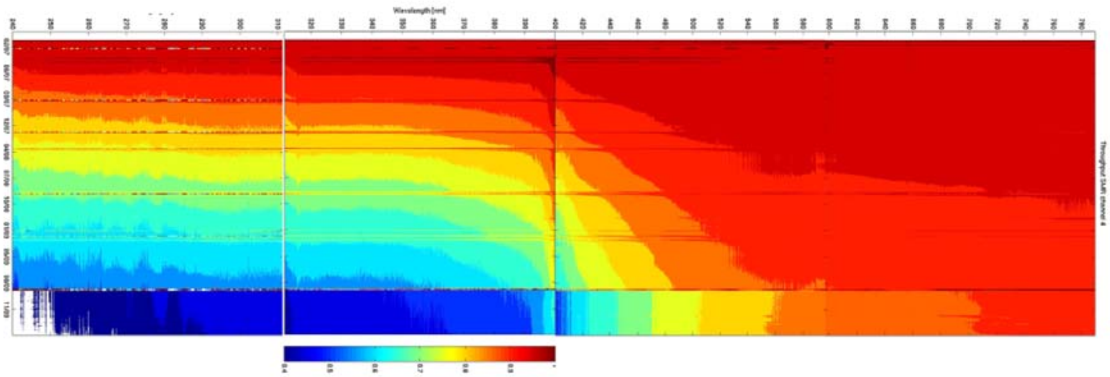
Current status of instrument throughput analysis (summary)

Most observations of short-term changes in throughput (e.g. during instrument tests) both for FPAs and PMDs are strongly linked to changes in detector temperature. The only exceptions to this observation are the long-term behaviour of the FPAs, their hysteresis-like behaviour following a switch-off, and their medium-term behaviour after heating to higher temperatures during the throughput test #2 (cf. figures of GOME-2 Newsletter #22). In conclusion we are therefore probably looking at two independent mechanisms:

1. A temperature-dependent effect in the detectors, mechanism unknown, but which is expected to be independent of contamination/degradation.
2. Degradation/contamination which affects both the FPAs and PMDs which shows different characteristics for the FPAs under switch-off conditions (but not the PMDs) and which has been increased by the operations of the last throughput test. However,

analysis subsequent to the test indicates that the rate of throughput loss has slowed with some variation between channels.

Currently the throughput is stable following the 2nd throughput test in channels 3 and 4 (between 400 and 800 nm; see the figure below). In channels 1 and 2 the throughput levels have stabilised following the throughput test in September; however, we observe the onset of additional degradation in Spring for both channels but on a significantly lower rate than before the 2nd throughput test.



For detailed documentation on the GOME-2 throughput performance and the results of the implemented throughput tests we refer the reader to gome.eumetsat.int > Product Validation Reports > "GOME-2 FM3 Long-Term In-Orbit Degradation".

Expert meeting on instrument throughput at KNMI in March 2010

On 3 March 2010, prior to the 45th GOME Scientific Advisory Group (GSAG) meeting, an instrument expert meeting was held at KNMI to discuss the current status and analysis of the available results from detailed investigations on the long-term instrument throughput degradation. The conclusions of the meeting were as follows:

1. Modelling results performed by SRON (R. Snel and M. Krijger) indicate that the scan mirror accounts for 20% throughput loss in the UV, and for this part the degradation is similar to GOME-1.

2. The remaining 30% of throughput loss is unaccounted for and unique to GOME-2 (also spectrally different), but LED measurements and results from the second throughput test seem to indicate that this happens in the path between LEDs and detectors.

3. There is a working hypothesis of volatile + non-volatile components which requires a cold trap for the volatile component. This cold trap can only be the detectors. Different relaxation times after switch-offs for FPA and PMD are not really understood.

4. Out-gassing tests have been performed at ESA (E. Corpaccioli et al.). Results did not show any sign of out-gassing due to the used glue. The final report however is still outstanding and an out-gassing test using the full detector has not been carried out yet.

5. It was noted that the environment in Baikonur was quite unfavourable for avoiding contamination, and there was a lot of external contamination of the satellite by dust. EUMETSAT state that thrusters can probably be excluded as a source of contamination. SRON (I. Aben) notes that the analysis is probably not sensitive enough though.

Forthcoming product and product format updates

FRESCO+

In the framework of an ongoing study conducted by the KNMI, the FRESCO algorithm, which is included in the level 0 to 1 processor providing effective cloud fraction and cloud pressure information, is currently being upgraded to FRESCO+. The following main changes to the current implementation apply to FRESCO+:

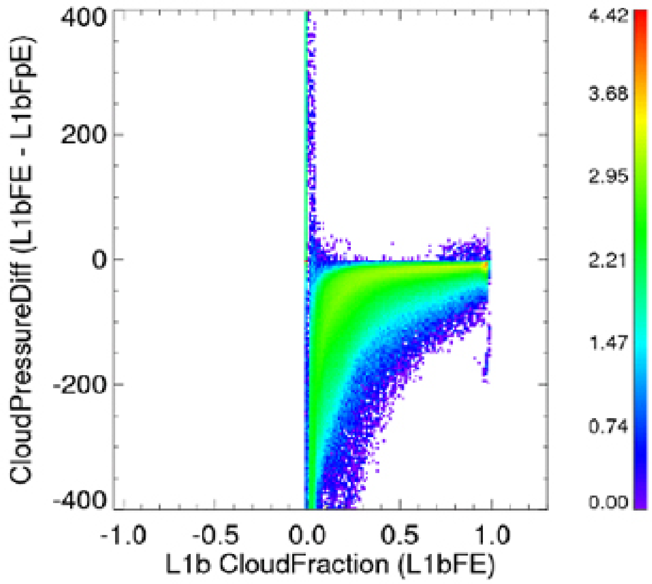
1. The Rayleigh single–scattering radiance contribution is added both in the reflectance database and in the retrieval algorithm.
2. A new surface-albedo climatology derived from MERIS data over land (and merged with the previous GOME-1-derived surface-albedo database over ocean) is applied.

Preliminary results of the ongoing validation campaign conducted by KNMI on the performance of FRESCO+ with respect to the original FRESCO implementation show the following main improvements on the two main product parameters, cloud-fraction and cloud pressure:

1. The FRESCO+ cloud pressure is more reliable than FRESCO for less cloudy scenes.
2. The FRESCO+ improvement is relevant for tropospheric trace-gas retrievals (like NO_2).

The figure below shows that the largest difference in cloud pressure between the current FRESCO implementation (L1bFE) and the new FRESCO+ implementation (L1bFpE) are found at lower cloud fractions (based on FRESCO L1bFE) and amount to 200 to 400 hPa higher cloud pressures (i.e. lower clouds) than for the current implementation of FRESCO. At higher pressures the differences are much smaller. In general cloud pressures from FRESCO+ are higher than those from the current FRESCO implementation. The latter is expected when taking Rayleigh single-scattering into account.

FRESCO+ is scheduled to be implemented with the next planned upgrade of the processor version (January 2011) and will be used after the successful finalisation of the validation campaign during the next reprocessing campaign of GOME-2 level 1b data.



Product Format update to version 8B (current version is 7.4/8A)

A major product format upgrade to accommodate user requests and to improve the handling of polarisation data usage has already been announced at various meetings and conferences during the last month. After the collection of user input and initial evaluation of technical implementation constraints, the engineering change proposal to be used this month has been finalised detailing all necessary changes. The main issues to be addressed with the update of the level 1b product format are:

1. to provide polarisation measurement device (PMD) data which are not corrected for the polarisation sensitivity of the instrument, hereafter tagged as “uncorrected PMD data”,
2. to provide geolocation and cloud information for individual PMD measurements, and,
3. to increase the spatial resolution of some of the currently provided product flags in order to increase the accuracy with which they can be applied.

A draft version of the updated product format specification document (version 8B) together with test level 1b input data both for orbits and 3 minute granules (pdus) will be made available to the interested users in July/August 2010 via a dedicated ftp link.

The new product version is planned to be implemented together with the next planned upgrade of the level 0 to 1 processor in January 2011.

Reprocessing R2 of GOME-2 level-1b data

In order to consistently characterise the impact of instrument continuous performance changes (most prominently the throughput degradation) and in order to be able to provide offline correction tables for both solar mean reference data, as well as scan angle-dependent earthshine data, the reprocessing campaign R2 of the current GOME-2 level 1b data record (January 2007 to December 2010) is currently scheduled for the 1st quarter of 2011, making use of all major forthcoming updates to the level 0 to 1 processor as detailed before. After the successful validation of the full record, data will be made available through the EUMETSAT Data Centre (formerly known as UMARF) via the bulk ordering option for large or complete records or through ftp or other media for individual orbit files.

System changes and data provision

Monitoring pages update

The GOME-2 online monitoring page gome.eumetsat.int has moved to a different server and the page has been substantially updated. There you will find all relevant near-real time information on GOME-2 level 1 data quality and additional continuously updated information on the long-term performance of the instrument (under “Documentation” > “Long-term monitoring report”) The documentation section also provides you with a list of processor changes and instrument events (under “Processor change history”) as well as with the Product Guide. The side-bar link “Product validation reports” will guide you to our technical document section on validation where you can find all validation reports on level 1b data quality including two reports on the GOME-2 instrument throughput degradation following the 1st and 2nd throughput tests and their annex of plots.

The new EPS operational monitoring pages also host near-real time information on IASI level 1 data quality. The page will be populated with more EPS instrument data quality monitoring information in the near future.

For near-real time monitoring of GOME-2 level-1 data, a backlog history of processor changes and additional technical documentation, we refer to gome.eumetsat.int. Any changes to the EUMETCAST system with (potential) impact on level 1 quality will be announced to operational and CalVal users via email and to all interested users via the Weekly Schedule.

2.17 Newsletter #22 Oct/Nov/Dec 2009

Level 1b developments

A new processor version 4.3.0 was released on 18 August 2009. This processor version introduces an online correction scheme used in the derivation of Stokes fractions which are applied for the polarisation correction of main channel data. The results show further improvement in the quality of level 1b radiances from GOME-2. For more details on the update, please refer to the GOME-2 Products Database and view the Processor change history (under Documentation).

Geophysical products

Following the last Operational Readiness Review (ORR) held at DLR in December 2009, the review board has recommended granting the offline formaldehyde product operational status and the offline total water vapour column pre-operational status. The start of the operational dissemination of both products is anticipated for the first quarter of 2010 following the resolution of minor outstanding technical issues. For an overview of the available products, and information on how to receive the data, please visit the O3MSAF web page or refer to the EUMETSAT online Product Navigator tool. GOME-2 geophysical value-added products are also available at the Global Ozone Monitoring Experiment-2 (GOME-2) website.

The list of products with (pre-)operational status is currently (December 2009):

- NRT (near-real time) and offline total ozone column
- NRT and offline total NO_2 column
- NRT and offline tropospheric NO_2
- Offline total SO_2 column
- NRT Clear-Sky UV index
- Offline total BrO column
- Offline UV products
- NRT and offline ozone profiles
- Absorbing aerosol index
- Offline Formaldehyde (expected start of operations Q1/2010)
- Offline water vapour (expected start of operations Q1/2010)

Detailed validation reports, product user manuals and algorithm theoretical basis documents for these products are available from the O3MSAF webpage under the “Documents” section.

Instrument throughput – status after the 2nd throughput test from September 2009

Following the conclusions drawn from the 1st instrument throughput test performed in January 2009, the instrument review team, involving industry and ESA, and the GSAG put forward a recommendation to issue a second throughput test but setting detector temperatures above the optical bench (environmental) temperatures, in order to avoid the detectors serving as a cold trap for potential contaminants. The target was to:

1. Examine the overall throughput behaviour of the instrument for various temperatures above the optical bench temperature (test part 1a). For this part of the test the detector temperatures were increased from 270 K to 300 K in steps of 5 K.

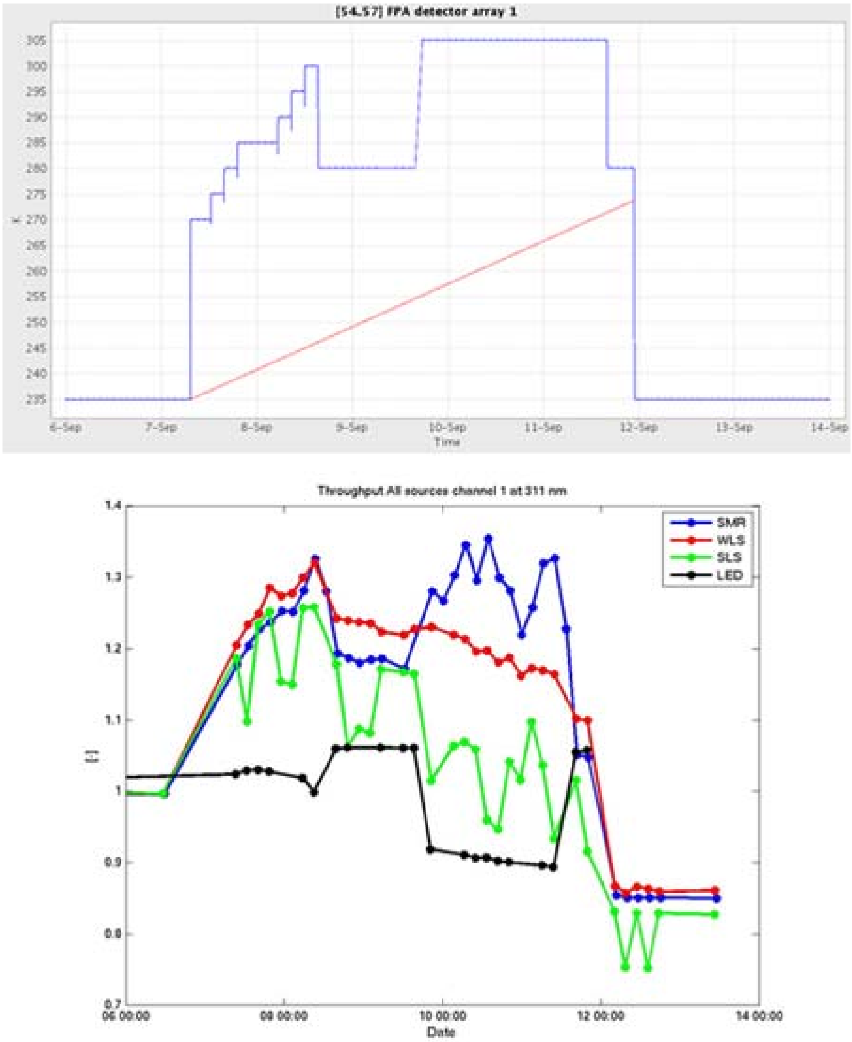
2. Perform one day of operations with detector temperatures set to a level above the environmental temperatures and optimised for signal-to-noise (where the expected increased throughput by increasing the detector temperature would balance the expected increase in noise). An optimal S/N above the 274 K of the optical bench has been found at 280 K (test part 1b). For higher temperatures the S/N has been found to become worse than during nominal operations because of the large increase in noise.

3. To keep the detectors at 305 K for more than one day of operations in order to attempt the out-gassing of the potential contaminants (test part 2).

The test has been performed during the course of 7-11 September. After half a day of recovery on 12 September, the instrument was brought back to nominal operations during the afternoon of 12 September when dissemination of data restarted (for the exact start and stop times and orbit numbers covered by the test we refer to the instrument section of the GOME-2 Products Database > processor change history). The complex operations carried out during the test have been implemented without anomalies and all data was processed either directly or through offline reprocessing of level 1b data for the testing period.

However, a major anomaly was detected when, after recovery to nominal operations, the overall throughput levels of the instrument were found to be lower on the order of 5 to 15% (NIR to UV). This unexpected drop of throughput after the test is larger than the expected “nominally” observed decrease in throughput during the course of one week.

The figure shows the relative signal levels (throughput) at 311 nm with respect to the situation before the test (the reference signal is from 31 August). A clear and immediate response to changes in detector temperatures is observed, superimposed however by a continuous drop in signal levels throughput the testing period. The latter has not been observed before and was unexpected. The reason for this overall drop in signal is so far unexplained.



The upper panel shows the GOME-2 main channel (FPA) detector temperature during the 2nd throughput test. The lower panel shows GOME-2 calibration source signals at 311 nm relative to 31 August 2009. Only the period from 6 September 0:00Z to 14 September 0:00Z is shown here. Relative signal levels are shown for the Solar Mean Reference (SMR), the on-board white light source (WLS), the on-board spectral light source (SLS) and the LEDs (note that the latter signal is not dispersed and is covering the green part of the spectrum). The continuous decrease in signal is visible especially during the period of 10-11 September (out-gassing period) during which the detectors were kept at a fixed temperature of 305 K. The observed scatter in SLS data is predominantly due to known variations in the output of the calibration lamp. The large scatter in SMR signals at high temperatures is due to a large error in the subtracted dark signal at relatively short integration times. In contrast, WLS and LED dark signals subtracted from the overall signal are measured at much longer integration times.

After detailed discussions with all partners and instrument experts on the signatures and outcome of the 2nd throughput test, the following summary of state of knowledge and conclusions drawn so far can be provided:

1. The long-term throughput degradation is generally similar for polarisation measurement device (PMD) data and main channel (Focal Plane Assembly: FPA) data with some differences between PMD and FPA in degradation rate and its change ("levelling off"). Whereas the PMD signals initially degraded faster than FPA, there is an earlier onset of slowing down of degradation observed for PMD than for FPA since the beginning of 2009. There is a clear indication for PMD that this levelling off is triggered by "accelerated out-gassing" after each instrument switch-off, whereas for FPA this becomes only evident after the first switch-offs in 2009 and the recent throughput test. The long-term degradation is observed for ALL sources including the LEDs. It has a characteristic spectral shape (stronger in UV and weaker in NIR) except for LED for which the long-term degradation is consistent overall with the degradation rate in the green part of the spectrum.

2. The "immediate" response of signal levels to changing temperatures for all light sources and for FPA data is more consistent when assuming a wavelength-dependent (stronger response in UV than in the visible) linear signal response to temperature for detector temperatures lower than or close to the optical bench temperature. There are some strong deviations from a linear response visible at high temperature levels. For high temperatures there are noticeable differences in signal-to-temperature change response found between different light sources per channel.

3. During the 2nd throughput test a "continuous" degradation during the period has been found for FPA signals, which resulted in the fact that even though a change in temperature triggered an immediate response in signal levels, measurements taken at the same temperature but with some separation in time (orbit-to-orbit) did not reproduce the same signal levels but were always lower than previously.

4. In a similar fashion, the signal levels from before the test when going back to nominal operations at 235 K after the test could not be reproduced for all calibration sources except for LEDs. This resulted in an overall drop of signals (including SMR and earthshine measurements) which was larger than anticipated due to the previously observed weekly degradation rate.

5. For LED measurements the situation before and after the test shows some significant channel-to-channel differences with higher signal levels in channel 1 and 2 and lower signal levels in channel 3 and 4. This channel-to-channel difference has only been observed for the 2nd throughput test.

6. The degradation rate for all other light sources is much smaller or even zero directly after the 2nd throughput test.

7. For FPA signals only, and only during instrument switch-off events, when optical bench temperatures are much lower than during operations (nominal or tests), a "hysteresis" effect is observed which results in an initial increase in throughput followed by a slow return to pre-switch off levels two or three weeks after the switch-off. This is NOT observed for PMDs.

8. A long-term (mission lifetime) and short-term (during instrument tests) change in the etalon phase and amplitude has been observed. The change of etalon amplitude and phase are close to the time-scale of the "continuous" degradation effect and no

immediate response to temperature is observed. The response of the observed etalon for PMDs to the different temperature set during the 2nd throughput test is similar than that for FPA but on a much smaller scale. For PMDs the situation after the test is largely reproducing the pre-test conditions.

9. The shape (width) of individual spectral lines from SLS measurements does not change during the 2nd instrument test, and there are no differences in the spectral line shape observed after the test with respect to the situation before.

10. The electronic offset has been found to be quite stable during the 2nd throughput test whereas the leakage contribution to dark signals increases significantly with temperature. Note that an expected saturation in the leakage term is confirmed for integration times (exposure times) longer than 3 seconds at the high test temperatures.

Unfortunately, to date there is no consistent explanation for the observed detector signatures available, neither for their long- nor for their short-term response. EUMETSAT is continuing to gather more information by involving additional expertise and expert meetings, and is also considering additional measurements involving the remaining flight models during their forthcoming delta calibration campaigns.

Forthcoming processor updates and instrument operations

An update to the operational level 1 processor version from version 4.3.0 to version 4.4.0 is planned for 21 January 2010. The main change applied with impact on the level 1b quality is an update of key data files for polarisation sensitivity to take into account stray light. Preliminary investigations show that this update may lead to differences in total column amounts of up to 1% depending on viewing geometry and for strong absorbers. For weak absorbers, profile retrievals and aerosol optical properties we expect even larger impacts depending on wavelength and viewing geometry. The impact is expected to be largest in the UV.

Test data for PPF version 4.4.0 with a set of reference data for the current version 4.3.0 is available via FTP under /out/GOME/Test Data and Tools/GOME-2 Test Data/TestPPF440.

For a history of processor changes please refer to the GOME-2 Products Database > processor change history. Any changes to the EUMETCAST system with (potential) impact on level 1 quality will be announced to operational and CalVal users via email and to all interested users via the UNS weekly LEO announcements.

2.18 Newsletter #21 March/April/May 2009

The GOME-2 level 0 to 1b operational processor version PPF 4.2 and 4.2.2 has been successfully activated in our core ground segment number one on 7 April and on 9 June 2009 respectively (for more details see the Processor Change history). PPF 4.2 introduces an improved dark-signal correction scheme for band 1a (channel 1) radiances only in the region of the SAA. PPF 4.2 also improves the high-level flagging of MDRs, degraded because of processing- or instrument-related problems (see below). In addition, it resolves a software problem due to which - and under rare circumstances - individual read-out radiances from channel 3 are not normalised correctly. This problem is restricted to data between the introduction of temporal co-adding in channel 3 on 4 March 2009 (see below) and the activation of PPF 4.2 on 7 April 2009. PPF 4.2.2 installed on 9 June 2009 resolves an issue with the reported radiance estimated errors for band 1a signals in the level 1b product and within the SAA region only. The problem has been introduced with the new dark signal correction scheme of PPF 4.2.

Geophysical products

Following the last Operational Readiness Review (ORR) held at FMI in May 2009 the BrO geophysical product generated by the O3MSAF has received the operational status. In addition, the near-real time and offline ozone profile, as well as the offline aerosol absorbing index products, are expected to receive operational status within the coming weeks. Also, the newly generated total water vapour product has been introduced to the list of geophysical products produced by the O3MSAF with demonstrational status. For an overview of the available products and information on how to receive the data, please visit the O3MSAF website or refer to EUMETSAT's online Product Navigator tool. GOME-2 geophysical value-added products are also available on the DLR/WDC GOME-2 website.

The list of products with operational status is currently (June 2009):

- NRT (near-real time) and offline total ozone column
- NRT and offline total NO_2 column
- NRT and offline tropospheric NO_2
- Offline total SO_2 column
- NRT Clear-Sky UV index
- Offline total BrO column
- Offline UV products
- NRT and offline ozone profiles (expected start of operations October 2009)
- Absorbing aerosol index (expected start of operations October 2009)

Detailed validation reports, product user manuals and algorithm theoretical basis documents for these products are available on the Documents section of the O3MSAF website.

Instrument throughput - preliminary conclusions and next steps

More in-depth analysis of the results of the instrument throughput test (completed end of January 2009; for details see Newsletter #20) and of long-term degradation-related signatures have been carried out for both level 1 signal response and level 2 data quality by the instrument review team (EUMETSAT/ESA and industrial partners), the GOME-2 Scientific Advisory Group members and teams (GSAG), as well as the O3MSAF project team and users.

The main conclusions to date are:

- The main sources of the observed dynamic throughput degradation are very likely associated with scan-mirror degradation and an additional contribution by an attenuating layer directly in front off or on the detectors. The latter is inferred from systematic degradation patterns of the LED calibration light sources situated directly in front of the detectors (see Figure 1), consistent with all other on-board calibration sources, and their recovery response.

- The observed recovery of throughput during instrument switch-offs and, in a controlled way, during the instrument throughput test, is linked to detector temperature at a rate of roughly 1 to 2.5% recovery per 5 degrees temperature increase depending on wavelength (with the largest recovery rates of 2.5% in the UV channels).

- Detector temperatures as high as those achieved during instrument switch-offs (around 265 K as compared to 235 K during nominal operations) could not be achieved during the dedicated test (see Newsletter #20 Figure 1). The root course of this is understood and can be overcome by putting the actively controlled Peltier cooling system into heating mode.

- The maximum recovery which can be achieved by increasing the temperature towards 270 K is currently unknown. However, it is expected that the scan mirror contribution will still be significant.

- From GOME-1 and SCIAMACHY ‘outgassing’ experience it is not expected that short-term outgassing campaigns (of the order of days) can substantially (and for a longer time) improve the situation because of the low on-board partial pressures and the limited escape routes for potential contaminants and water vapour out of the detector encapsulations.

- Long-term analysis of rms values derived from level 2 retrievals, as well as the observed long-term changes in the quality of Stokes fractions from level 1b data, clearly point to very small but statistically significant long-term degradation of the product quality due to instrument throughput degradation. The GSAG and the O3MSAF user community have therefore indicated (during recent meetings held in May and beginning of June 2009) that they would be in favour of EUMETSAT and its partners carrying out additional investigations and measures in order to improve on the long-term trend assessment and perspective with respect to the instrument throughput levels.

The results of these analyses and the individual conclusions drawn are currently being summarised in a dedicated report, which will be published during the next months on the EXTRANET GOME CalVal pages [now available as “GOME-2 FM3 Long-Term In-Orbit Degradation - Status After 2nd Throughput Test” on the EUMETSAT website under Data & Products > Resources > EPS Product Validation Reports section]. In response to the above findings, EUMETSAT and its partners are currently evaluating the need for issuing a second instrument throughput test targeting higher temperatures at around 270 K, in conjunction with collecting enough nominal earthshine data to evaluate the potential impact of decreasing signal-to-noise values on the quality of all GOME-2 products.

Test orbits of level-1b data taken during the previous throughput test at various detector temperatures in January 2009 are now available on our cvf-ftp site for download (out/GOME/Throughput Test) for all interested users. Please consult the provided readme file for information on the details of the test, especially with respect to the sequence of temperature changes carried out before nominal day-side data acquisition.

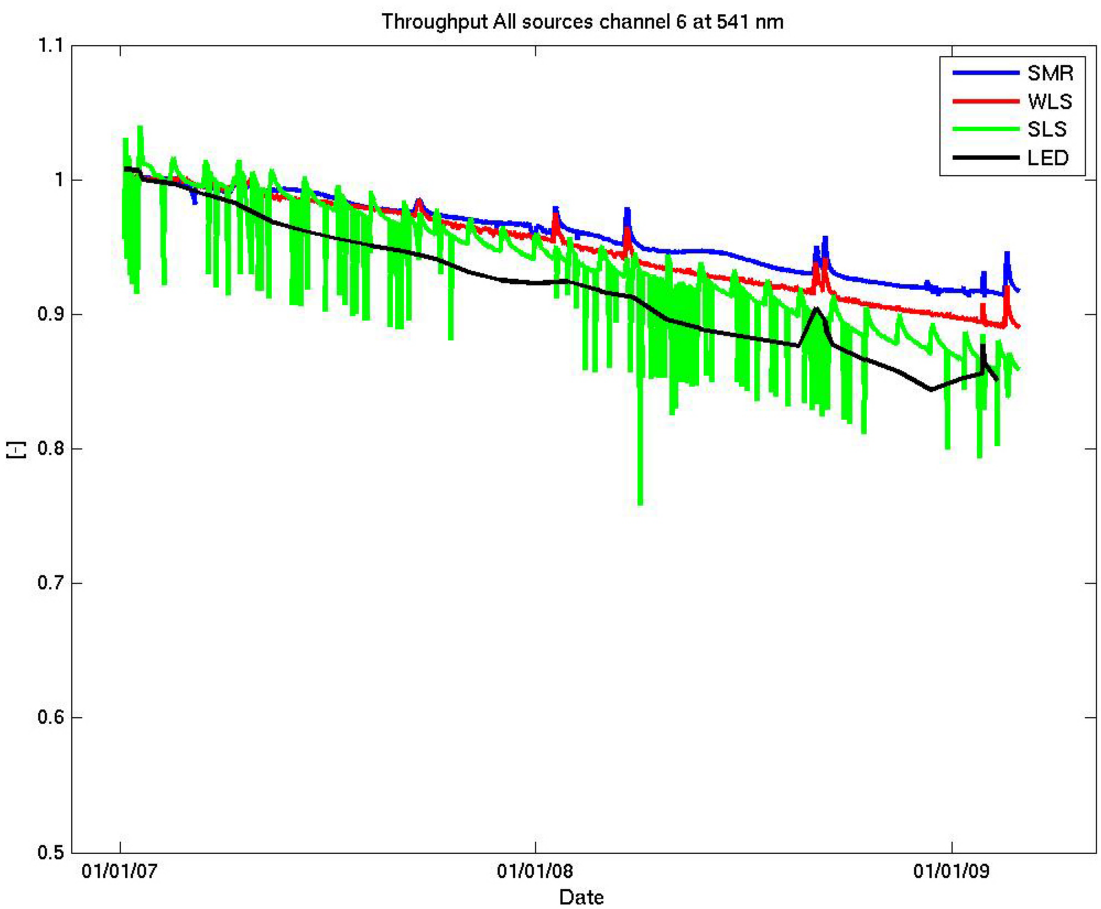


Figure 1: *GOME-2 instrument throughput evolution of various calibration sources (SMR: solar mean reference spectrum; WLS: white light source; SLS: spectral light source)*

normalised to 20 January 2007 at 541 nm. Note that the scatter on SLS throughput is due to nominal SLS ignition time and frequency patterns. Vertical spikes of throughput recovery are related to periods of instrument switch-offs or other non-nominal instrument operations for which the instrument detectors have been operated at higher temperatures. The on-board LED sources are located directly in front of the detector and emit in the green part of the spectrum - around 540 nm. All measurements are carried out on a daily basis except for LED measurements, which are only carried out once per month.

Saturation patch for channel 3 introduced

During 3-4 March 2009 (see also the continuously updated list of instrument history events) new on-board software was successfully uploaded to the GOME-2 instrument in order to enable on-board temporal co-adding of channel 3 read-outs. The new software consequently reduced the number of saturated measurements from channel 3 to close to 0. However, a few cases of saturation, predominantly in channel 4 in sun-glint regions and above very bright cloud tops, do still exist and are consequently flagged in the product and the secondary product header records (SPHR). These saturation events are now also automatically registered on our GOME monitoring page in the orbit-to-orbit comments section for individual orbits and instrument bands for which they occur (see also following section), together with other anomalies - if any.

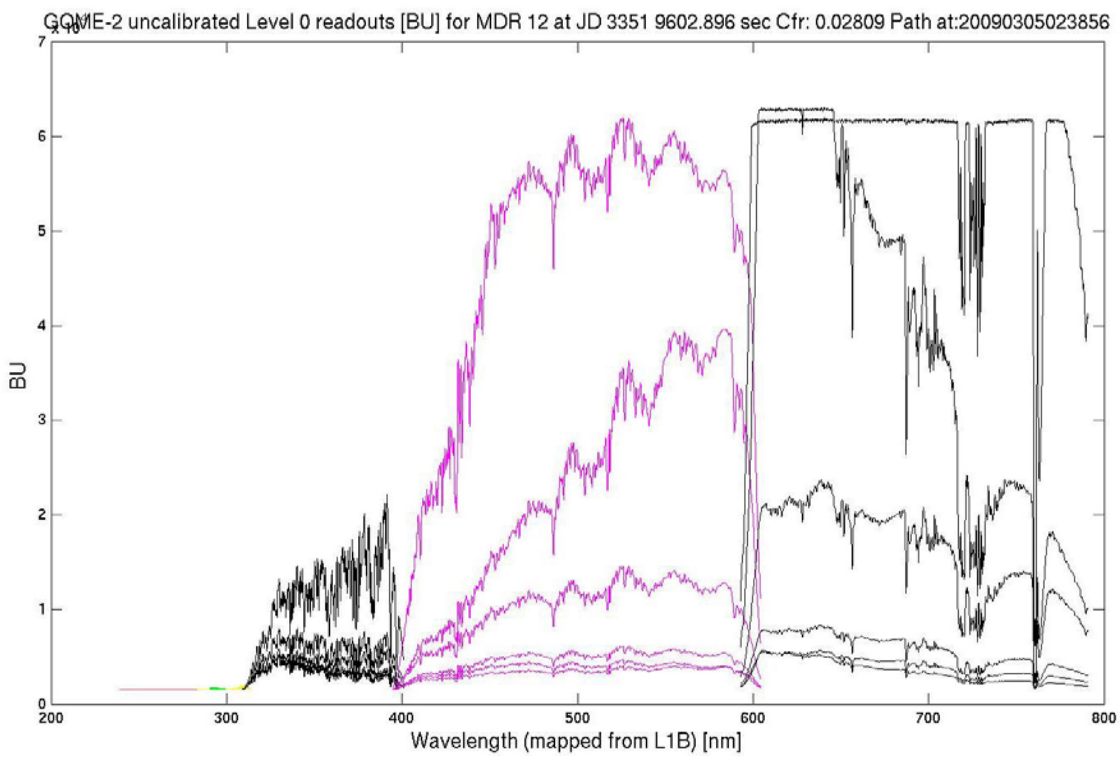


***Figure 2:** Rare occasion of saturation occurring in channel 4 in sun-glint areas in conjunction with very bright deep convective cloud tops. The figure shows six measurements scanning above the bright cloud top. Such a situation is flagged in the SPHR of the product by increasing the number of saturation events per band x (*N_SATURATED_x; *see also* gome.eumetsat.int, Details per orbit*) and is automatically raised as a comment in the* Comments *column on* gome.eumetsat.int.

Product quality flagging for operational and non-operational use

Operational use of high-level flags

Following the on-board software patch upload and the subsequent installation of PPF 4.2 in our ground segment on 4 April 2009, the high-level degradation flagging for individual scans (i.e. individual Measurement Data Records (MDRs)) has been further improved such that flagging of products at this high level - for degradation due to processing or due to an instrument anomaly - only occurs for events with substantial impact on the product quality. As a consequence of the significant reduction of saturation events, along with the improved operational data-quality monitoring, the number of products and orbits which are flagged as degraded (in 'red' for instrument degradation and 'orange' for processor degradation at gome.eumetsat.int) have been significantly reduced since the beginning of April 2009. High-level flagging of products as provided in the Main Product Header Record (MPHR) of each GOME-2 level 1b product (3 minutes pdus as well as orbits) as COUNT_DEGRADED_PROC_MDR and COUNT_DEGRADED_INST_MDR parameter should now be used for any operational system receiving GOME-2 data in NRT or using large amounts of offline level 1b data since the beginning of April 2009.

If any of the two flags are set then the data should be discarded or flags provided in the Secondary Product Header Record (SPHR) or/and the Product Confidence Records - and error estimates (see below) should be analysed in order to decide if the degradation can be regarded as substantial for the specific purpose of level 1b usage. For example, the current high level flagging strategy serves as a robust way to eliminate data during instrument anomalies or recovery phases or any other non-nominal processing or instrument situation.

Note that the current reprocessed data version L1b-R1 does not allow for such a robust filtering using the high level MPHR flagging only. More detailed analysis of SPHR flags and PCRs is required for NRT and offline data, including L1b-R1 data provided before April 2009.

MPHR and SPHR headers are also available for each orbit at gome.eumetsat.int in the dedicated Details column of the monitoring tables provided.

Use of Product Confidence Records (PCR)

The Product Confidence Records provided with every MDR (scan line) record in the product hold quite a lot of product quality indicators, starting with instrument-related parameters like hot pixels, saturation, or minimum signals - as well as a scan line-based indication of whether an increased risk of sun glint, rainbow or SAA impact on data quality can be expected (see Product Format Specification document (PFS), Appendix A – Compounds, provided in the Publications & Documents section). These PCDs are summarised in the PCD_BASIC record contained in each MDR-1b-Earthshine record. In addition, the quality of the polarisation correction applied during the processing of level 0 to 1b data can be derived from the PCD_EARTH record also contained within each MDR-1b-Earthshine record.

If the F_MISS_STOKES flag in PCD_EARTH is set, no polarisation correction has been applied for at least some of the read-outs in the scan. If the F_BAD_STOKES flag is set, the polarisation correction quality can be regarded as being degraded. The impact on level 1b data quality is, however, in the latter case often weak, whereas the impact on level 1b quality from the former can be substantial, depending on viewing geometry and surface type.

Note that since the introduction of PPF 4.1 on 7 January 2009 the number of missing Stokes fractions at high latitudes has been significantly reduced (see Newsletter #19).

Forthcoming processor updates and instrument operations

We are currently working on the introduction of a new online correction scheme for Stokes fraction in order to further improve their quality and the subsequent quality of the polarisation correction for main channel radiances - as well as the long-term impact of the differential PMD S to P throughput degradation on the Stokes fraction quality. This change is currently being tested offline and will be introduced with PPF 4.3 after successful test analysis.

Any changes to the EUMETCast system with potential impact on level 1 quality will be announced to operational and CalVal users via email and to all interested users via the UNS weekly LEO announcements.

2.19 Newsletter #20 December 2008 / January/February 2009

The GOME-2 level 0 to 1b operational processor version 4.1 was successfully activated in our core ground segment number one on 7 January 2009 (for more details see "Processor Change history" under Documentation section on http://gome.eumetsat.int/). Since then EUMETSAT has been disseminating GOME-2 level 1b data with a further improved quality of Stokes fractions used for the correction of main channel radiances and for geophysical parameter retrievals using polarisation information like aerosol and cloud optical properties.

Geophysical products

As a result of the continuous high quality of level 1b data and the very successful development and operations carried out during the last years by the O3M SAF consortium, five level 2 products of geophysical parameters generated by the O3M SAF have received the operational status during the last two months. All operational and pre-operational products are disseminated by the O3M SAF. Most of the near-real time (NRT) products are available via the EUMETCast system. NRT and offline products are both also available from the EUMETSAT Archive through special arrangement. For an overview of the available products and information on how to receive the data, please visit the O3M SAF website or refer to the EUMETSAT Product Navigator. GOME-2 geophysical value-added products are also available at http://wdc.dlr.de/sensors/gome2.

The list of products with operational status is currently (status February 2009):

- Total ozone column
- Total NO_2 column
- Tropospheric NO_2
- Total SO_2 column
- Near Real Time UV index

The list of products with pre-operational status is currently:

- Ozone profiles
- Absorbing aerosol index
- Offline UV index

Detailed validation reports, product user manuals and algorithm theoretical basis documents for these products are available from the O3M SAF webpage under the "Documents" section.

Instrument throughput test – test setup

Between 27 and 29 January 2009 a test of the GOME-2 instrument throughput behaviour has been carried out (see also Newsletter #19 below for a motivation for the test) which resulted in an outage of data dissemination for 34 orbits (exact orbit numbers and sensing start/stop times are provided in the Processor change history on http://gome.eumetsat.int). The test and data dissemination outage has been announced previously and via the UNS LEO/GOME-2 weekly announcements (http://oiswww.eumetsat.org/UNS/webapps/dataHome.do).

During the test the instrument's four main detector (channel 1 to 4) temperatures have been increased in steps of 5 K from 235 K to 260 K for at least three orbits per temperature step. PMD temperatures have been increased only once from 232 K to 266 K on 27 January at 9:30 UTC sensing time and remained at this temperature level until 29 January 09:30 UTC sensing time. Figure 1 shows the increase in temperature for main detector 1. The schedules of temperature increase as well as the target temperatures reached are the same for all main channels 1 to 4. At about 259 K the Peltier cooling system stopped the active controlling of the temperature since the latter reached the on-board environment temperature of the instrument (which has been gradually decreasing during the test as a result of the decrease in power output required for cooling). As a result the detector temperatures show orbital instrument temperature variations.

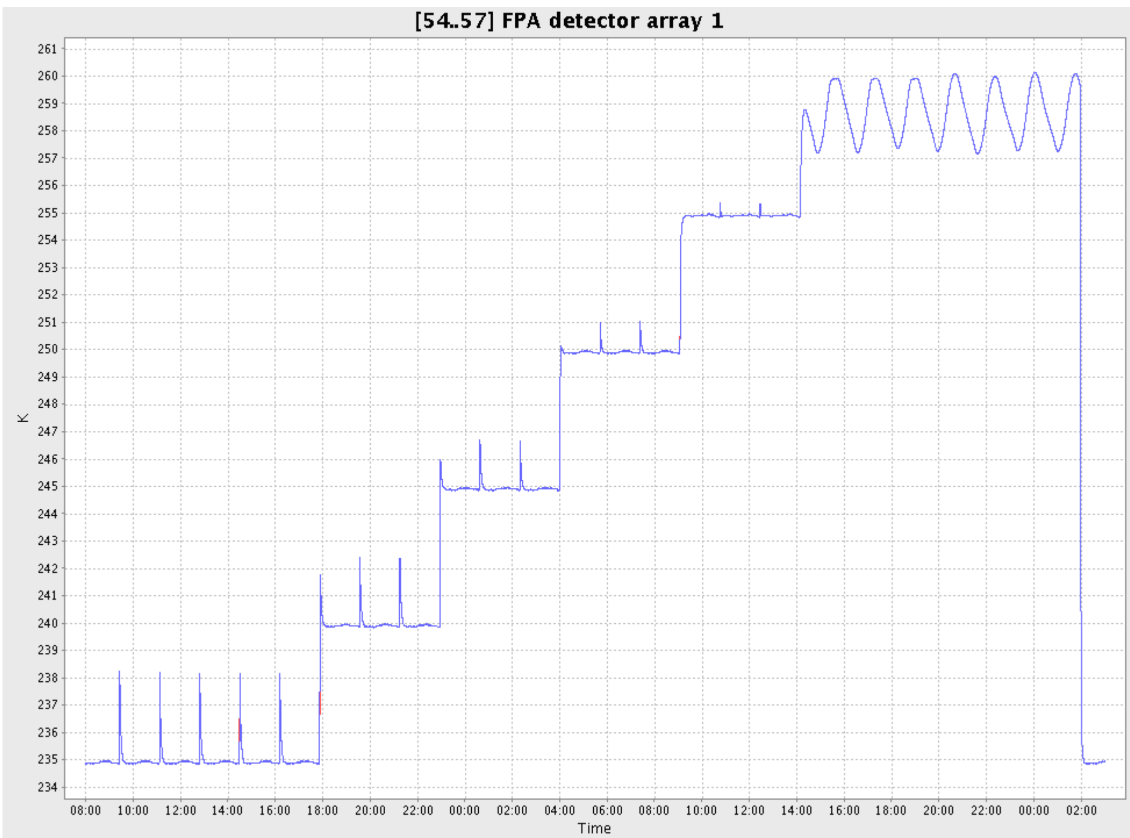


Figure 1: *Temperature of detector 1 starting on 27 January 8:00 UTC sensing time until 29 January 2:30 UTC sensing time. Note that detectors 2 to 4 show exactly the same temperature behaviour. The observed spikes are a result of the in-orbit commanding of detector temperatures at which active cooling control is resumed for a short period of time.*

A large amount of calibration measurements including LED detector pixel direct illumination, radiometric white light source (WLS), spectral calibration lamp (SLS), and solar mean reference (SMR) measurements have been carried out continuously during the test and on the night side of the orbit. Nominal earthshine measurement scanning has also been carried out at the bright side of the orbit. All data archived during the test has been flagged as "test-data" and can only be retrieved from the UMARF upon special request. However, reprocessed level 1b data from the testing period is now available to interested users under ftp://epscv:ftp4epscv@ftp.eumetsat.int/out/GOME/ThroughputTest. Note that due to an anomaly with the on-board test timelines, solar PMD signals could not be acquired and are irrecoverable.

Instrument throughput test – preliminary results

Analysis of the large amount of reference data acquired during the test is currently ongoing and will be discussed in depth at the forthcoming bi-annual instrument health assessment review meeting at SELEX/Galileo including ESA and TNO/Delft. In the following we will give a summary of the preliminary results from an initial analysis of the key throughput parameters:

Results for FPA

During the test a systematic recovery of throughput with temperature, and dependent on the spectral range, has been observed. The rate of recovery for the main channels 1 and 2 is about 2 to 2.5% per 5 degrees temperature based on the solar mean reference (SMR) and white light source (WLS) signals. The recovery of 2.5% per 5 degrees K appears to be robust over the complete spectral range of FPA channel 1 and 2. FPA channels 3 and 4 show a significantly lower recovery by a maximum of 1% per 5 degree temperature change (or lower) peaking at either ends of channel 3 and 4.

The LED signals (green light) show a spectrally flat behaviour in recovery at a rate of just below 1% per 5 degrees.

All sources show a consistent behaviour in throughput change for FPA measurements around 541 nm (used as LED reference wavelength).

A levelling-off of the rate of recovery with respect to temperature is not observed for the current scenario.

Overall the test led to a maximum SMR signal recovery (reached in channel 2) with respect to a reference Kitt Peak spectrum by 10% at temperatures around 259 K (see Figure 2).

Changes in the shape of the etalon for FPA appear to be quite small during the test and for all channels with the exception of a strong change in etalon for channel 1 at temperatures higher than 250 K.

Results for PMD

Temperatures of PMDs have only changed once (at the beginning of the test) from 232 K to 266.5 K and back to nominal temperatures after the test. During the test, temperatures for PMD decreased continuously, showing some orbital variations from 266.5 K to about 264 K.

The initial throughput recovery for PMDs is observed to be between 2% (visible) and 15% (UV) for WLS signals, which is close to the observed recovery rate for FPAs (2.5% per 5 degrees in the UV; note the lower initial and the higher target PMD temperatures reached!).

Because of the decreasing PMD detector temperatures, the PMD throughput decreased consistently by close to 2%.

The maximum LED signal for PMD recovery is 4.5% with a very flat spectral behaviour as expected.

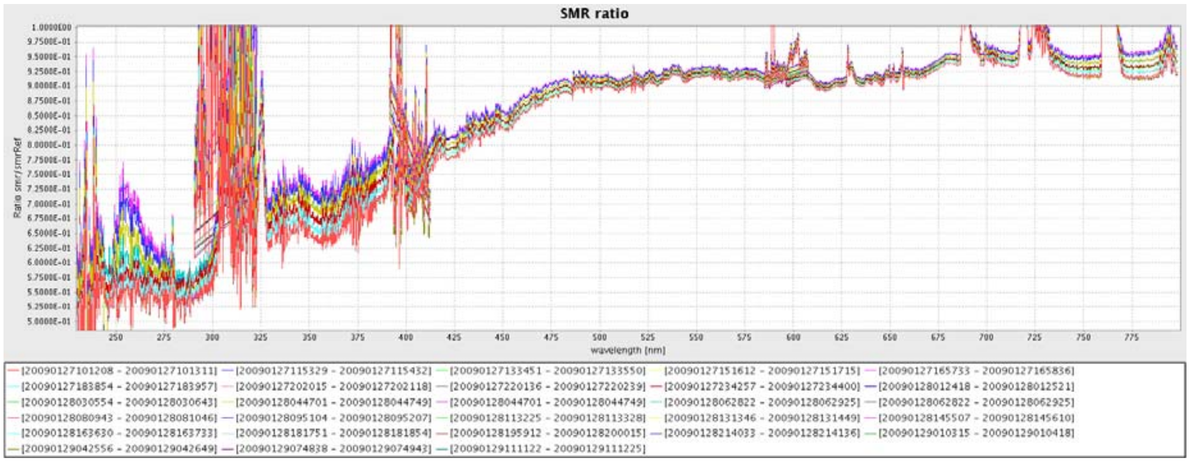


Figure 2: *Ratio of the solar mean reference spectra measurements with respect to a Kitt Peak solar measurement starting at 27 January 8:00 UTC (red line) sensing time until 29 January with a maximum recovery for temperatures around 259 K (blue and magenta lines for 28 January around 18:00 UTC). A maximum recovery of about 10% in channels 1 and 2 (240 to 400 nm) is observed. The throughput recovery of channels 3 and 4 is of the order of 1 to 4%. The overall decrease in throughput with respect to the Kitt Peak solar spectrum after close to 2.5 years in-orbit operations is between 50% in the UV and 5% in the IR (see also previous newsletters).*

Forthcoming instrument operations

The upload of the instrument on-board software patch resolving the outstanding issue with occasional saturation in channel 3 above bright cloud tops has been re-scheduled from 17 February (see previous newsletter #19) to 3/4 March 2009. Unfortunately this will result in an additional outage of data dissemination for about 1.5 days. However, following this patching activity, we expect to be able to set all instrument quality identifiers to green. The exact orbits and start and stop sensing times of data which will not be sent out in near-real time via the EUMETCast system will be announced to operational and CalVal users via email and to all interested users via the UNS weekly LEO announcements (http://oiswww.eumetsat.org/UNS/webapps/dataHome.do).

2.20 Newsletter #19 September/October/November 2008

During the last couple of months, and during various meetings and reviews (the EUMETSAT conference in September 2008, the 42nd GSAG meeting held on 13/14 October 2008, the 1st In-flight Performance review meeting at Selex Galileo on 22 October 2008 and the Polarisation Study Group final review meeting on 28 November 2008), open issues concerning the instrument performance, as well as the quality of the level 0 to 1b products, have been analysed in depth by EUMETSAT and its partners. The analysis of the results, as well as suggestions made for potential solutions or mitigating actions are summarised in the following.

We would like to stress the fact here, that despite the issues mentioned below which are currently under investigation, the GOME-2 level 1b data quality is generally regarded as being very high, as has been shown on many occasions to date, and as summarised in an exciting session at the EUMETSAT conference in September 2008 in Darmstadt. Very recently six level 2 products (including O_3, NO_2, SO_2 and UV index) produced by the O3MSAF have reached their final operational status during a review board meeting in October held at DLR/Oberpfaffenhofen and recently endorsed by the O3MSAF steering group meeting held on 24 November at KMI in Brussels.

I) Instrument performance and operations

Forthcoming Shift of band 1a/1b separation

The 42nd GSAG confirmed that the current band 1a/1b separation at 307 nm is not in line with the original GSAG recommendation to use the same separation wavelength for GOME-2 as has been used for GOME-1 since 1998 at around 283 nm. This is especially important for ozone profile retrievals in order to cleanly separate stratospheric information in band 1a (with a 640 x 40 km^2 ground pixel) from tropospheric information in band 1b (with a 80 by 40 km^2). The shift to detector pixel 658 at 282.98 nm mimicking the current GOME-1 separation of the first 2 bands is currently foreseen for 10 - 11 December 2008.

Instrument throughput degradation

The observed instrument throughput degradation in all six channels of the instrument (including the two PMD channels) has been analysed and discussed in depth during the 42nd GSAG meeting and during the 1st GOME-2 In-flight Performance Review meeting. The current analysis of the signals based on one and a half years of reprocessed data from G2RP-R1 (see also below) and including all available sources (such as solar-mean reference spectra, and on-board calibration sources) is not yet fully conclusive. However, there is a strong indication (as agreed by most of the involved partners and EUMETSAT) that the throughput change observed, which appears to be somewhat stronger than that observed for GOME-1 on the basis of 1.5 years of data, cannot be solely attributed to the expected scan-mirror degradation. Even though the latter may contribute to some extent to the observed signal there is a strong indication that a large part of the throughput change is related to an absorbing contamination layer directly on the detectors. This has been concluded from the fact that following instrument switch-off conditions (EQSOLs and PLSOLs), during which the detectors are warming up by approximately 20 degrees, we observe a strong recovery of the throughput for all observed calibration sources with only small differences between the various source types. The latter observation comprises a similar signal from the on-board LED light sources, which are installed directly in front of the detectors. The strong change in LED throughput behaviour observed during instrument switch-off cannot be solely attributed to a change in LED output alone because of a changing LED environment. Even though the observations above indicate that a contamination layer on the detectors may contribute strongly to the throughput degradation that cannot explain all of the investigated signals. The GSAG as well as the 1st In-flight Performance Review therefore strongly suggest performing a test addressing this open issue by running the detectors at warmer temperatures but in a controlled way and operating the instrument otherwise nominally for a sufficient but limited amount of time. This test, which hopefully will provide us with enough evidence to initiate mitigating actions concerning the throughput loss, is currently scheduled for 27-29 January 2009, during the course of one day of operations. Data acquired during this time will not be disseminated in NRT but will be made available to all CalVal partners via a dedicated ftp link.

Co-adding patch

On 2 and 10 September 2008 two attempts have been made to patch the on-board instrument processor to allow for correct on-board temporal co-adding of channel 3 signals. This will prevent the occurrence of occasional saturation events in some parts of the channel and above very bright surfaces such as, e.g. deep convective tropical convective cloud systems. However, due to a problem with the upload procedure and the patching of the on-board memory, the software update could not be activated. The original software has been rolled back shortly after the discovery of the problem and the instrument is currently operating nominally and in its original configuration. Meanwhile, and during the In-flight Performance Review meeting, the root cause of the patching problem has been identified and a new software package has been delivered to EUMETSAT by ESA and Selex Galileo. This software is currently being evaluated at EUMETSAT and we currently plan for an upload of this software patch for 17 February 2009.

II) Level 0 to 1b processor developments

C-shape feature introduced by the polarisation correction

As reported with previous newsletters, some very sensitive level 2 retrievals (for very weak absorbers or when absolute radiances are used especially in the UV) have been suffering from a C-shape-like feature introduced over the orbit (see figures of Newsletter #17) by a singularity in the formulations of the U/I-Stokes fractions used for the polarisation correction of main channel signals. Three methods to allow for a reduction of the introduced error have been suggested by the Polarisation Study Group lead by SRON, one of which has now been selected by EUMETSAT and implemented in the recent version of the level 0 to 1b processor 4.1 and which is currently being tested offline. The update to this processor version 4.1 is currently scheduled for the 2nd week of January. Test data of level 1b orbits comprising one day in June 2008 are now provided on our FTP CalVal ftp server under “/out/GOME/PPF410” together with a set of reference orbits using processor version PPF 4.0, which is the currently operational version. Retrievals which previously have not been affected by the problem are not expected to see substantial changes for this new level 1b product version. However, for those retrievals for which a C-shape feature has been observed, either in geophysical parameters directly or in the derived fit-residuals, we should see an improvement in data quality when using data from PPF 4.1. Please provide any feedback on this you may gather from the provided test orbits to us by sending your analysis and results to gome_calval@eumetsat.int.

Angular dependence of polarisation correction

The angular dependence observed in retrievals of geophysical parameters has been subject to intense discussions concerning level 1b data quality, as well as level 2 retrieval algorithms. To date, and also during the previously-mentioned meetings and reviews, a limited number of potential sources for the problem have been identified. First, the already used improved key data for the scan-angle dependence of the polarisation sensitivity (the Chi parameter) derived from in-flight data are probably still sub-optimal. An improved version based on a substantially increased data set using G2RP-R1 and using an improved modelling strategy will be implemented together with 4.1, and is expected to show an additional improvement of the problem in some cases. Second, differential throughput changes, e.g. between solar-mean reference spectra and earthshine data, or between PMD-P and S signals, may contribute to the problem, as initial studies by NOAA already suggested. Analysis on this issue is currently ongoing in the framework of the general studies on instrument throughput behaviour and by various partners. Finally, it has already been shown by DLR and the O3MSAF project team, that part of the observed offsets for some viewing geometries at extreme viewing angles and at specific latitudes may be related to polarisation effects not being accounted for in currently used radiative transfer schemes and AMF calculations. A dedicated visiting scientist study on the issue has now been approved by the steering group of the O3MSAF in its recent meeting and is expected to shed some light on the issue from a level 2 retrieval perspective.

PMD signal threshold

The fixed PMD signal strength acceptance threshold levels applied during the level 0 to 1b processing have been subject to some discussion during the 42nd GSAG meeting. One concern is that such a rigid threshold may introduce an artificial residuals signal whenever the threshold is reached. The latter systematically occurs for high latitudes and at high solar zenith angles and especially affects the UV PMD bands and the derived Stokes fractions. Recent analysis at EUMETSAT has shown that the signal threshold levels can be significantly reduced without a substantial effect on the quality of Stokes fractions used for polarisation correction of main channel signals. The reduction will allow for a ‘smoother’ transition between the parts of the orbits which are currently not polarisation-corrected and the nominal corrected signals. This will also significantly increase the areas at higher latitudes for which a polarisation correction of main channel signals is applied.

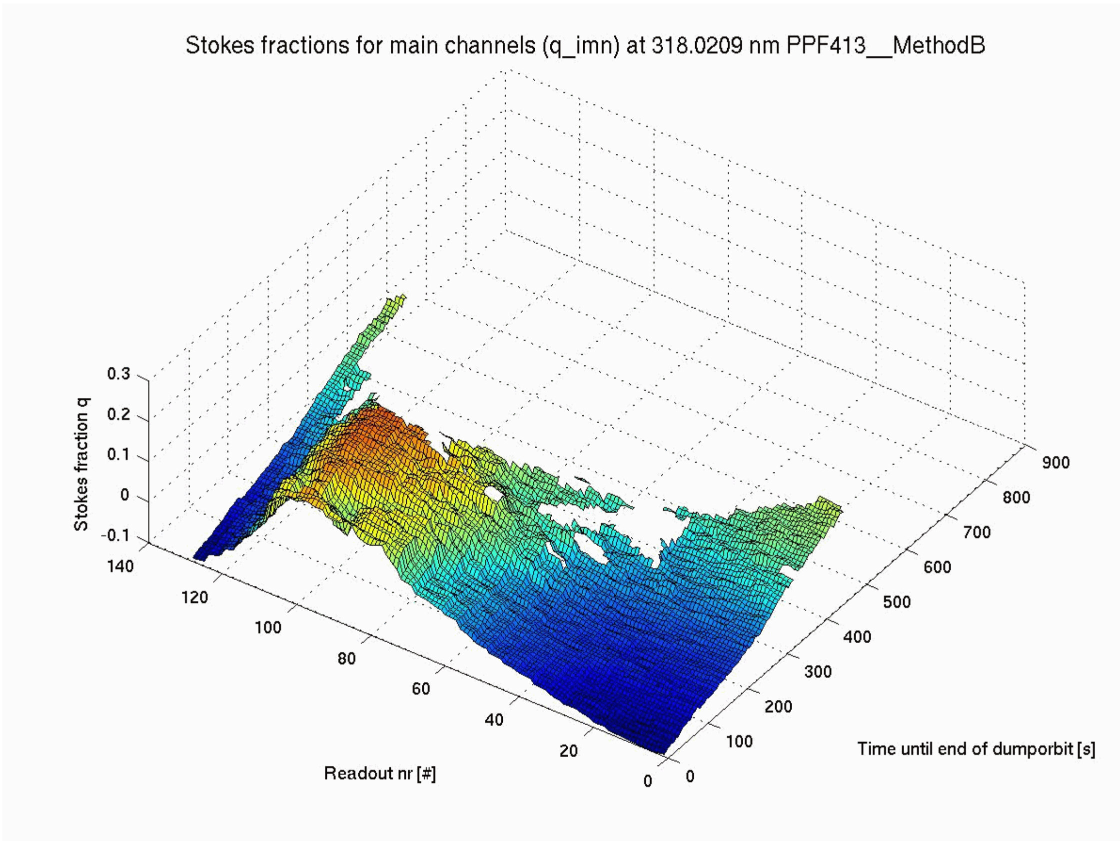


Figure 1: *Stokes fractions Q/I derived from signals of the two Polarisation Measurement Devices (PMDs) from GOME-2 and as applied for the main-channel signal correction of the instruments' sensitivity to polarised light. The measurement read-out number increases from East to West. The plot shows data covering a couple of minutes before the Metop reception station at Svalbard (Spitzbergen) when the instrument comes out of the polar night. Here the threshold for accepting PMD signals is set to the currently operational value (PPF 4.0) of 35 BU above noise.*

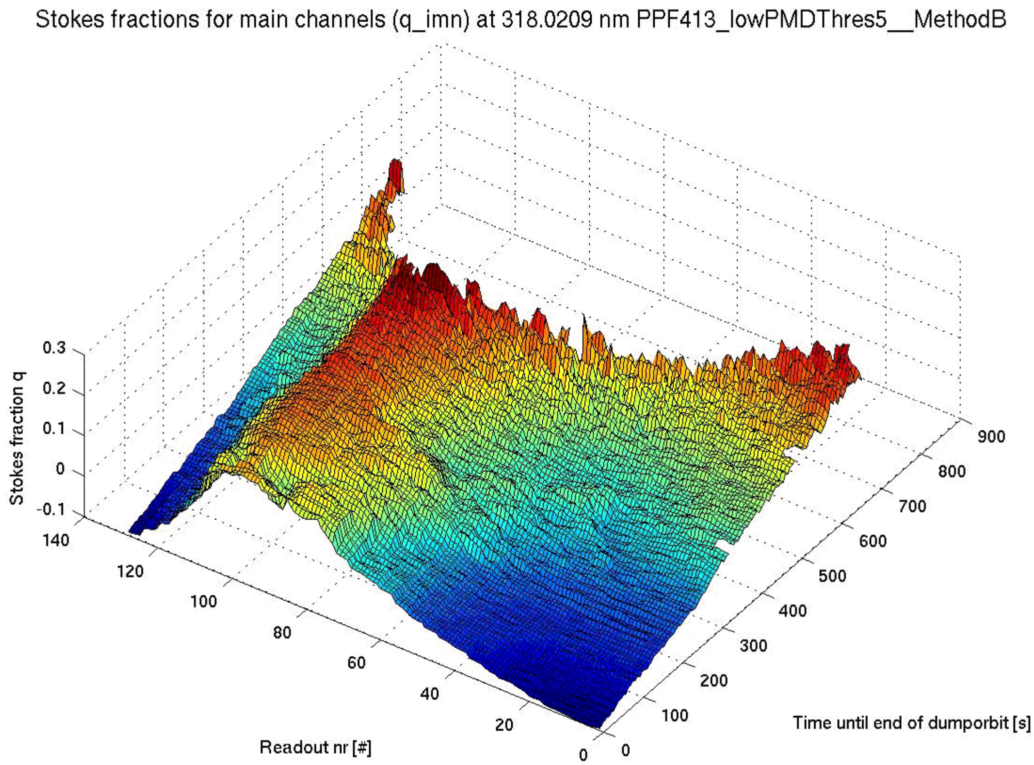


Figure 2: *The same as Figure 1 but now using a PMD signal acceptance threshold of only 5 BU above noise as implemented in the forthcoming level 0 to 1b processor version 4.1.*

III) Schedule of forthcoming instrument operations

• 10 December 2008, dark side of orbit 11118/11119 with sensing times between 07:38 and 08:15 UTC: Change of band1a/1b separation from pixel to pixel 658 at 282.98 nm. (No data dissemination outage expected.)
• 7 January 2009: Installation of PPF version 4.1 in core ground segment 1 and distribution via EUMETCast.
• 27-29 January 2009: One day test of instrument throughput behaviour. (A data dissemination outage of 1.5 days is expected. A substantial part of the data will be made available on a dedicated ftp server.)
• 17 February 2009: Upload of co-adding patch. (One day outage of data dissemination expected.)

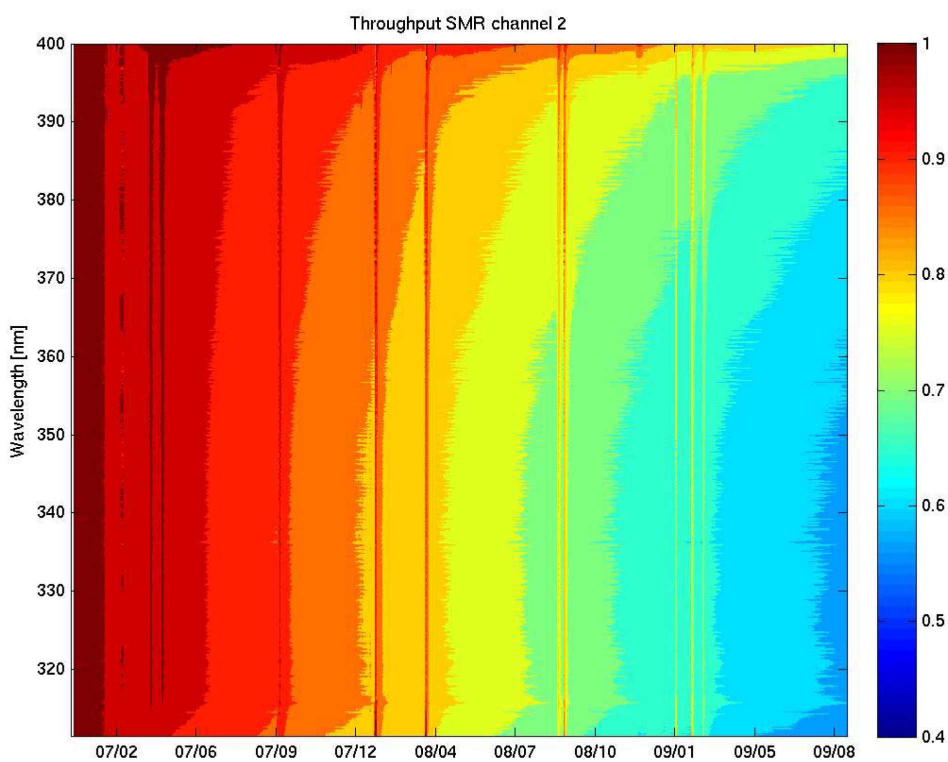
IV) Updates on G2RP-R1 reprocessed data set

During September 2008 the initial orders of the complete GOME-2 reprocessed level 1b data set comprising data from 1 January 2007 until 30 June 2008 produced with processor version 4.0 have been delivered to the users. More than ten copies have been sent initially and an additional set of four copies have been sent to subsequent users. This shows the large interest of the user community in GOME-2 homogeneous time series, already at this early stage of the project. A couple of small issues concerning the handling of the data have been identified by various users and additional information for clarification has been put in a disclaimer section of the technical document on the data set which is available here along with some information on data extraction from tapes. Users interested in the data can send a request for delivery of data of the GOME-2 reprocessed data set G2RP-R1 to ops@eumetsat.int indicating their preferred delivery medium, being either LTO-2 or LTO-4 tapes (see also previous Newsletter #18).

2.21 Newsletter #18 June/July/August 2008

Release of first GOME-2 reprocessed L1b data set R1

We are pleased to announce the first release of a GOME-2 reprocessed level 1b data set tagged GOME-2 L1b-R1. On 10 July 2008 the EUMETSAT Product Validation Board officially agreed to release this data set following an intense in-house evaluation and consistency checking campaign. The result of the latter is documented in the 4th version of the GOME-2 product validation report (PDF, 9582 KB). The data set characteristics and product identifiers are detailed in the EPS GOME-2 Reprocessing L1B-R1 data set technical document (PDF, 65 KB). The data set has already been uploaded to the EUMETSAT Archive and is now available to all users via the standard Archive online ordering interface. Note that from now on near-real time processed data (L1b-R0 data) for the reprocessing period R1 can only be ordered on special request via the Archive.



The figure above shows the relative instrument throughput for GOME-2 channel 1 solar irradiance measurements derived from GOME-2 reprocessed level 1b data R1. The colour scale denotes the relative change with respect to the 5 January 2007. Data are given for channel 2. The vertical stripes are related instrument or satellite platform switch-offs.

The reprocessing has been carried out using level 0 to 1b processor version 4.0, which was installed in the core ground segment on 26 June in order to guarantee a smooth transition between the reprocessing period and the near-real time archived data. GOME-2 L1b-R1 covers the time period from 1 January 2007 to 30 June 2008. It has already been demonstrated that Processor version 4.0 resolves a number of important issues regarding the level 1b polarisation correction (for details we refer to newsletter #17). We consider the current GOME-2 level 1b data produced with PPF 4.0 to be of very high quality (for open issues see below).

Users who already have ordered the complete GOME-2 L1b-R1 data set will receive the tapes within the next two months. In case you would like to order the complete set of data (more than 4TB compressed data, 9TB of uncompressed data) please send an email to ops@eumetsat.int indicating your preferred delivery media. Note that due to the large amount of data, the files can only be delivered on either LTO-2 or LTO-4 tapes.

Known open issues

Occasional saturation in channel 3

Saturation occasionally occurs in some parts of channel 3, predominantly above deep convective clouds. The issue will be resolved with the upload of new instrument on-board software currently planned for 2 September 2008. Note that a substantial rewriting of the on-board software was necessary to fix this issue and allow on-board co-adding of reduced integration times. The upload of the patch will therefore require a 24 hour outage of data dissemination. A separate user announcement will be sent out before the upload for more details on the precise scheduling of the event.

"C-shape" pattern in polarisation correction

For sensitive retrievals targeting, for example, weak absorbers such as BrO or using absolute radiances (such as O_3-profile or AAI retrievals) from channels 1 and 2, a C-shape-like residual pattern can sometimes be observed over the orbit, which occurs because of a singularity in the processor Stokes U-fraction (U/I) approximation for small values of the single-scattering Q-fraction (see newsletter #17 for more details). We are currently testing alternative estimations of (U/I) within the "C-shape" area and in the framework of the GOME-2 Polarisation Study led by SRON. First results look very promising and we are currently optimistic that the issue can be resolved within the near future.

Retrieval noise

Some users have reported elevated noise levels in retrieved concentrations of BrO with respect to GOME-1 and SCIAMACHY, varying with the spectral region used for the retrieval. First attempts to identify the underlying issue, either on level 1b or on level 2 retrieval side, have so far been unsuccessful or inconclusive.

Radiometric calibration

A further improvement of the radiometric calibration of the channel-overlap regions is still outstanding.

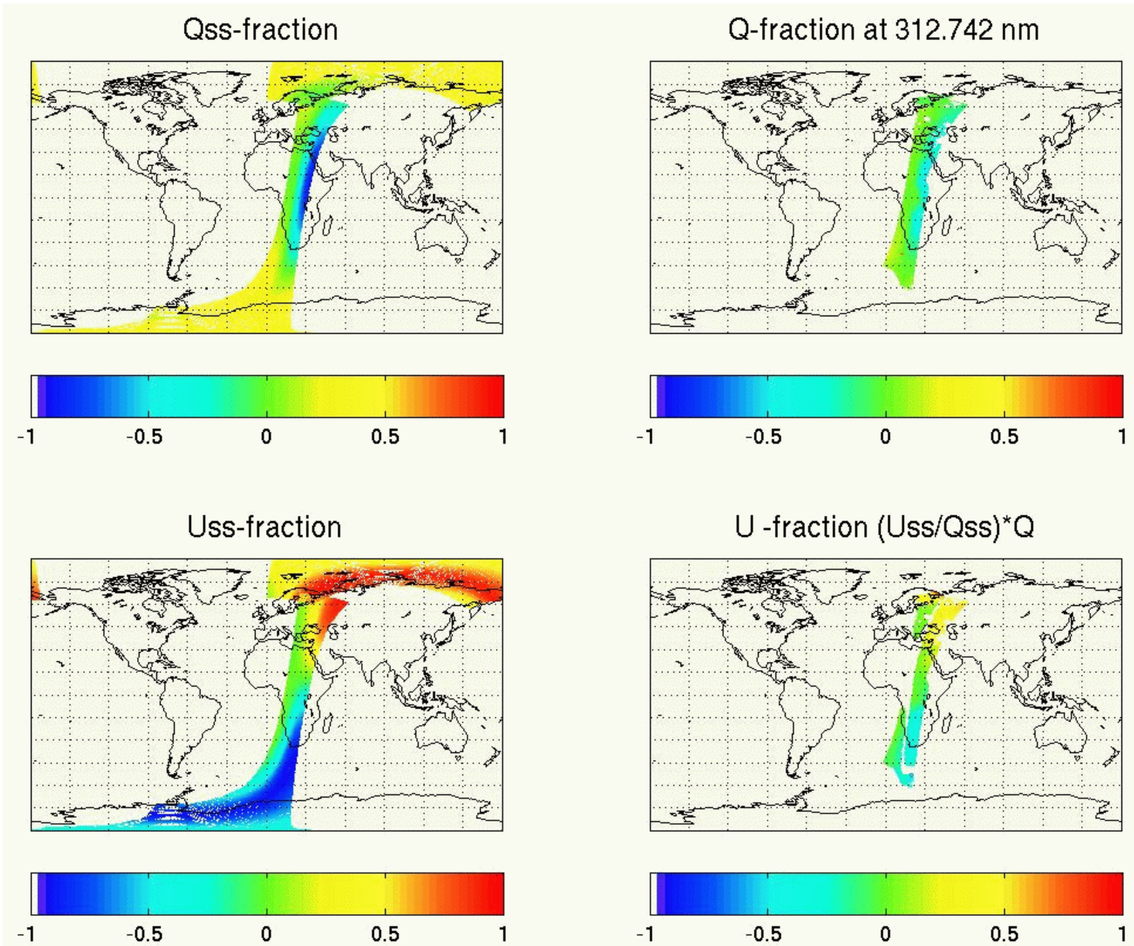
2.22 Newsletter #17 April/May 2008

Following the upgrade of GOME-2 level 1b products to operational status with the installation of processor version 3.9 in our core ground segment (CGS) and the update of the on-board PMD band definitions on 11 March 2008, a couple of important issues on Polarisation Measurement Device (PMD) data calibration have been resolved (see newsletter #16 below). As a consequence, a previously recognised scan-angle dependence pattern seen in level 2 data retrievals (predominantly for DOAS-type minor trace gas retrieval and retrievals using absolute radiances) became more apparent. Meanwhile, we discovered the root cause of the issue and were able to solve a large part of it with our latest processor version 4.0, which is to be installed during the course of June 2008 in the CGS. We consider the level 1b calibrated data produced by processor version 4.0 to be of very high quality.

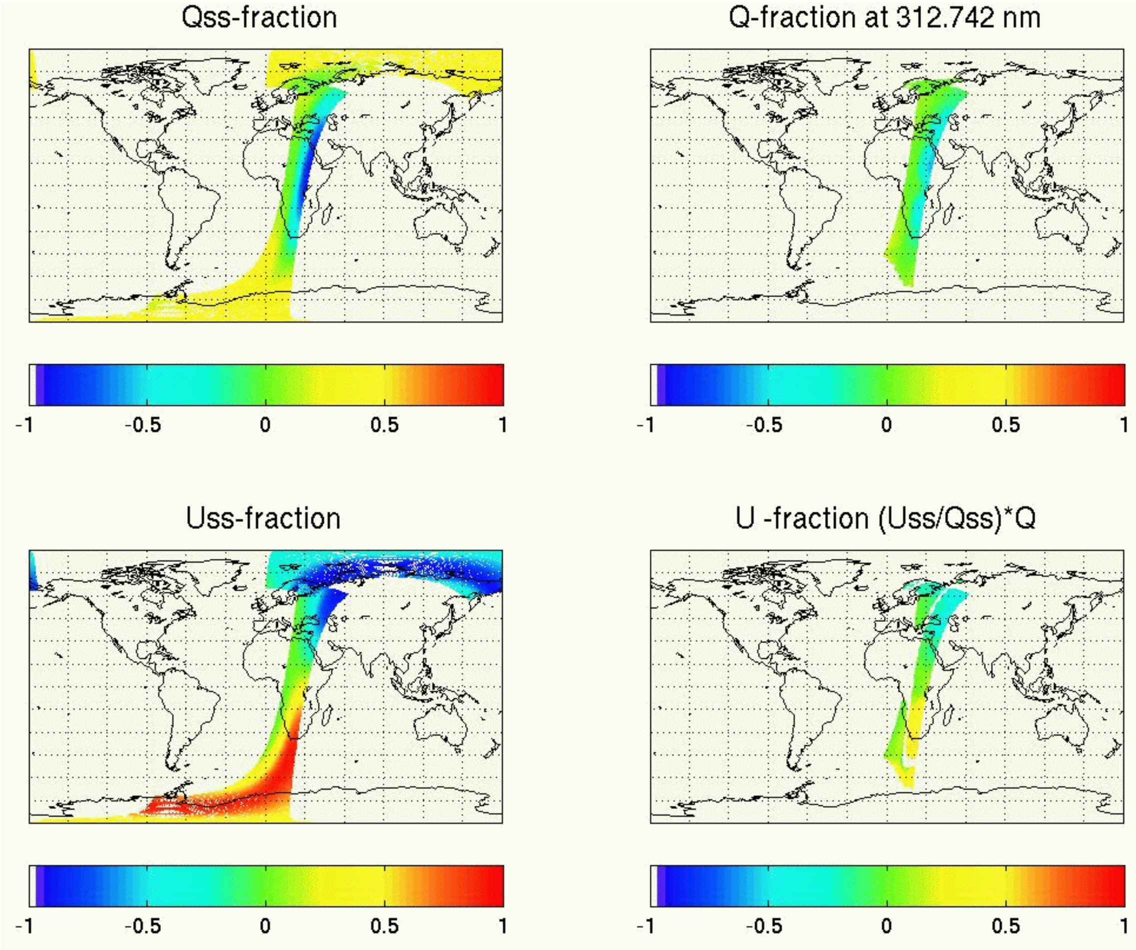
Scan-angle dependence pattern in level 2 retrievals for processor version up to 3.9

The scan-angle dependent biases for processor versions previous to 4.0 occur for very sensitive retrievals using level 1b data below 400 nm, i.e. for channels 1 and 2 only. For this region, the polarisation sensitivity of the main detector channels (Focal Plane Assembly - FPA) shows some response to 45-degree polarised light: the U Stokes-fraction sensitivity. The sensitivity of FPAs (and also PMDs) to the latter is characterised in the key data (see Calibration Data Sets section for the GOME-2 key data package) as the 45/45 response of FPAs called "zeta" (POL_ZETA and POL_PMD_ZETA key data files). The spectral behaviour of zeta shows that we only expect a large sensitivity to the latter for regions below 400 nm and for situations of strong polarisation in U. Since U cannot directly be measured with the PMDs only, it is currently approximated by (U/Q)_ss * Q, where (U/Q)_ss is the ratio of the single-scattering Q and U Stokes fractions, which are derived as being pure functions of viewing geometry (see e.g. PGS 6.1, section 5.2.23).

During our investigations we found a sign problem in the formulation of the single-scattering U fraction, which basically swaps the U_ss fraction pattern over the orbit from North to South (compare the two figures below) leading to the observed scan-angle dependence predominantly at higher latitudes and in the Eastern part of the swath, i.e. for large U fractions, for processor versions up to and including 3.9. In addition, we found that Q fractions from the first PMD band (i.e. around 314 nm) could not always be applied by the processor in the FPA polarisation correction and for the extreme Eastern part of the swath, because of the PMD signals falling below a predefined threshold. These drop-outs resulted in occasional significant degradation of the polarisation correction for regions below 318 nm also at mid-latitudes and again in the Eastern part of the swath. We have solved this for processor version 4.0 by safely decreasing the threshold on the PMD signals, but may consider introducing a longer integration time for the first PMD band in the near future. These initial results have been verified as part of the efforts of the Polarisation Study Group for GOME-2 led by SRON.



The figure above shows U and Q Stokes fractions as derived with processor version 3.9. The left panels show the single-scattering Stokes-fractions, whereas the right panels show Stokes fractions as derived from PMD band 1 around 312 nm. The data gaps in Q (right upper panel) are due to PMD signals falling below the predefined threshold. There is an additional C-shaped gap for the U approximation (right lower panel), which is due to avoiding the singularity of (U/Q)_ss. The figure below shows the same, but for processor version 4.0.



Outstanding issue

There is still an outstanding issue regarding the U approximation, U = (U/Q)_ss * Q, used for the polarisation correction. In cases where Q_ss is smaller than 0.05, (U/Q)_ss is artificially set to zero in order to avoid the singularity. For very sensitive retrievals (and again for regions smaller than 400 nm), this may cause a problem in cases where Q_ss < 0.05 and U_ss > 0.05 at the same time (see lower right panel of the figures around 50 degrees South). If you want to avoid these regions in your retrievals you can use the single-scattering U and Q fraction values for monitoring, as provided for each FPA read-out in the POL_SS field of the MDR-1b-Earthshine sub-class records. We are currently working on a solution for this problem.

Status of reprocessing of level 1b

We started the investigations on the above issue during the time of phase B of the reprocessing of the GOME-2 level 1b data set using processor version 3.9 (see Newsletter #16 below). After finding the problem with the sign of U_ss, we have put the reprocessing with processor version 3.9 on hold and, following a decision by the EUMETSAT Product Validation Board, restarted the reprocessing work with processor version 4.0. The reprocessed level 1b data set R1 will therefore comprise data from January 2007 until (including) June 2008. For users who have not yet ordered the R1 data set and are interested in the complete level 1b record comprising 18 months of data, please send an email to ops@eumetsat.int indicating your preferred media type for the delivery (either LTO-2 or LTO-4 tapes). Users who already ordered the previous set will receive the complete new data set, i.e. including the additional months.

Other known open issues

- Occasional saturation in channel 3 predominantly above deep convective clouds. Outstanding on-board software patch (see Newsletter #16).
- Full characterisation of instrument degradation pattern for earthshine data using the reprocessed data set R1.
- Further improvement of the radiometric calibration of the channel-overlap regions.

Test data for processor version 4.0

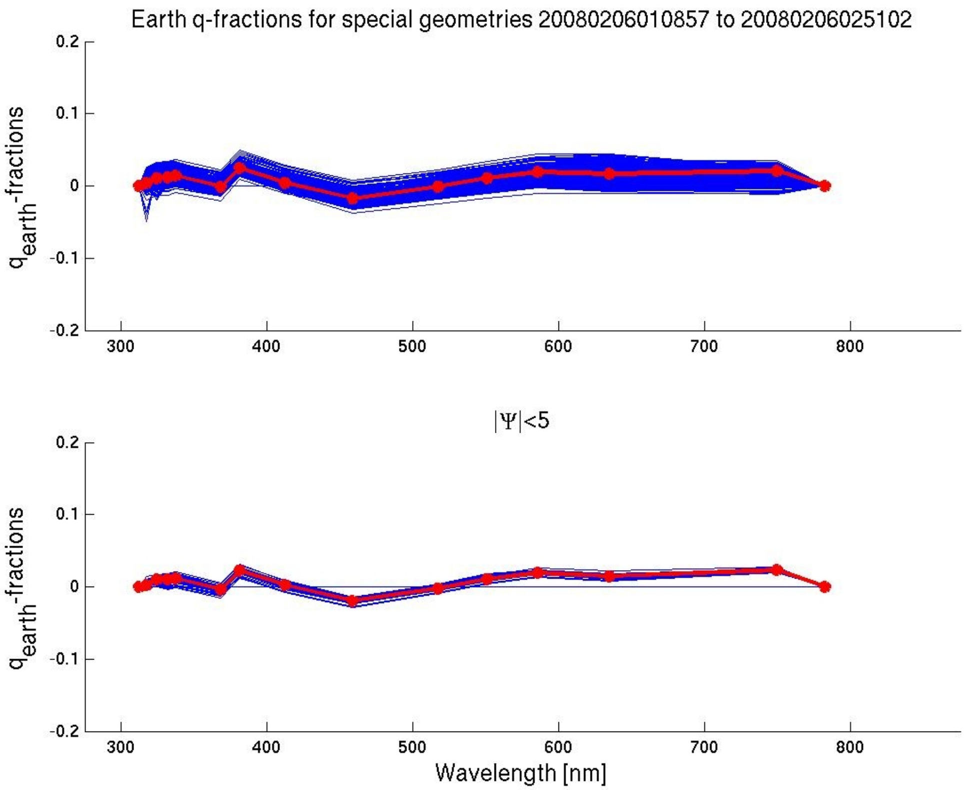
The installation of processor version 4.0 is currently foreseen for 28 June 2008 in CGS1 (TBC). Announcements for the installation will be made via the weekly UNS message. Test data for PPF 4.0 have been put on the GOME CalVal ftp server under ftp://epscv:ftp4epscv@ftp.eumetsat.int/ under /out/GOME/Test Data and Tools/GOME-2 Test Data/TestPPF400.

2.23 Newsletter #16 February/March 2008

In this newsletter we summarise the results and findings of the past couple of very busy and exciting weeks, which saw the implementation of a new processor version (3.8) on 31 January 2008 on our core ground segment (CGS1) and the test upload of the new PMD Band data definitions during 5-6 February. Both of the latter are important milestones with respect to promoting the GOME-2 level 1b data quality to an operational status. We are planning the status change during the course of the second week of March following the installation of the operational processor version 3.9 on 10 March in our Core Ground Segment 1 (CGS1) and the subsequent final upload of the new PMD Band definitions on 11 March. The latter activities will finalise the first part of the calibration and validation activities for GOME-2 level 1 data as laid out in the GOME-2 CalVal plan, Chapter 6, A4 to A5.

PMD spectral calibration: PPF change and test upload of new PMD band definitions v3.0

The spectral calibration of PMDs has improved significantly with the installation of PPF 3.8 on 31 January (see also newsletter #15). The differences between the spectral grid measured in flight and calibration measurements carried out on ground is now of the order of 0.001 nm (previously up to 1 nm) in the UV and around 0.01 nm (previously up to 9 nm) in the NIR. The stability of the spectral calibration of PMDs is now well within sub-pixel range. As a result of both, the co-registration of detector pixels between both PMDs has improved significantly. This in turn has a positive impact on the calculation of Stokes fractions for which the ratio of PMD signals are used and therefore a positive impact on the polarisation correction of main channel signals.



The figure above shows Stokes fractions q (Q/I) for viewing geometries for which q is expected to be zero (special geometries) and for the new PMD band definitions v3.0 uploaded for testing on 5-6 February. Note that the spread in the Stokes fractions for special geometries and all viewing angles (upper panel blue lines) appears to be, at least partly, related to a problem in the characterisation of the viewing angle dependency of the relative polarisation response between P and S (chi) as measured on ground. We therefore derived a slightly different viewing angle dependency using in-flight data from high resolution PMD measurements.

In addition, raw key data for the viewing angle dependence of the instrument sensitivity to 45 degrees polarised light (zeta) is now also being used for processor version 3.9. The update on the key data set being installed together with 3.9 has been carried out by EUMETSAT. The details have been discussed with all external partners including Officine Galileo, TNO-TPD, and the polarisation study group led by SRON. Details on these findings and activities can be found in the updated version of our document on PMD band definitions and PMD calibration.

Status of reprocessing Phase B

We are currently reprocessing GOME-2 level 1b data starting with January 2007 until the installation of PPF 3.9 in CGS1 (10 March 2008). Phase A carried out in November has led to the full characterisation of the instrument degradation (see also newsletter #14) and made the subsequent improvements in key data and other issues possible. Phase B will now make use of the latest PPF version 3.9 and the most recent set of auxiliary data files (including the updated key data). Phase B will be finalised by end of March. Reprocessed data will then be transferred to the UMARF by the second quarter of 2008. From then on the data will be visible to all users. Note that the full reprocessed data set of level 1b (approx. 5.5 TB) can only be delivered on request and on LTO-2 (approx. 25 tapes) and LTO-4 tapes (approx. 5 tapes). Requests for the full data set of 14 months of GOME-2 level 1b R1 data can then be placed through the normal UMARF interface.

Schedule of forthcoming activities

10 March 2008: Installation of PPF version 3.9
11 March 2008: Upload of final set of PMD band definitions v3.0
2nd quarter of 2008: Reprocessed data available from UMARF. For further questions on the delivery of GOME-2 reprocessed data please contact ops@eumetsat.int.

Outstanding issues

Note that we expect the upgrade of the on-board software, solving the issue of spurious saturation events in channel 3 above bright surfaces like deep convective clouds, for this month (2nd quarter of 2008). For this update the instrument has to be transferred to stand-by mode, which will lead to an interruption of data of approximately one day. We will announce the details in time at a later stage.

2.24 Newsletter #15 January 2008

PMD spectral calibration: PPF change and change of product format

During the course of investigations by the GSAG, the GOME-2 PMD study led by SRON, and in-house EUMETSAT investigations, we found problems in the key data representation of the PMD spectral calibration, as well as in the level 0 to 1b processor algorithm carrying out the same task based on the in-flight daily spectral calibration measurements. A detailed explanation of the problem is given in the EUMETSAT document on PMD band definitions and PMD spectral calibration. Note that Chapter 4 provides a brief summary and conclusion on our main findings in Section 4.1 [note: now in Chapter 5 of current version of document].

These findings led to a new PPF development now tagged version 3.8 which significantly improves the spectral calibration of the PMDs and their spectral co-registration. PPF 3.8 is currently scheduled for implementation in GS1, and subsequent dissemination via EUMETCast, by 31 January! Please note that the changes to 3.8 imply a change to the product format of level 1a and 1b GOME-2 data. For level 1b data we added one GIADR subclass record called GIADR-PmdBandDef holding the current PMD band definitions with start pixel number, width in pixels and centre wavelength information. The change is detailed in the updated GOME-2 PFS document tagged 7.3 (draft version) which can be found here.

To facilitate a smooth transition to PPF version 3.8 we are providing one day of data for 14 June 2007 plus one orbit including a PMDRAW timeline (10 July) on our CalVal ftp server under ftp://epscv:ftp4epscv@ftp.eumetsat.int/ under /out/GOME/Test Data and Tools/GOME-2 Test Data/TestPPF385. There, you will also find pdus for one orbit to test NRT ingestion for EUMETCast users. In the following sub-directory on the same ftp link you will find a patch to kai and eugene to make them capable of reading the new format with version number 11.0 (as denoted in the master product headers of the new files). A read-me file is supplied on how to implement the patch. Note that an updated version of eugene and kai implementing the changes (and later on also of EPS view) will be made available to you shortly (note that kai and eugene are downwards compatible). The same holds for users using the BEAT software (http://www.science-and-technology.nl/beat/). Should you face any problems reading the test-orbits, please let us know via the CalVal email (gome_calval@eumetsat.int) as soon as possible.

Status of reprocessing Phase B

Preliminary investigations of the new data set show a significant improvement in spectral calibration of PMD and a subsequent improvement in Stokes-fractions (see the above-mentioned document, Chapters 4 to 6). We therefore plan to start the second phase of reprocessing of level 1 GOME-2 data by beginning of February 2008. The reprocessed data set will then comprise one year of data from beginning of February 2007 to 31 January 2008 based on PPF 3.8 processing. The current schedule for making the reprocessed data available via UMARF is mid-March 2008.

Upload of PMD Band definitions v.3.0

Our findings on the PMD spectral calibration issues made a revision of the previously tested new PMD band definitions - based on GSAG recommendations - necessary (see PMD band definition evolution in the PMD band definitions and PMD spectral calibration document). We therefore plan for another test upload of the revised definitions v3.0 for 5 February 2008 (TBC). You will receive more information on this at a later stage, once the one day test-upload schedule has been consolidated.

Outstanding issues

A summary of all outstanding issues concerning GOME-2 level 1b quality based on the performance of PPF version 3.8 will be given in the next newsletter.

2.25 Newsletter #14 November/December 2007

Upload of new PMD band definitions

The upload of the new PMD band definitions originally scheduled for 11 December has been put on hold!

During a meeting of the GOME-2 Polarisation study group (including EUM, SRON and ESA) held on 5 December at EUMETSAT, we discovered a problem in the spectral calibration of the PMDs as carried out during the processing of the on-board spectral light source (SLS) measurements. Since the new PMD definitions have been based on the assumption that the spectral calibration for PMDs is correct (i.e. within a certain accuracy limit), the root cause of the problem observed has to be evaluated before uploading of the new band definitions! First evaluations on the situation suggest that limitations in the PMD spectral calibration key data of FM3 in the 320 nm to 400 nm region may be causing at least some of the problems. The evaluation of this issue is however ongoing.

In the event that the spectral calibrations of PMD can indeed be significantly improved, we will implement the changes to the processing as soon as possible (including our re-processing activities; see below). Since this will also imply a further change of the on-board band definitions, the date for their final upload is still to be defined.

Update of narrow-swath sequence

New rules updating the sequence of the narrow swath schedule (from three times to once per 29 orbit cycle) have already been implemented in the MPF on 16 September 00:00:00. October and November already showed the correct issuing of the narrow swath sequence following the change, with narrow swath measurements on both 19 October and 17 November. The new schedule is shown below:

GOME-2 timeline planning per 412/29 repeat cycle. Version 3.0, 19 Jul 2007

day	orbit offset	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	0	X	X	X	M1	M2	X	D	X	X	S	S	R	X	X	X
2	15	X	X	X	X	X	X	D	X	X	X	X	X	X	X	
3	29	X	X	X	X	X	X	D	X	X	X	X	X	X	X	
4	43	X	X	X	X	X	X	D	X	X	X	X	X	X	X	
5	57	X	X	X	X	X	X	D	X	X	X	X	X	X	X	X
6	72	X	X	X	X	X	X	D	X	X	X	X	X	X	X	
7	86	X	X	X	X	X	X	D	X	X	X	X	X	X	X	
8	100	X	X	X	X	X	X	D	X	X	X	X	X	X	X	
9	114	X	X	X	X	X	X	D	X	X	X	X	X	X	X	
10	128	X	X	X	X	X	X	D	X	X	X	X	X	X	X	X
11	143	X	X	X	X	X	X	D	X	X	X	X	X	X	X	
12	157	X	X	X	X	X	X	D	X	X	X	X	X	X	X	
13	171	X	X	X	X	X	X	D	X	X	X	X	X	X	X	
14	185	X	X	X	X	X	X	D	X	X	X	X	X	X	X	
15	199	N	N	N	N	N	N	D	N	N	N	N	N	N	N	N
16	214	X	X	X	X	X	X	D	X	X	X	X	X	X	X	
17	228	X	X	X	X	X	X	D	X	X	X	X	X	X	X	
18	242	X	X	X	X	X	X	D	X	X	X	X	X	X	X	
19	256	X	X	X	X	X	X	D	X	X	X	X	X	X	X	
20	270	X	X	X	X	X	X	D	X	X	X	X	X	X	X	X
21	285	X	X	X	X	X	X	D	X	X	X	X	X	X	X	
22	299	X	X	X	X	X	X	D	X	X	X	X	X	X	X	
23	313	X	X	X	X	X	X	D	X	X	X	X	X	X	X	
24	327	X	X	X	X	X	X	D	X	X	X	X	X	X	X	
25	341	X	X	X	X	X	X	D	X	X	X	X	X	X	X	X
26	356	X	X	X	X	X	X	D	X	X	X	X	X	X	X	
27	370	X	X	X	X	X	X	D	X	X	X	X	X	X	X	
28	384	X	X	X	X	X	X	D	X	X	X	X	X	X	X	
29	398	X	X	X	X	X	X	D	X	X	X	X	X	X	X	

D	CAL0	Daily calibration (incl. Sun mode)
M1	CAL4	Monthly calibration, part 1 (LED, WLS, SLS modes)
M2	CAL5	Monthly calibration, part 2 (SLS over diffuser mode)
N	NS	Narrow swath (320 km)
S	NADIR	Nadir static
R	PMDRAW	PMD monitoring (nominal readout/raw transfer mode)
X	NOT1920	Nominal swath (1920 km)

Status of reprocessing Phase A

As has been announced with Newsletter #13, the first reprocessing campaign Phase A of GOME-2 level 1b data has been carried out during the second and third week of November 2007.

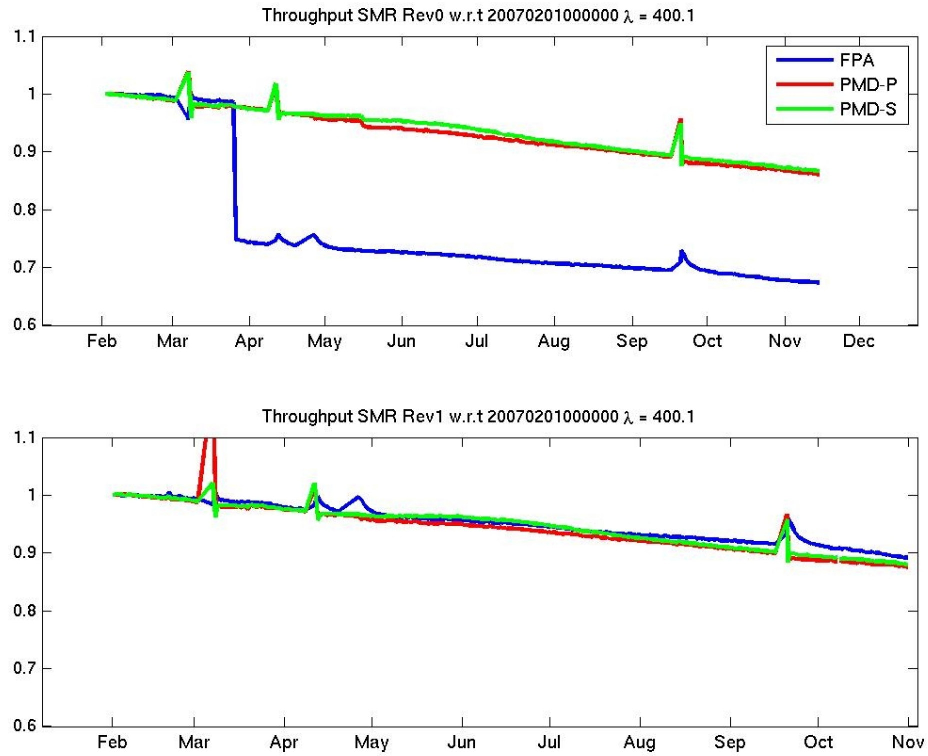


Figure 1 above shows the improvement in time series of degradation of the solar mean spectrum (predominantly related to degradation of the scan mirror) at 400 nm using original data (upper panel) and employing the reprocessed data set (lower panel). Phase A removes any inconsistencies related to processor updates and changes of auxiliary data input. Note that the times of instrument and payload switch-offs have not been masked out here. The data are currently being analysed to fully characterise the degradation pattern of all channels from earthshine (using selected target areas) as well as sunshine data and with respect to wavelength.

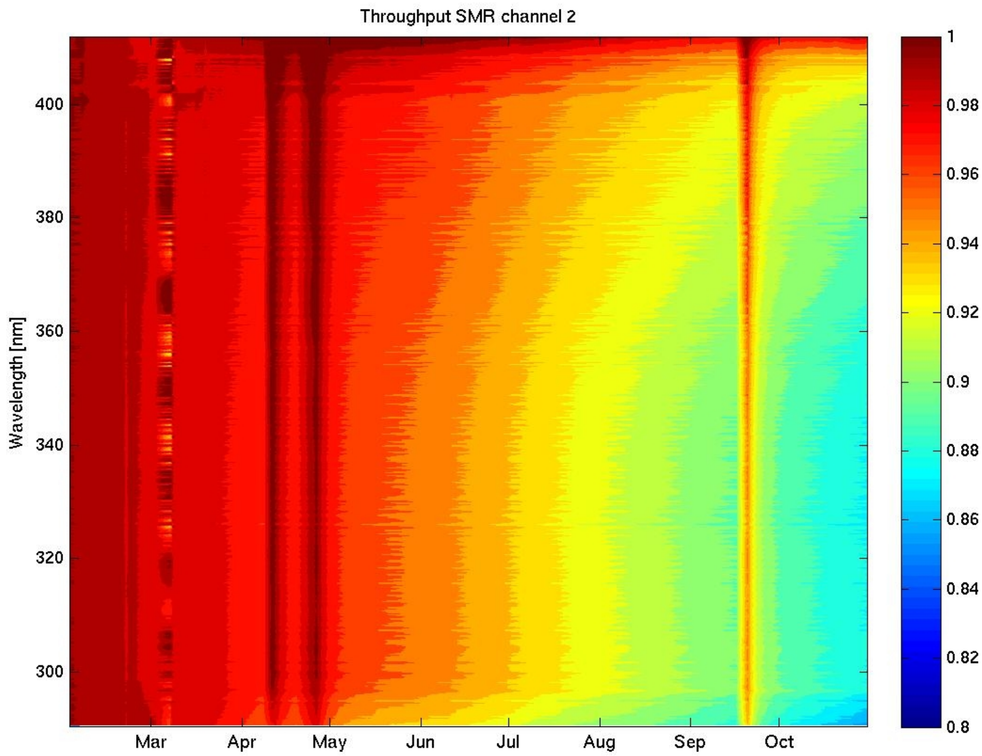


Figure 2 shows an analysis of the solar mean-spectrum change in throughput relative to 1 February 2007 using reprocessed data from phase A.

Results presented at the 41st GOME Scientific Advisory Group (GSAG) meeting

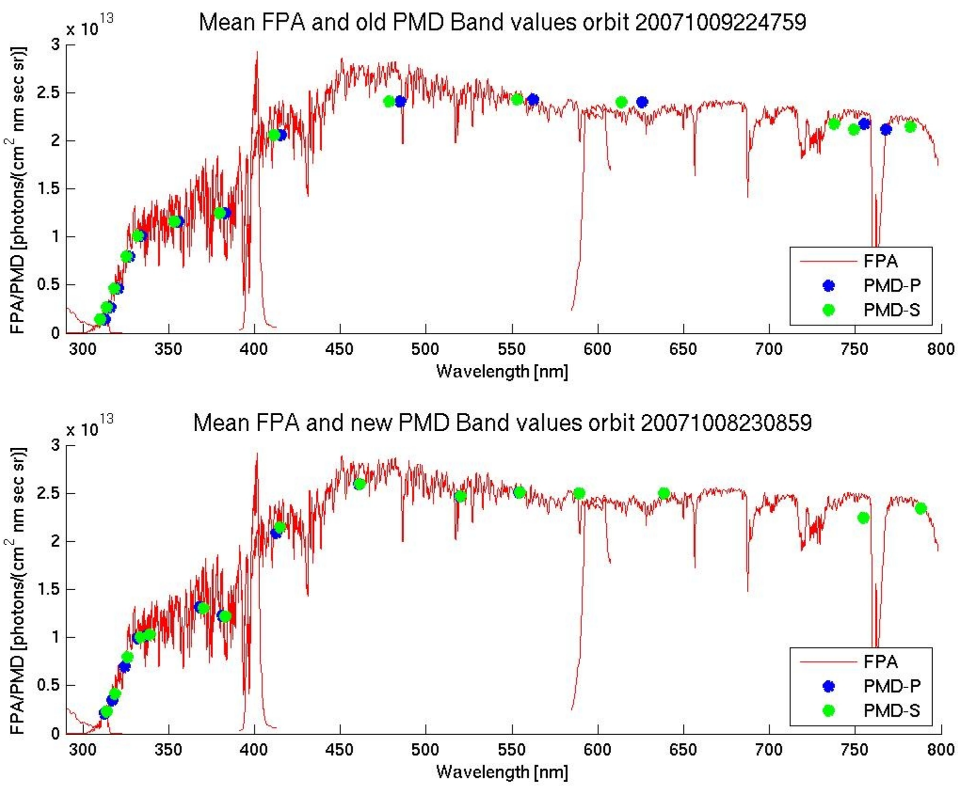
The 41st GSAG meeting took place at EUMETSAT during 21-22 November. The impact of the upload of the new PMD band definitions on level 1b data has been presented in detail by EUMETSAT and Ilse Aben from SRON. SRON leads the dedicated GOME-2 polarisation study. The results have already been summarised in the first section. Other important outstanding issues concerning level 1b data quality have also been addressed during the meeting. Results from various studies on level 1b quality have been presented in more than ten presentations. The presentations are available for GOME-2 CalVal users on our GOME-2 CalVal FTP server under ftp://epscv:ftp4epscv@ftp.eumetsat.int/ under out/GOME/GSAG (please read the disclaimer first!)

One important result from a study presented by Michel van Roozendael from BIRA (with support by Andreas Richter from the University of Bremen and EUMETSAT) should be noted here. The observed “scatter” in minor trace-gas slant-column density values derived from channel 2 is due to the signal-to-noise ratio of the instrument for this detector. The latter is in line with the specifications of the instrument. The difference in scatter with respect to GOME-1 from the same spectral region is solely a result of the difference in integration times, i.e. the improved spatial resolution of the instrument.

2.26 Newsletter #13 September/October 2007

New PMD Band data test upload

The on-board band definition parameters for our Polarisation Measurement Devices (PMDs) have to date not reflected the recommendations made by the GSAG in 2004. The original PMD band definitions were being used during on-ground testing and were retained for the In-Orbit Verification (IOV) phase to facilitate before- and after-launch inter-comparisons. In this version of the PMD band definition, the same detector pixels were selected for both PMD P and S since the on-ground spectral co-registration between the two PMDs was originally assumed to be sufficient. However, the GSAG recognised that the spectral co-registration of the PMD P and PMD S band measurements (and therefore the quality of the derived Stokes fractions) could be improved by selecting different pixels for PMD P and PMD S with the aim of optimising the spectral overlap between the two. This was reflected in the updated PMD band definitions endorsed in 2004. During orbit 5026 and 5037 of 8-9 October we carried out a test upload of the new PMD band definitions endorsed by GSAG with very small modifications added by EUMETSAT (the latter necessary for purely technical reasons related to the on-board software). The new band definitions for PMD-P and S can be found here.



The plot shows the old PMD band data for S and P in comparison to FPA data (upper panel) and the new PMD data taken during the test phase (lower panel). Most notably for the new

PMD band data the differences between S and P are now much smaller. The quality of the Stokes fractions has been further improved by employing a spectral interpolation scheme for the PMD band measurements used for calculation of Stokes fractions. The interpolation takes the remaining differences in spectral co-registration into account.

Note also that recent studies have revealed that the spectral calibration for PMD-S is less stable than that for PMD-P. Any remaining differences in the relative positions of the bands can therefore be referred to the latter and will be removed with the mentioned interpolation scheme. This scheme will also be applied during reprocessing of the old PMD band data. First tests have shown that this will significantly improve the quality of the default Stokes fractions.

The test upload has therefore successfully demonstrated a significant improvement in the overall quality of the level 1b data products after introducing the new band definitions. Following the successful adaptation of the operational retrieval algorithms from the O3MSAF to the new data, the date for the final upload of the new definitions will be issued soon.

"Pre-operational" status for GOME 1b data

During October 2007, approximately one year after launch, GOME level 1b data have been granted "pre-operational" status by the EUMETSAT internal Product Validation Board (PVB). The board has also identified four major outstanding issues before granting the "operational" status:

1) Fixing the problem with on-board temporal co-adding in channel 3 avoiding saturation effects (software patch will be provided by the Single Space Segment Team (SSST) in January 2008).

2) Further improvement of key data in the overlap regions between channel 1 and 2 as well as between 2 and 3 (An upgrade will be available by the end of November 2007).

3) Final upload of the PMD band data definitions scheduled for November 2007 (see above).

4) Characterisation of the degradation of the instrument including phase A of level 1b-Rev1 data reprocessing (November to February 2008; see below).

Upon solution of these issues GOME-2 level 1b data will be re-evaluated for upgrade to "operational" status by the PVB.

Further improvements in level 1b data quality

Obviously, the work on improving level 1b data quality will be ongoing and is considered a continuous task of the EUMETSAT GOME-2 CalVal team, as well as the supporting scientific groups via the O3MSAF and the RAO consortia. Outstanding issues include (amongst others) the reported scatter in some level 2 products involving retrievals from channel 2. Various tests at EUMETSAT and independent investigations at IFE, Bremen, by Andreas Richter and his team, as well as by DLR, suggest that the polarisation correction is an unlikely candidate for this problem. We are now also considering that the scatter may be inherent in the level 0 data. The investigation is ongoing. The source of residual scan angle-dependent variations reported in some level two products is also under investigation.

Spurious jumps between band 1B and band 2 around 312 nm could however have been identified as being related to the singularity cut-off in the correction of the “U” Stokes fraction polarisation contribution at high latitudes and/or large viewing angles. Since the related key data for the “zeta” parameter also lacks a viewing angle component, further improvements on the implementation of this correction will be considered in the future. The amount of data affected is however very small.

Characterisation of instrument degradation and reprocessing of level 1b data

The characterisation of instrument degradation with an additional focus on the observed differential degradation between PMD-S and P and significant changes in the patterns following instrument switch-offs, is currently investigated in close collaboration with SRON, the Netherlands, in the framework of a dedicated study. The reprocessing of the current GOME-2 level 1b data starting with the first sun measurement taken in December 2006 is a prerequisite for carrying out this task. The reprocessing of data resulting in revision 1 of GOME-2 level 1b data will consist of two phases A and B. Phase A reprocessing starting in November 2007 will remove any spurious jumps due to changes in processor and auxiliary data versions. Results from Phase A will be available only internally at EUMETSAT and on request for selected orbits. Data from Phase A will lead to a first characterisation of the instrument degradation. The application of the derived degradation correction parameters is then targeted for Phase B of the reprocessing currently scheduled for the beginning of January 2008. Revision 1 of GOME-2 level 1b data will subsequently be made available via the UMARF to all users following an internal evaluation of the reprocessed data set.

2.27 Newsletter #12 July/August 2007

During the summer, progress has been made on identifying problems in the level 0 to 1b processing related to key data usage and deficiency. The main issue identified was an erroneous reading of the angle dependence of the polarisation sensitivity and the radiance response functions called kappa and chi. The dependencies have been measured for viewing angles between -50 and 85 degrees to cover both Earth viewing geometries as well as Moon calibrations. Unfortunately the columns of these two key data parameters have been read in reversed order, i.e. from 85 to -50 degrees, introducing an asymmetric scan angle-dependent offset to the Mueller Matrix Elements M1, mu2 and M1_S/M1_P (see also the Product Generation Specification 6.1, Section 5.2.3). The effect of this error is to introduce offsets in the L1b calibrated radiances for main channels ranging between 0 to 5% or more depending on scan angle position and wavelength. The largest offsets can be expected in the eastern part of the scan but the size of the error will also depend on the polarisation state of the incoming light. The problem has been fixed with the new processor version 3.4.0, which is currently tested and expected to be released on 3 September on Ground Segment 1 for dissemination via EUMETCast.

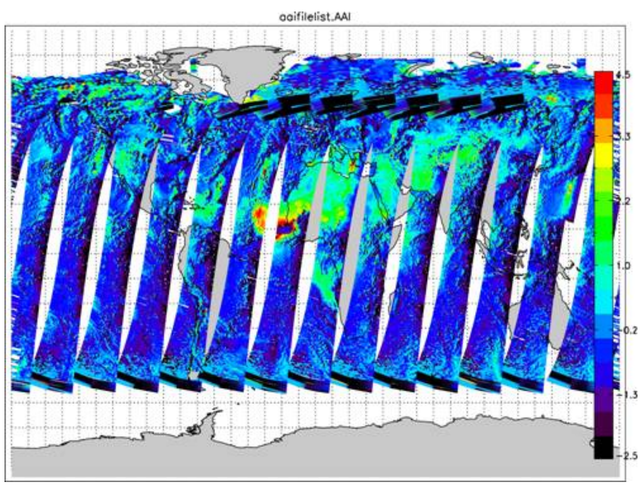
Further issues identified are occasional jumps between Band 1b and 2b occurring at positions where the single-scattering q-fraction falls below a defined limit of 0.05, which is the cut-off for the singularity point of the U_ss over Q_ss ratio. The latter is used to scale the polarisation sensitivity zeta (mu3) of the instrument detector in the equation applying the polarisation correction. In order to prevent the U_ss over Q_ss ratio increasing to infinity for certain geometries where Q_ss gets very small, it is set to 0 below the above-mentioned limit (see also Product Generation Specification 6.1, Section 5.3.12). Since zeta itself is strongly depending on wavelength around the region of Band 1b and 2b, the cut-off introduces the occasional jumps observed by some users. The single-scattering Stokes fractions are derived from geometric considerations only and the locations of these jumps are therefore SZA dependent, i.e. they change with seasons and are restricted to a small number at specific latitudinal bands.

We are currently still working with ESA-SSST on an upgrade of the channel overlap regions, both for channel 1 to 2 and channel 2 to 3. The overlap regions have improved following an earlier update of the key data received in March 2007, but still require further improvements. For example, the region between 310 and 314 nm can be affected since the 50% point of the current overlap is at 311.46. For retrievals employing both level 1b and 2b values, an extension of Band level 1b beyond the 50% point should be avoided until a further improvement of the radiometric response key data in this region is available.

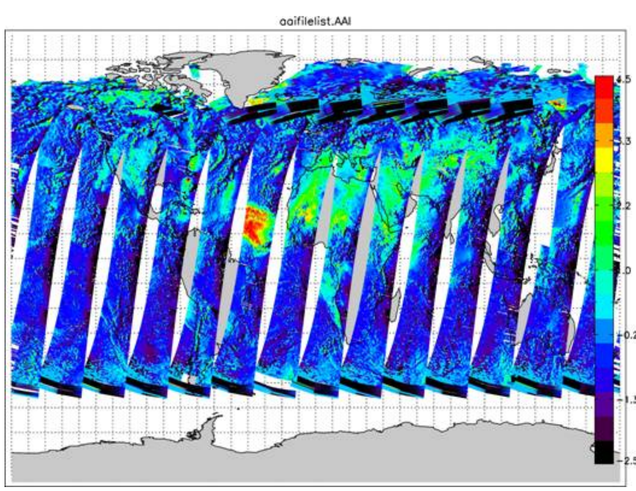
We also want to note that the current PMD Band definitions are set to their pre-flight and In-Orbit Verification (IOV) values and will be upgraded to the values suggested by the GSAG soon. This also holds for the GSAG’s suggestion of reducing the frequency of the scheduling of narrow swath orbits, currently performed three times per month for one day, to once per month for one day at orbit cycle day 15. The timing of the updates of both will be announced via the UNS message system as well as on our EXTRANET pages, along with an updated timeline planning schedule in the operations sections on these pages.

We are happy to announce the final presentation on the FRESCO-GOME2 project, “Additions to EPS/Metop RAO project #3060”. The study has been carried out by Ping Wang and Piet Stammes with EUMETSAT support. The results are summarised in the GOME-2 FRESCO final report summary and the GOME-2 FRESCO final report available on these pages under Publications and Documents. The FRESCO cloud parameters reported in the GOME-2 level 1b product are found to be already of very high quality. The comparisons between online processed results and results produced offline at the KNMI reveal very small differences of which nearly all of the remaining issues have been solved with processor version 3.4.0. Differences between SCIAMACHY and GOME-2 cloud data from FRESCO are also small with a correlation of 87% in cloud fraction as well as in cloud top pressure and a small offset of 0.05 and -31 hPa respectively due to systematic differences in SZA, since SCIAMACHY flies 30 minutes behind GOME-2.

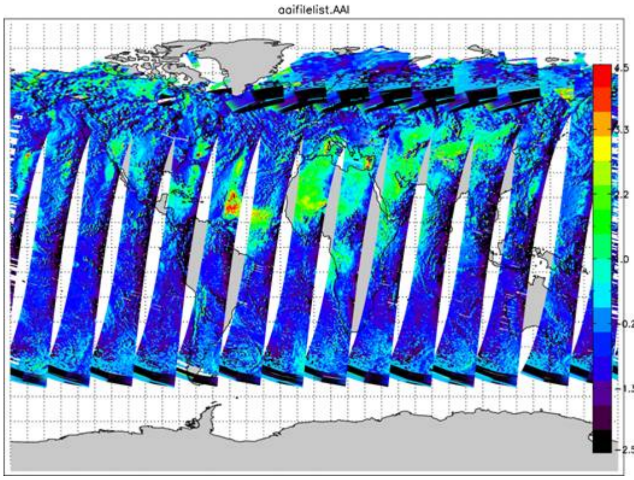
Finally, the plots shows a Sahara dust plume evolving over the Atlantic Ocean during 22, 23 and 24 June 2007 as observed by GOME-2. The plot has been provided by Olaf Tuinder, KNMI, the Netherlands in the framework of preliminary O3MSAF Aerosol Absorption Index (AAI) retrievals.



Sahara dust plume as seen on 22.06.2007.



Sahara dust plume as seen on 23.06.2007.



Sahara dust plume as seen on 24.06.2007.

2.28 Newsletter #11 June 2007

During the last two months we did not experience any major operational incidents on a satellite or instrument level. Instead investigations have turned to the resolution of still open anomalies (see also Newsletter #8 February 2007). These are related to the issue of inconsistencies between channels 2 and 3 in their overlap region (see newsletter #8) which is not yet fully resolved, the occasional saturations occurring in channel 3 over very bright surfaces (tropical clouds, etc.), and issues concerning the calibration of the PMD data.

We are already planning for an update of the on-board software provided by the instrument manufacturer Galileo Avionica in collaboration with ESA, to resolve the issue on saturation in channel 3 by introducing co-adding in the temporal domain. The exact date for the update is still to be confirmed and will be announced in due time via the User Notification Service (UNS). On the occasion of this software update there will be an interruption in the GOME-2 level 1 data flow. The exact times will also be announced via UNS. Since the channel overlap issues only affect a very small portion of the spectrum, we currently give priority to the investigations on PMD data. Please also note that there is a problem in the current version 3.3.3 of the level 0 to 1 processor concerning the calibration of the monthly PMD raw earthshine data (monthly PMDRAW timeline), which will be resolved with one of the next processor versions.

Finally, we would like to announce the next moon calibration opportunity coming up, which is scheduled to start on 6 July 2007 at 01:35:29 UTC and end 6 July 2007 at 18:33:11 UTC. Note that for these orbits the nominal NOT1920 timeline is issued at the day-side of the orbit. Also the daily CAL0 calibration is preserved.

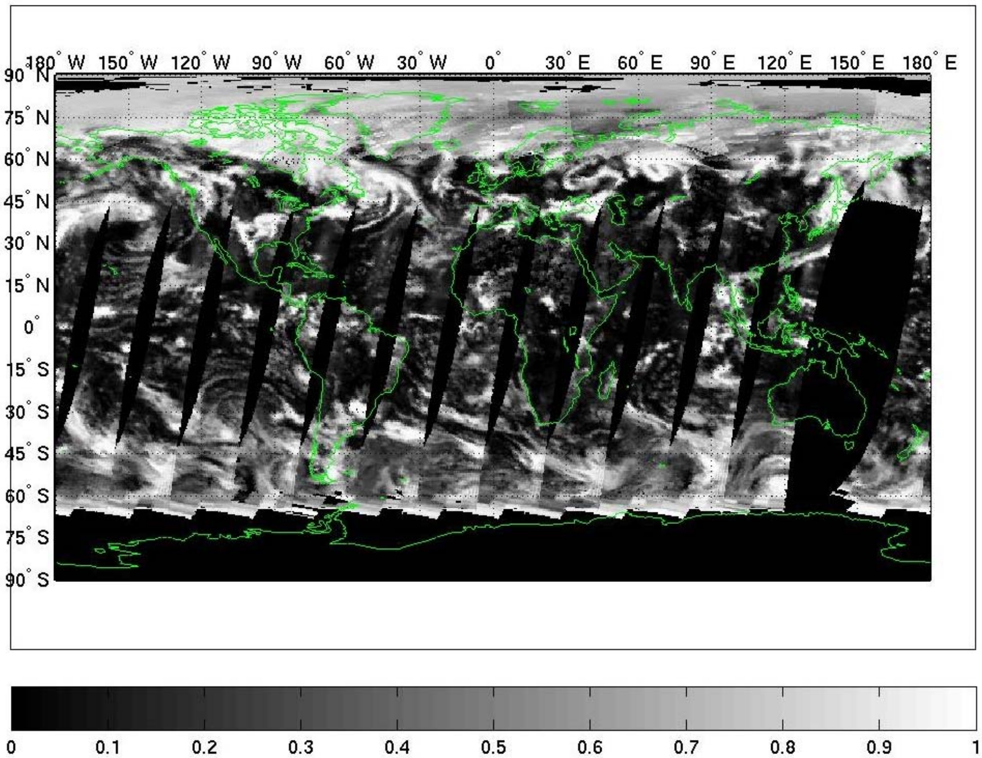
2.29 Newsletter #10 April/May 2007

On the evening of Friday 20 April around 20:00 MESZ, we encountered the second incident of a complete payload switch-off (PLSOL) triggered by the central on-board computer. The root cause of the problem was identified as a software problem leading to an erroneous memory access for specific command execution sequences. The problem is well understood and measures have been taken to prevent re-occurrence. The incident led to an interruption of data dissemination of one week. GOME dissemination was resumed on Friday 27 April at 15:00 UTC after the instrument reached thermal stability and we were able to successfully acquire the daily calibration and solar measurements. The last Metop instrument, IASI, resumed its level 1c dissemination the following Monday so that we were able to limit the impact of the PLSOL to a little more than a week of non-nominal satellite and instrument operations.

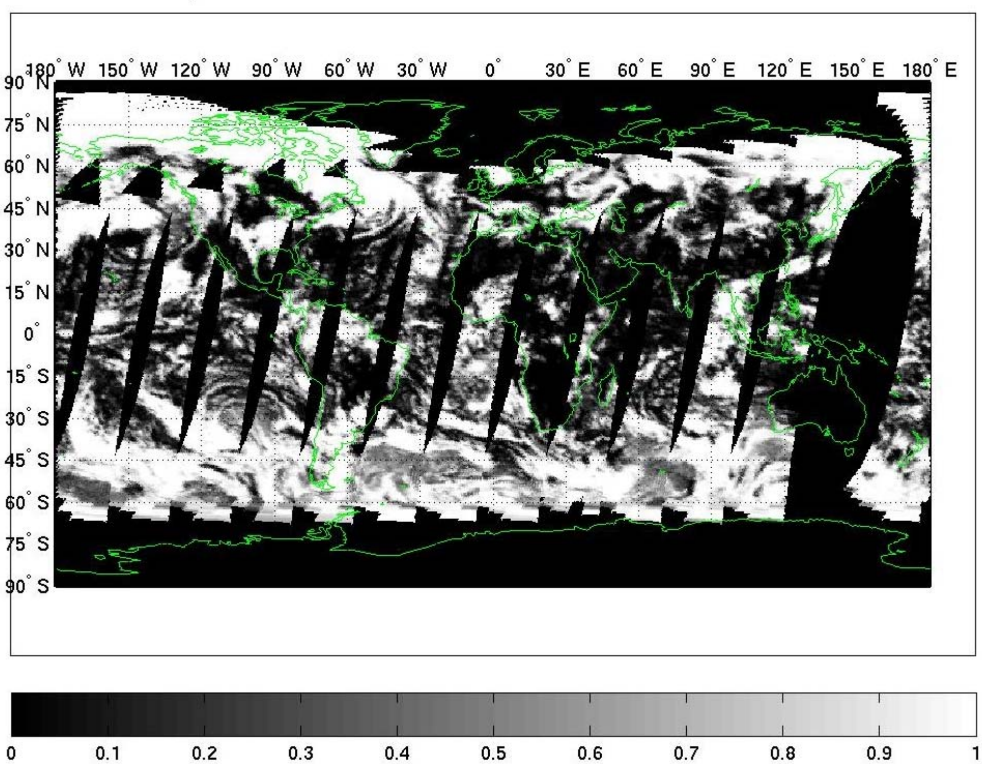
GOME-2 level 0 to 1b processor version 3.3.0 has been installed on our core ground segment number one (from which data are disseminated via EUMETCast) on 3 April, as already announced in Newsletter #9. This version has been updated with minor patch levels 3.3.1 and 3.3.2 on 12 April and 4 May, respectively. Version 3.3.1 resolved an issue with negative radiances occurring at the beginning of Band 1a and only within the SAA due to an erroneous SAA-related dark signal subtraction. 3.3.1 also fixed the issue of occasionally missing VIADR-SMR records in some PDUs, predominantly occurring at the end of a dump.

More important for the general level 1b quality has been the upgrade to 3.3.2. This version consolidates the FRESCO cloud parameter fitting. The FRESCO part of the PPF code, providing cloud fraction (CFR) and cloud top pressure (CTP) values in the level 1b product, has been improved and stream-lined in collaboration with Ping Wang and Piet Stammes from KNMI, the Netherlands, in the framework of RAO 3060 (see RAO section) and the GOME-2 FRESCO study. The GOME2 PPF FRESCO output is now confirmed to be similar within computational accuracy limits to the offline FRESCO fitting results performed at KNMI. The figure immediately below shows a complete day of GOME-2 cloud fraction values from the Level 1b product in comparison to GOME-2 equivalent CFR derived from AVHRR (following figure).

GOME2 CFR from L1B/FRESCO 20070502010259 to 20070502230859



GOME2 equiv. CFR from AVHRR L1B 20070502010259 to 20070502230859



The correlations between both have been evaluated to be better than 80% (Pearson's r-square value) with a systematic offset of 30% to higher AVHRR values as visible from comparing both plots. Higher AVHRR equivalent CFR values can however be expected because of the thresholding technique employed for AVHRR cloud masks. During the current CalVal phase of GOME2 level 0 to 1b processing more rigorous validation of the cloud products will be carried out at KNMI and at EUMETSAT.

Finally, the FRESCO transmission and LER database values have been upgraded on 16 May at 14:00 UTC. At the same time the specification of new Fourier coefficients for the ETALON correction of the PMD helped to improve the calibrated output.

Note that we have put a new section on the GOME-2 Products Database called Processor Change History where you will find the evolution history of the GOME2 level 0 to 1b processor and updates of auxiliary data affecting the level 1b data quality.

2.30 Newsletter #9 March 2007

On 1 March 2007, GOME-2 level 1b near real-time data dissemination started via EUMETCast-Europe in the framework of our commissioning activities. At the same time GOME-2 level 0, 1a and 1b data also became available to users from the EUMETSAT Archive. For up-to-date information on the product quality please click here. Unfortunately, only one day later, on Friday 2 March 20:00 UTC, the GOME-2 operations were suspended. The problem was related to transmission of housekeeping data from GOME-2 to the Payload Module Computer (PMC). The PMC recorded some errors in this communication and subsequently suspended the GOME-2 computer.

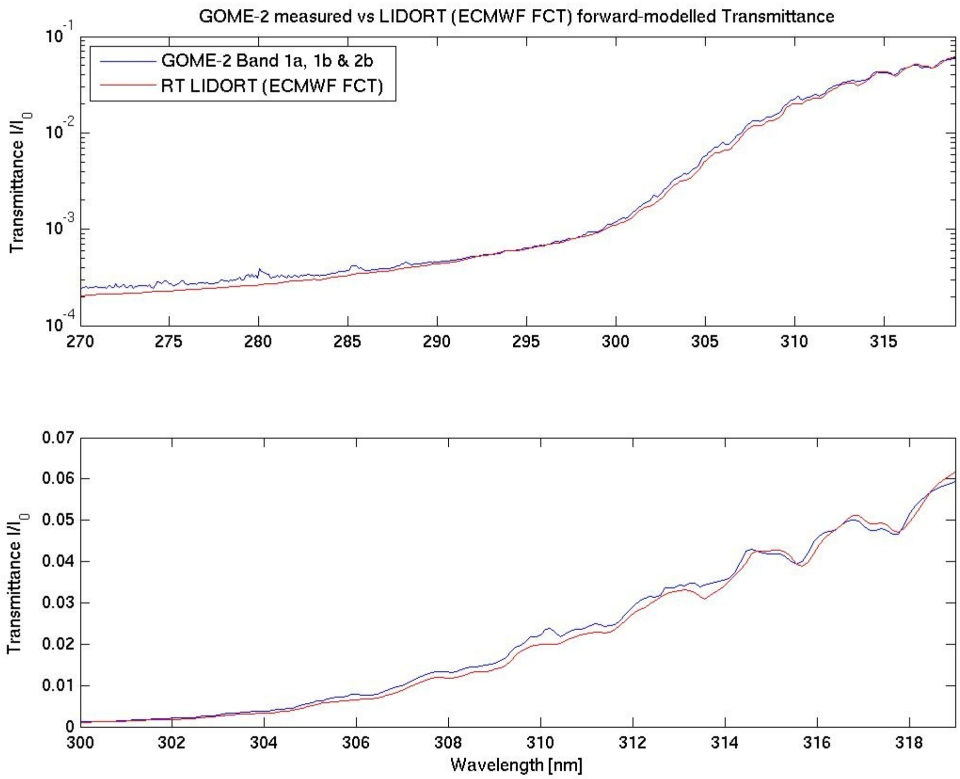
After a thorough investigation of the anomaly by EUMETSAT, ESA and Industry, GOME-2 was switched on again on the afternoon of the 5 March with coolers off. The instrument subsequently warmed up, heating to thermal stability in a so-called warm dark calibration mode. Nominal instrument timeline operations were resumed the following day for the “warm instrument” for collection of additional data for throughput monitoring. The coolers were turned on again on 7 March and data dissemination resumed, as announced, on 8 March following a thorough investigation of the level 1b data calibration quality, which is back to the levels from the time before the anomaly occurred.

For short-term information on anomalies involving interruption of the nominal data flow, we would like to refer to the EUMETSAT User Notification Service (UNS) and to the Operations section. For NRT EUMETCast users the UNS message service is also very helpful in identifying losses in transmission of the product dissemination units (3 minutes PDUs as transmitted by EUMETCast) which are reported on these pages. The losses announced are based on PDU reception at our local EUMETCast reference station in Darmstadt. Losses because of local weather conditions at the reception station can therefore not be taken into account.

Recently we received an update of the instrument key data regarding the open anomaly for channel overlap regions 1 to 2 and 2 to 3 (see February Newsletter #8 on “Status of instrument and processing quality”, issue 1) from TNO/TPD, which might be followed by an additional update later on. The result is a significant improvement in the channel overlap regions for sun measurement and a reasonable improvement in the earthshine data. The key data will be installed with the new processor version 3.3.0 in week 13 or 14. The latter will be announced via the UNS.

We would also like to announce an updated Product Format Specification version (7.2; see Publications and Documents) with minor changes to the format of level 1a and level 1b files. The most important issues are changes in the format of some of the cloud quality parameters and the provision of sun PMD band measurements in addition to the raw (high-spectral resolution) band read-outs as currently written to the sun mean reference spectrum (SMR) in the VIADR-SMR subclass. The corresponding PMD band values can be found in the first fifteen elements of the PMD channel vectors for S and P. For a detailed summary of all changes we refer to the version history of the document in the Annex of PFS 7.2 and additional changes marked in red.

On 20 March we had a short interruption in the EUMETCast dissemination of both level 0 and 1b PDUs. The reason was the on-board maintenance of the scan mirror unit (SU), for which a not-unexpected degradation in the performance has been detected since launch. A special timeline has been executed during visibility at the 9:12 UTC Svalbard pass to put the SU in full rotation in order to evenly distribute the lubricants. The operation was successful, even though the significantly improved performance is not yet at "launch" levels. It is now under consideration to perform this "cleaning" operation on a regular basis outside visibility in order to maintain the best possible performance of the SU.



Finally, the figure above shows a comparison between LIDORT forward modelling results employing ECMWF temperature, pressure and ozone profiles and a GOME co-located transmission measurement comprising data from three bands 1a, 1b and 2b.

2.31 Newsletter #8 February 2007

We are pleased to announce from 1 March 2007 the start of GOME Level 1 product dissemination on EUMETCast-Europe. These data are available via EUMETCast PID 510; EUMETCast Data Channel EPS-5.

Those EUMETSAT Member and Cooperating States registered for the pre-launch trial will be provided automatic access to the commissioning data via EUMETCast. If your NMS is not registered for these data and would like to receive them, please send an email to ops@eumetsat.int indicating the EUMETCast username(s) to be activated. Other users will be given access following completion of the licensing process. Additionally, these data can be ordered via the Online Archive Ordering service.

Access to Data During Commissioning

Users should note that until the entry into operational service, priority is given to commissioning activities. The early access to EPS data is therefore provided on a best effort basis, without full service commitment. This implies that schedule changes might occur at any time and that dissemination might be interrupted due to other commissioning activities. Data delivered during commissioning are not considered to be validated data. The data disseminated via EUMETCast will be access controlled.

Disclaimer - Status of instrument and processing quality (February 2007)

A full assessment of the quality of the calibration has yet to be completed, so while the calibration data are believed to be acceptable for this stage of commissioning, no guarantee of quality can be given. Some notable points are:

1) Radiometrically calibrated earth, sun and moon spectra show a clear jump between channels two and three. This can be explained by a spectral shift in the channel overlap region due to a physical shift of the channel separator prism since the on-ground characterisation was carried out. The effect is much less prominent in the reflectance spectra. During the remaining In-Orbit Verification activities, a correction to the calibration key data will be derived. This is not yet available so data in these spectral regions should be used with caution.

2) All polarisation products must be regarded as preliminary. These products are as yet unvalidated. In particular an offset between PMD-p and PMD-s radiometrically calibrated sun spectra is observed. This is currently under investigation but may arise from minor spectral misregistration between PMD-p and PMD-s. This will affect the quality of the polarisation correction in this data and will be further analysed.

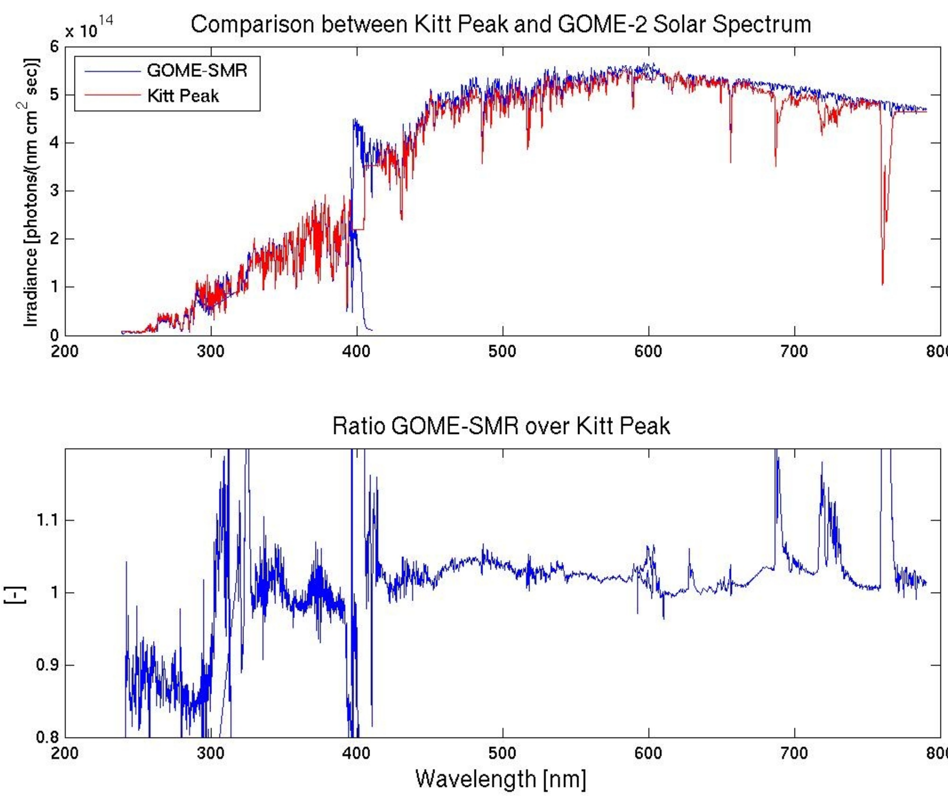
3) About 6.5% of channel 3 scans are flagged as saturated, especially in the tropical region over deep-convective, optically-thick cloud-tops. Note that flagging at the level of individual read-outs was not envisaged as this situation is non-nominal, so flags only indicate that at least one read-out in the scan may be affected. This situation has temporarily been resolved by halving the integration time in channel 3 to 93.75 ms and co-adding read-outs on board to an effective integration time of the nominal 187.5 ms. However, due to a feature of the co-adding synchronisation in the on-board software of the instrument, the two co-added read-

outs are not those corresponding to the original 187.5 ms read-out, but are offset by one read-out. As a result when co-adding is implemented, although saturation is eliminated, channel 3 and channels 2 and 4 see different ground scenes, clearly visible as a discontinuity between the channels for inhomogeneous scenes. As a consequence, the co-adding was turned off on Tuesday 6 February and the integration time returned to 187.5ms. Channels 2, 3 and 4 once again see the same ground scene but saturation in channel 3 remains a problem. A solution to this problem is currently under investigation but is expected to take several months as it will involve changes to the on-board software of the instrument. Until this time the problem of saturation in channel 3 will persist.

4) Loss in instrument throughput since launch, believed to be due to ice/contaminant build-up on the optical elements and/or detectors, has been observed and is currently under investigation.

2.32 Newsletter #7 January 2007

I) First Solar Measurement Taken on 22 December



On 22 December GOME-2 made its first solar measurement. The plot shows a comparison between the Solar Mean Reference (SMR) spectrum as seen by GOME-2 and a solar spectrum taken at the Kitt Peak observatory (Hawaii, 4000 m) convolved with the GOME-2 instrument slit-function. As shown, the differences between GOME-2 and Kitt Peak calibrated radiances are currently below 5% with the exception of channel 1 and the transition between channel 2 and 3 (see below).

II) Instrument and Processing Quality Evaluation Status

An intense phase of GOME-2 instrument In-Orbit Verification (GIOV) activities and level 0 to 1 processing investigations (with a strong focus on instrument performance) followed the sun acquisition. One of the important outputs of the GIOV activities during this phase has been the modification and fine-tuning of the instrument on-board timelines and timeline-sequence to optimise integration times and the scheduling of in-flight calibration measurements for routine operations. On 31 January GOME-2 successfully passed the technical instrument review which released the instrument for routine operations. In addition the general status of the instrument and its performance, as well as any instrument-related open issues, were discussed. In parallel with the GIOV activities, which have been carried out under the lead of ESA/SSST, the EUMETSAT GOME-2 Product Processing Facility (PPF) has been significantly improved. The most important tasks carried out were the fine-tuning of the initialisation parameters and limits governing the generation of in-flight calibration corrections, confirming that the new timelines ensure optimal level 0 to 1 processing for all calibration steps, and the removal of bugs from the code. The investigations and operational activities and evaluations are currently ongoing.

III) The GOME-2 Database and New Operational Services for our Users

All tasks on processing quality are carried out at EUMETSAT through a detailed evaluation of the current data stream offline, by evaluating individual calibration steps for all operational modes via a bottom-up approach, and also by making use of our instrument and processing database, already holding more than 80 GB of instrument and processing key-parameter records. This GOME-2 database will serve now and in the future together with the UMARF and the CalVal Local Data Store (CVF-LDS), as the core repository for GOME-2 performance evaluations (both instrument and processing) in the EUMETSAT Calibration and Validation Facility (CVF). It also provides detailed information for all users on the current and past status of GOME-2 data via our newly populated operations page (left-side link). There you will find information on the scheduling of the routine timelines for the operational measurement modes, as well as a link to our GOME2 webserver providing summary information on the product quality and instrument status, including daily level 1 and per-orbit level 0 reports. The daily reports also hold quick-look images of O_3 total column (line-ratio approach) and false-colour PMD images among others, together with summaries of all calibration measurements carried out that day.

Note, however, that during the commissioning period, there might be gaps in the data and reports, as well as delays in the reporting, since the system is still continuously being upgraded. Occasional downtime of the system is therefore to be expected! For the time of commissioning, reports on very recent data must also be regarded with caution because, depending on processing and system status, as well as planned changes in operations and processing, short-term reprocessing of reports might be necessary!

IV) Known Instrument and Processing Issues Affecting Current Product Quality

Note that a full assessment of the quality of the calibration and processing has yet to be completed. The current open known issues are therefore predominantly related to the instrument. Other minor issues are not listed here.

1) Radiometrically calibrated earth, sun and moon spectra show a clear jump between channels two and three. This can be explained by a spectral shift in the channel overlap region due to a physical shift of the channel separator prism (or of the incoming beam relative to the channel separator prism) since the on-ground characterisation was carried out. The effect is much less prominent in the reflectance spectra. During the remaining In-Orbit Verification activities, a correction to the calibration key data will be derived. This is expected to be available by the end of February, so until then data in these spectral regions should be used with caution.

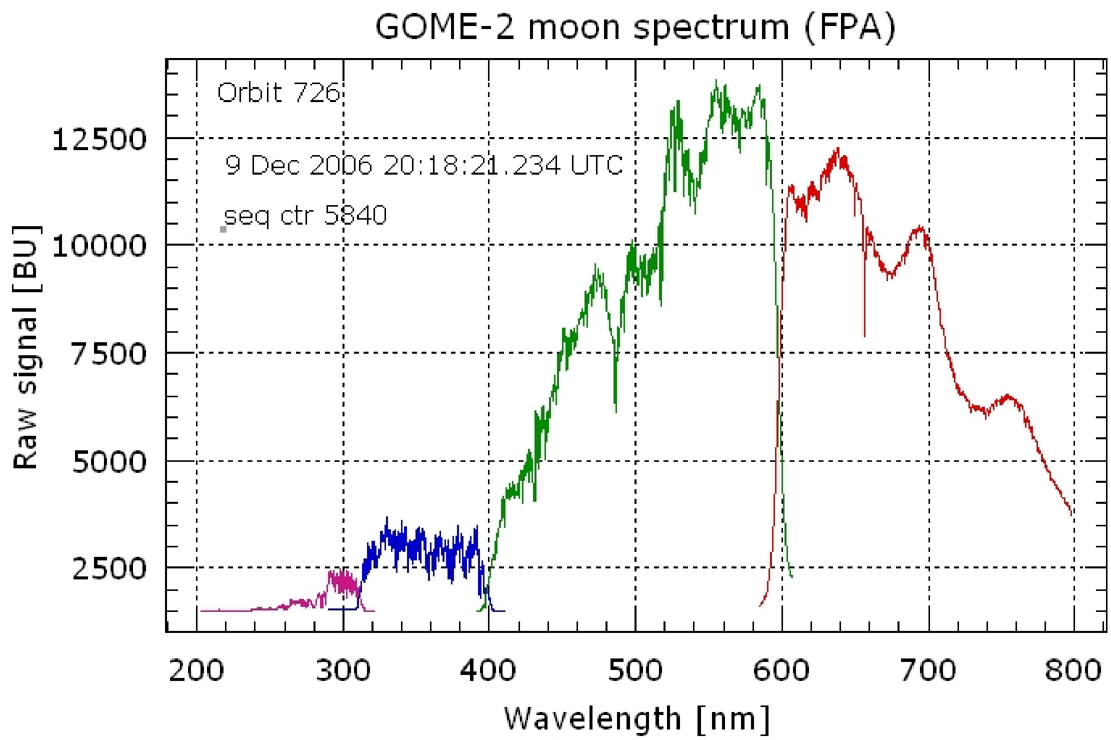
2) An offset between PMD-p and PMD-s radiometrically-calibrated sun spectra is observed. This is currently under investigation but may arise from minor spectral misregistration

between PMD-p and PMD-s. This currently affects the quality of the polarisation correction and will be further analysed.

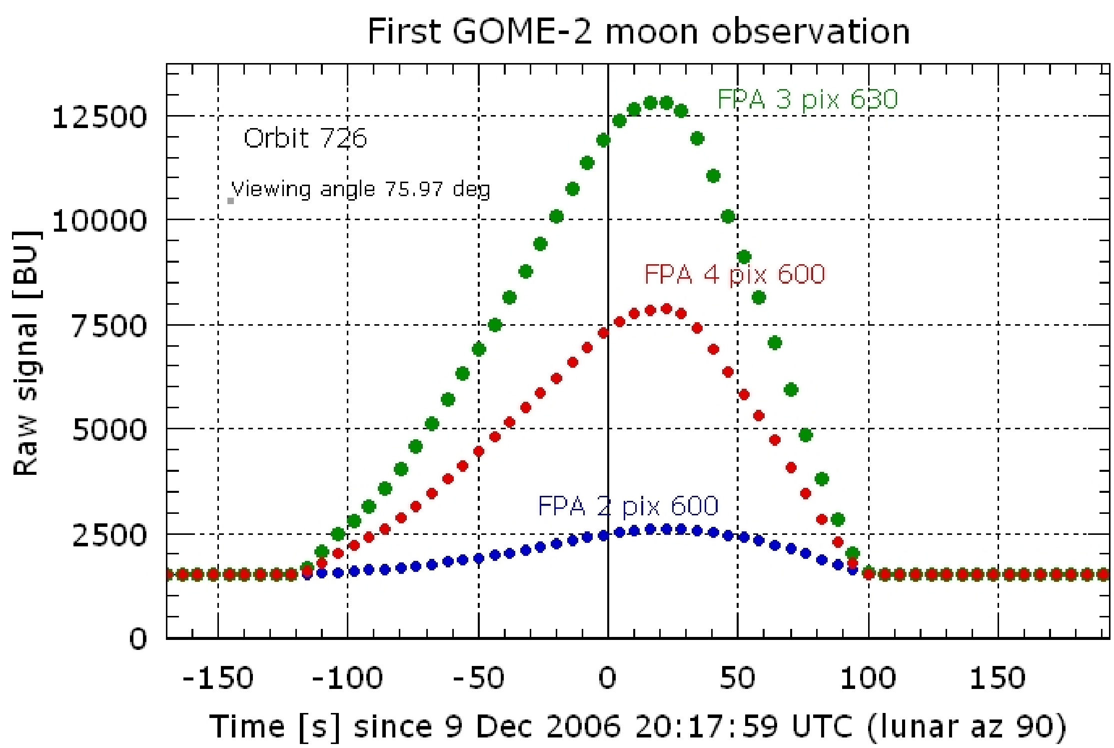
3) About 6.5% of channel 3 scans are flagged as saturated, especially in the tropical region over deep-convective, optically-thick cloud-tops. Note that flagging at the level of individual read-outs was not envisaged as this situation is non-nominal, so flags only indicate that at least one read-out in the scan may be affected. This situation has temporarily been resolved by halving the integration time in channel 3 to 93.75 ms and co-adding read-outs on board to an effective integration time of the nominal 187.5 ms. However, due to a feature of the co-adding synchronisation in the on-board software of the instrument, the two co-added read-outs are not those corresponding to the original 187.5 ms read-out, but are offset by one read-out. As a result channel 3 and channels 2 and 4 see different ground scenes when co-adding is implemented, clearly visible as a discontinuity between the channels for inhomogeneous scenes. As a consequence, the co-adding was turned off on Tuesday 6 February and the integration time returned to 187.5 ms. A solution to this problem is currently under investigation but is expected to take several months as it will involve changes to the on-board software of the instrument. Until this time the problem of saturation in channel 3 will persist.

2.33 Newsletter #6 December 2006

The GOME-2 IOV activities are progressing well. The coolers were activated on 5 December and the target operational temperature reached. Phase 3 of the IOV activities is ongoing with full performance testing underway. This will allow a gradual accumulation of in-flight calibration measurements representative of the nominal operational state of the instrument.



Another major achievement of the last weekend was the acquisition of the first moon spectrum, which was successfully acquired with no problems. The images, prepared by Michael Eisinger (SSST ESA/ESTEC), show the first GOME-2 moon spectrum (above) and the passage of the moon as observed by GOME-2. Note that as it is not a full moon the maximum signal is not necessarily expected at azimuth 90 degrees.

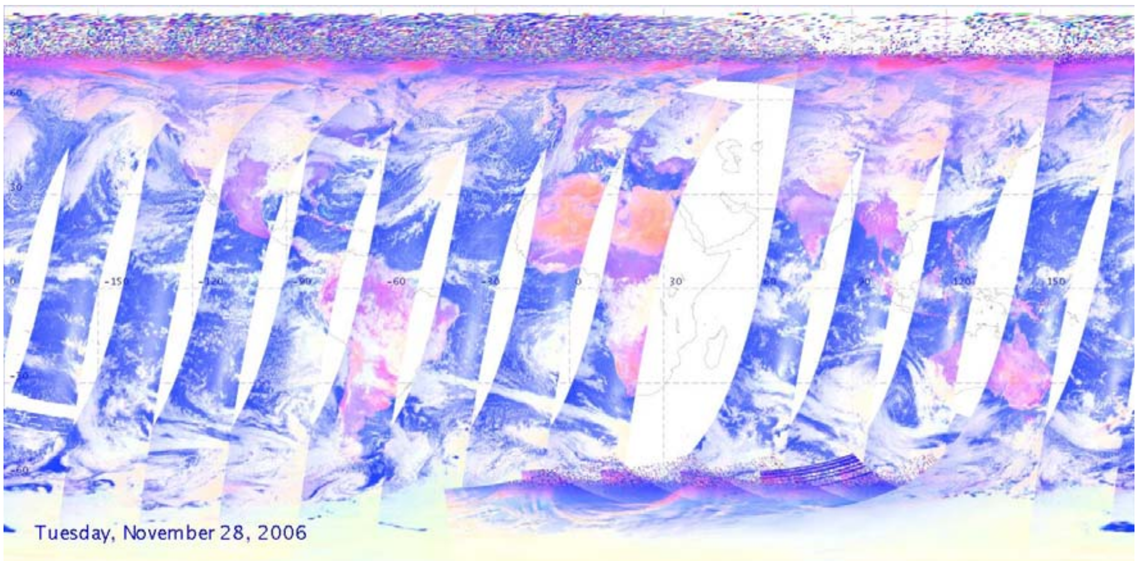


The next major milestone will be the acquisition of the first sun spectrum around the 20th of December.

2.34 Newsletter #5 November 2006

Following a revision of the Metop SIOV schedule, the GOME-2 coolers are now expected to be switched on around 5 December with the first solar spectrum acquisition expected around 18 December.

Meanwhile, the GOME2 instrument in-orbit verification phase is proceeding with more functional and performance testing and further analysis of initial earthshine data.



The image shows an uncalibrated false colour image plot from the PMD (Polarisation Measuring Devices) measured on 28 November 2006. The plot shows that the pointing accuracy of the instrument and geolocation of the products is already quite good and demonstrates the large potential of the high spatial resolution (23.4375 ms PMD read-outs roughly correspond to a 40 by 10 km^2 ground pixel size) polarisation measurements. We are now looking forward to execution of further interesting timelines including narrow-swath and static-nadir views. Additionally, gradual acquisition of more representative in-flight calibration data will allow improved calibration of the earthshine data and further exploration of the capabilities of the GOME2 instrument.

2.35 Newsletter #4 November 2006

The first GOME-2 earthshine spectra were acquired on 30 October after completion of the initial instrument functional testing. The plot shows an uncalibrated earthshine spectrum in [BU].

It should be noted that all bands were commanded with the same integration time for this acquisition, which accounts for the very low signal levels in band 1a. These data were successfully processed by the EUMETSAT ground segment with both level 1a and level 1b products being produced. However, accurate calibration of the level 1b data is not yet possible as this requires in-flight calibration data, which will be acquired progressively over the next weeks. Cooler switch-on is currently planned around 19 November, and the first solar spectrum is expected in early December when the shutter operation will be enabled.

2.36 Newsletter #3 October 2006

After a successful launch of Metop on Thursday 19 October and a very smooth handover of the satellite from ESOC to EUMETSAT on Sunday 22 October, we are now looking forward to starting the GOME In-Orbit Verification (GIOV) phase.

GOME-2 instrument switch-on is currently planned for 25 October followed by functional and limited performance testing. Cooler switch-on is expected for around 19 November, after which full performance testing, with the exception of the sun mode, will be carried out. Shutter operations will be allowed from 3 December, enabling full performance testing including the sun mode to be concluded.

Please check the GOME-2 CalVal page for updates on the instrument's performance during the coming weeks of GIOV.

2.37 Newsletter #2 September 2006

We have updated the version of our GOME-2 level 0 to 1 processor from 3.2.2 to 3.2.3 in the EUMETSAT Core Ground Segment. The updated version addresses some minor anomalies including a problem writing auxiliary surface elevation data to the final level 1 products. The problem caused all surface elevation data in the products to be set to “undefined”. This was also the case in test data set (TDS) 3.2.2. We have now updated the test data set using the latest processor version. You will find this new test data set 3.2.3, for use in development of product readers, under Test Data and Tools.

2.38 Newsletter #1 August 2006

Metop status

After three failed attempts to launch Metop from Baikonur 17 - 19 July the launcher has been taken back by Starsem for further investigations and the satellite has been returned to the clean-room and is currently in safe storage, awaiting the restart of the launch campaign. The original launch attempts were called off due to technical reasons related to the Soyuz ground check-out system. More details can be found on the EUMETSAT Internet pages.

The restart of the launch campaign is planned for 29 August, with the arrival of the launch team in Baikonur. Following approximately three weeks of activities on the satellite (mainly related to the solar array), it will be integrated together with the Fregat upper stage. The combined stack will then be encapsulated in the fairing, prior to being integrated with the three-stage Soyuz launcher. Roll-out to the launch pad is scheduled for 3 October, with the launch planned four days later, 7 October.

GOME-2 Processor status

The GOME-2 level 1b processor has been taken out of its frozen configuration mode and put back in evaluation mode for further improvements where and if necessary. In its current status the processor behaves in a very stable manner in the EPS Ground Segment environment (see Mission Control page) and the processing quality has reached the highest level that can be achieved with the current test data configuration. Currently we have only one open anomaly report (AR) with the status low severity and low criticality. (Check on the recent anomaly status of the processor on our EPS CalVal Extranet pages as laid out below.) Further improvements are currently limited by the available test data including data streams involving all ground segment facilities and their performance. Nevertheless we will continue to improve the output of the processor in the course of the coming weeks, particularly with respect to production of monitoring and validation information, used within our Calibration and Validation (CalVal) Facility (CVF) for daily to long-term instrument and processing monitoring and evaluation. The status of the latter and all user-relevant results and information can be found as per today on our Extranet Calibration and Validation pages.

Below you will find some general information on our current data dissemination and storage policy. It is very important that you send any kind of requests that you have concerning GOME-2 data to our local EUMETSAT helpdesk and/or to the generic EUMETSAT gome2-email account. This will help us to support your case internally.

All user-relevant dedicated GOME-2 instrument and processor performance information, as well as helpful documentation, tools and data sets, should be available from our EPS CalVal Extranet pages (including links to the relevant EUMETSAT internet pages).

More links to general sources of information can be found therein or via dedicated routes through the EUMETSAT website as given below. Note that the EPS CalVal Extranet pages are currently still under construction! So please come back from time to time to see how things are evolving. We appreciate any input from your side regarding additional information that would be useful for you to have available via the Web.

Data Dissemination and Storage

GOME-2 level 1 data dissemination plan

The first level 1b data dissemination to dedicated users is now foreseen for early February. Dedicated data for CalVal users who are not equipped with EUMETCast reception stations (see below) or specially prepared test cases will be made available via an ftp link from the EPS CalVal Extranet pages.

General sources of information

For a general overview on Metop and NOAA data (including links to pages where you can retrieve important documents and data handling/reading tools) have a look at the Data and Products pages.

Everything concerning near-real-time dissemination of GOME-2 level 1 data via EUMETCast (and how to set it up) can be found under the EUMETCast pages, and for EUMETSAT Archive Service under Archive Services.

EUMETCast: See also the EUMETCast Dissemination Scheme

Near-Real-Time (NRT) data sets

All NRT users should rely on the EUMETCast system. From EUMETCast you will receive a continuous stream of 3-minute Product Dissemination Units of level 1b data in native EPS format. The PDUs can be concatenated to arbitrary-sized files using the “KAI” and “EUGENE” tools available from our website under Useful Programs & Tools. Currently no level 1a data are sent out via EUMETCast! If you would like to have level 1a data via EUMETCast, please do not hesitate to send requests to the EUMETSAT helpdesk with a copy to gome_calval@eumetsat.int (this will help us to support the case internally).

Full data set

We strongly encourage all non-NRT users who would like to collect the whole GOME-2 data set to also set up a EUMETCast station for this purpose. Such a receiver is very easily installed and low cost. The only requirement is a standard PC with a special TV card and a satellite receiver like those used for TV (see EUMETCast). An additional benefit of this is that users who may also want to have a look at data from other instruments (e.g. IASI) will receive data for both instruments at the same time through EUMETCast on request.

Archive Services

The Archive Services pages contain general information on the EUMETSAT Archive and detailed information on current data for Meteosat/MSG. The retrieval functionality from the Archive for the EPS system will however be in large part the same as for MSG.

Older data sets

For long term storage, data are stored on tapes in the EUMETSAT Archive. Due to data handling and bandwidth issues, you should however avoid high frequencies of requests for historical data from the Archive (i.e. place a few requests for larger sets). You may order any type of historical data for free for the duration of the mission.

EPS CalVal Extranet access policy

For those who do not have access yet to our EPS CalVal Extranet pages or in case you know people who might be interested in joining the EUMETSAT GOME-2 community, please send us an email with a very brief description of your/their work and we will send you a login and password as soon as possible.