

Level 1b Product Quality Readme File

Field:	Contents:	Filled by:
Document title	Quality Readme File for GOMOS Level 1b data version GOMOS/6.01	SPPA Engineer
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Affected data sets	This Readme file applies to all GOM_TRA_1P and GOM_LIM_1P processed with processor version IPF 6.01	SPPA Engineer
Product specification references	<ul style="list-style-type: none"> • Algorithm Theoretical Baseline Document (ATBD): • Product Specification: PO-RS-MDA-GS-2009, Issue 3, Revision K, 28/10/2012 	SPPA Engineer

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- particular O₂ and H₂O
- Automatic DC bias correction: impacts O₃ (cold stars) and all other species
- Update of Cosmic Ray detection and correction algorithm (twilight): impact on all species, but mainly O₂
- SATU missing data correction: impact on all species

Other upgrades:

- Flag consolidation
- Attitude file written to DSD (MPH+SPH consolidation)
- Error due to DC included in the error budget of L1b (error on measured transmission)
- Threshold level of pixel saturation (bright limb) changed (lowered)
- New limb spectra error estimate

1.1.1 Note on re-processed Version 6.01 Level 1b products

A reprocessing campaign has been performed using version 6.01 of the GOMOS processor covering the period from 15th April 2002 to 8th April 2012 (end of mission). The Level 1b re-processed products are identified by the following flags reported in the MPH and in the product name:

MPH Field	Value
Processing stage flag	R
Processing centre	FINPAC ('FIN' in the product name)
Software version	GOMOS/6.01
REF_DOC	PO-RS-MDA-GS-2009 issue 3/K

2. GOMOS Level 1b products

Important information concerning all level 1b transmission and limb background spectra products

Due to an inaccurate PRNU (flat-field) correction and to an existing intra-pixel PRNU, all results concerning spectrometer B1 and B2 have to be used with great care. However for the eight brightest NIR stars (ID=1, 2, 3, 13, 14, 16, 26 and 63) the intra-PRNU correction replaces the nominal PRNU correction on SPB2. Thus the quality of the spectra for SPB2 (H₂O) for these eight stars is much improved.

SPB2 transmission spectra for non bright IR stars should be strictly discarded. SPB1 transmission spectra for all stars and SPB2 transmission spectrum for bright IR stars ((ID=1, 2, 3, 13, 14, 16, 26 and 63) must be used with caution because some residual flat-field fluctuation may be present.

Due to an inaccurate limb correction (estimated central background), results in bright limb illumination conditions have to be used with great care¹. Result in twilight conditions are also affected but to a less extent.

¹ The illumination condition is available in field #16 of the level 1b and limb summary quality GADS: 0 for full dark limb, 1 for bright limb, 2-4 for twilight/straylight illumination conditions

Due to the absence of stray-light correction, results in stray-light have also to be used with care. However the limb correction may act as a stray-light correction².

Sensibility of any single pixel could slightly vary in unpredictable way due to the existence of hot pixels and RTS. Variations may be large but their probability (for a given pixel) is rather small.

At low altitudes and in bright limb condition, it is possible that the instrument tracks a bright object different of the star. This is observable by looking at the variation of the SFA elevation angle (slope discontinuity). In that case, the estimated geolocation of the tangent point is not correct.

Besides light sources outside the atmosphere, such as stars, planets and Sun, the transmission, the reference and the background band spectra are affected by the emission of auroral lights.

The spectral signature of the auroral light has several emission lines located in the UV, visible and near IR. The most intense line is located at 557.7 nm. The spectra are affected by auroral emission in the polar region observations. While aurora are produced at high altitude, they can appear in the spectrum of low tangent altitude GOMOS measurement due to their location somewhere on the line of sight of the measurement.

Between August 25th and October 28th of each year, the second component of the Star S0034 is present in the upper background band. It is never present in the central and lower background bands. Consequently, for the occultation of S0034 during this period:

- the upper background band spectra contain the spectrum of this star second component.

- the estimated central background (ecb) correction is biased: reference star spectrum and transmission spectrum of SPB1 and SPB2 are affected by this biased ecb correction. SPA is not concerned as ecb is not removed for full dark occultation and S0034 is only observed in full dark during this period.

² *Due to the absence of specific stray-light correction, results in stray-light (pcd_illum=3 or 4) have also to be used with care. The estimated central background (ecb) correction acts as a stray-light correction but it is only approximative as it is in principle dedicated to the limb correction and not to the non-limb stray-light signal. Consequently, a small amount of stray-light signal may still contaminate the transmission spectra of all spectrometers, which can be used, but with caution.*

2.1.1 Data Organisation

To simplify the table description and the data storage. All four spectrometer arrays are written in a single vector (see Figure 1).

Several auxiliary index arrays are created in order to locate the spectrometer data in the global arrays, such as:

- $k_{min}(c)$ which contains the index of the first useful sample of CCD array c in the global arrays. This array is stored in the field #1 (Number of points of the spectra) of the Occultation data GADS.
- $k_{max}(c)$ which contains the index of the last useful sample of CCD array c in the global arrays

These arrays can be easily computed from the data stored in the field #1 (Number of points of the spectra) of the Occultation data GADS.

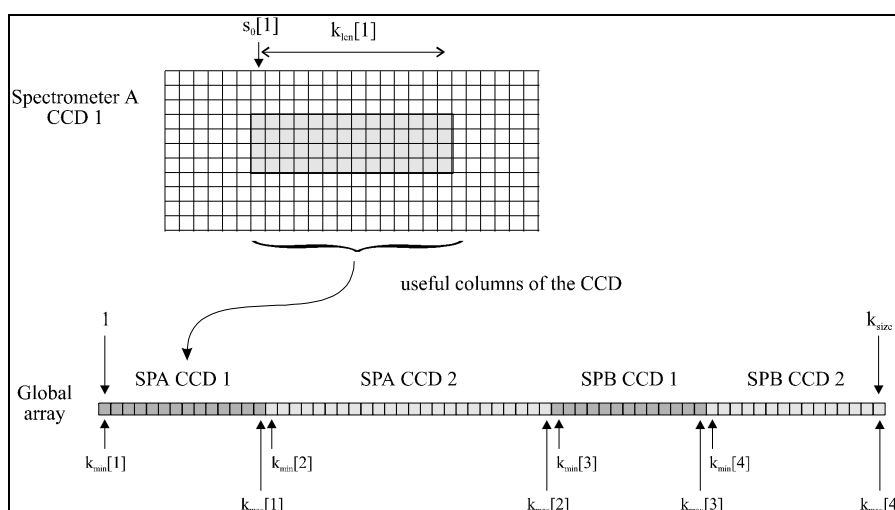


Figure 1: Description of the “ global ” arrays and of the auxiliary index k_{min} and k_{max}

2.2 Transmission Spectra Product (GOM_TRA_1P)

2.2.1 MPH and SPH

- Only products with PRODUCT_ERR=0 (in product MPH) shall be used
- Only products with STAR_ID<1000 (in product SPH) should be used. Others correspond to occultation of planets and should be used only for specific analysis.

2.2.2 Summary Quality GADS

- Only products with “No valid data flag” = 0 shall be used
- Only products with “PCD flag for reference star spectrum computation” = 0 shall be used
- Only products with “PCD indicating that the star spectrum has been read from the stellar spectra database ADF” = 0 shall be used
- Products with “Dark charge correction information” = 21 are of better quality than the others: dark charge map is estimated thanks to a DSA observation during the same orbit than the current occultation.
- Products with “Automatic dark charge bias correction” > 0 are of better quality than the others. The automatic dark charge bias correction intends to remove the residual dark charge due to the poor accuracy of the thermistor coding. This additional correction is

	<p>performed (or not)³ per CCD. The PCD indicates which CCD has been corrected.</p> <ul style="list-style-type: none"> • Products with “Observation illumination condition” = 0 are of better quality than the others due to an inaccurate correction of the sun light in straylight/twilight or bright limb illumination conditions. • Only products with “Ray tracing errors” = 0 shall be used. • Only products with “Geolocation errors” < 1000 shall be used. • Only for spectrometer B and photometers data: Products with “Vignetting correction” > 0 should be used with care as part of the occultation occurred in the pointing azimuth vignetting range (correction is part of the level 1b processing). • In bright, twilight and stray-light illumination conditions (PCD_illum=1, 2, 3, 4) the transmission spectra of SPA and SPB should be (at least partially) corrected from auroral emission signature due to the estimated central background (ecb) correction. • In full dark, only SPB should be (at least partially) corrected as in this illumination condition ecb correction is not applied for SPA. <p>2.2.3 Reference star spectrum GADS</p> <ul style="list-style-type: none"> • The reference star spectrum is impacted by the RTS effects, inaccurate limb correction in twilight/straylight/bright limb conditions. Spectrometer B is also affected by some inaccurate flat-field correction, which can trigger fluctuations in the reference spectrum. A detailed description of the flat-field correction is given in the ATBD document. In particular it is possible to distinguish several cases: <ul style="list-style-type: none"> • Non bright IR / SPB1 : fluctuations are small in SPB1 • Non bright IR / SPB2 : fluctuations are strong in SPB2 • bright IR / SPB1 : fluctuations are small in SPB1 • bright IR / SPB2 : fluctuations are very strong. This specific case is due to the fact that the intraPRNU correction algorithm for bright IR / SPB2 stars doesn't correct the spectral PRNU fluctuations, but only the variations due to vertical displacements in order to improve the transmission. <p>It is recommended to use the reference star spectrum in full dark limb for spectrometer A.</p> • Due to ageing effects, the reference star spectra slightly vary with time. • Only pixels where “Flags for the reference star spectrum” = 0 shall be used <p>2.2.4 Reference atmospheric density profile GADS</p> <ul style="list-style-type: none"> • The profile is derived from the interpolation of the ECMWF (up to about 1 hPa) and MSIS90 profiles (above 1 hPa). <p>2.2.5 Transmission MDS</p> <ul style="list-style-type: none"> • The full transmission spectra are affected by: <ul style="list-style-type: none"> • the RTS effects, • inaccurate limb correction in twilight/straylight/bright limb conditions, • inaccurate flat-field correction (only spectrometer B1 (all stars) and B2 (non bright IR stars)). As for the reference spectra, transmission spectra have as well fluctuations due 	
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³ The auto dark charge correction is applied or not depending on some threshold values in the amount of remaining DC.

	<p>to inaccurate flat-field correction, according to these cases:</p> <ul style="list-style-type: none"> • Non bright IR / SPB1: fluctuations are small in SPB1 • Non bright IR / SPB2: fluctuations are strong in SPB2 • bright IR / SPB1: fluctuations small in SPB1 • bright IR / SPB2: minor residual PRNU fluctuations exist especially at altitude with strong scintillations and for pixels around 942nm. <ul style="list-style-type: none"> • The transmission spectra in full dark limb for spectrometer A have the best quality. • The “Scaled estimated central background” is computed when the occultation is not in full dark limb condition (for spectrometer A) or for any occultation (spectrometer B). • The estimated central background (ecb) is not measured but is estimated from the background signal measured in the upper and lower bands. For limb analysis, the user should use the limb spectra stored in the GOM_LIM_1P product rather than the ecb of the GOM_TRA_1P product. • The photometer signal may be equal to 0 for several integration times (1/1000 s) during the last spectrometer integration time due to the star lost tolerance implemented in the instrument. • Only data where “PCD at sample level (SP)” = 0 shall be used • Only data where “PCD at sample level (FP)” = 0 shall be used <p>2.2.6 SATU data and SFA angles</p> <ul style="list-style-type: none"> • Some SATU data may be equal to 0 during the last spectrometer integration times due to the star lost tolerance implemented in the instrument. • Only for spectrometer B and photometers data: SFA azimuth and elevation angles: only products where the azimuth angle is greater than -5° should be used. An optical vignetting occurs between -10° and -5° and is as much as possible corrected during the level 1b processing. Since the data is corrected, it can be used, but with caution. <p>2.2.7 Auxiliary data ADS</p> <ul style="list-style-type: none"> • Spectral shift of the star spectra: see comments concerning the use of this variable in the chapter dedicated to the Nominal wavelength assignment GADS. • Only measurement where “PCD at measurement level” are all equal to 0 (except field #1, #14 and #16) shall be used • Field #1 of the “PCD at measurement level” shall be equal to 3. • Field #14 of the “PCD at measurement level” indicates the first integration time where the instrument pointing is assumed to be stable enough. This information is taken into account during the processing for the computation of the reference star spectrum. • Field #16 of the “PCD at measurement level” gives the ratio between the averaged upper band signal and the star signal (in %). This is a good indicator of the level of limb signal that should have been corrected by the level 1b processing. Pixels with a value greater than 25% shall be discarded. Note that in case of high mispointing, it appears that this ratio is not equal to 0 even in full dark limb: the upper (or lower) band could measure some part of the star signal. <p>2.2.8 Geolocation ADS</p> <ul style="list-style-type: none"> • Note that when two values are provided for each integration time: 	
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the first one is given at the beginning of the integration time while the second one is provided during the integration time, generally at half measurement (the temporal shift is given by the parameter *Time shift for the ray tracing* written in the Occultation data GADS).

- The “Instrument pointing direction” in azimuth and elevation is a theoretical value computed from the relative position of the satellite and of the star.
- The “Air density at the tangent point”, the “Atmospheric pressure at the tangent point” and the “Air temperature at the ray tracing grid nodes” are interpolated from the ECMWF+MSIS90 profile.

2.3 Background Limb Spectra Product (GOM_LIM_1P)

Limb radiances show a strong stray light contamination at tangent altitudes higher than 40km in bright limb conditions. Below 40km, the stray light contamination still exists but is very small compared to the limb radiance.

The pixel flags should be consulted for possible saturation problems. (reference to the Product spec)

2.3.1 MPH and SPH

- Only products with PRODUCT_ERR=0 (in product MPH) must be used
- Only products with STAR_ID<1000 should be used (in product SPH). Others correspond to occultation of planets and should be used only for specific analysis as the pointing information is not guaranteed.

2.3.2 Summary Quality GADS

- Only products with “No valid data flag” = 0 shall be used.
- Only products with “PCD flag for reference star spectrum computation” = 0 shall be used.
- Only products with “PCD indicating that the star spectrum has been read from the stellar spectra .database ADF” = 0 shall be used.
- Products with “Dark charge correction information” = 21 are of better quality than the other. The dark charge information used during the correction is the best possible one.
- Only products with “Ray tracing errors” = 0 shall be used.
- Only products with “Geolocation errors” < 1000 shall be used.
- Only for spectrometer B and photometers data: Products with “Vignetting correction” > 0 should be used with care as part of the occultation occurred in the pointing azimuth vignetting range (correction is part of the level 1b processing).

2.3.3 Occultation data GADS

- Fields #2, #3 and #4 define a LUT to convert the limb spectra (expressed in electrons in the product) into a physical unit (ph/s/cm²/nm/nsr).

2.3.4 Nominal wavelength assignment GADS

- The “Nominal wavelength assignment of the limb spectra” is identical for all integration times: the mispointing errors have no impact on the limb spectral projection on the CCD array as the limb spectra is an extended light source.

	<p>2.3.5 MDS</p> <ul style="list-style-type: none"> • In the current processing, there is no straylight correction implemented. • Saturation occurs in bright limb conditions. • Note that if the telescope is not in the vignetting azimuth angle range (see Summary Quality GADS), the two limb spectra (fields #3 and #4) are identical. <p>2.3.6 ADS</p> <ul style="list-style-type: none"> • Note that when two values are provided for each integration time: the first one is given at the beginning of the integration time while the second one is provided during the integration time, generally at half measurement (the temporal shift is given by the parameter <i>Time shift for the ray tracing</i> written in the Occultation data GADS). <p>3. Acronyms and Abbreviations</p> <p>ACE/MAESTRO Atmospheric Chemistry Experiment/Measurement of Aerosol Extinction in the Stratosphere and Troposphere Retrieved by Occultation</p> <p>ADF Auxiliary Data File</p> <p>ADS Annotation Data Set</p> <p>CCD Charge Coupled Device</p> <p>DOAS Differential Optical Absorption Spectroscopy</p> <p>DPM Detailed Processing Model</p> <p>ECB Estimated Central Background</p> <p>ECMWF European Centre for Medium-term Weather Forecast</p> <p>FP Fast Photometer</p> <p>GADS Global Annotation Data Set</p> <p>GOMOS Global Ozone Monitoring by Occultation of Stars</p> <p>HALOE HALogen Occultation Experiment</p> <p>HRTF High Resolution Temperature Profile</p> <p>IPF Instrument Processing Facility</p> <p>LUT Look-Up Table</p> <p>MDS Measurement Data Set</p> <p>MPH Main Product Header</p> <p>MSIS90 Mass-Spectrometer-Incoherent-Scatter-1990 atmosphere model</p> <p>NDSC Network for Detection of Stratospheric Changes</p> <p>PCD Product Confidence Data</p> <p>PRNU Pixel Response Non Uniformity</p> <p>RTS Random Telegraphic Signal</p> <p>SATU Star Acquisition and Tracking Unit</p> <p>SFA Steering Front Assembly</p> <p>SP Spectrometer</p> <p>SPH Specific Product Header</p> <p>4. Acknowledgement</p> <p>Input for this readme file came from the GOMOS Quality Working Group which is responsible for the processor development.</p>	
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