S3 Product Notice – OLCI

Mission	S3A & S3B	
Sensor	OLCI	
Product	OL_1_EFR in NRT and NTC OL_1_ERR in NRT and NTC	
Product Notice ID	S3.PN-OLCI-L1.11	EUM/OPS-SEN3/DOC/23/1346532
Issue/Rev Date	26/07/2023	
Version	1.1	
Preparation	This Product Notice was prepared by the Optical Mission Performance Cluster and by ESA and EUMETSAT experts	
Approval	Joint ESA-EUM Mission Management	

Summary

This Product Notice addresses both Sentinel-3A and -3B Ocean and Land Colour Imager (OLCI-A and OLCI-B) Level-1B processing baseline OL__L1_.003.03.00 from ESA deployed on S3B on 18/07/2023 and 25/07/2023 on S3A and OL__L1_.002.25.00 from EUMETSAT. The Notice is applicable to Near Real Time (NRT) and Non-Time Critical (NTC) timeliness.

The Notice describes the current Level-1B status, the processing baseline, the product quality and known limitations for both OLCI-A and OLCI-B.

The major changes concern

- modification in OLCI L1B flag definitions,
- detection and flagging of pixels that include partially saturated spectra,
- update in geometric spatial regridding to improve image continuity between the OLCI cameras,
- routine revision of OLCI geometric calibration,
- routine revision of OLCI radiometric calibration.

The difference between processing baseline OL__L1_.003.03.00 distributed by ESA and OL__L1_.002.25.00 distributed by EUMETSAT is the availability of per-pixel per-band OLCI L1B radiance uncertainty products: the uncertainties are present in OL__L1_.003.03.00 from ESA and are not available in OL__L1_.002.25.00 from EUMETSAT.

 	 	

Processing Baseline	
	S3A and S3B
Processing Baseline	• Processing Baseline: OL__L1_.003.03.00 (ESA) / OL__L1_.002.25.00 (EUM)
IPFs version	• OL_1 IPF version: 06.18
	• PUG version: 03.48

Current Operational Processing Baselines		
IPF	**IPF / PB Version**	**In the operation since**
OL1	06.18 / OL__L1_.003.03.00 (ESA) / OL__L1_.002.25.00 (EUM)	**Land Centres:** S3A: 25/07/2023 S3B: 18/07/2023 **Marine Centre:** S3A/B: to be defined
PUG	03.48	**Land Centres:** S3A: 25/07/2023 S3B: 18/07/2023 **Marine Centre:** S3A/B: to be defined

Status of the Processing Baselines

S3A

The current Processing Baseline for Sentinel-3A OLCI Level-1B products is OL__L1_.003.03.00 for ESA and OL__L1_.002.25.00 for EUMETSAT. The baseline was deployed on 25/07/2023 in the ESA Land Centres.

This Processing Baseline includes the following changes:

1. Detection and flagging of pixels affected by the partial saturation anomaly: some of the OLCI bands are built from several acquired subchannels (also known as microbands), in which case the anomalous saturation over very bright targets can affect only some of these subchannels, referred to as the partial saturation. Due to a weakness in the on-board software, these samples cannot be detected as saturated and appear with an abnormally low radiance relative to other bands of the same spatial pixel and non-saturated neighbours (see the note "OLCI anomalous spectral samples" mentioned in the References hereafter). An algorithm was implemented, based on spectral analysis, which allows identifying the partially saturated samples.
    a. Flag modifications are introduced in Level-1B Quality Flags data set:
        i. A new flag "partially saturated" is added indicating an occurrence of the partial saturation anomaly at, at least, one pixel's band;
        ii. The existing twenty-one 'saturated' flags per band are changed to a single 'saturated' flag that indicates that there is a normal pixel saturation at, at least, one band.
    b. All 'saturated' or 'partially saturated' bands of a pixel are now set to the "no data" value in their respective Level-1B radiance data files (i.e., set to the _FillValue attribute as specified in the NetCDF file). The corresponding uncertainty values, if enabled, are set to "no data" accordingly.
2. The spatial regridding step has been modified to accommodate camera to camera pointing disparities larger than initially expected. The regridding enables spatial continuity between the five OLCI cameras and provides a regularly sampled grid on the ground. The regridding change allows to correct spatial discontinuities at camera interfaces while preserving the per pixel georeferencing data (longitude, latitude and altitude). The consequence of this improvement is that the "frame offset" quantity available in the instrument_data.nc annotation file is now provided in the image grid and varies with time, i.e. with image row.
3. Routine update of the OLCI geometric calibration model.
4. Routine update of the OLCI radiometric calibration model.

The quality status of this processing baseline is as follows:

Geometric Calibration

- OLCI-A geolocation accuracy meets the mission requirements in terms of global RMS value (0.5 pixel according to S3 MRTD, 2011) with a RMS performance below 0.3 pixel. Validation of the Geometric Calibration, using Landsat ground control points on current datasets (20/04/23 to 20/07/2023), prior to the current baseline deployment, shows the following geolocation accuracy per camera:

	Georeferencing Biases (pixels)	
Camera Module	**Across Track**	**Along Track**
1	-0.05	-0.06
2	-0.04	-0.06
3	0.02	-0.13
4	-0.01	-0.08
5	-0.04	0.01

The misregistration at the interfaces of each camera is below 0.1 pixels.

Please note that the current baseline includes an update of the geometric calibration that should further improve the above performances, but their assessment requires more data than available at the time of writing. Actual performances will be published in coming Data Quality Reports, available on-line here: OLCI Data Quality Reports.

Spectral Calibration

- OLCI-A spectral model is based on a combination of pre-launch spectral characterisations and in-flight commissioning calibrations. The model meets the mission requirements (S3 MRTD, 2011), based on in-flight spectral measurements. OLCI-A spectral response information and datasets are provided online (S3 OLCI SRF, 2016).
- The in-flight spectral measurements also show that OLCI-A spectral response has been evolving over time by up to 0.3 nm. Therefore, OLCI spectral evolution should be taken into account for specific applications, particularly those using the O_2-A absorption bands. Further information and user resources to correct for OLCI spectral evolution are described below in the section on 'Known product quality limitations'.

Radiometric Calibration

- Radiometric validation results demonstrate that OLCI-A absolute radiometric calibration has a positive bias of about 2 to 3 percent throughout all bands, with the exception of band Oa21

(1020nm) at about 6 percent, OLCI being too bright. Actions are in place to provide detailed guidance to users about OLCI biases per band. Investigations are also instituted to achieve OLCI radiometric compliancy (2% absolute accuracy for bands ≤ 900 nm, 5% > 900 nm, S3 MRTD, 2011).

- OLCI-A Radiometric Gain Model is based on the set of in-flight radiometric calibrations ending on 30/09/2022. It includes radiometric gain coefficients at a reference date and a long-term evolution model. The set of radiometric gain coefficients used to derive both the Reference Gains and the Evolution Model have been computed using up-to-date geometric and spectral calibration, instrument settings, an upgraded diffuser BRDF model based on in-flight data, and diffuser ageing (browning) correction. The Radiometric Model is continuously monitored against new Radiometric Calibration acquisitions.

Per-pixel uncertainty estimates in ESA processing

- The Level 1b product of radiometric uncertainty for each spatial pixel and spectral channel are now provided in the ESA's OLCI L1 products in specific per channel netCDF files. However, it shall be noted that the uncertainty is coded on a log-scale, currently not decoded by the SNAP viewer. Per-pixel uncertainties are not yet included in EUMETSAT's OLCI L1 products.

S3B

The current Processing Baseline for Sentinel-3B OLCI Level-1B products is OL__L1_.003.03.00 for ESA and OL__L1_.002.25.00 for EUMETSAT. The baseline was deployed on 18/07/2023 in the ESA Land Centres.

This Processing Baseline includes the following changes:

1. Detection and flagging of pixels affected by the partial saturation anomaly: some of the OLCI bands are built from several acquired subchannels (also known as microbands), in which case the anomalous saturation over very bright targets can affect only some of these subchannels, referred to as the partial saturation. Due to a weakness in the on-board software, these samples cannot be detected as saturated and appear with an abnormally low radiance relative to other bands of the same spatial pixel and non-saturated neighbours (see the note "OLCI anomalous spectral samples" mentioned in the References hereafter). An algorithm was implemented, based on spectral analysis, which allows identifying the partially saturated samples.
    a. Flag modifications are introduced in Level-1B Quality Flags data set:
        i. A new flag "partially saturated" is added indicating an occurrence of the partial saturation anomaly at, at least, one pixel's band;

ii. The existing twenty-one 'saturated' flags per band are changed to a single 'saturated' flag that indicates that there is a normal pixel saturation at, at least, one band.

b. All 'saturated' or 'partially saturated' bands of a pixel are now set to the "no data" value in their respective Level-1B radiance data files (i.e., set to the _FillValue attribute as specified in the netCDF file). The corresponding uncertainty values, if enabled, are set to "no data" accordingly.

2. The spatial regridding step has been modified to accommodate camera to camera pointing disparities larger than initially expected. The regridding enables spatial continuity between the five OLCI cameras and provides a regularly sampled grid on the ground. The regridding change allows to correct spatial discontinuities at camera interfaces while preserving the per pixel georeferencing data (longitude, latitude and altitude). The consequence of this improvement is that the "frame offset" quantity available in the instrument_data.nc annotation file is now provided in the image grid and it varies with time.
3. Routine update of the OLCI geometric calibration model.
4. Routine update of the OLCI radiometric calibration model.

The quality status of this processing baseline is as follows:

Geometric calibration

- OLCI-B geolocation accuracy meets the mission requirements in terms of global RMS value (0.5 pixel according to S3 MRTD, 2011) with a RMS performance below 0.3 pixel. Validation of the Geometric Calibration, using Landsat ground control points on current datasets (20/04/23 to 20/07/2023), prior to the current baseline deployment, shows the following geolocation accuracy per camera:

	Georeferencing Biases (pixels)	
Camera Module	**Across Track**	**Along Track**
1	0.02	-0.19
2	0.01	-0.14
3	0.02	-0.16
4	0.04	-0.08
5	0.02	-0.1

The misregistration at the interfaces of each camera is below 0.2 pixel.

Please note that the current baseline includes an update of the geometric calibration that should further improve the above performances, but their assessment requires more data than available at the time

of writing. Actual performances will be published in coming Data Quality Reports, available on-line here: OLCI Data Quality Reports.

Spectral calibration information

- The OLCI-B spectral model is based on the pre-launch spectral characterisation. The model meets the mission requirements (S3 MRTD, 2011), based on in-flight spectral measurements. OLCI-B spectral response information and datasets are provided online (S3 OLCI SRF, 2016).
- The in-flight spectral measurements also show that OLCI-B spectral response has been evolving over time by up to 0.25 nm. Therefore, OLCI spectral evolution should be taken into account for specific applications, particularly those using the O_2-A absorption bands. Further information and user resources to correct for OLCI spectral evolution are described below in the section on 'Known product quality limitations'.

Radiometric calibration information

- Radiometric validation results demonstrate that OLCI-B provides measurements within the mission requirements of < 2% for the spectral range ≤ 900nm (S3 MRTD, 2011). OLCI-B radiometry is comparable to MERIS and by about 1-2% lower than OLCI-A (OLCI-A has a bright bias). Similarly to OLCI-A, the 1020 nm band is subject to a bright bias of about 4%.
- OLCI-B Radiometric Gain Model is based on the set of in-flight radiometric calibrations ending on 18/09/2022. It includes radiometric gain coefficients at a reference date and a long-term evolution model. The set of radiometric gain coefficients used to derive both the Reference Gains and the Evolution Model has been computed using up-to-date geometric and spectral calibration, instrument settings and the upgraded diffuser BRDF model based on in-flight data. Correction for diffuser ageing (browning) is included. The Radiometric Model is continuously monitored against new Radiometric Calibration acquisitions.

Per-pixel uncertainty estimates in ESA processing

- The Level 1b product of radiometric uncertainty for each spatial pixel and spectral channel are now provided in the ESA's OLCI L1 products in specific per channel netCDF files. However, it shall be noted that the uncertainty is coded on a log-scale, currently not decoded by the SNAP viewer. Per-pixel uncertainties are not yet included in EUMETSAT's OLCI L1 products.

Known product quality limitations

Common to S3A and S3B

Spectral Calibration

In-flight spectral measurements show that OLCI spectral response has been evolving over time compared to the defined centre wavelengths. OLCI spectral evolution should be taken into account for specific applications using the O_2-A absorption bands around 760 nm, i.e. bands Oa13, 14 and 15. Spectral evolution may also be important for additional bands: water vapour absorption bands Oa19 and 20; blue Rayleigh bands Oa01 and 2 at 400 and 412.5 nm; chlorophyll fluorescence bands; red-edge bands around 750 nm. Technical Notes, Look-up-Tables, python code and Jupyter Notebook scripts are available for users to correct for the spectral evolution. Two types of corrections are made available:

- **Spectral wavelength** correction is available from S3 OLCI SRF, 2021 and it allows to calculate the best estimate of centre wavelengths, bandwidth and in-band solar irradiance for all OLCI bands (Oa01 – Oa21) and all pixels through the mission at a given absolute orbit number. Note that a SRF adjustment must be performed as well.
- **Top Of the Atmosphere (TOA) radiance** correction for the O_2-A absorption bands only (also called "O_2-A harmonization") is also available from S3 OCTPO2, 2021 (see STUDY DOCUMENTS). A related correction is likewise implemented as a plugin in the SNAP toolbox.

Radiometric Calibration

- Anomalously low radiances occurring in some bands for pixels at the edges of saturated areas, occasionally present over bright clouds for both OLCI-A and OLCI-B instruments, are now detected, redefined to _FillValue, and flagged with the partially_saturated flag, as defined above in this Product Notice. The anomaly is described in a dedicated document (S3MPC.ACR.MEM.087, 2020). The detection algorithm is accurate but further verifications will continue.
- Vertical striping at the first 100 pixels at camera interfaces in bands Oa19 and Oa20, known as periodic noise, is now mitigated by using the most recent dark signal measurements. Residual periodic noise may be occasionally present.
- Single anomalous pixels, in particular in the region of the South Atlantic Anomaly, may occur due to prompt particle events.

Straylight

- Verification and update of the OLCI straylight correction performance is ongoing.

Flags

- Accuracy of OLCI L1B product flags is under assessment. No issue has been identified so far.

Removed pixels

- OLCI-A can include a maximum number of removed pixel higher than expected. This anomaly has been detected first on data corresponding to 15th of March 2023, on one line over high latitudes. Investigation about the root causes is on-going.

The maximum number of removed pixel stored in OLCI L1 product has been increased to 150. Any additionally removed pixels occurring during the spatial resampling step of the L1 processing will be filtered out from the OLCI L1 dataset ensuring the production of the OL_1_EFR product. Note that this issue is however transparent in OLCI L1 and L2 products and is not impacting data quality.
S3A
• Description of OLCI-A radiometric biases is included in the S3A Status of the Processing Baselines, Radiometric Calibration section.
S3B
• Nothing specific to S3B

Products Availability

☒ Copernicus Open Access Hub (https://scihub.copernicus.eu/), NRT and NTC

☒ EUMETSAT Data Store (https://data.eumetsat.int/), NRT and NTC

☒ EUMETCast (https://eoportal.eumetsat.int/), NRT

☒ EUMETSAT Data Centre (https://eoportal.eumetsat.int/), NRT and NTC

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Product	EUMETCast-Satellite	EUMETCast-Terrestrial	EUMETSAT Data Store and Centre
L1 RR	NRT	NRT	NRT, NTC
L1 FR		NRT	NRT, NTC

Note: The OLCI L1 products that include the L1 uncertainties are available only in the Copernicus Open Access Hub.

Any other useful information

- For further details on OLCI L1B status and validation results, refer to S3 OLCI Data Quality Reports available from https://sentinels.copernicus.eu/web/sentinel/technical-guides/sentinel-3-olci/data-quality-reports.

User Support

- Questions about OLCI products can be asked to the Sentinel-3 User Support desk at:
    - eosupport@copernicus.esa.int
    - ops@eumetsat.int

References

- MRTD: Sentinel-3 Mission Requirements Traceability Document, C. Donlon, EOP-SM/2184/CD-cd, 2011, https://sentinel.esa.int/documents/247904/1848151/Sentinel-3-Mission-Requirements-Traceability
- S3 OLCI SRF: Sentinel-3 OLCI-A and OLCI-B spectral response functions (SRF), Sentinel 3 CalVal Team and Mission Performance Centre, 2016 / 2021

  https://sentinel.esa.int/web/sentinel/technical-guides/sentinel-3-olci/olci-instrument/spectral-response-function-data
- S3 OCTPO2: Cloud Top Pressure development from S3 OLCI, 2021, https://www.eumetsat.int/S3-OLCI-CTP
- OLCI anomalous spectral samples - user note, S3MPC.ACR.MEM.087, 2020
  - https://www.eumetsat.int/media/47581
- Product Data Format Specification – OLCI Level 1 Products, Ref: S3IPF.PDS.004.1, Issue: 2.5, Date: 29/04/2022
  - https://sentinel.esa.int/web/sentinel/user-guides/sentinel-3-olci/document-library
  - https://www.eumetsat.int/media/38641
- S3 OLCI Data Quality Reports, Ref. OMPC.ACR.DQR, issued monthly, https://sentinels.copernicus.eu/web/sentinel/technical-guides/sentinel-3-olci/data-quality-reports
- S3 OLCI Land User Handbook, https://sentinel.esa.int/documents/247904/4598066/Sentinel-3-OLCI-Land-Handbook.pdf
- S3 OLCI Marine User Knowledge Base, https://eumetsatspace.atlassian.net/wiki/spaces/OC/overview
- S3 OLCI Ocean Colour monitoring, https://metis.eumetsat.int/oc

End of the Product Notice