PREPARATION AND OPERATIONS OF THE MISSION PERFORMANCE CENTRE (MPC) FOR THE COPERNICUS SENTINEL-3 MISSION

**S3-A OLCI Cyclic Performance Report** 

Cycle No. 009

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#### Disclaimer

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# **Changes Log**

Version	Date	Changes
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# 1 Instrument monitoring

# **1.1 CCD temperatures**

The monitoring of the CCD temperatures is based on MPMF data extractions not yet operational. In the meantime, we monitor the CCD temperatures on the long-term using Radiometric Calibration Annotations (see Figure 1). Variations are very small (0.08 C peak-to-peak) and no trend can be identified. Data from current cycle (2 rightmost data points) do not show any specificity.



Figure 1: long term monitoring of CCD temperatures using minimum value (top), time averaged values (middle), and maximum value (bottom) provided in the annotations of the Radiometric Calibration Level 1 products, for the Shutter frames, all radiometric calibrations so far.





Figure 2: Same as Figure 1 for diffuser frames.

# **1.2 Radiometric Calibration**

Two OLCI Radiometric Calibration Sequences have been acquired during Cycle 9:

- S01 sequence on 23/09/2016 10:26 to 10:28 (absolute orbit 3132)
- S01 sequence on 07/10/2016 09:24 to 09:26 (absolute orbit 3331)

This section presents the overall monitoring of the parameters derived from radiometric calibration data and highlights, if present, specificity of current cycle data.

## 1.2.1 Dark Offsets [OLCI-L1B-CV-230]

#### Dark offsets.

Dark offsets are continuously affected by the global offset induced by the Periodic Noise on the OCL convergence. Current Cycle calibrations (orbits 3132 & 3331) are affected the same way as others. The amplitude of the shift varies with band and camera from virtually nothing (e.g. camera 2, band 0a1) to



up to 5 counts (Oa21, camera 3). The Periodic Noise itself comes on top of the global shift with its known signature: high frequency oscillations with a rapid damp. This effect remains more or less stable with time in terms of amplitude, frequency and decay length, but its phase varies with time, introducing the global offset mentioned above.

There is no significant evolution of this parameter during the current cycle.



Figure 3: Dark Offset for band Oa1 (top) and Oa21 (bottom), all radiometric calibrations so far.



Figure 4: map of periodic noise for the 5 cameras, for band Oa21. Xaxis is detector number (East part, from 540 to 740, where the periodic noise occurs), Yaxis is the orbit number. The counts have been corrected from the west detectors mean value (non affected by periodic noise). Periodic noise amplitude is high in camera 2, 3 and 4. It is lower in camera 4 and small in camera 1. We see that the drift of the periodic noise tends to stabilize during the last radiometric calibrations.

## Dark Currents.

Dark Currents are not affected by the global offset of the Dark Offsets, thanks to the clamping to the average blind pixels value. However, the oscillations of Periodic Noise remain visible. There is no significant evolution of this parameter during the current cycle.



Figure 5: Dark Current for band Oa1 (top) and Oa21 (bottom), all radiometric calibrations so far.

## **1.2.2** Instrument response and degradation modelling [OLCI-L1B-CV-250]

Figure 6 below shows the gain coefficients of every pixel for two OLCI channels, Oa1 (400 nm) and Oa21 (1020 nm), highlighting the significant evolution of the instrument response since early mission.

Figure 7 on the other hand displays the time evolution of the cross-track averaged gain, for each module, as a function of time. It shows that if a significant evolution occurred during the early mission, the trends tend to stabilize. In particular the last two calibrations provide very stable results. This is further illustrated on Figure 8 and Figure 9. The latter shows that radiometric gains are becoming very stable: within 0.2% since 4 weeks without spectral signature, and within 0.5% since 9 weeks, still without spectral signature; beyond that a significant evolution can be seen globally as a "white" curvature of the AC profile, as well as spectrally with channel Oa1 raising out of the general trend.





Figure 6: Gain Coefficients for band Oa1 (top) and Oa21 (bottom), all diffuser 1 radiometric calibrations so far.



Figure 7: time evolution of the camera-averaged gain coefficients for bands Oa1, Oa7, Oa14 and Oa21 (from lft to right and top to bottom).





Figure 8: camera averaged gain relative evolution with respect to most recent calibration, as a function of elapsed time since first calibration acquired after the fix of the Start Trackers issue; one curve for each band (see colour code on plots), one plot for each module.



Figure 9: Across-track profiles of Gains relative evolution with respect to most recent calibration for time distance about 2, 4, 6, 9, 11 and 13 weeks (from left to right then top to bottom)

The time elapsed until the beginning of the mission is still too small to be able derive a degradation model.

#### 1.2.3 Ageing of nominal diffuser [OLCI-L1B-CV-240]

There has been no new calibration sequence S05 (reference diffuser) acquired during cycle 009.

# 1.2.4 Updating of calibration ADF [OLCI-L1B-CV-260]

There has been no OL\_1\_CAL\_AX update during cycle 009.



# 1.3 Spectral Calibration [OLCI-L1B-CV-400]

There has been no Spectral Calibration acquisition during cycle 008.

# 1.4 Signal to Noise assessment [OLCI-L1B-CV-620]

# 1.4.1 SNR from Radiometric calibration data.



Figure 10: Signal to Noise ratio as a function of the spectral band for the 5 cameras. These results have been computed from radiometric calibration data. All calibrations are presents with the colours corresponding to the orbit number (see legend). The SNR is very stable with time: the curves for all orbits are almost superimposed.





Figure 11: long-term stability of the SNR estimates from Calibration data, example of channel Oa1.

#### 1.4.2 SNR from EO data.

The SNR estimates are also obtained from EO data over oligotrophic waters, according to a published methodology (Hu et al, 2012). In order to reach statistical representativeness, 5 ROIs have been used, with about 100 products in each: North\_Atlantic, South\_Atlantic, North\_Pacific, North\_West\_Pacific and South\_Pacific. The results confirm OLCI compliance with its requirements with values significantly higher than those estimated from Calibration data. It should be kept in mind however that the applied methodology inherently tends to provide "best case" results, which may explain the differences.

The typical radiance obtained by the method's statistical selection is very close to the reference one used in the Requirement, and always below except at 400 nm (Oa1).



Figure 12: SNR estimates obtained from EO data (left, in red, compared to Requirement in blue) and corresponding typical radiance levels ( $L_{typ}$ , right in red, compared to the Requirement specified  $L_{ref}$ , in blue)



# **1.5 Geometric Calibration**

Since the introduction of the updated Instrument Pixels Pointing Vectors and Geometric Calibration Models, geolocation performance has been qualitatively monitored using the match between the radiometry and the geolocation based Coastline and Land/Water flags. The improvement, already reported in the previous Cyclic Report as well as in the ADF verification report (ref. S3MPC.ACR.VR.002) has been confirmed, and further verified using manually selected GCPs against GoogleEarth. However, it allowed identifying a potential quality issue on the geolocation-based masks ADFs. AS a matter of fact, a slight shift of the Coastline flag toward North-East with respect to OLCI radiometry is very often evidenced, but does not show the symmetry that could be expected form a systematic bias in geolocation: the shift is more pronounced along the South-West edge of land masses (where land radiometry goes into Water class by about 2 pixels) than on the opposite side where very few water radiometry can be identified over Land class pixels.

This is illustrated below over the Falkland (Malvinas) islands, from a OLCI EFR Level 1 product of the 28<sup>th</sup> of September, generated at the Marine Centre:



S3A\_OL\_1\_EFR\_\_\_\_20160928T130927\_20160928T131227\_20160929T175803\_0179\_009\_152\_3780\_MAR\_F\_NT\_002.SEN3

Figure 13: Oa21 radiometry (zoom) with the Coastline Flag on top (red).

In order to enhance the discrepancy between radiometry and the Coastline flag, a specific methodology has been put in place: lad and water pixels are classified using a manually determined threshold (Oa21



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offers a very good contrast in most cases) and compared to the geolocation based Land/Ocean classification. Then radiometric land pixels classified as water are highlighted with a green mask while radiometric water pixels classified as Land are highlighted in blue. The dissymmetry of the misclassification is obvious n the following figure, where most (if not all) misclassified water pixels appear as being inland waters (belonging to the Land class of the Land/Ocean mask).



Figure 14: same as Figure 13 with the misclassification masks on top (green for misclassified land pixel, dark blue for misclassified water pixels).



# **2** OLCI Level 1 Product validation

### [OLCI-L1B-CV-310] – Radiometric validation

#### S3ETRAC OLCI processing

The S3ETRAC service is now open. This service extracts OLCI L1 RR and SLSTR L1 RBT data and computes associated statistics over 49 sites corresponding to different surface types (desert, snow, ocean maximizing Rayleigh signal, ocean maximizing sunglint scattering and deep convective clouds). The S3ETRAC products available at <u>ftp://ftp.acri-cwa.fr</u> shall be used for the assessment and monitoring of the L1 radiometry by the ESLs.

476 S3ETRAC products have been generated (20/10/2016) with

- 246 S3ETRAC/OLCI products (182 for desert, 1 for snow, 38 for Rayleigh, 13 for sunglint and 12 for DCC)
- 230 S3ETRAC/SLSTR products (126 for desert, 2 for snow, 98 for Rayleigh and 4 for Rayleigh)

#### Radiometric validation with DIMITRI (ARGANS)

#### Highlights

- Due to the lack of OLCI and SLSTR products, ARGANS's ESL could not perform any further processing, consequently unable to provide new results.
- Previously highlighted: Successful download and ingestion of S3A/SLSTR products over PICS into DIMITRI.
- Unable to run PICS method over SLSTR due to the short time-series (Less than 3 products)

#### Activities done

- At ARGANS, the ESLs undertake analysis of the calibrated OLCI radiometry using external data (from other instruments, ground based measurements) or models, to assess performance, identify trends and detect anomalies.
- In the Reporting Period, the ESLs did not perform any further processing due to the lack of new OLCI products over PICS and Ocean.

#### **I-Validation over PICS**

N/A

#### **II-Validation over Rayleigh**

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The investigations of the discrepancy between the results from ARGANS and ESTEC, when both uses the same CFI (DIMITRI), are in progress.

### **III-Other activities**

- 1. About 15 SLTSR-RBT products were downloaded from MPC-ftp over the 6 desert calval-sites (Algeria3 & 5, Libya 1 & 4 and Mauritania 1 & 2).
- 2. The products are successfully ingested into DIMITRI and the quicklooks are generated.
- 3. Due to the low number of available acquisitions, we could not apply PICS method over SLTSR.

#### Activities planned during the next period

- 1. To consolidate the results over desert CalVal sites.
- 2. To consolidate the results over ocean CalVal sites
- 3. To compare Rayleigh results from ARGANS with those from VITO and ESTEC.
- 4. To run Glint methods when possible.
- 5. To run PICS over SLSTR and compare the results to OLCI one when possible.

## Any difficulties encountered

- 1. The delay to have access to S3A/OLCI products.
- 2. To find out the geographical location of the products.
- 3. To have enough information about the products processing, calibration, characteristics etc...
- 4. To separate/exclude the same products from different PDGS

## Radiometric validation with OSCAR (VITO)

## Highlights

- RAYLEIGH and GLITTER scenes of commissioning phase reprocessed for validation of the OLCI radiometry
- As discussed during the OLCI-SYN ESL TC results of the OSCAR Rayleigh (and GLITTER) method are in line with the results obtained by ARGANS with the Rayleigh DIMITRI tool; but there is a larger discrepancy for the blue bands with the results obtained by ESTEC (with DIMITRI tool) during the commissioning phase and especially with respect to the validation results provided by CNES. The cause (e.g. different data used/selected, different calibration parameters etc.) of this discrepancy is currently under investigation.

## Activities done

Reprocessing of the received S3ETRAC RAYLEIGH and GLITTER data with OSCAR

## Activities planned during the next period

- Processing of new S3ETRAC RAYLEIGH and GLITTER data (received on 17 October 2016).
- Attending the OLCI/SYN ESL Council



# 3 Level 2 Land products validation

#### OLCI-L2LRF-CV-300

Task Description	This task encompasses activities associated with overall initial assessment of performance over land and in particular TCI and troubleshooting activities.	
Summary of activities	Three activities were performed within this task: (i) overall data format, (ii) geometric accuracy and (iii) radiometric quality.	
Percentage of completion (phase E1)	20%	

#### **Description of activities done and results**

(i) Overall data format and access

Data access: Based on the request to MPC, we have now received the respective scenes covering our selected study sites for cal/val. The following sites were requested:

Site	Land cover	Latitude	Longitude
DE-Geb	Rainfed cropland	51.1001	10.9143
IT-Cat	Mosaic cropland/vegetation	37.2785	14.8833
IT-Isp	Mosaic vegetation/cropland	45.8128	8.6345
IT-Sro	Closed to open mixed broadleaved and needleleaved forest	43.7278	10.2844
IT-Tra	Mosaic cropland/vegetation	37.6456	12.8666
SP-Ali	Sparse vegetation	38.4516	-1.0646
SP-Val	Rainfed cropland	39.5707	-1.2882
UK-NFo	Mosaic forest or shrubland/grassland	50.8451	-1.5398
US-Ne1	Closed to open herbaceous vegetation	41.165	-96.4766
US-Ne2	Mosaic cropland/vegetation	41.1648	-96.4701
US-Ne3	Closed to open herbaceous vegetation	41.1797	-96.4396

As the geolocation issues still existed for most of data prior to mid-September, it was difficult to undertake a quantitative evaluation of the temporal evolution of the time series of OTCI. However, we started investigating the temporal profiles of OTCI for initial quality check. The figure below shows mean of 3X3 pixels over the new forest study site and variation of individual pixels between end of July and end of Sept 2016. As this period coincide with the peak of the growing season there is not much variation in mean OTCI, but there is a large variation between the pixels at the start of this period. This was mostly due to mismatch in the geolocation of individual pixels. However, the problem seems to disappeared for the late acquisitions.





#### UK-NFo (mean of 3 x 3 window)



UK-NFo (individual pixels within 3 x 3 window)

We will undertake further evaluation over other sites in near future and investigate the issue of geolocation.



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# 4 Level 2 Water products validation

[OLCI-L2WLR-CV-300, OLCI-L2WLR-CV-310, OLCI-L2WLR-CV-32, OLCI-L2WLR-CV-330, OLCI-L2WLR-CV-340, OLCI-L2WLR-CV-350, OLCI-L2WLR-CV-360 and OLCI-L2WLR-CV-370] – Level 2 Water-leaving Reflectance product validation

## Activities done

- In situ data collection, matchup extraction and statistics computation is now operational for AERONET-OC data.
- First BOUSSOLE (Mediterranean Sea) and IML (Gulf of Saint Lawrence, Canada) data have been provided by LOV and ARCTUS. Matchups extraction have been performed for both.
- Matchup extraction and statistics computation is now operational and refreshed every Sunday for all available datasets.
- Side-by-side in situ and OLCI trends are now generated at level-2 for available stations or moorings (AERONET-OC, BOUSSOLE, IML ; total of 17 stations)



Up to 200 useful matchups after only 5 months of OLCI Level-2 production



#### Activities planned during the next period

OLCI-L2WLR-CV-200 and OLCI-L2-CV-210

Initiate the implementation of NIR band vicarious adjustment routines and test them providing we have sufficient L2 RR marine data over South Pacific and Indian Ocean regions

#### **Difficulties encountered**

Difficulty to retrieve OLCI Level-2 products for CalVal activities



#### [OLCI-L2WLR-CV-400]

### **Task Description**

Previous experiences with OC data have demonstrated that Level-2 ocean colour products validation against in situ measurement is not sufficient. Owing to the limitation on in situ measurements availability in space and time, such validation will not capture long term trends or spatial incoherencies. The analysis of the Level-3 data is an essential contributor for the validation of both Level-1 (task [OLCI-L1B-CV-320]) and Level-2 (task [OLCI-L2WLR-CV-300]) data. The Level-3 data allows crucial scientific investigations as the data is available at both local and global spatial scales and at various time scales (daily, weekly, monthly).

#### Summary of activities

HYGEOS: Processed daily global products with Polymer, qualitatively compared with standard water reflectance products and I2gen/VIIRS.

The main conclusion is that the quality flags that have been used (by us) to generate daily composites for the standard product seem insufficient because a large scatter is observed with respect to Polymer and I2gen/VIIRS products. The Polymer/OLCI product compares reasonably well with I2gen/VIIRS.

Rem: The organization of products on the ftp server is now clearer and the products are easier to find.

#### **Description of activities done and results**

#### Comparison of daily global composites

Global daily composites have been generated for Polymer/OLCI and OLCI standard water reflectance products, and are compared to standard daily I2gen/VIIRS composites, for sept 22<sup>nd</sup>, 2016.

For the standard product, the following flags have been applied AC\_FAIL, RISKGLINT, INVALID, CLOUD.



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Figure 15: Example of standard (left) and Polymer (right) level2 water reflectance products at 443 nm over Atlantic (Brasil), using the same color scale. The standard level 2 product is not flagged.

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(Rw\_seadas). From top to bottom, the bands 400 to 665 are presented.

Even though the comparison of Rw\_std and Rw\_pol shows reasonably consistent results, a large scatter remains at all bands. The standard product visible requires additional filtering (probably cloud, glint, or high latitudes) because a large scatter is also present on the comparison between Rw\_std and Rw\_seadas, but the comparison between Rw\_pol and Rw\_seadas shows more consistent results. Linear regression is not performed at this stage because of visibly insufficient filtering of the standard product.



# 5 Level 2 SYN products validation

#### [SYN-L2-CV-100]

#### **Task Description**

The objectives is to validate the Land Surface Reflectance and Aerosol products (L2C SYN):

- Atmospherically corrected reflectances at SLSTR and OLCI waveband, other than within strong gaseous absorption bands (O2, H2O)
- \* AOD at reference waveband (550nm) τ550
- Angstrom coefficient
- Aerosol model index number Ma
- Error estimate (1 s.d.) in AOD Δτ550
- Error estimate (1 s.d.) in surface reflectance at each waveband
- Error flag to indicate high uncertainty in retrieval / interpolation of AOD used

#### Summary of activities

A large number of SYN L2 products have been generated since last report (June 2016). However, the main conclusions remain about the quality, i.e., is that the product is severely contaminated by cloud and there is some inconsistencies in the value range of the aerosols parameters. It seems that no significant changes to the processing lines have been applied to correct for these issues.

#### Percentage of completion (phase E1)

50%

#### **Description of activities done and results**

We checked the quality of the following product from the S3MPC ftp server

L2S3A\_SY\_2\_SYN\_\_\_\_20160912T130924 acquired over the Amazonia forest

Figure 1 displays the Aerosols Optical thickness at 550 nm and the Surface reflectance in band 1. The cloud contamination is obvious. The surface reflectance product is thus degraded. The T550 histogram on Figure 2 still shows some negative values for T550, even for pixels with the SYN-SUCCESS flag raised. In figure 3 we show that the OLCI bright flag could serve as an alternative for rejecting low quality pixels. However it is far from perfect

#### **Conclusion**

The L2 SYN product is not of sufficient quality at the moment. The cloud contamination is the main problem, and some investigations are still needed to understand why those pixels are not flagged at level 1 or inside the SYN level 2 processing and why negative values of AOT are permitted.

SYN-L1C, OLCI L1B and SLSTR L1B, images should be provided in the same folder as SYN-L2 for deeper investigation









# 6 Events

Two OLCI Radiometric Calibration Sequences have been acquired during Cycle 009:

- S01 sequence on 23/09/2016 10:26 to 10:28 (absolute orbit 3132)
- S01 sequence on 07/10/2016 09:24 to 09:26 (absolute orbit 3331)

A maintenance of the OLCI instrument occurred Thursday 22 September 2016. As a result, OLCI data is not be available over the following time window: from 07:20 to 07:30 UTC and from 08:26 to 08:36



# 7 Appendix A

Other reports related to the Optical mission are:

S3-A SLSTR Cyclic Performance Report, Cycle No. 009 (ref. S3MPC.RAL.PR.02-009)

All Cyclic Performance Reports are available on MPC pages in Sentinel Online website, at: <u>https://sentinel.esa.int</u>

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