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

## **S3-A OLCI Cyclic Performance Report**

Cycle No. 025

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### **Changes Log**

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### **List of Changes**

Version	Section	Answers to RID	Changes



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## **O** Processing Baseline Version

IPF	IPF / Processing Baseline version	Date of deployment
OL1	06.07 / 2.23	CGS: 05/07/2017 13:00 UTC (NRT)
		PAC: 05/07/2017 12:50 UTC (NTC)
OL2	06.11 / 2.23	CGS: 11/10/2017 08:53 UTC (NRT)
		PAC: 11/10/2017 08:15 UTC (NTC)



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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 (0.09 C peak-to-peak) and no trend can be identified. Data from current cycle (rightmost data points) do not show any specificity.

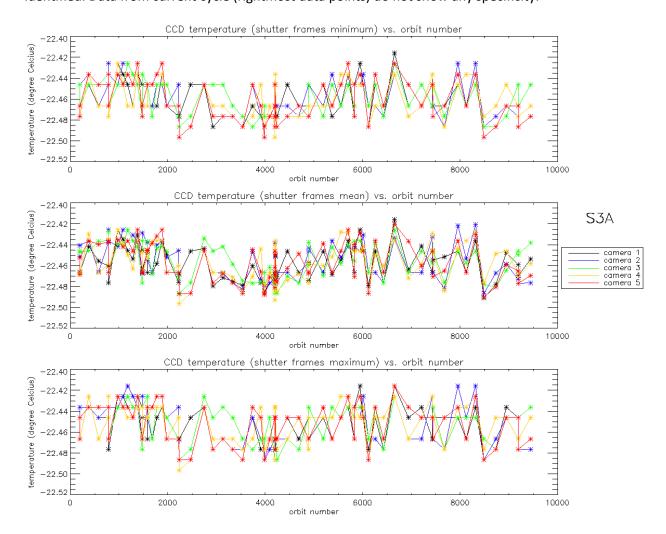


Figure 1: long term monitoring of CCD temperatures using minimum value (top), time averaged values (middle), and maximum value (bottom) provided in the annotations of the Radiometric Calibration Level 1 products, for the Shutter frames, all radiometric calibrations so far.

# SERTINEL 3 Mission Performance Centre

### **Sentinel-3 MPC**

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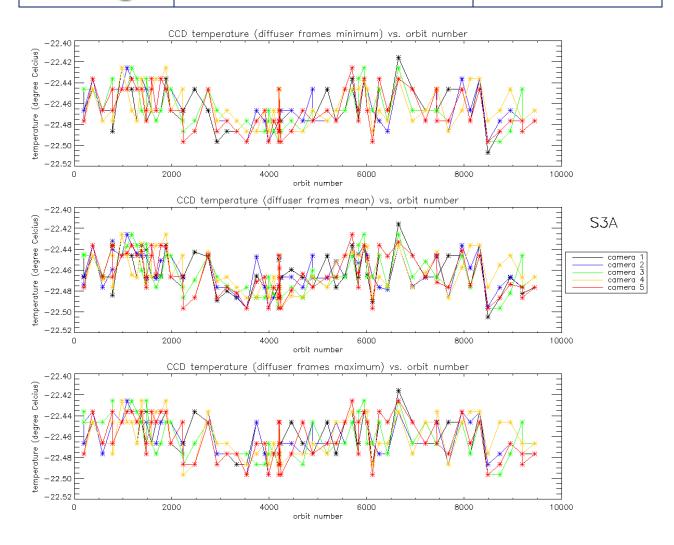


Figure 2: Same as Figure 1 for diffuser frames.

### 1.2 Radiometric Calibration

One OLCI Radiometric Calibration Sequences has been acquired during Cycle 025:

\$ S01 sequence (diffuser 1) on 10/12/2017 07:26 to 07:28 (absolute orbit 9447)

The acquired Sun azimuth angles are presented on below, on top of the nominal values without Yaw Manoeuvre (i.e. with nominal Yaw Steering control of the satellite).



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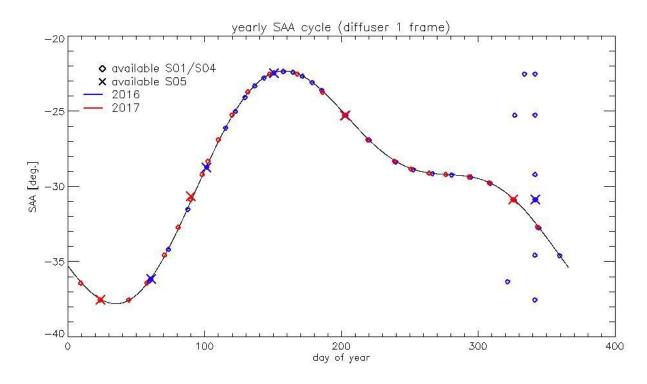


Figure 3: Sun azimuth angles during acquired Radiometric Calibrations (diffuser frame) on top of nominal yearly cycle (black curve). Diffuser 1 with diamonds, diffuser 2 with crosses, 2016 acquisitions in blue, 2017 in red.

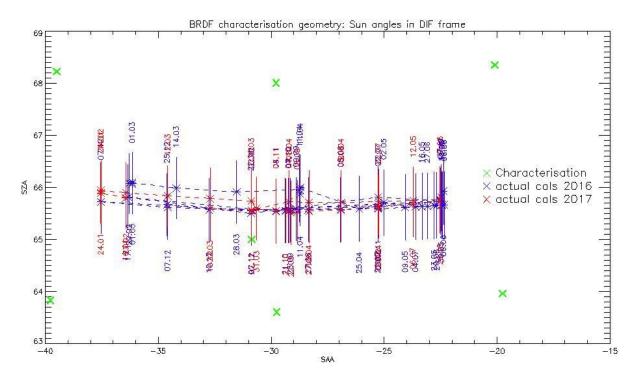


Figure 4: Sun geometry during radiometric Calibrations on top of characterization ones (diffuser frame)

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



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

### **Note about the High Energy Particles:**

The filtering of High Energy Particle (HEP) events from radiometric calibration data has been implemented (for shutter frames only) in a post processor, allowing generating Dark Offset and Dark Current tables computed on filtered data. The post-processor starts from IPF intermediate data (corrected counts), applies the HEP detection and filtering and finally computes the Dark Offset and Dark Current tables the same way as IPF. An example of the impact of HEP filtering is given in Figure 5.

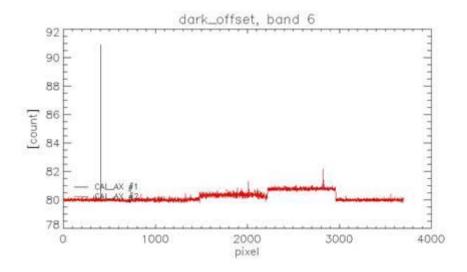


Figure 5: Dark Offset table for band Oa06 with (red) and without (black) HEP filtering (Radiometric Calibration of 22 July 2017). The strong HEP event near pixel 400 has been detected and removed by the HEP filtering.

All results presented below in this section have been obtained using the HEP filtered Dark Offset and Dark Current tables.

### **Dark offsets**

Dark offsets are continuously affected by the global offset induced by the Periodic Noise on the OCL convergence. Current Cycle calibrations 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.

### **Sentinel-3 MPC**

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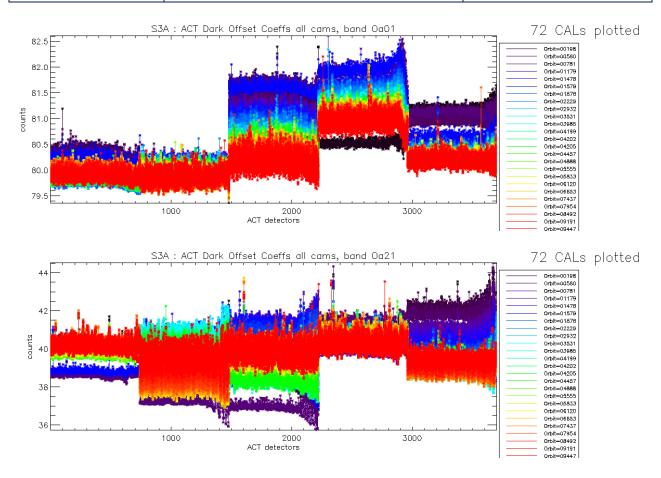


Figure 6: Dark Offset for band Oa1 (top) and Oa21 (bottom), all radiometric calibrations so far except the first one (orbit 183) for which the instrument was not thermally stable yet.



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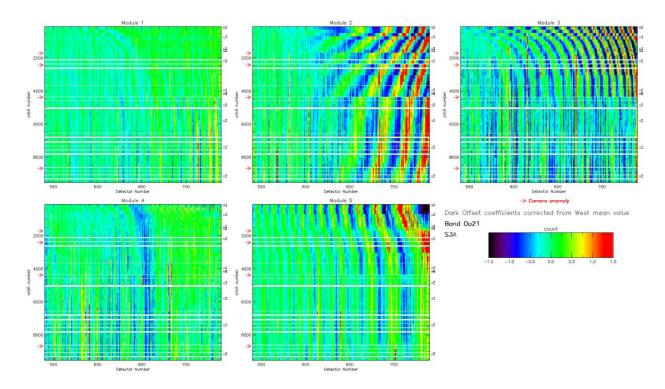


Figure 7: map of periodic noise for the 5 cameras, for band Oa21. X-axis is detector number (East part, from 540 to 740, where the periodic noise occurs), Y-axis is the orbit number. The counts have been corrected from the west detectors mean value (not affected by periodic noise) in order to remove mean level gaps and consequently to have a better visualisation of the long term evolution of the periodic noise structure. Periodic noise amplitude is high in camera 2, 3 and 4. It is lower in camera 4 and small in camera 1.

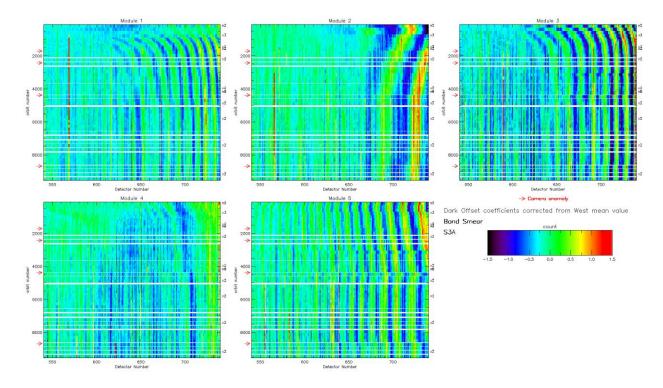


Figure 8: same as Figure 7 for smear band.



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Figure 7 and Figure 8 show the so-called 'map of periodic noise' in the 5 cameras, for respectively band 21 and smear band. These maps have been computed from the dark offsets after removal of the mean level of the WEST detectors (not impacted by PN) in order to remove mean level gaps and consequently to highlight the shape of the PN. Maps are focused on the last 200 EAST detectors where PN occurs. We see that the reset of the OLCI instrument performed on 16 OCT 2017 – in this case a soft reset only –, orbit 8666 (cycle #23) ,following a camera anomaly, had a significant impact on the shape of the PN. The most impacted band is the smear band for camera 5 (see also Figure 9), as well as, to a lesser extent, camera 2 and 3. In band Oa21, the reset of the instrument did not seem to have a significant impact on the shape of the PN even though we can notice that the phase of the PN of camera 2 keeps on drifting since several calibrations.

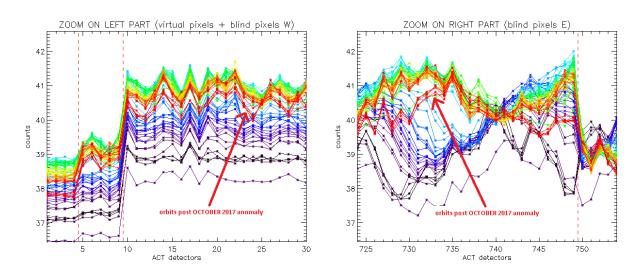


Figure 9: Dark Offset levels for smear band camera 5, for (left plot) first 30 WEST detectors including virtual and blind pixels, (right plot) last 30 EAST detectors including blind pixels. The colour of the curves is linked to the orbit number, from the beginning of the mission in black, to the last CALs in red. We see on the right plot that the shape of the PN for the CALs at orbit ≥ 8736 has been strongly modified by the reset of the OLCI instrument of orbit 8666 (Cycle #23). As a consequence, the global mean level of the dark offset is impacted by this change of PN, through the OCL convergence, as illustrated in the left plot.

Based on the results presented in Figure 8 and Figure 9, we recommend that the CAL\_AX used in PDGS is updated, as soon as possible, with a dark offset table and a dark current table computed from a Calibration sequence posterior to the October 2017-anomaly. This will be implemented at the next PB update (foreseen in December).

#### **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.



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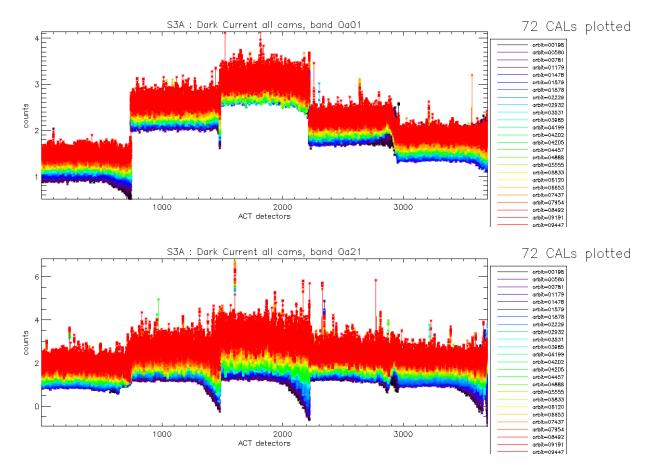


Figure 10: Dark Current for band Oa1 (top) and Oa21 (bottom), all radiometric calibrations so far except the first one (orbit 183) for which the instrument was not thermally stable yet.

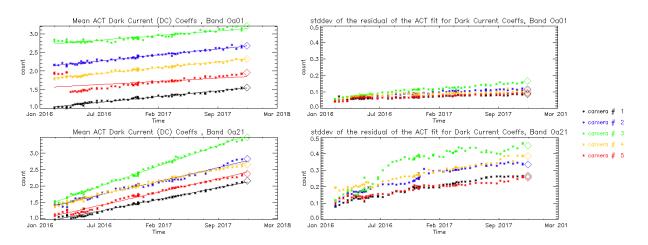


Figure 11: left column: ACT mean on 400 first detectors of Dark Current coefficients for spectral band Oa01 (top) and Oa21 (bottom). Right column: same as left column but for Standard deviation instead of mean. We see an increase of the DC level as a function of time especially for band Oa21. A possible explanation could be the increase of the number of hot pixels which is more important in Oa21 because this band is made of more CCD lines than band Oa01 and thus receives more cosmic rays impacts. It is known that cosmic rays degrade the structure of the CCD, generating more and more hot pixels at long term scales.



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

### 1.2.2.1 Instrument response monitoring

Figure 12 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.

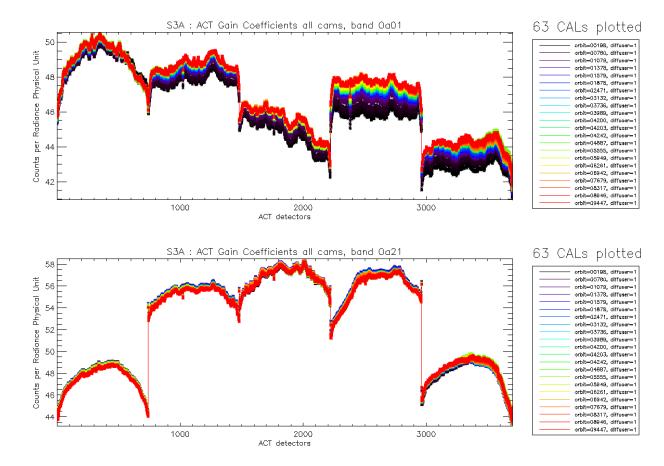


Figure 12: Gain Coefficients for band Oa1 (top) and Oa21 (bottom), all diffuser 1 radiometric calibrations so far except the first one (orbit 183) for which the instrument was not thermally stable yet.

The gains plotted in Figure 12, however are derived using the ground BRDF model — as the only one available in the operational processing software so far — which is known to suffer from illumination geometry dependent residual errors (see previous Cyclic Reports for more details). Consequently they are post-processed to replace the ground BRDF model by the in-flight version, based on Yaw Manoeuvres data, prior to determine the radiometric evolution.

Figure 13 displays a summary of the time evolution derived from post-processed gains: the cross-track average of the BRDF corrected gains is plotted as a function of time, for each module, relative to a given reference calibration (the 12/12/2016). It shows that, if a significant evolution occurred during the early mission, the trends tend to stabilize, with the exception of band 1 of camera 4.



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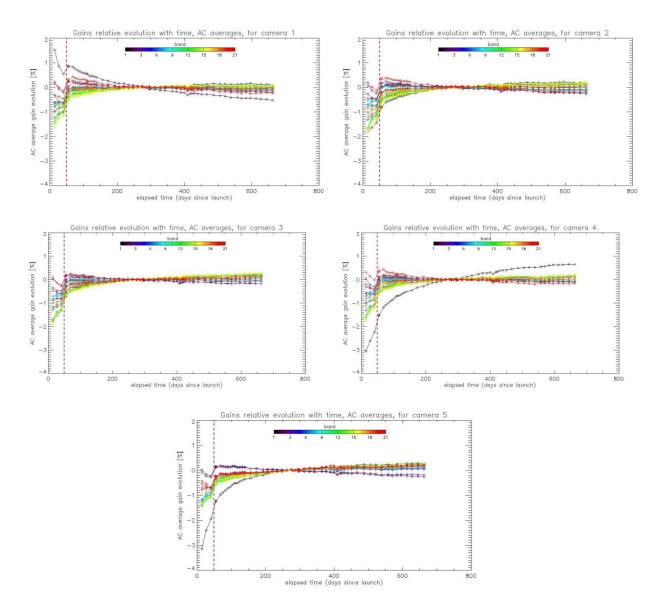


Figure 13: camera averaged gain relative evolution with respect to "best geometry" calibration (22/11/2016), as a function of elapsed time since launch; one curve for each band (see colour code on plots), one plot for each module. The star tracker anomaly fix (6/04/16) is represented by a vertical red dashed line.

The behaviour over the first two months of mission, really different and highlighted by Figure 13, is explained by the Star Tracker software anomaly during which the attitude information provided by the platform was corrupted, preventing to compute a correct illumination geometry, with a significant impact on the gain computation.

### 1.2.2.2 Instrument evolution modelling

As mentioned in previous cycle #22 Report, the OLCI Radiometric Model has been refreshed, and put in operations the 11/10/2017. The model has been derived on the basis of an extended Radiometric Calibration dataset (from 26/04/2016 to 27/08/2017), and includes the correction of the diffuser ageing for the five bluest bands (Oa1 to Oa5) for which it is clearly measurable. The model performance over



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the complete dataset (including the 7 calibrations in extrapolation over about four months) remains better than 0.1% when averaged over the whole field of view (Figure 14) even if a small drift of the model with respect to most recent data is now visible. The previous model, trained on a Radiometric Dataset limited to 12/03/2017, shows a stronger drift of the model with respect to most recent data (Figure 15). Comparison of the two figures shows the improvement brought by the updated Model.

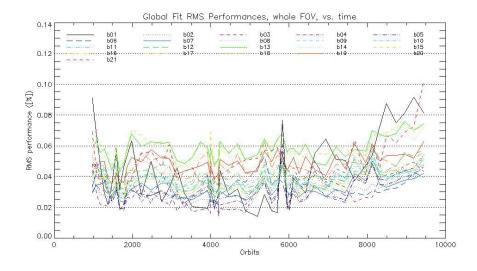


Figure 14: RMS performance of the Gain Model of current Processing Baseline as a function of orbit.

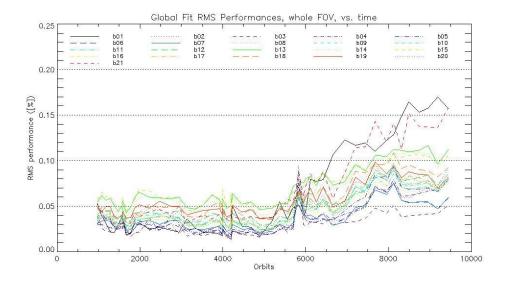


Figure 15: RMS performance of the Gain Model of previous Processing Baseline as a function of orbit.

The overall instrument evolution since channel programming change (25/04/2016) is shown on Figure 16.

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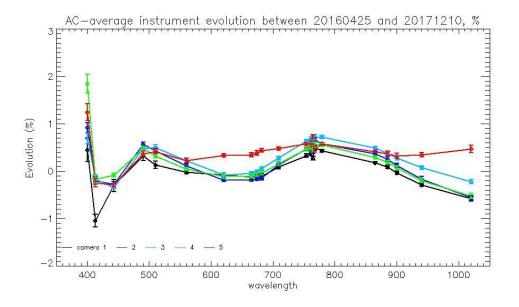


Figure 16: Camera-averaged instrument evolution since channel programming change (25/04/2016) and up to most recent calibration (10/12/2017) versus wavelength.

The overall per camera performance, as a function of wavelength, and at each orbit is shown on Figure 17 as the average and standard deviation of the model over data ratio.

Finally, Figure 18 to Figure 20 show the detail of the model performance, with across-track plots of the model over data ratios at each orbit, one plot for each channel.

Comparisons of Figure 17 to Figure 20 with their counterparts in Report of Cycle 22 clearly demonstrate the improvement brought by the new model whatever the level of detail.

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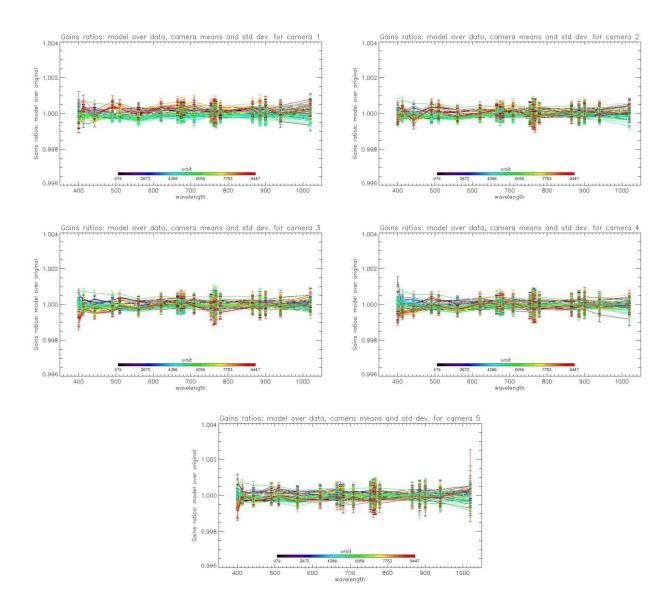


Figure 17: For the 5 cameras: Evolution model performance, as camera-average and standard deviation of ratio of Model over Data vs. wavelength, for each orbit of the test dataset, including 7 calibration in extrapolation, with a colour code for each calibration from blue (oldest) to red (most recent).

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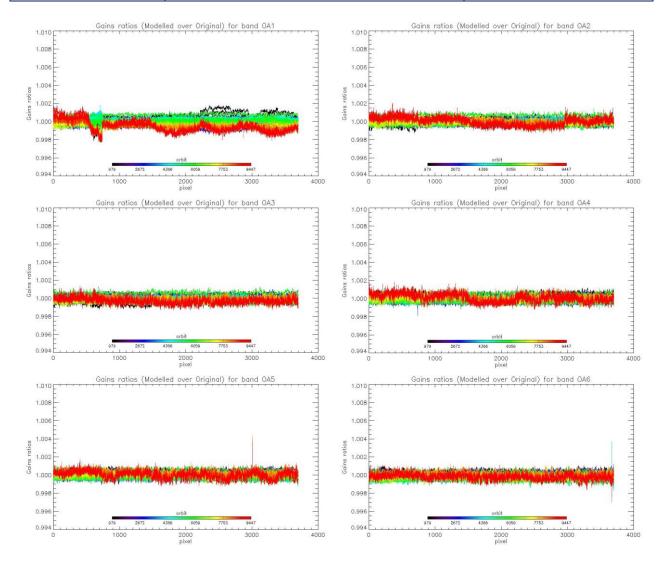


Figure 18: Evolution model performance, as ratio of Model over Data vs. pixels, all cameras side by side, over the whole current calibration dataset (since instrument programing update), including 7 calibrations in extrapolation, channels Oa1 to Oa6.

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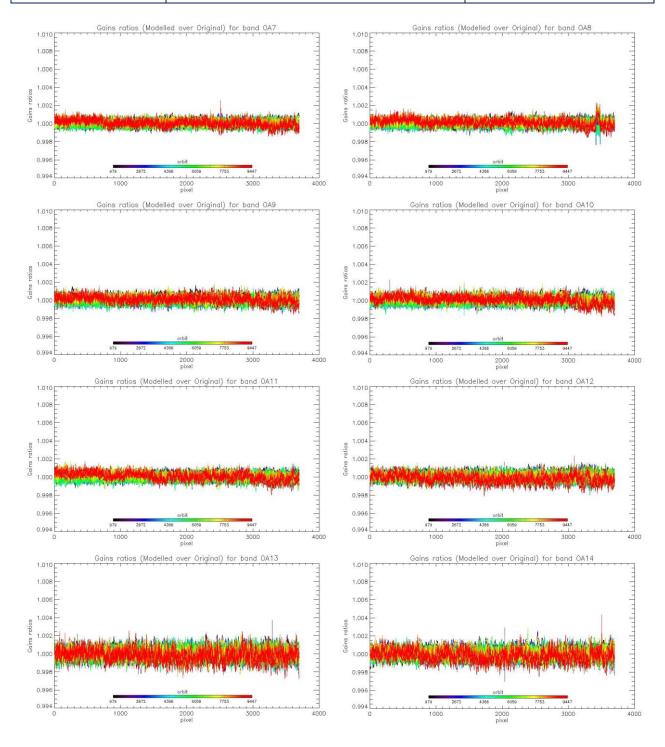


Figure 19: same as Figure 14 for channels Oa7 to Oa14.

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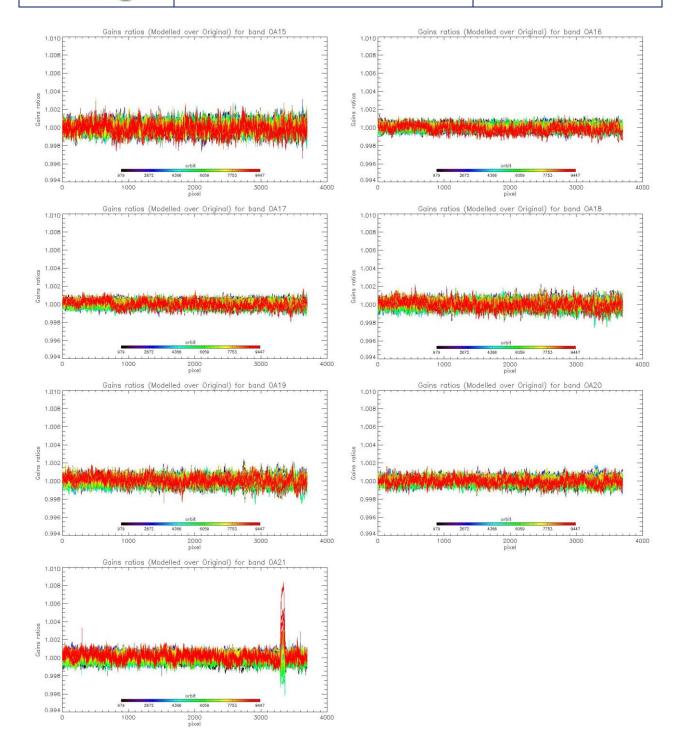


Figure 20: same as Figure 18 for channels Oa15 to Oa21.

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

There has been no calibration sequence S05 (reference diffuser) acquisition during cycle 025.

Consequently the last updated results (cycle 024) are still valid

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

One new calibration ADF has been generated during the reporting period. It includes the most recent Geometric Calibration Models delivered by ESTEC and is dedicated to internal performance assessment. It otherwise contain the operational calibration data and Dark LUTs from 22/1/2017. The product name is:

S3A\_OL\_1\_CAL\_AX\_20171122T083319\_20991231T235959\_20171219T174635\_\_\_\_\_\_\_MPC\_O\_AL\_R03.SEN3

## 1.2.5 Radiometric Calibrations for sun azimuth angle dependency and Yaw Manoeuvres for Solar Diffuser on-orbit re-characterization [OLCI-L1B-CV-270 and OLCI-L1B-CV-280]

This activity has not evolved during cycle 025 and results presented in previous report are still valid.

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

There has been no Spectral Calibration acquisitions sequence during cycle 025. However, two reasons triggered a repeated processing of the spectral calibration. First, the S09 acquisition from August 2017 (Orbit 7780) was not available in cycle 024 and second, we observed a slight change in the trend of the long term evolution. The change is remarkable for 770nm in cameras 1-4, shown in Figure 21.



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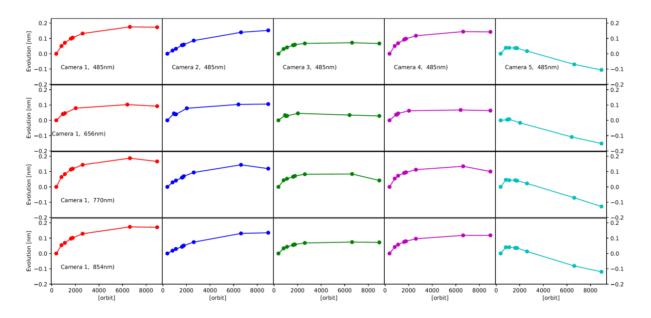
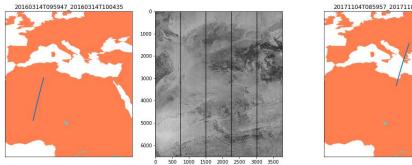


Figure 21: Temporal Evolution of the spectral calibration for absorption line features of S09: 485 nm, 656 nm, 770 nm and 854 nm, for the five modules of OLCI-A, as for cycle 024.

We suspected, that this feature is not reflecting a real spectral change but an artifact, induced by a change in the observed target. Within the commissioning phase, up to the S09 acquisition in May 2017 (orbit 6625), the investigated area was Saharan desert. Starting with the acquisitions in August 2017 (orbit 7780) and November 2017 (orbit 8935) the observed scene was South East Europe, the Mediterranean Sea and the northern Sahara. An example is given in Figure 22.



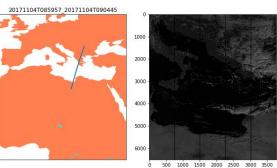


Figure 22: Ground track and gray scale image for two S09 acquisitions. Left: during commissioning phase, full desert, Right: operational phase, Eastern Europe → north Sahara.

To test our hypothesis, we reprocessed the last two acquisitions, but limited the processed lines to lines south of 29° N. The result is shown in Figure 23. In contrast to Figure 21, the acquisition from August 2017 (orbit 7780) was included, and further, the last two orbits (7780 and 8935) were limited to desert lines only. It follows, that our hypothesis, was wrong: **The change in temporal evolution is not an artefact due to the new target.** There are two main arguments against the hypothesis:

- 1. The change does not start with orbit 6625, but sometime between orbit 7780 and 8935
- 2. The change is also visible (but not as strong) for all used spectral line features (in particular in visible in Camera 1).

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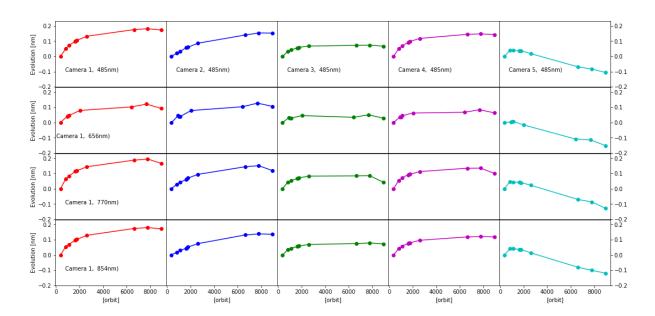


Figure 23: Temporal Evolution of the spectral calibration for absorption line features of S09: 485 nm, 656 nm, 770 nm and 854 nm, for the five modules of OLCI-A as for cycle 025.

#### 1.3.1.1 Conclusion

It remains undecided, if the observed change in temporal evolution is artificial or if it reflects a real spectral change. However, all changes are very small (< 0.02 nm within the last two acquisitions) and are not significant for all current L2 algorithms. We propose to further observe it.

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

### 1.4.1 SNR from Radiometric calibration data.

SNR computed for all calibration data as a function of band number is presented in Figure 24.

SNR computed for all calibration data as a function of orbit number for band Oa01 (the less stable band) is presented in Figure 25.

There is no significant evolution of this parameter during the current cycle and the ESA requirement is fulfilled for all bands.

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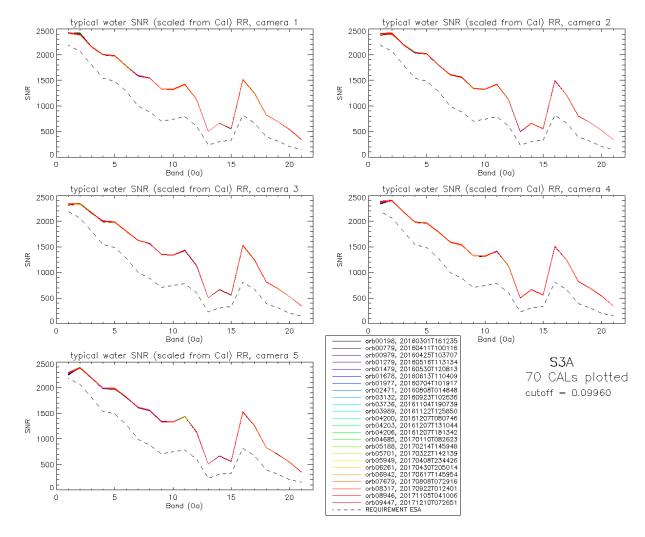


Figure 24: Signal to Noise ratio as a function of the spectral band for the 5 cameras. These results have been computed from radiometric calibration data. All calibrations except first one (orbit 183) are presents with the colours corresponding to the orbit number (see legend). The SNR is very stable with time: the curves for all orbits are almost superimposed. The dashed curve is the ESA requirement.

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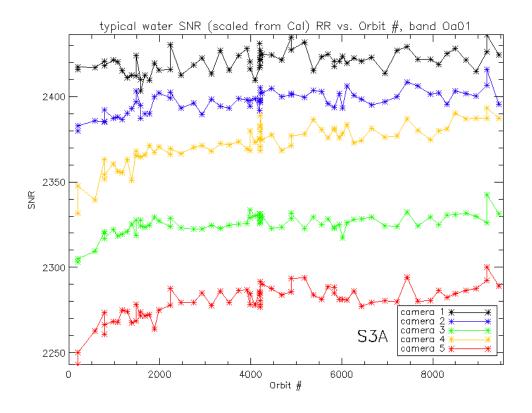


Figure 25: long-term stability of the SNR estimates from Calibration data, example of channel Oa1.

The mission averaged SNR figures are provided in Table 1 below, together with their radiance reference level. According to the OLCI SNR requirements, these figures are valid at these radiance levels and at Reduced Resolution (RR, 1.2 km). They can be scaled to other radiance levels assuming shot noise (CCD sensor noise) is the dominating term, i.e. radiometric noise can be considered Gaussian with its standard deviation varying as the square root of the signal; in other words:  $SNR(L) = SNR(L_{ref}) \cdot \sqrt{\frac{L}{L_{ref}}}$ . Following the same assumption, values at Full Resolution (300m) can be derived from RR ones as 4 times smaller.



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Table 1: SNR figures as derived from Radiometric Calibration data. Figures are given for each camera (time average and standard deviation), and for the whole instrument. The requirement and its reference radiance level are recalled (in mW.sr<sup>-1</sup>.m<sup>-2</sup>.nm<sup>-1</sup>).

?	$L_{ref}$	SNR	C	1	C	2	C	3	C4	1	С	5	А	II
nm	LU	RQT	avg	std	avg	std	avg	std	avg	std	avg	std	avg	std
400.000	63.0	2188	2420	6.3	2396	6.6	2325	6.0	2372	11.6	2279	9.8	2358	6.9
412.000	74.1	2061	2395	7.6	2409	5.5	2340	4.8	2402	4.4	2385	6.7	2386	3.9
442.000	65.6	1811	2161	5.3	2199	5.6	2166	4.7	2186	4.1	2197	4.8	2182	3.3
490.000	51.2	1541	2000	5.0	2036	5.5	1996	3.8	1981	4.0	1987	5.0	2000	3.6
510.000	44.4	1488	1979	5.4	2013	5.0	1983	4.8	1965	4.6	1984	4.9	1985	3.9
560.000	31.5	1280	1776	4.3	1801	4.3	1801	4.8	1794	4.1	1818	3.7	1798	3.2
620.000	21.1	997	1591	4.2	1610	4.2	1625	3.2	1593	3.4	1615	3.5	1607	2.7
665.000	16.4	883	1546	4.7	1558	4.2	1566	3.9	1533	4.1	1560	3.7	1553	3.2
674.000	15.7	707	1329	3.3	1338	3.8	1350	2.9	1324	3.0	1341	3.9	1336	2.6
681.000	15.1	745	1320	3.7	1326	3.1	1337	2.9	1314	2.6	1332	3.7	1326	2.3
709.000	12.7	785	1420	4.7	1420	4.3	1434	3.6	1413	3.7	1429	3.0	1423	3.1
754.000	10.3	605	1127	3.4	1120	3.1	1134	3.6	1124	2.5	1138	3.0	1128	2.6
761.000	6.1	232	502	1.3	498	1.3	505	1.3	500	1.1	507	1.5	502	1.0
764.000	7.1	305	662	1.7	657	1.6	667	2.2	661	1.7	669	2.0	663	1.5
768.000	7.6	330	558	1.7	554	1.3	562	1.4	556	1.6	564	1.3	559	1.2
779.000	9.2	812	1514	5.1	1496	5.1	1523	5.5	1509	5.5	1524	5.1	1513	4.7
865.000	6.2	666	1243	3.8	1213	4.4	1237	4.3	1245	3.9	1249	2.9	1238	3.3
885.000	6.0	395	823	1.9	801	1.7	814	2.1	824	1.5	831	1.8	818	1.3
900.000	4.7	308	691	1.5	673	1.3	683	1.8	693	1.5	698	1.5	687	1.1
940.000	2.4	203	534	1.1	522	1.1	525	1.1	539	1.2	542	1.3	532	0.8
1020.000	3.9	152	345	0.8	337	0.7	348	0.8	345	0.8	351	0.7	345	0.5

### 1.4.2 SNR from EO data.

There has been no update on SNR assessment from EO data during the cycle. Last figures (cycle 9) are considered valid.

### 1.5 Geometric Calibration/Validation

Regular monitoring using the GeoCal Tool implemented within the MPMF continues. Late August results confirm good performance. Monitoring of the geolocation performance by correlation with GCP imagettes using the GeoCal tool over the period confirms that OLCI is compliant with its requirement: the centroid of the geolocation error is around 0.25 to 0.35 pixel in both along-track and across-track directions (Figure 26 & Figure 27). Completion of the time series (started using the partial reprocessing



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dedicated to validation: 4 days every month between 26/04/16 and 12/03/2017) confirms the slow AL trend (Figure 28), the very last point, unless confirmed later on, is so far considered as an outlier.

Per camera analysis shows that a significant drift of camera 3 occurs yielding to non-compliance of that camera. Actions have been put in place for an update of the geometric Calibration in close cooperation with ESTEC. An updated set of Geometric Calibration Models from ESTEC has been delivered by mid-December and is currently under validation.

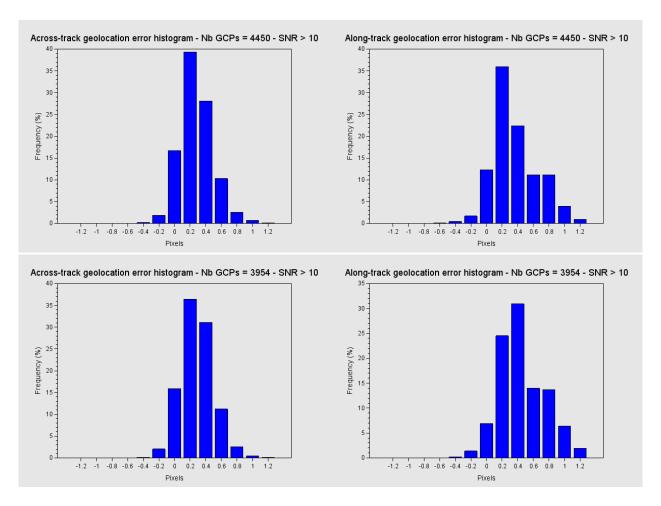


Figure 26: histograms of geolocation errors for the along-track (left) and across-track (right) directions, examples of 24/11/2017 (top) and 19/12/2017 (bottom).

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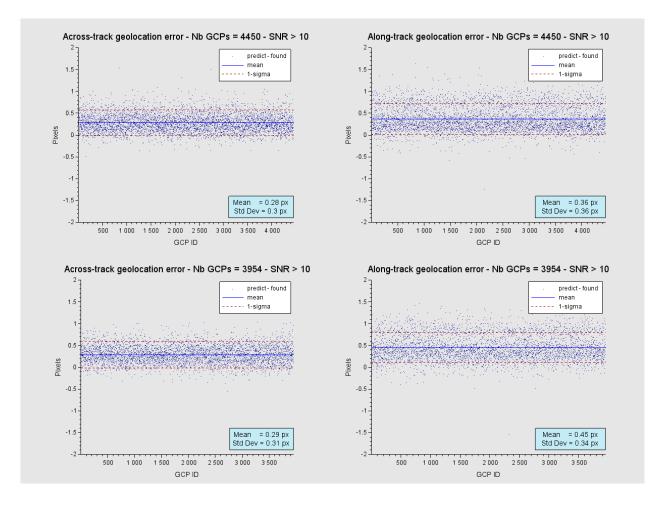


Figure 27: georeferencing error in along-track (left) and across-track (right) directions for all the GCPs, examples of 24/11/2017 (top) and 19/12/2017 (bottom).



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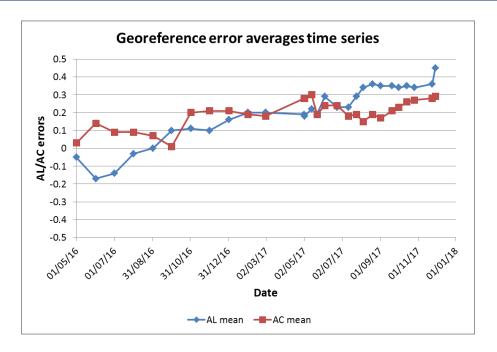


Figure 28: time series of geolocation errors for the along-track (blue) and across-track (red) directions over 18.7 months.

Several PDUs have been identified showing severely degraded geolocation performance (several km!). Investigation proved that all the affected products were NRT ones processed without the NAVATT data, an issue already identified in the past, still unexplained. Once reprocessed with appropriate NAVATT files product georeferencing is nominal, as for NTC products.

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### 2 OLCI Level 1 Product validation

### 2.1 [OLCI-L1B-CV-300], [OLCI-L1B-CV-310] - Radiometric Validation

#### 2.1.1 S3ETRAC Service

#### **Activities done**

The S3ETRAC 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 are used for the assessment and monitoring of the L1 radiometry (optical channels) by the ESLs.

All details about the S3ETRAC/OLCI and S3ETRAC/SLSTR statistics are provided on the S3ETRAC website <a href="http://s3etrac.acri.fr/index.php?action=generalstatistics">http://s3etrac.acri.fr/index.php?action=generalstatistics</a>

- Number of OLCI products processed by the S3ETRAC service
- Statistics per type of target (DESERT, SNOW, RAYLEIGH, SUNGLINT and DCC)
- Statistics per sites
- Statistics on the number of records

For illustration, we provide below statistics on the number of S3ETRAC/OLCI records generated per type of targets (DESERT, SNOW, RAYLEIGH, SUNGLINT and DCC). Note that due to a technical issue, S3ETRAC production rate has been reduced in December and came back to nominal only recently. As a consequence, figures below do not represent the full production of December 2017.



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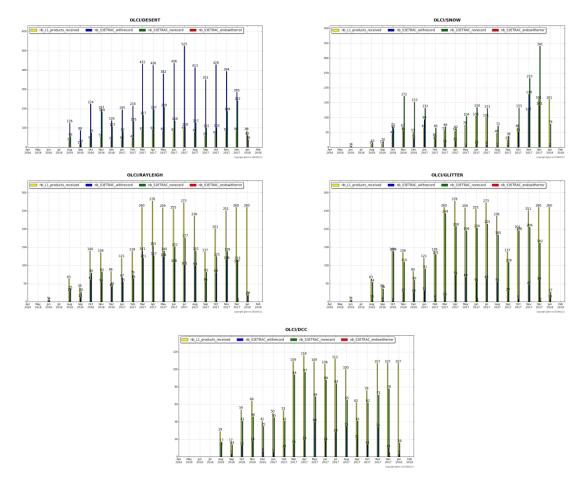


Figure 29: summary of S3ETRAC products generation for OLCI
(number of OLCI L1 products Ingested, yellow – number of S3ETRAC extracted products generated, blue –
number of S3ETRAC runs without generation of output product (data not meeting selection requirements), green
– number of runs ending in error, red, one plot per site type).

### 2.1.2 Radiometric validation with DIMITRI

### Highlights

- Run Rayleigh and Desert methods over the available products until 30<sup>th</sup> December 2017.
- About 116 new products from Cycle-25 are used in this analysis. The results (Rayleigh, Glint and PICS) are consistent with the previous cycle over the used CalVal sites.
- Good stability of the sensor could be observed, nevertheless, the time-series average shows higher reflectance over the VNIR spectral range with biases of 2%-4% except bands Oa06-Oa09
- Bands with high gaseous absorption are excluded.
- The results over Rayleigh and Glint methods from the reprocessed products (REP006: July 2016-July 2017) over ocean sites are analyzed, and seem to be consistent with the results of the current processing baseline (PB:2.23)..



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

1. Downloading and ingestion of all the available L1B-LN1-NT products in the S3A-Opt database over the 6 desert CalVal-sites (Algeria3 & 5, Libya 1 & 4 and Mauritania 1 & 2) has been performed until 30<sup>th</sup> December 2017.

- 2. The results are consistent overall the six used PICS sites (Figure 30). OLCI reflectance shows a good stability over the analyzed period.
- 3. The temporal average over the period **April 2016** December **2017** of the elementary ratios (observed reflectance to the simulated one) shows values higher than 2% (mission requirements) over all the VNIR bands (Figure 31). The spectral bands with significant absorption from water vapour and  $O_2$  (Oa11, Oa13 and Oa14) are excluded.
- 4. Algeria-3 site shows lower reflectance over the bands Oa17 (865 nm) than the other PICS since May 2017. This event is observed on Sentinel-2/MSI images too. It is most likely related to human/industrial activity in the area.

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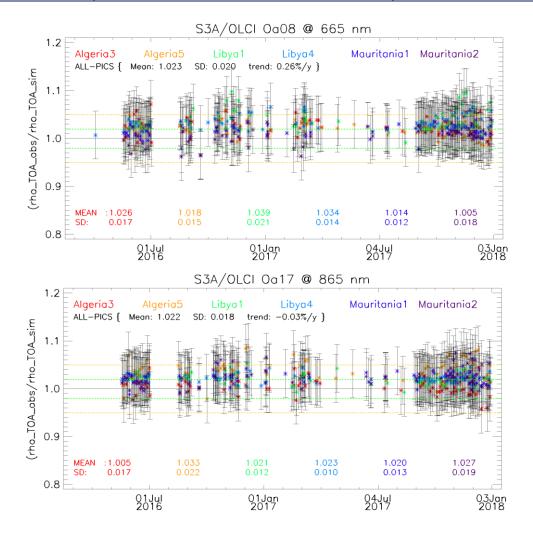


Figure 30: Time-series of the elementary ratios (observed/simulated) signal from S3A/OLCI for (top to bottom) bands Oa03, Oa8 and Oa17 respectively over Six PICS Cal/Val sites. Dashed-green and orange lines indicate the 2% and 5% respectively. Error bars indicate the desert methodology uncertainty.



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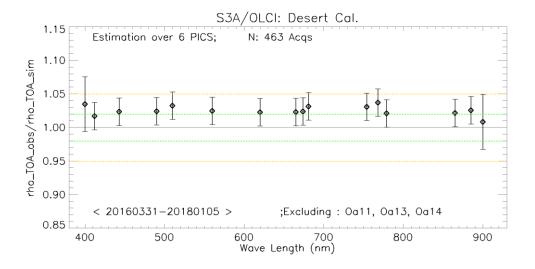


Figure 31: The estimated gain values for S3A/OLCI over the 6 PICS sites identified by CEOS over the period April 2016 – October 2017 as a function of wavelength. Dashed-green and orange lines indicate the 2% and 5% respectively. Error bars indicate the desert methodology uncertainty.

#### II-Intercomparison S3A/OLCI, S2A/MSI, LANDSAT/OLI and Aqua/MODIS over PICS

X-mission Intercomparison with MSI-A, OLI and MODIS-A is performed until December 2017. Figure 32 shows time-series of the elementary ratios from S2A/MSI, LANDSAT/OLI, Aqua/MODIS and S3A/OLCI over the LYBIA4 site over the period April-2016 until November -2017.

We observe a clear stability over the three sensors, associated with higher reflectance from OLCI wrt to MSI and MODISA. MODISA shows higher fluctuation wrt to MSI and OLCI ones.

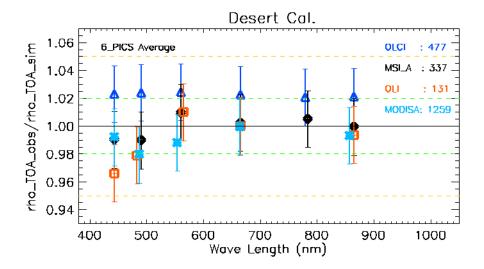


Figure 33 shows the estimated gain over the different time-series from different sensors (MODISA, MSIA, OLCI and OLI) over PICS for the common bands with S2A/MSI. The spectral bands with significant absorption from water vapor and  $O_2$  are excluded. OLCI-A seems to have higher gain (Figure 39) than the other sensors, which means that OLCI-A has higher reflectance that the ones simulated by PICS method.

# SENTINEL 3 Mission Performance Centre

#### **Sentinel-3 MPC**

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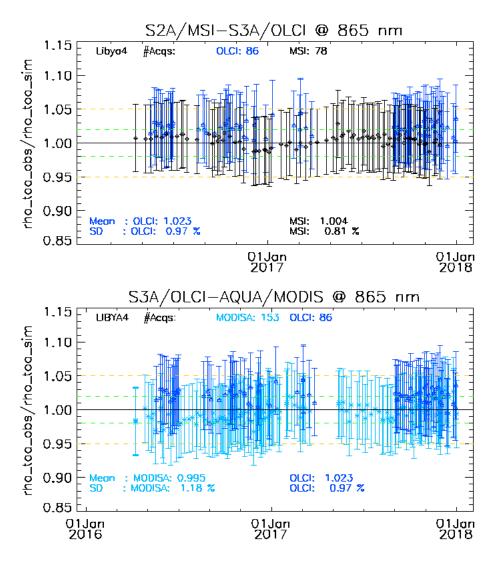


Figure 32: Time-series of the elementary ratios (observed/simulated) signal from (black) S2A/MSI, (blue) S3A/OLCI, and (Cyan) MODIS-A for band Oa17 (865nm) over the LIBYA4 site. Dashed-green and orange lines indicate the 2% and 5% respectively. Error bars indicate the desert methodology uncertainty.



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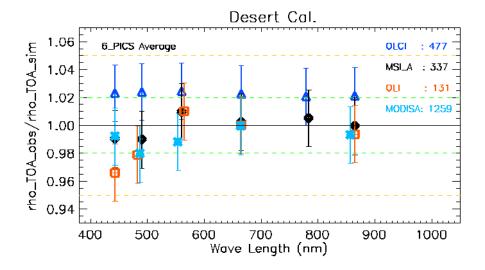


Figure 33: The estimated gain values (observed-signal /simulated-signal) averaged over different period (OLCI: 20160331-20180105; MSI-A: 20150701-20180105; MODIS-A: 20150101-20180101 and OLI: 20150701-20170330) over PICS as function of wavelength. The number of used-acquisitions from each sensor over the averaging period is indicated in the plot-legend.

#### **III-Validation over Rayleigh**

Rayleigh method has been performed over the available mini-files on the Opt-server until December 2017. The results produced with the configuration (ROI-AVERAGE) are consistent with the previous results of PICS method and from Cycles 24. While bands Oa01-Oa05 display a bias values between 2%-5%, bands Oa6-Oa9 exhibit biases within 2% (mission requirements) (Figure 34).

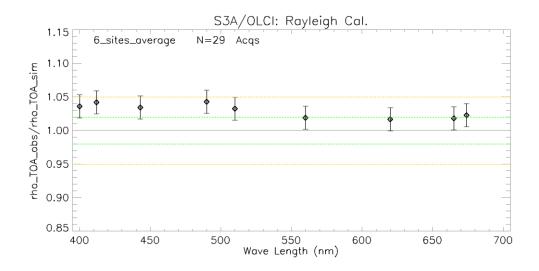


Figure 34: The estimated gain values for S3A/OLCI over the 6 Ocean CalVal sites (Atl-NW\_Optimum, Atl-SW\_Optimum, Pac-NE\_Optimum, Pac-NW\_Optimum, SPG\_Optimum and SIO\_Optimum) over the period December 2016 – December 2017 as a function of wavelength. Dashed-green, and orange lines indicate the 2%, 5% respectively. Error bars indicate the methodology uncertainty.



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#### **IV-Validation over Glint**

Glint calibration method with the configuration (ROI-PIXEL) has been performed over the period December 2016 – end December 2017 from the available mini-files. The outcome of this analysis shows a good consistency with Rayleigh and the desert outputs over the NIR spectral range (see Figure 35).

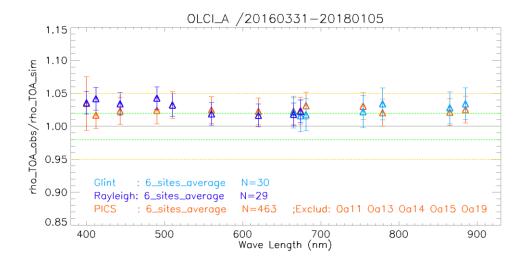


Figure 35: The estimated gain values for S3A/OLCI from Glint, Rayleigh and PICS over the period April 2016 – November 2017 for PICS and December 2016- December 2017 for Glint and December 2016-November 2017 for Rayleigh methods as a function of wavelength. We use the gain value of Oa8 from PICS method as reference gain for Glint. Dashed-green and orange lines indicate the 2% and 5% respectively. Error bars indicate the methods uncertainties.

#### V-Validation of the reprocessed products over ocean from REP006

Rayleigh and Glint method have been performed over the available granules from the reprocessed products (REP006: July 2016 – July 2017) over the 6 CalVal Ocean sites. Rayleigh results are produced with the configuration "ROI-AVERAGE" and Glint one with "ROI-PIXEL" configuration. We observe a slightly higher values of Rayleigh gain coefficients wrt the results of the current processing baseline (PB:2.23). This would be related to the different averaging periods (Compare Figure 36 with Figure 35).

The outcome of this analysis shows a good consistency with Glint and the Desert outputs of the current processing baseline (PB:2.23) over the NIR spectral range (see Figure 36).

# Mission Performance Control

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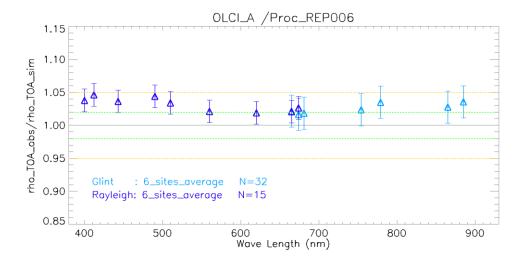
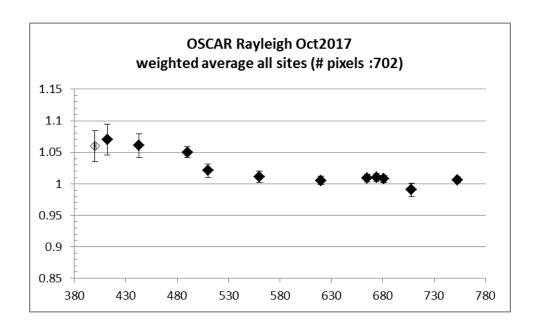


Figure 36: The estimated gain values for S3A/OLCI from Glint and Rayleigh methods over the reprocessed products (REP006: July 2016 – July 2017) as a function of wavelength. We use the gain value of Oa8 from Rayleigh method as reference gain for Glint. Dashed-green and orange lines indicate the 2% and 5% respectively.

Error bars indicate the methods uncertainties.

#### 2.1.3 Radiometric validation with OSCAR

The OSCAR Rayleigh method has been applied to the S3ETRAC data from the 6 oceanic calibration sites, over October and November. The average OSCAR Rayleigh results and the standard deviation calibration are shown below (Figure 37. Please note that the OSCAR Rayleigh results for band Oa01 have to be considered with care due to larger uncertainty in the Radiative transfer calculation.



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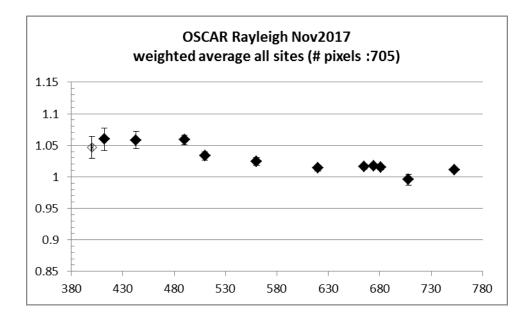


Figure 37: OSCAR Rayleigh Calibration results: weighted average over all sites and standard deviation for (a)
October 2017 and (b) November 2017

# 2.2 [OLCI-L1B-CV-320] - Radiometric Validation with Level 3 products

There has been no new result during the cycle. Last figures (cycle 20) are considered valid



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# 3 Level 2 Land products validation

# 3.1 [OLCI-L2LRF-CV-300]

In the frame of the validation of OTCI and OGVI, a specific study has been conducted regarding the impact of Cloud masking on the Land products. The current report presents an example of the repeatability of the OTCI products at 4 days distance, including the likely impact of undetected clouds.

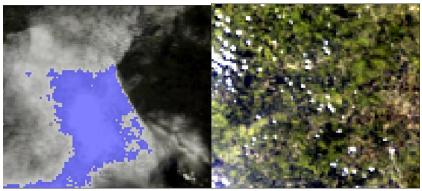


Figure 38: RGB images from the 10<sup>th</sup> and 14<sup>th</sup> of July 2017. Detected cloud pixels are shown in blue.

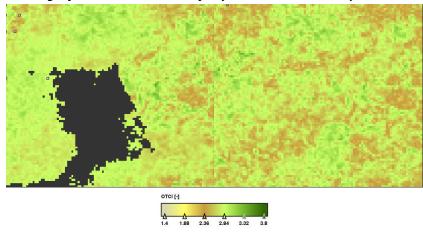


Figure 39: OTCI images for the 10<sup>th</sup> and 14<sup>th</sup> of July 2017. Scale bar is the same for both images.



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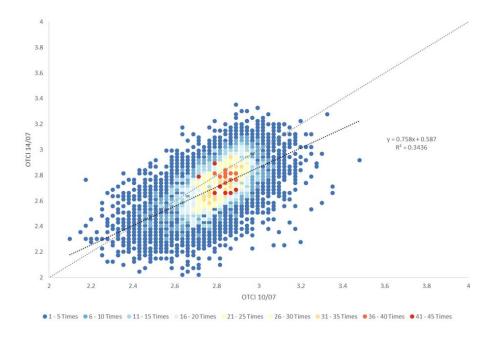


Figure 40: Relationship between the OTCI values for all pixels within the study area.

An area approximately 30 x 27 km was compared to see the affect that undetected cloud had upon OTCI values. Figure 38 shows the RGB images for each of the dates, within both images there were sections of undetected cloud. As can be seen within Figure 39 only a small section of the cloud seen on the  $10^{th}$  of July has been flagged and declared as *no data* in the OTCI band. None of the cloud has been picked up and flagged within the  $14^{th}$  of July image. The SZA in similar between the two images with a SZA of  $34^{\circ}$  on the  $10^{th}$  and  $35^{\circ}$  on the  $14^{th}$ , ruling out SZA as a factor in the differences in OTCI between the images.

Figure 40 shows how the OTCI values have changed between the two images for all of the pixels. For both images the range was similar, varying between 2 and 3.6. For the majority of the pixels OTCI levels are higher in the first image than in the second.

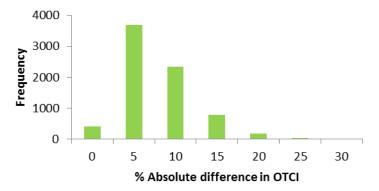


Figure 41: Percentage Absolute difference in OTCI

The percentage of absolute difference in OTCI between the pixels can be seen in Figure 41. The minimum absolute value was 0, the maximum value was 0.923 and the mean value was 0.149. 13.5% of pixels had a difference in OTCI values greater than 10%.

# SENTINEL 3 Mission

#### **Sentinel-3 MPC**

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# 3.2 [OLCI-L2LRF-CV-410 & OLCI-L2LRF-CV-420] — Cloud Masking & Surface Classification for Land Products

There has been no update of the Cloud Masking & Surface Classification for Land Products during Cycle 025. Last figures (cycle 24) are considered valid.



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# 4 Level 2 Water products validation

# 4.1 [OLCI-L2-CV-210, OLCI-L2-CV-220] — Vicarious calibration of the NIR and VIS bands

There has been no update of the SVC (System Vicarious Calibration) during Cycle 025. Last figures (cycle 17) are considered valid.

4.2 [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**

- The focus for this time period has been on the rolling archive None Time Critical (NT) data from September 1<sup>st</sup> onward. The switch from Near Real Time (NR) to NT data is motivated by the lack of provision to the NR rolling archive. The issue on the MPMF tools has been sorted out and the data provision has progressively returned to normal. However valid data (free of cloud for instance) are only available up to the end of November. This is probably due to bad winter weather conditions as all stations except for Lucinda are located in the Northern Hemisphere.
- All extractions and statistics have been regenerated from September 1<sup>st</sup> onward (rolling archive availability) for WFR data. The available matchups therefore cover the end of summer to fall situation. Time range available for last processing period covered September 1<sup>st</sup> to November 24<sup>th</sup> time period. The update in situ archive nonetheless provides a higher matchup number relative to last cyclic report.
- Only a few matchups with AERONET-OC stations and MOBY are available for this time period. These stations are located in the North Pacific (MOBY), Gulf of Mexico (WaveCIS) and Black Sea (Galata and Gloria) and Eastern US coast (MVCO). Aqua Alta Oceanographic Station hosting AERONET-OC AAOT has return to full operation late October after 5 months of full refurbishment. No Matchups are yet available.
- ARGANS did a specific study of Marine Reflectance validation from the reprocessed dataset over the Baltic Sea AERONET-OC in-situ sites. Preliminary results are presented below in sub-section "Validation against in-situ data in the Baltic Sea".

#### **Overall Water-leaving Reflectance performance**

Figure 42 below presents the scatterplots with statistics of OLCI FR versus in situ reflectance computed for the NT dataset. The data considered correspond to the latest processing baseline i.e. including SVC. Despite the winter season (all in situ data validation stations are in the Northern Hemisphere except for Lucinda), the statistics are remarkably good with r2 in the blue bands around 0.9 and RPD below 8% in



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the blue green bands. Table 2 to Table 10 below summarise the statistics over the previous and current reporting.

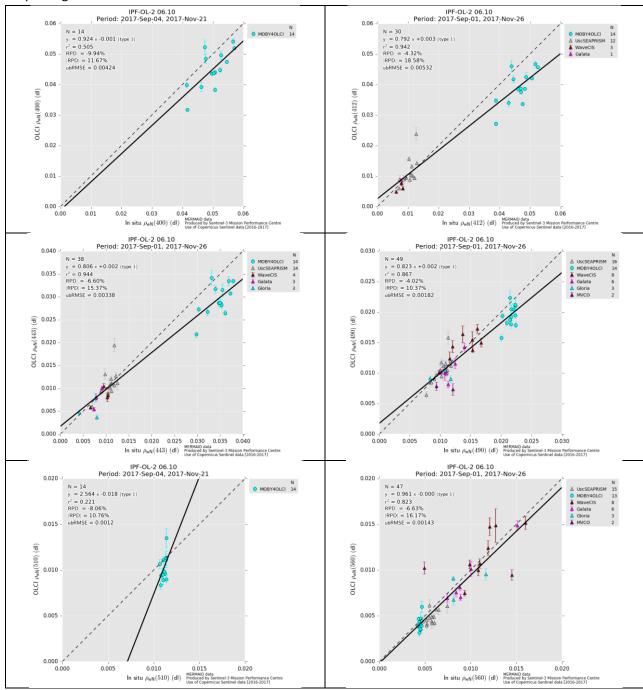


Figure 42: Scatter plots of OLCI versus in situ radiometry (FR data)



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Table 2: FR statistics over December 2016-March 2017 reporting period, cyclic report#17; FR data.

lambda	N	RPD	RPD	MAD	RMSE	slope	int.	r2
412	25	70,55%	77,47%	0,0055	0,0071	0,9486	0,0061	0,6787
443	25	43,34%	44,27%	0,0045	0,0056	1,1251	0,0028	0,9037
490	24	28,53%	28,53%	0,0048	0,0059	1,1634	0,0016	0,9611
510	2	31,69%	31,69%	0,0091	0,0093	2,0459	-0,0207	1,0000
560	17	15,44%	16,95%	0,0037	0,0052	1,1350	0,0003	0,9655
665	25	10,56%	34,24%	0,0010	0,0032	1,3661	-0,0013	0,9236

Table 3: FR statistics over February 2017-April 2017 reporting period, cyclic report#18; FR data.

lambda	N	RPD	RPD	MAD	RMSE	slope	int.	r2
412	60	88.15%	93.77%	0.0052	0.0066	1.0404	0.0048	0.6176
443	60	46.70%	50.43%	0.0038	0.0049	1.1195	0.0026	0.8046
490	59	31.38%	32.56%	0.0039	0.0046	1.1397	0.0019	0.9263
510	19	27.06%	27.06%	0.0050	0.0055	1.1474	0.0021	0.9486
560	53	13.42%	16.58%	0.0024	0.0035	1.1281	0.0001	0.9379
665	51	1.02%	29.79%	0.0000	0.0012	1.0202	-0.0001	0.7892

Table 4 FR statistics over April 2017-June 2017 reporting period, cyclic report#19; FR data.

lambda	N	RPD	RPD	MAD	RMSE	slope	intercept	r2
400	2	17.9%	17.9%	0.0088	0.0100	-2.3992	0.1784	1.0000
412	15	66.3%	66.3%	0.0055	0.0062	1.0618	0.0046	0.9611
443	15	36.7%	37.0%	0.0037	0.0044	1.1107	0.0023	0.9454
490	20	32.1%	32.3%	0.0038	0.0044	1.0153	0.0036	0.8224
510	10	35.9%	35.9%	0.0045	0.0048	0.8626	0.0064	0.7505
560	21	17.0%	21.9%	0.0020	0.0034	1.0925	0.0006	0.9205

Table 5: FR statistics over May 1<sup>st</sup> to July 10<sup>th</sup> reporting period, cyclic report#20; FR data.

lambda	N	RPD	RPD	MAD	RMSE	slope	intercept	r2
412	35	30.5%	38.2%	0.0025	0.0060	0.9699	0.0033	0.9364
443	43	25.2%	32.9%	0.0023	0.0061	1.0444	0.0012	0.9546
490	52	15.2%	22.2%	0.0020	0.0055	1.0462	0.0007	0.9756
510	21	24.1%	24.9%	0.0026	0.0039	1.1577	0.0004	0.9946
560	52	2.4%	11.1%	0.0004	0.0045	1.0196	-0.0002	0.9701
665	32	-6.9%	17.7%	-0.0002	0.0023	0.9830	-0.0001	0.8423

Table 6: FR statistics over the current reporting period (July 11<sup>th</sup> to August 23<sup>rd</sup>), cyclic report#21; FR data.

lambda	N	RPD	RPD	MAD	RMSE	slope	intercept	r2
412	19	18.0%	32.2%	0.0008	0.0066	1.0075	0.0006	0.9346
443	24	10.2%	24.1%	0.0012	0.0072	1.0752	-0.0012	0.9524
490	32	8.0%	18.8%	0.0012	0.0062	1.0504	-0.0005	0.9743
510	10	17.6%	19.3%	0.0011	0.0014	0.9560	0.0014	0.6316
560	32	-1.0%	13.0%	-0.0002	0.0055	1.0179	-0.0008	0.9618
665	22	-10.8%	18.4%	-0.0004	0.0027	0.9028	0.0003	0.7552



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Table 7: FR Statistics over the current reporting period (July 1s<sup>h</sup> to September 7<sup>th</sup>), cyclic report#22; FR data.

lambda	N	RPD	RPD	MAD	RMSE	slope	intercept	r2
412	6	81.5%	95.7%	0.0017	0.0064	0.6848	0.0063	0.7589
443	7	31.6%	49.7%	0.0003	0.0041	0.8661	0.0026	0.9401
490	11	5.8%	20.1%	0.0003	0.0022	0.9909	0.0004	0.9818
510	3	13.0%	20.2%	0.0009	0.0015	1.1289	0.0000	0.1477
560	11	-4.5%	12.9%	-0.0009	0.0021	0.9270	0.0004	0.9784
665	7	-22.5%	22.5%	-0.0008	0.0009	1.0191	-0.0009	0.9618

Table 8: FR Statistics over the current reporting period (September 13<sup>th</sup> to November 4<sup>th</sup>), cyclic report#23; FR data.

lambda	N	RPD	RPD	MAD	RMSE	slope	intercept	r2
400	0	None	None	None	None	None	None	None
412	7	-2.1%	32.6%	0.0006	0.0049	2.7334	-0.0157	0.7427
443	10	-2.2%	22.0%	-0.0001	0.0030	1.4778	-0.0043	0.5329
490	16	0.4%	11.9%	0.0000	0.0019	0.9282	0.0008	0.5065
560	16	-5.9%	13.7%	-0.0004	0.0014	1.0994	-0.0013	0.8961
665	4	-24.8%	24.8%	-0.0003	0.0003	1.0428	-0.0004	0.9994

Table 9: Statistics over the current reporting period (September 1<sup>st</sup> to November 24<sup>th</sup>), cyclic report#24; FR data.

lambda	N	RPD	RPD	MAD	RMSE	slope	intercept	r2
400	14	-9.9%	11.7%	-0.0049	0.0065	0.9241	-0.0012	0.5049
412	18	-14.1%	16.1%	-0.0057	0.0072	0.8357	0.0005	0.9427
443	24	-12.4%	16.2%	-0.0033	0.0046	0.8364	0.0005	0.9605
490	31	-5.5%	10.3%	-0.0011	0.0021	0.8081	0.0021	0.8710
510	14	-8.1%	10.8%	-0.0009	0.0015	2.5638	-0.0183	0.2207
560	30	-5.1%	12.1%	-0.0003	0.0011	1.0427	-0.0006	0.9236

Table 10: Statistics over the current reporting period (September 1<sup>st</sup> to November 26<sup>th</sup>), FR data.

lambda	N	RPD	RPD	MAD	RMSE	slope	intercept	r2
400	14	-9.9%	11.7%	-0.0049	0.0065	0.9241	-0.0012	0.5049
412	30	-4.3%	18.6%	-0.0030	0.0061	0.7920	0.0026	0.9417
443	38	-6.6%	15.4%	-0.0020	0.0039	0.8056	0.0017	0.9438
490	49	-4.0%	10.4%	-0.0008	0.0020	0.8235	0.0018	0.8666
510	14	-8.1%	10.8%	-0.0009	0.0015	2.5638	-0.0183	0.2207
560	47	-6.6%	16.2%	-0.0005	0.0015	0.9610	-0.0002	0.8234

Figure 43 and Figure 44 below present MOBY and WaveCIS in situ and OLCI time series over the current reprocessing period. MOBY in situ data have not yet available for the December and January time period. On the in situ and overlap time period, a good agreement is observed. WaveCIS present a more dynamic radiometric time series which is well captured by OLCI.

# Mission Performance Centre

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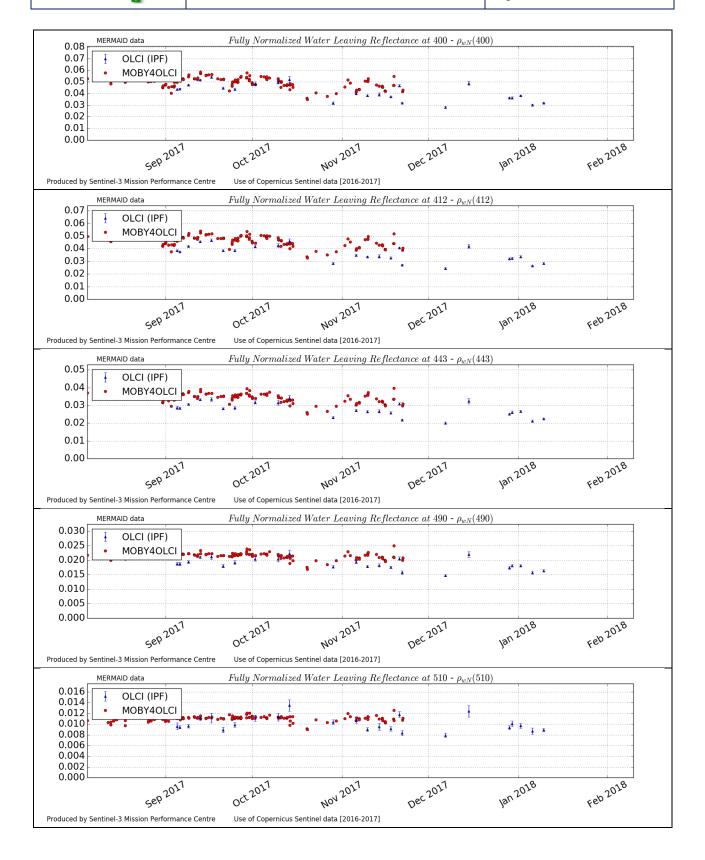
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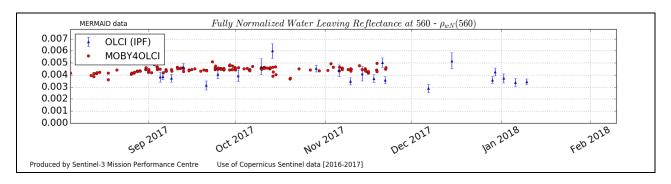
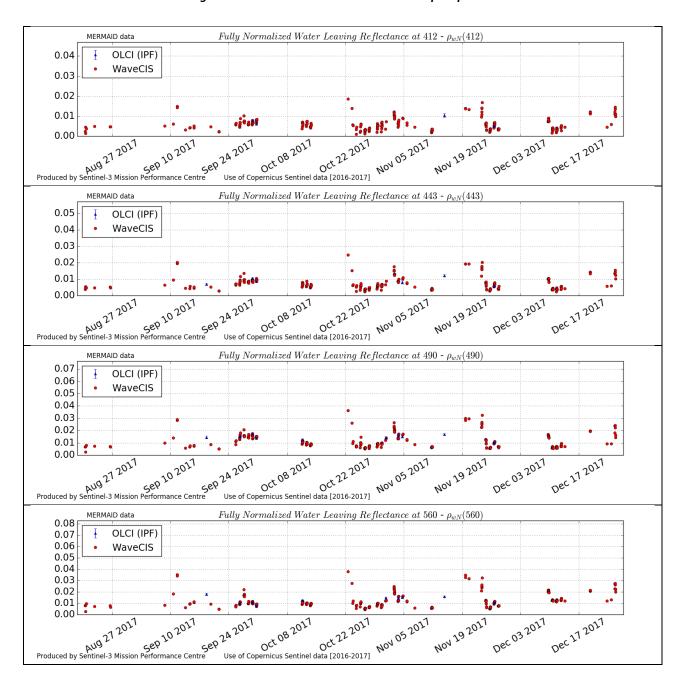


Figure 43: MOBY time series over current report period





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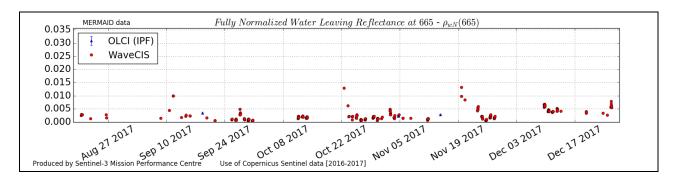


Figure 44: AERONET-OC WAVE-CIS time series over current report period

#### Validation against in-situ data in the Baltic Sea

#### **I-Used Datasets**

Downloading Ten S3A/OLCI L2-WFR products over the Baltic Seas in 2016 and 2017 were retrieved from the Copernicus Online Data Access web page (listed below).

It should be stressed here that the selected way of retrieving products do not ensure a consistent set of Processing Baseline over the dataset, thus limiting the representativeness of the results. Consolidated results will be presented in a future issue of the report.

#### **OLCI data around GDLT site**

- S3A\_OL\_2\_WFR\_\_\_20160507T095103\_20160507T095303\_20170515T085850\_0119\_004\_022\_\_\_\_\_MR1\_R\_NT\_002.SEN3
- S3A\_OL\_2\_WFR\_\_\_20160614T100601\_20160614T100801\_20170515T090106\_0119\_005\_179\_\_\_\_\_MR1\_R\_NT\_002.SEN3
- S3A\_OL\_2\_WFR\_\_\_20170713T095111\_201713T095411\_20170713T120404\_0179\_020\_022\_1980\_MAR\_O\_NR\_002.SEN3
- S3A\_OL\_2\_WFR\_\_\_20170731T084351\_20170731T084651\_20170731T124949\_0179\_020\_278\_1980\_MAR\_O\_NR\_002.SEN3
- S3A\_OL\_2\_WFR\_\_\_20170824T100224\_20170824T100524\_20170824T120733\_0179\_021\_236\_1980\_MARO\_NR\_002.SEN3

#### **OLCI data around HLT site**

- S3A OL 2 WFR 20170707T090618 20170707T090918 20170707T111250 0179 019 321 MAR O NR 002.SEN3
- S3A\_OL\_2\_WFR\_\_\_20170714T092500\_20170714T092800\_20170715T172655\_0179\_020\_036\_1979\_MAR\_O\_NR\_002.SEN3
- S3A OL 2 WFR 20170727T084735 20170727T085035 20170727T105331 0179 020 221 1979 MAR O NR 002.SEN3
- S3A OL 2 WFR 20170814T092115 20170814T092415 20170815T195055 0179 021 307 1908 MAR O NR 002.SEN3
- S3A\_OL\_2\_WFR\_\_\_20170923T084351\_20170923T084651\_20170923T104842\_0179\_022\_278\_1979\_MAR\_O\_NR\_002.SEN3

#### **The AERONET-OC** measurements from the following sites have been used:

- The Helsinki Lighthouse Tower (HLT), in the Gulf of Finland
- The Gustav Dalen Lighthouse Tower (GDLT), in the northern Baltic Proper.

The HLT, owned and managed by the Finnish Maritime Administration, is located in the Gulf of Finland (59.949° N, 24.926°), at approximately 12 nautical miles south-east of the harbour of Helsinki in an average water depth around 13 m.

GDLT, owned and managed by the Swedish Maritime Administration, is located in the northern Baltic Proper (58.594° N, 17.467° E) at approximately 10 nautical miles off the Swedish Coast and 5 nautical miles from the closest island with an average water depth around 16 m



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Both sites and their surroundings are shown in Figure 45.

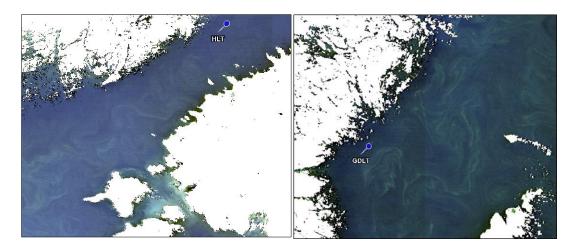


Figure 45: Location of the sites around the HLT (left) and the GDLT (right).

#### **II-Methods**

Comparisons were made using the OLCI L2-WFR products and AERONET-OC in-situ measurements for normalized water-leaving reflectance ( $\rho_{WN}$ ). The selection of OLCI L2-WRF products were restricted to images showing clear skies and filtered for contamination. For each band, the normalized water-leaving reflectance was filtered using invalid retrieval flag RWNEG\_\*. The AERONET-OC level 1.5 measurements have been used in this report. For the matchup analysis, data products were evaluated through the scattering and |RDP|, the bias as absolute relative percent difference  $|RDP| = \frac{1}{N} \sum_{|\mathcal{X}|} \frac{|\mathcal{Y} - \mathcal{X}|}{|\mathcal{X}|}$ . 100%

Where  $y_i$  is OLCI  $\rho_{WN}(\lambda)$ ,  $x_i$  is the in-situ  $\rho_w(\lambda)$ , and N the number of samples.

#### **III-Preliminary results**

The normalized water reflectance ( $\rho_{WN}$ ) from OLCI L2-WFR -averaged over the valid pixels from the 5 days - shows similar behaviors to the in-situ measurement of GDLT and HLT (Figure 46). The spectra and features are consistent with these of turbid coastal waters, and are similar to the values retrieved in oceanic areas by [Zibordi et al 2009b, Melin & Vantrepotte 2015]. Those features have been associated with case-2 waters dominated by color dissolved organic matter (CDOM) and a low aerosol load of continental origin. The measurement for total suspended matter (TSM) around GDLT and HLT by OLCI, respectively in Tables 1 and 2, are consistent with a strong presence of CDOM. Those results, for areas both located in intracontinental shallow waters, with limited exchange with the North Sea and important discharge of material due to human activities are consistent with previous local studies from [Darecki & Stramski 2004, Hojersley & Aas 2001].



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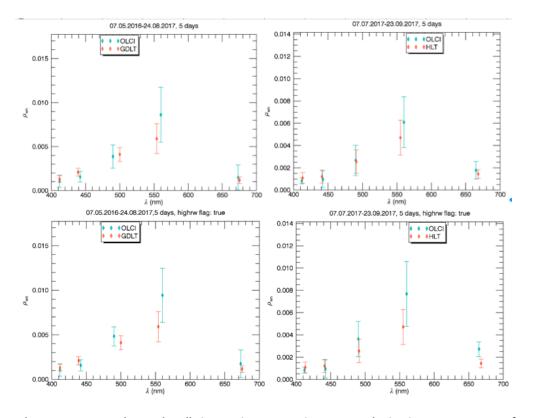


Figure 46: RhowWN averaged over the all-time series, comparing OLCI to the in-situ measurements from GDLT (left) and HLT (right). Top: OLCI flags RHWNEG\_b, bottom: OLCI flags RHWNEG\_b and WQSF\_lsb\_HIGHRW: raised

Although OLCI underestimates the value of  $\rho_{WN}$  compared to in-situ measurement for wavelength below 500nm and the opposite being noticeable above 560 nm, an important scattering of OLCI's estimation could be observed wrt in-situ measurements (Figure 46). In general, OLCI overestimates  $\rho_{WN}$  comparing to the in-situ measurements averaged over all the 9\*9 pixels matchups (Figure 47: upper row). The |RDP| values shown in Figure 48, reach maxima of 30-40% for both sites.

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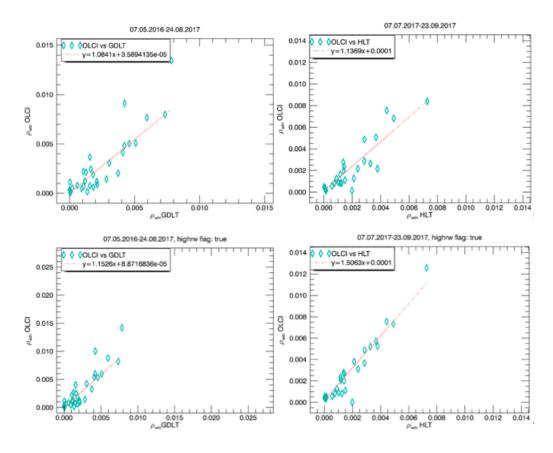
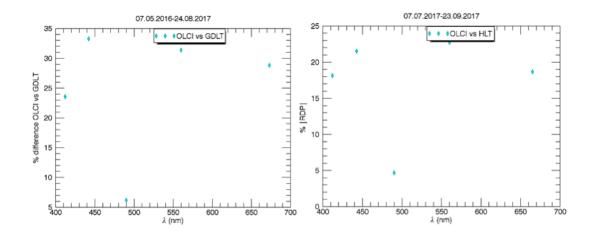


Figure 47: Regression plots over the 9\*9 matchups for the all-time series, comparing OLCI L2 to GDLT (left) and HLT (right) in-situ measurements of  $\rho_{WN}$ . Top: OLCI flags RHWNEG\_\*, bottom: OLCI flags RHWNEG\_\* and WQSF\_lsb\_HIGHRW: raised.





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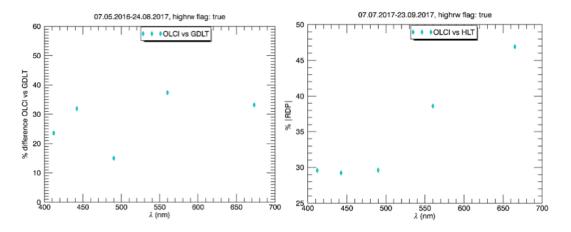


Figure 48: Absolute relative percent difference of OLCI L2  $\rho_{WN}$  estimations with in-situ measurements from GDLT (left) and HLT (right). Top: OLCI flags RHWNEG\_\*, bottom: OLCI flags RHWNEG\_\* and WQSF\_lsb\_HIGHRW\_\* raised.

The differences between OLCI and in-situ measurements in these areas can result from a combination of systematic effects in the in-situ measurements as well as inaccuracies in the algorithms used to build L2 OLCI products [S3 handbook]. In particular, in this coastal area, discrepancies at short wavelengths are likely to be linked with adjacency effects and limitations of the validity of the aerosol models and atmospheric correction algorithms near the coast. Indeed, the local aerosols may not be well represented by the operational aerosol model, as optically complex waters may trigger components of the atmospheric process [Franz et al 2007]. This is especially true in coastal areas dominated by CDOM and a low aerosol load of continental origin, as it is the case for the GDLT and HLT locations. In addition, those optically complex waters exhibit a lack of correlation between their optically significant constituents [Gordon & Morel 1983], which tend to affect the accuracy of remote sensing products and likely impacts the accuracy of measurement [Zibordi et al 2009b]. In this study, those effects are likely to be due to high spatial/temporal variability of seawater optical properties within and between the OLCI and in-situ measurement, the bottom reflectance due to shallow waters (13 and 16 m respectively). Adjacency effects are also expected, due to the high albedo of the nearby mainland with respect to that of the sea, likely to lead to overestimations in both satellite and in-situ data products [Zibordi et al 2009b].

The impact of the WQSF\_lsb\_HIGHRW flag, triggering the waters case 2 and case 1 OLCI L2 processors has also been considered in this study. Indeed, it has been shown that processing data using waters case 1 or 2 algorithms can have a strong impact, in particular at short wavelengths in coastal areas, as discussed in [Melin & Vantrepotte 2015]. The percent of pixels where the WQSF\_lsb\_HIGHRW flag has been raised in both areas is shown below in Table 11 and Table 12. On average, 52% of the pixels are considered as case 2 in the 9x9 pixel's matchups around GDLT, and only 28.6% around HLT.

The impact of the  $WQSF\_Isb\_HIGHRW$  flag on the  $\rho_{WN}$  can be noticed in for the average  $\rho_{WN}$  in middle and bottom part of Figure 2. As noticeable, the case 1 algorithm tends to underestimate  $\rho_{NW}$  compared to GDLT and HLT in-situ measurements below 490 nm. Generally, case 1 OLCI matchups tend to give lower values than case 1+2 OLCI matchups. The rise of the case 2 WQSF Isb HIGHRW flag has a



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particularly strong impact at 490 and 560 nm, with an increased overestimation of OLCI  $\rho_{NW}$  compared to in-situ measurements. These trends are confirmed by the scattering plots in Figures 3. The |RDP|, appearing in Figure 48 are increased respectively by 50% and 30% around GDLT and HLT at 560nm when considering only the case 2 (*WQSF\_lsb\_HIGHRW flag: true*) pixels.

The impact of the  $WQSF\_Isb\_HIGHRW$  flag is more highly noticeable around GDLT, where more pixels are flagged. In particular, the increased overestimation of  $\rho_{WN}$  by OLCI observed for the flagged pixel could indicate a link between the overestimation of  $\rho_{WN}$  by OLCI around GDLT and HLT above 490 nm and the rise of the  $WQSF\_Isb\_HIGHRW$  flag.

Figure 49 shows the total suspended matter from two different days were the number of case 2 pixels is high. However the integrated water vapor, aerosol T865 and A865 in the areas reach high level, especially the TSM, with high peak noticeable along the coasts and at the rivers' mouths, consistent with Case 2 water [Zibordi 2009 a, Darecki & Stramski 2004, Hojersley & Aas 2001].

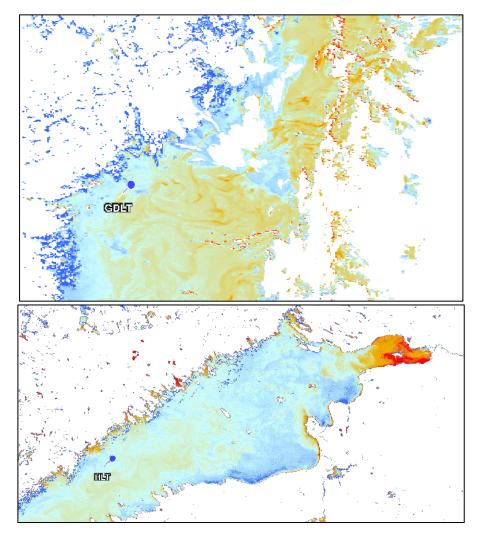


Figure 49: Total suspended matter concentration, estimated from OLCI L2 around GDLT on the 31/07/2017 (top) and HLT on the 14/08/2017 (bottom).



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#### Table 11: auxiliary data for OLCI around GDLT location.

date	% pixels	IWV	TSM	A865	T865	Ch. NN	Ch.	Ch.in-
	(highrw	(kg.m <sup>-2</sup> )	(mg.m <sup>-</sup>			(mg.m <sup>-</sup>	Oc4me	situ
	flag true)		3)			3)	(mg.m <sup>-</sup>	(mg.m <sup>-</sup>
							3)	3)
07.05.2016	55	6.61	0.30	0.27	0.39	0.67	4.81	1.88
14.06.2016	25	10.62	0.80	0.24	0.41	0.63	21.57	2.80
13.07.2017	32	24.62	2.24	0.37	0.17	10.35	2.52	1.36
31.07.2017	61	20.10	5.30	1.34	0.05	12.58	2.92	2.48
24.08.2017	87	18.26	1.08	1.42	0.14	5.52	0.50	2.61

#### Table 12: auxiliary data for OLCI around HLT location.

date	% pixels	IWV	TSM	A865	T865	Ch. NN	Ch.	Ch. in-
	(highrw	(kg.m <sup>-2</sup> )	(mg.m <sup>-3</sup> )			(mg.m <sup>-3</sup> )	Oc4me	situ
	flag true)						(mg.m <sup>-</sup>	(mg.m <sup>-</sup>
							3)	3)
07.07.2017	6	25.07	3.34	1.41	0.03	7.88	4.36	2.21
14.07.2017	7	22.05	2.94	0.60	0.09	12.90	6.12	2.49
27.07.2017	17	5.28	2.03	0.41	0.30	23.44	4.05	4.61
14.08.2017	4	28.41	3.72	1.30	0.02	6.48	5.11	5.54
23.09.2017	14	29.21	1.24	0.70	0.19	0.0	3.23	15.03

# 4.3 [OLCI-L2WLR-CV-510 & 520] - Cloud Masking & Surface Classification for Water Products

There has been no update of the Cloud Masking & Surface Classification for Land Products during Cycle 025. Last figures (cycle 24) are considered valid.

## 4.4 [OLCI-L2WLR-CV530] Validation of Aerosol Product

SpectralEarth is currently building a database that connects the *ProductIDs* of **all** OLCI level 1/2 data available at the Copernicus Open Access Hubs sites with data from the following ground based Networks:

SuomiNet (Integrated water vapour and cloud liquid water, based on GNSS measurements)



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AERONET (Aerosol optical thickness and Angstrom, integrated water vapour)

- MAN, Maritime Aerosol Network: (Aerosol optical thickness and Angstrom, integrated water vapour, from ship-borne aerosol optical depth measurements)
- AERONET-OC: (Aerosol optical thickness and Angstrom, integrated water vapour, water-leaving radiance)

The data hubs allow to identify **all** orbits, which are spatially and temporally close to ground based measurements. Currently, only the metadata is collected. In a next step, the corresponding OLCI files will be downloaded and the vicinity of the ground measurement will be cut out. The resulting dataset will then be used to quantitatively validate the aerosol and water vapour products.

This approach is similar to the validation activities, already performed. The difference is that the used OLCI-Data is as complete and extensive as possible.

In the meantime, last figures (cycle 24) are considered valid.

# 4.5 [OLCI-L2WLR-CV-380] Development of calibration, product and science algorithms

There has been no new developments on calibration, product and science algorithms during the cycle



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# 5 Validation of Integrated Water Vapour over Land & Water

SpectralEarth is currently building a database that connects the *ProductIDs* of **all** OLCI level 1/2 data available at the Copernicus Open Access Hubs sites with data from the following ground based Networks:

- SuomiNet (Integrated water vapour and cloud liquid water, based on GNSS measurements)
- AERONET (Aerosol optical thickness and Angstrom, integrated water vapour)
- MAN, Maritime Aerosol Network: (Aerosol optical thickness and Angstrom, integrated water vapour, from ship-borne aerosol optical depth measurements)
- AERONET-OC: (Aerosol optical thickness and Angstrom, integrated water vapour, water-leaving radiance)

The data hubs allow to identify **all** orbits, which are spatially and temporally close to ground based measurements. Currently, only the metadata is collected. In a next step, the corresponding OLCI files will be downloaded and the vicinity of the ground measurement will be cut out. The resulting dataset will then be used to quantitatively validate the aerosol and water vapour products.

This approach is similar to the validation activities, already performed. The difference is that the used OLCI-Data is as complete and extensive as possible.

In the meantime, last figures (cycle 24) are considered valid.



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# 6 Level 2 SYN products validation

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

Following the performance analysis of the SYN L2 aerosol retrieval module (see cycle 21), the following evolution has been implemented in the SYN L1/L2 IPF:

- Removal of SLSTR S4 channel associated with nadir and oblique views from the aerosol retrieval module and the Surface direction reflectance generation. This channel is dedicated to the cloud detection and should not be taken into account in the aerosol retrieval
- Removal of the remaining OLCI absorption channels, Oa13 and Oa19

This evolution implies a modification of the SYN L2 products with the suppression of 4 SDR files. The whole SYN SDR files have been renamed. The original OLCI or SLSTR channel index is now included in the filename instead if the internal SYN channel index.

The impact of this evolution on the SYN L2 Aerosol Optical Thickness values has been evaluated on 4 scenes, described in the following table:

INDEX	NAME	L1 Inputs	Geographical position
Scene_1	Australia	<ul> <li>OLCI L1         S3A_OL_1_EFR20170227T003223_20170227         T003523_20170228T054840_0179_015_002_324</li></ul>	or Consider  Or Co
Scene_2	BlackSea	<ul> <li>OLCI L1         S3A_OL_1_EFR20161119T083151_20161119         T083451_20161120T131651_0179_011_121_215         9_LN1_O_NT_002.SEN3</li> <li>SLSTR L1         S3A_SL_1_RBT20161119T083151_20161119         T083451_20161120T160211_0179_011_121_215         9_LN2_O_NT_002.SEN3</li> </ul>	Artic Ocean  Audition of the state of the st



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The range of retrieved AOT values over these 4 scenes before and after the implementation of this evolution has been compared to monthly values retrieved from TERRA/MODIS.

The following SYN images and histograms are created with SNAP, using the same color bar (see figure below). Global Monthly Maps have been downloaded from <a href="https://neo.sci.gsfc.nasa.gov">https://neo.sci.gsfc.nasa.gov</a>. The following images are ordered in a similar way:

- Top-left: SYN L2 Aerosol Optical Thickness before implementation and Top-right: SYN L2 AOT after implementation;
- Middle left: Histogram of the SYN L2 AOT before implementation and Middle right: Histogram of the SYN L2 AOT After implementation;
- Bottom: Aerosol Optical Thickness extracted from monthly Terra/MODIS maps



Figure 50 : Color Bar taken into account in Figure 51; Figure 52; Figure 53 and Figure 54 : (a) in the SYN L2 image from SNAP and (b) in the TERRA/MODIS images

# SENTINEL 3 Mission

## Sentinel-3 MPC

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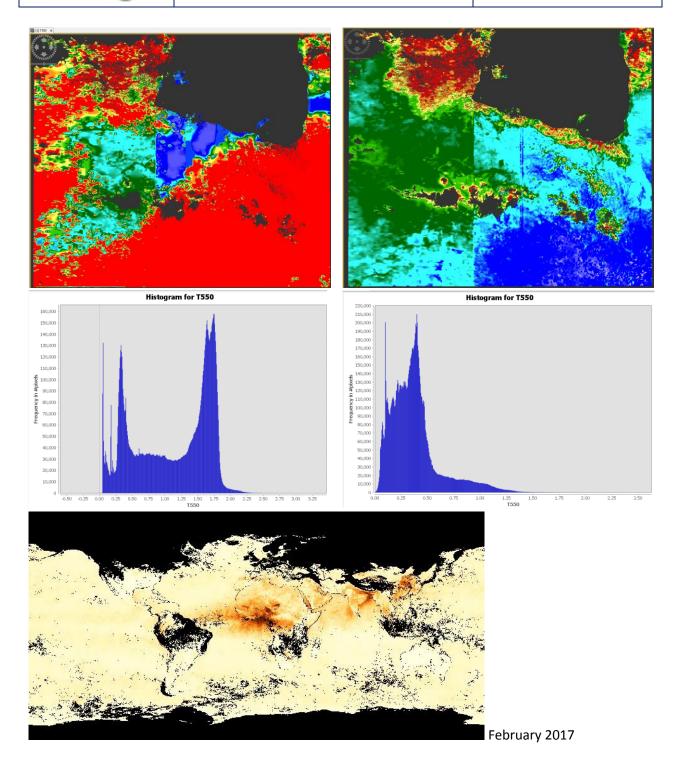


Figure 51 : Scene 1 – Australia

# SENTINEL 3 Mission Performance

#### **Sentinel-3 MPC**

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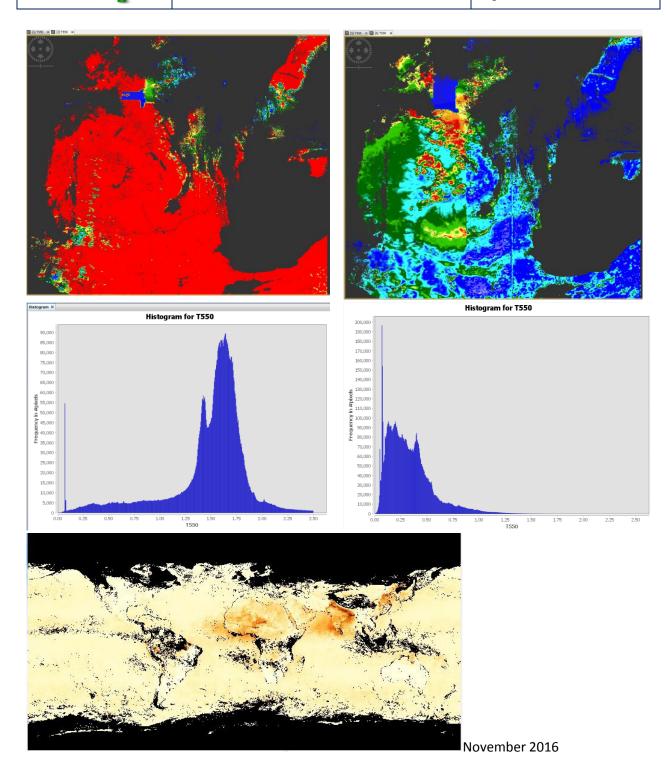


Figure 52 : Scene 2 – Black Sea

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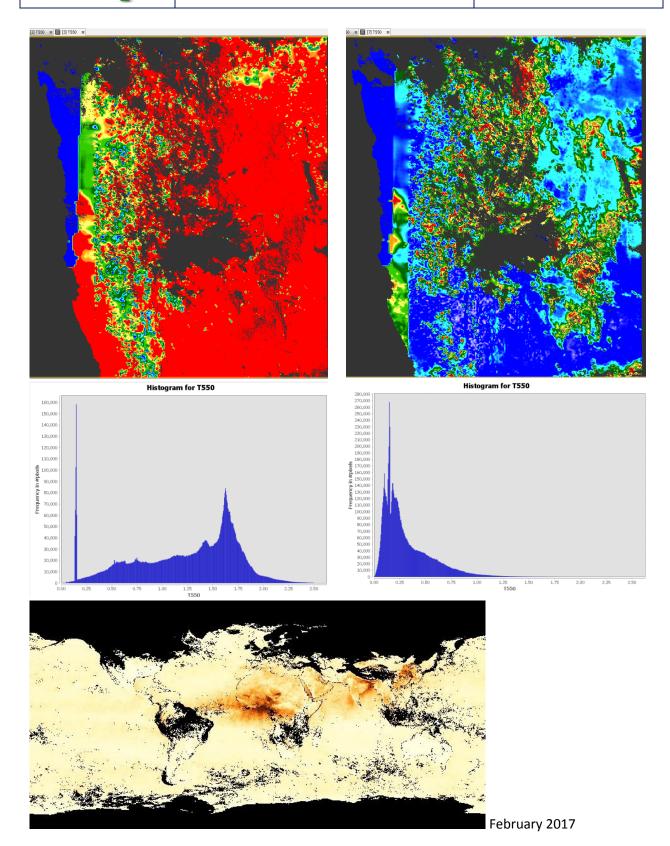


Figure 53 : Scene 3 - Chile



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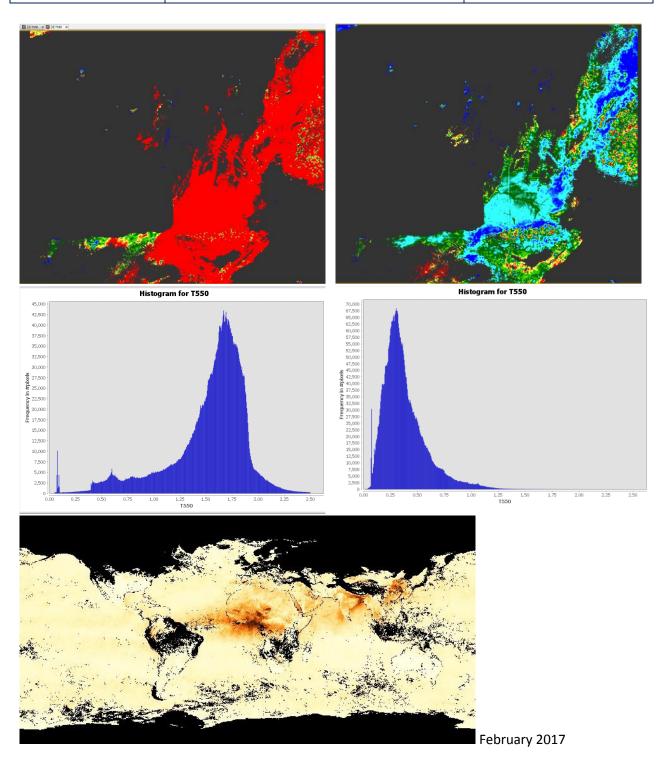


Figure 54 : Scene 4 - France

With this evolution, the resulting AOT values are very close to the expected ones (around 0.3) and no over-estimation is observed on the different geographical areas. In addition, the number of out-of-range SDR values has been drastically reduced for smallest OLCI channel.



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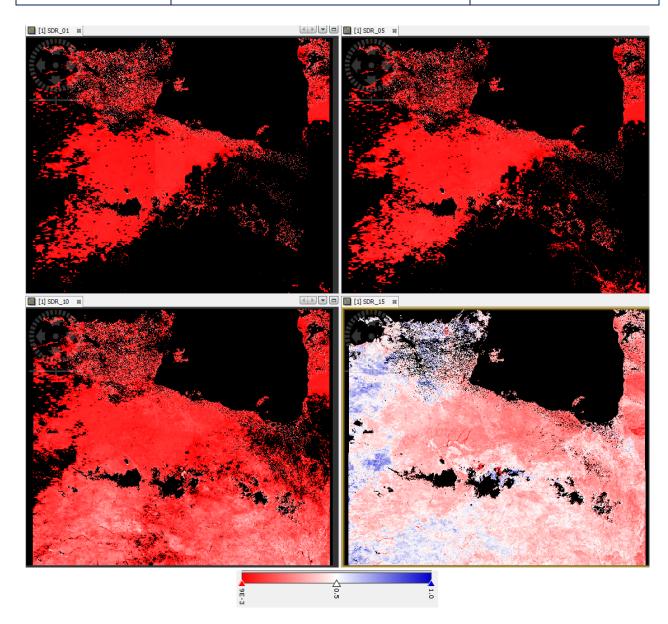


Figure 55: Surface direction reflectances outputted by IPF <u>before</u> implementation and associated with (top-left) Oa1; (top-right) Oa5; (bottom-left) Oa10; (bottom-right) Oa17; the used color bar is provided below the 4 images



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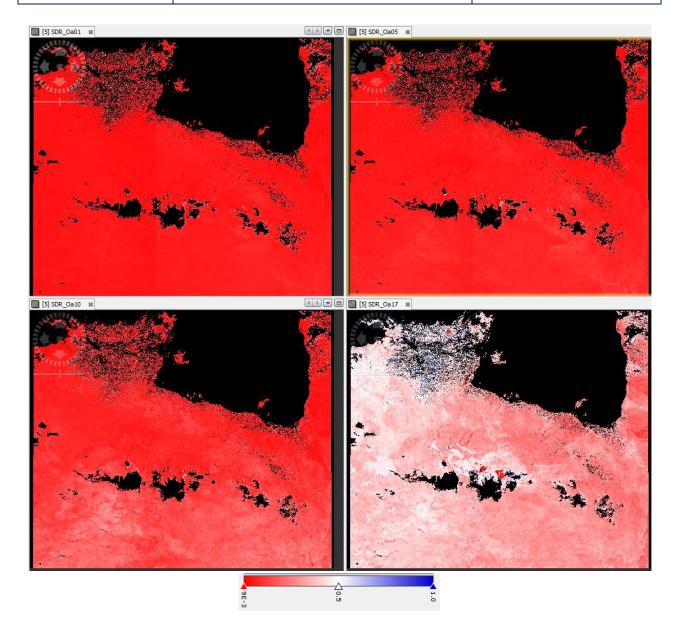


Figure 56 : Surface direction reflectances outputted by IPF <u>after</u> implementation and associated with (top-left)
Oa1; (top-right) Oa5; (bottom-left) Oa10; (bottom-right) Oa17; the used colour bar is provided below the 4
images

To assess the impact of this evolution of more product and, in particular on the VGT-like products, a global reprocessing of 1 week of data has been launched and is now available on the S3 MPC ESL server. This reprocessing includes all SY\_2\_SYN and all SY\_2\_VGP acquired during the first week of November 2016 and will be used to perform comparisons between SYN L2 products and in situ measurements.



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# **7** Events

One OLCI Radiometric Calibration Sequences has been acquired during Cycle 025:

S01 sequence (diffuser 1) on 10/12/2017 07:26 to 07:28 (absolute orbit 9447)



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# 8 Appendix A

Other reports related to the Optical mission are:

S3-A SLSTR Cyclic Performance Report, Cycle No. 025 (ref. S3MPC.RAL.PR.02-025)

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

**End of document**