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

## **S3 OLCI Cyclic Performance Report**

**S3-A** 

Cycle No. 041

Start date: 29/01/2019

End date: 25/02/2019

**S3-B** 

Cycle No. 022

Start date: 08/02/2019

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Mission
Performance
Centre

SENTINEL 3



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## **Changes Log**

Version	Date	Changes
1.0	14/03/2019	First Version

## **List of Changes**

Version	Section	Answers to RID	Changes



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## SENTINEL 3 Mission Performance

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

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## Sentinel-3 MPC

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## 1 Processing Baseline Version

### 1.1 Sentinel3-A

IPF	IPF / Processing Baseline version	Date of deployment
OL1	06.08 / 2.42	CGS: 12/12/2018 11:38 UTC (NRT) PAC: 12/12/2018 11:38 UTC (NTC)
OL2	06.12 / 2.38	CGS: 29/08/2018 09:24 UTC PAC: 29/08/2018 09:33 UTC
SY2	06.15 / 2.40	PAC: 13/09/2018 09:00 UTC
SY2_VGS	06.06 / 2.26	PAC: 11/01/2018 10:52 UTC

## 1.2 Sentinel3-B

IPF	IPF / Processing Baseline version	Date of deployment
OL1	06.08 / 1.12	CGS: 12/12/2018 11:38 UTC (NRT) PAC: 12/12/2018 11:38 UTC (NTC)
OL2	06.12 / 1.09	CGS: 29/08/2018 09:24 UTC PAC: 29/08/2018 09:33 UTC
SY2	06.16 / 1.16	PAC: 6/01/2019 10:09 UTC
SY2_VGS	06.06 / 1.00	PAC: 11/01/2018 10:52 UTC



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## 2 Instrument monitoring

### 2.1 CCD temperatures

#### 2.1.1 OLCI-A

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.

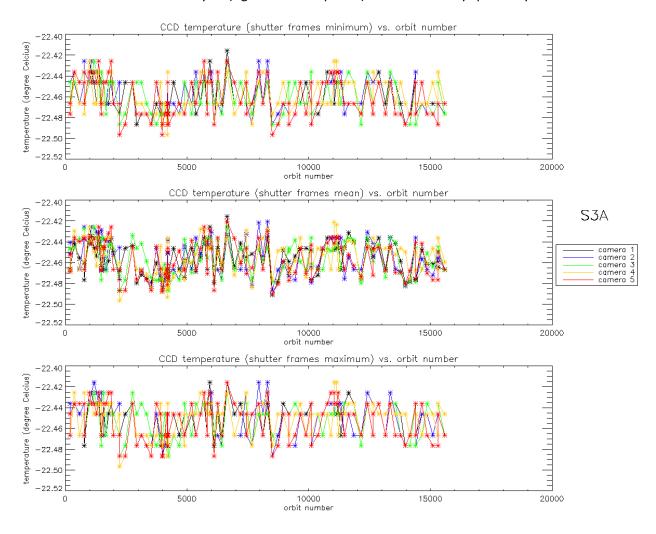


Figure 1: long term monitoring of OLCI-A CCD temperatures using minimum value (top), time averaged values (middle), and maximum value (bottom) provided in the annotations of the Radiometric Calibration Level 1 products, for the Shutter frames, all radiometric calibrations so far except the first one (absolut orbit 183) for which the instrument was not yet thermally stable.

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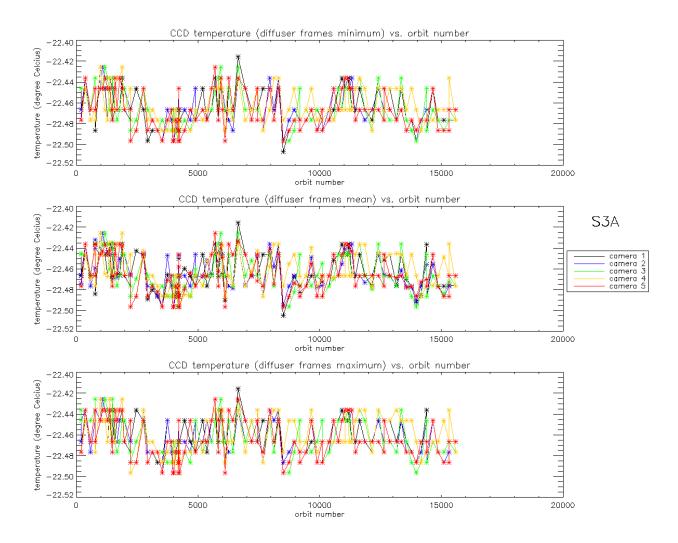


Figure 2: Same as Figure 1 for diffuser frames.

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

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#### 2.1.2 OLCI-B

As for OLCI-A, the variations of CCD temperature are very small (0.08 C peak-to-peak) and no trend can be identified. Data from current cycle (rightmost data points) do not show any specificity.

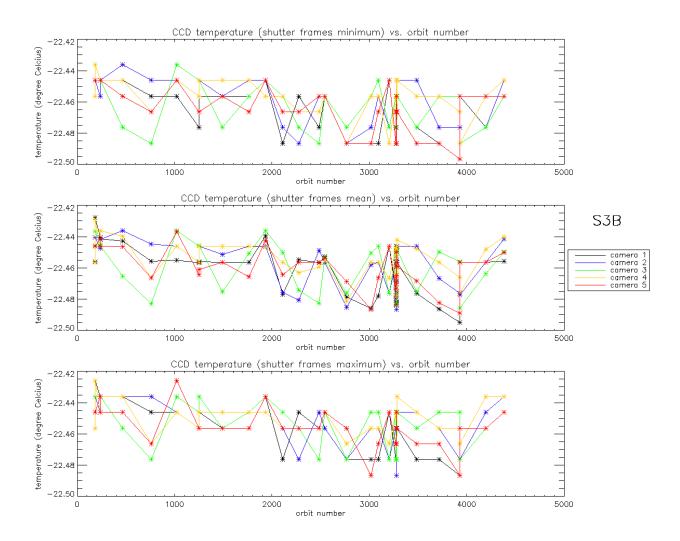


Figure 3: long term monitoring of OLCI-B CCD temperatures using minimum value (top), time averaged values (middle), and maximum value (bottom) provided in the annotations of the Radiometric Calibration Level 1 products, for the Shutter frames, all radiometric calibrations so far except the first one (absolute orbit 167) for which the instrument was not yet thermally stable.



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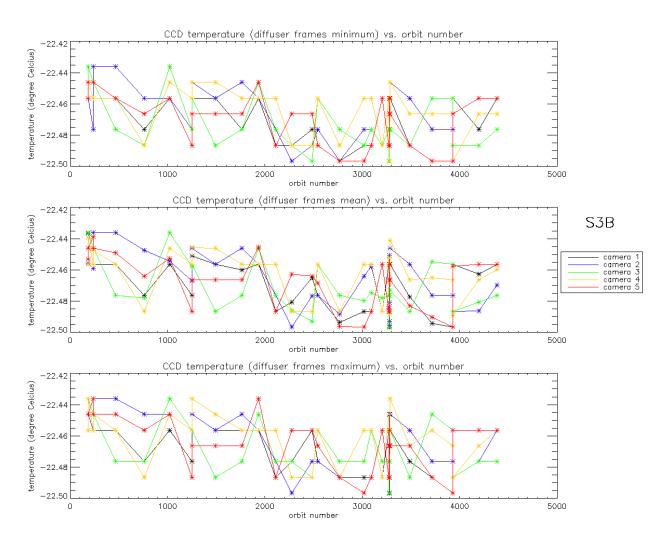


Figure 4: same as Figure 3 for diffuser frames.

#### 2.2 Radiometric Calibration

For OLCI-A, one Radiometric Calibration Sequence has been acquired during Cycle 041:

\$ S01 sequence (diffuser 1) on 14/02/2019 16:14 to 16:16 (absolute orbit 15598)

For OLCI-B, two Radiometric Calibration Sequences have been acquired during Cycle 022:

- S01 sequence (diffuser 1) on 14/02/2019 03:48 to 03:50 (absolute orbit 4197)
- S01 sequence (diffuser 1) on 27/02/2019 01:28 to 01:30 (absolute orbit 4381)

The acquired Sun azimuth angles are presented on Figure 5 for OLCI-A and Figure 6 for OLCI-B, on top of the nominal values without Yaw Manoeuvre (i.e. with nominal Yaw Steering control of the satellite).



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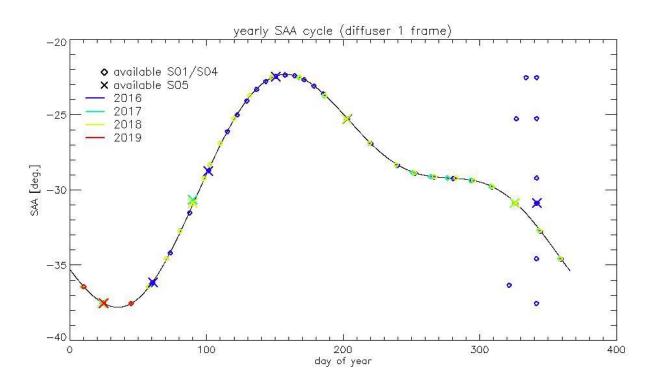


Figure 5: Sun azimuth angles during acquired OLCI-A Radiometric Calibrations (diffuser frame) on top of nominal yearly cycle (black curve). Diffuser 1 with diamonds, diffuser 2 with crosses, 2016 acquisitions in blue, 2017 in green, 2018 in yellow and 2019 in red.

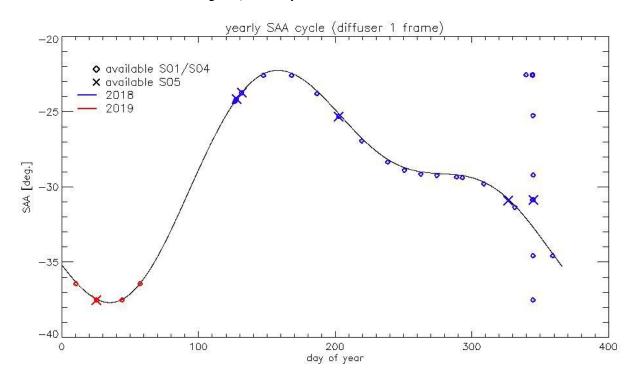


Figure 6: same as Figure 5 for OLCI-B (2018 in blue, 2019 in red).

Sun Azimuth Angles as a function of solar zenith Angles are presented in Figure 7 for OLCI-A and Figure 8 for OLCI-B.



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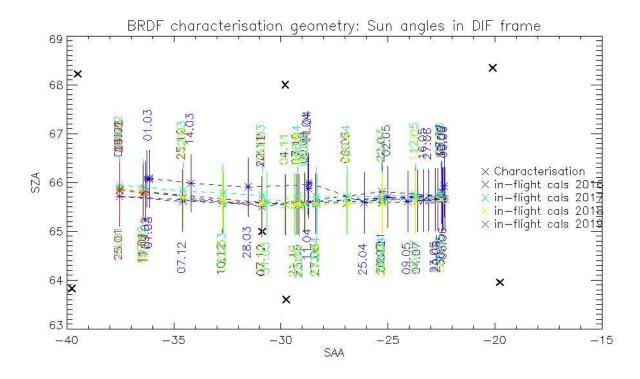


Figure 7: OLCI-A Sun geometry during radiometric Calibrations on top of characterization ones (diffuser frame)

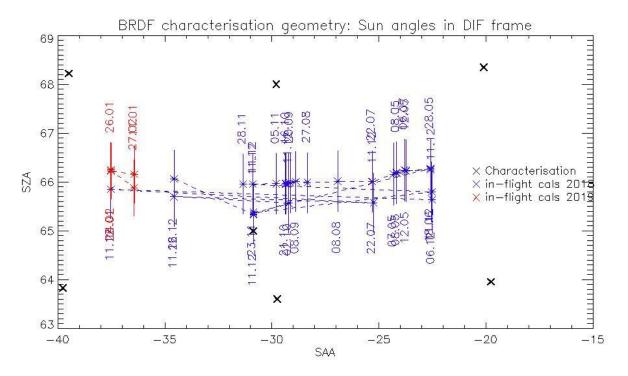


Figure 8: same as Figure 7 for OLCI-B



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#### 2.2.1 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 9.

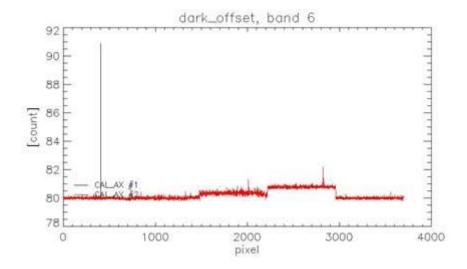


Figure 9: Dark Offset table for band Oa06 with (red) and without (black) HEP filtering (Radiometric Calibration of 22 July 2017). The strong HEP event near pixel 400 has been detected and removed by the HEP filtering.

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

#### 2.2.1.1 OLCI-A

#### **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.

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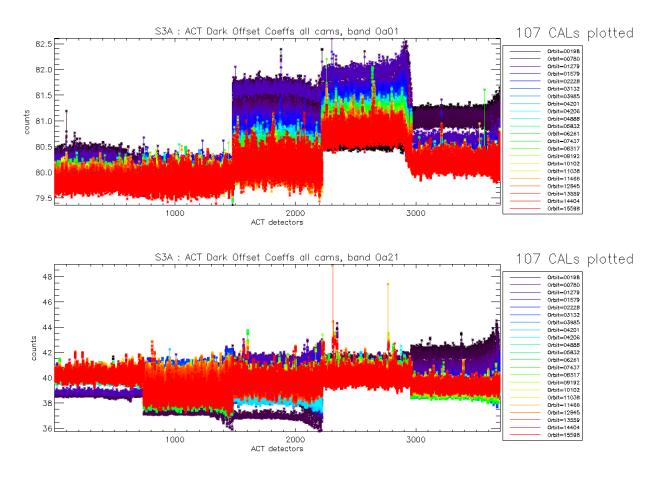


Figure 10: OLCI-A Dark Offset for band Oa1 (top) and Oa21 (bottom), all radiometric calibrations so far except the first one (orbit 183) for which the instrument was not thermally stable yet.

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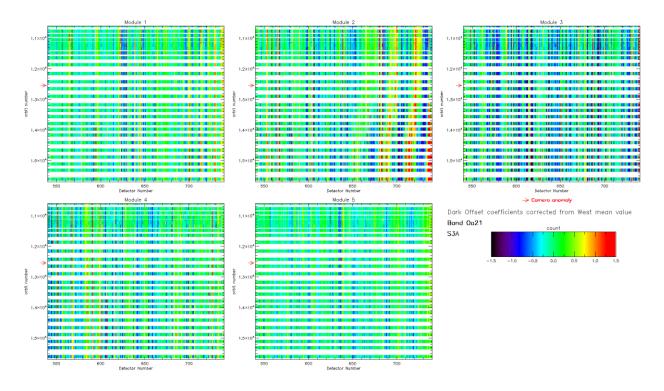


Figure 11: map of OLCI-A periodic noise for the 5 cameras, for band Oa21. X-axis is detector number (East part, from 540 to 740, where the periodic noise occurs), Y-axis is the orbit number. Y-axis range is focused on the most recent 5000 orbits. The counts have been corrected from the West detectors 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. At the beginning of the mission the periodic noise for band Oa21 had strong amplitude in camera 2, 3 and 5 compared to camera 1 and 4. However PN evolved through the mission and these discrepancies between cameras have been reduced. At the time of this Cyclic Report Camera 2 still shows a slightly higher PN than other cameras.



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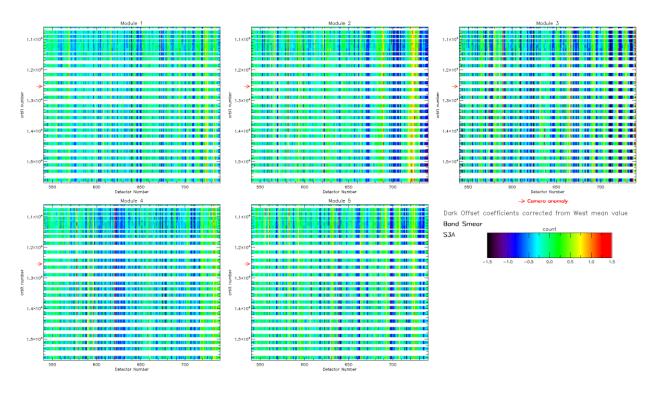


Figure 12: same as Figure 11 for smear band.

Figure 11 and Figure 12 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 from one CAL to the other and consequently to highlight the shape of the PN. Maps are focused on the last 200 EAST detectors where PN occurs and on a time range covering only the last 5000 orbits in order to better visualize the current cycle's CALs.

As there was no camera anomaly during the current cycle, there is no sudden change of periodic noise to report during the current cycle. For camera 2 band Oa21 a slight PN phase drift occurred between orbit 13500 and 14500 but is now stabilized. The hot pixel impacting one of the "East blind pixels" for camera 4 smear band, presented in cycle #26 report, is still present and stable.

#### **Dark Currents**

Dark Currents (Figure 13) 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 except the small regular increase (almost linear), for all detectors, since the beginning of the mission (see Figure 14).



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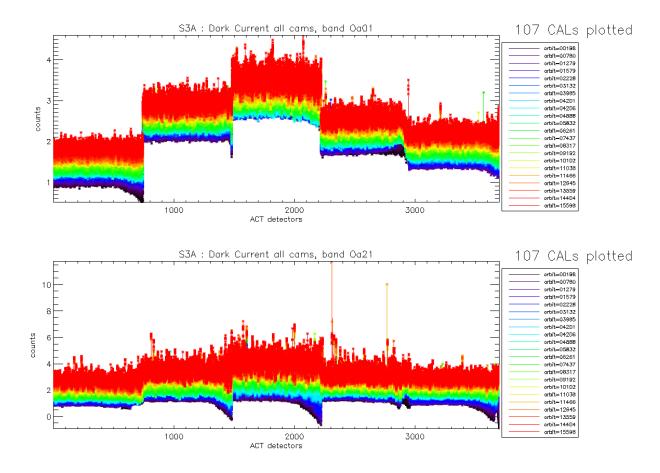


Figure 13: OLCI-A Dark Current for band Oa1 (top) and Oa21 (bottom), all radiometric calibrations so far except the first one (orbit 183) for which the instrument was not thermally stable yet.

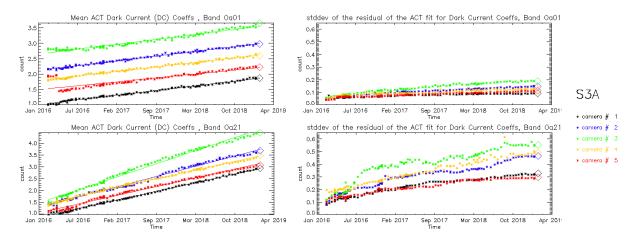


Figure 14: left column: ACT mean on 400 first detectors of OLCI-A Dark Current coefficients for spectral band Oa01 (top) and Oa21 (bottom). Right column: same as left column but for Standard deviation instead of mean.

We see an increase of the DC level as a function of time especially for band Oa21.

A possible explanation of the regular increase of DC 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,



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generating more and more hot pixels at long term scales. Indeed, when computing the time slopes of the spatially averaged Dark Current as a function of band, i.e. the slopes of curves in left plots of Figure 14, one can see that Oa21 is by far the most affected, followed by the smear band (Figure 15, left); when plotting these slopes against total band width (in CCD rows, regardless of the number of micro-bands), the correlation between the slope values and the width becomes clear (Figure 15, right).

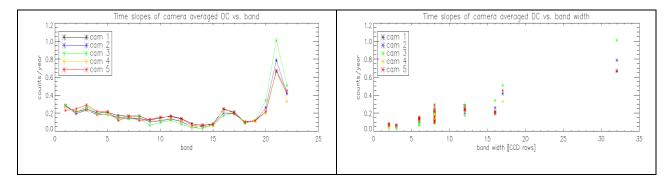


Figure 15: OLCI-A Dark current increase rates with time (in counts per year) vs. band (left) and vs. band width (right)

#### 2.2.1.2 OLCI-B

#### **Dark Offsets**

Dark offsets for OLCI-B show a similar behaviour than for OLCI-A: mean level gaps between different orbits, induced by the presence of a pseudo periodic noise on the east edge of the cameras with a drifting phase.

Evolution of OLCI-B Dark Offset coefficients for band Oa01 and Oa21 are represented in Figure 16.

The periodic noise maps are shown for band Oa21 and smear band respectively in Figure 17 and Figure 18. As for OLCI-A the strong periodic noise phase and amplitude drift, present at the very beginning of the mission, tends to stabilize.

There is no anomalous behaviour of dark offsets coefficients or periodic noise to report during the reporting period.

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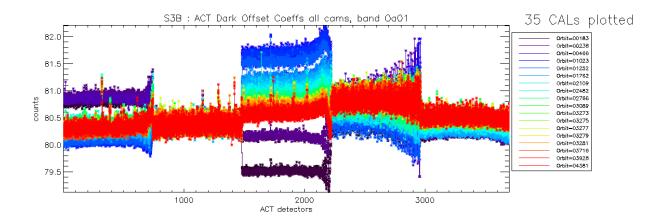
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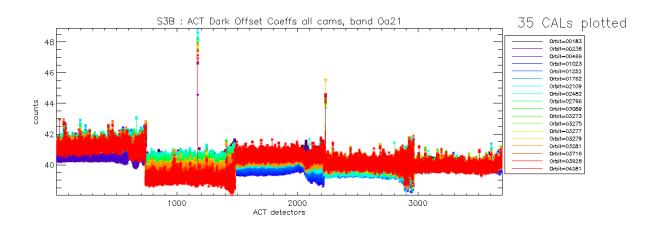


Figure 16: OLCI-B Dark Offset for band Oa1 (top) and Oa21 (bottom), all radiometric calibrations so far except the first one (orbit 167) for which the instrument was not thermally stable yet.



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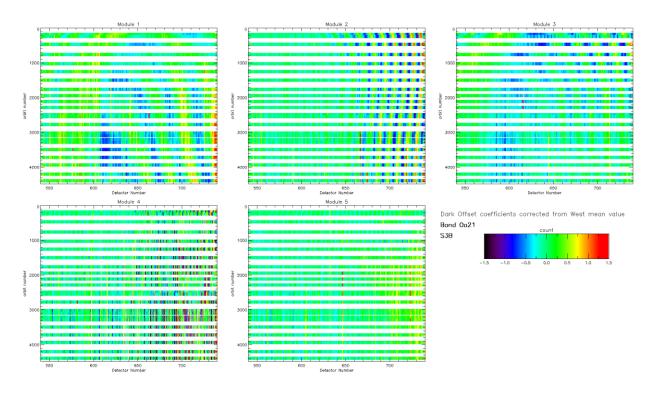


Figure 17: OLCI-B map of periodic noise for the 5 cameras, for band Oa21. X-axis is detector number (East part, from 540 to 740, where the periodic noise occurs), Y-axis is the orbit number. The counts have been corrected from the West detectors mean value (not affected by periodic noise) in order to remove mean level gaps and consequently to have a better visualisation of the long term evolution of the periodic noise structure.

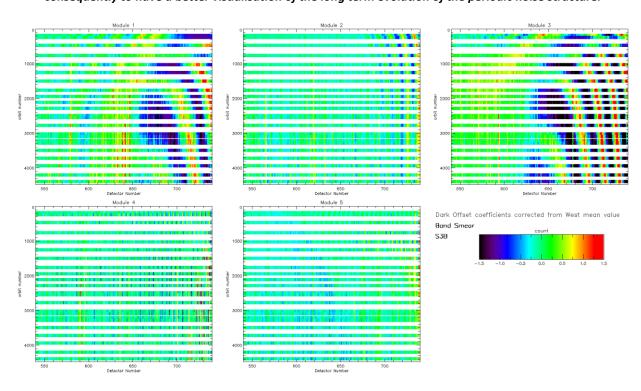


Figure 18: same as Figure 17 for smear band.

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#### **Dark Currents**

As for OLCI-A there is no significant evolution of the Dark Current coefficients (Figure 19) during the current cycle except the small regular increase (almost linear), for all detectors, since the beginning of the mission (see Figure 20) probably due to an increase of hot pixels (see Figure 21).

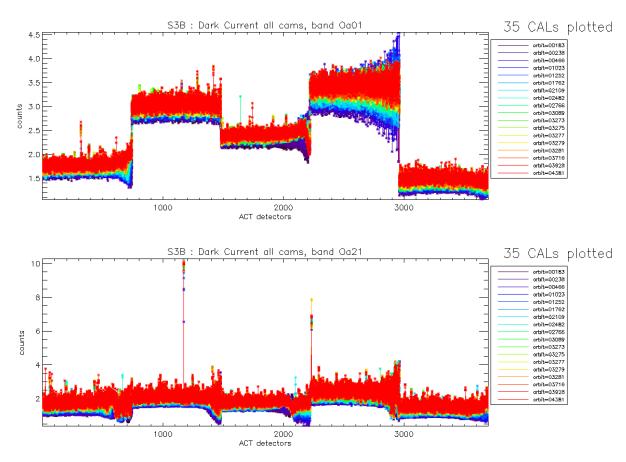


Figure 19: OLCI-B Dark Current for band Oa1 (top) and Oa21 (bottom), all radiometric calibrations so far except the first one (orbit 167) for which the instrument was not thermally stable yet.

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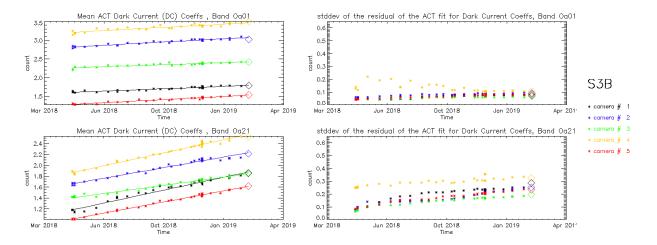


Figure 20: left column: ACT mean on 400 first detectors of OLCI-B Dark Current coefficients for spectral band Oa01 (top) and Oa21 (bottom). Right column: same as left column but for Standard deviation instead of mean.

We see an increase of the DC level as a function of time especially for band Oa21.

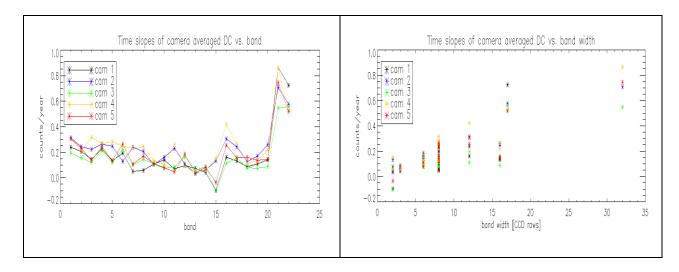


Figure 21: OLCI-B Dark Current increase rates with time (in counts per year) vs. band (left) and vs. band width (right)



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

#### 2.2.2.1 Instrument response monitoring

#### 2.2.2.1.1 OLCI-A

Figure 22 shows the gain coefficients of every pixel for two OLCI-A channels, Oa1 (400 nm) and Oa21 (1020 nm), highlighting the significant evolution of the instrument response since early mission.

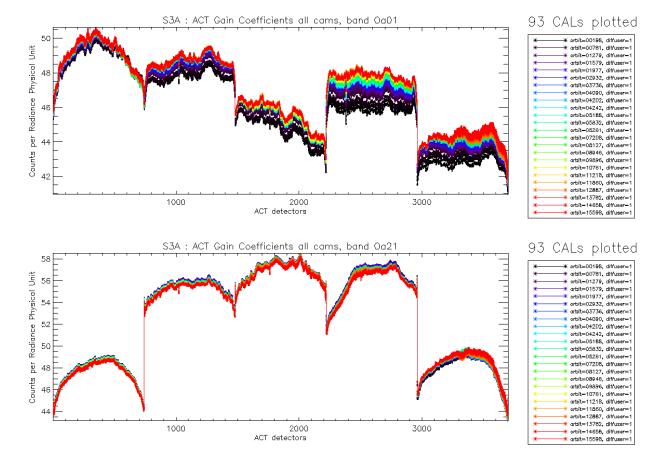


Figure 22: OLCI-A Gain Coefficients for band Oa1 (top) and Oa21 (bottom), all diffuser 1 radiometric calibrations so far except the first one (orbit 183) for which the instrument was not thermally stable yet.

The gains plotted in Figure 22, 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 23 displays a summary of the time evolution derived from post-processed gains: the cross-track average of the BRDF corrected gains (taking into account the diffuser ageing) is plotted as a function of



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time, for each module, relative to a given reference calibration (the 07/12/2016). 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 1 and 4.

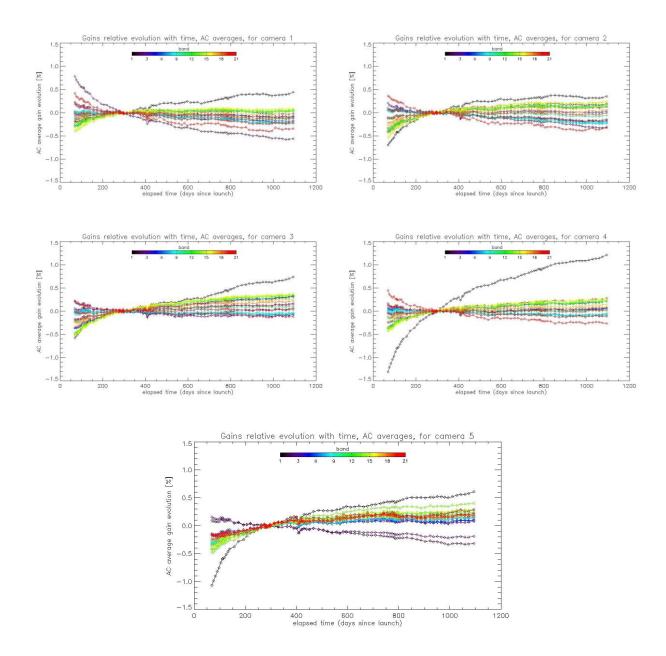


Figure 23: camera averaged gain relative evolution with respect to "best geometry" calibration (07/12/2016), as a function of elapsed time since the change in OLCI channels settings (25/04/16); one curve for each band (see colour code on plots), one plot for each module. The diffuser ageing has been taken into account.



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#### 2.2.2.1.2 OLCI-B

Figure 24 shows the gain coefficients of every pixel for two OLCI-B channels, Oa1 (400 nm) and Oa21 (1020 nm), highlighting the significant evolution of the instrument response since early mission.

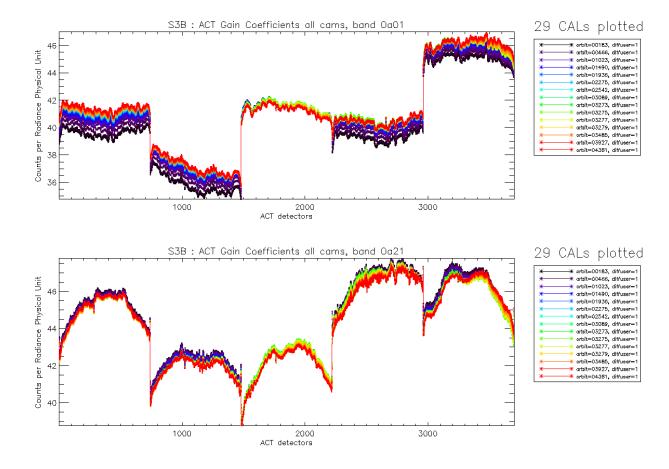


Figure 24: OLCI-B Gain Coefficients for band Oa1 (top) and Oa21 (bottom), all diffuser 1 radiometric calibrations so far except the first one (orbit 167) for which the instrument was not thermally stable yet.

Figure 25 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 last one 27/02/2019). It shows that, if a significant evolution occurred during the early mission, the trends tend to stabilize. The large amount of points near elapsed time = 220 days is due to the yaw manoeuvre campaign.

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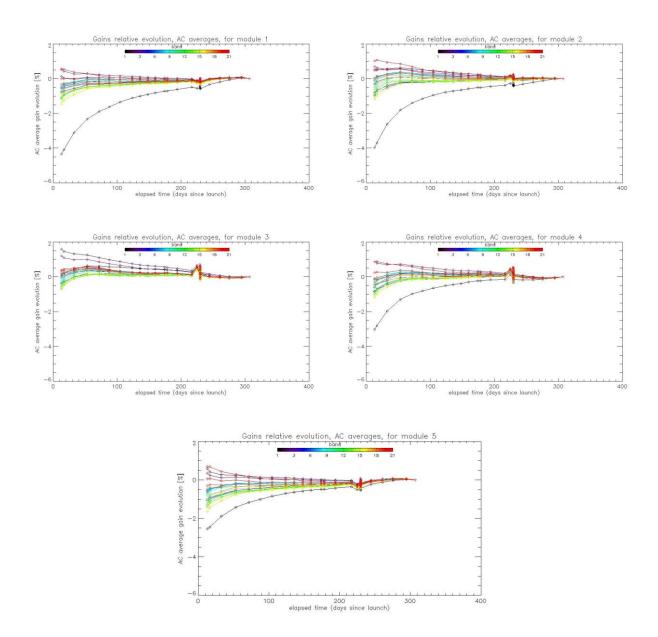


Figure 25: camera averaged gain relative evolution with respect to last calibration (26/01/2019), as a function of elapsed time since the beginning of the mission; one curve for each band (see colour code on plots), one plot for each module. The diffuser ageing is not taken into account (too early to model it yet).

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#### 2.2.2.2 Instrument evolution modelling

#### 2.2.2.2.1 OLCI-A

As mentioned in 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 25/04/2016 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 the complete dataset (including the 37 calibrations in extrapolation over about 19 months) remains better than 0.10% – except for five channels, the three worst channels being Oa1 (400 nm), Oa2 (412.5 nm) and Oa21 (1020 nm) which are respectively < 0.37%, < 0.18% and < 0.18% – when averaged over the whole field of view (Figure 26) even if a small drift of the model with respect to most recent data is now visible.

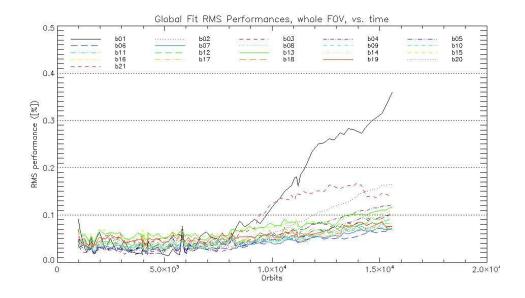


Figure 26: RMS performance of the OLCI-A Gain Model of current Processing Baseline as a function of orbit.

The overall instrument evolution since channel programming change (25/04/2016) is shown on Figure 27.

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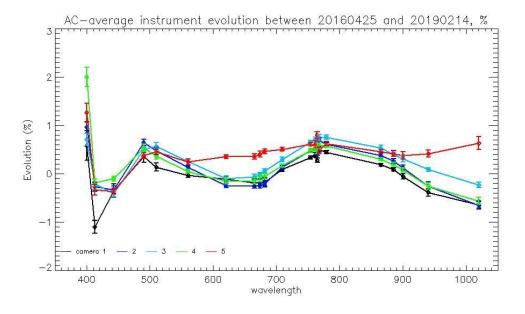


Figure 27: OLCI-A Camera-averaged instrument evolution since channel programming change (25/04/2016) and up to most recent calibration (14/02/2019) versus wavelength.

The overall per camera performance, as a function of wavelength, and at each orbit is shown on Figure 28 as the average and standard deviation of the model over data ratio.

Finally, Figure 29 to Figure 31 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 29 to Figure 31 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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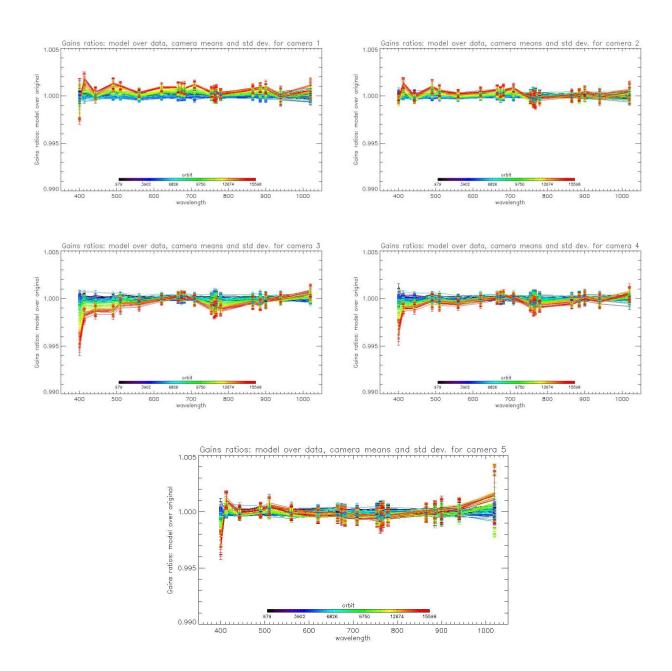


Figure 28: For the 5 cameras: OLCI-A Evolution model performance, as camera-average and standard deviation of ratio of Model over Data vs. wavelength, for each orbit of the test dataset, including 37 calibrations in extrapolation, with a colour code for each calibration from blue (oldest) to red (most recent).

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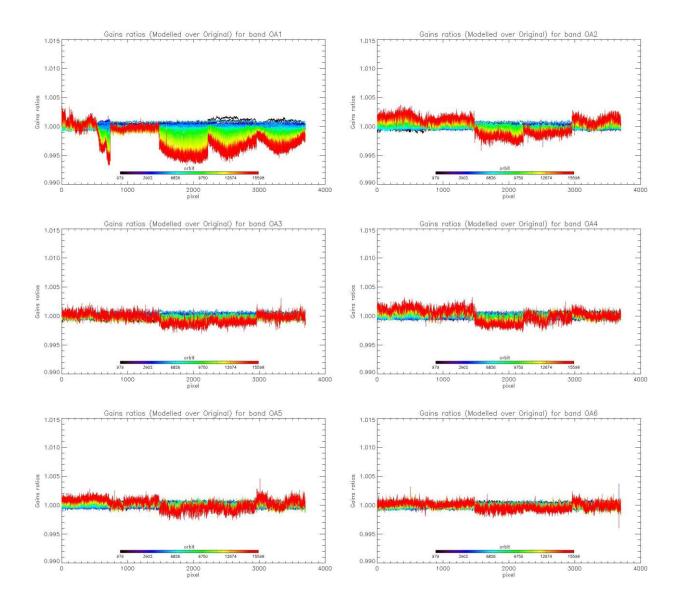


Figure 29: Evolution model performance, as ratio of Model over Data vs. pixels, all cameras side by side, over the whole current calibration dataset (since instrument programing update), including 37 calibrations in extrapolation, channels Oa1 to Oa6.

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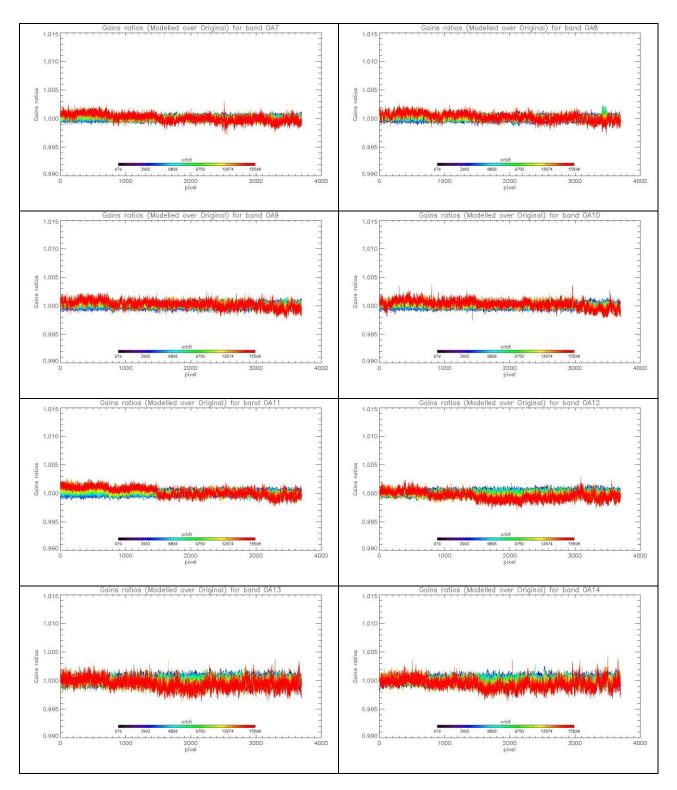


Figure 30: same as Figure 14 for channels Oa7 to Oa14.

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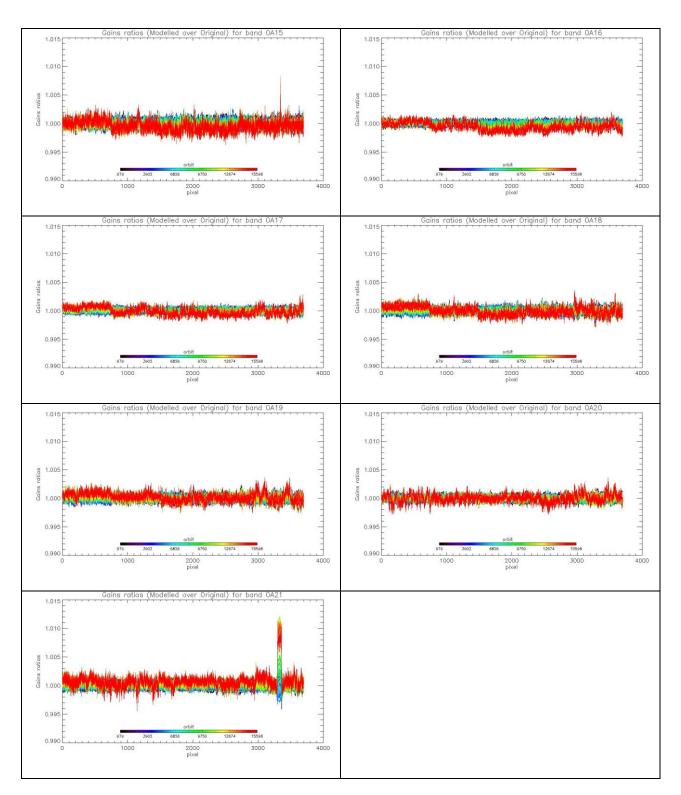


Figure 31: same as Figure 29 for channels Oa15 to Oa21.



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#### 2.2.2.2.2 OLCI-B

Instrument response and degradation modelling for S3B-OLCI has been achieved in a preliminary version. Pending the in-flight BRFD model (the derivation of which, on the basis of Yaw Manoeuvres acquired on 11/12, is on-going at EUMETSAT), it is based on NIR normalised evolution. It has been deemed necessary to develop such a trending model without waiting for the in-flight BRDF model to fulfil OC SVC temporal stability requirements (see section 5.1.2). However, it has not been put in operations in the PDGS and as such is not described here. A new model, including the use of the in-flight BRDF model, is foreseen to be available around the end of March 2019.

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

### 2.2.3.1.1 OLCI-A

There has been no calibration sequence S05 (reference diffuser) for OLCI-A during acquisition cycle 041.

Consequently the last ageing results presented in Cyclic Report #40/#21 (S3A/S3B) stay valid.

### 2.2.3.1.2 OLCI-B

There has been no calibration sequence S05 (reference diffuser) for OLCI-B during acquisition cycle 022.

Consequently the last ageing results presented in Cyclic Report #40/#21 (S3A/S3B) stay valid.

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

#### 2.2.4.1.1 OLCI-A

No CAL\_AX was delivered to PDGS during the reported period for OLCI-A.

## 2.2.4.1.2 OLCI-B

No CAL\_AX was delivered to PDGS during the reported period for OLCI-B.

## 2.2.5 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]

#### 2.2.5.1.1 OLCI-A

This activity has not evolved during cycle 041 and results presented in Cycle 15 report are still valid.



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## 2.2.5.1.2 OLCI-B

Activity has started for S3B-OLCI. The SAA domain explored is now increased by the acquisitions from the Yaw Manoeuvres and analysis becomes meaningful. Analysis is on-going.

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

#### 2.3.1.1.1 OLCI-A

There has been no Spectral Calibration (S02/S03, S09) acquisition for OLCI-A during the reporting period.

Consequently, last results, presented in S3A cycle 036 report are still valid.

#### 2.3.1.1.2 OLCI-B

There has been no Spectral Calibration (S02/S03, S09) acquisition for OLCI-B during the reporting period.

Consequently, last results, presented in cycle 039/020 (S3A/S3B) report are still valid.

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

## 2.4.1 SNR from Radiometric calibration data

## 2.4.1.1 OLCI-A

SNR computed for all calibration data (S01, S04 and S05 sequences) as a function of band number is presented in Figure 32.

SNR computed for all calibration data as a function of orbit number for band Oa01 (the less stable band) is presented in Figure 33.

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

## Alission Performance Centre

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

## **S3 OLCI Cyclic Performance Report**

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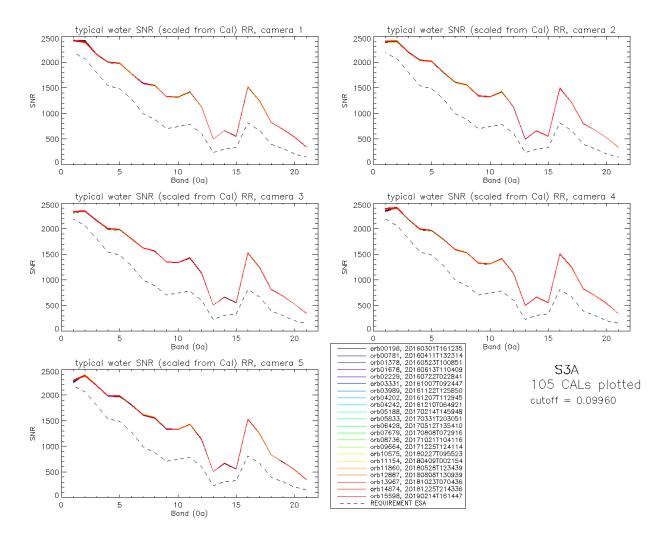


Figure 32: OLCI-A Signal to Noise ratio as a function of the spectral band for the 5 cameras. These results have been computed from radiometric calibration data. All calibrations except first one (orbit 183) are presents with the colours corresponding to the orbit number (see legend). The SNR is very stable with time: the curves for all orbits are almost superimposed. The dashed curve is the ESA requirement.

# Mission Performance Centre

## **Sentinel-3 MPC**

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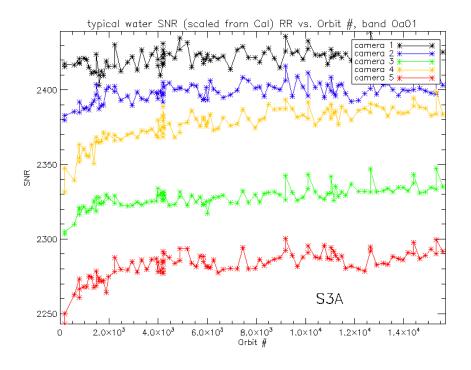


Figure 33: long-term stability of the SNR estimates from Calibration data, example of channel Oa1.

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: OLCI-A 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	C1		C2		C3		C4		<b>C</b> 5		All	
nm	LU	RQT	avg	std	avg	std	avg	std	avg	std	avg	std	avg	std
400.000	63.0	2188	2421	6.0	2398	6.6	2328	7.0	2376	11.7	2282	9.4	2361	7.1
412.000	74.1	2061	2393	8.1	2407	5.5	2340	4.7	2401	5.0	2384	7.5	2385	4.4
442.000	65.6	1811	2160	5.1	2198	5.7	2165	4.8	2185	4.1	2196	5.1	2181	3.5
490.000	51.2	1541	2001	4.7	2036	5.2	1997	4.0	1982	4.4	1988	4.9	2001	3.5
510.000	44.4	1488	1980	5.2	2014	4.9	1984	4.7	1966	4.7	1985	4.7	1986	3.8
560.000	31.5	1280	1776	4.4	1802	4.2	1802	5.0	1794	3.8	1818	3.5	1798	3.1
620.000	21.1	997	1591	4.2	1610	4.1	1624	3.2	1593	3.3	1615	3.6	1607	2.7
665.000	16.4	883	1547	4.3	1558	4.4	1567	3.8	1533	3.8	1561	4.0	1553	3.1
674.000	15.7	707	1329	3.4	1338	3.6	1350	2.8	1323	3.1	1342	3.8	1336	2.5
681.000	15.1	745	1320	3.6	1327	3.1	1338	2.8	1314	2.5	1333	3.7	1326	2.2
709.000	12.7	785	1421	4.5	1421	4.2	1435	3.5	1414	3.6	1430	3.2	1424	3.0
754.000	10.3	605	1127	3.3	1120	3.0	1135	3.6	1124	2.5	1139	3.1	1129	2.6
761.000	6.1	232	502	1.2	498	1.2	505	1.2	500	1.1	507	1.5	503	1.0
764.000	7.1	305	663	1.6	658	1.5	667	2.1	661	1.6	670	2.2	664	1.5
768.000	7.6	330	558	1.6	554	1.3	562	1.3	556	1.5	564	1.4	559	1.2
779.000	9.2	812	1515	5.1	1498	5.0	1524	5.4	1511	5.1	1525	5.1	1515	4.5
865.000	6.2	666	1244	3.6	1213	3.9	1238	4.1	1246	3.7	1250	2.9	1238	3.1
885.000	6.0	395	823	1.8	801	1.7	814	2.1	824	1.5	831	1.9	819	1.3
900.000	4.7	308	691	1.6	673	1.3	683	1.8	693	1.5	698	1.6	688	1.0
940.000	2.4	203	534	1.1	522	1.0	525	1.0	539	1.1	542	1.4	532	0.8
1020.000	3.9	152	345	0.8	337	0.9	348	0.7	345	8.0	351	0.8	345	0.5

## 2.4.1.2 OLCI-B

SNR computed for all OLCI-B calibration data (S01, S04 (but not the dark-only S04) and S05 sequences) as a function of band number is presented in Figure 34.

SNR computed for all OLCI-B calibration data as a function of orbit number for band Oa01 (the less stable band) is presented in Figure 35.

As for OLCI-A the SNR is very stable in time. There is no significant evolution of this parameter during the current cycle and the ESA requirement is fulfilled for all bands.

## SENTINEL 3 Mission Performance Centre

## **Sentinel-3 MPC**

## **S3 OLCI Cyclic Performance Report**

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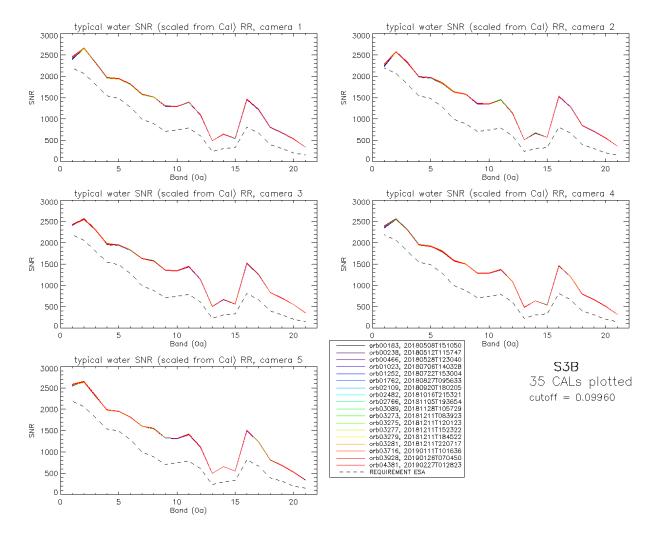


Figure 34: OLCI-B Signal to Noise ratio as a function of the spectral band for the 5 cameras. These results have been computed from radiometric calibration data. All calibrations except first one (orbit 167) are presents with the colours corresponding to the orbit number (see legend). The SNR is very stable with time: the curves for all orbits are almost superimposed. The dashed curve is the ESA requirement.

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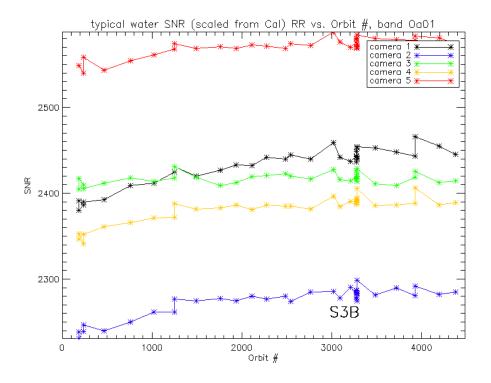


Figure 35: long-term stability of the OLCI-B SNR estimates from Calibration data, example of channel Oa1.



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Table 2: OLCI-B 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	C1		C2		C3		C4		C5		All	
nm	LU	RQT	avg	std	avg	std	avg	std	avg	std	avg	std	avg	std
400.000	63.0	2188	2432	22.1	2273	17.1	2416	6.2	2381	15.2	2569	11.4	2414	13.5
412.000	74.1	2061	2655	6.5	2571	6.2	2551	8.0	2549	6.1	2642	6.9	2594	4.8
442.000	65.6	1811	2328	5.9	2319	6.6	2305	6.5	2308	6.8	2313	5.4	2315	5.5
490.000	51.2	1541	1965	5.1	1985	6.3	1970	5.9	1949	4.6	1978	5.3	1970	4.4
510.000	44.4	1488	1936	5.9	1964	5.6	1941	5.3	1920	4.7	1950	4.2	1942	4.1
560.000	31.5	1280	1813	5.7	1845	6.2	1828	5.0	1801	5.5	1816	5.2	1820	4.7
620.000	21.1	997	1572	4.9	1627	4.7	1625	4.0	1575	4.7	1601	3.4	1600	3.4
665.000	16.4	883	1513	4.4	1579	4.1	1573	4.5	1501	3.4	1546	4.4	1542	3.2
674.000	15.7	707	1301	4.2	1358	4.7	1352	3.9	1292	3.4	1328	3.2	1326	3.0
681.000	15.1	745	1292	3.5	1347	3.2	1342	3.2	1285	2.9	1316	3.0	1317	2.4
709.000	12.7	785	1389	4.3	1447	4.4	1442	5.2	1372	3.7	1411	4.2	1412	3.7
754.000	10.3	605	1093	4.6	1140	4.0	1140	4.5	1087	3.3	1113	4.3	1115	3.8
761.000	6.1	232	487	1.3	508	1.2	508	1.4	485	1.3	496	1.5	497	1.1
764.000	7.1	305	642	1.8	671	2.3	671	2.3	640	1.9	656	2.3	656	1.8
768.000	7.6	330	540	1.5	566	1.3	563	1.6	540	1.5	554	1.8	553	1.2
779.000	9.2	812	1464	5.0	1533	5.7	1523	6.6	1464	3.9	1503	5.5	1497	4.7
865.000	6.2	666	1219	4.2	1285	4.5	1257	4.3	1202	3.7	1237	3.5	1240	3.4
885.000	6.0	395	807	2.6	847	1.8	833	2.2	798	1.8	814	2.2	820	1.7
900.000	4.7	308	679	1.6	714	2.0	704	1.7	669	1.6	682	1.6	689	1.3
940.000	2.4	203	527	1.3	550	1.7	550	1.5	509	1.1	522	1.3	532	1.1
1020.000	3.9	152	336	0.8	359	1.2	358	0.9	318	0.8	339	1.1	342	0.8

## 2.4.2 SNR from EO data

## 2.4.2.1 OLCI-A

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

## 2.4.2.2 OLCI-B

The SNR assessment from EO data has not been applied to OLCI-B considering a) that SNR estimates from RC data have been proved more reliable for OLCI-A and b) that it requires a significant amount of human and machine resources that can be more efficiently used for other tasks.



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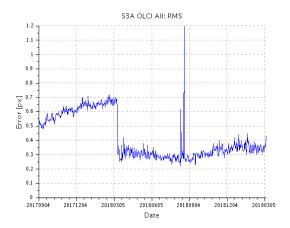
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## 2.5 Geometric Calibration/Validation

#### 2.5.1 OLCI-A

The good performance of OLCI-A georeferencing since the introduction of the upgraded Geometric Calibration on 14/03/2018 is confirmed. The following figures show time series of the overall RMS performance (requirement criterion) and of the across-track and along-track biases for each camera. The performance improvement on the 14/03/2018 is obvious on each figure, the most dramatic improvements affecting along-track bias of Camera 3 (Figure 40) and across-track biases of Cameras 4 and 5 (Figure 41 & Figure 42, respectively). Compliance is comfortably met since then (Figure 36): RMS values remain around 0.3 pixel and all biases below 0.2 pixel from 14/03 on, except for the along-track bias of camera 3 for which a small drift can be noticed, implying a performance slightly below -0.2 pixel since a few weeks (Figure 40, right).

It can be seen that the peak RMS value on 14/08/2018 is associated to a very low number of GCPs: only 345 (out of scale on Figure 37) and can be considered as an outlier. The same remark applies to the AC and AL biases displayed in Figure 38 to Figure 42.



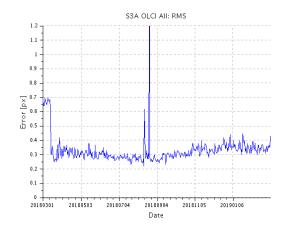


Figure 36: overall OLCI-A georeferencing RMS performance time series over the whole monitoring period (left) and restricted to March 2018 on (right)



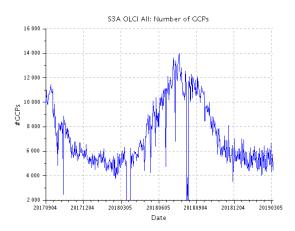
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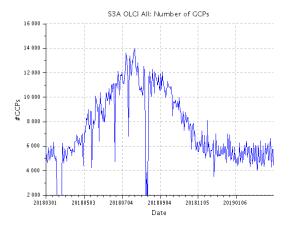
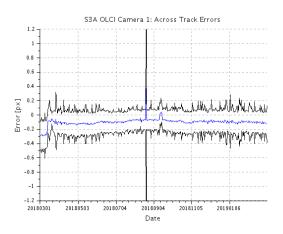


Figure 37: number of validated control points corresponding to the performance time series of Figure 36 for the same periods (complete, left, and restricted to March 2018, right).



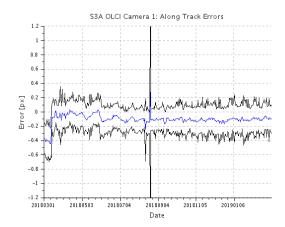
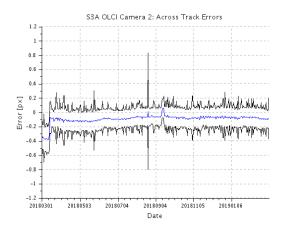


Figure 38: across-track (left) and along-track (right) georeferencing biases time series for Camera 1 (starting 01/03/2018).



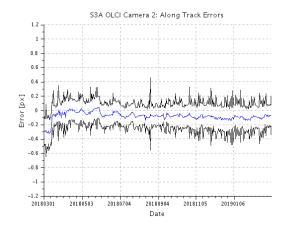


Figure 39: same as Figure 38 for Camera 2.

## SENTINEL 3 Mission

## **Sentinel-3 MPC**

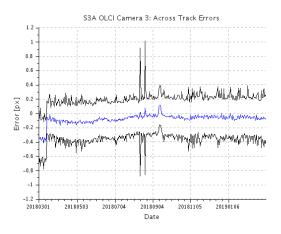
**S3 OLCI Cyclic Performance Report** 

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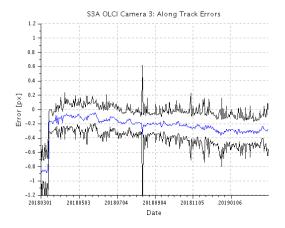
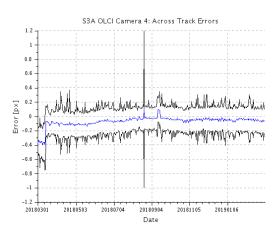


Figure 40: same as Figure 38 for Camera 3.



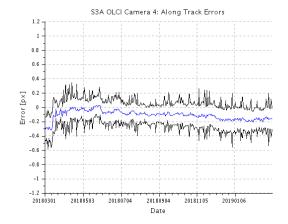
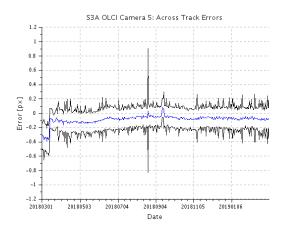


Figure 41: same as Figure 38 for Camera 4.



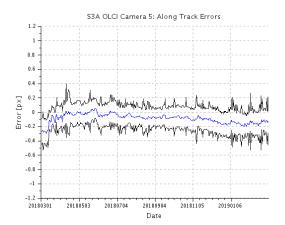


Figure 42: same as Figure 38 for Camera 5.



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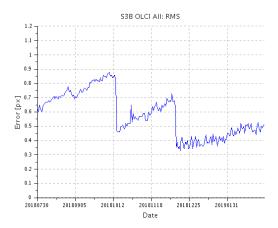
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#### 2.5.2 OLCI-B

The performance of OLCI-B georeferencing is within requirements since the introduction of the 3<sup>rd</sup> Geometric Calibration on 12/12/2018. The following figures show time series of the overall RMS performance (requirement criterion) and of the across-track and along-track biases for each camera. The performance of across-track pointing is excellent over the whole mission. The along-track performance, showing significant drifts for all cameras is well corrected with the latest Calibration. It seems fairly stable for cameras 3 and 4, but a small drift still seems present for cameras 1 2 & 5, challenging the compliance in the short term. Action has been put in place to generate a new Geometric Calibration.



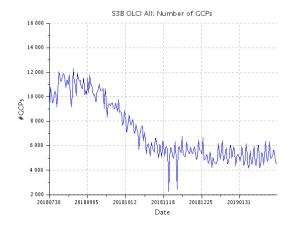
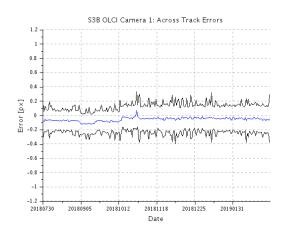


Figure 43: overall OLCI-B georeferencing RMS performance time series (left) and number of validated control points corresponding to the performance time series (right) over the whole monitoring period



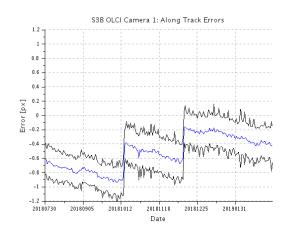


Figure 44: across-track (left) and along-track (right) georeferencing biases time series for Camera 1.



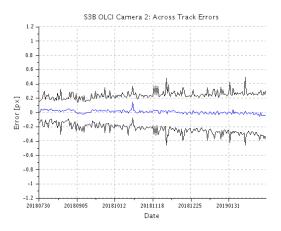
## **S3 OLCI Cyclic Performance Report**

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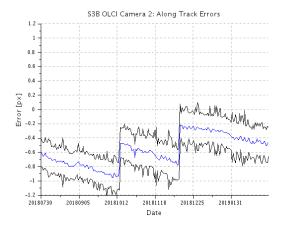
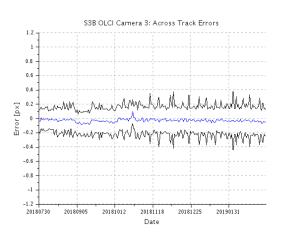


Figure 45: same as Figure 44 for Camera 2.



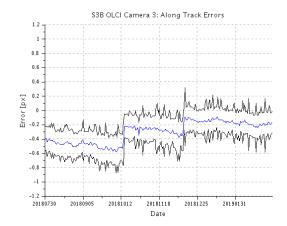
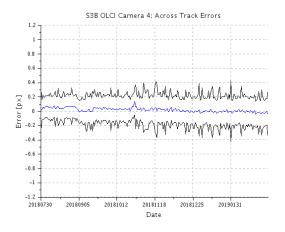


Figure 46: same as Figure 44 for Camera 3.



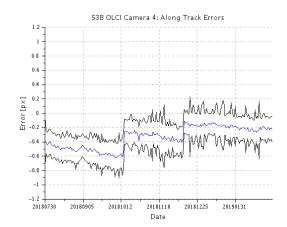


Figure 47: same as Figure 44 for Camera 4.

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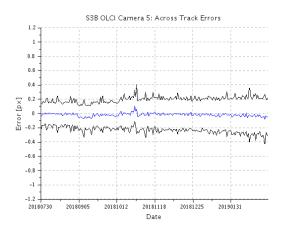
## **S3 OLCI Cyclic Performance Report**

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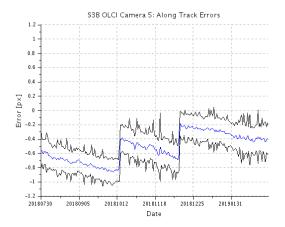


Figure 48: same as Figure 44 for Camera 5.

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## 3 OLCI Level 1 Product validation

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

## 3.1.1 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 http://s3etrac.acri.fr/index.php?action=generalstatistics

- 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) for both OLCI-A (Figure 49) and OLCI-B (Figure 50).

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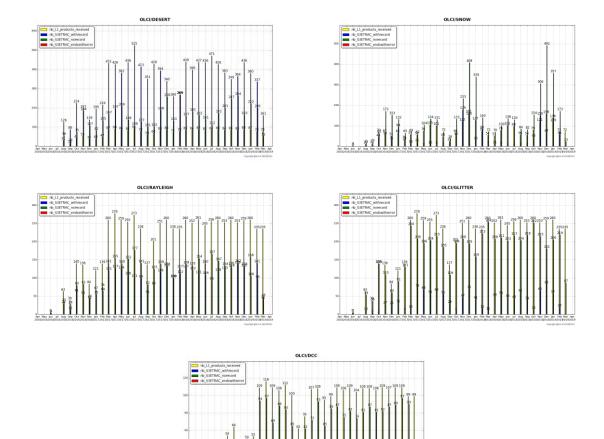


Figure 49: summary of S3ETRAC products generation for OLCI-A

(number of OLCI-A 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).

## Sentinel 3 Mission Performance Centre

## **Sentinel-3 MPC**

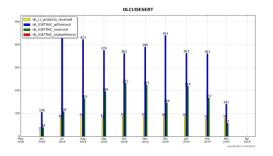
**S3 OLCI Cyclic Performance Report** 

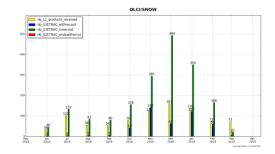
**S3A Cycle No. 041 – S3A Cycle No. 022** 

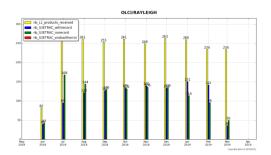
Ref.: S3MPC.ACR.PR.01-041-022

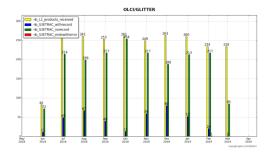
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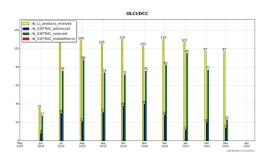


Figure 50: summary of S3ETRAC products generation for OLCI-B

(number of OLCI-B 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).



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#### 3.1.2 Radiometric validation with DIMITRI

## Highlights

S3A/OLCI and S3B/OLCI L1B radiometry verification as follow:

- The verification is performed until the 5<sup>th</sup> of March 2019.
- All OLCI-A and OLCI-B results over Rayleigh, Glint and PICS are consistent with the previous cycle over the used CalVal sites.
- Good stability of both sensors could be observed; nevertheless the time-series averages show slightly higher reflectance for OLCI-A.
- Bands with high gaseous absorption are excluded.

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

- 1. Ingestion of all the available L1B-LN1-NT products in the S3A-Opt database over the 6 desert calvalsites (Algeria 3 & 5, Libya 1 & 4 and Mauritania 1 & 2) has been performed until the 5<sup>th</sup> of March 2019.
- 2. The results are consistent overall the six used PICS sites (Figure 51 & Figure 52). Both sensors show a good stability over the analysed period.
- 3. The temporal average over the period January 2019 present of the elementary ratios (observed reflectance to the simulated one) for OLCI-A shows gain values within 2-4% over all the VNIR bands (Figure 53). Unlikely, the temporal average over the same period of the elementary ratios (observed reflectance to the simulated one) for OLCI-B shows values within 2% (mission requirement) over the whole spectral range (Figure 53).
- 4. The spectral bands with significant absorption from water vapour and O<sub>2</sub> (Oa11, Oa13, Oa14 and Oa15) are excluded.

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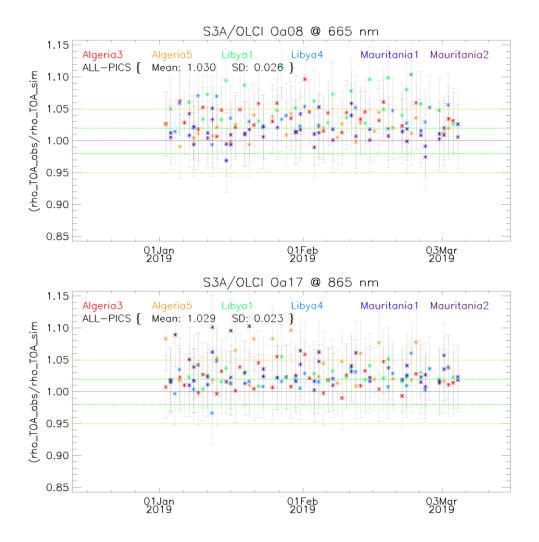


Figure 51: Time-series of the elementary ratios (observed/simulated) signal from S3A/OLCI for (top to bottom) bands Oa08 and Oa17 respectively over January 2019 - Present from the six PICS Cal/Val sites. Dashed-green and orange lines indicate the 2% and 5% respectively. Error bars indicate the desert methodology uncertainty.

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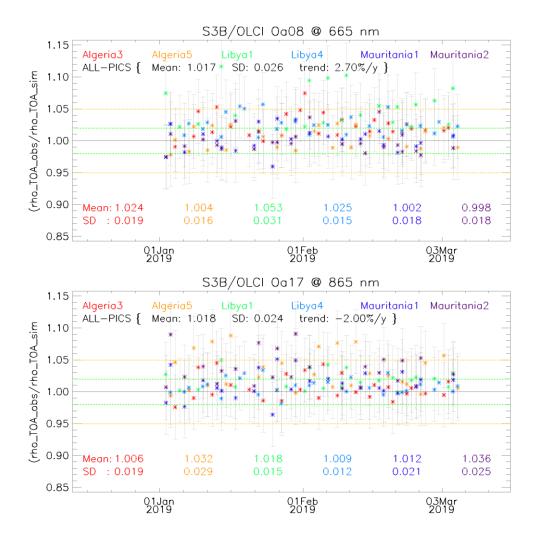


Figure 52: Same as Figure 51 for OLCI-B.



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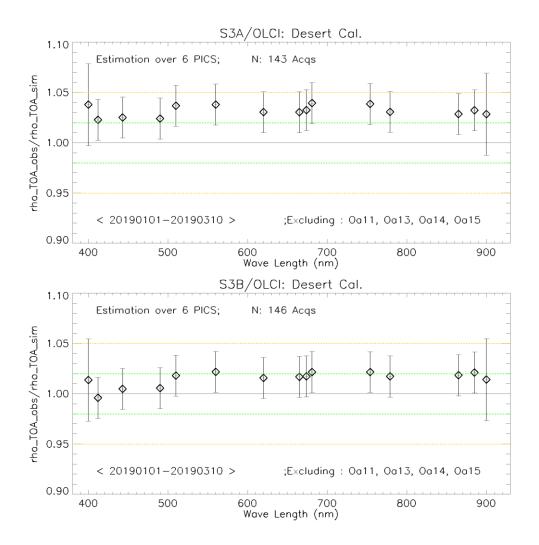


Figure 53: The estimated gain values for OLCI-A (top) and OLCI-B (bottom) from the 6 PICS sites identified by CEOS over the period January 2019 – present as a function of wavelength. Dashed-green and orange lines indicate the 2% and 5% respectively. Error bars indicate the desert methodology uncertainty.

## **II- Cross-mission Intercomparison over PICS**

X-mission Intercomparison with MODIS-A and MSI-A has been performed until February 2019. Results herein are identical to those of previous report but kept for completeness.

Figure 54 shows time-series of the elementary ratios from S2A/MSI, Aqua/MODIS and S3A/OLCI and S3B/OLCI over the LYBIA4 site over the period April-2016 until February 2019.

We observe a clear stability of the three sensors, associated with higher reflectance from OLCI-A wrt to MSI and MODISA. MODISA shows higher fluctuations with respect to MSI and OLCI ones.

Figure 55 shows the estimated gain over different time-series for different sensors MSI-A, MSI-B, OLCI-A, OLCI-B and MODIS-A) over PICS. The spectral bands with significant absorption from water vapour and O2 are excluded. OLCI-A seems to have higher gain with respect to the other sensors, which means that OLCI-A has brighter reflectance than its simulated one by PICS method.

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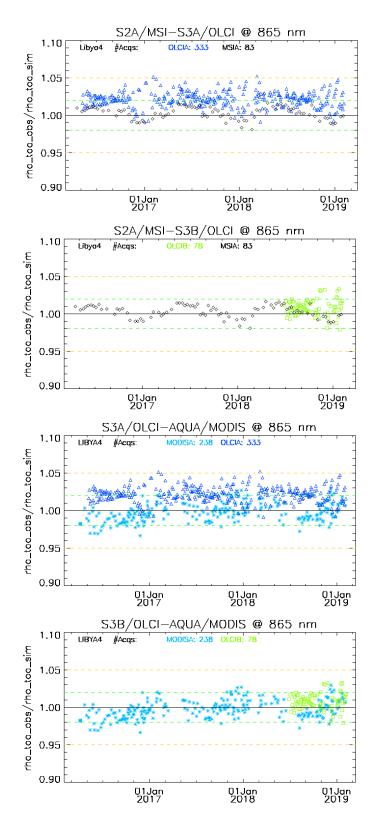


Figure 54: Time-series of the elementary ratios (observed/simulated) signal from (black) S2A/MSI, (blue) S3A/OLCI, (green) S3B/OLCI and (Cyan) Aqua/MODIS for band Oa17 (865nm) over the LIBYA4 site. Dashed-green and orange lines indicate the 2% and 5% respectively. The systematic and total uncertainties of the desert methodology are 1% and 5% respectively.

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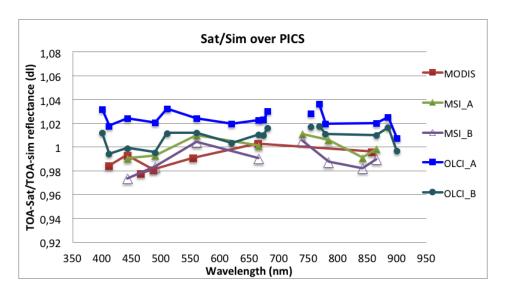


Figure 55: Ratio of observed TOA reflectance to simulated one for (green) S2A/MSI, (purple) S2B/MSI, (red)
Aqua/MODIS, (blue) S3A/OLCI and (dark-green) S3B/OLCI averaged over the six PICS test sites as a function of wavelength.

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

Rayleigh method has been performed over the available mini-files on the Opt-server from November 2018 to present for OLCI-A and OLCI-B. The results are produced with the configuration (ROI-AVERAGE). The gain coefficients of OLCI-A are consistent with the previous results. Bands Oa01-Oa04 display biases values between 4%-6% while bands Oa5-Oa9 exhibit biases between 2%-3%, higher than the 2% mission requirements (Figure 56 and Figure 57). The gain coefficients of OLCI-B are lower than OLCI-A ones, where bands Oa01-Oa04 display biases values about 3-4%, when bands Oa5-Oa9 exhibit biases better than 2%, the mission requirement (Figure 56 and Figure 57).



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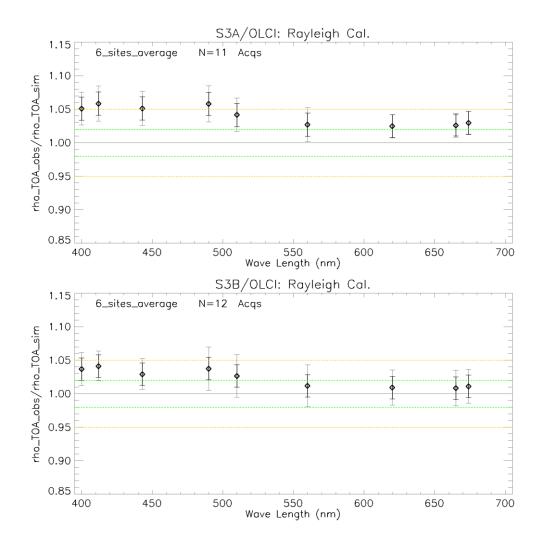


Figure 56: The estimated gain values for OLCI-A and OLCI-B over the 6 Ocean CalVal sites (Atl-NW\_Optimum, Atl-SW\_Optimum, Pac-NE\_Optimum, Pac-NW\_Optimum, SPG\_Optimum and SIO\_Optimum) over the period November 2018-Present as a function of wavelength. Dashed-green, and orange lines indicate the 2%, 5% respectively. Error bars indicate (black) the methodology uncertainty and (grey) the standard deviation over the 6 CalVal sites.

## **IV-Validation over Glint and synthesis**

Glint calibration method with the configuration (ROI-PIXEL) has been performed over the period November 2018-present for OLCI-A and OLCI-B. The outcome of this analysis shows a good consistency with the desert outputs over the NIR spectral range Oa06-Oa09 for both sensors. Glint results show that the VNIR bands are within 2% (mission requirement), except Oa21 which show biases of ~7% and ~6% respectively (see Figure 57). Again, the glint gain from OLCI-B looks slightly lower than OLCI-A one.



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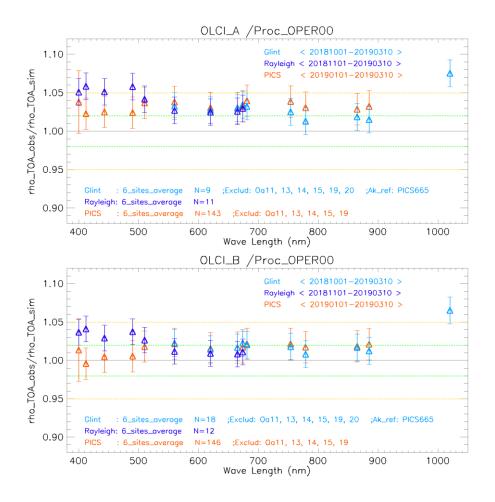


Figure 57: The estimated gain values for OLCI-A and OLCI-B from Glint, Rayleigh and PICS methods over the period November 2018-Present as a function of wavelength. We use the gain value of Oa8 from PICS-Desert method as reference gain for Glint method. Dashed-green and orange lines indicate the 2% and 5% respectively.

Error bars indicate the method uncertainties.

## 3.1.3 Radiometric validation with OSCAR

There has been no new result during the cycle. Last figures (cycle 40/21) are considered valid.

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

## 3.2.1 OLCI-A

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

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## **3.2.2** OLCI-B

This activity has not started for OLCI-B.

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## 4 Level 2 Land products validation

## 4.1 [OLCI-L2LRF-CV-300]

#### 4.1.1 Routine extractions

#### 4.1.1.1 OLCI-A

- The focus for this time period has been on the rolling archive Non Time Critical (NT) data until the 10<sup>th</sup> March 2019. More data available for statistical analysis as a concatenation procedure for all available data in the MERMAID processing has been implemented.
- Concatenated time series of OLCI Global Vegetation Index and OLCI Terrestrial Chlorophyll Index have been regenerated on the current rolling archive availability including previous extractions since April 2018. The time series therefore represent spring, summer and fall season.

Figure 58 to Figure 67 below present the CoreLand Sites OLCI time series over the current OLCI-A mission.

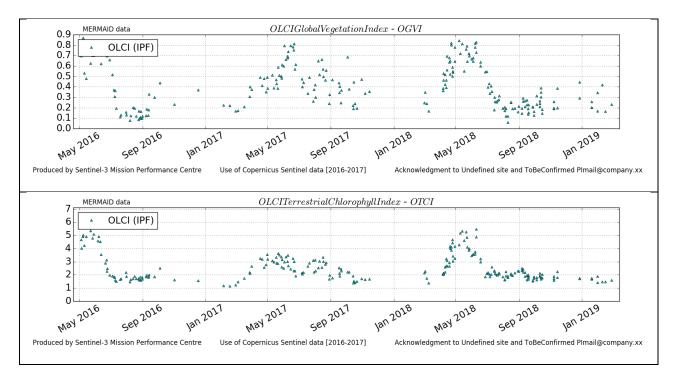


Figure 58: OLCI-A DeGeb time series over current report period



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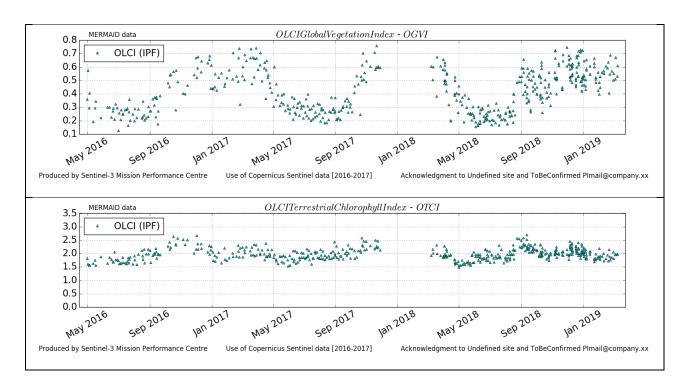


Figure 59: OLCI-A ITCat time series over current report period

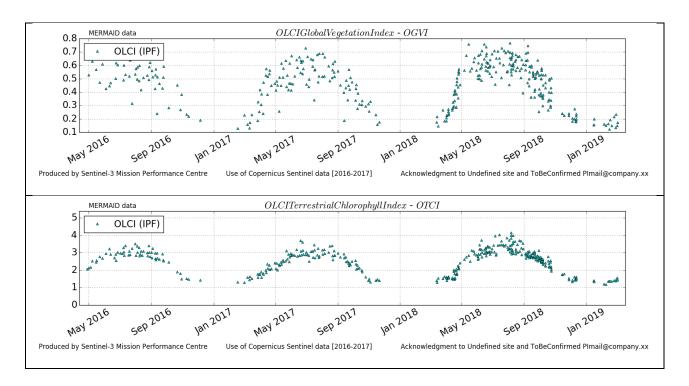


Figure 60: OLCI-A ITsp time series over current report period

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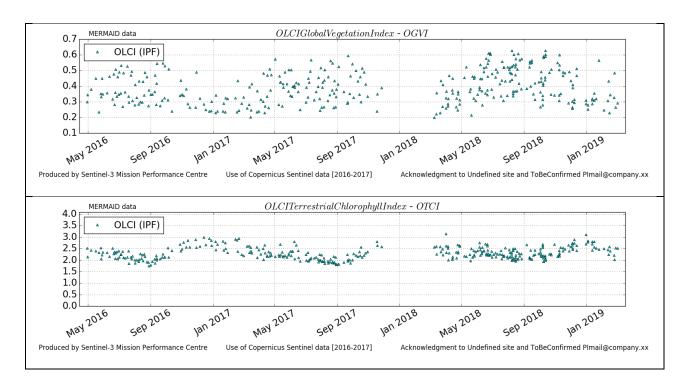


Figure 61: OLCI-A ITSro time series over current report period

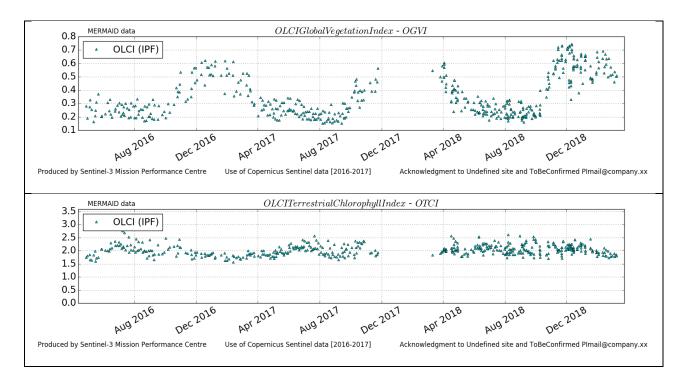


Figure 62: OLCI-A ITTra time series over current report period



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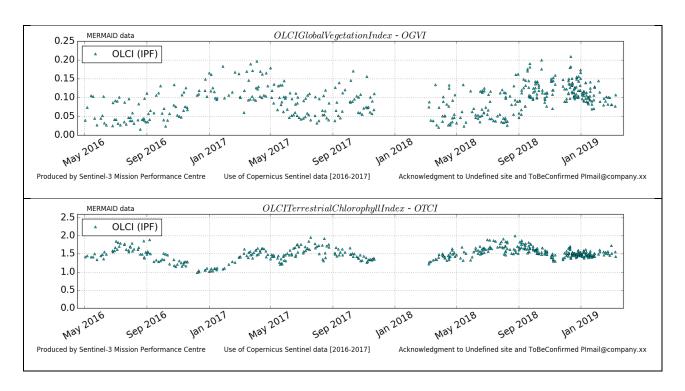


Figure 63: OLCI-A SPAli time series over current report period

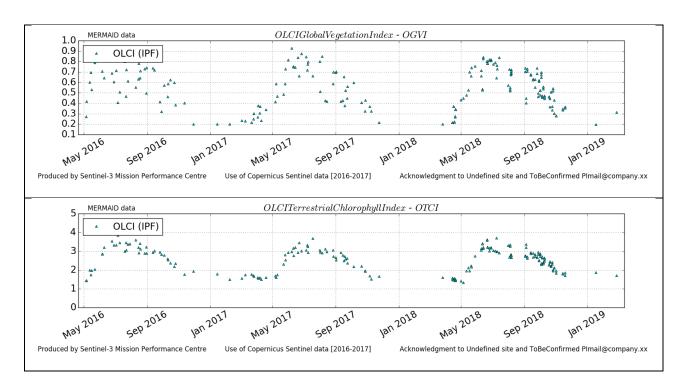


Figure 64: OLCI-A UKNFo time series over current report period



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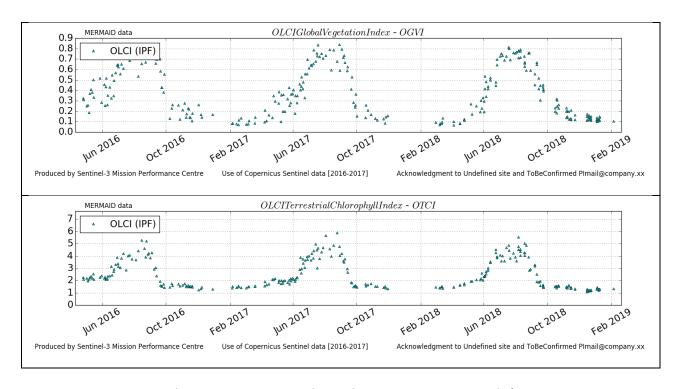


Figure 65: OLCI-A USNe1 time series over current report period

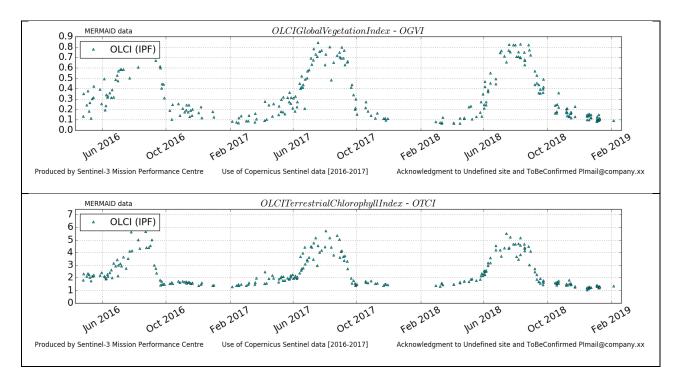


Figure 66: OLCI-A USNe2 time series over current report period



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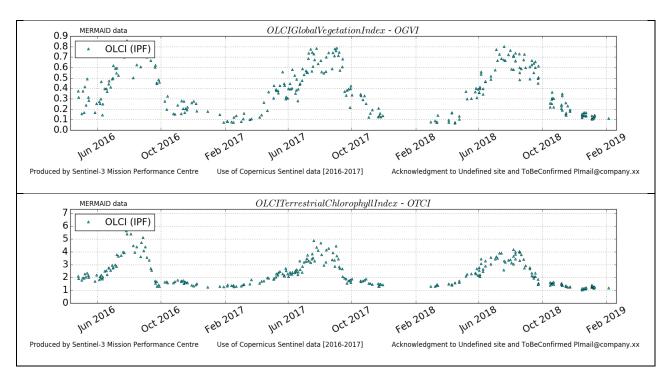


Figure 67: OLCI-A USNe3 time series over current report period

## 4.1.1.2 OLCI-B

Figure 68 to Figure 77 below present the CoreLand Sites OLCI S3B time series over the current reprocessing period.

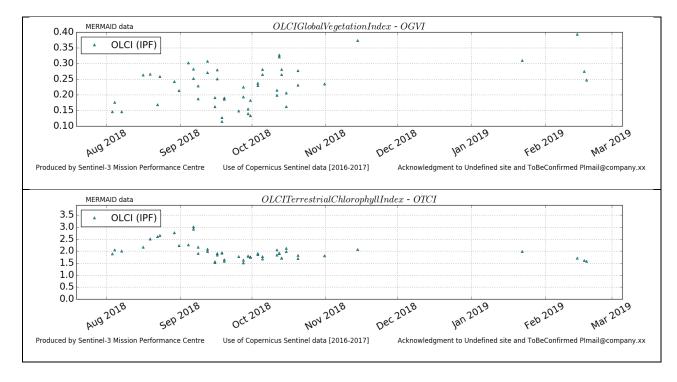


Figure 68: OLCI-B DeGeb time series over current report period

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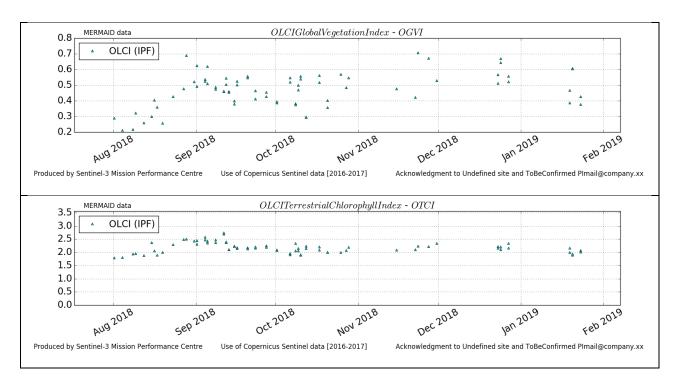


Figure 69: OLCI-B ITCat time series over current report period

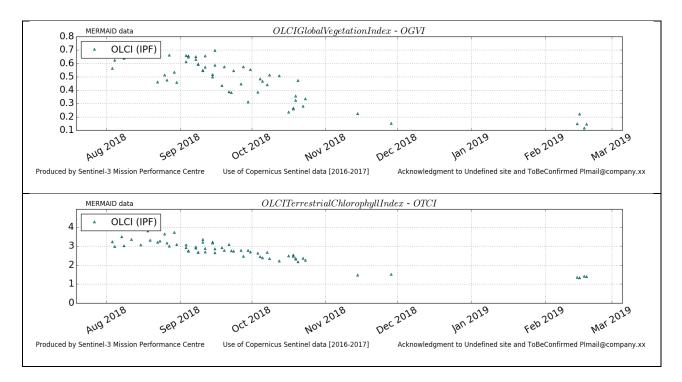


Figure 70: OLCI-B ITsp time series over current report period

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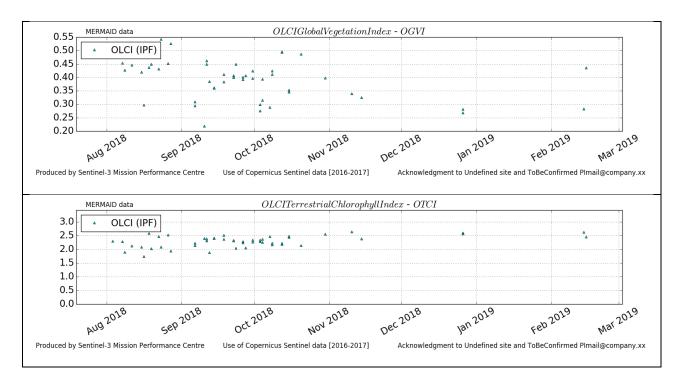


Figure 71: OLCI-B ITSro time series over current report period

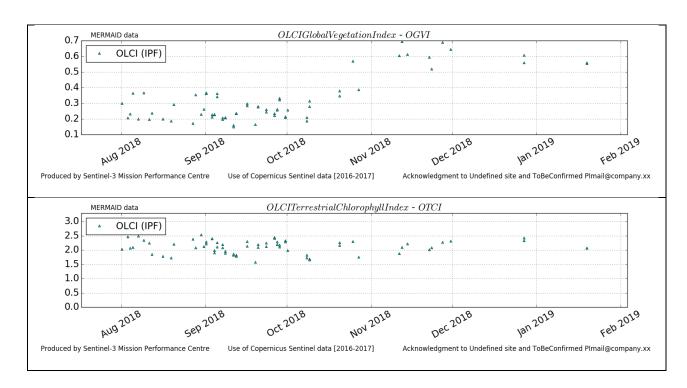


Figure 72: OLCI-B ITTra time series over current report period

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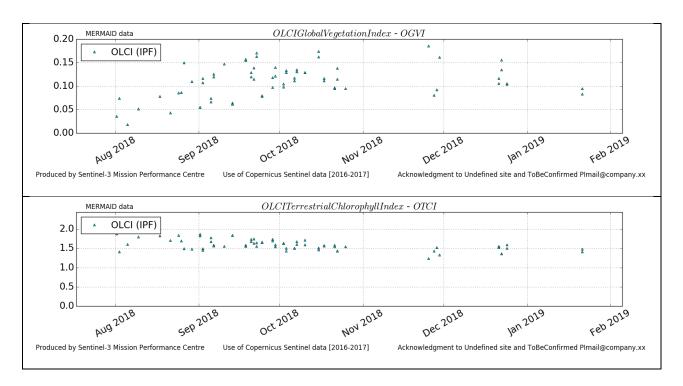


Figure 73: OLCI-B SPAli time series over current report period

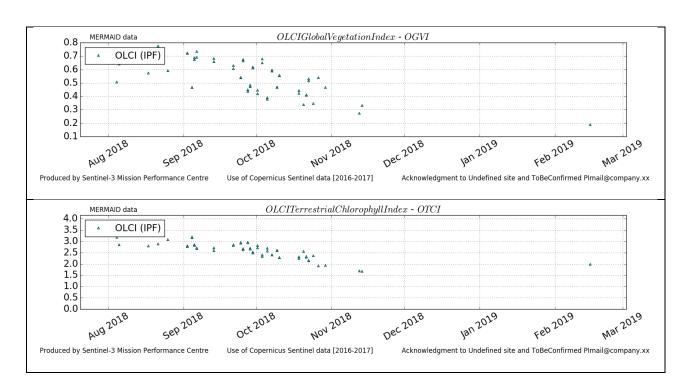


Figure 74: OLCI-B UKNFo time series over current report period

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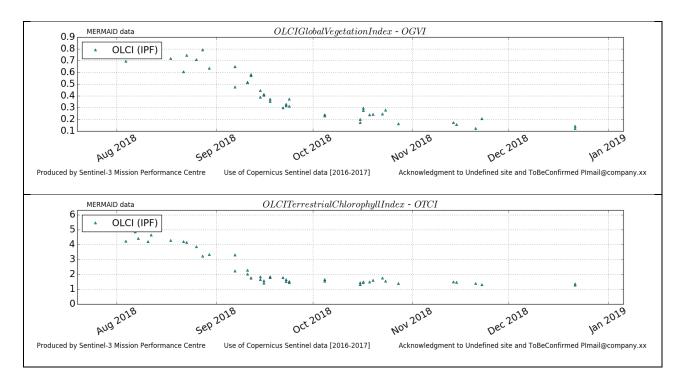


Figure 75: OLCI-B USNe1 time series over current report period

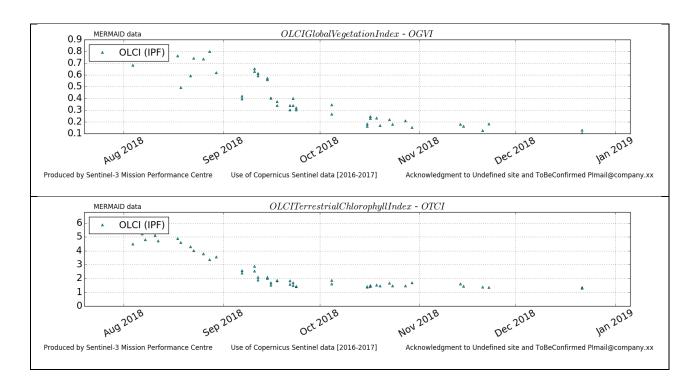


Figure 76: OLCI-B USNe2 time series over current report period

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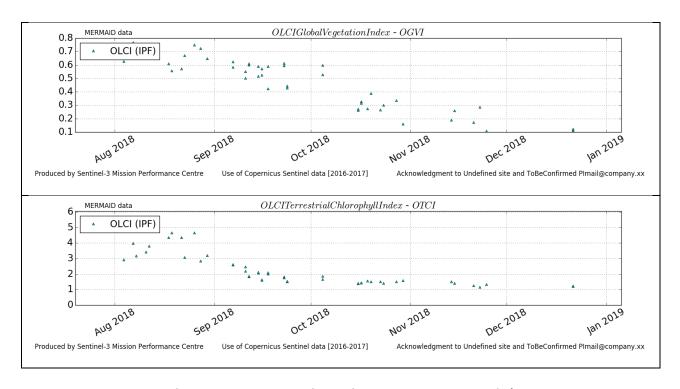


Figure 77: OLCI-B USNe3 time series over current report period

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#### 4.1.2 Comparisons with MERIS MGVI and MTCI climatology

This report shows the performance of OTCI and OGVI as compared to MERIS climatology. The report presents data from both, Sentinel-3A (S3A) and Sentinel 3B (S3B). Nine validation sites from Europe, United States and Australia are included (see Table 1). The validation sites include six representative land cover types. Overall, both land products follow the trend of MERIS archive (climatology) and the local trend for February. The reason for missing data over the last cycles (including the present cycle) is because of cloud and snow cover quality flags.

Table 1. Validation sites included in report cycle 40 S3A and 21 S3B.

Acronym	Country	Network	Lat	Lon	Land.cover
IT-Lison	Italy	ICOS	45.74	12.75	Cropland
FR-Estrees-Mons	France	ICOS Associated	49.872	3.021	Cultivated and managed areas
IT-Isp	Italy	CORE	45.813	8.635	Mixed forest
		TERN-SuperSites,			Shrub Cover, closed-open,
AU-Calperum	Australia	AusCover/OzFlux	-34.003	140.588	deciduous
					Tree Cover, broadleaved,
DE-Hones-Holz	Deutschland	ICOS	52.085	11.222	deciduous, closed
UK-Wytham-	United				Tree Cover, broadleaved,
Woods	Kingdom	ForestGeo - NPL	51.774	-1.338	deciduous, closed
					Tree Cover, broadleaved,
<b>US-Harvard</b>	<b>United States</b>	NEON, AERONET	42.537	-72.173	deciduous, closed
		TERN-SuperSites,			Tree Cover, broadleaved,
AU-Litchfield	Australia	AusCover/OzFlux	-13.18	130.79	evergreen
					Tree Cover, needle-leaved,
BE-Brasschaat	Belgium	ICOS	51.308	4.52	evergreen

WARNING: OLCI-B L2 products are still in phase of adjustment and are not yet delivered to the users, so corresponding validation results shall be considered as preliminary and unofficial.

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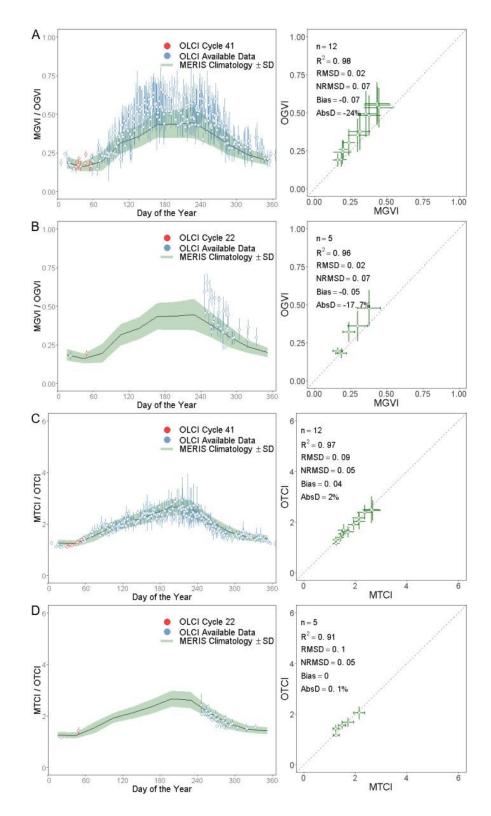


Figure 78: Time-series OGVI vs OTCI and corresponding scatterplot of monthly time-step for site IT-Lison, Italy, land cover Cropland. A and C represent S3A; B and D represent S3B.

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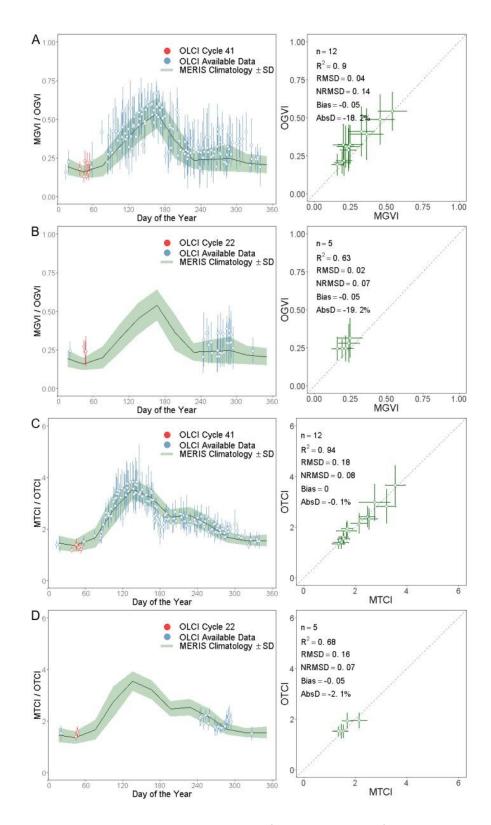


Figure 79: Time-series OGVI vs OTCI and corresponding scatterplot of monthly time-step for site FREstrees-Mons, France, land cover Cultivated and managed areas. A and C represent S3A; B and D represent S3B.

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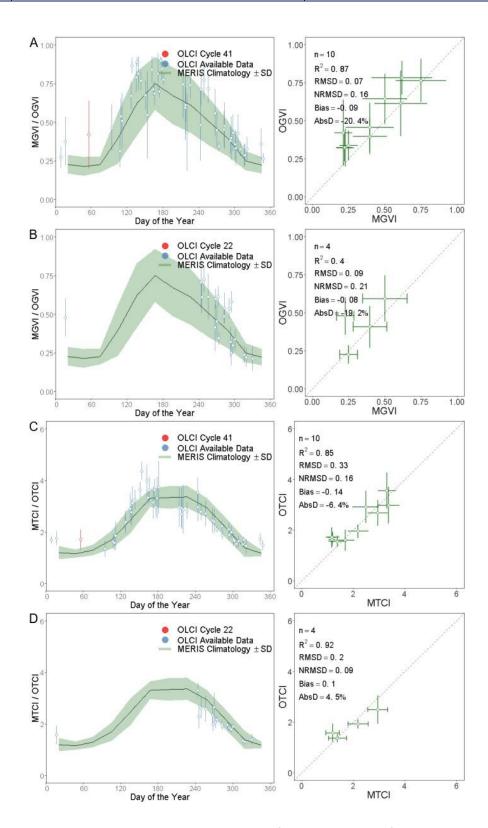


Figure 80: Time-series OGVI vs OTCI and corresponding scatterplot of monthly time-step for site UK-Wytham-Woods, United Kingdom, land cover Tree Cover, broadleaved, deciduous, closed . A and C represent S3A; B and D represent S3B.

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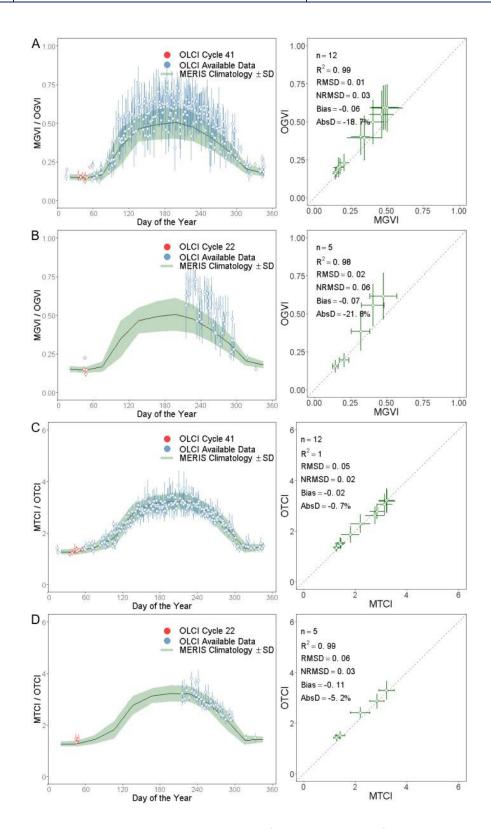


Figure 81: Time-series OGVI vs OTCI and corresponding scatterplot of monthly time-step for site IT-Isp, Italy, land cover Mixed forest. A and C represent S3A; B and D represent S3B

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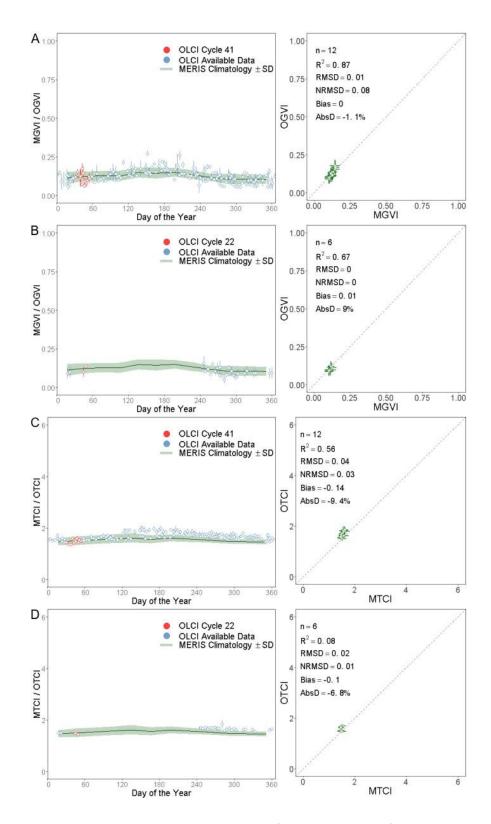


Figure 82: Time-series OGVI vs OTCI and corresponding scatterplot of monthly time-step for site AU-Calperum, Australia, land cover Shrub Cover, closed-open, deciduous. A and C represent S3A; B and D represent S3B.

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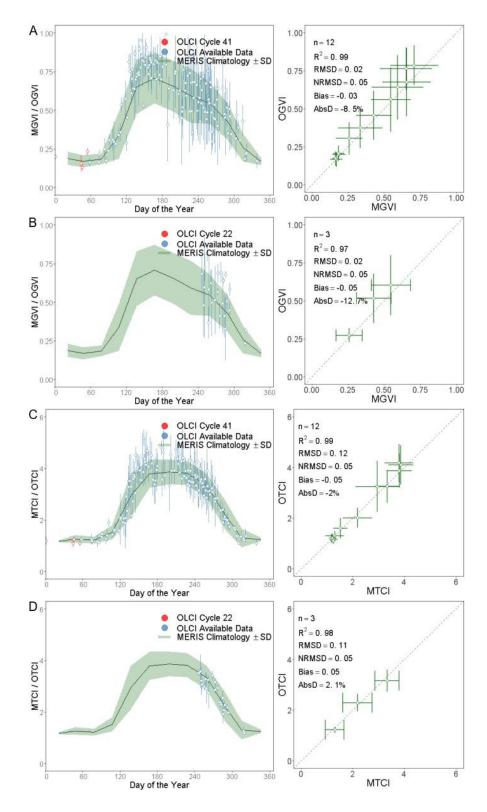


Figure 83 Time-series OGVI vs OTCI and corresponding scatterplot of monthly time-step for site DE-Hones-Holz, Deutschland, land cover Tree Cover, broadleaved, deciduous, closed. A and C represent S3A; B and D represent

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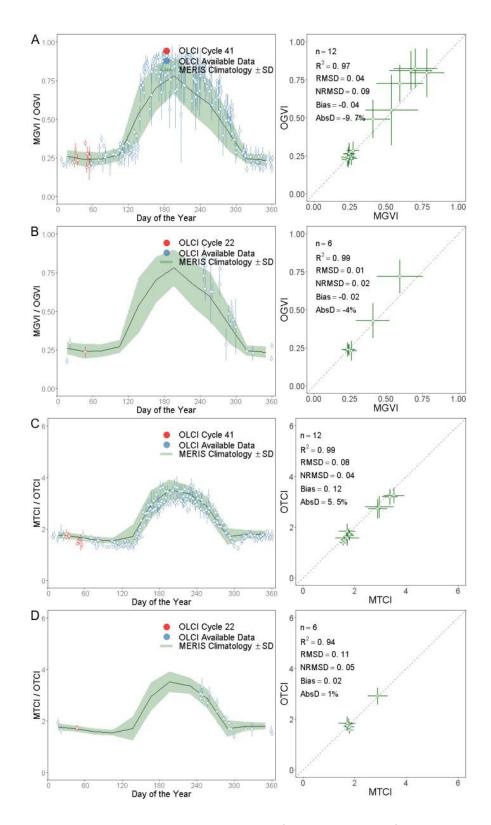


Figure 84: Time-series OGVI vs OTCI and corresponding scatterplot of monthly time-step for site US-Harvard, United States, land cover Tree Cover, broadleaved, deciduous, closed. A and C represent S3A; B and D represent S3B.

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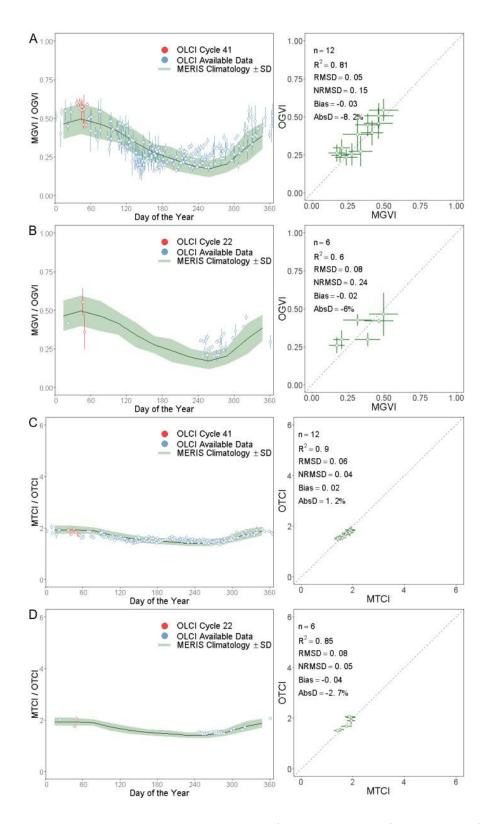


Figure 85: Time-series OGVI vs OTCI and corresponding scatterplot of monthly time-step for site AU-Litchfield, Australia, land cover Tree Cover, broadleaved, evergreen. A and C represent S3A; B and D represent S3B.

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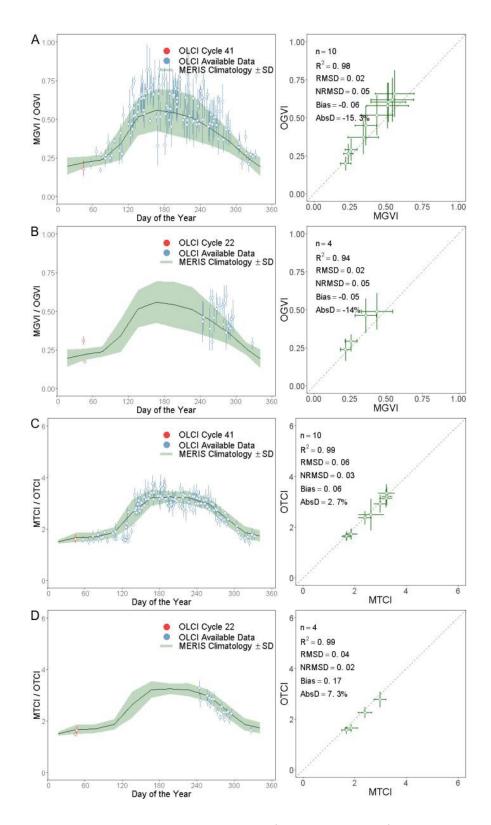


Figure 86: Time-series OGVI vs OTCI and corresponding scatterplot of monthly time-step for site BE-Brasschaat, Belgium, land cover Tree Cover, needle-leaved, evergreen. A and C represent S3A; B and D represent S3B.

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

There has been no new result during the cycle. Last figures (cycle 27) are considered valid.



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### 5 Level 2 Water products validation

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

#### 5.1.1 OLCI-A

There has been no update of the SVC (System Vicarious Calibration) during Cycle 041. Last figures (cycle 17) are considered valid.

#### 5.1.2 OLCI-B

Ocean Colour System Vicarious Calibration for OLCI-B has started. Current period activities consist in identifying the OLCI-B Level 0 data covering the CV sites for both NIR and VIS SVC, they have been completed in due time for the partial RP which took place end of December. Extractions from L1 reprocessed products were done early January and SVC calibration has started. Results are under analysis and refinement and will be presented in next Cyclic Performance Report.

5.2 [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.

#### 5.2.1 OLCI-A

#### **Activities done**

- The focus for this time period has been on the rolling archive None Time Critical (NT) data until March the 7<sup>th</sup>.
- Current reporting period is her after compared to the reprocessed archive covering the April 2016 to November 2017 period. None issues are reported neither in the extraction process nor in OLCI data.
- All extractions and statistics have been regenerated on the current rolling archive availability including all the extraction since July 2017. The available matchups therefore represent over one year of operation.

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At best 209 and 212 matchups at 490 and 560nm respectively are useful for this time period. OLCI's performances remain nominal.

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

Figure 87 and Figure 88 below presents the scatterplots and statistics of OLCI FR versus in situ reflectance. Two time periods are considered:

- The reprocessed archive covering the April 2016 to November 2017 time period
- The current reporting period computed on the NT dataset.

The current reporting period statistics are in line with the reprocessed dataset.

Table 3 and Table 4 below summarise the statistics over reprocessed time period and the current reporting period, respectively. Some statistical variables can differ very much as a consequence of the little number of points (ex: slope and intercept). Nonetheless RMSE are in the same order of magnitude for both dataset.



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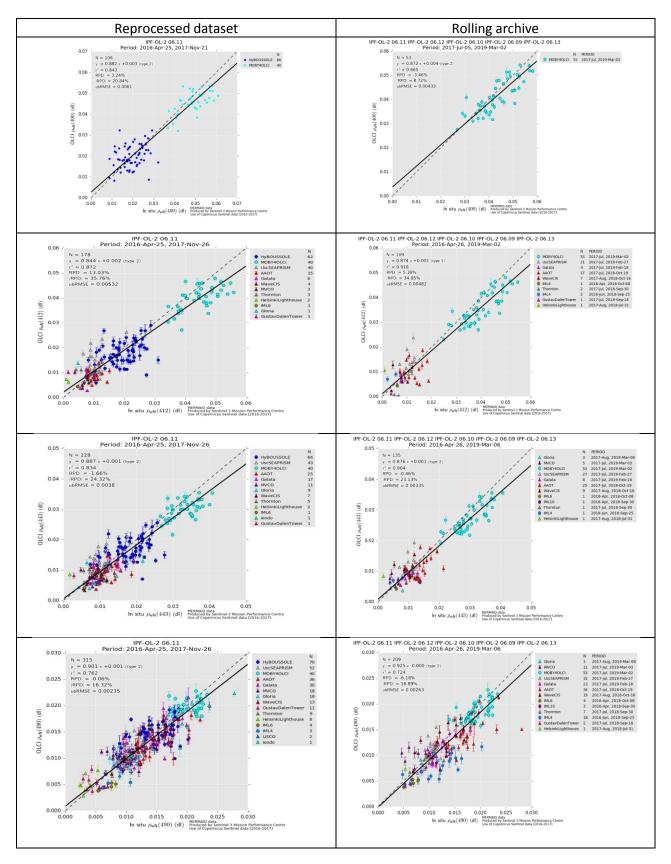


Figure 87: Scatter plots of OLCI versus in situ radiometry (FR data). Reprocessed dataset (left), all available data for the current time period (right), channels Oa1 to Oa4.

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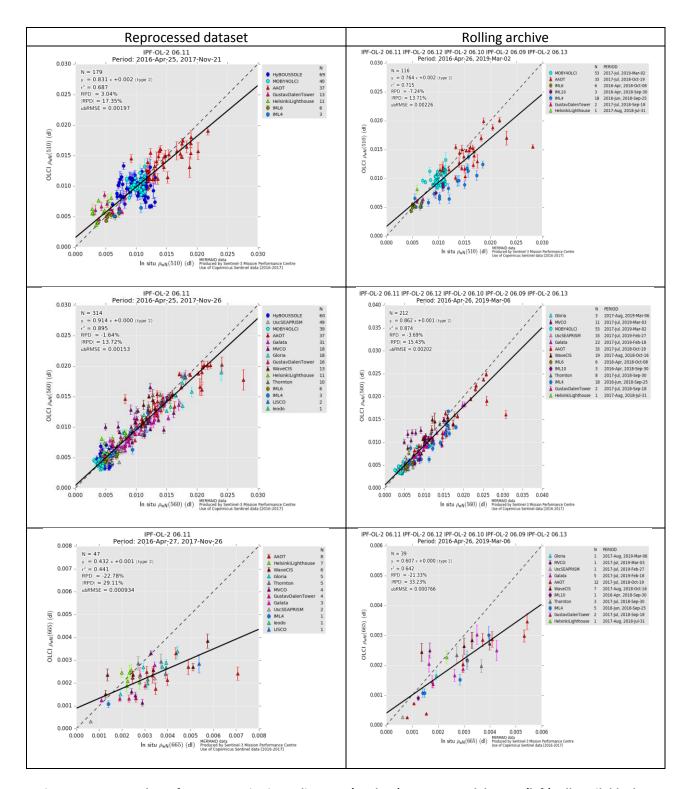


Figure 88: Scatter plots of OLCI versus in situ radiometry (FR data). Reprocessed dataset (left), all available data for the current time period (right), channels Oa5, Oa6 and Oa8

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Table 3: FR statistics over REP\_006 period; FR data.

lambda	N	RPD	RPD	MAD	RMSE	slope	intercept	r2
400	105	3.52%	20.74%	-0.0009	0.0062	0.8774	0.0029	0.8435
412	178	13.03%	35.76%	-0.0011	0.0054	0.8444	0.0021	0.8721
443	228	-1.66%	24.32%	-0.0013	0.0040	0.8874	0.0006	0.8336
490	315	-0.06%	16.32%	-0.0004	0.0024	0.9009	0.0009	0.7618
510	179	3.04%	17.35%	-0.0002	0.0020	0.8314	0.0015	0.6869
560	314	-1.64%	13.72%	-0.0003	0.0016	0.9139	0.0004	0.8946
665	47	-22.78%	29.11%	-0.0009	0.0013	0.4325	0.0009	0.4406

Table 4: FR statistics over July 2017 to March 2019, cycles 20 to 41; FR data.

lambda	N	RPD	RPD	MAD	RMSE	slope	intercept	r2
400	53	-3.46%	8.72%	-0.0018	0.0047	0.8720	0.0037	0.6647
412	109	5.39%	34.85%	-0.0020	0.0052	0.8741	0.0010	0.9179
443	135	-0.46%	23.13%	-0.0014	0.0036	0.8760	0.0008	0.9037
490	209	-6.18%	16.89%	-0.0012	0.0029	0.9254	-0.0001	0.7236
510	116	-7.24%	13.71%	-0.0011	0.0025	0.7645	0.0016	0.7146
560	212	-3.69%	15.43%	-0.0007	0.0021	0.8616	0.0006	0.8741
665	39	-21.33%	33.23%	-0.0007	0.0010	0.6070	0.0004	0.6424

#### **Time series**

Figure 89 and Figure 90 below present AAOT and MOBY in situ and OLCI time series over the current reporting period.

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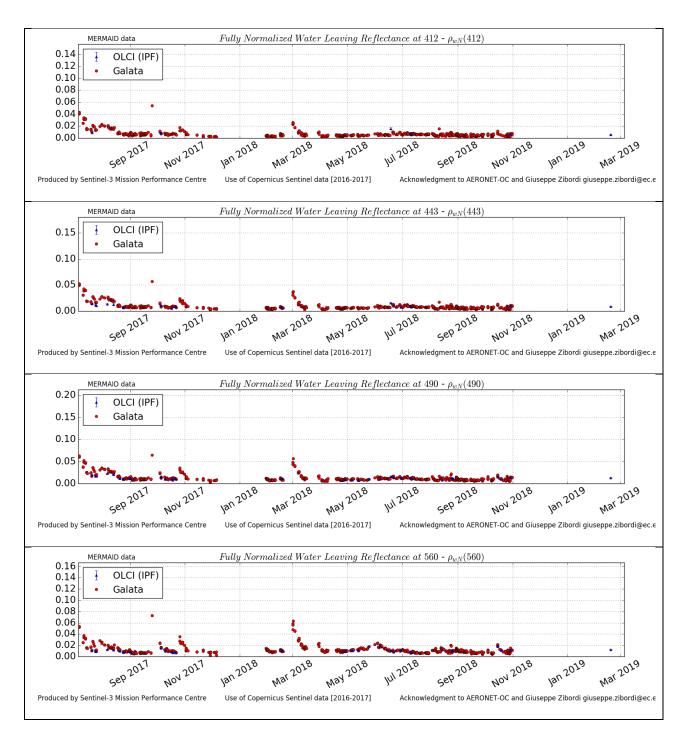


Figure 89: AAOT time series over current reporting period



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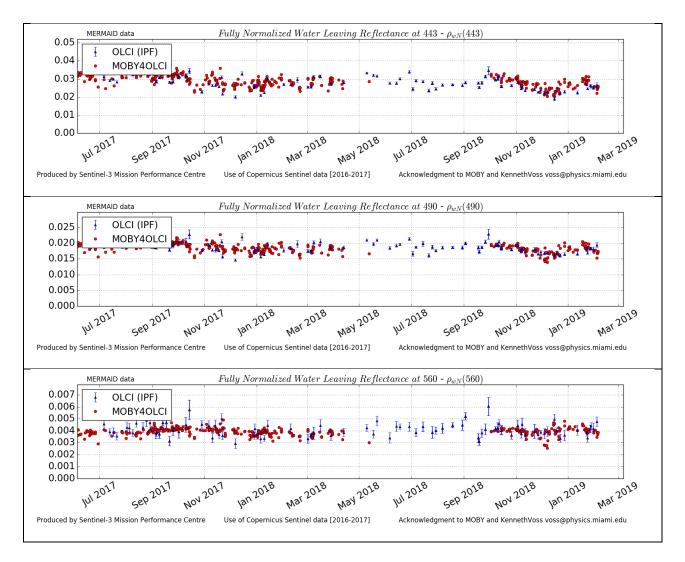


Figure 90: MOBY time series over current reporting period

#### 5.2.2 OLCI-B

The System Vicarious Calibration process being on-going for OLCI-B, no validation results are available yet.

### 5.3 [OLCI-L2WLR-CV-430] – Algorithm performance over spatial and temporal domains

There has been no new result during the cycle. Last figures (cycle 27) are considered valid.

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

There has been no new result during the cycle. Last figures (cycle 27) are considered valid.



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

#### 5.6 Validation of Aerosol Product

#### 5.6.1 Results

To validate OLCI's Aerosol product (aerosol optical thickness and Angstroem coefficient at 865nm), we continuously compare it with data from AERONET (Holben et al 1998), AERONET-OC (Zibordi et al 2009) and Maritime AERONET (MAN; Smirnow et al 2009). We limit the comparison to full-resolution non-time-critical data. Due to the limitation of OLCI's aerosol processing to water surfaces, the majority of matchups belong either to AERONET-OC or to Maritime AERONET acquisitions.

The validation is an ongoing process, where co-located data are continuously collected and analysed. Up to now only quality assured level 2 AERONET data have been used, which comes with a delay of up to one year. To broaden the amount of available data we started to additionally exploit level 1.5 data. This has the advantage that current OLCI-B commissioning products can be validated too. All recommended flags from *Sentinel-3 OLCI Marine User Handbook* (EUM/OPS-SEN3/MAN/17/907205) have been applied. Cloudy pixel have been filtered according to the standard cloud flags: *cloud, cloud margin and cloud ambiguous*. Eventually, to reduce the influence of undetected (sub pixel or sub visual) clouds, only matchups have been used, where the standard deviation of the aerosol optical thickness within the 10x10 km² area was less than 0.2. About 91,000 OLCI A scenes within the period of June 2016 to March 2019 and 6,200 OLCI B scenes between June 2018 and January 2019 have been analysed. For a valid matchup, the temporal distance between the satellite overpass and the AERONET acquisition was less than 60 minutes. shows the relevant comparisons for the aerosol optical thickness: a) OLCI-A vs AERONET level 2.0, b) OLCI-A vs AERONET level 1.5, c) OLCI-B vs AERONET level 1.5 and d) OLCI-A vs Maritime AERONET. The previous findings were confirmed:

- The relation between the AERONET and **OLCI A** aerosol optical thickness is linear, the explained variance is 0.75.
- The optical thickness of OLCI A is approximately 30% systematically larger than AERONET, leading to a systematic bias of 0.04.
- If the systematic difference is corrected, the root mean squared difference (*rmsd*) decreases from 0.06 to 0.03.

#### Further:

- The results for AERONET level 1.5 and 2.0 are basically the same. Thus the level 1.5 data is a valid data source.
- The OLCI-B comparison shows the same findings when compared with AERONET level 1.5, however based on much fewer matchups.



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The comparison of OLCI with Maritime AERONET does show a slightly larger *rmsd*, but no significant systematic difference.

What exactly causes the different behavior is uncertain. We suspect an influence of the coast on OLCI's aerosol product, which is effective for AERONET/ AERONET-OC but does not emerge on open sea MAN cruises. What kind of influence this is is unclear.

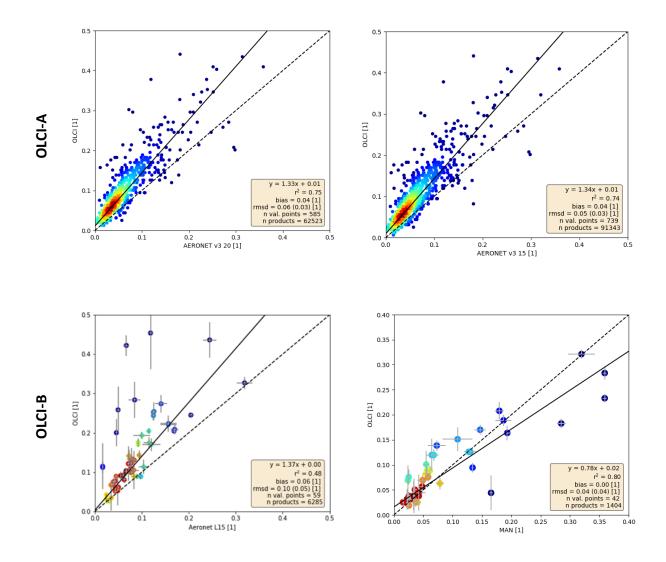


Figure 91: Upper left: Scatter plot of the AOT at 870 nm product (OLCI A) vs. AERONET level 2.0 Upper right: as left, but vs. AERONET level 1.5. Lower left: as upper but for OLCI B vs. AERONET level 1.5. Lower right: OLCI A vs Maritime AERONET.



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#### 5.6.2 References

Holben, B. N., et al., AERONET—A federated instrument network and data archive for aerosol characterization, Remote Sens. Environ.,66, 1–16, 1998.)

Smirnov, A., Holben, B.N., Slutsker, I., Giles, D.M., McClain, C.R., Eck, T.F., Sakerin, S.M., Macke, A., Croot, P., Zibordi, G., Quinn, P.K., Sciare, J., Kinne, S., Harvey, M., Smyth, T.J., Piketh, S., Zielinski, T., Proshutinsky, A., Goes, J.I., Nelson, N.B., Larouche, P., Radionov, V.F., Goloub, P., Krishna Moorthy, K., Matarrese, R., Robertson, E.J., Jourdin, F., 2009. Maritime aerosol network as acomponent of aerosol robotic network. J. Geophys. Res. 114, 1—10, http://dx.doi.org/10.1029/2008JD011257.

Zibordi G., B.Holben, I.Slutsker, D.Giles, D.D'Alimonte, F.Mélin, J.-F. Berthon, D. Vandemark, H.Feng,G.Schuster, B.Fabbri, S.Kaitala, J.Seppälä. AERONET-OC: a network for the validation of Ocean Color primary radiometric products. Journal of Atmospheric and Oceanic Technology, 26, 1634-1651, 2009.

### 5.7 [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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### 6 Validation of Integrated Water Vapour over Land & Water

There has been no new result during the cycle. Last figures (cycle 40/21) are considered valid.



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### 7 Level 2 SYN products validation

There has been no new OLCI-A result during the cycle. Last figures (cycle 38) are considered valid.

There has been no result for OLCI-B yet.

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#### **8** Events

For OLCI-A, one Radiometric Calibration Sequence has been acquired during Cycle 041:

\$ S01 sequence (diffuser 1) on 14/02/2019 16:14 to 16:16 (absolute orbit 15598)

For OLCI-B, two Radiometric Calibration Sequences have been acquired during Cycle 022:

- S01 sequence (diffuser 1) on 14/02/2019 03:48 to 03:50 (absolute orbit 4197)
- S01 sequence (diffuser 1) on 27/02/2019 01:28 to 01:30 (absolute orbit 4381)

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### 9 Appendix A

Other reports related to the Optical mission are:

S3 SLSTR Cyclic Performance Report, S3A Cycle No. 041, S3B Cycle No. 022 (ref. S3MPC.RAL.PR.02-041-022)

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>

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