

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

S3 OLCI Cyclic Performance Report

S3-A

Cycle No. 053

Start date: 19/12/2019

End date: 15/01/2020

S3-B

Cycle No. 034

Start date: 29/12/2019

End date: 25/01/2020



*Mission
Performance
Centre*



Ref.: S3MPC.ACR.PR.01-053-034

Issue: 1.0

Date: 31/01/2020

Contract: 4000111836/14/I-LG

Customer: ESA	Document Ref.: S3MPC.ACR.PR.01-053-034
Contract No.: 4000111836/14/I-LG	Date: 31/01/2020
	Issue: 1.0

Project:	PREPARATION AND OPERATIONS OF THE MISSION PERFORMANCE CENTRE (MPC) FOR THE COPERNICUS SENTINEL-3 MISSION		
Title:	S3 OLCI Cyclic Performance Report		
Author(s):	OLCI ESLs		
Approved by:	L. Bourg, OLCI ESL Coordinator	Authorized by	Frédéric Rouffi, OPT Technical Performance Manager
Distribution:	ESA, EUMETSAT, S3MPC consortium		
Accepted by ESA	S. Dransfeld, MPC Deputy TO for OPT P. Féménias, MPC TO		
Filename	S3MPC.ACR.PR.01-053-034 - i1r0 - OLCI Cyclic Report 053-034.docx		

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The work performed in the frame of this contract is carried out with funding by the European Union. The views expressed herein can in no way be taken to reflect the official opinion of either the European Union or the European Space Agency.



	<p style="text-align: center;">Sentinel-3 MPC S3 OLCI Cyclic Performance Report S3A Cycle No. 053 – S3B Cycle No. 034</p>	Ref.: S3MPC.ACR.PR.01-053-034 Issue: 1.0 Date: 31/01/2020 Page: iii
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Changes Log

Version	Date	Changes
1.0	31/01/2020	First Version

List of Changes

Version	Section	Answers to RID	Changes

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1 Processing Baseline Version

1.1 Sentinel3-A

IPF	IPF / Processing Baseline version	Date of deployment
OL1	06.08 / 2.58	NRT: 29/10/2019 08:26UTC NTC 29/10/2019 08:26UTC
OL2 LAND	06.13 / 2.60	NRT: 27/11/2019 09:38 UTC NTC: 27/11/2019 09:38 UTC
OL2 MAR	06.12 / 2.38	NRT: 29/08/2018 09:24 UTC NTC: 29/08/2018 09:33 UTC
SY2	06.17 / 2.51	NTC: 30/05/2019 11:00 UTC
SY2_VGS	06.07 / 2.44	NTC: 21/01/2019 10:06 UTC

1.2 Sentinel3-B

IPF	IPF / Processing Baseline version	Date of deployment
OL1	06.08 / 1.30	NRT: 29/10/2019 08:26 UTC NTC: 29/10/2019 08:26 UTC
OL2 LAND	06.13 / 1.32	NRT: 27/11/2019 09:38 UTC NTC: 27/11/2019 09:38 UTC
OL2 MAR	06.12 / 1.09	NRT: 29/08/2018 09:24 UTC NTC: 29/08/2018 09:33 UTC
SY2	06.17 / 1.23	NTC: 30/05/2019 11:00 UTC
SY2_VGS	06.07 / 1.16	NTC: 21/01/2019 10:06 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.

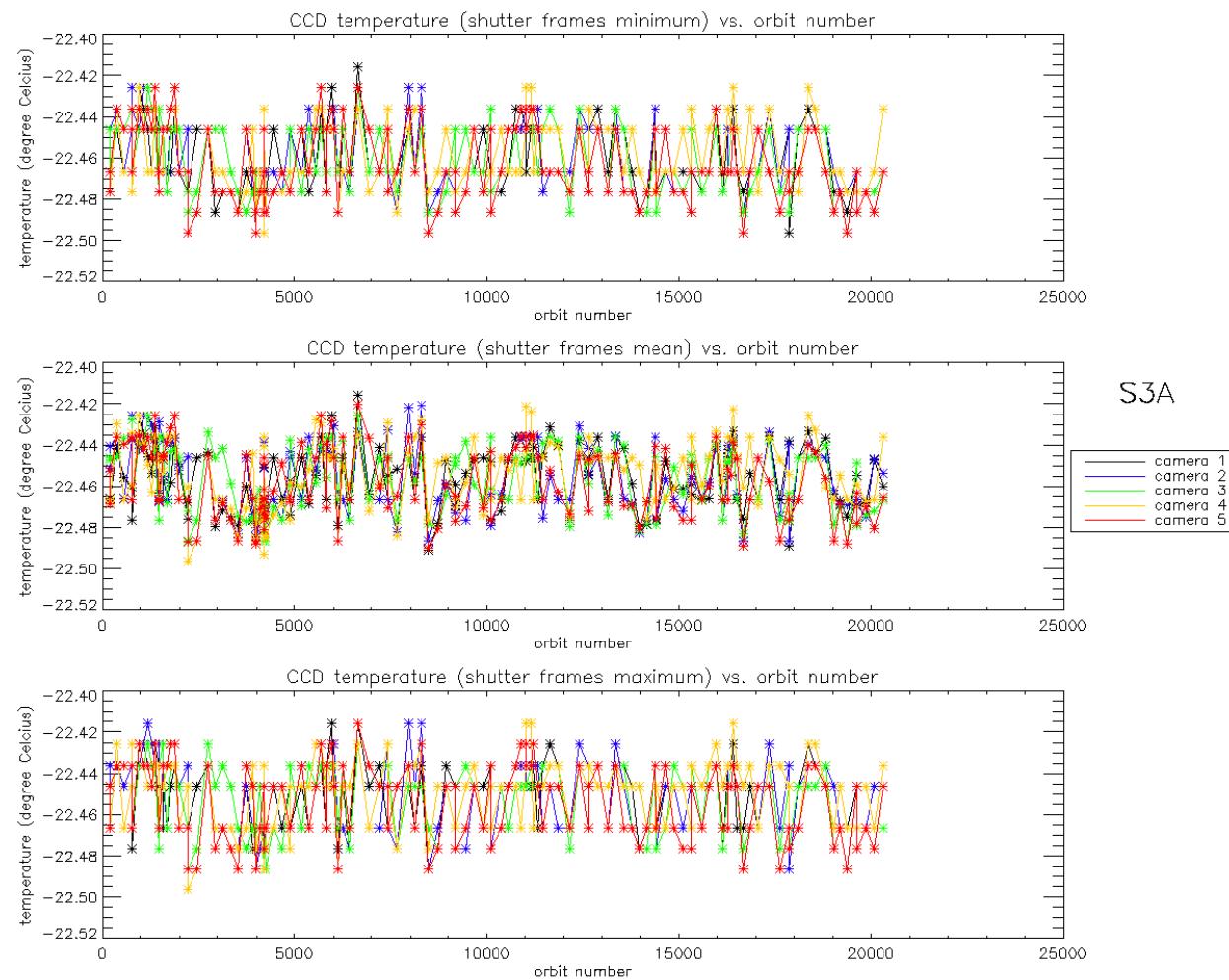


Figure 1: long term monitoring of OLCI-A CCD temperatures using minimum value (top), time averaged values (middle), and maximum value (bottom) provided in the annotations of the Radiometric Calibration Level 1 products, for the Shutter frames, all radiometric calibrations so far except the first one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



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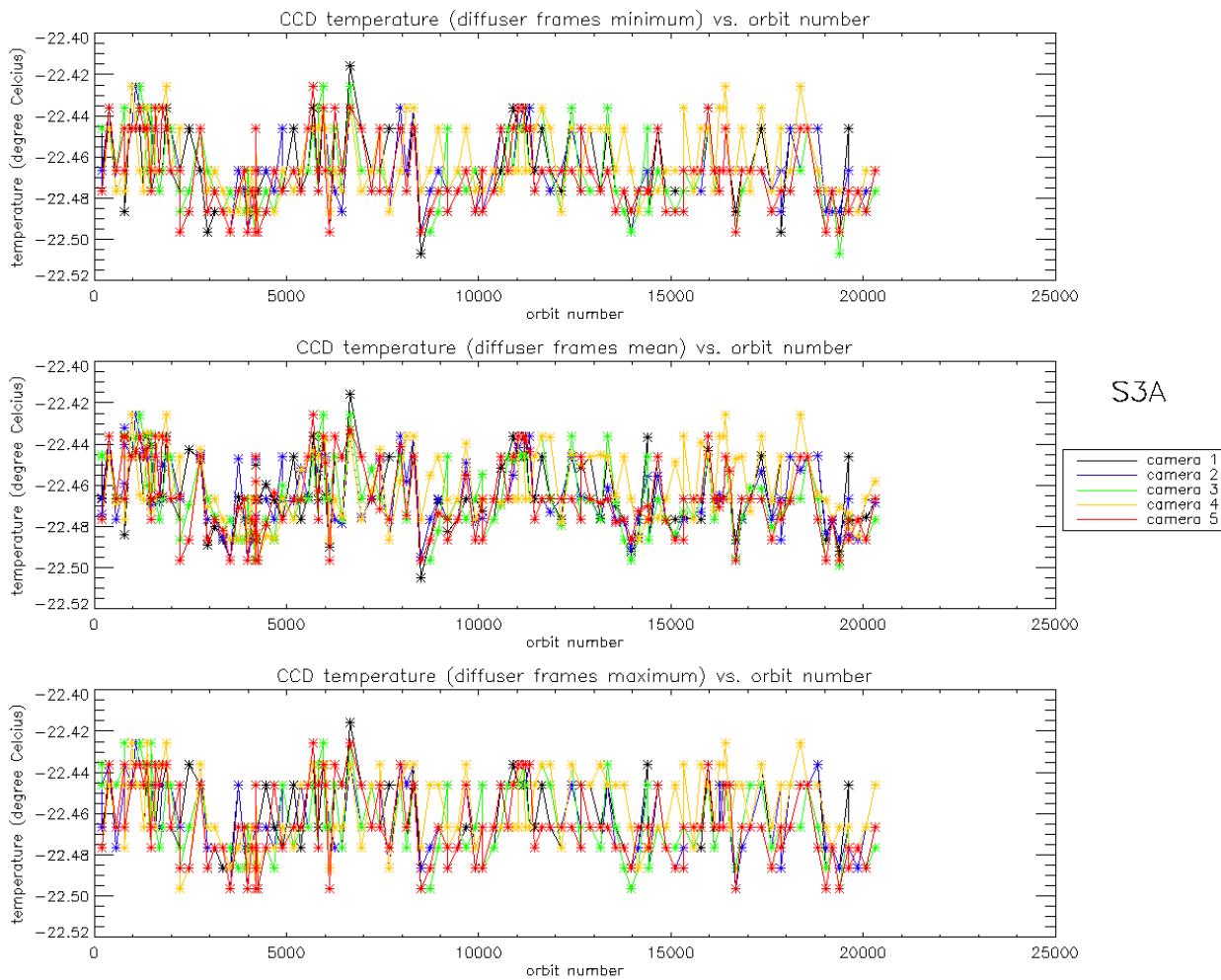


Figure 2: Same as Figure 1 for diffuser frames.



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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.

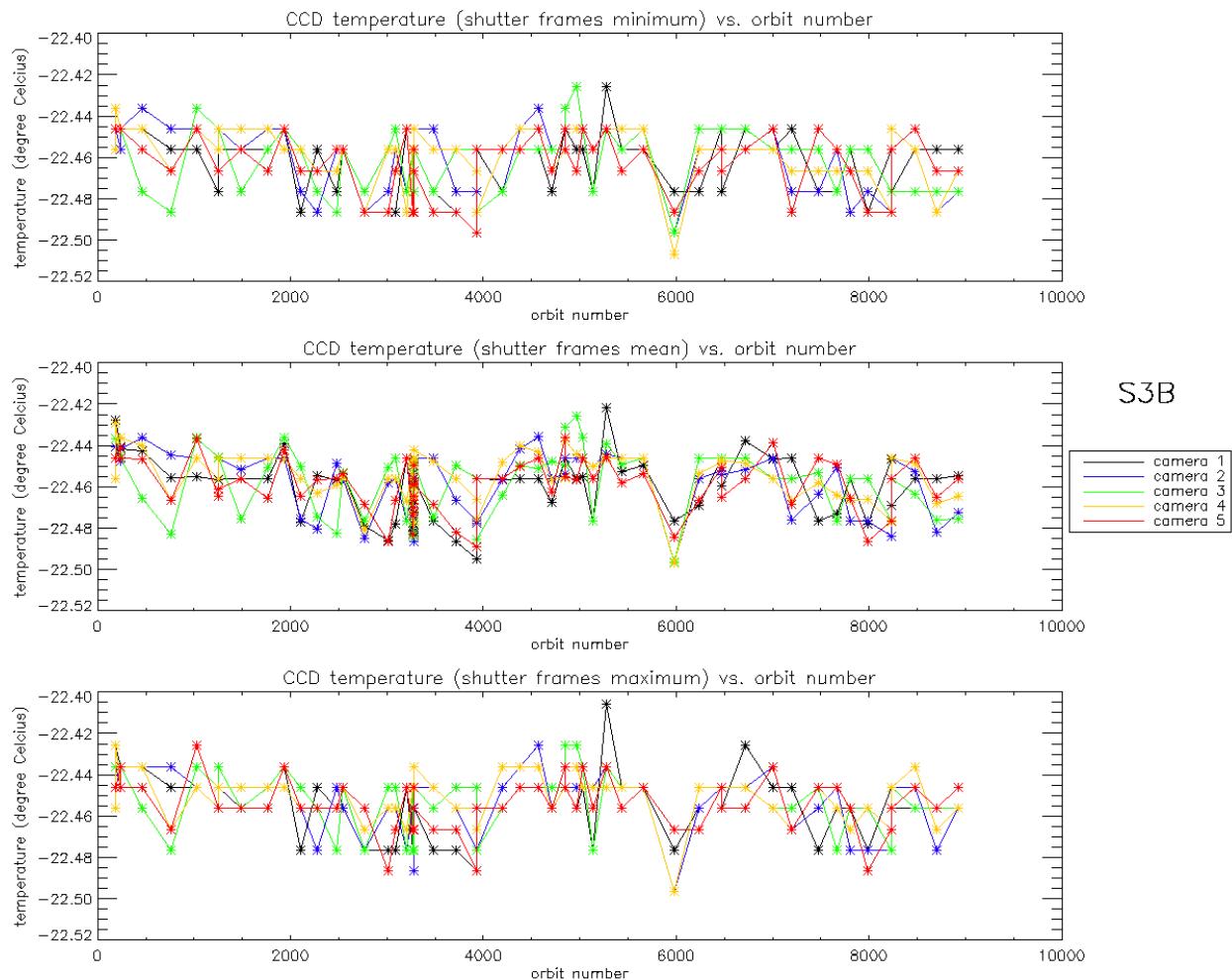


Figure 3: long term monitoring of OLCI-B CCD temperatures using minimum value (top), time averaged values (middle), and maximum value (bottom) provided in the annotations of the Radiometric Calibration Level 1 products, for the Shutter frames, all radiometric calibrations so far except the first one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



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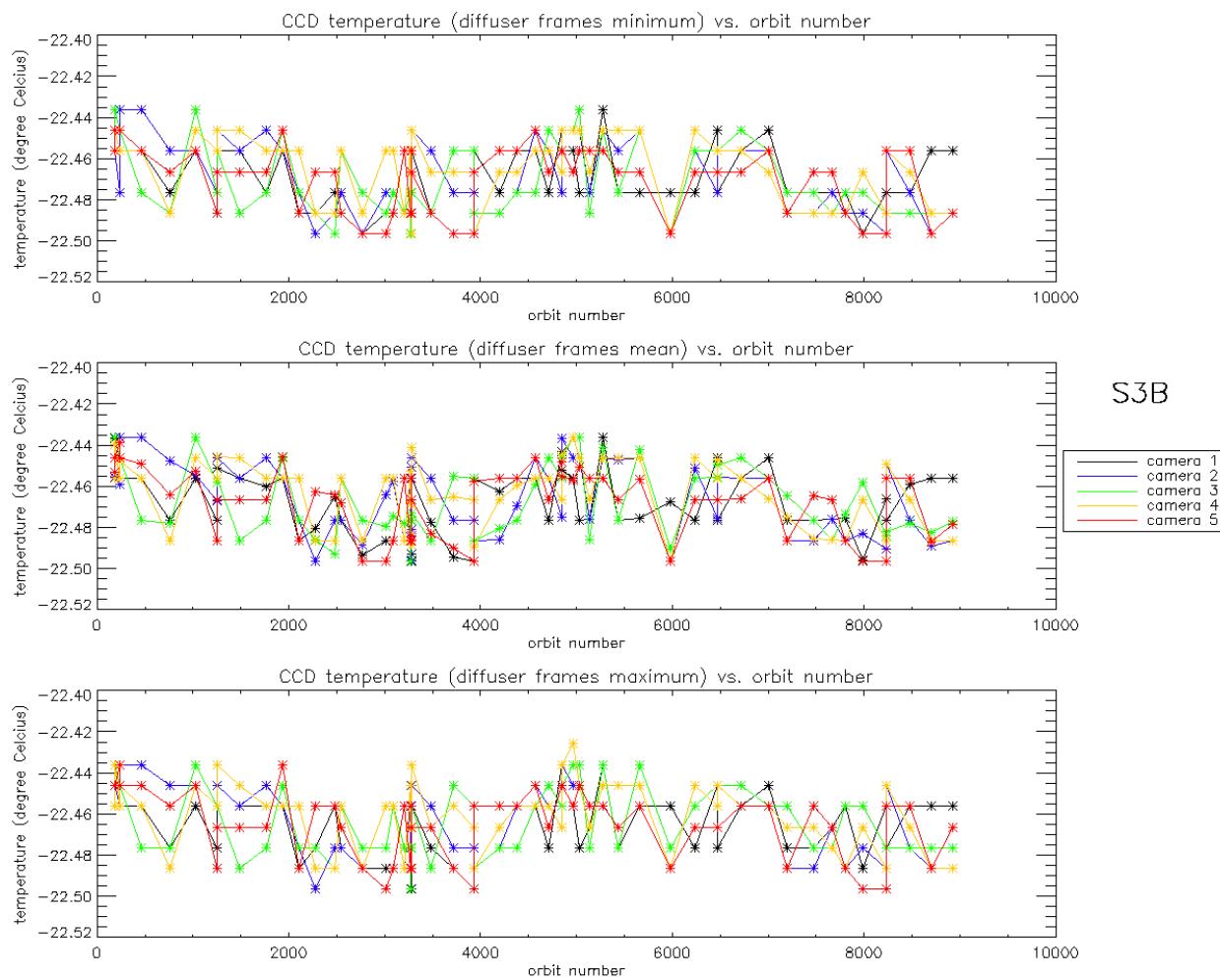


Figure 4: same as Figure 3 for diffuser frames.

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2.2 Radiometric Calibration

For OLCI-A, two Radiometric Calibration Sequences have been acquired during Cycle 053:

- ❖ S01 sequence (diffuser 1) on 26/12/2019 08:26 to 08:28 (absolute orbit 20085)
- ❖ S01 sequence (diffuser 1) on 11/01/2020 13:14 to 13:16 (absolute orbit 20316)

For OLCI-B, one Radiometric Calibration Sequences has been acquired during Cycle 034:

- ❖ S01 sequence (diffuser 1) on 12/01/2020 00:21 to 00:23 (absolute orbit 8929)

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).

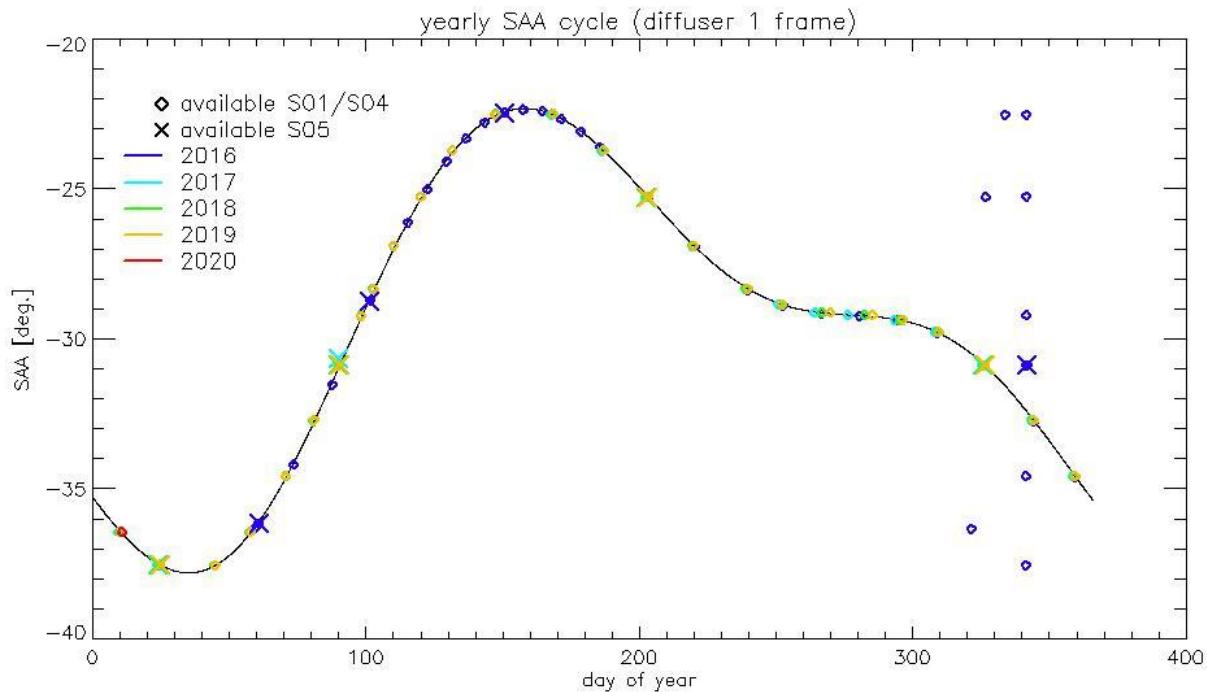


Figure 5: Sun azimuth angles during acquired OLCI-A Radiometric Calibrations (diffuser frame) on top of nominal yearly cycle (black curve). Diffuser 1 with diamonds, diffuser 2 with crosses, 2016 acquisitions in dark blue, 2017 in clear blue, 2018 in green, 2019 in yellow and 2020 in red.

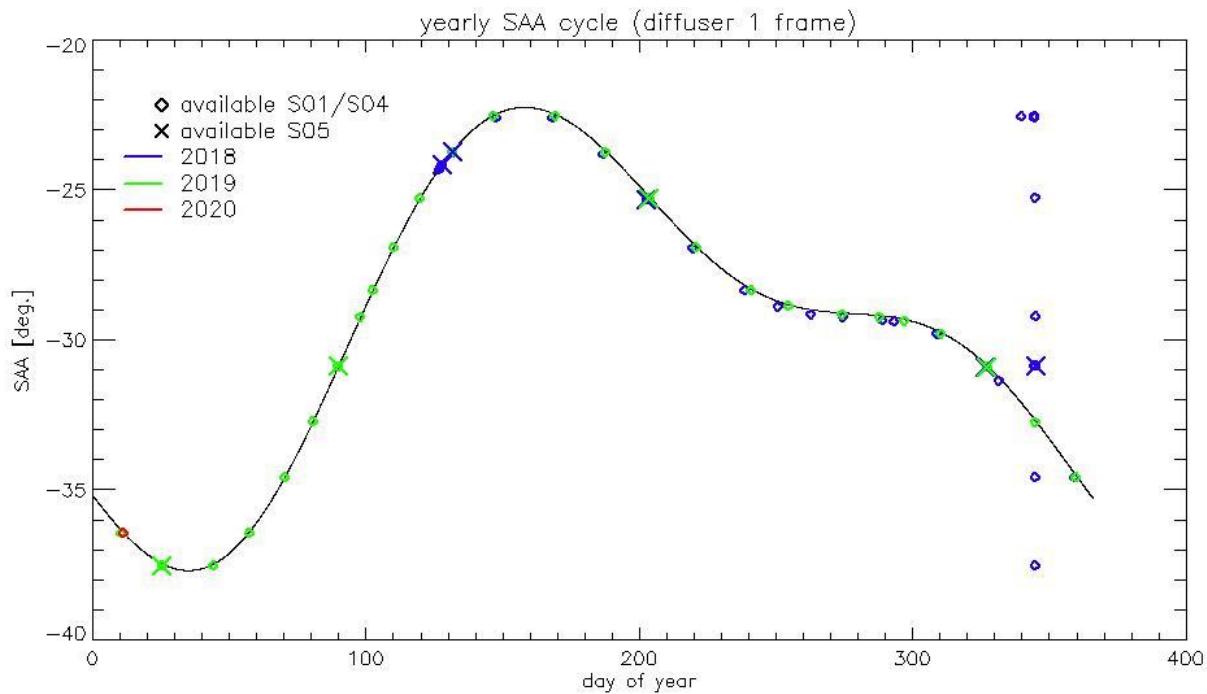


Figure 6: same as Figure 5 for OLCI-B (2018 in blue, 2019 in green and 2020 in red).

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

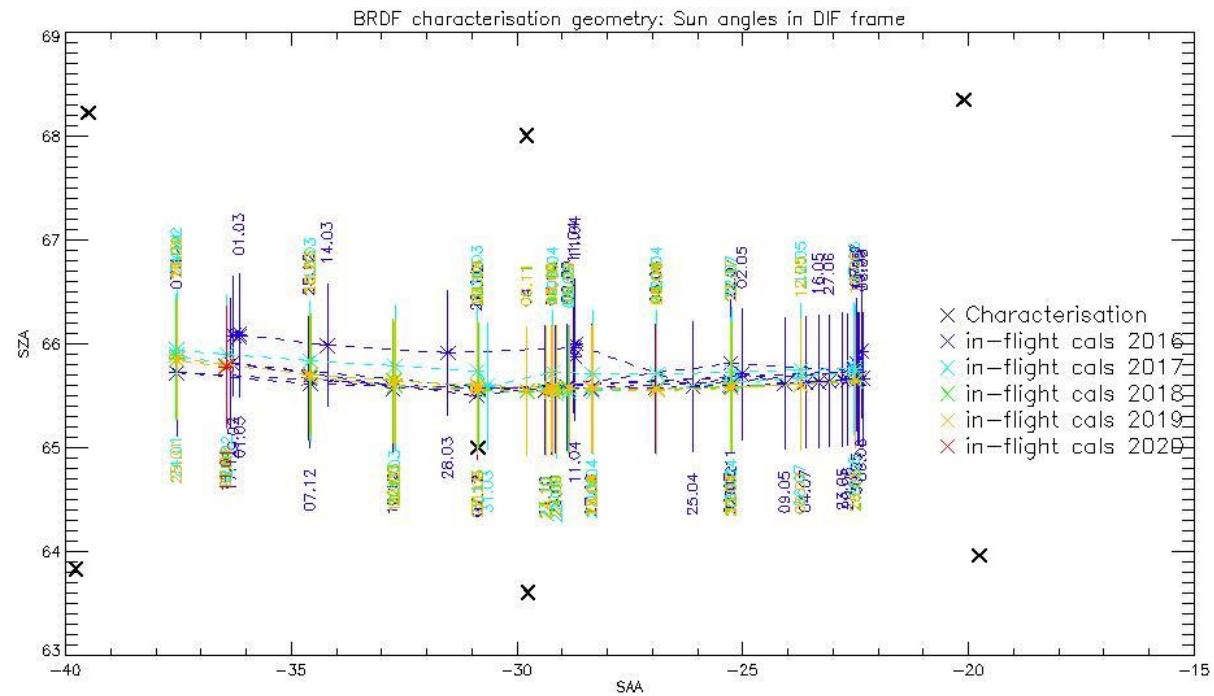


Figure 7: OLCI-A Sun geometry during radiometric Calibrations on top of characterization ones (diffuser frame)



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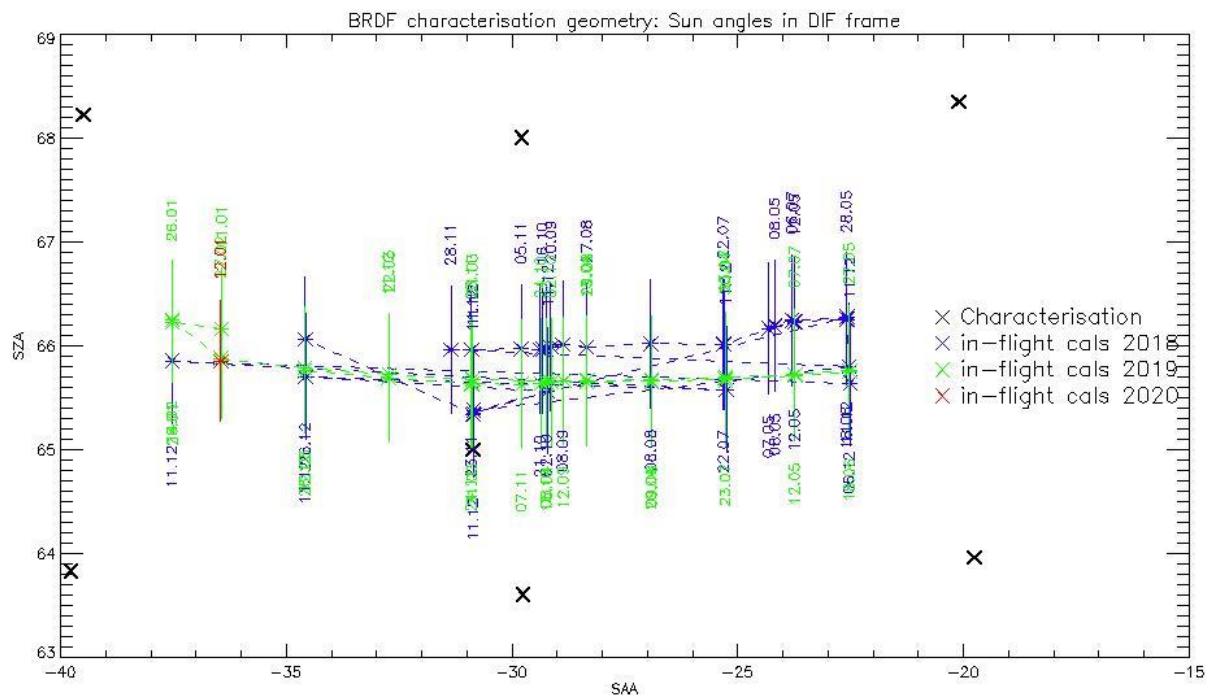


Figure 8: same as Figure 7 for OLCI-B

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2.2.2 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.

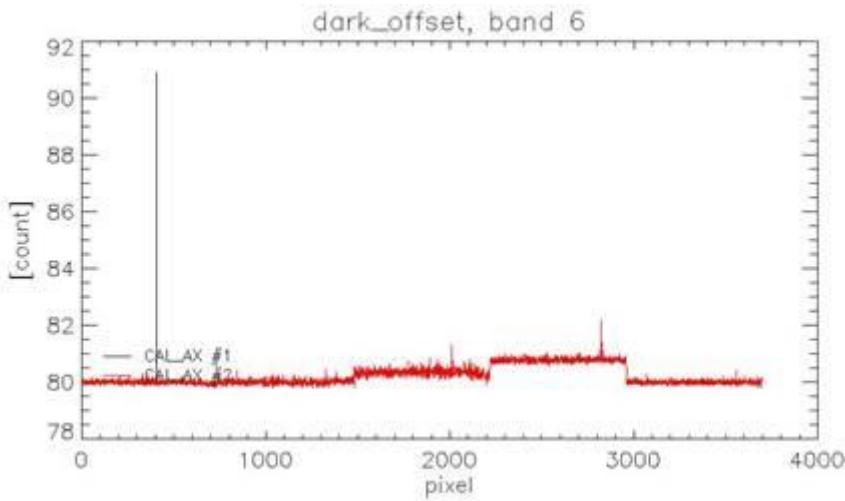


Figure 9: Dark Offset table for band Oa06 with (red) and without (black) HEP filtering (Radiometric Calibration of 22 July 2017). The strong HEP event near pixel 400 has been detected and removed by the HEP filtering.

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

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2.2.2.2 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 Oa1) 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.

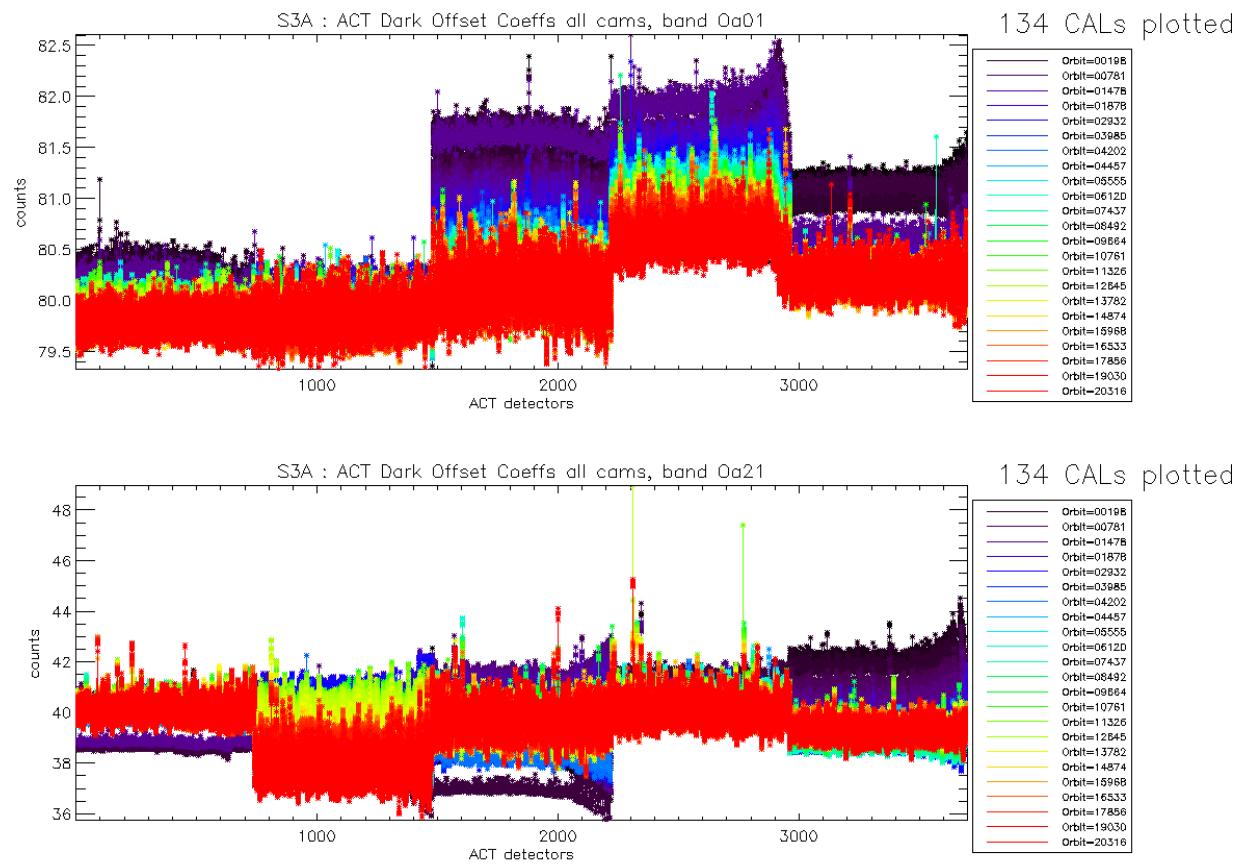


Figure 10: OLCI-A Dark Offset for band Oa1 (top) and Oa21 (bottom), all radiometric calibrations so far except the first one (orbit 183) for which the instrument was not thermally stable yet.



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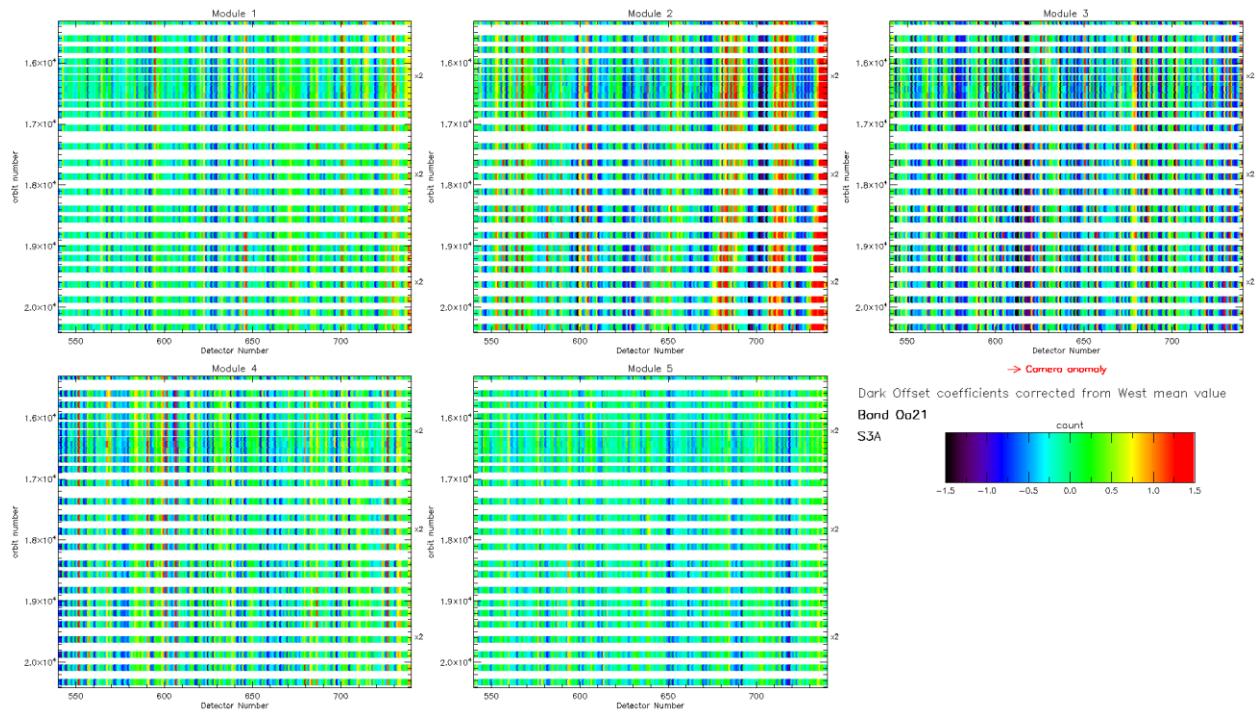


Figure 11: map of OLCI-A periodic noise for the 5 cameras, for band Oa21. X-axis is detector number (East part, from 540 to 740, where the periodic noise occurs), Y-axis is the orbit number. Y-axis range is focused on the most recent 5000 orbits. The counts have been corrected from the West detectors 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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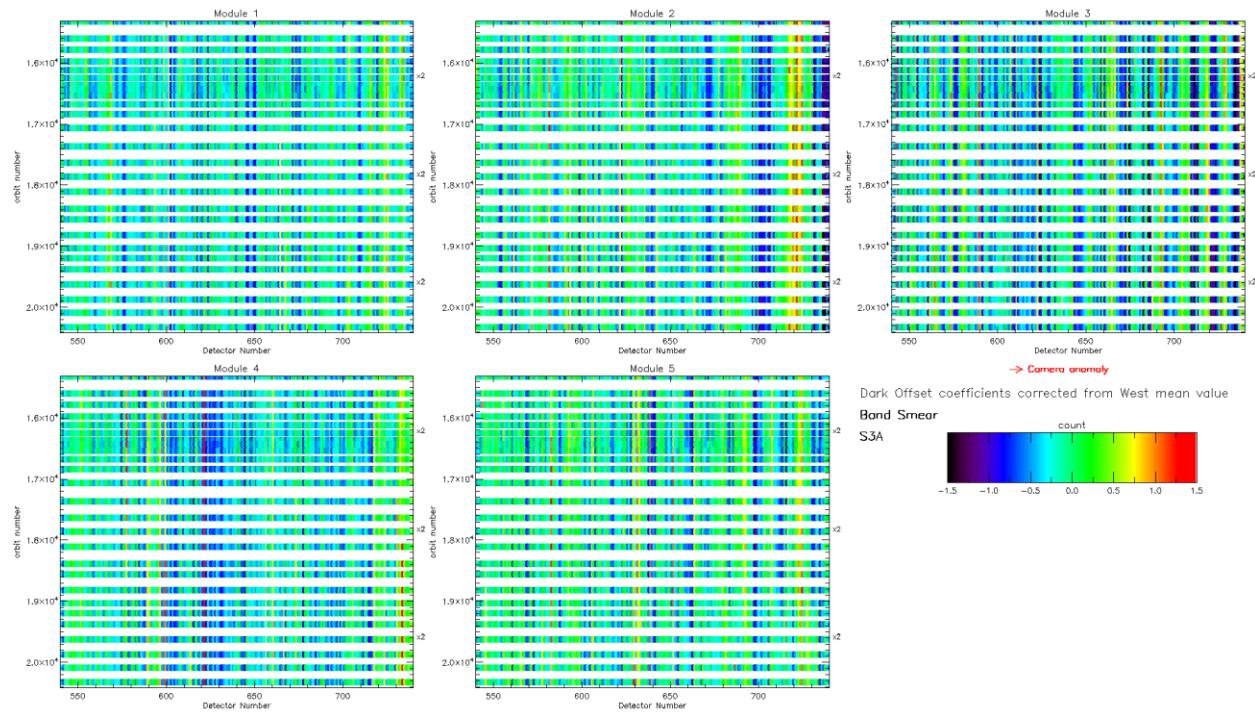


Figure 12: same as Figure 11 for smear band.

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 CALs of the current cycle.

As there was no camera anomaly during the current cycle, there is no sudden change of periodic noise to report during the current cycle. We can notice however that a small drift of the PN phase is present since about orbit 18000 in camera 2 Oa21 for the 100 eastern pixels (see Figure 11). This kind of behaviour was already encountered for the same camera/band between orbit 13500 and 14500.

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).

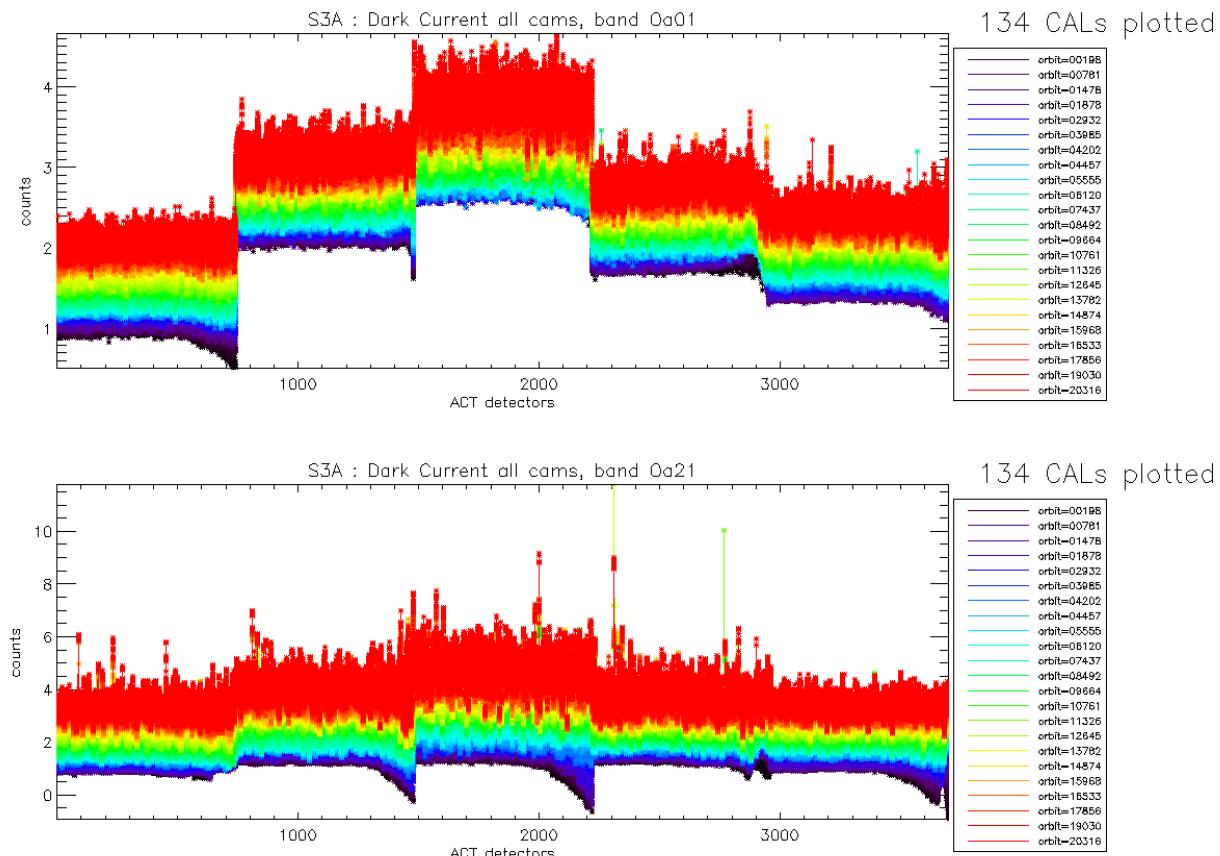


Figure 13: OLCI-A Dark Current for band Oa01 (top) and Oa21 (bottom), all radiometric calibrations so far except the first one (orbit 183) for which the instrument was not thermally stable yet.

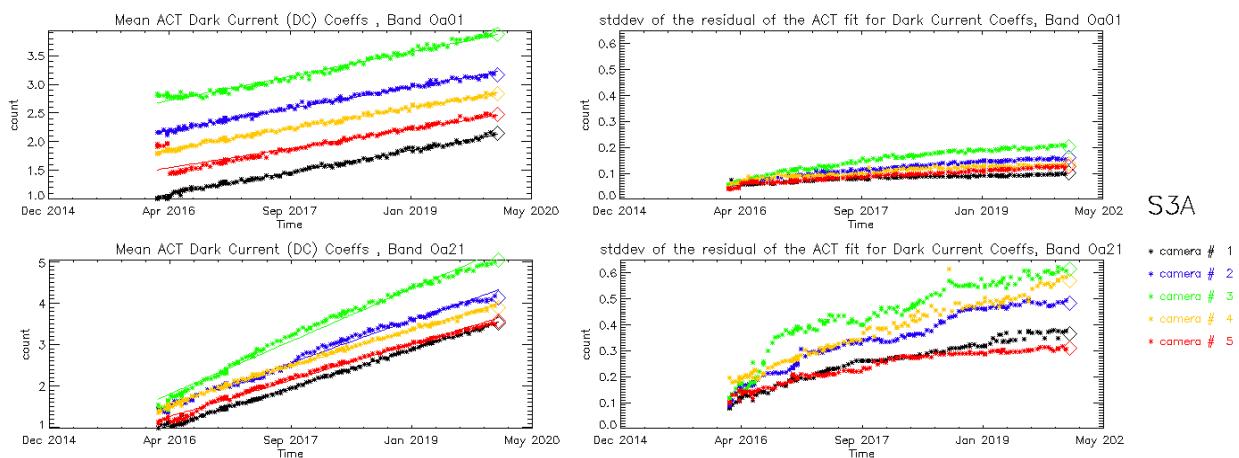


Figure 14: left column: ACT mean on 400 first detectors of OLCI-A Dark Current coefficients for spectral band Oa01 (top) and Oa21 (bottom). Right column: same as left column but for Standard deviation instead of mean. We see an increase of the DC level as a function of time especially for band Oa21.

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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, 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).

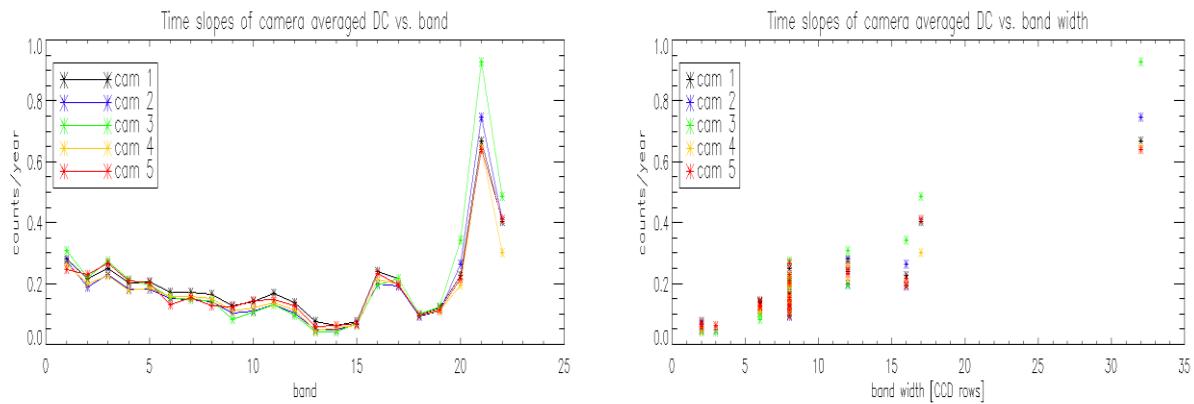


Figure 15: OLCI-A Dark current increase rates with time (in counts per year) vs. band (left) and vs. band width (right)

2.2.2.3 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 it happened for OLCI-A after a few thousands of orbits, the strong periodic noise phase and amplitude drift, present at the very beginning of the mission is now showing a clear stabilization.

There is no specific behaviour of the PN to report in the current cycle.

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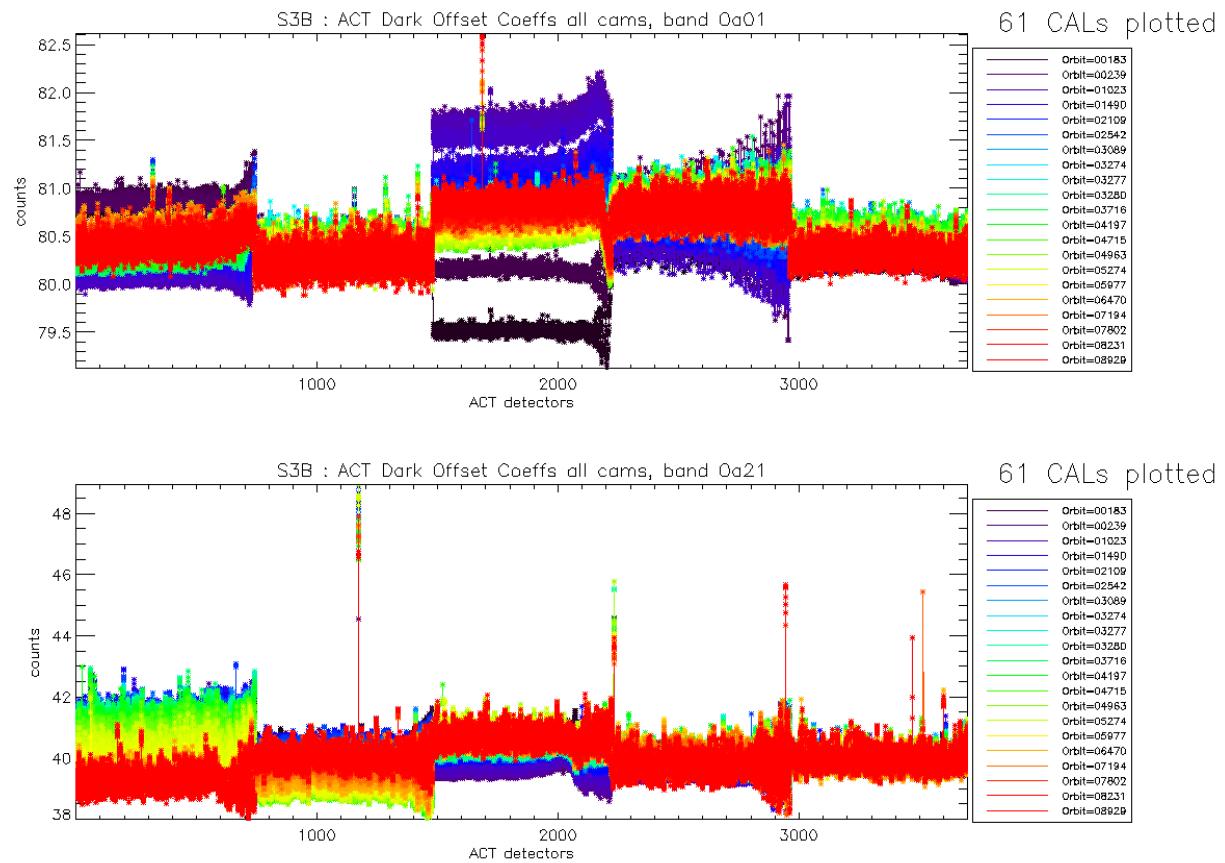


Figure 16: OLCI-B Dark Offset for band Oa1 (top) and Oa21 (bottom), all radiometric calibrations so far except the first one (orbit 167) for which the instrument was not thermally stable yet.



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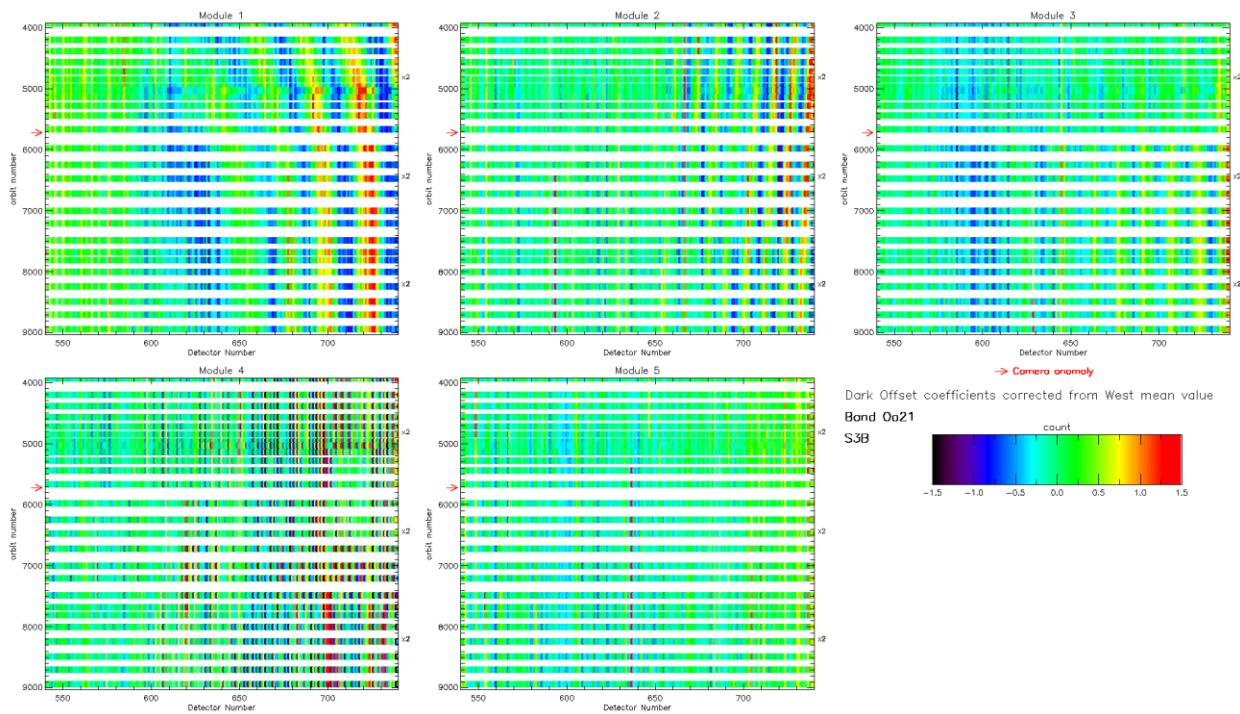


Figure 17: OLCI-B map of periodic noise for the 5 cameras, for band Oa21. X-axis is detector number (East part, from 540 to 740, where the periodic noise occurs), Y-axis is the orbit number. The counts have been corrected from the West detectors mean value (not affected by periodic noise) in order to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

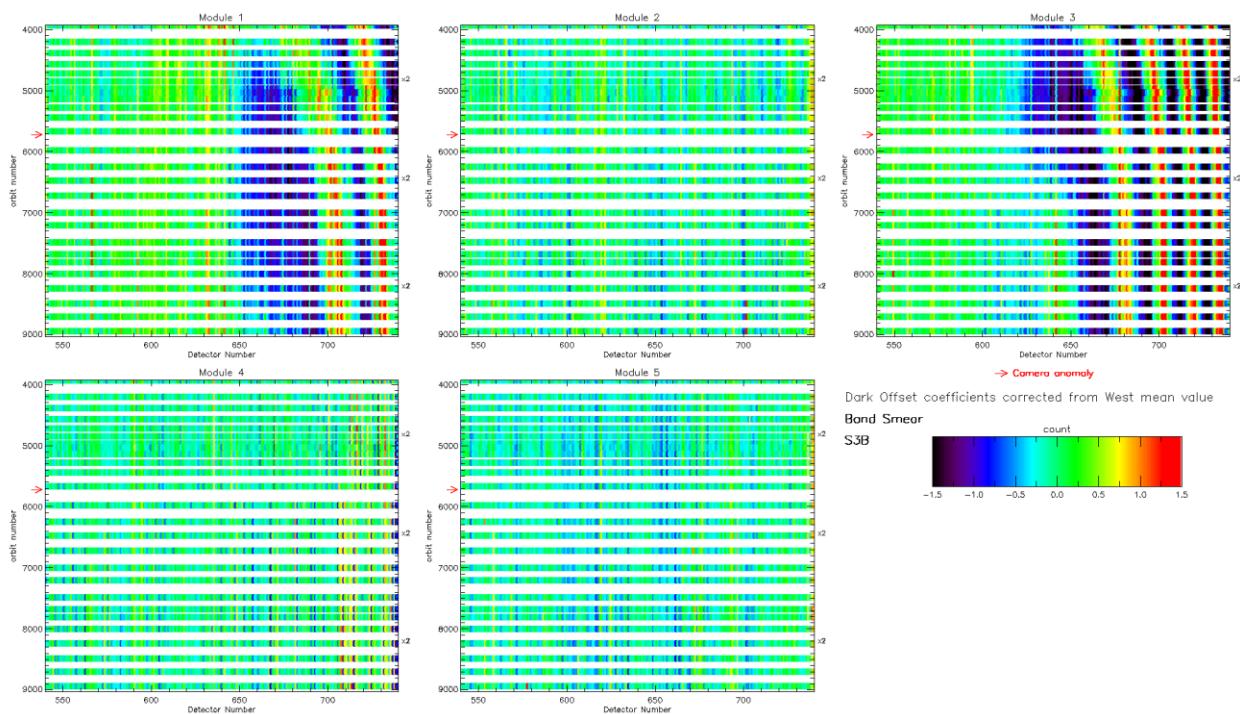


Figure 18: same as Figure 17 for smear band.



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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).

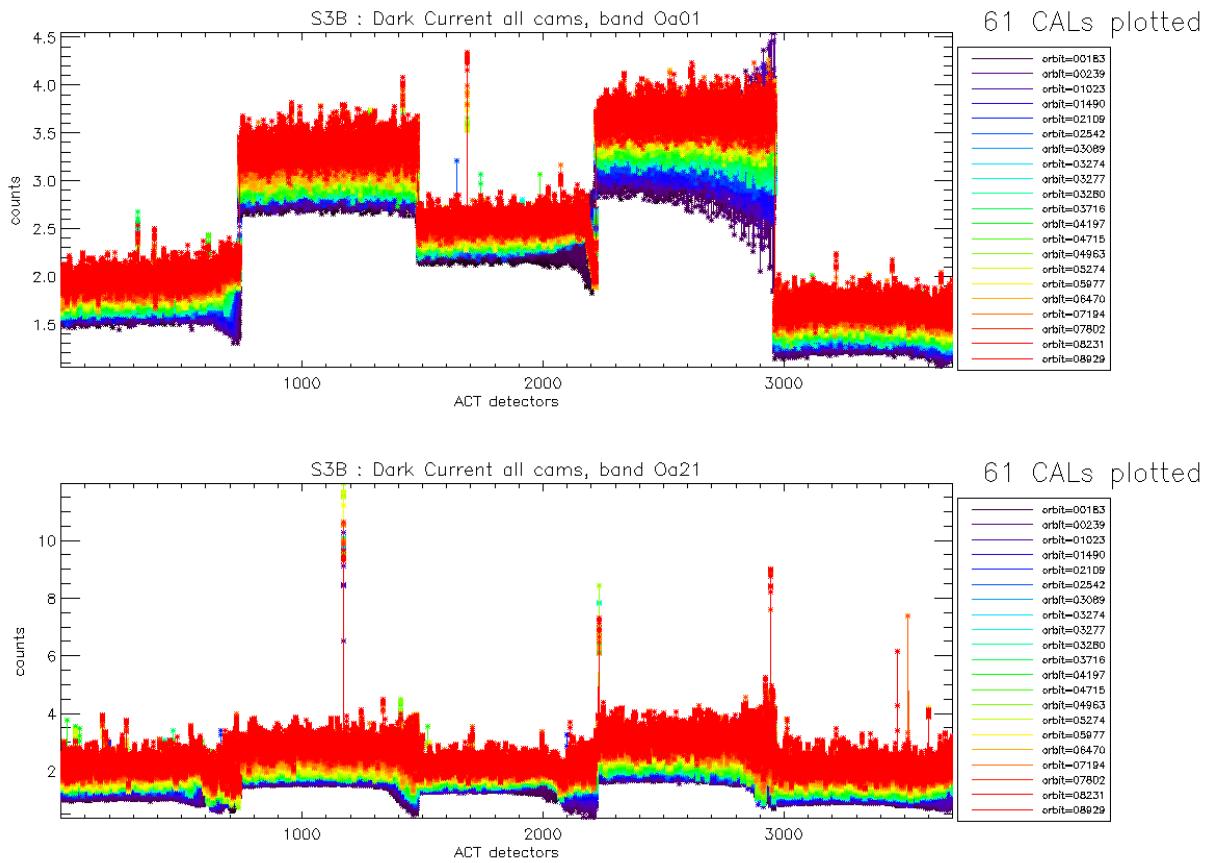


Figure 19: OLCI-B Dark Current for band Oa01 (top) and Oa21 (bottom), all radiometric calibrations so far except the first one (orbit 167) for which the instrument was not thermally stable yet.

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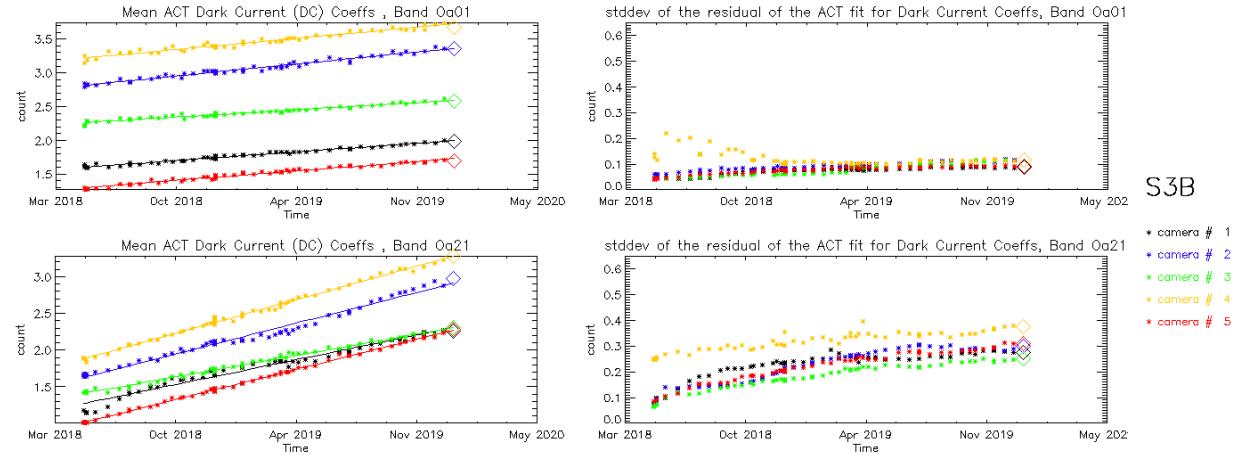


Figure 20: left column: ACT mean on 400 first detectors of OLCI-B Dark Current coefficients for spectral band Oa01 (top) and Oa21 (bottom). Right column: same as left column but for Standard deviation instead of mean.
We see an increase of the DC level as a function of time especially for band Oa21.

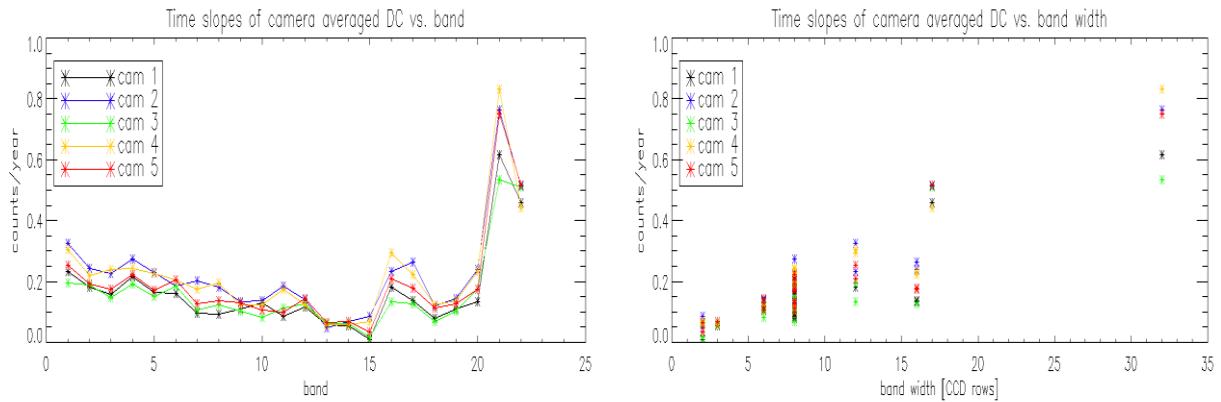


Figure 21: OLCI-B Dark Current increase rates with time (in counts per year) vs. band (left) and vs. band width (right)

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

2.2.3.1 Instrument response monitoring

2.2.3.1.1 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.

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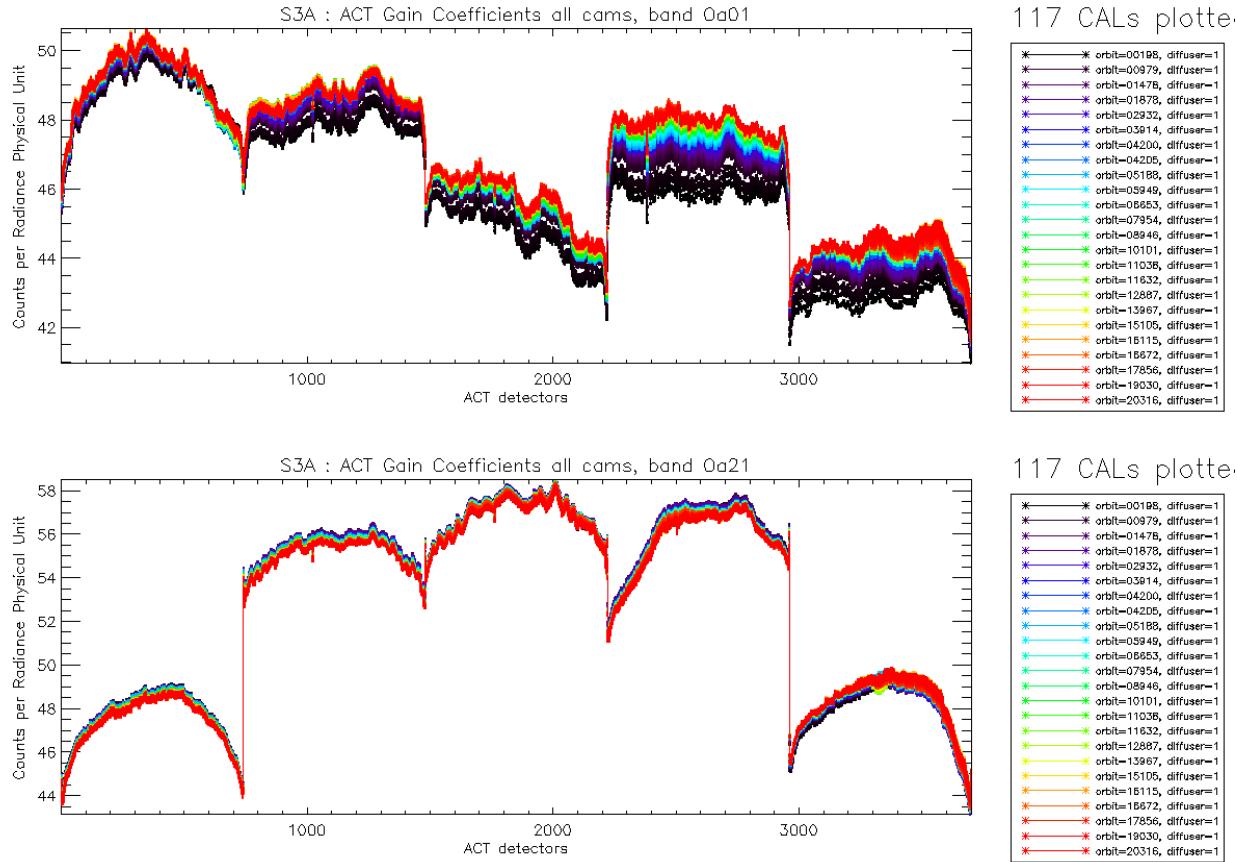


Figure 22: OLCI-A Gain Coefficients for band Oa1 (top) and Oa21 (bottom), all diffuser 1 radiometric calibrations so far except the first one (orbit 183) for which the instrument was not thermally stable yet.

The gains plotted in Figure 22, however are derived using the ground BRDF model 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 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.



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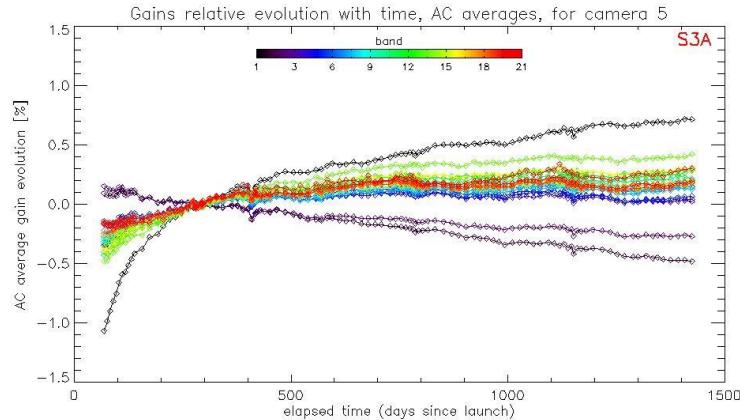
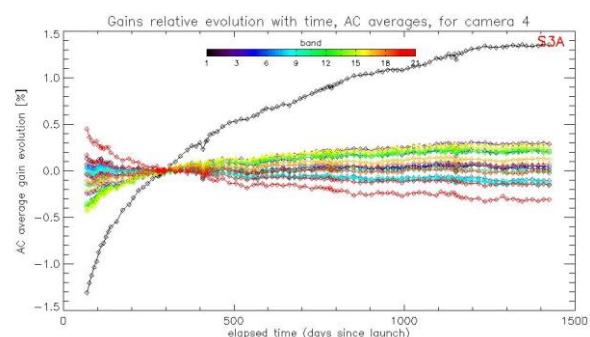
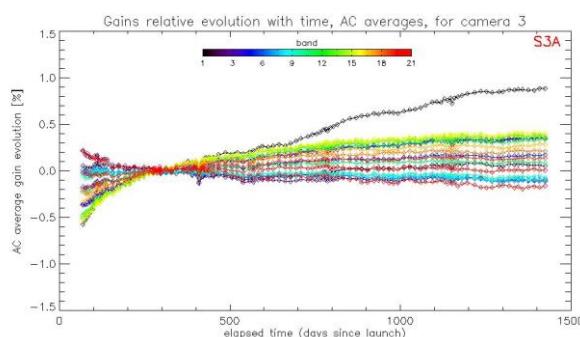
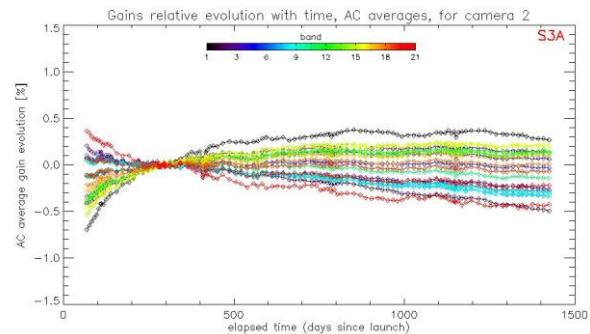
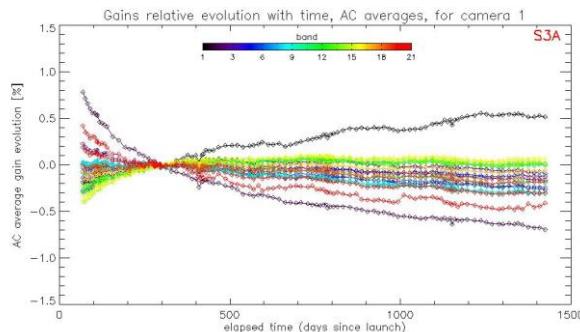


Figure 23: camera averaged gain relative evolution with respect to “best geometry” calibration (07/12/2016), as a function of elapsed time since the change in OLCI channels settings (25/04/16); one curve for each band (see colour code on plots), one plot for each module. The diffuser ageing has been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

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2.2.3.1.2 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.

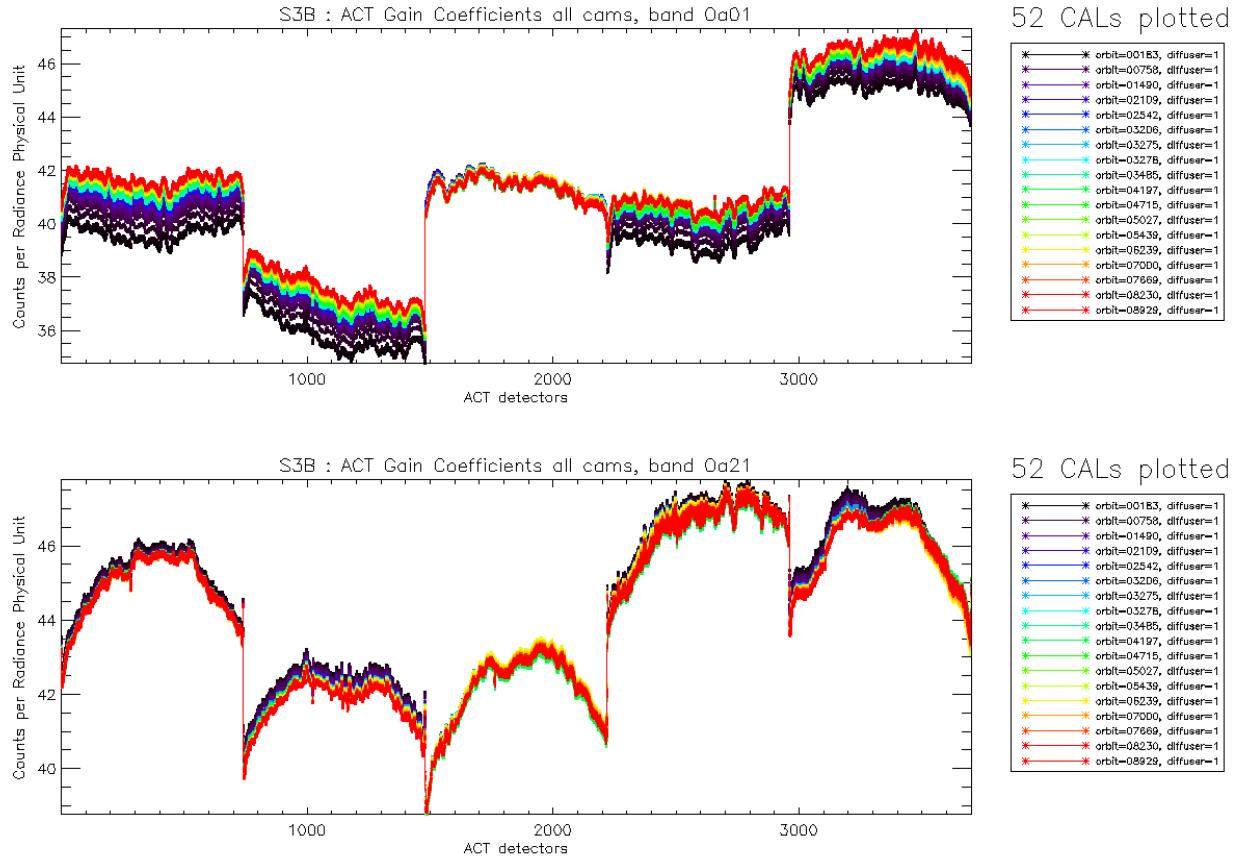


Figure 24: OLCI-B Gain Coefficients for band Oa1 (top) and Oa21 (bottom), all diffuser 1 radiometric calibrations so far except the first one (orbit 167) for which the instrument was not thermally stable yet.

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 (first calibration after channel programming change: 18/06/2018). 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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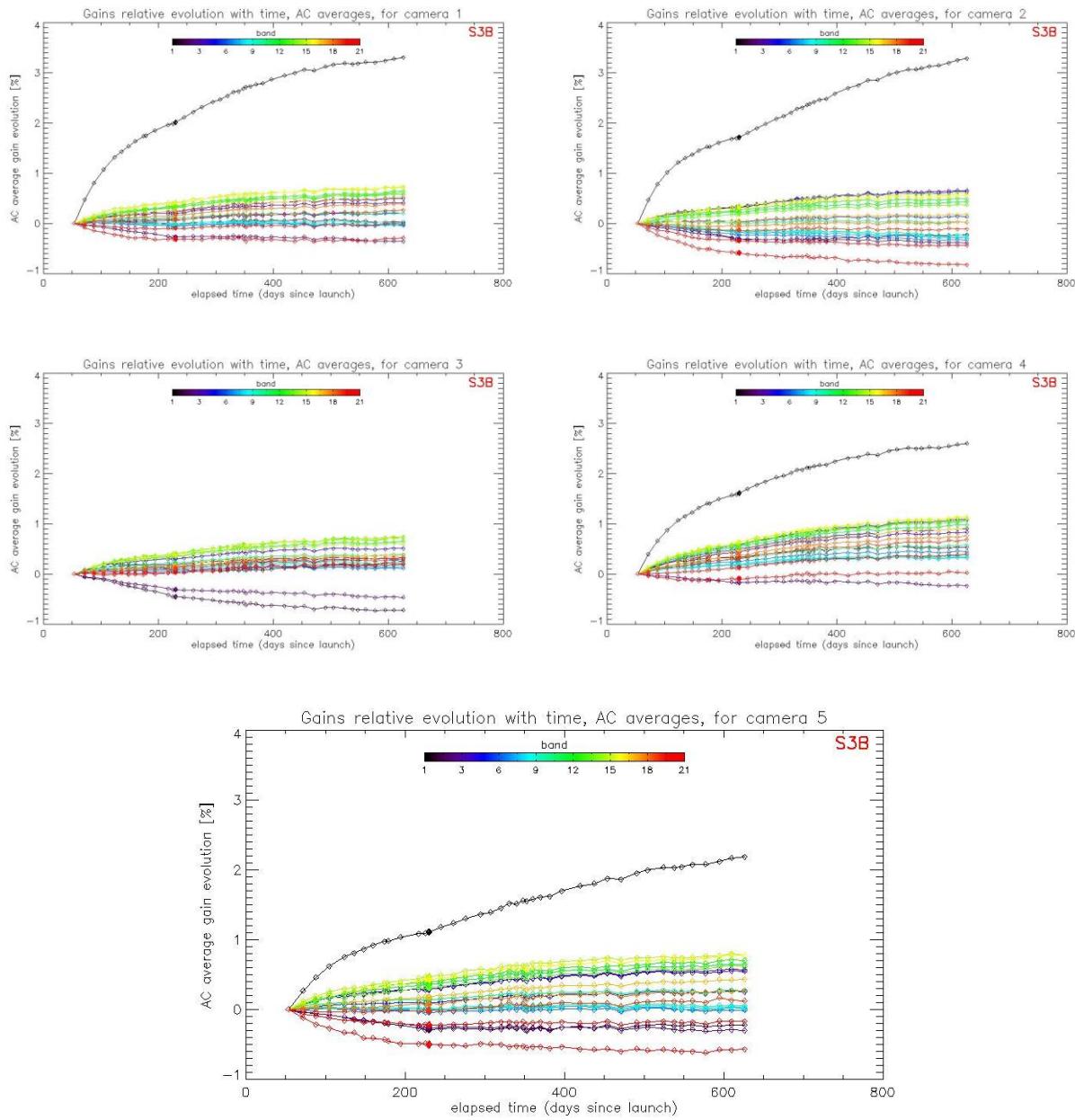


Figure 25: OLCI-B camera averaged gain relative evolution with respect to first calibration after channel programming change (18/06/2018), as a function of elapsed time since the beginning of the mission; one curve for each band (see colour code on plots), one plot for each module. The diffuser ageing has been taken into account.

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2.2.3.2 Instrument evolution modelling

2.2.3.2.1 OLCI-A

The OLCI-A Radiometric Model has been refreshed and put in operations the 29/10/2019 (Processing Baseline 2.58). The model has been derived on the basis of an extended Radiometric Calibration dataset (from 25/04/2016 to 28/08/2019). It 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 9 calibrations in extrapolation over about 5 months), despite a very small drift with respect to the most recent data, remains better than 0.1% (at the exception of band Oa01 for the very first CAL) when averaged over the whole field of view (Figure 26). The previous model, trained on a Radiometric Dataset limited to 11/04/2019, shows clearly a bigger drift of the model with respect to most recent data (Figure 27). Comparison of the two figures shows the improvement brought by the updated Model over almost all the mission: only Oa01 show a lower performance for the very first calibration with the new model.

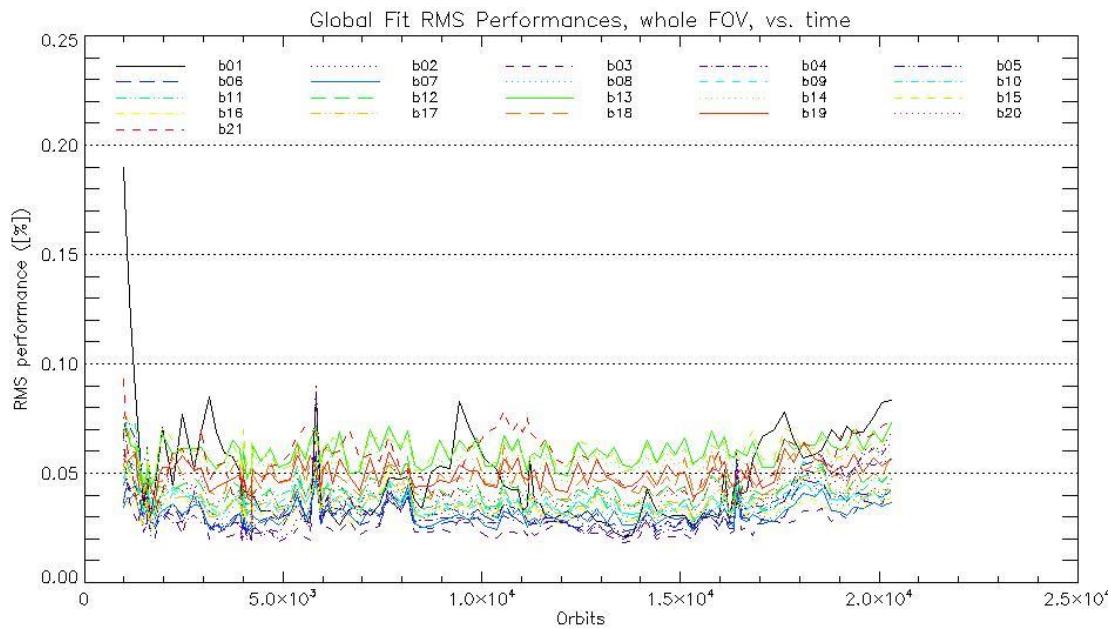


Figure 26: RMS performance of the OLCI-A Gain Model of the current processing baseline as a function of orbit.

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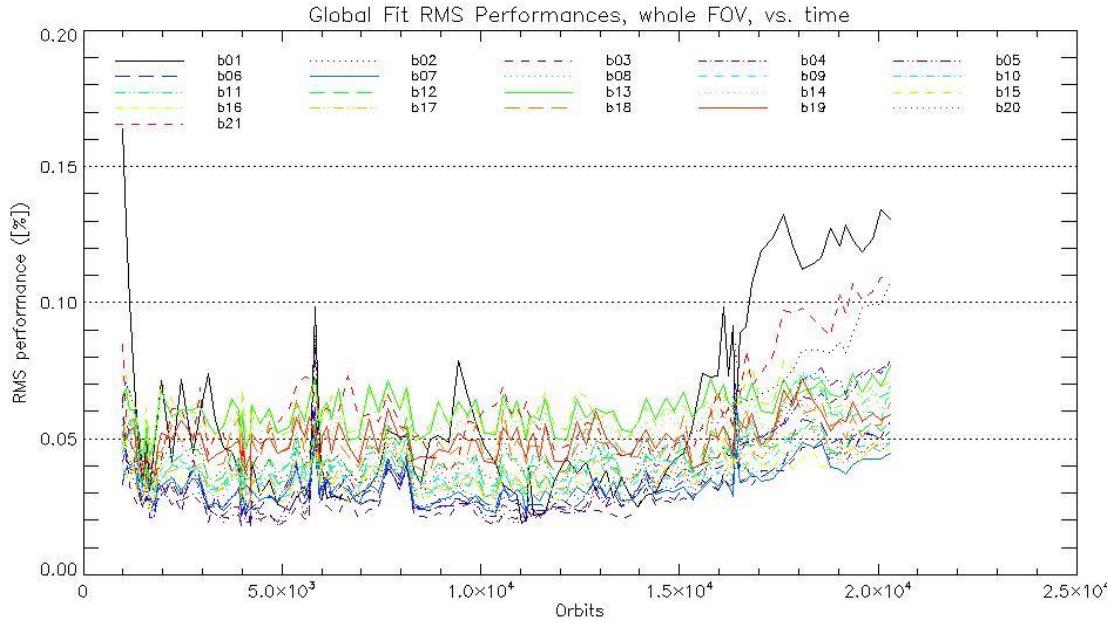


Figure 27: RMS performance of the OLCI-A Gain Model of the previous Processing Baseline as a function of orbit.

The overall instrument evolution since channel programming change (25/04/2016) is shown on Figure 28.

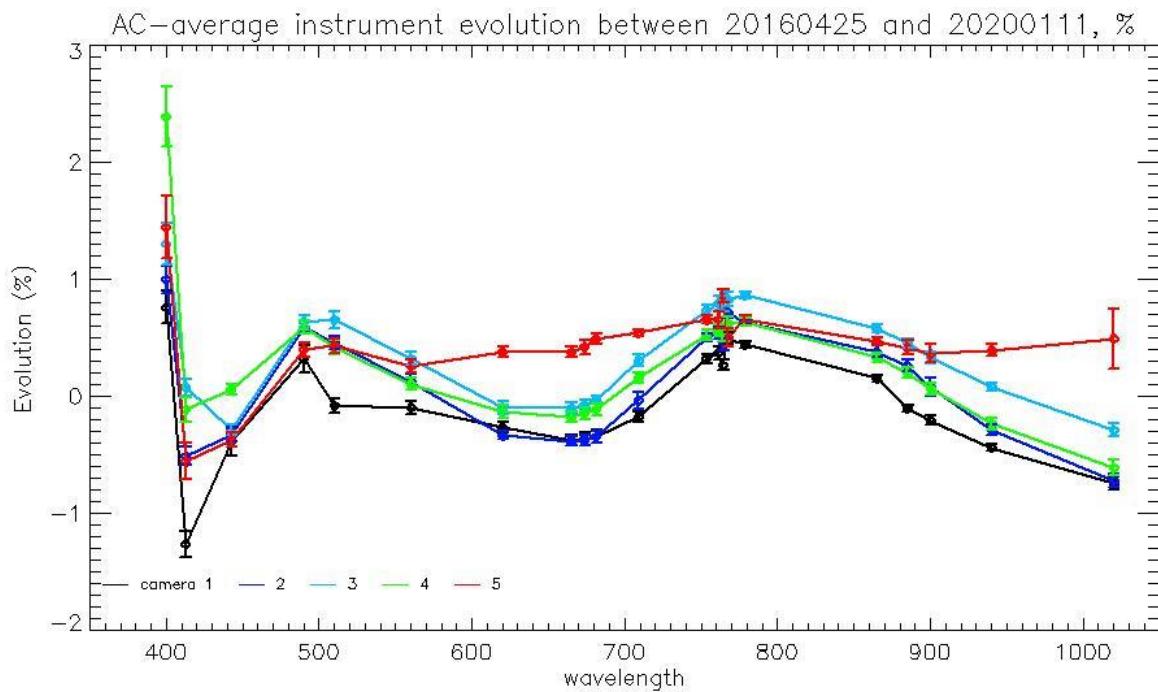


Figure 28: OLCI-A Camera-averaged instrument evolution since channel programming change (25/04/2016) and up to most recent calibration (11/01/2020) versus wavelength.



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The overall per camera performance, as a function of wavelength, and at each orbit is shown on Figure 29 as the average and standard deviation of the model over data ratio.

Finally, Figure 30 to Figure 32 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 30 to Figure 32 with their counterparts in Report of Cycle 49 clearly demonstrate the improvement brought by the new model whatever the level of detail.

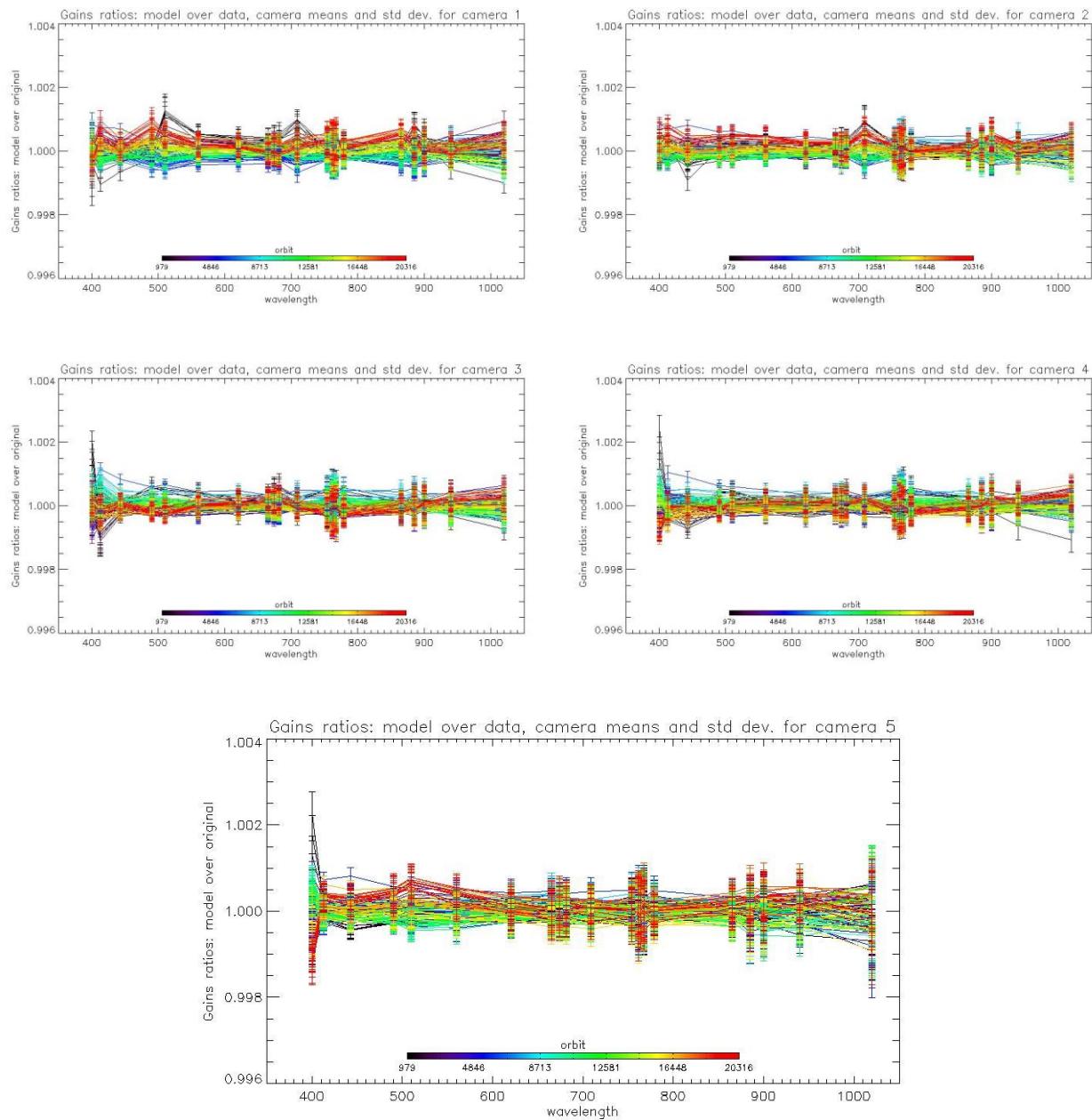


Figure 29: For the 5 cameras: OLCI-A Evolution model performance, as camera-average and standard deviation of ratio of Model over Data vs. wavelength, for each orbit of the test dataset, including 9 calibrations in extrapolation, with a colour code for each calibration from blue (oldest) to red (most recent).



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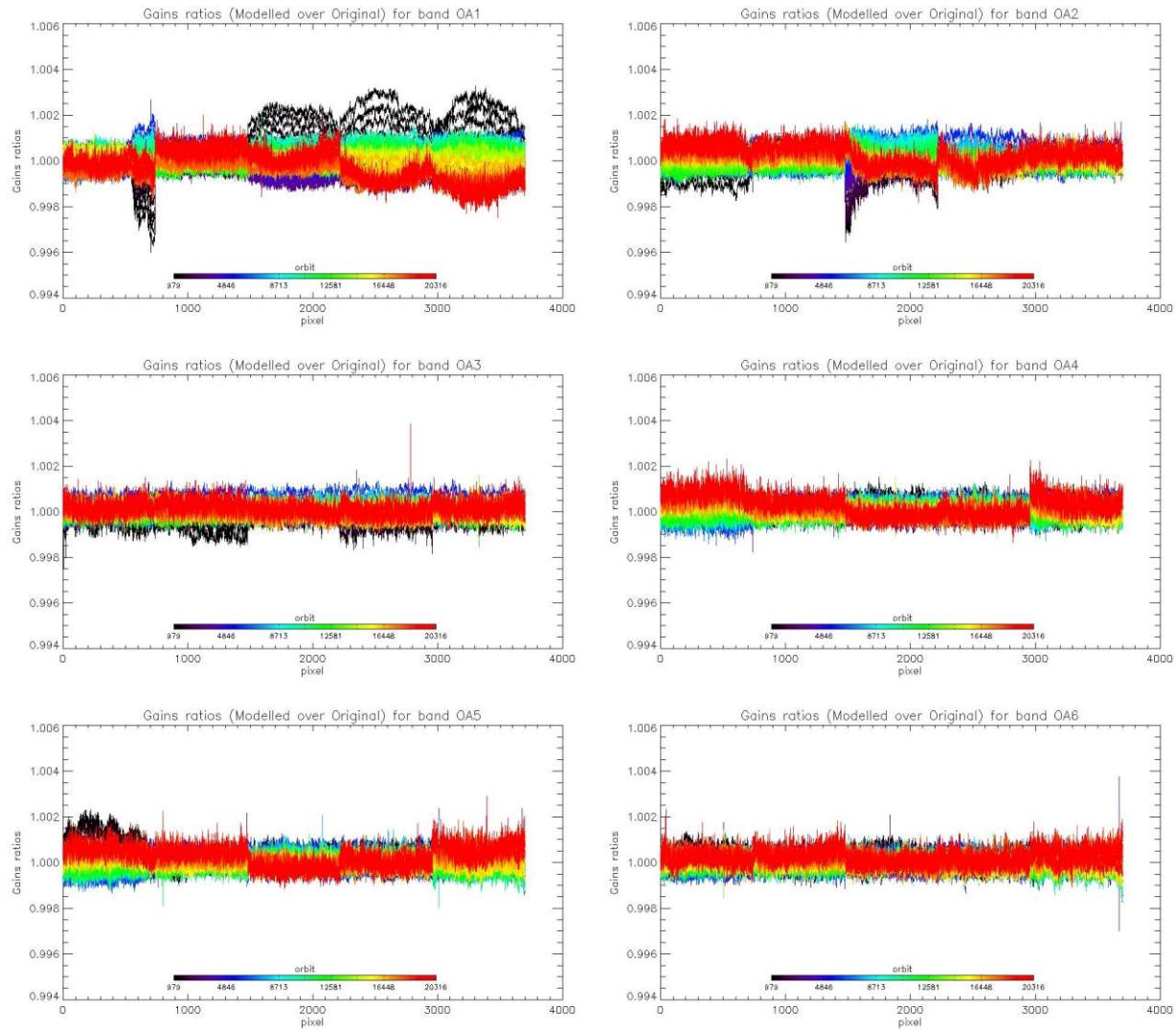


Figure 30: Evolution model performance, as ratio of Model over Data vs. pixels, all cameras side by side, over the whole current calibration dataset (since instrument programming update), including 9 calibrations in extrapolation, channels Oa1 to Oa6.



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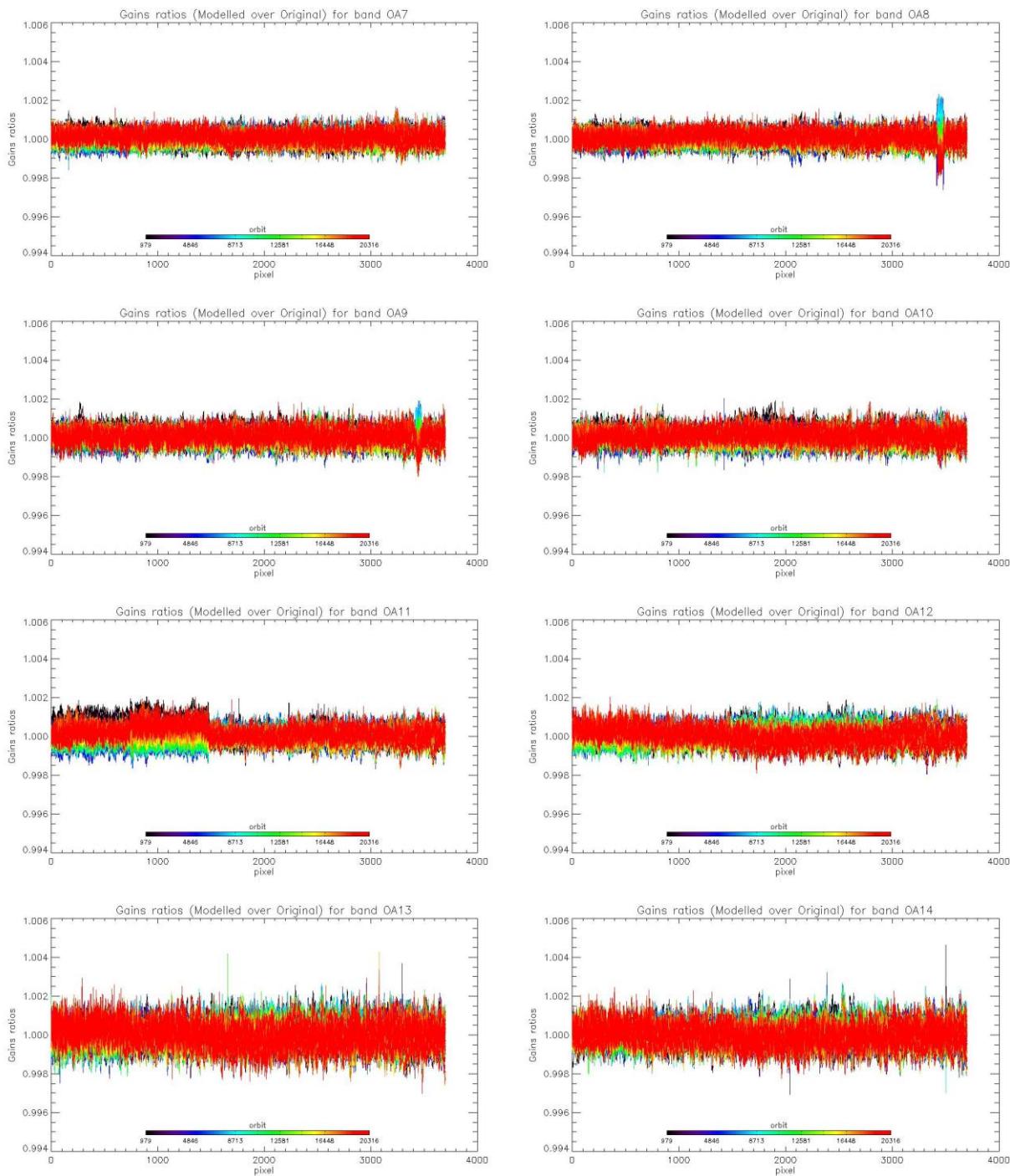


Figure 31: same as Figure 30 for channels Oa7 to Oa14.



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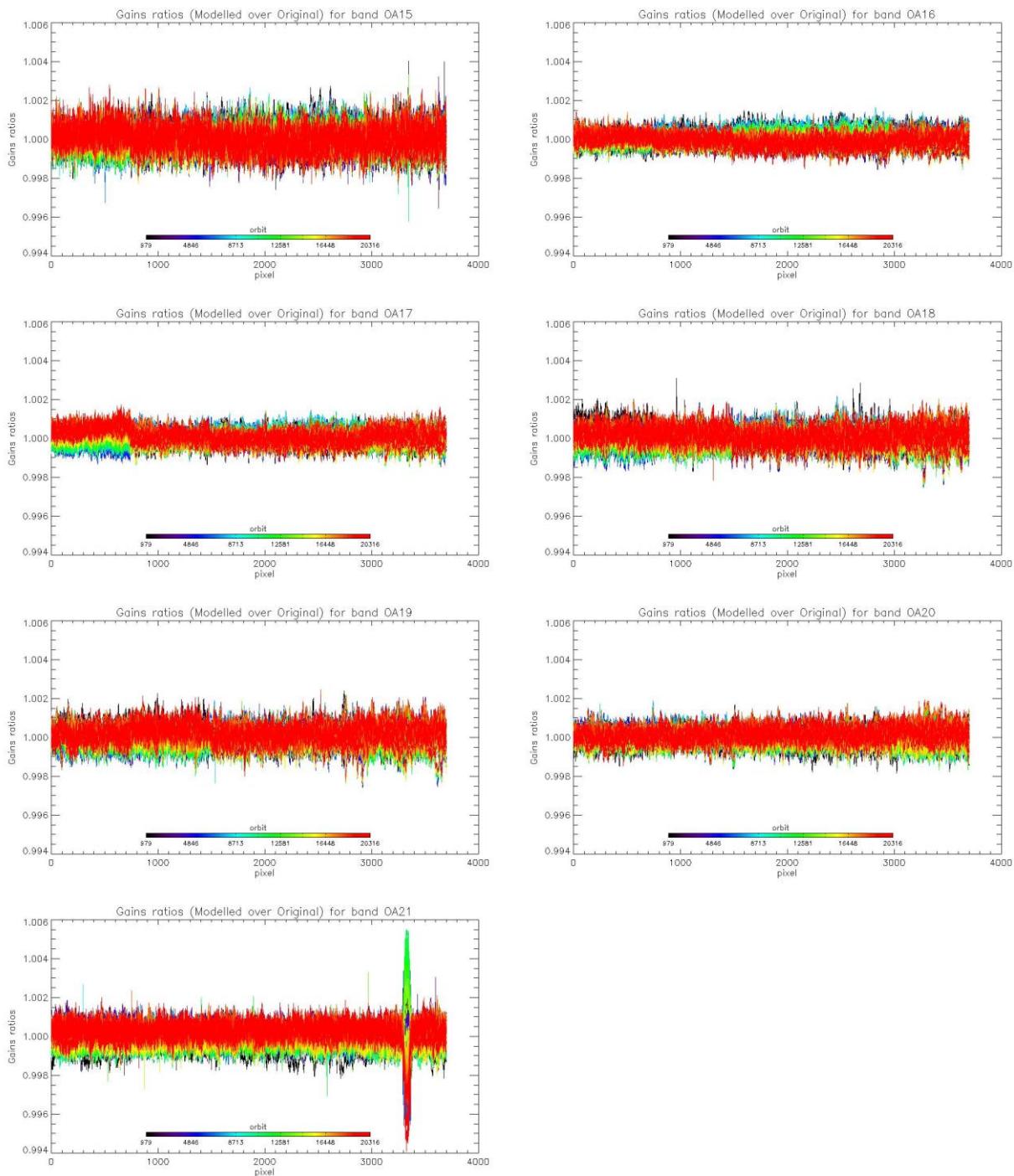


Figure 32: same as Figure 30 for channels Oa15 to Oa21.

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2.2.3.2.2 OLCI-B

Instrument response and degradation modelling for OLCI-B, including the use of the in-flight BRDF model (based on 11th December 2018 Yaw Manoeuvres), has been refreshed and deployed at PDGS on 29th October 2019 (Processing Baseline 1.30). The model has been derived on the basis of an extended Radiometric Calibration dataset (from 11/05/2018 to 02/10/2019). It 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 7 calibrations in extrapolation over about 4 month) is illustrated in Figure 33. It remains better than 0.1% when averaged over the whole field of view while the previous model, trained on a Radiometric Dataset limited to 27/02/2019, shows a drift of the model with respect to most recent data, especially for band Oa01 (Figure 34). Comparison of the two figures shows the improvement brought by the updated Model over all the mission.

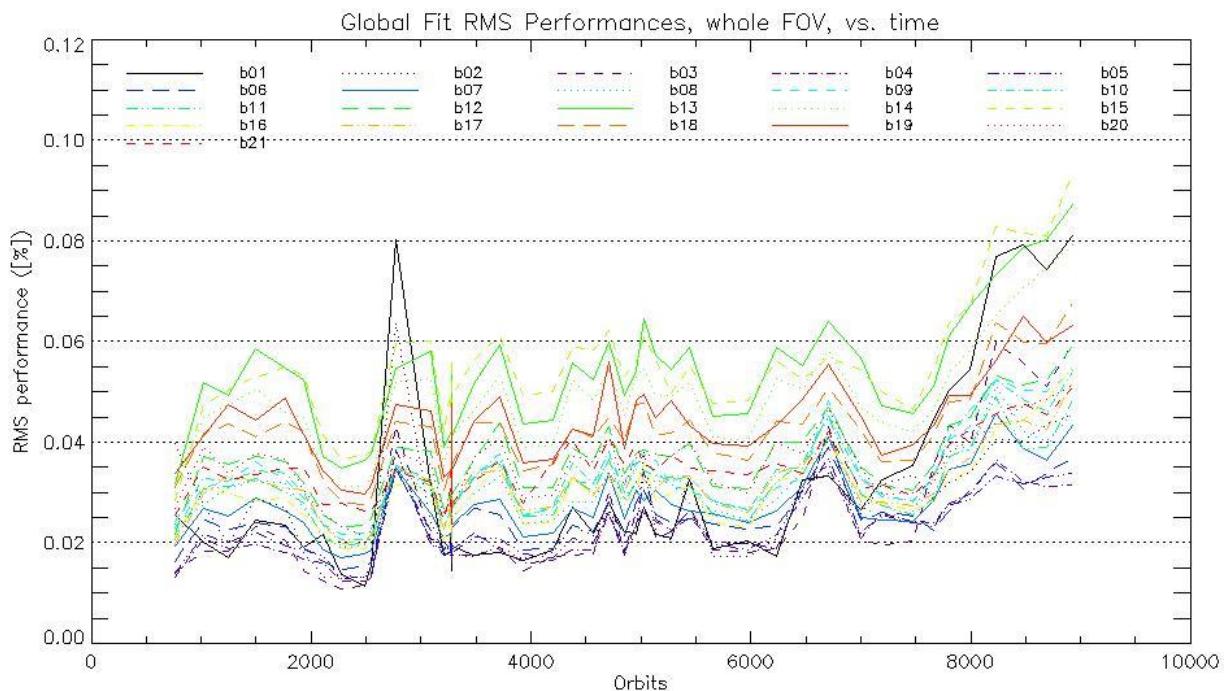


Figure 33: RMS performance of the OLCI-B Gain Model of the current processing baseline as a function of orbit



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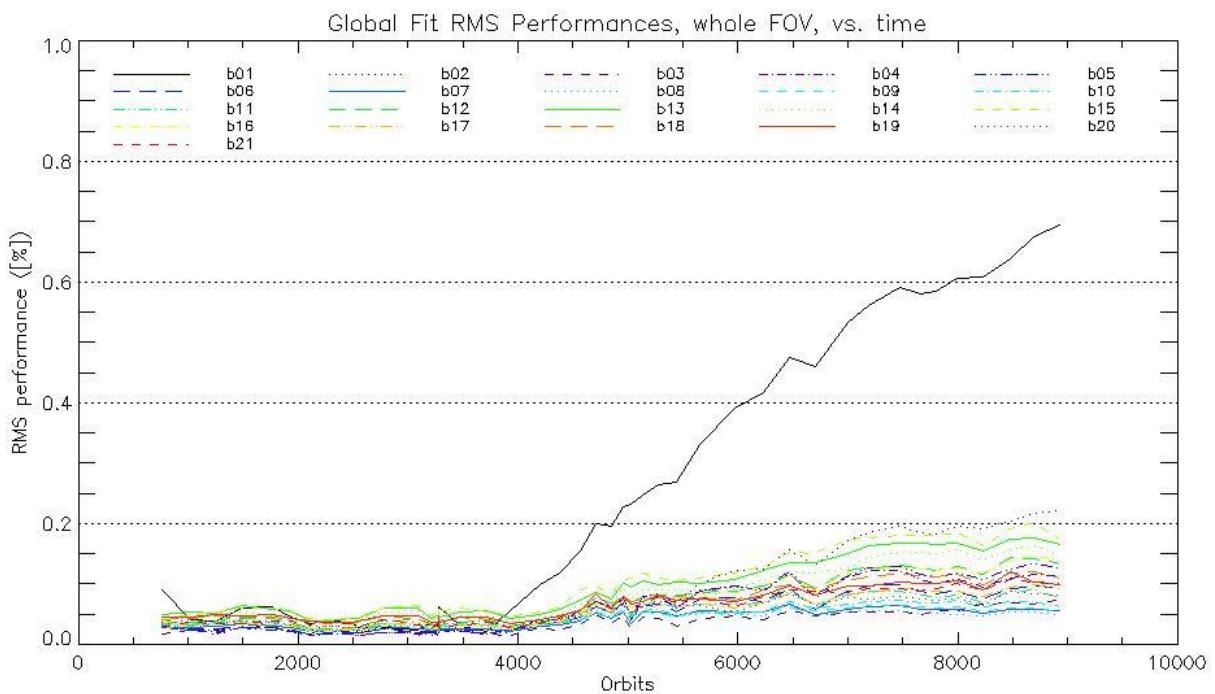


Figure 34: RMS performance of the OLCI-B Gain Model of the previous processing baseline as a function of orbit (please note the different vertical scale with respect to Figure 33)

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The overall instrument evolution since channel programming change (18/06/2018) is shown on Figure 35.

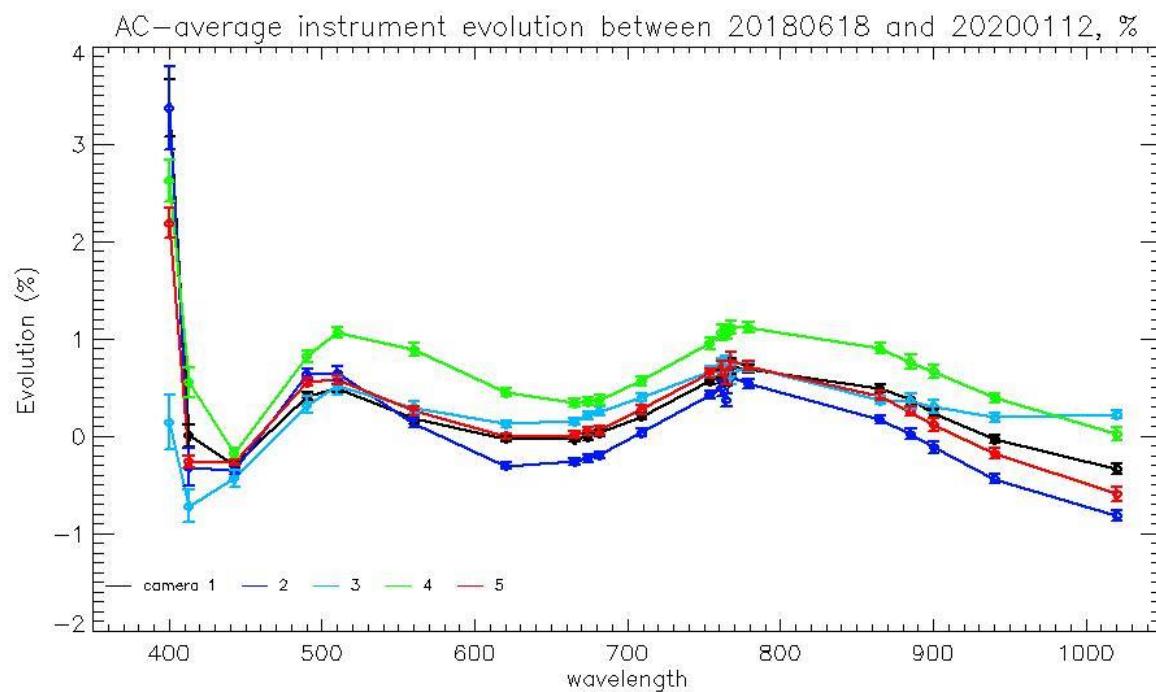


Figure 35: OLCI-B Camera-averaged instrument evolution since channel programming change (18/06/2018) and up to most recent calibration (12/01/2020) versus wavelength.

The overall per camera performance, as a function of wavelength, and at each orbit is shown on Figure 36 as the average and standard deviation of the model over data ratio.

Finally, Figure 37 to Figure 39 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.



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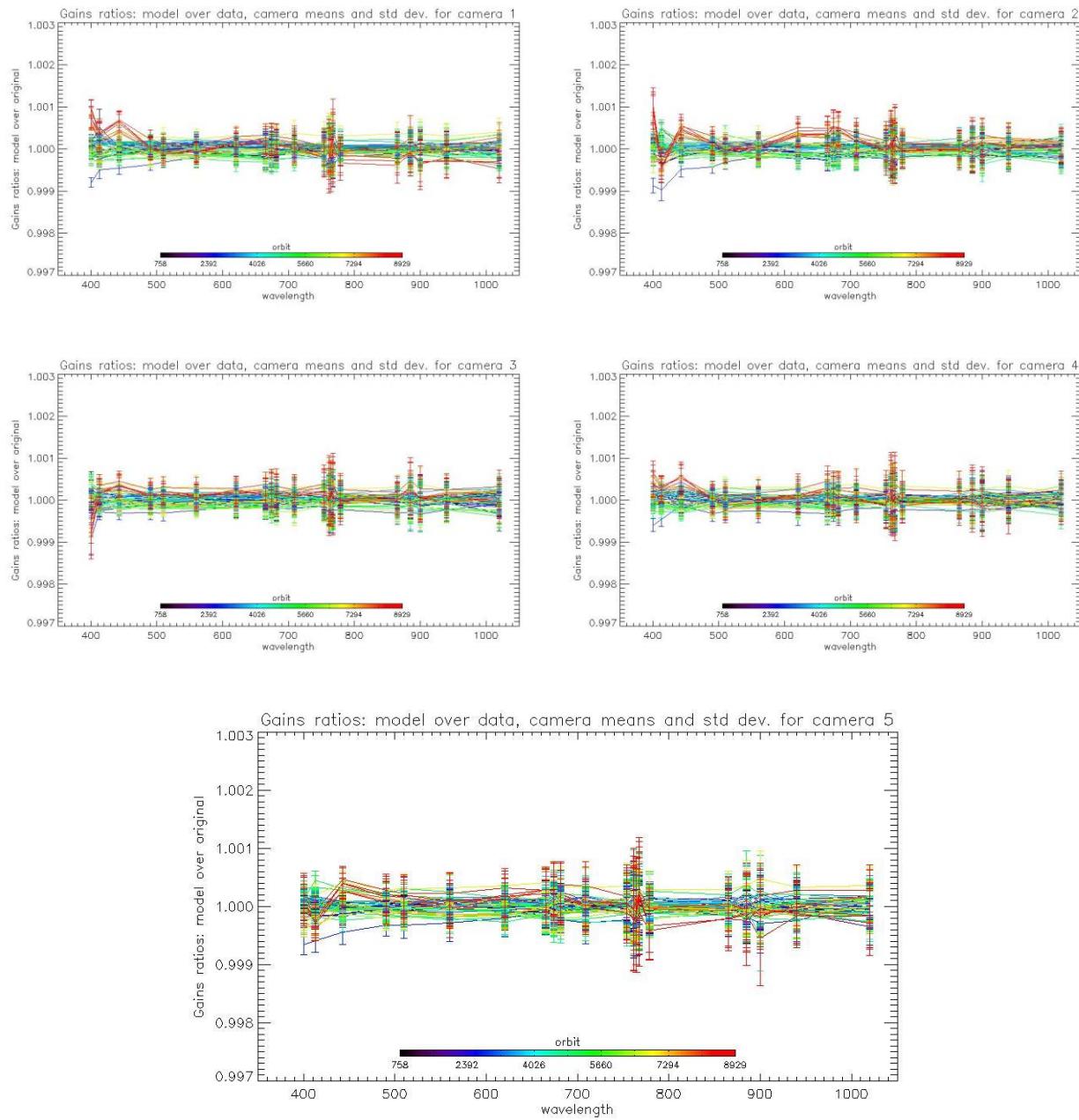


Figure 36: For the 5 cameras: OLCI-B Evolution model performance, as camera-average and standard deviation of ratio of Model over Data vs. wavelength, for each orbit of the test dataset, including 7 calibrations in extrapolation, with a colour code for each calibration from blue (oldest) to red (most recent).



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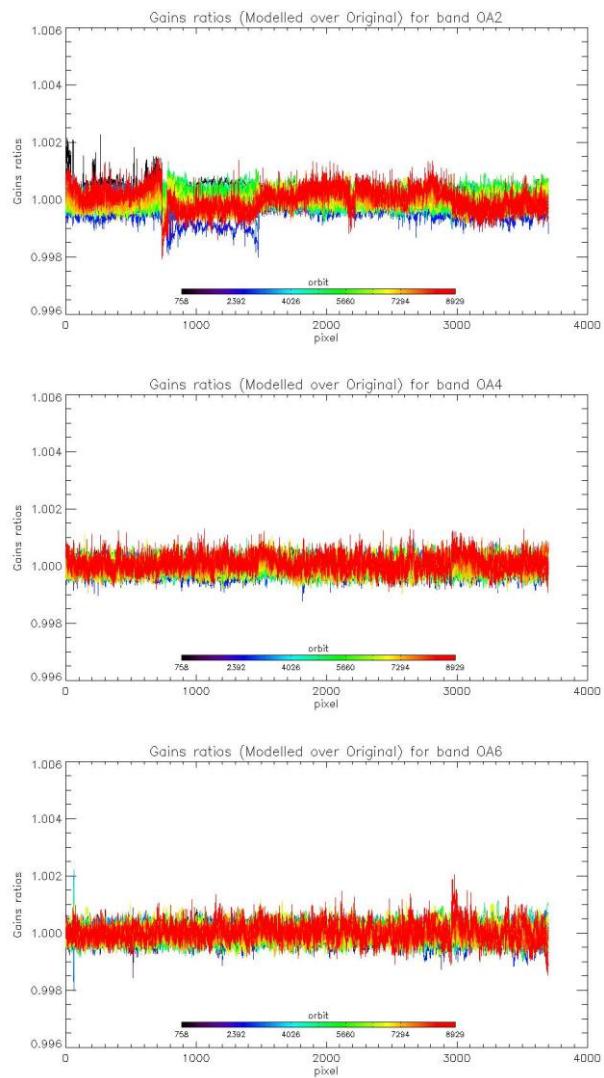
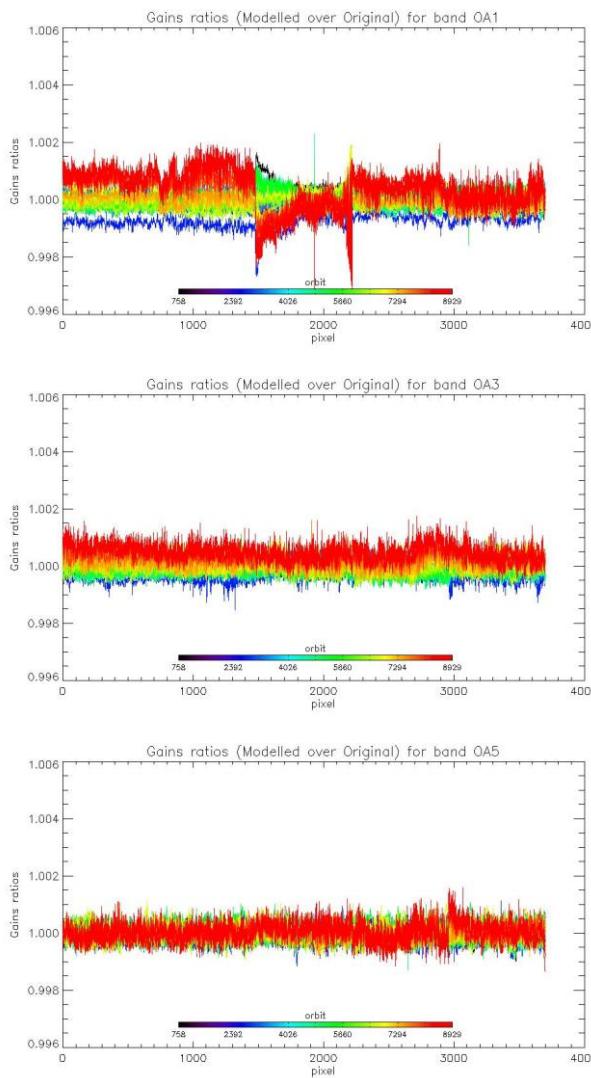


Figure 37: Evolution model performance, as ratio of Model over Data vs. pixels, all cameras side by side, over the whole current calibration dataset (since instrument programming update), including 7 calibrations in extrapolation, channels Oa1 to Oa6.



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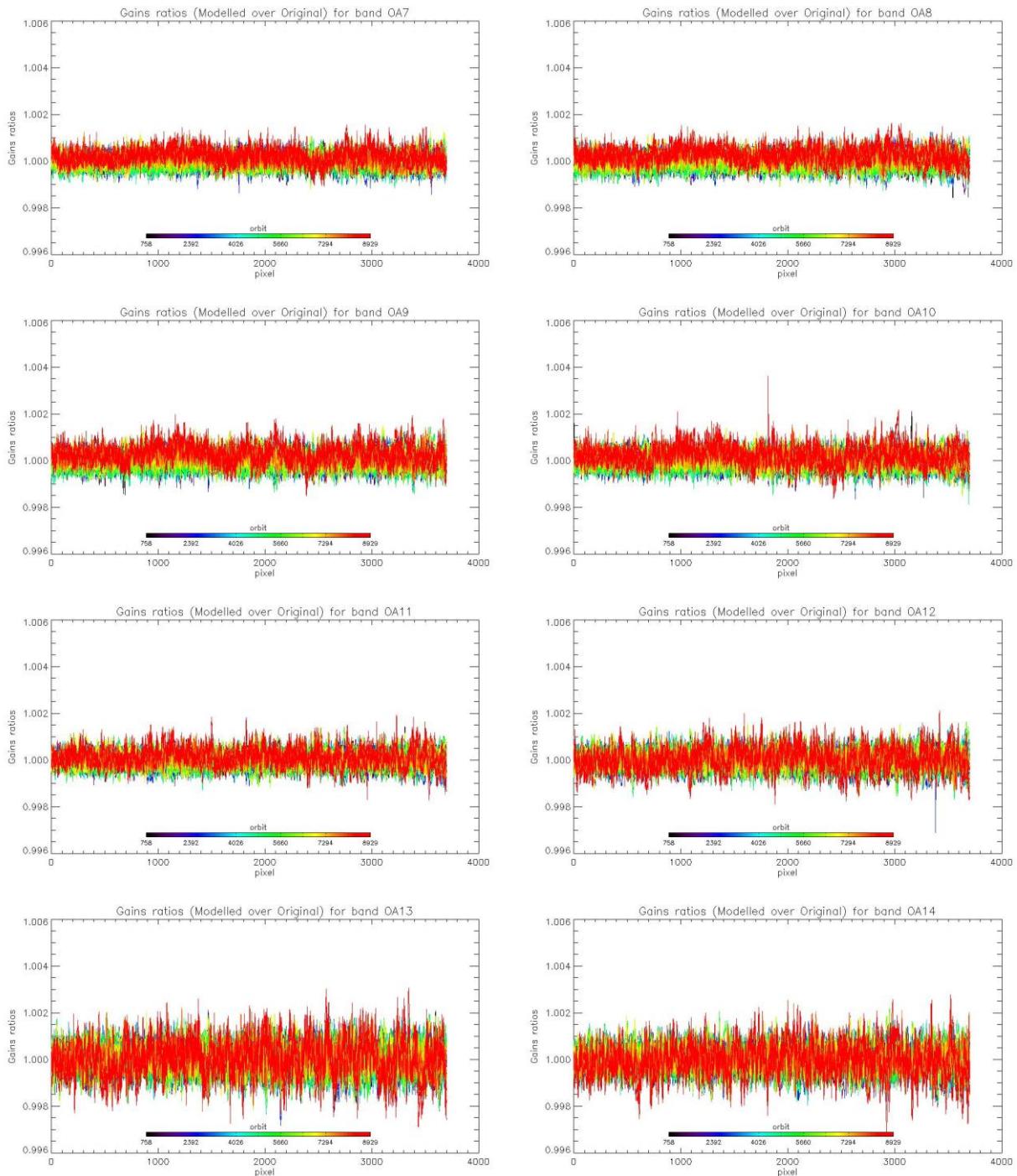


Figure 38: same as Figure 37 for channels Oa7 to Oa14.



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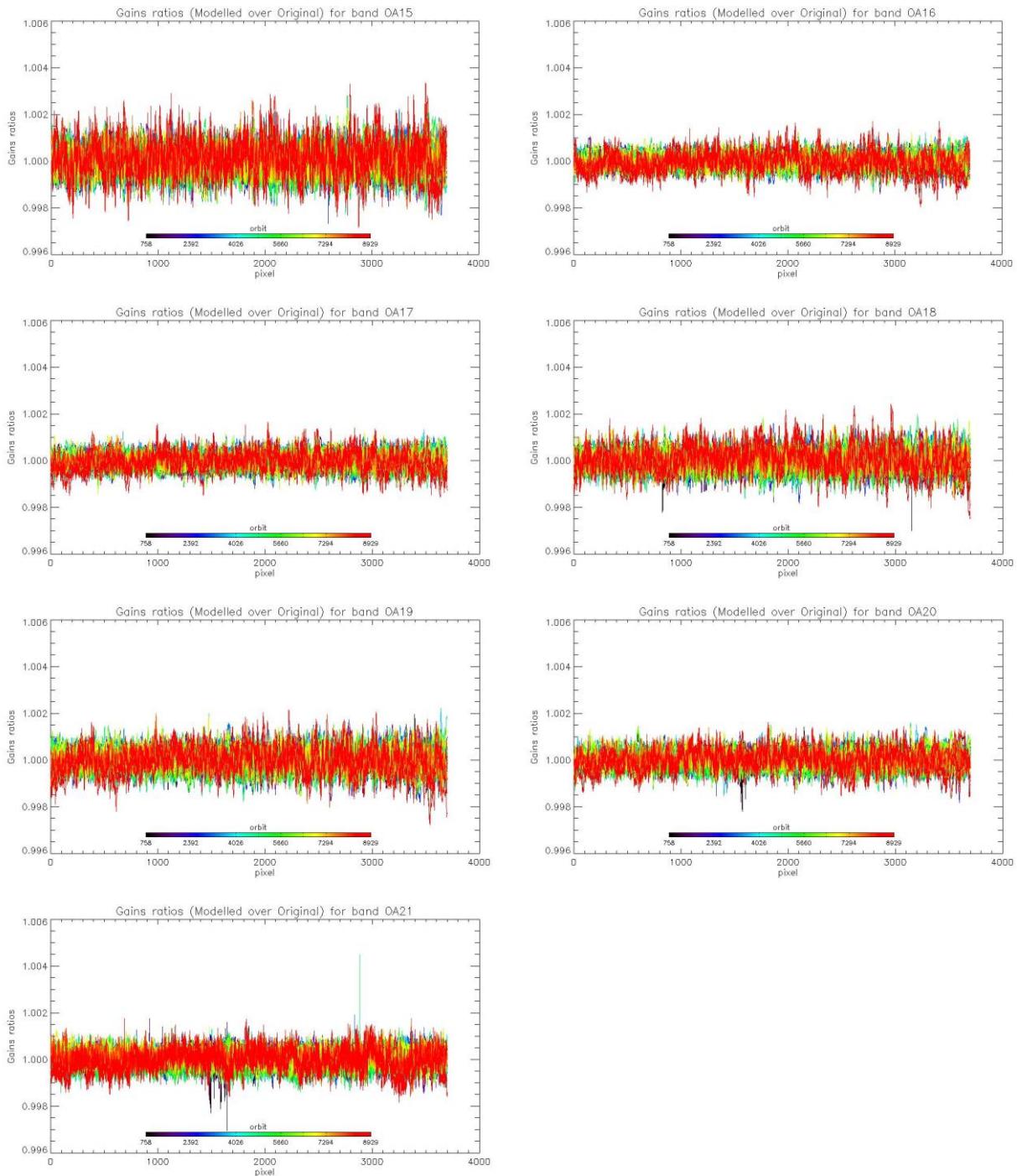


Figure 39: same as Figure 37 for channels Oa15 to Oa21.

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2.2.4 Ageing of nominal diffuser [OLCI-L1B-CV-240]

2.2.4.1 OLCI-A

There has been no calibration sequence S05 (reference diffuser) for OLCI-A during acquisition cycle **053**.

Consequently, the last results presented in Cycle Report #52/#33 (S3A/S3B) remain valid.

2.2.4.2 OLCI-B

There has been no calibration sequence S05 (reference diffuser) for OLCI-B during acquisition Cycle 034.

Consequently, the last results presented in Cycle Report #51/#32 (S3A/S3B) remain valid.

2.2.5 Updating of calibration ADF [OLCI-L1B-CV-260]

2.2.5.1.1 OLCI-A

No CAL_AX ADF has been delivered to PDGS during the report period.

2.2.5.1.2 OLCI-B

Two CAL_AX ADFs have been delivered to PDGS during the reported period, covering the early OLCI-B mission, before electronic gains tuning at Commissioning Mid-Term Review (MTR). They are intended to reprocessing and have been updated for:

- Specific Radiometric Gain model, adapted to the pre-MTR instrument gain settings;
- Specific Geometric Calibration models, corresponding to the relevant time period
- Dark Correction LUTs

The two versions only differ by the Dark Correction LUTs.

S3B_OL_1_CAL_AX_20180515T000000_20180528T123040_20200120T180543_____MPC_O_AL_RP1.SEN3

S3B_OL_1_CAL_AX_20180528T123040_20180618T000147_20200120T180543_____MPC_O_AL_RP1.SEN3

2.2.6 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]

2.2.6.1.1 OLCI-A

This activity has not evolved during cycle 053 and results presented in Cycle 15 report are still valid.

	<p style="text-align: center;">Sentinel-3 MPC S3 OLCI Cyclic Performance Report S3A Cycle No. 053 – S3B Cycle No. 034</p>	Ref.: S3MPC.ACR.PR.01-053-034 Issue: 1.0 Date: 31/01/2020 Page: 37
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2.2.6.1.2 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 OLCI-A

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

The last results presented in Cyclic Report 51/32 (S3A/S3B) stay valid.

2.3.2 OLCI-B

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

The last results presented in Cyclic Report 51/32 (S3A/S3B) stay 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 40.

SNR computed for all calibration data as a function of orbit number for band Oa01 (the less stable band) is presented in Figure 41.

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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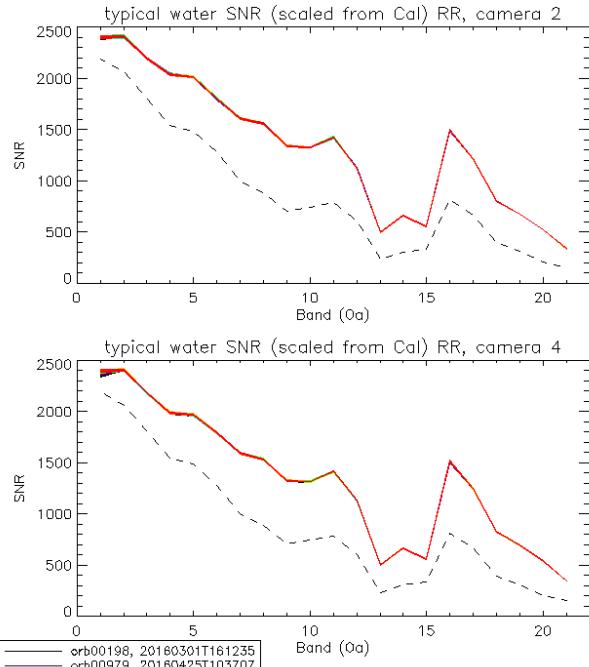
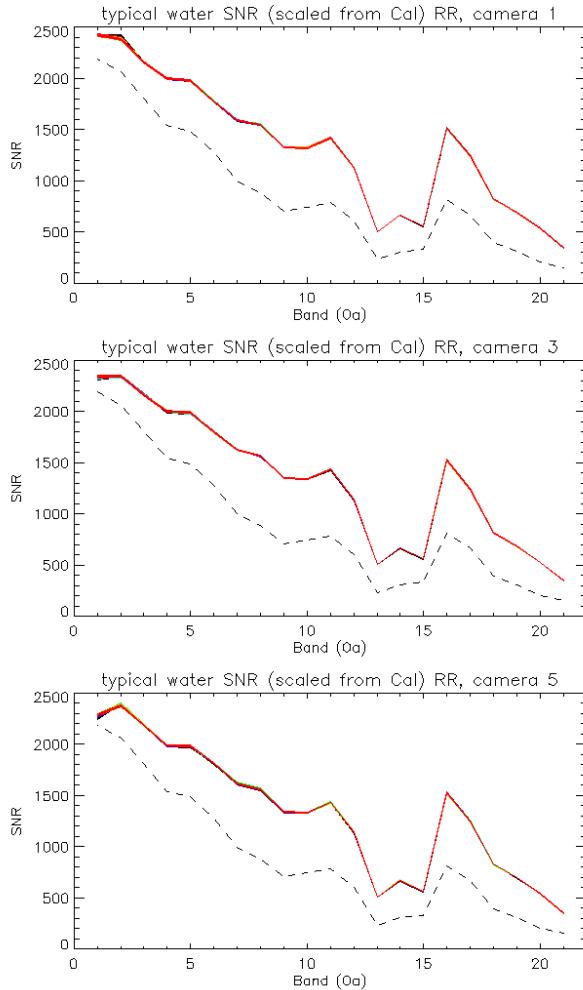
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orb00198, 20180301T161235
orb00979, 20180425T103707
orb01479, 20180530T120813
orb01977, 20180704T101917
orb03132, 20180923T102636
orb04203, 20181207T131044
orb03989, 20181122T125850
orb04685, 20181110T082623
orb05701, 20180322T142139
orb06261, 20180443T205014
orb07679, 20180808T072916
orb08946, 20181105T041006
orb10101, 20180125T041112
orb11036, 20180331T210819
orb11632, 20180551T2125036
orb12887, 20180808T150939
orb14161, 20181105T213730
orb15311, 20190125T131333
orb16245, 20190401T010746
orb16838, 20190551T2150906
orb18098, 20190808T235505
orb19373, 20191106T100152
orb20316, 20200111T131433
- - - REQUIREMENT ESA

S3A
132 CALs plotted
cutoff = 0.09960

Figure 40: 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.

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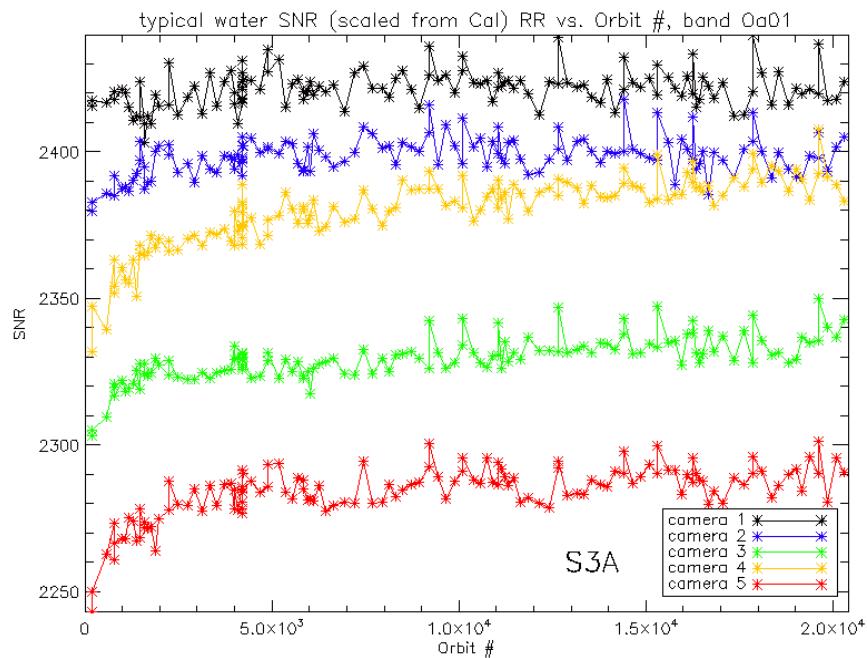


Figure 41: long-term stability of the SNR estimates from Calibration data, example of channel Oa1.

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 $mW.sr^{-1}.m^{-2}.nm^{-1}$).

nm	L _{ref}	SNR	C1		C2		C3		C4		C5		All	
			LU	RQT	avg	std	avg	std	avg	std	avg	std	avg	std
400.000	63.0	2188	2421	6.1	2398	6.6	2329	7.3	2379	12.0	2284	9.1	2362	7.0
412.000	74.1	2061	2391	8.7	2406	5.9	2339	4.8	2401	4.9	2383	8.0	2384	4.9
442.000	65.6	1811	2159	5.2	2198	5.8	2164	4.9	2185	4.1	2195	5.3	2180	3.6
490.000	51.2	1541	2000	4.7	2036	5.1	1997	4.1	1983	4.4	1988	4.7	2001	3.4
510.000	44.4	1488	1979	5.3	2014	4.7	1985	4.6	1967	4.6	1985	4.5	1986	3.7
560.000	31.5	1280	1776	4.5	1802	4.1	1803	4.9	1794	3.9	1818	3.4	1799	3.1
620.000	21.1	997	1591	4.0	1609	4.1	1624	3.2	1593	3.3	1615	3.6	1607	2.6
665.000	16.4	883	1546	4.1	1558	4.3	1567	3.8	1533	3.6	1561	3.9	1553	3.1
674.000	15.7	707	1329	3.4	1337	3.7	1350	2.8	1323	3.2	1342	3.6	1336	2.5
681.000	15.1	745	1319	3.7	1326	3.1	1338	2.7	1314	2.4	1333	3.6	1326	2.2
709.000	12.7	785	1421	4.4	1420	4.1	1435	3.4	1414	3.5	1430	3.1	1424	2.9
754.000	10.3	605	1127	3.2	1120	3.0	1135	3.4	1124	2.5	1139	3.0	1129	2.4
761.000	6.1	232	502	1.1	498	1.2	505	1.2	500	1.1	508	1.4	503	0.9
764.000	7.1	305	663	1.6	658	1.5	668	2.1	661	1.6	670	2.1	664	1.4
768.000	7.6	330	558	1.5	554	1.3	562	1.3	557	1.5	564	1.3	559	1.1
779.000	9.2	812	1516	4.9	1498	4.8	1525	5.4	1511	5.1	1526	5.0	1515	4.3
865.000	6.2	666	1244	3.6	1213	3.6	1239	4.0	1246	3.6	1250	2.8	1238	3.0
885.000	6.0	395	823	1.7	801	1.7	814	2.0	824	1.5	831	1.8	819	1.2
900.000	4.7	308	691	1.6	673	1.3	683	1.7	693	1.4	698	1.5	688	1.0
940.000	2.4	203	534	1.1	522	1.1	525	0.9	539	1.1	542	1.4	532	0.7
1020.000	3.9	152	345	0.9	337	0.9	348	0.7	345	0.8	351	0.8	345	0.5



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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 42.

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 43.

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.

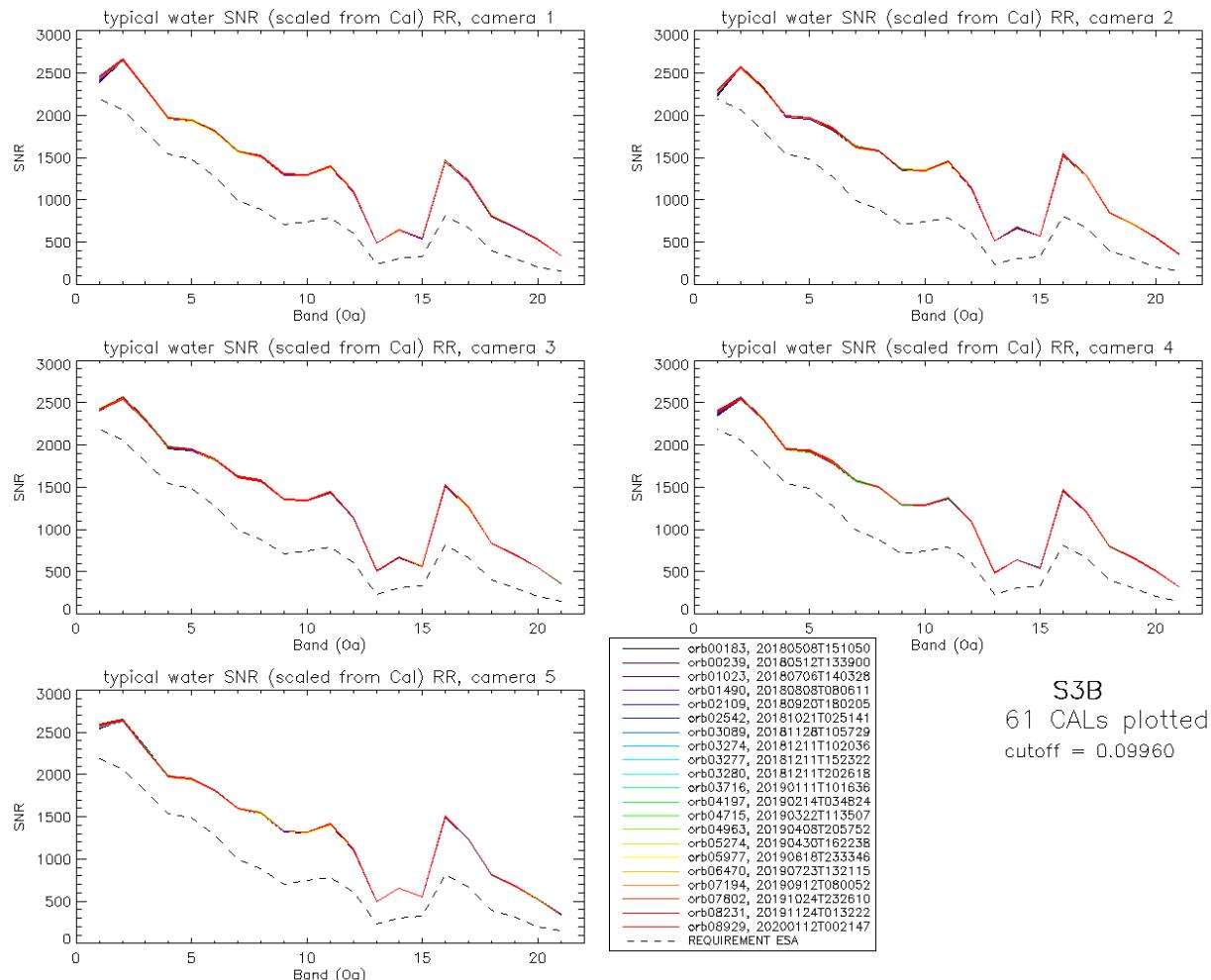


Figure 42: OLCI-B Signal to Noise ratio as a function of the spectral band for the 5 cameras. These results have been computed from radiometric calibration data. All calibrations except first one (orbit 167) are presents with the colours corresponding to the orbit number (see legend). The SNR is very stable with time: the curves for all orbits are almost superimposed. The dashed curve is the ESA requirement.



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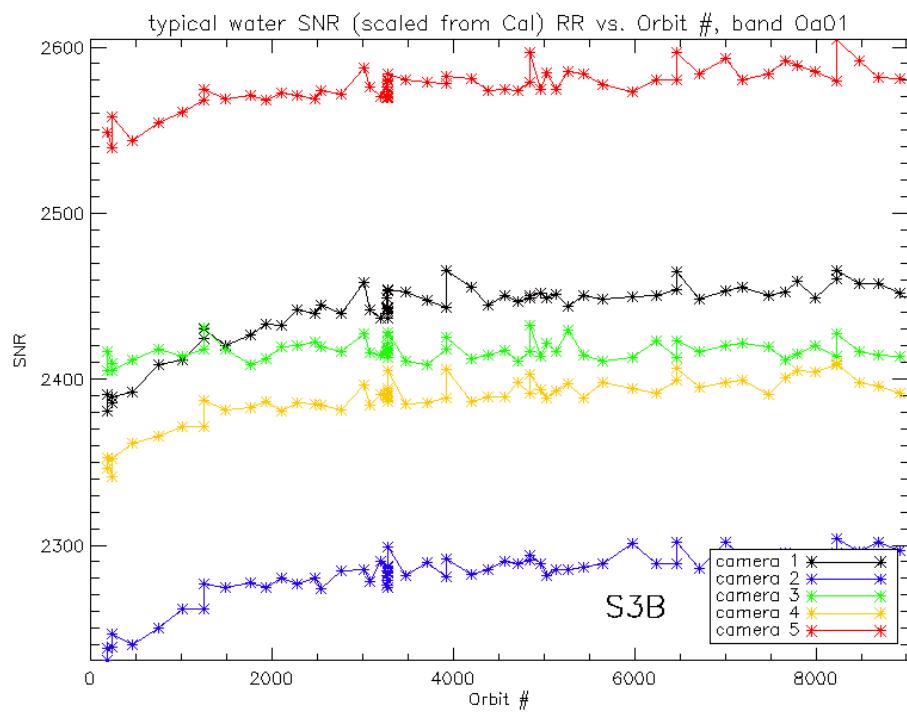


Figure 43: long-term stability of the OLCI-B SNR estimates from Calibration data, example of channel Oa1.

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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 $mW.sr^{-1}.m^{-2}.nm^{-1}$).

nm	L _{ref}	SNR	C1		C2		C3		C4		C5		All	
			avg	std	avg	std	avg	std	avg	std	avg	std	avg	std
400.000	63.0	2188	2441	19.7	2281	16.3	2417	6.0	2388	14.4	2575	12.2	2420	12.7
412.000	74.1	2061	2655	6.7	2570	6.0	2548	8.3	2549	5.9	2640	6.8	2593	4.9
442.000	65.6	1811	2326	6.1	2318	6.1	2303	6.1	2306	6.1	2311	6.1	2313	5.1
490.000	51.2	1541	1965	4.8	1987	5.9	1971	5.1	1951	4.9	1978	4.9	1971	4.0
510.000	44.4	1488	1937	5.3	1965	5.5	1942	5.1	1922	5.1	1951	4.6	1944	4.1
560.000	31.5	1280	1813	5.1	1846	5.6	1829	4.6	1803	5.3	1816	4.7	1821	4.1
620.000	21.1	997	1573	4.4	1626	4.8	1625	3.8	1576	4.1	1602	3.3	1600	3.0
665.000	16.4	883	1513	4.3	1579	4.0	1574	4.1	1501	3.0	1546	3.9	1543	3.0
674.000	15.7	707	1301	3.8	1358	4.0	1353	3.5	1292	2.9	1329	3.2	1327	2.7
681.000	15.1	745	1293	3.4	1347	3.3	1343	3.1	1285	2.8	1316	2.9	1317	2.1
709.000	12.7	785	1390	4.4	1447	4.2	1443	4.5	1373	3.2	1412	4.1	1413	3.4
754.000	10.3	605	1095	4.2	1141	3.8	1141	3.9	1088	3.0	1115	3.8	1116	3.4
761.000	6.1	232	487	1.3	509	1.2	508	1.4	485	1.2	497	1.5	497	1.0
764.000	7.1	305	643	1.7	672	2.1	671	2.1	640	1.7	657	2.0	657	1.6
768.000	7.6	330	541	1.6	567	1.4	564	1.4	540	1.4	554	1.7	553	1.2
779.000	9.2	812	1466	4.7	1534	5.0	1525	6.1	1465	4.0	1505	4.9	1499	4.3
865.000	6.2	666	1220	4.0	1286	4.0	1258	4.1	1203	3.6	1237	3.2	1241	3.1
885.000	6.0	395	808	2.6	847	1.9	834	2.1	798	1.9	814	2.0	820	1.7
900.000	4.7	308	679	1.4	714	2.0	704	1.6	669	1.5	682	1.6	690	1.2
940.000	2.4	203	527	1.3	550	1.7	550	1.4	509	1.2	522	1.4	532	1.0
1020.000	3.9	152	336	0.8	359	1.2	358	0.9	318	0.8	339	1.2	342	0.7

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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.

2.5 Geometric Calibration/Validation

2.5.1 OLCI-A

OLCI georeferencing performance was compliant since the introduction of MPC Geometric Calibration, put in production on the 14th of March 2018. It has however significantly improved after its last full revision of GCMs (Geometric Calibration Models, or platform to instrument alignment quaternions) and IPPVMs (Instrument Pixels Pointing Vectors) both derived using the GeoCal Tool.

The following figures (Figure 44 to Figure 49) show time series of the overall RMS performance (requirement criterion) and of the across-track and along-track biases for each camera. New plots (Figure 50 and Figure 51) introduce monitoring of the performance homogeneity within the field of view: georeferencing errors in each direction at camera transitions (difference between last pixel of camera N and first pixel of camera N+1) and within a given camera (maximum bias minus minimum inside each camera). The performance improvement since the 30/07/2019 is significant on most figures: the global RMS value decreases from around 0.35 to about 0.2 (Figure 44), the across-track biases decrease significantly for all cameras (Figure 45 to Figure 49), the along-track bias reduces for at least camera 3 (Figure 47) and the field of view homogeneity improves drastically (Figure 50 and Figure 51, but also reduction of the dispersion – distance between the ± 1 sigma lines – in Figure 45 to Figure 49).

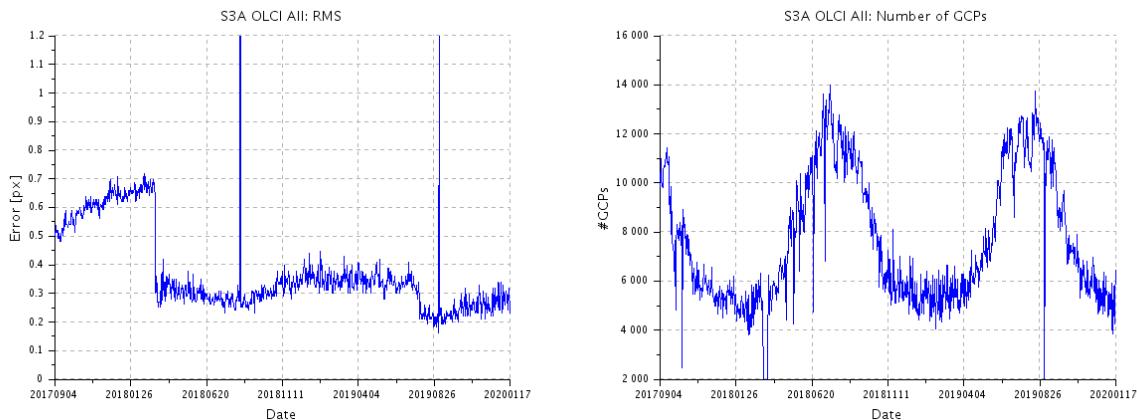


Figure 44: overall OLCI-A georeferencing RMS performance time series (left) and number of validated control points corresponding to the performance time series (right) over the whole monitoring period

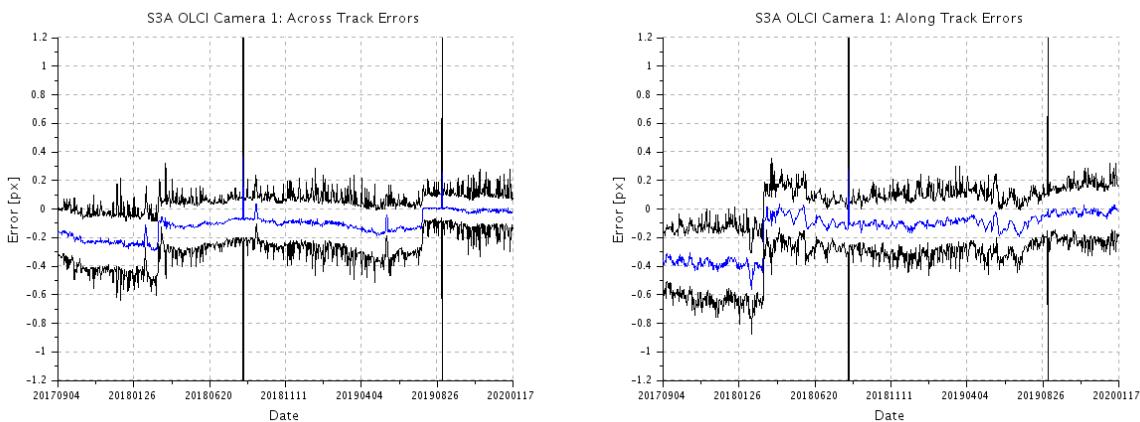


Figure 45: across-track (left) and along-track (right) OLCI-A georeferencing biases time series for Camera 1. Blue line is the average, black lines are average plus and minus 1 sigma.

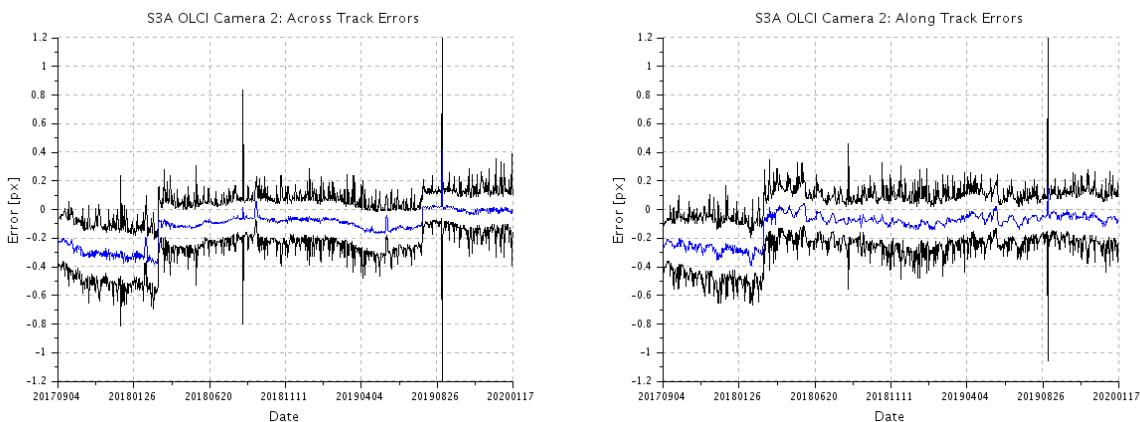


Figure 46: same as Figure 45 for Camera 2.



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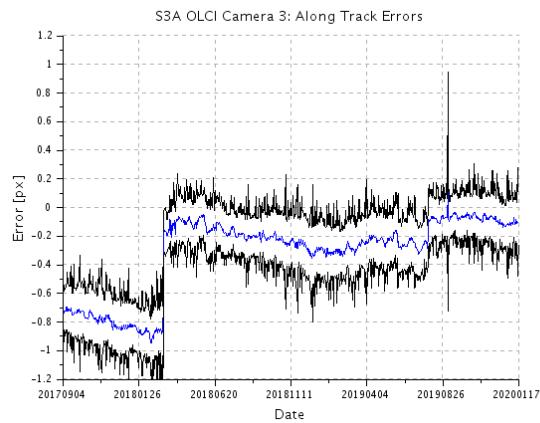
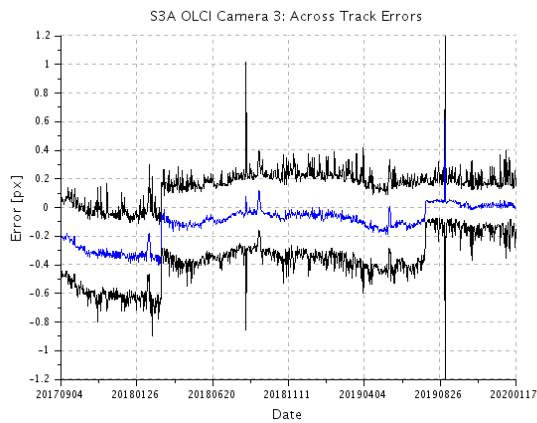


Figure 47: same as Figure 45 for Camera 3.

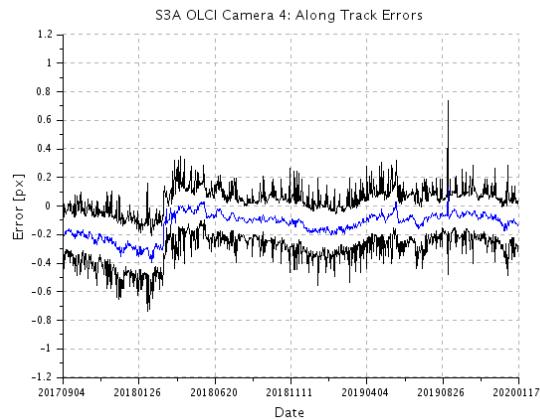
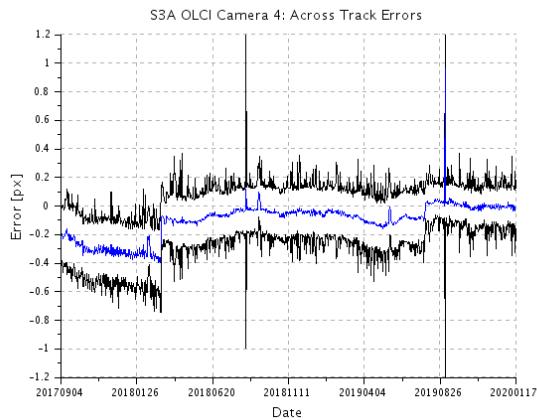


Figure 48: same as Figure 45 for Camera 4.

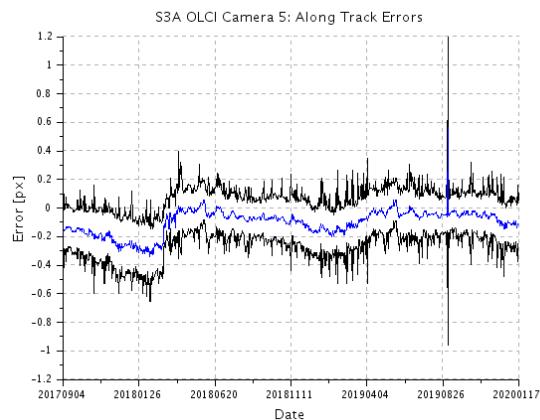
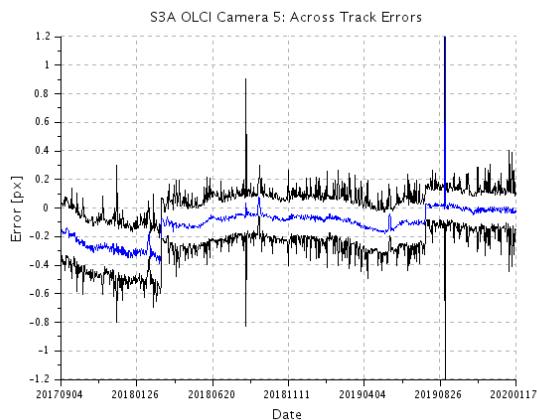


Figure 49: same as Figure 45 for Camera 5.

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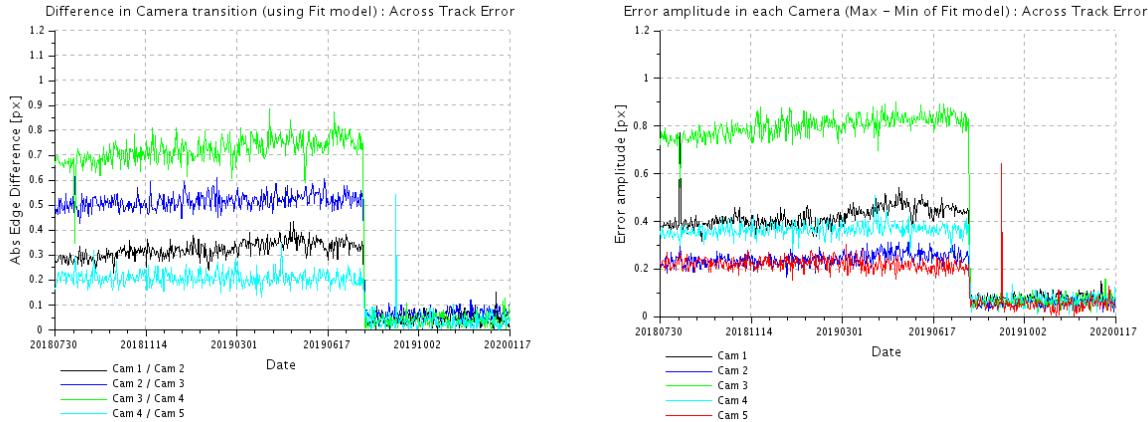


Figure 50: OLCI-A spatial across-track misregistration at each camera transition (left) and maximum amplitude of the across-track error within each camera (left).

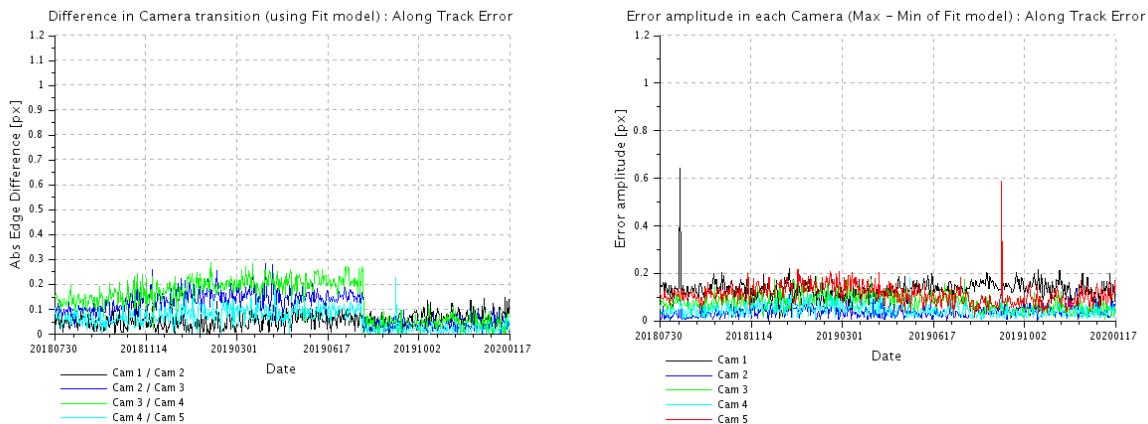


Figure 51: OLCI-A spatial along-track misregistration at each camera transition (left) and maximum amplitude of the along-track error within each camera (left).

2.5.2 OLCI-B

The current Geometric Calibration currently in production is the fourth one, introduced the 30/07/2019. As for OLCI-A, despite compliance to the RMS requirement of 0.5 pixel, OLCI-B showed significant heterogeneity of the performance within the field of view, with discrepancies at camera transitions of up to 1 pixel. Introduction of upgraded IPPVMs greatly improves many performance indicators: the global RMS value decreases from around 0.4 to about 0.3 (Figure 52), the across-track biases decrease significantly for all cameras (Figure 53 to Figure 57) and the field of view homogeneity improves drastically (Figure 58 and Figure 59, but also reduction of the dispersion – distance between the ± 1 sigma lines – in Figure 53 to Figure 57).

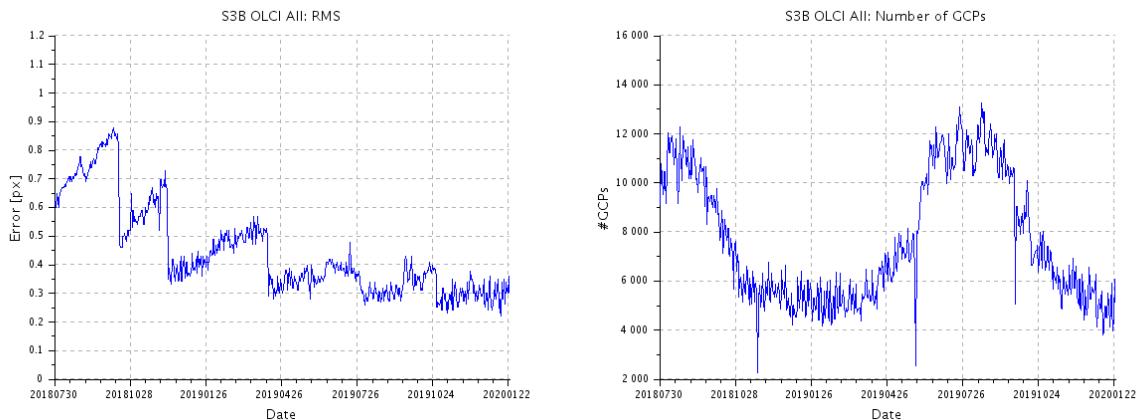


Figure 52: overall OLCI-B georeferencing RMS performance time series over the whole monitoring period (left) and corresponding number of validated control points (right)

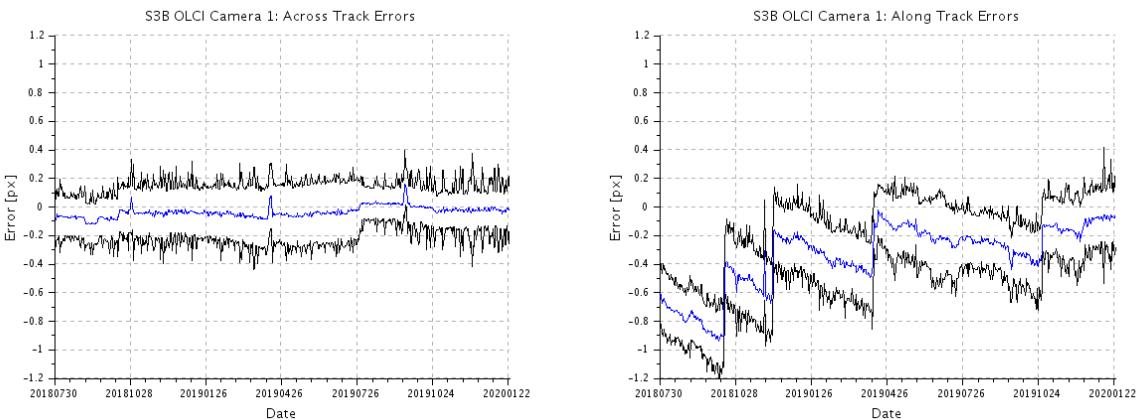


Figure 53: across-track (left) and along-track (right) OLCI-B georeferencing biases time series for Camera 1.

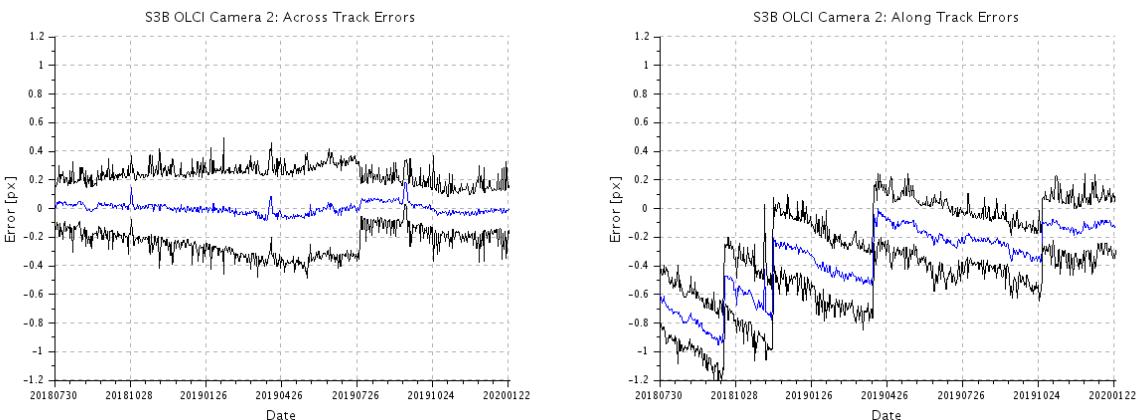


Figure 54: same as Figure 45 for Camera 2.

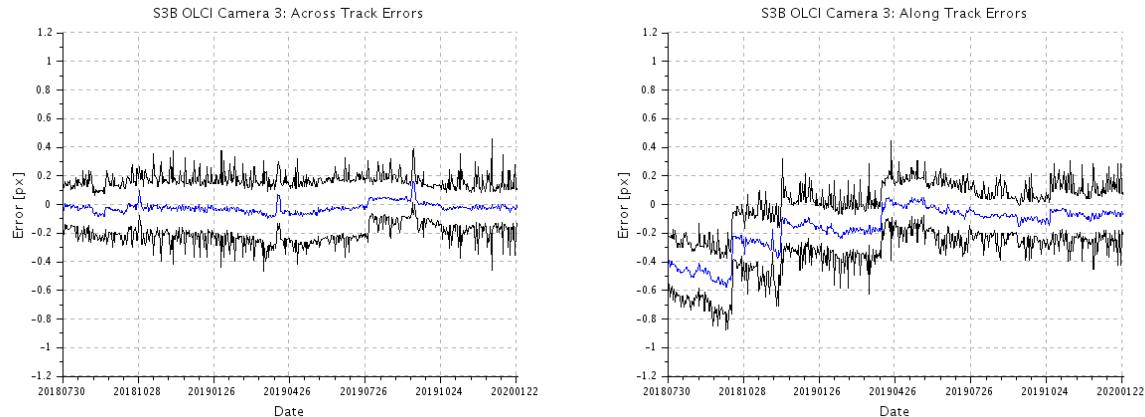


Figure 55: same as Figure 45 for Camera 3.

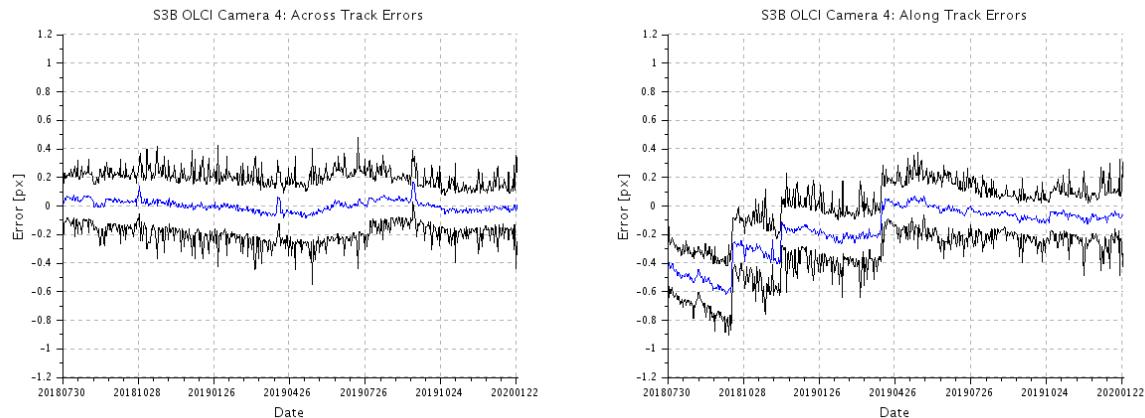


Figure 56: same as Figure 45 for Camera 4.

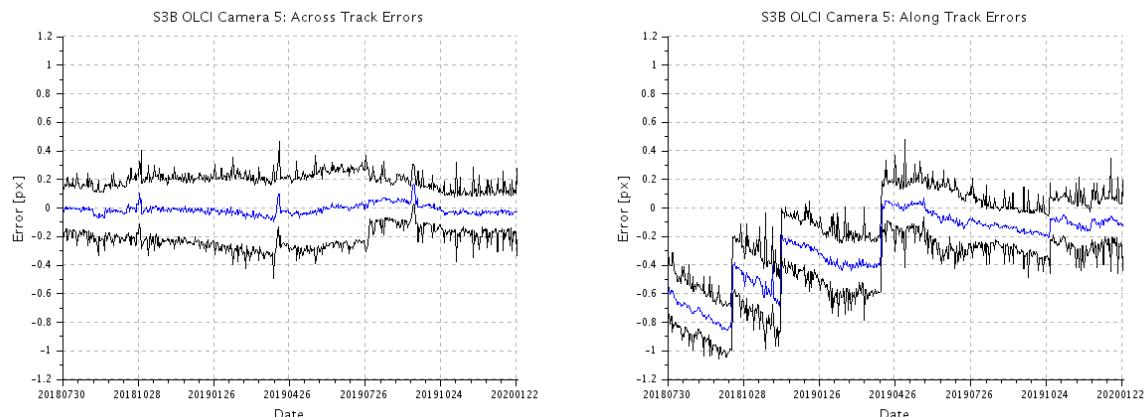


Figure 57: same as Figure 45 for Camera 5.

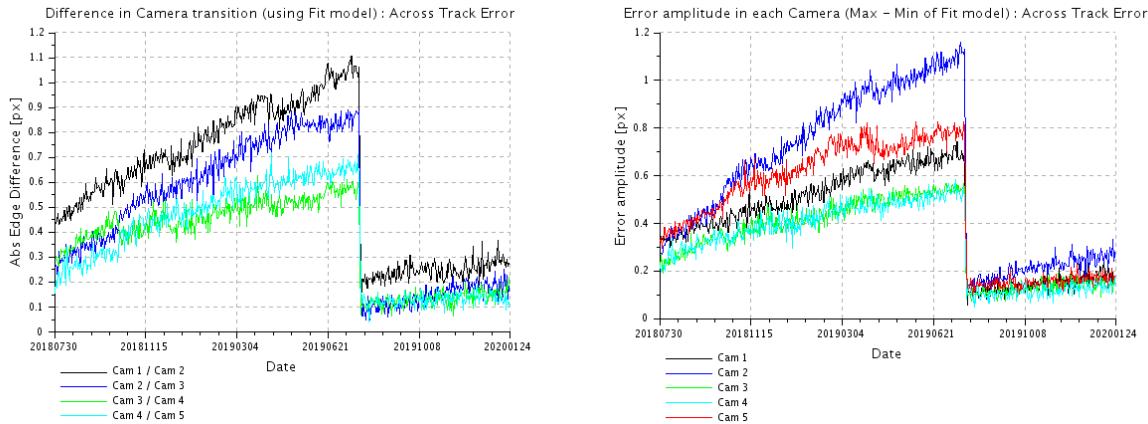


Figure 58: OLCI-B spatial across-track misregistration at each camera transition (left) and maximum amplitude of the across-track error within each camera (left).

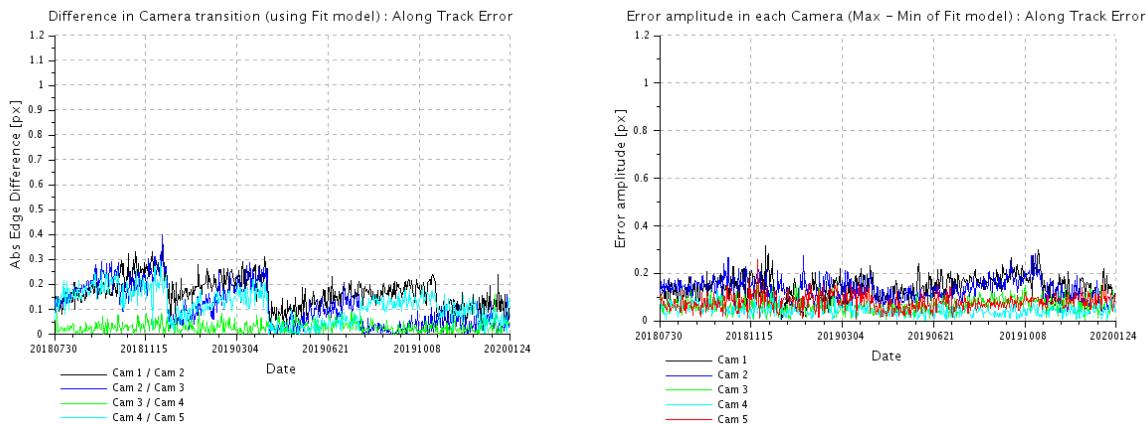


Figure 59: OLCI-B spatial along-track misregistration at each camera transition (left) and maximum amplitude of the along-track error within each camera (left).

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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://s3etrap.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 60) and OLCI-B (Figure 61).



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Figure 60: summary of S3ETRAC products generation for OLCI-A
(number of OLCI-A L1 products Ingested, blue – number of S3ETRAC extracted products generated, green – number of S3ETRAC runs without generation of output product (data not meeting selection requirements), yellow – number of runs ending in error, red, one plot per site type).



Figure 61: 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

There has been no new result during the cycle. Last figures (cycles 52-A / 33-B) are considered valid.

3.1.3 Radiometric validation with OSCAR

The OSCAR Rayleigh method has been applied to the S3A and S3B S3ETRAC data from the 6 oceanic calibration sites listed in Table 3, for December 2019.

Table 3. S3ETRAC Ocean Calibration sites

Site Name	Ocean	North Latitude	South Latitude	East Longitude	West Longitude
PacSE	South-East of Pacific	-20.7	-44.9	-89	-130.2
PacNW	North-West of Pacific	22.7	10	165.6	139.5
PacN	North of Pacific	23.5	15	200.6	179.4
AtlN	North of Atlantic	27	17	-44.2	-62.5
AtlS	South of Atlantic	-9.9	-19.9	-11	-32.3
IndS	South of Indian	-21.2	-29.9	100.1	89.5

The weighted average OSCAR S3A and S3B Rayleigh results for December 2019 and the whole mission periods are shown below (Table 4, Figure 62 and Figure 63). Similarly to previous reporting periods, S3A is brighter than S3B.

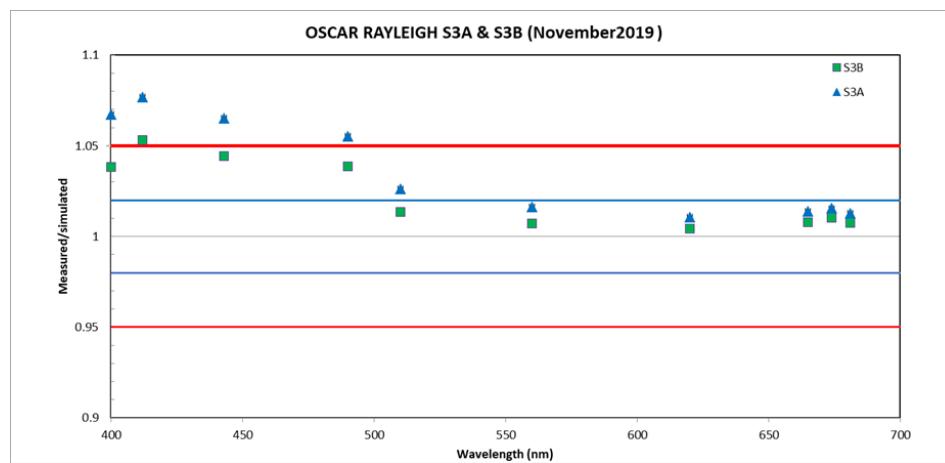


Figure 62. OSCAR Rayleigh S3A and S3B Calibration results: weighted average from December 2019.

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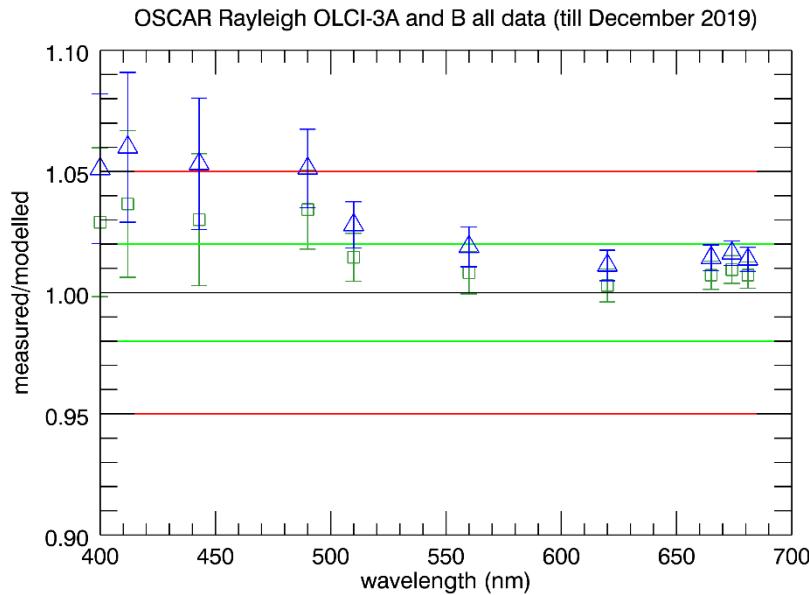


Figure 63. OSCAR Rayleigh S3A and S3B Calibration results: average over all months (till December 2019).

Table 4: OSCAR Rayleigh S3A and S3B results for the periods December 2019 and whole mission.

OLCI band	wvl (nm)	Sentinel-3A				Sentinel-3B			
		December 2019		Whole Mission		December 2019		Whole Mission	
		w_avg	stdev	w_avg	stdev	w_avg	stdev	w_avg	stdev
Oa01*	400	1.042	0.032	1.051	0.031	1.014	0.027	1.029	0.031
Oa02	412	1.053	0.034	1.060	0.031	1.030	0.029	1.037	0.030
Oa03	443	1.048	0.030	1.053	0.027	1.030	0.026	1.030	0.027
Oa04	490	1.047	0.015	1.051	0.016	1.037	0.017	1.034	0.016
Oa05	510	1.025	0.012	1.028	0.010	1.017	0.015	1.015	0.010
Oa06	560	1.017	0.011	1.019	0.008	1.011	0.013	1.008	0.009
Oa07	620	1.012	0.005	1.011	0.006	1.004	0.008	1.003	0.007
Oa08	665	1.015	0.005	1.014	0.005	1.008	0.007	1.007	0.006
Oa09	674	1.017	0.005	1.016	0.005	1.010	0.007	1.010	0.006
Oa10	681	1.014	0.005	1.014	0.005	1.008	0.007	1.007	0.005
Oa11	709	0.997	0.010	0.996	0.008	0.992	0.009	0.993	0.008
Oa12	754	1.010	0.002	1.010	0.002	1.008	0.001	1.009	0.002
Oa13	761.25	NA	NA	NA	NA	NA	NA	NA	NA
Oa14	764.375	NA	NA	NA	NA	NA	NA	NA	NA
Oa15	767.5	NA	NA	NA	NA	NA	NA	NA	NA
Oa16	778.75	NA	NA	NA	NA	NA	NA	NA	NA
Oa17	865	NA	NA	NA	NA	NA	NA	NA	NA
Oa18	885	NA	NA	NA	NA	NA	NA	NA	NA
Oa19	900	NA	NA	NA	NA	NA	NA	NA	NA
Oa20	940	NA	NA	NA	NA	NA	NA	NA	NA
Oa21	1020	NA	NA	NA	NA	NA	NA	NA	NA

*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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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.

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 28th of January 2020. 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 June 2016 and April 2018 for S3A and S3B respectively.

Figure 64 to Figure 73 below present the Core Land Sites OLCI-A time series over the current period.

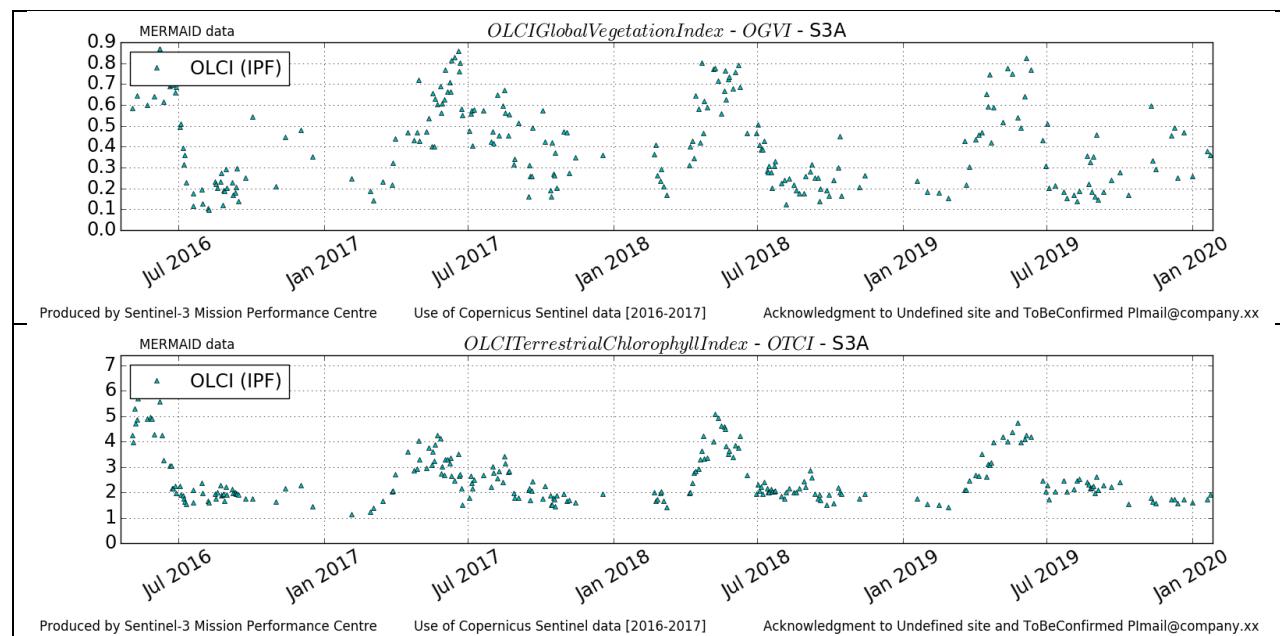


Figure 64: DeGeb time series over current report period

 <p>Sentinel-3 MPC</p> <p>S3 OLCI Cyclic Performance Report</p> <p>S3A Cycle No. 053 – S3B Cycle No. 034</p>	Ref.: S3MPC.ACR.PR.01-053-034 Issue: 1.0 Date: 31/01/2020 Page: 58
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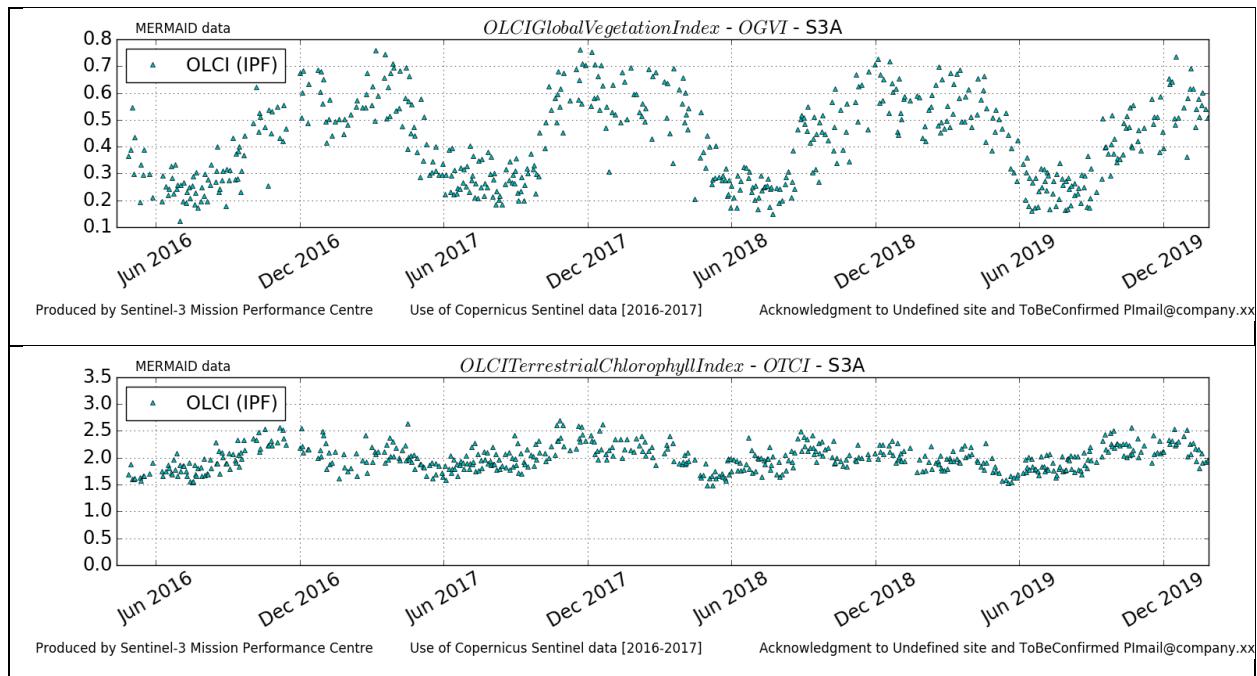


Figure 65: ITcat time series over current report period

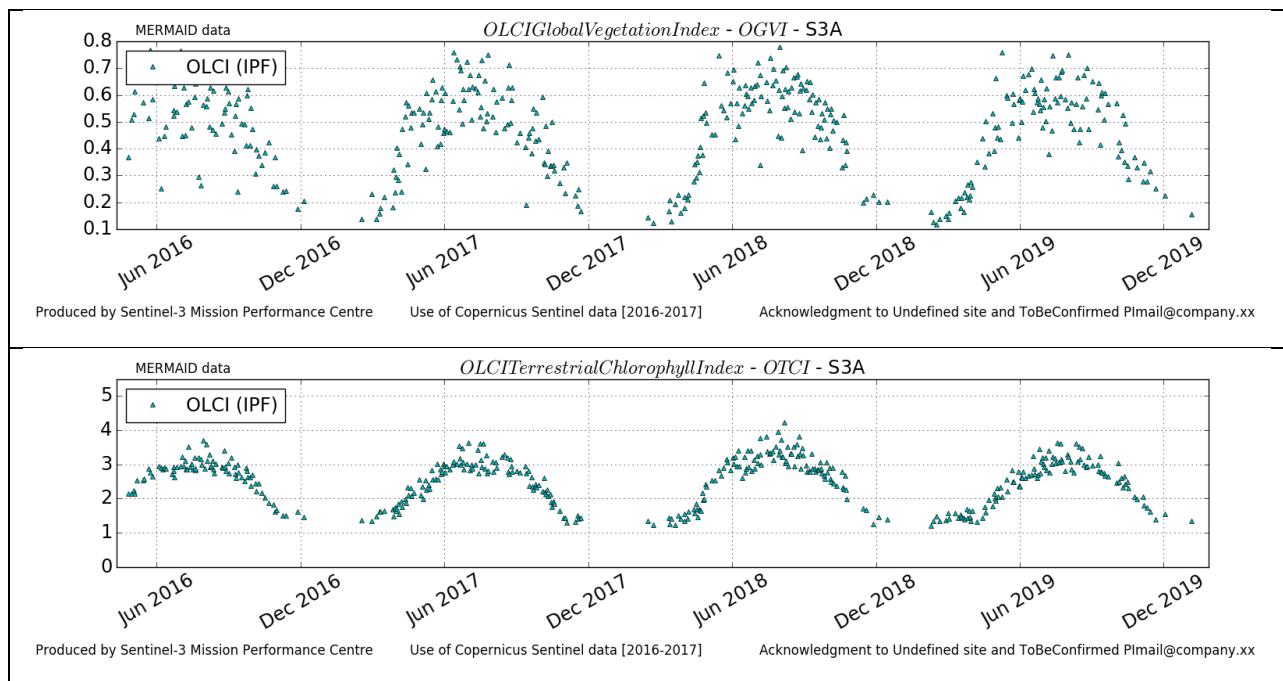


Figure 66: ITsp time series over current report period

 <p>Sentinel-3 MPC</p> <p>S3 OLCI Cyclic Performance Report</p> <p>S3A Cycle No. 053 – S3B Cycle No. 034</p>	Ref.: S3MPC.ACR.PR.01-053-034 Issue: 1.0 Date: 31/01/2020 Page: 59
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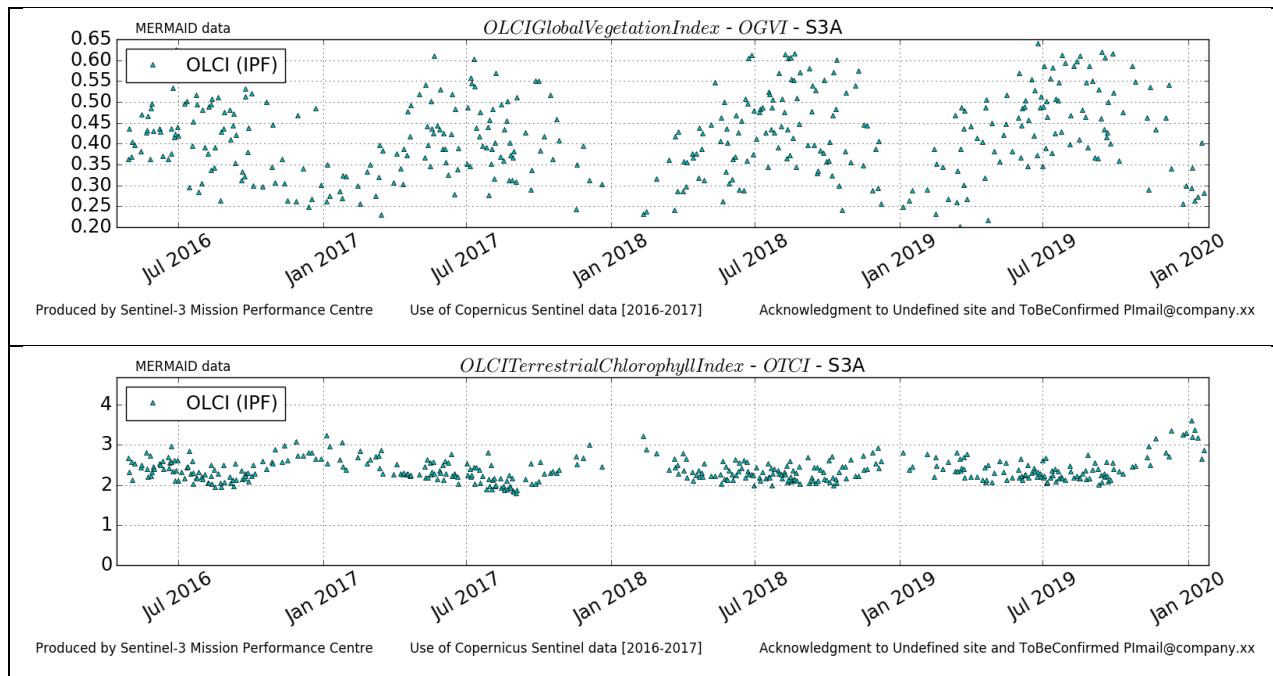


Figure 67: ITsro time series over current report period

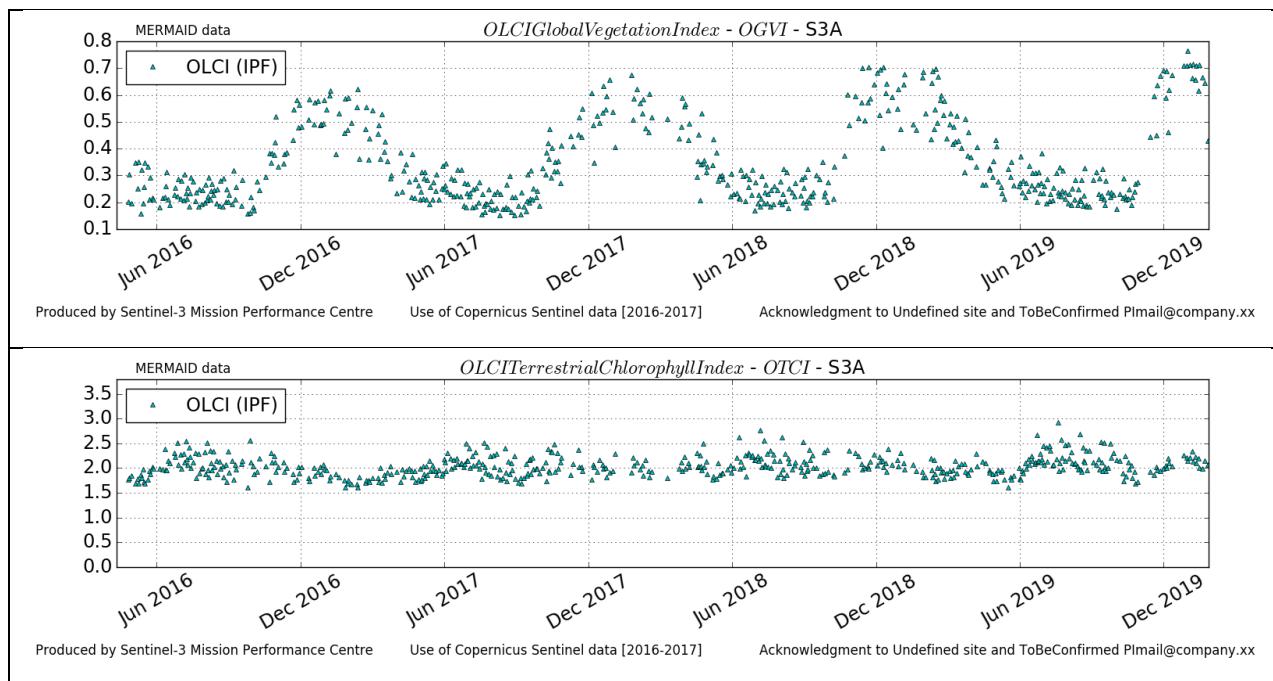


Figure 68: ITtra time series over current report period

 <p>Sentinel-3 MPC</p> <p>S3 OLCI Cyclic Performance Report</p> <p>S3A Cycle No. 053 – S3B Cycle No. 034</p>	Ref.: S3MPC.ACR.PR.01-053-034 Issue: 1.0 Date: 31/01/2020 Page: 60
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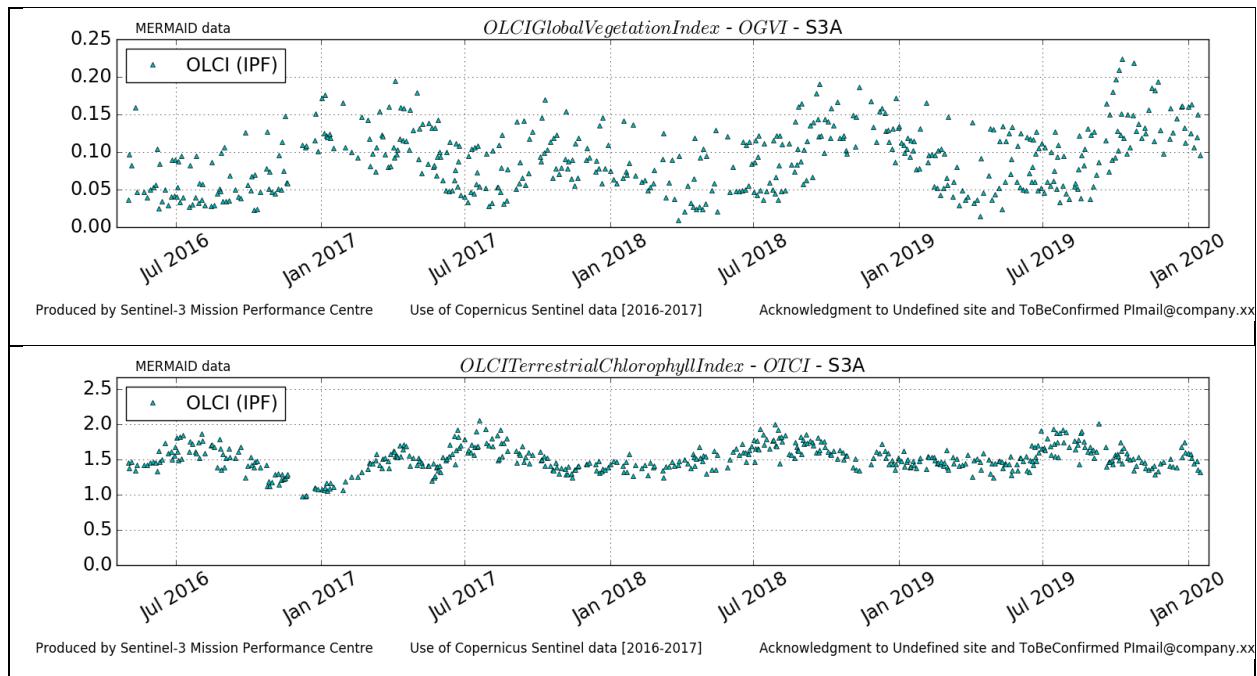


Figure 69: SPAli time series over current report period

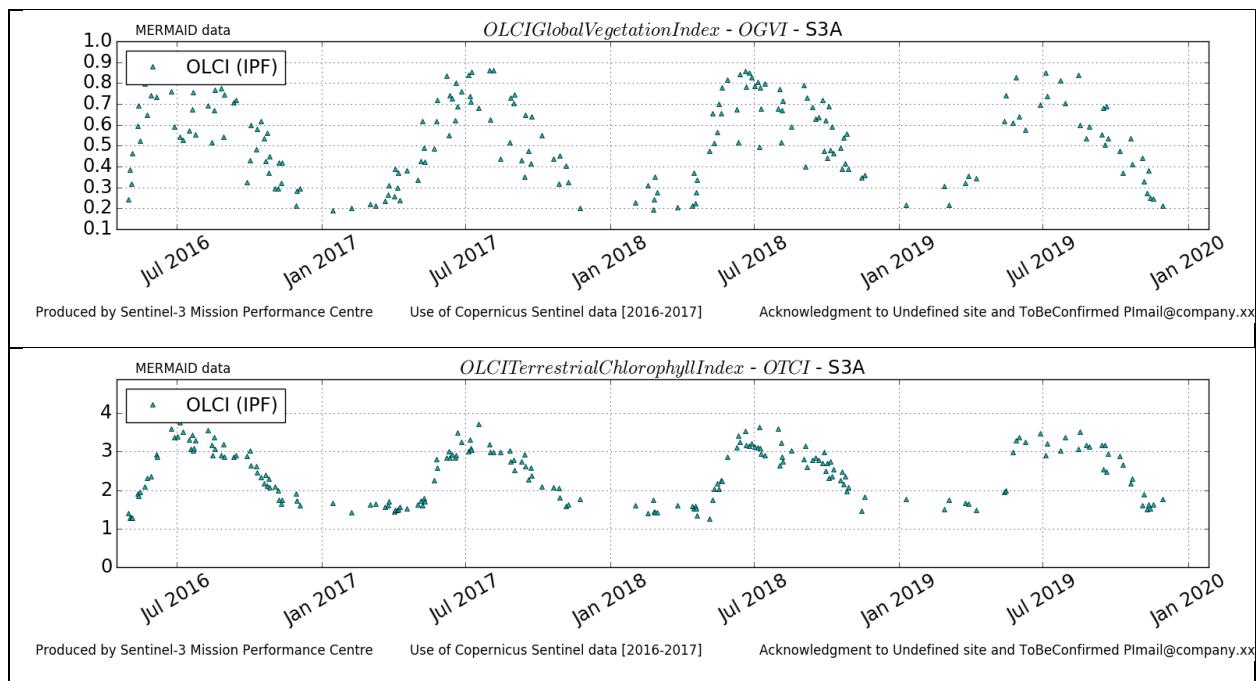


Figure 70: UKNfo time series over current report period

 <p>Sentinel-3 MPC</p> <p>S3 OLCI Cyclic Performance Report</p> <p>S3A Cycle No. 053 – S3B Cycle No. 034</p>	Ref.: S3MPC.ACR.PR.01-053-034 Issue: 1.0 Date: 31/01/2020 Page: 61
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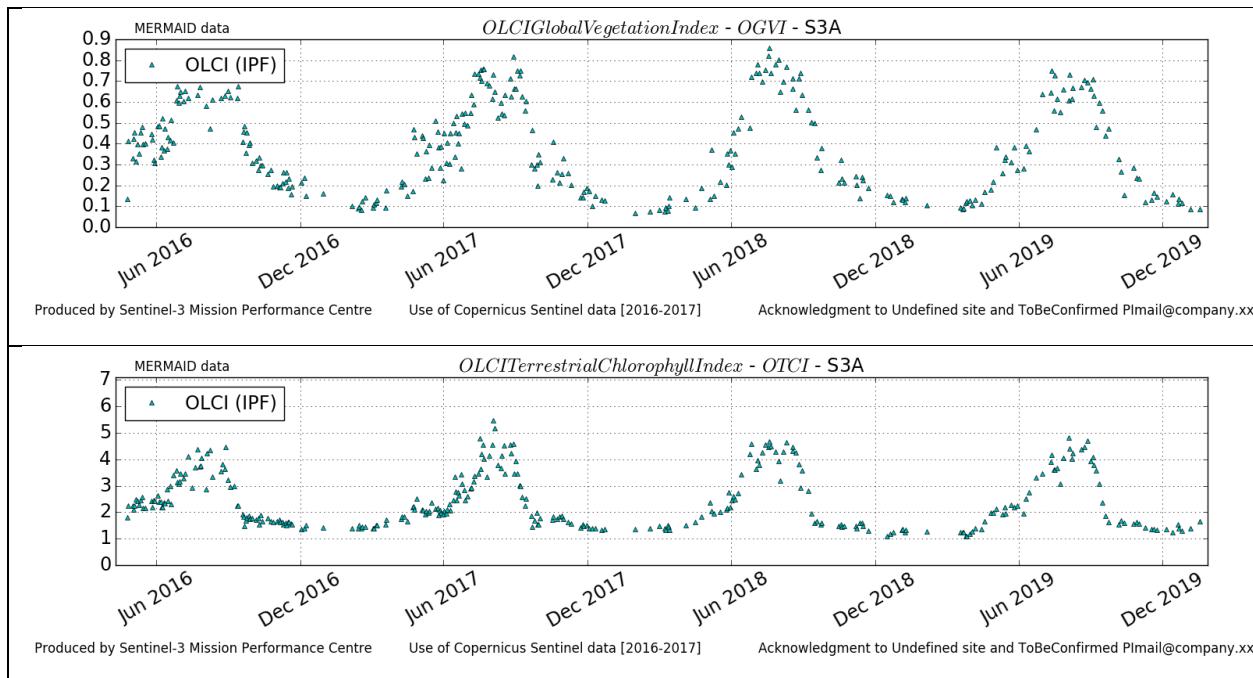


Figure 71: USNe1 time series over current report period

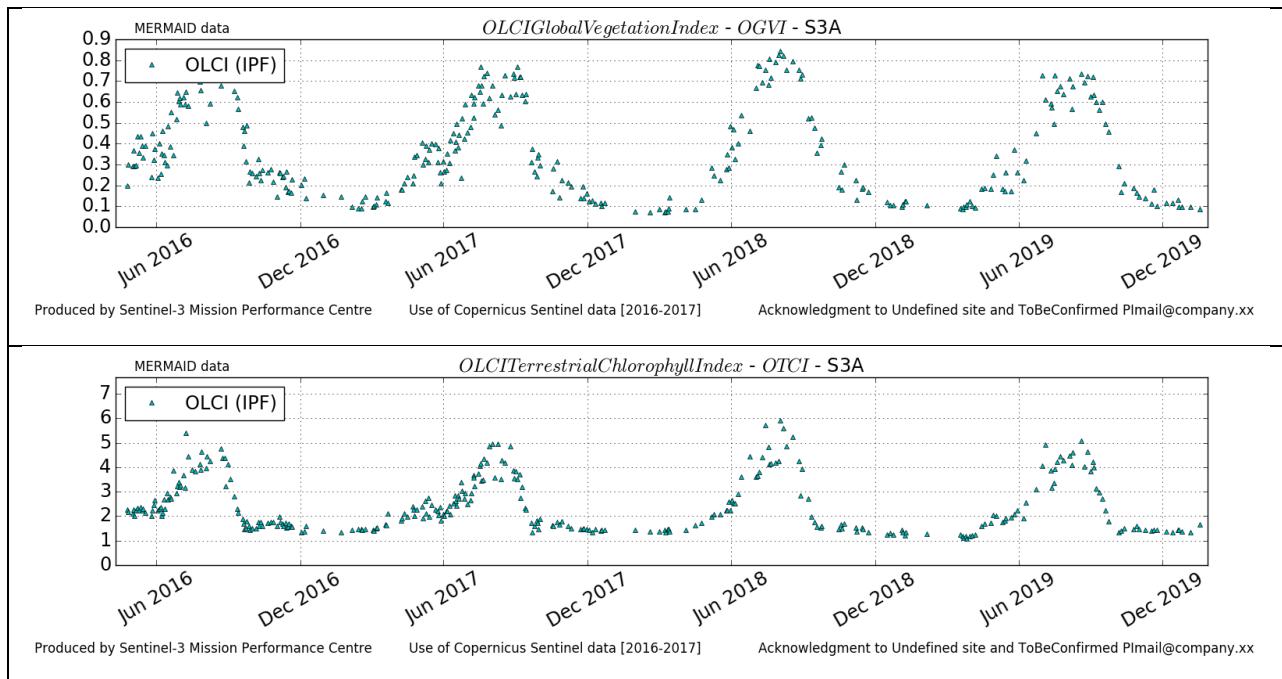


Figure 72: USNe2 time series over current report period

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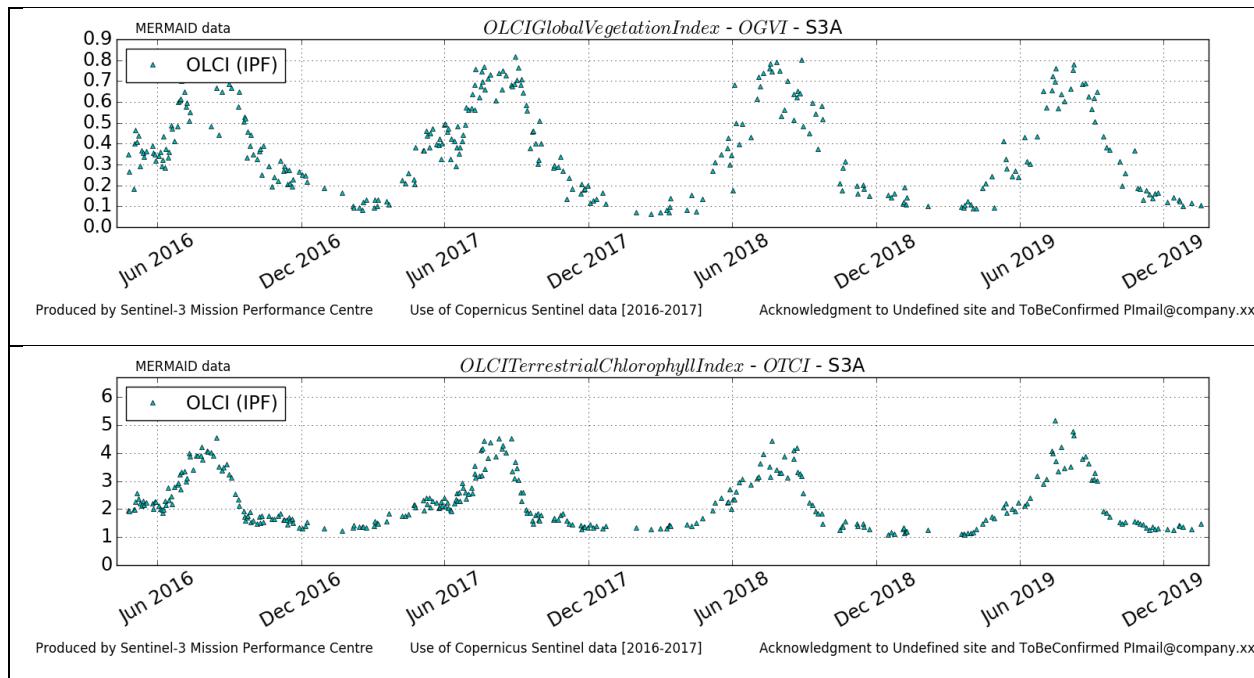


Figure 73: USNe3 time series over current report period

4.1.1.2 OLCI-B

Figure 74 to Figure 83 below present the Core Land Sites OLCI-B time series over the current period.

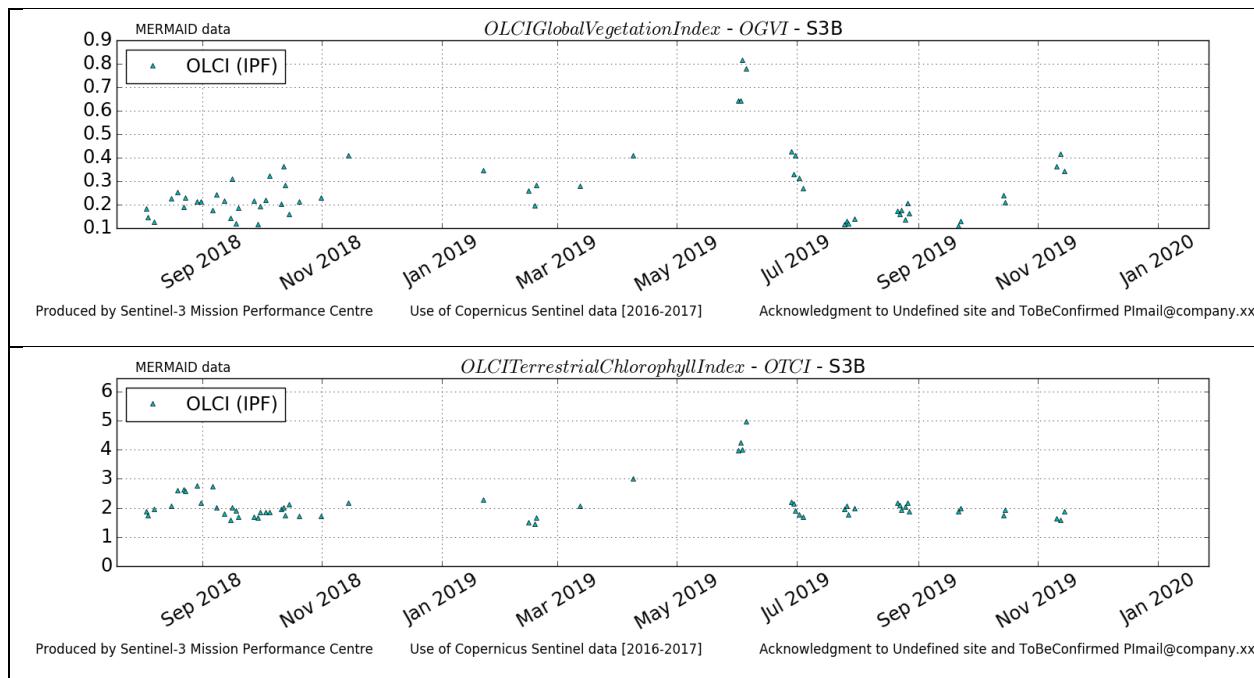


Figure 74: DeGeb time series over current report period

 <p>Sentinel-3 MPC</p> <p>S3 OLCI Cyclic Performance Report</p> <p>S3A Cycle No. 053 – S3B Cycle No. 034</p>	Ref.: S3MPC.ACR.PR.01-053-034 Issue: 1.0 Date: 31/01/2020 Page: 63
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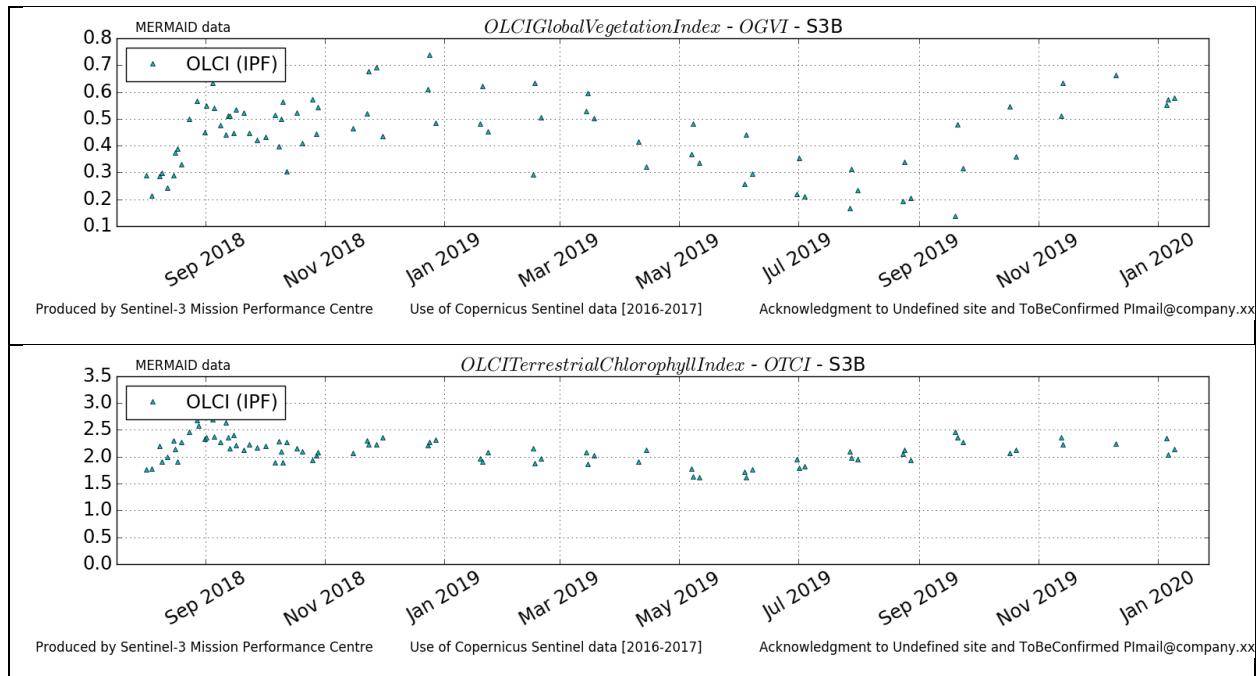


Figure 75: ITCat time series over current report period

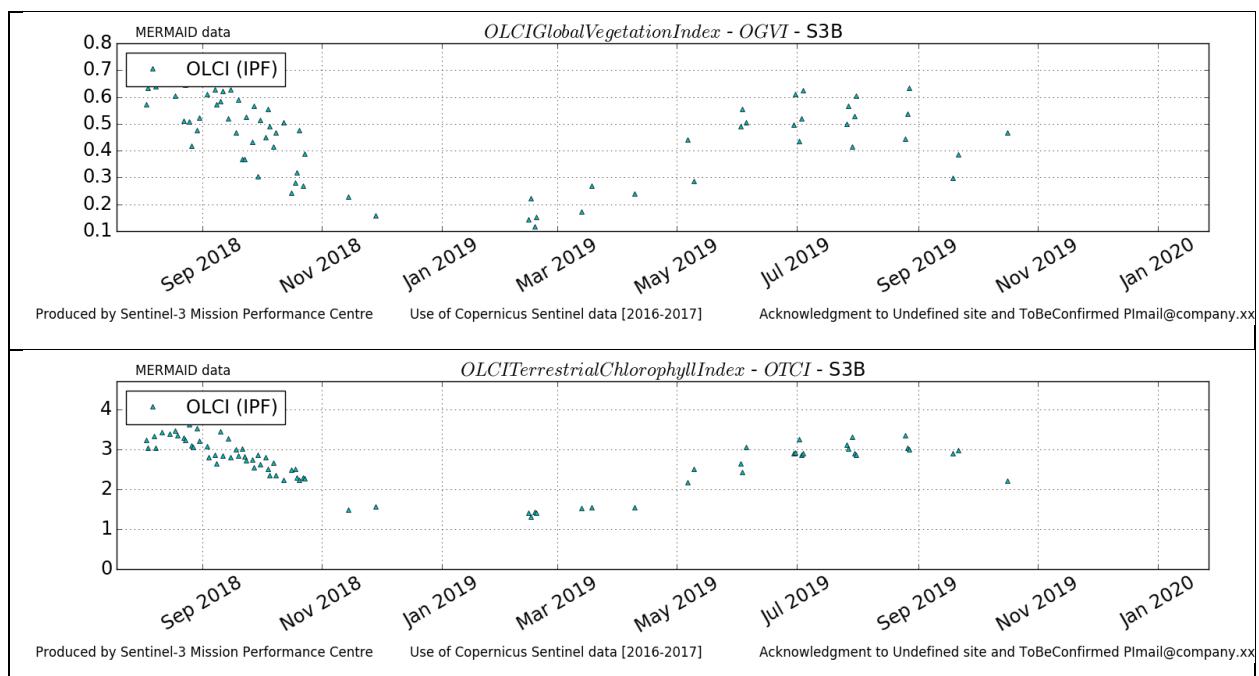


Figure 76: ITsp time series over current report period

 <p>Sentinel-3 MPC</p> <p>S3 OLCI Cyclic Performance Report</p> <p>S3A Cycle No. 053 – S3B Cycle No. 034</p>	Ref.: S3MPC.ACR.PR.01-053-034 Issue: 1.0 Date: 31/01/2020 Page: 64
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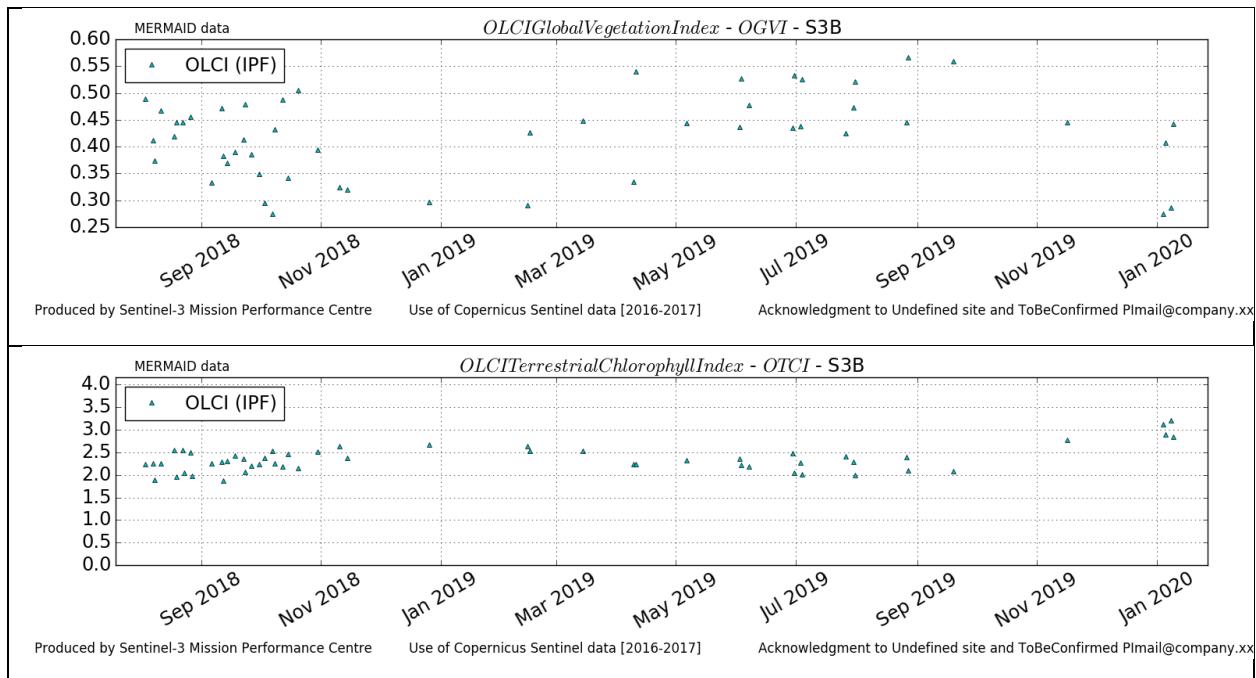


Figure 77: ITsro time series over current report period

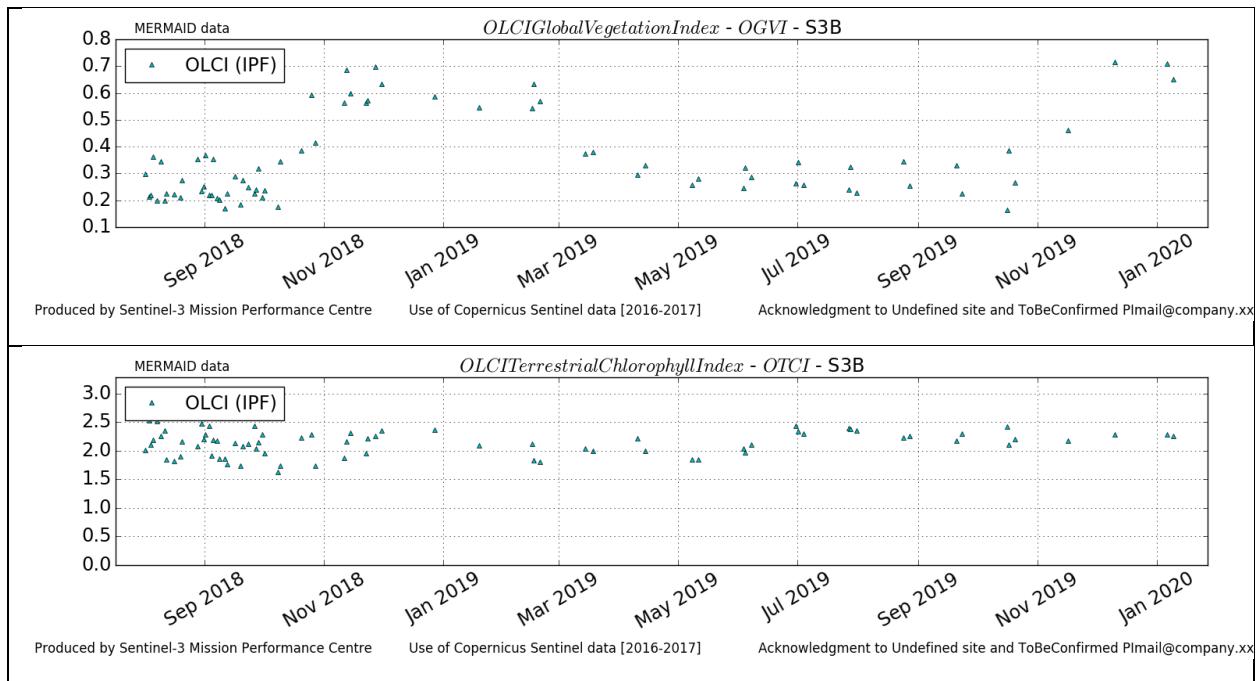


Figure 78: ITtra time series over current report period

 <p>Sentinel-3 MPC</p> <p>S3 OLCI Cyclic Performance Report</p> <p>S3A Cycle No. 053 – S3B Cycle No. 034</p>	Ref.: S3MPC.ACR.PR.01-053-034 Issue: 1.0 Date: 31/01/2020 Page: 65
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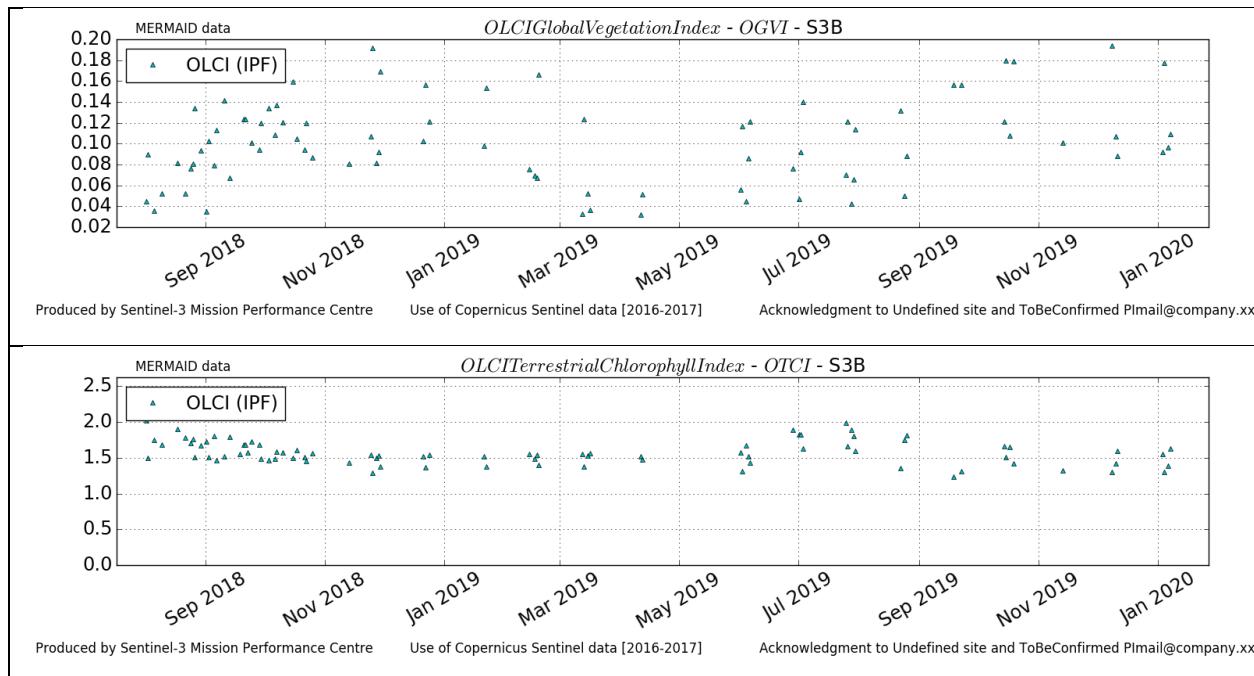


Figure 79: SPAli time series over current report period

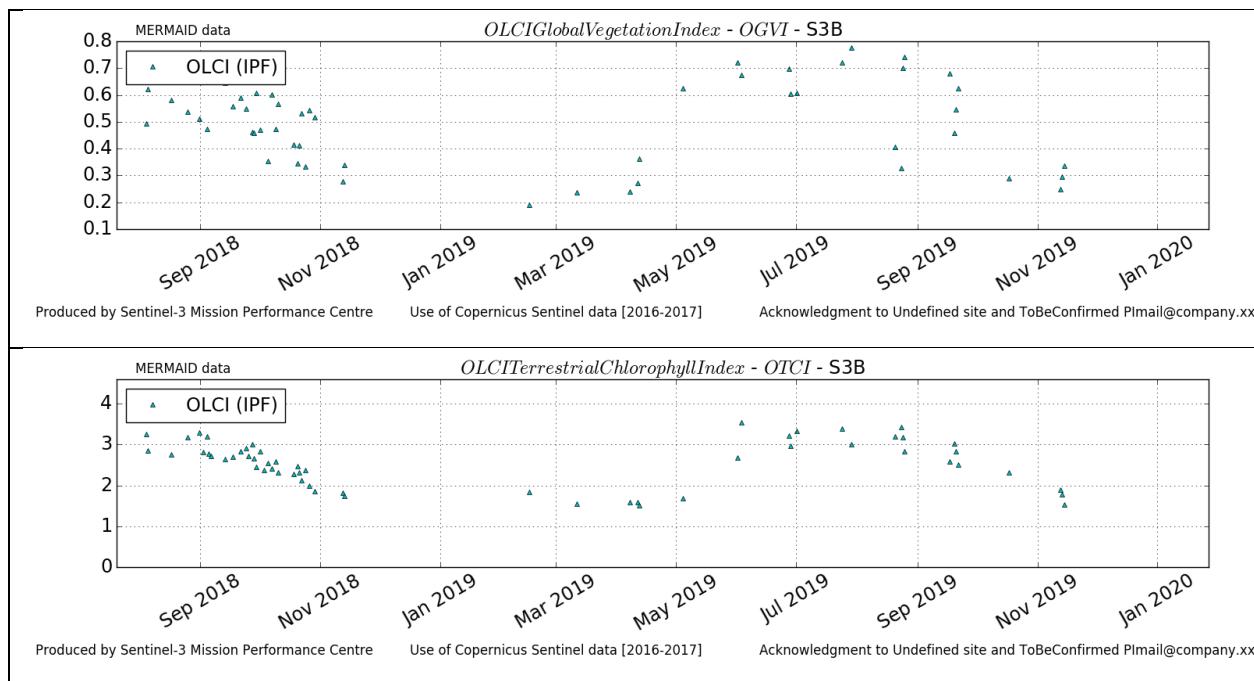


Figure 80: UKNFO time series over current report period

 <p>Sentinel-3 MPC</p> <p>S3 OLCI Cyclic Performance Report</p> <p>S3A Cycle No. 053 – S3B Cycle No. 034</p>	Ref.: S3MPC.ACR.PR.01-053-034 Issue: 1.0 Date: 31/01/2020 Page: 66
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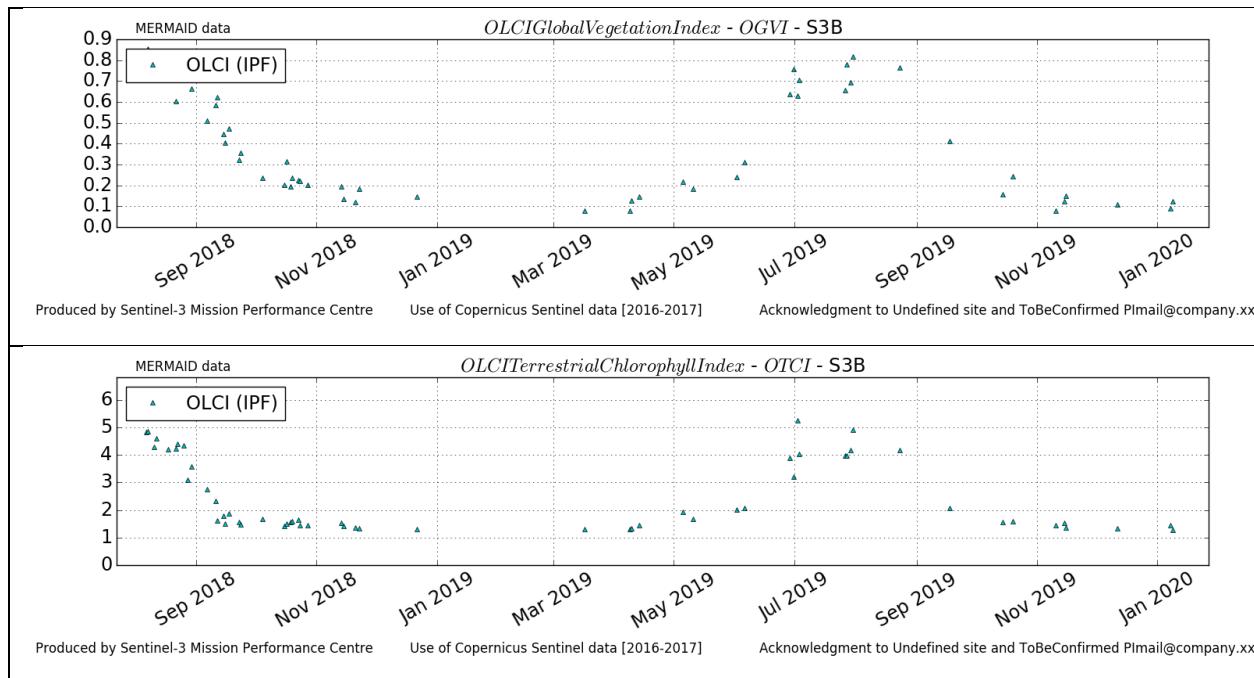


Figure 81: USNe1 time series over current report period

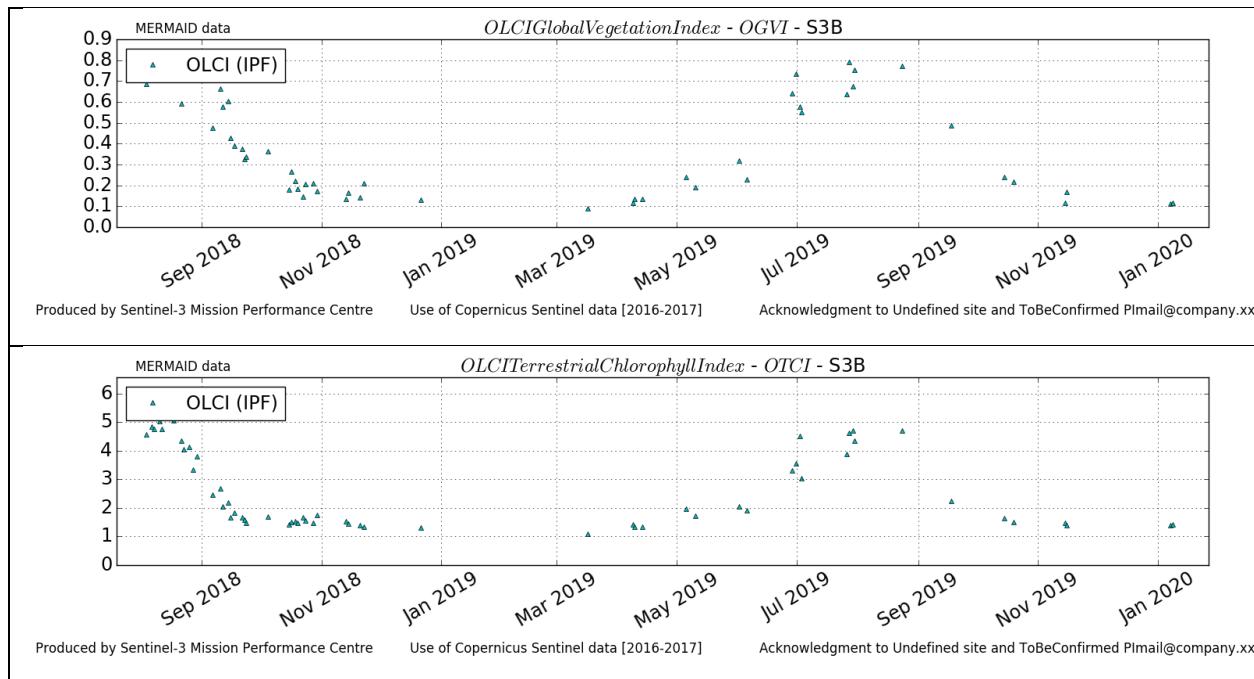


Figure 82: USNe2 time series over current report period

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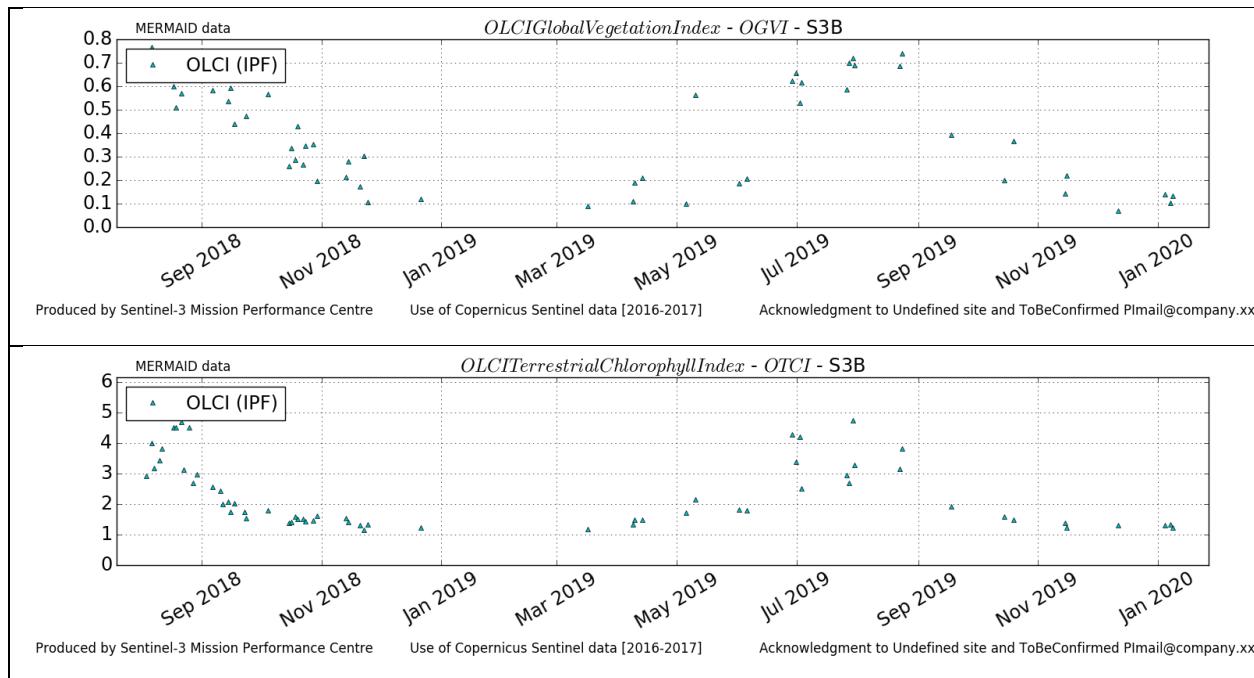


Figure 83: USNe3 time series over current report period

4.1.2 Comparisons with MERIS MGVI and MTCI climatology

Assessment

This section reports the performance of the OLCI Level-2 land products OTCI and OGVI for cycle S3A 53 and S3B 34. The assessment consists on comparisons between the OLCI and MERIS archives, incorporating OLCI's most recent acquisitions. The report covers the period 19 December 2019 to 15 January 2020. Pixel extractions were obtained over 53 CEOS and ESA Core sites from both, OLCI and MERIS (sites 1 to 35 shown in Table 5). Comparison statistics are computed and summarised in Table 6. Time-series of OLCI acquisitions overlaid on long-term monthly mean (+/- SD) of MERIS, and monthly mean between MERIS and OLCI scatterplots are presented in Figure 84 to Figure 86. The evaluation of OLCI is conducted over 10 land cover types. To illustrate, three typical land cover types were selected for these figures: broadleaved deciduous, forest, cropland and evergreen forest. Figure 87 shows the agreement between monthly mean of MERIS and OLCI pooling all 53 validation sites. In general, OLCI land products follow the trend of the climatology and the seasonal pattern. At the moment, northern hemisphere products values are at their seasonal lowest due to wintertime senescence. Systematic under and overestimations are consistent with previous cycles. Figure 87 shows the monthly mean of all validation sites together, points are coloured by cover type. The figure depicts slight underestimation of OTCI and slight overestimation of OGVI. This pattern is more evident for broadleaved deciduous and evergreen sites (Figure 87). On average, NRMSD is lower for S3A compared to S3B in both products (Table 6), meaning that the data falls closer to the one to one line. This is due to the lower number of acquisitions in S3B, which makes it more sensitive to outliers. The graphical interface of the interactive report is now updated in the following link: https://s3mpc-soton.shinyapps.io/s3mpc_gui/



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Table 5: Validation sites included in report S3A 51/S3B 32. Land cover data from GLC2000.

Acronym	Country	Network	Lat	Lon	Land.cover
DE-Hones-Holz	Deutschland	ICOS	52.09	11.22	Broadleaved, deciduous, closed
FR-Hesse	France	ICOS	48.67	7.07	Broadleaved, deciduous, closed
FR-Montiers	France	ICOS	48.54	5.31	Broadleaved, deciduous, closed
IT-isp	Italy	CORE	45.81	8.64	Mixed forest
US-Harvard	United States	NEON, AERONET	42.54	-72.17	Broadleaved, deciduous, closed
US-Mountain-Lake	United States	NEON, AERONET	37.38	-80.53	Broadleaved, deciduous, closed
US-Oak-Rige	United States	NEON, AERONET	35.96	-84.28	Broadleaved, deciduous, closed
US-Smithsonian	United States	NEON, AERONET	38.89	-78.14	Broadleaved, deciduous, closed
US-Steigerwaldt	United States	NEON	45.51	-89.59	Broadleaved, deciduous, closed
BE-Brasschaat	Belgium	ICOS	51.31	4.52	Needle-leaved, evergreen
DE-Haininch	Deutschland	ICOS Associated	51.08	10.45	Broadleaved, deciduous, closed
DE-Tharandt	Deutschland	ICOS	50.96	13.57	Needle-leaved, evergreen
IT-Collelongo	Italy	EFDC	41.85	13.59	Broadleaved, deciduous, closed
UK-NFo	United Kingdom	CORE	50.85	-1.54	Deciduous forest
US-Talladega	United States	NEON, AERONET	32.95	-87.39	Needle-leaved, evergreen
CR-Santa-Rosa	Costa Rica	ENVIRONET	10.84	-85.62	Broadleaved, evergreen
IT-Lison	Italy	ICOS	45.74	12.75	Cropland
UK-Wytham-Woods	United Kingdom	ForestGeo - NPL	51.77	-1.34	Broadleaved, deciduous, closed
AU-Great-Western	Australia	TERN-SuperSites, AusCover/OzFlux	-30.19	120.65	Broadleaved, deciduous, open
AU-Robson-Creek	Australia	TERN-SuperSites, AusCover/OzFlux	-17.12	145.63	Broadleaved, evergreen
BE-Vielsalm	Belgium	ICOS	50.31	6.00	Needle-leaved, evergreen
BR-Mata-Seca	Brazil	ENVIRONET	-14.88	-43.97	Herbaceous, closed-open
FR-Estrees-Mons	France	ICOS Associated	49.87	3.02	Cultivated and managed areas
IT-Casterporziano2	Italy	ICOS	41.70	12.36	Mixed forest
SP-Ali	Spain	CORE	38.45	-1.07	Cropland
US-Bartlett	United States	NEON, AERONET	44.06	-71.29	Broadleaved, deciduous, closed
CA-Mer-Bleue	Canada	National Capitol Comission	45.40	-75.49	Peatland
AU-Litchfield	Australia	TERN-SuperSites, AusCover/OzFlux	-13.18	130.79	Broadleaved, evergreen
CZ-Bili-Kriz	Czechia	ICOS	49.50	18.54	Needle-leaved, evergreen
AU-Cumberland	Australia	TERN-SuperSites, AusCover/OzFlux	-33.62	150.72	Broadleaved, evergreen
AU-Tumbarumba	Australia	TERN-SuperSites, AusCover/OzFlux	-35.66	148.15	Broadleaved, evergreen
AU-Wombat	Australia	TERN-SuperSites, AusCover/OzFlux	-37.42	144.09	Broadleaved, evergreen
DE-Geb	Deutschland	CORE	51.10	10.91	Cropland
IT-Sro	Italy	CORE	43.73	10.28	Mixed forest
DE-Selhausen	Deutschland	ICOS	50.87	6.45	Cropland
AU-Cape-Tribulation	Australia	TERN-SuperSites, OzFlux	-16.11	145.38	Broadleaved, evergreen
AU-Rushworth	Australia	TERN-AusCover	-36.75	144.97	Broadleaved, deciduous, open
US-Jornada	United States	LTER	32.59	-106.84	Shrub, closed-open, deciduous



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Table 6: Comparison statistics between monthly S3A/B OLCI land products and MERIS archive data.

Site Acronym	S3A						S3B					
	OTCI vs MTCI			OGVI vs MGVI			OTCI vs MTCI			OGVI vs MGVI		
	n	R2	NRMSD	Bias	n	R2	NRMSD	Bias	n	R2	NRMSD	Bias
DE-Hones-Holz	11	0.99	0.04	0.03	11	0.99	0.05	0.04	9	0.89	0.15	-0.22
FR-Hesse	12	0.99	0.03	0.01	12	0.99	0.04	0.06	10	0.89	0.12	-0.05
FR-Montiers	12	0.99	0.05	-0.09	12	0.98	0.06	0.05	9	0.97	0.07	-0.10
IT-Isp	12	0.99	0.03	0.00	12	0.99	0.06	0.06	10	0.91	0.09	-0.07
US-Harvard	12	0.99	0.03	-0.12	12	0.97	0.09	0.05	10	0.97	0.05	-0.20
US-Mountain-Lake	12	0.99	0.03	-0.22	12	0.99	0.05	0.03	11	0.96	0.06	-0.52
US-Oak-Rige	12	0.99	0.04	-0.04	12	0.97	0.09	0.05	11	0.99	0.05	-0.12
US-Smithsonian	11	0.99	0.03	-0.21	11	0.99	0.05	0.03	10	0.98	0.07	-0.18
US-Steigerwaldt	11	0.99	0.03	0.01	11	0.98	0.08	0.00	7	0.81	0.11	-0.10
BE-Brasschaat	10	0.98	0.03	-0.11	10	0.98	0.05	0.05	9	0.90	0.08	-0.18
DE-Haininch	10	0.98	0.08	-0.09	10	0.99	0.08	0.07	10	0.92	0.16	-0.12
DE-Tharandt	10	0.98	0.03	-0.02	10	0.96	0.09	0.10	10	0.94	0.07	-0.24
IT-Collelongo	12	0.98	0.06	-0.01	12	0.98	0.08	0.01	11	0.81	0.24	0.03
UK-NFo	11	0.98	0.03	-0.26	11	0.97	0.08	0.08	10	0.97	0.05	-0.24
US-Talladega	12	0.98	0.02	-0.14	12	0.98	0.05	0.07	10	0.91	0.05	-0.20
CR-Santa-Rosa	12	0.97	0.05	0.16	12	0.58	0.20	0.13	12	0.84	0.12	-0.04
IT-Lison	12	0.97	0.04	-0.04	12	0.96	0.07	0.08	11	0.88	0.07	-0.07
UK-Wytham-Woods	12	0.97	0.05	0.08	12	0.96	0.07	0.11	10	0.89	0.08	-0.15
AU-Great-Western	12	0.96	0.02	0.12	12	0.90	0.10	0.04	12	0.89	0.03	0.13
AU-Robson-Creek	12	0.96	0.02	-0.04	12	0.89	0.04	0.10	12	0.81	0.05	-0.17
BE-Vielsalm	10	0.96	0.03	0.02	10	0.97	0.06	0.10	7	0.72	0.08	-0.01
BR-Mata-Seca	12	0.96	0.06	-0.09	12	0.98	0.07	0.00	12	0.95	0.06	-0.12
FR-Estrees-Mons	12	0.94	0.08	0.06	12	0.92	0.11	0.06	10	0.89	0.11	0.11
IT-Casterporziano2	12	0.94	0.03	-0.09	12	0.84	0.03	0.07	12	0.75	0.08	0.02
SP-Ali	12	0.94	0.02	0.06	12	0.00	0.28	0.02	11	0.90	0.02	0.13
US-Bartlett	12	0.94	0.05	-0.03	12	0.98	0.10	0.06	11	0.81	0.10	0.02
CA-Mer-Bleue	9	0.93	0.06	-0.03	9	0.99	0.03	0.05	7	0.91	0.06	-0.06
AU-Litchfield	12	0.92	0.02	-0.01	12	0.94	0.06	0.03	12	0.61	0.07	0.00
CZ-Bili-Kriz	11	0.92	0.03	0.09	11	0.95	0.07	0.06	8	0.81	0.06	-0.05
AU-Cumberland	12	0.91	0.02	0.00	12	0.49	0.07	0.07	12	0.50	0.06	0.02
AU-Tumbarumba	12	0.91	0.04	0.40	12	0.77	0.06	0.13	12	0.91	0.03	0.26
AU-Wombat	12	0.91	0.03	0.20	12	0.31	0.08	0.10	12	0.61	0.05	-0.09
DE-Geb	12	0.89	0.10	-0.10	12	0.91	0.12	0.03	10	0.81	0.10	-0.07
IT-Sro	12	0.89	0.03	-0.21	12	0.90	0.06	0.08	12	0.68	0.05	-0.26
DE-Selhausen	12	0.87	0.09	-0.01	12	0.52	0.21	0.07	10	0.74	0.09	-0.20
AU-Cape-Tribulation	12	0.86	0.04	-0.06	12	0.28	0.06	0.14	10	0.89	0.02	-0.21
AU-Rushworth	12	0.84	0.04	0.22	12	0.32	0.08	0.11	12	0.16	0.10	-0.10
US-Jornada	10	0.84	0.04	0.01	10	0.73	0.20	0.01	8	0.69	0.04	0.11
									8	0.28	0.20	-0.01



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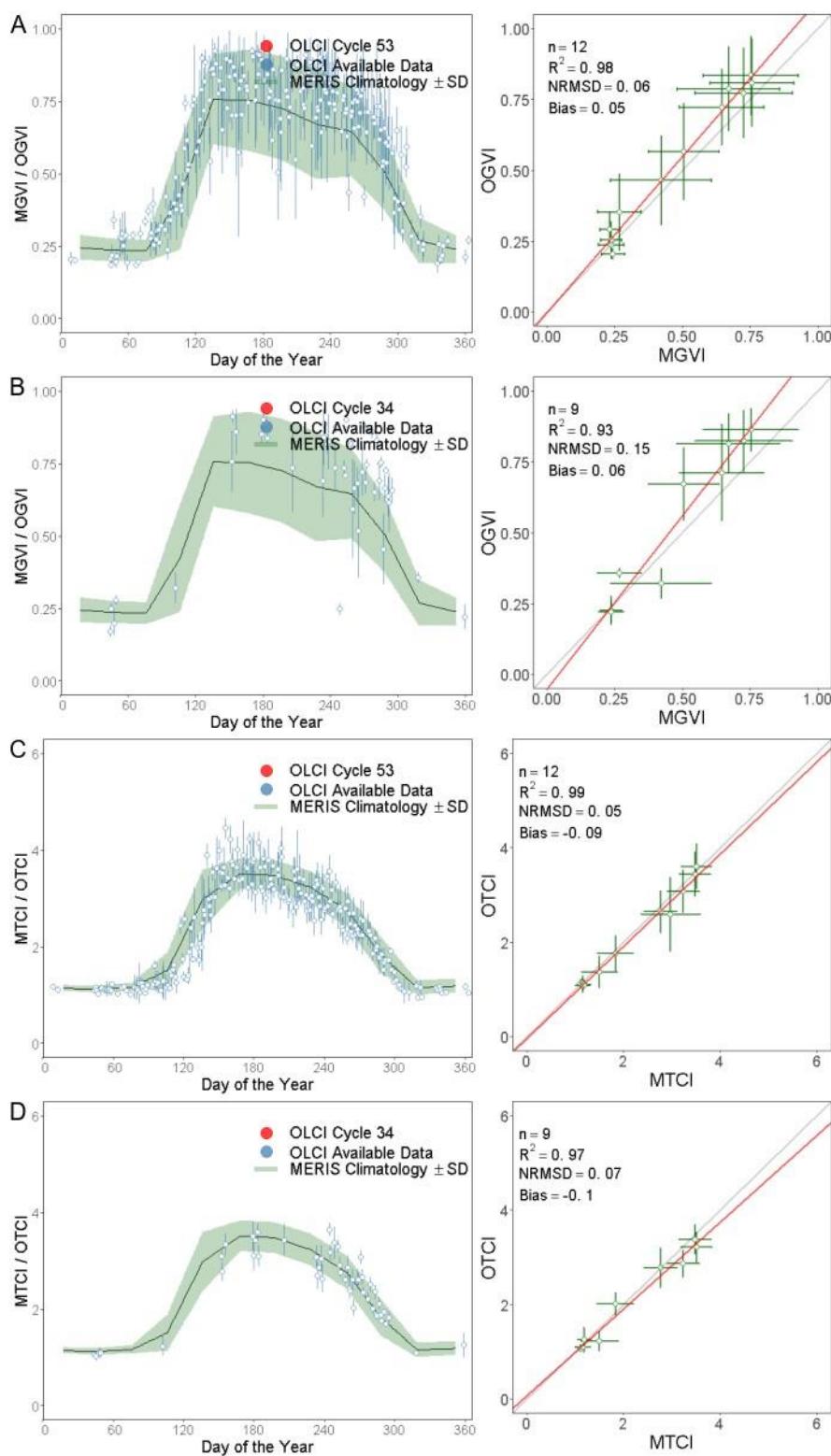


Figure 84: Time-series OGVI and OTCI and corresponding scatterplot of monthly mean for site FR-Montiers, France, land cover Broadleaved, deciduous, closed. A and C represent S3A; B and D represent S3B.



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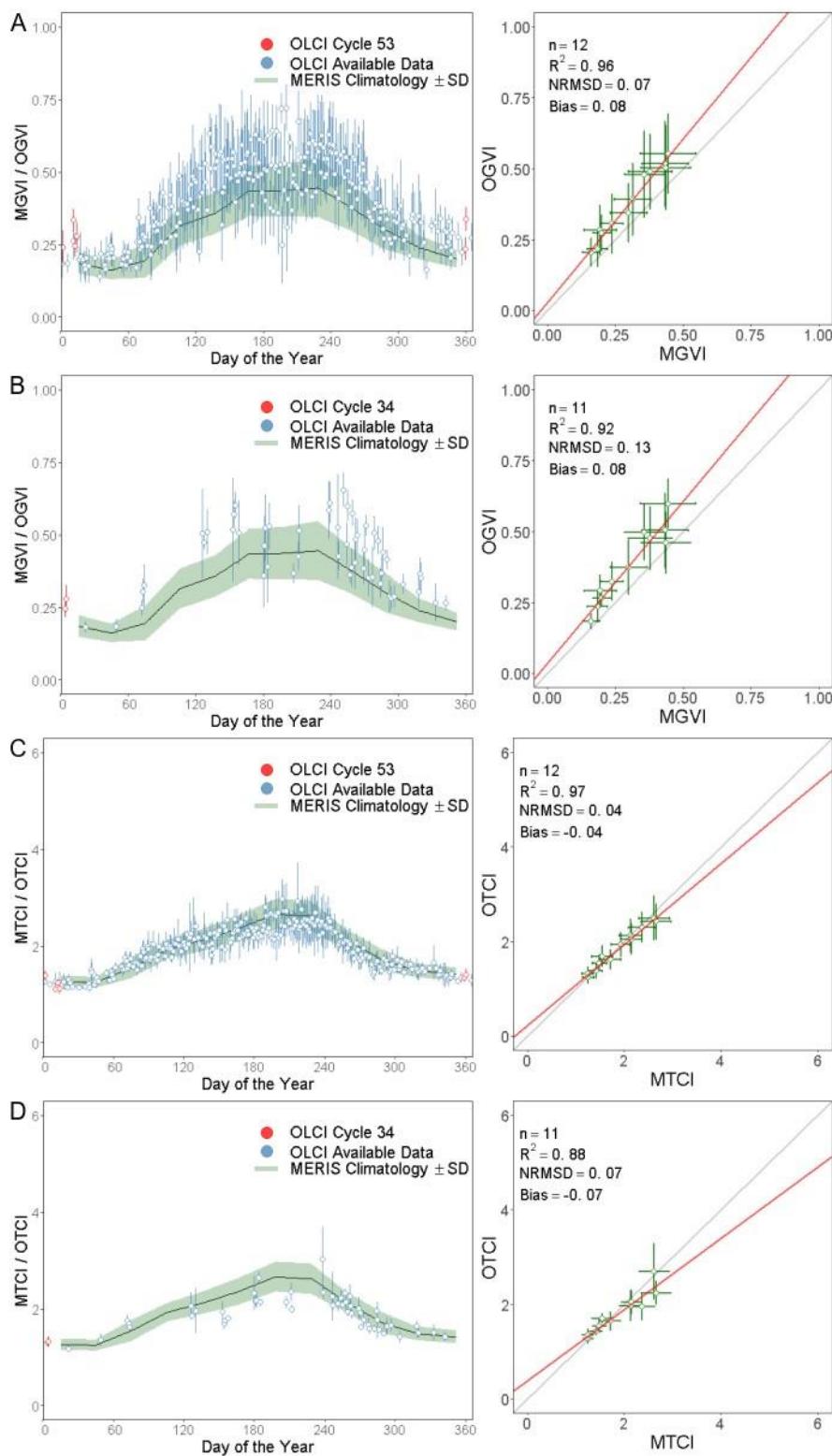


Figure 85: Time-series OGVI and OTCI and corresponding scatterplot of monthly mean for site IT-Lison, Italy, land cover Cropland. A and C represent S3A; B and D represent S3B.

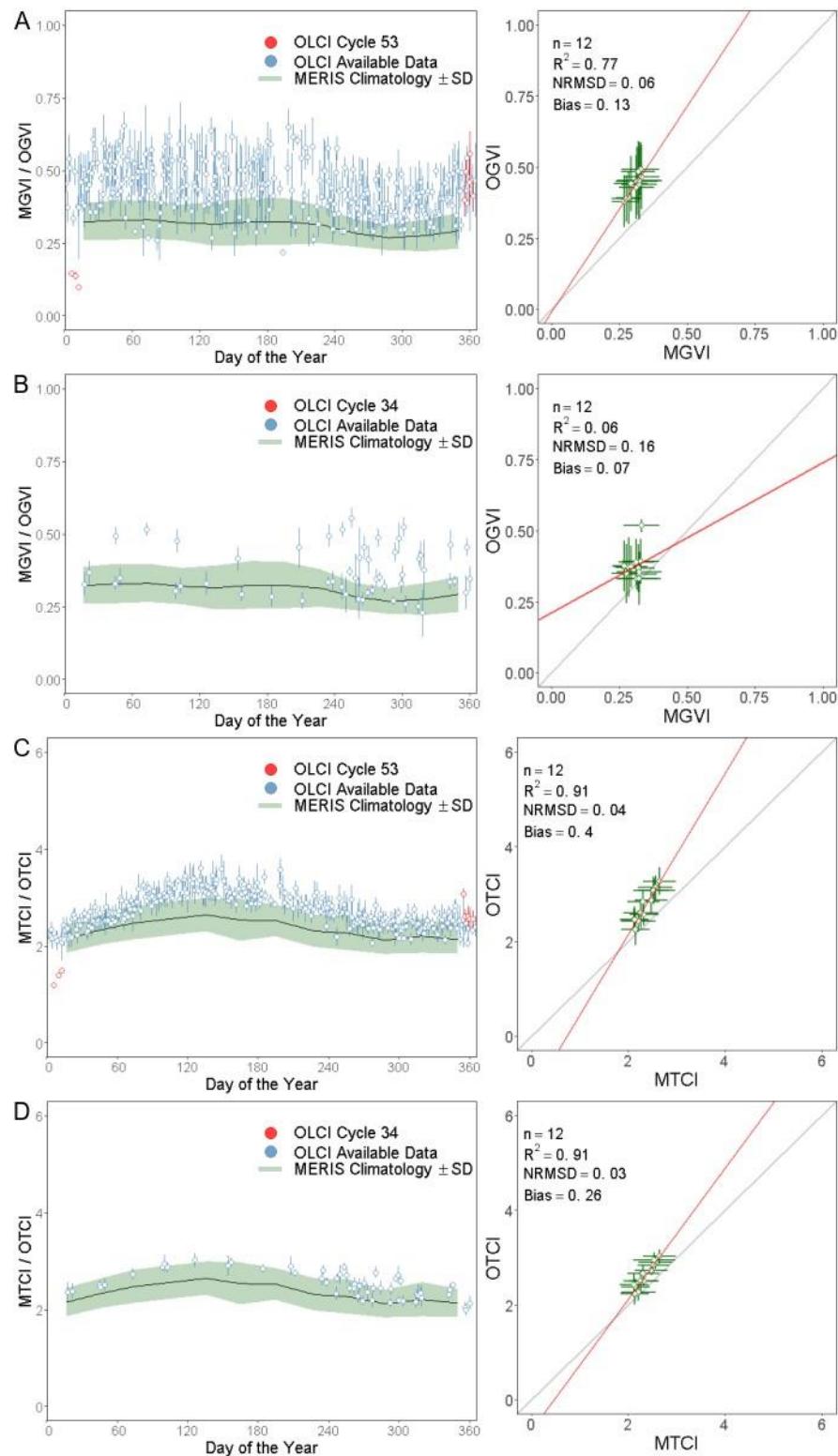


Figure 86: Time-series OGVI and OTCI and corresponding scatterplot of monthly mean for site AU-Tumbarumba, Australia, land cover Broadleaved, evergreen. A and C represent S3A; B and D represent S3B.

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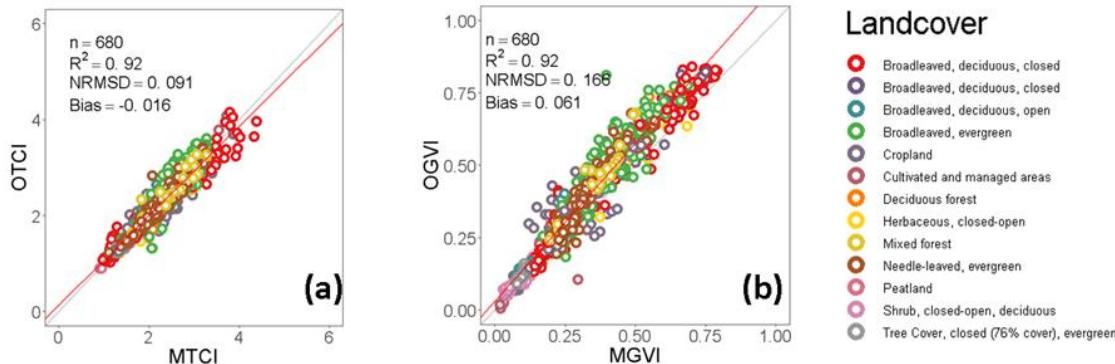


Figure 87: Comparison of OTCI-MTCI (a) and OGVI-MGVI (b). Points in the scatterplot represent the monthly mean of all available S3A and MERIS archive over 53 validation sites. Red and grey lines represent the modelled and 1:1 lines respectively. The scatterplots are updated to include extractions from cycles up to S3A 53.

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 053. Last figures (cycle 17) are considered valid.

5.1.2 OLCI-B

OLCI-B SVC has been reattempted using (a) current OL_2 Marine PB and (b) latest delivered one (PB 1.32-B), including BPC upgrade, as no decision has been taken yet regarding the use of PB 1.32 in operations. Corresponding results are presented below for the two cases. It clearly demonstrates two points:

1. SVC is now feasible for OLCI-B and yields good performance on validation
2. The BPC upgrade of PB 1.32 is beneficial for the SVC match-up selection (increase of the number of selected calibration match-ups by about 25%) as well as for the validation performance with independent in-situ data.

Results are not further discussed here since there is no decision yet regarding implementation in the Ground Segment.

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 Acknowledgements

S3-MPC acknowledges all PIs mentioned below and their respective institutions for their valuable contribution to the validation of OLCI L2 water products with a special emphasis on AERONET-OC PIs for their unique contribution to NRT data validation and a special mention to Giuseppe Zibordi maintaining and providing data over 5 ground stations. AERONET-OC is indeed from far the largest contributor of Fiducial Reference Measurements for routine quantitative data validation.

- ❖ AERONET-OC
 - **AAOT, Galata, Gloria, GDT, HLH, Irbe Lighthouse:** Giuseppe Zibordi, Joint Research Centre of the European Commission
 - **Ieodo, Socheongcho:** Young-Je Park & Hak-Yeol You, Korean Institute of Ocean Science and Technology & Korea Hydrographic and Oceanographic Administration

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- **LISCO:** Sam Ahmed, Alex Gilerson, City College of New York
- **MVCO:** Hui Feng and Heidi Sosik, Ocean Process Analysis Laboratory (OPAL), Woods Hole Oceanographic Institution
- **Thornton:** Dimitry Van der Zande, RBINS/OD Nature
- **Lucinda:** Thomas Schroeder, Integrated Marine Observing System, IMOS
- **USC_SEAPRISM:** Burton Jones and Curtiss Davis, University Southern California | USC, Oregon State University
- **WaveCIS:** Alan Weidemann, Bill Gibson, Robert Arnone, University of Southern MS, Coastal Studies Inst – LSU, Naval Research Laboratory
- **Ariake tower:** Joji Ishizaka, Kohei Arai, Nagoya University & Saga University
- **Blyth NOAH:** Rodney Forster, University of Hull, UK
- **Casablanca platform:** Giuseppe Zibordi, Marco Malone, Joint Research Centre of the European Commission
- **Grizzly bay, Lake Okeechobee, South Greenbay:** NimaPahlevan, NASA
- **Lake Erie:** Tim Moore, Steve Ruberg, Menghua Wang, University of New Hampshire & NOAA
- ❖ **BOUSSOLE**
 - David Antoine, Enzo Vellucci (Curtin University, Perth & Laboratoire d'Oceanographie de Villefranche, CNRS)
- ❖ **MOBY**
 - Kenneth Voss & Carol Johnson (University of Miami & NIST)
- ❖ **SLGO**
 - Simon Belanger, Thomas Jaegler & Peter Galbraith (Arctus, Inc & Department of fisheries and Ocean Canada)
- ❖ **AWI**
 - Astrid Bracher (Alfred-Wegener-Institut)
- ❖ **IMOS**
 - Thomas Schroeder (Integrated Marine Observing System, IMOS)
- ❖ **BSH**
 - Holger Klein (Bundesamt für Seeschifffahrt und Hydrographie, BSH)
- ❖ **Proval**
 - Edouard Leymarie (Laboratoire d'Oceanographie de Villefranche, CNRS)

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5.2.2 OLCI-A

Activities done

- ❖ The focus for this time period has been on the rolling archive Non Time Critical (NT) data until the 27th of January 2020.
- ❖ Current reporting period is hereafter compared to the reprocessed archive covering the April 2016 to November 2017 period. No 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 almost three years of operation.
- ❖ At best 377 and 384 matchups at 490 and 560nm respectively are useful for this time period. OLCI's performances remain nominal.

Overall Water-leaving Reflectance performance

Scatter plots and Performance Statistics

Figure 88 and Figure 89 below present 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 7 below summarises the statistics over the reprocessing period while Table 8 provides the same figures for the NT rolling Archive over July 2017 – present. The latter statistics are almost within the requirements (5% accuracy in the blue/green bands) – as demonstrated by the RPD values between 2 and 7.5% – performances over the current period appear a bit lower than for the calibration period (except at 412 nm), but of the same order of magnitude.



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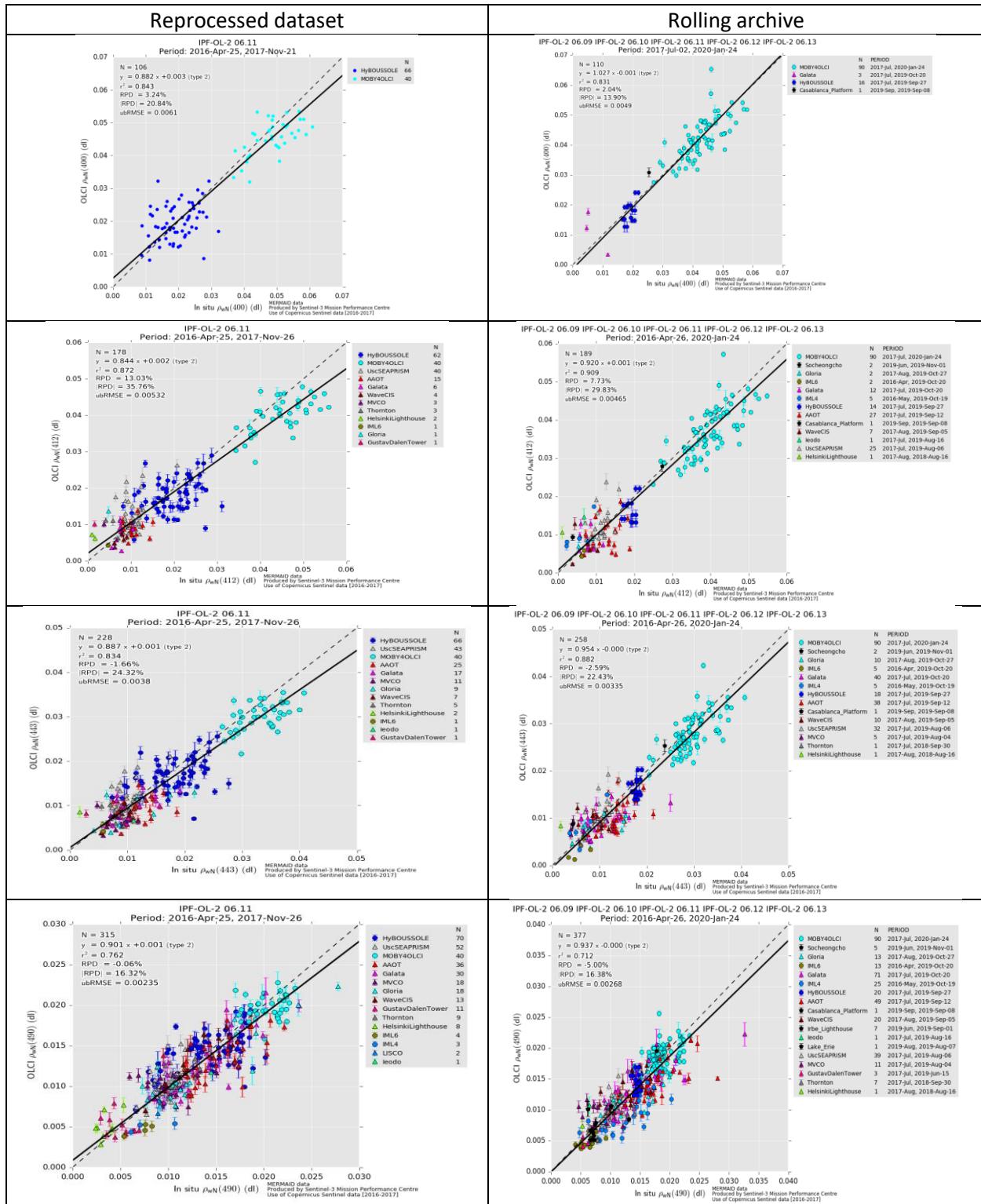


Figure 88: Scatter plots of OLCI-A versus in situ radiometry (FR data). Reprocessed dataset (left), all available data for the current time period (right), Oa1 to Oa4 (400 to 490 nm)



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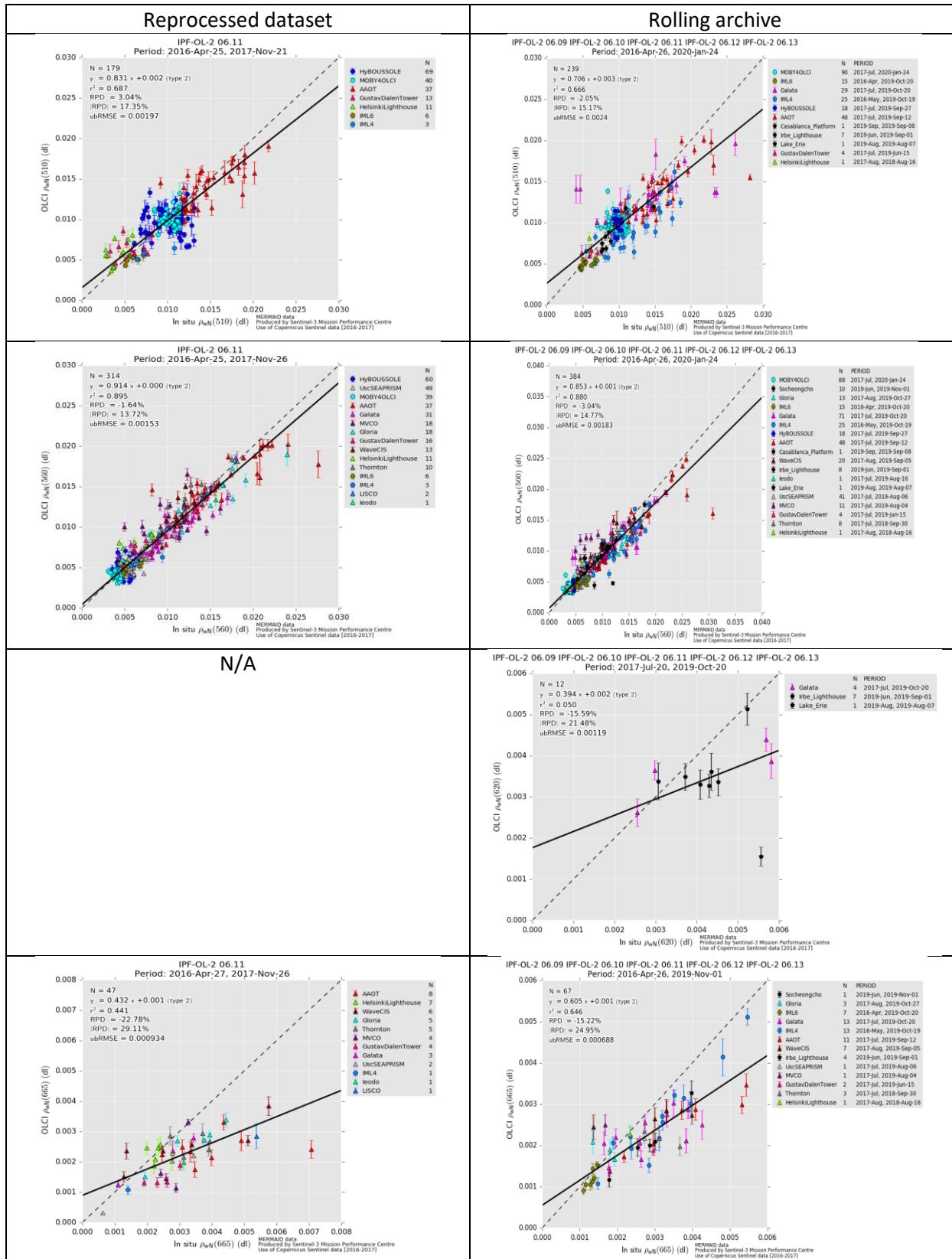


Figure 89: Scatter plots of OLCI-A versus in situ radiometry (FR data). Reprocessed dataset (left), all available data for the current time period (right), Oa5 Oa6 and Oa8 (510, 560 and 665 nm).

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Table 7: OLCI-A 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 8: OLCI-A FR statistics over July 2017-September 2019 reporting period.

lambda	N	RPD	RPD	MAD	RMSE	slope	intercept	r2
400	110	2.04%	13.90%	-0.0003	0.0049	1.0265	-0.0013	0.8313
412	189	7.73%	29.83%	-0.0013	0.0048	0.9197	0.0007	0.9089
443	258	-2.59%	22.43%	-0.0013	0.0036	0.9543	-0.0004	0.8824
490	377	-5.00%	16.38%	-0.0010	0.0028	0.9370	-0.0001	0.7124
510	239	-2.05%	15.17%	-0.0007	0.0025	0.7057	0.0026	0.6664
560	384	-3.04%	14.77%	-0.0006	0.0019	0.8526	0.0007	0.8799
620	12	-15.59%	21.48%	-0.0009	0.0015	0.3942	0.0018	0.0503
665	67	-15.22%	24.95%	-0.0006	0.0009	0.6047	0.0005	0.6460

Time series

Figure 90 and Figure 91 below present Galata and AAOT in situ and OLCI time series over the June 2017-present period, for the same IPF configuration (from a scientific point of view).

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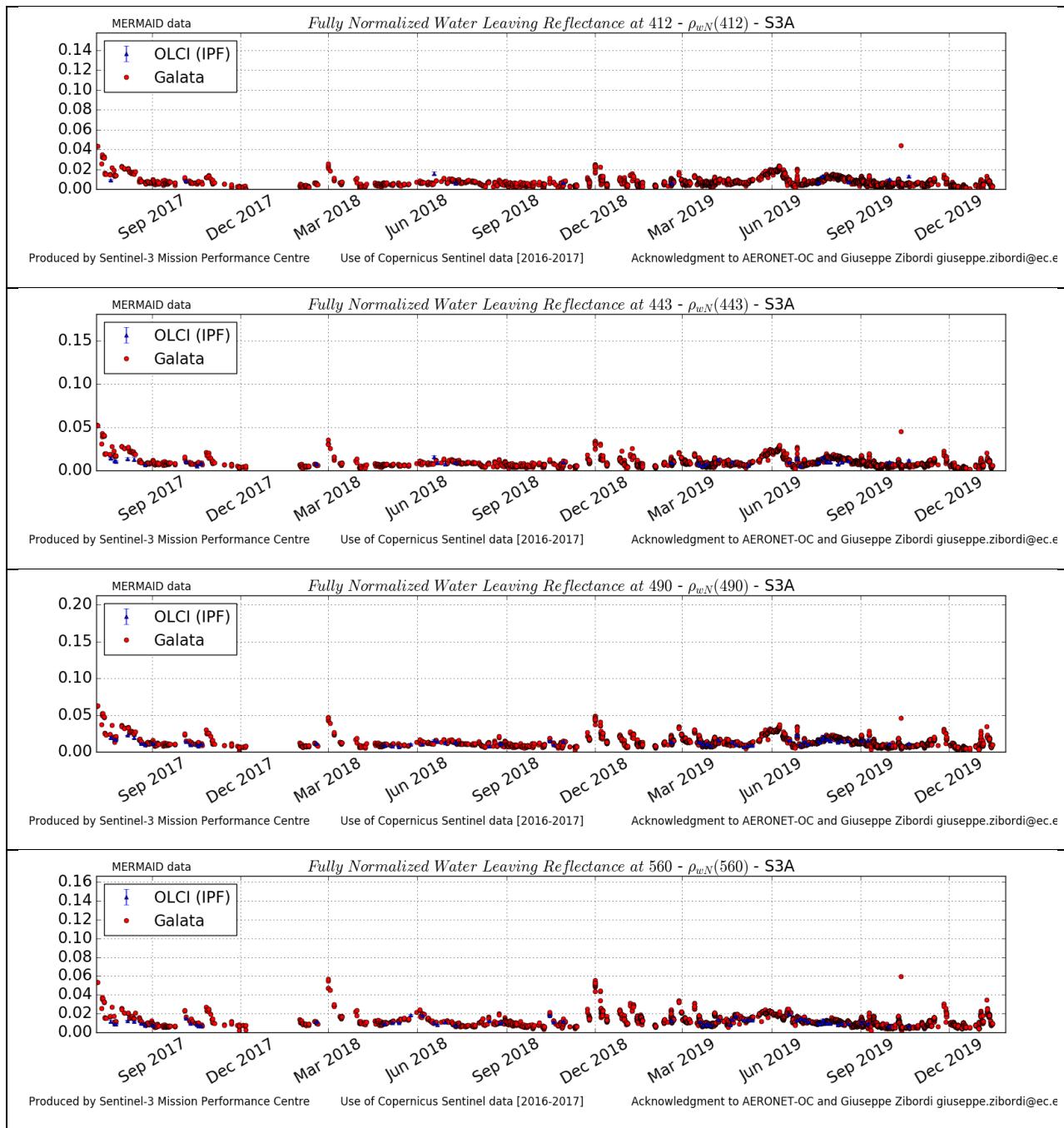


Figure 90: Galata time series over current report period

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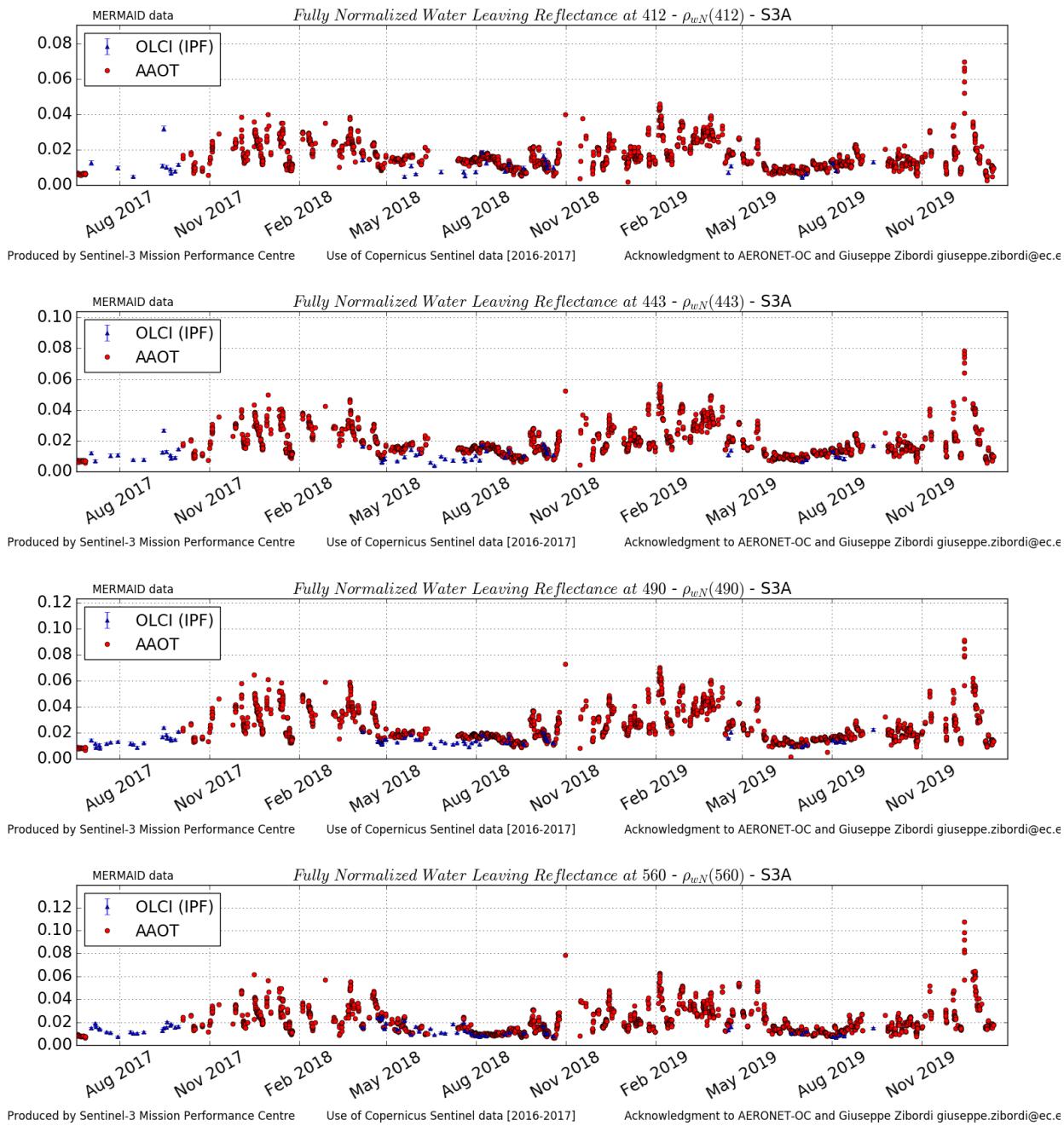


Figure 91: AAOT time series over current report period

Overall CHL_OCME performance

The proposed algorithm “OC4Me” developed by Morel et al. (2007a) is provided as the standard product for the Chlorophyll concentration assessment. The objectives of this section is to provide an insight of the overall performance of the OC4Me algorithm.

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- ❖ The focus for this time period has been the whole archives of OLCI data since April 2016.
- ❖ In-situ data were gathered from public data base such as SEABASS, Hawai Ocean Time-series (HOTS), Bermuda Atlantic Time-series Study (BATS), using HPLC and fluorometric chlorophyll.
- ❖ Chlorophyll data provided by PIs such as Holger Klein (Bundesamt für Seeschifffahrt und Hydrographie), Peter Galbraith (Maurice Lamontagne Institute), David Antoine (Laboratoire d'optique de Villefrance)
- ❖ At best 120 matchups are useful for this time period.

In situ chlorophyll concentration derived from HPLC analysis should be the preferred value to validate satellite products. Based on the sole in situ HPLC chlorophyll, OLCI product is in good agreement with in-situ measurements in the mesotrophic domain.

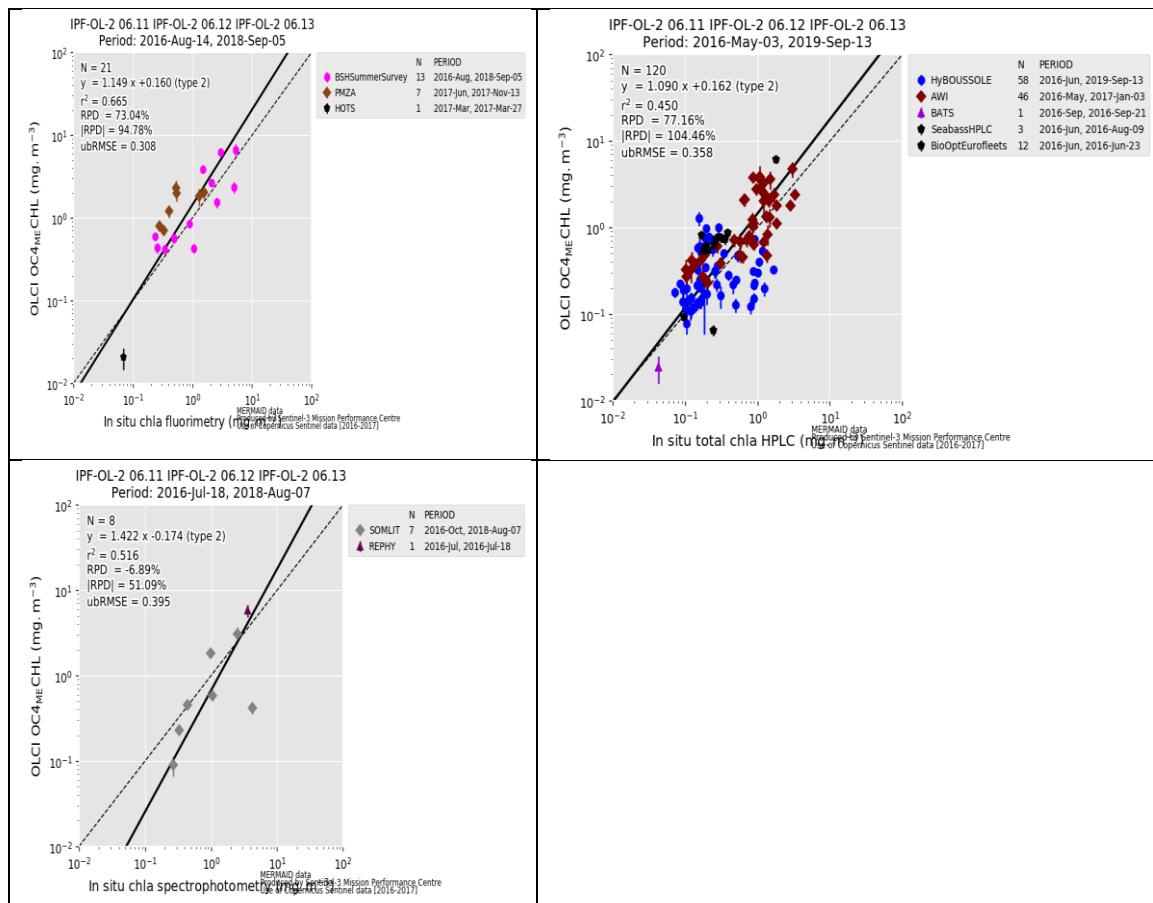


Figure 92: Scatter plots of OLCI-A versus in situ Chlorophyll a data. All available data for the current time period, in-situ Chlorophyll from fluorimetry (top left), from HPLC (top right) and from spectrophotometry (bottom left).

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Table 9: OLCI-A CHL_OC4Me statistics over April 2016 - present period

Chlorophyll	N	RPD	RPD	MAD	RMSE	slope	intercept	r2
CHL_OC4ME vs SPECT_chla_IS	8	-6.89%	51.09%	-0.1638	0.4275	1.4218	-0.1736	0.5163
CHL_OC4ME vs HPLC_chla_TOTAL_IS	120	77.16%	104.46%	0.1234	0.3786	1.0900	0.1621	0.4499
CHL_OC4ME vs Fluor_chla_IS	21	73.04%	94.78%	0.2708	0.5244	1.2687	0.3144	0.3636

5.2.3 OLCI-B

Activities done

- ❖ The focus for this time period has been on the rolling archive Non Time Critical (NT) data until the 27th of January 2020.
- ❖ All extractions and statistics have been regenerated on the current rolling archive availability including all the extraction since February 2019.
- ❖ At best 181 and 196 matchups at 490 and 560nm respectively are useful for this time period.

It must be noted that OLCI-B has no SVC adjustment and as such cannot be expected to provide performances of the same level of quality than OLCI-A.

Overall Water-leaving Reflectance performance

Scatter plots and Performance Statistics

- ❖ Figure 93 below presents the scatterplots and statistics of OLCI-B FR versus in situ reflectance.
- ❖ Table 10 below summarises the statistics over the current reporting period.



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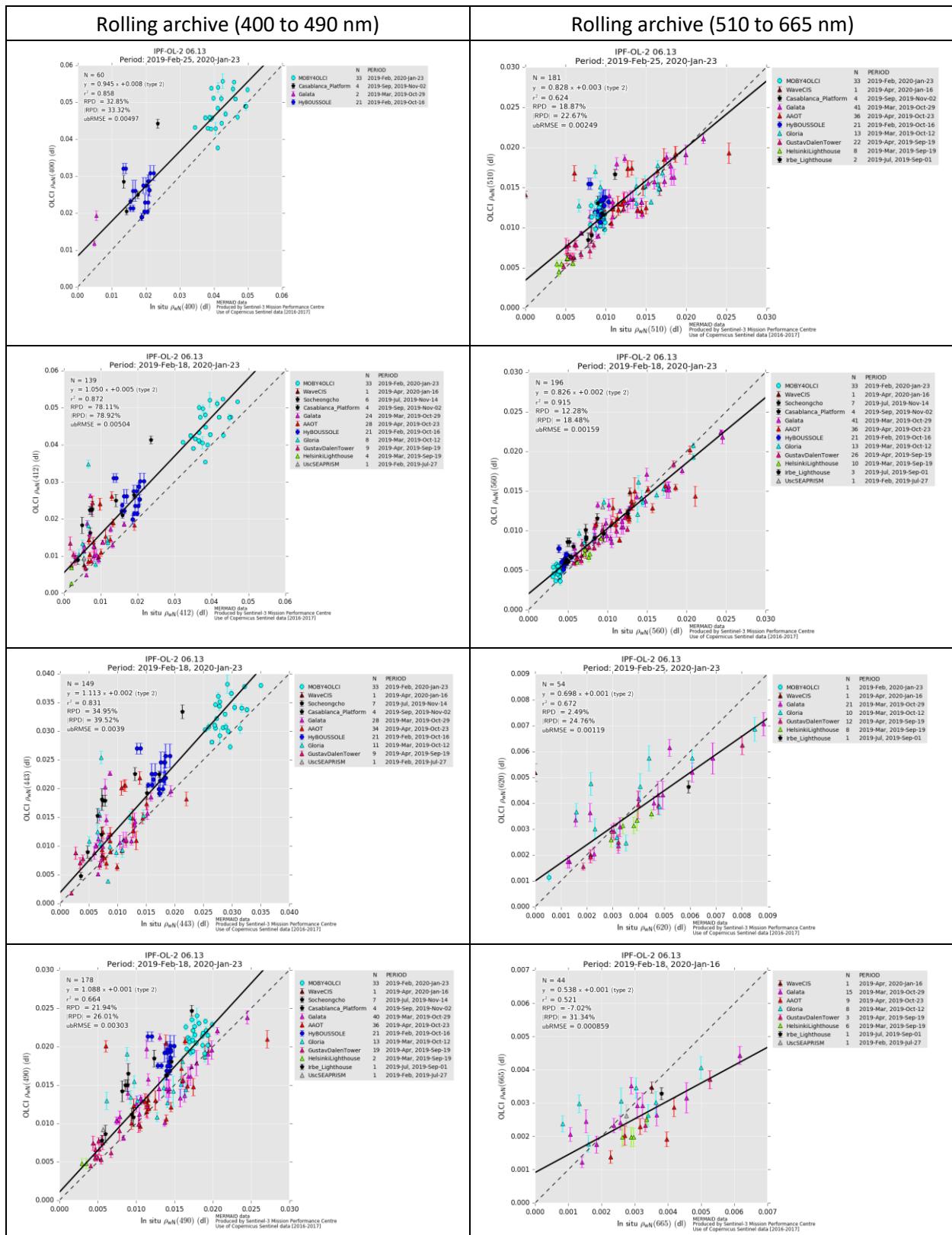


Figure 93: Scatter plots of OLCI-B versus in situ radiometry (FR data). All available data for the current time period.

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Table 10: OLCI-B FR statistics over February to December 2019 reporting period.

lambda	N	RPD	RPD	MAD	RMSE	slope	intercept	r2
400	60	32.85%	33.32%	0.0066	0.0083	0.9448	0.0084	0.8582
412	139	78.11%	78.92%	0.0063	0.0081	1.0501	0.0054	0.8715
443	149	34.95%	39.52%	0.0036	0.0053	1.1130	0.0019	0.8307
490	178	21.94%	26.01%	0.0022	0.0038	1.0883	0.0011	0.6640
510	181	18.87%	22.67%	0.0016	0.0029	0.8277	0.0034	0.6242
560	196	12.28%	18.48%	0.0004	0.0016	0.8262	0.0020	0.9149
620	54	2.49%	24.76%	-0.0002	0.0012	0.6982	0.0010	0.6722
665	44	-7.02%	31.34%	-0.0005	0.0010	0.5379	0.0009	0.5208

Time series

Figure 94 and Figure 95 below present AAOT and GALATA in situ and OLCI-B time series over the current period.



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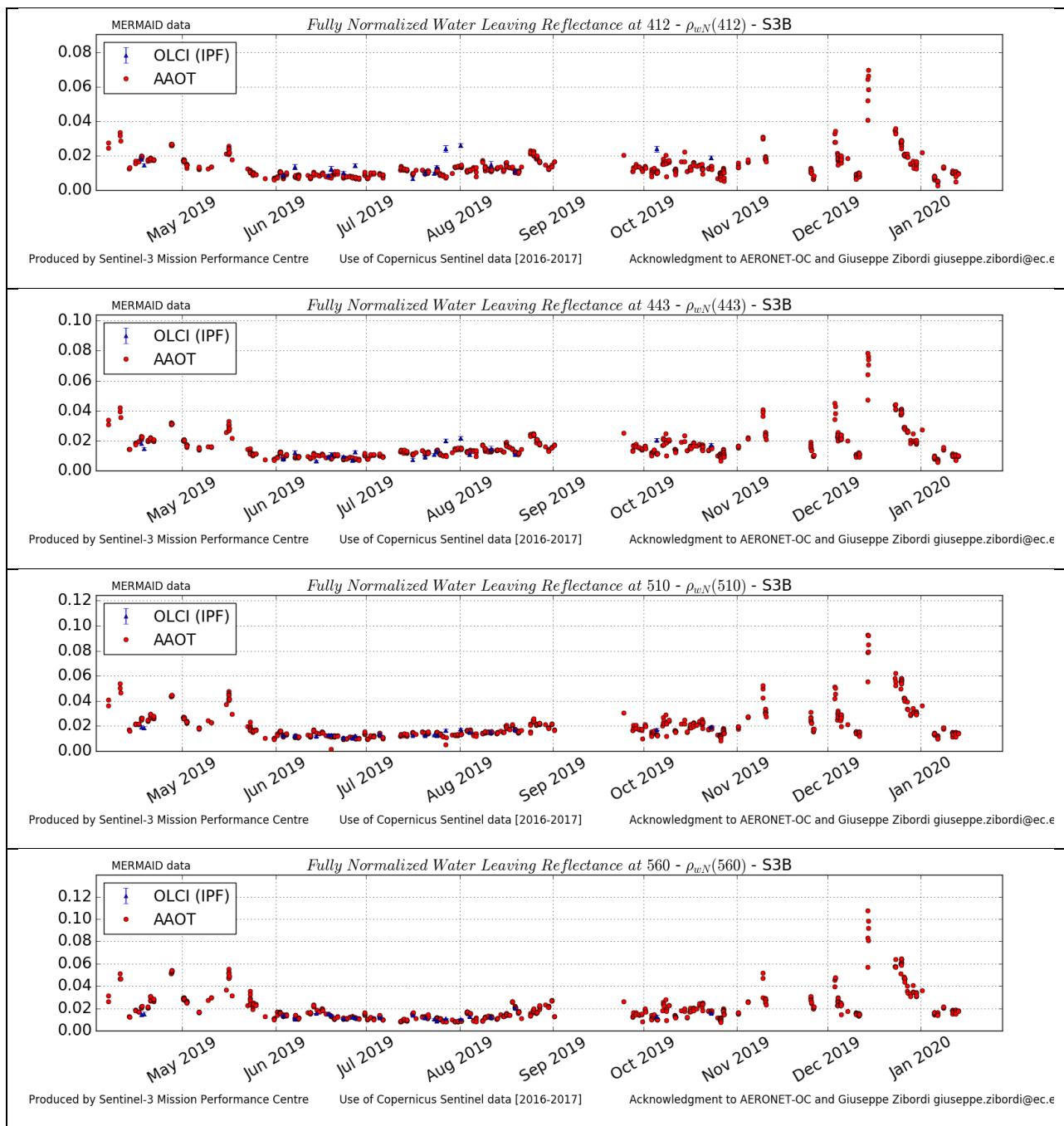


Figure 94: AAOT time series over current report period



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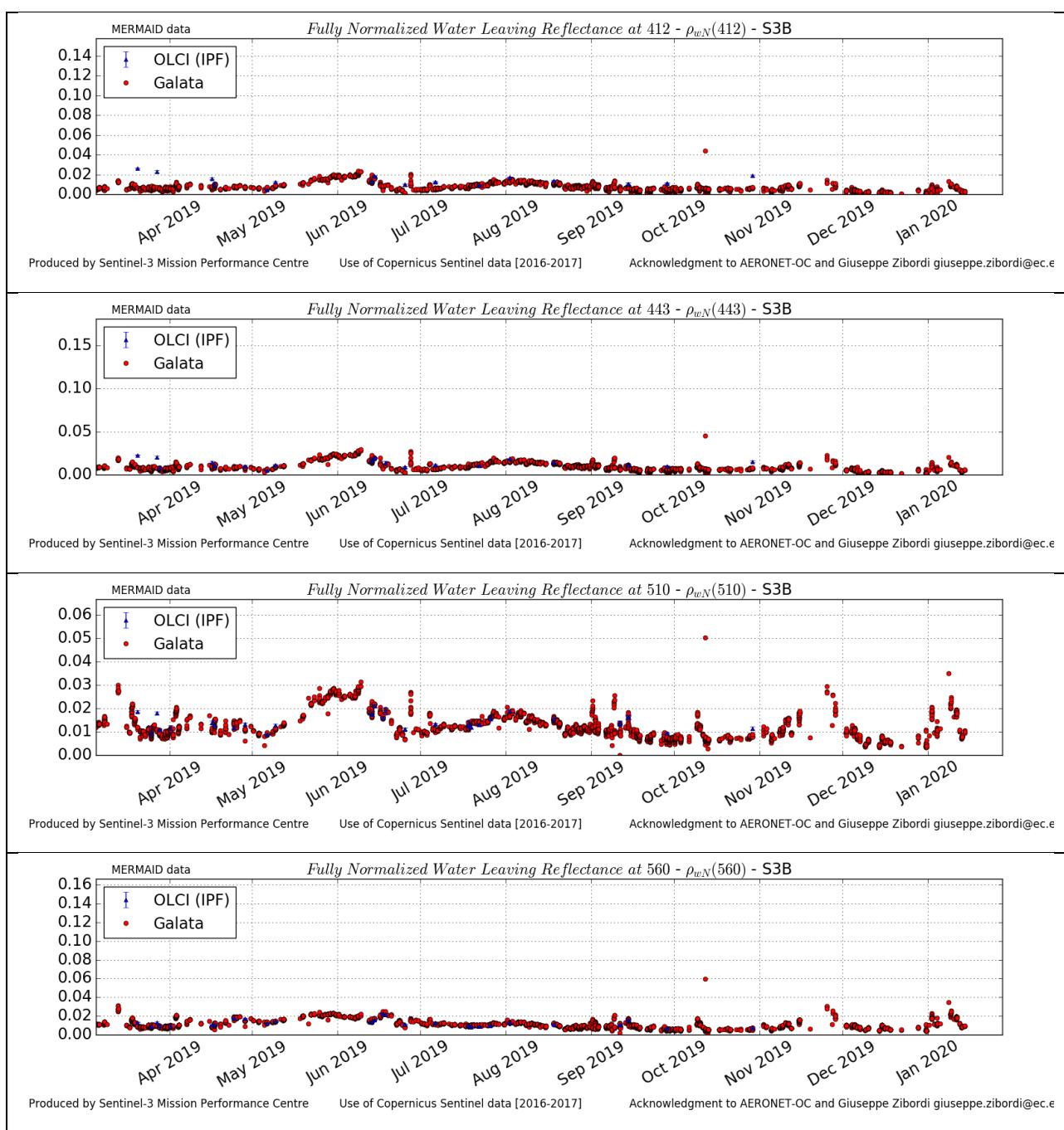


Figure 95: GALATA time series over current report period

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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.

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

There has been no new result during the cycle. Last figures (cycle 047/028) are considered valid.

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

There has been no new development 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 047/028) are considered valid.



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7 Level 2 SYN products validation

There has been no new result during the cycle. Last figures (cycle 43/24) are considered valid.

	<p style="text-align: center;">Sentinel-3 MPC S3 OLCI Cyclic Performance Report S3A Cycle No. 053 – S3B Cycle No. 034</p>	Ref.: S3MPC.ACR.PR.01-053-034 Issue: 1.0 Date: 31/01/2020 Page: 91
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8 Events

For OLCI-A, two Radiometric Calibration Sequences have been acquired during Cycle 053:

- ❖ S01 sequence (diffuser 1) on 26/12/2019 08:26 to 08:28 (absolute orbit 20085)
- ❖ S05 sequence (diffuser 1) on 11/01/2020 13:14 to 13:16 (absolute orbit 20316)

For OLCI-B, one Radiometric Calibration Sequences has been acquired during Cycle 034:

- ❖ S01 sequence (diffuser 1) on 12/01/2020 00:21 to 00:23 (absolute orbit 8929)

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9 Appendix A

Other reports related to the Optical mission are:

- ❖ S3 SLSTR Cyclic Performance Report, S3A Cycle No. 053, S3B Cycle No. 034 (ref. S3MPC.RAL.PR.02-053-034)

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

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