

COPERNICUS SPACE COMPONENT SENTINEL OPTICAL IMAGING
MISSION PERFORMANCE CLUSTER SERVICE

Data Quality Report

Sentinel-3 OLCI

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Changes Log

Version	Date	Changes
1.0	09/03/2022	First version
1.1	11/03/2022	Update following ESA remarks

List of Changes

Version	Section	Answers to RID	Changes
1.1	1		Processing Baseline versions corrected
	6		Renaming some of the 2 nd level sections

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1 Processing Baseline Version

1.1 Sentinel3-A

IPF	IPF / Processing Baseline version	Date of deployment
OL1	06.12 / OL__L1_.002.22.00	20/01/2022 11:08 UTC
OL2 LAND	06.16 / OL__L2L.002.10.00	26/01/2021 10:15 UTC
SY2	06.22 / SYN_L2_.002.15.00	27/01/2022 10:15 UTC
SY2_VGS	06.10 / SYN_L2V.002.07.00	27/01/2022 10:15 UTC
SY2_AOD	01.06 / AOD_NTC.002.06.00	27/01/2022 10:15 UTC

1.2 Sentinel3-B

IPF	IPF / Processing Baseline version	Date of deployment
OL1	06.12 / OL__L1_.002.22.00	20/01/2022 11:08 UTC
OL2 Land	06.16 / OL__L2L.002.10.00	26/01/2021 10:15 UTC
SY2	06.22 / SYN_L2_.002.15.00	27/01/2022 10:15 UTC
SY2_VGS	06.10 / SYN_L2V.002.07.00	27/01/2022 10:15 UTC
SY2_AOD	01.06 / AOD_NTC.002.06.00	27/01/2022 10:15 UTC

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 reporting period (rightmost data points) do not show any specificity.

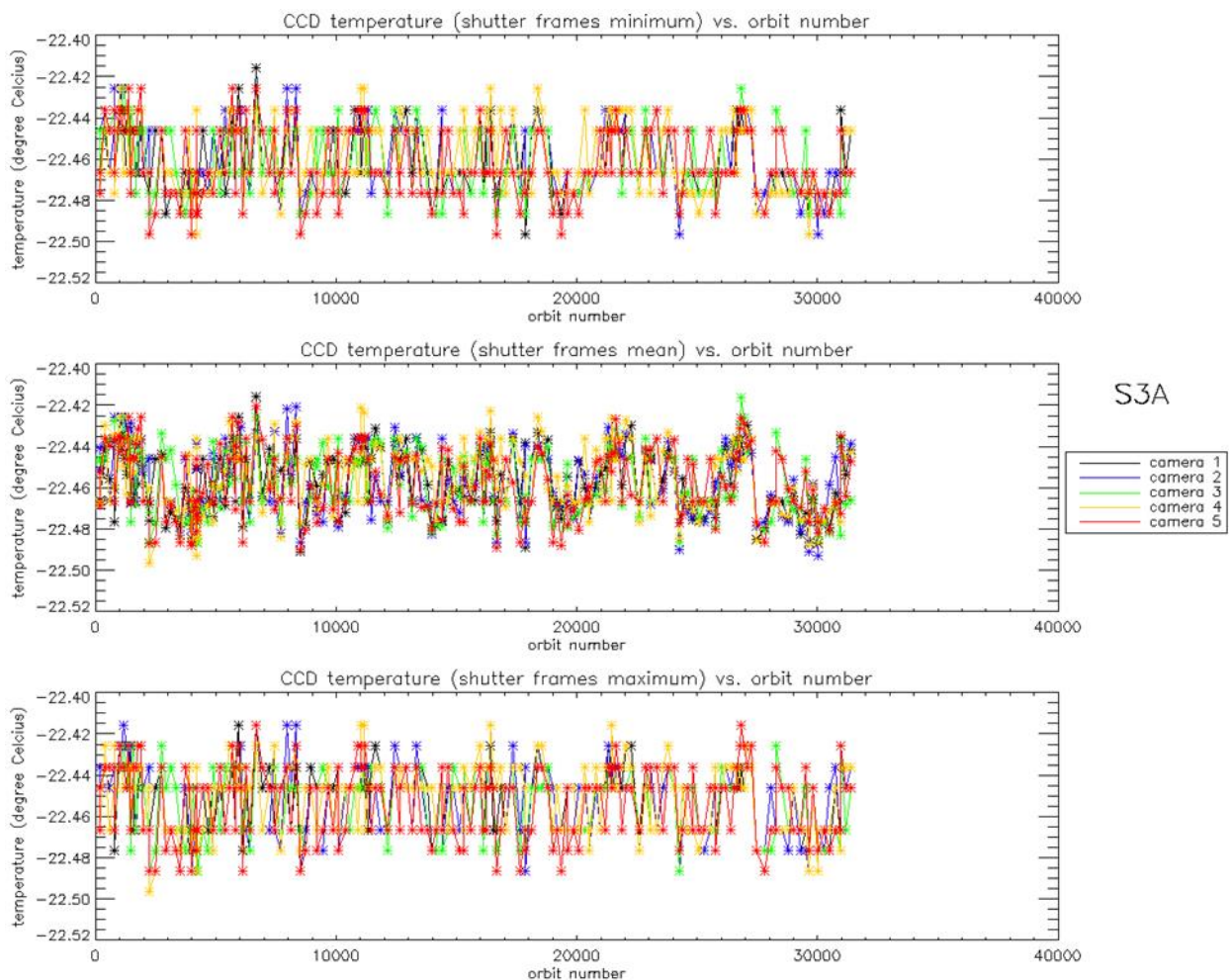


Figure 1: long term monitoring of OLCI-A CCD temperatures using minimum value (top), time averaged values (middle), and maximum value (bottom) provided in the annotations of the Radiometric Calibration Level 1 products, for the shutter frames, all radiometric calibrations so far except the first one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

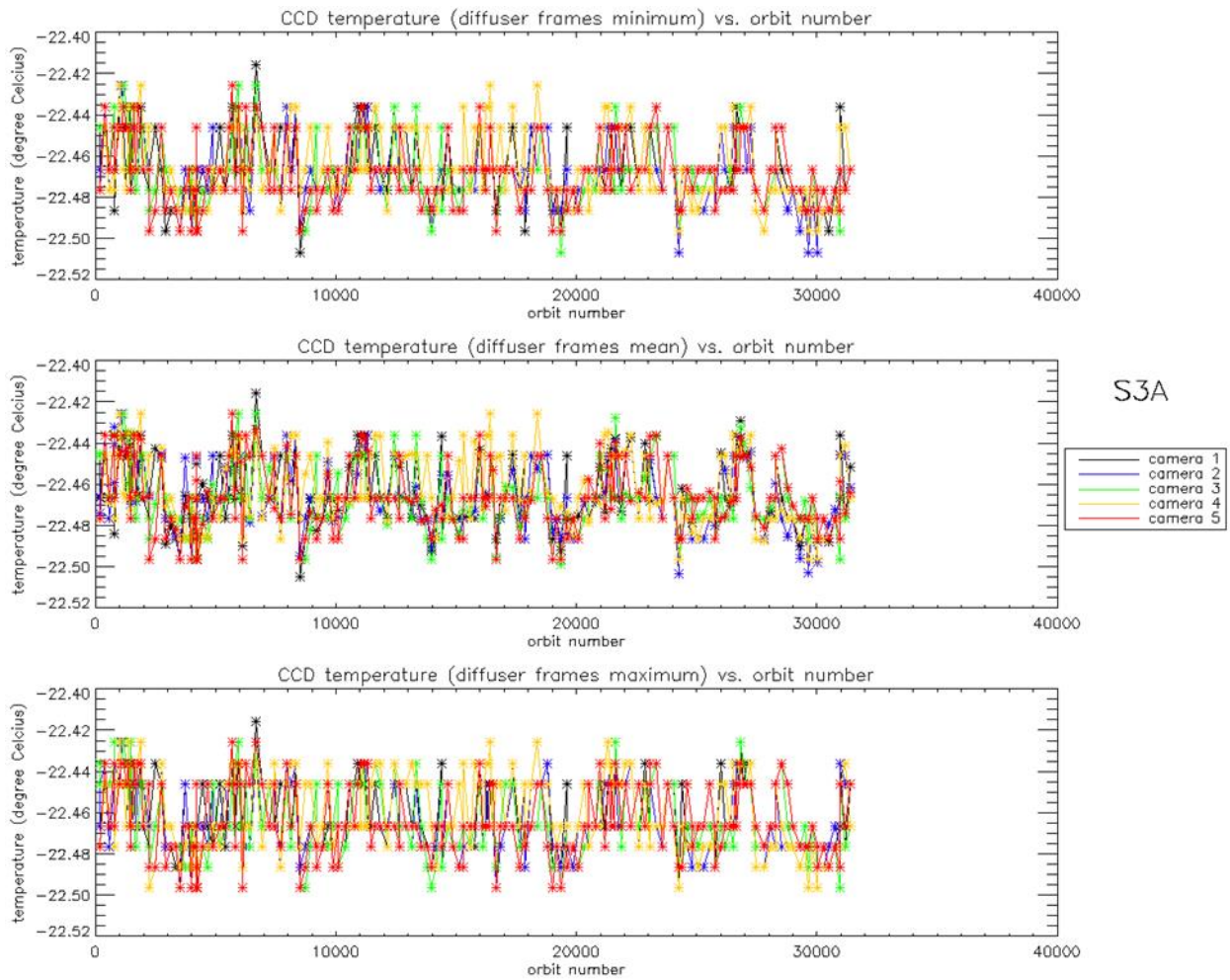


Figure 2: Same as Figure 1 for diffuser frames.

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 reporting period (rightmost data points) do not show any specificity.

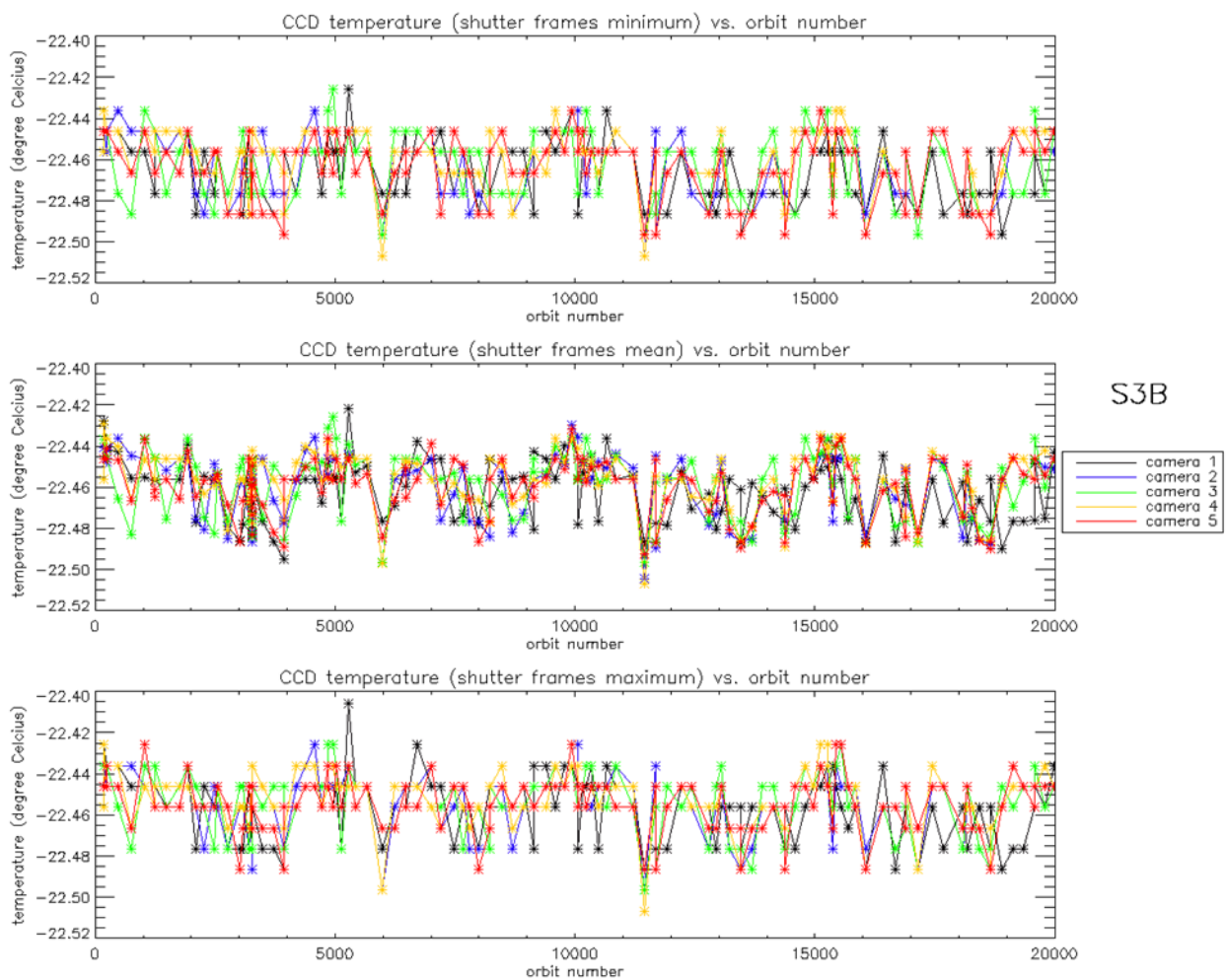


Figure 3: long term monitoring of OLCI-B CCD temperatures using minimum value (top), time averaged values (middle), and maximum value (bottom) provided in the annotations of the Radiometric Calibration Level 1 products, for the Shutter frames, all radiometric calibrations so far except the first one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

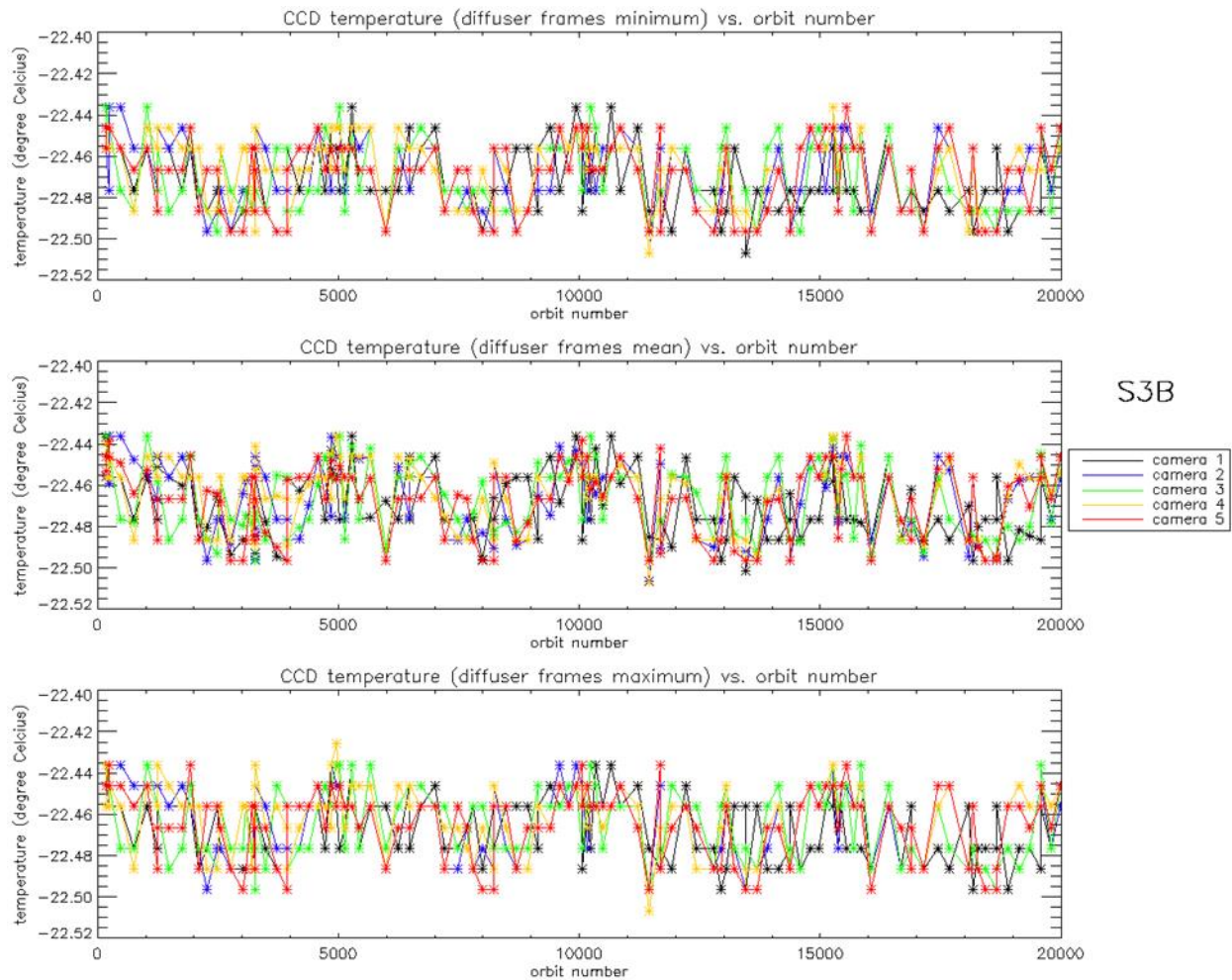


Figure 4: same as Figure 3 for diffuser frames.

2.2 Radiometric Calibration

For OLCI-A, two Radiometric Calibration sequences have been acquired during the reported period:

- ❖ S01 sequence (diffuser 1) on 12/02/2022 18:33 to 18:35 (absolute orbit 31199)
- ❖ S01 sequence (diffuser 1) on 26/02/2022 19:09 to 19:11 (absolute orbit 31399)

For OLCI-B, two Radiometric Calibration sequences have been acquired during the reported period:

- ❖ S01 sequence (diffuser 1) on 11/02/2022 21:42 to 21:44 (absolute orbit 19793)
- ❖ S01 sequence (diffuser 1) on 26/02/2022 01:39 to 01:41 (absolute orbit 19995)

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).

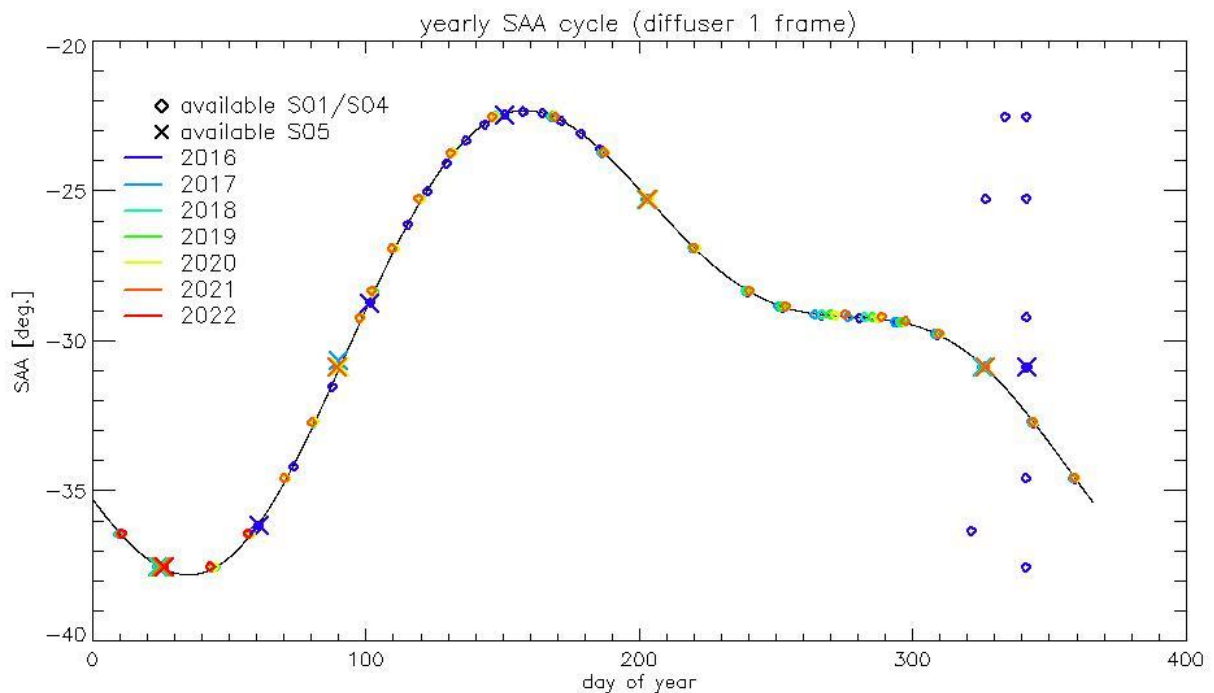


Figure 5: Sun azimuth angles during acquired OLCI-A Radiometric Calibrations (diffuser frame) on top of nominal yearly cycle (black curve). Diffuser 1 with diamonds, diffuser 2 with crosses. Different colours correspond to different years of acquisition (see the legend inside the figure).

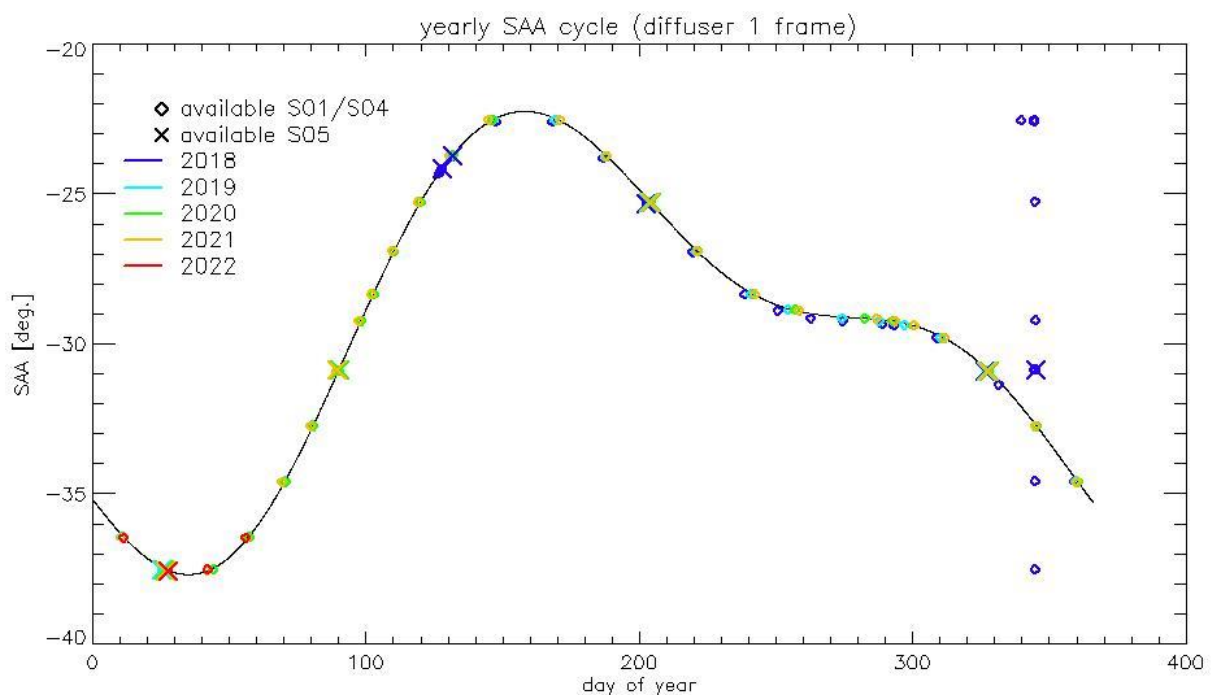


Figure 6: same as Figure 5 for OLCI-B.

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

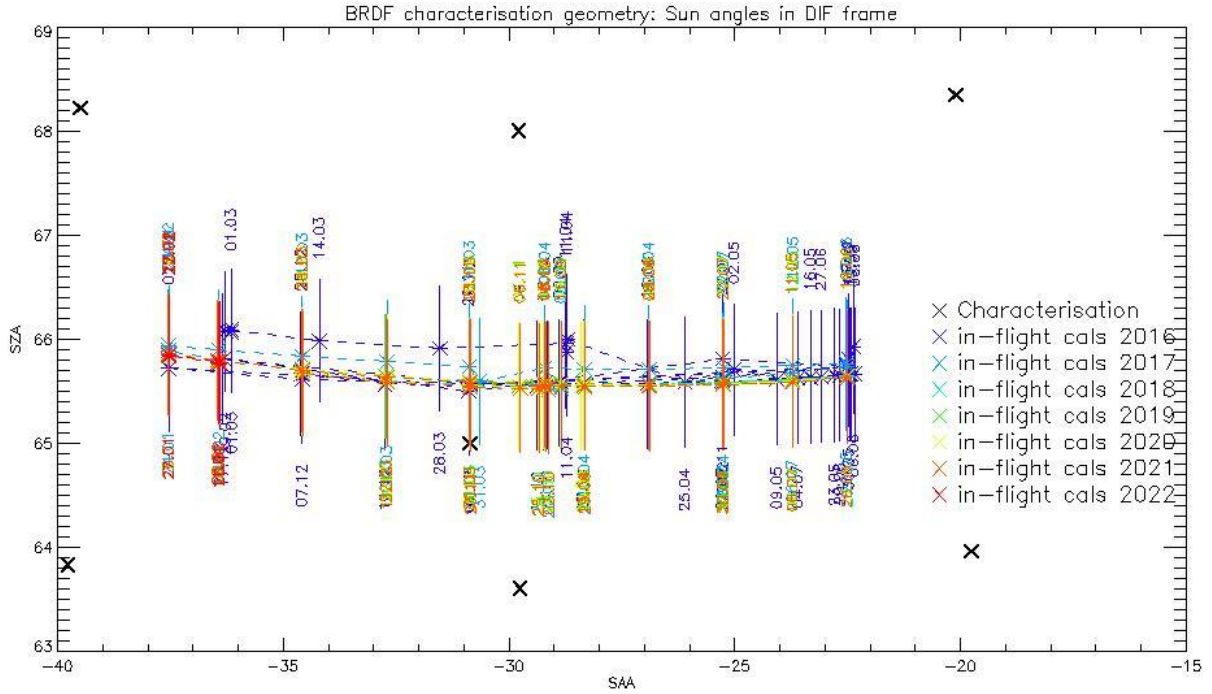


Figure 7: OLCI-A Sun geometry during radiometric Calibrations on top of characterization ones (diffuser frame)

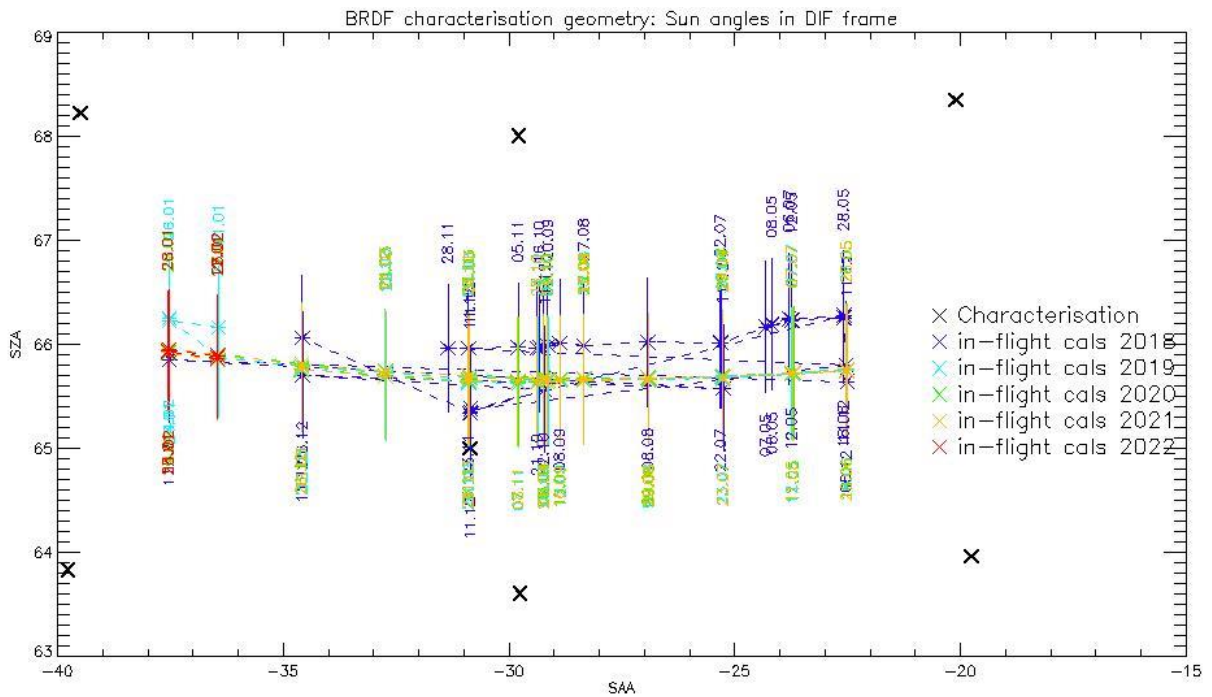


Figure 8: same as Figure 7 for OLCI-B

2.2.1 Dark Offsets [OLCI-L1B-CV-230]

Note about the High Energy Particles:

The filtering of High Energy Particle (HEP) events from radiometric calibration data has been implemented (for shutter frames only) in a post processor, allowing generating Dark Offset and Dark Current tables computed on filtered data. The post-processor starts from IPF intermediate data (corrected counts), applies the HEP detection and filtering and finally computes the Dark Offset and Dark Current tables the same way as IPF. An example of the impact of HEP filtering is given in Figure 9.

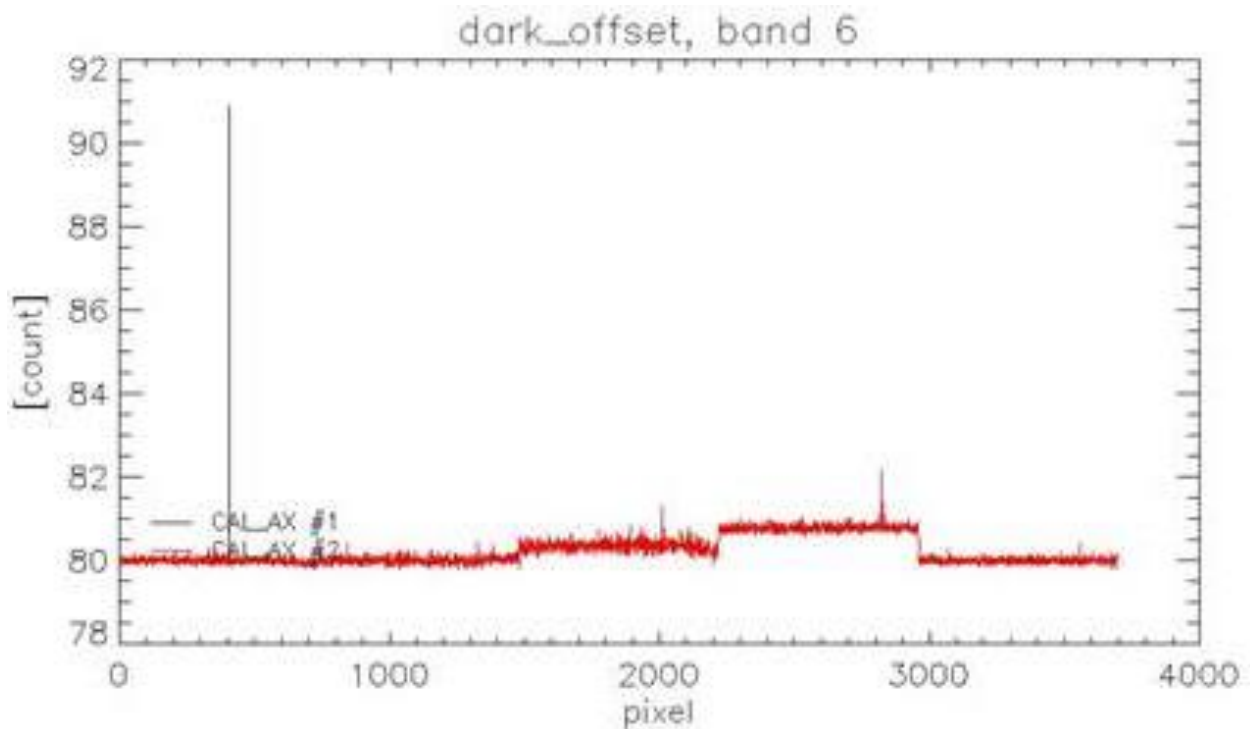


Figure 9: Dark Offset table for band Oa06 with (red) and without (black) HEP filtering (Radiometric Calibration of 22 July 2017). The strong HEP event near pixel 400 has been detected and removed by the HEP filtering.

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

2.2.1.2 OLCI-A

Dark offsets

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

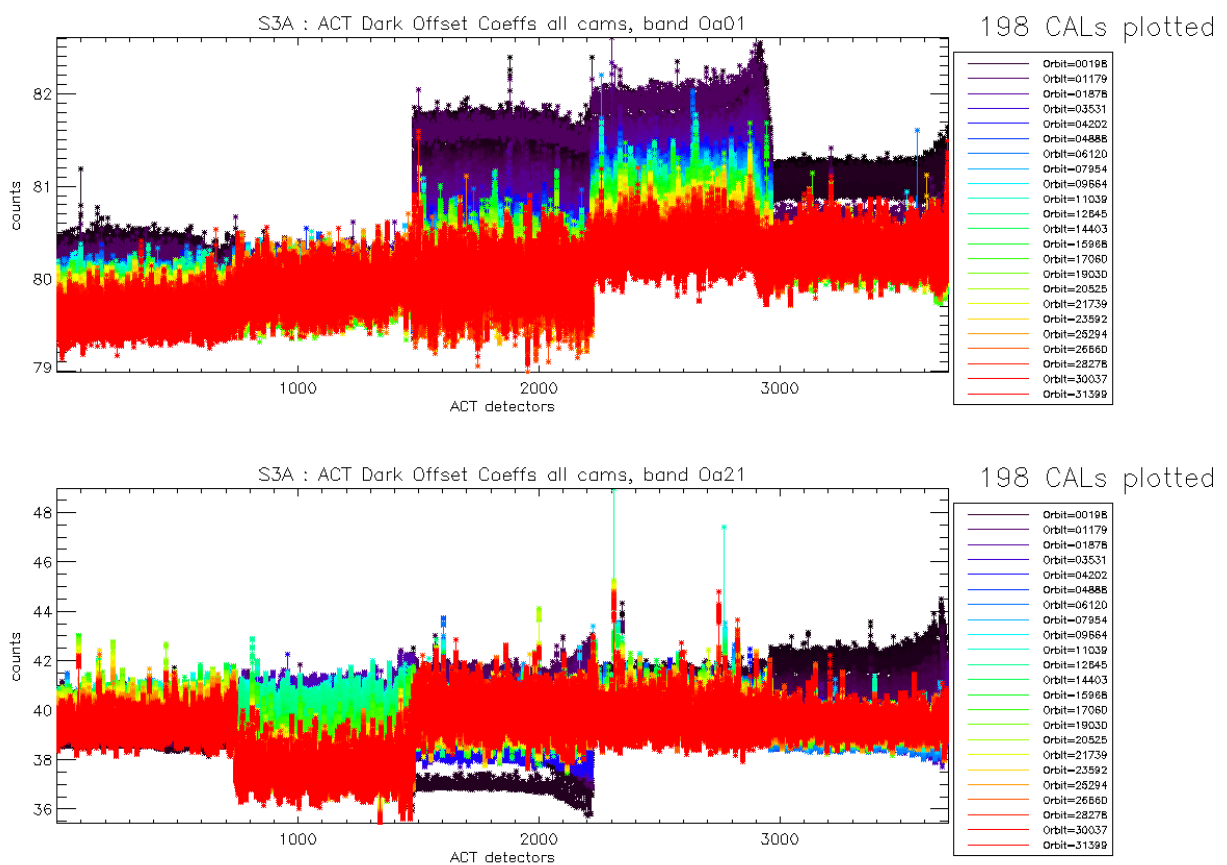


Figure 10: OLCI-A Dark Offset for band Oa1 (top) and Oa21 (bottom), all radiometric calibrations so far except the first one (orbit 183) for which the instrument was not thermally stable yet.

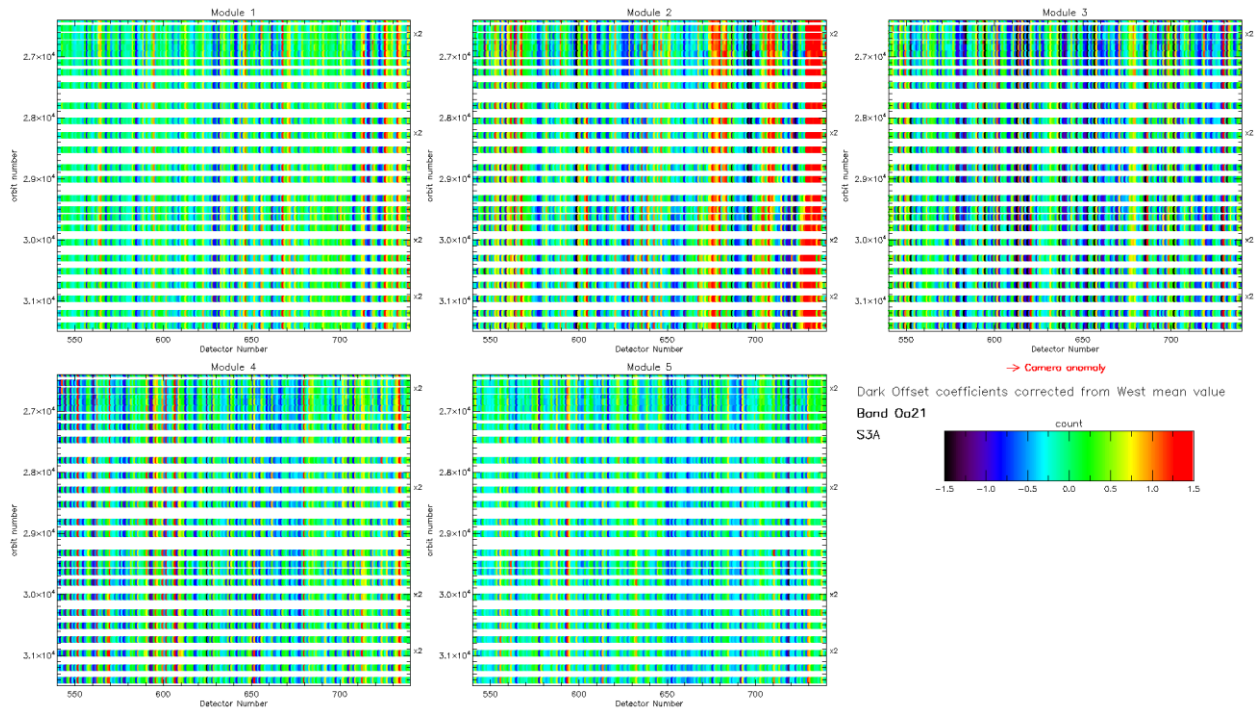


Figure 11: map of OLCI-A periodic noise for the 5 cameras, for band Oa21. X-axis is detector number (East part, from 540 to 740, where the periodic noise occurs), Y-axis is the orbit number. Y-axis range is focused on the most recent 5000 orbits. The counts have been corrected from the West detectors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

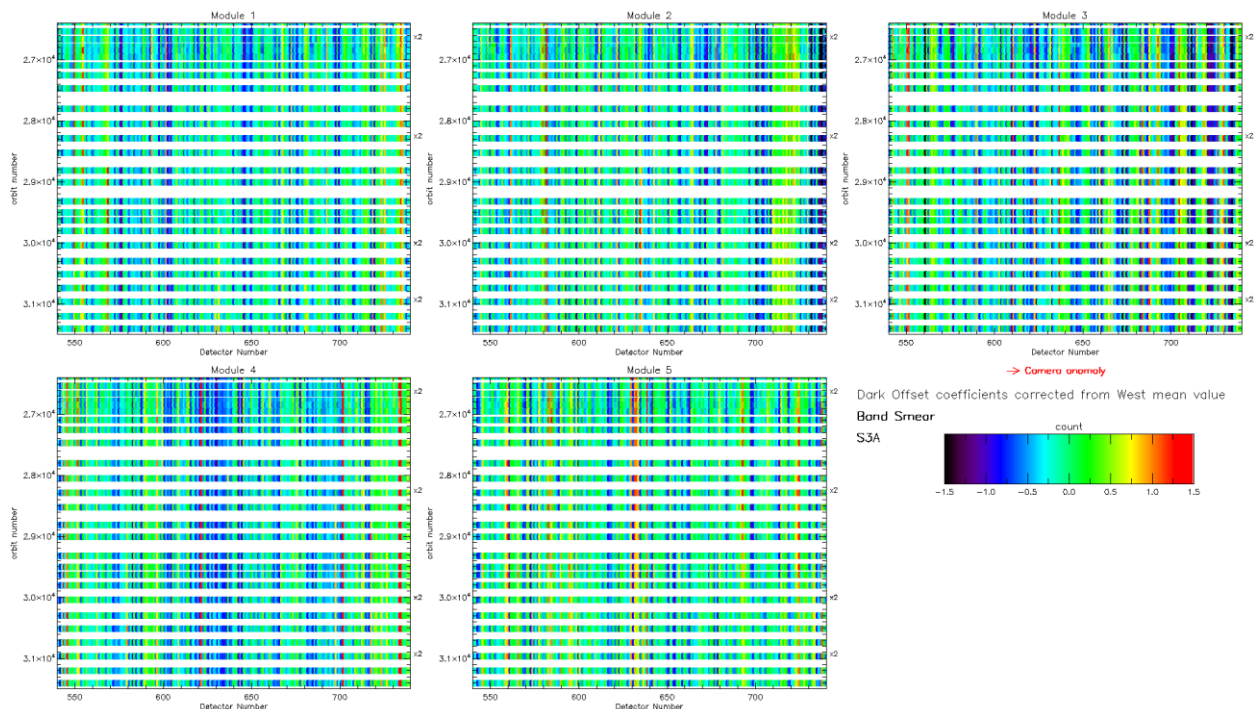


Figure 12: same as Figure 11 for smear band.

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 reporting period.

Figure 11 and Figure 12 show that at this stage of the mission the PN is very stable in all cameras. There is no special behaviour noticed during the reporting period.

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

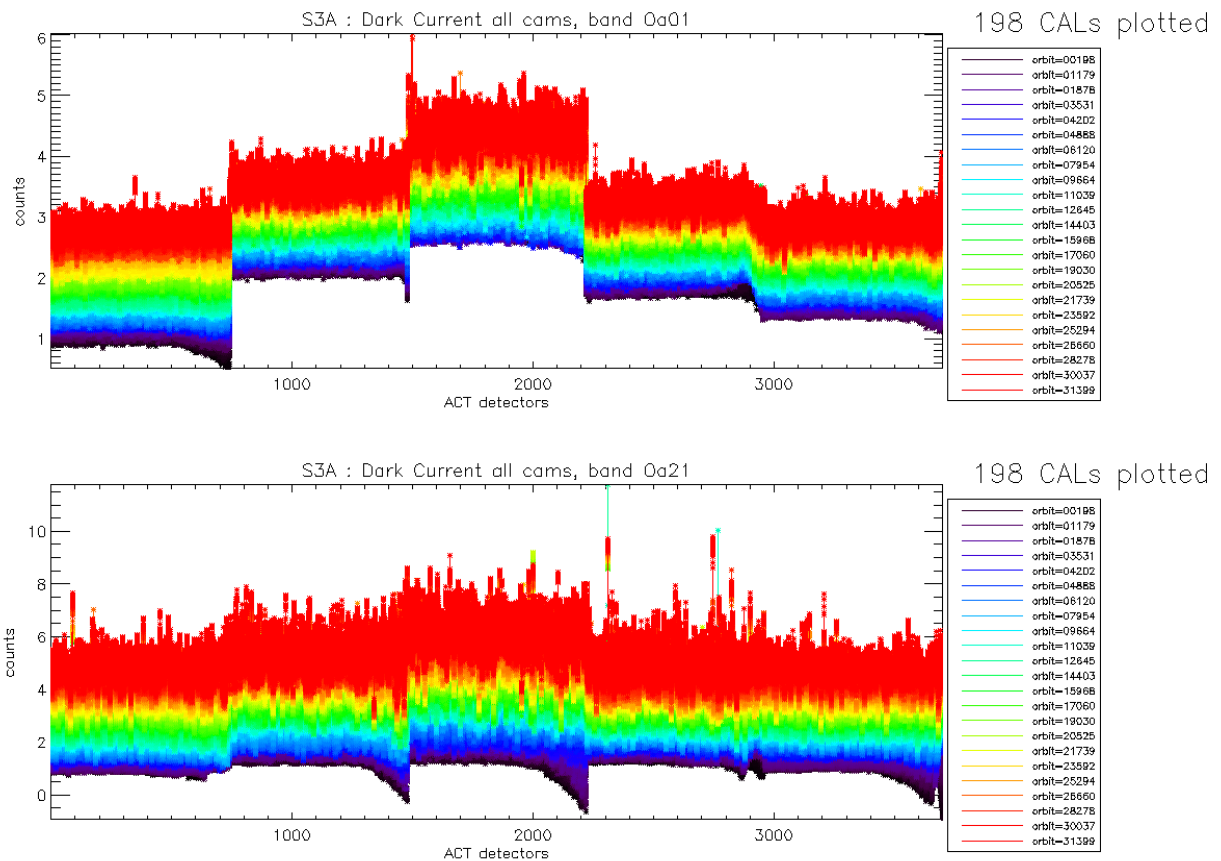


Figure 13: OLCI-A Dark Current for band Oa1 (top) and Oa21 (bottom), all radiometric calibrations so far except the first one (orbit 183) for which the instrument was not thermally stable yet.

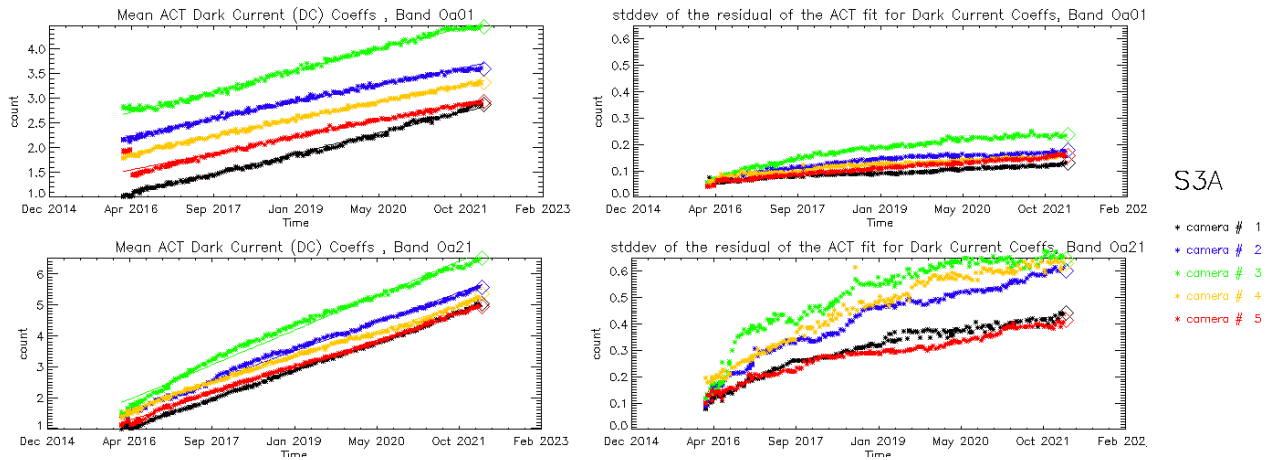


Figure 14: left column: ACT mean on 400 first detectors of OLCI-A Dark Current coefficients for spectral band Oa01 (top) and Oa21 (bottom). Right column: same as left column but for Standard deviation instead of mean. We see an increase of the DC level as a function of time especially for band Oa21.

A possible explanation of the regular increase of DC could be the increase of the number of hot pixels which is more important in Oa21 because this band is made of more CCD lines than band Oa01 and thus receives more cosmic rays impacts. It is known that cosmic rays degrade the structure of the CCD, generating more and more hot pixels at long term scales. Indeed, when computing the time slopes of the spatially averaged Dark Current as a function of band, i.e. the slopes of curves in left plots of Figure 14, one can see that Oa21 is by far the most affected, followed by the smear band (Figure 15, left); when plotting these slopes against total band width (in CCD rows, regardless of the number of micro-bands), the correlation between the slope values and the width becomes clear (Figure 15, right).

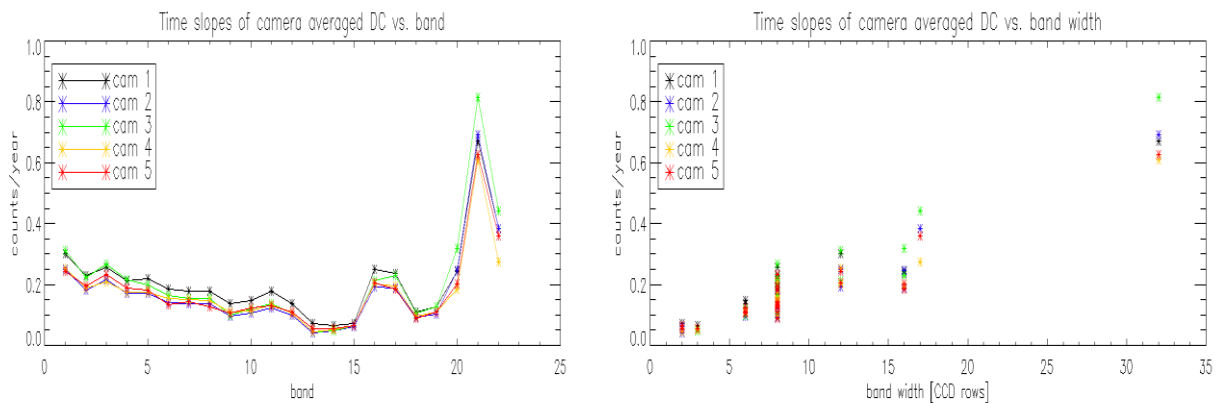


Figure 15: OLCI-A Dark current increase rates with time (in counts per year) vs. band (left) and vs. band width (right)

2.2.1.3 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.

Despite this overall stabilization, small evolutions are still noticeable in some bands/camera, like for example camera 1 in band Oa21 (upper left map in Figure 17) or in camera 1 band smear (upper left map in Figure 18).

Globally, OLCI-B PN is slightly less stabilized than OLCI-A PN.

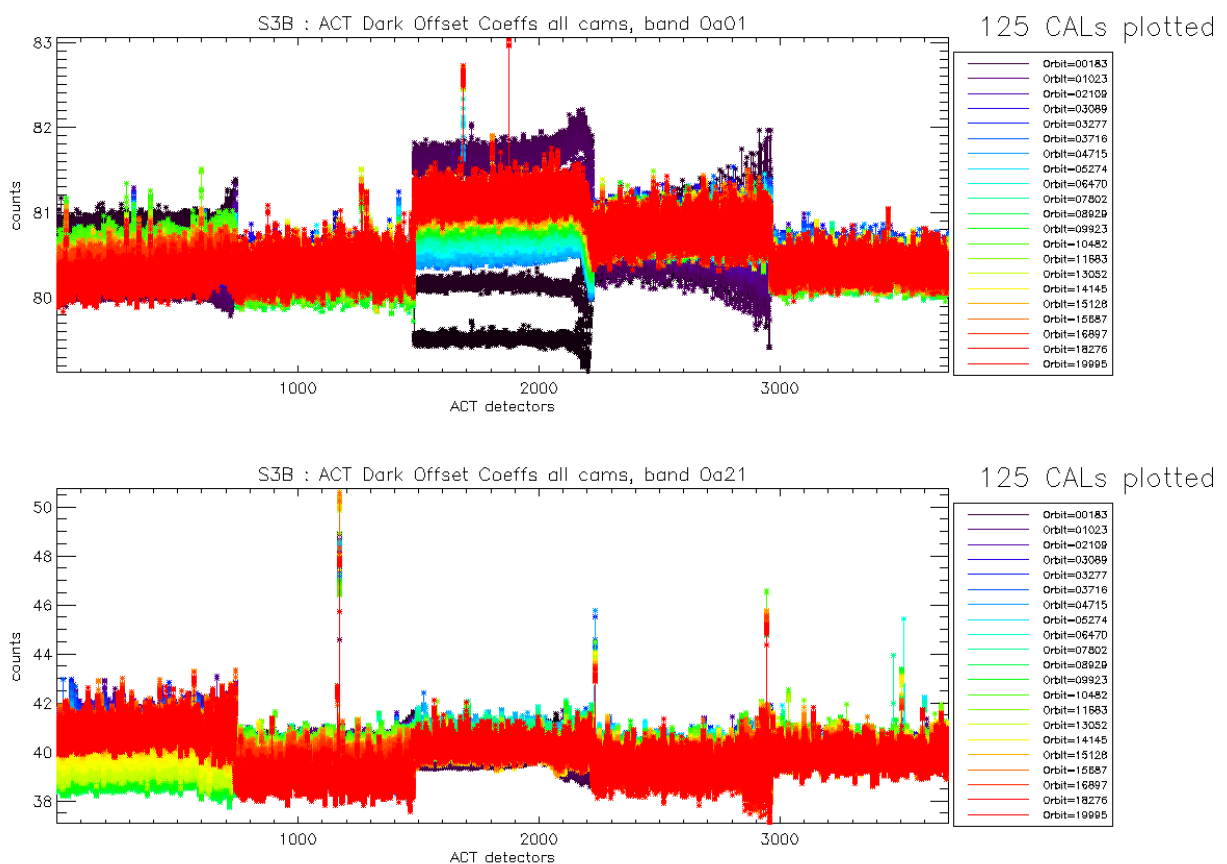


Figure 16: OLCI-B Dark Offset for band Oa1 (top) and Oa21 (bottom), all radiometric calibrations so far except the first one (orbit 167) for which the instrument was not thermally stable yet.

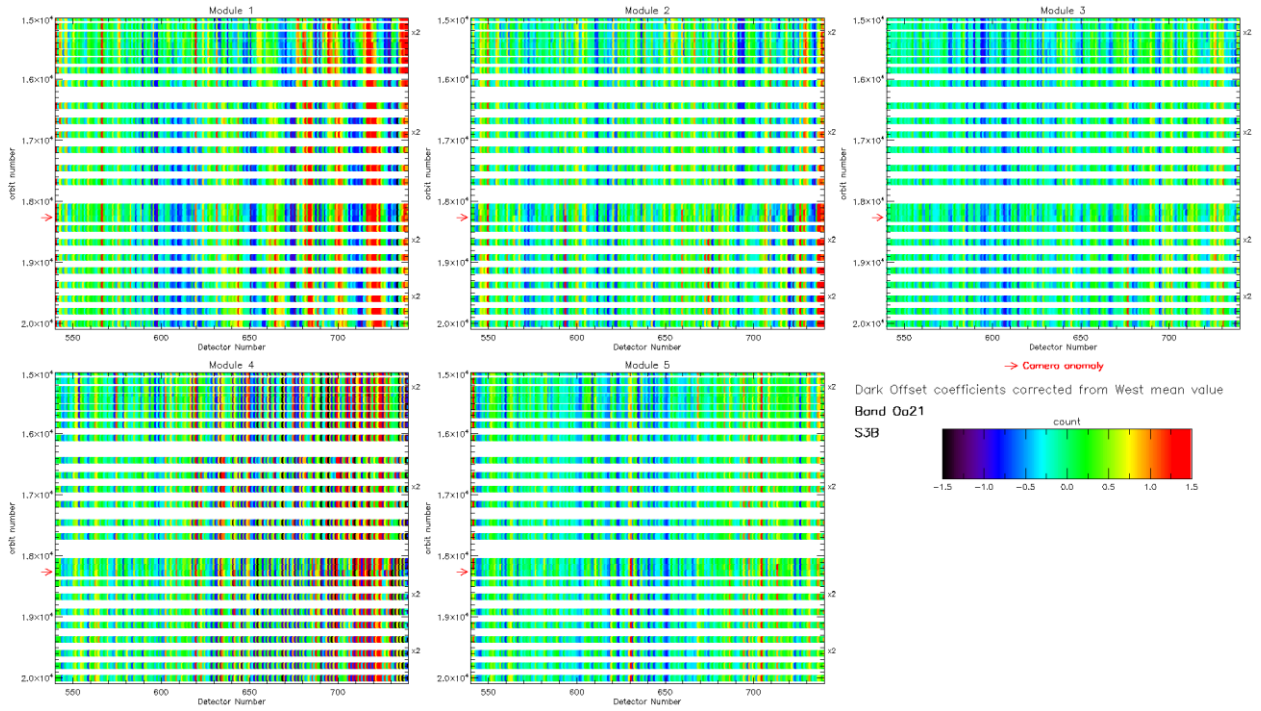


Figure 17: OLCI-B map of periodic noise for the 5 cameras, for band Oa21. X-axis is detector number (East part, from 540 to 740, where the periodic noise occurs), Y-axis is the orbit number. The counts have been corrected from the West detectors mean value (not affected by periodic noise) in order to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

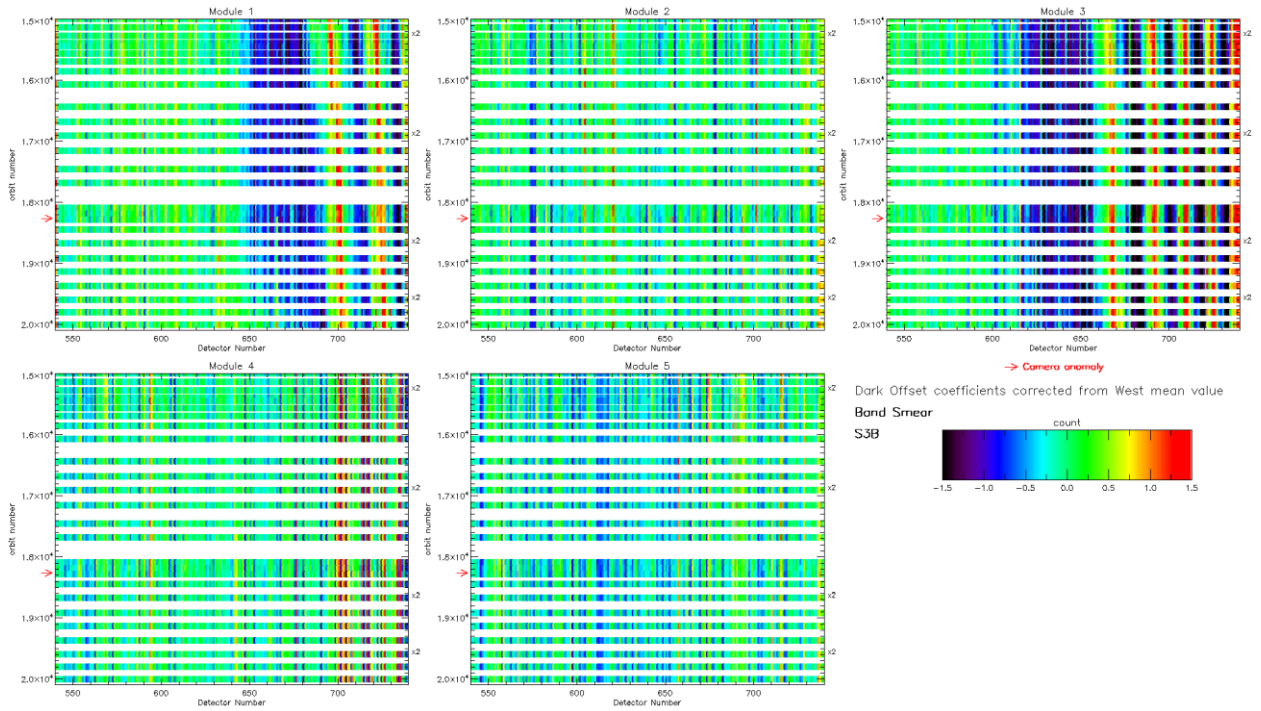


Figure 18: same as Figure 17 for smear band.

Dark Currents

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

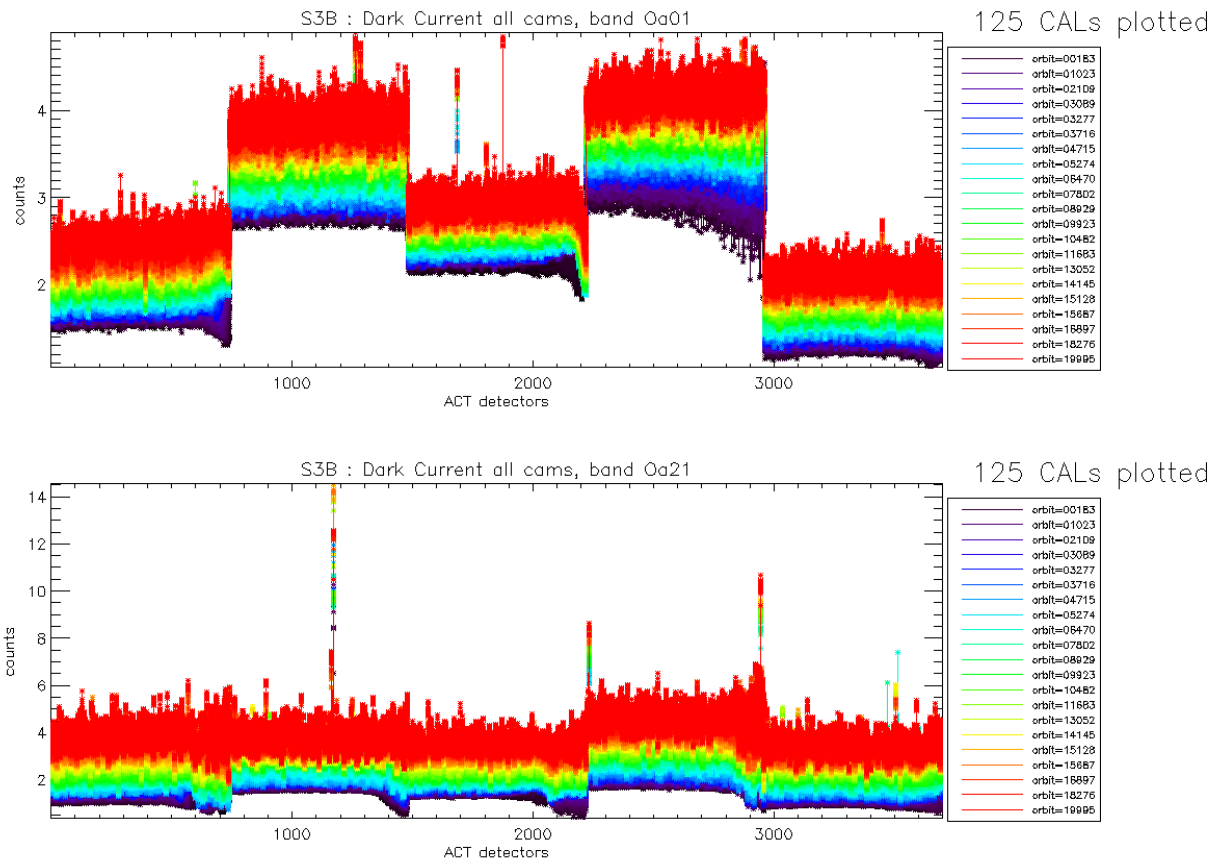


Figure 19: OLCI-B Dark Current for band Oa1 (top) and Oa21 (bottom), all radiometric calibrations so far except the first one (orbit 167) for which the instrument was not thermally stable yet.

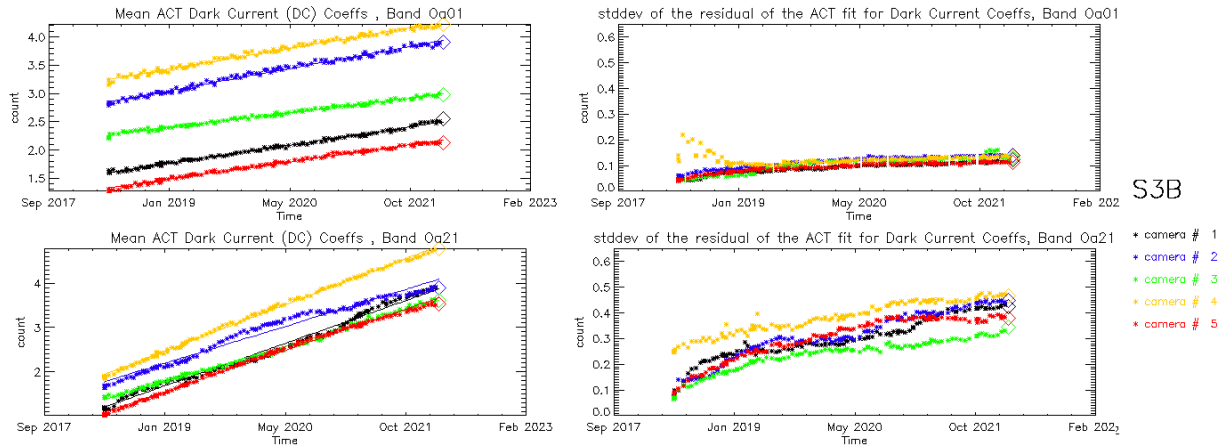


Figure 20: left column: ACT mean on 400 first detectors of OLCI-B Dark Current coefficients for spectral band Oa01 (top) and Oa21 (bottom). Right column: same as left column but for Standard deviation instead of mean. We see an increase of the DC level as a function of time especially for band Oa21.

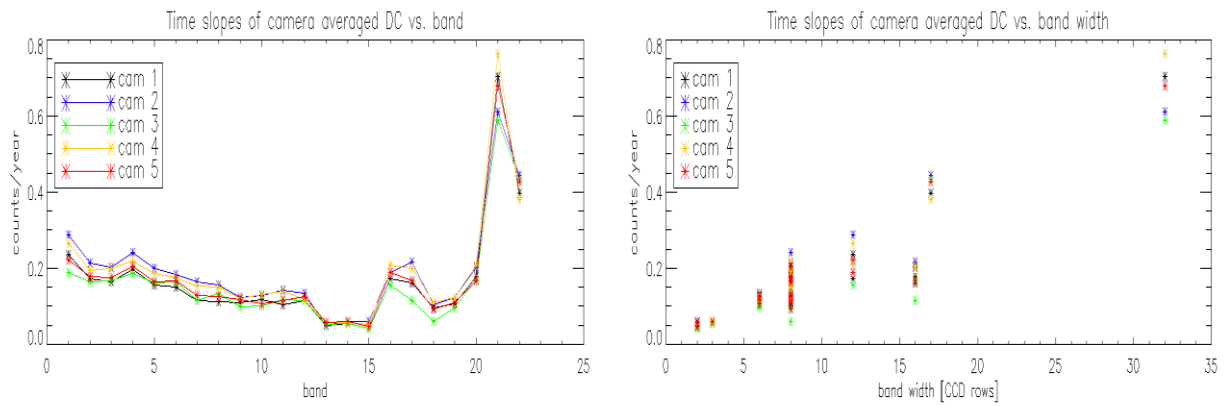


Figure 21: OLCI-B Dark Current increase rates with time (in counts per year) vs. band (left) and vs. band width (right)

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

2.2.2.1 Instrument response monitoring

2.2.2.1.1 OLCI-A

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

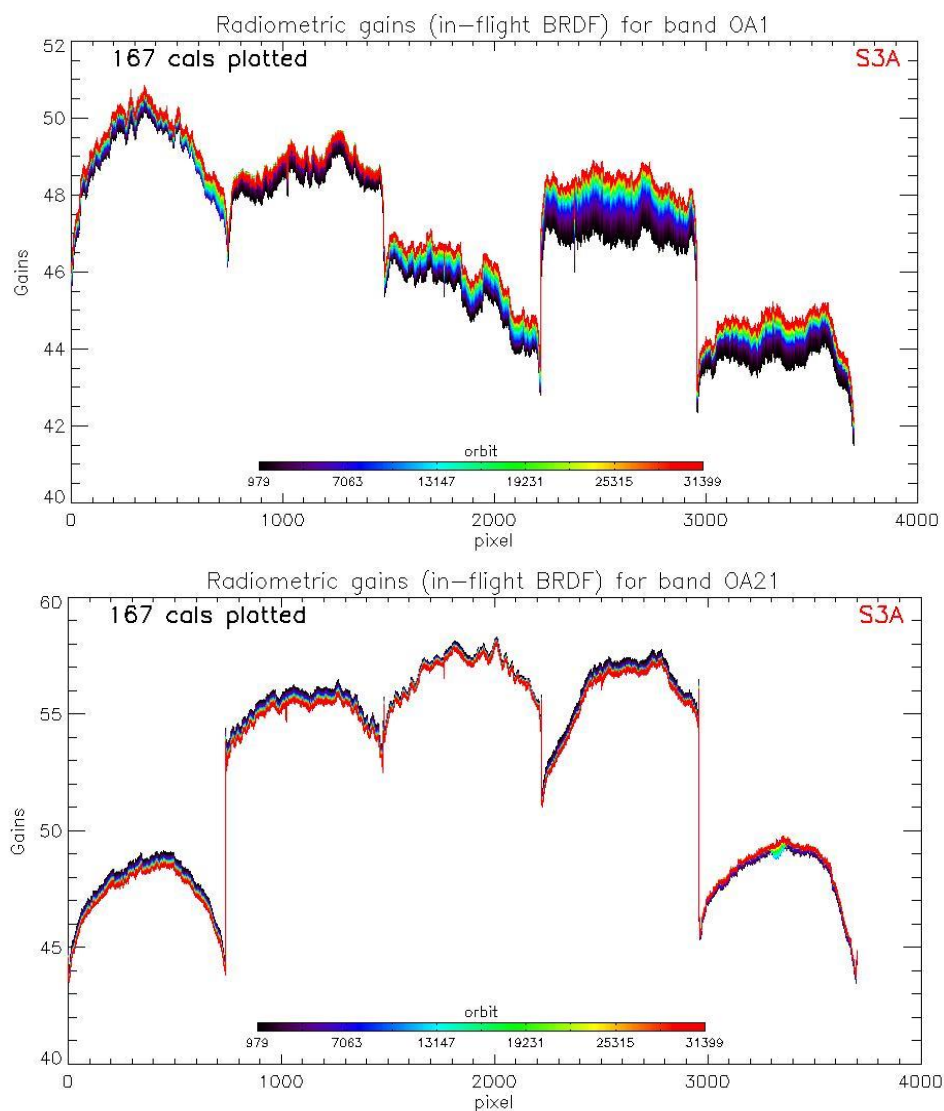


Figure 22: OLCI-A Gain Coefficients for band Oa1 (top) and Oa21 (bottom), derived using the in-flight BRDF model. The dataset is made of all diffuser 1 radiometric calibrations since orbit 979.

Figure 23 displays a summary of the time evolution of the cross-track average of the gains (in-flight BRDF, taking into account the diffuser ageing), for each module, relative to a given reference calibration (the 25/04/2016, change of OLCI channel settings). It shows that, if a significant evolution occurred during the early mission, the trends tend in general to stabilize, with some exceptions (e.g. band 1 of camera 1 and 4, bands 2 & 3 of camera 5).

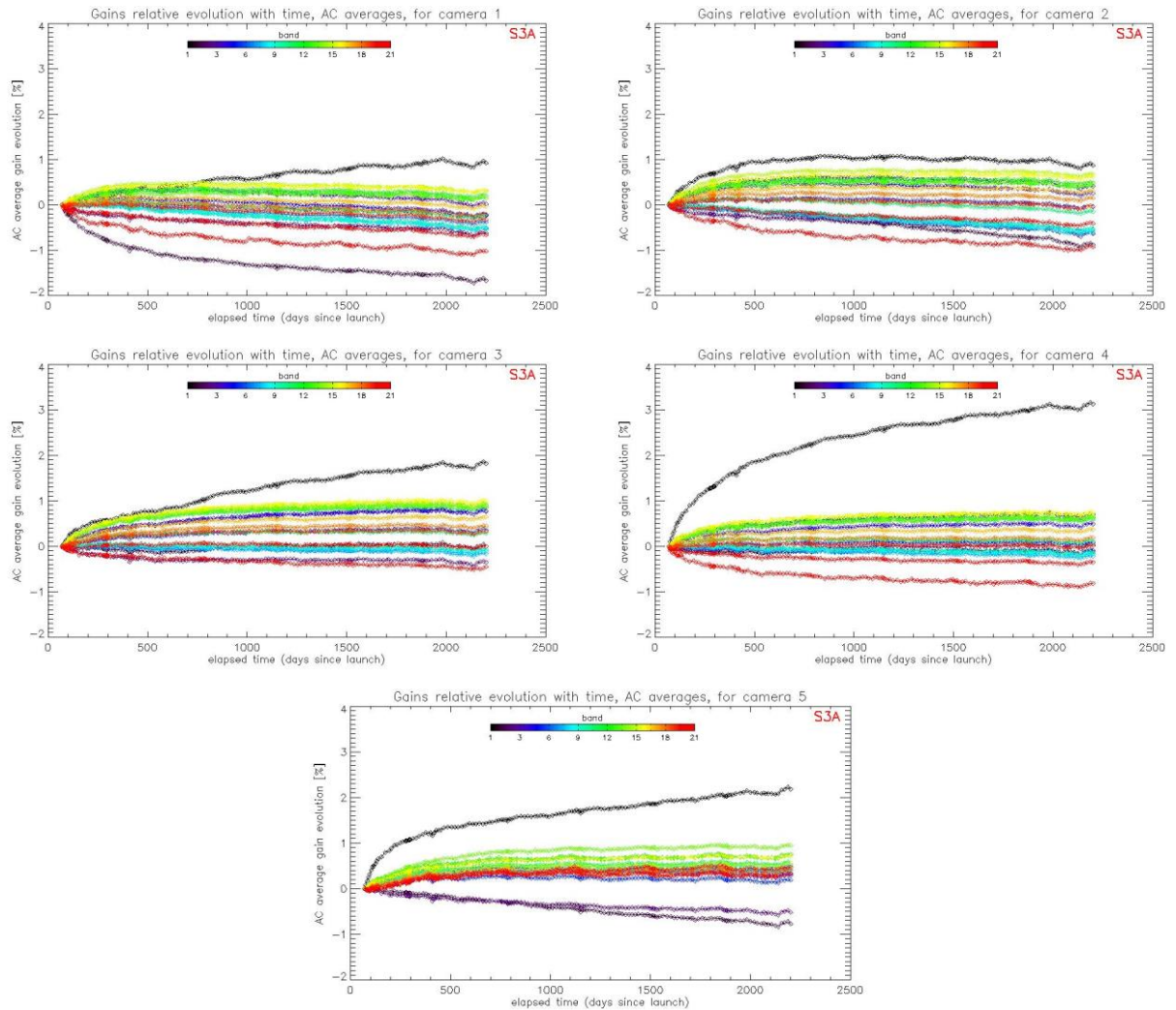


Figure 23: camera averaged gain relative evolution with respect to calibration of 25/04/2016 (change of OLCI channel settings), as a function of elapsed time since the beginning of the mission; one curve for each band (see colour code on plots), one plot for each module. The diffuser ageing is taken into account.

2.2.2.1.2 OLCI-B

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

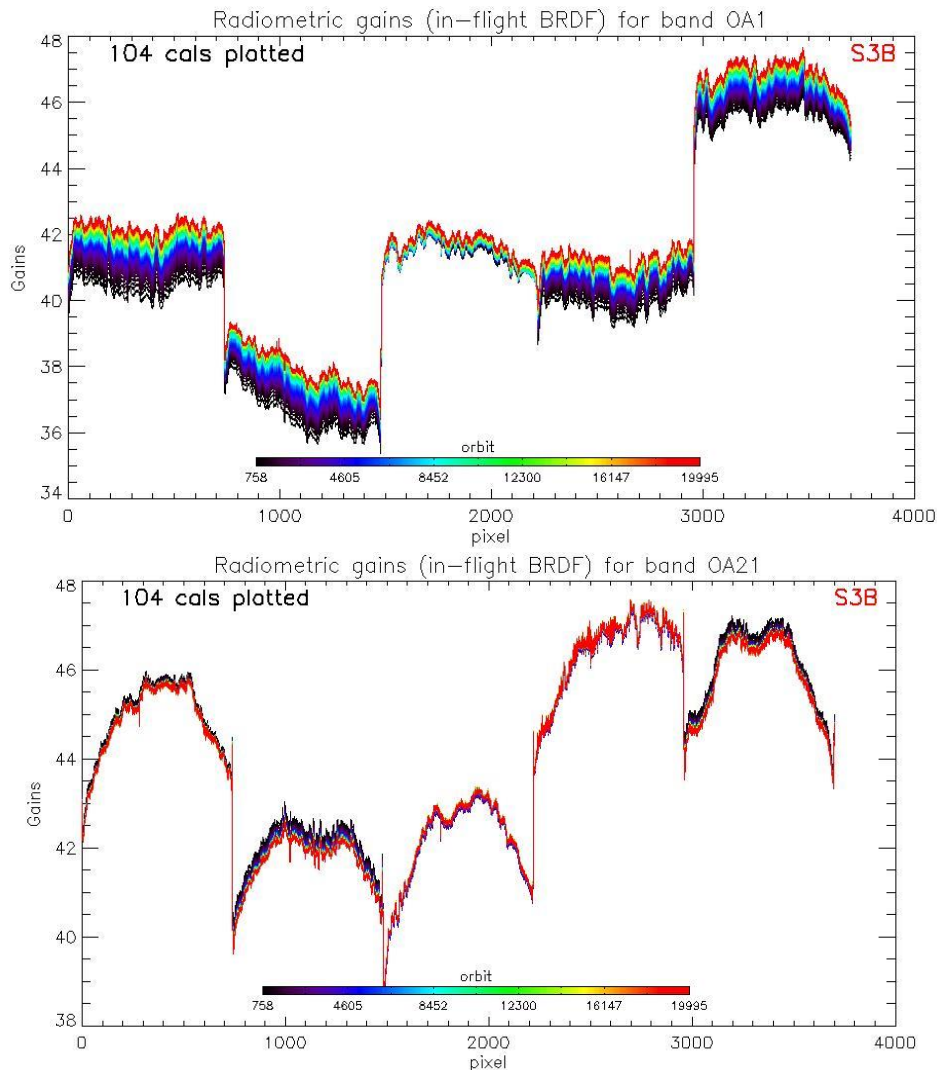


Figure 24: OLCI-B Gain Coefficients for band Oa1 (top) and Oa21 (bottom), derived using the in-flight BRDF model. The dataset is made of all diffuser 1 radiometric calibrations since orbit 758.

Figure 25 displays a summary of the time evolution of the cross-track average of the gains (in-flight BRDF, taking into account diffuser ageing), 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. The slight discontinuity near "day 920 since launch" is due to the upgrade of the Ageing model.

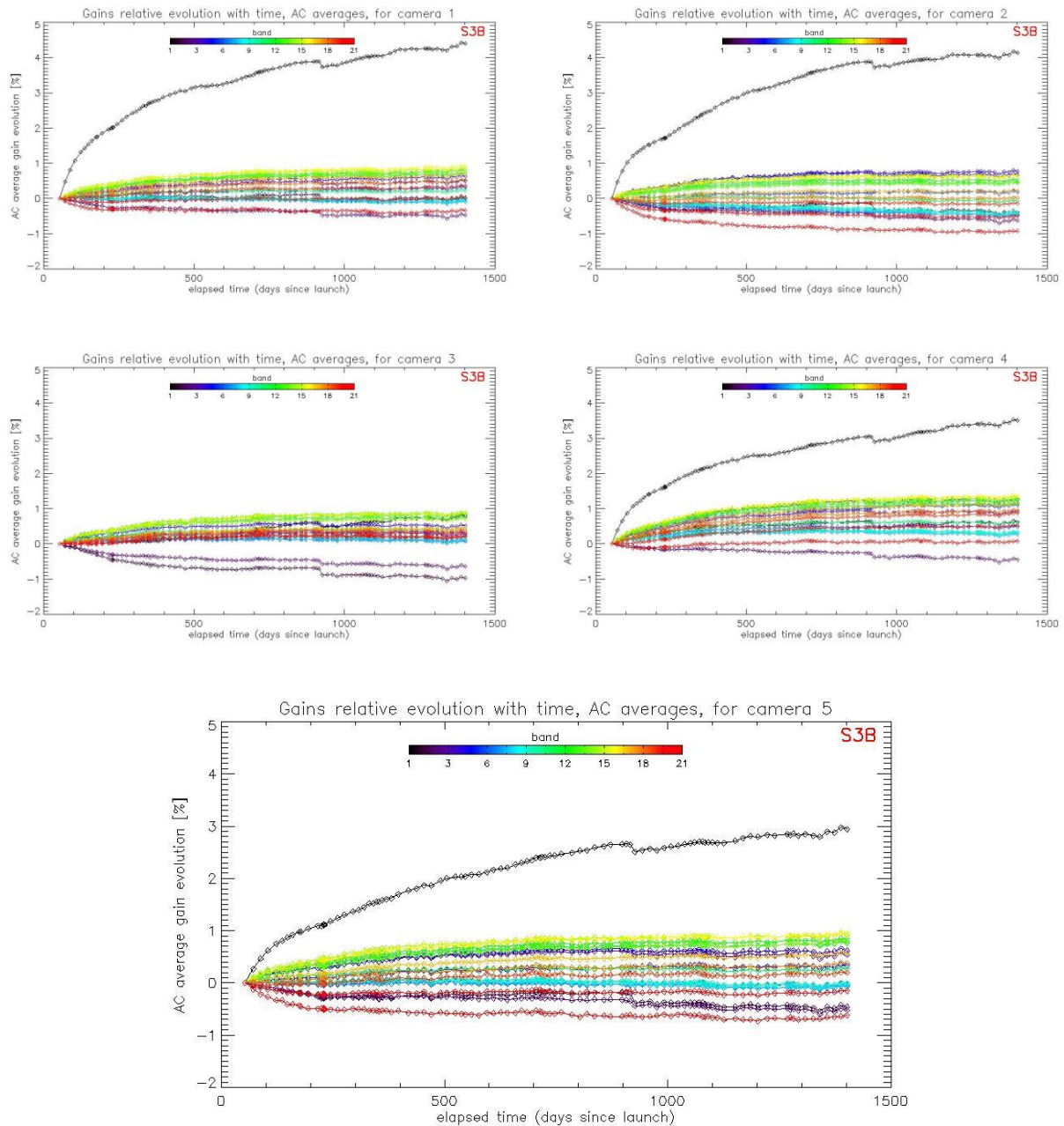


Figure 25: OLCI-B camera averaged gain relative evolution with respect to first calibration after channel programming change (18/06/2018), as a function of elapsed time since the beginning of the mission; one curve for each band (see colour code on plots), one plot for each module. The diffuser ageing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

2.2.2.2 Instrument evolution modelling

2.2.2.2.1 OLCI-A

The current OLCI-A Radiometric Model has been put in operations at PDGS the 18/11/2021 (Processing Baseline 3.01). This model has been derived on the basis of a more recent (compared to the previous model) Radiometric Calibration dataset, going from 25/01/2018 to 03/10/2021. It includes the correction of the diffuser ageing for the six bluest bands (Oa1 to Oa6) for which it is clearly measurable. The model performance over the complete dataset (including the 10 calibrations in extrapolation over about 4 months) remains better than about 0.09% for all bands at the exception of the presence of an isolated peak in the recent data near orbit 30500 where performance degrades for all bands, up to about 0.13% for band Oa01. This peak is present in Gain measurements, thus reflects in model performance. It is not yet understood and is under investigation. The same behaviour is seen on OLCI-B (see Figure 33), suggesting that it is not linked to the instrument sensitivity. The previous model, trained on a Radiometric Dataset limited to 08/08/2020, shows clearly a more pronounced 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. Performance shown on Figure 26 adopts, as for OLCI-B, the multiple model approach, i.e. different models (three for OLCI-A since PB, three for OLCI-B since PB 1.57) are used to cover the whole mission (red dashed line on Figure 26), each model being fitted on a partial dataset (green dashed line on Figure 26) whose coverage is optimised to provide best performance.

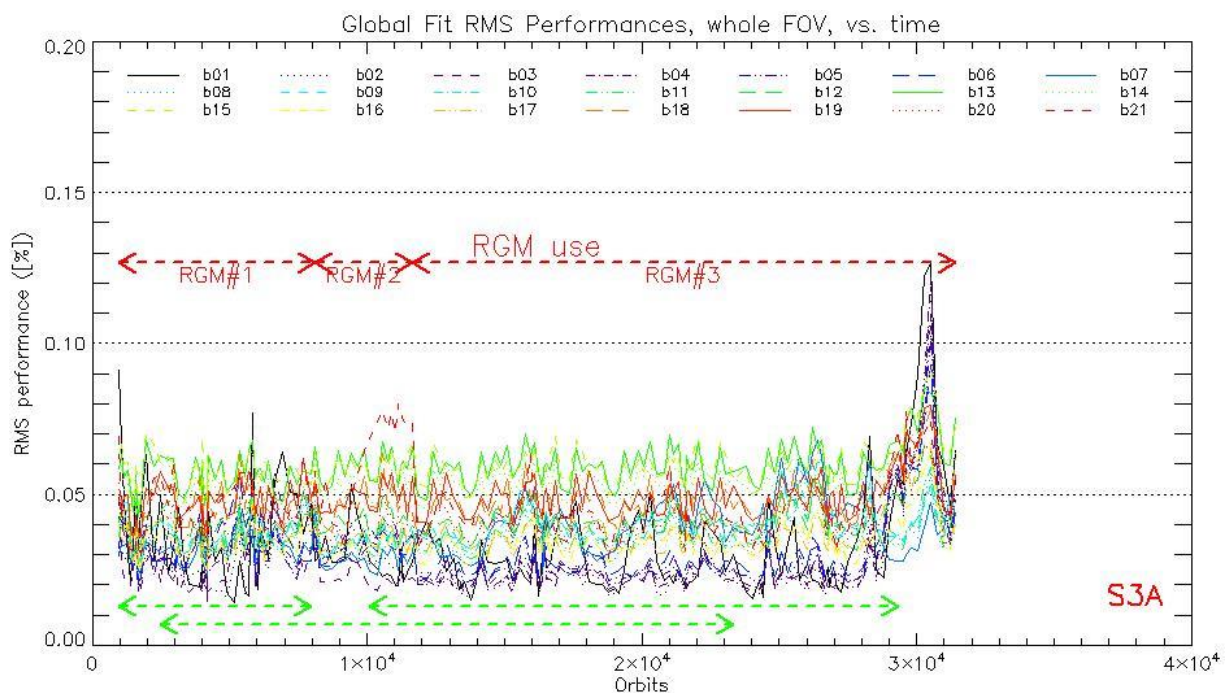


Figure 26: RMS performance of the OLCI-A Gain Model of the current processing baseline as a function of orbit.

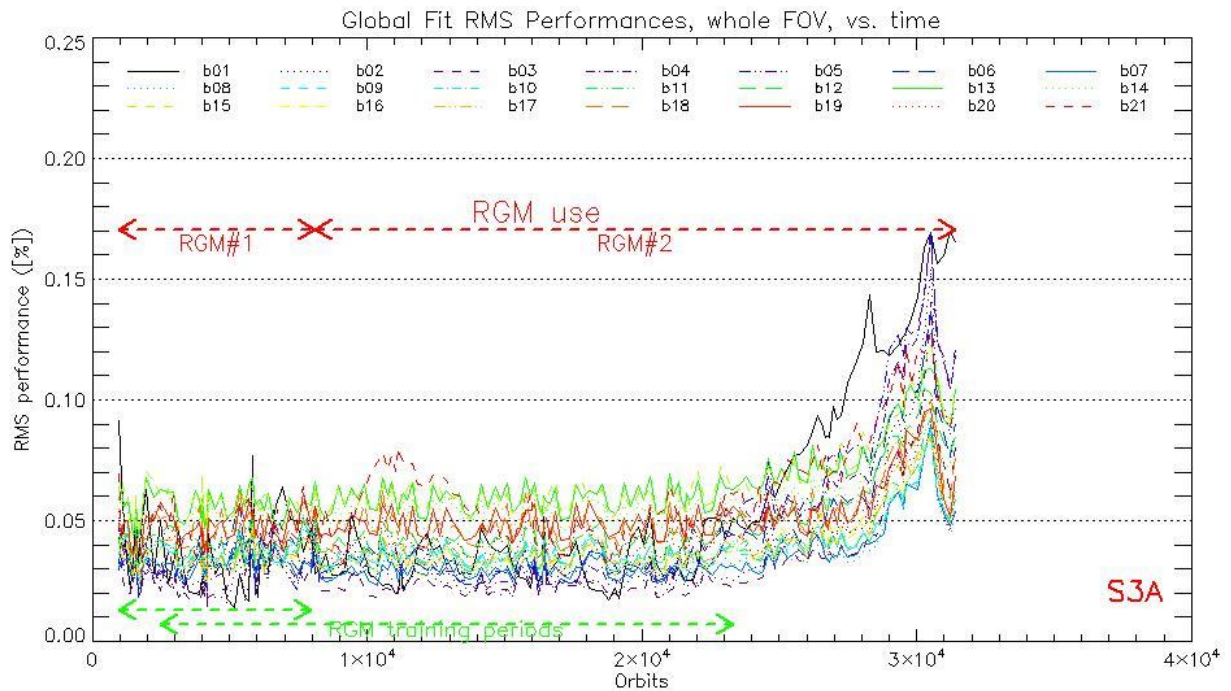


Figure 27: RMS performance of the OLCI-A Gain Model of the previous Processing Baseline as a function of orbit.

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

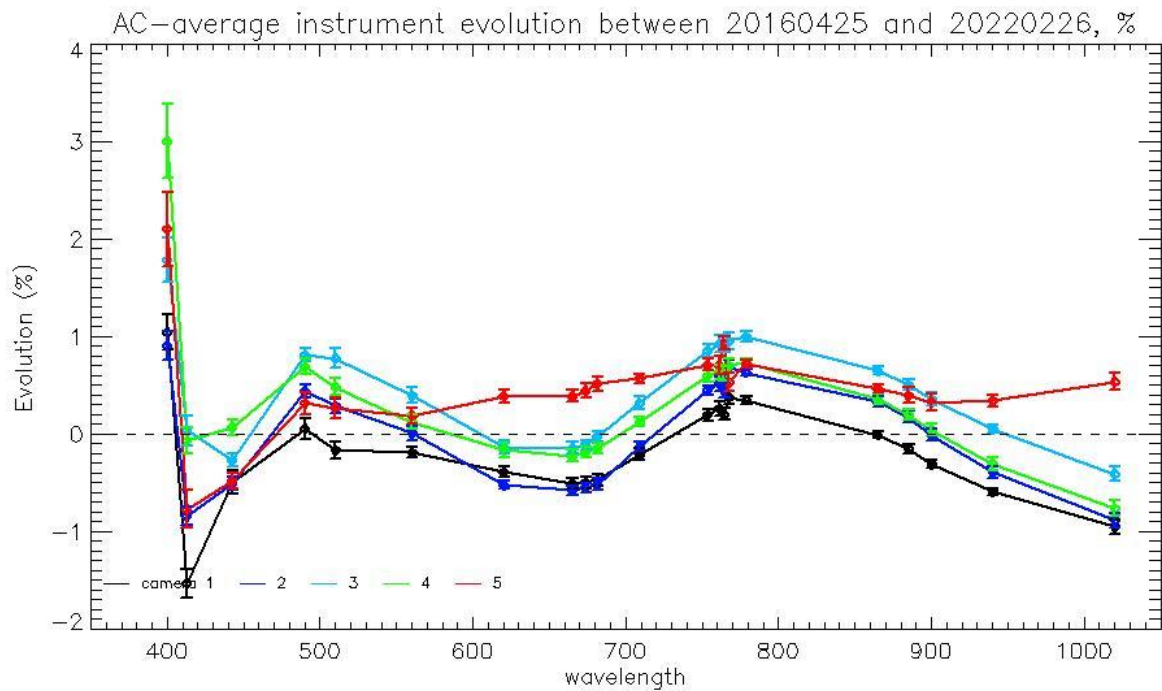


Figure 28: OLCI-A Camera-averaged instrument evolution since channel programming change (25/04/2016) and up to the most recent calibration (27/01/2022) versus wavelength.

The overall per camera performance, as a function of wavelength, and at each orbit is shown on

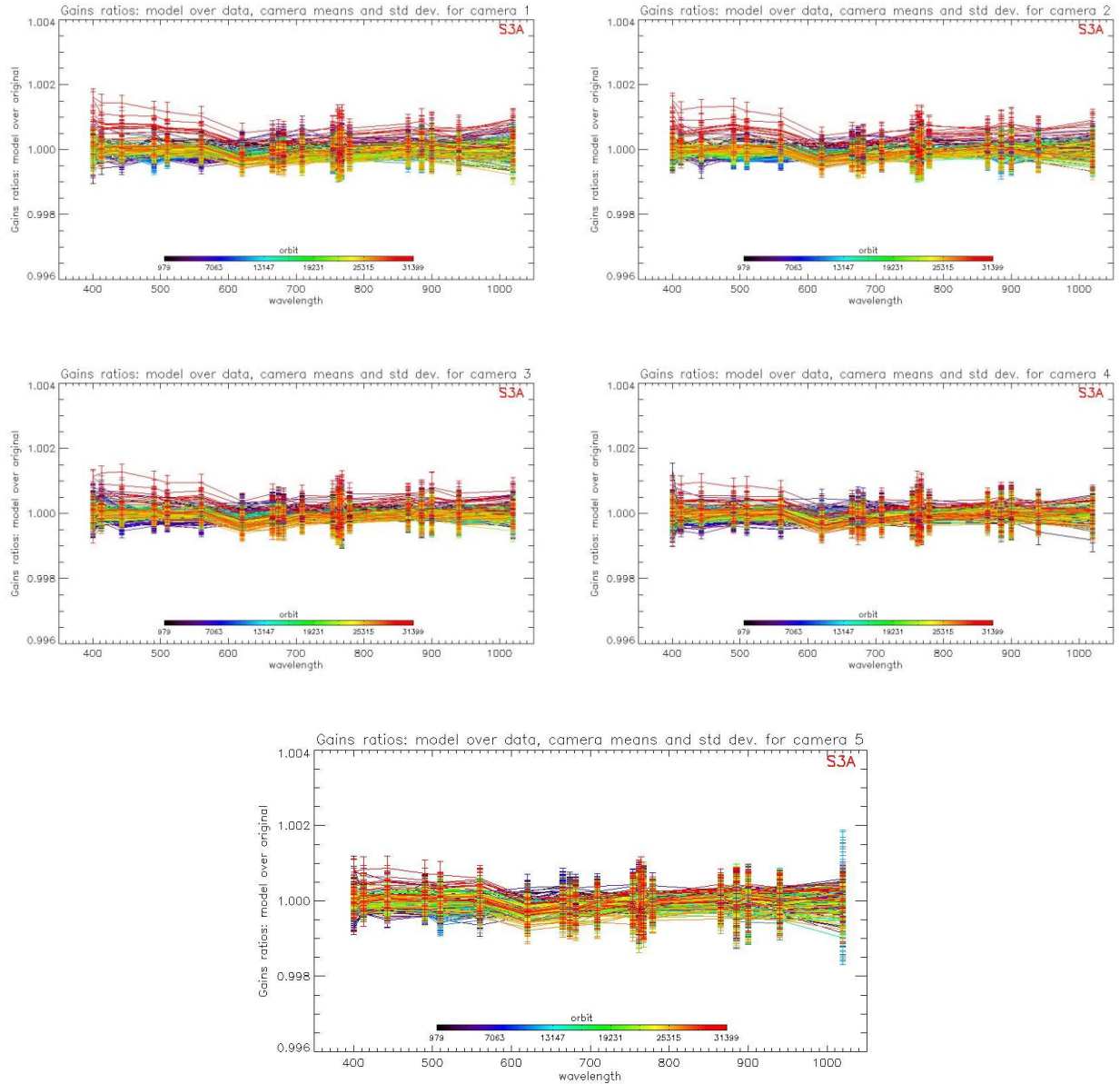


Figure 29 as the average and standard deviation of the model over data ratio.

Finally,

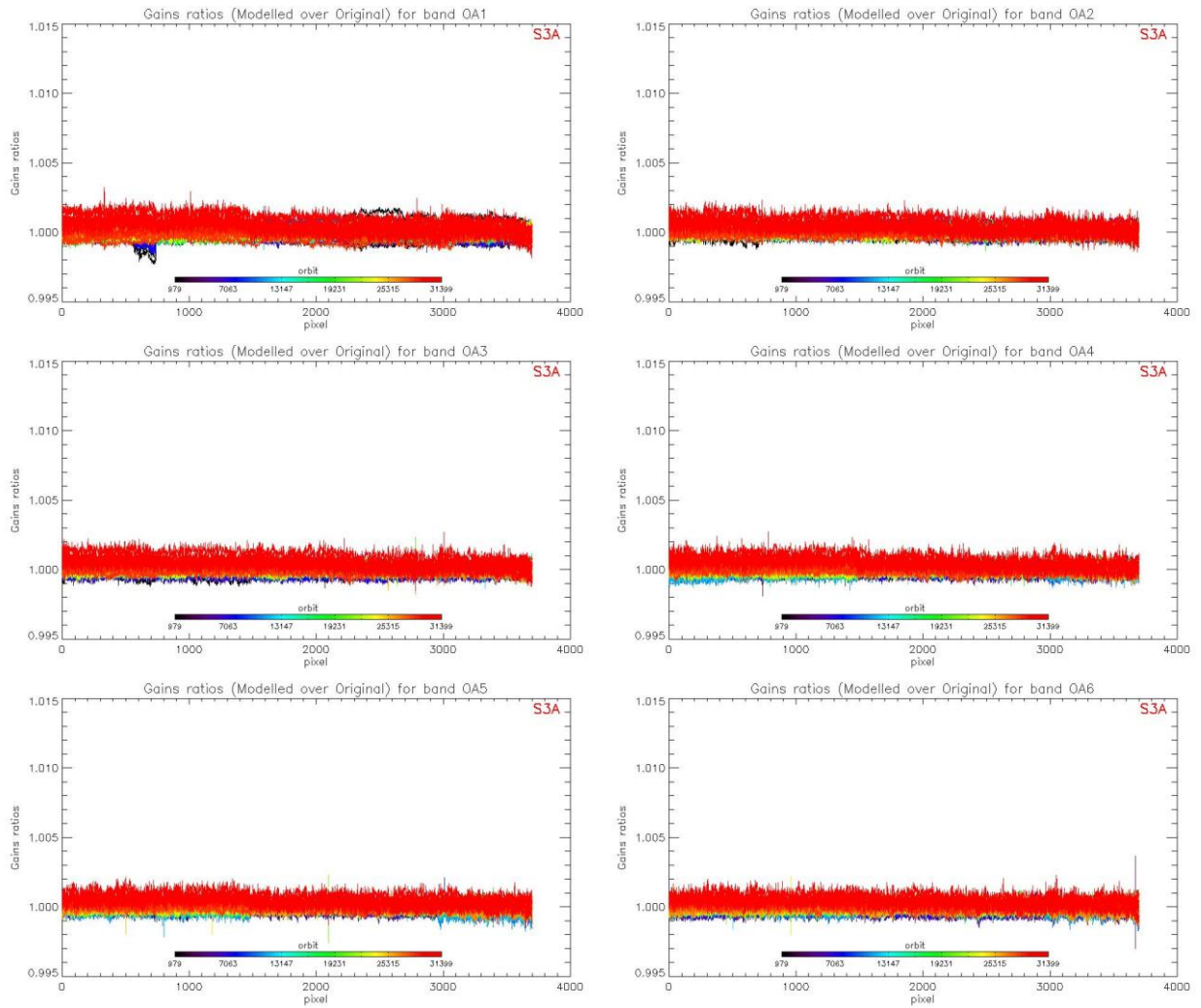


Figure 30 to

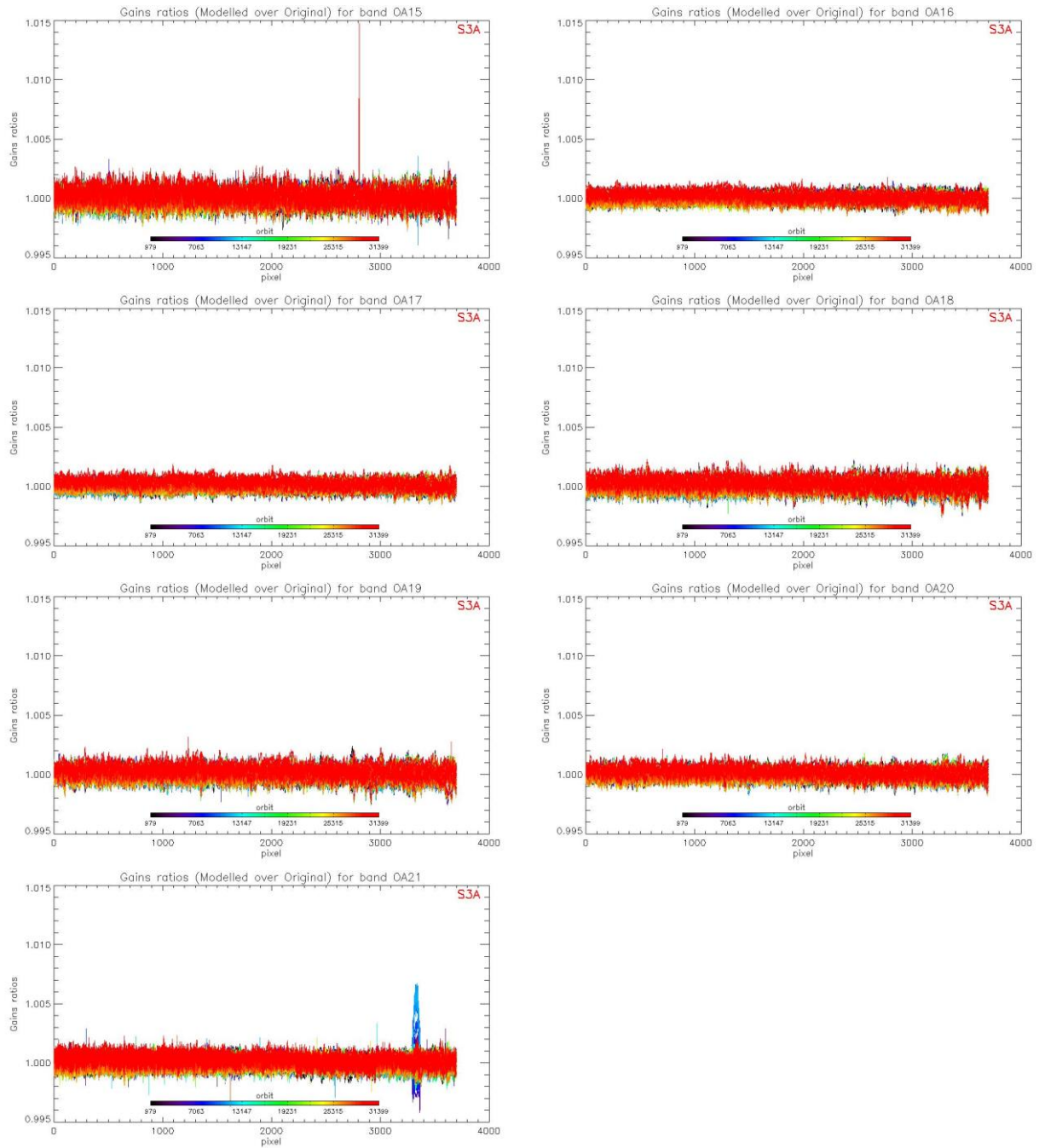


Figure 32 show the detail of the model performance, with across-track plots of the model over data ratios at each orbit, one plot for each channel.

Comparisons of

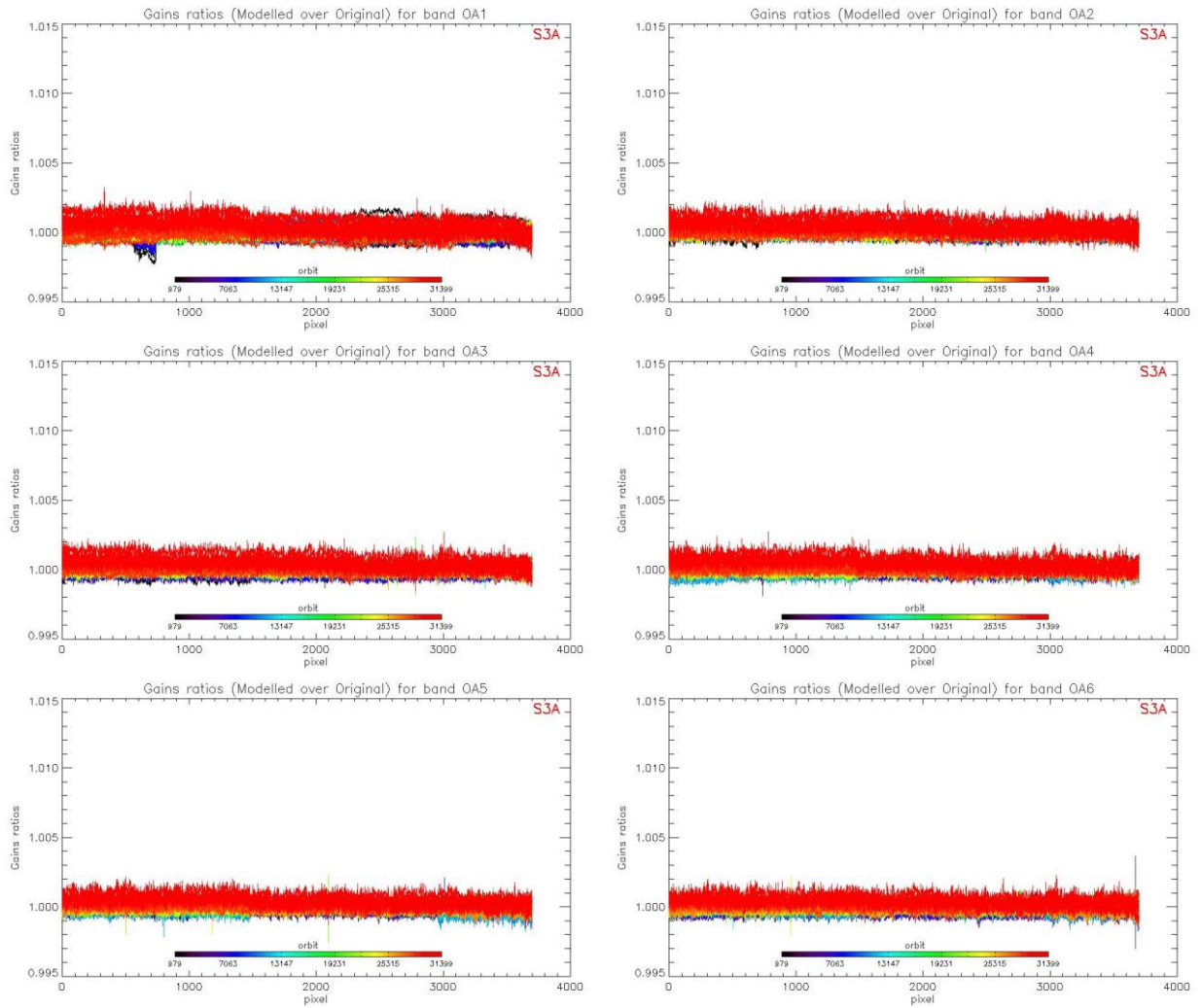


Figure 30 to

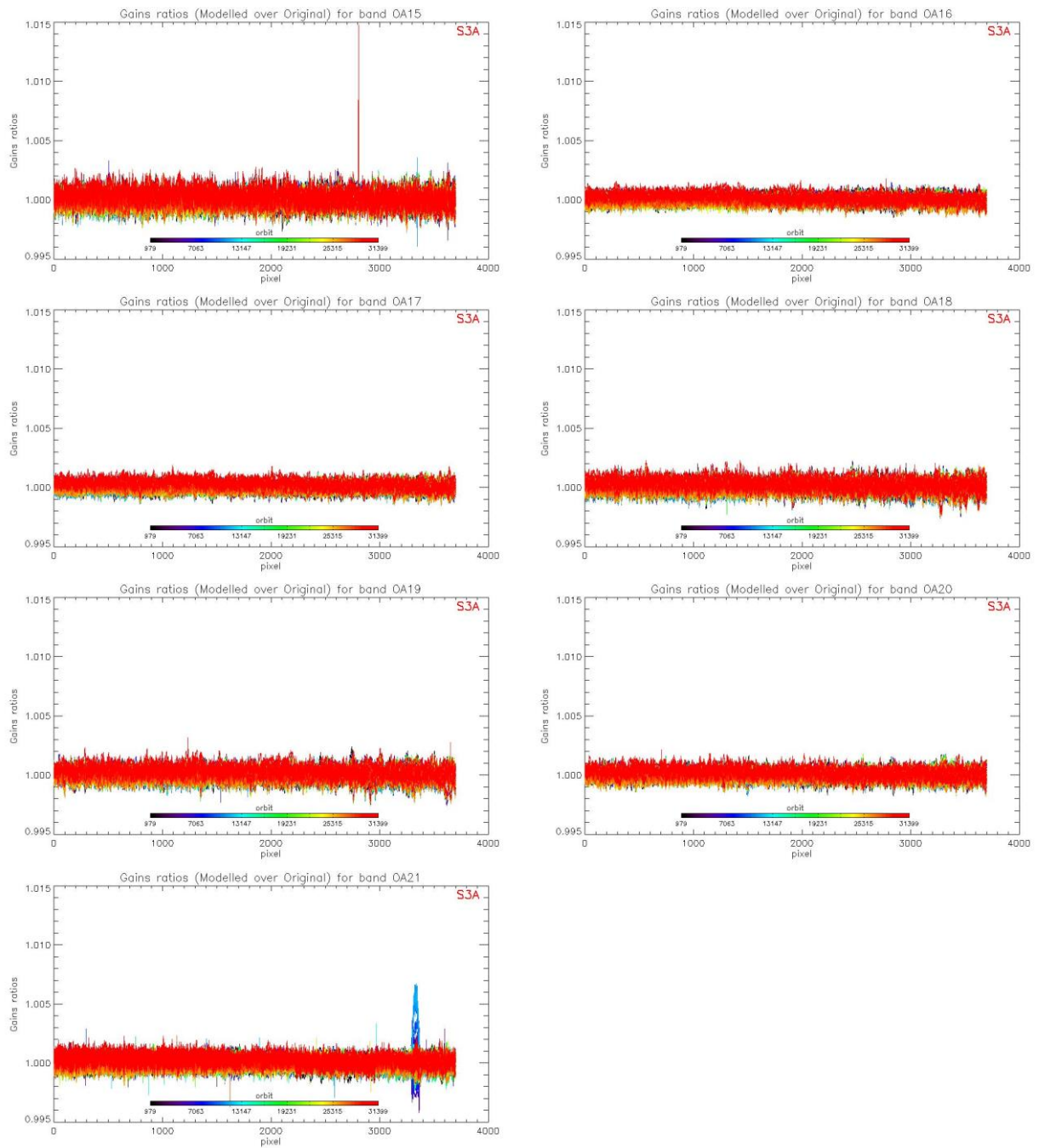


Figure 32 with their counterparts in Report of Cycle 62 clearly demonstrate the improvement brought by the new model whatever the level of detail.

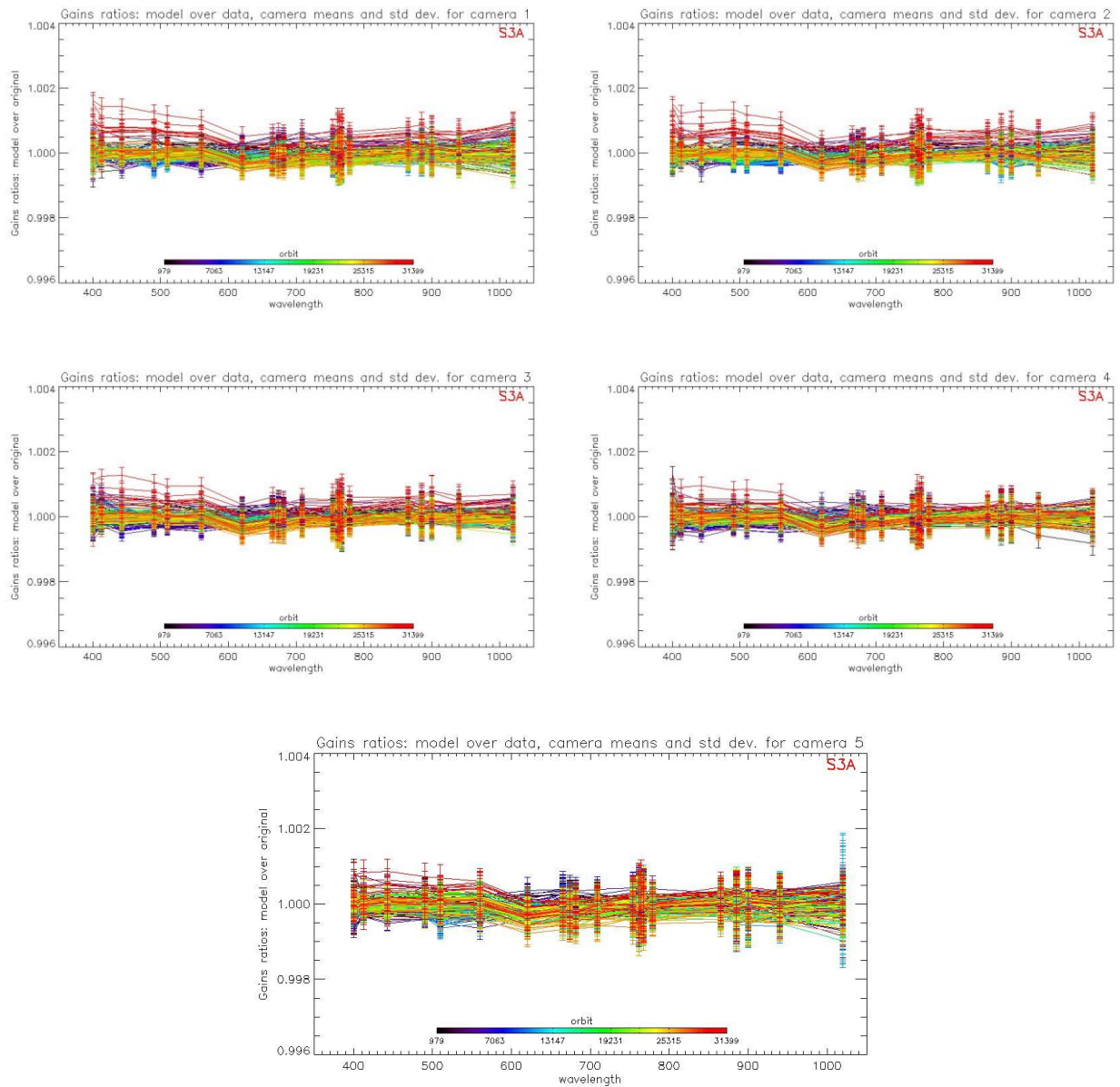


Figure 29: For the 5 cameras: OLCI-A Evolution model performance, as camera-average and standard deviation of ratio of Model over Data vs. wavelength, for each orbit of the test dataset, including 10 calibrations in extrapolation, with a colour code for each calibration from blue (oldest) to red (most recent).

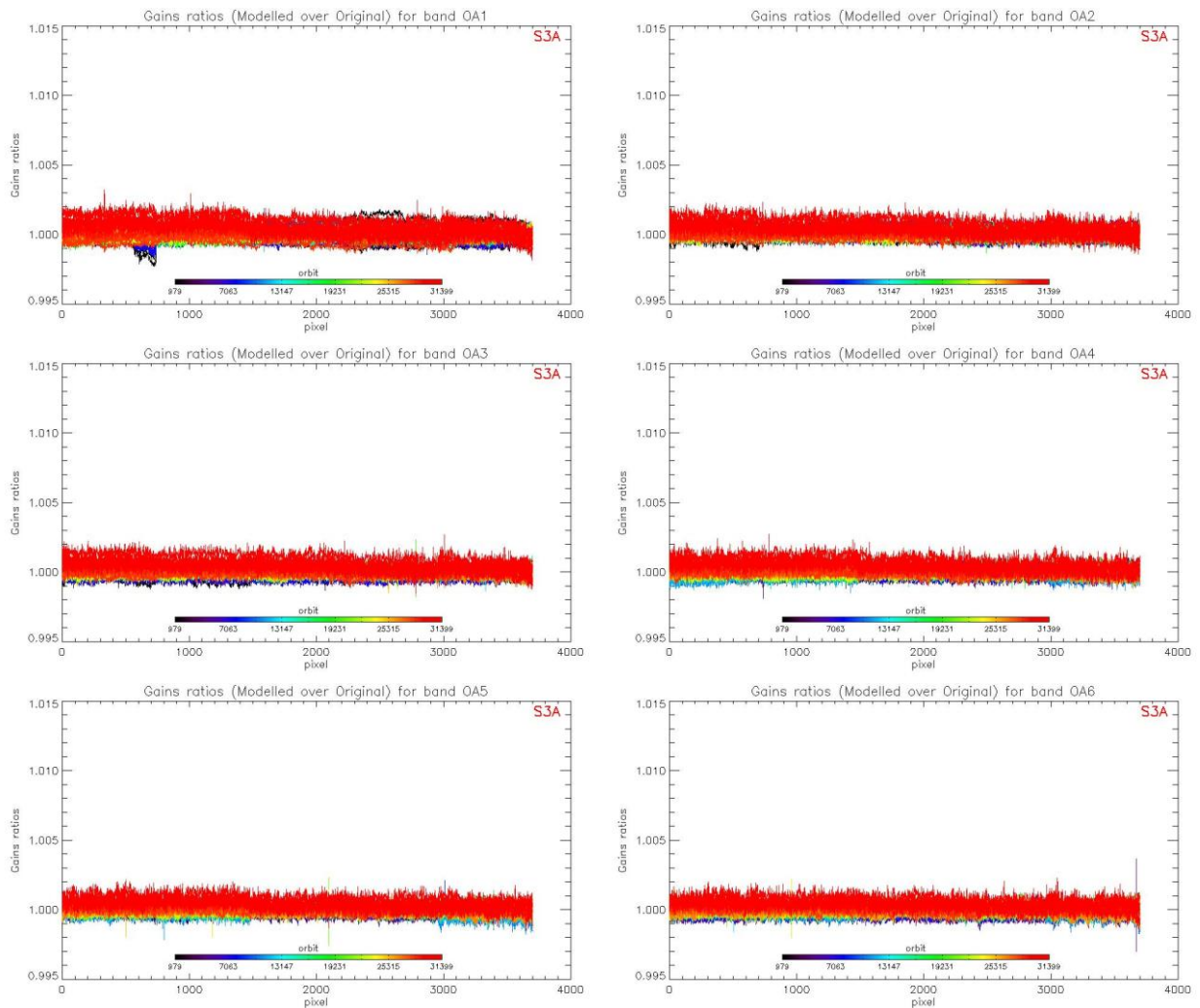


Figure 30: OLCI-A evolution model performance, as ratio of Model over Data vs. pixels, all cameras side by side, over the whole current calibration dataset (since instrument programming update), including 10 calibrations in extrapolation, channels Oa1 to Oa6.

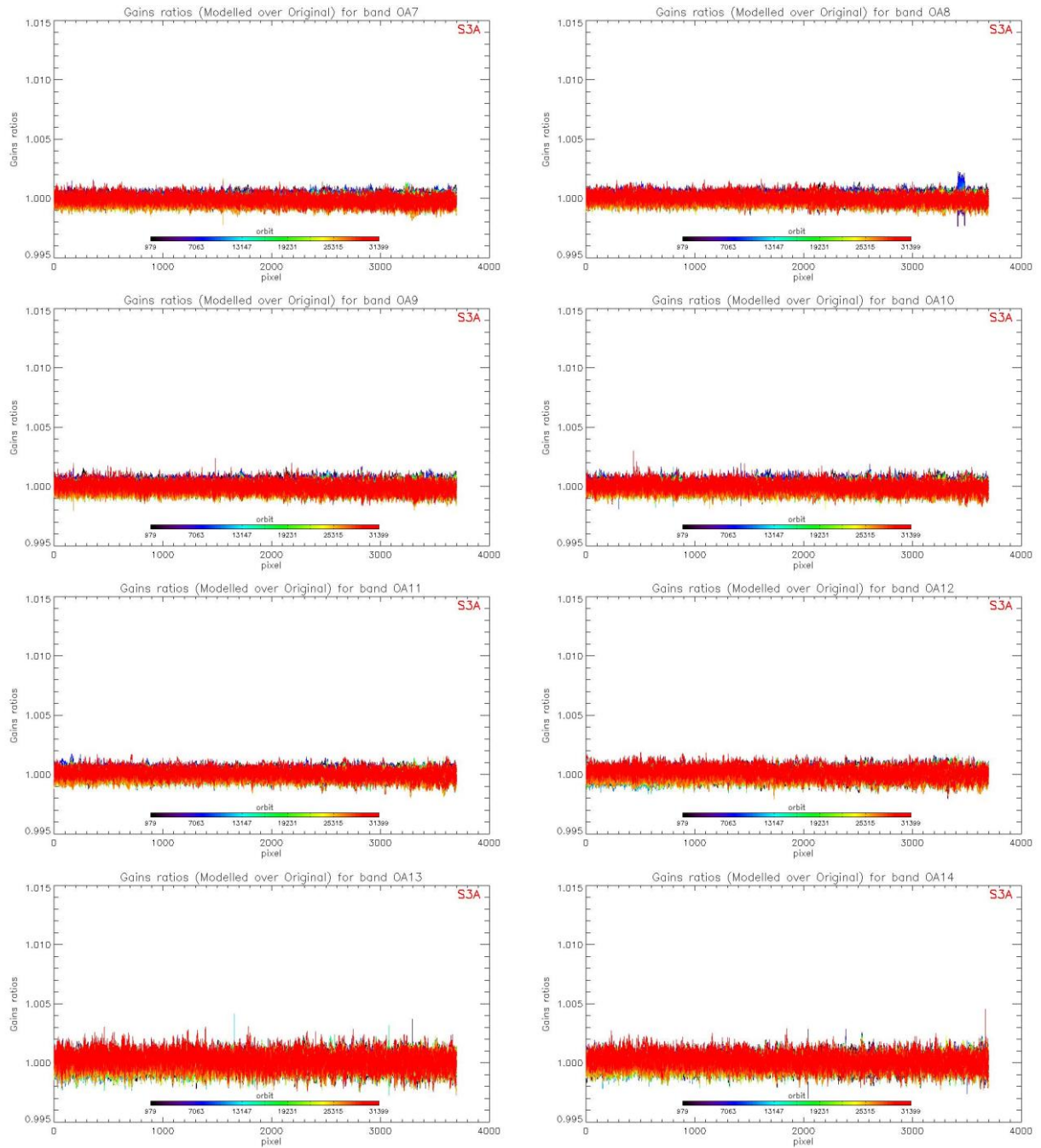


Figure 31: same as

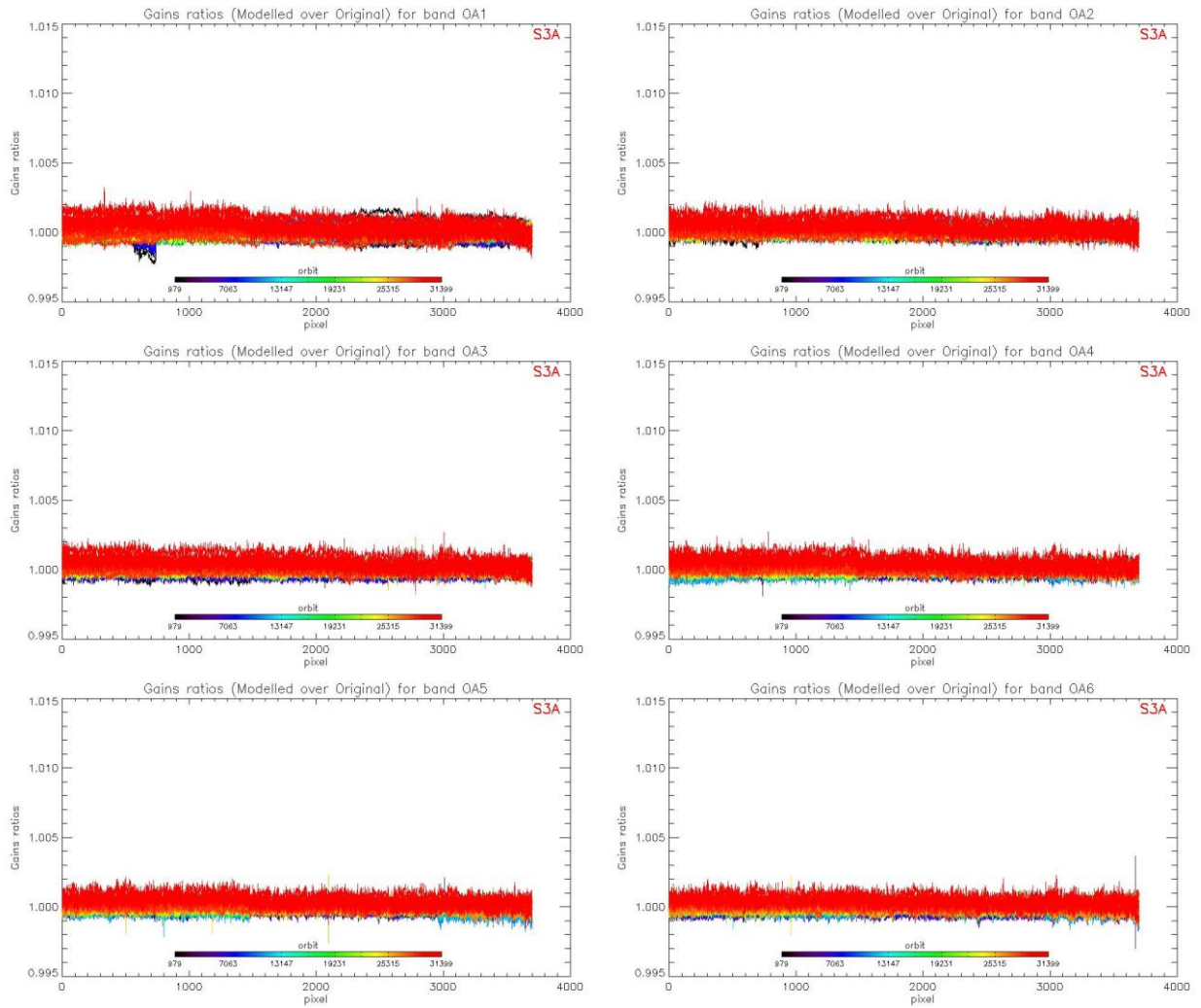


Figure 30 for channels Oa7 to Oa14.

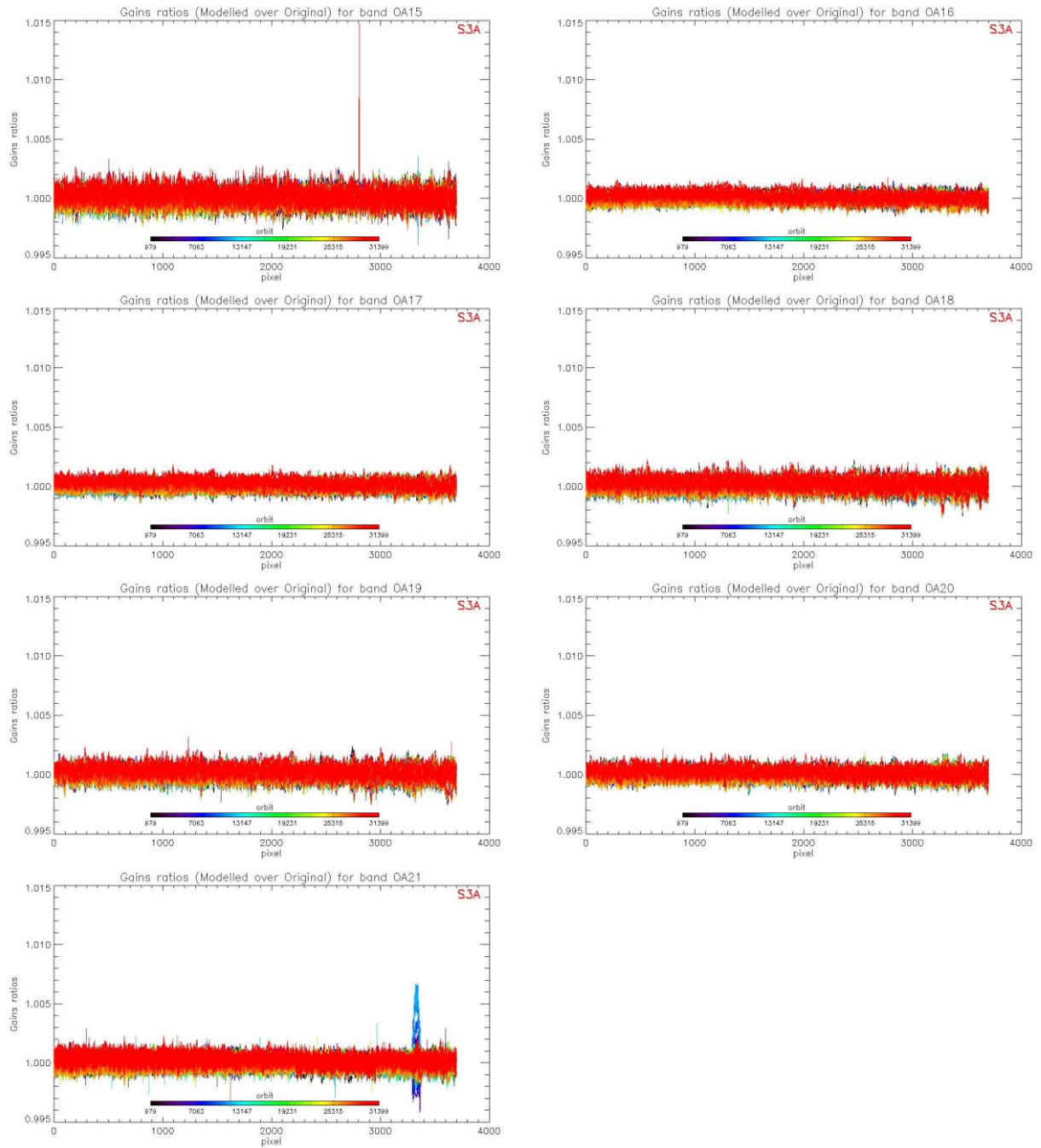


Figure 32: same as

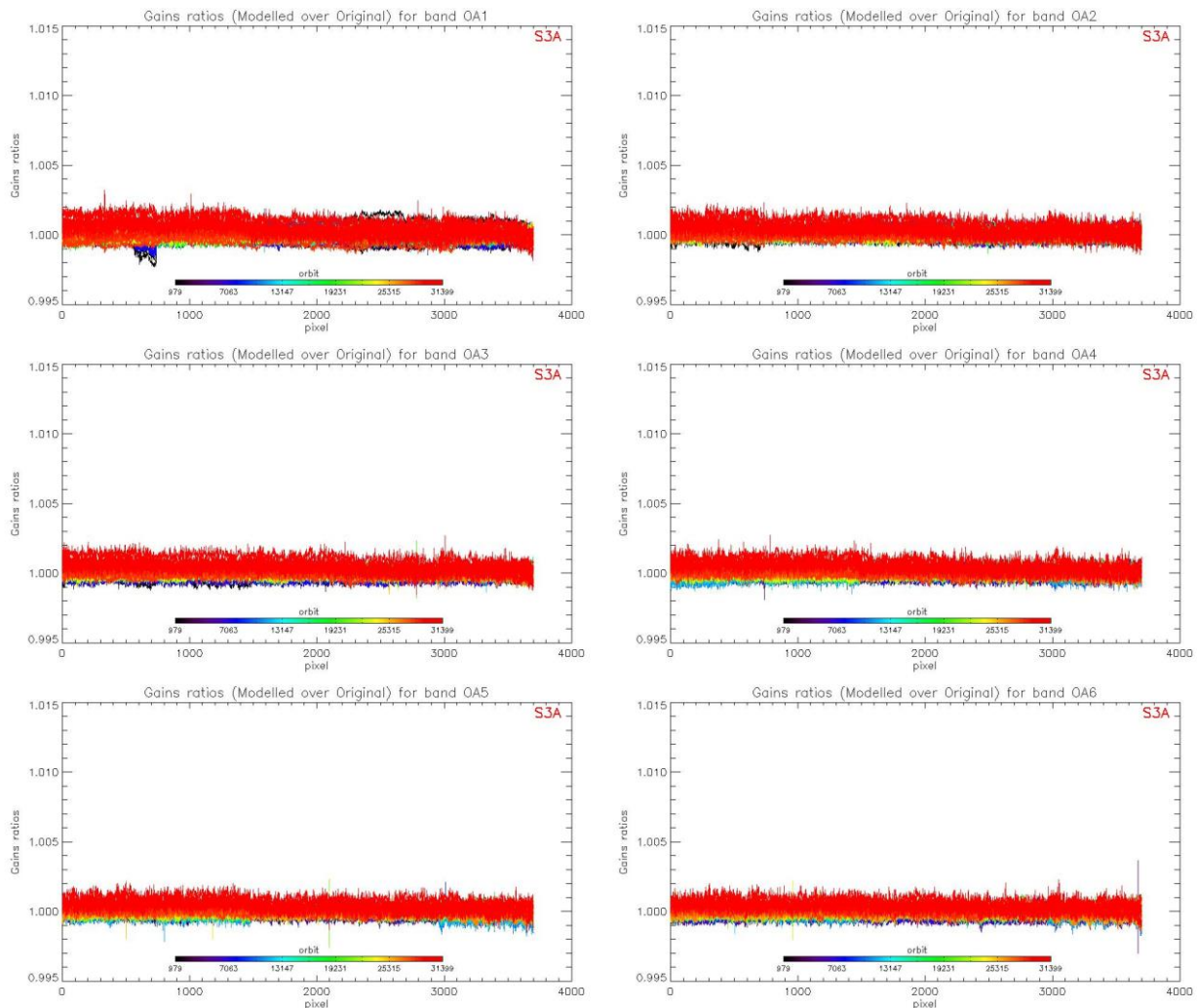


Figure 30 for channels Oa15 to Oa21.

2.2.2.2.2 OLCI-B

The current 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 deployed at PDGS on 18/11/2021 (Processing Baseline 3.01). This model has been derived on the basis of an extended Radiometric Calibration dataset (from 18/06/2019 to 16/09/2021), and most of all a revised Ageing model. 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 11 calibrations in extrapolation over about 5.5 months) is illustrated in Figure 33. It remains better than 0.10% when averaged over the whole field of view for all bands, at the exception of an isolated peak which is present in recent data near orbit 19000 where performance degrades for all bands, up to about 0.15 % for band Oa01. This peak is present in Gain measurements, thus reflects in model performance. It is not yet understood and is under investigation. The same behaviour is seen on OLCI-A (see Figure 26), suggesting that it is not linked to the instrument sensitivity. The previous model, trained on a Radiometric Dataset limited to 09/08/2020, shows a strong 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.

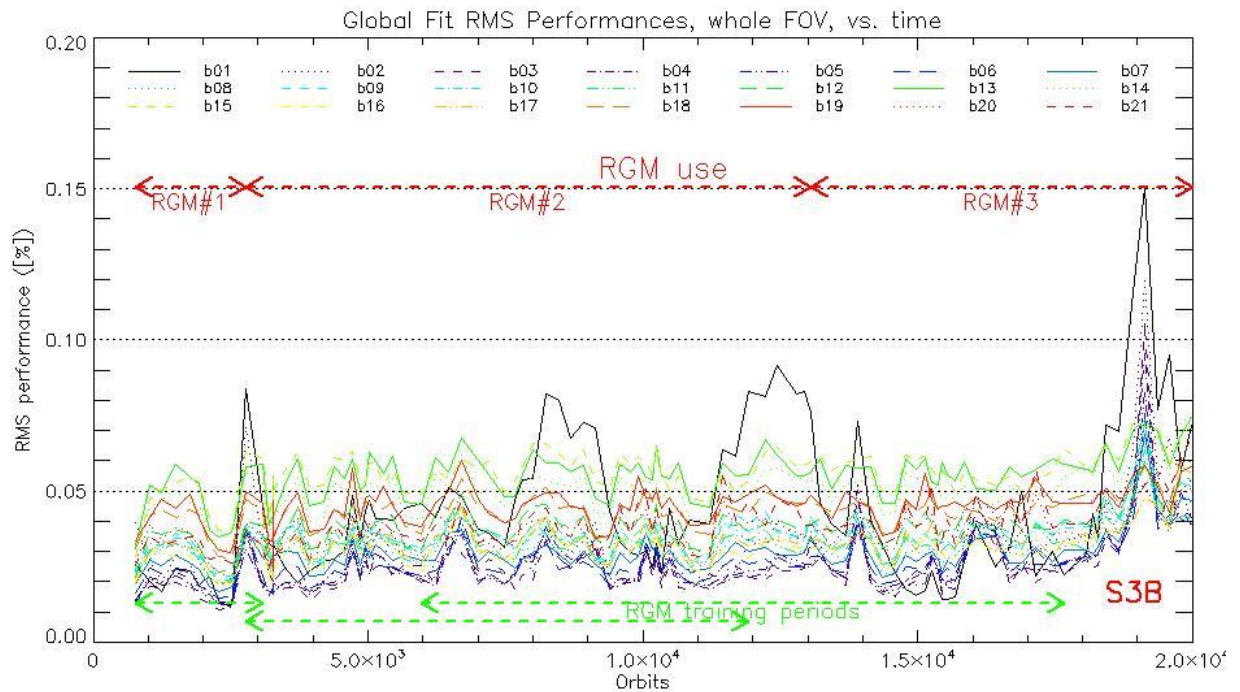


Figure 33: RMS performance of the OLCI-B Gain Model of the current processing baseline as a function of orbit.

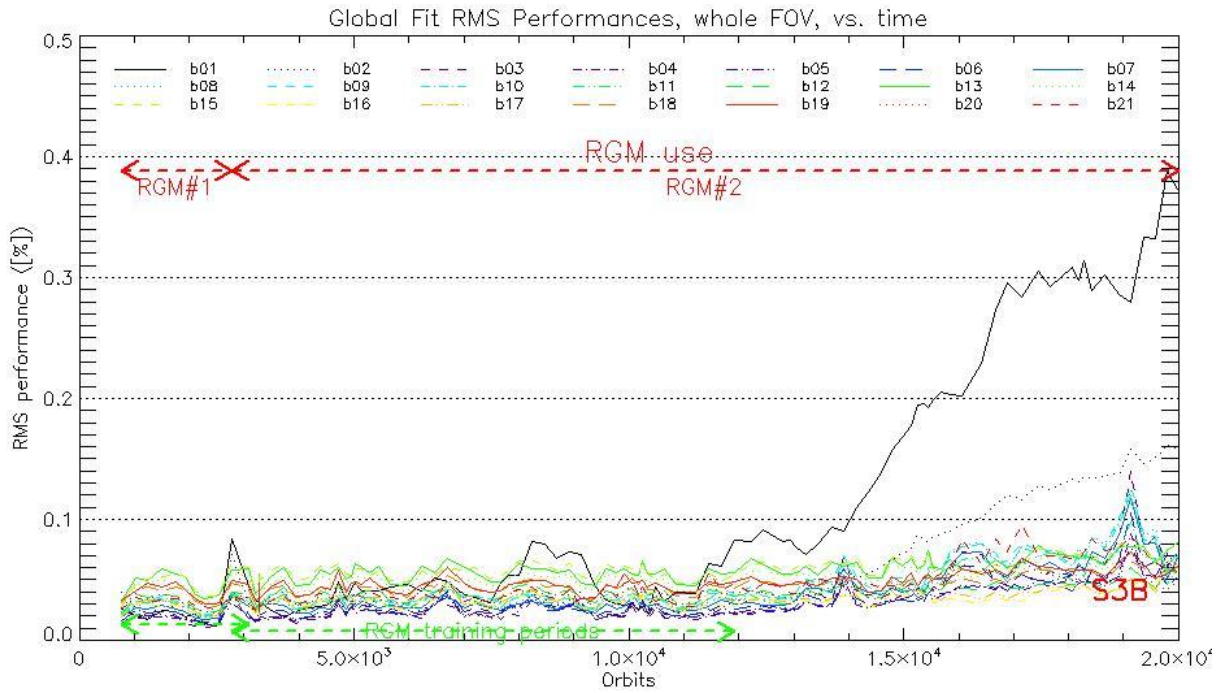


Figure 34: RMS performance of the OLCI-B Gain Model of the previous processing baseline as a function of orbit (please note the different vertical scale with respect to Figure 33).

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

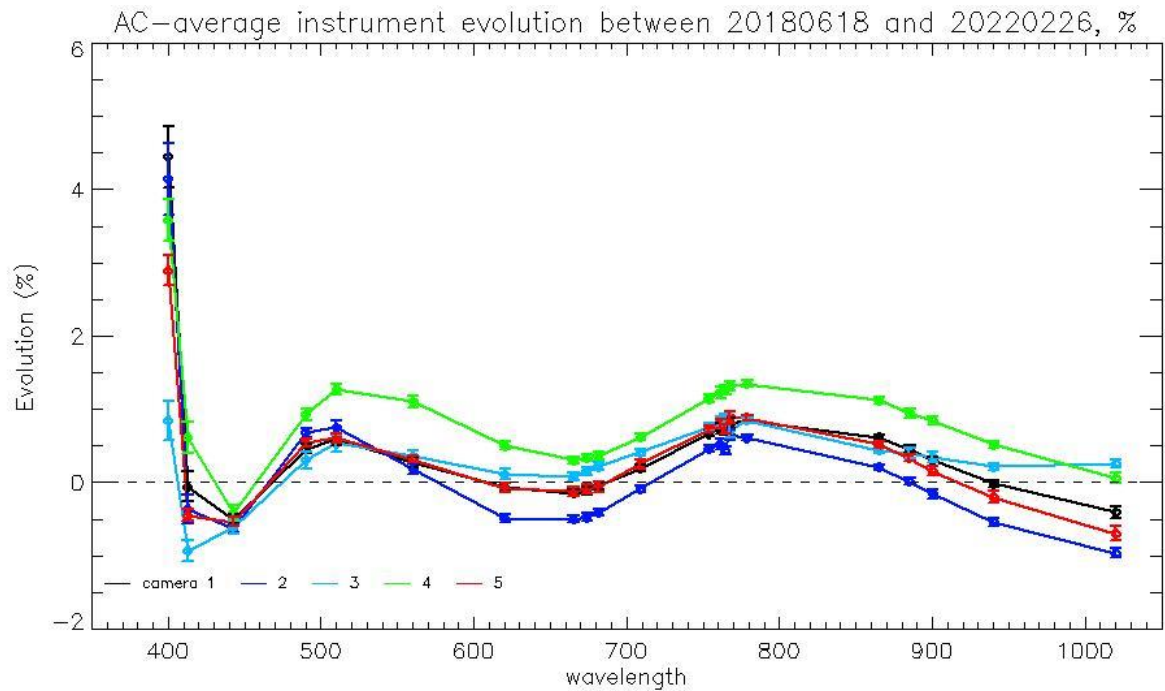


Figure 35: OLCI-B Camera-averaged instrument evolution since channel programming change (18/06/2018) and up to most recent calibration (28/01/2022) versus wavelength.

The overall per camera performance, as a function of wavelength, and at each orbit is shown on

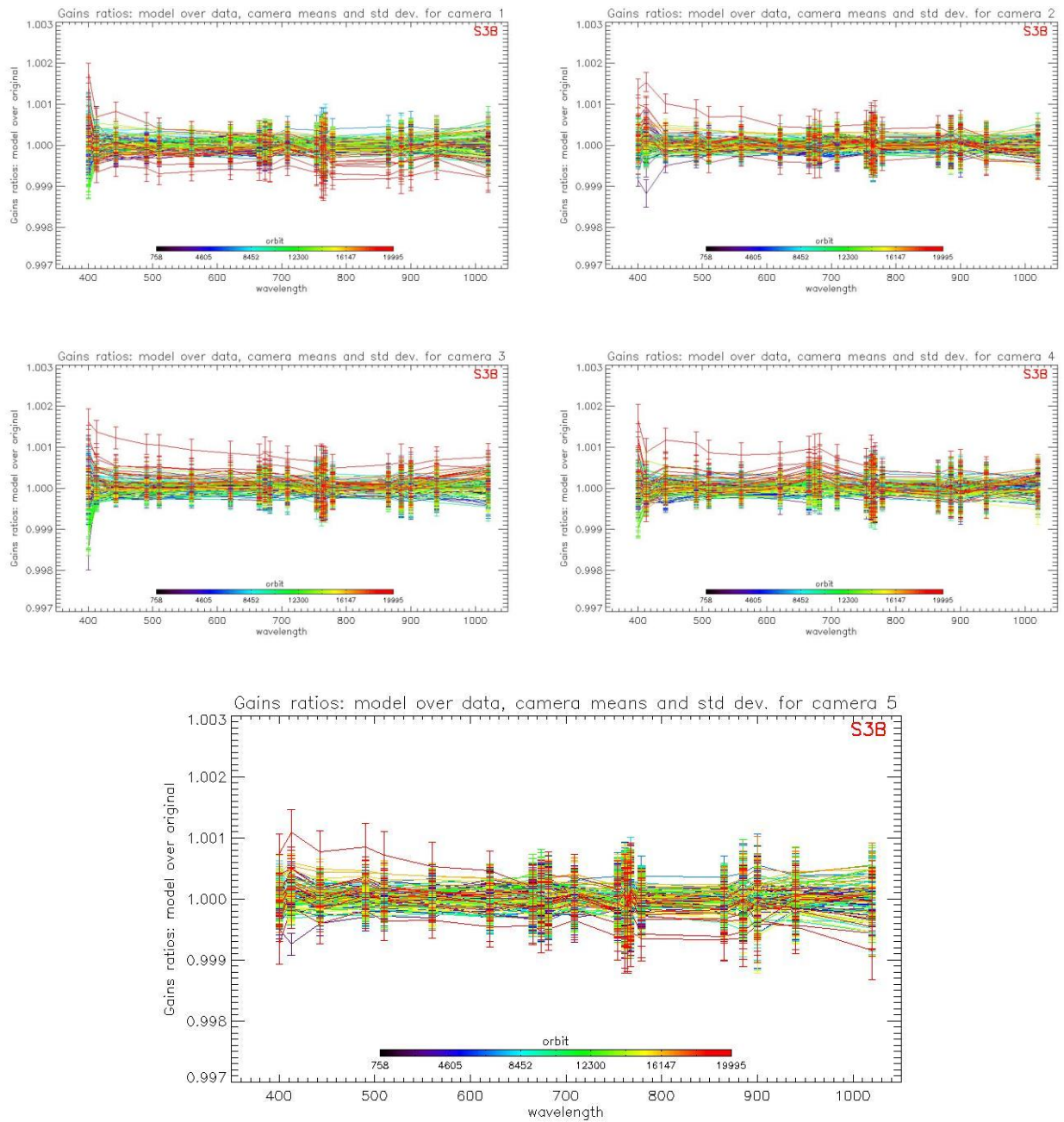


Figure 36 as the average and standard deviation of the model over data ratio.

Finally,

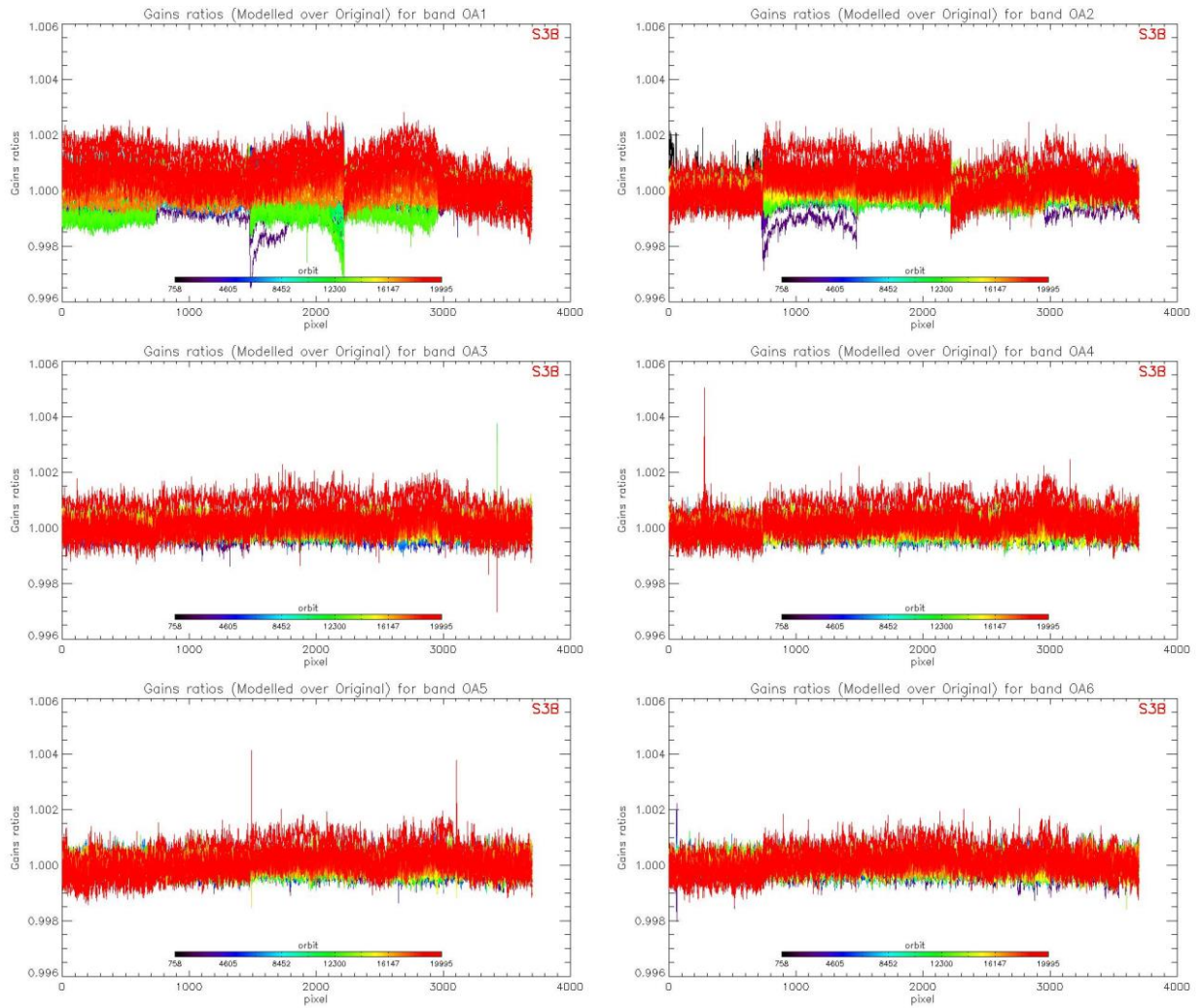


Figure 37 to

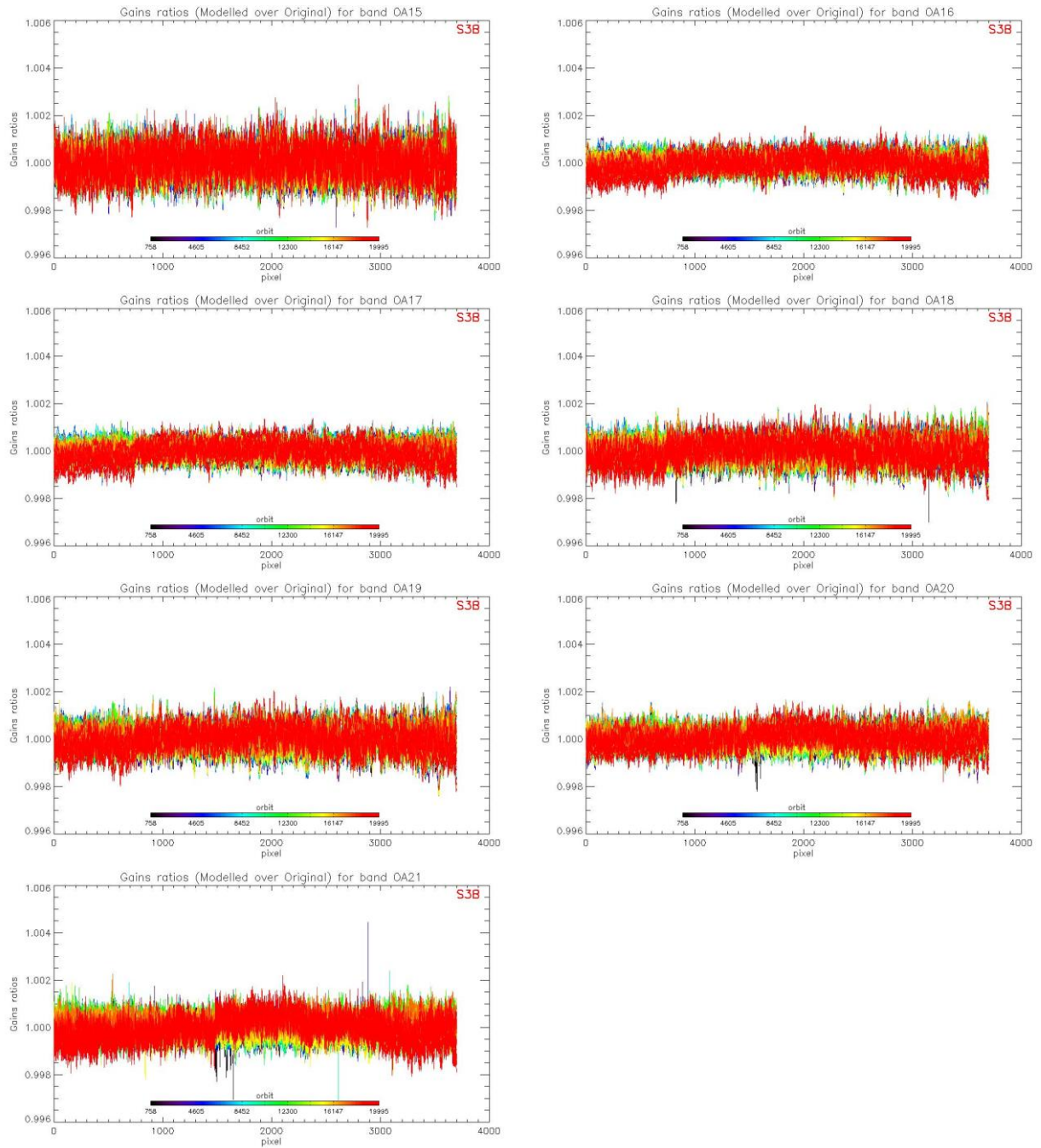


Figure 39 show the detail of the model performance, with across-track plots of the model over data ratios at each orbit, one plot for each channel.

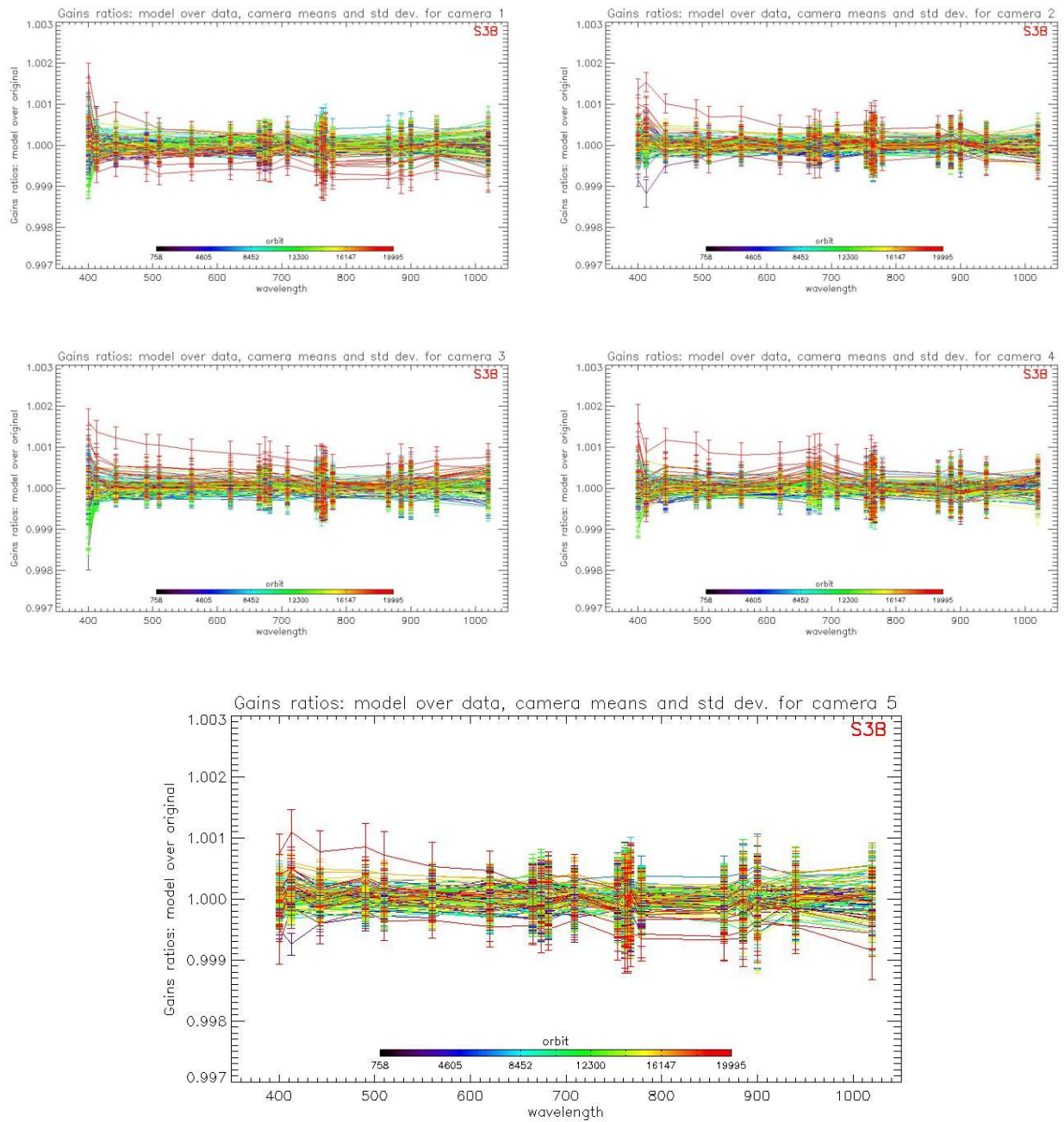


Figure 36: For the 5 cameras: OLCI-B Evolution model performance, as camera-average and standard deviation of ratio of Model over Data vs. wavelength, for each orbit of the test dataset, including 9 calibrations in extrapolation, with a colour code for each calibration from blue (oldest) to red (most recent).

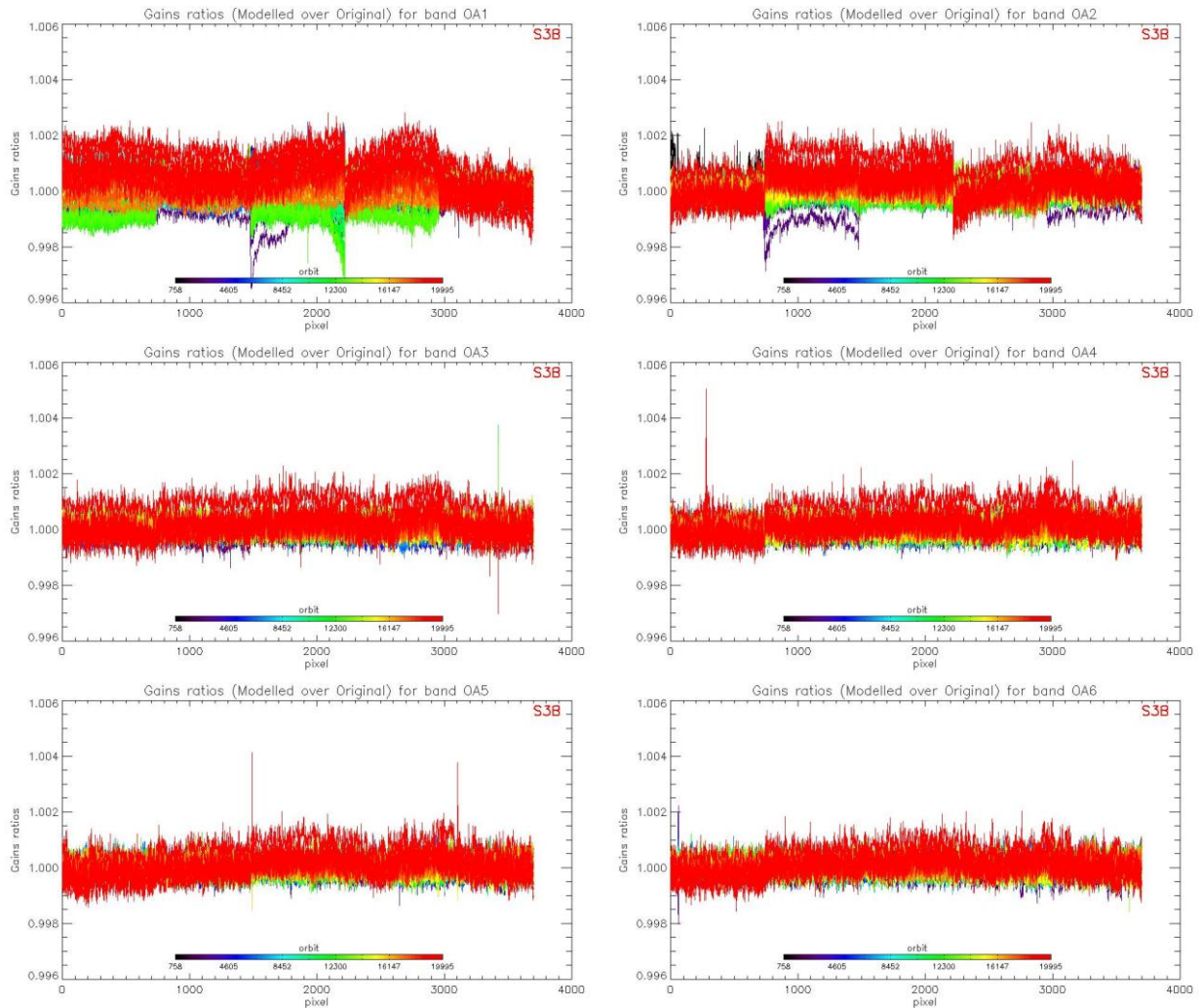


Figure 37: OLCI-B evolution model performance, as ratio of Model over Data vs. pixels, all cameras side by side, over the whole current calibration dataset (since instrument programming update), including 9 calibrations in extrapolation, channels Oa1 to Oa6.

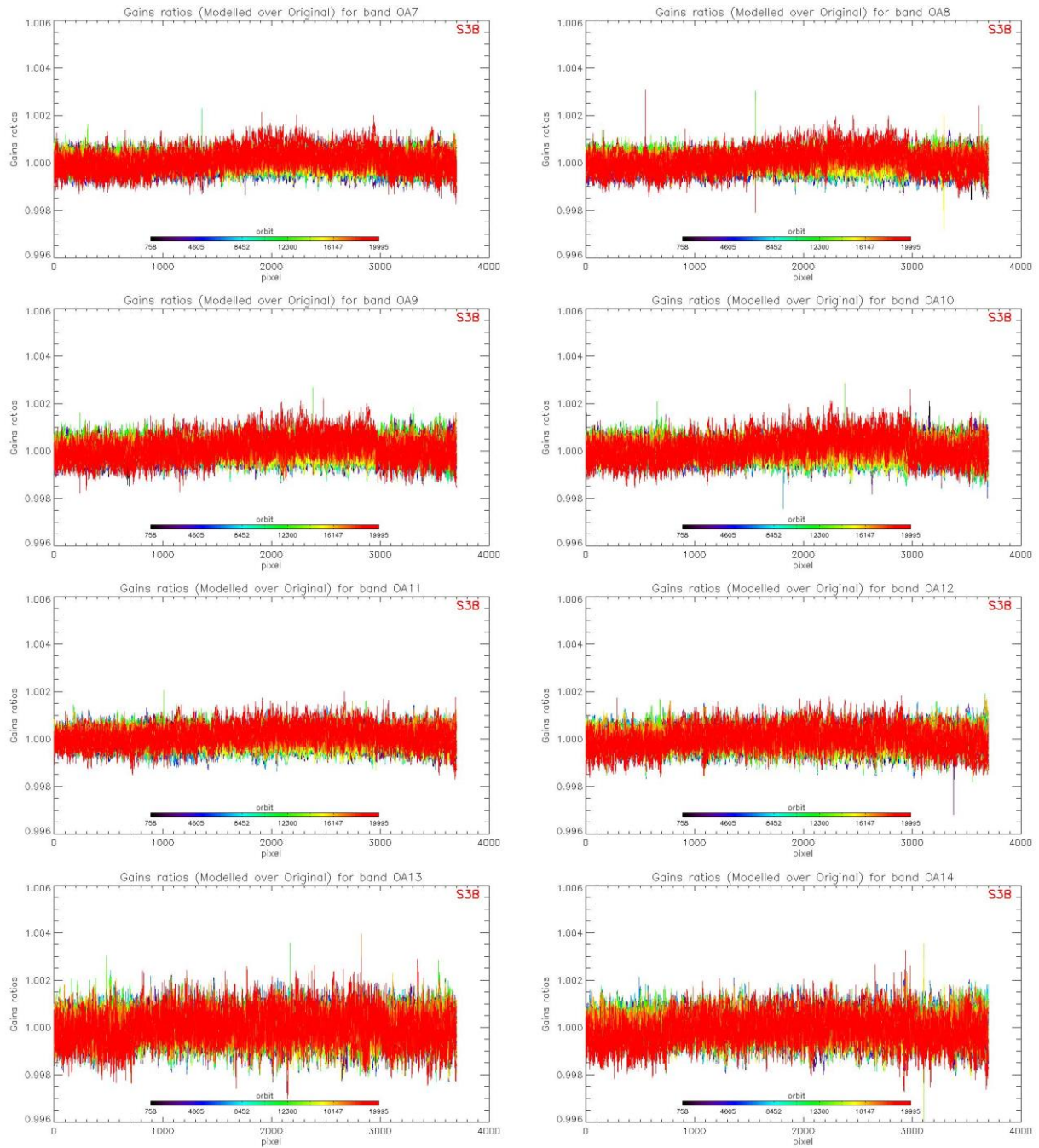


Figure 38: same as

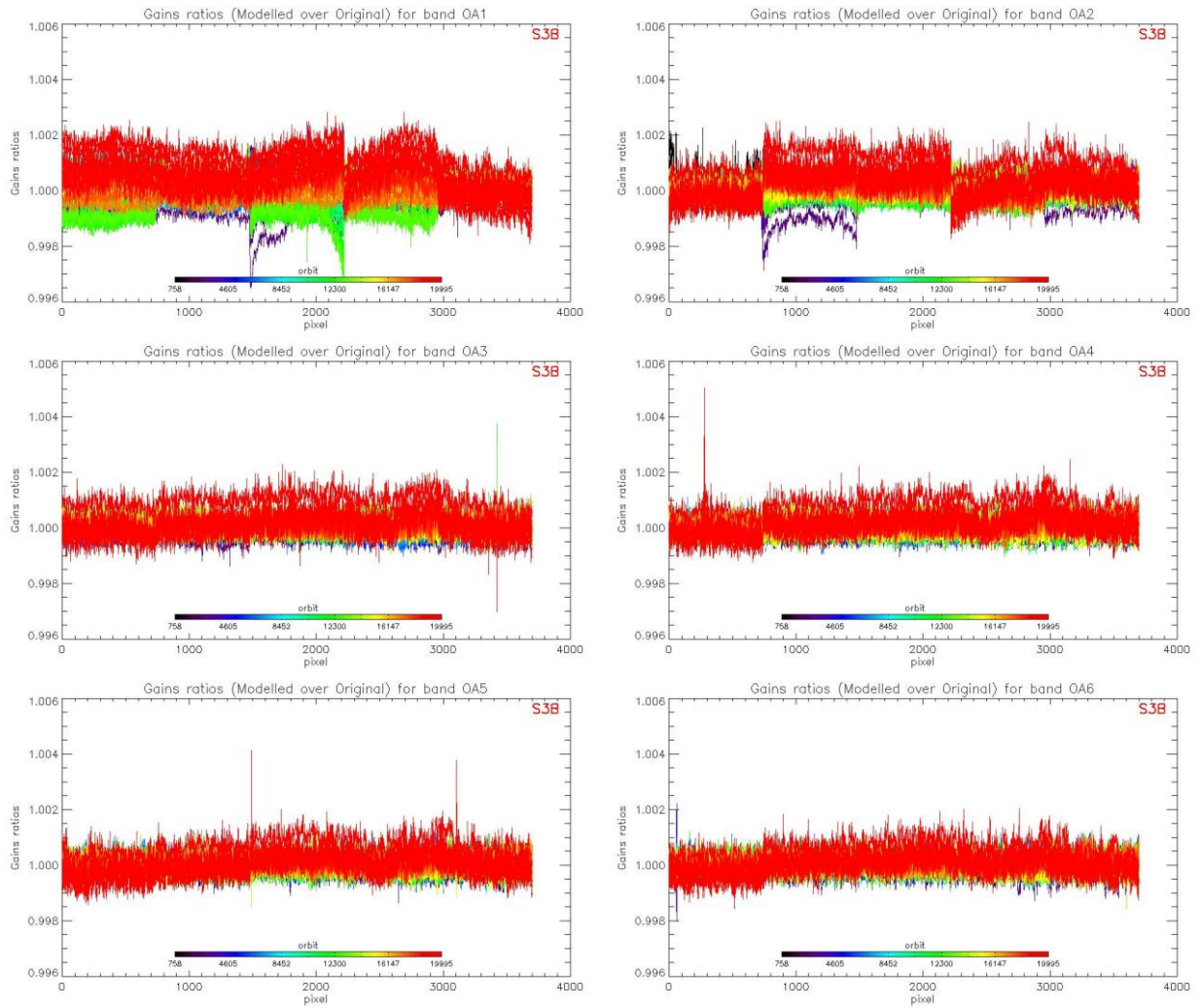


Figure 37 for channels Oa7 to Oa14.

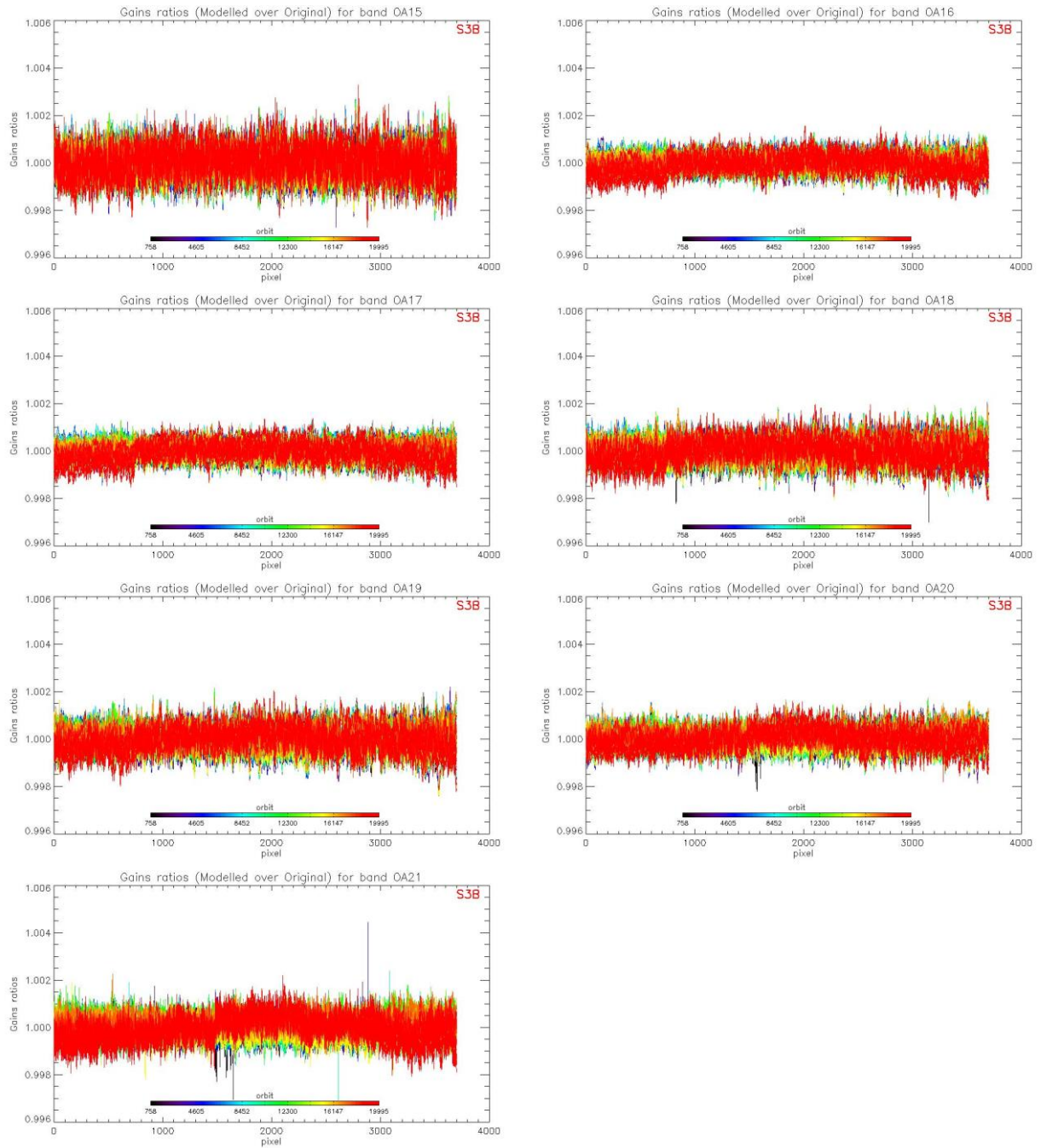


Figure 39: same as

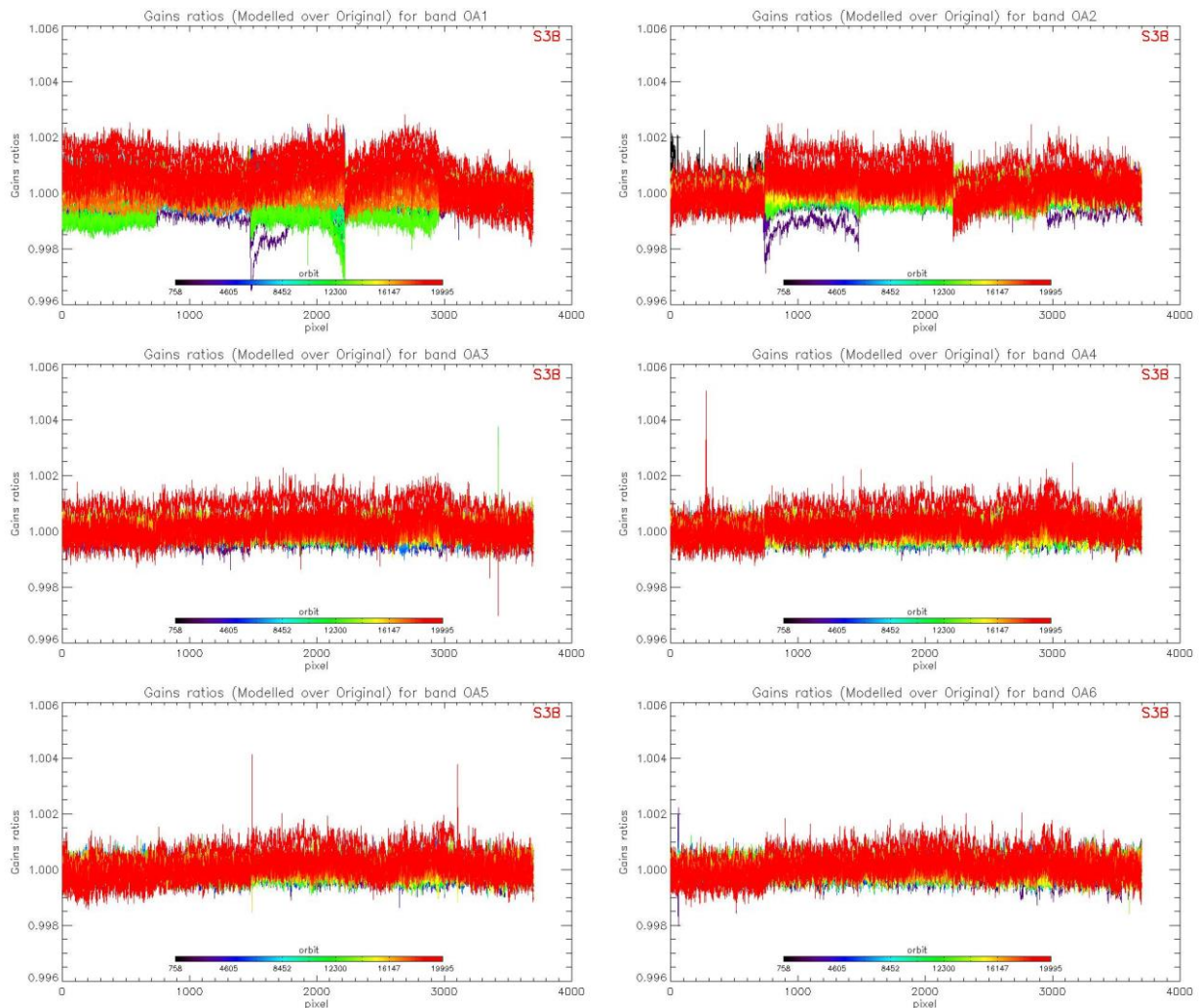


Figure 37 for channels Oa15 to Oa21.

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

2.2.3.1 OLCI-A


There has been no calibration sequence S05 (reference diffuser) for OLCI-A during the current reported period.

Consequently, the last ageing results, presented in January 2022 DQR, stay valid.

2.2.3.2 OLCI-B

There has been no calibration sequence S05 (reference diffuser) for OLCI-B during the current reported period.

Consequently, the last ageing results, presented in January 2022 DQR, stay valid.

	<p>Optical MPC</p> <p>Data Quality Report –Sentinel-3 OLCI</p>	<p>Ref.: OMPC.ACR.DQR.03.02-2022</p> <p>Issue: 1.1</p> <p>Date: 11/03/2022</p> <p>Page: 46</p>
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2.2.4 Updating of calibration ADF [OLCI-L1B-CV-260]

2.2.4.1.1 OLCI-A

No CAL_AX ADF has been delivered to PDGS during the report period for OLCI-A.

2.2.4.1.2 OLCI-B

No CAL_AX ADF has been delivered to PDGS during the report period for OLCI-B.

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

2.3.1 OLCI-A

There has been one S02+S03 Spectral Calibration for OLCI-A in the reporting period:

- ❖ S02 sequence (diffuser 1) on 17/02/2022 11:19 to 11:21 (absolute orbit 31266)
- ❖ S03 sequence (Erbium doped diffuser) on 17/02/2022 13:00 to 13:02 (absolute orbit 31267)

and one Spectral calibration S09:

- ❖ S09 sequence on 17/02/2022 09:04:54 to 09:05:00 (absolute orbit 31265)

The S02/S03 data have been processed and analysed to assess OLCI-A spectral long-term evolution. The absolute results are presented in Figure 40 while its long-term evolution is presented Figure 41.

The processing of the S09 calibration sequence (spectral calibration using O₂ absorption and Fraunhofer lines) is illustrated in Figure 43.

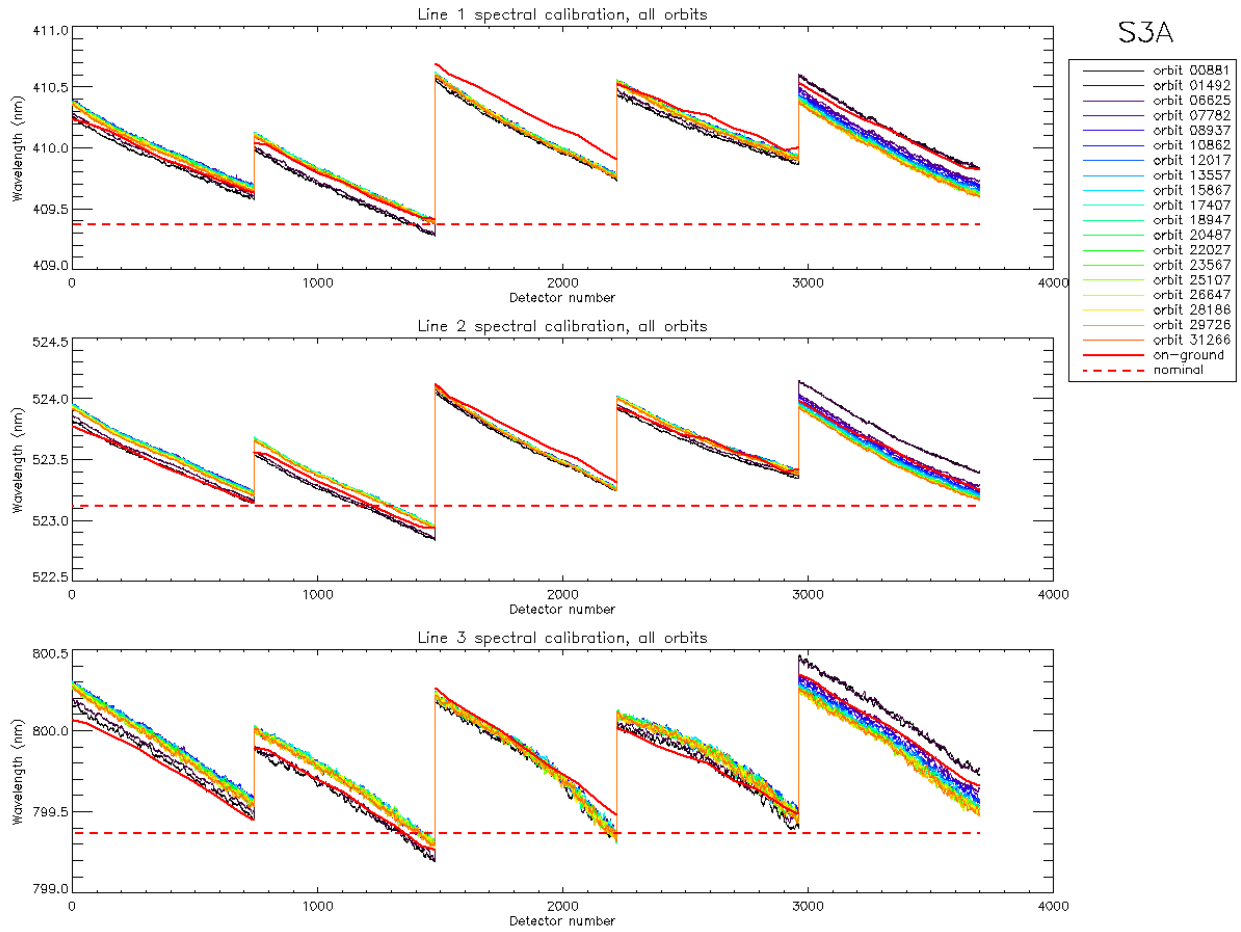


Figure 40: OLCI-A across track spectral calibration from all S02/S03 sequences since the beginning of the mission. Top plot is spectral line 1, middle plot is spectral line 2 and bottom plot spectral line 3. The nominal spectral calibration is plotted as a red horizontal dotted line and the on-ground spectral calibration as a red thick line.

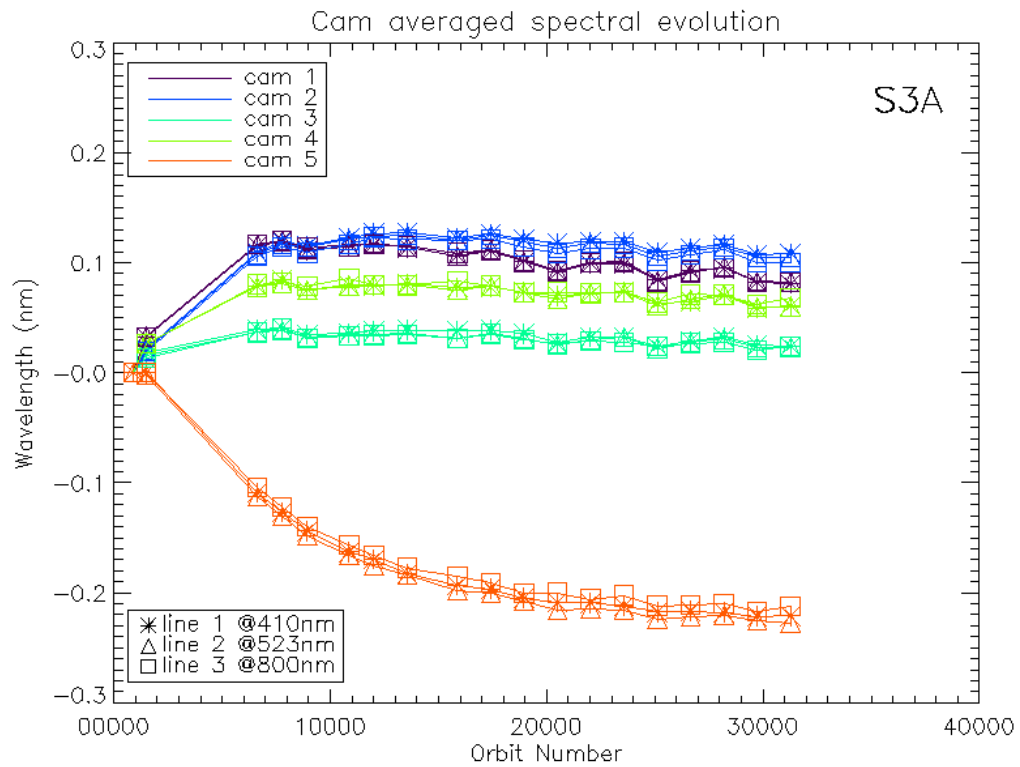


Figure 41: OLCI-A camera averaged spectral calibration evolution as a function of time since launch (all spectral S02/S03 calibrations since the beginning of the mission are included). The data are normalized with the first Spectral Calibration of the plot.

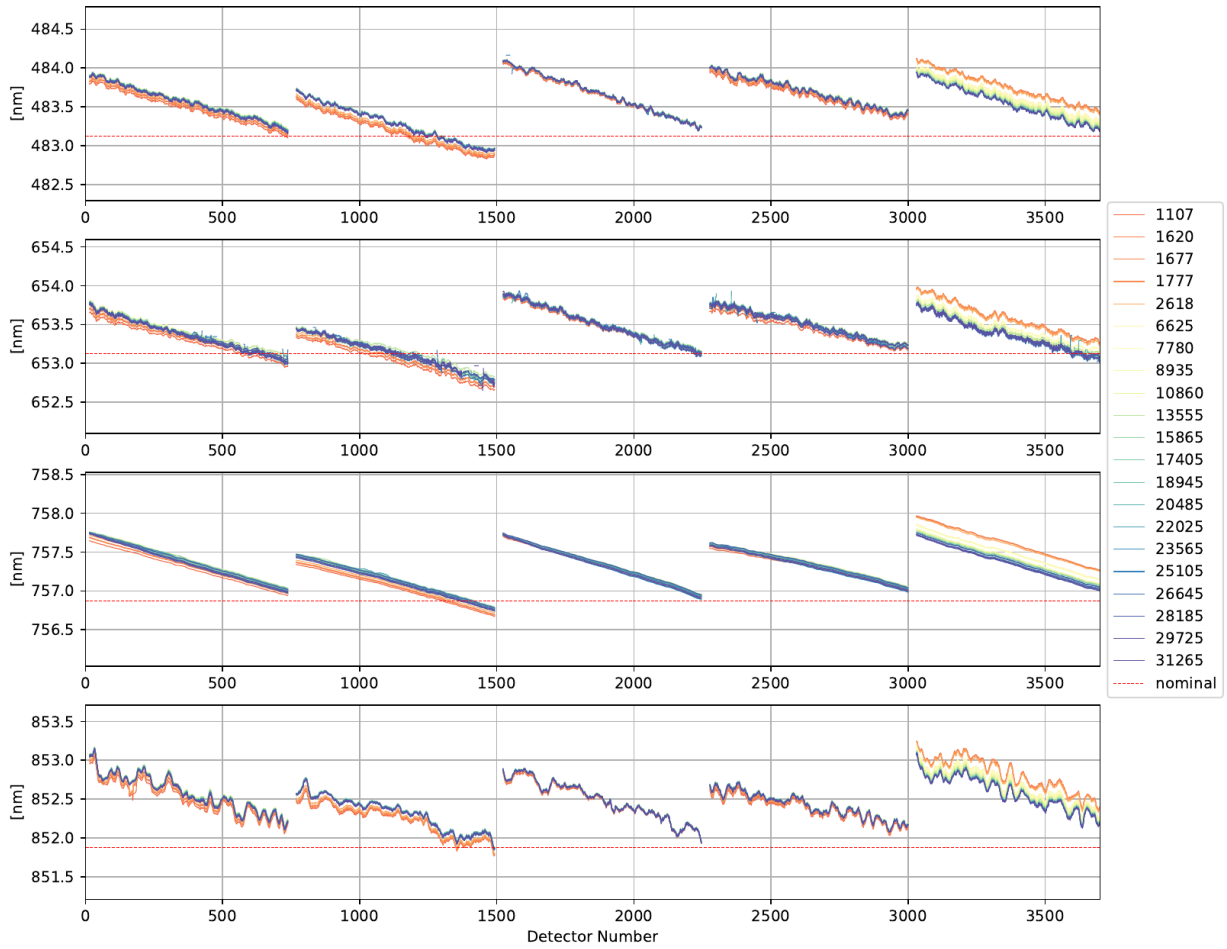


Figure 42: OLCI-A across track spectral calibration from all S09 sequences since the beginning of the mission. The used features are the atmospheric oxygen at 759nm and the Fraunhofer lines at 485nm, 656nm and 854nm. The nominal spectral calibration is plotted as a red dotted line.

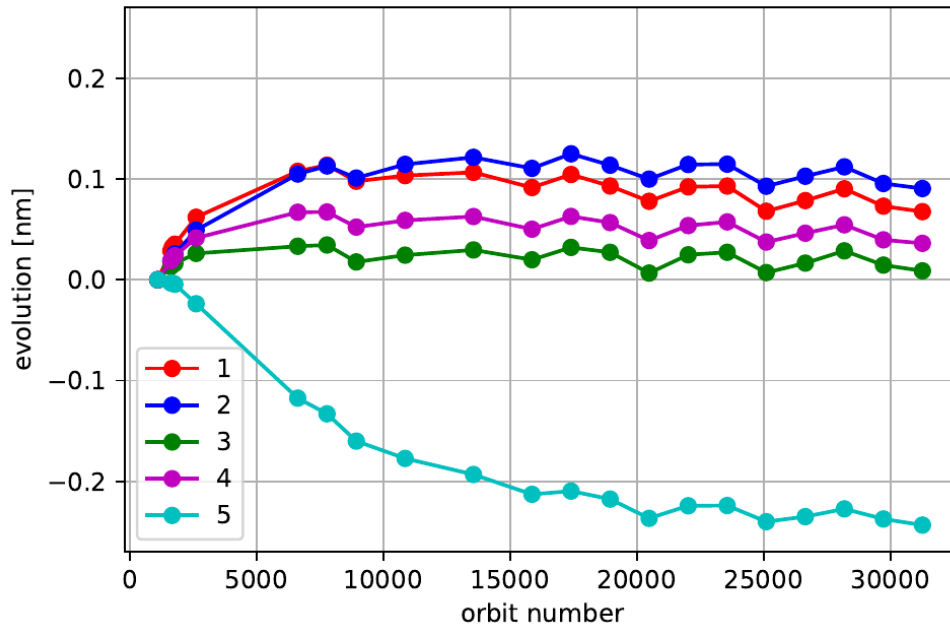


Figure 43: OLCI-A camera averaged spectral calibration evolution as a function of orbit number from S09 calibrations since the 4th May 2016. The last calibration for S09 is from 17 Feb 2022. For each camera, the spectral evolution corresponding derived from spectral lines at 485 nm, 656 nm, 770 nm and 854 nm have been averaged. The data are normalized with the first Spectral Calibration of the plot.

We see that the long term evolution of the spectral calibration obtained with sequence S09 (Figure 43) is in rather good agreement with the one obtained with sequence S02/S03 (Figure 41). Indeed, for camera 1, 2, 3 and 4, we observe for the two methods a positive trend of the spectral calibration at the beginning of the mission, which is now rather stabilized, and for camera 5, an obvious negative trend since almost the beginning of the mission which is also stabilizing but more progressively. In all cases, the spectral calibration drift since the beginning of the mission is smaller than ≈ 0.23 nm and the change with respect to the values included in the Auxiliary Data files is less than 0.1 nm. However, camera 5 still evolves but with a slower rate; only further monitoring will allow to assess the need for an evolution of the Auxiliary Parameters impacted by the instrument spectral model, reflecting the current or future state of the instrument.

2.3.2 OLCI-B

There has been one S02+S03 Spectral Calibration for OLCI-B in the reporting period:

- ❖ S02 sequence (diffuser 1) on 27/02/2022 11:19 to 11:21 (absolute orbit 20015)
- ❖ S03 sequence (Erbium doped diffuser) on 27/02/2022 13:00 to 13:02 (absolute orbit 20016)

and one Spectral calibration S09:

- ❖ S09 sequence on 27/02/2022 09:06:37 to 09:06:43 (absolute orbit 20014)

The S02/S03 data have been processed and analysed to assess OLCI-B spectral long-term evolution. The absolute results are presented in Figure 44 while its long term evolution is presented on Figure 45. The

processing of the S09 calibration sequence (spectral calibration using O₂ absorption and Fraunhofer lines) is now available and presented in Figure 46 and Figure 47.

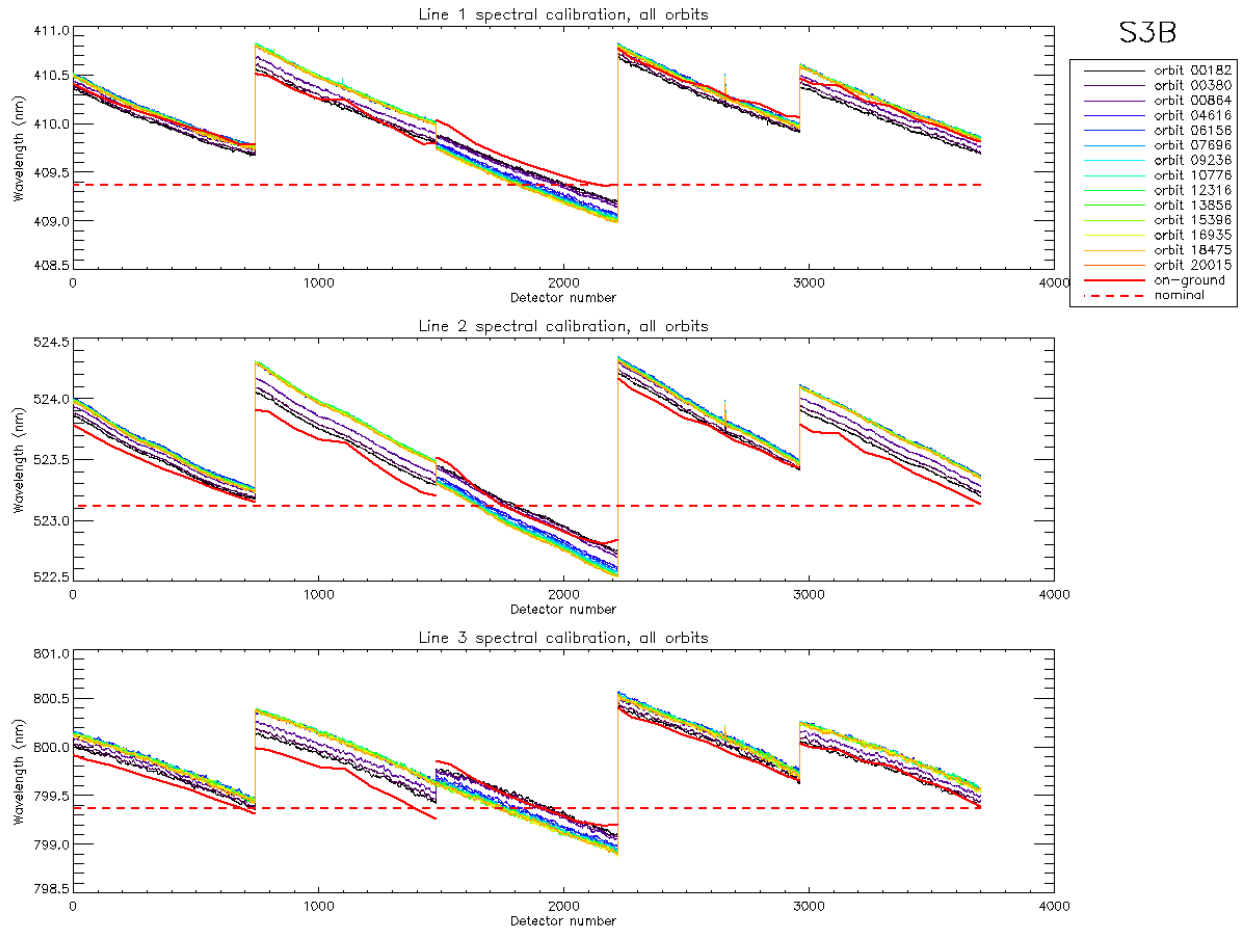


Figure 44: OLCI-B across track spectral calibration from all S02/S03 sequences since the beginning of the mission. Top plot is spectral line 1, middle plot is spectral line 2 and bottom plot spectral line 3. The nominal spectral calibration is plotted as a red dotted line and the on-ground spectral calibration as a red thick line.

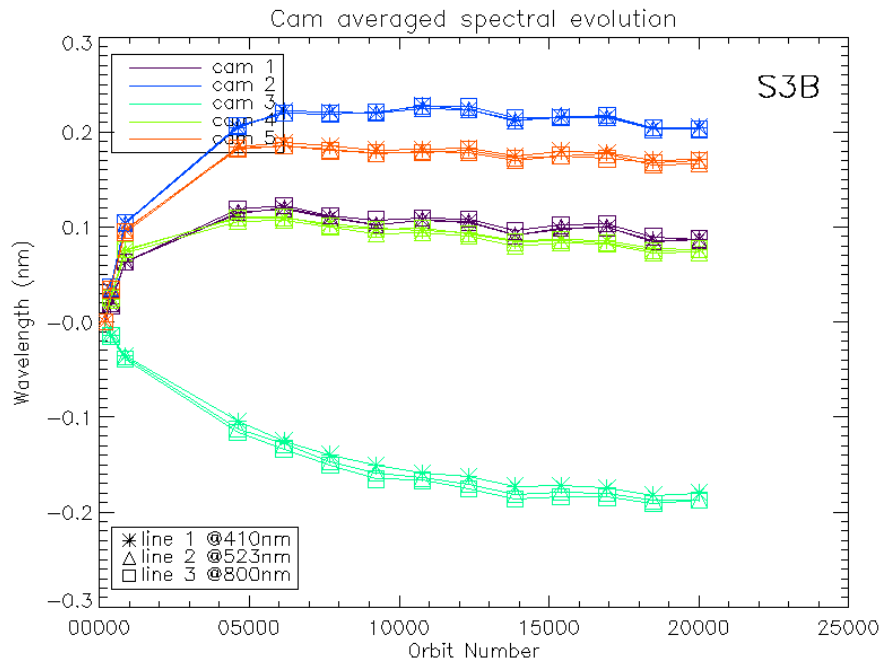


Figure 45: OLCI-B camera averaged spectral calibration evolution as a function of time since launch (all spectral S02/S03 calibrations since the beginning of the mission are included). The data are normalized with the first Spectral Calibration.

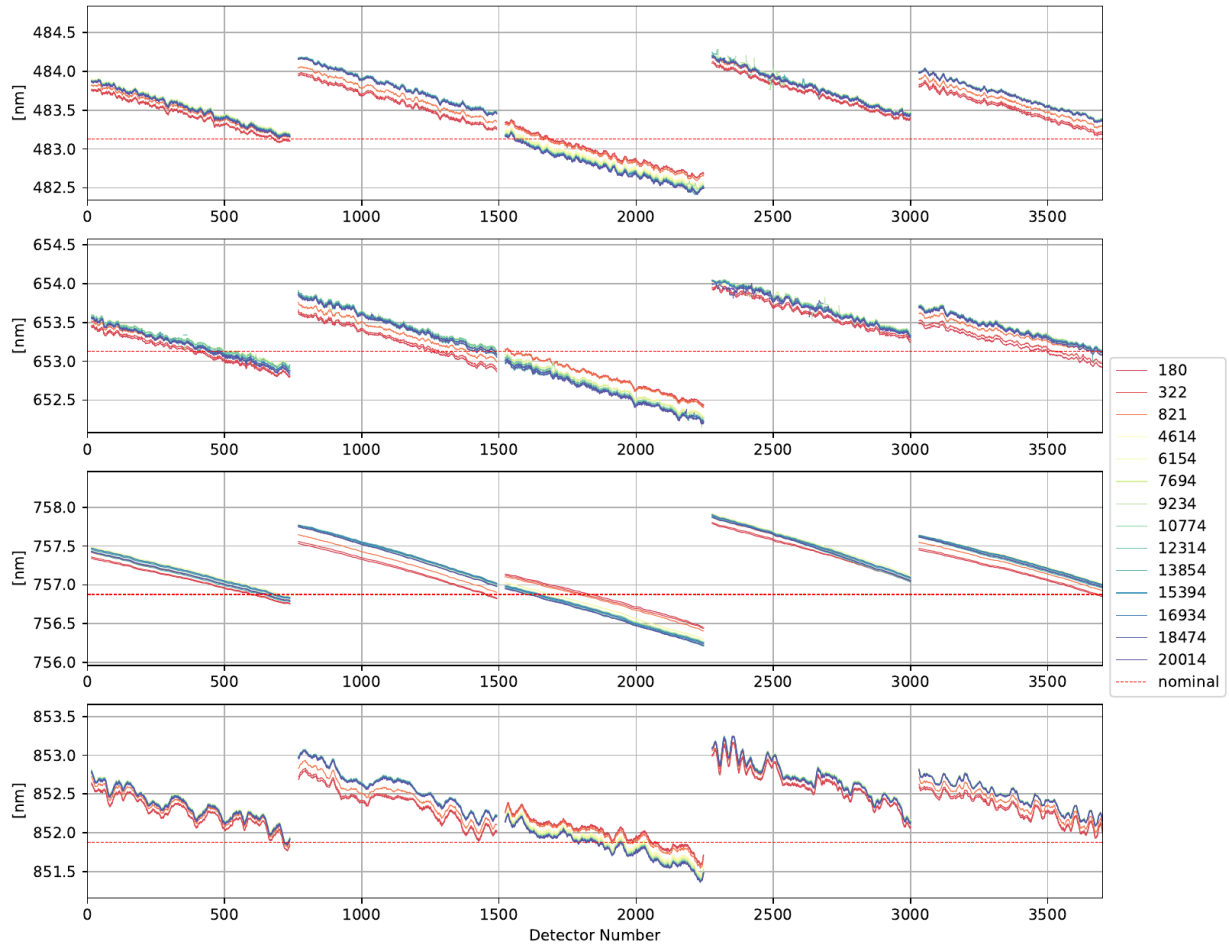


Figure 46: OLCI-B cross track spectral calibration from all (few during commissioning have been left out for the sake of clarity) S09 sequences since the beginning of the mission. The used features are the atmospheric oxygen at 759nm and the Fraunhofer lines at 485nm, 656nm and 854nm. The nominal spectral calibration is plotted as a red dotted line.

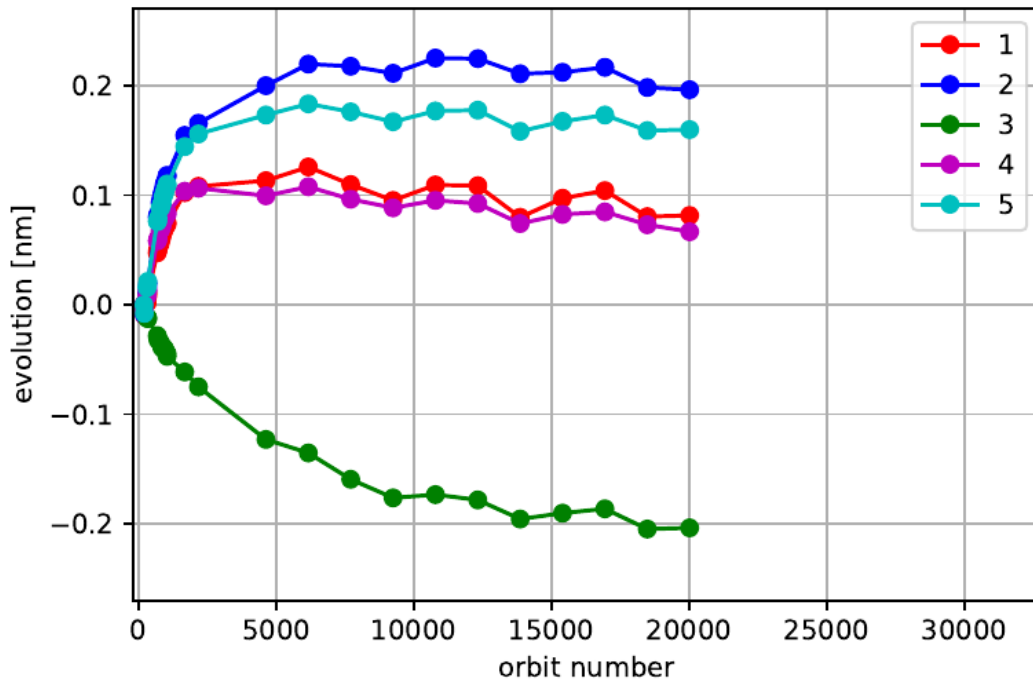


Figure 47: OLCI-B camera averaged spectral calibration evolution as a function of orbit number since launch from S09 calibrations since the beginning of the mission. The last calibration for S09 is from 27 Feb 2022. For each camera, the spectral evolution corresponding derived from spectral lines at 485 nm, 656 nm, 770 nm and 854 nm have been averaged. The data are normalized with the first Spectral Calibration.

Figure 44 to Figure 47 show that:

- ❖ As for OLCI-A camera 5, the wavelength calibration drift of OLCI-B camera 3 goes in the opposite direction than for the other cameras.
- ❖ It seems that the quick drift of the early mission has stabilized especially for camera 1, 2, 4 and 5. The stabilization for camera 3 is now also clearly visible even though it took more time to stabilize than for other camera.
- ❖ The results obtained with the S02/S03 method and the one obtained with the S09 method are rather similar.

The spectral calibration drift is smaller than ≈ 0.23 nm for all cases.

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 48.

SNR computed for all calibration data as a function of orbit number for band Oa01 (the less stable band) is presented in Figure 49.

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

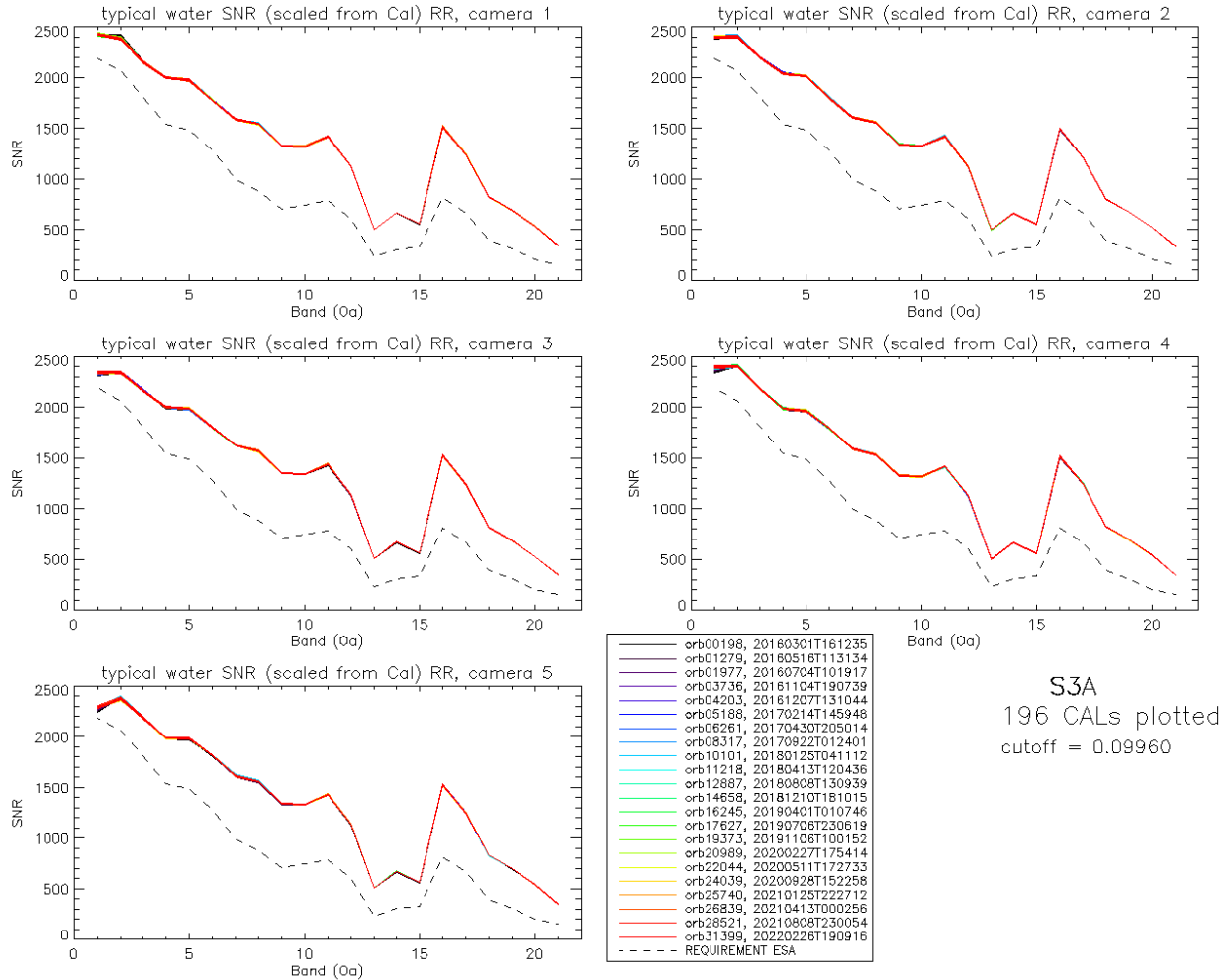


Figure 48: OLCI-A Signal to Noise ratio as a function of the spectral band for the 5 cameras. These results have been computed from radiometric calibration data. All calibrations except first one (orbit 183) are presents with the colours corresponding to the orbit number (see legend). The SNR is very stable with time: the curves for all orbits are almost superimposed. The dashed curve is the ESA requirement.

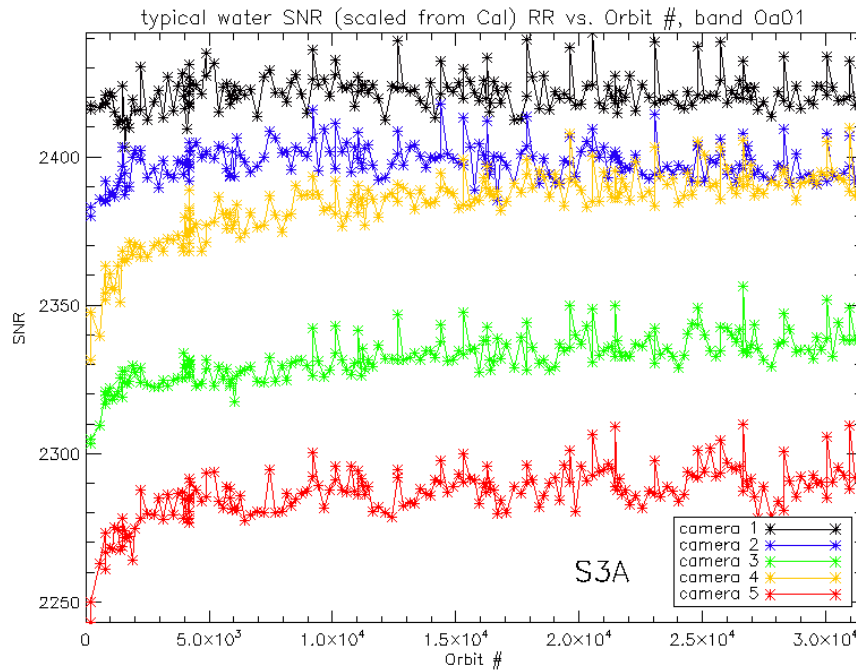


Figure 49: long-term stability of the SNR estimates from Calibration data, example of channel Oa01.

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.

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	avg	std
400.000	63.0	2188	2421	6.1	2398	6.2	2332	7.9	2383	12.0	2286	9.2	2364	6.9
412.000	74.1	2061	2387	9.3	2404	6.8	2339	4.9	2401	4.9	2380	9.0	2382	5.5
442.000	65.6	1811	2158	5.9	2196	6.0	2163	4.8	2185	4.1	2194	5.7	2179	4.0
490.000	51.2	1541	2000	4.6	2036	4.8	1998	4.2	1984	4.4	1988	4.5	2001	3.2
510.000	44.4	1488	1979	5.3	2014	4.9	1986	4.5	1967	4.4	1985	4.3	1986	3.5
560.000	31.5	1280	1775	4.5	1802	4.1	1803	4.7	1794	3.8	1818	3.3	1799	3.0
620.000	21.1	997	1591	4.1	1608	4.3	1624	3.1	1593	3.2	1615	3.5	1606	2.6
665.000	16.4	883	1546	4.1	1557	4.4	1567	3.9	1533	3.5	1561	3.7	1553	3.0
674.000	15.7	707	1328	3.4	1337	3.7	1350	2.8	1323	3.2	1343	3.5	1336	2.4
681.000	15.1	745	1319	3.6	1326	3.2	1338	2.7	1314	2.5	1334	3.4	1326	2.1
709.000	12.7	785	1420	4.2	1420	4.0	1435	3.3	1414	3.5	1431	3.1	1424	2.7
754.000	10.3	605	1127	3.1	1121	2.8	1136	3.2	1125	2.5	1139	2.7	1130	2.2
761.000	6.1	232	502	1.1	498	1.1	505	1.2	501	1.1	508	1.4	503	0.8
764.000	7.1	305	663	1.6	658	1.5	668	2.0	661	1.5	670	2.1	664	1.3
768.000	7.6	330	558	1.4	554	1.3	563	1.3	557	1.3	564	1.3	559	1.0
779.000	9.2	812	1516	4.7	1498	4.5	1526	5.2	1512	4.9	1527	4.9	1516	4.1
865.000	6.2	666	1244	3.5	1213	3.4	1239	3.8	1246	3.5	1250	2.8	1239	2.8
885.000	6.0	395	823	1.7	801	1.6	814	2.0	824	1.5	831	1.6	819	1.1
900.000	4.7	308	691	1.5	673	1.3	683	1.6	693	1.5	698	1.4	688	1.0
940.000	2.4	203	534	1.2	522	1.2	525	0.9	539	1.1	542	1.3	532	0.7
1020.000	3.9	152	345	0.9	337	0.8	348	0.7	345	0.8	351	0.8	345	0.5

2.4.1.2 OLCI-B

SNR computed for all OLCI-B calibration data (S01, S04 (but not the dark-only S04) and S05 sequences) as a function of band number is presented in Figure 50.

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 51.

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

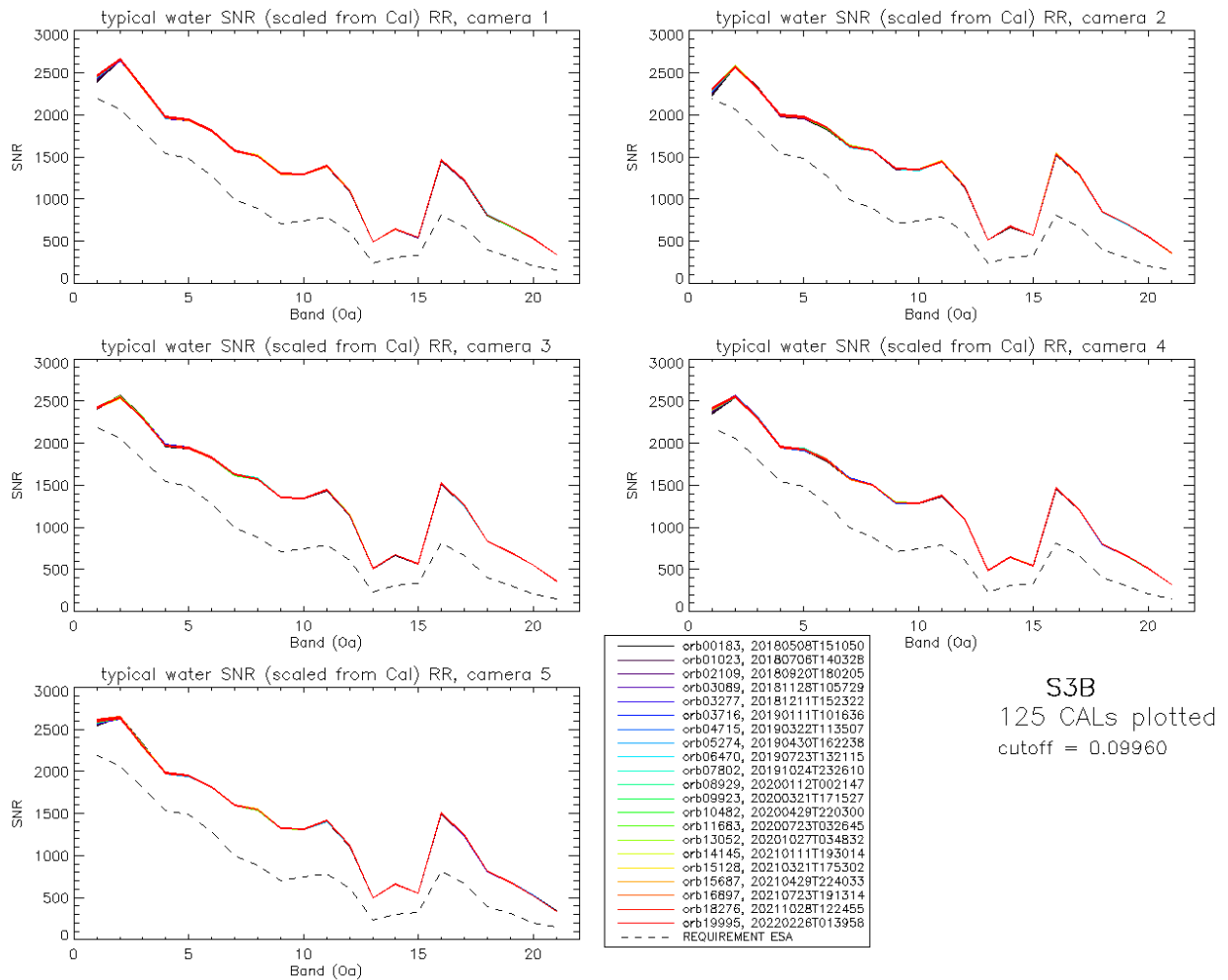


Figure 50: OLCI-B Signal to Noise ratio as a function of the spectral band for the 5 cameras. These results have been computed from radiometric calibration data. All calibrations except first one (orbit 167) are presents with the colours corresponding to the orbit number (see legend). The SNR is very stable with time: the curves for all orbits are almost superimposed. The dashed curve is the ESA requirement.

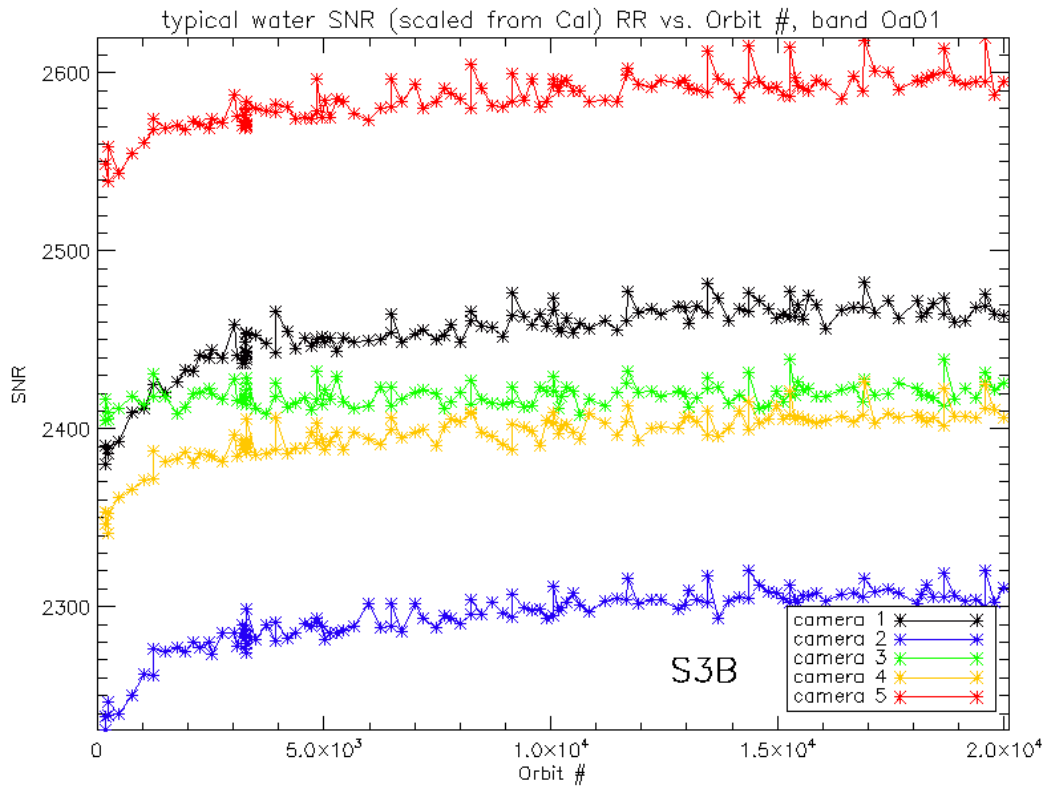


Figure 51: long-term stability of the OLCI-B SNR estimates from Calibration data, example of channel Oa1.

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	
	LU	RQT	avg	std	avg	std	avg	std	avg	std	avg	std	avg	std
400.000	63.0	2188	2453	19.1	2293	16.9	2419	6.3	2396	14.0	2585	14.1	2429	13.1
412.000	74.1	2061	2655	6.7	2569	6.0	2544	8.2	2550	6.0	2638	7.1	2591	5.1
442.000	65.6	1811	2324	6.4	2317	5.8	2300	6.3	2303	6.7	2309	6.3	2311	5.3
490.000	51.2	1541	1966	4.7	1989	5.6	1971	5.0	1952	4.6	1979	4.6	1972	3.8
510.000	44.4	1488	1939	4.8	1968	5.9	1943	4.9	1924	5.0	1951	4.8	1945	4.0
560.000	31.5	1280	1813	4.8	1848	5.1	1829	4.6	1804	4.9	1817	4.1	1822	3.7
620.000	21.1	997	1573	4.2	1626	4.6	1625	3.6	1576	3.6	1601	3.2	1600	2.8
665.000	16.4	883	1513	4.1	1579	3.8	1573	3.8	1501	3.0	1546	3.8	1543	2.8
674.000	15.7	707	1301	3.8	1358	3.5	1353	3.2	1292	2.7	1328	3.0	1326	2.3
681.000	15.1	745	1293	3.5	1347	3.2	1343	2.9	1285	2.7	1316	2.9	1317	2.1
709.000	12.7	785	1390	4.1	1447	4.1	1443	4.0	1373	2.9	1413	3.7	1413	3.0
754.000	10.3	605	1096	3.7	1143	3.7	1142	3.5	1089	2.9	1116	3.3	1117	2.9
761.000	6.1	232	487	1.2	509	1.2	509	1.4	485	1.2	498	1.4	498	1.0
764.000	7.1	305	643	1.6	672	2.0	672	1.9	641	1.7	658	1.9	657	1.5
768.000	7.6	330	541	1.5	568	1.5	564	1.4	541	1.4	555	1.6	554	1.1
779.000	9.2	812	1467	4.2	1535	4.7	1527	5.4	1467	4.1	1506	4.5	1501	3.9
865.000	6.2	666	1221	3.6	1287	3.8	1258	3.6	1205	3.6	1238	2.9	1242	2.9
885.000	6.0	395	808	2.3	847	1.8	834	1.9	799	1.7	815	2.1	821	1.5
900.000	4.7	308	679	1.5	714	1.9	704	1.7	670	1.6	683	1.5	690	1.2
940.000	2.4	203	527	1.3	549	1.5	551	1.3	510	1.1	522	1.3	532	0.9
1020.000	3.9	152	336	0.8	358	1.2	358	0.8	318	0.7	338	1.0	342	0.6

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 current reporting period. 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-A georeferencing performance is 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 and put in production on 30/07/2019.

The following figures (Figure 52 to Figure 57) 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 58 and Figure 59) 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 52), the across-track biases decrease significantly for all cameras (Figure 53 to Figure 57), the along-track bias reduces for at least camera 3 (Figure 55) 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).

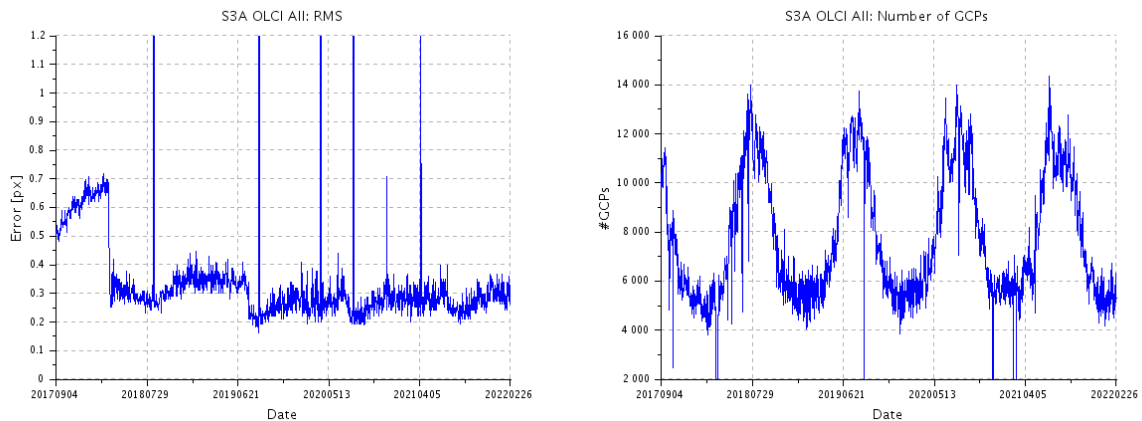


Figure 52: overall OLCI-A georeferencing RMS performance time series (left) and number of validated control points corresponding to the performance time series (right) over the whole monitoring period

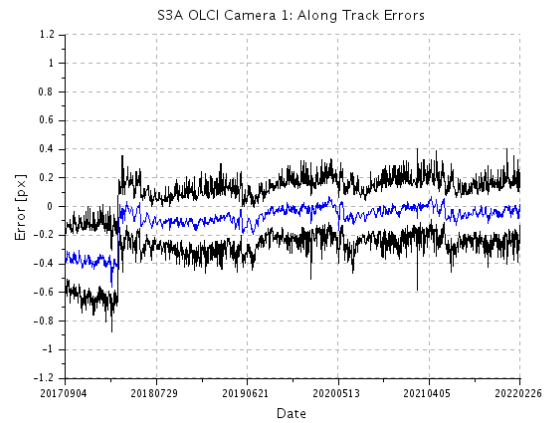
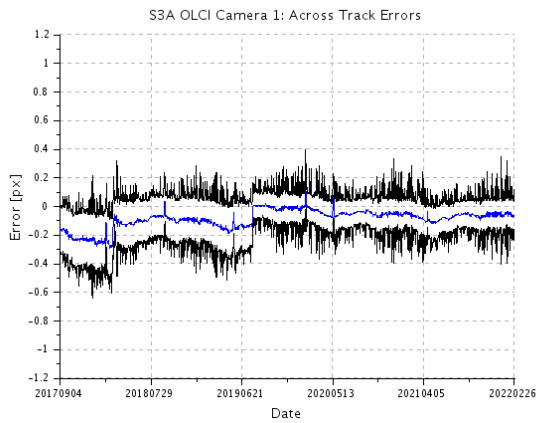


Figure 53: across-track (left) and along-track (right) OLCI-A georeferencing biases time series for Camera 1. Blue line is the average, black lines are average plus and minus 1 sigma.

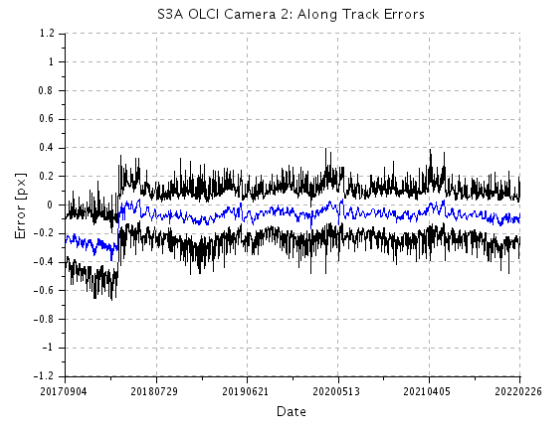
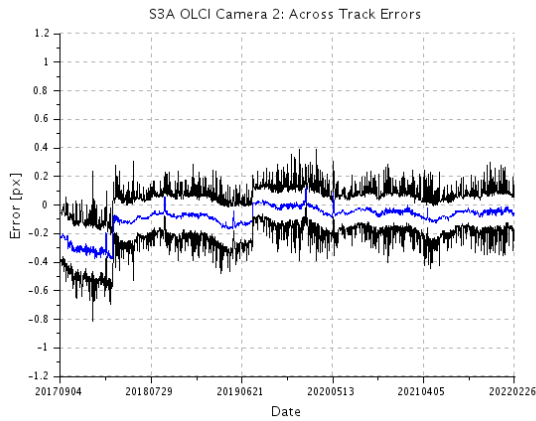


Figure 54: same as Figure 53 for Camera 2.

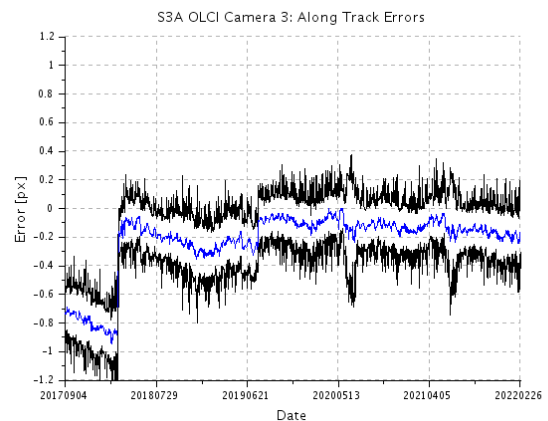
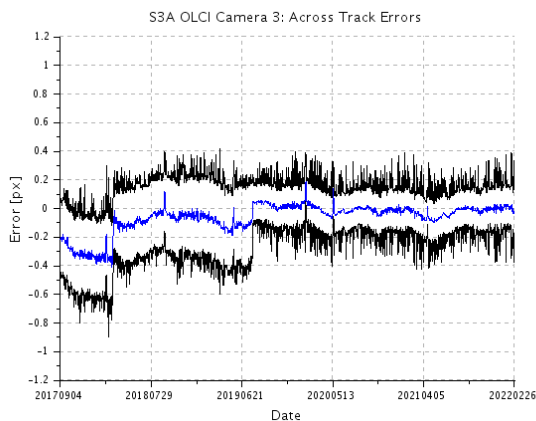


Figure 55: same as Figure 53 for Camera 3.

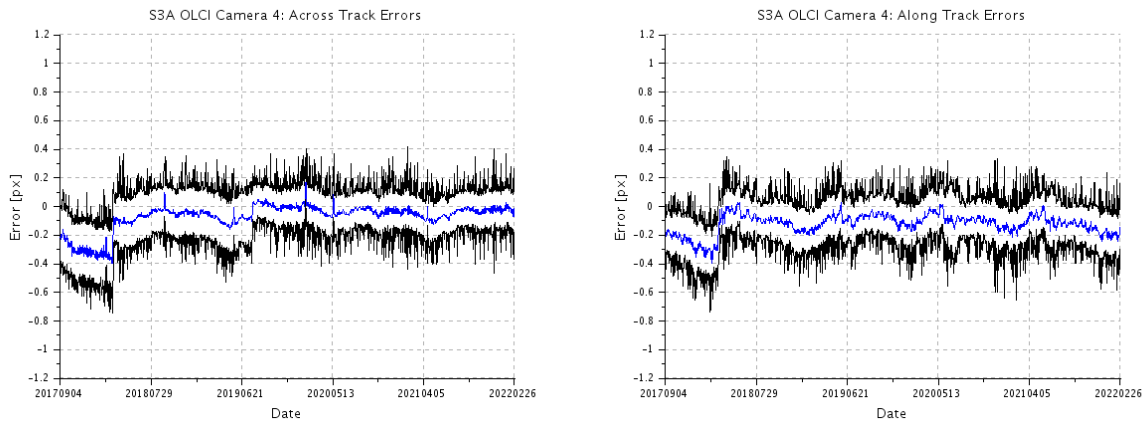


Figure 56: same as Figure 53 for Camera 4.

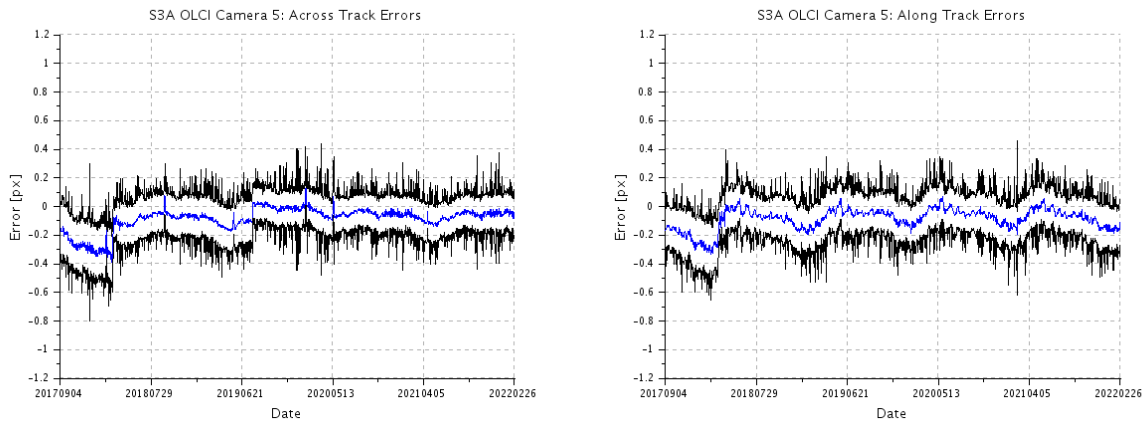


Figure 57: same as Figure 53 for Camera 5.

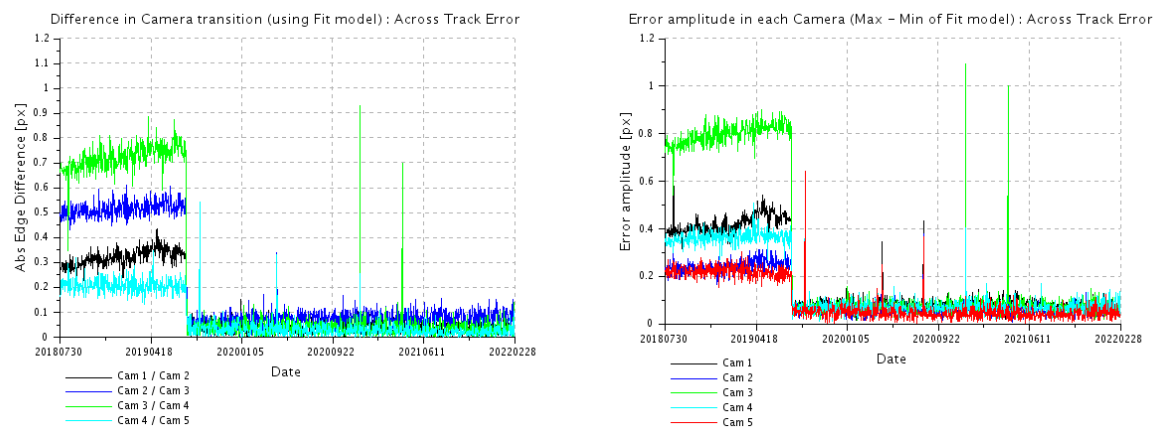


Figure 58: OLCI-A spatial across-track misregistration at each camera transition (left) and maximum amplitude of the across-track error within each camera (left).

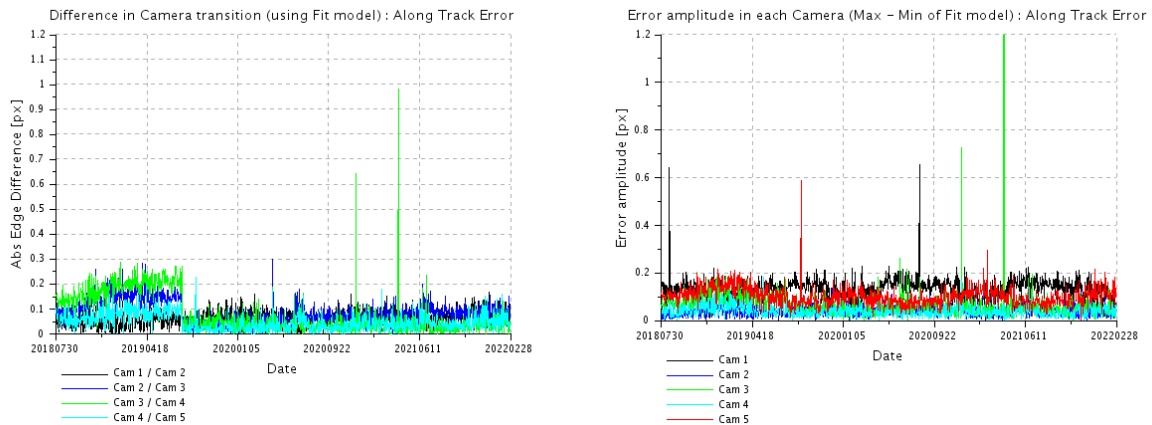


Figure 59: OLCI-A spatial along-track misregistration at each camera transition (left) and maximum amplitude of the along-track error within each camera (left).

2.5.2 OLCI-B

Georeferencing performance of OLCI-B improved significantly with the fourth geometric calibration introduced the 30/07/2019. However, the instrument pointing is still evolving, in particular for camera 2 (Figure 66) and a new geometric calibration has been done and introduced in the processing chain on the 16th of April 2020. Its impact is significant on the along-track biases of all cameras (Figure 61 to Figure 65), but also on the continuity at camera interfaces (Figure 66, left) and on intra-camera homogeneity (Figure 66, right). Since then, further adjustments to the geometric calibration have been introduced, mainly to correct the along-track drifts. The most recent was put in production on 29/07/2021 and its effect can be seen e.g. on left graphs of Figure 62, Figure 63 and Figure 65 (across-track biases of cameras 2, 3 & 5).

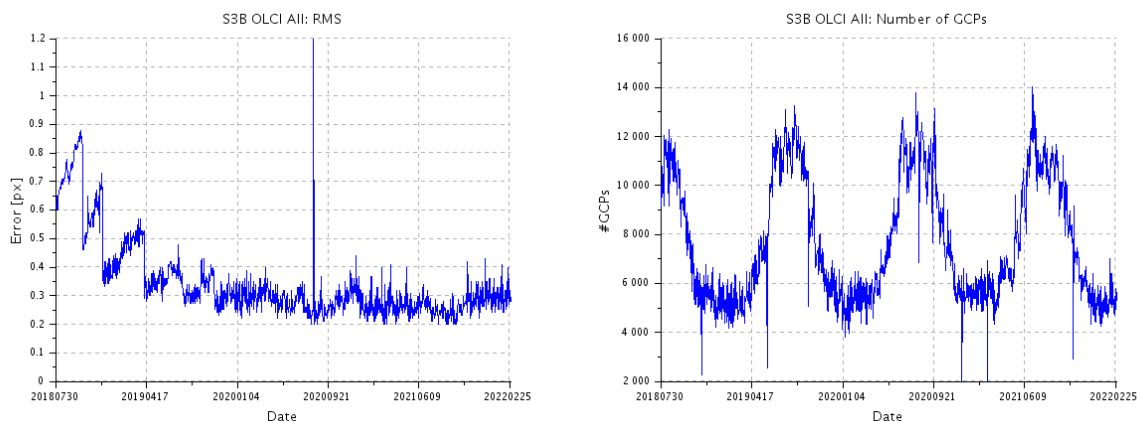


Figure 60: overall OLCI-B georeferencing RMS performance time series over the whole monitoring period (left) and corresponding number of validated control points (right)

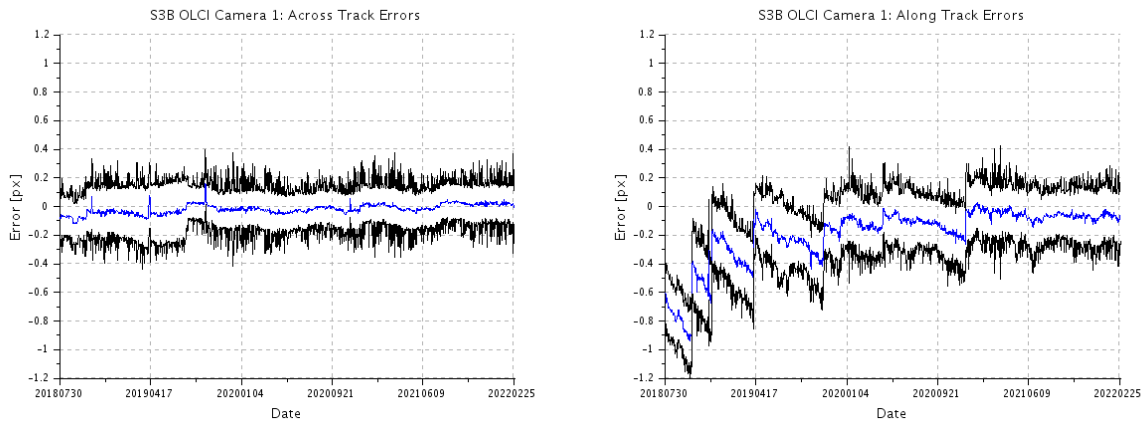


Figure 61: across-track (left) and along-track (right) OLCI-B georeferencing biases time series for Camera 1.

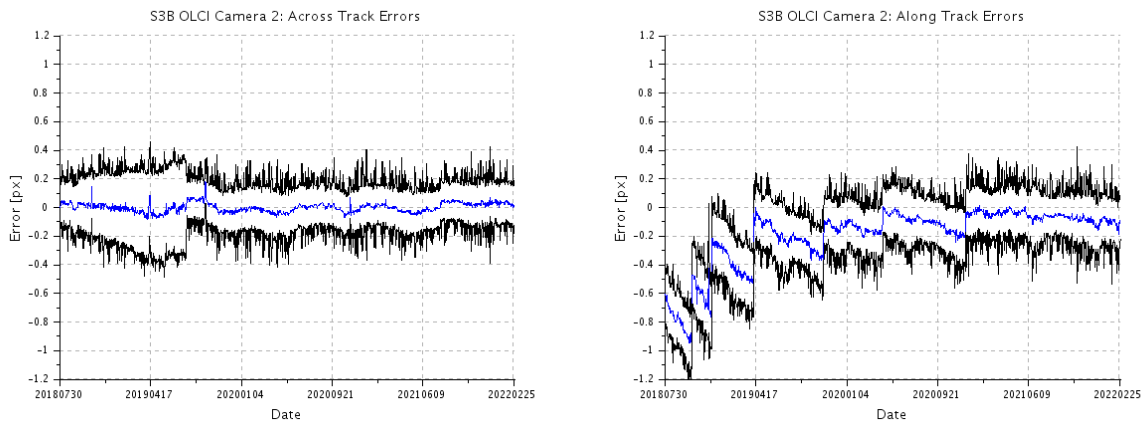


Figure 62: same as Figure 61 for Camera 2.

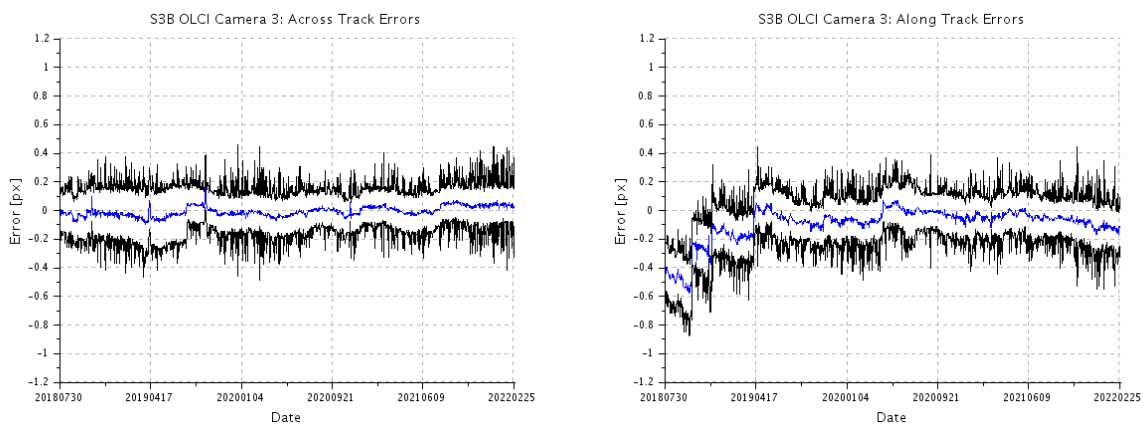


Figure 63: same as Figure 61 for Camera 3.

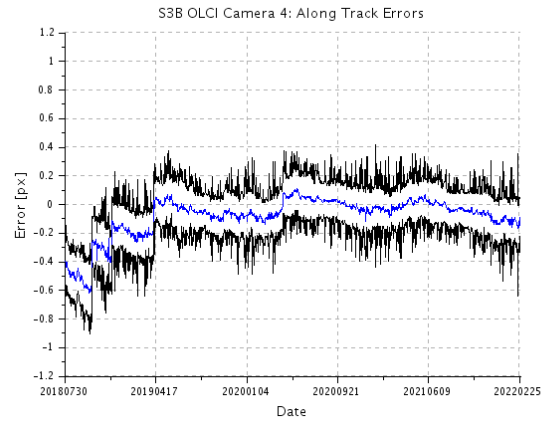
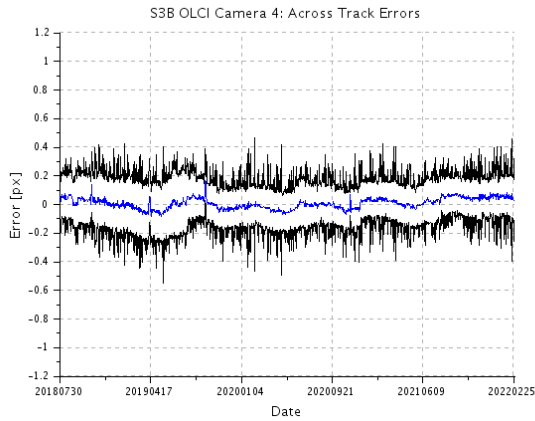


Figure 64: same as Figure 61 for Camera 4.

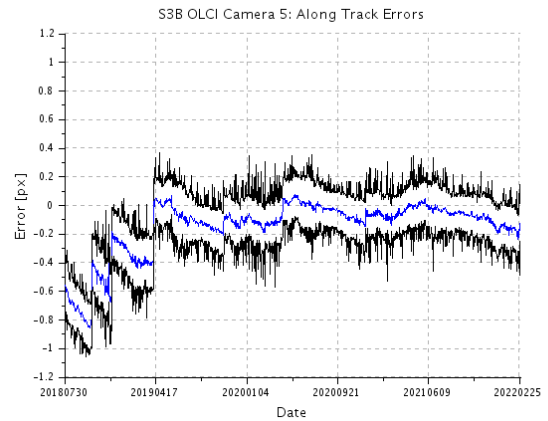
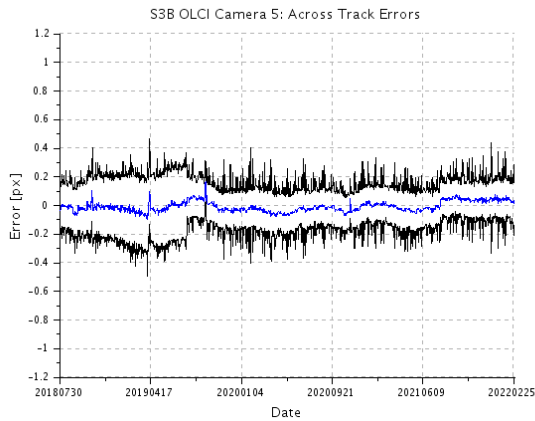


Figure 65: same as Figure 61 for Camera 5.

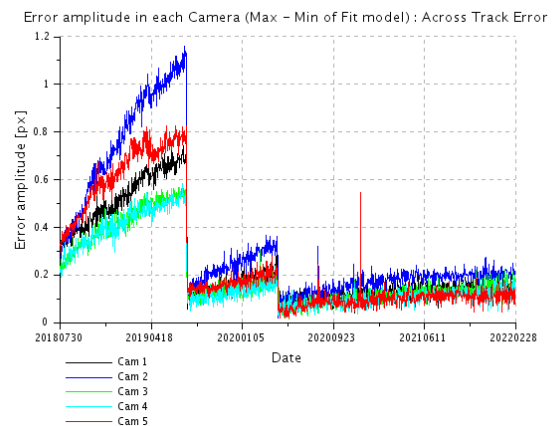
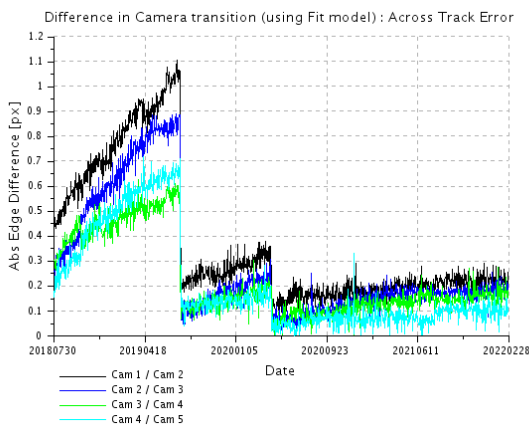


Figure 66: OLCI-B spatial across-track misregistration at each camera transition (left) and maximum amplitude of the across-track error within each camera (left).

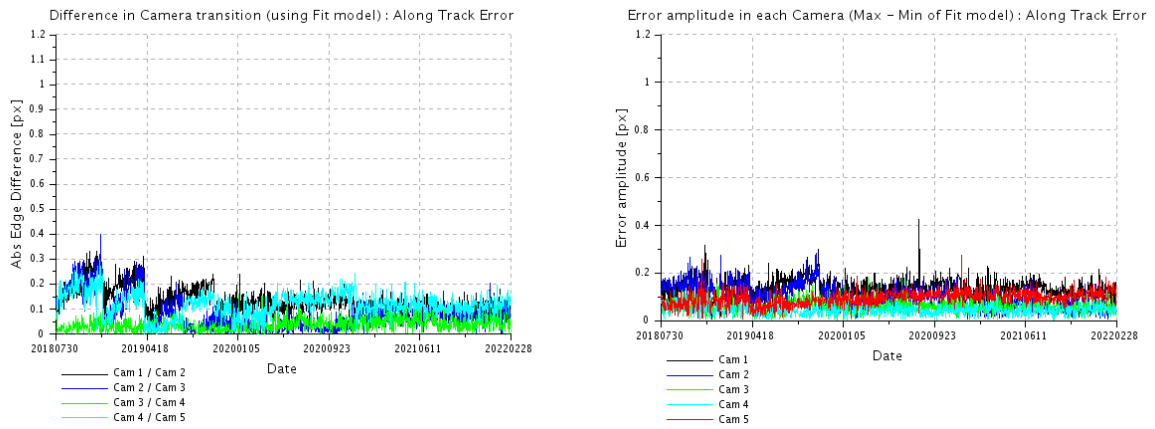



Figure 67: OLCI-B spatial along-track misregistration at each camera transition (left) and maximum amplitude of the along-track error within each camera (left).

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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://s3etrac.acri.fr/index.php?action=generalstatistics>.

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

For illustration, we provide below statistics on the number of S3ETRAC/OLCI records generated per type of targets (DESERT, SNOW, RAYLEIGH, SUNGLINT and DCC) for both OLCI-A (Figure 68) and OLCI-B (Figure 69).



Figure 68: 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).

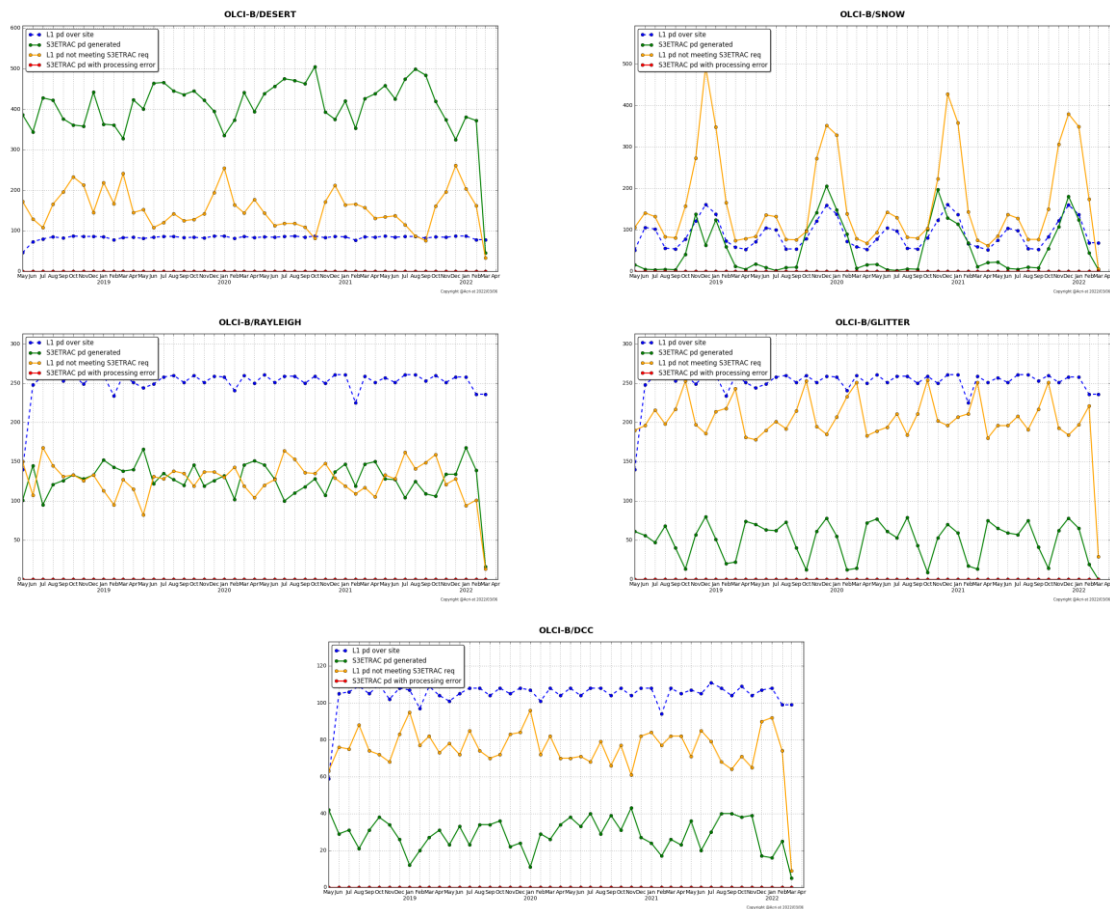


Figure 69: summary of S3ETRAC products generation for OLCI-B (number of OLCI-B L1 products Ingested, yellow – number of S3ETRAC extracted products generated, blue – number of S3ETRAC runs without generation of output product (data not meeting selection requirements), green – number of runs ending in error, red, one plot per site type).

3.1.2 Radiometric validation with DIMITRI

Highlights

OLCI-A and OLCI-B L1B radiometry verification as follow:

- ❖ The verification is performed over Ocean-sites **until 28th of February 2022** and over Desert-sites **until 30th of December 2021**.
- ❖ All results from OLCI-A and OLCI-B over Rayleigh, Glint and PICS are consistent with the previous cycle over the used CalVal sites.
- ❖ Good stability of both sensors OLCI-A and OLCI-B could be observed, nevertheless the time-series average shows higher reflectance from OLCI-A.
- ❖ Bands with high gaseous absorption are excluded.

Verification and Validation over PICS

1. The ingestion of all the available L1B-LN1-NT products from OLCI-A and OLCI-B over the 6 desert CalVal-sites (Algeria3 & 5, Libya 1 & 4 and Mauritania 1 & 2) has been performed until the **28th of February 2022**.
2. The results are consistent over all the six used PICS sites (Figure 70 and Figure 71). Both sensors show a good stability over the analysed period.
3. The temporal average over the period **January 2021 - 30th December 2021** of the elementary ratios (observed reflectance to the simulated one) for **OLCI-A** shows gain values between 2-4% over all the VNIR bands (Figure 72). Unlikely, the temporal average over the same period of the elementary ratios for **OLCI-B** shows gain values within 2% (mission requirements) over the VNIR spectral range (Figure 72). The spectral bands with significant absorption from water vapor and O₂ (Oa11, Oa13, Oa14, Oa15 and Oa20) are excluded.

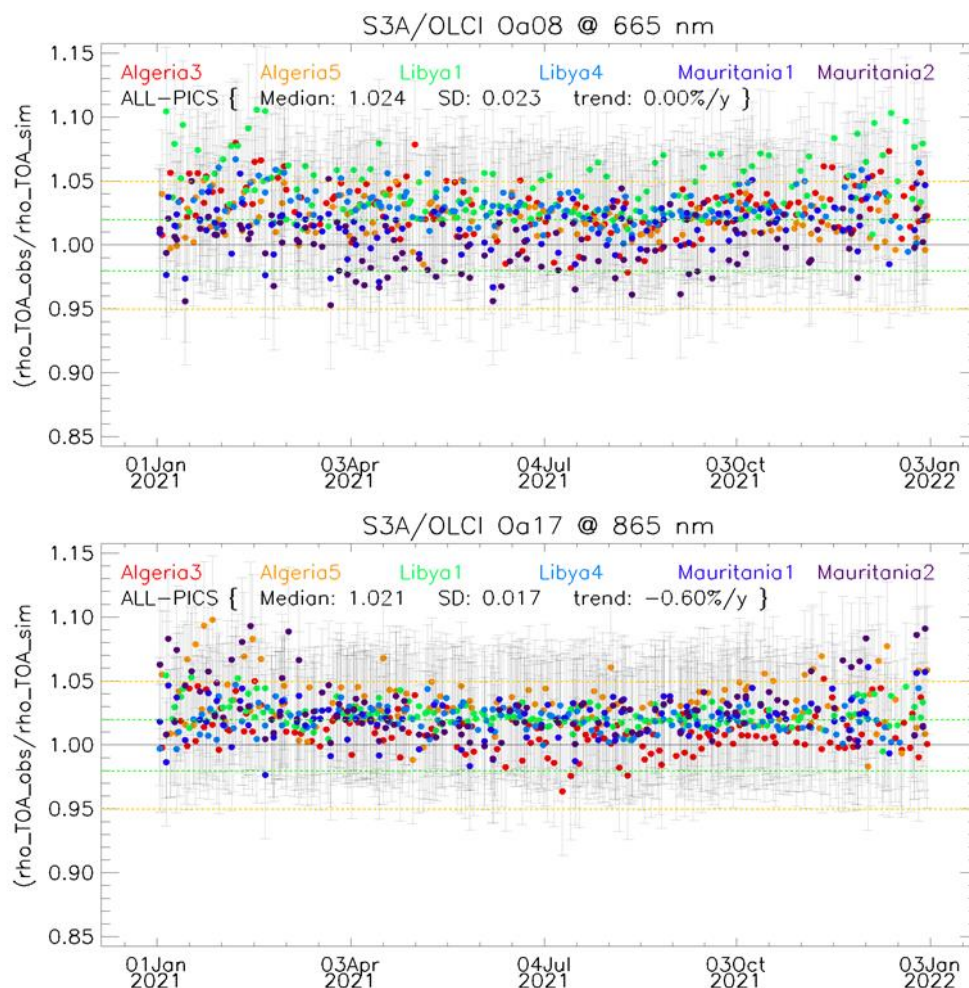


Figure 70: Time-series of the elementary ratios (observed/simulated) signal from OLCI-A for (top to bottom) bands Oa03 and Oa17 respectively over January 2021-Present from the six PICS Cal/Val sites. Dashed-green and orange lines indicate the 2% and 5% respectively. Error bars indicate the desert methodology uncertainty.

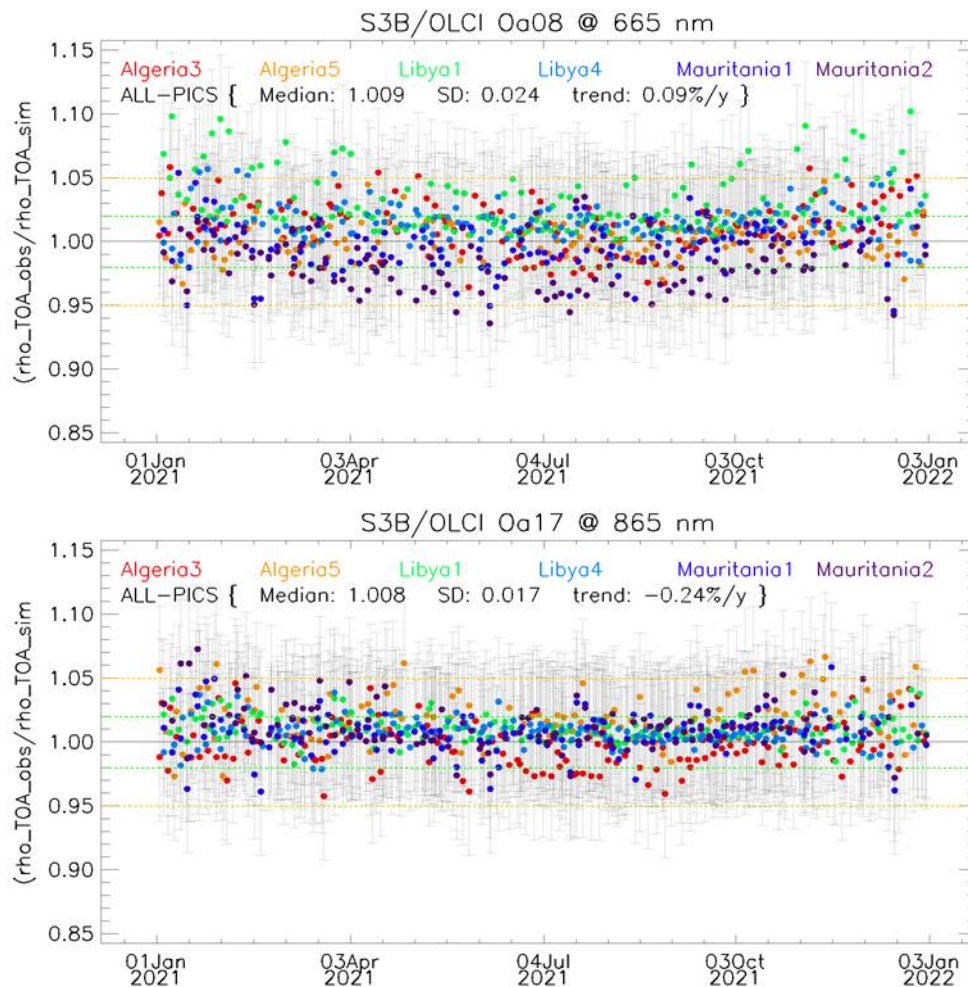


Figure 71: Time-series of the elementary ratios (observed/simulated) signal from OLCI-B for (top to bottom) bands Oa08 and Oa17 respectively over January 2021-Present from the six PICS Cal/Val sites. Dashed-green and orange lines indicate the 2% and 5% respectively. Error bars indicate the desert methodology uncertainty.

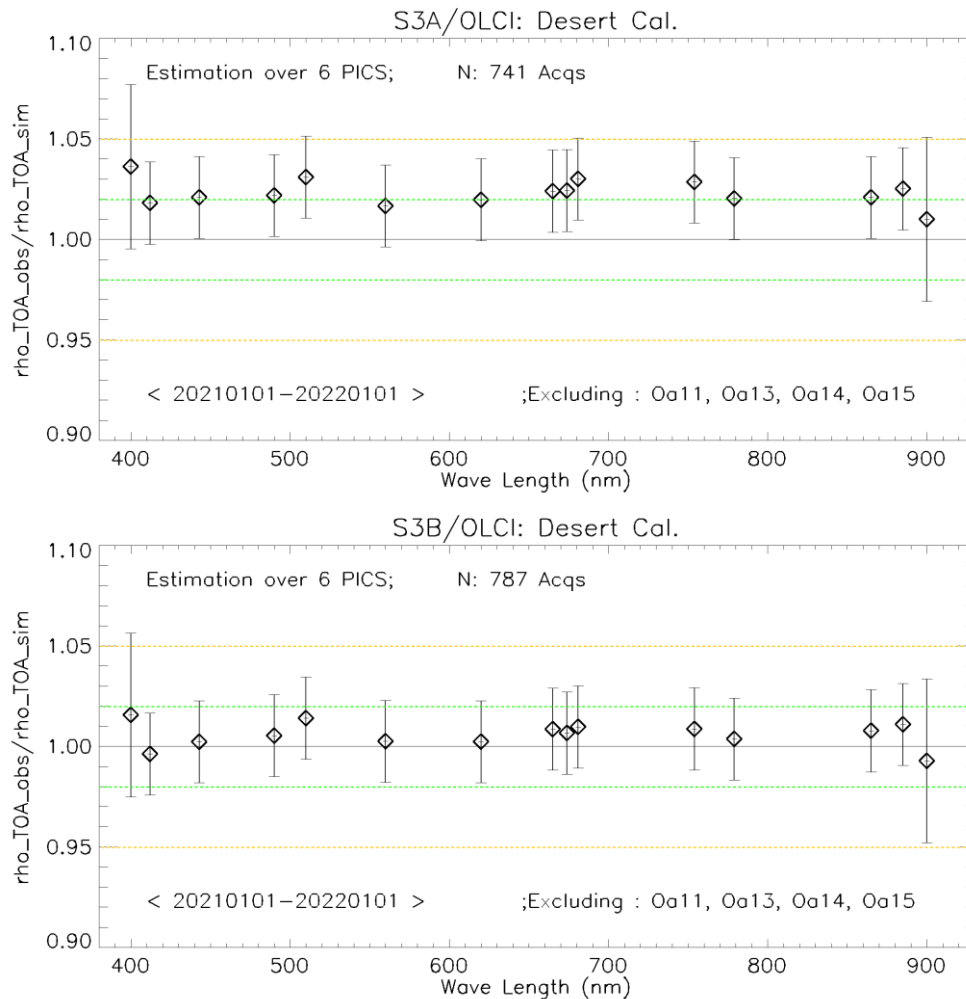


Figure 72: The estimated gain values for OLCI-A and OLCI-B over the 6 PICS sites identified by CEOS over the period January 2021-December 2021 as a function of wavelength. Dashed-green and orange lines indicate the 2% and 5% respectively. Error bars indicate the desert methodology uncertainty.

Validation over Rayleigh

Rayleigh method has been performed from the available mini-files over the **last 12 months** for OLCI-A and OLCI-B. The results were produced with the configuration (ROI-AVERAGE). The gain coefficients of OLCI-A are consistent with the previous results. Bands Oa01-Oa05 display biases values between 3%-5% while bands Oa06-Oa09 exhibit biases between about 2%, just within the mission requirement (Figure 73). The gain coefficients of OLCI-B are lower than OLCI-A ones, where bands Oa01-Oa05 display biases values about 2-5%, when bands Oa6-Oa9 exhibit biases around the 2% mission requirement (Figure 73).

Validation over Glint and synthesis

Glint calibration method with the configuration (ROI-PIXEL) has been performed over the **last 12 months** for OLCI-A and OLCI-B. The outcome of this analysis shows a good consistency with the desert and Rayleigh outputs over the NIR spectral range Oa06-Oa09 for both sensors. Glint results from OLCI-A show that the NIR bands are within the 2% (mission requirements), except Oa21 which shows higher biases more than

~5% for both sensors (see Figure 73). Again, the glint gain from OLCI-B looks slightly lower than OLCI-A one.

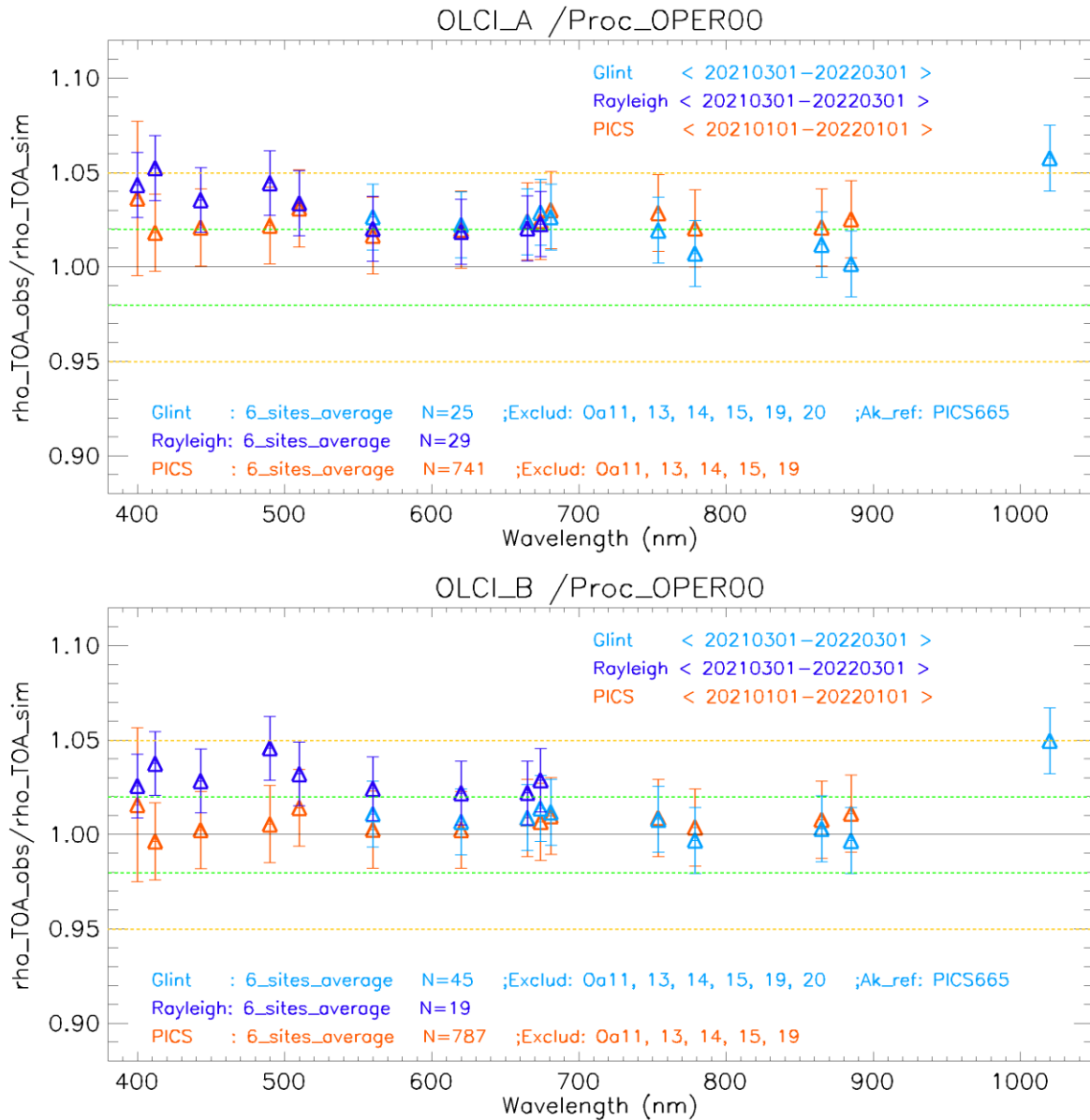


Figure 73: The estimated gain values for OLCI-A and OLCI-B from Glint, Rayleigh and PICS methods over the past twelve months as a function of wavelength. We use the gain value of Oa8 from PICS-Desert method as reference gain for Glint method. Dashed-green and orange lines indicate the 2% and 5% respectively. Error bars indicate the method uncertainties.

Cross-mission Intercomparison over PICS:

X-mission Intercomparison with MODIS-A MSI-A and MSI-B has been performed until October 2021.

Figure 74 shows the estimated gain over different time-series for different sensors over PICS. The spectral bands with significant absorption from water vapor and O₂ are excluded. OLCI-A seems to have higher gain wrt the other sensors, and about 1-2% higher gain wrt to OLCI-B over VNIR spectral range.

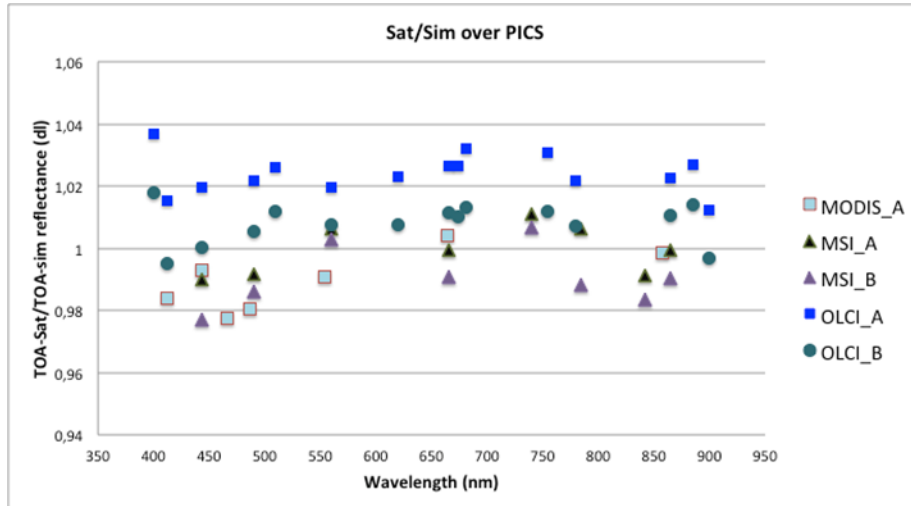


Figure 74: Ratio of observed TOA reflectance to simulated one for (green-yellow) S2A/MSI, (red) Aqua/MODIS, (blue) S3A/OLCI and (green) S3B/OLCI averaged over the six PICS test sites as a function of wavelength.

3.1.3 Radiometric validation with OSCAR

OSCAR Rayleigh results

The OSCAR Rayleigh have been applied to the S3A and S3B S3ETRAC data from the 6 oceanic calibration sites (Table 3) using a new chlorophyll climatology which has been derived from the CMEMS OLCI monthly CHL products from considering the years 2017, 2018 and 2019.

Table 3: S3ETRAC Rayleigh 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
AtIN	North of Atlantic	27	17	-44.2	-62.5
AtIS	South of Atlantic	-9.9	-19.9	-11	-32.3
IndS	South of Indian	-21.2	-29.9	100.1	89.5

In Figure 75 the average OSCAR OLCI-A and OLCI-B Rayleigh results are given for January 2022. In Figure 77 and Table 4 the average of all scenes currently (re)processed with this new climatology is given. The (re)processing was done on the S3ETRAC scenes from all months of 2019 and 2020, and Jan – Nov. 2021.

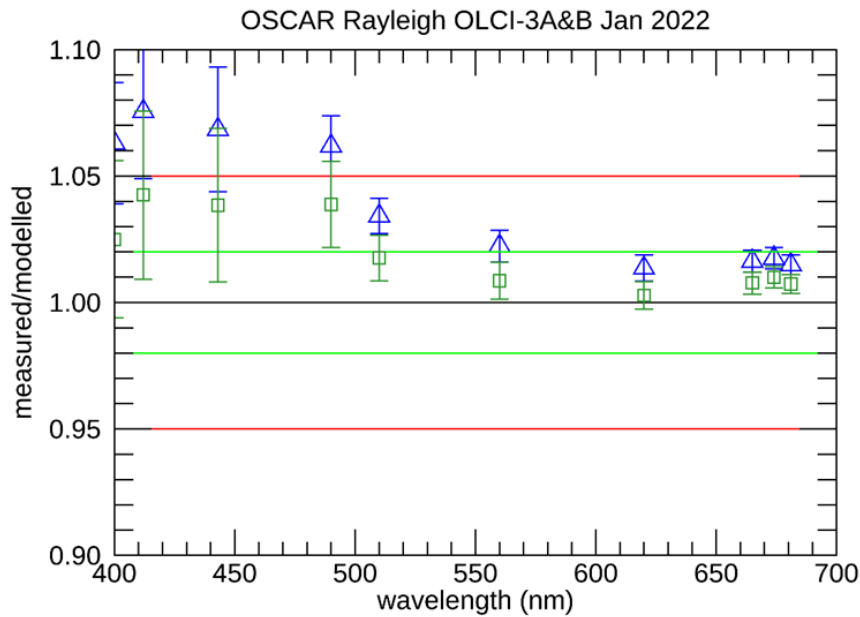


Figure 75: OSCAR Rayleigh S3A and S3B Calibration results as a function of wavelength for January 2022. The results are obtained with a new climatology derived from CMEMS OLCI monthly CHL products.

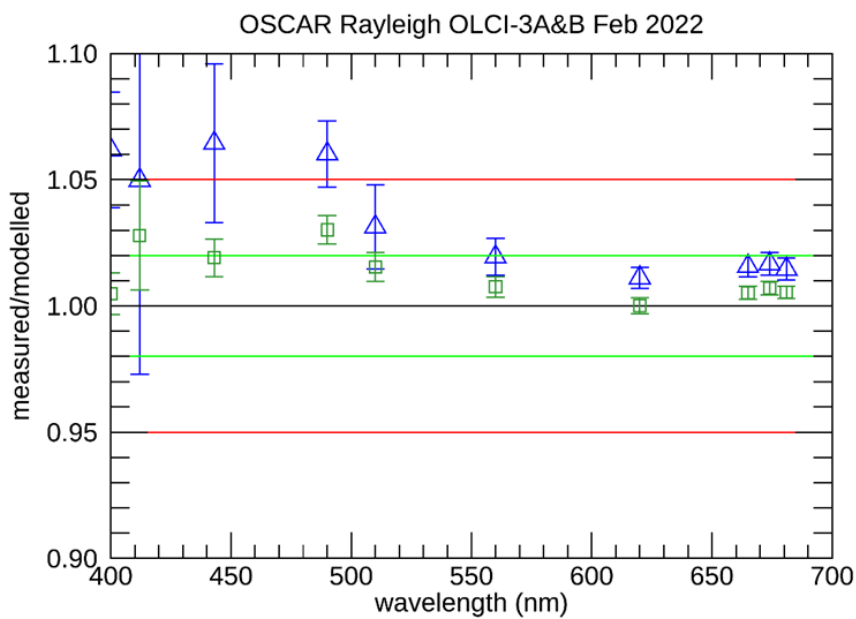


Figure 76: OSCAR Rayleigh S3A and S3B Calibration results as a function of wavelength for February 2022. The results are obtained with a new climatology derived from CMEMS OLCI monthly CHL products.

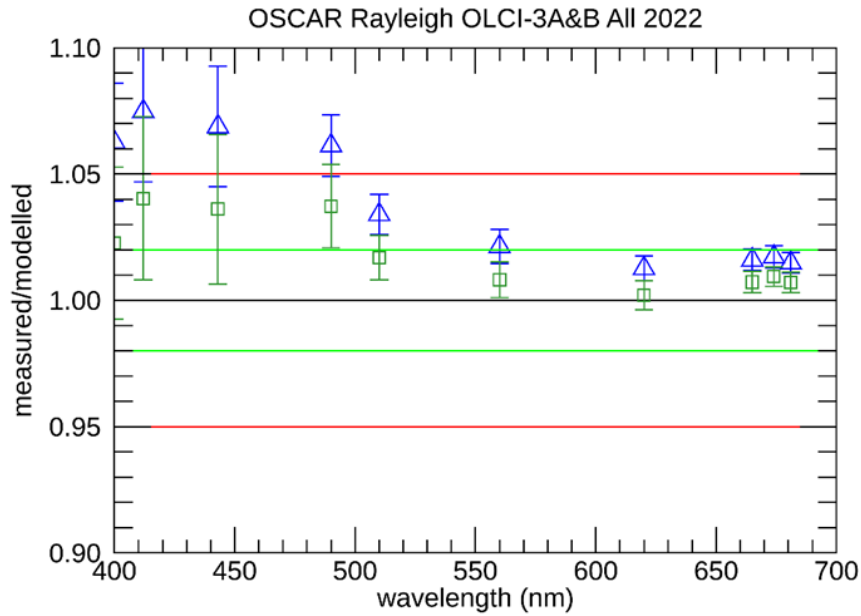


Figure 77. OSCAR Rayleigh S3A and S3B Calibration results as a function of wavelength for Jan – February 2022. Average and standard deviation over all scenes currently (re)processed with the new climatology.

Table 4. OSCAR Rayleigh calibration results for S3A and S3B (average and standard deviation over all acquisitions) over all scenes currently (re)processed with the new climatology and observed difference (in %) between OLCIA and OLCIB

OLCI band	Wavelength	Oscar Rayleigh OLCIA		Oscar Rayleigh OLCIB		% difference OLCIA and OLCIB
	(nm)	avg	stdev	avg	stdev	
Oa01	400	1.063	0.024	1.025	0.031	3.58%
Oa02	412	1.076	0.027	1.043	0.033	3.08%
Oa03	443	1.068	0.025	1.038	0.030	2.81%
Oa04	490	1.062	0.012	1.039	0.017	2.18%
Oa05	510	1.034	0.007	1.018	0.009	1.60%
Oa06	560	1.022	0.006	1.009	0.007	1.35%
Oa07	620	1.014	0.005	1.003	0.005	1.06%
Oa08	665	1.016	0.004	1.008	0.004	0.85%
Oa09	674	1.018	0.004	1.010	0.004	0.74%
Oa10	681	1.015	0.004	1.007	0.004	0.75%
Oa11	709	0.998	0.005	0.991	0.005	0.66%
Oa12	754	1.010	0.001	1.008	0.001	0.18%

3.1.4 Radiometric validation with Moon observations

Currently only 2 OLCI lunar acquisitions are processed adequately to contribute to Radiometric Validation. One for OLCI-A, taken at 04/07/2020 and one for OLCI-B, recorded 27/07/2018. Both measurements are compared with the LIME model and plotted in Figure 78. The difference between both OLCI Lunar measurements is plotted in Figure 79. In both plots a +/-2% uncertainty is plotted on top of the results as a reference to the model.

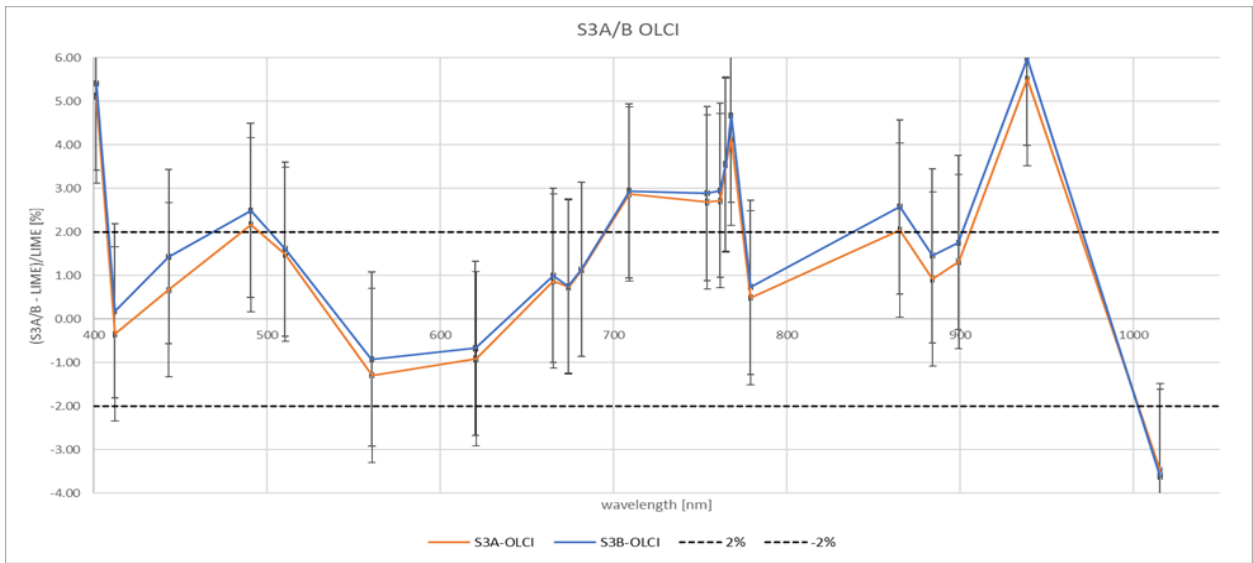


Figure 78. Comparison between OLCI A&B and LIME

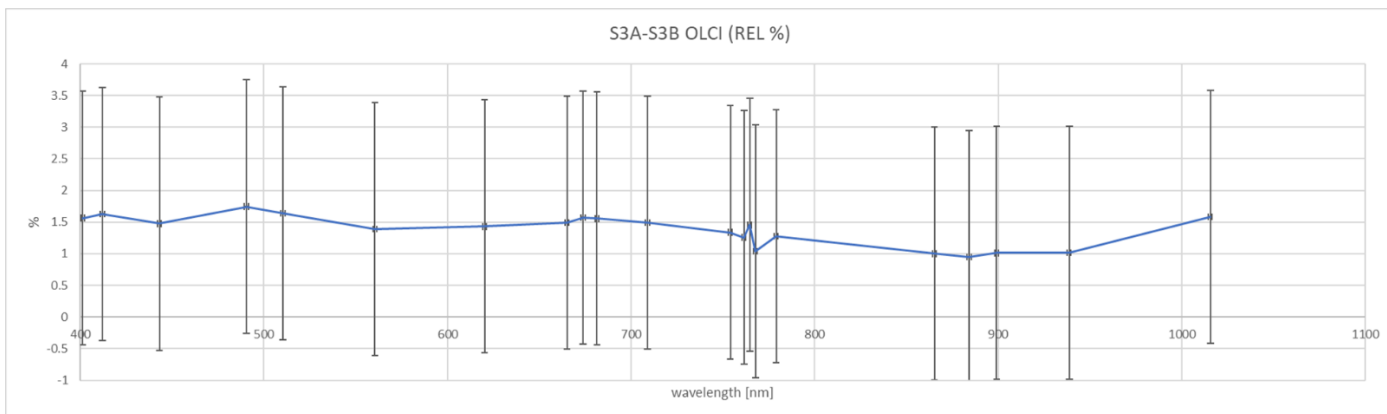


Figure 79. Difference between OLCI A&B compared with LIME

4 Level 2 Land products validation

4.1 [OLCI-L2LRF-CV-300]

4.1.1 Routine extractions

- ❖ The focus for this time period has been on the rolling archive Non Time Critical (NT) data until the 3rd of December 2021. 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.

4.1.1.1 OLCI-A

Figure 80 to Figure 89 below present the Core Land Sites OLCI-A time series over the current period.

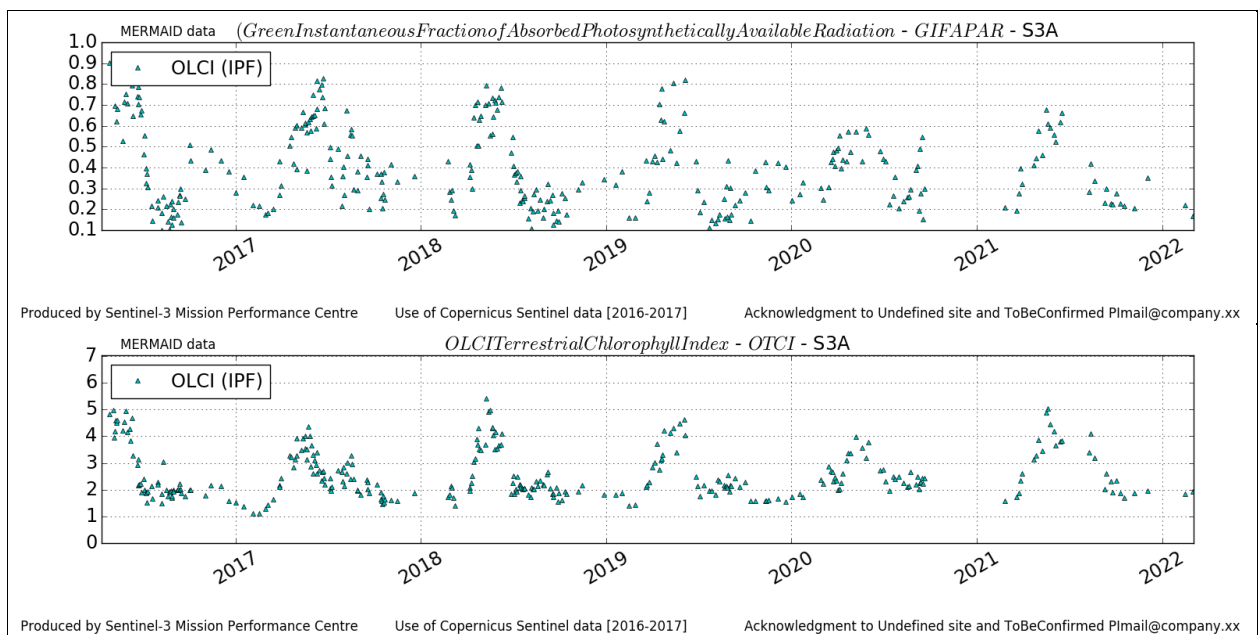


Figure 80: DeGeb time series over current report period

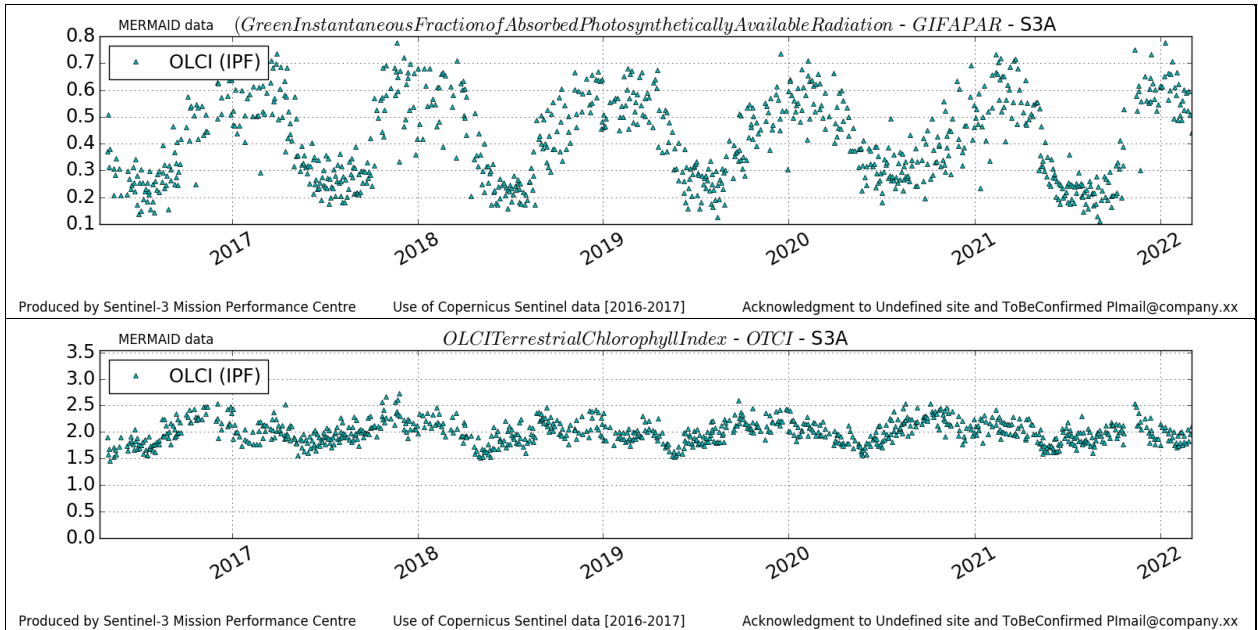


Figure 81: ITCat time series over current report period

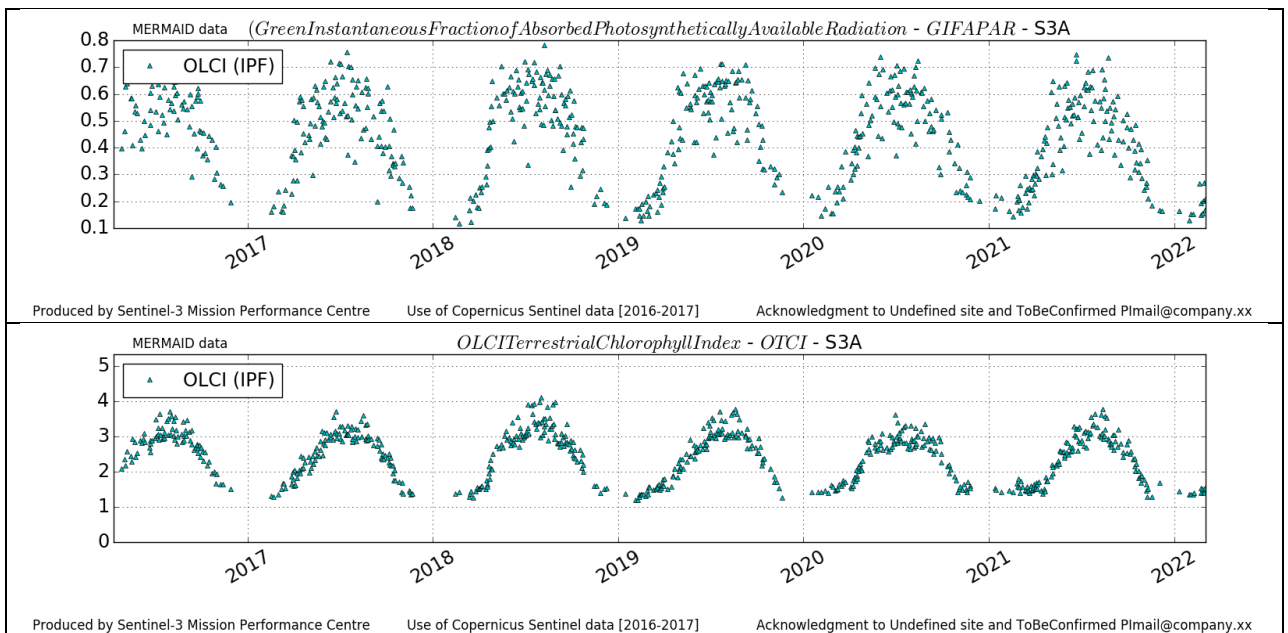


Figure 82: ITIsp time series over current report period

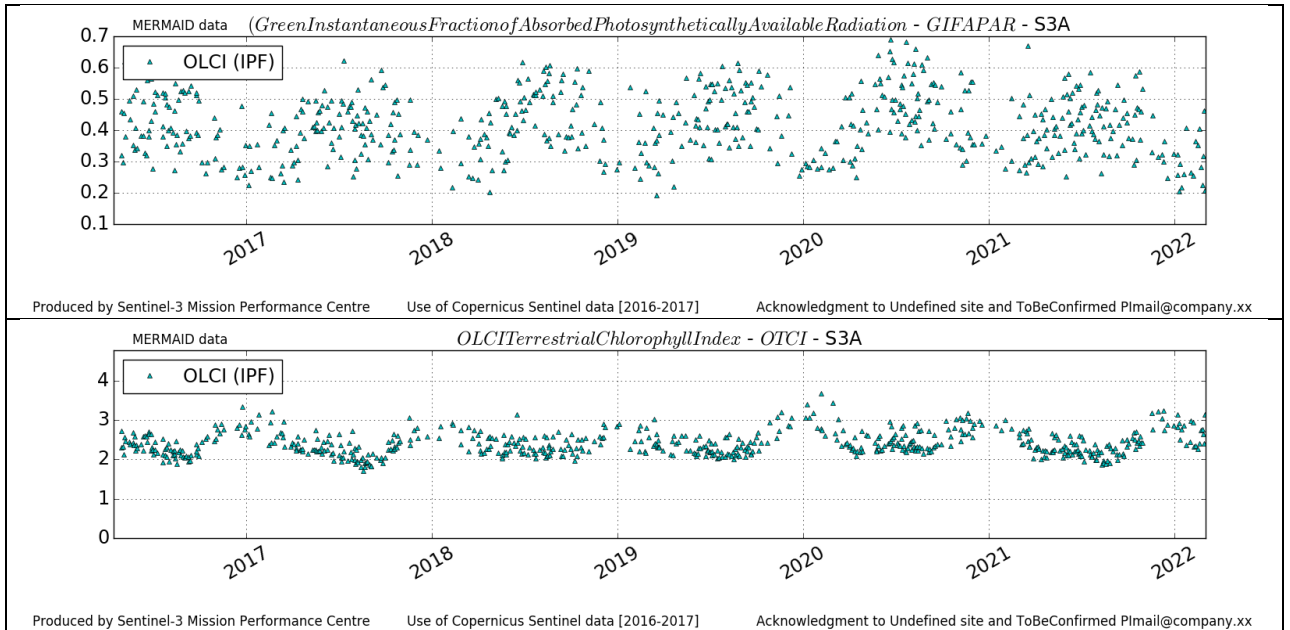


Figure 83: ITSro time series over current report period

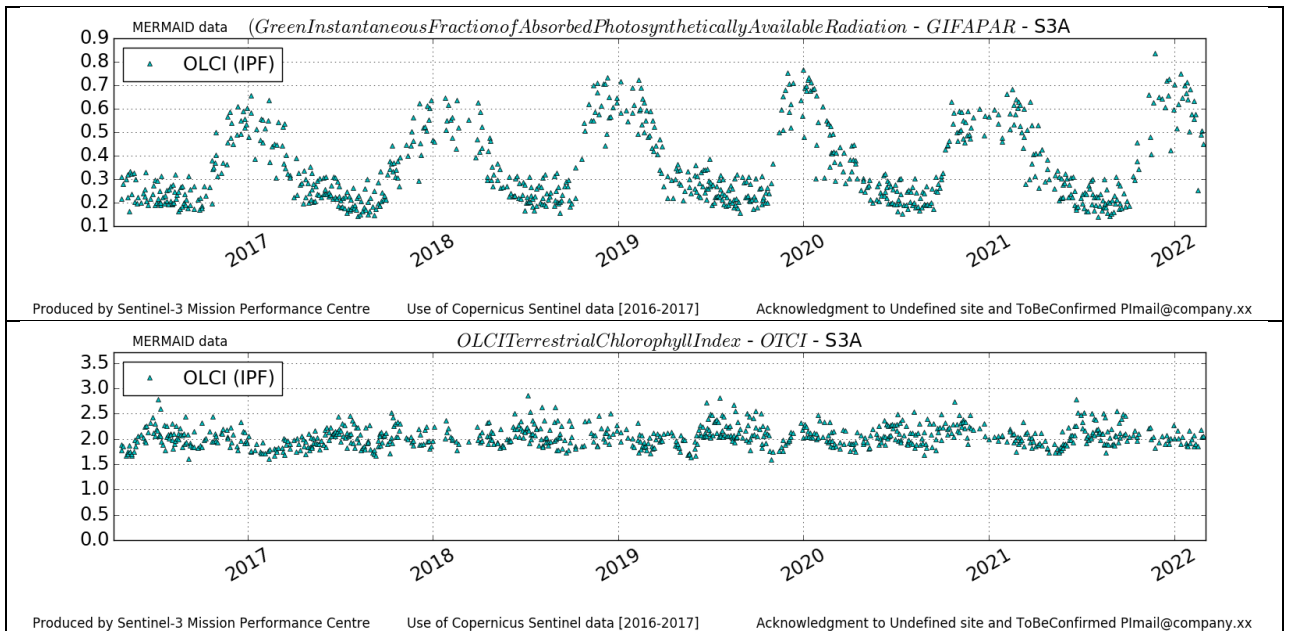


Figure 84: ITTra time series over current report period

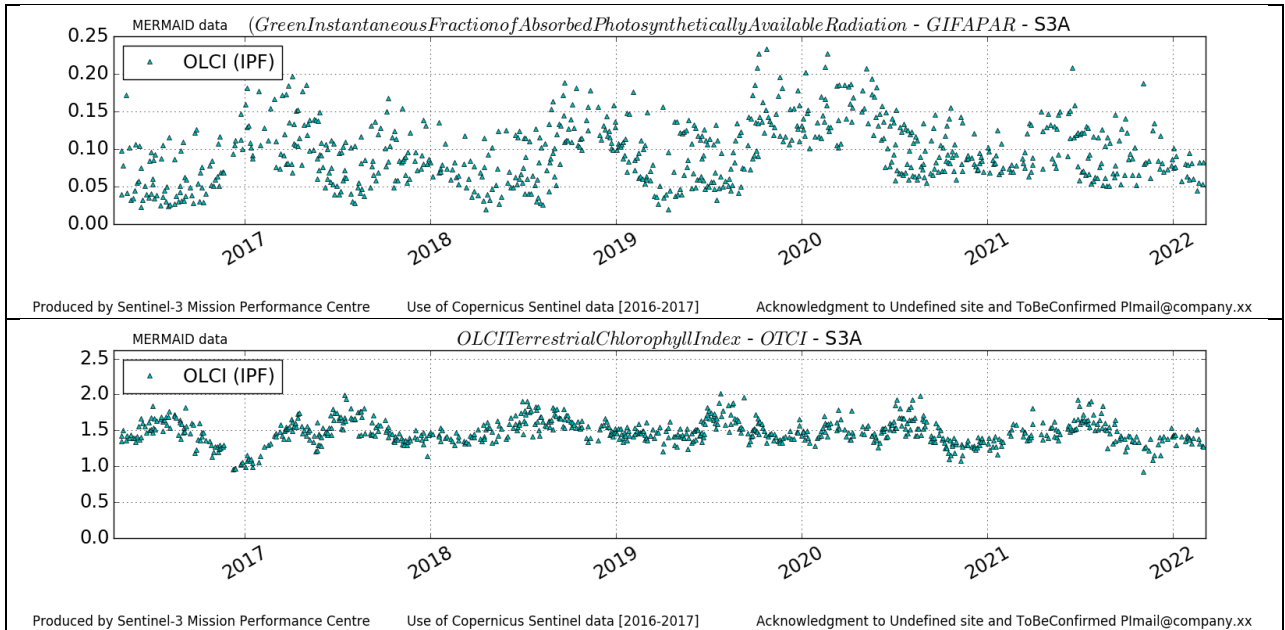


Figure 85: SPAl time series over current report period

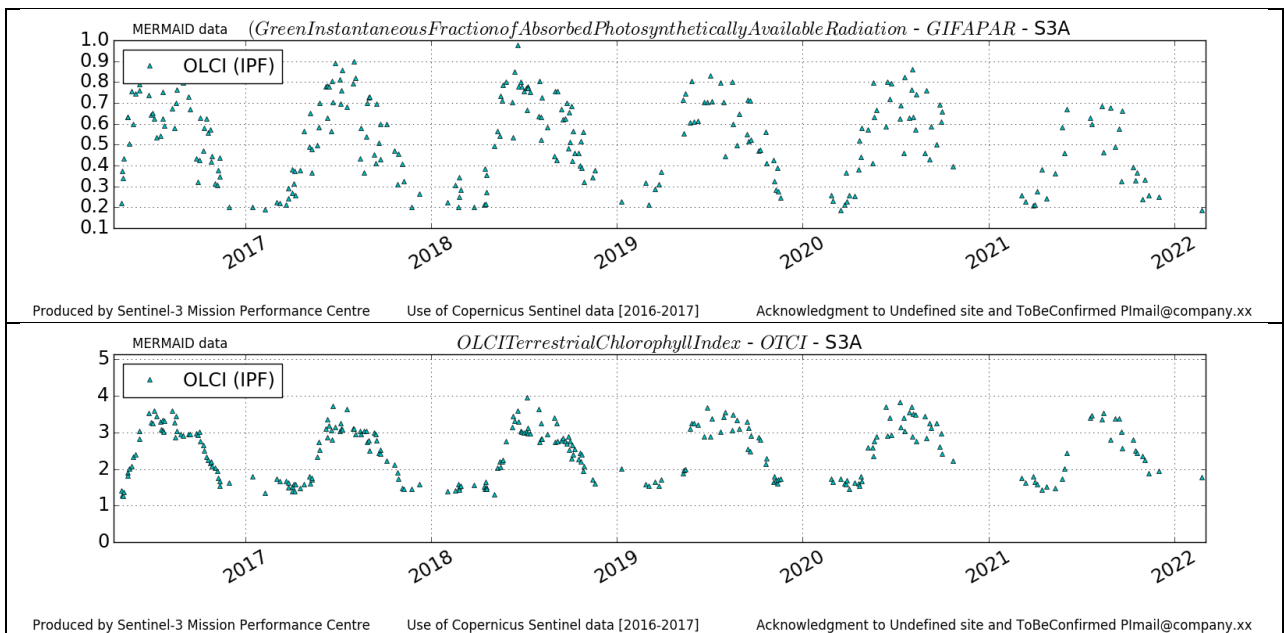


Figure 86: UKNFo time series over current report period

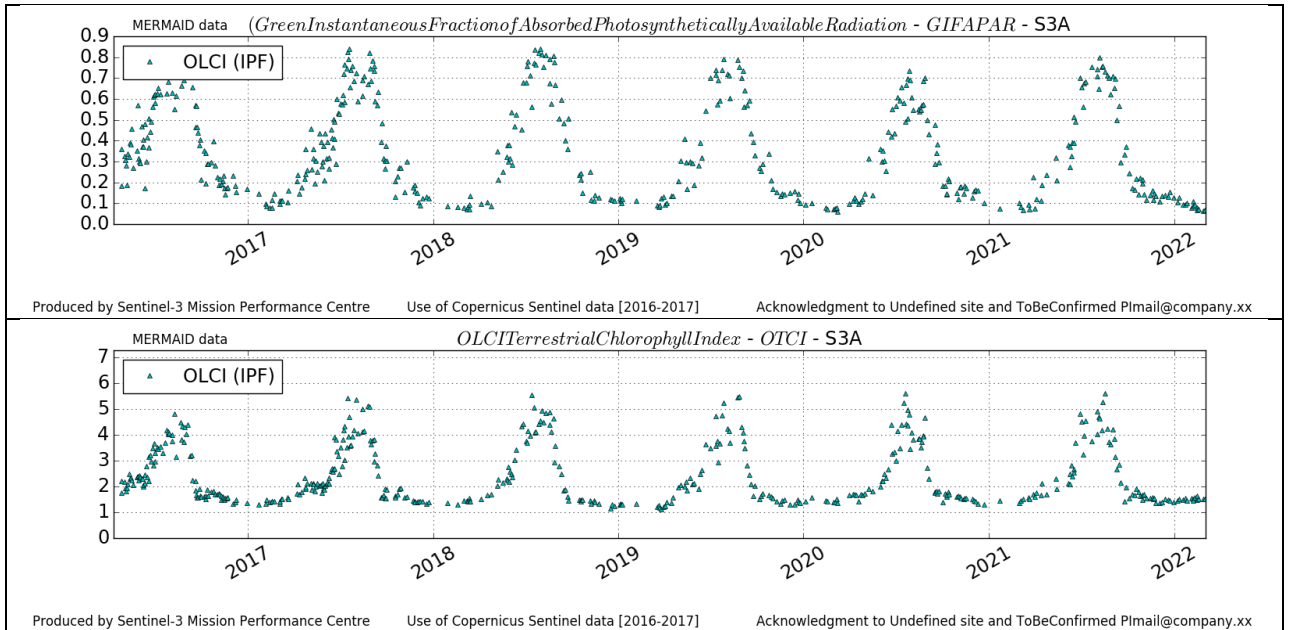


Figure 87: USNe1 time series over current report period

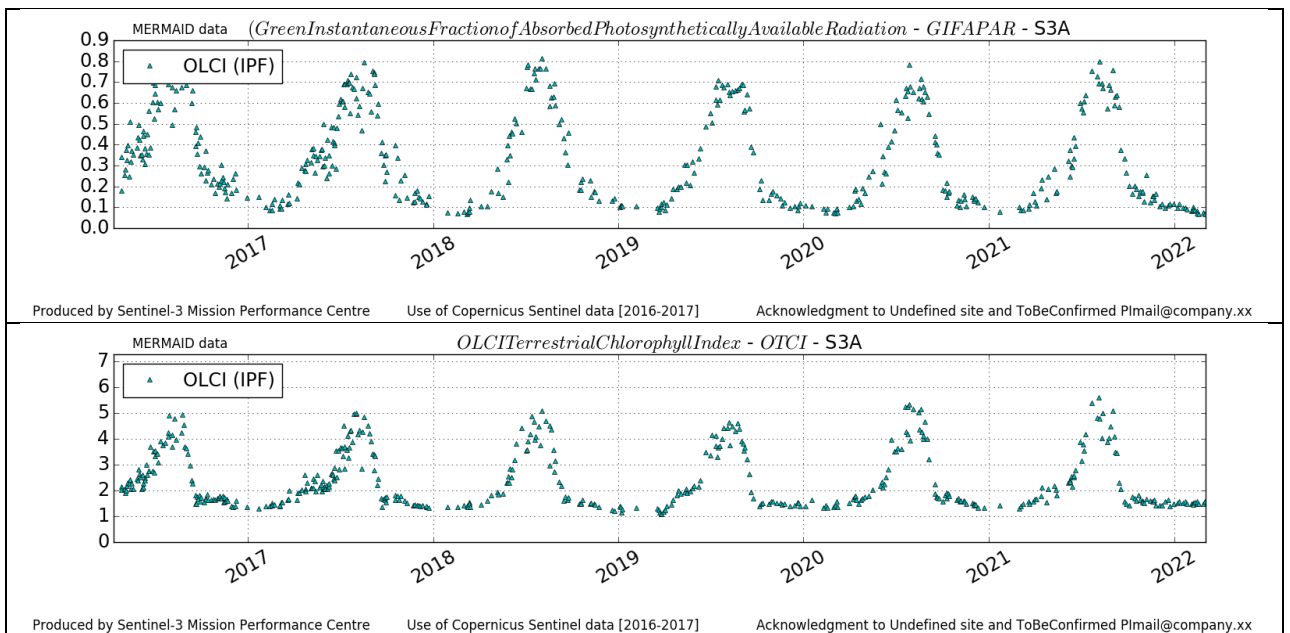


Figure 88: USNe2 time series over current report period

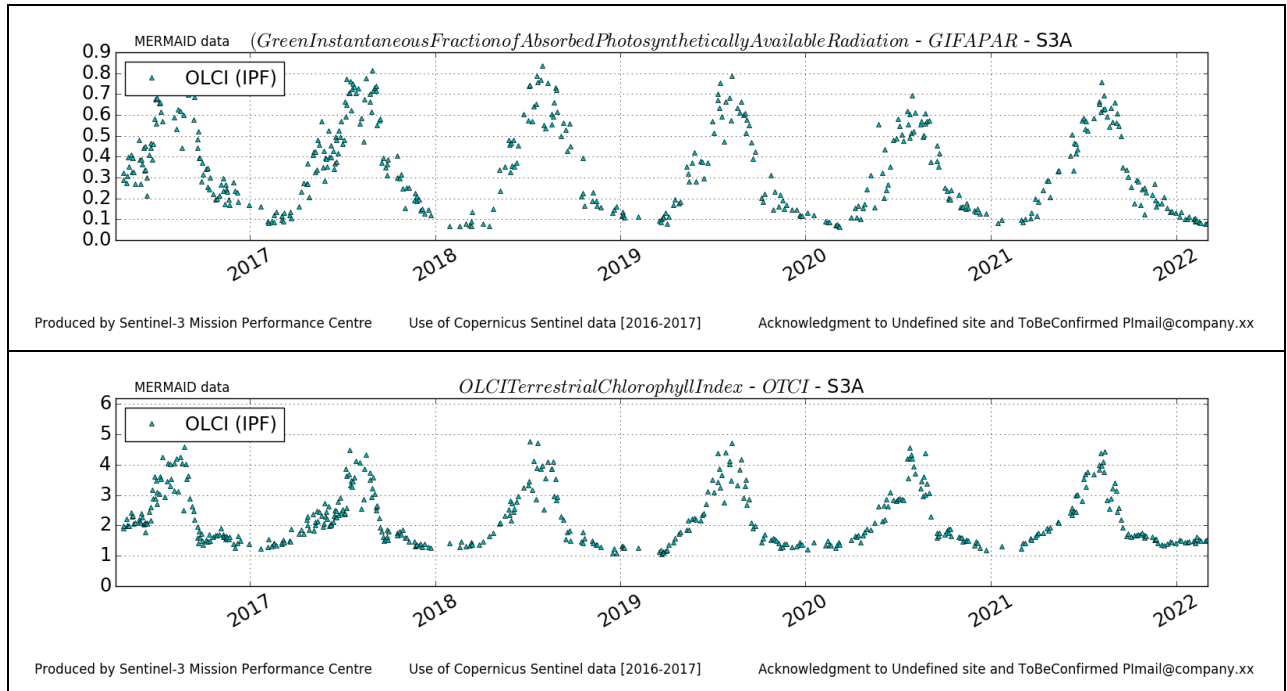


Figure 89: USNe3 time series over current report period

4.1.1.2 OLCI-B

Figure 90 to Figure 99 below present the Core Land Sites OLCI-B time series over the current period.

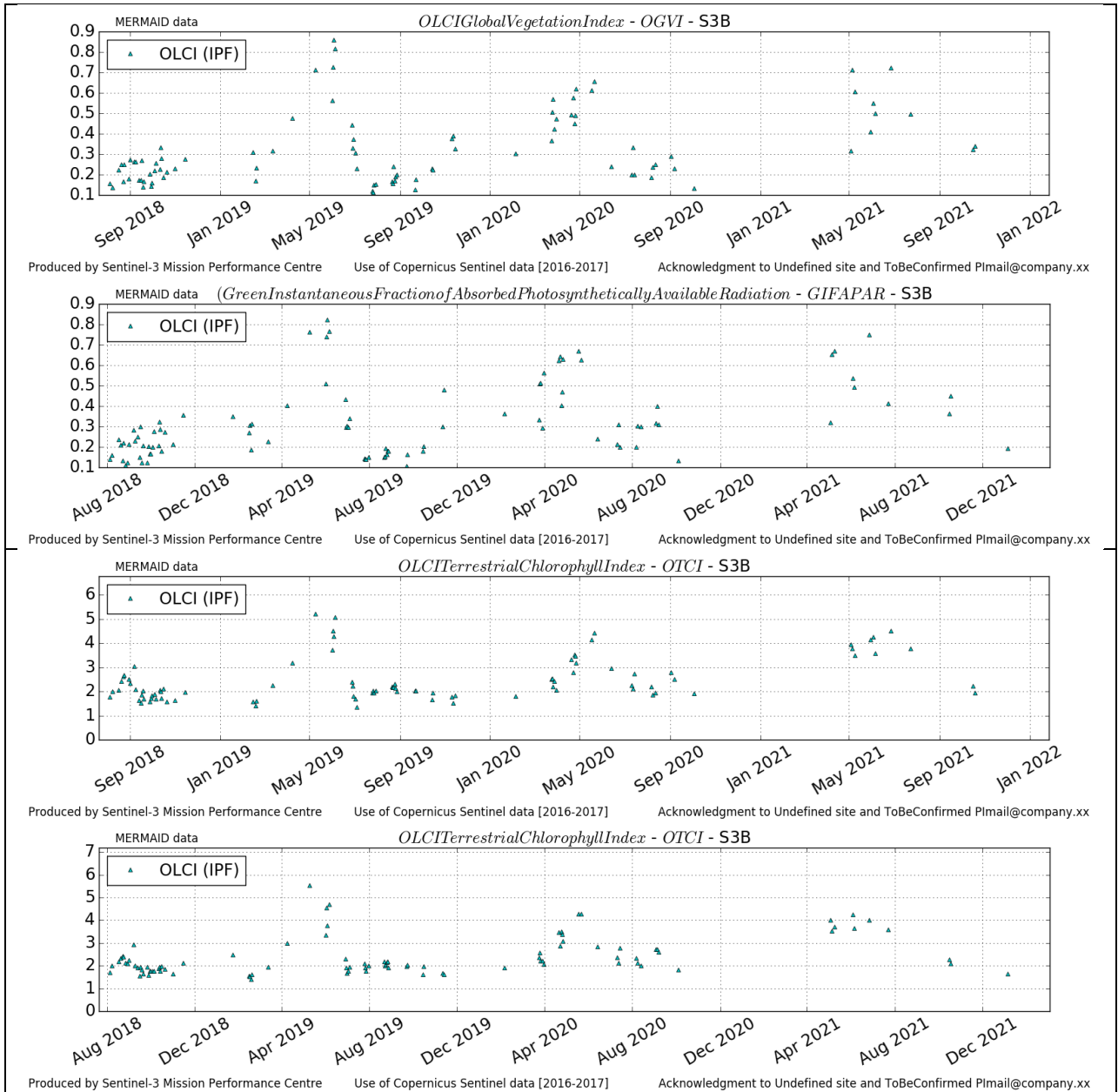


Figure 90: DeGeb time series over current report period

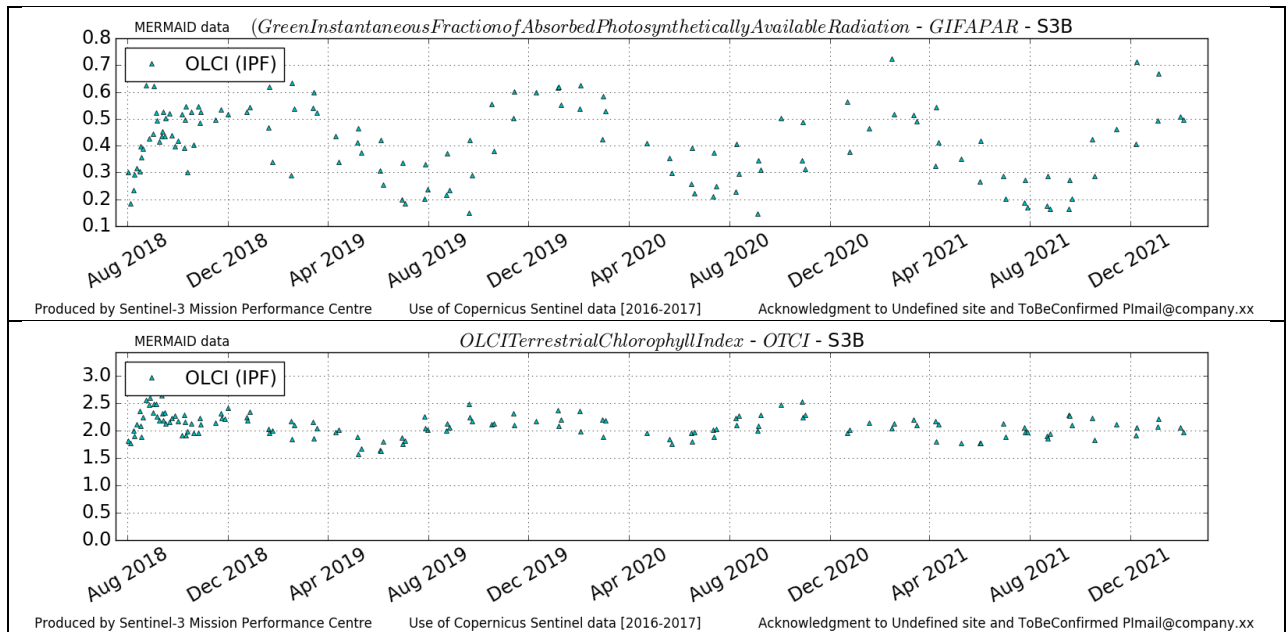


Figure 91: ITCat time series over current report period

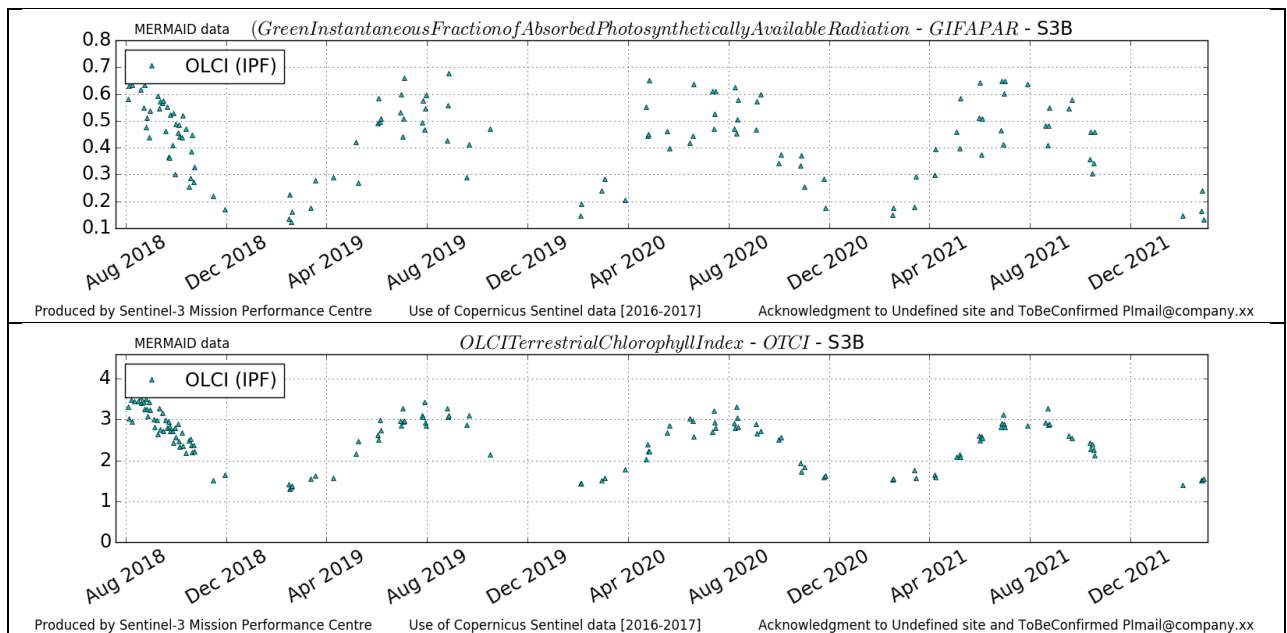


Figure 92: ITIsp time series over current report period

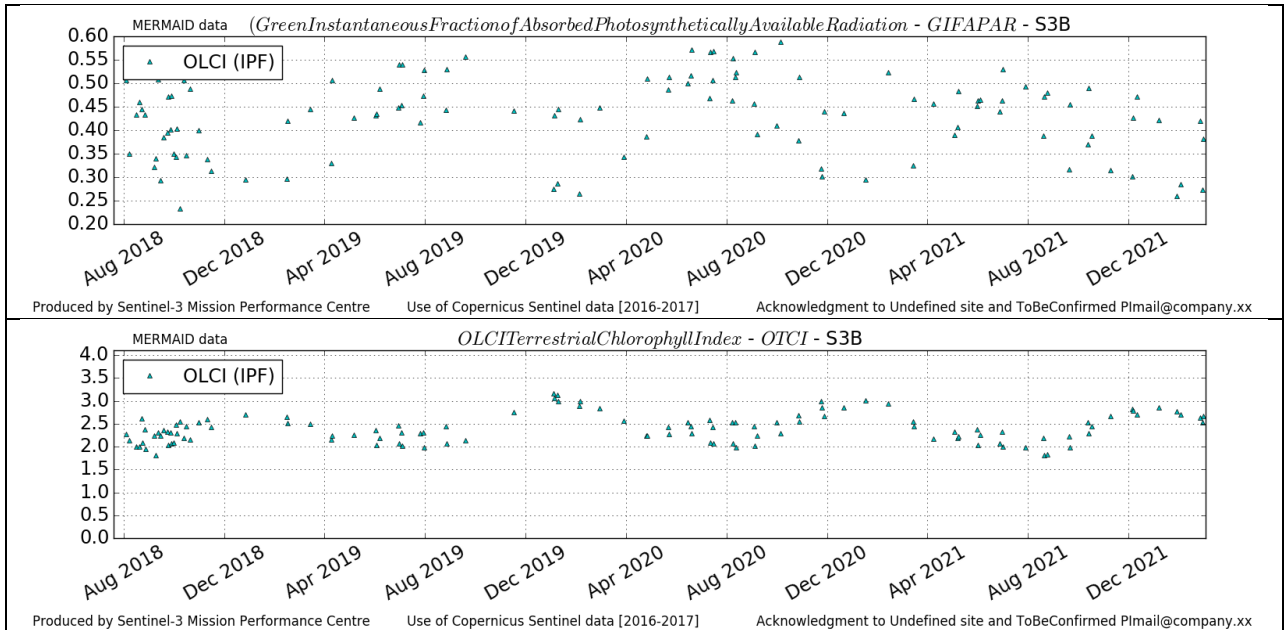


Figure 93: ITSro time series over current report period

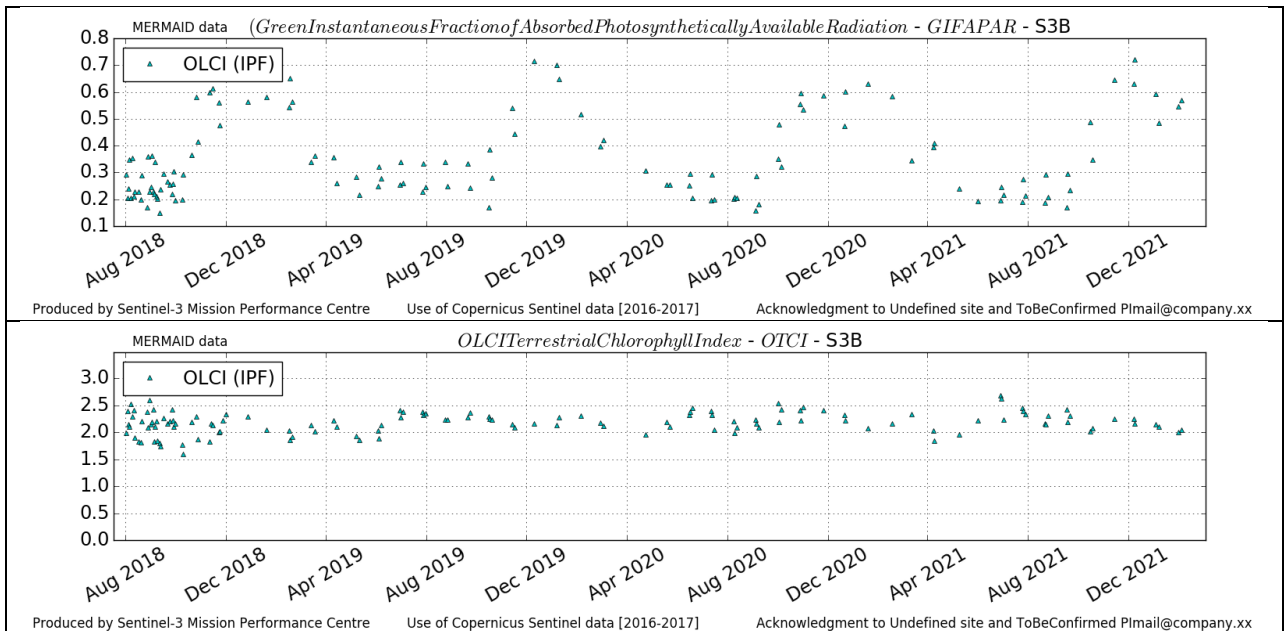


Figure 94: ITTra time series over current report period

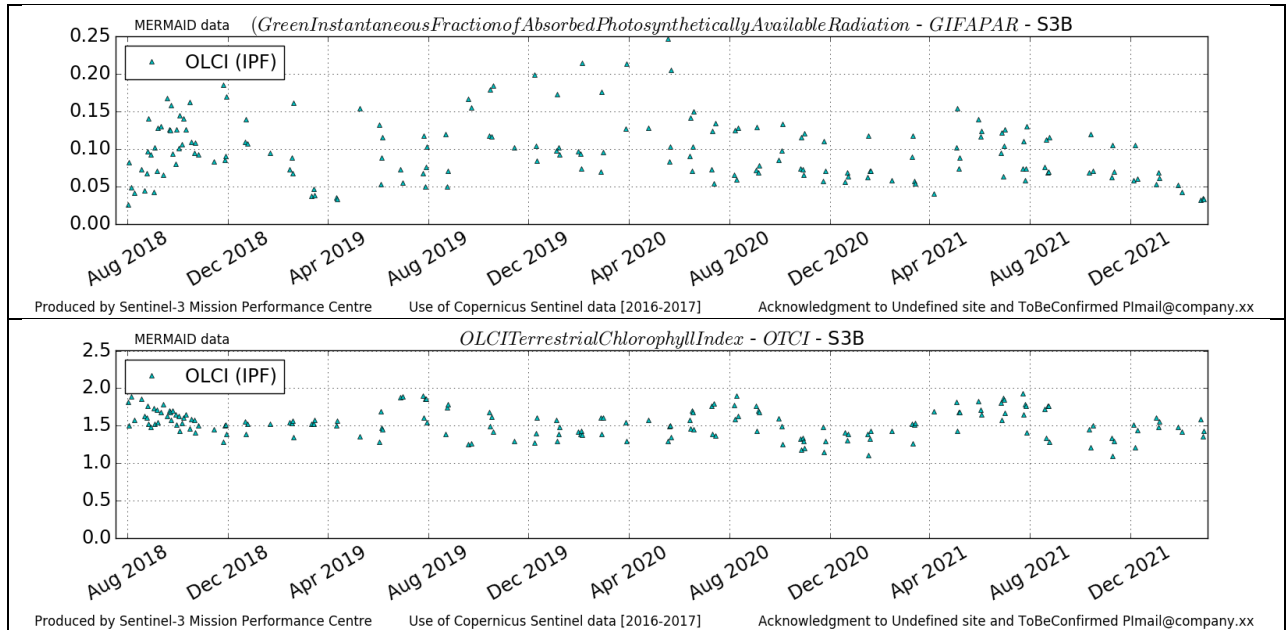


Figure 95: SPAl time series over current report period

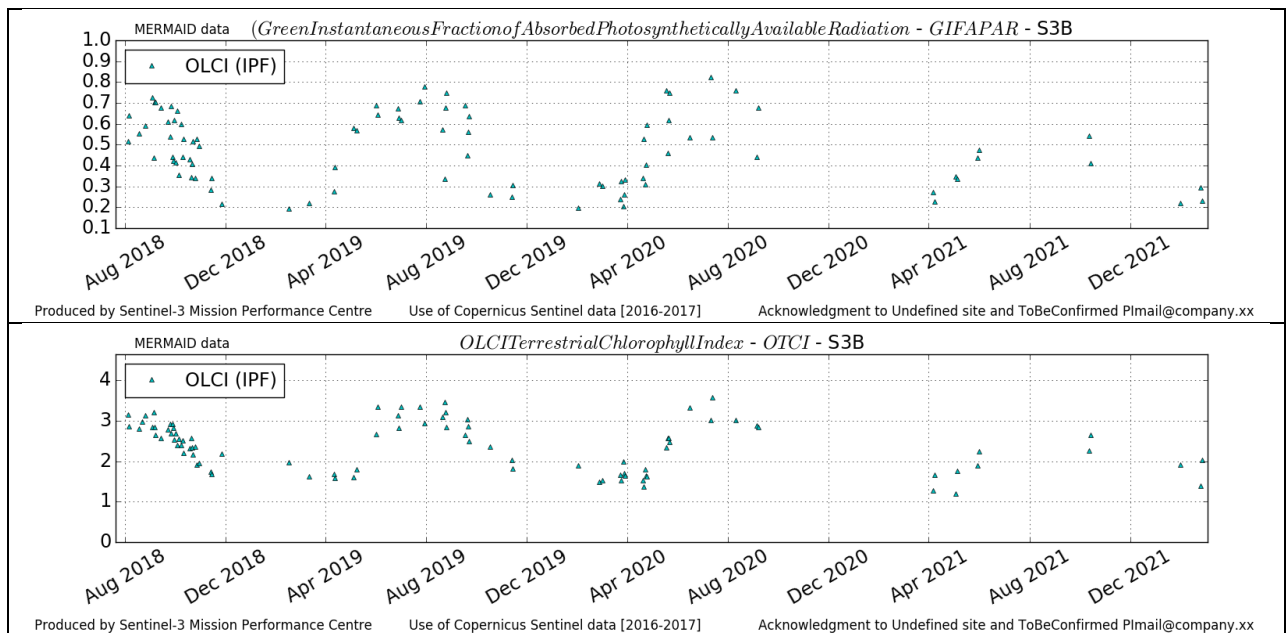


Figure 96: UKNFo time series over current report period

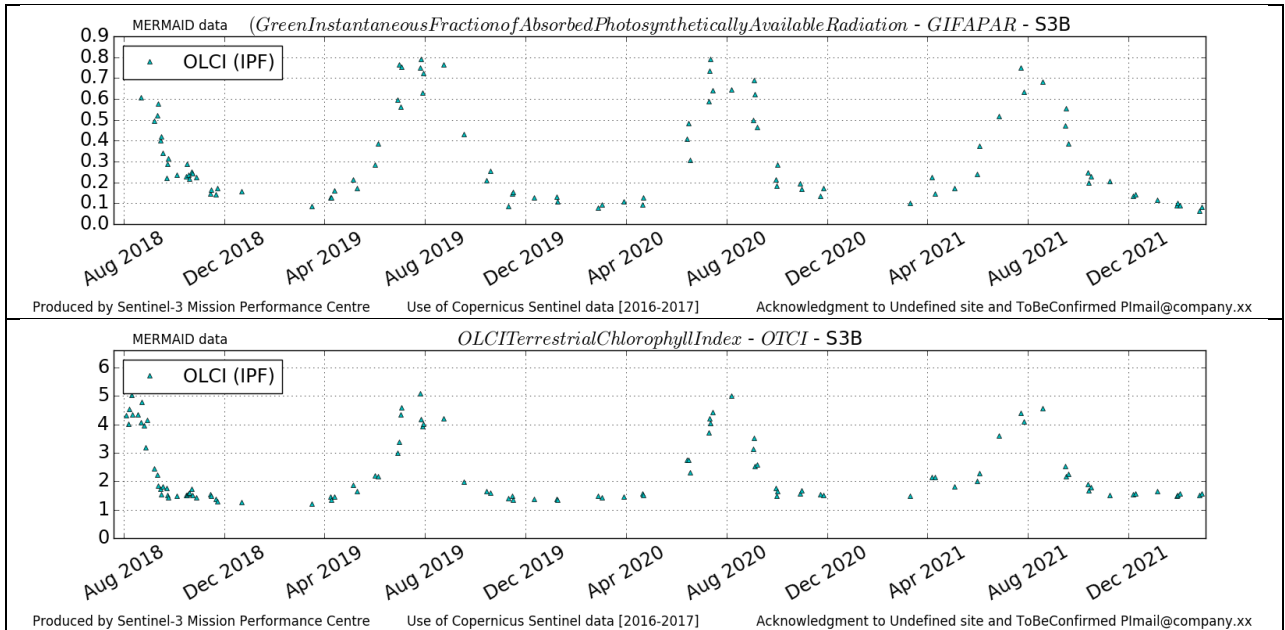


Figure 97: USNe1 time series over current report period

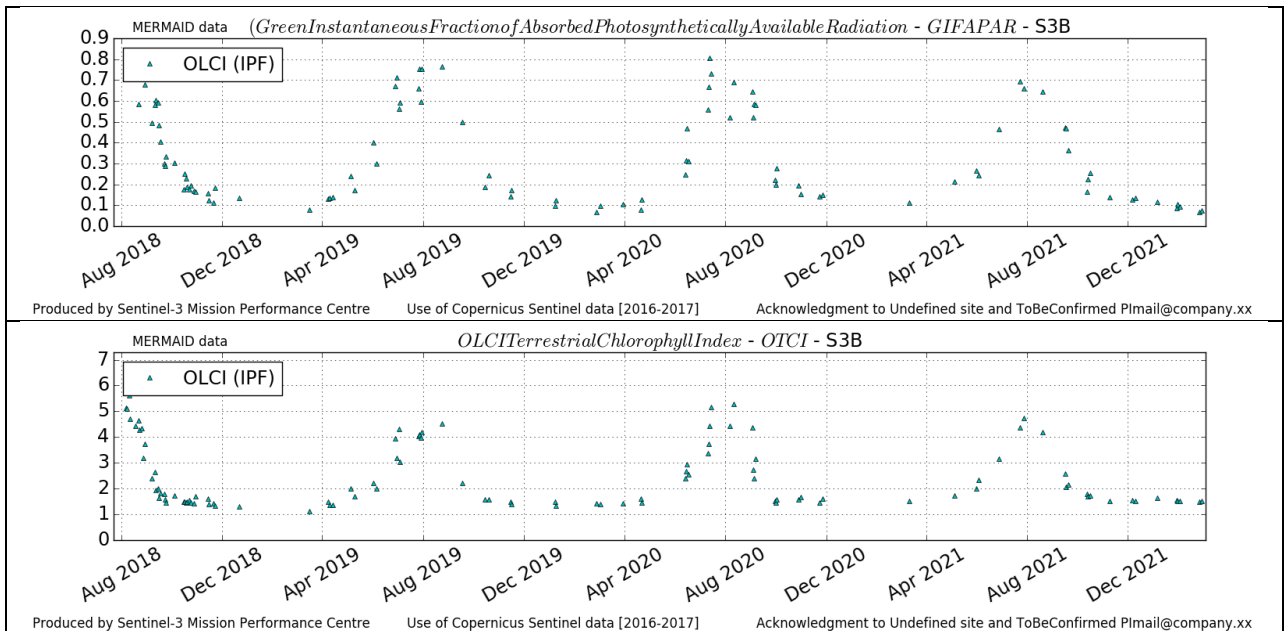


Figure 98: USNe2 time series over current report period

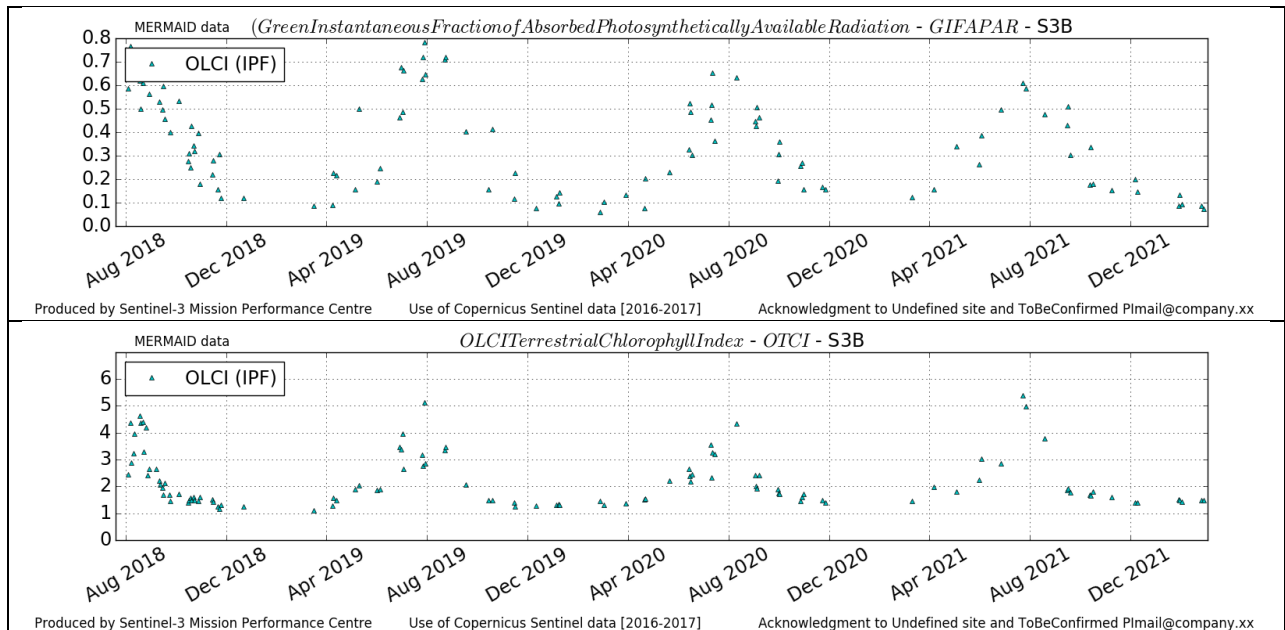


Figure 99: USNe3 time series over current report period

4.1.2 Comparisons with MERIS MGVI and MTCI climatology

This report presents the comparison between MERIS and OLCI land products between the 1st February and the 28th February 2022. It is the second contribution to the new Optical MPC monthly reports. The comparison is conducted using 3x3 pixel extractions over 42 established validation sites. The sites are distributed across a range of latitudes and include representative land cover types (Table 5). Statistical measures of the comparison between MERIS and OLCI products are presented in Table 2. In general, there is good agreement between the land products with strong R^2 values and biases around 0. There are similar seasonal trajectories and timings shown in the extractions from both products at the following sites reviewed in this monthly report: BE-Brasschaat, DE-Haininch and FR-EstreesMons (Figure 100 to Figure 102). The monthly mean extractions from all sites is shown in Figure 103. OTCI from S3A shows a strong agreement with the MERIS archive, $R^2 = 0.93$, NRMSD < 0.08 with a low bias, -0.02. OGVI similarly shows a strong agreement with the MERIS archive, $R^2 = 0.93$, NRMSD < 0.15 with a slightly higher bias of 0.06.

Table 5: Validation sites analysed in monthly report. Land cover data from GLC2000 grouped according to the International Geosphere-Biosphere Programme (IGBP) designations.

Acronym	Country	Network	Lat	Lon	Land cover
AU-Cape-Tribulation	Australia	TERN-SuperSites, OzFlux	-16.106	145.378	EBF
AU-Cumberland	Australia	TERN-SuperSites, AusCover/OzFlux	-33.615	150.723	EBF
AU-Great-Western	Australia	TERN-SuperSites, AusCover/OzFlux	-30.192	120.654	DBF
AU-Litchfield	Australia	TERN-SuperSites, AusCover/OzFlux	-13.18	130.79	EBF
AU-Robson-Creek	Australia	TERN-SuperSites, AusCover/OzFlux	-17.117	145.63	EBF
AU-Rushworth	Australia	TERN-AusCover	-36.753	144.966	DBF
AU-Tumbarumba	Australia	TERN-SuperSites, AusCover/OzFlux	-35.657	148.152	EBF
AU-Warra-Tall	Australia	TERN-SuperSites, AusCover/OzFlux	-43.095	146.654	EBF
AU-Watts-Creek	Australia	TERN-AusCover	-37.689	145.685	EBF
AU-Wombat	Australia	TERN-SuperSites, AusCover/OzFlux	-37.422	144.094	EBF
BE-Brasschaat	Belgium	ICOS	51.308	4.52	ENF
BE-Vielsalm	Belgium	ICOS	50.305	5.998	ENF
BR-Mata-Seca	Brazil	ENVIRONET	-14.88	-43.973	non-forest
CA-Mer-Bleue	Canada	National Capitol Comission	45.4	-75.493	non-forest
CR-Santa-Rosa	Costa Rica	ENVIRONET	10.842	-85.616	EBF
CZ-Bili-Kriz	Czechia	ICOS	49.502	18.537	ENF
DE-Haininch	Deutschland	ICOS Associated	51.079	10.453	DBF
DE-Hones-Holz	Deutschland	ICOS	52.085	11.222	DBF
DE-Selhausen	Deutschland	ICOS	50.866	6.447	cultivated
DE-Tharandt	Deutschland	ICOS	50.964	13.567	ENF
FR-Aurade	France	ICOS	43.55	1.106	cultivated
FR-Estrees-Mons	France	ICOS Associated	49.872	3.021	cultivated
FR-Guayaflux	France	ICOS Associated	5.279	-52.925	EBF
FR-Hesse	France	ICOS	48.674	7.065	DBF
FR-Montiers	France	ICOS	48.538	5.312	DBF
FR-Puechabon	France	ICOS	43.741	3.596	ENF
IT-Casterporziano2	Italy	ICOS	41.704267	12.357293	DBF
IT-Collelongo	Italy	EFDC	41.849	13.588	DBF
IT-Lison	Italy	ICOS	45.74	12.75	cultivated
NE-Loobos	Netherlands	ICOS Associated	52.166	5.744	ENF
SE-Dahra	Senegal	KIT / UC	15.4	-15.43	cultivated
UK-Wytham-Woods	United Kingdom	ForestGeo - NPL	51.774	-1.338	DBF
US-Bartlett	United States	NEON, AERONET	44.064	-71.287	DBF
US-Central-Plains	United States	NEON, AERONET	40.816	-104.746	non-forest
US-Harvard	United States	NEON, AERONET	42.537	-72.173	DBF
US-Moab-Site	United States	NEON, AERONET	38.248	-109.388	non-forest
US-Mountain-Lake	United States	NEON, AERONET	37.378	-80.525	DBF
US-Oak-Rige	United States	NEON, AERONET	35.964	-84.283	DBF
US-Ordway-Swisher	United States	NEON, AERONET	29.689	-81.993	ENF
US-Smithsonian	United States	NEON, AERONET	38.893	-78.14	DBF
US-Steigerwarldt	United States	NEON	45.509	-89.586	DBF
US-Talladega	United States	NEON, AERONET	32.95	-87.393	ENF

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	n	R2	NRMSD	Bias
AU-Calperum	12	0.45	0.04	0.09	12	0.9	0.08	-0.01	12	0.15	0.05	0.03	12	0.71	0.16	0
AU-Cape-Tribulation	12	0.8	0.04	-0.09	12	0.42	0.04	0.15	12	0.73	0.05	-0.17	12	0.08	0.12	0.16
AU-Cumberland	12	0.55	0.04	-0.05	12	0.56	0.07	0.07	12	0.56	0.04	0.02	12	0.69	0.1	0.09
AU-Great-Western	12	0.97	0.02	0.11	12	0.93	0	0.04	12	0.94	0.02	0.11	12	0.74	0.1	0.02
AU-Robson-Creek	12	0.9	0.03	-0.04	12	0.86	0.07	0.1	12	0.8	0.05	-0.15	12	0.75	0.09	0.12
AU-Rushworth	12	0.84	0.04	0.14	12	0.33	0.08	0.09	12	0.8	0.04	0.02	12	0.36	0.12	0.06
AU-Tumbarumba	12	0.88	0.05	0.3	12	0.61	0.06	0.09	12	0.77	0.04	0.12	12	0.19	0.13	0.01
AU-Warra-Tall	12	0.7	0.05	-0.09	12	0.33	0.21	0.03	9	0.73	0.05	-0.31	9	0.35	0.17	-0
AU-Watts-Creek	12	0.68	0.05	0.03	12	0.43	0.08	0.09	12	0.73	0.05	-0.02	12	0.24	0.11	0.08
AU-Wombat	12	0.92	0.03	0.11	12	0.39	0.05	0.08	12	0.88	0.03	-0.01	12	0	0.08	0.05
BE-Brasschaat	11	0.99	0.03	-0.04	11	0.97	0.08	0.05	10	0.96	0.05	-0.09	10	0.92	0.08	0.01
BE-Vielsalm	11	0.89	0.05	0.06	11	0.98	0.06	0.1	10	0.87	0.04	0.01	10	0.93	0.11	0.11
CA-Mer-Bleue	10	0.96	0.04	-0.01	10	0.98	0.06	0.03	10	0.94	0.05	-0.01	10	0.97	0.08	0.01
CZ-Bili-Kriz	11	0.94	0.03	0.04	11	0.97	0.07	0.07	9	0.91	0.04	-0.1	9	0.82	0.13	0.06
DE-Haininch	10	0.99	0.06	-0.04	10	0.98	0.08	0.05	9	0.97	0.09	-0.04	9	0.97	0.1	0.1
DE-Hones-Holz	10	1	0.03	0.08	10	1	0.02	0.04	10	0.97	0.08	-0.11	10	0.94	0.12	0.01
DE-Selhausen	12	0.89	0.08	-0.02	12	0.48	0.21	0.06	12	0.79	0.11	-0.14	12	0.25	0.27	0.02
DE-Tharandt	10	0.98	0.03	0	10	0.97	0.09	0.1	9	0.98	0.03	-0.18	9	0.96	0.09	0.1
FR-Aurade	12	0.83	0.1	0.07	12	0.79	0.19	0.14	11	0.88	0.08	0.03	11	0.86	0.16	0.08
FR-Estrees-Mons	12	0.94	0.07	0.01	12	0.89	0.11	0.06	12	0.9	0.1	0.15	12	0.91	0.11	0.04
FR-Guayaflux	12	0.76	0.03	-0.15	12	0.38	0.07	0.17	12	0.68	0.04	-0.23	12	0.11	0.2	0.19
FR-Hesse	12	0.99	0.03	0.03	12	0.99	0.04	0.06	11	0.96	0.07	0.03	11	0.86	0.15	0.08
FR-Montiers	12	1	0.03	-0.13	12	0.99	0.06	0.05	12	0.96	0.08	-0.15	12	0.94	0.13	0.07
FR-Puechabon	12	0.83	0.03	-0.05	12	0.94	0.06	0.09	12	0.85	0.04	0.04	12	0.87	0.09	0.05
IT-Casterporziano2	12	0.95	0.02	-0.13	12	0.88	0.03	0.06	12	0.93	0.04	-0.05	12	0.63	0.08	0.03
IT-Collelongo	12	0.98	0.06	0	12	0.99	0.05	0.02	12	0.94	0.12	0.05	12	0.93	0.16	0.03
IT-Lison	12	0.98	0.03	-0.05	12	0.97	0.07	0.08	12	0.93	0.06	-0.07	12	0.92	0.1	0.08
NE-Loobos	12	0.71	0.07	0.09	12	0.9	0.1	0.05	12	0.61	0.07	0.05	12	0.88	0.1	0.03
UK-Wytham-Woods	12	0.98	0.04	0.07	12	0.97	0.07	0.1	11	0.94	0.07	-0.06	11	0.86	0.16	0.07
US-Bartlett	12	0.98	0.03	-0.04	12	0.98	0.1	0.06	12	0.89	0.08	-0.05	12	0.95	0.12	0.04
US-Central-Plains	12	0.69	0.03	-0.02	12	0.92	0.1	0.01	11	0.73	0.04	-0.04	11	0.8	0.21	0
US-Harvard	12	0.99	0.04	-0.17	12	0.97	0.09	0.04	12	0.97	0.05	-0.24	12	0.92	0.16	0.02
US-Jornada	10	0.8	0.04	0.02	10	0.87	0.2	0.01	9	0.8	0.04	0.06	9	0.33	0.4	0.01
US-Moab-Site	12	0.7	0.03	0.06	12	0.08	0.22	0.01	11	0.88	0.02	0.02	11	0.04	0.43	0.04
US-Mountain-Lake	12	0.99	0.05	-0.2	12	0.99	0.05	0.04	11	0.96	0.07	-0.41	11	1	0.05	0
US-Oak-Rige	12	1	0.02	-0.06	12	0.98	0.07	0.05	12	0.98	0.05	-0.07	12	0.99	0.05	0.05
US-Smithsonian	11	0.99	0.04	-0.19	11	0.99	0.05	0.05	9	0.99	0.06	-0.22	9	0.97	0.09	0.01
US-Steigerwardt	11	0.99	0.02	0.02	11	0.98	0.08	0	9	0.94	0.07	-0.06	9	0.99	0.05	0.01
US-Talladega	12	0.98	0.02	-0.13	12	0.98	0.05	0.07	12	0.91	0.05	-0.19	12	0.93	0.1	0.06

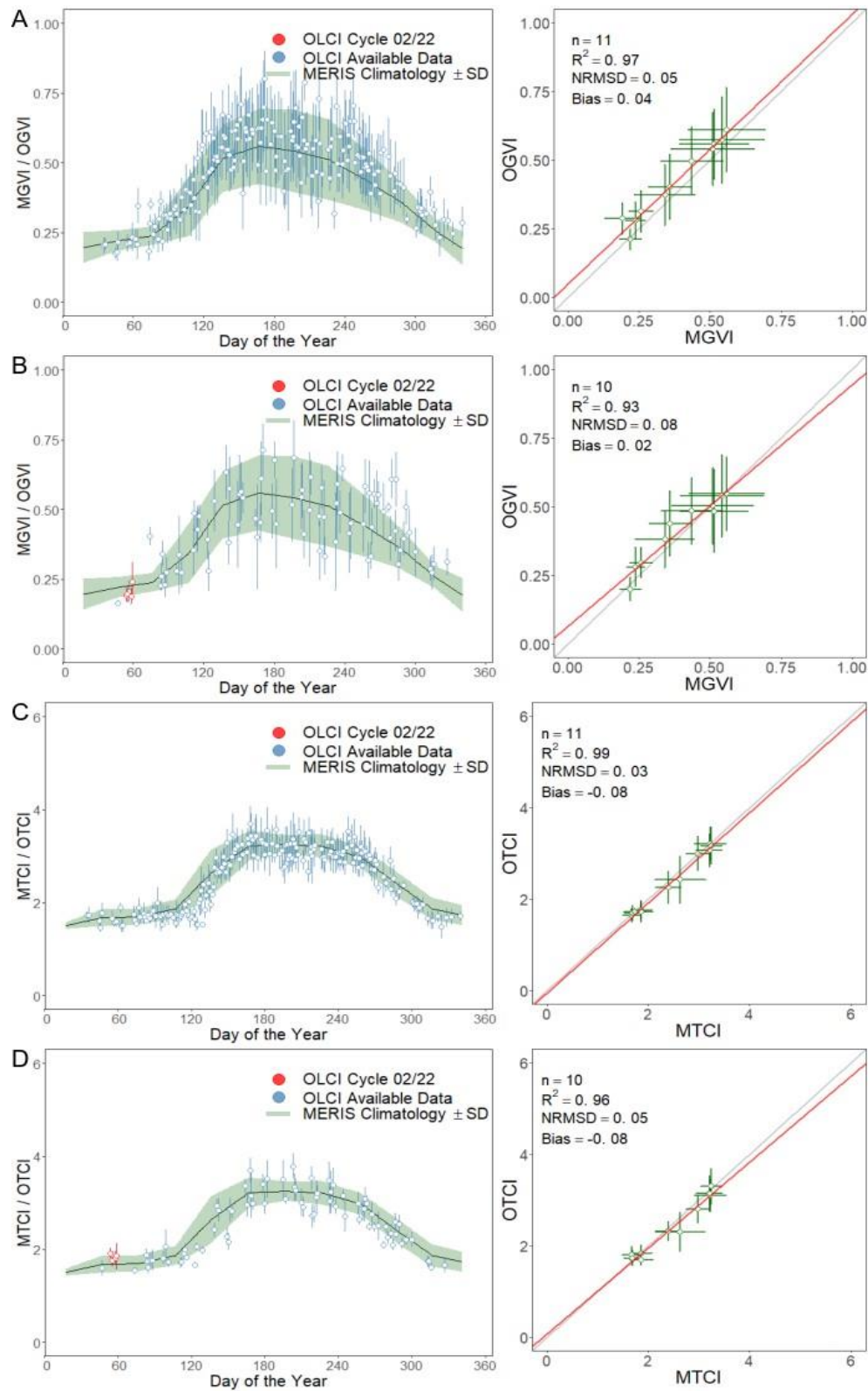


Figure 100: Time-series OGVI and OTCI and corresponding scatterplot of monthly mean for site BE-Brasschaat, Belgium, land cover Needle-leaved, evergreen. A and C represent S3A; B and D represent S3B.

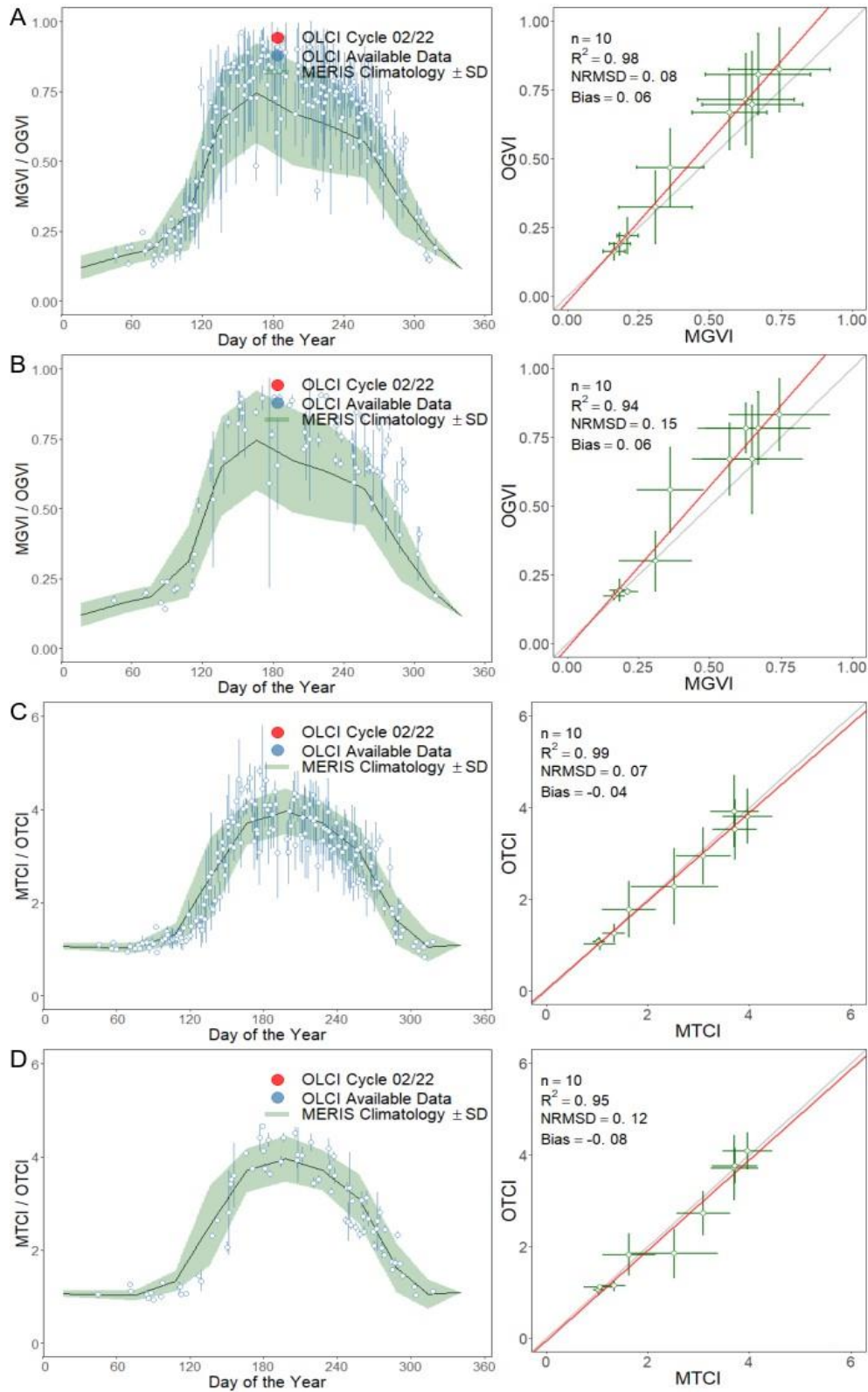


Figure 101: Time-series OGVI and OTCI and corresponding scatterplot of monthly mean for site DE-Haininch, Deutschland, land cover Broadleaved, deciduous, closed. A and C represent S3A; B and D represent S3B.

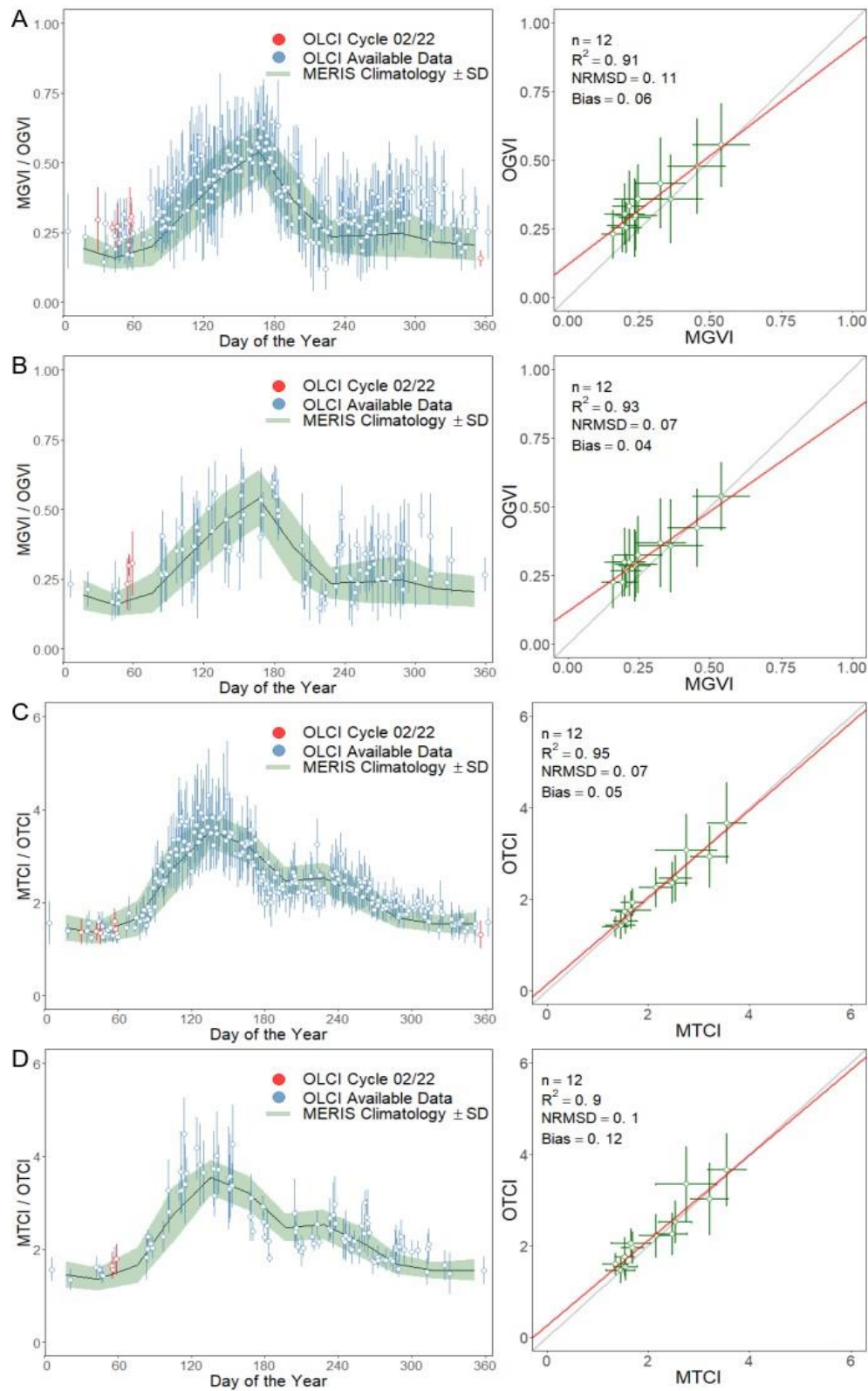


Figure 102: Time-series OGVI and OTCI and corresponding scatterplot of monthly mean for site FR-EstreesMons, France, land cover Cultivated and managed areas. A and C represent S3A; B and D represent S3B.

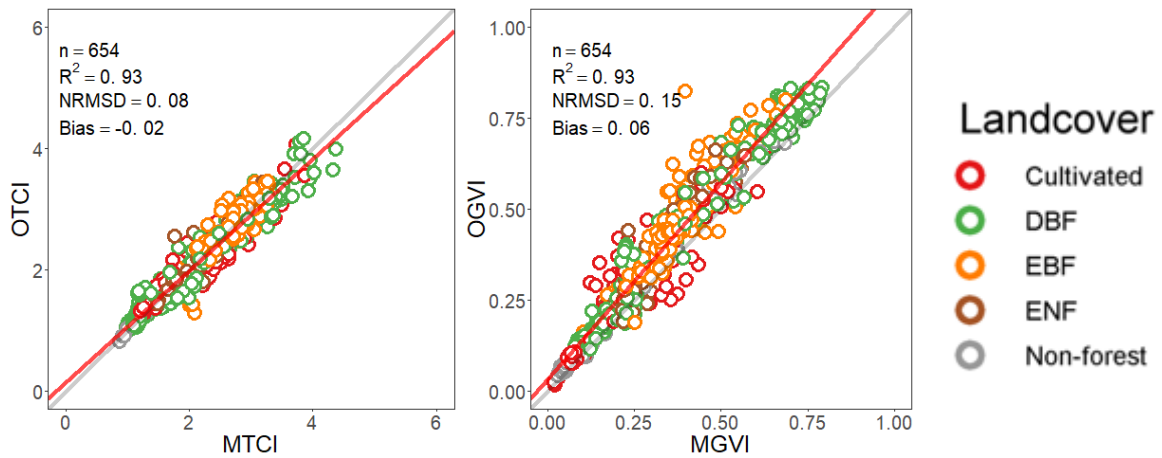



Figure 103: Comparison of OTCI-MTCI (a) and OGVI-MGVI (b). Points in the scatterplot represent the monthly mean of all available S3A and MERIS archive over 42 validation sites. Red and grey lines represent the modelled and 1:1 lines respectively. The scatterplots are updated to include extractions from the latest month

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 reporting period. Last figures (reported in [OLCI Cyclic Report 074-055](#)) are considered valid.

Routine monitoring activities have been continued.

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5 Validation of Integrated Water Vapour over Land & Water

The OLCI L2 IWV processor distinguishes between ocean and land surfaces and works very differently above the respective surfaces. The algorithm above water shows some serious flaws and is therefore not further investigated. A new version is under development, that will be integrated into an atmospheric branch. However, despite of a small systematic overestimation, the water vapour above land works very well and stable, and it is a good indicator for a system monitoring.

OLCI's IWV above land surface is validated using the following ground truth data:

1. Global GNSS data, with a focus to north America (SUOMI NET, Ware et al. 2000)
2. Microwave radiometer measurements at the *Atmospheric Radiation Measurement (ARM) Climate Research Facility* of the US Department of Energy (Turner et al. 2003, Turner et al. 2007).
3. GRUAN radiosonde observations IWV (Immler et al 2010, Bodeker 2015)
4. AERONET (Holben et al 1998), using atmospheric transmission measurements at 0.9 μ m

All L2 product types have been validated: full resolution and reduced resolution, near real time and non time critical, Ocean Colour (*wrr*, *wfr*) and Land Colour (*lrr*, *lfr*). The found results for all product types are identical, as expected, since the used processor is the same. The following quantitative comparisons are hence restricted to *wrr NT* (Ocean Colour Product, reduced resolution, non time critical). Since the ocean colour product and the land colour product provide water vapour above land and water surfaces, the comparison is comprehensive. OLCI A data partly belong to reprocessed data if processed before Nov/2017. The ocean colour products from OLCI A have been taken from Eumetsats rolling archive CODA (Copernicus Online Data Access, <https://coda.eumetsat.int/#/home>) or reprocessed OLCI A CODAREP (<https://codarep.eumetsat.int/#/home>) websites. All OLCI B data is from Eumetsats CODA.

SUOMI-net provides by far the most data with an almost near real time availability and a low uncertainty. On this account, we choose it for system monitoring. 582,000 (OLCI-A) and 271000 (OLCI-B) potential matchups within the period of June 2016 (OLCI-A) January 2019 (OLCI-B) to January 2022 have been analysed yet. The global service of SUOMI-NET has been reduced end 2018, thus OLCI-B collocations are rare outside North America. Only OLCI measurements are taken for the validation which are above land and are cloud-free in an area of about 10x10 km² around the GNSS stations. For the cloud detection, the standard L2 cloud-mask has been applied (including the cloud ambiguous and cloud margin flags). The comparison of OLCI and GNSS shows a very high agreement (Figure 104). The correlation between both quantities is 0.97-0.98. The root-mean-squared-difference is 2.0 -2.1 kg/m². The systematic overestimation by OLCI is 11%-12%. The bias corrected *rmsd* is around 1.3 kg/m². Actually, both instruments behave almost equal. The temporal evolution of several quality measures (Figure 105), indicates small seasonal variations, which are certainly related to retrieval assumptions. Apart from these features, no systematic changes have been observed.

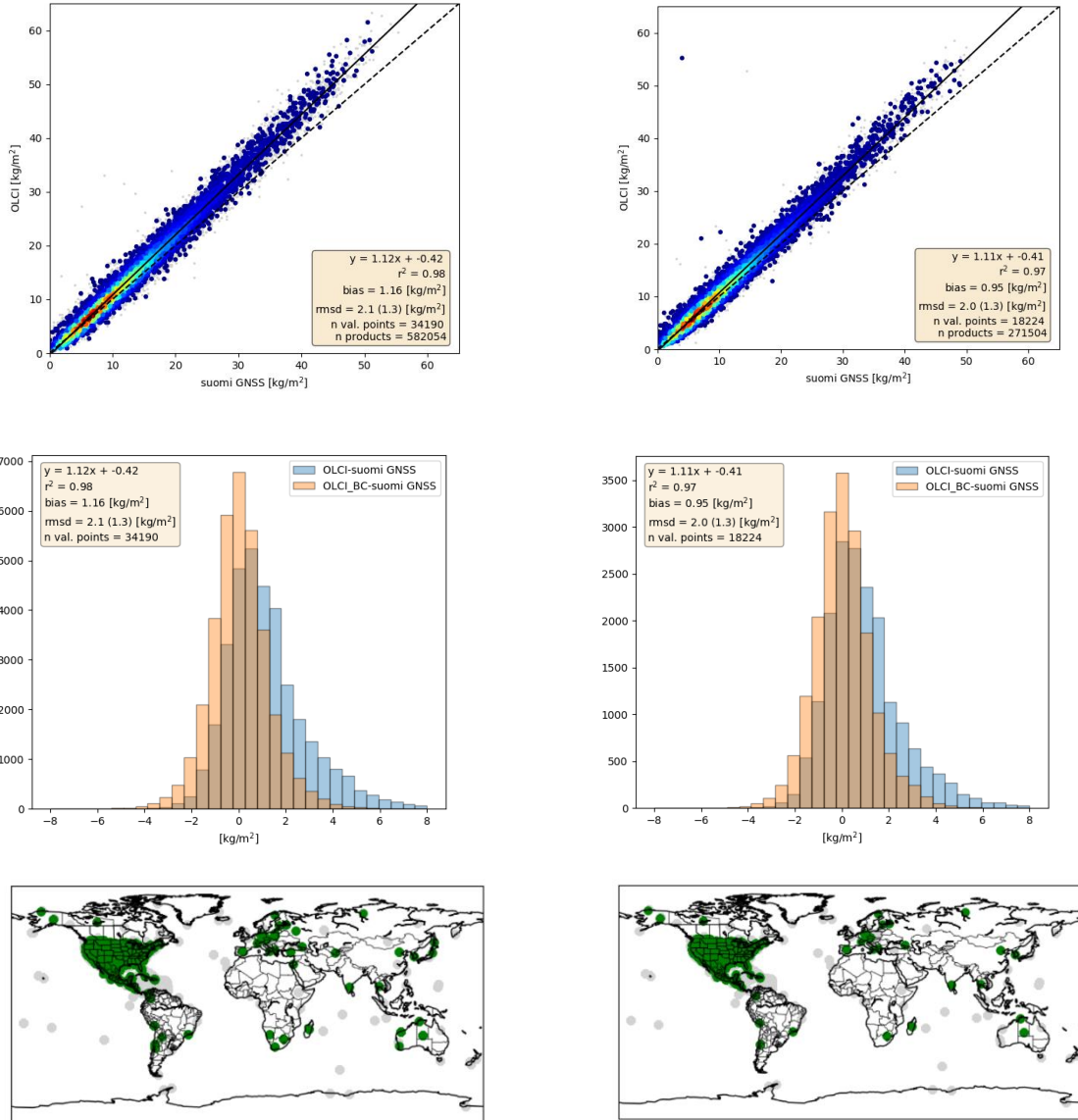


Figure 104: Upper: Scatter plot of the IWV products, derived from OLCI (A left, B right) above land and from SUOMI NET GNSS measurements. Middle: Histogram of the difference between OLCI (A: left, B: right) and GNSS (blue: original OLCI, orange: bias corrected OLCI). Lower: Positions of the GNSS (A: left, B: right).

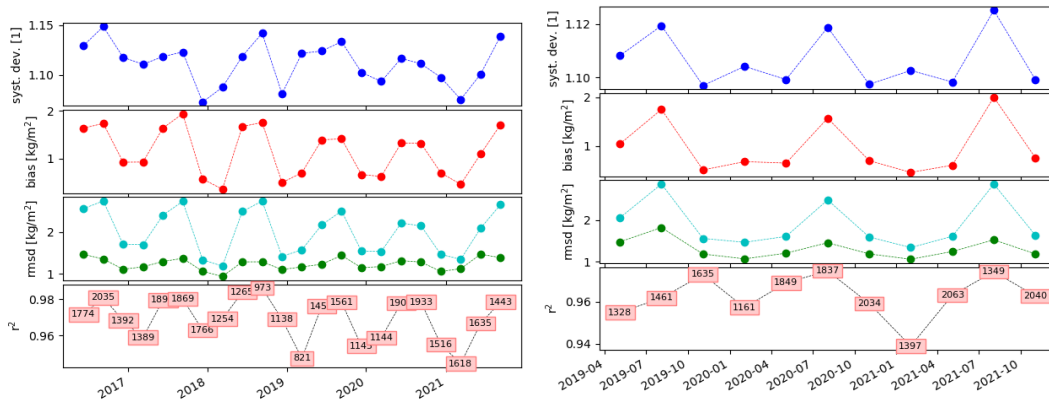



Figure 105: Temporal evolution of different quality measures for OLCI A (left) and OLCI B (right) with respect to SUOMI Net. From top to bottom: systematic deviation factor, bias, root mean squared difference (with and without bias correction), explained variance (number in boxes are the numbers of matchups)

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6 Level 2 SYN products validation

6.1 SYN L2 SDR products

There has been no new result during the reporting period. Most recent performance figures can be found in the S3MPC OPT Annual Performance Report - Year 2021 (S3MPC.ACR.APR.009, issue 1.0, 08/12/2021), available on-line at:

<https://sentinels.copernicus.eu/web/sentinel/user-guides/sentinel-3-olci/document-library>.

6.2 SY_2_VGP, SY_2_VG1 and SY_2_V10 products

There has been no new result during the reporting period. Most recent performance figures can be found in the S3MPC OPT Annual Performance Report - Year 2021 (S3MPC.ACR.APR.009, issue 1.0, 08/12/2021), available on-line at:

<https://sentinels.copernicus.eu/web/sentinel/user-guides/sentinel-3-olci/document-library>.

6.3 SYN L2 AOD NTC products

Validation of a new global aerosol product, derived from Synergy (Sy_2) of data from the OLCI and SLSTR sensors on the Sentinel-3A and -3B satellites was performed in the frame of ESA LAW project. The aim of the project was to provide global characterisation of the current aerosol retrieval, and to guide future algorithm development.

The study has included comparison of the aerosol products (Aerosol Optical Depth (AOD) at different wave lengths, Prognostic Uncertainties (PU), Angström exponent (AE), Fine Mode AOD (FMAOD)) with surface photometer data from the four networks AERONET, SKYNET, SURFRAD, and MAN, and comparison with MODIS combined Dark Target and Deep Blue algorithms for the period 01.2020-09.2021. Validation was performed for the whole product, as well as for groups of pixels retrieved with dual- and single-view approaches.

Main validation results obtained in the LAW project over land (AERONET) and ocean (MAN) are summarized below.

6.3.1 Validation over land with AERONET

6.3.1.1 AOD550

Scatter density plots for S3A SY_2 AOD at 550 nm wavelength (syAOD₅₅₀) and corresponding AERONET AOD₅₅₀ (aAOD₅₅₀) for all matchups available globally and separately for the NH and SH, are shown in Figure 106; validation statistics are summarized in Table 7.

Over land, overall AERONET correlation is ~0.6; performance has a high rms error, approximately 0.25 when compared to AERONET. Reduced performance over land is expected, since the surface reflectance and angular distribution of scattering is higher and more difficult to predict than ocean reflectance. However, the results indicate statistics are affected by a large number of outliers. The main causes are (i) poor screening of snow/ice covered surfaces (ii) in some regions, for example tropical forest areas, screening of cloud is not adequate, where care needs to be taken to fully exclude any pixels containing cloud including sub-pixel amounts in either nadir or oblique view and pixel neighbours. Bright desert

surfaces (see LAW final validation report for details) also have less stable retrieval, with land/ocean contrast suggesting high values in dust plumes are underestimated over land. Inspection of these outliers and patterns of disagreement with AERONET (see LAW final validation report for details) indicates reasons and targets for future algorithm evolution.

Overall statistics are slightly better for S3B and in the SH (Table 7).

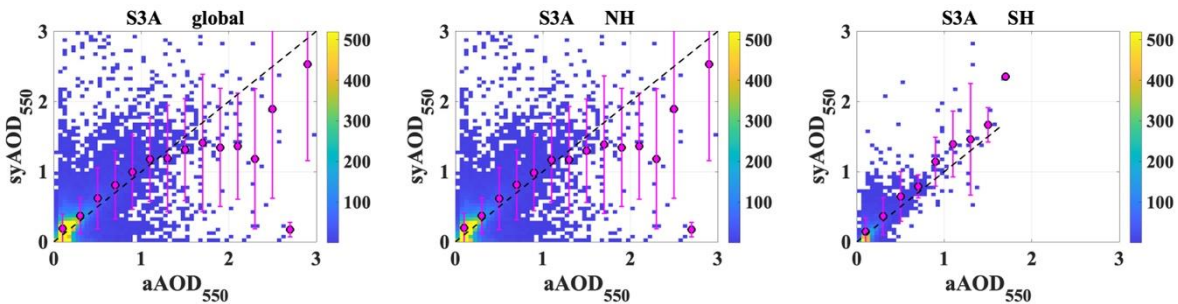


Figure 106 Scatter density plots for S3A syAOD₅₅₀ and corresponding aAOD₅₅₀ for matchups with AERONET available globally, over the NH and SH (panels left to right), for 01.2020-09.2021.

Table 7 Validation statistics (number of points, N; percentage of matchups which fit into MODIS AOD error envelope, EE, defined as $\pm 0.05 \pm 0.2 * AOD$ (ref); percentage of matchups which satisfy GCOS requirements (0.03 or 10% of AOD); correlation coefficient, R; root mean square, rms; standard deviation, σ ; bias and slope defined with linear regression applied to all available matchups) for S3A and S3B syAOD₅₅₀ for the globe, NH and SH for the period 01.2020-09.2021.

area	N		EE , %		GCOS , %		R		rms		std		bias		slope	
	S3A	S3B	S3A	S3B	S3A	S3B	S3A	S3B	S3A	S3B	S3A	S3B	S3A	S3B	S3A	S3B
globe	38376	38829	51,4	57,9	23,8	27,7	0,60	0,63	0,28	0,24	0,001	0,001	0,12	0,10	0,89	0,87
NH	32856	33240	48,2	55,1	20,5	24,8	0,60	0,62	0,28	0,25	0,001	0,001	0,13	0,11	0,86	0,85
SH	5520	5589	70,8	74,6	43,0	44,9	0,62	0,70	0,22	0,15	0,003	0,002	0,04	0,04	1,19	1,06

6.3.1.2 Prognostic uncertainties

To qualitatively illustrate an accuracy of prognostic uncertainties (PU), we show in Figure 107 the comparison between the prognostic uncertainties, AOD error (which is a difference between syAOD and aAOD) distribution and theoretical Gaussian distribution (with a mean of 0 and standard deviation of the AODerror) for the whole Sy_2 AOD product, as well as for the groups of pixels retrieved with different (dual- or single-view) approaches. PU distribution shows a double peak, (first peak is at ca. 0.02-0.04 for all groups; the second peak in a range of 0.12-18, for different groups). For singleN, two peaks are located close to each other. Mean PU for dual group is higher; standard deviation (std) is higher for singleN group. AOD error distributions are Gauss-like with partly some asymmetry in positive AODerror direction.

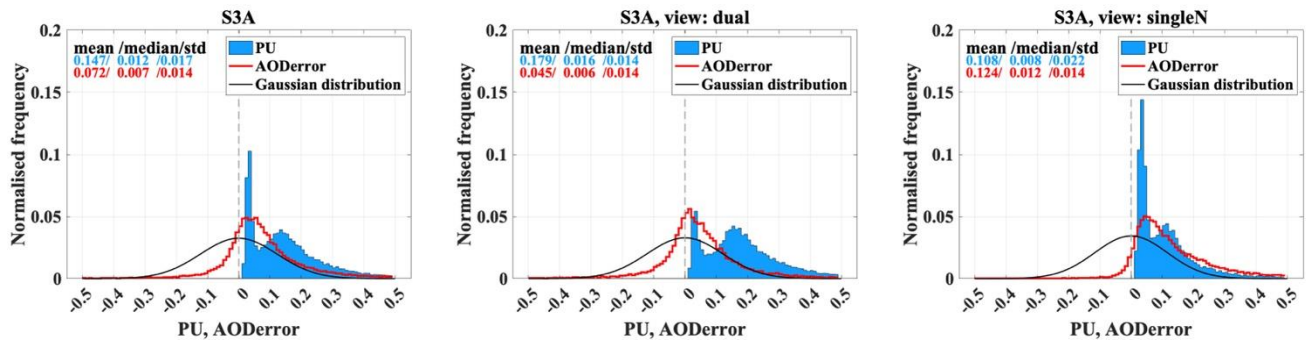


Figure 107: Comparison between prognostic uncertainties, AOD error distribution and theoretical Gaussian distribution for the whole product (left panel), dual- (middle panel) and singleN (right panel) groups of matchups.

Comparison between the normalized error (NE, which is a ratio between AODerror and expected discrepancy, ED) and theoretical Gaussian distribution (with a mean of 0 and standard deviation of NE) is shown in Figure 108. Positive NE means that syAOD was higher than aAOD. Absolute $NE < 1$ means that AOD error was lower than ED (or PU, since the contribution of AERONET error to the ED is not significant). The high peak of small positive NE, considerable positive bias, especially for singleN group, and longer positive than negative tail, negative tail below expected Gaussian distribution (positive tail is longer than negative) say that the fraction of small (< 1) NE, when actual error is smaller than expected discrepancy, is higher than expected and ED, which is defined mostly from the PU, is overestimated (for $NE \ll 1$). Clear difference exists in NE footprints for dual- and single-view groups of pixels. PU was considerably underestimated for the cases when syAOD was lower than aAOD.

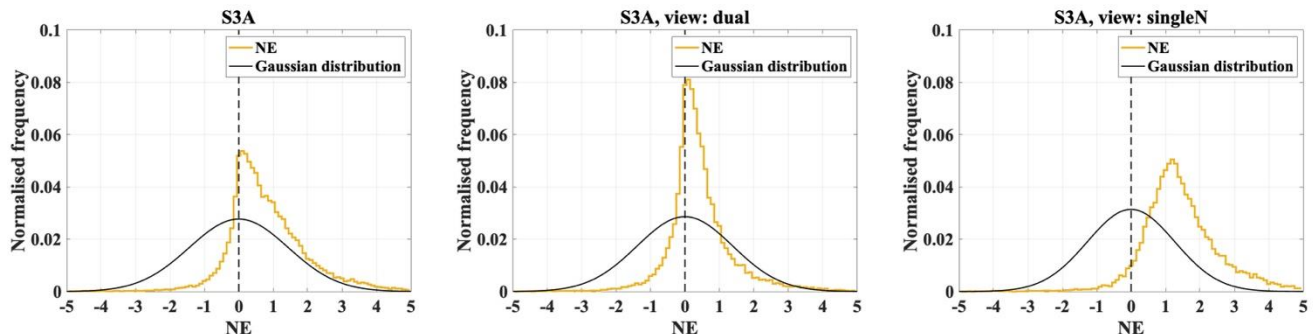


Figure 108 Comparison between normalized error and theoretical Gaussian distribution for the whole product (left panel), dual- (middle panel) and singleN (right panel) groups of matchups.

6.3.1.3 Fine mode AOD

Scatter density plots for the Sy_2 Fine mode AOD (syFMAOD, Figure 109) show similar footprint with underestimation of high (> 1) AERONET aFMAOD, as for AOD₅₅₀. Validation statistics for syFMAOD are slightly better than for syAOD₅₅₀.

Overall statistics are slightly better for S3B and in the SH.

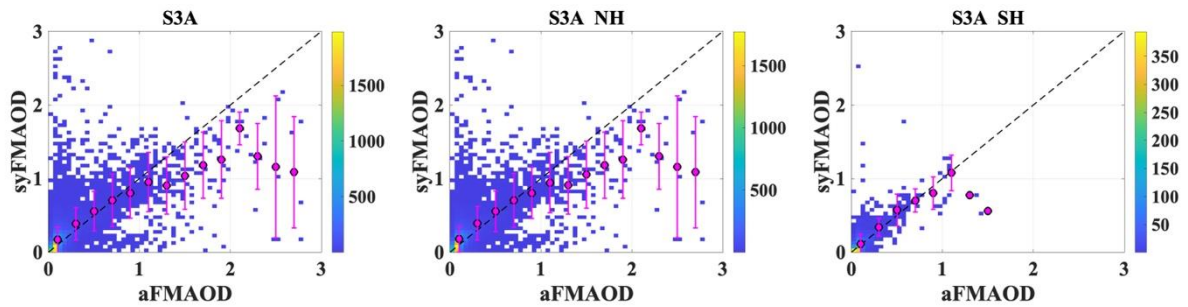


Figure 109: Scatter density plots for S3A syFMAOD and corresponding aFMAOD for matchups available globally, over the NH and SH (panels left to right), for 01.2020-09.2021.

Table 8: For S3A and S3B, annual (for the globe, NH and SH) validation statistics for syFMAOD

area	N		R		rms		std		bias		slope	
	S3A	S3B	S3A	S3B	S3A	S3B	S3A	S3B	S3A	S3B	S3A	S3B
globe	18145	18262	0,63	0,67	0,22	0,20	0,001	0,001	0,13	0,12	0,72	0,72
NH	15883	15982	0,63	0,66	0,23	0,20	0,002	0,001	0,14	0,12	0,70	0,71
SH	2262	2280	0,67	0,72	0,15	0,15	0,003	0,002	0,06	0,06	0,93	0,91

6.3.1.4 Angström exponent

The retrieval of Sy₂ Angström exponent, syAE, related to aerosol size distribution, shows spatial correlation with expected sources but generally overestimates syAE for cases where aAE is low, which is resulting in overall high bias (Figure 110, Table 9). This is dependent on retrieval of fine mode fraction in the algorithm, which needs to be investigated further and improved.

Overall statistics are similar for S3A and S3B and slightly better in the SH (Table 9).

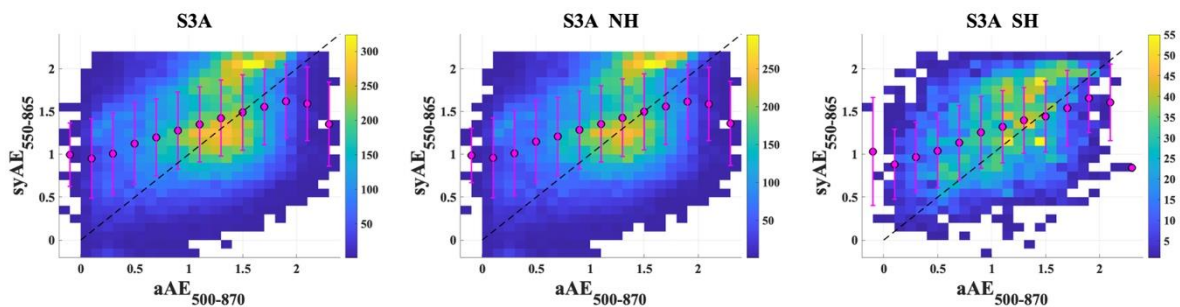


Figure 110: Scatter density plots for S3A syAE₅₅₀₋₈₆₅ and aAE₅₀₀₋₈₇₀ for the globe, NH and SH (panels left to right) for matchups available globally, over the NH and SH (panels left to right), for 01.2020-09.2021.

Table 9: Validation statistics (number of points, N; correlation coefficient, R; root mean square, rms; standard deviation, σ ; bias and slope defined with linear regression applied to all available matchups) for S3A and S3B syAE₅₅₀₋₈₆₅ for the globe, NH and SH for the whole period for all matchups and for three groups of matchups, defined with the processor applied.

area	N		R		rms		std		bias		slope	
	S3A	S3B	S3A	S3B	S3A	S3B	S3A	S3B	S3A	S3B	S3A	S3B
globe	38469	38920	0,35	0,34	0,57	0,58	0,003	0,003	0,94	0,97	0,36	0,35
NH	32939	33323	0,34	0,33	0,58	0,58	0,003	0,003	0,96	1,00	0,35	0,33
SH	5530	5597	0,39	0,42	0,54	0,53	0,007	0,006	0,86	0,83	0,41	0,44

6.3.2 Validation over ocean with MAN

Over ocean, the performance of SYNERGY retrieved AOD is good and consistent with reference MAN dataset (mAOD, rms ~0.05), although the MAN validation has a limited set of higher AOD examples. Against MODIS, agreement is good, although syAOD shows lower values at high AOD (>1.5) in dust regions potentially indicating cloud screening improvement needed for high dust levels.

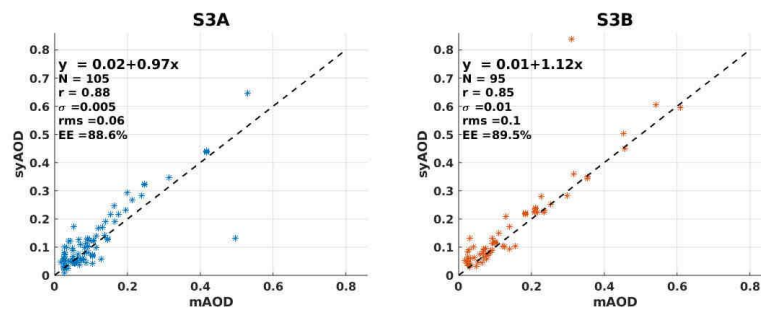


Figure 111: Scatter plots between S3A and S3B syAOD and MAN AOD (mAOD) with validation statistics.

6.3.3 General conclusions

Overall statistics are slightly better for S3B and in the SH.

Recommendations for improvement of S2_2 AOD product are given in the final LAW AOD validation report.

7 Events

For OLCI-A, three Radiometric Calibration sequences have been acquired during the reported period:

- ❖ S01 sequence (diffuser 1) on 11/01/2022 12:22 to 12:24 (absolute orbit 30739)
- ❖ S01 sequence (diffuser 1) on 27/01/2022 00:19 to 00:21 (absolute orbit 30960)
- ❖ S05 sequence (diffuser 2) on 27/01/2022 02:00 to 02:02 (absolute orbit 30961)

For OLCI-B, three Radiometric Calibration sequences have been acquired during the reported period:

- ❖ S01 sequence (diffuser 1) on 12/01/2022 07:54 to 07:56 (absolute orbit 18908)
- ❖ S01 sequence (diffuser 1) on 28/01/2022 11:00 to 11:08 (absolute orbit 19587)
- ❖ S05 sequence (diffuser 2) on 28/01/2022 12:41 to 12:43 (absolute orbit 19588)


As there was no Cyclic Performance Report delivered since Cyclic Performance Report #78/#59 (OLCI-A/OLCI-B), we report hereafter the Radiometric calibration sequences that have been acquired between the release of the last CPR and the beginning of the current reporting period. These acquisitions are taken into account in the current Data Quality report:

For OLCI-A, four Radiometric Calibration sequences have been acquired since the last CPR:

- ❖ S01 sequence (diffuser 1) on 23/11/2021 06:48 to 06:50 (absolute orbit 30037)
- ❖ S05 sequence (diffuser 2) on 23/11/2021 08:29 to 08:31 (absolute orbit 30038)
- ❖ S01 sequence (diffuser 1) on 11/12/2021 00:39 to 00:41 (absolute orbit 30290)
- ❖ S01 sequence (diffuser 1) on 26/12/2021 04:12 to 04:14 (absolute orbit 30056)

For OLCI-B, two Radiometric Calibration sequences have been acquired since the last CPR:

- ❖ S01 sequence (diffuser 1) on 11/12/2021 20:11 to 20:13 (absolute orbit 18908)
- ❖ S01 sequence (diffuser 1) on 26/12/2021 22:04 to 22:06 (absolute orbit 19123)

 <p>OPT-MPC Copernicus Sentinel Optical Mission Performance Cluster</p>	<p>Optical MPC</p> <p>Data Quality Report –Sentinel-3 OLCI</p>	<p>Ref.: OMPC.ACR.DQR.03.02-2022 Issue: 1.1 Date: 11/03/2022 Page: 107</p>
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8 Appendix A

Other reports related to the Optical mission are:

- ❖ Data Quality Report – Sentinel-3 SLSTR, January 2022, (ref. OMPC.RAL.DQR.04.01-2022)

All Data Quality Reports, as well as past years Cyclic Performance Reports and Annual Reports, are available on dedicated pages in Sentinel Online website, at:

- <https://sentinel.esa.int/web/sentinel/technical-guides/sentinel-3-olci/data-quality-reports>
- <https://sentinels.copernicus.eu/web/sentinel/technical-guides/sentinel-3-slstr/data-quality-reports>
- [OPT Annual Performance Report Year 02021 \(PDF document\)](#)

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