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

S3 OLCI Cyclic Performance Report

S3-A

Cycle No. 070

Start date: 23/03/2021

End date: 19/04/2021

S3-B

Cycle No. 051

Start date: 01/04/2021

End date: 28/04/2021



Mission
Performance
Centre

SENTINEL 3



Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

Contract: 4000111836/14/I-LG

Customer:	ESA	Document Ref.:	S3MPC.ACR.PR.01-070-051
Contract No.:	4000111836/14/I-LG	Date:	05/05/2021
		Issue:	1.0

Project:	PREPARATION AND OPERATION FOR THE COPERNICUS SENTINE		PERFORMANCE CENTRE (MPC)
Title:	S3 OLCI Cyclic Performance Report		
Author(s):	OLCI ESLs		
Approved by:	L. Bourg, OLCI ESL Coordinator	Authorized by	Frédéric Rouffi, OPT Technical Performance Manager
Distribution:	ESA, EUMETSAT, S3MPC consortium		
Accepted by ESA	S. Dransfeld, MPC Deputy TO for OPT		
	P. Féménias, MPC TO		
Filename	S3MPC.ACR.PR.01-070-051 - i1r0 - OLCI Cyclic Report 070-051.docx		

Disclaimer

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









S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

Page: iii

Changes Log

Version	Date	Changes
1.0	05/05/2021	First Version

List of Changes

Version	Section	Answers to RID	Changes



S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

Page: iv

Table of content

1	PROC	ESSING BASELINE VERSION	1
	1.1	Sentinel3-A	1
	1.2	Sentinel3-B	1
2	INST	RUMENT MONITORING	2
	2.1	CCD temperatures	2
	2.1.1	OLCI-A	2
	2.1.2	OLCI-B	4
	2.2	Radiometric Calibration	6
	2.2.1		
	2.2.2	Instrument response and degradation modelling [OLCI-L1B-CV-250]	. 19
	2.2.3	Ageing of nominal diffuser [OLCI-L1B-CV-240]	. 38
	2.2.4	Updating of calibration ADF [OLCI-L1B-CV-260]	. 48
	2.2.5 Diffu	Radiometric Calibrations for sun azimuth angle dependency and Yaw Manoeuvres for Sol ser on-orbit re-characterization [OLCI-L1B-CV-270 and OLCI-L1B-CV-280]	
	2.3	Spectral Calibration [OLCI-L1B-CV-400]	. 49
	2.3.1	OLCI-A	. 49
	2.3.2	OLCI-B	. 52
	2.4	Signal to Noise assessment [OLCI-L1B-CV-620]	. 54
	2.4.1	SNR from Radiometric calibration data	. 54
	2.4.2	SNR from EO data	. 61
	2.5	Geometric Calibration/Validation	. 61
	2.5.1	OLCI-A	. 61
	2.5.2	OLCI-B	. 64
3	OLCI	LEVEL 1 PRODUCT VALIDATION	68
	3.1	[OLCI-L1B-CV-300], [OLCI-L1B-CV-310] — Radiometric Validation	. 68
	3.1.1	S3ETRAC Service	. 68
	3.1.2	Radiometric validation with DIMITRI	. 71
	3.1.3	Radiometric validation with OSCAR	. 78
	3.2	[OLCI-L1B-CV-320] – Radiometric Validation with Level 3 products	. 82
	3.2.1	OLCI-A	. 82
	2 2 2	OLCI-R	82



S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Issue: 1.0

Date: 05/05/2021

Ref.: S3MPC.ACR.PR.01-070-051

Page: v

4	LEVEL	. 2 LAND PRODUCTS VALIDATION	83
	4.1	[OLCI-L2LRF-CV-300]	83
	4.1.1	Routine extractions	83
	4.1.2	Comparisons with MERIS MGVI and MTCI climatology	93
		[OLCI-L2LRF-CV-410 & OLCI-L2LRF-CV-420] — Cloud Masking & Surface Classification for Lar	
5	LEVEL	. 2 WATER PRODUCTS VALIDATION	.100
	5.2 L2WLR-	[OLCI-L2-CV-210, OLCI-L2-CV-220] – Vicarious calibration of the NIR and VIS bands	er- 100
	5.2.2	OLCI-A	101
	5.2.3		
		[OLCI-L2WLR-CV-430] – Algorithm performance over spatial and temporal domains	
		[OLCI-L2WLR-CV-510 & 520] — Cloud Masking & Surface Classification for Water Products [OLCI-L2WLR-CV530] Validation of Aerosol Product	
		[OLCI-L2WLR-CV-380] Development of calibration, product and science algorithms	
6		DATION OF INTEGRATED WATER VAPOUR OVER LAND & WATER	
		Preface	
		Quantitative validation using GNSS – Land	
		Quantitative validation using GNSS - Water	
	6.4	Quantitative validation using AERONET IWV Retrievals – Land	120
		Validation by AERONET IWV Retrievals – Ocean	
	6.6	Quantitative validation using ARM MWR IWV Retrievals — Land	122
	6.7	Summary	124
	6.8	References:	125
7	LEVEL	2 SYN PRODUCTS VALIDATION	126
8	EVEN.	TS	.127
۵	ADDE	NDIY A	120



S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

Page: vi

List of Figures

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 3
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 frames5
Figure 5: Sun azimuth angles during acquired OLCI-A Radiometric Calibrations (diffuser frame) on top of nominal yearly cycle (black curve). Diffuser 1 with diamonds, diffuser 2 with crosses, 2016 acquisitions in dark blue, 2017 in clear blue, 2018 in green, 2019 in light green, 2020 in orange and 2021 in red7
Figure 6: same as Figure 5 for OLCI-B (2018 in blue, 2019 in green, 2020 in yellow and 2021 in red)7
Figure 7: OLCI-A Sun geometry during radiometric Calibrations on top of characterization ones (diffuser frame)8
Figure 8: same as Figure 7 for OLCI-B8
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 filtering9
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 12
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 13
Figure 15: OLCI-A Dark current increase rates with time (in counts per year) vs. band (left) and vs. band width (right)



S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

Page: vii

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 17
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)
Figure 22: OLCI-A Gain Coefficients for band Oa1 (top) and Oa21 (bottom), derived using the ground BRDF model. The dataset is made of all diffuser 1 radiometric calibrations so far except the first one (orbit 183) for which the instrument was not thermally stable yet 20
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 has been taken into account
Figure 24: OLCI-B Gain Coefficients for band Oa1 (top) and Oa21 (bottom), derived using the ground BRDF model. The dataset is made of all diffuser 1 radiometric calibrations so far except the first one (orbit 167) for which the instrument was not thermally stable yet 22
Figure 25: OLCI-B camera averaged gain relative evolution with respect to first calibration after channel programming change (18/06/2018), as a function of elapsed time since the beginning of the mission; one curve for each band (see colour code on plots), one plot for each module. The diffuser ageing has been taken into account
Figure 26: RMS performance of the OLCI-A Gain Model of the current processing baseline as a function of orbit 24
Figure 27: RMS performance of the OLCI-A Gain Model of the previous Processing Baseline as a function of orbit. The blue vertical dotted line defines the limit from which the gain model starts to be extrapolated (i.e. it corresponds to the most recent CAL of the dataset used to build the model)25
Figure 28: OLCI-A Camera-averaged instrument evolution since channel programming change (25/04/2016) and up to the most recent calibration (13/04/2021) versus wavelength 26
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 18 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 programing update), including 18 calibrations in extrapolation, channels Oa1 to Oa6



S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

Page: viii

Figure 31: same as Figure 30 for channels Oa7 to Oa14 29
Figure 32: same as Figure 30 for channels Oa15 to Oa21 30
Figure 33: RMS performance of the OLCI-B Gain Model of the current processing baseline as a function of orbit 31
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)
Figure 35: OLCI-B Camera-averaged instrument evolution since channel programming change (18/06/2018) and up to most recent calibration (20/04/2021) versus wavelength 33
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 19 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 19 calibrations in extrapolation, channels Oa1 to Oa6.
Figure 38: same as Figure 37 for channels Oa7 to Oa14 36
Figure 39: same as Figure 37 for channels Oa15 to Oa21 37
Figure 40: diffuser 1 ageing for spectral band Oa01. We see strong ACT low frequency structures that are due to residual of BRDF modelling 38
Figure 41: same as Figure 40 for spectral band Oa17. We use this band in order to normalize other bands and remove the ACT structures due to residual of BRDF modelling. Normalized curve for spectral band Oa01 is presented in Figure 42 39
Figure 42: same as Figure 40 after normalization by band Oa17. Ageing of the diffuser 1 is now visible in the 5 cameras
Figure 43: Diffuser 1 ageing as a function of wavelength (or spectral band). Ageing is clearly visible in spectral band #1 to #6 40
Figure 44: Camera averaged ageing for band Oa01 (normalized by band Oa17) as a function of elapsed time. Linear fit for each camera is plotted. The slope (% loss per year) and the correlation coefficient. 41
Figure 45: Slope of ageing fit (% of loss per exposure) vs wavelengths, using all the available ageing sequence at the time of the current cycle (red curve) and at the time of previous cycle for which an ageing sequence was measured (see legend within the figure)
Figure 46: OLCI-B diffuser 1 ageing for spectral band Oa01. We see strong ACT low frequency structures that are due to residual of BRDF modelling 43
Figure 47: same as Figure 46 for spectral band Oa17. We use this band in order to normalize other bands and remove the ACT structures due to residual of BRDF modelling. Normalized curve for spectral band Oa01 is presented in Figure 48.
Figure 48: same as Figure 46 after normalization by band Oa17. Ageing of the diffuser 1 is now visible in the 5 cameras
Figure 49: OLCI-B Diffuser 1 ageing as a function of wavelength (or spectral band). Ageing is clearly visible in spectral band #1 to #5 46



S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

Page: ix

Figure 50: Slope of ageing fit (% of loss per exposure) vs wavelengths, using all the available ageing sequence at the time of the current cycle (red curve) and at the time of previous cycle for which an ageing sequence was measured (see legend within the figure)
Figure 51: OLCI-B diffuser ageing (after 100 exposures, i.e. about two years) according to direct assessment from Yaw Manoeuvres (blue) and nominal method at Cycle 28 (orange) 48
Figure 52: 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 53: 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 50
Figure 54: OLCI-A camera averaged spectral calibration evolution as a function of time from S09 calibrations since the 4th may 2016. The last calibration for S09 is from 12 Dec 2020. 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
thick line 52
Figure 56: 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 57: OLCI-B camera averaged spectral calibration evolution as a function of time since launch from S09 calibrations since the beginning of the mission. The last calibration for S09 is from 22 Dec 2020. 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 53
Figure 58: 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 55
Figure 59: long-term stability of the SNR estimates from Calibration data, example of channel Oa1 56
Figure 60: 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 58
Figure 61: long-term stability of the OLCI-B SNR estimates from Calibration data, example of channel Oa1.
Figure 62: 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 62
Figure 63: 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 64: same as Figure 63 for Camera 2 62



S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

Page: x

Figure 65: same as Figure 63 for Camera 3 6
Figure 66: same as Figure 63 for Camera 4 6
Figure 67: same as Figure 63 for Camera 5 6
Figure 68: OLCI-A spatial across-track misregistration at each camera transition (left) and maximur amplitude of the across-track error within each camera (left).
Figure 69: OLCI-A spatial along-track misregistration at each camera transition (left) and maximur amplitude of the along-track error within each camera (left).
Figure 70: overall OLCI-B georeferencing RMS performance time series over the whole monitoring perio (left) and corresponding number of validated control points (right)
Figure 71: across-track (left) and along-track (right) OLCI-B georeferencing biases time series for Camer 1
Figure 72: same as Figure 71 for Camera 2 6
Figure 73: same as Figure 71 for Camera 3 6
Figure 74: same as Figure 71 for Camera 4 6
Figure 75: same as Figure 71 for Camera 5 6
Figure 76: OLCI-B spatial across-track misregistration at each camera transition (left) and maximur amplitude of the across-track error within each camera (left).
Figure 77: OLCI-B spatial along-track misregistration at each camera transition (left) and maximur amplitude of the along-track error within each camera (left).
Figure 78: 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 withougeneration of output product (data not meeting selection requirements), yellow — number of runs endin in error, red, one plot per site type).
Figure 79: 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 withougeneration of output product (data not meeting selection requirements), green – number of runs ending in error, red, one plot per site type).
Figure 80: Time-series of the elementary ratios (observed/simulated) signal from OLCI-A 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 desermethodology uncertainty
Figure 81: 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 desermethodology uncertainty
Figure 82: The estimated gain values for OLCI-A and OLCI-B over the 6 PICS sites identified by CEOS over the period January 2021-Present as a function of wavelength. Dashed-green and orange lines indicate th 2% and 5% respectively. Error bars indicate the desert methodology uncertainty.
Figure 83: Time-series of the elementary ratios (observed/simulated) signal from (black) S2A/MSI, (blue S3A/OLCI, (green) S3B/OLCI and (Cyan) Aqua/MODIS for NIR band 865nm over LIBYA4 site. Dashed-gree and orange lines indicate the 2% and 5% respectively. The systematic and total uncertainties of the deserged by the delays are 10% and 50% respectively.
methodology are 1% and 5% respectively



S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

Page: xi

Figure 84: 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 77
Figure 85: 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.————————————————————————————————————
Figure 86. OSCAR Rayleigh S3A and S3B Calibration results as a function of wavelength. Average and standard deviation over all scenes currently (re)processed with the new climatology 79
Figure 87. OLCI-A & OLCI-B OSCAR Rayleigh Calibration results for 2019 and 2020 as a function of wavelength
Figure 88. OSCAR Glitter OLCI-A and OLCI-B Calibration results (adapted to Rayleigh result at 665 nm) for 2020 as a function of wavelength 80
Figure 89: DeGeb time series over current report period 83
Figure 90: ITCat time series over current report period 84
Figure 91: ITIsp time series over current report period 84
Figure 92: ITSro time series over current report period 85
Figure 93: ITTra time series over current report period 85
Figure 94: SPAli time series over current report period 86
Figure 95: UKNFo time series over current report period 86
Figure 96: USNe1 time series over current report period 87
Figure 97: USNe2 time series over current report period 87
Figure 98: USNe3 time series over current report period 88
Figure 99: DeGeb time series over current report period 88
Figure 100: ITCat time series over current report period 89
Figure 101: ITIsp time series over current report period 89
Figure 102: ITSro time series over current report period 90
Figure 103: ITTra time series over current report period 90
Figure 104: SPAli time series over current report period 91
Figure 105: UKNFo time series over current report period 91
Figure 106: USNe1 time series over current report period 92
Figure 107: USNe2 time series over current report period 92
Figure 108: USNe3 time series over current report period 93
Figure 109: 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 110: 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 97



S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

Page: xii

Figure 111: 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 98
Figure 112: 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 cycle S3A 70.
Figure 113: Scatter plots of OLCI-A versus in situ radiometry (FR data). Reprocessed dataset (left), all available data for the current time period (right), Oa1 to Oa4 (400 to 490 nm)103
Figure 114: Scatter plots of OLCI-A versus in situ radiometry (FR data). Reprocessed dataset (left), all available data for the current time period (right), Oa5 Oa6 and Oa07 (510, 560 and 620 nm)104
Figure 115: Scatter plots of OLCI-A versus in situ radiometry (FR data). Reprocessed dataset (left), all available data for the current time period (right), Oa8 and Oa10 (665 and 681 nm)105
Figure 116: Galata time series over current report period106
Figure 117: AAOT time series over current report period107
Figure 118: Scatter plots of OLCI-B versus in situ radiometry (FR data). All available data for the current time period109
Figure 119: AAOT time series over current report period111
Figure 120: GALATA time series over current report period112
Figure 121: Upper and middle: Scatter plot of the aerosol products (upper: aerosol optical thickness, middle: Angstroem coefficient), derived from OLCI (A left, B right) and AERONET-OC measurements. Lower left: Positions of the AERONET-OC stations. Lower-right: Temporal evolution of different quality measures for the optical thickness derived from OLCI A (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))
Figure 122: Upper and middle: Scatter plot of the aerosol products (upper: aerosol optical thickness, middle: Angstroem coefficient), derived from OLCI (A left, B right) and MAN measurements. Lower: Positions of the MAN acquisitions (left: OLCI A, right: OLCI B)
Figure 123: 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 124: Temporal evolution of different quality measures for OLCI A (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))
Figure 125: Upper: Scatter plot of the IWV products, derived from OLCI (A left, B right) above ocean and from SUOMI NET GNSS measurements. Lower: Positions of the GNSS (A: left, B: right)120
Figure 126: Upper: Scatter plot of the IWV products, derived from OLCI (A left, B right) above land and from Aeronet v.3 L1.5 measurements. Middle: Histogram of the difference between OLCI (A: left, B: right) and Aeronet (blue: original OLCI, orange: bias corrected OLCI). Lower: Positions of the Aeronet (A matchups: left, B matchups: right).



S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

Page: xiii

Figure 127: Upper: Scatter plot of the IWV products, derived from OLCI (A left, B right) above ocean and
from Aeronet-OC v.3 L1.5 measurements. Lower: Positions of the used Aeronet match ups (A: left, B:
right)122
Figure 128: Upper: Scatter plot of the IWV products, derived from OLCI (A left, B right) above land and
from ARM microwave measurements. Middle: Histogram of the difference between OLCI (A: left, B: right)
and ARM-MWR (blue: original OLCI, orange: bias corrected OLCI). Lower: Temporal evolution of different
quality measures for OLCI A (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))123
Figure 129: ARM vs. GNSS IWV retrievals for the SGP site for the one year period between Nov 2017 and
Oct 2018. Only cloud free data has been used, according to the liquid/ice water path from the microwave
radiometer124

List of Tables

able 1: OLCI-A SNR figures as derived from Radiometric Calibration data. Figures are given for easternance of E Camera (time average and standard deviation), and for the whole instrument. The requirement and efference radiance level are recalled (in mW.sr ⁻¹ .m ⁻² .nm ⁻¹)	its
Table 2: OLCI-B SNR figures as derived from Radiometric Calibration data. Figures are given for extramera (time average and standard deviation), and for the whole instrument. The requirement and reference radiance level are recalled (in mW.sr ⁻¹ .m ⁻² .nm ⁻¹)	ach lits
able 3: S3ETRAC Rayleigh Calibration sites	79
able 4. Overview of the OSCAR Rayleigh and Glitter calibration results for OLCI-A and OLCI-B	81
Table 5: Validation sites analysed in report S3A 70/S3B 51. Land cover data from GLC2000 group according to the International Geosphere-Biosphere Programme (IGBP) designations.	
able 6: Comparison statistics between monthly S3A/B OLCI land products and MERIS archive data	95
able 7: OLCI-A FR statistics over REP_006 period; FR data1	105
able 8: OLCI-A FR statistics over December 2017-febrary 2021	105
able 9: OLCI-B FR statistics over February to August 2020 reporting period	110

SINTINEL 3 Mission Performance Centre

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

Page: 1

1 Processing Baseline Version

1.1 Sentinel3-A

IPF	IPF / Processing Baseline version	Date of deployment
OL1	06.11 / 2.76	NRT: 28/04/2021 07:15 UTC NTC: 28/04/2021 07:15 UTC
OL2 LAND	06.14 / 2.66	NRT: 23/06/2020 08:00 UTC NTC: 23/06/2020 08:00 UTC
OL2 MAR	07.00 / 2.72M	NRT: 16/02/2021 08:35 UTC NTC: 15/02/2021 05:46 UTC
SY2	06.20 / 2.66	NTC: 23/06/2020 08:00 UTC
SY2_VGS	06.08 / 2.56	NTC: 15/01/2020 11:00 UTC

1.2 Sentinel3-B

IPF	IPF / Processing Baseline version	Date of deployment
OL1	06.11 / 1.54	NRT: 28/04/2021 07:15 UTC NTC: 28/04/2021 07:15 UTC
OL2 LAND	06.14 / 1.40	NRT: 23/06/2020 08:00 UTC NTC: 23/06/2020 08:00 UTC
OL2 MAR	07.00 / 2.72M	NRT: 16/02/2021 07:56 UTC NTC: 15/02/2021 06:47 UTC
SY2	06.20 / 1.40	NTC: 23/06/2020 08:00 UTC
SY2_VGS	06.08 / 1.28	NTC: 15/01/2020 11:00 UTC

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 - S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

Page: 2

2 Instrument monitoring

2.1 CCD temperatures

2.1.1 OLCI-A

The monitoring of the CCD temperatures is based on MPMF data extractions not yet operational. In the meantime, we monitor the CCD temperatures on the long-term using Radiometric Calibration Annotations (see Figure 1). Variations are very small (0.09 C peak-to-peak) and no trend can be identified. Data from current cycle (rightmost data points) do not show any specificity.

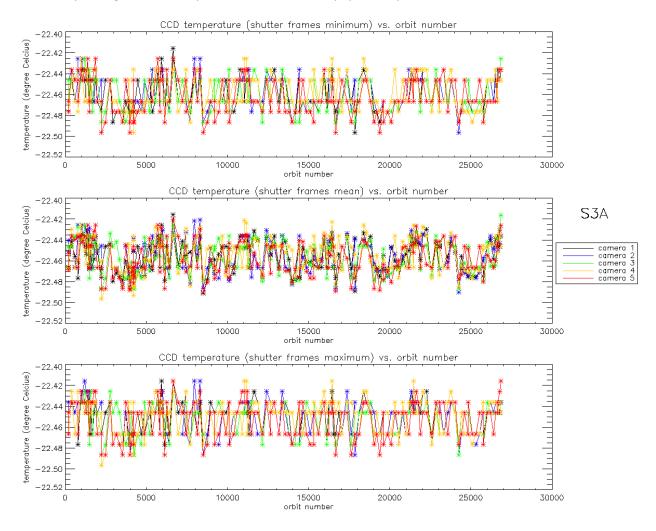


Figure 1: long term monitoring of OLCI-A CCD temperatures using minimum value (top), time averaged values (middle), and maximum value (bottom) provided in the annotations of the Radiometric Calibration Level 1 products, for the shutter frames, all radiometric calibrations so far except the first one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

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

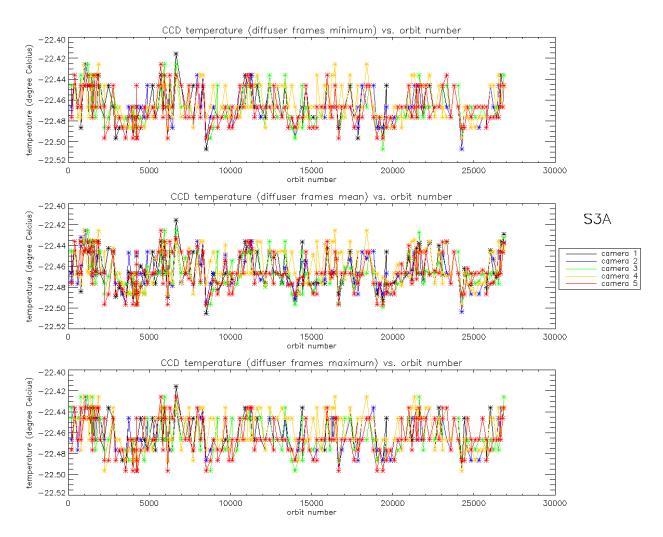


Figure 2: Same as Figure 1 for diffuser frames.

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

Page: 4

2.1.2 OLCI-B

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

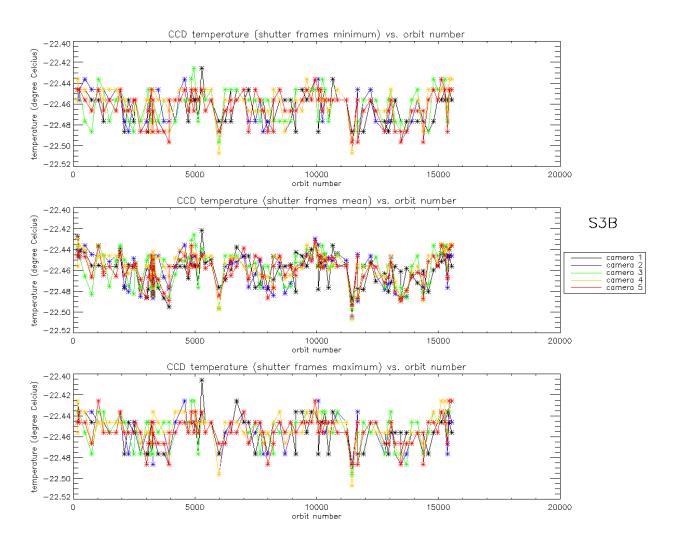


Figure 3: long term monitoring of OLCI-B CCD temperatures using minimum value (top), time averaged values (middle), and maximum value (bottom) provided in the annotations of the Radiometric Calibration Level 1 products, for the Shutter frames, all radiometric calibrations so far except the first one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

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

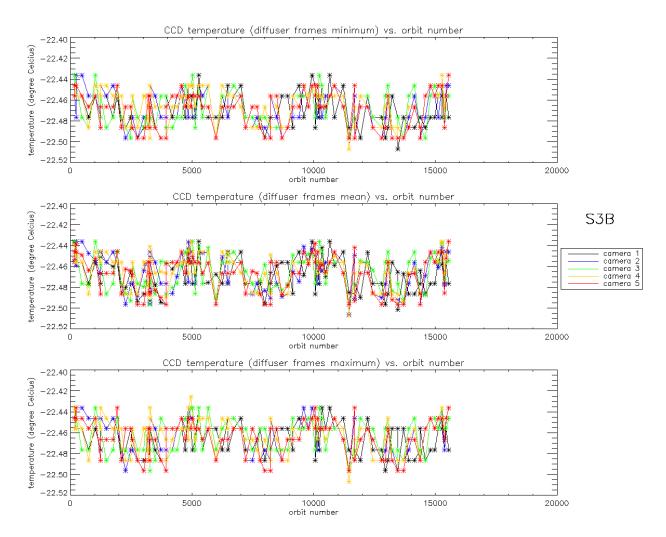


Figure 4: same as Figure 3 for diffuser frames.

SENTINEL 3 Mission Performance Centre

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

Page: 6

2.2 Radiometric Calibration

For OLCI-A, four Radiometric Calibration sequences have been acquired during Cycle 070:

- \$ S01 sequence (diffuser 1) on 31/03/2021 09:06 to 09:08 (absolute orbit 26659)
- S05 sequence (diffuser 2) on 31/03/2021 10:47 to 10:49 (absolute orbit 26660)
- S01 sequence (diffuser 1) on 08/04/2021 12:20 to 12:22 (absolute orbit 26775)
- S01 sequence (diffuser 1) on 13/04/2021 00:02 to 00:04 (absolute orbit 26839)

For OLCI-B, three Radiometric Calibration sequences have been acquired during Cycle 051:

- \$ S01 sequence (diffuser 1) on 08/04/2021 06:37 to 06:39 (absolute orbit 15378)
- S01 sequence (diffuser 1) on 12/04/2021 18:20 to 18:22 (absolute orbit 15442)
- S01 sequence (diffuser 1) on 20/04/2021 08:06 to 08:08 (absolute orbit 15550)

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).

SENTINEL 3 Mission Performance Contra

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 - S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

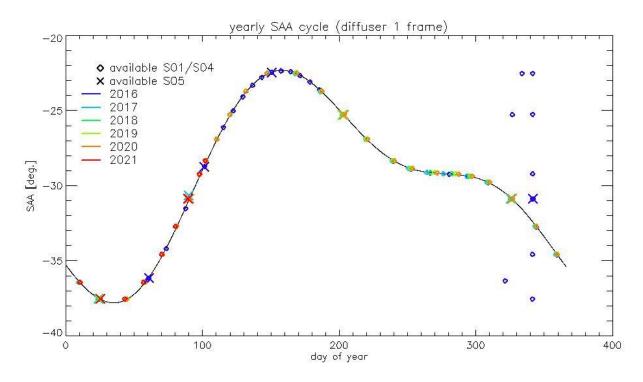


Figure 5: Sun azimuth angles during acquired OLCI-A Radiometric Calibrations (diffuser frame) on top of nominal yearly cycle (black curve). Diffuser 1 with diamonds, diffuser 2 with crosses, 2016 acquisitions in dark blue, 2017 in clear blue, 2018 in green, 2019 in light green, 2020 in orange and 2021 in red.

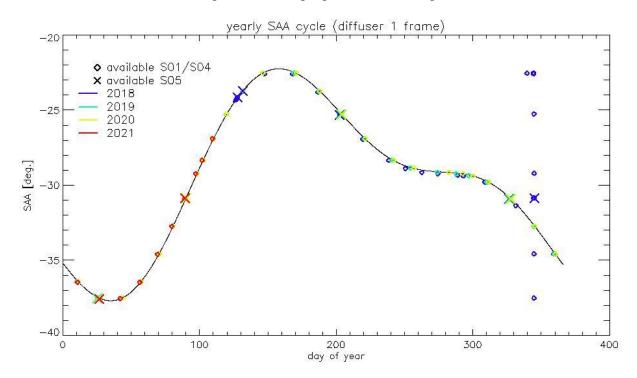


Figure 6: same as Figure 5 for OLCI-B (2018 in blue, 2019 in green, 2020 in yellow and 2021 in red).



S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

Page: 8

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

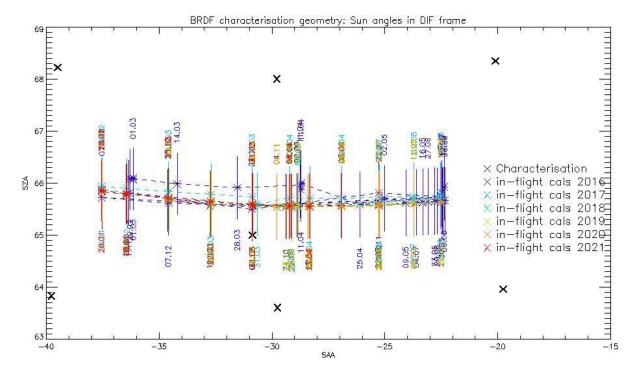


Figure 7: OLCI-A Sun geometry during radiometric Calibrations on top of characterization ones (diffuser frame)

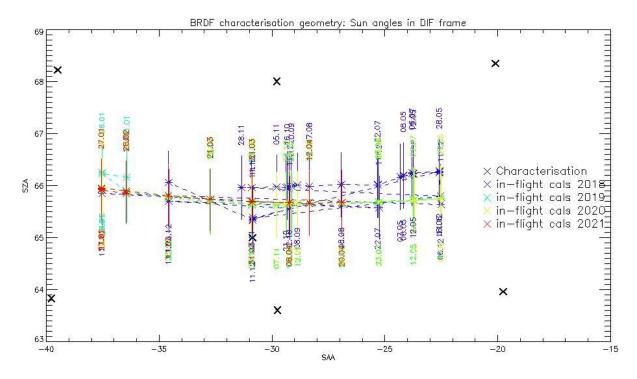


Figure 8: same as Figure 7 for OLCI-B

SENTINEL 3 Mission Performance

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

Page: 9

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.

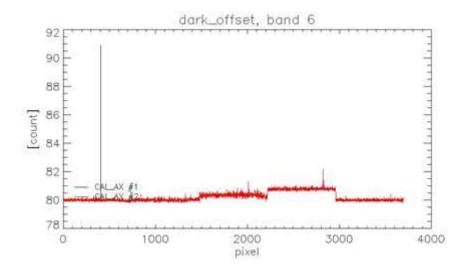


Figure 9: Dark Offset table for band Oa06 with (red) and without (black) HEP filtering (Radiometric Calibration of 22 July 2017). The strong HEP event near pixel 400 has been detected and removed by the HEP filtering.

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

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

Page: 10

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 Cycle calibrations are affected the same way as others. The amplitude of the shift varies with band and camera from virtually nothing (e.g. camera 2, band 0a1) to up to 5 counts (Oa21, camera 3). The Periodic Noise itself comes on top of the global shift with its known signature: high frequency oscillations with a rapid damp. This effect remains more or less stable with time in terms of amplitude, frequency and decay length, but its phase varies with time, introducing the global offset mentioned above.

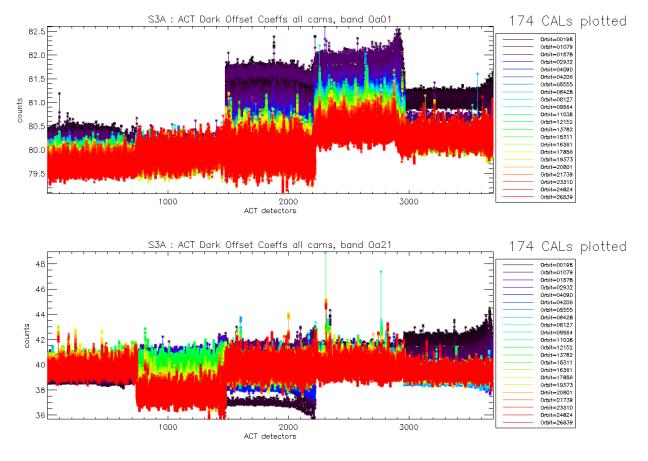


Figure 10: OLCI-A Dark Offset for band Oa1 (top) and Oa21 (bottom), all radiometric calibrations so far except the first one (orbit 183) for which the instrument was not thermally stable yet.

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

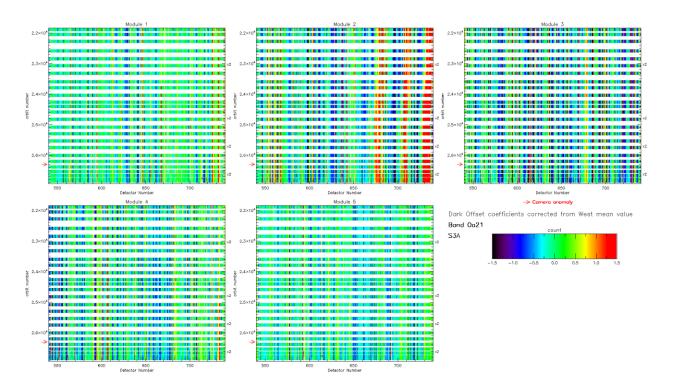


Figure 11: map of OLCI-A periodic noise for the 5 cameras, for band Oa21. X-axis is detector number (East part, from 540 to 740, where the periodic noise occurs), Y-axis is the orbit number. Y-axis range is focused on the most recent 5000 orbits. The counts have been corrected from the West detectors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



S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

Page: 12

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.

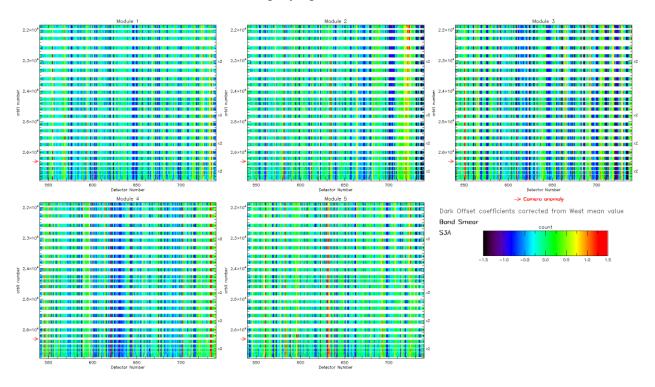


Figure 12: same as Figure 11 for smear band.

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 cycle.

The small drift in camera 2 Oa21 (Figure 11 upper middle plot) near orbit 24000 for the last 100 pixels is now pretty stabilized. This kind of drift had already been encountered for the same camera/band/pixels, for example between orbit 13500 and 14500 and between orbit 18000 and 19500 (see previous CR reports).

Dark Currents

Dark Currents (Figure 13) are not affected by the global offset of the Dark Offsets, thanks to the clamping to the average blind pixels value. However, the oscillations of Periodic Noise remain visible. There is no significant evolution of this parameter during the current cycle except the small regular increase (almost linear), for all detectors, since the beginning of the mission (see Figure 14).

SENTINEL 3 Mission Performance Centre

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 - S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

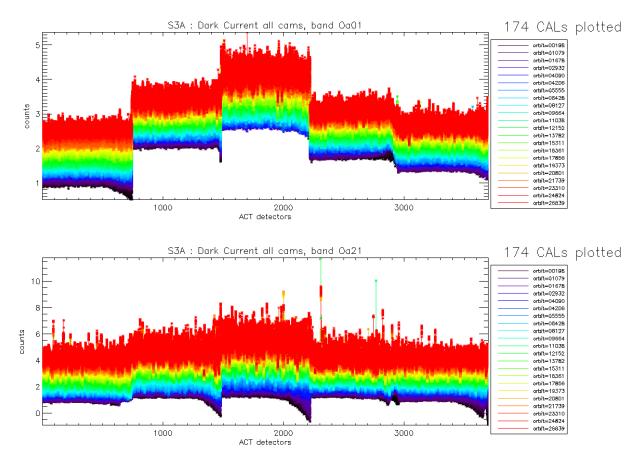


Figure 13: OLCI-A Dark Current for band Oa1 (top) and Oa21 (bottom), all radiometric calibrations so far except the first one (orbit 183) for which the instrument was not thermally stable yet.

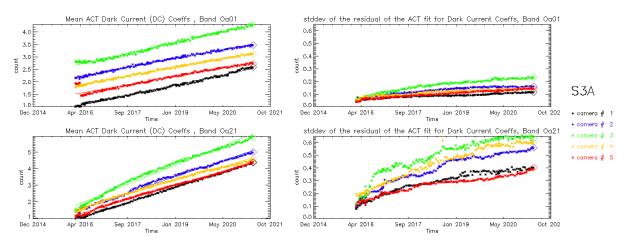


Figure 14: left column: ACT mean on 400 first detectors of OLCI-A Dark Current coefficients for spectral band Oa01 (top) and Oa21 (bottom). Right column: same as left column but for Standard deviation instead of mean.

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



S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

Page: 14

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).

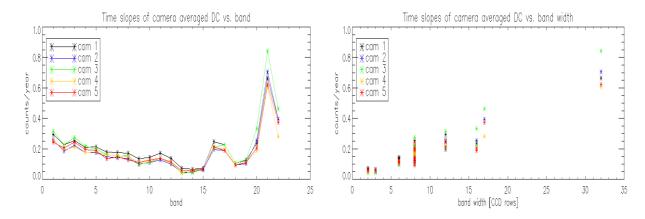


Figure 15: OLCI-A Dark current increase rates with time (in counts per year) vs. band (left) and vs. band width (right)

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).

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

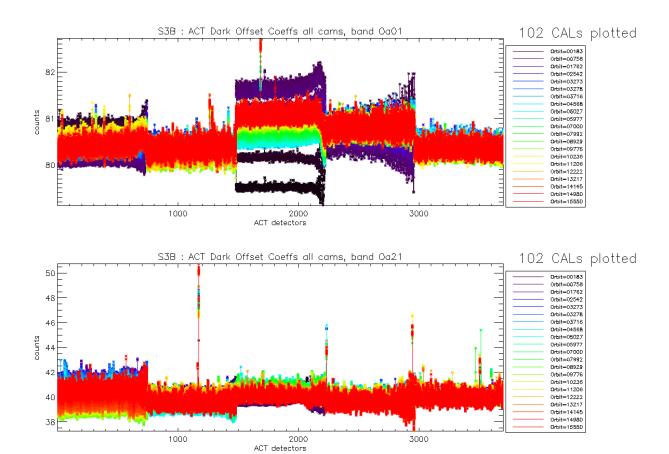


Figure 16: OLCI-B Dark Offset for band Oa1 (top) and Oa21 (bottom), all radiometric calibrations so far except the first one (orbit 167) for which the instrument was not thermally stable yet.

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

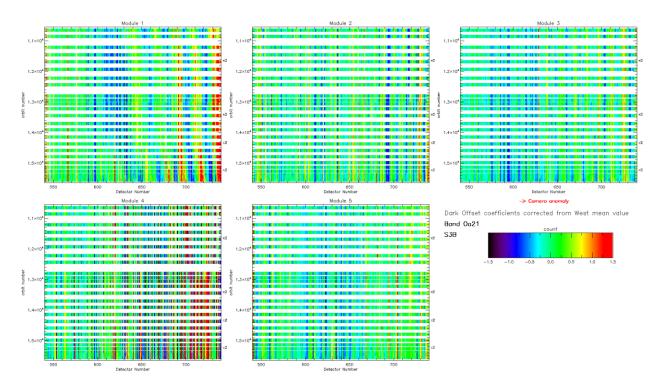


Figure 17: OLCI-B map of periodic noise for the 5 cameras, for band Oa21. X-axis is detector number (East part, from 540 to 740, where the periodic noise occurs), Y-axis is the orbit number. The counts have been corrected from the West detectors mean value (not affected by periodic noise) in order to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

SENTINGL 3 Mission Performance Contre

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

Page: 17

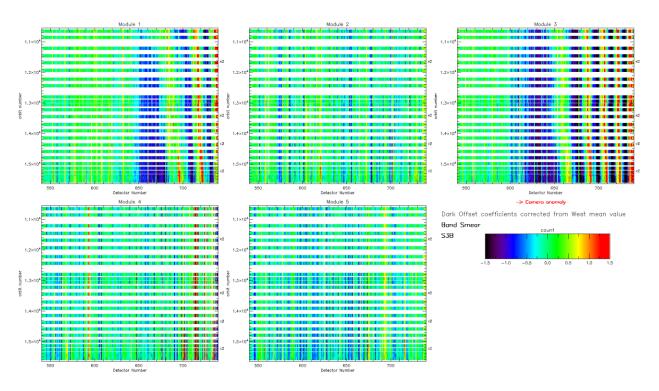


Figure 18: same as Figure 17 for smear band.

Dark Currents

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

SENTINEL 3 Mission Performance Control

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

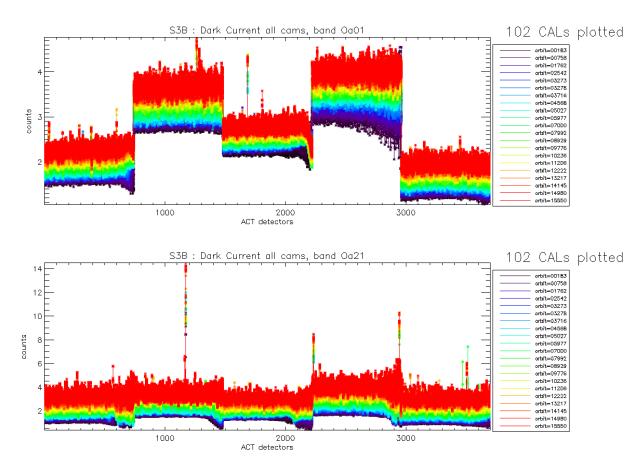


Figure 19: OLCI-B Dark Current for band Oa1 (top) and Oa21 (bottom), all radiometric calibrations so far except the first one (orbit 167) for which the instrument was not thermally stable yet.

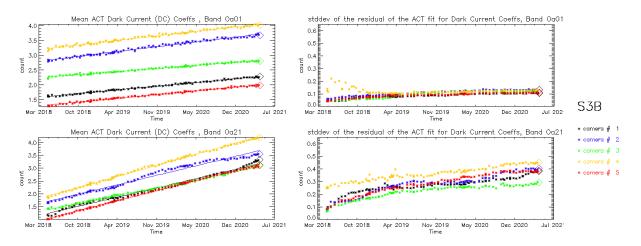


Figure 20: left column: ACT mean on 400 first detectors of OLCI-B Dark Current coefficients for spectral band Oa01 (top) and Oa21 (bottom). Right column: same as left column but for Standard deviation instead of mean.

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

SENTINEL 3 Mission Performance Centre

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

Page: 19

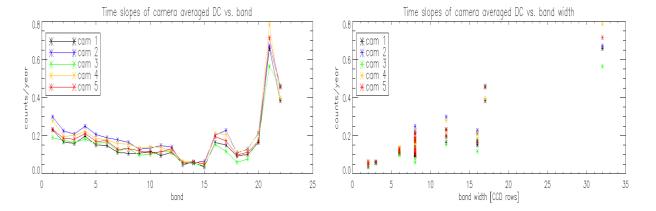


Figure 21: OLCI-B Dark Current increase rates with time (in counts per year) vs. band (left) and vs. band width (right)

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.



S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

Page: 20

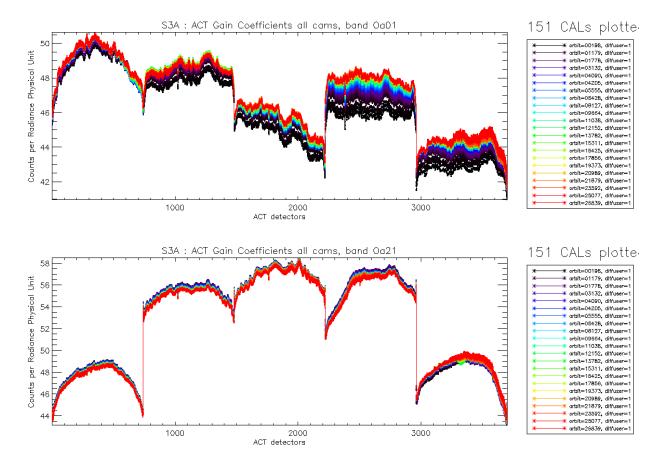


Figure 22: OLCI-A Gain Coefficients for band Oa1 (top) and Oa21 (bottom), derived using the ground BRDF model. The dataset is made of all diffuser 1 radiometric calibrations so far except the first one (orbit 183) for which the instrument was not thermally stable yet.

The gains plotted in Figure 22, however are derived using the ground BRDF model which is known to suffer from illumination geometry dependent residual errors (see previous Cyclic Reports for more details). Consequently they are post-processed to replace the ground BRDF model by the in-flight version, based on Yaw Manoeuvres data, prior to determine the radiometric evolution.

Figure 23 displays a summary of the time evolution derived from post-processed gains: the cross-track average of the BRDF corrected gains (taking into account the diffuser ageing) is plotted as a function of time, for each module, relative to a given reference calibration (the 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).

SENTINEL 3 Mission Performance Centre

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

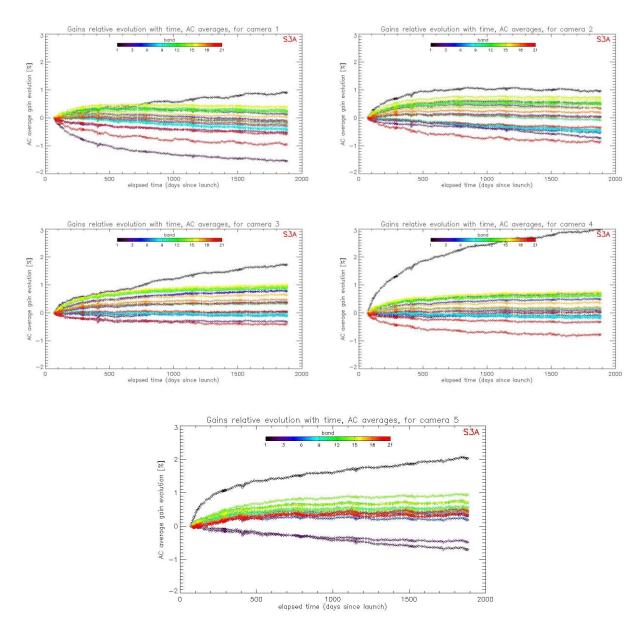


Figure 23: camera averaged gain relative evolution with respect to calibration of 25/04/2016 (change of OLCI channel settings), as a function of elapsed time since the beginning of the mission; one curve for each band (see colour code on plots), one plot for each module. The diffuser ageing has been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

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

Page: 22

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.

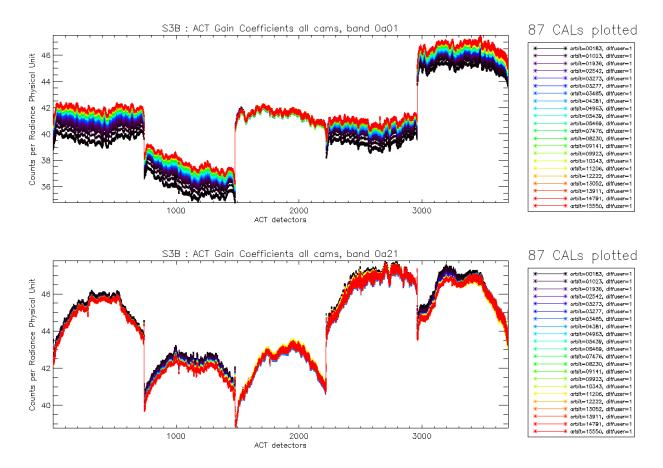


Figure 24: OLCI-B Gain Coefficients for band Oa1 (top) and Oa21 (bottom), derived using the ground BRDF model. The dataset is made of all diffuser 1 radiometric calibrations so far except the first one (orbit 167) for which the instrument was not thermally stable yet.

Figure 25 displays a summary of the time evolution derived from post-processed gains: the cross-track average of the BRDF corrected gains is plotted as a function of time, for each module, relative to a given reference calibration (first calibration after channel programming change: 18/06/2018). It shows that, if a significant evolution occurred during the early mission, the trends tend to stabilize. The large amount of points near elapsed time = 220 days is due to the yaw manoeuvre campaign.

SENTINEL 3 Mission Performance Centre

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

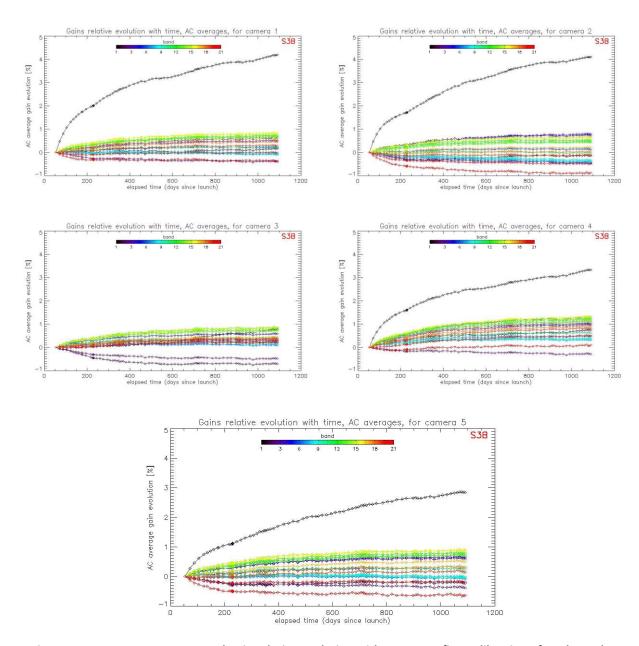


Figure 25: OLCI-B camera averaged gain relative evolution with respect to first calibration after channel programming change (18/06/2018), as a function of elapsed time since the beginning of the mission; one curve for each band (see colour code on plots), one plot for each module. The diffuser ageing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



S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

Page: 24

2.2.2.2 Instrument evolution modelling

2.2.2.2.1 OLCI-A

The OLCI-A Radiometric Model has been refreshed and put in operations at PDGS the 15/10/2020 (Processing Baseline 2.71). The model has been derived on the basis of an extended Radiometric Calibration dataset (from 08/08/2016 to 08/08/2020). 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 18 calibrations in extrapolation over about 9 months) remains better than 0.095% when averaged over the whole field of view (Figure 26) even though a small drift is now visible for all bands with respect to the most recent data. The previous model, trained on a Radiometric Dataset limited to 28/08/2019, 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 dual model approach, i.e. two different models 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.

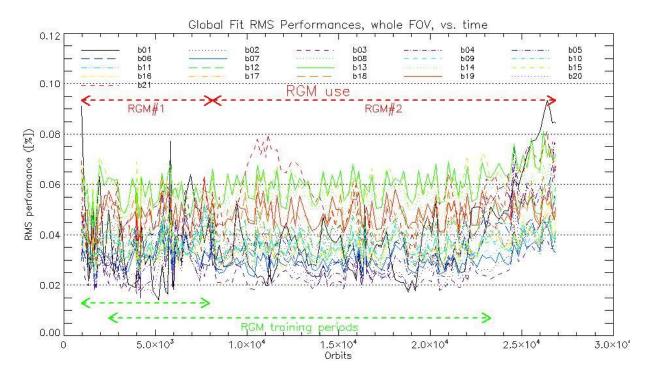


Figure 26: RMS performance of the OLCI-A Gain Model of the current processing baseline as a function of orbit.

Sentine: 3 Mission Performance Centre

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

Page: 25

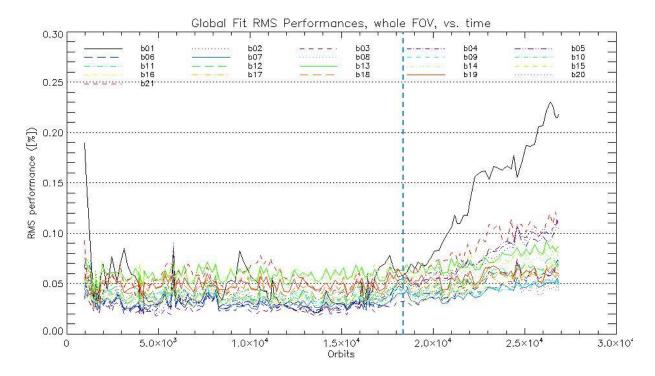


Figure 27: RMS performance of the OLCI-A Gain Model of the previous Processing Baseline as a function of orbit.

The blue vertical dotted line defines the limit from which the gain model starts to be extrapolated (i.e. it corresponds to the most recent CAL of the dataset used to build the model).

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

SENTINEL 3 Mission Performance Centre

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 - S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

Page: 26

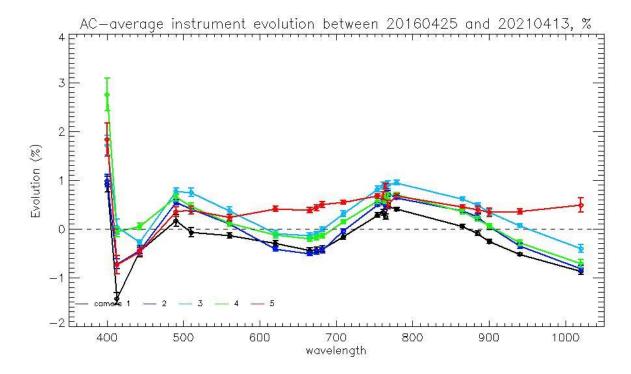


Figure 28: OLCI-A Camera-averaged instrument evolution since channel programming change (25/04/2016) and up to the most recent calibration (13/04/2021) versus wavelength.

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.

Sentinel 3 Mission Performance Contre

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

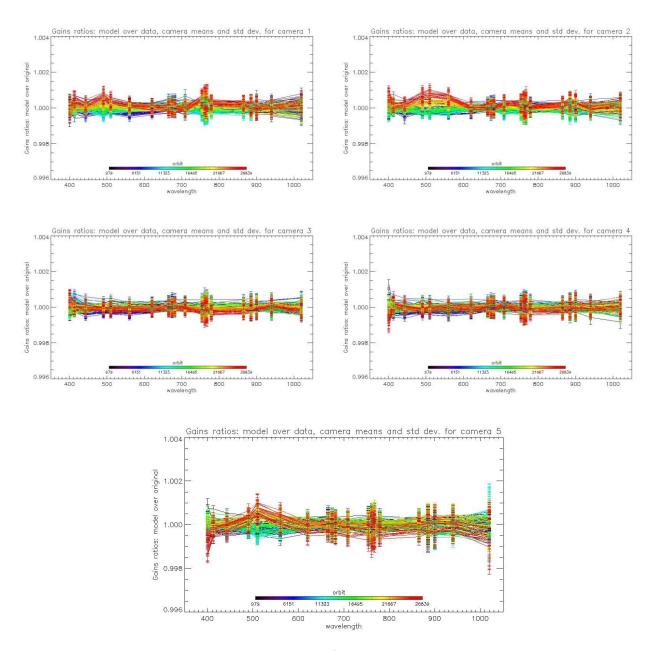


Figure 29: For the 5 cameras: OLCI-A Evolution model performance, as camera-average and standard deviation of ratio of Model over Data vs. wavelength, for each orbit of the test dataset, including 18 calibrations in extrapolation, with a colour code for each calibration from blue (oldest) to red (most recent).

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

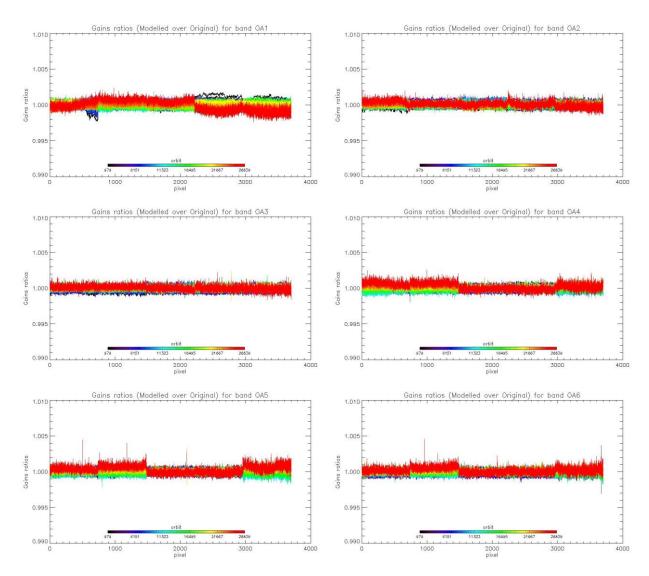


Figure 30: OLCI-A evolution model performance, as ratio of Model over Data vs. pixels, all cameras side by side, over the whole current calibration dataset (since instrument programing update), including 18 calibrations in extrapolation, channels Oa1 to Oa6.

SENTING, 3 Mission Performance Centre

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

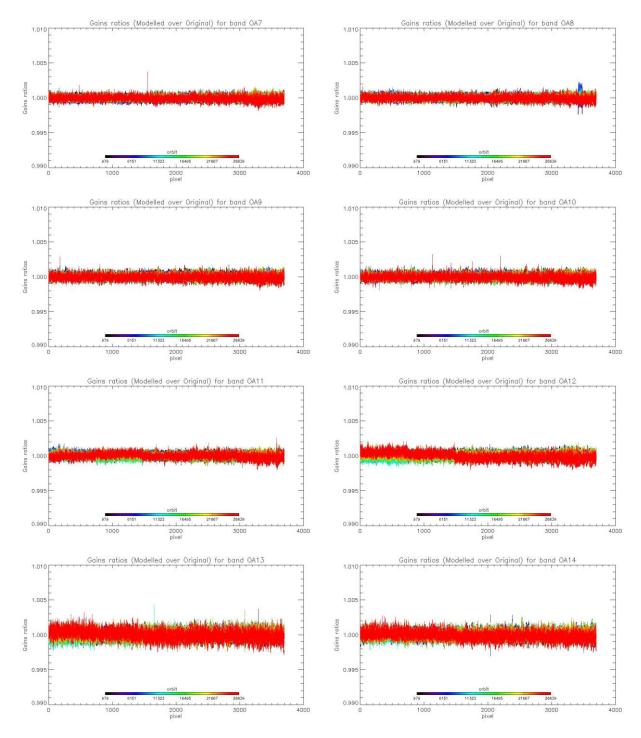


Figure 31: same as Figure 30 for channels Oa7 to Oa14.

Sentinel 3 Mission Performance Centre

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

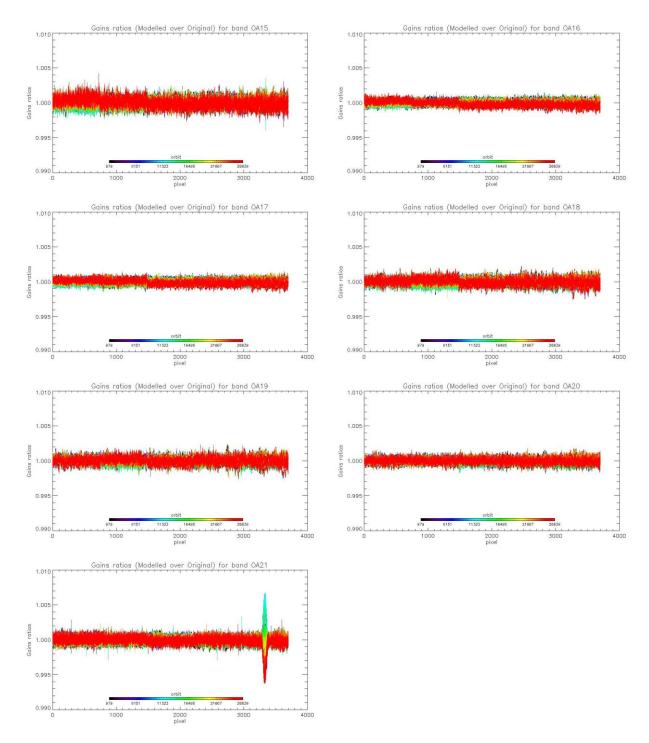


Figure 32: same as Figure 30 for channels Oa15 to Oa21.



S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

Page: 31

2.2.2.2. OLCI-B

Instrument response and degradation modelling for OLCI-B, including the use of the in-flight BRDF model (based on 11th December 2018 Yaw Manoeuvres), has been refreshed and deployed at PDGS on 15th October 2020 (Processing Baseline 1.48). The model has been derived on the basis of an extended Radiometric Calibration dataset (from 05/11/2018 to 09/08/2020). It includes the correction of the diffuser ageing for the five bluest bands (Oa1 to Oa5) for which it is clearly measurable. The model performance over the complete dataset (including the 19 calibrations in extrapolation over about 9 months) is illustrated in Figure 33. It remains better than 0.09% when averaged over the whole field of view for all band except Oa01 (< 0.2%) which starts to show a strong drift compared to the small drift of the other bands. The previous model, trained on a Radiometric Dataset limited to 02/10/2019, 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.

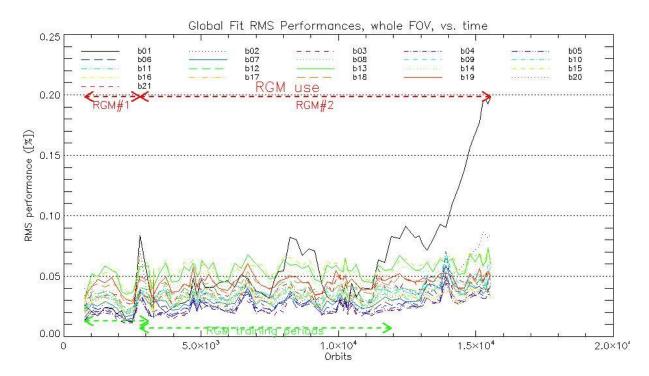


Figure 33: RMS performance of the OLCI-B Gain Model of the current processing baseline as a function of orbit.

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

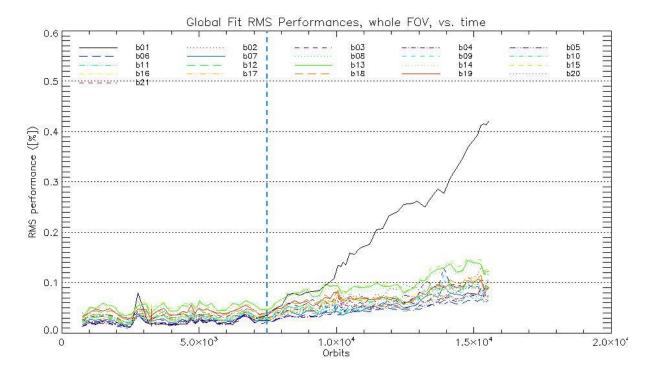


Figure 34: RMS performance of the OLCI-B Gain Model of the previous processing baseline as a function of orbit (please note the different vertical scale with respect to Figure 33).

SENTINEL 3 Mission Performance

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

Page: 33

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

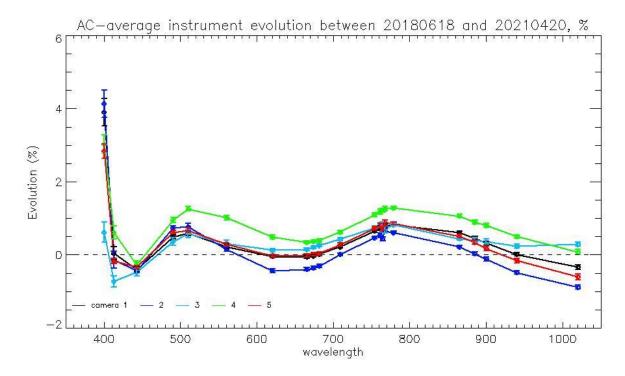


Figure 35: OLCI-B Camera-averaged instrument evolution since channel programming change (18/06/2018) and up to most recent calibration (20/04/2021) versus wavelength.

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.

SENTINEL 3 Mission Performance

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

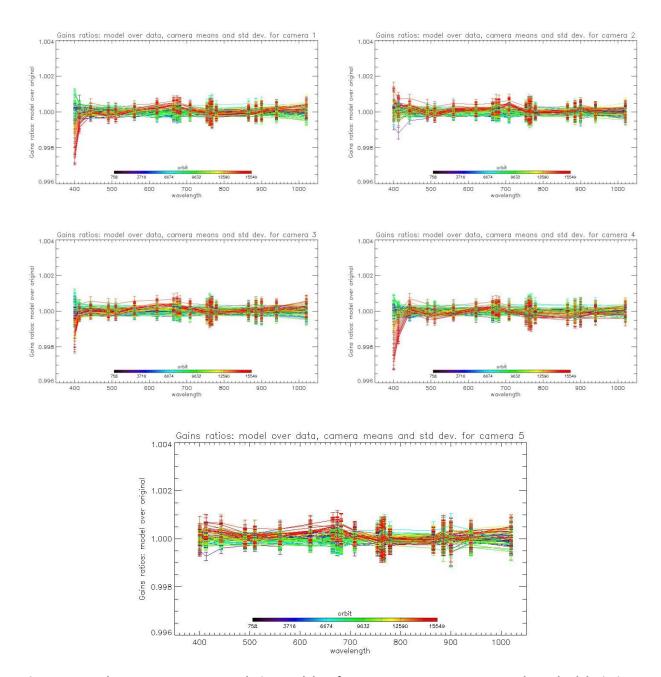


Figure 36: For the 5 cameras: OLCI-B Evolution model performance, as camera-average and standard deviation of ratio of Model over Data vs. wavelength, for each orbit of the test dataset, including 19 calibrations in extrapolation, with a colour code for each calibration from blue (oldest) to red (most recent).

Sentinel 3 Mission Performance Centre

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

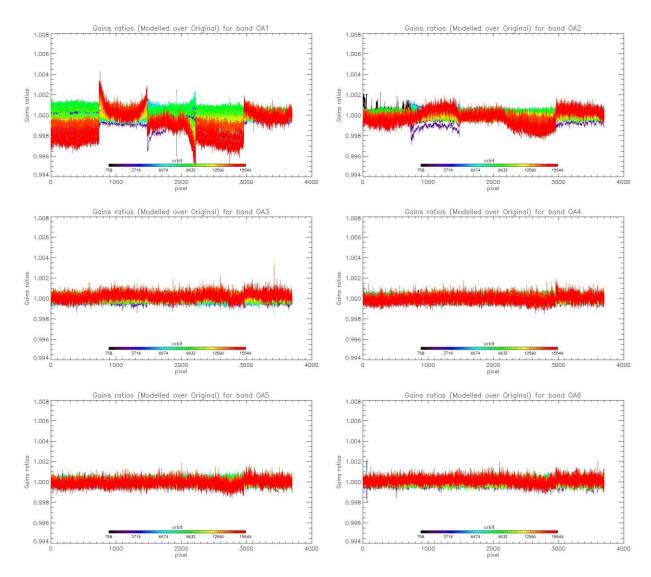


Figure 37: OLCI-B evolution model performance, as ratio of Model over Data vs. pixels, all cameras side by side, over the whole current calibration dataset (since instrument programming update), including 19 calibrations in extrapolation, channels Oa1 to Oa6.

Sentinel 3 Mission Performance Centre

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 - S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

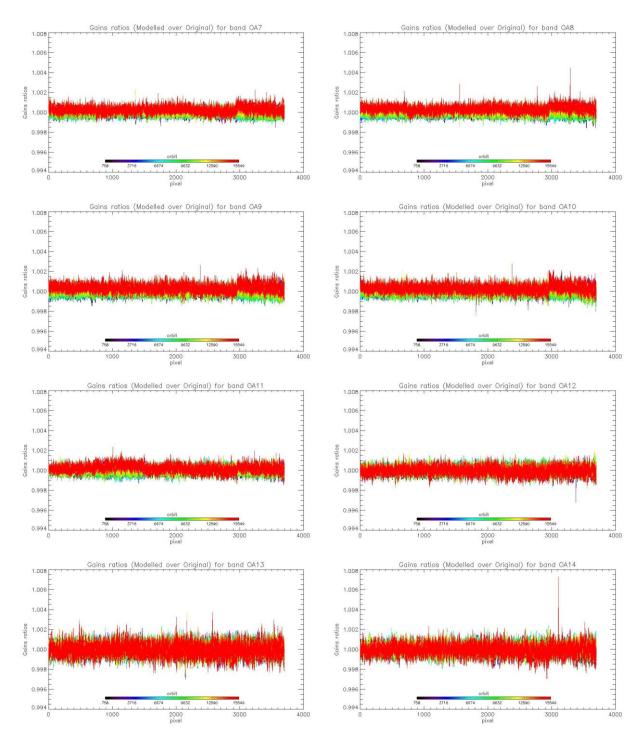


Figure 38: same as Figure 37 for channels Oa7 to Oa14.

Sentinet, 3 Mission Performance Centre

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 - S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

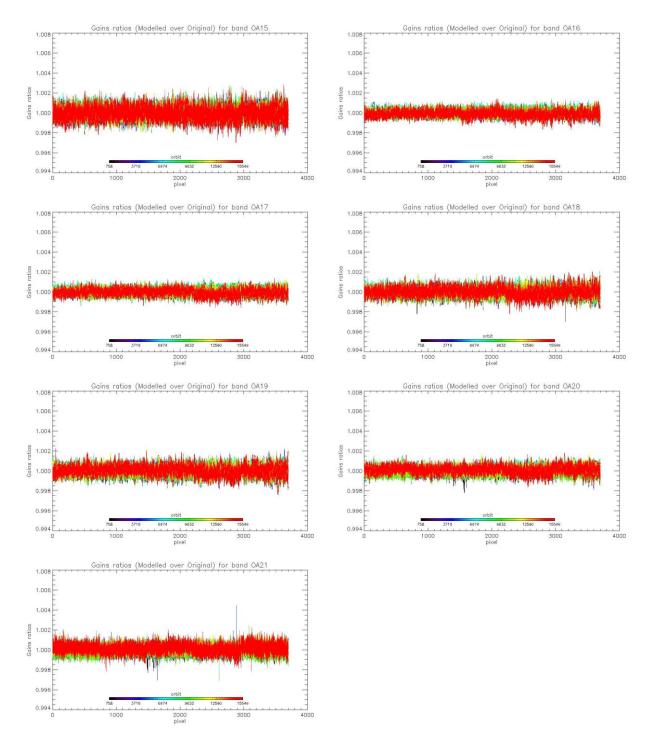


Figure 39: same as Figure 37 for channels Oa15 to Oa21.

Mission Gentre Gentre

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

Page: 38

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

2.2.3.1 OLCI-A

There has been one calibration sequence S05 (reference diffuser) for OLCI-A during acquisition cycle 070:

\$05 sequence (diffuser 2) on 31/03/2021 10:47 to 10:49 (absolute orbit 26660)

With the associated S01 sequence (nominal diffuser) in order to compute ageing:

\$ S01 sequence (diffuser 1) on 31/03/2021 09:06 to 09:08 (absolute orbit 26659)

The diffuser 1 Ageing is computed for each 3700 detector and each spectral band by formula:

Ageing(orb)=G1(orb)/G2(orb)-G1(orb_ref)/G2(orb_ref)

Where:

- G1 is the diffuser 1 (= nominal diffuser) Gain coefficients
- G2 is the diffuser 2 (= reference diffuser) Gain coefficients
- orb_ref is a reference orbit chosen at the beginning of the mission

Ageing is represented in Figure 40 for band Oa01 and in Figure 41 for band Oa17. The negative shift of the sequence at orbit 5832 (for which a slight increase would be expected instead) is not explained so far and still under investigation. It should be noted that the corresponding orbit of diffuser 1 (nominal) has also been detected as an outlier in the modelling of the radiometric long-term trend with an unexpected excess of brightness.

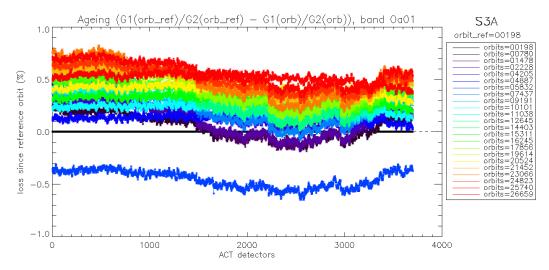


Figure 40: diffuser 1 ageing for spectral band Oa01. We see strong ACT low frequency structures that are due to residual of BRDF modelling.

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

Page: 39

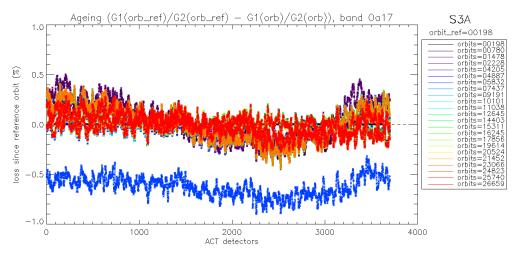


Figure 41: same as Figure 40 for spectral band Oa17. We use this band in order to normalize other bands and remove the ACT structures due to residual of BRDF modelling. Normalized curve for spectral band Oa01 is presented in Figure 42.

Figure 40 and Figure 41 show that the Ageing curves are impacted by a strong ACT pattern which is due to residuals of the bad modelling (on-ground) of the diffuser BRDF. This pattern is dependant of the azimuth angle. It is a 'white' pattern which means it is the same for all spectral bands. As such, we can remove this pattern by normalizing the ageing of all bands by the curve of band Oa17 which is expected not to be impacted by ageing because in the red part of the spectrum. We use an ACT smoothed version (window of 100 detectors) of band Oa17 in order to reduce the high frequency noise. Normalized ageing for spectral band Oa01 is represented in Figure 42 where we can see that this band is impacted by ageing of the diffuser.



S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

Page: 40

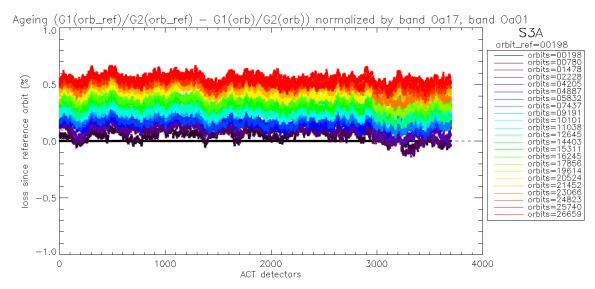


Figure 42: same as Figure 40 after normalization by band Oa17. Ageing of the diffuser 1 is now visible in the 5 cameras.

Camera averaged ageing (normalized by band Oa17) as a function of wavelength is represented in Figure 43 where we can see that ageing is stronger in the 'bluest' spectral bands (short wavelengths). Ageing is clearly visible only for the 6 first spectral bands so far in the OLCI mission life.

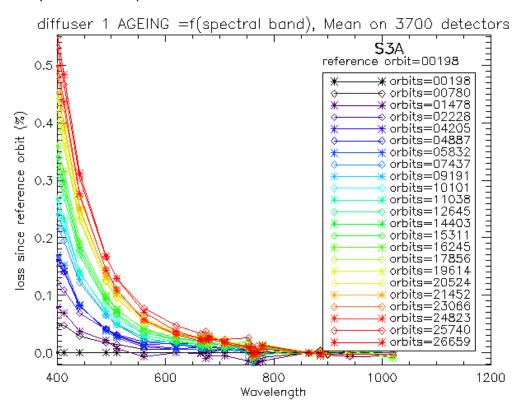


Figure 43: Diffuser 1 ageing as a function of wavelength (or spectral band). Ageing is clearly visible in spectral band #1 to #6.

SENTINEL 3

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

Page: 41

Figure 44 shows the evolution, for spectral band Oa01, of the 5 cameras averaged ageing as a function of time.

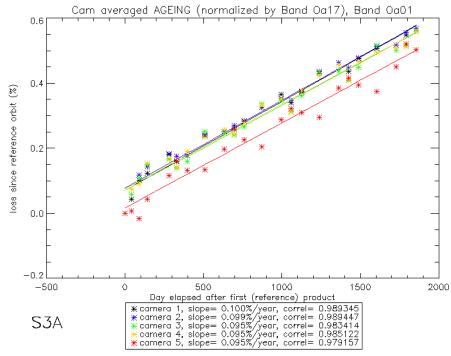


Figure 44: Camera averaged ageing for band Oa01 (normalized by band Oa17) as a function of elapsed time.

Linear fit for each camera is plotted. The slope (% loss per year) and the correlation coefficient.

A model of diffuser ageing as a function of cumulated exposure time (i.e. number of acquisition sequence on nominal diffuser, regardless of the band setting) has been built and is described in Cyclic #23 Report. The results of this model confirm the need to model ageing against cumulated exposure rather than elapsed time, as it provides a more linear trend, even if not perfect (see Figure 21 of Cyclic #23 Report).

The slope of this ageing model (% of loss per exposure) as a function of wavelength is presented in Figure 45).



S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

Page: 42

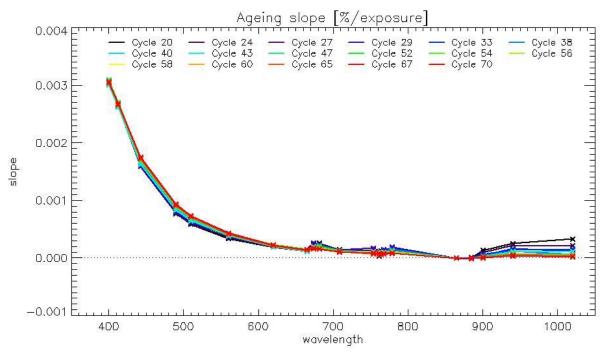


Figure 45: Slope of ageing fit (% of loss per exposure) vs wavelengths, using all the available ageing sequence at the time of the current cycle (red curve) and at the time of previous cycle for which an ageing sequence was measured (see legend within the figure).

In Figure 45, we see that the Ageing slopes have not significantly changed between the current Cycle and the last 16 cycles with a S05 sequence (cycles #67, #65, #60, #56, #58, #54, #52, #47, #43, #40, #38, #33, #29, #27, #24 and #20). Cycle #47 has been used to derive the Ageing Correction model used for the currently operational Gain Model. The exposure time dependent ageing model is used to derive the Gain Model, the most recent version of which has been put in operations in PDGS on 15th October 2020 (Processing Baseline 2.71).

2.2.3.2 OLCI-B

There was no calibration sequence S05 (reference diffuser) for OLCI-B during acquisition Cycle 051. However there was a S05 (and its associated S01) measured one day before the end of the previous cycle (i.e. S3B cycle #50), for which the ageing results were not reported in the Cyclic Performance Report #69/#50 (S3A/S3B). Therefore, we present these ageing results below:

The calibration sequence S05 (reference diffuser) for OLCI-B is:

\$ S05 sequence (diffuser 5) on 31/03/2021 03:24 to 03:26 (absolute orbit 15262)

with the associated S01 sequence in order to compute ageing:

S01 sequence (diffuser 1) on 31/03/2021 01:43 to 01:45 (absolute orbit 15261)

The diffuser 1 Ageing is computed for each 3700 detector and each spectral band by formula:

Ageing(orb)=G1(orb)/G2(orb)-G1(orb_ref)/G2(orb_ref)

SENTINEL 3

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

Page: 43

Where:

- G1 is the diffuser 1 (= nominal diffuser) Gain coefficients
- G2 is the diffuser 2 (= reference diffuser) Gain coefficients
- orb_ref is a reference orbit chosen at the beginning of the mission

Ageing is represented in Figure 46 for band Oa01 and in Figure 47 for band Oa17.

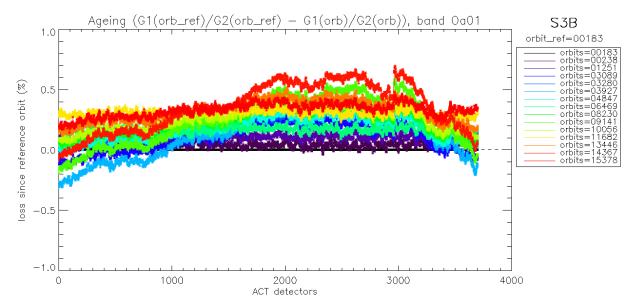


Figure 46: OLCI-B diffuser 1 ageing for spectral band Oa01. We see strong ACT low frequency structures that are due to residual of BRDF modelling.

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 - S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

Page: 44

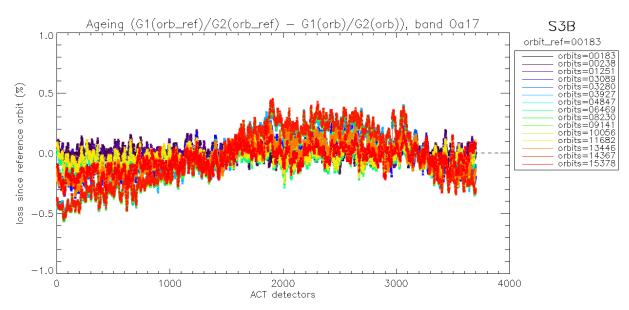


Figure 47: same as Figure 46 for spectral band Oa17. We use this band in order to normalize other bands and remove the ACT structures due to residual of BRDF modelling. Normalized curve for spectral band Oa01 is presented in Figure 48.

Figure 46 and Figure 47 show that the Ageing curves are impacted by a strong ACT pattern which is due to residuals of the bad modelling (on-ground) of the diffuser BRDF. This pattern is dependant of the azimuth angle. It is a 'white' pattern which means it is the same for all spectral bands. As such, we can remove this pattern by normalizing the ageing of all bands by the curve of band Oa17 which is expected not to be impacted by ageing because in the red part of the spectrum. We use an ACT smoothed version (window of 100 detectors) of band Oa17 in order to reduce the high frequency noise. Normalized ageing for spectral band Oa01 is represented in Figure 48 where we can see that this band is impacted by ageing of the diffuser.

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

Page: 45

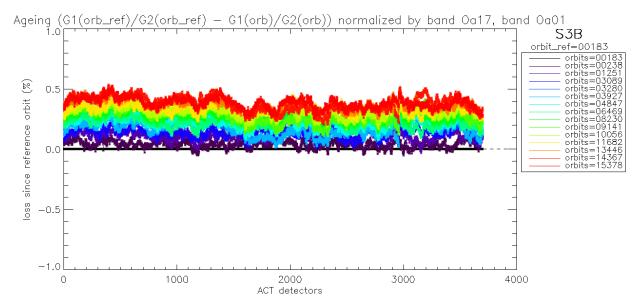


Figure 48: same as Figure 46 after normalization by band Oa17. Ageing of the diffuser 1 is now visible in the 5 cameras.

Camera averaged ageing (normalized by band Oa17) as a function of wavelength is represented in Figure 49 where we can see that ageing is stronger in the 'bluest' spectral bands (short wavelengths). Ageing is clearly visible only for the 5 first spectral bands so far in the OLCI mission life. We see a bump around 680 nm which is probably due to characterisation errors that are strongly geometry dependant and affect differently the various camera. This behaviour is under investigation.

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

Page: 46

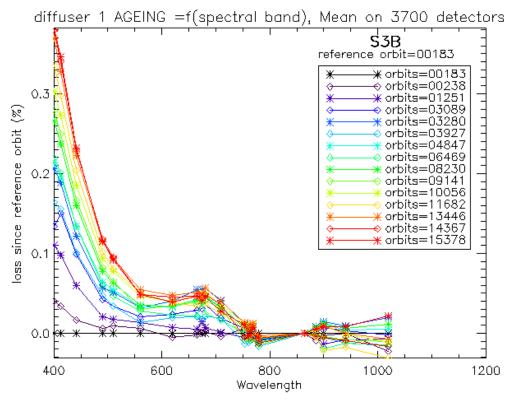


Figure 49: OLCI-B Diffuser 1 ageing as a function of wavelength (or spectral band). Ageing is clearly visible in spectral band #1 to #5.

As for OLCI-A, the OLCI-B Diffuser Ageing has been modelled as a function of cumulated exposure time (i.e. number of acquisition sequence on nominal diffuser, regardless of the band setting). The OLCI-A modelling methodology has been applied to OLCI-B. The results of this modelling, iterated at each new Ageing Sequence acquisition, expressed as the rate of ageing (% of loss per exposure) as a function of wavelength is presented in Figure 50).

SENTINEL 3 Mission Performance Centre

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 - S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

Page: 47

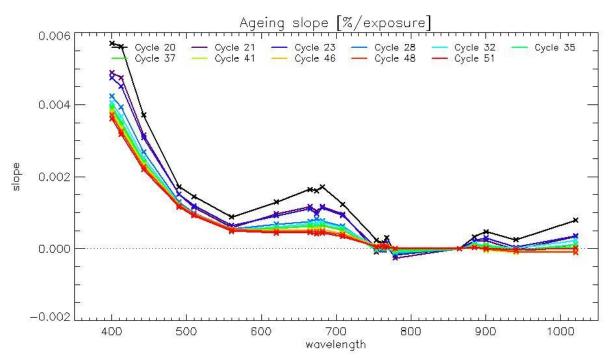


Figure 50: Slope of ageing fit (% of loss per exposure) vs wavelengths, using all the available ageing sequence at the time of the current cycle (red curve) and at the time of previous cycle for which an ageing sequence was measured (see legend within the figure).

In Figure 50, we see that the Ageing slopes have significantly changed between the current Cycle and the last ten cycles with a S05 sequence (cycles #48, #46, #41, #37, #35, #32, #28, #23, #21, #20). However, the behaviour tends to stabilize. The slope in the high wavelengths bands (red, NIR) is close to 0 in the three last cycles which is the expected behaviour (No Ageing expected at high wavelength). A workaround has been used instead of the nominal Ageing Assessment and modelling to allow accounting for Diffuser Ageing in the Radiometric Gain Model. Ageing was assessed by direct comparisons of two nominal diffuser observations, acquired under the same geometry (i.e. directly comparable) and the same day (i.e. with no significant instrument sensitivity evolution) but separated by 7 more exposures to light (during the Yaw Manoeuvres dedicated to the in-flight BRDF modelling). This exposure time dependent ageing model is used to derive the Gain Model, the most recent version of which has been put in operations in PDGS on 15th October 2020 (Processing Baseline 1.48).

SENTINEL 3 Mission Performance

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

Page: 48

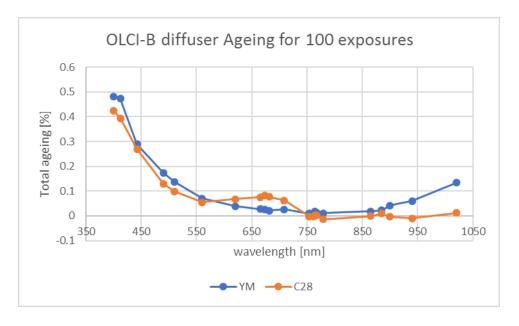


Figure 51: OLCI-B diffuser ageing (after 100 exposures, i.e. about two years) according to direct assessment from Yaw Manoeuvres (blue) and nominal method at Cycle 28 (orange).

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.

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

2.2.5.1.1 OLCI-A

This activity has not evolved during cycle 070 and results presented in Cycle 15 report are still valid.

2.2.5.1.2 OLCI-B

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

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 - S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

Page: 49

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

2.3.1 OLCI-A

There has been one SO2+SO3 Spectral Calibration for OLCI-A in the reporting period:

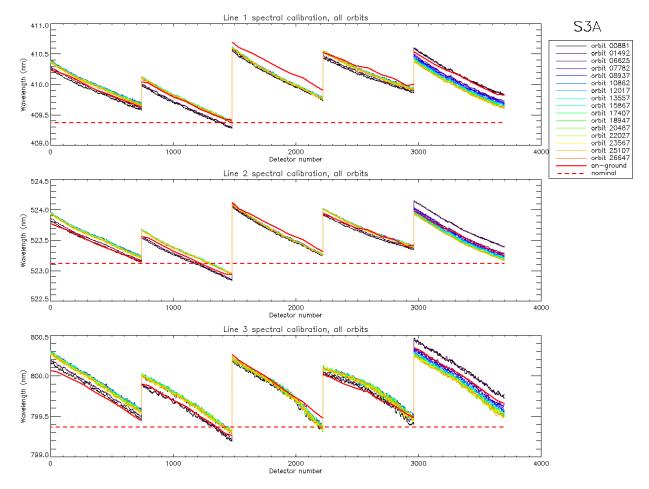
- S02 sequence (diffuser 1) on 30/03/2021 11:13 to 11:15 (absolute orbit 26646)
- So sequence (Erbium doped diffuser) on 30/03/2021 12:54 to 12:56 (absolute orbit 26647)

and one Spectral calibration S09:

\$ S09 sequence on 30/03/2021 09:04:49 to 09:04:55 (absolute orbit 26645)

The S02/S03 data have been processed and analysed to assess OLCI-A spectral long-term evolution. The absolute results are presented in Figure 52 while its long term evolution is presented Figure 53.

The processing of the S09 calibration sequence (spectral calibration using O_2 absorption and Fraunhofer lines) is illustrated in Figure 54.



SENTINEL 3 Mission Performance Centre

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

Figure 52: 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.

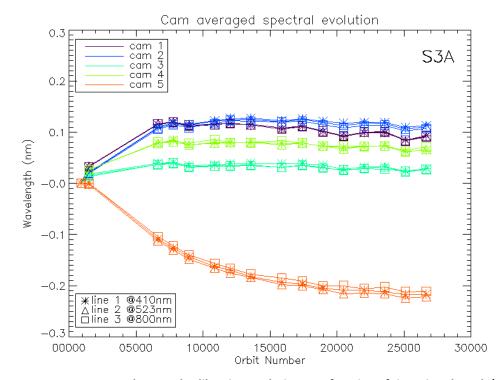


Figure 53: OLCI-A camera averaged spectral calibration evolution as a function of time since launch (all spectral S02/S03 calibrations since the beginning of the mission are included). The data are normalized with the first Spectral Calibration.

SENTINEL 3 Mission Performance Contre

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

Page: 51

OLCI-A spectral evolution (S09)

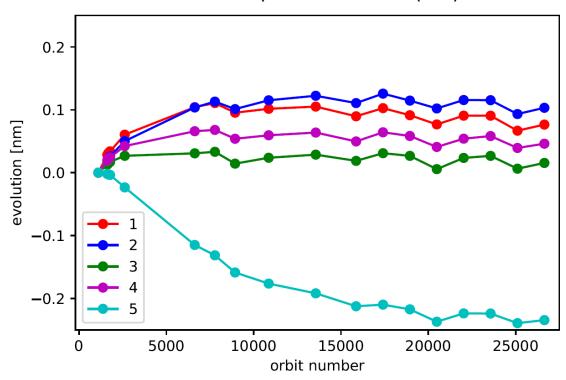


Figure 54: OLCI-A camera averaged spectral calibration evolution as a function of time from S09 calibrations since the 4th may 2016. The last calibration for S09 is from 12 Dec 2020. For each camera, the spectral evolution corresponding derived from spectral lines at 485 nm, 656 nm, 770 nm and 854 nm have been averaged. The data are normalized with the first Spectral Calibration.

We see that the long term evolution of the spectral calibration obtained with sequence S09 (Figure 54) is in rather good agreement with the one obtained with sequence S02/S03 (Figure 53). 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.



S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

Page: 52

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 09/04/2021 11:14 to 11:16 (absolute orbit 15395)
- \$ S03 sequence (Erbium doped diffuser) on 09/04/2021 12:55 to 12:57 (absolute orbit 15396)

and one Spectral calibration S09:

\$ S09 sequence on 09/04/2021 09:06:29 to 09:06:35 (absolute orbit 15394)

The SO2/SO3 data have been processed and analysed to assess OLCI-B spectral long-term evolution. The absolute results are presented in Figure 55 while its long term evolution is presented on Figure 56. The processing of the SO9 calibration sequence (spectral calibration using O2 absorption and Fraunhofer lines) is now available and presented in Figure 57.

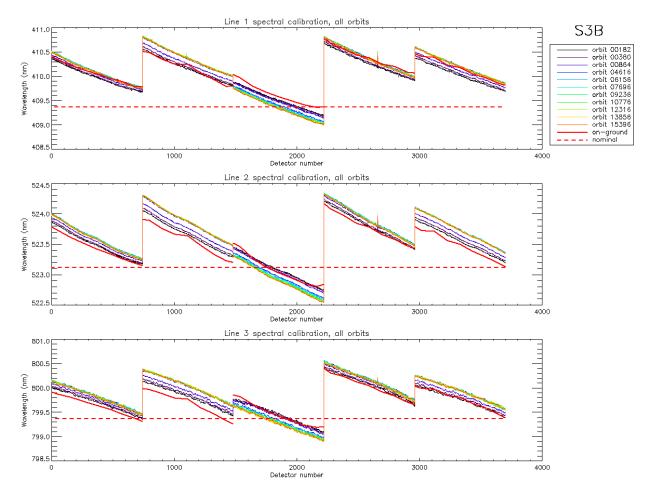


Figure 55: OLCI-B across track spectral calibration from all S02/S03 sequences since the beginning of the mission.

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.

S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

Page: 53

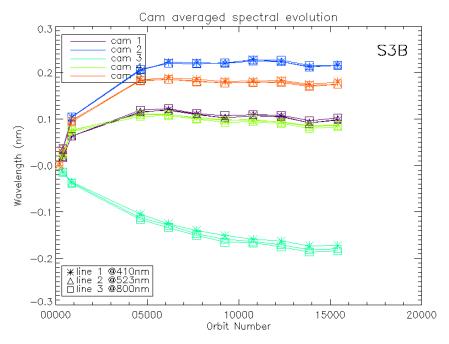


Figure 56: OLCI-B camera averaged spectral calibration evolution as a function of time since launch (all spectral S02/S03 calibrations since the beginning of the mission are included). The data are normalized with the first Spectral Calibration.

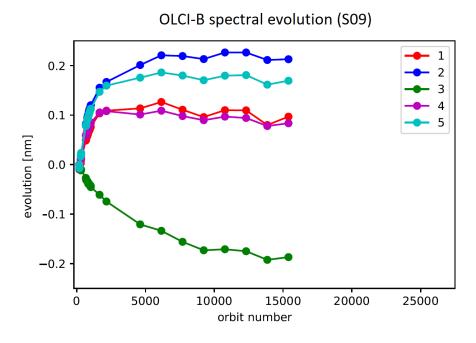


Figure 57: OLCI-B camera averaged spectral calibration evolution as a function of time since launch from S09 calibrations since the beginning of the mission. The last calibration for S09 is from 22 Dec 2020. For each camera, the spectral evolution corresponding derived from spectral lines at 485 nm, 656 nm, 770 nm and 854 nm have been averaged. The data are normalized with the first Spectral Calibration.

Figure 55 to Figure 57 show that:



S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

Page: 54

- 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 than 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 58.

SNR computed for all calibration data as a function of orbit number for band Oa01 (the less stable band) is presented in Figure 59.

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

SEMINEL 3 Mission Performance Centre

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

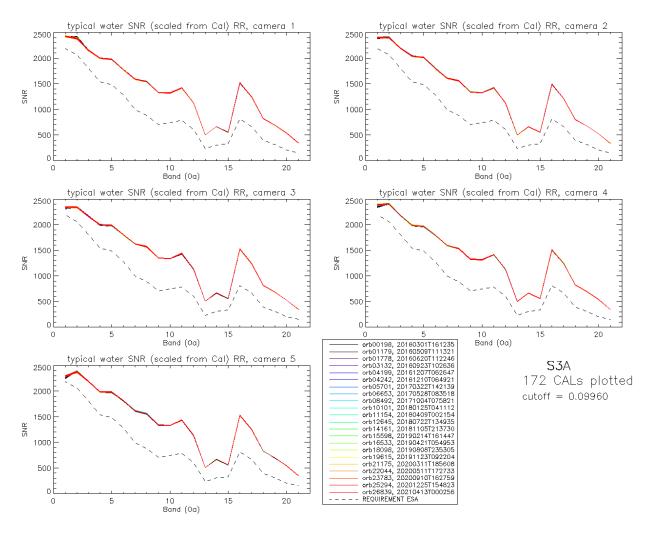


Figure 58: OLCI-A Signal to Noise ratio as a function of the spectral band for the 5 cameras. These results have been computed from radiometric calibration data. All calibrations except first one (orbit 183) are presents with the colours corresponding to the orbit number (see legend). The SNR is very stable with time: the curves for all orbits are almost superimposed. The dashed curve is the ESA requirement.

SENTINEL 3 Mission Performance Centre

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

Page: 56

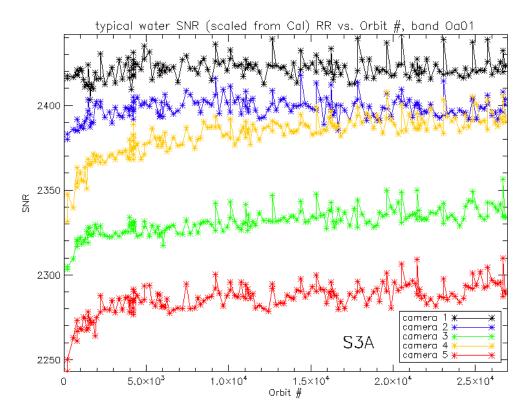


Figure 59: long-term stability of the SNR estimates from Calibration data, example of channel Oa1.

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



S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

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).

	L_{ref}	SNR	C1		C2		C3		C4		C 5		All	
														I
nm	LU	RQT	avg	std	avg	std	avg	std	avg	std	avg	std	avg	std
400.000	63.0	2188	2421	6.2	2398	6.3	2331	7.8	2382	12.1	2286	9.4	2364	7.1
412.000	74.1	2061	2389	9.1	2405	6.4	2339	4.8	2401	5.0	2381	8.8	2383	5.3
442.000	65.6	1811	2159	5.5	2197	5.9	2164	4.9	2185	4.1	2194	5.5	2180	3.9
490.000	51.2	1541	2000	4.5	2036	4.9	1997	4.1	1984	4.4	1988	4.7	2001	3.3
510.000	44.4	1488	1979	5.3	2015	4.8	1985	4.5	1967	4.4	1985	4.4	1986	3.5
560.000	31.5	1280	1775	4.4	1802	4.1	1803	4.7	1794	3.9	1819	3.4	1799	3.0
620.000	21.1	997	1591	4.0	1609	4.1	1624	3.2	1593	3.2	1615	3.5	1606	2.5
665.000	16.4	883	1546	4.2	1557	4.4	1567	3.9	1533	3.6	1561	3.8	1553	3.0
674.000	15.7	707	1328	3.4	1337	3.6	1350	2.8	1323	3.2	1342	3.6	1336	2.5
681.000	15.1	745	1319	3.6	1326	3.1	1338	2.7	1314	2.5	1334	3.5	1326	2.2
709.000	12.7	785	1420	4.2	1420	4.0	1435	3.4	1414	3.4	1431	3.1	1424	2.7
754.000	10.3	605	1127	3.1	1121	2.9	1136	3.2	1125	2.5	1139	2.8	1130	2.3
761.000	6.1	232	502	1.1	498	1.1	505	1.2	501	1.1	508	1.4	503	0.9
764.000	7.1	305	663	1.6	658	1.5	668	2.0	661	1.5	670	2.1	664	1.4
768.000	7.6	330	558	1.5	554	1.3	562	1.3	557	1.4	564	1.3	559	1.0
779.000	9.2	812	1516	4.7	1498	4.7	1526	5.2	1512	5.0	1526	5.1	1516	4.2
865.000	6.2	666	1244	3.5	1213	3.5	1239	3.9	1246	3.4	1250	2.8	1239	2.8
885.000	6.0	395	823	1.7	801	1.6	814	1.9	824	1.5	831	1.7	819	1.1
900.000	4.7	308	691	1.6	673	1.3	683	1.6	693	1.5	698	1.5	688	1.0
940.000	2.4	203	534	1.2	522	1.1	525	1.0	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



S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 - S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

Page: 58

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 60.

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 61.

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

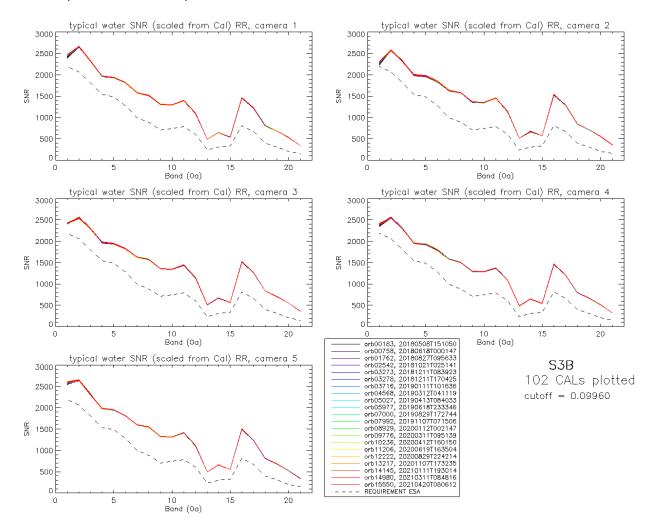


Figure 60: OLCI-B Signal to Noise ratio as a function of the spectral band for the 5 cameras. These results have been computed from radiometric calibration data. All calibrations except first one (orbit 167) are presents with the colours corresponding to the orbit number (see legend). The SNR is very stable with time: the curves for all orbits are almost superimposed. The dashed curve is the ESA requirement.

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

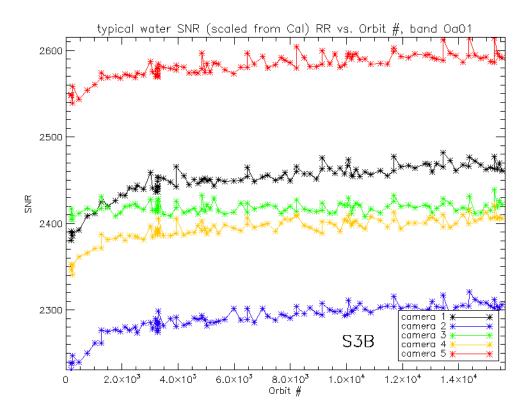


Figure 61: long-term stability of the OLCI-B SNR estimates from Calibration data, example of channel Oa1.



S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

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).

										··· ····· /·						
	L _{ref}	SNR	C1		C2		C3		C4		C5		All			
nm	LU	RQT	avg	std	avg	std	avg	std	avg	std	avg	std	avg	std		
400.000	63.0	2188	2450	19.7	2290	17.1	2418	6.3	2394	13.9	2582	13.6	2427	13.1		
412.000	74.1	2061	2655	6.6	2570	6.0	2546	8.4	2550	6.0	2639	7.0	2592	5.0		
442.000	65.6	1811	2325	6.1	2318	5.7	2301	6.4	2304	6.7	2310	6.1	2311	5.1		
490.000	51.2	1541	1966	4.7	1989	5.8	1972	4.9	1952	4.6	1979	4.6	1972	3.8		
510.000	44.4	1488	1938	4.9	1967	5.7	1943	4.8	1923	5.1	1952	4.8	1945	4.1		
560.000	31.5	1280	1813	4.9	1847	5.3	1829	4.6	1804	5.1	1817	4.3	1822	3.8		
620.000	21.1	997	1573	4.2	1626	4.7	1625	3.7	1576	3.7	1601	3.3	1600	2.8		
665.000	16.4	883	1514	4.2	1579	3.9	1573	3.9	1501	3.1	1547	4.0	1543	2.8		
674.000	15.7	707	1301	3.8	1358	3.6	1353	3.3	1292	2.7	1328	3.0	1327	2.4		
681.000	15.1	745	1293	3.6	1347	3.1	1343	2.9	1285	2.7	1316	2.8	1317	2.1		
709.000	12.7	785	1390	4.1	1447	4.3	1443	4.2	1373	2.9	1413	3.9	1413	3.1		
754.000	10.3	605	1096	3.9	1142	3.8	1142	3.7	1089	2.8	1116	3.4	1117	3.1		
761.000	6.1	232	487	1.2	509	1.2	508	1.4	485	1.2	497	1.5	497	1.0		
764.000	7.1	305	643	1.6	672	2.0	672	2.0	641	1.7	657	1.9	657	1.5		
768.000	7.6	330	541	1.6	567	1.5	564	1.4	541	1.4	555	1.7	554	1.2		
779.000	9.2	812	1467	4.4	1535	4.9	1527	5.6	1467	4.1	1506	4.6	1500	4.1		
865.000	6.2	666	1221	3.7	1287	3.8	1258	3.8	1205	3.7	1238	3.0	1242	2.9		
885.000	6.0	395	808	2.4	847	1.8	834	1.9	799	1.8	814	2.2	820	1.5		
900.000	4.7	308	679	1.5	714	2.0	704	1.7	669	1.5	683	1.5	690	1.2		
940.000	2.4	203	527	1.3	549	1.6	551	1.3	510	1.2	522	1.3	532	0.9		
1020.000	3.9	152	336	0.8	358	1.3	358	0.8	318	0.8	339	1.0	342	0.7		



S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

Page: 61

2.4.2 SNR from EO data

2.4.2.1 OLCI-A

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

2.4.2.2 OLCI-B

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

2.5 Geometric Calibration/Validation

2.5.1 OLCI-A

OLCI-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 62 to Figure 67) 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 68 and Figure 69) 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 form around 0.35 to about 0.2 (Figure 62), the across-track biases decrease significantly for all cameras (Figure 63 to Figure 67), the along-track bias reduces for at least camera 3 (Figure 65) and the field of view homogeneity improves drastically (Figure 68 and Figure 69, but also reduction of the dispersion – distance between the ± 1 sigma lines – in Figure 63 to Figure 67).



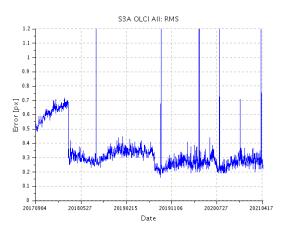
S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 - S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021



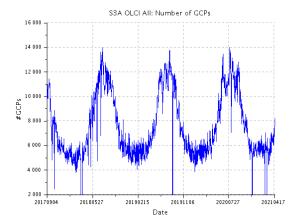
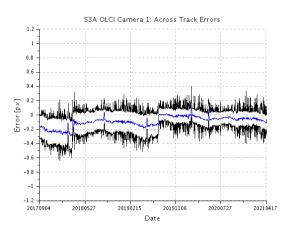


Figure 62: overall OLCI-A georeferencing RMS performance time series (left) and number of validated control points corresponding to the performance time series (right) over the whole monitoring period



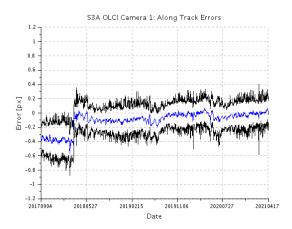
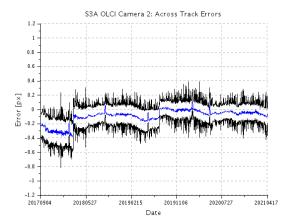


Figure 63: across-track (left) and along-track (right) OLCI-A georeferencing biases time series for Camera 1. Blue line is the average, black lines are average plus and minus 1 sigma.



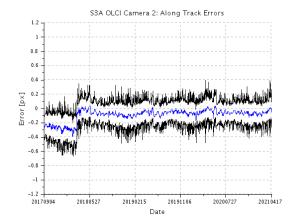


Figure 64: same as Figure 63 for Camera 2.

Mission Performance Contre

Sentinel-3 MPC

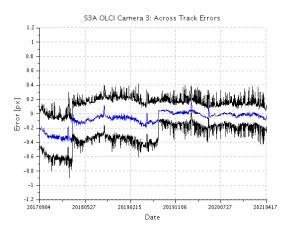
S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 - S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021



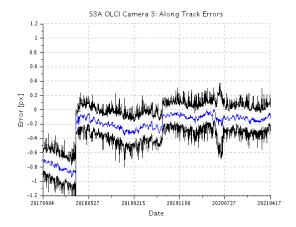
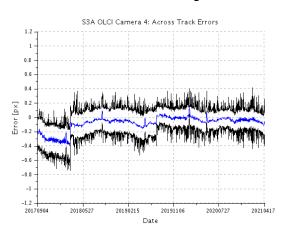


Figure 65: same as Figure 63 for Camera 3.



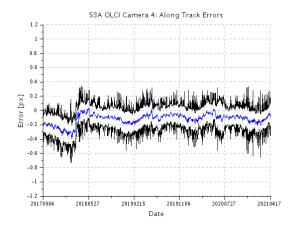
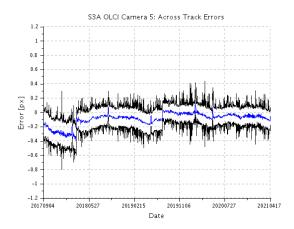


Figure 66: same as Figure 63 for Camera 4.



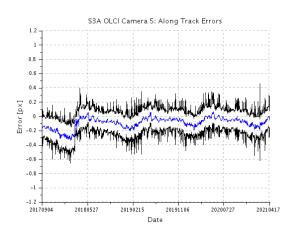


Figure 67: same as Figure 63 for Camera 5.



S3 OLCI Cyclic Performance Report

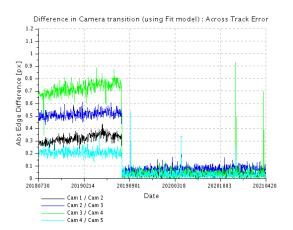
S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

Page: 64



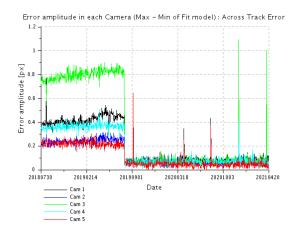
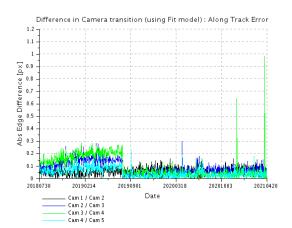


Figure 68: OLCI-A spatial across-track misregistration at each camera transition (left) and maximum amplitude of the across-track error within each camera (left).



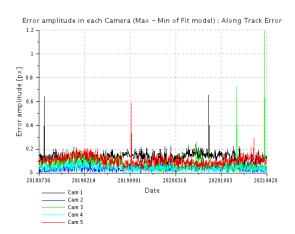


Figure 69: OLCI-A spatial along-track misregistration at each camera transition (left) and maximum amplitude of the along-track error within each camera (left).

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 76) 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 71 to Figure 75), but also on the continuity at camera interfaces (Figure 76, left) and on intra-camera homogeneity (Figure 76, 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 10/12/2020 and its effect can be seen e.g. on left graphs of Figure 71 and Figure 72 (along-track biases of cameras 1 & 2).



S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 - S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

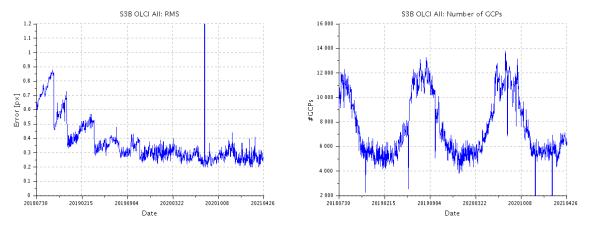


Figure 70: overall OLCI-B georeferencing RMS performance time series over the whole monitoring period (left) and corresponding number of validated control points (right)

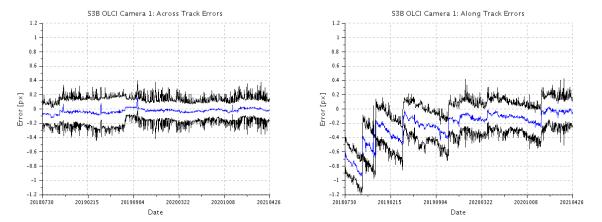


Figure 71: across-track (left) and along-track (right) OLCI-B georeferencing biases time series for Camera 1.

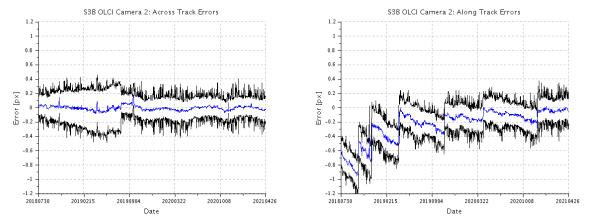


Figure 72: same as Figure 71 for Camera 2.



S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 - S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

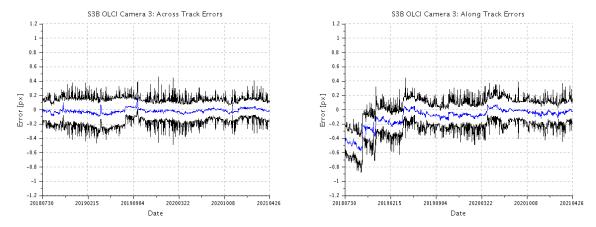


Figure 73: same as Figure 71 for Camera 3.

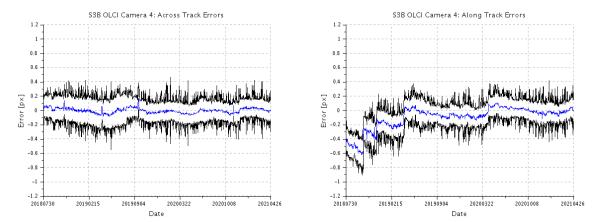


Figure 74: same as Figure 71 for Camera 4.

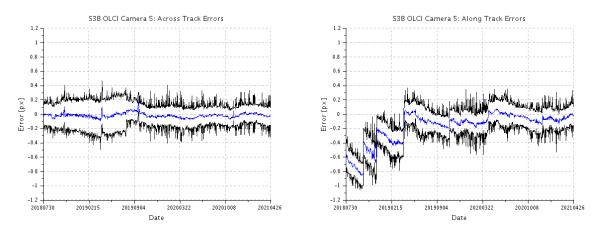


Figure 75: same as Figure 71 for Camera 5.

SENTINEL 3 Mission Performance Centre

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 - S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

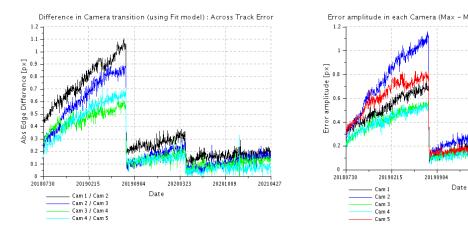


Figure 76: OLCI-B spatial across-track misregistration at each camera transition (left) and maximum amplitude of the across-track error within each camera (left).

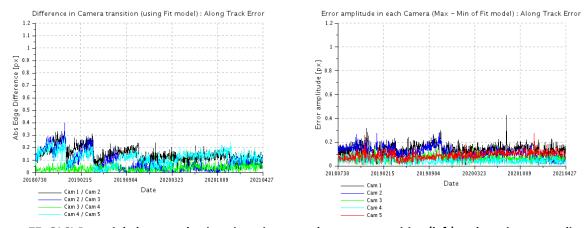


Figure 77: OLCI-B spatial along-track misregistration at each camera transition (left) and maximum amplitude of the along-track error within each camera (left).



S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

Page: 68

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 78) and OLCI-B (Figure 79).

SENTINEL 3 Mission Performance Centre

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021



Figure 78: 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).

Mission Performance Centre

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

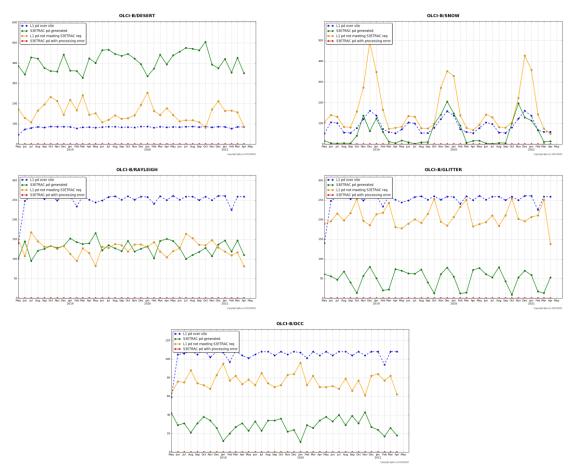


Figure 79: summary of S3ETRAC products generation for OLCI-B

(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).

Mission Performance Centre

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

Page: 71

3.1.2 Radiometric validation with DIMITRI

Highlights

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

- The verification is performed over Desert and Ocean-sites until the 31st of March 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 timeseries average shows higher reflectance from OLCI-A.
- Bands with high gaseous absorption are excluded.

Verification and Validation over PICS

- The ingestion of all the available L1B-LN1-NT products from OLCI-A and OLCI-B over the 6 desert CalVal-sites (Algeria 3 & 5, Libya 1 & 4 and Mauritania 1 & 2) has been performed until the 30th of April 2021.
- 2. The results are consistent over all the six used PICS sites (Figure 80 and Figure 81). Both sensors show a good stability over the analysed period.
- 3. The temporal average over the period **January 2021 Present** 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 82). 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 82). The spectral bands with significant absorption from water vapor and O₂ (Oa11, Oa13, Oa14, Oa15 and Oa20) are excluded.

Sentines 3 Mission Performance Centre

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

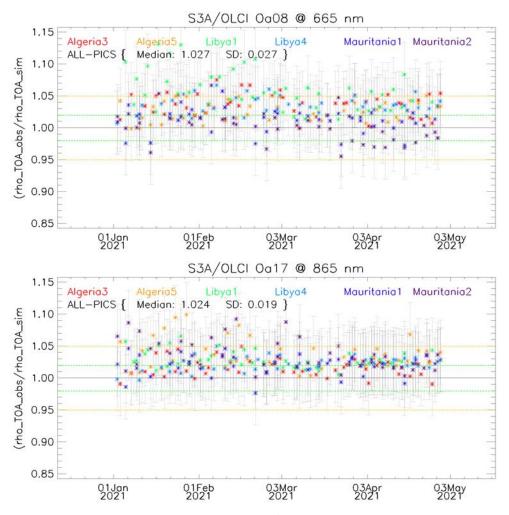


Figure 80: Time-series of the elementary ratios (observed/simulated) signal from OLCI-A for (top to bottom) bands Oa08 and Oa17 respectively over January 2021-Present from the six PICS Cal/Val sites. Dashed-green and orange lines indicate the 2% and 5% respectively. Error bars indicate the desert methodology uncertainty.

Mission Performance Centre

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

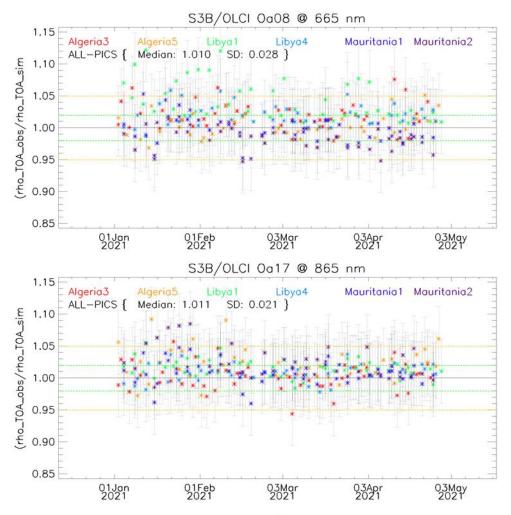


Figure 81: Time-series of the elementary ratios (observed/simulated) signal from OLCI-B for (top to bottom) bands Oa08 and Oa17 respectively over January 2021-Present from the six PICS Cal/Val sites. Dashed-green and orange lines indicate the 2% and 5% respectively. Error bars indicate the desert methodology uncertainty.



S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

Page: 74

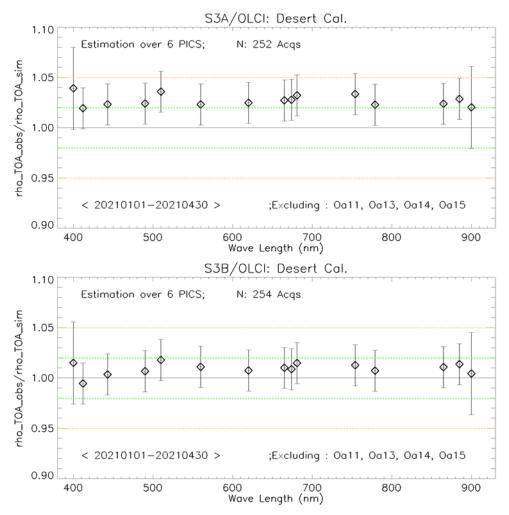


Figure 82: The estimated gain values for OLCI-A and OLCI-B over the 6 PICS sites identified by CEOS over the period January 2021-Present as a function of wavelength. Dashed-green and orange lines indicate the 2% and 5% respectively. Error bars indicate the desert methodology uncertainty.

Cross-mission Intercomparison over PICS:

X-mission Intercomparison with MODIS-A and MSI-A has been performed until March 2021. Figure 83 shows time-series of the elementary ratios from S2A/MSI, Aqua/MODIS, S3A/OLCI and S3B/OLCI over the LYBIA4 site for the period April 2016 until March 2021.

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

Figure 84 shows the estimated gain over different time-series for different sensors (MSI-A, OLCI-A, OLCI-B and MODIS-A) over PICS. The spectral bands with significant absorption from water vapour and O2 are excluded. OLCI-A seems to have higher gain wrt the other sensors, which means that OLCI-A has brighter reflectance than its simulated one by PICS method.

Sentines, 3 Mission Performance Centre

Sentinel-3 MPC

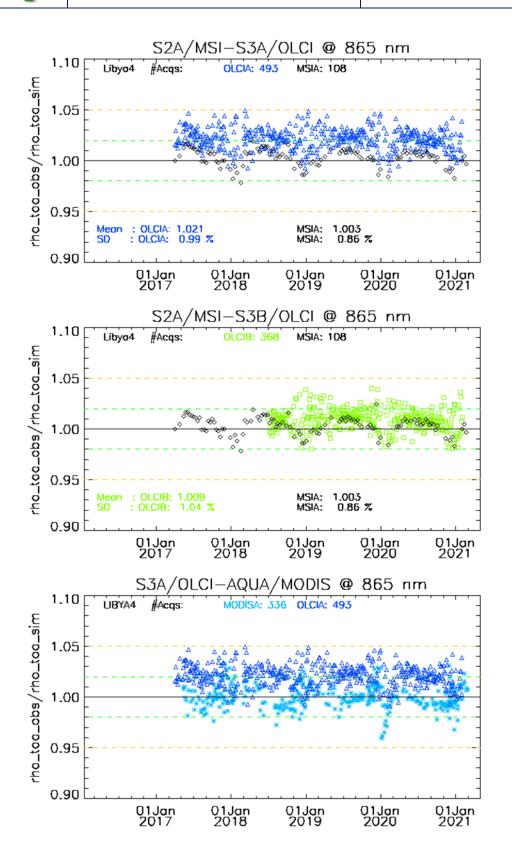
S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021



Sentine 3 Mission Performance Centre

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

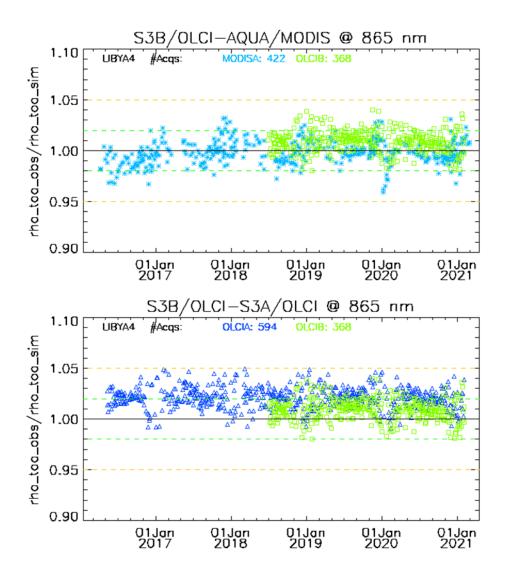


Figure 83: Time-series of the elementary ratios (observed/simulated) signal from (black) S2A/MSI, (blue) S3A/OLCI, (green) S3B/OLCI and (Cyan) Aqua/MODIS for NIR band 865nm over LIBYA4 site. Dashed-green and orange lines indicate the 2% and 5% respectively. The systematic and total uncertainties of the desert methodology are 1% and 5% respectively.

Mission Performance Centre

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

Page: 77

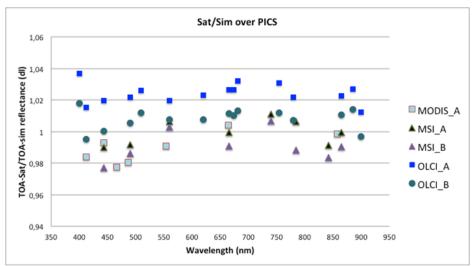


Figure 84: Ratio of observed TOA reflectance to simulated one for (green-yellow) S2A/MSI, (red) Aqua/MODIS, (blue) S3A/OLCI and (green) S3B/OLCI averaged over the six PICS test sites as a function of wavelength.

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 5%-7% while bands Oa06-Oa09 exhibit biases between 2%-3% higher than the 2% mission requirements (Figure 85). The gain coefficients of OLCI-B are lower than OLCI-A ones, where bands Oa01-Oa05 display biases values about 3-5%, when bands Oa6-Oa9 exhibit biases better than 2% mission requirements (Figure 85).

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 85). Again, the glint gain from OLCI-B looks slightly lower than OLCI-A one.



S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

Page: 78

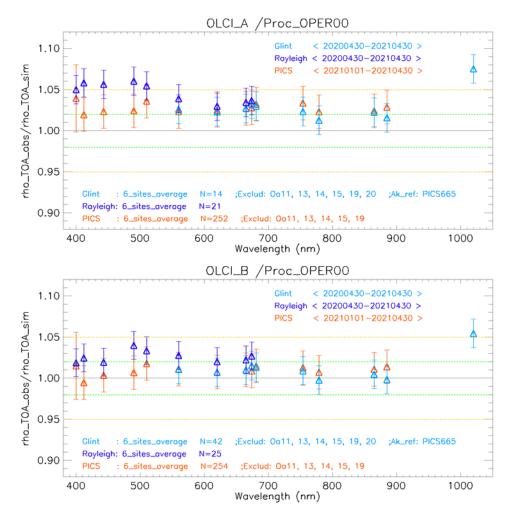


Figure 85: The estimated gain values for OLCI-A and OLCI-B from Glint, Rayleigh and PICS methods over the past twelve months as a function of wavelength. We use the gain value of Oa8 from PICS-Desert method as reference gain for Glint method. Dashed-green and orange lines indicate the 2% and 5% respectively. Error bars indicate the method uncertainties.

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.

SENTINEL 3 Mission Performance Centre

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

Page: 79

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
AtlN	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 86 and Figure 87, the average of all scenes currently (re)processed with this new climatology is given. The (re)processing was done on the S3ETRAC scenes for all months of 2019 and 2020, January and February 2021. In Figure 87, the average results for 2020 are compared with the average results of 2019 for respectively OLCI-A and OLCI-B. The results are very consistent between the years, both for OLCI-A and OLCI-B.

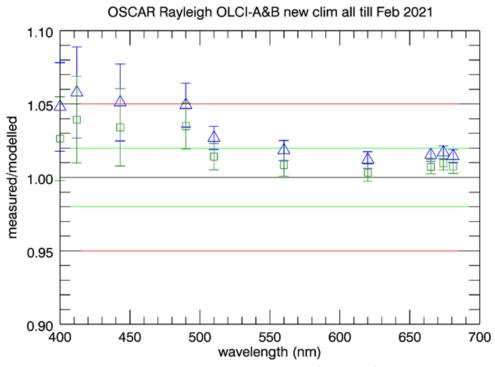


Figure 86. OSCAR Rayleigh S3A and S3B Calibration results as a function of wavelength. Average and standard deviation over all scenes currently (re)processed with the new climatology.



S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

Page: 80

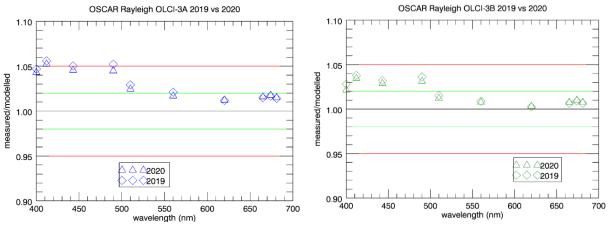


Figure 87. OLCI-A & OLCI-B OSCAR Rayleigh Calibration results for 2019 and 2020 as a function of wavelength

OSCAR Glitter results

In Figure 88 the average OSCAR OLCI-A and OLCI-B Glitter results, adapted to the Rayleigh result at 665 nm, are given for the year 2020. Similarly to the Rayleigh results, a bias is observed between OLCI-A and OLCI-B, OLCI-A being slightly brighter than OLCI-B, the bias decreasing with wavelength. Inter-band differences are small (< 1%) and well within the requirements except for the bands Oa21 (i.e. 1020 nm) and Oa4 (490 nm).

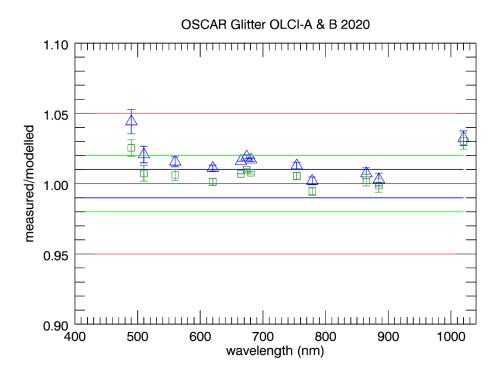


Figure 88. OSCAR Glitter OLCI-A and OLCI-B Calibration results (adapted to Rayleigh result at 665 nm) for 2020 as a function of wavelength.

Mission Performance Contra

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

Page: 81

Synthesis OSCAR Results

The synthesis of the OSCAR results is given in Table 4. This table shows a good consistency between the Rayleigh and Glitter results.

Table 4. Overview of the OSCAR Rayleigh and Glitter calibration results for OLCI-A and OLCI-B

OLCI	Wvl	Oscar R	ayleigh BA		lint S3A	Oscar R	ayleigh BB	Oscar Glint S3B		
band	(nm)	avg	stdev	avg	stdev	avg	stdev	avg	stdev	
Oa01	400	1.048	0.03	NA	NA	1.026	0.029	NA	NA	
Oa02	412	1.058	0.031	NA	NA	1.039	0.03	NA	NA	
Oa03	443	1.051	0.026	NA	NA	1.034	0.026	NA	NA	
Oa04	490	1.049	0.015	1.044	0.009	1.035	0.016	1.025	0.006	
Oa05	510	1.027	0.008	1.021	0.006	1.014	0.009	1.007	0.006	
Oa06	560	1.018	0.007	1.015	0.003	1.008	0.008	1.006	0.004	
Oa07	620	1.012	0.006	1.011	0.002	1.003	0.006	1.001	0.002	
Oa08	665	1.015	0.005	NA	NA	1.007	0.005	NA	NA	
Oa09	674	1.017	0.004	1.019	0.001	1.01	0.005	1.01	0.001	
Oa10	681	1.015	0.004	1.017	0.001	1.007	0.005	1.008	0.001	
Oa11	709	0.997	0.008	NA	NA	0.993	0.008	NA	NA	
Oa12	754	1.009	0.001	1.013	0.002	1.008	0.002	1.006	0.003	
Oa13	761.25	NA	NA	NA	NA	NA	NA	NA	NA	
Oa14	764.375	NA	NA	NA	NA	NA	NA	NA	NA	
Oa15	767.5	NA	NA	NA	NA	NA	NA	NA	NA	
Oa16	778.75	NA	NA	1.002	0.003	NA	NA	0.994	0.003	
Oa17	865	NA	NA	1.007	0.004	NA	NA	1.003	0.004	
Oa18	885	NA	NA	1.003	0.004	NA	NA	0.999	0.005	
Oa19	900	NA	NA	NA	NA	NA	NA	NA	NA	
Oa20	940	NA	NA	NA	NA	NA	NA	NA	NA	
Oa21	1020	NA	NA	1.032	0.005	NA	NA	1.03	0.006	

SENTINEL 3 Mission Performance Centre

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

Page: 82

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

3.2.1 OLCI-A

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

3.2.2 OLCI-B

This activity has not started for OLCI-B.

SENTINEL 3 Mission Performance

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

Page: 83

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 25th of April 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 89 to Figure 98 below present the Core Land Sites OLCI-A time series over the current period.

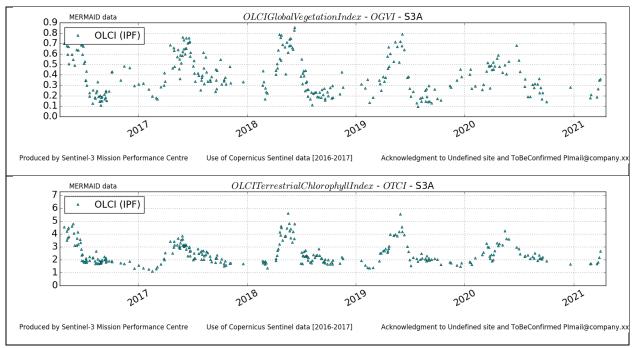


Figure 89: DeGeb time series over current report period

.

SENTINEL 3 Mission Performance

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

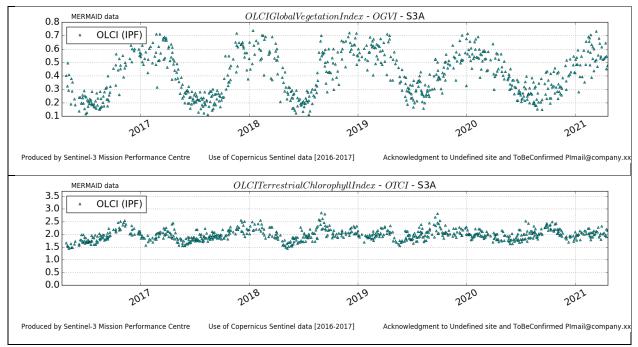


Figure 90: ITCat time series over current report period

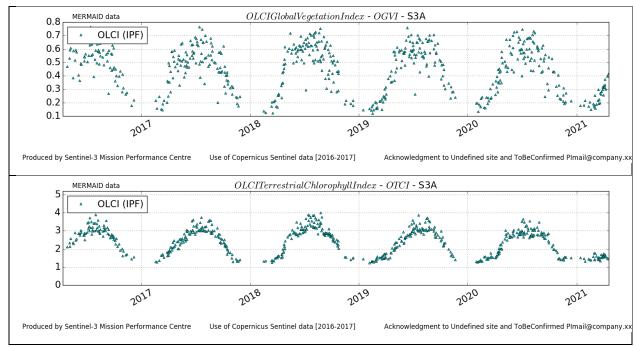


Figure 91: ITIsp time series over current report period

SENTINEL 3 Mission Performance Centre

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

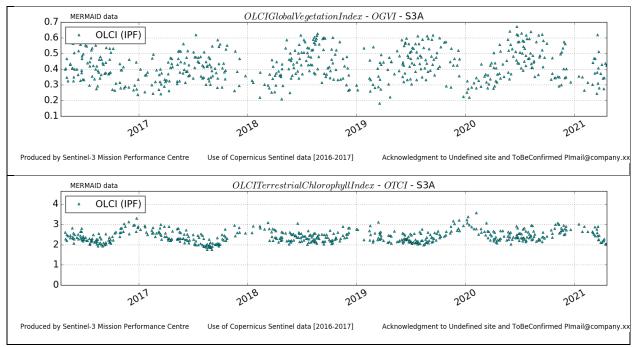


Figure 92: ITSro time series over current report period

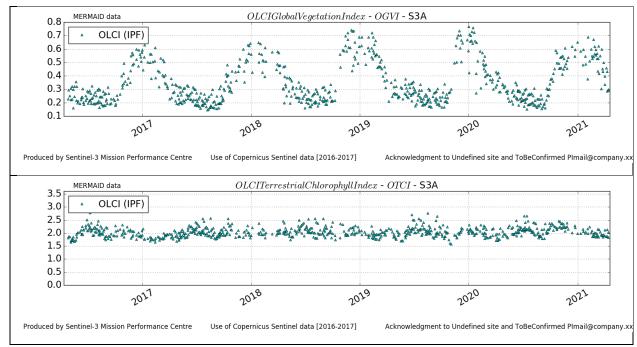


Figure 93: ITTra time series over current report period

Mission Performance Centre

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

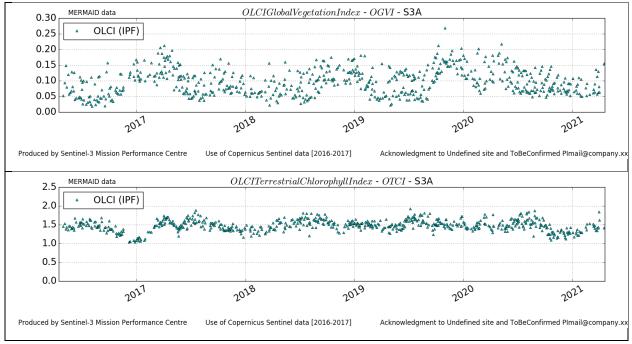


Figure 94: SPAli time series over current report period

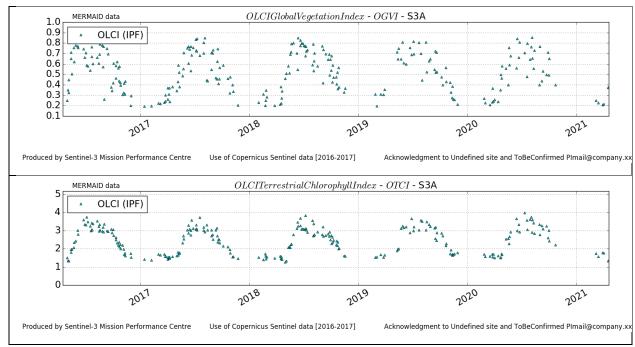


Figure 95: UKNFo time series over current report period

Mission Performance Contre

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

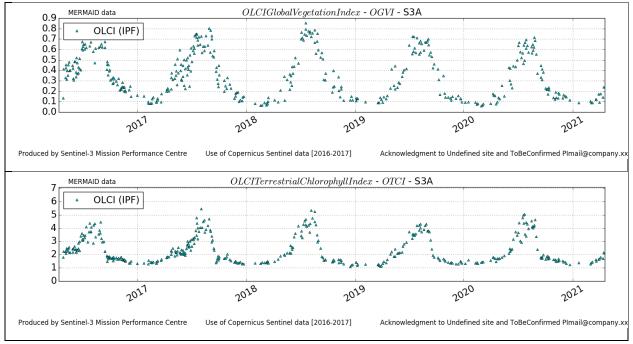


Figure 96: USNe1 time series over current report period

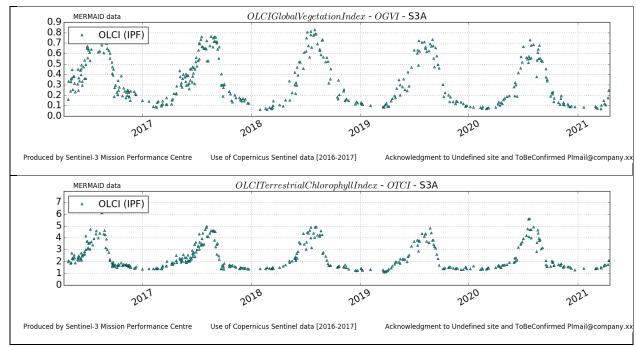


Figure 97: USNe2 time series over current report period



S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 - S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

Page: 88

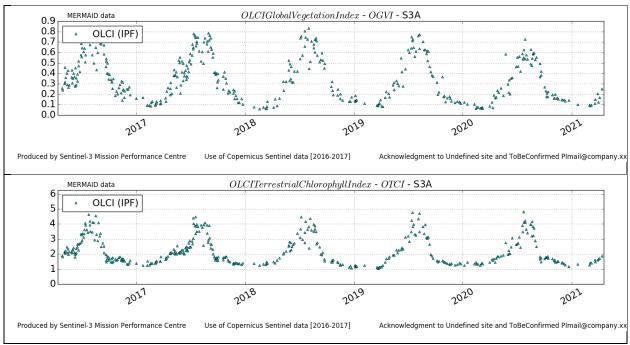


Figure 98: USNe3 time series over current report period

4.1.1.2 OLCI-B

Figure 99 to Figure 108 below present the Core Land Sites OLCI-B time series over the current period.

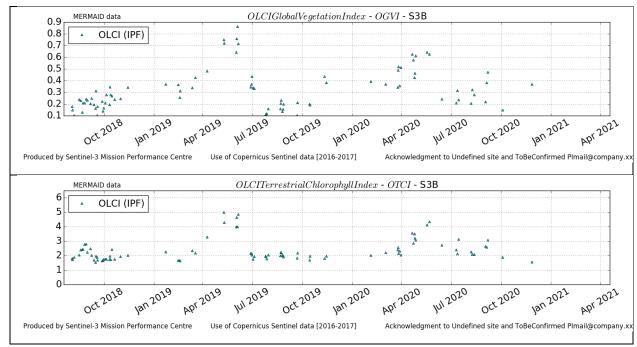


Figure 99: DeGeb time series over current report period

Sentinel 3 Mission Performance Centre

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

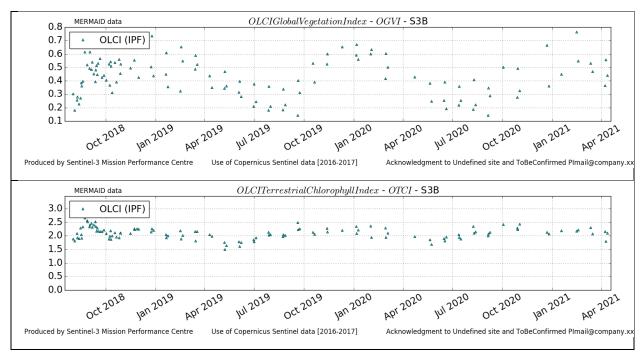


Figure 100: ITCat time series over current report period

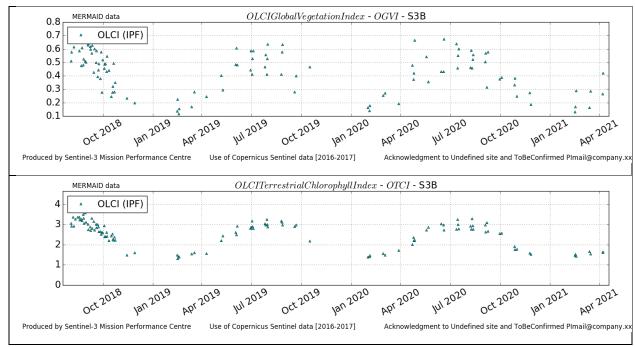


Figure 101: ITIsp time series over current report period

Mission Performance Centre

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 - S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

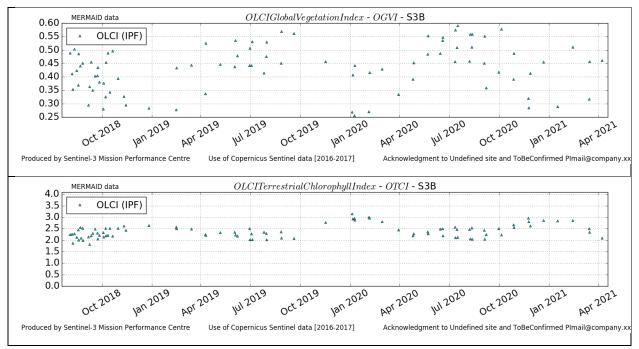


Figure 102: ITSro time series over current report period

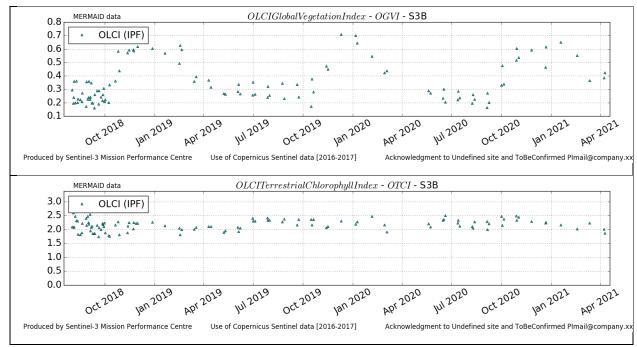


Figure 103: ITTra time series over current report period

Sentinel 3 Mission Performance Centre

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 - S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

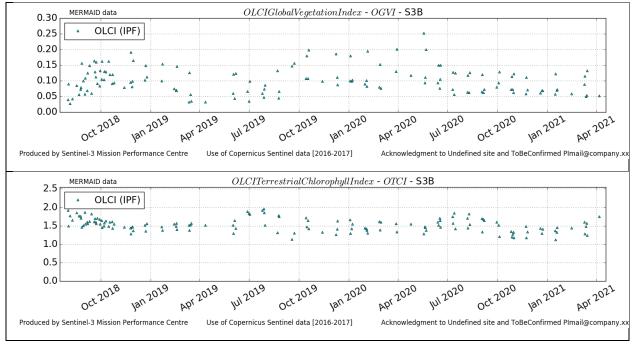


Figure 104: SPAli time series over current report period

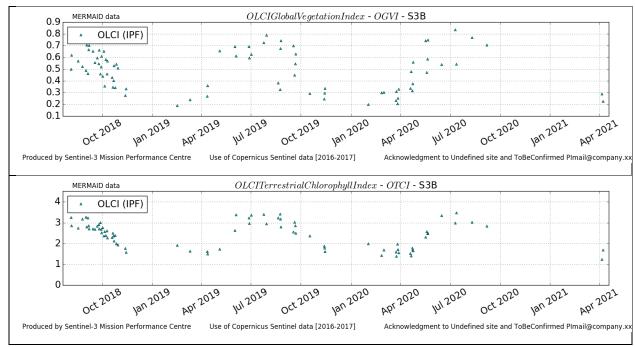


Figure 105: UKNFo time series over current report period

Sentinet 3 Mission Performance Centre

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

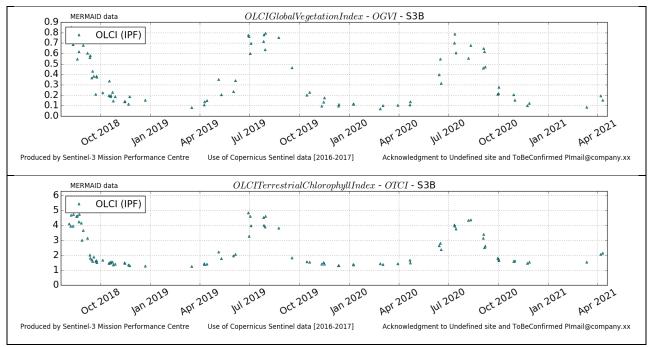


Figure 106: USNe1 time series over current report period

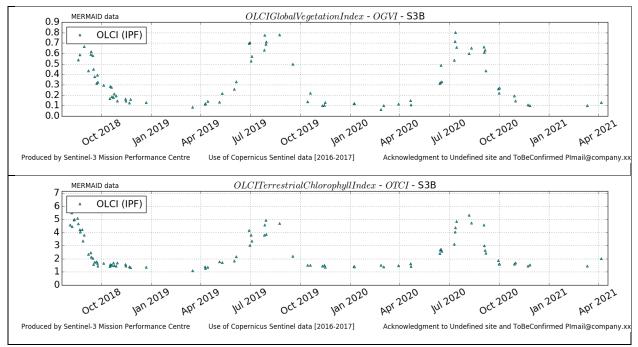


Figure 107: USNe2 time series over current report period

SENTINEL 3 Mission Performance

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

Page: 93

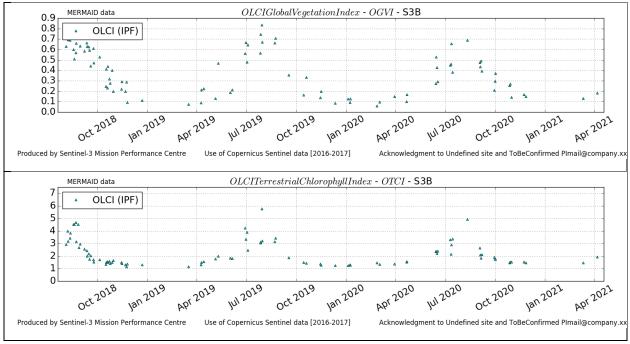


Figure 108: USNe3 time series over current report period

4.1.2 Comparisons with MERIS MGVI and MTCI climatology

This report presents the comparison between MERIS and OLCI land products between 9th March 2021 and 27th April 2021. 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 6. In general, there is good agreement between the land products with strong R² 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 109 to Figure 111). The monthly mean extractions from all sites is shown in Figure 112. OTCI from S3A shows a strong agreement with the MERIS archive, R² = 0.93, NRMSD < 0.08 with a low bias, -0.01. OGVI similarly shows a strong agreement with the MERIS archive, R² = 0.93, NRMSD < 0.15 with a slightly higher bias of 0.06. The performance results are available in the MPC web app (https://s3mpc-soton.shinyapps.io/s3mpc_gui/).



S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

Table 5: Validation sites analysed in report S3A 70/S3B 51. Land cover data from GLC2000 grouped according to the International Geosphere-Biosphere Programme (IGBP) designations.

Acronym	Country	Network	Lat Lo	n 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

Mission Performance Contre

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

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

		S3A									S3B							
Site Acronym	OTCI vs MTCI					OGV	/I vs MGV	1		OTCI vs MTCI OG\					GVI 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	0.2	0.05	0.04	12	0.68	0.16	-0.01	
AU-Cape-Tribulation	12	0.82	0.04	-0.1	12	0.21	0.06	0.15		11	0.8	0.03	-0.22	11	0.27	0.12	0.15	
AU-Cumberland	12	0.9	0.02	0.02	12	0.5	0.07	0.09		12	0.48	0.04	0.03	12	0.52	0.13	0.09	
AU-Great-Western	12	0.97	0.02	0.12	12	0.92	0.1	0.04		12	0.96	0.02	0.12	12	0.78	0.1	0.03	
AU-Robson-Creek	12	0.91	0.03	-0.05	12	0.9	0.04	0.11		12	0.83	0.05	-0.19	12	0.64	0.11	0.13	
AU-Rushworth	12	0.8	0.04	0.12	12	0.23	0.08	0.09		12	0.26	0.06	-0.07	12	0.32	0.08	0.05	
AU-Tumbarumba	12	0.83	0.06	0.33	12	0.48	0.1	0.1		12	0.65	0.07	0.18	12	0.16	0.1	0.03	
AU-Warra-Tall	12	0.66	0.07	-0.04	12	0.38	0.14	0.05		9	0.42	0.08	-0.41	9	0.27	0.1	-0.03	
AU-Watts-Creek	12	0.64	0.05	0.03	12	0.43	0.08	0.09		12	0.7	0.06	0.01	12	0.06	0.2	0.07	
AU-Wombat	12	0.89	0.03	0.11	12	0.38	0.05	0.08		12	0.83	0.03	-0.08	12	0.01	0.11	0.03	
BE-Brasschaat	11	0.99	0.03	-0.05	11	0.97	0.08	0.06		10	0.99	0.03	-0.07	10	0.93	0.08	0.03	
BE-Vielsalm	11	0.86	0.05	0.07	11	0.98	0.06	0.1		10	0.77	0.06	0.04	10	0.84	0.17	0.1	
CA-Mer-Bleue	10	0.96	0.05	-0.01	10	0.99	0.06	0.03		10	0.9	0.06	-0.03	10	0.97	0.08	0	
CZ-Bili-Kriz	10	0.91	0.03	0.04	10	0.95	0.07	0.06		9	0.89	0.04	-0.09	9	0.85	0.13	0.06	
DE-Haininch	10	0.99	0.06	-0.05	10	0.99	0.05	0.06		9	0.97	0.09	-0.04	9	0.97	0.1	0.1	
DE-Hones-Holz	12	1	0.03	0.04	12	1	0.02	0.04		10	0.97	0.08	-0.11	10	0.94	0.12	0.01	
DE-Selhausen	12	0.87	0.09	-0.03	12	0.46	0.21	0.07		12	0.73	0.12	-0.15	12	0.21	0.3	0.02	
DE-Tharandt	12	0.97	0.04	-0.05	12	0.97	0.09	0.08		10	0.98	0.03	-0.2	10	0.98	0.06	0.1	
FR-Aurade	12	0.82	0.1	0.06	12	0.81	0.19	0.13		11	0.88	0.08	0.03	11	0.86	0.16	0.08	
FR-Estrees-Mons	12	0.95	0.07	0.05	12	0.88	0.11	0.06		11	0.84	0.13	0.11	11	0.86	0.11	0.04	
FR-Guayaflux	12	0.7	0.03	-0.16	12	0.06	0.1	0.18		11	0.68	0.04	-0.22	11	0.02	0.25	0.2	
FR-Hesse	12	0.99	0.04	0.04	12	0.98	0.04	0.06		11	0.97	0.07	0.09	11	0.85	0.17	0.08	
FR-Montiers	12	0.99	0.03	-0.13	12	0.98	0.06	0.04		12	0.97	0.07	-0.09	12	0.95	0.13	0.08	
FR-Puechabon	12	0.85	0.03	-0.05	12	0.95	0.03	0.09		12	0.9	0.03	0.04	12	0.88	0.09	0.06	
IT-Casterporziano2	12	0.96	0.02	-0.13	12	0.89	0.03	0.06		12	0.91	0.04	-0.06	12	0.76	0.08	0.04	
IT-Collelongo	12	0.98	0.05	-0.02	12	0.99	0.05	0.02		12	0.92	0.13	0.05	12	0.97	0.11	0.03	
IT-Lison	12	0.98	0.03	-0.05	12	0.97	0.07	0.09		12	0.92	0.06	-0.06	12	0.91	0.13	0.08	
NE-Loobos	12	0.7	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	0.96	0.05	0.06	12	0.95	0.07	0.1		11	0.92	0.08	-0.03	11	0.91	0.14	0.08	
US-Bartlett	12	0.98	0.03	-0.03	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	0.6	0.04	-0.03	12	0.91	0.1	0.01		11	0.65	0.03	-0.05	11	0.87	0.21	0	
US-Harvard	12	0.99	0.03	-0.17	12	0.97	0.09	0.04		12	0.97	0.05	-0.23	12	0.95	0.12	0.01	
US-Jornada	10	0.71	0.05	0.03	10	0.89	0.2	0.01		8	0.81	0.04	0.09	8	0.26	0	0	
US-Moab-Site	12	0.74	0.02	0.05	12	0.22	0.22	0.01		11	0.86	0.02	0.01	11	0.01	0.43	0.04	
US-Mountain-Lake	12	0.99	0.03	-0.23	12	0.99	0.05	0.03		11	0.96	0.07	-0.41	11	1	0.05	0	
US-Oak-Rige	12	0.99	0.03	-0.05	12	0.99	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	0.07	0.04		9	0.99	0.06	-0.22	9	0.97	0.09	0.01	
US-Steigerwarldt	11	0.95	0.06	0	11	0.99	0.05	0		9	0.94	0.07	-0.06	9	1	0.03	0	
US-Talladega	12	0.99	0.01	-0.14	12	0.98	0.05	0.07		12	0.92	0.05	-0.18	12	0.94	0.1	0.07	



S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

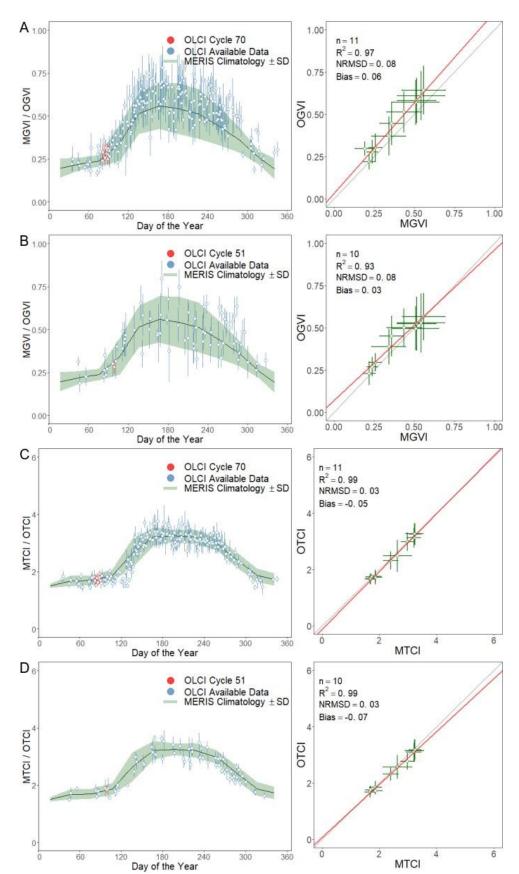


Figure 109: Time-series OGVI and OTCI and corresponding scatterplot of monthly mean for site BE-Brasschaat, Belgium, land cover Needle-leaved, evergreen. A and C represent S3A; B and D represent S3B.



S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

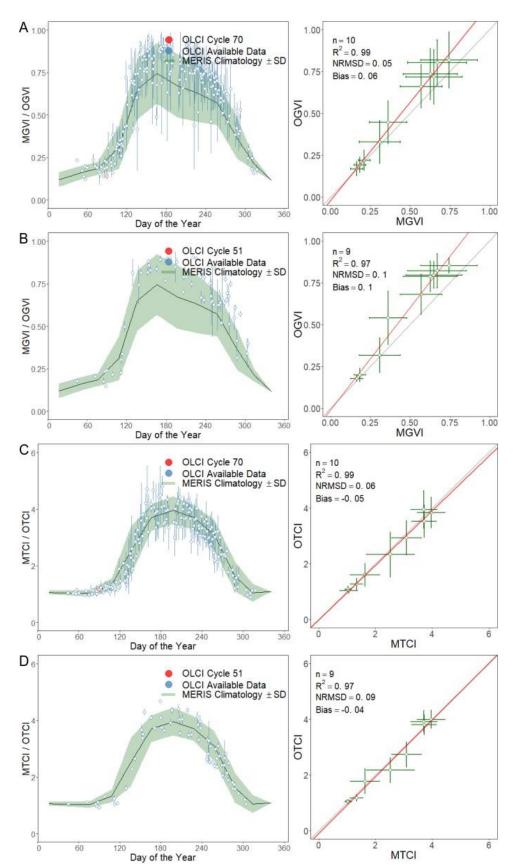


Figure 110: Time-series OGVI and OTCI and corresponding scatterplot of monthly mean for site DE-Haininch, Deutschland, land cover Broadleaved, deciduous, closed. A and C represent S3A; B and D represent S3B.



S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

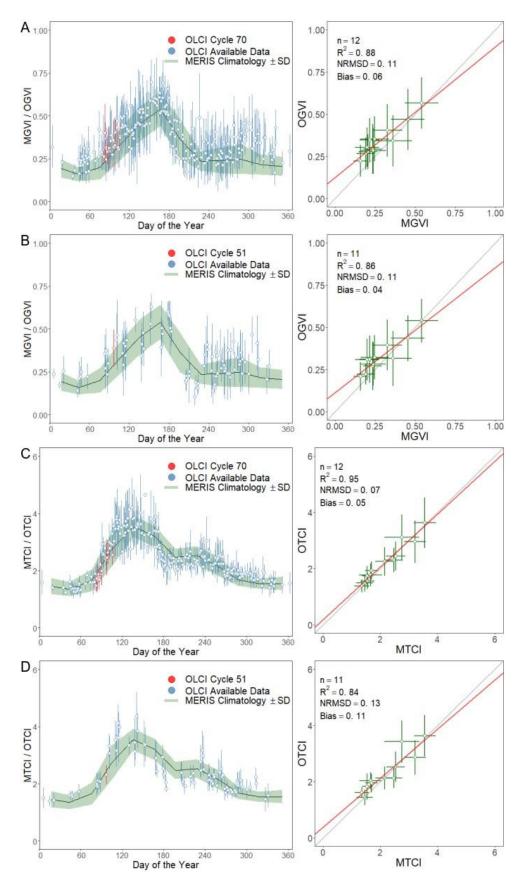


Figure 111: Time-series OGVI and OTCI and corresponding scatterplot of monthly mean for site FR-EstreesMons, France, land cover Cultivated and managed areas. A and C represent S3A; B and D represent S3B.

SENTINEL 3 Mission Performance Centre

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

Page: 99

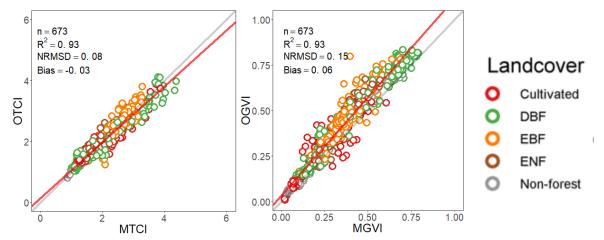


Figure 112: Comparison of OTCI-MTCI (a) and OGVI-MGVI (b). Points in the scatterplot represent the monthly mean of all available S3A and MERIS archive over 42 validation sites. Red and grey lines represent the modelled and 1:1 lines respectively. The scatterplots are updated to include extractions from cycle S3A 70.

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

There has been no new result during the cycle. Last figures (cycle 065/046) are considered valid.



S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

Page: 100

5 Level 2 Water products validation

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

Results are not further discussed here as SVC is now implemented directly by EUMETSAT.

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

5.2.1 Acknowledgements

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

AERONET-OC

- AAOT, Galata, Gloria, GDT, HLH, Irbe Lighthouse: Giuseppe Zibordi, Joint Research Centre of the European Commission
- leodo, Socheongcho: Young-Je Park & Hak-Yeol You, Korean Institute of Ocean Science and Technology & Korea Hydrographic and Oceanographic Administration
- LISCO: Sam Ahmed, Alex Gilerson, City College of New York
- MVCO: Hui Feng and Heidi Sosik, Ocean Process Analysis Laboratory (OPAL), Woods Hole Oceanographic Institution
- Thornton: Dimitry Van der Zande, RBINS/OD Nature
- Lucinda: Thomas Schroeder, Integrated Marine Observing System, IMOS
- USC_SEAPRISM: Burton Jones and Curtiss Davis, University Southern California | USC, Oregon State University
- WaveCIS: Alan Weidemann, Bill Gibson, Robert Arnone, University of Southern MS, Coastal Studies Inst – LSU, Naval Research Laboratory
- Ariake tower: Joji Ishizaka, Kohei Arai, Nagoya University & Saga University
- Blyth NOAH: Rodney Forster, University of Hull, UK
- Casablanca platform: Giuseppe Zibordi, Marco Talone, Joint Research Centre of the European Commission



S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

Page: 101

- Grizzly bay, Lake Okeechobee, South Greenbay: NimaPahlevan, NASA
- Lake Erie: Tim Moore, Steve Ruberg, Menghua Wang, University of New Hampshire & NOAA

BOUSSOLE

 David Antoine, Enzo Vellucci (Curtin University, Perth & Laboratoire d'Oceanographie de Villefranche, CNRS)

MOBY

Kenneth Voss & Carol Johnson (University of Miami & NIST)

SLGO

 Simon Belanger, Thomas Jaegler & Peter Galbraith (Arctus, Inc & Department of fisheries and Ocean Canada)

AWI

Astrid Bracher (Alfred-Wegener-Institut)

IMOS

Thomas Schroeder (Integrated Marine Observing System, IMOS)

BSH

Holger Klein (Bundesamt für Seeschifffahrt und Hydrographie, BSH)

Proval

Edouard Leymarie (Laboratoire d'Oceanographie de Villefranche, CNRS)

5.2.2 OLCI-A

Activities done

- The focus for this time period has been on the rolling archive Non Time Critical (NT) data until the 25th of April 2021.
- Current reporting period is hereafter compared to the reprocessed archive covering the April 2016 to November 2017 period. No issues are reported neither in the extraction process nor in OLCI data.
- All extractions and statistics have been regenerated on the current rolling archive availability including all the extraction since July 2017. The available matchups therefore represent over almost three years of operation.
- At best 403 and 408 matchups at 490 and 560nm respectively are useful for this time period. OLCI's performances remain nominal.



S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

Page: 102

Since 16 February 2021, EUMETSAT has released a new L2 Ocean Colour processor in Sentinel-3 OLCI operations. L2 operational Ocean Colour data now belong to Collection 3, OL_L2M.003.00. Collection-3 introduces major changes in Level-2 Ocean Colour processing. The goal of the changes is to achieve accuracy and consistency between OLCI-A and -B and to introduce several algorithm improvements:

- o System Vicarious Calibration gains are updated in OLCI-A and OLCI-B.
- Revised Bright Pixel Correction, new Chlorophyll Index algorithm, and updated whitecap correction are introduced in the open water processing chain.
- New Neural Network v.2 (NNv.2) is introduced in the complex water processing chain.
- New and updated flags are available, together with a new flag recommendation for users.

Overall Water-leaving Reflectance performance

Scatter plots and Performance Statistics

Figure 113 to Figure 115 below present the scatterplots and statistics of OLCI FR versus in situ reflectance. Two time periods are considered:

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

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

Table 7 below summarises the statistics over the reprocessing period while Table 8 provides the same figures for the NT rolling Archive over July 2017 – present. The latter statistics are almost within the requirements (5% accuracy in the blue/green bands) – as demonstrated by the RPD values between 2 and 4.8%, with the noticeable exception of 400 and 412 nm with 9-10%. Performances over the current period appear a bit lower than for the calibration period (except at 412 nm), but of the same order of magnitude.

S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

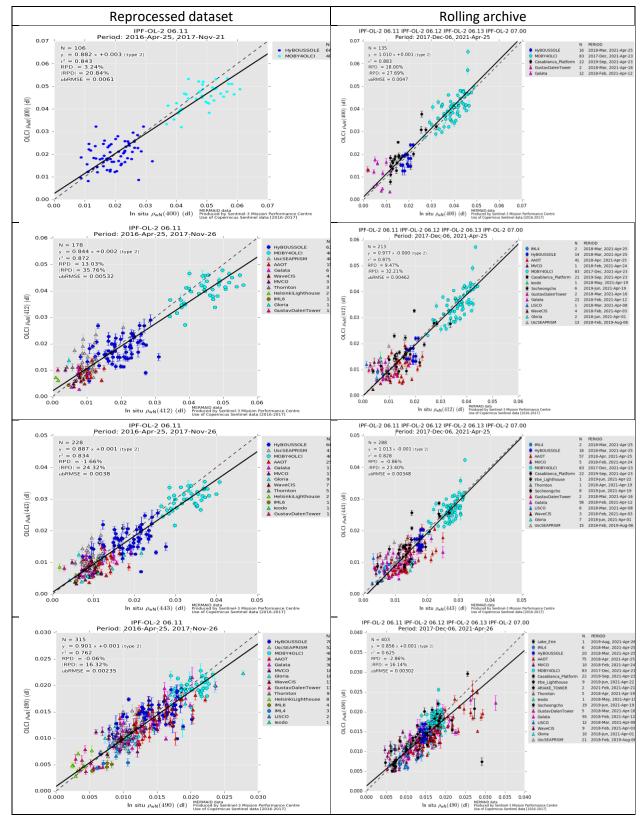


Figure 113: Scatter plots of OLCI-A versus in situ radiometry (FR data). Reprocessed dataset (left), all available data for the current time period (right), Oa1 to Oa4 (400 to 490 nm)

Sentinel 3 Mission Performance Centre

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

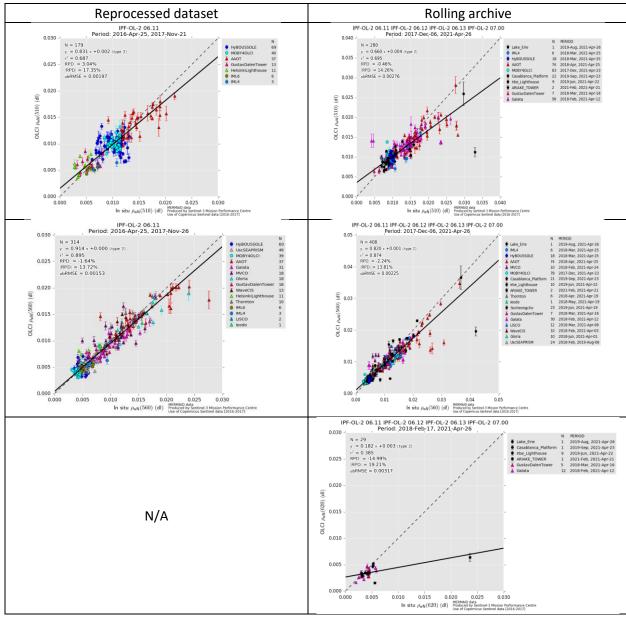


Figure 114: Scatter plots of OLCI-A versus in situ radiometry (FR data). Reprocessed dataset (left), all available data for the current time period (right), Oa5 Oa6 and Oa07 (510, 560 and 620 nm).



S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

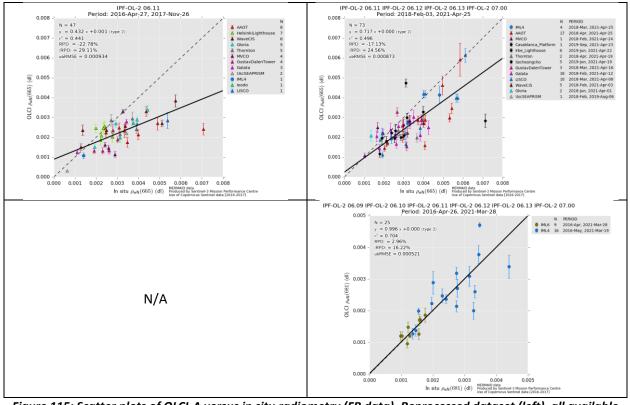


Figure 115: Scatter plots of OLCI-A versus in situ radiometry (FR data). Reprocessed dataset (left), all available data for the current time period (right), Oa8 and Oa10 (665 and 681 nm).

Table 7: OLCI-A FR statistics over REP_006 period; FR data.

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

Table 8: OLCI-A FR statistics over December 2017-febrary 2021.

lambda	N	RPD	RPD	MAD	RMSE	slope	intercept	r2	
400	135	18.00%	27.69%	0.0015	0.0049	1.0102	0.0012		0.88
412	213	9.47%	32.21%	-0.0007	0.0047	0.9767	-0.0002		0.88
443	288	-0.86%	23.40%	-0.0009	0.0036	1.0133	-0.0011		0.83
490	403	-2.86%	16.14%	-0.0009	0.0031	0.8560	0.0013		0.62
510	280	-0.46%	14.26%	-0.0007	0.0028	0.6602	0.0036		0.70
560	408	-2.24%	13.81%	-0.0007	0.0024	0.8197	0.0011		0.87
620	29	-14.99%	19.21%	-0.0012	0.0034	0.1820	0.0027		0.38
665	73	-17.13%	24.56%	-0.0007	0.0011	0.7165	0.0002		0.50
681	5	-15.20%	19.01%	-0.0005	0.0008	1.0736	-0.0008		0.32



S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

Page: 106

Time series

Figure 116 and Figure 117 below present Galata and AAOT in situ and OLCI time series over the June 2017-present period, for the same IPF configuration (from a scientific point of view).

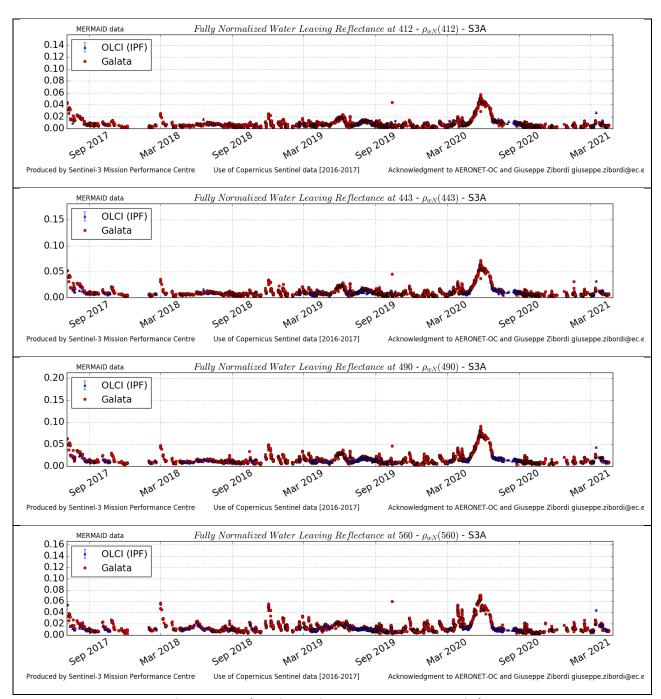


Figure 116: Galata time series over current report period

Mission Performance Centre

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 - S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

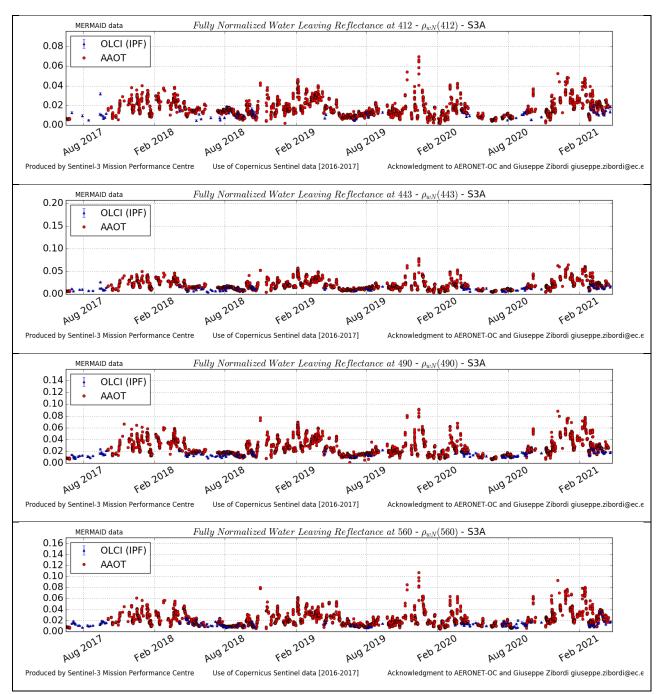


Figure 117: AAOT time series over current report period

SENTINEL 3 Mission Performance

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

Page: 108

5.2.3 OLCI-B

Activities done

- The focus for this time period has been on the rolling archive Non Time Critical (NT) data until the 23rd of April 2021.
- All extractions and statistics have been regenerated on the current rolling archive availability including all the extraction since February 2019.
- At best 359 and 383 matchups at 490 and 560nm respectively are useful for this time period.
- Since 16 February 2021, EUMETSAT has released a new L2 Ocean Colour processor in Sentinel-3 OLCI operations. L2 operational Ocean Colour data now belong to Collection 3, OL_L2M.003.00. Collection-3 introduces major changes in Level-2 Ocean Colour processing. The goal of the changes is to achieve accuracy and consistency between OLCI-A and -B and to introduce several algorithm improvements:
 - o System Vicarious Calibration gains are updated in OLCI-A and OLCI-B.
 - Revised Bright Pixel Correction, new Chlorophyll Index algorithm, and updated whitecap correction are introduced in the open water processing chain.
 - o New Neural Network v.2 (NNv.2) is introduced in the complex water processing chain.
 - o New and updated flags are available, together with a new flag recommendation for users.

It must be noted that OLCI-B has SVC adjustment only since 16/02/2021.

Overall Water-leaving Reflectance performance

Scatter plots and Performance Statistics

- Figure 118 below presents the scatterplots and statistics of OLCI-B FR versus in situ reflectance.
- ❖ Table 9 below summarises the statistics over the current reporting period.

SENTINEL 3 Mission Performance Centre

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

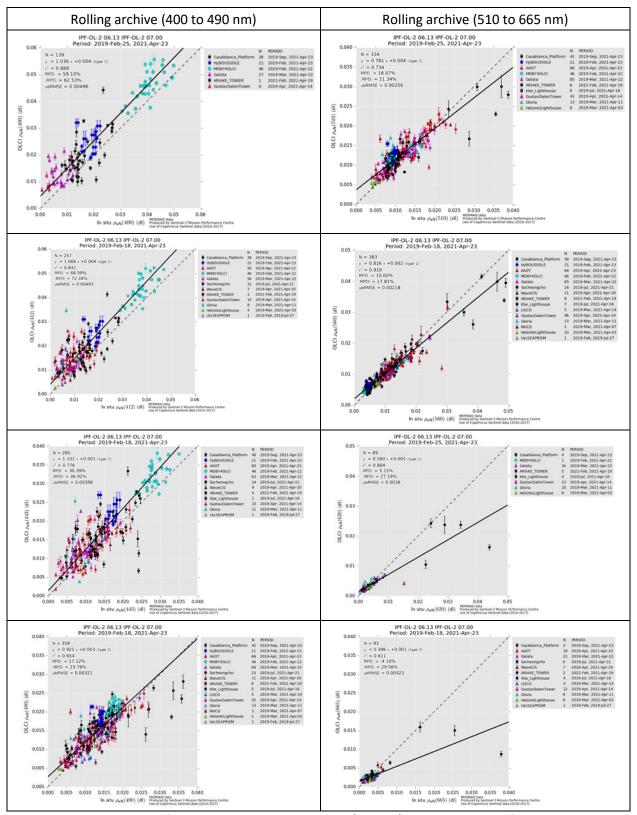


Figure 118: Scatter plots of OLCI-B versus in situ radiometry (FR data). All available data for the current time period.

SENTINEL 3 Mission Performance Contre

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

Page: 110

Table 9: OLCI-B FR statistics over February to August 2020 reporting period.

lambda	N	RPD	RPD	MAD	RMSE	slope	intercept	r2	
400	139	59.10%	62.53%	0.0053	0.0073	1.0363	0.0045		0.89
412	257	68.59%	72.34%	0.0051	0.0071	1.0662	0.0041		0.84
443	285	30.39%	36.92%	0.0028	0.0049	1.1010	0.0014		0.78
490	359	17.12%	23.78%	0.0016	0.0036	0.9211	0.0026		0.65
510	334	16.07%	21.34%	0.0012	0.0028	0.7808	0.0037		0.73
560	383	10.00%	17.81%	0.0002	0.0022	0.8165	0.0021		0.91
620	89	5.15%	27.19%	-0.0009	0.0037	0.5803	0.0013		0.80
665	93	-4.10%	29.56%	-0.0008	0.0033	0.3957	0.0015		0.61

It is recalled that that OLCI-B has SVC adjustment only since 16/02/2021, hence the above statistics are not representative of the new processing baseline.

Time series

Figure 119 and Figure 120 below present AAOT and GALATA in situ and OLCI-B time series over the current period.

Mission Performance Centre

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

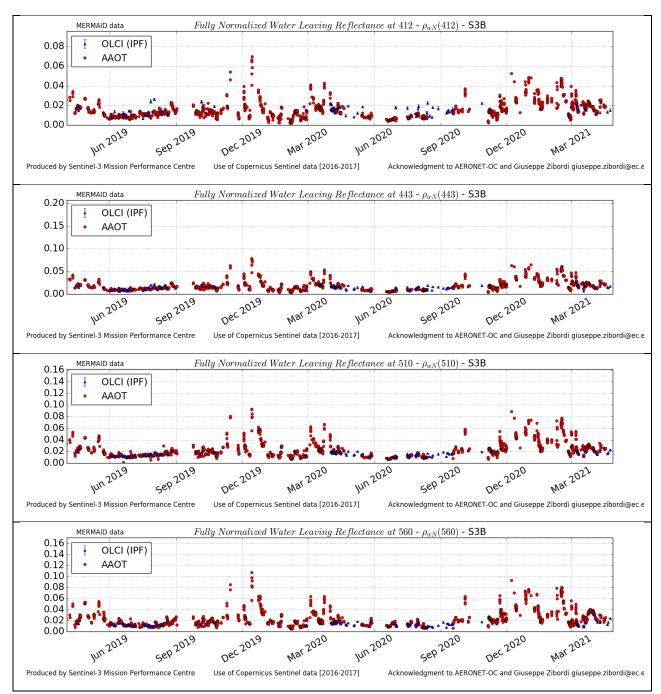


Figure 119: AAOT time series over current report period

Mission Performance Centre

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 - S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

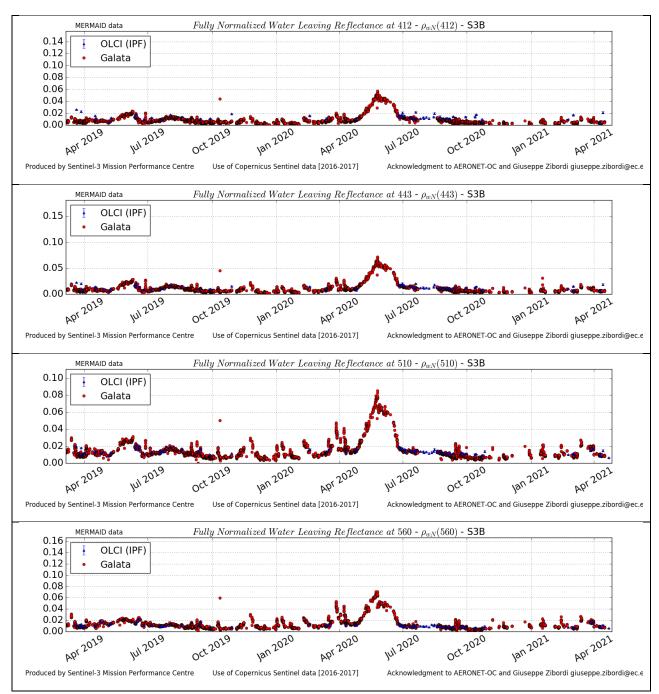


Figure 120: GALATA time series over current report period



S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

Page: 113

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

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

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

There has been no new result during the cycle. Last figures (cycle 065/046) are considered valid.

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

To validate OLCI's Aerosol product (aerosol optical thickness and Angstroem coefficient at 865nm), we continuously compare it with data from AERONET (Holben et al 1998), AERONET-OC (Zibordi et al 2009) and maritime AERONET (MAN: Smirnow et al 2009). This is an ongoing process, where co-located data are collected and analysed. Since, the AERONET L2 data is stringently quality controlled, it is published with a delay of up to 1 yr. The level 1.5 data, however, is similar to L2 with respect to direct transmission retrievals, including the optical thickness. Hence we are using level 1.5 data. The OLCI-A data is either reprocessed or from after Nov 2017. We show the comparison of non-time-critical full-resolution data (wfr NT). Only OLCI measurements are used for the validation which are cloud-free (according to the standard cloud flags: cloud, cloud margin and cloud ambiguous) in an area of about 10x10 km² around the AERONET acquisition. Further, all recommended flags from Sentinel-3 OLCI Marine User Handbook (EUM/OPS-SEN3/MAN/17/907205) have been applied. Eventually, to reduce the influence of undetected (sub pixel or sub visual) clouds, only matchups have been used, where the standard deviation of the aerosol optical thickness within the 10x10 km² area was less than 0.3. The valid matchups evolved for AERONET and AERONET-OC are shown in Figure 121. The linear correlation of the aerosol optical thickness at 865nm is about 0.75-0.8, with a systematic bias of around 0.04 and a systematic overestimation of around 27-33%. The bias corrected root mean squared distance is 0.03. The Angstrom coefficients from maritime AERONET and OLCI are not directly comparable, since they belong to different wavelength ranges (AERONET: 870nm-440nm, OLCI: 865nm - 779nm). Nevertheless, there should be a co-relation. It is remarkable, that the majority of Angstroem coefficients found by OLCI and AERONET is around 1.5, pointing to non-maritime aerosols. The temporal evolution does not show significant changes, the recent month show a higher variability, but there the number of matchups is usually smaller.



S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

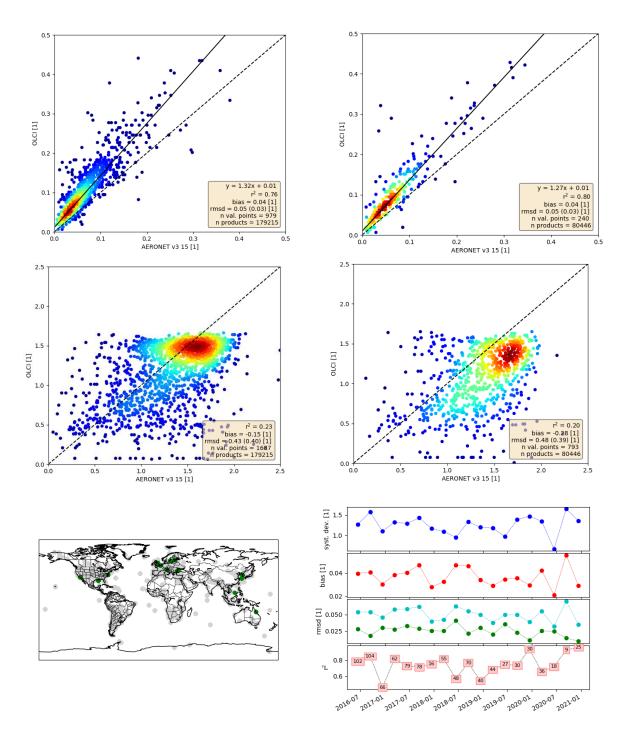


Figure 121: Upper and middle: Scatter plot of the aerosol products (upper: aerosol optical thickness, middle: Angstroem coefficient), derived from OLCI (A left, B right) and AERONET-OC measurements. Lower left: Positions of the AERONET-OC stations. Lower-right: Temporal evolution of different quality measures for the optical thickness derived from OLCI A (from top to bottom: systematic deviation factor, bias, root mean squared



S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

Page: 115

difference (with and without bias correction), explained variance (number in boxes are the numbers of matchups)).

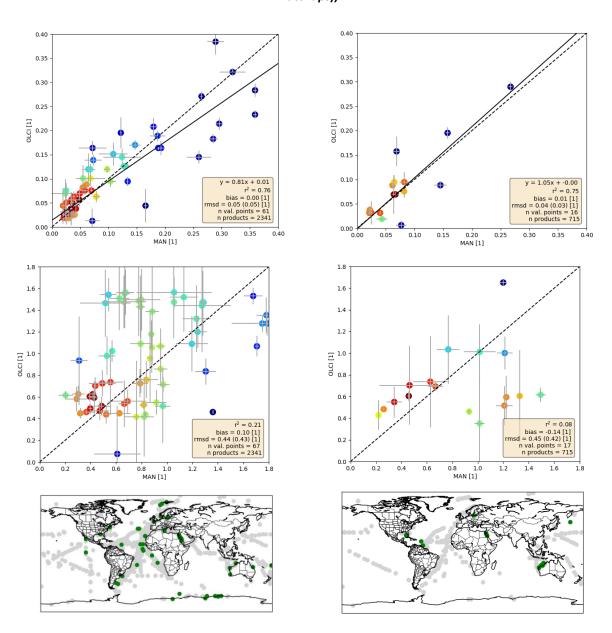


Figure 122: Upper and middle: Scatter plot of the aerosol products (upper: aerosol optical thickness, middle: Angstroem coefficient), derived from OLCI (A left, B right) and MAN measurements. Lower: Positions of the MAN acquisitions (left: OLCI A, right: OLCI B).

The 2341 (OLCI-A) and 715 (OLCI-B) MAN co-locations, acquired during ship cruises, evolved to 61 (OLCI-A) and 16 (OLCI-B) valid matchups, shown in Figure 122. Here the agreement of the aerosol optical thickness at 865nm is better than for the AERONET-OC comparisons. The linear correlation is still 0.75-0.8 and also the root mean squared distance is around 0.05, but no significant bias is found. The Angstrom coefficients don't show a significant co-relation, the clustering at 1.5 found for the AERONET-OC matchups, is not perceivable.



S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

Page: 116

References

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

- Smirnov, A., Holben, B.N., Slutsker, I., Giles, D.M., McClain, C.R., Eck, T.F., Sakerin, S.M., Macke, A., Croot, P., Zibordi, G., Quinn, P.K., Sciare, J., Kinne, S., Harvey, M., Smyth, T.J., Piketh, S., Zielinski, T., Proshutinsky, A., Goes, J.I., Nelson, N.B., Larouche, P., Radionov, V.F., Goloub, P., Krishna Moorthy, K., Matarrese, R., Robertson, E.J., Jourdin, F., 2009. Maritime aerosol network as acomponent of aerosol robotic network. J. Geophys. Res. 114, 1—10, http://dx.doi.org/10.1029/2008JD011257.
- Zibordi G., B.Holben, I.Slutsker, D.Giles, D.D'Alimonte, F.Mélin, J.-F. Berthon, D. Vandemark, H.Feng,G.Schuster, B.Fabbri, S.Kaitala, J.Seppälä. AERONET-OC: a network for the validation of Ocean Color primary radiometric products. Journal of Atmospheric and Oceanic Technology, 26, 1634-1651, 2009.

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

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



S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

Page: 117

6 Validation of Integrated Water Vapour over Land & Water

6.1 Preface

The OLCI L2 IWV processor distinguishes between ocean and land surfaces and works very differently above the respective surfaces. Hence, the validation of the IWV product is performed for both surface types independently.

The validation above land is performed via comparisons with ground based GNSS (Ware et al 2000) measurements, water vapor from AERONET (Pérez-Ramírez et al 2014, Holben et al 1998) and water vapor from ground based microwave radiometer at the *Atmospheric Radiation Measurement* (ARM) *Climate Research Facility* of the US Department of Energy ARM. (Turner et al. 2003, Turner et al. 2007).

Above ocean a quantitative verification has been undertaken using AERONET-OC (Zibordi et al 2009).

6.2 Quantitative validation using GNSS – Land

518,000 (OLCI-A) and 208000 (OLCI-B) potential matchups within the period of June 2016 (OLCI-A) January 2019 (OLCI-B) to April 2021 have been analysed yet. The scenes cover high and low elevations, however the majority of the used SUOMI-NET ground stations are in North and Central America. The global service of SUOMI-NET has been reduced end 2018, thus OLCI-B colocations 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 123). The correlation between both quantities is 0.98. The root-mean-squared-difference is 1.9 -2.1 kg/m². The systematic overestimation by OLCI is 10%-12%. The bias corrected *rmsd* is 1.3-1.4 kg/m². Actually, both instruments behave almost equal. Nevertheless, there might be small systematic differences between OLCI-A and B. The systematic overestimation is smaller for OLCI-B. This could be a sampling bias, but also due to small spectral differences between both instruments. The comparison to other reference data does not show this peculiarity.

Figure 124 shows the temporal evolution of OLCI-A's quality measures. Interesting is the strong seasonal pattern of the bias. This belongs to the seasonality of water vapor in North Amerika. It is also partly visible in the systematic overestimation, oscillating between 7 and 12 %. This however, could be a sampling effect too.

SENTINEL 3 Mission Performance Centre

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

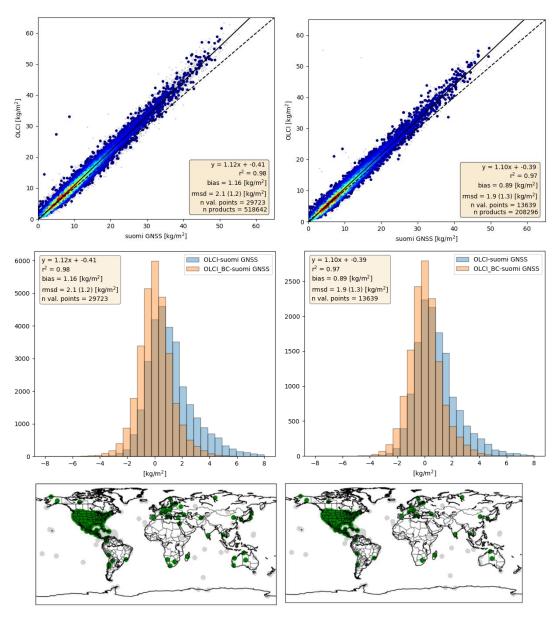


Figure 123: Upper: Scatter plot of the IWV products, derived from OLCI (A left, B right) above land and from SUOMI NET GNSS measurements. Middle: Histogram of the difference between OLCI (A: left, B: right) and GNSS (blue: original OLCI, orange: bias corrected OLCI). Lower: Positions of the GNSS (A: left, B: right).

Mission Performance Centre

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 - S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

Page: 119

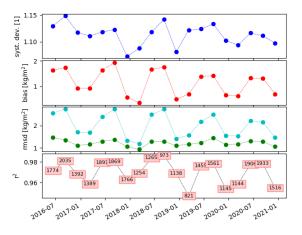


Figure 124: Temporal evolution of different quality measures for OLCI A (from top to bottom: systematic deviation factor, bias, root mean squared difference (with and without bias correction), explained variance (number in boxes are the numbers of matchups))

6.3 Quantitative validation using GNSS - Water

OLCIs IWV above water surfaces has been quantitatively validated via global GNSS measurements too, however with few additional assumptions:

- Since the GNSS stations are usually not directly above water, the closest water pixel (within 1km) is used for the satellite measurement.
- No height correction has been applied to account for the potentially elevated GNSS station.

For OLCI-A, 70 matchups remain after filtering (Figure 125). They show a large bias 10 kg/m² and a large scatter (>6 kg/m²). For OLCI-B the number of valid matchups is smaller (30), but all indications point to similar systematic deviations and retrieval noise. This is in accordance with the visual inspection.



S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

Page: 120

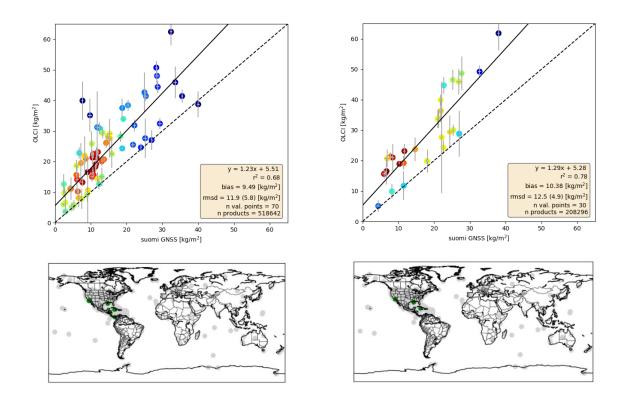


Figure 125: Upper: Scatter plot of the IWV products, derived from OLCI (A left, B right) above ocean and from SUOMI NET GNSS measurements. Lower: Positions of the GNSS (A: left, B: right).

6.4 Quantitative validation using AERONET IWV Retrievals - Land

Aeronet observations, allow the estimation of the total column of water vapour by measuring the extinction of the direct solar irradiance at 900 nm. The used operational algorithm is quite simple and eventually relies on a logarithmic fit (incl. quadratic corrections). AERONET data are better globally distributed than SUOMI-NET. Since, the AERONET L2 is stringently quality controlled, it is published with a delay of up to 1 yr. However, the L1.5 data is similar to L2 with respect to direct transmission retrievals, including the water vapor. Only OLCI measurements are used for the validation which are cloud-free (according to the standard cloud flags: cloud, cloud margin and cloud ambiguous) in an area of about 10x10 km2 around the AERONET acquisition. From the 150000 (OLCI-A) and 505000 (OLCI-B) potential matchups until April 2021, 33000 (OLCI-A) and 15000 (OLCI-B) valid matchups could be used. (Figure 126). The correlation between both quantities is 0.96. The root-mean-squared-difference is 3.4-3.5 kg/m². The systematic overestimation by OLCI is 19%. The bias corrected rmsd is ~ 1.6 kg/m². The systematic deviation between OLCI and AERONET of 19% is significantly larger than the one found for GNSS and ARM (next section). We are certain that this stems from a dry bias of AERONET and accordingly deficits in the AERONET algorithm, but we have not investigated it deeper.

SENTINEL 3 Mission Performance Centre

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

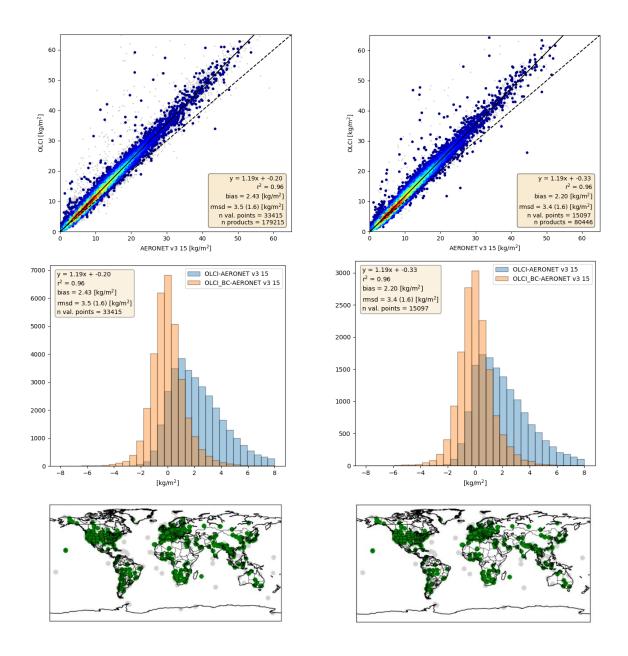


Figure 126: Upper: Scatter plot of the IWV products, derived from OLCI (A left, B right) above land and from Aeronet v.3 L1.5 measurements. Middle: Histogram of the difference between OLCI (A: left, B: right) and Aeronet (blue: original OLCI, orange: bias corrected OLCI). Lower: Positions of the Aeronet (A matchups: left, B matchups: right).



S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

Page: 122

6.5 Validation by AERONET IWV Retrievals - Ocean

OLCIs IWV above water surfaces has been quantitatively validated via global AERONET-OC measurements. All filter are as for land matchups. The remaining 2157 (OLCI-A) and 1000 (OLCI-B) matchups show a large bias of about 9 kg/m 2 , a large scatter (>6 kg/m 2) and a systematic overestimation of about 20% (Figure 127). This is in accordance with the visual inspection and with the GNNS matchups (Figure 125) over oceans.

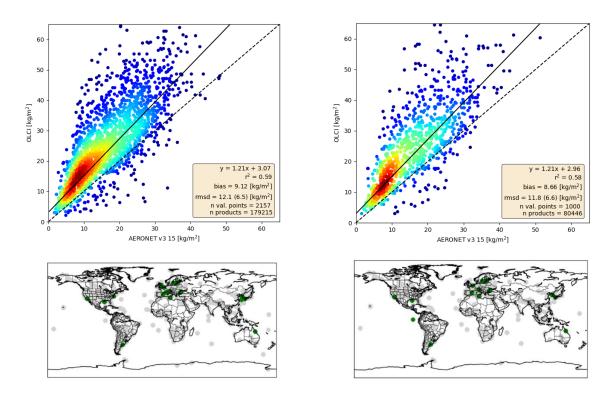


Figure 127: Upper: Scatter plot of the IWV products, derived from OLCI (A left, B right) above ocean and from Aeronet-OC v.3 L1.5 measurements. Lower: Positions of the used Aeronet match ups (A: left, B: right).

6.6 Quantitative validation using ARM MWR IWV Retrievals – Land

Microwave radiometer measurements at the *Atmospheric Radiation Measurement* (ARM) *Climate Research Facility* of the US Department of Energy provides the ground truth with the highest accuracy (0.6 kg/m²). Only the SGP (southern great planes) site provided cloud free measurements. 2900 potential matchups within the period of June 2016 to April 2021 have been analysed yet. Apparently the dissemination of one file type (*sgpmwrret1liljclouC1.s1*) has been discontinued. Instead we are using a precursor product (*sgpmwrret1liljclouC1.c1*), that already contains all necessary data, but not stringently filtered for glitches (e.g. rain on MWR window or thermal anomalies). We had to extended the matchup by an according preprocessing. 3300 (OLCI-A) and 1200 (OLCI-B) measurements are taken for the validation which are cloud-free in an area of about 10x10 km² around SGP. For the cloud detection, the standard L2 cloud-mask has been applied (including the cloud ambiguous and cloud margin flags), resulting in 176 (OLCI-A) and 79 (OLCI-B) valid matchups. The comparison shows a very high agreement.



S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

Page: 123

The correlation between both quantities is 0.99. The root-mean-squared-difference is 1.4 kg/m 2 . The systematic overestimation by OLCI A and B is 8%. The bias corrected rmsd is 0.8 kg/m 2 , close to the uncertainty of a ground based microwave radiometer.

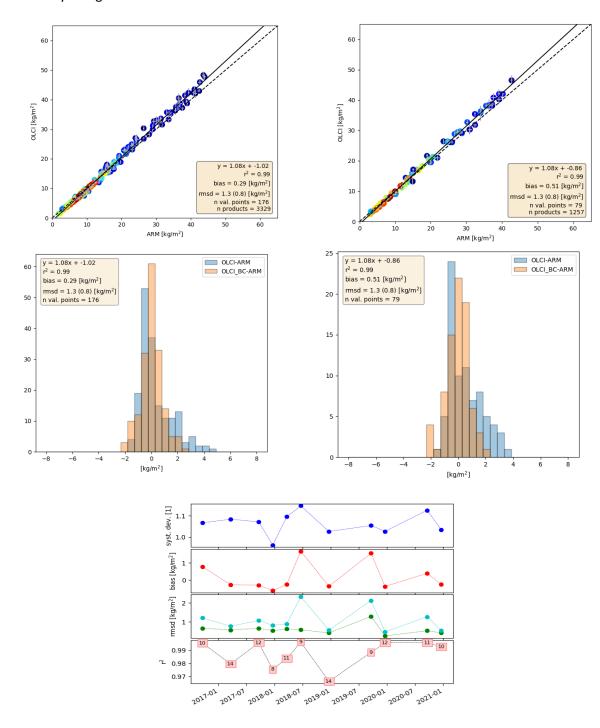


Figure 128: Upper: Scatter plot of the IWV products, derived from OLCI (A left, B right) above land and from ARM microwave measurements. Middle: Histogram of the difference between OLCI (A: left, B: right) and ARM-MWR (blue: original OLCI, orange: bias corrected OLCI). Lower: Temporal evolution of different quality measures for OLCI A (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)).



S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

Page: 124

6.7 Summary

• The validation exercise of the OLCI IWV product has been successful. It demonstrates that the product is stable and provides of high quality for retrievals above land surfaces.

- There is a systematic overestimation of around 8%-10% depending on the used ground base reference. The AMR microwave radiometer is regarded as the most accurate method, thus we assume, that the bias is in the order of 9%. Further, we know that SUOMI-GNSS has a dry-bias of 3% with respect to ARM measurements (see Figure 129), which is fully consistent to our observations.
- Retrievals above ocean show an overestimation in transition zones between glint and off glint.
 This is a clear deficit of the description of the scattering-absorption interaction. Further the IWV
 has a large wet bias over ocean. A redesigned algorithm will overcome this. The new algorithm is
 under development.
- The IWV OLCI algorithm uses measurements at 865, 885 and 900 nm, while the bands at 935 and 1020 nm are not used. We expect better results, in particular less noise, if all relevant bands are used.

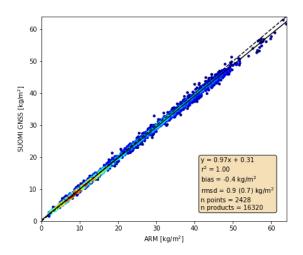


Figure 129 : ARM vs. GNSS IWV retrievals for the SGP site for the one year period between Nov 2017 and Oct 2018. Only cloud free data has been used, according to the liquid/ice water path from the microwave radiometer



S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

Page: 125

6.8 References:

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

- Pérez-Ramírez, D., D. N. Whiteman, A. Smirnov, H. Lyamani, B. N. Holben, R. Pinker, M. Andrade, and L. Alados- Arboledas (2014), Evaluation of AERONET precipitable water vapor versus microwave radiometry, GPS, and radiosondes at ARM sites, J. Geophys. Res. Atmos., 119, 9596–9613, doi:10.1002/2014JD021730
- Smirnov, A., Holben, B.N., Slutsker, I., Giles, D.M., McClain, C.R., Eck, T.F., Sakerin, S.M., Macke, A., Croot, P., Zibordi, G., Quinn, P.K., Sciare, J., Kinne, S., Harvey, M., Smyth, T.J., Piketh, S., Zielinski, T., Proshutinsky, A., Goes, J.I., Nelson, N.B., Larouche, P., Radionov, V.F., Goloub, P., Krishna Moorthy, K., Matarrese, R., Robertson, E.J., Jourdin, F., 2009. Maritime aerosol network as acomponent of aerosol robotic network. J. Geophys. Res. 114, 1—10, http://dx.doi.org/10.1029/2008JD011257.
- Turner, D. D., Lesht, B. M., Clough, S. A., Liljegren, J. C., Revercomb, H. E., and Tobin, D. C.: Dry Bias and Variability in Vaisala RS80-H Radiosondes: The ARM Experience, J. Atmos. Ocean. Tech., 20, 117–132, doi:10.1175/15200426(2003)020<0117:DBAVIV>2.0.CO;2, 2003.
- Turner, D. D., Clough, S. A., Liljegren, J. C., Clothiaux, E. E., Cady-Pereira, K. E., and Gaustad, K. L.: Retrieving Liquid Water Path and Precipitable Water Vapor From the Atmospheric Radiation Measurement (ARM) Microwave Radiometers, IEEE T. Geosci. Remote Sens., 45, 3680–3690,doi:10.1109/TGRS.2007.903703, 2007.
- Ware, R. H., D. W. Fulker, S. A. Stein, D. N. Anderson, S. K. Avery, R. D. Clark, K. K. Droegemeier, J. P. Kuettner, J. B. Minster, and S. Sorooshian (2000), SuomiNet: A real-time national GPS network for atmospheric research and education, Bull. Am. Meteorol. Soc., 81(4), 677–694.
- Zibordi G., B.Holben, I.Slutsker, D.Giles, D.D'Alimonte, F.Mélin, J.-F. Berthon, D. Vandemark, H.Feng,G.Schuster, B.Fabbri, S.Kaitala, J.Seppälä. AERONET-OC: a network for the validation of Ocean Color primary radiometric products. Journal of Atmospheric and Oceanic Technology, 26, 1634-1651, 2009.

SENTINEL 3 Mission Performance Centre

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

Page: 126

7 Level 2 SYN products validation

There has been no new result during the cycle. Most recent performance figures can be found in the S3MPC OPT Annual Performance Report - Year 2020 (S3MPC.ACR.APR.007, issue 1.0, 26/02/2021), available on-line at:

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

SENTINEL 3 Mission Performance Contre

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

Page: 127

8 Events

For OLCI-A, four Radiometric Calibration Sequences have been acquired during Cycle 070:

- S01 sequence (diffuser 1) on 31/03/2021 09:06 to 09:08 (absolute orbit 26659)
- S05 sequence (diffuser 2) on 31/03/2021 10:47 to 10:49 (absolute orbit 26660)
- S01 sequence (diffuser 1) on 08/04/2021 12:20 to 12:22 (absolute orbit 26775)
- S01 sequence (diffuser 1) on 13/04/2021 00:02 to 00:04 (absolute orbit 26839)

For OLCI-B, three Radiometric Calibration Sequences have been acquired during Cycle 051:

- So1 sequence (diffuser 1) on 08/04/2021 06:37 to 06:39 (absolute orbit 15378)
- So1 sequence (diffuser 1) on 12/04/2021 18:20 to 18:22 (absolute orbit 15442)
- \$ S01 sequence (diffuser 1) on 20/04/2021 08:06 to 08:08 (absolute orbit 15550)

Sentinel 3 Mission Performance Centre

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 070 – S3B Cycle No. 051

Ref.: S3MPC.ACR.PR.01-070-051

Issue: 1.0

Date: 05/05/2021

Page: 128

9 Appendix A

Other reports related to the Optical mission are:

❖ S3 SLSTR Cyclic Performance Report, S3A Cycle No. 070, S3B Cycle No. 051 (ref. S3MPC.RAL.PR.02-070-051)

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

End of document