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

S3 OLCI Cyclic Performance Report

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Cycle No. 055

Start date: 11/02/2020

End date: 09/03/2020

S3-B

Cycle No. 036

Start date: 27/02/2020

End date: 19/03/2020



Mission
Performance
Centre

SENTINEL 3



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S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 – S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

Page: iii

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Version	Date	Changes
1.0	26/03/2020	First Version

List of Changes

Version	Section	Answers to RID	Changes



S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 – S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

Page: iv

Table of content

1	PROC	ESSING BASELINE VERSION	1
	1.1	Sentinel3-A	1
	1.2	Sentinel3-B	1
2	INSTR	UMENT MONITORING	2
	2.1	CCD temperatures	2
	2.1.1	OLCI-A	2
	2.1.2	OLCI-B	4
	2.2	Radiometric Calibration	6
	2.2.2		
	2.2.3	Instrument response and degradation modelling [OLCI-L1B-CV-250]	19
	2.2.4	Ageing of nominal diffuser [OLCI-L1B-CV-240]	37
	2.2.5	Updating of calibration ADF [OLCI-L1B-CV-260]	37
	2.2.6 Diffu	Radiometric Calibrations for sun azimuth angle dependency and Yaw Manoeuvres for Soser on-orbit re-characterization [OLCI-L1B-CV-270 and OLCI-L1B-CV-280]	
	2.3	Spectral Calibration [OLCI-L1B-CV-400]	37
	2.3.1	OLCI-A	37
	2.3.2	OLCI-B	38
	2.4	Signal to Noise assessment [OLCI-L1B-CV-620]	38
	2.4.1	SNR from Radiometric calibration data	38
	2.4.2	SNR from EO data	45
	2.5	Geometric Calibration/Validation	45
	2.5.1	OLCI-A	45
	2.5.2	OLCI-B	48
3	OLCI I	EVEL 1 PRODUCT VALIDATION	52
	3.1	[OLCI-L1B-CV-300], [OLCI-L1B-CV-310] – Radiometric Validation	52
	3.1.1	S3ETRAC Service	52
	3.1.2	Radiometric validation with DIMITRI	55
	3.1.3	Radiometric validation with OSCAR	62
	3.2	[OLCI-L1B-CV-320] – Radiometric Validation with Level 3 products	64
	3.2.1	OLCI-A	64
	2 2 2	OLCLR	64



S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 – S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

Page: v

4	LEVEL	2 LAND PRODUCTS VALIDATION	65
	4.1 [OLCI-L2LRF-CV-300]	. 65
	4.1.1	Routine extractions	. 65
	4.1.2	Comparisons with MERIS MGVI and MTCI climatology	. 76
	_	OLCI-L2LRF-CV-410 & OLCI-L2LRF-CV-420] — Cloud Masking & Surface Classification for Lan	
5	LEVEL	2 WATER PRODUCTS VALIDATION	83
	5.1 [5.1.1	OLCI-L2-CV-210, OLCI-L2-CV-220] – Vicarious calibration of the NIR and VIS bands	
		OLCI-B	
	L2WLR-0	OLCI-L2WLR-CV-300, OLCI-L2WLR-CV-310, OLCI-L2WLR-CV-32, OLCI-L2WLR-CV-330, OLCI-CV-340, OLCI-L2WLR-CV-350, OLCI-L2WLR-CV-360 and OLCI-L2WLR-CV-370] — Level 2 Wate	
	5.2.1	Reflectance product validation	
	5.2.2	OLCI-A	
	5.2.3	OLCI-B	
	_	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	
	5.5.1	Aeronet comparisons with OLCI A	
	5.5.2	Marine Aeronet comparisons with OLCI A	
	5.5.3	Aeronet comparisons with OLCI B	
	5.5.4	Summary	
	5.6 [OLCI-L2WLR-CV-380] Development of calibration, product and science algorithms	101
6	VALID	ATION OF INTEGRATED WATER VAPOUR OVER LAND & WATER	102
	6.1 li	ntegrated water vapour above land	102
	6.1.1	Validation of OLCI A IWV using GNSS	102
	6.1.2	Validation of OLCI A IWV using passive microwave radiometer at ARM sites	104
	6.1.3	Validation of OLCI A IWV using GRUAN radiosonde observations	106
	6.1.4	Validation of OLCI A IWV using AERONET observations	106
	6.1.5	Validation of OLCI B IWV	107
	6.2 S	ummary	109
			100



S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 – S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

Page: vi

7	LEVEL 2 SYN PRODUCTS VALIDATION	.110
8	EVENTS	.111
9	APPENDIX A	.112



S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 – S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

Page: vii

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. —————4
Figure 4: same as Figure 3 for diffuser frames 5
Figure 5: Sun azimuth angles during acquired OLCI-A Radiometric Calibrations (diffuser frame) on top of nominal yearly cycle (black curve). Diffuser 1 with diamonds, diffuser 2 with crosses, 2016 acquisitions in dark blue, 2017 in clear blue, 2018 in green, 2019 in yellow and 2020 in red7
Figure 6: same as Figure 5 for OLCI-B (2018 in blue, 2019 in green and 2020 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 13
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
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. 055 – S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

Page: viii

except the first one (orbit 167) for which the instrument was not thermally stable yet 16
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), all diffuser 1 radiometric calibrations so far except the first one (orbit 183) for which the instrument was not thermally stable yet.
Figure 23: camera averaged gain relative evolution with respect to "best geometry" calibration (07/12/2016), as a function of elapsed time since the change in OLCI channels settings (25/04/16); one curve for each band (see colour code on plots), one plot for each module. The diffuser ageing has been taken into account
Figure 24: OLCI-B Gain Coefficients for band Oa1 (top) and Oa21 (bottom), all diffuser 1 radiometric calibrations so far except the first one (orbit 167) for which the instrument was not thermally stable yet.
Figure 25: 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. The blue vertical dotted lines 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).————————————————————————————————————
Figure 28: OLCI-A Camera-averaged instrument evolution since channel programming change (25/04/2016) and up to most recent calibration (27/02/2020) versus wavelength 25
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 12 calibrations in extrapolation, with a colour code for each calibration from blue (oldest) to red (most recent)
Figure 30: Evolution model performance, as ratio of Model over Data vs. pixels, all cameras side by side, over the whole current calibration dataset (since instrument programing update), including 12 calibrations in extrapolation, channels Oa1 to Oa6



S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 – S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

Page: ix

Figure 31: same as Figure 30 for channels Oa7 to Oa14
Figure 32: same as Figure 30 for channels Oa15 to Oa21 29
Figure 33: RMS performance of the OLCI-B Gain Model of the current processing baseline as a function or orbit. The blue vertical dotted lines 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)
Figure 34: RMS performance of the OLCI-B Gain Model of the previous processing baseline as a function of orbit (please note the different vertical scale with respect to Figure 33). The 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 of the previous baseline)
Figure 35: OLCI-B Camera-averaged instrument evolution since channel programming change (18/06/2018) and up to most recent calibration (11/03/2020) versus wavelength
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 1: calibrations in extrapolation, with a colour code for each calibration from blue (oldest) to red (most recent).
Figure 37: Evolution model performance, as ratio of Model over Data vs. pixels, all cameras side by side over the whole current calibration dataset (since instrument programming update), including 1: calibrations in extrapolation, channels Oa1 to Oa6.
Figure 38: same as Figure 37 for channels Oa7 to Oa14 3!
Figure 39: same as Figure 37 for channels Oa15 to Oa21 30
Figure 40: OLCI-A Signal to Noise ratio as a function of the spectral band for the 5 cameras. These result have been computed from radiometric calibration data. All calibrations except first one (orbit 183) are presents with the colours corresponding to the orbit number (see legend). The SNR is very stable with time: the curves for all orbits are almost superimposed. The dashed curve is the ESA requirement.
Figure 41: long-term stability of the SNR estimates from Calibration data, example of channel Oa1 40
Figure 42: OLCI-B Signal to Noise ratio as a function of the spectral band for the 5 cameras. These result 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 43
Figure 43: long-term stability of the OLCI-B SNR estimates from Calibration data, example of channel Oa1
Figure 44: overall OLCI-A georeferencing RMS performance time series (left) and number of validated control points corresponding to the performance time series (right) over the whole monitoring period 40
Figure 45: across-track (left) and along-track (right) OLCI-A georeferencing biases time series for Camera 1. Blue line is the average, black lines are average plus and minus 1 sigma.
Figure 46: same as Figure 45 for Camera 2 40
Figure 47: same as Figure 45 for Camera 3 4'
Figure 48: same as Figure 45 for Camera 4 4
Figure 49: same as Figure 45 for Camera 5 4 ⁻
Figure 50: OLCI-A spatial across-track misregistration at each camera transition (left) and maximun Samplitude of the across-track error within each camera (left).



S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 – S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

Page: x

amplitude of the along-track error within each camera (left) 48
Figure 52: overall OLCI-B georeferencing RMS performance time series over the whole monitoring period (left) and corresponding number of validated control points (right) 49
Figure 53: across-track (left) and along-track (right) OLCI-B georeferencing biases time series for Camera 1 49
Figure 54: same as Figure 45 for Camera 2 49
Figure 55: same as Figure 45 for Camera 3 50
Figure 56: same as Figure 45 for Camera 4 50
Figure 57: same as Figure 45 for Camera 5 50
Figure 58: OLCI-B spatial across-track misregistration at each camera transition (left) and maximum amplitude of the across-track error within each camera (left) 51
Figure 59: OLCI-B spatial along-track misregistration at each camera transition (left) and maximum amplitude of the along-track error within each camera (left) 51
Figure 60: summary of S3ETRAC products generation for OLCI-A (number of OLCI-A L1 products Ingested, blue – number of S3ETRAC extracted products generated, green – number of S3ETRAC runs without generation of output product (data not meeting selection requirements), yellow – number of runs ending in error, red, one plot per site type)
Figure 61: summary of S3ETRAC products generation for OLCI-B (number of OLCI-B L1 products Ingested, yellow — number of S3ETRAC extracted products generated, blue — number of S3ETRAC runs without generation of output product (data not meeting selection requirements), green — number of runs ending in error, red, one plot per site type). ————————————————————————————————————
Figure 62: Time-series of the elementary ratios (observed/simulated) signal from OLCI-A for (top to bottom) bands Oa08 and Oa17 respectively over January 2020-Present from the six PICS Cal/Val sites. Dashed-green and orange lines indicate the 2% and 5% respectively. Error bars indicate the desert methodology uncertainty
Figure 63: Time-series of the elementary ratios (observed/simulated) signal from OLCI-B for (top to bottom) bands Oa08 and Oa17 respectively over January 2020-Present from the six PICS Cal/Val sites. Dashed-green and orange lines indicate the 2% and 5% respectively. Error bars indicate the desert methodology uncertainty
Figure 64: The estimated gain values for OLCI-A and OLCI-B over the 6 PICS sites identified by CEOS over the period January 2020-Present as a function of wavelength. Dashed-green and orange lines indicate the 2% and 5% respectively. Error bars indicate the desert methodology uncertainty 58
Figure 65: 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. —————————————————60
Figure 66: Ratio of observed TOA reflectance to simulated one for (green) S2A/MSI, (purple) S2B/MSI, (red) Aqua/MODIS, (blue) S3A/OLCI and (dark-green) S3B/OLCI averaged over the six PICS test sites as a function of wavelength
Figure 67: The estimated gain values for OLCI-A and OLCI-B from Glint, Rayleigh and PICS methods over the period missions start-Present as a function of wavelength. We use the gain value of Oa8 from PICS-



S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 – S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

Page: xi

Desert method as reference gain for Glint method. Dashed-green and orange lines indicate the 2% 5% respectively. Error bars indicate the method uncertainties	
Figure 68. OSCAR Rayleigh S3A and S3B Calibration results: averaged results over all acquisitions start.	ince
Figure 69: DeGeb time series over current report period	
Figure 70: ITCat time series over current report period	
Figure 71: ITsp time series over current report period	
Figure 72: ITSro time series over current report period	
Figure 73: ITTra time series over current report period	
Figure 74: SPAli time series over current report period	
Figure 75: UKNFo time series over current report period	
Figure 76: USNe1 time series over current report period	
Figure 77: USNe2 time series over current report period	
Figure 78: USNe3 time series over current report period	
Figure 79: DeGeb time series over current report period	
Figure 80: ITCat time series over current report period	71
Figure 81: ITsp time series over current report period	72
Figure 82: ITSro time series over current report period	72
Figure 83: ITTra time series over current report period	73
Figure 84: SPAli time series over current report period	73
Figure 85: UKNFo time series over current report period	74
Figure 86: USNe1 time series over current report period	74
Figure 87: USNe2 time series over current report period	75
Figure 88: USNe3 time series over current report period	75
Figure 89: Time-series OGVI and OTCI and corresponding scatterplot of monthly mean for site Montiers, France, land cover Broadleaved, deciduous, closed. A and C represent S3A; B and D represent S3B	FR- sent
Figure 90: Time-series OGVI and OTCI and corresponding scatterplot of monthly mean for site IT-List Italy, land cover Cropland. A and C represent S3A; B and D represent S3B.	
Figure 91: Time-series OGVI and OTCI and corresponding scatterplot of monthly mean for site Tumbarumba, Australia, land cover Broadleaved, evergreen. A and C represent S3A; B and D represent S3B	sent
Figure 92: Comparison of OTCI-MTCI (a) and OGVI-MGVI (b). Points in the scatterplot represent monthly mean of all available S3A and MERIS archive over 53 validation sites. Red and grey lines represent the modelled and 1:1 lines respectively. The scatterplots are updated to include extractions from c S3A 55.	sent cycle
Figure 93: Scatter plots of OLCI-A versus in situ radiometry (FR data). Reprocessed dataset (left) available data for the current time period (right), Oa1 to Oa4 (400 to 490 nm)	
Figure 94: Scatter plots of OLCI-A versus in situ radiometry (FR data). Reprocessed dataset (left) available data for the current time period (right), Oa5 Oa6 and Oa8 (510, 560 and 665 nm),	



S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 – S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

Page: xii

Figure 95: Galata time series over current report period 89
Figure 96: AAOT time series over current report period 90
Figure 97: Scatter plots of OLCI-B versus in situ radiometry (FR data). All available data for the current time period 92
Figure 98: AAOT time series over current report period 94
Figure 99: GALATA time series over current report period 95
Figure 100: Upper left: OLCI aerosol optical thickness at 865nm against Aeronet at 870nm, upper right: OLCIs Angström exponent at 865nm against the Aeronet Angström exponent at 865nm-440nm. Lower left: Temporal evolution of different quality measures of the optical thickness comparison (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). Lower right: positions of the used AERONET stations
Figure 101: Upper left: OLCI aerosol optical thickness at 865nm against maritime. Aeronet at 870nm, upper right: OLCIs Angström exponent at 865nm against the maritime Aeronet Angström exponent at 865nm-440nm. Lower right: positions of the used cruises99
Figure 102: Upper left: OLCI aerosol optical thickness at 865nm against Aeronet v3 L1.5 AOT at 870nm, upper right: OLCIs Angström exponent at 865nm against the Aeronet v3 L1.5 Angström exponent at 865nm-440nm. The error bars correspond to the standard deviation within 10x10km (OLCI) or 60 minutes (AERONET). Lower: positions of the used AERONET stations.
Figure 103: Upper left: Scatter plot of the IWV products, derived from OLCI A above land and from SUOMINET GNSS measurements. Upper right: Histogram of the difference between OLCI and GNSS (blue: original OLCI, orange: bias corrected OLCI). Lower left: Temporal evolution of different quality measures (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)). Lower right: Positions of the GNSS stations (grey: no valid matchup)
Figure 104: Upper left: Scatter plot of the IWV products, derived from OLCI A above land and from AMR MWR. Upper right: Histogram of the difference between OLCI and ARM (blue: original OLCI, orange: bias corrected OLCI). Lower left: Temporal evolution of different quality measures (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)). Lower right: Position of ARM SGP.
Figure 105: Left: Scatter plot of the IWV products, derived from OLCI A above land and from GRUAN radiosonde measurements. Right: Histogram of the difference between OLCI and GRUAN (blue: original OLCI, orange: bias corrected OLCI).
Figure 106: Upper left: Scatter plot of the IWV products, derived from OLCI A above land and from AERONET. Upper right: Histogram of the difference between OLCI and AERONET (blue: original OLCI, orange: bias corrected OLCI). Lower: Positions of the used AERONET stations (grey: no valid matchup).
Figure 107: Scatter plot of the IWV products, derived from OLCI B above land and from SUOMI NET GNSS measurements (upper left), from ARM MWR (upper right) and AERONET (lower)108
measurements tubber letti. Holli Allivi ivivit tubber HRIILI allu AEROINET (10Wei)100



S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 – S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

Page: xiii

List of Tables

Table 1: OLCI-A SNR figures as derived from Radiometric Calibration data. Figures are given for ea camera (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)	its
Table 2: OLCI-B SNR figures as derived from Radiometric Calibration data. Figures are given for eacamera (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)	its
Table 3. S3ETRAC Ocean Calibration sites	63
Table 4: Validation sites analysed in report S3A 55/S3B 36. Land cover data from GLC2000	77
Table 5: Comparison statistics between monthly S3A/B OLCI land products and MERIS archive data	78
Table 6: OLCI-A FR statistics over REP_006 period; FR data	88
Table 7: OLCI-A FR statistics over July 2017-present	88
Table 8: OLCI-B FR statistics over February to Decemver 2019 reporting period	92

SENTINGEL 3 Mission Performance Centre

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 – S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

Page: 1

1 Processing Baseline Version

1.1 Sentinel3-A

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

1.2 Sentinel3-B

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

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 – S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

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.

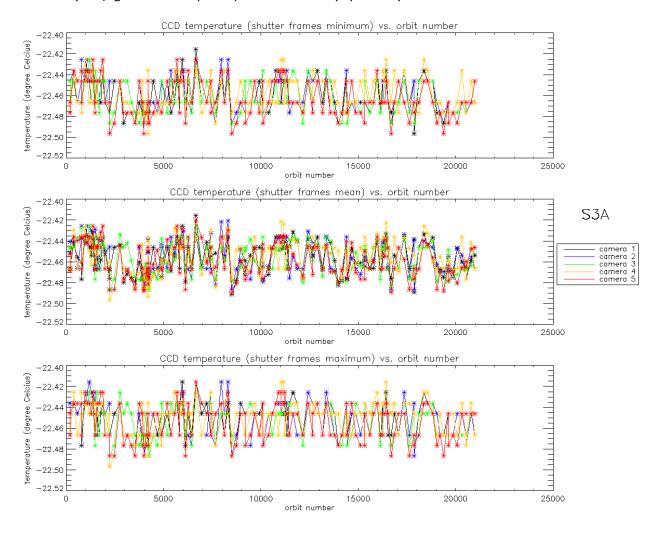


Figure 1: long term monitoring of OLCI-A CCD temperatures using minimum value (top), time averaged values (middle), and maximum value (bottom) provided in the annotations of the Radiometric Calibration Level 1 products, for the Shutter frames, all radiometric calibrations so far except the first one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

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 – S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

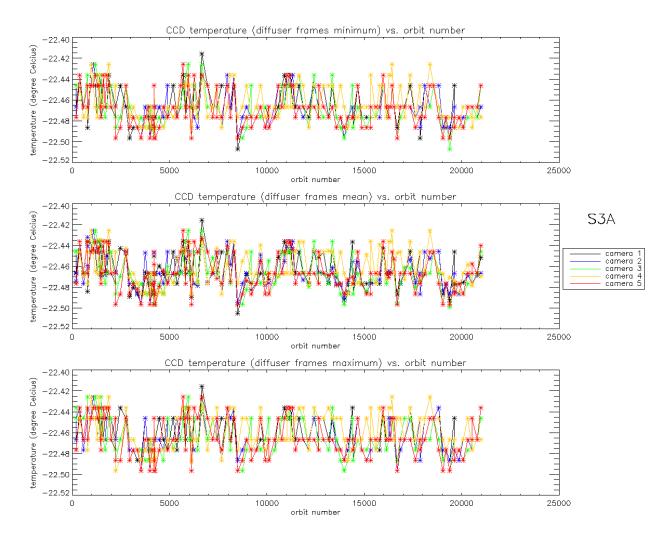


Figure 2: Same as Figure 1 for diffuser frames.

SENTINGL 3 Mission Performance Centre

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 – S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

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.

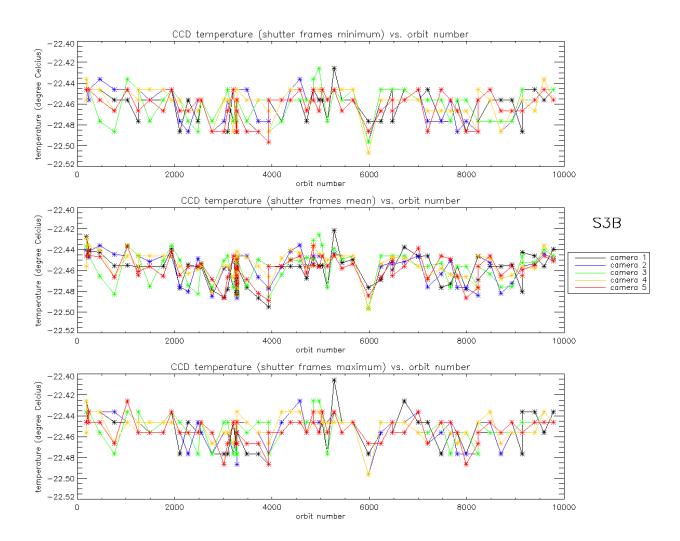


Figure 3: long term monitoring of OLCI-B CCD temperatures using minimum value (top), time averaged values (middle), and maximum value (bottom) provided in the annotations of the Radiometric Calibration Level 1 products, for the Shutter frames, all radiometric calibrations so far except the first one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

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 – S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

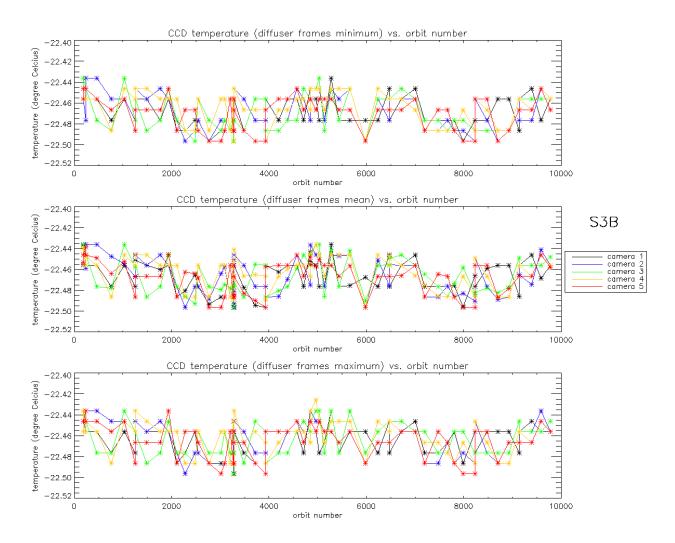


Figure 4: same as Figure 3 for diffuser frames.

SENTINEL 3 Mission Performance Centre

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 – S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

Page: 6

2.2 Radiometric Calibration

For OLCI-A, two Radiometric Calibration Sequences have been acquired during Cycle 055:

- S01 sequence (diffuser 1) on 14/02/2020 13:30 to 13:32 (absolute orbit 20801)
- \$ S01 sequence (diffuser 1) on 27/02/2020 17:54 to 17:56 (absolute orbit 20989)

For OLCI-B, three Radiometric Calibration Sequences have been acquired during Cycle 036:

- S01 sequence (diffuser 1) on 27/02/2020 08:49 to 08:51 (absolute orbit 9590)
- S01 sequence (diffuser 1) on 11/03/2020 09:51 to 09:53 (absolute orbit 9776)

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).



S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 – S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

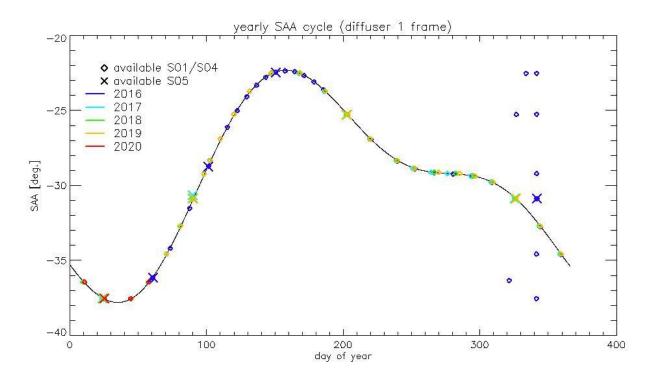


Figure 5: Sun azimuth angles during acquired OLCI-A Radiometric Calibrations (diffuser frame) on top of nominal yearly cycle (black curve). Diffuser 1 with diamonds, diffuser 2 with crosses, 2016 acquisitions in dark blue, 2017 in clear blue, 2018 in green, 2019 in yellow and 2020 in red.

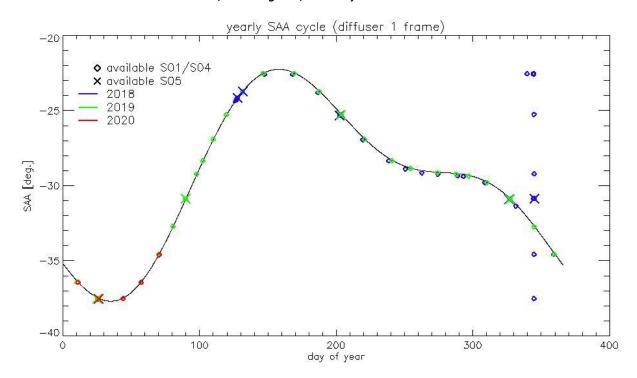


Figure 6: same as Figure 5 for OLCI-B (2018 in blue, 2019 in green and 2020 in red).



S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 – S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

Page: 8

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

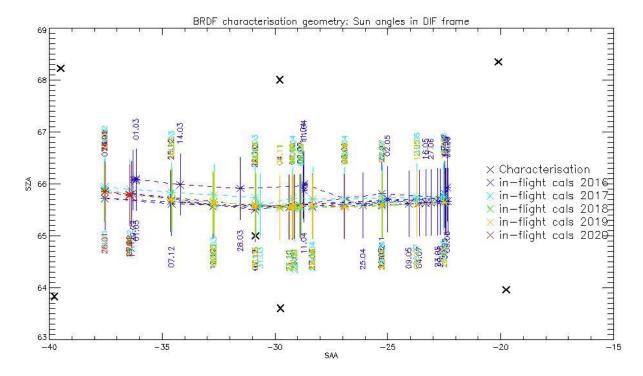


Figure 7: OLCI-A Sun geometry during radiometric Calibrations on top of characterization ones (diffuser frame)

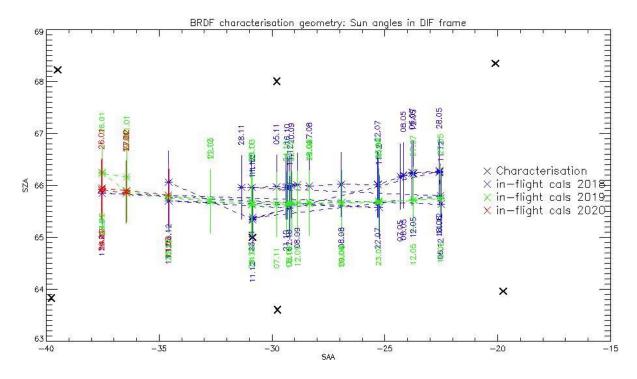


Figure 8: same as Figure 7 for OLCI-B

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 - S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

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.

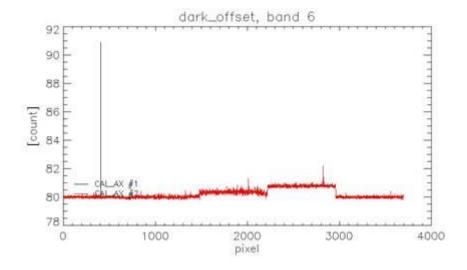


Figure 9: Dark Offset table for band Oa06 with (red) and without (black) HEP filtering (Radiometric Calibration of 22 July 2017). The strong HEP event near pixel 400 has been detected and removed by the HEP filtering.

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

SENTINEL 3 Mission Performance

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 – S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

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.

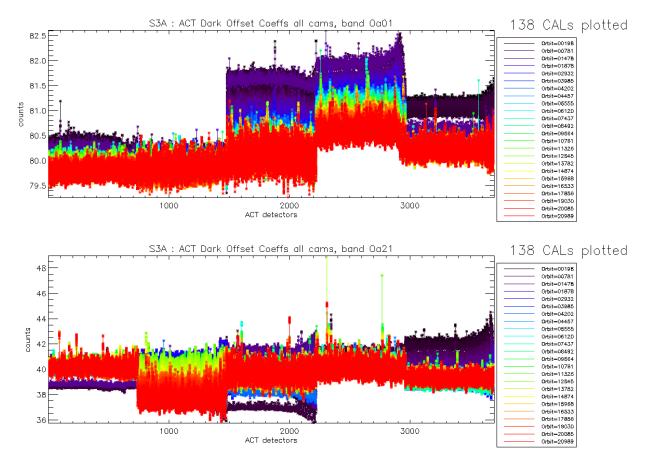


Figure 10: OLCI-A Dark Offset for band Oa1 (top) and Oa21 (bottom), all radiometric calibrations so far except the first one (orbit 183) for which the instrument was not thermally stable yet.

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 – S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

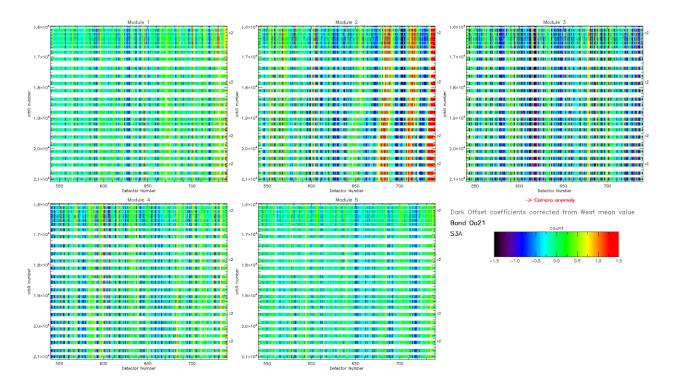


Figure 11: map of OLCI-A periodic noise for the 5 cameras, for band Oa21. X-axis is detector number (East part, from 540 to 740, where the periodic noise occurs), Y-axis is the orbit number. Y-axis range is focused on the most recent 5000 orbits. The counts have been corrected from the West detectors 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. 055 - S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

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.

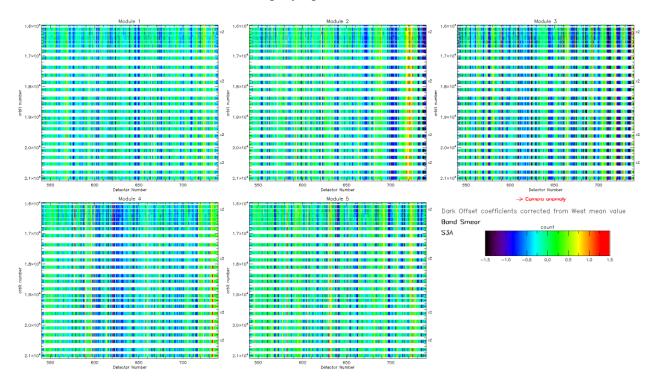


Figure 12: same as Figure 11 for smear band.

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.

As there was no camera anomaly during the current cycle, there is no sudden change of periodic noise to report during the current cycle. The very small drift of the PN phase which is present since about orbit 18000 in camera 2 Oa21 for the 100 eastern pixels (see Figure 11) seems to be stabilizing. This kind of drift had already been encountered for the same camera/band between orbit 13500 and 14500.

Dark Currents

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

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 – S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

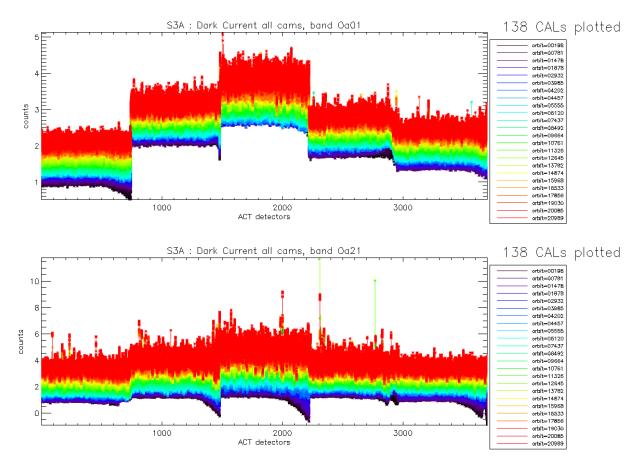


Figure 13: OLCI-A Dark Current for band Oa1 (top) and Oa21 (bottom), all radiometric calibrations so far except the first one (orbit 183) for which the instrument was not thermally stable yet.

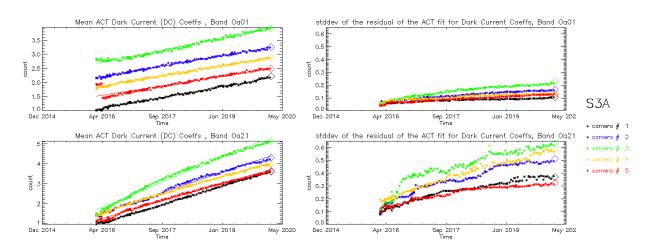


Figure 14: left column: ACT mean on 400 first detectors of OLCI-A Dark Current coefficients for spectral band Oa01 (top) and Oa21 (bottom). Right column: same as left column but for Standard deviation instead of mean.

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. 055 – S3B Cycle No. 036

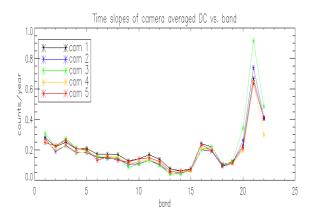
Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

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).



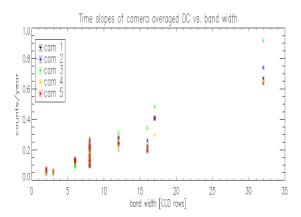


Figure 15: OLCI-A Dark current increase rates with time (in counts per year) vs. band (left) and vs. band width (right)

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.

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

SENTINEL 3 Mission Performance Centre

Sentinel-3 MPC

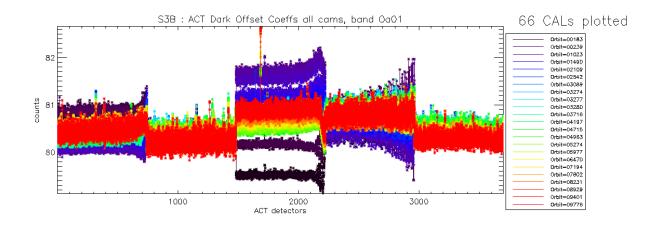
S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 – S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020



Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 – S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

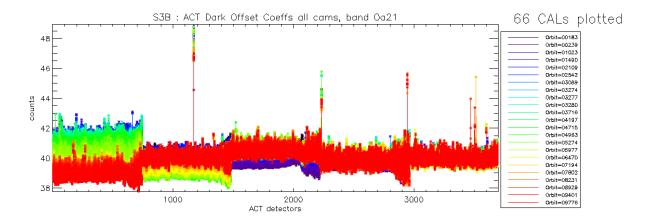


Figure 16: OLCI-B Dark Offset for band Oa1 (top) and Oa21 (bottom), all radiometric calibrations so far except the first one (orbit 167) for which the instrument was not thermally stable yet.

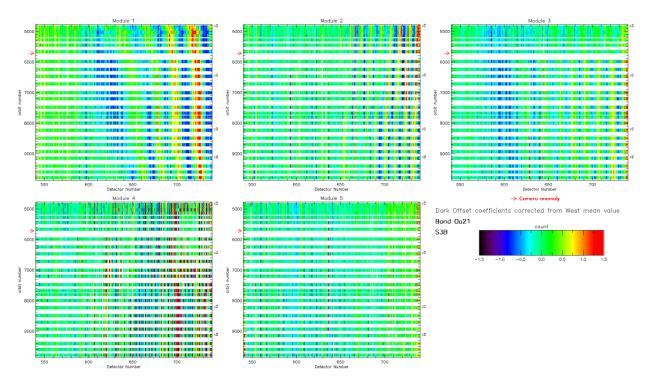


Figure 17: OLCI-B map of periodic noise for the 5 cameras, for band Oa21. X-axis is detector number (East part, from 540 to 740, where the periodic noise occurs), Y-axis is the orbit number. The counts have been corrected

SEATINGE 3 Mission Performance Control

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 – S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

Page: 17

from the West detectors mean value (not affected by periodic noise) in order to remove mean level gaps and consequently to have a better visualisation of the long term evolution of the periodic noise structure.

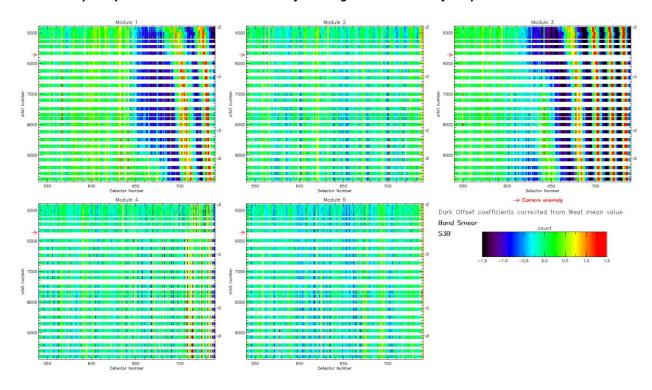


Figure 18: same as Figure 17 for smear band.

Dark Currents

As for OLCI-A there is no significant evolution of the Dark Current coefficients (Figure 19) during the current 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).



S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 – S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

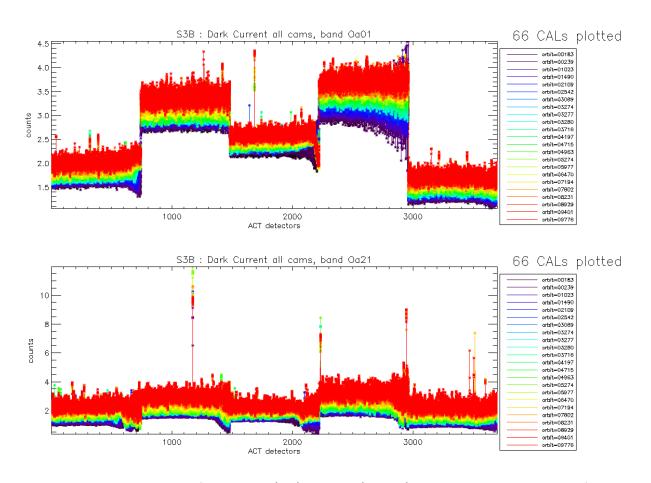


Figure 19: OLCI-B Dark Current for band Oa1 (top) and Oa21 (bottom), all radiometric calibrations so far except the first one (orbit 167) for which the instrument was not thermally stable yet.

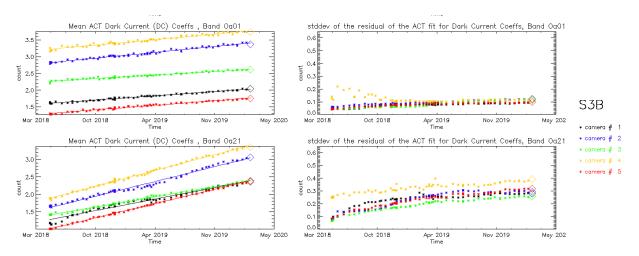


Figure 20: left column: ACT mean on 400 first detectors of OLCI-B Dark Current coefficients for spectral band Oa01 (top) and Oa21 (bottom). Right column: same as left column but for Standard deviation instead of mean.

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

SENTINGE, 3 Mission Performance Centre

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 – S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

Page: 19

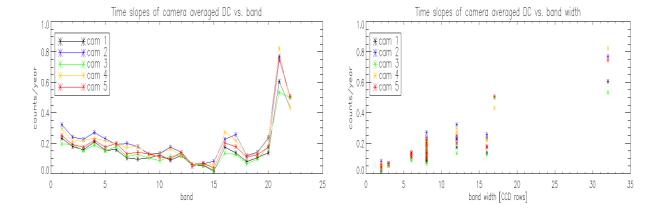


Figure 21: OLCI-B Dark Current increase rates with time (in counts per year) vs. band (left) and vs. band width (right)

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. 055 – S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

Page: 20

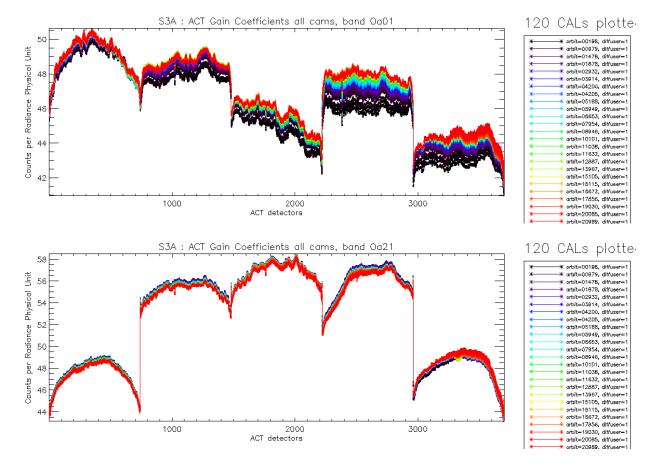


Figure 22: OLCI-A Gain Coefficients for band Oa1 (top) and Oa21 (bottom), all diffuser 1 radiometric calibrations so far except the first one (orbit 183) for which the instrument was not thermally stable yet.

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

Figure 23 displays a summary of the time evolution derived from post-processed gains: the cross-track average of the BRDF corrected gains (taking into account the diffuser ageing) is plotted as a function of time, for each module, relative to a given reference calibration (the 07/12/2016). It shows that, if a significant evolution occurred during the early mission, the trends tend to stabilize, with the exception of band 1 of camera 1 and 4.

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 – S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

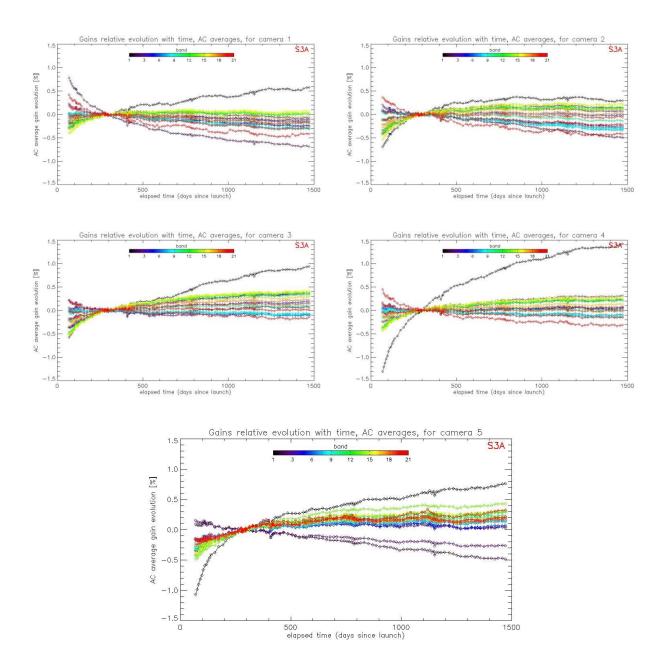


Figure 23: camera averaged gain relative evolution with respect to "best geometry" calibration (07/12/2016), as a function of elapsed time since the change in OLCI channels settings (25/04/16); one curve for each band (see colour code on plots), one plot for each module. The diffuser ageing has been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

SSINTINEL 3 Mission Performance

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 – S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

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.

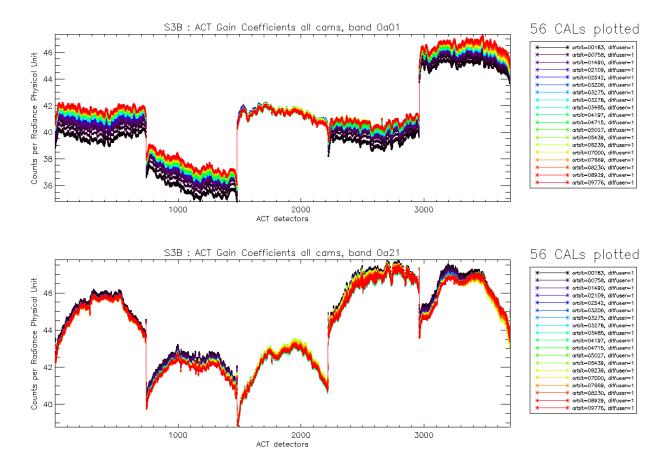


Figure 24: OLCI-B Gain Coefficients for band Oa1 (top) and Oa21 (bottom), all diffuser 1 radiometric calibrations so far except the first one (orbit 167) for which the instrument was not thermally stable yet.

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. 055 – S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

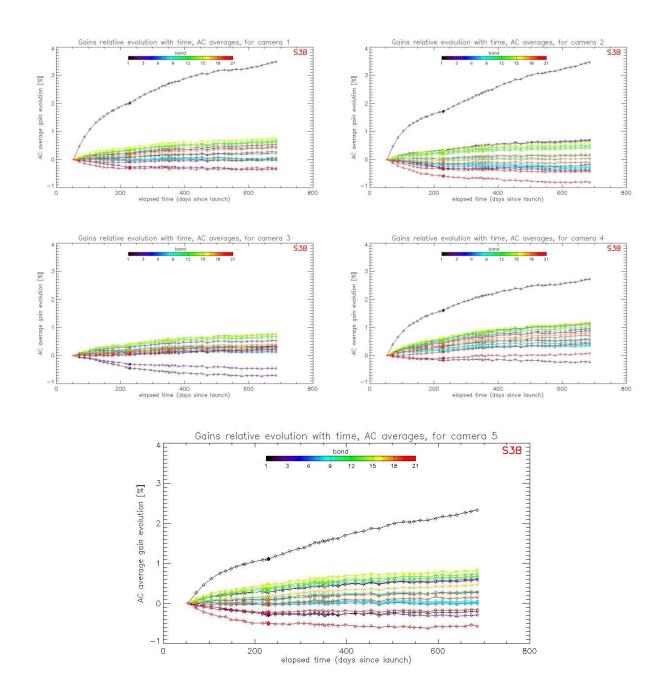


Figure 25: OLCI-B camera averaged gain relative evolution with respect to first calibration after channel programming change (18/06/2018), as a function of elapsed time since the beginning of the mission; one curve for each band (see colour code on plots), one plot for each module. The diffuser ageing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



S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 – S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

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 the 29/10/2019 (Processing Baseline 2.58). The model has been derived on the basis of an extended Radiometric Calibration dataset (from 25/04/2016 to 28/08/2019). It includes the correction of the diffuser ageing for the six bluest bands (Oa1 to Oa6) for which it is clearly measurable. The model performance over the complete dataset (including the 12 calibrations in extrapolation over about 7 months), despite a very small drift with respect to the most recent data, remains better than 0.11% (at the exception of band Oa01 for the very first CAL) when averaged over the whole field of view (Figure 26). The previous model, trained on a Radiometric Dataset limited to 11/04/2019, shows clearly a bigger drift of the model with respect to most recent data (Figure 27). Comparison of the two figures shows the improvement brought by the updated Model over almost all the mission: only Oa01 show a lower performance for the very first calibration with the new model.

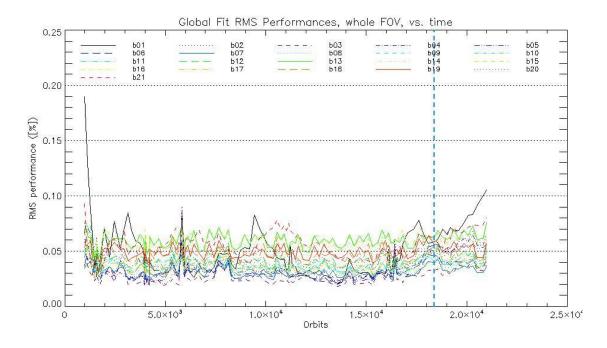


Figure 26: RMS performance of the OLCI-A Gain Model of the current processing baseline as a function of orbit.

The blue vertical dotted lines 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).

S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 - S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

Page: 25

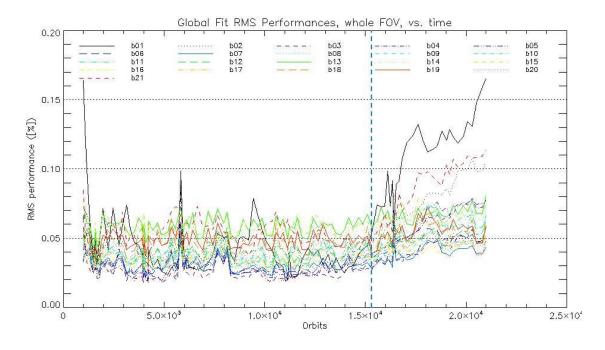


Figure 27: RMS performance of the OLCI-A Gain Model of the previous Processing Baseline as a function of orbit.

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

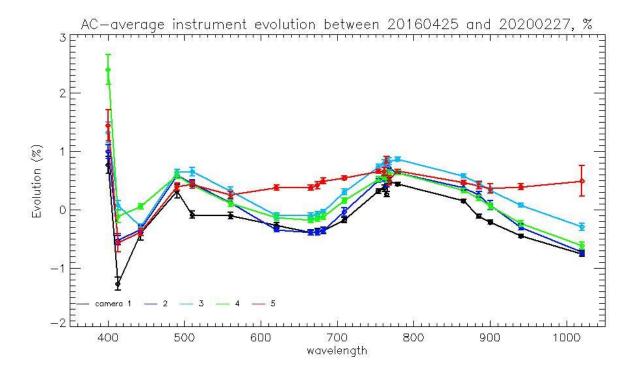


Figure 28: OLCI-A Camera-averaged instrument evolution since channel programming change (25/04/2016) and up to most recent calibration (27/02/2020) versus wavelength.



S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 – S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

Page: 26

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

Finally, Figure 30 to Figure 32 show the detail of the model performance, with across-track plots of the model over data ratios at each orbit, one plot for each channel.

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

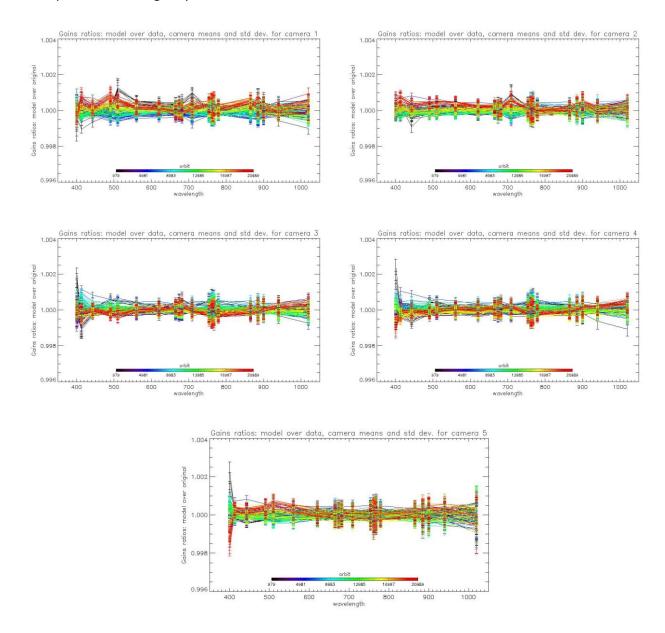


Figure 29: For the 5 cameras: OLCI-A Evolution model performance, as camera-average and standard deviation of ratio of Model over Data vs. wavelength, for each orbit of the test dataset, including 12 calibrations in extrapolation, with a colour code for each calibration from blue (oldest) to red (most recent).

Mission Performance Centre

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 – S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

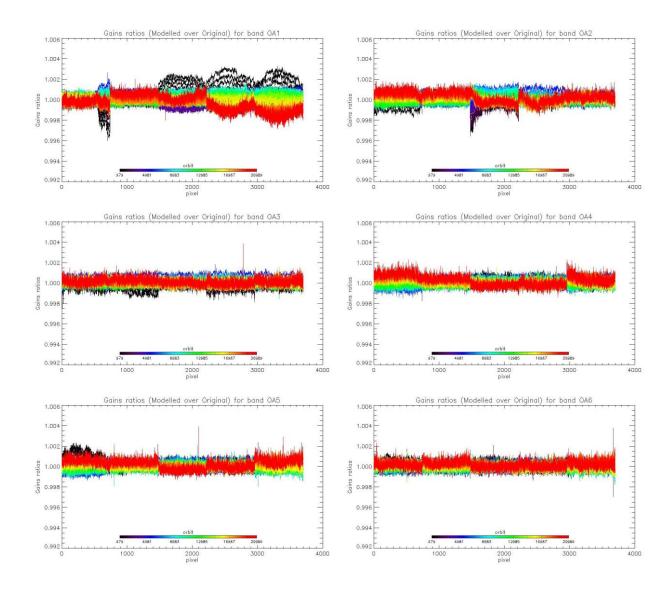


Figure 30: Evolution model performance, as ratio of Model over Data vs. pixels, all cameras side by side, over the whole current calibration dataset (since instrument programing update), including 12 calibrations in extrapolation, channels Oa1 to Oa6.

SENTINEL 3 Mission Performance Centre

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S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 – S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

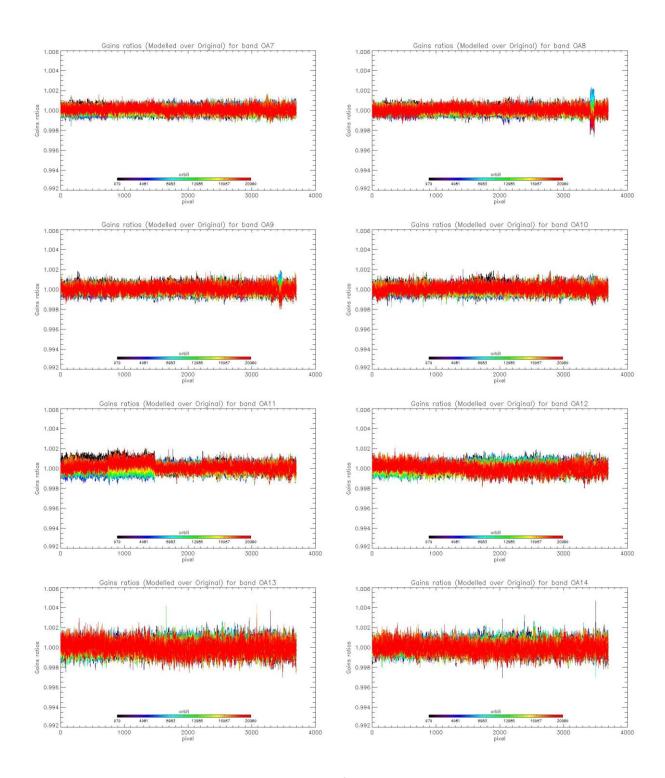


Figure 31: same as Figure 30 for channels Oa7 to Oa14.

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S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 – S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

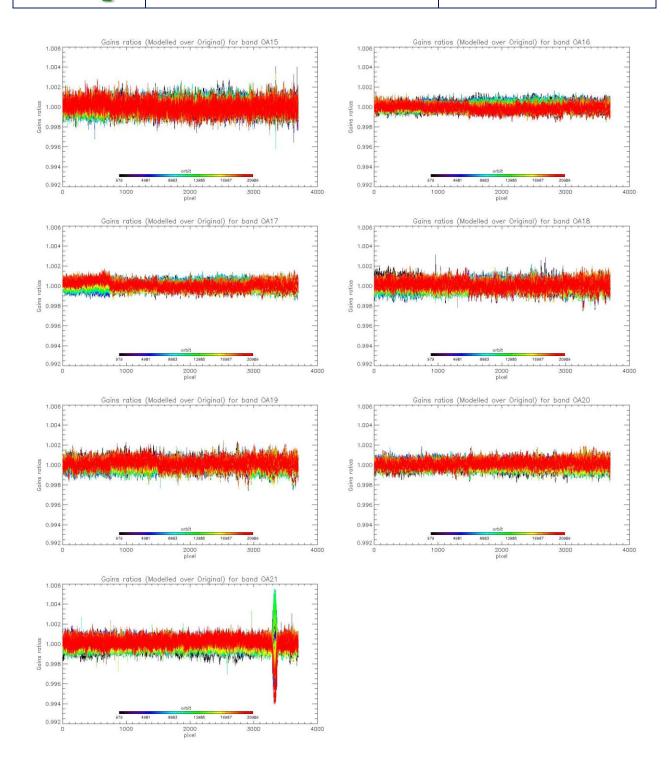


Figure 32: same as Figure 30 for channels Oa15 to Oa21.



S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 – S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

Page: 30

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 29th October 2019 (Processing Baseline 1.30). The model has been derived on the basis of an extended Radiometric Calibration dataset (from 11/05/2018 to 02/10/2019). It includes the correction of the diffuser ageing for the five bluest bands (Oa1 to Oa5) for which it is clearly measurable. The model performance over the complete dataset (including the 11 calibrations in extrapolation over about 6 months) is illustrated in Figure 33. Despite a small drift with respect to the most recent data, It remains better than 0.11% when averaged over the whole field of view while the previous model, trained on a Radiometric Dataset limited to 27/02/2019, shows a stronger 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.

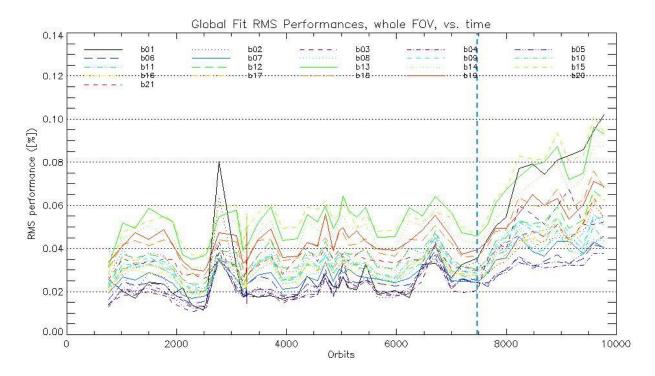


Figure 33: RMS performance of the OLCI-B Gain Model of the current processing baseline as a function of orbit.

The blue vertical dotted lines 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).

Mission Performance Centre

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 – S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

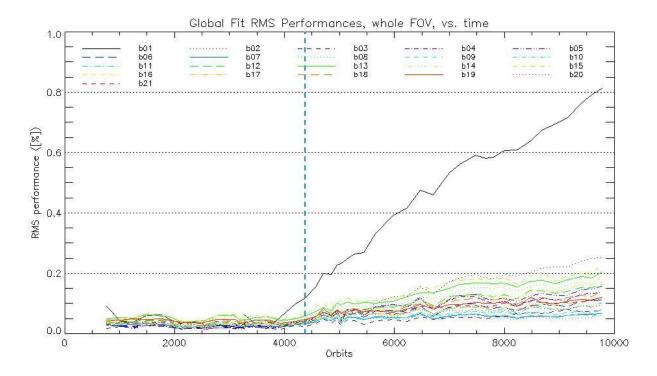


Figure 34: RMS performance of the OLCI-B Gain Model of the previous processing baseline as a function of orbit (please note the different vertical scale with respect to Figure 33). The blue vertical dotted line defines the limit from which the gain model starts to be extrapolated (i.e. it corresponds to the most recent CAL of the dataset used to build the model of the previous baseline).



S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 – S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

Page: 32

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

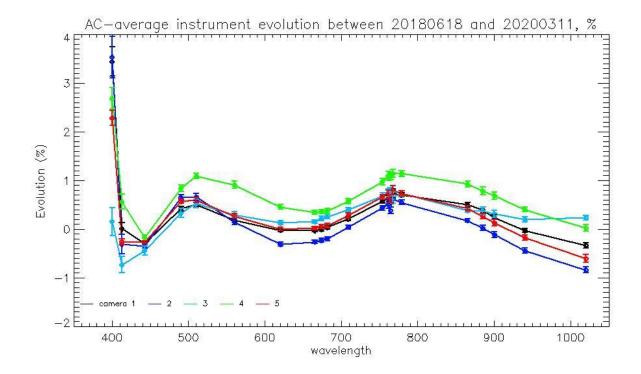


Figure 35: OLCI-B Camera-averaged instrument evolution since channel programming change (18/06/2018) and up to most recent calibration (11/03/2020) versus wavelength.

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

Finally, Figure 37 to Figure 39 show the detail of the model performance, with across-track plots of the model over data ratios at each orbit, one plot for each channel.

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Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 – S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

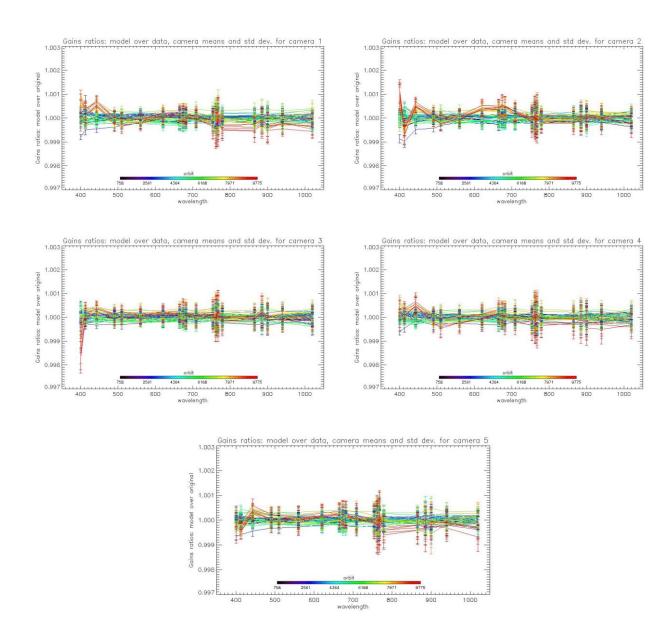


Figure 36: For the 5 cameras: OLCI-B Evolution model performance, as camera-average and standard deviation of ratio of Model over Data vs. wavelength, for each orbit of the test dataset, including 11 calibrations in extrapolation, with a colour code for each calibration from blue (oldest) to red (most recent).

SENTINEL 3 Mission Performance Centre

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 – S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

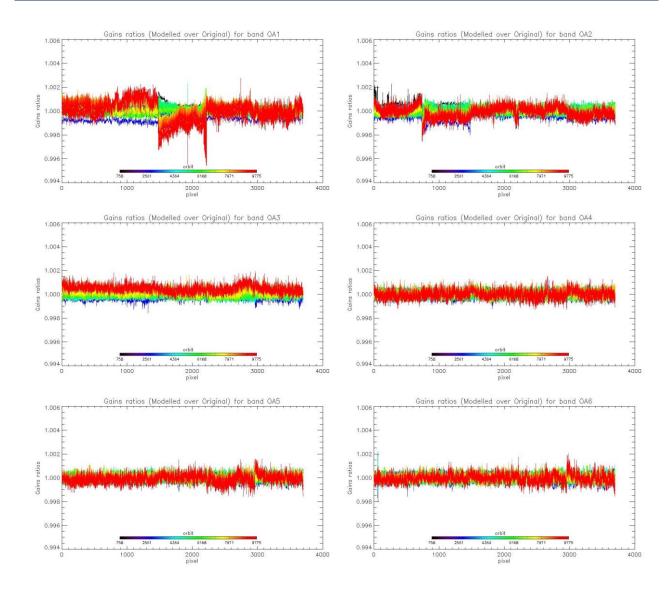


Figure 37: Evolution model performance, as ratio of Model over Data vs. pixels, all cameras side by side, over the whole current calibration dataset (since instrument programming update), including 11 calibrations in extrapolation, channels Oa1 to Oa6.

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S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 – S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

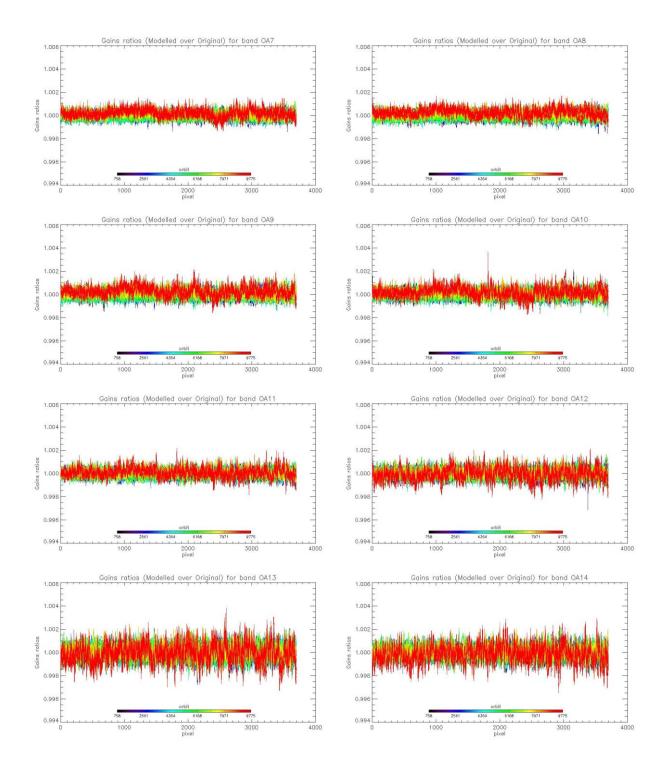


Figure 38: same as Figure 37 for channels Oa7 to Oa14.

Mission Performance Centre

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 – S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

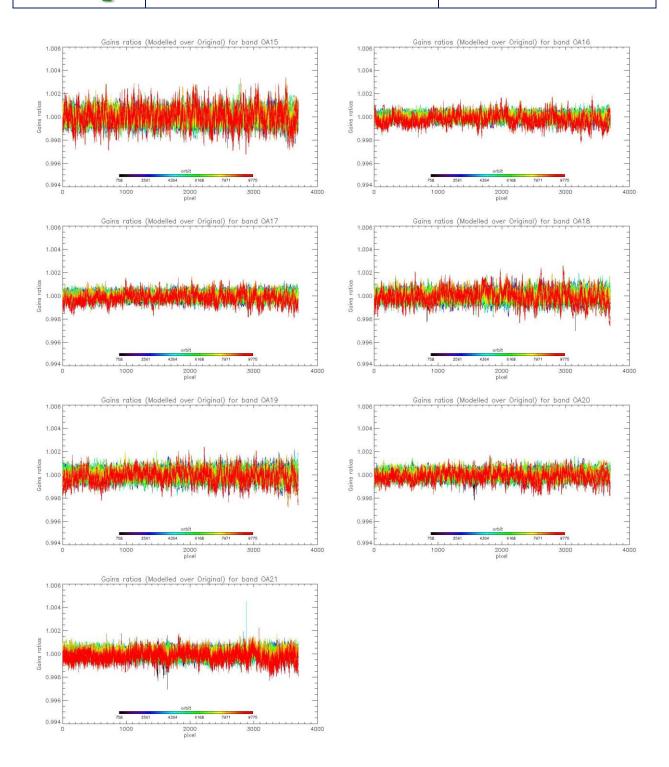


Figure 39: same as Figure 37 for channels Oa15 to Oa21.



S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 – S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

Page: 37

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

2.2.3.1 OLCI-A

There has been no calibration sequence S05 (reference diffuser) for OLCI-A during acquisition cycle 055.

Consequently, the last results presented in Cycle Report #54/#35 (S3A/S3B) remain valid.

2.2.3.2 OLCI-B

There has been no calibration sequence S05 (reference diffuser) for OLCI-B during acquisition Cycle 036.

Consequently, the last results presented in Cycle Report #54/#35 (S3A/S3B) remain valid.

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.

2.2.4.1.2 OLCI-B

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

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 055 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.

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

2.3.1 OLCI-A

There has been no Spectral Calibration (S02 + S03, S09) acquisition for OLCI-A during acquisition cycle 055.

The last results presented in Cyclic Report #54/#35 (S3A/S3B) stay valid.

SENTING 3 Mission Performance Centre

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 – S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

Page: 38

2.3.2 OLCI-B

There has been no Spectral Calibration (S02 + S03, S09) acquisition for OLCI-B during acquisition Cycle 036.

The last results presented in Cyclic Report #54/#35 (S3A/S3B) stay valid.

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

2.4.1 SNR from Radiometric calibration data

2.4.1.1 OLCI-A

SNR computed for all calibration data (S01, S04 and S05 sequences) as a function of band number is presented in Figure 40.

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

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

SENTINEL 3 Mission Performance Centre

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 – S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

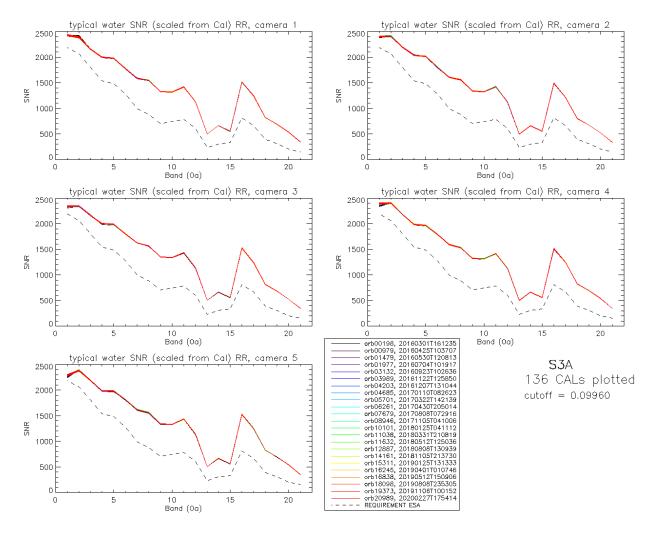


Figure 40: OLCI-A Signal to Noise ratio as a function of the spectral band for the 5 cameras. These results have been computed from radiometric calibration data. All calibrations except first one (orbit 183) are presents with

Mission Performance Centre

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 – S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

Page: 40

the colours corresponding to the orbit number (see legend). The SNR is very stable with time: the curves for all orbits are almost superimposed. The dashed curve is the ESA requirement.

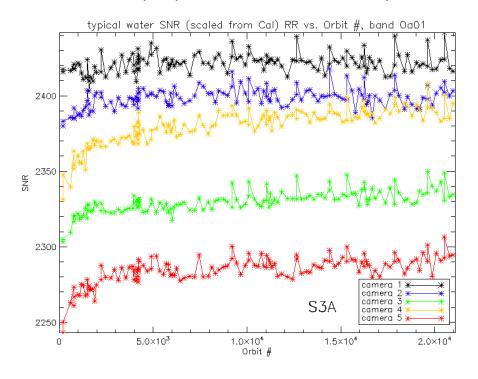


Figure 41: long-term stability of the SNR estimates from Calibration data, example of channel Oa1.

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



S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 – S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

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).

radiance level are recalled (in this is.														
	L _{ref}	SNR	NR 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	2421	6.3	2398	6.6	2329	7.4	2379	12.1	2284	9.3	2362	7.1
412.000	74.1	2061	2391	8.7	2406	5.8	2339	4.8	2401	4.9	2383	8.0	2384	4.8
442.000	65.6	1811	2160	5.2	2198	5.7	2164	4.9	2186	4.1	2195	5.2	2180	3.6
490.000	51.2	1541	2000	4.6	2037	5.1	1997	4.2	1983	4.4	1988	4.7	2001	3.4
510.000	44.4	1488	1979	5.2	2014	4.7	1985	4.6	1967	4.6	1985	4.5	1986	3.6
560.000	31.5	1280	1776	4.5	1802	4.2	1803	4.8	1794	4.0	1818	3.4	1799	3.1
620.000	21.1	997	1591	4.0	1609	4.1	1624	3.2	1593	3.3	1615	3.6	1607	2.6
665.000	16.4	883	1546	4.1	1558	4.3	1567	3.8	1533	3.6	1561	3.9	1553	3.1
674.000	15.7	707	1329	3.4	1337	3.6	1350	2.8	1323	3.2	1342	3.7	1336	2.5
681.000	15.1	745	1319	3.6	1326	3.1	1338	2.7	1314	2.4	1333	3.6	1326	2.2
709.000	12.7	785	1421	4.3	1420	4.1	1435	3.4	1414	3.5	1430	3.2	1424	2.8
754.000	10.3	605	1127	3.2	1120	3.0	1135	3.4	1125	2.5	1139	3.0	1129	2.4
761.000	6.1	232	502	1.1	498	1.2	505	1.2	500	1.1	508	1.4	503	0.9
764.000	7.1	305	663	1.6	658	1.6	668	2.1	661	1.6	670	2.2	664	1.4
768.000	7.6	330	558	1.5	554	1.3	562	1.3	557	1.5	564	1.4	559	1.1
779.000	9.2	812	1516	4.8	1498	4.8	1525	5.3	1511	5.1	1526	5.0	1515	4.3
865.000	6.2	666	1244	3.6	1213	3.6	1239	3.9	1246	3.6	1250	2.8	1238	3.0
885.000	6.0	395	823	1.7	801	1.7	814	2.0	824	1.5	831	1.7	819	1.2
900.000	4.7	308	691	1.6	673	1.3	683	1.7	693	1.5	698	1.5	688	1.0
940.000	2.4	203	534	1.1	522	1.1	525	0.9	539	1.1	542	1.4	532	0.7
1020.000	3.9	152	345	0.9	337	0.9	348	0.7	345	0.8	351	0.8	345	0.5



S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 – S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

Page: 42

2.4.1.2 OLCI-B

SNR computed for all OLCI-B calibration data (S01, S04 (but not the dark-only S04) and S05 sequences) as a function of band number is presented in Figure 42.

SNR computed for all OLCI-B calibration data as a function of orbit number for band Oa01 (the less stable band) is presented in Figure 43.

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

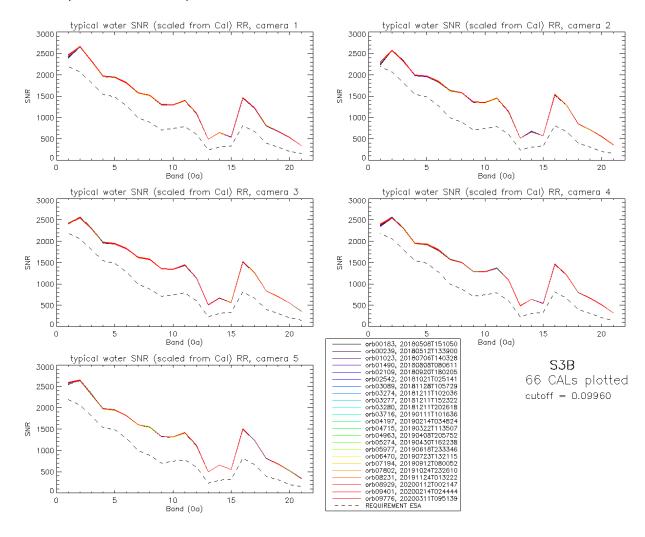


Figure 42: OLCI-B Signal to Noise ratio as a function of the spectral band for the 5 cameras. These results have been computed from radiometric calibration data. All calibrations except first one (orbit 167) are presents with the colours corresponding to the orbit number (see legend). The SNR is very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

Mission Performance Centre

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 – S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

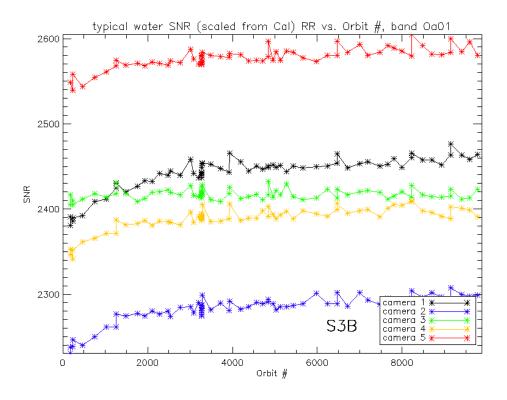


Figure 43: long-term stability of the OLCI-B SNR estimates from Calibration data, example of channel Oa1.



S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 – S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

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).

									<i>γ</i> .						
	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	2442	20.1	2283	16.5	2417	5.9	2388	14.1	2576	12.4	2421	12.7	
412.000	74.1	2061	2656	6.6	2570	6.1	2548	8.3	2549	6.0	2640	6.6	2593	4.9	
442.000	65.6	1811	2326	6.1	2318	6.1	2303	6.1	2306	6.3	2311	5.9	2313	5.0	
490.000	51.2	1541	1966	4.8	1987	5.8	1971	5.0	1951	4.8	1979	5.0	1971	4.0	
510.000	44.4	1488	1937	5.3	1966	5.4	1942	5.1	1922	5.2	1951	4.7	1944	4.2	
560.000	31.5	1280	1813	5.1	1847	5.5	1829	4.8	1803	5.2	1816	4.6	1821	4.1	
620.000	21.1	997	1573	4.3	1626	4.8	1625	3.8	1576	4.2	1602	3.3	1600	3.0	
665.000	16.4	883	1513	4.2	1579	3.9	1574	4.1	1501	3.1	1546	3.8	1543	2.9	
674.000	15.7	707	1301	3.7	1358	3.9	1353	3.5	1292	2.8	1329	3.1	1327	2.6	
681.000	15.1	745	1293	3.6	1347	3.2	1343	3.0	1285	2.8	1316	2.9	1317	2.1	
709.000	12.7	785	1390	4.6	1447	4.2	1443	4.6	1373	3.2	1412	4.2	1413	3.4	
754.000	10.3	605	1095	4.3	1142	4.0	1141	3.8	1088	2.9	1115	3.8	1116	3.4	
761.000	6.1	232	487	1.3	509	1.3	508	1.4	485	1.2	497	1.5	497	1.1	
764.000	7.1	305	643	1.8	672	2.1	671	2.0	640	1.7	657	2.0	657	1.6	
768.000	7.6	330	541	1.6	567	1.5	564	1.4	540	1.4	554	1.7	553	1.2	
779.000	9.2	812	1466	4.7	1534	5.0	1525	6.0	1465	3.9	1505	4.9	1499	4.3	
865.000	6.2	666	1221	4.1	1286	4.0	1258	4.0	1204	3.8	1237	3.3	1241	3.2	
885.000	6.0	395	808	2.6	847	1.9	834	2.1	798	1.8	814	2.1	820	1.6	
900.000	4.7	308	679	1.5	714	2.0	704	1.6	669	1.5	682	1.6	690	1.2	
940.000	2.4	203	527	1.3	550	1.6	550	1.3	509	1.2	522	1.3	532	1.0	
1020.000	3.9	152	336	0.8	359	1.2	358	0.9	318	0.8	339	1.1	342	0.7	

S3 OLCI Cyclic Performance Report S3A Cycle No. 055 – S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

Page: 45

2.4.2 SNR from EO data

2.4.2.1 OLCI-A

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

2.4.2.2 OLCI-B

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

2.5 Geometric Calibration/Validation

2.5.1 OLCI-A

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

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



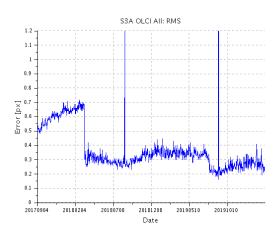
S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 – S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020



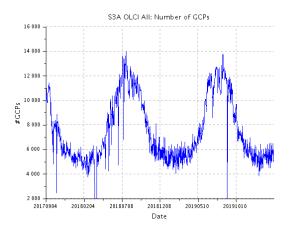
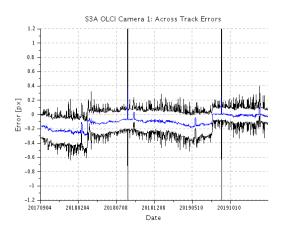


Figure 44: overall OLCI-A georeferencing RMS performance time series (left) and number of validated control points corresponding to the performance time series (right) over the whole monitoring period



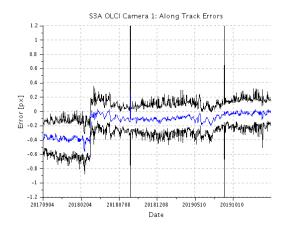
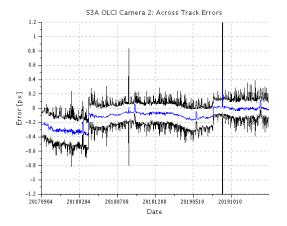


Figure 45: across-track (left) and along-track (right) OLCI-A georeferencing biases time series for Camera 1. Blue line is the average, black lines are average plus and minus 1 sigma.



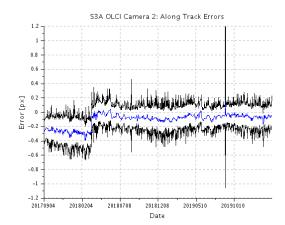


Figure 46: same as Figure 45 for Camera 2.



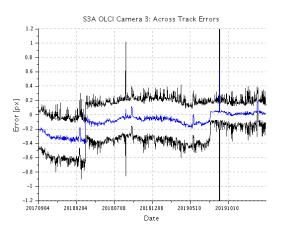
S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 - S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020



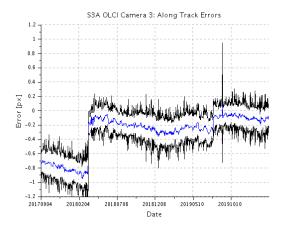
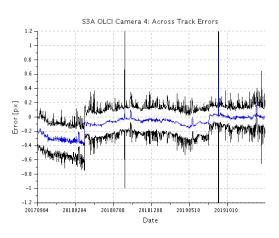


Figure 47: same as Figure 45 for Camera 3.



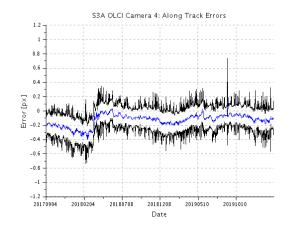
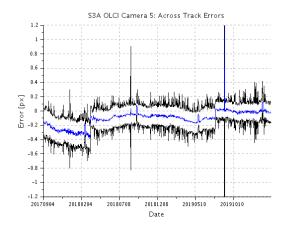


Figure 48: same as Figure 45 for Camera 4.



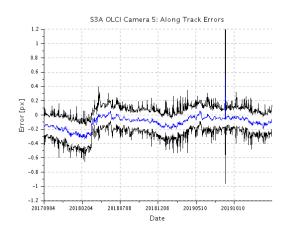


Figure 49: same as Figure 45 for Camera 5.



S3 OLCI Cyclic Performance Report

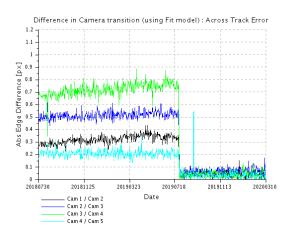
S3A Cycle No. 055 – S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

Page: 48



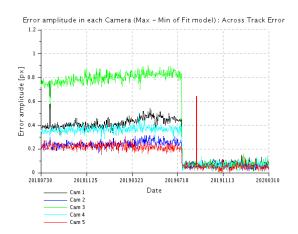
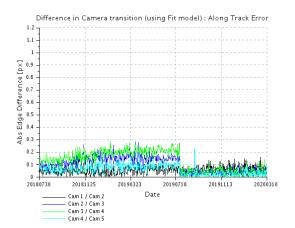


Figure 50: OLCI-A spatial across-track misregistration at each camera transition (left) and maximum amplitude of the across-track error within each camera (left).



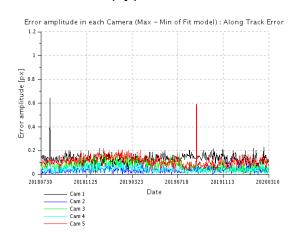


Figure 51: OLCI-A spatial along-track misregistration at each camera transition (left) and maximum amplitude of the along-track error within each camera (left).

2.5.2 OLCI-B

The current Geometric Calibration currently in production is the fourth one, introduced the 30/07/2019. As for OLCI-A, despite compliance to the RMS requirement of 0.5 pixel, OLCI-B showed significant heterogeneity of the performance within the field of view, with discrepancies at camera transitions of up to 1 pixel. Introduction of upgraded IPPVMs greatly improves many performance indicators: the global RMS value decreases form around 0.4 to about 0.3 (Figure 52), the across-track biases decrease significantly for all cameras (Figure 53 to Figure 57) and the field of view homogeneity improves drastically (Figure 58 and Figure 59, but also reduction of the dispersion – distance between the ± 1 sigma lines – in Figure 53 to Figure 57). It appears however that the instrument pointing is still evolving, in particular for camera 2 (Figure 58) and a new geometric calibration has been done; corresponding ADFs with updated GCMs and IPPVMs are in preparation and should be delivered to PDGS in the coming days.



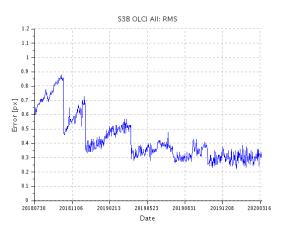
S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 - S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020



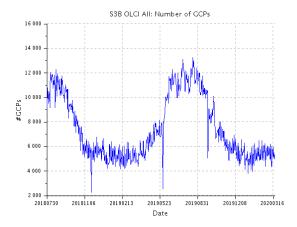
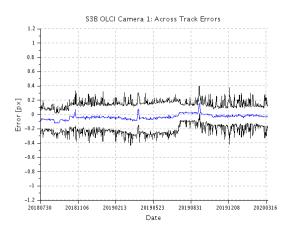


Figure 52: overall OLCI-B georeferencing RMS performance time series over the whole monitoring period (left) and corresponding number of validated control points (right)



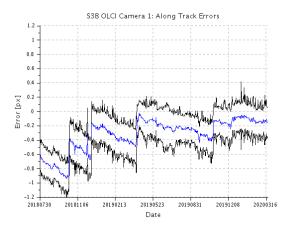
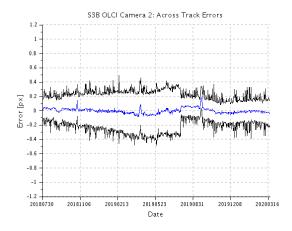


Figure 53: across-track (left) and along-track (right) OLCI-B georeferencing biases time series for Camera 1.



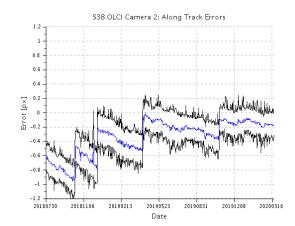


Figure 54: same as Figure 45 for Camera 2.

SENTINEL 3 Mission Performance

Sentinel-3 MPC

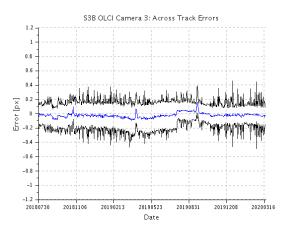
S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 - S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020



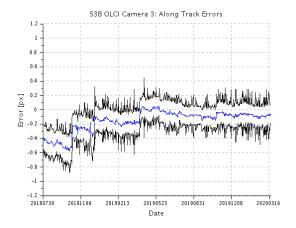
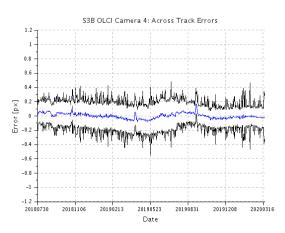


Figure 55: same as Figure 45 for Camera 3.



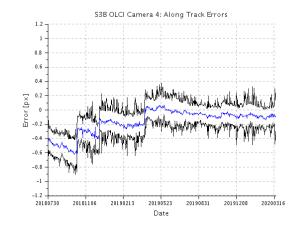
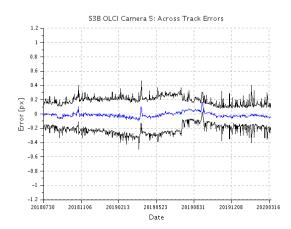


Figure 56: same as Figure 45 for Camera 4.



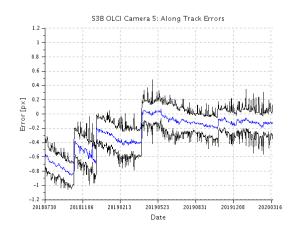


Figure 57: same as Figure 45 for Camera 5.

SENTINEL 3 Mussion Performance Centre

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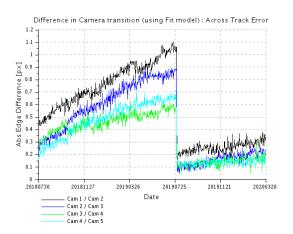
S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 - S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020



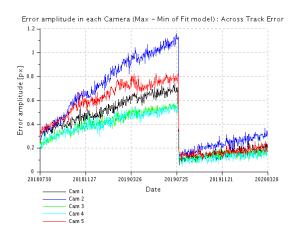
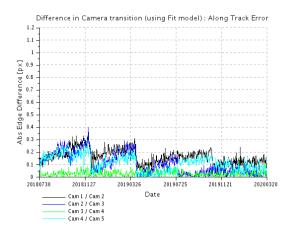


Figure 58: OLCI-B spatial across-track misregistration at each camera transition (left) and maximum amplitude of the across-track error within each camera (left).



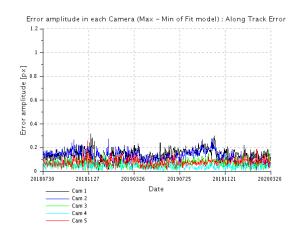


Figure 59: OLCI-B spatial along-track misregistration at each camera transition (left) and maximum amplitude of the along-track error within each camera (left).



S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 – S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

Page: 52

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 60) and OLCI-B (Figure 61).

Mission Performance Centre

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 – S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020



Figure 60: summary of S3ETRAC products generation for OLCI-A (number of OLCI-A L1 products Ingested, blue – number of S3ETRAC extracted products generated, green –

SENTINEL 3 Mission Performance Centre

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 – S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

Page: 54

number of S3ETRAC runs without generation of output product (data not meeting selection requirements), yellow – number of runs ending in error, red, one plot per site type).



Figure 61: summary of S3ETRAC products generation for OLCI-B

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

SENTINEL 3 Mission Performance Centre

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 – S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

Page: 55

3.1.2 Radiometric validation with DIMITRI

Highlights

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

- The verification is performed until the 15th of March 2020.
- 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 (Algeria3 & 5, Libya 1 & 4 and Mauritania 1 & 2) has been performed until the 15th of March 2020.
- 2. The results are consistent overall the six used PICS sites (Figure 62 and Figure 63). Both sensors show a good stability over the analyzed period.
- 3. The temporal average over the period **January 2020 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 64). 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 64). The spectral bands with significant absorption from water vapor and O₂ (Oa11, Oa13, Oa14, Oa15 and Oa20) are excluded.

Mission Performance Centre

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 – S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

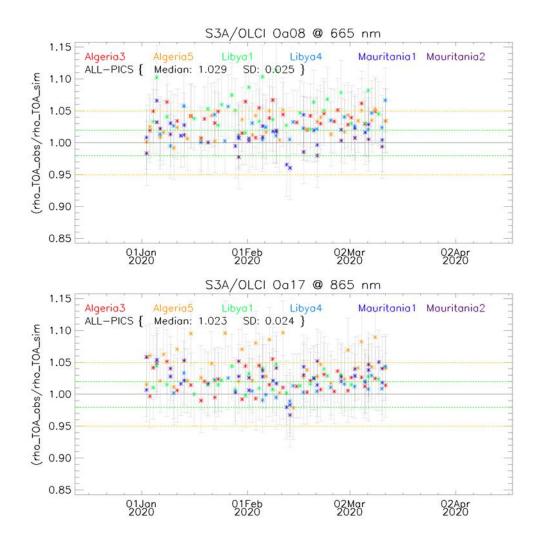


Figure 62: Time-series of the elementary ratios (observed/simulated) signal from OLCI-A for (top to bottom) bands Oa08 and Oa17 respectively over January 2020-Present from the six PICS Cal/Val sites. Dashed-green and orange lines indicate the 2% and 5% respectively. Error bars indicate the desert methodology uncertainty.

Mission Performance Centre

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 – S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

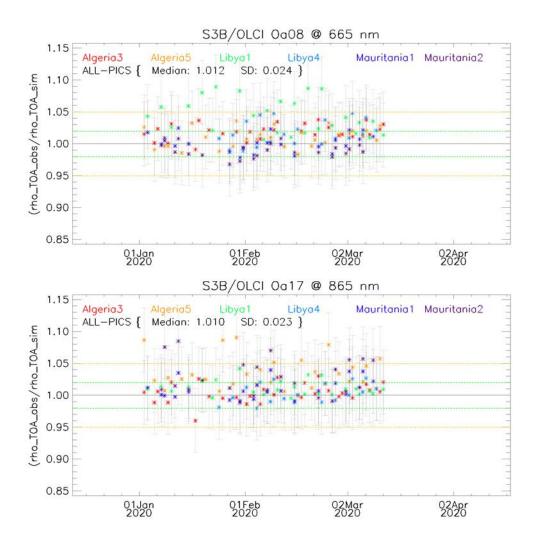


Figure 63: Time-series of the elementary ratios (observed/simulated) signal from OLCI-B for (top to bottom) bands Oa08 and Oa17 respectively over January 2020-Present from the six PICS Cal/Val sites. Dashed-green and orange lines indicate the 2% and 5% respectively. Error bars indicate the desert methodology uncertainty.



S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 – S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

Page: 58

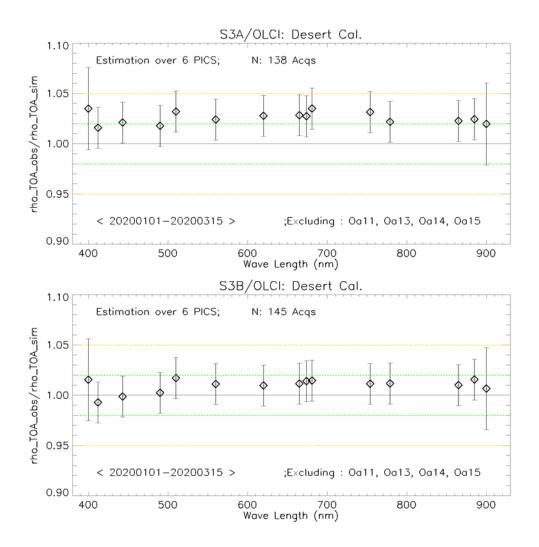


Figure 64: The estimated gain values for OLCI-A and OLCI-B over the 6 PICS sites identified by CEOS over the period January 2020-Present as a function of wavelength. Dashed-green and orange lines indicate the 2% and 5% respectively. Error bars indicate the desert methodology uncertainty.

Cross-mission Intercomparison over PICS:

X-mission Intercomparison with MODIS-A and MSI-A has been performed until February 2019 and February 2020 respectively. Figure 65 shows time-series of the elementary ratios from S2A/MSI, Aqua/MODIS, S3A/OLCI and S3B/OLCI over LYBIA4 sites over the period April 2016 until February 2019 and February 2020 respectively.

We observe a clear stability over 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 66 shows the time averages of estimated gains for the same 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.

Mission Performance Centre

Sentinel-3 MPC

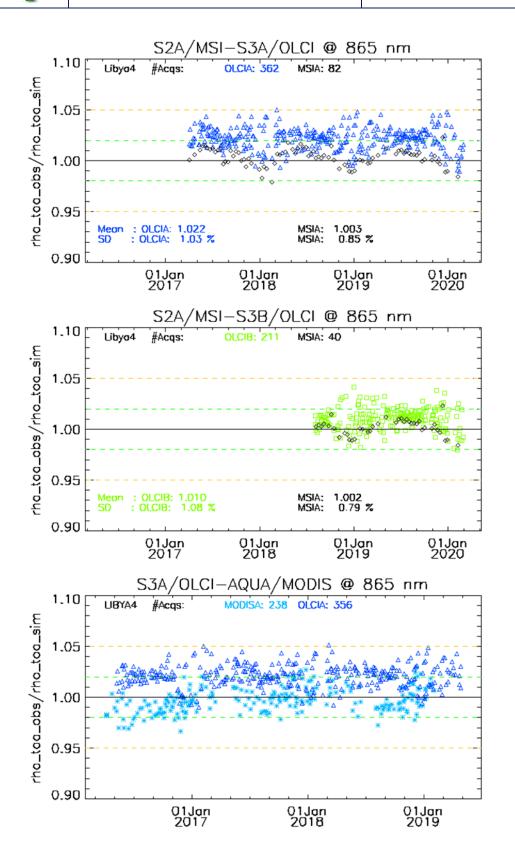
S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 – S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020



Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 – S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

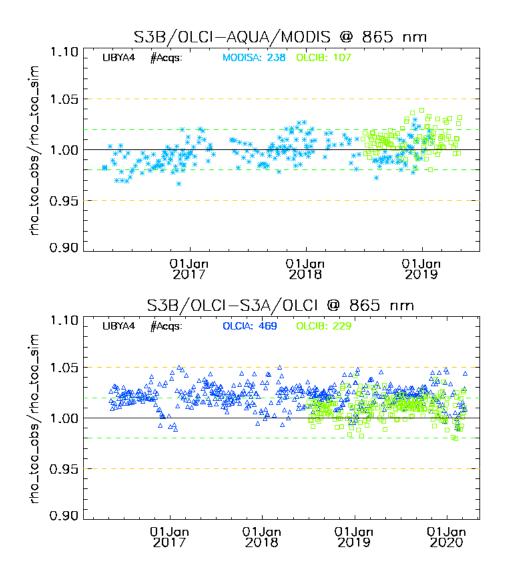


Figure 65: Time-series of the elementary ratios (observed/simulated) signal from (black) S2A/MSI, (blue) S3A/OLCI, (green) S3B/OLCI and (Cyan) Aqua/MODIS for NIR band 865nm over LIBYA4 site. Dashed-green and orange lines indicate the 2% and 5% respectively. The systematic and total uncertainties of the desert methodology are 1% and 5% respectively.

Mission Performance Centre

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 – S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

Page: 61

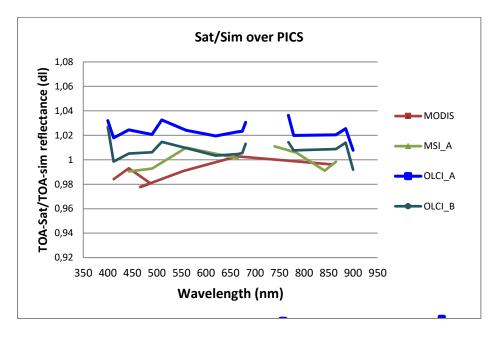


Figure 66: Ratio of observed TOA reflectance to simulated one for (green) S2A/MSI, (purple) S2B/MSI, (red)
Aqua/MODIS, (blue) S3A/OLCI and (dark-green) S3B/OLCI averaged over the six PICS test sites as a function of wavelength.

Validation over Rayleigh

Rayleigh method has been performed over the available mini-files on the Opt-server from missions start to Present from OLCI-A and OLCI-B. The results 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 67). 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 67).

Validation over Glint

Glint calibration method with the configuration (ROI-PIXEL) has been performed over the period missions start-present from 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 67). Again, the glint gain from OLCI-B looks slightly lower than OLCI-A one.

Sentinel-3 MPC



S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 – S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

Page: 62

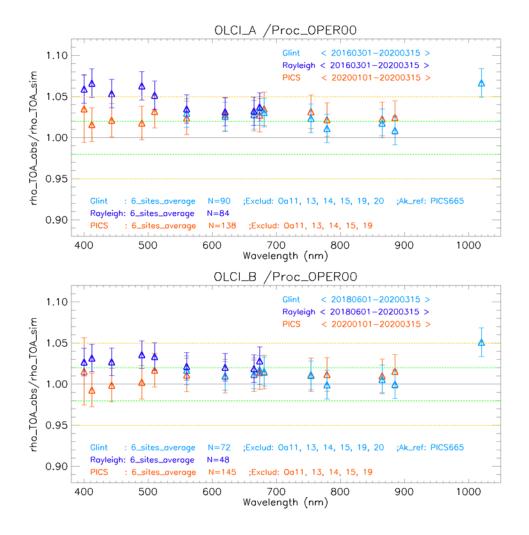


Figure 67: The estimated gain values for OLCI-A and OLCI-B from Glint, Rayleigh and PICS methods over the period missions start-Present as a function of wavelength. We use the gain value of Oa8 from PICS-Desert method as reference gain for Glint method. Dashed-green and orange lines indicate the 2% and 5% respectively.

Error bars indicate the method uncertainties.

3.1.3 Radiometric validation with OSCAR

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

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 – S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

Page: 63

Table 3. S3ETRAC Ocean Calibration sites

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

Due to an unecpected interruption in the OSCAR workflow S3ETRAC data from 2020 onwards have only been partially processed. Therefore, it was decided not to plot the monthly calibration results for January 2020 as they are averaged over a too low number of observations. In Figure 68 the average over the entire period are given for OLCI-A and OLCI-B with OLCI-A about 2 % brighter than OLCIB in blue bands.

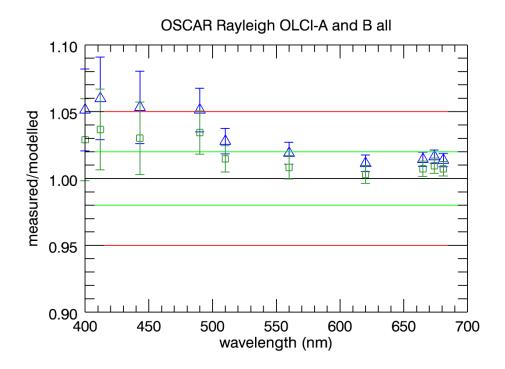


Figure 68. OSCAR Rayleigh S3A and S3B Calibration results: averaged results over all acquisitions since start.

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 – S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

Page: 64

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.

Mission Performance Centre

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 – S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

Page: 65

4 Level 2 Land products validation

4.1 [OLCI-L2LRF-CV-300]

4.1.1 Routine extractions

4.1.1.1 OLCI-A

- The focus for this time period has been on the rolling archive Non Time Critical (NT) data until the 20th of March 2020. More data available for statistical analysis as a concatenation procedure for all available data in the MERMAID processing has been implemented.
- Concatenated time series of OLCI Global Vegetation Index and OLCI Terrestrial Chlorophyll Index have been regenerated on the current rolling archive availability including previous extractions since June 2016 and April 2018 for S3A and S3B respectively.

Figure 69 to Figure 78 below present the Core Land Sites OLCI-A time series over the current period.

Sentinel 3 Mission Performance Centre

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 - S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

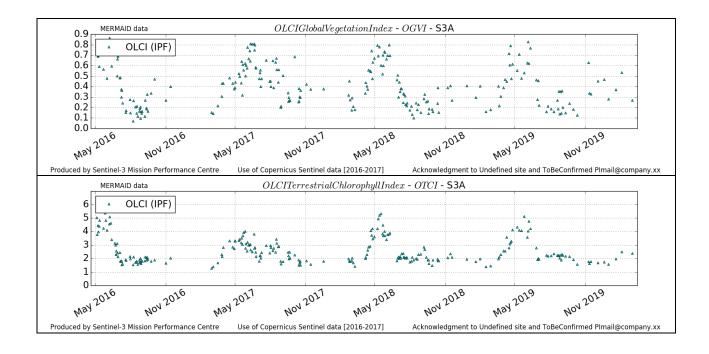


Figure 69: DeGeb time series over current report period

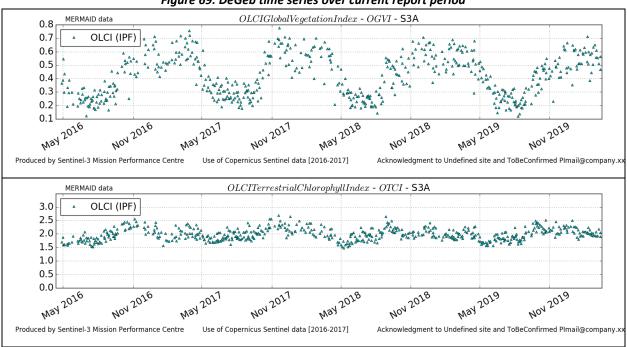


Figure 70: ITCat time series over current report period

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 - S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

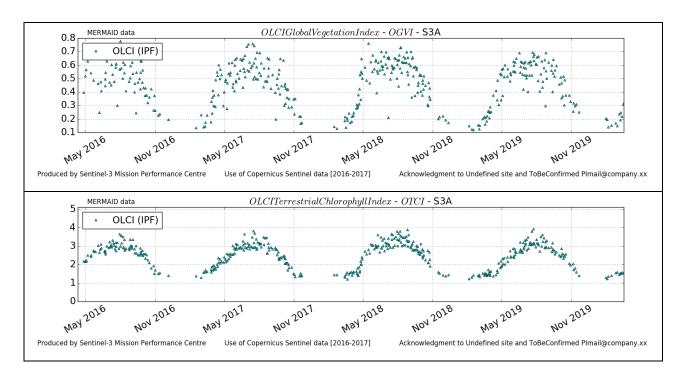


Figure 71: ITsp time series over current report period

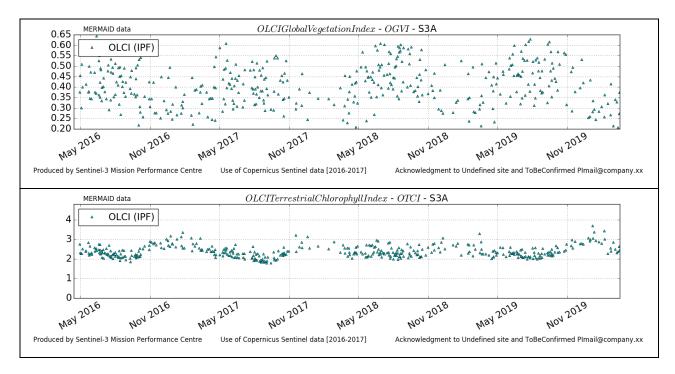


Figure 72: ITSro time series over current report period

Mission Performance Centre

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 - S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

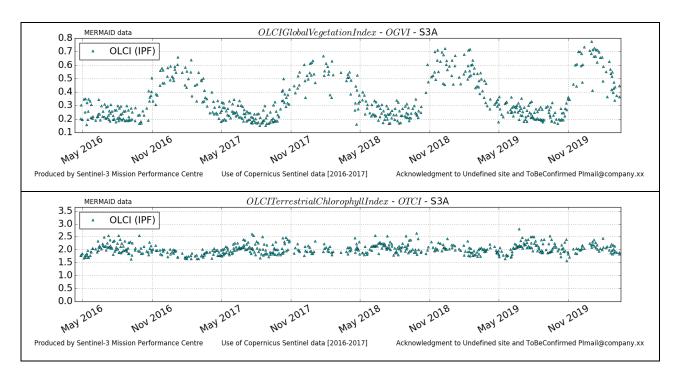


Figure 73: ITTra time series over current report period

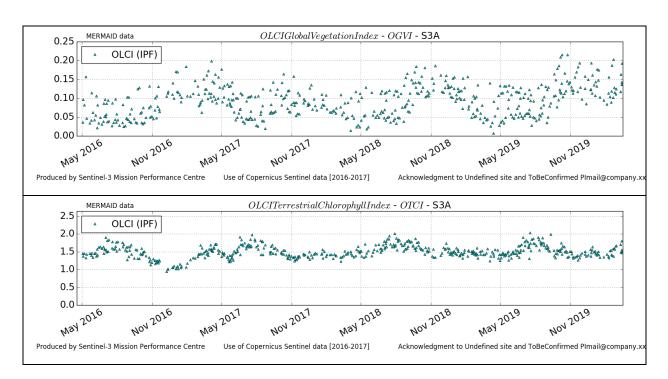


Figure 74: SPAli time series over current report period

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 - S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

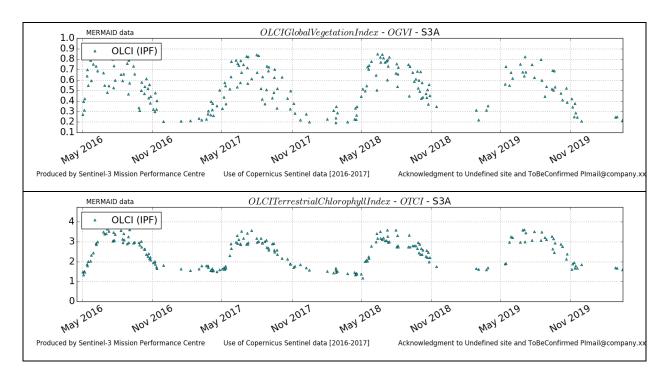


Figure 75: UKNFo time series over current report period

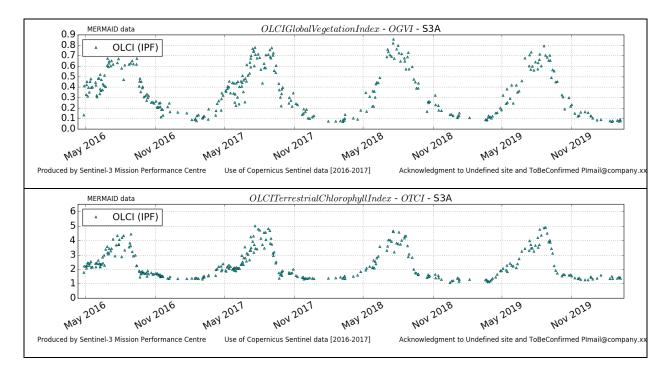


Figure 76: USNe1 time series over current report period

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 - S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

Page: 70

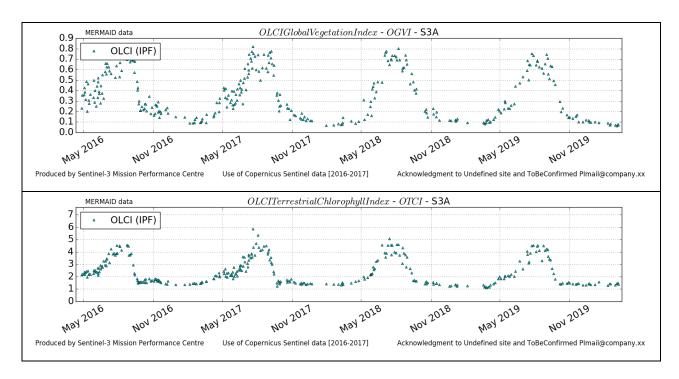


Figure 77: USNe2 time series over current report period

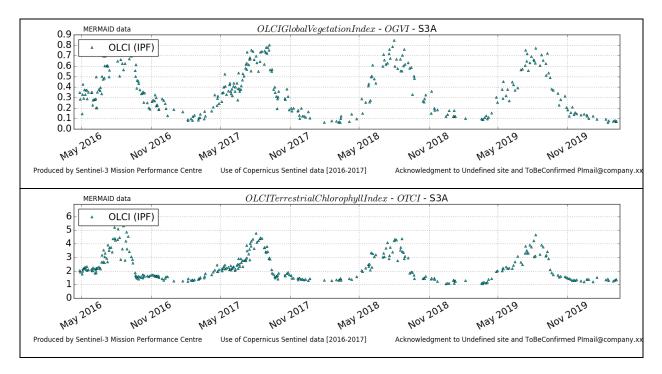


Figure 78: USNe3 time series over current report period

4.1.1.2 OLCI-B

Figure 79 to Figure 88 below present the Core Land Sites OLCI-B time series over the current period.

SENTINEL 3 Mission Parformance

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 - S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

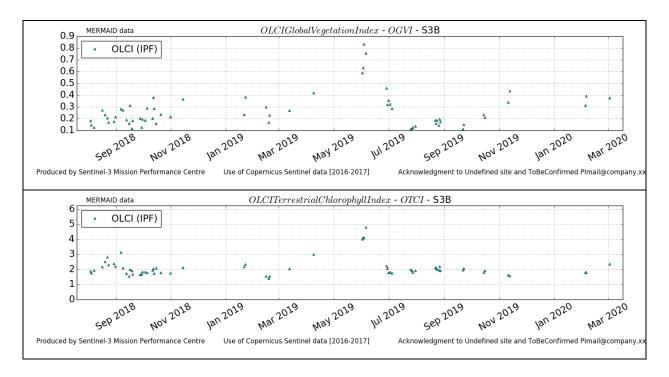


Figure 79: DeGeb time series over current report period

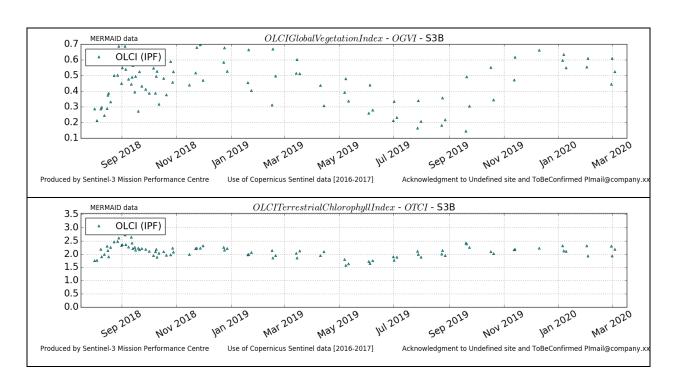


Figure 80: ITCat time series over current report period

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Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 - S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

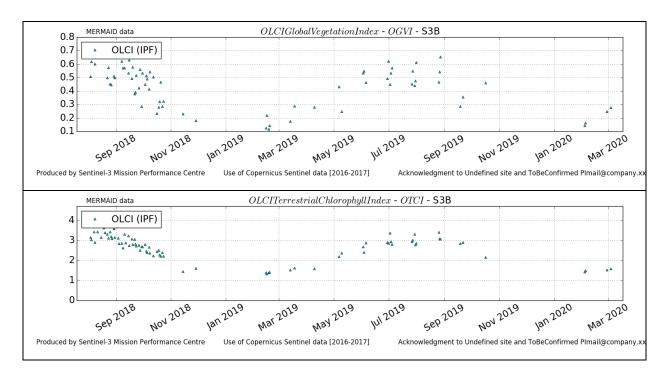


Figure 81: ITsp time series over current report period

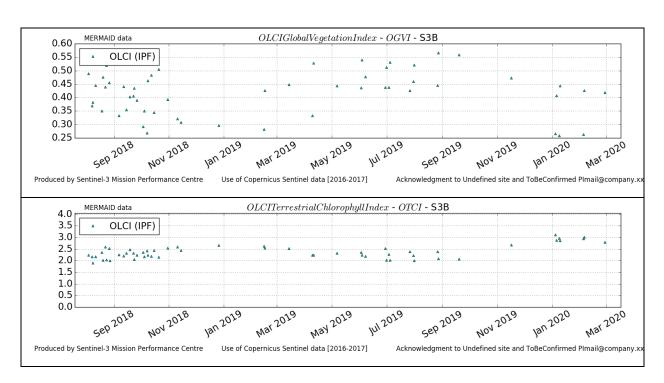


Figure 82: ITSro time series over current report period

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Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 – S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

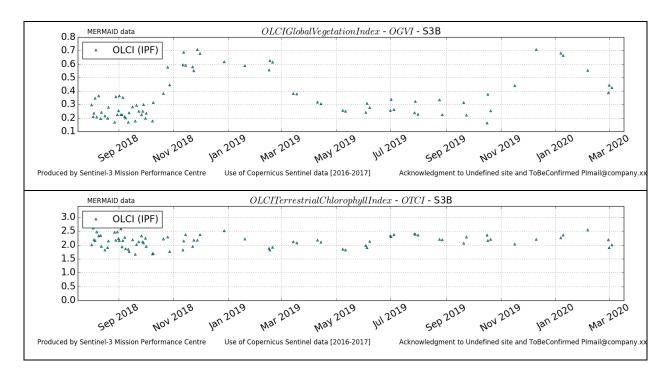


Figure 83: ITTra time series over current report period

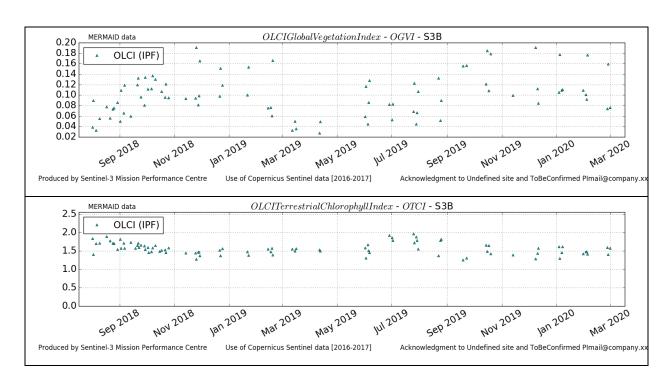


Figure 84: SPAli time series over current report period

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Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 - S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

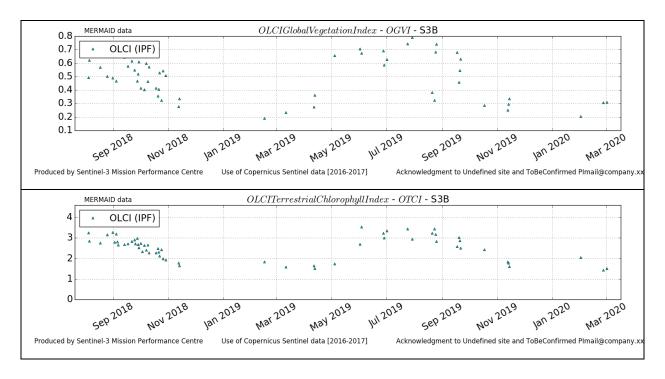


Figure 85: UKNFo time series over current report period

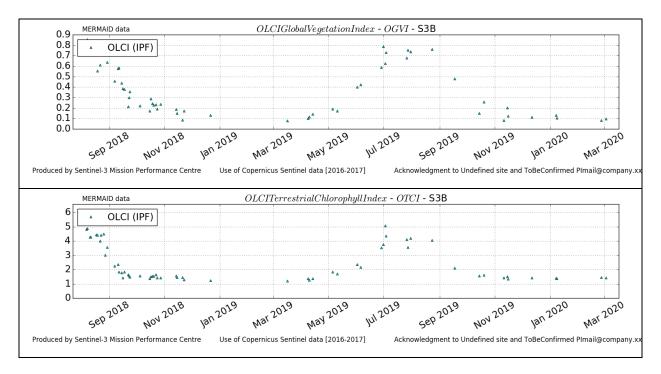


Figure 86: USNe1 time series over current report period

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Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 - S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

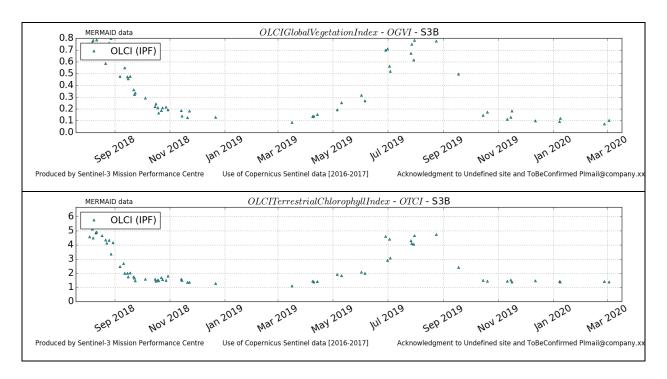


Figure 87: USNe2 time series over current report period

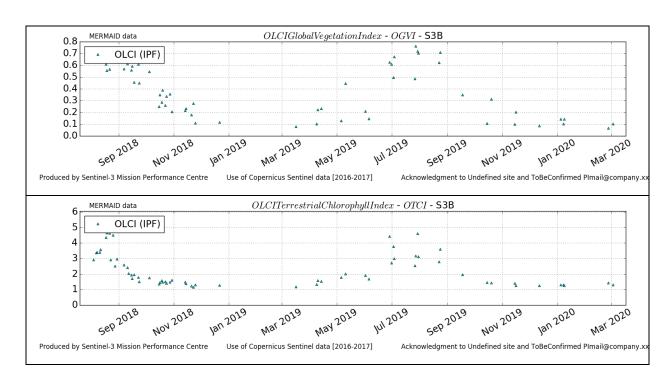


Figure 88: USNe3 time series over current report period

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 – S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

Page: 76

4.1.2 Comparisons with MERIS MGVI and MTCI climatology

Assessment

Here is presented the performance of the Level-2 (L2) OLCI land products, the Terrestrial Chlorophyll Index (OTCI) and the Green Vegetation Index (OGVI). The OTCI is directly related to the canopy chlorophyll content, useful to understand vegetation condition, phenology and productivity. The OGVI is a proxy of the Absorbed Photosynthetic Active Radiation (FAPAR), an Essential Climate Variable (ECV) by the Global Climate Observing System (GCOS). This report includes the new L2 product acquisitions from the period 11 February 2020 to 09 March 2020. To assess the OLCI products' consistency they are contrasted to the MERIS archive. Pixel extractions over ESA and CEOS validation sites (Table 4) are obtained and comparisons statistics are computed such as R², normalised root mean square difference (NRMSD), and average difference or Bias (Table 5). Time-series in Figure 89 to Figure 91 show the products' latest acquisitions are in line with the seasonal pattern. Figure 91 shows systematic underestimation of both products over sparse canopies of evergreen broadleaf in Australia, this requires further inspection. Table 5 presents the comparison statistics for the rest of the sites. In general, there is good agreement between OLCI products and MERIS climatology; high R² (>0.85) and low NRMSD and absolute Bias (<0.1). When data from all sites are pooled together (Figure 92), slight systematic underestimation is revealed for OTCI and systematic overestimation is observed for OGVI. This pattern is particularly evident for higher values of broadleaved forests. The findings are in conformity with previous cycles.

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Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 – S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

Table 4: Validation sites analysed in report S3A 55/S3B 36. Land cover data from GLC2000.

Acronym	Contry	Network	Lat		Lon	Land.cover
BE-Brasschaat	Belgium	ICOS		51.31	4.5	2 Needle-leaved, evergreen
DE-Hones-Holz	Deutschland	ICOS		52.09	11.2	2 Broadleaved, deciduous, closed
FR-Montiers	France	ICOS		48.54	5.3	L Broadleaved, deciduous, closed
IT-Isp	Italy	CORE		45.81	8.6	4 Mixed forest
US-Harvard	United States	NEON, AERONET		42.54	-72.1	7 Broadleaved, deciduous, closed
US-Mountain-Lake	United States	NEON, AERONET		37.38	-80.5	3 Broadleaved, deciduous, closed
US-Oak-Rige	United States	NEON, AERONET		35.96	-84.2	Broadleaved, deciduous, closed
US-Smithsonian	United States	NEON, AERONET		38.89	-78.1	4 Broadleaved, deciduous, closed
US-Steigerwarldt	United States	NEON		45.51	-89.5	Broadleaved, deciduous, closed
CR-Santa-Rosa	Costa Rica	ENVIRONET		10.84	-85.6	2 Broadleaved, evergreen
DE-Haininch	Deutschland	ICOS Associated		51.08	10.4	5 Broadleaved, deciduous, closed
T-Lison	Italy	ICOS		45.74	12.7	5 Cropland
JS-Talladega	United States	NEON, AERONET		32.95	-87.3	Needle-leaved, evergreen
T-Casterporziano2	Italy	ICOS		41.70		5 Mixed forest
T-Collelongo	Italy	EFDC		41.85	13.5	Broadleaved, deciduous, closed
JK-NFo	United Kingdom	CORE		50.85	-1.5	1 Deciduous forest
JK-Wytham-Woods	United Kingdom	ForestGeo - NPL		51.77	-1.3	1 Broadleaved, deciduous, closed
AU-Great-Western	Australia	TERN-SuperSites, AusCover/OzFlux		-30.19	120.6	5 Broadleaved, deciduous, open
3R-Mata-Seca	Brazil	ENVIRONET		-14.88	-43.9	7 Herbaceous, closed-open
DE-Tharandt	Deutschland	ICOS		50.96	13.5	7 Needle-leaved, evergreen
CA-Mer-Bleue	Canada	National Capitol Comission		45.40	-75.4	9 Peatland
JS-Bartlett	United States	NEON, AERONET		44.06	-71.2	Broadleaved, deciduous, closed
AU-Cumberland	Australia	TERN-SuperSites, AusCover/OzFlux		-33.62	150.7	2 Broadleaved, evergreen
R-Estrees-Mons	France	ICOS Associated		49.87	3.0	2 Cultivated and managed areas
AU-Robson-Creek	Australia	TERN-SuperSites, AusCover/OzFlux		-17.12	145.6	Broadleaved, evergreen
AU-Litchfield	Australia	TERN-SuperSites, AusCover/OzFlux		-13.18	130.7	Broadleaved, evergreen
AU-Wombat	Australia	TERN-SuperSites, AusCover/OzFlux		-37.42	144.0	Broadleaved, evergreen
DE-Geb	Deutschland	CORE		51.10	10.9	L Cropland
DE-Selhausen	Deutschland	ICOS		50.87	6.4	5 Cropland
T-Sro	Italy	CORE		43.73	10.2	3 Mixed forest
AU-Tumbarumba	Australia	TERN-SuperSites, AusCover/OzFlux		-35.66	148.1	5 Broadleaved, evergreen
BE-Vielsalm	Belgium	ICOS		50.31) Needle-leaved, evergreen
US-Jornada	United States	LTER		32.59		1 Shrub, closed-open, deciduous

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Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 – S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

Table 5: Comparison statistics between monthly S3A/B OLCI land products and MERIS archive data.

		S3A						S3B								
Site Acronym		OTCI 1	vs MTCI			OGVI v	/s MGVI			OTCI v	/s MTCl			OGVI v	s MGVI	
	n	R2	NRMSD	Bias	n	R2	NRMSD	Bias	n	R2	NRMSD	Bias	n	R2	NRMSD	Bias
BE-Brasschaat	10	0.99	0.03	-0.11	10	0.98	0.05	0.05	9	0.9	0.08	-0.17	9	0.9	0.11	0.02
DE-Hones-Holz	10	0.99	0.05	0.07	10	0.99	0.05	0.05	10	0.91	0.14	-0.22	10	0.92	0.15	-0.01
FR-Montiers	12	0.99	0.05	-0.11	12	0.98	0.06	0.05	9	0.97	0.08	-0.12	9	0.92	0.15	0.06
IT-Isp	12	0.99	0.03	-0.01	12	0.99	0.06	0.06	10	0.91	0.09	-0.06	10	0.77	0.22	0.03
US-Harvard	12	0.99	0.03	-0.14	12	0.97	0.09	0.05	11	0.98	0.05	-0.21	11	0.92	0.16	0.02
US-Mountain-Lake	12	0.99	0.03	-0.22	12	0.99	0.08	0.03	11	0.97	0.05	-0.52	11	0.98	0.08	0.00
US-Oak-Rige	12	0.99	0.05	-0.05	12	0.98	0.09	0.04	12	0.98	0.05	-0.12	12	0.94	0.12	0.03
US-Smithsonian	11	0.99	0.03	-0.19	11	0.99	0.05	0.04	10	0.98	0.07	-0.19	10	0.99	0.07	0.00
US-Steigerwarldt	11	0.99	0.03	0.05	11	0.99	0.08	0.00	7	0.83	0.10	-0.10	7	0.97	0.10	0.02
CR-Santa-Rosa	12	0.98	0.04	0.14	12	0.63	0.20	0.13	12	0.84	0.12	-0.03	12	0.37	0.29	0.07
DE-Haininch	10	0.98	0.08	-0.10	10	0.99	0.05	0.06	9	0.92	0.16	-0.13	9	0.94	0.15	0.06
IT-Lison	12	0.98	0.04	-0.04	12	0.96	0.07	0.08	11	0.9	0.06	-0.08	11	0.94	0.10	0.08
US-Talladega	12	0.98	0.02	-0.14	12	0.98	0.05	0.07	11	0.91	0.05	-0.18	11	0.95	0.10	0.08
IT-Casterporziano2	12	0.97	0.02	-0.06	12	0.83	0.03	0.07	12	0.76	0.06	0.00	12	0.36	0.10	0.08
IT-Collelongo	12	0.97	0.07	-0.01	12	0.97	0.08	0.01	11	0.8	0.23	0.02	11	0.86	0.24	0.02
UK-NFo	12	0.97	0.04	-0.26	12	0.97	0.08	0.07	10	0.98	0.04	-0.25	10	0.95	0.11	0.07
UK-Wytham-Woods	12	0.97	0.05	0.06	12	0.99	0.05	0.10	11	0.87	0.11	-0.11	11	0.81	0.19	0.08
AU-Great-Western	12	0.96	0.02	0.12	12	0.93	0.00	0.04	12	0.89	0.03	0.13	12	0.79	0.10	0.03
BR-Mata-Seca	12	0.96	0.06	-0.09	12	0.98	0.07	0.00	12	0.97	0.05	-0.11	12	0.98	0.10	0.01
DE-Tharandt	12	0.96	0.04	-0.05	12	0.96	0.09	0.08	10	0.94	0.07	-0.24	10	0.97	0.09	0.09
CA-Mer-Bleue	9	0.95	0.05	-0.02	9	0.99	0.03	0.05	7	0.91	0.06	-0.06	7	0.95	0.08	0.02
US-Bartlett	12	0.95	0.05	0.03	12	0.97	0.10	0.06	11	0.88	0.08	-0.03	11	0.86	0.22	0.02
AU-Cumberland	12	0.94	0.01	0.01	12	0.52	0.07	0.07	12	0.48	0.07	0.04	12	0.33	0.13	0.05
FR-Estrees-Mons	12	0.94	0.08	0.06	12	0.92	0.11	0.06	10	0.89	0.11	0.14	10	0.91	0.11	0.06
AU-Robson-Creek	12	0.93	0.03	-0.05	12	0.87	0.07	0.10	11	0.8	0.05	-0.19	11	0.6	0.11	0.12
AU-Litchfield	12	0.92	0.02	-0.01	12	0.93	0.09	0.03	12	0.62	0.08	0.01	12	0.77	0.12	0.01
AU-Wombat	12	0.89	0.04	0.19	12	0.29	0.08	0.09	12	0.61	0.05	-0.09	12	0	0.11	0.07
DE-Geb	12	0.88	0.10	-0.08	12	0.88	0.15	0.05	10	0.79	0.10	-0.06	10	0.59	0.23	-0.02
DE-Selhausen	12	0.87	0.09	-0.01	12	0.55	0.21	0.07	11	0.65	0.10	-0.16	11	0.15	0.24	0.00
IT-Sro	12	0.87	0.03	-0.20	12	0.89	0.06	0.08	12	0.8	0.04	-0.23	12	0.56	0.13	0.09
AU-Tumbarumba	12	0.85	0.06	0.37	12	0.49	0.06	0.12	12	0.85	0.05	0.25	12	0	0.16	0.06
BE-Vielsalm	11	0.85	0.05	0.11	11	0.95	0.08	0.10	7	0.72	0.08	-0.03	7	0.8	0.23	0.08
US-Jornada	10	0.85	0.03	0.01	10	0.72	0.20	0.01	8	0.68	0.05	0.10	8	0.27	0.20	-0.01

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Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 – S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

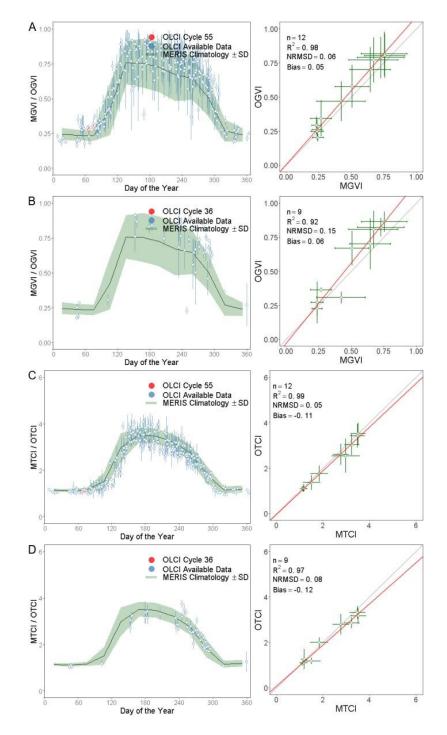


Figure 89: Time-series OGVI and OTCI and corresponding scatterplot of monthly mean for site FR-Montiers, France, land cover Broadleaved, deciduous, closed. A and C represent S3A; B and D represent S3B.

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 – S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

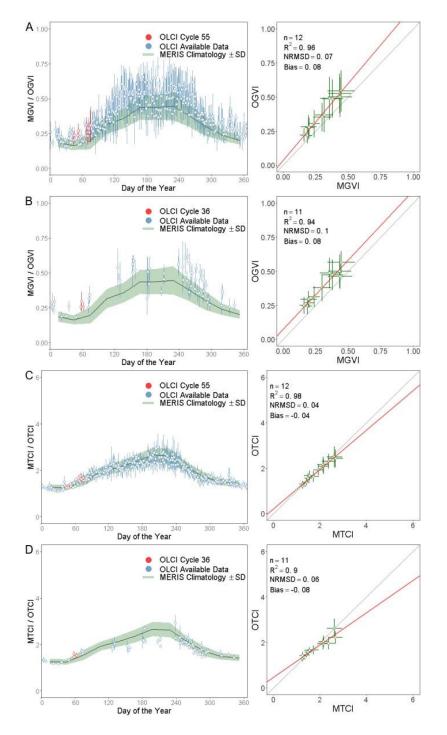


Figure 90: Time-series OGVI and OTCI and corresponding scatterplot of monthly mean for site IT-Lison, Italy, land cover Cropland. A and C represent S3A; B and D represent S3B.

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 – S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

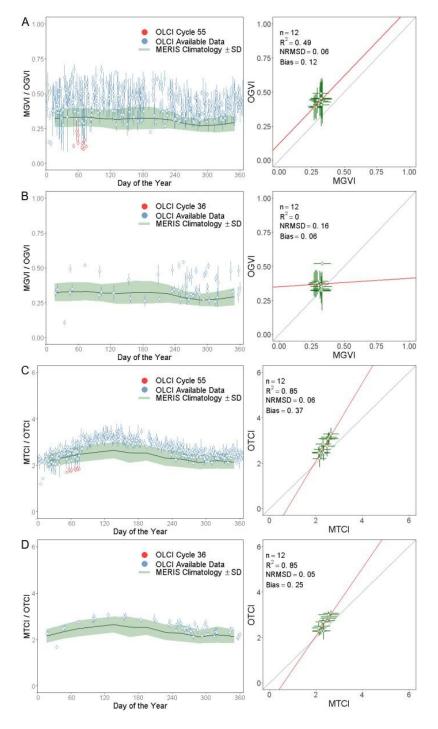


Figure 91: Time-series OGVI and OTCI and corresponding scatterplot of monthly mean for site AU-Tumbarumba, Australia, land cover Broadleaved, evergreen. A and C represent S3A; B and D represent S3B.

Sentinel 3 Mission Performance Centre

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 – S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

Page: 82

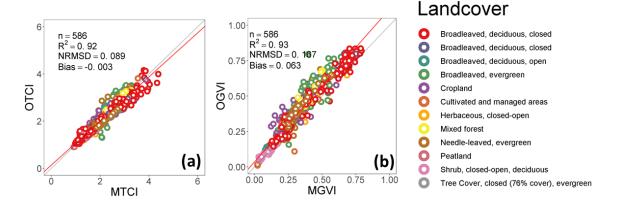


Figure 92: Comparison of OTCI-MTCI (a) and OGVI-MGVI (b). Points in the scatterplot represent the monthly mean of all available S3A and MERIS archive over 53 validation sites. Red and grey lines represent the modelled and 1:1 lines respectively. The scatterplots are updated to include extractions from cycle S3A 55.

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

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

Sentinel-3 MPC



S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 – S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

Page: 83

5 Level 2 Water products validation

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

5.1.1 OLCI-A

There has been no update of the SVC (System Vicarious Calibration) during Cycle 055. Last figures (cycle 17) are considered valid.

5.1.2 OLCI-B

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

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

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

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

5.2.1 Acknowledgements

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

AERONET-OC

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

Sentinel-3 MPC



S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 – S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

Page: 84

- o LISCO: Sam Ahmed, Alex Gilerson, City College of New York
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- 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
- Grizzly bay, Lake Okeechobee, South Greenbay: NimaPahlevan, NASA
- Lake Erie: Tim Moore, Steve Ruberg, Menghua Wang, University of New Hampshire & NOAA

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AWI

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Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 – S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

Page: 85

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 21st of March 2020.

- Current reporting period is hereafter compared to the reprocessed archive covering the April 2016 to November 2017 period. No issues are reported neither in the extraction process nor in OLCI data.
- All extractions and statistics have been regenerated on the current rolling archive availability including all the extraction since July 2017. The available matchups therefore represent over almost three years of operation.
- At best 386 and 392 matchups at 490 and 560nm respectively are useful for this time period. OLCI's performances remain nominal.

Overall Water-leaving Reflectance performance

Scatter plots and Performance Statistics

Figure 93 and Figure 94 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 6 below summarises the statistics over the reprocessing period while Table 7 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 4.5%, with the noticeable exception of 412 nm with 8.5%. Performances over the current period appear a bit lower than for the calibration period (except at 412 nm), but of the same order of magnitude.

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Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 – S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

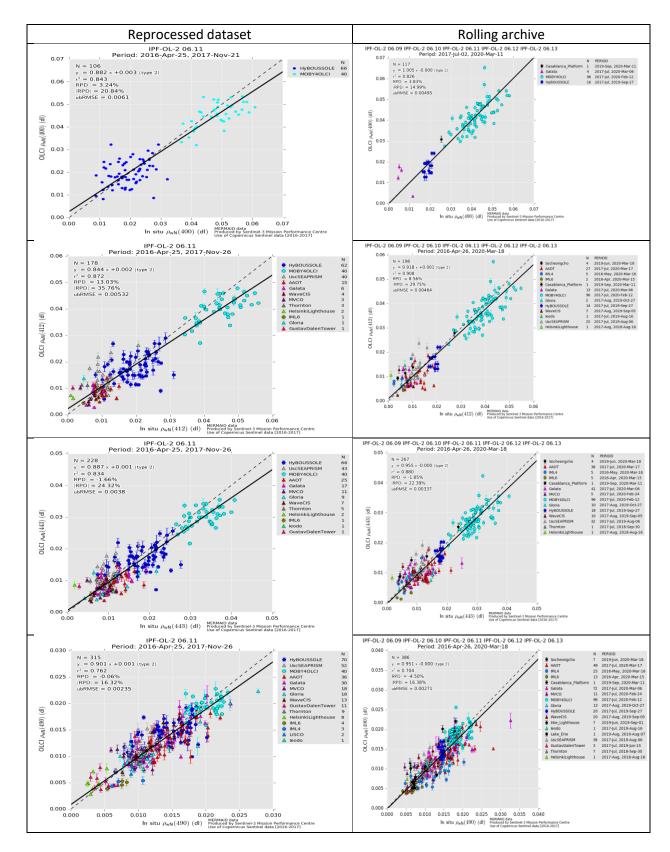


Figure 93: Scatter plots of OLCI-A versus in situ radiometry (FR data). Reprocessed dataset (left), all available data for the current time period (right), Oa1 to Oa4 (400 to 490 nm)

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 - S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

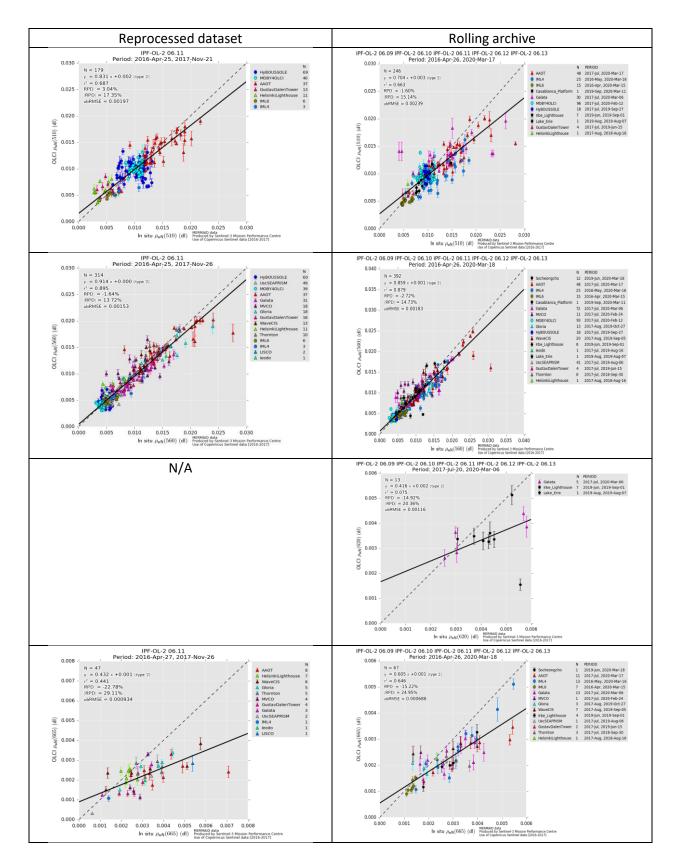


Figure 94: Scatter plots of OLCI-A versus in situ radiometry (FR data). Reprocessed dataset (left), all available data for the current time period (right), Oa5 Oa6 and Oa8 (510, 560 and 665 nm).

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 – S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

Page: 88

Table 6: 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 7: OLCI-A FR statistics over July 2017-present.

lambda	N	RPD	RPD	MAD	RMSE	slope	intercept	r2	
400	117	3.83%	14.99%	0.0000	0.0050	1.0049	-0.0002		0.83
412	198	8.56%	29.75%	-0.0011	0.0048	0.9182	0.0009		0.91
443	267	-1.85%	22.39%	-0.0011	0.0036	0.9553	-0.0003		0.88
490	386	-4.50%	16.38%	-0.0009	0.0028	0.9511	-0.0002		0.70
510	246	-1.60%	15.14%	-0.0006	0.0025	0.7037	0.0027		0.66
560	392	-2.72%	14.73%	-0.0006	0.0019	0.8586	0.0007		0.88
620	13	-14.92%	20.36%	-0.0008	0.0014	0.4158	0.0017		0.08
665	67	-15.22%	24.95%	-0.0006	0.0009	0.6047	0.0005		0.65

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 – S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

Page: 89

Time series

Figure 95 and Figure 96 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).

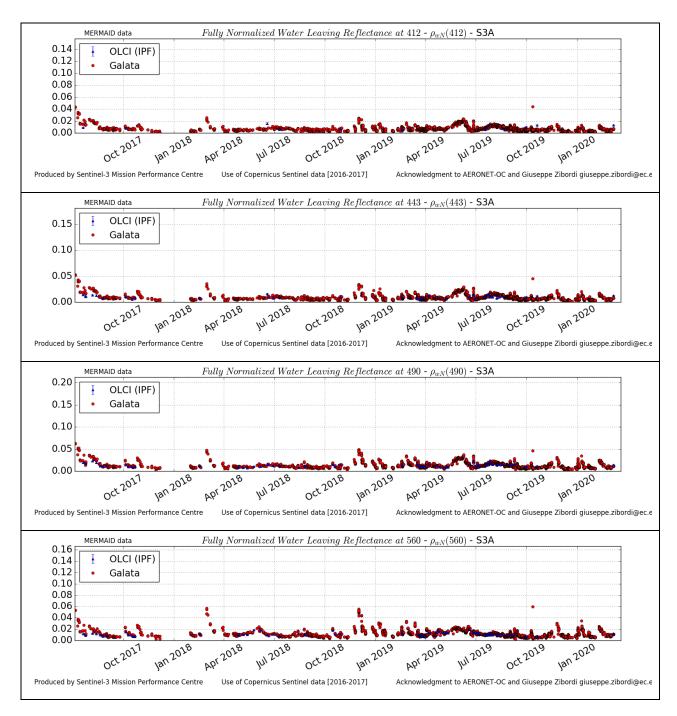


Figure 95: Galata time series over current report period

Mission Performance Centre

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 - S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

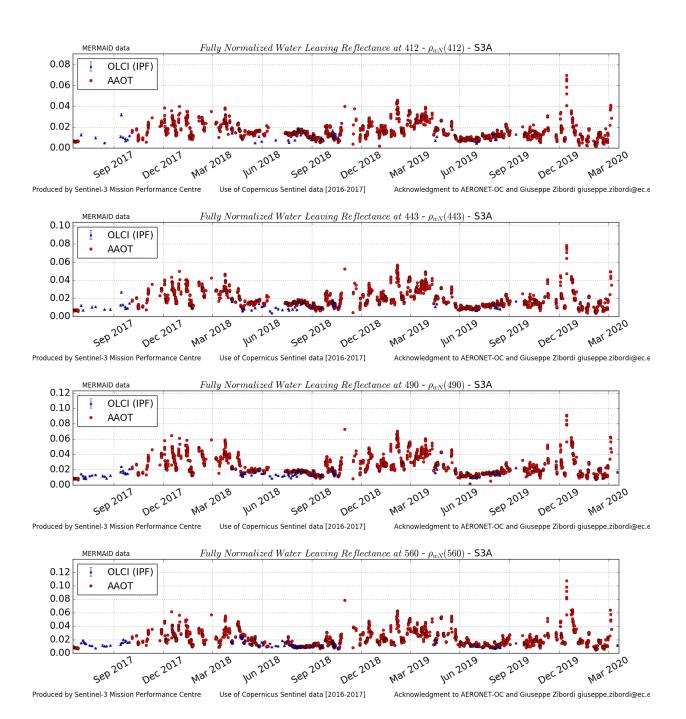


Figure 96: AAOT time series over current report period

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 – S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

Page: 91

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 20th of March 2020.
- All extractions and statistics have been regenerated on the current rolling archive availability including all the extraction since February 2019.
- At best 189 and 204 matchups at 490 and 560nm respectively are useful for this time period.

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

Overall Water-leaving Reflectance performance

Scatter plots and Performance Statistics

- Figure 97 below presents the scatterplots and statistics of OLCI-B FR versus in situ reflectance.
- ❖ Table 8 below summarises the statistics over the current reporting period.

Sentinel-3 MPC



S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 – S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

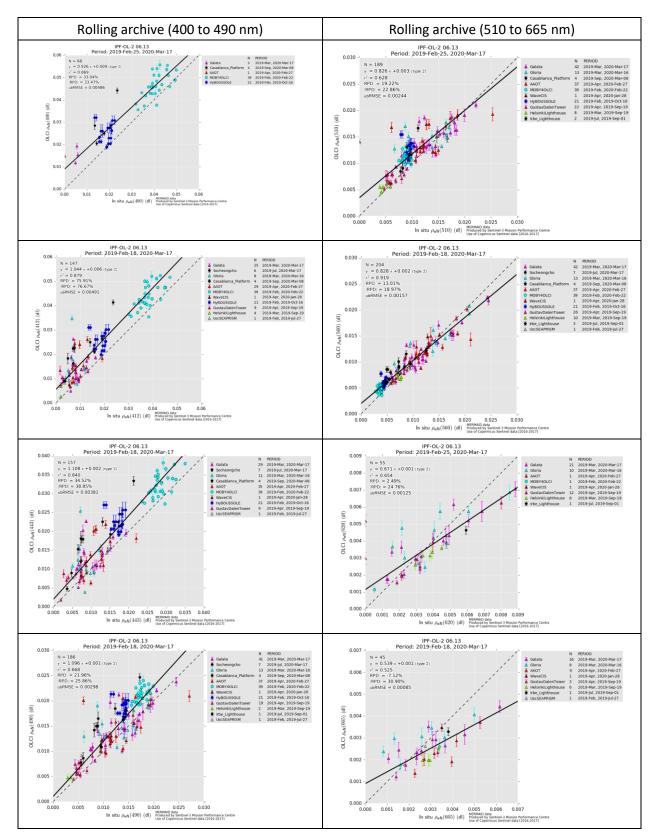


Figure 97: Scatter plots of OLCI-B versus in situ radiometry (FR data). All available data for the current time period.

Table 8: OLCI-B FR statistics over February to Decemver 2019 reporting period.

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 – S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

Page: 93

lambda	N	RPD	RPD	MAD	RMSE	slope	intercept	r2	
400	68	33.04%	33.47%	0.0067	0.0082	0.9255	0.0089	0.8	87
412	147	75.91%	76.67%	0.0063	0.0080	1.0444	0.0055	0.8	88
443	157	34.52%	38.85%	0.0036	0.0053	1.1076	0.0020	3.0	84
490	186	21.96%	25.86%	0.0023	0.0038	1.0962	0.0010	0.6	67
510	189	19.22%	22.86%	0.0016	0.0029	0.8263	0.0035	0.6	63
560	204	13.01%	18.97%	0.0004	0.0016	0.8278	0.0020	0.9	92
620	55	2.49%	24.76%	-0.0001	0.0013	0.6706	0.0011	0.6	65
665	45	-7.12%	30.90%	-0.0005	0.0010	0.5392	0.0009	0.5	52

Time series

Figure 98 and Figure 99 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. 055 – S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

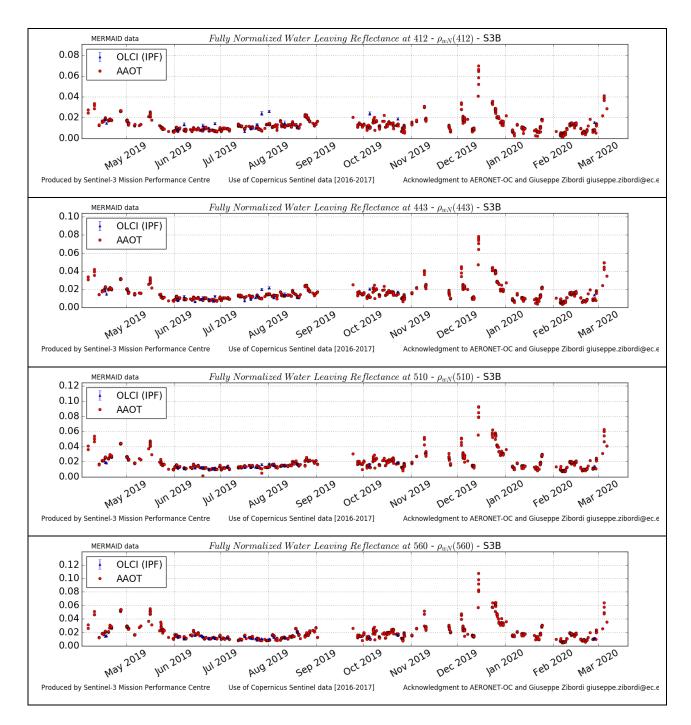


Figure 98: AAOT time series over current report period

Mission Performance Centre

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 – S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

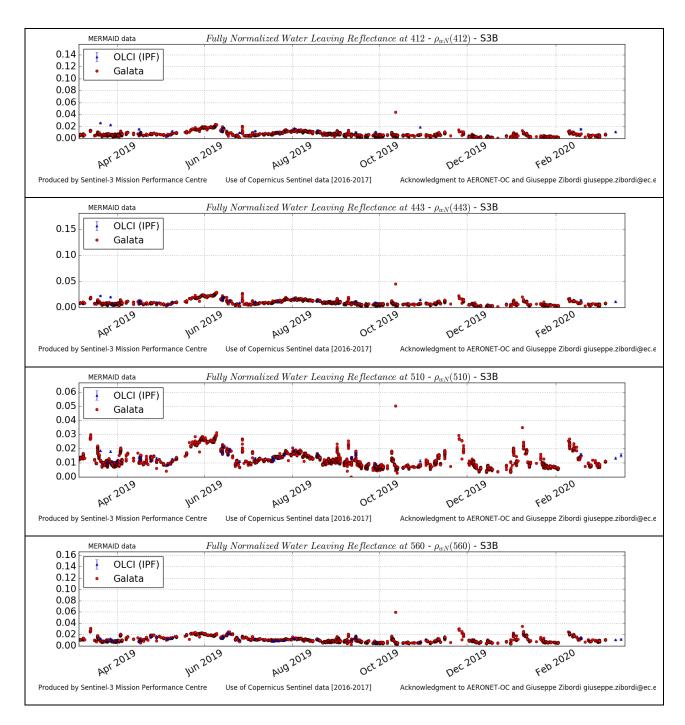


Figure 99: GALATA time series over current report period



S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 – S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

Page: 96

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

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

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

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

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

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 (Smirnow et al 2009). This is an ongoing process, where co-located data are collected and analysed. In contrast to last year, we switched to AERONET **V3** data. Only quality assured level data are used for OLCI A. For OLCI B we used AERONET level 1.5, since the amount is much larger. All OLCI-L2 ocean product types have been validated: full resolution and reduced resolution (*wrr, wfr*); near real time and non time critical (*NR, NT*). The ocean colour products from OLCI A and B have been taken from Eumetsats CODA (Copernicus Online Data Access, https://coda.eumetsat.int/#/home) or reprocessed OLCI A CODAREP (https://coda.eumetsat.int/#/home) websites. Although the following quantitative comparisons are restricted to *full resolution non time critical*, the found results are valid for all product types.

5.5.1 Aeronet comparisons with OLCI A

88000 OLCI-A scenes within the period of June 2016 to January 2020 have been analysed so far. For a matchup, the temporal distance between the satellite overpass and the AERONET acquisition was less than 60 minutes. Since, the AERONET L2 is expensively quality controlled, it is published with a delay of up to 1 year, thus the latest AERONET data is from early Summer 2019. 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 0.2. Due to the fact, that most of the AERONET stations are on land, the number of matchups reduced to 690 only. The results are plotted in Figure 100.

SENTINEL 3 Mission Performance

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 – S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

Page: 97

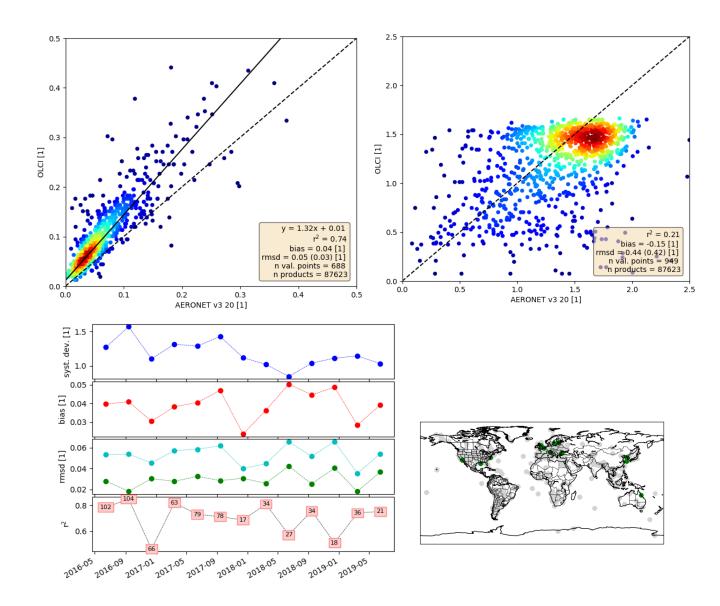


Figure 100: Upper left: OLCI aerosol optical thickness at 865nm against Aeronet at 870nm, upper right: OLCIs Angström exponent at 865nm against the Aeronet Angström exponent at 865nm-440nm. Lower left: Temporal evolution of different quality measures of the optical thickness comparison (from top to bottom: systematic deviation factor, bias, root mean squared difference (with and without bias correction), explained variance (number in boxes are the numbers of matchups). Lower right: positions of the used AERONET stations.



S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 – S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

Page: 98

It becomes apparent, that:

- There is a highly linear relation between the AERONET and OLCI AOT, the explained variance is 0.8.
- The optical thickness of OLCI A is systematically overestimated by 20% 50%, the majority of the cases is at around 35%.
- This leads to a systematic bias of 0.04.
- If the systematic overestimation is corrected, the root mean squared difference decreases from 0.05 do 0.03.
- There is only a weak (r2 = 0.2) linear relation for the Angstroem exponent.
- The majority of AERONET has an angstroem of 1.6, whereas OLCI gives 1.4, thus OLCI underestimates the spectral extinction by 0.2.

All investigated quality measures show no significant temporal evolution. There is a slight improvement of the systematic deviation from 1.5 to 1.1, but the significance is low.

5.5.2 Marine Aeronet comparisons with OLCI A

1400 OLCI-A scenes within the period of June 2016 to January 2020 have been analysed so far. For a matchup, the temporal distance between the satellite overpass and the AERONET acquisition was less than 60 minutes. Since, the maritime AERONET L2 is expensively quality controlled, it is published with a delay of up to 1 year, thus the latest data is from early Summer 2019. 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 0.2. After this rigid filtering only 39 leftovers remain. The results are summarized in Figure 101Figure 100.:

- There is a highly linear relation between the AERONET and OLCI aot, the explained variance is 0.8.
- The data shows a systematic underestimation of 20%, contrary to the AERONET comparison. This is probably a sampling effect due to few points with high AOT.
- There is no linear relation for the Angström exponent.



S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 – S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

Page: 99

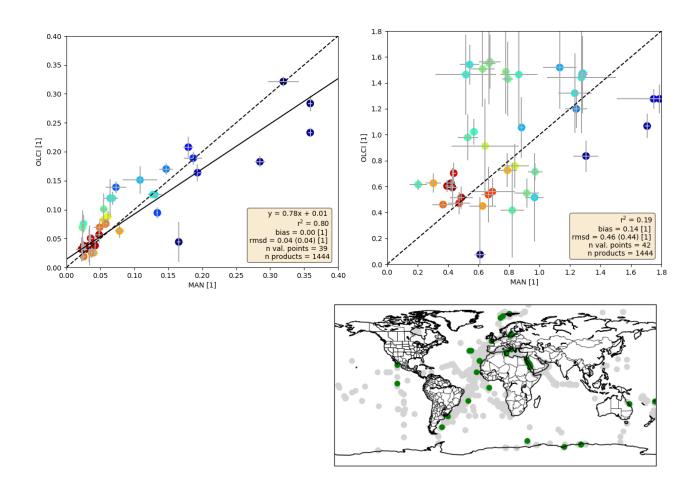


Figure 101: Upper left: OLCI aerosol optical thickness at 865nm against maritime Aeronet at 870nm, upper right: OLCIs Angström exponent at 865nm against the maritime Aeronet Angström exponent at 865nm-440nm. Lower right: positions of the used cruises.

5.5.3 Aeronet comparisons with OLCI B

36000 OLCI-B scenes within the period of June 2018 to January 2020 have been analysed so far. For a matchup, the temporal distance between the satellite overpass and the AERONET acquisition was less than 60 minutes. We used the AERONET L1.5, which is not is expensively quality controlled, but available in near time. As for OLCI A, only 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 0.2. Eventually the number of matchups reduced to 60 only. The results are shown in Figure 102. It becomes apparent, that OLCI B behaves like OLCI A:

There is a highly linear relation between the AERONET and OLCI AOT. The explained variance is 0.7.



S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 - S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

Page: 100

- Similar to OLCI-A, OLCI-B systematically overestimates AOT by 40%.
- The pattern of the Angström comparison is as for OLCI A; a weak relation, the majority around 1.4 and a systematic underestimate of OLCI by 0.3.

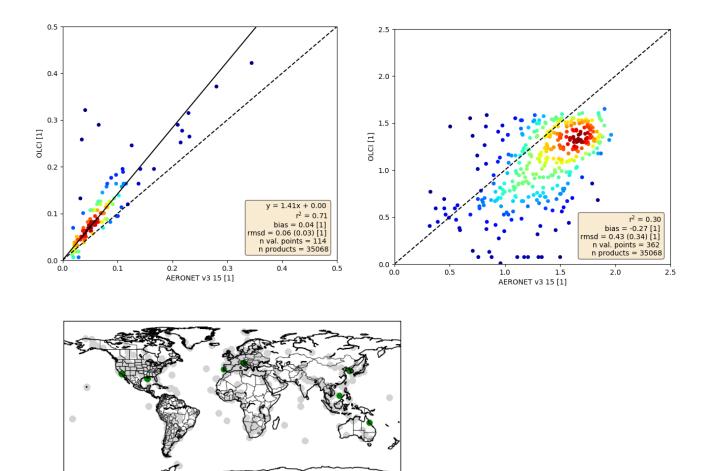


Figure 102: Upper left: OLCI aerosol optical thickness at 865nm against Aeronet v3 L1.5 AOT at 870nm, upper right: OLCIs Angström exponent at 865nm against the Aeronet v3 L1.5 Angström exponent at 865nm-440nm. The error bars correspond to the standard deviation within 10x10km (OLCI) or 60 minutes (AERONET). Lower: positions of the used AERONET stations.

5.5.4 Summary

The validation of OLCI aerosols products shows a high agreement for the aerosol optical thickness ($rmsd \sim 0.02$), if a systematic overestimation of around 40% is corrected. The Angström exponent agrees hardly ($r^2 = 0.2$), but the order of magnitude (1.6) is almost met (bias =-0.2). A validation of OLCI B using AERONET level 1.5 data, shows the same pattern as for OLCI A. The number of matchups with maritime AERONET is still too low to reach valid results.

SEXTINGEL 3 Mission Parformance Centre

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 – S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

Page: 101

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. 055 – S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

Page: 102

6 Validation of Integrated Water Vapour over Land & Water

The OLCI L2 IWV processor distinguishes between ocean and land surfaces and works very differently above the respective surfaces. The algorithm above water shows some serious flaws and therefor is under development. OLCI's IWV above land surface is validated using the following ground truth data:

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

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

6.1 Integrated water vapour above land

6.1.1 Validation of OLCI A IWV using GNSS

380,000 potential matchups within the period of June 2016 to January 2020 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. 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 103). The correlation between both quantities is 0.98 The root-mean-squared-difference is 2.2 kg/m². The systematic overestimation by OLCI is 12%. The bias corrected *rmsd* is 1.3 kg/m². Interesting is the strong seasonal pattern of the bias. This clearly belongs to the seasonality of water vapor in North Amerika. It is also partly visible in the systematic overestimation swinging 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. 055 – S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

Page: 103

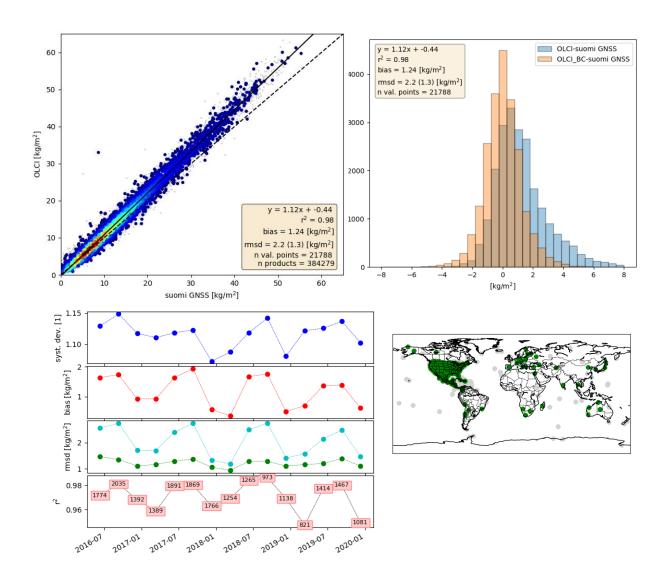


Figure 103: Upper left: Scatter plot of the IWV products, derived from OLCI A above land and from SUOMI NET GNSS measurements. Upper right: Histogram of the difference between OLCI and GNSS (blue: original OLCI, orange: bias corrected OLCI). Lower left: Temporal evolution of different quality measures (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)). Lower right: Positions of the GNSS stations (grey: no valid matchup)

Mission Performance Centre

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 – S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

Page: 104

6.1.2 Validation of OLCI A IWV using passive microwave radiometer at ARM sites

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). Currently 3 ARM sites are operated continuously, only the SGP (southern great planes) site provided cloud free measurements. 2600 potential matchups within the period of June 2016 to November 2019 have been analysed yet. Only OLCI measurements are taken for the validation which are above land and 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 110 valid matchups. The comparison shows a very high agreement (Figure 104Figure 103). The correlation between both quantities is 0.99. The root-mean-squared-difference is 1.4 kg/m². The systematic overestimation by OLCI is 8%. The bias corrected *rmsd* is 0.8 kg/m², close to the uncertainty of ARM. The investigation of the temporal evolution shows the same seasonal pattern as the GNSS comparisons, again belonging to the same seasonality of water vapor in North Amerika.

Mission Performance Centre

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 – S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

Page: 105

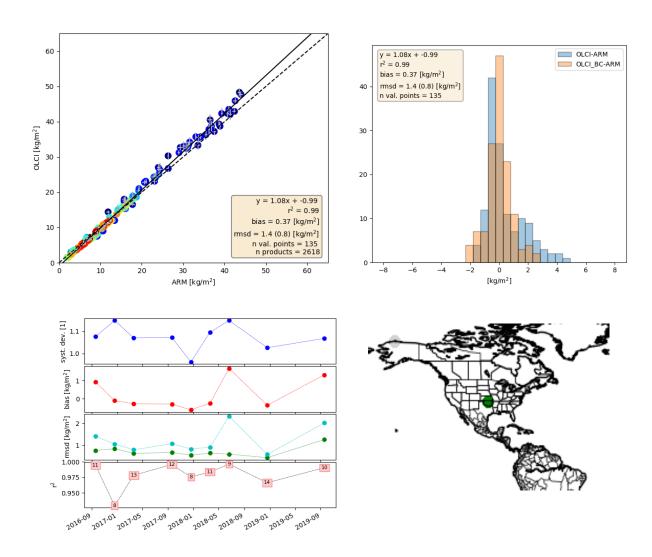


Figure 104: Upper left: Scatter plot of the IWV products, derived from OLCI A above land and from AMR MWR.

Upper right: Histogram of the difference between OLCI and ARM (blue: original OLCI, orange: bias corrected OLCI). Lower left: Temporal evolution of different quality measures (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)). Lower right: Position of ARM SGP.



S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 – S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

Page: 106

6.1.3 Validation of OLCI A IWV using GRUAN radiosonde observations

Radiosonde observations of temperature, humidity and pressure allow a direct integration of water vapour. The emphasis of GRUAN is to provide long-term, highly accurate measurements of the atmospheric profile. This is achieved by a very rigid quality control and uncertainty quantification. From the 3200 potential matchups within the period of June 2016 to November 2019, 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 radiosonde launch place. For the cloud detection, the standard L2 cloud-mask has been applied (including the cloud ambiguous and cloud margin flags). Eventually only 38 valid matchups could be used. This number is less than the number of valid matchups for the ARM site, since radiosondes launches are rare. That is why the time constraints have been relaxed to 6h. Still, the comparison shows a very high agreement (Figure 105). The correlation between both quantities is 0.99. The root-mean-squared-difference is 2.4 kg/m². The systematic overestimation by OLCI is 12%. The bias corrected *rmsd* is 1.3 kg/m². The number of valid matchups is currently too low to investigate a temporal evolution.

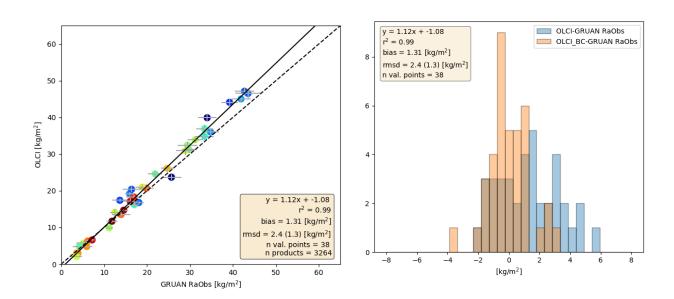


Figure 105: Left: Scatter plot of the IWV products, derived from OLCI A above land and from GRUAN radiosonde measurements. Right: Histogram of the difference between OLCI and GRUAN (blue: original OLCI, orange: bias corrected OLCI).

6.1.4 Validation of OLCI A IWV using AERONET observations

Aeronet observations, regardless not primary made for water vapour, allow the direct 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). We are using AERONET for the IWV comparison, since AERONET data are better globally



S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 – S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

Page: 107

distributed, than ARM and SUOMINET, and are more frequent than GRUAN. Since, the AERONET L2 is stringently quality controlled, it is published with a delay of up to 1 year, thus the latest AERONET data used here is from early Summer 2019. 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 87000 potential matchups within the period of June 2016 to September 2019, 17000 valid matchups could be used. (Figure 106). The correlation between both quantities is 0.96. The root-mean-squared-difference is 3.7 kg/m². The systematic overestimation by OLCI is 19%. The bias corrected *rmsd* is 1.8 kg/m². The systematic deviation between OLCI and AERONET of 19% is significantly larger than the one found for GNSS, ARM and GRUAN (~10%). We think that this stems from a dry bias of AERONET and accordingly deficits in the operational algorithm, but we have not investigated it deeper.

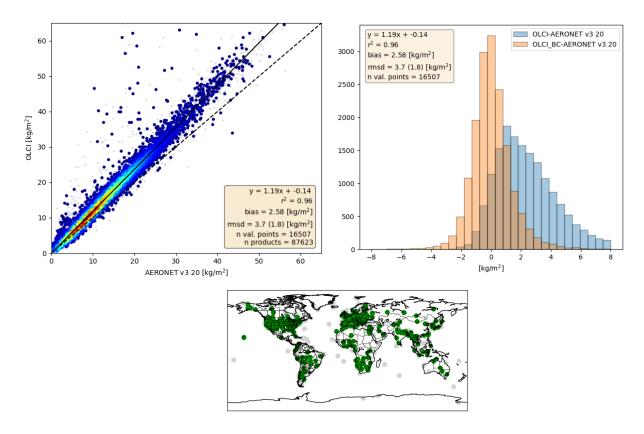


Figure 106: Upper left: Scatter plot of the IWV products, derived from OLCI A above land and from AERONET.

Upper right: Histogram of the difference between OLCI and AERONET (blue: original OLCI, orange: bias corrected OLCI). Lower: Positions of the used AERONET stations (grey: no valid matchup).

6.1.5 Validation of OLCI B IWV

74000 potential matchups within the period of June 2018 to November 2019 have been analysed yet. 5000 of them are valid for SUOMI-NET CONUS ground stations in North and Central America, 34 for ARM MWR and 6500 for AERONET. As for OLCI A, only measurements are taken for the validation which are above land and are cloud-free in an area of about 10x10 km² around the corresponding stations. For the



S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 - S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

Page: 108

cloud detection, the standard L2 cloud-mask has been applied (including the cloud ambiguous and cloud margin flags). The comparison of OLCI B shows almost identical results as for OLCI A (Figure 107).

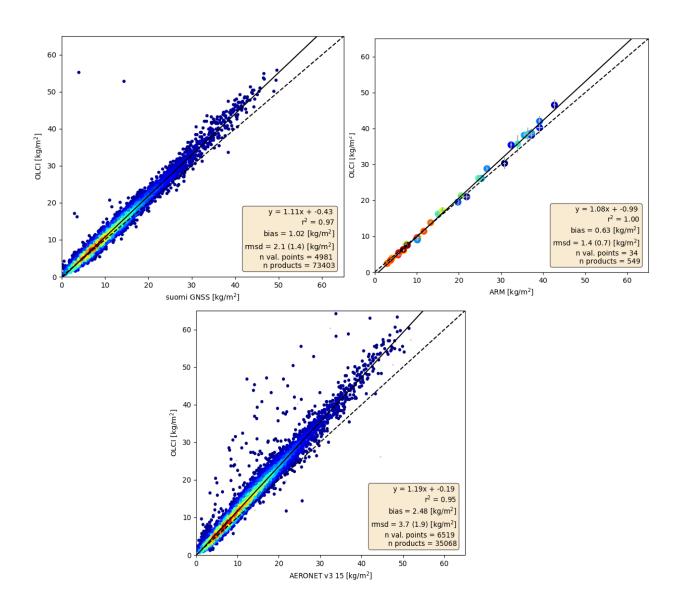


Figure 107: Scatter plot of the IWV products, derived from OLCI B above land and from SUOMI NET GNSS measurements (upper left), from ARM MWR (upper right) and AERONET (lower)



S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 – S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

Page: 109

6.2 Summary

The validation exercise of the OLCI A IWV over land product using 4 different sources of ground truth showed consistently, that the product is of high quality (bias corrected root mean squared distance of down to 1.5 -0.8 kg/m²). However, there is a systematic overestimation of 9% to 13%. Validation of OLCI B shows the same results.

6.3 References

- Bodeker, G. E., Bojinski, S., Cimini, D., Dirksen, R. J., Haeffelin, M., Hannigan, J. W., Hurst, D. F., Leblanc, T., Madonna, F., Maturilli, M., Mikalsen, A. C., Philipona, R., Reale, T., Seidel, D. J., Tan, D. G. H., Thorne, P. W., Vömel, H., and Wang, J.: Reference upper-air observations for climate: From concept to reality, B. Am. Meteorol. Soc., doi:10.1175/BAMS-D-14-00072.1, 2015.
- Holben, B. N., et al., AERONET—A federated instrument network and data archive for aerosol characterization, Remote Sens. Environ.,66, 1–16, 1998.)
- Immler, F. J., Dykema, J., Gardiner, T., Whiteman, D. N., Thorne, P.W., and Vömel, H.: Reference Quality Upper-Air Measurements: guidance for developing GRUAN data products, Atmos. Meas.Tech., 2, 1217–1231, doi:10.5194/amt-3-1217-2010, 2010.
- 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.
- 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.



S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 – S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

Page: 110

7 Level 2 SYN products validation

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

Sentinel 3 Mission Performance Centre

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 – S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

Page: 111

8 Events

For OLCI-A, two Radiometric Calibration Sequences have been acquired during Cycle 055:

- So1 sequence (diffuser 1) on 14/02/2020 13:30 to 13:32 (absolute orbit 20801)
- S01 sequence (diffuser 1) on 27/02/2020 17:54 to 17:56 (absolute orbit 20989)

For OLCI-B, three Radiometric Calibration Sequences have been acquired during Cycle 036:

- S01 sequence (diffuser 1) on 27/02/2020 08:49 to 08:51 (absolute orbit 9590)
- S01 sequence (diffuser 1) on 11/03/2020 09:51 to 09:53 (absolute orbit 9776)

Mission Performance Centre

Sentinel-3 MPC

S3 OLCI Cyclic Performance Report

S3A Cycle No. 055 – S3B Cycle No. 036

Ref.: S3MPC.ACR.PR.01-055-036

Issue: 1.0

Date: 26/03/2020

Page: 112

9 Appendix A

Other reports related to the Optical mission are:

❖ S3 SLSTR Cyclic Performance Report, S3A Cycle No. 055, S3B Cycle No. 036 (ref. S3MPC.RAL.PR.02-055-036)

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

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