Technical Note on Quality Assessment for OceanSat-2 OCM (Quarterly report for Q1 2020)

Author(s): ***Samantha Lavender***
Task 2 Mission Expert

Approval: ***Amy Beaton***
Task 2 Lead

Accepted: ***Clement Albinet***
EOP-GMQ EDAP Technical Officer

EDAP.REP.033 *Issue: 1.0* *04 June 2020*

AMENDMENT RECORD SHEET

The Amendment Record Sheet below records the history and issue status of this document.

ISSUE	DATE	REASON
0.1	05/05/2020	First EDAP version (Report No. 5)
1.0	04/06/2020	Revised version addressing ESA comments

TABLE OF CONTENTS

1. INTRODUCTION

This document is the Q1 2020 (January – March 2020) quarterly Quality Assessment (**QA**) report for the latest Ocean Colour Monitor (**OCM**) instrument, OCM-2, on-board the Indian satellite, OceanSat-2.

This QA provides a series of product checks, using a sample of OCM-2 products retrieved through ESA's *Online Dissemination* service, that relate to product format consistency as well as product content consistency and quality. This QA also provides a derivation of product quality statistics.

1.1 Reference Documents

The following is a list of documents with a direct bearing on the content of this report. Where referenced in the text, these are identified as RD.n, where 'n' is the number in the list below:

[RD.1] Oceansat-2 Quarterly Report No.1, IDEAS+-VEG-OQC-REP-2655, Issue 1.0, 5 December 2016.

[RD.2] EDAP Mission Quality Assessment Guidelines, Issue 1.2, 19 July 2019.

[RD.3] Oceansat-2 Quarterly Report No.5, IDEAS+-VEG-OQC-REP-2892, Issue 1.0, December 2017.

[RD.4] EO-SIP Specialisation for OceanSat-2 Mission, EMSS-EOPG-TN-15-002, Issue 1.0, 19 October 2015.

[RD.5] Technical Note on Quality Assessment for OceanSat-2 OCM (Quarterly report for Q4 2018), EDAP.REP.004, Issue 0.2, March 2019.

[RD.6] Natural Earth datasets, accessible at http://www.naturalearthdata.com/

[RD.7] Chauhan *et al.* 2002. Surface chlorophyll a estimation in the Arabian Sea using IRS-P4 Ocean Colour Monitor (OCM) satellite data, *International Journal of Remote Sensing*, 23:8, 1663-1676, DOI: 10.1080/01431160110075866.

[RD.8] DIMITRI Software User Manual, v3.1.1, 20 February 2015.

[RD.9] Technical Note on DIMITRI Quality Assessment for OceanSat-2 OCM (Internal report), EDAP.REP.014, Issue 1.0, January 2020.

[RD.10] Zibordi *et al.* 2009. AERONET-OC: A Network for the Validation of Ocean Color Primary Products. *J. Atmos. and Oceanic Technology*. 26: 1634-1651 (DOI:10.1175/2009JTECHO654.1).

[RD.11] Technical Note on Quality Assessment for OceanSat-2 OCM (Quarterly report for Q1 2019), EDAP.REP.005, Issue 0.21, April 2019.

[RD.12] OCM-2 (OCEANSAT-2) LEVEL-2 HDF Data Products Format, v1.4, April 2017.

[RD.13] Preethi Latha *et al.* 2014. Validation of Chlorophyll-a concentrations in the Estuarine Waters of Bay of Bengal using OCM-2 Data: A case study in the Godavari basin, *J. Indian Soc. Remote Sens.*, 42(1): 129-138.

[RD.14] O'Reilly *et al.* 1998. Ocean color chlorophyll algorithms for SeaWiFS. *Journal of Geophysics*, 103: 24937–24963.

[RD.15] Shanthi et al. 2013. Validation of OCM-2 sensor performance in retrieving chlorophyll and TSM along the southwest Bay of Bengal coast, *J. Earth Syst. Sci.,* 122(2): 479–489.

[RD.16] Baret *et al.* 2009. Report on the CEOS Land Product Validation Sub-group Meeting. *The Earth Observer*, 21(6): 26-30.

[RD.17] Bailey, S.W. and Werdell, P.J. 2006. A multi-sensor approach for the on-orbit validation of ocean color satellite data products. *Rem. Sens. Environ*, 102: 12-23.

2. EXECUTIVE SUMMARY

The aim has been to ensure, principally, that the format and content (i.e. radiance and geophysical data) of OCM-2 products (L1B, L2B and L2C), already available to users, are of suitable quality.

This Quarterly QA report updates the previous reporting to include the daily data acquired during January to March 2020; performed by following the QA process and tools (e.g. QA scripts) detailed in [RD.1] and since improved upon within successive EDAP reports.

Going forward, within EDAP, the aim is to expand the quarterly reporting in the following ways:

- Expand the sensor comparison to include Top of Atmosphere data: started and detailed in Section 4.4.1. (not the focus on this update)
- Expand the in-situ comparison to a higher number of AERONET-OC stations: detailed in Section 4.4.2. and expanded over time.

2.1 EDAP Quality Assessment

An assessment has been performed using the National Physical Laboratory (**NPL**) EDAP guidelines [RD.2], with the summary reported in Figure 1 and detailed analysis within Section 3. With each iteration of this report, the available documentation has been checked and updated where necessary.

Product Details	Product Generation	Ancillary Information	Uncertainty Characterisation	Validation
Product Information	Sensor Calibration & Characterisation Pre-Flight	Product Flags	Uncertainty Characterisation Method	Reference Data Representativeness
Availability & Accessibility	Sensor Calibration & Characterisation Post-Launch	Additional Information	Uncertainty Sources Included	Reference Data Quality
Product Format	Retrieval Algorithm Method	If target mission data product is Level 2	Uncertainty Values Provided	Validation Method
User Documentation	Retrieval Algorithm Tuning		Geolocation Uncertainty	Validation Results
Metrological Traceability Documentation	Additional Processing			

Key
Not Assessed
Not Assessable
Basic
Intermediate
Good
Excellent

Information Not Public

Figure 1 – OCM-2 Quality Evaluation Matrix

2.2 OCM-2 Detailed Assessment

For this QA period, OCM-2 products were assessed from January to March 2020 with older products included within the plots. The Product Format Consistency Check was repeated for a small number of products alongside an update of the time-series for the Product Content Check. Also, a Product Coverage check was added as it was noticed that the spatial coverage didn't always match what was expected.

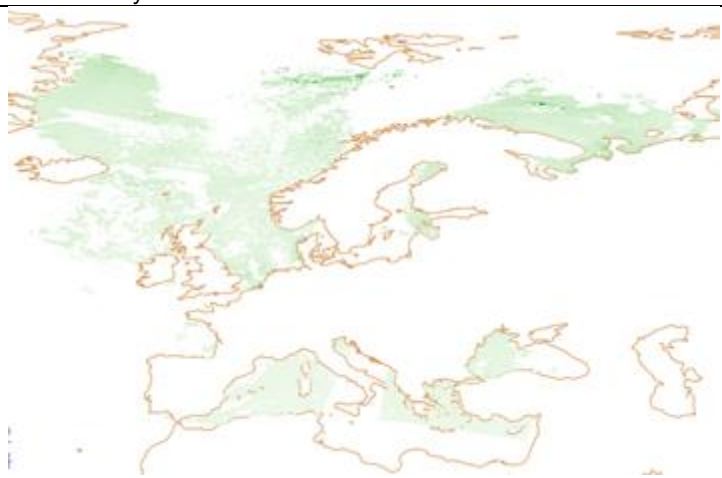
The results are summarised in Table 1.

Table 1. OCM-2 Q1 2020 QA Summary Results

OCM-2 Product Type	Product Format Consistency Check	Product Content Check	Comment
L1B	Six dates analysed and no issues detected – historical detailed analysis in [RD.2],	N/A	-
L2B	No issues detected – see above, for scenes being analysed	N/A	-
L2C	No issues detected – see above, for scenes being analysed	No issues detected	Sections 4.2, 4.3 and 4.4 for detailed analysis

3. EDAP QUALITY ASSESSMENT

3.1 Product Details

Product Information	
Product Name	Oceansat-2 OCM2 Level 1 (**L1**) Local Area Coverage (**LAC**) products downlinked then processed on behalf of ESA, by GAF/NSG, to Level 2 (**L2**)
Sensor Name	OCM2
Sensor Type	Optical – Multichannel spectrometer
Product Version Number	Not provided
Product ID	OC2_OPER_OCM2
Processing level of product	L1 B and L2 B & C
Measured Quantity Name	L1: Radiance L2: CL for Chlorophyll-a concentration; DA for Vertical Diffuse attenuation coefficient (Kd) at 490-nm; SE for Total Suspended Matter concentration; AO for Aerosol Optical Depth
Measured Quantity Units	L2 nLw: W cm^{-2} nm^{-1} sr^{-1} L2: CL 0.0 – 60.0 mg m^{-3}; DA 0.01-0.50 m^{-1}; SE 0.0-200 mg L^{-1}; AO 0.0-1.0 unitless
Stated Measurement Quality	Not provided
Spatial Resolution	L1 A & B: 360 by 236 m L2 C: 360 by 360 m
Spatial Coverage	
Temporal Resolution	Daily
Temporal Coverage	October 2015 onwards
Mission coverage	Global
Point of Contact	ESA Helpdesk
Product locator (DOI/URL)	ESA: https://tpm-ds.eo.esa.int/oads/access/collection/OceanSat2 Space Applications Centre, India: https://mosdac.gov.in/data/Missions/oceansat/oscat_home.jsp Global Area Coverage (**GAC**) available free of charge, while LAC data is charged for.
Conditions for access and use	ESA Single Sign-On (**SSO**) account
Limitations on public access	Registration with ESA

Product Abstract	N/A

Product Availability & Accessibility	
Compliant with FAIR principles	ESA archive is available for download after registration
Data Management Plan	Not available to users
Availability Status	Near-Real-Time availability within the ESA archive

Product Format	
Product File Format	HDF
Metadata Conventions	Metadata file provided (filename.meta within product directory) – list of parameters detail in the product specification documents
Analysis Ready Data?	Yes – L2C

Product User Documentation		
Document	*Reference*	*QA4ECV Compliant*
Product User Guide (**PUG**)	• OceanSat-2-Level-1-Product-Specifications, Ver. 1.1, Jun 2010 • OceanSat-2-Level-2-Product-Specifications, Ver. 1.4, Apr. 2017 • PDF on IOCCG website: www.ioccg.org/sensors/OCM-2.pdf	N/A
Algorithm Theoretical Basis Document (**ATBD**)	Not publicly available, but peer-reviewed papers are published, see Section 3.2	N/A

Metrological Traceability Documentation	
Document Reference	Error budget mentioned from Sriperambudur et al. (2015) http://dx.doi.org/10.4236/ojms.2015.54035
Traceability Chain / Uncertainty Tree Diagram Available	Level 1: not provided Level 2: • Normalized water leaving radiance (nLw) < 5% - not provided as a product • CL <30%; DA < 15%; SE < 20%; AO < 20%

3.2 Product Generation

Sensor Calibration & Characterisation – Pre-Flight	
Summary	Sensor characterisation: spatial and radiometric
References	• Pre-launch calibration & Post-launch performance, May 2013 https://iocs.ioccg.org/wp-content/uploads/1450-samir-pal-ocm-2.pdf

Sensor Calibration & Characterisation – Post-Launch	
Summary	Sensor characterisation includes:

	• On-board calibration using Light-Emitting Diodes (**LEDs**) • Vicarious calibration using an oceanographic buoy • Lunar calibration • Spatial and radiometric Image-based characterization system
References	• Pre-launch calibration & Post-launch performance, May 2013 https://iocs.ioccg.org/wp-content/uploads/1450-samir-pal-ocm-2.pdf • Post-launch calibration of Ocean Colour Monitor 2 using Kavaratti CAL-VAL site observations, Jan 2013 https://www.currentscience.ac.in/Volumes/104/01/0023.pdf • Update of post-launch vicarious, lunar calibrations & current status, June 2015 https://iocs.ioccg.org/2015/files/THU-935-BO9-Chauhan-Calibration.pdf • Cross-calibration of the Oceansat-2 Ocean Colour Monitor (OCM) with Terra and Aqua MODIS, May 2016, https://doi.org/10.1117/12.2224046

Retrieval Algorithm Method *(Include for Level 2 Products Only)*	
Summary	ATBD is not made publicly available: • Sriperambudur et al. (2015) lists SeaDAS (https://seadas.gsfc.nasa.gov/) as the processor for HDF files • Shanthi et al. (2013) validated the Chlorophyll and TSM products, highlighting that OCM-2 underestimated the high chlorophyll concentration (in-situ) and overestimates the low chlorophyll concentration (in-situ). For TSM, OCM-2 values consistently underestimated the in-situ measurements. • Nagamani et al. (2008) developed an empirical Chlorophyll algorithm for the future launch of OCM-2 based on NASA's NOMAD in-situ datasets
References	• Sriperambudur et al. (2015) http://dx.doi.org/10.4236/ojms.2015.54035 • Shanthi et al. (2013) J. Earth Syst. Sci. 122(2), pp. 479–489 • Nagamani et al. (*2008*) https://ieeexplore.ieee.org/document/4558016

Retrieval Algorithm Tuning *(Include for Level 2 Products Only)*	
Summary	No relevant documentation has been found.
References	N/A

Additional Processing	
Description	No relevant documentation has been found.
Reference	N/A

3.3 Ancillary Information

Product Flags	
Product Flag Documentation	OceanSat-2-Level-2-Product-Specifications, Ver. 1.4, Apr. 2017
Comprehensiveness of Flags	Section 5.1.8, L2 Flag Data Group – brief description of the L2 product flags

Additional Information	
Ancillary Data Documentation	None provided

Comprehensiveness of Data	N/A
Uncertainty Quantified	N/A

3.4 Uncertainty Characterisation

Uncertainty Characterisation Method	
Summary	No relevant documentation has been found.
Reference	N/A

Uncertainty Sources Included	
Summary	No relevant documentation has been found.
Reference	N/A

Uncertainty Values Provided	
Summary	No relevant documentation has been found.
Reference	N/A
Analysis Ready Data?	N/A

Geolocation Uncertainty	
Summary	The geolocation is visually assessed within Section 4.4.2 where the data is displayed alongside the Natural Earth [RD.6] vector coastline layer at 50 m resolution within QGIS. The two inputs match within the uncertainty of the coastline itself, and there is no indication of systematic errors due to attitude or other errors.
Reference	N/A

3.5 Validation

Validation Activity #1	
Independently Assessed?	Yes – within this report for the derived L2 Chlorophyll-a product
Reference Data Representativeness	
Summary	For this report, we have used data from two AERONET-OC stations and BOUSSOLE with further expansion expected in future iterations. Other, referenced papers, have used cruise measurements.
Reference	Section 4.4.2
Reference Data Quality & Suitability	

Summary	The AERONET-OC stations and BOUSSOLE have known origins while the data quality of the reference data used within the cited peer-reviewed papers is less quantifiable; one paper uses fluorometrically derived Chlorophyll while the other is based on High Performance Liquid Chromatography (**HPLC**).
Reference	Section 4.4.2
Validation Method	
Summary	Follows the marine approach that is defined in [RD.17]
Reference	Section 4.4.2
Validation Results	
Summary	Simple plots at this stage
Reference	Section 4.4.2

4. DETAILED OCM-2 ASSESSMENT

This QA is performed using a sample of OCM-2 L1B (local area coverage radiance products), L2B (local area coverage products as four geophysical parameters: Chlorophyll-a concentration (**clo**), aerosol optical depth (**aod**), total suspended matter (**tsm**) and depth attenuation coefficient (**dac**)) and L2C (local area coverage geo-referenced products as four geophysical parameters) products that have been downloaded for all scenes (i.e. all tracks and frames) applicable to a selection of dates between the 01 January 2017 and 31 March 2020 (dates chosen within this reporting period, based on presence of reduced cloud cover).

4.1 Product Format Consistency Checks

At this stage of the QA process, product format consistency checks are performed on the retrieved OCM-2 products to ensure that, as far as possible, the correct input files were used in the relevant processing stage(s) and that the product format conforms to the format defined in the *EO-SIP Specialisation for OceanSat-2 Mission* document [RD.4].

4.1.1 Product Format Consistency Check Results

For the format consistency check*, a total of 549 OCM-2 products were checked previously [RD.5], and all were shown to have used the correct input files and be of the correct product format; see Table 2. Since then, a smaller number of files have been checked within the period under analysis and for this period that was 6 files.

Table 2. OCM-2 EO-SIP Consistency Check

OCM-2 Product Type	Product SIP Information File	Product Metadata File	Product HDF File**
L1B	6/6	6/6	N/A
L2B	6/6	6/6	N/A
L2C	6/6	6/6	6/6

**The consistency check does not include checking for the existence of a QL/browse image (.png file).*

**The consistency check for *each L2C product includes an additional check of the HDF files found, and their validity, within the (further zipped) product folder.*

4.2 Product Coverage Check

L2C inconsistencies in data coverage were discovered, in particular, (as seen in Figure 5) the OCM-2 composite is missing data in the western Mediterranean region for the chosen date. After confirmation of all available L2C data being retrieved from the ESA portal, and composited, an investigation was conducted into the product coverage available on the online portal.

The OCM-2 orbital coverage results in 2 sets of coverage patterns that alternate daily. The first set contains 15 scenes with sections of the western and eastern Mediterranean not

having any coverage (as seen in Figure 2). The second set has 13 scenes and lacks coverage in the central Mediterranean, southern Italy and the Portuguese Atlantic Ocean (as seen in Figure 3). The coverage indicated on the ESA portal can also be an overestimate due to the simplification in how the extent is displayed, e.g. in Figure 2 the Mediterranean scene coverage appears to extend as far as the middle of Crete but Figure 5 shows the cut-off is through Greece and Crete itself is not covered.

Figure 2: Image of data coverage lacking data for the eastern and far western Mediterranean.

Figure 3: Image of data coverage lacking for the central Mediterranean and Portuguese Atlantic Ocean.

For the date range investigated, three dates were found not to have all of the expected L2C for unknown reasons. These dates included 3rd January 2020 missing one file, 7th February 2020 missing six files and the 12th February 2020 missing six files.

4.3 Product Content Checks

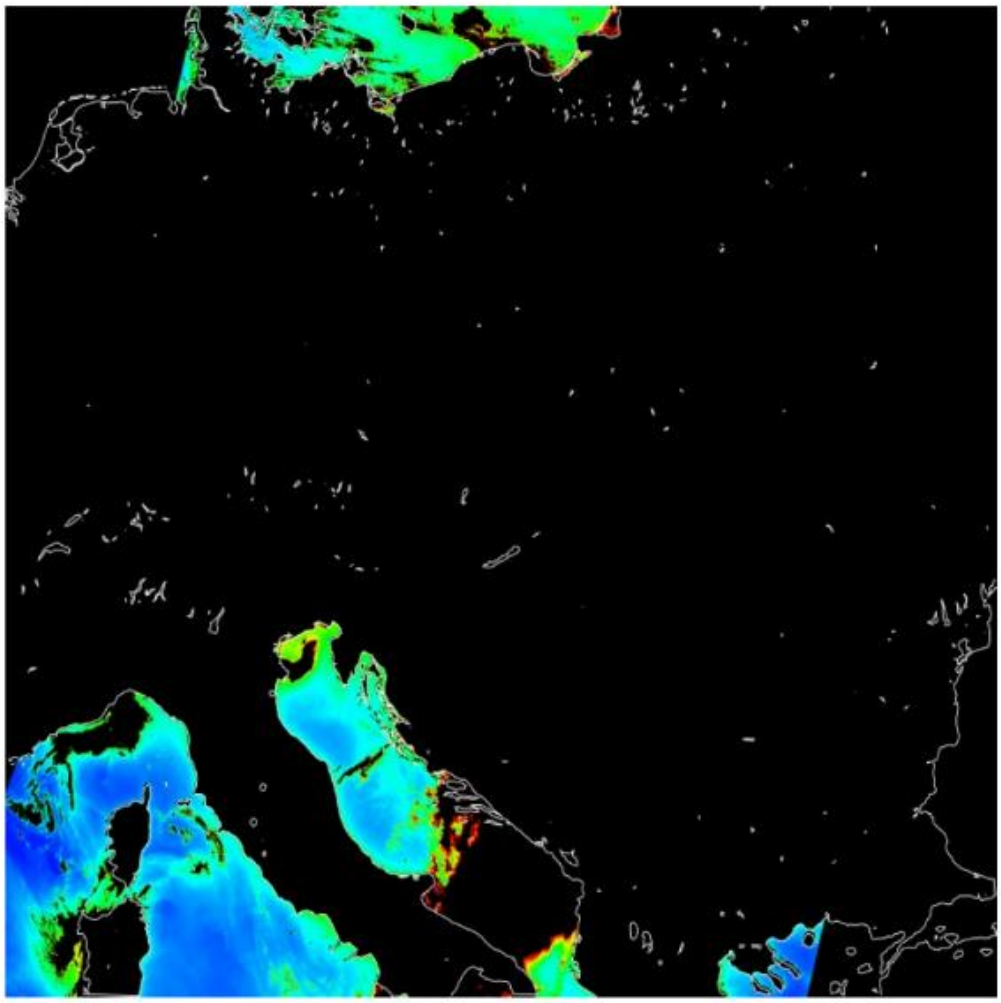
At this stage of the QA process, product content checks are performed. These checks use both the Quicklooks (**QLs**) and GeoTIFFs within the retrieved OCM-2 L2C products to visually assess product content (i.e. radiance and geophysical data) in terms of consistency and quality.

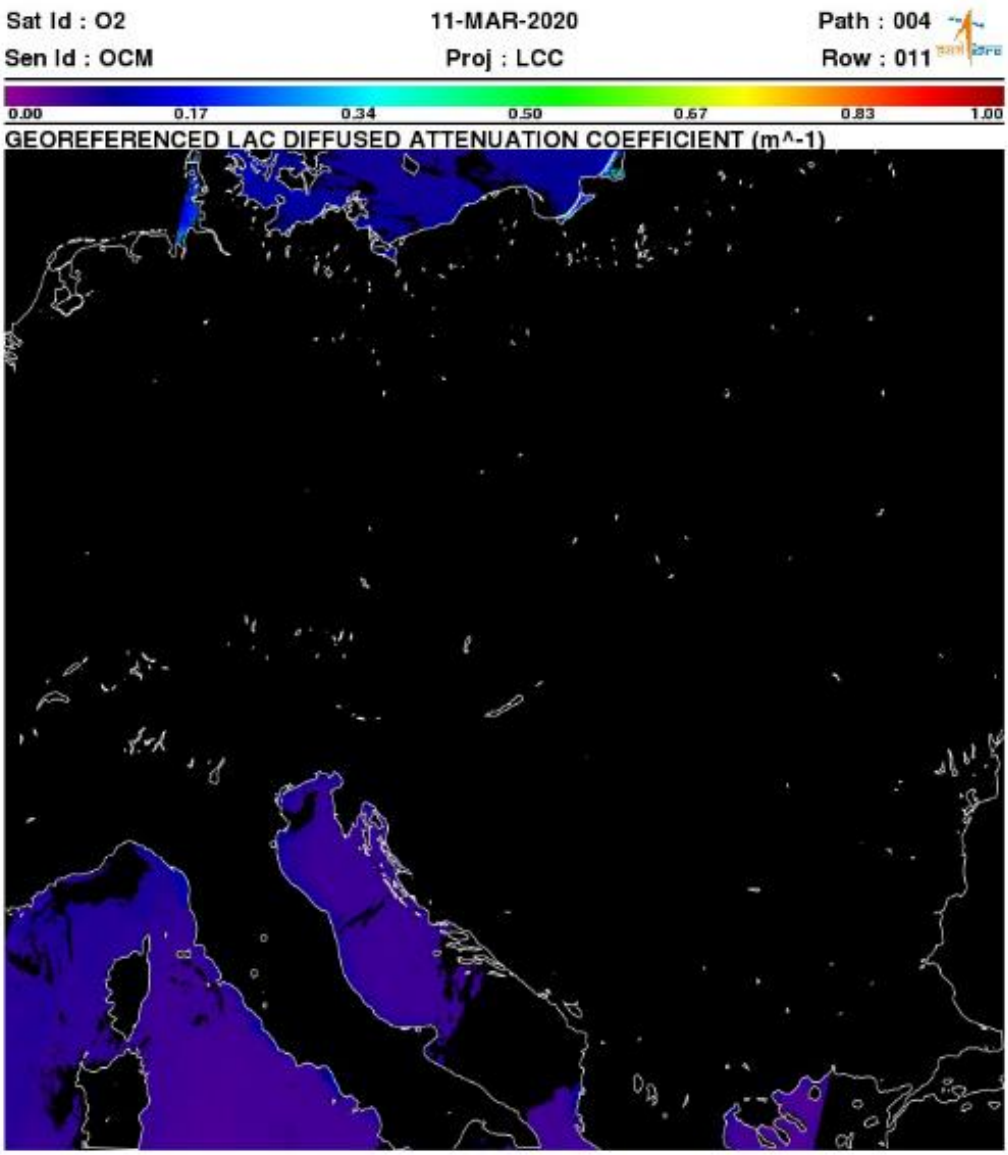
4.3.1 Product Content Check Results

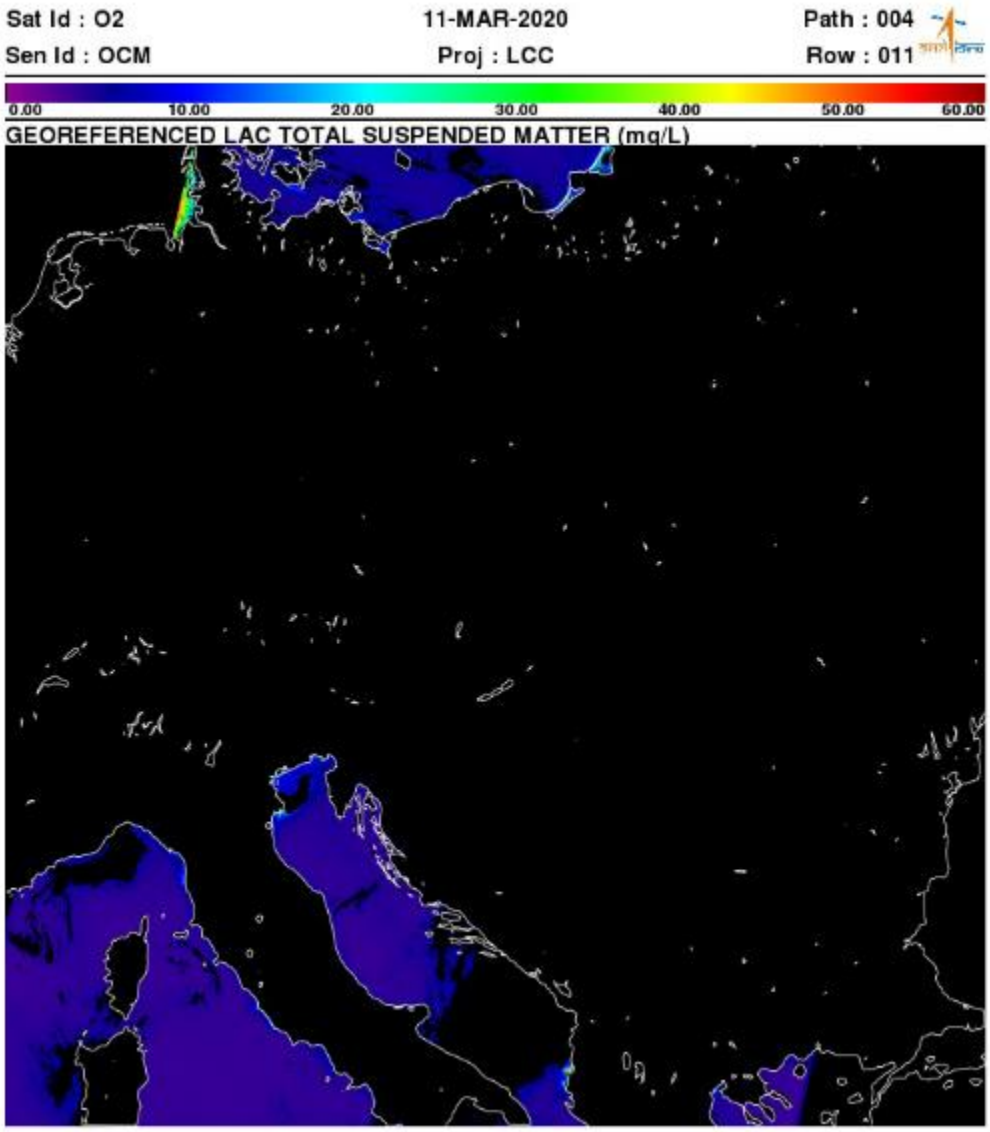
A selection of QLs, associated with the OCM-2 L2C products retrieved for this reporting period, are shown in Figure 4; it is important to note that the Chlorophyll-a concentration values provided in these OCM-2 QLs are restricted by a pre-specified range (i.e. $0 \leq clo \leq 5$ mg.m^{-3}) and not the actual range. Therefore, consistency and quality assessments on Chlorophyll-a concentration values cannot be accurately performed using the QLs alone.

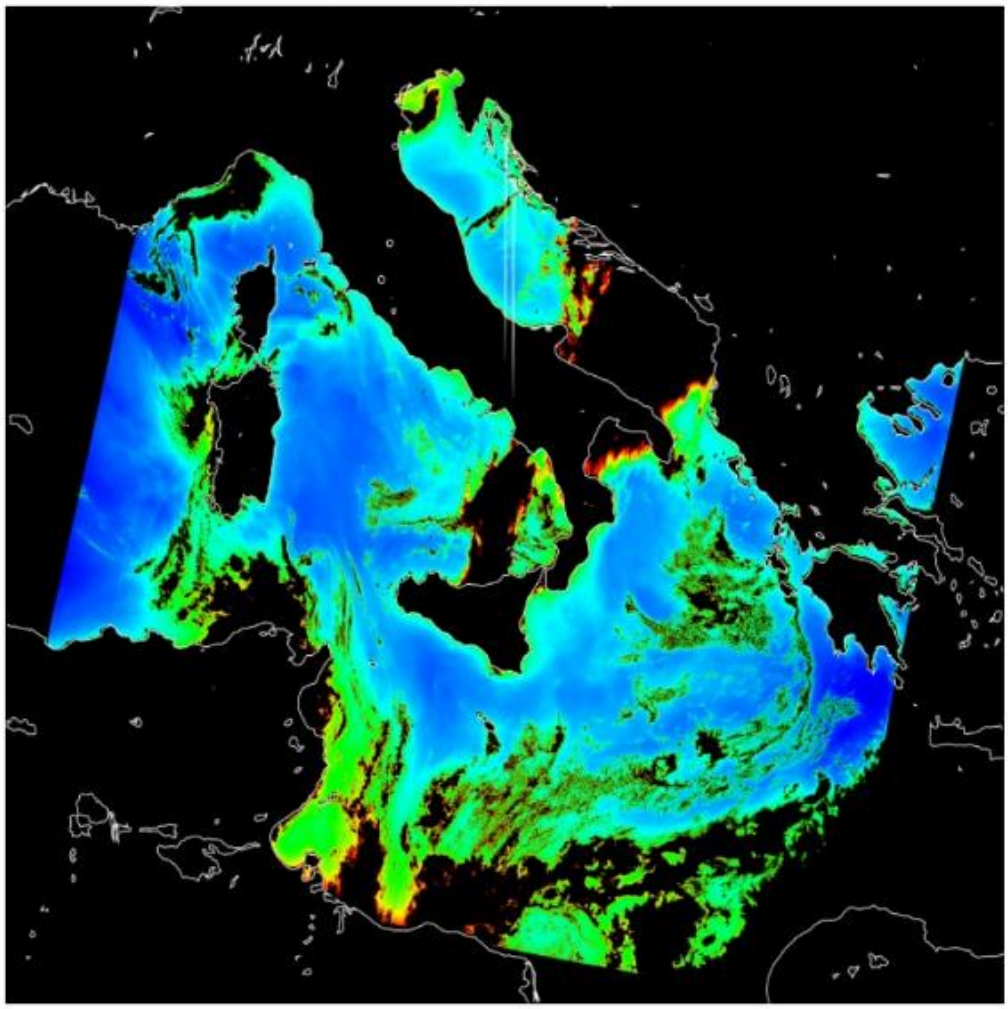
The Chlorophyll-a concentration consistency and quality assessments are best performed using the Chlorophyll-a concentration composite generated for this assessment (shown in Figure 5), which does not enforce a pre-specified range. It also includes the Natural Earth [RD.6] vector coastline layer at 50 m resolution, which allows geometric accuracy to be assessed visually. Overall, the OCM-2 composites are comparable to the estimations derived from the ocean colour products produced by NASA's MODIS-Aqua and Suomi-NPP VIIRS sensors (see Figure 6). The high concentrations in the southern North Sea and German Bight are related to suspended sediment, which is visible in the VIIRS true colour composite as lighter coloured water.

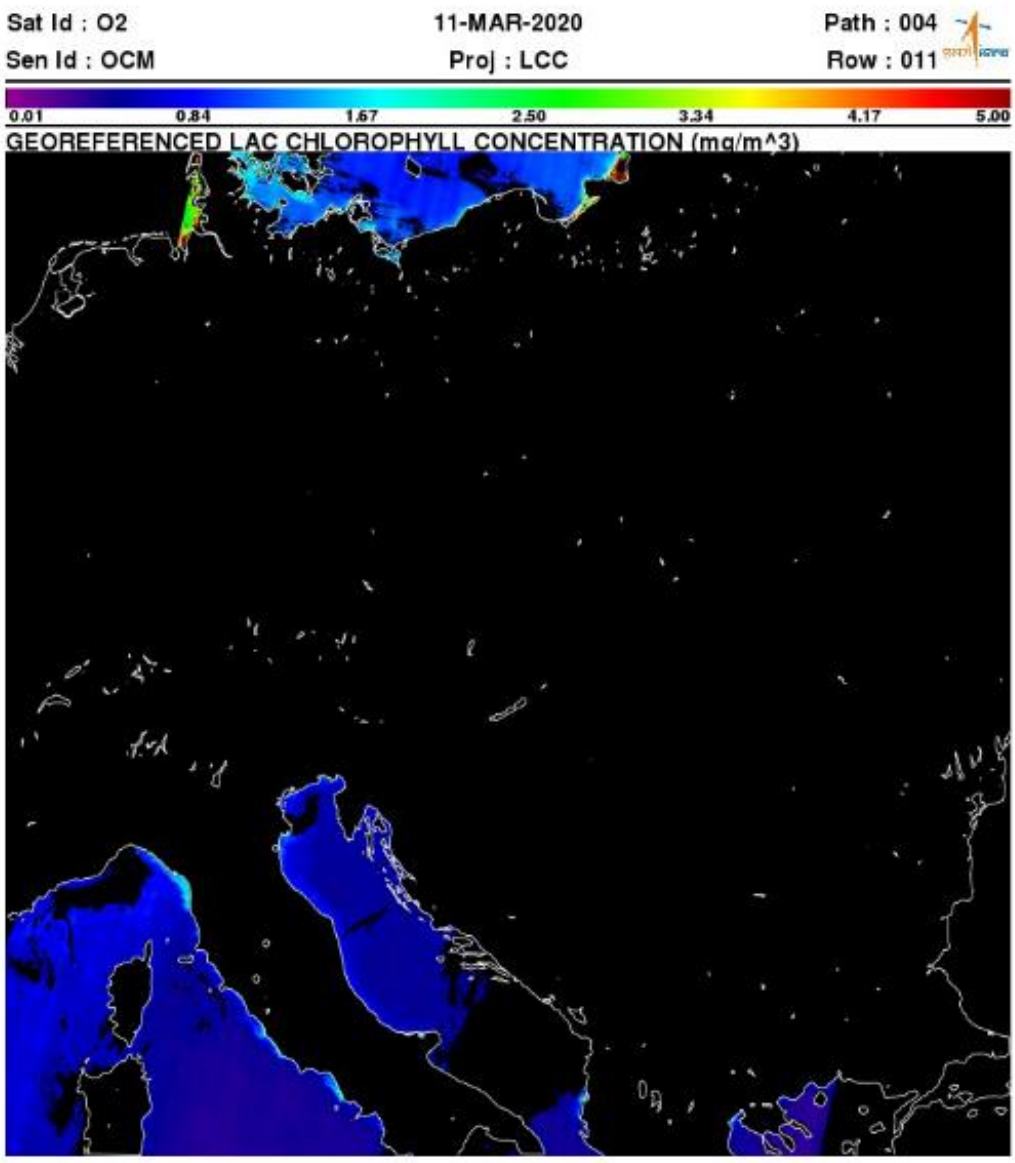
Note: In previously analysed imagery, as expected, poor Chlorophyll-a concentration estimations are seen to dominate high latitude regions where radiance retrievals are primarily impacted by the high solar zenith angles. Also, those regions that have dense cloud cover, coastlines and turbid coastal waters; as expected when using an 'open ocean' band ratio algorithm, e.g. [RD.7].




Sat Id : O2
11-MAR-2020
Path : 004
Sen Id : OCM
Proj : LCC
Row : 011
0.00
0.17
0.34
0.50
0.67
0.83
1.00
GEOREFERENCED LAC DIFFUSED ATTENUATION COEFFICIENT (m^-1)


Sat Id : O2
11-MAR-2020
Path : 004
Sen Id : OCM
Proj : LCC
Row : 011
0.00
10.00
20.00
30.00
40.00
50.00
60.00
GEOREFERENCED LAC TOTAL SUSPENDED MATTER (mg/L)




Sat Id : O2
11-MAR-2020
Path : 004
Sen Id : OCM
Proj : LCC
Row : 011
0.01
0.84
1.67
2.50
3.34
4.17
5.00
GEOREFERENCED LAC CHLOROPHYLL CONCENTRATION (mg/m^3)

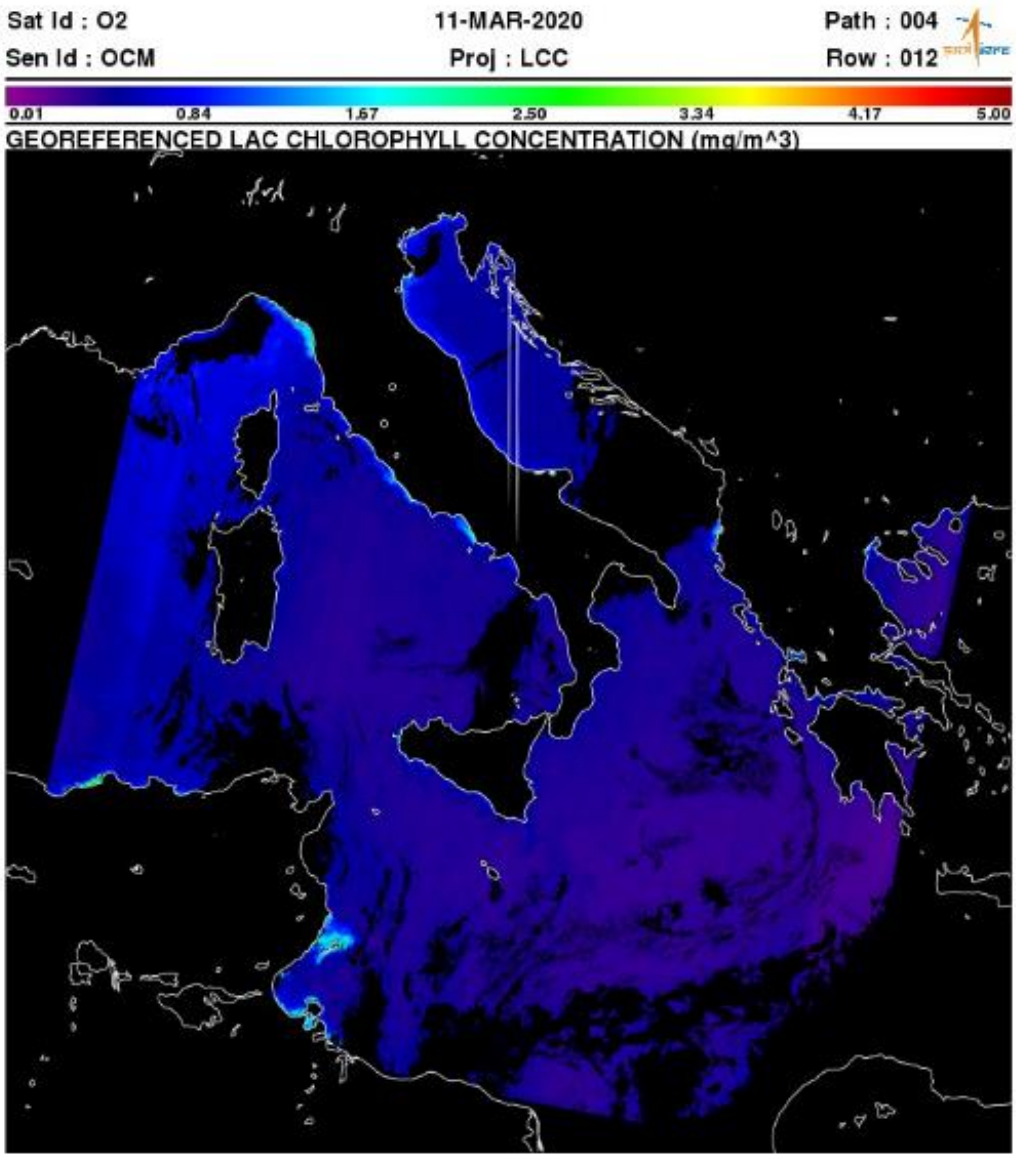


Figure 4. A sample of OCM-2 QLs for the 11th March 2020.

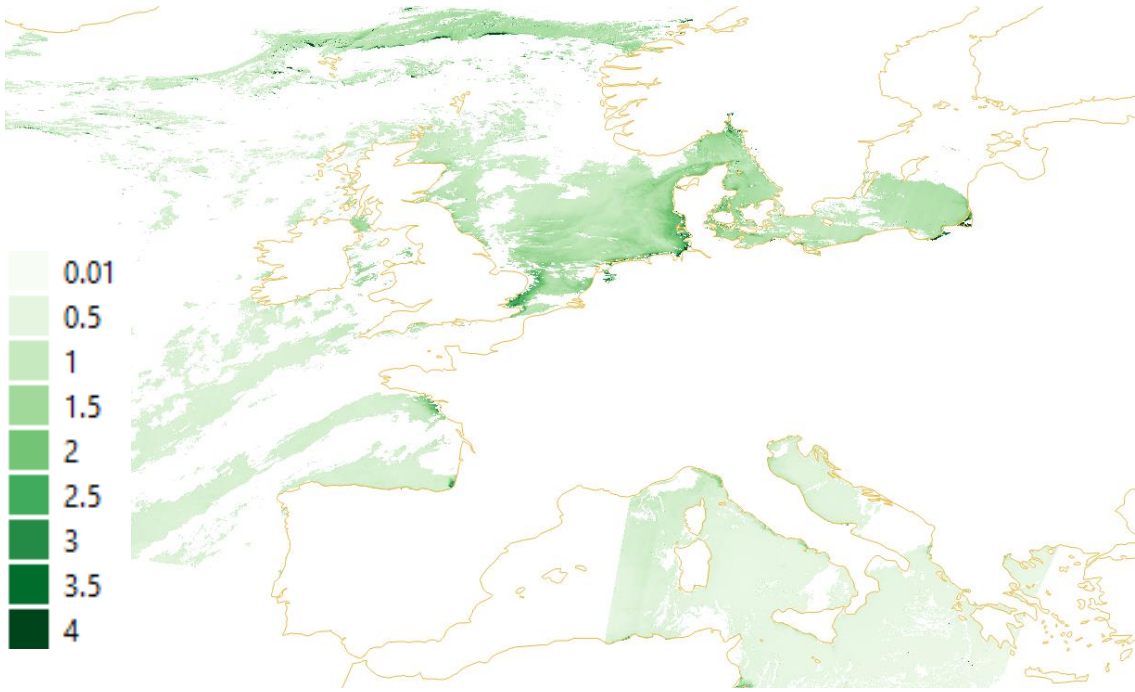


Figure 5. A snapshot from QGIS showing the daily Chlorophyll-a (mg/m3) composite using data from 11th March 2020.

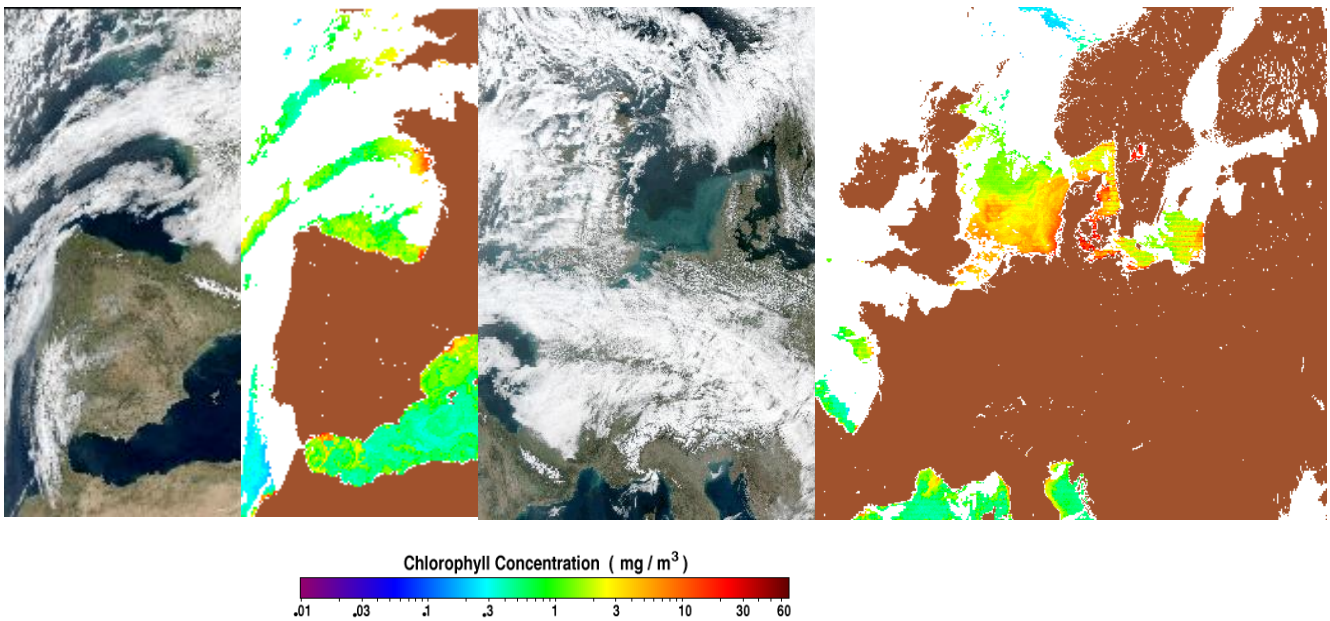


Figure 6. MODIS-Aqua and Suomi-NPP VIIRS Chlorophyll-a products from the 11th March 2020 (left to right, respectively) over Central Europe as the true colour composite and then chlorophyll product.

4.4 Product Quality Assessment

4.4.1 Top of Atmosphere DIMITRI Assessment

Initial activities have started related to expanding the sensor comparison to include Top of Atmosphere (**TOA**), through the Database for Imaging Multi-spectral Instruments and Tools for Radiometric Intercomparison (**DIMITRI**) software [RD.8]. The software has been received from ARGANS and has been updated to a newer version of IDL with OceanSat-2 data ingestion and processing included. An internal report [RD.9] was produced to show the progress in the previous period, and since then work has focused on using the relative spectral responses, which have been digitized from papers, to create an improved specification of the sensor.

4.4.2 Level 2 Product Validation

A Python script was developed to produce product quality statistics for inclusion in these quarterly OCM-2 QA reports; in this report, the time-series has been expanded to include February 2019 onwards with historical data also processed for the newly included Gustav Dalen AERONET location in the Baltic. As described by [RD.10], the AERONET-OC network consists of globally distributed autonomous radiometer systems maintained at fixed offshore sites.

The script extracts a point of interest from a set of supplied L2C OCM-2 products, with the plot showing time-series values that correspond to the mean and standard deviation of the point of interest specified (a kernel that is three by three pixels in size and is centred on the supplied latitude/longitude).

For Figure 7, 236 products were analysed for the period from 3rd January 2017 to 31st March 2020 (within this report, 18 new products added from the start of January to the end of March 2020); the values shown correspond to the location of the AERONET-OC Acqua Alta Oceanographic Tower. The OCM-2 Chlorophyll-a (clo) concentration and Aerosol Optical Depth (aod) for each chosen date (that appeared cloud-free from a visual inspection of the QLs) have been plotted. Also, the plot shows AERONET-OC (*in-situ* sensor) estimated Chlorophyll-a values; provided as part of the AERONET-OC dataset.

Additional plots have also been produced for Gustav Dalen (Figure 8) and BOUSSOLE (Figure 9). BOUSSOLE uses the same path and row as the Acqua Alta Oceanographic Tower, while Gustav Dalen uses Path 4 Row 10. One hundred and seventy-two scenes were analysed from 2017 to 2020, to overlap with available AERONET-OC data, with the Gustav Dalen AERONET-OC instrument operating during the summer months (May to September); for this report, another 14 dates were used for 2020.

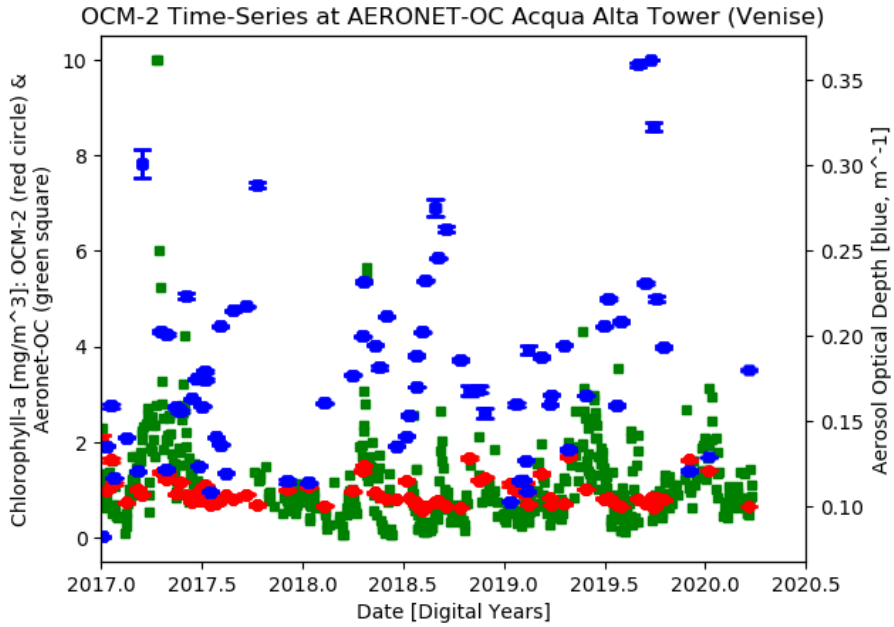


Figure 7. Time-series plot of the OCM-2 Chlorophyll-a (clo) and Aerosol Optical Depth (aod) products extracted from the Level 2C files, and AERONET-OC estimated Chlorophyll-a for the location of the AERONET-OC Acqua Alta Oceanographic Tower; data courtesy of AERONET website[1]/Giuseppe Zibordi.

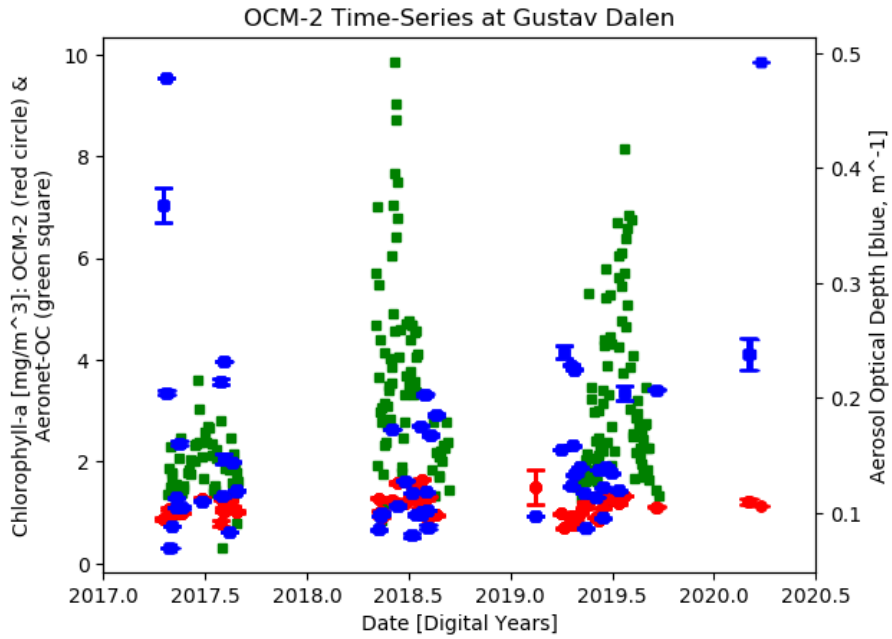


Figure 8. Time-series plot of the OCM-2 Chlorophyll-a (and Aerosol Optical Depth from the Level 2C files, and AERONET-OC estimated Chlorophyll-a for the Gustav Dalen Tower; data courtesy of AERONET website/Giuseppe Zibordi.

[1] https://aeronet.gsfc.nasa.gov/cgi-bin/type_one_station_seaprism_new?site=Venise&nachal=0&year=25&aero_water=0&level=1&if_day=0&if_err=0&year_or_month=1

BOUSSOLE is a data buoy rather than AERONET-OC station, and so the in-situ data has been acquired differently; currently, the surface sampling (fluorometrically and HPLC derived Chlorophyll) is being plotted; surface sampling data only available up until Jan 2018.

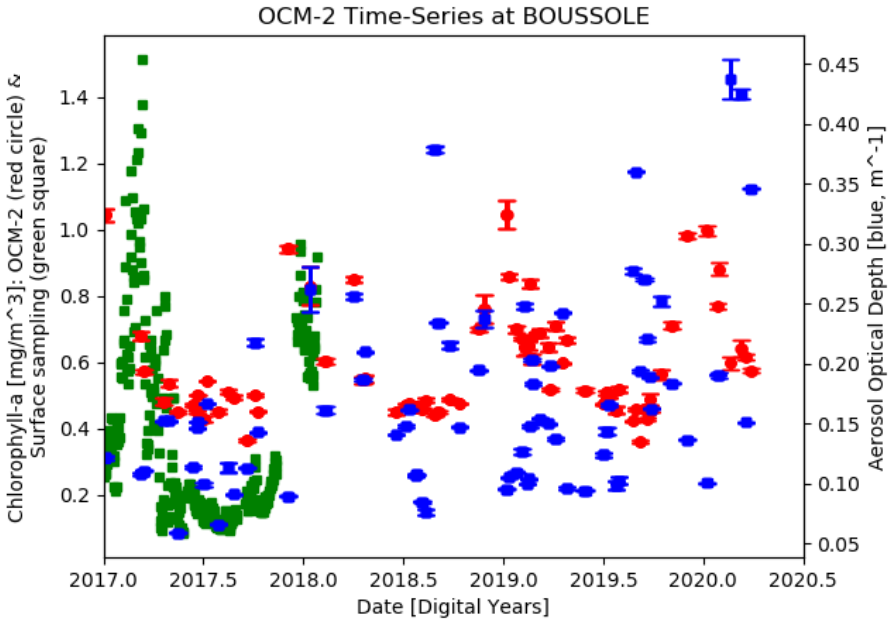


Figure 9. Time-series plot of the OCM-2 Chlorophyll-a and Aerosol Optical Depth from the Level 2C files, and surface sampling Chlorophyll-a for BOUSSOLE; data courtesy of BOUSSOLE website[2]

There are several sources of uncertainty, e.g. the AERONET-OC bands are not the same are the OCM-2 bands. However, overall, the plots for both the Acqua Alta Oceanographic Tower and Gustav Dalen show that the AERONET-OC estimated Chlorophyll-a concentrations are significantly higher than the OCM-2 estimates, which could mean that the OCM-2 output is underrepresenting the natural phytoplankton variability.

[2] http://www.obs-vlfr.fr/Boussole/html/boussole_data/other_useful_files.php

4.5 Conclusion

The conclusions from this quarterly Quality Assessment report for OceanSat-2 OCM (for Q1 2020) are:

- It has been noticed that occasionally **scenes are missing when we would expect them to be present** in the ESA portal. As we do not have visibility of the receiving station data we cannot determine the reason for this.

- **No specific issues have been detected for the L1B or L2B products**: at this stage, they have been checked in terms of product format consistency rather than scientific data quality; although it is acknowledged the L1 quality will have an impact on the L2 analysis and so needs to be analysed going forward.

- **L2C: No Issues have been detected with the product format consistency with minor issues detected for the product content**:
  - From the Q1 report [RD.11], poor Chlorophyll-a concentration estimations are seen to dominate high latitude regions where radiance retrievals are primarily impacted by high solar zenith angles not correctly accounted for within the atmospheric correction; acknowledged as an issue within version 1.4 of the L2 Product Spec [RD.12].
  - Inaccurately estimated OCM-2 Chlorophyll-a concentrations also dominate in those regions with dense cloud cover, coastlines and turbid coastal waters – a combination of cloud pixels not masked, or pixels affected by nearby clouds alongside a simplistic (band ratio) algorithm that does not account for changes in the water reflectance due to components other than Chlorophyll-a.
    Overestimating chlorophyll-a in complex Case 2 waters was noted by Preethi Latha et al. (2014) [RD.13] where OCM-2 L2 LAC data was processed using SeaDAS and chlorophyll algorithms like OC2 and OC4-V4 O'Rielly et al. (1998) [RD.14].
  - The Product Quality Assessment analysed 241 products across 3 sites. There are several sources of uncertainty, but, overall, the OCM-2 Chlorophyll-a concentration product appears to be underrepresenting the natural phytoplankton variability. It is difficult to assess the cause as the L2 Bottom of Atmosphere (**BOA**) radiance/reflectance product is not provided as part of the L2C product. Still, by increasing this analysis to a greater number of locations in future reports, we will be able to provide statistical comparison details. Lower chlorophyll estimates, than expected in open ocean waters, were reported by Shanthi *et al.* (2013) [RD.15] where cloud-free L2 processed, OCM data covering the southwest Bay of Bengal demonstrated underestimates for high (in-situ) chlorophyll concentrations and overestimates the low (in-situ) chlorophyll concentrations.

These findings potentially limit the applicability of the Oceansat-2 data in terms of it being classed as a 'Climate Quality' dataset. However, the derived biogeochemical products are comparable to several other ocean colour missions and so are of value to more operational applications.

Going forward, within EDAP, the aim is to continue to expand the quarterly reporting to include a more in-depth analysis of the product quality:

- Improve the assessment of the absolute and relative geometric accuracy: on hold until the DIMITRI code is running.
- Expand the sensor comparison to include TOA data: DIMITRI has been updated to handle OceanSat-2, and the approach is being tested / results analysed – current focus, planning to show results in the Q2 2020 report.

- Expand the in-situ comparison to a higher number of AERONET locations BOUSSOLE, and Gustav Dalen were added as new sites in the last report; once the DIMITRI analysis is complete, this will be considered again.

An increased number of in-situ validation points will allow us to reach the Committee for Earth Observation Satellites (**CEOS**) Land Product Validation Sub-group Stage 1 Validation, where product accuracy is assessed from a small (typically < 30) set of locations and time periods by comparison with in-situ or other suitable reference data [RD.16]. The validation approach will continue to follow the marine approach that defined in [RD.17].

[End of Document]