Supplementary Material to

Assessment of OLCI absorption coefficients for all non-water components across all optical water classes

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**S1: Details on the different in-situ data compilations used in this study**

Below we provide a detailed description of the different data set collections which were used for the *in situ* validation in this study. The main characteristics of each collection are provided in Tables S1 and S2 and the distribution of their data on Earth are illustrated in Figure S1.

* Bracher22: This collection contains spectral absorption data (matching all absorption products validated in this exercise) published in PANGAEA (www.pangaea.de) from AWI (Liu et al. 2019a, 2019b; Bracher and Liu 2021a, b; Bracher et al. 2021a, 2021b, 2021c, 2021d, 2021e, 2021f, 2021g, 2021h, 2021i, 2021j, 2021k, 2021l) matching the S3A and S3B mission time and considered for coupled model evaluation in Álvarez et al. (2022). This data set encompasses data from six Atlantic expeditions (2016-2019: PS99.1, PS99.2, PS103, PS107, PS113, PS121) covering polar, temperate, tropical and shelf seas. For completeness we added the *acdom*(*λ*) data sets from PS99.2 and PS107 (Bracher et al. 2025a, 2025b, 2025c, 2025d), which were missing in the original “Bracher” data set used in Álvarez (2022). The method to determine *acdom(λ)* including its configuration for specific instruments’ setup is described in Álvarez et al. 2022 (Suppl. Material) and is following the protocol of Lefering et al. (2017) where the uncertainty has been assessed as <5%. The method used to determine the spectral particulate and non-algal absorption coefficients which are the baseline to determine *aphy(λ)* and, together with *acdom*(λ), to determine *acdm*(λ) and *anw(λ)*, is following Röttgers and Gehnke (2012), as specified for the specific setup in Röttgers et al. (2016) and Liu et al. (2018). Uncertainties for this method have been quantified by Neeley et al. (2015) and Lefering et al. (2016), as confirmed in IOCCG (2018), as 10%. For all samples the standard deviation of the spectral optical depth (for all particles, non-algal particles and CDOM) are stored within the raw data set and can be obtained from the authors by request.
* Castagna22: This collection from Castagna et al. (2022a) contains spectral absorption data (matching all absorption products validated in this study) published in PANGAEA which have been measured from water samples of many campaigns during 2017-2019 in Belgian waters (Castagna et al. 2022b). The methods for determination follow Pegau et al. (2002) and IOCCG (2018). The method to determine *acdom*(λ) is described in detail in Castagna et al. (2022b) and follows the IOCCG protocol series for this coefficient (Mannino et al. 2019) and uses a 5 cm cuvette for these very high CDOM waters (*acdom*(443) 0.4-2.8 m-1). We assume similar uncertainty as determined for Bracher22 *acdom*(λ) data. The method used to determine the spectral particulate and non-algal absorption coefficients which are the baseline to determine *aphy(λ)* and, together with *acdom*(λ), to determine *acdm*(λ) and *anw(λ)*, is following Pegau et al. (2002). Uncertainties for this method have been quantified by Neeley et al. (2015) and Lefering et al. (2016), as confirmed in IOCCG (2018), as 10%.
* Röttgers23: From the large inherent optical properties (IOP) data compilation measured during many campaigns in the German Bight and adjacent regions from 2008-2021 by Röttgers et al. (2023), published in PANGAEA, we selected the data from the S3 mission lifetime. This data set contains spectral absorption data (matching all absorption products validated in this exercise) from two RV Heincke North Sea campaigns (HE488 and HE517 in late spring 2017 and late summer 2018, respectively) and additionally *acdom(λ)* data from the LP2021 German Bight campaign in summer 2021. The method to determine *acdom(λ)* including its configuration for specific instruments’ setup is described in Röttgers et al. (2023) and is following as well the protocol of Lefering et al. (2017) where the uncertainty has been assessed as <5%. The method used to determine the spectral particulate and non-algal absorption coefficients which are the baseline to determine *aphy(λ)* and, together with *acdom*(λ), to determine *acdm*(λ) and *anw(λ)*, is following Röttgers and Gehnke (2012, referenced in the protocol of IOCCG 2018), as specified for its setup in Röttgers et al. (2016) and applying beta-factor corrections as detailed in Lefering et al. (2016) based on using point-source integrating cavity absorption meter (PSICAM) measurements (Röttgers et al. 2007, Röttgers and Doerffer 2007). Uncertainties for this method have been quantified in Neeley et al. (2015) and Lefering et al. (2016) as 5%. For all samples the standard deviation of the spectral optical depth (for all particles, non-algal particles and CDOM) are stored within the raw data set and can be obtained from the authors by request.
* SEABASS: From the absorption coefficient data submissions to SeaBASS (<https://seabass.gsfc.nasa.gov/>, downloaded on 28 September 2023) we used all data matching the absorption products validated in this exercise and overlapping the S3A and S3B missions. This published data comprises many campaigns in US waters (campaigns: ACIDD, CARBON\_ESTUARIES, CBWQ, Cyanate, ECOA2, ECOMON, gomecc-3, IDS\_LIS. PACE\_ABSCLOSURE, PLUMES\_AND\_BLOOMS, Sea2Space, SFMBON) and two Arctic expeditions (Arctic-RSWQ in Kaktovik, Norton Sound and Yukon, ArcticCC in Northern Bering Sea in 2022,). All contributors applied the standard protocols referenced in IOCCG (2018) or Mannino et al. (2019). To determine *acdom*(λ), for samples from campaigns in meso- and oligotrophic waters the liquid waveguide technique, while in the complex waters a 5 or 10 cm cuvette was used. For most of the SEABASS data the standard deviation for each sample’s optical depth measurement of spectral particulate and non-algal particles and the standard deviation of the CDOM absorption coefficient were provided. The uncertainties for the particulate absorption measurements are provided for each campaign in Table S1. For SeaBASS data submissions, specific data submission guidelines were implemented on data submissions from 2023 onward (https://seabass.gsfc.nasa.gov/wiki/Data\_Submission). Earlier datasets didn't have specific guidelines and data was often processed, smoothed and filtered, in particular *acdom*(λ) data, instead of the original acquisition data. This may have an impact on the estimated uncertainties for those datasets which we cannot account for in this study.
* AODN: We included new IOP data submissions of the IMOS Integrated Marine Observing System (IMOS, <https://research.csiro.au/hydrochemistry/projects/integrated-marine-observing-system-imos/>) Bio-optical Database (Schroeder et al. 2016) available through the Australian Open Access to Ocean Data portal (AODN, https://portal.aodn.org.au/search?uuid=97b9fe73-ee44-437f-b2ae-5b8613f81042, downloaded 19 July 2023), not provided in Lehmann et al. (2022) and matching the S3A and S3B OLCI lifetime. AODN-1 contains the hyperspectral *acdm*(*λ*), *acdom*(*λ*), *aphy*(*λ*), *anw*(*λ*) data from the CSIRO (Commonwealth Scientific and Industrial Research) collected during several expeditions in Australian waters (Torres Strait in 2016, the mouth of the Fitzroy River in 2017, and the Coral Sea and Queensland Shelf in 2016 (IN2016) and from Tasmanian Waters 2020 (IN2020)) and from the Lucinda Jetty Coastal Observatory. For measurements and data processing Clementson et al. (2022) was used which is in compliance to IOCCG (2018) and Mannino et al. (2019). The AODN-2 data set contains just *acdom*(*443*) data from the Great Barrier Reef Inshore Water Quality Monitoring Program (<https://www2.gbrmpa.gov.au/our-work/programs-and-projects/marine-monitoring-program/inshore-water-quality>) which is a partnership between the Great Barrier Reef Marine Park Authority, the Australian Institute of Marine Science (AIMS), the James Cook University (JCU), and the Cape York Water Monitoring Partnership. Further, data from the Fitzroy Basin Marine Monitoring Program for Inshore Water Quality, funded by the partnership between the Australian Government’s ReefTrust, the Great Barrier Reef Foundation and AIMS are used. For this collection, measurements of *acdom*(λ) follow Clementson et al. (2001) using a 10 cm cuvette. For both collections, uncertainties are provided in Table S1 for each campaign according to the specific method used based on Neeley et al. (2015), Lefering et al. (2016), Lefering et al. (2017) and Mannino et al. (2019).
* Banks-new: These are hyperspectral *anw*(*λ*), *aphy*(*λ*), *acdm*(*λ*), and *acdom*(*λ*) data from the under-sampled oligotrophic Eastern Mediterranean. These were collected by HCMR (PI: A. Banks) and the Joint Research Centre (JRC) on a joint optics cruise (HCMR-JRC OPTICS) in April to May 2022 and these data are also included in Zibordi et al. (2023). The data were acquired following the spectral particulate absorption procedure of Tassan and Ferrari (1995) which is in accordance to IOCCG (2018). Uncertainties for this method have been quantified by Neeley et al. (2015) and updated by Lefering et al. (2016) as 18%. For the *acdom* data also another HCMR cruise was included from the same area (MARRE in September 2020). To derive *acdom* data from the two cruises the method by Pitta et al. (2017) compliant with Mannino et al. (2019) using a 5 cm cuvette. However, for the rather low range of *acdom*(443) (0.011-0.038 m-1) in these waters, uncertainties higher than 5% are expected. This was confirmed by a mean standard deviation of 14% derived from the replicate measurements. This value was then used as an estimate of measurement uncertainty.
* Bracher-new: AWI (PI: A. Bracher) has conducted recently (January 2020 until November 2022) four more large expeditions spread over the temperate and polar Atlantic Ocean (MSM93, PS126, PS131 and PS133-1) and four weekly campaigns at Germany’s largest inland water, Lake Constance (BS-1, BS-2, BS-3, BS-4) where about 1000 valid measurements for hyperspectral *anw*(*λ*), *aphy*(*λ*), *acdm*(*λ*), and *acdom*(*λ*) have been collected. The measurement protocol and uncertainties is the same as for the “Bracher22” data set.
* Lehmann22: This collection is from the global coastal and inland water compilation from Lehmann et al. (2022), focusing on hyperspectral *in situ* *Rrs* (Lehmann et al. 2023). We included the accompanying *in situ* *acdom*(443) data which fall within the S3A and S3B OLCI lifetime and are not contained in any of the other data sets (Castagna22, SEABASS, Bracher-new). The data set finally included, encompasses data from numerous researchers and campaigns and measurements from many coastal areas, lakes, estuaries and large rivers in Argentina, Australia, Brazil, Canada, China, Estonia, France, Germany, Italy, Japan, New Zealand, Norway and U.S.A.. Except for the measurements lead by A. S. Kristoffersen (University of Bergen) where the liquid waveguide technique was used, all other laboratories used a 5 or 10 cm cuvette to determine *acdom*(λ).

Note: We also checked the global marine *in situ* data compilation for ocean color validation extracted from many data repositories (e.g., SEABASS, PANGAEA, BODC) by Valente et al. (2022). However, it only provides *aph*(*λ*) data for the lifetime of OLCI data. AWI *aph*(*λ*) data contained in Bracher22 were excluded (n=304). The remaining data are from four laboratories whose data were also provided in the SEABASS collection.

All data have been acquired from measurements on discrete water samples. All methods follow standard protocols for the determination of the spectral absorption coefficients for particulates and non-algal particulates (IOCCG 2018, chapter 5) and of *acdom*(λ) (Mannino et al. 2019). Uncertainties affecting the *in situ* measurements determining the *a*p(*λ*), *a*nap(*λ*) and *a*phy(*λ*) have been quantified for the methods used in our data collection by Neeley et al. (2015) and Lefering et al. (2016). Depending on the method, uncertainties range from below 5% (for the quantitative filtration technique (QFT) measuring inside an integrative sphere (IS) using measurements of a PSICAM for correction), over 10% (QFT within or in front of a IS) to 15% (QFT without IS). Similarly, uncertainties below 5% have been quantified by Lefering et al. (2017) for the liquid waveguide *acdom*(*λ*) measurements as used by Bracher22, Röttgers23, Bracher-new and part of the SEABASS and Lehmann22 data sets. Uncertainties for *acdom*(*λ*) measurements using instead a 5 or 10 cm cuvette in high CDOM waters (above 0.8 m-1 or 0.4 m-1, respectively) are expected to be similarly low (Mannino et al. 2019). This is the case for most of the other data, except for the Banks-new data set where a 5 cm cuvette was used in case-1 waters (OWC 10 to 14). While for all other data sets (when available) standard deviation of replicate or triplicate measurements of absorption coefficients are far below the values of uncertainty, they are significantly higher for the Banks-new data set with an average of 14%. We use this value as uncertainty for the Banks-new *acdom*(*λ*) measurements which is very close to the mean standard deviation of 16% determined for the replicates of *in situ acdom*(*λ*) data used by Zibordi et al. (2023). Table S1 lists the uncertainties provided for each method used in our data compilation to determine on one hand *ap*, *anap* and *aphy* (named *up*, *unap*, and *uphy*, respectively) and on the other hand *acdom* (*ucdom*). Since the two measurements are not correlated to each other, the uncertainty for *acdm* (*ucdm*) and the uncertainty for *anw* (*unw*) were calculated as combined uncertainty from *ucdom* and *unap* (eq. 1) and from *ucdm* and *uphy* (eq. 2), respectively, according to the Guide of Uncertainty in Measurements (JCGM 2008):

$u\_{cdm}=\sqrt{u\_{cdom}^{2}+u\_{nap}^{2}}$ (eq. 1)

$u\_{nw}=\sqrt{u\_{cdm}^{2}+u\_{phy}^{2}}$ (eq. 2)

These uncertainties were used in the matchup statistics when evaluating the satellite products (see main manuscript chapter 2.3). For each campaign the values of *ucdom* and for *up*, *unap*, and *uphy* are listed in Table S2.

Table S1: *In situ* data sets for the global open ocean, coastal and inland waters used in this study for matchup extractions for specific OLCI absorption products. Details on each data set are provided in the section above and their location is shown in Fig. S1. As additional PIs are listed: \*Kelsey Bisson, Dylan Catlett, James Allen (UCSB); \*\* Maria Tzortziou (CCNY), Chelsea Lopez (NASA); \*\*\* Michael Novak (SSAIHQ); \*\*\*\* Aimee Neeley (NASA), Ryan Vandermeulen (NASA); \*\*\*\*\*Aimee Neeley (NASA), Ivona Cetinic (NASA), Michael Novak (SSAIHQ).

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Dataset name** | **Campain** | **PI (Name/institution)** | **PI email** | **Location** | **Period** |
| AODN-1 | Lucinda 2016, Lucinda 2017, Lucinda 2018, Lucinda 2019, Lucinda 2020, Lucinda 2021, Lucinda 2022 | T. Schroeder (CSIRO) | Thomas.Schroeder@csiro.au | Lucinda Jetty Coastal Observatory, AU | May 2016-Dec 2022 |
|   | Fitzroy 2017 | J. Crosswell (CSIRO) | Joey.Crosswell@csiro.au | Fitzroy River Mouth, AU | Apr 2017 |
|   | INV2016 v05 | J. Anstee (CSIRO) | Janet.Anstee@csiro.au | Coral Sea and Queensland Shelf, AU | Sep-Oct 2016 |
|   | INV2020 v10 | R. Erikson (CSIRO) | Ruth.Eriksen@csiro.au | Tasmanian Waters, AU | Nov 2020 |
|   | TSep2016 | J. Anstee (CSIRO) | Janet.Anstee@csiro.au | Torre Strait and Great Barrier Reef, AU | Sep 2016 |
| AODN-2 | GBR\_WQP\_2020\_2021, GBR\_WQP\_2021\_2022 | R. Gruber (AIMS) | R.Gruber@aims.gov.au | Great Barrier Reef inshore sites | Sep 2020-Jul 2022 |
| Bracher22 | PS99-1 | A. Bracher (AWI) | astrid.bracher@awi.de | North Sea to Fram Strait | Jun 2016 |
|   | PS99-2 | A. Bracher (AWI) | astrid.bracher@awi.de | Fram Strait | Jul-Aug 2016 |
|   | PS103 | A. Bracher (AWI) | astrid.bracher@awi.de | South Atlantic (Africa-Antarctic-South America) | Dec 2016-Jan2017 |
|   | PS107 | A. Bracher (AWI) | astrid.bracher@awi.de | Fram Strait | Jul-Aug 2017 |
|   | PS113 | A. Bracher (AWI) | astrid.bracher@awi.de | Atlantic (South America - English Channel) | May-Jun 2018 |
|   | PS121 | A. Bracher (AWI) | astrid.bracher@awi.de | North Sea to Fram Strait | Aug-Sep 2019 |
| Castagna22 | Belgium17-19 | A. Castagna (UGENT) | alexandre.castagna@ugent.be | 8 Belgian lakes, 1 brakish Belgian water | 2017-2019 |
| Lehmann22 | Estonian lakes & coastal Baltic Sea  | K. Alikas (UT-TO) | krista.alikas@ut.ee | Estoniam lakes & coastal Baltic Sea  | Jun 2016-Aug 2018 |
|   | Various Australian lakes, reservoirs, lagoons | J. Anstee (CSIRO) | janet.anstee@csiro.au | Various Australian lakes, reservoirs, lagoons | Mar 2017-Mar 2021 |
|   | Amazonas, Tiete River, some Brazilian Lakes | C.C.F. Barbosa (INPE) | claudio.barbosa@inpe.br | Amazonas, Tiete River, some Brazlian Lakes | Aug 2016; Aug 2018 |
|   | High Rock Lake (USA) | C. DiVittorio (WFU) | divittoc@wfu.edu | High Rock Lake (USA) | Oct-Nov2021; Oct2022 |
|   | North- and Mid-Italian lakes | C. Giardino (CNR-IREA) | giardino.c@irea.cnr.it | North- and Mid-Italian Lakes | May-Oct 2019/2020/2021 |
|   | Lakes in Wisconsin and Michigan (USA) | S. R. Greb (UWisconsin) | srgreb@wisc.edu | Lakes in Wisconsin and Michigan (USA) | Jun-Oct 2016/2018/2019 |
|   | Coast of Guiana (F), English Channel (F, UK) | C. Jamet (ULCO-LOG) | cedric.jamet@univ-littoral.fr | Guiana COAST (FRA), English Chan. (FRA, UK) | Jun 2016-Jun 2018 |
|   | Hardanger- and Kurefjorden (NOR) | A. S. Kristoffersen (UBergen) | arne.kristoffersen@uib.no | Hardanger- and Kurefjorden (NOR) | May-Jun 2022 |
|   | Various lakes in New Zealand | M. K. Lehmann (Xerra) | moritz.lehmann@gmail.com | Various Lakes in New Zealand | Apr 2019-May 2021 |
|   | Various lakes in Japan | B. Matsushita (UTsukuba) | matsushita.bunkei.gn@u.tsukuba.ac.jp | Various Lakes in Japan | Mar-Oct 2016/2018/2019 |
|   | Lake Kummerow (DE) | N. Oppelt (UKiel) | oppelt@geographie.uni-kiel.de | Lake Kummerow (DE) | May & Sep 2016 |
|   | Various lakes in Minnesota (USA) | L. Olmanson (UMinesota) | olman002@umn.edu | Various lakes in Minnesota (USA) | Aug-Sep 2018 |
|   | Lake Hawea (NZL) | M. Werther (UStirling) | mortimer.werther@stir.ac.uk | Lake Hawea (NZL) | Feb 2020 |
|   | Various Lakes in China | L. Yue (CUG) | yuelw@cug.edu.cn | Various Lakes in China | Apr 2021-Nov 2021 |
| Röttgers23 | HE488 | R. Röttgers (Hereon) | ruediger.roettgers@hereon.de | North Sea | May-Jun 2017 |
|   | HE517 | R. Röttgers (Hereon) | ruediger.roettgers@hereon.de | North Sea | Aug-Sep 2018 |
|   | LP2021 | R. Röttgers (Hereon) | ruediger.roettgers@hereon.de | German Bight and Elbe River estuary | Jun-Jul 2021 |
| SEABASS-new | ACIDD2017 | Sasha Kramer (CSB)\* | sasha.kramer@lifesci.ucsb.edu | Santa Barbara Basin | Dec 2017 |
|   | gomecc-3 | C. Hu (USF) | huc@usf.edu | Gulf of Mexico | Jul-Aug 2017 |
|   | Carbon\_Estuaries | C. Hu (USF) | huc@usf.edu | Tampa Bay & Biscayne Bay (Fl, USA) | Jul & Oct 2017, Jul 2018 |
|   | ArcticCC\_Northern\_Bering\_Sea | A. Mannino (NASA)\*\* | antonio.mannino@nasa.gov | Northern Bering Sea  | Sep 2022 |
|   | Arctic\_RSWQ | A. Mannino (NASA)\*\*\* | antonio.mannino@nasa.gov | Northern Bering Sea  | Aug 18, May-Jun 19 |
|   | ECOA2 | A. Mannino (NASA) | antonio.mannino@nasa.gov | East Atlantic (NY/NJ Bight) | Jul 2018 |
|   | Cyanate2016 | A. Mannino (NASA)\*\*\*\* | antonio.mannino@nasa.gov | East Atlantic 33°N, 71°W | Aug 2016 |
|   | Sea2space | A. Mannino (NASA)\*\*\*\*\* | antonio.mannino@nasa.gov | Pacific (Hawaii, USA; Rock Island, Palau) | Apr 2017 |
|   | ECONOM | C. Mouw (URI) | cmouw@uri.edu | East Atlantic 38°N-41°N |  Nov 2018 |
|   | SFMBON | F. Muller-Karger (USF) | carib@usf.edu | in / around Florida Keys  | Oct2019 |
|   | PACE\_ABSclosure | C. Roesler (BOW) | croesler@bowdoin.edu | Florida East Coast (USA) | Jan 2017 |
|   | Plums&Blooms | David Siegel (UCSB) | david.siegel@ucsb.edu | Santa Barbara Basin | Apr 2016-Aug 2023 |
|   | CBWQ | S. Scholaert (NASA) | stephanie.uz@nasa.gov | Chesapeake Bay | Nov19-Oct21 |
|   | IDS\_LIS | M. Tzortziou (CCNY, NASA) | mtzortziou@ccny.cuny.edu | East Atlantic (New York/New Jersey Bight) | Sep 2017-Jul 2022 |
| Banks-new | MARE20 | A. Banks (HCMR) | andyb@hcmr.gr | Eastern Mediterranean | Sep 2020 |
|   | HCMR-JRC | A. Banks (HCMR) | andyb@hcmr.gr | Eastern Mediterranean | Apr-May 2022 |
| Bracher-new | BS1-BS4 | A. Bracher (AWI) | astrid.bracher@awi.de | Lake Constance (DE) | Mar 2020, Sep 2020-2022 |
|   | MSM93 | A. Bracher (AWI) | astrid.bracher@awi.de | North Sea and East Greenland Sea | Jun 2020 |
|   | PS126 | A. Bracher (AWI) | astrid.bracher@awi.de | North Sea to Fram Strait | May-Jun 2021 |
|   | PS131 | A. Bracher (AWI) | astrid.bracher@awi.de | North Sea and East Greenland Sea | Jul-Aug 2022 |
|   | PS133 | A. Bracher (AWI) | astrid.bracher@awi.de | South Atlantic (ZA-South Georgia-ARG) | Oct-Nov 2022 |
|  |  |  |  |  |  |

Table S2: Corresponding to the *in situ* data set listed in Table S1 for each validated absorption product the total number of available data and of matchups only (the latter provided in brackets) together with the information about the provision of standard deviation (SD) for each data point (with y=yes, n= no, and r= only in raw data), the percent uncertainty (Uncert.) estimated for *acdom*(λ) and particulate absorption measurements (separated by “;”, respectively) and its data source (either exact reference or doi is provided)*.*

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| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Dataset name** | **Campain** | ***acdom*(443)** | ***acdm*(λ)** | ***aphy*(λ)** | ***anw*(λ)** | **SD** | **Uncert.** | **Data source** |
| AODN-1 | Lucinda 2016, Lucinda 2017, Lucinda 2018, Lucinda 2019, Lucinda 2020, Lucinda 2021, Lucinda 2022 | 100(19) | 97(18) | 111(20) | 95(19) | n | 5%, 10% | After login to https://portal.aodn.org.au/, go tohttps://thredds.aodn.org.au/thredds/catalog/IMOS/catalog.htmlthen to subdirectory: SRS/OC/BODBAW and select <campaign> |
|   | Fitzroy 2017 | 25(2) |  |  |   | n | 5%; |  |
|   | INV2016 v05 | 25(2) | 25(3) | 25(3) | 25(3) | n | 5%, 10% |  |
|   | INV2020 v10 | 8(0) |  |  |   | n | 5%; |  |
|   | TSep2016 | 19(0) | 19(0) | 19(0) | 19(0) | n | 5%, 10% |  |
| AODN-2 | GBR\_WQP\_2020\_2021, GBR\_WQP\_2021\_2022 | 768(101) |  |  |   | n | 5%; | As for AODN-1 |
| Bracher22 | PS99-1 | 71(2) | 50(0) | 50(0) | 50(0) | y,r | 5%, 10% | Bracher et al. 2021a-b, Liu et al. 2019a |
|   | PS99-2 | 251(42) | 66(0) | 69(0) | 66(0) | y | 5%, 10% | Bracher et al. 2024a-b, Liu et al. 2019a |
|   | PS103 | 312(6) | 162(3) | 241(5) | 160(3) | y,r | 5%, 10% | Bracher and Liu 2021a-b, Bracher et al. 2021c-d |
|   | PS107 | 195(9) | 187(0) | 187(0) | 187(0) | y | 5%, 10% | Bracher et al. 2024c-d, Liu et al. 2019b |
|   | PS113 | 225(19) | 225(10) | 225(21) | 225(19) | y,r | 5%, 10% | Bracher et al. 2021i-l |
|   | PS121 | 179(16) | 179(16) | 179(16) | 179(16) | y,r | 5%, 10% | Bracher et al. 2021e-h |
| Castagna22 | Belgium17-19 | 120(0) | 69(1) | 140(1) | 69(1) | n | 5%, 10% | Castagna et al. 2022a |
| Lehmann22 | Estonian lakes & coastal Baltic Sea  | 123(9) |  |  |   | n | 5%; | Lehmann et al. 2022 |
|   | Various Australian lakes, reservoirs, lagoons | 100(9) |  |  |   | n | 5%; | Lehmann et al. 2022 |
|   | Amazonas, Tiete River, some Brazilian Lakes | 20(6) |  |  |   | n | 5%; | Lehmann et al. 2022 |
|   | High Rock Lake (USA) | 78(7) |  |  |   | n | 5%; | Lehmann et al. 2022 |
|   | North- and Mid-Italian lakes | 68(7) |  |  |   | n | 5%; | Lehmann et al. 2022 |
|   | Various lakes in Wisconsin and Michigan (USA) | 58(1) |  |  |   | n | 5%; | Lehmann et al. 2022 |
|   | Coast of Guiana (FRA), English Channel (FRA, UK) | 135(17) |  |  |   | n | 5%; | Lehmann et al. 2022 |
|   | Hardanger- and Kurefjorden (NOR) | 10(3) |  |  |   | y | 5%; | Lehmann et al. 2022 |
|   | Various lakes in New Zealand | 73(4) |  |  |   | n | 5%; | Lehmann et al. 2022 |
|   | Various lakes in Japan | 28(3) |  |  |   | n | 5%; | Lehmann et al. 2022 |
|   | Lake Kummerow (DE) | 5(0) |  |  |   | n | 5%; | Lehmann et al. 2022 |
|   | Various lakes in Minnesota (USA) | 12(0) |  |  |   | n | 5%; | Lehmann et al. 2022 |
|   | Lake Hawea (NZL) | 2(0) |  |  |   | n | 5%; | Lehmann et al. 2022 |
|   | Various Lakes in China | 101(35) |  |  |   | n | 5%; | Lehmann et al. 2022 |
| Röttgers23 | HE488 | 40(9) | 40(8) | 40(8) | 40(8) | y,r | 5%; 5% | Röttgers et al. 2023 |
|   | HE517 | 44(24) | 39(14) | 44(7) | 39(14) | y,r | 5%; 5% | Röttgers et al. 2023 |
|   | LP2021 | 39(2) |  |  |   | y,r | 5%; 5% | Röttgers et al. 2023 |
| SEABASS-new | ACIDD2017 |   |   | 25(1) |   | y | 5%; 10% | Doi: 10.5067/SeaBASS/ACIDD/DATA001 |
|   | gomecc-3 | 6(0) | 6(0) | 6(0) | 6(0) | y | 5%; 10% | Doi: 10.5067/SeaBASS/GOMECC/DATA001 |
|   | Carbon\_Estuaries | 24(7) | 24(7) | 24(7) | 24(7) | y | 5%; 10% | Doi: 10.5067/SeaBASS/CARBON\_ESTUARIES/DATA001 |
|   | ArcticCC\_Northern\_Bering\_Sea | 1(1) | 1(0) | 1(0) | 1(1) | y | 5%; 10% | Doi: 10.5067/SeaBASS/ARCTICCC/DATA001 |
|   | Arctic\_RSWQ | 47(1) |  |  |   | y | 5%; 10% | Doi: 10.5067/SeaBASS/ARCTIC\_RSWQ/DATA001 |
|   | ECOA2 | 5(5) |  |  |   | y | 5%; 10% | Doi: 10.5067/SeaBASS/ECOA/DATA001 |
|   | Cyanate2016 | 2(0) | 1(0) | 1(0) | 1(0) | y | 5%; 10% | Doi: 10.5067/SeaBASS/CYANATE/DATA001 |
|   | Sea2space | 1(0) | 1(0) | 1(0) | 1(0) | y | 5%; 10% | Doi: 10.5067/SeaBASS/SEA2SPACE/DATA001 |
|   | ECONOM |  |  | 6(0) |  | y | 5%; 10% | Doi: 10.5067/SeaBASS/ECOMON/DATA001 |
|   | SFMBON | 669(145) | 642(213) | 647(218) | 647(241) | y | 5%; 10% | Doi: 10.5067/SeaBASS/SFMBON/DATA001 |
|   | PACE\_ABSclosure |  |  | 12(0) |   | y | ;15% | Doi: 10.5067/SeaBASS/PACE\_ABSCLOSURE/DATA001 |
|   | Plums&Blooms | 94(39) | 88(41) | 88(37) | 88(37) | y | 5%; 10% | Doi: 10.5067/SeaBASS/PLUMES\_AND\_BLOOMS/DATA001 |
|   | CBWQ | 161(10) |  |  |   | n | 5%; | Doi:10.5067/SeaBASS/CHESAPEAKE\_BAY\_WATER\_QUALITY/DATA001 |
|   | IDS\_LIS | 388 (93) |   |   |   | y | 5%; | Doi: 10.5067/SeaBASS/IDS\_LIS/DATA001 |
| Banks-new | MARE20 | 6(1) |  |  |   | y,r | 16%; | new |
|   | HCMR-JRC | 13 | 31(17) | 31(17) | 24(13) | y,r | 16%;10% | new |
| Bracher-new | BS1-BS4 | 233(110) | 158(73) | 158(89) | 233(106) | y,r | 5%; 10% | new |
|   | MSM93 | 185?(52) | 160(49) | 209(53) | 160(49) | y,r | 5%; 10% | new |
|   | PS126 | 143(19) | 142(13) | 175(19) | 142(19) | y,r | 5%; 10% | new |
|   | PS131 | 204(20) | 204(10) | 218(7) | 204(35) | y,r | 5%; 10% | new |
|   | PS133 | 295(33) | 293(34) | 312(36) | 294(34) | y,r | 5%; 10% | new |

Figure S1: Distribution of the *in situ acdom*(λ), *acdm*(λ), *aphy*(λ), *and anw*(λ) data collections used for matchup analyses with S3 OLCI L2 IOP absorption products. Data sets are from the following collections: AODN (purple), Bracher22 (dark blue), Castagna22 (cyan), Lehmann22 (green), Röttgers23 (yellow), SEABASS (red), Bracher-new (light blue), and Banks-new (orange).

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Fig. S2 Comparison of EUMETSAT and NASA processed *aphy*(443) and *acdm*(443) for 2019 monthly 9 km gridded OLCI-B products as *Howmöller* plots and as mean relative difference for 2019 (EUMETSAT-NASA/NASA).



*Figure S3: Comparison of classification in OWC and time difference of matchups between in situ and EUMETSAT OLCI acdom(443). Median is shown as horizontal line inside the box, 25th and 75th percentiles (Q1 and Q3, respectively) are presented as bottom and top edges of the box, the height of the box provides the interquartile range (IQR) the extend of the whiskers presents the smallest and largest values within the 1.5 IQR of Q1 and Q3 and points outside this range (outliers) are plotted as individual points beyond the whiskers.*

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*Table S3: Statistics (N (number of matchups), slope, intercept and correlation coefficient on log10 scale (Slog, Ilog, Rlog), Median Deviation (MD in m-1), Median Absolute Deviation (MAD in m-1), Median Percentage Deviation (MPD in %) and Median Absolute Percentage Deviation (MAPD in %)) of the comparisons of in situ to EUMETSAT S3 acdom(443) and aphy(λ)products at eight OLCI bands matchups. Matchups extracted within +1 hr, 3x3 pixels, >50% of valid pixels and coefficient of variation (CV)<0.2 at Rrs(560). Number of matchups in Matchups in OWC: aph(λ) 1: 4, 2: 45, 3: 2, 4: 17, 6: 9, 8:9, 9: 13, 11:7, 13: 1, 14:1, unclassified: 7; acdom(λ) 1: 18, 2: 48, 3: 7, 4: 21, 5:3, 6: 13, 7:4, 8:11, 9: 15, 11:10, 13: 2, 14:1, unclassified: 13. Red highlights lower quality as Table 2 and green highlights higher quality.*

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Band** | **N** | **Slog**  | **Ilog** | **Rlog**  | **MD** | **MAD** | **MPD** | **MAPD** |
| ***acdom*** | 443 | 153 | 0.88 | -0.18 | 0.65 | 0.001 | 0.036 | 3 | 53 |
|  | **Band** | **N** | **Slog**  | **Ilog**  | **Rlog** | **MD** | **MAD** | **MPD** | **MAPD** |
| ***aphy***  | 400 | 106 | 1.11 | 0.10 | 0.66 | -0.004 | 0.022 | -15 | 62 |
|  | 412 | 115 | 1.06 | 0.05 | 0.69 | -0.002 | 0.025 |  -9 | 58 |
|  | 443 | 115 | 0.96 | -0.05 | 0.71 | -0.003 | 0.024 | -1 | 50 |
|  | 490 | 115 | 1.06 | 0.11 | 0.67 | -0.002 | 0.021 | -9 | 57 |
|  | 510 | 115 | 1.18 | 0.30 | 0.66 | -0.001 | 0.016 | -7 | 62 |
|  | 560 | 115 | 1.32 | 0.55 | 0.51 | -0.002 | 0.009 | -26 | 83 |
|  | 620 | 115 | 1.35 | 0.63 | 0.69 | -0.002 | 0.006 | -15 | 79 |
|  | 665 | 109 | 1.31 | 0.50 | 0.61 |  0.000 | 0.015 | -4 | 81 |

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