DUE CoastColour
Round Robin Protocol
In situ reflectance data set

Version 1.0

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Revision History

Version	Date	Change	Contributors
Draft0.1	9.2.2011	First draft version	Kevin Ruddick et al
Draft0.2	11.2.2011	Corrections	Carolina Sa
Draft0.3	24.2.2011	Updates from COAS (Table 3, section 4.1) and ITC (section 4.4 and 8). Correction of RLw units in Annex 1, Table 5.	Jasmine Nahorniak, Suhyb Salama
Release V1.0	15.4.2011	Updates from HZG, CISR and MUMM	Lisl Robertson Lain, Wolfgang Schoenfeld, Griet Neukermans

Contents

1 SCOPE OF THIS DOCUMENT

This document describes the "In situ reflectance" dataset that has been assembled for the CoastColour (CC) project Regional Algorithm Round Robin (CCRR). It provides an overview of the measurement protocols/conditions adopted/encountered by the Data Providers (DPs) and details of how the individual datasets have been combined together. This information is provided as a basis for usage of this dataset by the Algorithm Providers (APs) participating in the CCRR. This document supplements the CCRR protocol, which provides the high level framework for algorithm intercomparison, including objectives, intercomparison methodology, internal policies, etc. The CCRR protocol covers 4 datasets (matchups, in situ reflectance, simulated, images), of which the second is described here in more detail. For this dataset, algorithms receive water-leaving radiance reflectance data as input and provide one or more level 2 water (L2W) products as output.

2 INTRODUCTION

Various in situ data has been provided to the Coastcolour project by DPs, which include project partners and "users" (where it is noted that the term users in this project does not generally mean end-users, but generally covers ocean colour scientists with similar interests and activities to those of the project contractors). This in situ data is intended for usage in various parts of the project including regional algorithm calibration, product validation and algorithm intercomparison (CCRR). A small subset of the full in situ data provided will be used in the "in situ reflectance" dataset component of the CCRR and it is only this subset that is described here.

3 Data Selection

3.1 Radiometric input (L2R) data

An important specificity of the CCRR in situ reflectance dataset as opposed to similar precursor datasets, such as the NASA/NOMADS dataset (Werdell and Bailey 2005), is the requirement for reflectance data at 709nm. This enables the testing of algorithms which take advantage of the 709nm band of the MERIS sensor, which may be particularly useful for chlorophyll *a* retrieval in turbid waters. The drawback of this requirement is that the number of potential DPs is very much reduced because of the limited number of instruments that cover this spectral range and because of the difficulties in extrapolating underwater radiometric measurements to the surface at this wavelength. Another consequence of this requirement is that this dataset has little overlap with other algorithm intercomparison datasets, such as NOMADS, and hence the CCRR provides quite new and complementary information rather than duplicating previous work.

To avoid further reduction of the number of data available, the data assembled here is not restricted to sunny conditions. Obviously the inclusion of cloudy conditions within the dataset adds some uncertainty when transposing results obtained here to the sunny sky conditions necessary for ocean colour remote sensing, although it is though that this will not be the main source of difference between algorithms and between algorithms and data.

A further important consideration is the heterogeneity of protocols used for the measurement of water-leaving reflectance (L2R) and the level 2 water products (L2W): chlorophyll a, Total Suspended Matter (TSM), Inherent and Apparent Optical properties. This is probably the most severe limitation of the current dataset, since considerable uncertainty is added by the use of different instruments and sometimes very different protocols. It is clearly important that the ocean colour community define and adopt common measurement protocols, perform common (or at least commonly traceable) calibration of instruments and carry out intercomparison exercises where any differences between DPs can be reduced. While some convergence has been achieved over the last ten years within groups such as SIMBIOS and the MERIS Validation Team (MVT) this convergence is very far from complete. Moreover the Coastcolour project encompasses DPs with a broad international coverage, including teams that have not previously participated in SIMBIOS/MVT activities or have not previously submitted data to the SeaBASS or MERMAIDS data archives. Despite such heterogeneity and awaiting the future improved convergence of measurements within the

ocean colour community, it is hoped that the current dataset will still be useful for algorithm intercomparison. The analysis of algorithm results may be subdivided according to DP to determine whether such difference in protocols is likely to affect the conclusions of the exercise. The results for this dataset will also be analysed in parallel with the results of the CCRR simulated dataset, where neither the problems nor the realism of measurements are present.

At the time of writing of this report Six Data Providers (COAS, CSIR, HZG, ITC, MSU and MUMM) were able to provide in situ reflectance data meeting the requirements of this study.

3.2 Water product (L2W) data

The CCRR activity covers potentially the complete range of standard L2W products offered by Coastcolour, as given in Table 1 and further defined in Annex A. In practice sufficient in situ data corresponding to the L2R data requirements was available only for the CHL and TSM products and so **the in situ reflectance component of the CCRR will cover only the CHL and TSM products**. If more in situ data for the other L2W products becomes available at a later stage it may be possible to extend this activity to cover extra L2W products.

Acronym	Product
a_tot	Total absorption coefficient
b_tot	Total scattering coefficient
a_pig	Phytoplankton pigment absorption coefficient
a_ys	Yellow substance absorption coefficient
a_bp	Absorption by bleached particulate matter
Chl	**Chlorophyll a concentration**
TSM	**Total suspended matter**
Kd	Spectral downwelling irradiance attenuation coefficient
Z90_max	Maximal signal depth
Z_eu	Euphotic layer depth
Z_SD	Secchi disc depth
TUR	Turbidity in Nephelometric Turbidity Units (NTU)

Table 1 List of Coastcolour L2W products, which are potentially suitable for comparison as output in the Round Robin activity (if sufficient in situ data exists). In this list some product names have been clarified since the Round Robin Data Protocol v1.2 issued in October 2010.

3.3 Data inventory

The number of in situ data provided for this activity is summarised in Table 2. Often in situ measurements are designed, acquired, processed, quality controlled and managed by a number of different people – first contacts for further information are given in Table 2.

Data Provider	RLw	CHL	TSM	Contact
COAS	19	19	0	Jasmine Nahorniak
CSIR	135	135	0	Stewart Bernard, Lisl Robertson, Mark Matthews
HZG	48	48	48	Roland Doerffer, Wolfgang Schoenfeld
ITC	119	92	119	Suhyb Salama

MSU	6	0	6	Zhongping Lee
MUMM	19	19	19	Griet Neukermans, Kevin Ruddick
TOTAL	**346**	**303**	**192**	

Table 2 Inventory of in situ data where a L2W product exists for a corresponding L2R reflectance spectrum.

4 Measurement protocols

This section summarises the measurement protocols and conditions relevant to the selected datasets and is based on documentation provided by the Data Providers. Further information can generally be found in the publications of these DPs.

Data Provider	RLw	CHL	TSM
COAS	Underwater profile (Lu-, Ed-, Ed+) 3*Satlantic HyperPro	HPLC Extraction Method: 90% Methanol (Goericke and Repeta 1993)	N/A
CSIR	Floating buoy tethered to ship (Lu-,Ed+) 2*TriOS RAMSES	2002: HPLC Other years: Fluorimetric (Parson et al. 1984) Extraction Method: Acetone (Barlow et al. 1997)	N/A
HZG	Abovewater, z45°/a135° (Lu+, Lsky, Ed+) 3*TriOS RAMSES	HPLC	Gravimetric GF/F Rinsing?
ITC	Abovewater, z40°/a135° (Lu+, Lsky, Ed+) 2*TriOS RAMSES	Spectrophotometric	Gravimetric GF/F
MSU	??	N/A	??
MUMM	Abovewater, z40°/a135° (Lu+, Lsky, Ed+) 3*TriOS RAMSES	HPLC 90% acetone, cell homogeniser	Gravimetric GF/F Rinsing ~400ml milli-Q + rim

Table 3 Summary of key aspects of measurement protocols. Zenith (z) and Sun-viewing relative azimuth (a) angles are given for abovewater radiometric measurements.

4.1 COAS in situ data

4.1.1 Region

The in situ data from the College of Oceanic and Atmospheric Sciences of the Oregon State University that are included in the CCRR in situ reflectance dataset were collected as part of the Microbial Initiative in Low Oxygen areas off Concepción and Oregon (MI-LOCO) project (http://mi-loco.coas.oregonstate.edu) funded by the Gordon and Betty Moore Foundation. One-day cruises off the Oregon coast visited station SH70 (among others) in the oxygen minimum zone during the period May 2009 – September 2009.

Figure 1 Location of COAS data reported here.

4.1.2 Reflectance measurement protocol

Reflectance measurements were made from underwater profiles made from a free falling HyperPRO optical profiler platform deployed at a distance from a research vessel. Hyperspectral Satlantic sensors are mounted on the profiler for measurement of downwelling irradiance and upwelling radiance. A third hyperspectral Satlantic sensor is mounted abovewater on the ship as a reference to account for variations of illumination conditions during the profile. Data from the profiles is extrapolated to the surface and is then converted to above-water water-leaving radiance. Further details on the measurement protocol and data processing can be found at www.satlantic.com. The same water sample data (chlorophyll *a*) is used for each of the duplicate/triplicate reflectance measurements

4.1.3 Chlorophyll *a* measurement protocol

Water samples are collected within 60 minutes of the reflectance measurements, and are filtered onboard onto Whatman GF/F glass fiber filters (nominal pore size 0.7 µm) and stored at a temperature of -80°C for subsequent analysis. Filters are analysed for concentration of a suite of photosynthetic pigments including chlorophyll *a* using High Performance Liquid Chromatography (HPLC).

4.1.4 Total Suspended Matter measurement protocol

TSM measurements are not made during these cruises.

4.1.5 Additional data

Additional data that is available for some or all of stations used in this dataset include:

- HyperPRO profiles of backscatter, Photosynthetically Available Radiation and its diffuse attenuation coefficient, downwelling irradiance and its diffuse attenuation coefficient, fluorescence, salinity, temperature.
- Flow cytometer data, dissolved nutrients.

4.2 CSIR in situ data

4.2.1 Region

The in situ data from the Council for Scientific and Industrial Research (CSIR) in South Africa that is included in the CCRR in situ reflectance dataset was collected in the framework of studies (Bernard et al. 2006) of Harmful Algae Blooms (HABs) occurring in the Benguela current region of the West coast of South Africa during the period 2002-2008.

4.2.2 Reflectance measurement protocol

Reflectance measurements were made from a tethered Satlantic hyperspectral radiometer buoy deployed from a 9m boat, measuring underwater upwelling radiance (nadir) and abovewater downwelling irradiance.

Data from the underwater sensor is extrapolated from 0.66m water depth to the surface and is then converted to above-water water-leaving radiance. Data was supplied at 5nm intervals from 400nm to 750nm. Further details on the measurement protocol and data processing are available on request from the Data Providers.

4.2.3 Chlorophyll *a* measurement protocol

Water samples are collected just below the surface (0m), simultaneously with the reflectance measurement, and are transported to shore for filtering trough 25mm GF/F filters (in 2002 samples were immediately frozen in liquid nitrogen for later analysis onshore). Filters were analysed for chlorophyll a concentration using High Performance Liquid Chromatography (HPLC) in 2002, Spectrofluorimetry in 2003 and thereafter.

4.2.4 Total Suspended Matter measurement protocol

TSM measurements are not made during these cruises.

4.2.5 Additional data

Additional data that is available for some or all of the stations used in this dataset include:

- Chl a was measured at both near-surface (“0m”) and 5m depths. In this region subsurface blooms are often encountered which are clearly visible from above water so the surface Chl a is not always representative of the satellite view. Where the near-surface measurement is <5µg/l, an average of the 0m and 5m measurements is used.
- Phytoplankton assemblage and size distributions
- Inherent optical properties: CDOM absorption, phytoplankton absorption, particulate absorption.
- Aerosol optical thickness from a Microtops sunphotometer.

4.3 HZG in situ data

4.3.1 Region

The in situ data from the HZG team (formerly called GKSS) in Germany that is included in the CCRR in situ reflectance dataset was collected in the framework of ferry cruises in the period 2005-6 between Cuxhaven and Heligoland, carried out essentially for the purposes of MERIS validation.

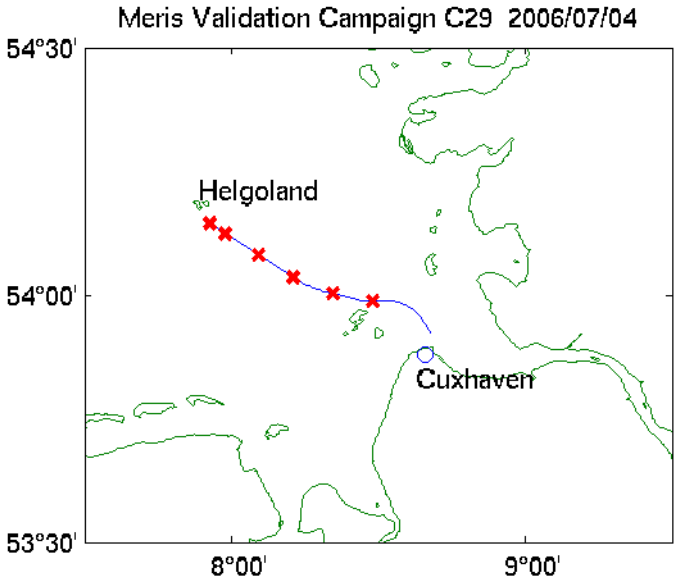


Figure 2 Typical ship track (blue line) and water sample stations (red crosses) for in situ data of HZG.

4.3.2 Reflectance measurement protocol

Reflectance measurements were made from a commercial ferry, travelling a regular route, on which were mounted abovewater three hyperspectral Trios radiometers measuring upwelling radiance (45° zenith angle), sky radiance in the direction corresponding to that for specular reflection into the upwelling radiance sensor and downwelling irradiance. The relative sun/viewing azimuth angle is about 130-140 degrees. The proportion of sky radiance to be subtracted from upwelling radiance to achieve water-leaving radiance is given by the Fresnel reflection law, with a wavelength dependent refractive index for the mean salinity along the transect.

Further details on the measurement protocol and data processing can be provided on request by the Data Provider.

4.3.3 Chlorophyll *a* measurement protocol

Water samples are collected from surface water during the cruise at up to six stations (see Figure 2) (simultaneously with the reflectance measurement and stored at ambient temperature for subsequent filtering and analysis. Water samples are processed directly after the cruise in the laboratory of the *Biologische Anstalt* on Helgoland where filtration is made on a Whatman GF/F filter. Filters are stored in liquid nitrogen until analysis for chlorophyll *a* concentration and other pigments using High Performance Liquid Chromatography (HPLC).

4.3.4 Total Suspended Matter (TSM) measurement protocol

Water samples are collected as for Chlorophyll a and processed after the cruise in the laboratory of the *Biologische Anstalt* on Helgoland, where filtration is made on a Whatman GF/F filter and filters are analysed gravimetrically for TSM.

4.3.5 Additional data

Additional data that is available for some or all of stations used in this dataset include:

- Dry weight of the inorganic and organic fractions of TSM.
- Inherent optical properties: CDOM absorption (after filtration using a pore size of 0.2µm), phytoplankton absorption (total – bleached), total particulate absorption.
- Water temperature and salinity.

4.4 ITC in situ data

4.4.1 Region

The in situ data from the ITC (Netherlands) team that is included in the CCRR in situ reflectance dataset was collected in the framework of cruises in the Mahakam Delta region (from the upstream turbid Mahakam River to the clearer seaward area influenced by the Makassar Strait) in the period 2008-9. The Mahakam Delta is a mixed fluvial-tidal dominated delta. The delta is located almost on the equator (between 0°19'S to 0°55'S and 117°15'E to 117°40'E) on the east coast of Kalimantan (Borneo), Indonesia (Figure 3).

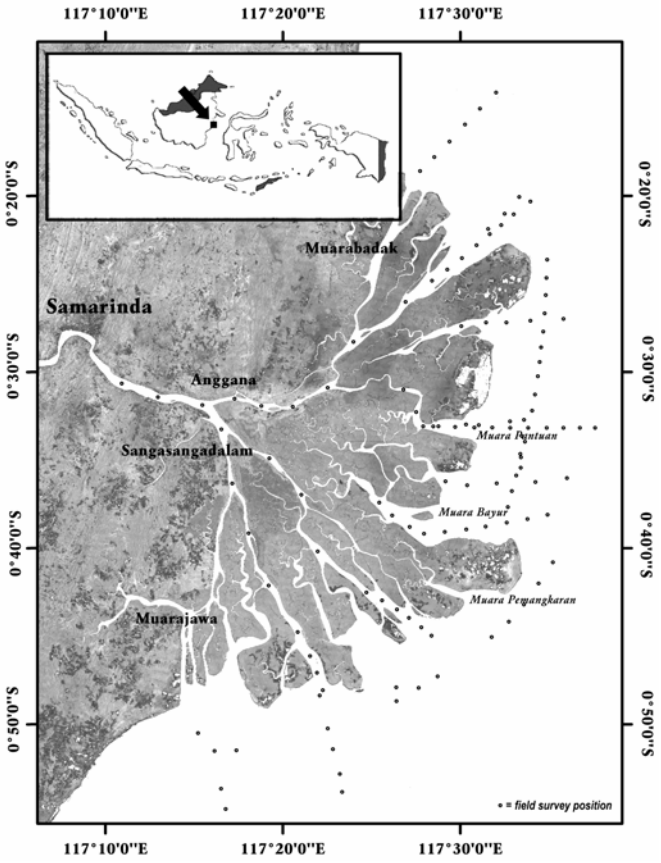
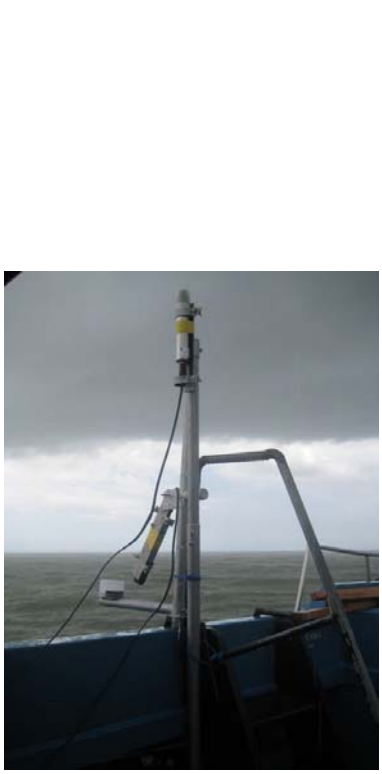


Figure 3 Mahakam Delta, East Kalimantan. The locations of field sampling sites are indicated by the black dots.

4.4.2 Reflectance measurement protocol

Reflectance measurements were made from a small ship, on which were mounted abovewater two hyperspectral Trios radiometers measuring: a) alternately upwelling radiance (40° zenith angle) and sky radiance in the direction corresponding to that for specular reflection into the upwelling radiance sensor and downwelling irradiance. The relative sun/viewing azimuth angle is about 135 degrees. The proportion of sky radiance to be subtracted from upwelling radiance to achieve water-leaving radiance is given by a Fresnel reflection coefficient, chosen to give small (but non-zero) near infrared reflectance and in any case chosen less than the value of 0.07 given as a maximum by (Mobley 1999).



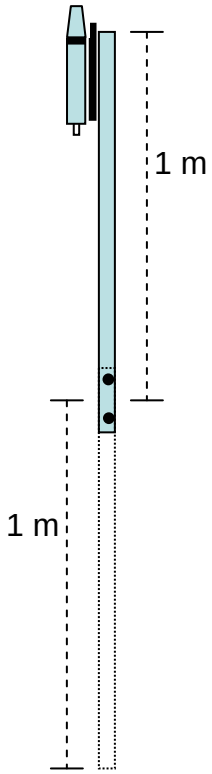


Figure 4 Photo (left) and diagram (right) of frame for downwelling irradiance meter (ITC data).

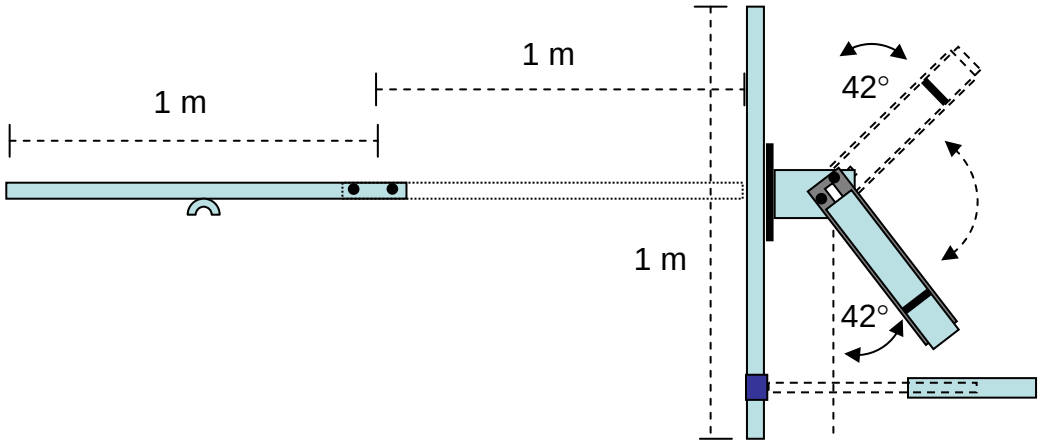


Figure 5 Diagram (right) of frame for sky and sea radiance meter (ITC data).

Further details on the measurement protocol and data processing can be found at Budhiman et al. 2011 (submitted).

4.4.3 Chlorophyll *a* measurement protocol

Water samples are collected from surface water during the cruise simultaneously (within 10 minutes) of the reflectance measurement and stored in the dark in an ice-box onboard for subsequent analysis. Water samples are processed after the cruise in the laboratory of the Mulawarman Univesity Faculty of Fisheries laboratory and the Bogor Agricultural University Faculty of Fisheries laboratory, where filtration is made on a 47mm diameter membrane filters with a pore size of 0.45µm (Clesceri et al. 1998) and filters are analysed for chlorophyll *a* concentration using the spectrophotometric technique.

4.4.4 Total Suspended Matter (TSM) measurement protocol

Water samples are collected and stored as for Chlorophyll a. Water samples are processed after the cruise in the laboratory of the Mulawarman Univesity Faculty of Fisheries laboratory and the Bogor Agricultural University Faculty of Fisheries laboratory, where filtration is made on pre-weighed Whatman GF/F filters (47mm diameter, pore size of 0.7µm) and filters are analysed gravimetrically for TSM.

4.4.5 Additional data

Additional data that is available for some or all of stations used in this dataset include:

- Secchi depth
- Water salinity measured with a Horiba U-10 water quality checker (www.horiba.com)
- CDOM fluorescence intensity measured with a MicroFlu-CDOM fluorimeter (www.trios.de)
- Wind speed and cloud cover.

4.5 MSU in situ data

4.5.1 Region

The in situ data from the Mississippi State University (MSU, USA) team that is included in the CCRR in situ reflectance dataset was collected in the framework of cruises in the Mississippi Sound area of the Gulf of Mexico in December 2005.

4.5.2 Reflectance measurement protocol

Further details on the measurement protocol and data processing can be obtained on request from the Data Provider.

4.5.3 Chlorophyll *a* measurement protocol

Chlorophyll *a* was not measured for this dataset.

4.5.4 Total Suspended Matter (TSM) measurement protocol

Further details on the measurement protocol can be obtained on request from the Data Provider.

4.5.5 Additional data

Additional data that is available for some or all of stations used in this dataset include:

- Inorganic/Organic fractions of Total Suspended Matter.

4.6 MUMM in situ data

4.6.1 Region

The in situ data from the MUMM (Belgium) team that is included in the CCRR in situ reflectance dataset was collected in the framework of cruises in the period 2008-10 in the Southern North Sea and English Channel and in the Ligurian Sea, carried out for the purposes of ocean colour satellite validation and marine optics research.

4.6.2 Reflectance measurement protocol

Reflectance measurements were made from Research vessels (*Alliance-93m, Belgica-51m, Zeeleeuw-56m,*), on which were mounted abovewater three hyperspectral Trios radiometers measuring upwelling radiance (40° zenith angle), sky radiance, Lsky, in the direction corresponding to that for specular reflection into the upwelling radiance sensor and downwelling irradiance, Ed. The relative sun/viewing azimuth angle was set at 135 degrees, by manoeuvring the ship on station. The proportion of sky radiance to be subtracted from upwelling radiance to achieve water-leaving radiance is given by a wind-roughened Fresnel reflectance coefficient with wind speed dependance based on the simulations of (Mobley 1999).

Further details on the measurement protocol and data processing, including a discussion of measurement uncertainties, can be found in (Ruddick et al. 2006) and particularly in the Web Appendices of this paper, which can be found online at http://www.mumm.ac.be/BELCOLOUR/EN/Publications/index.php.

For the purposes of the CCRR the data that is made available is very significantly reduced from the complete set of acquired data in the period 2008-2010 in order to prioritise data quality rather than quantity. The following quality control steps were applied to remove stations with data that is not suitable for the purpose:

- Removal of all data taken in conditions of wind speed>10 m/s.
- Removal of all data with Lsky/Ed(750nm)>0.05. This ratio, given in equation (1) of Web Appendix 2 of (Ruddick et al. 2006), is an objective test for blue sky with clear sun since a clouded sun reduces Ed and clouded sky in the viewing direction increases Lsky. The uncertainty of the skyglint correction is also proportional to this ratio.
- Removal of all data where the variability of Rhow over the 5 selected scans exceeds 10% of Rhow at 709nm.

4.6.3 Chlorophyll *a* measurement protocol

Water samples are collected from surface water during the cruise simultaneously (generally within 10 minutes) of the reflectance measurement, filtered onboard on Whatman GF/F filters and stored onboard in liquid nitrogen for subsequent analysis. Prior to subsampling for each filtration, the water sample is carefully homogenised by inverting three times the container. Filters are analysed for chlorophyll *a* concentration after the cruise in the Marine Chemistry (MARCHEM) laboratory of MUMM using High Performance Liquid Chromatography (HPLC).

4.6.4 Total Suspended Matter (TSM) measurement protocol

Water samples are collected as for Chlorophyll *a*, filtered onboard on pre-weighed Whatman GF/F filters and stored in a freezer. The measuring cylinders and the filtration funnels are rinsed with milli-Q water

(3*50ml+3*150ml rinsing of the funnel + measuring cylinders plus 250ml of the filters) and the rim of the filter is rinsed with a small volume of milli-Q water after removal of the filtration funnels.

The turbidity of the water sample is measured using a portable Hach 2100P ISO turbidimeter both before any subsamples are taken for filtration and after all subsamples have been taken for filtration. Triplicate measurements are made for turbidity and the median of the three values is used.

Filters are analysed gravimetrically for TSM after the cruise in the Marine Chemistry (MARCHEM) laboratory of MUMM. Filters are analysed in triplicate and the median of the three values is used.

The following quality control steps were applied to remove stations with data that is not suitable for the purpose:

- Removal of data for which the difference between pre- and post-filtration turbidity is >15% of the average of pre- and post-filtration turbidity.
- Removal of data where the standard deviation over the 3 TSM values exceeded 30% of the median value. High values of the standard deviation/median (10-30%) are generally recorded for concentration close to 1 g/m^3 where the method has higher relative uncertainty.

While TSM and turbidity are strongly correlated and the turbidity measurement may, for some applications, be used to identify outlier TSM data, this correlation was not used here for quality control. The turbidity measurement was used only for quality control of the homogeneity of the water sample before/after subsampling.

4.6.5 Additional data

Additional data that is available for the stations used in this dataset include:

- Turbidity.
- Water temperature and salinity.
- Intermediate radiometric data (upwelling radiance, sky radiance, downwelling irradiance, etc.).
- Various auxiliary data (wind, waves, cloud cover, etc.).

5 Data preparation for the CCRR

All in situ data used here was collected by the University of Lisbon from the Data Providers, was selected for appropriateness for the CCRR activity (particularly in terms of spectral resolution) and was assembled in a unique format. Checks were made on availability and plausibility of geographical coordinates and other auxiliary data. Reflectance spectra were checked qualitatively. Data submitted as Remote Sensing Reflectance (by CSIR, ITC and MSU) or as water-leaving radiance and abovewater downwelling irradiance (COAS) was converted to water leaving radiance reflectance by multiplication by .

Spectral interpolation was made by linear interpolation to the nominal MERIS central wavelengths given in Table 4 by the Coastcolour project for DPs where data was provided hyperspectrally, not at the MERIS bands:

- COAS supplied data at (412.3, 442.4, 489.2, 509.3, 559.5, 619.8, 666.6, 679.9, 710)nm. This was slightly reinterpolated to match Table 4.
- CSIR supplied data at 5nm intervals from 400nm.
- HZG supplied data at 2.5nm intervals from 350nm.
- ITC supplied data at about 3.3nm resolution, corresponding to the wavelengths of the spectrometer used.
- MSU supplied data at (380,410,440,490,510,530,550,580,630,660,680,710,750,780)nm. This was slightly reinterpolated to match Table 4.

- MUMM supplied data at 2.5nm intervals from 400nm.

Band	Central wavelength (nm)
1	412.5
2	442.5
3	490
4	510
5	560
6	620
7	665
8	681.25
9	708.75

Table 4 MERIS band central wavelengths for "SciHiO2" band set (used since 24th December 2002). (Bourg et al. 2008)

6 Data distribution

Data is made available to CCRR Algorithm Providers who have registered and signed the CC data policy agreeing that:

"The data will be used for CoastColour validation exercises and in the CoastColour Round Robin experiments as appropriate, and the results published in graphic form in CoastColour reports and eventual publications. The data source will be duly acknowledged in all coast-colour reports and eventual publications. The digital data will not be shared with others or placed in the public domain without consent of the data provider. Nor will the data be used for any other application without the prior consent of the data provider. If the data provider agrees to the data being placed in the public domain, then the data will also be included in the planned web-based, interactive, geographic database of CoastColour, with due acknowledgements."

7 Conclusions

The in situ reflectance dataset collected for the purposes of the Coastcolour Round Robin algorithm intercomparison has been summarised here. The in situ data assembled within Coastcolour is considered sufficient for testing chlorophyll a and Total Suspended Matter algorithms (but not inherent optical property algorithms). A particularly of the current dataset, as compared to other algorithm benchmark datasets, is the inclusion of reflectance data for 709nm, suitable for testing this band which is unique to the MERIS and potentially valuable in turbid coastal waters. This requirement, on the other hand, significantly reduced the number of Data Providers contributing to this dataset.

Some heterogeneity is noted in the protocols used to collect data and quality control procedures specific to each Data Provider. It is expected that some iteration may be necessary between Data Providers and Algorithm Providers to further refine this dataset and improve its suitability for use as a benchmark for algorithm intercomparison.

8 Acknowledgements

ITC acknowledges funding of the Foundation for the Advancement of Tropical Research (WOTRO) – Royal Netherlands Acadmey of Arts and Sciences (KNAW) in the framework of the East Kalimantan project.

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Annex A – Clarification of Coastcolour L2W product definitions

The purpose of this annex is to define as precisely as possible the level 2 water (L2W) parameters to be considered in the Coastcolour Round Robin activity. A list of L2W parameters is specified in various Coastcolour documentation including the Coastcolour web site, the CCRR protocol (v1.2, dated 5.10.2010) and the CCRR registration form. However, these lists contain some ambiguity and some parameters for which different definitions are possible. These ambiguities should be removed by the present note, enabling a sound basis for the intercomparison of algorithm output.

Acronym	Product	Units	Spectral/Scalar
RLw	**Directional water leaving radiance reflectance**	**-**	**Spectral**
RLwn	Fully normalized water leaving radiance reflectance	-	Spectral
a_tot	**Total absorption coefficient**	**m^{-1}**	**Spectral (443)**
b_tot	**Total scattering coefficient**[1]	**m^{-1}**	**Spectral (443)**
a_pig	**Phytoplankton pigment absorption coefficient**	**m^{-1}**	**Spectral (443)**
a_ys	**Yellow substance absorption coefficient**	**m^{-1}**	**Spectral (443)**
a_bp[2]	**Absorption by bleached particulate matter**	**m^{-1}**	**Spectral (443)**
Chl	**Chlorophyll *a* concentration**	**mg m^{-3}**	**Scalar**
TSM	**Total suspended matter**	**g m^{-3}**	**Scalar**
kd	**Spectral downwelling irradiance attenuation coefficient**	**m^{-1}**	**Spectral (490)**
Z90_max	Maximal signal depth	m	Scalar
Z_eu	**Euphotic layer depth**	**m**	**Scalar**
Z_SD	**Secchi disc depth**	**m**	**Scalar**
TUR	**Turbidity in Formazine Units**	**NTU**	**Scalar**

Table 5 List of Coastcolour L2W products mentioned in various Coastcolour documentation. Parameters presented in bold will be considered in at least one of the four datasets included in the CCRR activity. For the spectral products the wavelength given in nm will be used in priority for single wavelength comparisons, although full spectral comparison is also of interest.

Definitions

Directional water leaving radiance reflectance, RLw, is defined as PI times the directional water-leaving radiance (after removal of sky reflection at the air-sea interface), divided by abovewater downwelling irradiance. This is simply related to the commonly used "Remote sensing reflectance", Rrs, by RLw=PI*Rrs. No correction is made for bidirectional effects in this product.

[1] Backscattering coefficient is mentioned in some documentation, but will not be considered as a primary Coastcolour product, although it can be estimated from scattering coefficient using further assumptions.

[2] This has been termed "a_poc, absorption by particulate organic matter" in some documentation.

Total absorption coefficient, a_tot, is the total absorption coefficient of all water constituents except pure water molecules.

Total scattering coefficient, b_tot, is the total scattering coefficient of all water particles (but excluding scattering from pure water molecules).

Phytoplankton pigment absorption coefficient, a_pig, is the absorption coefficient for all phytoplankton pigments, measured as the difference between total particulate absorption and bleached particle absorption.

Yellow substance absorption coefficient, a_ys, is the absorption coefficient of all matter passing through a filter with pore size 0.2µm. This is commonly referred to as Coloured Dissolved Organic Matter (CDOM).

Absorption by bleached particulate matter, a_bp, is the absorption coefficient of particulate matter after phytoplankton pigments have been removed by bleaching.

Chlorophyll *a* concentration, Chl, is the concentration of chlorophyll a pigment as measured by High Performance Liquid Chromatography (HPLC).

Total suspended matter, TSM, is the dry weight of all particulate matter retained on a GF/F filter.

Spectral downwelling irradiance attenuation coefficient, Kd, is the near-surface attenuation coefficient of downwelling irradiance.

Maximal signal depth, Z90_max, is proposed as a Coastcolour product but will not be included in the CCRR because of lack of algorithms retrieving this parameter.

Euphotic layer depth, Z_eu, is the depth at which scalar Photosynthetically Available Radiation (PAR) quantum irradiance reaches 1% of its below-surface value.

Secchi disc depth, Z_SD, is the depth at which a 50cm white disk lowered vertically on the shaded side of a ship disappears from view as judged by a human observer.

Turbidity, TUR, is defined by ISO 7027 (1999) as the 90°-scattered light of wavelength 860nm as compared to a standard suspension of Formazin.

END OF DOCUMENT