Product User’s Guide
Reference: GC-UM-ACR-PUG-01
Version 4.2.1
March 2020
Document Signature Table

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Change record

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| 4.2   | 15/03/2020 | Update all NASA sensors to R2018.0 for the whole archive (including new error bars)  
|       |           | Add OLCI-B sensor  
|       |           | Add VIIRS JPSS-1 (NOAA-20) sensor  
|       |           | Update KD490 equation (minor impact)  
| 4.2.1 | 30/03/2020 | Fix minor issues in Download the data from the GlobColour ftp server |
# Table of Content

1 INTRODUCTION .................................................................................................................. 8  
1.1 Background .................................................................................................................... 8  
1.2 Scope of the document .................................................................................................... 8  
1.3 Acronyms ....................................................................................................................... 9  
1.4 Brief overview of GlobColour products ......................................................................... 10  
  1.4.1 Parameters .................................................................................................................. 10  
  1.4.2 Spatial Domain .......................................................................................................... 11  
  1.4.3 Sensors ....................................................................................................................... 12  
  1.4.4 Spatial and Temporal resolutions .............................................................................. 12  

2 THE PRODUCTS CONTENT ................................................................................................. 13  
2.1 Parameters overview ..................................................................................................... 13  
  2.1.1 Biological parameters ............................................................................................... 13  
  2.1.2 Atmospheric Optical parameters ............................................................................. 14  
  2.1.3 Ocean Surface Optical parameters ...................................................................... 15  
  2.1.4 Ocean Subsurface Optical parameters ................................................................. 16  
  2.1.5 OSS2015 Demonstration Biological Products ....................................................... 17  
2.2 Parameter Detailed Description .................................................................................... 17  
  2.2.1 CHL1 ......................................................................................................................... 18  
  2.2.2 CHL-OC5 ................................................................................................................ 20  
  2.2.3 SPM-OC5 .............................................................................................................. 22  
  2.2.4 CHLz ....................................................................................................................... 23  
  2.2.5 TSM ......................................................................................................................... 24  
  2.2.6 PIC .......................................................................................................................... 25  
  2.2.7 POC ......................................................................................................................... 26  
  2.2.8 NFLH ....................................................................................................................... 27  
  2.2.9 WVCS ..................................................................................................................... 28  
  2.2.10 Txxx ....................................................................................................................... 29  
  2.2.11 Axxx ....................................................................................................................... 31  
  2.2.12 CF .......................................................................................................................... 33  
  2.2.13 ABSD ..................................................................................................................... 34  
  2.2.14 (N)RRSxxx ........................................................................................................... 35  
  2.2.15 PAR ....................................................................................................................... 38  
  2.2.16 BBP ......................................................................................................................... 39  
  2.2.17 CDM ....................................................................................................................... 40  
  2.2.18 KD490 .................................................................................................................... 42  
  2.2.19 KDPAR ................................................................................................................... 44  
  2.2.20 ZHL ....................................................................................................................... 46  
  2.2.21 ZEU ....................................................................................................................... 47  
  2.2.22 ZSD ....................................................................................................................... 48  
  2.2.23 CHL-CIA ............................................................................................................... 50  
  2.2.24 BBPxxx-LOG ....................................................................................................... 51  
  2.2.25 BBPS-LOG .......................................................................................................... 52  
  2.2.26 PSD-XXX ............................................................................................................. 53  
  2.2.27 POC-SURF ......................................................................................................... 54  
  2.2.28 POC-INT ............................................................................................................. 55
3 THE GLOBCOLOUR SYSTEM.............................................................................61

3.1 Overall description of the processor ..........................................................61
3.2 The preprocessor .........................................................................................63
  3.2.1 MERIS .................................................................................................64
  3.2.2 OLCI ..................................................................................................66
  3.2.3 MODIS/SeaWiFS/VIIRS .................................................................67
3.3 The spatial and temporal binning schemes ................................................71
3.4 The GlobColour data–day approach ............................................................71

4 THE PRODUCTS FORMAT .............................................................................73

4.1 General rules..................................................................................................73
4.2 Naming convention .......................................................................................73
4.3 The binned products ....................................................................................74
4.4 The mapped products ..................................................................................80

5 HOW TO…? .....................................................................................................82

5.1 Access the GlobColour data .......................................................................82
  5.1.1 The HERMES interface ....................................................................82
  5.1.2 Ordering GlobColour Products .........................................................83
  5.1.3 Ordering OSS2015 demonstration products .....................................86
  5.1.4 Ordering a list of products ..................................................................87
  5.1.5 Retrieving the data .......................................................................... 87
5.2 Download the data from the GlobColour ftp server ..................................88
5.3 Read the data .............................................................................................88
5.4 Visualize the data .......................................................................................89

6 APPENDICES ..................................................................................................92

6.1 Global ISIN grid definition .........................................................................92
6.2 Summary of products content ....................................................................93
6.3 The main characteristics of the products ....................................................94
6.4 The steps of the binning and merging schemes .........................................95
  6.4.1 Step 1: L2 to L3 track .......................................................................95
  6.4.2 Step 2: L3 track to L3 daily for each single instrument .......................96
  6.4.3 Step 3: L3 daily for each single instrument to merged L3 daily ...........97
  6.4.4 Step 4: L3 daily merged to 8-days and monthly L3 ............................98
  6.4.5 Step 5: L3 daily/8days/monthly merged products to mapped products. 98
  6.4.6 Step 6: generation of the quicklooks ..................................................99
6.5 The error bars .............................................................................................99
6.6 Common Data Language description .........................................................100
6.7 References ..................................................................................................103
  6.7.1 GlobColour products references .....................................................103
  6.7.2 References for OSS2015 demonstration products ............................105
List of Tables

Table 1-1: Available sensors in the GlobColour data set ..................................................12
Table 1-2: Overview of the GlobColour products .................................................................12
Table 2-1: List of GlobColour Biological Parameters..........................................................13
Table 2-2: List of GlobColour Atmospheric Optical parameters .......................................14
Table 2-3: List of GlobColour Ocean Surface Optical parameters ....................................15
Table 2-4: GlobColour Ocean Subsurface parameters .......................................................16
Table 2-5: Main characteristics of the ISIN grids ..............................................................60
Table 3-1: List of variables with a specific preprocessing ......................................................63
Table 3-2: List of parameters and filters applied to the MERIS level 2 data .......................65
Table 3-3: List of parameters and filters applied to the OLCI level 2 data ........................66
Table 3-4: List of parameters and filters applied to the MODIS/SeaWiFS/VIIRS level 2 data 67
Table 3-5: Input parameters for data-day classification .....................................................71
Table 3-6: CNT of satellites .................................................................................................72
Table 4-1: Dimensions - binned products ...........................................................................75
Table 4-2: Variables - binned products .............................................................................75
Table 4-3: Flags description ................................................................................................76
Table 4-4: Variables attributes - binned products ...............................................................77
Table 4-5: Global attributes - binned products (1/3) ............................................................78
Table 4-6: Global attributes - binned products (2/3) ............................................................79
Table 4-7: Global attributes - binned products (3/3) ............................................................80
Table 4-8: Dimensions of the grid - mapped products .......................................................80
Table 4-9: Dimensions - mapped products .........................................................................81
Table 4-10: Variables - mapped products (1/2) .................................................................81
Table 4-11: Variables - mapped products (2/2) .................................................................81
Table 6-1: ISIN grid definition ..........................................................................................92
Table 6-2: Summary of products content ..........................................................................93
Table 6-3: Error Bars used to generate Weighted Average products ..............................100
List of Figures

Figure 1-1: A sample GlobColour Global product .................................................................11
Figure 1-2: A sample GlobColour Europe product ..................................................................11
Figure 3-1: The GlobColour processor high-level description .................................................62
Figure 3-2: MERIS pixels UTC as a function of the pixel longitude (35 days - October 2003) ................................................................................................................................69
Figure 3-3: MODIS pixels UTC as a function of the pixel longitude (1 day - June 2003) ........69
Figure 3-4: SeaWiFS pixels UTC as a function of the pixel longitude (1 day - December 2003) ........................................................................................................................................70
Figure 3-5: Data-day definition line above MODIS pixels UTC versus longitude plot. ..........70
Figure 3-6: Data-day definition line above one SeaWiFS track .................................................71
Figure 5-1: the HERMES Interface .......................................................................................82
Figure 5-2: GlobColour Data Access interface ........................................................................83
Figure 5-3: Selection of the map overlays ..............................................................................84
Figure 5-4: Selected products list and previsualisation screen ................................................86
Figure 5-5: OS2015 products data access ..............................................................................87
Figure 5-6: Visualization of a GlobColour L3m product using Visat .......................................89
Figure 5-7: Visualization of a GlobColour L3m product using ncview ...................................89
Figure 5-8: Visualizing GlobColour products with matplotlib ..............................................90
Figure 5-9: Generated image ...............................................................................................91
1 Introduction

1.1 Background

The GlobColour project started in 2005 as an ESA Data User Element (DUE) project to provide a continuous data set of merged L3 Ocean Colour products. Merging outputs from different sensors ensures data continuity, improves spatial and temporal coverage and reduces data noise. This allows in particular to process long time series of consistent products (trend analysis, climatology, data assimilation for model hindcast).

Since then, ACRI has maintained the archive and Near Real Time data access services through the Hermes website.

The 2014 reprocessing and the update of the Hermes interface were performed in the framework of the OSS2015 project, with funding from the EU FP7 under grant n°282723.

The GlobColour project has received additional funding from European Union FP7 under grant agreement n° 218812 (MyOcean) and from PACA Region under project RegiColour.

From May 2015, the GlobColour project also contributes to the Copernicus Marine Environment Monitoring Service (CMEMS). A subset of the GlobColour products is disseminated by CMEMS. It concerns at present Chlorophyll, reflectances, Secchi depth, Primary Production, SPM, BBP, KD490 merged products (Near Real Time and the long time series).

In addition, support from NASA regarding access to L2 products is acknowledged.

The GlobColour primary data set has now been delivered as a Group on Earth Observations System of Systems (GEOSS) core data set under reference:


1.2 Scope of the document

This User Guide contains a description of:

- the products content
  - the parameters
  - the spatial and temporal coverage
  - the processing system
- the products format
- Hermes interface user’s guide
- Appendices containing additional information on products and processing
### 1.3 Acronyms

<table>
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<tr>
<th>Acronym</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>AV</td>
<td>Simple average method</td>
</tr>
<tr>
<td>AVW</td>
<td>Weighted average method</td>
</tr>
<tr>
<td>$b_{bp}$</td>
<td>Particulate back-scattering coefficient</td>
</tr>
<tr>
<td>BEAM</td>
<td>Basic ERS and Envisat (A)ATSR and MERIS Toolbox</td>
</tr>
<tr>
<td>BOUSSOLE</td>
<td>Bouée pour l’acquisition de Séries Optiques à Long Terme</td>
</tr>
<tr>
<td>CDL</td>
<td>Common Data Language</td>
</tr>
<tr>
<td>CDM</td>
<td>Coloured dissolved and detrital organic materials absorption coefficient</td>
</tr>
<tr>
<td>CF</td>
<td>Climate and Forecast</td>
</tr>
<tr>
<td>CF</td>
<td>Cloud Fraction</td>
</tr>
<tr>
<td>CHL</td>
<td>Chlorophyll-a</td>
</tr>
<tr>
<td>CMEMS</td>
<td>COPERNICUS Marine Environment Monitoring Service</td>
</tr>
<tr>
<td>CZCS</td>
<td>Coastal Zone Color Scanner</td>
</tr>
<tr>
<td>DLR</td>
<td>Deutsches Zentrum für Luft- und Raumfahrt</td>
</tr>
<tr>
<td>DPM</td>
<td>Detailed Processing Model</td>
</tr>
<tr>
<td>DUE</td>
<td>Data User Element of the ESA Earth Observation Envelope Programme II</td>
</tr>
<tr>
<td>EEA</td>
<td>European Environment Agency</td>
</tr>
<tr>
<td>EL555</td>
<td>Relative excess of radiance at 555 nm (%)</td>
</tr>
<tr>
<td>EO</td>
<td>Earth observation</td>
</tr>
<tr>
<td>GHRSSST-PP</td>
<td>GODAE High Resolution Sea Surface Temperature - Pilot Project</td>
</tr>
<tr>
<td>GSM</td>
<td>Garver, Siegel, Maritorena Model</td>
</tr>
<tr>
<td>ICESS</td>
<td>Institute for Computational and Earth Systems Science</td>
</tr>
<tr>
<td>IOCCG</td>
<td>International Ocean Colour Coordinating Group</td>
</tr>
<tr>
<td>IOCCP</td>
<td>International Ocean Carbon Coordination Project</td>
</tr>
<tr>
<td>IODD</td>
<td>Input Output Data Definition</td>
</tr>
<tr>
<td>ISIN</td>
<td>Integerised SINusoidal projection</td>
</tr>
<tr>
<td>LOV</td>
<td>Laboratoire Océanologique de Villefranche-sur-mer</td>
</tr>
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<td>LUT</td>
<td>Look-Up Table</td>
</tr>
<tr>
<td>MER</td>
<td>Acronym for the MERIS instrument used in the GlobColour filenames</td>
</tr>
<tr>
<td>MERIS</td>
<td>Medium Resolution Imaging Spectrometer</td>
</tr>
<tr>
<td>MERSEA</td>
<td>Marine Environment Imaging Spectrometer for the European Area – Integrated Project of the EC Framework Programme 6</td>
</tr>
<tr>
<td>MOBY</td>
<td>Marine Optical Buoy</td>
</tr>
<tr>
<td>MOD</td>
<td>Acronym for the MODIS instrument used in the GlobColour filenames</td>
</tr>
<tr>
<td>MODIS</td>
<td>Moderate Resolution Imaging Spectrometer</td>
</tr>
<tr>
<td>netCDF</td>
<td>Network Common Data Format</td>
</tr>
<tr>
<td>NIVA</td>
<td>Norwegian Institute for Water Research</td>
</tr>
<tr>
<td>(N)RRSXXX</td>
<td>Fully normalised remote sensing reflectances at xxx nm (sr-1)</td>
</tr>
<tr>
<td>NRT</td>
<td>Near-real time</td>
</tr>
</tbody>
</table>
1.4 Brief overview of GlobColour products

1.4.1 Parameters

The parameters of the GlobColour data set are:

- Biological parameters: Chlorophyll (several algorithms), Particulate Organic/Inorganic Carbon, Primary Production, Fluorescence…
- Atmosphere optical parameters: aerosol thickness, cloud fraction, water vapour column…
- Ocean-surface optical parameters: reflectances
- Sub-surface optical parameters: attenuation and back-scattering coefficients, turbidity

The full list of parameters is provided in section 2.1.

For some parameters, several alternative algorithms are proposed. This is the case when no algorithm is clearly superior to the other(s). The relative performance may vary depending on the conditions (water types, regions, sensors…), and users are advised to compare the results on a case-by-case basis.
1.4.2 Spatial Domain

Two spatial domains are covered:

- the global Earth domain:

![Image 1](image1.jpg)

*Figure 1-1: A sample GlobColour Global product*

- an extended Europe area at full resolution (1km):

![Image 2](image2.jpg)

*Figure 1-2: A sample GlobColour Europe product*
1.4.3 Sensors

The GlobColour data set is built using the following sensors:

<table>
<thead>
<tr>
<th>Sensor</th>
<th>Resolution</th>
<th>Start Date</th>
<th>End Date</th>
<th>Reprocessing Version</th>
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<tr>
<td>SeaWiFS</td>
<td>GAC 4km</td>
<td>1997-09-04</td>
<td>2010-12-11</td>
<td>NASA R2018.0</td>
</tr>
<tr>
<td>MERIS</td>
<td>RR 1km</td>
<td>2002-04-28</td>
<td>2012-04-08</td>
<td>ESA 3rd reprocessing</td>
</tr>
<tr>
<td>MODIS AQUA</td>
<td>1km</td>
<td>2002-07-03</td>
<td>Present</td>
<td>NASA R2018.1</td>
</tr>
<tr>
<td>VIIRS NPP</td>
<td>1km</td>
<td>2012-01-02</td>
<td>Present</td>
<td>NASA R2018.0</td>
</tr>
<tr>
<td>OLCI-A</td>
<td>RR 1km</td>
<td>2016-04-25</td>
<td>Present</td>
<td>ESA PB 2.16 to 2.55</td>
</tr>
<tr>
<td>VIIRS JPSS-1</td>
<td>1km</td>
<td>2017-11-29</td>
<td>Present</td>
<td>NASA R2018.0</td>
</tr>
<tr>
<td>OLCI-B</td>
<td>RR 1km</td>
<td>2019-03-25</td>
<td>Present</td>
<td>ESA PB 1.14 to 1.27</td>
</tr>
</tbody>
</table>

*Table 1-1: Available sensors in the GlobColour data set*

**Note:** GlobColour products more recent than this documentation may use sensors version newer than in the table above.

The data set includes single-sensor and merged products. Merged products are generated for three merging techniques:
- simple averaging
- weighted averaging
- GSM model

The relative performance of the weighting methods depends on the conditions (water types, region, glint/aerosol conditions…) Users are advised to compare the results on a case-by-case basis as far as possible.

OLCI-A/B and VIIRS JPSS-1 are not merged with other sensors for all parameters for the moment.

1.4.4 Spatial and Temporal resolutions

The spatial and temporal resolutions of the products distributed to the end-users are:

<table>
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<th>Spatial domain</th>
<th>Grid</th>
<th>Temporal domain</th>
<th>Resolution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Global</td>
<td>ISIN</td>
<td>Daily, 8 days, monthly</td>
<td>1/24°</td>
</tr>
<tr>
<td>Europe</td>
<td>ISIN</td>
<td>Daily, 8 days, monthly</td>
<td>1/96°</td>
</tr>
<tr>
<td>Global</td>
<td>PC</td>
<td>Daily, 8 days, monthly</td>
<td>1/24°, 0.25°, 1.0°</td>
</tr>
<tr>
<td>Europe</td>
<td>PC</td>
<td>Daily, 8 days, monthly</td>
<td>0.01°</td>
</tr>
</tbody>
</table>

*Table 1-2: Overview of the GlobColour products*

**Note:** SeaWiFS GAC products have a spatial sampling distance of 4 km approximately. Oversampling is used when generating Europe “1 km” products.
2 The products content

2.1 Parameters overview

This section provides the detailed description of the exhaustive list of all parameters that are available in the GlobColour products.

The GlobColour merged products are generated by different simple averaging techniques (see IOCCG reports N°4 and 5) or by the use of the GSM model (see Maritorena and Siegel, 2005).

In the following tables, the following acronyms are used:

- **AV**: simple averaging,
- **AVW**: weighted averaging,
- **GSM**: GSM model,
- **AN**: analytical from other L3 products,
- **STAT**: classification statistics.

2.1.1 Biological parameters

The GlobColour biological Parameters are listed in Table 2-1.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>L3 merging method</th>
<th>Sensor availability</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHL1</td>
<td>Chlorophyll concentration (mg/m³)</td>
<td>AVW, GSM</td>
<td>○ ○ ○ ○ ○ ○ ○ ○ ○</td>
</tr>
<tr>
<td>CHL-OC5</td>
<td>Chlorophyll concentration (mg/m³) – OC5 algorithm</td>
<td>AVW</td>
<td>○ ○ ○ ○ ○ ○ ○ ○ ○</td>
</tr>
<tr>
<td>SPM-OC5</td>
<td>Inorganic suspended particulate matter concentration (g/m³) – OC5 algorithm</td>
<td>AVW</td>
<td>○ ○ ○ ○ ○ ○ ○ ○ ○</td>
</tr>
<tr>
<td>PP</td>
<td>Primary production</td>
<td>AN</td>
<td>○ ○ ○ ○ ○ ○ ○ ○ ○</td>
</tr>
<tr>
<td>CHL2</td>
<td>Chlorophyll concentration (mg/m³) – Neural Network algorithm</td>
<td>AV</td>
<td>○ ○ ○ ○ ○ ○ ○ ○ ○</td>
</tr>
<tr>
<td>TSM</td>
<td>Total suspended matter concentration (g/m³)</td>
<td>AV</td>
<td>○ ○ ○ ○ ○ ○ ○ ○ ○</td>
</tr>
<tr>
<td>PIC</td>
<td>Particulate Inorganic Carbon (mol/m³)</td>
<td>AVW</td>
<td>○ ○ ○ ○ ○ ○ ○ ○ ○</td>
</tr>
<tr>
<td>POC</td>
<td>Particulate Organic Carbon (mg/m³)</td>
<td>AVW</td>
<td>○ ○ ○ ○ ○ ○ ○ ○ ○</td>
</tr>
<tr>
<td>NFLH</td>
<td>Normalised Fluorescence Line Height (mW/cm²/microm/sr)</td>
<td>AV</td>
<td>○ ○ ○ ○ ○ ○ ○ ○ ○</td>
</tr>
</tbody>
</table>

*Table 2-1: List of GlobColour Biological Parameters*
## 2.1.2 Atmospheric Optical parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>L3 merging method</th>
<th>Sensor availability</th>
</tr>
</thead>
<tbody>
<tr>
<td>WVCS</td>
<td>Total water vapor column, clear sky (g/cm²)</td>
<td>AV</td>
<td></td>
</tr>
<tr>
<td>T865</td>
<td>Aerosol optical thickness over water (-)</td>
<td>AVW</td>
<td>✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓</td>
</tr>
<tr>
<td>A865</td>
<td>Angstrom alpha coefficient over water (-)</td>
<td>AVW</td>
<td>✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓</td>
</tr>
<tr>
<td>T443</td>
<td>Aerosol optical thickness over land (-)</td>
<td>AV</td>
<td>✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓</td>
</tr>
<tr>
<td>A443</td>
<td>Angstrom alpha coefficient over land (-)</td>
<td>AV</td>
<td>✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓</td>
</tr>
<tr>
<td>T550</td>
<td>Aerosol optical thickness over water+land (-)</td>
<td>AN</td>
<td>✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓</td>
</tr>
<tr>
<td>A550</td>
<td>Angstrom alpha coefficient over water+land (-)</td>
<td>AN</td>
<td>✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓</td>
</tr>
<tr>
<td>CF</td>
<td>Cloud fraction (%)</td>
<td>STAT</td>
<td>✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓</td>
</tr>
<tr>
<td>ABSD</td>
<td>ABSOA_DUST flag statistics (%)</td>
<td>STAT</td>
<td>✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓</td>
</tr>
</tbody>
</table>

*Table 2-2: List of GlobColour Atmospheric Optical parameters*
## 2.1.3 Ocean Surface Optical parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>L3 merging method</th>
<th>Sensor availability</th>
</tr>
</thead>
<tbody>
<tr>
<td>NRRS400</td>
<td>NRRS412 NRRS443 NRRS469 NRRS490 NRRS510 NRRS531 NRRS547 NRRS551 NRRS555</td>
<td>AV AVW AV AVW</td>
<td>♠ ♠ ♠ ♠ ♠ ♠ ♠ ♠ ♠ ♠</td>
</tr>
<tr>
<td></td>
<td>Fully normalised remote sensing reflectance at xxx nm (sr⁻¹)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NRRS560</td>
<td>AV</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NRRS620</td>
<td>AV</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NRRS645</td>
<td>AV</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NRRS670</td>
<td>AVW</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NRRS674</td>
<td>AV</td>
<td>♠ ♠ ♠ ♠ ♠ ♠ ♠ ♠ ♠ ♠</td>
<td></td>
</tr>
<tr>
<td>NRRS678</td>
<td>AV</td>
<td>♠ ♠ ♠ ♠ ♠ ♠ ♠ ♠ ♠ ♠</td>
<td></td>
</tr>
<tr>
<td>NRRS709</td>
<td>AV</td>
<td>♠ ♠ ♠ ♠ ♠ ♠ ♠ ♠ ♠ ♠</td>
<td></td>
</tr>
<tr>
<td>RRS681</td>
<td>RRS709 RRS754 RRS779 RRS865 RRS885 RRS1020 RRS861 RRS709 RRS681 RRS681</td>
<td>AV AV AV AV</td>
<td>♠ ♠ ♠ ♠ ♠ ♠ ♠ ♠ ♠ ♠</td>
</tr>
<tr>
<td></td>
<td>Non normalised remote sensing reflectance at xxx nm (sr⁻¹)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EL555</td>
<td>Relative excess of radiance at 555 nm (%)</td>
<td>AN</td>
<td>♠ ♠ ♠ ♠ ♠ ♠ ♠ ♠ ♠ ♠</td>
</tr>
<tr>
<td>PAR</td>
<td>Photosynthetically Available Radiation (einstein/m²/day)</td>
<td>AVW</td>
<td>♠ ♠ ♠ ♠ ♠ ♠ ♠ ♠ ♠ ♠</td>
</tr>
</tbody>
</table>

(1): spectral inter-calibration is applied prior to the merging.
## 2.1.4 Ocean Subsurface Optical parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>L3 merging method</th>
<th>Sensor availability</th>
</tr>
</thead>
<tbody>
<tr>
<td>BBP</td>
<td>Particulate back-scattering coefficient at 443 nm (m(^{-1}))</td>
<td>GSM</td>
<td></td>
</tr>
<tr>
<td>CDM</td>
<td>Coloured dissolved and detrital organic materials absorption coefficient at 443 nm (m(^{-1}))</td>
<td>AV</td>
<td></td>
</tr>
<tr>
<td>KD490</td>
<td>Diffuse attenuation coefficient at 490 nm (m(^{-1})) Algorithms of Morel and Lee</td>
<td>AN (2 methods)</td>
<td></td>
</tr>
<tr>
<td>KDPAR</td>
<td>Diffuse attenuation coefficient for the Photosynthetically Available Radiation (m(^{-1})) Algorithms of Morel and Saulquin</td>
<td>AN (2 methods)</td>
<td></td>
</tr>
<tr>
<td>ZHL</td>
<td>Heated layer depth (m)</td>
<td>AN</td>
<td></td>
</tr>
<tr>
<td>ZEU</td>
<td>Depth of the bottom of the euphotic layer (m)</td>
<td>AN</td>
<td></td>
</tr>
<tr>
<td>ZSD</td>
<td>Secchi disk depth (m) Algorithms of Morel and Doron</td>
<td>AN (2 methods)</td>
<td></td>
</tr>
</tbody>
</table>

### Table 2-4: GlobColour Ocean Subsurface parameters

(1): OLCI has 3 methods for KD490 retrieval
2.1.5 OSS2015 Demonstration Biological Products

This section lists the demonstration products developed in the frame of the OSS2015 project. All the products are available as merged products (averaging method) at global scale with 25 km resolution. Note that they are based on the GlobColour archive version of 2015. Archive and product format conventions are not applicable to Third-Party products PP and PHYSAT.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Product type</th>
</tr>
</thead>
<tbody>
<tr>
<td>BBP-xxx-LOG</td>
<td>Particulate Back-scattering coefficients at xxx nm (m-1) - LOG algorithm</td>
<td>Monthly analytical</td>
</tr>
<tr>
<td>BBPS</td>
<td>Spectral slope of the particulate back-scattering coefficient ((\cdot))</td>
<td>Monthly analytical</td>
</tr>
<tr>
<td>POC-SURF</td>
<td>Surface Particulate Organic Carbon Concentration (mg/m3)</td>
<td>Monthly analytical</td>
</tr>
<tr>
<td>POC-INT</td>
<td>Column-integrated Particulate Organic Carbon Concentration (mg/m2)</td>
<td>Monthly analytical</td>
</tr>
<tr>
<td>PSD-XXX</td>
<td>Number concentration of pico, nano and micro particles (#/m3)</td>
<td>Monthly analytical</td>
</tr>
<tr>
<td>PP-AM</td>
<td>Primary Production - Antoine- Morel Algorithm</td>
<td>Third party, monthly analytical</td>
</tr>
<tr>
<td>PP-UITZ</td>
<td>Primary Production - Uitz Algorithm</td>
<td>Third party, monthly analytical</td>
</tr>
<tr>
<td>PHYSAT</td>
<td>Phytoplankton Functional Types</td>
<td>Third party, monthly analytical</td>
</tr>
</tbody>
</table>

2.2 Parameter Detailed Description
2.2.1 CHL$_1$

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
<th>PARAMETER</th>
<th>Sensor availability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biological</td>
<td>L3 merging method</td>
<td>CHL1</td>
<td>ALL</td>
</tr>
</tbody>
</table>

Chlorophyll concentration (mg/m³) for case 1 waters (see below). It is commonly used as a proxy for the biomass of the phytoplankton.

AVW

**MERIS/MODIS/VIRPIN merged CHL$_1$ - OCH$\alpha$/OCH$_{\alpha}$/OCH$_{\alpha}$/N$_{\alpha}$/N$_{\alpha}$ weighted average**

GlobColour monthly Level 3 product 2012-03-01 to 2012-03-31

GSM

**MERIS/MODIS/VIRPIN merged CHL$_1$ - GSM method**

GlobColour monthly Level 3 product 2012-03-01 to 2012-03-31
## Algorithm

<table>
<thead>
<tr>
<th>Algorithm</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>SWF: OC4v5</td>
<td>O’Reily et al., 2000</td>
</tr>
<tr>
<td>MER: OC4Me</td>
<td>O’Reily et al., 2000</td>
</tr>
<tr>
<td>MOD/VIR/VJ1: OC3v5</td>
<td>O’Reily et al., 2000</td>
</tr>
<tr>
<td>OLA/OLB: OC4Me</td>
<td>OLCI guide</td>
</tr>
</tbody>
</table>

**AVW**: weighted average of single-sensor Level 2 CHL1 products

**GSM**: GSM merging of single sensor L3 NRRS. The GSM method uses the normalized reflectances at the original sensor wavelengths, without intercalibration. CHL1 is one of the outputs of the method, in addition to bbp and CDM.

Maritorena and Siegel, 2005

## Validity

The CHL1 algorithms are applicable for “case 1” waters, i.e. waters where the phytoplankton concentration dominates over inorganic particles.

## References


OLCI guide: [https://earth.esa.int/web/sentinel/technical-guides/sentinel-3-olci/level-2/ocean-processing](https://earth.esa.int/web/sentinel/technical-guides/sentinel-3-olci/level-2/ocean-processing)

## Related products

Other Chlorophyll-a products: CHL-OC5, CHL2, CHL-CIA (OSS2015 demonstration product)

Other GSM algorithm outputs: CDM, BBP
2.2.2 CHL-OC5

<table>
<thead>
<tr>
<th>Category</th>
<th>Biological</th>
<th>PARAMETER</th>
<th>CHL1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
<td>L3 merging method</td>
<td>Sensor availability</td>
<td></td>
</tr>
<tr>
<td>Chlorophyll concentration (mg/m³). It is commonly used as a proxy for the biomass of the phytoplankton.</td>
<td>AVW</td>
<td>ALL</td>
<td></td>
</tr>
</tbody>
</table>

Algorithm

OC5 + Hu

The Merged product can be downloaded on the CMEMS website http://marine.copernicus.eu/services-portfolio/access-to-products/

Please use the search facilities with "Globcolour" keyword to access the long times series from 1997 to present.

Three products are available: daily, monthly and a daily interpolated (temporal and spatial).

References


Related products

Other Chlorophyll-a products: CHL1, CHL2, CHL-CIA (OSS2015 demonstration product)
Other OCS algorithm output: SPM-OCS
### 2.2.3 SPM-OC5

<table>
<thead>
<tr>
<th>Category</th>
<th>Biological</th>
<th>PARAMETER</th>
<th>CHL1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
<td></td>
<td>L3 merging method</td>
<td>Sensor availability</td>
</tr>
<tr>
<td></td>
<td>Inorganic suspended particulate matter concentration (g/m³).</td>
<td>AVW</td>
<td>ALL</td>
</tr>
</tbody>
</table>

![SPM-OC5 Image]

#### Algorithm

OC5

#### Reference

Gohin, F., 2011

#### References


#### Related products

Other suspended matter product: TSM, BBP
Other OC5 algorithm output: CHL-OC5
2.2.4 CHL₂

<table>
<thead>
<tr>
<th>Category</th>
<th>Biological</th>
<th>PARAMETER</th>
<th>CHL2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
<td>L3 merging method</td>
<td>Sensor availability</td>
<td></td>
</tr>
</tbody>
</table>

CHL₂ is the chlorophyll concentration (mg/m³) for Case 2 waters (see section validity). It is commonly used as a proxy for the biomass of the phytoplankton.

Algorithm

CHL₂ uses the a Neural Network algorithm. Another output of the algorithm is TSM.

Reference

Doerffer and Schiller (2007)  
OLCI guide

Validity

The product is valid for case 2 waters, i.e. waters where inorganic particles dominate over phytoplankton (typically in coastal waters).

References

OLCI guide: https://earth.esa.int/web/sentinel/technical-guides/sentinel-3-olci/level-2/ocean-processing

Related products

Other Chlorophyll-a products: CHL1, CHL-OCS, CHL-CIA (OSS2015 demonstration product)  
Other MERIS/OLCI Neural Network outputs: TSM, CDM
2.2.5 TSM

<table>
<thead>
<tr>
<th>Category</th>
<th>Biological</th>
<th>PARAMETER</th>
<th>TSM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
<td></td>
<td>L3 merging method</td>
<td>Sensor availability</td>
</tr>
</tbody>
</table>

TSM is the total suspended matter concentration (g/m³). It is a measure of the turbidity of the water.

AV
MER, OLA, OLB

TSM is the total suspended matter concentration (g/m³). It is a measure of the turbidity of the water.

Algorithm

TSM uses a Neural Network algorithm. Another output of the algorithm is CHL2.

Reference

Doerffer and Schiller (2007)
OLCI guide

Validity

The product is valid for case 2 waters, i.e. waters where inorganic particles dominate over phytoplankton (typically in coastal waters).

References

OLCI guide: https://earth.esa.int/web/sentinel/technical-guides/sentinel-3-olci/level-2/ocean-processing

Related products
The MERIS/OLCI TSM product is computed from the back-scattering coefficient at 444 nm using the following assumptions: $BP = BBP/0.015$, $TSM = 1.73*BP$. Therefore the BBP variable issued from the GSM algorithm is closely related to TSM. SPM-OC5 provides the inorganic suspended particulate matter, a product closely linked to TSM, according to the OC5 algorithm.

Other MERIS/OLCI Neural Network outputs: CHL2, CDM

### 2.2.6 PIC

<table>
<thead>
<tr>
<th>Category</th>
<th>Biological</th>
<th>PARAMETER</th>
<th>PIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
<td>L3 merging method</td>
<td>Sensor availability</td>
<td></td>
</tr>
</tbody>
</table>

PIC is the Particulate Inorganic Carbon or suspended calcium carbonate concentration (mol/m$^3$). CaCO$_3$ is produced in shallow waters by either coral reefs or macrophytic algae, or in the plankton, by coccolithophores, foraminifera, and pteropods.

![PIC Map](image)

**Algorithm**

PIC uses the original NASA algorithms: 2-band look-up table approach and 3-band algorithm at high concentrations

**Reference**

Bach et al. (2005)

Gordon et al. (2001)
Related products

POC provides the Particulate Organic Concentration

2.2.7 POC

<table>
<thead>
<tr>
<th>Category</th>
<th>Biological</th>
<th>PARAMETER</th>
<th>POC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
<td>L3 merging method</td>
<td>Sensor availability</td>
<td></td>
</tr>
</tbody>
</table>

POC is the Particulate Organic Carbon (mg/m³). POC is an important component in the carbon cycle and serves as a primary food sources for aquatic food webs.

AV, AVW

AV, SWF, MOD, VIR, VJ1

Algorithm

POC uses the original NASA algorithm (correlation of band ratios).

References

Stramski et al. (2008)

Related products

PIC provides the Particulate Inorganic Concentration
The OSS2015 archive includes a similar POC product and a column-integrated POC product.

2.2.8 NFLH

<table>
<thead>
<tr>
<th>Category</th>
<th>Biological</th>
<th>PARAMETER</th>
<th>NFLH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
<td>L3 merging method</td>
<td>Sensor availability</td>
<td></td>
</tr>
</tbody>
</table>

NFLH is the Normalised Fluorescence Line Height (mW/cm²/microm/sr) at 678 nm. Fluorescence is a marker of the photosynthetic activity of the phytoplankton.

NFLH is based on the original MODIS L2 product using the spectral band of MODIS at 678 nm.

References

Berhenfeld et al. (2009)

2.2.9 WVCS

<table>
<thead>
<tr>
<th>Category</th>
<th>Atmosphere</th>
<th>PARAMETER</th>
<th>WVCS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>L3 merging method</td>
<td>Sensor availability</td>
<td></td>
</tr>
</tbody>
</table>

WVCS is the total water vapor column over clear sky (g/cm²) coming from the MERIS/OLCI L2 data. Water vapour is the most effective greenhouse gas in the atmosphere. It influences weather and climate and is responsible for cloud development, precipitation, and modulates the atmospheric radiative energy transfer.

Algorithm

WCVS is an average of the corresponding MERIS/OLCI L2 data.

Reference

MERIS ATBD
OLCI guide

References

MERIS ATBD: [http://envisat.esa.int/handbooks/meris/CNTR2-7.html](http://envisat.esa.int/handbooks/meris/CNTR2-7.html) (accessed October 2016)
OLCI guide: [https://earth.esa.int/web/sentinel/technical-guides/sentinel-3-olci/level-2/ocean-processing](https://earth.esa.int/web/sentinel/technical-guides/sentinel-3-olci/level-2/ocean-processing)
### 2.2.10 Txxx

<table>
<thead>
<tr>
<th>Category</th>
<th>Atmosphere</th>
<th>PARAMETER</th>
<th>Txxx</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
<td>L3 merging method</td>
<td>Sensor availability</td>
<td></td>
</tr>
</tbody>
</table>

Txxx (xxx=443, 550, 865) are the aerosol optical thicknesses at 443 (over land), 550 (over land and water) and 865 nm (over water). The optical thickness is the logarithm of the ratio between the down-welling irradiances and the bottom of the atmosphere.

#### T443 (Land)

![T443 Land Map](image1)

#### T550 (Land + Water)

![T550 Land + Water Map](image2)
Algorithm

T443 is computed from the MERIS L2 product.
T865 is merged from corresponding L2 products for the various sensors.
T550 is extrapolated from the land and water products using the corresponding Angström $\alpha$ exponent:

$$T550 = T_{xx} \times \left(\frac{550}{xx}\right)^{-\alpha}$$

with $\alpha=1$ for land (xxx=443) and $\alpha=A865$ for water (xxx=865)

Reference

Gordon, 1997
MERIS ATBD
OLCI guide

Validity

The GlobColour merged atmosphere products are not yet validated. The validity of the products is not certified.

References

MERIS ATBD: http://envisat.esa.int/handbooks/meris/CNTR2-7.html (accessed October 2016)
OLCI guide: https://earth.esa.int/web/sentinel/technical-guides/sentinel-3-olci/level-2/ocean-processing
2.2.11 Axxx

<table>
<thead>
<tr>
<th>Category</th>
<th>Atmosphere</th>
<th>PARAMETER</th>
<th>Axxx</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
<td>L3 merging method</td>
<td>Sensor availability</td>
<td></td>
</tr>
</tbody>
</table>
| Axxx (xxx=443, 550, 865) are the Angström exponents at 443 (over land), 550 (over land and water) and 865 nm (over water). The Angström $\alpha$ exponent is related to the aerosol optical thickness $\tau$ by $\tau_1/\tau_0 = (\lambda_1/\lambda_0)^{-\alpha}$.

| 443: AV | MER |
| 550: AN | ALL |
| 865: AVW | ALL |

A443 (Land)

A550 (Land + Water)
A865 (Water)

Algorithm

A443 is computed from the MERIS L2 product.
A865 is a weighted average of the corresponding products from all sensors.
A550 is obtained by merging A443 (over land) and A865 (over water) products.

Reference

MODIS ATBD
MERIS ATBD
OLCI guide

Validity

The GlobColour merged atmosphere products are not yet validated. The validity of the products is not certified.

References

MERIS ATBD: http://envisat.esa.int/handbooks/meris/CNTR2-7.html (accessed October 2016)
OLCI guide: https://earth.esa.int/web/sentinel/technical-guides/sentinel-3-olci/level-2/ocean-processing
### 2.2.12 CF

<table>
<thead>
<tr>
<th>Category</th>
<th>PARAMETER</th>
<th>CF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atmosphere</td>
<td>L3 merging method</td>
<td>Sensor availability</td>
</tr>
</tbody>
</table>

CF is the Cloud Fraction (%), i.e. the percentage of pixels with flags Cloud, Ice, or haze per bin.

**Algorithm**

This parameter is determined by using the following flags:

- CLDICE = "Probable cloud or ice contamination" for MODIS, SeaWiFS and VIIRS instruments
- "CLOUD or (WATER and ICE_HAZE)" where ICE_HAZE = "Ice or high aerosol load pixel or Cloud" for the MERIS instrument.
- "CLOUD or CLOUD_AMBIGUOUS" for the OLCI instrument.

Two products are available:

- daily products: percentage of input pixels per bin flagged as cloudy in the original level 2 products
- 8-days and monthly products: percentage of merged days per bin where the daily cloud fraction is greater than a specified threshold (50% in current GlobColour processor)

**Reference**

MODIS ATBD
MERIS ATBD
OLCI guide

![Cloud Fraction Map](image-url)

References:
2.2.13 ABSD

<table>
<thead>
<tr>
<th>Category</th>
<th>Atmosphere</th>
<th>PARAMETER</th>
<th>ABSD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
<td>L3 merging method</td>
<td>Sensor availability</td>
<td></td>
</tr>
</tbody>
</table>

ABSD is the MERIS/OLCI L2 ABSOA DUST flag statistics (%), which is raised to indicate the presence of dust-like absorbing aerosols.

![ABSD Map]

Algorithm

ABSD is computed from the corresponding MERIS/OLCI L2 product.

References

MERIS ATBD: [http://envisat.esa.int/handbooks/meris/CNTR2-7.html](http://envisat.esa.int/handbooks/meris/CNTR2-7.html) (accessed October 2016)
OLCI guide: [https://earth.esa.int/web/sentinel/technical-guides/sentinel-3-olci/level-2/ocean-processing](https://earth.esa.int/web/sentinel/technical-guides/sentinel-3-olci/level-2/ocean-processing)
### 2.2.14 (N)RRSxxx

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
<th>L3 merging method</th>
<th>Sensor availability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ocean Surface Optical</td>
<td>The (N)RRSxxx are the remote sensing reflectances at xxx nm (expressed in sr-1). The remote sensing reflectance is the ratio of the upwelling radiance to the downwelling irradiance at Sea surface. NRRSxxx reflectances are fully normalized. RRSxxx are not normalized. (1) For NRRS 555, an inter-calibration is performed before merging (see algorithm description below).</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>400 AV</td>
<td>OLA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>412 AVW</td>
<td>ALL</td>
</tr>
<tr>
<td></td>
<td></td>
<td>443 AVW</td>
<td>ALL</td>
</tr>
<tr>
<td></td>
<td></td>
<td>469 AV</td>
<td>MOD</td>
</tr>
<tr>
<td></td>
<td></td>
<td>490 AVW</td>
<td>ALL</td>
</tr>
<tr>
<td></td>
<td></td>
<td>510 AVW</td>
<td>MER, SWF, OLA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>531 AV</td>
<td>MOD</td>
</tr>
<tr>
<td></td>
<td></td>
<td>547 AV</td>
<td>MOD</td>
</tr>
<tr>
<td></td>
<td></td>
<td>551 AV</td>
<td>VIR</td>
</tr>
<tr>
<td></td>
<td></td>
<td>555 AVW (1)</td>
<td>ALL</td>
</tr>
<tr>
<td></td>
<td></td>
<td>560 AV</td>
<td>MER, OLA, OLB</td>
</tr>
<tr>
<td></td>
<td></td>
<td>620 AV</td>
<td>MER, OLA, OLB</td>
</tr>
<tr>
<td></td>
<td></td>
<td>645 AV</td>
<td>MOD</td>
</tr>
<tr>
<td></td>
<td></td>
<td>670 AVW</td>
<td>ALL</td>
</tr>
<tr>
<td></td>
<td></td>
<td>674 AVW</td>
<td>OLA, OLB</td>
</tr>
<tr>
<td></td>
<td></td>
<td>678 AV</td>
<td>MOD</td>
</tr>
<tr>
<td></td>
<td></td>
<td>681 AV</td>
<td>MER, OLA, OLB</td>
</tr>
<tr>
<td></td>
<td></td>
<td>709 AV</td>
<td>MER, OLA, OLB</td>
</tr>
<tr>
<td></td>
<td></td>
<td>754 AV</td>
<td>OLA, OLB</td>
</tr>
<tr>
<td></td>
<td></td>
<td>779 AV</td>
<td>OLA, OLB</td>
</tr>
<tr>
<td></td>
<td></td>
<td>865 AV</td>
<td>OLA, OLB</td>
</tr>
<tr>
<td></td>
<td></td>
<td>885 AV</td>
<td>OLA, OLB</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1020 AV</td>
<td>OLA, OLB</td>
</tr>
</tbody>
</table>
Algorithm

MERIS and OLCI normalised water leaving reflectances from the L2 products are initially converted into fully normalised water leaving reflectances (except for the MERIS 681 nm and 709 nm bands and for the OLCI bands ≥ 754 nm).

The NRRSxxx daily L3 products are generated for each instrument, using the corresponding L2 data. The merged NRRSxxx concentration is then computed as the weighted average of all the single-sensor products.

The 547-560 nm bands are submitted to a specific processing just before averaging to prepare a more consistent merging between the instruments. First of all, all bands are spectrally re-affected to 555 nm, using an inter-spectral conversion LUT which is a function of the CHL1 concentration (weighted average version):

- **MODIS**: 
  \[ NRRS555 = NRRS547 \times (0.93573 + 0.0861 \times y + 0.01545 \times y^2 - 0.00714 \times y^3 - 0.00245 \times y^4) \]

- **VIIRS NPP**: 
  \[ NRRS555 = NRRS551 \times (0.97979 + 0.03583 \times y + 0.0057 \times y^2 - 0.00277 \times y^3 - 0.00085 \times y^4) \]

- **SeaWiFS/VIIRS JPSS-1**: No change as their band is actually at 555/556 nm

- **MERIS/OLCI**: 
  \[ NRRS555 = NRRS560 \times (1.02542 - 0.03757 \times y - 0.00171 \times y^2 + 0.0035 \times y^3 + 0.00057 \times y^4) \]

where \( y = \log_{10}(\text{CHL1}) \).

Validity

The validity limit for the spectral interpolation method at 555 nm is \( 0.01 \leq \text{CHL1} \leq 30 \).

References

N/A
EL555 is an indicator of an excess of luminance at 555 nm (%) after removal of the chlorophyll contribution in case 1 water. It is an indicator of the quality of the Chlorophyll retrieval and may indicate that the presence of other constituents (especially suspended matter) might have impact on the inversion.

The parameter is computed from the corresponding merged fully normalised remote sensing reflectance at 555 nm and the CHL1 (weighted method) products, using the following algorithm:

If (CHL1 > 0.2) and (NRRS$_{555}$ > $\text{Rho}_{\text{lim}}$(CHL1)) then

raise the turbid flag for all products

$$EL_{555} = 100 \cdot \frac{\text{NRRS}_{555} - \text{Rho}_{\text{lim}}(\text{CHL1})}{\text{Rho}_{\text{lim}}(\text{CHL1})}$$

Endif,

where $\text{Rho}_{\text{lim}}$(CHL1) is expressed as:

$$y = \log_{10}(\text{CHL1})$$

$$\text{Rho}_{\text{lim}}(y) = 0.0104 + 0.006665 \cdot y + 0.00099233 \cdot y^2 - 0.0006382 \cdot y^3$$

References

## 2.2.15 PAR

<table>
<thead>
<tr>
<th>Category</th>
<th>Ocean Subsurface Optical</th>
<th>PARAMETER</th>
<th>PAR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
<td></td>
<td>L3 merging method</td>
<td>Sensor availability</td>
</tr>
</tbody>
</table>

PAR is the Photosynthetically Available Radiation (einstein/m²/day). It is the mean daily photon flux density in the visible range (400 to 700 nm) that can be used for photosynthesis.

<table>
<thead>
<tr>
<th>Algorithm</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>PAR uses the original L2 products.</td>
<td>Frouin et al.</td>
</tr>
</tbody>
</table>

**References**

https://oceancolor.gsfc.nasa.gov/atbd/par/seawifs_par_wfigs.pdf


**Related products**

KdPAR provides the attenuation coefficient of the PAR in the water.
2.2.16 BBP

<table>
<thead>
<tr>
<th>Category</th>
<th>Ocean Subsurface Optical</th>
<th>PARAMETER</th>
<th>BBP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
<td>L3 merging method</td>
<td>Sensor availability</td>
<td></td>
</tr>
<tr>
<td>BBP is the particulate back-scattering coefficient (m(^{-1})) at the reference wavelength of (\lambda_0 = 443) nm. The back-scattering coefficient can be used as a proxy for the concentration of suspended particles in sea water.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GSM</td>
<td>ALL</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Algorithm Reference

BBP is an output of the GSM merging algorithm applied to L3 single-sensors reflectances NRRS.

Maritorena and Siegel, 2005

References


Related products

The MERIS/OLCI TSM product is computed from the back-scattering coefficient at 444 nm using the following assumptions: \(BP = BBP/0.015\), \(TSM = 1.73*BP\). Therefore the BBP variable issued from the GSM algorithm is closely related to TSM. SPM-OC5 provides the inorganic suspended particulate matter, a product closely linked to bbp, according to the OC5 algorithm.

The OSS2015 demonstration products include backscattering coefficients at several wavelength computed by the Non-Spectral Algorithm of Loisel et al. 2006.

Other GSM algorithm outputs: CHL1 (GSM), CDM
2.2.17 CDM

<table>
<thead>
<tr>
<th>Category</th>
<th>Ocean Subsurface Optical</th>
<th>PARAMETER</th>
<th>BBP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
<td></td>
<td>L3 merging method</td>
<td>Sensor availability</td>
</tr>
</tbody>
</table>

CDM is the absorption coefficient ($m^{-1}$) of Coloured Dissolved and detrital organic Materials at the reference wavelength of $\lambda_0 = 443$ nm.

**MERIS**

**GSM**
### Algorithm

<table>
<thead>
<tr>
<th>Algorithm</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MER</strong>: MERIS Neural Network algorithm</td>
<td>Doerffer and Schiller (2007)</td>
</tr>
<tr>
<td><strong>OLA/OLB</strong>: OLCI Neural Network algorithm</td>
<td>OLCI guide</td>
</tr>
<tr>
<td><strong>GSM</strong>: GSM merging of single sensor L3 NRCS. The GSM method uses the normalized reflectances at the original sensor wavelengths, without intercalibration. CDM is one of the outputs of the method, in addition to BBP and CHL1.</td>
<td>Maritorena et al. 2010</td>
</tr>
</tbody>
</table>

### References


OLCI guide: [https://earth.esa.int/web/sentinel/technical-guides/sentinel-3-olci/level-2/ocean-processing](https://earth.esa.int/web/sentinel/technical-guides/sentinel-3-olci/level-2/ocean-processing)

### Related products

Other MERIS/OLCI Neural Network outputs: CHL2, TSM

Other GSM algorithm outputs: CHL1 (GSM), BBP
### 2.2.18 KD490

<table>
<thead>
<tr>
<th>Category</th>
<th>Ocean Subsurface Optical</th>
<th>PARAMETER</th>
<th>KD490, KD490-LEE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
<td></td>
<td>L3 merging method</td>
<td>Sensor availability</td>
</tr>
</tbody>
</table>

KDd(490) is the diffuse attenuation coefficient (m$^{-1}$) of the downwelling irradiance at 490 nm. It is one indicator of the turbidity of the water column.

- KD490 is computed according to the Morel algorithm, while KD490-LEE is computed from the Lee and Arnone algorithm.

The Merged product can be downloaded on the CMEMS website [http://marine.copernicus.eu/services-portfolio/access-to-products/](http://marine.copernicus.eu/services-portfolio/access-to-products/)

Please use the search facilities with "Globcolour" keyword to access the long times series from 1997 to present.

Three products are available: daily, monthly and a daily interpolated (temporal and spatial).

- KD490-M07 is coming from the OLCI Level-2 algorithm.

**Diagram:**

KD490 (Morel)

MERISMODER/VIRIDIN merged KD490
GlobColour monthly Level-2 product
2012-01-01 to 2012-03-31

**Legend:**

- AN: MER, MOD, SWF, VIR, VI1
- AV: OLA, OLB
Algorithm

KD490 is computed from the corresponding merged CHL-OC5 products, using the following empirical formula:

\[ KD490 = 0.0166 + 0.077298 \times \text{CHL-OC5}^{0.67155} \]

KD490-LEE is computed from the corresponding merged fully normalised remote sensing reflectance products at 443, 490, 555 and 670 nm using the semi-analytical method of Lee and Arnone.

Reference

Morel et al. 2007

References


Related products

KDPAR provides the diffuse attenuation coefficient of the Photosynthetically Available Radiation.
2.2.19 KDPAR

<table>
<thead>
<tr>
<th>Category</th>
<th>Ocean Subsurface Optical</th>
<th>PARAMETER</th>
<th>KDPAR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
<td></td>
<td>L3 merging method</td>
<td>Sensor availability</td>
</tr>
</tbody>
</table>

KdPAR is the diffuse attenuation coefficient (m$^{-1}$) of the downwelling Photosynthetically Available Radiation in the 400 to 700 nm range.

KDPAR is computed according to the Morel algorithm, while KDPAR-SAULQUIN is computed from the Saulquin algorithm.

KDPAR (Morel)

[Image of world map with KDPAR values]
Algorithm

The merged KDPAR (Morel) is computed from the corresponding merged KD490 (Morel) product, using the following equation:

\[ \text{KDPAR} = 0.0665 + 0.874 \times \text{Kd(490)} - 0.00121 / \text{Kd(490)} \]

KDPAR-SAULQUIN is computed from the KD490-LEE product, using the following equations:

for \( \text{KD490-LEE} \leq 0.115 \text{ m}^{-1} \):

\[ \text{KDPAR-SAULQUIN} = 4.6051 \times \text{Kd(490)} / (6.07 \times \text{Kd(490)} + 3.2) \]

for \( \text{KD490-LEE} > 0.115 \text{ m}^{-1} \):

\[ \text{KDPAR-SAULQUIN} = 0.81 \times \text{Kd(490)}^{0.8256} \]

References


Related products

KDPAR (Morel) is computed from KD490.

KDPAR-SAULQUIN is computed from KD490-LEE.
2.2.20 ZHL

<table>
<thead>
<tr>
<th>Category</th>
<th>Ocean Subsurface Optical</th>
<th>PARAMETER</th>
<th>ZHL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
<td></td>
<td>L3 merging method</td>
<td>Sensor availability</td>
</tr>
</tbody>
</table>

ZHL is the depth of the bottom of the heated layer (m).

AN ALL

Algorithm

ZHL is computed from the corresponding merged KDPAR MOREL product, using the following equation:

\[
ZHL = \frac{2}{KDPAR}
\]

Reference

Morel et al. 2007

References


Related products

ZHL is computed from KD490.
### 2.2.21 ZEU

<table>
<thead>
<tr>
<th>Category</th>
<th>Ocean Subsurface Optical</th>
</tr>
</thead>
<tbody>
<tr>
<td>PARAMETER</td>
<td>ZEU</td>
</tr>
</tbody>
</table>

**Description**

ZEU is the depth of the euphotic layer (m), i.e. the depth for which the down-welling irradiance is 1% of its value at the surface. It characterizes the upper layer of the ocean which can support phytoplankton photosynthesis. It depends on the turbidity of the water.

**Algorithm**

ZEU computed from the corresponding merged CHL-OC5 products, using the following empirical equation:

\[

ZEU = 10^{1.524 - 0.436y - 0.0145y^2 + 0.0186y^3} \quad \text{with} \quad y = \log_{10}(\text{CHL-OC5})

\]

**Reference**

Morel et al. 2007

**References**


**Related products**

ZHL is computed from KD490.
2.2.22 ZSD

<table>
<thead>
<tr>
<th>Category</th>
<th>Ocean Subsurface Optical</th>
<th>PARAMETER</th>
<th>ZSD, ZSD-DORON</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
<td></td>
<td>L3 merging method</td>
<td>Sensor availability</td>
</tr>
<tr>
<td></td>
<td></td>
<td>AN</td>
<td>ALL</td>
</tr>
</tbody>
</table>

ZSD is the Secchi Disk depth (m). It represents the maximum depth at which a calibrated black and white disk (the so-called Secchi disk) is still visible from the surface. As such, it is a good indication of the maximum depth of underwater vertical visibility.

Two algorithms are available:
- ZSD-DORON according to Doron et al
- ZSD is computed according to the Morel et al. algorithm

The Merged product can be downloaded on the CMEMS website [http://marine.copernicus.eu/services-portfolio/access-to-products/](http://marine.copernicus.eu/services-portfolio/access-to-products/)

Please use the search facilities with "Globcolour" keyword to access the long times series from 1997 to present.

Three products are available: daily, a monthly and a daily interpolated (temporal and spatial).

![ZSD (Morel et al.)](image.png)
ZSD-DORON (Doron et al.)

Algorithm

ZSD is computed from the corresponding merged CHL-OCS products, using the following empirical equation:

\[ ZSD = 8.5 - 12.6y + 7.36y^2 - 1.43y^3 \quad \text{with} \quad y = \log_{10}(\text{CHL-OCS}) \]

The merged ZSD DORON is computed from the corresponding merged fully normalised remote sensing reflectance products at 490 and 555 nm using the DORON method.

Reference

Morel et al. 2007

Doron et al.

References


Related products

Another parameter linked to light penetration is the euphotic layer depth ZEU.
### 2.2.23 CHL-CIA

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demonstration Biochemical</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>CHL-CIA</th>
</tr>
</thead>
<tbody>
<tr>
<td>L3 merging method</td>
<td>AN</td>
</tr>
<tr>
<td>Sensor availability</td>
<td>MER, MOD, SWF, VIR</td>
</tr>
</tbody>
</table>

Chlorophyll concentration (mg/m³) according to Color Index Algorithm (see below). It is commonly used as a proxy for the biomass of the phytoplankton.

#### Algorithm

CHL-CIA is computed from L3 monthly merged products CHL1 (AVW) and NRRS using the Color Index band ratio algorithm. For chlorophyll concentrations higher than 0.3 mg/m³, CHL-CIA is equal to CHL1. A linear interpolation between the Color Index band ratio algorithm and CHL1 is performed in the range 0.25 to 0.3 mg/m³.

#### Reference


#### Related Products

Other chlorophyll products available in the GlobColour data set: CHL1 (weighted average and GSM), CHL-OC5, CHL2
2.2.24 BBPxxx-LOG

<table>
<thead>
<tr>
<th>Category</th>
<th>Demonstration Optical Subsurface</th>
<th>PARAMETER</th>
<th>BBPxxx-LOG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
<td>L3 merging method</td>
<td>Sensor availability</td>
<td></td>
</tr>
</tbody>
</table>

BBPxxx-LOG is the particulate back-scattering coefficient (m\(^{-1}\)) at wavelengths \(\lambda = 443, 490, 510\) and 555 nm. The bbp provide information on the particulate concentration and size distributions.

Algorithm

BBPxxx-LOG uses the Non Spectral Algorithm, based on a Neural Network approach. The product is computed from the monthly merged L3 reflectances NRRSxxx.

Reference

Loisel et al. 2006

References


Related products

The GlobColour BBP product provides the backscattering coefficient at 443 nm determined from the GSM approach. TSM provides the total suspended matter, a product closely linked to bbp, according to the MERIS/OLCI Neural Network algorithm. SPM-OC5 provides the inorganic suspended particulate matter, a product closely linked to bbp, according to the OC5 algorithm. The OSS2015 products BBPS and PSD are computed from the BBPxxx-LOG.
## 2.2.25 BBPS-LOG

<table>
<thead>
<tr>
<th>Category</th>
<th>Demonstration Optical Subsurface</th>
<th>PARAMETER</th>
<th>BBPS-LOG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
<td>L3 merging method</td>
<td>Sensor availability</td>
<td>AN</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>MER, MOD, SWF, VIR</td>
</tr>
</tbody>
</table>

BBPS-LOG provides the spectral exponent (logarithmic slope) of the particulate back-scattering coefficient. BBPS provides information about the size distribution of particles.

![Map of BBPS-LOG](image)

### Algorithm

BBPS-LOG is computed by linear regression of log(BBPxxx-LOG) at 443, 490, 510 and 555 nm.

### Reference

Loisel et al. 2006

### References


### Related products

See the BBPxxx-LOG info sheet for more information on the product.

BBPS-LOG is used to determine the particle size distributions PSD-XXX
# 2.2.26 PSD-XXX

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demonstration Biochemical</td>
<td>PSD-XXX (Particle Size Distribution) provide the number density of micro-, nano- and pico-plankton (#/m³) particles in the Ocean, with the following definitions:</td>
</tr>
<tr>
<td></td>
<td>- Micro: 20 and 50 µm</td>
</tr>
<tr>
<td></td>
<td>- Nano: between 2 and 20 µm</td>
</tr>
<tr>
<td></td>
<td>- Pico: between 0.5 and 2 µm</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>L3 merging method</th>
<th>Sensor availability</th>
</tr>
</thead>
<tbody>
<tr>
<td>PSD-XXX</td>
<td>AN</td>
<td>MER, MOD, SWF, VIR</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Algorithm</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>The PSD products are computed from the BBPS-LOG according to a semi-analytical formula based on the Mie theory.</td>
</tr>
<tr>
<td></td>
<td>Loisel et al. 2006</td>
</tr>
<tr>
<td></td>
<td>Kostadinov et al. 2009</td>
</tr>
</tbody>
</table>

### References


### Related products

BBPS-LOG is used to determine the particle size distributions PSD-XXX

Another classification of phytoplankton (according to the functional types) is provided by the PHYSAT product.
2.2.27 POC-SURF

**Category**
- Demonstration Biochemical

**PARAMETER**
- POC-SURF

<table>
<thead>
<tr>
<th>Description</th>
<th>L3 merging method</th>
<th>Sensor availability</th>
</tr>
</thead>
<tbody>
<tr>
<td>POC-SURF is the Particulate Organic Carbon (mol/m³) at sea surface. POC is an important component in the carbon cycle and serves as a primary food sources for aquatic food webs.</td>
<td>AN</td>
<td>MER, MOD, SWF, VIR</td>
</tr>
</tbody>
</table>

**Algorithm**

POC-SURF is computed from monthly merged L3 reflectances NRRS using a band ratio algorithm.

**Reference**

Stramski et al. 2008

**References**


**Related products**

The OSS2015 product POC-SURF is equivalent to the GlobColour POC product but it is computed in a different way (from monthly merged reflectances). POC-SURF uses data from MERIS. POC-SURF is used to compute the column integrated product POC-INT.
## 2.2.28 POC-INT

<table>
<thead>
<tr>
<th>Category</th>
<th>Demonstration Biochemical</th>
<th>PARAMETER</th>
<th>POC-INT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
<td></td>
<td>L3 merging method</td>
<td>Sensor availability</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>AN</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>MER, MOD, SWF, VIR</td>
</tr>
</tbody>
</table>

POC-INT is the Particulate Organic Carbon integrated over the vertical water column (mol/m²). POC is an important component in the carbon cycle and serves as a primary food sources for aquatic food webs.

---

### Algorithm

POC-INT is computed from POC-SURF and from the Mixed Layer Depth World Ocean Atlas Climatology, using an empirical formula. Duforet-Gaurier et al. (2010),

### References


### Related products

See the POC-SURF datasheet for information on this product.
2.2.29 PP

<table>
<thead>
<tr>
<th>Category</th>
<th>Biological</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
<td>PP is the primary production (mgC/m²/day). This represent the amount of carbon which fix by oceanic phytoplankton</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>PP</th>
</tr>
</thead>
<tbody>
<tr>
<td>L3 merging method</td>
<td>AVW</td>
</tr>
<tr>
<td>Sensor availability</td>
<td>merged</td>
</tr>
</tbody>
</table>

Primary production is computed using the Antoine and Morel algorithm from merged monthly L3 product.

The product can be downloaded on the CMEMS website [http://marine.copernicus.eu/services-portfolio/access-to-products/](http://marine.copernicus.eu/services-portfolio/access-to-products/)

Please use the search facilities with "Globcolour" keyword to access the long times series from 1997 to present.

**References**

### 2.2.30 PP-AM, PP-UITZ

<table>
<thead>
<tr>
<th>Category</th>
<th>Demonstration Biochemical</th>
<th>PARAMETER</th>
<th>PP-AM, PP-UITZ</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
<td></td>
<td>L3 merging method</td>
<td>Sensor availability</td>
</tr>
<tr>
<td>PP is the primary production (gC/m²/day) of the biomass. Two algorithms are available PP-AM (Antoine and Morel) and PP-UITZ (Uitz et al.)</td>
<td></td>
<td>AN</td>
<td>MER, MOD, SWF, VIR</td>
</tr>
<tr>
<td>PP-AM and PP-UITZ are available only from the GlobColour ftp server.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### PP-AM

**Primary Production 12-2010**

![PP-AM Primary Production 12-2010](image)

#### PP-UITZ

**Primary Production 12-2010**

![PP-UITZ Primary Production 12-2010](image)
### Algorithm

<table>
<thead>
<tr>
<th>Algorithm</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>PP-AM and PP-UITZ are computed from merged monthly L3 products using the respective algorithms.</td>
<td>Antoine and Morel 1996 Uitz et al. 2008</td>
</tr>
</tbody>
</table>

### References


PHYSAT is a data set of Phytoplankton functional types. The freq-xxx products contain the detection frequency of group xxx (0 < freq-xxx < 1):

- 0 = group never detected;
- 1 = all valid pixels are associated with the group

The xxx code refers to the phytoplankton groups:

- Nan: Nanoeucaryotes (group 1)
- Pro: Prochlorococcus (group 2)
- Slc: Synechococcus (group 3)
- Dia: Diatoms (group 4)
- Pha: Phaeocystis-like (group 5)

The GlobalMapOfMonthlyDominantsGroups product contains a map of the dominant (highest detection frequency) group for each month, using the numbering convention defined above.

The PHYSAT data set is available from the GlobColour Ftp server only.

References

Ben Mustapha Z., Alvain S., Jamet C, Loisel H. and D. Dessailly. Automatic classification of water-leaving radiance anomalies from global SeaWiFS imagery: Application to the detection of phytoplankton groups in open ocean waters, RSE-08794, 2014
2.3 The spatial and temporal coverage

2.3.1 The binned products

The GlobColour level-3 binned products have a resolution of 1/24° at the equator (i.e. around 4.63 km) for global products and of 1/96° (i.e. around 1.16 km) for Europe products. They consist of the accumulated data of all merged level 2 products, corresponding to periods of one day (a data-day algorithm is applied), 8 days and a calendar month. 8-days binning periods are continuous, starting from the first day of each calendar year.

The geographical location and extend of each bin is determined by the so-called Integerized Sinusoidal (ISIN) grid. The complete ISIN grid definition is provided in appendix.

In GlobColour binned ISIN products, bins are always written in sequential order, from the southernmost-westernmost bin to the northernmost-easternmost bin. Only valid bins are written in a binned product. Bins with no contributions (i.e. uncovered bins) are not contained in the files as well as the covered bins where no valid data has been found. The spatial resolutions of global and Europe products yield to the following grid characteristics:

<table>
<thead>
<tr>
<th>Area</th>
<th>GLOBAL</th>
<th>Europe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average bin size:</td>
<td>4.63 km</td>
<td>1.16 km</td>
</tr>
<tr>
<td>Average bin area:</td>
<td>21.44 km²</td>
<td>1.35 km²</td>
</tr>
<tr>
<td>Total number of rows in the grid:</td>
<td>4320</td>
<td></td>
</tr>
<tr>
<td>Number of columns at equator:</td>
<td>8640</td>
<td></td>
</tr>
<tr>
<td>Number of columns at poles:</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Total number of bins in the grid:</td>
<td>23,761,676</td>
<td>28,307,867</td>
</tr>
</tbody>
</table>

*Table 2-5: Main characteristics of the ISIN grids*

2.3.2 The mapped products

The GlobColour level-3 mapped products have a resolution of 1/24°, 0.25° or 1.0° (i.e. respectively around 4.63 km, 28 km and 111 km at the equator) for global products and of 0.015°x0.01° for Europe products. They consist of the flux-conserving resampling of the global level-3 binned products. Daily, 8-days and monthly products are available. Quicklooks of these products are available in PNG format.
3 The GlobColour system

3.1 Overall description of the processor

The GlobColour processor is the computation element of the GlobColour processing system. Its function is the transformation of EO level 2 products (or level 3 products) from independent instrument/missions into a single merged level 3 product.

The level-2 products are transformed after the sensor-specific preprocessing to the global and Europe ISIN grids. This binning is separately applied to each level-2 input product for each instrument. Outputs are intermediate spatially binned level-3 products for each instrument, also called level 3 at track level.

The term binning refers to the process of distributing the contributions of the level-2 pixels in satellite coordinates to a fixed level-3 grid using a geographic reference system.

When images of different resolutions are to be accumulated together, if the spatial coverage of each pixel is not taken into account, the importance of the image of the highest resolution are largely predominant over the images of smaller resolutions; this may result in introducing a bias in the final product.

Computing a flux value associated to each pixel may solve that problem. Assuming that the data flux for each input pixel is constant, the resampling problem is actually reduced to the problem of finding the set of pixels overlapping each level-3 bin, and then calculating the relative overlapped area.

This approach not only allows to properly mix data of various resolutions together, it also allows to distribute data properly among different level-3 bins as the input image pixel is usually overlapping several of them. This also makes it possible to produce level-3 data at a higher resolution than the input data with no "holes".

Though very attractive, the major drawback to this method is that it is significantly slower than the usual method; different techniques are being investigated to increase the speed of this approach.

The algorithm implemented in the GlobColour processing chain uses the fast Sutherland-Hodgeman area clipping. For more information on the algorithm used refer to ["A fast flux-conserving resampling algorithm", available at http://skyview.gsfc.nasa.gov/polysamp/].

The same binning algorithm is applied to each kind of input variables. Only the flags taken into account when filtering the data are different. These flags are listed in the next sub-section.

Following this logic, the GlobColour processor is mainly composed of 4 separate modules, namely:

1. a preprocessor module
2. a spatial binning module
3. a merging module
4. a temporal binning module

For each sensor, a pre-processing is foreseen just after extraction of the L2. This preprocessor serves for example in the case of MERIS/OLCI and wherever requested to transform the L2 normalised water leaving reflectances into fully normalised remote sensing reflectance. It could be used also to apply cross calibration LUT to be in position to merge equivalent data.
The complete binning scheme for the production of the GlobColour ocean colour products is a three steps approach comprising spatial binning, data merging and temporal binning as shown in the Figure 3-1.

Figure 3-1: The GlobColour processor high-level description
3.2 The preprocessor

A preprocessing function is implemented in the processing chain before applying the binning module. This preprocessing is needed to transform some input data read from the level 2 products into the requested variable. For example, the MERIS/OLCI normalised water leaving reflectances must be converted into fully normalised remote sensing reflectances.

The preprocessing could be a simple equation or a more complex algorithm using several external auxiliary files.

The following table lists the parameters on which a specific preprocessing is applied. The last column indicates which instrument data is affected.

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Variable description</th>
<th>Unit</th>
<th>Instruments</th>
</tr>
</thead>
<tbody>
<tr>
<td>NRRS400</td>
<td>Fully normalised remote sensing reflectance at 400 nm</td>
<td>sr-1</td>
<td>OLCI (pp1)</td>
</tr>
<tr>
<td>NRRS412</td>
<td>Fully normalised remote sensing reflectance at 412 nm</td>
<td>sr-1</td>
<td>MERIS (pp1) - OLCI (pp1)</td>
</tr>
<tr>
<td>NRRS443</td>
<td>Fully normalised remote sensing reflectance at 443 nm</td>
<td>sr-1</td>
<td>MERIS (pp1) - OLCI (pp1)</td>
</tr>
<tr>
<td>NRRS490</td>
<td>Fully normalised remote sensing reflectance at 490 nm</td>
<td>sr-1</td>
<td>MERIS (pp1) - OLCI (pp1)</td>
</tr>
<tr>
<td>NRRS510</td>
<td>Fully normalised remote sensing reflectance at 510 nm</td>
<td>sr-1</td>
<td>MERIS (pp1) - OLCI (pp1)</td>
</tr>
<tr>
<td>NRRS560</td>
<td>Fully normalised remote sensing reflectance at 560 nm</td>
<td>sr-1</td>
<td>MERIS (pp1) - OLCI (pp1)</td>
</tr>
<tr>
<td>NRRS620</td>
<td>Fully normalised remote sensing reflectance at 620 nm</td>
<td>sr-1</td>
<td>MERIS (pp1) - OLCI (pp1)</td>
</tr>
<tr>
<td>NRRS670</td>
<td>Fully normalised remote sensing reflectance at 670 nm</td>
<td>sr-1</td>
<td>MERIS (pp1) - OLCI (pp1)</td>
</tr>
<tr>
<td>NRRS674</td>
<td>Fully normalised remote sensing reflectance at 674 nm</td>
<td>sr-1</td>
<td>OLCI (pp1)</td>
</tr>
<tr>
<td>NRRS681</td>
<td>Fully normalised remote sensing reflectance at 681 nm</td>
<td>sr-1</td>
<td>OLCI (pp1)</td>
</tr>
<tr>
<td>NRRS709</td>
<td>Fully normalised remote sensing reflectance at 709 nm</td>
<td>sr-1</td>
<td>OLCI (pp1)</td>
</tr>
<tr>
<td>RRS681</td>
<td>None normalised remote sensing reflectance at 681 nm</td>
<td>sr-1</td>
<td>MERIS (pp2)</td>
</tr>
<tr>
<td>RRS709</td>
<td>None normalised remote sensing reflectance at 709 nm</td>
<td>sr-1</td>
<td>MERIS (pp2)</td>
</tr>
<tr>
<td>RRS754</td>
<td>None normalised remote sensing reflectance at 754 nm</td>
<td>sr-1</td>
<td>OLCI (pp2)</td>
</tr>
<tr>
<td>RRS779</td>
<td>None normalised remote sensing reflectance at 779 nm</td>
<td>sr-1</td>
<td>OLCI (pp2)</td>
</tr>
<tr>
<td>RRS865</td>
<td>None normalised remote sensing reflectance at 865 nm</td>
<td>sr-1</td>
<td>OLCI (pp2)</td>
</tr>
<tr>
<td>RRS885</td>
<td>None normalised remote sensing reflectance at 885 nm</td>
<td>sr-1</td>
<td>OLCI (pp2)</td>
</tr>
<tr>
<td>RRS1020</td>
<td>None normalised remote sensing reflectance at 1020 nm</td>
<td>sr-1</td>
<td>OLCI (pp2)</td>
</tr>
<tr>
<td>LON, LAT, SZA, SAA, VZA, VAA, PRESSURE, WIND</td>
<td>Geometrical characteristics of the observations</td>
<td></td>
<td>MERIS (pp3) - OLCI (pp3)</td>
</tr>
<tr>
<td>SZA, SAA</td>
<td>Geometrical characteristics of the observations</td>
<td></td>
<td>MODIS (pp4) - SeaWiFS (pp4) - VIIRS (pp4)</td>
</tr>
</tbody>
</table>

Table 3-1: List of variables with a specific preprocessing

(pp1): MERIS/OLCI fully normalised remote sensing reflectances
The MERIS/OLCI fully normalised remote sensing reflectances are computed from the normalised water leaving reflectances available in the MERIS/OLCI level-2 products.

(pp2): MERIS/OLCI none normalisation remote sensing reflectances.
(pp3): Geometrical characteristics of the observations
The geometrical characteristics of the observations are provided in the level 2 products for each pixel or every N pixels and frames (e.g. MERIS/OLCI tie-points). In the latter case, the preprocessing includes the reconstruction of the information for every pixel. For example, in MERIS level 2 products, the geometry observation and some other auxiliary data are stored every 16 pixels and 16 frames. One of the preprocessing tasks is to rebuild the characteristics of each pixel at each frame by bilinear interpolation.

(pp4): MODIS, SeaWiFS and VIIRS L2 products now provide LAT/LON for each pixel but SZA and SAA are not available so the preprocessor recomputed them from pixel position and date/time.

The following tables list, for each instrument, all variables coming from the preprocessing module, their symbols and their associated validity equation(s).

For all sensors we consider that a pixel is invalid if the absolute value of its sun zenith angle is greater than 70° (excepting for OC5 products).

Convention: $FFFF\text{ enlarged}X = FFFF$ flag enlarged by X swath pixels (flag neighbouring pixels at a distance $\leq X$)

### 3.2.1 MERIS

For all MERIS products we discard input Level-2 pixels with packed value equal to 0 (except for the flags band).

Convention: $CLOUD\_HAZE = CLOUD$ or $ICE\_HAZE$

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Variable</th>
<th>Validity equation</th>
</tr>
</thead>
<tbody>
<tr>
<td>NRRSxxx</td>
<td>Fully (or None) normalised remote sensing reflectance at xxx nm</td>
<td>WATER and not (PCD_19_WHITECAPS15 [Note 1] or CLOUD_HAZE_enlarged2 or HIGH_GLINT_enlarged2 or ABSOA_DUST)</td>
</tr>
<tr>
<td>RRSxxx</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CHL1</td>
<td>Chlorophyll concentration (from OC4Me)</td>
<td>WATER and not (PCD_15_WHITECAPS15 [Note 1] or CLOUD_HAZE_enlarged2 or HIGH_GLINT_enlarged2 or ABSOA_DUST or WHITE_SCATTERER)</td>
</tr>
<tr>
<td>CHL2</td>
<td>Chlorophyll concentration (from Neural Net)</td>
<td>WATER and not (PCD_17 for CHL2 or PCD_16 for CDM/TSM or CLOUD_enlarged2 or HIGH_GLINT_enlarged2 or ice from climatology)</td>
</tr>
<tr>
<td>CDM</td>
<td>Coloured dissolved and detrital organic materials absorption coefficient (from Neural Net)</td>
<td>WATER and not (PCD_17 for CHL2 or PCD_16 for CDM/TSM or CLOUD_enlarged2 or HIGH_GLINT_enlarged2 or ice from climatology)</td>
</tr>
<tr>
<td>TSM</td>
<td>Total suspended matter concentration (from Neural Net)</td>
<td>WATER and not (HIGH_GLINT or ABSOA_DUST)</td>
</tr>
<tr>
<td>CHL-OC5</td>
<td>Chlorophyll concentration (from OC5)</td>
<td>WATER and not (HIGH_GLINT or ABSOA_DUST)</td>
</tr>
</tbody>
</table>

Note 1: For OC5 products, the absolute sun zenith angle is greater than 80°.
Inorganic suspended particulate matter (from OC5) or COSMETIC or SUSPECT) and use 78° as maximum sun zenith angle and specific noise filter.

Total water vapor column over clear sky (WATER or LAND) and not (PCD14 or CLOUD_HAZE_enlarged2 or TOAVI_CSI_enlarged2 or HIGH_GLINT_enlarged2).

Aerosol optical thickness over water WATER and not (PCD_19_WHITECAPS15 [Note 1] or CLOUD_HAZE_enlarged3 or HIGH_GLINT_enlarged2) and [ CASE2_S or not (WHITE_SCATTERER or CASE2_ANOM) ]

Angstrom alpha coefficient over water

Aerosol optical thickness over land LAND and not (PCD19 or CLOUD_enlarged3 or TOAVI_CSI_enlarged3) and [Note 2]

Angstrom alpha coefficient over land

Cloud fraction WATER or CLOUD

ABSOA_DUST flag statistics WATER and not (PCD_19_WHITECAPS15 [Note 1] or HIGH_GLINT) and [ CASE2_S or not (WHITE_SCATTERER or CASE2_ANOM) ]

Table 3-2: List of parameters and filters applied to the MERIS level 2 data

**Note 1:** PCD_15_WHITECAPS15 and PCD_19_WHITECAPS15 are respectively recomputed PCD_15 and PCD_19 flags modified to accept wind speed modulus up to 15 m/s instead of 10 (WHITECAPS is an intermediary internal L2 processing flag raised when the wind speed modulus is greater than the threshold). Detailed definition:

- **PCD_15_WHITECAPS15** = PCD_18 or CASE2ANO or CASE2Y or (T865 > 0.6) or (wind speed modulus > 15)
- **PCD_19_WHITECAPS15** = PCD_18 or (wind speed modulus > 15)

**Note 2:** Santer & Vidot aerosol over land algorithm implementation:

- discard pixel if A865 (with scale/offset applied) not in [0, 2.5]
- apply a standard deviation filter on T865 (with scale/offset applied) on a 9x9 box: discard the pixel if it is not in [mean – max(2*stddev, scale), mean + max(2*stddev, scale)], with mean and stddev computed using all T865 valid pixels. The term max(2*stddev, scale) allows to handle homogeneous areas (we don’t want discard all pixels if stddev is very small).
3.2.2 OLCI

OLCI parameters validity equations are based on The Sentinel-3A Product Notice – OLCI Level-2 Ocean Colour

Conventions:
CLOUDS = CLOUD or CLOUD_AMBIGUOUS or CLOUD_MARGIN
COMMON_FLAGS = CLOUDS or INVALID or COSMETIC or SATURATED or SUSPECT or HIGHLINT or SNOW_ICE or AC_FAIL or WHITECAPS or ANNOT_ABSO_D or ANNOT_MIXR1 or ANNOT_DROUT or ANNOT_TAU06 or RWNEG_O2..O8

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Variable</th>
<th>Validity equation</th>
</tr>
</thead>
<tbody>
<tr>
<td>NRRSxxx RRSxxx</td>
<td>Fully (or None) normalised remote sensing reflectance at xxx nm</td>
<td>(WATER or INLAND_WATER) and not COMMON_FLAGS</td>
</tr>
<tr>
<td>CHL1</td>
<td>Chlorophyll concentration (from OC4Me)</td>
<td>(WATER or INLAND_WATER) and not (COMMON_FLAGS or OC4ME/KDM_FAIL)</td>
</tr>
<tr>
<td>KD490-M07</td>
<td>Diffuse attenuation coefficient (from M07)</td>
<td></td>
</tr>
<tr>
<td>CHL2</td>
<td>Chlorophyll concentration (from Neural Net)</td>
<td>(WATER or INLAND_WATER) and not (OCNN_FAIL or INVALID or COSMETIC or SATURATED or SUSPECT or CLOUDS or HIGHLINT)</td>
</tr>
<tr>
<td>CDM</td>
<td>Coloured dissolved and detrital organic materials absorption coefficient (from Neural Net)</td>
<td></td>
</tr>
<tr>
<td>TSM</td>
<td>Total suspended matter concentration (from Neural Net)</td>
<td></td>
</tr>
<tr>
<td>CHL-OC5</td>
<td>Chlorophyll concentration (from OC5)</td>
<td>(WATER or INLAND_WATER) and not (COMMON_FLAGS excepting ANNOT_MIXR1, ANNOT_DROUT, RWNEG_O2,07,08 or HIGH_GLINT_enlarged2) and use 78° as maximum sun zenith angle and specific noise filter</td>
</tr>
<tr>
<td>SPM-OC5</td>
<td>Inorganic suspended particulate matter (from OC5)</td>
<td></td>
</tr>
<tr>
<td>WVCS</td>
<td>Total water vapor column over clear sky</td>
<td>(WATER or INLAND_WATER or LAND) and not (WV_FAIL or CLOUDS or MEGLINT)</td>
</tr>
<tr>
<td>T865</td>
<td>Aerosol optical thickness over water</td>
<td>(WATER or INLAND_WATER) and not COMMON_FLAGS</td>
</tr>
<tr>
<td>A865</td>
<td>Angstrom alpha coefficient over water</td>
<td></td>
</tr>
<tr>
<td>CF</td>
<td>Cloud fraction</td>
<td>WATER or INLAND_WATER or CLOUD</td>
</tr>
<tr>
<td>ABSD</td>
<td>ABSOA_DUST flag statistics</td>
<td>(WATER or INLAND_WATER) and not (COMMON_FLAGS excepting ANNOT_ABSO_D or ANNOT_ACLIM)</td>
</tr>
</tbody>
</table>

Table 3-3: List of parameters and filters applied to the OLCI level 2 data
### 3.2.3 MODIS/SeaWiFS/VIIRS

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Variable</th>
<th>Validity equation</th>
</tr>
</thead>
<tbody>
<tr>
<td>NRRSxxx</td>
<td>Fully normalised remote sensing</td>
<td>not (ATMFAIL or LAND or HILT or HISATZEN or STRAYLIGHT or CLDICE or COCCOLITH or LOWLW or CHLFAIL or CHLWARN or NAVWARN or MAXAERITER or ATMWARN or NAVFAIL or FILTER or HIGLINT)</td>
</tr>
<tr>
<td>CHL1</td>
<td>Chlorophyll concentration</td>
<td></td>
</tr>
<tr>
<td>POC</td>
<td>Particulate Organic Carbon</td>
<td></td>
</tr>
<tr>
<td>T865</td>
<td>Aerosol optical thickness over</td>
<td></td>
</tr>
<tr>
<td>A865</td>
<td>Angstrom alpha coefficient over</td>
<td></td>
</tr>
<tr>
<td>PIC</td>
<td>Particulate Inorganic Carbon</td>
<td>not (ATMFAIL or LAND or HISATZEN or STRAYLIGHT or CLDICE or LOWLW or NAVWARN or ATMWARN or NAVFAIL or FILTER or HIGLINT)</td>
</tr>
<tr>
<td>CHL-OC5</td>
<td>Chlorophyll concentration (from</td>
<td>not (ATMFAIL or HILT or CLDICE or LOWLW or NAVWARN or MAXAERITER or ATMWARN or NAVFAIL or HIGLINT or ATMFAIL or (sensor == SeaWiFS and HISATZEN) or (sensor == SeaWiFS and resolution == MLAC and no LAND at a distance &lt;= 4 pixels and STRAYLIGHT)) and use 78° as maximum sun zenith angle and specific noise filter</td>
</tr>
<tr>
<td>SPM-OC5</td>
<td>Inorganic suspended particulate</td>
<td></td>
</tr>
<tr>
<td>NFLH</td>
<td>Normalised Fluorescence Line</td>
<td>(same as for CHL1) and not(PRODWARN or MODGLINT)</td>
</tr>
<tr>
<td>PAR</td>
<td>Photosynthetically Available</td>
<td>Not (LAND or NAVFAIL or FILTER or HIGLINT)</td>
</tr>
<tr>
<td>CF</td>
<td>Cloud fraction</td>
<td>not LAND</td>
</tr>
</tbody>
</table>

*Table 3-4: List of parameters and filters applied to the MODIS/SeaWiFS/VIIRS level 2 data*

#### 3.3 The spatial and temporal binning schemes

The list of steps for the generation of the whole set of GlobColour products is:
- step 1: L2 to L3 track on ISIN grid
- step 2: L3 track to L3 daily for each single instrument
- step 3: L3 daily for each single instrument to merged L3 daily
- step 4: L3 daily merged to 8days and monthly L3 products
- step 5: L3 daily/8days/monthly merged products to mapped products on PC grid
- step 6: generation of the quicklooks

These steps are fully described in appendix.

The temporal binning algorithm is rather simple and the complexity comes from the selection of the input level-3 products to generate the daily products. The simple, obvious, selection of
all data measured between 00:00 and 23:59 leads to possible large temporal aliasing in the same region of observation.

The temporal binning process needs the definition of a data-day, as we don’t want to mix at the same (or at close geographical locations) pixels observed at too different times. The data-day definition used in the frame of the GlobColour project is fully described in the following sub-chapter.

### 3.4 The GlobColour data-day approach

A new spatial and temporal definition of a data-day has been used in the frame of the GlobColour project. The aim of the data-day definition is to avoid mixing pixels observed at too different times. As for other classic definitions, we accept to increase the duration of a day in order to include the previous and next day data. Then, at the same spatial area we could select the best input, i.e. the one leading to the lowest temporal discrepancies. A data-day therefore may represent data taken over a 24 to 28 hour period.

As the Seastar, Aqua, ENVISAT and NPP satellites have different orbits, each of them has its own data-day definition.

In the following figures, we have plotted the UTC hour as a function of the pixel longitude for the three instruments for one day in the year. The colour of the dots is proportional to the absolute value of the data latitude (purple-blue for latitude=0° and red-brown for latitude>80°). The idea behind that representation is that if we want to avoid mixing pixels of different hours of the day at the same longitude, something should be visible on this kind of graphic.

We can observe that the data is split in three groups. As expected, the high latitudes of the data cover more longitude values while the equatorial latitudes lead to less scattered longitude values (the orbits are polar). Of course, a bigger width of the instrument track leads to a higher dispersion.

We can also observe that the temporal variation of the pixels of each instrument covers a large period of the day, especially for MODIS, SeaWiFS and VIIRS: if we look at the width of the central set of pixels at any longitude, we can see that this width is equal to 8 hours for MERIS, 20 hours for SeaWiFS and 24 hours for MODIS. This is directly linked to the satellite orbit and the track width. If we avoid pixels above 80°, the temporal variation decreases to: 8 hours for MERIS and SeaWiFS and 16 hours for MODIS. In this new estimation, we have discarded a few valid pixels that belongs to the ascending track (or descending track, depending of the satellite orbit) that are of course far away in longitude with respect to the median part of the track and so will mix with pixels of a previous track, observed several hours before.

These groups are attached to three different data-days:

- the pixels belonging to the median group are attached to the current data-day (i.e. the day given by the current UTC date).
- the pixels belonging to the upper group are attached to the next data-day
- the pixels belonging to the lower group are attached to the previous data-day
Figure 3-2: MERIS pixels UTC as a function of the pixel longitude (35 days - October 2003)

Figure 3-3: MODIS pixels UTC as a function of the pixel longitude (1 day - June 2003)
Figure 3-4: SeaWiFS pixels UTC as a function of the pixel longitude (1 day - December 2003)

Obviously, we can see on these graphics that the groups are separated by two regular, more or less large white bands. The slope of these bands is equal to -24/360°. If we plot a line defined by the crossing nodal time of the satellite at -180° and this slope, we can see that this line is almost always located in the white bands and so can be used to distinguish between data of very different day time at the same longitude.

Figure 3-5: Data-day definition line above MODIS pixels UTC versus longitude plot.
As some instrument are able to observe through the pole, there is not always such full discontinuity between the groups. Anyway, this is only true for pixels at very high latitudes (>80°), as shown on the following figure where we have plotted only one SeaWiFS track and the data-day separation line.

![Figure 3-6: Data-day definition line above one SeaWiFS track.](image)

Despite this limitation, there are several reasons to use this data-day separation lines:

- the observation will be probably flagged due to the limitation in sun zenith angle (70°)
- the data is not lost. Only few pixels are shifted to the next of previous data-day
- the coding is very simple

The implementation of this data-day definition is described here:

**Input parameters:**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Unit</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CNT</td>
<td>hour</td>
<td>crossing nodal time in ascending track</td>
</tr>
<tr>
<td>τ</td>
<td>hr/°</td>
<td>slope of the data-day definition lines</td>
</tr>
<tr>
<td>d</td>
<td>UTC date</td>
<td>UTC date (day) of the measured pixel</td>
</tr>
<tr>
<td>h</td>
<td>UTC hour</td>
<td>UTC date (hour) of the measured pixel</td>
</tr>
<tr>
<td>φ</td>
<td>deg</td>
<td>longitude of the measured pixel</td>
</tr>
</tbody>
</table>

**Table 3-5: Input parameters for data-day classification**

Note: τ has a constant value equal to -24/360.
<table>
<thead>
<tr>
<th>Instrument</th>
<th>MODIS (Aqua)</th>
<th>VIIRS</th>
<th>SeaWiFS (SeaStar)</th>
<th>MERIS (Envisat)</th>
<th>OLCI (Sentinel-3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CNT</td>
<td>13.5</td>
<td>12.0</td>
<td></td>
<td>10.0</td>
<td></td>
</tr>
</tbody>
</table>

*Table 3-6: CNT of satellites*

**Algorithm:**

if \( h < \text{CNT} + (\phi + 180)^\tau \) then

pixel is attached to data-day (d-1)

else if \( h > \text{CNT} + (\phi + 180)^\tau + 24 \) then

pixel is attached to data-day (d+1)

else

pixel is attached to data-day (d)

end if
4 The products format

4.1 General rules

The GlobColour Level-3 binning scheme and its output products have been designed with respect to a number of widely used definitions and de-facto standards:

- netCDF Climate and Forecast Metadata Conventions CF
- NASA Ocean Color Level-3 products
- GHRSST-PP Level-4 products
- IOCCG Report number 4

GlobColour Level-3 output data includes binned, mapped and quicklook products which are described in the following sections. The binned and mapped products are stored in netCDF-4 files. The netCDF-4 library or third-party tools including netCDF-4 readers must be used to read the GlobColour products. The quicklook products are written in PNG format.

netCDF (Network Common Data Form) is a machine-independent, self-describing, binary data format standard for exchanging scientific data. The project homepage is hosted by the Unidata program at the University Corporation for Atmospheric Research (UCAR). They are also the chief source of netCDF software, standards development, updates etc. The format is an open standard (see http://www.unidata.ucar.edu/software/netcdf).

The version 4 of the netCDF format provides new features which are used for GlobColour products: chunking and internal compression. These two features allow us to distribute files with reduced compressed size and optimized random access: reading a small window on a product needs only to read and decompress the chunks covering it, without decompressing the whole file. Other new feature of netCDF-4 like new unsigned data types and groups are not used for GlobColour products to keep compatibility with the netCDF-3 data model: existing netCDF-3 tools could be easily re-used without any other modification than re-linking the program with the version 4 of the library. Note that the netCDF-4 format is now based on the widely supported HDF5 scientific data format, which means that any HDF5 tool will be also able to read the GlobColour products.

The following rules are applied when writing the binned (ISIN grid) and mapped products (PC grid):

- each parameter is stored in a single file including metadata and accumulated statistical data.
- global metadata are stored as global attributes
- accumulated statistical data are stored as variables
- metadata related to statistical data are stored as variable attributes.

4.2 Naming convention

This naming convention is common to all GlobColour products (but not to OSS2015 third-party products). The file naming convention of the files follows the following rules:

Lzz_date_time_ROI_SR_INS_PRD_TC_nn.ext

where:

- Lzz is the product level (L3b for level 3 binned ISIN grid, L3m for level 3 mapped grid)
- **date** is specified in UTC format as yyyymmdd[-yyyymmdd]. The end date is optional for track and daily products.
- **time** is specified in UTC format as hhmmss[-duration]. The time field is needed only for track products. The duration is expressed in seconds.
- **ROI** is the name of the region of interest (e.g. GLOB for global coverage, EURO for Europe area).
- **SR** indicates the resolution of the grid (e.g. 4 for 1/24° ISIN grid).
- **INS** is the instrument acronym (MER for MERIS, MOD for MODIS, SWF for SeaWiFS, VIR for VIIRS, OLA for OLCI-A, or any combination of these names for the merged products). For the merged products, the instrument acronym is prefixed with the merging method (AV for simple average, AVW for weighted average, GSM for the GSM model).
- **PRD** is the product type (CHL for chlorophyll...). The various parameter algorithms can be indicated in this field using a "-" delimiter (e.g. CHL1-OC5, KD490-LEE). Note that wavelengths in parameters name (for example for (N)RRSxxx) are not accurate because we use the same naming convention for merged and single-sensor products, so for example NRRS670 for a MERIS-only product is at 665nm and NRRS490 for a MODIS-only product is at 488nm.
- **TC** is the time coverage (TR for track-level products, DAY for daily, 8D for 8days, MO for monthly).
- **nn** is a counter. For track products, we store in this counter the data-day in yyyymmdd format.
- **ext** is the file extension (nc for netCDF files, png for PNG files)

The number of field is constant. Missing information leads to two adjacent underscores.

Examples:

L3b_20040101_072312-2363_GLOB_4_MER_NRRS555_TR_20040101.nc
L3m_20040401__EURO_1_MOD_CHL1_DAY_00.nc
L3b_20040401-20040430__GLOB_4_MER_NRRS413_MO_00.nc
L3b_20021001-20021031__GLOB_4_AV-MERMODSWF_T865_MO_00.nc

### 4.3 The binned products

A netCDF dataset is made up of three basic components:

- dimensions
- variables
- variables attributes
- global attributes

The variables store the actual data, the dimensions give the relevant dimension information for the variables, and the attributes provide auxiliary information about the variables or the dataset itself.

**Dimensions**

All variables stored in the ISIN binned product use one of the two dimensions:
### Table 4-1: Dimensions - binned products

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Parameter Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>bin</td>
<td>Number of bins written in the product</td>
</tr>
<tr>
<td>row</td>
<td>Number of useful rows in the global ISIN grid (number of row between northernmost and southernmost bins)</td>
</tr>
</tbody>
</table>

### Variables

ISIN grid location variables (only present in ISIN case). Some variable names are prefixed by the name of the parameter (e.g. CHL1_mean, EL555_weight).

<table>
<thead>
<tr>
<th>Variable Name</th>
<th>netCDF Type</th>
<th>Nb of bytes</th>
<th>Parameter Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>row(bin)</td>
<td>NC_SHORT or NC_INT (3)</td>
<td>2 or 4 (3)</td>
<td>Latitudinal band index of the bins stored in the product, zero based and beginning at south</td>
</tr>
<tr>
<td>col(bin)</td>
<td>NC_SHORT or NC_INT (3)</td>
<td>2 or 4 (3)</td>
<td>Longitudinal index of the bins stored in the product, zero based and beginning at west</td>
</tr>
<tr>
<td>center_lat(row)</td>
<td>NC_FLOAT</td>
<td>4</td>
<td>Center latitude for each useful row</td>
</tr>
<tr>
<td>center_lon(row)</td>
<td>NC_FLOAT</td>
<td>4</td>
<td>Center longitude of the first bin (the first bin in the ISIN grid, not the first valid bin) for each useful row</td>
</tr>
<tr>
<td>lon_step(row)</td>
<td>NC_FLOAT</td>
<td>4</td>
<td>Longitude step for each useful row</td>
</tr>
<tr>
<td>PRM_mean(bin)</td>
<td>NC_FLOAT</td>
<td>4</td>
<td>Average value of the binned pixels values</td>
</tr>
<tr>
<td>PRM_stdev(bin)</td>
<td>NC_FLOAT</td>
<td>4</td>
<td>Standard deviation of the square of the binned pixels values</td>
</tr>
<tr>
<td>PRM_count(bin)</td>
<td>NC_SHORT</td>
<td>2</td>
<td>Number of binned pixels</td>
</tr>
<tr>
<td>PRM_weight(bin)</td>
<td>NC_FLOAT</td>
<td>4</td>
<td>Sum of the weights of the binned pixels</td>
</tr>
<tr>
<td>PRM_flags(bin)</td>
<td>NC_SHORT</td>
<td>2</td>
<td>Flags (4)</td>
</tr>
<tr>
<td>PRM_error(bin)</td>
<td>NC_SHORT</td>
<td>2</td>
<td>Error estimation for the geophysical variable</td>
</tr>
</tbody>
</table>

Note 1: the row(), col(), center_lat, center_lon and lon_step() arrays allow an easier conversion of the bin index into geographical coordinates rather than the global idx() array written in the SeaWiFS and MODIS level 3 products.

Equations to compute center longitude and latitude for a bin $b$ are:

- $\text{index} = \text{row}(b) - \text{first_row}$ \hspace{1cm} ($\text{first_row}$ is a global attribute)
- $\text{lat}(b) = \text{center_lat}( \text{index} )$
- $\text{lon}(b) = \text{center_lon}( \text{index} ) + \text{col}(b) \times \text{lon_step}( \text{index} )$

Note 2: the error associated to each bin is computed from representative values of the bin (e.g. arithmetic mean) and observation conditions (e.g. zenith angles) using a LUT read from an
external auxiliary file. The error variable is stored only in products where it is significant (i.e. the error bar is not used for simple averaging merging, and so the error is of course not stored). The error bar is stored in % packed into a 2 bytes integers using a scale factor of 0.01 (this kind of data packing is standard in netCDF). The biggest error bar possible in this format is 327.67, so if a computed error bar is greater than 327.67 then it is set to 327.67.

Note 3: these variables type could be NC_SHORT or NC_INT depending on the ISIN grid resolution.

Note 4: the quality control is available through a flags array (2 bytes), provided for each bin of each product (source of instrument: all, MODIS only..., green reflectance threshold, mostly cloudy pixel, etc...). The next table contains the current flags definition. A flag is set if its bit is set to 1. The "Bit" column contains each flag bit number, from the least to the most significant bit of the 2 bytes. The flags definition is also stored in the product itself following the netCDF “CF” (Climate and Forecast) convention.

<table>
<thead>
<tr>
<th>Bit</th>
<th>Flag code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>NO_MEASUREMENT</td>
<td>Bin not covered by any L2 swaths pixel, valid or invalid (out of swaths)</td>
</tr>
<tr>
<td>1</td>
<td>INVALID</td>
<td>Bin covered, but only by invalid pixel(s) (invalid because L2 flags, clouds, land, …)</td>
</tr>
<tr>
<td>2</td>
<td>OLCI_A</td>
<td>OLCI(A) valid pixel(s) contribute to the bin value</td>
</tr>
<tr>
<td>3</td>
<td>LAND</td>
<td>Bin covered by more than 50% of land. If not set, bin is considered as water. (1) (4)</td>
</tr>
<tr>
<td>4</td>
<td>CLOUD1</td>
<td>Cloud fraction (2)</td>
</tr>
<tr>
<td>5</td>
<td>CLOUD2</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>DEPTH1</td>
<td>Water depth (1) (3)</td>
</tr>
<tr>
<td>7</td>
<td>DEPTH2</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>TURBID</td>
<td>Computed from EL555. TURBID flag is raised when EL555 is greater than 0</td>
</tr>
<tr>
<td>9</td>
<td>ICE</td>
<td>Bin covered by ice. Computed from an ice climatology.</td>
</tr>
<tr>
<td>10</td>
<td>TROPHIC1</td>
<td>Trophic classification (5)</td>
</tr>
<tr>
<td>11</td>
<td>TROPHIC2</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>VIIRS_N</td>
<td>VIIRS(N) valid pixel(s) contribute to the bin value</td>
</tr>
<tr>
<td>13</td>
<td>SEAWIFS or VIIRS_J1</td>
<td>SeaWiFS or VIIRS(J1) valid pixel(s) contribute to the bin value</td>
</tr>
<tr>
<td>14</td>
<td>MODIS</td>
<td>MODIS valid pixel(s) contribute to the bin value</td>
</tr>
<tr>
<td>15</td>
<td>MERIS or OLCI_B</td>
<td>MERIS or OLCI(B) valid pixel(s) contribute to the bin value</td>
</tr>
</tbody>
</table>

Table 4-3: Flags description

Note 1: computed using a common global land elevation and ocean bathymetry product (data from ESA). This product is computed at 4.63 km on the global ISIN and PC grids.

Note 2: for 8-days or longer periods, cloud fraction flags are not yet defined (flags are currently set to 0). For daily products they define a cloud coverage classification based on the value of the CF product:

- (CLOUD2=0) + (CLOUD1=0): CF < 5%
- (CLOUD2=0) + (CLOUD1=1): 5% <= CF < 25%
- (CLOUD2=1) + (CLOUD1=0): 25% <= CF < 50%
(CLOUD2=1) + (CLOUD1=1): CF >= 50%

Note 3: (DEPTH2=0) + (DEPTH1=0): depth < 30m
  (DEPTH2=0) + (DEPTH1=1): 30m <= depth < 200m
  (DEPTH2=1) + (DEPTH1=0): 200m <= depth < 1000m
  (DEPTH2=1) + (DEPTH1=1): depth >= 1000m

Note 4: it is possible that a bin flagged LAND has a valid parameter value near the coastline.

Note 5: (TROPHIC2=0) + (TROPHIC1=1): Oligotrophic water
  (TROPHIC2=1) + (TROPHIC1=0): Mesotrophic water
  (TROPHIC2=1) + (TROPHIC1=1): Eutrophic water

Variables attributes

The following table lists the variable attributes used in the GlobColour project. These attributes are commonly used to annotate variable in netCDF files and their usage is strongly encouraged by the CF metadata conventions (excepting for pct_characterised_error which is GlobColour specific).

<table>
<thead>
<tr>
<th>Attribute Name</th>
<th>netCDF type</th>
<th>Attribute Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>long_name</td>
<td>string</td>
<td>A descriptive name that indicates a variable's content. We set it to the &quot;Parameter Description&quot; of the previous table</td>
</tr>
<tr>
<td>standard_name</td>
<td>string</td>
<td>If available, a CF standard name that references a description of variable's content</td>
</tr>
<tr>
<td>_FillValue</td>
<td>same type as variable</td>
<td>A value used to indicate array elements containing no valid data</td>
</tr>
<tr>
<td>units</td>
<td>string</td>
<td>Text description of the physical units, preferably S.I. Some variables (row, col, count, flags, ...) don't have any units attribute</td>
</tr>
<tr>
<td>pct_characterised_err or</td>
<td>NC_FLOAT</td>
<td>Characterised error, expressed in %</td>
</tr>
</tbody>
</table>

Table 4-4: Variables attributes - binned products

Global attributes

This section presents the metadata that are written in the main product file. Metadata is stored as global attributes in the netCDF file.

General product information

<table>
<thead>
<tr>
<th>Attribute Name</th>
<th>netCDF type</th>
<th>Attribute Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conventions</td>
<td>string</td>
<td>Indicates compatibility with the Climate and Forecast (CF) netCDF convention. &quot;CF-1.4&quot;</td>
</tr>
<tr>
<td>title</td>
<td>string</td>
<td>A high-level descriptive title for the product</td>
</tr>
<tr>
<td>product_name</td>
<td>string</td>
<td>The name of the product without path.</td>
</tr>
<tr>
<td>product_type</td>
<td>string</td>
<td>Temporal binning period: e.g. &quot;track&quot;, &quot;day&quot;, &quot;week&quot;, &quot;8-day&quot;, &quot;month&quot;</td>
</tr>
<tr>
<td><strong>product_version</strong></td>
<td>string</td>
<td>Version of the product format</td>
</tr>
<tr>
<td>---------------------</td>
<td>---------</td>
<td>-------------------------------</td>
</tr>
<tr>
<td><strong>product_level</strong></td>
<td>NC_SHORT</td>
<td>Product level: 3</td>
</tr>
<tr>
<td><strong>parameter_code</strong></td>
<td>string</td>
<td>Parameter short name (e.g. “CHL1”)</td>
</tr>
<tr>
<td><strong>parameter</strong></td>
<td>string</td>
<td>Parameter long name (e.g. “Chlorophyll-a case 1 water”)</td>
</tr>
<tr>
<td><strong>parameter_algo_list</strong></td>
<td>string</td>
<td>List of the algorithms name that were used to generate this parameter or input data (comma delimiter, e.g. “OC4Me,OC3v5”)</td>
</tr>
<tr>
<td><strong>site_name</strong></td>
<td>string</td>
<td>Name of the region of interest (e.g. “GLOB” or “EURO”)</td>
</tr>
<tr>
<td><strong>sensor_name</strong></td>
<td>string</td>
<td>Instrument short name, e.g. “MERIS”</td>
</tr>
<tr>
<td></td>
<td></td>
<td>In case of merged product, this field is an acronym of the merging algorithm applied.</td>
</tr>
<tr>
<td><strong>sensor</strong></td>
<td>string</td>
<td>Instrument full name, e.g. “MEdium Resolution Imaging Spectrometer Instrument”</td>
</tr>
<tr>
<td></td>
<td></td>
<td>In case of merged product, this field describes the merging algorithm applied.</td>
</tr>
<tr>
<td><strong>sensor_name_list</strong></td>
<td>string</td>
<td>List of all input data sensors (comma delimiter)</td>
</tr>
<tr>
<td><strong>software_name</strong></td>
<td>string</td>
<td>Name of the processing software</td>
</tr>
<tr>
<td><strong>software_version</strong></td>
<td>string</td>
<td>Version string of the processing software</td>
</tr>
<tr>
<td><strong>institution</strong></td>
<td>string</td>
<td>Processing centre where the product has been generated</td>
</tr>
<tr>
<td><strong>processing_time</strong></td>
<td>string</td>
<td>UTC time of generation of the product in the ISO 8601 yyyyymmddThhmmssZ standard format</td>
</tr>
<tr>
<td><strong>netcdf_version</strong></td>
<td>string</td>
<td>The netCDF file format version</td>
</tr>
<tr>
<td><strong>DPM_reference</strong></td>
<td>string</td>
<td>Reference to a document describing the model used to generate the data</td>
</tr>
<tr>
<td><strong>IODD_reference</strong></td>
<td>string</td>
<td>Reference to a document describing the content and format of the product</td>
</tr>
<tr>
<td><strong>references</strong></td>
<td>string</td>
<td>Published or web-based references that describe the data or methods used to produce it</td>
</tr>
<tr>
<td><strong>contact</strong></td>
<td>string</td>
<td>A free text string giving the primary contact for information about the data set</td>
</tr>
<tr>
<td><strong>copyright</strong></td>
<td>string</td>
<td>Copyright of the product</td>
</tr>
<tr>
<td><strong>history</strong></td>
<td>string</td>
<td>Provides an audit trail for modifications to the original data. Well-behaved generic netCDF filters will automatically append their name and the parameters with which they were invoked to the global history attribute of an input netCDF file. We recommend that each line begin with a timestamp indicating the date and time of day that the program was executed</td>
</tr>
<tr>
<td><strong>input_files</strong></td>
<td>string</td>
<td>List of the input products that were used to generate this product (comma delimiter)</td>
</tr>
<tr>
<td><strong>input_files_reprocessings</strong></td>
<td>string</td>
<td>List of the reprocessings versions of each input product when available (comma delimiter). The reprocessing version is given by the MPH SOFTWARE_VER attribute for MERIS, by the global netCDF &quot;processing_version&quot; attribute for MODIS, SeaWiFS and VIIRS, and by the global netCDF &quot;source&quot; attribute for OLCI.</td>
</tr>
</tbody>
</table>

Table 4-5: Global attributes - binned products (1/3)
Temporal information

<table>
<thead>
<tr>
<th>Attribute Name</th>
<th>netCDF type</th>
<th>Attribute Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>start_time</td>
<td>string</td>
<td>UTC date and time of the first valid or invalid measurement falling in the product,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>in the ISO 8601 yyyymmddThhmmssZ standard format</td>
</tr>
<tr>
<td>end_time</td>
<td>string</td>
<td>UTC date and time of the last valid or invalid measurement falling in the product,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>in the ISO 8601 yyyymmddThhmmssZ standard format</td>
</tr>
<tr>
<td>duration_time</td>
<td>NC_LONG</td>
<td>Duration in seconds between the first and last valid or invalid measurement falling</td>
</tr>
<tr>
<td></td>
<td></td>
<td>in the product, in the ISO 8601 PTxxxS standard format</td>
</tr>
<tr>
<td>period_start_day</td>
<td>string</td>
<td>UTC start day of the binning period in the ISO 8601 yyyymmdd standard format</td>
</tr>
<tr>
<td>period_end_day</td>
<td>string</td>
<td>UTC end day of the binning period in the ISO 8601 yyyymmdd standard format</td>
</tr>
<tr>
<td>period_duration_day</td>
<td>NC_LONG</td>
<td>Duration in days of the binning period in the ISO 8601 PxxxD standard format</td>
</tr>
</tbody>
</table>

Table 4-6: Global attributes - binned products (2/3)

Note: the binning period is not identical to the period resulting from the effective time period of the contributing data. And due to the data-day temporal splitting of the data, the binning period could be included in the effective time period.

Grid information

<table>
<thead>
<tr>
<th>Attribute Name</th>
<th>netCDF type</th>
<th>Attribute Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>grid_type</td>
<td>string</td>
<td>Grid used to project the data: “Equirectangular” or “Integerized Sinusoidal Grid”</td>
</tr>
<tr>
<td>spatial_resolution</td>
<td>NC_FLOAT</td>
<td>Spatial resolution of the product in km</td>
</tr>
<tr>
<td>nb_equ_bins</td>
<td>NC_LONG</td>
<td>Number of equatorial bins (used to built the sinusoidal grid)</td>
</tr>
<tr>
<td>registration</td>
<td>NC_LONG</td>
<td>Location of characteristic point within bin (5: centre)</td>
</tr>
<tr>
<td>straddle</td>
<td>NC_LONG</td>
<td>Indicates if a longitudinal band straddle the equator (0: no and 1: yes; only present</td>
</tr>
<tr>
<td></td>
<td></td>
<td>in ISIN case)</td>
</tr>
<tr>
<td>first_row</td>
<td>NC_SHORT or</td>
<td>First useful row, zero based and beginning at south (only present in ISIN case)</td>
</tr>
<tr>
<td>lon_step</td>
<td>NC_FLOAT</td>
<td>Latitude step</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Longitude step (only present in PC case)</td>
</tr>
<tr>
<td>earth_radius</td>
<td>NC_DOUBLE</td>
<td>Earth radius in kilometres (used to build the sinusoidal grid)</td>
</tr>
<tr>
<td>max_north_grid</td>
<td>NC_FLOAT</td>
<td>Northernmost latitude of the grid (range: -90° to +90°) (1)</td>
</tr>
<tr>
<td>max_south_grid</td>
<td>NC_FLOAT</td>
<td>Southernmost latitude of the grid (range: -90° to +90°) (1)</td>
</tr>
<tr>
<td>max_west_grid</td>
<td>NC_FLOAT</td>
<td>Westernmost longitude of the grid (range: -180° to +180°) (1)</td>
</tr>
<tr>
<td>max_east_grid</td>
<td>NC_FLOAT</td>
<td>Easternmost longitude of the grid (range: -180° to +180°) (1)</td>
</tr>
<tr>
<td>northernmost_latitude</td>
<td>NC_FLOAT</td>
<td>Latitude in degrees of the northernmost side of the northernmost valid bin (range: -90° to +90°)</td>
</tr>
</tbody>
</table>
Attribute Name | netCDF type | Attribute Description
--- | --- | ---
southernmost_latitude | NC_FLOAT | Latitude in degrees of the southernmost side of the southernmost valid bin (range: -90° to +90°)
westernmost_longitude | NC_FLOAT | Longitude in degrees of the westernmost side of the westernmost valid bin (range: -180° to +180°)
easternmost_longitude | NC_FLOAT | Longitude in degrees of the easternmost side of the easternmost valid bin (range: -180° to +180°)

<table>
<thead>
<tr>
<th>Attribute Name</th>
<th>netCDF type</th>
<th>Attribute Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>nb_grid_bins</td>
<td>NC_LONG</td>
<td>Total number of bins of the grid</td>
</tr>
<tr>
<td>nb_bins</td>
<td>NC_LONG</td>
<td>Total number of bins saved in the product</td>
</tr>
<tr>
<td>pct_bins</td>
<td>NC_FLOAT</td>
<td>( \frac{(nb_bins \times 100)}{nb_grid_bins} )</td>
</tr>
<tr>
<td>nb_valid_bins</td>
<td>NC_LONG</td>
<td>Number of valid bins in the product (i.e. bins not equal to _FillValue)</td>
</tr>
<tr>
<td>pct_valid_bins</td>
<td>NC_FLOAT</td>
<td>( \frac{(nb_valid_bins \times 100)}{nb_bins} )</td>
</tr>
</tbody>
</table>

**Table 4-7: Global attributes - binned products (3/3)**

### 4.4 The mapped products

The mapped product is the level 3 binned product projected on a Plate-Carrée. This product is created by a re-projection of the level 3 binned data using an equal-angle latitude-longitude projection.

Land bins and missing data are represented by a "no-data" value (values identified by the netCDF global _FillValue attribute).

There is a one-to-one correspondence between the level 3 binned and mapped products. The averaging periods are the same as for the binned products: daily, 8-days and monthly.

The following table gives the grid size as a function of the spatial resolution:

<table>
<thead>
<tr>
<th>Area</th>
<th>EURO</th>
<th>GLOB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Angular resolution</td>
<td>1/96°</td>
<td>1/24°</td>
</tr>
<tr>
<td>Longitudinal grid size</td>
<td>5867</td>
<td>8640</td>
</tr>
<tr>
<td>Latitudinal grid size</td>
<td>5201</td>
<td>4320</td>
</tr>
</tbody>
</table>

**Table 4-8: Dimensions of the grid - mapped products**

A PNG representation of the level 3 mapped product is distributed. The format of the PNG file is not described here. The colour scale table is also provided.

The layout of the mapped products is similar to the layout of the binned products. Most of the global attributes and variable attributes are identical. The differences are listed below.

**Dimensions**

Due to their rectangular grid layout, the mapped products include two dimensions for each variable (instead of a single one for the binned products). The naming of the dimensions refers to the "Independent latitude, longitude, vertical and time axes" definition of the CF convention.
Dimension | Value | Description
---|---|---
lon | Number of pixels in the longitudinal axis of the map grid. A corresponding variable named lon contains the actual longitude values.
lat | Number of pixels in the latitudinal axis of the map grid. A corresponding variable named lat contains the actual latitude values.

**Table 4-9: Dimensions - mapped products**

With respect to the binned products, the mapped product includes variables to specify the geolocation of the map pixels (for the binned products, the geolocation of the bins shall be recomputed from formulas and parameters provided in the product or read in a specific file).

<table>
<thead>
<tr>
<th>Variable Name</th>
<th>netCDF Type</th>
<th>Nb of bytes</th>
<th>Parameter Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>lon(lon)</td>
<td>NC_FLOAT</td>
<td>4</td>
<td>Center longitude of each column of the grid, beginning at west. Following the CF convention, the attributes of this variable are: long_name = &quot;longitude&quot; unit = &quot;degrees_east&quot;.</td>
</tr>
<tr>
<td>lat(lat)</td>
<td>NC_FLOAT</td>
<td>4</td>
<td>Center latitude of each row of the grid, beginning at north. Following the CF convention, the attributes of this variable are: long_name = &quot;latitude&quot; unit = &quot;degrees_north&quot;.</td>
</tr>
</tbody>
</table>

**Table 4-10: Variables - mapped products (1/2)**

The definition of the variables is also modified by the fact that 2D maps are written in the products instead of 1D vectors of bins. Note also that the row and col variables needed to locate the bin in the sinusoidal grid is no more needed as all the map is stored in the file.

<table>
<thead>
<tr>
<th>Variable Name</th>
<th>netCDF Type</th>
<th>Nb of bytes</th>
<th>Parameter Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>PRM_mean(lat,lon)</td>
<td>NC_FLOAT</td>
<td>4</td>
<td>Average value of the binned pixels values</td>
</tr>
<tr>
<td>PRM_stdev(lat,lon)</td>
<td>NC_FLOAT</td>
<td>4</td>
<td>Standard deviation of the square of the binned pixels values</td>
</tr>
<tr>
<td>PRM_count(lat,lon)</td>
<td>NC_SHORT</td>
<td>2</td>
<td>Number of binned pixels</td>
</tr>
<tr>
<td>PRM_weight(lat,lon)</td>
<td>NC_FLOAT</td>
<td>4</td>
<td>Sum of the weights of the binned pixels</td>
</tr>
<tr>
<td>PRM_flags(lat,lon)</td>
<td>NC_SHORT</td>
<td>2</td>
<td>Flags</td>
</tr>
<tr>
<td>PRM_error(lat,lon)</td>
<td>NC_SHORT</td>
<td>2</td>
<td>Error estimation for the geophysical variable</td>
</tr>
</tbody>
</table>

**Table 4-11: Variables - mapped products (2/2)**
5 How to…?

5.1 Access the GlobColour data

5.1.1 The HERMES interface

The GlobColour products are also available through the HERMES web interface: http://hermes.acri.fr

![HERMES Interface](image)

**Figure 5-1: the HERMES Interface**

HERMES provides the following access:

- **GlobColour Data Set**

  The GlobColour data set consists of daily, 8-days and monthly Level-3 ocean colour products generated in near real time at day+1 and consolidated at day+25. MODIS and merged products are also regenerated at day+120 to handle MODIS level-2 refined delay. The archive data is based on the merging of MERIS, SeaWIFS, MODIS, VIIRS (NPP/JPSS-1) and OLCI-A/B level-2 data over the whole globe and the Europe area, with data extraction capability over user-defined
regions of interest. Single-sensor products are also available. OLCI-A/B and VIIRS JPSS-1 are not merged with other sensors for all parameters for the moment.

- OSS 2015 Demonstration products

The OSS2015 new EO products are available from a dedicated page.

### 5.1.2 Ordering GlobColour Products

![GlobColour Data Access interface](image)

*Figure 5-2: GlobColour Data Access interface*

The GlobColour Data Access interface is depicted in Figure 5-2.

The selection of the spatial coverage is performed by:

- Selecting Global (4/25/100 km products) or Europe (1 km) products
• Selecting an extraction zone (optional) through the interactive map or the coordinate boxes. Use shift+click to select a rectangle on the map. Use to resize the selection zone, and to navigate on the map.

The map overlays can be changed by clicking on the “+” button, see figure below.

![Figure 5-3: Selection of the map overlays](image)

Check boxes allow selecting:

• Grid type (sinusoidal L3b or Plate-Carrée L3m)

• Spatial resolution

• And temporal resolution (binning period).

The temporal coverage is adjusted through the interactive calendar.

Finally, the products selection is performed by checking the corresponding boxes.
Once the product order is finished, click on Search to retrieve the products of the database corresponding to the order. A list of products appears on the screen. Products can be de-selected or re-selected by clicking on their name in the list. The number of selected products and the estimated size of the order are refreshed automatically.

A pre-visualisation of the selected images is possible by clicking on the “Visualize” button.
5.1.3 Ordering OSS2015 demonstration products

OSS2015 products can be accessed using a similar but different interface, see Figure 5-5.
5.1.4 Ordering a list of products

The products can also be ordered by uploading a list of products in a text file (comma separated). This functionality can be used to generate automatically a list of products using the naming convention. Clicking on the “Upload List” button opens a file browser to select the file.

5.1.5 Retrieving the data

After completion of the order, the user is asked to provide his/her e-mail address. Once the order has been processed, an email is sent to the user providing directions to retrieve the data on the GlobColour ftp server.
### 5.2 Download the data from the GlobColour ftp server

The GlobColour project maintains an ftp site from where the products can be downloaded. Read the information provided by the GlobColour web site ("Data Access" section) to get the latest news about this service.


Login and passwords can be obtained by filling the request on-line on the hermes page "FTP access".

The distribution structure of the ftp archive is:

```
/zone (GLOB | EURO)
 /sensor (merged | seawifs | meris | modis | viirs | olcia | viirsj1 | olcib)
 /binning period (day | 8-day | month)
/yyyy/mm/dd
```

Each directory contains the netCDF products (L3b*.nc | L3m*.nc) as well as the associated "quicklook" images.

The ftp also delivers the third party products (NPP and PFT).

A convenient way to download the products is to use the Unix wget command. This command is also available in the cygwin package for Windows systems. wget is particularly efficient to download specific files from scattered sub-directories. It can be used also to check for new products - mirroring (already downloaded files are not transferred, updated products on the server are transferred).

Here is an example for downloading all the MERIS CDM binned products. You can adapt this command to your specific needs. The specification of the GlobColour products filenames is useful to use the correct wildcarding included in the wget commands.

```
wget -r -l10 -t10 -A "L3b*_4_*MER_CDM*.nc" -w3 -Q1000m
ftp://login:password@ftp.hermes.acri.fr/GLOB/meris/
```

Another example to download all the CHL1 monthly quicklooks at 25 km resolution.

```
wget -r -l10 -t10 -A "L3m*_25_*CHL1_MO*.png" -w3 -Q1000m
ftp://login:password@ftp.hermes.acri.fr/GLOB/merged/
```

The products will be stored in a local directory called ftp.hermes.acri.fr using the same structure as on the ftp server. All options of the wget command are described at:


The following options are recommended:

- `-w3` is specified to pause the process 3s after each download to decrease our server load by making the requests less frequent. Please keep it to share the bandwidth with other users.

- `-Q1000m` limits the amount of data you can retrieve in one command (1 Gb). Please, keep this option too.

### 5.3 Read the data

The products may be read using the netCDF library or any third-party tool reading netCDF files. The format of the data is provided in a dedicated chapter ("The Products format").
5.4 Visualize the data

GlobColour mapped products (“L3m”) can be visualized using tools accepting NetCDF format, such as BEAM / Visat\(^1\) (Figure 5-6) and ncview\(^2\) (Figure 5-7).

---

\(^{1}\) [http://www.brockmann-consult.de/cms/web/beam/](http://www.brockmann-consult.de/cms/web/beam/)

\(^{2}\) [http://meteora.ucsd.edu/~pierce/ncview_home_page.html](http://meteora.ucsd.edu/~pierce/ncview_home_page.html)
```python
import matplotlib.pyplot as plt
from matplotlib.colors import LogNorm
import pglab
import numpy as np
import netCDF4 as nc

# settings for Chlorophyll
infile = 'L3n_20050101-20050131__GLOB_4_AW4-HERMOSWF_CHL1_MO_00.nc'
cmap='jet'
norm=LogNorm()

vmin, vmax = 0, 0.1, 100

# open dataset
ncfile=nc.Dataset(infile, 'r')

# get grid
longitudes = ncfile.variables['lon'][:]
lattitudes = ncfile.variables['lat'][:]
extent = [longitudes.min(), longitudes.max(), lattitudes.min(), lattitudes.max()]

# get parameter
varname = getattrs(ncfile,u'parameter_code')+'_mean'
thevar = ncfile.variables[varname]
label = getattrs(ncfile,'parameter')+' ['+thevar.getncattr('units')+']'
var_val = thevar[:].data
var_mask= thevar[:].mask
var = np.ma.MaskedArray(var_val,mask=var_mask)
var[var_mask] = np.nan

# get Earth mask
flagname = getattrs(ncfile,u'parameter_code')+'_flags'
earth = (ncfile.variables[flagname][0]==0)
earthmasked = np.ma.MaskedArray(earth,mask=earth)
earthmasked[earth]=np.nan

#--- Plot -----------------------------------------------
# Plot Earth Mask
plot.image(earthmasked,cmap='gray',vmin=-1,vmax=1,extent=extent)
plot.hold(True)

# Plot variable
CS=plot.imshow(var, cmap=cmap, vmin=vmin,vmax=vmax,extent=extent,norm=norm)

# colorbar
plot.colorbar(CS,orientation='horizontal',aspect=30,label=label)

# axes labels
plot.xlabel('Longitude [deg]')
plot.ylabel('Latitude [deg]')

# save file
outfile = infile[:-3]+'.png'
pglab.caxisfig(outfile,dpi=300)
plot.close()
```

Figure 5-8: Visualizing GlobColour products with matplotlib
Figure 5-9: Generated image
6 Appendices

6.1 Global ISIN grid definition

The following formulas shall clarify the ISIN grid definition.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Formula</th>
</tr>
</thead>
<tbody>
<tr>
<td>Earth radius (km)</td>
<td>$R_e = 6378.137$</td>
</tr>
<tr>
<td>Total number of latitude rows</td>
<td>$N_{lat} = 4320$ for GLOB area</td>
</tr>
<tr>
<td>Latitudinal bin width (km)</td>
<td>$d_t = \frac{\pi \cdot R_e}{N_{lat}}$</td>
</tr>
<tr>
<td>Latitudinal angular discretisation (radians)</td>
<td>$\Delta \Phi = \frac{\pi}{N_{lat}}$</td>
</tr>
<tr>
<td>Centre latitude of each row $n$ (radians)</td>
<td>$\phi_n = -\frac{\pi}{2} + n \cdot \Delta \Phi + \frac{\Delta \Phi}{2}$ (*)</td>
</tr>
<tr>
<td>Longitudinal length of each row $n$ i.e. local perimeter (km)</td>
<td>$p_n = 2 \cdot \pi \cdot R_e \cdot \cos(\phi_n)$</td>
</tr>
<tr>
<td>Number of columns in row $n$</td>
<td>$N_{lon}(n) = \text{nearest}\left(\frac{p_n}{d_t}\right)$</td>
</tr>
<tr>
<td>Effective longitudinal bin width for row $n$ (km)</td>
<td>$d_{e,lon}^n(n) = \frac{p_n}{N_{lon}(n)}$</td>
</tr>
<tr>
<td>Effective longitudinal angular discretisation for row $n$ (radians)</td>
<td>$\Delta \phi_n = \frac{2 \cdot \pi}{N_{lon}(n)}$</td>
</tr>
<tr>
<td>Total number of bins in the grid</td>
<td>$N_{tot} = \sum_{n=0}^{N_{lat}-1} N_{lon}(n)$</td>
</tr>
</tbody>
</table>

*Table 6-1: ISIN grid definition*

(\text{**}) index $n$ varies from 0 to $N_{lat}-1$
6.2 Summary of products content

The next table lists all products generated in the frame of GlobColour and their content (only the variable fields, not the metadata).

- **error**: error estimate. This can be a theoretical computation using external LUT, variable value and observation conditions or the output of the merging model.
- **count(n)**: is the number of binned pixels that contribute to the computation of mean and stdev

The green cells identify the variables stored in the products.

<table>
<thead>
<tr>
<th>L3 type</th>
<th>grid</th>
<th>mean</th>
<th>stdev</th>
<th>error</th>
<th>weight</th>
<th>count</th>
<th>flags</th>
</tr>
</thead>
<tbody>
<tr>
<td>track</td>
<td>ISIN</td>
<td>x</td>
<td>x</td>
<td>(2)</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>daily</td>
<td>ISIN</td>
<td>x</td>
<td></td>
<td>(3)</td>
<td></td>
<td>(5)</td>
<td>x</td>
</tr>
<tr>
<td>8days/monthly</td>
<td>ISIN</td>
<td>x</td>
<td></td>
<td>(4)</td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>mapped</td>
<td>PC</td>
<td>x</td>
<td></td>
<td>(4)</td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>quicklook</td>
<td>PC</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(7)</td>
</tr>
</tbody>
</table>

*Table 6-2: Summary of products content*

(2): before merging step, error is not provided pixel-wise, but the global relative error (%) coming from the characterisation is saved in metadata.

(3): stdev is not defined at the output of the merging module. Only error is estimated.

(4): error is the output of the weighted average or GSM merging models. Only products merged using these methods contain the error pixel-wise field; other products does not contain this field.

(5): for merged daily, 8-days and monthly products, count is not the number of L2 binned pixels, but the number of days contributing to the bin. So for merged daily products, it is always set to 1.

(6): for the moment there is no associated error bar in the 8-days and monthly L3 products.

(7): quicklook product does not contain any geophysical variable
6.3 The main characteristics of the products

The following lists summarises the main characteristics of the different products generated in the frame of the GlobColour project. Note that not all these products are available to external users (internal products are written in dark blue).

**Level 3 track global at 4.63 km (ISIN grid):**
- global product
- one variable per file
- no observation geometry
- only valid bins are written in the product

**Level 3 daily global at 4.63 km (ISIN grid):**
- computed from the level 3 track global products
- same as for the level 3 track global at 4.63 km (ISIN grid), single instrument product, except:
  - temporal binning algorithm using GlobColour data-day definition
  - weight is the sum of weight at track level

**Level 3 merged global at 4.63 km (ISIN grid):**
- computed from the level 3 daily global products using one merging method
- multi-instruments product
- same format as for the level 3 daily global products, except:
  - no weight and stdev fields
  - the "mean" field is an output of the merging model
  - only the weighted average and GSM model merging method provides the pixel-wise error (stored in the “error” field)
  - parameters with no characterised error are not merged using the weighted average method
  - the global relative error (%) is stored in the variable attribute pct_characterised_error. It is actually set to the maximum of the global relative characterised errors for each input sensor.
  - for merged daily, 8-days and monthly products, count is not the number of L2 binned pixels, but the number of days contributing to the bin. At this step it is always set to 1.

**Level 3 8-days/monthly global at 4.63 km (ISIN grid):**
- computed from the level 3 merged daily products
- temporal binning algorithm applied
**Level 3 daily/8-days/monthly merged global low resolution at 0.25°/1° (PC grid):**

- computed from the corresponding level 3 merged products
- mean and error are computed from the parent products fields using of a flux-conserving algorithm to reproject the 4.63 km bins onto the 0.25°/1° PC grid
- the whole grid is written in the output product

**Level 3 daily/8-days/monthly merged global quicklook at 0.25° (PC grid):**

- computed from the corresponding level 3 merged low resolution 0.25° PC products
- “Quicklook” image in PNG RGB lossless format
- the quicklook image is computed using the mean field of the low resolution product

### 6.4 The steps of the binning and merging schemes

The list of steps for the generation of the whole set of GlobColour products is:

- step 1: L2 to L3 track at 4.63 km
- step 2: L3 track to L3 daily for each single instrument
- step 3: L3 daily for each single instrument to merged L3 daily
- step 4: L3 daily merged to 8days and monthly L3 products
- step 5: L3 daily/8days/monthly merged products to mapped products
- step 6: generation of the quicklooks

We describe here below the way to accumulate information for each of these steps and the corresponding means to account for error bars, taking into account the way the information is stored at the end of each step.

It is assumed here that the quality of the data is characterised, so that we know the standard deviation of a single measurement (through available characterisation). The error bars are provided in appendix.

#### 6.4.1 Step 1: L2 to L3 track

The L3 grid (either sinusoidal or geographical regular) is not aligned with the satellite swath, so the first action is to determine the fraction of each L3 bin impacted by the projection of L2 pixel. Let $F_{ij}$ be the fraction of bin L3 number $j$ impacted by the pixel L2 number $i$.

The final output of the binning of the L2 pixels on the L3 grid is given by:

$$T_j = \frac{\sum_{i} (F_{ij} \cdot P_i)}{\sum_{i} F_{ij}}$$

in which $N_j$ is the number of L2 pixels that effectively impact the L3 bin number $j$; $P_i$ is the value of the parameter at pixel $i$, $T_j$ is the value of the parameter for the bin number $j$.

The standard deviation of $T_j$ is given by:
\[ \sigma(T_j) = \sqrt{\frac{\sum N_j (F_{ij} \cdot P_i^2)}{\sum N_j F_{ij}} - T_j^2} \]

The weight of \( T_j \) is given by:
\[ W_j = \sum_{N_j} F_{ij} \]

The quantities stored in the L3 products at track level are:
\( T_j, \sigma(T_j), W_j \) and \( N_j \)

### 6.4.2 Step 2: L3 track to L3 daily for each single instrument

The output \( D_j \) of the temporal accumulation of the L3 at track level for the L3 daily product generation is computed as:
\[ D_j = \frac{\sum_{M_j} \left[ \sum_{N_j} (F_{ij} \cdot P_i) \right]}{\sum_{M_j} \left[ \sum_{N_j} (F_{ij}) \right]} \]

in which \( M_j \) is the effective number of L3 at track level bins used for the temporal accumulation for the bin number \( j \).

As we must be able to compute these quantities using the values written in the L3 products at track level, we have to express them as:
\[ D_j = \frac{\sum M_j |T_j \cdot W_j|}{\sum M_j [W_j]} \]

The daily standard deviation is expressed from the quadratic sum of the L3 bin variances at track level:
\[ \sigma(D_j) = \sqrt{\frac{\sum M_j (\sigma^2(T_j))}{M_j}} \]

The total daily weighting factor is given by:
\[ \overline{W}_j = \sum_{M_j} [W_j] \]

The total daily number of L2 pixels that effectively impact the L3 bin is given by:
\[ \overline{N}_j = \sum_{M_j} [N_j] \]

The quantities stored in the daily L3 products are:
\( D_j, \sigma(D_j), \overline{W}_j \) and \( \overline{N}_j \)
6.4.3 Step 3: L3 daily for each single instrument to merged L3 daily

At this stage, we use only single instrument daily bins which have a weight greater than 10%, and discard the others.

Let’s introduced $\tilde{N}_i$, which is the effective number of valid instruments for the L3 bin (could be for example 2 if only MERIS and MODIS daily bins cover at least 10% of the L3 bin), and $\tilde{N}_d$, which is the number of days in the temporal binning period. For the merging step, $\tilde{N}_d$ is always set to 1 because we merge one day.

Simple average:

$$\tilde{D}_{j\text{-SIMPLE}} = \frac{\sum D_j}{\tilde{N}_i}$$

The quantities stored in the daily merged L3 products when using simple averaging are:

$\tilde{D}_{j\text{-SIMPLE}}$ and $\tilde{N}_d$

Weighted average:

Here we compute the relative error for each sensor $\varepsilon(D_j)$ by applying the error bars (%) of each sensor on the result of the simple averaging $\tilde{D}_{j\text{-SIMPLE}}$:

$$\varepsilon(D_j) = \frac{\text{ErrorBar} \cdot \tilde{D}_{j\text{-SIMPLE}}}{100}$$

Then, the weighted mean is given by:

$$\tilde{D}_{j\text{-WEIGHTED}} = \sum_{N_i} \frac{D_j}{\varepsilon(D_j)^2}$$

The corresponding error bar is given by:

$$\varepsilon(\tilde{D}_{j\text{-WEIGHTED}}) = \sqrt{\sum_{N_i} \frac{1}{\varepsilon(D_j)^2}}$$

This error is translated into relative error in packed % to be saved in the product:

$$\Delta(\tilde{D}_{j\text{-WEIGHTED}}) = 10000 \cdot \frac{\varepsilon(\tilde{D}_{j\text{-WEIGHTED}})}{\tilde{D}_{j\text{-WEIGHTED}}}$$

The quantities stored in the daily merged L3 products when using weight averaging are:

$\tilde{D}_{j\text{-WEIGHTED}}$, $\Delta(\tilde{D}_{j\text{-WEIGHTED}})$ and $\tilde{N}_d$

GSM method
Inputs of the GSM minimisation process are the fully normalised remote sensing reflectances NRRSxxx ($D_j$ individually computed for each band) and their associated error bars. The outputs of the GSM model are: CHL1, CDM and BBP and their associated error bars.

The GSM output error bars are translated into relative error in packed % using the same equation than for the weighted average method.

The quantities stored in the daily merged L3 products when using the GSM method are:

$$\tilde{D}_{j-GSM}, \Delta(\tilde{D}_{j-GSM})$$ and $\tilde{N}_d$

### 6.4.4 Step 4: L3 daily merged to 8-days and monthly L3

Let’s introduce $\tilde{N}_d$, which is the number of effective valid daily bins during the binning period.

The 8-days or monthly parameter is computed as the arithmetic mean of the daily merged data.

$$\tilde{D}_j = \frac{\sum \tilde{D}_i}{\tilde{N}_d}$$

The corresponding error bar is given by:

$$\varepsilon(\tilde{D}_j) = \sqrt{\frac{1}{\sum \tilde{N}_d \varepsilon(\tilde{D}_j)^2}}$$

This error is translated into relative error in packed % to be saved in the product:

$$\Delta(\tilde{D}_j) = \frac{10000 \cdot \varepsilon(\tilde{D}_j)}{\tilde{D}_j}$$

The quantities stored in the daily L3 products are:

$$\tilde{D}_j, \Delta(\tilde{D}_j)$$ and $\tilde{N}_d$

### 6.4.5 Step 5: L3 daily/8days/monthly merged products to mapped products

Re-projection of the corresponding L3 ISIN product on the PC grid using a flux-conserving algorithm:

Let $\tilde{F}_{i,j}$ be the fraction of the L3 PC bin number j impacted by the L3 ISIN bin number i.

The final output of the binning of the L3 ISIN bins on the mapped PC grid is given by:

$$\tilde{D}_j = \frac{\sum \tilde{F}_{i,j} \tilde{D}_i}{\sum \tilde{F}_{i,j}}$$
in which $N_j$ is the number of L3 ISIN bins that effectively impact the L3 mapped PC bin number $j$; $D_j$ is the value of the parameter at ISIN bin $i$, $D_j$ is the value of the parameter for the PC bin number $j$.

When the input ISIN product contains an error bar variable, the corresponding error bar in the mapped PC product is given by:

$$
\varepsilon(D_j) = \sqrt{\frac{\sum_{N_j} F_{i,j}^2 \cdot \varepsilon(D_j)^2}{\sum_{N_j} F_{i,j}^2}}
$$

in which $\varepsilon(D_j)$ is the absolute error bar of the ISIN bin $i$ recomputed using the relative error bar $\Delta(D_j)$ of the ISIN L3 product:

$$
\varepsilon(D_j) = \frac{\Delta(D_j) \cdot D_j}{10000}
$$

The quantities stored in the daily L3 products are:

$D_j$ and when available $\varepsilon(D_j)$

6.4.6 Step 6: generation of the quicklooks

No special processing, the mean field of the mapped product is used to create the image.

6.5 The error bars

The following table details the error bars assumed for the computation of weighted average products. When a characterized error is available from comparison with in-situ measurements, this value is used. Otherwise, an arbitrary value is selected in order to obtain a consistent data set.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>MERIS</th>
<th>MODIS</th>
<th>SeaWiFS</th>
<th>VIIRS</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHL1</td>
<td>38.46</td>
<td>32.06</td>
<td>33.79</td>
<td>43.31</td>
</tr>
<tr>
<td>CHL-OC5</td>
<td>50$^{(1)}$</td>
<td>50$^{(1)}$</td>
<td>50$^{(1)}$</td>
<td>50$^{(1)}$</td>
</tr>
<tr>
<td>SPM-OC5</td>
<td>50$^{(1)}$</td>
<td>50$^{(1)}$</td>
<td>50$^{(1)}$</td>
<td>50$^{(1)}$</td>
</tr>
<tr>
<td>PIC</td>
<td>—</td>
<td>50$^{(1)}$</td>
<td>50$^{(1)}$</td>
<td>50$^{(1)}$</td>
</tr>
<tr>
<td>POC</td>
<td>—</td>
<td>20.3</td>
<td>18.06</td>
<td>20.30$^{(1)}$</td>
</tr>
<tr>
<td>T865</td>
<td>39.26</td>
<td>68.1$^{(2)}$</td>
<td>57.66$^{(2)}$</td>
<td>68.1$^{(2)}$</td>
</tr>
<tr>
<td>A865</td>
<td>1312.8</td>
<td>50$^{(1)}$</td>
<td>50$^{(1)}$</td>
<td>50$^{(1)}$</td>
</tr>
<tr>
<td>NRRS412</td>
<td>9.63</td>
<td>8.89</td>
<td>8.62</td>
<td>7.28</td>
</tr>
<tr>
<td>NRRS443</td>
<td>9.08</td>
<td>9.48</td>
<td>9.28</td>
<td>6.37</td>
</tr>
<tr>
<td>NRRS490</td>
<td>9.23</td>
<td>8.34</td>
<td>9.21</td>
<td>6.51</td>
</tr>
<tr>
<td>NRRS510</td>
<td>10.99</td>
<td>—</td>
<td>10.75</td>
<td>—</td>
</tr>
<tr>
<td>NRRS547-560</td>
<td>15.58</td>
<td>13.16</td>
<td>14.14</td>
<td>9.4</td>
</tr>
</tbody>
</table>
6.6 Common Data Language description

CDL representation of a global mapped level-3 daily merged product:

```c
netcdf L3m_20120301-20120331__GLOB_4_AVW-MERMODVIR_CHL1_MO_00 {

dimensions:
   lat = 4320 ;
   lon = 8640 ;

variables:
   float lat(lat) ;
      lat:long_name = "latitude" ;
      lat:units = "degrees_north" ;
      lat:axis = "Y" ;
   float lon(lon) ;
      lon:long_name = "longitude" ;
      lon:units = "degrees_east" ;
      lon:axis = "X" ;
   float CHL1_mean(lat, lon) ;
      CHL1_mean:standard_name = "mass_concentration_of_chlorophyll_a_in_sea_water" ;
      CHL1_mean:long_name = "Chlorophyll concentration - Mean of the binned pixels" ;
      CHL1_mean:_FillValue = -999.f ;
      CHL1_mean:units = "mg/m3" ;
      CHL1_mean:pct_characterised_error = 43.31f ;
   short CHL1_flags(lat, lon) ;
      CHL1_flags:long_name = "Chlorophyll concentration - Flags" ;
      CHL1_flags:_FillValue = 0s ;
   short CHL1_error(lat, lon) ;
      CHL1_error:long_name = "Chlorophyll concentration - Error estimation" ;
      CHL1_error:_FillValue = -32768s ;
      CHL1_error:units = "%" ;
      CHL1_error:scale_factor = 0.01f ;

// global attributes:
   :Conventions = "CF-1.4" ;
```

Table 6-3: Error Bars used to generate Weighted Average products

<table>
<thead>
<tr>
<th></th>
<th>(1) Arbitrary value</th>
<th>(2) Value from the first reprocessing</th>
</tr>
</thead>
<tbody>
<tr>
<td>NRRS670</td>
<td>80.89</td>
<td>35.5</td>
</tr>
<tr>
<td></td>
<td>49</td>
<td>29.66</td>
</tr>
<tr>
<td>PAR</td>
<td>8.21(i)</td>
<td>3.92(i)</td>
</tr>
<tr>
<td></td>
<td>12.91</td>
<td>8.21(i)</td>
</tr>
</tbody>
</table>

(1) Arbitrary value
(2) Value from the first reprocessing
:title = "GlobColour monthly merged MERIS/MODIS/VIIRSN product";
:product_name = "L3m_20120301-20120331__GLOB_4_AVW-MERMODVIR_CHL1_MO_00.nc";
:product_type = "month";
:product_level = 3s;
:parameter_code = "CHL1";
:parameter = "Chlorophyll concentration";
:parameter_algo_list = "OC4Me,OC3v5,OC3v5";
:site_name = "GLOB";
:sensor_name = "WEIGHTED_AVERAGING";
:sensor = "Merged data - weighted mean";
:sensor_name_list = "MER,MOD,VIR";
:start_time = "20120229T214722Z";
:end_time = "20120401T025400Z";
:duration_time = "PT2696799S";
:period_start_day = "20120301";
:period_end_day = "20120331";
:period_duration_day = "P31D";
:grid_type = "Equirectangular";
:spatial_resolution = 4.638312f;
:nb_equ_bins = 8640;
:registration = 5;
:lat_step = 0.04166667f;
:lon_step = 0.04166667f;
:earth_radius = 6378.137f;
:max_north_grid = 90.f;
:max_south_grid = -90.f;
:max_west_grid = -180.f;
:max_east_grid = 180.f;
:northernmost_latitude = 74.41666f;
:southernmost_latitude = -76.25001f;
:westernmost_longitude = -180.f;
:easternmost_longitude = 180.f;
:nb_grid_bins = 37324800;
:nb_bins = 37324800;
pct_bins = 100.f;
:nb_valid_bins = 19406411;
pct_valid_bins = 51.99334f;
:software_name = "globcolour_l3_reproject";
:institution = "ACRI";
:processing_time = "20140724T080509Z";
:netcdf_version = "4.1.3 of Sep 5 2011 16:53:33 $";
:DPM_reference = "GC-UD-ACRI-PUG";
:IODD_reference = "GC-UD-ACRI-PUG";
:references = "http://www.globcolour.info";
:contact = "service@globcolour.info";
:history = "20140724T080509Z: globcolour_l3_reproject.sh -inlist globcolour/data/merged/month/2012/03/01 -outdir globcolour/data/merged/month/2012/03/01 -startdataday 20120301 -enddataday 20120331 -resolution 0.041666666666666664 -resolutioncode 4 -tmpdir /work/scratch";
:httpfile1 = "...
:httpfile2 = "...
:product_version = "2014.0";
:software_version = "2014.0";
:copyright = "Copyright ACRI-ST - GlobColour. GlobColour has been originally funded by ESA with data from ESA, NASA, NOAA and GeoEye. This reprocessing version has received funding from the European Community’s Seventh Framework Programme ([FP7/2007-2013]) under grant agreement n° 282723 [OSS2015 project].";
6.7 References

6.7.1 GlobColour products references


6.7.2 References for OSS2015 demonstration products


