INDESO

Product User Manual - SST and ChlA and NPP cloudless (OA) satellite observations

Reference:	IN-WP6.2-PUM-298
Nomenclature:	-
Issue:	1. 0
Date:	Sep. 4, 15

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Chronology Issues:			
Issue:	Date:	Reason for change:	Author:
0.1	22/04/15	Preliminary version	V. Rosmorduc
0.2	31/08/15	expert revision	J. Stum
1.0	04/09/15	Initial version	V. Rosmorduc

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Index Sheet:	
Context:	
Keywords:	[Mots clés]
Hyperlink:	

Distribution:		
Company	Means of distribution	Names
CLS	Notification	CLS Management review team
CLS	Soft copy	CLS INDESO team
Balitbang KP	Soft copy	Balitbang KP INDESO team

FORM-SP-AN-3-0

List of tables and figures

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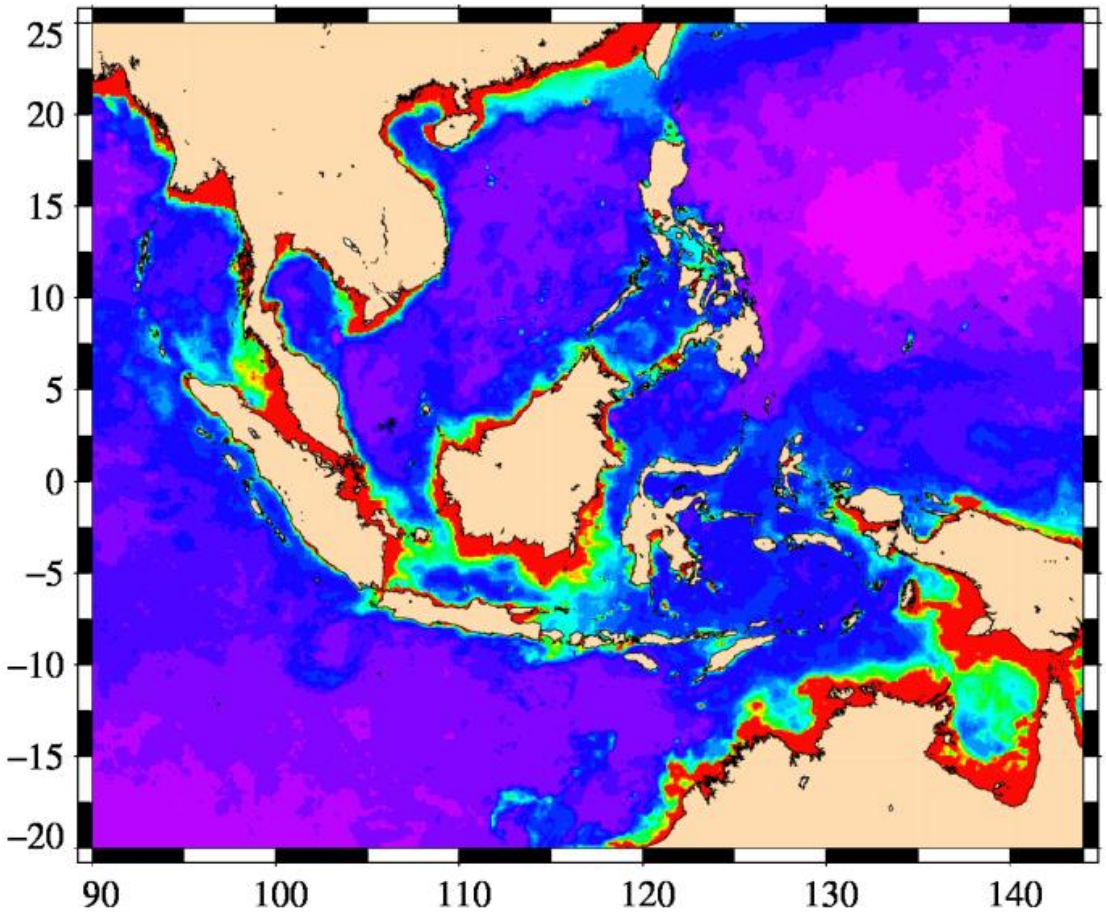
1. PURPOSE

This document presents the information needed by users for the **SST and ChlA and NPP cloudless (OA) satellite observations** products provided in the frame of the Indeso project.

This document is organized as follows:

- Chapter 2; processing: input data and method applied.
- Chapter 3; the product description, with the different files provided, the nomenclature
- Chapter 4; the file format
- Chapter 5; how to download products.
- Chapter 6; bibliographical references



2. PROCESSING

The main parameter contained in this product is the Net Primary Production (NPP) product that is used as input of the Micronekton model. The product also contains three additional parameters, namely the Sea Surface Temperature, the Chlorophyll-a concentration and the Euphotic layer depth. These three additional parameters are used in input of the NPP model to compute the NPP.

All these parameters are provided on a 1/12° horizontal resolution grid. The corresponding geographical grids are gap-free (no clouds present). Maps are produced every day D and are representative of the state of the ocean for day D-1.

2.1. NPP MATHEMATICAL STATEMENT

2.1.1. INTRODUCTION

Primary production is defined as the amount of organic compounds fixed by autotrophic organisms (in the ocean: phytoplankton), from inorganic compounds such as CO2 and H2O (see e.g. Thurman, 1994). The major process through which primary production occurs is photosynthesis. Some part of this primary production is used by these organisms for their own maintenance through respiration. That which remains is the Net Primary Production (NPP), which is manifested as growth and reproduction products. It is NPP that supports the heterotrophic marine populations (animals and bacteria).

Global ocean chlorophyll maps derived by using ocean colour satellite measurements can be used to estimate phytoplankton biomass, and are ingested into productivity models to estimate the NPP (see e.g. Fasham, 2003). There are several models for estimating global NPP. They differ by their level of complexity (depth integrated or depth resolved, wavelength integrated or wavelength resolved), but fundamentally all these models are conceptually similar. They all use satellite-based estimates of phytoplankton and sea surface temperature (SST), as well as incident solar photosynthetically available radiation (PAR) to derive a vertically integrated value of NPP on the model grid (typically 10 to 25 km horizontal resolution). Several model intercomparison exercises have been carried out (e.g., Campbell et al., 2002, Carr et al., 2006). The most recent intercomparison study is the one by Saba et al., 2011, in which a round robin exercise assessed the skill of 21 models against 1156 in situ NPP measurements. This study showed that no one best model existed for all conditions, but some are better suited for specific regions. For example, the model by Antoine and Morel (1996) was better performing in deeper waters. In the INDESO area, the VGPM model by Behrenfeld and Falkowski (1997), with and without Eppley modification, has one of the best performances.

2.1.2. NPP COMPUTATION

Oregon State University maintains a global archive of NPP products from 3 different models, namely the VGPM model by Behrenfeld and Falkowski (1997), the “Eppley modified” VGPM model which uses a temperature-dependent description of photosynthetic efficiencies by Eppley (1972), and the Carbon-based Production Model (CbPM) by Behrenfeld et al. (2005), improved by Westberry et al. (2008).

All these products are freely available at OSU Web site (http://www.science.oregonstate.edu/ocean.productivity) at various temporal and spatial resolution (e.g., 8-day products at 1/12 degree spatial resolution). The main input of these products is MODIS chlorophyll. These products however are available with a delay up to several months, not compatible with a near real time monitoring of the ocean.

CLS runs the VGPM model in near real time for the needs of fishing stock assessment studies. The VGPM model equations are the following :

NPP = pb_opt * chl * dayL * irrFunc * z_eu

With : NPP net primary production in mg of Carbon per square meter and per day;

Pb_opt = 1.2956 + 2.749e-1*sst + 6.17e-2*sst^2 - 2.05e-2*sst^3

+ 2.462e-3*sst^4 - 1.348e-4*sst^5 + 3.4132e-6*sst^6

- 3.27e-8*sst^7;

sst is the sea surface temperature in degree Celsius

chl is the chlorophyll concentration in mg/m^3

dayL is the duration of the day in hours (analytical function of time and latitude).

irrFunc = 0.66125 * PAR / (PAR + 4.1);

With PAR : Photosynthetically Available Radiation in Einstein/m^2/day, is the amount of solar radiation at the ocean surface, available for photosynthesis.

Z_eu is the depth of the euphotic layer in m, and is computed from the Morel algorithm (Morel and Berthon, 1989), which is a simple function of chl. The euphotic zone is the layer of water that is exposed to sufficient sunlight for photosynthesis to occur. It extends from the surface down to a depth where light intensity falls to one percent of that at the surface. Accordingly, its thickness depends on the extent of light attenuation in the water column. Typical euphotic depths vary from a few meters to around 200 meters in the open ocean.

Three different input data are thus necessary to estimate NPP : sst, chl and PAR.

2.2. INPUT DATA

2.2.1. CHLOROPHYLL MAPS

Chlorophyll maps are built from the VIIRS sensor on board the Suomi-NPP satellite (more sensors will be incorporated in the future when available).

2.2.1.1. DATA ACQUISITION

VIIRS Level 1A products are acquired at the Ocean Color Web (NASA) in near real time with a delay of about 5 hours. Three different steps are required to build the final product :

- Level 2 processing
- Level 2 editing
- Level 3 processing

2.2.1.2. LEVEL 2 PROCESSING

Level 1A products are top-of-atmosphere products (they contain reflectances of the Earth-atmosphere system in different wavelengths from blue to near infra-red). To derive the phytoplankton concentration from these reflectances, the so-called level 2 processing has to be applied. The level 2 processing in use in CLS is using the Polymer algorithm (Steinmetz et al., 2011), adapted to VIIRS sensor. The main advantage of this Polymer processing of the VIIRS data is to be able to compute the phytoplankton in presence of semi-transparent clouds, heavy dust, and part of sunglint areas.

2.2.1.3. LEVEL 2 EDITING

The so-called editing processing consists in removing poor-quality pixels, (e.g., contaminated by cloud shadows or high sunglint), in image destriping (based on Gaussian filtering), and in data re-mapping on regular latitude-longitude grid to produce Level 2 grid products at 0.01° resolution.

2.2.1.4. LEVEL 3 PROCESSING

Chlorophyll map calculation is done using the objective analysis method, inherited from the work of Pottier et al., 2005. Simple compositing (see ChlA/SST product) does not consider information from the surrounding pixels: a pixel is filled in the mosaics by the same pixels found in the past time. Objective analysis considers pixel values of the vicinity of the pixel to be filled in. The resulting value is a weighted average of all pixel values found in the past and in the vicinity. A monthly mean phytoplankton climatology is also used in input to ensure that a value is always returned by the analysis in case where no actual data is available, or is too far away (in time or distance) from the pixel to be filled in. This leads to build a product without gaps.

2.2.2. SST MAPS

SST maps used are from the OSTIA analysis, available from the MyOcean data portal (http://www.myocean.eu/web/69-myocean-interactive-catalogue.php). This product is a merging of all available infra-red and microwave SST sensors together with in-situ observations.

3. DESCRIPTION OF THE PRODUCT SPECIFICATION

3.1. PRODUCT GENERAL CONTENT AND SPECIFICATIONS

Each Indeso product includes a series of related datasets. Those datasets are delivered with different names (see nomenclature), contents (see NetCDF contents) and format (be*low)*.

Note that the datasets available for a given user depend on the user profile.

Dataset Name	Dataset time coverage	Production frequency	Geographical coverage	Spatial Resolution	File format
Map of LR SST+ Chla+NPP+EuphoticLayer historical	from start to (T0 - 30 days)	daily	20S-25N/90E-144E	1/12°	netCDF CF
Map of LR SST+ Chla+NPP+Euphotic Layer historical & real-time	from start to T0	daily	20S-25N/90E-144E	1/12°	netCDF CF

Table 1: list of SST/ChlA/NPP without cloud datasets

3.2. NOMENCLATURE OF FILES

Files downloaded using Indeso downloading services are named using a unique identifier (13 digits, corresponding to the current time (downloading time) in milliseconds since January 1, 1970 midnight UTC.) at the end of the file name.

Map of LR SST+Chla+NPP+EuphoticLayer historical&real-time
SST_CHLA_NPP_LR-RT_%nnnnnnnnnnnn.nc

Map of LR SST+Chla+NPP+EuphoticLayer historical
SST_CHLA_NPP_LR_%nnnnnnnnnnnn.nc

Where %nnnnnnnnnnnn is the identifier inserted by the downloading service

3.3. ACKNOWLEDGMENTS

Original INDESO Products - or Value Added Products or Derivative Works developed from INDESO Products including pictures - shall include the following credit conspicuously displayed and written in full:

"© INDESO, 2013, a system implemented by CLS for Balitbang KP, all rights reserved".

(b) In case of any publication, the Licensees will ensure credit INDESO in the following manner:

"© INDESO, 2013, a system implemented by CLS for Balitbang KP, all rights reserved".

4. DATA FORMAT

4.1. NETCDF

The products are stored using the NetCDF CF format. NetCDF (network Common Data Form) is an interface for array-oriented data access and a library that provides an implementation of the interface. The netCDF library also defines a machine-independent format for representing scientific data. Together, the interface, library, and format support the creation, access, and sharing of scientific data. The netCDF software was developed at the Unidata Program Center in Boulder, Colorado. The netCDF libraries define a machine-independent format for representing scientific data. Please see Unidata NetCDF pages for more information, and to retreive NetCDF software package on: http://www.unidata.ucar.edu/packages/netcdf/

NetCDF data is:

- Self-Describing. A netCDF file includes information about the data it contains.
- Architecture-independent. A netCDF file is represented in a form that can be accessed by computers with different ways of storing integers, characters, and floating-point numbers.
- Direct-access. A small subset of a large dataset may be accessed efficiently, without first reading through all
- the preceding data.
- Appendable. Data can be appended to a netCDF dataset along one dimension without copying the dataset or redefining its structure. The structure of a netCDF dataset can be changed, though this sometimes causes the dataset to be copied.
- Sharable. One writer and multiple readers may simultaneously access the same netCDF file.

4.2. STRUCTURE AND SEMANTIC OF NETCDF FILES

Variable name	Description (long_name)	Standard_name	Dimensions	Units (INDESO)
SST_CHLA_NPP_LR-RT_%nnnnnnnnnnnn.nc or SST_CHLA_NPP_LR_%nnnnnnnnnnnn.nc				
Netcdf-CF Grid Dimensions: lat=541, lon=649, time=1				
lat	Latitude	latitude	(NbLatitudes)	degrees_north
lon	Longitude	longitude	(NbLongitudes)	degrees_east
time	time	time	(time)	hours since 1950-01-01
ZEU	Euphotic layer depth from Morel algorithm	euphotic_layer_depth	(time,NbLongitudes,NbLatitudes)	m
NPP	Net primary production from VGPM	net_primary_production	(time,NbLongitudes,NbLatitudes)	$mgC/m^2/d$
SST	infrared_hr_sst	sea_surface_temperature	(time,NbLongitudes,NbLatitudes)	°C
CHLA	hr_plankton	chloro-phyll_concentration_in_sea_water	(time,NbLongitudes,NbLatitudes)	mg/m^3

5. HOW TO DOWNLOAD A PRODUCT

5.1. REGISTRATION

To access data, registration is required. During registration process, the user shall accept using licenses for the use of INDESO products and services.

License shall include:

- Data use conditions,
- Legal and contractual clauses

5.2. ACCESS SERVICES

Different services enable registered users to access the data. Depending on the dataset, not all of them are relevant.

Dataset Name	File format	Discover	View	Get
Map of LR SST+ Chla+NPP+Euphotic Layer historical & real-time	netCDF CF	Yes	Yes	Yes
Map of LR SST+ Chla+NPP+Euphotic Layer historical	netCDF CF	Yes	Yes	Yes

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