INDESO

Product User Manual – Micronekton model outputs

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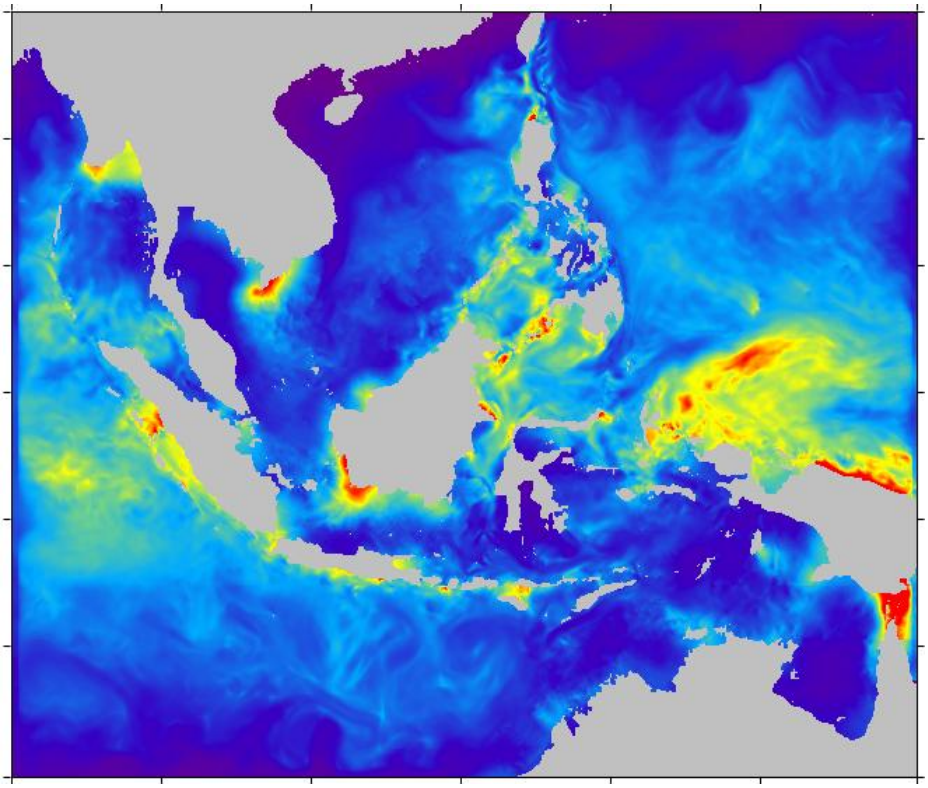
1. PURPOSE

This document is prepared for the users of INDESO project datasets in order to provide necessary information to understand the mid-trophic level model outputs.

This document is organized as follows:

- Chapter 2: input data and method.
- Chapter 3: the product description, files provided, the nomenclature
- Chapter 4: the data formats
- Chapter 5: how to download products.
- Chapter 6: bibliographical references



2. PROCESSING

2.1. INTRODUCTION

The Operational INDESO zooplankton and micronekton biomass distribution analysis and forecast system, at 1/12° horizontal resolution, provides 10 days of 3-Layer ocean forecast and ocean analysis updated weekly. This product includes daily mean fields of zooplankton and micronekton biomass distribution and validation metrics.

The ocean zooplankton and micronekton model used for the INDESO project is a regionalized version of the SEAPODYM model (Lehodey et al., 1998; Lehodey et al., 2008; Lehodey et al., 2010). SEAPODYM simulates the temporal evolution and the spatial distribution of fish populations and

their prey. The latter are combined to several functional groups, one for zooplankton and 6 for micronekton (organisms in the range of ~1-20 g).

The regional SEAPODYM model is resolved at a regular horizontal resolution of 1/12° and 3 vertical layers defined relatively to the euphotic depth (Z_{eu}):

- 1st layer between surface and 1.5 Z_{eu}
- 2nd layer between 1.5 and 4.5 Z_{eu}
- 3rd layer between 4.5 and 10.5 $Z_{eu,}$ with a maximum depth of 1000 meters.

The regional SEAPODYM zooplankton and micronekton model is forced by Net Primary Production and Chlorophyll-a concentration provided by the INDESO project (see SST&Chla&NPP Cloudless Satellite Observations) and by physical parameters (temperature and velocities) provided by the regional INDESO physical ocean model (see Physical model outputs). At the lateral open boundaries, the regional SEAPODYM model uses analysis and forecast fields from a global version of the SEAPODYM model implemented by CLS. The regional SEAPODYM model provides analysis of the past two weeks and forecasts for the next 10 days. The model is updated once a week. Validation metrics are provided as pdf files.

Vertically integrated biomass (g/m^2) distribution is available for:

- Zooplankton (all zooplankton organisms, i.e., holo- and mero-zooplankton)
- Epipelagic micronekton (Epi)
- Mesopelagic micronekton (Meso)
- Migrant mesopelagic micronekton (Mmeso)
- Bathypelagic micronekton (Bathy)
- Migrant bathypelagic micronekton (Mbathy)
- Highly migrant bathypelagic micronekton (Hmbathy)

To obtain the total biomass of micronekton by layer, it is necessary to make the sums as follow:

Layer	Day time	Night time
Layer 1	Epi	Epi+ Mmeso + HmBathy
Layer 2	Meso + Mmeso	Meso + Mbathy
Layer 3	Bathy +Mbathy + Hmbathy	Bathy

2.2. INPUT DATA

2.2.1. Global SEAPODYM forcing

The quality of SEAPODYM model optimization and simulation outputs is linked to the accuracy of its forcing variables. These include the physical forcing (3D temperature and currents), the biogeochemical (primary production and euphotic depth; dissolved oxygen concentration) and the tuna biomass removal due to fishing.

2.2.1.1. PHYSICAL FORCING (TEMPERATURE AND CURRENTS),

The SEAPODYM model requires temperature and horizontal currents produced by global ocean circulation models. The first phase, i.e., the optimization, requires long hindcasts or reanalyses together with historical fishing data to achieve the best possible model parameterization.

2.2.1.2. BIOGEOCHEMICAL FORCING

Primary production (PP) and associated euphotic depth can be estimated either from the sum of small and large phytoplankton production simulated with the PISCES biogeochemical model, or with satellite ocean colour data (Behrenfeld and Falkowski, 1997).

The NCEP-ORCA2 hindcast simulation was coupled to the biogeochemical model PISCES (Pelagic Interaction Scheme for Carbon and Ecosystem Studies; Aumont and Bopp, 2006). PISCES incorporates both multi-nutrient limitation (NO3, NH_4, PO_4, SiO_3 and Fe) and a description of the plankton community structure with four plankton functional groups (Diatoms, Nano-phytoplankton, Micro-zooplankton and Meso-zooplankton). This model provided biogeochemical variables needed to run SEAPODYM

For the ocean reanalyses the primary production and euphotic depth were derived from satellite data. Because ocean reanalyses assimilate satellites (SST and altimetry) and *in situ* data, their predicted fields of temperature and currents are globally coherent with those of primary production derived from ocean color data. However, there are many satellite "chlorophyll-based" models with empirically determined functions that can predict quite different estimates of primary production (**Figure 2.1**).

The first series of optimization experiments were conducted with VGPM primary production. However, given the uncertainty on this key input variable and the contrasted distributions predicted at basin scale, a second series of optimization is currently conducted with the Eppley-VGPM, being different from VGPM model (Behrenfeld and Falkowski, 1997) by the relashionship of the phytoplanktonic growth and the temperature (Eppley, 1972) model estimates. Based on the difference obtained between predicted biomass distributions of micronekton groups (**Figure 2.2**), it can be expected substantial differences also in the optimal parameterization achieved with these two forcings.

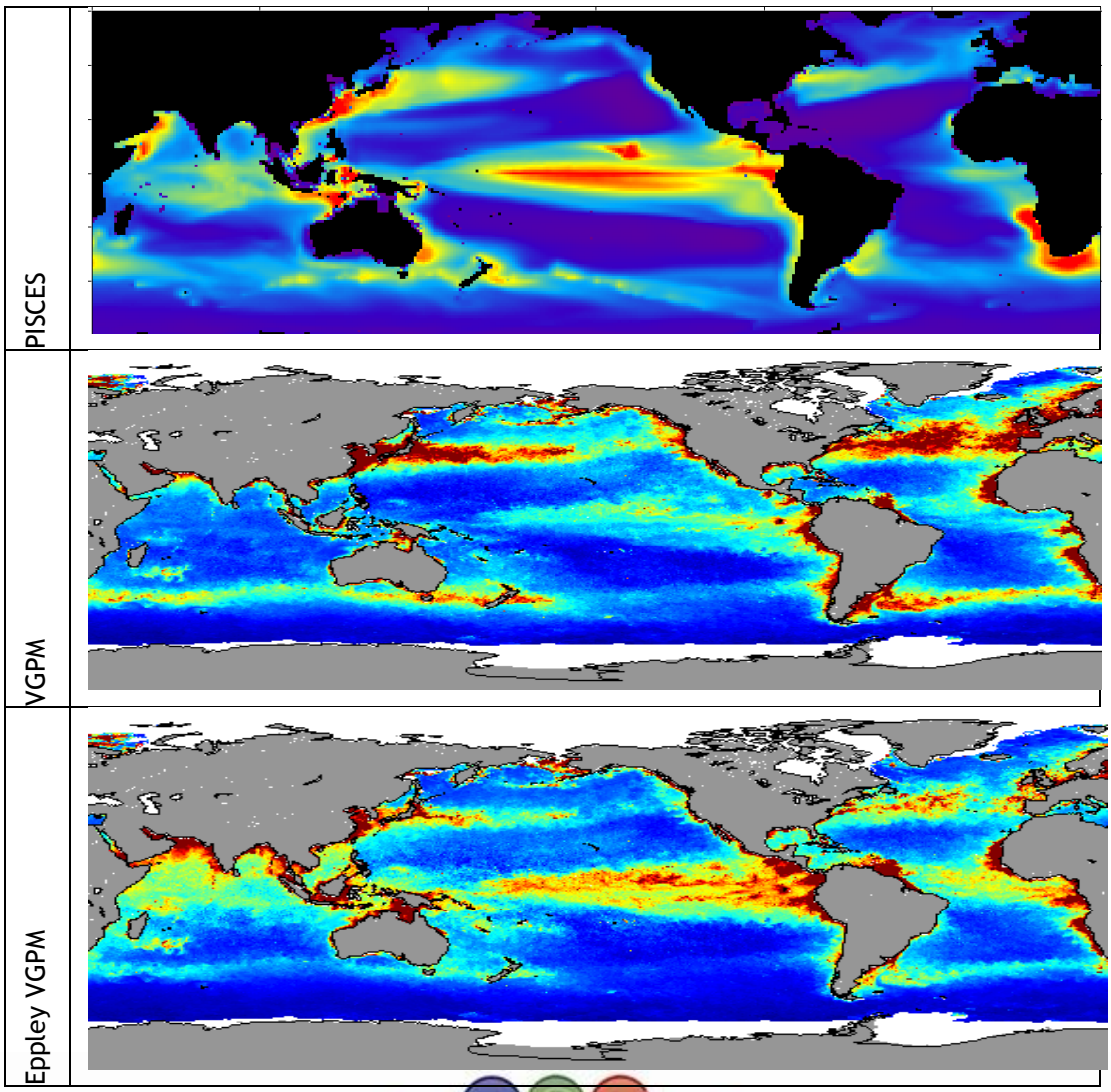


Figure 2.1. Mean primary production predicted from the PISCES biogeochemical model and from two empirical models based on satellite ocean colour data.

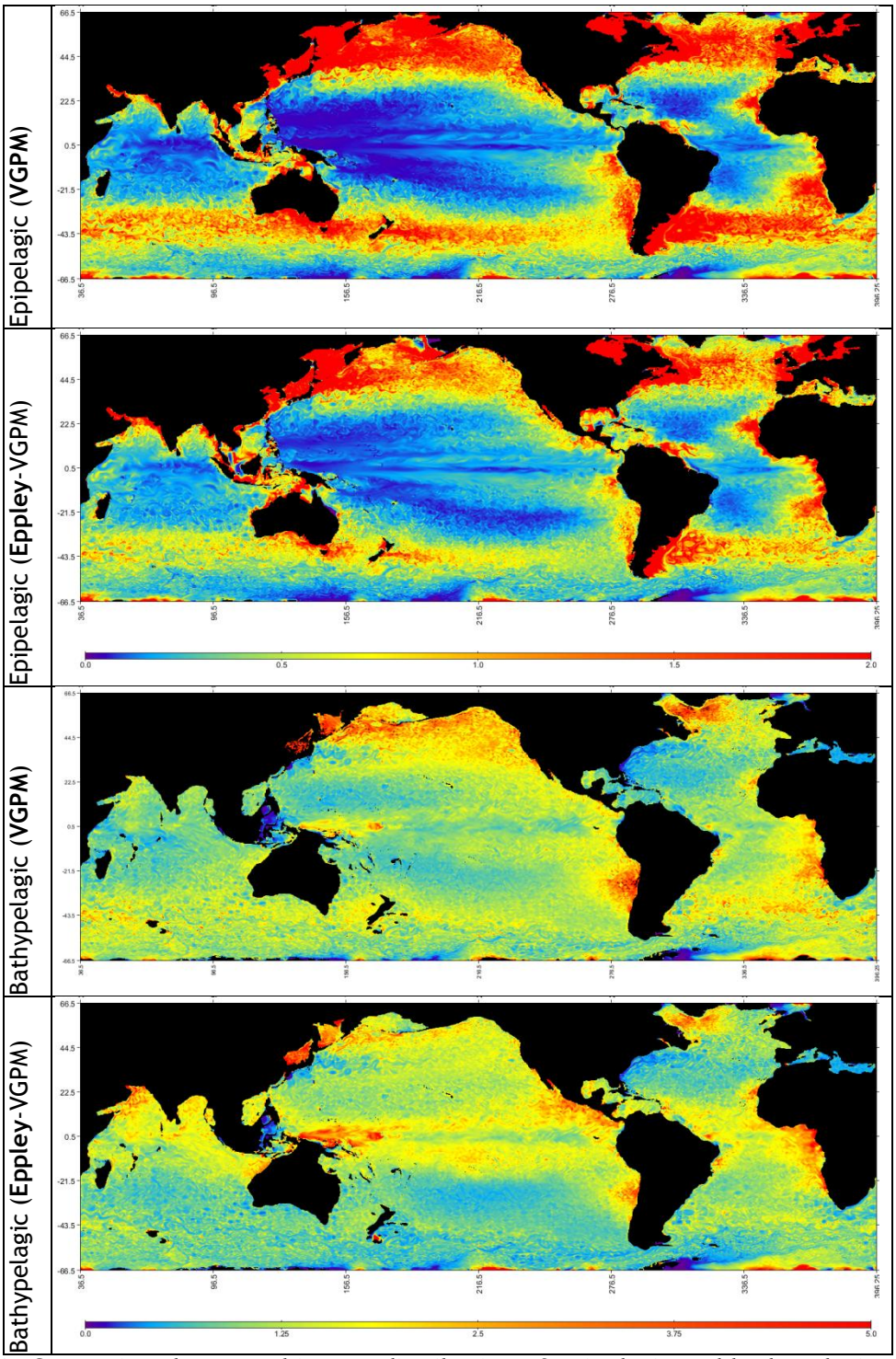


Figure 2.2. Comparison between biomass distribution of epipelagic and bathypelagic micronekton predicted with SEAPODYM global model using primary production estimates from VGPM and EPPLEY-VGPM (week of 14 Dec 2014).

2.3. METHOD: SEAPODYM-MTL MODEL

SEAPODYM-MTL is a model developed for predicting the micronektonic groups spatio-temporal distributions. The model includes three vertical layers and six functional groups characterized by their vertical behaviour, that is, with or without occurrence of diel migration between three vertical layers. Recruitment, ageing, mortality, and passive transport with horizontal currents are modelled by a system of advection-diffusion-reaction equations, taking into account the vertical behaviour of organisms (Lehodey et al. 2010; Lehodey et al., 2014).

Development and results from this modeling approach are regularly presented to the Western Central Pacific Fisheries Commission (Lehodey, 2004a, b,2005a, b, 2008; Lehodey et al. 2008, 2009, 2010, 2011) and published in peer-reviewed scientific journals (Bertignac et al 1998; Lehodey 2001; Lehodey et al. 1998, 2003, 2008, 2010a; 2010b; 2012; Senina et al 2008; Sibert et al 2012; Bell et al 2013).

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 PDF contents) and format (below).

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
Micronekton daily historical & real-time biomass distribution	from start to (T0+10 days)	weekly	20S-25N/90E-144E	1/12° regular grid	netcdf
Micronekton daily historical	from start to (T0-30 days)	weekly	20S-25N/90E-144E	1/12° regular grid	netcdf
Critical Micronekton model historical & real-time metrics	from start to (T0+10 days)	weekly	NA	NA	Pdf
Critical Micronekton model historical	from start to (T0-30 days)	weekly	NA	NA	Pdf
Long term biogeochemical model metrics	from start to (T0+10 days)	weekly	NA	NA	Pdf

Table 1: List of Micronekton model output 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. The metrics pdf are compressed within a zip file (nomenclature of both the zip file and the pdf within are listed here).

Micronekton daily historical&real-time biomass distribution
INDESO_MICRONEKTON-RT_%nnnnnnnnnnnn.nc

Micronekton daily historical biomass distribution
INDESO_MICRONEKTON_%nnnnnnnnnnnn.nc

Critical Micronekton model historical&real-time metrics
INDESO_TUNA_CMetrics-RT_%nnnnnnnnnnnn.zip
INDESO_TUNA_CMetrics_%Y%m%d(prod).pdf

Critical Micronekton model historical metrics
INDESO_TUNA_CMetrics_%nnnnnnnnnnnn.zip
INDESO_TUNA_CMetrics_%Y%m%d(prod).pdf

Long term Micronekton model metrics (à confirmer)
INDESO_TUNA_LTMetrics_%Y%m%d(Min)_%Y%m%d(Max)_%Y%m%d(prod).pdf

Where

%nnnnnnnnnnnn is the identifier inserted by the downloading service

and

Date	Macro used	# digits	Ex: Date 2001/03/20 9H15M20S
Year	%Y	4	2001
Year	%y	2	01
Month	%m	2	03
Day in month	%d	2	20
Day of the year	%j	3	079
Hour	%H	2	09
Minute	%M	2	15
Second	%S	2	20

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	Standard_name	Dimensions	Units
Daily ZOOPLANKTON & MICRONEKTON biomass distribution INDESO_MICRONEKTON-RT_%nnnnnnnnnnnnn.nc or INDESO_MICRONEKTON_%nnnnnnnnnnnnn.nc			
Netcdf-CF Grid Dimensions: lon, lat, time=1			
lon	longitude	(lon)	degrees_east
lat	latitude	(lat)	degrees_north
time	time	(time)	tbd
meso_mnk	mesopelagic_micronekton_potential_biomass	(time,lat,lon)	g/m2
mbathy_mnk	migrant_bathypelagic_micronekton_potential_biomass	(time,lat,lon)	g/m2
bathy_mnk	bathypelagic_micronekton_potential_biomass	(time,lat,lon)	g/m2
hmbathy_mnk	highly_migrant_bathypelagic_micronekton_potential_biomass	(time,lat,lon)	g/m2
mmeso_mnk	migrant_mesopelagic_micronekton_potential_biomass	(time,lat,lon)	g/m2
epi_mnk	epipelagic_micronekton_potential_biomass	(time,lat,lon)	g/m2
pk	lower_trophic_level_plankton_potential_biomass	(time,lat,lon)	g/m2

4.3. STRUCTURE AND SEMANTIC OF PDF FILES

The metrics files are automated pdf reports, computed for micronekton and for all three species of tuna .

Typical contents of those reports is:

1. Compliance table for the number of valid points in the grid
2. Compliance table for the values of the tuna model Fields

In both tables the short names used are the names of the variables as defined in the NetCDF files.

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
Micronekton daily historical & real-time biomass distribution	NetCDF	Yes	Yes	Yes
Micronekton daily historical biomass distribution	NetCDF	Yes	Yes	Yes
Critical Micronekton model historical & real-time metrics	Pdf	Yes	No	Yes
Critical Micronekton model historical metrics	Pdf	Yes	No	Yes
Long term micronekton model metrics	pdf	Yes	No	Yes

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