SSALTO/DUACS Experimental Product Handbook:

Gridded Sea Level Height and geostrophic velocities computed with Multiscale Interpolation

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Chronology Issues:			
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List of Acronyms:

ADT	Absolute Dynamic Topography
Aviso+	Archiving, Validation and Interpretation of Satellite Oceanographic data
CMEMS	Copernicus Marine Environment Monitoring Service
Cnes	Centre National d'Etudes Spatiales
DUACS	Data Unification and Altimeter Combination System
ECMWF	European Centre for Medium-range Weather Forecasting
ESA	European Space Agency
EUMETSAT	European Organisation for the Exploitation of Meteorological Satellites
L3	Level-3 products (along-track)
L4	Level 4 products (gridded)
MIOST	Multiscale Interpolation Ocean Science Topography
SALP	Service d'Altimétrie et de Localisation Précise
SAR(M)	Synthetic Aperture Radar (Mode)
Ssalto	Segment Sol multimissions d'ALTimétrie, d'Orbitographie et de localisation précise.
SLA	Sea Level Anomaly
SSH	Sea Surface Height

Contents

1 Introduction

For 20 years, the DUACS system has been producing, as part of the CNES/SALP project, the Copernicus Marine Environment and Monitoring Service (CMEMS) and the Copernicus Climate Change Service (C3S), high quality multimission altimetry Sea Level products for oceanographic applications, climate forecasting centers, geophysic and biology communities... While the operational production of the Sea Level along track and maps is now generated as part as CMEMS and C3S, the development of a new experimental DUACS products started mid 2016 at CNES **aiming at improving the resolution of the current products and designing new products**. Using the global Synthetic Aperture Radar mode (SARM) coverage of Sentinel3A/B and optimizing the LRM altimeter processing (retracking, editing, ...) will notably allow us to fully exploit the fine-scale content of the altimetric missions. Thanks to this increase of real time altimetry observations we will also be able to improve Level-4 products by combining these new Level-3 products and new mapping methodology, such as dynamic interpolation. Finally, these improvements will benefit to downstream products: geostrophic currents, Lagrangian products, eddy atlas…

This document describes the Gridded (level4) Sea Level Heights and geostrophic velocities computed with Multiscale interpolation for the global ocean.

1.1 Acknowledgments

When using the experimental SSALTO/DUACS experimental products, please cite: "Those products were processed by SSALTO/DUACS and distributed by AVISO+ (https://www.aviso.altimetry.fr) with support from CNES"

1.2 User's feedback

The product is an experimental product. Therefore, each and every question, comment, example of use, and suggestion will help us improve the product. You're welcome to ask or send them to aviso@altimetry.fr .

It is foreseen to deliver new versions of some products: for any new future version delivered, you will be informed via the AVISO+ user service, by email and on the website. The version number is indicated in the ftp folder and in the file ('product_version' attribute).

2 Gridded products obtained with Multiscale Interpolation

Those products are distributed in version 01_00.

It is foreseen to deliver new versions of some products: for any new future version delivered, you will be informed via the AVISO+ user service, by email and on the website. The version number is indicated in the ftp folder and in the file ('product_version' attribute).

2.1 Processing

2.1.1 Input data

The input data used to compute the gridded products obtained with Multiscale Interpolation Ocean Science Topography (MIOST) are the along-track (or Level-3) SEA LEVEL products delivered by the Copernicus Marine Service (CMEMS, http://marine.copernicus.eu/) for satellites OSTM/Jason-2, Jason-3, SARAL/AltiKa, Cryosat-2, HaiYang-2A, Copernicus Sentinel-3A&B as described in **Erreur ! Source du renvoi introuvable.**. The details of the input L3 products processing is described in the Product User Manual http://resources.marine.copernicus.eu/documents/PUM/CMEMS-SL-PUM-008-032-062.pdf and the Quality information Document http://resources.marine.copernicus.eu/documents/QUID/CMEMS-SL-QUID-008-032-062.pdf .

Altimeter mission	Name of SEALEVEL CMEMS product	Name of SEALEVEL CMEMS dataset	Variable used
OSTM/Jason-2	SEALEVEL_ GLO_ PHY_L3_REP_ OBSERVATIONS_ 008_062	dataset-duacs-rep-global-j2-phy-l3	sla_unfiltered
SARAL/AltiKa		dataset-duacs-rep-global-al-phy-l3	
Cryosat-2		dataset-duacs-rep-global-c2-phy-l3	
HaiYang-2A		dataset-duacs-rep-global-h2-phy-l3	
Jason-3		dataset-duacs-rep-global-j3-phy-l3	
Copernicus Sentinel-3A		dataset-duacs-rep-global-s3a-phy-l3	
Copernicus Sentinel-3B		dataset-duacs-rep-global-s3b-phy-l3	

Table 1: List of input data and their definition in CMEMS.

2.1.2 Processing

The Multiscale Interpolation (MIOST) merges along-track ocean altimetry data into continuous maps in time and space. Like the DUACS mapping system, it is based on a linear optimal interpolation scheme, with a different level of covariance function definitions. For this experimental product, we have only considered covariance functions representative of the mesoscale geostrophic variability.

The method and assessment results (obtained within an Observing Simulation System Experiment framework) are described in Ubelmann et al. (2021).

2.2 Product description

2.2.1 Geographical characteristics

The MIOST gridded products cover the entire global ocean. Boundaries have been defined as follows:

Area	Geographical coverage	Spatial resolution
Global	-80°N-0°W/90°N-360°E	1/10°

Table 2. Geographical characteristics of gridded SLA computed with MIOST.

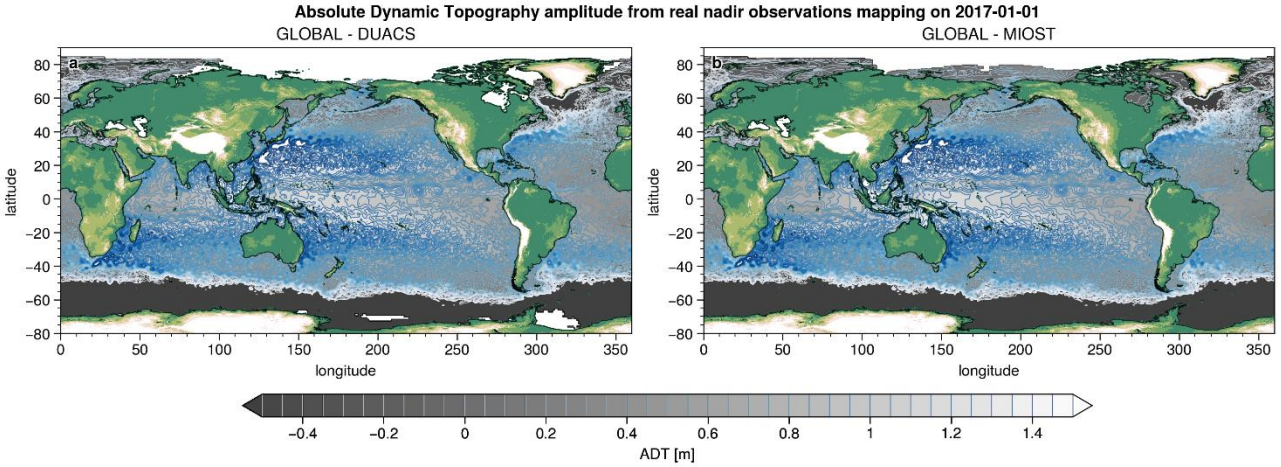

Figure 1: Geographical coverage of Gridded (level4 and level4+) Sea Level Heights and geostrophic velocities computed with a) Duacs global product and b) Miost

2.2.2 Temporal availability

One file per day is delivered.

area	Start dates	End dates
Global	2017/01/01	2017/12/31

Table 3 Temporal availability of gridded SLA with MIOST Interpolation.

2.2.3 Nomenclature

This is the generic model of filename :

dt_<zone>_allsat_phy_<begin_date>_ <prod_date>.nc

The products name components are:

- The type of data timeliness dt=delayed-time
- <zone>=area
- allsat means that all the available missions are taken into account.
- The begin and production dates of the data: <begin_date>_<prod_date>

2.2.4 Format

All the products are distributed in NetCDF with norm CF.

NetCDF (Network Common Data Form) is an open source, generic and multi-platform format developed by Unidata. An exhaustive presentation of NetCDF and additional conventions is available on the following web site:

http://www.unidata.ucar.edu/packages/netcdf/index.html.

All basic NetCDF conventions are applied to files.

Additionally the files are based on the attribute data tags defined by the Cooperative Ocean/Atmopshere Reasearch Data Service (COARDS) and Climate Forecast (CF) metadata conventions. The CF convention generalises and extends the COARDS convention but relaxes the COARDS constraints on dimension and order and specifies methods for reducing the size of datasets. A wide range of software is available to write or read NetCDf/CF files. API made available by UNIDATA (http://www.unidata.ucar.edu/software/netcdf):

- C/C++/Fortran
- Java
- MATLAB, Objective-C, Perl, Python, R, Ruby, Tcl/Tk.

2.2.4.1 Dimensions

The defined dimensions are:

- **time:** number of grids in current file (one grid for one day).
- **Latitude :** number of grid points in latitude
- **Longitude :** number of grid points in longitude
- Nv: for graphical needs

2.2.4.2 Data Handling Variables

You will find hereafter the definitions of the variables defined in the product:

Name of variable	Type	Content	Unit
time	float	Time of measurements	days since 1950-01-01 00:00:00 UTC
latitude	float	Latitude value of measurements	degrees_north
longitude	float	Longitude value of measurements	degrees_east
lat_bnds	float	latitude values at the north and south bounds of each pixel.	degrees_north
lon_bnds	float	longitude values at the north and south bounds of each pixel.	degrees_east
sla	int	Sea Level Anomaly relative to a mean sea surface	Meters
adt	int	Absolute dynamic topography	meters
ugosa	int	Geostrophic velocity anomalies: zonal component	meters/second
vgosa	int	Geostrophic velocity anomalies: meridian component	meters/second
ugos	int	Absolute geostrophic velocity: zonal component"	meters/second
vgos	int	Absolute geostrophic velocity: meridian component"	meters/second

Table 4. Overview of data handling variables in gridded DI NetCDF file.

2.2.4.3 Attributes

Additional attributes may be available in files. They are providing information about the type of product or the processing and parameter used.

3 Products accessibility

The products are available via the authenticated **Aviso+ FTP (online products)**:

- You first need to register via the Aviso+ web portal and sign the License Agreement: https://www.aviso.altimetry.fr/en/data/data-access/registration-form.html
- You have to choose the product **"Ssalto/Duacs Experimental products: along-track and gridded Sea Level Heights and velocities"** in the list of products

A login /Password will be provided via email with all the necessary information to access the products.

4 Contacts

For more information, please contact:

Aviso+ User Services
CLS
11 rue Hermès
Parc Technologique du canal
31520 Ramonville Cedex
France
E-mail: aviso@altimetry.fr
On Internet: https://www.aviso.altimetry.fr/

The user service is also interested in user feedbacks; questions, comments, proposals, requests are much welcome.

5 Examples of files

5.1 Gridded Sea Level Anomalies computed with Multiscale Interpolation

```
netcdf dt_global_allsat_phy_l4_20170413_20210318 {
dimensions:
        time = 1 ;
        latitude = 1700 ;
        longitude = 3600 ;
        nv = 2 ;
variables:
        int crs ;
                crs:comment = "This is a container variable that describes the grid_mapping used by the data in this file. This
variable does not contain any data; only information about the geographic coordinate system." ;
                crs:grid_mapping_name = "latitude_longitude" ;
                crs:inverse_flattening = 298.257 ;
                crs:semi_major_axis = 6378136.3 ;
        float time(time) ;
                time:axis = "T" ;
                time:calendar = "gregorian" ;
                time:long_name = "Time" ;
                time:standard_name = "time" ;
                time:units = "days since 1950-01-01 00:00:00" ;
        float latitude(latitude) ;
                latitude:axis = "Y" ;
                latitude:bounds = "lat_bnds" ;
                latitude:long_name = "Latitude" ;
                latitude:standard_name = "latitude" ;
                latitude:units = "degrees_north" ;
                latitude:valid_max = 89.8000015258789 ;
                latitude:valid_min = -80.0999984741211 ;
        float lat_bnds(latitude, nv) ;
                lat_bnds:comment = "latitude values at the north and south bounds of each pixel." ;
                lat_bnds:units = "degrees_north" ;
        float longitude(longitude) ;
                longitude:axis = "X" ;
                longitude:bounds = "lon_bnds" ;
                longitude:long_name = "Longitude" ;
                longitude:standard_name = "longitude" ;
                longitude:units = "degrees_east" ;
                longitude:valid_max = 180. ;
                longitude:valid_min = -179.899993896484 ;
        float lon_bnds(longitude, nv) ;
                lon_bnds:comment = "longitude values at the west and east bounds of each pixel." ;
                lon_bnds:units = "degrees_east" ;
        int nv(nv) ;
                nv:comment = "Vertex" ;
                nv:long_name = "Number of cell vertices" ;
                nv:units = "1" ;
        int adt(time, latitude, longitude) ;
                adt:_FillValue = -2147483647 ;
                adt:comment = "The absolute dynamic topography is the sea surface height above geoid; the adt is obtained as
follows: adt=sla+mdt where mdt is the mean dynamic topography; see the product user manual for details" ;
                adt:coordinates = "longitude latitude" ;
                adt:grid_mapping = "crs" ;
                adt:long_name = "Absolute dynamic topography" ;
                adt:scale_factor = 0.0001 ;
```

```
        adt:standard_name = "sea_surface_height_above_geoid" ;
        adt:units = "m" ;
    int ugos(time, latitude, longitude) ;
        ugos:_FillValue = -2147483647 ;
        ugos:coordinates = "longitude latitude" ;
        ugos:grid_mapping = "crs" ;
        ugos:long_name = "Absolute geostrophic velocity: zonal component" ;
        ugos:scale_factor = 0.0001 ;
        ugos:standard_name = "surface_geostrophic_eastward_sea_water_velocity" ;
        ugos:units = "m/s" ;
    int vgos(time, latitude, longitude) ;
        vgos:_FillValue = -2147483647 ;
        vgos:coordinates = "longitude latitude" ;
        vgos:grid_mapping = "crs" ;
        vgos:long_name = "Absolute geostrophic velocity: meridian component" ;
        vgos:scale_factor = 0.0001 ;
        vgos:standard_name = "surface_geostrophic_northward_sea_water_velocity" ;
        vgos:units = "m/s" ;
    int sla(time, latitude, longitude) ;
        sla:_FillValue = -2147483647 ;
        sla:ancillary_variables = "err" ;
        sla:comment = "The sea level anomaly is the sea surface height above mean sea surface; it is referenced to the
[1993, 2012] period; see the product user manual for details" ;
        sla:coordinates = "longitude latitude" ;
        sla:grid_mapping = "crs" ;
        sla:long_name = "Sea level anomaly" ;
        sla:scale_factor = 0.0001 ;
        sla:standard_name = "sea_surface_height_above_sea_level" ;
        sla:units = "m" ;
    int ugosa(time, latitude, longitude) ;
        ugosa:_FillValue = -2147483647 ;
        ugosa:ancillary_variables = "err_ugosa" ;
        ugosa:comment = "The geostrophic velocity anomalies are referenced to the [1993, 2012] period" ;
        ugosa:coordinates = "longitude latitude" ;
        ugosa:grid_mapping = "crs" ;
        ugosa:long_name = "Geostrophic velocity anomalies: zonal component" ;
        ugosa:scale_factor = 0.0001 ;
        ugosa:standard_name = "surface_geostrophic_eastward_sea_water_velocity_assuming_sea_level_for_geoid" ;
        ugosa:units = "m/s" ;
    int vgosa(time, latitude, longitude) ;
        vgosa:_FillValue = -2147483647 ;
        vgosa:ancillary_variables = "err_vgosa" ;
        vgosa:comment = "The geostrophic velocity anomalies are referenced to the [1993, 2012] period" ;
        vgosa:coordinates = "longitude latitude" ;
        vgosa:grid_mapping = "crs" ;
        vgosa:long_name = "Geostrophic velocity anomalies: meridian component" ;
        vgosa:scale_factor = 0.0001 ;
        vgosa:standard_name = "surface_geostrophic_northward_sea_water_velocity_assuming_sea_level_for_geoid" ;
        vgosa:units = "m/s" ;

// global attributes:
        :Conventions = "CF-1.6" ;
        :Metadata_Conventions = "Unidata Dataset Discovery v1.0" ;
        :cdm_data_type = "Grid" ;
        :comment = "Sea Surface Height measured by Altimetry and derived variables" ;
        :contact = "aviso@altimetry.fr" ;
        :creator_email = "aviso@altimetry.fr" ;
        :creator_name = "SSALTO/DUACS-MR" ;
        :creator_url = "http://www.aviso.altimetry.fr" ;
        :date_created = "2021-03-18T17:27:38Z" ;
        :date_issued = "2021-03-18T17:27:38Z" ;
        :date_modified = "2021-03-18T17:27:38Z" ;
```

:geospatial_lat_max = 89.8000015258789 ;
:geospatial_lat_min = -80.0999984741211 ;
:geospatial_lat_resolution = 0.0999999999999943 ;
:geospatial_lat_units = "degrees_north" ;
:geospatial_lon_max = 180. ;
:geospatial_lon_min = -179.899993896484 ;
:geospatial_lon_resolution = 0.1 ;
:geospatial_lon_units = "degrees_east" ;
:geospatial_vertical_max = 0. ;
:geospatial_vertical_min = 0. ;
:geospatial_vertical_positive = "down" ;
:geospatial_vertical_resolution = "point" ;
:geospatial_vertical_units = "m" ;
:history = "2021-03-18 17:27:43Z: Creation" ;
:institution = "CLS, CNES" ;
:keywords = "Oceans > Ocean Topography > Sea Surface Height" ;
:keywords_vocabulary = "NetCDF COARDS Climate and Forecast Standard Names" ;
:platform = "Altika OSTM/Jason-2 Haiyang-2A Cryosat-2 Jason-3 Sentinel-3A Sentinel-3B" ;
:processing_level = "L4" ;
:product_version = "1.0" ;
:project = "SSALTO/DUACS-MR" ;
:reference = "http://www.aviso.altimetry.fr" ;
:source = "Altimetry measurements" ;
:ssalto_duacs_comment = "The reference mission used for the altimeter inter-calibration processing is Topex/Poseidon between 1993-01-01 and 2002-04-23, Jason-1 between 2002-04-24 and 2008-10-18, OSTM/Jason-2 between 2008-10-19 and 2016-06-25, Jason-3 since 2016-06-25." ;
:standard_name_vocabulary = "NetCDF Climate and Forecast (CF) Metadata Convention Standard Name Table v37" ;
:summary = "CLS Delayed-Time Level-4 sea surface height and derived variables measured by multi-satellite altimetry observations over the Global Ocean. Merging method is based on Multiscale interpolation (Ubelmann et al., 2021)" ;
:time_coverage_duration = "P1D" ;
:time_coverage_end = "2017-04-13T12:00:00Z" ;
:time_coverage_resolution = "P1D" ;
:time_coverage_start = "2017-04-12T12:00:00Z" ;
:title = "DT merged all satellites Global Gridded CLS Sea Surface Height L4 product and derived variables" ;
}

Bibliography

Ubelmann et al, 2021: Reconstructing Ocean Surface Current Combining Altimetry and Future Spaceborne Doppler Data, JGR Oceans, 10.1029/2020JC016560