MSS Combined SIO/CNES_CLS2015/DTU15:

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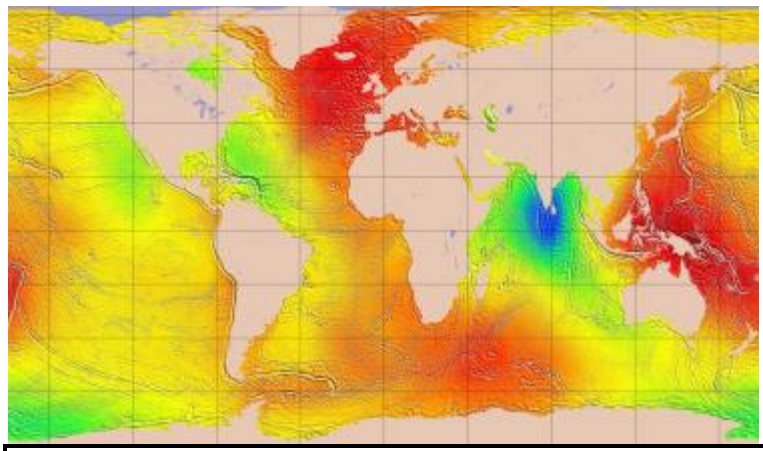

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Aviso+ Altimetry
11 rue Hermès, 31520 Ramonville St Agne, France – aviso@altimetry.fr

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List of Acronyms:

AVISO+	Archivage, Validation et Interprétation des données des Satellites Océanographiques
CLS	Collecte Localisation Satellites
CNES	Centre National d'Etudes Spatiales
DUACS	Data Unification and Altimeter Combination System
DTU SPACE	Denmark's National Space Institute
FTP	File Transfer Protocol
MSS	Mean Sea Surface
NetCDF	Network Common Data Format
SIO	Scripps Institution of Oceanography
SLA	Sea Level Anomaly (a.k.a. sea surface height with respect to a mean sea surface)

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Contents

1. Overview of this document

This document is the user manual for the **Mean Sea Surface** products, processed by CNES/CLS and used in the DUACS system.

This document describes the MSS Combined SIO/CNES_CLS2015/DTU15 model that is used for the DUACS DT-2021 reprocessing. It combines different MSS models in order to benefits from the advantages of each model.

The document is organized as follows:

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

2. Mean Sea Surface

2.1. Definition

The altimeter measures the 'Altimeter Range' which is the distance between the center of mass of satellite to the surface of the Earth (see

Figure 1). This allows computing the 'Sea Surface Height' (SSH) which is the height of the sea surface above the reference ellipsoid. The 'Satellite Altitude' refers to the distance of the center of mass of the satellite above a reference point. The reference point will usually be either on the reference ellipsoid or the center of the Earth.

SSH = Satellite Altitude - Altimeter Range – Corrections

The 'Corrections' due to environmental conditions need to be applied in order to retrieve the correct 'Sea Surface Height'. They are listed in **Erreur ! Source du renvoi introuvable.** (for NRT) and **Erreur ! Source du renvoi introuvable.** (for DT).

The MSS field corresponds to the reference sea surface removed from the total sea surface height (SSH) deduced from the altimeter measurement in order to retrieve a Sea Level Anomaly (SLA; also named Sea Surface Height Anomaly SSHA). It corresponds to the temporal mean of the SSH over a period N. It is a mean surface above the ellipsoid of reference and it includes the Geoid.

$$MSS_N = \langle SSH \rangle_N$$

$$SLA_N = SSH - MSS_N$$

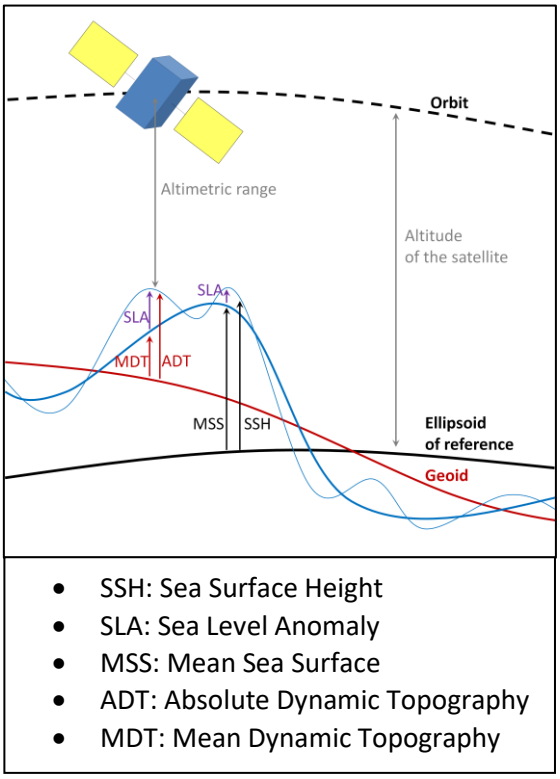

Figure 1: Different notions of sea surface height used in altimetry (Credits CLS)

2.2. Rationale

The MSS is a key component in the altimeter data processing.

The MSS presented in this handbook corresponds to MSS field that has been selected for Level-2p to Level-4 altimeter production in DT-2021 standard, as part of the CNES/CLS Data Unification and Altimeter Combination System (DUACS) processing.

The MSS is an important field that contributes to the quality of the DUACS products. The MSS thus

- Needs to be representative of the reference period chosen for SLA computation : [1993, 2012] for DUACS products
- Needs to resolve large and small scales (> ~30km), in open ocean and coastal areas
- Needs to be defined over all the oceans

As different MSS models are available, all with some quality and default, a multi-model combined solution was computed, with the aims to benefit from the advantages of 3 different models.

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2.3. Refence and acknowledgments

When using the **MSS Combined SIO/CNES_CLS2015/DTU15** model, please cite in the text:

"The Mean Sea Surface Combined SIO/CNES_CLS2015/DTU15 model (DOI: 10.24400/527896/a01-2021.004
) was produced by SSALTO/DUACS and distributed by AVISO+ (https://www.aviso.altimetry.fr/) with support from CNES, in collaboration with SIO and DTU ".

The total citation is : Auteurs, Date, Titre, https://DOI.org/10.24400/527896/a01-2021.004, see in Reference Documents.

3. Processing

3.1. Input data

The data used are described in Table 1. The Table 2 gives an overview of the quality and defaults of the different MSS models.

MSS model	Origin	Reference
SIO	SIO	Sandwell D., Schaeffer P., Dibarboure G., Picot N., (2017). High Resolution Mean Sea Surface for SWOT. https://spark.adobe.com/page/MkjujdFYVbHsZ/
CNES_CLS2015	AVISO+ https://www.aviso.altimetry.fr/en/data/products/auxiliary-products/mss.html	Pujol, M.-I., Schaeffer, P., Faugère, Y., Raynal, M., Dibarboure, G., & Picot, N. (2018). Gauging the improvement of recent mean sea surface models: A new approach for identifying and quantifying their errors. Journal of Geophysical Research: Oceans, 123. https://doi.org/10.1029/2017JC013503
DTU15	DTU https://ftp.space.dtu.dk/pub/DTU15/	Ole Baltazar Andersen, G. Piccioni, L. Stenseng and P Knudsen. The DTU15 MSS (Mean Sea Surface) and DTU15LAT (Lowest Astronomical Tide) reference surface. https://ftp.space.dtu.dk/pub/DTU15/DOCUMENTS/MSS/DTU15MSS+LAT.pdf

Table 1: Input products used

	CNES15	SIO	DTU15
Spatial coverage	-	+	++
Reference period	++	++	--
Accuracy at short wavelengths	--	++	+
Accuracy at long wavelengths	+	+	+
Coastal areas	+	-	

Table 2: Summary of the quality and default of the different MSS models tested.

3.2. method

The methodology used to combine CNES15, SCRIPPS and DTU15 MSS models consisted in defining a transition band where a weighted mean is used to combine both the MSSs.

- in order to benefit from the SIO MSS model capability to better resolve the small scales, this model will be used in open ocean.

- the CNES15 model will be used near the coast and in the Antarctic region.
    - The transition near the coast is defined by the 20 to 30km coastal distance band.
    - The transition between open ocean and seasonally ice covered Antarctic areas is defined using the minimal spatial coverage of the DUACS L4 DT-2018 DT products. This criterium allowed us to define a transition band in the Antarctic region.
- In the Arctic region, DTU15 model was used in order to benefit from the DTU15 spatial coverage. The transition in the Arctic region is defined between 80 and 81°N. a 1.4 cm bias correction was applied on DTU15.

Whatever the transition considered, the weights are defined as a sinus function over the transition wide band. An example of the weight used is given in Figure 2.

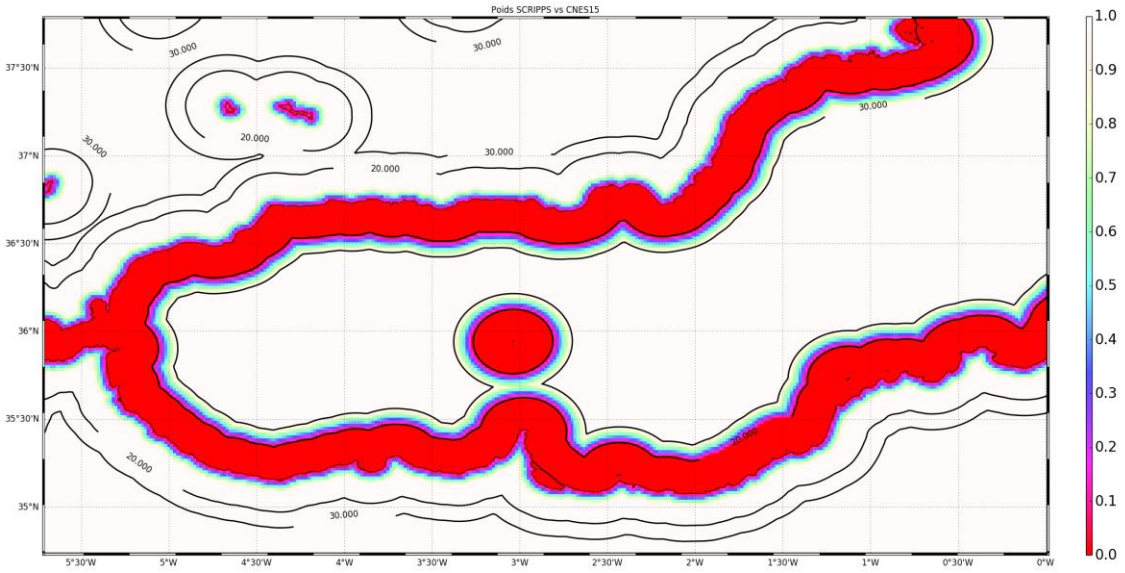

Figure 2: Illustration of the weights used to combine the CNES15 and SIO MSSs in the Gibraltar area. Weights = 0 (1) means that the CNES15 (SIO) model is used; Weight ranging between 0 and 1 means that both the MSSs are combined. This transition occurs between 20 and 30km near the coast.

4. Description of the product

4.1. Product general content and specifications

The MSS is representative of the 20-year reference period [1993, 2012].

It is referenced on the WGS84 ellipsoid.

It is defined over the global area [0, 360°E][-79.5, 90.0]. However, the MSS content is validated only over sea surfaces.

The MSS is disseminated on NetCDF file format. The file contains is described below.

4.2. MSS file content

The following table lists the variables included in the NetCDF file

Variable	Description
latitude	Latitude coordinates defining the regular grid points
longitude	Longitude coordinates defining the regular grid points
mssh	Mean Sea Surface Height over the [1993, 2012] period
ellipsoid_correction	Correction to change ellipsoid reference for Topex ellipsoid
crs	Gives the information of the ellipsoid the mssh is referenced on

4.3. 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 on the NetCDF software package: 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 of 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.

The NetCDF version provided here is version 4 “classic”.

5. How to download a product

5.1. Registration

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

- if not registered on AVISO+, please, fill the form and select the product '**MSS'** on http://www.aviso.altimetry.fr/en/data/data-access/registration-form.html

- if already registered on AVISO+, please request the addition of '**MSS'** on your personal account on https://www.aviso.altimetry.fr/en/my-aviso-plus.html

On the AVISO+ FTP server, all MSS are in subdirectories of the main directory 'MSS'.

5.2. Access Services

Note that once your registration is processed (see above), AVISO+ will validate your registration by e-mail as soon as possible (within 5 working days during working hours, Central European Time). The access information will be available in your personal account on https://www.aviso.altimetry.fr/en/my-aviso-plus.html.


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