SSALTO/DUACS Experimental Product Handbook:

Along-track Sea Level Anomalies 5Hz

Gridded Sea Level Height and geostrophic velocities computed with Dynamic Interpolation

Gridded Sea Level Anomalies and geostrophic velocities combining altimetry and drifters

Gridded optimally merged velocities combining altimetry and SST

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List of Acronyms:

ADT	Absolute Dynamic Topography
AMR	Advanced Microwave Radiometer
AOML	Atlantic Oceanographic & Meteorological Laboratory
ATP	Along Track Product
Aviso+	Archiving, Validation and Interpretation of Satellite Oceanographic data
CMEMS	Copernicus Marine Environment Monitoring Service
Cnes	Centre National d'Etudes Spatiales
DAC	Dynamic Atmospheric Correction
DI	Dynamic Interpolation
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
FES	Finite Element Solution tidal model
GDR	Geophysical Data Record(s)
IB	Inverse Barometer
IGDR	Interim Geophysical Data Record(s)
ISRO	Indian Space Research Organisation
IW	Internal Wave
LASER	Lagrangian Submesoscale ExpeRiment campaign
LRM	Low Resolution Mode
LWE	Large Wavelength Error
L2P	Level-2+ product: global 1 Hz along-track data (sea level anomaly, its components and validity flag) over marine surfaces based on Level-2 products
L3	Level-3 products (along-track)
L4	Level 4 products (gridded)
MOG2D	Modèle aux Ondes de Gravité 2D
MSS	Mean Sea Surface
MWR	Microwave Radiometer
Nasa	National Aeronautics and Space Administration
NOAA	National Oceanic and Atmospheric Administration
NRT	Near Real Time
NTC	Non Time Critical
OSDR	Operational Sensor Data Records
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.
SSB	Sea State Bias
SST	Sea Surface Temperature
SLA	Sea Level Anomaly
SSB	Sea State Bias

SSH	Sea Surface Height
STC	Short Time Critical
TAI	IAT – International Atomic Time
UTC	Universal Time Coordinated

Contents

1 Introduction

For 20 years, the DUACS system has been producing, as part of the CNES/SALP project, and the Copernicus Marine Environment and Monitoring Service (CMEMS), 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, 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 four products:

- Along-track (level3) Sea Level Anomalies at 5 Hz for 2 areas: agulhas and north_atlantic,
- Gridded (level4) Sea Level Heights and geostrophic velocities computed with Dynamic interpolation for 2 areas: gulfstream and udintsev,
- Gridded (level4) Sea Level Anomalies and geostrophic velocities combining altimetry and drifters for 1 area: Gulf of Mexico,
- Gridded (level4) optimally merged velocities combining altimetry and SST with global coverage.

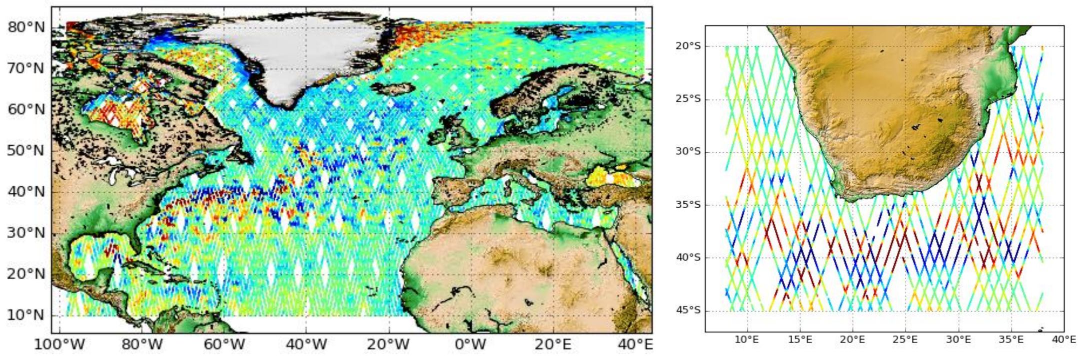

Figure 1: Geographical coverage of Along-track (level3) Sea Level Anomalies at 5 Hz for north atlantic (left) and agulhas (right) with 20 days of Sentinel-3A Sea Level Anomalies

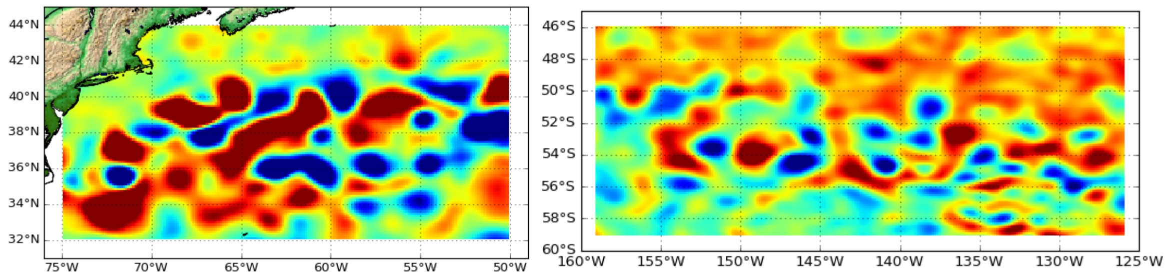

Figure 2: Geographical coverage of Gridded (level4) Sea Level Heights and geostrophic velocities computed with Dynamic interpolation, for gulfstream (left) and udintsev (right) with one day of merged Sea Level Anomalies

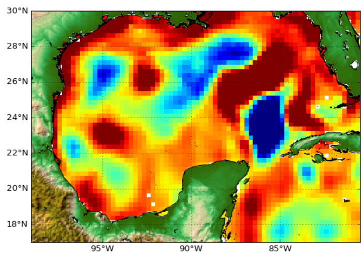

Figure 3: Geographical coverage of Gridded (level4) Sea Level Anomalies and geostrophic velocities combining altimetry and drifters, for Gulf of Mexico with one day of merged Sea Level Anomalies

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"

Please note that the gridded optimally merged velocities combining altimetry and SST with global coverage have been calculated in the framework of three different projects:

- a Marie-Curie Fellowship cofunded by the European Union under the FP7-PEOPLE-Cofunding of Regional, National and International Programmes Grant Agreement 600407 and the RITMARE FLAG project (2014-2016),
- the ESA Globcurrent project (2014-2018),
- the DUACS-MR CNES project (2016-2018).

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 .

2 Processing

2.1 Versioning

The chapters below describe the processing of the version 01_00 of the products. 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).

2.2 Along-track Sea Level Anomalies 5Hz

DUACS Experimental products system is to provide a consistent and user-friendly altimeter database using the state-of-the-art recommendations from the altimetry community. Delayed time data (more accurate) are used to create this database and the final resolution for all available altimeters is 5 Hz frequency.

The Level 3 (L3) DUACS Experimental products have been developed with the aim to provide to the users simple and homogeneous products along the tracks of the different altimeters with a resolution consistent with the physical signal observable, and different physical fields (see Table 2) that can be used to better fit the physical content of the altimeter field to the different applications.

The L3 along-track products are delivered with a 5Hz (i.e. nearly 1km) sampling. The Sea Level Anomaly (SLA) field has been optimally low-pass filtered (see §2.2.4.2) in order to reduce the noise measurement and in the same time keep as much as possible the physical signal at small wavelengths.

The following figure gives an overview of the system, where the main processing sequences can be divided into 6 main steps:

- acquisition
- Pre-processing homogenization
- Input data quality control
- multi-mission cross-calibration
- along-track products generation
- final quality control

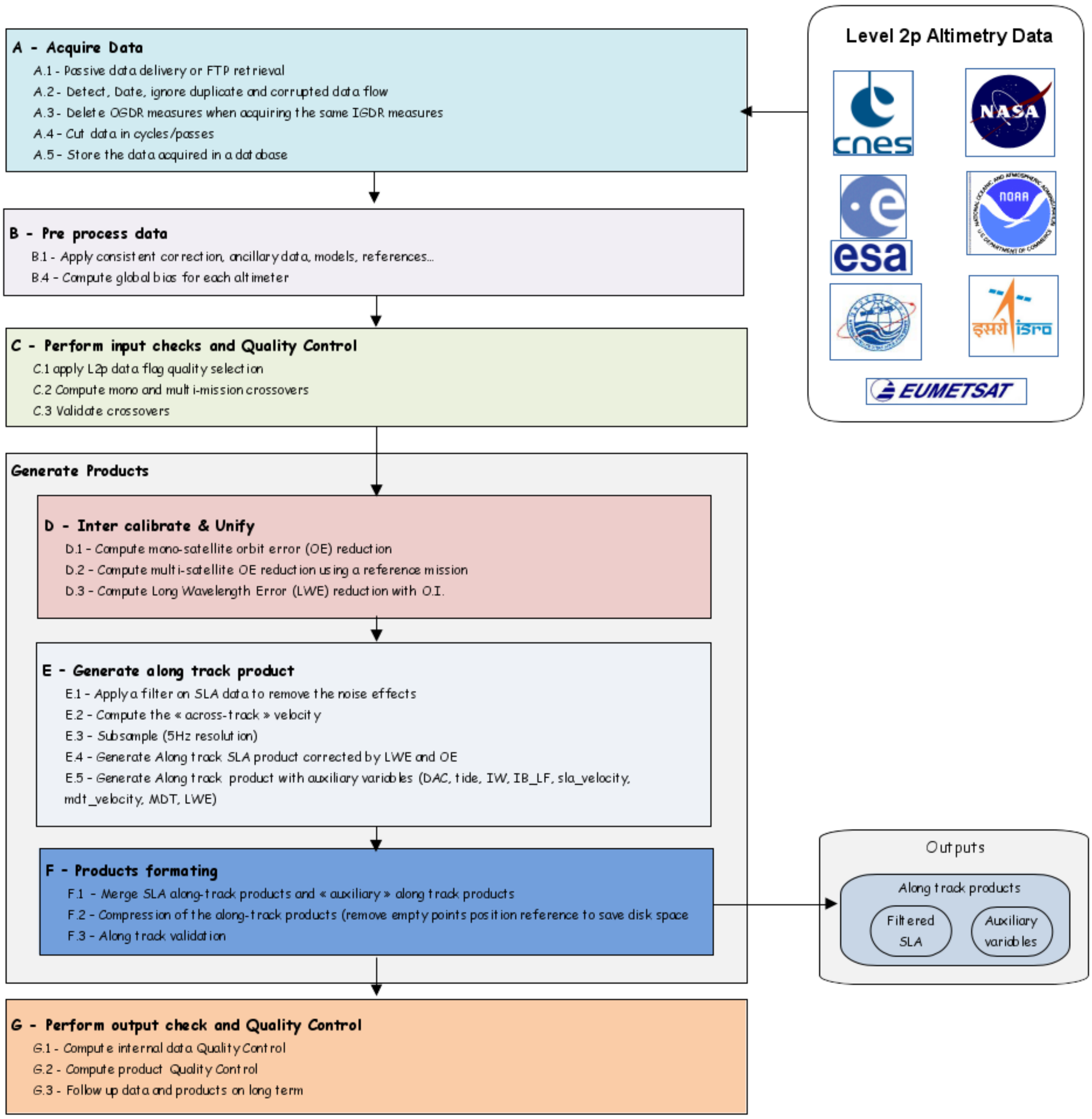

Figure 4: DUACS Experimental system processing

2.2.1 Altimeter Input data description

The altimeter measurements used in input of the DUACS Experimental products system consist in Level2p (L2P) products. They are generated from Delayed Time or Non Time Critical product (GDR or NTC) products from different missions as described in Table 1.

Altimeter mission	Type of product	Source
OSTM/Jason-2	GDR	CNES
SARAL/AltiKa	GDR	CNES
Jason-3	GDR	CNES
Cryosat-2	GDR	Derived from the CNES Processing Prototype (PP) which was developed for Cryosat-2 and Sentinel-3A (Boy et al, 2017)
Sentinel-3A	NTC	

Table 1: input data for the Along-track SLA 5Hz

2.2.2 Input data quality control

The L2 Input Data Quality Control is a critical process applied to guarantee that DUACS Experimental uses only the most accurate altimeter data. DUACS Experimental system is supplied with L2p altimeter products that include a quality flag for each measurement. The valid data selection is directly based on this quality flag. Thanks to the high quality of current missions, this process rejects a small percentage of altimeter measurements, but these erroneous data could be the cause of a significant quality loss.

Data selection on SAR areas :

A classical Iterative editing is used.

Data selection on LRM areas :

A new iterative editing dedicated to high rate altimeter measurements (20 or 40 Hz) based on the SLA coherence between consecutive measurements was used to select valid measurements.

First, aberrant values are detected using thresholds and removed.

Then, the standard deviation of the SLA around its mean on a defined windows (SLARunSTD) is calculated. As this quantity is linearly dependent on waves at first order, it is possible to estimate an expected SLARunSTD in relation with observed waves. By the comparison between observed and expected SLARunSTD it is possible to detect the incoherent values of SLA.

2.2.3 Homogenization and cross-calibration

Homogenization and cross-calibration are done at different steps of the processing.

The first homogenization step consists of acquiring altimeter and ancillary data from the different altimeters that are a priori as homogeneous as possible. They include the most recent standards recommended for altimeter global products by the different agencies and expert groups such as OSTST, ESA Quality Working groups or ESA SL_cci project. Each mission is processed separately as its needs depend on the input data. The different standards applied are summarized in the Table 2.

Input L2p products includes a first cross-calibration processing that consists in ensuring mean sea level continuity between the four altimeter reference missions (Topex/Poseidon, Jason-1, 2 and 3). This step, crucial for climate signals, is done as accurately as possible in REP/DT conditions, taking into account both the global and the regional biases, as presented in Pujol et al (2016).

We also apply global bias to reduce the impact of different standards between available missions.

Nevertheless, they are not always coherent at large regional scales due to various sources of geographically correlated errors (instrumental, processing, orbit residuals errors). Consequently, the DUACS Experimental multi-mission cross-calibration algorithm aims to reduce these errors in order to generate a global, consistent and accurate dataset for all altimeter constellations. This step processing consists of applying the Orbit Error Reduction (OER) algorithm. This process consists of reducing orbit errors through a global minimization of the crossover differences observed for the reference mission, and between the reference and other missions also identified as complementary and opportunity missions, as presented by Le Traon and Ogor (1998).

The last step consists in applying the long wavelength error (LWE) reduction algorithm based on Optimal Interpolation (see for instance; Le Traon et al, 2003; Pujol et al, 2016). This process reduces geographically-correlated errors between neighboring tracks from different sensors. This optimal-interpolation based empirical correction also contributes to reduction of the residual high frequency signal that is not fully corrected by the different corrections that are applied (mainly the Dynamic Atmospheric Correction and Ocean tides). LWE, DAC and Ocean tides corrections are provided in the final along track products.

	OSTM/Jason-2	Jason-3	Sentinel-3A	SARAL/AltiKa	Cryosat-2
Orbit	GDR-E				
Sea State Bias	Non Parametric SSB [Tran 2012]	Non parametric SSB	Non parametric SSB [Tran 2015]	Non parametric SSB	Non parametric SSB
Ionosphere	Dual-frequency altimeter range measurement	GIM [Ijima et al., 1999]			
Wet troposphere	Neural Network correction (3 entries), [Fréry et al. in prep]	From J3-AMR radiometer	From S3A-AMR radiometer	Neural Network correction (5 entries) [Picard et al., in prep]	From ECMWF model
Dry troposphere	Model based on ECMWF Gaussian grids				
Combined atmospheric correction	MOG2D High frequencies forced with analysed ECMWF pressure and wind field [Carrere and Lyard, 2003; operational version used, current version is 3.2.0] + inverse barometer Low frequencies				
Ocean tide	FES2014 [Carrère et al., 2015]				
Solid Earth tide	Elastic response to tidal potential [Cartwright and Tayler, 1971], [Cartwright and Edden, 1973]				
Pole tide	[DESAI, 2015]				
MSS	CNES-CLS-2015				

Table 2: Standards of the different corrections applied on altimeter measurements.

2.2.4 Along-track (L3) products generation

The L3 products are along-track products selected and cross-calibrated.

2.2.4.1 SLA computation

The Sea Level Anomalies (SLA) are used in oceanographic studies. They are computed from the difference of the instantaneous SSH minus a temporal reference. The temporal reference used in the DUACS Experimental production is a gridded Mean Sea Surface (MSS) (see Table 2).

2.2.4.2 Along track noise filtering

The filtering processing consists in removing from along-track measurements the noise signal and short wavelength affected by this noise. This processing consists in a low-pass filtering with a cut-off wavelength defined over the regional area considered (see the following table for different altimeter cut-off). This cut-off wavelengths come from regional studies with spectral analysis in order to preserve as much as possible the short wavelength signal.

The filtered along-track products are subsampled before the delivery in order to keep every fourth point along the tracks and height for SARAL/AltiKa, leading to a nearly 1 km distance between successive points (5Hz sampling).

Satellite	OSTM/Jason-2	Jason-3	Sentinel-3A	SARAL/ALtiKa	Cryosat-2
North Atlantic area	45	35	30	30	35
Agulhas area	55	50	45	40	50

Table 3: Cut-off wavelengths (unit: km) used for along-track noise filtering

2.3 Gridded products obtained with Dynamic Interpolation

2.3.1 Input data

The input data used to compute the gridded products obtained with Dynamic Interpolation over all areas 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, SARAL/AltiKa, Cryosat-2, HaiYang-2A as described in Table 4 and from 2015/01/01 to 2016/04/30. The details of the input L3 products processing is described in the Product User Manual http://cmems-resources.cls.fr/documents/PUM/CMEMS-SL-PUM-008-032-051.pdf and the Quality information Document http://cmems-resources.cls.fr/documents/QUID/CMEMS-SL-QUID-008-032-051.pdf .

Altimeter mission	Name of SEALEVEL CMEMS product	Name of SEALEVEL CMEMS dataset
OSTM/Jason-2	SEALEVEL_ GLO_PHY_L3_REP_ OBSERVATIONS_008_ 045	dataset-duacs-rep-global-j2-phy-unfiltered-l3-v3
SARAL/AltiKa		dataset-duacs-rep-global-al-phy-unfiltered-l3-v3
Cryosat-2		dataset-duacs-rep-global-c2-phy-unfiltered-l3-v3
HaiYang-2A		dataset-duacs-rep-global-h2-phy-unfiltered-l3-v3

Table 4: List of input data and their definition in CMEMS.

2.3.2 Processing

The Dynamic Interpolation (DI) merges along-track ocean altimetry data into continuous maps in time and space. Contrary to classical linear optimal interpolation as distributed by CMEMS (Bretherton et al, 1976; Ducet et al., 2000), DI has the advantage of accounting for non-linear processes allowing to significantly reduce the interpolation error in highly turbulent region. It includes both statistical and physical (dynamical) knowledge of the field to map. The dynamic interpolation method is based on forward/backward transport of the SSH field by a nonlinear propagator conserving the potential vorticity. Ubelmann et al. (2015, 2016) and Rogé et al. (2017) describe, test and validate the DI method.

The method and assessment results are described in Ubelmann et al, (2017).

2.4 Gridded products combining altimetry and drifters

2.4.1 Input data

2.4.1.1 Altimetry

The altimetry input data used to compute the gridded products combining altimetry and drifters 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, SARAL/AltiKa, Cryosat-2, HaiYang-2A as described in Table 5 and from 2015/09/01 to 2016/04/30. The details of the input L3 products processing is described in the Product User Manual http://cmems-resources.cls.fr/documents/PUM/CMEMS-SL-PUM-008-032-051.pdf and the Quality information Document http://cmems-resources.cls.fr/documents/QUID/CMEMS-SL-QUID-008-032-051.pdf .

Altimeter mission	Name of SEALEVEL CMEMS product	Name of SEALEVEL CMEMS dataset
OSTM/Jason-2	SEALEVEL_ GLO_PHY_L3_REP_ OBSERVATIONS_008_ 045	dataset-duacs-rep-global-j2-phy-unfiltered-l3-v3
SARAL/AltiKa		dataset-duacs-rep-global-al-phy-unfiltered-l3-v3
Cryosat-2		dataset-duacs-rep-global-c2-phy-unfiltered-l3-v3
HaiYang-2A		dataset-duacs-rep-global-h2-phy-unfiltered-l3-v3

Table 5: List of altimetry and input data and their definition in CMEMS for the gridded maps combining altimetry and drifters

2.4.1.2 Drifters

The drifters input data used to compute the gridded products combining altimetry and drifters are from the Horizon Marine (HMI) Company, part of CLS group. This Company launches their own drifters in the Gulf of Mexico for their downstream services. The drifters are processed from 2014 to 2016 to extract anomalies of geostrophic currents.

2.4.2 processing

Strong improvements have been made in our knowledge of the surface ocean geostrophic circulation thanks to satellite observations. However, the synergy of different sources of observation (satellite and in-situ) is mandatory to go toward higher resolution. In this study, we combined altimetric along track Sea Level Anomalies (SLA) with geostrophic velocity estimated from surface drifters to map SLA and associated geostrophic current anomalies in the Gulf of Mexico.

First, an important work is done to pre-process drifter data as detail by the following steps:

1- foreward/backward editing process as done by *Hansen and Poulain, 96*

2- Spike detection

3- Interpolation with regular frequency (6h00)

4- Computation of the velocities

5- Remove ageostrophic signal to have a physical content consistent with altimetry:

  5.1- Remove high frequency ageostrophic signal: Filter at 3days

  5.2- Remove Ekman model (Rio et al., 2014)

Second, anomalies of geostrophic current estimated from drifters and along track SLA from Jason2, HY2, Saral and C2 are combined through multivariate objective analysis to map a time series of SLA and associated geostrophic current anomalies in the Gulf of Mexico. The multivariate objective analysis is based on objective analysis proposed by Bretherton (1976) and adapted to merge height and geostrophic velocities as done by Rio et Hernandez (2004).

The method and assessment results are described in Mulet et al, 2017 OSTST.

2.5 Gridded products obtained combining altimetry and Sea Surface Temperature

2.5.1 Input data

2.5.1.1 Altimetry

The altimeter input data used to compute the gridded products of optimally merged SSH/SST velocities is the gridded (or Level-4) SEA LEVEL products delivered by the Copernicus Marine Service (CMEMS, http://marine.copernicus.eu/). The details of the input L4 products processing is described in the Product User Manual http://cmems-resources.cls.fr/documents/PUM/CMEMS-SL-PUM-008-032-051.pdf and the Quality information Document http://cmems-resources.cls.fr/documents/QUID/CMEMS-SL-QUID-008-032-051.pdf .

2.5.1.2 Sea Surface Temperature

The Sea Surface Temperature input data used to compute the gridded products of optimally merged SSH/SST velocities are the gridded (or Level-4) Optimally Interpolated (OI) SST produced daily on a 25 km resolution grid by Remote Sensing System using only microwave data (MW) (http://www.remss.com/measurements/sea-surface-temperature/oisst-description/). It contains the SST measurements from all operational radiometers (TMI, AMSR-E, AMSR-2, WindSat, GMI).

2.5.2 Processing

The optimal SSH/SST blended velocities are obtained by inverting the SST conservation equation for the velocity field using the altimeter geostrophic velocities as background velocities. The atmospheric forcing term (heat fluxes) in the SST conservation equation is approximated using the large spatial scales of the daily SST temporal derivatives. Both the errors on the background velocities and the forcing term are taken into account to obtain the optimal blended velocities. The method is fully described in the papers by Piterbarg et al (2009), Rio et al (2016) and Rio and Santoleri (submitted).

2.6 Gridded confidence flag product

2.6.1 Input data

2.6.1.1 "allsat" altimeter derived velocities

The altimeter input data used to compute the confidence flag is the gridded (or Level-4) SEA LEVEL products delivered by the Copernicus Marine Service (CMEMS, http://marine.copernicus.eu/). The details of the input L4 products processing is described in the Product User Manual http://cmems-resources.cls.fr/documents/PUM/CMEMS-SL-PUM-008-032-051.pdf and the Quality information Document http://cmems-resources.cls.fr/documents/QUID/CMEMS-SL-QUID-008-032-051.pdf.

2.6.1.2 Drifting buoy velocities

The in-situ drifting buoy velocities used to calculate the confidence flag are the velocities from the 15m drogued SVP drifters distributed by the SD-DAC (http://www.aoml.noaa.gov/phod/dac/dacdata.php).

2.6.1.3 Processing

The background (bck) "allsat" altimeter geostrophic velocities and the optimal (opt) SSH/SST blended velocities are interpolated along the drifting buoy trajectories and Root Mean Square (RMS) differences between the different products and the buoy velocities are calculated in 20° by 20° boxes for both components of the velocity (U: zonal, V: meridional). Then in each box a % of improvement (U_{impr},V_{impr}) is obtained using:

$$U_{impr} = 100 * (1 - (RMSU_{opt} / RMSU_{bck})^2)$$

$$V_{impr} = 100 * (1 - (RMSV_{opt} / RMSV_{bck})^2)$$

These % of improvement are used as confidence flag for this demonstration dataset. A positive value means that, on average over the period, the optimally combined SSH/SST velocities are closer to the drifting buoy velocities than the "allsat" altimeter velocities so that the confidence level is good. The higher the % of improvement, the better. On the contrary, negative values indicate that the optimally combined SSH/SST velocities does not compare to drifting buoy velocities as well as the "allsat" altimeter velocities do. The confidence level is thus lower.

The method to derive this confidence flag is fully described in the paper by Rio and Santoleri (submitted).

3 Product Description

3.1 Along-Track Sea Level anomaly 5Hz product

3.1.1 Area of interest

Several areas have been defined as follows:

Area	latitudes	longitudes
north_atlantic	10°N/88°N	98°W/42°E
agulhas	45°S/20°S	8°E/38°E

Table 6. Geographical characteristics of along-track SLA 5Hz.

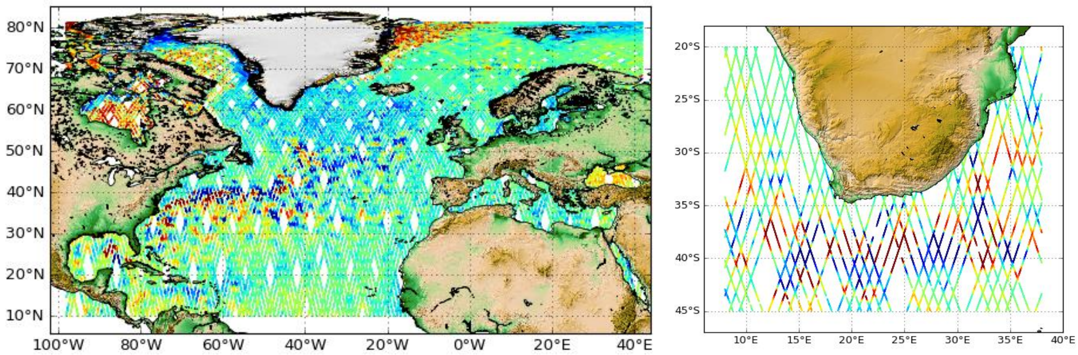

Figure 5: Geographical coverage of Along-track (level3) Sea Level Anomalies at 5 Hz for north atlantic [10°N/88°N-98°W/42°E] (left) and agulhas [45°S/20°S-8°E/38°E] (right) with 20 days of Sentinel-3A Sea Level Anomalies

3.1.2 Temporal availability

One file per day is delivered.

Altimeter mission	Start dates	End dates
Jason-3	2016/03/28	2017/03/29
OSTM/Jason-2	2015/01/01	2016/02/29
Saral/AltiKa	2015/01/01	2017/02/03
Cryosat-2	2015/01/01	2015/12/31
Sentinel-3A	2016/04/06	2017/04/17

Table 7 Temporal availability of along-track SLA 5Hz products.

3.2 Gridded products computed with Dynamic Interpolation

3.2.1 Geographical characteristics

Several areas have been defined as follows:

Area	Geographical coverage	Spatial resolution
Gulfstream	30°N-87°W/50°N-30°W	¼°
Udintsev	59°S-159°W/46°S-126W	1/8°

Table 8. Geographical characteristics of gridded SLA computed with DI.

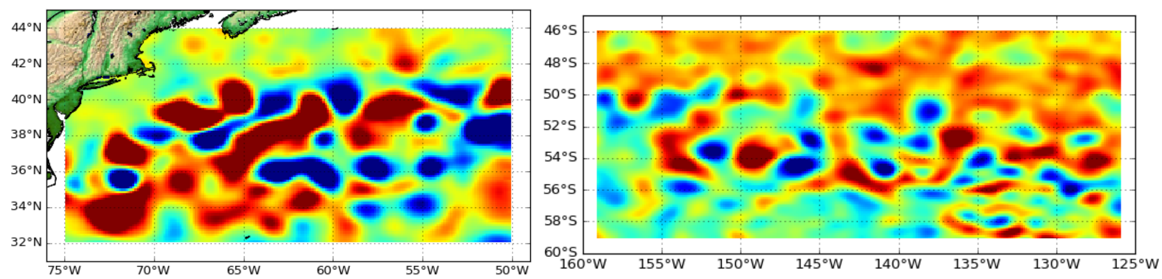

Figure 6: Geographical coverage of Gridded (level4 and level4+) Sea Level Heights and geostrophic velocities computed with Dynamic interpolation, for Gulf Stream [30°N-87°W/50°N-30°W] (left) and Udintsev [59°S-159°W/46°S-126W] (right) with one day of merged Sea Level Anomalies

3.2.2 Temporal availability

One file per day is delivered.

area	Start dates	End dates
Gulfstream	2014/04/12	2015/12/31
Udinstev	2015/11/01	2016/04/30

Table 9 Temporal availability of gridded SLA with Dynamic Interpolation.

3.3 Gridded products combining altimetry and drifters

3.3.1 Geographical characteristics

Area	Geographical coverage	Spatial resolution
Gulf of Mexico	17°N/31°N-105°W/82°W	1/4°

Table 10. Geographical characteristics of gridded SLA combining altimetry and drifters.

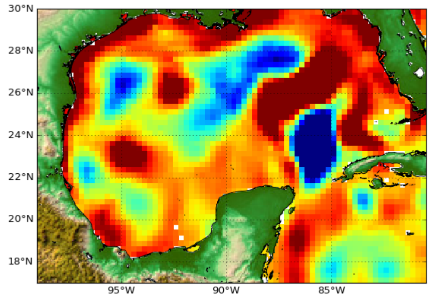

Figure 7: Geographical coverage of Gridded (level4 and level4+) Sea Level Anomalies and geostrophic velocities combining altimetry and drifters, for Gulf of Mexico [17°N/31°N-105°W/82°W] with one day of merged Sea Level Anomalies

3.3.2 Temporal availability

One file per day is delivered.

Area	Start dates	End dates
Gulf of Mexico	2015/09/01	2016/04/30

Table 11 Temporal availability of gridded products combining altimetry and drifters.

3.4 Gridded products obtained combining altimetry and Sea Surface Temperature

3.4.1 Geographical characteristics

The geographical coverage of the blended SSH/SST velocities is global (excluding the Mediterranean Sea).

Area	Geographical coverage	Resolution
Global	0.125-359.875; -89.875-89.875	0.25°

Table 12. Geographical characteristics of gridded products combining altimetry and SST.

3.4.2 Temporal availability

One file per day is delivered over year 2015.

Area	Start Date	End Date
Global	01/01/2015	31/12/2015

Table 13 Temporal availability of gridded products combining altimetry and SST.

3.5 Gridded confidence flag product

3.5.1 Geographical characteristics

The geographical coverage of the confidence flag is global (excluding the Mediterranean Sea). Effective resolution is 20° (the % of improvement is calculated in 20° by 20° boxes).

Area	Geographical coverage	Resolution
Global	0.125-359.875; -89.875-89.875	0.25°

Table 14. Geographical characteristics of gridded confidence flag product.

3.5.2 Temporal availability

One file is delivered over year 2015 (static file).

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.

4.1 Along-Track Sea Level anomaly 5Hz product

4.1.1 Nomenclature

This is the generic model of filename :

dt_hr_<zone>_<mission>_phy_vfec_<dataset_date>_ <production_date>.nc

The products name components are:

- The type of data timeliness dt=delayed-time
- <zone>=area (north_atlantic or agulhas)
- <mission> mission taken into account:
    - s3a: Sentinel-3A
    - al: Saral/AltiKa
    - j2: OSTM/Jason-2
    - c2: Cryosat-2
    - j3: Jason-3
- The date of the dataset YYYYMMDD: <dataset_date>
- The date of the production YYYYMMDD: <end_date>

4.1.2 Format

4.1.2.1 Dimensions

The defined dimension is:

- **time:** number of grids in current file (one grid for one day).

4.1.2.2 Data Handling Variables

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

Name of variable	Type	Content	Unit
time	double	Time of measurements	seconds since 1950-01-01 00:00:00 UTC
latitude	int	Latitude value of measurements	degrees_north
longitude	int	Longitude value of measurements	degrees_east
cycle	short	Cycle the measurement belongs to	-
track	short	Track the measurement belongs to	-
iw	short	Internal Wave surface signature component from Ray and Zaron 2016 - M2	meters
ib_lf	short	Low Frequency component of the inverse barometer	meters
lwe	short	Long Wavelength Error	meters
dac	short	Dynamic atmospheric correction	meters
ocean_tide	short	Ocean tide height	meters
mdt	short	Mean dynamic topography	meters
mdt_velocity	short	Absolute geostrophic velocity on the across-track direction	meters/second
sla_filtered	short	Sea Level Anomaly relative to MSS	meters
sla_velocity	short	Anomaly of the geostrophic velocity on the across-track direction	meters/second

Table 6. Overview of data handling variables in Along-track 5Hz NetCDF file.

4.1.2.3 Attributes

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

4.1.2.4 Example of file

```
netcdf dt_hr_AtlanticN_s3a_sla_vfec_20170418_20171113 {
dimensions:
	time = 37365 ;
variables:
	double time(time) ;
```

```
		time:units = "days since 1950-01-01 00:00:00 UTC" ;
		time:long_name = "Time of measurement" ;
		time:standard_name = "time" ;
		time:axis = "T" ;
	int longitude(time) ;
		longitude:units = "degrees_east" ;
		longitude:long_name = "Longitude of measurement" ;
		longitude:standard_name = "longitude" ;
		longitude:scale_factor = 1.e-06 ;
		longitude:add_offset = 0. ;
	int latitude(time) ;
		latitude:units = "degrees_north" ;
		latitude:long_name = "Latitude of measurement" ;
		latitude:standard_name = "latitude" ;
		latitude:scale_factor = 1.e-06 ;
		latitude:add_offset = 0. ;
	short cycle(time) ;
		cycle:units = "1" ;
		cycle:long_name = "Cycle the measurement belongs to" ;
		cycle:coordinates = "longitude latitude" ;
	short track(time) ;
		track:units = "1" ;
		track:long_name = "Track in cycle the measurement belongs to" ;
		track:coordinates = "longitude latitude" ;
	short dac(time) ;
		dac:units = "m" ;
		dac:_FillValue = 32767s ;
		dac:coordinates = "longitude latitude" ;
		dac:long_name = "Dynamic Atmospheric Correction" ;
		dac:scale_factor = 0.001 ;
		dac:add_offset = 0. ;
		dac:comment = "The sla in this file is already corrected for the dac; the uncorrected sla can be computed as follows: [uncorrected sla]=[sla]+[dac]" ;
		dac:standard_name = "sea_surface_height_correction_due_to_air_pressure_and_wind_at_high_frequency" ;
	short iw(time) ;
		iw:units = "m" ;
		iw:_FillValue = 32767s ;
		iw:coordinates = "longitude latitude" ;
		iw:long_name = "Internal Wave surface signature component from Ray and Zaron 2016 - M2" ;
		iw:scale_factor = 0.001 ;
		iw:add_offset = 0. ;
		iw:comment = "The sla in this file is not corrected with the iw component; the corrected sla can be computed as follows: [corrected sla]=[sla]-[iw]" ;
	short ocean_tide(time) ;
		ocean_tide:units = "m" ;
		ocean_tide:_FillValue = 32767s ;
		ocean_tide:coordinates = "longitude latitude" ;
		ocean_tide:long_name = "Ocean tide model" ;
		ocean_tide:scale_factor = 0.001 ;
		ocean_tide:add_offset = 0. ;
		ocean_tide:comment = "The sla in this file is already corrected for the ocean_tide; the uncorrected sla can be computed as follows: [uncorrected sla]=[sla]+[ocean_tide]" ;
		ocean_tide:standard_name = "sea_surface_height_amplitude_due_to_geocentric_ocean_tide" ;
	short ib_lf(time) ;
		ib_lf:units = "m" ;
		ib_lf:_FillValue = 32767s ;
		ib_lf:coordinates = "longitude latitude" ;
		ib_lf:long_name = "Low Frequency component of the inverse barometer" ;
		ib_lf:scale_factor = 0.001 ;
		ib_lf:add_offset = 0. ;
		ib_lf:comment = "The dac in this file includes the ib_lf and the hight frequency sea surface height from MOG2D model: [dac]=[MOG2D_hf]+[ib_lf]" ;
```

```
            ib_lf:standard_name = "sea_surface_height_correction_due_to_air_pressure_at_low_frequency" ;
      short sla_velocity(time) ;
            sla_velocity:units = "m/s" ;
            sla_velocity:_FillValue = 32767s ;
            sla_velocity:coordinates = "longitude latitude" ;
            sla_velocity:long_name = "Anomaly of the geostrophic velocity on the across-track direction" ;
            sla_velocity:scale_factor = 0.001 ;
            sla_velocity:add_offset = 0. ;
      short mdt_velocity(time) ;
            mdt_velocity:units = "m/s" ;
            mdt_velocity:_FillValue = 32767s ;
            mdt_velocity:coordinates = "longitude latitude" ;
            mdt_velocity:long_name = "Absolute geostrophic velocity on the across-track direction" ;
            mdt_velocity:scale_factor = 0.001 ;
            mdt_velocity:add_offset = 0. ;
      short sla_filtered(time) ;
            sla_filtered:units = "m" ;
            sla_filtered:_FillValue = 32767s ;
            sla_filtered:coordinates = "longitude latitude" ;
            sla_filtered:long_name = "Sea Level Anomaly filtered" ;
            sla_filtered:scale_factor = 0.001 ;
            sla_filtered:add_offset = 0. ;
            sla_filtered:comment = "The sea level anomaly is the sea surface height above mean sea surface height; the
uncorrected sla can be computed as follows: [uncorrected sla]=[sla]+[dac]+[ocean_tide]-[lwe]" ;
            sla_filtered:standard_name = "sea_surface_height_above_sea_level" ;
      short mdt(time) ;
            mdt:units = "m" ;
            mdt:_FillValue = 32767s ;
            mdt:coordinates = "longitude latitude" ;
            mdt:long_name = "Mean Dynamic Topography" ;
            mdt:scale_factor = 0.001 ;
            mdt:add_offset = 0. ;
            mdt:comment = "The mean dynamic topography is the sea surface height above geoid; it is used to compute the
absolute dynamic topography adt=sla+mdt" ;
      short lwe(time) ;
            lwe:units = "m" ;
            lwe:_FillValue = 32767s ;
            lwe:coordinates = "longitude latitude" ;
            lwe:long_name = "Long Wavelength Error" ;
            lwe:scale_factor = 0.001 ;
            lwe:add_offset = 0. ;
            lwe:comment = "The sla in this file is already corrected for the lwe; the uncorrected sla can be computed as
follows: [uncorrected sla]=[sla]-[lwe]" ;

// global attributes:
            :cdm_data_type = "Swath" ;
            :title = "Ocean Along track Sea Surface Height and derived L3 product" ;
            :summary = "This dataset contains Near Real Time Level-3  sea surface height above ellipsoid and derived products
from Sentinel-3A observations over Global Ocean" ;
            :comment = "Sea surface height measured by altimeters referenced to the [1993, 2012] period; with additional
corrections; the proposed sla is already corrected for dac, ocean_tide and lwe; [uncorrected sla]=[sla]+[dac]+[ocean_tide]-
[lwe]" ;
            :time_coverage_resolution = "P1D" ;
            :product_version = "1.0.0" ;
            :institution = "CNES, CLS" ;
            :project = "SSALTO/DUACS" ;
            :references = "http://www.aviso.altimetry.fr" ;
            :contact = "aviso@altimetry.fr" ;
            :license = "http://www.aviso.altimetry.fr/fileadmin/documents/data/License_Aviso.pdf" ;
            :date_created = "13-Nov-2017 13:37:19 UTC" ;
            :history = "13-Nov-2017 13:37:19 UTC : creation" ;
            :Conventions = "CF-1.5" ;
```

```
        :standard_name_vocabulary = "http://cf-pcmdi.llnl.gov/documents/cf-standard-names/standard-name-
table/25/cf-standard-name-table.html" ;
        :geospatial_lat_min = 10.000704 ;
        :geospatial_lat_max = 81.249451 ;
        :geospatial_lon_min = 0.000673 ;
        :geospatial_lon_max = 359.997774 ;
        :geospatial_vertical_min = "0" ;
        :geospatial_vertical_max = "0" ;
        :geospatial_lat_units = "degrees_north" ;
        :geospatial_lon_units = "degrees_east" ;
        :first_meas_time = 24579.0011919781 ;
        :last_meas_time = 24579.9864538634 ;
```

4.2 Gridded Sea Level Anomalies computed with Dynamic Interpolation

4.2.1 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>

4.2.2 Format

4.2.2.1 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

4.2.2.2 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 6. Overview of data handling variables in gridded DI NetCDF file.

4.2.2.3 Attributes

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

4.2.2.4 Example of file

```
netcdf dt_gulfstream_allsat_phy_l4_20150723_20170626 {
dimensions:
    time = 1 ;
    latitude = 95 ;
    longitude = 199 ;
    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 = 43.875 ;
        latitude:valid_min = 32.125 ;
    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 = 309.875 ;
        longitude:valid_min = 285.125 ;
    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: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 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: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 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 ugosa(time, latitude, longitude) ;
		ugosa:_FillValue = -2147483647 ;
		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: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 = "DYMOST" ;
		:creator_url = "http://www.aviso.altimetry.fr" ;
		:date_created = "2017-10-12T14:56:58Z" ;
		:date_issued = "2017-10-12T14:56:58Z" ;
		:date_modified = "2017-10-12T14:56:58Z" ;
		:geospatial_lat_max = 43.875 ;
		:geospatial_lat_min = 32.125 ;
		:geospatial_lat_resolution = 0.125 ;
```

:geospatial_lat_units = "degrees_north" ;
:geospatial_lon_max = 309.875 ;
:geospatial_lon_min = 285.125 ;
:geospatial_lon_resolution = 0.125 ;
: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 = "2017-10-12 14:56:58Z: Created by DUACS DT - 2016-07-18T12:03:09Z: Change of some attributes" ;
:institution = "CLS, CNES" ;
:keywords = "Oceans > Ocean Topography > Sea Surface Height" ;
:keywords_vocabulary = "NetCDF COARDS Climate and Forecast Standard Names" ;
:platform = "Altika, Cryosat-2, Haiyang-2A, OSTM/Jason-2," ;
:processing_level = "L4" ;
:product_version = "1.0" ;
:project = "DYMOST" ;
: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 Mediterranean Sea." ;
:time_coverage_duration = "P1D" ;
:time_coverage_end = "2015-07-23T00:00:00Z" ;
:time_coverage_resolution = "P1D" ;
:time_coverage_start = "2015-07-23T00:00:00Z" ;
:title = "DT merged all satellites Gulfstream Area Gridded CLS Sea Surface Height L4 product and derived variables" ;

4.3 Gridded products combining altimetry and drifters

4.3.1 Nomenclature

This is the generic model of filename :

dt_gulf_mexico_allsat_drifters_phy_<begin_date>_ <prod_date>.nc

The products name components are:

- The type of data timeliness dt=delayed-time
- <zone>=Gulf of Mexico
- Allsat_drifters means that all the available missions are taken into account and drifters are added
- The begin and production dates of the data: <begin_date>_<prod_date>

4.3.2 Format

4.3.2.1 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

4.3.2.2 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 estimate	degrees_north
longitude	float	Longitude value of estimate	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
err_sla	int	Formal error on sla	meters
ugosa	int	Geostrophic velocity anomalies: zonal component	meters/second
err_ugosa	int	Formal error on ugosa	meters/second
vgosa	int	Geostrophic velocity anomalies: meridian component	meters/second
err_vgosa	int	Formal error on vgosa	meters/second

Table 7. Overview of data handling variables in gridded Alti+drifter NetCDF file.

4.3.2.3 Attributes

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

4.3.2.4 Example of file

```
netcdf dt_gulf_mexico_allsat_drifters_phy_20160429_20171014 {
dimensions:
    time = 1 ;
    latitude = 56 ;
    longitude = 92 ;
    nv = 2 ;
variables:
    float time(time) ;
        time:long_name = "Time" ;
        time:standard_name = "time" ;
        time:units = "days since 1950-01-01 00:00:00 UTC" ;
        time:calendar = "gregorian" ;
        time:axis = "T" ;
    float latitude(latitude) ;
        latitude:long_name = "Latitude" ;
```

```
		latitude:standard_name = "latitude" ;
		latitude:units = "degrees_north" ;
		latitude:bounds = "lat_bnds" ;
		latitude:axis = "Y" ;
		latitude:valid_min = 17.125 ;
		latitude:valid_max = 30.875 ;
	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:long_name = "Longitude" ;
		longitude:standard_name = "longitude" ;
		longitude:units = "degrees_east" ;
		longitude:bounds = "lon_bnds" ;
		longitude:axis = "X" ;
		longitude:valid_min = 260.125 ;
		longitude:valid_max = 282.875 ;
	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:units = "1" ;
	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:semi_major_axis = 6378136.3 ;
		crs:inverse_flattening = 298.257 ;
	int sla(time, latitude, longitude) ;
		sla:_FillValue = -2147483647 ;
		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:long_name = "Sea level anomaly" ;
		sla:standard_name = "sea_surface_height_above_sea_level" ;
		sla:units = "m" ;
		sla:scale_factor = 0.0001 ;
		sla:grid_mapping = "crs" ;
	int ugosa(time, latitude, longitude) ;
		ugosa:_FillValue = -2147483647 ;
		ugosa:comment = "The geostrophic velocity anomalies are referenced to the [1993, 2012] period" ;
		ugosa:coordinates = "longitude latitude" ;
		ugosa:long_name = "Geostrophic velocity anomalies: zonal component" ;
		ugosa:standard_name = "surface_geostrophic_eastward_sea_water_velocity_assuming_sea_level_for_geoid" ;
		ugosa:units = "m/s" ;
		ugosa:scale_factor = 0.0001 ;
		ugosa:grid_mapping = "crs" ;
	int vgosa(time, latitude, longitude) ;
		vgosa:_FillValue = -2147483647 ;
		vgosa:comment = "The geostrophic velocity anomalies are referenced to the [1993, 2012] period" ;
		vgosa:coordinates = "longitude latitude" ;
		vgosa:long_name = "Geostrophic velocity anomalies: meridian component" ;
		vgosa:standard_name = "surface_geostrophic_northward_sea_water_velocity_assuming_sea_level_for_geoid" ;
		vgosa:units = "m/s" ;
		vgosa:scale_factor = 0.0001 ;
		vgosa:grid_mapping = "crs" ;
	int err_sla(time, latitude, longitude) ;
		err_sla:_FillValue = -2147483647 ;
		err_sla:long_name = "Formal error on Sea level anomaly" ;
		err_sla:units = "m" ;
		err_sla:scale_factor = 0.0001 ;
```

```
        err_sla:grid_mapping = "crs" ;
    int err_ugosa(time, latitude, longitude) ;
        err_ugosa:_FillValue = -2147483647 ;
        err_ugosa:long_name = "Formal error on zonal geostrophic velocity anomaly" ;
        err_ugosa:units = "m/s" ;
        err_ugosa:scale_factor = 0.0001 ;
        err_ugosa:grid_mapping = "crs" ;
    int err_vgosa(time, latitude, longitude) ;
        err_vgosa:_FillValue = -2147483647 ;
        err_vgosa:long_name = "Formal error on meridional geostrophic velocity anomaly" ;
        err_vgosa:units = "m" ;
        err_vgosa:scale_factor = 0.0001 ;
        err_vgosa:grid_mapping = "crs" ;

// global attributes:
        :cdm_data_type = "Grid" ;
        :Conventions = "CF-1.6" ;
        :Metadata_Conventions = "Unidata Dataset Discovery v1.0" ;
        :comment = "Sea level anomaly and associated geostrophic current anomaly referenced to the [1993, 2012]
period and estimated from altimetry and drifters from HMI-CLS goup" ;
        :contact = "aviso@altimetry.fr" ;
        :creator_email = "aviso@altimetry.fr" ;
        :creator_url = "http://www.aviso.altimetry.fr" ;
        :date_created = "2017-10-14T10:52:01Z" ;
        :date_issued = "2017-10-12T10:52:01Z" ;
        :date_modified = "2017-10-12T10:52:01Z" ;
        :geospatial_lat_min = 17.125 ;
        :geospatial_lat_max = 30.875 ;
        :geospatial_lon_min = 260.125 ;
        :geospatial_lon_max = 282.875 ;
        :geospatial_vertical_min = "0.0" ;
        :geospatial_vertical_max = "0.0" ;
        :geospatial_lat_units = "degrees_north" ;
        :geospatial_lon_units = "degrees_east" ;
        :geospatial_lat_resolution = 0.25 ;
        :geospatial_lon_resolution = 0.25 ;
        :institution = "CLS, CNES" ;
        :keywords = "Oceans > Ocean Topography > Sea Surface Height" ;
        :keywords_vocabulary = "NetCDF COARDS Climate and Forecast Standard Names" ;
        :platform = "Altika, Cryosat-2, Haiyang-2A, OSTM/Jason-2, HMI drifters" ;
        :processing_level = "L4" ;
        :product_version = "1.0" ;
        :project = "SSALTO/DUACS Experimental" ;
        :references = "http://www.aviso.altimetry.fr" ;
        :source = "Altimetry measurements and geostrophic velocity estimated from drifters from HMI-CLS Group" ;
        :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." ;
        :summary = "Delayed-Time Level-4 sea surface height and derived variables measured by multi-satellite altimetry
observations and geostrophic velocity estimated from drifters from HMI-CLS Group over Gulf of Mexico." ;
        :title = "DT merged all satellites and HMI drifters Gulf of Mexico Area Gridded CLS Sea Surface Height L4 product
and derived variables" ;
        :standard_name_vocabulary = "NetCDF Climate and Forecast (CF) Metadata Convention Standard Name Table
v37" ;
```

4.4 Gridded products obtained combining altimetry and Sea Surface Temperature

4.4.1 Nomenclature

This is the generic model of filename:

dt_global_allsat_merged_ssh_sst_phy_<begin_date>_ <prod_date>.nc

The products name components are:

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

4.4.2 Format

4.4.2.1 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

4.4.2.2 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 estimate	degrees_north
longitude	float	Longitude value of estimate	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
eastward_eulerian_current_velocity	int	eulerian current velocity : zonal component	meters/second
northward_eulerian_current_velocity	int	eulerian current velocity : meridian component	meters/second

Table 6. Overview of data handling variables in gridded Alti+SST NetCDF file.

4.4.2.3 Attributes

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

4.4.2.4 Example of file

```
netcdf dt_global_allsat_merged_ssh_sst_phy_20151219_20180328 {
dimensions:
	time = 1 ;
	latitude = 720 ;
	longitude = 1440 ;
	nv = 2 ;
variables:
	float time(time) ;
		time:long_name = "Time" ;
		time:standard_name = "time" ;
		time:units = "days since 1950-01-01 00:00:00 UTC" ;
		time:calendar = "gregorian" ;
		time:axis = "T" ;1
	float latitude(latitude) ;
		latitude:long_name = "Latitude" ;
		latitude:standard_name = "latitude" ;
		latitude:units = "degrees_north" ;
		latitude:bounds = "lat_bnds" ;
		latitude:axis = "Y" ;
		latitude:valid_min = -89.875 ;
```

```
        latitude:valid_max = 89.875 ;
    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:long_name = "Longitude" ;
        longitude:standard_name = "longitude" ;
        longitude:units = "degrees_east" ;
        longitude:bounds = "lon_bnds" ;
        longitude:axis = "X" ;
        longitude:valid_min = 0.125 ;
        longitude:valid_max = 359.875 ;
    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:units = "1" ;
    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:semi_major_axis = 6378136.3 ;
        crs:inverse_flattening = 298.257 ;
    int eastward_eulerian_current_velocity(time, latitude, longitude) ;
        eastward_eulerian_current_velocity:_FillValue = -2147483647 ;
        eastward_eulerian_current_velocity:limitations = "merged currents are less accurate at high latitudes, where
REMSS SST product error is larger. See the static Optimally_merged_SSH_SST_velocity_flag.nc file for more information" ;
        eastward_eulerian_current_velocity:coordinates = "longitude latitude" ;
        eastward_eulerian_current_velocity:long_name = "eulerian current velocity : zonal component" ;
        eastward_eulerian_current_velocity:standard_name = "eastward_sea_water_velocity" ;
        eastward_eulerian_current_velocity:units = "m/s" ;
        eastward_eulerian_current_velocity:scale_factor = 0.0001 ;
        eastward_eulerian_current_velocity:grid_mapping = "crs" ;
    int northward_eulerian_current_velocity(time, latitude, longitude) ;
        northward_eulerian_current_velocity:_FillValue = -2147483647 ;
        northward_eulerian_current_velocity:limitations = "merged currents are less accurate at high latitudes, where
REMSS SST product error is larger. See the static Optimally_merged_SSH_SST_velocity_flag.nc file for more information" ;
        northward_eulerian_current_velocity:coordinates = "longitude latitude" ;
        northward_eulerian_current_velocity:long_name = "eulerian current velocity : meridian component" ;
        northward_eulerian_current_velocity:standard_name = "northward_sea_water_velocity" ;
        northward_eulerian_current_velocity:units = "m/s" ;
        northward_eulerian_current_velocity:scale_factor = 0.0001 ;
        northward_eulerian_current_velocity:grid_mapping = "crs" ;

// global attributes:
        :cdm_data_type = "Grid" ;
        :Conventions = "CF-1.6" ;
        :Metadata_Conventions = "Unidata Dataset Discovery v1.0" ;
        :comment = "Velocities at 10m estimated from the optimal merging of the ssalto-duacs dt allsat altimeter derived
geostrophic velocities and REMSS microwave Sea Surface Temperature" ;
        :contact = "aviso@altimetry.fr" ;
        :creator_email = "aviso@altimetry.fr" ;
        :creator_url = "http://www.aviso.altimetry.fr" ;
        :date_created = "2018-03-28T10:52:01Z" ;
        :date_issued = "2018-03-28T10:52:01Z" ;
        :date_modified = "2018-03-28T10:52:01Z" ;
        :geospatial_lat_min = -89.875 ;
        :geospatial_lat_max = 89.875 ;
        :geospatial_lon_min = 0.125 ;
        :geospatial_lon_max = 359.875 ;
        :geospatial_vertical_min = "0.0" ;
```

:geospatial_vertical_max = "0.0" ;
:geospatial_lat_units = "degrees_north" ;
:geospatial_lon_units = "degrees_east" ;
:geospatial_lat_resolution = 0.25 ;
:geospatial_lon_resolution = 0.25 ;
:institution = "CLS, CNES, CNR, ESA" ;
:keywords = "Oceans > Ocean circulation > Ocean currents " ;
:keywords_vocabulary = "NetCDF COARDS Climate and Forecast Standard Names" ;
:platform = "Altika, Cryosat-2, Haiyang-2A, OSTM/Jason-2, TMI, AMSR-E, AMSR2, WindSat, GMI" ;
:processing_level = "L4" ;
:product_version = "1.0" ;
:project = "SSALTO/DUACS Experimental" ;
:references = "http://www.aviso.altimetry.fr" ;
:source = "10m depth velocity estimated from the combination of allsat altimeter gridded geostrophic velocities and REMSS microwave Sea Surface Temperature data" ;
: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." ;
:summary = "Delayed-Time Level-4 global horizontal velocities at 10m depth calculated from the optimal merging of ssalto-duacs allsat altimeter velocity products and REMSS MW SST products following a method described in Rio et al (2016)." ;
:title = "DT optimally merged SSH/SST velocities for the global ocean" ;
:standard_name_vocabulary = "NetCDF Climate and Forecast (CF) Metadata Convention Standard Name Table v37" ;

4.5 Gridded confidence flag product

Only one file is delivered:

Optimally_merged_SSH_SST_velocity_flag.nc

4.5.1 Format

4.5.1.1 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

4.5.1.2 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 estimate	degrees_north
longitude	float	Longitude value of estimate	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
eastward_eulerian_current_velocity	int	eulerian current velocity confidence flag: zonal component	-
northward_eulerian_current_velocity	int	eulerian current velocity confidence flag: meridian component	-

Table 6. Overview of data handling variables in gridded Alti+SST NetCDF file.

4.5.1.3 Attributes

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

4.5.2 Dump of file

```
netcdf Optimally_merged_SSH_SST_velocity_flag {
dimensions:
	time = 1 ;
	latitude = 720 ;
	longitude = 1440 ;
	nv = 2 ;
variables:
	float latitude(latitude) ;
		latitude:long_name = "Latitude" ;
		latitude:standard_name = "latitude" ;
		latitude:units = "degrees_north" ;
		latitude:bounds = "lat_bnds" ;
		latitude:axis = "Y" ;
		latitude:valid_min = -89.875 ;
		latitude:valid_max = 89.875 ;
	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:long_name = "Longitude" ;
		longitude:standard_name = "longitude" ;
		longitude:units = "degrees_east" ;
		longitude:bounds = "lon_bnds" ;
		longitude:axis = "X" ;
		longitude:valid_min = 0.125 ;
		longitude:valid_max = 359.875 ;
	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:units = "1" ;
	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:semi_major_axis = 6378136.3 ;
		crs:inverse_flattening = 298.257 ;
	int eastward_eulerian_current_velocity_flag(time, latitude, longitude) ;
		eastward_eulerian_current_velocity_flag:_FillValue = -2147483647 ;
		eastward_eulerian_current_velocity_flag:coordinates = "longitude latitude" ;
		eastward_eulerian_current_velocity_flag:long_name = "eulerian current velocity confidence flag : zonal
component" ;
		eastward_eulerian_current_velocity_flag:standard_name = "eastward_sea_water_velocity confidence flag" ;
		eastward_eulerian_current_velocity_flag:units = "-" ;
		eastward_eulerian_current_velocity_flag:scale_factor = 0.01 ;
		eastward_eulerian_current_velocity_flag:grid_mapping = "crs" ;
	int northward_eulerian_current_velocity_flag(time, latitude, longitude) ;
		northward_eulerian_current_velocity_flag:_FillValue = -2147483647 ;
		northward_eulerian_current_velocity_flag:coordinates = "longitude latitude" ;
		northward_eulerian_current_velocity_flag:long_name = "eulerian current velocity confidence flag: meridian
component" ;
		northward_eulerian_current_velocity_flag:standard_name = "northward_sea_water_velocity confidence flag" ;
		northward_eulerian_current_velocity_flag:units = "-" ;
		northward_eulerian_current_velocity_flag:scale_factor = 0.01 ;
		northward_eulerian_current_velocity_flag:grid_mapping = "crs" ;
```

```
// global attributes:
		:cdm_data_type = "Grid" ;
		:Conventions = "CF-1.6" ;
		:Metadata_Conventions = "Unidata Dataset Discovery v1.0" ;
		:comment = "Confidence flag for the Velocities at 10m estimated from the optimal merging of the ssalto-duacs dt allsat altimeter derived geostrophic velocities and REMSS microwave Sea Surface Temperature. Negative values indicate a poor confidence level, positive values indicate a good confidence level." ;
		:contact = "aviso@altimetry.fr" ;
		:creator_email = "aviso@altimetry.fr" ;
		:creator_url = "http://www.aviso.altimetry.fr" ;
		:date_created = "2018-03-28T10:52:01Z" ;
		:date_issued = "2018-03-28T10:52:01Z" ;
		:date_modified = "2018-03-28T10:52:01Z" ;
		:geospatial_lat_min = -89.875 ;
		:geospatial_lat_max = 89.875 ;
		:geospatial_lon_min = 0.125 ;
		:geospatial_lon_max = 359.875 ;
		:geospatial_vertical_min = "0.0" ;
		:geospatial_vertical_max = "0.0" ;
		:geospatial_lat_units = "degrees_north" ;
		:geospatial_lon_units = "degrees_east" ;
		:geospatial_lat_resolution = 0.25 ;
		:geospatial_lon_resolution = 0.25 ;
		:institution = "CLS, CNES, CNR, ESA" ;
		:keywords = "Oceans > Ocean circulation > Ocean currents " ;
		:keywords_vocabulary = "NetCDF COARDS Climate and Forecast Standard Names" ;
		:platform = "Altika, Cryosat-2, Haiyang-2A, OSTM/Jason-2, TMI, AMSR-E, AMSR2, WindSat, GMI" ;
		:processing_level = "L4" ;
		:product_version = "1.0" ;
		:project = "SSALTO/DUACS Experimental" ;
		:references = "http://www.aviso.altimetry.fr" ;
		:source = "confidence flag on the 10m depth velocities estimated from the combination of allsat altimeter gridded geostrophic velocities and REMSS microwave Sea Surface Temperature data" ;
		:summary = "This confidence flag is issued from the comparison between the optimally merged SSH/SST velocities and in-situ drifting buoy velocities (Rio and Santoleri, submitted)." ;
		:title = "Confidence flags for the DT optimally merged SSH/SST velocities for the global ocean" ;
		:standard_name_vocabulary = "NetCDF Climate and Forecast (CF) Metadata Convention Standard Name Table v37" ;
}
```

5 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" in the list of products

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

6 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.

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