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Copernicus Climate Change Service

# Product User Guide and Specification

## Sea Level v1.2


Issued by: CLS / F. Mertz and J.-F. Legeais



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# Contributors

**CLS**
F. Mertz
J.-F. Legeais

## History of modifications

| Version | Date | Description of modification | Chapters / Sections |
|---|---|---|---|
| 1.0 | 30/03/2017 | creation | |
| 1.1 | 15/05/2017 | Review from ECMWF | |
| 1.2 | 04/07/2017 | Addition of S3A mission | |

## Related documents

| Reference ID | Document |
|---|---|
| C3S_ATBD | C3S_312a_Lot2 Algorithm Theoretical Basis Document, D312a_Lot2.2.1.2-v1_ATBD_201703_v1 |
| C3S_TRD | C3S_312a_Lot2 Target Requirement Document, D312a_Lot2.1.1.1-2017_v2 |
| C3S_SQAD | C3S_312a_Lot2 System Quality Assurance Document, D312a_Lot2.2.2.2-v1_201703_v1 |
| C3S_PQAD | C3S_312a_Lot2 Product Quality Assurance Document, D312a_Lot2.3.3.2-v1 |
| C3S_PQAR | C3S_312a_Lot2 Product Quality Assessment Report, D312a_Lot2.3.3.3-v1 |

## Acronyms

| Acronym | Definition |
|---|---|
| AL | AltiKa |
| ADT | Absolute Dynamic Topography |
| C2 | Cryosat-2 |
| CCI | ESA Climate Change Initiative Project |
| CDR | Climate Data Record |
| DAC | Dynamic Atmospheric Correction |
| DUACS | Data Unification and Altimeter Combination System |
| E1 | ERS-1 |
| E2 | ERS-2 |
| ECMWF | European Centre for Medium-range Weather Forecasting |
| EN | ENVISAT |
| ESA | European Space Agency |
| GCOS | Global Climate Observing System |
| GIM | Global Ionosphere Maps |
| GDR | Geophysical Data Record |
| ICDR | Intermediate Climate Data Record |
| IGDR | Interim Geophysical Data Record(s) |
| J1 | Jason-1 |
| J2 | OSTM/Jason-2 |
| J3 | Jason-3 |
| L2P | Level-2 Plus |
| LWE | Long Wavelength Errors |
| MDT | Mean Dynamic Topography |

| | |
|---|---|
| MSL | Mean Sea Level |
| MSS | Mean Sea Surface |
| NTC | Non Time Critical |
| SLA | Sea Level Anomaly |
| SSH | Sea Surface Height |
| T/P | Topex/Poseidon |

# General definitions

# Table of Contents

# Scope of the document

This document is the Product User Guide and Specification (PUGS) of the Sea level products disseminated in the Copernicus Climate Change Service (C3S) in the frame of the 2016/C3S_312a_Lot2_CLS/SC1 contract. It provides the end user with practical information regarding the use of these products.

# Executive summary

The Product User Guide and Specification explains the basic altimetry principles that allow the computation of the altimeter sea level products and provides a brief description of the associated production system. The details of the input data are provided, including their origin. The technical characteristics of each altimeter mission used in the production system are described as well as the level 2 altimeter algorithms (geophysical standards and orbit solutions). The characteristics of the satellite constellation are described and the principle of the sea level mapping procedure is provided. At last, the product characteristics are described (format, nomenclature and data handling variables) and a description of the file content is provided in Annex.

# 1. Sea Level product

This section provides the specifications of the Sea Level products.

## 1.1 Product description

The Sea Level product is a time series of gridded Sea Surface Height and derived variables obtained by merging two satellite altimetry measurements. It is generated by the DUACS processing system including data from several altimetry missions. Three areas are delivered: the global Ocean, the Mediterranean Sea and the Black Sea.

The C3S products mainly focuses on the retrieval of a realistic long term variability of the ocean which is only obtained using a stable altimeter constellation and homogeneous corrections and standards in time. One way to answer to the later constraints is to use **a two satellite constellation** during all the altimeter period (see 1.1.2.2).

### 1.1.1 Usual variables in Altimetry

The Altimetry gives access to the Sea Surface Height (SSH) above the reference ellipsoid (see Figure 1)

$$SSH = Orbit - Altimetric\ Range$$

The Mean Sea Surface ($MSS_N$) is the temporal mean of the SSH over a period N. It is a mean surface above the reference ellipsoid and it includes the Geoid.

$$MSS_N = \langle SSH \rangle_N$$

The Sea Level Anomaly ($SLA_N$) is the anomaly of the signal around the mean component. It is deduced from the SSH and $MSS_N$ :

$$SLA_N = SSH - MSS_N$$

The Mean Dynamic Topography ($MDT_N$) is the temporal mean of the SSH above the Geoid over a period N.

$$MDT_N = MSS_N - Geoid$$

The Absolute Dynamic Topography (ADT) is the instantaneous height above the Geoid. The geoid is a gravity equipotential surface that would correspond to the ocean surface if ocean was at rest (i.e. without any currents and only under the gravity field). Then, when the ocean is also influenced by wind, differential heating and precipitation and other sources of energy, the ocean surface moves from the geoid. Thus, the departure from the geoid provides information on the ocean dynamics.
The ADT is the sum of the $SLA_N$ and $MDT_N$:

$$ADT = SLA_N + MDT_N = SSH - MSS_N + MDT_N$$

The reference period N considered can be changed as described in Pujol et al (2016).

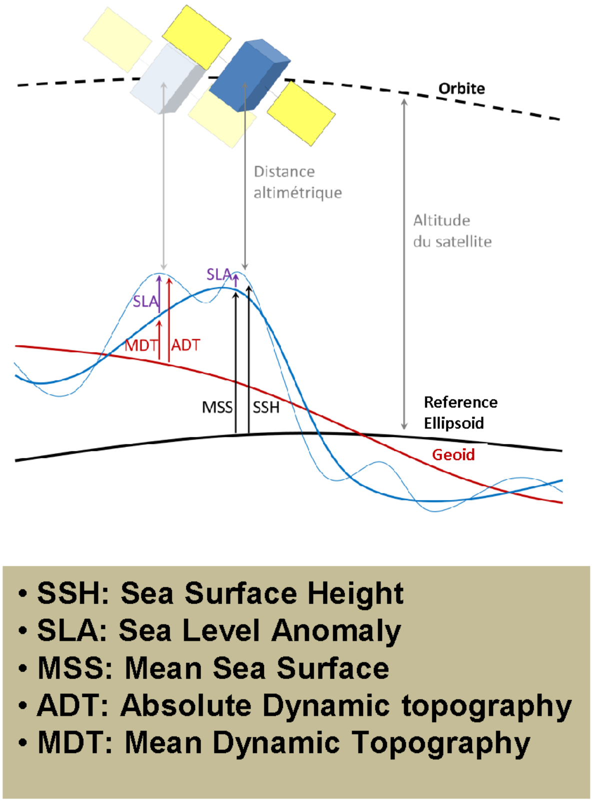


Figure 1: Different notions of sea surface height used in altimetry

The geostrophic current products disseminated to users are issued from the SLAs and the ADTs. They are computed using a nine-point stencil width methodology (Arbic et al., 2012) for latitudes outside the 5°S/5°N band. In the equatorial band, the Lagerloef methodology (Lagerloef et al., 1999) is used.

The variables disseminated to users are the Sea Level Anomalies (sla), Absolute Dynamic Topography (adt, except for Black Sea), formal mapping error (err), the geostrophic velocities anomalies (ugosa and vgosa) and the absolute geostrophic velocities (ugos and vgos, except for Black Sea).

### 1.1.2 Processing

The Delayed Time DUACS component maintains a consistent and user-friendly altimeter database using the state-of-the-art recommendations from the altimetry community.

The processing sequences can be divided into the following main steps (fully described in [C3S_ATBD]):

- Acquisition
- Pre-processing homogenization

- Input data quality control
- Multi-mission cross-calibration
- Along-track products generation
- Gridded merged products generation
- Final quality control

### 1.1.2.1 Input data and corrections

The altimeter measurements used to compute the C3S Sea Level products consist in Level2 products from different missions called Delayed Time Geophysical Data Records (GDR) or Non Time Critical (NTC) products. Details of the different L2 altimeter products sources and delay of availability are given in Table 1.

Table 1: Source and delay of availability of the different altimeter data used in input of DUACS system

| Altimeter mission | Type of product | Source | Availability delay |
|---|---|---|---|
| Sentinel-3A | NTC | ESA/EUMETSAT | ~1 month |
| Jason-3 | GDR | CNES/EUMETSAT | ~3 months |
| OSTM/Jason-2 | GDR | CNES | Reprocessing only |
| Cryosat-2 | GDR | ESA | Best effort |
| SARAL/AltiKa | GDR | CNES | ~2 months |
| Topex/POSEIDON | GDR | CNES | Reprocessing only |
| Jason-1 | GDR | CNES | Reprocessing only |
| Envisat | GDR | ESA | Reprocessing only |
| ERS-1 | GDR | ESA | Reprocessing only |
| ERS-2 | GDR | ESA | Reprocessing only |

The auxiliary products (altimeter standards, geophysical corrections) used in the production are described in the table 2. More details regarding the description of these standards can be found in Pujol et al, 2016. Note that some other versions of standards are available for some algorithms. The most up-to-date standards (whose timeliness is compatible with the C3S production planning) will be included in the next C3S delivery of the sea level products.

Table 2: Altimeter standards used in the C3S Sea Level v0 products.

| | Jason-3 | OSTM/ Jason-2 | Jason-1 | Topex/ POSEIDON | ERS-1 | ERS-2 | ENVISAT | Cryosat-2 | SARAL/ AltiKa | Sentinel-3A |
|---|---|---|---|---|---|---|---|---|---|---|
| **Product standard ref** | GDR-D | GDR-D | GDR-D | GDR-C | OPR | | GDRV2.1+ | CPP CNES | GDR-T patch2 | |
| **Orbit** | Cnes POE (GDR-E) | Cnes POE (GDR_D for cycles ≤253 and | Cnes POE (GDR_D) | GSFC (ITRF2005, Grace last standards) | Reaper [Rudenko et al., 2012] | | Cnes POE (GDR-D) | Cnes POE (GDR-D for cycle ≤66 and | Cnes POE (GDR-D for cycle ≤23 and | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | GDR-E afterward) | | | | | | GDR-E afterwards) | GDR-E afterward) | See L2P product handbook [Aviso+, 2017] |
| **Ionosphere** | dual-frequency altimeter range measurements | | | dual-frequency altimeter range measurements (Topex), Doris (Poseidon) | Reaper (NIC09 model, Scharroo and Smith, 2010) | Bent model (cycle ≤ 36), GIM model (cycle > 36) [Iijima et al., 1999] | dual-frequency altimeter range measurement (cycle 6-64) and GIM model >cycle 65 [Iijima et al., 1999] corrected from 8 mm bias | GIM model [Iijima et al., 1999] | | |
| **Dry troposphere** | Model computed from ECMWF Gaussian grids (new S1 and S2 atmospheric tides are applied) | | Model computed from ECMWF rectangular grids (new S1 and S2 atmospheric tides are included) | Model computed from ERA Interim Gaussian grids (new S1 and S2 atmospheric tides are applied) | | | Model computed from ECMWF Gaussian grids (new S1 and S2 atmospheric tides included) | Model computed from ECMWF Gaussian grids (new S1 and S2 atmospheric tides included) | Model computed from ECMWF Gaussian grids (new S1 and S2 atmospheric tides included) | |
| **Wet troposphere** | J3 radiometer | JMR radio meter | AMR radiometer (enhancement product) | TMR radiometer [Scharoo et al. 2004] | MWR radio meter | MWR corrected for 23.6Ghz TB drift [Scharoo et al. 2004] before Neutral Network algorithm | MWR ≥50km from the coast + ECMWF between 10-50 km from the coast (cycle ≤94); MRW (cycle >94) | ECMWF model | WMR radiometer | |
| **DAC** | MOG2D High Resolution forced with ECMWF pressure and wing fields (S1 and S2 were excluded) + inverse barometer computed from rectangular grids . | | | MOG2D High Resolution forced with ERA Interim pressure and wing fields (S1 and S2 were excluded) + inverse barometer computed from rectangular grids . | | | MOG2D High Resolution forced with ECMWF pressure and wing fields (S1 and S2 were excluded) + inverse barometer computed from rectangular grids . | | | |
| **Ocean tide** | GOT4v8 (S1 and S2 are included) | | | | | | | | | |
| **Pole tide** | [Wahr, 1985] | | | | | | | | | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Solid earth tide** | Elastic response to tidal potential [Cartwright and Tayler, 1971], [Cartwright and Edden, 1973] | | | | | | | | |
| **Loading tide** | GOT4v8 (S1 parameter is included) | | | | | | | | |
| **Sea state bias** | Non parametric SSB [Tran, 2012] (using J2 cycles 1 to 36 with GDR-D standards) | Non parametric SSB [Tran, 2012] (using J1 cycles 1 to 111 with GDR-C standards and GDR-D orbit) | Non parametric SSB [N. Tran and al. 2010] (using cycles 21 to 131 with GSFC orbit for TP-A; cycles 240 to 350 with GSFC orbit for TP-B) | BM3 | Non parametric SSB (using cycles 70 to 80 with DELFT orbit and equivalent of GDR-B standards) | Non parametric SSB [Tran, 2012] compatible with enhanced MWR | Non parametric SSB from J1, with unbiased sigma0 | Hybrid SSB from R. Scharroo et al (2005) | |
| **Mean Sea Surface** | CNES_CLS_2011 referenced to the 1993-2012 period | | | | | | | | |

### 1.1.2.2 Altimetry constellation

The complete altimetry satellite constellation used in the C3S Sea Level products is illustrated in Figure 2.

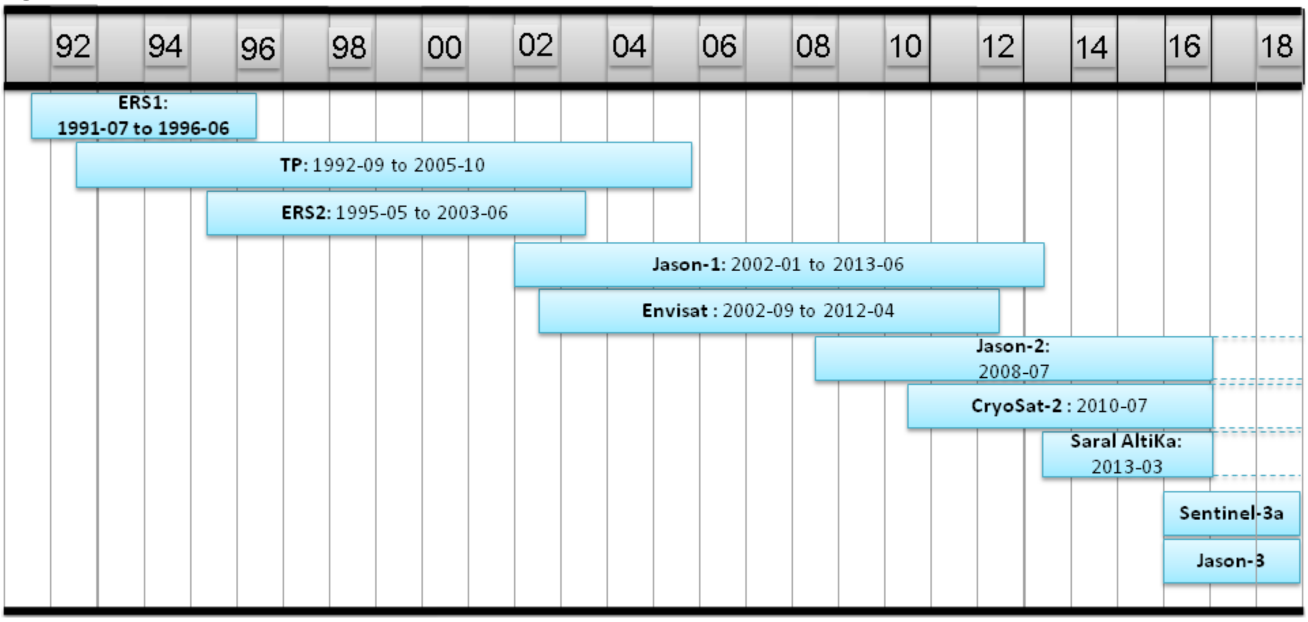


Figure 2: overview of the altimetric missions (note that Sentinel-3A is not yet integrated in the products, will be done in a future extension of the time series)

The C3S sea level altimeter product is based on a satellite constellation with a stable number of altimeters in order to ensure the long-term stability of the ocean observation system. The two altimeter satellites included in the products are the reference missions and the complementary missions as illustrated in Figure 3.

- the first ones are the TOPEX/Poséidon, Jason-1 and Jason-2 missions which are successively introduced in the system of production. These missions are essential for the computation of the long-term trend of the MSL. As soon as delayed–time data are available, Jason-3 will be the next reference mission used in the system and it should be followed by Sentinel-6 (also called Jason - Continuity of Service) around 2020.
- the complementary missions provide additional information for the estimation of mesoscale signals variability (>200-300 km) and also increase the observing capacity at high latitude which is of a great interest for climate. The missions that are successively included in the C3S products are ERS-1, ERS-2, Envisat and SARAL/Altika. Sentinel-3A will be the next mission included in the system of production so that the C3S product will be based in the future on the Jason-3 and Sentinel-3A altimeter data. Note that ERS-1 mission was used in an ice phase (phase D, 23/12/1993 – 10/04/1994) and no ERS-1 altimeter measurements are used as input of the sea level production system during this period. As no other altimeter data are available, this means that the C3S product is based on TOPEX/Poséidon data only during this 3.5-month period. During the following two successive geodetic phases (phase E, 10/04/1994 – 28/09/1994 and phase F, 28/09/1994 – 21/03/1995), the ERS-1 mission has been taken into account.
- In addition, after the loss of the Envisat mission in April 2012, only the opportunity CryoSat-2 mission has been available. Thus, this opportunity mission was included in the C3S product until SARAL/AltiKa delayed-time measurements become available in March 2013. Finally in December 2016, the Sentinel-3A dataset has been taken into account to compute C3S products.

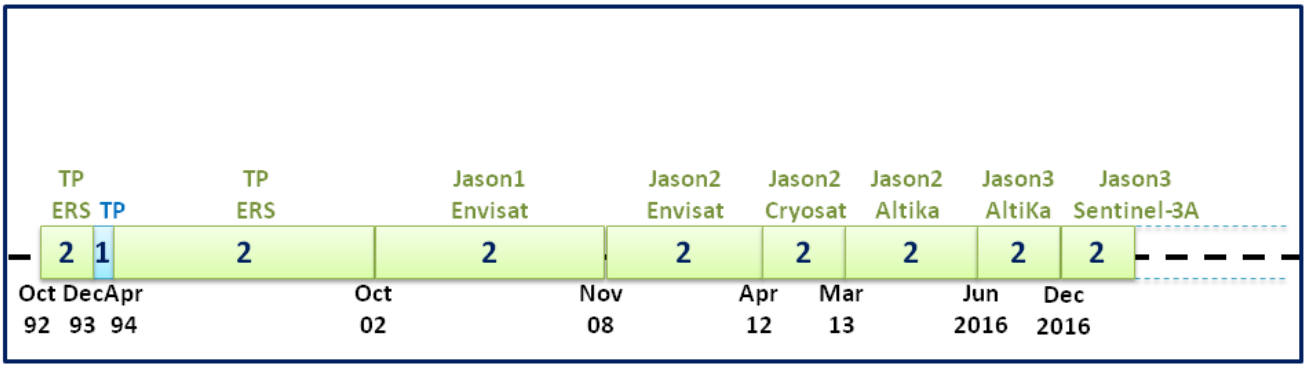


Figure 3: Satellite constellation in the C3S time series (note that Sentinel-3A is not yet integrated in the products, will be done in a future extension of the time series)

Note that the information about the satellites used to compute each map is given in the global attribute “platform” of each file.
The use of such a constant number in the satellite constellation contributes to ensure the long-term Mean Sea Level (MSL) stability which is not the case when using all satellites available through the altimeter period.

#### 1.1.2.3 Gridded merged product generation

The gridded merged products are based on the along-track altimeter measurements which benefit from several processing as already mentioned. First of all, global and regional inter missions biases are removed. Then, the along-track measurements are cross-calibrated following Le Traon and Ogor (1998), which allows the reduction of the long wavelength errors (LWE) also considered as geographically correlated errors. Along-track high frequency aliased signals are also removed. In addition, the data are filtered (Dufau et al., 2016) with a 65km cut-off length low-pass filtering. The along-track measurements are also sub sampled for the mapping procedure keeping one along-track point out of two. All the details are described in Pujol et al (2016). These procedures ensure the long-term stability of the sea level record.
An optimal interpolation method is used for the mapping procedure following Ducet et al., 2000 and Le Traon et al., 2003. This ensures the mesoscale signal reconstruction. The parameters used for the mapping procedure are a compromise between the characteristics of the physical field we focus on and the sampling capabilities associated with the altimeter constellation.

## 1.2 Specifications and target requirements

### 1.2.1 Spatial and temporal coverage

The daily time series begins on 01/01/1993. The times series benefit from regular temporal extensions approximately 3 times per year (ICDR production) and the timeliness of the products is of 5 months at the minimum. Such a delay depends on:

- The input data availability (FCDR of all missions of the constellation have to be available),
- The production algorithms (centred temporal windows, [C3S_SQAD]) and
- The time required for the computation and validation processes.

The time delay can be longer in case of missing altimeter measurements of a mission or longer than usual validation process for instance.

The characteristics of the different missions used in the C3S sea level products are described in Table 3.

Table 3: Characteristics and time availability of the different altimeter data used in input of DUACS system

| Altimeter mission | Cycle duration (days) | Latitude range (°N) | Number of tracks in the cycle | Inter-track distance at equator (km) | Sun-synchronous | Dual-frequency Altimeter | Radiometer on board | Input data availability Start-End dates |
|---|---|---|---|---|---|---|---|---|
| **Sentinel-3A** | 27 | ±81.5 | 770 | ~100 | Yes | Yes | Yes | 2016/12/13 (cycle 12) Ongoing |
| **Jason-3** | 10 | ±66 | 254 | ~315 | No | Yes | Yes | 2016/02/17 (cycle 1) / Ongoing |
| **OSTM/Jason-2** | 10 | ±66 | 254 | ~315 | No | Yes | Yes | 2008/07/12 (cycle1) / 2016/10/02 (cycle 303) |
| **Cryosat-2** | 29 (sub cycle) | ±88 | 840 | ~98 | No | No | No | 2011/01/01 (cycle 13) / Ongoing |
| **SARAL/AltiKa** | 35 | ±81.5 | 1002 | ~80 | Yes | No | Yes | 2013/03/14 (cycle 1) / 2016/07/04 (cycle 35) |
| **SARAL-DP/AltiKa** | - | ±81.5 | - | - | | | | 2016/07/04 (cycle 100) / Ongoing |
| **Topex/Poseidon** | 10 | ±66 | 254 | ~315 | No | Yes | Yes | 1992/09/25 (cycle 1) / 2002/08/21 (cycle 365) |
| **Jason-1** | 10 | ±66 | 254 | ~315 | No | Yes | Yes | 2002/01/15 (cycle 1) / 2009/01/26 (cycle 259) |
| **Envisat** | 35 | ±81.5 | 1002 | ~80 | Yes | Yes (S-band lost after cycle 65) | Yes | 2002/04/10 (cycle 5) / 2010/10/18 (cycle 93) |
| **Envisat-New** | 30 | ±81.5 | 862 | - | | | | 2010/11/27 (cycle 96) / 2012/04/08 (cycle 113) |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **ERS-1** | 35 | ±81.5 | 1002 | ~80 | Yes | Yes | Yes | 1992/10/23 (cycle 15) / 1993/12/20 (cycle 27) And 1995/03/240 (cycle 41) / 1996/06/02 (cycle 53) |
| **ERS-2** | 35 | ±81.5 | 1002 | ~80 | Yes | Yes | Yes | 1995/05/15 (cycle 1) / 2011/07/04 (cycle 169) |

Such characteristics (spatial and temporal coverage) are in phase with the target requirements (see [C3S_TRD]).

### 1.2.2 Validation and uncertainty estimates

Validation activities are carried out to assess the quality of the products. The validation method is described in [C3S_PQAD] and details of the validation results are provided in [C3S_PQAR].

The internal consistency of the product is first evaluated. In practice, the impact analyses are carried out separating different temporal (trends, inter annual and annual signals) and spatial (global and regional) scales. The consistency between the different missions (sea level geographical bias reduction) is also analyzed. The tools applied here are only based on altimetry data analyses (sea surface height –SSH- differences at crossovers between ascending and descending tracks, along-track statistics, global and local MSL trends, etc.), which allow us to measure the intrinsic performances of altimeter systems at the different scales.

In addition, external altimetry data and diagnoses are generated. In this case, the analyses are based on comparisons with other sea level products distributed by different groups and also with external and independent in-situ measurements from tide gauges (Valladeau et al., 2012) and dynamic heights from the Argo profiling floats (Legeais et al., 2016). This allows the detection of altimeter SSH drift.

The product quality is also assessed thanks to dedicated scientific quality assessment activities based on comparison with reanalyses and other products (ECVs) testing closure of sea level budget (conservation of water and energy).

An error budget dedicated to the main spatio-temporal scales (i.e., global and regional, long-term - 5~10 years or more -, inter annual - <5 years - and seasonal) has been recently established, in particular within the ESA Sea Level Climate Change Initiative (SL_cci). For each of these scales, an error was determined. Regarding the Global MSL trend, an uncertainty of 0.5 mm/yr was estimated over the whole altimetry era (1993-2015). The main source of the error remains the radiometer wet tropospheric correction with a drift uncertainty in the range of 0.2~0.3 mm/yr (Legeais et al., 2014). To a lesser extent, the orbit error (Couhert et al., 2014) and the altimeter parameters (range, sigma-0, SWH) instabilities (Ablain et al., 2012) also add additional uncertainty, of the order of 0.1 mm/yr. Notice that for these two corrections, the uncertainties are higher in the first altimetry decade (1993-2002) where TOPEX/Poseidon, ERS-1 and ERS-2 measurements display stronger errors (Dieng et al. 2017). Furthermore, imperfect links between TOPEX-A and TOPEX-B (February 1999), TOPEX-B and Jason-1 (April 2003), Jason-1 and Jason-2 (October 2008) lead to the errors of 2 mm, 1 mm and

0.5 mm respectively (Zawadzki et al., 2016). They cause a GMSL trend error of about 0.15 mm/yr over the 1993-2010 period. All sources of errors described above have also had an impact at the inter annual time scale (< 5 years) close to 2 mm over a 2 to 5 year period.

At the regional scale, the regional trend uncertainty ranges from 2 to 3 mm/yr. Although the orbit error has been significantly reduced for this spatial scale, it remains the main source of the error (in the range of 1~2 mm/yr; Couhert et al., 2014) with large spatial patterns at hemispheric scale. Furthermore, errors are higher during the first decade (1993-2002) where the Earth gravity field models are less accurate due to the unavailability of the Gravity Recovery and Climate Experiment (GRACE) data before 2002. Additional errors are still observed, e.g., for the radiometer-based wet tropospheric correction in tropical areas, other atmospheric corrections in high latitudes, and high frequency corrections in coastal areas. The combined errors give rise to an uncertainty of 0.5~1.5 mm/yr. Finally, the 2~3 mm/yr uncertainty on regional sea level trends remains a significant error compared to the GCOS requirement of 1 mm/yr (see [C3S_TRD]).

In addition, an improved characterization of the altimetry errors and uncertainties has been carried out within the SL_cci project with the estimation of an uncertainty envelope for the global MSL and with the determination of a map of realistic uncertainties of the regional MSL trends (Prandi et al., 2017). This work has significantly contributed to increase the accuracy of climate studies. More details can be found in SL_cci_CECR and in Ablain et al. (2015). These validation activities allow the estimation of the global errors associated with the dataset, notably in terms of MSL trend. Table 4 (from Ablain et al., 2015) summarizes the current knowledge of the error budget of SL_cci products for the main climate scales.

It has been demonstrated that the global MSL trend is 3.3±0.5 mm/yr over the period 1993-2016 with a confidence interval of 90%.

| Spatial scales | Temporal scales | Altimetry errors |
|---|---|---|
| Global MSL | Long-term evolution (> 10 years) | < 0.5 mm/yr |
| | Interannual signals (< 5 years) | < 2 mm over 1 year |
| | Annual signals | < 1 mm |
| Regional MSL | Long term evolution (> 10 years) | < 3 mm/yr |
| | Annual signals | < 1 cm |

Table 4: Error budget of SL_cci products for the main climate scales.

Such altimetry errors remain higher than the target requirements (see [C3S_TRD]).

## 1.3 Data usage information

### 1.3.1 Grid characteristics

The products are delivered in a Cartesian grid with the coverage definition detailed in the table below:

| Area | Latitude coverage | Longitude coverage |
|---|---|---|
| Global Ocean | 90°S/90°N | 0°/360° |
| Mediterranean Sea | 30°N/46°N | 6°W/37°E |
| Black Sea | 40°N/47°N | 27°E/42°E |

Note that the spatial coverage of the maps is maximum 82° and depends on the ice coverage.

Note that the values taken into account to generate a map are ocean values and the mapping process (see 1.1.2.3) computes some slight extrapolation into the coasts: this allows avoiding gaps that can occur near the coast and also computing the velocities more precisely.

### 1.3.2 Format

The products are stored using the NetCDF (Network Common Data Form) using CF (Climate and Forecast) Metadata convention.

### 1.3.3 File nomenclature

The nomenclature of the file is the following:

dt_<area>_twosat_phy_l4_<DateMap>_<DateProd>.nc.gz

where

<area>=global or blacksea or med
<DateMap>=the date of the map in the form YYYYMMDD
<DateProd>=the date the map is produced in the form YYYYMMDD

### 1.3.4 Data Handling Variables

- 4 dimensions are defined:
- time
- latitude
- longitude
- nv

The variables are listed below

| Type | Name | Content | Unit | Scale Factor |
|---|---|---|---|---|
| float | time(time) | Time of measurement | days since 1950-01-01 00:00:00 UTC | none |
| float | latitude(latitude) | Latitude of measurement | degrees_north | none |
| float | longitude(longitude) | Longitude of measurement | degrees_east | none |
| float | lat_bnds (latitude,nv) | latitude values at the north and south bounds of each pixel. | degrees_north | none |
| float | lon_bnds(longitude,nv) | longitude values at the west and east bounds of each pixel. | degrees_east | none |
| int | nv(nv) | | none | none |
| int | crs | Describes the grid_mapping used by the data in this file. This variable does not contain any data; only information about the geographic coordinates system. | none | none |
| int | sla(time,latitude,longitude) | Sea level anomaly | meters | $10^{-4}$ |
| int | err(time,latitude,longitude) | Formal mapping error | meters | $10^{-4}$ |
| int | ugosa(time,latitude,longitude) | Geostrophic velocity anomalies: zonal component | meters | $10^{-4}$ |
| int | vgosa(time,latitude,longitude) | Geostrophic velocity anomalies: meridian component | meters | $10^{-4}$ |
| int | adt(time,latitude,longitude) (*) | Absolute dynamic topography | meters | $10^{-4}$ |
| int | ugos(time,latitude,longitude) (*) | Absolute geostrophic velocity: zonal component | meters | $10^{-4}$ |
| int | vgos(time,latitude,longitude) (*) | Absolute geostrophic velocity: meridian component | meters | $10^{-4}$ |

(*) not delivered for Black Sea products

# Appendix A - Specifications of the Sea Level product

The description of the content specification of the product is presented in this section for the global ocean, Mediterranean Sea en Black Sea areas.

## The global Ocean:

```
netcdf dt_global_twosat_phy_l4_20160101_20170110 {
dimensions:
	time = 1 ;
	latitude = 720 ;
	longitude = 1440 ;
	nv = 2 ;
variables:
	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 = 89.875 ;
		latitude:valid_min = -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:axis = "X" ;
		longitude:bounds = "lon_bnds" ;
		longitude:long_name = "Longitude" ;
		longitude:standard_name = "longitude" ;
		longitude:units = "degrees_east" ;
		longitude:valid_max = 359.875 ;
		longitude:valid_min = 0.125 ;
	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 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 ;
	int nv(nv) ;
		nv:comment = "Vertex" ;
		nv:units = "1" ;
	int sla(time, latitude, longitude) ;
		sla:_FillValue = -2147483647 ;
		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" ;
		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" ;
	int err(time, latitude, longitude) ;
```

```
		err:_FillValue = -2147483647 ;
		err:comment = "The formal mapping error represents a purely theoretical mapping error. It mainly traduces errors induced by the constellation sampling capability and consistency with the spatial/temporal scales considered, as described in Le Traon et al (1998) or Ducet et al (2000)" ;
		err:coordinates = "longitude latitude" ;
		err:grid_mapping = "crs" ;
		err:long_name = "Formal mapping error" ;
		err:scale_factor = 0.0001 ;
		err:units = "m" ;
	int ugosa(time, latitude, longitude) ;
		ugosa:_FillValue = -2147483647 ;
		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" ;
		ugosa:comment = "The geostrophic velocity anomalies are referenced to the [1993, 2012] period" ;
	int vgosa(time, latitude, longitude) ;
		vgosa:_FillValue = -2147483647 ;
		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" ;
		vgosa:comment = "The geostrophic velocity anomalies are referenced to the [1993, 2012] period" ;
	int adt(time, latitude, longitude) ;
		adt:_FillValue = -2147483647 ;
		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" ;
		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" ;
	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" ;

// 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 = "http://climate.copernicus.eu/c3s-user-service-desk" ;
		:creator_email = "http://climate.copernicus.eu/c3s-user-service-desk" ;
		:creator_name = "Copernicus Climate Change Service (C3S)" ;
		:creator_url = "http://climate.copernicus.eu" ;
		:date_created = "2016-06-30T22:08:26Z" ;
```

```
		:date_issued = "2016-06-10T00:00:00Z" ;
		:date_modified = "2016-07-18T12:03:23Z" ;
		:geospatial_lat_max = 89.875 ;
		:geospatial_lat_min = -89.875 ;
		:geospatial_lat_resolution = 0.25 ;
		:geospatial_lat_units = "degrees_north" ;
		:geospatial_lon_max = 359.875 ;
		:geospatial_lon_min = 0.125 ;
		:geospatial_lon_resolution = 0.25 ;
		: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 = "2016-06-30T22:08:26Z: created by DUACS DT - 2016-07-18T12:03:23Z: Change of some attributes -  2017-03-31 12:12:12Z: Change of some attributes for C3S" ;
		:institution = "CLS, CNES" ;
		:keywords = "Oceans > Ocean Topography > Sea Surface Height" ;
		:keywords_vocabulary = "NetCDF COARDS Climate and Forecast Standard Names" ;
		:license = "http://climate.copernicus.eu/c3s-user-service-desk " ;
		:platform = "AltiKa, OSTM/Jason-2" ;
		:processing_level = "L4" ;
		:product_version = "5.7" ;
		:project = "Copernicus Climate Change Service (C3S)" ;
		:references = "http://climate.copernicus.eu" ;
		: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 since 2008-10-19." ;
		:standard_name_vocabulary = "NetCDF Climate and Forecast (CF) Metadata Convention Standard Name Table v37" ;
		:summary = "SSALTO/DUACS Delayed-Time Level-4 sea surface height and derived variables measured by multi-satellite altimetry observations over Global Ocean." ;
		:time_coverage_duration = "P1D" ;
		:time_coverage_end = "2016-01-01T12:00:00Z" ;
		:time_coverage_resolution = "P1D" ;
		:time_coverage_start = "2015-12-31T12:00:00Z" ;
		:title = "DT merged two satellites Global Ocean Gridded SSALTO/DUACS Sea Surface Height L4 product and derived variables" ;
}
```

### The Mediterranean Sea:

```
netcdf dt_med_twosat_phy_l4_20160101_20170110 {
dimensions:
	longitude = 344 ;
	time = 1 ;
	latitude = 128 ;
	nv = 2 ;
variables:
	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 = 36.9375 ;
		longitude:valid_min = -5.9375 ;
	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 = 45.9375 ;
		latitude:valid_min = 30.0625 ;
	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 lon_bnds(longitude, nv) ;
		lon_bnds:comment = "longitude values at the west and east bounds of each pixel." ;
		lon_bnds:units = "degrees_east" ;
	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 ;
	int nv(nv) ;
		nv:comment = "Vertex" ;
		nv:units = "1" ;
	int sla(time, latitude, longitude) ;
		sla:_FillValue = -2147483647 ;
		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" ;
		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" ;
	int err(time, latitude, longitude) ;
		err:_FillValue = -2147483647 ;
		err:comment = "The formal mapping error represents a purely theoretical mapping error. It mainly traduces errors induced by
the constellation sampling capability and consistency with the spatial/temporal scales considered, as described in Le Traon et al (1998)
or Ducet et al (2000)" ;
		err:coordinates = "longitude latitude" ;
		err:grid_mapping = "crs" ;
```

```
        err:long_name = "Formal mapping error" ;
        err:scale_factor = 0.0001 ;
        err:units = "m" ;
    int ugosa(time, latitude, longitude) ;
        ugosa:_FillValue = -2147483647 ;
        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" ;
        ugosa:comment = "The geostrophic velocity anomalies are referenced to the [1993, 2012] period" ;
    int vgosa(time, latitude, longitude) ;
        vgosa:_FillValue = -2147483647 ;
        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" ;
        vgosa:comment = "The geostrophic velocity anomalies are referenced to the [1993, 2012] period" ;
    int adt(time, latitude, longitude) ;
        adt:_FillValue = -2147483647 ;
        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" ;
        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" ;
    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" ;

// 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 = "http://climate.copernicus.eu/c3s-user-service-desk" ;
        :creator_email = "http://climate.copernicus.eu/c3s-user-service-desk" ;
        :creator_name = "Copernicus Climate Change Service (C3S)" ;
        :creator_url = "http://climate.copernicus.eu" ;
        :date_created = "2016-06-30T22:50:17Z" ;
        :date_issued = "2016-06-10T00:00:00Z" ;
        :date_modified = "2016-07-18T12:03:29Z" ;
        :geospatial_lat_max = 45.9375 ;
        :geospatial_lat_min = 30.0625 ;
        :geospatial_lat_resolution = 0.125 ;
        :geospatial_lat_units = "degrees_north" ;
```

:geospatial_lon_max = 36.9375 ;
:geospatial_lon_min = -5.9375 ;
: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 = "2014-02-26T12:12:12Z: created by DUACS DT - 2015-11-10T12:12:12Z: Change of some attributes - 2017-03-31 12:12:12Z: Change of some attributes for C3S" ;
:institution = "CLS, CNES" ;
:keywords = "Oceans > Ocean Topography > Sea Surface Height" ;
:keywords_vocabulary = "NetCDF COARDS Climate and Forecast Standard Names" ;
:license = "http://climate.copernicus.eu/c3s-user-service-desk " ;
:platform = "AltiKa, OSTM/Jason-2" ;
:processing_level = "L4" ;
:product_version = "5.7" ;
:project = "Copernicus Climate Change Service (C3S)" ;
:references = "http://climate.copernicus.eu" ;
: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 since 2008-10-19." ;
:standard_name_vocabulary = "NetCDF Climate and Forecast (CF) Metadata Convention Standard Name Table v37" ;
:summary = "SSALTO/DUACS 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 = "2016-01-01T12:00:00Z" ;
:time_coverage_resolution = "P1D" ;
:time_coverage_start = "2015-12-31T12:00:00Z" ;
:title = "DT merged two satellites Mediterranean Sea Gridded SSALTO/DUACS Sea Surface Height L4 product and derived variables" ;
}

## The Black Sea:

```
netcdf dt_blacksea_twosat_phy_l4_20160101_20170110 {
dimensions:
	time = 1 ;
	latitude = 56 ;
	longitude = 120 ;
	nv = 2 ;
variables:
	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 = 46.9375 ;
		latitude:valid_min = 40.0625 ;
	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 = 41.9375 ;
		longitude:valid_min = 27.0625 ;
	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 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 ;
	int nv(nv) ;
		nv:comment = "Vertex" ;
		nv:units = "1" ;
	int sla(time, latitude, longitude) ;
		sla:_FillValue = -2147483647 ;
		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" ;
		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" ;
	int err(time, latitude, longitude) ;
		err:_FillValue = -2147483647 ;
		err:comment = "The formal mapping error represents a purely theoretical mapping error. It mainly traduces errors induced by the constellation sampling capability and consistency with the spatial/temporal scales considered, as described in Le Traon et al (1998) or Ducet et al (2000)" ;
		err:coordinates = "longitude latitude" ;
		err:grid_mapping = "crs" ;
```

```
        err:long_name = "Formal mapping error" ;
        err:scale_factor = 0.0001 ;
        err:units = "m" ;
    int ugosa(time, latitude, longitude) ;
        ugosa:_FillValue = -2147483647 ;
        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" ;
        ugosa:comment = "The geostrophic velocity anomalies are referenced to the [1993, 2012] period" ;
    int vgosa(time, latitude, longitude) ;
        vgosa:_FillValue = -2147483647 ;
        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" ;
        vgosa:comment = "The geostrophic velocity anomalies are referenced to the [1993, 2012] period" ;

// 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 = "http://climate.copernicus.eu/c3s-user-service-desk" ;
        :creator_email = "http://climate.copernicus.eu/c3s-user-service-desk" ;
        :creator_name = "Copernicus Climate Change Service (C3S)" ;
        :creator_url = "http://climate.copernicus.eu" ;
        :date_created = "2016-06-30T22:52:47Z" ;
        :date_issued = "2016-06-10T00:00:00Z" ;
        :date_modified = "2016-07-18T12:03:27Z" ;
        :geospatial_lat_max = 46.9375 ;
        :geospatial_lat_min = 40.0625 ;
        :geospatial_lat_resolution = 0.125 ;
        :geospatial_lat_units = "degrees_north" ;
        :geospatial_lon_max = 41.9375 ;
        :geospatial_lon_min = 27.0625 ;
        :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 = "2016-06-30T22:52:47Z: created by DUACS DT - 2016-07-18T12:03:27Z: Change of some attributes -  2017-03-31 12:12:12Z: Change of some attributes for C3S" ;
        :institution = "CLS, CNES" ;
        :keywords = "Oceans > Ocean Topography > Sea Surface Height" ;
        :keywords_vocabulary = "NetCDF COARDS Climate and Forecast Standard Names" ;
        :license = "http://climate.copernicus.eu/c3s-user-service-desk " ;
        :platform = "AltiKa, OSTM/Jason-2" ;
        :processing_level = "L4" ;
        :product_version = "5.7" ;
        :project = "Copernicus Climate Change Service (C3S)" ;
        :references = "http://climate.copernicus.eu" ;
        :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 since 2008-10-19." ;
        :standard_name_vocabulary = "NetCDF Climate and Forecast (CF) Metadata Convention Standard Name Table v37" ;
        :summary = "SSALTO/DUACS Delayed-Time Level-4 sea surface height and derived variables measured by multi-satellite altimetry observations over Black Sea." ;
```

```
        :time_coverage_duration = "P1D" ;
        :time_coverage_end = "2016-01-01T12:00:00Z" ;
        :time_coverage_resolution = "P1D" ;
        :time_coverage_start = "2015-12-31T12:00:00Z" ;
        :title = "DT merged two satellites Black Sea Gridded SSALTO/DUACS Sea Surface Height L4 product and derived
variables" ;
}
```

# References

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Copernicus Climate Change Service

ECMWF - Shinfield Park, Reading RG2 9AX, UK

Contact: info@copernicus-climate.eu