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**SSALTO/DUACS product handbook:
MERSEA regional products**



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LIST OF ACRONYMS

AD	Applicable Document
IB	Inverse Barometer
LWE	Long Wavelength Error
MSS	Mean Sea Surface
OER	Orbit Error Reduction
RD	Reference Document
SLA	Sea Level Anomaly
SSH	Sea Surface Height
TBC	To be confirmed
TBD	To be defined

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APPLICABLE DOCUMENTS / REFERENCE DOCUMENTS

RD 1 : SSALTO/DUACS Product Handbook
http://www.jason.oceanobs.com/documents/donnees/duacs/handbook_duacs.pdf

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1. INTRODUCTION

1.1. SCOPE OF THE DOCUMENT

The purpose of this document is to describe the along-track SLA+ regional products generated by the SSALTO/DUACS near-real time and delayed time altimeter data processing system. This document is an extension of the main handbook for SSALTO/DUACS products, which is used hereafter as reference document #1 (RD1). Therefore, redundant information will not be provided in this document.

After an overview of their generation process in section 2, the regional products will be presented in section 3. Information regarding data access will be given in section 4.

1.2. WHAT IS SSALTO/DUACS?

SSALTO/DUACS is the CNES near-real time and delayed time multi-mission altimeter data processing system. It serves the main operational oceanography and climate forecasting centres in Europe and worldwide. SSALTO/DUACS data are used in particular by GODAE and its French contribution Mercator.

Developed and operated by CLS, it started as an European Commission Project (Developing Use Of Altimetry for Climate Studies), funded under the European Commission and the Midi-Pyrénées regional council. It is now part of the CNES SSALTO multi-mission ground segment with funding from CNES and the Midi-Pyrénées regional council. At the beginning of 2004, DUACS was redefined as the Data Unification and Altimeter Combination System.

More information can be found on the AVISO/DUACS website:

<http://www.aviso.oceanobs.com/duacs/>

1.3. WHAT IS MERSEA?

MERSEA stands for Marine Environment and Security for the European Area.

The MERSEA ocean monitoring system is envisioned as an operational network that systematically acquires data (earth observation from satellites, in situ from ocean observing networks, and surface forcing fields from numerical weather prediction agencies). These data from diverse sources are combined and merged with numerical ocean circulation models (i.e. *assimilated*) to produce best estimates of the actual state of the ocean (*nowcasts*) and

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forecasts. That information is then disseminated to enable various users to develop specific applications. The project itself has identified areas of Special Focus Experiments on seasonal weather forecasting, and on ecosystem modelling in regional and shelf seas. Specific applications on marine safety concern improved wave forecasts, offshore operations, ship routing, and oil spill drift.

More information can found on the MERSEA website:

<http://www.mersea.eu.org/>

1.4. OVERVIEW OF THE MERSEA-SPECIFIC PRODUCTS

As part of MERSEA, new regional products with specific altimeter corrections have been developed for the European Shelves. These products have been implemented in the SSALTO/DUACS suite of operational products.

Version 1 is based on extended along-track Sea Level Anomaly product. The tidal correction, inverse barometer and high frequency corrections will be provided so as to allow de-correction by MERSEA users who want to apply custom corrections/models.

The SLA will be produced on the MERSEA areas of interest. Contrary to the sub-sampled global data set, they are delivered at full resolution ($\Delta x=7\text{km}$), without filtering, and on a daily basis (in real time).

Version 2 will include improvements in the processing of altimeter data close to the coasts. It will be available by mid 2006. These products are not described in this document.

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2. PRODUCT GENERATION

2.1. INPUT DATA

The input altimeter data used to generate the MERSEA product are the same as the input data used by DUACS for its global data set.

To produce MSLA and SLA in near-real time, the SSALTO/DUACS system uses the latest high-quality altimeter data produced in Near-Real-Time (IGDR). These input data are distributed by multiple space/environmental agencies from the United States or from Europe: CNES, ESA, NASA and NOAA.

For Topex/Poseidon, the SSALTO/DUACS system uses IGDR data available within 72 hours from PO.DAAC at JPL. GFO data are daily IGDR files provided by NOAA with a preliminary MOE orbit. They are usually available within 72 hours. The altimeter data for Jason-1 and ENVISAT are respectively delivered within 24 and 48 hours by SSALTO/CMA on the SSALTO data server. These data are routinely produced by CNES and ESA.

Altimetric product	Source	Availability	Type of orbit
Topex/Poseidon IGDR	NASA/CNES	~72 h	CNES MOE
GFO IGDR	NOAA	~72 h	NOAA MOE
Jason-1 IGDR	CNES/NASA	~48 h	CNES MOE
ENVISAT IGDR	ESA/CNES	~48 h	CNES MOE

Table 1: SSALTO/DUACS Near-Real Time Input data overview

2.2. PROCESSING STEPS

The MERSEA product generation can be divided into

- Data acquisition
- Data enhancement
- MERSEA Product Generation
- MERSEA Product Validation

The first two steps are not specific to regional products. They are routinely performed by DUACS for the global production. They are detailed in RD1.

The MERSEA product generation itself is composed of four steps:

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- Precise Orbit Error Reduction (OER). The crossover database is first used to reduce the orbit errors for the reference mission (T/P up to August 2002 and then Jason-1). Multi-mission crossover differences are minimized by a multi-satellite orbit error determination. This software was specifically designed for missions that do not have a very accurate orbit determination (ERS and GFO) but also to remove biases and systematic differences with the reference mission (T/P from February 2004, ENVISAT) (Le Traon et al., 1995), (Le Traon and Ogor, 1998). Using the precision of the reference mission orbit, a very accurate orbit error can be estimated.

- Time/space extraction of altimeter data of interest for MERSEA (Europe zone, data not distributed in the past). DUACS routinely produces one daily data set for each altimeter.

As long as the satellite and its ground segment are functioning normally, this data set will span 24h and about 24 passes (global coverage). If an altimeter is unavailable for a few days, no data set will be distributed for this mission. When the altimeter is functional again, new data sets will be selected and processed automatically.

When old altimeter data are delivered to DUACS, two situations may occur. If the data set has not been distributed by DUACS, the data flow will be selected and processed normally. If the data set has already been distributed by DUACS, it will not be delivered again in order to avoid confusion. Note that this behaviour is different than what is performed by DUACS for the global data sets.

- SLA Computation by repeat track analysis. This processing step is identical to the global processing: individual measurements are resampled along a theoretical track (Mean Track) associated to each mission. Then a Mean Profile is subtracted from the resampled data to obtain SLA.

The Mean Profile is a time average of similarly resampled data over a long period. The mean profile used for the Topex/Poseidon and Jason-1 track has been computed with T/P data from January 1993 to December 1999. The mean profile used for ENVISAT has been computed with ERS data over a five year period corresponding to the T/P-Jason-1 Mean Profile. A specific processing has been used to ensure that it is consistent with the T/P-Jason-1 Mean Profile (reduction of orbit error and correction of ocean variability). The Mean Profile used for GFO has been computed using 3 years of GFO GDR data provided by Noaa with the same processing to ensure the consistency with the Jason-1 Mean Profile. T/P Mean Profile has been computed using 9 months of T/P GDRs.

Note that neither filtering nor sub-sampling is performed, as opposed to the global processing. The final SLAs produced in the Europe zone are delivered at their natural resolution of about 7km (the exact value is altimeter specific). Likewise, Long Wavelength Error (LWE) reduction scheme is not applied on regional products.

- Interpolation of various corrections (see section 2.3) on the same dates/positions as SLAs. This processing step is quite similar to the SLA computation. Corrections are resampled on a theoretical track associated to each mission. No mean profile is subtracted.

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The final processing step is the product validation. A first validation is routinely performed by an automated process which uses cross-validation techniques to detect rare erroneous measurements which may have been able to slip through standard altimeter editing. A second validation is performed twice a week. This off-line quality assessment step involves altimetry experts who monitor the intrinsic quality of altimeter data.

A small quality assessment report is delivered by DUACS for users to monitor the quality of their NRT altimeter data. This raw PDF document is a small compilation of the most relevant figures analysed twice a week by the DUACS quality assessment team: input data delay, missing data, edited/valid data, crossover statistics, pass by pass statistics... It is provided 'as is' on a best effort basis, without neither documentation/tutorial nor user support. DUACS users can download the latest reports from this FTP directory:

<ftp://ftp.cls.fr/pub/oceano/DUACS/QualityReports/latest/>

2.3. CORRECTIONS/REFERENCES USED AND PROVIDED

2.3.1. SLA formula

The Sea Level Anomalies are obtained with:

SLA = Orbit Altitude

- Altimeter Range (Raw, no geophysical correction applied)
- Dry Troposphere Correction
- High Frequency Signal Correction (High Frequency from MOG2D barotropic model, Low Frequency from Inverse Barometer)
- Ocean Tide Correction (GOT00 enhanced with dynamic Long Period tide)
- Ionosphere Correction (filtered dual frequency or GIM)
- Wet Troposphere Correction (ECMWF)
- Pole Tide Correction
- Solid Earth Tide Correction
- Sea State Bias Correction
- Orbit Error Reduction Correction
- Mean Profile

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2.3.2. Corrections provided

Three corrections are provided on MERSEA regional products. The first two corrections have been applied in the SLA computation. They are delivered for experienced users who want to de-correct them and/or to apply a custom correction instead. The last correction has **not** been used during the SLA computation. It is provided for users who want to use the ‘classic’ IB in place of the precise HF correction based on MOG2D.

- High Frequency Signal Correction (High Frequency from MOG2D barotropic model, Low Frequency from Inverse Barometer)
- Ocean Tide Correction (GOT00 enhanced with dynamic Long Period tide)
- Inverse Barometer (based on ECMWF pressure)

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3. PRODUCT DESCRIPTION

3.1. PRODUCT NOMENCLATURE

All DUACS filenames are in lower-case. The nomenclature used for MERSEA files is:

`<DELAY>_<MIS>_<DATATYPE1>_<DATATYPE2>_<DATE_BEG>_<DATE_END>_<DATE_PROD>.nc`

where:

- **DELAY** is RT for real time products (daily), and DT for delayed time products
- **MIS** is the satellite name on 2 characters (J1 for Jason, EN for Envisat, TP for Topex Poseidon, E2 for ERS2, G2 for GFO)
- **DATATYPE1** is the main data type (SLAEXT for Extended SLA, that is to say, SLA provided with a small set of additional corrections)
- **DATATYPE2** is the data sub-type (GLOBAL for the global products, MERSEA for mersea-specific products)
- **DATE_BEG** is the beginning date of the data set. The format used is YYYYMMDD.
- **DATE_END** is the end date of the data set. The format used is YYYYMMDD.
- **DATE_PROD** is the production date of the data set, that is to say when the data set has been produced. The format used is YYYYMMDD.

Example:

dt_j1_slaext_mersea_20040101_20040701_20050523.nc: contains delayed time data based on Jason-1 measurements. The data set contains sea level anomalies plus additional corrections (SLA+) from January 1, 2004 to July 1, 2004. It has been produced on May 23, 2005.

3.2. PRODUCT FORMAT

All DUACS data are distributed in netCDF. Information regarding this format and the storage convention used by DUACS are detailed in Reference Document #1.

Four netCDF variables are used for MERSEA products. The main variable is "SLA". It obviously contains the Sea Level Anomalies computed as per 2.3.1. Three other variables are

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available in along track SLA+ datasets: MOG2D, TIDE, and INVBAR. These variables correspond to the corrections presented in section 2.3.2.

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4. DATA ACCESS

4.1. DATA DISTRIBUTION

4.1.1. Temporal availability

Three temporal classes of SSALTO/DUACS products can be distinguished:

- Near-Real Time (NRT) products available within one week after the date of measurement and delivered every day,
- NRT products also called “historical data” available one month after the date of measurement,
- Delayed Time (DT) products, reprocessed products updated nearly every 6 months.

4.1.2. Near Real-Time SSALTO/DUACS products:

These products are accessible via **FTP** (username and password identification). For this, the user must send a request by mail to AVISO User Service (aviso@cls.fr) and fill in the data use agreement that will be approved for scientific applications only (http://www.jason.oceanobs.com/html/donnees/duacs/agreement_uk.html).

The following acknowledgement has to be cited: “The near real time regional altimeter products have been produced by SSALTO/DUACS and distributed by AVISO”.

4.1.3. “Historical” NRT products

These products are freely distributed on the anonymous FTP site of AVISO:

<ftp://ftp.cls.fr/pub/oceano/AVISO/SSH/duacs/regional-mersea/nrt/sla-ext/>

The following acknowledgement has to be cited: “The near real time regional altimeter products have been produced by SSALTO/DUACS and distributed by AVISO”.

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4.1.4. Delayed Time SSALTO/DUACS products:

These products are freely distributed on the anonymous FTP site of AVISO:

<ftp://ftp.cls.fr/pub/oceano/AVISO/SSH/duacs/regional-mersea/dt/sla-ext/>

The following acknowledgement has to be cited: “The delayed time regional altimeter products have been produced by SSALTO/DUACS and distributed by AVISO”.

4.2. SOFTWARE ROUTINES

All DUACS data are distributed in netCDF. Software routines for this format are provided in Reference Document #1.