Range latitudinal empirical correction for Jason-1/2/3 GDR User Handbook

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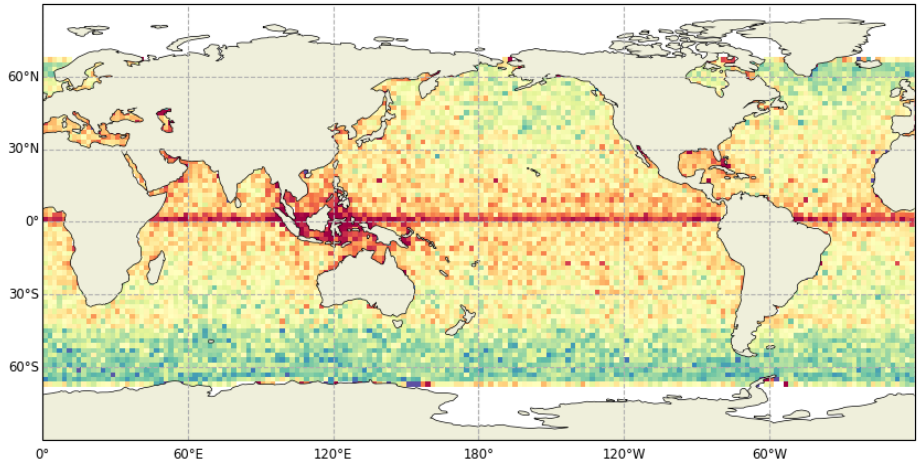

Nomenclature: SALP-MU-P-EA-23665-CLS
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Chronology Issues:			
Issue:	Date:	Validated by	Reason for change:
1.0	August 2024		First issue

List of Acronyms

Aviso+	Archiving, Validation and Interpretation of Satellite Oceanographic data
CLS	Collecte, Localisation, Satellites
CNES	Centre National d'Etudes Spatiales
SLA	Sea Level Anomaly
DAC	Dynamical atmospheric correction
L2	Level-2 product

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1 Introduction

1.1 Context

Comparison between Sentinel-6MF and Jason-3 range over their tandem phase (Figure 1) shows a 4 mm-amplitude band around the equator (between 1°S and 3.5°N) and a second band around 40°S on ascending tracks only ([1], [2]).

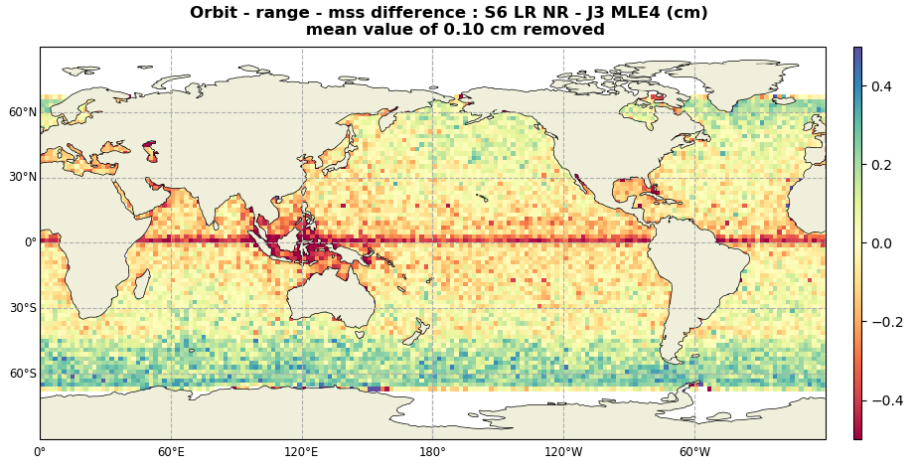

Figure 1: Orbit - Range - MSS difference between Sentinel-6MF LR NR and Jason-3 MLE4 over the tandem phase (cm)

This behavior is not observed between Jason-2 and Jason-3, nor between Jason-1 and Jason-2. But identical signature is observed between TOPEX and Jason-1 (Figure 2). As the Jason missions are consistent with one another, the responsibility was naturally put on TOPEX, until the launch of Sentinel-6MF.

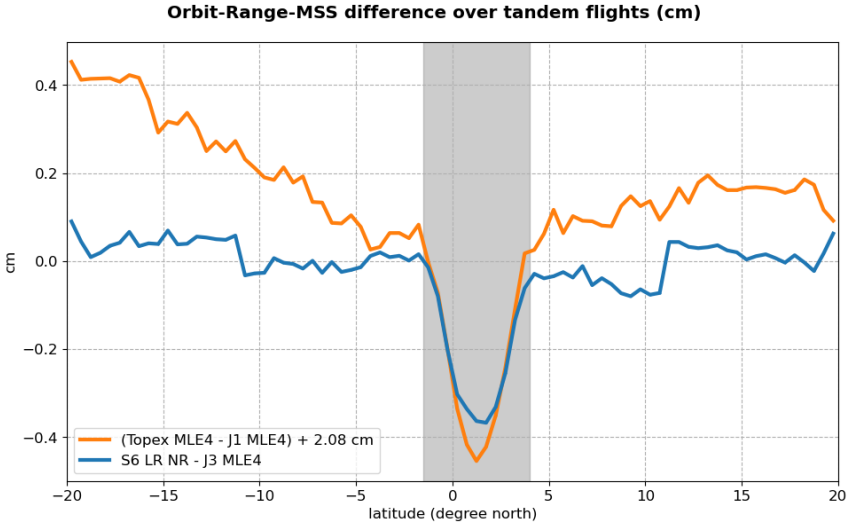

Figure 2: Orbit - Range - MSS difference between Sentinel-6MF LR NR and Jason-3 MLE4 and between Topex MLE4 and Jason-1 MLE4, over their respective tandem phases

Following investigations in Jason-3 ground segment, an anomaly has been detected in the altimeter range estimation (inconsistent rounding methods). This anomaly has shown to be the root cause of the behavior observed ([3]). The anomaly affects Jason-1, Jason-2, Jason-3 and SWOT Nadir ground

segments, for all retrackers and all frequencies. It will be corrected in the upcoming ground segments versions: GDR-S2 for SWOT Nadir in fall 2024, and GDR-G for the Jasons in 2025.

The product named “Range latitudinal empirical correction for Jason-1/2/3 GDR” described in this user manual, aims at providing an empirical correction for the Jason missions awaiting the exact correction in the ground segments. This abacus was produced by CLS as part of the CNES SALP project, distributed by AVISO+ with the support of CNES. It has to be applied on the GDR measurements for these 3 missions. This correction applies to GDR products in version F and previous. Note that this abacus is only valid for the Jason missions flying over the reference orbit. It cannot be applied over period where the satellites fly on other obits.

1.2 Data Policy and conditions of use

This product is available free of charge for scientific studies and commercial activities.

Publications should include the following statement in the Acknowledgments:

This product " Range latitudinal empirical correction for Jason-1/2/3 GDR " was produced by CLS as part of the CNES SALP project, distributed by AVISO+ with the support of CNES. DOI: 10.24400/527896/a01-2024.008 "

2 Processing

2.1 Input data

Two sets of Jason-3 L2 GDR products have been used to build this correction:

- The first set is composed of the original GDR-F products.
- The second set has been generated with a test version of GDR-F including a patch correcting for the ground segment rounding anomaly.

These two datasets covers 3 cycles of Jason-3 (cycles number 220, 221 and 222).

Ku-band MLE4 altimeter range has been used. But the result is identical for all frequencies and retrackers.

2.2 Abacus creation

Direct difference between original and patched range has been used to build the correction. As the impact depend on the track orientation, the difference is done separately for ascending and descending tracks (Figure 3).

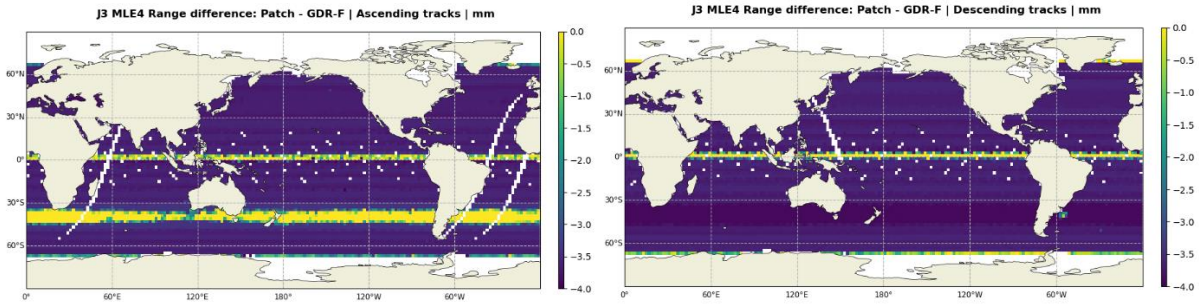

Figure 3: Difference between patched and original range for Jason-3

The effect of the ground segment rounding anomaly is function of latitude. The abacus has thus been built function of the latitude. The small oscillations have been removed to keep only the main impact of the anomaly.

The resulting correction is presented in Figure 4.

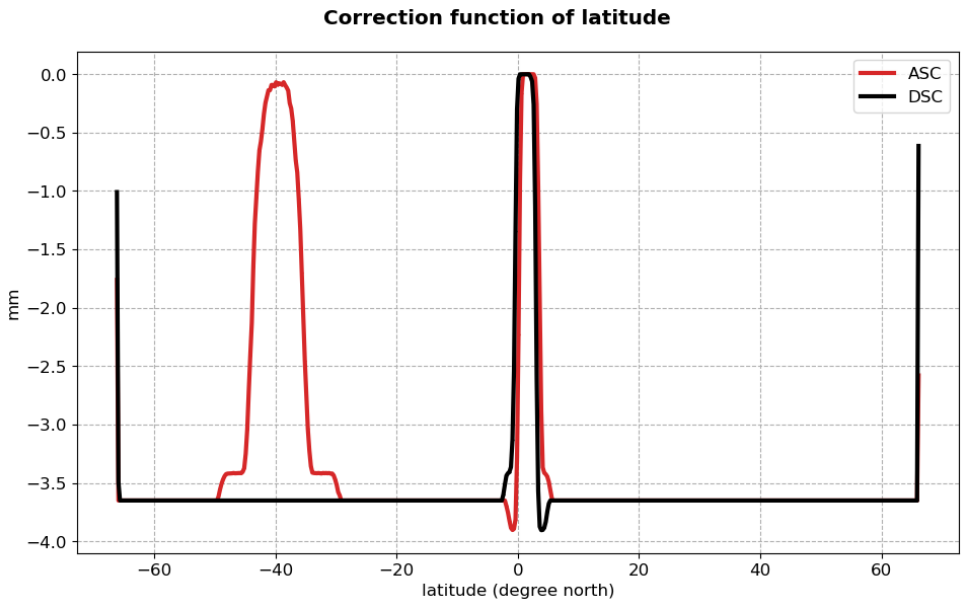

Figure 4: Correction versus latitude in mm for ascending and descending tracks

Figure 5 and Figure 6 shows how this correction properly corrects for the ground segment anomaly on Jason-3 and Jason-1 respectively.

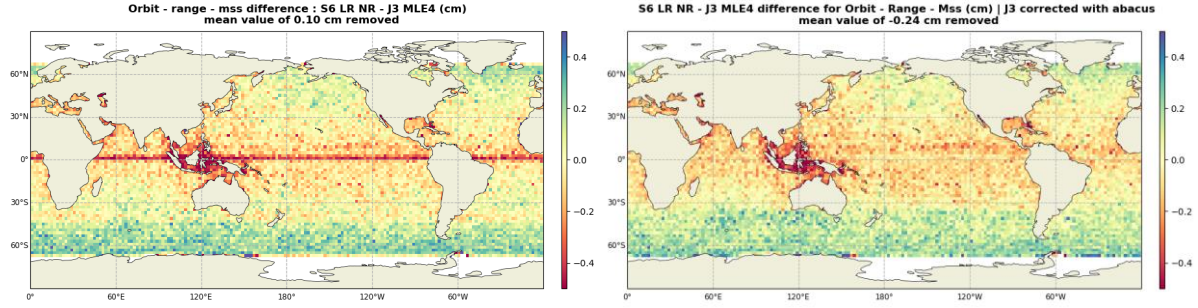

Figure 5: Orbit - Range - MSS difference Sentinel-6MF - Jason-3 (cm) before (left) and after (right) applying the correction on Jason-3 over the complete tandem phase

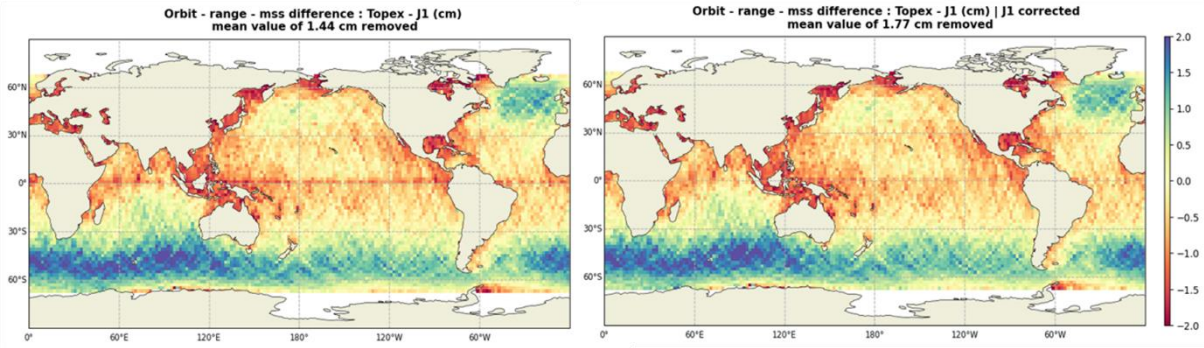

Figure 6: Orbit - Range - MSS difference Topex - Jason-1 (cm) before (left) and after (right) applying the correction on Jason-1 over the complete tandem phase

3 Range latitudinal empirical correction for Jason-1/2/3 GDR Product

3.1 List of variables

Name of variable	Signification	Unit
latitude	Latitude	Degrees North
correction_asc	Correction for ascending tracks. To add to the altimeter range	Meters
correction_dsc	Correction for descending tracks. To add to the altimeter range	Meters

Table 1: List of variables in the NetCDF files

3.2 Nomenclature of files

The nomenclature used for these products is: J1J2J3_range_correction_abacus.nc

3.3 How to apply the correction

The correction must be **added** to the altimeter range.

On ascending tracks (uneven pass number), the variable "*correction_asc*" has to be used.

On descending tracks (even pass number), the variable "*correction_dsc*" has to be used.

Linear interpolation can be used to get the correction value at a given latitude.

4 Data format

This chapter presents the data storage format used for the products.

4.1 NetCDF

The product is stored using the NetCDF format.

NetCDF (network Common Data Form) is an interface for array-oriented data access and a library that provides an implementation of the interface. The netCDF library also defines a machine-independent format for representing scientific data. Together, the interface, library, and format support the creation, access, and sharing of scientific data. The netCDF software was developed at the Unidata Program Center in Boulder, Colorado. The netCDF libraries define a machine-independent format for representing scientific data. Please see Unidata NetCDF pages for more information, and to retreive NetCDF software package on:

https://www.unidata.ucar.edu/software/netcdf/

NetCDF data is:

- Self-Describing. A netCDF file includes information about the data it contains.
- Architecture-independent. A netCDF file is represented in a form that can be accessed by computers with different ways of storing integers, characters, and floating-point numbers.
- Direct-access. A small subset of a large dataset may be accessed efficiently, without first reading through all the preceding data.
- Appendable. Data can be appended to a netCDF dataset along one dimension without copying the dataset or redefining its structure. The structure of a netCDF dataset can be changed, though this sometimes causes the dataset to be copied.
- Sharable. One writer and multiple readers may simultaneously access the same netCDF file.

The product is stored in **NetCDF** defined by the Cooperative Ocean/Atmosphere Research Data Service (COARDS) and Climate and 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 are made available by UNIDATA http://www.unidata.ucar.edu/software/netcdf :

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

In addition to these conventions, the file uses the structure and semantic shown in the example below:

```
netcdf J1J2J3_range_correction_abacus {
dimensions:
    latitude = 536 ;
variables:
    double latitude(latitude) ;
        latitude:_FillValue = NaN ;
        latitude:description = "Latitude" ;
        latitude:units = "degrees_north" ;
    double correction_asc(latitude) ;
        correction_asc:_FillValue = NaN ;
        correction_asc:description = "Correction for ascending tracks. To add to the altimeter range.";
        correction_asc:units = "m" ;
    double correction_dsc(latitude) ;
        correction_dsc:_FillValue = NaN ;
        correction_dsc:description = "Correction for descending tracks. To add to the altimeter range." ;
        correction_dsc:units = "m" ;

// global attributes:
        :Conventions = "CF-1.7" ;
        :Metadata_Conventions = "Unidata Dataset Discovery v1.0" ;
        :title = "Range latitudinal empirical correction for Jason-1/2/3 GDR" ;
        :comment = "Abacus of the range latitudinal empirical correction for Jason-1/2/3 GDR. To apply function of the latitude, with a distinction between ascending and descending tracks. Valid for GDR products in version F and previous. Only valid for Jason-1/2/3 flying over the reference orbit." ;
        :geospatial_lat_units = "degrees_north" ;
        :keywords = "Oceans > Ocean Topography > Sea Surface Height" ;
        :keywords_vocabulary = "NetCDF COARDS Climate and Forecast Standard Names" ;
        :product_version = "1.0" ;
        :standard_name_vocabulary = "NetCDF Climate and Forecast (CF) Metadata Convention Standard Name Table v37" ;
        :institution = "CLS, CNES" ;
        :doi = "10.24400/527896/a01-2024.008" ;
        :contact = "aviso@altimetry.fr" ;
        :creator_url = "https://aviso.altimetry.fr" ;
        :license = "https://www.aviso.altimetry.fr/fileadmin/documents/data/License_Aviso.pdf" ;
        :references="https://aviso.altimetry.fr";
        :date_created="2024-08-20T12:02:22Z";
}
```

5 Accessibility of the products

The files are available on the ftp/sftp server:

FTP access: ftp://ftp-access.aviso.altimetry.fr/

SFTP access: sftp://ftp-access.aviso.altimetry.fr:2221/

With your AVISO personal account

In the following folders:

/geophysical_data_record/range_latitudinal_empirical_correction_jason_1_2_3_gdr/

6 Contact

For more information, please contact:

Aviso+ User Services
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.

7 Bibliography

[1] Cadier E., Courcol B., Prandi P., Quet V., Moreau T., Maraldi C., Bignalet-Cazalet F., Dinardo S., Martin-Puig C., Donlon C.: Assessment of Sentinel-6MF low resolution numerical retracker over ocean: continuity on reference orbit and improvements, under review.

[2] Nilsson J., Forster L., Desai S., Desjonqueres J.-D., Haines B., Global cross-calibration of the jason-3 and sentinel-6 michael freilich missions during their tandem period. Poster OSTST 2022. doi: 10.24400/527896/a03-2022.3354.

[3] Cadier E., Bracher G., Maraldi C., Courcol B., Kocha C., Prandi P., Pujol M.-I., Bignalet-Cazalet F. : "Comparison of Jason-3 and Sentinel-6MF observations in the equatorial band: was Topex right from the start?". 30 Years of Progress in Radar Altimetry Symposium (2024). Poster.