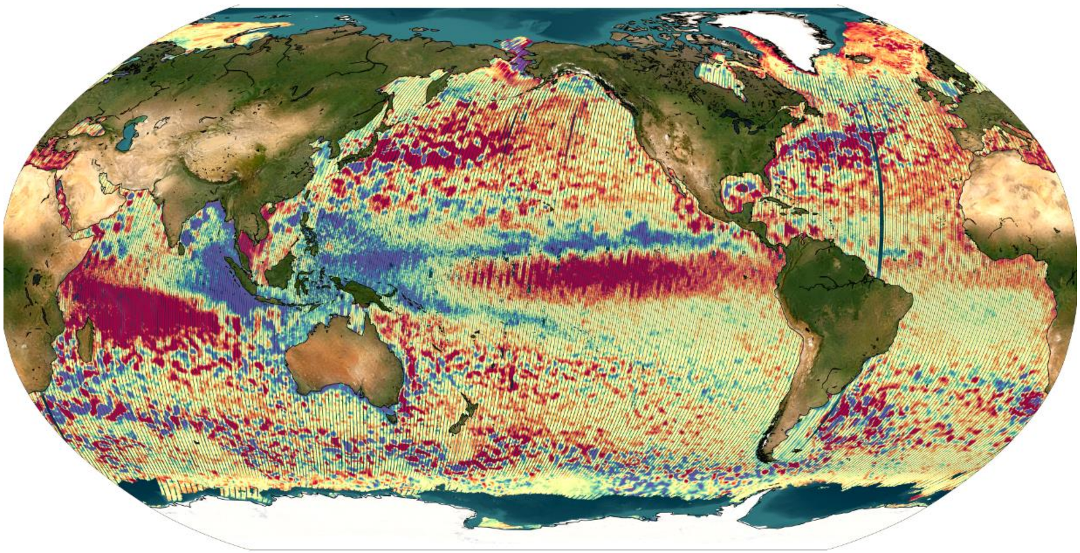
DUACS Level-3 SWOT KaRIn (L3_LR_SSH)
User Handbook



Nomenclature: SALP-MU-P-EA-23629-CLS

Issue:1.3

Date: September 2024

Chronology Issues:			
Issue:	Date:	Validated by	Reason for change:
1.0	September 2023		First issue
1.1	May 2024		Updated product release (V1.0)
1.2	June 2024		Addition of Unsmoothed products
1.3	September 2024		Add product versions changes V1.0.1 and V1.0.2 (Basic and Expert datasets)

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
L2P	Level-2+ product
L3	Level-3 product

Table of Contents

1 Introduction

This user manual describes the products named “Swot L3 KaRIn”. Level-3 products are formally part of the Science Team Project DESMOS and funded by the French Early Adopter Program (i.e. PIA). Those products are lightweight, simple, and usable out-of-the-box; moreover, Nadir altimeter & KaRIn measurements are displayed in one single image.

The Value-added compared to SWOT L2 KaRIn (L2_LR_SSH) products are:

- State of the art research-grade upgrades (incl. very recent & submitted papers)
- Multi-mission calibration (SWOT is consistent with other altimeters)
- Noise-mitigation for SSHA derivatives (experimental, AI-based)
- Pre-made sophisticated editing procedure KaRIn and nadir instruments blended into a single image
- L3 has new layers (optional) that can blend with L2 fields

3 types of files are distributed: Basic, Expert and Unsmoothed.

Basic L3_LR_SSH (or lightweight) include only SSHA (Sea Surface Height Anomaly) and mean dynamic topography.

Expert L3_LR_SSH (or extended) include the backscatter coefficient (sigma0), the mean sea surface (MSS) and geostrophic currents (absolute and anomalies) in addition to SSHA and mean dynamic topography (MDT). It also integrates algorithms, corrections and external models as separate layers.

Unsmoothed L3_LR_SSH: which includes the MSS, MDT and geostrophic currents (absolute and anomalies) in addition to the SSHA and MDT on the 250 m KaRIn native grid. Like the Expert subproduct, it also integrates a quality flag, corrections and external models as separate layers.

Publications should include the following statement in the Acknowledgments:

Citation Basic L3_LR_SSH:

"The SWOT_L3_LR_SSH product, derived from the L2 SWOT KaRIn Low rate ocean data products (L2_LR_SSH) (NASA/JPL and CNES), is produced and made freely available by AVISO and DUACS teams as part of the DESMOS Science Team project". AVISO/DUACS., 2023. SWOT Level-3 SSH Basic (v1.0.2) [Data set]. CNES. https://doi.org/10.24400/527896/A01-2023.017

Citation Expert L3_LR_SSH:

"The SWOT_L3_LR_SSH product, derived from the L2 SWOT KaRIn low rate ocean data products (L2_LR_SSH) (NASA/JPL and CNES), is produced and made freely available by AVISO and DUACS teams as part of the DESMOS Science Team project". AVISO/DUACS, 2023. SWOT Level-3 SSH Expert (v1.0.2) [Data set]. CNES. https://doi.org/10.24400/527896/A01-2023.018

Citation Unsmoothed L3_LR_SSH:

"The SWOT_L3_LR_SSH product, derived from the L2 SWOT KaRIn low rate ocean data products (NASA/JPL and CNES), is produced and made freely available by AVISO and DUACS teams as part of the DESMOS Science Team project". AVISO/DUACS, 2024. SWOT Level-3 KaRIn Low Rate SSH Unsmoothed (v1.0.1) [Data set]. CNES. https://doi.org/10.24400/527896/A01-2024.003

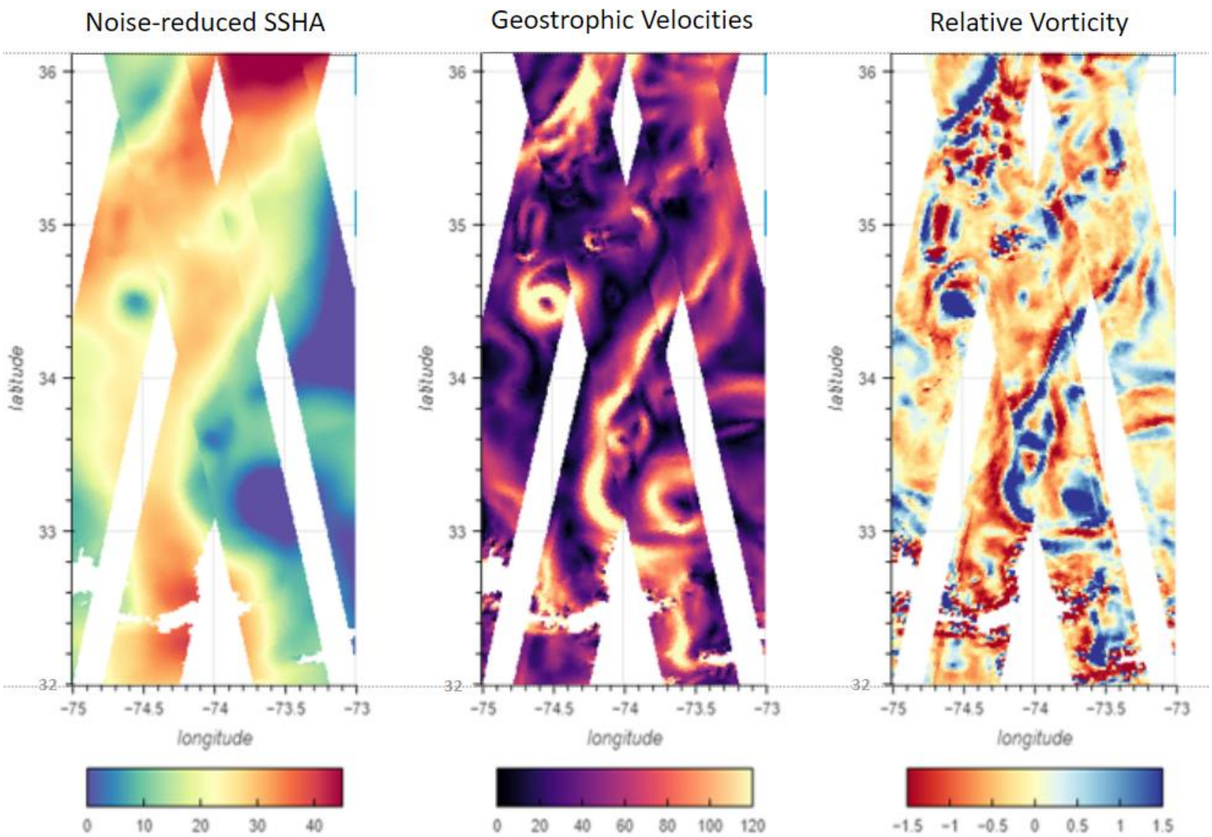


Figure 1: Example of SSHA (after noise reduction) (left), geostrophic velocities (middle) and relative vorticity (right) obtained with SWOT measurements contained in the SWOT KaRIn L3 products.

1.1 Data Policy and conditions of use

The SWOT L3 KaRIn Ocean product is available free of charge for scientific studies and commercial activities.

2 Processing

This section describes the processing of the SWOT L3 KaRIn (L3_LR_SSH) product. This product contains the KaRIn measurements as well as the Nadir measurements (only in Expert and Basic products): KaRIn and Nadir instruments are blended into a single image.

Note that a poster and a presentation dedicated to the processing named "SWOT Level-3 Overview algorithms and examples", from Dibarboure et al., have been presented at the SWOT Science Team in September 2023. (Poster and Presentation)
And a forthcoming paper authored by Dibarboure et al. (2024) intends to outline the processing methodology employed for SWOT Level 3 products.

2.1 Processing method

The following figure gives an overview of the system for the generation of the SWOT KaRIn L3 products. The Nadir component follows the same processing as the other altimeters as described in Pujol et al., 2023, and the L3 KaRIn processing sequence is given. The resultant L3 SWOT products contain both KaRIn and Nadir measurements.

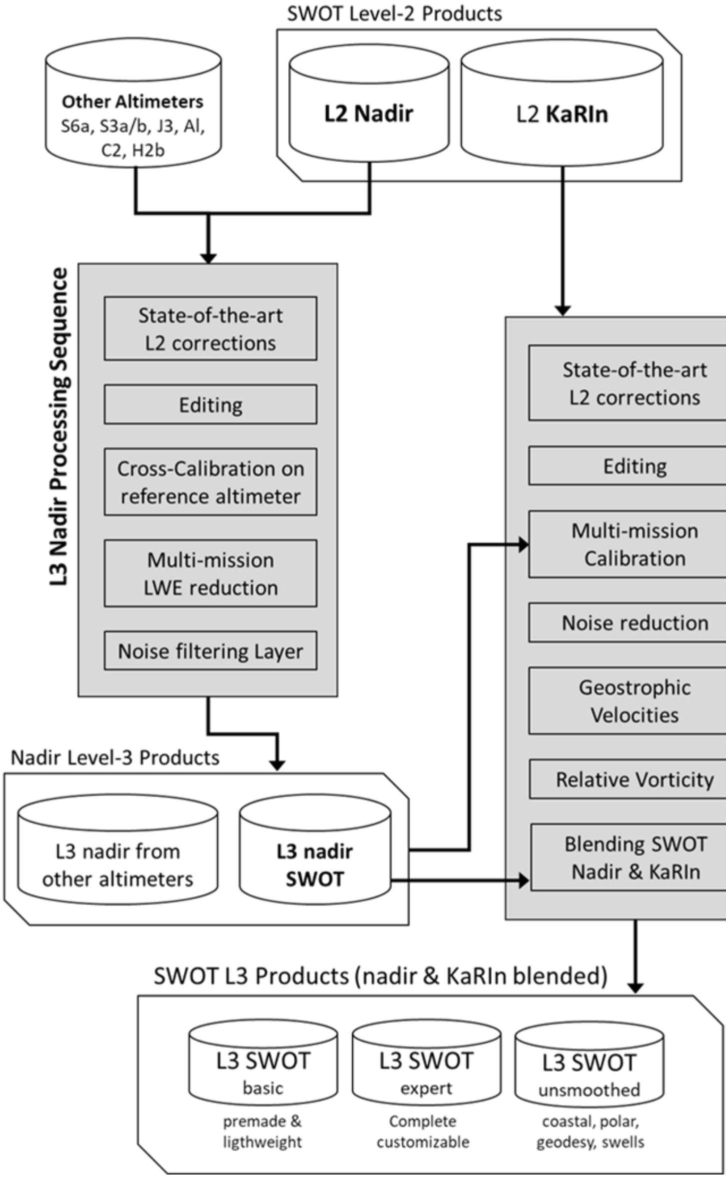


Figure 2: DUACS and SWOT L3 KaRIn and Nadir system processing

2.1.1 Input data

The input data used to compute these L3 KaRIn products are the L2 SWOT LR SSH, defined with a 2x2km or 250x250m spatial posting rate and distributed by AVISO+ (https://doi.org/10.24400/527896/a01-2023.015). The version of these products evolves with time. The Table 1 lists the L2 product version used in the L3 production.

2.1.2 Up-to-date standards

The measurements are then updated with the standards as follows:

	L3 SWOT-KaRIn v0.3	L3 SWOT-KaRIn v1.0	L3 SWOT-KaRIn v1.0.2
Product standard ref	PIA1 before 2023/09/06; PIB0 between 2023/09/06 and 2023/11/20; PIC0 after	PGC0 before 23/11/2023 PIC0 after	PGC0 before 10/01/2024 PIC0 after (see change notes for more details)
Orbit	POE-F		
Ionospheric	GIM model computed from vertical Total Electron Content maps (Chou et al. 2023) rescaled on the orbit altitude with IRI95 model (https://irimodel.org/)		
Wet troposphere	Model computed from ECMWF Gaussian grids		
Sea State Bias	Non-parametric SSB from AltiKa GDR-F (Tran 2019)		
Mean Profile/ Mean Sea Surface	Hybrid MSS (SIO22,CNES/CLS22,DTU21) (Schaeffer et al. 2023; Laloue et al., s. d.)		
Mean Dynamic Topography	MDT CNES_CLS_2022 (Jousset et Mulet 2020; Jousset et al. 2022) available on AVISO+ (https://doi.org/10.24400/527896/a01-2023.003)		
Dry troposphere	Model computed from ECMWF Gaussian grids (new S1 and S2 atmospheric tides are applied)		
DAC	DAC v4.0: TUGO forced with ECMWF pressure and wing fields (S1 and S2 were excluded) + inverse barometer computed from rectangular grids		
Ocean tide	FES2022: (Lyard et al. 2023; Loren Carrère et al. 2023) (https://doi.org/10.24400/527896/a01-2024.004)		
Internal tide	(Zaron 2019)(HRETv8.1 tidal frequencies: M2, K1, S2, O1)		
Pole tide	(Desai, Wahr, et Beckley 2015)& Mean Pole Location		
Solid earth tide	Elastic response to tidal potential (Cartwright et Edden 1973; Cartwright et Tayler 1971)		
Loading tide	FES2022: (Lyard et al. 2023; Loren Carrère et al. 2023)		

Table 1: Altimeter standards used in the L3 KaRIn production

2.1.3 Cross Calibration

The correction is computed with the XCAL algorithm. The reference for the XCAL algorithm is Dibarboure et al., June 2022, SWOT Science Team meeting, SWOT simulated Level-2 and Level-3 data-driven calibration and Dibarboure et al., Sep 2023, SWOT Science Team meeting, Crossover Calibration Status and Examples.

The methodology was improved in the L3 V1.0 version with an updated phase screen correction with two components (varying with beta angle and in-orbit position) and an improved interpolation method for short segments

The correction applied on the 250x250m product is an interpolation of the solution computed using 2x2km data.

2.1.4 Editing

The editing process mainly consists in applying the flags that are in the L2 input files. The variables taken into account are:

- ancillary_surface_classification_flag (to keep only ocean data),
- ssha_KaRIn_2_qual (L2 product flags)
- ssh_KaRIn_uncert (measurement uncertainty)
- distance_to_coast (for the coastal flag)
- cross_track_distance (distance from the nadir)

In the L3 v1.0, the sea ice concentration is no longer used.

In the L3 v1.0, a flag expert was created. Each step of the editing process can be activated or deactivated.

- Flag #102: No SSHa values available
- Flag #101: Pixels over land.
- Flag #100: Edges of swath. Only values between 10 to 60 km to the nadir are considered as valid data.
- Flag #70: Pixels impacted by spacecraft events.
- Flag #50: Abnormally high SSHA values.
- Flag #30: SSHA pixels out of the expected statistical distribution.
- Flag #20: Suspected sea-ice pixels.
- Flag #10: Suspected coastal pixels.
- Flag #5: SSHA pixels out of the local distribution.
- Flag #0: Valid data.

More details about each flag are available in Dibarboure et al (2024). The following figures show some cases of use of the flag expert. For most studies, we recommend keeping only flag #0.

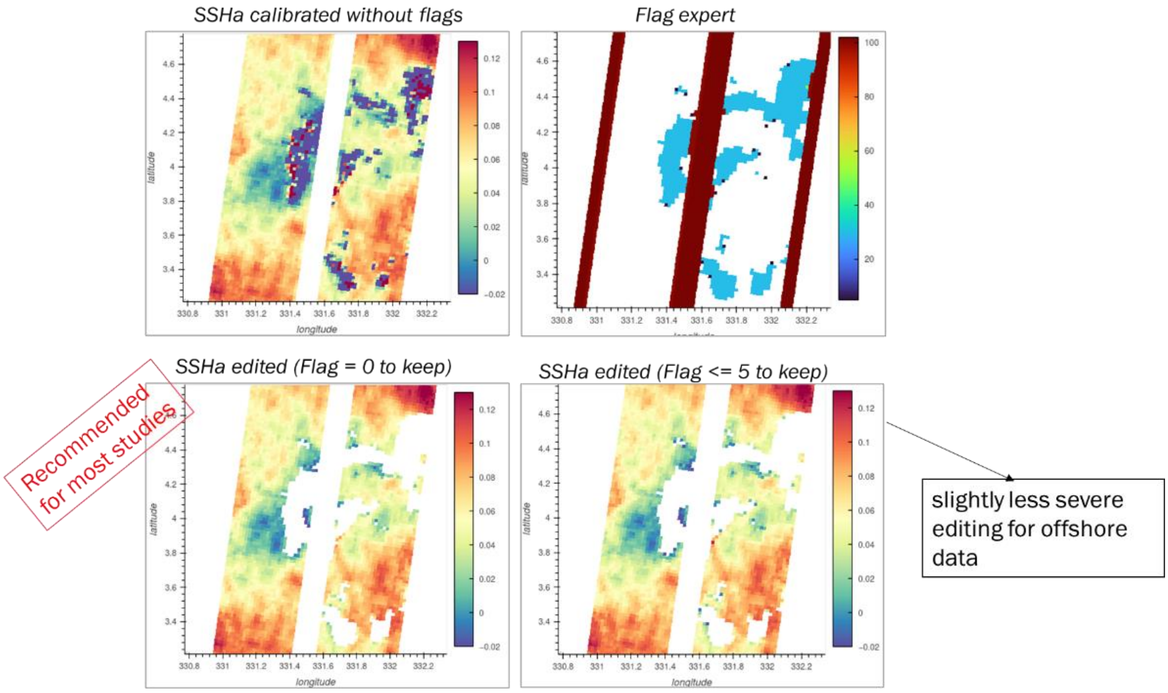


Figure 3: Editing of the rain cells. Keeping the flag #0 is recommended.

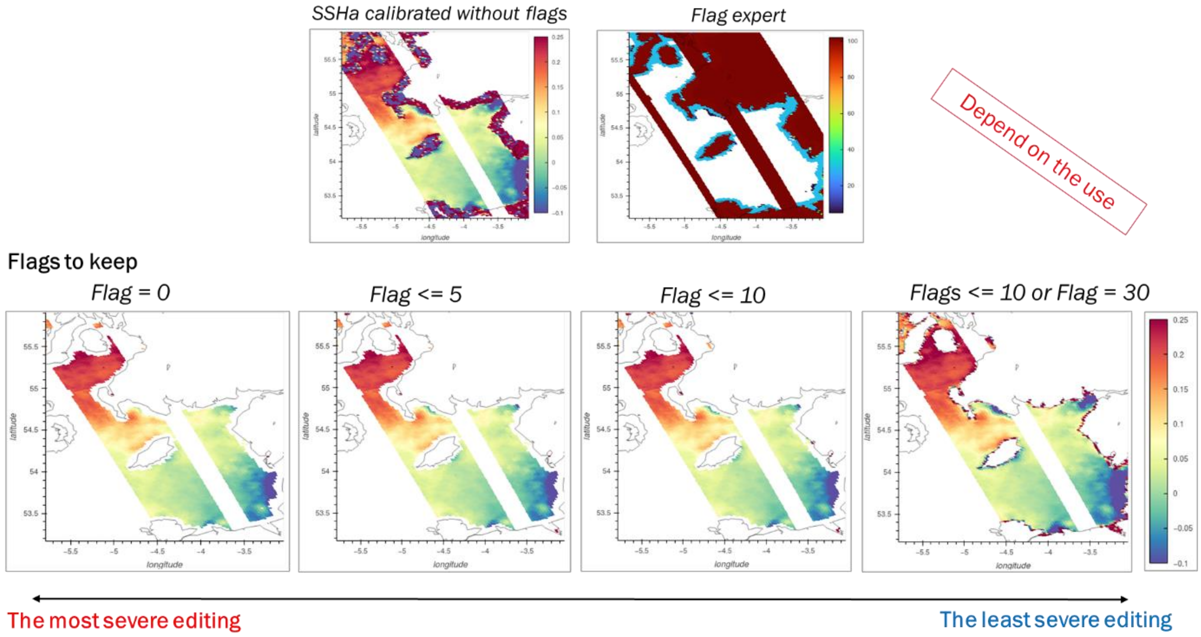


Figure 4: Editing of coastlines

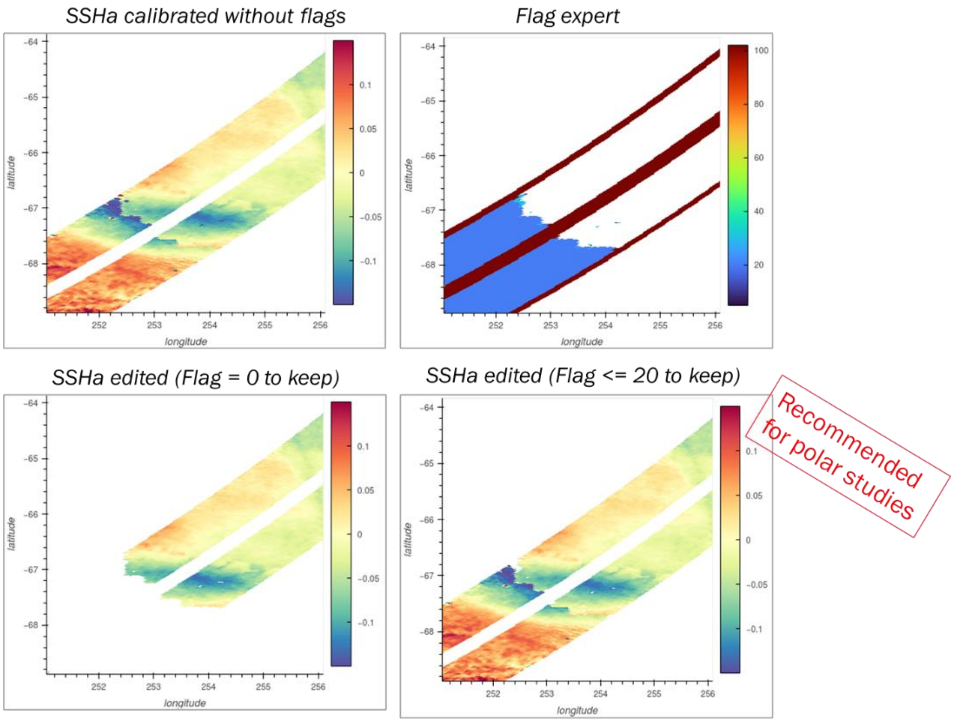


Figure 5: Editing of polar areas

2.1.5 Filtering

Despite its unprecedented precision, SWOT's Ka-band Radar Interferometer (KaRIn) still exhibits a substantial amount of random noise. A filtering method is then applied, it is described in Treboutte et al., 2023. It consists of a Neural Network which is based on a U-Net architecture and is trained and tested with simulated data from the North Atlantic. The following table presents the differences between the L3 v0.3 and the L3 v1.0 :

	Version 0.3	Version 1.0
Training dataset	Based on the eNATL60 ocean model without tides Noise generated by the SWOT simulator	Based on the eNATL60 ocean model with tides Correlated Noise generated by style transfer to be as realistic as possible
Use of the [Gomez et al, 2020] algorithm	Yes after the UNet	No

Table 2: Filtering method applied for L3 SWOT v0.3 and v1.0

More details about the training dataset are available in Dibarboure et al. (2024).

The **Figure 4** shows the impact of the filtering in the resultant current and the vorticity.

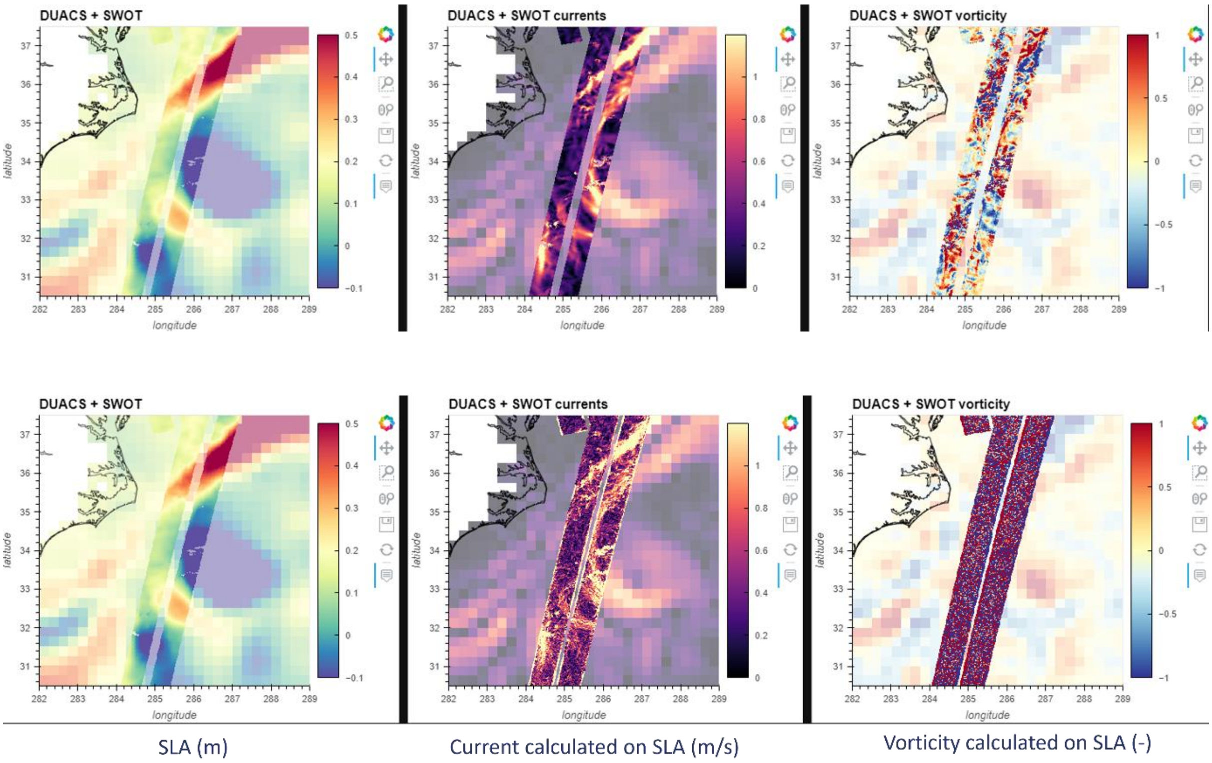


Figure 4: Sea Level Anomalies of DUACS and SWOT measurements (left), deduced current (middle) and vorticity (right) with the filtering applied (top) and without (bottom)

3 SWOT L3 KaRIn (L3_LR_SSH) Products

3.1 Temporal availability

Table 3**Erreur ! Source du renvoi introuvable.** indicates the first and last dates available (and the corresponding cycle number).

	V0.3	V1.0	V1.0.2
1-day CalVal phase	C474/T007 - C578/T002 29th March 2023 – 10th July 2023	C474/T003 - C578/T004 28th March 2023 – 10th July 2023	C474/T003 - C578/T004 28th March 2023 – 10th July 2023
21-day Science phase	C003/T170 - C006/T544 6th September 2023 – 21th November 2023	C001/T149 - C017/T557 26th July 2023 – 8th July 2024	C001/T149 - now 26th July 2023 - now

Table 3: Temporal availability of the SWOT L3 KaRIn time series

3.2 List of variables

Name of variable	Signification	Unit
time	Time of measurement in seconds in the UTC time scale since 1 Jan 1950 00:00:00 UTC.	s
longitude	Longitude	Degrees East
latitude	Latitude	Degrees North
ssha	sea surface height anomaly	meters
ssha_noiseless	sea surface height anomaly without noise	meters
ssha_unedited	sea surface height anomaly without editing	meters
ocean_tide	geocentric ocean tide height (FES)	meters
mdt	mean dynamic topography	meters
mss	mean sea surface height above the reference ellipsoid	meters
dac	dynamic atmospheric correction	meters
ugos,vgos	Geostrophic velocity anomalies: zonal and meridian component	meters/second
vgosa,vgosa	Absolute geostrophic velocity: zonal and meridian component	meters/second
sigma0	normalized radar cross section (sigma0) from KaRIn	-
cross_track_distance	Distance of sample from nadir.	meters
calibration	phase screen + xcal	meters
i_num_line	alongtrack indice of the nearest KaRIn pixel from the nadir data	count
i_num_pixel	acrosstrack indice of the nearest KaRIn pixel from the nadir data	count
quality_flag	Quality flag (see section 2.1.4 for details)	-

Table 4: List of variables in the NetCDF files (the variables in the blue lines are in Expert and Unsmoothed files only)

3.3 Nomenclature of files

The nomenclature used for these products is:

SWOT_L3_LR_SSH_<FileIdentifier>_<CCC>_<PPP>_<DateBegin>_<DateEnd>_v<Version>.nc

Where:

FileIdentifier is ‘Basic’ or ‘Expert’ or ‘Unsmoothed’

CCC is the number of cycle on 3 digits

PPP is the number of pass on 3 digits

DateBegin and DateEnd are the begin and end dates in UTC of the measurements in each file.

Version is ‘0.3’ or ‘1.0’ or ‘1.0.1’ or ‘1.0.2’

4 Change notes

This chapter presents the changes introduced by the successive new product versions

4.1 Version 1.0.1

4.1.1 Unsmoothed

An anomaly was detected in the Unsmoothed V1.0 netcdfs. The geophysical corrections (ocean_tide, DAC), the MSS, MDT and sigma0 values in the product had an inverted sea/land mask.

Below is an illustration of the anomaly and its correction:

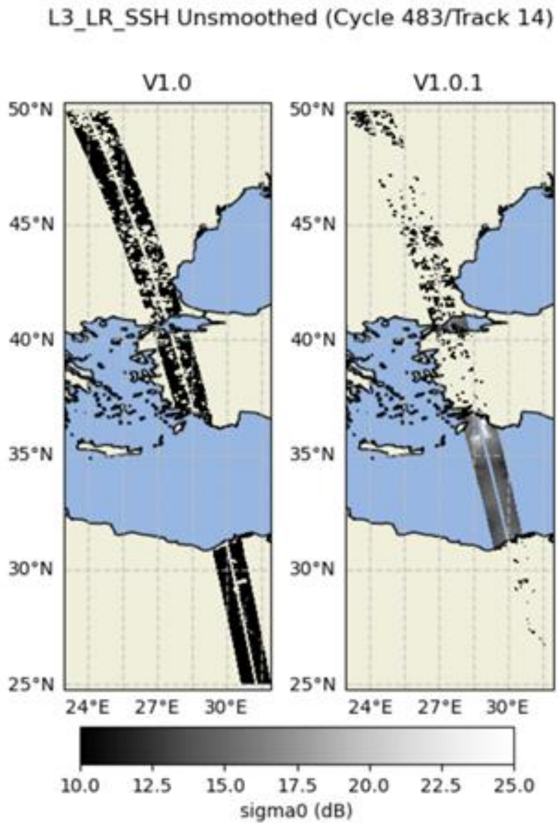


Figure 5: illustration of a badly filled field in V1.0.1 (left) and its correction in V1.0.2 (right)

4.2 Version 1.0.2

4.2.1 Basic, Expert and Unsmoothed

4.2.1.1 M0 wave removal

The M0 wave has been removed from the ocean tide correction FES2022 configuration. This change has a very small impact for users using the calibrated Sea Level Anomaly, because this large scale signal is absorbed by the calibration error in the V1.0.0.

The following figure illustrates the impact of removing the M0 wave over the ocean tide correction (left) and over the calibration (right). The patterns are similar, confirming the small impact over the calibrated Sea Level Anomaly.

Figure 6: illustration of a badly filled field in V1.0.1 (left) and its correction in V1.0.2 (right)

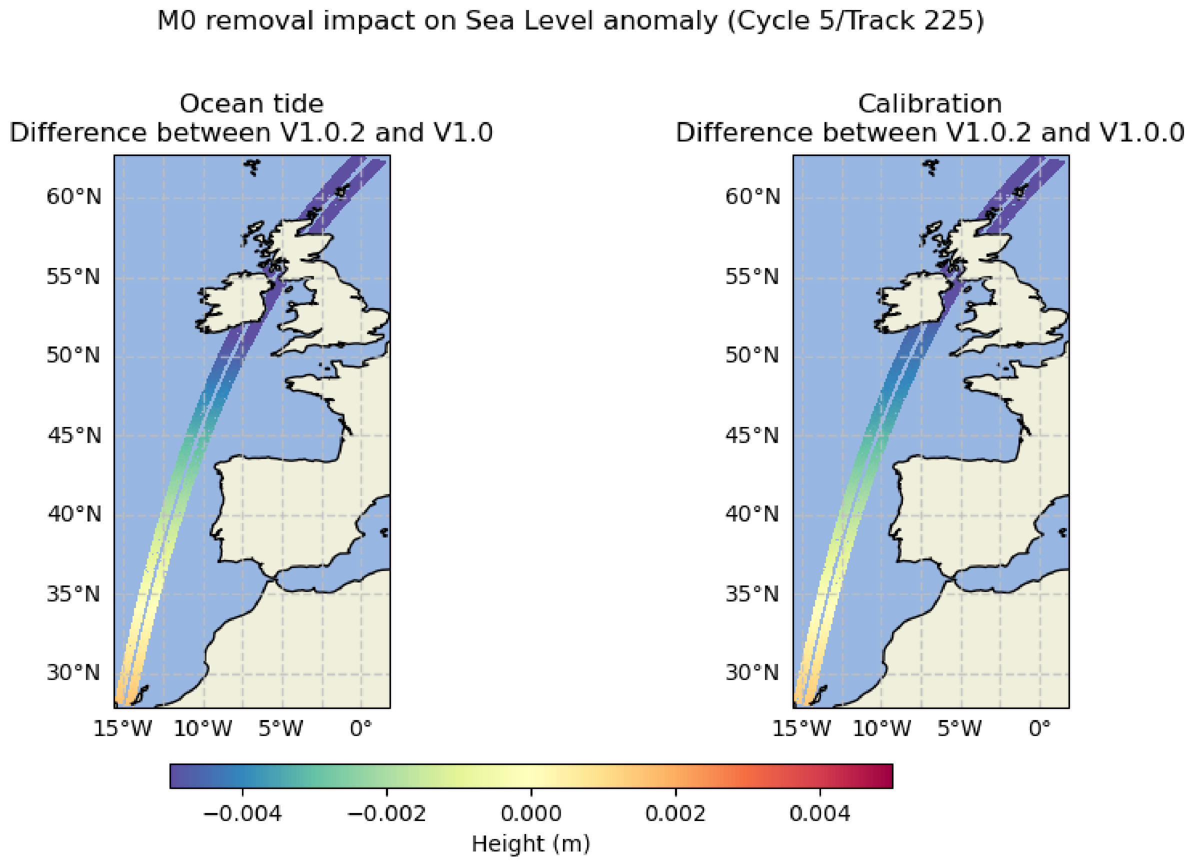


Figure 7: illustration of the M0 wave absorption by the calibration correction

4.2.2 Basic and Expert

4.2.2.1 Editing near the coast

The V1.0 introduced a newer and finer land-sea mask. The editing parametrization for pixels near the coast was not properly adjusted, which can cause wrongly-edited lines in the quality flag near the coast. The new parametrization fixes this issue in the V1.0.2

Figure 8: illustration of the M0 wave absorption by the calibration correction

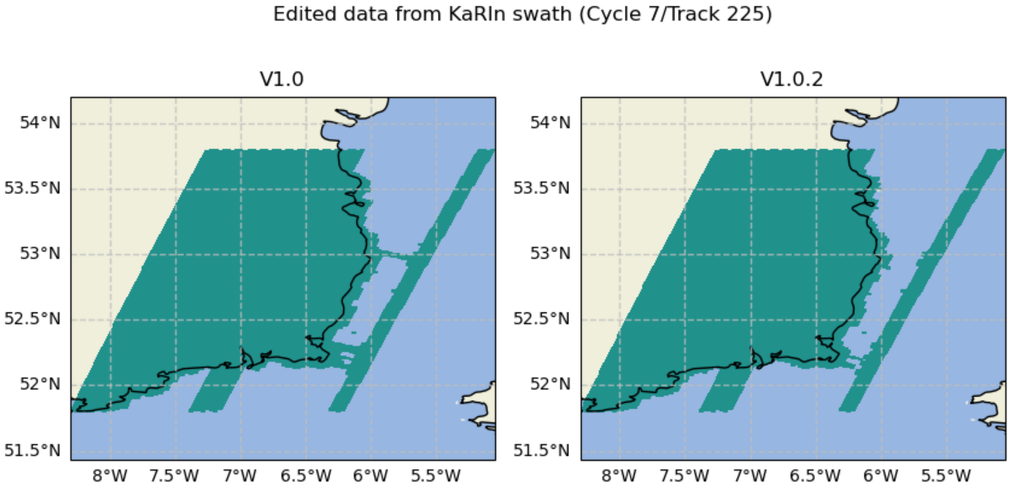


Figure 9: change in editing parametrization. The V1.0 (left) exhibits lines near the coast that should not by edited and are not present in the V1.0.2 (right)

4.2.2.2 Ocean tide in Sea Level Anomaly

For products based on PIC upstream data, the ocean tide correction has been wrongly applied. The ocean_tide field contains the expected FES2022 model, but the sea level anomaly has been corrected using an alternative FES2014 field. The V1.0.2 fixes the tide correction in the sea level anomaly.

This issue only impacts Basic and Expert datasets starting from cycle 7

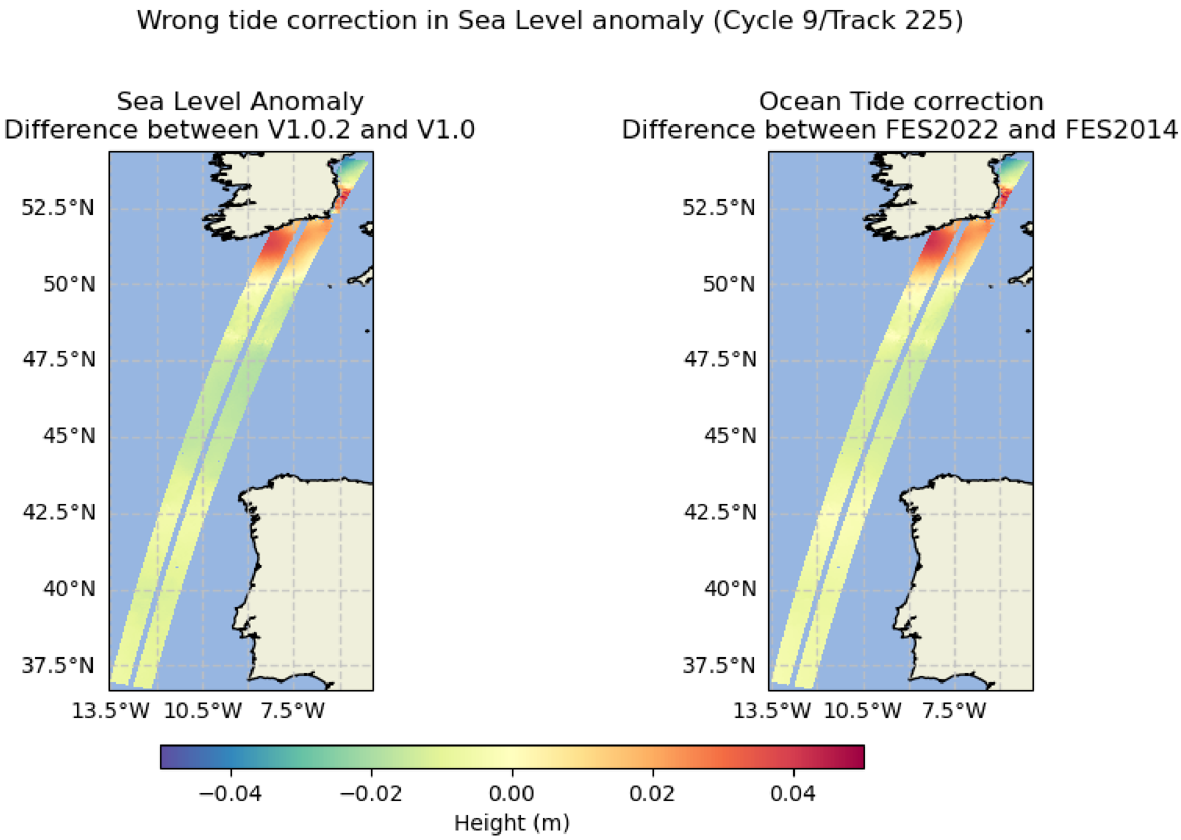


Figure 10: illustration of the Sea Level Anomaly change caused by a proper application of the ocean tide between V1.0 and V1.0.2

4.2.2.3 Sea state bias filling

Regions with ice have a default value for the Sea State Bias (SSB) correction. This default value introduced a bias on the non edited Sea Level Anomaly between the high latitudes and the rest of the ocean. This is of no consequence over the edited ssha or filtered Sea Level Anomaly ssha_noiseless because these regions are edited. However, this can be seen on the calibrated Sea Level Anomaly ssha_unedited. The SSB filling method has changed to mitigate this effect.

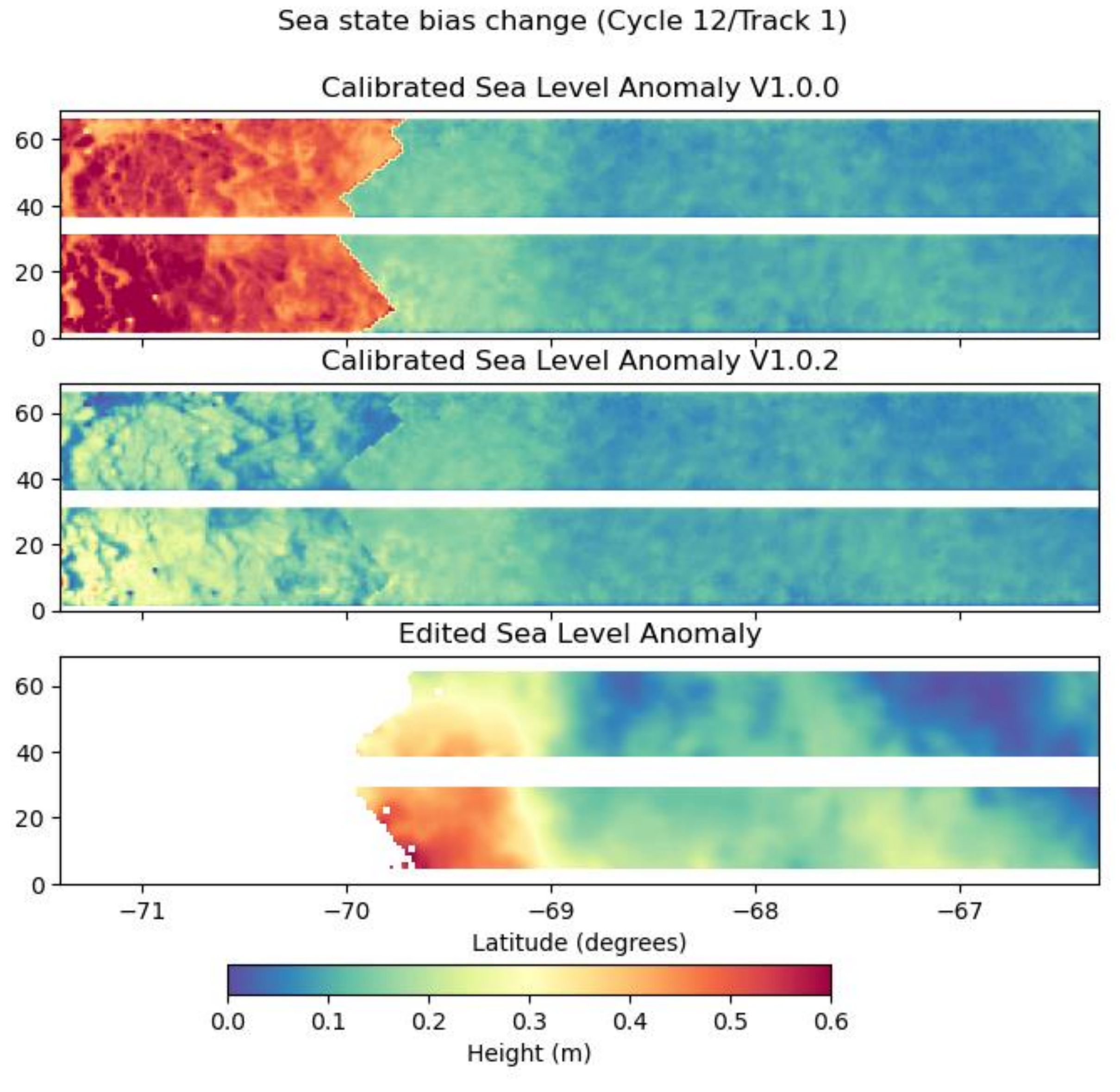


Figure 11: Sea State Bias filling method illustration

This change only affects the sea state bias correction in the Basic and Expert products. The Unsmoothed product still uses the old filling method.

4.2.2.4 PIC/PGC blending

Because the PGC does not cover the most recent periods, the L3_LR_SSH upstream data is a blending of two L2_LR_SSH versions: PIC and PGC. Previously, the PGC to PIC switch was at Cycle 7 but newly available data made it possible to use PGC data up to Cycle 9.

To summarize the upstream data versions:

- PIC0 starting from Cycle 9 / Track 388
- PGC0 up to Cycle 9 / Track 387 included, minus the exceptions listed in the following table

List of PIC half orbits (ranges are inclusive)

Cycle 7	[521-531], 533, [535-536], [538-542], [544-547]
Cycle 9	[335-336], [388, 584]

5 Data format

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

5.1 NetCDF

The products are 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 products are 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 files are using a common structure and semantic as shown in the example below:

EXPERT

```
netcdf SWOT_L3_LR_SSH_Expert_560_012_20230622T175823_20230622T184927_v1.0.2 {
dimensions:
	num_lines = 9860 ;
	num_pixels = 69 ;
	num_nadir = 1619 ;
variables:
	double time(num_lines) ;
		time:comment = "Time of measurement in seconds in the UTC time scale since 1 Jan 2000 00:00:00 UTC. [tai_utc_difference] is the difference between TAI and UTC reference time (seconds) for the first measurement of the data set. If a leap second occurs within the data set, the attribute leap_second is set to the UTC time at which the leap second occurs." ;
		time:leap_second = "0000-00-00T00:00:00Z" ;
		time:long_name = "time in UTC" ;
		time:standard_name = "time" ;
		time:tai_utc_difference = 37. ;
		time:calendar = "gregorian" ;
		time:units = "seconds since 2000-01-01 00:00:00.0" ;
	int calibration(num_lines, num_pixels) ;
		calibration:_FillValue = -2147483647 ;
		calibration:scale_factor = 0.0001 ;
		calibration:comment = "phase screen + phase_screen_static + phase_screen_orbit + xcal. the uncorrected ssha can be computed as follows: [uncorrected ssha]=[ssha from product] + [calibration]; see the product user manual for details" ;
		calibration:coordinates = "longitude latitude" ;
		calibration:long_name = "satellite calibration" ;
		calibration:units = "m" ;
	double cross_track_distance(num_pixels) ;
		cross_track_distance:comment = "Distance of sample from nadir. Negative values indicate the left side of the swath, and positive values indicate the right side of the swath.)" ;
		cross_track_distance:coordinates = "longitude latitude" ;
		cross_track_distance:long_name = "cross track distance" ;
		cross_track_distance:units = "m" ;
		cross_track_distance:valid_max = 75000. ;
		cross_track_distance:valid_min = -75000. ;
	short dac(num_lines, num_pixels) ;
		dac:_FillValue = -32767s ;
		dac:scale_factor = 0.0001 ;
		dac:comment = "Model estimate of the effect on sea surface topography due to high frequency air pressure and wind effects and the low-frequency height from inverted barometer effect. The ssha in this file is already corrected for the dac; the uncorrected ssha can be computed as follows: [uncorrected ssha]=[ssha from product]+[dac]; see the product user manual for details" ;
		dac:coordinates = "longitude latitude" ;
		dac:institution = "LEGOS/CNES/CLS" ;
		dac:long_name = "dynamic atmospheric correction" ;
		dac:source = "MOG2D" ;
		dac:units = "m" ;
	int latitude(num_lines, num_pixels) ;
```

```
        latitude:scale_factor = 1.e-06 ;
        latitude:comment = "Latitude of measurement [-80,80]. Positive latitude is North latitude, negative latitude is South latitude." ;
        latitude:long_name = "latitude (positive N, negative S)" ;
        latitude:standard_name = "latitude" ;
        latitude:units = "degrees_north" ;
    int longitude(num_lines, num_pixels) ;
        longitude:scale_factor = 1.e-06 ;
        longitude:comment = "Longitude of measurement. East longitude relative to Greenwich meridian." ;
        longitude:long_name = "longitude (degrees East)" ;
        longitude:standard_name = "longitude" ;
        longitude:units = "degrees_east" ;
    int mdt(num_lines, num_pixels) ;
        mdt:_FillValue = -2147483647 ;
        mdt:scale_factor = 0.0001 ;
        mdt:comment = "The mean dynamic topography is the sea surface height above geoid; it is used to compute the absolute dynamic topography adt=ssha+mdt" ;
        mdt:coordinates = "longitude latitude" ;
        mdt:long_name = "mean dynamic topography" ;
        mdt:standard_name = "mean_dynamic_topography_cnes_cls" ;
        mdt:units = "m" ;
    int mss(num_lines, num_pixels) ;
        mss:_FillValue = -2147483647 ;
        mss:scale_factor = 0.0001 ;
        mss:comment = "Mean sea surface height above the reference ellipsoid. The value is referenced to the mean tide system, i.e. includes the permanent tide (zero frequency)." ;
        mss:coordinates = "longitude latitude" ;
        mss:long_name = "mean sea surface height (CNES/CLS)" ;
        mss:units = "m" ;
    int ocean_tide(num_lines, num_pixels) ;
        ocean_tide:_FillValue = -2147483647 ;
        ocean_tide:scale_factor = 0.0001 ;
        ocean_tide:comment = "Geocentric ocean tide height. Includes the total sum of the ocean tide, the corresponding load tide and equilibrium long-period ocean tide height. The ssha in this file is already corrected for the ocean_tide; the uncorrected ssha can be computed as follows: [uncorrected ssha]=[ssha from product]+[ocean_tide]; see the product user manual for details" ;
        ocean_tide:coordinates = "longitude latitude" ;
        ocean_tide:institution = "LEGOS/CNES" ;
        ocean_tide:long_name = "geocentric ocean tide height (FES)" ;
        ocean_tide:source = "FES2022" ;
        ocean_tide:units = "m" ;
    ubyte quality_flag(num_lines, num_pixels) ;
        quality_flag:comment = "Deduced from L3 DUACS processing." ;
        quality_flag:coordinates = "longitude latitude" ;
        quality_flag:flag_masks = 0LL, 5LL, 10LL, 20LL, 30LL, 50LL, 70LL, 100LL, 101LL, 102LL ;
        quality_flag:flag_meanings = "good local_outliers bad_quality_coast ice soft_outliers extremes mission_event bad_swath_extremities not_on_sea no_data" ;
        quality_flag:long_name = "Quality Flag" ;
        quality_flag:standard_name = "valid_flag_for_data" ;
    int sigma0(num_lines, num_pixels) ;
        sigma0:_FillValue = -2147483647 ;
        sigma0:scale_factor = 0.0001 ;
        sigma0:comment = "Normalized radar cross section (sigma0) from KaRIn in real, linear units (not decibels).  The value may be negative due to noise subtraction.  The value is corrected for instrument calibration and atmospheric attenuation. A meteorological model provides the atmospheric attenuation (sig0_cor_atmos_model).)" ;
        sigma0:coordinates = "longitude latitude" ;
        sigma0:long_name = "normalized radar cross section (sigma0) from KaRIn)" ;
```

```
		sigma0:standard_name = "surface_backwards_scattering_coefficient_of_radar_wave" ;
		sigma0:units = "1" ;
		sigma0:valid_max = 10000000 ;
		sigma0:valid_min = -1000 ;
	int ssha(num_lines, num_pixels) ;
		ssha:_FillValue = -2147483647 ;
		ssha:scale_factor = 0.0001 ;
		ssha:comment = "Height of the sea surface anomaly with all corrections applied." ;
		ssha:coordinates = "longitude latitude" ;
		ssha:long_name = "sea surface height anomaly" ;
		ssha:standard_name = "sea_surface_height_above_reference_ellipsoid" ;
		ssha:units = "m" ;
	int ssha_noiseless(num_lines, num_pixels) ;
		ssha_noiseless:_FillValue = -2147483647 ;
		ssha_noiseless:scale_factor = 0.0001 ;
		ssha_noiseless:comment = "Height of the sea surface anomaly with all corrections applied
and denoised using Unet model." ;
		ssha_noiseless:coordinates = "longitude latitude" ;
		ssha_noiseless:long_name = "sea surface height anomaly without noise" ;
		ssha_noiseless:standard_name = "sea_surface_height_above_reference_ellipsoid" ;
		ssha_noiseless:units = "m" ;
	int ssha_unedited(num_lines, num_pixels) ;
		ssha_unedited:_FillValue = -2147483647 ;
		ssha_unedited:scale_factor = 0.0001 ;
		ssha_unedited:comment = "Height of the sea surface anomaly with all corrections applied
but without editing." ;
		ssha_unedited:coordinates = "longitude latitude" ;
		ssha_unedited:long_name = "sea surface height anomaly" ;
		ssha_unedited:standard_name = "sea_surface_height_above_reference_ellipsoid" ;
		ssha_unedited:units = "m" ;
	int ugos(num_lines, num_pixels) ;
		ugos:_FillValue = -2147483647 ;
		ugos:scale_factor = 0.0001 ;
		ugos:coordinates = "longitude latitude" ;
		ugos:long_name = "Absolute geostrophic velocity: zonal component" ;
		ugos:standard_name = "surface_geostrophic_eastward_sea_water_velocity" ;
		ugos:units = "m/s" ;
	int ugosa(num_lines, num_pixels) ;
		ugosa:_FillValue = -2147483647 ;
		ugosa:scale_factor = 0.0001 ;
		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" ;
	int vgos(num_lines, num_pixels) ;
		vgos:_FillValue = -2147483647 ;
		vgos:scale_factor = 0.0001 ;
		vgos:coordinates = "longitude latitude" ;
		vgos:long_name = "Absolute geostrophic velocity: meridian component" ;
		vgos:standard_name = "surface_geostrophic_northward_sea_water_velocity" ;
		vgos:units = "m/s" ;
	int vgosa(num_lines, num_pixels) ;
		vgosa:_FillValue = -2147483647 ;
		vgosa:scale_factor = 0.0001 ;
		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" ;
        short i_num_line(num_nadir) ;
            i_num_line:comment = "alongtrack indice of the nearest karin pixel from the nadir data" ;
            i_num_line:long_name = "alongtrack indice of the nearest karin pixel from the nadir data"
;
            i_num_line:units = "count" ;
        byte i_num_pixel(num_nadir) ;
            i_num_pixel:comment = "acrosstrack indice of the nearest karin pixel from the nadir data"
;
            i_num_pixel:long_name = "acrosstrack indice of the nearest karin pixel from the nadir
data" ;
            i_num_pixel:units = "count" ;

// global attributes:
            :Conventions = "CF-1.7" ;
            :Metadata_Conventions = "Unidata Dataset Discovery v1.0" ;
            :cdm_data_type = "Swath" ;
            :comment = "Sea Surface Height measured by Altimetry" ;
            :data_used = "SWOT KaRIn L2_LR_SSH PGC0/PIC0 (NASA/CNES). DOI associated:
https://doi.org/10.24400/527896/a01-2023.015" ;
            :doi = "https://doi.org/10.24400/527896/A01-2023.018" ;
            :geospatial_lat_units = "degrees_north" ;
            :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" ;
            :institution = "CLS, CNES" ;
            :keywords = "Oceans > Ocean Topography > Sea Surface Height" ;
            :keywords_vocabulary = "NetCDF COARDS Climate and Forecast Standard Names" ;
            :platform = "Swot" ;
            :processing_level = "L3" ;
            :product_version = "1.0.2" ;
            :project = "SSALTO/DUACS" ;
            :reference_altimeter = "S6" ;
            :source = "Altimetry measurements" ;
            :ssalto_duacs_comment = "The reference mission used for the altimeter inter-calibration
processing is Sentinel-6A" ;
            :standard_name_vocabulary = "NetCDF Climate and Forecast (CF) Metadata Convention
Standard Name Table v37" ;
            :time_coverage_resolution = "P1S" ;
            :title = "NRT SWOT KaRIn & nadir Global Ocean swath SSALTO/DUACS Sea Surface Height
L3 product" ;
            :contact = "aviso@altimetry.fr" ;
            :creator_email = "aviso@altimetry.fr" ;
            :creator_name = "DUACS - Data Unification and Altimeter Combination System" ;
            :creator_url = "https://aviso.altimetry.fr" ;
            :license                                                                            =
"https://www.aviso.altimetry.fr/fileadmin/documents/data/License_Aviso.pdf" ;
            :references = "https://aviso.altimetry.fr" ;
            :time_coverage_begin = "2023-06-22T17:58:23Z" ;
            :time_coverage_end = "2023-06-22T18:49:27Z" ;
            :geospatial_lat_min = -78.272132 ;
            :geospatial_lat_max = 78.272321 ;
            :geospatial_lon_min = 0.000205 ;
            :geospatial_lon_max = 359.999104 ;
            :date_modified = "2024-08-07T20:53:08Z" ;
            :history = "2024-08-07T20:53:08Z: Created by DUACS KaRIn prototype" ;
```

```
        :date_created = "2024-08-07T20:53:08Z" ;
        :date_issued = "2024-08-07T20:53:08Z" ;
}
```

6 Accessibility of the products

If you already have an AVISO account, data access is available through the following services:

CNES AVISO FTP/SFTP (with AVISO+ credentials)

- FTP access: ftp://ftp-access.aviso.altimetry.fr:21
- SFTP access: sftp://ftp-access.aviso.altimetry.fr:2122
    - /swot_products/l3_karin_nadir/l3_lr_ssh/

CNES AVISO THREDDS Data Server, TDS (with AVISO+ credentials)

- TDS access: https://tds.aviso.altimetry.fr
- https://tds.aviso.altimetry.fr/thredds/L3/dataset-l3-swot-karin-nadir-validated.html

7 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.

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