


SARAL/ALTIKA GDR-F USER GUIDE

Date et Signature		DIFFUSION	nb
Préparé par	F. BIGNALET-CAZALET (CNES)		AVISO Web Site
	S. URIEN (CLS)		
	S. COUSTANCE (CNES)		
	G. JETTOU (CLS)		
Vérifié par	N. PICOT (CNES)		
	P. BONNEFOND (SARAL mission P.I.Obs. De Paris, SYRTE)		
	N. QUERUEL (CNES)		
Visa Qualité	N/A		
Application autorisée par	T. GUINLE (CNES) 		

Page d'analyse documentaire

Classification (+ qualification pour Diffusion Limitée) : Non sensible		
Mots clés : SARAL ALTIKA GDR-F		
Rédacteurs : F. BIGNALET-CAZALET, S. URIEN (CLS), S. COUSTANCE, G. JETTOU (CLS)		
Résumé : This user guide provides the users with the differences between SARAL/AltiKa GDR-T format and GDR-F formats		
Gestion en configuration : non	A dater du :	Par :
Contrat :		
Logiciel(s) hôte : Word MS-Office	Nombre de pages supplémentaires :	

HISTORIQUE DES MODIFICATIONS

Version	Date	Chapitres modifiés / Raison / Nature de l'évolution
1.0	19/11/2019	Creation
1.1	20/01/2020	Update for Operational switch

Documents de référence

Référence		Titre du document
DR1	SALP-MU-M-OP-15984-CN	SARAL/AltiKa Products Handbook

ABBREVIATIONS

Sigle	Definition
AD	Applicable Documents
AGC	Automatic Gain Control
CAL	Calibration
CAL1	Calibration mode 1 : PTR calibration



CAL2	Calibration mode 2 : LPF calibration
CAG	French acronym for AGC (Automatic Gain Control)
CDL	Common Data Language
CF	Climate and Forecast convention
CLS	Collecte Localisation Satellites
CNES	Centre National d'Etudes Spatiales
CNG	Commande Numérique de Gain
COG	Center Of Gravity
DAD	Dynamic Auxiliary Data
DORIS	Doppler Orbitography and Radiopositioning Integrated by Satellite
ECMWF	European Centre for Medium-Range Weather Forecasts
FFT	Fast Fourier Transform
GDR	Geophysical Data Record
GPS	Global Positioning System
IGDR	Interim Geophysical Data Record
LPF	Low Pass Filter
LSB	Least Significant Bit
LTM	Long Term Monitoring
LUT	Look Up Table
MDS	Measurement Data Set
MQE	Mean Quadratic Error
N/A	Not Applicable
NC	NetCDF
NRT	Near Real Time
OFL	Off Line
OGDR	Operational Geophysical Data Record
POD	Precise Orbit Determination
POE	Precise Orbit Ephemeris
PTR	Point Target Response
RD	Reference Documents
RMS	Root Mean Square
SAD	Static Auxiliary Data
SALP	Service d'Altimétrie et Localisation Précise
SDR	Sensor Data Record
SGDR	Sensor Geophysical Data Record
SNR	Signal to Noise Ratio
SSALTO	Segment Sol ALTimétrie et Orbitographie

SSHA	Sea-Surface Height Anomaly
SSB	Sea State Bias
SST	Sea Surface Temperature
SWH	Significant WaveHeight
TBC	To Be Confirmed
TBD	To Be Defined
TEC	Total Electron Content
TFMRA	Threshold First-Maximum Retracker Algorithm
USO	Ultra Stable Oscillator
UTC	Universal Time Coordinate

SOMMAIRE

1. INTRODUCTION	6
2. FROM GDR-T TO GDR-F	7
2.1. MAJOR IMPROVEMENTS	7
2.2. MODEL EVOLUTIONS.....	8
2.3. MAJOR INTERFACE CHANGES.....	8
2.4. VARIABLE EVOLUTIONS	18
2.5. REFERENCES	31
3. CALVAL ASSESSMENT MAIN RESULTS : GLOBAL EFFECT ON SEA SURFACE HEIGHT AT ALTIKA CROSSOVERS	32
4. LIMITATIONS AND KNOWN ISSUES IN GDR-F 2015 DEMO RELEASE	33
4.1. INTERNAL TIDE	33
4.2. MISSING SECTIONS	33
4.3. AGE OF CALIBRATION.....	33
5. TENTATIVE SCHEDULE FOR SARAL GDR-F DELIVERIES	34

1. INTRODUCTION

SARAL/AltiKa was launched on February, 25th 2013, as a follow-on mission to ENVISAT ESA's mission. The satellite name SARAL stands for SAtellite for ARgos and ALtiKa. SARAL/AltiKa is a collaboration between CNES and ISRO (Indian Space Research Organization).

For the last 2 years and as announced during successive OST Science Team meetings, CNES has made a lot of efforts in order to define, implement and validate the new GDR-F standard. In November 2019, the task is almost completed and CNES is able to deliver a one-year demo of SARAL/AltiKa products reprocessed in GDR-F format.

As the evolution between T and F standard is a major one leading to a lot of changes, this Handbook is aimed to guide the users for a better understanding of differences between SARAL/AltiKa GDR-T format and GDR-F format.

The NetCDF-4/HDF5 with compression model data format has been chosen to store the different data sets. As for GDR-T, the files will follow as much as possible the Climate and Forecast NetCDF conventions CF-1.1.

This guide provides:

1. This introduction
2. The listing of differences between GDR-T and GDR-F
 - the major evolutions
 - the exhaustive evolution list of models
 - the exhaustive evolution list of dataset variables
3. The main results of Cal/Val assessment
4. The known issues of the demo release
5. The forecast schedule for GDR-F global reprocessing and routine production

For a complete GDR-T description, users can refer to the SARAL/AltiKa Products Handbook:

SALP-MU-M-OP-15984-CN Issue: 3 rev 0 (May 15th 2016)

A new issue of this document will be provided with the global reprocessing.

2. FROM GDR-T TO GDR-F

The transition between Saral GDR-T and Saral GDR-F includes about 50 improvements. Some of those upgrades have an impact on one or several GDR variables, some others only in S-GDR variables, some others in global attributes.

Globally, around 45 GDR-T existing variables are impacted, and from 43 (GDR) to 48 variables (S-GDR) are added.

After a summary of major upgrades which have a significant impact on data quality, we provide in this chapter two exhaustive reading grids: the first is model upgrade oriented, while the second is variable oriented.

2.1. MAJOR IMPROVEMENTS

The major evolutions are listed hereafter.

New fields	Updated fields
3-Parameter SSB (SWH, wind and swell)	Retracking accounting for the actual altimeter antenna aperture
Wet & dry tropospheric correction based on 3D ECMWF fields	Updated altimeter calibration schemes (CAL2 normalization, CAL1 not corrected by CAL2, updated gains values)
Atmospheric correction derived from ECMWF fields	New Radiometer processing algorithms
New geophysical corrections: E. Zaron internal tide model	Updated geophysical corrections: FES2014 & GOT4.10 ocean tide models S. Desai pole tide with new IERS linear mean pole 2018 Mean Dynamic Topography model EGM 2008 geoid model
Platform mispointing angles	Netcdf v4 product format

2.2. MODEL EVOLUTIONS

The table below provides all the model changes implemented in GDR-F wrt GDR-T.

In the table, changes are grouped in four main categories:

- Product file: changes that impacts the product format or non-altimetry data.
- Altimeter: changes that impact altimeter data (waveforms, retracked estimates, calibration data, etc.)
- Radiometer: changes that impact radiometer data or estimates.
- Geophysical: changes that impact the geophysical data provided by external sources, used for computing correction terms included in Sea Level Anomaly.

For a better reading, categories are divided in sub-categories. Main sub-categories are :

- Altimeter category: Range, Retracking, Sigma0, Ice, Mispointing, SSHA, wind, waveform, calibration
- Radiometer category: Wet Tropo Correction
- Geophysical : Tides, Sea State, MSS, MDT, Geoid, etc.

2.3. MAJOR INTERFACE CHANGES

Three variable names change (see §2.4 for details):

- `mean_sea_surface` is no longer available, replaced by `mean_sea_surface_sol1`
- `interp_flag_mean_sea_surface` is no longer available, replaced by `interp_flag_mean_sea_surface_sol1`
- In Reduced Products Only, `ocean_tide_sol1` is no longer available, replaced by `ocean_tide_sol2`

Category	sub cat	Title	Description	Saral main impacted variables
Product file	Format	Netcdf v4 format	<p>The NetCDF-4/HDF5 classic model format is used, replacing the NetCDF-3 format.</p> <p>A NetCDF native compression is applied: nc_def_var_deflate using : - Shuffle = 0 (False) - Deflate = 1 (True) - deflate_level = 6</p>	all
Product file	Version	Set version to 'F'	Change the Data Record version to «GDR-F» .	none
Product file	Contacts	Update email address	Products' header : modify the contact email addresses. aviso@altimetry.fr	global attribute "contact" contains aviso@altimetry.fr
Altimeter	Range	Existing Doppler correction applied to all ranges	Previously applied only on ocean retracking estimates.	ice1_range_40hz; seaice_range_40hz; ice2_range_40hz; ice3_range_40hz



PARIS - Les Halles
SIÈGE
2, place Maurice Quentin
75039 Paris Cedex 01
☎ +33 (0)1 44 76 75 00

PARIS - Daumesnil
DIRECTION DES LANCEURS
52, rue Jacques Hillairet
75612 Paris Cedex
☎ +33 (0)1 80 97 71 11

TOULOUSE
CENTRE SPATIAL DE TOULOUSE
18, avenue Édouard Belin
31401 Toulouse Cedex 9
☎ +33 (0)5 61 27 31 31

GUYANE
CENTRE SPATIAL GUYANAIS
BP 726
97387 Kourou Cedex
☎ +594 (0)5 94 33 51 11

RCS Paris B 775 665 912
Siret 775 665 912 000 82
Code APE 731 Z
N° identification :
TVA FR 49 775 665 912

Altimeter	Range	SSB	<p>Implement the new SSB tables based on SWH&wind, computed using 2015 GDR-F dataset based on the method proposed by [Tran 2018]</p> <p>Method to use to stabilize the mean value : N Tran OSTST 2018.</p>	sea_state_bias
Altimeter	Range	SSB 3 parameters	<p>Included in GDR and IGDR. This SSB is computed using SWH, wind and swell period. Refer to Ngan Tran presentations in previous OSTST meetings. Based on 2015 GDR-F dataset.</p>	sea_state_bias_3d_mp2
Altimeter	Range	Add the tracking range rate	<p>Add the HPR (tracker range rate counter) range values in the S-IGDRs and S-GDRs products.</p>	tracker_counter_40hz; tracker_rate_counter_40hz
Altimeter	Retracking	MQE on 4 Bytes	<p>The retracker MQE format changed into "integer" in order to allow a better precision</p>	ice2_mqe_40hz; mqe_40hz;
Altimeter	Sigma0	Model atmospheric attenuation	<p>Update the model atmospheric attenuation in GDR products with 3D data (unchanged for O+IGDR) based on [Lilibridge 2014] & ECMWF analyzed data</p>	model_atmos_corr_sig0
Altimeter	Sigma0	Add sigma0_mle3 in products	<p>Add sigma0 mle3 (used for LAND ICE and SEA-ICE).</p> <p>Sigma0_mle3 includes no instrumental LUT correction, no MQE criteria in 1Hz compression.</p>	sig0_mle3; sig0_rms_mle3; sig0_numval_mle3; sig0_40hz_mle3; sig0_used_40hz_mle3

Altimeter	Ice	ICE2 retracking with antenna gain	The ice-2 retracking is modified to account for the antenna gain effect.	ice2_range_40hz; ice2_le_sig0_40hz; ice2_sig0_40hz; ice2_signal_40hz; ice2_slope1_40hz; ice2_slope2_40hz; ice2_epoch_40hz; ice2_amplitude_40hz; ice2_mean_amplitude_40hz; ice2_thermal_noise_40hz; ice2_slope_40hz
Altimeter	Ice	TFMRA retracking	Add TFMRA retracking (=ice3), required by sea-ice users Based on [Davis 1997] and [Helm 2014]	all ice3 retracking estimates
Altimeter	Ice	LAND ICE ET SEA-ICE FLAGS	Add LAND ICE and SEA-ICE FLAGS : the method to classify the ice type developed in the frame of PEACHI prototype, is implemented. These two fields are added in the products. LAND ICE : Continental ice 14-states flag (type of the ice-sheet snow faces) SEA-ICE : Ocean/Sea-ice flag 6-states (flag indicating open water or sea ice pixel type) Based on normalized MLE3 Sigma0 and brightness temperatures.	open_sea_ice_flag; ice_sheet_snow_facies_flag
Altimeter	Instrumental corrections	Update the instrumental correction LUT (Look-Up Table)	New instrumental Look Up Tables taking into account the actual antenna pattern. Theses 4 LUT are used to correct the MLE4 retracked parameters.	modeled_instr_corr_sig0; modeled_instr_corr_range; modeled_instr_corr_swh; modeled_instr_corr_off_nadir_angle_wf;

Altimeter	Mispointing	Add the platform pointing info	Add the platform mispointing in the GDR products	off_nadir_angle_pf; off_nadir_roll_angle_pf; off_nadir_pitch_angle_pf; off_nadir_yaw_angle_pf; qual_alt_1hz_off_nadir_angle_pf
Altimeter	Mispointing	Provide the validity map for mispointing	Provide the mispointing validity map from the MLE4 retracking	qual_alt_1hz_off_nadir_angle_wf
Altimeter	Mispointing	Provide the mispointing LUT in products	Provide the mispointing Look Up Table in products	modeled_instr_corr_off_nadir_angle
Altimeter	Orbit	Doppler correction on geoid track	Derive the orbital altitude rate with respect to the reference MSS/geoid (formerly removed for Saral)	doppler_corr orb_alt_rate
Altimeter	ssha	SSHA Tide	Replace the ocean tide solution GOT 4.10c by FES 2014b in the SSHA computation.	ssha
Altimeter	ssha	SSHA MSS	Use CNES/CLS 2015 MSS in the SSHA computation	ssha
Altimeter	Wind	New wind LUT	Implement new wind look up tables computed with GDR-F 2015-year data with the method proposed by N. Tran. Based on MLE4 Sigma0.	wind_speed_alt
Altimeter	waveform	Peakiness on 4 Bytes	The « peakiness » information on 2 Bytes was not sufficient enough to observe all the dynamic. The field is now written on 4 Bytes "integer". Moreover, we added a flag in the products which will indicates if the waveform is full/saturated.	peakiness_40hz; wvf_saturation_40hz
Altimeter	waveform	Waveforms corrected from CAL2 filter	Provide the waveforms corrected from the filter in the SI/GDRS products	waveforms_40hz

Altimeter	waveform	Waveform classification	A new algorithm to classify the waveforms created in the frame of PEACHI prototype is implemented. Flag to classify the waveforms is added in the products.	wvf_main_class; wvf_main_class_40hz; wvf_main_class_proba_40hz
Altimeter	CAL	Enhanced Total Power of the PTR calibration (CAL1) precision in the LTM file	The LSB of the Total Power of the PTR calibration in the Long Term Monitoring file change from 1e-2 to 1e-4	sig0; wind_speed_alt
Altimeter	CAL	Update the altimeter characterization file	New gain values in the characterization file.	sig0; wind_speed_alt
Altimeter	CAL	LPF normalization	Change the LPF calibration (CAL2) normalization : normalization by averaging gates written in the characterization file.	all retracked estimates
Altimeter	CAL	CAL1 shall not be corrected from CAL2	Do not correct CAL1 from CAL2 any-more.	all retracker estimates
Radiometer	WTC	Radiometer coastal processing based on ENVISAT heritage	A new algorithm was implemented to interpolate the radiometer data at the altimeter date, taking into account the surface type for the used radiometer data. This method is similar to the one implemented for ENVISAT. A flag to indicate the interpolation quality is also added to the products.	rad_wet_tropo_corr; interp_flag_tb tb_k tb_ka
Radiometer	WTC	Radiometer count saturation	A new algorithm to compute the gains and residual temperature has been developed to correct the saturation of the radiometer 37GHz channel for the cycles which are saturated. The use or not of this specific treatment depends on a flag added in the radiometer characterization file. Three new radiometer characterization files are necessary depending on the period (before, during and after the saturation). A flag is added in the products to indicate if this specific treatment was used or not.	rad_wet_tropo_corr; rad_state_flag_gain

Radiometer	WTC	Neural network based on 5 parameters (2BT, Sigma0Ka, SST and Lapse rate climatology)	<p>A new neural network algorithm has been developed. It is based on the analysis performed in the frame of PEACHI prototype.</p> <p>The network coefficients and the number of inputs used for the computation have been modified. The algorithm uses 5 inputs to determine the wet troposphere correction (Sigma0 Ku, 2 BT, Lapse rate and SST²), 2 new SAD (STT seasonal tables and Lapse rate climatology) and a new DAD (daily global Reynolds SST).</p> <p>For O/IGDR, the SST parameter is obtained thanks to seasonal SAD files, for GDR it is obtained thanks to the global DAD maps. A single DAD file is used to treat a half orbit.</p>	rad_wet_tropo_corr
Geophysical	DAC	DAC in OGDR	Fill the a DAC field in OGDR products. (The I&GDR algorithm is used with predicted inputs).	hf_fluctuations_corr ssha (for OGDR)
Geophysical	Geoid	Geoid update to EGM 2008	Take into account the EGM 2008 geoid model	geoid
Geophysical	MDT	MDT CNES-CLS-2018	Take into account the MDT CNES/CLS 2018	mean_topography
Geophysical	Meteo	Add Altitude Gaussian grid Ref	Product's header : add the altitude Gaussian grid reference	global attribute "xref_meteorological_files" contains SMM_ALT_*
Geophysical	MSS	MSS CLS updates to 2015 versions	Take into account the new 2015 CNES/CLS MSS.	mean_sea_surface_sol1

Geophysical	MSS	MSS DTU	Take into account 2015 DTU MSS	mean_sea_surface_sol2
Geophysical	SST	SST	Add a SST value coming from OISST: for O/IGDR, the SST parameter is obtained thanks to seasonal static files, for GDR it is obtained thanks to the global dynamic maps. A single dynamic file is used to treat a half orbit.	sst
Geophysical	SST	SST origin	Add a flag indicating the origin of the SST information (DAD, SAD or climatology)	sst_origin_flag
Geophysical	Tides	Pole Tide	Take into account the pole tide (Shailen Desai 2015 with 2017 coefficients)	pole_tide
Geophysical	Tides	Add one internal tide solution (4 waves Zaron model)	Add one internal tide solution (Zaron model including 4 internal waves = M2, K1, O1,S2)	internal_tide; interp_flag_internal_tide
Geophysical	Tides	Tide models	The new GOT 4.10c et FES 2014b models shall replace the current tide models.	ocean_tide_sol1; ocean_tide_sol2 load_tide_sol1; load_tide_sol2; ocean_tide_non_equil
Geophysical	Tides	Tidal correction on hydrological areas, enclosed seas and lakes	For hydrological areas, enclosed seas, and lakes : Set ocean tide and equilibrium ocean tide contributors to zero....so sum total of three contributors is just the valid load tide. Set equilibrium ocean tide to zero	ocean_tide_sol1; ocean_tide_sol2; ocean_tide_equil; ocean_tide_non_equil

Geophysical	Tides	Ocean tide extrapolation flag	Modify the quality flag of the ocean tide models in order to add the extrapolation information of the ocean tide models.	interp_flag_ocean_tide_sol1; interp_flag_ocean_tide_sol2
Geophysical	Tropo	Add the ECMWF wet and dry tropospheric corrections based on 3D fields	Add the 3D model dry and wet tropospheric corrections in the GDR products.	model_dry_tropo_corr_meas_alt; model_dry_tropo_corr_meas_alt_40hz; model_wet_tropo_corr_meas_alt; model_wet_tropo_corr_meas_alt_40hz; interp_flag_meteo_meas_alt
Geophysical	bathymetry	Bathymetry	Use the bathymetry SAD file "ACE-2"	bathymetry
Geophysical	Sea State	Add the swell and swell direction	Add the swell and swell direction	mean_wave_period_t02; mean_wave_direction; mfwam_map_avail; interp_flag_mfwam

Geophysical	surface	Surface flag	<p>Add a 7 state flag to classify the surface (as ENVISAT) This mask consists in the combination of 3 data sources :</p> <ul style="list-style-type: none"> • GMT surface mask developed by Noveltis for the generation of the Jason-2 MNT (also including water body outlines from the LEGOS database) • GLOBCOVER LC V2.0 • MODIS Mosaic of Antarctica from NSIDC 	surf_class
Geophysical	surface	Coastal distance	<p>Add the distance to the coast (same approach than the one used for ENVISAT & Sentinel-3). Computed with GSHHG 2.3.7 shoreline dataset</p>	dist_coast; dist_coast_40hz

2.3.2.4.VARIABLE EVOLUTIONS

With regards to GDR-T, scientific content of 45 variables is changed in GDR-F, and almost as much are added:

- 1 variable added in Reduce products (Internal Tide)
- 43 variables added in Native products
- 48 variables added in Sensor products

The table hereafter provides exhaustively the dataset variables in GDR-T, in GDR-F, and their differences.

Legend of variables table:

"	Variable is present in both "GDR-T" and "GDR-F" format, with same model and processing, but possibly different data For example : whereas no localization algorithm differs between "T" and "F", "lat" and "lon" variables can differ because the 1 Hz time can differ
<>	Variable is present in both "GDR-T" and "GDR-F" format but have different model, computation or information
/	New Variable : present in "GDR-F" but not in "GDR-T"
N/A	Removed Variable : present in "GDR-T" but not in "GDR-F"
R	Reduced product : 1 Hz subset of the full dataset
N	Native product : contain 1Hz records as well as 40 Hz high-rate values
S	Sensor product : an expert product containing the full radar-echo waveforms
	Pink color for variables that are only in "Sensor" products
	Blue color for existing variables in "Sensor" products , added in "Native Products"



GDR-T	R	N	S	GDR-F	R	N	S	GDR-T	GDR-F
Variable (dimensions)	28	102	134	Variable (dimensions)	29	145	182		
time(time)	x	x	x	<>	x	x	x		1 Hz time may slightly differs from GDR-T due to recomputation.
meas_ind(meas_ind)		x	x	"		x	x		
wvf_ind(wvf_ind)			x	"			x		
time_40hz(time,meas_ind)		x	x	"		x	x		
lat(time)	x	x	x	"	x	x	x		
lon(time)	x	x	x	"	x	x	x		
lon_40hz(time,meas_ind)		x	x	"		x	x		
lat_40hz(time,meas_ind)		x	x	"		x	x		
surface_type(time)	x	x	x	"	x	x	x		
rad_surf_type(time)	x	x	x	"	x	x	x		
/				surf_class(time)		x	x		add a 7 states surface classification computed from a mask built with MODIS and GlobCover data
/				dist_coast(time)		x	x		add a distance to the coast computed with GSHHG shoreline dataset



PARIS - Les Halles
SIÈGE
 2, place Maurice Quentin
 75039 Paris Cedex 01
 ☎ +33 (0)1 44 76 75 00

PARIS - Daumesnil
DIRECTION DES LANCEURS
 52, rue Jacques Hillairet
 75612 Paris Cedex
 ☎ +33 (0)1 80 97 71 11

TOULOUSE
CENTRE SPATIAL DE TOULOUSE
 18, avenue Édouard Belin
 31401 Toulouse Cedex 9
 ☎ +33 (0)5 61 27 31 31

GUYANE
CENTRE SPATIAL GUYANAIS
 BP 726
 97387 Kourou Cedex
 ☎ +594 (0)5 94 33 51 11

RCS Paris B 775 665 912
 Siret 775 665 912 000 82
 Code APE 731 Z
 N° identification :
 TVA FR 49 775 665 912

/		dist_coast_40hz(time)		x		add a distance to the coast computed with GSHHG shoreline dataset
qual_alt_1hz_range(time)	x	x	"	x	x	
qual_alt_1hz_swh(time)	x	x	"	x	x	
qual_alt_1hz_sig0(time)	x	x	"	x	x	
qual_alt_1hz_off_nadir_angle_wf(time)	x	x	"	x	x	
qual_alt_1hz_off_nadir_angle_pf(time)		x	<>	x	x	only in "S" product Matched with mispointing fields
qual_inst_corr_1hz_range(time)	x	x	"	x	x	
qual_inst_corr_1hz_swh(time)	x	x	"	x	x	
qual_inst_corr_1hz_sig0(time)	x	x	"	x	x	
qual_rad_1hz_tb_k(time)	x	x	"	x	x	
qual_rad_1hz_tb_ka(time)	x	x	"	x	x	
alt_state_flag_acq_mode_40hz(time,meas_ind)	x	x	"	x	x	
alt_state_flag_tracking_mode_40hz(time,meas_ind)	x	x	"	x	x	
/		rad_state_flag_gain(time)		x	x	add flag for radiometer saturation management
orb_state_flag_diode(time)	x	x	"	x	x	
orb_state_flag_rest(time)	x	x	"	x	x	
/		sst_origin_flag(time)		x	x	add a flag to indicate the origin of the sst

ecmwf_meteo_map_avail(time)	x x x	"	x x x		
trailing_edge_variation_flag(time)	x x x	"	x x x		
trailing_edge_variation_flag_40hz(time,meas_ind)	x x	"	x x		
ice_flag(time)	x x x	"	x x x		
/		open_sea_ice_flag(time)	x x		6 states open sea-ice flag computed from the radiometer brightness temperatures and from the backscatter coefficient
/		ice_sheet_snow_facies_flag(time)	x x		14 states ice-sheet snow faces type flag computed from the radiometer brightness temperatures and from the backscatter coefficient
/		mfwam_map_avail(time)	x x		Add flag for mfwam data availability
/		interp_flag_tb(time)	x x		Add flag for coastal radiometer interpolation
interp_flag_mean_sea_surface(time)	x x	N/A			removed to replace one MSS solution by two (CNES & DTU)
/		interp_flag_mean_sea_surface_sol1(time)	x x		added to replace one MSS solution by two (CNES & DTU)
/		interp_flag_mean_sea_surface_sol2(time)	x x		added to replace one MSS solution by two (CNES & DTU)
interp_flag_mdt(time)	x x	"	x x		
interp_flag_ocean_tide_sol1(time)	x x	<>	x x		add one more state in flag
interp_flag_ocean_tide_sol2(time)	x x	<>	x x		add one more state in flag
/		interp_flag_internal_tide(time)	x x		Add flag for internal tie data interpolation

interp_flag_meteo(time)	x x	"	x x		
/		interp_flag_meteo_meas_alt(time)	x x		add flag for quality of dynamic data interpolation
/		interp_flag_meteo_meas_alt_40hz(time,meas_ind)	x x		add flag for quality of dynamic data interpolation
/		interp_flag_mfwam(time)	x x		add flag for quality of dynamic data interpolation
alt(time)	x x x	"	x x x		
alt_40hz(time,meas_ind)	x x	"	x x		
orb_alt_rate(time)	x x	<>	x x		To derive the orbital altitude rate with respect to the reference MSS/geoid
range(time)	x x x	"	x x x		Impacted by included updated corrections
range_40hz(time,meas_ind)	x x	"	x x		
range_used_40hz(time,meas_ind)	x x	"	x x		
range_rms(time)	x x	"	x x		
range_numval(time)	x x	"	x x		
number_of_iterations(time,meas_ind)	x x	"	x x		
net_instr_corr_range(time)	x x	<>	x x		New look up tables taking into account real antenna diagram
model_dry_tropo_corr(time)	x x x	"	x x x		
/		model_dry_tropo_corr_meas_alt(time)	x x		model dry tropospheric correction at measurement altitude computed from ECMWF 3d meteorological fields at measurement altitude

/		model_dry_tropo_corr_meas_alt_40hz(time,meas_ind)	x x		40 Hz model dry tropospheric correction at measurement altitude computed from ECMWF 3d meteorological fields at measurement altitude
model_wet_tropo_corr(time)	x x	"	x x		
/		model_wet_tropo_corr_meas_alt(time)	x x		model wet tropospheric correction at measurement altitude computed from ECMWF 3d meteorological fields at measurement altitude
/		model_wet_tropo_corr_meas_alt_40hz(time,meas_ind)	x x		40 Hz model wet tropospheric correction at measurement altitude computed from ECMWF 3d meteorological fields at measurement altitude
rad_wet_tropo_corr(time)	x x x	<>	x x x		New neuronal network, comment field & quality flag for GPN & GPS
iono_corr_gim(time)	x x x	"	x x x		
sea_state_bias(time)	x x x	<>	x x x	NOAA	[Tran 2019] - empirical solution fitted on one year of SARAL GDR-F data
/		sea_state_bias_3d_mp2(time)	x x		[Tran 2019] - 3D empirical solution fitted on one year of SARAL GDR-F data
swh(time)	x x x	"	x x x		Impacted by included updated corrections
swh_40hz(time,meas_ind)	x x	"	x x		
swh_used_40hz(time,meas_ind)	x x	"	x x		
swh_rms(time)	x x	"	x x		

swh_numval(time)	x x	"	x x		
net_instr_corr_swh(time)	x x	<>	x x		New look up tables taking into account real antenna diagram
sig0(time)	x x x	"	x x x		Impacted by included updated corrections
sig0_40hz(time,meas_ind)	x x	<>	x x		Impact of CAL2 modification
sig0_used_40hz(time,meas_ind)	x x	"	x x		
sig0_rms(time)	x x	"	x x		
sig0_numval(time)	x x	"	x x		
/		sig0_mle3(time)	x x		add sigma0 MLE3 in "N" & "S" for ice algorithms ; not corrected from instrumental LUT ; no MQE criteria in 1hz compression
/		sig0_rms_mle3(time)	x x		add sigma0 MLE3 in "N" & "S" for ice algorithms ; not corrected from instrumental LUT ; no MQE criteria in 1hz compression
/		sig0_numval_mle3(time)	x x		add sigma0 MLE3 in "N" & "S"
agc(time)	x x	"	x x		
agc_rms(time)	x x	"	x x		
agc_numval(time)	x x	"	x x		
net_instr_corr_sig0(time)	x x	"	x x		
atmos_corr_sig0(time)	x x	"	x x		

/		model_atmos_corr_sig0(time)	x	x		[Lilibridge 2014] model atmospheric attenuation correction on backscatter coefficient
off_nadir_angle_wf(time)	x	x	<>	x	x	Takes into account a new LUT correcting for model errors
off_nadir_angle_wf_40hz(time,meas_ind)	x	x	<>	x	x	Takes into account a new LUT correcting for model errors
/		off_nadir_angle_wf_used_40hz(time,meas_ind)	x	x		
/		off_nadir_angle_wf_rms(time)	x	x		
/		off_nadir_angle_wf_numval(time)	x	x		
off_nadir_angle_pf(time)		x	<>	x	x	only in GPS add in GPN Matched with mispointing fields
/		off_nadir_roll_angle_pf(time)	x	x		add off_nadir platform info
/		off_nadir_pitch_angle_pf(time)	x	x		add off_nadir platform info
/		off_nadir_yaw_angle_pf(time)	x	x		add off_nadir platform info
/		modeled_instr_corr_off_nadir_angle_wf(time)	x	x		New instrumental LUT with real antenna diagram
tb_k(time)	x	x	<>	x	x	Improvement of coastal processing
tb_ka(time)	x	x	<>	x	x	Improvement of coastal processing
mean_sea_surface(time)	x	x	x	N/A		MSS_CNES_CLS-2011 replace one MSS solution by two (CNES & DTU)
/		mean_sea_surface_sol1(time)	x	x	x	MSS_CNES_CLS-2015

/		mean_sea_surface_sol2(time)	x x		DTU15
mean_topography(time)	x x x	<>	x x x	MDT_CNES_CLS-2009	MDT_CNES_CLS-2018
geoid(time)	x x	<>	x x	EGM1996	EGM2008
bathymetry(time)	x x x	<>	x x x	GSFC DTM2000.1	ACE2
inv_bar_corr(time)	x x x	"	x x x		
hf_fluctuations_corr(time)	x x x	<>	x x x		DAC added in OGDR products
ocean_tide_sol1(time)	x x x	<>	x x	GOT4.8	GOT4.10c (replaced by sol2 in Reduced Product); modified tidal correction on hydrological areas, enclosed seas and lakes
ocean_tide_sol2(time)	x x	<>	x x x	FES2012	FES2014b (replace sol1 in Reduced Product); modified tidal correction on hydrological areas, enclosed seas and lakes
ocean_tide_equil(time)	x x	<>	x x		modified tidal correction on hydrological areas, enclosed seas and lakes
ocean_tide_non_equil(time)	x x	<>	x x	FES2012	FES2014b ; modified tidal correction on hydrological areas, enclosed seas and lakes
load_tide_sol1(time)	x x	"	x x	GOT4.8	GOT4.10c
load_tide_sol2(time)	x x	"	x x	GOT4.8	FES2014b
solid_earth_tide(time)	x x x	"	x x x		
pole_tide(time)	x x x	<>	x x x	[Wahr 1985]	[Desai 2017]

/		internal_tide(time)	x x x		Add Zaron Internal Tide 4 waves (M2 S2 K1 O1) [Zaron 2019]
wind_speed_model_u(time)	x x	"	x x		
wind_speed_model_v(time)	x x	"	x x		
wind_speed_alt(time)	x x x	<>	x x x	[Lillibridge 2014]	[Tran 2014]
rad_water_vapor(time)	x x x	<>	x x x		Impacted by updated rad_wet_tropo_corr new quality flag in GPN & GPS
rad_liquid_water(time)	x x x	<>	x x x		Impacted by included updated corrections new quality flag in GPN & GPS
/		sst(time)	x x		NOAA OISST when available ; seasonal or static otherwise
/		mean_wave_period_t02(time)	x x		MFWAM
/		mean_wave_direction(time)	x x		MFWAM
ice1_range_40hz(time,meas_ind)	x x	<>	x x		include doppler_corr
ice1_sig0_40hz(time,meas_ind)	x x	"	x x		
ice1_qual_flag_40hz(time,meas_ind)	x x	"	x x		
seaice_range_40hz(time,meas_ind)	x x	<>	x x		include doppler_corr
seaice_sig0_40hz(time,meas_ind)	x x	"	x x		
seaice_qual_flag_40hz(time,meas_ind)	x x	"	x x		

ice2_range_40hz(time,meas_ind)	x	x	<>	x	x		include doppler_corr; take into account antenna gain
ice2_le_sig0_40hz(time,meas_ind)	x	x	<>	x	x		take into account antenna gain
ice2_sig0_40hz(time,meas_ind)	x	x	<>	x	x		take into account antenna gain
ice2_sigmal_40hz(time,meas_ind)	x	x	<>	x	x		take into account antenna gain
ice2_slope1_40hz(time,meas_ind)	x	x	<>	x	x		take into account antenna gain
ice2_slope2_40hz(time,meas_ind)	x	x	<>	x	x		take into account antenna gain
ice2_mqe_40hz(time,meas_ind)	x	x	<>	x	x		change data type
ice2_qual_flag_40hz(time,meas_ind)	x	x	"	x	x		
/			ice3_range_40hz(time,meas_ind)	x	x		add TFMRA retracking
/			ice3_sig0_40hz(time,meas_ind)	x	x		add TFMRA retracking
/			ice3_qual_flag_40hz(time,meas_ind)	x	x		add TFMRA retracking
mqe_40hz(time,meas_ind)	x	x	<>	x	x		change data type
peakiness_40hz(time,meas_ind)	x	x	<>	x	x		change data type
/			wvf_saturation_40hz(time,meas_ind)	x	x		add 40hz waveform saturation status
/			wvf_main_class(time)	x	x		add 40hz waveform classification
/			wvf_main_class_40hz(time,meas_ind)	x	x		add 40hz waveform classification
/			wvf_main_class_proba_40hz(time,meas_ind)	x	x		add 40hz waveform classification
ssha(time)	x	x	x	<>	x	x	x include ocean_tide1 include ocean_tide2
tracker_40hz(time,meas_ind)		x	"		x		

tracker_used_40hz(time,meas_ind)	x	"	x	
tracker_diode_40hz(time,meas_ind)	x	"	x	
/		tracker_counter_40hz(time,meas_ind)	x	add the HPR distance in "S" products
/		tracker_rate_counter_40hz(time,meas_ind)	x	add the HPR distance in "S" products
pri_counter_40hz(time,meas_ind)	x	"	x	
off_nadir_angle_rain_40hz(time,meas_ind)	x	"	x	
uso_corr(time)	x	"	x	
internal_path_delay_corr(time)	x	"	x	
modeled_instr_corr_range(time)	x	<>	x	New instrumental LUT with real antenna diagram
doppler_corr(time)	x	<>	x	The orbital altitude rate is derived with respect to the reference MSS/geoid
cog_corr(time)	x	"	x	
modeled_instr_corr_swh(time)	x	<>	x	New instrumental LUT with real antenna diagram
internal_corr_sig0(time)	x	"	x	
modeled_instr_corr_sig0(time)	x	<>	x	New instrumental LUT with real antenna diagram
agc_40hz(time,meas_ind)	x	"	x	
agc_corr_40hz(time,meas_ind)	x	"	x	
scaling_factor_40hz(time,meas_ind)	x	"	x	

epoch_40hz(time,meas_ind)	x	"	x	
width_leading_edge_40hz(time,meas_ind)	x	"	x	
amplitude_40hz(time,meas_ind)	x	"	x	
thermal_noise_40hz(time,meas_ind)	x	"	x	
/		sig0_40hz_mle3(time,meas_ind)	x	add sigma0 MLE3 in "N" & "S"
/		sig0_used_40hz_mle3(time,meas_ind)	x	add sigma0 MLE3 in "N" & "S"
seaice_epoch_40hz(time,meas_ind)	x		x	
seaice_amplitude_40hz(time,meas_ind)	x		x	
ice2_epoch_40hz(time,meas_ind)	x	<>	x	
ice2_amplitude_40hz(time,meas_ind)	x	<>	x	
ice2_mean_amplitude_40hz(time,meas_ind)	x	<>	x	
ice2_thermal_noise_40hz(time,meas_ind)	x	<>	x	
ice2_slope_40hz(time,meas_ind)	x	<>	x	
/		ice3_epoch_40hz(time,meas_ind)	x	add TFMRA retracking
/		ice3_amplitude_40hz(time,meas_ind)	x	add TFMRA retracking
signal_to_noise_ratio(time)	x		x	
waveforms_40hz(time,meas_ind,wvf_ind)	x		x	

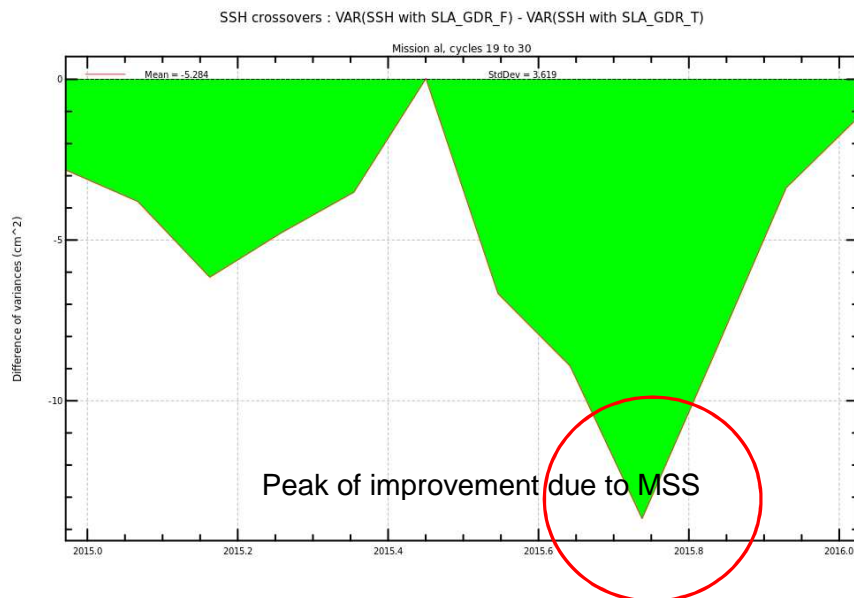
2.4.2.5. REFERENCES

- [Davis 1997] : Davis, C.H. A robust threshold retracking algorithm for measuring ice-sheet surface elevation change from satellite radar altimeters. IEEE Trans. Geosci. Remote Sens. 1997, 35, 974–979.
- [Desai 2017] : J. C. Ries and S. D. Desai, "Conventional model update for rotational deformation," in Fall AGU Meeting, New Orleans, LA, 2017,
- [Helm 2014] : Helm, V., Humbert, A., and Miller, H.: Elevation and elevation change of Greenland and Antarctica derived from CryoSat-2, The Cryosphere, 8, 1539–1559, doi: 10.5194/tc-8-1539-2014, URL <http://www.the-cryosphere.net/8/1539/2014/>, 2014.
- [Jettou 2019] : Global Quality Assessment of SARAL/AltiKa's reprocessed GDR-F dataset, Chicago, OSTST 2019
- [Lillibridge [2014] : J. Lillibridge, R. Scharroo, S. Abdalla, D. Vandemark, 2014: One- and Two-Dimensional Wind Speed Models for Ka-Band Altimetry , Journal of atmospheric and oceanic technology Volume 31, 630-638. doi: <http://dx.doi.org/10.1175/JTECH-D-13-00167.1>
- [Tran 2014] : Tran N.: PEACHI Lot 1.3 final report Wind., CLS-DOS-NT-14-151
- [Tran 2018] : N. Tran, G. Dibarboure, N. Picot, P. Féménias : Improving the continuity of the Jason SSB time-series ; OSTST meeting, September 27-28, 2018
- [Tran 2019] : N. Tran, D. Vandemark, E. D. Zaron, P. Thibaut, G. Dibarboure and N. Picot Assessing the effects of sea-state related errors on the precision of high-rate Jason-3 altimeter sea level data, ASR 2019.
- [Wahr 1985] : John M. Wahr; Deformation induced by polar motion; <https://doi.org/10.1029/JB090iB11p09363> |
- [Zaron 2019]: E. D. Zaron. Baroclinic tidal sea level from exact-repeat mission altimetry. Journal of Physical Oceanography, 49(1):193-210, 2019; "HRET_v8.1": <http://web.cecs.pdx.edu/~zaron/pub/HRET.html>

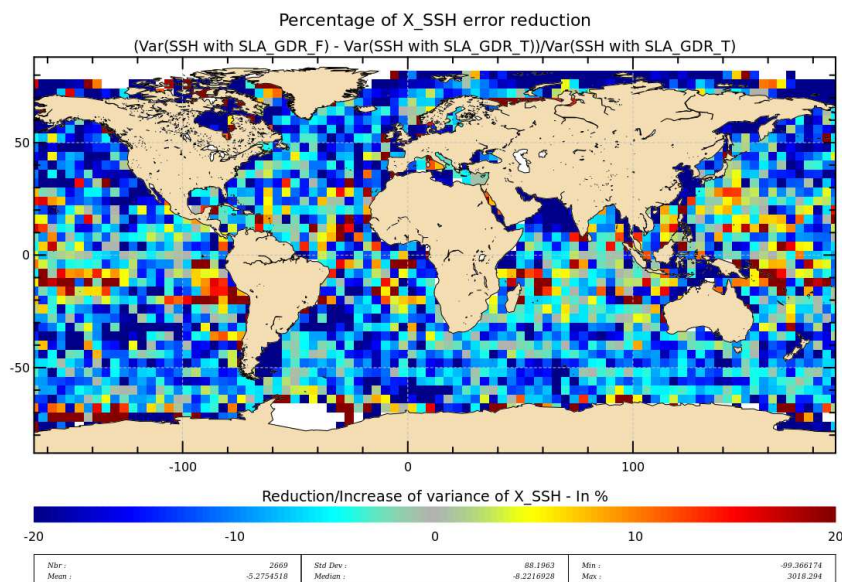
3. CALVAL ASSESSMENT MAIN RESULTS : GLOBAL EFFECT ON SEA SURFACE HEIGHT AT ALTIKA CROSSOVERS

A global assessment of GDR-F Cal/Val has been performed, see Jettou[2019] presentation.

As a major result, this assessment shows a significant improvement of the SSH variance over crossovers. In the following plots, negative values show a lower global variance of AltiKa's SSH differences at crossovers when using GDR-F compared to GDR-T.



Variance difference (per cycle) between GDR-F and GDR-T SSH differences at crossovers (mean=-5.3cm²)



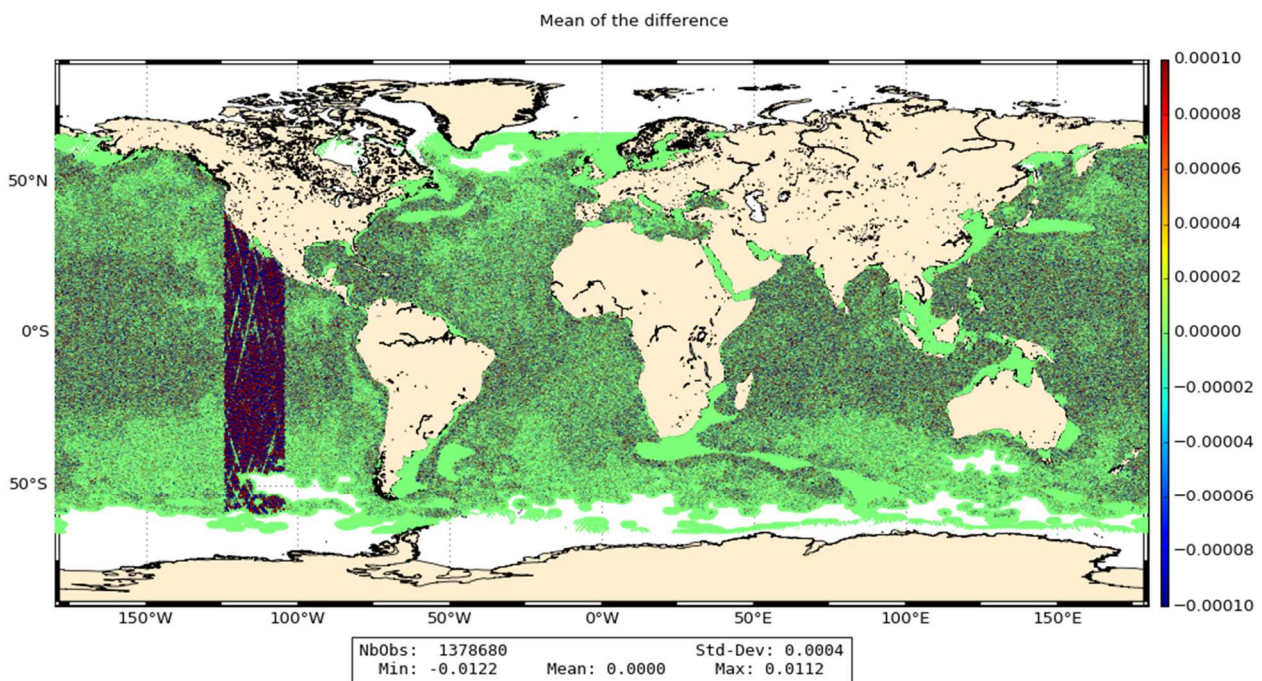
Variance difference (per box) between GDR-F and GDR-T SSH differences at crossovers (mean=-5.3cm²)

4. LIMITATIONS AND KNOWN ISSUES IN GDR-F 2015 DEMO RELEASE

The exhaustive Cal/Val analysis performed on the 2015 demo products has identified some minor bugs in the implementation. All will be corrected in the final release of the software which will be used for the routine data production and for the full reprocessing of the SARAL/AltiKa mission.

4.1. INTERNAL TIDE

Internal Tide correction is not well computed between longitude 103°W to 125°W. The impact remains however low.



4.2. MISSING SECTIONS

Two sections of track are missing in GDR-F while they were not in GDR-T: passes 876 and 877 of cycle 20

4.3. AGE OF CALIBRATION

Some processing have not been performed with the latest applicable calibration file. Usually, the calibration applied for a GDR product is younger than 24h hours, but in the release some GDR may have a 2 or 3 days aged calibration. The impact on the retracked parameters is very low as SARAL instrument is very stable

5. TENTATIVE SCHEDULE FOR SARAL GDR-F DELIVERIES

The routine delivery in GDR-F is planned :

- for IGDR ~~+GDR~~ produced by CNES : ~~by mid-20~~ January 2020 (Cycle 137)
- for GDR produced by CNES : 20 January 2020 (Cycle 135)
- for OGDR produced by EUMETSAT : by end of January / beginning of February 2020
- for OGDR produced by ISRO : Not before April 2020

The delivery of the full reprocessed SARAL/AltiKa GDR-F data set is scheduled in May 2020. Updated news will be available on the AVISO+ web site <https://www.aviso.altimetry.fr>

◆◆◆◆ END OF DOCUMENT ◆◆◆◆