SARAL/ALTIKA GDR-F USER GUIDE

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HISTORIQUE DES MODIFICATIONS

Version	Date	Chapitres modifiés / Raison / Nature de l'évolution
1.0	19 Nov 2019	Creation
1.1	20 Jan 2020	Update for Operational switch
1.2	03 Feb 2020	Add product name convention & O/I/GDR applicability of each evolution
1.3	18 Feb 2020	Add §3.2 about specific analysis on the impact on the Sea Level Anomaly (SLA)
1.4	30 Sept 2020	Internal Tides : Correct the HRET version ; add Annex 1 ; update §3.2 Removal of §4. 4. LIMITATIONS AND KNOWN ISSUES IN GDR-F 2015 DEMO RELEASE (obsolete)

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 Biais
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

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. MAJOR INTERFACE CHANGES

2.2.1. PRODUCT NAME

The product names convention is unchanged, but the product version <v> is set to 'f' (previously 'T'):

SRL_<O/I/G>P<N/R/S>_2P<v><S/P><ccc>_<pppp>_<yyyymmdd_hhnnss>_<yyyymmdd_hhnnss>.aaaa.nc

With : <O/I/G> : product family (O : OGDR, I : IGDR, G: GDR)
<N/R/S> : product type (N : native, R: reduced, S : sensor)
<v> : product version (set to 'T' before GDR-F Standard, then set to 'f')
<S/P> : product duration (S : segment for OGDR, P : pass for I/GDR)
<ccc>: cycle number of 1st product record
<pppp> : pass number of 1st product record (1-1002)
<yyyymmdd_hhnnss> : date of 1st product record
<yyyymmdd_hhnnss> : date of last product record
<aaaa> : Name of the agency producing the data (EUM/CNES/ISRO)

2.2.2. VARIABLE NAMES

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

2.3. 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.

Category	sub cat	Title	Description	Saral main impacted variables	OGDR	IGDR	GDR
Product file	Format	Netcdf v4 format	The NetCDF-4/HDF5 classic model format is used, replacing the NetCDF-3 format. A NetCDF native compression is applied: nc_def_var_deflate using : - Shuffle = 0 (False) - Deflate = 1 (True) - deflate_level = 6	all	X	X	X
Product file	Version	Set version to 'F'	Change the Data Record version to «GDR-F » .	none	X	X	X
Product file	Contacts	Update email address	Products' header : modify the contact email addresses. aviso@altimetry.fr	global attribute "contact" contains aviso@altimetry.fr	X	X	X
Orbit	orbit	POE-F	Use of POE-F orbit standard (formerly POE-E)	lat, lon, alt		X	X
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	X	X	X

Altimeter	Range	SSB	Implement the new SSB tables based on SWH&wind, computed using 2015 GDR-F dataset based on the method proposed by [Tran 2018] Method to use to stabilize the mean value : N Tran OSTST 2018.	sea_state_bias	X	X	X
Altimeter	Range	SSB 3 parameters	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.	sea_state_bias_3d_mp2	NA	X	X
Altimeter	Range	Add the tracking range rate	Add the HPR (tracker range rate counter) range values in the S-IGDRs and S-GDRs products.	tracker_counter_40hz; tracker_rate_counter_40hz	NA	X	X
Altimeter	Retracking	MQE on 4 Bytes	The retracker MQE format changed into "integer" in order to allow a better precision	ice2_mqe_40hz; mqe_40hz;	X	X	X
Altimeter	Sigma0	Model atmospheric attenuation	Update the model atmospheric attenuation in GDR products with 3D data (unchanged for O+IGDR) based on [Lilibridge 2014] & ECMWF analyzed data	model_atmos_corr_sig0	NA	NA	X

Altimeter	Sigma0	Add sigma0_mle3 in products	Add sigma0 mle3 (used for LAND ICE and SEA-ICE). Sigma0_mle3 includes no instrumental LUT correction, no MQE criteria in 1Hz compression.	sig0_mle3; sig0_rms_mle3; sig0_numval_mle3; sig0_40hz_mle3; sig0_used_40hz_mle3	X	X	X
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_sigmal_40hz; ice2_slope1_40hz; ice2_slope2_40hz; ice2_epoch_40hz; ice2_amplitude_40hz; ice2_mean_amplitude_40hz; ice2_thermal_noise_40hz; ice2_slope_40hz	X	X	X
Altimeter	Ice	TFMRA retracking	Add TFMRA retracking (=ice3), required by sea-ice users Based on [Davis 1997] and [Helm 2014]	all ice3 retracking estimates	X	X	X

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	X	X	X
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;	X	X	X
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	NA	NA	X
Altimeter	Mispointing	Provide the validity map for mispointing	Provide the mispointing validity map from the MLE4 retracking	qual_alt_1hz_off_nadir_angle_wf	X	X	X

Altimeter	Mispointing	Provide the mispointing LUT in products	Provide the mispointing Look Up Table in products	modeled_instr_corr_off_nadir_angle	X	X	X
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	X	X	X
Altimeter	ssha	SSHA Tide	Replace the ocean tide solution GOT 4.10c by FES 2014b in the SSHA computation.	ssha	X	X	X
Altimeter	ssha	SSHA MSS	Use CNES/CLS 2015 MSS in the SSHA computation	ssha	X	X	X
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	X	X	X
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	X	X	X
Altimeter	waveform	Waveforms corrected from CAL2 filter	Provide the waveforms corrected from the filter in the SI/GDRS products	waveforms_40hz	NA	X	X

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	X	X	X
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	X	X	X
Altimeter	CAL	Update the altimeter characterization file	New gain values in the characterization file.	sig0; wind_speed_alt	X	X	X
Altimeter	CAL	LPF normalization	Change the LPF calibration (CAL2) normalization : normalization by averaging gates written in the characterization file.	all retracked estimates	X	X	X
Altimeter	CAL	CAL1 shall not be corrected from CAL2	Do not correct CAL1 from CAL2 anymore.	all retracker estimates	X	X	X

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	X	X	X
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)	A new neural network algorithm has been developed. It is based on the analysis performed in the frame of PEACHI prototype. 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 SST), 2 new SAD (STT seasonal tables and Lapse rate climatology) and a new DAD (daily global Reynolds SST). 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.	rad_wet_tropo_corr	X with seasonal SST	X with seasonal SST	X with OISST
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)	X	NA	NA
Geophysical	Geoid	Geoid update to EGM 2008	Take into account the EGM 2008 geoid model	geoid	X	X	X
Geophysical	MDT	MDT CNES-CLS-2018	Take into account the MDT CNES/CLS 2018	mean_topography	X	X	X

Geophysical	Meteo	Add Altitude Gaussian grid Ref	Product's header : add the altitude Gaussian grid reference	global attribute "xref_meteorological_files" contains SMM_ALT_*	X	X	X
Geophysical	MSS	MSS CLS updates to 2015 versions	Take into account the new 2015 CNES/CLS MSS.	mean_sea_surface_sol1	X	X	X
Geophysical	MSS	MSS DTU	Take into account 2015 DTU MSS	mean_sea_surface_sol2	X	X	X
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	X with seasonal SST	X with seasonal SST	X with OISST
Geophysical	SST	SST origin	Add a flag indicating the origin of the SST information (DAD, SAD or climatology)	sst_origin_flag	X	X	X
Geophysical	Tides	Pole Tide	Take into account the pole tide (Shailen Desai 2015 with 2017 coefficients)	pole_tide	X	X	X

Geophysical	Tides	Add one internal tide solution (4 waves Zaron model)	Add Zaron (2019) internal tide 4 waves, M2, S2, K1, O1, from the HRETv7.0 model analyzed by Carrere et al (2020). [see Annex 1 for difference analysis compared to last HRET version HRET_8.1]	internal_tide; interp_flag_internal_tide	X	X	X
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	X	X	X
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	X	X	X
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	X	X	X

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	NA	NA	X
Geophysical	bathymetry	Bathymetry	Use the bathymetry SAD file "ACE-2"	bathymetry	X	X	X
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	NA	X	X
Geophysical	surface	Surface flag	Add a 7 state flag to classify the surface (as ENVISAT)This mask consists in the combination of 3 data sources : • 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	X	X	X

Geophysical	surface	Coastal distance	Add the distance to the coast (same approach than the one used for ENVISAT & Sentinel-3). Computed with GSHHG 2.3.7 shoreline dataset	dist_coast; dist_coast_40hz	X	X	X

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: contains 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 differ from GDR-T due to re-computation.
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 GMT, MODIS and GlobCover data
/				dist_coast(time)		x	x		add a distance to the coast computed with GSHHG shoreline dataset

/			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	add also in "N" 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
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		Includes an updated LUT correcting for model errors
off_nadir_angle_wf_40hz(time,meas_ind)	x	x	<>	x	x		Includes an updated 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	added 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 accounting for the real antenna diagram, and applied to the waveform estimate of mispointing (off_nadir_angle_wf)
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; seasonnal 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		

2.5. REFERENCES

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3. CALVAL ASSESSMENT MAIN RESULTS

A global assessment of GDR-F Cal/Val has been performed and presented at OSTST 2019 (see [Jettou 2019] for the full presentation).

3.1. GLOBAL EFFECT ON SEA SURFACE HEIGHT AT ALTIKA CROSSOVERS

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.

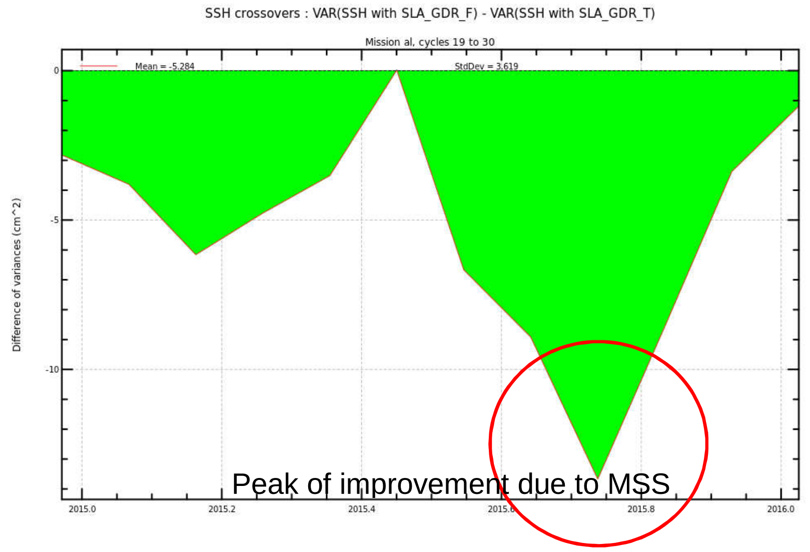

Figure 1: Variance difference (per cycle) between GDR-F and GDR-T SSH differences at crossovers (mean=-5.3cm2)

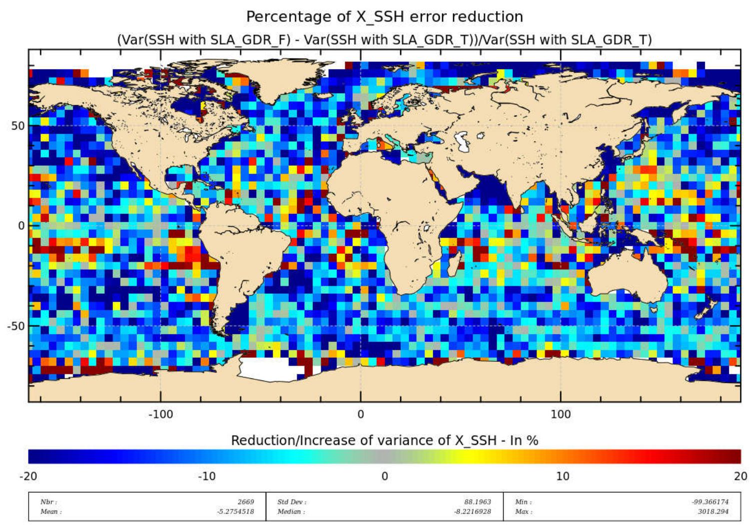

Figure 2 : Variance difference (per box of 1°x1°) between GDR-F and GDR-T SSH differences at crossovers (mean=-5.3cm2)

3.2. GLOBAL EFFECT ON SEA LEVEL ANOMALY (SLA)

Are presented hereafter the global impacts of the main geophysical and instrumental corrections included in Sea Level Anomaly (SLA) computation.

SLA *= Orbit – Range – Dry troposphere effects – Wet troposphere effects – Ionosphere effects – Ocean tide effects – Earth tide effects – Pole tide effects – Sea state effects – Mean sea surface.*

Please note that, the mean sea surface model has changed within the "T "version (MSS CNES/CLS 11 until cycle 34, CNES/CLS 15 onward), hence the global bias of SLA between the "T" and "F" versions is not constant and changes at cycle 35.

SLA contibutors	GDR-T	GDR-F	GDR-F – GDR-T
Orbit	POE-E	POE-F	< 0.1 cm
Range	Includes GDR-T Look-Up tables	Includes GDR-F Look_Up Tables	~-1 cm
Dry troposphere effects	ECMWF model	ECMWF model	0 cm
Wet troposphere effects	Patch 2 neuronal network (3-parameters)	Patch 4 neuronal network (5-parameters)	~-0.85 cm
Atmospheric effects	MOG2D HR	MOG2D HR	0 cm
Ionosphere effects	GIM model	GIM model	0 cm
Ocean tide effects	GOT 4.8	FES 14b	~1 mm
Earth tide effects	Cartwright and Taylor tidal potential	Cartwright and Taylor tidal potential	0 cm
Pole tide effects	Wahr85	DESAI2015	~15 mm
Sea state effects	Hybrid sea state bias	Non parametric sea state bias	~4.4 cm
Mean sea surface effects	CNES/CLS 11-model until cycle 34 then 2015-model	CNES/CLS 15 model	~2.5 cm until cycle 34 then 0 cm
Internal tide	-	Zaron (2019) with M2, S2, K1, O1(HRETv7.0 model)	~0.13 mm
SLA	"T" version	"F" version	-4.9 cm until cycle 34 then -2.5 cm

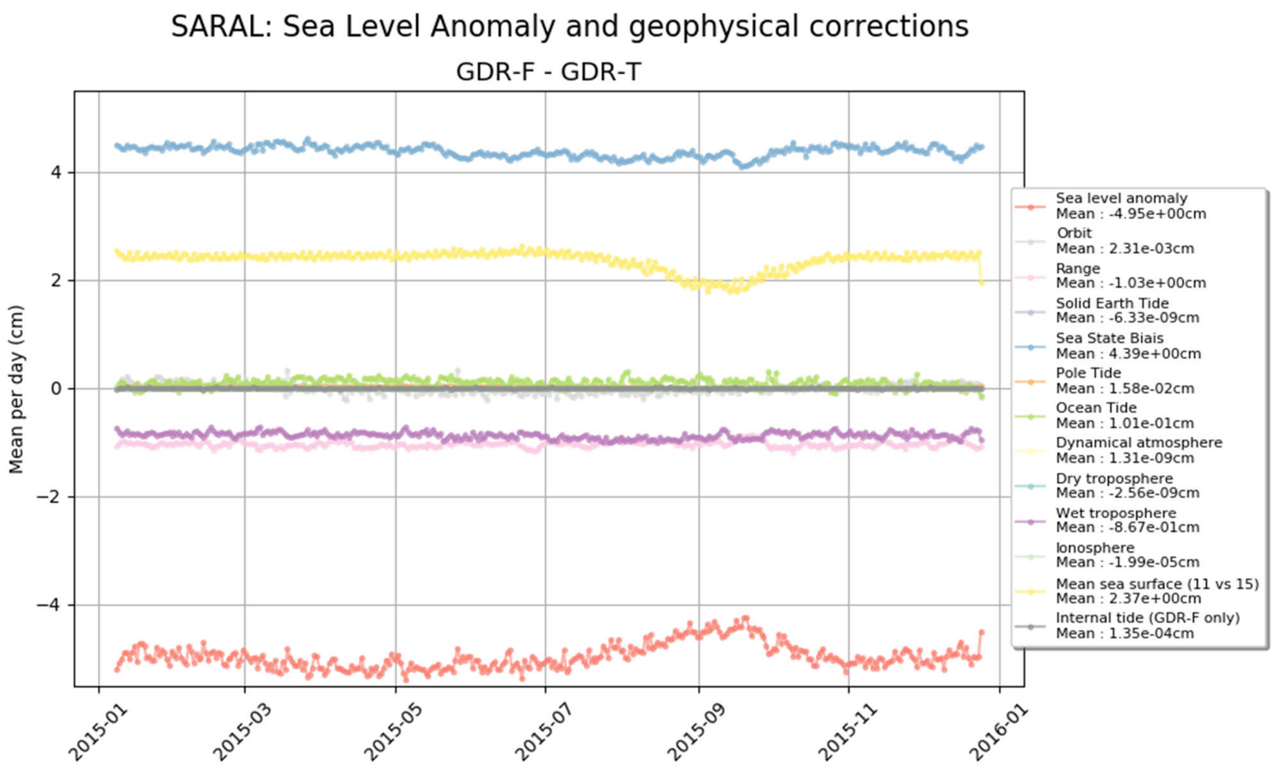

Figure 3: Monitoring of daily averaged differences between SLA's contributors in "T" and "F" versions. This bias is relevant for all cycles with MSS CNES/CLS11 in "T" standard (until cycle 34)

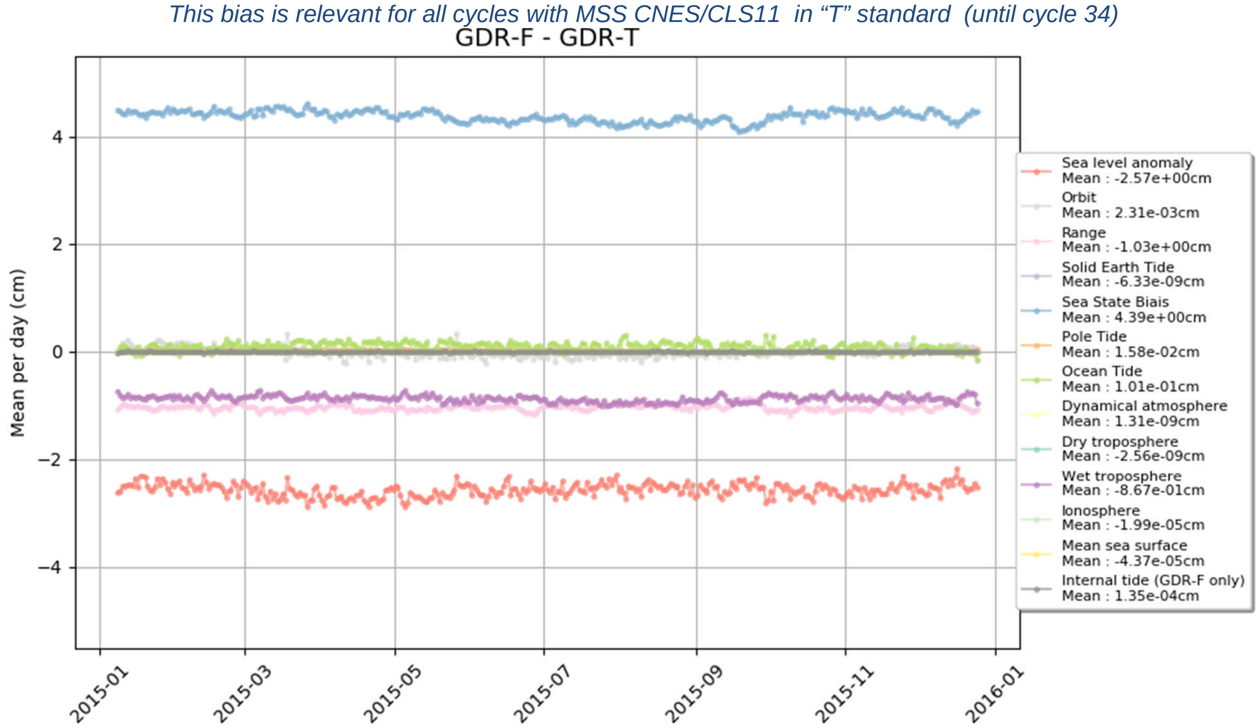

Figure 4 : Figure 3 :Monitoring of daily averaged differences between SLA's contributors in "T" and "F" versions. This bias is relevant for all cycles with MSS CNES/CLS15 in "T" standard (cycle 35 onwards).

4. SARAL GDR-F SCHEDULE

The routine delivery in GDR-F has occured :

- for IGDR produced by CNES : 20 January 2020 (Cycle 137)
- for GDR produced by CNES : 20 January 2020 (Cycle 135)
- for OGDR produced by EUMETSAT : 26 February 2020 (Cycle 138)
- for OGDR produced by ISRO : TBC

The first years of the reprocessed SARAL/AltiKa GDR-F data set is available https://www.aviso.altimetry.fr

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

5. ANNEXES

5.1. ANNEX 1 : HRET INTERNAL TIDES : DIFFERENCES BETWEEN SARAL/ALTIKA GDR-F (HRET_V7.0) , PSU (HRET_V8.1), DGFI-TUM (HRET_V8.1)

Analysis: courtesy of Michael G. Hart-Davis ; Deutsches Geodätisches Forschungsinstitut der Technischen Universität München (DGFI-TUM) and Ed Zaron; Portland State University.

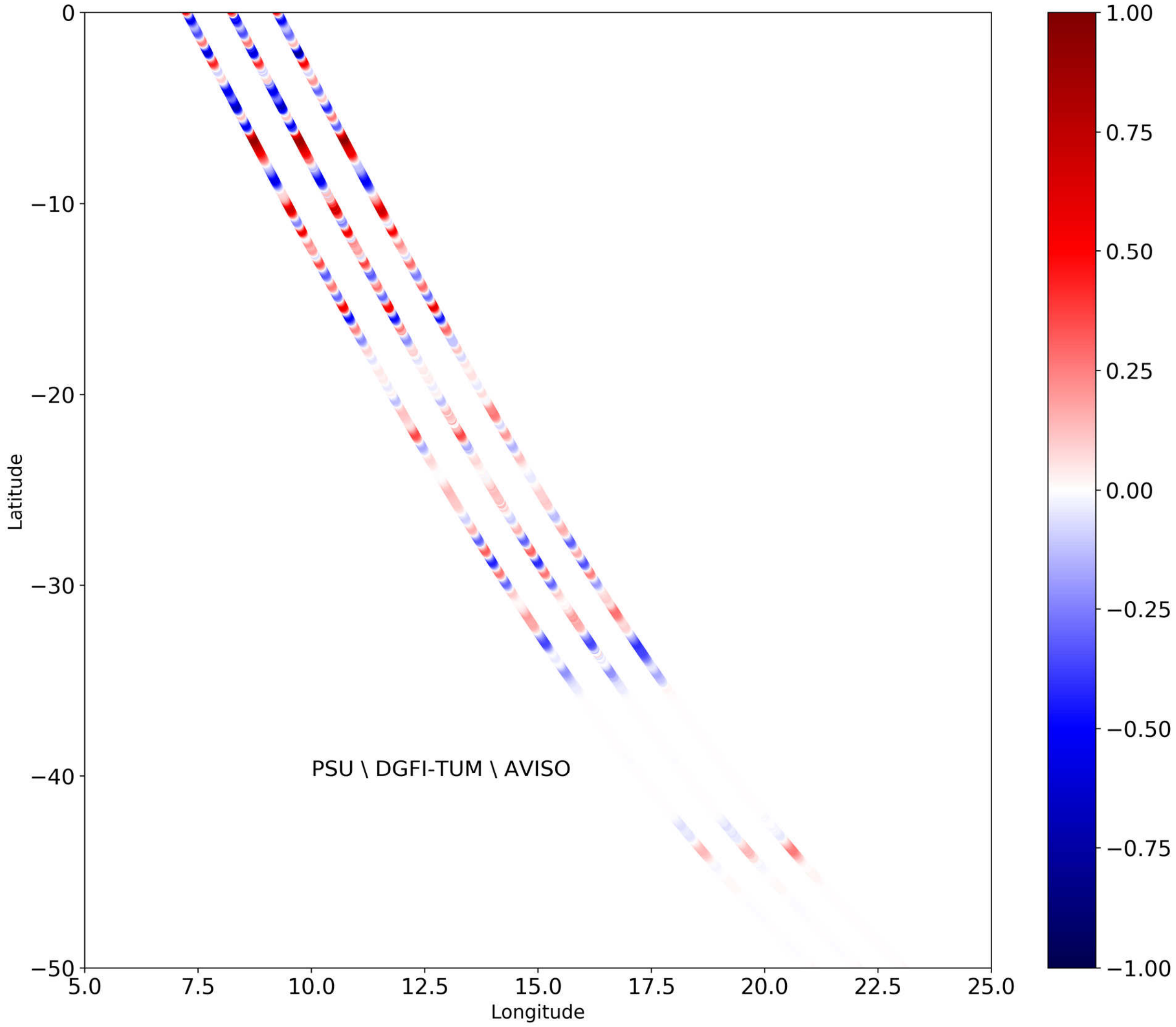

Figure 1. An illustration of the predicted tidal height (cm) from PSU, DGFI-TUM and AVISO SARAL/AltiKa GDR-F for a pass of the SARAL/AltiKa altimeter. Presented here is region subset of cycle #135 and pass #501. The tracks have been offset by 1 degree to the east to better illustrate the differences between predictions.

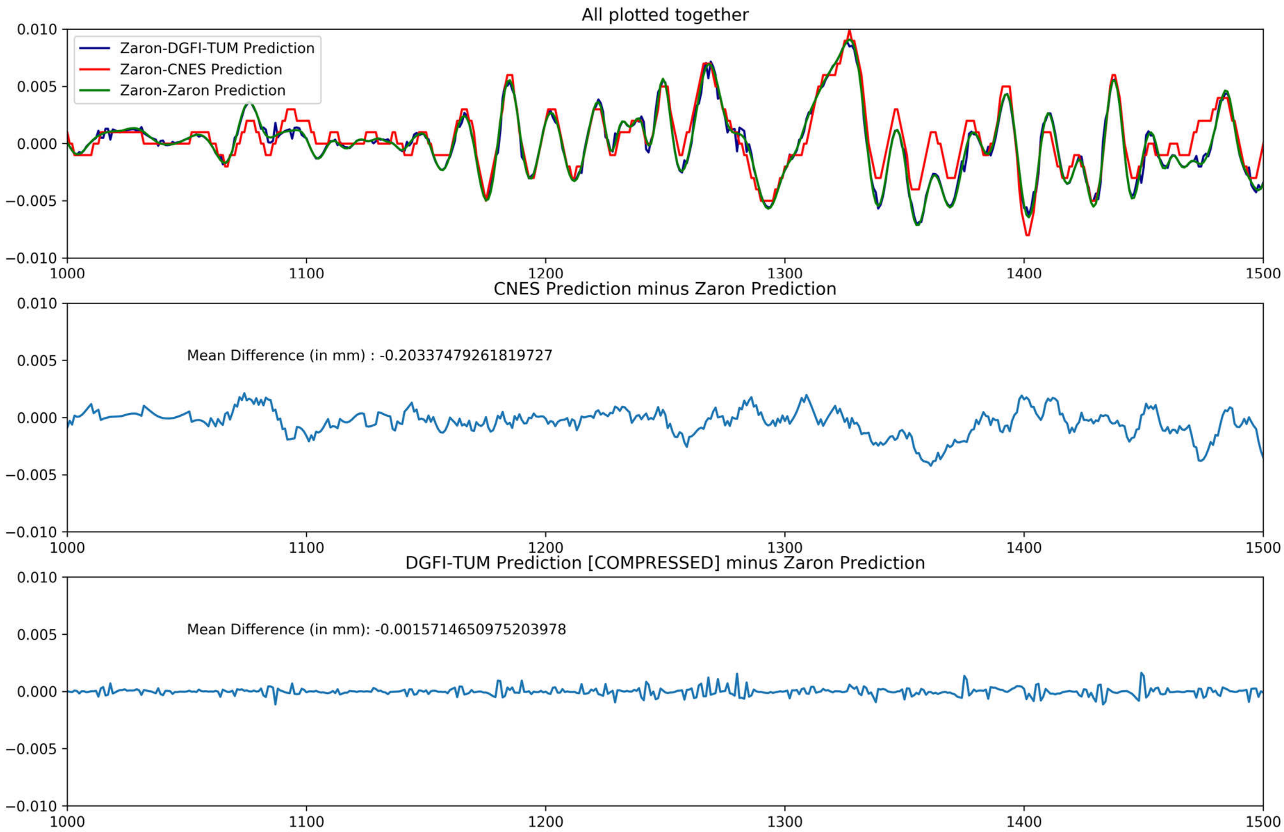

Figure 2. The estimated tidal height for all three predictions (top); the differences between the AVISO SARAL/AltiKa GDR-F and PSU predictions (middle); and the difference between the DGFI-TUM and PSU predictions (bottom). Note: in order to reduce clutter in the figures, only a certain region along the pass is shown here.

DGFI-TUM noticed that the internal tide correction on the GDR did not correspond to HRETv8.1, the version documented in Zaron (2019). To verify their computations, they compared with the HRETv8.1 tide prediction prepared to PSU with the HRETv8.1 prediction prepared at DGFI-TUM, which differs with the prediction prepared by CNES (Figure 1) based on HRETv7.0. The Cnes documentation was thus uptated (e1r4).

♦♦♦♦♦ END OF DOCUMENT ♦♦♦♦♦