DeDop

Fully Adaptable and Configurable Altimeter Delay Doppler Processor

Test Dataset Manual
– WP5000 –

Sentinel 3 For Science – SAR Altimetry Studies – SEOM Study 1. SARAE

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1 Introduction

1.1 Purpose

This document, the Test Dataset Manual (TDM), describes how the test data supplied for use with the DeDop processor was created. To understand the format of the test data, see [R1].

This document forms DeDop Deliverable 2.3

1.2 Reference documents

[R1] DeDop IODD/PFS , DeDop_ESA_TBD

[R2] SRAL/MWR Level 1 & 2 Instrument Products, S3IPF.PDS.003

[R3] CryoSat Products Specification Format, CS-RS-ACS-GS-5106

[R4] Johns Hopkins Applied Physics Laboratory S1R group IDL library. http://fermi.jhuapl.edu/s1r/idl/idl.html

[R5] Cryosat Product Handbook, June 2012

[R6] CryoSat Characterization for FBR users, C2-TN-ARS-GS-5179 issue 2.0

2 Overview

The DeDop processor is designed to ingest data in Sentinel-3 L1A format ([R2]) for processing. Due to the DeDop project requiring input data before the scheduled availability of L1A data from Sentinel-3, test data has been created by reconditioning CryoSat FBR data (see [R3] for format) into the format used for S3 L1A.

This reconditioning is performed by reading the CryoSat binary FBR data into a program written in IDL. This program also ingests a file of default calibration values for the CryoSat mission. Together, these files are used to output a file in netCDF format.

The S3 L1A data is *not* calibrated. Therefore (unless calibration is performed during processing) L1b data created from it will show a bias in range when compared to CryoSat L1b data. Calibration parameters in the L1A file have been filled using averaged CryoSat calibration data from [R6].

3 Data Reconditioning

3.1 Mapping Parameters

The following table, Table 1, shows which parameters in the CryoSat FBR file are used to fill each of the parameters in the S3 L1A file. The variables in the table are presented in the order they are defined in the file.

Table 1: Mapping S3 L1A from CryoSat FBR

L1A variable	FBR field or other value
echo_sample_ind	Counts from 0
sar_ku_pulse_burst_ind	Counts from 0
sar_c_pulse_burst_ind	Counts from 0
ltm_max_ind	Counts from 0
time_l1a_echo_sar_ku	1 : Data record time
UTC_day_l1a_echo_sar_ku	1 : Data record time
UTC_sec_l1a_echo_sar_ku	1 : Data record time
UTC_time_20hz_l1a_echo_sar_ku	1 : Data record time
isp_coarse_time_l1a_echo_sar_ku	not filled
isp_fine_time_l1a_echo_sar_ku	not filled
flag_time_status_l1a_echo_sar_ku	Set to 0=synchronised
sral_fine_time_l1a_echo_sar_ku	not filled
lat_l1a_echo_sar_ku	7 : Latitude
lon_l1a_echo_sar_ku	8 : Longitude
surf_type_l1a_echo_sar_ku	46: Surface type flag
burst_count_prod_l1a_echo_sar_ku	Counts from 1
seq_count_l1a_echo_sar_ku	Counts from 1
burst_count_cycle_l1a_echo_sar_ku	Counts 1..4 repeating
nav_bul_status_l1a_echo_sar_ku	Set to 0=OK

nav_bul_source_l1a_echo_sar_ku	Set to 0=GPS
oper_instr_l1a_echo_sar_ku	Set to 0=Side A
SAR_mode_l1a_echo_sar_ku	Set to 0=Closed Loop
cl_gain_l1a_echo_sar_ku	Set to 0=Nominal
acq_stat_l1a_echo_sar_ku	Set to 1=acquisition
dem_eeprom_l1a_echo_sar_ku	Set to 0=Enabled
weighting_l1a_echo_sar_ku	Set to 0=Nominal
loss_track_l1a_echo_sar_ku	Set to 0=Normal
h0_nav_dem_l1a_echo_sar_ku	Set to Fill Value
h0_applied_l1a_echo_sar_ku	16 : H0 Initial Height Word
cor2_nav_dem_l1a_echo_sar_ku	Set to Fill Value
cor2_applied_l1a_echo_sar_ku	17 : COR2 Height Rate
dh0_l1a_echo_sar_ku	Set to Fill Value
agccode_ku_l1a_echo_sar_ku	Field 20 : AGC_1
agccode_c_l1a_echo_sar_ku	Set to Fill Value
alt_l1a_echo_sar_ku	9 : Altitude
orb_alt_rate_l1a_echo_sar_ku	10 : Altitude Rate
x_pos_l1a_echo_sar_ku	Computed, see below
y_pos_l1a_echo_sar_ku	Computed, see below
z_pos_l1a_echo_sar_ku	Computed, see below
x_vel_l1a_echo_sar_ku	11 : Velocity
y_vel_l1a_echo_sar_ku	11 : Velocity
z_vel_l1a_echo_sar_ku	11 : Velocity
roll_sat_pointing_l1a_echo_sar_ku	Computed, see below
pitch_sat_pointing_l1a_echo_sar_ku	Computed, see below
yaw_sat_pointing_l1a_echo_sar_ku	Computed, see below

roll_sral_mispointing_l1a_echo_sar_ku	Computed, see below
pitch_sral_mispointing_l1a_echo_sar_ku	Computed, see below
yaw_sral_mispointing_l1a_echo_sar_ku	Computed, see below
range_ku_l1a_echo_sar_ku	Computed, see below
int_path_cor_ku_l1a_echo_sar_ku	26 : Instrument Range Correction
uso_cor_l1a_echo_sar_ku	Computed, see below
cog_cor_l1a_echo_sar_ku	Set to 0
agc_ku_l1a_echo_sar_ku	Field 20 : AGC_1
agc_c_l1a_echo_sar_ku	Set to FillValue
scale_factor_ku_l1a_echo_sar_ku	Computed from L1b, see below
scale_factor_c_l1a_echo_sar_ku	Set to Fill Value
sig0_cal_ku_l1a_echo_sar_ku	28 : Instrument Gain Correction
sig0_cal_c_l1a_echo_sar_ku	Set to Fill Value
i_meas_ku_l1a_echo_sar_ku	Computed, see below
q_meas_ku_l1a_echo_sar_ku	Computed, see below
i_meas_c_l1a_echo_sar_ku	Set to Fill Value
q_meas_c_l1a_echo_sar_ku	Set to Fill Value
gprw_meas_ku_l1a_echo_sar_ku	Set to Fill Value
gprw_meas_c_l1a_echo_sar_ku	Set to Fill Value
cal2_ku_ind_l1a_echo_sar_ku	Filled from external CAL file
burst_power_cor_ku_l1a_echo_sar_ku	Filled from external CAL file
burst_phase_cor_ku_l1a_echo_sar_ku	Filled from external CAL file
cal1_ku_ind_l1a_echo_sar_ku	Set to Fill Value
time_l1a_echo_plrm	Counts from 0
i2q2_meas_ku_l1a_echo_plrm	Set to Fill Value
i2q2_meas_c_l1a_echo_plrm	Set to Fill Value

3.2 Transforming Parameters

The subsections below show how parameters that cannot be filled simply by copying data from the FBR file are filled.

3.2.1 [x/y/z]_pos_l1a_echo_sar_ku

Spacecraft lat/lon/alt from the FBR (Fields 7,8,9) are converted into XYZ coordinates using the WGS84 reference ellipsoid, via the publicly available IDL routine ell_llh2xyz [R4].

3.2.2 [roll/pitch/yaw]_sat_pointing_l1a_echo_sar_ku

Pointing was derived from the FBR baseline and real-beam direction vectors (Fields 12,13) as detailed in [R5].

3.2.3 [roll/pitch/yaw]_sral_mispointing_l1a_echo_sar_ku

Pointing was derived from the FBR baseline and real-beam direction vectors (Fields 12,13) as detailed in [R5].

3.2.4 range_ku_l1a_echo_sar_ku

The FBR window delay (Field 15) is used to fill `range_ku_l1a_echo_sar_ku` with the range value. Cryosat references this value to the CoM, but in S3 it is referenced to the antenna. Therefore, the S3 CoM correction value is removed from the range so that it can be added back in during the processing. As the correction value for the CoM is present in the L1A data, it is currently set to zero for simplicity

```
range_ku_l1a_echo_sar_ku = window_delay * 1.0d-12 * 0.5 * c - COG
```

3.2.5 uso_cor_l1a_echo_sar_ku

The USO correction is stored in a very different manner between the two datasets. To compute a simple USO correction value to apply, the CryoSat USO correction is applied (in the specified manner) to the range window delay in the FBR after conversion to a range. The uncorrected range window delay is then subtracted to leave a correction value that is then placed in the L1A product.

```
uso_corrected_range = window_delay * ( uso_correction * 1.0d-15 + 1 ) ) * 1.0d-
12 * 0.5 * d_c
```

3.2.6 scale_factor_ku_l1a_echo_sar_ku

In the S3 L1 processing, a scaling is performed so that adding the scaling value presented in the product to the power in dB gives the backscatter in dB.

Working from CryoSat FBR data, we have no information about the power values of the waveforms (without reproducing the L1b processing), so this value is approximated by using the L1b data corresponding to the FBR data.

The parameters in the CryoSat L1b product that can be used to scale from counts to watts are used to produce a value in dB. This is then scaled by a constant value to give a number that is representative of the values found in sample L1A products. The result will not be correct, but should be proportional to the correct value, and the constant value can be tuned to make the result closer if necessary.

The linear and power2 coefficients for the counts to watts scaling from the L1b product are used as follows.

$$\text{scale\_factor\_ku\_l1a\_echo\_sar\_ku} = 10\log(1\times10^{-9} \times \text{linear} \times 2^{power2}) + 250$$

3.2.7 i_meas_ku_l1a_echo_sar_ku

Copied directly from the CryoSat FBR waveform. No scaling is performed as that would invalidate the estimation of power.

3.2.8 q_meas_ku_l1a_echo_sar_ku

Copied directly from the CryoSat FBR waveform. No scaling is performed as that would invalidate the estimation of power.

3.3 External Data Sources

Some fields in the L1A file (calibrations) need data that is not present in the FBR file. The way in which these fields are filled is described below.

3.3.1 cal2_ku_ind_l1a_echo_sar_ku

Parameter cal2_lpf_sar from CryoSat averaged calibration information.

3.3.2 burst_power_cor_ku_l1a_echo_sar_ku

Parameter cal1_p2p_amplitude_sar from CryoSat averaged calibration information.

3.3.3 burst_phase_cor_ku_l1a_echo_sar_ku

Parameter cal1_p2p_phase_sar from CryoSat averaged calibration information.

4 Test Data Validation

4.1 Overview

As the test data is created from CryoSat data, the primary method of validation is to compare the output of the DeDop processor against the CryoSat L1b data file that corresponds to the CryoSat FBR data that was used to create the input file passed to the DeDop processor. Due to differences in processing, exact correspondence is not expected. To make the differences easier to assess, a very simple dataset is used for primary testing — a pass over a transponder.

4.2 Transponder Data

4.2.1 Data Used

This test was performed with the file:

CS_OFFL_SIR1SAR_FR_20120724T000711_20120724T000724_C001.DBL.nc

This dataset contains a pass over a transponder.

4.2.2 Method

The transponder pass was processed by the DeDop processor, and the results were sent to isardSAT for analysis.

4.2.3 Results

The L1b waveform over the transponder shows the expected shape, see Figure 1.

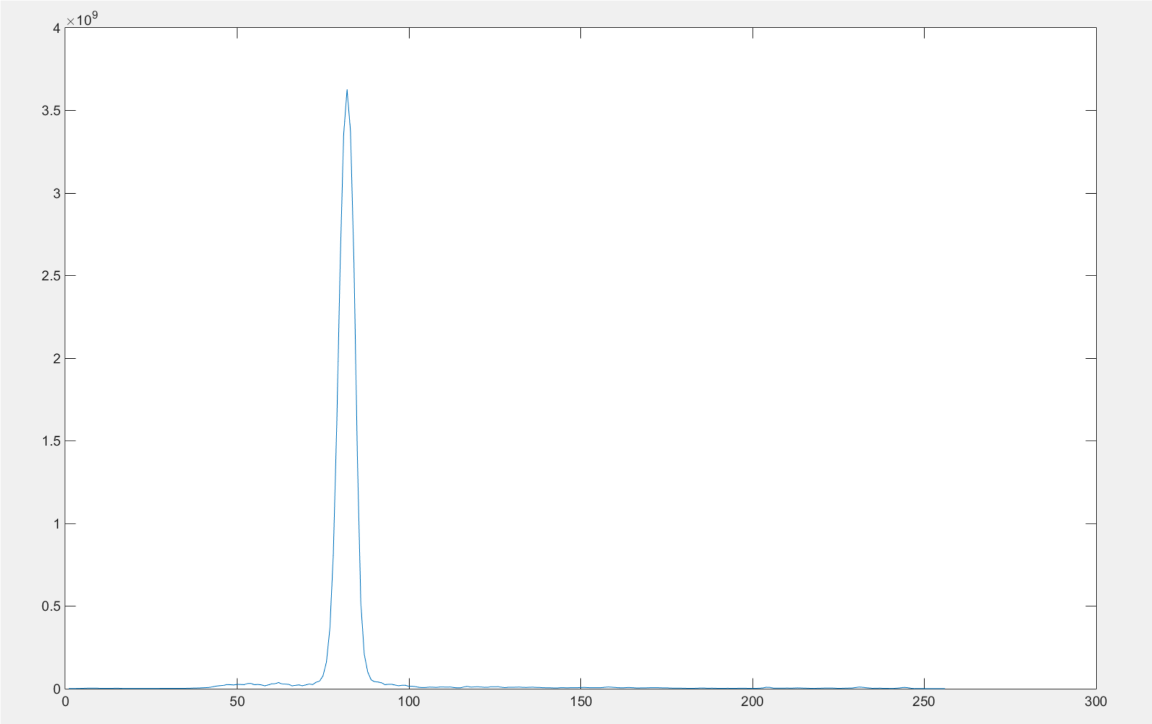

Figure 1: DeDop L1b waveform over transponder

Similarly, the DeDop L1S stack output file shows that the waveforms gathered for stacking show the expected shape over the transponder, see Figure 2.

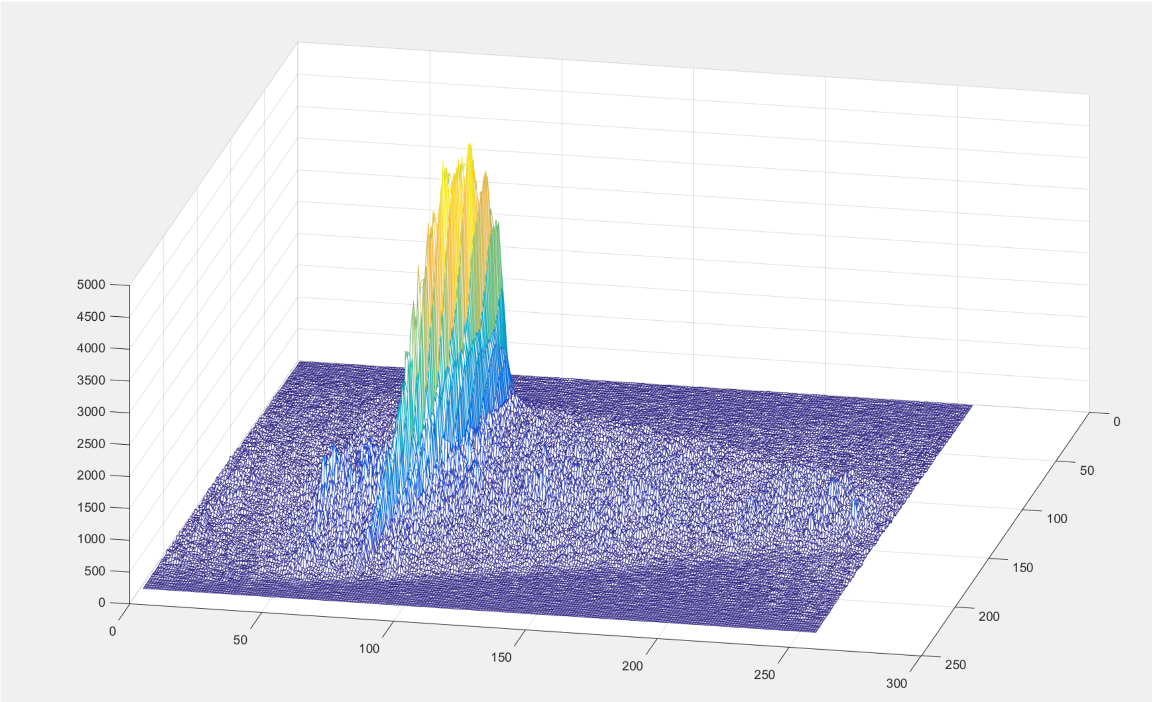

Figure 2: DeDop gather of beams over transponder

4.3 Ocean data

4.3.1 Data Used

This dataset contains a pass over the ocean close to Antarctica, and contains sea-ice and icebergs as well as open-ocean.

4.3.2 Results

To check the suitability of the L1A data created from CryoSat FBR for use in the case-studies, DeDop processed L1b data was used to create a rough estimate of surface height (no retracking). This was compared against the same value from CryoSat L1b, noting that the DeDop L1b data is uncalibrated. The expected bias is of order 4m, and matches with what is observed in Figure 3.

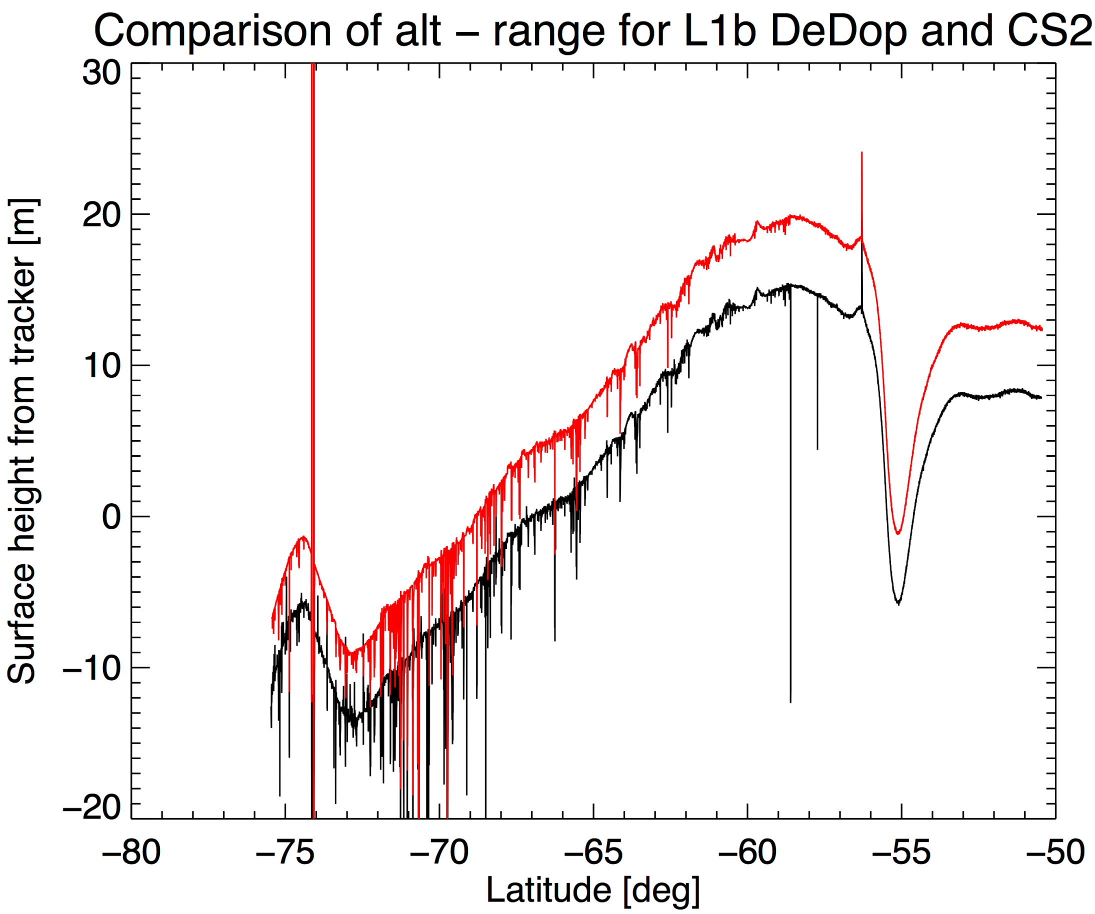

Figure 3: L1b range comparison

To check the shape of the created waveforms will be suitable for retracking, an OCOG retrack was used to determine the retracking point of 1,000 waveforms over open ocean and over sea-ice. These waveforms were then shifted via FFT to place the retracking point in the middle of the range window and then averaged. This allows a comparison of waveform shape to be made. Waveform shapes are shown in Figure 4 to be very similar between DeDop L1b and CryoSat L1b, with the differences observable (mainly in the toe of the leading edge) explained by the difference in weighting method in the two processing runs.

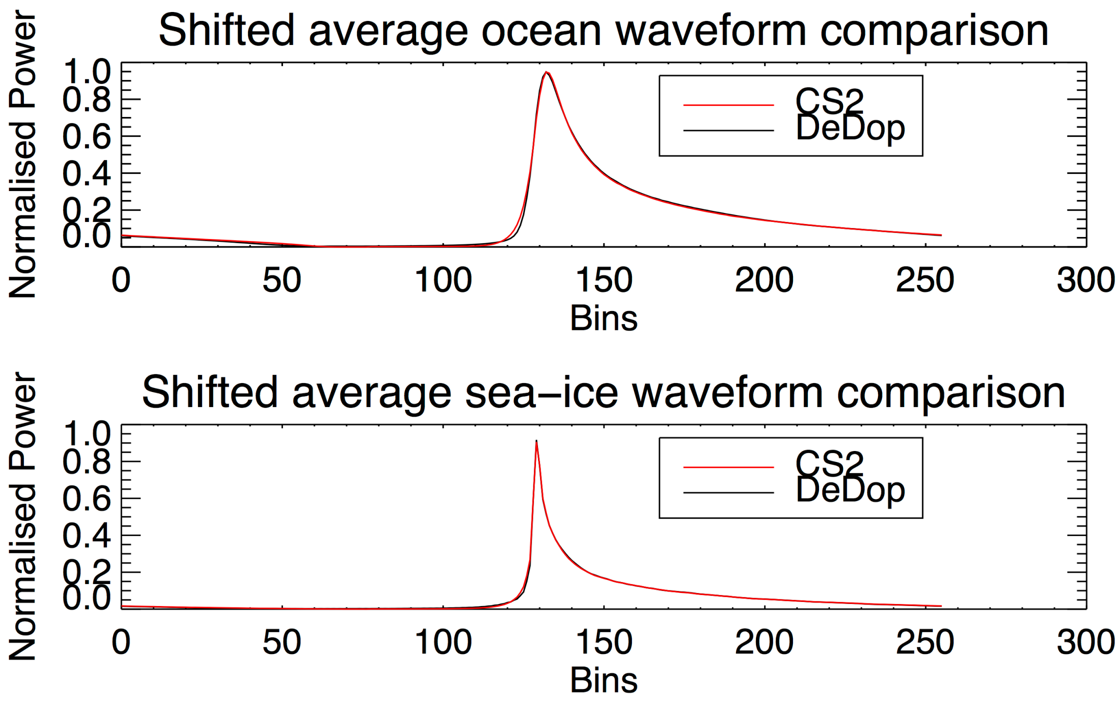

Figure 4: L1b waveform comparison