Level 2 ENVISAT ALTIMETRY Products

Read-Write C, IDL and FORTRAN Programs

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1. Scope

This document has the purpose to describe the three sets of programs developed for reading and writing Level 2 Envisat Altimetry Products.

The programs are implemented in C, IDL and FORTRAN 77. They are custom-made for and initially released to the RA-2 / MWR Cross-Calibration and Validation Team to facilitate the processing of the Altimetry Level 2 data Products.

2. Software Description

2.1 Generalities

The user is expected to be familiar with Envisat Altimetry Products (described in the document: RA-TN-ESR-GS-0013, " ENVISAT RA-2 and MWR Products and Algorithms User Guide ").

The programs read Level 2 products headers (MPH and SPH) and extract some information which will be also used for consistency checks (see appendix for details). If any error is detected in the headers the processing is stopped, error messages appear on the screen and no output data is produced. Otherwise the product name and the name, size and number of records of each DS in the input file are displayed, MPH and SPH are written in an ASCII file and the DS records having passed some simple checks are rewritten in a binary file. The system notation of integers (Big Endian or Little Endian) is checked and bytes are swapped in case of Little Endian systems.

Each set of programs consists of the following files:

C Programs:

1 - a file containing the main source for reading Level 2 FDGDR-IGDR-GDR products, SGDR products and FDMAR-IMAR products, i.e.

- *read_and_write_L2.c*

2- a file containing the functions that make the software run on Little and Big Endian machines, i.e.

- *aux_file.c*

3 - a file containing three functions (*check_L2_mwg, check_L2_mws, check_L2_wwv*)

which implement the checks on the binary records and produce the output files, i.e.

- *check_L2_prod.c*

4 - an include file containing the variables definition, i.e.

- *ra2_pr20.h*

5 - a Makefile for easy compilation and execution

IDL Programs:

1 - the file '*read_and_write_L2_prod.pro'* containing:

a procedure for reading the Level 2 FDGDR-IGDR-GDR products, SGDR products and FDMAR-IMAR products, i.e.

- *read_and_write_L2*

a procedure to establish the system notation of integers (Big or Little Endian), i.e.

- *ltlend*

some procedures to check the binary records of each DS and produce the output files, i.e.

- *check_L2_ra2_mdsr* checks on the RA2 MDS (FDGDR-IGDR-GDR and SGDR products)
- *check_L2_mwr_mdsr* checks on the MWR MDS (FDGDR-IGDR-GDR and SGDR products)
- *check_L2_18hz_mdsr* checks on the RA2 Average (18hz) Waveforms MDS (SGDR products)
- *check_L2_burst_mdsr* checks on the RA2 Burst Waveforms MDS (SGDR products)
- *check_L2_wwv_mdsr* checks on the RA2/MWR Marine Abridged MDS (FDMAR-IMAR products)

2 - an include file containing the variables definition, i.e.

- *ra2_prod_idl.h*

3 - a file for “batch” compilation and execution, i.e.

- *exec.pro*

FORTRAN Programs:

1 - a file containing the source code for reading Level 2 FDGDR-IGDR-GDR products, SGDR products and FDMAR-IMAR products, i.e.

- *read_and_write_L2.f*

2 - some C and FORTRAN routines to perform the reading of this type of data files;

3 - a file containing the function to check the system notation of integers (Big or Little Endian), i.e.

- *ltlend.f*

4 - two files containing the subroutines that make the software run on Little and Big Endian machines, i.e.

- *swap_L2_prod.f*
- *int_swap.f*

5 - the file *‘check_L2_prod.f’* containing the functions which implement the checks on the binary records of each DS and produce the output files, i.e.

- *check_L2_ra2_mdsr* checks on the RA2 MDS (FDGDR-IGDR-GDR and SGDR products)
- *check_L2_mwr_mdsr* checks on the MWR MDS (FDGDR-IGDR-GDR and SGDR products)
- *check_L2_18hz_mdsr* checks on the RA2 Average (18hz) Waveforms MDS (SGDR products)
- *check_L2_burst_mdsr* checks on the RA2 Burst Waveforms MDS (SGDR products)
- *check_L2_wwv_mdsr* checks on the RA2/MWR Marine Abridged MDS (FDMAR-IMAR products)

6 - some include files containing the variables definition, i.e.

- *RA2_L2.inc*

- *MWR_L2.inc*
- *BURST_L2.inc*
- *Hz18_L2.inc*
- *WWV_L2.inc*

7- an user defined input file specifying the input data for the programs run, i.e.

- *input_L2*

8 - a Makefile for easy compilation and execution

2.2 C Programs

The C main program reads any of the Level 2 ENVISAT Altimetry product, establishes the type of product to be analysed and calls a specific function to process it.

A Makefile is available for compilation and execution. The user has to type at the prompt:

- 'make all' (or just 'make') to create the executable file,

- 'make tests' to test the execution of the program,

- 'make clean' to clean up the object, executable and output files.

The user has to specify the name of the input data file in the Makefile for each product to be processed, followed by an integer value determining the range of longitude in the binary output file. The value 180 means that longitude will fall in the range (-180 deg / +180 deg], the value 360 means that longitude will fall in the range [0 deg / +360 deg).

An include file '*ra2_pr20.h*' contains the definition of the variables associated to each product. These variables are declared as structures, making it easier for the user to directly refer to any product field.

The produced outputs are:

- an ASCII file containing MPH and SPH,

- a binary file with the data records that have passed some checks,

- an ASCII file specifying the number and the indexes of the records that haven't passed those checks.

Some information about the product are displayed on the screen and error messages always appear if the calls to the fread, fwrite, fseek, fopen ..... C routines fail or any discrepancy is found in data. If this happens the processing is stopped.

2.3 IDL Programs

The IDL procedure *'read_and_write_L2'* reads any of the Level 2 ENVISAT Altimetry product recognising the product type, searching for one or more attached data sets and writing them out in a binary file.

This procedure is called in the "batch" file *'exec.pro'* for each product to be processed, with two input parameters, i.e.

1. a character string representing the input data file name,
2. an integer variable specifying the range of longitude in the binary ouput file. The value 180 means that longitude will fall in the range (-180 deg / +180 deg], the value 360 means that longitude will fall in the range [0 deg / +360 deg).

The batch mode is entered from the interactive mode by typing

@exec

at the IDL prompt.

An include file *'ra2_prod_idl.h'* contains the definition of the variables associated to each product. These variables are declared as structures, making it easier for the user to directly refer to any product field.

The produced outputs are:

- an ASCII file containing MPH and SPH,
- a binary file with the data records that have passed some checks,
- an ASCII file specifying the number and the indexes of the records that haven't passed those checks.

2.4 FORTRAN Programs

The FORTRAN main program reads any of the Level 2 ENVISAT Altimetry product recognising the product type, searching for one or more attached data sets and writing them out in a binary file.

Level 2 executables are produced compiling some '.f' sources, some '.c' sources and some '.inc' files that contain the variables associated to each DS. An EQUIVALENCE statement, also declared in the '.inc' files, makes it easier for the user to refer to each record field value. This way is fine for Level 2 altimetry products where the record fields are "aligned" (in the Fortran sense). The Level 2 binary output files are produced writing records composed of each variable of the input records.

The user has to write the input data for the programs to be run in an input file (*input_L2*) specifying the number of data files to be processed and each input file name followed by an integer variable. This variable is referred to the range of longitude in the binary output file; the value 180 means that longitude will fall in the range (-180 deg / +180 deg], the value 360 means that longitude will fall in the range [0 deg / +360 deg).

A Makefile is available for compiling and testing FORTRAN programs typing at the prompt:

- 'make all' (or just 'make') to create the executable files,
- 'make test' to test the execution of the programs,
- 'make clean' to clean up the test result, the executable and the object files.

The produced outputs are:

- an ASCII file containing MPH and SPH,
- a binary file with the data records that have passed the checks,
- an ASCII file specifying the number and the indexes of the records that haven't passed those checks.

NB: FORTRAN language doesn't support unsigned integers and this could result in a

wrong reading of some DS record fields if the variable stored in an unsigned integer exceeds half its dynamic range.

Usually this problem rises up for those record fields which assume the default value (i.e. the default value for short unsigned integer is 65535 which result in a negative value (-1) when it's read in a Fortran integer*2 variable).

Nevertheless the software package includes two FORTRAN functions (*'uns_short'* and *'uns_lon')* that the user could call in order to expand the unsigned short and unsigned long variables respectively in signed long and signed long-long ones. An example is given as comment in the FORTRAN source.

The problem cannot be solved for the unsigned doubles; however there is only one unsigned double variable in the Level 2 products (i.e. OBDH datation word in the Burst Waveforms MDS of the SGDR products).

3. Acronyms

DS	Data Set
FDGDR	Fast-Delivery Geophysical Data Record
FDMAR	Fast-Delivery Marine Abridged Record
GDR	Geophysical Data Record
IGDR	Interim Geophysical Data Record
IMAR	Interim Marine Abridged Record
MDS	Measurement Data Set
MPH	Main Product Header
MWG	identifier in the FDGDR / IGDR / GDR product ID
MWS	identifier in the SGDR product ID
RA-2 / MWR CCVT	Cross-Calibration and Validation Team
SGDR	Sensor Geophysical Data Record
SPH	Specific Product Header
WWV	identifier in the FDMAR / IMAR product

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APPENDIX 1

A.1 Level 2 Products checks details

The checks performed on Level 2 Products are detailed in this appendix. They are given here as examples and can be adjusted to user needs.

The programs check the filename ID and the satellite ID before reading MPH and SPH; if they aren't the ones specified in the product name convention the processing is stopped. Otherwise the following fields are extracted from the headers:

the product total size	(TOT_SIZE; field 36 of MPH),
SPH size	(SPH_SIZE; field 37 of MPH),
the offset of each DS	(DS_OFFSET; field 4 of each DS),
the size of each DS	(NUM_DSR; field 5 of each DS),
the number of records for each DS	(DS_SIZE; field 6 of each DS).

The programs check first MPH and SPH sizes. A consistency check on the binary data size is also performed based on the following equations:

1) TOT_SIZE - MPH_SIZE - SPH_SIZE = Σ MDS_SIZE
2) DS_SIZE / NUM_DSR = record length).

If any error is detected in the headers the processing is stopped and no output data is produced, just an error message is displayed. Otherwise the product name and the name, size and number of records of each DS are displayed, MPH and SPH are written in an ASCII file and the reading of the binary part begins.

A quality check is performed on each record of each DS and only the correct ones are written into the output binary file, whilst the number and the indexes of those DS records not having passed the checks are ouput in an ASCII file.

The implemented checks are as follows:

Level 2 Geophysical Data Record Products (FDGDR-IGDR-GDR)

RA-2 MDS check on quality indicator, latitude, longitude, bits 16-22 of MCD field;

MWR MDS check on quality indicator, latitude, longitude, bits 30, 31 of MCD field;

Level 2 Sensor Geophysical Data Record Products (SGDR)

RA-2 MDS check on quality indicator, latitude, longitude, bits 16-22 of MCD field;

MWR MDS check on quality indicator, latitude, longitude, bits 30, 31 of MCD field;

18-Hz Waveforms MDS check on quality indicator;

Burst Waveforms MDS check on quality indicator;

Level 2 Marine Abridged Record Products (FDMAR-IMAR)

RA2/MWR Marine Abridged Record check on quality indicator, latitude, longitude, bits 16-22 of MCD field

The programs inspect the quality indicator and the MCD fields values: if they are not equal to zero the checks fail.

The check on latitude and longitude verifies if their values fall respectively in the (-90 deg / +90 deg] range and (-180 deg / +180 deg] range. The user can choose the range for the longitude in the output binary file ((-180 deg / +180 deg] or [0 deg / +360 deg)) giving an appropriate value in input.