CryoSat L2

L2 Prototype Input & Output Definition Document

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Document History

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0.7	25/4/03	SGB	Issued for internal review comments
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Entries in italics denote non-deliverable versions provided for information or internally.

Detailed change history

Version	Section	Updated by	Modification

Table of Contents

1 Introduction

1.1 Purpose And Scope

The CryoSat Instrument Processing Facility (IPF) processes L0 SIRAL data to level 2. The Processing chains to process the L0 data to L1b are called the IPF1. The processors which convert L1b data to Level 2 are called the IPF2. This document defines the main external data interfaces for the IPF2 activity.

This issue is the second delivery in the IPF2 contract aligned with the mature vB algorithm specifications and applicable to the vB delivery, of the ESL IPF2 code, in January 2004.
Notes for this issue:-

- Data content has been updated to match the changes to the L1b product and to take account of CSAG review comments.

1.2 Applicable References

R1 ESL IPF1 IODD: CS-IS-MSL-GS-0001 (ESL-IODD)
R2 CryoSat Data Products Requirements: CS-RS-UCL-SY-0003, CryoSat SAG, Draft 2
R3 Earth Explorer Mission Conventions Document : CS-MA-DMS-GS-0001
R4 Earth Explorer: Ground Segment File Format Guidelines : CS-TN-ESA-GS-0154 (Is 1.3)
R5 SIRAL Software Interface Control Document: SIRAL-ASPI-IR-0052, 24/07/2002 Iss 7
R6 Mission CFI, General Software User Manual : CS-MA-DMS-GS-0002
R7 Mission CFI, EXPLORER_LIB Software User Manual : CS-MA-DMS-GS-0003
R8 Mission CFI, EXPLORER_ORBIT Software User Manual : CS-MA-DMS-GS-0004
R9 EXPLORER_GEO_CORRECTIONS CFI Software User Manual : CS-MA-CLS-GS-0001
R10 EXPLORER_RETRACKER CFI Software User Manual : CS-MA-CLS-GS-0002
R11 CryoSat IPF1 Products Format Specification [CS-RS-ACS-GS-5106]
R12 CryoSat PDS Generic Processor ICD [CS-ID-ACS-GS-0118] "PROC_ICD"
R13 CryoSat PDS L1b Processor ICD [CS-ID-ACS-GS-0116] "L1B_ICD"
R14 CryoSat PDS L2 Processor ICD [CS-ID-ACS-GS-5121] "L2_ICD"
R15 CS-TN-MSL-GS-2001, CryoSat Level 2 prototype processor FRAPPE data structures
R16 ENVISAT: Product Data Conventions PO-RS-MDA-GS-2009-Annex-A

1.3 Definitions, Acronyms and Abbreviations

AGC	Automatic Gain Control (output value of)
API	Application Programmers Interface
CEOS	Committee for Earth Observation Standards
CFI	Customer Furnished Item
CRYMPS	CRYOSAT Mission Performance Simulator
DORIS	Doppler Orbitography and Radiopositioning Integrated by Satellite
D-PAF	German Processing and Archiving Facility
DEM	Digital Elevation Model
DSR	Data Set Record
ENVISAT	ENVIronmental SATellite (ESA mission)
ESA	European Space Agency
ERS	European Remote Sensing (satellites)
ESTEC	European Space agency Technical Centre
FBR	Full Bit Rate (Processed SIRAL data before stacking of echoes = Level 1)
FRAPPE	Flexible Radar Altimeter Processor for Performance Evaluation
GDR	Geophysical Data Record (Altimeter Level 2.0 Geophysical Product)
GEF	Global Earth Fixed (reference frame)
GMMI / GUI	Graphical Man-Machine Interface / Graphical User Interface
HSRRA	High Spatial Resolution Radar Altimeter (CRYOSAT concept simulator)
IERF	International Earth Reference Frame
IFF	Inertial Fixed Frame (a reference frame)
IPF1	Instrument Processing Facility up to level 1b (part of the PDS)
IRS	Instrument and Retrieval Simulation
ISP	Instrument Source Packet
L0 /L1b/L2	Processing Levels 0 / 1b / 2
LEF	Local Earth Fixed (a reference frame)
LLPA	Long Loop Performance Analysis
LRM	Low Rate Mode i.e. Pulse Limited operation of the altimeter
MDS	Measurement Data Set
MPH	Main Product Header
MS	Mission Simulation
MSSL	Mullard Space Science Laboratory
PDS	Payload Data Segment
PH	Product Header
PRI	Pulse Repetition Interval
RA-2	Radar Altimeter on ENVISAT

RMS	Root Mean Square
SAR	Synthetic Aperture Radar
SARin	Interferometric Synthetic Aperture Radar
SAT	Site Acceptance Tests
SCCS	Software Configuration Control System
SDD	System Design Document
SIRAL	SAR/Interferometric Radar ALtimeter
SP	Source Packet
SPH	Specific Product Header
srf	a Satellite Reference Frame TBD
TAI	International Atomic Time
ToD	True of Date (reference frame)
UCL	University College London
VDU	Video Display Unit
WGS84	World Geodetic System 1984
XML	eXtensible Markup Language

1.4 Conventions

Bit numbering 0 = LSB, and hence 15 = MSB (2-byte int) or 31=MSB (4-byte int). This convention is required by [R4]. and referred to as 'PDS' convention. Note that the documentation on CryoSat telemetry uses the opposite convention (which we call Space Segment or 'SS' convention).

All file formats will follow the CryoSat mission guidelines [R4]

In the tables describing record formats within this document we use a syntax similar to the 'C' programming language to describe the parameter type.
Hence the column labelled " Type 'C' " may contain the following entries:

Type 'C' code	code meaning	length
uc	unsigned character	1 byte
us	unsigned short integer	2 bytes
ss	signed short integer	2 bytes
ul	unsigned long integer	4 bytes
sl	signed long integer	4 bytes
ull	unsigned long long integer	8 bytes
sll	signed long long integer	8 bytes
[n]	denotes an array of length n	

MDSR Time Stamp is formatted as defined for the ENVISAT Mission [R15]. However, it is a TAI Time with a datum of 1 Jan 2000 at 00:00 (TAI), and not a MJD as used in ENVISAT.
expressed as 3 integers :- Day(sl), seconds-of-day(ul) and microseconds(ul).
Note that:
i) Time in File headers (MPH, SPH) is in UTC and not TAI
ii) time correlations between UTC and TAI are provided via Orbit files - these must account for the correct offsets due to leap seconds
iii) 1 Jan 2000 at 00:00 UTC = 1 Jan 2000 at 00:32 TAI

The reference ellipsoid is WGS84.

Longitude : expressed in the range -180 to +180, +ve East does not contain 180.0, -ve West does contain -180.0. (same definition as ENVISAT)

2 IPF2 External Interfaces

The IPF2 is a science data processing chain forming part of the Payload Data Segment which in turn is a component of the CryoSat Mission Ground Segment (GS). Logically the IPF2 lies inside the PDS so that all external IPF2 interfaces are with the PDS.

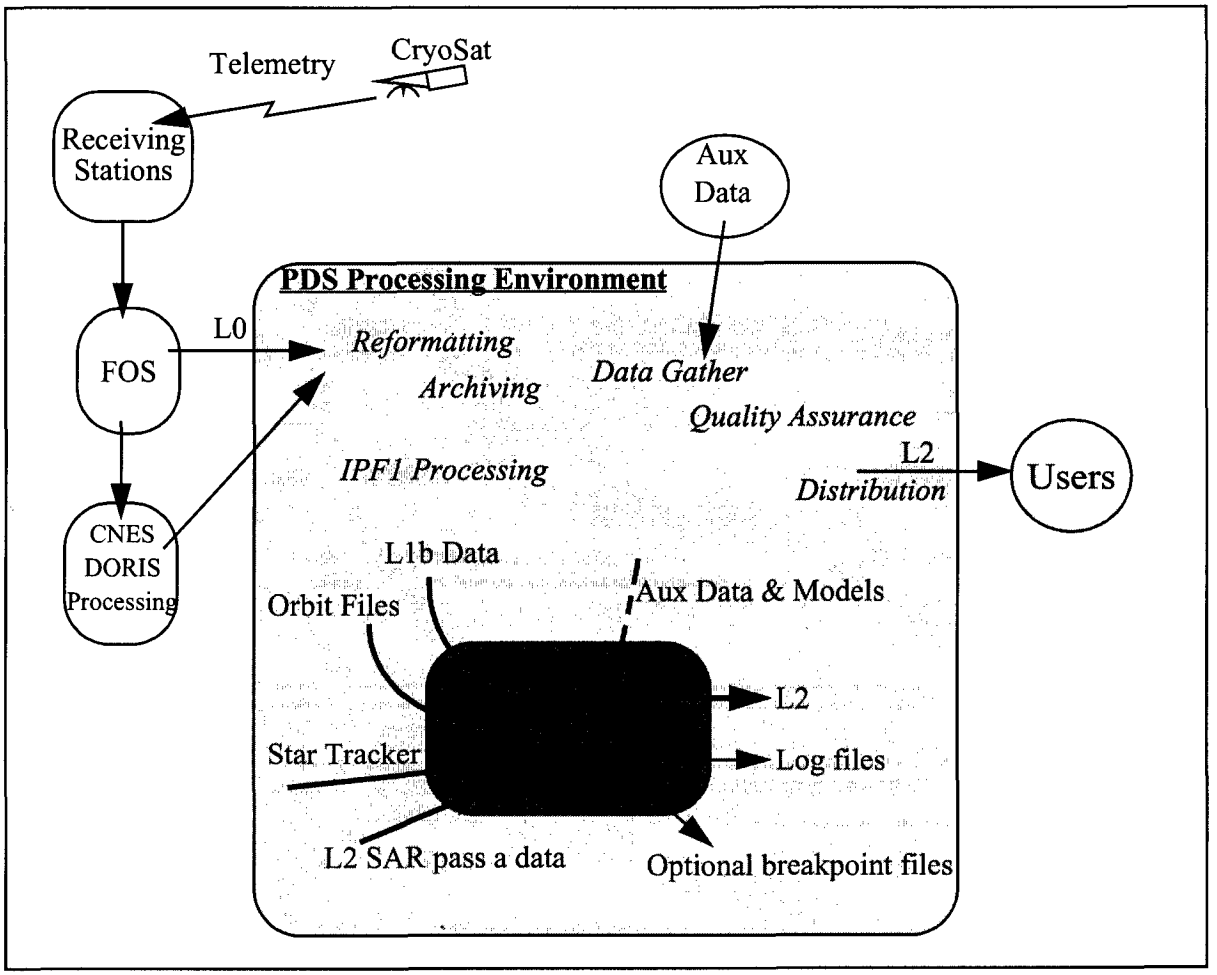

Figure 2-1. The Context of the IPF2 Processor

The main input data format is CryoSat L1b products. For development and testing these files have the correct format as defined within the CryoSat Ground Segment (IPF1 development). The data content of these files is created by simulators and/or data editors.

In addition to the main L2 data output the environment allows two other kinds of output:

- an output stream for log files : to provide job tracability and record processing messages
- switchable Breakpoint files for certain IPF2 algorithms : to provide de-bugging information and visibility of internal parameters. The latter are not archived by the PDS.

2.1 List Of IPF2 External Interfaces

Here we only consider data interfaces. Control interfaces, including the processing run instruction (or Job Control Card) and error and progress reporting, are discussed elsewhere.

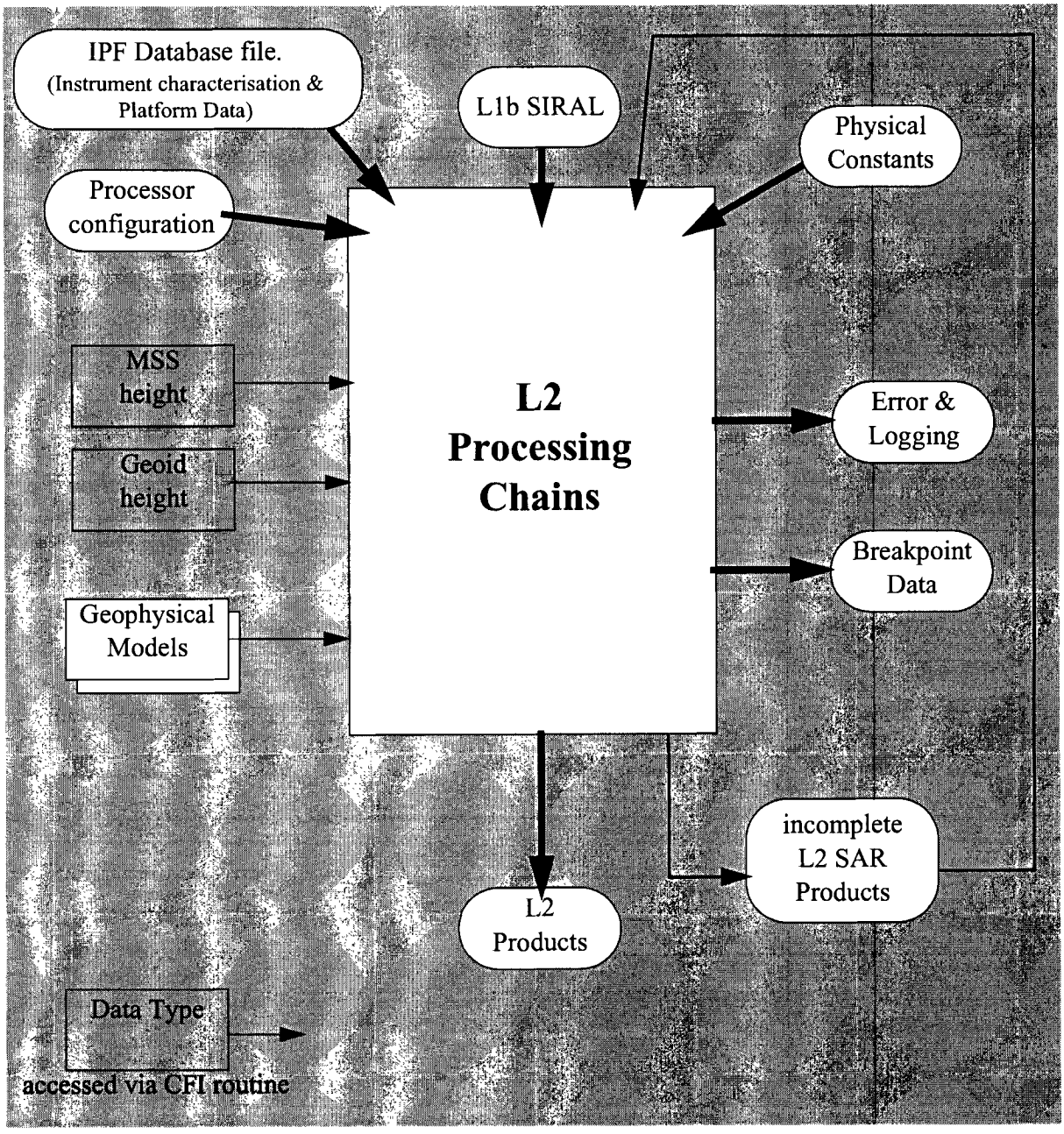

Figure 2.1-1. L2 Data Interfaces

Input files are accessed either directly or indirectly through CFI library functions. Where files are accessed directly the system must have a full description of the file and record structure. Where files are accessed indirectly the system only needs to know about the CFI routine interface.
CFI routines are available for the Mean Sea Surface and Geoid heights [R10].

2.1.1 Inputs

Input Data Type	Access Direct / CFI	Defined in
L1b Data Files (partitioned by mode)	direct	[R1]
Mean Sea Surface height	CFI library	[R10]
Geoid height	CFI library	[R10]
Physical and Geophysical Constants	direct	[R1]
Radar Altimeter Parameter Database (Characterisation data)	direct	[R1]
Processor configuration (Algorithm Tunable Constants)	direct	[R14]
Snow depth climatology	direct	TBD
DEMs	direct	TBD
Slope Models	direct	section 6.9
Sea Ice Concentration Files	direct	TBD

Most input files are defined by other sources therefore their format is defined in external reference documents. However to aid understanding herein some auxiliary data formats may be included in Appendix TBD.

2.1.2 Outputs

The format of these output products is part of the IPF2 design. These formats are defined in this document.

Output Data Type	Comment	Defined in
CryoSat L2 data	distributed to users	Section 5
Incomplete L2 SAR data	i/p to 2nd pass SAR processing	Section 5
Breakpoint Files	for testing only	[a]Appx TBD
others TBC		

a. Currently breakpoint files are defined in the processing chain design TecNotes (internal project documentation).

3 File Formats

All files are formatted in accordance with the mission file format guidelines [R3][R4].

NB: For the prototyping work file headers are not used - the definition is not yet sufficiently stable.

All Product files consist of a Header block and a Data block. Generally the Headers will be ASCII text and the data block may be binary or ASCII format. Each product will additionally have a separate XML Header File (ASCII text). The Fixed portion of the XML header will be the same for all CRYOSAT files. File organisation is illustrated by the diagram below.

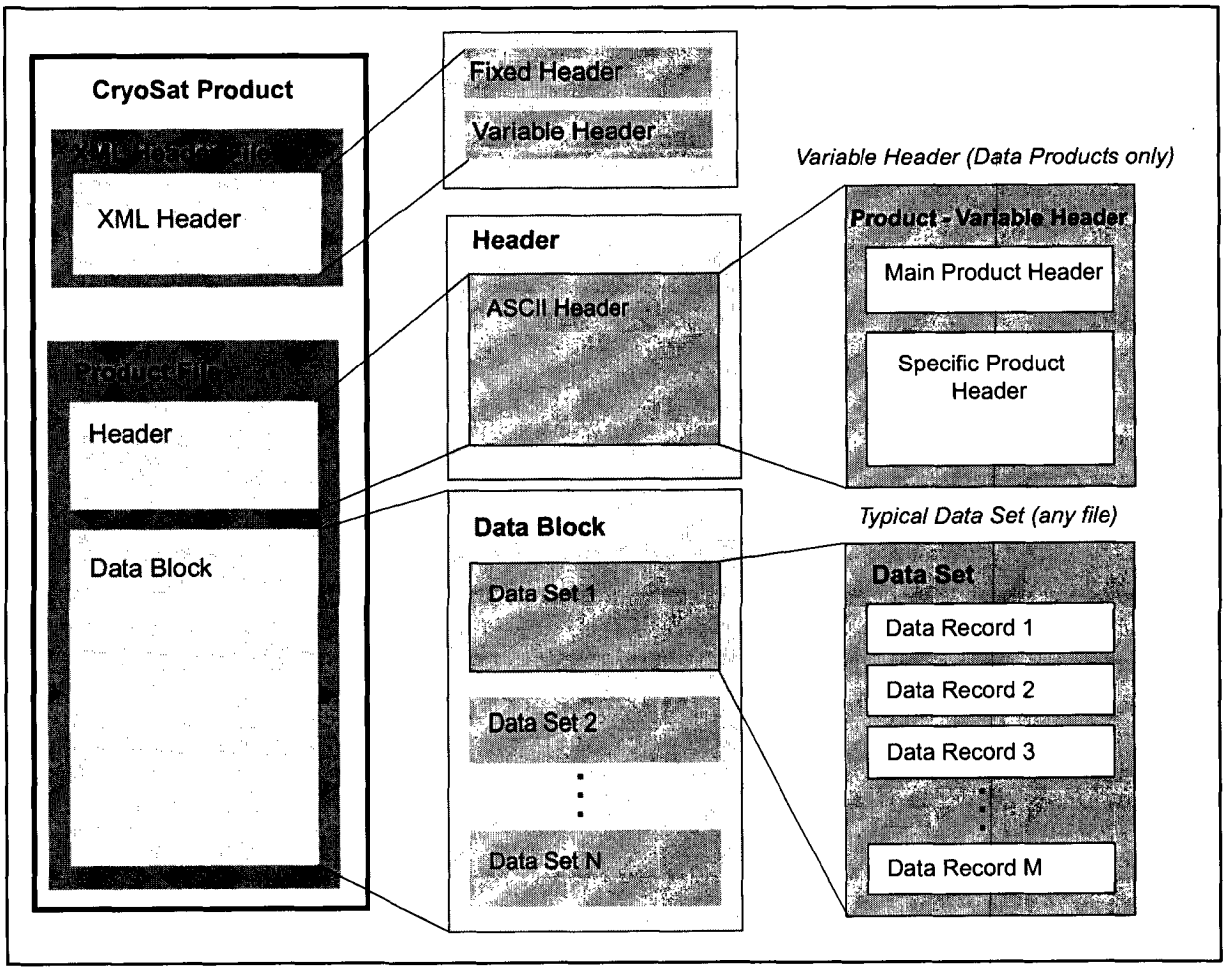

Figure 3-1. CryoSat Data File Structure.

3.1 File Headers

File headers shall be in ASCII text. The main L2 product will have a file header, and XML product headers shall be contained in a separate file.

3.1.1 CryoSat Products Fixed Header

Fixed headers shall be in ASCII text using XML syntax. Details TBD

3.1.2 Standard Variable Header And MPH Format

The Variable Header shall contain an MPH which is the same format for all CryoSat data files and a SPH which varies with the file type. The XML variable header shall be an XML version of the MPH and SPH in the main product file. The MPH and SPH will be similar in layout to ENVISAT products.
Variable headers are TBD

Table 3.1.2-1: MPH content

Field	Description	Values	Bytes	Total Length
1	<MPH>			
2	TBD			
3	<FILE_TYPE>*Type_code*</FILE_TYPE>			
4	TBD			
n	<SPH_SIZE>*size_in_bytes*</SPH_SIZE>			
n+1	</MPH>			
	Total			

NB
For the L2 prototyping development files shall consist only of a single binary MDS. The file type may be determined from the filename. Number of records in a file may be determined from its size.

4 L1b Data Products

The L1b data is output from the IPF1 in 3 different formats corresponding to 3 modes of operation: SAR, SARin and LRM.

L1b data is described in the ESL-IODD [R1]. (this issue is inline with v3.3)

For this prototype we are using an interim L1b format which differs from the IPF L1b product in the following ways :

- No file headers are used.
- Some data fields and flags may contain zero

5 L2 Data Products

The L2 data is the main output from the L2 processor.
The format of the L2 data is independent of the SIRAL instrument operating mode.

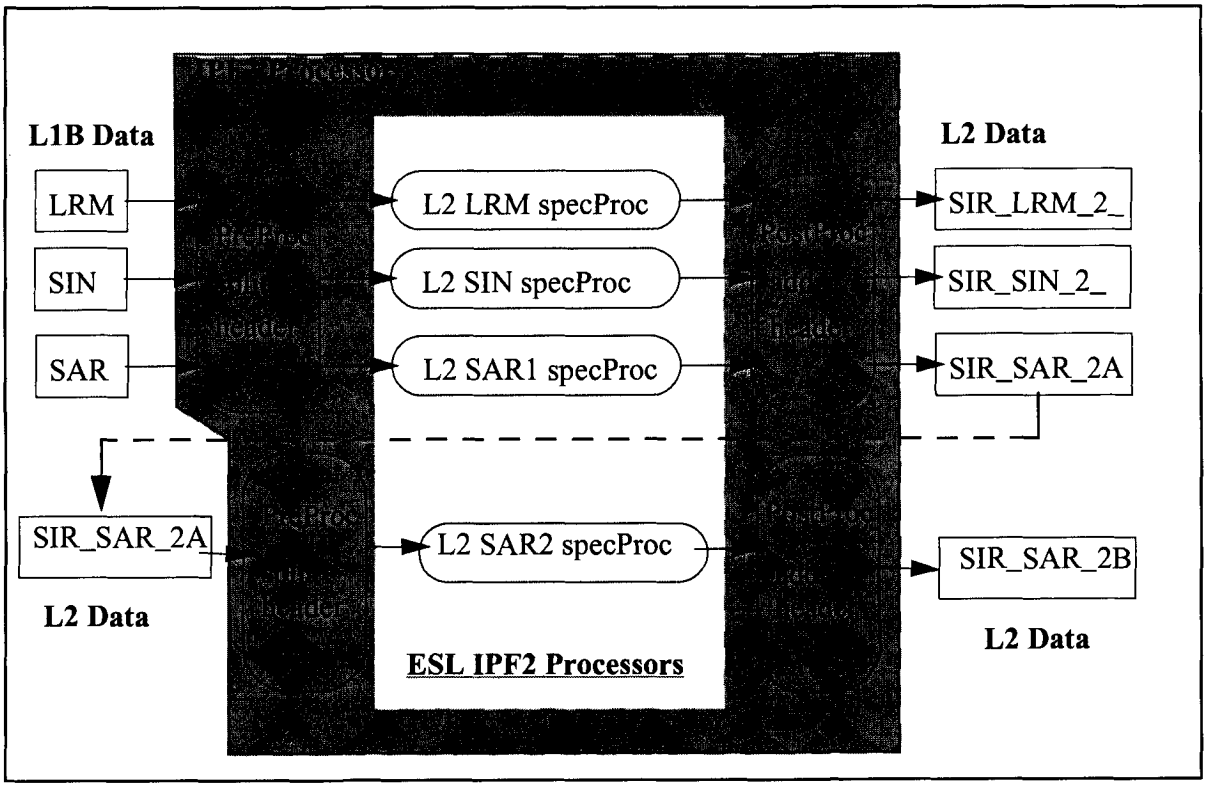

Figure 5-1. Outline of L2 Product Generation

Final L2 SAR data requires 2 processing passes. In the second pass the Ocean Height is interpolated to all measurements over sea ice. The output from the 2 passes are distinguished by the file type strings 'SIR_SAR_2A' and 'SIR_SAR_2B'. The data format is identical but SIR_SAR_2A has some zero-filled parameters. Hence all 4 output types have the same format but at this stage are still partitioned by mode.

To produce a consolidated L2 GDR product the mode-dependent segments around an orbit are merged together. Two 'flavours' of GDR are possible depending on which type of L2 SAR data is used. 'SIR_GDR_2A' results if SIR_SAR_2A data is used, and 'SIR_GDR_2B' products are produced when SIR_SAR_2B data is used. This is illustrated in figure 5-2.

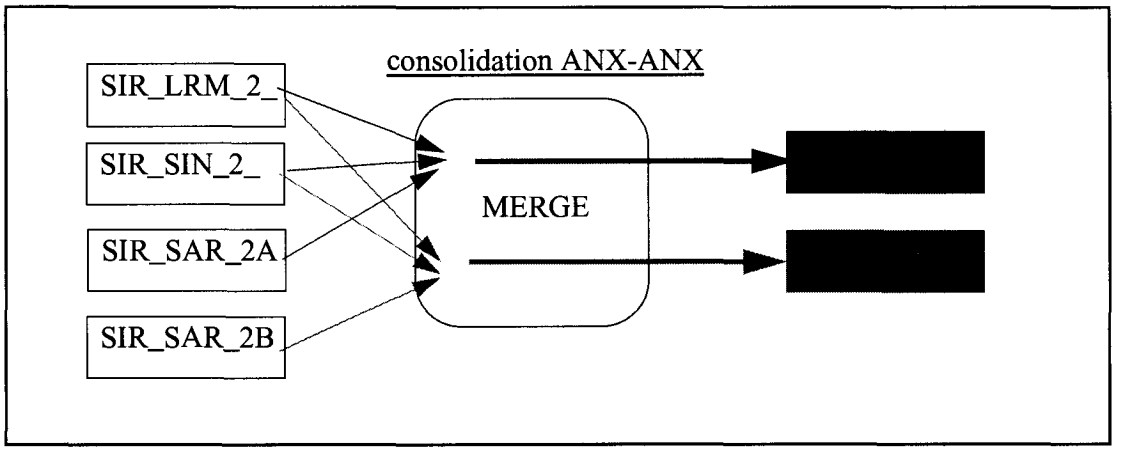

Figure 5-2. Consolidation of L2 data

5.1 The L2 File Format

The L2 product will consist of two files: an XML header file and the L2 data file. The L2 data file has an MPH, an SPH and a MDS containing a variable number of records. This is true for the mode-segmented L2 files as well as for the consolidated GDR products.

The frequency of L2 data records is approximately 20/second.

L2 data files are partitioned in whole-orbit segments cut at the ascending equator crossing (ANX). Therefore each L2 product will be approximately 4,948 seconds long.

Filename: the format will follow Earth Explorer Mission standards (which is similar to ENVISAT). Hence the name of the data file will be of the form:
MM_CCCC_TTTTTTTTTT_yyyymmddThhmmss_YYYYMMDDTHHMMSS_vvvv.DBL
where the ten-character type string will be SIR_GDR_2A or SIR_GDR_2B.

5.2 The L2 SPH

The SPH is not yet defined. The ESL IPF code outputs an 'interim' L2 product with only the MDS. Headers are added by the Postprocessor. The definition will be in [R14].

Table 5.2-1: L2 SPH

Field	Symb	Descriptor	Values	Size (bytes)	Tot. Size (bytes)
1.		<SPH>		6	6
2.		</SPH>		7	

The SPH should contain the COM (centre of Mass Offset) value used in the processing.

5.3 L2 MDS

The L2 Measurement Dataset has a single format which is independent of mode. However the meaning of some fields is mode dependent.

NB: There is no 'Blocking' of high-rate data in the record (as in L1b). All L2 parameters are output at the same frequency giving a 'flat' record structure.

Product parameters are grouped according to function into 5 sub-structures as follows:

Location Group	time and orbit location
Measurements Group	derived from instrument measurement parameters
Auxiliary Measurements Group	from auxiliary data or models
External Corrections Group	geophysical corrections
Internal Corrections Group	calibration corrections etc

The record structure is illustrated in the following diagram. The repetition frequency of each sub-structure is 1.

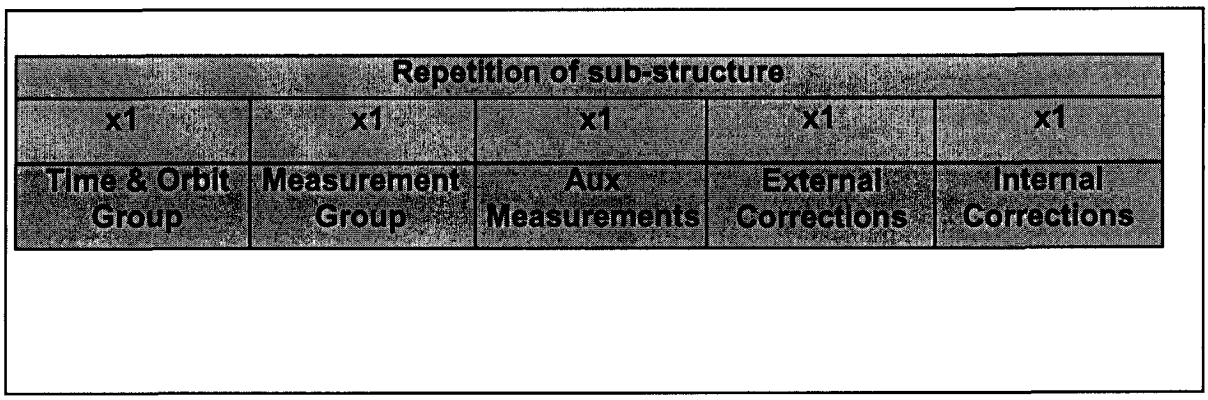

Figure 5.3-1. L2 MDS record structure.

In the following table the symbol column provides a cross reference to parameters defined in [R2] or in the L1 IODD [R1].

Table 5.3-1: L2 MDS Record Structure

ID	Symb	Descriptor	Unit	Type 'C'	Size (bytes)	Tot. Size (bytes)
Time and Orbit group						
1.	t_k	Data Record Time (MDSR Time Stamp)	TAI	sl+2*ul	12	12
2.		USO Correction factor (definition tbd)	(ratio)	sl	4	4
3.	p_3	Mode ID (Instrument mode information)	-	us	2	2
4.	p3	Source Sequence Counter (from telemetry)	-	us	2	2
5.	s_1	Instrument Config (including loop status)	-	ul	4	4

Table 5.3-1: L2 MDS Record Structure

ID	Symb	Descriptor	Unit	Type 'C'	Size (bytes)	Tot. Size (bytes)
6.	K	Surface Sample counter (Record Counter)	-	ul	4	4
7.	$\mathbf{r}^{(1)}\,\phi_e$	Latitude of measurement	**10^{-1} μ-degree**	sl	4	4
8.	$\mathbf{r}^{(1)}\,\lambda_e$	Longitude of measurement	**10^{-1} μ-degree**	sl	4	4
9.	$\mathbf{r}^{(1)}\,h_e$	Altitude of COG above reference ellipsoid (interpolated value)	mm	sl	4	4
10.		Instantaneous altitude rate derived from orbit	mm/sec	sl	4	4
11.	v_g	Satellite velocity vector[3] (in IERF)	mm/sec	sl	3*4	12
12.	m_a	Real beam direction vector[3] (in CRF)	μm	sl	3*4	12
13.	m_b	Interferometer baseline vector[3] (in CRF)	μm	sl	3*4	12
14.		Level 2 Measurement Confidence Data (flag word)	-	ul	4	4
Measurements group						
15.	h	Height of surface w.r.t. ellipsoid	mm	sl	4	4
16.		Sigma 0	dB/100	sl	4	4
17.		spare (reserved for future use)	-	sl	4	4
18.		Peakiness	**1/100**	sl	4	4
19.		Retracked range correction	mm	sl	4	4
20.		Retracked Sigma 0 correction	dB/100	sl	4	4
21.		Retracker output 3	tbd	sl	4	4
22.		Retracker output 4	tbd	sl	4	4
23.		Retracker output 5	tbd	sl	4	4
24.		Retracker output 6	tbd	sl	4	4
25.		Retracker output 7	tbd	sl	4	4
26.		Retracker output 8	tbd	sl	4	4
27.		Retracker output 9	tbd	sl	4	4
28.		Retracker output 10	tbd	sl	4	4
29.		Retracker output 11	tbd	sl	4	4
30.		Retracker output 12	tbd	sl	4	4
31.		Retracker output 13	tbd	sl	4	4
32.	σ_s	Power echo shape parameter	dB/100	sl	4	4

Table 5.3-1: L2 MDS Record Structure

ID	Symb	Descriptor	Unit	Type 'C'	Size (bytes)	Tot. Size (bytes)
33.	Θ	Beam behaviour parameter [50][a]	-	ss	50*2	100
34.		x-Track Angle (interferometric angle computed at Retrack point)	μ radians	sl	4	4
35.		Coherence (at Retrack point)	1/1000	sl	4	4
36.		Interpolated Ocean Height	mm	sl	4	4
37.		Freeboard (initially =0)	mm	sl	4	4
38.		Surface Height Anomaly	mm	sl	4	4
39.		Interpolated Sea Surface Height Anomaly	mm	sl	4	4
40.		Interpolation error for Ocean Height	mm	us	2	2
41.		Number of interpolation points used -forward	-	us	2	2
42.		Number of interpolation points used -backward	-	us	2	2
43.		Radius of interpolation -forward (in time)	ms	us	2	2
44.		Radius of interpolation -backward (in time)	ms	us	2	2
45.		Interpolation error flag	-	us	2	2
46.		Measurement mode (SAR / SARin / LRM)	-	ul	4	4
47.		Measurement Quality Flags	-	ul	4	4
48.		Retracker Flags	-	ul	4	4
49.		Height Status Flags	-	ul	4	4
50.		SAR Freeboard Status Flags	-	ul	4	4
51.		Measurement Spares	-	uc	16x1	16
Auxiliary Measurements group						
52.		Ice concentration parameter	%/1000	sl	4	4
53.		Snow Depth	mm	sl	4	4
54.		Discriminator result (enumerated type)	-	sl	4	4
55.		SARin Discriminator Parameter 1	tbd	sl	4	4
56.		SARin Discriminator Parameter 2	tbd	sl	4	4
57.		SARin Discriminator Parameter 3	tbd	sl	4	4
58.		SARin Discriminator Parameter 4	tbd	sl	4	4
59.		SARin Discriminator Parameter 5	tbd	sl	4	4
60.		SARin Discriminator Parameter 6	tbd	sl	4	4
61.		SARin Discriminator Parameter 7	tbd	sl	4	4

Table 5.3-1: L2 MDS Record Structure

ID	Symb	Descriptor	Unit	Type 'C'	Size (bytes)	Tot. Size (bytes)
62.		SARin Discriminator Parameter 8	tbd	sl	4	4
63.		SARin Discriminator Parameter 9	tbd	sl	4	4
64.		SARin Discriminator Parameter 10	tbd	sl	4	4
65.		Discriminator status flag	-	ul	4	4
66.		Slope model correction attitude	µdeg	sl	4	4
67.		Slope model correction azimuth	µdeg	sl	4	4
68.		Uncorrected Latitude	µdeg	sl	4	4
69.		Uncorrected Longitude	µdeg	sl	4	4
70.		Ambiguity indicator	-	**ul**	4	4
71.		MSS from model	mm	sl	4	4
72.		Geoid from standard model	mm	sl	4	4
73.		DEM elevation (interpolated)	mm	sl	4	4
74.		DEM identifier (used in SARin)	-	ul	4	4
75.		Auxiliary Spares	-	uc	16x1	16
External Corrections group						
76.	c_3	Dry Tropospheric Correction	mm	sl	4	4
77.	c_4	Wet Tropospheric Correction	mm	sl	4	4
78.	c_{10}	Inverse Barometric Correction	mm	sl	4	4
79.	c_1	DORIS Ionospheric Correction	mm	sl	4	4
80.	c_2	Model Ionospheric Correction	mm	sl	4	4
81.	c_5	Ocean Tide 1	mm	sl	4	4
82.		Spare (reserved for alternative tide correction)	-	sl	4	4
83.	c_8	Ocean Loading Tide	mm	sl	4	4
84.	c_7	Solid Earth Tide	mm	sl	4	4
85.		Geocentric Polar Tide	mm	sl	4	4
86.	d_{si}	Surface type flag	-	ul	4	4
87.		Correction status flags	-	ul	4	4
88.		Correction error flags	-	ul	4	4
89.		Spare		uc	12x1	12
Internal Corrections group						

Table 5.3-1: L2 MDS Record Structure

ID	Symb	Descriptor	Unit	Type 'C'	Size (bytes)	Tot. Size (bytes)
90.	c_9	Doppler range correction (inc slope)	mm	sl	4	4
91.	c_{12}	Instrument Range Correction, t-r antenna	mm	sl	4	4
92.	c_{13}	Instrument Range Correction, r only antenna	mm	sl	4	4
93.	c_{14}	Instrument Sigma 0 correction, t-r antenna	dB/100	sl	4	4
94.	c_{15}	Instrument Sigma 0 correction, r only antenna	dB/100	sl	4	4
95.	c_{16}	Internal Phase Correction	milli-radians	sl	4	4
96.	c_{17}	External Phase Correction	milli-radians	sl	4	4
97.	p_i	Noise power measurement	dB/100	sl	4	4
98.		Spare		uc	12x1	12
					Total size	540

a. Beam Behaviour parameter is a set of numbers related to surface characteristics seen in the set of Doppler beams prior to stacking.

notes:
i. COM offset is contained in the SPH.
ii. Doppler Range correction is computed from the line-of-sight vector and thus includes slope model component where slope model is used.

5.3.1 L2 Parameters and Flag Words

field 1. MDSR Time Stamp - corresponding to ground bounce time of the individual pulse, or middle of group of pulses for LRM. See section 1.4 for definition.
field 2. USO Correction factor (definition tbd) - this is the correction factor for USO drift
field 3. Mode ID - (us giving 16 bits) Identifies the SIRAL instrument measurement mode. see

Table 5.3.1-1:

Table 5.3.1-1: Mode ID

Definition	PDS Bit	SS Bit	Setting
Instrument mode - derived from configuration bits in the L0	15-10	0-5	000001 = 1 = LRM 000010 = 2 = SAR 000011 = 3 = SARin 001011 = 11 = CAL1-LRM 001100 = 12 = CAL1-SAR 001101 = 13 = CAL1-SARin 010110 = 22 = CAL2-SAR 010111 = 23 = CAL2-SARin 100001 = 33 = CAL3
SARin degraded case	9	6	set to 1 if one receive chain is missing
Reserved	8	7	set to 0
CAL4 Mode	7	8	set to 1 for CAL4 packets
Platform attitude control	**6-5**	**9-10**	**00 = unknown** **01 = Local Normal Pointing mode (affirmed)** **10 = Yaw Steering mode (affirmed)**
Reserved	4-0	11-15	set to 0

field 4. Source Sequence Counter - passed through from the L1b record. Originally read from the L0 Echo telemetry packet (of the master channel in the case of SARin). This is a 16384 cyclic modulo counter, starting from 0, incrementing by 1. A separate counter is maintained for each instrument mode.

field 5. Instrument Config flag - (ul giving 31 bits) This is derived from flags in the L0 packets for tracking and the echo [R1]. see Table 5.3.1-2:

Table 5.3.1-2: Instrument Configuration Flag

Definition	PDS Bit	SS Bit	Setting
Reception_chain_to_use	31-30	0-1	00 = 0 = unknown 01 = 1 = chain 1 10 = 2 = chain 2 11 = 3 = both
Reserved	29	2	set to 0
Reserved	28	3	set to 0
Bandwidth	27-26	4-5	00 = unknown 01 = 320MHz 10 = 40 MHz

Table 5.3.1-2: Instrument Configuration Flag

Definition	PDS Bit	SS Bit	Setting
Reserved	25	6	set to 0
Reserved	24	7	set to 0
Tracking_mode	23-22	8-9	00 = 0 = unknown 01 = 1 = LRM 10 = 2 = SAR 11 = 3 = SARin
External Calibration	21	10	0 = no, 1 = External calibration
Reserved	20	11	set to 0
Loop_status	19	12	0 = closed loop 1 = open loop
Loss of echo (from cycle report)	18	13	0= OK, 1 = loss of echo
Real-time error (from cycle report)	17	14	0= OK, 1 = real time computation error (computing cycle too long)
Echo saturation error (from cycle report)	16	15	0= OK, 1 = echo saturation detected
Reception_Band_Attenuation	15	16	0 = not attenuated 1 = attenuated
Cycle Report General Error	14	17	0 = cycle report is 0 1 = cycle report is not 0
Reserved	13-0	18-31	set to 0

field 6. Record counter - will increment from 1 for each record in the L2 product.

field 7. Latitude of measurement - Corrected for off-nadir position of the retracked point; in SARin by using the inferred x-track angle and in LRM using slope models. The L1b Latitude (at Nadir) is preserved in field 68. Units are 10^{-1} μdegrees at User request.

field 8. Longitude of measurement - (as for Latitude). Longitude (at Nadir) is preserved in field 69.

field 9. Altitude - Altitude of the Satellite CoG above reference ellipsoid at Nadir. This is not modified by SARin or LRM processing.

field 10. Altitude rate - instantaneous rate of change of Altitude with time (from L1b)

field 11. Satellite velocity vector -described in the International Terrestrial Reference Frame in the International Earth Fixed System. From Orbit CFI call. This is not a unit vector as the velocity magnitude is also required.

field 12. Real beam direction vector - described in the CryoSat Reference Frame (see [R2] section 2.4). From CFI call. This is a unit vector and note that the units are micro-metres.

field 13. Interferometric baseline vector - described in the Cryosat Reference Frame. From CFI call. This is a unit vector and note that the units are micro-metres.

field 14.L2 MCD - Measurement confidence flags. See Table 5.3.1-3:

Table 5.3.1-3: Level 2 Measurement Confidence Data

Definition	PDS Bit	SS Bit	Setting
Block degraded	31	0	0= OK, 1= degraded **(set if the block should not be processed)**[a]
Blank Block	30	1	0= OK, 1= Blank block inserted for record padding
Datation degraded	29	2	0= OK, 1= datation is bad or not set
Orbit propagation error	28	3	0= OK, 1= error (returned by CFI or by independent check)
Orbit file change	27	4	0= OK, 1= Orbit file has changed w.r.t. previous record
Orbit discontinuity	26	5	0= OK, 1= discontinuity (eg gap)
Echo Saturation -from L0	25	6	0= OK, 1= saturated (from echo saturation flag in the telemetry)
Other Echo error (e.g. empty waveform)	24	7	0= OK, 1= echo error
Receive Ch1 error for SARin	23	8	0= OK, 1= degraded or missing
Receive Ch2 error for SARin	22	9	0= OK, 1= degraded or missing
Window Delay Inconsistency	21	10	0= OK, 1= degraded, Value out of range or computation error
AGC Inconsistency	20	11	0= OK, 1= degraded, Value out of range or computation error
CAL 1 Correction Missing	19	12	0= OK, 1= missing - not applied
CAL1 from IPF DB used	18	13	0= default not used 1= default from IPF DB used
DORIS USO correction missing	17	14	0= OK, correction available 1= correction factor not available
External COM correction missing	16	15	0= OK, correction available 1= correction not available
TRK Echo Error	15	16	0= OK, 1= degraded tracking echo
Echo Rx1 Error	14	17	0= OK, 1= bad raw echo
Echo Rx2 Error	13	18	0= OK, 1= bad raw echo
NPM Inconsistency	12	19	0= OK, 1= degraded, Value out of range or computation error
Azimuth Calibration Missing	**11**	**20**	**0= OK, Azimuth calibration applied** **1= No Azimuth calibration**

Table 5.3.1-3: Level 2 Measurement Confidence Data

Definition	PDS Bit	SS Bit	Setting
Azimuth Calibration from IPF DB	**10**	**21**	**0= default not used 1= default from IPF DB used**
Range window[b] calibration function Missing	**9**	**22**	**0= OK, calibrated 1= No Calibration applied.**
Range window calibration function from IPF DB	**8**	**23**	**0= default not used 1= default from IPF DB used**
reserved	7	24	set to 0
CAL 2 Correction Missing	6	25	0= OK, 1= missing - not applied
CAL 2 from IPF DB used	5	26	0= default not used 1= default from IPF DB used
Power scaling error	4	27	0= OK, 1= Error in power scaling
Attitude Correction Missing	**3**	**28**	**0= OK, Attitude correction applied 1= Not corrected**
reserved	2	29	set to 0
reserved	1	30	set to 0
reserved	0	31	set to 0

a. Indicates that the degradation of the block is serious so that the block is not processed - the conditions for this must be defined.
b. the frequency dependent phase and amplitude correction function applicable to the range window

field 15. Height of surface : At measurement point w.r.t. the reference ellipsoid.
field 16. Sigma 0 : fully corrected including instrument gain corrections and retracker correction.
field 17. spare : reserved for future use
field 18. Peakiness : of the echo in the L1b product. Note that this will require different interpretation for SAR and SARin echoes which are not the 'usual' pulse-limited echo shape.
field 19. Retracked range correction : the offset of the retracked point on the echo from the reference point of the range window. This is a 1-way correction in mm.
field 20. Retracked Sigma 0 correction : correction to Sigma0 resulting from the actual echo power being different from the nominal, or expected, echo power.
field 21. Retracker output 3 : reserved for other retracker algorithm output parameters -
LRM = amplitude estimate
SARin= tbd
SAR = unused =0
field 22. Retracker output 4 : reserved for other retracker algorithm output parameters -
LRM = leading edge width (sigma c)
SARin= tbd
SAR = unused =0
field 23. Retracker output 5 : reserved for other retracker algorithm output parameters -

LRM = tbd
SARin= tbd
SAR = unused =0

field 24. Retracker output 6 : reserved for other retracker algorithm output parameters -
LRM = reserved for U10 tbc.
SARin= tbd
SAR = unused =0

field 25. Retracker output 7 : reserved for other retracker algorithm output parameters -
LRM = reserved for SSB tbc.
SARin= tbd
SAR = unused =0

field 26. Retracker output 8 : reserved for other retracker algorithm output parameters -
LRM = unused = 0
SARin= tbd
SAR = unused =0

field 27. Retracker output 9 : reserved for other retracker algorithm output parameters -
LRM = unused = 0
SARin= tbd
SAR = unused =0

field 28. Retracker output 10 : reserved for other retracker algorithm output parameters -
LRM = unused = 0
SARin= tbd
SAR = unused =0

field 29. Retracker output 11 : reserved for other retracker algorithm output parameters -
LRM = unused = 0
SARin= tbd
SAR = unused =0

field 30. Retracker output 12 : reserved for other retracker algorithm output parameters -
LRM = unused = 0
SARin= tbd
SAR = unused =0

field 31. Retracker output 13 : reserved for other retracker algorithm output parameters -
LRM = unused = 0
SARin= tbd
SAR = unused =0

field 32. Power echo shape parameter : **TBD**

field 33. Beam Behaviour parameter - an array of 50 integers to characterise the shape of the set of Doppler echoes from a common surface location prior to stacking (averaging). Currently the first 5 numbers are defined as follows, while the remainder are reserved for future use:-

Table 5.3.1-4: Beam Behaviour Parameters

Index	Name	Description
[0]	STACK_HALF_WIDTH	standard deviation [type=us]

Table 5.3.1-4: Beam Behaviour Parameters

Index	Name	Description
[1]	STACK_CENTRE	beam in stack at maximum of the fitted Gaussian [type=us]
[2]	STACK_AMPLITUDE	stack scaled amplitude [type=us]
[3]	STACK_SKEWNESS	Stack skewness [type=ss] val/100, -99900 (TBD) if cannot be computed
[4]	STACK_KURTOSIS	Stack kurtosis [type=ss] val/100, -99900 (TBD) if cannot be computed

field 34. x-Track Angle : from the interferometric processing in SARin mode. This is the inferred cross-track angle corresponding to the Retrack point of the SARin echo. This can be used in combination with the Altitude to derive a horizontal offset from Nadir. The Latitude and Longitude in field 7. and field 8. include this offset. Set to zero for SAR and LRM.

field 35. Coherence : derived from the SARin echoes at the Retrack point, this provides a measure of confidence in the interferometric result. Set to 0 for SAR and LRM modes.

<<< question - should this be =1 for SAR & LRM ? (i.e. '1000')>>>

field 36. Interpolated Ocean Height (or MSS) : the ocean height interpolated from the SAR data or read from a MSS model (TBD) which is used in conjunction with surface height (field 15.) to compute a freeboard.

field 37. Freeboard : SAR mode computed freeboard of the Sea Ice. Initially (e.g. for launch plus 1 year) this will be set to zero, when there is greater confidence in the knowledge of the Arctic basin sea surface height then freeboard will be computed in the L2 products. Set to 0 in SARin and LRM modes.

field 38. Surface Height Anomaly : TBD

field 39. Interpolated Sea Surface Height Anomaly : TBD

field 40. Interpolation error for Ocean Height : height error in mm associated with the interpolated Ocean Height.

field 41. Number of interpolation points used -forward : the number of measurement points in front of current record that were used to interpolate the Ocean Height to this record.

field 42. Number of interpolation points used -backward : the number of measurement points behind current record that were used to interpolate the Ocean Height to this record.

field 43. Radius of interpolation -forward (in time) : maximum distance, in front of current location, of points used to interpolate the Ocean Height to this record. Units are in time (ms) which can be converted to km by multiplying by the satellite ground-speed.

field 44. Radius of interpolation -backward (in time) : maximum distance, behind current location, of points used to interpolate the Ocean Height to this record. Units are in time (ms) which can be converted to km by multiplying by the satellite ground-speed.

field 45. Interpolation error flag : Indicates errors in ocean height interpolation.

field 46. Measurement mode (LRM / SAR / SARin) : LRM=1, SAR=2, SARin=3

field 47. Measurement Quality Flags : Used to indicate errors with any component parameters in

this group.

Table 5.3.1-5: Measurement Quality flags

Definition	PDS Bit	SS Bit	Setting
Height error	15	0	0 = no, 1 = yes
Sigma0 error	14	1	0 = no, 1 = yes
SWH or Slope error	13	2	0 = no, 1 =yes
Peakiness error	12	3	0 = no, 1 = yes
Echo shape error	11	4	0 = no, 1 = yes
x-track angle error	10	5	0 = no, 1 = ambiguous angle
Coherence error	9	6	0 = no, 1 = yes
unused	8-0	7-15	set to 0

field 48. Retracker Flags : Indicate errors from the retracker algorithms in each mode.

Table 5.3.1-6: Retracker flags

Definition	PDS Bit	SS Bit	Setting
Overall retracker failure flag	31	0	0 = no, 1 = yes
Low or zero power in waveform flag	30	1	0 = no, 1 = yes
Low peakiness flag	29	2	0 = no, 1 = yes
High peakiness flag	28	3	0 = no, 1 = yes
High noise flag	27	4	0 = no, 1 = yes
Low variance flag	26	5	0 = no, 1 = yes
Bad leading edge flag	25	6	0 = no, 1 = yes
Retrack position out of range	24	7	0 = no, 1 = yes
Abnormal beam behaviour parameters	23	8	0 = no, 1 = yes
Bad backscatter calculation	22	9	0 = no, 1 = yes
Reserved SWH	21	10	0 = no, 1 = yes
Reserved U10	20	11	0 = no, 1 = yes
Reserved SSB	19	12	0 = no, 1 = yes
Spare 4	18	13	0 = no, 1 = yes
SARin Retrack interpolation failure flag	17	14	0 = no, 1 = yes
SARin low coherence flag	16	15	0 = no, 1 = yes
Spare 6	15	16	0 = no, 1 = yes

Table 5.3.1-6: Retracker flags

Definition	PDS Bit	SS Bit	Setting
Spare 7	14	17	0 = no, 1 = yes
Spare 8	13	18	0 = no, 1 = yes
Spare 9	12	19	0 = no, 1 = yes
Spare 10	11	20	0 = no, 1 = yes
Spare 11	10	21	0 = no, 1 = yes
SAR spare 12	9	22	0 = no, 1 = yes
SAR spare 13	8	23	0 = no, 1 = yes
SAR spare 14	7	24	0 = no, 1 = yes
SAR spare 15	6	25	0 = no, 1 = yes
SAR spare 16	5	26	0 = no, 1 = yes
SAR spare 17	4	27	0 = no, 1 = yes
SAR spare 18	3	28	0 = no, 1 = yes
SAR spare 19	2	29	0 = no, 1 = yes
LRM Retracker was CFI Ocean	1	30	0 = no, 1 = yes
LRM Retracker was OCOG	0	31	0 = no, 1 = yes

field 49.Height Status Flags : Shows if corrections have been applied to the height field 15.

Table 5.3.1-7: Height Status flag

Definition	PDS Bit	SS Bit	Setting
Corrected for internal calibration	31	0	0 = no, 1 = yes
Corrected for Radial Doppler	30	1	0 = no, 1 = yes
Corrected for Dry Tropo	29	2	0 = no, 1 = yes
Corrected for Wet Tropo	28	3	0 = no, 1 = yes
Corrected for Inverse Barometer	27	4	0 = no, 1 = yes
Corrected for Ionosphere - DORIS	26	5	0 = no, 1 = yes
Corrected for Ionosphere - Model	25	6	0 = no, 1 = yes
Ocean tide 1 used	24	7	0 = no, 1 = yes
Ocean tide 2 used	23	8	0 = no, 1 = yes
Ocean loading tide used	22	9	0 = no, 1 = yes

Table 5.3.1-7: Height Status flag

Definition	PDS Bit	SS Bit	Setting
Solid earth tide used	21	10	0 = no, 1 = yes
Geocentric Polar tide used	20	11	0 = no, 1 = yes
Slope Doppler corrected	19	12	0 = no, 1 = yes
Mode specific window offset applied	18	13	0 = no, 1 = yes
SAR retracker applied	17	14	0 = no, 1 = yes
SARin retracker applied	16	15	0 = no, 1 = yes
LRM retracker applied	15	16	0 = no, 1 = yes
LRM Ocean bias applied	14	17	0 = no, 1 = yes
LRM Ice bias applied	13	18	0 = no, 1 = yes
SAR Ocean bias applied	12	19	0 = no, 1 = yes
SAR Ice bias applied	11	20	0 = no, 1 = yes
SARin Ocean bias applied	10	21	0 = no, 1 = yes
SARin Ice bias applied	9	22	0 = no, 1 = yes
LRM Slope model data valid	8	23	0 = no, 1 = yes
SARin baseline downward flag	7	24	0 = no, 1 = yes
SARin baseline forward flag	6	25	0 = no, 1 = yes
SARin out of range flag	5	26	0 = no, 1 = yes
Unused	4 - 0	27-31	set to 0

field 50.SAR Freeboard Status Flags : flags to indicate availability and reliability of the freeboard measurement

Table 5.3.1-8: Freeboard Status flag

Definition	PDS Bit	SS Bit	Setting
Freeboard measurement unavailable	31	0	0 = no, 1 = yes
Freeboard measurement unreliable	30	1	0 = no, 1 = yes
Freeboard measurement is in northern geographical boundary	29	2	0 = no, 1 = yes
Freeboard measurement is in southern geographical boundary	28	3	0 = no, 1 = yes
spare - tbd	27 - 0	4 - 31	set to 0

field 51. Measurement Spares : reserved for possible future use

field 52. Ice concentration parameter : a percentage estimate of Sea Ice concentration merged from model data.

field 53. Snow Depth : in mm merged from a climatology model data. This can be used (by L2 product User) to adjust the freeboard estimate.

field 54. Discriminator result : enumerated type code showing the result of the discriminator algorithm in each chain.

Table 5.3.1-9: Discriminator result

Value	Definition
1	Result of LRM discrimination is undefined
2	Result of LRM discrimination is ocean
3	Result of LRM discrimination is land ice plateau
101	Result of SARIN discrimination is undefined
102	Result of SARIN discrimination is altimeter mode
201	Result of SAR discrimination is undefined.
202	Result of SAR discrimination is ocean.
203	Result of SAR discrimination is Sea Ice.
204	Result of SAR discrimination is Leads.

field 55. SARin Discriminator Parameter 1 : reserved for output parameters from the SARin discriminator algorithm - TBD.

field 56. SARin Discriminator Parameter 2 : TBD

field 57. SARin Discriminator Parameter 3 : TBD

field 58. SARin Discriminator Parameter 4 : TBD

field 59. SARin Discriminator Parameter 5 : TBD

field 60. SARin Discriminator Parameter 6 : TBD

field 61. SARin Discriminator Parameter 7 : TBD

field 62. SARin Discriminator Parameter 8 : TBD

field 63. SARin Discriminator Parameter 9 : TBD

field 64. SARin Discriminator Parameter 10 : TBD

field 65. Discriminator status flag : shows quality of the discriminator result for each chain.

Table 5.3.1-10: Discriminator flags

Definition	PDS Bit	SS Bit	Setting
Overall discriminator failure flag	31	0	0 = no, 1 = yes
LRM discriminator flags TBD	30	1	0 = no, 1 = yes

Table 5.3.1-10: Discriminator flags

Definition	PDS Bit	SS Bit	Setting
TBD - reserved for LRM	29-22	2-9	set to 0
SARin Low Variance flag	21	10	0 = no, 1 = yes
SARin Bad Leading Edge flag	20	11	0 = no, 1 = yes
SARin High Noise flag	19	12	0 = no, 1 = yes
SARin Low Peakiness flag	18	13	0 = no, 1 = yes
SARin Hi Peakiness flag	17	14	0 = no, 1 = yes
SARin Low Power flag	16	15	0 = no, 1 = yes
TBD - reserved for SARin	15-12	16-19	set to 0
SAR very high peakiness flag	11	20	0 = no, 1 = yes
SAR very low peakiness flag	10	21	0 = no, 1 = yes
SAR Low or zero power flag	9	22	0 = no, 1 = yes
SAR abnormal beam behaviour parameters	8	23	0 = no, 1 = yes
SAR ice concentration unavailable	7	24	0 = no, 1 = yes
SAR ice concentration unreliable	6	25	0 = no, 1 = yes
SAR signal to noise ratio too low	5	26	0 = no, 1 = yes
Waveform is too wide	4	27	0 = no, 1 = yes
No votes for any available waveform classification	3	28	0 = no, 1 = yes
Voting for discrimination classification tied	2	29	0 = no, 1 = yes
TBD	1	30	set to 0
SAR partial match	0	31	0 = no, 1 = yes

field 66. Slope model correction attitude : attitude angle of nearest echoing point on surface as determined from slope models in LRM processing. 0 if model not present or invalid. Set to 0 for SAR and SARin but may be used in the event of SARin mode with only 1 receive chain operating.

field 67. Slope model correction azimuth : as for attitude

field 68. Uncorrected Latitude : of the Nadir position - this allows for removal of the slope corrected position if desired.

field 69. Uncorrected Longitude : of the Nadir position - this allows for removal of the slope corrected position if desired.

field 70. Ambiguity indicator : to flag the case where the interferometric angle may be ambiguous

due to phase wrapping.

Table 5.3.1-11: SARin Ambiguity Indicator flags

Definition	PDS Bit	SS Bit	Setting
Overall Ambiguity	31	0	0 = no, 1 = yes
TBD Ambiguity	30	1	0 = no, 1 = yes
unused	29-22	2-9	set to 0
DEM not available	21	10	0 = no, 1 = yes
Different elevations	20	11	0 = no, 1 = yes
unused	19-0	12-31	set to 0

field 71. MSS from model : from the ocean model supplied in the CFI library.
field 72. Geoid from standard model : from the Geoid model supplied in the CFI library.
field 73. DEM elevation : interpolated from a DEM (model tbd) to act as a check against the SARin derived elevation. Set in SARin mode only, =0 for LRM & SAR.
field 74. DEM identifier : to identify the DEM model used in SARin
field 75. Auxiliary Spares : reserved for possible future use

field 76. Dry Tropospheric Correction - added to range measurement to correct for the propagation delay to the radar pulse, caused by the dry-gas component of the Earth's atmosphere.
field 77. Wet Tropospheric Correction - added to range measurement to correct for the propagation delay to the radar pulse, caused by the H20 component of the Earth's atmosphere.
field 78. Inverse Barometric Correction - added to range measurement to correct for the depression of the ocean surface caused by the local barometric pressure.
field 79. DORIS Ionospheric Correction - added to range measurement to correct for the delay to the Radar pulse caused by free electrons in the ionosphere. Computed from the concurrent DORIS data.
field 80. Model Ionospheric Correction - added to range measurement to correct for the delay to the Radar pulse caused by free electrons in the ionosphere. Computed from an Ionospheric model.
field 81. Ocean Tide 1 - added to the range to remove the effect of local tide and adjust the measurement to the mean sea surface.
field 82. Spare - reserved for possible future use.
field 83. Ocean Loading Tide - added to the range to remove the effect of local tidal distortion to the Earth's crust.
field 84. Solid Earth Tide - added to the range to remove the effect of local tidal distortion in the Earth's crust.
field 85. Geocentric Polar Tide - added to the range to remove a 'wobble' effect of the poles w.r.t. Earth centre caused by tidal forces.
field 86. Surface type flag - enumerated key to classify surface at nadir.
field 87. Correction status flag - used to show which correction algorithms have been called, see

Table 5.3.1-12:. First 11 fields are as in L1b.

field 88. Correction error flag - used to show if a correction algorithms returned an error when called see Table 5.3.1-13:. First 11 fields are as in L1b.

field 89. Correction spares - reserved for future use.

Table 5.3.1-12: Correction status flags

Definition	PDS Bit	SS Bit	Setting
Dry Tropospheric Correction Called	31	0	0 = no, 1 = yes
Wet Tropospheric Correction Called	30	1	0 = no, 1 = yes
Inverse Barometric Correction Called	29	2	0 = no, 1 = yes
DORIS Ionospheric Correction Called	28	3	0 = no, 1 = yes
Model Ionospheric Correction Called	27	4	0 = no, 1 = yes
Ocean Tide 1 Called	26	5	0 = no, 1 = yes
Ocean Tide 2 Called	25	6	0 = no, 1 = yes
Ocean Loading Tide Called	24	7	0 = no, 1 = yes
Solid Earth Tide Called	23	8	0 = no, 1 = yes
Geocentric Polar Tide Called	22	9	0 = no, 1 =yes
Surface type flag Called	21	10	0 = no, 1 = yes
Ice concentration model called	20	11	0 = no, 1 = yes
Snow depth model Called	19	12	0 = no, 1 = yes
MSS model called	18	13	0 = no, 1 = yes
Geoid model Called	17	14	0 = no, 1 = yes
DEM model called	16	15	0 = no, 1 = yes
Slope model Called	15	16	0 = no, 1 = yes
reserved	14-0	17-31	set to 0

Table 5.3.1-13: Correction error flags

Definition	PDS Bit	SS Bit	Setting
Dry Tropospheric Correction Error	31	0	0 = OK, 1 = error
Wet Tropospheric Correction Error	30	1	0 = OK, 1 = error
Inverse Barometric Correction Error	29	2	0 = OK, 1 = error
DORIS Ionospheric Correction Error	28	3	0 = OK, 1 = error

Table 5.3.1-13: Correction error flags

Definition	PDS Bit	SS Bit	Setting
Model Ionospheric Correction Error	27	4	0 = OK, 1 = error
Ocean Tide 1 Error	26	5	0 = OK, 1 = error
Ocean Tide 2 Error	25	6	0 = OK, 1 = error
Ocean Loading Tide Error	24	7	0 = OK, 1 = error
Solid Earth Tide Error	23	8	0 = OK, 1 = error
Geocentric Polar Tide Error	22	9	0 = OK, 1 = error
Surface type flag Error	21	10	0 = OK, 1 = error
Ice concentration Error	20	11	0 = OK, 1 = error
Snow depth Error	19	12	0 = OK, 1 = error
MSS model Error	18	13	0 = OK, 1 = error
Geoid model Error	17	14	0 = OK, 1 = error
DEM model Error	16	15	0 = OK, 1 = error
Slope model Error	15	16	0 = OK, 1 = error
reserved	14-0	17-31	set to 0

6 Auxiliary Input Data Files

A number of auxiliary data files are required for the L2 processing. These are:-

Job Order - Specifies the type of processing to perform and names the input files.

Physical constants - Physical and geophysical constants. These should remain fixed throughout the mission.

IPF Database - Parameters which characterise the SIRAL instrument such as Radar frequency and bandwidth.

Processor configuration file - Parameters controlling run-time processing options or performance.

Sea Ice Concentration file - An input to the SAR processing chain to facilitate surface type discrimination.

Mean Sea Level file - Provides the Global (Including Arctic) ice-free mean sea level to allow freeboard computation.

Snow Depth file - Aids ice thickness determination as snow cover on sea ice affects freeboard/ thickness ratio.

Slope Models - corrects LRM mode data for the direction of echoing point when over sloping terrain.

DEMs - used by SARin chain to help resolve ambiguity in the interferometric phase difference.

6.1 Auxiliary Data File Format

Auxiliary files will have a mission standard [R16] and an SPH [R16] followed by a single data set record.

Table 6.1.0-1: Auxiliary Data File SPH

Field	Symb	Descriptor	Values	Size (bytes)	Tot. Size (bytes)
		TBD			
		The SPH shall contain The MDS type MDS record length Number of MDS records			

6.2 Constants

Table 6.2-1: Physical and Geophysical Constants

Mnemonic	value	Units	description	used by algorithm
C	299792458.0	m/s	speed of light (c_vacuo)	
PI	3.14159265358979	-	circular ratio π	
grav_accl_mu	3.9860044 e14	m^3 s^-2	Gravitational Constant x Earth Mass = G * Mass of Earth[a]	
Boltzmanns_Const	1.380662e-23	J/K	Boltzmann's Constant	
Ref_elp	WGS84	-	Name of Reference Ellipsoid	
ellipse_semi_maj	6378137.0000	m	WGS 84	
ellipse_semi_min	6356752.3142	m	WGS 84	
Deg2Rad	0.017453292	-	conversion of degrees to radians	

a. IERS standards document

note: ellipse flattening is calculated from the two axes.
In the operational IPF system this is a common file with the IPF1 processing. (see [R12])

6.3 IPF Database Parameters

This file is used by the IPF1 system as well as IPF2. (see [R13])

6.4 Job Order File

This file defines the processing job type and identifies the input filenames. It is very similar to the L1b JobOrder file. (see [R12])

6.5 Processor Configuration File

This file defines all the run-time parameters and thresholds used to "tune" the IPF2 algorithms in the LRM, SAR and SARin processing chains.
These are currently detailed in [R14]

6.6 Sea Ice Concentration

Two options are available and the preferred is option 1, but this requires processing the 5 channels of daily Brightness Temperatures to ice concentration, supplied on a 25km stereographic grid in HDF format. If no daily ice concentration files are available then either a default climatology can be used (UCL can generate this) or use the last available daily data files.

1) Near Real- Time SSM/I daily SSM/I brightness temperatures available from: http://nsidc.org/data/docs/daac/nsidc0081_ssmi_nrt_seaice.gd.html They point out that the most recent daily datasets (usually the previous day) do not have quality checks. They suggest that if this is required, then you should wait at least 3 days for the required dataset. Also, they indicate that the near real time products may have different values compared to the standard data products they release with data latency of ~4months. The ice concentration files are generated following the NASA Team algorithm (Cavalieri, D.J., P.Gloersen and W.J.Cambell, Determination of sea ice parameters with the NIMBUS 7 SMMR, J.G.R, 89, (D4), 5355-5369, 1984).

2) The Near Real-Time SSM/I EASE-Grid Daily Global Ice Concentration and Snow Extent product: http://nsidc.org/data/nise1.html.
Sea ice concentration and snow extent maps are provided in two 25 km azimuthal, equal-area projections: the Southern Hemisphere 25 km low resolution. (Sl) and Northern Hemisphere 25 km low resolution (Nl) Equal-Area Scalable Earth-Grids (EASE-Grids). Data in Hierarchical Data Format - Earth Observing System (HDF-EOS) format, and browse files in GIF and HDF formats, are updated daily and are available via ftp for two weeks after initial posting.

6.7 Mean Sea Level

UCL will supply the MSL derived MSS from ERS-2 radar altimeter data containing the latitude, longitude and MSL spanning a period of nearly 4 years (Cycles 0 to 41 corresponding to dates between May 95 and April 1999). For ESA the 1Hz datafiles without detrending will be concatenated together and supplied as one file. The provisional aim is to grid the data onto a 0.0625 degree grid, using the CFI routine to assign the nearest neighbour value to the acquired CryoSat nadir record locations.
This proposal is to be subjected to an investigation and may be changed if the method is deemed unsuitable.

6.8 Snow Depth Climatology

UCL could supply 12 files of monthly data containing the latitude, longitude and snow depth. A new API is required to interpolate the model files to any given record location.

(An alternative is to regrid the climatology on a 25km (tbc) grid, and use the CFI routine to assign the nearest neighbour value to the acquired CryoSat nadir record locations. However this is

deemed to be higher risk as it restricts the interpolation method and may not be suitable for the task required).

6.9 Slope Model Files

A slope model is a pair of two-dimensional arrays of single-precision numbers representing range slopes. The X and Y components of slope are accessed separately.

The slope model is created from a digital elevation model. The data are processed, essentially by differentiation, so that for each pair of array elements corresponding to a position, a unique pair of derivatives can be assigned. The required geometry of the slope models uses a hemispherical cartesian coordinate system. The slope model is therefore defined on the X,Y plane, but the transformation from the DEM coordinates to the X,Y plane must be performed when creating the model.

The X,Y coordinate mapping is ambiguous with respect to the hemisphere of the Earth under consideration. Therefore a 'hemisphere flag' is included in the slopes file.

A slope model is required for both Antarctica and for Greenland. The accuracy of the slopes will depend upon the quality of the source DEMs used. The slope models shall be derived from the best available DEMs. Note that slope models will continue to evolve, and ENVISAT RA-2 and CryoSat SIRAL data will also be used to improve and update the models. Thus the Auxiliary Files used may be updated during the processing phase.

The horizontal sampling of the models shall be up to 1Km. This is appropriate for the best altimetric DEMs of Antarctica and Greenland derived from ERS geodetic mission data. With this sampling resolution, we can estimate the size of the slope files as follows:

Greenland (Model number = 1) is a land mass of 2000 by 3000 km extent. At 1km resolution, we can represent its slopes by an array of approximately 2000 x 3000 numbers. These are specified as floats, and so the file will be approximately 48 Megabyte in size. The whole of Antarctica (Model number = 2) can be contained within a square of 6670 kms per side. At 1km resolution this file will be a little over 360 Megabyte.

These sizes refer to the simplest possible implementation of the slope models as pairs of rectangular 2-dimensional arrays of real numbers. Coding with variable resolution, taking into account areas of low slope variability could be exploited. Also areas of ocean within the model could be eliminated. The models are probably too large to be held in memory, and so an efficient cacheing scheme may be needed. One way to achieve this is to note that radar altimeter data is normally processed one orbit at a time. Thus it should be possible to pre-load a narrow along-orbit strip of the range slope models for each orbit. The strip would need to extend a number points either side of the orbit track to satisfy the requirements for the interpolation requirementsof the algorithm.

Slopes of 1 in 10,000 lead to slope corrections at the ~ 5 millimetre level, and so the slopes in the

models may be safely represented as single-precision, 32-bit floating-point numbers, as the 24-bit precision available translates to approximately 8 decimal significant figures. Slopes of greater than a few degrees will not be tracked at high precision (if at all) by the LRM mode , and so precision in areas of high surface slope is less important.

The number of models required initially is 2, 1 for Greenland, and 1 for Antarctica. However we require that the system shall be able to take additional slope models as more and better models become available. Hence we recommend that the number of slope models in the system be variable. The minimum number of slope models to be handled by the system should be 10.

6.10 DEMs

Gridded Digital Elevation Models of Antarctica and Greenland. Initially there will only be these two models but we require that the system can take additional models and that the minimum number be 10. These models will be the best available. File sizes will be half of the corresponding slope models described above.

7 Internal Interfaces To ESL Processing

This section defines TBD intermediate data interfaces.

7.1 Intermediate Inputs

TBD

Input to pass 2 of the SeaIce chain is exactly the same L2 data structure defined in section 5.3

7.2 Intermediate Outputs

TBD

Output from pass 1 of the SeaIce chain is exactly the same L2 data structure defined in section 5.3

Break point files - to be detailed in a later issue.