ERS Wind product specifications.

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Introduction

This paper describes the wind products generated in real time in the ESA Ground Stations. It is based on a document available for distribution “ERS Ground Stations Products specification”, ER-IS-EPO-GS-0201. The issue available today is the issue 3/1 and will referenced [1] in this paper.

A major revision of this document is in preparation and will be issued by the end of the year 1998.

If most of the generic information can be found in [1], more details and explanation are added in particular in reference to “The ERS Scatterometer instrument and the On-Groung processing of its Data” presented during this workshop [2].

The ERS Ground Stations

The ERS ground stations at Kiruna, Fucino, Maspalomas, Gatineau and Prince Albert acquire, process and distribute data from the two European Remote Sensing satellites ERS-1 and ERS-2.

The Kiruna Station, having also Tracking, Telecommand and Control (TTC or TT&C) capability for the ERS satellites, is controlled by the Mission Monitoring and Control Centre (MMCC) at ESOC (Darmstadt). All parameters and commands to Kiruna Station will be originating from MMCC and will be processed in the Data Processing Monitoring and Control (DPMC), subsystem.

All other ERS Ground Stations are controlled by the Esrin ERS Central Facility (EECF) at Esrin (Frascati). The processing parameters and commands will be processed by the Control and Monitor Subsystem (CMS) at the Ground Stations.

Fig. 1 presents the block diagram for an ERS ground segmentand shows the main product dataflow from the acquisition subsystem to the dissemination to EECF.

The ERS telemetry consists of two parts: High rate data and low rate data. Kiruna, Fucino and Maspalomas acquire high rate data. Kiruna, Maspalomas, Gatineau and Prince Albert acquire low rate data.

Due to its geographical position the Kiruna station acquires 10 out of 14 1/3 ERS-2 orbits per day. Fucino covers the southern Europe and Mediterranean area for

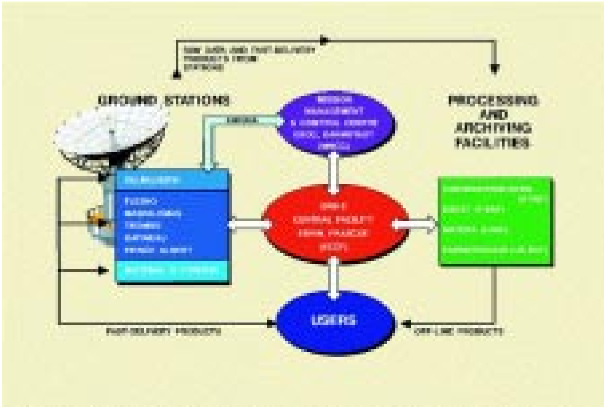

Figure 1: ERS Ground Segment Block diagram

4 to 5 passes of high rate data acquistion per day. The acquistion of 3 orbits of low bit rate data are shared between Maspalomas and Gatineau. Prince-Albert takes care of the acquisition of the 14th orbit of low bit rate data.

Kiruna, Maspalomas and Gatineau station have the capacity to process the Low Bit Rate data in real time. This data is sent to EECF (via MMCC for Kiruna) and disseminated in less than three hours to the users. Prince-Albert doesn’t have that capacity.

In Prince-Albert, the data are recorded on HDDT and shipped to Gatineau for processing, transcription and dissemination to EECF and the users. The delay introduced by the shipment of the tape is 3 to 5 days.

Prince-Albert is being upgraded to ingest directly on disk the data acquired and to transmit it the Gatineau via land line in order to be processed in near real time. This capacity of real time of the last orbit should be made available by the end of the year 1998.

This upgrade will not only make available in near real time the Orbit acquired in Prince-Albert, but will also make possible an optimisation of the station acquisition as it will give the possibility to distribute better the different passes between Gatineau, Prince-Albert and Kiruna and to improve the descoping strategy.

Product generation and distribution

The products are generated and distributed accordingly to a strategy based on the High Level Operation Plan (HLOP) approved at delegations level and detailed in the Mission Operation Plan (MOP).

The MOP takes into account all the Space and Ground segment technical constraints and is the basis for MMCC and EECF mission planning and station scheduling.

This schedules, which are elaborated by MMCC for Kiruna and EECF for the other stations, contain separate commands to generate, transcribe and disseminate the products.

The ground stations were completly upgraded in 1994 in preparation for ERS-2. This major upgrade was the opportunity not only to install more performant hardware, but also to install new algorithm, to integrate the transcription facility in the LRDPF and to prepare the installation of the SAR Wave processing in the LRDPF. This last step was done in 1997. The following two paragraphs give a description of the station setup before and after this major upgrade.

Initial Ground Station Setup

The products are generated by the three Fast Delivery Processors (FDP's), SARFDP 1, SARFDP 2 and LRDPF. Once completed, the products are sent to the DPMC or the CMS, which provides temporary storage on disk until the products are disseminated to EECF (through MMCC for Kiruna) and from there to the users.

In the original station design (Fig. 1), the two SAR Fast Delivery Processors, (SARFDP), were producing AMI Image and AMI Wave products. All other products were produced by the Low bit Rate Data Processing Facility (LRDPF).

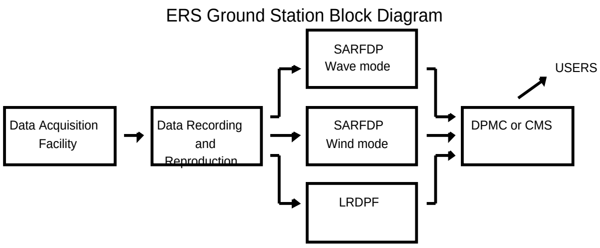

Figure 2: ERS Ground Station Block diagram

The Low Bit Rate Transcription Facility (LRDTF), for the transcription of ERS-1 low bit rate data from HDDT to Optical disk and Exabyte was installed at Fucino. This facility worked off-line from the CMS.

The Low Bit Rate data for ERS-2 is transcribed to Exabyte directly at the receiving station by the second generation of the LRDPF system. If necessary (e.g. failure of an exabyte drive during transcription, or lost of an exabyte) these transcribed Exabytes can be copied in a Copy Utility runned on the same hardware as the LRDPF but off-line from the rest of the station.

Initial Ground Station Setup

In the newstation design (Fig. 1), the two SAR Fast Delivery Processors have been dismissed as there was no user for the Images produced in real time, and AMI Wave processor has been included into the LRDPF. Therefore, all real-time products are generated by the Low bit Rate Data Processing Facility (LRDPF).

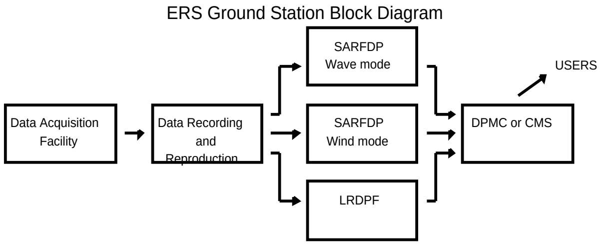

Figure 3: ERS Ground Station Block diagram

All Low Bit Rate data for ERS-2 is transcribed to Exabyte directly at the receiving station by the second generation of the LRDPF system. If necessary (e.g. failure of an exabyte drive during transcription, or lost of an exabyte) these transcribed Exabytes can be copied in a Copy Utility runned on the same hardware as the LRDPF but off-line from the rest of the station.

Fig. 1 shows the complete product distribution scheme as of today. The inclusion of the Direct Ingest system at Prince-Albert will allow the substitution of the tape shipment from Prince-Albert to Gatineau for Processing by a Land line. It is important to note that on this line no product will be disseminated but raw data which will be processed at Gatineau.

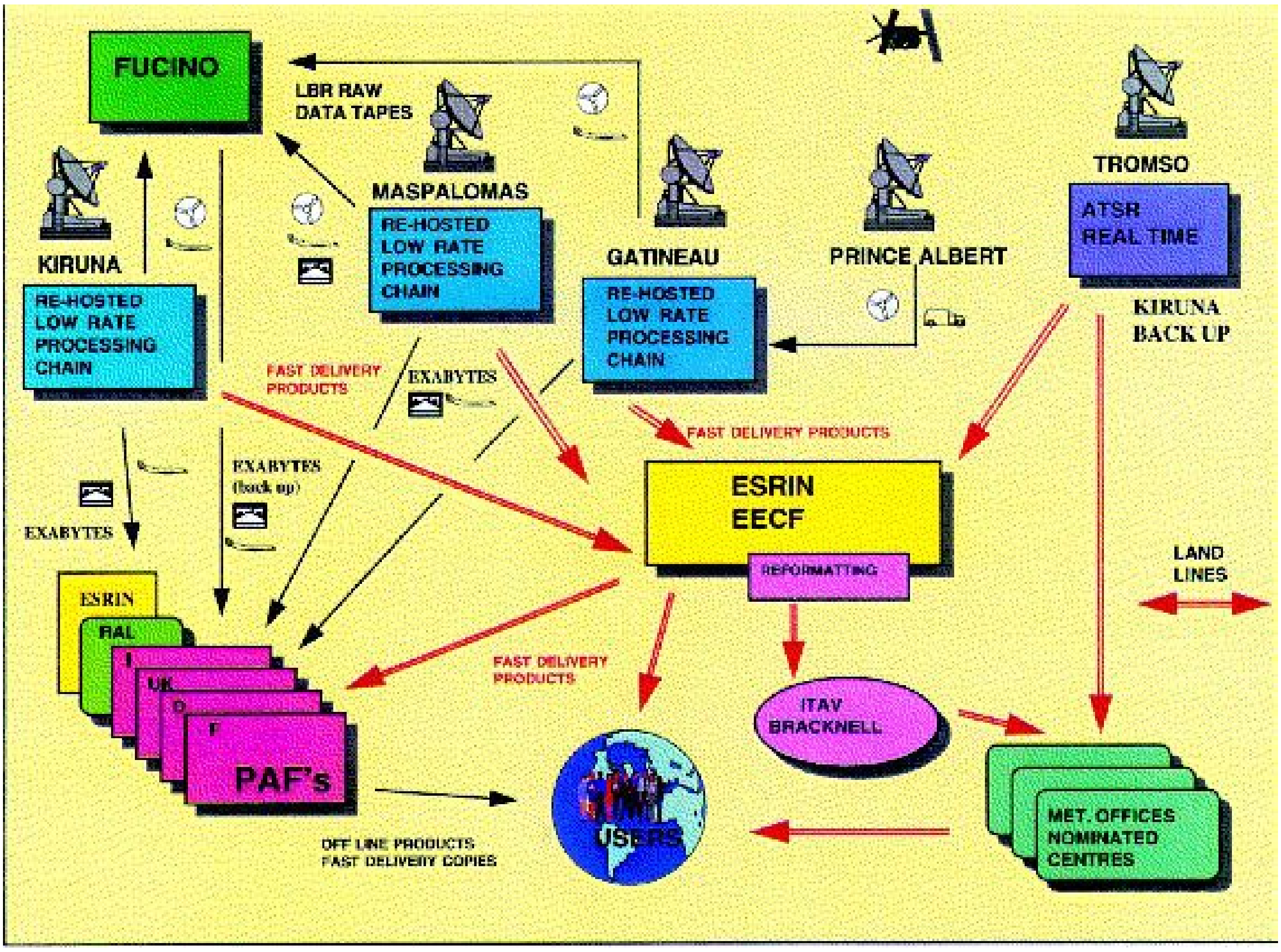

Figure 4: ERS Ground Segment - Product Distribution

Product types

This section gives a description of all products generated in the ESA ERS Ground Stations at Kiruna, Fucino, Maspalomas and Gatineau.

The products fall into six categories:

- Raw data products, acronym starting with ‘R’
- Fast Delivery Products, acronym starting with ‘U’
- Intemediate Products, acronym starting with ‘I’
- Extracted Calibration products, acronym starting with ‘E’ and ending with ‘C’1
- Extracted General and Instrument header products, acronym starting with ‘E’ and ending with ‘I’
- Text products, acronym starting with ‘T’

The list of ERS ground station products and their size is given in Table 1.

Product Format

Each product, with the exception of the raw data products stored on HDDT, has the same structure. This product structure consists of three parts. Fig. 5 shows the product structure.

Main Product Header	
Specific Product Header	*Optional*
Data Set Record #1	
Data Set Record #2	
...	
...	
Data Set Record last	

Figure 5: Product Structure

The MPH has a single 176-byte record with an identical format for all products. The format of the Main Product Header record is given in Table 5 on page 9. The Main Product Header contains information applicable to all processing chain products.

The specific product header is optional. The number and length of the record varies by product type.

All products have a product data set, consisting of one or more records. Length and number of records is determined by the product type and is given in the Main Product Header.

Table 1: ERS Ground Station Product Sizes

Products		SPH Size in Bytes	DSR Size in Bytes	Number of DSR	Product Size in Bytes
EATC2	ATSR-2 Low rate Extracted Calibration data	282	6804	1	7262
EATC2	ATSR-2 High rate Extracted Calibration data	282	6804	2	14066
EATI1	ATSR-1 Instrument Headers	40	40043	N6	15000005
EATI2	ATSR-2 Instrument Headers	40	68043	N6	15000005
EEP	Ephemeris Data	N/A	388	1	564
EGH	General Headers	N/A	260	16	4336
EGOC	GOME Extracted Calibration data	303	8004	1	8483
EGOI	GOME Instrument Headers	40	80043	N6	15000005
EIC	AMI Image Extracted Calibration data Calibration Data	N/A	11466	1	11642
EII	AMI Image Instrument Headers	40	234	N	1500000
EMWC	Microwave Sounder Extracted Calibration data	315	900	1	1391
ERAC	Radar Altimeter Extracted Calibration Data	282	3136	1	3594
ERAI	Radar Altimeter Instrument Headers	40	31363	N6	15000005
EWAC	AMI Wave Extracted Calibration data Calibration Data	4480	4332	299	1299924
EWAI	AMI Wave Instrument Headers	40	1083	299	15000005
EWIC	AMI Wind Extracted Calibration data Calibration Data	282	7864	1	8322
EWII	AMI Wind Instrument Headers	40	723	N	15000005
II16	AMI Image Intermediate Products	600	10004	6300	63025976
IWA	AMI Wave Intermediate Products, OGRC	260	16004	17	272504
IWA	AMI Wave Intermediate Products, OBRC	260	24004	17	408504
RATSR1	ATSR-1 Extracted Calibration data	282	4004	1	4462
RH	High rate raw data on HDDT	N/A	N/A	N/A	N/A
RL	Low rate raw data on HDDT	N/A	N/A	N/A	N/A
TP	Text Product	N/A	84	1	260
UI16	AMI Image 16-bit Fast delivery	260	10004	6300	63025636
UI8	AMI Image 8-bit Fast delivery	260	5004	6300	31525636
UIC	AMI Image Chirp Replica	N/A	1540	2	3256
UIND	AMI Image Noise Statistics and Drift Calibration	28	1540	4	6364
URA	Radar Altimeter Fast delivery	56	88	77	7008
UWA	AMI Wave Fast delivery	260	148	1	584
UWAC	AMI Wave Chirp Replica	N/A	1540	1	1716
UWAND	AMI Wave Noise Statistics and Drift Calibration, OGRC	28	1540	4	6364
UWAND	AMI Wave Noise Statistics and Drift Calibration, OBRC	28	124	4	700
UWI	AMI Wind Fast delivery	166	46	361	16948

Data Types

Table 2 shows the simple common data types in the ERS Ground station products. There are two important complex data types as well: the prod_type_list and the utc_time_m. The first specifies a list of product types for a command, the second gives the time in two integers.

Table 2: Data types in the ERS Ground station products

Data Type	Meaning
I1	1-byte unsigned integer
I2	2-byte integer in DEC format
I4	4-byte integer in DEC format
A	ASCII
B	1 byte or bits (flags)
S	Special format, as defined in description field

Data type prod_type_list

The prod_type_list data type is an array of 50 Bytes. Each byte indicates one product type. Several product types can be indicated. Table 3 shows the indices for each product type. The processing subsystems read this list from the parameters in the commands and interprets which products they have to process, for example transcrib_list [15] = 0 in the C_Config_Trans command means that product type 15, ERAC, will be transcribed.

In that particular case, the logic behind is that by default all products are transcribed (all flags set to zero). The flag corresponding to the product which shall not be transcribed have to be set to 1.

Table 3: Product types

Type	Product	
0	RATSR	ATSR-1 Extracted Calibration data
1	UI16	AMI Image 16-bit Fast delivery
2	UI8	AMI Image 8-bit Fast delivery
3	UIND	AMI Image Noise Statistics and Drift Calibration
4	UIC	AMI Image Chirp Replica
5	UWA	AMI Wave Fast delivery
6	UWAND	AMI Wave Noise Statistics and Drift Calibration
7	UWAC	AMI Wave Chirp Replica
8	UWI	AMI Wind Fast delivery
9	URA	Radar Altimeter Fast delivery
10	IWA	AMI Wave Intermediate Products
11	II16	AMI Image Intermediate Products
12	EIC	AMI Image Extracted Calibration data Calibration Data
13	EWAC	AMI Wave Extracted Calibration data Calibration Data
14	EWIC	AMI Wind Extracted Calibration data Calibration Data
15	ERAC	Radar Altimeter Extracted Calibration Data
16	EII	AMI Image Instrument Headers
17	EWAI	AMI Wave Instrument Headers
18	EWII	AMI Wind Instrument Headers
19	ERAI	Radar Altimeter Instrument Headers
20	EGH	General Headers
21	EEP	Ephemeris Data
22	TP	Text Product
23	UILR	User Image Low Resolution Image
30	VI	Verification Image
31	VIC	Verification Image Calibration
32	VWA	Verification Wave
33	VWAC	Verification Wave Calibration
34	EGOC	GOME Extracted Calibration data
35	EGOI	GOME Instrument Headers
36	EATI2	ATSR-2 Instrument Headers
37	EATI1	ATSR-1 Instrument Headers
38	EATC2	ATSR-2 Low rate Extracted Calibration data
39	EMWC	Microwave Sounder Extracted Calibration data
40	EICM	Multiple AMI Image Calibration Data

Data type utc_time_m

The data type utc_time_m contains the Julian day and time format in two four byte integers. The first integer gives the number of days since January 1, 1950. The second shows the number of milliseconds the actual day.

Nonvalid Fields

If a Ground Station does not have a value for a field, either because the field is not applicable or a value is unavailable the field is set according to the following table:

If a value exceeds the range of a type, the positive or negative maximum is given.

Field value	Used for data type
0	for integer numbers
space	for ASCII
0	for bit fields within a byte
0	for special format. Note that there may also exist a ‘non-value’ definition by special format itself.

Byte and Bit Order

Data which are stored in Digital Equipment Corporation (DEC) internal storage formats have the following layout:

16-bit or 32-bit integer numbers have the Least Significant Byte first; for example:

Byte		
1 2 3 4	Least significant byte . . Most significant byte	Integer 1 (32 bits)
5 6 7 8	Least significant byte . . Most significant byte	Integer 2 (32 bits)
9 10 11 12	Least significant byte . . Most significant byte	Integer 3 (32 bits)
…	…	…
…	…	…

Data addressed on bit level; for example, Product Confidence Data (PCD), have the bit addresses starting at the least significant bit of a byte and increase to the most significant bit in the byte, i.e. the data item with the following description:

Bit	Meaning
bit 1 - 3	PCD_A
bit 4	PCD_B
bit 5 - 7	PCD_C
bit 8 - 10	PCD_D
bit 11 - 16	PCD_E

These bits are stored in two bytes as follows:

	byte 1	byte 2
bit number:	8 7 6 5 4 3 2 1	16 15 14 13 12 11 10 9
bit position:	7 6 5 4 3 2 1 0	15 14 13 12 11 10 9 8
storage of PCD:	D C C C B A A A	E E E E E E D D

A bit is defined to be set if the bit has a value 1.

Main Product Headers

Table 4 describes the Main Product Header valid for all products.

This MPH is not used for raw data products stored High Density Digital Tapes (HDDT) .

Table 4: Main Product header Detailed Description

Field	Bytes	Type	Description
1	17	A/I	Product identifier (for ESA internal operational use only), i.e. a set of characters and integers which form a unique identifier. The set of 17 Bytes is defined as follows: Byte 1: Originator of logical schedule (for ESA internal use only) e.g.: I: MMCC/EECF, Immediate Command M: MMCC/EECF, Logical Schedule J: Local operator, Immediate Command K: Local operator, Logical Schedule Byte 2-5: Sequential Counter of Logical Schedule Byte 6-9: Unique Identification or Schedule Offset Byte 10-13: Not used, set to 0 Byte 14-17: Sequential Number of Currently Generated Product
2	1	I1	Type of Product, see Table 3
3	1	I1	Spacecraft 1: ERS-1 2: ERS-2
4	24	A	UTC time of subsatellite point at beginning of product. Format in ASCII: DD-MMM-YYYY hh:mm:ss.ttt For example: 30-JAN-1987 14:30:27.123
5	1	I1	Station ID, where data was processed 1: Kiruna Station (KS) 2: Fucino Station (FS) 3: Gatineau Station (GS) 4: Maspalomas Station (MS) 5: EECF Station (ES) 6: Prince Albert Station (PS)
6	2	B	Product Confidence Data bit 1 PCD Summary Flag 0: product correctly generated 1: at least one of the remaining 15 bits of the PCD in the MPH is set. In particular the specific header flags are not read when this bit is set. bit 2 - 3 spare bit 4 - 5 Downlink Performance and X-Band acquisition chain. This value summarizes the PCD snapshots rel. to the products. 0: performance better than MMCC/EECF-supplied minimum threshold 1: performance equal to or worse than threshold 2: performance unknown bit 6 - 7 HDDT Summary. This value summarizes the PCD snapshots rel. to the product. 1: performance equal to or worse than threshold 2: performance unknown bit 8 - 9 Frame Synchronizer. This value summarizes the PCD snapshots rel. to the product. 0: performance better than MMCC/EECF-supplied minimum threshold 1: performance equal to or worse than threshold 2: performance unknown bit 10 - 11 FS to Processor I/F The LRDPF and SARFDP reads the status of the FS interface. 0: no parity error detected 1: at least one parity error detected 2: performance unknown bit 12 - 13 Checksum Analysis on LR Frames. The percentage of source packets, featuring a checksum error, and used in the actual product is compared to a MMCC/EECF given threshold. 0: lower than threshold 1: greater than threshold 2: performance unknown bit 14 - 15 Quality of Downlinked Formats and Source Packets. The RA product is based on using 80 consecutive source packets. The percentage of erroneous ones is determined and compared to a MMCC/EECF given threshold. 1: greater than threshold 2: performance unknown bit 16 Existence of Auxiliary Data. 0: auxiliary data and/or chirp correctly extracted 1: not all auxiliary data extracted
7	24	A	UTC time when MPH was generated; Format as in field 4.
8	4	I4	Size of Specific Product Header: Record in Bytes
9	4	I4	Number of Product Data Set Records
10	4	I4	Size of each Product Data Set Record in Bytes
11	1	B	Subsystem that generated the product. 0: SARFDP 1 1: SARFDP 2 2: LRDPF 3: VMP 4: LRDTF
12	1	B	OBRC flag used for SAR products only bit 1 - 2 0: not used 1: OGRC data 2: OBRC data
13	24	A	UTC reference time. Time relation used to convert from satellite to ground, used together with the next two fields.

Table 4: Main Product header Detailed Description

Field	Bytes	Type	Description
14	4	I4	Reference binary time of satellite clock (32-bit unsigned integer)
15	4	I4	Step length of satellite clock in nanoseconds
16	8	I2	Processor software version used to generate product. Format as defined by MMCC/EECF. 8 bytes = 4 words of integer x 2
17	2	I2	Threshold table version number.
18	2	B	Spare
19	24	A	UTC time of ascending node state vector
20-25	24	6I4	Ascending node state vector in earth-fixed reference system
20	4	I4	State vector; X in 10-2 m
21	4	I4	State vector; Y in 10-2 m
22	4	I4	State vector; Z in 10-2 m
23	4	I4	State vector; X velocity in 10-5 m/s
24	4	I4	State vector; Y velocity in 10-5 m/s
25	4	I4	State vector; Z velocity in 10-5 m/s

Product Quality Control

In case there is a loss of data between products, null products may be generated. The interval of null products is determined by the PCD update rate (nominally 2.5 seconds) during ingestion. In terms of satellite time, the interval of null products will be:

Low Rate Real-time data: 1.25 seconds

Low Rate Playback data: 17.1 seconds

High Rate data: 0.078 seconds

This variation is due to the difference between record speed and the speed of reproduction of data for ingestion.

SAR FDP Input Data Error Handling

The SAR FDP has two basic schemes for minimizing the effects of bit errors in the high-rate and low-rate data:

- For extracted parameters which are relatively static (for example, PRF code, sampling window start time code, gain codes), the processor searches for the same value in two consecutive range lines or source packets;
- For dynamic extracted parameters (for example, range line number, satellite binary time code), the processor compares each value with previous and next values and thereby establishes the validity of each value based on acceptable ranges of change.

Missing or incomplete range lines of image mode data or source packets of wave mode data are replaced with zeroes. No parameters are extracted from the auxiliary data fields of these data sets. Missing data is indicated in the header of each affected product and summarized in the product confidence data field. Duplicate and obsolete wave mode source packets are detected by the SAR FDP on the basis of the satellite binary time code and are discarded.

If data are not received for the generation of a product, then no product is generated and the SAR FDP indicates so in its status report to the DPMC/CMS.

LRDPF Input Data Error Handling

Error handling within the LRDPF is performed on a product-type basis. The following section describes the error handling strategy for the User Wind Product.

Wind Scatterometer Error Handling.

Wind Scatterometer Fast Delivery Products will always be generated for the complete specified processing time interval with reference to the mid-beam.

Each product will correspond to an array of 19 nodes across-track by 19 nodes along-track with a node spacing of about 25 km.

For each node within the processing interval, the processor will attempt to find and process the corresponding satellite telemeter data of each beam (fore, mid and aft). For each beam and each node, the processor will calculate the corresponding sigma-nought value only if sufficient valid data are available for this node calculation.

The wind extraction algorithm will not be attempted for nodes having less than 2-beam sigma-nought calculated values. For each of the records of the products generated within the processing time interval, the appropriate data fields will be filled or flagged according to the number of processed beams and the possibility of wind vector extraction.

If a source packet is valid but not error-free, then calibration values contained in the auxiliary data of the packet will be ignored and the previous values, obtained from the last error-free source packet, will be used.

If at the end of the processing time interval, the last product is incomplete, it will be completed either by processed data or by blank records to make a complete product.

Product Confidence Data

All products disseminated from ESA Ground Stations contain information on the quality of the content. This data is referred to as Product Confidence Data (PCD). Six areas are covered:

- Performance of downlink and X-Band acquisition chain;
- Checksum analysis on LR frames;
- Quality of downlinked formats and source packets;
- Quality of auxiliary data;
- Performance and status of processing chain equipment;
- Quality assessment performed during product generation.

In the context of the direct ingestion system which is being installed at Prince-Albert

Location of Product Confidence Data in Product Format

Product confidence data are stored in several places throughout a product. As a general rule, acquisition-related information is stored in the MPH, processing information covering the entire product is given in the SPH, and information affecting the quality of individual cells is recorded on a cell basis together with the other cell contents. The location of the PCD in a product is as follows:

- Main Product Header: Within the main product header (same format for all products), 16 bits provide a summary of all checks performed before product dissemination;
  - PCD summary flag;
  - performance of downlinked and X-Band acquisition chain;
  - performance and status of processing chain;
  - checksum analysis on LR frames;
  - quality of downlinked formats and source packets;
  - quality of auxiliary data;
- Specific Product Header (FD and intermediate products):
  - product processor hardware equipment;
  - quality of downlinked formats and source packets (image and wave products only);
  - performance during product generation;
- Data Set Cell (RA and Wind products only):
  - checksum analysis on LR frames;
  - quality of downlinked formats and source packets;
  - performance during product generation;
  - quality assessment performed during product generation.

All PCD collected during acquisition and product generation are summarized in a single flag, product confidence factor. This flag is stored in the MPH of every product.

Performance of Downlink and X-Band Acquisition Chain

During acquisition, the following PCD is collected from the demodulator/bit synchronizer:

- Bit Error Rate (BER) estimate;
- Downlink channel signal strength (through the automatic gain control);
- I and Q bit synch lock status;
- Demodulator lock status.

These PCD, called PCD_DEMOD, are passed via the Time Code Generator (TCG) Interface to the TCG, to be embedded in the IRIG time code and passed on to the Data Path Switcher (DPS). The DPS outputs the down linked data in parallel with the time code for recording on HDDT. When data are read back from the HDDT for processing, the DPMC collects the PCD_DEMOD from the time code. It checks the PCD_DEMOD against limits, and passes the result as PCD flags (correct, incorrect, unknown) every 2.5 seconds on to the LRDPF and SAR FDP. The LRDPF and the SAR FDPs attach the PCD flags to all products which are generated from the downlinked data associated with the PCD_DEMOD.

Checksum Analysis on Low Rate Frames

The LR transfer frame checksums are analyzed by the Frame Synchronizer. Any detected errors are flagged by the Frame Synchronizer. The LRDPF takes action by replacing the noise and calibration pulse data with defaults, and by flagging the event in the MPH. In the SAR FDP (in Wave Mode), auxiliary data are checked for self consistency between consecutive source packets. A count of checksum errors is maintained and a flag in the MPH set if the ratio of erroneous frames to total frames exceeds a threshold.

Quality of Downlinked Formats and Source Packets

The performance of instrument formats and source packets is monitored by the SAR FDPs and the LRDPF through analysis of the data from the Frame Synchronizer. If a source packet (LR) or format (HR) cannot be reassembled; that is, it is too short or too long, all data are either replaced by ‘’0’’ (AMI image or wave products) before processing, or totally disregarded (AMI wind and RA products). In addition, a flag is set accordingly in the MPH, the SPH (image and wave products), and in the PCD of the cell (RA and wind products).

Quality of Auxiliary Data

Auxiliary data in the header of the downlinked source packets are checked by the processors against predefined limits. If a processor is unable to extract the auxiliary data needed for product generation, a flag is set accordingly in the MPH or in the PCD of the cell (RA and wind products).

Performance and Status of Processing Chain Equipment

The following equipment is monitored during product generation:

- High Density Digital Recorders (HDDRs)
- Frame Synchronizers (FSs)
- Frame Synchronizer to product processor interfaces

• SAR FDP and LRDPF processor status

The HDDRs are monitored by the DPMC/CMS, which collects status information generated by the Tape Search Units (TSUs). The DPMC/CMS also collects Synch Lock status via the Tape Search Units every 2.5 seconds, checks the parameters against predefined limits, and passes the resulting flag (correct, incorrect, unknown) every 2.5 seconds on to the LRDPF and the SAR FDPs.

During the replay of the recorder, the Frame Synchronizers monitor the:

- BER, and
- Lock status

of the downlinked data. The DPMC/CMS samples the Frame Synchronizer status every 2.5 seconds, checks the parameters against predefined limits, and passes the resulting flag (correct, incorrect, unknown) every 2.5 seconds on to the LRDPF and the SAR FDPs. The Frame Synchronizers to processor interfaces are monitored in the SAR FDPs and the LRDPF. The processors check the parity bit in the incoming data from the Frame Synchronizer. Performance below a certain threshold is recorded in the MPH of the related products.

Generally, the processing hardware is checked out in the daily or in the prepass test. Each test usually produces a Pass or Fail result, which is reported to the MMCC/EECF in the relevant test report. In certain ambiguous cases, where processing is done with uncertain hardware conditions, a flag is set in the SPH of each product.

Performance during Product Generation

During product generation, algorithm-specific data for product confidence parameters are generated. Depending on whether a PCD applies to an entire product or a product cell, the PCD is stored in the SPH or in the cell PCD. Cell-dependent PCD exist for wind and RA products.

Fast Delivery Product Descriptions

Fast Delivery products include all products which are disseminated over an electronic telecommunication link from the Stations or from EECF. This includes the following products:

- AMI Image-16-bit (UI16)
- AMI Image-8-bit (UI8)
- AMI Image Noise Statistic and Drift Calibration (UIND)
- AMI Image Chirp Replica (UIC)
- AMI Wave (UWA)
- AMI Wave Noise Statistic and Drift Calibration (UWAND)
- AMI Wave Chirp Replica (UWAC)
- AMI Wind (UWI)
- Radar Altimeter (URA)

Only AMI Wind product is described in this document.

AMI Wind (UWI)

Description

This product includes the intermediate and final results of the wind product generation. It consists of an array of wind vectors expressed in wind speed and direction. The product corresponds to a 500 x 500-km area. This area is represented by a 19 x 19 array of cells, with nominal 25-km spacing.

The produced wind field corresponds to an equivalent neutral stability wind field, referenced to a height of 10 m. For each cell a wind vector is given together with latitude and longitude. The sigma nought and other information needed to convert these to wind fields are also provided for each cell.

Satellite Source:AMI Wind Mode

Originating Subsystem:LRDPF

Production Generation:Products are generated for MMCC/EECF- defined start and stop times with reference to the midbeam.

Command:C_GEN_WI

On-Line Storage Specification:200 minutes

Throughput:70 products per orbit

Format

One product includes:

- Main Product Header: See Table 5 on page 9.
- Specific Product Header: See Table 17 on page 46.
- 361 Product Data Set Records: One cell is stored in one record.

Cells are stored in ascending time order within each cell line across-track; cells closer to the satellite track precede farther cells.

Comment on Product Confidence

Product confidence is monitored on a product-wide and cell basis.

Factors which apply to the entire product, are included in the SPH:

- Doppler Compensation accuracy (power spectrum monitoring) for each beam
- Mean power on I and Q Channel for each beam
- Internal Calibration level for each beam.

Table 17 Specific Product Header for UWI

Table 18 Data Set Record for UWI

Figure 5 Wind Direction Definitions

Figure 6 PCD flags for UWI relations with ambiguity removal

Table 5: Specific Product Header for User Wind Product (UWI)

Field	Bytes	Type	Description	Units
1	2	B	Product Confidence Data for Processing bit 1 & 2: Processing equipment status 0: equipment working 1: some problems with equipment 2: equipment failed during product generation bit 3: Spare bit 4: I/Q Imbalance Flag 0: all beams better than MMCC/EECF-defined threshold 1: any beam above or equal to MMCC/EECF-defined threshold bit 5: Internal Calibration level flag 0: all beams within MMCC/EECF-defined level window 1: any beam out of MMCC/EECF-defined level window bit 6: Blank Product Flag 0: data available 1 no data available bit 7: Doppler Compensation: Center of Gravity flag 0: all beams below MMCC/EECF defined threshold 1: any beam above or equal to MMCC/EECF-defined threshold bit 8: Doppler Compensation: Standard Deviation flag 0: all beams below MMCC/EECF defined interval 1: any beam outside MMCC/EECF-defined interval bit 9 - 16: Spare	N/A
2	4	I4	Geodetic latitude of Product Center; A negative value denotes South latitude, and a positive value denotes North latitude.	10^{-3} deg
3	4	I4	East longitude (i.e. 0-360º) from Greenwich to East)	10^{-3} deg
4	4	I4	Subsatellite Track Heading w.r. to North, turning clockwise 0at time of product center	10^{-3} deg
5	2	I2	Mean distance between two successive along track nodes at product center	meter
6	2	I2	Center of Gravity of averaged power spectrum (forebeam)	2.344 Hz
7	2	I2	’’Standard Deviation’’ of averaged power spectrum (forebeam)	2.344 Hz
8	2	I2	Center of Gravity of averaged power spectrum (midbeam)	2.344 Hz
9	2	I2	’’Standard Deviation’’ of averaged power spectrum (midbeam)	2.344 Hz
10	2	I2	Center of Gravity of averaged power spectrum (aftbeam)	2.344 Hz
11	2	I2	’’Standard Deviation’’ of averaged power spectrum (aftbeam)	2.344 Hz
12	4	I4	I Mean Noise Power, forebeam	10^{-3} ADC units
13	4	I4	Q Mean Noise Power, forebeam	10^{-3} ADC units
14	4	I4	I Mean Noise Power, midbeam	10^{-3} ADC units
15	4	I4	Q Mean Noise Power, midbeam	10^{-3} ADC units
16	4	I4	I Mean Noise Power, aftbeam	10^{-3} ADC units
17	4	I4	Q Mean Noise Power, aftbeam	10^{-3} ADC units
18	4	I4	Internal Calibration level monitoring factor, forebeam	10^{-3} ADC units
19	4	I4	Internal Calibration level monitoring factor, midbeam	10^{-3} ADC units
20	4	I4	Internal Calibration level monitoring factor, aftbeam	10^{-3} ADC units
21	2	B	Mode of operation - set by the first midbeam source packet contributing to spatial filtering for the first node (near swath) in the center row of a product. bit 1 and 2: 0: windmode 1: wind/wave mode 2: no data found to identify mode bit 3 - 16: Spare	N/A
22-71	82	I2	Parameter Table ID. Details as follows:	N/A
22	2	I2	Global threshold Parameter Table ID	N/A
23	2	I2	Static parameter Parameter Table ID	N/A
24	2	I2	Dynamic parameter Parameter Table ID	N/A
25	2	I2	F R_b(n) Parameter Table ID	N/A
26	2	I2	$T_{orbit,ref,D}$ Parameter Table ID	N/A
27	2	I2	$*_F$ Parameter Table ID	N/A
28	2	I2	$*_M$ Parameter Table ID	N/A
29	2	I2	$*_A$ Parameter Table ID	N/A
30	2	I2	F T_b(n) Parameter Table ID	N/A

Table 5: Specific Product Header for User Wind Product (UWI)

Field	Bytes	Type	Description	Units
31	2	I2	$C_{ADC,b}(n)$ Parameter Table ID	N/A
32	2	I2	$T_{orbit,ref,N}$ Parameter Table ID	N/A
33	2	I2	$F_{N,F}$ Parameter Table ID	N/A
34	2	I2	$F_{N,M}$ Parameter Table ID	N/A
35	2	I2	$F_{N,F}$ Parameter Table ID	N/A
36	2	I2	$*_{N,b}(j,k)$ Parameter Table ID	N/A
37	2	I2	$*_{N,b}(j,k)$ Parameter Table ID	N/A
38	2	I2	$M_{eff,b}(j,k)$ Parameter Table ID	N/A
39	2	I2	N(j,k) Parameter Table ID	N/A
40	2	I2	Wind extraction software configuration Table ID	N/A
41	2	I2	$LA_b(i_r,i_c)$ Parameter Table ID	N/A
42	2	I2	$LZ_b(i_r,i_c)$ Parameter Table ID	N/A
43	2	I2	LN_b Parameter Table ID	N/A
44	2	I2	MA_b Parameter Table ID	N/A
45	2	I2	MS_b Parameter Table ID	N/A
46	2	I2	$NA_F(*,i_c)$ fore Parameter Table ID	N/A
47	2	I2	$NA_M(*,i_c)$ mid Parameter Table ID	N/A
48	2	I2	$NA_A(*,i_c)$ aft Parameter Table ID	N/A
49	2	I2	$NS_F(*,i_c)$ fore Parameter Table ID	N/A
50	2	I2	$NS_M(*,i_c)$ mid Parameter Table ID	N/A
51	2	I2	$NS_A(*,i_c)$ aft Parameter Table ID	N/A
52	2	I2	$NN_F(*,i_c)$ fore Parameter Table ID	N/A
53	2	I2	$NN_M(*,i_c)$ mid Parameter Table ID	N/A
54	2	I2	$NN_A(*,i_c)$ aft Parameter Table ID	N/A
55	2	I2	l_{ref} Parameter Table ID	N/A
56	2	I2	$a_F(*,i_c)$ fore Parameter Table ID	N/A
57	2	I2	$a_M(*,i_c)$ mid Parameter Table ID	N/A
58	2	I2	$a_A(*,i_c)$ aft Parameter Table ID	N/A
59	2	I2	$av_F(k,i_r,i_c)$ fore Param. Table ID	N/A
60	2	I2	$av_M(k,i_r,i_c)$ mid Parameter Table ID	N/A
61	2	I2	$av_A(k,i_r,i_c)$ aft Parameter Table ID	N/A
62	2	I2	i_b Parameter Table ID	N/A
63	2	I2	Spare	N/A
64	2	I2	Spare	N/A
65	2	I2	Meteo Table ID (table type 83, Forecast F18)	N/A
66	2	I2	Meteo Table ID (table type 84, Forecast F24)	N/A
67	2	I2	Meteo Table ID (table type 85, Forecast F30)	N/A
68	2	I2	Meteo Table ID (table type 86, Forecast F36)	N/A
69	2	I2	Spare	N/A
70	2	I2	Spare	N/A
71	2	I2	Spare	N/A

Table 6: Data Set Header for User Wind Product (UWI)

Field	Bytes	Type	Description	Units
1	4	I4	Data record number, starting with 1.	Count
2	4	I4	Geodetic latitude of Node. A negative value denotes South latitude, and a positive value denotes North latitude.	10^{-3} deg
3	4	I4	East longitude (i.e. 0-360* from Greenwich to east)	10^{-3} deg

Table 6: Data Set Header for User Wind Product (UWI)

Field	Bytes	Type	Description	Units
4	4	I4	σ° of forebeam	10^{-7} dB
5	2	I2	Incidence Angle for forebeam	0.1 deg
6	2	I2	Look Angle of forebeam clock- wise w.r.t. North at grid point	0.1 deg
7	1	I1	Kp Value of forebeam, set to 255 if the calculation is not possible.	%
8	1	I1	Counter of forebeam corrupted or missing source packets	Count
9	4	I4	σ° of midbeam	10^{-7} dB
10	2	I2	Incidence Angle of midbeam	0.1 deg
11	2	I2	Look Angle of midbeam clock- wise w.r.t. North at grid point .	0.1 deg
12	1	I1	Kp Value of midbeam, set to 255 if the calculation is not possible.	%
13	1	I1	Counter of midbeam corrupted or missing source packets	Count
14	4	I4	σ° of aftbeam	10^{-7} dB
15	2	I2	Incidence Angle of aftbeam	0.1 deg
16	2	I2	Look Angle of aftbeam clock- wise w.r.t. North at grid point.	0.1 deg
17	1	I1	Kp Value of aftbeam, set to 255 if the calculation is not possible.	%
18	1	I1	Counter of aftbeam corrupted or missing source packets	Count
19	1	I1	Wind speed (set to 255 if wind extraction is not possible)	0.2 m/s
20	1	I1	Wind direction with respect to North turning clockwise at grid point (set to 255 if wind extraction is not possible)	2 deg.
21	2	B	Product Confidence Data bit 1 Summary PCD factor 0: processing of cell according to full specification 1: result to be viewed with limitation, i.e. one of the PCD flags listed below is not 0 (except bits 11-13). bit 2 Forebeam Flag 0: beam OK 1: no forebeam calculation bit 3 Midbeam Flag 0: beam OK 1: no midbeam calculation bit 4 Aftbeam Flag 0: beam OK 1: no aftbeam calculation bit 5 Forebeam Arcing Flag 0: no arcing detected on forebeam 1: arcing detected on forebeam bit 6 Midbeam Arcing Flag 0: no arcing detected on midbeam 1: arcing detected on midbeam bit 7 Aftbeam Arcing Flag 0: no arcing detected on aftbeam 1: arcing detected on aftbeam bit 8 Limit of Kp value 0: all beams below MMCC/EECF-supplied threshold 1: any beam above or equal to MMCC/EECF-supplied threshold bit 9 Land-Sea Flag 0: Sea 1: Land bit 10 Rank one solution flag . 0: Ambiguity removed 1: No ambiguity removal performed or ambiguity removal not successful See Note 6. bit 11-12 Ambiguity Removal Method . 0: ambiguity removed autonomously 1: use of meteorological tables after failure of autonomous ambiguity removal 2: ambiguity removed using meteorological data only 3: no ambiguity removal attempted bit 13 Maximum likelihood distance flag . 0: Maximum Likelihood Distance M of the rank 1 solution is less than or equal to a threshold 1: Maximum Likelihood Distance M of the rank 1 solution (i.e. solution of minimum residual) is greater than a threshold (see note 9). bit 14 Frame Checksum Flag 0: Checksum correct 1: Checksum error detected, noise and calibration replaced with default bit 15 and 16 Spare	N/A

Remark

The case bit 10 = 0, bit 11-12 = 3 and bit 13 = 0, with the given solution v* may occur in the following example. The ambiguity removal is attempted over 6 consecutive products with a displacement of 2 products. After the first 2 products with successful ambiguity removal the results are kept. In case of non-successful ambiguity removal on the next products, the old results (after ambiguity removal) are used, but the indicator of the method used is lost.

UWI Product Confidence Measures and Product Annotations.

Remark: The meaning of any LRDPF flag is as follows:

- 1: wrong (bit set)
- 0: nominal.

UWI PCD at Main Product Header summary is given in the field 6, bit 1 of the MPH, see Table 5 on page 9: the product is considered as correctly generated when none of the bits 2 to 16 of the MPH field 6 has been raised.

UWI PCD's in Specific Product Header are presented in Table 17 on page 46.

Equipment status flag (bits 1 and 2): This flag is always zero in the current implementation.

I/Q Imbalance flag (bit 4): Input statistics of noise channels, per beam: The I/Q imbalance monitoring factor is calculated by averaging the I and Q noise power, over a given number of consecutive F/M/A sequences. This number (nominally 8), is an external parameter. The respective quantities; I mean noise power and Q mean noise power for each beam are reported on fields 9 to 14. The given values are before unbiasing.

Flag on mean power on I and Q: For each beam the I/Q imbalance is estimated by forming the ratio: mean I power / mean Q power. However, these two values are separately checked against a threshold, without forming the ratio. Therefore 3 * 2 = 6 thresholds are used;

The flag is set when either the I or Q channels exceeds its threshold.

Internal Calibration level (bit 5): This calculation is performed for every beam, once per product.

Blank Product flag (bit 6): When no source packet, as necessary to generate a product in the time interval (t1,t2), is found, a dummy product is generated and this flag is set.

Remark: the above means that if at least one source packet has been found, this flag is not raised.

Doppler compensation flags (bits 7 and 8): The on-board Doppler compensation is refined on ground. The overall performance of the Doppler compensation scheme is measured by taking the resulting signal power spectrum, averaged over a number of L1 measurements blocks and comparing its Center of Gravity and 'Standard Deviation' with those of an externally specified reference spectrum corresponding to an ideal Doppler compensation. This is done for all beams and per product. When no beam and no estimate is available, the following default values below are used in the table. In case of lack of input data, the standard deviation fields should not be filled with the best case values.

Fields 6,8,10Averaged power spectrum Center of Gravity999

Fields 7,9,11Averaged power spectrum Standard Deviation-1

Fields 12-17I/Q Mean Noise power -1

Fields 18-20Internal Calibration level -1

UWI PCD's at Data Set Record level are presented in Table 18 on page 49.

Wind speed (field 19) may lie in the range 0 to 50.8 m/s. The value of 51.0 m/s (field value of 255) is reserved to indicate that an invalid wind speed was determined. So, when no wind extraction is possible, the product is written with the following default values:

Wind speed255

Wind direction255

The product UWI contains various product confidence measures at node level, one record corresponding to one node, as indicated in field 21:

Forebeam, Midbeam and Aftbeam Flag (bits 2,3 and 4):

If a source packet is incomplete or too long, it is disregarded. During the calculations of the 3 ** values, the number of missing or erroneous packets is counted. This flag is set when no source packet contributing to a node has been found, for this beam.

Remark 1: the above means that when at least one source packet, out of a maximum number of 36, is found, the spatial filtering is performed.

Remark 2: This flag is not related to the arcing problem (see later). The wind extraction software looks at these flags to determine which branch of the algorithm to use:

3 Beam wind extraction

2 Beam wind extraction

In case of only one beam data is available, no wind extraction is attempted.

Forebeam, Midbeam and Aftbeam arcing flag (bits 5,6 and 7): A possible arcing of the transmitting tube (TWT) leads to an automatic switching off of the transmission. As a new transmission is not attempted before 15 sec, an arcing results in loss of data. These missing data are identified by looking at the statistics of the received data; as no transmission occurs, received data feature noise statistics. The corresponding beam data for a given node are flagged.

Remark: above information is not read and therefore not used by the wind extraction software.

Limit of Kp value (bit 8): Before the wind extraction, the Kp value for each beam, for a given node is estimated. For every beam the actual value is compared to a given limit (e.g. 20%), and this flag raised in case at least one exceeds this limit. In case this flag is raised no wind extraction is attempted.

Land/sea flag (bit 9): A high resolution grid (5' x 5') is used to determine the percentage of land contamination within an area surrounding the center of the node, given by its latitude and longitude. The larger zone extends (beyond the 5' x 5' area) outwards at least 25 km. A scatterometer point falling within a given 5' x 5' area, is processed only if no surrounding cell is indicated as land in the larger zone. The land/sea flag is therefore raised when the contamination is more than 0% of land.

Flag on frame checksum (bit 14): For every source packet contributing to a node (up to 36), there is an input flag set by the frame synchronizer. This flag is set whether at least one out of these 36 input flags has been set by the frame synchronizer. If a checksum error happens, the calibration and noise data are replaced with defaults.

Product distribution

Media and file formats

Product distribution media

The ERS ground stations use a number of different media to distribute their products. The products can either be distributed via telecommunication links or on some magnetic or optical media. This part of the document presents the magnetic and optical media and their data formats.

- The High Density Digital Tape, HDDT: The stations use HDDT to acquire and store the original telemetry from the satellite. The tapes contain the unprocessed datastream as it is received from the satellite. The stations distribute this 'raw data' to the PAF's for high rate data and to the raw data archive in Fucino for low rate data.
- The Computer Compatible Tape, CCT: The stations use the CCT to archive low rate fast delivery products. The tapes contain processed data. The stations distribute data on CCT on request when the normal telecommunications links are unavailable.
- The Exabyte, EXA: The stations use the Exabyte for several purposes:
- To archive fast delivery and intermediate high rate and Wave products. The cassettes contain processed data. The station distribute them to the PAF's for archiving.
- To transcribe low bit rate data from HDDT to Exabyte. The cassettes contain unprocessed annotated source packets in a computer readable format. The stations distribute these cassettes to the PAF's for low bit rate data processing and archiving.
- To archive low bit rate fast delivery products. The cassettes contain processed data. These cassettes will not nominally be distributed outside the station.
- The Optical Disc, OD: The station at Fucino uses the OD to transcribe ERS-1 low bit rate data from HDDT. The discs contain unprocessed source packets in computer readable format. The station distributes the discs to the French PAF for low bit rate processing and archiving. This media will be replaced by the Exabyte when ERS-2 becomes the operational satellite.
- The BUFR format

References

[1] "ERS Ground Stations Products specification", ER-IS-EPO-GS-0201, issue 3/1.

[2] Lecomte P.,"The ERS Scatterometer instrument and the On-Groung processing of its Data", Proc

[3] Albani M., V. Beruti & S. D'Elia, "Evolution of the ERS-2 Data Processing Ground Segment", ESA Bulletin Nr. 83, August 1995.