esa
esrin

european space agency
agence spatiale européenne

ERS SAR BROWSE PRODUCT

Browse image
Greenland (North-East Coast)
ERS-2 / 27 June 1995

H. LAUR, P. BALLY, Projects & Engineering Department, Earth Observation Division

ES-TN-DPE-OM-HL06, Issue 1.0 *November 1995*

Table of Contents

1. INTRODUCTION

The ERS SAR Browse product (BRW) is the basic product to populate browse systems or station catalogues.

The Browse product is generated by the ***ERS SAR Browse Processor***, developed by Advanced Computer Systems (ACS) within ESA/ESRIN contract No. 11315/95/I-HGE. The Browse processor is an upgrade of the ERS SAR screening function initially developed for the Bangkok SAR processing facility [1].
The Browse processor is part of the Transcription and Browse Facility [2] installed at UK-PAF.

The ERS SAR Browse product has the following characteristics:

- it corresponds to ***one acquisition segment*** (i.e. several ERS SAR frames),
- it is generated ***within 1h 30*** after raw data ingestion,
- its size is ***less than 3 MBytes*** (usual size is about 2 MBytes) in order to be quickly transferred through terrestrial network from the browse processor to the browse systems,
- it is ***easily ingested into browse systems*** such as the ESRIN Multi Mission Browse System (MMBS),

The Browse product consists of two files (Fig. 1):
- the ***Image file*** (file.jpeg), containing the browse image compressed into Jpeg blocks,
- the ***Inventory file*** (file.inv), containing information on the acquired segment and the standard frames.

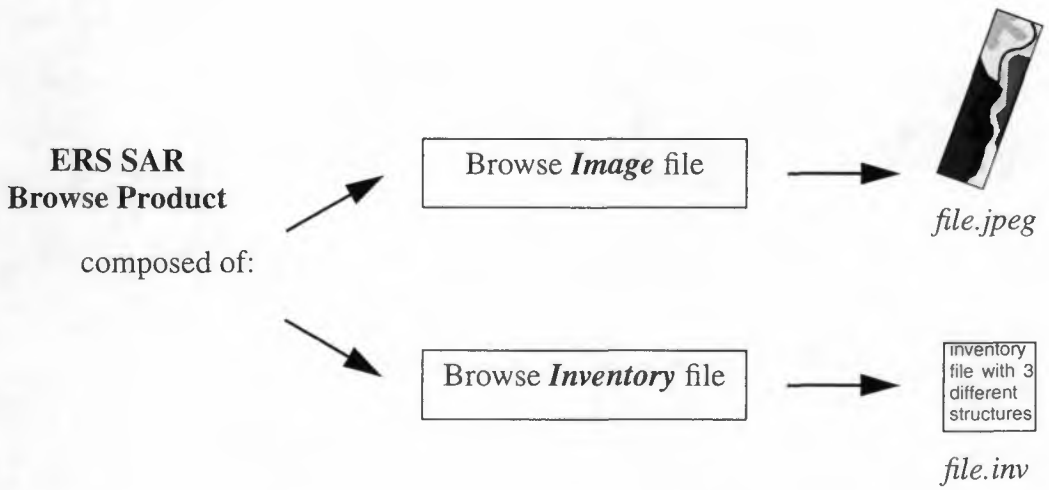


Figure 1: ERS SAR Browse Product

2. BROWSE PRODUCT IMAGE FILE

2.1 Browse image file generation

The browse image of the Browse product is generated as a post-processing of the ERS Quick Look function [1] developed for the Bangkok SAR processing facility.

The browse image is obtained as follows (Fig. 2):

- the Quick Look (QL) image is generated from the SAR raw data archived on HDDT or on Sony D1 tape,
- the QL image is converted from slant range to ground range,
- the image is resampled to a 200 x 200 m pixel spacing,
- the image is oriented with first pixel representing the North-West corner,
- the image is padded with black lines, at the beginning and at the end of the file, in order to contain complete standard frames,
- the image is Jpeg compressed by blocks of 256 lines.

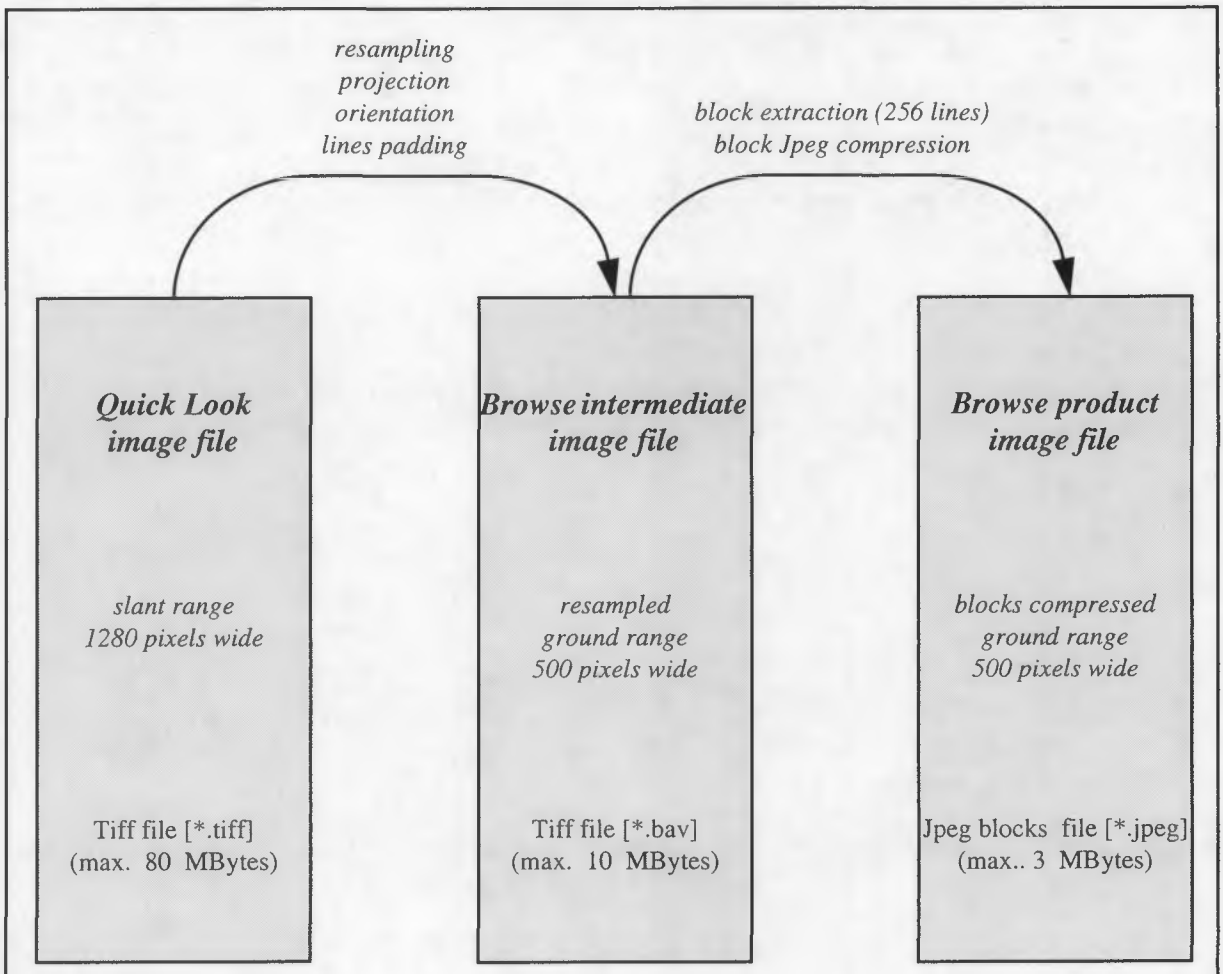


Figure 2: Browse image file generation

The conversion function in Quick Look processing:

Quick Look processing comprises a conversion from 32 bit float data to 8 bit format using an exponential function to transform data distribution:

$$b(x) = k \cdot (1 - e^{-C \cdot g \cdot x})$$

where x is the input data (float)
b is the output data (8 bit integer)
k is the maximum output data value i.e. 255
g is the gain of the transformation
C is a constant

The transformation gain g remains the same for the generation of the intermediate and final browse images.

The impact of gain change on ouput data distribution is determined as follows: given a fractional change of the function gain $\Delta g/g$, the fractional change of converted data $\Delta b/b$ can be approximated by:

$$\Delta b/b = - (k / b) \cdot (1 - b / k) \cdot \ln(1 - b / k) \cdot \Delta g/g$$

As an example, if the gain g is increased by 25%, the ouput value is increased as follows :

output (b value)	0	20	60	80	140	160	220	240	255
output variation (Δb)	0	5	13	17	23	24	17	11	0

The impact of gain change on the output is dependent on the output value. Medium values are the most affected by a gain change while extreme values remain almost unchanged. The gain g currently used by the ERS SAR browse processor for data conversion during Quick Look generation is 5.

Compression in the Jpeg software:

The Jpeg software library used by the browse processor allows the selection of output image quality through a quality parameter ranging from 1 to 20. When the value of the quality parameter is set to 20, the compression software processes the image minimising the losses (highest quality). In this case the compression ratio is very low (around 3).

The quality parameter currently used by the ERS SAR browse processor is 15 which corresponds to a compression ratio of around 8 (the exact value depends on image heterogeneity). Such ratio ensures suitable quality of the browse image.

2.2 Browse image characteristics

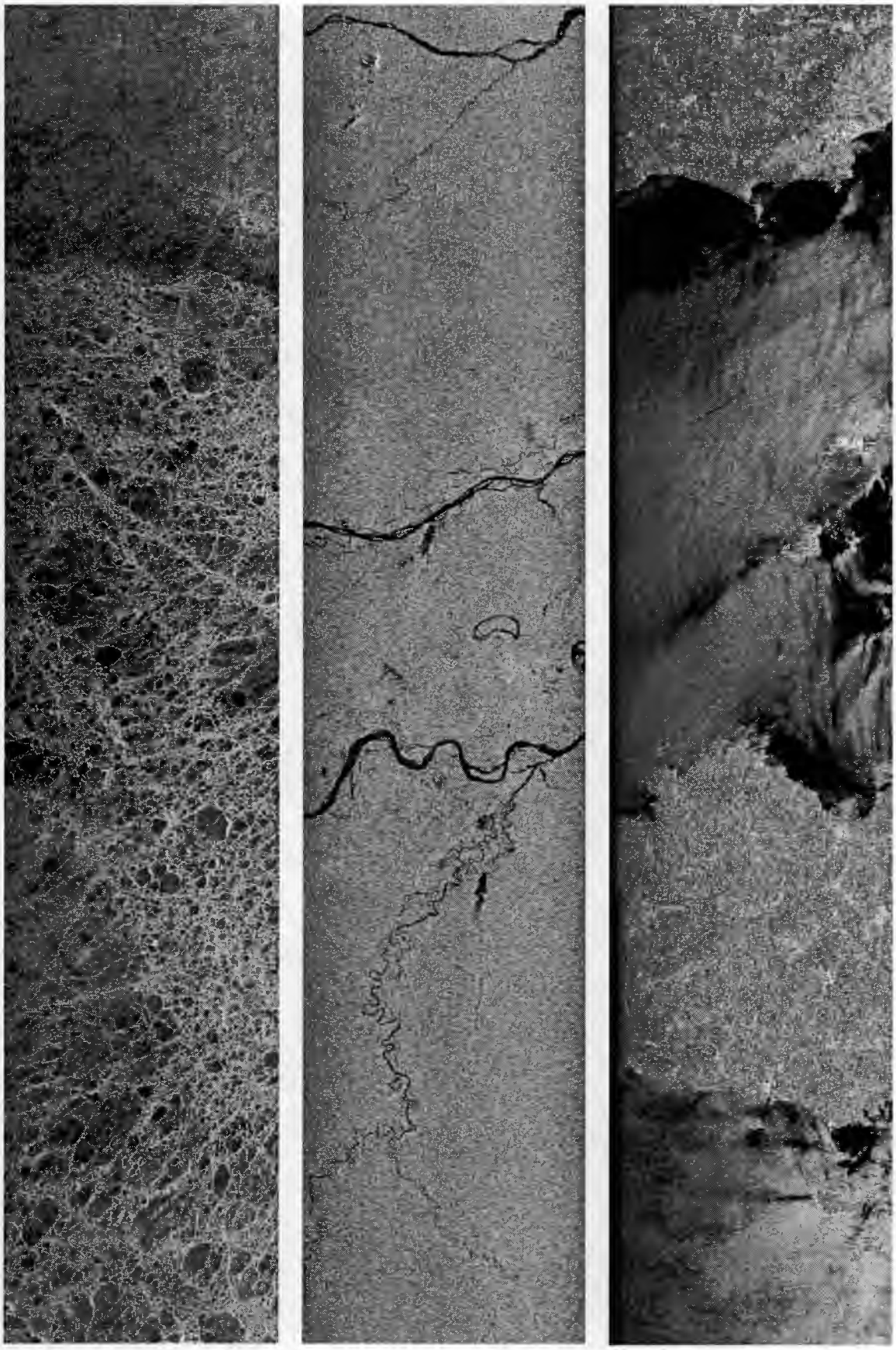
The ERS SAR browse image has the following characteristics:

- format: blocks of Jpeg compressed data
- pixel spacing: 200 m in both directions
- width: 500 pixels
- length: as segment acquisition (maximum 22000 lines)
- projection: ground range, track oriented
- calibration: no corrections
- radiometry: no contrast enhancement (i.e. a constant gain is applied during browse image generation)

The browse product corresponds to one ERS SAR acquisition segment, i.e. up to a maximum of 12 min. of acquired data (4400 km or 44 SAR frames). If one orbit contains two (or more) acquisition segments, the browse processor generates two (or more) browse products.

Some examples of browse images are given in Fig. 3. These images cover only a part of the corresponding browse products.

Note: the Browse image file is composed of Jpeg compressed blocks. The image file shall be decompressed before displaying (see file structure in chapter 2.3). This is automatically done by browse systems such as MMBS.



Ice floes - Greenland Sea
ERS-2 / 27 June 1995

Rain forest - Brazil
ERS-2 / 13 June 1995

English Channel
ERS-1 / 5 May 1995

Figure 3: Examples of browse images (the displayed image represent only part of the browse image file).

Note that the Multi Mission Browse System (MMBS) processes the ERS SAR Browse product in order to display *framed browse image* (Fig. 4). When an user does a SAR image request with MMBS, he obtains a set of Jpeg images displayed frame by frame and no more as a full segment. The size of one frame browse image within MMBS is about 60 kilobytes.

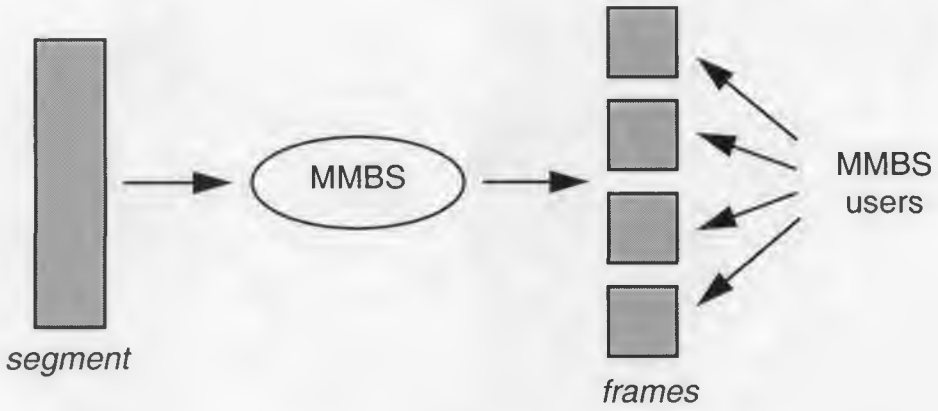


Figure 4: Ingestion of ERS SAR Browse products by MMBS

Some framed browse images as retrieved by MMBS users are displyed in Fig. 5a and 5b.

Fig. 5a: Frame browse image retrieved from MMBS
ERS-2 - Orbit 766 - Frame 3663 - Amazon river (Brazil)

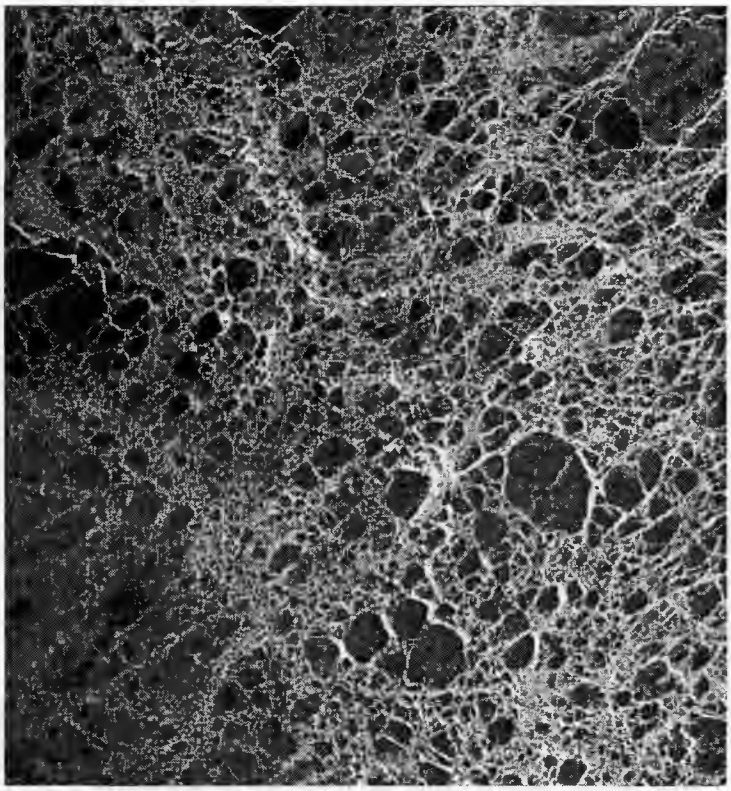


Fig. 5b: Frame browse image retrieved from MMBS
ERS-2 - Orbit 966 - Frame 1827 - Ice floes (Greenland Sea)

2.3 Browse Image file structure

The file is organised (Fig. 6) with a first part (header) containing general information, addresses and sizes of the successive compressed blocks. The format of the header structure is described in chapter 2.4.
The successive parts (block structures) contain Jpeg compressed data. Each block is generated from the compression of a fixed number of lines (256). The number of lines is selected to optimise the floating display. Pointers to the standard ERS SAR frames are stored in the inventory file, for each frame.

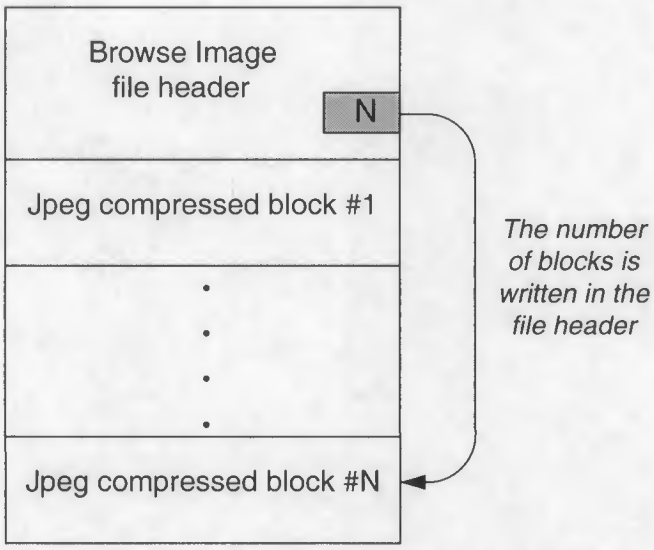


Figure 6: Browse product - Image file (.jpeg) structure*

2.4 Browse Image file header

The Browse Image file header is a variable length data structure, written at the beginning of the Browse Image file (Fig. 7). The data structure consists of a fixed length portion (containing identification information) plus a block description portion, containing addresses for each block of Jpeg compressed SAR data. The block description structure is repeated as many times as the number of compressed blocks.

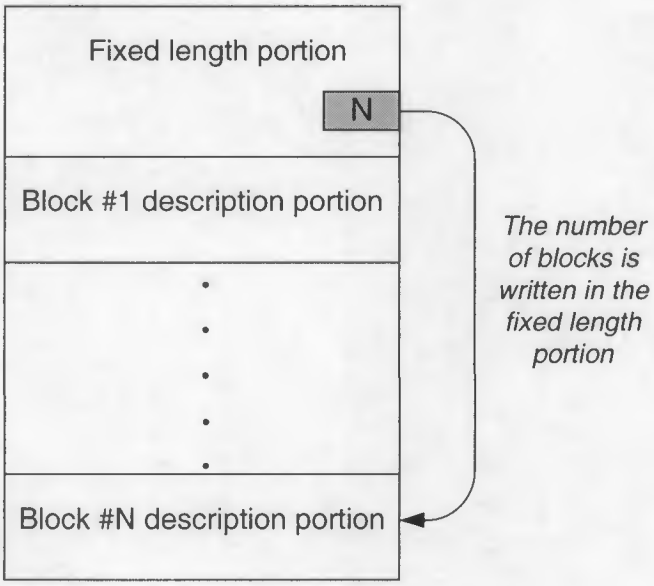


Figure 7: Browse product - Image file - Header structure

The format of the fixed length portion and the block description portion of the header

structure is shown in Table 1.

Field	*Type*	*Length [Bytes]*	*Position*	*Name*	*Comments*
				Fixed length portion	
1	long	4	01-04	MagicNumber	UNIX file type code
2	long	4	05-08	Video_Format	Format of the Video Data: 1 = Black and White (BW) Format 3 = Red, Green, Blue (RGB) Format For ERS SAR, always set to 1.
3	long	4	09-12	Line_Size	Length in pixels of the Browse Video Line
4	long	4	13-16	Lines_Number	Number of lines of the intermediate browse file (file.bav)
5	long	4	17-20	Lines_per_Jpeg_Block	Number of original lines in each Jpeg compressed block
6	long	4	21-24	Jpeg_Block_Number (**N**)	Number of Jpeg compressed blocks
7	long	4	25-28	Lines_per_Last_Jpeg_Block	Number of compressed lines for the last Jpeg block
8	long	4	29-32	Padding_at_segment_start	Number of black lines at segment beginning (in file.bav)
9	long	4	33-36	Padding_at_segment_end	Number of black lines at segment end (in file.bav)
10	float	4	37-40	PixelSizeX	Pixel size in the X direction in metres
11	float	4	41-44	PixelSizeY	Pixel size in the Y direction in metres
				Variable length portion (Jpeg block addresses)	
12	long	4	45-48	Jpeg_Block_Start	Address of block #1 from file beginning (0 relative - in bytes)
13	long	4	49-52	Jpeg_Block_Size	Size of Jpeg compressed block #1 (in bytes)
14	long	4	53-56	Jpeg_Block_Start	Address of block #2 from file beginning (0 relative - in bytes)
15	long	4	57-60	Jpeg_Block_Size	Size of Jpeg compressed block #2 (in bytes)
. . . .			. . . .	The block structure is repeated as many time as the number of Jpeg compressed blocks composing the Browse image file.	
.	long	4	.	Jpeg_Block_Start	Address of block #N from file beginning (0 relative - in bytes)
.	long	4	.	Jpeg_Block_Size	Size of Jpeg compressed block #N (in bytes)

Table 1: Browse product - Image file - Header structure format

3. BROWSE PRODUCT INVENTORY FILE

The inventory file contains the description data for the acquired segment. The file contains three types of data structures (Fig. 8):

- a ***segment description*** data structure, containing information valid for the whole segment,
- a ***frame description*** data structure, containing ERS SAR standard frame related information,
- a ***state vectors*** data structure, containing orbital data valid for the segment.

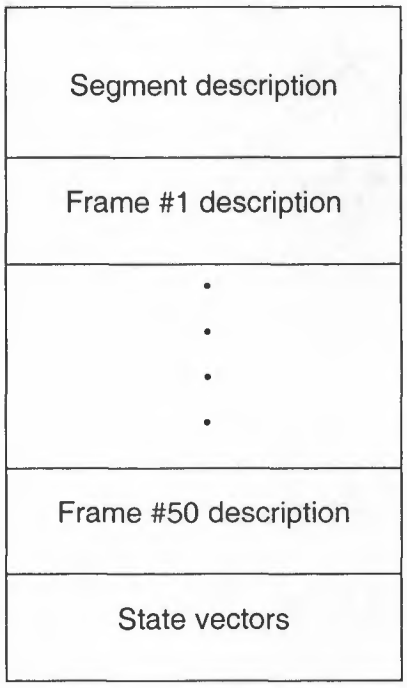


Figure 8: Browse product - Inventory file (.inv) structure*

The frame description data structure is repeated 50 times in the file. This space is always occupied in the file, even though the number of frames really acquired is lower. Only the first N frame structures are filled with information, where N is the number of frames really acquired. The number N is given at bytes 2629-2632 of the segment description structure (Table 2).

The frame description is also provided for frames partially covered by the segment (this occurs for the first and last frame of the segment).

The format for the three data structures is given in Table 2 (Segment description), Table 3 (Frame description) and Table 4 (State vectors).

3.1 Segment description

Table 2: Browse product - Inventory file - Segment description structure format

Field	*Start*	*Stop*	*Bytes*	*Type*	*Description*
	1	12	12	long	Physical Address of the Block on Tape
NumOfVertex	13	16	4	long	Number of vertexes
Lon	17	20	4	float	Vertex #1 Longitude
Lat	21	24	4	float	Vertex #1 Latitude
.	.	.	.	.	.
Lon	809	812	4	float	Vertex #100 Longitude
Lat	813	816	4	float	Vertex #100 Latitude
MediumType	817	828	12	char	HD-96, DIR 1000, etc.
MediumId	829	840	12	char	Station dependent
OrigMediumType	841	852	12	char	Only for transcription
OrigMediumid	853	864	12	char	Station dependent
NumOfPasses	865	868	4	long	Passes on original medium
TimeCodeType	869	876	8	char	IRIG A, IRIG B, NASA 36
StorageStation	877	880	4	long	Centre where medium is currently stored
MediumLoc	881	892	12	char	Station dependent
MediumSpare	893	912	20	4*long	
NPass	913	916	4	long	Passes within storage medium
AscendingFlag	917	920	4	long	0 = desc ; 1 = asc
SatId	921	924	4	long	5 = ERS
SatMis	925	928	4	long	1 or 2 for ERS
SensId	929	936	8	long	10 = ERS AMI SAR
BegRecordDate	937	944	8	double	Julian Date - Pass recording start time
EndRecordDate	945	952	8	double	Julian Date - Pass recording stop time
Orbit	953	956	4	long	Orbit number
StartBlock	957	960	4	long	Block number of pass start
EndBlock	961	964	4	long	Block number of pass end
StartFeet	965	968	4	long	Feet number of pass start
EndFeet	969	972	4	long	Feet number of pass end
FirstAddress	973	976	4	long	Address for pass start on transcription medium
SecondAddress	977	980	4	long	Address for pass header on transcription medium
ReceiveStdRec	981	984	4	long	Acquisition station, listed in Stations Table (see annex)
SegNum	985	988	4	long	Number of valid segments for SPOT, ERS
Cycle	989	992	4	long	Satellite cycle in days
ProcStation	993	1000	8	long	Station that generated inventory, listed in Stations Table
dBInsertDate	1001	1008	8	double	Date of the record insertion into local catalogue
Version	1009	1020	12	char	Version of inventory program
Passspare	1021	1056	36	long	
SegmentOrder	1057	1060	4	long	Number of present segments in acquired sequence of segments
RollAngle	1061	1064	4	long	SAR incidence angle
BegTimeCod	1065	1072	8	double	Segment start time

EndTimeCod	1073	1080	8	double	Segment stop time
BegFormat	1081	1084	4	u_long	Segment start format counter
EndFormat	1085	1088	4	u_long	Segment stop format counter
ICUOnBoardBegT	1089	1092	4	u_long	Satellite binary counter at segment start
ICUOnBoardEndT	1093	1096	4	u_long	Satellite binary counter at segment end
ILatMin	1097	1100	4	float	Lower latitude coded as degrees decimal
ILonMin	1101	1104	4	float	Lower longitude coded as degrees decimal
ILatMax	1105	1108	4	float	Upper latitude coded as degrees decimal
ILonMax	1109	1112	4	float	Upper longitude coded as degrees decimal
CompressionMode	1113	1120	8	char	Coded as "OGRC$$$$" or "OBRC$$$$"
FirstFrameNum	1121	1124	4	long	Number of first standard frame
LastFrameNum	1125	1128	4	long	Number of last standard frame
Spare	1129	1136	8	2*long	
PulseRepInt	1137	1144	8	double	Pulse repetition interval (Hz)
SamplingRate	1145	1152	8	double	Range Sampling Frequency
CalibSubAtt	1153	1156	4	long	Calibration Sub-attenuation
ReceivGain	1157	1160	4	long	Receiving gain
Ellipsoid	1161	1168	8	char	Ellipsoid name
EllipsParam	1169	1184	16	float	Ellipsoid parameters (radius,flattening)
NoiseFlag	1185	1188	4	long	Noise Availability
SWSTFlag	1189	1192	4	long	SWST Availability
CalibFlag	1193	1196	4	long	Calibration Values
QualityFlag	1197	1200	4	long	Quality Estimation
DopplerFlag	1201	1204	4	long	Doppler Data Availability
QLFlag	1205	1208	4	long	Quick Look Availability
HistogFlag	1209	1212	4	long	Histogram Availability
BegFormatNoise1	1213	1216	4	long	Start format of noise pulse (Segment start)
EndFormatNoise1	1217	1220	4	long	End format of noise pulse (Segment end)
BegFormatNoise2	1221	1224	4	long	
EndFormatNoise2	1225	1228	4	long	
BegFormatCalib1	1229	1232	4	long	Start format of calib pulse
EndFormatCalib1	1233	1236	4	long	End format of calib pulse
BegFormatCalib2	1237	1240	4	long	
EndFormatCalib2	1241	1244	4	long	
CalibFileName	1245	1308	64	char	File name of associated calibration data
NoiseFileName	1309	1376	64	char	File name of associated noise data
SampleTChange	1377	1384	8	long	Number of SWST changes (Max 20)
ChangTimeValue	1385	1392	8	double	Value of SWST (sampling window start time) #1
.	.	.	.	.	.
ChangTimeValue	1537	1544	8	double	Value of SWST #20
ChangTimeFormat	1545	1548	4	long	Format counter where SWST change occurred #1
.	.	.	.	.	.
ChangTimeFormat	1621	1624	4	long	Format counter where SWST change occurred #20
DCentrMeasures	1625	1632	8	long	Number of computed Doppler centroids (Max 50)
DCentrValue	1633	1640	8	double	Value of the Doppler centroid #1

.	.	.	.	.	.
DCentrValue	2025	2032	8	double	Value of the Doppler centroid #50
DCentrFormat	2033	2036	4	long	Format counter of Doppler centr. computation #1
.	.	.	.	.	.
DCentrFormat	2229	2232	4	long	Format counter of Doppler centr. computation #50
NOfMissingLines	2233	2236	4	long	Number of missing lines in the whole segment
OverallQuality	2237	2240	4	long	Overall segment quality estimation
QualityDensity	2241	2244	4	long	Num of lines of validity for each value
QualityVotes	2245	2500	256	u_char	256 quality estimations - *see explanation below*
QLBavFileName	2501	2564	64	char	File name of the associated Browse image file
HistFileName	2565	2628	64	char	File name of the histogram
NumOfFrames	2629	2632	4	long	Number of frames (standard frames - includes also partial ones at beginning and end of segment)
PaddLinesBegFF	2633	2636	4	long	Num of black lines added at QL file start to complete the 1st standard scene
PaddLinesEndLF	2637	2640	4	long	Num of black lines added at QL file end to complete the last standard scene
BPID	2641	2660	20	char	Browse Product ID for MMBS Database link
SegmentSpare	2661	2696	36		

Quality Density field and Quality Vote field:

Whatever the length of the segment, 256 votes equally distributed along the segment are given. i.e. the interval of validity (Quality Density field) of each vote is given by the ration between the total number of lines in the segment and the value 256. If Quality Density field is set to e.g. 3000 then the first quality vote is valid for lines from 1 to 3000 of the segment, the second from 3001 to 6000, and so on. Line number is given for the input raw data stream.

Each quality vote is derived from the number of missing lines detected in the interval of validity. In order to fit a one byte code, the number of missing lines is scaled to a maximum value of 255. The scale factor is fixed for all the values. It is given by the ratio between the Quality Density (Interval of Validity) and value 256. The ratio is rounded to the closest integer value. As an example, let us assume a Quality Density set to 1200 (segment length about 307200 lines, corresponding to about 3 minutes). A quality vote equal to 3 indicates that the number of missing lines is around 15 i.e. FIX(1200 / 256) x 3.

Calibration and Noise information are collected during raw data screening and stored in separate files. They can be used in a Station Catalogue such as the ACS IDEAS catalogue for analysis and inspection. Flags inform of the availability of such files.

Doppler Centroids and Sampling Window Start Time are computed during raw data screening. Values are stored in fields: SampleTChange, ChangTimeValue, ChangTimeFormat, DCentrMeasures, DCentrValue and DCentrFormat.

3.2 Frame description

The frame structure contains information on the ERS SAR frame location, timing, quality, plus addresses of the frame within the Browse image file (file.jpeg) associated to the inventory file.

Table 3: Browse product - Inventory file - Frame structure format

Field	*Name*	*Start Stop / Length*	*Type*	*Comments*
1	FrameNum	2697 2704 / 8	long	According to standard ERS framing
2	BegTimeCod	2705 2712 / 8	double	Scene Start Time -Julian Date format
3	EndTimeCod	2713 2720 / 8	double	Scene Stop Time -Julian Date format
4	Spare	2721 2728 / 8	2*u_long	
5	ULLat	2729 2732 / 4	float	Upper left corner latitude (range -90.0 +90.0)
6	ULLon	2733 2736 / 4	float	Upper left corner longitude (range-180 +180)
7	URLat	2737 2740 / 4	float	Upper right corner latitude (range-90.0 +90.0)
8	URLon	2741 2744 / 4	float	Upper right corner longitude (range -180 +180)
9	LLLat	2745 2748 / 4	float	Lower left corner latitude (range -90.0 +90.0)
10	LLLon	2749 2752 / 4	float	Lower left corner longitude (range -180 +180)
11	LRLat	2753 2756 / 4	float	Lower right corner latitude (range -90.0 +90.0)
12	LRLon	2757 2760 / 4	float	Lower right corner longit(range -180 +180)
13	MeanI	2761 2764 / 4	float	Computed on input raw data
14	MeanQ	2765 2768 / 4	float	Computed on input raw data
15	SdevI	2769 2772 / 4	float	Computed on input raw data
16	SdevQ	2773 2776 / 4	float	Computed on input raw data
17	MissLinPerc	2777 2780 / 4	long	Percentage of missing input lines (0-99)
18	DopplerCentroid	2781 2784 / 4	float	Doppler Centroid value valid for the frame
19	BlockNumber	2785 2788 / 4	long	Numb of JPEG block containing 1st frame line
20	LineNumber	2789 2792 / 4	long	Position in the block i.e. number of first line of the frame
21	MaxI	2793 2796 / 4	u_long	Max value of I channel in input raw data
22	MaxQ	2797 2800 / 4	u_long	Max value of Q channel in input raw data

<u>Julian Date Format</u>: expressed in days (and decimal fractions of days) since January 1st, 1950. It is contained in a double floating point variable (8 bytes). January 1st, 1950 is day 0. As an example the value 16362.046313 corresponds to 19-OCT-1994 01:06:41.443. Resolution is millisecond. It is assumed that one day equals 86 400.000 seconds.

<u>BlockNumber and LineNumber fields</u>: to generate the ERS Browse Image file, the ERS Browse intermediate file (.bav) is divided into blocks of 256 lines. Each block is compressed separately and added to the ERS Browse Image file (.jpeg). In order to extract data for a specific standard frame, the user needs to know the location of the beginning of the frame in the file (the size of the frame being fixed). BlockNumber contains the number of the block where the first line of the frame is located. LineNumber contains the location of such line within the decompressed block.

3.3 State vectors

The State Vector structure is added at the end of the ERS inventory file.

Table 4: Browse product - Inventory file - State vectors structure format

Name	*Start*	*Stop*	*Length [Bytes]*	*Type*	*Comments*
SVtype	7897	7904	8	int	Type of state vector(0=predicted 1=restituted)
pos_x	7905	7912	8	double	Position (x axis) - unit is km
pos_y	7913	7920	8	double	Position (y axis) - unit is km
pos_z	7921	7928	8	double	Position (z axis) - unit is km
vel_x	7929	7936	8	double	Sat velocity (x axis) - unit is km/sec
vel_y	7937	7944	8	double	Sat velocity (y axis) - unit is km/sec
vel_z	7945	7952	8	double	Sat velocity (z axis) - unit is km/sec
AscNodeJdt	7953	7960	8	double	Time of the state vector (julian date.decimals)
ReferenceJdt	7961	7968	8	double	Reference time (julian date.decimals)
SatBinTime	7969	7972	4	u_long	Satellite binary counter
ClockStepLength	7973	7976	4	u_long	Satellite binary counter period

4. REFERENCES

[1] Matra Cap Systemes / Advanced Computer Systems, *'Bangkok station SAR processing facility - System technical specification'*, BKK-ST-1300-0005-MS, Issue 1, May 1993.

[2] Advanced Computer Systems, *'ERS Screening and Transcription Facility - External Interfaces'*, Version 1.0, September 1995.

ANNEX

Stations Table

Only includes the acquisition stations and processing stations relevant for ERS SAR

1	Fucino
2	Kiruna
3	Maspalomas
4	Tromso
5	Tel-Aviv
6	Bangkok
7	Fairbanks
8	Cotopaxi
9	Gatineau
10	Alice Spring
13	Prince Albert
14	West Freugh
15	O'Higgins
23	Cuiaba
24	Farnborough (UK-PAF)
25	Pretoria
27	Oberpfaffenhoffen (D-PAF)
35	Frascati (ESRIN)