esa DOCUMENT

document title/ titre du document

THE NEW ESA ERS SAR PRODUCTS

REPLACEMENT OF THE VMP BY THE PGS-ERS PROCESSOR

prepared by/*préparé par*	EOP-GOQ
reference/*réference*	ERSE-GSEV-EOPG-TN-05-0003
issue/*édition*	1
revision/*révision*	0
date of issue/*date d'édition*	29-07-2005
status/*état*	Approved
Document type/*type de document*	Technical Note
Distribution/*distribution*	

European Space Agency
Agence spatiale européenne

Title *titre*	The new ERS SAR Products - Replacement of the VMP by the PGS-ERS	issue *issue*	1	revision *revision*	0

Author *auteur*	C. Santella, N. Miranda, B.Rosich, P. Meadows, A. Monti-Guarnieri	date *date*	29-07-2005

CHANGE LOG

reason for change */raison du changement*	issue/*issue*	revision/*revision*	date/*date*

CHANGE RECORD

Issue: 1 Revision: 0

reason for change/*raison du changement*	page(s)/*page(s)*	paragraph(s)/*paragraph(s)*

Table Of Contents

1 INTRODUCTION

1.1 Background

The VMP processor has been used by ESA to generate standard SAR products in CEOS format (http://earth.esa.int/services/esa_doc/doc_sar.html) for both ERS-1/2 missions since the ERS-1 launch.

ENVISAT ASAR data is being processed by ESA using the PF-ASAR processor and ASAR products are delivered to users in the ENVISAT format (http://earth.esa.int/pub/ESA_DOC/ENVISAT/ASAR/). The same processing facility has been tailored to the ERS SAR data characteristics and it has been extensively used for the pre-launch and post-launch ASAR data verification activities.

In order to offer a uniform family of ESA SAR products to the users, both in terms of product characteristics, algorithms used and final formatting, it has been decided to use the same core processor both for ASAR and for ERS data. The ESA VMP processor will therefore be replaced by the ERS PGS system, which uses the same core processor as PF-ASAR and which is able to generate ERS SAR products both in ENVISAT and in CEOS format (ensuring continuity with VMP products).

Using the new ERS PGS system it will be possible to provide users with an extended family of ERS SAR products, similar to the set of products available for ASAR Image Mode data. A table showing the ERS PGS products and formats is provided in Chapter 2.

Although the ERS-PGS system will be able to provide ERS SAR products equivalent to those that were available from the VMP processor, it shall be stressed that CEOS SAR products from both processor will show some minor differences in terms of formatting and product characteristics. These differences are described in Chapters 2and 3.

The scope of this note is to present the new set of ERS SAR products available from the PGS-ERS systems and to provide a complete overview of differences between the new ERS SAR products and the VMP ones.

The ERS-PGS system is being used pre-operationally since early 2005 and it is planned to progressively replace the VMP processor by the new system. During the transition period, users might receive ERS SAR products from any of the processors. For products generated by the ERS-PGS case, it will be possible for the users to choose between the CEOS and the ENVISAT format.

It is expected that users might need to combine products generated from the VMP processor in the past with the new ERS-PGS products. Combining the data from the two different systems might be an issue only for InSAR related applications. An assessment of the implications is presented in Chapter 4.

1.2 Definition, acronyms and abbreviation

ASAR	**A**dvanced **S**ynthetic **A**perture **R**adar
BEST	**B**asic **E**NVISAT **S**AR **T**oolbox
CEOS	**C**ommittee on **E**arth **O**bservation **S**atellites
GEC	**G**eocoded **E**llipsoid **C**orrected image
IMP	**I**mage **M**ode **P**recision image
IMS	**I**mage **M**ode **S**ingle-look complex image
IMG	**I**mage **M**ode ellipsoid **G**eocoded Image
IMM	**I**mage **M**ode **M**edium resolution image
PF-ASAR	**P**rocessing **F**acility **ASAR**
PGS-ERS	Processing Facility ERS SAR
PGS	**P**roduct **G**eneration **S**ystem
PRI	**PR**ecision **I**mage
SAR	**S**ynthetic **A**perture **R**adar
SLC	**S**ingle **L**ook **C**omplex image
VMP	**V**erification **M**ode **P**rocessor

1.3 Reference documents

R-1 ENVISAT-1 Product specifications. Volume 5: Product structures, PO-RS-MDA-GS-2009

R-2 ENVISAT-1 Product specifications. Volume 8: ASAR Product Specifications, PO-RS-MDA-GS-2009, Is.4 ,Rev.A, 11/05/04, http://earth.esa.int/pub/ESA_DOC/ENVISAT/ASAR/ASAR_productspecs_issue4A.pdf

R-3 ERS VMP RAW CEOS Format, Annex A, ERS SAR.RAW CCT and EXABYTE, ER-IS-EPO-5902.1, http://earth.esa.int/rootcollection/sysutil/sarraw.html

R-4 ERS VMP SLC CEOS Format, Annex C, ERS SAR.SLC/SLC-I CCT and EXABYTE, ER-IS-EPO-5902.3, http://earth.esa.int/rootcollection/sysutil/sarslc.html

R-5 ERS VMP PRI CEOS Format, Annex D, ERS SAR.RAW CCT and EXABYTE, ER-IS-EPO-5902.4, http://earth.esa.int/rootcollection/sysutil/sarpri.html

2 ERS-PGS SAR PRODUCTS VERSUS ERS SAR VMP PRODUCTS

The complete list of products available from the PGS-ERS system is presented in Table 1. The table indicates as well per each product type:

- Whether it was available from the VMP and the corresponding product name.
- The product format.
- Those product characteristics that will be different between VMP and PGS-ERS products. It is not intended here to provide a complete product characteristics description but only to highlight the main processing parameters that will change from one facility to the other.

It shall be noted that for PGS-ERS products where both CEOS and ENVISAT format are available, only the product format is different but the data content is exactly the same.

ERS-PGS products in ENVISAT format follow the same format specifications as the ENVISAT ASAR products and they can be read using standard ENVISAT reading tools such as EnviView.

ERS-PGS products in CEOS format follow basically the same format specifications as the VMP CEOS products with some minor differences (see Chapter 3 and 4). These products can be read with standard ESA tools such as BEST.

Product Type	Processing facility	Product name	Formatting	Number of Looks (Az*Rg)	Total Azimuth BW [MHz]	Azimuth Look BW [MHz]	Ellipsoid
Level 0	VMP	RAW	CEOS	-	-	-	-
	PGS-ERS	RAW / IM__0	CEOS / ENVISAT	-	-	-	-
Single Look Complex Image	VMP	SLC	CEOS	1x1	1378	1378	GEM6
	PGS-ERS	SLC / IMS	CEOS / ENVISAT	1x1	1378	1378	WGS84
Precision Image	VMP	PRI	CEOS	3x1	960	320	GEM6
	PGS-ERS	PRI / IMP	CEOS / ENVISAT	4x1	1280	320	WGS84
Geocoded Image	VMP	GEC[1]	CEOS	3x1	960	320	GEM6
	PGS-ERS	IMG[1]	ENVISAT	4x1	1280	320	WGS84
Medium Rersolution Image	VMP	-	-	-	-	-	-
	PGS-ERS	IMM[2]	ENVISAT	8x7	1280	-	WGS84

Table 1. List of VMP and PGS-ERS products and main characteristics

Notes:

(1) Geocoded Images were available in the past but they were not standard VMP products. They will be standard products with the PGS-ERS system, equivalent to those available for ASAR Image Mode.

(2) Medium resolution products were not available in the past. They will be standard products with the PGS-ERS system, equivalent to those available for ASAR Image Mode IS2. Initially, ERS SAR IMM products will have a maximum duration of 60 sec (1 slice). ERS SAR IMM stripline products, a long as the acquisition segment, will be available in autumn 2005.

2.1 Naming convention for ERS-PGS products in ENVISAT format

For products provided in ENVISAT format, the product naming convention is similar to the one used for ENVISAT products:

i) Level-0 products:
SAR_IM__0PsxxxYYYYMMDD_HHMMSS_ddddddddPCCC_TTTTT_OOOOO_iiii.Ey

Where:

SAR_IM__0P:	defines the product type
s:	processing stage flag
xxx:	Originating facility
YYYYMMDD (UTC):	start date of first MDS record
HHMMSS (UTC):	start time of first MDS record
dddddddd:	product duration in seconds
P:	phase identifier
CCC:	cycle number
TTTTT:	track (or relative orbit) number
OOOOO:	orbit number
iiii:	product file counter
y:	1 (for ERS-1 products, ending with “E1”)
	2 for ERS-2 products (ending with “E2”)

ii) Level-1 products:
SAR_IMX_1PsxxxYYYYMMDD_HHMMSS_ddddddddPCCC_TTTTT_OOOOO_iiii.Ey

Where:

SAR_IMX_0P: defines the product type, namely:

SAR_IMS_1P for Single Look Complex Images

SAR_IMP_1P for Precision Images

SAR_IMG_1G for Geocoded Images

SAR_IMM_1P for Medium Resolution Images

And the other characters are defined as for the Level-0 products.

More detailed information regarding the product naming convention can be found in R-1.

3 VMP AND ERS-PGS CEOS FORMAT COMPARISON

There are some differences between CEOS products generated by the VMP and the PGS-ERS systems, mainly due to the fact that some fields:

- ✓ aren't filled in the annotations
- ✓ are computed in a different way.

It shall be stressed that fields not filled in the PGS-ERS CEOS format are not key parameters but redundant or auxiliary information not required for further post-processing.

3.1 General structure

The CEOS format is the same for VMP and PGS-ERS products, based on the following four files:

- Volume Directory File
- Leader File
- Data Set File
- Null Volume File

The files structure is the same for the VMP and the PGS-ERS with the following differences:

2) The Leader File is smaller in the PGS-ERS Level-1 CEOS products (PRI and SLC) since the "Facility Data Record (PCS type)" of 12288 bytes is not available.

	RAW	PRI	SLC
VMP	28228 bytes	28228 bytes	28228 bytes
PGS-ERS	28228 bytes	**17560 bytes**	**17560 bytes**

Table 2. Size of Leader file in CEOS format products

3) The Data Set File is smaller in the PGS-ERS Level-1 CEOS products (PRI and SLC). In fact, VMP CEOS Level-1 products have a fixed number of samples per line (8000) and the record size in the Data Set File is therefore constant for any product and equal to 16012 bytes. Instead, the number of samples per line in the PGS-ERS Level-1 CEOS products is variable from product to product (but constant for all the records of the same product) and in general smaller than 8000 samples.

The tables in the next sections report the differences in the annotations for RAW, SLC and PRI products processed with the VMP and PGS-ERS system.

3.2 Format differences for CEOS SAR RAW products

The table below reports the differences in the CEOS annotations for RAW products generated by the VMP and by the PGS-ERS systems. The table is not intended to be a product format description but only to highlight the main differences between the CEOS parameters provided by both systems.

Please note that when a parameter is "Not provided" by the PGS-ERS, it means that the field is filled in with a dummy value (in general "-9999999.9999999') but the product format structure remains the same between both systems (i.e. there is room allocated for that parameter, as in the VMP, even if it is not filled in or filled with dummy values) so that remaining parameters stay at the same absolute location within the file).

FIELD	BYTES	FORMAT	DESCRIPTION	VMP	PGS-ERS	Comment
VOLUME DIRECTORY FILE						
Record Name: Volume Descriptor Record						
13	45-60	A16	ID of physical volume containing this volume descriptor	Provided	Not Provided	
LEADER FILE						
Record Name: Data Set Summary Record						
16	165-180	A16	Ellipsoid designator	GEM6	WGS84	The used ellipsoid is different for VMP and PGS products in order to be complaint with the one used for ENVISAT products. The ellipsoid axes are slightly different.
17	181-196	F16.7	Ellipsoid semimajor axis	6378.1440000	6378.1370000	
18	197-212	F16.7	Ellipsoid semiminor axis	6356.7590000	6356.7523000	
38	469-476	F8.3	Sensor platform heading at nadir corresponding to scene centre (clockwise positive from North)	Provided	Not Provided	
66	819-834	F16.7	DC bias for I component	Provided	Not Provided	Derived by the PGS-ERS during the processing to Level-1
67	835-850	F16.7	DC bias for Q component	Provided	Not Provided	Derived by the PGS-ERS during the processing to Level-1
126/1	1767-1782	F16.7	Zero-doppler range time (two-way) of first range pixel	Provided	Not Provided	Derived by the PGS-ERS during the processing to Level-1
126/2	1783-1798	F16.7	Zero-doppler range time (two-way) of centre range pixel	Provided	Not Provided	Derived by the PGS-ERS during the processing to Level-1
126/3	1799-1814	F16.7	Zero-doppler range time (two-way) of last range pixel	Provided	Not Provided	Derived by the PGS-ERS during the processing to Level-1
Record Name: Facility Related Data Record (General Type)						
11	91-94	I4	Overall QA summary flag (Sum of the next 9 following flags)	Provided	Not Provided	
12	95-98	I4	PRF code change flag (0 = PRF constant in scene)	Provided	Not Provided	
13	99-102	I4	Sampling window start time change flag (0 = SWST constant)	Provided	Not Provided	
14	103-106	I4	Cal. system & receiver gain change flag (0 =	Provided	Not Provided	This is always equal to 0. No changes expected in the receiver gain within one

			Cal/Rx gain constant)			scene.
15	107-110	I4	Chirp replica quality flag (0 = Replica XCF in limits)	Provided	Not Provided	
16	111-114	I4	Input data statistics flag (0 = Raw data mean & sd in limits)	Provided	Not Provided	
22	131-134	I4	Number of PRF code changes	Provided	Not Provided	
23	135-138	I4	Number of sampling window time changes	Provided	Not Provided	Derived by the PGS-ERS during the processing to Level-1
24	139-142	I4	Number of calibration subsystems gain changes	Provided	Not Provided	This is always equal to 0. No changes expected within one scene.
25	147-150	I4	Number of missing lines (i.e. raw data input lines)	Provided	Not Provided	Derived by the PGS-ERS during the processing to Level-1
26	151-154	I4	Number of receiver gain changes	Provided	Not Provided	This is always equal to 0. No changes expected within one scene.
27	155-170	F16.7	3-dB width of Cross Correlation Function (CCF) between first extracted chirp and nominal chirp	Provided	Not Provided	Derived by the PGS-ERS during the processing to Level-1
28	171-186	F16.7	First side lobe level of chirp CCF	Provided	Not Provided	Derived by the PGS-ERS during the processing to Level-1
29	187-202	F16.7	ISLR of chirp CCF	Provided	Not Provided	Derived by the PGS-ERS during the processing to Level-1
32	235-250	F16.7	Estimated mean of I input data (once the nominal bias of 15.5 has been applied)	Provided	Not Provided	Derived by the PGS-ERS during the processing to Level-1
33	251-266	F16.7	Estimated mean of Q input data (once the nominal bias of 15.5 has been applied)	Provided	Not Provided	Derived by the PGS-ERS during the processing to Level-1
34	267-282	F16.7	Estimated standard deviation of I input data	Provided	Not Provided	Derived by the PGS-ERS during the processing to Level-1
35	283-298	F16.7	Estimated standard deviation of Q input data	Provided	Not Provided	Derived by the PGS-ERS during the processing to Level-1
36	299-314	F16.7	Calibration system gain of first processed line (telemetry value)	Provided	Not Provided	Telemetry value
37	315-330	F16.7	Receiver gain of first processed line (telemetry value)	Provided	Not Provided	Telemetry value
40	363-378	F16.7	Bias correction applied to I channel (to be added to the nominal bias)	Provided	Not Provided	Derived by the PGS-ERS during the processing to Level-1
41	379-394	F16.7	Bias correction applied to Q channel (to be added to the nominal bias)	Provided	Not Provided	Derived by the PGS-ERS during the processing to Level-1
43	395-410	F16.7	I/Q gain imbalance correction (applied	Provided	Not Provided	Derived by the PGS-ERS during the processing to

			to Q channel)			Level-1
44	427-442	F16.7	I/Q non-orthogonality correction (applied to Q channel)	Provided	Not Provided	Derived by the PGS-ERS during the processing to Level-1
54	551-566	F16.7	Range compression normalisation factor	Provided	Not Provided	
55	567-582	F16.7	Replica pulse power	Provided	Not Provided	Derived by the PGS-ERS during the processing to Level-1
56	583-598	F16.7	Incidence angle at first range pixel (at mid-azimuth)	Provided	Not Provided	Derived by the PGS-ERS during the processing to Level-1
57	599-614	F16.7	Incidence angle at centre range pixel (at mid-azimuth)	Provided	Not Provided	Derived by the PGS-ERS during the processing to Level-1
58	615-630	F16.7	Incidence angle at last range pixel (at mid-azimuth)	Provided	Not Provided	Derived by the PGS-ERS during the processing to Level-1
86	1049-1052	I4	Peak location of Cross Correlation Function (CCF) between first extracted chirp and nominal chirp	Provided	Not Provided	Derived by the PGS-ERS during the processing to Level-1
87	1053-1068	F16.7	3-dB width of Cross Correlation Function (CCF) between last extracted chirp and nominal chirp	Provided	Not Provided	Derived by the PGS-ERS during the processing to Level-1
88	1069-1084	F16.7	First side lobe level of chirp CCF between last extracted chirp and nominal chirp	Provided	Not Provided	Derived by the PGS-ERS during the processing to Level-1
89	1085-1100	F16.7	ISLR of chirp CCF between last extracted chirp and nominal chirp	Provided	Not Provided	Derived by the PGS-ERS during the processing to Level-1
90	1101-1104	I4	Peak location of Cross Correlation Function (CCF) between last extracted chirp and nominal chirp	Provided	Not Provided	Derived by the PGS-ERS during the processing to Level-1
96	1125-1128	I4	Samples per line used for the raw data analysis	Provided	Not Provided	Derived by the PGS-ERS during the processing to Level-1
97	1129-1132	I4	Range lines skip factor for raw data analysis	Provided	Not Provided	Derived by the PGS-ERS during the processing to Level-1
112	1483-1486	I4	PRF code of first range line (telemetry value)	Provided	Not Provided	Derived by the PGS-ERS during the processing to Level-1
113	1487-1490	I4	PRF code of last range line (telemetry value)	Provided	Not Provided	Derived by the PGS-ERS during the processing to Level-1
114	1491-1494	I4	Sampling window start time code of first range line (telemetry value)	Provided	Not Provided	Derived by the PGS-ERS during the processing to Level-1
115	1495-1498	I4	Sampling window start time code of last range line (telemetry value)	Provided		Telemetry value
127	1731-1746	F16.7	I/ gain imbalance - Lower bound	Provided	Not Provided	
128	1747-1762	F16.7	I/ gain imbalance - Upper bound	Provided	Not Provided	
129	1763-1778	F16.7	I/Q quadrature	Provided	Not Provided	

			departure - Lower bound			
130	1779-1794	F16.7	I/Q quadrature departure - Upper bound	Provided	Not Provided	
133	1827-1830	I4	Range spreading loss compensation flag (0 = no compensation	Provided	Not Provided	Range spreading loss compensation does not apply to level-0 products. This flag is always equal to 0 for both the VMP and the PGS-ERS
NULL VOLUME						
Record Name: Null Volume Descriptor Record						
13	45-60	A16	ID of physical volume containing this volume descriptor	Provided	Not Provided	

Table 3. Format differences between ERS VMP and PGS-ERS RAW CEOS products

3.3 Format differences for CEOS SAR SLC products

The table below reports the differences in the CEOS annotations for SLC products generated by the VMP and by the PGS-ERS systems. The table is not intended to be a product format description but only to highlight the main differences between the CEOS parameters provided by both systems.

Please note that when a parameter is "Not provided" by the PGS-ERS, it means that the field is filled in with a dummy value (in general "-9999999.9999999') but the product format structure remains the same between both systems (i.e. there is room allocated for that parameter, as in the VMP, even if it is not filled in or filled with dummy values) so that remaining parameters stay at the same absolute location within the file).

FIELD	BYTES	FORMAT	DESCRIPTION	VMP	PGS	Comment
VOLUME DIRECTORY FILE						
Record Name: Volume Descriptor Record						
13	45-60	A16	ID of physical volume containing this volume descriptor	Provided	Not Provided	
LEADER FILE						
Record Name: File Descriptor Record						
69	421-426	I6	Number of facility data records	2	1	The facility data record PCS type is empty for PGS processed data (see at the bottom of the table)
Record Name: Data Set Summary Record						
15	149-164	F16.7	Processed scene centre true heading	Provided	Not Provided	
16	165-180	A16	Ellipsoid designator	GEM6	WGS84	The used ellipsoid is different for VMP and PGS products in order to be complaint with the one used for ENVISAT products. The ellipsoid axes are slightly different.
17	181-196	F16.7	Ellipsoid semimajor axis	6378.1440000	6378.1370000	
18	197-212	F16.7	Ellipsoid semiminor axis	6356.7590000	6356.7523000	
36	453-460	F8.3	Sensor platform geodetic latitude at nadir	Provided	Not Provided	

			corresponding to scene centre (positive for North latitude)			
37	461-468	F8.3	Sensor platform longitude at nadir corresponding to scene centre (negative for West longitude)	Provided	Not Provided	
116	1639-1654	F16.7	Cross track Doppler frequency rate at early edge of image quadratic term	Not Provided	Provided	
Record Name: Map Projection Data Record						
13	125-140	F16.7	Orientation at output scene centre	Provided	Not Provided	
20	237-268	A32	Name of reference ellipsoid	GEM6	WGS84	The used ellipsoid is different for VMP and PGS products in order to be complaint with the one used for ENVISAT products. The ellipsoid axes are slightly different.
21	269-284	F16.7	Semimajor axis of ref. Ellipsoid	6378.1440000	6378.1370000	
22	285-300	F16.7	Semiminor axis of ref. Ellipsoid	6356.7590000	6356.7523000	
Record Name: Facility Related Data Record (General Type)						
10	85-90	A6	Date of the last calibration update <YYMMDD>	Provided	Not Provided	This information is provided in the External Calibration auxiliary file used by the PGS-ERS system in the Level-1 processing, similar to the ENVISAT ASAR case.
54	551-566	F16.7	Range compression normalization factor	Provided	Not Provided	
66	727-732	A6	Date on which K was generated as YYMMDD	Provided	Not Provided	This information is provided in the External Calibration auxiliary file used by the PGS-ERS system in the Level-1 processing, similar to the ENVISAT ASAR case.
67	733-736	A4	K version number	Provided	Not Provided	
76 to 81	865-996	6 D22.15	Ascending node state vectors (X,Y,Z,X',Y',Z')	Not Provided	Provided	
87	1053-1068	F16.7	3-dB width of Cross Correlation Function (CCF) between last extracted chirp and nominal chirp	Provided	Not Provided	
88	1069-1084	F16.7	First side lobe level of chirp (CCF) between last extracted chirp and nominal chirp	Provided	Not Provided	
89	1085-1100	F16.7	ISLR of chirp CCF between last extracted chirp and nominal chirp	Provided	Not Provided	
90	1101-1104	I4	Peak location of Cross Correlation Function (CCF) between last extracted chirp and nominal chirp	Provided	Not Provided	
108	1325-1328	I4	Update period of range-matched filter	Provided	Not Provided	
120	1515-1518	I4	Number of azimuth blocks processed	Provided	Not Provided	
124	1707-1722	I16	Satellite binary time of first range line	Not Provided	Provided	

			(telemetry value)			
126	1727-1730	I4	Number of range samples discarded during processing interpolations	Provided	Not Provided	
Record Name: Facility Related Data Record (PCS Type)						
	1-12288			Filled record	Empty Record	
NULL VOLUME						
Record Name: Null Volume Descriptor Record						
13	45-60	A16	ID of physical volume containing this volume descriptor	Provided	Not Provided	

Table 4. Format differences between ERS VMP and PGS-ERS SLC CEOS products

3.4 Format differences for CEOS SAR PRI products

The table below reports the differences in the CEOS annotations for PRI products generated by the VMP and by the PGS-ERS systems. The table is not intended to be a product format description but only to highlight the main differences between the CEOS parameters provided by both systems.

Please note that when a parameter is "Not provided" by the PGS-ERS, it means that the field is filled in with a dummy value (in general "-9999999.9999999') but the product format structure remains the same between both systems (i.e. there is room allocated for that parameter, as in the VMP, even if it is not filled in or filled with dummy values) so that remaining parameters stay at the same absolute location within the file).

FIELD	BYTES	FORMAT	DESCRIPTION	VMP	PGS	Comment
LEADER FILE						
Record Name: File Descriptor Record						
69	421-426	I6	Number of facility data records	2	1	The facility data record PCS type is empty for PGS processed data (see at the bottom of the table)
Record Name: Data Set Summary Record						
15	149-164	F16.7	Processed scene centre true heading as calculated relative to North	Provided	Not Provided	
16	165-180	A16	Ellipsoid designator	GEM6	WGS84	The used ellipsoid is different for VMP and PGS products in order to be complaint with the one used for ENVISAT products. The ellipsoid axes are slightly different.
17	181-196	F16.7	Ellipsoid semimajor axis	6378.1440000	6378.1370000	
18	197-212	F16.7	Ellipsoid semiminor axis	6356.7590000	6356.7523000	
36	453-460	F8.3	Sensor platform geodetic latitude at nadir corresponding to scene centre (positive for North latitude)	Provided	Not Provided	
37	461-468	F8.3	Sensor platform longitude at nadir corresponding to scene centre	Provided	Not Provided	

			(negative for West longitude)			
116	1639-1654	F16.7	Cross track Doppler frequency rate at early edge of image quadratic term	Not Provided	Provided	
Record Name: Map Projection Data Record						
13	125-140	F16.7	Orientation at output scene centre	Provided	Not Provided	
20	237-268	A32	Name of reference ellipsoid	GEM6	WGS84	The used ellipsoid is different for VMP and PGS products in order to be complaint with the one used for ENVISAT products. The ellipsoid axes are slightly different.
21	269-284	F16.7	Semimajor axis of ref. ellipsoid	6378.1440000	6378.1370000	
22	285-300	F16.7	Semiminor axis of ref. ellipsoid	6356.7590000	6356.7523000	
Record Name: Facility Related Data Record (General Type)						
10	85-90	A6	Date of the last calibration update <YYMMDD>	Provided	Not Provided	This information is provided in the External Calibration auxiliary file used by the PGS-ERS system in the Level-1 processing, similar to the ENVISAT ASAR case
48	491-494	I4	Number of valid calibration pulses	0	Not Provided	
49	494-498	I4	Number of valid noise pulses	0	Not Provided	
54	551-566	F16.7	Range compression normalization factor	Provided	Not Provided	
66	727-732	A6	Date on which K was generated as YYMMDD	Provided	Not Provided	This information is provided in the External Calibration auxiliary file used by the PGS-ERS system in the Level-1 processing, similar to the ENVISAT ASAR case
67	733-736	A4	K version number	Provided	Not Provided	
75	841-864	A24	Time of ascending node state vector (UTC) <dd-MMM-yyyy$hh:mm:ss.ttt>	Not Provided	Provided	
76 to 81	865-996	6 D22.15	Ascending node state vectors (X,Y,Z,X',Y',Z')	Not Provided	Provided	
87	1053-1068	F16.7	3-dB width of Cross Correlation Function (CCF) between last extracted chirp and nominal chirp	Provided	Not Provided	
88	1069-1084	F16.7	First side lobe level of chirp (CCF) between last extracted chirp and nominal chirp	Provided	Not Provided	
89	1085-1100	F16.7	ISLR of chirp CCF between last extracted chirp and nominal chirp	Provided	Not Provided	
90	1101-1104	I4	Peak location of Cross Correlation Function (CCF) between last extracted chirp and nominal chirp	Provided	Not Provided	
108	1325-1328	I4	Update period of range-matched filter	Provided	Not Provided	
120	1515-1518	I4	Number of azimuth blocks processed	Provided	Not Provided	
124	1707-1722	I16	Satellite binary time of first range line	Not Provided	Provided	

			(telemetry value)			
126	1727-1730	I4	Number of range samples discarded during processing interpolations	Provided	Not Provided	
Record Name: Facility Related Data Record (PCS Type)						
	1-12288			Filled record	Empty Record	

Table 5. Format differences between ERS VMP and PGS-ERS PRI CEOS products

4 CROSS-PROCESSOR INTERFEROMETRY

Combining products generated by different processing systems is particularly critical when they are used for interferometric post-processing and applications.

It is therefore important to assess the consistency between VMP and PGS-ERS SAR products and to ensure they can be combined in the InSAR processing without degrading the quality of the interferometric results.

A detailed analysis has been performed using an ERS-1/2 tandem dataset acquired over the ERS calibration site (Flevoland) in The Netherlands. The dataset is described in Table 6.

Platform	Orbit	Track	Acquisition Date
ERS-2	01508	2547	04-AUG-1995 10:35:01
ERS-1	21181	2547	03-AUG-1995 10:35:06

Table 6: Input dataset definition

The pair described above was acquired during the ERS-1/2 tandem operations where the mission scenario had been optimized for interferometric applications:

- ✓ same orbital plane ensuring similar geometric acquisition conditions
- ✓ close Doppler Centroid frequency
- ✓ one day delay between the two passes ensuring similar speckle characteristics

Furthermore, the chosen area is almost flat which should avoid topographic effects.

Figure 1: Location of the ERS-1/2 scenes.

For the tests described below, SLC products have been generated by the VMP and the PGS-ERS in CEOS format. It has been arbitrary chosen to make the E2 scene the master image and the E1 scene the slave. The resulting products have been combined in the InSAR processing according to the following test configurations, as described in Table 7:

1. Reference test configuration:

   In this case, the standard SLC products generated by the ESA VMP processor are used. This test will provide the reference interferometric results, to be compared with the cross-processor test results. The reference results are detailed in section 4.1.

2. Cross-processor test configuration:

   In this case, the same interferometric processing as in the first test is performed> However, now the ERS-2 SLC product is the same as in the first test (VMP) while the ERS-1 SLC product has been here generated by the PGS-ERS system.

   The results are detailed in section 4.2 and they are to be compared with the reference test ones.

   It is shown that the use of images coming from both VMP and PGS-ERS processor doesn't impact on the quality of the interferometric results. Coherence is well preserved and coherence statistics are globally and locally respected. Also the phase characteristics are preserved.

3. Phase preservation test configuration:

   The purpose of this test is to ensure that the PGS-ERS/SLC products are phase preserving. The obtained interferometric phase should ideally have a constant phase while the coherence should be close to one over the whole image. Any variation from these expected results should highlight any problem coming from processing issues.

   It is indeed shown in section 4.3 that the cross-processor phase preservation test gives results in agreement of the expected ones. The coherence is close to one almost everywhere in the image and the phase difference characteristics are within the requirements given above.

Test	Platform	Processor	Doppler (Hz)	ID
1-Reference	ERS-2	VMP	179.434	E2_VMP
	ERS-1	VMP	457.544	E1_VMP
2-Cross-processor	ERS-2	VMP	179.434	E2_VMP
	ERS-1	PGS-ERS	469.654	E1_PGSERS
3-Cross-processor Phase preservation	ERS-1	VMP	457.544	E1_VMP
	ERS-1	PGS-ERS	469.654	E1_PGSERS

Table 7: Test definition

4.1 Reference test

The purpose of this test is to generate the reference results to be compared against the cross-processor results (test 2) in section 4.2. Figure 2 presents the main results of this test, (a) the coherence, (b) the wrapped phase difference and (c) the unwrapped phase difference.

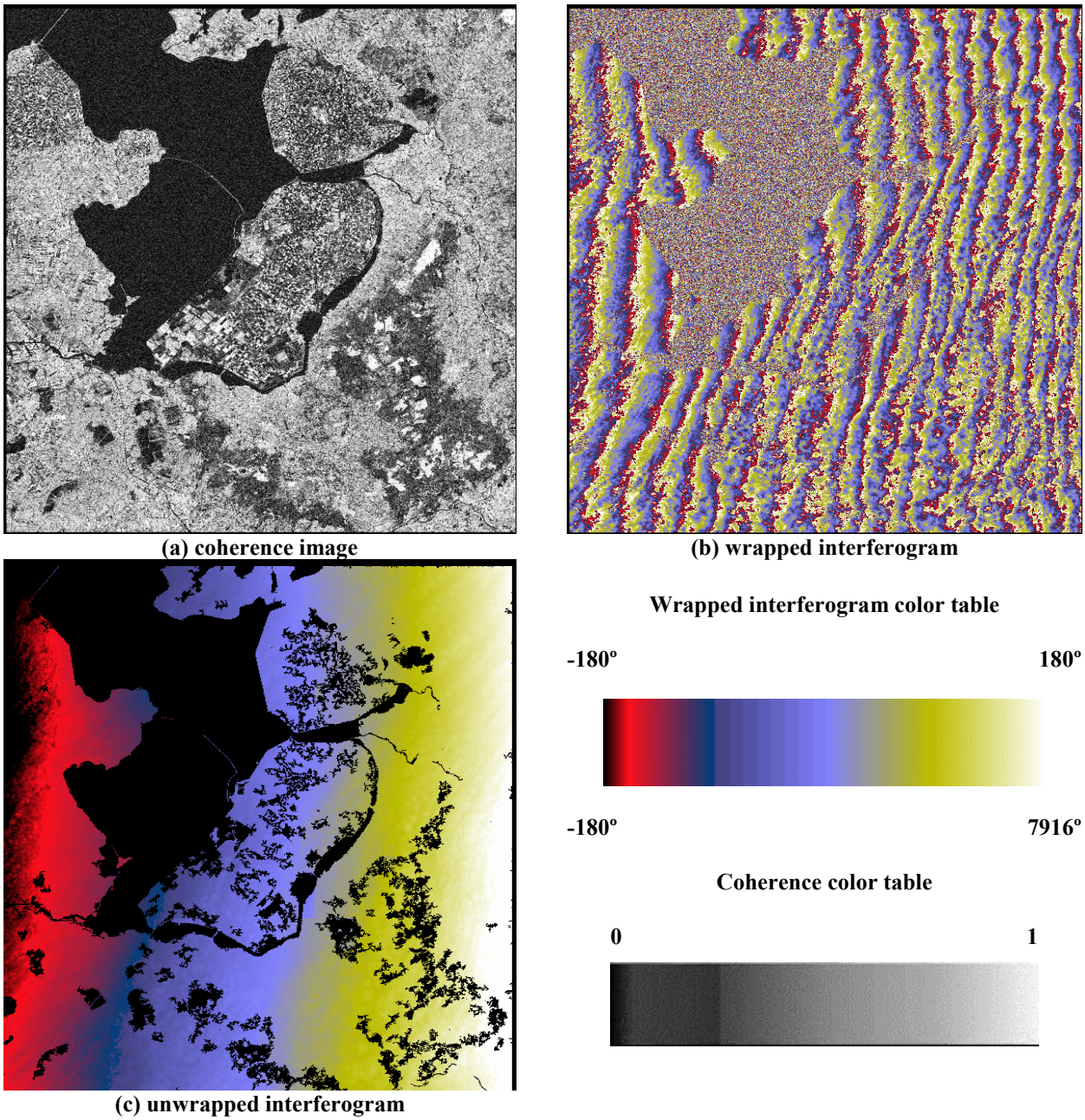


Figure 2: coherence and interferogram images from the reference pair E2_VMP/E1_VMP

Please note that the images of Figure 2 as for all the images of this report are left in the original imaging geometry (i.e. flipped east-west in this case).

4.1.1 BASELINE CHARACTERISTICS

Table 8 provides the interferometric baseline at different image positions. For this data set, the baseline is rather small (~52 m) ensuring same geometric characteristics.

|baseline|, ,_|_, || in (m)		Range position		
		Near	Mid	Far
Azimuth position	Early	59.861831, 53.819072, 26.209661	59.879095, 52.300947, 29.156765	59.898950 50.775502, 31.776291
	Mid	60.285027, 54.280414, 26.228250	60.302196, 52.761707, 29.198579	60.319656, 51.235460, 31.833763
	Late	60.694023, 54.647169, 26.409304	60.708338, 53.118490, 29.392659	60.725717, 51.581671, 32.045967

Table 8: Baseline parameters of the reference pair. First the module and its decomposition in perpendicular and parallel component given in meters

4.1.2 COHERENCE CHARACTERISTICS

The coherence histogram over the full scene (covering land and sea) is shown in Figure 3. Table 9 summarizes the coherence statistics.

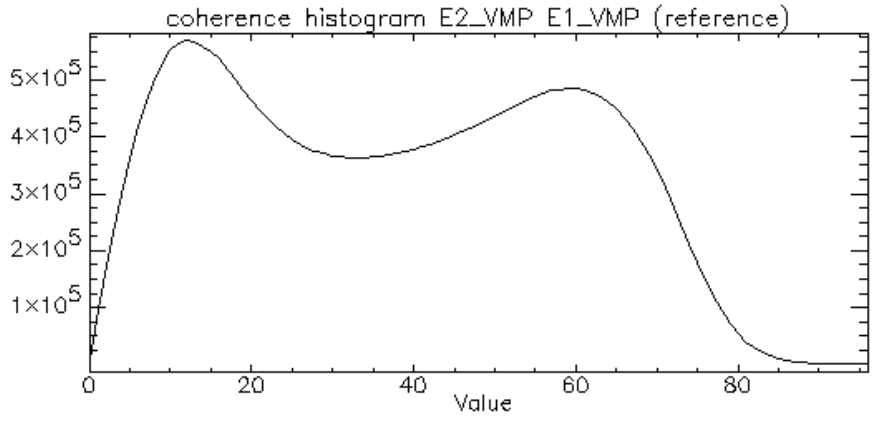


Figure 3:Coherence histogram. A value of 100 corresponds to the maximum coherence of "1"

Mean	Std deviation	Min	Max
0.3815	0.214	0	0.96

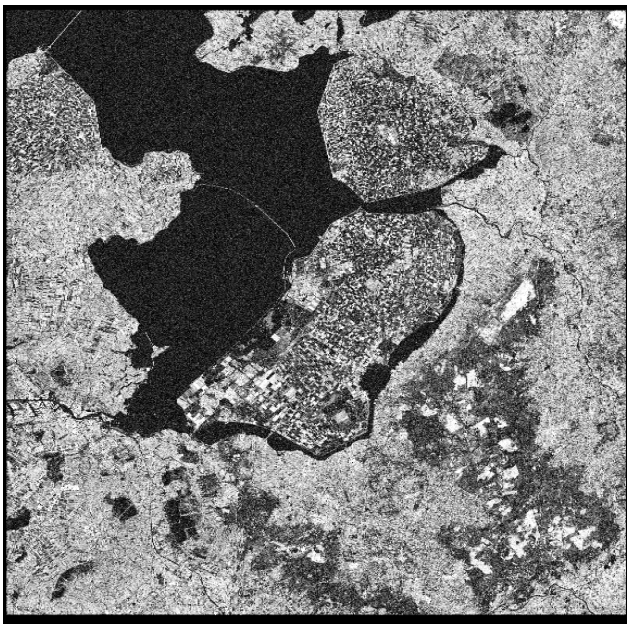
Table 9: Statistics of the reference coherence image

4.1.3 PHASE DIFFERENCE CHARACTERISTICS

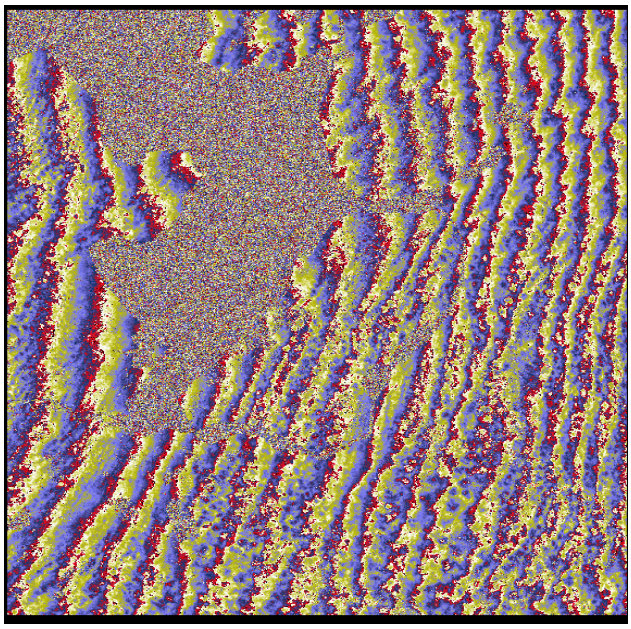
Figure 2.b shows the wrapped interferogram where a pattern of ~20 orbital fringes is clearly visible leading to the unwrapped interferogram shown in Figure 2.c.

4.2 *InSAR cross-processor test*

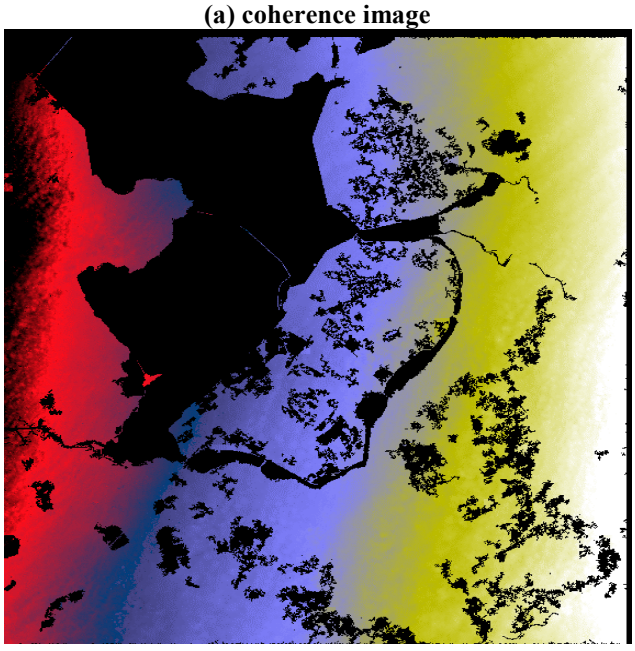
The images displayed in Figure 4 show the results of the test using the ERS2/VMP and ERS-1/PGS-ERS images. The results obtained have to be directly compared with those presented in section 4.1.



(a) coherence image



(b) wrapped interferogram



(c) unwrapped interferogram

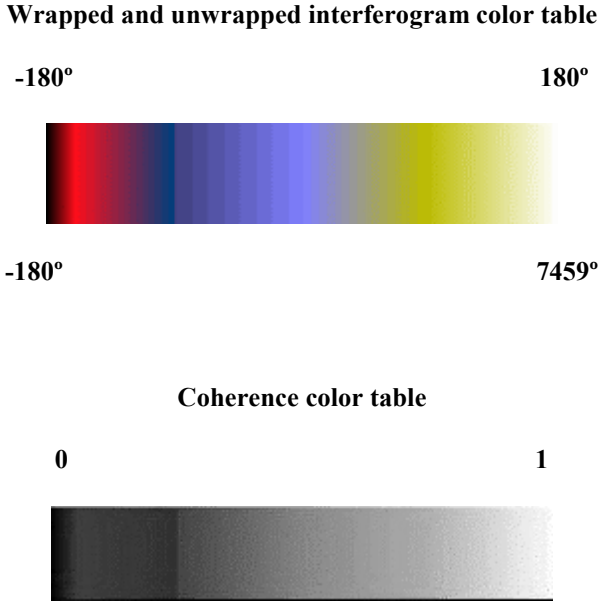


Figure 4: Coherence and interferogram image from the pair E2_VMP/E1_PGSERS

4.2.1 BASELINE CHARACTERISTICS

The baseline calculations given below have to be compared with the reference one in section 4.1. With respect to the reference given in Table 8, one should note that a very small baseline discrepancy of less than 7cm is obtained. This is due to the fact that the orbit propagation software used by both processing systems is slightly different.

|baseline|, _|_,	(m)|	Range position		
		Near	Mid	Far
Azimuth position	Early	59.836529, 53.879099, 26.02792	59.847086 52.363779, 28.977721	59.855342, 50.831507, 31.604111
	Mid	60.246150, 54.329843, 26.035874	60.246040, 52.801892, 29.009403	60.252010 51.265439, 31.656902
	Late	60.677094, 54.712491, 26.234577	60.683865 53.183302, 29.224440	60.692002 51.640009, 31.887750

Table 10: Baseline parameters of the pair E2/VMP & E1/PGS-ERS. First the module and its decomposition in perpendicular and parallel component given in meters

4.2.2 COHERENCE CHARACTERISTICS

In terms of coherence, the results obtained are in agreement with the reference ones. One should note the high similarities between the coherence images (Figure 2.a and Figure 4.a) and between the related histograms (Figure 3 and Figure 5). Table 11 provides a quantitative confirmation of the consistency between both coherence results.

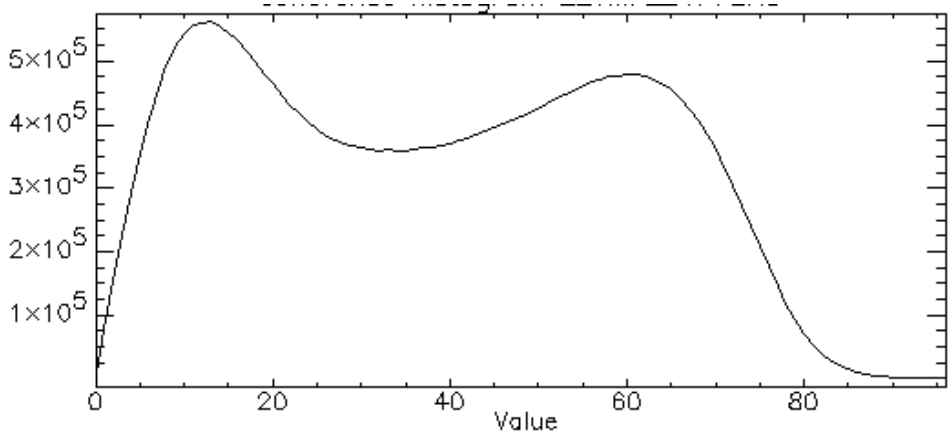


Figure 5:Coherence histogram. A value of 100 corresponds to the maximum coherence of "1"

Pair	Mean	Std deviation	Min	Max
E2_VMP E1_PFERS	0.3863	0.2176	0	0.96
E2_VMP E1_VMP (ref)	0.3815	0.2149	0	0.96

Table 11: Coherence statistics

The consistency of coherence results from both tests can be assessed through the ratio image between both coherence images. Clearly, a perfect match will result in an image with all values equal to 1. Indeed, masking the pixels that have coherence below 0.2 (mainly the sea/lakes, naturally non-coherent), a mean ratio of 0.997±0.126 is obtained confirming a very high coherence similarity.

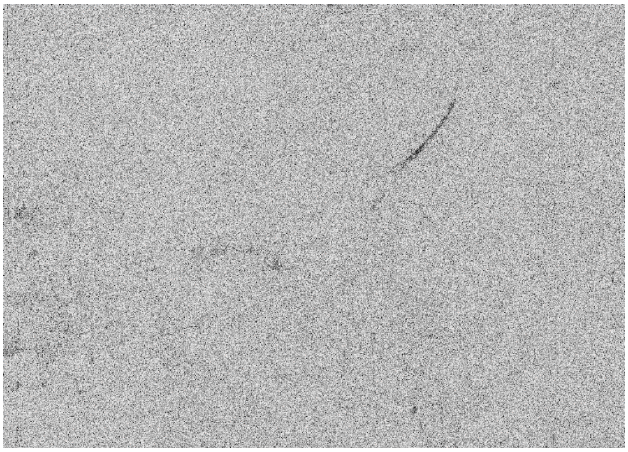
4.2.3 PHASE DIFFERENCE CHARACTERISTICS

The Figure 4.b and 4.c show the interferograms obtained from the pair ERS-2-VMP / ERS-1-PGS-ERS. It is possible to see the similarities with the reference interferograms (Figure 2.b and 2.c). Also the orbital fringe pattern is consistent.

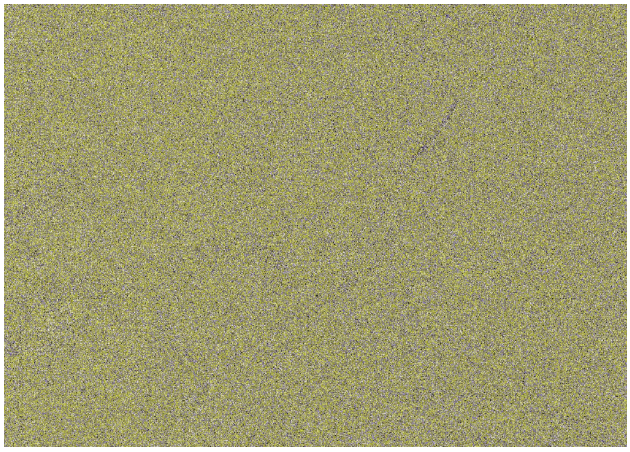
4.3 Cross-processor phase preservation test

A special phase preserving test has been carried out between the SLC products generated from the same ERS-1 RAW data by both the VMP and the PGS-ERS (these are the ERS-1 products used in Test 1 and 2 previously). The purpose of this test is to demonstrate the phase consistency between the VMP and the PGS-ERS processing. This test is usually performed between 2 products generated by the same processing system but when starting the processing at different range and azimuth positions. In this case, the processing start time in range and azimuth is not modified but two different processors have been used.

Figure 6 shows the results of this test: (a) the coherence, (b) the wrapped phase difference and (c) the coherence obtained in the first test to assist the localization of the sub-images (a) and (b) within the full product.

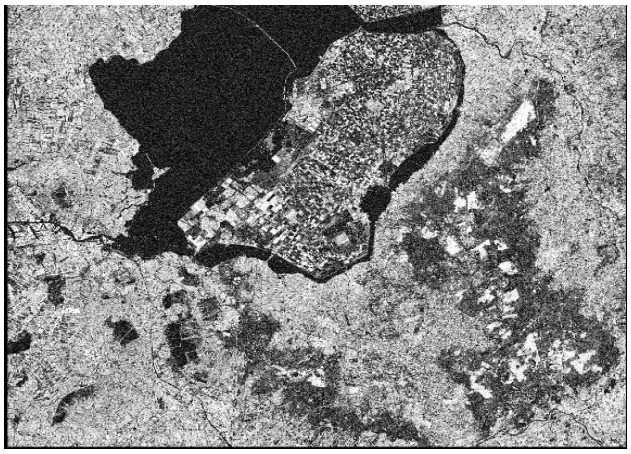


(a) coherence image ERS-1 VMP / ERS-1 PGSERS



(b) wrapped interferogram ERS-1 VMP / ERS-1 PGSERS

Wrapped interferogram colour table



(c) coherence image ERS-2 VMP / ERS-1 VMP

Figure 6: Interferometric results from the pair E1_VMP/E1_PGSERS

4.3.1 BASELINE CHARACTERISTICS

Since both processors don't use the same orbit propagator, the resulting baseline is not exactly equal to 0. Table 11 gives the baseline at different image positions.

|baseline|, Mod, _|_, || (m)		Range position		
		Near	Mid	Far
Azimuth position	Early	0.552649, 0.522809, -0.179142	0.994853, 0.979169, -0.175958	0.410072, 0.372356, -0.171785
	Mid	1.864212, 1.854440, -0.190627	1.973680, 1.964724, -0.187812	1.832195, 1.823347, -0.179843
	Late	0.873039, 0.873039, -0.168159	0.944538, 0.929770, -0.166374	0.940332, 0.926049, -0.163273

Table 11: Baseline parameters of the pair E1_VMP / E1_PFERS. First the module and then the decomposition in perpendicular and parallel component given in meters

4.3.2 COHERENCE CHARACTERISTICS

A uniform coherence very close to 1 is obtained almost everywhere as shown in Figure 7 that illustrates the histogram of coherence.

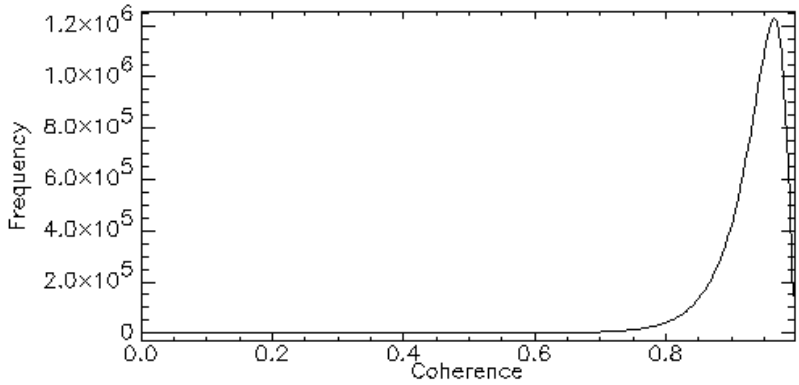


Figure 7: Coherence histogram

4.3.3 PHASE DIFFERENCE CHARACTERISTICS

The histogram of the phase difference in Figure 8, shows a stable phase having a mean value close to 0.1˚ with an average standard deviation of 5.6˚, which are within the requirements of the standard phase preserving test (using twice the same processor).

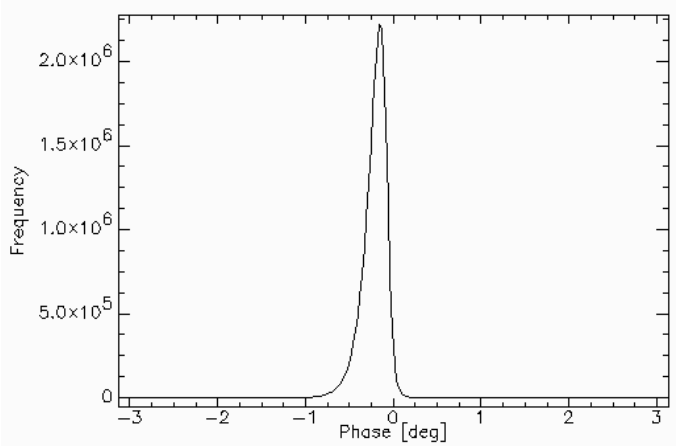


Figure 8: Histogram of interferometric phase for the pair E1_VMP/E1_PGSERS