MEMORANDUM

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To	**:**	(A)ATSR Users	**Date**	**:**	20 April 2017
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SUBJECT : (A)ATSR 4th Reprocessing Product Format - User Summary

The main focus of the (A)ATSR 4th reprocessing is to harmonise the (A)ATSR data product format with that of the follow-on instrument, SLSTR. This Memorandum provides basic information on this format and the products. A comprehensive User Document will be issued alongside the 4th reprocessing products. It is anticipated that the 4th reprocessing AATSR L1B dataset will be available in 2017/18, with the ATSR-1/-2 datasets to follow.

Users should note the following:

- The 4th reprocessing product format will mimic that used for Sentinel-3 SLSTR products, but cannot replicate it exactly.
- The 4th reprocessing will generate Level 1 products only. However, Level 2 SST and LST products will be generated by other ESA projects and made available alongside the Level 1 products.

The contents of this memo are as follows:

Summary of 4th reprocessing L1B product format

The 4th reprocessing product format will mimic that used for Sentinel-3 SLSTR products [RD.1]. The 4th reprocessing L1B product specification is given in [RD.2]. The Sentinel-3 Toolbox [RD.3] can read SLSTR products, and will be adapted to read 4th reprocessing products.

Product naming convention: The naming convention for the 4th reprocessing products follows that for Sentinel-3 products [RD.4] and is given in Annex 1: Product naming convention. Note that the 4th reprocessing products do not contain the absolute orbit number within the product names.

Product types: Only Level 1 products will be generated. The Product Type is specified within the product name by:

AT_<*level*>_<*mode*>

where there is only one Product Type for the 4th reprocessing:

AT_1_RBT___	(A)ATSR Thermal IR brightness temperatures and VIS SWIR radiances

General product structure: The product structure is an XFDU (XML Formatted Data Unit) package and is shown in Figure 1 (from [RD.1]).

- The manifest file is a set of metadata information related to the description of the product. It includes a common structure section (primary metadata), and a specific section (secondary metadata). It contains pointers to the components, and quality information about the product.
- The components comprise the measurement and annotation data files, in NetCDF-4 format. A general description of the contents of the measurement and annotation data files can be found in Table 6 in Appendix 1.

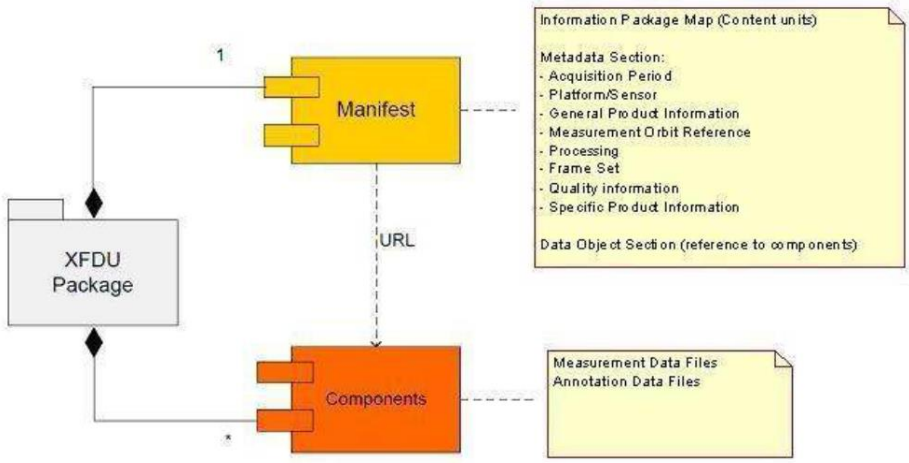

Figure 1. XFDU product package (from [RD.1]).

Comparison with (A)ATSR 3rd reprocessing products

The product specification for 3rd reprocessing AATSR products is given in [RD.5]. It is the intention of the 4th reprocessing to transfer all information currently contained in 3rd reprocessing products to the 4th reprocessing products.

Users may note that the use of quality indicators within the manifest will eliminate the need for physical segregation of products, as evident in the 3rd reprocessing product archives.

Table 1 outlines the differences in terminology between 3rd and 4th reprocessing products.

Table 2 outlines the differences in data content between the 3rd and 4th reprocessing products.

Table 3 gives a summary of the additional data periods that will be available in the 4th reprocessing when compared with v3.0 of the 3rd reprocessing. Users are advised that some additional data will also be available in v3.0.1 of the 3rd reprocessing.

Table 1. Differences in terminology between the 3rd and 4th reprocessing products

Third Reprocessing	Fourth Reprocessing
Forward view	Oblique view
0.55 µm channel	S1 radiance channel
0.66 µm channel	S2 radiance channel
0.87 µm channel	S3 radiance channel
1.6 µm channel	S5 radiance channel
3.7 µm channel	S7 BT channel
11 µm channel	S8 BT channel
12 µm channel	S9 BT channel

Table 2. Differences in data content between the 3rd and 4th reprocessing products

Third Reprocessing	Fourth Reprocessing
Orphan pixels from curved scan lost after L1B product regridding to 512-km product swath	Orphan pixels from curved scan retained after L1B product regridding and placed in orphan bucket
Bayesian cloud mask over ocean not available in L1B	Bayesian cloud mask available in L1B (not for orphan pixels)
Probabilistic cloud mask over land not available in L1B	Probabilistic cloud mask available in L1B (possibly for orphan pixels)
Model data not available in L1B	ECMWF ERA Interim data available in L1B
Uncertainty estimates not available in L1B	Uncertainty estimates available in L1B
L1B gridded data are geolocated	L1B gridded data are orthogeolocated to a DEM
Envisat surface classification used	Sentinel-3 surface classification used
Visible–SWIR channel data is in percentage reflectance	Visible–SWIR channels data is in radiance units

Table 3. Extra data to be included in the 4th reprocessing

Instrument	Fourth Reprocessing
AATSR	Some data gaps evident within the 3rd reprocessing dataset will be filled
ATSR-2	Data from July 2003 – January 2008 (also in v3.0.1)
	Other data availability (gap filling) (also in v3.0.1)
ATSR-1	Products with missing 1.6 µm data due to channel switching (1.6/3.7 µm) (also in v3.0.1)
	Other data availability (commissioning period; gap filling) (also in v3.0.1)

Comparison with SLSTR products

The SLSTR format is specified in [RD.1] and products can be viewed via the Sentinel-3 Toolbox [RD.3]. It can easily be noted that the SLSTR products contain more information than is available for (A)ATSR. Therefore, some sections will be absent and some will contain fill values.

Table 4 outlines the main differences between SLSTR and (A)ATSR instruments and 4th reprocessing products.

Table 4. Main differences between SLSTR and (A)ATSR products

SLSTR	(A)ATSR
Oblique view: backwards facing	Oblique view: forwards facing
Vis – SWIR channel resolution 500 m	Vis – SWIR channel resolution 1 km
Spectral channels S1–S9 Fire channels F1, F2	No spectral channels S4, S6 No fire channels
No atsr_in / atsr_io files	atsr_in / atsr_io files included
Swath widths are 1420 km (nadir), 750 km (oblique)	Product swath width is 512 km (pixels outside this are placed into the orphan bucket)
'i', 'a', 'b', 'c' and 't' stripe grids available	'i' and 't' stripe grids available
Tie point data is computed per line	Tie point data is computed every 16 lines
Cloud word definitions	For differences, see Table 11
Pointing word definitions	For differences, see Table 13
Confidence word definitions	For differences, see Table 14
viscal.nc file included	No viscal.nc for (A)ATSR
Bayesian and probabilistic cloud threshold flags only	Bayesian and probabilistic cloud percentages per pixel will be available

Note that the 4th reprocessing intends to pioneer the inclusion of Bayesian and probabilistic cloud percentages per pixel within the product. These values are not specified within the current SLSTR product specification [RD.1].

Table 5 shows the information that has been retained from the 3rd reprocessing products, and transferred to the 4th reprocessing products, but that have no equivalents in the SLSTR format. The extra information will be stored either in spare fields in the 4th reprocessing products or in extra NetCDF files within the product.

Table 5. Information retained from 3rd reprocessing products and added to 4th reprocessing products (no equivalent exists in SLSTR)

Information	Placing in 4th reprocessing products
Blanking pulse	Bit 7 of the Confidence word (Table 14)
(A)ATSR telemetry downlink rate	To go in extra data files (atsr_in/io)
ATSR-2 pixel selection map	To go in extra data files (atsr_in/io)

Further information

If any (A)ATSR user would like further information, please contact ESA at https://earth.esa.int/web/guest/contact-us

References

[RD.1] Sentinel-3 Product Data Format Specification - SLSTR Level 1 & 2 Instrument Products, S3IPF.PDS.005 (Issue 1.11, 28 May 2015): https://earth.esa.int/documents/247904/1872792/Sentinel-3_Product_Data_Format_Specification-SLSTR_Level-1-2_Products

[RD.2] (A)ATSR Expert Support Laboratory – FAST Level 1b Product Definition, PO-TN-RAL-AT-0568 (Issue 1.2, April 2016; *update pending*): http://bit.ly/2oU7wRY

[RD.3] Sentinel-3 Toolbox: https://sentinel.esa.int/web/sentinel/toolboxes/sentinel-3/

[RD.4] Sentinel 3 PDGS File Naming Convention, EUM/LEO-SEN3/SPE/10/0070 GMES-S3GS-EOPG-TN-09-0009 (Issue 1.3): https://sentinel.esa.int/documents/247904/1964331/Sentinel-3_PDGS_File_Naming_Convention

[RD.5] Envisat-1 Products Specifications, Vol. 7: AATSR Products Specifications, IDEAS-SER-IPF-SPE-0288 (Issue 4/C, 5 September 2013): https://earth.esa.int/documents/10174/437508/Vol-07-Aats-4C.pdf

[RD.6] ATSR-1/-2 User Guide: http://www.atsr.rl.ac.uk/documentation/docs/userguide/index.shtml

Appendix 1: Content of (A)ATSR 4th reprocessing L1B products

Each 4th reprocessing product will be composed of several files. A summary of the content of each file is provided in Table 6. Users can compare this with the SLSTR format [RD.1]. Note that some information is provided on a per-scan basis (referenced to the nadir pixel at sub-satellite point) and not the image grid; these are noted in Table 6.

Table 6. Summary of (A)ATSR 4th reprocessing L1B product contents

File name	Contents of file	File format
xfdumanifest.xml	Metadata and pointers to contents, also contains quality information about the product	XML
Measurement datasets		
S1_radiance_in.nc	S1 nadir 1 km radiance measurement dataset	NetCDF4
S1_radiance_io.nc	S1 oblique 1 km radiance measurement dataset	NetCDF4
S2_radiance_in.nc	S2 nadir 1 km radiance measurement dataset *etc.* Each MDS contains, *for both gridded and orphan pixels*: Pixel radiances Pixel radiance uncertainty estimates Pixel exception flags (see Table 8)	NetCDF4
S2_radiance_io.nc		NetCDF4
S3_radiance_in.nc		NetCDF4
S3_radiance_io.nc		NetCDF4
S5_radiance_in.nc		NetCDF4
S5_radiance_io.nc		NetCDF4
S7_BT_in.nc	S7 nadir 1 km brightness temperature measurement dataset *etc.* Each MDS contains, *for both gridded and orphan pixels*: Pixel BTs Pixel BT uncertainty estimates Pixel exception flags (see Table 8)	NetCDF4
S7_BT_io.nc		NetCDF4
S8_BT_in.nc		NetCDF4
S8_BT_io.nc		NetCDF4
S9_BT_in.nc		NetCDF4
S9_BT_io.nc		NetCDF4
Quality annotation datasets		
S1_quality_in.nc	S1 nadir 1 km quality annotation dataset *etc.* The VIS – SWIR quality ADS contain estimates of detector noise measured at the black bodies and VISCAL, and the ancillary information required to scale these to estimates of radiance noise for each pixel	NetCDF4
S1_quality_io.nc		NetCDF4
S2_quality_in.nc		NetCDF4
S2_quality_io.nc		NetCDF4
S3_quality_in.nc		NetCDF4
S3_quality_io.nc		NetCDF4
S5_quality_in.nc		NetCDF4
S5_quality_io.nc		NetCDF4
S7_quality_in.nc	S7 nadir 1 km quality annotation dataset *etc.* The IR quality ADS contain estimates of detector noise	NetCDF4
S7_quality_io.nc		NetCDF4
S8_quality_in.nc		NetCDF4

File name	Contents of file	File format
S8_quality_io.nc	measured at the black bodies and the ancillary information required to scale this to estimates of NEΔT for each pixel	NetCDF4
S9_quality_in.nc		NetCDF4
S9_quality_io.nc		NetCDF4
ATSR additional information annotation datasets (scan-based information)		
atsr_in.nc	Nadir 1 km ATSR additional information annotation dataset	NetCDF4
atsr_io.nc	Oblique 1 km ATSR additional information annotation dataset	NetCDF4
	ATSR ADS contain the following (associated with the sub-satellite point included on each line): Telemetry rate information (see Table 9) ATSR-2 pixel selection map information (see Table 10)	
Global flags annotation datasets		
flags_in.nc	Nadir 1 km global flags annotation dataset	NetCDF4
flags_io.nc	Oblique 1 km global flags annotation dataset	NetCDF4
	Global flags ADS contain, for gridded and orphan pixels: Global cloud flags (see Table 11); *subset of orphan only* Bayesian cloud flags (see Table 12); *subset of orphan only* Global pointing flags (see Table 13) Global confidence flags (see Table 14)	
Coordinate annotation datasets		
indices_in.nc	Nadir 1 km scan, pixel and detector number annotation dataset	NetCDF4
indices_io.nc	Oblique 1 km scan, pixel and detector number annotation dataset	NetCDF4
	These indices map both gridded and orphan pixels to their original positions in the instrument measurement frame	
cartesian_in.nc	Nadir 1 km Cartesian coordinates annotation dataset	NetCDF4
cartesian_io.nc	Oblique 1 km Cartesian coordinates annotation dataset	NetCDF4
	The Cartesian coordinate datasets contain the orthogeolocated quasi-Cartesian coordinates x and y of the centre of each gridded and orphan pixel in the field of view on the earth's surface, determined from a digital elevation model, where x is the across track distance on the ellipsoid, locally perpendicular to the sub-satellite track and y is the distance along the sub-satellite track. The dataset is generated in the image frame	
cartesian_tx.nc	16 km Cartesian coordinates annotation dataset	NetCDF4
	The Tie Points Cartesian coordinate dataset contains the quasi-Cartesian swath coordinates of the tie-points on the ellipsoid. The resolution is 16 km along track and 16 km across track	
geodetic_in.nc	Nadir 1 km geodetic coordinates annotation dataset	NetCDF4
geodetic_io.nc	Oblique 1 km geodetic coordinates annotation dataset	NetCDF4
	The geodetic ADS contains the orthogeolocated geodetic coordinates, for both gridded and orphan pixels, in latitude and longitude, and the surface elevation of the centre of each pixel in the field of view on the earth's surface, determined from a digital elevation model. The dataset is generated in the image frame	

File name	Contents of file	File format
geodetic_tx.nc	16 km geodetic coordinates annotation dataset	NetCDF4
	The Tie Points geodetic coordinates dataset contains the geodetic coordinates, in latitude and longitude, of the tie-points on the ellipsoid. The resolution is 16 km along track and 16 km across track	
time_in.nc	Nadir *and oblique* combined 1 km time coordinate annotation dataset **(scan-based information)**	NetCDF4
	This dataset contains the measurement times for each image line. The main time information is the scan acquisition time associated with the sub-satellite point included on each line. Others parameters are included to retrieve the exact acquisition time of each instrument pixel	
Solar and satellite geometry annotation datasets		
geometry_tn.nc	Nadir 16 km solar and satellite geometry annotation dataset	NetCDF4
geometry_to.nc	Oblique 16 km solar and satellite geometry annotation dataset	NetCDF4
	This dataset contains the solar and satellite azimuth and zenith angles at the earth's surface and the corresponding distances to the surface, on a tie point grid. The resolution is 16 km along track and 16 km across track	
Meteorological parameters auxiliary dataset		
met_tx.nc	16 km meteorological parameters auxiliary dataset	NetCDF4
	The meteorological parameters data file contains ECMWF analysis fields, regridded onto tie points. The resolution is 16 km along track and 16 km across track. The dataset contains three types of field: (1) single surface or near-surface values, (2) surface time series, (3) profiles. By default, the synoptic time is the time nearest to the product centre time	

Pixel exception values and flag meanings are given in Annex 2: Exception values and flag tables.

Note that the file names in Table 6 have the format **<dataset ID>_rv.nc** where

<dataset ID> = dataset identifier, where:

S1_radiance – S3_radiance, S5_radiance	Visible/SWIR radiance measurement dataset
S7_BT – S9_BT	Brightness temperature measurement dataset
S1_quality – S3_quality, S5_quality	Visible/SWIR radiance quality annotation dataset
S7_quality – S9_quality	Brightness temperature quality annotation dataset
atsr	Additional ATSR information
indices	Scan, pixel and detector number annotation dataset
flags	Global flags annotation dataset
cartesian	Quasi-Cartesian ("x/y") coordinates annotation dataset
geodetic	Latitude/longitude coordinates annotation dataset
time	Time coordinate annotation dataset
geometry	Solar and satellite geometry annotation dataset
met	Meteorological parameters annotation dataset

r = grid/resolution, where:

i	1 km image grid
t	16 km tie-point grid

v = swath/view, where:

n	Nadir swath
o	Oblique (forward) swath
x	Both/no distinction

Annex 1: Product naming convention

The 4th reprocessing product names will follow the naming convention for Sentinel-3 products, given in [RD.4], which is:

MMM_SS_L_TTTTTT_yyyymmddThhmmss_YYYYMMDDTHHMMSS_YYYYMMDDTHHMMSS_<instance ID>_GGG_<class ID>.<extension>

The product names consist of 99 characters; details of the naming convention are given in Table 7. The "Product Type" is specified by the characters SS_L_TTTTTT.

It can be noted that the absolute orbit number does not appear in the filenames for the 4th reprocessing products. The 4th reprocessing products will take their data start and data stop times from the sensing start and stop data contained within the header of the parent Level 0 product.

Example

Comparisons of the name formats are given below, using a 3rd reprocessing example:

Envisat format:

ATS_TOA_1PUUPA20120406_145752_000065273113_00240_52840_6782.N1

Sentinel format:

ENV_AT_1_RBT____20120406T145752_20120406T164306_20130409T062629_6527_113_240_____UPA_R_NT_003.SEN3

Table 7. Sentinel-3 product naming convention details and options for the 4th reprocessing products

Field	Length	Purpose	SLSTR L1B value	(A)ATSR L1B value	Comment
MMM	3	Mission ID	S3A, S3B, S3_	ER1, ER2, ENV	
SS	2	Instrument	SL	AT	AT since MMM differentiates instruments
L	1	Processing Level	1	1	
TTTTTT	6	Data Type ID	RBT___, (RBT_BW)	RBT___	
yyyymmdd**T**hhmmss	15	Data Start Time	<yyyymmdd**T**hhmmss>	<yyyymmdd**T**hhmmss>	
YYYYMMDD**T**HHMMSS	15	Data Stop Time	<YYYYMMDD**T**HHMMSS>	<YYYYMMDD**T**HHMMSS>	
YYYYMMDD**T**HHMMSS	15	Creation Time	<YYYYMMDD**T**HHMMSS>	<YYYYMMDD**T**HHMMSS>	
<instance ID>	17	<Duration>_ <Cycle>_ <Relative Orbit>	<DDDD>_<CCC>_ <LLL>_____	<DDDD>_<CCC>_<LLL>_____	Variable by stripes, tiles or frames: 4th reprocessing follows "stripes" pattern

Field	Length	Purpose	SLSTR L1B value	(A)ATSR L1B value	Comment
GGG	3	Product Generating Centre	LN2, MAR	DSI	
<class ID>	8	<Processing platform>_ <Timeliness>_ <Free Text>	<P>_<XX>_<NNN>	R_NT_*nnn*[3]	[1]P = O, F, D, R or _ [2]XX = NR, ST, NT or __ NNN can be anything, such as baseline collection
<extension>	≤ 4	Filename extension	SEN3	SEN3	To show it is S3 format, as first 6 characters (MMM_SS) show it is (A)ATSR data not SLSTR

[1]O = operational, F = reference, D = development, R = reprocessing
[2]NR= Near Real Time, ST = Short Time Critical, NT = Non Time Critical
[3]*nnn=an identifier specifying the reprocessing version*

Annex 2: Exception values and flag tables

This Annex contains tables for the definitions of pixel exception values and flags for SLSTR products. Differences or changes for the (A)ATSR 4th reprocessing products are shown in red type.

- The MDS pixel exception values and meaning are given in Table 8.
- New table for the ATSR telemetry data rate is shown in Table 9.
- New table for ATSR-2 pixel map information is shown in Table 10.
- Cloud word definitions are given in Table 11. Note that the cloud tests within the 4th reprocessing products are the same as those within the 3rd reprocessing products.
- Bayesian/probabilistic cloud word definitions are given in Table 12.
- Pointing word definitions are given in Table 13.
- Confidence word definitions are given in Table 14.

Table 8. SLSTR MDS pixel exception values
(4th reprocessing differences in red)

Bit number	Text code	Description
0	ISP_absent	ISP/scan absent
1	pixel_absent	Pixel absent
2	not_decompressed	Not decompressed
3	no_signal	No signal in channel
4	saturation	Saturation in channel
5	invalid_radiance	Derived radiance outside calibration
6	no_parameters	Calibration parameters unavailable
7	unfilled_pixel	Unfilled pixel

Table 9. ATSR telemetry data rate
(new table for 4th reprocessing)

Code	Text code	Description
0	fixed_rate	ATSR-1, AATSR fixed rate data
2519	low_rate	ATSR-2 low rate data
60304	high_rate	ATSR-2 high rate data

Table 10. ATSR-2 routine pixel maps
(table 9 from [RD.6])
(new table for 4th reprocessing)

Pixel map	IR data	Visible data	
High-rate	All 12-bit	0.55, 0.67 & 0.87 µm	All channels full 500 km swath with 12-bit digitisation
Map 12	Not sent	0.55, 0.67 & 0.87 µm	Full 500 km swath with 12-bit digitisation
Map 13	As ATSR-1	0.55, 0.67 & 0.87 µm	Reduced 180 km swath width with 12-bit digitisation
Map 14	As ATSR-1	0.55 µm	Reduced 300 km swath with 8-bit digitisation in nadir
		0.67 & 0.87 µm	Full 500 km swath with 8-bit digitisation in nadir & alternate (interlaced) pixels in forward with 8-bit digitisation

Table 11. SLSTR Cloud word definitions
(4th reprocessing differences in red)

Bit	Text code	Meaning if set	Comment
0		Visible channels cloud test	Day time only
1		1.37 µm threshold test (not implemented)	Set to 0
2		1.6 µm small-scale histogram test (*previously referred to as the 1.6 µm spatial coherence test*)	Day time only
3		1.6 µm large-scale histogram test (*previously referred to as the 1.6 µm reflectance histogram test*)	Day time only
4		2.25 µm small-scale histogram test (not implemented)	Set to 0
5		2.25 µm large-scale histogram test (not implemented)	Set to 0
6		11 µm spatial coherence test	
7		12 µm gross cloud test	
8	thin_cirrus	11 µm/12 µm thin cirrus test	
9		3.7 µm/12 µm medium/high level test	
10	fog_low_stratus	11 µm/3.7 µm fog/low stratus test	
11		11 µm/12 µm view difference test	Uses both views
12		3.7 µm/11 µm view difference test	Uses both views
13	thermal_histogram	11 µm/12 µm thermal histogram test	
14		spare	
15		spare	

Table 12. SLSTR Bayesian/probabilistic cloud word definitions in the Global flags ADS

Bit number	Meaning if set	Comment
0	Single view low probability threshold	Climate-quality clearing
1	Single view moderate probability threshold	Operational-quality clearing
2	Dual view low probability threshold	Climate-quality clearing
3	Dual view moderate probability threshold	Operational-quality clearing
4	spare	
5	spare	
6	spare	
7	Unchecked by cloud processor	(A)ATSR additional flag (previously spare)

Table 13. SLSTR Pointing word definitions
(4th reprocessing differences in red)

Bit number	Text code	Meaning if set	Comment
0	FlipMirrorAbsoluteError	(not implemented)	Set to 0
1	FlipMirrorIntegratedError	(not implemented)	Set to 0
2	FlipMirrorRMSError	(not implemented)	Set to 0
3	ScanMirrorAbsoluteError	(not implemented)	Set to 0
4	Scan_mirror_integrated_error	Pixel counter not equal to 2000	
5	ScanMirrorRMSError	(not implemented)	Set to 0
6	ScanTimeError	(not implemented)	Set to 0
7	platform_mode	Platform mode	0 if nominal, else 1

Table 14. Confidence word definitions
(4th reprocessing differences in red)

Bit number	Text code	Meaning if set	Comment
0	coastline	Coastline in field of view	
1	ocean	Ocean in field of view	
2	tidal	Tidal zone in field of view	
3	land	Land in field of view	
4	inland_water	Inland water in field of view	
5	unfilled	Unfilled pixel (1 if this pixel is never tested or filled)	

Bit number	Text code	Meaning if set	Comment
6	spare	spare	
7	blanking_pulse	RADAR active	(A)ATSR additional flag (previously spare)
8	cosmetic	Cosmetic fill pixel	
9	duplicate	Pixel has a duplicate	
10	day	Pixel in daylight	
11	twilight	Pixel in twilight	
12	sun_glint	Sun glint in pixel	
13	snow	Snow	
14	summary_cloud	Summary cloud test	
15	summary_pointing	Summary pointing	