Draft specification of ATSR/SADIST-2 products

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1 Introduction

This document is a draft specification of the scientific products from RAL's SADIST-2 ATSR data-processing software. Since SADIST-2 is being developed such that it can process data from both ATSR-1 and ATSR-2 instruments, the products described here have been designed to be sufficiently flexible and modular that they are equally valid for either instrument. SADIST-2 is intended to replace SADIST-1 as the definitive ATSR-1 data-processing software.

Forget the arcane processing levels which have riddled the SADIST product documentation until now. Part of the development of the products described here has been a deliberate blurring of the divisions between processing levels. There is no longer a rigid idea of the processing level a product belongs to, and therefore the things the product may legitimately contain. If the data-processing algorithms allow parameters to be made available in a product, they are now made available.

The set of products described in this document form three logical groups:

Ungridded products contain pixels in the ATSR scan geometry. There is a direct correspondence between the contents of a product record and the contents of an ATSR scan. Nadir- and forward-view pixels are contemporaneous, and have not been regridded or resampled.

Gridded products contain 512×512 pixel *images*. The correspondence between a pixel and the ATSR scan from which it came has been lost. Nadir- and forward-view pixels are collocated, and have been regridded onto a 1km grid.

Spatially-averaged products contain raw data (from up to a whole orbit) which have been spatially-averaged, to a ten-arcminute or half-degree resolution.

1.1 Ungridded products

There are two ungridded products:

UCOUNTS is an ungridded detector count product (an extension of the SADIST-1 COUNTS product). The product contains ungridded, uncalibrated detector counts from all or some of the ATSR-1/ATSR-2 detectors. Although the product remains ungridded, the product may optionally contain pixel latitude/longitude positions, and/or pixel x/y coordinates.

UBT is an ungridded brightness temperature/reflectance product (a new product for SADIST-2). The product contains ungridded, calibrated brightness temperatures or reflectances from all or some of the ATSR-1/ATSR-2 detectors. Although the product remains ungridded, the product may optionally contain pixel latitude/longitude positions, and/or pixel x/y coordinates.

1.2 Gridded products

There are three gridded products:

GBT is a gridded brightness temperature/reflectance product (an extension of the SADIST-1 BT product). The product contains gridded, calibrated brightness temperature/reflectance images from all or some of the ATSR-1/ATSR-2 detectors. The product optionally includes pixel latitude/longitude positions, x/y offsets (sub-pixel positions), and the results of cloud-clearing/land-flagging.

GBROWSE is a gridded browse product (an extension of the SADIST-1 BROWSE product). The product contains gridded, sub-sampled, calibrated brightness temperature/reflectance images from all or some of the ATSR-1/ATSR-2 detectors. The product optionally includes the results of cloud-clearing/land-flagging.

GSST is a gridded sea-surface temperature product (an extension of the SADIST-1 SST product). The product contains gridded sea-surface temperature images using both nadir-only and dual-view retrieval algorithms. The product optionally includes pixel latitude/longitude positions, x/y offsets (sub-pixel positions), and the results of cloud-clearing/land-flagging.

1.3 Spatially-averaged products

There are three spatially-averaged products:

ABT is a spatially-averaged brightness temperature/reflectance product (a new product for SADIST-2). The product contains spatially-averaged brightness temperatures/reflectances from all or some of the ATSR-1/ATSR-2 detectors, categorised by surface type and cloud-presence.

ACLOUD is a spatially-averaged cloud temperature/coverage product (unchanged from the SADIST-1 ACLOUD product). The product contains spatially-averaged measures of cloud temperature and abundance.

ASST is a spatially-averaged sea-surface temperature product (an extension of the SADIST-1 ASST product). The product contains spatially-averaged sea-surface temperatures, at ten-arcminute and half-degree resolution, using nadir-only and dual-view retrieval algorithms.

A significant change in the algorithms by which spatially-averaged products are generated by SADIST-2, is that the pixels which contribute to such products are taken from *gridded* (and therefore collocated), rather than *ungridded* (and therefore uncollocated) pixel data. The benefits of this approach are:

- Spatially-averaged products may make use of the optimal performance of the SADIST cloud-clearing algorithms, which are most successful when applied to collocated pixel images;
- The gridding process results in a rectification of pixel sizes, which provides a more accurate spread of signal between nadir and forward views and across the ATSR swath.

Previously, in SADIST-1, the ungridded ATSR scan pixels were the basis of spatially-averaged product generation. Implicit in this process was an assumption that all ATSR pixels have the same size, and should therefore be given the same weight. This is clearly not so. Forward-view pixels are very much larger than nadir-view pixels, and pixels towards the edge of the swath are larger than pixels close to the ground-track. Both effects are due to the variability of path-length.

The business of regridding places each ATSR pixel into a 1×1km box. Again, this assumes all pixels have the same size. Regridding has two interesting effects. Pixels which are small, and whose Earth-locations are therefore very small, may be placed within the same 1×1km box (in which case the first would be overwritten).

Also, some pixels in the regridded image may remain unfilled. This unfilling occurs when pixels are large, and therefore further apart than 1km.

After regridding, each pixel image is "cosmetically" filled; that is, pixels which remain unfilled are filled by copying the nearest (filled) neighbour. It can be seen that this process of cosmetic filling has the effect of reconstituting original pixel sizes. Filling occurs only where actual pixels are large, and therefore widely-spaced, but have been squeezed into 1×1km boxes. Nearest-neighbour copying reverses the pixel squeezing, and allows pixels to expand to a more representative size.

This is a simplistic description, but the argument remains that the integrity of spatially-averaged products is improved when their generation uses regridded, rather than ungridded pixels. There is no bias towards the nadir-view, and towards the ground-track, where pixels are smallest.

1.4 Other products

SADIST-2 will also include a general-purpose auxiliary data product, whose principal use will be for the maintenance at RAL of a long-term archive of ATSR-1/ATSR-2 instrument performance, and short-term diagnosis of instrument anomalies. This product will be documented elsewhere.

At the time of writing, it is intended that the generation of the SADIST-1 products MWR and MCLOUD will not be continued into SADIST-2. The MWR product is redundant for ATSR-2, since the low-rate data tapes which will be the primary source of raw data for SADIST-2 will also include transcribed ATSR/M raw data, independent of the ATSR source packets.

1.5 SADIST-2 product header

The header shown in table 1 is present in *all* SADIST-2 products (though not all header contents are relevant to, and will be provided for, all products).

Byte range	# bytes	Parameter description	Type	Unit
0 – 59	60	Product file-name	Char	None
		Orbit and platform parameters		
60 – 80	21	Source of ERS-1 state vector used by orbit propagation	Char	None
81 – 95	15	Ascending node time (days since January 1st, 1950)	Real	Days
96 – 117	22	Universal time at ascending node	Char	None
118 – 153	3×12	Ascending node state vector position (x, y, z)	Real	Km
154 – 183	3×10	Ascending node state vector velocity (x, y, z)	Real	Km/s
184 – 193	10	Longitude of the ascending node	Real	Degrees
194 – 223	30	ERS-1/ERS-2 platform modes during product: YSM FCM OCM FPM RTMM RTMC	Char	None
		Instrument temperature parameters		
224 – 231	8	Stirling Cycle Cooler (SCC) cold-tip temperature	Real	Kelvin
232 – 287	7×8	Instrument detector temperatures, 12.0μm, 11.0μm, 3.7μm, 1.6μm, 0.87μm, 0.65μm, 0.55μm	Real	Kelvin
		Product optional contents parameters		
288 – 289	2	(N) Nadir-only records present	Integer	None
290 – 291	2	(T) Thermal infra-red detector records present	Integer	None
292 – 293	2	(V) Visible/near-infra-red detector records present	Integer	None
294 – 295	2	(L) Latitude/longitude records present	Integer	None
296 – 297	2	(X) x/y coordinate records present	Integer	None
298 – 299	2	(C) Cloud-clearing/land-flagging records present	Integer	None
		Product position and time parameters		
300 – 305	6	Along-track distance of start of product	Integer	Km
306 – 311	6	Along-track distance of end of product	Integer	Km
312 – 332	21	Universal time at start of product	Char	None
333 – 353	21	Universal time at end of product	Char	None
354 – 393	4×10	Latitudes of product corner-points	Real	Degrees
394 – 433	4×10	Longitudes of product corner-points	Real	Degrees
		Solar angle parameters **(not spatially-averaged products)**		
434 – 521	11×8	Solar elevations at 11 points along central nadir scan	Real	Degrees
522 – 609	11×8	Pixel-to-sun/pixel-to-ERS1 elevation differences at 11 points along central nadir scan	Real	Degrees
610 – 697	11×8	ERS1-to-sun/ERS1-to-pixel azimuth differences at 11 points along central nadir scan	Real	Degrees
698 – 785	11×8	Solar elevations at 11 points along central forward scan	Real	Degrees
786 – 873	11×8	Pixel-to-sun/pixel-to-ERS1 elevation differences at 11 points along central forward scan	Real	Degrees
874 – 961	11×8	ERS1-to-sun/ERS1-to-pixel azimuth differences at 11 points along central forward scan	Real	Degrees

Table 1: SADIST-2 product header

2 Ungridded detector count product (UCOUNTS)

2.1 General description

The ungridded detector count product (UCOUNTS) contains ATSR-1/ATSR-2 detector counts from up to 512 consecutive instrument scans. with optional pixel positional information.

The data are uncollocated and ungeolocated; that is, the nadir and forward views are contemporaneous (and therefore are separated along-track by approximately 900km), and retain the ATSR scan geometry.

Also contained are ancillary values which provide: detector counts obtained from views of the ATSR hot and cold black-body calibration targets; detector counts obtained from views of the ATSR-2 VISCAL unit; measured temperatures of the black bodies; coefficients for use during calibration of the detector signals (detector counts to brightness temperatures); and signal channel processor (SCP) gains and offsets for each of the detectors.

2.2 Product format

The UCOUNTS product has a fixed-length 2048-byte record format. Table 2 shows the maximum of 14 product records which may be present within the UCOUNTS product for every ATSR scan.

Record #	Code	Contents	Unit
1	T	12.0μm detector record, as described by table 3	n/a
2	T	11.0μm detector record	n/a
3	T	3.7μm detector record	n/a
4	T/V	1.6μm detector record	n/a
5	V	0.87μm detector record (ATSR-2 only)	n/a
6	V	0.65μm detector record (ATSR-2 only)	n/a
7	V	0.55μm detector record (ATSR-2 only)	n/a
8	L	Latitudes of nadir-view pixels 0–511, 512 four-byte integers	degrees/1000
9	L	Latitudes of nadir-view pixels 512–554 and forward-view pixels 0–370, 414 four-byte integers	degrees/1000
10	L	Longitudes of nadir-view pixels 0–511, 512 four-byte integers	degrees/1000
11	L	Longitudes of nadir-view pixels 512–554 and forward-view pixels 0–370, 414 four-byte integers	degrees/1000
12	X	x-coordinates (across-track) of nadir- and forward-view pixels, 926 signed two-byte integers	km
13	X	y-coordinate (along-track) of nadir- and forward-view pixels, 926 unsigned two-byte integers	km
14	X	x-coordinate offsets (across-track) of nadir- and forward-view pixels, 926 unsigned one-byte integers y-coordinate offsets (along-track) of nadir- and forward-view pixels, 926 unsigned one-byte integers	km/256 km/256

Table 2: Ungridded detector count product: records for single ATSR scan

The product contents are variable, and are determined by the precise nature of the product request. The records provided for each ATSR scan may be requested/omitted in logical groups:

- (T) Thermal infra-red detector records (12.0μm, 11.0μm, 3.7μm, 1.6μm);
- (V) Visible/near-infra-red detector records (1.6μm, 0.87μm, 0.65μm, 0.55μm);

- (L) Pixel latitude/longitude positions;
- (X) Pixel x/y coordinate positions.

Note that, since the nadir and forward views remain uncollocated in this product, latitude/longitude and x/y coordinate information must be provided separately for nadir- and forward-view pixels. This necessarily increases the product size.

The base-line (default) ATSR-1 UCOUNTS product includes the thermal infra-red detector (T) records, but omits all other records. If required, they must be requested explicitly. The base-line (default) ATSR-2 UCOUNTS product includes the thermal and visible/nir detector (TV) records, but omits the latitude/longitude and x/y coordinate records.

UCOUNTS products include within their file-name extensions, the codes required to identify the product contents. For example, a UCOUNTS product with a file-name extension

UCOUNTS-VX

includes only the visible/nir detector records, and the x/y coordinate records, and a UCOUNTS product with a file-name extension

UCOUNTS-TVL

includes all detector records, and the latitude/longitude records. It can be seen that the base-line ATSR-1 and ATSR-2 products are defined by:

UCOUNTS-T

and

UCOUNTS-TV

respectively. Note that the visible detectors are unavailable for ATSR-1 products. Note also that the 1.6μm near-infra-red channel is supplied as part of the thermal infra-red *and* visible/nir detector records. If, for ATSR-2, all detectors are requested, the 1.6μm detector record is provided only once in the product.

Table 3 describes the contents of each detector record. Note that detector counts in the 12.0μm and 0.87μm detector records are negated to show the presence of the blanking pulse. To avoid confusion between (negative) error codes and blanking-pulsed counts, the blanking pulse is represented in this way only when the detector count is greater than the absolute value of all error codes.

2.3 Exceptional values

Table 4 lists the exceptional values which may be encountered within the UCOUNTS product.

2.4 Product size

Since the product contents are variable, product sizes are also variable. Table 5 provides approximate sizes for a range of typical product contents.

Byte range	Parameter description	Type	Unit
0 – 3	Time of scan (days since January 1st, 1950)	Integer	Days
4 – 7	Time of scan (milliseconds within current day)	Integer	msecs
8 – 1117	555 two-byte nadir-view pixel detector counts (12.0μm & 0.87μm negated to show presence of blanking pulse)	Integer	None
1118 – 1859	371 two-byte forward-view pixel detector counts (12.0μm & 0.87μm negated to show presence of blanking pulse)	Integer	None
1860 – 1891	16 two-byte plus black body (+bb) pixel detector counts (12.0μm & 0.87μm negated to show presence of blanking pulse)	Integer	None
1892 – 1923	16 two-byte minus black body (-bb) pixel detector counts (12.0μm & 0.87μm negated to show presence of blanking pulse)	Integer	None
1924 – 1955	16 two-byte VISCAL unit detector counts (12.0μm & 0.87μm negated to show presence of blanking pulse)	Integer	None
1956 – 1983	7 four-byte measured plus black body (+bb) temperatures	Integer	K/1000
1984 – 2011	7 four-byte measured minus black body (-bb) temperatures	Integer	K/1000
2012 – 2015	Four-byte calibration bias for even pixels	Integer	1/1000000
2016 – 2019	Four-byte calibration bias for odd pixels	Integer	1/1000000
2020 – 2023	Four-byte calibration slope for even pixels	Integer	1/1000000
2024 – 2027	Four-byte calibration slope for odd pixels	Integer	1/1000000
2028 – 2031	Gain used by signal channel processor (SCP)	Integer	None
2032 – 2035	Offset used by signal channel processor (SCP)	Integer	None
2036 – 2039	IDF scan count when SCP gain/offset last changed	Integer	None
2040 – 2047	Unused	None	None

Table 3: Ungridded detector count product: detector record

Parameter	Value	Reason
Detector count	-1	Entire scan absent from telemetry
	-2	Pixel absent from telemetry (possible reasons are disablement of channel, or visible channel fixed to narrow swath)
	-3	No signal in channel (zero count)
	-4	Saturation in channel (4095 count)

Table 4: Ungridded detector count product: exceptional values

Product contents	**# records/scan**	**Size of product**	**Size/orbit**
UCOUNTS-T (ATSR-1 base-line)	4	4.2mb	336mb
UCOUNTS-TL (ATSR-1 base-line & lat/long)	8	8.4mb	671mb
UCOUNTS-TLX (ATSR-1 base-line & lat/long & x/y)	11	11.5mb	923mb
UCOUNTS-TV (ATSR-2 base-line)	7	7.3mb	587mb
UCOUNTS-TVL (ATSR-2 base-line & lat/long)	11	11.5mb	923mb
UCOUNTS-TVLX (ATSR-2 base-line & lat/long & x/y)	14	14.7mb	1.17gb

Table 5: Ungridded detector count product: product sizes

3 Ungridded brightness temperature/reflectance product (UBT)

3.1 General description

The ungridded brightness temperature/reflectance product (UBT) contains calibrated ATSR-1/ATSR-2 brightness temperatures and/or reflectances from up to 512 consecutive instrument scans, with optional pixel positional information.

The data are uncollocated and ungeolocated; that is, the nadir and forward views are contemporaneous (and therefore are separated along-track by approximately 900km), and retain the ATSR scan geometry.

Also contained are ancillary values which provide: detector counts obtained from views of the ATSR hot and cold black-body calibration targets; detector counts obtained from views of the ATSR-2 VISCAL unit; measured temperatures of the black bodies; coefficients for use during calibration of the detector signals (detector counts to brightness temperatures); and signal channel processor (SCP) gains and offsets for each of the detectors.

3.2 Product format

The UBT product has a fixed-length 2048-byte record format. Table 6 shows the maximum of 14 product records which may be present within the UBT product for every ATSR scan.

Record #	Code	Contents	Unit
1	T	12.0μm detector record, as described by table 7	n/a
2	T	11.0μm detector record	n/a
3	T	3.7μm detector record	n/a
4	T/V	1.6μm detector record	n/a
5	V	0.87μm detector record (ATSR-2 only)	n/a
6	V	0.65μm detector record (ATSR-2 only)	n/a
7	V	0.55μm detector record (ATSR-2 only)	n/a
8	L	Latitudes of nadir-view pixels 0–511, 512 four-byte integers	degrees/1000
9	L	Latitudes of nadir-view pixels 512–554 and forward-view pixels 0–370, 414 four-byte integers	degrees/1000
10	L	Longitudes of nadir-view pixels 0–511, 512 four-byte integers	degrees/1000
11	L	Longitudes of nadir-view pixels 512–554 and forward-view pixels 0–370, 414 four-byte integers	degrees/1000
12	X	x-coordinates (across-track) of nadir- and forward-view pixels, 926 signed two-byte integers	km
13	X	y-coordinates (along-track) of nadir- and forward-view pixels, 926 unsigned two-byte integers	km
14	X	x-coordinate offsets (across-track) of nadir- and forward-view pixels, 926 unsigned one-byte integers y-coordinate offsets (along-track) of nadir- and forward-view pixels, 926 unsigned one-byte integers	km/256 km/256

Table 6: Ungridded brightness temperature/reflectance product: records for single ATSR scan

The product contents are variable, and are determined by the precise nature of the product request. The records provided for each ATSR scan may be requested/omitted in logical groups:

- (T) Thermal infra-red detector records (12.0μm, 11.0μm, 3.7μm, 1.6μm);
- (V) Visible/near-infra-red detector records (1.6μm, 0.87μm, 0.65μm, 0.55μm);
- (L) Pixel latitude/longitude positions;
- (X) Pixel x/y coordinate positions.

Note that, since the nadir and forward views remain uncollocated in this product, latitude/longitude and x/y coordinate information must be provided separately for nadir- and forward-view pixels. This necessarily increases the product size.

The base-line (default) ATSR-1 UBT product includes the thermal infra-red detector (T) records, but omits all other records. If required, they must be requested explicitly. The base-line (default) ATSR-2 UBT product includes the thermal and visible/nir detector (TV) records, but omits the latitude/longitude and x/y coordinate records.

UBT products include within their file-name extensions, the codes required to identify the product contents. For example, a UBT product with the file-name extension

UBT-VX

includes only the visible/nir detector records; and the x/y coordinate records, and a UBT product with the file-name extension

UBT-TVL

includes all detector records, and the latitude/longitude records. It can be seen that the base-line ATSR-1 and ATSR-2 products are defined by

UBT-T

and

UBT-TV

respectively. Note that the visible detectors are unavailable for ATSR-1 products, and for ATSR-2 products during night-time. Note also that the 1.6μm near-infra-red channel is supplied as part of the thermal infra-red *and* visible/nir detector records. If, for ATSR-2, all detectors are requested, the 1.6μm detector record is provided only once in the product.

Table 7 describes the contents of each detector record. Note that brightness temperatures/reflectances in the 12.0μm and 0.87μm detector records are negated to show the presence of the blanking pulse. To avoid confusion between (negative) error codes and blanking-pulsed pixel values, the blanking pulse is only represented in this way when the brightness temperature/reflectance is greater than the absolute value of all error codes.

3.3 Exceptional values

Table 8 lists the exceptional values which may be encountered within the UBT product.

3.4 Product size

Since the product contents are variable, product sizes are also variable. Table 9 provides approximate sizes for a range of typical product contents.

Byte range	Parameter description	Type	Unit
0 – 3	Time of scan (days since January 1st, 1950)	Integer	Days
4 – 7	Time of scan (milliseconds within current day)	Integer	msecs
8 – 1117	(for thermal channels: 12.0μm, 11.0μm, 3.7μm) 555 two-byte nadir-view pixel brightness temperatures (for visible/nir channels: 1.6μm, 0.87μm, 0.65μm, 0.55μm) 555 two-byte nadir-view pixel reflectances (12.0μm and 0.87μm negated to show presence of blanking pulse)	Integer Integer	K/100 %/100
1118 – 1859	(for thermal channels: 12.0μm, 11.0μm, 3.7μm) 371 two-byte forward-view pixel brightness temperatures (for visible/nir channels: 1.6μm, 0.87μm, 0.65μm, 0.55μm) 371 two-byte forward-view pixel reflectances (12.0μm and 0.87μm negated to show presence of blanking pulse)	Integer Integer	K/100 %/100
1860 – 1891	16 two-byte plus black body (+bb) pixel detector counts (12.0μm and 0.87μm negated to show presence of blanking pulse)	Integer	None
1892 – 1923	16 two-byte minus black body (-bb) pixel detector counts (12.0μm and 0.87μm negated to show presence of blanking pulse)	Integer	None
1924 – 1955	16 two-byte VISCAL unit detector counts (12.0μm and 0.87μm negated to show presence of blanking pulse)	Integer	None
1956 – 1983	7 four-byte measured plus black body (+bb) temperatures	Integer	K/1000
1984 – 2011	7 four-byte measured minus black body (-bb) temperatures	Integer	K/1000
2012 – 2015	Four-byte calibration bias for even pixels	Integer	1/1000000
2016 – 2019	Four-byte calibration bias for odd pixels	Integer	1/1000000
2020 – 2023	Four-byte calibration slope for even pixels	Integer	1/1000000
2024 – 2027	Four-byte calibration slope for odd pixels	Integer	1/1000000
2028 – 2031	Gain used by signal channel processor (SCP)	Integer	None
2032 – 2035	Offset used by signal channel processor (SCP)	Integer	None
2036 – 2039	IDF scan count when SCP gain/offset last changed	Integer	None
2040 – 2047	Unused	None	None

Table 7: Ungridded brightness temperature/reflectance product: detector record

Parameter	Value	Reason
Brightness temperature/ reflectance	-1	Entire scan absent from telemetry
	-2	Pixel absent from telemetry (possible reasons are disablement of channel, or visible channel fixed to narrow swath)
	-3	No signal in channel (zero count)
	-4	Saturation in channel (4095 count)
	-5	Derived radiance too small for calibration
	-6	Derived radiance too large for calibration
	-7	Calibration parameters unavailable for pixel

Table 8: Ungridded brightness temperature/reflectance product: exceptional values

Product contents	# records/scan	Size of product	Size per orbit
UBT-T (ATSR-1 base-line)	4	4.2mb	336mb
UBT-TL (ATSR-1 base-line & lat/long)	8	8.4mb	671mb
UBT-TLX (ATSR-1 base-line & lat/long & x/y)	11	11.5mb	923mb
UBT-TV (ATSR-2 base-line)	7	7.3mb	587mb
UBT-TVL (ATSR-2 base-line & lat/long)	11	11.5mb	923mb
UBT-TVLX (ATSR-2 base-line & lat/long & x/y)	14	14.7mb	1.17gb

Table 9: Ungridded brightness temperature/reflectance product: product sizes

4 Gridded brightness temperature/reflectance product (GBT)

4.1 General description

The gridded brightness temperature/reflectance product consists of 512×512km geolocated, collocated nadir- and forward-view brightness temperature and/or reflectance images, at a 1km resolution, from some or all available ATSR channels.

4.2 Product format

The GBT product has a fixed-length 1024-byte record format. Table 10 shows the sequence of records within a complete product.

The actual product contents are variable, and are determined by the precise nature of the product request. The records may be requested/omitted in logical groups:

- (T) Thermal infra-red detector brightness temperature images (12.0μm, 11.0μm, 3.7μm, 1.6μm);
- (V) Visible/near-infra-red detector reflectance images (12.0μm, 11.0μm, 3.7μm, 1.6μm);
- (L) Pixel latitude/longitude positions;
- (X) Pixel x/y coordinate offsets;
- (C) Nadir- and forward-view cloud-clearing/land-flagging results.
- Also (N) may be used to request only nadir-view brightness temperature/reflectance images.

The base-line (default) ATSR-1 GBT product includes the thermal infra-red detector brightness temperature images (T), and the pixel latitude/longitude positions (L), but omits (natch) the visible/nir reflectance images (V), the pixel x/y coordinate offsets (X), and the cloud-clearing/land-flagging results (C). The base-line (default) ATSR-2 GBT product omits only the pixel x/y coordinate offsets and the cloud-clearing/land-flagging results.

GBT products include within their file-name extensions, the codes required to identify the product contents. For example, a GBT product with the file-name extension

GBT-VL

includes only the visible/nir reflectance images, and the pixel latitude/longitude positions; and a GBT product with the file-name extension

GBT-TVLC

includes all product contents, except for the pixel x/y coordinate offsets. It can be seen that the base-line ATSR-1 and ATSR-2 products are defined by

GBT-TL

and

GBT-TVL

respectively. Note that the visible detectors are unavailable for ATSR-1 products, and for ATSR-2 products during night-time. Note also that the 1.6μm near-infra-red channel is supplied as part of the thermal infra-red *and* visible/nir records. If, for ATSR-2, all detector records are requested, the 1.6μm reflectance images (nadir and forward views) are provided only once in the product.

Record #	Code	Contents	Unit
0–511	T	Nadir-view 12.0μm brightness temperature image, 512 records of 512 two-byte integers (12.0μm negated to show presence of blanking pulse)	K/100
512–1023	T	Nadir-view 11.0μm brightness temperature image, (11.0μm negated to show cosmetic fill)	K/100
1024–1535	T	Nadir-view 3.7μm brightness temperature image	K/100
1536–2047	T/V	Nadir-view 1.6μm reflectance image	%/100
2048–2559	V	Nadir-view 0.87μm reflectance image (ATSR-2 only) (0.87μm negated to show presence of blanking pulse)	%/100
2560–3071	V	Nadir-view 0.65μm reflectance image (ATSR-2 only) (0.65μm negated to show cosmetic fill)	%/100
3072–3583	V	Nadir-view 0.55μm reflectance image (ATSR-2 only)	%/100
3584–4095	T (not N)	Forward-view 12.0μm brightness temperature image 512 records of 512 two-byte integers (12.0μm negated to show presence of blanking pulse)	K/100
4096–4607	T (not N)	Forward-view 11.0μm brightness temperature image (11.0μm negated to show cosmetic fill)	K/100
4608–5119	T (not N)	Forward-view 3.7μm brightness temperature image	K/100
5120–5631	T/V (not N)	Forward-view 1.6μm reflectance image	%/100
5632–6143	V (not N)	Forward-view 0.87μm reflectance image (ATSR-2 only) (0.87μm negated to show presence of blanking pulse)	%/100
6144–6655	V (not N)	Forward-view 0.65μm reflectance image (ATSR-2 only) (0.65μm negated to show cosmetic fill)	%/100
6656–7167	V (not N)	Forward-view 0.55μm reflectance image (ATSR-2 only)	%/100
7168–8191	L	Latitudes of image pixels, 1024 records of 256 four-byte integers	degrees/1000
8192–9215	L	Longitudes of image pixels, 1024 records of 256 four-byte integers	degrees/1000
9216–9471	X	x-coordinate offsets (across-track) of nadir-view pixels, 256 records of 1024 unsigned one-byte integers	km/256
9472–9727	X	y-coordinate offsets (along-track) of nadir-view pixels, 256 records of 1024 unsigned one-byte integers	km/256
9728–9983	X	x-coordinate offsets (across-track) of forward-view pixels, 256 records of 1024 unsigned one-byte integers	km/256
9984–10239	X	y-coordinate offsets (along-track) of forward-view pixels, 256 records of 1024 unsigned one-byte integers	km/256
10240–10751	C	Nadir-view cloud-clearing/land-flagging results, 512 records of 512 two-byte composite words, see table 11	n/a
10752–11263	C	Forward-view cloud-clearing/land-flagging results, 512 records 512 two-byte composite words, see table 11	n/a

Table 10: Gridded brightness temperature/reflectance product: product contents

Bit #	Meaning
0 (lsb)	Pixel is over land
1	Pixel is cloudy (result of all cloud tests)
2	Sunglint detected in pixel
3–15	**Individual cloud tests (bit set if pixel cloudy)**
3	1.6μm reflectance histogram test (day-time only)
4	1.6μm spatial coherence test (day-time only)
5	11.0μm spatial coherence test
6	12.0μm gross cloud test
7	11.0/12.0μm thin cirrus test
8	3.7/12.0μm medium/high level test (night-time only)
9	11.0/3.7μm fog/low-stratus test (night-time only)
10	11.0/12.0μm view-difference test
11	3.7/11.0μm view-difference test (night-time only)
12	11.0/12.0μm thermal histogram test
13–15	Unused

Table 11: Gridded brightness temperature/reflectance product: cloud-clearing/land-flagging results

Note that brightness temperatures in the 12.0μm records and reflectances in the 0.87μm records are negated to show the presence of the blanking pulse.

In the same way, brightness temperatures in the 11.0μm records and reflectances in the 0.65μm records are negated to show that pixels did not originate from the ATSR scan, but have been "cosmetically" copied from the nearest neighbour pixel.

To avoid confusion between (negative) error codes and blanking-pulsed/cosmetically-filled pixels, pixel negation is used in this way only when the brightness temperature/reflectance is greater than the absolute value of all error codes.

4.3 Exceptional values

Table 12 lists the exceptional values which may be encountered within the GBT product.

Parameter	Value	Reason
Brightness temperature/ reflectance	-1	Entire scan absent from telemetry
	-2	Pixel absent from telemetry (possible reasons are disablement of channel, or visible channel fixed to narrow swath)
	-3	No signal in channel (zero count)
	-4	Saturation in channel (4095 count)
	-5	Derived radiance too small for calibration
	-6	Derived radiance too large for calibration
	-7	Calibration parameters unavailable for pixel
	-8	Pixel unfilled (cosmetic filling algorithm unable to find nearest-neighbour pixel)

Table 12: Gridded brightness temperature/reflectance product: exceptional values

4.4 Product size

Since the product contents are variable, product sizes are also variable. Table 13 provides approximate sizes for a range of typical product contents.

Product contents	# records	Size of product	Size per orbit
GBT-TL (ATSR-1 base-line)	6144	6.3mb	503mb
GBT-TLX (ATSR-1 base-line & x/y)	7168	7.3mb	587mb
GBT-TLXC (ATSR-1 base-line & x/y & cloud)	8192	8.4mb	671mb
GBT-TVL (ATSR-2 base-line)	9216	9.4mb	755mb
GBT-TVLX (ATSR-2 base-line & x/y)	10240	10.5mb	839mb
GBT-TVLXC (ATSR-2 base-line & x/y & cloud)	11264	11.5mb	923mb

Table 13: Gridded brightness temperature/reflectance product: product sizes

5 Gridded browse product (GBROWSE)

5.1 General description

The gridded browse product (GBROWSE) consists of sub-sampled 512×512km geolocated, collocated nadir- and forward-view brightness temperature and/or reflectance images, at a 4km resolution, from some or all available ATSR channels.

5.2 Product format

The GBROWSE product has a fixed-length 256-byte record format. Table 14 shows the sequence of records within a complete product.

Record #	Code	Contents	Unit
0–127	T	Nadir-view 12.0μm brightness temperature image 128 records of 128 two-byte integers	K/100
128–255	T	Nadir-view 11.0μm brightness temperature image 128 records of 128 two-byte integers	K/100
256–383	T	Nadir-view 3.7μm brightness temperature image 128 records of 128 two-byte integers	K/100
384–511	T/V	Nadir-view 1.6μm reflectance image 128 records of 128 two-byte integers	%/100
512–639	V	Nadir-view 0.87μm reflectance image (ATSR-2 only) 128 records of 128 two-byte integers	%/100
640–767	V	Nadir-view 0.65μm reflectance image (ATSR-2 only) 128 records of 128 two-byte integers	%/100
768–895	V	Nadir-view 0.55μm reflectance image (ATSR-2 only) 128 records of 128 two-byte integers	%/100
896–1023	T (not N)	Forward-view 12.0μm brightness temperature image 128 records of 128 two-byte integers	K/100
1024–1151	T (not N)	Forward-view 11.0μm brightness temperature image 128 records of 128 two-byte integers	K/100
1152–1279	T (not N)	Forward-view 3.7μm brightness temperature image 128 records of 128 two-byte integers	K/100
1280–1407	T/V (not N)	Forward-view 1.6μm reflectance image 128 records of 128 two-byte integers	%/100
1408–1535	V (not N)	Forward-view 0.87μm reflectance image (ATSR-2 only) 128 records of 128 two-byte integers	%/100
1536–1663	V (not N)	Forward-view 0.65μm reflectance image (ATSR-2 only) 128 records of 128 two-byte integers	%/100
1664–1791	V (not N)	Forward-view 0.55μm reflectance image (ATSR-2 only) 128 records of 128 two-byte integers	%/100
1792–1919	C	Nadir-view cloud-clearing/land-flagging results, 128 records of 128 two-byte composite words, see table 15	n/a
1920–2047	C	Forward-view cloud-clearing/land-flagging results, 128 records of 128 two-byte composite words, see table 15	n/a

Table 14: Gridded browse product: product contents

The actual product contents are variable, and are determined by the precise nature of the product request. The records may be requested/omitted in logical groups:

Bit #	Meaning
0 (lsb)	Pixel is over land
1	Pixel is cloudy (result of all cloud tests)
2	Sunglint detected in pixel
3–15	**Individual cloud tests (bit set if pixel cloudy)**
3	1.6μm reflectance histogram test (day-time only)
4	1.6μm spatial coherence test (day-time only)
5	11.0μm spatial coherence test
6	12.0μm gross cloud test
7	11.0/12.0μm thin cirrus test
8	3.7/12.0μm medium/high level test (night-time only)
9	11.0/3.7μm fog/low-stratus test (night-time only)
10	11.0/12.0μm view-difference test
11	3.7/11.0μm view-difference test (night-time only)
12	11.0/12.0μm thermal histogram test
13–15	Unused

Table 15: Gridded browse product: cloud-clearing/land-flagging results

- (T) Thermal infra-red detector brightness temperature images (12.0μm, 11.0μm, 3.7μm, 1.6μm);
- (V) Visible/near-infra-red detector reflectance images (12.0μm, 11.0μm, 3.7μm, 1.6μm);
- (C) Nadir- and forward-view cloud-clearing/land-flagging results.
- Also (N) may be used to request only nadir-view brightness temperature/reflectance images.

The base-line (default) ATSR-1 GBROWSE product includes only the thermal infra-red detector brightness temperature images (T), The base-line (default) ATSR-1 GBROWSE product includes the thermal infra-red detector brightness temperature images (T), and the visible/near-infra-red reflectance images (V).

GBROWSE products include within their file-name extensions, the codes required to identify the product contents. For example, a GBROWSE product with the file-name extension

GBROWSE-VC

includes only the visible/nir reflectance images, and the cloud-clearing/land-flagging results; and a GBROWSE product with the file-name extension

GBT-TVC

includes all product contents. It can be seen that the base-line ATSR-1 and ATSR-2 products are defined by

GBROWSE-T

and

GBROWSE-TV

respectively. Note that the visible detectors are unavailable for ATSR-1 products, and for ATSR-2 products during night-time. Note also that the 1.6μm near-infra-red channel is supplied as part of the thermal infra-red *and* visible/nir records. If, for ATSR-2, all detector records are requested, the 1.6μm reflectance images (nadir and forward views) are provided only once in the product.

Parameter	Value	Reason
Brightness temperature/ reflectance	-1	Entire scan absent from telemetry
	-2	Pixel absent from telemetry (possible reasons are disablement of channel, or visible channel fixed to narrow swath)
	-3	No signal in channel (zero count)
	-4	Saturation in channel (4095 count)
	-5	Derived radiance too small for calibration
	-6	Derived radiance too large for calibration
	-7	Calibration parameters unavailable for pixel
	-8	Pixel unfilled (cosmetic filling algorithm unable to find nearest-neighbour pixel)

Table 16: Gridded browse product: exceptional values

5.3 Exceptional values

Table 16 lists the exceptional values which may be encountered within the GBROWSE product.

5.4 Product size

Since the product contents are variable, product sizes are also variable. Table 17 provides approximate sizes for a range of typical product contents.

Product contents	# records	Size of product	Size per orbit
GBROWSE-NT (ATSR-1 nadir-view only)	512	131kb	10.5mb
GBROWSE-T (ATSR-1 base-line)	1024	262kb	20.9mb
GBROWSE-TC (ATSR-1 base-line & cloud)	1280	328kb	26.2mb
GBROWSE-NTV (ATSR-2 nadir-view only)	896	229kb	18.3mb
GBROWSE-TV (ATSR-2 base-line)	1792	459kb	36.7mb
GBROWSE-TVC (ATSR-2 base-line & cloud)	2048	524kb	41.9mb

Table 17: Gridded browse product: product sizes

6 Gridded sea-surface temperature product (GSST)

6.1 General description

The gridded sea-surface temperature (GSST) product consists of 512×512km sea-surface temperature images, at 1km resolution, derived using nadir-only and nadir/forward-view retrieval algorithms, with precise pixel latitudes/longitudes and confidence information.

6.2 Product format

The GSST product has a fixed-length 1024-byte record format. Table 18 shows the sequence of records within a complete product.

Record #	Code	Contents	Unit
0–511	n/a	Nadir-only sea-surface temperature, 512 records of 512 two-byte integers	K/100
512–1023	n/a	Dual-view sea-surface temperature, 512 records of 512 two-byte integers	K/100
1024–1535	n/a	Sea-surface temperature confidence words, 512 records of 512 two-byte composite words, see table 19	n/a
1536–2559	L	Latitudes of image pixels, 1024 records of 256 four-byte integers	degrees/1000
2560–3583	L	Longitudes of image pixels, 1024 records of 256 four-byte integers	degrees/1000
3584–3839	X	x-coordinate offsets (across-track) of nadir-view pixels 256 records of 1024 unsigned one-byte integers	km/256
3840–4095	X	y-coordinate offsets (along-track) of nadir-view pixels 256 records of 1024 unsigned one-byte integers	km/256
4096–4351	X	x-coordinate offsets (across-track) of forward-view pixels 256 records of 1024 unsigned one-byte integers	km/256
4352–4607	X	y-coordinate offsets (along-track) of forward-view pixels 256 records of 1024 unsigned one-byte integers	km/256
4608–5119	C	Nadir-view cloud-clearing/land-flagging results, 512 records of 512 two-byte composite words, see table 20	n/a
5120–5631	C	Forward-view cloud-clearing/land-flagging results, 512 records of 512 two-byte composite words, see table 20	n/a

Table 18: Gridded sea-surface temperature product: product contents

The actual product contents are variable, and are determined by the precise nature of the product request. The nadir-only/dual-view sea-surface temperature records are always present within the product. The other records may be requested/omitted in logical groups:

- (L) Pixel latitude/longitude positions;
- (X) Pixel x/y coordinate offsets;
- (C) Nadir- and forward-view cloud-clearing/land-flagging results.

The base-line (default) GSST product for ATSR-1 *and* ATSR-2 includes the pixel latitude/longitude positions (L), but omits the pixel x/y coordinate offsets (X), and the cloud-clearing/land-flagging results (C).

Bit number	Meaning if set
0 (lsb)	Nadir-only sea-surface temperature is valid (if false, pixel contains nadir-view 11.0μm brightness temperature)
1	Nadir-only sea-surface temperature retrieval includes 3.7μm channel
2	Dual-view sea-surface temperature is valid (if false, pixel contains nadir-view 11.0μm brightness temperature)
3	Dual-view sea-surface temperature retrieval includes 3.7μm channel
4	Pixel is over land
5	Nadir-view pixel is cloudy
6	Nadir-view pixel has blanking pulse
7	Nadir-view pixel is cosmetic (nearest-neighbour fill)
8	Forward-view pixel is cloudy
9	Forward-view pixel has blanking pulse
10	Forward-view pixel is cosmetic (nearest-neighbour fill)
11–15	Unused

Table 19: Gridded sea-surface temperature product: confidence word

Bit #	Meaning
0 (lsb)	Pixel is over land
1	Pixel is cloudy (result of all cloud tests)
2	Sunglint detected in pixel
3–15	**Individual cloud tests (bit set if pixel cloudy)**
3	1.6μm reflectance histogram test (day-time only)
4	1.6μm spatial coherence test (day-time only)
5	11.0μm spatial coherence test
6	12.0μm gross cloud test
7	11.0/12.0μm thin cirrus test
8	3.7/12.0μm medium/high level test (night-time only)
9	11.0/3.7μm fog/low-stratus test (night-time only)
10	11.0/12.0μm view-difference test
11	3.7/11.0μm view-difference test (night-time only)
12	11.0/12.0μm thermal histogram test
13–15	Unused

Table 20: Gridded sea-surface temperature product: cloud-clearing/land-flagging results

GSST products include within their file-name extensions, the codes required to identify the product contents. For example, a GSST product with the file-name extension

GSST-LX

includes the pixel latitude/longitude positions and pixel x/y coordinate offsets; and a GSST product with the file-name extension

GBT-LXC

also includes nadir- and forward-view cloud-clearing/land-flagging results. It can be seen that the base-line ATSR 1/ATSR 2 product is defined by

GSST-L

6.3 Exceptional values

Table 21 lists the exceptional values which may be encountered within the GSST product.

Parameter	Value	Reason
Sea-surface temperature	-1	Entire scan absent from telemetry
	-2	Pixel absent from telemetry (possible reasons are disablement of channel, or visible channel fixed to narrow swath)
	-3	No signal in channel (zero count)
	-4	Saturation in channel (4095 count)
	-5	Derived radiance too small for calibration
	-6	Derived radiance too large for calibration
	-7	Calibration parameters unavailable for pixel
	-8	Pixel unfilled (cosmetic filling algorithm unable to find nearest-neighbour pixel)

Table 21: Gridded sea-surface temperature product: exceptional values

6.4 Notes

- Over sea, if the nadir-view 12.0μm and 11.0μm brightness temperatures are available for a pixel, the nadir-only sea-surface temperature is always retrieved, irrespective of whether the nadir-view pixel is identified as cloud-contaminated. If the 3.7μm brightness temperature is available (and the pixel is in night-time), it is always included in the retrieval. The nadir-view sea-surface temperature should of course be used with caution if the nadir-view pixel is identified as cloud-contaminated: the nadir-view cloud flag in the product confidence word should be the source of this information.

- Over sea, if the nadir-view *and* forward-view 12.0μm and 11.0μm brightness temperatures are available for a pixel, the dual-view sea-surface temperature is always retrieved, irrespective of whether the nadir-view and/or forward-view pixels are identified as cloud-contaminated. If the nadir- and forward-view 3.7μm brightness temperatures are available (and the pixel is in night-time), they are always included in the retrieval. The dual-view sea-surface temperature should of course be used with caution if either nadir- or forward-view pixels are identified as cloud-contaminated: the nadir-view and forward-view cloud-flags in the product confidence word should be the source of this information.

- Over land, sea-surface temperature retrieval is not performed. Both nadir-view and dual-view sea-surface temperature pixels contain nadir-view 11.0μm brightness temperatures. A flag in the confidence word identifies pixels which are over land.
- Similarly, sea-surface temperature retrieval cannot be performed when 12.0μm and/or 11.0μm brightness temperatures are unavailable. In such cases, both nadir-view and dual-view sea-surface temperature pixels contain nadir-view 11.0μm brightness temperatures (or the error codes associated with such pixels). Flags in the product confidence word identify when nadir-only and/or dual-view sea-surface temperature retrieval has not been performed.

6.5 Product size

Since the product contents are variable, product sizes are also variable. Table 22 provides approximate sizes for a range of typical product contents.

Product contents	# records	Size of product	Size per orbit
GSST-L (base-line)	3584	3.7mb	294mb
GSST-LX (base-line & x/y)	4608	4.7mb	377mb
GSST-LXC (base-line & x/y & cloud)	5632	5.8mb	461mb

Table 22: Gridded sea-surface temperature product: product sizes

7 Spatially-averaged brightness temperature/reflectance product (ABT)

7.1 General description

The spatially-averaged brightness temperature/reflectance product (ABT) contains ten-arcminute spatially-averaged brightness temperatures/reflectances, with associated positional and confidence information.

The ABT product contains spatially-averaged brightness temperatures/reflectances derived from up to a complete file of ATSR raw data (which may in most circumstances be considered to be equivalent to one ERS-1 orbit).

The ABT product has a variable length, though the largest volume of ATSR raw data which can contribute to a single spatially-averaged land-surface temperature product (approximately one orbit) places an upper limit on the product size.

7.2 Product format

The ABT product has a 48-byte fixed-length record structure. The contents of each product record are shown in table 23.

Time of data. The integer value containing the number of days since January 1st, 1950, does not include the current, incomplete day. Note that the time used within each record is the time of the first ATSR nadir-view scan within the orbit to contribute to the spatially-averaged brightness temperature/reflectance derivation.[1] The variable nature of cloud-cover makes it impossible to predict the position of this scan relative to the centre of the half-degree cell. Under any circumstances, this time cannot be more than approximately six seconds from the time at which the centre of the cell is scanned by the nadir view.

Latitude. The latitude is provided as a cell number. The edges of ten-arcminute cells are sections of parallels and meridians. The latitude cells are numbered from the South Pole to the North Pole, in the range 0 to 1079. Latitude cell number 0 extends from 90° South to 89°50' South; latitude cell number 359 extends from 89°50' North to 90° North. The latitude of the cell centre may be derived by:

$$latitude = ((lat\_cell\_num - 540.0)/6.0) + 0.0833.$$

Longitude. The longitude is provided as a cell number. The edges of ten-arcminute cells are sections of parallels and meridians. The longitude cells are numbered from 180° West to 180° East, in the range 0 to 2159. Longitude cell number 0 extends from 180° West to 179°50' West; longitude cell number 2159 extends from 179°50' East to 180° East. The longitude of the cell centre may be derived by:

$$longitude = ((lon\_cell\_num - 1080.0)/6.0) + 0.0833.$$

Mean across-track band number. The five across-track bands (numbered 0 to 4) are symmetric about the ground-track. Each band is 50km wide (except the fifth, which is 62km wide, and extends to the edge of the swath).

7.3 Product record types

There are six types of ABT product record:

- Thermal infra-red/near-infra-red channels (12.0μm, 11.0μm, 3.7μm, 1.6μm):

[1] Though note that, if and when no nadir data contributed to the temperature derivation, the time of the first contributing forward-view scan is used.

Byte range	Parameter description	Type	Unit
0 – 3	Time of data (days since January 1st, 1950)	Integer	Days
4 – 7	Time of data (seconds within current day)	Integer	Seconds
8 – 9	Latitude of ten-arcminute cell	Integer	Cell
10 – 11	Longitude of ten-arcminute cell	Integer	Cell
12 – 13	Mean across-track band number	Integer	None
	Nadir-view		
14 – 15	Spatially-averaged 12.0μm brightness temperature (or 1.6μm reflectance)	Integer	K/100 or %/100
16 – 17	12.0μm or 1.6μm pixel count	Integer	None
18 – 19	Spatially-averaged 11.0μm brightness temperature (or 0.87μm reflectance)	Integer	K/100 or %/100
20 – 21	11.0μm or 0.87μm pixel count	Integer	None
22 – 23	Spatially-averaged 3.7μm brightness temperature (or 0.65μm reflectance)	Integer	K/100 or %/100
24 – 25	3.7μm or 0.65μm pixel count	Integer	None
26 – 27	Spatially-averaged 1.6μm reflectance (or 0.55μm reflectance)	Integer	%/100
28 – 29	1.6μm or 0.55μm pixel count	Integer	None
	Forward-view		
30 – 31	Spatially-averaged 12.0μm brightness temperature (or 1.6μm reflectance)	Integer	K/100 or %/100
32 – 33	12.0μm or 1.6μm pixel count	Integer	None
34 – 35	Spatially-averaged 11.0μm brightness temperature (or 0.87μm reflectance)	Integer	K/100 or %/100
36 – 37	11.0μm or 0.87μm pixel count	Integer	None
38 – 39	Spatially-averaged 3.7μm brightness temperature (or 0.65μm reflectance)	Integer	K/100 or %/100
40 – 41	3.7μm or 0.65μm pixel count	Integer	None
42 – 43	Spatially-averaged 1.6μm reflectance (or 0.55μm reflectance)	Integer	%/100
44 – 45	1.6μm or 0.55μm pixel count	Integer	None
46 – 47	Confidence word, as described in table 24	None	None

Table 23: Spatially-averaged brightness temperature/reflectance product: contents of product record

- over cloud-free sea;
- over cloud-free land;
- over cloud.

- Visible/near-infra-red channels (1.6μm, 0.87μm, 0.65μm, 0.55μm):
  - over cloud-free sea;
  - over cloud-free land;
  - over cloud.

This combination of product records allows the pixel types and channel types to be stored clearly and efficiently in the product. It follows that the product contains up to six records for each ten-arcminute cell: the actual number depends on the presence of cloud/land, and the availability of thermal/visible channels. Note that the 1.6μm channel is present in thermal/nir *and* visible/nir records.

The type of each product record may be determined using the combination of flags in the confidence word. There are flags which identify thermal/nir and visible/nir records, and which identify sea/land/cloud records. Note that separate records are used for the cloud-free pixels over sea and the cloud-free pixels over land, within a particular ten-arcminute cell, but that a single record is used for all cloudy pixels within a cell. Since the cloud within a cell may be over both land and sea, two flags are required to identify the surface type(s).

Bit #	Meaning if set
0 (lsb)	Record contains thermal infra-red channels (12.0μm, 11.0μm, 3.7μm, 1.6μm)
1	Record contains visible/near-infra-red channels (1.6μm, 0.87μm, 0.65μm, 0.55μm)
2	Record contains cloud-free pixels over sea
3	Record contains cloud-free pixels over land
4	Record contains cloudy pixels over sea
5	Record contains cloudy pixels over land
6	Nadir-view contains day-time data (night-time if zero)
7	Forward-view contains day-time data (night-time if zero)
8 – 15 (msb)	Unused

Table 24: Spatially-averaged brightness temperature/reflectance product: confidence word

7.4 Notes

- No explicit or implicit ordering of product values may be assumed. The Earth-location must be derived using the latitude and longitude information provided with each record.

7.5 Product size

The estimated size of the ABT product is 0.5mb/orbit for ATSR-1, and 0.75mb/orbit for ATSR-2, which includes visible channels.

8 Spatially-averaged cloud temperature/coverage product (ACLOUD)

8.1 General description

The spatially-averaged cloud temperature/coverage product (ACLOUD) contains information concerning the temperature and abundance of cloud within the ATSR nadir and forward views, at a half-degree spatial resolution, with associated positional and confidence information.

The ACLOUD product contains spatially-averaged cloud temperature/coverage information derived from up to a complete file of ATSR raw data (which may in most circumstances be considered to be equivalent to one ERS-1 orbit).

The ACLOUD product has a variable length, though the largest volume of ATSR raw data which can contribute to a single spatially-averaged cloud temperature/coverage product (approximately one orbit) places an upper limit on the product size.

8.2 Cloud temperature/coverage derivation

It should be emphasised that *cloudy pixels*, in the context of the cloud temperature/coverage product, are those pixels which have been identified as cloudy by SADIST's cloud-identification tests. No assurance can be made that all true cloud will be detected by such tests; nor that all detected pixels will be truly cloudy.

Cloud temperature and coverage results are derived independently for the nadir and forward views; no attempt is made to combine the two views within a cloud temperature retrieval algorithm. Similarly, no attempt is made to combine information from ATSR's multiple detectors. All cloud temperature information within this product is based on brightness temperatures from the 11.0μm channel.

For reasons of processing efficiency, derivation of cloud temperatures (i.e. calculation of brightness temperature means) proceeds via the construction of a histogram of 11.0μm brightness temperatures within each half-degree cell. Each histogram records the distribution of brightness temperatures of cloudy pixels from 190.0 Kelvin to 290.0 Kelvin, at a 0.1 Kelvin resolution, within 1000 boxes; the first box records the number of cloudy pixels with 11.0μm brightness temperatures between 190.0 Kelvin and 190.1 Kelvin; the last box records the number of cloudy pixels with 11.0μm brightness temperatures between 289.9 Kelvin and 290.0 Kelvin. It can be seen that construction of the 0.1 Kelvin histogram involves a loss of the precision with which brightness temperatures are known.

No cloud temperature derivation is performed if fewer than 20 cloudy pixels have been identified, in either view. If sufficient pixels *have* been identified, two cloud temperatures are calculated, via the 0.1 Kelvin histogram.

The first is a simple mean of the 11.0μm brightness temperatures of all cloudy pixels. The second is an attempt to derive a cloud-top temperature; the 11.0μm brightness temperatures of only the coldest 25% of the cloudy pixels contribute to this derivation.

The product also contains the numbers of cloudy and cloud-free pixels which have been located. From these numbers, the percentage cloud-cover is derived, and is provided.

8.3 Product format

The ACLOUD product has a fixed-length 244-byte record format. The contents of each product record are shown in table 25.

Time of data. The integer value containing the number of days since January 1st, 1950, does not include the current, incomplete day. Note that the time used within each record is the time of the first ATSR nadir-view scan within the orbit to contribute to the spatially-averaged sea-surface temperature derivation. The variable nature of cloud-cover makes it impossible to predict the position of this scan

Byte range	Parameter description	Type	Unit
0 – 3	Time of data (days since January 1st, 1950)	Integer	Days
4 – 7	Time of data (seconds within current day)	Integer	Seconds
8 – 9	Latitude of half-degree cell	Integer	Cell
10 – 11	Longitude of half-degree cell	Integer	Cell
12 – 13	Mean across-track band number	Integer	None
	Nadir-view		
14 – 15	Number of cloudy pixels	Integer	None
16 – 17	Number of cloud-free pixels	Integer	None
18 – 19	Spatially-averaged 11.0μm brightness temperature of all cloudy pixels	Integer	K/100
20 – 21	Standard deviation of 11.0μm brightness temperatures of all cloudy pixels	Integer	K/100
22 – 23	Lowest 11.0μm brightness temperature of cloudy pixels	Integer	K/100
24 – 25	Cloud-top temperature: spatially-averaged 11.0μm brightness temperature of coldest 25% of cloudy pixels	Integer	K/100
26 – 27	Percentage cloud-cover	Integer	%/100
28 – 127	One Kelvin histogram of 11.0μm brightness temperatures of all cloudy pixels	Integer	None
	Forward-view		
128 – 129	Number of cloudy pixels	Integer	None
130 – 131	Number of cloud-free pixels	Integer	None
132 – 133	Spatially-averaged 11.0μm brightness temperature of all cloudy pixels	Integer	K/100
134 – 135	Standard deviation of 11.0μm brightness temperatures of all cloudy pixels	Integer	K/100
136 – 137	Lowest 11.0μm brightness temperature of cloudy pixels	Integer	K/100
138 – 139	Cloud-top temperature: spatially-averaged 11.0μm brightness temperature of coldest 25% of cloudy pixels	Integer	K/100
140 – 141	Percentage cloud-cover	Integer	%/100
142 – 241	One Kelvin histogram of 11.0μm brightness temperatures of all cloudy pixels	Integer	None
242 – 243	Confidence word associated with spatially-averaged cloud temperature/coverage derivation, as described in table 26	None	None

Table 25: Spatially-averaged cloud temperature/coverage product: contents of product record

relative to the centre of the half-degree cell. Under any circumstances, this time cannot be more than approximately six seconds from the time at which the centre of the cell is scanned by the nadir view.

Latitude. The latitude is provided as a cell number. The edges of half-degree cells are sections of parallels and meridians. The latitude cells are numbered from the South Pole to the North Pole, in the range 0 to 359. Latitude cell number 0 extends from 90° South to 89° South; latitude cell number 359 extends from 89° North to 90° North. The latitude of the cell centre may be derived by:

$$latitude = ((lat\_cell\_num - 180.0)/2.0) + 0.25.$$

Longitude. The longitude is provided as a cell number. The edges of half-degree cells are sections of parallels and meridians. The longitude cells are numbered from 180° West to 180° East, in the range 0 to 719. Longitude cell number 0 extends from 180° West to 179° West; longitude cell number 719 extends from 179° East to 180° East. The longitude of the cell centre may be derived by:

$$longitude = ((lon\_cell\_num - 360.0)/2.0) + 0.25.$$

Mean across-track band number. The five across-track bands (numbered 0 to 4) are symmetric about the ground-track. Each band is 50km wide (except the fifth, which is 62km wide, and extends to the edge of the swath).

Number of cloudy pixels. This is the number of pixels within the half-degree cell which were identified as cloudy by the SADIST cloud-identification tests. Note that, since the surface area covered by a half-degree cell decreases towards the poles, the maximum value this parameter may have will also decrease (to a limit of zero at the poles themselves). Note also that, since no cloud temperature/coverage information may be derived using fewer than 20 cloudy pixels, 20 is the practical minimum for this parameter.

Number of cloud-free pixels. This is the number of pixels within the half-degree cell which were identified as cloud-free by the SADIST cloud-identification tests. Note that, since the surface area covered by a half-degree cell decreases towards the poles, the maximum value this parameter may have will also decrease (to a limit of zero at the poles themselves). This parameter may be zero.

Spatially-averaged brightness temperature of all cloudy pixels. This mean is calculated from the 0.1 Kelvin histogram described in Section 10.2. Therefore, although it is supplied at a precision of 0.01 Kelvin, its accuracy (with respect to the *true* mean), can only be assumed to be ±0.05 Kelvin. The derivation is:

$$mean\_of\_cloudy = 19000 + 10 \times \frac{\sum_{i=0}^{999}((i+0.5) \times histogram[i])}{\sum_{i=0}^{999} histogram[i]}$$

Standard deviation of brightness temperatures of cloudy pixels. Again, this is calculated from the 0.1 Kelvin histogram, described above, so its accuracy (with respect to the *true* mean), can only be assumed to be ±0.05 Kelvin. The derivation is:

$$sd\_of\_cloudy = 10 \times \sqrt{\frac{\sum_{i=0}^{999}(((i+0.5)-((mean\_of\_cloudy-19000)/10)) \times histogram[i])^2}{(\sum_{i=0}^{999} histogram[i])-1}}$$

Lowest 11.0μm brightness temperature of cloudy pixels. This is simply the lowest 11.0μm brightness temperature of the pixels identified as cloudy within the half-degree cell.

Cloud-top temperature. This value, which is known as the cloud-top temperature (though which makes no great claims to represent exactly that physical parameter), is calculated from the 0.1 Kelvin histogram, described above. Only the coldest 25% of the histogram is used; that is, only those histogram boxes up to and including that which contains the twenty-fifth percentile are included within the mean derivation.

Its accuracy (with respect to the *true* mean of the coldest 25% of the cloudy pixels) can only be assumed to be ±0.05 Kelvin. The derivation is:

$$ctt = 19000 + 10 \times \frac{\sum_{i=0}^{n}((i+0.5) \times histogram[i])}{\sum_{i=0}^{n} histogram[i]}$$

where n is the histogram box containing the twenty-fifth percentile.

Percentage cloud-cover. This is the percentage of all pixels within the half-degree cell which were identified as cloudy by the SADIST cloud-identification tests. The derivation is:

$$percentage\_cover = 10000 \times \frac{number\_of\_cloudy\_pixels}{number\_of\_cloudy\_pixels + number\_of\_cloud\_free\_pixels}$$

since the percentage is provided in units of %/100. Values of percentage cloud-cover for half-degree cells within across-track band 4 of the ATSR swath should be used with caution; such cells may not be wholly covered by the swath.

One Kelvin histogram of 11.0μm brightness temperatures of all cloudy pixels. This histogram, which describes the temperature distribution of the pixels identified as cloudy, is derived from the 0.1 Kelvin histogram constructed during calculation of the spatially-averaged cloud temperatures shown above. The derivation involves two steps:

1. The 0.1 Kelvin histogram is reduced to a 1.0 Kelvin histogram, by merging histogram boxes in groups of ten.
2. The 1.0 histogram is normalised, so that each histogram value may be represented by a single byte. The normalisation is:

   $$normalised\_value[i] = 255 \times \frac{merged\_histogram[i]}{merged\_histogram[max]}$$

   where i is each of the boxes of the (merged) 1.0 Kelvin histogram (from 0 to 99), and *max* is the histogram box containing the largest number of cloudy pixels.

The resulting 1.0 Kelvin histogram is a one-hundred element array of one-byte normalised values, scaled so that a value of 255 represents the most populous histogram box. The first histogram box represents brightness temperatures between 190.0 Kelvin and 191.0 Kelvin; the last histogram box represents brightness temperatures between 289.0 Kelvin and 290.0 Kelvin. Note that the values within the normalised histogram remain in correct proportion, so the values of the number of cloudy and cloud-free pixels may be used to (approximately) reconstitute the original (non-normalised) 1.0 Kelvin histogram.

Bit #	Meaning if set
0 (lsb)	Contributing nadir-view data acquired during day-time
1	Contributing forward-view data acquired during day-time
2	Half-degree cell contains land
3	Half-degree cell contains sea
4 – 15 (msb)	Unused

Table 26: Spatially-averaged cloud temperature/coverage product: confidence word

8.4 Notes

- No explicit or implicit ordering of product values may be assumed. The Earth-location must be derived using the latitude and longitude information provided with each cloud temperature/coverage record.
- Note that, apart from the time/position information, and the confidence word, all product contents are duplicated for nadir and forward views. There is no attempt to combine nadir and forward views within a cloud temperature retrieval algorithm.

8.5 Exceptional values

Exceptional values within the spatially-averaged cloud temperature/coverage product are described in table 27.

Parameter	Value	Reason
Number of cloudy pixels	-999	Fewer than 20 cloudy pixels identified
Number of cloud-free pixels	-999	Fewer than 20 cloudy pixels identified
Spatially-averaged brightness temperature	-999	Fewer than 20 cloudy pixels identified
Standard deviation of brightness temperatures	-999	Fewer than 20 cloudy pixels identified
Lowest brightness temperature	-999	Fewer than 20 cloudy pixels identified
Cloud-top temperature	-999	Fewer than 20 cloudy pixels identified
Percentage cloud-cover	-999	Fewer than 20 cloudy pixels identified

Table 27: Spatially-averaged cloud temperature/coverage product: exceptional values

8.6 Product size

The estimated size of the ACLOUD product is 2mb/orbit for both ATSR-1 and ATSR-2.

9 Spatially-averaged sea-surface temperature product (ASST)

9.1 General description

The spatially-averaged sea-surface temperature product (ASST) contains ten-arcminute spatially-averaged sea-surface temperatures, grouped into half-degree cells, with associated positional and confidence information.

The ASST product contains spatially-averaged sea-surface temperatures derived from up to a complete file of ATSR raw data (which may in most circumstances be considered to be equivalent to one ERS-1 orbit).

The ASST product has a variable length, though the largest volume of ATSR raw data which can contribute to a single spatially-averaged sea-surface temperature product (approximately one orbit) places an upper limit on the product size.

9.2 Product format

The ASST product has a fixed-length 58-byte record format. The contents of each product record are shown in table 28.

Byte range	Parameter description	Type	Unit
0 – 3	Time of data (days since January 1st, 1950)	Integer	Days
4 – 7	Time of data (seconds within current day)	Integer	Seconds
8 – 9	Latitude of half-degree cell	Integer	Cell
10 – 11	Longitude of half-degree cell	Integer	Cell
12 – 13	Mean across-track band number	Integer	None
14 – 15	Mean of nadir-only ten-arcminute spatially-averaged sea-surface temperatures	Integer	K/100
16 – 33	Nadir-only spatially-averaged sea-surface temperatures, 9 two-byte integers (one for each ten-arcminute cell)	Integer	K/100
34 – 35	Mean of dual-view ten-arcminute spatially-averaged sea-surface temperatures	Integer	K/100
36 – 53	Dual-view spatially-averaged sea-surface temperatures, 9 two-byte integers (one for each ten-arcminute cell)	Integer	K/100
54 – 57	Confidence word associated with spatially-averaged sea-surface temperature derivation, as described in table 29	None	None

Table 28: Spatially-averaged sea-surface temperature product: contents of product record

Time of data. The integer value containing the number of days since January 1st, 1950, does not include the current, incomplete day. Note that the time used within each record is the time of the first ATSR nadir-view scan within the orbit to contribute to the spatially-averaged sea-surface temperature derivation. The variable nature of cloud-cover makes it impossible to predict the position of this scan relative to the centre of the half-degree cell. Under any circumstances, this time cannot be more than approximately six seconds from the time at which the centre of the cell is scanned by the nadir view.

Latitude. The latitude is provided as a cell number. The edges of half-degree cells are sections of parallels and meridians. The latitude cells are numbered from the South Pole to the North Pole, in the range 0 to 359. Latitude cell number 0 extends from 90° South to 89°30' South; latitude cell number 719 extends from 89°30' North to 90° North. The latitude of the cell centre may be derived by:

$$latitude = ((lat\_cell\_num - 180.0)/2.0) + 0.25.$$

Longitude. The longitude is provided as a cell number. The edges of half-degree cells are sections of parallels and meridians. The longitude cells are numbered from 180° West to 180° East, in the range 0 to 719. Longitude cell number 0 extends from 180° West to 179°30' West; longitude cell number 719 extends from 179°30' East to 180° East. The longitude of the cell centre may be derived by:

$$longitude = ((lon\_cell\_num - 360.0)/2.0) + 0.25.$$

Mean across-track band number. The five across-track bands (numbered 0 to 4) are symmetric about the ground-track. Each band is 50km wide (except the fifth, which is 62km wide, and extends to the edge of the swath).

Ten-arcminute sea-surface temperatures. Each half-degree cell contains nine ten-arcminute cells. Where sufficient radiometric pixels are available, nadir-only and dual-view sea-surface temperatures are retrieved separately for each ten-arcminute cell. Each product record includes space for the potential nine nadir-only and nine dual-view sea-surface temperatures. The position of each ten-arcminute within the half-degree cell is implicit in the ten-arcminute ordering. Figure 1 shows the relative positions of the ten-arcminute cells, where North is towards the top of the page, and East is towards the right of the page.

Bit number(s)	Meaning if set
0 (lsb) – 8	Nadir-only ten-arcminute sea-surface temperature retrieval used 3.7μm channel (one bit per ten-arcminute cell)
9 – 17	Dual-view ten-arcminute sea-surface temperature retrieval used 3.7μm channel (one bit per ten-arcminute cell)
18	Nadir-view contains day-time data (night-time if zero)
19	Forward-view contains day-time data (night-time if zero)
20 – 31 (msb)	Unused

Table 29: Spatially-averaged sea-surface temperature product: confidence word

7	**8**	**9**
4	**5**	**6**
1	**2**	**3**

Figure 1: Spatially-averaged sea-surface temperature product: relative positions of ten-arcminute cells within half-degree cell

9.3 Notes

- No explicit or implicit ordering of product values may be assumed. The Earth-location must be derived using the latitude and longitude information provided with each sea-surface temperature record.

9.4 Product size

The estimated size of the ASST product is 100kb/orbit for both ATSR-1 and ATSR-2.

Draft specification of ATSR/SADIST-2 products

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30th November 1994

1 Introduction

This document is a draft specification of the scientific products from RAL's SADIST-2 ATSR data-processing software. Since SADIST-2 is being developed such that it can process data from both ATSR-1 and ATSR-2 instruments, the products described here have been designed to be sufficiently flexible and modular that they are equally valid for either instrument. SADIST-2 is intended to replace SADIST-1 as the definitive ATSR-1 data-processing software.

Forget the arcane processing levels which have riddled the SADIST product documentation until now. Part of the development of the products described here has been a deliberate blurring of the divisions between processing levels. There is no longer a rigid idea of the processing level a product belongs to, and therefore the things the product may legitimately contain. If the data-processing algorithms allow parameters to be made available in a product, they are now made available.

The set of products described in this document form three logical groups:

Ungridded products contain pixels in the ATSR scan geometry. There is a direct correspondence between the contents of a product record and the contents of an ATSR scan. Nadir- and forward-view pixels are contemporaneous, and have not been regridded or resampled.

Gridded products contain 512×512 pixel *images*. The correspondence between a pixel and the ATSR scan from which it came has been lost. Nadir- and forward-view pixels are collocated, and have been regridded onto a 1km grid.

Spatially-averaged products contain raw data (from up to a whole orbit) which have been spatially-averaged, to a ten-arcminute or half-degree resolution.

1.1 Ungridded products

There are two ungridded products:

UCOUNTS is an ungridded detector count product (an extension of the SADIST-1 COUNTS product). The product contains ungridded, uncalibrated detector counts from all or some of the ATSR-1/ATSR-2 detectors. Although the product remains ungridded, the product may optionally contain pixel latitude/longitude positions, and/or pixel x/y coordinates.

UBT is an ungridded brightness temperature/reflectance product (a new product for SADIST-2). The product contains ungridded, calibrated brightness temperatures or reflectances from all or some of the ATSR-1/ATSR-2 detectors. Although the product remains ungridded, the product may optionally contain pixel latitude/longitude positions, and/or pixel x/y coordinates.

1.2 Gridded products

There are three gridded products.

GBT is a gridded brightness temperature/reflectance product (an extension of the SADIST-1 BT product). The product contains gridded, calibrated brightness temperature/reflectance images from all or some of the ATSR-1/ATSR-2 detectors. The product optionally includes pixel latitude/longitude positions, x/y offsets (sub-pixel positions), and the results of cloud-clearing/land-flagging.

GBROWSE is a gridded browse product (an extension of the SADIST-1 BROWSE product). The product contains gridded, sub-sampled, calibrated brightness temperature/reflectance images from all or some of the ATSR-1/ATSR-2 detectors. The product optionally includes the results of cloud-clearing/land-flagging.

GSST is a gridded sea-surface temperature product (an extension of the SADIST-1 SST product). The product contains gridded sea-surface temperature images using both nadir-only and dual-view retrieval algorithms. The product optionally includes pixel latitude/longitude positions, x/y offsets (sub-pixel positions), and the results of cloud-clearing/land-flagging.

1.3 Spatially-averaged products

There are three spatially-averaged products:

ABT is a spatially-averaged brightness temperature/reflectance product (a new product for SADIST-2). The product contains spatially-averaged brightness temperatures/reflectances from all or some of the ATSR-1/ATSR-2 detectors, categorised by surface type and cloud-presence.

ACLOUD is a spatially-averaged cloud temperature/coverage product (unchanged from the SADIST-1 ACLOUD product). The product contains spatially-averaged measures of cloud temperature and abundance.

ASST is a spatially-averaged sea-surface temperature product (an extension of the SADIST-1 ASST product). The product contains spatially-averaged sea-surface temperatures, at ten-arcminute and half-degree resolution, using nadir-only and dual-view retrieval algorithms.

A significant change in the algorithms by which spatially-averaged products are generated by SADIST-2, is that the pixels which contribute to such products are taken from *gridded* (and therefore collocated), rather than *ungridded* (and therefore uncollocated) pixel data. The benefits of this approach are:

- Spatially-averaged products may make use of the optimal performance of the SADIST cloud-clearing algorithms, which are most successful when applied to collocated pixel images;
- The gridding process results in a rectification of pixel sizes, which provides a more accurate spread of signal between nadir and forward views and across the ATSR swath.

Previously, in SADIST-1, the ungridded ATSR scan pixels were the basis of spatially-averaged product generation. Implicit in this process was an assumption that all ATSR pixels have the same size, and should therefore be given the same weight. This is clearly not so. Forward-view pixels are very much larger than nadir-view pixels, and pixels towards the edge of the swath are larger than pixels close to the ground-track. Both effects are due to the variability of path-length.

The business of regridding places each ATSR pixel into a 1×1km box. Again, this assumes all pixels have the same size. Regridding has two interesting effects. Pixels which are small, and whose Earth-locations are therefore very small, may be placed within the same 1×1km box (in which case the first would be overwritten).

Also, some pixels in the regridded image may remain unfilled. This unfilling occurs when pixels are large, and therefore further apart than 1km.

After regridding, each pixel image is "cosmetically" filled; that is, pixels which remain unfilled are filled by copying the nearest (filled) neighbour. It can be seen that this process of cosmetic filling has the effect of reconstituting original pixel sizes. Filling occurs only where actual pixels are large, and therefore widely-spaced, but have been squeezed into 1 x 1km boxes. Nearest-neighbour copying reverses the pixel squeezing, and allows pixels to expand to a more representative size.

This is a simplistic description, but the argument remains that the integrity of spatially-averaged products is improved when their generation uses regridded, rather than ungridded pixels. There is no bias towards the nadir-view, and towards the ground-track, where pixels are smallest.

1.4 Other products

SADIST-2 will also include a general-purpose auxiliary data product, whose principal use will be for the maintenance at RAL of a long-term archive of ATSR-1/ATSR-2 instrument performance, and short-term diagnosis of instrument anomalies. This product will be documented elsewhere.

At the time of writing, it is intended that the generation of the SADIST-1 products MWR and MCLOUD will not be continued into SADIST-2. The MWR product is redundant for ATSR-2, since the low-rate data tapes which will be the primary source of raw data for SADIST-2 will also include transcribed ATSR/M raw data, independent of the ATSR source packets.

1.5 SADIST-2 product header

The header shown in table 1 is present in *all* SADIST-2 products (though not all header contents are relevant to, and will be provided for, all products).

Byte range	# bytes	Parameter description	Type	Unit
0 – 59	60	Product file-name	Char	None
		Orbit and platform parameters		
60 – 80	21	Source of ERS-1 state vector used by orbit propagation	Char	None
81 – 95	15	Ascending node time (days since January 1st, 1950)	Real	Days
96 – 117	22	Universal time at ascending node	Char	None
118 – 153	3×12	Ascending node state vector position (x, y, z)	Real	Km
154 – 183	3×10	Ascending node state vector velocity (x, y, z)	Real	Km/s
184 – 193	10	Longitude of the ascending node	Real	Degrees
194 – 223	30	ERS-1/ERS-2 platform modes during product: YSM FCM OCM FPM RTMM RTMC	Char	None
		Instrument temperature parameters		
224 – 231	8	Stirling Cycle Cooler (SCC) cold-tip temperature	Real	Kelvin
232 – 287	7×8	Instrument detector temperatures, 12.0μm, 11.0μm, 3.7μm, 1.6μm, 0.87μm, 0.65μm, 0.55μm	Real	Kelvin
		Product optional contents parameters		
288 – 289	2	(N) Nadir-only records present	Integer	None
290 – 291	2	(T) Thermal infra-red detector records present	Integer	None
292 – 293	2	(V) Visible/near-infra-red detector records present	Integer	None
294 – 295	2	(L) Latitude/longitude records present	Integer	None
296 – 297	2	(X) x/y coordinate records present	Integer	None
298 – 299	2	(C) Cloud-clearing/land-flagging records present	Integer	None
		Product position and time parameters		
300 – 305	6	Along-track distance of start of product	Integer	Km
306 – 311	6	Along-track distance of end of product	Integer	Km
312 – 332	21	Universal time at start of product	Char	None
333 – 353	21	Universal time at end of product	Char	None
354 – 393	4×10	Latitudes of product corner-points	Real	Degrees
394 – 433	4×10	Longitudes of product corner-points	Real	Degrees
		Solar angle parameters **(not spatially-averaged products)**		
434 – 521	11×8	Solar elevations at 11 points along central nadir scan	Real	Degrees
522 – 609	11×8	Pixel-to-sun/pixel-to-ERS1 elevation differences at 11 points along central nadir scan	Real	Degrees
610 – 697	11×8	ERS1-to-sun/ERS1-to-pixel azimuth differences at 11 points along central nadir scan	Real	Degrees
698 – 785	11×8	Solar elevations at 11 points along central forward scan	Real	Degrees
786 – 873	11×8	Pixel-to-sun/pixel-to-ERS1 elevation differences at 11 points along central forward scan	Real	Degrees
874 – 961	11×8	ERS1-to-sun/ERS1-to-pixel azimuth differences at 11 points along central forward scan	Real	Degrees

Table 1: SADIST-2 product header

2 Ungridded detector count product (UCOUNTS)

2.1 General description

The ungridded detector count product (UCOUNTS) contains ATSR-1/ATSR-2 detector counts from up to 512 consecutive instrument scans, with optional pixel positional information.

The data are uncollocated and ungeolocated; that is, the nadir and forward views are contemporaneous (and therefore are separated along-track by approximately 900km), and retain the ATSR scan geometry.

Also contained are ancillary values which provide: detector counts obtained from views of the ATSR hot and cold black-body calibration targets; detector counts obtained from views of the ATSR-2 VISCAL unit; measured temperatures of the black bodies; coefficients for use during calibration of the detector signals (detector counts to brightness temperatures); and signal channel processor (SCP) gains and offsets for each of the detectors.

2.2 Product format

The UCOUNTS product has a fixed-length 2048-byte record format. Table 2 shows the maximum of 14 product records which may be present within the UCOUNTS product for every ATSR scan.

Record #	Code	Contents	Unit
1	T	12.0μm detector record, as described by table 3	n/a
2	T	11.0μm detector record	n/a
3	T	3.7μm detector record	n/a
4	T/V	1.6μm detector record	n/a
5	V	0.87μm detector record (ATSR-2 only)	n/a
6	V	0.65μm detector record (ATSR-2 only)	n/a
7	V	0.55μm detector record (ATSR-2 only)	n/a
8	L	Latitudes of nadir-view pixels 0–511, 512 four-byte integers	degrees/1000
9	L	Latitudes of nadir-view pixels 512–554 and forward-view pixels 0–370, 414 four-byte integers	degrees/1000
10	L	Longitudes of nadir-view pixels 0–511, 512 four-byte integers	degrees/1000
11	L	Longitudes of nadir-view pixels 512–554 and forward-view pixels 0–370, 414 four-byte integers	degrees/1000
12	X	x-coordinates (across-track) of nadir- and forward-view pixels, 926 signed two-byte integers	km
13	X	y-coordinate (along-track) of nadir- and forward-view pixels, 926 unsigned two-byte integers	km
14	X	x-coordinate offsets (across-track) of nadir- and forward-view pixels, 926 unsigned one-byte integers y-coordinate offsets (along-track) of nadir- and forward-view pixels, 926 unsigned one-byte integers	km/256 km/256

Table 2: Ungridded detector count product: records for single ATSR scan

The product contents are variable, and are determined by the precise nature of the product request. The records provided for each ATSR scan may be requested/omitted in logical groups:

- (T) Thermal infra-red detector records (12.0μm, 11.0μm, 3.7μm, 1.6μm);
- (V) Visible/near-infra-red detector records (1.6μm, 0.87μm, 0.65μm, 0.55μm);

- (L) Pixel latitude/longitude positions;
- (X) Pixel x/y coordinate positions.

Note that, since the nadir and forward views remain uncollocated in this product, latitude/longitude and x/y coordinate information must be provided separately for nadir- and forward-view pixels. This necessarily increases the product size.

The base-line (default) ATSR-1 UCOUNTS product includes the thermal infra-red detector (T) records, but omits all other records. If required, they must be requested explicitly. The base-line (default) ATSR-2 UCOUNTS product includes the thermal and visible/nir detector (TV) records, but omits the latitude/longitude and x/y coordinate records.

UCOUNTS products include within their file-name extensions, the codes required to identify the product contents. For example, a UCOUNTS product with a file-name extension

UCOUNTS.VX

includes only the visible/nir detector records, and the x/y coordinate records, and a UCOUNTS product with a file-name extension

UCOUNTS-TVL

includes all detector records, and the latitude/longitude records. It can be seen that the base-line ATSR-1 and ATSR-2 products are defined by:

UCOUNTS-T

and

UCOUNTS-TV

respectively. Note that the visible detectors are unavailable for ATSR-1 products. Note also that the 1.6μm near-infra-red channel is supplied as part of the thermal infra-red *and* visible/nir detector records. If, for ATSR-2, all detectors are requested, the 1.6μm detector record is provided only once in the product.

Table 3 describes the contents of each detector record. Note that detector counts in the 12.0μm and 0.87μm detector records are negated to show the presence of the blanking pulse. To avoid confusion between (negative) error codes and blanking-pulsed counts, the blanking pulse is represented in this way only when the detector count is greater than the absolute value of all error codes.

2.3 Exceptional values

Table 4 lists the exceptional values which may be encountered within the UCOUNTS product.

2.4 Product size

Since the product contents are variable, product sizes are also variable. Table 5 provides approximate sizes for a range of typical product contents.

Byte range	Parameter description	Type	Unit
0 – [illegible]	Time of scan (days since January 1st, 195[illegible]	Integer	Days
4 – [illegible]	Time of scan (milliseconds within current day)	Integer	msecs
8 – 1117	555 two-byte nadir-view pixel detector counts (12.0μm & 0.87μm negated to show presence of blanking pulse)	Integer	None
1118 – 1859	371 two-byte forward-view pixel detector counts (12.0μm & 0.87μm negated to show presence of blanking pulse)	Integer	None
1860 – 1891	16 two-byte plus black body (+bb) pixel detector counts (12.0μm & 0.87μm negated to show presence of blanking pulse)	Integer	None
1892 – 1923	16 two-byte minus black body (-bb) pixel detector counts (12.0μm & 0.87μm negated to show presence of blanking pulse)	Integer	None
1924 – 1955	16 two-byte VISCAL unit detector counts (12.0μm & 0.87μm negated to show presence of blanking pulse)	Integer	None
1956 – 1983	7 four-byte measured plus black body (+bb) temperatures	Integer	K/1000
1984 – 2011	7 four-byte measured minus black body (-bb) temperatures	Integer	K/1000
2012 – 2015	Four-byte calibration bias for even pixels	Integer	1/1000000
2016 – 2019	Four-byte calibration bias for odd pixels	Integer	1/1000000
2020 – 2023	Four-byte calibration slope for even pixels	Integer	1/1000000
2024 – 2027	Four-byte calibration slope for odd pixels	Integer	1/1000000
2028 – 2031	Gain used by signal channel processor (SCP)	Integer	None
2032 – 2035	Offset used by signal channel processor (SCP)	Integer	None
2036 – 2039	IDF scan count when SCP gain/offset last changed	Integer	None
2040 – 2047	Unused	None	None

Table 3: Ungridded detector count product: detector record

Parameter	Value	Reason
Detector count	-1	Entire scan absent from telemetry
	-2	Pixel absent from telemetry (possible reasons are disablement of channel, or visible channel fixed to narrow swath)
	-3	No signal in channel (zero count)
	-4	Saturation in channel (4095 count)

Table 4: Ungridded detector count product: exceptional values

Product contents	# records/scan	Size of product	Size/orbit
UCOUNTS-T (ATSR-1 base-line)	4	4.2mb	336mb
UCOUNTS-TL (ATSR-1 base-line & lat/long)	8	8.4mb	671mb
UCOUNTS-TLX (ATSR-1 base-line & lat/long & x/y)	11	11.5mb	923mb
UCOUNTS-TV (ATSR-2 base-line)	7	7.3mb	587mb
UCOUNTS-TVL (ATSR-2 base-line & lat/long)	11	11.5mb	923mb
UCOUNTS-TVLX (ATSR-2 base-line & lat/long & x/y)	14	14.7mb	1.17gb

Table 5: Ungridded detector count product: product sizes

3 Ungridded brightness temperature/reflectance product (UBT)

3.1 General description

The ungridded brightness temperature/reflectance product (UBT) contains calibrated ATSR-1/ATSR-2 brightness temperatures and/or reflectances from up to 512 consecutive instrument scans, with optional pixel positional information.

The data are uncollocated and ungeolocated; that is, the nadir and forward views are contemporaneous (and therefore are separated along-track by approximately 900km), and retain the ATSR scan geometry.

Also contained are ancillary values which provide: detector counts obtained from views of the ATSR hot and cold black-body calibration targets, detector counts obtained from views of the ATSR-2 VISCAL unit; measured temperatures of the black bodies; coefficients for use during calibration of the detector signals (detector counts to brightness temperatures); and signal channel processor (SCP) gains and offsets for each of the detectors.

3.2 Product format

The UBT product has a fixed-length 2048-byte record format. Table 6 shows the maximum of 14 product records which may be present within the UBT product for every ATSR scan.

Record #	Code	Contents	Unit
1	T	12.0μm detector record, as described by table 7	n/a
2	T	11.0μm detector record	n/a
3	T	3.7μm detector record	n/a
4	T/V	1.6μm detector record	n/a
5	V	0.87μm detector record (ATSR-2 only)	n/a
6	V	0.65μm detector record (ATSR-2 only)	n/a
7	V	0.55μm detector record (ATSR-2 only)	n/a
8	L	Latitudes of nadir-view pixels 0–511, 512 four-byte integers	degrees/1000
9	L	Latitudes of nadir-view pixels 512–554 and forward-view pixels 0–370, 414 four-byte integers	degrees/1000
10	L	Longitudes of nadir-view pixels 0–511, 512 four-byte integers	degrees/1000
11	L	Longitudes of nadir-view pixels 512–554 and forward-view pixels 0–370, 414 four-byte integers	degrees/1000
12	X	x-coordinates (across-track) of nadir- and forward-view pixels, 926 signed two-byte integers	km
13	X	y-coordinates (along-track) of nadir- and forward-view pixels, 926 unsigned two-byte integers	km
14	X	x-coordinate offsets (across-track) of nadir- and forward-view pixels, 926 unsigned one-byte integers y-coordinate offsets (along-track) of nadir- and forward-view pixels, 926 unsigned one-byte integers	km/256 km/256

Table 6: Ungridded brightness temperature/reflectance product: records for single ATSR scan

The product contents are variable, and are determined by the precise nature of the product request. The records provided for each ATSR scan may be requested/omitted in logical groups:

- (T) Thermal infra-red detector records (12.0μm, 11.0μm, 3.7μm, 1.6μm);
- (V) Visible/near-infra-red detector records (1.6μm, 0.87μm, 0.65μm, 0.55μm);
- (L) Pixel latitude/longitude positions;
- (X) Pixel x/y coordinate positions.

Note that, since the nadir and forward views remain uncollocated in this product, latitude/longitude and x/y coordinate information must be provided separately for nadir- and forward-view pixels. This necessarily increases the product size.

The base-line (default) ATSR-1 UBT product includes the thermal infra-red detector (T) records, but omits all other records. If required, they must be requested explicitly. The base-line (default) ATSR-2 UBT product includes the thermal and visible/nir detector (TV) records, but omits the latitude/longitude and x/y coordinate records.

UBT products include within their file-name extensions, the codes required to identify the product contents. For example, a UBT product with the file-name extension

UBT-VX

includes only the visible/nir detector records; and the x/y coordinate records, and a UBT product with the file-name extension

UBT-TVL

includes all detector records, and the latitude/longitude records. It can be seen that the base-line ATSR-1 and ATSR-2 products are defined by

UBT-T

and

UBT-TV

respectively. Note that the visible detectors are unavailable for ATSR-1 products, and for ATSR-2 products during night-time. Note also that the 1.6μm near-infra-red channel is supplied as part of the thermal infra-red *and* visible/nir detector records. If, for ATSR-2, all detectors are requested, the 1.6μm detector record is provided only once in the product.

Table 7 describes the contents of each detector record. Note that brightness temperatures/reflectances in the 12.0μm and 0.87μm detector records are negated to show the presence of the blanking pulse. To avoid confusion between (negative) error codes and blanking-pulsed pixel values, the blanking pulse is only represented in this way when the brightness temperature/reflectance is greater than the absolute value of all error codes.

3.3 Exceptional values

Table 8 lists the exceptional values which may be encountered within the UBT product.

3.4 Product size

Since the product contents are variable, product sizes are also variable. Table 9 provides approximate sizes for a range of typical product contents.

Byte range	Parameter description	Type	Unit
0 – 3	Time of scan (days since January 1st, 1950)	Integer	Days
4 – 7	Time of scan (milliseconds within current day)	Integer	msecs
8 – 1117	(for thermal channels: 12.0μm, 11.0μm, 3.7μm) 555 two-byte nadir-view pixel brightness temperatures (for visible/nir channels: 1.6μm, 0.87μm, 0.65μm, 0.55μm) 555 two-byte nadir view pixel reflectances (12.0μm and 0.87μm negated to show presence of blanking pulse)	Integer Integer	K/100 %/100
1118 – 1859	(for thermal channels: 12.0μm, 11.0μm, 3.7μm) 371 two-byte forward-view pixel brightness temperatures (for visible/nir channels: 1.6μm, 0.87μm, 0.65μm, 0.55μm) 371 two-byte forward-view pixel reflectances (12.0μm and 0.87μm negated to show presence of blanking pulse)	Integer Integer	K/100 %/100
1860 – 1891	16 two-byte plus black body (+bb) pixel detector counts (12.0μm and 0.87μm negated to show presence of blanking pulse)	Integer	None
1892 – 1923	16 two-byte minus black body (-bb) pixel detector counts (12.0μm and 0.87μm negated to show presence of blanking pulse)	Integer	None
1924 – 1955	16 two-byte VISCAL unit detector counts (12.0μm and 0.87μm negated to show presence of blanking pulse)	Integer	None
1956 – 1983	7 four-byte measured plus black body (+bb) temperatures	Integer	K/1000
1984 – 2011	7 four-byte measured minus black body (-bb) temperatures	Integer	K/1000
2012 – 2015	Four-byte calibration bias for even pixels	Integer	1/1000000
2016 – 2019	Four-byte calibration bias for odd pixels	Integer	1/1000000
2020 – 2023	Four-byte calibration slope for even pixels	Integer	1/1000000
2024 – 2027	Four-byte calibration slope for odd pixels	Integer	1/1000000
2028 – 2031	Gain used by signal channel processor (SCP)	Integer	None
2032 – 2035	Offset used by signal channel processor (SCP)	Integer	None
2036 – 2039	IDF scan count when SCP gain/offset last changed	Integer	None
2040 – 2047	Unused	None	None

Table 7: Ungridded brightness temperature/reflectance product: detector record

Parameter	Value	Reason
Brightness temperature/ reflectance	-1	Entire scan absent from telemetry
	-2	Pixel absent from telemetry (possible reasons are disablement of channel, or visible channel fixed to narrow swath)
	-3	No signal in channel (zero count)
	-4	Saturation in channel (4095 count)
	-5	Derived radiance too small for calibration
	-6	Derived radiance too large for calibration
	-7	Calibration parameters unavailable for pixel

Table 8: Ungridded brightness temperature/reflectance product: exceptional values

Product contents	# records/scan	Size of product	Size per orbit
UBT-T (ATSR-1 base-line)	4	4.2mb	336mb
UBT-TL (ATSR-1 base-line & lat/long)	8	8.4mb	671mb
UBT-TLX (ATSR-1 base-line & lat/long & x/y)	11	11.5mb	923mb
UBT-TV (ATSR-2 base-line)	7	7.3mb	587mb
UBT-TVL (ATSR-2 base-line & lat/long)	11	11.5mb	923mb
UBT-TVLX (ATSR-2 base-line & lat/long & x/y)	14	14.7mb	1.17gb

Table 9: Ungridded brightness temperature/reflectance product: product sizes

4 Gridded brightness temperature/reflectance product (GBT)

4.1 General description

The gridded brightness temperature/reflectance product consists of 512×512km geolocated, collocated nadir- and forward-view brightness temperature and/or reflectance images, at a 1km resolution, from some or all available ATSR channels.

4.2 Product format

The GBT product has a fixed length 1024-byte record format. Table 10 shows the sequence of records within a complete product.

The actual product contents are variable, and are determined by the precise nature of the product request. The records may be requested/omitted in logical groups:

- (T) Thermal infra-red detector brightness temperature images (12.0μm, 11.0μm, 3.7μm, 1.6μm);
- (V) Visible/near-infra-red detector reflectance images (12.0μm, 11.0μm, 3.7μm, 1.6μm);
- (L) Pixel latitude/longitude positions;
- (X) Pixel x/y coordinate offsets;
- (C) Nadir- and forward-view cloud-clearing/land-flagging results.
- Also (N) may be used to request only nadir-view brightness temperature/reflectance images.

The base-line (default) ATSR-1 GBT product includes the thermal infra-red detector brightness temperature images (T), and the pixel latitude/longitude positions (L), but omits (natch) the visible/nir reflectance images (V), the pixel x/y coordinate offsets (X), and the cloud-clearing/land-flagging results (C). The base-line (default) ATSR-2 GBT product omits only the pixel x/y coordinate offsets and the cloud-clearing/land-flagging results.

GBT products include within their file-name extensions, the codes required to identify the product contents. For example, a GBT product with the file-name extension

GBT-VL

includes only the visible/nir reflectance images, and the pixel latitude/longitude positions; and a GBT product with the file-name extension

GBT-TVLC

includes all product contents, except for the pixel x/y coordinate offsets. It can be seen that the base-line ATSR-1 and ATSR-2 products are defined by

GBT-TL

and

GBT-TVL

respectively. Note that the visible detectors are unavailable for ATSR-1 products, and for ATSR-2 products during night-time. Note also that the 1.6μm near-infra-red channel is supplied as part of the thermal infra-red *and* visible/nir records. If, for ATSR-2, all detector records are requested, the 1.6μm reflectance images (nadir and forward views) are provided only once in the product.

Record #	Code	Contents	Unit
0–511	T	Nadir-view 12.0μm brightness temperature image, 512 records of 512 two-byte integers (12.0μm negated to show presence of blanking pulse)	K/100
512–1023	T	Nadir-view 11.0μm brightness temperature image, (11.0μm negated to show cosmetic fill)	K/100
1024–1535	T	Nadir-view 3.7μm brightness temperature image	K/100
1536–2047	T/V	Nadir-view 1.6μm reflectance image	%/100
2048–2559	V	Nadir-view 0.87μm reflectance image (ATSR-2 only (0.87μm negated to show presence of blanking pulse)	%/100
2560–3071	V	Nadir-view 0.65μm reflectance image (ATSR-2 only) (0.65μm negated to show cosmetic fill)	%/100
3072–3583	V	Nadir-view 0.55μm reflectance image (ATSR-2 only)	%/100
3584–4095	T (not N)	Forward-view 12.0μm brightness temperature image 512 records of 512 two-byte integers (12.0μm negated to show presence of blanking pulse)	K/100
4096–4607	T (not N)	Forward-view 11.0μm brightness temperature image (11.0μm negated to show cosmetic fill)	K/100
4608–5119	T (not N)	Forward-view 3.7μm brightness temperature image	K/100
5120–5631	T/V (not N)	Forward-view 1.6μm reflectance image	%/100
5632–6143	V (not N)	Forward-view 0.87μm reflectance image (ATSR-2 only) (0.87μm negated to show presence of blanking pulse)	%/100
6144–6655	V (not N)	Forward-view 0.65μm reflectance image (ATSR-2 only) (0.65μm negated to show cosmetic fill)	%/100
6656–7167	V (not N)	Forward-view 0.55μm reflectance image (ATSR-2 only)	%/100
7168–8191	L	Latitudes of image pixels, 1024 records of 256 four-byte integers	degrees/1000
8192–9215	L	Longitudes of image pixels, 1024 records of 256 four-byte integers	degrees/1000
9216–9471	X	x-coordinate offsets (across-track) of nadir-view pixels, 256 records of 1024 unsigned one-byte integers	km/256
9472–9727	X	y-coordinate offsets (along-track) of nadir-view pixels, 256 records of 1024 unsigned one-byte integers	km/256
9728–9983	X	x-coordinate offsets (across-track) of forward-view pixels, 256 records of 1024 unsigned one-byte integers	km/256
9984–10239	X	y-coordinate offsets (along-track) of forward-view pixels, 256 records of 1024 unsigned one-byte integers	km/256
10240–10751	C	Nadir-view cloud-clearing/land-flagging results, 512 records of 512 two-byte composite words, see table 11	n/a
10752–11263	C	Forward-view cloud-clearing/land-flagging results, 512 records 512 two-byte composite words, see table 11	n/a

Table 10: Gridded brightness temperature/reflectance product: product contents

Bit #	Meaning
0 (lsb)	Pixel is over land
1	Pixel is cloudy (result of all cloud tests)
2	Sunglint detected in pixel
3–15	**Individual cloud tests (bit set if pixel cloudy)**
3	1.6μm reflectance histogram test (day-time only)
4	1.6μm spatial coherence test (day-time only)
5	11.0μm spatial coherence test
6	12.0μm gross cloud test
7	11.0/12.0μm thin cirrus test
8	3.7/12.0μm medium/high level test (night-time only)
9	11.0/3.7μm fog/low-stratus test (night-time only)
10	11.0/12.0μm view-difference test
11	3.7/11.0μm view-difference test (night-time only)
12	11.0/12.0μm thermal histogram test
13–15	Unused

Table 11: Gridded brightness temperature/reflectance product: cloud-clearing/land-flagging results

Note that brightness temperatures in the 12.0μm records and reflectances in the 0.87μm records are negated to show the presence of the blanking pulse.

In the same way, brightness temperatures in the 11.0μm records and reflectances in the 0.65μm records are negated to show that pixels did not originate from the ATSR scan, but have been "cosmetically" copied from the nearest neighbour pixel.

To avoid confusion between (negative) error codes and blanking-pulsed/cosmetically-filled pixels, pixel negation is used in this way only when the brightness temperature/reflectance is greater than the absolute value of all error codes.

4.3 Exceptional values

Table 12 lists the exceptional values which may be encountered within the GBT product.

Parameter	Value	Reason
Brightness temperature/ reflectance	-1	Entire scan absent from telemetry
	-2	Pixel absent from telemetry (possible reasons are disablement of channel, or visible channel fixed to narrow swath)
	-3	No signal in channel (zero count)
	-4	Saturation in channel (4095 count)
	-5	Derived radiance too small for calibration
	-6	Derived radiance too large for calibration
	-7	Calibration parameters unavailable for pixel
	-8	Pixel unfilled (cosmetic filling algorithm unable to find nearest-neighbour pixel)

Table 12: Gridded brightness temperature/reflectance product: exceptional values

4.4 Product size

Since the product contents are variable, product sizes are also variable. Table 13 provides approximate sizes for a range of typical product contents.

Product contents	# records	Size of product	Size per orbit
GBT-TL (ATSR-1 base-line)	6144	6.3mb	503mb
GBT-TLX (ATSR-1 base-line & x/y)	7168	7.3mb	587mb
GBT-TLXC (ATSR-1 base-line & x/y & cloud)	8192	8.4mb	671mb
GBT-TVL (ATSR-2 base-line)	9216	9.4mb	755mb
GBT-TVLX (ATSR-2 base-line & x/y)	10240	10.5mb	839mb
GBT-TVLXC (ATSR-2 base-line & x/y & cloud)	11264	11.5mb	923mb

Table 13: Gridded brightness temperature/reflectance product: product sizes

5 Gridded browse product (GBROWSE)

5.1 General description

The gridded browse product (GBROWSE) consists of sub-sampled 512×512km geolocated, collocated nadir- and forward-view brightness temperature and/or reflectance images, at a 4km resolution, from some or all available ATSR channels.

5.2 Product format

The GBROWSE product has a fixed-length 256-byte record format. Table 14 shows the sequence of records within a complete product.

Record #	Code	Contents	Unit
0–127	T	Nadir-view 12.0μm brightness temperature image 128 records of 128 two-byte integers	K/100
128–255	T	Nadir-view 11.0μm brightness temperature image 128 records of 128 two-byte integers	K/100
256–383	T	Nadir-view 3.7μm brightness temperature image 128 records of 128 two-byte integers	K/100
384–511	T/V	Nadir-view 1.6μm reflectance image 128 records of 128 two-byte integers	%/100
512–639	V	Nadir-view 0.87μm reflectance image (ATSR-2 only) 128 records of 128 two-byte integers	%/100
640–767	V	Nadir-view 0.65μm reflectance image (ATSR-2 only) 128 records of 128 two-byte integers	%/100
768–895	V	Nadir-view 0.55μm reflectance image (ATSR-2 only) 128 records of 128 two-byte integers	%/100
896–1023	T (not N)	Forward-view 12.0μm brightness temperature image 128 records of 128 two-byte integers	K/100
1024–1151	T (not N)	Forward-view 11.0μm brightness temperature image 128 records of 128 two-byte integers	K/100
1152–1279	T (not N)	Forward-view 3.7μm brightness temperature image 128 records of 128 two-byte integers	K/100
1280–1407	T/V (not N)	Forward-view 1.6μm reflectance image 128 records of 128 two-byte integers	%/100
1408–1535	V (not N)	Forward-view 0.87μm reflectance image (ATSR-2 only) 128 records of 128 two-byte integers	%/100
1536–1663	V (not N)	Forward-view 0.65μm reflectance image (ATSR-2 only) 128 records of 128 two-byte integers	%/100
1664–1791	V (not N)	Forward-view 0.55μm reflectance image (ATSR-2 only) 128 records of 128 two-byte integers	%/100
1792–1919	C	Nadir-view cloud-clearing/land-flagging results, 128 records of 128 two-byte composite words, see table 15	n/a
1920–2047	C	Forward-view cloud-clearing/land-flagging results, 128 records of 128 two-byte composite words, see table 15	n/a

Table 14: Gridded browse product: product contents

The actual product contents are variable, and are determined by the precise nature of the product request. The records may be requested/omitted in logical groups:

Bit #	Meaning
0 (lsb)	Pixel is over land
1	Pixel is cloudy (result of all cloud tests)
2	Sunglint detected in pixel
3–15	**Individual cloud tests (bit set if pixel cloudy)**
3	1.6μm reflectance histogram test (day-time only)
4	1.6μm spatial coherence test (day-time only)
5	11.0μm spatial coherence test
6	12.0μm gross cloud test
7	11.0/12.0μm thin cirrus test
8	3.7/12.0μm medium/high level test (night-time only)
9	11.0/3.7μm fog/low-stratus test (night-time only)
10	11.0/12.0μm view-difference test
11	3.7/11.0μm view-difference test (night-time only)
12	11.0/12.0μm thermal histogram test
13–15	Unused

Table 15: Gridded browse product: cloud-clearing/land-flagging results

- (T) Thermal infra-red detector brightness temperature images (12.0μm, 11.0μm, 3.7μm, 1.6μm);
- (V) Visible/near-infra-red detector reflectance images (12.0μm, 11.0μm, 3.7μm, 1.6μm);
- (C) Nadir- and forward-view cloud-clearing/land-flagging results.
- Also (N) may be used to request only nadir-view brightness temperature/reflectance images.

The base-line (default) ATSR-1 GBROWSE product includes only the thermal infra-red detector brightness temperature images (T), The base-line (default) ATSR-1 GBROWSE product includes the thermal infra-red detector brightness temperature images (T), and the visible/near-infra-red reflectance images (V).

GBROWSE products include within their file-name extensions, the codes required to identify the product contents. For example, a GBROWSE product with the file-name extension

GBROWSE-VC

includes only the visible/nir reflectance images, and the cloud-clearing/land-flagging results; and a GBROWSE product with the file-name extension

GBT-TVC

includes all product contents. It can be seen that the base-line ATSR-1 and ATSR-2 products are defined by

GBROWSE-T

and

GBROWSE-TV

respectively. Note that the visible detectors are unavailable for ATSR-1 products, and for ATSR-2 products during night-time. Note also that the 1.6μm near-infra-red channel is supplied as part of the thermal infra-red *and* visible/nir records. If, for ATSR-2, all detector records are requested, the 1.6μm reflectance images (nadir and forward views) are provided only once in the product.

Parameter	Value	Reason
Brightness temperature/ reflectance	-1	Entire scan absent from telemetry
	-2	Pixel absent from telemetry (possible reasons are disablement of channel, or visible channel fixed to narrow swath)
	-3	No signal in channel (zero count)
	-4	Saturation in channel (4095 count)
	-5	Derived radiance too small for calibration
	-6	Derived radiance too large for calibration
	-7	Calibration parameters unavailable for pixel
	-8	Pixel unfilled (cosmetic filling algorithm unable to find nearest-neighbour pixel)

Table 16: Gridded browse product: exceptional values

5.3 Exceptional values

Table 16 lists the exceptional values which may be encountered within the GBROWSE product.

5.4 Product size

Since the product contents are variable, product sizes are also variable. Table 17 provides approximate sizes for a range of typical product contents.

Product contents	# records	Size of product	Size per orbit
GBROWSE-NT (ATSR-1 nadir-view only)	512	131kb	10.5mb
GBROWSE-T (ATSR-1 base-line)	1024	262kb	20.9mb
GBROWSE-TC (ATSR-1 base-line & cloud)	1280	328kb	26.2mb
GBROWSE-NTV (ATSR-2 nadir-view only)	896	229kb	18.3mb
GBROWSE-TV (ATSR-2 base-line)	1792	459kb	36.7mb
GBROWSE-TVC (ATSR-2 base-line & cloud)	2048	524kb	41.9mb

Table 17: Gridded browse product: product sizes

6 Gridded sea-surface temperature product (GSST)

6.1 General description

The gridded sea-surface temperature (GSST) product consists of 512×512km sea-surface temperature images, at 1km resolution, derived using nadir-only and nadir/forward-view retrieval algorithms, with precise pixel latitudes/longitudes and confidence information.

6.2 Product format

The GSST product has a fixed-length 1024-byte record format. Table 18 shows the sequence of records within a complete product.

Record #	Code	Contents	Unit
0–511	n/a	Nadir-only sea-surface temperature, 512 records of 512 two-byte integers	K/100
512–1023	n/a	Dual-view sea-surface temperature, 512 records of 512 two-byte integers	K/100
1024–1535	n/a	Sea-surface temperature confidence words, 512 records of 512 two-byte composite words, see table 19	n/a
1536–2559	L	Latitudes of image pixels, 1024 records of 256 four-byte integers	degrees/1000
2560–3583	L	Longitudes of image pixels, 1024 records of 256 four-byte integers	degrees/1000
3584–3839	X	x-coordinate offsets (across-track) of nadir-view pixels 256 records of 1024 unsigned one-byte integers	km/256
3840–4095	X	y-coordinate offsets (along-track) of nadir-view pixels 256 records of 1024 unsigned one-byte integers	km/256
4096–4351	X	x-coordinate offsets (across-track) of forward-view pixels 256 records of 1024 unsigned one-byte integers	km/256
4352–4607	X	y-coordinate offsets (along-track) of forward-view pixels 256 records of 1024 unsigned one-byte integers	km/256
4608–5119	C	Nadir-view cloud-clearing/land-flagging results, 512 records of 512 two-byte composite words, see table 20	n/a
5120–5631	C	Forward-view cloud-clearing/land-flagging results, 512 records of 512 two-byte composite words, see table 20	n/a

Table 18: Gridded sea-surface temperature product: product contents

The actual product contents are variable, and are determined by the precise nature of the product request. The nadir-only/dual-view sea-surface temperature records are always present within the product. The other records may be requested/omitted in logical groups:

- (L) Pixel latitude/longitude positions;
- (X) Pixel x/y coordinate offsets;
- (C) Nadir- and forward-view cloud-clearing/land-flagging results.

The base-line (default) GSST product for ATSR-1 *and* ATSR-2 includes the pixel latitude/longitude positions (L), but omits the pixel x/y coordinate offsets (X), and the cloud-clearing/land-flagging results (C).

Bit number	Meaning if set
0 (lsb)	Nadir-only sea-surface temperature is valid (if false, pixel contains nadir-view 11.0μm brightness temperature)
1	Nadir-only sea-surface temperature retrieval includes 3.7μm channel
2	Dual-view sea-surface temperature is valid (if false, pixel contains nadir-view 11.0μm brightness temperature)
3	Dual-view sea-surface temperature retrieval includes 3.7μm channel
4	Pixel is over land
5	Nadir-view pixel is cloudy
6	Nadir-view pixel has blanking pulse
7	Nadir-view pixel is cosmetic (nearest-neighbour fill)
8	Forward-view pixel is cloudy
9	Forward-view pixel has blanking pulse
10	Forward-view pixel is cosmetic (nearest-neighbour fill)
11–15	Unused

Table 19: Gridded sea-surface temperature product: confidence word

Bit #	Meaning
0 (lsb)	Pixel is over land
1	Pixel is cloudy (result of all cloud tests)
2	Sunglint detected in pixel
3–15	**Individual cloud tests (bit set if pixel cloudy)**
3	1.6μm reflectance histogram test (day-time only)
4	1.6μm spatial coherence test (day-time only)
5	11.0μm spatial coherence test
6	12.0μm gross cloud test
7	11.0/12.0μm thin cirrus test
8	3.7/12.0μm medium/high level test (night-time only)
9	11.0/3.7μm fog/low-stratus test (night-time only)
10	11.0/12.0μm view-difference test
11	3.7/11.0μm view-difference test (night-time only)
12	11.0/12.0μm thermal histogram test
13–15	Unused

Table 20: Gridded sea-surface temperature product: cloud-clearing/land-flagging results

GSST products include within their file-name extensions, the codes required to identify the product contents. For example, a GSST product with the file-name extension

GSST-LX

includes the pixel latitude/longitude positions and pixel x/y coordinate offsets; and a GSST product with the file-name extension

GBT-LXC

also includes nadir- and forward-view cloud-clearing/land-flagging results. It can be seen that the base-line ATSR 1/ATSR 2 product is defined by

GSST-L

6.3 Exceptional values

Table 21 lists the exceptional values which may be encountered within the GSST product.

Parameter	Value	Reason
Sea-surface temperature	-1	Entire scan absent from telemetry
	-2	Pixel absent from telemetry (possible reasons are disablement of channel, or visible channel fixed to narrow swath)
	-3	No signal in channel (zero count)
	-4	Saturation in channel (4095 count)
	-5	Derived radiance too small for calibration
	-6	Derived radiance too large for calibration
	-7	Calibration parameters unavailable for pixel
	-8	Pixel unfilled (cosmetic filling algorithm unable to find nearest-neighbour pixel)

Table 21: Gridded sea-surface temperature product: exceptional values

6.4 Notes

- Over sea, if the nadir-view 12.0μm and 11.0μm brightness temperatures are available for a pixel, the nadir-only sea-surface temperature is always retrieved, irrespective of whether the nadir-view pixel is identified as cloud-contaminated. If the 3.7μm brightness temperature is available (and the pixel is in night-time), it is always included in the retrieval. The nadir-view sea-surface temperature should of course be used with caution if the nadir-view pixel is identified as cloud-contaminated: the nadir-view cloud flag in the product confidence word should be the source of this information.

- Over sea, if the nadir-view *and* forward-view 12.0μm and 11.0μm brightness temperatures are available for a pixel, the dual-view sea-surface temperature is always retrieved, irrespective of whether the nadir-view and/or forward-view pixels are identified as cloud-contaminated. If the nadir- and forward-view 3.7μm brightness temperatures are available (and the pixel is in night-time), they are always included in the retrieval. The dual-view sea-surface temperature should of course be used with caution if either nadir- or forward-view pixels are identified as cloud-contaminated: the nadir-view and forward-view cloud-flags in the product confidence word should be the source of this information.

- Over land, sea-surface temperature retrieval is not performed. Both nadir-view and dual-view sea-surface temperature pixels contain nadir-view 11.0μm brightness temperatures. A flag in the confidence word identifies pixels which are over land.

- Similarly, sea-surface temperature retrieval cannot be performed when 12.0μm and/or 11.0μm brightness temperatures are unavailable. In such cases, both nadir-view and dual-view sea-surface temperature pixels contain nadir-view 11.0μm brightness temperatures (or the error codes associated with such pixels). Flags in the product confidence word identify when nadir-only and/or dual-view sea-surface temperature retrieval has not been performed.

6.5 Product size

Since the product contents are variable, product sizes are also variable. Table 22 provides approximate sizes for a range of typical product contents.

Product contents	# records	Size of product	Size per orbit
GSST-L (base-line)	3584	3.7mb	294mb
GSST-LX (base-line & x/y)	4608	4.7mb	377mb
GSST-LXC (base-line & x/y & cloud)	5632	5.8mb	461mb

Table 22: Gridded sea-surface temperature product: product sizes

7 Spatially-averaged brightness temperature/reflectance product (ABT)

7.1 General description

The spatially-averaged brightness temperature/reflectance product (ABT) contains ten-arcminute spatially-averaged brightness temperatures/reflectances, with associated positional and confidence information.

The ABT product contains spatially-averaged brightness temperatures/reflectances derived from up to a complete file of ATSR raw data (which may in most circumstances be considered to be equivalent to one ERS-1 orbit).

The ABT product has a variable length, though the largest volume of ATSR raw data which can contribute to a single spatially-averaged land-surface temperature product (approximately one orbit) places an upper limit on the product size.

7.2 Product format

The ABT product has a 48-byte fixed-length record structure. The contents of each product record are shown in table 23.

Time of data. The integer value containing the number of days since January 1st, 1950, does not include the current, incomplete day. Note that the time used within each record is the time of the first ATSR nadir-view scan within the orbit to contribute to the spatially-averaged brightness temperature/reflectance derivation.[1] The variable nature of cloud-cover makes it impossible to predict the position of this scan relative to the centre of the half-degree cell. Under any circumstances, this time cannot be more than approximately six seconds from the time at which the centre of the cell is scanned by the nadir view.

Latitude. The latitude is provided as a cell number. The edges of ten-arcminute cells are sections of parallels and meridians. The latitude cells are numbered from the South Pole to the North Pole, in the range 0 to 1079. Latitude cell number 0 extends from 90° South to 89°50' South; latitude cell number 359 extends from 89°50' North to 90° North. The latitude of the cell centre may be derived by:

$$latitude = ((lat\_cell\_num - 540.0)/6.0) + 0.0833.$$

Longitude. The longitude is provided as a cell number. The edges of ten-arcminute cells are sections of parallels and meridians. The longitude cells are numbered from 180° West to 180° East, in the range 0 to 2159. Longitude cell number 0 extends from 180° West to 179°50' West; longitude cell number 2159 extends from 179°50' East to 180° East. The longitude of the cell centre may be derived by:

$$longitude = ((lon\_cell\_num - 1080.0)/6.0) + 0.0833.$$

Mean across-track band number. The five across-track bands (numbered 0 to 4) are symmetric about the ground-track. Each band is 50km wide (except the fifth, which is 62km wide, and extends to the edge of the swath).

7.3 Product record types

There are six types of ABT product record:

- Thermal infra-red/near-infra-red channels (12.0μm, 11.0μm, 3.7μm, 1.6μm):

[1] Though note that, if and when no nadir data contributed to the temperature derivation, the time of the first contributing forward-view scan is used.

Byte range	Parameter description	Type	Unit
0 – 3	Time of data (days since January 1st, 1950)	Integer	Days
4 – 7	Time of data (seconds within current day)	Integer	Seconds
8 – 9	Latitude of ten-arcminute cell	Integer	Cell
10 – 11	Longitude of ten-arcminute cell	Integer	Cell
12 – 13	Mean across-track band number	Integer	None
	Nadir-view		
14 – 15	Spatially-averaged 12.0μm brightness temperature (or 1.6μm reflectance)	Integer	K/100 or %/100
16 – 17	12.0μm or 1.6μm pixel count	Integer	None
18 – 19	Spatially-averaged 11.0μm brightness temperature (or 0.87μm reflectance)	Integer	K/100 or %/100
20 – 21	11.0μm or 0.87μm pixel count	Integer	None
22 – 23	Spatially-averaged 3.7μm brightness temperature (or 0.65μm reflectance)	Integer	K/100 or %/100
24 – 25	3.7μm or 0.65μm pixel count	Integer	None
26 – 27	Spatially-averaged 1.6μm reflectance (or 0.55μm reflectance)	Integer	%/100
28 – 29	1.6μm or 0.55μm pixel count	Integer	None
	Forward-view		
30 – 31	Spatially-averaged 12.0μm brightness temperature (or 1.6μm reflectance)	Integer	K/100 or %/100
32 – 33	12.0μm or 1.6μm pixel count	Integer	None
34 – 35	Spatially-averaged 11.0μm brightness temperature (or 0.87μm reflectance)	Integer	K/100 or %/100
36 – 37	11.0μm or 0.87μm pixel count	Integer	None
38 – 39	Spatially-averaged 3.7μm brightness temperature (or 0.65μm reflectance)	Integer	K/100 or %/100
40 – 41	3.7μm or 0.65μm pixel count	Integer	None
42 – 43	Spatially-averaged 1.6μm reflectance (or 0.55μm reflectance)	Integer	%/100
44 – 45	1.6μm or 0.55μm pixel count	Integer	None
46 – 47	Confidence word, as described in table 24	None	None

Table 23: Spatially-averaged brightness temperature/reflectance product: contents of product record

- over cloud-free sea;
- over cloud-free land;
- over cloud.

- Visible/near-infra-red channels (1.6μm, 0.87μm, 0.65μm, 0.55μm):
  - over cloud-free sea;
  - over cloud-free land;
  - over cloud.

This combination of product records allows the pixel types and channel types to be stored clearly and efficiently in the product. It follows that the product contains up to six records for each ten-arcminute cell: the actual number depends on the presence of cloud/land, and the availability of thermal/visible channels. Note that the 1.6μm channel is present in thermal/nir *and* visible/nir records.

The type of each product record may be determined using the combination of flags in the confidence word. There are flags which identify thermal/nir and visible/nir records, and which identify sea/land/cloud records. Note that separate records are used for the cloud-free pixels over sea and the cloud-free pixels over land, within a particular ten-arcminute cell, but that a single record is used for all cloudy pixels within a cell. Since the cloud within a cell may be over both land and sea, two flags are required to identify the surface type(s).

Bit #	Meaning if set
0 (lsb)	Record contains thermal infra-red channels (12.0μm, 11.0μm, 3.7μm, 1.6μm)
1	Record contains visible/near-infra-red channels (1.6μm, 0.87μm, 0.65μm, 0.55μm)
2	Record contains cloud-free pixels over sea
3	Record contains cloud-free pixels over land
4	Record contains cloudy pixels over sea
5	Record contains cloudy pixels over land
6	Nadir-view contains day-time data (night-time if zero)
7	Forward-view contains day-time data (night-time if zero)
8 – 15 (msb)	Unused

Table 24: Spatially-averaged brightness temperature/reflectance product: confidence word

7.4 Notes

- No explicit or implicit ordering of product values may be assumed. The Earth-location must be derived using the latitude and longitude information provided with each record.

7.5 Product size

The estimated size of the ABT product is 0.5mb/orbit for ATSR-1, and 0.75mb/orbit for ATSR-2, which includes visible channels.

8 Spatially-averaged cloud temperature/coverage product (ACLOUD)

8.1 General description

The spatially-averaged cloud temperature/coverage product (ACLOUD) contains information concerning the temperature and abundance of cloud within the ATSR nadir and forward views, at a half-degree spatial resolution, with associated positional and confidence information.

The ACLOUD product contains spatially-averaged cloud temperature/coverage information derived from up to a complete file of ATSR raw data (which may in most circumstances be considered to be equivalent to one ERS-1 orbit).

The ACLOUD product has a variable length, though the largest volume of ATSR raw data which can contribute to a single spatially-averaged cloud temperature/coverage product (approximately one orbit) places an upper limit on the product size.

8.2 Cloud temperature/coverage derivation

It should be emphasised that *cloudy pixels*, in the context of the cloud temperature/coverage product, are those pixels which have been identified as cloudy by SADIST's cloud-identification tests. No assurance can be made that all true cloud will be detected by such tests; nor that all detected pixels will be truly cloudy.

Cloud temperature and coverage results are derived independently for the nadir and forward views; no attempt is made to combine the two views within a cloud temperature retrieval algorithm. Similarly, no attempt is made to combine information from ATSR's multiple detectors. All cloud temperature information within this product is based on brightness temperatures from the 11.0μm channel.

For reasons of processing efficiency, derivation of cloud temperatures (i.e. calculation of brightness temperature means) proceeds via the construction of a histogram of 11.0μm brightness temperatures within each half-degree cell. Each histogram records the distribution of brightness temperatures of cloudy pixels from 190.0 Kelvin to 290.0 Kelvin, at a 0.1 Kelvin resolution, within 1000 boxes; the first box records the number of cloudy pixels with 11.0μm brightness temperatures between 190.0 Kelvin and 190.1 Kelvin; the last box records the number of cloudy pixels with 11.0μm brightness temperatures between 289.9 Kelvin and 290.0 Kelvin. It can be seen that construction of the 0.1 Kelvin histogram involves a loss of the precision with which brightness temperatures are known.

No cloud temperature derivation is performed if fewer than 20 cloudy pixels have been identified, in either view. If sufficient pixels *have* been identified, two cloud temperatures are calculated, via the 0.1 Kelvin histogram.

The first is a simple mean of the 11.0μm brightness temperatures of all cloudy pixels. The second is an attempt to derive a cloud-top temperature; the 11.0μm brightness temperatures of only the coldest 25% of the cloudy pixels contribute to this derivation.

The product also contains the numbers of cloudy and cloud-free pixels which have been located. From these numbers, the percentage cloud-cover is derived, and is provided.

8.3 Product format

The ACLOUD product has a fixed-length 244-byte record format. The contents of each product record are shown in table 25.

Time of data. The integer value containing the number of days since January 1st, 1950, does not include the current, incomplete day. Note that the time used within each record is the time of the first ATSR nadir-view scan within the orbit to contribute to the spatially-averaged sea-surface temperature derivation. The variable nature of cloud-cover makes it impossible to predict the position of this scan

Byte range	Parameter description	Type	Unit
0 - 3	Time of data (days since January 1st, 1950)	Integer	Days
4 - 7	Time of data (seconds within current day)	Integer	Seconds
8 - 9	Latitude of half-degree cell	Integer	Cell
10 - 11	Longitude of half-degree cell	Integer	Cell
12 - 13	Mean across-track band number	Integer	None
	Nadir-view		
14 - 15	Number of cloudy pixels	Integer	None
16 - 17	Number of cloud-free pixels	Integer	None
18 - 19	Spatially-averaged 11.0μm brightness temperature of all cloudy pixels	Integer	K/100
20 - 21	Standard deviation of 11.0μm brightness temperatures of all cloudy pixels	Integer	K/100
22 - 23	Lowest 11.0μm brightness temperature of cloudy pixels	Integer	K/100
24 - 25	Cloud-top temperature: spatially-averaged 11.0μm brightness temperature of coldest 25% of cloudy pixels	Integer	K/100
26 - 27	Percentage cloud-cover	Integer	%/100
28 - 127	One Kelvin histogram of 11.0μm brightness temperatures of all cloudy pixels	Integer	None
	Forward-view		
128 - 129	Number of cloudy pixels	Integer	None
130 - 131	Number of cloud-free pixels	Integer	None
132 - 133	Spatially-averaged 11.0μm brightness temperature of all cloudy pixels	Integer	K/100
134 - 135	Standard deviation of 11.0μm brightness temperatures of all cloudy pixels	Integer	K/100
136 - 137	Lowest 11.0μm brightness temperature of cloudy pixels	Integer	K/100
138 - 139	Cloud-top temperature: spatially-averaged 11.0μm brightness temperature of coldest 25% of cloudy pixels	Integer	K/100
140 - 141	Percentage cloud-cover	Integer	%/100
142 - 241	One Kelvin histogram of 11.0μm brightness temperatures of all cloudy pixels	Integer	None
242 - 243	Confidence word associated with spatially-averaged cloud temperature/coverage derivation, as described in table 26	None	None

Table 25: Spatially-averaged cloud temperature/coverage product: contents of product record

relative to the centre of the half-degree cell. Under any circumstances, this time cannot be more than approximately six seconds from the time at which the centre of the cell is scanned by the nadir view.

Latitude. The latitude is provided as a cell number. The edges of half-degree cells are sections of parallels and meridians. The latitude cells are numbered from the South Pole to the North Pole, in the range 0 to 359. Latitude cell number 0 extends from 90° South to 89° South; latitude cell number 359 extends from 89° North to 90° North. The latitude of the cell centre may be derived by:

$$latitude = ((lat\_cell\_num - 180.0) / 2.0) + 0.25.$$

Longitude. The longitude is provided as a cell number. The edges of half-degree cells are sections of parallels and meridians. The longitude cells are numbered from 180° West to 180° East, in the range 0 to 719. Longitude cell number 0 extends from 180° West to 179° West, longitude cell number 719 extends from 179° East to 180° East. The longitude of the cell centre may be derived by:

$$longitude = ((lon\_cell\_num - 360.0) / 2.0) - 0.25.$$

Mean across-track band number. The five across-track bands (numbered 0 to 4) are symmetric about the ground-track. Each band is 50km wide (except the fifth, which is 62km wide, and extends to the edge of the swath).

Number of cloudy pixels. This is the number of pixels within the half-degree cell which were identified as cloudy by the SADIST cloud-identification tests. Note that, since the surface area covered by a half-degree cell decreases towards the poles, the maximum value this parameter may have will also decrease (to a limit of zero at the poles themselves). Note also that, since no cloud temperature/coverage information may be derived using fewer than 20 cloudy pixels, 20 is the practical minimum for this parameter.

Number of cloud-free pixels. This is the number of pixels within the half-degree cell which were identified as cloud-free by the SADIST cloud-identification tests. Note that, since the surface area covered by a half-degree cell decreases towards the poles, the maximum value this parameter may have will also decrease (to a limit of zero at the poles themselves). This parameter may be zero.

Spatially-averaged brightness temperature of all cloudy pixels. This mean is calculated from the 0.1 Kelvin histogram described in Section 10.2. Therefore, although it is supplied at a precision of 0.01 Kelvin, its accuracy (with respect to the *true* mean), can only be assumed to be ±0.05 Kelvin. The derivation is:

$$mean\_of\_cloudy = 19000 + 10 \times \frac{\sum_{i=0}^{999}((i+0.5) \times histogram[i])}{\sum_{i=0}^{999} histogram[i]}$$

Standard deviation of brightness temperatures of cloudy pixels. Again, this is calculated from the 0.1 Kelvin histogram, described above, so its accuracy (with respect to the *true* mean), can only be assumed to be ±0.05 Kelvin. The derivation is:

$$sd\_of\_cloudy = 10 \times \sqrt{\frac{\sum_{i=0}^{999}(((i+0.5) - ((mean\_of\_cloudy - 19000)/10)) \times histogram[i])^2}{(\sum_{i=0}^{999} histogram[i]) - 1}}$$

Lowest 11.0μm brightness temperature of cloudy pixels. This is simply the lowest 11.0μm brightness temperature of the pixels identified as cloudy within the half-degree cell.

Cloud-top temperature. This value, which is known as the cloud-top temperature (though which makes no great claims to represent exactly that physical parameter), is calculated from the 0.1 Kelvin histogram, described above. Only the coldest 25% of the histogram is used; that is, only those histogram boxes up to and including that which contains the twenty-fifth percentile are included within the mean derivation.

Its accuracy (with respect to the *true* mean of the coldest 25% of the cloudy pixels) can only be assumed to be ±0.05 Kelvin. The derivation is:

$$ctt = 19000 + 10 \times \frac{\sum_{i=0}^{n} ((i+0.5) \times histogram[i])}{\sum_{i=0}^{n} histogram[i]}$$

where n is the histogram box containing the twenty-fifth percentile

Percentage cloud-cover. This is the percentage of all pixels within the half-degree cell which were identified as cloudy by the SADIST cloud-identification tests. The derivation is:

$$percentage\_cover = 10000 \times \frac{number\_of\_cloudy\_pixels}{number\_of\_cloudy\_pixels + number\_of\_cloud\_free\_pixels}$$

since the percentage is provided in units of %/100. Values of percentage cloud-cover for half-degree cells within across-track band 4 of the ATSR swath should be used with caution; such cells may not be wholly covered by the swath.

One Kelvin histogram of 11.0μm brightness temperatures of all cloudy pixels. This histogram, which describes the temperature distribution of the pixels identified as cloudy, is derived from the 0.1 Kelvin histogram constructed during calculation of the spatially-averaged cloud temperatures shown above. The derivation involves two steps:

1. The 0.1 Kelvin histogram is reduced to a 1.0 Kelvin histogram, by merging histogram boxes in groups of ten.
2. The 1.0 histogram is normalised, so that each histogram value may be represented by a single byte. The normalisation is:

   $$normalised\_value[i] = 255 \times \frac{merged\_histogram[i]}{merged\_histogram[max]}$$

   where i is each of the boxes of the (merged) 1.0 Kelvin histogram (from 0 to 99), and *max* is the histogram box containing the largest number of cloudy pixels.

The resulting 1.0 Kelvin histogram is a one-hundred element array of one-byte normalised values, scaled so that a value of 255 represents the most populous histogram box. The first histogram box represents brightness temperatures between 190.0 Kelvin and 191.0 Kelvin; the last histogram box represents brightness temperatures between 289.0 Kelvin and 290.0 Kelvin. Note that the values within the normalised histogram remain in correct proportion, so the values of the number of cloudy and cloud-free pixels may be used to (approximately) reconstitute the original (non-normalised) 1.0 Kelvin histogram.

Bit #	Meaning if set
0 (lsb)	Contributing nadir-view data acquired during day-time
1	Contributing forward-view data acquired during day-time
2	Half-degree cell contains land
3	Half-degree cell contains sea
4 – 15 (msb)	Unused

Table 26: Spatially-averaged cloud temperature/coverage product: confidence word

8.4 Notes

- No explicit or implicit ordering of product values may be assumed. The Earth-location must be derived using the latitude and longitude information provided with each cloud temperature/coverage record.
- Note that, apart from the time/position information, and the confidence word, all product contents are duplicated for nadir and forward views. There is no attempt to combine nadir and forward views within a cloud temperature retrieval algorithm.

8.5 Exceptional values

Exceptional values within the spatially-averaged cloud temperature/coverage product are described in table 27.

Parameter	Value	Reason
Number of cloudy pixels	-999	Fewer than 20 cloudy pixels identified
Number of cloud-free pixels	-999	Fewer than 20 cloudy pixels identified
Spatially-averaged brightness temperature	-999	Fewer than 20 cloudy pixels identified
Standard deviation of brightness temperatures	-999	Fewer than 20 cloudy pixels identified
Lowest brightness temperature	-999	Fewer than 20 cloudy pixels identified
Cloud-top temperature	-999	Fewer than 20 cloudy pixels identified
Percentage cloud-cover	-999	Fewer than 20 cloudy pixels identified

Table 27: Spatially-averaged cloud temperature/coverage product: exceptional values

8.6 Product size

The estimated size of the ACLOUD product is 2mb/orbit for both ATSR-1 and ATSR-2.