AATSR Frequently Asked Questions (FAQ)

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AMENDMENT RECORD SHEET

The Amendment Record Sheet below records the history and issue status of this document.

ISSUE	DATE	REASON
1	20 Dec 2005	Initial Issue (as AEP_REP_001)
2	02 Oct 2013	Updated with new questions and information (issued as IDEAS-VEG-OQC-REP-0955)
3	14 Dec 2016	General updates, major edits to Q34., new questions: Q17., Q25., Q26., Q28., Q30., Q35., Q36., Q42. Now issued as IDEAS+-VEG-OQC-REP-2117
4	16 Feb 2023	General updates after release of the fourth reprocessing dataset, with obsolete questions removed. Now issued as QA4EO-VEG-OQC-REP-5031

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1. INTRODUCTION

The purpose of this document is to act as a repository for common, or frequently asked, questions that are raised by users concerning the Advanced Along-Track Scanning Radiometer (**AATSR**) sensor and the latest AATSR dataset. It includes questions that have been raised with the AATSR Expert Support Laboratory (**ESL**), the AATSR Quality Working Group (**QWG**) or the ESA User Helpdesk, and questions that may be of particular interest to new users.

The information contained within this document is supplementary to some of the information contained in the AATSR Product Handbook, such as the information relating to the sensor. Note that the AATSR Handbook will not be updated further, and so the information it contains on the datasets are out of date, as new processors have been used to generate new and improved datasets since its publication.

The questions fall into four basic categories:

- General questions, covering background to the AATSR mission
- Common questions from new users
- Questions concerning the instrument
- Questions on data processing and products.

Updates to this document are expected, as new questions arise and feedback on existing questions is collected from readers of the document. Any comments and questions on this document should be sent via the ESA Tellus system.

1.1 The 4th AATSR Reprocessing Dataset

It is strongly recommended that users use the most recently generated AATSR dataset, which is from the 4th Reprocessing and was released early in 2023. Further information can be found at https://earth.esa.int/eogateway/news/envisat-aatsr-4th-reprocessing-data-now-available.

For third reprocessing Envisat-format products, the previous version of this FAQ should be consulted (IDEAS+-VEG-OQC-REP-2117, v3.0)

The Level 1B (**L1B**) products from this latest reprocessing adopt a new product format, which enables continuity with the product format adopted by the sensor's successors (the Sea and Land Surface Temperature Radiometer (**SLSTR**) instruments onboard Sentinel-3*X*), and can be identified by the product name as follows:

ENV_AT_1_RBT____20120204T071225_20120204T075501_20210818T094129_2556_111_207_____TPZ_R_NT_004.SEN3.

Note that the entities responsible for the generation of any new Level 2 (**L2**) datasets are the ESA Climate Change Initiative (**CCI**) Sea Surface Temperature (**SST**) and Land Surface Temperature (**LST**) projects.

Information on accessing AATSR 4th reprocessing products is available from the ESA EO Data Access webpage:
https://earth.esa.int/eogateway/catalog/envisat-aatsr-l1b-brightness-temperature-or-radiance-env_at_1_rbt

Useful documentation for the 4th reprocessing L1B dataset is shown below:

Product Specification

User Documentation for (A)ATSR 4th Reprocessing Level 1B Products

1.2 References

References within this FAQ are posted as working links at the time of issue. Most documents may be found in the ESA document library.

1.3 Glossary

The following acronyms and abbreviations have been used in this report.

AATSR	Advanced Along-Track Scanning Radiometer
ANX	ascending node crossing
AO	Announcement of Opportunity
BEIS	Department of Business, Energy and Industrial Strategy
CCI	Climate Change Initiative
EO	Earth Observation
ESA	European Space Agency
ESL	Expert Support Laboratory
L1B	Level 1B
L2	Level 2
LST	Land Surface Temperature
NRT	Near-Real-Time
QWG	Quality Working Group
SLSTR	Sea and Land Surface Temperature Radiometer
SST	Sea Surface Temperature
XML	Extensible Markup Language

2. GENERAL QUESTIONS

Q1. What does AATSR stand for?

AATSR stands for 'Advanced Along-Track Scanning Radiometer'.

Q2. What is AATSR and what does it do?

AATSR was one of the Announcement of Opportunity (**AO**) instruments on board the European Space Agency (**ESA**) satellite called 'Envisat'. It was the most recent in a series of sensors designed primarily to measure Sea Surface Temperature (SST), following on from the ATSR-1 and ATSR-2 instruments on-board ERS-1 and ERS-2, respectively. AATSR data have a resolution of 1 km at nadir, and are derived from measurements of reflected and emitted radiation taken at the following wavelengths: 0.55 µm, 0.66 µm, 0.87 µm, 1.6 µm, 3.7 µm, 11 µm and 12 µm. Additional information on the ATSR series of sensors is available from: http://atsrsensors.org/.

Special features of the AATSR sensor include its use of a conical scan to give a dual-view of the Earth's surface, on-board calibration targets and use of mechanical coolers to maintain the thermal environment necessary for optimal operation of the infrared detectors. Further information on AATSR is available from the ESA AATSR webpages.

The AATSR instrument was funded by the predecessor departments of the UK Department of Business, Energy and Industrial Strategy (**BEIS**) and the Australian Department of Innovation, Industry and Science.

Q3. What is Envisat?

Envisat was launched on 1st March 2002 by ESA, and was an advanced sun-synchronous polar-orbiting Earth Observation (**EO**) satellite that provided measurements of the atmosphere, ocean, land, and ice (see https://earth.esa.int/eogateway/missions/envisat).

Envisat continued the work of the ERS satellites (see https://earth.esa.int/eogateway/missions/ers), and its data continues to support Earth science research and allows monitoring of the evolution of environmental and climatic changes.

Following the loss of communications with Envisat on 8th April 2012, ESA declared the official end of mission on 9th May 2012.

Q4. What orbit does Envisat use?

Following its launch, Envisat was in a sun-synchronous polar orbit of about 800 km altitude. The repeat cycle of the reference orbit was 35 days.

In order to prolong the Envisat mission past its original planned end date, a set of orbit manoeuvres was performed at the end of October 2010.

After this date, Envisat's orbit was lowered by approximately 17.4 km and the inclination was allowed to drift. The repeat cycle in the new orbit configuration was 30 days.

Q5. What can AATSR data be used for?

AATSR primarily measured SST to the high levels of accuracy and precision required for monitoring and detecting climate change. Together with its predecessors, ATSR-1 and ATSR-2, AATSR established a unique SST dataset spanning almost 21 years (from 1991 to 2012), supporting oceanographic and climate research.

AATSR data can also be used for a number of land surface, cryosphere and atmospheric applications. Further information is available from: http://atsrsensors.org/applications.htm

Q6. If this FAQ does not answer my question, what should I do?

All queries regarding Envisat and AATSR should be directed via the ESA Tellus system

If your question relates to a particular problem with an AATSR product, then it may also be worthwhile checking the Product Quality Notices, available from ESA's AATSR Product Information webpage.

3. COMMON QUESTIONS FROM NEW USERS

Q7. Where can I find a 'user guide' to receiving and utilising AATSR data?

The AATSR Product Handbook is available to users. Section 1 of the Handbook was designed as a Product User Guide, intended to help users familiarise themselves with AATSR and get started with using AATSR data. This is supported by later sections containing detailed information on the instrument, the products it generates and the algorithms used to generate them. Other resources are listed on the page https://earth.esa.int/eogateway/instruments/aatsr/description; they can provide updated or new information on specific aspects such as algorithm updates and data product detailed content/format descriptions.

Q8. How can I be kept up to date with events that might affect my use of AATSR data?

During operations, AATSR Cyclic Reports were made available by ESA ESRIN to keep the AATSR community informed of any modifications to the processor, updates of auxiliary products, instrument anomalies, the status of data acquisition and processing, and the status of the calibration, validation, and quality control activities.

Daily Reports were also produced, providing an overview of the status of the instrument and data processing on each day.

The Cyclic and Daily Reports are still available from the ESA web site at: https://qras.earth.esa.int/

See also Question 19. on how to locate information on instrument operations which may affect AATSR data.

ESA News can be found at https://earth.esa.int/eogateway/news, where users can sign up to receive the ESA Newsletter.

Q9. What are the main differences between ATSR-1, ATSR-2 and AATSR?

ATSR-1 measured in the infrared at 1.6 µm, 3.7 µm, 11 µm and 12 µm and had no visible channels. ATSR-2 and AATSR included the same four infrared channels of ATSR-1 and three additional channels at 0.55 µm, 0.67 µm and 0.87 µm.

The ATSR-2 instrument was largely the same as ATSR-1, differing only in the inclusion of the extra visible channels and an on-board visible calibration system.

AATSR was functionally largely similar to ATSR-2, but components were redesigned to match the new platform environment of Envisat. The details of the scan, calibration systems, spatial resolution and swath were kept as close as possible to the earlier sensors to ensure data continuity. The major advantage of AATSR over ATSR-2 was in the downlinking of data. ATSR-2 had restrictions on the amount of data that could be downlinked, due to platform constraints, which particularly affected the visible channels, whereas AATSR could send down data from all the channels continuously at full 12-bit radiometric resolution. This also simplified the data processing for AATSR, since the

processor did not have to cope with the wide range of instrument data formats that could be used for ATSR-2.

The specific differences between the ATSR-2 and AATSR source packets are discussed in Section 2.5.2 of the AATSR handbook (see Q7.).

Q10. How can I order AATSR data?

ESA defined a new Earth Observation Data Policy which was approved by the ESA Earth Observation Programme Board in May 2010 (https://earth.esa.int/eogateway/documents/20142/1564626/ESA-Data-Policy-ESA-PB-EO-2010-54.pdf). The new data policy applies to ESA missions, including **ERS-1, ERS-2** and **Envisat.** It is derived from the full and open access approach established in the Sentinel Data Policy.

More information on EO data distributed by ESA is available at: https://earth.esa.int/eogateway/catalog.

Further information on accessing EO data can be found via ESA Tellus, where users can register for access.

In their capacity as AO Instrument Provider, BEIS have the right to make and distribute copies of AATSR data for its own use, for use by other funding entities of AATSR and for research groups designated by BEIS. Users with links to BEIS or the other AATSR programme partners should consult their local contacts within these agencies.

Q11. I have used ATSR-1 and ATSR-2 data before – are the contents of the ATSR-1 and ATSR-2 products and those from AATSR identical?

A summary of the relationship between Envisat-format AATSR and earlier ATSR-1 and ATSR-2 products is given in Section 2.2.3 of the AATSR Handbook (see Q7.) Details on the subsequent generation of ATSR-1 and ATSR-2 data into Envisat format are also available in a separate Technical Note: Envisat-style products for ATSR-1 and ATSR-2 data.

However, for the recommended fourth reprocessing dataset (see Section 1.1: The 4th AATSR Reprocessing Dataset), L1B products from all three instruments are now available in Sentinel/SAFE-like format, comprising a named folder containing NetCDF datafiles and an Extensible Markup Language (**XML**) metadata file. Although the formats are identical, users will find that some parameters and fields are not available for ATSR-1 and/or ATSR-2 due to the historic differences between the instruments.

See also Q9.

Q12. I want to look at data from ATSR-1 and ATSR-2 as well as from AATSR. How do I get ATSR-1 and ATSR-2 data?

BEIS, NERC and ESA have developed an (A)ATSR series archive in which data from ATSR-1, ATSR-2 and AATSR are reprocessed and stored together in an identical format; from the fourth reprocessing this is Sentinel/SAFE-like format.

There is an archive held at ESA (contact ESA Tellus for registration) and an archive held at CEDA that users can access after registration. See also Q10.

Q13. Where can I find articles/papers on the exploitation of (A)ATSR data?

Any advanced search engine can find papers that have used (A)ATSR instrument data in recent times. Of note is the following special issue from 2012:

- Remote Sensing of the Environment Special Issue on AATSR: http://www.sciencedirect.com/science/journal/00344257/116

The following list shows historic meetings that have taken place; some still have accessible links:

- MERIS and (A)ATSR Workshops
  - ESRIN (15–19 October 2012)
  - ESRIN (22–26 September 2008) https://earth.esa.int/eogateway/events/2nd-meris-a-atsr-user-workshop
  - ESRIN (26–30 September 2005)
- Envisat / ERS Symposia (which evolved into the Living Planet Symposium from 2010)
  - Bonn (23–27 May 2022) https://lps22.eu/
  - Milan (13–17 May 2019) https://lps19.esa.int/NikalWebsitePortal/living-planet-symposium-2019/lps19
  - Prague (9–13 May 2016) https://lps16.esa.int/
  - Edinburgh (09–13 September 2013) http://www.livingplanet2013.org/index.asp
  - Bergen (28 June–2 July 2010)
  - Montreux (23–27 April 2007)
  - Salzburg (6–10 September 2004)
  - Gothenburg (16–20 October 2000
- Envisat MERIS and AATSR Validation Team (MAVT) Workshops
  - MAVT-2006 (20–24 March 2006)
  - MAVT-2003 (20–24 October 2003)
- Envisat Validation Workshop (9–13 December 2002)
- Envisat Calibration Review (9–13 September 2002)

Other useful links are given below:

- ESA Data User Element (DUE) Projects http://due.esrin.esa.int/
- ATSR Project Web Site – Documentation Section http://www.atsr.rl.ac.uk/documentation/index.shtml
- Search the ESA EO document library
- The ATSR Exploitation Board website gives a list of ATSR science publications up to 2017 at: http://atsrsensors.org/publications.htm

Q14. What tools are available for reading AATSR products?

There are specific tools available; see https://earth.esa.int/eogateway/instruments/aatsr (Data Tools section):

- **SNAP and the Sentinel-3 Toolbox:** consist of visualisation, analysis and processing tools for the exploitation of SLSTR (and OLCI) data from Sentinel-3. It supports (A)ATSR Envisat-format products and 4th Reprocessing products in Sentinel/SAFE-like format. The tools can be run from an intuitive desktop application or via a command-line interface. A rich application programming interface (API) allows for development of plugins using Java or Python.
- **NetCDF readers:** given that the 4th Reprocessing products contain NetCDF files, then any generic NetCDF reader will be able to read them individually. This method, however, does not link all connected data files in the viewer, as happens if use is made of the Sentinel-3 Toolbox, mentioned above.

Users can also write their own routines to read and process AATSR data. The AATSR 4th Reprocessing product specifications will assist with this task (see Section 1.1).

It can be noted that the data files are self-describing NetCDF so use can be made of various NetCDF tools; more information is available from:
https://www.unidata.ucar.edu/software/netcdf/

If users have tools that can already read SLSTR products, then minor revisions only would need to be made in order to read AATSR 4th reprocessing products.

Q15. Why can't one of the recommended tools open my data product?

In the first instance, users should check whether the tool they are using can open the product in question.

If a tool reports an error with an AATSR product it is supposed to be able to read, then the likely cause is that the file has been corrupted somehow. This can be avoided via the following means:

- When downloading AATSR data products, or transferring via FTP, then this must always be done as a binary (not ASCII) transfer.
- If WinZip is used to extract data from a tar archive (compressed folder with extension such as .tar, .tar.gz or .tgz), then ensure the option "TAR file smart CR/LF conversion" is unchecked.

If none of the above resolves the issue with the file, then there may be a problem with the data within the file. In which case, contact the ESA Tellus system for further assistance.

4. QUESTIONS ABOUT THE INSTRUMENT

4.1 Instrument Characteristics

Q16. What is the range of nadir and forward view incidence angles for (A)ATSR?

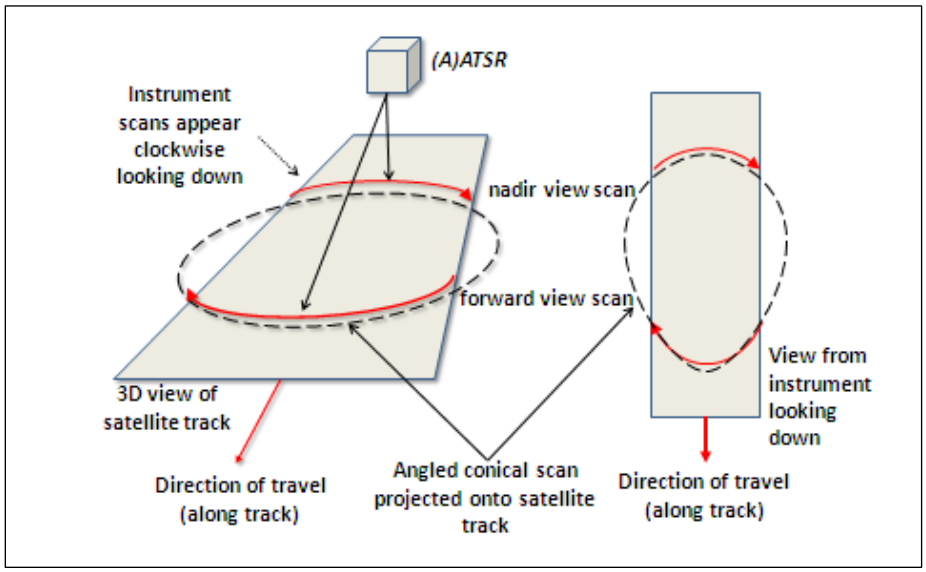
The range of incidence angles between the swath centre and edge was an input to the SST coefficients generation process. The values that are used in the current Radiative Transfer Modelling code, in degrees, are:

- nadir 0.0 (swath centre) 21.732 (swath edge)
- forward 55.587 (swath centre) 53.009 (swath edge)

Strictly the value depends on which instrument is being considered (because the cone angles differ slightly), but in practice the differences are small.

Q17. In which direction did AATSR scan?

The AATSR scan mirror rotated clockwise when viewed from the satellite looking downwards towards the earth. This is clearly illustrated in the diagram below.



Some diagrams of the AATSR instrument may seem to show the scan direction in the opposite sense. Whilst these may seem contradictory, this is actually because such diagrams are drawn from the point of view of looking toward the instrument from outside rather than looking at the earth through the instrument.

Q18. Where can I obtain the full set of AATSR spectral response functions?

There is a link to these data from Section 3.2.1.1.2 of the AATSR handbook (see Q7.)

Q19. How can I obtain information about any interruptions to AATSR data acquisition or identify periods of special instrument operations?

Envisat End of Mission reports were produced for the AATSR instrument, highlighting particular events that took place and giving a summary of AATSR performance throughout the mission. The AATSR Mission Event history and associated periods of special instrument operations are available from the ESA EO website at: https://earth.esa.int/eogateway/instruments/aatsr/description

The AATSR Events Report is available at:
https://earth.esa.int/eogateway/documents/20142/37627/Envisat_AATSR_Events_Report.pdf/089bf35a-5d96-287e-046b-0d2713f847ab

The AATSR Performance Report is available at:
https://earth.esa.int/eogateway/documents/20142/37627/Envisat_AATSR_Performance_Report.pdf/c1d38013-fdc4-e2b2-80ae-2d0e71ef0163

Background information on issues relating to AATSR Flight Operations can be found in Sections 1.1.3.2 and 3.2.2.2.1 of the AATSR handbook (see Q7.).

5. QUESTIONS ON DATA PROCESSING AND PRODUCTS

5.1 Data Processing

Q20. Which version of the AATSR IPF was used to produce my data?

The fourth reprocessing IPF version details are contained in the xfdumanifest XML file, under the following tag: `<sentinel-safe:software name="FAST" version="2.0.5"/>`

Differences between the various IPF versions, and the date of their introduction, are given in the AATSR IPF Change Log, accessible from:
https://earth.esa.int/eogateway/instruments/aatsr/processor-releases

Q21. What differences are there between data processed in Near-Real-Time (NRT) and Off-Line (Consolidated)? [*historic question, applicable during the Envisat operational lifetime, retained for information*]

NRT and off-line products, even if using the same processor version, could differ slightly due to the auxiliary files used in their production (ref. Section 2.10.1 of the AATSR Handbook (see Q7.)) and coverage. Updates to most AATSR auxiliary files were infrequent, with the exception of the ATS_VC1_AX files containing visible channel calibration coefficients. The version of this file used for NRT processing did not contain the exact coefficients for that orbit. A file from one or two days previous to the acquisition of the orbit in question was used instead. For more information on this, see Section 2.11.2 of the AATSR Handbook (see Q7.). Under normal circumstances VC1 files used for off-line processing and reprocessing should correspond to that orbit (assuming that visible calibration information could be extracted from the L1B product). NRT data were also processed with predicted rather than restituted Orbit State Vectors, but this does not have a significant effect on geolocation/colocation for AATSR.

Q22. Is there a repository of known problems with the AATSR data processing/products that can be consulted before raising queries with the helpdesk?

Product Quality Notice and Readme files, addressing issues affecting AATSR product quality, are published at: https://earth.esa.int/eogateway/instruments/aatsr/products-information.

Other points to Note for the 4th reprocessing are contained within the User Documentation report (see Section 1.1).

Q23. What value of cone angle was used to define the edge of the swath air mass when the AATSR SST coefficients were derived? Could differences in this parameter between datasets explain discrepancies in retrieved SST? [*historic question no longer applicable, since the 4th reprocessing did not generate Level 2 products*]

The auxiliary file of SST coefficients used by the Level 2 processor included distinct coefficients for each of 38 across-track distances. The process by which these 38 sets of coefficients are generated involves first deriving two sets of coefficients, for the swath centre and swath edge, and then computing intermediate values by linear interpolation with respect to air mass. (Here the air mass refers to the normalised length of the atmospheric path traversed by the line of sight — essentially the secant of the angle of incidence at the pixel.)

The air mass at the swath centre is unity (that is the normalisation), but that at the edge depends on factors such as the cone angle of the AATSR scan and the satellite height.

A study of the sensitivity of the edge of swath air mass to changes in the cone angle and the satellite height has been conducted. In general, the results are very insensitive to cone angle; satellite height is a slightly more significant parameter, but as it varied around the orbit there is not much that can be done about it other than to use a suitable average value.

Q24. What visible channel calibration corrections have been applied to my data?

Different modifications for the visible calibration have been implemented in the operational processing from launch to mission end. Briefly, these included a non-linearity correction for the 1.6 micron channel (introduced by updating the ATS_GC1_AX auxiliary file in 2004), and several versions of a drift correction for the visible channels.

The corrections for the visible channel calibration drift which were applied during operations were not the best representation of the instrument behaviour. Instead, a look-up table containing actual drift values and a set of instructions and tools on how to apply these were produced. These are no longer publicly available.

A discrepancy within AATSR's 12 µm channel was characterised after the completion of the third reprocessing. User recommendations and a Technical Note (PO-TN-RAL-AT-0562) containing empirical correction values are available from:
https://earth.esa.int/eogateway/instruments/aatsr/cal-val

Note that the above-mentioned corrections have been incorporated into the 4th reprocessing L1B dataset, such that users do not have to apply any corrections.

Q25. Are there any other corrections to be applied to the data?

All current known corrections have been incorporated into the 4th reprocessing L1B dataset.

Q26. What is known about the calibration of the AATSR 3.7 and 11 micron channels?

As part of the investigation into the AATSR 12-micron anomaly, the calibration of the 3.7 and 11 micron channels was also considered. Results for simulated and observed BT differences for the 3.7 and 11 micron channels are shown in Figure 1 as a function of total column water vapour (TCWV).

For the 3.7-micron channel, the results are outside the expected uncertainty for such a comparison (0.1 K) and a notable dependence on TCWV is seen. Additional analysis (not shown) looking at each sensor individually suggests the disagreement is due to a calibration error with the ATSR-2 3.7-micron channel. During the ATSR-2 pre-flight calibration, an unexpected nonlinearity was observed with the 3.7-micron channel and a spectral shift was introduced to minimise the effect (see Smith *et al.,* Test and Calibration of the Along Track Scanning Radiometer 2, ER-RP-OXF-AT-2001, Issue 2, 21st December 1993).

For the 11-micron channel the results for both views are within the expected uncertainty (0.1 K) and no notable TCWV dependence is seen.

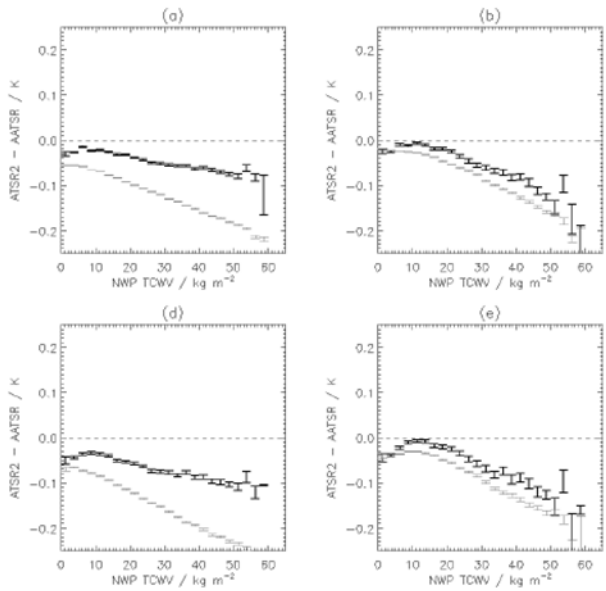


Figure 1. Simulated (grey lines) and observed (black lines) difference between colocated AATSR and ATSR-2 brightness temperatures for (a) nadir 3.7 micron, (b) nadir 11 micron), (d) forward 3.7 micron) and (e) forward 11 micron) as a function of total column water vapour.

5.2 Products

Q27. How do I interpret the information in the filename of my AATSR data?

This is explained in section 4.2 of the Product Specification (see Section 1.1)

Q28. Where can I find information on product specification?

A link to the fourth reprocessing L1B dataset Product Specification is given in Section 1.1.

The following Envisat Product Specification documents may still be of use to AATSR users and are contained within the ESA library

- Volume 1: Introduction
- Volume 2: Overview of Instruments
- Volume 3: Product Terms and Definitions
- Volume 4: Products Overview
- Volume 5: Product Structures
- Volume 6: Level 0 Products Specifications
- Volume 7: AATSR Products Specifications (3rd reprocessing and earlier only)
- Volume 16: Auxiliary Data Files
- Volume 17: Extracted Instrument Headers
- Annex A: Product Data Conventions

Q29. Why does the orbit number in the metadata of AATSR data files claiming to be over a particular location sometimes differ from the orbit number returned by software tools or other instrument products for the same location?

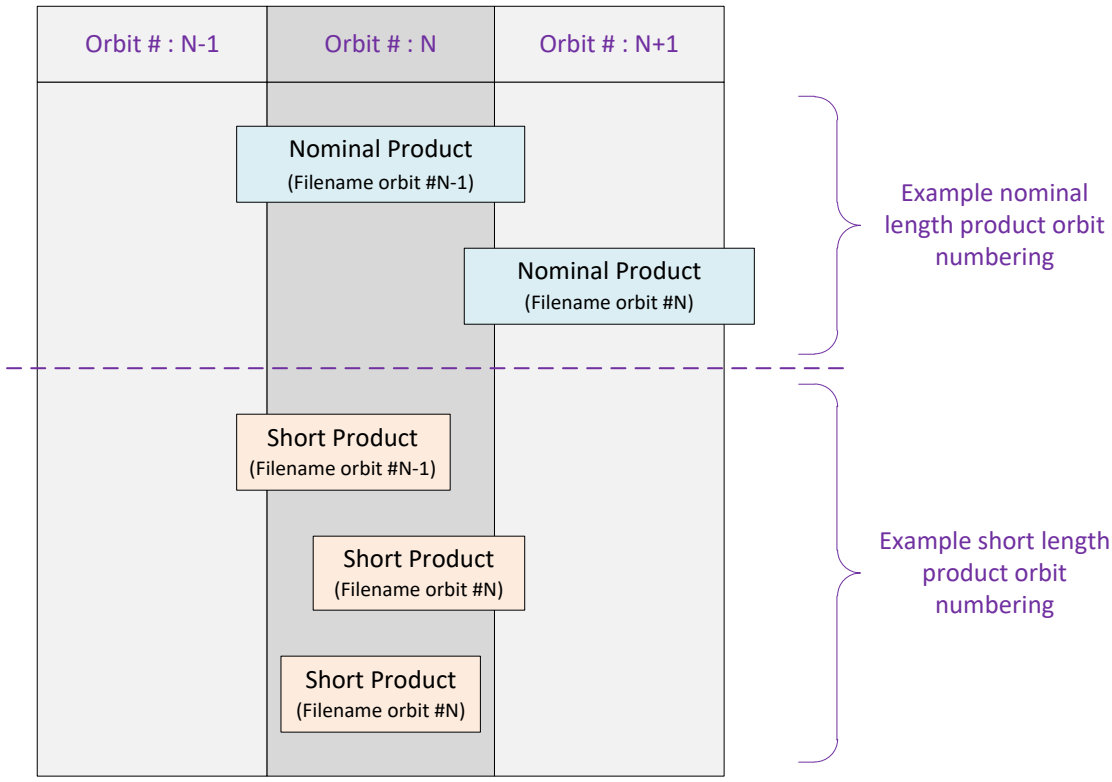
The orbit number in the xfdumanifest XML file of an L1B product is that in which the first data contributing to the product falls. This was not a problem for NRT data, as NRT products are not expected to begin exactly at ascending node crossing (**ANX**) point.

However, in the case of consolidated and reprocessed data (orbits defined from ANX to ANX), the first data records usually precede the ascending node, and so the product is named with an orbit number one lower than one might expect.

Taking the following (historic Envisat-format) file as an example:
ATS_TOA_1PRUPA20040605_001218_000065272027_00259_**11836**_4472.N1

The start of data (00:12:18, 5 June 2004) is very close to, but before, the ascending node at the start of absolute orbit 11837 (00:14:48, 5 June 2004). Therefore, although the product predominantly represents orbit **11837**, the start of data falls within the preceding orbit and so the filename contains the orbit number **11836**.

This is further illustrated in the diagram below:



This is of particular importance when identifying which data products to order by querying a data catalogue.

To be absolutely safe, one should use the product date and time information to ensure the product identified contains the desired data.

Q30. How do I remove overlap between successive consolidated products?

A fully consolidated complete orbit of (A)ATSR data should run from the ANX to the next ANX one orbit later; the ANX point is the location at which the satellite transits the Earth's Equator in the South to North direction. Successive consolidated full orbits of (A)ATSR data are likely to contain measurements from the immediate orbits before and after. This is due to the dual-view nature of the (A)ATSR instruments meaning there is a timing difference that needs to be corrected between the nadir and forward views to correctly align them in the final product.

Two methods are suggested to remove the extra data:

1. ANX detection

In this approach the user can detect the location of any ANX points by identifying where the latitude changes from negative to positive at the centre of the swath. Three possible outcomes are (i) two ANX positions are found, (ii) only one ANX position is found or (iii) no ANX positions are found. For case (i) the user should reject data before the first ANX and after the second ANX. For case (ii) the product is missing data at either the beginning or

end. In this case the user should look at the line number within the orbit. If the line number for the ANX is < 2000 then this means the user should reject data before the ANX position; if not, then the user should reject data after the ANX. Note: It is theoretically possible to have a very short orbit where the first data is just before the 2nd ANX position. For case (iii) all data lies between the two ANX points so no rejection is needed.

2. ANX time lookup

In this approach the user can use an external file of ANX transit times, and remove any data with a time flag outside the acceptable time range for each orbit (defined as greater than or equal to the ANX time for the orbit to less than the ANX time for the subsequent orbit). ANX time files for the operational segments of the satellites can be requested via the ESA Tellus system. It should be noted that the Mission orbit number within these files does not always coincide with the Product orbit number, for the reason stated in Q29.

Q31. There appears to be something wrong with my calculations when I use the values for visible channel bandwidth in ATS_PC1_AX as defined in the Envisat Product Specifications.

The units for the visible channel bandwidth in the Envisat Product auxiliary data specifications are given as microns, but the actual numerical value is in nm.

Q32. What are the units for integrated solar irradiance values in the visible channel calibration auxiliary file ATS_VC1_AX as they do not appear anywhere in the documentation?

The units for the integrated solar irradiance values are microwatts/cm^2.

Q33. What is the relationship between the contents of the geolocation ADS and the latitudes and longitudes of the pixels in the MDSs of the AATSR gridded products? [*historic question no longer applicable*]

The Sentinel/SAFE-like format products contain geodetic latitude and longitude information for each instrument measurement (geodetic_in and geodetic_io); users are referred to the Product Specification and User Information Documents listed in Section 1.1 for further information. Some slowly varying parameters have positional data every 16 rows and 16 columns (the tie-point resolution).

Users should be aware of an issue with metadata that can affect tie-point data alignment on the same grid as 1-km resolution data, if being applied by the user; this is explained in the Product Notice (see Q22.). The SNAP software tool automatically applies the necessary correction.

Q34. Do the resulting across-track co-ordinates associated to each pixel after interpolation refer to the left-hand edge of the pixel? Similarly, do the along-track tie points refer to the centre of the pixel or to one pixel edge (i.e. does the line of tie points go through the centre of the associated line of pixels in the image)? [*historic question no longer applicable*]

The Sentinel/SAFE-like format products from the fourth reprocessing contain exact latitude and longitude information for each instrument measurement, for both those within the 1-km grid and those that did not populate the 1-km gridded data ("orphan pixels"). Exact visualisation is therefore now possible for each measurement, including how it relates to the 16-km tie-point grid. Users are referred to the Product Specification and User Information Documents listed in Section 1.1 for further information.

Q35. What are the consequences of the curved-swath instrument data being transferred onto a quasi-Cartesian grid?

The transfer of curved-swath instrument data, in two different views and retrieved at different times, to a quasi-Cartesian 1 x 1 km gridded product with colocated nadir and forward views necessitates a certain amount of data processing, since the sampling and spatial resolution of AATSR does not match the required grid. The main consequences of the transfer of the measured instrument data to the gridded product are as follows:

- A nearest-neighbour approach to remapping means that one instrument measurement is selected to be placed within each 1-km pixel of the L1B product; the location of this measurement is contained with the geodetic data files. Any measurements that would be eligible to be placed within the same 1-km pixel are now contained within the "orphan" parameters.
- The nearest-neighbour approach results in many unfilled pixels in the oblique view (and some in the nadir view); these are then *cosmetically filled* by neighbouring pixel data. Therefore, a 1-km gridded pixel value does not always represent actual measured data; see Figure 2 (right) which shows the forward-view measured data on the gridded product. The cosmetically filled pixels have been blacked out, which reveals the true sampling of the forward view when viewed on a 1-km grid.
- Since the instrument pixel size and field of view is much larger in the forward view than in the nadir view, due to the oblique angle of sight for the forward view, any identified feature will be smeared, or blurred, over a larger number of 1-km pixels in the forward view than in the nadir view; see Figure 2 and compare the nadir-view image (left) with the forward-view images (centre and right). When users are comparing nadir data with forward data, these characteristics need to be taken into account.

Figure 2. Lough Neagh, Northern Ireland. Left: nadir view; centre: forward view; right: forward view with cosmetically filled pixels in black

Q36. Can the instrument co-ordinates be regenerated from the gridded product?

Yes. The Sentinel/SAFE-like format products from the fourth reprocessing contain location and time coordinates for each measurement, as well as instrument scan and pixel information. This then allows the reconstruction of the instrument view, and can also incorporate the “orphan” pixel data that does not appear on the L1B 1-km grid.

Key points to note:

- The gridded product contains cosmetically filled pixels (as explained in Q35.), and so regenerating instrument pixel co-ordinates will reveal the true sampling characteristics of the instrument as long as cosmetically filled pixels are not included in the reconstruction.
- AATSR products are commonly longer than one standard full orbit (measured from equator to equator). They continue with empty pixels for several minutes after passing the equator in the ascending node. (This can be seen in the satellite ground track diagram in Q34.) The next sequential product should be used once the equator has been passed in the ascending node.
- The field of view of all AATSR measurements extends into neighbouring pixels (see Section 2.12.1.7 of the AATSR handbook, Q7.), therefore care should be taken when conducting analysis on instrument coordinate data, or on gridded products, on the pixel resolution (~1 km) scale.
- The regeneration of instrument co-ordinate data from the L1B 1-km grid will reveal spaces where instrument data could not be transferred to the 1-km grid; the information for these measurements have been placed within the “orphan” pixel information.

Q37. Why is the forward/nadir view sometimes missing at the start/end of the products when the other one is present?

AATSR products are generated from instrument source packets, each of which contains a single scan incorporating both nadir and forward view pixels. As such a product will start with a nadir view portion of the scan. The forward view data from the same scan is offset by approximately 1000 km, hence the forward view data appears to start after the nadir view data (in terms of ground location). Likewise at the end of the product, the nadir view ends at the geographical point contained in the scan from the last contributing source packet, and the corresponding forward view data appears to continue for approximately 1000 km.

Q38. Why do small negative values appear to be set in some visible channel data at night?

At night, noise in the visible channels generates small negative values, akin to exception values. This is not strictly an error in the AATSR processing scheme, but rather an unexpected result of adopting the ATSR-2 processing scheme for AATSR (ATSR-2 visible channel data were not available at night).

Users are advised to take note of this effect if using visible channel radiances in night-time data.

Q39. How can I ensure that I do not include any data from non-nominal instrument operations such as outgassings and blackbody crossover tests?

The acquisition date of the data product in question can be cross-checked against the instrument operations at the time; a comprehensive list of outgassing periods and times of blackbody crossover tests (along with other operations and unavailabilities) can be found at the RAL AATSR Ops site: http://www.aatsrops.rl.ac.uk/status.html and the ESA EO AATSR site: https://earth.esa.int/eogateway/instruments/aatsr/description (see Housekeeping Activities and Non-Nominal Data Periods).

For the fourth reprocessing dataset, the quality tag within the xfdumanifest XML file can also be inspected to see if the data in the product is `passed` or `degraded`. The 4th Reprocessing User Document (see Section 1.1) can be inspected to note times when the quality tag is not optimal.

Q40. Is there any offset between the nadir and oblique view pixels?

Early mission assessments of the AATSR colocation (meaning co-registration between the nadir and forward views) showed that the forward view was shifted in relation to the nadir view by around 3 pixels in the along-track direction and by around 1 pixel in the across-track direction. Corrections for this discrepancy were identified and incorporated into CH1 auxiliary file update for subsequent reprocessings, and the L1B dataset from the fourth reprocessing contains no systematic view shift at the centre of the orbit track.

However, it should be noted that the geolocation, and hence the colocation, of the instrument pixels is dependent on several input parameters, including the satellite orbit. Small errors in assumptions about the yaw, pitch and roll of the spacecraft translate to relocation errors. This is particularly true for the oblique-view data and data at the edge of the scan, where, due to the high view zenith angle, there is a greater sensitivity to pointing errors.

See Q35. for further information on geolocation and colocation in the context of dual-view curved swath instrument data.

Q41. Why do the coordinates from my AATSR data differ slightly with reference data for the same point?

Early mission comparisons with other data (GlobCover and MERIS Full Resolution, which have both been independently assessed to be accurate to the order of 150 m) showed

evidence of a systematic AATSR geolocation offset of 1 AATSR pixel along track and 1 AATSR pixel across track. There was no evidence of variation around the orbit.

Subsequent modifications made to the CH1 auxiliary file (see Q40.) incorporated a 1 x 1 pixel shift in order to improve the absolute nadir geolocation of AATSR products. The fourth reprocessing AATSR nadir geolocation accuracy is to within 1 km (1 pixel), which is the resolution of the instrument.

Q42. Where can I find AATSR LST and SST data products?

From the fourth reprocessing, responsibility for Level 2 LST products has been passed to the ESA CCI LST team; please see https://climate.esa.int/en/projects/land-surface-temperature/about/

Likewise, responsibility for Level 2 SST products has been passed to the ESA CCI SST team; please see https://climate.esa.int/en/projects/sea-surface-temperature/

Q43. Where can I find examples of AATSR Level 3 products?

Details of AATSR products and how to obtain examples can be accessed from https://earth.esa.int/eogateway/instruments/aatsr/quality-control-reports/products-availability

Q44. Why does the archive of AATSR data start where it does?

The AATSR archive originally contained data for the operational phase from July 2002 to April 2012. Although Envisat was launched in March 2002, AATSR had to be thoroughly tested, completing what is known as its commissioning phase, before the quality of the data it was acquiring could be assured.

After the third reprocessing, data from the commissioning period was added to the archive of available data, and the archive now starts from 20 May 2002. Products from data acquired before 22 July 2002 23:42 UTC have their manifest quality indicator set to `degraded` to indicate they were not fully operational products.