



*National Aeronautics and Space Administration
Goddard Earth Science Data Information and
Services Center (GES DISC)*

NASA Advanced Technology Microwave Sounder (ATMS) Level 1B Data Product User Guide: File Format and Definition

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Version 3.0

Product Version 3.15

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Goddard Earth Sciences Data and Information Services Center (GES DISC)

<http://disc.gsfc.nasa.gov>

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Revision History

<i>Product Version</i>	<i>Software Version</i>	<i>Date</i>	<i>Changes</i>
		2015-08-19	Initial Internal Release
		2016-04-06	Beta Release
v01_08	v01_08_00	2017-04	Version 1 Release
v02_05	v02_05_00	2018-05	Version 2 Release <ul style="list-style-type: none"> - Update Geolocation - Completed implementation of all L1a QA definitions - Updated Correction Coefficients - Re-designed calib_degraded quality flag - Added a brightness temperature status flag: antenna_temp_qc.
v02_11	v02_11_02		Version 2 Release <ul style="list-style-type: none"> - Added support for JPSS-1 - Updated some hyperlinks - Added list of acronyms
v03_15	v03_15		Version 3 Release Refinements: <ul style="list-style-type: none"> - obs_rad_count - calculation of sun_glint - leapsec handling - qa_pct_data_sci_mode - setting of instrument_state - computation of scan calibration Changed geospatial bounds order to lon, lat

Table of Contents

.....	i
1.0 Introduction	1
1.1 Overview of Sounder SIPS.....	1
1.2 Mission Instrument Description	2
1.3 Data Disclaimer	2
1.4 Obtaining the Product.....	3
1.5 Contact Information.....	3
1.6 References	3
1.7 What’s different/new in Version 3	4
2.0 ATMS Level 1B Product Overview	5
2.1 Product Granulation and Identification	5
2.2 Algorithm Background.....	5
2.3 Data Organization.....	7
2.4 File Format and Structure.....	7
2.5 Metadata.....	7
2.6 Missing Data / Fill Values.....	8
2.7 File Naming Convention.....	8
2.8 Time Representation	9
3.0 Data Content	11
3.1 Dimensions.....	11
3.2 Global Attributes.....	12
3.3 Variable Attributes	20
3.4 Science Variables	21
3.5 Auxilliary Variables.....	27
3.6 Geolocation.....	29
4.0 Options for Reading the Data	31
5.0 Data Services	31
6.0 Acronyms and Abbreviations	32
Appendix A: Differences in implementation between Algorithm Theoretical Basis Document (ATBD) and ATMS L1B V2	33
A.1 Calculation of Calibration Coefficients and Non-Linearity Correction	33
A.2 Lunar Intrusion or Contamination	33
A.3 Smoothing of Calibration Counts	34
A.4 Blackbody Emissivity	34
Appendix B: Geolocation Quality Flags	35
Appendix C: Interface Specification	38
SNPP L1B ATMS Interface Specification	39
Groups	39
Global Dimensions	39
Global Variables	40

Global Attributes	46
aux group	58
Variables for the aux group	58

1.0 Introduction

This document provides basic information about Version 3.15 of the Advanced Technology Microwave Sounder (ATMS) Level 1B (L1B) product. The ATMS instrument is on both the Suomi-National Polar-orbiting Partnership (S-NPP) and the Joint Polar Satellite System - 1 (JPSS-1) / National Oceanic and Atmospheric Administration - 20 (NOAA-20) satellites.

The ATMS Level 1B product consists of calibrated radiances (antenna is geolocated and calibrated to antenna temperature. This product has been annotated with both file and attribute level metadata to fully describe its contents.

The ATMS Level 1A product is not described in detail in this document.

The JPSS-1 / NOAA-20 satellite will be referred to as JPSS-1 or J1 throughout this document. NOAA-20 is used in NOAA documentation.

1.1 Overview of Sounder SIPS

The Joint Polar Satellite System (JPSS) S-NPP Sounder Science Investigator-led Processing Systems (SIPS), is one of six SIPSs formed by National Aeronautics and Space Administration (NASA) to provide the processing of level 0 data through level 1, level 2 and level 3 from the Suomi-NPP (previously known as NPP) satellite. The Suomi-NPP and JPSS-1 satellites are managed by the National Polar-orbiting Partnership (NPP) which includes elements from NASA, NOAA and Department of Defense (DoD). Specific details about the S-NPP and JPSS Missions can be found at:

https://www.jpss.noaa.gov/mission_and_instruments.html.

The S-NPP and JPSS-1 Sounder SIPS is a team made up of the Jet Propulsion Laboratory (JPL) and the Goddard Earth Sciences Data and Information Services Center (GES DISC). JPL provides the overall project management, science algorithm software integration, test and validation support. The GES DISC performs level 0 data acquisition and routine data processing operations. The GES DISC / Distributed Active Archive Center (DAAC) archives and distributes the data products and associated documentation.

Table 1.1 S-NPP / JPSS-1 SIPSs.

Science Team	SIPS	Instrument(s) Analyzed
Sounder	Sounder	ATMS and CrIS
Ozone	Ozone	OMPS
Ceres	CERES CARS	CERES
Land	Land	VIIRS
Atmospheres	Atmospheres	VIIRS
Ocean	Ocean	VIIRS

The SIPSs may also develop additional products to help their science teams analyze the potential usefulness of S-NPP products for continuing ongoing climate studies. Consequently, most SIPSs produce a variety of data products for their science teams. Because the possibility exists that many of these data products provide utility to the science community beyond the S-NPP science teams, NASA requests that SIPS products be made available to the public. This is consistent with NASA’s Earth Science Data Policy <https://science.nasa.gov/earth-science/earth-science-data/data-information-policy>

1.2 Mission Instrument Description

S-NPP is the first in a series of next generation U.S. weather satellites of the JPSS. ATMS is one of 5 instruments onboard the S-NPP satellite. The other instruments are: Clouds and the Earth's Radiant Energy System (CERES), Cross-track Infrared Sounder (CrIS), Ozone Mapping and Profiler Suite (OMPS) and Visible Infrared Imaging Radiometer Suite (VIIRS). These same 5 instruments are also flying onboard JPSS-1.

ATMS is a 22-channel microwave, cross-track scanning sounder providing both temperature and humidity soundings. Table 1.2.1 and Table 1.2.2 contain a summary of the ATMS instrument and platform parameters.

The ATMS instrument’s Scan Drive Mechanism on S-NPP has been experiencing additional wear on the bearings. To extend the life of the instrument, a decision was made to perform scan reversals for the purpose of ‘re-wetting’ the bearings. The scan reversals are now occurring twice per orbit, starting Aug 9, 2016. The end result of this maneuver is a slight loss of data. This loss of data is represented by the use of Fill Values.

Table 1.2.1 Instrument parameters for ATMS on S-NPP and JPSS-1.

Instrument Type	Scan Rate (s)	Scan Range (°)	Scan Pattern	FOR Dia (km, nadir)	Spectral Channels
Microwave (MW)	8/3	±53	96	16-75	22

Table 1.2.2 Approximate orbital parameters.

Platform	Alt (km)	Orbit Incl. (°)	Equator X Time	Period	Repeat Orbits	Repeat Days	Launch
S-NPP	824	98.7	13:30	101	228	16	28 Oct 2011
JPSS-1	824	98.7	13:30	101	228	16	18 Nov 2017

1.3 Data Disclaimer

Version 3.15 ATMS Level 1B data are released to the public as is. Every effort has been made to properly represent the data for which this document describes.

1.4 Obtaining the Product

The ATMS Level 1A & 1B software is written and integrated by the Sounder SIPS. The software then gets delivered to the Goddard Earth Sciences Data and Information Services Center (GES DISC) where it's installed and put into Operations. The ATMS Level 1B product can be found at and downloaded from the GES DISC. There you will find additional information and documentation about this product and other products of interest.

<https://disc.gsfc.nasa.gov>

Use the ECS Shortnames in the search string to quickly find the ATMS Level 1B product:

Mission	ECS Shortname	DOI
SNPP	SNPPATMSL1B	10.5067/FCXKUUE9VCLN
JPSS-1/NOAA-20	SNDRJ1ATMSL1B	10.5067/MUNII2DHSSY3

1.5 Contact Information

For information, questions or concerns with this ATMS L1B data set, please contact: Ruth Monarrez at Ruth.Monarrez@jpl.nasa.gov or send your question to: sounder.sips@jpl.nasa.gov.

1.6 References

1. B. Lambrigsten, Suomi National Polar Partnership Mission; Algorithm Theoretical Basis Document NASA L1b: Advanced Technology Microwave Sounder, Version 1, July 2004
2. M. Schreier, Advanced Technology Microwave Sounder (ATMS) Assessment Report for Suomi National Polar-orbiting Partnership (S-NPP) and Joint Polar Satellite System (JPSS-1) / National Oceanic and Atmospheric Administration (NOAA-20) Sounder Science Investigator-led Processing System (SIPS) Data Level 1, Data Product Version 3.0, July 2021.
3. NOAA Technical Report NESDIS 143 Cross Track Infrared Sounder (CrIS) Sensor Data Record (SDR) User's Guide. Version 1.0, Washington, D.C., December, 2013
4. NASA ESO EARTHDATA Standards, Requirements and References, <<https://earthdata.nasa.gov/user-resources/standards-and-references>>
5. NASA ESO EARTHDATA Data Levels, <<https://earthdata.nasa.gov/collaborate/open-data-services-and-software/data-information-policy/data-levels>>

1.7 What's different/new in Version 3

What is new in version 3.15:

- Changed the global attribute `geospatial_bounds`. The order of latitude and longitude have been changed to (lon lat). This now complies with the EPSG:4326 coordinate system.
- Updated the `qa_pct_data_sci_mode` definition to include geolocated observations.
- L1A:
 - Corrected the calculation of sun glint for both SNPP & JPSS-1/NOAA-20.
 - Corrected a bug in computing the observed radiance counts: `sci_cnt_rads`. Observations with invalid packet `sci_cnt_rads` are now labeled with `instrument_state = MISSING`.
 - Fixed an issue to handle scan position 0 when the first valid science packet is in reverse observation.
 - Made a couple of leap second related time format corrections.
- L1B:
 - Fixed calculation of degraded scan calibration to use previous coefficients if later coefficients are not available when scan calibration can't be performed based on the current scan calibration data.
 - Fixed software that previously failed during a leap second event.

2.0 ATMS Level 1B Product Overview

The ATMS Level 1B product is generated using L0 data that has been processed by the Earth Observing System (EOS) Data and Operations System (EDOS) located at NASA's Goddard Earth Sciences Data and Information Services Center (GES DISC). An ATMS Level 1A product is produced as an interim product but is not archived and distributed publicly.

The ATMS Level 1B product consists of calibrated radiances and geolocation along with any metadata necessary to use and interpret this product.

2.1 Product Granulation and Identification

The ATMS product is divided into a series of 6-minute segments or granules with each granule making up one file and 240 granules per day. Each file contains all observations for a given type made during a period of exactly 6 minutes. For each day, each 240 files are identified by granule number in the filename. For example, **g156** for granule 156 out of 240.

The nominal start time of granule 1 is defined to be 00:00:00. Because both CrIS and ATMS instruments are synced to International Atomic Time (TAI), the start time of the first 8-second scanset of a day can be anywhere up to 8 seconds later. It moves 1 second with each leap second. If the first scanset starts 8 seconds after the nominal start time, then the data can extend up to 8 seconds past the nominal end time.

The ability to uniquely identify a granule is built in to the ATMS L1B product. This is extremely useful when publishing analysis results. The nominal time coverage, represented as a string: `yyyymmddThhmm`, is used to construct a unique granule identifier called "gran_id". gran_id is stored as a global attribute that is also used in the filename, see section 2.6 File Naming Convention.

In addition, there is an observation identifier variable called "obs_id" that can further uniquely identify an observation within the granule. The obs_id is formatted as the gran_id with observation information appended to it.

The format of obs_id is: `yyyymmddThhmm.aaaExx` where 'aaa' is the 3-digit along-track index (001 – 135) and xx is the cross-track index (01 – 96). The "E" indicates earth view.

Example of obs_id: `20170401T2354.001E01`

2.2 Algorithm Background

The Sounder SIPS ATMS L1B data products are a product of processing NASA Level 0 data through Level 1A/Geolocation and Level 1B. See Figure 1. For a definition of the NASA Data

Processing Levels go to: <https://science.nasa.gov/earth-science/earth-science-data/data-processing-levels-for-eosdis-data-products>

The ATMS Level 1A processing extracts radiance counts from ATMS science telemetry, converts engineering counts from the health and status telemetries into physical measurements such as temperatures.

The L1A geolocation processing derives spacecraft positions and attitude according to spacecraft diary telemetry. It also projects ATMS sounding field-of-views (FOV) onto the topographic surface with geolocation, line-of-site (LOS) view angles, solar angles, and surface parameters such as elevations and land fractions. All the geolocation parameters from L1A processing are propagated to the L1B product.

The L1B processing then applies calibration coefficients (gain and offset) and non-linearity correction to the radiance counts to convert them to antenna temperatures. For more detail on how the calibration coefficients and the non-linearity corrections are computed can be found in Appendix A.

Technical and scientific details of the L1B processing steps and calibrations can be found in the Algorithm Theoretical Basis Document, NASA L1b: Advanced Technology Microwave Sounder Algorithm Theoretical Basis Document (ATBD) [Reference 1].

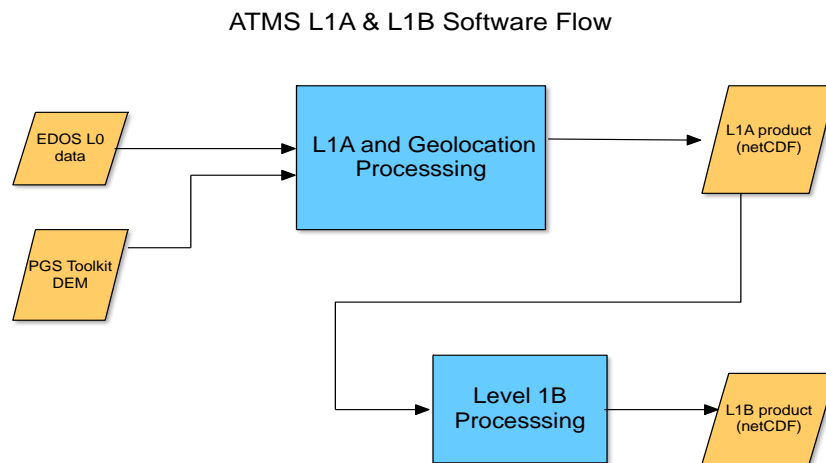


Figure 1. Sounder SIPS processing development cycle.

2.3 Data Organization

The ATMS products are divided into a series of 6 minute segments with one segment per file. Each file contains all observations of a given type made during a period of exactly 6 minutes. For each day there are 240 files (also known as granules), identified by the granule number in the filename. For granule start time details, refer to section 2.1.

2.4 File Format and Structure

The ATMS L1B files, similar to the CrIS L1B files, are in Network Common Data Form, version 4 / Hierarchical Data Format version 5 (NetCDF4/HDF5) format.

The product format takes advantage of the NetCDF4 data model and makes use of groups, dimensions, variables and attributes to fully describe the science data. Below is a basic structure of a l1b datafile.

```
netcdf l1b_atms {
    dimensions:
    // global attributes:
    variables:
    group: aux {
        variables:
    } // aux
} // l1b_atms
```

2.5 Metadata

Every effort has been made to ensure that metadata conforms to the Climate and Forecasting (CF), Version 1.6, and Attribute Conventions for Data Discovery (ACDD), Version 1.3, guidelines.

See the full product specification in Appendix C.

For more information on CF, refer to:

<http://cfconventions.org/Data/cf-documents/requirements-recommendations/requirements-recommendations-1.6.html>

For more information on ACDD, refer to:

http://wiki.esipfed.org/index.php/Attribute_Convention_for_Data_Discovery_1-3

2.6 Missing Data / Fill Values

On occasion, there will be data that is missing for whatever reason. In the situation where there are incomplete granules within the 6-minute product granule, the missing data will be filled with a 'Fill Values'. The fill value is indicated by the attribute '_FillValue'. The fill value will exist in the same location the missing data would exist. This will preserve the shape of the 6-minute granule. Should the data for an entire 6-minute granule be missing, a granule will still be produced and will contain all fill values. In other words, a full fill-value granule will be produced. With this in mind, it is advised to check the data for fill values before it is used. The fill values per variable datatype are listed in the table below.

Table: 3.6.1 Fill Values

Variable Type	Fill Value
ubyte	255UB
ushort	65535US
uint	4294967295U
float	9.96921e+36f
double	9.96920996838687e+36

At the scan level, the ATMS L1B Program Generation Executive (PGE) tries to calculate antenna temperature for all scans, even there is not enough information to calculate scan-specific calibration coefficients. If we can't calculate coefficients for a particular scan, but we do have science counts for this scan, then we use calibration coefficients from the nearest, earlier scan. If we don't have good coefficients from the earlier scan, we use nearest coefficients from the later scan. So, in fact, if we can calculate a calibration coefficients for any scan within a 10 minute interval from a current scan, we will calculate a 'degraded' antenna temperature for a current scan. The PGE sets the corresponding quality flags if the antenna temperature for a scan was calculated using calibration coefficients from a different scan.

2.7 File Naming Convention

File naming for Sounder SIPS products will be unique and include the following tokens separated by the delimiter '.' For each token that makes up the filename, there will be an attribute in the data product that it maps to (see Table 2.6 ATMS L1B Filenaming).

Filename tokens:

<product_name_project>.<product_name_platform>.<product_name_instr>.<gran_id>.<product_name_duration>.<granule_number>.<product_name_type_id>.<product_name_variant>.<product_name_version>.<product_name_producer>.<product_name_timestamp>.<product_name_extension>

Table 2.6 ATMS L1B File naming

Attribute name in CDF (mapping)	Format	Value(s)	Description
product_name_project	text	SNDR	Sounder SIPS project ID
product_name_platform	text	SNPP, J1	Satellite platform: SNPP = Suomi-NPP, J1 = JPSS-1 / NOAA-20
product_name_instr	text	ATMS	Instrument identifier
gran_id	yyyymmddThhmm		Unique granule identifier; Nominal granule start time
product_name_duration	m###	m06	6 minutes
granule_number	g###	g001 - g240	Only for 6-minute granule products
product_name_type_id + (optional identifier for uniqueness)	Freeform text. No whitespace or any punctuation except underscore.	L1B	Identifies the processing level, if applicable, according to NASA's EOSDIS Data Processing Levels. See: reference 5
product_name_variant	Freeform text. No whitespace or any punctuation except underscore.	std	Used to identify special runs. The default is: std = standard.
product_name_version	v02_##; v02_##_##	V02_11	e.g. v02_11; v02_11_00 (when produced at JPL)
product_name_producer		J, G, T, W	J: Jet Propulsion Laboratory G: Goddard Space Flight Center T: Test W: University of Wisconsin
product_name_timestamp	yymmddhhmmss		Time the file was produced
product_name_extension		nc	NetCDF file extension

Example Filename: 6-minute ATMS Level 1B granule
 SNDR.SNPP.ATMS.yyyymmddThhmm.m06.g196.L1B.std.vmm_mm.G.yymmddhhmmss.nc
 SNDR.SNPP.ATMS.20150407T0906.m06.g196.L1B.std.v03_15.G.150407104359.nc

2.8 Time Representation

Times in the ATMS L1B product are generally represented as UTC. However, observation times are provided in both UTC and TAI93 representations as a convenience to users. Coordinated Universal Time (UTC) is the international standard for representation of time. UTC times are expressed in human-readable form, as a set of values indicating year, month, day, hour and so on. In the data stream received from the satellite, observation times are represented as UTC.

Timestamps in ATMS L1B product filenames and attributes are represented as UTC and formatted according to the “ISO 8601:2004” standard. For example, the time January 25, 2016 at 13:00 may be represented as either of the following:

2016-01-25T13:00Z
20160125T1300

The longer form is used in attributes, and the more compact form is used in filenames. The character “Z” indicates “Zulu time”, or UTC.

International Atomic Time (TAI) is expressed as number of seconds elapsed on the surface of the Earth since some reference UTC time. The term “TAI93” indicates that the reference time is the beginning of the year 1993, or 1993-01-01T00:00:00Z. This reference time was chosen to be consistent with data products from other instruments, and to allow for precise representation of times spanning the expected mission length.

Leap seconds are one-second adjustments that are occasionally applied to UTC as 23:59:60, to account for irregularities in the rotation of the Earth. There were 27 leap seconds applied to UTC between Jan 1, 1958 and Jan 1, 1993. Between Jan 1, 1993 and Jan 1, 2017, an additional 10 leap seconds were applied to UTC. Leap seconds must be accounted for when doing certain kinds of time calculations, especially in astronomy and satellite applications. Leap seconds can occur on December 31 or June 30 of a given year, and are announced months in advance.

Leap seconds must be accounted for in the following operations:

- When calculating exact elapsed time between two UTC times. If one or more leap seconds were inserted between the UTC endpoints, they must be accounted for in order for the result to be accurate.
- When converting between UTC and TAI times. Any leap seconds that occurred between the TAI reference time and the UTC time must be accounted for, or the result will be wrong.
- When comparing TAI times with different reference times, or converting from one TAI reference time to the other. Any leap seconds that occurred between the reference times must be accounted for, or the result will be wrong. An example would be when comparing TAI93 times in L1B products to “IET” microseconds in operational ATMS SDR products, which use a reference time of 1958-01-01T00:00Z. In this case 27 leap seconds occurred between the reference times.

In general, these operations can be error-prone. Therefore it is recommended that time calculations and conversions be done with leap-second-aware third party tools that rely on an up-to-date table of leap seconds, such as the “astropy” python package. As a generality, it can be assumed that most computational systems use POSIX time scale and cannot represent leap seconds, unless specifically stated in the software specifications.

3.0 Data Content

The ATMS Level 1B data products are written in NetCDF4 format and therefore make use of groups, dimensions, variables and attributes (global & variable). Every NetCDF4/HDF5 file contains, at a minimum, one root group which is unnamed.

Attention should be given to quality flags and checked for fill values before being used for any analysis or higher processing of the L1B product.

Selected groups and fields are highlighted in this section. A full profile of the contents of the files is included in a Common Data Language (CDL) output file in Appendix C.

3.1 Dimensions

Global dimensions used throughout the ATMS L1B products.

Table 3.1 Global Dimensions

Dimension name	Size	Meaning
atrack	135	Along-track spatial dimension
xtrack	96	Cross-track spatial dimension
channel	22	ATMS channels
band	5	Microwave bands: K, Ka, V, W, G
utc_tuple	8	Parts of the UTC date/time: year, month, day, hour, minute, second, millisec, microsec
spatial	3	Directions: x, y, z
fov_poly	8	Lat/lon points defining the polygon bounding a field of view (anticlockwise as viewed from above)
attitude	3	Roll, pitch, yaw
spacetrack	4	Space view

3.2 Global Attributes

There are two types of attributes: global & variable. In this section we will talk about global attributes. Global attributes, sometimes referred to as ‘file-level attributes’, provide information about the entire file or 6-minute granule. This includes observation times, publisher and creator information, data provenance, geolocation information, etc. Many attributes are required to conform to the CF & ACDD standards while other attributes are written for consistency with legacy products, hence, you may find some information to be a little redundant or differing in the naming convention.

There are some QA global attributes that should be considered before using the data in analysis or processing. See Table 3.2.1 QA Related Global Attributes, if AutomaticQualityFlag equals ‘Suspect’, you should look at other QA fields such as qa_pct_data_missing to see what percent of the data may be missing and decide to use the data or not. See Table 3.2.2 Global Attributes or Appendix C: CDL File Definition for full file definition.

Table 3.2.1 QA Related Global Attributes

Attribute Name	Type	Dimension	Description
AutomaticQualityFlag	string		<p>Passed: the granule contains a non-degraded calibrated brightness temperature or radiance for at least one channel in a geolocated FOV</p> <p>Suspect: the granule does not qualify as "Passed" but contains a (possibly degraded) calibrated brightness temperature or radiance for at least one channel (possibly without associated geolocation)</p> <p>Failed: the granule contains no calibrated brightness temperatures/radiances.</p>
geo_qual	ushort	atrack, xtrack	<p>Overall value of 0 indicates no critical issues.</p> <p>Bit 2 (surface_loc)- Failed geolocation on Earth topographic surface</p> <p>Bit 3 (DEM) - Could not set FOV surface elevations and land water fraction</p> <p>Bit 4 (geoid_loc) - Failed geolocation on Earth geoid</p> <p>Bit 5 (solar_ang) - Failed to set solar zenith or azimuth angles</p>

			Bit 6 (spacecraft_ang) - Failed to set spacecraft zenith or azimuth angles Bit 7 - Unused (0) Bit 8 (band_specific) - Failed geolocation of some bands
qa_pct_data_missing	float		Percentage of expected observations that are missing.
qa_pct_data_geo	float		Percentage of expected observations that are successfully geolocated.
qa_pct_data_sci_mode	float		Percentage of expected observations that were taken while the instrument was in science mode and are successfully geolocated.
qa_no_data	string		A simple indicator of whether this is an "empty" granule with no data from the instrument. "TRUE" or "FALSE".

A full definition of the global attributes can be found in Appendix C: CDL File Definition.

Table 3.2.2 Global Attributes

Name	Type	Description
keywords	string	A comma-separated list of key words and/or phrases. Keywords may be common words or phrases, terms from a controlled vocabulary (GCMD is often used), or URIs for terms from a controlled vocabulary (see also "keywords_vocabulary" attribute).
Conventions	string	A comma-separated list of the conventions that are followed by the dataset.
history	string	Provides an audit trail for modifications to the original data. This attribute is also in the NetCDF Users Guide: 'This is a character array with a line for each invocation of a program that has modified the dataset. Well-behaved generic netCDF applications should append a line containing: date, time of day, user name, program name and command arguments.' To include a more complete description you can append a reference to an ISO Lineage entity; see NOAA EDM ISO Lineage guidance.
source	string	The method of production of the original data. If it was model-generated, source should name the model and its version. If it is observational, source should characterize it. This attribute is defined in the CF Conventions. Examples: 'temperature from CTD #1234'; 'world model v.0.1'.
processing_level	string	A textual description of the processing (or quality control) level of the data.

Name	Type	Description
product_name_type_id	string	Product name as it appears in product_name (L1A, L1B, L2, SNO_AIRS_CrIS)
comment	string	Miscellaneous information about the data or methods used to produce it. Can be empty.
acknowledgment	string	A place to acknowledge various types of support for the project that produced this data.
license	string	Provide the URL to a standard or specific license, enter "Freely Distributed" or "None", or describe any restrictions to data access and distribution in free text.
standard_name_vocabulary	string	The name and version of the controlled vocabulary from which variable standard names are taken. (Values for any standard_name attribute must come from the CF Standard Names vocabulary for the data file or product to comply with CF.) Example: 'CF Standard Name Table v27'.
date_created	string	The date on which this version of the data was created. (Modification of values implies a new version, hence this would be assigned the date of the most recent values modification.) Metadata changes are not considered when assigning the date_created. The ISO 8601:2004 extended date format is recommended, as described in the Attribute Content Guidance section.
creator_name	string	The name of the person (or other creator type specified by the creator_type attribute) principally responsible for creating this data.
creator_email	string	The email address of the person (or other creator type specified by the creator_type attribute) principally responsible for creating this data.
creator_url	string	The URL of the person (or other creator type specified by the creator_type attribute) principally responsible for creating this data.
institution	string	Processing facility that produced this file
project	string	The name of the project(s) principally responsible for originating this data. Multiple projects can be separated by commas, as described under Attribute Content Guidelines. Examples: 'PATMOS-X', 'Extended Continental Shelf Project'.
product_name_project	string	The name of the project as it appears in the file name. 'SNDP' for all Sounder SIPS products, even AIRS products.
publisher_name	string	The name of the person (or other entity specified by the publisher_type attribute) responsible for publishing the data file or product to users, with its current metadata and format.

Name	Type	Description
publisher_email	string	The email address of the person (or other entity specified by the publisher_type attribute) responsible for publishing the data file or product to users, with its current metadata and format.
publisher_url	string	The URL of the person (or other entity specified by the publisher_type attribute) responsible for publishing the data file or product to users, with its current metadata and format.
geospatial_bounds	string	Describes the data's 2D or 3D geospatial extent in OGC's Well-Known Text (WKT) Geometry format (reference the OGC Simple Feature Access (SFA) specification). The meaning and order of values for each point's coordinates depends on the coordinate reference system (CRS). The ACDD default is 2D geometry in the EPSG:4326 coordinate reference system. The default may be overridden with geospatial_bounds_crs and geospatial_bounds_vertical_crs (see those attributes). EPSG:4326 coordinate values are longitude (decimal degrees_east) and latitude (decimal degrees_north), in that order. Longitude values in the default case are limited to the (-180, 180) range. Example: "POLYGON ((37.23 -77.81, -36.93 -66.37, -92.65 -67.71, -178.05 -80.74, 37.23 -77.81))".
geospatial_bounds_crs	string	The coordinate reference system (CRS) of the point coordinates in the geospatial_bounds attribute. This CRS may be 2-dimensional or 3-dimensional, but together with geospatial_bounds_vertical_crs, if that attribute is supplied, must match the dimensionality, order, and meaning of point coordinate values in the geospatial_bounds attribute. If geospatial_bounds_vertical_crs is also present then this attribute must only specify a 2D CRS. EPSG CRSs are strongly recommended. If this attribute is not specified, the CRS is assumed to be EPSG:4326. Examples: 'EPSG:4979' (the 3D WGS84 CRS), 'EPSG:4047'.
geospatial_lat_min	float	Describes a simple lower latitude limit; may be part of a 2- or 3-dimensional bounding region. Geospatial_lat_min specifies the southernmost latitude covered by the dataset.
geospatial_lat_max	float	Describes a simple upper latitude limit; may be part of a 2- or 3-dimensional bounding region. Geospatial_lat_max specifies the northernmost latitude covered by the dataset.
geospatial_lon_min	float	Describes a simple longitude limit; may be part of a 2- or 3-dimensional bounding region. geospatial_lon_min specifies the westernmost longitude covered by the dataset. See also geospatial_lon_max.

Name	Type	Description
geospatial_lon_max	float	Describes a simple longitude limit; may be part of a 2- or 3-dimensional bounding region. geospatial_lon_max specifies the easternmost longitude covered by the dataset. Cases where geospatial_lon_min is greater than geospatial_lon_max indicate the bounding box extends from geospatial_lon_max, through the longitude range discontinuity meridian (either the antimeridian for -180:180 values, or Prime Meridian for 0:360 values), to geospatial_lon_min; for example, geospatial_lon_min=170 and geospatial_lon_max=-175 incorporates 15 degrees of longitude (ranges 170 to 180 and -180 to -175).
time_coverage_start	string	Nominal start time. Describes the time of the first data point in the data set. Use the ISO 8601:2004 date format, preferably the extended format as recommended in the Attribute Content Guidance section.
time_of_first_valid_obs	string	Describes the time of the first valid data point in the data set. Use the ISO 8601:2004 date extended format.
time_coverage_mid	string	Describes the midpoint between the nominal start and end times. Use the ISO 8601:2004 date format, preferably the extended format as recommended in the Attribute Content Guidance section.
time_coverage_end	string	Nominal end time. Describes the time of the last data point in the data set. Use ISO 8601:2004 date format, preferably the extended format as recommended in the Attribute Content Guidance section.
time_of_last_valid_obs	string	Describes the time of the last valid data point in the data set. Use the ISO 8601:2004 date extended format.
time_coverage_duration	string	Describes the duration of the data set. Use ISO 8601:2004 duration format, preferably the extended format as recommended in the Attribute Content Guidance section.
product_name_duration	string	Product duration as it appears in product_name (m06 means six minutes)
creator_type	string	Specifies type of creator with one of the following: 'person', 'group', 'institution', or 'position'. If this attribute is not specified, the creator is assumed to be a person.
creator_institution	string	The institution of the creator; should uniquely identify the creator's institution. This attribute's value should be specified even if it matches the value of publisher_institution, or if creator_type is institution.

Name	Type	Description
product_version	string	Version identifier of the data file or product as assigned by the data creator. For example, a new algorithm or methodology could result in a new product_version.
keywords_vocabulary	string	If you are using a controlled vocabulary for the words/phrases in your "keywords" attribute, this is the unique name or identifier of the vocabulary from which keywords are taken. If more than one keyword vocabulary is used, each may be presented with a prefix and a following comma, so that keywords may optionally be prefixed with the controlled vocabulary key. Example: 'GCMD:GCMD Keywords, CF:NetCDF COARDS Climate and Forecast Standard Names'.
platform	string	Name of the platform(s) that supported the sensor data used to create this data set or product. Platforms can be of any type, including satellite, ship, station, aircraft or other. Indicate controlled vocabulary used in platform_vocabulary.
platform_vocabulary	string	Controlled vocabulary for the names used in the "platform" attribute.
product_name_platform	string	Platform name as it appears in product_name
instrument	string	Name of the contributing instrument(s) or sensor(s) used to create this data set or product. Indicate controlled vocabulary used in instrument_vocabulary.
instrument_vocabulary	string	Controlled vocabulary for the names used in the "instrument" attribute.
product_name_instr	string	Instrument name as it appears in product_name
product_name	string	Canonical fully qualified product name (official file name)
product_name_variant	string	Processing variant identifier as it appears in product_name. 'std' (shorthand for 'standard') is to be the default and should be what is seen in all public products.
product_name_version	string	Version number as it appears in product_name (v01_00_00)
product_name_producer	string	Production facility as it appears in product_name (single character) 'T' is the default, for unofficial local test products
product_name_timestamp	string	Processing timestamp as it appears in product_name (yymmddhhmmss)
product_name_extension	string	File extension as it appears in product_name (typically nc)
granule_number	ushort	granule number of day (1-240)
product_name_granule_number	string	zero-padded string for granule number of day (g001-g240)

Name	Type	Description
gran_id	string	Unique granule identifier yyyyymmddThhmm of granule start, including year, month, day, hour, and minute of granule start time
geospatial_lat_mid	float	granule center latitude
geospatial_lon_mid	float	granule center longitude
featureType	string	structure of data in file
data_structure	string	a character string indicating the internal organization of the data with currently allowed values of 'grid', 'station', 'trajectory', or 'swath'. The 'structure' here generally describes the horizontal structure and in all cases data may also be functions, for example, of a vertical coordinate and/or time. (If using CMOR pass this in a call to cmor_set_cur_dataset_attribute.)
cdm_data_type	string	The data type, as derived from Unidata's Common Data Model Scientific Data types and understood by THREDDS. (This is a THREDDS "dataType", and is different from the CF NetCDF attribute 'featureType', which indicates a Discrete Sampling Geometry file in CF.)
id	string	An identifier for the data set, provided by and unique within its naming authority. The combination of the "naming authority" and the "id" should be globally unique, but the id can be globally unique by itself also. IDs can be URLs, URNs, DOIs, meaningful text strings, a local key, or any other unique string of characters. The id should not include white space characters.
naming_authority	string	The organization that provides the initial id (see above) for the dataset. The naming authority should be uniquely specified by this attribute. We recommend using reverse-DNS naming for the naming authority; URIs are also acceptable. Example: 'edu.ucar.unidata'.
identifier_product_doi	string	digital signature
identifier_product_doi_auth ority	string	digital signature source
algorithm_version	string	The version of the algorithm in whatever format is selected by the developers. Versions from multiple sub-algorithms may be concatenated with semicolon separators. (ex: 'CCAST 4.2; BB emis from MIT 2016-04-01')
production_host	string	Identifying information about the host computer for this run. (Output of linux "uname -a" command.)
format_version	string	Format version.

Name	Type	Description
input_file_names	string	Semicolon-separated list of names or unique identifiers of files that were used to make this product. There will always be one space after each semicolon. There is no final semicolon.
input_file_types	string	Semicolon-separated list of tags giving the role of each input file in input_file_names. There will always be one space after each semicolon. There is no final semicolon.
input_file_dates	string	Semicolon-separated list of creation dates for each input file in input_file_names. There will always be one space after each semicolon. There is no final semicolon.
orbitDirection	string	Orbit is ascending and/or descending. Values are "Ascending" or "Descending" if the entire granule fits that description. "NorthPole" and "SouthPole" are used for polar-crossing granules. "NA" is used when a determination cannot be made.
day_night_flag	string	Data is day or night. "Day" means subsatellite point for all valid scans has solar zenith angle less than 90 degrees. "Night" means subsatellite point for all valid scans has solar zenith angle greater than 90 degrees. "Both" means the dataset contains valid observations with solar zenith angle above and below 90 degrees. "NA" means a value could not be determined.
AutomaticQualityFlag	string	"Passed": the granule contains a non-degraded calibrated brightness temperature, radiance, or retrieved value for at least one value in a geolocated FOV; "Suspect": the granule does not qualify as "Passed" but contains a (possibly degraded) calibrated or retrieved value (possibly without associated geolocation); "Failed": the granule contains no calibrated or retrieved values.
qa_pct_data_missing	float	Percentage of expected observations that are missing.
qa_pct_data_geo	float	Percentage of expected observations that are successfully geolocated.
qa_pct_data_sci_mode	float	Percentage of expected observations that were taken while the instrument was in science mode and are successfully geolocated.
qa_no_data	string	A simple indicator of whether this is an "empty" granule with no data from the instrument. "TRUE" or "FALSE".
title	string	a succinct description of what is in the dataset. (= ECS long name)
summary	string	A paragraph describing the dataset, analogous to an abstract for a paper.

Name	Type	Description
shortname	string	ECS Short Name
product_group	string	The group name to be used for this product when it is collected in a multi-group file type, like SNO or calsub.
metadata_link	string	A URL that gives the location of more complete metadata. A persistent URL is recommended for this attribute.
references	string	ATDB and design documents describing processing algorithms. Can be empty.
contributor_name	string	The names of any individuals or institutions that contributed to the creation of this data.
contributor_role	string	The roles of any individuals or institutions that contributed to the creation of this data.

3.3 Variable Attributes

Each variable has its own associated attributes. Variable attributes are mostly a CF or ACDD standard and are used to describe the variable in more detail to properly interpret its value. See section 2.5 Metadata for a link to get more detailed information about the attributes conforming to CF and ACDD standards.

Table 3.3: Variable Attributes

Attribute	Relevant standard(s)	Description
units	CF, UDUNITS	units, for variables that represent physical quantities
_FillValue	CF, NetCDF	a single sentinel value indicating the data point contains fill instead of valid data
standard_name	CF	standard name from the CF standard name table, if one exists for the quantity being represented
long_name	CF	a longer name describing the quantity being represented, suitable for a plot title
valid_range	CF	a pair of values indicating the minimum and maximum values to be considered valid
coordinates	CF	a space-separated list of the names of other variables that are coordinates for this variable
description		a longer description of the quantity being represented

coverage_content_type	ACDD, ISO 19115-1	indicates the source of the data
ancillary_variables	CF	a space-separated list of the names of other variables that contain information about this variable
bounds	CF	defines the extent, for cell variables
cell_methods	CF	describes statistical methods used to derive data, for cell variables
flag_values	CF	a comma-separated list of flag values, for variables that represent flags
flag_meanings	CF	a space separated list of the meanings of each flag value, for variables that represent flags
flag_masks	CF	a comma-separated list of flag masks, for variables that represent flags. If this attribute is present, the basic rule is “apply the flag mask and if you get the flag value, it means the flag meaning”

3.4 Science Variables

Science data fields are in the variables group within the netCDF file. These fields are the most heavily used. Included in this group are satellite and solar geometry information, spacecraft position and orbital characteristics, surface information and related metadata.

Table 3.4.1 Science Data Variables

Variable Name	Dimensions	Type	Description	Units
obs_id	atrack, xtrack	string	unique earth view observation identifier: yyyymmddThhmm.aa[a]Exx . Includes gran_id plus two- or three-digit along-track index (01-45 or 001-135) and 2-digit cross-track index (01-96).	
instrument_state	atrack, xtrack	ubyte	instrument/data state: 0/'Process' - Data is usable for science; 1/'Special' - Observations are valid but instrument is not configured for science data (ex: stare mode); 2/'Erroneous' - Data is not usable (ex: checksum error); 3/'Missing' - No data was received.	
obs_time_tai93	atrack, xtrack	double	earth view observation midtime for each FOV	seconds since 1993-01-01 00:00
obs_time_utc	atrack, xtrack, utc_tuple	uint16	UTC earth view observation time as an array of integers: year, month, day, hour, minute, second, millisec, microsec	
lat	atrack, xtrack	float	terrain corrected latitude of FOV center	degrees_north
lat_geoid	atrack, xtrack	float	latitude of FOV center on the geoid (without terrain correction)	degrees_north
lon	atrack, xtrack	float	terrain corrected longitude of FOV center	degrees_east
lon_geoid	atrack, xtrack	float	longitude of FOV center on the geoid (without terrain correction)	degrees_east

land_frac	atrack, xtrack	float	land fraction over the FOV	unitless
surf_alt	atrack, xtrack	float	mean surface altitude wrt earth model over the FOV	m
surf_alt_sdev	atrack, xtrack	float	standard deviation of surface altitude within the FOV	m
sun_glint_lat	atrack	float	sun glint spot latitude at scan_mid_time. Fill for night observations.	degrees_north
sun_glint_lon	atrack	float	sun glint spot longitude at scan_mid_time. Fill for night observations.	degrees_east
sol_zen	atrack, xtrack	float	solar zenith angle at the center of the spot	degree
sol_azi	atrack, xtrack	float	solar azimuth angle at the center of the spot (clockwise from North)	degree
sun_glint_dist	atrack, xtrack	float	distance of sun glint spot to the center of the spot. Fill for night observations.	m
view_ang	atrack, xtrack	float	off nadir pointing angle	degree
sat_zen	atrack, xtrack	float	satellite zenith angle at the center of the spot	degree
sat_azi	atrack, xtrack	float	satellite azimuth angle at the center of the spot (clockwise from North)	degree
sat_range	atrack, xtrack	float	line of sight distance between satellite and spot center	m
asc_flag	atrack	ubyte	ascending orbit flag: 1 if ascending, 0 descending	
subsat_lat	atrack	float	sub-satellite latitude at scan_mid_time	degrees_north
subsat_lon	atrack	float	sub-satellite longitude at scan_mid_time	degrees_east
scan_mid_time	atrack	double	TAI93 at middle of earth scene scans	seconds since 1993-01-01 00:00

sat_alt	atrack	float	satellite altitude with respect to earth model at scan_mid_time	m
sat_pos	atrack, spatial	float	satellite ECR position at scan_mid_time	m
sat_vel	atrack, spatial	float	satellite ECR velocity at scan_mid_time	m s-1
sat_att	atrack, attitude	float	satellite attitude at scan_mid_time. An orthogonal triad. First element is angle about the +x (roll) ORB axis. +x axis is positively oriented in the direction of orbital flight. Second element is angle about +y (pitch) ORB axis. +y axis is oriented normal to the orbit plane with the positive sense opposite to that of the orbit's angular momentum vector H. Third element is angle about +z (yaw) axis. +z axis is positively oriented Earthward parallel to the satellite radius vector R from the spacecraft center of mass to the center of the Earth.	degree
moon_ang	atrack, spacextrack	float	angle between moon and FOV center for space view	degree
local_solar_time	atrack, xtrack	float	local apparent solar time in hours from midnight	hours
mean_anom_wrt_equat	atrack	float	spacecraft mean anomaly measured with respect to the ascending node	degree
sat_sol_zen	atrack	float	solar zenith angle at the satellite	degree

sat_sol_azi	atrack	float	solar azimuth angle at the satellite (clockwise from North)	degree
asc_node_lon		float	Longitude of the last ascending node of spacecraft orbit before time_coverage_end.	degrees_east
asc_node_tai93		double	TAI93 time of the last ascending node of spacecraft orbit before time_coverage_end.	seconds since 1993-01-01 00:00
asc_node_local_solar_time		float	local apparent solar time at the last ascending node before time_coverage_end in hours from midnight	hours
solar_beta_angle		float	Beta angle for the spacecraft orbit, determining the percentage of the orbit that the spacecraft is in direct sunlight.	degree
attitude_lbl	attitude	string	list of rotational directions (roll, pitch, yaw)	
spatial_lbl	spatial	string	list of spatial directions (X, Y, Z)	
utc_tuple_lbl	utc_tuple	string	names of the elements of UTC when it is expressed as an array of integers year,month,day,hour,minute,second,millisecond,microsecond	
band_lat	atrack, xtrack, band	float	band-specific fov center latitude	degrees_north
band_lon	atrack, xtrack, band	float	band-specific fov center longitude	degrees_east
band_land_frac	atrack, xtrack, band	float	band-specific land fraction over the fov	unitless

band_surf_alt	atrack, xtrack, band	float	band-specific mean surface altitude over the fov	m
band_geoloc_chan	band	unsigned short int	Channel used in determining the geolocation information for each band	unitless
antenna_temp	atrack, xtrack, channel	float	Calibrated scene brightness temperature for each ATMS channel and beam position. This output is the Rayleigh equivalent temperature and not the Planck blackbody equivalent temperature	Kelvin
cold_nedt	channel	float	Noise equivalent delta temperature derived from observations of cold space	Kelvin
warm_nedt	channel	float	Noise equivalent delta temperature derived from observations of the warm calibration target	Kelvin
band_lbl	band	string	List of Microwave bands (K, Ka, V, W, G)	
channel	channel	unsigned short int	Number for each channel (1-22)	unitless
chan_band	channel	string	Name of band for each channel	
antenna	channel	char	Name of antenna for each channel	
center_freq	channel	float	Channel center frequency	MHz
if_offset_1	channel	float	Offset of first intermediate frequency stage (zero for no mixing)	MHz
if_offset_2	channel	float	Offset of second intermediate frequency stage (zero for no mixing)	MHz

bandwidth	channel	float	bandwidth of sum of 1, 2, or 4 channels	MHz
polarization	channel	char	Nominal polarization: Vertical or Horizontal	
beam_width	channel	float	Nominal beam width	degree

3.5 Auxilliary Variables

The auxiliary information, provided in an aux group, is not readily used by the wider user community but is provided here for completeness.

Table 3.4.2 Aux Group - Variables

Variable Name	Dimensions	Type	Description
geo_qualflag	atrack, xtrack	int32	Bit 7 - Failed geolocation on Earth topographic surface (surface_loc)
			Bit 6 - Could not set FOV surface elevations and land water fraction (DEM)
			Bit 5 - Failed geolocation on Earth geoid (geoid_loc)
			Bit 4 - Failed to set solar zenith or azimuth angles (solar_ang)
			Bit 3 - Failed to set spacecraft zenith or azimuth angles (spacecraft_ang)
			Bit 2 - Unused (0)
			Bit 1 (LSB) - Failed geolocation of some bands (band_specific)
cal_qualflag	atrack, channel	int32	(Bit 32 is most significant. It is not used because it can cause confusion when this flag is used as a signed or unsigned integer.)
			Bit 7 : No usable calibration. Scan is not calibrated. (cal_failed)
			Bit 6 : Calibration values used from different scan. (cal_from_diff_scan)
			Bit 5: Insufficient valid shelf temperature values to use in a scan calibration. Fall-back constant shelf temperatures are used. (shelf_temp_bad)
			Bit 4: Excess noise (noise)
			Bit 3: Telemetry out of limits (telem)
			Bit 2: Spectral quality is poor (spectral)
			Bit 1 (LSB): reserved (0)

cal_space_qualflag	atrack, channel	int32	(Bit 32 is most significant. It is not used because it can cause confusion when this flag is used as a signed or unsigned integer.)
			Bit 14 : Insufficient valid space (cold calibration) observation counts to produce a scan-specific calibration. Scan may still be calibrated using coefficients from another scan. (cold_cal_bad)
			Bit 13: Insufficient effective space temperature values to produce a scan-specific calibration. Scan may still be calibrated using coefficients from another scan. (space_temp_bad)
			Bit 12: This scan's space view #1 not used because of lunar intrusion or other problem. A scan-specific calibration may still be calculated using space views from neighboring views and scans. (sv1_bad)
			Bit 11: This scan's space view #2 not used because of lunar intrusion or other problem. A scan-specific calibration may still be calculated using space views from neighboring views and scans. (sv2_bad)
			Bit 10 : This scan's space view #3 not used because of lunar intrusion or other problem. A scan-specific calibration may still be calculated using space views from neighboring views and scans. (sv3_bad)
			Bit 9 : This scan's space view #4 not used because of lunar intrusion or other problem. A scan-specific calibration may still be calculated using space views from neighboring views and scans. (sv4_bad)
			Bit 8: Missing moon angle for this scan's space view #1. Lunar intrusion status is unknown. (sv1_moon_unknown)
			Bit 7: Missing moon angle for this scan's space view #2. Lunar intrusion status is unknown. (sv2_moon_unknown)
			Bit 6: Missing moon angle for this scan's space view #3. Lunar intrusion status is unknown. (sv3_moon_unknown)
			Bit 5: Missing moon angle for this scan's space view #4. Lunar intrusion status is unknown. (sv4_moon_unknown)
Bits 1-4: reserved (0)			

cal_blackbody_qualflag	atrack, channel	int32	(Bit 32 is most significant. It is not used because it can cause confusion when this flag is used as a signed or unsigned integer.)
			Bit 3: Insufficient valid black body (warm calibration) observation counts to produce a scan-specific calibration. Scan may still be calibrated using coefficients from another scan. (warm_cal_bad)
			Bit 2: Insufficient valid black body temperature readings to produce a scan-specific calibration. Scan may still be calibrated using coefficients from another scan. (bb_temp_bad)
			Bit 1 (LSB): This scan's black body view not used. A scan-specific calibration may still be calculated using black body views from neighboring scans. (bb_bad)
offset	atrack, channel	float	Offset used in calibrating earth scene brightness temps.
gain	atrack, channel	float	Gain factor used in calibrating earth scene brightness temps.
nonlin	atrack, xtrack, channel	float	Nonlinearity correction used in calibrating earth scene brightness temps.
cold_temp	atrack, channel	float	Effective temperature of cold calibration view (space) (Tcc)
warm_temp	atrack, channel	float	Effective temperature of warm calibration view (black body) (Twc)

3.6 Geolocation

Geolocation variables are located in the file at the root level in the group named variables. They include latitudes and longitudes associated with each observation, as well as satellite and solar geometry information, spacecraft position and orbital characteristics, surface information and related metadata. Table 3.4.1 Science Variables above has the complete list of variables that includes all the geolocation variables as well. We felt it was worth calling out a few key variables here.

Geolocation parameters are used for determining location of each observation on earth.

Table 3.5.1 Geolocation Dimensions

Dimension name	Size	Meaning
atrack	135	Along-track spatial dimension
xtrack	96	Cross-track spatial dimension

And the key geolocation variables are:

Table 3.5.2 Geolocation Variables

Geolocation Variable	Dimensions	Type	Meaning
lat	atrack, xtrack	32-bit floating-point	latitude of fov center
lon	atrack, xtrack	32-bit floating-point	longitude of fov center
obs_time_tai93	atrack, xtrack	64-bit floating-point	earth view observation midtime for each fov in units of seconds since 1993-01-01T00:00:00
obs_time_utc	atrack, xtrack, utc_tuple	16-bit integer	UTC earth view observation time as an array of integers: year, month, day, hour, minute, second, msec

The geolocation quality flags are listed in Appendix B.

4.0 Options for Reading the Data

The ATMS L1B files are written in NetCDF4/HDF5. Because NetCDF4 builds upon the classic NetCDF data model using HDF5 as the storage layer, a user of the data product can take full advantage of tools and libraries readily available to access the data.

Every NetCDF4 file is considered an HDF5 file, however, not every HDF5 file is necessarily a NetCDF4 file. A limited subset of the HDF5 data model and file format features are used in NetCDF4 files. Conformance to the earlier mentioned CF & ACDD standards allows for users to take advantage of most NetCDF interfaces.

Tools and libraries for reading NetCDF4 as well as a NetCDF Users' Guide are written and maintained by Unidata and can be found online at:

<http://www.unidata.ucar.edu/software/netcdf/>

There are a number of interfaces available for reading NetCDF for different programming languages including: C/C++, Fortran, Matlab, IDL, Python and Perl.

Additionally, but can also be accessed with HDF5 tools and libraries available at:

https://www.hdfgroup.org/products/hdf5_tools/

5.0 Data Services

The ATMS Level 1B products are available to the user community via the Goddard Distributed Active Archive Center (GDAAC) also referred to as the Goddard Earth Sciences Data and Information Services Center (GES DISC). See section [1.4 Obtaining the Product](#) of this document. There you will find additional information and documentation about this product and other products of interest. Ordering and data sub-setting tools and services

<https://disc.gsfc.nasa.gov>

Use the ECS Shortnames in the search string to quickly find the ATMS Level 1B product:

Mission	ECS Shortname	DOI
SNPP	SNPPATMSL1B	10.5067/FCXKUUE9VCLN
JPSS-1/NOAA-20	SNDRJ1ATMSL1B	10.5067/MUNII2DHSSY3

Unlike the ATMS Level 1B products, the ATMS Level 1A products are not archived at the GDAAC and therefore not made publicly available. No other Data Services are provided for these products.

6.0 Acronyms and Abbreviations

ACDD	Attribute Convention for Dataset Discovery
ATBD	Algorithm Theoretical Basis Document
ATMS	Advanced Technology Microwave Sounder
CDL	Common Data Language
CF	Climate and Forecast
CrIS	Cross-Track Infrared Sounder
DoD	Department of Defense
EDOS	EOS Data and Operations System
EOS	Earth Observing System
ESDIS	Earth Science Data and Information System
ESO	ESDIS Standards Office
FOV	Field Of View
GES DISC	Goddard Earth Science Data and Information Services Center
JPL	Jet Propulsion Laboratory
JPSS	Joint Polar Satellite System
NASA	National Aeronautics and Space Administration
NOAA	National Oceanic and Atmospheric Administration
SIPS	Science Investigator-led Processing Systems
S-NPP	Suomi-National Polar-orbiting Partnership
UTC	Coordinated Universal Time
VIIRS	Visible Infrared Imaging Radiometer Suite

Appendix A: Differences in implementation between Algorithm Theoretical Basis Document (ATBD) and ATMS L1B V2

A.1 Calculation of Calibration Coefficients and Non-Linearity Correction

The implementation of calculation of calibration coefficients differs from the one described in the ATBD [1] section 5.5.4 (page 37). The approach described in the ATBD does not work with the non-linearity coefficients that we have from NOAA's Interface Data Processing Segment (IDPS) calibration coefficients file. Version 2 of Level 1B PGE uses the same approach as NOAA's IDPS software. We do not calculate a_0 , a_1 , a_2 coefficients, instead, we calculate 'offset', 'gain' and 'non linearity correction'. The implemented algorithm is as follows:

$$T_b = T_{bl} + Q$$

$$T_{bl} = T_{wc} + (C_s - C_{wa}) / \text{gain}$$

$$Q = T_{nl} * (1 - 4 * [(T_{bl} - T_{cc}) / (T_{wc} - T_{cc}) - 0.5]^2)$$

where

T_b = Brightness temperature, as reported in antenna_temp parameter

Q = non-linearity correction

T_{nl} = Peak nonlinearity, as determined from calibration tests (non-linear term interpolated for cold plate temperature)

T_{bl} = Brightness temperature assuming linear transfer function

T_{wc} = Effective temperature of warm calibration (hot target)

C_s = Number of counts for the scene sample

C_{wa} = Number of counts from the warm calibration view, averaged

T_{cc} = Brightness temperature of cold calibration (cold space view) for each channel

C_{cca} = Number of counts from the cold calibration view, averaged

The "offset" is the temperature used when scene counts are 0 assuming linear transfer function. We calculate offset as:

$$T_{\text{offset}} = T_{wc} - C_{wa} / \text{gain}$$

A.2 Lunar Intrusion or Contamination

The lunar contamination threshold is a configurable parameter that is defined for each ATMS channel. If the angle between moon center and field-of-view center for space view is less than a set threshold, the count for such space view are not included in the calculation

of the averaged cold calibration counts. The lunar contamination threshold is a configurable parameter, defined for each channel. It could be changed in APF XML configuration file. This approach is different from the NOAA's IDPS handling of lunar contamination.

A.3 Smoothing of Calibration Counts

The ATBD [1] describes a triangular smoothing function for calibration counts on section 5.4 (page 34). Version 2 of the ATMS Level 1B PGE uses a rectangular smoothing function (calibration counts from 9 scans are averaged with the same weight). This is similar to what NOAA IDPS does. This is done to make a comparison with IDPS antenna temperature more straightforward. The smoothing weights are configurable parameters that are defined for each channel. They can be changed in APF XML configuration files.

A.4 Blackbody Emissivity

The black body emissivity for warm calculation black body temperature is currently set to 1 for all channels. This is the same value that NOAA IDPS uses.

Appendix B: Geolocation Quality Flags

Flag name	Bit Index	Num Bits	Meaning
geo_qualflag	7	1	Failed geolocation on Earth topographic surface (surface_loc)
	6	1	Could not set FOV surface elevations and land water fraction (DEM)
	5	1	Failed geolocation on Earth geoid (geoid_loc)
	4	1	Failed to set solar zenith or azimuth angles (solar_ang)
	3	1	Failed to set spacecraft zenith or azimuth angles (spacecraft_ang)
	2	1	Unused (0)
	1	1	(LSB) - Failed geolocation of some bands (band_specific)
cal_qualflag	32	1	(Bit 32 is most significant. It is not used because it can cause confusion when this flag is used as a signed or unsigned integer.)
	7	1	No usable calibration. Scan is not calibrated. (cal_failed)
	6	1	Calibration values used from different scan. (cal_from_diff_scan)
	5	1	Insufficient valid shelf temperature values to use in a scan calibration. Fall-back constant shelf temperatures are used. (shelf_temp_bad)
	4	1	Excess noise (noise)
	3	1	Telemetry out of limits (telem)
	2	1	Spectral quality is poor (spectral)
	1	1	(LSB): reserved (0)
cal_space_qualflag	32	1	(Bit 32 is most significant. It is not used because it can cause confusion when this flag is used as a signed or unsigned integer.)
	14	1	Insufficient valid space (cold calibration) observation counts to produce a scan-specific calibration. Scan may still be calibrated using coefficients from another scan. (cold_cal_bad)

	13	1	Insufficient effective space temperature values to produce a scan-specific calibration. Scan may still be calibrated using coefficients from another scan. (space_temp_bad)
	12	1	This scan's space view #1 not used because of lunar intrusion or other problem. A scan-specific calibration may still be calculated using space views from neighboring views and scans. (sv1_bad)
	11	1	This scan's space view #2 not used because of lunar intrusion or other problem. A scan-specific calibration may still be calculated using space views from neighboring views and scans. (sv2_bad)
	10	1	This scan's space view #3 not used because of lunar intrusion or other problem. A scan-specific calibration may still be calculated using space views from neighboring views and scans. (sv3_bad)
	9	1	This scan's space view #4 not used because of lunar intrusion or other problem. A scan-specific calibration may still be calculated using space views from neighboring views and scans. (sv4_bad)
	8	1	Missing moon angle for this scan's space view #1. Lunar intrusion status is unknown. (sv1_moon_unknown)
	7	1	Missing moon angle for this scan's space view #2. Lunar intrusion status is unknown. (sv2_moon_unknown)
	6	1	Missing moon angle for this scan's space view #3. Lunar intrusion status is unknown. (sv3_moon_unknown)
	5	1	Missing moon angle for this scan's space view #4. Lunar intrusion status is unknown. (sv4_moon_unknown)
	Bits 1 - 4	1	reserved (0)
cal_blackbody_qualflag	32	1	(Bit 32 is most significant. It is not used because it can cause confusion when this flag is used as a signed or unsigned integer.)
	3	1	Insufficient valid black body (warm calibration) observation counts to produce a scan-specific calibration. Scan may still be

			calibrated using coefficients from another scan. (warm_cal_bad)
	2	1	Insufficient valid black body temperature readings to produce a scan-specific calibration. Scan may still be calibrated using coefficients from another scan. (bb_temp_bad)
	1	1	(LSB): This scan's black body view not used. A scan-specific calibration may still be calculated using black body views from neighboring scans. (bb_bad)
offset	atrack, channel	float	Offset used in calibrating earth scene brightness temps.
gain	atrack, channel	float	Gain factor used in calibrating earth scene brightness temps.
nonlin	atrack, xtrack, channel	float	Nonlinearity correction used in calibrating earth scene brightness temps.
cold_temp	atrack, channel	float	Effective temperature of cold calibration view (space) (Tcc)
warm_temp	atrack, channel	float	Effective temperature of warm calibration view (black body) (Twc)

Appendix C: Interface Specification

A full data product specification for S-NPP ATMS is shown below in table format. A CDL text file showing the full structure of the ATMS L1b datafile can be generated by using the NetCDF4 library and using the ncdump utility.

S-NPP data product specification is identical to JPSS-1/NOAA-20 with the only differences being in platform, product_name_platform, title and shortname.

The command used to generate the CDL file is: `ncdump -h <filename>.nc`

SNPP L1B ATMS Interface Specification

Version v02.02.08

Groups

Path	Description
/	User data
/aux	Internal product team data

Global Dimensions

Name	Size	Description
atrack	135	along-track horizontal dimension
xtrack	96	cross-track horizontal dimension
channel	22	channel number
band	5	Microwave bands
spacetrack	4	space view
utc_tuple	8	parts of UTC time: year, month, day, hour, minute, second, millisec, microsec
fov_poly	8	lat_bnds, lon_bnds points defining the polygon bounding an FOV (anticlockwise as viewed from above)
spatial	3	directions: x, y, z for satellite position and velocity

Name	Size	Description
attitude	3	roll, pitch, yaw

Global Variables

Name	Type	Dimensions	Description	Units	Ancillary Variables
obs_id	string	atrack, xtrack	unique earth view observation identifier: yyyyymmddThhmm.aa[a]Exx . Includes gran_id plus two- or three-digit along-track index (01-45 or 001-135) and 2-digit cross-track index (01-96).		
instrument_state	ubyte	atrack, xtrack	instrument/data state: 0/'Process' - Data is usable for science; 1/'Special' - Observations are valid but instrument is not configured for science data (ex: stare mode); 2/'Erroneous' - Data is not usable (ex: checksum error); 3/'Missing' - No data was received.		
obs_time_tai93	double	atrack, xtrack	earth view observation midtime for each FOV	seconds since 1993-01-01 00:00	
obs_time_utc	uint16	atrack, xtrack, utc_tuple	UTC earth view observation time as an array of integers: year, month, day, hour, minute, second, millisec, microsec		
lat	float	atrack, xtrack	latitude of FOV center	degrees_north	bnds

Name	Type	Dimensions	Description	Units	Ancillary Variables
lat_geoid	float	atrack, xtrack	latitude of FOV center on the geoid (without terrain correction)	degrees_north	
lon	float	atrack, xtrack	longitude of FOV center	degrees_east	bnds
lon_geoid	float	atrack, xtrack	longitude of FOV center on the geoid (without terrain correction)	degrees_east	
land_frac	float	atrack, xtrack	land fraction over the FOV	unitless	
surf_alt	float	atrack, xtrack	mean surface altitude wrt earth model over the FOV	m	sdev
sun_glnt_lat	float	atrack	sun glint spot latitude at scan_mid_time. Fill for night observations.	degrees_north	
sun_glnt_lon	float	atrack	sun glint spot longitude at scan_mid_time. Fill for night observations.	degrees_east	
sol_zen	float	atrack, xtrack	solar zenith angle at the center of the spot	degree	
sol_azi	float	atrack, xtrack	solar azimuth angle at the center of the spot (clockwise from North)	degree	
sun_glnt_dist	float	atrack, xtrack	Distance from the center of the calculated sun glint spot to the center of the spot. Note that there may not be a glint for cloudy or land cases and in ocean cases the glint can move based on wind conditions. Fill for night observations.	m	

Name	Type	Dimensions	Description	Units	Ancillary Variables
view_ang	float	atrack, xtrack	off nadir pointing angle	degree	
sat_zen	float	atrack, xtrack	satellite zenith angle at the center of the spot	degree	
sat_azi	float	atrack, xtrack	satellite azimuth angle at the center of the spot (clockwise from North)	degree	
sat_range	float	atrack, xtrack	line of sight distance between satellite and spot center	m	
asc_flag	ubyte	atrack	ascending orbit flag: 1 if ascending, 0 descending		
subsat_lat	float	atrack	sub-satellite latitude at scan_mid_time	degrees_north	
subsat_lon	float	atrack	sub-satellite longitude at scan_mid_time	degrees_east	
scan_mid_time	double	atrack	TAI93 at middle of earth scene scans	seconds since 1993-01-01 00:00	
sat_alt	float	atrack	satellite altitude with respect to earth model at scan_mid_time	m	
sat_pos	float	atrack, spatial	satellite ECR position at scan_mid_time	m	
sat_vel	float	atrack, spatial	satellite ECR velocity at scan_mid_time	m s-1	

Name	Type	Dimensions	Description	Units	Ancillary Variables
sat_att	float	atrack, attitude	satellite attitude at scan_mid_time. An orthogonal triad. First element is angle about the +x (roll) ORB axis. +x axis is positively oriented in the direction of orbital flight. Second element is angle about +y (pitch) ORB axis. +y axis is oriented normal to the orbit plane with the positive sense opposite to that of the orbit's angular momentum vector H. Third element is angle about +z (yaw) axis. +z axis is positively oriented Earthward parallel to the satellite radius vector R from the spacecraft center of mass to the center of the Earth.	degree	
moon_ang	float	atrack, spacetrack	angle between moon and FOV center for space view	degree	
local_solar_time	float	atrack, xtrack	local apparent solar time in hours from midnight	hours	
mean_anom_wrt_equat	float	atrack	spacecraft mean anomaly measured with respect to the ascending node	degree	
sat_sol_zen	float	atrack	solar zenith angle at the satellite	degree	
sat_sol_azi	float	atrack	solar azimuth angle at the satellite (clockwise from North)	degree	
asc_node_lon	float		Longitude of the last ascending node of spacecraft orbit before time_coverage_end.	degrees_east	
asc_node_tai93	double		TAI93 time of the last ascending node of spacecraft orbit before time_coverage_end.	seconds since 1993-01-01 00:00	

Name	Type	Dimensions	Description	Units	Ancillary Variables
asc_node_local_solar_time	float		local apparent solar time at the last ascending node before time_coverage_end in hours from midnight	hours	
solar_beta_angle	float		Beta angle for the spacecraft orbit, determining the percentage of the orbit that the spacecraft is in direct sunlight.	degree	
attitude_lbl	string	attitude	list of rotational directions (roll, pitch, yaw)		
spatial_lbl	string	spatial	list of spatial directions (X, Y, Z)		
utc_tuple_lbl	string	utc_tuple	names of the elements of UTC when it is expressed as an array of integers year,month,day,hour,minute,second,millisecond,microsecond		
band_lat	float	atrack, xtrack, band	band-specific fov center latitude	degrees_north	bnds
band_lon	float	atrack, xtrack, band	band-specific fov center longitude	degrees_east	bnds
band_land_frac	float	atrack, xtrack, band	band-specific land fraction over the fov	unitless	
band_surf_alt	float	atrack, xtrack, band	band-specific mean surface altitude over the fov	m	
band_geoloc_chan	unsigned short int	band	Channel used in determining the geolocation information for each band	unitless	

Name	Type	Dimensions	Description	Units	Ancillary Variables
antenna_temp	float	atrack, xtrack, channel	Calibrated scene brightness temperature for each ATMS channel and beam position. This output is the Rayleigh equivalent temperature and not the Planck blackbody equivalent temperature	Kelvin	qc
cold_nedt	float	channel	Noise equivalent delta temperature derived from observations of cold space	Kelvin	
warm_nedt	float	channel	Noise equivalent delta temperature derived from observations of the warm calibration target	Kelvin	
band_lbl	string	band	List of Microwave bands (K, Ka, V, W, G)		
channel	unsigned short int	channel	Number for each channel (1-22)	unitless	
chan_band	string	channel	Name of band for each channel		
antenna	char	channel	Name of antenna for each channel		
center_freq	float	channel	Channel center frequency	MHz	
if_offset_1	float	channel	Offset of first intermediate frequency stage (zero for no mixing)	MHz	
if_offset_2	float	channel	Offset of second intermediate frequency stage (zero for no mixing)	MHz	
bandwidth	float	channel	bandwidth of sum of 1, 2, or 4 channels	MHz	
polarization	char	channel	Nominal polarization: Vertical or Horizontal		

Name	Type	Dimensions	Description	Units	Ancillary Variables
beam_width	float	channel	Nominal beam width	degree	

Global Attributes

Name	Type	Size	Value	Description
keywords	string	1	EARTH SCIENCE > SPECTRAL/ENGINEERING > MICROWAVE > ANTENNA TEMPERATURE	A comma-separated list of key words and/or phrases. Keywords may be common words or phrases, terms from a controlled vocabulary (GCMD is often used), or URIs for terms from a controlled vocabulary (see also "keywords_vocabulary" attribute).
Conventions	string	1	CF-1.6\, ACDD-1.3	A comma-separated list of the conventions that are followed by the dataset.
history	string	1		Provides an audit trail for modifications to the original data. This attribute is also in the NetCDF Users Guide: 'This is a character array with a line for each invocation of a program that has modified the dataset. Well-behaved generic netCDF applications should append a line containing: date, time of day, user name, program name and command arguments.' To include a more complete description you can append a reference to an ISO Lineage entity; see NOAA EDM ISO Lineage guidance.
source	string	1	ATMS instrument telemetry	The method of production of the original data. If it was model-generated, source should name the model and its version. If it is observational, source should characterize it. This attribute is defined in the CF Conventions. Examples: 'temperature from CTD #1234'; 'world model v.0.1'.

Name	Type	Size	Value	Description
processing_level	string	1	1B	A textual description of the processing (or quality control) level of the data.
product_name_type_id	string	1	L1B	Product name as it appears in product_name (L1A, L1B, L2, SNO_AIRS_CrIS)
comment	string	1		Miscellaneous information about the data or methods used to produce it. Can be empty.
acknowledgment	string	1	Support for this research was provided by NASA.	A place to acknowledge various types of support for the project that produced this data.
license	string	1	Limited to Sounder SIPS affiliates	Provide the URL to a standard or specific license, enter "Freely Distributed" or "None", or describe any restrictions to data access and distribution in free text.
standard_name_vocabulary	string	1	CF Standard Name Table v28	The name and version of the controlled vocabulary from which variable standard names are taken. (Values for any standard_name attribute must come from the CF Standard Names vocabulary for the data file or product to comply with CF.) Example: 'CF Standard Name Table v27'.
date_created	string	1	Unassigned	The date on which this version of the data was created. (Modification of values implies a new version, hence this would be assigned the date of the most recent values modification.) Metadata changes are not considered when assigning the date_created. The ISO 8601:2004 extended date format is recommended, as described in the Attribute Content Guidance section.

Name	Type	Size	Value	Description
creator_name	string	1	Unassigned	The name of the person (or other creator type specified by the creator_type attribute) principally responsible for creating this data.
creator_email	string	1	Unassigned	The email address of the person (or other creator type specified by the creator_type attribute) principally responsible for creating this data.
creator_url	string	1	Unassigned	The URL of the person (or other creator type specified by the creator_type attribute) principally responsible for creating this data.
institution	string	1	Unassigned	Processing facility that produced this file
project	string	1	Sounder SIPS	The name of the project(s) principally responsible for originating this data. Multiple projects can be separated by commas, as described under Attribute Content Guidelines. Examples: 'PATMOS-X', 'Extended Continental Shelf Project'.
product_name_project	string	1	SNDR	The name of the project as it appears in the file name. 'SNDR' for all Sounder SIPS products, even AIRS products.
publisher_name	string	1	Unassigned	The name of the person (or other entity specified by the publisher_type attribute) responsible for publishing the data file or product to users, with its current metadata and format.
publisher_email	string	1	Unassigned	The email address of the person (or other entity specified by the publisher_type attribute) responsible for publishing the data file or product to users, with its current metadata and format.

Name	Type	Size	Value	Description
publisher_url	string	1	Unassigned	The URL of the person (or other entity specified by the publisher_type attribute) responsible for publishing the data file or product to users, with its current metadata and format.
geospatial_bounds	string	1		Describes the data's 2D or 3D geospatial extent in OGC's Well-Known Text (WKT) Geometry format (reference the OGC Simple Feature Access (SFA) specification). The meaning and order of values for each point's coordinates depends on the coordinate reference system (CRS). The ACDD default is 2D geometry in the EPSG:4326 coordinate reference system. The default may be overridden with geospatial_bounds_crs and geospatial_bounds_vertical_crs (see those attributes). EPSG:4326 coordinate values are longitude (decimal degrees_east) and latitude (decimal degrees_north), in that order. Longitude values in the default case are limited to the [-180, 180) range. Example: 'POLYGON ((-111.29 40.26, -111.29 41.26, -110.29 41.26, -110.29 40.26, -111.29 40.26))'.
geospatial_bounds_crs	string	1	EPSG:4326	The coordinate reference system (CRS) of the point coordinates in the geospatial_bounds attribute. This CRS may be 2-dimensional or 3-dimensional, but together with geospatial_bounds_vertical_crs, if that attribute is supplied, must match the dimensionality, order, and meaning of point coordinate values in the geospatial_bounds attribute. If geospatial_bounds_vertical_crs is also present then this attribute must only specify a 2D CRS. EPSG CRSs are strongly recommended. If this attribute is not specified, the CRS is assumed to be EPSG:4326. Examples: 'EPSG:4979' (the 3D WGS84 CRS), 'EPSG:4047'.

Name	Type	Size	Value	Description
geospatial_lat_min	float	1	9.9692099683868690e+36f	Describes a simple lower latitude limit; may be part of a 2- or 3-dimensional bounding region. Geospatial_lat_min specifies the southernmost latitude covered by the dataset.
geospatial_lat_max	float	1	9.9692099683868690e+36f	Describes a simple upper latitude limit; may be part of a 2- or 3-dimensional bounding region. Geospatial_lat_max specifies the northernmost latitude covered by the dataset.
geospatial_lon_min	float	1	9.9692099683868690e+36f	Describes a simple longitude limit; may be part of a 2- or 3-dimensional bounding region. geospatial_lon_min specifies the westernmost longitude covered by the dataset. See also geospatial_lon_max.
geospatial_lon_max	float	1	9.9692099683868690e+36f	Describes a simple longitude limit; may be part of a 2- or 3-dimensional bounding region. geospatial_lon_max specifies the easternmost longitude covered by the dataset. Cases where geospatial_lon_min is greater than geospatial_lon_max indicate the bounding box extends from geospatial_lon_max, through the longitude range discontinuity meridian (either the antimeridian for -180:180 values, or Prime Meridian for 0:360 values), to geospatial_lon_min; for example, geospatial_lon_min=170 and geospatial_lon_max=-175 incorporates 15 degrees of longitude (ranges 170 to 180 and -180 to -175).
time_coverage_start	string	1		Nominal start time. Describes the time of the first data point in the data set. Use the ISO 8601:2004 date format, preferably the extended format as recommended in the Attribute Content Guidance section.

Name	Type	Size	Value	Description
time_of_first_valid_obs	string	1		Describes the time of the first valid data point in the data set. Use the ISO 8601:2004 date extended format.
time_coverage_mid	string	1		Describes the midpoint between the nominal start and end times. Use the ISO 8601:2004 date format, preferably the extended format as recommended in the Attribute Content Guidance section.
time_coverage_end	string	1		Nominal end time. Describes the time of the last data point in the data set. Use ISO 8601:2004 date format, preferably the extended format as recommended in the Attribute Content Guidance section.
time_of_last_valid_obs	string	1		Describes the time of the last valid data point in the data set. Use the ISO 8601:2004 date extended format.
time_coverage_duration	string	1	P0000-00-00T00:06:00	Describes the duration of the data set. Use ISO 8601:2004 duration format, preferably the extended format as recommended in the Attribute Content Guidance section.
product_name_duration	string	1	m06	Product duration as it appears in product_name (m06 means six minutes)
creator_type	string	1	institution	Specifies type of creator with one of the following: 'person', 'group', 'institution', or 'position'. If this attribute is not specified, the creator is assumed to be a person.
creator_institution	string	1	Jet Propulsion Laboratory -- California Institute of Technology	The institution of the creator; should uniquely identify the creator's institution. This attribute's value should be specified even if it matches the value of publisher_institution, or if creator_type is institution.

Name	Type	Size	Value	Description
product_version	string	1	vxx.xx.xx	Version identifier of the data file or product as assigned by the data creator. For example, a new algorithm or methodology could result in a new product_version.
keywords_vocabulary	string	1	GCMD:GCMD Keywords	If you are using a controlled vocabulary for the words/phrases in your "keywords" attribute, this is the unique name or identifier of the vocabulary from which keywords are taken. If more than one keyword vocabulary is used, each may be presented with a prefix and a following comma, so that keywords may optionally be prefixed with the controlled vocabulary key. Example: 'GCMD:GCMD Keywords, CF:NetCDF COARDS Climate and Forecast Standard Names'.
platform	string	1	SUOMI-NPP > Suomi National Polar-orbiting Partnership	Name of the platform(s) that supported the sensor data used to create this data set or product. Platforms can be of any type, including satellite, ship, station, aircraft or other. Indicate controlled vocabulary used in platform_vocabulary.
platform_vocabulary	string	1	GCMD:GCMD Keywords	Controlled vocabulary for the names used in the "platform" attribute.
product_name_platform	string	1	SNPP	Platform name as it appears in product_name
instrument	string	1	ATMS > Advanced Technology Microwave Sounder	Name of the contributing instrument(s) or sensor(s) used to create this data set or product. Indicate controlled vocabulary used in instrument_vocabulary.
instrument_vocabulary	string	1	GCMD:GCMD Keywords	Controlled vocabulary for the names used in the "instrument" attribute.

Name	Type	Size	Value	Description
product_name_instr	string	1	ATMS	Instrument name as it appears in product_name
product_name	string	1		Canonical fully qualified product name (official file name)
product_name_variant	string	1	std	Processing variant identifier as it appears in product_name. 'std' (shorthand for 'standard') is to be the default and should be what is seen in all public products.
product_name_version	string	1	vxx_xx_xx	Version number as it appears in product_name (v01_00_00)
product_name_producer	string	1	T	Production facility as it appears in product_name (single character) 'T' is the default, for unofficial local test products
product_name_timestamp	string	1	yymmddhhmmss	Processing timestamp as it appears in product_name (yymmddhhmmss)
product_name_extension	string	1	nc	File extension as it appears in product_name (typically nc)
granule_number	ushort	1		granule number of day (1-240)
product_name_granule_number	string	1	g000	zero-padded string for granule number of day (g001-g240)
gran_id	string	1	yyyymmddThhmm	Unique granule identifier yyyymmddThhmm of granule start, including year, month, day, hour, and minute of granule start time
geospatial_lat_mid	float	1	9.9692099683868690e+36f	granule center latitude
geospatial_lon_mid	float	1	9.9692099683868690e+36f	granule center longitude
featureType	string	1	point	structure of data in file

Name	Type	Size	Value	Description
data_structure	string	1	swath	a character string indicating the internal organization of the data with currently allowed values of 'grid', 'station', 'trajectory', or 'swath'. The 'structure' here generally describes the horizontal structure and in all cases data may also be functions, for example, of a vertical coordinate and/or time. (If using CMOR pass this in a call to cmor_set_cur_dataset_attribute.)
cdm_data_type	string	1	Swath	The data type, as derived from Unidata's Common Data Model Scientific Data types and understood by THREDDS. (This is a THREDDS "dataType", and is different from the CF NetCDF attribute 'featureType', which indicates a Discrete Sampling Geometry file in CF.)
id	string	1	Unassigned	An identifier for the data set, provided by and unique within its naming authority. The combination of the "naming authority" and the "id" should be globally unique, but the id can be globally unique by itself also. IDs can be URLs, URNs, DOIs, meaningful text strings, a local key, or any other unique string of characters. The id should not include white space characters.
naming_authority	string	1	Unassigned	The organization that provides the initial id (see above) for the dataset. The naming authority should be uniquely specified by this attribute. We recommend using reverse-DNS naming for the naming authority; URIs are also acceptable. Example: 'edu.ucar.unidata'.
identifier_product_doi	string	1	Unassigned	digital signature
identifier_product_doi_authority	string	1	Unassigned	digital signature source

Name	Type	Size	Value	Description
algorithm_version	string	1		The version of the algorithm in whatever format is selected by the developers. After the main algorithm name and version, versions from multiple sub-algorithms may be concatenated with semicolon separators. (ex: 'CCAST 4.2; BB emis from MIT 2016-04-01') Must be updated with every delivery that changes numerical results.
production_host	string	1		Identifying information about the host computer for this run. (Output of linux "uname -a" command.)
format_version	string	1	v02.02.08	Format version.
input_file_names	string	1		Semicolon-separated list of names or unique identifiers of files that were used to make this product. There will always be one space after each semicolon. There is no final semicolon.
input_file_types	string	1		Semicolon-separated list of tags giving the role of each input file in input_file_names. There will always be one space after each semicolon. There is no final semicolon.
input_file_dates	string	1		Semicolon-separated list of creation dates for each input file in input_file_names. There will always be one space after each semicolon. There is no final semicolon.
orbitDirection	string	1		Orbit is ascending and/or descending. Values are "Ascending" or "Descending" if the entire granule fits that description. "NorthPole" and "SouthPole" are used for polar-crossing granules. "NA" is used when a determination cannot be made.

Name	Type	Size	Value	Description
day_night_flag	string	1		Data is day or night. "Day" means subsatellite point for all valid scans has solar zenith angle less than 90 degrees. "Night" means subsatellite point for all valid scans has solar zenith angle greater than 90 degrees. "Both" means the dataset contains valid observations with solar zenith angle above and below 90 degrees. "NA" means a value could not be determined.
AutomaticQualityFlag	string	1	Missing	"Passed": the granule contains a non-degraded calibrated brightness temperature, radiance, or retrieved value for at least one value in a geolocated FOV; "Suspect": the granule does not qualify as "Passed" but contains a (possibly degraded) calibrated or retrieved value (possibly without associated geolocation); "Failed": the granule contains no calibrated or retrieved values.
qa_pct_data_missing	float	1		Percentage of expected observations that are missing.
qa_pct_data_geo	float	1		Percentage of expected observations that are successfully geolocated.
qa_pct_data_sci_mode	float	1		Percentage of expected observations that were taken while the instrument was in science mode and are successfully geolocated.
qa_no_data	string	1	TRUE	A simple indicator of whether this is an "empty" granule with no data from the instrument. "TRUE" or "FALSE".
title	string	1	SNPP ATMS Level-1B	a succinct description of what is in the dataset. (= ECS long name)

Name	Type	Size	Value	Description
summary	string	1	The Level-1B ATMS product includes data from the ATMS instrument for one six-minute interval. Data is geolocated and calibrated to antenna temperature.	A paragraph describing the dataset, analogous to an abstract for a paper.
shortname	string	1	SNPPATMSL1B	ECS Short Name
product_group	string	1	l1b_atms	The group name to be used for this product when it is collected in a multi-group file type, like SNO or calsub
metadata_link	string	1	http://disc.sci.gsfc.nasa.gov /	A URL that gives the location of more complete metadata. A persistent URL is recommended for this attribute.
references	string	1	ATMS ATBD is in review. It will be published at http://eosps0.gsfc.nasa.gov /content/algorithm-theoretical-basis-documents	ATDB and design documents describing processing algorithms. Can be empty.
contributor_name	string	1	Jet Propulsion Laboratory: Bjorn Lambrigtsen	The names of any individuals or institutions that contributed to the creation of this data.
contributor_role	string	1	ATMS Scientist	The roles of any individuals or institutions that contributed to the creation of this data.

aux group

Variables for the aux group

Name	Type	Dimensions	Description	Units	Ancillary Variables
geo_qualflag	int32	atrack, xtrack	Bit 7 - Failed geolocation on Earth topographic surface (surface_loc) Bit 6 - Could not set FOV surface elevations and land water fraction (DEM) Bit 5 - Failed geolocation on Earth geoid (geoid_loc) Bit 4 - Failed to set solar zenith or azimuth angles (solar_ang) Bit 3 - Failed to set spacecraft zenith or azimuth angles (spacecraft_ang) Bit 2 - Unused (0) Bit 1 (LSB) - Failed geolocation of some bands (band_specific)		
cal_qualflag	int32	atrack, channel	(Bit 32 is most significant. It is not used because it can cause confusion when this flag is used as a signed or unsigned integer.) Bit 7 : No usable calibration. Scan is not calibrated. (cal_failed) Bit 6 : Calibration values used from different scan. (cal_from_diff_scan) Bit 5: Insufficient valid shelf temperature values to use in a scan calibration. Fall-back constant shelf temperatures are used. (shelf_temp_bad)		

Name	Type	Dimensions	Description	Units	Ancillary Variables
			Bit 4: Excess noise (noise) Bit 3: Telemetry out of limits (telem) Bit 2: Spectral quality is poor (spectral) Bit 1 (LSB): reserved (0)		
cal_space_qualflag	int32	atrack, channel	(Bit 32 is most significant. It is not used because it can cause confusion when this flag is used as a signed or unsigned integer.) Bit 14 : Insufficient valid space (cold calibration) observation counts to produce a scan-specific calibration. Scan may still be calibrated using coefficients from another scan. (cold_cal_bad) Bit 13: Insufficient effective space temperature values to produce a scan-specific calibration. Scan may still be calibrated using coefficients from another scan. (space_temp_bad) Bit 12: This scan's space view #1 not used because of lunar intrusion or other problem. A scan-specific calibration may still be calculated using space views from neighboring views and scans. (sv1_bad) Bit 11: This scan's space view #2 not used because of lunar intrusion or other problem. A scan-specific calibration may still be calculated using space views from neighboring views and scans. (sv2_bad) Bit 10 : This scan's space view #3 not used because of lunar intrusion or other problem. A scan-specific calibration may still be calculated using space		

Name	Type	Dimensions	Description	Units	Ancillary Variables
			<p>views from neighboring views and scans. (sv3_bad) Bit 9 : This scan's space view #4 not used because of lunar intrusion or other problem. A scan-specific calibration may still be calculated using space views from neighboring views and scans. (sv4_bad) Bit 8: Missing moon angle for this scan's space view #1. Lunar intrusion status is unknown. (sv1_moon_unknown) Bit 7: Missing moon angle for this scan's space view #2. Lunar intrusion status is unknown. (sv2_moon_unknown) Bit 6: Missing moon angle for this scan's space view #3. Lunar intrusion status is unknown. (sv3_moon_unknown) Bit 5: Missing moon angle for this scan's space view #4. Lunar intrusion status is unknown. (sv4_moon_unknown) Bits 1-4: reserved (0)</p>		
cal_blackbody_qualflag	int32	atrack, channel	<p>(Bit 32 is most significant. It is not used because it can cause confusion when this flag is used as a signed or unsigned integer.) Bit 3: Insufficient valid black body (warm calibration) observation counts to produce a scan-specific calibration. Scan may still be calibrated using coefficients from another scan. (warm_cal_bad)</p>		

Name	Type	Dimensions	Description	Units	Ancillary Variables
			Bit 2: Insufficient valid black body temperature readings to produce a scan-specific calibration. Scan may still be calibrated using coefficients from another scan. (bb_temp_bad) Bit 1 (LSB): This scan's black body view not used. A scan-specific calibration may still be calculated using black body views from neighboring scans. (bb_bad)		
offset	float	atrack, channel	Offset used in calibrating earth scene brightness temps.	Kelvin	
gain	float	atrack, channel	Gain factor used in calibrating earth scene brightness temps.	Count/Kelvin	
nonlin	float	atrack, xtrack, channel	Nonlinearity correction used in calibrating earth scene brightness temps.	Kelvin	
cold_temp	float	atrack, channel	Effective temperature of cold calibration view (space) (Tcc)	Kelvin	
warm_temp	float	atrack, channel	Effective temperature of warm calibration view (black body) (Twc)	Kelvin	