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

NASA RAMSES II Level-2 Products User Guide: File Format and Definition

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Revision History

Document Version	***Software Version***	***Revision Date***	***Changes / Comments***
1	v01.41	2021-07-01	Initial Release
1.1	v01.41	2021-08-17	Added a note about RAMSES l vs RAMSES ll
1	v03_21	2023-03-03	Expanding software support to JPSS-2 Added a 'Support' product on 100 levels

Table of Contents

1.0 Introduction

This document provides basic information for using Version 3 Level-2 products from Retrieval Algorithm for Microwave Sounders in Earth Science (RAMSES II). The RAMSES II algorithm approach is briefly described in Section 2.2 and Appendix A. Users are encouraged to read the Algorithm Theoretical Basis document for algorithm details. [Reference 1]

The products described in this document are derived from the Advanced Technology Microwave Sounder (ATMS) microwave sounder on the Suomi-NPP satellite.

The RAMSES II Level-2 retrieval products contain a variety of geophysical parameters retrieved from ATMS measurements, including profiles of temperature, water in all phases as well as surface properties for six minutes of instrument observation at a time. RAMSES II products have been annotated with both file and variable level attributes to fully describe their contents.

A note on the name RAMSES II. During the development of the algorithm two tracks were being pursued, which were similar in some respects and different in others. After the name RAMSES was settled on, one track was named RAMSES-I and the other RAMSES-II. As the development of the two proceeded, it became clear that the second track performed best and would be ready for implementation first. While RAMSES-I is still viable and has advantages in certain areas, it is not currently planned for implementation. However, since there is a possibility that it could be completed and implemented in the future, the suffix (I and II) is being maintained in the documentation, although it is not currently reflected in the file names.

1.1 Overview of Sounder SIPS

The S-NPP / JPSS Sounder SIPS, is one of six SIPSs formed by NASA to provide climate-quality products by processing of level 0 data through level 1, level 2 and level 3 from the Suomi NPP (previously known as NPP) satellite and the NOAA-20 / JPSS-1 satellite using Principle Investigator provided systems. The Sounder SIPS is specifically responsible for producing atmospheric sounding products from both the CrIS and ATMS instruments as well as continuity products from the corresponding AIRS/AMSU-A instrument suite on the EOS-Aqua platform.

The S-NPP 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) is responsible for distribution of the data products and associated documentation.

1.2 Mission Description

Sounder suites use the complementary sensing abilities of MW or IR sounding instruments to retrieve atmospheric conditions. A series of these instrument suites on platforms in similar 1:30 PM sun-synchronous orbits provide information on the atmospheric state for weather prediction and collectively provide a climate record from 2003. Infrared (IR) and microwave (MW) sounders are often designed to be used together as IR/MW sounding suites. The typical retrieval algorithm combines IR data from AIRS or CrIS with MW data from AMSU-A or ATMS in a single IR+MW retrieval.

An atmospheric sounder measures how the physical properties of a column of air vary with altitude. The measurement as a function of altitude is sometimes called a “profile”, a “sounding”, or a “retrieval”. The term "sounder" refers to measuring how the temperature and salinity are similarly measured in the ocean using sound waves. “Retrieval” refers to using a computer algorithm to extract the profile from the measured data.

The RAMSES II algorithm is different from most sounder algorithms because it is solely based on MW sounder data. The algorithm uses only information from the MW instrument without any help from the IR instruments and tries to optimize the retrieval. Most clouds have a strong impact on IR sounding and limit the IR capacity in the presence of clouds. MW sounding is only affected by large particles, like ice and rain. So, the MW retrieval allows an “all sky” approach independent of the cloud coverage.

The S-NPP satellite was launched on October 28, 2011 into an orbit with an altitude of 824 km above the Earth surface, an inclination angle of 98.7 deg and a 13:30 local time ascending node. SNPP is the bridge between NASA's Earth Observing System and the Joint Polar Satellite System (JPSS) and is a result of a partnership between NOAA, NASA and the Department of Defense (DoD). SNPP is the first in a series of five next generation U.S. weather satellites of the JPSS. CrIMSS (CrIS and ATMS) are two of the five instruments onboard the S-NPP satellite. The other instruments are: Clouds and the Earth's Radiant Energy System (CERES), Ozone Mapping and Profiler Suite (OMPS) and Visible Infrared Imaging Radiometer Suite (VIIRS).

The NOAA-20 / JPSS-1 satellite was launched on November 18, 2017 from Vandenburg Air Force Base in California with similar orbital parameters and instruments as S-NPP. It is the second of 5 planned satellites of the JPSS. As is practice with NOAA when a satellite has successfully reached orbit, completed all on-orbit checkouts and is declared 'operational' it is renamed to follow the naming of NOAA satellites. JPSS-1 was renamed to NOAA-20 on May 30, 2018. The satellite will be referred to as JPSS-1 or J1 in this document.

More information about both the S-NPP and JPSS Missions can be found at: https://www.nasa.gov/mission_pages/NPP and https://www.jpss.noaa.gov/, respectively.

Table 1.2.1 contains a summary of orbital platform parameters.

Table 1.2.1 Approximate Aqua, S-NPP and JPSS-1 orbital parameters

Platform	Alt (km)	Orbit Incl. (°)	Equator X Time	Period (mins)	Repeat Orbits	Repeat Days	Launch
S-NPP	824	98.7	13:30	101	228	16	28 Oct 2011
NOAA-20/JPSS-1	824	98.7	13:30	101	228	16	18 Nov 2017

1.3 ATMS Instrument Description

ATMS is a 22-channel cross-track scanning microwave sounder providing both temperature and humidity soundings.

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. [Section 3.8]

1.4 Data Disclaimer

Version 3 RAMSES II Level-2 data are released to the public as is. Every effort has been made to properly represent the data which this document describes.

All users are encouraged to read the appropriate documentation listed in the references related to these data products to further understand the contents.

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

1.5 Where to find the Product

RAMSES II Level-2 products can be found at and downloaded from the NASA GES DISC. First time users are asked to register and create an EARTHDATA login account to access the GES DISC collections. There you will find additional information and documentation about this product and other products of interest. The preferred method to locate a data collection is via the unique Digital Object Identifier (DOI) link [see Table 1.6].

Alternatively, users can enter the ShortName directly into the EARTHDATA search string to quickly find RAMSES II level 2 products. The data at the GES DISC is organized by unique versioned ShortNames. Also, a general search using the string "RAMSES" under Data Collections will take to you a listing of RAMSES II products.

NASA EARTHDATA login: https://disc.gsfc.nasa.gov

Table 1.6. ECS ShortName and DOIs

ECS ShortName	DOI	Title
SNDRSNML2RMS	10.5067/FT9GRABK1CMK	Sounder SIPS: Suomi NPP ATMS Level 2 RAMSES2 Standard: Atmosphere, precipitation and surface geophysical state V3
SNDRSNML2RMSSUP	10.5067/KMEMD53MTTU8	Sounder SIPS: Suomi NPP ATMS Level 2 RAMSES2 Support V3
SNDRJ1ML2RMS	10.5067/69Y2R9BJAJS3	Sounder SIPS: JPSS-1 ATMS Level 2 RAMSES2 Standard: Atmosphere, precipitation and surface geophysical state V3
SNDRJ1ML2RMSSUP	10.5067/WEO3KIK1GBGT	Sounder SIPS: JPSS-1 ATMS Level 2 RAMSES2 Support V3

1.6 Contact Information

For information, questions or concerns with the RAMSES II Level-2 data set, please send to: sounder.sips@jpl.nasa.gov.

For information, questions or concerns with dataset completeness or downloading issues, please send to: gsfc-dl-help-disc@mail.nasa.gov

1.7 References

1. Lambrigtsen B, Fishbein E, and Schreier M. 2021 RAMSES II ATBD

2. Roman J, Wang T, Yue Q., and Wong S. 2022 Test Report of Performance of RAMSES II and Retrievals

3. Manning M and Monarrez R 2023 NASA Advanced Technology Microwave Sounder (ATMS) Level 1B Data Product User Guide

4. NetCDF Climate and Forecast (CF) Metadata Conventions, Version 1.6, http://cfconventions.org/cf-conventions/v1.6.0/cf-conventions.html

5. NASA Data Processing Levels https://earthdata.nasa.gov/collaborate/open-data-services-and-software/data-information-policy/data-levels

6. Suomi-NPP: https://www.nasa.gov/mission_pages/NPP

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9. Rosenkranz, P.W., 2001. Retrieval of temperature and moisture profiles from AMSU-A and AMSU-B measurements. IEEE Tran. Geosci. Remote Sens., 39(11), pp.2429-2435.

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2.0 Level-2 Product Overview

2.1 Product Granulation and Identification

RAMSES-II Level 2 products are comprised of a standard retrieval (RET) and a support product (SUP) each at different resolutions. See section 3.1 for more detail.

The Level-2 products are 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. See Figure 4 to see how the granules for a given day map to the globe.

The nominal start time of granule 1 of each day for CrIMSS is defined to be T00:00:00Z. Because both CrIS and ATMS instruments are synced to TAI93, 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. AIRS/AMSU-A granules are permanently synchronized to the start of year 1956, so the actual start time of granule 1 of a given day is about five and half minutes into the day, with the exact time depending on how many leap seconds there have been. In 2002 the start times for granule 1 is T00:05:26Z, and by January 2021 it is T00:05:21Z.

The ability to uniquely identify a granule is built in to the Level-1B and Level-2 products. 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. Because of the different viewing geometry, AIRS, AMSU-A, ATMS and CrIS obs_ids differ. Level-2 RAMSES II obs_ids follow the ATMS pattern.

The format of ATMS 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.

For example:

20160125T1300.001E18

The dimensions of this variable (atrack=135, xtrack=96) correspond to the first two dimensions of the science data variables, such as air temperature. An observation ID can be associated with data by applying the same indices into these common dimensions.

2.2 Algorithm Background

The Sounder SIPS Level-2 data products are a product of processing NASA Level 0 data through Level 1A, Level 1B, and Level-2. For a definition of the NASA Data Processing Levels please see reference 8 or go to: NASA Processing Levels

The RAMSES II retrieval is an optimal estimation algorithm developed for microwave sounders. The algorithm uses background information, together with a radiative transfer algorithm and a non-linear solver to achieve an optimized retrieval of atmospheric profiles, based on the observed MW brightness temperatures.

The algorithm provides uncertainty estimates and quality flags based on the optimization and convergence between observed and calculated brightness temperatures. The basic system is actually an agglomeration of various modular components and options for background and radiative transfer. It supports comparisons of different combinations for optimization. The current version of RAMSES II uses the following components:

- Background information as well as a-priori components from MERRA-2
- Solver routines are based on the Limited Memory Bundle Method (LMBM) by Karmitsa, 2007.
- The radiative transfer is based on code by Phil Rosenkranz (Rosenkranz, 2001)

The radiative transfer code provides analytical Jacobians and eliminates the use of finite differences or analytical calculations. The current code does not allow scattering, which can affect radiative transfer in the microwave region, but only if large hydrometeors, large ice particles, rain, graupel or hail, are present. This allows the retrieval of "all sky" profiles in the presence of clouds and also the retrieval of liquid water to some extent.

The main output from the optimization retrieval is temperature and water vapor profiles, together with liquid water content and surface temperature on 72-sigma levels. Additional regression algorithms allow the detection of rain within the field of view, as well as snow or ice on the surface. The regressions in this case are adapted from studies done Ferraro et al. (2000) and Laviola and Levizzani (2011).

The output of the optimal estimation algorithm and the regression routines is converted to SIPS variables by a post processor. That includes conversion to 100-levels, saturation estimates and tropopause calculations. The details of the interpolation are described in section 3.10.

Technical details of the Level-2 processing steps can be found in the Algorithm Theoretical Basis Document (ATBD). [Reference 1]

2.3 Data Organization

The Level-2 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 granule number in the filename: g021 is granule 21 out of 240. For granule start time details, refer to section 2.1.

2.4 File Format and Structure

The files are in Network Common Data Form, version 4 (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. See section 3.0 Data Content for a listing of key dimensions and attributes.

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 specifications in Appendix B.

For more information on CF, refer to: http://cfconventions.org/

For more information on ACDD, refer to:
http://wiki.esipfed.org/index.php?title=Category:Attribute_Conventions_Dataset_Discovery

2.6 File Naming Convention

File naming for Sounder SIPS products will be unique and include the following tokens separated by the delimiter '.'

<Sounder_SIPS_ID>.<platform>.<inst_ID>.<gran_ID>.<product_granularity>.<granule_number>.<product_type>.<variant>.<version>.<production_location>.<prod_timestamp>.<extension>

SNDR.*platform.inst_id.yyyymmdd*T*hhmm*.m06.g101.L2_RAMSES_RET.std.v*mm_mm*.G.*yymmddhhmmss*.nc

Where:

- platform = SNPP
- inst_ID = ATMS
- gran_ID = Unique granule identifier yyyymmddThhmm of granule start, including year, month, day, hour, and minute of granule start time
- product_granularity = m06 (6 minute)
- granule_number = g###
    - The granule number in the day (001-240)
- product_type = L2_RAMSES2_RET , L2_RAMSES2_SUP
- variant = std
    - This value is reserved for the operational data system to identify non-standard processing
- version = vmm_mm_mm - eg. v03_21_00
    - Versioning will be synchronized across Sounder SIPS products
    - Version 3 Level-2 products are derived from version 3 ATMS Level-1B products
- production_location = J
    - "G" for Sounder SIPS at GES DISC - Operations
    - "J" for Sounder SIPS at JPL
    - "T" for a test data set
- prod_timestamp is in the form yymmddhhmmss
    - This field is designed to ensure LocalGranuleIDs are unique, even when the same software is used to reprocess the same data.
- Extension (.nc)

Example Filename: 6-minute RAMSES II/S-NPP Level-2 granule #240 from April 5th 2015:

SNDR.SNPP.ATMS.20150405T2354.m06.g240.L2_RAMSES2_RET.std.v03_21.G.210503090253.nc

2.7 Time Representation

Times in the Level-2 products 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 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 (long)
20160125T1300 (compact)

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.

2.8 Data Holdings

For the initial release of version 1 RAMSES II, a test data set of 8 months is provided. This includes the months of January, April, July and October of the years 2013 and 2015. Version 3 is created for the entire SNPP and JPSS-1 mission record.

3.0 Data Content

The Level-2 data products are written in netCDF4 format and therefore make use of groups, dimensions, variables and attributes (global & variable). Every netCDF4 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 product.

A full profile of the contents of the files is included in Appendix B.

Selected fields are highlighted in this section.

3.1 Dimensions

Key dimensions for RAMSES II Level-2 RET and SUP products.

Table 3.1.1 Key Dimensions for RET

Name	Size	Description
atrack	135	along-track spatial dimension
xtrack	96	cross-track spatial dimension
air_pres_stand	27	Standard atmospheric pressure levels starting from the surface
air_pres_h2o_stand	11	Standard atmospheric pressure levels for water vapor starting from the surface

Table 3.1.2 Key Dimensions for SUP

Name	Size	Description
atrack	135	along-track spatial dimension
xtrack	96	cross-track spatial dimension
air_pres	100	Fine atmospheric pressure levels starting from the top
air_pres_h2o	66	Fine atmospheric pressure levels starting from the top

The original RAMSES-II retrieval product is in sigma-pressure coordinates. To conform with other Sounder SIPS products and for easier usability, we adjust the initial retrieval to uniform pressure levels, one with lower and one with higher resolution. As a result, Level 2 is available in two vertical resolutions, consistent with other Sounder SIPS products: The standard product is on 28 levels (11 for water vapor), and the support product is on 100 levels (66 for water vapor). Both products have the exact temporal and horizontal resolution (96 scans, 135 lines per granule, 240 granules daily). But the support product is much larger than the standard product because it contains more levels and the original sigma-pressure retrieval (available in the aux-group). So, the standard retrieval product is more dedicated to users that need months or years of data. In contrast, the support product is more devoted to users that prefer more detailed higher vertical resolution.

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, and location information. Many attributes are required to conform to the CF & ACDD standards while other attributes are written for consistency with legacy products.

A full definition of the global attributes can be found in Appendix B.

Table 3.2.2 Key Global Attributes

Name	Description
date_created	The date on which this version of the data was created
geospatial_lat_min	The southernmost latitude covered by the dataset
geospatial_lat_max	The northernmost latitude covered by the dataset
geospatial_lon_min	The westernmost longitude covered by the dataset. See also geospatial_lon_max.
geospatial_lon_max	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 at the antimeridian, 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).
geospatial_lat_mid	granule center latitude
geospatial_lon_mid	granule center longitude
geospatial_bounds	Describes the data's 2D or 3D geospatial extent in Open Geospatial Consortium's (OGC) Well-Known Text (WKT) Geometry format. Longitude values are limited to the (-180, 180) range. Example: 'POLYGON ((40.26 -111.29, 41.26 -111.29, 41.26 -110.29, 40.26 -110.29, 40.26 -111.29))'.
product_name_granule_number	zero-padded string for granule number of day (g001-g240)
gran_id	Unique granule identifier yyyymmddThhmm of granule start, including year, month, day, hour, and minute of granule start time
identifier_product_doi	digital object identifier (DOI); digital signature
AutomaticQualityFlag	"Passed": the granule contains a non-degraded retrieved value for at least one value in a geolocated FOV; "Suspect": the granule does not qualify as "Passed" but contains a (possibly degraded) retrieved value (possibly without associated geolocation); "Failed": the granule contains no retrieved values.
qa_no_data	A simple indicator of whether this is an "empty" granule with no data from the instrument. "TRUE" or "FALSE".

3.3 Variable Attributes

Each variable has its own associated attributes. Variable attributes are a CF standard and are used to describe the variable in more detail to properly interpret its value.

Table 3.3: Variable Attributes

Attribute	Description
units	units, for variables that represent physical quantities
_FillValue	a single sentinel value indicating the data point contains fill instead of valid data
standard_name	standard name from the CF standard name table, if one exists for the quantity being represented
long_name	a longer name describing the quantity being represented, suitable for a plot title
description	a longer description of the quantity being represented
valid_range	a pair of values indicating the minimum and maximum values to be considered valid
coordinates	a space-separated list of the names of other variables that are coordinates for this variable
coverage_content_type	ACDD/ISO field categorizing types of data: • image • thematicClassification • physicalMeasurement • auxillaryInformation • coordinate • modelResult • qualityInformation • referenceInformation MD_CoverageContentTypeCode
ancillary_variables	a space-separated list of the names of other variables that contain information about this variable
bounds	defines the extent, for cell variables
cell_methods	describes statistical methods used to derive data, for cell variables
flag_values	These attributes collectively tell how to interpret flag variables. See the CF standard for details. In these Level-2 products, these attributes are mostly used in association with the *_qc QC ancillary variables.
flag_meanings	
flag_masks	
AIRS_HDF_name	For users of AIRS retrieval products, this attribute gives the name of the most similar field in the AIRS HDF-EOS products. (Aqua)

3.4 Group Structure

One feature which was added to netCDF4 is the ability to structure files with “groups”, which are similar to a directory hierarchy. SounderCDF files are designed so that all of the most commonly needed information is contained in “/”, the root group. Subgroups contain more specialized information. Appendix B has a complete list of all the variables contained in each of the groups.

Table 3.4 netCDF4 Groups for retrieval files

Group	Purpose

/ (root)	Main group, with temperature and water profiles, along with supporting location and quality information
/aux	Supporting information primarily for the algorithm developers, including retrieved profiles on the internal hybrid sigma levels.

3.5 Geolocation

Geolocation parameters are used for determining location of each observation on Earth and associated information about that location.

Geolocation variables are located in the file at the root level. These 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 3.5.1 Geolocation Dimensions

Dimension name	Size	Meaning
atrack	135	Along-track FOV horizontal dimension
xtrack	96	Cross-track FOV horizontal dimension
fov_poly	8	latitude/longitude points defining the polygon bounding an fov (anticlockwise as viewed from above)

The key geolocation variables are:

Table 3.5.2 Key Geolocation Variables

Geolocation Variable	Dimensions	Meaning
lat	atrack, xtrack	latitude of FOR center
lon	atrack, xtrack	longitude of FOR center
lat_bnds	atrack, xtrack, fov_poly	latitude of FOR bounding polygon
lon_bnds	atrack, xtrack, fov_poly	longitude of FOR bounding polygon
land_frac	atrack, xtrack	Land fraction over the FOR
surf_alt	atrack, xtrack	mean surface altitude WRT Earth model over FOR

obs_time_tai93	atrack, xtrack	earth view observation midtime for each fov in units of seconds since 1993-01-01T00:00:00
obs_time_utc	atrack, xtrack, utc_tuple	UTC earth view observation time as an array of integers: year, month, day, hour, minute, second, millisecond, microsecond

Full geolocation includes information about solar geometry (sol_zen, sol_azi, sun_glint_dist), viewing geometry (sat_zen, sat_azi, view_ang, sat_range, subsat_lat, …) and orbital parameters. See Appendix B for full specification.

One key feature is boundaries. Each FOV has a bounding 8-point polygon in variables {lat_bnds, lon_bnds}. This makes it easy to place values in appropriate regions on a map, including the elongated shapes of FOVs at the edges of the swath.

3.6 Science Data Variables

These retrievals provide information on a wide variety of geophysical parameters, including temperature, water in all phases, constituents, clouds, and surface parameters. This results in a large number of science data variables.

Many variables have associated quality control and error estimate information. These are contained in variables with the same name but with "_qc" and "_err" appended. In the table below the ancillary variables are not listed.

3.6.1 Retrieval Product Science Data Variables

Key retrieval product science data fields are defined below and are found in the /(root) group. See Appendix B for a full listing.

Table 3.6.1 Key RAMSES II Science Data Variables

Name	Type	Dimensions	Description	Units
air_temp	float32	atrack, xtrack, air_pres	air temperature profile	Kelvin
surf_air_temp	float32	atrack, xtrack	near-surface air temperature (~2 meters above surface)	Kelvin
h2o_vap_tot	float32	atrack, xtrack	total precipitable water vapor	kg / m2
spec_hum	float32	atrack, xtrack, air_pres_h2o	mass fraction of water vapor in moist air	unitless
rel_hum	float32	atrack, xtrack, air_pres_h2o	relative humidity over equilibrium phase	unitless

h2o_liq_tot	float32	atrack, xtrack	total cloud liquid water	kg / m2
h2o_liq_mmr	float32	atrack, xtrack, air_pres_h2o	cloud liquid water mass mixing ratio to moist air	unitless
h2o_ice_tot	float32	atrack, xtrack	total cloud solid water	kg / m2
h2o_ice_mmr	float32	atrack, xtrack, air_pres_h2o	cloud ice mass mixing ratio to moist air	unitless
surf_temp	float32	atrack, xtrack	radiative temperature of the surface	Kelvin
tpause_gp_hgt	float32	atrack, xtrack	tropopause geopotential height, where tropopause is determined according to the WMO definition	m
tpause_pres	float32	atrack, xtrack	tropopause pressure, where tropopause is determined according to the WMO definition	Pa
mw_surf_class	int16	atrack, xtrack	Microwave spectral surface class. 0 for coastline; 1 for land; 2 for ocean; 3 for first-year sea-ice; 4 for multi-year sea-ice; 5 for snow (higher-freq scattering); 6 for glacier/snow (very low-freq scattering); 7 for snow (lower-freq scattering);	

3.7 Quality Information

For most retrieved geophysical variables, a numerical error estimate in the same physical units is provided in a corresponding ancillary_variable with a name ending in "_err". There are also Quality Control (QC) scores of {0, 1, 2} in corresponding ancillary_variables with a name ending in "_qc".

Table: 3.7.1 *_qc Values

Value	Meaning
0	Highest quality – use without reservation
1	Good quality – suitable for most purposes
2	Do not use. In some cases, a physical value is present but is not considered reliable. In other cases, only fill values are present.

While these flags exist per species and per level, RAMSES II mostly treats entire profiles as of the same quality for all species and levels.

The quality flags for this version are based on thresholds of the convergence of the retrieval. Preliminary testing showed that the thresholds might be too forgiving, especially with respect to a cold bias that was found in the results (see Section 3.11)

However, users can adjust and create their own filtering based on a variety of options.

One simple option is the variable error_value in the aux-group: It describes the convergence of all channels with respect to observed and simulated brightness temperatures. The closer the value is to 0, the closer are the simulated and observed brightness temperatures. “Highest quality” is currently based on a threshold of < 1, which might be too lenient. The user can therefore filter the data by selecting a smaller threshold value for error_value.

Another option, which tries to create a level-dependent quality estimate, are the *_err” values for each profile variable (e.g. air_temp_err). The values are based on a matrix multiplication of the covariance matrix and the brightness temperature differences. The values are preliminary and experimental, but they allow users to look into the vertical uncertainty of a variable in connection with the convergence. This filters by uncertainties in specific levels to a certain degree.

A few examples to create your own filtering will be given in section 3.11.

3.8 Missing Data / Fill Values

Fill values are used where there is no valid data or where data is missing, including profiles level with pressures greater than the surface pressure. The fill value is indicated by the attribute ‘_FillValue’. 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: 3.8.1 Fill Values

Variable Type	Fill Value
unsigned 8-bit integer	255UB
unsigned 16-bit integer	65535US
unsigned 32-bit integer	4294967295U
floating point	9.96921e+36

3.9 Key supporting information variables for profiles

These variables provide supporting information to interpret the science variables.

Name	Dimensions	Description	Units
air_pres_stand	air_pres_stand	pressure levels	Pa
air_pres_h2o_stand	air_pres_h2o_stand	Standard H2O vapor pressure levelsH2O pressure levels	Pa
air_pres_stand_nsurf	atrack, xtrack	Index in air_pres of the level at the surface. Values at levels	unitless

		beyond this are invalid, representing data below the Earth's surface.	
air_pres_h2o_stand_nsurf	atrack, xtrack	Index in air_pres_h2o of the level at the surface. Values at levels beyond this are invalid, representing data below the Earth's surface.	unitless

3.10 Vertical profile representation

RAMSES II retrieves temperature and water in all phases as vertical profiles on surface-following hybrid sigma levels. Its background profiles are horizontally interpolated from the MERRA2 analysis using the same 72 layers as reported by MERRA2. These are 72 layer-mean mixing ratios (or layer-mean temperatures) assigned to the mid-points of each layer. The 72-layer-mean retrieved profiles are preserved in the "aux" subgroup. We do this to allow data users to calculate integrated column densities that are specifically targeted to their applications.

For the products in the root group, water temperature and geopotential height are reported on a standard set of 100 fixed-pressure levels. The interpolation is done after the retrieval and for water quantities, levels at pressures less than 5153 Pa (51.53 hPa) are not reported. Pressure levels below the surface are always filled with fill values.

Level concentrations of gases, like water vapor, or level temperature, are estimated from the layer-mean concentrations. RAMSES II, using a linear interpolation in log pressure, but extrapolates for the surface value.

Figure 3 below illustrates the differences between the internal and output layering for the lower atmosphere, 1-km above the surface. This profile was measured near the Himalayas where the surface pressure is only 751-hPa and the near surface layers are anomalously thin. The internal layers have boundaries shown by the dotted light-blue lines and near the surface, there are two layers for each level in the standard product. The black '+' are the internal retrieved layer-mean quantities. The smooth black line is a smooth representation of the continuous profile passing through the mid-points of the layers. Linear interpolation (or extrapolates for the surface) in log pressure estimates the mixing ratio on the 100 fixed levels (plus surface) shown by the red '+'. The red line shows a piece-wise linear representation of the 100 levels and the error in decimating the internal profile to the standard profile; in this worse-case example, the error is less than 2%.

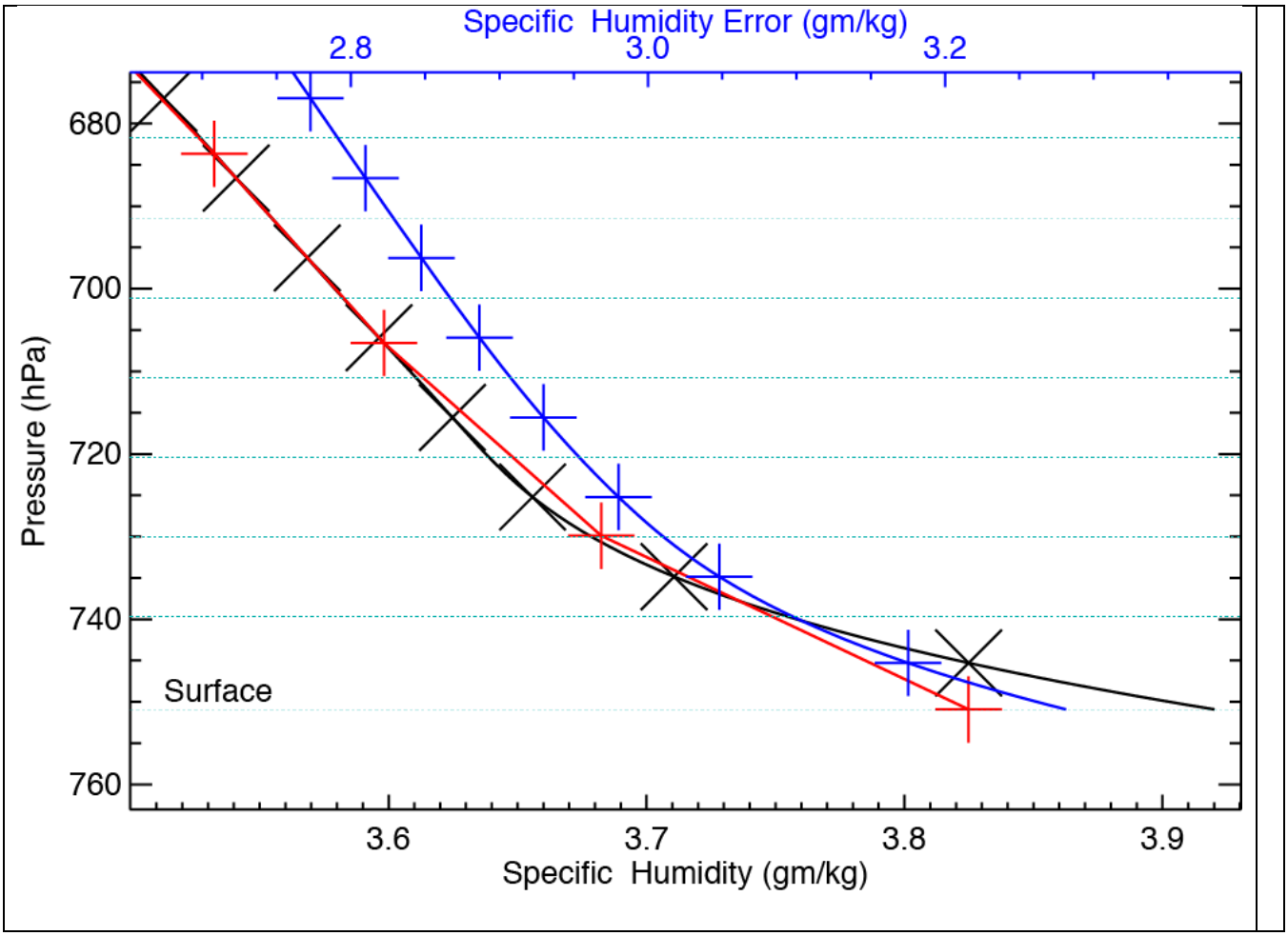


Figure 1. Example comparison of the internal (black) and standard (red) water vapor profiles for RAMSES II near the surface;

Error estimates for the level mixing ratios are interpolated from the fractional layer-amount errors. Fractional error is assumed to be fully correlated and linearly interpolated in log pressure from the arithmetic mean pressures of each level (uncorrelated error involves linearly interpolating variance). The error profile on sigma coordinates is shown in Figure 3 plotted against the upper blue scale.

3.11 Known issues

Based on preliminary testing and comparisons with radiosondes, we established that the old version 1 had a cold bias in the upper troposphere, especially in tropical areas, compared to radio sondes and IR sounders.

We corrected this temperature bias in the current Version, which has much weaker implications now. Nevertheless, the main quality criterion is convergence of the retrieval and sometimes the retrieval achieves convergence by unnecessary adjustments of the profiles: RAMSES II is an “all-sky” retrieval that measures profiles “through” the cloud if

clouds are present. So, large cloud particles, or the possibility of precipitation below, can still lead to unnecessary temperature adjustments in the upper troposphere to achieve convergence, and singular temperature deviations are, therefore, still possible.

Apart from the temperature bias, the testing of Version 1 was also able to provide indications for a dry bias in the water vapor profile, often in the lower troposphere. We also improved this water vapor bias in the current Version. But especially comparisons with radiosondes still show a trend towards drier atmospheres in some instances, possibly resulting from influence of the first guess.

The simplified quality flag (quality_flag) has only 3 categories and is not always able to catch these instances of temperature or dry bias. Users are therefore advised to play with additional selection criteria, if they want to make sure to avoid cases with temperature or water vapor bias. We propose two options to adjust the quality filtering themselves:

1. Retrievals over the ocean tend to have a smaller bias than over land, so filtering of data with the land/ocean flag helps to improve the overall bias.

2. Use additional filtering criteria, based on additional values that were described in section 3.7: “aux/error_value” and the profile dependent variables “*_err” allows users to create their own user-dependent filtering and adjust it to the needs of the approach or analysis. “aux/error_value” is simpler and helps to filter out entire profiles by using higher thresholds. “*_err” on the other side helps to filter out specific variables and is also height dependent.

To give a few examples:

If a threshold value of 0.4 for “aux/error_value” is used to create a more restrictive filtering, the bias is slightly reduced. However, it also leads to a loss of around 30% more profiles, especially over land.

A threshold value of 5.46 at 160 hPa for air_temp_err can be used to decrease the mean bias in that level, but it also decreases the available data by ~ 50%.

The error estimate for each variable (“_err”-appendix B) is still experimental, and the current version often uses fill values, especially in the lower troposphere. Therefore, the values can be unreasonably high for some profiles or the lower troposphere - even if the quality flag "("_qc"-appendix B) shows a good profile. If this causes complications (e.g., for assimilation processes), then we suggest to use these generalized replacement options:

- air_temp_err: values > 10 can be replaced with an error estimate of 10K
- spec_hum_err: values > 0.02 can be replaced with 0.02 kg/kg
- rel_hum_err: all values > 0.5 can be replaced with 0.5
- h2o_liq_mmr_err/ h2o_ice_mmr : all values > 0.01 can be replaced with 0.01 kg/kg
- h2o_vap_tot_err: all vales > 15 kg/m^2 can be replaced with 15 kg/ m^2
- h2o_liq_tot_err and h2o_ice_tot_err: all values > 0.2 kg/ m^2 can be replaced with 0.2 kg/ m^2

4.0 Options for Reading the Data

The product 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/

Panoply is a good netCDF data viewer tool for visualizing these files.
https://www.giss.nasa.gov/tools/panoply/

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

The files can also be accessed with HDF5 tools and libraries available at:
https://www.hdfgroup.org/products/hdf5_tools/

5.0 Data Services

The products are available to the user community via the GES DISC:
https://disc.gsfc.nasa.gov/

In addition to the netCDF data files, there you can also get daily granule maps, showing the location of each granule of each day.

Descending Data

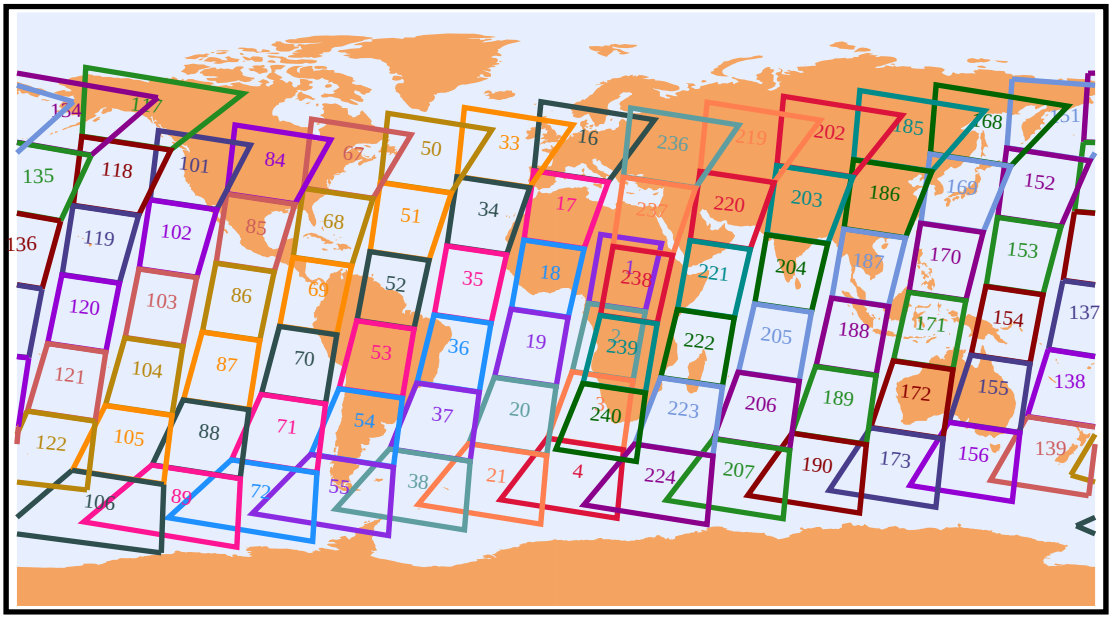
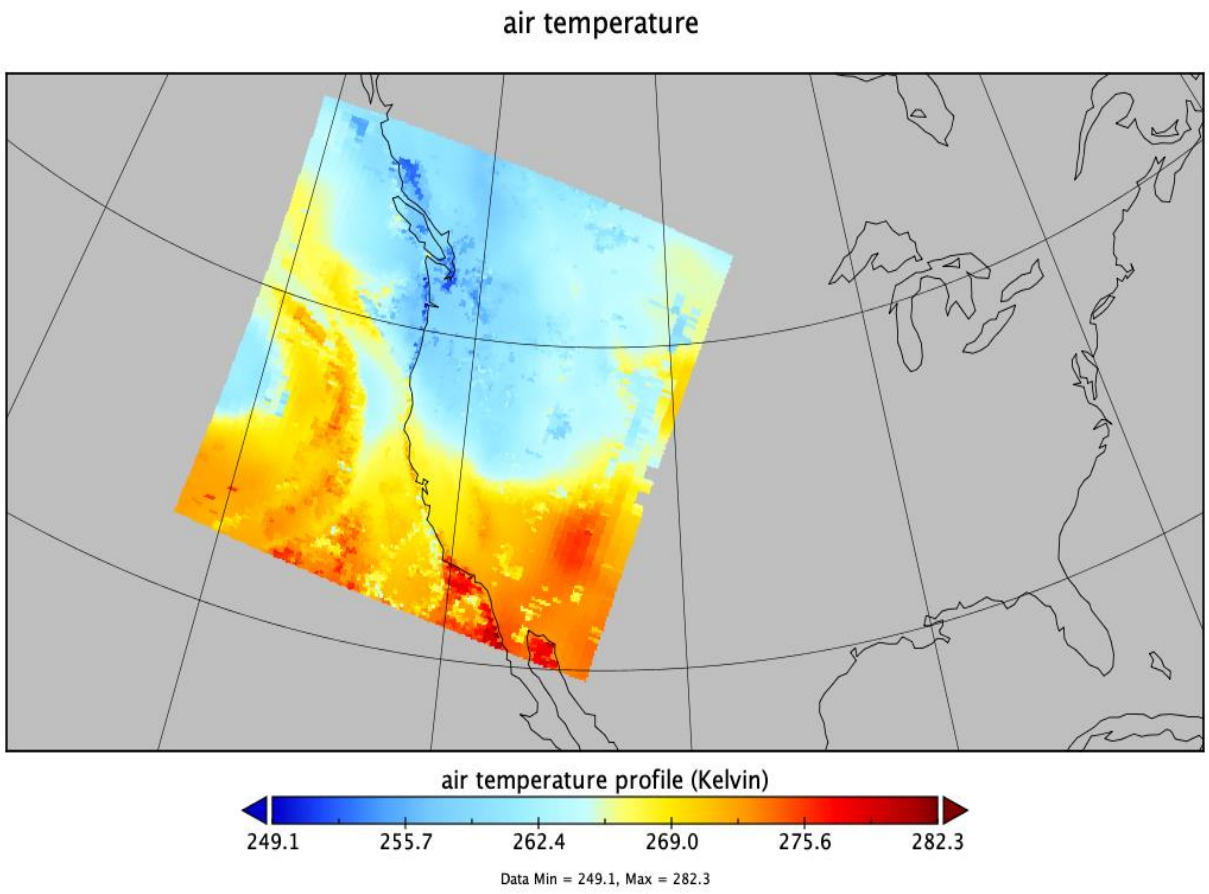


Figure 2. SNPP Granule map for nighttime data 2016-01-14.

Appendix A: Sample images

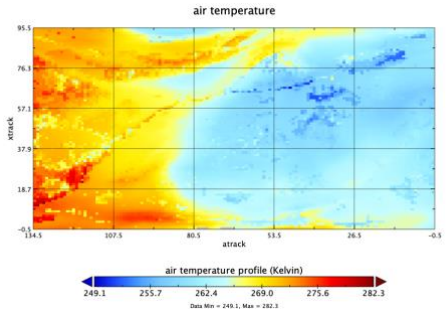
These images for 2016-01-14 SNPP granule 101 (gran_id = 20160114T1005) were generated with Panoply. See section 4.0 for the link to obtaining and installing Panoply.

We show RAMSES II SNPP air_temp for level 85, which is 706564 Pa (= 707 hPa). This granule covers the western part of the US and the adjacent part of the Pacific Ocean at night.

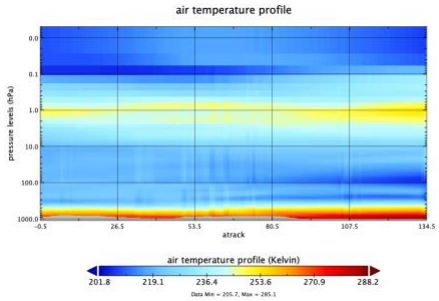


Next we look at this level of air_temp in a simple rectangular grid of atrack x xtrack and as a vertical slice along the long axis. The Pacific Ocean is now at the top of each horizontal image and the Rocky Mountains near the bottom.

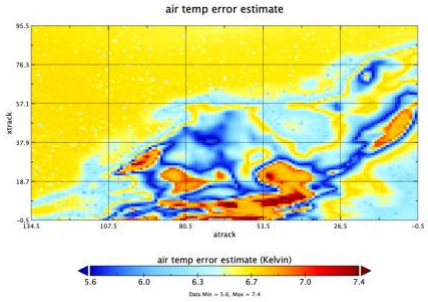
RAMSES II Air Temperature Images



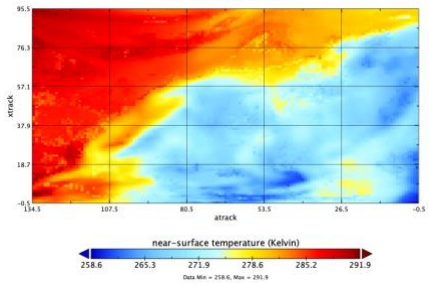
air_temp 707 hPa



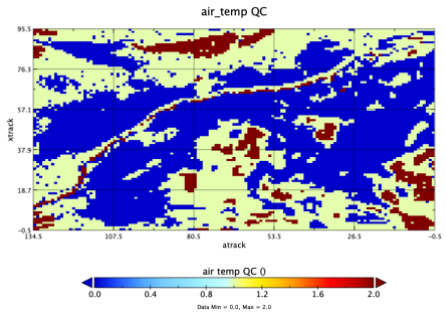
air_temp vertical slice



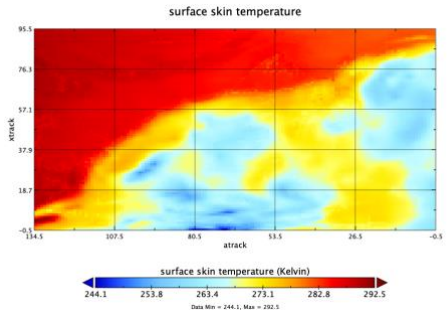
air_temp_err 707 hPa



surf_air_temp

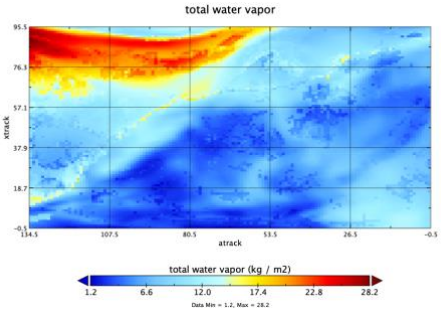


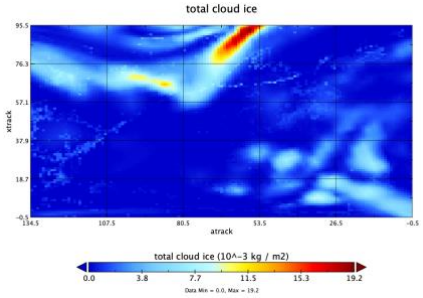
air_temp_qc 707 hPa

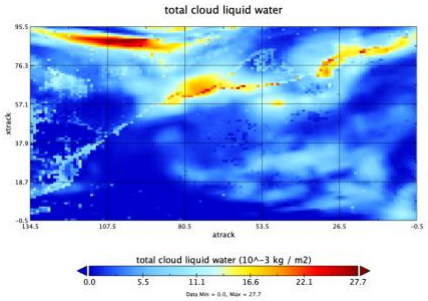


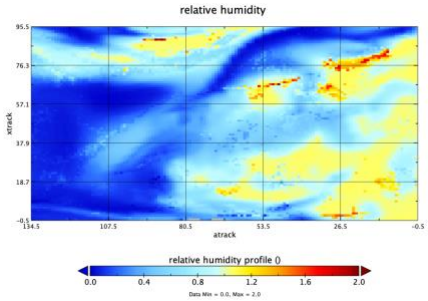
surf_temp

Here are some water granule images from the RET file.

<table>
<tr><th colspan="2">RAMSES II Water Images</th></tr>
<tr><td> 

Total water vapor</td><td> 

Total cloud ice</td></tr>
<tr><td> 

Total cloud liquid water</td><td> 

Relative humidity 707 hPa</td></tr>
</table>

Appendix B: Detailed file formats

The tables in this appendix list all the dimensions, global attributes, and variables in the JPSS-1 product files.

For clarity, some variable attributes are omitted, including long_name, standard_name, coverage_content_type, axis, valid_range, coordinates, AIRS_HDF_name, and _FillValue.

Ancillary variables are also omitted. The presence of “bnds” in the ancillary_variables column for “lat” means that there is also a variable named “lat_bnds”.

To get a complete listing including all variable attributes and the actual values contained in the header, apply “ncdump -h <filename>” to any netCDF4 product file.

B.1 RAMSES II Retrieval product

This section lists the interface specification for Level 2 RAMSES II standard retrieval and support products for JPSS-1. The interface specification version is 02.02.25.

J1 L2 STD RAMSES-2 Interface Specification

Interface Specification Version v02.02.25
02-16-2022

B.1.1 Groups

Path	Description
/	Main science data
/aux	Internal product team data

B.1.2 Global Dimensions

Name	Size	Description
atrack	135	along-track horizontal dimension
xtrack	96	cross-track horizontal dimension
utc_tuple	8	parts of UTC time: year, month, day, hour, minute, second, millisec, microsec
air_pres_stand	27	Standard atmospheric pressure levels starting from the surface
air_pres_h2o_stand	11	Standard atmospheric pressure levels for water vapor starting from the surface
fov_poly	8	lat_bnds, lon_bnds points defining the polygon bounding an FOV (anticlockwise as viewed from above)

Name	Size	Description
spatial	3	directions: x, y, z for satellite position and velocity
attitude	3	roll, pitch, yaw

B.1.3 Global Variables

Name	Type	Dimensions	Description	Units	Ancillary Variables
obs_id	string	atrack, xtrack	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).		
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
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_glint_lat	float	atrack	sun glint spot latitude at scan_mid_time. Fill for night observations.	degrees_north	
sun_glint_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	

Name	Type	Dimensions	Description	Units	Ancillary Variables
sol_azi	float	atrack, xtrack	solar azimuth angle at the center of the spot (clockwise from North)	degree	
sun_glint_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	
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	
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	degree	

Name	Type	Dimensions	Description	Units	Ancillary Variables
			Earthward parallel to the satellite radius vector R from the spacecraft center of mass to the center of the Earth.		
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	
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		
air_temp	float32	atrack, xtrack, air_pres_stand	air temperature profile	Kelvin	qc, err
surf_air_temp	float32	atrack, xtrack	near-surface air temperature (~2 meters above surface)	Kelvin	qc, err
h2o_vap_tot	float32	atrack, xtrack	total precipitable water vapor	kg / m2	qc, err

Name	Type	Dimensions	Description	Units	Ancillary Variables
spec_hum	float32	atrack, xtrack, air_pres_h2o_stand	mass fraction of water vapor in moist air	kg / kg	qc, err
surf_spec_hum	float32	atrack, xtrack	Near-surface mass fraction of water vapor in moist air	kg / kg	qc, err
rel_hum	float32	atrack, xtrack, air_pres_h2o_stand	relative humidity over equilibrium phase	unitless	qc, err
surf_rel_hum	float32	atrack, xtrack	relative humidity near the surface over equilibrium phase	unitless	qc, err
h2o_liq_tot	float32	atrack, xtrack	total cloud liquid water	kg / m2	qc, err
h2o_liq_mmr	float32	atrack, xtrack, air_pres_h2o_stand	cloud liquid water mass mixing ratio to moist air	kg / kg	qc, err
h2o_ice_tot	float32	atrack, xtrack	total cloud solid water	kg / m2	qc, err
h2o_ice_mmr	float32	atrack, xtrack, air_pres_h2o_stand	cloud ice mass mixing ratio to moist air	kg / kg	qc, err
gp_hgt	float32	atrack, xtrack, air_pres_stand	Geopotential is the sum of the specific gravitational potential energy relative to the geoid and the specific centripetal potential energy. Geopotential height is the geopotential divided by the standard acceleration due to gravity.	m	qc, err
surf_gp_hgt	float32	atrack, xtrack	geopotential height at the surface	m	qc, err
surf_temp	float32	atrack, xtrack	radiative temperature of the surface	Kelvin	qc, err
tpause_gp_hgt	float32	atrack, xtrack	tropopause geopotential height, where tropopause is determined according to the WMO definition	m	qc
tpause_pres	float32	atrack, xtrack	tropopause pressure, where tropopause is determined according to the WMO definition	Pa	qc

Name	Type	Dimensions	Description	Units	Ancillary Variables
tpause_temp	float32	atrack, xtrack	tropopause temperature, where tropopause is determined according to the WMO definition	Kelvin	qc
air_pres_stand	float32	air_pres_stand	Standard pressure levels	Pa	
air_pres_stand_nsurf	int16	atrack, xtrack	Index in air_pres_stand of the level at the surface. Values at levels before this are invalid, representing data below the Earth's surface.	unitless	
air_pres_h2o_stand	float32	air_pres_h2o_stand	Standard H2O vapor pressure levels	Pa	
mw_surf_class	int16	atrack, xtrack	Microwave spectral surface class. 0 for coastline; 1 for land; 2 for ocean; 3 for first-year sea-ice; 4 for multi-year sea-ice; 5 for snow (higher-freq scattering); 6 for glacier/snow (very low-freq scattering); 7 for snow (lower-freq scattering);		

B.1.4 Global Attributes

Name	Type	Size	Value	Description
keywords	string	1	ATMOSPHERE > ATMOSPHERIC TEMPERATURE > UPPER AIR TEMPERATURE\, ATMOSPHERE > ATMOSPHERIC WATER VAPOR > WATER VAPOR	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

Name	Type	Size	Value	Description
				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'.
processing_level	string	1	2	A textual description of the processing (or quality control) level of the data.
product_name_type_id	string	1	L2_RAMSES2_RET	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

Name	Type	Size	Value	Description
				extended date format is recommended, as described in the Attribute Content Guidance section.
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.
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

Name	Type	Size	Value	Description
				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'.
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

Name	Type	Size	Value	Description
				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.
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.

Name	Type	Size	Value	Description
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.
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	JPSS-1 > Joint Polar Satellite System - 1	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	J1	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.
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)

Name	Type	Size	Value	Description
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
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

Name	Type	Size	Value	Description
				'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
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	v02.02.25	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.

Name	Type	Size	Value	Description
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.
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	Sounder SIPS: Level-2 RAMSES-2 JPSS-1 ATMS Standard Retrieval	a succinct description of what is in the dataset. (= ECS long name)

Name	Type	Size	Value	Description
summary	string	1	The Level-2 RAMSES-2 product includes atmospheric state retrieval products from the RAMSES-2 algorithm for one six-minute interval. These include temperature and water vapor profiles as well as surface products and precipitation.	A paragraph describing the dataset, analogous to an abstract for a paper.
shortname	string	1	SNDRJ1ML2RMS	ECS Short Name
product_group	string	1	l2_ramses2	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	Unassigned	A URL that gives the location of more complete metadata. A persistent URL is recommended for this attribute.
references	string	1		ATDB and design documents describing processing algorithms. Can be empty.
contributor_name	string	1	Bjorn Lambrigsen\, NASA JPL; Mathias Schreier\, NASA JPL; Philip W. Rosenkranz\, MIT	The names of any individuals or institutions that contributed to the creation of this data.
contributor_role	string	1	Retrieval PI; Retrieval developer; Forward model originator	The roles of any individuals or institutions that contributed to the creation of this data.

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aux group

B.1.5 Dimensions for the aux group

Name	Size	Description
channel_atms	22	ATMS channels

B.1.6 Variables for the aux group

Name	Type	Dimensions	Description	Units	Ancillary Variables
bkgd_air_temp	float32	atrack, xtrack, air_pres_stand	Background state for the air temperature profile	Kelvin	
bkgd_surf_air_temp	float32	atrack, xtrack	Background state for the near-surface air temperature	Kelvin	
bkgd_h2o_vap_tot	float32	atrack, xtrack	Background state for the total precipitable water vapor	kg / m2	
bkgd_spec_hum	float32	atrack, xtrack, air_pres_h2o_stand	Background state for the mass fraction of water vapor in moist air	kg / kg	
bkgd_surf_spec_hum	float32	atrack, xtrack	Background state for the near-surface mass fraction of water vapor in moist air	kg / kg	
bkgd_h2o_liq_tot	float32	atrack, xtrack	Background state for total cloud liquid water	kg / m2	
bkgd_h2o_liq_mmr	float32	atrack, xtrack, air_pres_h2o_stand	Background state for the cloud liquid water mass mixing ratio to moist air	kg / kg	
bkgd_h2o_ice_tot	float32	atrack, xtrack	Background state for total cloud ice	kg / m2	
bkgd_h2o_ice_mmr	float32	atrack, xtrack, air_pres_h2o_stand	Background state for the cloud ice mass mixing ratio to moist air	kg / kg	
error_value	float32	atrack, xtrack	error value	unitless	
quality_flag	byte	atrack, xtrack	Internal overall profile quality flag		
precip_strat_regr	byte	atrack, xtrack	Stratiform precipitation test from regression		
precip_convec_regr	byte	atrack, xtrack	Convective precipitation test from regression		
rainrate_regr	float32	atrack, xtrack	Rain rate from regression	m / sec	
convective_index_regr	byte	atrack, xtrack	Convective index from regression	unitless	

Name	Type	Dimensions	Description	Units	Ancillary Variables
surf_air_temp_regr	float32	atrack, xtrack	Near surface temperature (2m) from regression	Kelvin	
mw_sea_frac	float32	atrack, xtrack	MW surface fraction: lake or sea without snow or ice	unitless	
mw_land_frac	float32	atrack, xtrack	MW surface fraction: land without snow or ice	unitless	
mw_surf_ice_frac	float32	atrack, xtrack	MW surface fraction: snow or ice on lake or sea	unitless	
mw_surf_ice_area_type	string		area type for ms_surf_ice_frac		
mw_surf_snow_frac	float32	atrack, xtrack	MW surface fraction: snow or ice on land	unitless	
mw_surf_snow_area_type	string		area type for ms_surf_snow_frac		
bkgd_surf_temp	float32	atrack, xtrack	background state for the radiative temperature of the surface	Kelvin	
bkgd_surf_mw_emis	float32	atrack, xtrack, channel_atms	Background state for microwave surface emissivity	unitless	
prior_surf_pres	float32	atrack, xtrack	surface pressure from forecast	Pa	
prior_sea_lev_pres	float32	atrack, xtrack	sea level surface pressure from forecast	Pa	

J1 L2 SUP RAMSES-2 Interface Specification

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B.1.7 Groups

Path	Description
/	Main science data
/aux	Internal product team data

B.1.8 Global Dimensions

Name	Size	Description
atrack	135	along-track horizontal dimension
xtrack	96	cross-track horizontal dimension
utc_tuple	8	parts of UTC time: year, month, day, hour, minute, second, millisec, microsec
air_pres	100	Fine atmospheric pressure levels starting from the top
air_pres_h2o	66	Fine atmospheric pressure levels starting from the top
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
attitude	3	roll, pitch, yaw

B.1.9 Global Variables

Name	Type	Dimensions	Description	Units	Ancillary Variables
obs_id	string	atrack, xtrack	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).		
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
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_glint_lat	float	atrack	sun glint spot latitude at scan_mid_time. Fill for night observations.	degrees_north	
sun_glint_lon	float	atrack	sun glint spot longitude at scan_mid_time. Fill for night observations.	degrees_east	

Name	Type	Dimensions	Description	Units	Ancillary Variables
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_glint_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	
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	

Name	Type	Dimensions	Description	Units	Ancillary Variables
sat_vel	float	atrack, spatial	satellite ECR velocity at scan_mid_time	m s-1	
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	
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	
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)		

Name	Type	Dimensions	Description	Units	Ancillary Variables
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		
air_temp	float32	atrack, xtrack, air_pres	air temperature profile	Kelvin	qc, err
surf_air_temp	float32	atrack, xtrack	near-surface air temperature (~2 meters above surface)	Kelvin	qc, err
h2o_vap_tot	float32	atrack, xtrack	total precipitable water vapor	kg / m2	qc, err
spec_hum	float32	atrack, xtrack, air_pres_h2o	mass fraction of water vapor in moist air	kg / kg	qc, err
surf_spec_hum	float32	atrack, xtrack	Near-surface mass fraction of water vapor in moist air	kg / kg	qc, err
rel_hum	float32	atrack, xtrack, air_pres_h2o	relative humidity over equilibrium phase	unitless	qc, err
surf_rel_hum	float32	atrack, xtrack	relative humidity near the surface over equilibrium phase	unitless	qc, err
spec_hum_sat_ice	float32	atrack, xtrack, air_pres_h2o	saturation specific humidity in equilibrium with ice	kg / kg	qc, err
surf_spec_hum_sat_ice	float32	atrack, xtrack	Near-surface saturation specific humidity in equilibrium with ice	kg / kg	qc, err

Name	Type	Dimensions	Description	Units	Ancillary Variables
spec_hum_sat_liq	float32	atrack, xtrack, air_pres_h2o	saturation specific humidity in equilibrium with liquid water	kg / kg	qc, err
surf_spec_hum_sat_liq	float32	atrack, xtrack	Near-surface saturation specific humidity in equilibrium with liquid water	kg / kg	qc, err
h2o_liq_tot	float32	atrack, xtrack	total cloud liquid water	kg / m2	qc, err
h2o_liq_mmr	float32	atrack, xtrack, air_pres_h2o	cloud liquid water mass mixing ratio to moist air	kg / kg	qc, err
h2o_ice_tot	float32	atrack, xtrack	total cloud solid water	kg / m2	qc, err
h2o_ice_mmr	float32	atrack, xtrack, air_pres_h2o	cloud ice mass mixing ratio to moist air	kg / kg	qc, err
gp_hgt	float32	atrack, xtrack, air_pres	Geopotential is the sum of the specific gravitational potential energy relative to the geoid and the specific centripetal potential energy. Geopotential height is the geopotential divided by the standard acceleration due to gravity.	m	qc, err
surf_gp_hgt	float32	atrack, xtrack	geopotential height at the surface	m	qc, err
surf_temp	float32	atrack, xtrack	radiative temperature of the surface	Kelvin	qc, err
tpause_gp_hgt	float32	atrack, xtrack	tropopause geopotential height, where tropopause is determined according to the WMO definition	m	qc
tpause_pres	float32	atrack, xtrack	tropopause pressure, where tropopause is determined according to the WMO definition	Pa	qc

Name	Type	Dimensions	Description	Units	Ancillary Variables
tpause_temp	float32	atrack, xtrack	tropopause temperature, where tropopause is determined according to the WMO definition	Kelvin	qc
air_pres	float32	air_pres	pressure levels	Pa	
air_pres_nsurf	int16	atrack, xtrack	Index in air_pres of the level at the surface. Values at levels beyond this are invalid, representing data below the Earth's surface.	unitless	
air_pres_h2o	float32	air_pres_h2o	H2O vapor pressure levels	Pa	
air_pres_h2o_nsurf	int16	atrack, xtrack	Index in air_pres_h2o of the level at the surface. Values at levels beyond this are invalid, representing data below the Earth's surface.	unitless	
mw_surf_class	int16	atrack, xtrack	Microwave spectral surface class. 0 for coastline; 1 for land; 2 for ocean; 3 for first-year sea-ice; 4 for multi-year sea-ice; 5 for snow (higher-freq scattering); 6 for glacier/snow (very low-freq scattering); 7 for snow (lower-freq scattering);		

B.1.10 Global Attributes

Name	Type	Size	Value	Description
keywords	string	1	ATMOSPHERE > ATMOSPHERIC TEMPERATURE > UPPER AIR TEMPERATURE\, ATMOSPHERE > ATMOSPHERIC WATER VAPOR > WATER VAPOR	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

Name	Type	Size	Value	Description
				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'.
processing_level	string	1	2	A textual description of the processing (or quality control) level of the data.
product_name_type_id	string	1	L2_RAMSES2_SUP	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.
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.

Name	Type	Size	Value	Description
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.
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:

Name	Type	Size	Value	Description
				'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'.
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.
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:

Name	Type	Size	Value	Description
				'GCMD:GCMD Keywords, CF:NetCDF COARDS Climate and Forecast Standard Names'.
platform	string	1	JPSS-1 > Joint Polar Satellite System - 1	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	J1	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.
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)

Name	Type	Size	Value	Description
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
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
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-

Name	Type	Size	Value	Description
				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	v02.02.25	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.
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.

Name	Type	Size	Value	Description
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	Sounder SIPS: Level-2 RAMSES-2 JPSS-1 ATMS Support	a succinct description of what is in the dataset. (= ECS long name)
summary	string	1	The Level-2 RAMSES-2 product includes atmospheric state retrieval products from the RAMSES-2 algorithm for one six-minute interval. These include temperature and water vapor profiles as well as surface products and precipitation.	A paragraph describing the dataset, analogous to an abstract for a paper.
shortname	string	1	SNDRJ1ML2RMSSUP	ECS Short Name
product_group	string	1	l2_ramses2	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	Unassigned	A URL that gives the location of more complete metadata. A persistent URL is recommended for this attribute.
references	string	1		ATDB and design documents describing processing algorithms. Can be empty.
contributor_name	string	1	Bjorn Lambrigsen\, NASA JPL; Mathias Schreier\, NASA JPL; Philip W. Rosenkranz\, MIT	The names of any individuals or institutions that contributed to the creation of this data.
contributor_role	string	1	Retrieval PI; Retrieval developer; Forward model originator	The roles of any individuals or institutions that contributed to the creation of this data.

aux group

B.1.11 Dimensions for the aux group

Name	Size	Description
channel_atms	22	ATMS channels
sig_lev	72	Hybrid sigma levels

B.1.12 Variables for the aux group

Name	Type	Dimensions	Description	Units	Ancillary Variables
bkgd_air_temp	float32	atrack, xtrack, air_pres	Background state for the air temperature profile	Kelvin	
bkgd_surf_air_temp	float32	atrack, xtrack	Background state for the near-surface air temperature	Kelvin	
bkgd_h2o_vap_tot	float32	atrack, xtrack	Background state for the total precipitable water vapor	kg / m2	
bkgd_spec_hum	float32	atrack, xtrack, air_pres_h2o	Background state for the mass fraction of water vapor in moist air	kg / kg	
bkgd_surf_spec_hum	float32	atrack, xtrack	Background state for the near-surface mass fraction of water vapor in moist air	kg / kg	
bkgd_h2o_liq_tot	float32	atrack, xtrack	Background state for total cloud liquid water	kg / m2	
bkgd_h2o_liq_mmr	float32	atrack, xtrack, air_pres_h2o	Background state for the cloud liquid water mass mixing ratio to moist air	kg / kg	
bkgd_h2o_ice_tot	float32	atrack, xtrack	Background state for total cloud ice	kg / m2	
bkgd_h2o_ice_mmr	float32	atrack, xtrack, air_pres_h2o	Background state for cloud ice mass mixing ratio to moist air	kg / kg	

Name	Type	Dimensions	Description	Units	Ancillary Variables
error_value	float32	atrack, xtrack	error value	unitless	
quality_flag	byte	atrack, xtrack	Internal overall profile quality flag		
precip_strat_regr	byte	atrack, xtrack	Stratiform precipitation test from regression		
precip_convec_regr	byte	atrack, xtrack	Convective precipitation test from regression		
rainrate_regr	float32	atrack, xtrack	Rain rate from regression	m / sec	
convective_index_regr	byte	atrack, xtrack	Convective index from regression	unitless	
surf_air_temp_regr	float32	atrack, xtrack	Near surface temperature (2m) from regression	Kelvin	
mw_sea_frac	float32	atrack, xtrack	MW surface fraction: lake or sea without snow or ice	unitless	
mw_land_frac	float32	atrack, xtrack	MW surface fraction: land without snow or ice	unitless	
mw_surf_ice_frac	float32	atrack, xtrack	MW surface fraction: snow or ice on lake or sea	unitless	
mw_surf_ice_area_type	string		area type for ms_surf_ice_frac		
mw_surf_snow_frac	float32	atrack, xtrack	MW surface fraction: snow or ice on land	unitless	
mw_surf_snow_area_type	string		area type for ms_surf_snow_frac		
sig_lev_pres	float32	atrack, xtrack, sig_lev	sigma level pressure	Pa	
air_temp_sig_lev	float32	atrack, xtrack, sig_lev	air temperature profile	Kelvin	qc, err
bkgd_air_temp_sig_lev	float32	atrack, xtrack, sig_lev	Background state for the air temperature profile	Kelvin	
spec_hum_sig_lev	float32	atrack, xtrack, sig_lev	mass fraction of water vapor in moist air	kg / kg	qc, err
bkgd_spec_hum_sig_lev	float32	atrack, xtrack, sig_lev	Background state for the mass fraction of water vapor in moist air	kg / kg	

Name	Type	Dimensions	Description	Units	Ancillary Variables
h2o_liq_mmr_sig_lev	float32	atrack, xtrack, sig_lev	cloud liquid water mass mixing ratio to moist air	kg / kg	qc, err
bkgd_h2o_liq_mmr_sig_lev	float32	atrack, xtrack, sig_lev	background state for the cloud liquid water mass mixing ratio to moist air	kg / kg	
h2o_ice_mmr_sig_lev	float32	atrack, xtrack, sig_lev	cloud ice mass mixing ratio to moist air	kg / kg	qc, err
bkgd_h2o_ice_mmr_sig_lev	float32	atrack, xtrack, sig_lev	Background state for the cloud ice mass mixing ratio to moist air	kg / kg	
bkgd_surf_temp	float32	atrack, xtrack	background state for the radiative temperature of the surface	Kelvin	
bkgd_surf_mw_emis	float32	atrack, xtrack, channel_atms	Background state for microwave surface emissivity	unitless	
prior_surf_pres	float32	atrack, xtrack	surface pressure from forecast	Pa	
prior_sea_lev_pres	float32	atrack, xtrack	sea level surface pressure from forecast	Pa	