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

Data Product User Guide for S-NPP Sounder SIPS CHART and CLIMCAPS CrIS and ATMS Level-2 Products

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Product Version 1.0

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Revision History

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2019-09-09	Initial Release	Evan Manning

1.0 Introduction

This document provides basic information for using Version 1 Level-2 products from the Cross-track Infrared and Microwave Sounding Suite (CrIMSS) instruments on the Suomi-NPP spacecraft. The CrIMSS instrument suite consists of the Cross-track Infrared Sounder (CrIS) infrared sounder and the Advanced Technology Microwave Sounder (ATMS) microwave sounder.

The products the result from two retrieval algorithms: Climate Heritage AIRS Retrieval Technique (CHART) and Community Long-term Infrared Microwave Coupled Atmospheric Product System (CLIMCAPS). The different approaches of these two algorithms are briefly described in Section 2.2 and Appendix A.

The main Level-2 retrieval product from each algorithm contains a variety of geophysical parameters derived from the CrIMSS data, including temperature profiles, water vapor, constituents, clouds, and surface properties for six minutes of observations. An additional cloud-cleared radiance product contains estimated radiances that would have been observed in the absence of clouds. These files can be valuable because the retrieval algorithms utilize cloud cleared radiances. These products have been annotated with both file and variable level attributes to fully describe their contents.

1.1 Overview of Sounder SIPS

The Suomi-National Polar-Orbiting Partnership (S-NPP) Sounder SIPS, is one of six SIPSs formed by NASA to provide the processing of level 0 data through level 1, level 2 and level 3 from the Suomi NPP (previously known as NPP) satellite. The Suomi-NPP satellite is managed by the National Polar-orbiting Partnership (NPP) which includes elements from NASA, NOAA and DoD. Details about the S-NPP Mission can be found at: https://www.jpss.noaa.gov/.

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 and distribution of the data products and associated documentation.

1.2 Mission Description

The S-NPP satellite was launched on October 28, 2011 from Vandenburg Air Force Base in California 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 [Reference 3]. SNPP is the first in a series of next generation U.S. weather satellites of the Joint Polar Satellite System (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).

Table 1.2.1 contains a summary of platform parameters.

Table 1.2.1 Approximate S-NPP orbital parameters.

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

CrIS and ATMS are designed to be used together as CrIMSS, the Cross-track Infrared and Microwave Sounding Suite. Both algorithms used here combine infrared (IR) data from CrIS with microwave (MW) data from ATMS in a single IR+MW retrieval.

1.3 CrIS Instrument Description

The Cross-track Infrared Sounder (CrIS) is a Fourier Transform Spectrometer (FTS) which measures interferograms in three Infrared (IR) bands simultaneously. The CrIS interferometer includes a beamsplitter, a stationary and moving mirror, and a laser sampling system. The scene radiance entering the interferometer is split by the beamsplitter into two beams along two separate paths. One beam travels towards the moving mirror; the other to a stationary mirror. The two beams are reflected from the corresponding mirrors and recombine before converging on the detector. The optical path difference (OPD) traveled by the two beams is twice the physical path difference between the two mirrors. As the moving mirror sweeps from one side of the zero path difference (ZPD) to the other, a time-varying interference pattern known as the interferogram is recorded. A convolution of the interferogram with a Finite Impulse Response (FIR) numerical filter is applied in real-time on the spacecraft to reduce the internal data rate to meet telemetry requirements. This results in a complex-valued interferogram of a fixed number of sample points which is included in the downlinked data packets.

During a single scene scan mirror dwell period, one interferogram is recorded for each of 27 detectors simultaneously (3 focal planes (LW, MW, SW) each containing 9 bore-sighted detectors in a 3x3 pattern). The CrIS uses a 45-degree scene scan mirror to provide sequential views of an internal blackbody (ICT), a deep space view (DS), and 30 Earth views in the cross-track direction in a repeating pattern as the spacecraft moves along-track. The interferograms associated with the ICT and DS views and a measurement of ICT temperature are used in the ground processing software to calibrate the Earth views to produce radiance spectra. Prior to calibration, a correction is applied to account for measured signal nonlinearity of selected detectors. Corrections are also applied in the ground processing software to remove FTS self-apodization effects and to resample the spectra to a predefined user spectral grid.

These products were produced using version 1 of the CrIS Level-1B product in Normal Spectral Resolution (NSR).

1.4 ATMS Instrument Description

ATMS is a 22-channel cross-track scanning microwave sounder providing both temperature and humidity soundings. Table 1.4.1 contains a summary of the ATMS instrument parameters.

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

Table 1.4.1 ATMS instrument parameters.

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

1.5 Data Disclaimer

Version 1.0 CrIMSS Level-2 data are released to the public as is. Every effort has been made to properly represent the data which this document describes.

1.6 Where to find the Product

The CrIMSS Level-2 products can be found at and downloaded from the Goddard Distributed Active Archive Center (GDAAC). There you will find additional information and documentation about this product and other products of interest. Search "Suomi-NPP CrIMSS" (with quotes) under Data Collections.

https://disc.gsfc.nasa.gov

1.7 Contact Information

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

1.8 References

If links do not resolve, copy the url to a browser.

1. NASA SNPP Cross Track Infrared Sounder (CrIS) Level 1B Product Users' Guide

2. NASA SNPP Cross Track Infrared Sounder (CrIS) Level 1B Quality Flags Description Document

3. Data Product User Guide for Suomi-National Polar-Orbiting Partnership (S-NPP) Sounder Science Investigator-led Processing System (SIPS) Advanced Technology Microwave Sounder (ATMS) Level 1B Products

4. CHART Level-2 ATBD
https://docserver.gesdisc.eosdis.nasa.gov/public/project/SNPP/SNPP_limited_edition/SNPP.CrIMSS.CHART_V1.ATBD.pdf

5. CLIMCAPS Level-2 ATBD
https://docserver.gesdisc.eosdis.nasa.gov/public/project/SNPP/SNPP_limited_edition/SNPP.CrIMSS.CLIMCAPS_V1.ATBD.pdf

6. NetCDF Climate and Forecast (CF) Metadata Conventions, Version 1.7,
http://cfconventions.org/Data/cf-conventions/cf-conventions-1.7/cf-conventions.html

7. MERRA-2 https://gmao.gsfc.nasa.gov/reanalysis/MERRA-2/

2.0 Level-2 Product Overview

Level-2 products are created from CrIS and ATMS Level-1B observations using two algorithms: CHART and CLIMCAPS. Each of these algorithms creates a main retrieval product with geophysical parameters and an additional cloud-cleared radiance product, so four product file types are described in this document:

1) Level-2 CHART Retrieval product (L2_CHART_RET)
2) Level-2 CLIMCAPS Retrieval product (L2_CLIMCAPS_RET)
3) Level-2 CHART Cloud-Cleared Radiances (L2_CHART_CCR)
4) Level-2 CLIMCAPS Cloud-Cleared Radiances (L2_CLIMCAPS_CCR)

2.1 Product Granulation and Identification

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.

The nominal start time of granule 1 is defined to be 00:00:00. 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.

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, ATMS and CrIS obs_ids differ. Level-2 CHART and CLIMCAPS obs_ids follow the CrIS pattern because their retrieved information corresponds to CrIS geometry.

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

CrIS/Level-2 obs_id: Each field of regard (FOR), defined as a set of 9 simultaneously observed fields of view, has a globally unique ID stored in the variable "obs_id". The observation ID is created from the granule ID, with information appended to identify the FOR observation within the granule.

The dimensions of this variable (atrack=45, xtrack=30) correspond to the first two dimensions of the science data variables, such as radiances. An observation ID can be associated with data by applying the same indices into these common dimensions.

The format of the CrIS/Level-2 observation ID string is "yyyymmddThhmm.aaExx", where "aa" is the 2- digit along-track index (01-45), and "xx" is the 2-digit cross-track index (01-30). The "E" indicates that it is an earth view.

For example:

20160125T1300.01E18

FOV Observation ID: At the finest level of granularity, each field of view (FOV) within a FOR observation has a globally unique ID that is stored in a variable called "fov_obs_id". The FOV observation ID is created from the observation ID, with extra information appended to identify the FOV within the FOR observation.

The dimensions of this variable (atrack=45, xtrack=30, fov=9) correspond to the first three dimensions of the science data variables, such as radiances. A FOV observation ID can be associated with data by applying the same indices into these common dimensions.

The format of the FOV observation ID string is "yyyymmddThhmm.aaExx.f" where "f" is the 1-digit FOV number (1-9).

For example:

20160125T1300.01E18.6

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 go to: https://earthdata.nasa.gov/earth-science-data-systems-program/policies/data-information-policy/data-levels

Both CHART and CLIMCAPS are based on the AIRS Level-2 team algorithm [https://disc.gsfc.nasa.gov/information/documents?title=AIRS%20Documentation]. CHART v6.46 remains very close to the AIRS v6 algorithm, with changes consistent with changes towards the AIRS v7 algorithm [

https://airs.jpl.nasa.gov/system/presentations/files/321_Susskind_AIRS_CrIS_Retrieval.pdf]. CLIMCAPS v1.01 is based on an earlier AIRS team algorithm. It replaces the SCCNN neural net first guess with MERRA2 (see Section 3.11, GFS was accidentally used as the first guess), streamlines the algorithm flow to use a single pass, and uses optimal estimation in the individual species retrieval steps [https://airs.jpl.nasa.gov/system/presentations/files/381_StatusBarnet.pdf].

Technical details of the Level-2 processing steps and calibrations can be found in the Algorithm Theoretical Basis Documents (ATBDs). See references.

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. 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.

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 C.

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 '.' For each token that makes up the filename, there will be an attribute in the data product that it maps to (see Table 2.6.1 Filenaming).

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

Where:

- **Sounder_SIPS_ID** as a project identifier <product_name_project> = SNDR
- **platform** <product_name_platform> = SNPP
- **inst_ID** <product_name_instr> = CRIMSS
- **granuleID** (yyyymmddThhmm) <gran_id> nominal start time where:
  - yyyy = year
  - mm = month of year (01-12)
  - dd = day of month (01-31)
  - hh = hour (00-24)
  - mm = minute (00-59)
- **product_granularity** <product_name_duration> = m06 (6 minute)
- **granule_number** <granule_number> = g###
- **product_type** with an optional identifier for testing <product_type_name_id>
  - L2_CHART_RET_NSR for CHART geophysical retrieved products derived from CrIS NSR spectral resolution.
  - L2_CLIMCAPS_RET_NSR for CLIMCAPS geophysical retrieved products derived from CrIS NSR spectral resolution.
  - L2_CHART_CCR_NSR for CHART cloud-cleared radiances at NSR spectral resolution.
  - L2_CLIMCAPS_CCR_NSR for CLIMCAPS cloud-cleared radiances at NSR spectral resolution.
- **variant** <product_name_variant> = std
- **version** vmm_mm <product_name_version> - eg. v01_25
  - Versioning will be synchronized across Sounder SIPS products
  - Version 1 Level-2 products are derived from version 1 Level-1B products
- **production_location** <product_name_producer>- J=SIPS at JPL, G=Operations, T=Test, W = CrIS Team at Univ of Wisc
- **prod_timestamp** so each product has a unique name (yymmddhhmmss) <product_name_timestamp>- 150407123456
- **Extension** (.nc)

Table 2.6.1 Product Filenaming

Filename token	Attribute name in CDF (mapping)	Format	Value(s)	Notes
Sounder_SIPS_ID	product_name_project		SNDR	
platform	product_name_platform		SNPP	

inst_ID	product_name_instr		CRIMSS	CRIMSS = CrIS + ATMS
granuleID	gran_id	yyyymmddThhmm	Nominal start time	
product_granularity	product_name_duration		m06	6 minutes
granule_number	granule_number	g###	g001 – g240	Only for 6-minute granule Leve-1 and Level-2 products
product_type	product_name_type_id + optional identifier for uniqueness	L2_<alg>_<prod>_NSR	L2_CHART_RET_NSR L2_CHART_CCR_NSR L2_CLIMCAPS_RET_NSR L2_CLIMCAPS_CCR_NSR	<alg> is CHART or CLIMCAPS <prod> is RET or CCR _NSR is always present in the v1 release because v1 Level-1B CrIS is only NSR
Version	product_name_version	v01_##; v01_##_##		e.g. v01_05; (v01_05_00 when produced at JPL)
variant	product_name_variant	Freeform text. No whitespace or any punctuation except underscore.	std	Used to identify special runs. The default is: std = standard.
production_location	product_name_producer		J: JPL G: GSFC T: Test	
prod_timestamp	product_name_timestamp	yymmddhhmmss		

Example Filename: 6-minute CrIMSS Level-2 granule

SNDR.SNPP.CRIMSS.*yyyymmdd*T*hhmm*.m06.g101.L2_CLIMCAPS_RET_NSR.std.v*mm_mm*.G.*yymmddhhmmss*.nc

SNDR.SNPP.CRIMSS.20160114T1000.m06.g101.L2_CLIMCAPS_RET_NSR.std.v02_04.G.180110183539.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
20160125T1300

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

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

2.8 Data Holdings

For the initial release of v1 CHART & CLIMCAPS, a test data set of 8 months of data is provided. This data covers the months of {January, April, July, October} of the years 2013 & 2015. This set is designed to allow research and comparisons over a full seasonal cycle and comparisons of different phases of the ENSO cycle.

3.0 Data Content

The Level-2 data products are written in netCDF4 format and therefore makes 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 C.

Selected fields are highlighted in this section.

3.1 Dimensions

Key dimensions for CHART and CLIMCAPS Level-2 RET and CCR products.

Table 3.1 Key RET Dimensions

Name	Size	Description
atrack	45	along-track spatial dimension
xtrack	30	cross-track spatial dimension
fov	9	Field-of-view dimension
air_pres	100	Fine atmospheric pressure levels for temperature and most gases
air_pres_h2o	66	Fine atmospheric pressure levels for water-vapor variables

Table 3.2 Key CCR Dimensions

Name	Size	Description
atrack	45	along-track spatial dimension
xtrack	30	cross-track spatial dimension
wnum_lw	717	longwave IR channel number
wnum_mw	437	midwave IR channel number
wnum_sw	163	shortwave IR channel number

3.2 Global Attributes (metadata)

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 C.

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 OGC's 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 signature (DOI)
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 https://geo-ide.noaa.gov/wiki/index.php?title=ISO_19115_and_19115-2_CodeList_Dictionaries#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	

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.

These are the groups for retrieval files:

Group	Purpose
/ (root)	Main group, with temperature and water vapor profiles, along with supporting location and quality information
/mw	Results from the Microwave-Only retrieval step
/mol_lay	Retrieved values of water vapor and other gases in units of molecules per square meter per layer -- the SI equivalent of the "column density" used in the SARTA forward model
/aux	Supporting information primarily for the algorithm developers
/ave_kern	Averaging kernels (not included in the v1 release)

These are the groups for cloud-cleared radiance files:

Group	Purpose
/ (root)	Main group, with cloud-cleared spectra, along with supporting location and quality information
/aux_l2	Supporting information about the Level-2 retrieval primarily for the algorithm developers
/aux_l1b_cris	Supporting instrument characterization information propagated from Level-1 (not included in the v1 release)

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.

These products come from retrieval algorithms that do a cloud-clearing on a Field-of-Regard (FOR) made up of 9 Fields-of-View (FOVs). In this retrieval it is assumed that most geophysical parameters are constant over the area of a FOR, and these are provided at FOR spatial resolution (45 x 30). For some variables, including some cloud quantities, information is available at FOV spatial resolution (45 x 30 x 9). The product contains two

sets of location information: {lat, lon, land_frac, ...} provide information about the larger FOR while {fov_lat, fov_lon, fov_land_frac, ...} provide information about the smaller FOV. The "coordinates" variable attribute attached to each geophysical field specifies which set of latitude and longitude is appropriate.

Table 3.5.1 Geolocation Dimensions

Dimension name	Size	Meaning
atrack	45	Along-track FOR horizontal dimension
xtrack	30	Cross-track FOR horizontal dimension
fov	9	CrIS FOV dimension within FOR
fov_poly	8	latitude/longitude points defining the polygon bounding an fov (anticlockwise as viewed from above)

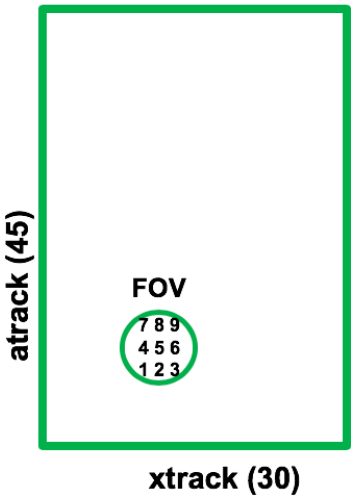


Figure 1. geolocation horizontal dimensions

The key geolocation variables are:

Table 3.5.2 Key FOR 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

Corresponding variables fov_lat, fov_lon, fov_lat_bnds, fov_lon_bnds, fov_land_frac, fov_surf_alt provide information at the FOV spatial resolution.

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 C for full specification.

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

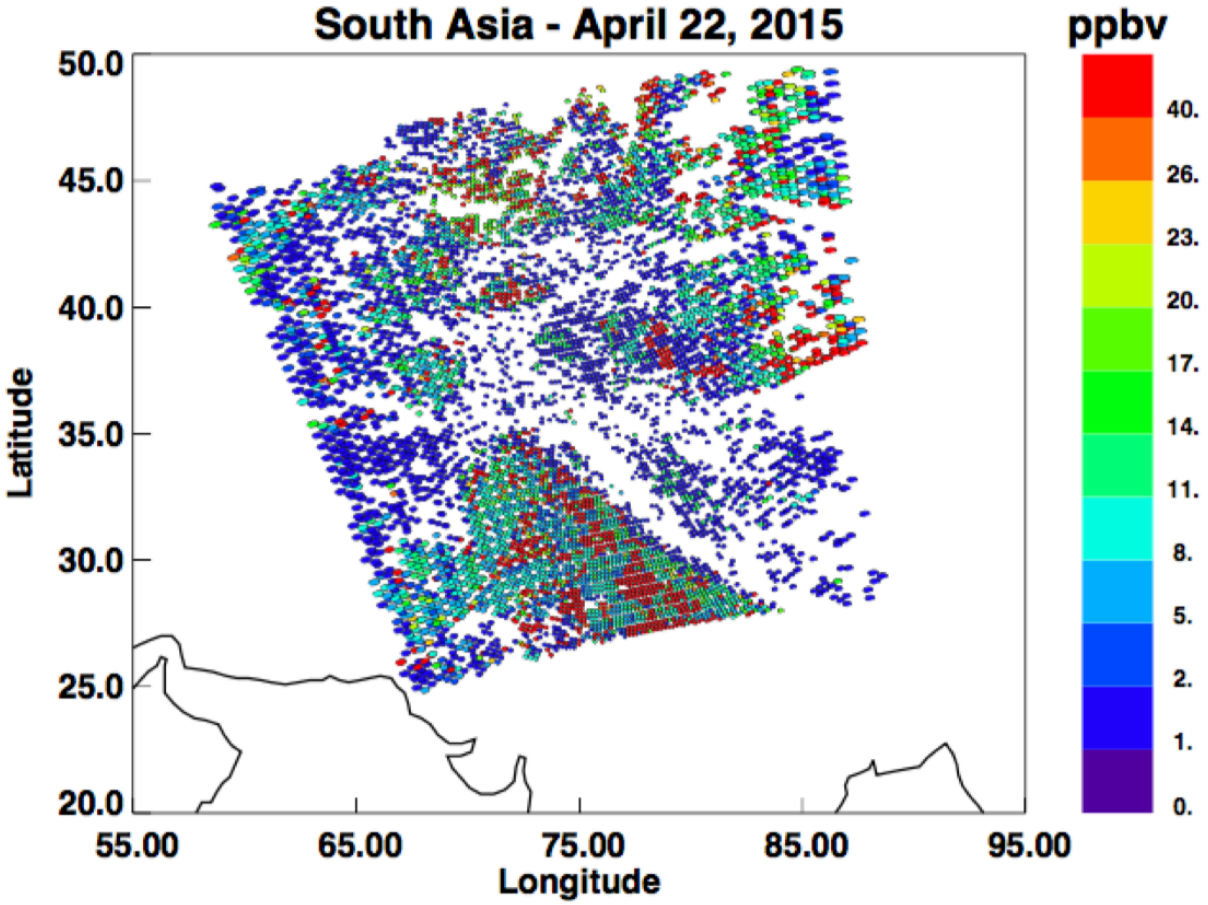


Figure 2. Sample plot of retrieved CrIS NH_3 using bounding polygons. Credit: Karen Cady-Pereira.

3.6 Science Data Variables

These retrievals provide information on a wide variety of geophysical parameters, including temperature, water vapor, 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. For example the air temperature profile is contained in a variable named "air_temp"; its error estimate is in "air_temp_err" and its quality control is "air_temp_qc". The "ancillary_variables" variable attribute of air_temp lists "air_temp_qc, air_temp_err". In the tables below the ancillary variables are not listed explicitly. They are indicated in the "ancillary variables" column.

Key science data fields are defined below. See the appendixes for a full listing.

Table 3.6.1 Key RET Science Data Variables

Name	Dimensions	Description	Units	Ancillary Variables
air_temp	atrack, xtrack, air_pres	air temperature profile	Kelvin	err, qc
surf_air_temp	atrack, xtrack	near-surface air temperature (~2 meters above surface)	Kelvin	err, qc
h2o_vap_tot	atrack, xtrack	total precipitable water vapor	kg / m2	err, qc
spec_hum	atrack, xtrack, air_pres_h2o	mass fraction of water vapor in moist air	unitless	err, qc
surf_spec_hum	atrack, xtrack	Near-surface mass fraction of water vapor in moist air	unitless	err, qc
rel_hum	atrack, xtrack, air_pres_h2o	relative humidity over equilibrium phase	unitless	err, qc
surf_rel_hum	atrack, xtrack	relative humidity near the surface over equilibrium phase	unitless	err, qc
gp_hgt	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	err, qc
surf_gp_hgt	atrack, xtrack	geopotential height at the surface	m	err, qc
o3_tot	atrack, xtrack	Total column ozone. (Multiply by 4.670e5 to convert to Dobson Units from kg m^-2)	kg m-2	err, qc
o3_mmr	atrack, xtrack, air_pres	ozone mass mixing ratio to moist air	unitless	err, qc
co_mmr_midtrop	atrack, xtrack	Carbon monoxide mass mixing ratio to moist air at 50000 Pa, near the peak of sensitivity	unitless	err, qc
ch4_mmr_midtrop	atrack, xtrack	Methane mass mixing ratio to moist air at 40000 Pa, near the peak of sensitivity	unitless	err, qc
h2o_liq_tot	atrack, xtrack	total column cloud liquid water	kg m-2	err, qc
h2o_liq_mol_lay	atrack, xtrack, air_pres_lay	cloud liquid water layer total	unitless	err, qc
cld_frac	atrack, xtrack, fov, cld_lay	effective cloud fraction	unitless	err, qc
cld_top_pres	atrack, xtrack, fov, cld_lay	cloud top pressure in order of increasing pressure	Pa	err, qc

cld_top_temp	atrack, xtrack, fov, cld_lay	cloud top temperature	Kelvin	err, qc
num_cld	atrack, xtrack, fov	Number of cloud layers with nonzero cloud fraction	unitless	
tpause_gp_hgt	atrack, xtrack	tropopause geopotential height, where tropopause is determined according to the WMO definition	m	qc
tpause_pres	atrack, xtrack	tropopause pressure, where tropopause is determined according to the WMO definition	Pa	qc
tpause_temp	atrack, xtrack	tropopause temperature, where tropopause is determined according to the WMO definition	Kelvin	qc
surf_freq_mw	surf_freq_mw	Microwave surface emissivity frequencies (hinge points)	Hz	

Table 3.6.2 Key CCR Science Data Variables

Name	Dimensions	Description	Units	Ancillary Variables
rad_lw	atrack, xtrack, wnum_lw	longwave clear spectral radiance	mW/(m2 sr cm-1)	err, qc
rad_mw	atrack, xtrack, wnum_mw	midwave clear spectral radiance	mW/(m2 sr cm-1)	err, qc
rad_sw	atrack, xtrack, wnum_sw	shortwave clear spectral radiance	mW/(m2 sr cm-1)	err, qc
nedn_lw	fov, wnum_lw	longwave noise equivalent differential radiance	mW/(m2 sr cm-1)	
nedn_mw	fov, wnum_mw	midwave noise equivalent differential radiance	mW/(m2 sr cm-1)	
nedn_sw	fov, wnum_sw	shortwave noise equivalent differential radiance	mW/(m2 sr cm-1)	

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 the CHART and CLIMCAPS products both have this structure, the philosophy of setting individual values is different. CLIMCAPS decides an entire FOR retrieval is good or bad and sets all levels of all variables collectively to 0 or 2. CHART makes different judgements per physical quantity and per pressure level, and uses the "1" intermediate quality level.

In addition to the _qc and _err variables, there are other indicators of quality. *_dof are degrees-of-freedom for retrievals of individual quantities (air_temp_dof, h2o_vap_dof, o3_dof, ...). In the /aux subgroup there are more detailed internal quality indicators including cloud-clearing noise amplification factors and Chi-squared.

3.8 Missing Data / Fill Values

Fill values are used where there is no valid data, 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	air_pres	pressure levels	Pa
air_pres_h2o	air_pres_h2o	H2O vapor pressure levels	Pa
air_pres_lay	air_pres_lay	pressure at the middle of each layer	Pa

air_pres_lay_bnds	air_pres_lay, bnds_1d	Min and max pressure of each layer	Pa
air_pres_nsurf	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_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
air_pres_lay_nsurf	atrack, xtrack	Index in air_pres_lay of the layer at the surface. Values for layers beyond this are invalid, representing data below the Earth's surface.	unitless

3.10 Vertical profile representation of gases

Both retrievals maintain internal vertical profiles of gases on 100 fixed-pressure layers. This information is preserved in the "mol_lay" subgroup. For the main public products in the root group, water vapor and ozone are reported on the 100 fixed-pressure levels which bound the layers. For water vapor, levels at pressures under 5153 Pa (51.53 hPa) are not reported.

For gases CO and CH_4, where there is less than a single degree of freedom, we report MMR only at a single pressure level near the peak of the retrieval sensitivity: 40000 Pa for CH_4, and 50000 Pa for CO.

Pressure levels below the surface are always filled with fill values.

Level concentrations of gases are estimated from the layer gas amounts using different approaches, based on different philosophies. For CHART, we use a smoothing spline fit to represent the limits of the vertical information that is present in the input CrIMSS data by removing sharper features which may be artifacts from SCCNN. For CLIMCAPS, a more direct interpolation preserves information from MERRA2 (see Section 3.11, GFS was accidentally used as the first guess) along with the information from the retrieval.

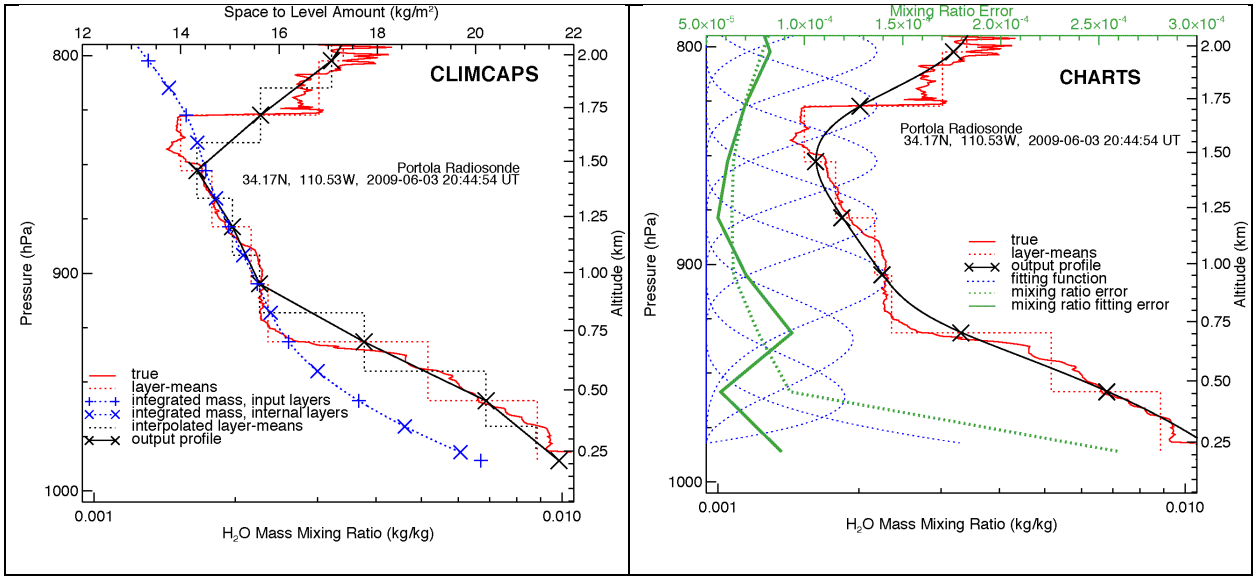


Figure 3. Water vapor level concentration for CLIMCAPS and CHART.

For CLIMCAPS, level concentrations of gases are estimated from layer-amounts using the mean-value theorem and assuming that layers with boundaries at

$$P_{\text{bnd}} = {}^{P_i - P_{i-1}}/_{\ln P_i - \ln P_{i-1}}$$

have mean values which estimate the profile at the levels P_i. Layer-mean mixing ratios are uniquely specified by the layer amounts, the temperature profile and pressure differences through the hydrostatic and hypsometric equations [Wallace and Hobbs, 1977, pgs. 53-54].

Figure 3a illustrates the procedure. A true radiosonde profile of water vapor mixing ratio is converted to layer amounts as would be produced by the CLIMCAPS algorithm. These are shown in the figure as mean mass mixing ratio, which is obtained by dividing the layer water vapor amount by the layer dry air amount. The amounts in each layer are summed from top to bottom to produce a piecewise linear profile of top-to-level integrated amount. The integrated amount is then interpolated to a new set of levels, P_{bnd}, and differenced to produce a new set of layer amount. Similarly, the dry-air top-to-level integrated amounts are interpolated to the new levels, and mean mixing ratios (ratio of gas amount to dry-air amount) are assumed to be the mixing ratio at the levels P_i. Values at the end points are linearly extrapolated from the profile at interior points. The reported profiles have errors from the interpolations and use of the mean value theorem[1]. The algorithm uses linear interpolation in log pressure and top-to-level amount which introduces larger errors when top-to-level amount second derivative is large; these errors are not included in mixing ratio error estimates.

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).

CHART level concentrations are estimated from the layer amounts by least squares fitting a profile to the CHART output layer amounts. The mixing ratio profile is represented as a sum of 4th-order bsplines:

$$X(P) = \sum_i A_i \, b_i(P),$$

the fitting solves for the coefficients A_i, subject to the layer column amounts, a climatological smoothness a priori, and constrained to match the column total. Figure 3b shows the same profile as in the previous figure, and shows the bspline functions, the fitted profile, and the error profile error estimates. This algorithm adds some smoothness to the output profile and performs comparably to the mean-value-theorem method, when the fitting functions are representative of the structure contained in the input layer quantities.

3.11 Known issues

a) The MERRA-2 first guess profile was accidentally overwritten by the GFS forecast file, so that in this 8-month sample run the apriori and all the "fg" variables are actually the

[1] The mean value theorem says that some point in the interval has the mean value, but not where the point is located.

GFS forecast interpolated to the time and location of the observation. For the purpose of evaluation of the behavior of CLIMCAPS versus CHART the use of GFS forecasts should not be significantly different than MERRA-2.

b) CLIMCAPS surf_emis_mw is wrong.
c) Reported error estimates are all fill values for

   i. [surf_]spec_hum_sat_[ice|liq]_err
   ii. [surf_]gp_hgt_err
   iii. h2o_liq_mol_lay_err
   iv. mw_[surf_]air_temp_err
   v. mw_surf_temp_err
   vi. CLIMCAPS surf_ir_emis_err, cld_frac_err, cld_top_pres_err, for_cld_frac_tot_err, for_cld_top_pres_tot_err, for_cld_frac_2lay_err, for_cld_top_pres_2lay_err, h2o_liq_tot_err
   vii. CLIMCAPS cloud-cleared radiances, rad_*w_err

d) CLIMCAPS co2_mol_lay is all fill values, but retrieved CO2 info is available in VMR units in aux/co2_vmr.
e) Even though the description of o3_mmr and co_mmr_midtrop says they are MMR to moist air, the values are calculated as MMR to dry air. The differences are very small.

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 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 Goddard Distributed Active Archive Center (GDAAC). 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.

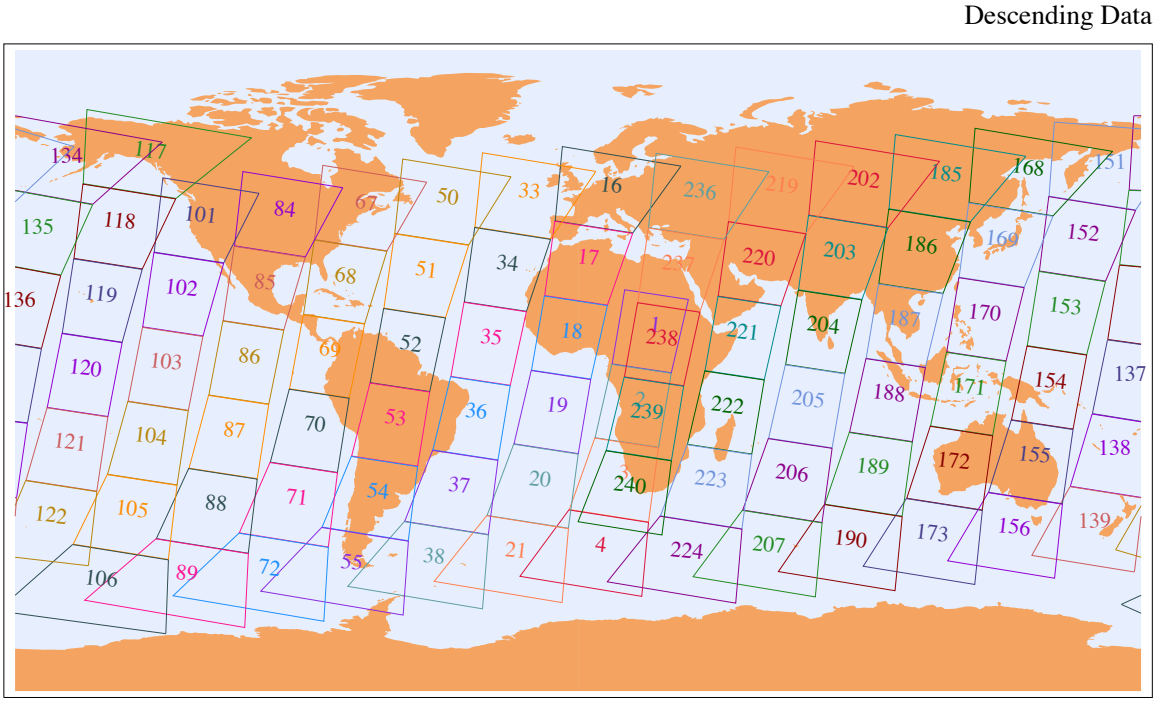


Figure 4. Granule map for nighttime data 2016-01-14. Granule 101 is used in App

Data at the GDAAC is organized by unique shortnames and version numbers.

Table 5.1 Shortnames

shortname.version	Description
CHART + CLIMCAPS Level-2 products described in this document	
SNDRSNIML2CCPRETN.1	CLIMCAPS Level-2 retrieved product
SNDRSNIML2CCPCCRN.1	CLIMCAPS Level-2 Cloud-cleared radiances
SNDRSNIML2CHTRETN.1	CHART Level-2 retrieved product
SNDRSNIML2CHTCCRN.1	CHART Level-2 Cloud-cleared radiances
Related data sets at GDAAC	
N/A (on demand)	SNPP granule maps
SNPPCrISL1BNSR.1	SNPP CrIS Level 1B Normal Spectral Resolution V1

	used as input for these retrievals
SNPPATMSL1B.1	SNPP ATMS Level 1B Brightness Temperature V1 used as input for these retrievals
SNDRSNIML3DCCPN.1	CLIMCAPS Level-3 1-day retrieved product
SNDRSNIML3MCCPN.1	CLIMCAPS Level-3 monthly retrieved product
SNDRSNIML3DCHTN.1	CHART Level-3 1-day retrieved product
SNDRSNIML3MCHTN.1	CHART Level-3 monthly retrieved product

Appendix A: Differences between CLIMCAPS and CHART algorithms

Although CHART and CLIMCAPS share a common heritage, there are significant differences in implementation. They use different channels and vertical basis functions among other changes. Please see their respective ATBD documents for full details. Here are a few key differences.

A.1 First guess

CLIMCAPS starts from a background geophysical state derived from MERRA2 (see Section 3.11, GFS was accidentally used as the first guess). CHART starts from the results of a neural net using CrIMSS data, and trained using ECMWF forecasts. This neural net is Stochastic Cloud Clearing Neural Net (SCCNN), and is provided by Adam Milstein of MIT.

A.2 Iteration

CHART converges through several iterations of cloud clearing and refining geophysical state; CLIMCAPS does only a single cloud clearing.

A.3 Error estimation approach

CLIMCAPS error estimates are produced as part of the SVD retrieval. CHART uses a regression trained on ECMWF data to predict likely errors.

A.4 Quality Control approach

Both products include variables with names ending in "_qc" telling which values are safe to use (0: best quality; 1: good quality, 2: do not use) but the values are derived differently. CLIMCAPS declares each retrieval as successful or not based on whether all steps of the retrieval were able to execute successfully, so the values for almost all quantities and levels are identical. CHART uses thresholds based on the predicted error levels, applied individually to different retrieved parameters and atmospheric levels.

A.5 Retrieved quantities

After the core retrieval of temperature, water vapor, clouds, and ozone, CHART and CLIMCAPS add different additional retrievals.

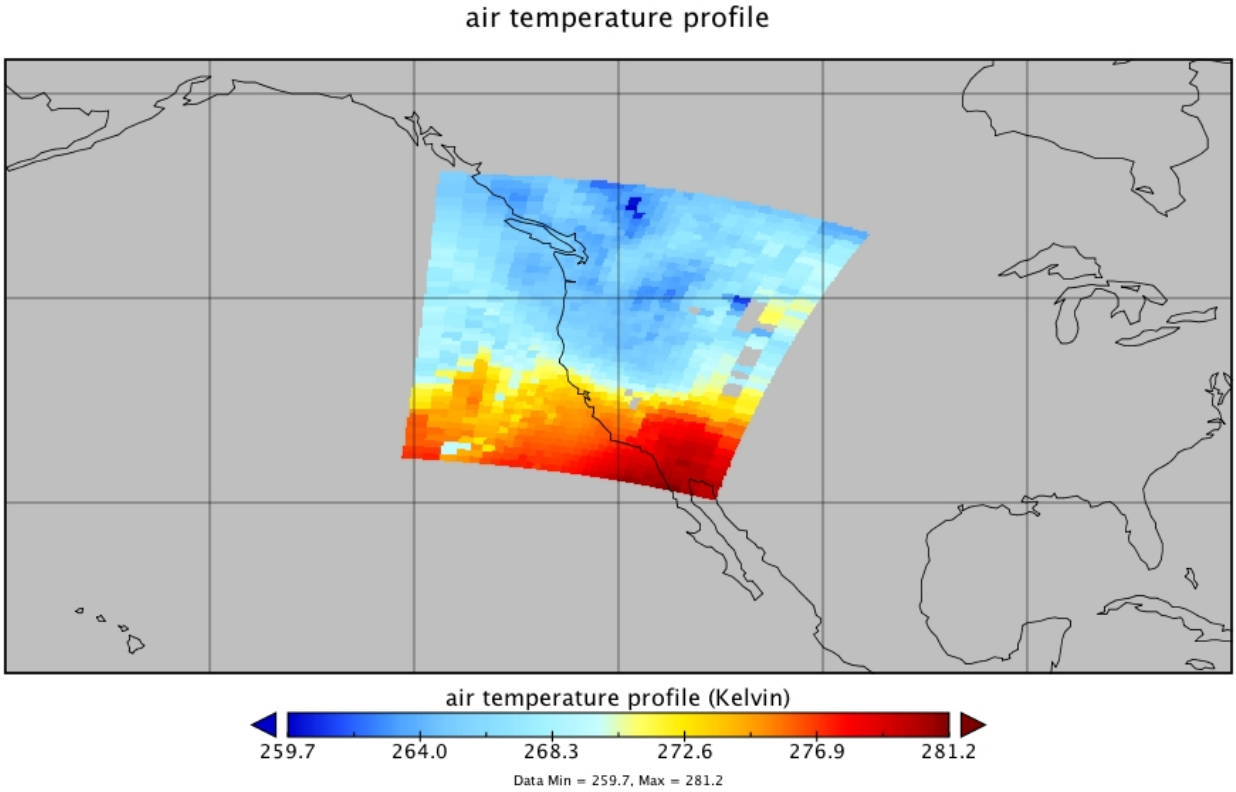
CHART has various Outgoing Longwave Radiation (OLR), independent per-FOV cloud pressure, and an infrared-based precipitation estimate.

CLIMCAPS retrieves these additional gases: HNO_3, SO_2, N_2O, and CO_2. For the v1 release, they are considered preliminary and only provided in the mol_lay or aux subgroups.

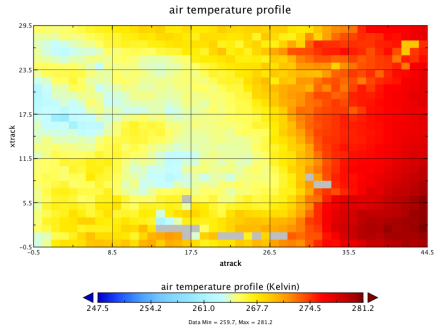
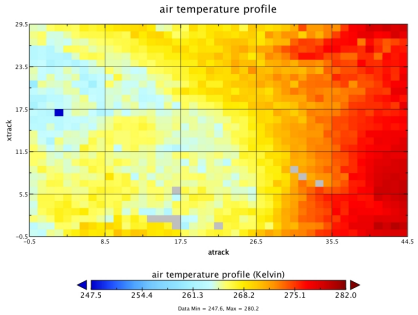
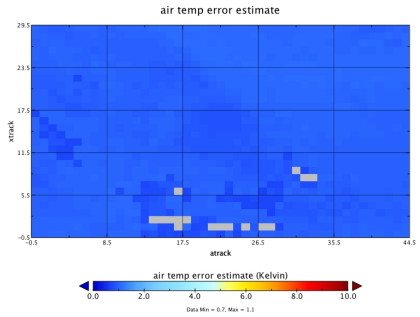
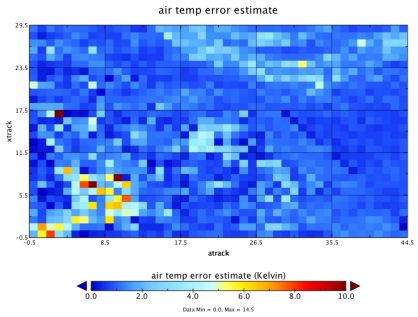
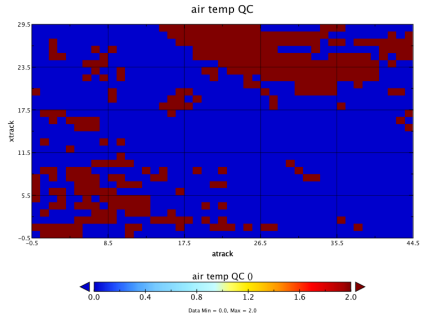
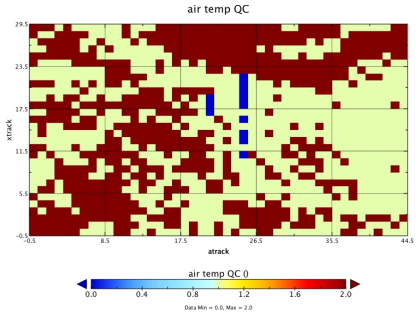
Appendix B: Sample images

These images for 2016-01-14 granule 101 (gran_id = 20160114T1005) were generated with Panoply.

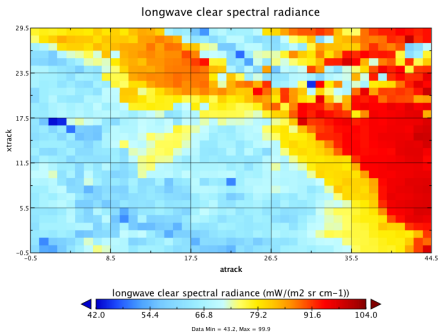
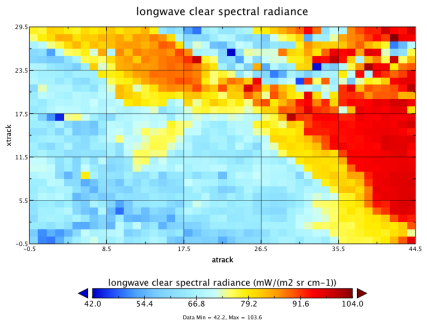
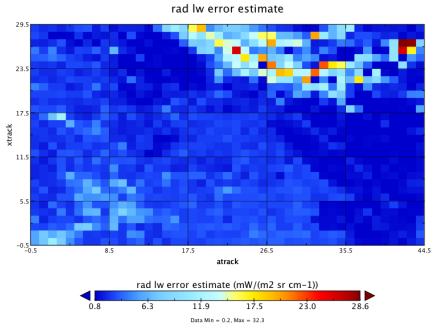
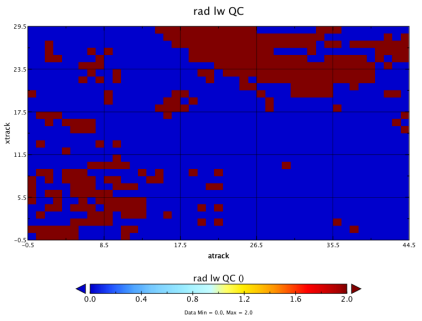
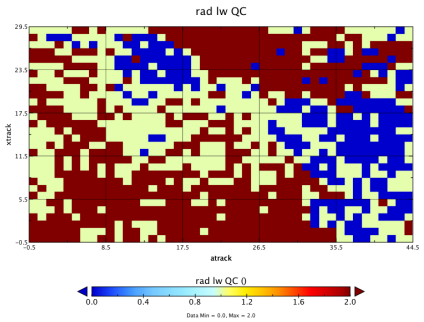
We show CLIMCAPS air_temp for level 87, which is 75400 Pa (= 754 hPa). This granule covers the western part of the US and the adjacent part of the Pacific Ocean at night. Some of the taller mountains bring the surface pressure below 75400 hPa, so no data is present for these FORs.



Next we look at this level of air_temp in a simple rectangular grid of atrack x xtrack. The Pacific Ocean is now at the top of each image and the Rocky Mountains near the bottom. This means we're actually looking out from inside the Earth. The table shows CLIMCAPS and CHART images for this level, with associated error estimates and QC.

	CLIMCAPS	CHART
air_temp		
air_temp_err		
air_temp_qc		

Looking at the cloud-cleared radiance product, LW channel 401, 898.75 cm^{-1}.

	CLIMCAPS	CHART
rad_lw		
rad_lw_err	**N/A (all filler)**	
rad_lw_qc		

Appendix C: Detailed file formats

These tables show all of the dimensions, global attributes, and variables in the four product types.

For clarity, some variable attributes are omitted, including long_name, standard_name, coverage_content_type, axis, valid_range, coordinates, 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, apply "ncdump -h" to any netCDF4 product file.

C.1 CLIMCAPS Retrieval product

SNPP L2 CLIMCAPS CRIMSS Interface Specification

Interface Specification Version 02.00.28
04-10-2019

Global Groups

Path	Description
/	Main science data
/mw	MW-Only data
/mol_lay	Layer molecule amounts
/aux	Internal product team data

Global Dimensions

Name	Size	Description
spatial	3	directions: x, y, z for satellite position and velocity
fov_poly	8	latitude/longitude points defining the polygon bounding an FOV (anticlockwise as viewed from above)
utc_tuple	8	parts of UTC time: year, month, day, hour, minute, second, millisec, microsec
attitude	3	roll, pitch, yaw
fov	9	Field-of-view dimension
atrack	45	along-track horizontal dimension
xtrack	30	cross-track horizontal dimension
air_pres	100	Fine atmospheric pressure levels starting from the top
air_pres_h2o	66	Fine atmospheric pressure levels starting from the top
air_pres_lay	100	Fine atmospheric pressure layers starting from the top
surf_wnum_ir	100	IR surface emissivity hinge points
surf_freq_mw	7	MW surface emissivity hinge points
cld_lay	2	Measured cloud layers: top, bottom
bnds_1d	2	Boundaries for 1-d fields like air_pres_lay: min, max

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 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	CrIS and 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_CLIMCAPS_RET_NSR	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.)

Name	Type	Size	Value	Description
				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.
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 latitude (decimal degrees_north) and longitude

Name	Type	Size	Value	Description
				(decimal degrees_east), in that order. Longitude values in the default case 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))'.
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.
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.

Name	Type	Size	Value	Description
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	v01.00.00	Version identifier of the data file or product as assigned by the data creator. For example, a new algorithm or methodology could result in a new product_version.
keywords_vocabulary	string	1	GCMD:GCMD Keywords	If you are using a controlled vocabulary for the words/phrases in your "keywords" attribute, this is the unique name or identifier of the vocabulary from which keywords are taken. If more than one keyword vocabulary is used, each may be presented with a prefix and a following comma, so that keywords may optionally be prefixed with the controlled vocabulary key. Example: 'GCMD:GCMD Keywords, CF:NetCDF COARDS Climate and Forecast Standard Names'.
platform	string	1	SUOMI-NPP > Suomi National Polar-orbiting Partnership	Name of the platform(s) that supported the sensor data used to create this data set or product. Platforms can be of any type, including satellite, ship, station, aircraft or other. Indicate controlled vocabulary used in platform_vocabulary.
platform_vocabulary	string	1	GCMD:GCMD Keywords	Controlled vocabulary for the names used in the "platform" attribute.
product_name_platform	string	1	SNPP	Platform name as it appears in product_name

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

Name	Type	Size	Value	Description
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-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	v02.00.29	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

Name	Type	Size	Value	Description
				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	Level-2 CLIMCAPS SNPP CrIMSS	a succinct description of what is in the dataset. (= ECS long name)
summary	string	1	The Level-2 CLIMCAPS product includes atmospheric state retrieval products from the CLIMCAPS algorithm for one six-minute interval. These include temperature and water vapor profiles as well as cloud and surface products and minor gases.	A paragraph describing the dataset, analogous to an abstract for a paper.
shortname	string	1	SNDRSNIML2CCPRETN	ECS Short Name
product_group	string	1	l2_crimss	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.

Name	Type	Size	Value	Description
contributor_name	string	1	Christopher D. Barnet\, STC; L. Larrabee Strow\, UMBC; 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; Forward Model PI; Microwave PI	The roles of any individuals or institutions that contributed to the creation of this data.

Global Variables

Name	Type	Dimensions	Description	Units	Ancillary Variables
obs_id	string	atrack, xtrack	unique earth view observation identifier: yyyymmddThhmm.aaExx. Includes gran_id plus 2-digit along-track index (01-45) and 2-digit cross-track index (01-30).		
fov_obs_id	string	atrack, xtrack, fov	unique earth view observation identifier for FOV: yyyymmddThhmm.aaExx.f . Includes gran_id plus 2-digit along-track index (01-45), 2-digit cross-track index (01-30), and 1-digit FOV number (1-9).		
obs_time_tai93	double	atrack, xtrack	earth view observation midtime for each FOV	seconds since 1993-01-01 00:00	bnds
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 FOR center	degrees_north	bnds
lat_geoid	float	atrack, xtrack	latitude of FOR center on the geoid (without terrain correction)	degrees_north	
fov_lat	float	atrack, xtrack, fov	latitude of FOV center	degrees_north	bnds
lon	float	atrack, xtrack	longitude of FOR center	degrees_east	bnds
lon_geoid	float	atrack, xtrack	longitude of FOR center on the geoid (without terrain correction)	degrees_east	
fov_lon	float	atrack, xtrack, fov	longitude of FOV center	degrees_east	bnds
land_frac	float	atrack, xtrack	land fraction over the FOR	unitless	
fov_land_frac	float	atrack, xtrack, fov	land fraction over the FOV	unitless	
surf_alt	float	atrack, xtrack	mean surface altitude wrt earth model over the FOR	m	

Name	Type	Dimensions	Description	Units	Ancillary Variables
fov_surf_alt	float	atrack, xtrack, fov	mean surface altitude wrt earth model over the FOV	m	
surf_alt_sdev	float	atrack, xtrack	standard deviation of surface altitude within the FOR	m	
fov_surf_alt_sdev	float	atrack, xtrack, fov	standard deviation of surface altitude within the FOV	m	
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	
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 of sun glint spot to the center of the spot. 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	

Name	Type	Dimensions	Description	Units	Ancillary Variables
sat_att	float	atrack, attitude	satellite attitude at scan_mid_time. An orthogonal triad. First element is angle about the +x (roll) ORB axis. +x axis is positively oriented in the direction of orbital flight. Second element is angle about +y (pitch) ORB axis. +y axis is oriented normal to the orbit plane with the positive sense opposite to that of the orbit's angular momentum vector H. Third element is angle about +z (yaw) axis. +z axis is positively oriented Earthward parallel to the satellite radius vector R from the spacecraft center of mass to the center of the Earth.	degree	
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	air temperature profile	Kelvin	err, qc
surf_air_temp	float32	atrack, xtrack	near-surface air temperature (~2 meters above surface)	Kelvin	err, qc
air_temp_dof	float32	atrack, xtrack	The trace of the averaging kernel matrix as a measure of the number of pieces of information about the air temperature profile provided by the physical retrieval step.	unitless	

Name	Type	Dimensions	Description	Units	Ancillary Variables
h2o_vap_tot	float32	atrack, xtrack	total precipitable water vapor	kg / m2	err, qc
spec_hum	float32	atrack, xtrack, air_pres_h2o	mass fraction of water vapor in moist air	unitless	err, qc
surf_spec_hum	float32	atrack, xtrack	Near-surface mass fraction of water vapor in moist air	unitless	err, qc
h2o_vap_dof	float32	atrack, xtrack	The trace of the averaging kernel matrix as a measure of the number of pieces of information about the water vapor profile provided by the physical retrieval step.	unitless	
rel_hum	float32	atrack, xtrack, air_pres_h2o	relative humidity over equilibrium phase	unitless	err, qc
surf_rel_hum	float32	atrack, xtrack	relative humidity near the surface over equilibrium phase	unitless	err, qc
spec_hum_sat_ice	float32	atrack, xtrack, air_pres_h2o	saturation specific humidity in equilibrium with ice	unitless	err, qc
surf_spec_hum_sat_ice	float32	atrack, xtrack	Near-surface saturation specific humidity in equilibrium with ice	unitless	err, qc
spec_hum_sat_liq	float32	atrack, xtrack, air_pres_h2o	saturation specific humidity in equilibrium with liquid water	unitless	err, qc
surf_spec_hum_sat_liq	float32	atrack, xtrack	Near-surface saturation specific humidity in equilibrium with liquid water	unitless	err, qc
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	err, qc
surf_gp_hgt	float32	atrack, xtrack	geopotential height at the surface	m	err, qc
o3_tot	float32	atrack, xtrack	Total column ozone. (Multiply by 4.670e5 to convert to Dobson Units from kg m^-2)	kg m-2	err, qc
o3_mmr	float32	atrack, xtrack, air_pres	ozone mass mixing ratio to moist air	unitless	err, qc
o3_dof	float32	atrack, xtrack	The trace of the averaging kernel matrix as a measure of the number of pieces of information about the ozone profile provided by the physical retrieval step.	unitless	

Name	Type	Dimensions	Description	Units	Ancillary Variables
co_mmr_midtrop	float32	atrack, xtrack	Carbon monoxide mass mixing ratio to moist air at 50000 Pa, near the peak of sensitivity	unitless	err, qc
co_dof	float32	atrack, xtrack	The trace of the averaging kernel matrix as a measure of the number of pieces of information about the carbon monoxide profile provided by the physical retrieval step.	unitless	
ch4_mmr_midtrop	float32	atrack, xtrack	Methane mass mixing ratio to moist air at 40000 Pa, near the peak of sensitivity	unitless	err, qc
ch4_dof	float32	atrack, xtrack	The trace of the averaging kernel matrix as a measure of the number of pieces of information about the methane profile provided by the physical retrieval step.	unitless	
co2_dof	float32	atrack, xtrack	The trace of the averaging kernel matrix as a measure of the number of pieces of information about the carbon dioxide profile provided by the physical retrieval step.	unitless	
n2o_dof	float32	atrack, xtrack	The trace of the averaging kernel matrix as a measure of the number of pieces of information about the nitrous oxide profile provided by the physical retrieval step.	unitless	
hno3_dof	float32	atrack, xtrack	The trace of the averaging kernel matrix as a measure of the number of pieces of information about the nitric acid profile provided by the physical retrieval step.	unitless	
so2_dof	float32	atrack, xtrack	The trace of the averaging kernel matrix as a measure of the number of pieces of information about the sulfur dioxide profile provided by the physical retrieval step.	unitless	
mw_cld_phase	int16	atrack, xtrack, air_pres_lay	Cloud Ice/Water flag from microwave. 0 for liquid clouds or no clouds; 1 for ice clouds.		
h2o_liq_tot	float32	atrack, xtrack	total column cloud liquid water	kg m-2	err, qc
h2o_liq_mol_lay	float32	atrack, xtrack, air_pres_lay	cloud liquid water layer total	unitless	err, qc
surf_temp	float32	atrack, xtrack	radiative temperature of the surface	Kelvin	err, qc
surf_temp_dof	float32	atrack, xtrack	The trace of the averaging kernel matrix as a measure of the number of pieces of information about the surface skin temperature provided by the physical retrieval step.	unitless	
surf_ir_emis	float32	atrack, xtrack, surf_wnum_ir	infrared surface emissivity	unitless	err, qc

Name	Type	Dimensions	Description	Units	Ancillary Variables
surf_ir_refl	float32	atrack, xtrack, surf_wnum_ir	infrared surface reflectivity	unitless	qc
surf_ir_wnum_cnt	int16	atrack, xtrack	Number of infrared surface emissivity frequencies	unitless	
surf_ir_wnum	float32	atrack, xtrack, surf_wnum_ir	Surface infrared emissivity frequencies (hinge points)	cm-1	
surf_mw_emis	float32	atrack, xtrack, surf_freq_mw	Microwave surface emissivity	unitless	err, qc
cld_frac	float32	atrack, xtrack, fov, cld_lay	effective cloud fraction	unitless	err, qc
cld_top_pres	float32	atrack, xtrack, fov, cld_lay	cloud top pressure in order of increasing pressure	Pa	err, qc
cld_top_temp	float32	atrack, xtrack, fov, cld_lay	cloud top temperature	Kelvin	err, qc
num_cld	byte	atrack, xtrack, fov	Number of cloud layers with nonzero cloud fraction	unitless	
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
tpause_temp	float32	atrack, xtrack	tropopause temperature, where tropopause is determined according to the WMO definition	Kelvin	qc
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_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	
air_pres_lay_nsurf	int16	atrack, xtrack	Index in air_pres_lay of the layer at the surface. Values for layers beyond this are invalid, representing data below the Earth's surface.	unitless	
air_pres	float32	air_pres	pressure levels	Pa	
air_pres_h2o	float32	air_pres_h2o	H2O vapor pressure levels	Pa	

Name	Type	Dimensions	Description	Units	Ancillary Variables
air_pres_lay	float32	air_pres_lay	pressure at the middle of each layer	Pa	bnds
cld_lay_lbl	string	cld_lay	Cloud layer {top, bottom}		
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);		
surf_freq_mw	float32	surf_freq_mw	Microwave surface emissivity frequencies (hinge points)	Hz	

aux Variables

Name	Type	Dimensions	Description	Units	Ancillary Variables
co2_vmr	float32	atrack, xtrack, air_pres	carbon dioxide volume mixing ratio	unitless	err, qc
for_cld_frac_tot	float32	atrack, xtrack	Field-Of-Regard effective cloud fraction summed over all cloud layers	unitless	err, qc
for_cld_top_pres_tot	float32	atrack, xtrack	Field-Of-Regard weighted cloud top pressure	Pa	err, qc
for_cld_frac_2lay	float32	atrack, xtrack, cld_lay	Effective cloud fraction assuming 2 common cloud layers over the whole Field-Of-Regard	unitless	err, qc
for_cld_top_pres_2lay	float32	atrack, xtrack, cld_lay	Cloud top pressure assuming 2 common cloud layers over the whole Field-of-Regard	Pa	err, qc
clim_o3_mol_lay	float32	atrack, xtrack, air_pres_lay	Ozone column density on 100 layers from the climatology first guess	molecules / m2	
clim_surf_ir_emis	float32	atrack, xtrack, surf_wnum_ir	Infrared surface emissivity from the climatology first guess	unitless	
clim_surf_ir_refl	float32	atrack, xtrack, surf_wnum_ir	infrared surface reflectivity from the climatology first guess	unitless	
clim_surf_ir_wnum_cnt	int16	atrack, xtrack	Number of infrared surface emissivity frequencies for the climatology first guess	unitless	
clim_surf_ir_wnum	float32	atrack, xtrack, surf_wnum_ir	Surface infrared emissivity frequencies (hinge points) for the climatology first guess	cm-1	
clim_co2_mmr	float32	atrack, xtrack	Assumed carbon dioxide concentration	unitless	
prior_surf_pres	float32	atrack, xtrack	surface pressure from forecast	Pa	

Name	Type	Dimensions	Description	Units	Ancillary Variables
prior_sea_lev_pres	float32	atrack, xtrack	sea level surface pressure from forecast	Pa	
idprof	string	atrack, xtrack	profile ID		
etarej	float32	atrack, xtrack	cloud clearing residual used f/ rej at iteration = ieta_rej	unitless	
cldfrc_tot	float32	atrack, xtrack	Total cloud fraction over FOR	unitless	
cldfrc_500	float32	atrack, xtrack	Total cloud fraction over FOR below 500 hPa	unitless	
ampl_eta	float32	atrack, xtrack	cloud clearing noise amplification factor	unitless	
ir_x	float32	atrack, xtrack	RMS(rad(IR.ret)-radobs()) for AMSU channels	unitless	
bt2	float32	atrack, xtrack	RMS(T(p) f/IR.ret - T(p) f/ AMSU.ret)	unitless	
qualsurf	float32	atrack, xtrack	qualsurf		
qualtemp	float32	atrack, xtrack	qualtemp		
softcode	float32	atrack, xtrack	software rejection code		
aeff_1	float32	atrack, xtrack	A_eff(1st eta step)	unitless	
aeff_end	float32	atrack, xtrack	A_eff(last eta step)	unitless	
a0_cloud	float32	atrack, xtrack	intercept of alpha(1)=f(alpha(2)) fitting	unitless	
totliqwat	float32	atrack, xtrack	total liquid water (MW)	unitless	
fg_air_temp	float32	atrack, xtrack, air_pres	air temperature profile from the MERRA2 (see Section 3.11, GFS was accidentally used as the first guess) first guess	Kelvin	
fg_h2o_vap_mol_lay	float32	atrack, xtrack, air_pres_lay	water vapor layer totals from the MERRA2 (see Section 3.11, GFS was accidentally used as the first guess) first guess	molecules / m2	
fg_surf_air_temp	float32	atrack, xtrack	near-surface air temperature (~2 meters above surface) from the MERRA2 (see Section 3.11, GFS was accidentally used as the first guess) first guess	Kelvin	
fg_surf_temp	float32	atrack, xtrack	radiative temperature of the surface from the MERRA2 (see Section 3.11, GFS was accidentally used as the first guess) first guess	Kelvin	
chi2_temp	float32	atrack, xtrack	Temperature profile chi^2 of alpha(1)=f(alpha(2)) fitting	unitless	
chi2_h2o	float32	atrack, xtrack	Water vapor chi^2 of alpha(1)=f(alpha(2)) fitting	unitless	
chi2_o3	float32	atrack, xtrack	Ozone chi^2 of alpha(1)=f(alpha(2)) fitting	unitless	
chi2_ch4	float32	atrack, xtrack	Methane chi^2 of alpha(1)=f(alpha(2)) fitting	unitless	
chi2_co	float32	atrack, xtrack	Carbon monoxide chi^2 of alpha(1)=f(alpha(2)) fitting	unitless	

Name	Type	Dimensions	Description	Units	Ancillary Variables
chi2_co2	float32	atrack, xtrack	Carbon dioxide chi^2 of alpha(1)=f(alpha(2)) fitting	unitless	
chi2_n2o	float32	atrack, xtrack	Nitrous oxide chi^2 of alpha(1)=f(alpha(2)) fitting	unitless	
chi2_hno3	float32	atrack, xtrack	Nitric acid chi^2 of alpha(1)=f(alpha(2)) fitting	unitless	
chi2_so2	float32	atrack, xtrack	Sulfur dioxide chi^2 of alpha(1)=f(alpha(2)) fitting	unitless	
ispare_2	ushort	atrack, xtrack	bit flags for rejection of retrieval steps. Details are algorithm-specific.		
bad_phys_ret	ubyte	atrack, xtrack	Flag for bad physical retrieval.		
bad_mw_ret	ubyte	atrack, xtrack	Flag for bad microwave retrieval.		
bad_reg_ret	ubyte	atrack, xtrack	Flag for bad regression retrieval.		
pbest	float32	atrack, xtrack	Maximum value of pressure for which temperature is Quality = 0	Pa	
pgood	float32	atrack, xtrack	Maximum value of pressure for which temperature is Quality = 0 or 1	Pa	
nbest	int16	atrack, xtrack	level index of highest pressure (i.e. lowest altitude) for which Quality = 0. A value of 0 indicates that no part of the profile passes the test.	unitless	
ngood	int16	atrack, xtrack	level index of highest pressure (i.e. lowest altitude) for which Quality = 0 or 1. A value of 0 indicates that no part of the profile passes the test.	unitless	

mol_lay Variables

Name	Type	Dimensions	Description	Units	Ancillary Variables
h2o_vap_mol_lay	float32	atrack, xtrack, air_pres_lay	Water vapor layer total on 100 layers	molecules / m2	err, qc
o3_mol_lay	float32	atrack, xtrack, air_pres_lay	Ozone layer total on 100 layers	molecules / m2	err, qc
co_mol_lay	float32	atrack, xtrack, air_pres_lay	Carbon monoxide layer total on 100 layers	molecules / m2	err, qc
ch4_mol_lay	float32	atrack, xtrack, air_pres_lay	Methane layer total on 100 layers	molecules / m2	err, qc
co2_mol_lay	float32	atrack, xtrack, air_pres_lay	carbon dioxide layer total on 100 layers	molecules / m2	err, qc
n2o_mol_lay	float32	atrack, xtrack, air_pres_lay	nitrous oxide layer total on 100 layers	molecules / m2	err, qc
hno3_mol_lay	float32	atrack, xtrack, air_pres_lay	nitric acid layer total on 100 layers	molecules / m2	err, qc
so2_mol_lay	float32	atrack, xtrack, air_pres_lay	sulfur dioxide layer total on 100 layers	molecules / m2	err, qc

mw Variables

Name	Type	Dimensions	Description	Units	Ancillary Variables
mw_air_temp	float32	atrack, xtrack, air_pres	air temperature profile from the MW-only step	Kelvin	err, qc
mw_surf_air_temp	float32	atrack, xtrack	Near-surface air temperature (~2 meters above surface) from the MW-only step	Kelvin	err, qc
mw_surf_temp	float32	atrack, xtrack	Radiative temperature of the surface from the MW-only step	Kelvin	err, qc
mw_h2o_vap_tot	float32	atrack, xtrack	Total precipitable water vapor from the MW-only step	kg / m2	err, qc
mw_h2o_vap_mol_lay	float32	atrack, xtrack, air_pres_lay	Water vapor layer total from the MW-only step	molecules / m2	err, qc
mw_spec_hum	float32	atrack, xtrack, air_pres_h2o	mass fraction of water vapor in moist air from the MW-Only step	unitless	err, qc
mw_surf_spec_hum	float32	atrack, xtrack	Near-surface mass fraction of water vapor in moist air from the MW-Only step	unitless	err, qc

C.2 CHART Retrieval product

SNPP L2 CHART CRIMSS Interface Specification

Interface Specification Version 02.00.28
04-10-2019

Global Groups

Path	Description
/	Main science data
/mw	MW-Only data
/mol_lay	Layer molecule amounts
/aux	Internal product team data

Global Dimensions

Name	Size	Description
spatial	3	directions: x, y, z for satellite position and velocity
fov_poly	8	latitude/longitude points defining the polygon bounding an FOV (anticlockwise as viewed from above)
utc_tuple	8	parts of UTC time: year, month, day, hour, minute, second, millisec, microsec
attitude	3	roll, pitch, yaw
fov	9	Field-of-view dimension
atrack	45	along-track horizontal dimension
xtrack	30	cross-track horizontal dimension
air_pres	100	Fine atmospheric pressure levels starting from the top
air_pres_h2o	66	Fine atmospheric pressure levels starting from the top
air_pres_lay	100	Fine atmospheric pressure layers starting from the top
surf_wnum_ir	100	IR surface emissivity hinge points
surf_freq_mw	7	MW surface emissivity hinge points
olr_wnum	16	frequency bands for spectrally decomposed outgoing longwave radiation
cld_lay	2	Measured cloud layers: top, bottom
bnds_1d	2	Boundaries for 1-d fields like air_pres_lay: min, max

Global Attributes

Name	Type	Size	Value	Description
keywords	string	1	ATMOSPHERE > ATMOSPHERIC TEMPERATURE > UPPER	A comma-separated list of key words and/or phrases. Keywords may be common words or phrases, terms from a controlled vocabulary

Name	Type	Size	Value	Description
			AIR TEMPERATURE\, ATMOSPHERE > ATMOSPHERIC WATER VAPOR > WATER VAPOR	(GCMD is often used), or URIs for terms from a controlled vocabulary (see also "keywords_vocabulary" attribute).
Conventions	string	1	CF-1.6\, ACDD-1.3	A comma-separated list of the conventions that are followed by the dataset.
history	string	1		Provides an audit trail for modifications to the original data. This attribute is also in the NetCDF Users Guide: 'This is a character array with a line for each invocation of a program that has modified the dataset. Well-behaved generic netCDF applications should append a line containing: date, time of day, user name, program name and command arguments.' To include a more complete description you can append a reference to an ISO Lineage entity; see NOAA EDM ISO Lineage guidance.
source	string	1	CrIS and 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_CHART_RET_NSR	Product name as it appears in product_name (L1A, L1B, L2, SNO_AIRS_CrIS)
comment	string	1		Miscellaneous information about the data or methods used to produce it. Can be empty.
acknowledgment	string	1	Support for this research was provided by NASA.	A place to acknowledge various types of support for the project that produced this data.
license	string	1	Limited to Sounder SIPS affiliates	Provide the URL to a standard or specific license, enter "Freely Distributed" or "None", or describe any restrictions to data access and distribution in free text.
standard_name_vocabulary	string	1	CF Standard Name Table v28	The name and version of the controlled vocabulary from which variable standard names are taken. (Values for any standard_name attribute must come from the CF Standard Names vocabulary for the data file or product to comply with CF.) Example: 'CF Standard Name Table v27'.
date_created	string	1	Unassigned	The date on which this version of the data was created. (Modification of values implies a new version, hence this would be assigned the date of the most recent values modification.) Metadata changes are not considered when assigning the date_created. The ISO 8601:2004 extended date format is recommended, as described in the Attribute Content Guidance section.

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

Name	Type	Size	Value	Description
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.
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.

Name	Type	Size	Value	Description
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	v01.00.00	Version identifier of the data file or product as assigned by the data creator. For example, a new algorithm or methodology could result in a new product_version.
keywords_vocabulary	string	1	GCMD:GCMD Keywords	If you are using a controlled vocabulary for the words/phrases in your "keywords" attribute, this is the unique name or identifier of the vocabulary from which keywords are taken. If more than one keyword vocabulary is used, each may be presented with a prefix and a following comma, so that keywords may optionally be prefixed with the controlled vocabulary key. Example: 'GCMD:GCMD Keywords, CF:NetCDF COARDS Climate and Forecast Standard Names'.
platform	string	1	SUOMI-NPP > Suomi National Polar-orbiting Partnership	Name of the platform(s) that supported the sensor data used to create this data set or product. Platforms can be of any type, including satellite, ship, station, aircraft or other. Indicate controlled vocabulary used in platform_vocabulary.
platform_vocabulary	string	1	GCMD:GCMD Keywords	Controlled vocabulary for the names used in the "platform" attribute.
product_name_platform	string	1	SNPP	Platform name as it appears in product_name
instrument	string	1	CRIMSS > Cross-track Infrared and Advanced Technology Microwave Sounders\, CrIS > Cross-track Infrared 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.

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

Name	Type	Size	Value	Description
				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	v02.00.29	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

Name	Type	Size	Value	Description
				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	Level-2 CHART SNPP CrIMSS	a succinct description of what is in the dataset. (= ECS long name)
summary	string	1	The Level-2 CHART product includes atmospheric state retrieval products from the CHART algorithm for one six-minute interval. These include temperature and water vapor profiles as well as cloud and surface products and minor gases.	A paragraph describing the dataset, analogous to an abstract for a paper.
shortname	string	1	SNDRSNIML2CHTRETN	ECS Short Name
product_group	string	1	l2_crimss	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	Joel Susskind\, NASA GSFC; William J. Blackwell\, MIT; L. Larrabee Strow\, UMBC; Philip W. Rosenkranz\, MIT	The names of any individuals or institutions that contributed to the creation of this data.

Name	Type	Size	Value	Description
contributor_role	string	1	Retrieval PI; Neural Network PI; Forward Model PI; Microwave PI	The roles of any individuals or institutions that contributed to the creation of this data.

Global Variables

Name	Type	Dimensions	Description	Units	Ancillary Variables
obs_id	string	atrack, xtrack	unique earth view observation identifier: yyyymmddThhmm.aaExx. Includes gran_id plus 2-digit along-track index (01-45) and 2-digit cross-track index (01-30).		
fov_obs_id	string	atrack, xtrack, fov	unique earth view observation identifier for FOV: yyyymmddThhmm.aaExx.f . Includes gran_id plus 2-digit along-track index (01-45), 2-digit cross-track index (01-30), and 1-digit FOV number (1-9).		
obs_time_tai93	double	atrack, xtrack	earth view observation midtime for each FOV	seconds since 1993-01-01 00:00	bnds
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 FOR center	degrees_north	bnds
lat_geoid	float	atrack, xtrack	latitude of FOR center on the geoid (without terrain correction)	degrees_north	
fov_lat	float	atrack, xtrack, fov	latitude of FOV center	degrees_north	bnds
lon	float	atrack, xtrack	longitude of FOR center	degrees_east	bnds
lon_geoid	float	atrack, xtrack	longitude of FOR center on the geoid (without terrain correction)	degrees_east	
fov_lon	float	atrack, xtrack, fov	longitude of FOV center	degrees_east	bnds
land_frac	float	atrack, xtrack	land fraction over the FOR	unitless	
fov_land_frac	float	atrack, xtrack, fov	land fraction over the FOV	unitless	
surf_alt	float	atrack, xtrack	mean surface altitude wrt earth model over the FOR	m	
fov_surf_alt	float	atrack, xtrack, fov	mean surface altitude wrt earth model over the FOV	m	
surf_alt_sdev	float	atrack, xtrack	standard deviation of surface altitude within the FOR	m	

Name	Type	Dimensions	Description	Units	Ancillary Variables
fov_surf_alt_sdev	float	atrack, xtrack, fov	standard deviation of surface altitude within the FOV	m	
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	
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 of sun glint spot to the center of the spot. 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	degree	

Name	Type	Dimensions	Description	Units	Ancillary Variables
			positively oriented 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	air temperature profile	Kelvin	err, qc
surf_air_temp	float32	atrack, xtrack	near-surface air temperature (~2 meters above surface)	Kelvin	err, qc
air_temp_dof	float32	atrack, xtrack	The trace of the averaging kernel matrix as a measure of the number of pieces of information about the air temperature profile provided by the physical retrieval step.	unitless	
h2o_vap_tot	float32	atrack, xtrack	total precipitable water vapor	kg / m2	err, qc
spec_hum	float32	atrack, xtrack, air_pres_h2o	mass fraction of water vapor in moist air	unitless	err, qc

Name	Type	Dimensions	Description	Units	Ancillary Variables
surf_spec_hum	float32	atrack, xtrack	Near-surface mass fraction of water vapor in moist air	unitless	err, qc
h2o_vap_dof	float32	atrack, xtrack	The trace of the averaging kernel matrix as a measure of the number of pieces of information about the water vapor profile provided by the physical retrieval step.	unitless	
rel_hum	float32	atrack, xtrack, air_pres_h2o	relative humidity over equilibrium phase	unitless	err, qc
surf_rel_hum	float32	atrack, xtrack	relative humidity near the surface over equilibrium phase	unitless	err, qc
spec_hum_sat_ice	float32	atrack, xtrack, air_pres_h2o	saturation specific humidity in equilibrium with ice	unitless	err, qc
surf_spec_hum_sat_ice	float32	atrack, xtrack	Near-surface saturation specific humidity in equilibrium with ice	unitless	err, qc
spec_hum_sat_liq	float32	atrack, xtrack, air_pres_h2o	saturation specific humidity in equilibrium with liquid water	unitless	err, qc
surf_spec_hum_sat_liq	float32	atrack, xtrack	Near-surface saturation specific humidity in equilibrium with liquid water	unitless	err, qc
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	err, qc
surf_gp_hgt	float32	atrack, xtrack	geopotential height at the surface	m	err, qc
o3_tot	float32	atrack, xtrack	Total column ozone. (Multiply by 4.670e5 to convert to Dobson Units from kg m^-2)	kg m-2	err, qc
o3_mmr	float32	atrack, xtrack, air_pres	ozone mass mixing ratio to moist air	unitless	err, qc
o3_dof	float32	atrack, xtrack	The trace of the averaging kernel matrix as a measure of the number of pieces of information about the ozone profile provided by the physical retrieval step.	unitless	
co_mmr_midtrop	float32	atrack, xtrack	Carbon monoxide mass mixing ratio to moist air at 50000 Pa, near the peak of sensitivity	unitless	err, qc
co_dof	float32	atrack, xtrack	The trace of the averaging kernel matrix as a measure of the number of pieces of information about the carbon monoxide profile provided by the physical retrieval step.	unitless	

Name	Type	Dimensions	Description	Units	Ancillary Variables
ch4_mmr_midtrop	float32	atrack, xtrack	Methane mass mixing ratio to moist air at 40000 Pa, near the peak of sensitivity	unitless	err, qc
ch4_dof	float32	atrack, xtrack	The trace of the averaging kernel matrix as a measure of the number of pieces of information about the methane profile provided by the physical retrieval step.	unitless	
mw_cld_phase	int16	atrack, xtrack, air_pres_lay	Cloud Ice/Water flag from microwave. 0 for liquid clouds or no clouds; 1 for ice clouds.		
h2o_liq_tot	float32	atrack, xtrack	total column cloud liquid water	kg m-2	err, qc
h2o_liq_mol_lay	float32	atrack, xtrack, air_pres_lay	cloud liquid water layer total	unitless	err, qc
surf_temp	float32	atrack, xtrack	radiative temperature of the surface	Kelvin	err, qc
surf_temp_dof	float32	atrack, xtrack	The trace of the averaging kernel matrix as a measure of the number of pieces of information about the surface skin temperature provided by the physical retrieval step.	unitless	
surf_ir_emis	float32	atrack, xtrack, surf_wnum_ir	infrared surface emissivity	unitless	err, qc
surf_ir_refl	float32	atrack, xtrack, surf_wnum_ir	infrared surface reflectivity	unitless	qc
surf_ir_wnum_cnt	int16	atrack, xtrack	Number of infrared surface emissivity frequencies	unitless	
surf_ir_wnum	float32	atrack, xtrack, surf_wnum_ir	Surface infrared emissivity frequencies (hinge points)	cm-1	
surf_mw_emis	float32	atrack, xtrack, surf_freq_mw	Microwave surface emissivity	unitless	err, qc
cld_frac	float32	atrack, xtrack, fov, cld_lay	effective cloud fraction	unitless	err, qc
cld_top_pres	float32	atrack, xtrack, fov, cld_lay	cloud top pressure in order of increasing pressure	Pa	err, qc

Name	Type	Dimensions	Description	Units	Ancillary Variables
cld_top_temp	float32	atrack, xtrack, fov, cld_lay	cloud top temperature	Kelvin	err, qc
num_cld	byte	atrack, xtrack, fov	Number of cloud layers with nonzero cloud fraction	unitless	
olr	float32	atrack, xtrack, fov	outgoing longwave radiation flux integrated over 2 to 2800 cm-1	W / m2	err, qc
olr_band	float32	atrack, xtrack, fov, olr_wnum	outgoing longwave radiation flux per band	W / m2	err, qc
olr_clr	float32	atrack, xtrack	clear-sky outgoing longwave radiation flux integrated over 2 to 2800 cm-1	W / m2	err, qc
olr_clr_band	float32	atrack, xtrack, olr_wnum	clear-sky outgoing longwave radiation flux per band	W / m2	err, qc
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
tpause_temp	float32	atrack, xtrack	tropopause temperature, where tropopause is determined according to the WMO definition	Kelvin	qc
ir_precip_est_24hr	float32	atrack, xtrack, fov	The thickness of a layer of liquid water equivalent to the estimted preciptitation over 24 hours.	m	err, qc
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_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	
air_pres_lay_nsurf	int16	atrack, xtrack	Index in air_pres_lay of the layer at the surface. Values for layers beyond this are invalid, representing data below the Earth's surface.	unitless	
air_pres	float32	air_pres	pressure levels	Pa	
air_pres_h2o	float32	air_pres_h2o	H2O vapor pressure levels	Pa	
air_pres_lay	float32	air_pres_lay	pressure at the middle of each layer	Pa	bnds
cld_lay_lbl	string	cld_lay	Cloud layer {top, bottom}		
olr_wnum	float32	olr_wnum	OLR frequency band centers	cm-1	bnds

Name	Type	Dimensions	Description	Units	Ancillary Variables
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);		
surf_freq_mw	float32	surf_freq_mw	Microwave surface emissivity frequencies (hinge points)	Hz	

aux Variables

Name	Type	Dimensions	Description	Units	Ancillary Variables
for_cld_frac_tot	float32	atrack, xtrack	Field-Of-Regard effective cloud fraction summed over all cloud layers	unitless	err, qc
for_cld_top_pres_tot	float32	atrack, xtrack	Field-Of-Regard weighted cloud top pressure	Pa	err, qc
for_cld_frac_2lay	float32	atrack, xtrack, cld_lay	Effective cloud fraction assuming 2 common cloud layers over the whole Field-Of-Regard	unitless	err, qc
for_cld_top_pres_2lay	float32	atrack, xtrack, cld_lay	Cloud top pressure assuming 2 common cloud layers over the whole Field-of-Regard	Pa	err, qc
clim_o3_mol_lay	float32	atrack, xtrack, air_pres_lay	Ozone column density on 100 layers from the climatology first guess	molecules / m2	
clim_surf_ir_emis	float32	atrack, xtrack, surf_wnum_ir	Infrared surface emissivity from the climatology first guess	unitless	
clim_surf_ir_refl	float32	atrack, xtrack, surf_wnum_ir	infrared surface reflectivity from the climatology first guess	unitless	
clim_surf_ir_wnum_cnt	int16	atrack, xtrack	Number of infrared surface emissivity frequencies for the climatology first guess	unitless	
clim_surf_ir_wnum	float32	atrack, xtrack, surf_wnum_ir	Surface infrared emissivity frequencies (hinge points) for the climatology first guess	cm-1	
clim_co2_mmr	float32	atrack, xtrack	Assumed carbon dioxide concentration	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	
idprof	string	atrack, xtrack	profile ID		
etarej	float32	atrack, xtrack	cloud clearing residual used f/ rej at iteration = ieta_rej	unitless	
cldfrc_tot	float32	atrack, xtrack	Total cloud fraction over FOR	unitless	

Name	Type	Dimensions	Description	Units	Ancillary Variables
cldfrc_500	float32	atrack, xtrack	Total cloud fraction over FOR below 500 hPa	unitless	
ampl_eta	float32	atrack, xtrack	cloud clearing noise amplification factor	unitless	
ir_x	float32	atrack, xtrack	RMS(rad(IR.ret)-radobs()) for AMSU channels	unitless	
bt2	float32	atrack, xtrack	RMS(T(p) f/IR.ret - T(p) f/ AMSU.ret)	unitless	
qualsurf	float32	atrack, xtrack	qualsurf		
qualtemp	float32	atrack, xtrack	qualtemp		
softcode	float32	atrack, xtrack	software rejection code		
aeff_1	float32	atrack, xtrack	A_eff(1st eta step)	unitless	
aeff_end	float32	atrack, xtrack	A_eff(last eta step)	unitless	
a0_cloud	float32	atrack, xtrack	intercept of alpha(1)=f(alpha(2)) fitting	unitless	
chi2_cloud	float32	atrack, xtrack	chi^2 of alpha(1)=f(alpha(2)) fitting	unitless	
fzeta	float32	atrack, xtrack	fzeta_effect	unitless	
rzeta	float32	atrack, xtrack	rzeta_effect	unitless	
bias_ccdiff	float32	atrack, xtrack	BIAS(-Rccr) in 800-900 cm-1 region	unitless	
lambda_max	float32	atrack, xtrack	lambda(2,iter_eta) = U^TS^TN^{-1}SU	unitless	
totliqwat	float32	atrack, xtrack	total liquid water (MW)	unitless	
etarejfinal	float32	atrack, xtrack	etarejfinal	unitless	
gtest_a	float32	atrack, xtrack	gtest_a	unitless	
tsurfnoaa	float32	atrack, xtrack	tsurfnoaa	unitless	
noaadifftest	float32	atrack, xtrack	noaadifftest	unitless	
mitdifftest	float32	atrack, xtrack	T(p)final - T(p)startup	unitless	
mitsurftest	float32	atrack, xtrack	abs(Tsurfret-Tsurfstartup)	unitless	
nn_air_temp	float32	atrack, xtrack, air_pres	air temperature profile from the neural net first guess	Kelvin	
nn_h2o_vap_mol_lay	float32	atrack, xtrack, air_pres_lay	water vapor layer totals from the neural net first guess	molecules / m2	
nn_surf_air_temp	float32	atrack, xtrack	near-surface air temperature (~2 meters above surface) from the neural net first guess	Kelvin	
nn_surf_temp	float32	atrack, xtrack	radiative temperature of the surface from the neural net first guess	Kelvin	

Name	Type	Dimensions	Description	Units	Ancillary Variables
nn_olr	float32	atrack, xtrack	outgoing longwave radiation flux integrated over 2 to 2800 cm-1 from the neural net first guess. Suspect because no cloud retrieval contributed.	Watts/meter2	
nn_clrolr	float32	atrack, xtrack	clear-sky outgoing longwave radiation flux integrated over 2 to 2800 cm-1 from the neural net first guess	Watts/meter2	
ispare_2	ushort	atrack, xtrack	bit flags for rejection of retrieval steps. Details are algorithm-specific.		
bad_phys_ret	ubyte	atrack, xtrack	Flag for bad physical retrieval.		
bad_mw_ret	ubyte	atrack, xtrack	Flag for bad microwave retrieval.		
bad_sccnn_ret	ubyte	atrack, xtrack	Flag for bad SCCNN neural net retrieval.		
pbest	float32	atrack, xtrack	Maximum value of pressure for which temperature is Quality = 0	Pa	
pgood	float32	atrack, xtrack	Maximum value of pressure for which temperature is Quality = 0 or 1	Pa	
nbest	int16	atrack, xtrack	level index of highest pressure (i.e. lowest altitude) for which Quality = 0. A value of 0 indicates that no part of the profile passes the test.	unitless	
ngood	int16	atrack, xtrack	level index of highest pressure (i.e. lowest altitude) for which Quality = 0 or 1. A value of 0 indicates that no part of the profile passes the test.	unitless	

mol_lay Variables

Name	Type	Dimensions	Description	Units	Ancillary Variables
h2o_vap_mol_lay	float32	atrack, xtrack, air_pres_lay	Water vapor layer total on 100 layers	molecules / m2	err, qc
o3_mol_lay	float32	atrack, xtrack, air_pres_lay	Ozone layer total on 100 layers	molecules / m2	err, qc
co_mol_lay	float32	atrack, xtrack, air_pres_lay	Carbon monoxide layer total on 100 layers	molecules / m2	err, qc
ch4_mol_lay	float32	atrack, xtrack, air_pres_lay	Methane layer total on 100 layers	molecules / m2	err, qc

mw Variables

Name	Type	Dimensions	Description	Units	Ancillary Variables
mw_air_temp	float32	atrack, xtrack, air_pres	air temperature profile from the MW-only step	Kelvin	err, qc

Name	Type	Dimensions	Description	Units	Ancillary Variables
mw_surf_air_temp	float32	atrack, xtrack	Near-surface air temperature (~2 meters above surface) from the MW-only step	Kelvin	err, qc
mw_surf_temp	float32	atrack, xtrack	Radiative temperature of the surface from the MW-only step	Kelvin	err, qc
mw_h2o_vap_tot	float32	atrack, xtrack	Total precipitable water vapor from the MW-only step	kg / m2	err, qc
mw_h2o_vap_mol_lay	float32	atrack, xtrack, air_pres_lay	Water vapor layer total from the MW-only step	molecules / m2	err, qc
mw_spec_hum	float32	atrack, xtrack, air_pres_h2o	mass fraction of water vapor in moist air from the MW-Only step	unitless	err, qc
mw_surf_spec_hum	float32	atrack, xtrack	Near-surface mass fraction of water vapor in moist air from the MW-Only step	unitless	err, qc

C.3 CLIMCAPS Cloud-Cleared Radiance product

SNPP L2 CLIMCAPS CRIMSS CC NSR Interface Specification

Interface Specification Version 02.00.28
04-10-2019

Global Groups

Path	Description
/	Main science data
/aux_l2	Internal product team data from L2

Global Dimensions

Name	Size	Description
spatial	3	directions: x, y, z for satellite position and velocity
fov_poly	8	latitude/longitude points defining the polygon bounding an FOV (anticlockwise as viewed from above)
utc_tuple	8	parts of UTC time: year, month, day, hour, minute, second, millisec, microsec
attitude	3	roll, pitch, yaw
atrack	45	along-track horizontal dimension
xtrack	30	cross-track horizontal dimension
fov	9	Field-of-view dimension
wnum_lw	717	longwave IR channel number
wnum_mw	437	midwave IR channel number
wnum_sw	163	shortwave IR channel number

Global Attributes

Name	Type	Size	Value	Description
keywords	string	1	EARTH SCIENCE > SPECTRAL/ENGINEERING > INFRARED WAVELENGTHS > INFRARED RADIANCE	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

Name	Type	Size	Value	Description
				NetCDF Users Guide: 'This is a character array with a line for each invocation of a program that has modified the dataset. Well-behaved generic netCDF applications should append a line containing: date, time of day, user name, program name and command arguments.' To include a more complete description you can append a reference to an ISO Lineage entity; see NOAA EDM ISO Lineage guidance.
source	string	1	CrIS and 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_CLIMCAPS_CCR_NSR	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.
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.

Name	Type	Size	Value	Description
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 latitude (decimal degrees_north) and longitude (decimal degrees_east), in that order. Longitude values in the default case 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))'.
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.

Name	Type	Size	Value	Description
				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.
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.

Name	Type	Size	Value	Description
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	v01.00.00	Version identifier of the data file or product as assigned by the data creator. For example, a new algorithm or methodology could result in a new product_version.
keywords_vocabulary	string	1	GCMD:GCMD Keywords	If you are using a controlled vocabulary for the words/phrases in your "keywords" attribute, this is the unique name or identifier of the vocabulary from which keywords are taken. If more than one keyword vocabulary is used, each may be presented with a prefix and a following comma, so that keywords may optionally be prefixed with the controlled vocabulary key. Example: 'GCMD:GCMD Keywords, CF:NetCDF COARDS Climate and Forecast Standard Names'.
platform	string	1	SUOMI-NPP > Suomi National Polar-orbiting Partnership	Name of the platform(s) that supported the sensor data used to create this data set or product. Platforms can be of any type, including satellite, ship, station, aircraft or other. Indicate controlled vocabulary used in platform_vocabulary.
platform_vocabulary	string	1	GCMD:GCMD Keywords	Controlled vocabulary for the names used in the "platform" attribute.
product_name_platform	string	1	SNPP	Platform name as it appears in product_name
instrument	string	1	CRIMSS > Cross-track Infrared and Advanced Technology Microwave Sounders\, CrIS > Cross-track Infrared Sounder\, 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	CRIMSS	Instrument name as it appears in product_name

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

Name	Type	Size	Value	Description
				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	v02.00.29	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,

Name	Type	Size	Value	Description
				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	Level-2 CLIMCAPS SNPP CrIMSS Clear Radiances	a succinct description of what is in the dataset. (= ECS long name)
summary	string	1	The Level-2 CLIMCAPS cloud-cleared product includes infrared radiances adjusted to simulate clear-sky conditions.	A paragraph describing the dataset, analogous to an abstract for a paper.
shortname	string	1	SNDRSNIML2CCPCCRN	ECS Short Name
product_group	string	1	l2_crimss_cc	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	Christopher D. Barnet\, STC; L. Larrabee Strow\, UMBC; 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; Forward Model PI; Microwave PI	The roles of any individuals or institutions that contributed to the creation of this data.

Global Variables

Name	Type	Dimensions	Description	Units	Ancillary Variables
obs_id	string	atrack, xtrack	unique earth view observation identifier: yyyymmddThhmm.aaExx. Includes gran_id plus 2-digit along-track index (01-45) and 2-digit cross-track index (01-30).		
fov_obs_id	string	atrack, xtrack, fov	unique earth view observation identifier for FOV: yyyymmddThhmm.aaExx.f . Includes gran_id plus 2-digit along-track index (01-45), 2-digit cross-track index (01-30), and 1-digit FOV number (1-9).		
obs_time_tai93	double	atrack, xtrack	earth view observation midtime for each FOV	seconds since 1993-01-01 00:00	bnds
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 FOR center	degrees_north	bnds
lat_geoid	float	atrack, xtrack	latitude of FOR center on the geoid (without terrain correction)	degrees_north	
fov_lat	float	atrack, xtrack, fov	latitude of FOV center	degrees_north	bnds
lon	float	atrack, xtrack	longitude of FOR center	degrees_east	bnds
lon_geoid	float	atrack, xtrack	longitude of FOR center on the geoid (without terrain correction)	degrees_east	
fov_lon	float	atrack, xtrack, fov	longitude of FOV center	degrees_east	bnds
land_frac	float	atrack, xtrack	land fraction over the FOR	unitless	
fov_land_frac	float	atrack, xtrack, fov	land fraction over the FOV	unitless	
surf_alt	float	atrack, xtrack	mean surface altitude wrt earth model over the FOR	m	
fov_surf_alt	float	atrack, xtrack, fov	mean surface altitude wrt earth model over the FOV	m	
surf_alt_sdev	float	atrack, xtrack	standard deviation of surface altitude within the FOR	m	
fov_surf_alt_sdev	float	atrack, xtrack, fov	standard deviation of surface altitude within the FOV	m	
sun_glint_lat	float	atrack	sun glint spot latitude at scan_mid_time. Fill for night observations.	degrees_north	

Name	Type	Dimensions	Description	Units	Ancillary Variables
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	
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 of sun glint spot to the center of the spot. 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 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	

Name	Type	Dimensions	Description	Units	Ancillary Variables
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		
rad_lw	float32	atrack, xtrack, wnum_lw	longwave clear spectral radiance	mW/(m2 sr cm-1)	err, qc
rad_mw	float32	atrack, xtrack, wnum_mw	midwave clear spectral radiance	mW/(m2 sr cm-1)	err, qc
rad_sw	float32	atrack, xtrack, wnum_sw	shortwave clear spectral radiance	mW/(m2 sr cm-1)	err, qc
cal_qualflag	int32	atrack, xtrack, fov	per-observation L1B product quality		
cal_lw_qualflag	int32	atrack, xtrack, fov	per-observation L1B LW product quality		
cal_mw_qualflag	int32	atrack, xtrack, fov	per-observation L1B MW product quality		
cal_sw_qualflag	int32	atrack, xtrack, fov	per-observation L1B SW product quality		
nedn_lw	float32	fov, wnum_lw	longwave noise equivalent differential radiance	mW/(m2 sr cm-1)	

Name	Type	Dimensions	Description	Units	Ancillary Variables
nedn_mw	float32	fov, wnum_mw	midwave noise equivalent differential radiance	mW/(m2 sr cm-1)	
nedn_sw	float32	fov, wnum_sw	shortwave noise equivalent differential radiance	mW/(m2 sr cm-1)	
wnum_lw	float64	wnum_lw	longwave wavenumber	cm-1	
wnum_mw	float64	wnum_mw	midwave wavenumber	cm-1	
wnum_sw	float64	wnum_sw	shortwave wavenumber	cm-1	

aux_l2 Variables

Name	Type	Dimensions	Description	Units	Ancillary Variables
idprof	string	atrack, xtrack	profile ID		
etarej	float32	atrack, xtrack	cloud clearing residual used f/ rej at iteration = ieta_rej	unitless	
cldfrc_tot	float32	atrack, xtrack	Total cloud fraction over FOR	unitless	
cldfrc_500	float32	atrack, xtrack	Total cloud fraction over FOR below 500 hPa	unitless	
ampl_eta	float32	atrack, xtrack	cloud clearing noise amplification factor	unitless	
ir_x	float32	atrack, xtrack	RMS(rad(IR.ret)-radobs()) for AMSU channels	unitless	
bt2	float32	atrack, xtrack	RMS(T(p) f/IR.ret - T(p) f/ AMSU.ret)	unitless	
qualsurf	float32	atrack, xtrack	qualsurf		
qualtemp	float32	atrack, xtrack	qualtemp		
softcode	float32	atrack, xtrack	software rejection code		
aeff_1	float32	atrack, xtrack	A_eff(1st eta step)	unitless	
aeff_end	float32	atrack, xtrack	A_eff(last eta step)	unitless	
a0_cloud	float32	atrack, xtrack	intercept of alpha(1)=f(alpha(2)) fitting	unitless	
totliqwat	float32	atrack, xtrack	total liquid water (MW)	unitless	
chi2_temp	float32	atrack, xtrack	Temperature profile chi^2 of alpha(1)=f(alpha(2)) fitting	unitless	
chi2_h2o	float32	atrack, xtrack	Water vapor chi^2 of alpha(1)=f(alpha(2)) fitting	unitless	
chi2_o3	float32	atrack, xtrack	Ozone chi^2 of alpha(1)=f(alpha(2)) fitting	unitless	
chi2_ch4	float32	atrack, xtrack	Methane chi^2 of alpha(1)=f(alpha(2)) fitting	unitless	

Name	Type	Dimensions	Description	Units	Ancillary Variables
chi2_co	float32	atrack, xtrack	Carbon monoxide chi^2 of alpha(1)=f(alpha(2)) fitting	unitless	
chi2_co2	float32	atrack, xtrack	Carbon dioxide chi^2 of alpha(1)=f(alpha(2)) fitting	unitless	
chi2_n2o	float32	atrack, xtrack	Nitrous oxide chi^2 of alpha(1)=f(alpha(2)) fitting	unitless	
chi2_hno3	float32	atrack, xtrack	Nitric acid chi^2 of alpha(1)=f(alpha(2)) fitting	unitless	
chi2_so2	float32	atrack, xtrack	Sulfur dioxide chi^2 of alpha(1)=f(alpha(2)) fitting	unitless	

C.4 CHART Cloud-Cleared Radiance product

SNPP L2 CHART CRIMSS CC NSR Interface Specification

Interface Specification Version 02.00.28
04-10-2019

Global Groups

Path	Description
/	Main science data
/aux_l2	Internal product team data from L2

Global Dimensions

Name	Size	Description
spatial	3	directions: x, y, z for satellite position and velocity
fov_poly	8	latitude/longitude points defining the polygon bounding an FOV (anticlockwise as viewed from above)
utc_tuple	8	parts of UTC time: year, month, day, hour, minute, second, millisec, microsec
attitude	3	roll, pitch, yaw
atrack	45	along-track horizontal dimension
xtrack	30	cross-track horizontal dimension
fov	9	Field-of-view dimension
wnum_lw	717	longwave IR channel number
wnum_mw	437	midwave IR channel number
wnum_sw	163	shortwave IR channel number

Global Attributes

Name	Type	Size	Value	Description
keywords	string	1	EARTH SCIENCE > SPECTRAL/ENGINEERING > INFRARED WAVELENGTHS > INFRARED RADIANCE	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.

Name	Type	Size	Value	Description
history	string	1		Provides an audit trail for modifications to the original data. This attribute is also in the NetCDF Users Guide: 'This is a character array with a line for each invocation of a program that has modified the dataset. Well-behaved generic netCDF applications should append a line containing: date, time of day, user name, program name and command arguments.' To include a more complete description you can append a reference to an ISO Lineage entity; see NOAA EDM ISO Lineage guidance.
source	string	1	CrIS and 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_CHART_CCR_NSR	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.
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.

Name	Type	Size	Value	Description
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 latitude (decimal degrees_north) and longitude (decimal degrees_east), in that order. Longitude values in the default case 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))'.
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.

Name	Type	Size	Value	Description
				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.
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.

Name	Type	Size	Value	Description
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	v01.00.00	Version identifier of the data file or product as assigned by the data creator. For example, a new algorithm or methodology could result in a new product_version.
keywords_vocabulary	string	1	GCMD:GCMD Keywords	If you are using a controlled vocabulary for the words/phrases in your "keywords" attribute, this is the unique name or identifier of the vocabulary from which keywords are taken. If more than one keyword vocabulary is used, each may be presented with a prefix and a following comma, so that keywords may optionally be prefixed with the controlled vocabulary key. Example: 'GCMD:GCMD Keywords, CF:NetCDF COARDS Climate and Forecast Standard Names'.
platform	string	1	SUOMI-NPP > Suomi National Polar-orbiting Partnership	Name of the platform(s) that supported the sensor data used to create this data set or product. Platforms can be of any type, including satellite, ship, station, aircraft or other. Indicate controlled vocabulary used in platform_vocabulary.
platform_vocabulary	string	1	GCMD:GCMD Keywords	Controlled vocabulary for the names used in the "platform" attribute.
product_name_platform	string	1	SNPP	Platform name as it appears in product_name
instrument	string	1	CRIMSS > Cross-track Infrared and Advanced Technology Microwave Sounders\, CrIS > Cross-track Infrared Sounder\, 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	CRIMSS	Instrument name as it appears in product_name

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

Name	Type	Size	Value	Description
				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	v02.00.29	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,

Name	Type	Size	Value	Description
				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	Level-2 CHART SNPP CrIMSS Clear Radiances	a succinct description of what is in the dataset. (= ECS long name)
summary	string	1	The Level-2 CHART cloud-cleared product includes infrared radiances adjusted to simulate clear-sky conditions.	A paragraph describing the dataset, analogous to an abstract for a paper.
shortname	string	1	SNDRSNIML2CHTCCRN	ECS Short Name
product_group	string	1	l2_crimss_cc	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	Joel Susskind\, NASA GSFC; William J. Blackwell\, MIT; L. Larrabee Strow\, UMBC; 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; Neural Network PI; Forward Model PI; Microwave PI	The roles of any individuals or institutions that contributed to the creation of this data.

Global Variables

Name	Type	Dimensions	Description	Units	Ancillary Variables
obs_id	string	atrack, xtrack	unique earth view observation identifier: yyyymmddThhmm.aaExx. Includes gran_id plus 2-digit along-track index (01-45) and 2-digit cross-track index (01-30).		
fov_obs_id	string	atrack, xtrack, fov	unique earth view observation identifier for FOV: yyyymmddThhmm.aaExx.f . Includes gran_id plus 2-digit along-track index (01-45), 2-digit cross-track index (01-30), and 1-digit FOV number (1-9).		
obs_time_tai93	double	atrack, xtrack	earth view observation midtime for each FOV	seconds since 1993-01-01 00:00	bnds
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 FOR center	degrees_north	bnds
lat_geoid	float	atrack, xtrack	latitude of FOR center on the geoid (without terrain correction)	degrees_north	
fov_lat	float	atrack, xtrack, fov	latitude of FOV center	degrees_north	bnds
lon	float	atrack, xtrack	longitude of FOR center	degrees_east	bnds
lon_geoid	float	atrack, xtrack	longitude of FOR center on the geoid (without terrain correction)	degrees_east	
fov_lon	float	atrack, xtrack, fov	longitude of FOV center	degrees_east	bnds
land_frac	float	atrack, xtrack	land fraction over the FOR	unitless	
fov_land_frac	float	atrack, xtrack, fov	land fraction over the FOV	unitless	
surf_alt	float	atrack, xtrack	mean surface altitude wrt earth model over the FOR	m	
fov_surf_alt	float	atrack, xtrack, fov	mean surface altitude wrt earth model over the FOV	m	
surf_alt_sdev	float	atrack, xtrack	standard deviation of surface altitude within the FOR	m	
fov_surf_alt_sdev	float	atrack, xtrack, fov	standard deviation of surface altitude within the FOV	m	
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 of sun glint spot to the center of the spot. 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 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	

Name	Type	Dimensions	Description	Units	Ancillary Variables
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		
rad_lw	float32	atrack, xtrack, wnum_lw	longwave clear spectral radiance	mW/(m2 sr cm-1)	err, qc
rad_mw	float32	atrack, xtrack, wnum_mw	midwave clear spectral radiance	mW/(m2 sr cm-1)	err, qc
rad_sw	float32	atrack, xtrack, wnum_sw	shortwave clear spectral radiance	mW/(m2 sr cm-1)	err, qc
cal_qualflag	int32	atrack, xtrack, fov	per-observation L1B product quality		
cal_lw_qualflag	int32	atrack, xtrack, fov	per-observation L1B LW product quality		
cal_mw_qualflag	int32	atrack, xtrack, fov	per-observation L1B MW product quality		
cal_sw_qualflag	int32	atrack, xtrack, fov	per-observation L1B SW product quality		
nedn_lw	float32	fov, wnum_lw	longwave noise equivalent differential radiance	mW/(m2 sr cm-1)	
nedn_mw	float32	fov, wnum_mw	midwave noise equivalent differential radiance	mW/(m2 sr cm-1)	

Name	Type	Dimensions	Description	Units	Ancillary Variables
nedn_sw	float32	fov, wnum_sw	shortwave noise equivalent differential radiance	mW/(m2 sr cm-1)	
wnum_lw	float64	wnum_lw	longwave wavenumber	cm-1	
wnum_mw	float64	wnum_mw	midwave wavenumber	cm-1	
wnum_sw	float64	wnum_sw	shortwave wavenumber	cm-1	

aux_l2 Variables

Name	Type	Dimensions	Description	Units	Ancillary Variables
idprof	string	atrack, xtrack	profile ID		
etarej	float32	atrack, xtrack	cloud clearing residual used f/ rej at iteration = ieta_rej	unitless	
cldfrc_tot	float32	atrack, xtrack	Total cloud fraction over FOR	unitless	
cldfrc_500	float32	atrack, xtrack	Total cloud fraction over FOR below 500 hPa	unitless	
ampl_eta	float32	atrack, xtrack	cloud clearing noise amplification factor	unitless	
ir_x	float32	atrack, xtrack	RMS(rad(IR.ret)-radobs()) for AMSU channels	unitless	
bt2	float32	atrack, xtrack	RMS(T(p) f/IR.ret - T(p) f/ AMSU.ret)	unitless	
qualsurf	float32	atrack, xtrack	qualsurf		
qualtemp	float32	atrack, xtrack	qualtemp		
softcode	float32	atrack, xtrack	software rejection code		
aeff_1	float32	atrack, xtrack	A_eff(1st eta step)	unitless	
aeff_end	float32	atrack, xtrack	A_eff(last eta step)	unitless	
a0_cloud	float32	atrack, xtrack	intercept of alpha(1)=f(alpha(2)) fitting	unitless	
chi2_cloud	float32	atrack, xtrack	chi^2 of alpha(1)=f(alpha(2)) fitting	unitless	
fzeta	float32	atrack, xtrack	fzeta_effect	unitless	
rzeta	float32	atrack, xtrack	rzeta_effect	unitless	
bias_ccdiff	float32	atrack, xtrack	BIAS(-Rccr) in 800-900 cm-1 region	unitless	
lambda_max	float32	atrack, xtrack	lambda(2,iter_eta) = U^TS^TN^{-1}SU	unitless	
totliqwat	float32	atrack, xtrack	total liquid water (MW)	unitless	
etarejfinal	float32	atrack, xtrack	etarejfinal	unitless	

Name	Type	Dimensions	Description	Units	Ancillary Variables
gtest_a	float32	atrack, xtrack	gtest_a	unitless	
tsurfnoaa	float32	atrack, xtrack	tsurfnoaa	unitless	
noaadifftest	float32	atrack, xtrack	noaadifftest	unitless	
mitdifftest	float32	atrack, xtrack	T(p)final - T(p)startup	unitless	
mitsurftest	float32	atrack, xtrack	abs(Tsurfret-Tsurfstartup)	unitless	