README Document for

AIRS Level-3 Version 5 Standard Products:

Daily (AIRH3STD, AIRX3STD, AIRS3STD)

8-day (AIRH3ST8, AIRX3ST8, AIRS3ST8)

& Monthly (AIRH3STM, AIRX3STM, AIRS3STM)

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Revision History

Revision Date	***Changes***	***Author***
10/24/2007	Initial version	Young-In Won
1/9/2008	Revisions based on review	Young-In Won
3/3/2008	Revision to account for version 4 products; info on changes from version 4 to version 5 added	Young-In Won
7/21/2009	Removed reference to retired WHOM search engine	Randy Barth

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1. Introduction

1.1 Brief background

This document applies to the Atmospheric Infrared Sounder (AIRS) **Version 5 Level 3 Standard** Gridded products which contain standard retrieval means, standard deviations and input counts. A brief description on changes from Version 4 to version 5 products is given in the following section.

Each product is separately derived from MW(Micro Wave)-Only retrievals and combined IR/MW retrievals. The geophysical products provide global temperature profiles at an accuracy of 1 K per 1 km thick layer in the troposphere and moisture profiles at an accuracy of 20% per 2 km thick layer in the lower troposphere (20% - 60% in the upper troposphere). With the Version 5 release the Level-3 products also include the profiles of the minor gases: O_3, CO and CH_4.

The temporal resolution of the AIRS Level 3 Standard products is **daily**, **8-day** (half of the 16 day Aqua orbit repeat cycle) and **monthly** (calendar) based on their specific needs. The multi-day products are simply the arithmetic mean weighted by the counts of the daily data combined in each grid box. Each product is divided into three types (see section 2.1 for further details): retrieval products using AIR IR, AMSU with HSB (**AIRH3STD, AIRH3ST8, AIRH3STM),** using AIR IR, AMSU without HSB **(AIRX3STD, AIRX3ST8, AIRX3STM)** and AIR IR only **(AIRS3STD, AIRS3ST8, AIRS3STM).**

Daily Level 3 products are intended to address the needs of the Numerical Weather Prediction (NWP) and numerical modeling community. This community is interested in temperature, specific humidity, and geopotential height profiles, cloud thickness, height and fraction, surface moisture and emissivity. In addition, individual users can easily aggregate daily Level products into custom multi-day global products based on their specific needs. These data are also used as input to the 8-day and monthly Level 3 products.

8-day Level 3 products address the needs of researchers interested in climate quasi-oscillations and assorted phenomena, such as the Madden-Julian Oscillation, annular modes, etc.

The monthly Level 3 products address the interests of those involved in climate trend analysis. They are typically interested in monthly means over long timescales and prefer data products with the lowest possible systematic errors.

Users of AIRS Level 3 products should be aware that the temporal span of Level 3 daily files is not midnight-to-midnight. The data proceeds in time from left (-180.0°) to right (180.0°) with neighboring cells of data no more than a swath of time apart. This ensures that data points in a grid box are always coincident in time, if the data were gridded using a midnight-to-midnight time scheme, the start of the day and the end of the day would be in the same grid cell, producing an artificial time discontinuity across the grid. The edges of the AIRS Level 3 cells are at the date line (the 180E/W longitude boundary). When plotted, this produces a map with 0 degrees longitude in the center of the image. This method is preferred because the left side of the grid

and the right side of the grid contain data farthest apart in time. The method used analogous to that used to create TOVS Pathfinder level 3 products.

Each Level 3 daily product contains information for a temporal period of 24 hours for either the descending or ascending orbit (rather than midnight-to-midnight) where "ascending or descending" refers to the direction of movement of the sub-satellite point in the satellite track at the equatorial crossing. The ascending direction of movement is from Southern Hemisphere to Northern Hemisphere, with an equatorial crossing time of 1:30 PM local time; the descending direction of movement is from Northern Hemisphere to Southern Hemisphere, with an equatorial crossing time of 1:30 AM local time. Outside of the polar zones, these correspond respectively to daytime and nighttime.

The data covers period from August 30, 2002 to current.

Table 1. Level-3 Standard Product Characteristics.

Daily	8-Day	-90° to 90°N
"Complex" data, leaves in gores between satellite tracks (missing)	"Moderate" data, no gores, and some data dropouts	"Simple" data, no gores, complete coverage
1° by 1° spatial resolution	1° by 1° spatial resolution	1° by 1° spatial resolution
1 day temporal resolution	8 day temporal resolution based on Aqua 16-day repeat cycle	Monthly (calendar)

1.2 Significant changes from V4 to V5

We strongly encourage users to use V5 products rather than V4 (GES DISC Collection 3 data products). A short description on changes from V4 to V5 that are most visible to the user is given below.

Improved Quality Indicators and Error Estimates
In the V5 release, an improved set of quality indicators has been provided to inform the user separately about the quality of the retrieval of various products. Please read the Level 2 Quality Control and Error Estimation documentation for a description of these indicators and how they are set.
V5_L2_Quality_Control_and_Error_Estimation.pdf

The V5 temperature profile yield is increased and the error estimate improved. The greatest yield increase is in the polar regions, and the greatest improvement in quality is over land. The yield in moisture retrievals has decreased slightly, but the quality of the accepted retrieval has increased, their error estimates improved and there are fewer outliers. In particular, there are no longer anomalously high moisture retrievals over warm scenes and the upper tropospheric dry bias and total water vapor wet bias have both improved over V4.

Correction to Saturation and Relative Humidity
The layer-average vapor pressure saturation relation for water vapor is provided over liquid and over liquid/ice dependent upon air temperature. The relative humidity calculation error present in V4 has been corrected.

Correction to Outgoing Longwave Radiation
The OLR calculation error present in V4 has been corrected. There was no error in the calculation for clear-sky OLR (clrolr) in V4.

Improved O3 Product
The V5 ozone retrieval channel set has been refined and an observationally based climatology is used for a first guess rather than a regression. The result is that the V5 ozone retrievals are less biased in the mid to low troposphere.

Addition of CO and CH4 Products
V5 L2 products now include total burden and profiles for carbon monoxide and methane. V5 L3 products contain profiles for both carbon monoxide and methane along with total column carbon monoxide. The methane product is an unvalidated research product that is still being refined.

Averaging Kernel, Verticality and Degrees of Freedom
V5 L2 products now provide averaging kernel (in support product), verticality and degrees of freedom for moisture, ozone, carbon monoxide and methane profiles.

AMSU-A Level 1B Sidelobe Correction Implemented
V5 AMSU-A L1B products now provide a sidelobe-correct brightness temperature in addition to the antenna temperature. The temperature error calculation is now fully implemented.

no HSB and including HSB
The HSB instrument ceased operation on February 5, 2003 due to a mirror motor failure. Released V5 of AIRS Data Products provide two versions of the L2 and L3 data products up to the date of HSB failure, and a single version thereafter.
See **V5_Released_Proc_FileDesc.pdf** for a complete description of the AIRS Data Product file name and local granule ID (LGID) convention.

Removal of VIS/NIR Derived Cloud Fields
The Visible/Near Infrared derived cloud fields have been removed in V5.

Preparation of AIRS-Only Processing Option
We have prepared an AIRS-Only processing option whose products become visible to users due to a degrade of AMSU channel.

A complete listing of the noteworthy changes from V4 to V5 is provided in the document:
V5_Changes_from_V4.pdf

1.3 AIRS Instrument Description

The Atmospheric Infrared Sounder (AIRS) instrument suite is designed to measure the Earth's atmospheric water vapor and temperature profiles on a global scale. It is comprised of a space-based hyperspectral infrared instrument (AIRS) and two multichannel microwave instruments, the Advanced Microwave Sounding Unit (AMSU-A) and the Humidity Sounder for Brazil (HSB). The AIRS instrument suite is one of several instruments onboard the Earth Observing System (EOS) Aqua spacecraft launched May 4, 2002. The HSB instrument ceased operation on February 5, 2003.

1.3.1 AIRS

AIRS is a high spectral resolution spectrometer on board Aqua satellite with 2378 bands in the thermal infrared (3.7 - 15.4 μm) and 4 bands in the visible (0.4 - 1.0 μm). These ranges have been specifically selected to allow determination of atmospheric temperature with an accuracy of 1°C in layers 1 km thick, and humidity with an accuracy of 20% in layers 2 km thick in the troposphere. In the cross-track direction, a ±49.5 degree swath centered on the nadir is scanned in 2 seconds, followed by a rapid scan in 2/3 second taking routine calibration related data that consist of four independent Cold Space Views, one view of the Onboard Blackbody Calibrator, one view of the Onboard Spectral Reference Source, and one view of a photometric calibrator for the VIS/NIR photometer. Each scan line contains 90 IR footprints, with a resolution of 13.5 km at nadir and 41km x 21.4 km at the scan extremes from nominal 705.3 km orbit. The Vis/NIR spatial resolution is approximately 2.3 km at nadir.

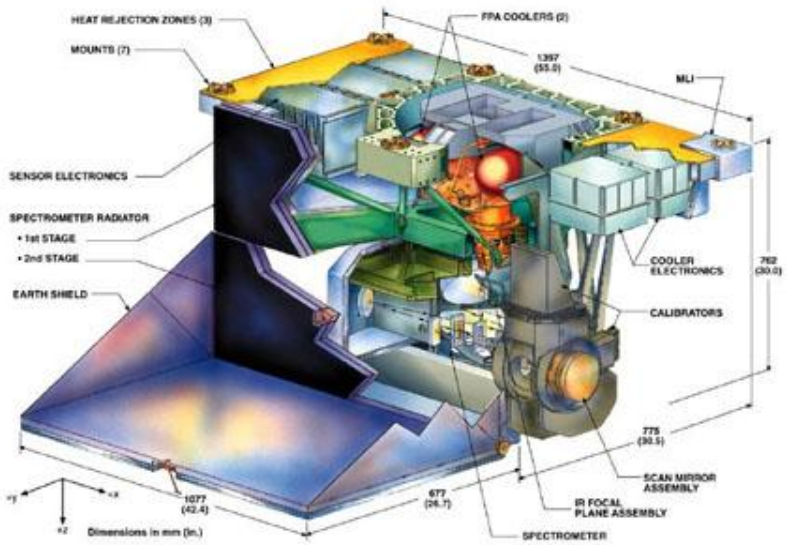

Figure 1. AIRS instrument cutaway drawing.

The primary spectral calibration of the AIRS spectrometer is based on the cross-correlation between spectral features observed in the upwelling radiance spectrum with precalculated

spectra. And additional spectral reference source is provided to aid pre-launch testing in the thermal vacuum chamber during spacecraft integration and for quality monitoring in orbit.

Table 1. Technology - Specifications

Instrument Type	Multi-aperture, non-Littrow echelle array grating spectrometer.
Infrared Spectral Coverage	3.74 - 4.61 μm 6.20 - 8.22 μm 8.80 - 15.4 μm
Spectral Response	$\lambda/\Delta\lambda > 1200$ nominal
Spectral Resolution	$\Delta\lambda/2$
Spectral Sampling	$\pm 1\ \Delta\lambda$
Integrated Response (95%)	$0.05\ \Delta\lambda$ 24 hours
Wavelength Stability	$0.01\ \Delta\lambda$
Scan Angle	±49.5° around nadir
Swath Width	1650 km nominal
Instantaneous Field of View (IFOV)	1.1°
Measurement Simultaneity	>99%
Sensitivity (NEDT)	0.14 K at 4.2 μm 0.20 K from 3.7 - 13.6 μm 0.35 K from 13.6 - 15.4 μm
Radiometric Calibration	±3% absolute error

1.3.2 AMSU-A

AMSU-A primarily provides temperature soundings. It is a 15-channel microwave temperature sounder implemented as two independently operated modules. Module 1 (AMSU-A1) has 12 channels in the 50-58 GHz oxygen absorption band which provide the primary temperature sounding capabilities and 1 channel at 89 GHz which provides surface and moisture information. Module 2 (AMSU-A2) has 2 channels: one at 23.8 GHz and one at 31.4 GHz which provide surface and moisture information (total precipitable water and cloud liquid water). Like AIRS, AMSU-A is a cross-track scanner. The three receiving antennas, two for AMSU-A1 and one for AMSU-A2, are parabolic focusing reflectors that are mounted on a scan axis at a 45° Tilt angle, so that radiation is reflected from a direction along the scan axis (a 90° reflection). AMSU-A scans three times as slowly as AIRS (once per 8 seconds) and its footprints are approximately three times as large as those of AIRS (45 km at nadir). This result in three AIRS scans per AMSU-A scans and nine AIRS footprints per AMSU-A footprint.

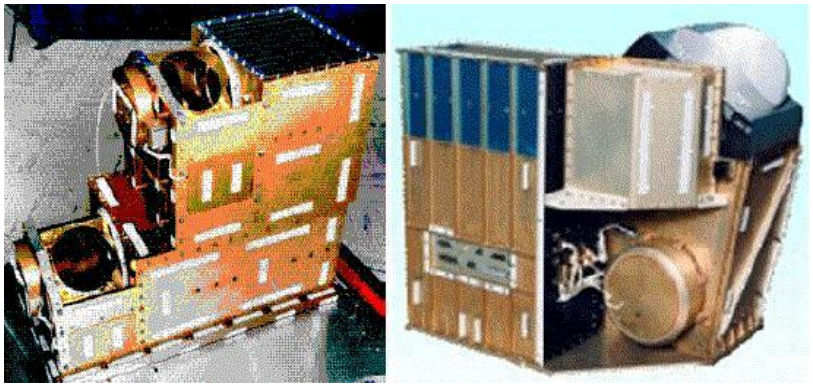

Figure 2. View of AMSU-A1 (left) and AMSU-A2 right.

Table 2. AMSU instrument characteristics

	AMSU-A1	AMSU-A2
Data Rate	1.5 kbits/s	0.5 kbits/s
Antenna Size	15 cm (2 units)	31 cm (1unit)
Instantaneous Field of View (IFOV)	3.3°	3.3°
Swath Width	100; 1650 km	100; 1650 km
Pointing Accuracy	± 0.2°	± 0.2°
Number of Channels	13	2

Sensor	Channel	Central Frequency (GHz)	Bandwidth (MHz)	Sensitivity NEDT (K)
AMSU-A2	1	23.8	270	0.3
	2	31.4	180	0.3
AMSU-A1	1	50.300	180	0.4
	2	52.800	400	0.25
	3	53.596±0.115	170	0.25
	4	54.400	400	0.25
	5	54.940	400	0.25
	6	55.500	330	0.25
	7	57.290344 = Flo	330	0.25
	8	Flo±0.217	78	0.4
	9	Flo±0.3222 (±0.048)	36	0.4
	10	Flo±0.3222 (±0.022)	16	0.6
	11	Flo±0.3222 (±0.010)	8	0.8
	12	Flo±0.3222 (±0.0045)	3	1.2
	13	89.000	< 6,000	0.5

1.3.3 HSB

The Humidity Sounder for Brazil (HSB) is primarily a humidity sounder providing supplementary water vapor and liquid data to be used in the cloud clearing process. The HSB is a 4-channel microwave moisture sounder implemented as a single module. Three channels are located near 183 GHz, while the fourth is a window channel at 150 GHz. Physically HSB is identical to AMSU-B, which is operated by NOAA on its most recent POES satellites, but HSB lacks the fifth channel (89 GHz) of AMSU-B. Like AMSU-B, it samples ninety 1.1 ° scenes per 2.67-second crosstrack scan. Due to the higher spatial resolution (which equals that of AIRS) and a higher scan rate, the measurement density is 2.4 times that of AMSU-A (20 % less than for AMSU-B). HSB is very similar to AMSU-A, except that is contains only one antenna/receiver system. Its scan speed as well as its footprints is similar to AIRS (three scans per 8 seconds and about 15 km at nadir, respectively). There is therefore one HSB footprint per AIRS footprint.

The HSB is the object of a scientific and technical cooperation agreement between NASA and AEB (Agencia Espacial Brasileira), Brazilian Space Agency. The HSB instrument ceased operation on February 5, 2003 due to a mirror scan motor failure.

Table 3. HSB instrument characteristics

		HSB
Data Rate		4.2 kbps
Antenna Size		21.9 cm diameter
Instantaneous Field of View (IFOV)		1.1° degree circular
Swath Width		1650 km
Number of Channels		4
Channel Number	Central Frequency (GHz)	Bandwidth (MHz)
1*	Deleted (89GHz)	
2	150.0	4000
3	183.31 ± 1.0	2x500
4	183.31 ± 3.0	2x1000
5	183.31 ± 7.0	2x2000

1.4 Brief background on algorithm

The V5 Level 3 gridded products are derived from the Level 2 standard swath products. The Level 2 quality indicators determine which of the Level 2 Standard Product data are combined to create the Level 3 Product. Therefore, it is important that the user of Level 3 Products become familiar with these quality indicators, and we urge the user to read the documentation describing the AIRS Level 2 Standard Products. The following is the table of contents of the quick start.

Level-2 Standard Products Quick Start
(http://disc.sci.gsfc.nasa.gov/AIRS/documentation/v5_docs/AIRS_V5_Release_User_Docs/V5_L2_Standard_Product_QuickStart.pdf)

1.5 Data Disclaimer

AIRS science team provides AIRS/AMSU/HSB Version 5 Data Disclaimer document as a part of Version 005 data release, here is the table of contents: (http://disc.gsfc.nasa.gov/AIRS/documentation/v5_docs/AIRS_V5_Release_User_Docs/V5_Data_Disclaimer.pdf)

AUGUST 24, 2007 – CLEAR AIRS FOVS REPORTED IN L1B RADIANCE PRODUCT AND CALIBRATION SUBSET PRODUCT

2. Data Organization

2.1 File naming convention

There exist two versions of the Level 3 Standard Product files before February 5, 2003. On that date, the Humidity Sounder for Brazil (**HSB**) failed. Our retrieval algorithm was adjusted to allow operation with and without ingesting HSB radiances. Retrievals for the period before February 5, 2003 are carried out with and without HSB. The AIRS Level 3 Products resulting from including AIRS IR, AMSU and HSB radiances have shortname "**AIRH3STD**", "**AIRH3ST8**", "**AIRH3STM**" and their file names incorporate this character string. Products resulting from AIRS IR, AMSU, but not ingesting HSB radiances have shortname "**AIRX3STD**", "**AIRX3ST8**", "**AIRX3STM**" and their file names incorporate this character string. This latter set carries through after February 5, 2003 to the current date. It is produced for the period before HSB failed so that a consistent product exists for the entire period of the operation of AIRS. New products resulting from AIRS IR only have shortname "**AIRS3STD**", "**AIRS3ST8**", "**AIRS3STM**" and their file names incorporate this character string. It is produced since the radiometric noise in AMSU channel 4 started to increase significantly (since June 2007).

The AIRS Level-3 files are named in accordance to the following convention:

AIRS.*yyyy.mm.dd***.L3.RetStd_H**day**.v***m.m.r.b.productionTimeStamp***.hdf (AIRS, AMSU, HSB)**
AIRS.*yyyy.mm.dd***.L3.RetStd**day**.v***m.m.r.b.productionTimeStamp***.hdf (AIRS and AMSU)**
AIRS.*yyyy.mm.dd***.L3.RetStd_IR**day**.v***m.m.r.b.productionTimeStamp***.hdf (AIRS only)**

For example:
AIRS.2007.01.02.L3.RetStd001.v5.0.14.0.G07195214654.hdf

Where:

- **yyyy** = 4 digit year number [2002 -].
- **mm** = 2 digit month number [01-12]
- **dd** = day of month [01-31]
- **L3** = Level 3
- **RetStd =** string defining the product file type (Standard Retrieval product)
- **day =** the number of days covered (001: daily product,
  028, 029, 030, 031: monthly product
  008: 8-day product)
- **vm.m.r.b** = algorithm version identifier is made up of major version, minor version, release version and build number respectively.
- **productionTimeStamp** = file creation time stamp. Starts off with a letter G for GES DISC processing facility, followed by yydddhhmmss.
  - yy: year number without century;
  - ddd: day of a year [1-366];
  - hhmmss: hours, minutes and seconds UTC time.
- **hdf** = format of the file.

2.2 File Format

AIRS Level-3 files are stored in the Hierarchical Data Format-Earth Observing System (HDF-EOS4) format. HDF-EOS4 format is an extension of the HDF4 format (developed by NCSA) to meet the needs of EOS data products

HDF: The following website contains detailed information on HDF file format, http://hdf.ncsa.uiuc.edu/. HDFView, one of visual tool for browsing and editing NCSA HDF4 and HDF5 files would be of great help in viewing, creating, or modifying the contents of a dataset.

HDF-EOS: In 1993 NASA chose NCSA's HDF format to be the standard file format for storing data from the Earth Observing System (EOS), which is the data gathering system of sensors (mainly satellites) supporting the Global Climate Change Research Program. Since NASA's selection of HDF, NCSA (and now THG) has been working with NASA to prepare for the enormous data management challenges that will come when the system is fully functional. This has included the development of a specialized form of HDF called HDF-EOS, which deals specifically with the kinds of data that EOS produces.

2.3 Data Structure inside File

An AIRS Level-3 file is made of five Grids; “location”, “ascending”, “descending”, “ascending _MW_only” and "descending_MW_only”.

2.4 Key data fields

(see the following section for a complete list)

The data fields most likely to be used by users are as follows.

Location data Fields:

- Latitude
  geodetic latitude of center of grid box
  (degrees north, -90. to +90.), dimension (360,180)
- Longitude
  geodetic longitude of center of grid box
  (degrees East, -180. to +180.), dimension (360,180)
- LandSeaMask
  unitless, (1 = land, 0 = ocean), dimension (360,180)

- Topography
  height of surface above the geoid (meters) (360,180)

Attributes: These fields appear once per Level 3 Grids

- NumOfDays
  total number of days of input Level 2 data included in gridded maps.
- AscendingGridStartTimeUTC
  begin time of mapped fields (UTC), ascending.
- AscendingGridEndTimeUTC
  end time of mapped fields (UTC), ascending.
- DescendingGridStartTimeUTC
  begin time of mapped fields (UTC), descending.
- DescendingGridEndTimeUTC
  end time of mapped fields (UTC), descending.
- TempPresLvls
  standard pressure (mb) for each of 24 levels in the atmosphere associated with temperature profiles and geopotential height. The array order is from AIRS/AMSU/HSB Version 5 Data Release User Guide Page 57 the surface upward, in conformance with WMO standard. Note that the Level-3 pressure levels are a subset of Level-2 pressure levels and are constrained to begin at 1000.0 mb and end at 1.0 mb
- H2OpresLvls
  standard pressure (mb) for each of 12 layers in the atmosphere associated with AIRS Level-3 water vapor profiles. The array order is from surface upward in accordance with the WMO standard. Note that Level-3 pressure levels for water vapor are constrained to be between 1000.0 and 100.0 mb.
- IREmisFreqs
  Frequencies for emissivities reported in the AIRS Level-3 product in cm^{-1}
- MWEmisFreqs
  Frequencies for microwave emissivity products reported in AIRS Level-3 in GHz.
- CH4_TrapezoidLayers
  Layers on which the methane values reported in the AIRS Level-3 product are defined.
- CO_TrapezoidLayers
  Layers on which the carbon monoxide values reported in the AIRS Level-3 product are defined.

Ascending and Descending Grid Fields:

- CalChanSummary
  Bit field that is a bitwise OR of CalFlag by channel over all scanlines. Zero means that channel was well calibrated in the entire granule, dimension (2378)
- TotalCounts_A, TotalCounts_D.
  The total counts of non-missing (-9999) points that fell within grid cell, whether included in the final L3 product or not. Used for QC, dimension (360,180).
- Temperature_A, Temperature_D
  Atmospheric temperature profile (K) at 24 standard pressure levels:

1000-1 mb., dimension (360,180,24)

- GPHeight_A, GPHeight_D
  Geopotential height (meters) at 24 standard pressure levels:
  1000-1 mb., dimension (360,180,24)
- H2OVapMMR_A, H2OVapMMR_D
  Water vapor mass mixing ratio (gm/kg dry air) at 12 layers:
  1000 - 100 mb, dimension (360,180,12)
- RelHumid_A, RelHumid_D
  Relative humidity (percent) at 12 layers:
  1000 - 100 mb, dimension (360,180,12)
- TotO3_A, TotO3_D
  total integrated column ozone burden (Dobson Units), dimension (360,180)
  AIRS/AMSU/HSB Version 5 Data Release User Guide Page 58
- TotH2OVap_A, TotH2OVap_D
  total integrated column water vapor burden (kg/m2), dimension (360, 180)
- SurfPres_A, SurfPres_D
  Mean surface pressure (mb), dimension(360,180).
- TotCldLiqH2O_A, TotCldLiqH2O_D
  Total integrated column cloud liquid water (kg/m2), dimension (360,180)
- SurfAirTemp_A, SurfAirTemp_D
  Surface air temperature (K), dimension (360,180)
- SurfSkinTemp_A, SurfSkinTemp_D
  Surface skin temperature (K), dimension(360,180)
- CloudTopPress_A, Cloud_Top_Press_D
  Combined cloud top pressure (mb) weighted by cloud fraction, dimension (360,180)
- CloudFrc_A, CloudFrc_D
  Combined layer cloud fraction (unitless), dimension(360,180)
- OLR_A, OLR_D
  Outgoing long-wave radiation flux (watts/m2), dimension (360,180)
- ClrOLR_A, ClrOLR_D
  Clear-sky outgoing long-wave radiation flux (watts/m2), dimension(360,180)
- EmisIR_A, EmisIR_D
  IR surface emissivity (unitless) on a frequency grid
  (832, 961, 1203, 2616 cm-1), dimension(360,180,4)
- CO_total_column_A, CO_total_column_D
  retrieved total column carbon monoxide (molecules/cm2), dimension (360, 180)
- CH4_VMR_eff_A, CH4_VMR_eff_D
  effective methane volume mixing ratio for three trapezoids layers (ppm), dimension (360, 180, 3)
- CO_VMR_eff_A, CO_VMR_eff_D
  effective carbon monoxide volume mixing ratio for seven trapezoid layers (ppm), dimension (360, 180, 7)
- CO_dof_A, CO_dof_D
  measure of the amount of information in the carbon monoxide retrieval (degrees of freedom), dimension (360, 180)
- CO_Verticality_A, CO_verticality_D

sum of carbon monoxide averaging kernels at 7 trapezoidal layers (unitless), dimension (360, 180, 7)

- CH4_dof_A, CH4_dof_D
  measure of the amount of information in the methane retrieval (degrees of freedom), dimension (360, 180)
- CoarseCloudFrc_A, CoarseCloudFrc_D
  cloud fraction at coarse cloud resolution, 3 layers: low, middle, high.
  AIRS/AMSU/HSB Version 5 Data Release User Guide Page 59
  Where low is between 1100-680 hPa, middle is between 680-440 hPa
  and high is 440-10 hPa (unitless), dimension (360, 180, 3)
- CoarseCloudTemp_A, CoarseCloudTemp_D
  cloud top temperature at coarse cloud resolution (Kelvin), dimension (360, 180, 3)
- CoarseCloudPres_A, CoarseCloudPres_D
  cloud layer pressure in coarse cloud resolution (hPa), dimension (360, 180, 3)
- FineCloudFrc_A, FineCloudFrc_D
  cloud fraction at fine resolution at 12 vertical layers (unitless), dimension (360, 180, 12)
- TropPres_A, TropPres_D
  pressure of the tropopause (hPa), dimension (360, 180)
- TropHeight_A, TropHeight_D
  height of the tropopause (meters), dimension (360, 180)
- TropTemp_A, TropTemp_D
  temperature at the tropopause (Kelvin), dimension (360, 180)
- RelHumidLiq_A, RelHumidLiq_D
  liquid water mass mixing ratio at 12 vertical layers, dimension (360, 180, 12)

Ascending_MW_only and Descending_MW_only Grid Fields:

- TotalCounts_A, TotalCounts_D
  The total counts of non-missing (-9999) points that fell within grid cell, whether included in the final L3 product or not. Used for QC, dimension (360,180).
- Temperature_MW_A, Temperature_MW_D
  Atmospheric temperature profile (K) measured by AMSU at 24 standard pressure levels: 1000.0 - 1.0 mb, dimension(360,180,24)
- GPHeight_MW_A, GPHeight_MW_D
  Geopotential height (meters) at standard pressure levels: 1000 - 1 mb, dimension (360,180,24)
- EmisMW_MW_A, EmisMW_MW_D
  MW spectral emissivity (unitless) on a frequency grid (23.8, 50.3, & 89.0 GHz), dimension (360,180,3)
- TotH2OVap_MW_A, TotH2OVap_MW_D
  Total integrated column water vapor burden (kg/m2), dimension (360,180).

3. Data Contents

Many science parameters come with companion error estimates as well as standard deviation and number of input points for them. Typically, their names are constructed by appending the "_err" , '_sdev' and "_ct" tag to the science parameter name. For example, TotH2OVap_A_err is the error estimate for the TotH2OVap_A (total integrated column water vapor). Described below are all the parameters contained within an AIRS Version 5 Level-3 Standard Product file.

3.1 Geolocation Fields

These fields are within the location grid and document pertinent information for determining the location and characteristics of a given grid cell.

Name	Type	Extra Dimensions	Explanation
Latitude	32-bit floating-point	None	Array of 360 x 180 latitude values at the center of the grid box (Degrees).
Longitude	32-bit floating-point	None	Array of 360 x 180 longitude values at the center of the grid box (Degrees).
LandSeaMask	16-bit integer	None	Land sea mask. 1 = land, 0 = ocean. (Unitless)
Topography	32-bit floating-point	None	Topography of the Earth in meters above the geoid. Original data source: PGS Toolkit

3.2 Attributes

These fields appear only once per Level 3 granule.

Name	Type	Extra Dimensions	Explanation
NumOfDays	32-bit integer	None	Total number of days of input Level 2 data included in gridded maps.
AscendingGridStartTimeUTC	String of 8-bit characters	None	Begin time of mapped fields (UTC), ascending.
AscendingGridEndTimeUTC	String of 8-bit characters	None	End time of mapped fields (UTC), ascending.
DescendingGridStartTimeUTC	String of 8-bit characters	None	Begin time of mapped fields (UTC), descending.
DescendingGridEndTimeUTC	String of 8-bit characters	None	End time of mapped fields (UTC), descending.
TempPresLvlNum	32-bit integer	None	Number of pressure levels associated with temperature profiles and geopotential height.
TmpPresLvls	32-bit floating point	TempPresLvlNum (24)	Standard pressure (mb) for each of 24 levels in the atmosphere associated with temperature profiles and geopotential height. The array order is from the surface upward, in conformance with WMO standard. Note that the Level-3 pressure

			levels are a subset of Level-2 pressure levels and are constrained to begin at 1000.0 mb and end at 1.0 mb.
H2OPresLvlNum	32-bit integer	None	Number of pressure levels associated with AIRS Level-3 water vapor profiles.
H2OPresLvls	32-bit floating point	H2OPresLvlNum (12)	Standard pressure (mb) for each of 12 layers in the atmosphere associated with AIRS Level-3 water vapor profiles. The array order is from surface upward in accordance with the WMO standard. Note that Level-3 pressure levels for water vapor are constrained to be between 1000.0 and 100.0 mb.
IREmisFreqs	32-bit floating point	4	Frequencies corresponding to each of the 4 IR emissivity values reported in the AIRS Level 3 Standard Product. (832.0, 961.0, 1203.0, 2616.0 cm-1)
MWEmisFreqs	32-bit floating point	3	Frequencies corresponding to each of the 3 microwave emissivity values reported in the AIRS Level 3 Standard Product. (23.0, 50.3, and 89.0 GHz)
CH4TrapLyrNum	32-bit integer	None	Number of trapezoid layers associated with AIRS Level-3 CH4 profiles.
CH4_TrapezoidLayers	32-bit integer	CH4TrapLyrNum (3)	Trapezoid layers associated with AIRS Level-3 CH4 profiles. (51, 60, 67)
COTrapLyrNum	32-bit integer	None	Number of trapezoid layers associated with AIRS Level-3 CO profiles.
CO_TrapezoidLayers	32-bit integer	COTrapLyrNum (7)	Trapezoid layers associated with AIRS level-3 CO profiles. (45, 56, 63, 70, 81, 89, 93)

3.3 Ascending and Descending Grid Fields

The terms “ascending or descending” refer to the direction of the sub-satellite point in the satellite track. The direction of the ascending node is north and the descending node is south. We separate Level 3 Standard products by ascending (day) and descending (night) orbits to mitigate diurnal differences in the data parameters (e. g., Surface Skin Temperature, etc.).
These fields (data, error estimates where applicable, counts and standard deviation) appear once per ascending or descending grid. The ‘_A’ or ‘_D’ following a parameter name identifies the orbital node (A=ascending, D=descending) and thus, the grid.

Name	**Type**	**Extra Dimensions**	**Explanation**
TotalCounts_A TotalCounts_D	16-bit integer	None	Total counts of all points that fell within a 1°x1° grid cell whether they were included in the final L3 product or not. Used for QC.
TotCldLiqH2O_A TotCldLiqH2O_D	32-bit floating point	None	Mean total integrated column cloud liquid water. (kg/m2)
TotCldLiqH2O_A_sdev	32-bit floating point	None	Standard deviation for cloud liquid water. (kg/m2)

TotCldLiqH2O_D_sdev			
TotCldLiqH2O_A_ct TotCldLiqH2O_D_ct	16-bit integer	None	Number of input points for cloud liquid water per 1°x1° grid cell. (Count)
TotCldLiqH2O_A_err TotCldLiqH2O_D_err	32-bit floating point	None	Error estimate of total integrated column cloud liquid water. (kg/m2)
TotH2OVap_A TotH2OVap_D	32-bit floating point	None	Total integrated column water vapor burden. (kg/m2)
TotH2OVap_A_sdev TotH2OVap_D_sdev	32-bit floating point	None	Standard deviation for precipitable water. (kg/m2)
TotH2OVap_A_ct TotH2OVap_D_ct	16-bit integer	None	Number of input points for precipitable water per 1°x1° grid cell. (Count)
TotH2OVap_A_err TotH2OVap_D_err	32-bit floating point	None	Error estimate for total integrated column water vapor burden. (kg/m2)
TotO3_A TotO3_D	32-bit floating point	None	Total integrated column ozone burden. (Dobson units)
TotO3_A_sdev TotO3_D_sdev	32-bit floating point	None	Standard deviation for total ozone. (Dobson units)
TotO3_A_ct TotO3_D_ct	16-bit integer	None	Number of input points for total ozone per 1°x1° grid cell. (Count)
TotO3_A_err TotO3_D_err	32-bit floating point	None	Error estimate of total column ozone (Dobson units).
SurfAirTemp_A SurfAirTemp_D	32-bit floating point	None	Temperature of the atmosphere at the Earth's surface. (Kelvin)
SurfAirTemp_A_sdev SurfAirTemp_D_sdev	32-bit floating point	None	Standard deviation for atmospheric surface temperature. (Kelvin)
SurfAirTemp_A_ct SurfAirTemp_D_ct	16-bit integer	None	Number of input points for atmospheric surface temperature per 1°x1° grid cell. (Count)
SurfAirTemp_A_err SurfAirTemp_D_err	32-bit floating point	None	Error estimate of surface air temperature (Kelvin).
SurfSkinTemp_A SurfSkinTemp_D	32-bit floating point	None	Surface skin temperature. (Kelvin)
SurfSkinTemp_A_sdev SurfSkinTemp_D_sdev	32-bit floating point	None	Standard deviation for surface skin temperature. (Kelvin)
SurfSkinTemp_A_ct SurfSkinTemp_D_ct	16-bit integer	None	Number of input points for surface skin temperature per 1°x1° grid cell. (Count)
SurfSkinTemp_A_err SurfSkinTemp_D_err	32-bit floating point	None	Error estimate of surface skin temperature. (Kelvin)
SurfPres_A SurfPres_D	32-bit floating point	None	Mean surface pressure. (mb)
SurfPres_A_sdev SurfPres_D_sdev	32-bit floating point	None	Standard deviation for surface pressure. (mb)
SurfPres_A_ct SurfPres_D_ct	16-bit integer	None	Number of input points for mean surface pressure per 1°x1° grid cell. (Count)
OLR_A OLR_D	32-bit floating point	None	Outgoing long-wave radiation flux. (watts/m2)
OLR_A_sdev OLR_D_sdev	32-bit floating point	None	Standard deviation for outgoing long-wave radiation. (watts/m2)
OLR_A_ct OLR_D_ct	16-bit integer	None	Number of input points for outgoing log-wave radiation per 1°x1° grid cell. (Count)
ClrOLR_A ClrOLR_D	32-bit floating point	None	Clear-sky outgoing long-wave radiation flux. (watts/m2)
ClrOLR_A_sdev	32-bit floating point	None	Standard deviation for clear-sky outgoing long-

ClrOLR_D_sdev			wave radiation. (watts/m2
ClrOLR_A_ct ClrOLR_D_ct	16-bit integer	None	Number of input points for clear-sky outgoing log-wave radiation per 1°x1° grid cell. (Count)
EmisIR_A EmisIR_D	32-bit floating point	4	IR surface emissivity on a frequency grid (832, 961, 1203, 2616 cm-1.)
EmisIR_A_sdev EmisIR_D_sdev	32-bit floating point	4	Standard deviation for IR surface emissivity. (832, 961, 1203, 2616 cm-1.)
EmisIR_A_ct EmisIR_D_ct	16-bit integer	4	Number of input points for IR surface emissivity per 1°x1° grid cell and for each frequency grid point. (Count)
EmisIR_A_err EmisIR_D_err	32-bit floating point	4	Error estimate of IR surface emisivity for each frequency grid point.
GPHeight_A GPHeight_D	32-bit floating point	24	Geopotential height in meters at 24 standard pressure levels from 1000. to 1.0 mb. (Meters)
GPHeight_A_sdev GPHeight_D_sdev	32-bit floating point	24	Standard deviation for Geopotential height. (Meters)
GPHeight_A_ct GPHeight_D_ct	16-bit integer	24	Number of input points for geopotential height per 1°x1° grid cell and at each pressure level. (Count)
CloudFrc_A CloudFrc_D	32-bit floating point	None	Combined layer cloud fraction. (0-1). (Unitless)
CloudFrc_A_sdev CloudFrc_D_sdev	32-bit floating point	None	Standard deviation of combined layer cloud fraction. (Unitless)
CloudFrc_A_ct CloudFrc_D_ct	16-bit integer	None	Number of input points for cloud fraction per 1°x1° grid cell. (Count)
CloudFrc_A_err CloudFrc_D_err	32-bit floating point	None	Error estimate of combined layer cloud fraction. (Unitless)
CloudTopPres_A CloudTopPres_D	32-bit floating point	None	Combined cloud top pressure (weighted by cloud fraction). (mb)
CloudTopPres_A_sdev CloudTopPres_D_sdev	32-bit floating point	None	Standard deviation of combined cloud top pressure. (mb)
CloudTopPres_A_ct CloudTopPres_D_ct	16-bit integer	None	Number of input points for cloud pressure per 1°x1° grid cell. (Count)
CloudTopPres_A_err CloudTopPres_D_err	32-bit floating point	None	Error estimate of combined cloud top pressure. (millibar)
CoarseCloudFrc_A CoarseCloudFrc_D	32-bit floating point	3	Cloud fraction at coarse cloud resolution. 3 layers: low, middle, high. (Unitless)
CoarseCloudFrc_A_sdev CoarseCloudFrc_D_sdev	32-bit floating point	3	Standard deviation of coarse cloud layers. (Unitless)
CoarseCloudFrc_A_ct CoarseCloudFrc_D_ct	16-bit integer	3	Number of input points for coarse fraction per 1°x1° grid cell and at each coarse layer. (Count)
CoarseCloudTemp_A CoarseCloudTemp_D	32-bit floating point	3	Cloud top temperature at coarse cloud resolution. 3 layers: low, middle, high. (Kelvin)
CoarseCloudTemp_A_sdev CoarseCloudTemp_D_sdev	32-bit floating point	3	Standard deviation of coarse cloud top temperature. (Unitless)
CoarseCloudTemp_A_ct CoarseCloudTemp_D_ct	16-bit integer	3	Number of input points for coarse cloud top temperature per 1°x1° grid cell and at each coarse layer. (Count)
CoarseCloudPres_A CoarseCloudPres_D	32-bit floating point	3	Cloud layer pressure at coarse cloud resolution. 3 layers: low, middle, high. (millibars)
CoarseCloudPres_A_sdev CoarseCloudPres_D_sdev	32-bit floating point	3	Standard deviation of coarse cloud layer pressure. (millibars)
CoarseCloudPres_A_ct	16-bit integer	3	Number of input points for coarse cloud layer

CoarseCloudPres_D_ct			pressure per 1°x1° grid cell and at each coarse layer. (Count)
FineCloudFrc_A FineCloudFrc_D	32-bit floating point	12	Cloud fraction at fine cloud resolution. 12 vertical layers. (Unitless)
FineCloudFrc_A_sdev FineCloudFrc_D_sdev	32-bit floating point	12	Standard deviation of fine cloud fraction. (Unitless)
FineCloudFrc_A_ct FineCloudFrc_D_ct	16-bit integer	12	Number of input points for fine cloud fraction per 1°x1° grid cell and at each coarse layer. (Count)
RelHumid_A RelHumid_D	32-bit floating point	12	Relative humidity profile in 12 Standard pressure levels from 1000. to 100. mb. (Percent)
RelHumid_A_sdev RelHumid_D_sdev	32-bit floating point	12	Standard deviation for relative humidity profiles. (Percent)
RelHumid_A_ct RelHumid_D_ct	16-bit integer	12	Number of input points for relative humidity profiles per 1°x1° grid cell and at each pressure level. (Count)
H2OVapMMR_A H2OVapMMR_D	32-bit floating point	12	Water vapor mass mixing ratio at 12 standard pressure levels from 1000. to 100. mb (gm/kg dry air)
H2OVapMMR_A_sdev H2OVapMMR_D_sdev	32-bit floating point	12	Standard deviation for water vapor mass mixing ratio. (gm/kg dry air)
H2OVapMMR_A_ct H2OVapMMR_D_ct	16-bit integer	12	Number of input points for water vapor mass mixing ratio per 1°x1° grid cell and at each pressure level. (Count)
H2OVapMMR_A_err H2OVapMMR_D_err	32-bit floating point	12	Error estimate of water vapor mass mixing ratio at 12 standard pressure levels. (gm/kg dry air)
Temperature_A Temperature_D	32-bit floating point	24	Atmospheric temperature profile in 24 standard pressure levels from 1000. to 1.0 mb. (Kelvin)
Temperature_A_sdev Temperature_D_sdev	32-bit floating point	24	Standard deviation for Temperature profiles. (Kelvin)
Temperature_A_ct Temperature_D_ct	16-bit integer	24	Number of input points for temperature profiles per 1°x1° grid cell and at each pressure level. (Count)
Temperature_A_err Temperature_D_err	32-bit floating point	24	Error estimate of atmospheric temperature profile at 24 standard pressure levels from 1000. To 1.0 mb. (Kelvin)
TropPres_A Trop_Pres_D	32-bit floating point	None	Pressure of the tropopause. (millibars)
TropPres_A_sdev Trop_Pres_D_sdev	32-bit floating point	None	Standard deviation of the tropoause pressure within the grid box. (millibars)
TropPres_A_ct Trop_Pres_D_ct	16-bit integer	None	Number of input points for tropopause pressure per 1°x1° grid cell. (Count)
TropHeight_A Trop_Height_D	32-bit floating point	None	Height of the tropopause. (meters)
TropHeight_A_sdev Trop_Height_D_dev	32-bit floating point	None	Standard deviation of the height of the tropopause. (meters)
TropHeight_A_ct Trop_Height_D_ct	16-bit integer	None	Number of input points for tropopause height per 1°x1° grid cell. (Count)
TropTemp_A TropTemp_D	32-bit floating point	None	Temperature of the tropopause. (Kelvin)
TropTemp_A_sdev TropTemp_D_sdev	32-bit floating point	None	Standard deviation of the tropopause temperature. (Kelvin)
TropTemp_A_ct TropTemp_D_ct	16-bit integer	None	Number of input points for tropopause temperature per 1°x1° grid cell. (Count)

CO_total_column_A CO_total_column_D	32-bit floating point	None	Retrieved total column CO. (molecules/cm2)
CO_total_column_A_sdev CO_total_column_D_sdev	32-bit floating point	None	Standard deviation of total column CO. (molecules/cm2)
CO_total_column_A_ct CO_total_column_D_ct	16-bit integer	None	Number of input points for total column CO per 1°x1° grid cell. (Count)
CO_VMR_eff_A CO_VMR_eff_D	32-bit floating point	7	Effective CO volume mixing ratio for 7 trapezoid layers between 45 and 100. (ppmv)
CO_VMR_eff_A_sdev CO_VMR_eff_D_sdev	32-bit floating point	7	Standard deviation of effective CO volume mixing ratio. (ppmv)
CO_VMR_eff_A_ct CO_VMR_eff_D_ct	16-bit integer	7	Number of input points for effective CO volume mixing ratio per 1°x1° grid cell and at each trapezoid layer. (Count)
CO_VMR_eff_A_err CO_VMR_eff_D_err	32-bit floating point	7	Error estimate for CO volume mixing ratio. (ppmv)
CO_Verticality_A CO_Verticality_D	32-bit floating point	7	CO verticality (sum of averaging kernels) at 7 trapezoid layers. (Unitless)
CO_Verticality_A_sdev CO_Verticality_D_sdev	32-bit floating point	7	Standard deviation of CO verticality. (Unitless)
CO_Verticality_A_ct CO_Verticality_D_ct	16-bit integer	7	Number of input points for CO verticality per 1°x1° grid cell for 7 trapezoid layers. (Count)
CO_eff_press_A CO_eff_press_D	32-bit floating point	7	Effective pressure of CO retrieval for each of 7 trapezoid layers. (millibars)
CO_eff_press_A_sdev CO_eff_press_D_sdev	32-bit floating point	7	Standard deviation of CO effective pressure. (millibars)
CO_eff_press_A_ct CO_eff_press_D_ct	16-bit integer	7	Number of input points for CO effective pressure per 1°x1° grid cell at 7 trapezoid layers. (Unitless)
CH4_VMR_eff_A CH4_VMR_eff_D	32-bit floating point	3	Effective CH4 volume mixing ratio for 3 trapezoid layers between 51 and 73. (ppmv)
CH4_VMR_eff_A_sdev CH4_VMR_eff_D_sdev	32-bit floating point	3	Standard deviation of effective CH4 volume mixing ratio. (ppmv)
CH4_VMR_eff_A_ct CH4_VMR_eff_D_ct	16-bit integer	3	Number of input points for effective CH4 volume mixing ratio per 1°x1° grid cell and at each trapezoid layer. (Count)
CH4_VMR_eff_A_err CH4_VMR_eff_D_err	32-bit floating point	3	Error estimate for CH4 volume mixing ratio. (ppmv)
CH4_eff_press_A CH4_eff_press_D	32-bit floating point	3	Effective pressure of CH4 retrieval for each of 3 trapezoid layers. (millibars)
CH4_eff_press_A_sdev CH4_eff_press_D_sdev	32-bit floating point	3	Standard deviation of CH4 effective pressure. (millibars)
CH4_eff_press_A_ct CH4_eff_press_D_ct	16-bit integer	3	Number of input points for CH4 effective pressure per 1°x1° grid cell at 3 trapezoid layers. (Unitless)

3.4 Microwave_only Ascending and Descending Grid Fields

Name	Type	Extra Dimensions	Explanation
TotalCounts_MW_A TotalCounts_MW_D	16-bit integer	None	Total counts of all points that fell within a 1°x1° grid cell whether they were included in the final L3 product or not. Used for QC.
TotH2OVap_MW_A TotH2OVap_MW_D	32-bit floating point	None	Total integrated column water vapor burden. (kg/m2)
TotH2OVap_MW_A_sdev TotH2OVap_MW_D_sdev	32-bit floating point	None	Standard deviation for total integrated column water vapor burden. (kg/m2)
TotH2OVap_MW_A_ct TotH2OVap_MW_D_ct	16-bit integer	None	Number of input points for total integrated column water vapor burden 1°x1° grid cell. (Count)
EmisMW_MW_A EmisMW_MW_D	32-bit floating point	3	Microwave spectral emissivity on a frequency grid (23.8, 50.3 and 89.0 GHz).
EmisMW_MW_A_sdev EmisMW_MW_D_sdev	32-bit floating point	3	Standard deviation for microwave spectral emissivity.
EmisMW_MW_A _ct EmisMW_MW_D_ct	16-bit integer	3	Number of input points for microwave spectral emissivity per 1°x1° grid cell and frequency grid point. (Count)
GPHeight_MW_A GPHeight_MW_D	32-bit floating point	24	Microwave-only geopotential height in meters at 24 standard pressure levels from 1000. to 1.0 mb. (Meters)
GPHeight_MW_A_sdev GPHeight_MW_D_sdev	32-bit floating point	24	Standard deviation for microwave-only geopotential height. (Meters)
GPHeight_MW_A_ct GPHeight_MW_D_ct	16-bit integer	24	Number of input points for geopotential height per 1°x1° grid cell and at each pressure level. (Count)
Temperature_MW_A Temperature_MW_D	32-bit floating point	24	Microwave-only atmospheric temperature profile in 24 standard pressure levels from 1000. to 1.0 mb. (Kelvin)
Temperature_MW_A_sdev Temperature_MW_D_sdev	32-bit floating point	24	Standard deviation for microwave-only temperature profiles. (Kelvin)
Temperature_MW_A_ct Temperature_MW_D_ct	16-bit integer	24	Number of input points for temperature profiles per 1°x1° grid cell and at each pressure level. (Count)

4. Options for Reading Data

The HDF Group provides various utilities for viewing the contents of HDF files and extracting the raster, binary, or ASCII objects (see http://hdf.ncsa.uiuc.edu/products/index.html)

4.1 Command-line utilities

4.1.1 read_hdf

The read_hdf tool is a command-line utility developed by GES DISC. It allows user to browse the file structure and display data values if desired. The source code is written in C language and can be obtained from: ftp://disc1.gsfc.nasa.gov/software/aura/read_hdf

Command line syntax:

```
read_hdf [-l] | [[-i | -d] [-a <output> | -b <base>.*.bin ]]  filename

Options/Arguments:

   [-i] -- run in interactive mode (default), or
   [-l] -- list a tree of file objects, or
   [-d] -- dump all HDF object types (no filtering)
   [-a <output>] -- ASCII output file name (default is <filename>.txt)
   [-b <base>] -- base binary output file name (default is <filename>)
                  creates two files per HDF object:
                  <base>.*.met for metadata, and <base>.*.bin for binary data
                  (default output to stdout)
   filename -- name of the input HDF file
```

4.1.2 ncdump

The **ncdump** dumps HDF to ASCII format

```
ncdump [-c|-h] [-v ...] [[-b|-f] [c|f]] [-l len] [-n name] [-d n[,n]]
filename

Options/Arguments:
  [-c]               Coordinate variable data and header information
  [-h]               Header information only, no data
  [-v var1[,...]]    Data for variable(s) <var1>,... only
  [-b [c|f]]         Brief annotations for C or Fortran indices in data
  [-f [c|f]]         Full annotations for C or Fortran indices in data
  [-l len]           Line length maximum in data section (default 80)
  [-n name]          Name for netCDF (default derived from file name)
  [-d n[,n]]         Approximate floating-point values with less precision
  filename           File name of input netCDF file
e.g.
     ncdump <inputfilename.hdf>
            dumps the entire contents of an HDF file to ASCII format
     ncdump -v <variable name> <inputfilename.hdf>
```

```
       dump one data variable from the HDF file to ASCII format
ncdump -h <inputfilename.hdf> | more
       dump only the metadata information to the screen
ncdump -h <inputfilename.hdf> > ascii.out
       dump this metadata information to an output file named ascii.out
```

Note: the ncdump tool will only display variables whose ranks are great than 1.

Step-by-step instructions how to download, install and execute ncdump commands.
(from http://nsidc.org/data/hdfeos/hdf_to_ascii.html#unix/linx)

The ncdump -H command provides instructions for using ncdump. Comprehensive yet simple instructions for extracting data and metadata from HDF files are given below.

UNIX/Linux Users

Download HDF Libraries from The HDF Group Web Site
**Note that HDFgroup may change its web page at any time and the URLs below cannot be guaranteed.

HDF libraries are required to run ncdump on UNIX/Linux platforms. The following instructions assume you are using either sh, csh, or tcsh on a UNIX/Linux system.
Go to the szip compression external libraries pre-compiled binaries at:
ftp://ftp.hdfgroup.org/lib-external/szip/2.0/bin/.

Follow the link to the directory for your operating system and download the corresponding "noenc" file to your home directory.
Example: szip2.0-linux-noenc.tar.gz

Gunzip the file you downloaded using the following command:
gunzip szip2.0-linux-noenc.tar.gz
Untar the resulting tar file using the following command:
tar xvf szip2.0-linux-noenc.tar

Note: This creates the directory szip2.0-linux-noenc in your home directory.
Check to see if you have the environment variable LD_LIBRARY_PATH defined by typing:
echo $LD_LIBRARY_PATH
Choose one of the following steps:
If the environment variable LD_LIBRARY_PATH is defined, add the szip library directory to your existing LD_LIBRARY_PATH environment variable by typing:

setenv LD_LIBRARY_PATH LD_LIBRARY_PATH\:$HOME/szip2.0-linux-noenc/lib
If the environment variable LD_LIBRARY_PATH is not defined, the following message displays on your screen:
LD_LIBRARY_PATH:Undefined variable, set the LD_LIBRARY_PATH environment variable to the szip library directory by typing:

setenv LD_LIBRARY_PATH $HOME/szip2.0-linux-noenc/lib
Download ncdump from The HDF Group Web Site
Go to Pre-Compiled Binary Distributions. (ftp://ftp.hdfgroup.org/HDF/HDF_Current/bin)
Select the appropriate directory for your platform.
Follow the link to the utilities directory.
Download ncdump to your local drive using an ftp application.
Type the following command to ensure the owner and the group of the file have read, write, and execute permission for running ncdump:

chmod 775 ncdump

Dump HDF to ASCII Format
Choose one of the following steps:
To dump the entire contents of an HDF file to ASCII format, type the following command:
ncdump <inputfilename.hdf>

To dump one data variable from the HDF file to ASCII format, type the following command:
ncdump –v <variable name> <inputfilename.hdf>

To dump only the metadata information to the screen, type the following command:
ncdump -h <inputfilename.hdf> | more

To dump this metadata information to an output file named ascii.out, type the following command:
ncdump -h <inputfilename.hdf> > ascii.out

Windows NT/98/2000/XP Users
Download ncdump from The HDF Group Web Site
Go to: ftp://ftp.hdfgroup.org/HDF/HDF_Current/bin/windows/utilities.

Download the ncdump.exe file to your local drive.
For Windows XP users, you must download library files, to the same directory where you downloaded the ncdump.exe file.
For further information, check http://hdf.ncsa.uiuc.edu/release4/obtain.html

Choose one of the following steps:
To dump the entire contents of an HDF file to ASCII format, type the following command:
ncdump <inputfilename.hdf>

To dump one data variable from the HDF file to ASCII format, type the following command:
ncdump –v <variable name> <inputfilename.hdf>

To dump only the metadata information to the screen, type the following command:
ncdump -h <inputfilename.hdf> | more

Note: Either Microsoft Word or WordPad can read the metadata file. If your computer does not automatically open the file with one of these applications, you may have to manually open the file after starting Word or WordPad.

4.1.3 hdp

hdp is a command line utility designed for quick display of contents and data of HDF objects. It can list the contents of hdf files at various levels with different details. It can also dump the data of one or more specific objects in the file.

```
Usage: hdp [-H] command [command options] <filelist>
         -H  Display usage information about the specified command.
             If no command is specified, -H lists all commands.

         Commands:
             list       lists contents of files in <filelist>
             dumpsds    displays data of SDSs in <filelist>
             dumpvd     displays data of vdatas in <filelist>.
             dumpvg     displays data of vgroups in <filelist>.
             dumprig    displays data of RIs in <filelist>.
             dumpgr     displays data of RIs in <filelist>.
```

Detailed information on how to download, install and execute **hdp** command is found at http://nsidc.org/data/hdfeos/hdf_to_binary.html

4.2 GUI tools

The HDFView (http://hdf.ncsa.uiuc.edu/hdf-java-html/hdfview/) is a visual tool for browsing and editing NCSA HDF4 and HDF5 files and is available for various platforms (Windows 98/NT/2000/XP, Solaris, Linux, AIX, Irix 6.5, MacOSX). Using HDFView, you can:

(1) view a file hierarchy in a tree structure
(2) create new file, add or delete groups and datasets
(3) view and modify the content of a dataset
(4) add, delete and modify attributes
(5) replace I/O and GUI components such as table view, image view and metadata view

User, especially **those who are not familiar with Unix/Linux environment** are strongly encouraged to use HDFView for a quick access to data contents.
There is also an add-on plug-in for handling HDFEOS data specifically, which you can download from: http://opensource.gsfc.nasa.gov/projects/hdf/hdf.php

4.3 Read software in C, Fortran, IDL and MATLAB

AIRS science team provides reader software in IDL, MATLAB, C and FORTRAN programming language. You can download them from GES DISC web site:

(1) IDL / MATLAB suite along with sample HDFEOS data files (http://disc.gsfc.nasa.gov/AIRS/documentation/v5_docs/AIRS_V5_Release_User_Docs/IDL_MATLAB_READERS.tar.gz)
(2) FORTRAN / C suite along with sample HDFEOS data files (http://disc.gsfc.nasa.gov/AIRS/documentation/v5_docs/AIRS_V5_Release_User_Docs/FORTRAN_C_READERS.tar.gz)

5. Data Interpretation and Screening

5.1 Geolocation Fields

These fields are within the location grid and document pertinent information for determining the location and characteristics of a given grid cell.

Coastlines
Atmospheric and surface fields such as surface temperature, and lower tropospheric temperature and water vapor depend on the properties of the surface, specifically whether it is land or ocean/sea. Interpreting infrared and microwave radiances is more complicated over land, and interpreting coastal footprints seeing both ocean and land is still more complicated. Because of this, AIRS Level 3 processing sorts input Level 2 data footprints based on the surface scene type (land or ocean) for the purpose of averaging fields within a grid box. We developed a static 1°x1° LandSeaMask based on the EOS Digital Elevation Map (DEM) where each cell is defined as one of the following 8 types:

Mask	Cell Characterization
0	Shallow Ocean
1	Land Only
2	Ocean/Lake Coast
3	Shallow Inland H2O
4	Ephemeral H2O
5	Deep Inland H2O
6	Continental Shelf Ocean
7	Deep Ocean

A Level 2 retrieval is first classified according to the mask value of the bin into which its centroid latitude/longitude falls as water (mask value = 0,3,5,6,7) or land (mask value = 1,2,4). A threshold test is then applied to its associated landFrac to filter out coastline FOVs. If landFrac for the FOV falls within the range:

$$0.1 < \text{landFrac} < 0.5$$

the FOV is considered to include a coastline and is not included in the generation of the Level 3 product. We do this to avoid mixing land and water in a single grid box. We attempt to maintain separation between land and ocean in the Level 3 gridded product, and a retrieval spanning a coastline is by nature heterogeneous.

The location grid contains 4 fields each of which are 360x180 element arrays. The elements provide the location and characteristics of the grid cells:

Name	Type	Extra Dimensions	Explanation
Latitude	32-bit floating-point	None	Array of 360 x 180 latitude values at the center of the grid box (Degrees).
Longitude	32-bit floating-point	None	Array of 360 x 180 longitude values at the center of the grid box (Degrees).
LandSeaMask	16-bit integer	None	Land sea mask. 1 = land, 0 = ocean. (Unitless)
Topography	32-bit floating-point	None	Topography of the Earth in meters above the geoid. Original data source: PGS Toolkit

Values of -9999 (if integer) and -9999.0 (if float) or a count of 0 indicate invalid or missing data.

The data included in the gridding on a particular day start at the international dateline and progress westward (as do the subsequent orbits of the satellite) so that neighboring gridded cells of data are no more than a swath of time apart (about 90 minutes). The two parts of a scan line that crosses the dateline are included in separate data sets, according to the appropriate date. This ensures that data points in a grid box are always coincident in time. The edge of the AIRS Level 3 gridded cells is at the date line (the 180E/W longitude boundary). When plotted, this produces a map with 0 degrees longitude in the center of the image unless the bins are reordered. This method is preferred because the left (West) side of the image and the right (East) side of the image contain data farthest apart in time. The daily Level 3 products will have gores (cells with no data) between the satellite paths where there is no coverage for that day.

Each product is separated into ascending and descending portion of the orbit, where “ascending or descending” refers to the direction of movement of the sub-satellite point in the satellite track at the equatorial crossing. The ascending direction of movement is from Southern Hemisphere to Northern Hemisphere, with an equatorial crossing time of 1:30 PM local time; the descending direction of movement is from Northern Hemisphere to Southern Hemisphere, with an equatorial crossing time of 1:30 AM local time. Outside of the polar zones, these correspond respectively to daytime and nighttime.

Users of AIRS Level 3 products should be aware that the temporal span of Level 3 daily files is not midnight-to-midnight. The data proceeds in time from left (-180.0°) to right (180.0°) with neighboring cells of data no more than a swath of time apart. This ensures that data points in a grid box are always coincident in time, if the data were gridded using a midnight-to-midnight time scheme, the start of the day and the end of the day would be in the same grid cell, producing an artificial time discontinuity across the grid. The edges of the AIRS Level 3 cells are at the date line (the 180E/W longitude boundary). When plotted, this produces a map with 0 degrees longitude in the center of the image. This method is preferred because the left side of the grid and the right side of the grid contain data farthest apart in time. The method used analogous to that used to create TOVS Pathfinder level 3 products.

5.2 Error Estimates

Each Level 3 Product (including daily) contains four grids containing fields created using the appropriate Level 2 products whose quality indicators are "best" or "good. Each grid provides a 360x180xn array of the mean, standard deviation and count of Level 2 retrievals combined, where the "extra dimension" n=1 if the product not a profile. This allows the user to create custom Level 3 products over any desired time span via a simple combination of the published products. Each grid also provides a 360x180 array of total count of observations, whether included in the calculation of the Level 3 product or not. This provides a measure of the sampling of a reported Level 3 product, but not of the sampling bias.

The V5 Level 3 gridded products are derived from the Level 2 standard swath products. The Level 2 quality indicators determine which of the Level 2 Standard Product data are combined to create the Level 3 Product. It is important that the user of Level 3 Products become familiar with these quality indicators, and we urge the user to read the documentation describing the AIRS Level 2 Standard Products and the AIRS Level 2 Quality Control and Error Estimation for a description of the quality indicators, how they are set and how to use them. As a general rule, Level 2 retrieved quantities whose quality indicators are "best" (=0) or "good" (=1) are included in the sums that generate the Level 3 product. Information contained within these two documents will not be repeated in this document, and users MUST read them to avoid misuse of the Level 3 products in their research.

Level-2 Standard Products Quick Start
(http://disc.sci.gsfc.nasa.gov/AIRS/documentation/v5_docs/AIRS_V5_Release_User_Docs/V5_L2_Standard_Product_QuickStart.pdf)
V5_L2_Quality_Control_and_Error_Estimation
(http://disc.sci.gsfc.nasa.gov/AIRS/documentation/v5_docs/AIRS_V5_Release_User_Docs/V5_L2_Quality_Control_and_Error_Estimation.pdf)

Table of contents for **V5_L2_Quality_Control_and_Error_Estimation**

Qual_O3
Qual_CO
Qual_CH4
Qual_CO2
Qual_Cloud_OLR
Qual_clrolr
Qual_CC_Rad
Qual_Precip_Est
Qual_Clim_Ind

Also, please refer to the Advanced Theoretical Basis Document (ATBD) for AIRS Full Validation, AIRS Validation Plan (http://eospso.gsfc.nasa.gov/eos_homepage/for_scientists/atbd/docs/AIRS/AIRSValP2doc.pdf)

The retrieval flow is also summarized in the AIRS/AMSU/HSB Version 5 Retrieval Flow (http://disc.sci.gsfc.nasa.gov/AIRS/documentation/v5_docs/AIRS_V5_Release_User_Docs/V5_Retrieval_Flow.pdf) document.

6. More Information

6.1 Pointers/References to articles discussing product validity and quality

Report on the status of V5 calibration and validation is provided in the document:
V5_CalVal_Status_Summary.pdf
(http://disc.gsfc.nasa.gov/AIRS/documentation/v5_docs/AIRS_V5_Release_User_Docs/V5_CalVal_Status_Summary.pdf)

Users are also encouraged to read the following document.
Level-3 Standard 1x1° Gridded Products Quick Start
(http://disc.sci.gsfc.nasa.gov/AIRS/documentation/v5_docs/AIRS_V5_Release_User_Docs/V5_L3_QuickStart.pdf)

6.2 Pointers/References to articles using the data.

AIRS/AMSU/HSB will observe and characterize the entire atmospheric column from the surface to the top of the atmosphere in terms of surface emissivity and temperature, atmospheric temperature and humidity profiles, cloud amount and height, and the spectral outgoing infrared radiation. These data and scientific investigations will answer long-standing questions about the exchange and transformation of energy and radiation in the atmosphere and at the Earth's surface such as: (http://disc.sci.gsfc.nasa.gov/AIRS/applications.shtml)

- Determination of the factors that control the global energy and water cycles
- Investigation of atmosphere-surface interactions
- Improving numerical weather prediction
- Detection of the effects of increased greenhouse gases
- Assessing climate variations and feedbacks
- Atmospheric Sounding

Other references and/or applicable documents can also be found at
http://airs.jpl.nasa.gov/Science/
http://airs.jps.nasa.gov/Documents/

6.3 Point of Contact

Short Name	NASA/GSFC/SED/ESD/GCDC/GESDISC	
Long Name	Goddard Earth Sciences Data and Information Services Center (formerly Goddard DAAC), Global Change Data Center, Earth Sciences Division, Science and Exploration Directorate, Goddard Space Flight Center, NASA	
URL	http://disc.gsfc.nasa.gov/ Data can be accessed via http://disc.gsfc.nasa.gov/AIRS/data_access.shtml Mirador: http://mirador.gsfc.nasa.gov/cgi-bin/mirador/homepageAlt.pl?keyword=AIRX3STD Anonymous FTP: ftp://acdisc.sci.gsfc.nasa.gov/ftp/data/s4pa/Aqua_AIRS_Level3 Giovanni (online visualization and analysis tool): http://acdisc.sci.gsfc.nasa.gov/Giovanni/airs/	
Contact	Name	GES DISC HELP DESK SUPPORT GROUP
	Email	gsfc-help-disc@lists.nasa.gov
	Phone	301-614-5224
	Fax	301-614-5268
	Address	Goddard Earth Sciences Data and Information Services Center, Code 610.2 NASA Goddard Space Flight Center, Greenbelt, MD, 20771, USA

7. Acronyms

ADPUPA Automatic Data Processing Upper Air (radiosonde reports)
ADPUPA Automatic Data Processing Upper Air (radiosonde reports)
AIRS Atmospheric infraRed Sounder
AMSU Advanced Microwave Sounding Unit
DAAC Distributed Active Archive Center
DISC Data and Information Services Center
DN Data Number
ECMWF European Centre for Medium Range Weather Forecasts (UK)
ECS EOSDIS Core System
EDOS Earth Observing System Data and Operations System
EOS Earth Observing System
EOSDIS Earth Observing System Data and Information System
ESDT Earth Science Data Type
EU Engineering Unit
FOV Field of View
GDAAC Goddard Space Flight Center Distributed Active Archive Center
GES Goddard Earth Sciences
GSFC Goddard Space Flight Center
HDF Hierarchical Data Format
HSB Humidity Sounder for Brazil
L1A Level 1A Data
L1B Level 1B Data
L2 Level 2 Data
L3 Level 3 Data
LGID Local Granule IDentification
MW Microwave
NCEP National Centers for Environmental Prediction
NESDIS National Environmental Satellite, Data and Information Service
NIR Near Infrared
NOAA National Oceanic and Atmospheric Administration
PGE Product Generation Executive
PGS Product Generation System
PREPQC NCEP quality controlled final observation data
QA Quality Assessment
RTA Radiative Transfer Algorithm
SPS Science Processing System
URL Universal Reference Link
VIS Visible
WMO World Meteorological Organization