



**README Document for**

**AIRS Level-1B Version 5**

**VIS/NIR Calibrated Radiance Products:**

AIRVBRAD, AIRVBRAD\_NRT,  
AIRVBQAP, AIRVBQAP\_NRT

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## Revision History

<i>Revision Date</i>	<i>Changes</i>	<i>Author</i>
12/14/2007	Initial version	Young-In Won
2/15/2008	Revised to include NRT	Young-In Won
3/7/2008	Revised to add info on changes from version 4 to version 5 and info on AIRVBQAP	Young-In Won
7/21/2009	Removed reference to retired WHOM search engine	Randy Barth

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# 1. Introduction

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## 1.1 Brief background

This document applies to the Atmospheric Infrared Sounder (AIRS) Version 5 Level 1B Vis/Near Infrared Products (**AIRVBRAD**) which contain calibrated and geolocated radiance in milliWatts/m<sup>2</sup>·cm<sup>-1</sup>·steradian. The corresponding **AIRVBQAP** subset files exclude radiances and other large fields to deliver only Quality Assurance (QA) parameters in a compact format. There are many QA parameters that users may use to filter AIRS data to create a subset for analysis (see section 6 for more information). **AIRVBRAD\_NRT** and **AIRVBQAP\_NRT** (Near Real Time) products are also available within ~3 hours of observations globally and stay for about 5 days from the time they are generated. A brief description on changes from Version 4 to version 5 products is given in the following section.

This data set is generated from AIRS level 1A digital numbers (DN) and contains 4 channels in the 0.4 to 1.0  $\mu\text{m}$  region of the spectrum. A day's worth of AIRS data is divided into 240 scenes (granules), each of 6 minute duration. For the AIRS Visible/Near IR measurements, an individual scene contains 135 scanlines with a scanline containing 720 cross-track pixels by 9 along-track pixels. There is a total of  $720 \times 9 \times 135 = 874,800$  visible/near-IR pixels per scene.

AIRS employs a 49.5 degree cross-track scanning with a 1.1 degree IR (**Vis/NIR: 0.2 degree**) instantaneous field of view (IFOV) to provide twice daily coverage of essentially the entire globe in a 1:30 PM sun synchronous orbit. The primary purpose of the visible/near IR channels is the detection and flagging of clouds and significant inhomogeneities in the AIRS infrared field-of-view, which may adversely impact the quality of the temperature and moisture soundings. The AIRS visible/near IR channels will also be used for comparative studies with the higher resolution MODIS channels contained within this spectral region.

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

**Table 1. Basic characteristics of the AIRVBRAD data.**

Latitude Range	-90° to 90°N
Longitude extent	-180° to 180°E
horizontal resolution	2.3 x 2.3 km at nadir
Temporal resolution	6 minutes

## 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 (clr\_olr) 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  $\mu\text{m}$ ) and 4 bands in the visible (0.4 - 1.0  $\mu\text{m}$ ). 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  $\pm 49.5$  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.

## AIRS L1B Visible/NIR Calibrated Radiance Data

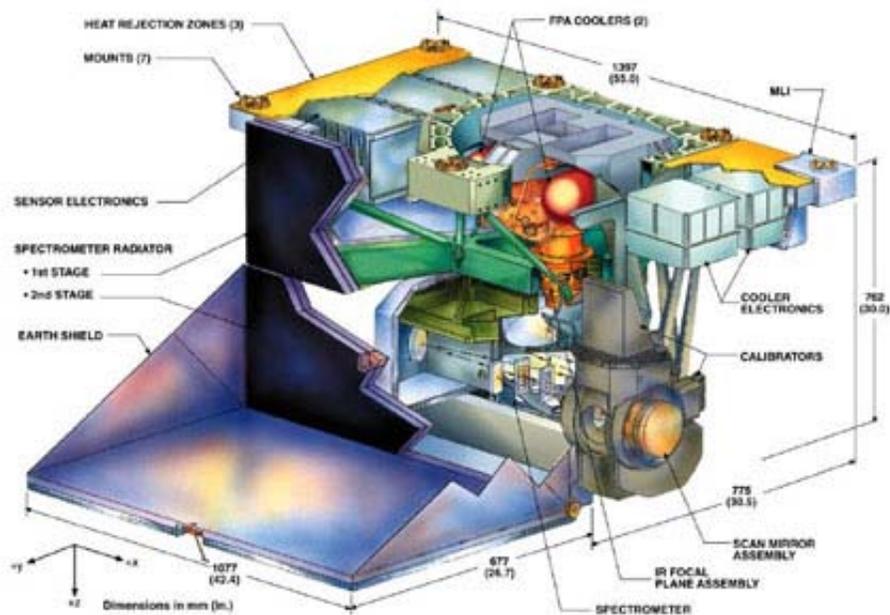


Figure 1. AIRS instrument cutaway drawing.

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. An 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 2. Technology - Specifications**

Instrument Type	Multi-aperture, non-Littrow echelle array grating spectrometer.
Infrared Spectral Coverage	3.74 - 4.61 $\mu\text{m}$ 6.20 - 8.22 $\mu\text{m}$ 8.80 - 15.4 $\mu\text{m}$
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	$\pm 49.5^\circ$ around nadir
Swath Width	1650 km nominal
Instantaneous Field of View (IFOV)	1.1 $^\circ$

## AIRS L1B Visible/NIR Calibrated Radiance Data

Measurement Simultaneity	>99%
Sensitivity (NEDT)	0.14 K at 4.2 $\mu\text{m}$ 0.20 K from 3.7 - 13.6 $\mu\text{m}$ 0.35 K from 13.6 - 15.4 $\mu\text{m}$
Radiometric Calibration	$\pm 3\%$ absolute error

### 1.3.2 AIRS Vis/NIR

AIRS has four Vis/NIR channels. Channel 1 (0.40 to 0.44  $\mu\text{m}$ ) is designed to be most sensitive to aerosols. Channels 2 (0.58 to 0.68  $\mu\text{m}$ ) and 3 (0.71 to 0.92  $\mu\text{m}$ ) approximate the response of AVHRR channels 1 and 2, respectively, and are particularly useful for surface studies. Channel 4 has a broadband response (0.49 to 0.94  $\mu\text{m}$ ) and can be used for energy balance studies. The VIS/NIR channels help to account for the effect of low-level clouds. The infrared and microwave channels sometimes have difficulty distinguishing low clouds from the surface. A photometric reference source is provided for calibration of the VIS/NIR channels.

The VIS/NIR channels have nominally six times the spatial resolution of the IR Sensor Assembly. Each IR footprint of the AIRS instrument is associated with a 9x8 array of Vis/NIR pixels. A single across-track scan of AIRS (90 IR footprints) corresponds to a Vis/NIR image of 720 pixels across-track, and 9 pixels along-track. The across-track pixels overlap with their neighbors by  $\sim 1/3$  of a pixel on each side. In the along-track direction, successive scan-lines overlap by 1.57 pixels.

**Table 3. AIRS Vis/NIR Specifications**

Instrument Type	Photometer boresighted to the the AIRS spectrometer
Spectral Coverage	0.41 - 0.44 $\mu\text{m}$ 0.58 - 0.68 $\mu\text{m}$ 0.71 - 0.92 $\mu\text{m}$ 0.49 - 0.94 $\mu\text{m}$
Scan Angle	$\pm 49.5^\circ$
Instantaneous Field of View (IFOV)	$0.185^\circ$
SNR @ albedo = 0.4	> 100
Polarization	< 0.5%

## 1.4 Brief background on algorithm

Level 1B Product Generation Executives (PGEs) receive 240 granules of AIRS IR Level 1A Engineering Units (EU) data and produce calibrated, geolocated radiance products. Calibration data and calibration control parameters are analyzed to develop processing specifications for Level 1B processing. Then, the Level 1A data are processed, yielding our Level 1B standard products. Each type of AIRS Level 1A data is processed by a specialized Level 1B PGE. Each Level 1B PGE generates 240 granules of Level 1B standard products.

**Level 1B NRT products** are produced by the same core science algorithms as in the regular science data production, but using predicted ephemeris in place of definitive ephemeris data and without one of optional dynamics inputs (next granule of AIRVACAL for the case of AIRVBRAD). The advantage of NRT data is its fast turnaround time, generally available within 3 hours of observations globally. They can be utilized in regional weather forecast models as well as in support of field campaigns.

Level 1B PGEs produce 240 granules of four Level 1B standard products and two quality assessment (QA) subset products. Each granule is composed of 45 scansets. The Earth Science Data Type (ESDT) short names and normal granule sizes are:

**Table 3. Shortname and Granule size (normal)**

Data Set Granule Size	Short Name	Granule Size
L1B AMSU-A radiances	AIRABRAD	0.5 MB
L1B HSB radiances	AIRHBRAD	1.7 MB
L1B AIRS radiances	AIRIBRAD	56 MB
<b>L1B VIS/NIR radiances</b>	<b>AIRVBRAD</b>	<b>21 MB</b>
L1B AIRS QA	AIRIBQAP	5.6 MB
L1B VIS QA	<b>AIRVBQAP</b>	<b>1.1 MB</b>

The user is encouraged to read the documentation describing the [Level 1B Algorithm Theoretical Basis Document for Visible/Near-Infrared Channels](http://eosps0.gsfc.nasa.gov/eos_homepage/for_scientists/atbd/docs/AIRS/AIRS_L1B_A_TBD_Part_2.pdf) for further details. ([http://eosps0.gsfc.nasa.gov/eos\\_homepage/for\\_scientists/atbd/docs/AIRS/AIRS\\_L1B\\_A\\_TBD\\_Part\\_2.pdf](http://eosps0.gsfc.nasa.gov/eos_homepage/for_scientists/atbd/docs/AIRS/AIRS_L1B_A_TBD_Part_2.pdf))

## 1.5 Data Disclaimer

AIRS science team provides [AIRS/AMSU/HSB Version 5 Data Disclaimer](http://disc.gsfc.nasa.gov/AIRS/documentation/v5_docs/AIRS_V5_Release_User_Docs/V5_Data_Disclaimer.pdf) ([http://disc.gsfc.nasa.gov/AIRS/documentation/v5\\_docs/AIRS\\_V5\\_Release\\_User\\_Docs/V5\\_Data\\_Disclaimer.pdf](http://disc.gsfc.nasa.gov/AIRS/documentation/v5_docs/AIRS_V5_Release_User_Docs/V5_Data_Disclaimer.pdf)) document as a part of Version 005 data release. Some of highlights related to L1B products are:

### Invalid Values

Fields in Level 1B and Level 2 data products may contain an invalid value:  
 -9999 for floating-point and 16-bit and 32-bit integers  
 -1 or 255 for 8-bit fields.

### The validation states for Level 1B Data Products in release V5

Level 1B Product	RMS Requirement	Uncertainty Estimate	Vertical Coverage	Val Status
AIRS VIS/NIR Radiance	20%	15-20%	N/A	Prov*

\*Prov: Provisionally validated -- Product quality may not be optimal and incremental product improvements are still occurring. General research community is encouraged to participate in the QA and validation of the product, but need to be aware that product validation and QA are ongoing. Users are urged to contact science team representatives prior to use of the data in publications. Provisional products may be replaced in the archive when the validated product becomes available.

### Instrument States and Liens

The AIRS instrument entered 'operate' mode on 24 July 2002.  
 AIRS data are unavailable for the period 29 July 2002-14:14:13 to 30 August 2002-09:25:10 UTC because of instrument defrost activities and unexpected cooler shutdowns. (The shutdowns were apparently caused by ionizing radiation affecting the cooler electronics in the South Atlantic Anomaly.)

AIRS data are unavailable for the period 19 October 2002-17:03:5 to 22 October 2002-01:37:25 UTC due to a false overstroke trip by the AIRS cooler (likely caused by a radiation 'hit').

AIRS data are unavailable for the period 29 October 2003-02:00:00 to 14 November 2003-21:01:00 due to the instrument being placed in safe mode following a very large solar flare and associated coronal mass ejection. The purpose was to guard against possible permanent damage caused by the expected large flux of high energy particles (including protons). The instrument was completely off except for its survival heaters. Consequently, the AIRS instrument warmed. Upon restoration of power the instrument required prolonged cool-down and subsequent full recalibration of the spectral parameters.

### **AIRS VIS/NIR Liens**

In each scanline, at the left edge of the swath (first 3 IR footprints), the first few detectors of Channel 4 (the ones furthest South in ascending granules) have anomalously low values, less than 10% of their expected value. Since Channel 4 is primarily intended for use in a research product (energy balance studies) and the swath edges are of limited value, this problem is not considered critical.

### **Aqua Spacecraft Safing Events**

The Aqua spacecraft underwent two safing events. The AIRS / AMSU / HSB instrument suite did not collect data during the following periods (all times are approximate to several minutes):

27 June 2002-15:40:30 to 28 June 2002-20:36 UTC 12 September 2002-13:15:00 to 23:24 UTC.

### **Aqua Spacecraft Shutdown for Coronal Mass Ejection Event**

AIRS data are unavailable for the period 29 October 2003-02:00:00 to 14 November 2003-21:01:00 due to the instrument being placed in safe mode following a very large solar flare and associated coronal mass ejection.

### **August 24, 2007 – Clear AIRS FOVs Reported in L1B Radiance Product and Calibration Subset Product**

The AIRS FOVs designated as “clear” in the L1B AIRS Radiance Product (AIRIBRAD) and the Calibration Subset Product (AIRXBCAL) will overlap but are not identical sets in Version 5 (Collection 5) for three reasons:

- The Calibration Subset Product uses a more recent version of the "clear FOV" algorithm which employs among its tests pseudo lapse rates obtained from 2-degree global grids, differentiated by month of year and ascending/descending node. The L1B AIRS Radiance Product employs a constant pseudo lapse rate among its tests.
- AIRS FOVs are never flagged as "clear" for Granule 240 in the L1B AIRS Radiance Product, due to a programming error that fails to set the AIRS FOV's spectral\_clear\_indicator. The Calibration Subset Product flags clear AIRS FOV's in Granule 240 correctly, i.e. reason is set to 1 for AIRS FOVs satisfying the Calibration Subset clear test.
- Each of the 240 6-minute granules per day contains 12,150 FOVs (i.e., a granule contains 90 AIRS scene footprints in each of 135 AIRS scans). The first footprint in the first granule of a day is always taken at 5 minutes, 31.36 seconds, after midnight. The L1B AIRS Radiance Product always includes the 12,150 FOVs for each granule, including Granule 240. The Calibration Subset Product processing begins and ends exactly at midnight. The midnight boundary is reached during scan 11, between scene footprints 89 and 90, in Granule 240. Thus clear AIRS FOVs for Granule 240 will be divided amongst the Calibration Subset Product files for two consecutive days.

## 2. Data Organization

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### 2.1 File naming convention

The AIRS Level-1 B Vis/NIR Radiance (AIRVBRAD) and its QA subset (AIRVBQAP) files are named in accordance to the following convention:

**AIRS.yyyy.mm.dd.ggg.L1B.VIS\_Rad.v.m.r.b.productionTimeStamp.hdf**  
**AIRS.yyyy.mm.dd.ggg.L1B.VIS\_QaSub.v.m.r.b.productionTimeStamp.hdf**

For example:

[AIRS.2007.01.01.001.L1B.VIS\\_Rad.v5.0.0.0.G07068114156.hdf](#)

Where:

- **yyyy** = 4 digit year number [2002 - ].
- **mm** = 2 digit month number [01-12]
- **dd** = day of month [01-31]
- **ggg** = granule number [1-240]
- **L1B** = Level 1B
- **VIS\_Rad**= string defining the product file type (AIRS VIS/NIR Radiation product)
- **VIS\_QaSub**= string defining the product file type (AIRS VIS/NIR QA subset 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, **R** for NRT product, 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.

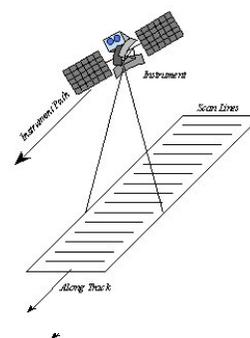
### 2.2 File Format

AIRS Level-1B files are stored in the Hierarchical Data Format-Earth Observing System (HDF-EOS4) Swath 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.

**Swath:** The swath concept for HDF-EOS is based on a typical satellite swath, where an instrument takes a series of scans perpendicular to the ground track of the satellite as it moves along that ground track (see Diagram on the right). As the AIRS is profiling instrument that scans across the ground track, the data would be a three dimensional array of measurements where two of the dimensions correspond to the standard scanning dimensions (along the ground track and across the ground track), and the third dimension represents a range from the sensor. The "horizontal" dimensions can be handled as normal geographic dimensions, while the third dimensions can be handled as a special "vertical" dimension.



### 2.3 Data Structure inside File

An AIRVBRAD file is made of four major groups; "Dimensions", "geolocation fields", "Attributes", and "Data fields" with data fields sub-divided into "Per-Granule Data Fields", "Along-Track Data Fields, and "Full Swath Data Fields".

**Dimensions:** These are HDF-EOS swath dimensions. The names "GeoTrack" and "GeoXTrack" have a special meaning for this document: "GeoTrack" is understood to be the dimension along the path of the spacecraft, and "GeoXTrack" is the dimension across the spacecraft track, starting on the left looking forward along the spacecraft track. There may also be a second across-track dimension "CalXTrack," equivalent to "GeoXTrack," except that "CalXTrack" refers to the number of calibration footprints per scanline. "GeoTrack" is 45 for large-spot products (AMSU-A, Level-2, cloud-cleared AIRS) and 135 for small-spot products (AIRS, Vis/NIR, HSB).

**geolocation fields:** These are all 64-bit floating-point fields that give the location of the data in space and time. If the note before the table specifies that these fields appear once per scanline then they have the single dimension "GeoTrack." Otherwise, they appear once per footprint per scanline and have dimensions "GeoTrack,GeoXTrack."

**Attributes:** These are scalar or string fields that appear only once per granule. They are attributes in the HDF-EOS Swath sense.

**Per-Granule Data Fields:** These are fields that are valid for the entire granule but that are not scalars because they have some additional dimension.

**Along-Track Data Fields:** These are fields that occur once for every scanline. These fields have dimension "GeoTrack" before any "Extra Dimensions." So an "Along-Track Data Field" with "Extra Dimensions" of "None" has dimensions "GeoTrack"; whereas, if the "Extra Dimensions" is "SpaceXTrack (= 4)," then it has dimensions "GeoTrack,SpaceXTrack."

## 2.4 Key data fields (see the following section for a complete list)

The data fields (of AIRVBRAD) most likely to be used by users are as follows.

### Location data Fields:

- **Latitude**  
AIRS spot boresight geodetic latitude  
(degrees North, -90->+90), dimension (90,135)
- **Longitude**  
AIRS spot boresight geodetic longitude  
(degrees East, -180->+180), dimension (90,135)
- **Time**  
Footprint "shutter" TAI Time: floating-point elapsed seconds since Jan 1, 1993

**Attributes:** These fields appear once per Level 3 Grids

- **VISDarkAMSUFOVCount**  
number of AMSU-A footprints in the granule that are uniformly dark in the L1B VIS/NIR and are thus likely to be uniformly clear, dimension (1)
- **VISBrightAMSUFOVCount**  
number of AMSU-A footprints in the granule that are uniformly bright in the L1B VIS/NIR and are thus likely to be uniformly cloudy, dimension (1)

### The per-granule data fields

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- **gain**  
number of radiance units per count, dimension (9,4)
- **gain\_err**  
error estimate for number of radiance units per count caused by imperfect fit for gain, dimension (9,4)

### The along-track data fields

- **NeN**  
noise equivalent radiance for each channel (Watts/m<sup>2</sup>/micron/steradian), dimension (9,4,135)

### The swath data fields

- **radiances**  
calibrated, geolocated channel-by-channel radiances for each channel (Watts/m<sup>2</sup>/micron/steradian), dimension (8,9,4,90,135) AIRS/AMSU/HSB Version 5 Data Release User Guide

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- **landFrac**  
fraction of AIRS spot that is land (0.0 -> 1.0), dimension (90,135)
- **landFrac\_err**  
error estimate for landFrac, dimension (90,135)
- **sun\_glint\_distance**  
distance from AIRS spot center to location of sun glint; -9999 if unknown and 30000 for no glint visible because platform is in the Earth's shadow (km), dimension (90,135)
- **solzen**  
solar zenith angle (degrees, 0->180; daytime if < 85), dimension (90,135)

### 3. Data Contents

Described below are all the parameters contained within an AIRS Version 5 Level-1B AIRS Visible/NIR Radiance Product file (AIRVBRAD). For parameter lists of AIRVBQAP, see [File Descriptions for Released Products](#).

#### 3.1 Dimensions

Name	Value	Explanation
GeoXTrack	90	Dimension across track for footprint positions. Same as number of footprints per scanline. -- starting at the left and increasing towards the right as you look along the satellite's path
GeoTrack	# of scan lines in swath	Dimension along track for footprint positions. Same as number of scanlines in granule. Parallel to the satellite's path, increasing with time. (Nominally 45 for Level-2, AMSU-A, and AIRS/Vis low-rate engineering; 135 for AIRS/Vis and HSB high-rate quantities)
SubTrack	9	VIS detector elements per AIRS footprint along track (9). Direction is the same as GeoTrack -- parallel to the satellite's path, increasing with time. (opposite order to detector ordering -- detector 0 is last)
SubXTrack	8	VIS samples per AIRS footprint across track (8). Direction is the same as GeoXTrack -- starting at the left and increasing towards the right as you look along the satellite's path
GeoLocationsPerSpot	4	Geolocations for the 4 corner pixels in the order: trailing first scanned; trailing last-scanned; leading first-scanned; leading last-scanned. Each footprint also has a central geolocation associated with the swath geolocation lat/lon/time of the footprint.
Channel	4	Dimension of channel array (Channel 1: ~0.40 micron; Ch 2: ~0.6 micron; Ch 3: ~0.8 micron; Ch 4: broadband)

#### 3.2 Geolocation Fields

These fields appear for every footprint (GeoTrack \* GeoXTrack times) and correspond to footprint center coordinates and "shutter" time.

Name	Explanation
Latitude	Footprint boresight geodetic Latitude in degrees North (-90.0 ... 90.0)
Longitude	Footprint boresight geodetic Longitude in degrees East (-180.0 ... 180.0)
Time	Footprint "shutter" TAI Time: floating-point elapsed seconds since Jan 1, 1993

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### 3.3 Attributes

These fields appear only once per granule and use the HDF-EOS "Attribute" interface.

Name	Type	Explanation
VISDarkAMSUFOVCount	32-bit integer	Number of AMSU-A footprints that are uniformly dark in the level-1B VIS/NIR and are thus likely to be uniformly clear
VISBrightAMSUFOVCount	32-bit integer	Number of AMSU-A footprints that are uniformly bright in the level-1B VIS/NIR and are thus likely to be uniformly cloudy
processing_level	string of 8-bit characters	Zero-terminated character string denoting processing level ("level1B")
instrument	string of 8-bit characters	Zero-terminated character string denoting instrument ("VIS")
DayNightFlag	string of 8-bit characters	Zero-terminated character string set to "Night" when the subsatellite points at the beginning and end of a granule are both experiencing night according to the "civil twilight" standard (center of refracted sun is below the horizon). It is set to "Day" when both are experiencing day, and "Both" when one is experiencing day and the other night. "NA" is used when a determination cannot be made.
AutomaticQAFlag	string of 8-bit characters	Zero-terminated character string denoting granule data quality: (Always "Passed", "Failed", or "Suspect")
NumTotalData	32-bit integer	Total number of expected scene footprints
NumProcessData	32-bit integer	Number of scene footprints which are present and can be processed routinely (state = 0)
NumSpecialData	32-bit integer	Number of scene footprints which are present and can be processed only as a special test (state = 1)
NumBadData	32-bit integer	Number of scene footprints which are present but cannot be processed (state = 2)
NumMissingData	32-bit integer	Number of expected scene footprints which are not present (state = 3)
NumLandSurface	32-bit integer	Number of scene footprints for which the surface is more than 90% land
NumOceanSurface	32-bit integer	Number of scene footprints for which the surface is less than 10% land
node_type	string of 8-bit characters	Zero-terminated character string denoting whether granule is ascending, descending, or pole-crossing: ("Ascending" and "Descending" for entirely ascending or entirely descending granules, or "NorthPole" or "SouthPole" for pole-crossing granules. "NA" when determination cannot be made.)
start_year	32-bit integer	Year in which granule started, UTC (e.g. 1999)
start_month	32-bit integer	Month in which granule started, UTC (1 ... 12)
start_day	32-bit integer	Day of month in which granule started, UTC (1 ... 31)
start_hour	32-bit integer	Hour of day in which granule started, UTC (0 ... 23)
start_minute	32-bit integer	Minute of hour in which granule started, UTC (0 ... 59)
start_sec	32-bit floating-point	Second of minute in which granule started, UTC (0.0 ... 59.0)
start_orbit	32-bit integer	Orbit number of mission in which granule started
end_orbit	32-bit integer	Orbit number of mission in which granule ended
orbit_path	32-bit integer	Orbit path of start orbit (1 ... 233 as defined by EOS project)
start_orbit_row	32-bit integer	Orbit row at start of granule (1 ... 248 as defined by EOS project)
end_orbit_row	32-bit integer	Orbit row at end of granule (1 ... 248 as defined by EOS project)
granule_number	32-bit integer	Number of granule within day (1 ... 240)

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num_scansets	32-bit integer	Number of scansets in granule (1 ... 45)
num_scanlines	32-bit integer	Number of scanlines in granule (3 * num_scansets)
start_Latitude	64-bit floating-point	Geodetic Latitude of spacecraft at start of granule (subsattellite location at midpoint of first scan) in degrees North (-90.0 ... 90.0)
start_Longitude	64-bit floating-point	Geodetic Longitude of spacecraft at start of granule (subsattellite location at midpoint of first scan) in degrees East (-180.0 ... 180.0)
start_Time	64-bit floating-point	TAI Time at start of granule (floating-point elapsed seconds since start of 1993)
end_Latitude	64-bit floating-point	Geodetic Latitude of spacecraft at end of granule (subsattellite location at midpoint of last scan) in degrees North (-90.0 ... 90.0)
end_Longitude	64-bit floating-point	Geodetic Longitude of spacecraft at end of granule (subsattellite location at midpoint of last scan) in degrees East (-180.0 ... 180.0)
end_Time	64-bit floating-point	TAI Time at end of granule (floating-point elapsed seconds since start of 1993)
eq_x_longitude	32-bit floating-point	Longitude of spacecraft at southward equator crossing nearest granule start in degrees East (-180.0 ... 180.0)
eq_x_tai	64-bit floating-point	Time of eq_x_longitude in TAI units (floating-point elapsed seconds since start of 1993)
orbitgeoqa	32-bit unsigned integer	Orbit Geolocation QA:: Bit 0: (LSB, value 1) bad input value (last scanline); Bit 1: (value 2) bad input value (first scanline); Bit 2: (value 4) PGS_EPH_GetEphMet() gave PGSEPH_E_NO_SC_EPHEM_FILE; Bit 3: (value 8) PGS_EPH_GetEphMet() gave PGSEPH_E_BAD_ARRAY_SIZE; Bit 4: (value 16) PGS_EPH_GetEphMet() gave PGSTD_E_TIME_FMT_ERROR; Bit 5: (value 32) PGS_EPH_GetEphMet() gave PGSTD_E_TIME_VALUE_ERROR; Bit 6: (value 64) PGS_EPH_GetEphMet() gave PGSTD_E_SC_TAG_UNKNOWN; Bit 7: (value 128) PGS_EPH_GetEphMet() gave PGS_E_TOOLKIT; Bit 8: (value 256) PGS_TD_UTCtoTAI() gave PGSTD_E_NO_LEAP_SECS; Bit 9: (value 512) PGS_TD_UTCtoTAI() gave PGSTD_E_TIME_FMT_ERROR; Bit 10: (value 1024) PGS_TD_UTCtoTAI() gave PGSTD_E_TIME_VALUE_ERROR; Bit 11: (value 2048) PGS_TD_UTCtoTAI() gave PGS_E_TOOLKIT; Bit 12: (value 4096) PGS_CSC_DayNight() gave PGSTD_E_NO_LEAP_SECS; Bit 13: (value 8192) PGS_CSC_DayNight() gave PGSCSC_E_INVALID_LIMITTAG; Bit 14: (value 16384) PGS_CSC_DayNight() gave PGSCSC_E_BAD_ARRAY_SIZE; Bit 15: (value 32768) PGS_CSC_DayNight() gave PGSCSC_W_ERROR_IN_DAYNIGHT; Bit 16: (value 65536) PGS_CSC_DayNight() gave PGSCSC_W_BAD_TRANSFORM_VALUE; Bit 17: (value 131072) PGS_CSC_DayNight() gave PGSCSC_W_BELOW_HORIZON; Bit 18: (value 262144) PGS_CSC_DayNight() gave PGSCSC_W_PREDICTED_UT1 (This is expected except when reprocessing.); Bit 19: (value 524288) PGS_CSC_DayNight() gave PGSTD_E_NO_UT1_VALUE; Bit 20: (value 1048576) PGS_CSC_DayNight() gave

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		PGSTD_E_BAD_INITIAL_TIME; Bit 21: (value 2097152) PGS_CSC_DayNight() gave PGSCBP_E_TIME_OUT_OF_RANGE; Bit 22: (value 4194304) PGS_CSC_DayNight() gave PGSCBP_E_UNABLE_TO_OPEN_FILE; Bit 23: (value 8388608) PGS_CSC_DayNight() gave PGSMEM_E_NO_MEMORY; Bit 24: (value 16777216) PGS_CSC_DayNight() gave PGS_E_TOOLKIT; Bit 25-31: not used
num_satgeoqa	16-bit integer	Number of scans with problems in satgeoqa
num_glintgeoqa	16-bit integer	Number of scans with problems in glintgeoqa
num_moongoqa	16-bit integer	Number of scans with problems in moongoqa
num_ftptgeoqa	16-bit integer	Number of footprints with problems in ftptgeoqa
num_zengeoqa	16-bit integer	Number of footprints with problems in zengeoqa
num_demgeoqa	16-bit integer	Number of footprints with problems in demgeoqa
num_fpe	16-bit integer	Number of floating point errors
LonGranuleCen	16-bit integer	Geodetic Longitude of the center of the granule in degrees East (-180 ... 180)
LatGranuleCen	16-bit integer	Geodetic Latitude of the center of the granule in degrees North (-90 ... 90)
LocTimeGranuleCen	16-bit integer	Local solar time at the center of the granule in minutes past midnight (0 ... 1439)
VegMapFileName	string of 8-bit characters	Name of AVHRR input file used as Vegetation Map
limit_vis_det_temp	Color Counts (see below)	Input limit checking on Vis sensor array temperature
input_vis_det_temp	Limited Engineering Struct (see below)	Input statistics on Vis sensor array temperature
granules_present	string of 8-bit characters	Zero-terminated character string denoting which adjacent granules were available for smoothing ("All" for both previous & next, "Prev" for previous but not next, "Next" for next but not previous, "None" for neither previous nor next)
align_1_2_nadir	32-bit floating-point	Expected error (km) between the pixel locations for the corner locations of near-nadir AIRS footprints (45 & 46) between VIS channels 1 & 2
align_2_3_nadir	32-bit floating-point	Expected error (km) between the pixel locations for the corner locations of near-nadir AIRS footprints (45 & 46) between VIS channels 2 & 3
align_2_4_nadir	32-bit floating-point	Expected error (km) between the pixel locations for the corner locations of near-nadir AIRS footprints (45 & 46) between VIS channels 2 & 4
align_1_2_maxang	32-bit floating-point	Expected error (km) between the pixel locations for the corner locations of near-limb AIRS footprints (1 & 90) between VIS channels 1 & 2
align_2_3_maxang	32-bit floating-point	Expected error (km) between the pixel locations for the corner locations of near-limb AIRS footprints (1 & 90) between VIS channels 2 & 3
align_2_4_maxang	32-bit floating-point	Expected error (km) between the pixel locations for the corner locations of near-limb AIRS footprints (1 & 90) between VIS channels 2 & 4
align_vis_airs	32-bit floating-point	Expected error (km) between the pixel locations for the corner locations of near-nadir AIRS footprints (45 & 46) between the AIRS center and all VIS channels

### 3.4 Per-Granule Data Fields

These fields appear only once per granule and use the HDF-EOS "Field" interface.

Name	Type	Extra Dimensions	Explanation
limit_scene_counts	Color Counts (see below)	Channel (= 4) * SubTrack (= 9)	Input limit checking on scene data numbers
limit_bb_counts	Color Counts (see below)	Channel (= 4) * SubTrack (= 9)	Input limit checking on data numbers from the blackbody (dark target)
limit_phot_counts	Color Counts (see below)	Channel (= 4) * SubTrack (= 9)	Input limit checking on data numbers from the photometric calibration source (bright target)
input_scene_counts	Limited Engineering Struct (see below)	Channel (= 4) * SubTrack (= 9)	Input statistics on scene data numbers
input_bb_counts	Limited Engineering Struct (see below)	Channel (= 4) * SubTrack (= 9)	Input statistics on data numbers from the blackbody (dark target)
input_phot_counts	Limited Engineering Struct (see below)	Channel (= 4) * SubTrack (= 9)	Input statistics on data numbers from the photometric calibration source (bright target)
limit_offsets	Color Counts (see below)	Channel (= 4) * SubTrack (= 9)	Output limit checking on offsets
offset_stats	Unlimited Engineering Struct (see below)	Channel (= 4) * SubTrack (= 9)	Statistics on offsets
offset_unc_stats	Unlimited Engineering Struct (see below)	Channel (= 4) * SubTrack (= 9)	Statistics on offset uncertainties
gain	32-bit floating-point	Channel (= 4) * SubTrack (= 9)	Gain: number of radiance units per count.
gain_err	32-bit floating-point	Channel (= 4) * SubTrack (= 9)	Error caused by imperfect fit for gain (gain units).
rad_stats	Unlimited Engineering Struct (see below)	Channel (= 4) * SubTrack (= 9)	Statistics over the granule of radiances (radiance units)
NeN_stats	Limited Engineering Struct (see below)	Channel (= 4) * SubTrack (= 9)	Statistics over the granule of Noise-equivalent Radiance (NeN)
xtrack_err	32-bit floating-point	Channel (= 4)	cross-track pixel location error estimate per channel (km)
track_err	32-bit floating-point	Channel (= 4)	Along-track pixel location error estimate per channel (km)

### 3.5 Along-Track Data Fields

These fields appear once per scanline (GeoTrack times).

Name	Type	Extra Dimensions	Explanation
offset	32-bit floating-point	Channel (= 4) * SubTrack (= 9)	Offset: number of counts expected for no radiance at time nadirTAI
offset_err	32-bit floating-point	Channel (= 4) * SubTrack (= 9)	Error caused by imperfect fit for offset (radiance units)

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NeN	32-bit floating-point	Channel (= 4) * SubTrack (= 9)	Noise-equivalent Radiance (radiance units)
satheight	32-bit floating-point	None	Satellite altitude at nadirTAI in km above reference ellipsoid (e.g. 725.2)
satroll	32-bit floating-point	None	Satellite attitude roll angle at nadirTAI (-180.0 ... 180.0 angle about the +x (roll) ORB axis, +x axis is positively oriented in the direction of orbital flight completing an orthogonal triad with y and z.)
satpitch	32-bit floating-point	None	Satellite attitude pitch angle at nadirTAI (-180.0 ... 180.0 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.)
satyaw	32-bit floating-point	None	Satellite attitude yaw angle at nadirTAI (-180.0 ... 180.0 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.)
satgeoqa	32-bit unsigned integer	None	<p>Satellite Geolocation QA flags: Bit 0: (LSB, value 1) bad input value;            Bit 1: (value 2) PGS_TD_TAItUTC() gave PGSTD_E_NO_LEAP_SECS;            Bit 2: (value 4) PGS_TD_TAItUTC() gave PGS_E_TOOLKIT;            Bit 3: (value 8) PGS_EPH_EphemAttit() gave PGSEPH_W_BAD_EPHEM_VALUE;            Bit 4: (value 16) PGS_EPH_EphemAttit() gave PGSEPH_E_BAD_EPHEM_FILE_HDR;            Bit 5: (value 32) PGS_EPH_EphemAttit() gave PGSEPH_E_NO_SC_EPHEM_FILE;            Bit 6: (value 64) PGS_EPH_EphemAttit() gave PGSEPH_E_NO_DATA_REQUESTED;            Bit 7: (value 128) PGS_EPH_EphemAttit() gave PGSTD_E_SC_TAG_UNKNOWN;            Bit 8: (value 256) PGS_EPH_EphemAttit() gave PGSEPH_E_BAD_ARRAY_SIZE;            Bit 9: (value 512) PGS_EPH_EphemAttit() gave PGSTD_E_TIME_FMT_ERROR;            Bit 10: (value 1024) PGS_EPH_EphemAttit() gave PGSTD_E_TIME_VALUE_ERROR;            Bit 11: (value 2048) PGS_EPH_EphemAttit() gave PGSTD_E_NO_LEAP_SECS;            Bit 12: (value 4096) PGS_EPH_EphemAttit() gave PGS_E_TOOLKIT;            Bit 13: (value 8192) PGS_CSC_ECItECR() gave PGSCSC_W_BAD_TRANSFORM_VALUE;            Bit 14: (value 16384) PGS_CSC_ECItECR() gave PGSCSC_E_BAD_ARRAY_SIZE;            Bit 15: (value 32768) PGS_CSC_ECItECR() gave PGSTD_E_NO_LEAP_SECS;            Bit 16: (value 65536) PGS_CSC_ECItECR() gave PGSTD_E_TIME_FMT_ERROR;            Bit 17: (value 131072) PGS_CSC_ECItECR() gave PGSTD_E_TIME_VALUE_ERROR;            Bit 18: unused (set to zero);            Bit 19: (value 524288) PGS_CSC_ECItECR() gave PGSTD_E_NO_UT1_VALUE;            Bit 20: (value 1048576) PGS_CSC_ECItECR() gave PGS_E_TOOLKIT;            Bit 21: (value 2097152) PGS_CSC_ECRtoGEO() gave PGSCSC_W_TOO_MANY_ITERS;            Bit 22: (value 4194304) PGS_CSC_ECRtoGEO() gave PGSCSC_W_INVALID_ALTITUDE;</p>

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			<p>Bit 23: (value 8388608) PGS_CSC_ECRtoGEO() gave PGSCSC_W_SPHERE_BODY;</p> <p>Bit 24: (value 16777216) PGS_CSC_ECRtoGEO() gave PGSCSC_W_LARGE_FLATTENING;</p> <p>Bit 25: (value 33554432) PGS_CSC_ECRtoGEO() gave PGSCSC_W_DEFAULT_EARTH_MODEL;</p> <p>Bit 26: (value 67108864) PGS_CSC_ECRtoGEO() gave PGSCSC_E_BAD_EARTH_MODEL;</p> <p>Bit 27: (value 134217728) PGS_CSC_ECRtoGEO() gave PGS_E_TOOLKIT;</p> <p>Bit 28-31: not used</p>
glintgeoqa	16-bit unsigned integer	None	<p>Glint Geolocation QA flags: Bit 0: (LSB, value 1) bad input value;</p> <p>Bit 1: (value 2) glint location in Earth's shadow (Normal for night FOVs);</p> <p>Bit 2: (value 4) glint calculation not converging;</p> <p>Bit 3: (value 8) glint location sun vs. satellite zenith mismatch;</p> <p>Bit 4: (value 16) glint location sun vs. satellite azimuth mismatch;</p> <p>Bit 5: (value 32) bad glint location;</p> <p>Bit 6: (value 64) PGS_CSC_ZenithAzimuth() gave any 'W' class return code;</p> <p>Bit 7: (value 128) PGS_CSC_ZenithAzimuth() gave any 'E' class return code;</p> <p>Bit 8: (value 256) PGS_CBP_Earth_CB_Vector() gave any 'W' class return code;</p> <p>Bit 9: (value 512) PGS_CBP_Earth_CB_Vector() gave any 'E' class return code;</p> <p>Bit 10: (value 1024) PGS_CSC_ECIttoECR() gave any 'W' class return code except PGSCSC_W_PREDICTED_UT1 (for Glint);</p> <p>Bit 11: (value 2048) PGS_CSC_ECIttoECR() gave any 'E' class return code (for Glint);</p> <p>Bit 12: (value 4096) PGS_CSC_ECRtoGEO() gave any 'W' class return code (for Glint);</p> <p>Bit 13: (value 8192) PGS_CSC_ECRtoGEO() gave any 'E' class return code (for Glint);</p> <p>Bit 14: (value 16384) PGS_CSC_ECIttoECR() gave any 'W' class return code except PGSCSC_W_PREDICTED_UT1 ;</p> <p>Bit 15: (value 32768) PGS_CSC_ECIttoECR() gave any 'E' class return code</p>
moongeoa	16-bit unsigned integer	None	<p>Moon Geolocation QA flags: Bit 0: (LSB, value 1) bad input value;</p> <p>Bit 1: (value 2) PGS_TD_TAIttoUTC() gave PGSTD_E_NO_LEAP_SECS;</p> <p>Bit 2: (value 4) PGS_TD_TAIttoUTC() gave PGS_E_TOOLKIT;</p> <p>Bit 3: (value 8) PGS_CBP_Sat_CB_Vector() gave PGSCSC_W_BELOW_SURFACE;</p> <p>Bit 4: (value 16) PGS_CBP_Sat_CB_Vector() gave PGSCBP_W_BAD_CB_VECTOR;</p> <p>Bit 5: (value 32) PGS_CBP_Sat_CB_Vector() gave PGSCBP_E_BAD_ARRAY_SIZE;</p> <p>Bit 6: (value 64) PGS_CBP_Sat_CB_Vector() gave PGSCBP_E_INVALID_CB_ID;</p> <p>Bit 7: (value 128) PGS_CBP_Sat_CB_Vector() gave PGSMEM_E_NO_MEMORY;</p> <p>Bit 8: (value 256) PGS_CBP_Sat_CB_Vector() gave PGSCBP_E_UNABLE_TO_OPEN_FILE;</p> <p>Bit 9: (value 512) PGS_CBP_Sat_CB_Vector() gave PGSTD_E_BAD_INITIAL_TIME;</p> <p>Bit 10: (value 1024) PGS_CBP_Sat_CB_Vector() gave PGSCBP_E_TIME_OUT_OF_RANGE;</p> <p>Bit 11: (value 2048) PGS_CBP_Sat_CB_Vector() gave PGSTD_E_SC_TAG_UNKNOWN;</p> <p>Bit 12: (value 4096) PGS_CBP_Sat_CB_Vector() gave</p>

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			PGSEPH_E_BAD_EPHEM_FILE_HDR; Bit 13: (value 8192) PGS_CBP_Sat_CB_Vector() gave PGSEPH_E_NO_SC_EPHEM_FILE; Bit 14: (value 16384) PGS_CBP_Sat_CB_Vector() gave PGS_E_TOOLKIT; Bit 15: not used
nadirTAI	64-bit floating-point	None	TAI time at which instrument is nominally looking directly down. (between footprints 15 & 16 for AMSU or between footprints 45 & 46 for AIRS/Vis & HSB) (floating-point elapsed seconds since start of 1993)
sat_lat	64-bit floating-point	None	Satellite geodetic latitude in degrees North (-90.0 ... 90.0)
sat_lon	64-bit floating-point	None	Satellite geodetic longitude in degrees East (-180.0 ... 180.0)
scan_node_type	8-bit integer	None	'A' for ascending, 'D' for descending, 'E' when an error is encountered in trying to determine a value.
glintlat	32-bit floating-point	None	Solar glint geodetic latitude in degrees North at nadirTAI (-90.0 ... 90.0)
glintlon	32-bit floating-point	None	Solar glint geodetic longitude in degrees East at nadirTAI (-180.0 ... 180.0)
ViSnsrArrTemp	32-bit floating-point	None	Vis/NIR Sensor Array Temperature (Celcius)
ScHeadTemp1	32-bit floating-point	None	Scanner Head Housing Temperature 1 (active A or B) (Celcius)
OpMode	16-bit unsigned integer	None	Instrument Operations Mode. See AIRS Command Handbook, section 6.4 for a definition of each bit. Bits 0 (LSB)-2 cal phase; bits 3-6 Cal Func; Bit 7 quicklook (expedited) flag; bits 8-11 submode Bits 12-14 Mode (0=standby, 1=ready, 2=operate, 3=checkout, 4=decontaminate, 5=off, 6=survival); bit 16 transition flag

### 3.6 Full Swath Data Fields

These fields appear for every footprint of every scanline in the granule (GeoTrack \* GeoXTrack times).

Name	Type	Extra Dimensions	Explanation
radiances	32-bit floating-point	Channel (= 4) * SubTrack (= 9) * SubXTrack (= 8)	Radiances for each channel in Watts/m**2/micron/steradian
PrelimCldQA	8-bit integer	None	Cloud QA index (0-good or 1-bad) -1 for not calculated
PrelimCldFracVis	32-bit floating-point	None	Cloud Fraction (0.0-1.0) -9999.0 for not calculated
PrelimCldFracVisErr	32-bit	None	Cloud Fraction Error (0.0-1.0) -9999.0 for not calculated

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	floating-point		
PrelimClrFracVis	32-bit floating-point	None	Clear Fraction (0.0-1.0) -9999.0 for not calculated
PrelimClrFracVisErr	32-bit floating-point	None	Clear Fraction Error (0.0-1.0) -9999.0 for not calculated
PrelimCldMapVis	8-bit integer	SubTrack (= 9) * SubXTrack (= 8)	Cloud Map (0-clear, 1-cloudy) -1 for not calculated
PrelimNDVI	32-bit floating-point	SubTrack (= 9) * SubXTrack (= 8)	Vegetation Index (-1.0 to 1.0) -999.0 for not calculated
bright_index	16-bit integer	None	Brightness index (1...5, 5 is brightest. -1 for not calculated)
inhomo_index	16-bit integer	None	Inhomogeneity index (0...64, 1st digit NDVI-Dev, 2nd digit Ch1-Dev, -9999 for not calculated)
scanang	32-bit floating-point	None	Scanning angle of AIRS instrument with respect to the AIRS Instrument for this footprint (-180.0 ... 180.0, negative at start of scan, 0 at nadir)
ftptgeoqa	32-bit unsigned integer	None	Footprint Geolocation QA flags: Bit 0: (LSB, value 1) bad input value; Bit 1: (value 2) PGS_TD_TAtoUTC() gave PGSTD_E_NO_LEAP_SECS; Bit 2: (value 4) PGS_TD_TAtoUTC() gave PGS_E_TOOLKIT; Bit 3: (value 8) PGS_CSC_GetFOV_Pixel() gave PGSCSC_W_MISS_EARTH; Bit 4: (value 16) PGS_CSC_GetFOV_Pixel() gave PGSTD_E_SC_TAG_UNKNOWN; Bit 5: (value 32) PGS_CSC_GetFOV_Pixel() gave PGSCSC_W_ZERO_PIXEL_VECTOR; Bit 6: (value 64) PGS_CSC_GetFOV_Pixel() gave PGSCSC_W_BAD_EPH_FOR_PIXEL; Bit 7: (value 128) PGS_CSC_GetFOV_Pixel() gave PGSCSC_W_INSTRUMENT_OFF_BOARD; Bit 8: (value 256) PGS_CSC_GetFOV_Pixel() gave PGSCSC_W_BAD_ACCURACY_FLAG; Bit 9: (value 512) PGS_CSC_GetFOV_Pixel() gave PGSCSC_E_BAD_ARRAY_SIZE; Bit 10: (value 1024) PGS_CSC_GetFOV_Pixel() gave PGSCSC_W_DEFAULT_EARTH_MODEL; Bit 11: (value 2048) PGS_CSC_GetFOV_Pixel() gave PGSCSC_W_DATA_FILE_MISSING; Bit 12: (value 4096) PGS_CSC_GetFOV_Pixel() gave PGSCSC_E_NEG_OR_ZERO_RAD; Bit 13: (value 8192) PGS_CSC_GetFOV_Pixel() gave PGSMEM_E_NO_MEMORY; Bit 14: (value 16384) PGS_CSC_GetFOV_Pixel() gave PGSTD_E_NO_LEAP_SECS; Bit 15: (value 32768) PGS_CSC_GetFOV_Pixel() gave PGSTD_E_TIME_FMT_ERROR; Bit 16: (value 65536) PGS_CSC_GetFOV_Pixel() gave PGSTD_E_TIME_VALUE_ERROR; Bit 17: (value 131072) PGS_CSC_GetFOV_Pixel() gave PGSCSC_W_PREDICTED_UT1; Bit 18: (value 262144) PGS_CSC_GetFOV_Pixel() gave PGSTD_E_NO_UT1_VALUE;

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			<p>Bit 19: (value 524288) PGS_CSC_GetFOV_Pixel() gave PGS_E_TOOLKIT;</p> <p>Bit 20: (value 1048576) PGS_CSC_GetFOV_Pixel() gave PGSEPH_E_BAD_EPHEM_FILE_HDR;</p> <p>Bit 21: (value 2097152) PGS_CSC_GetFOV_Pixel() gave PGSEPH_E_NO_SC_EPHEM_FILE;</p> <p>Bit 22-31: not used</p>
zengeoqa	16-bit unsigned integer	None	<p>Satellite zenith Geolocation QA flags: Bit 0: (LSB, value 1) (Spacecraft) bad input value;</p> <p>Bit 1: (value 2) PGS_CSC_ZenithAzimuth(S/C) gave PGSCSC_W_BELOW_HORIZON;</p> <p>Bit 2: (value 4) PGS_CSC_ZenithAzimuth(S/C) gave PGSCSC_W_UNDEFINED_AZIMUTH;</p> <p>Bit 3: (value 8) PGS_CSC_ZenithAzimuth(S/C) gave PGSCSC_W_NO_REFRACTION;</p> <p>Bit 4: (value 16) PGS_CSC_ZenithAzimuth(S/C) gave PGSCSC_E_INVALID_VECTAG;</p> <p>Bit 5: (value 32) PGS_CSC_ZenithAzimuth(S/C) gave PGSCSC_E_LOOK_PT_ALTIT_RANGE;</p> <p>Bit 6: (value 64) PGS_CSC_ZenithAzimuth(S/C) gave PGSCSC_E_ZERO_INPUT_VECTOR;</p> <p>Bit 7: (value 128) PGS_CSC_ZenithAzimuth(S/C) gave PGS_E_TOOLKIT;</p> <p>Bit 8: (value 256) (Sun) bad input value;</p> <p>Bit 9: (value 512) (suppressed) PGS_CSC_ZenithAzimuth(Sun) gave PGSCSC_W_BELOW_HORIZON (This is not an error condition - the sun is below the horizon at night);</p> <p>Bit 10: (value 1024) PGS_CSC_ZenithAzimuth(Sun) gave PGSCSC_W_UNDEFINED_AZIMUTH;</p> <p>Bit 11: (value 2048) PGS_CSC_ZenithAzimuth(Sun) gave PGSCSC_W_NO_REFRACTION;</p> <p>Bit 12: (value 4096) PGS_CSC_ZenithAzimuth(Sun) gave PGSCSC_E_INVALID_VECTAG;</p> <p>Bit 13: (value 8192) PGS_CSC_ZenithAzimuth(Sun) gave PGSCSC_E_LOOK_PT_ALTIT_RANGE;</p> <p>Bit 14: (value 16384) PGS_CSC_ZenithAzimuth(Sun) gave PGSCSC_E_ZERO_INPUT_VECTOR;</p> <p>Bit 15: (value 32768) PGS_CSC_ZenithAzimuth(Sun) gave PGS_E_TOOLKIT</p>
demgeoqa	16-bit unsigned integer	None	<p>Digital Elevation Model (DEM) Geolocation QA flags: Bit 0: (LSB, value 1) bad input value;</p> <p>Bit 1: (value 2) Could not allocate memory;</p> <p>Bit 2: (value 4) Too close to North or South pole. Excluded. (This is not an error condition - a different model is used);</p> <p>Bit 3: (value 8) Layer resolution incompatibility. Excluded;</p> <p>Bit 4: (value 16) Any DEM Routine (elev) gave PGSDEM_E_IMPROPER_TAG;</p> <p>Bit 5: (value 32) Any DEM Routine (elev) gave PGSDEM_E_CANNOT_ACCESS_DATA;</p> <p>Bit 6: (value 64) Any DEM Routine (land/water) gave PGSDEM_E_IMPROPER_TAG;</p> <p>Bit 7: (value 128) Any DEM Routine (land/water) gave PGSDEM_E_CANNOT_ACCESS_DATA;</p> <p>Bit 8: (value 256) Reserved for future layers;</p> <p>Bit 9: (value 512) Reserved for future layers;</p> <p>Bit 10: (value 1024) PGS_DEM_GetRegion(elev) gave PGSDEM_M_FILLVALUE_INCLUDED;</p> <p>Bit 11: (value 2048) PGS_DEM_GetRegion(land/water) gave PGSDEM_M_FILLVALUE_INCLUDED;</p> <p>Bit 12: (value 4096) Reserved for future layers;</p>

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			Bit 13: (value 8192) PGS_DEM_GetRegion(all) gave PGSDEM_M_MULTIPLE_RESOLUTIONS; Bit 14: (value 16384) PGS_CSC_GetFOV_Pixel() gave any 'W' class return code except PGSCSC_W_PREDICTED_UT1; Bit 15: (value 32768) PGS_CSC_GetFOV_Pixel() gave any 'E' class return code
satzen	32-bit floating-point	None	Spacecraft zenith angle (0.0 ... 180.0) degrees from zenith (measured relative to the geodetic vertical on the reference (WGS84) spheroid and including corrections outlined in EOS SDP toolkit for normal accuracy.)
satazi	32-bit floating-point	None	Spacecraft azimuth angle (-180.0 ... 180.0) degrees E of N GEO)
solzen	32-bit floating-point	None	Solar zenith angle (0.0 ... 180.0) degrees from zenith (measured relative to the geodetic vertical on the reference (WGS84) spheroid and including corrections outlined in EOS SDP toolkit for normal accuracy.)
solazi	32-bit floating-point	None	Solar azimuth angle (-180.0 ... 180.0) degrees E of N GEO)
sun_glint_distance	16-bit integer	None	Distance (km) from footprint center to location of the sun glint (-9999 for unknown, 30000 for no glint visible because spacecraft is in Earth's shadow)
topog	32-bit floating-point	None	Mean topography in meters above reference ellipsoid
topog_err	32-bit floating-point	None	Error estimate for topog
landFrac	32-bit floating-point	None	Fraction of spot that is land (0.0 ... 1.0)
landFrac_err	32-bit floating-point	None	Error estimate for landFrac
state	32-bit integer	None	Data state: 0:Process, 1:Special, 2:Erroneous, 3:Missing
cornerlats	32-bit floating-point	GeoLocationsPerSpot (= 4) * Channel (= 4)	Geodetic Latitudes at the centers of the pixels at the corners of the IR footprint by channel in degrees North (-90.0 ... 90.0)
cornerlons	32-bit floating-point	GeoLocationsPerSpot (= 4) * Channel (= 4)	Geodetic Longitudes at the centers of the pixels at the corners of the IR footprint by channel in degrees East (-180.0 ... 180.0)

### 3.7 Special AIRS Types

AIRS works around the lack of support for records in HDF-EOS Swath by grouping related fields into pseudo-records. HDF-EOS fieldnames are generated by concatenating the pseudo-record name with the subfield name, putting a "." character in between. Since these record types do not exist at the HDF-EOS swath level, reading subfield "min" of AIRS field "input\_scene\_counts" involves reading HDF-EOS Swath field "input\_scene\_counts.min". Limited Engineering Struct:

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Limited Engineering Struct: This type is used for engineering data fields for which there are known "yellow" limits.

Field Name	Type	Explanation
min	32-bit floating-point	Minimum value field takes on in granule (not valid when num_in = 0)
max	32-bit floating-point	Maximum value field takes on in granule (not valid when num_in = 0)
mean	32-bit floating-point	Mean of values field takes on in granule (not valid when num_in = 0)
dev	32-bit floating-point	Standard Deviation of values field takes on in granule (not valid when num_in < 2)
num_in	32-bit integer	Count of in-range values field takes on in granule
num_lo	32-bit integer	Count of out-of-range low values field takes on in granule
num_hi	32-bit integer	Count of out-of-range high values field takes on in granule
num_bad	32-bit integer	Count of occasions on which field takes on invalid flag value (-9999) in granule
range_min	32-bit floating-point	Minimum in-range value.
range_max	32-bit floating-point	Maximum in-range value.
missing	8-bit integer	Missing limits flags. Bit 0 (LSB) is 1 when yellow low (range_min) limit is missing; Bit 1 is high when yellow high (range_max) limit is missing; other bits unused, set to 0.
max_track	32-bit integer	GeoTrack index (counting from 1) where max was found
max_xtrack	32-bit integer	GeoXTrack index (counting from 1) where max was found
min_track	32-bit integer	GeoTrack index (counting from 1) where min was found
min_xtrack	32-bit integer	GeoXTrack index (counting from 1) where min was found

Unlimited Engineering Struct: This type is used for engineering data fields for which there are NOT known "yellow" limits.

Field Name	Type	Explanation
min	32-bit floating-point	Minimum value field takes on in granule (not valid when num = 0)
max	32-bit floating-point	Maximum value field takes on in granule (not valid when num = 0)
mean	32-bit floating-point	Mean of values field takes on in granule (not valid when num = 0)
dev	32-bit floating-point	Standard Deviation of values field takes on in granule (not valid when num < 2)
num	32-bit integer	Count of occurrences of field in granule (not including those counted in num_bad)
num_bad	32-bit integer	Count of occasions on which field takes on invalid flag value (-9999) in granule
max_track	32-bit integer	GeoTrack index (counting from 1) where max was found
max_xtrack	32-bit integer	GeoXTrack index (counting from 1) where max was found
min_track	32-bit integer	GeoTrack index (counting from 1) where min was found
min_xtrack	32-bit integer	GeoXTrack index (counting from 1) where min was found

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Color Counts: This type tracks counts of values received during an interval by how they compare to corresponding "red" and "yellow" limits.

Field Name	Type	Explanation
red_lo_limit	32-bit floating-point	Value of the low "red" limit.
red_lo_cnt	32-bit integer	Count of values less than the low "red" limit. This is an "Alarm" condition.
to_red_lo	32-bit integer	Count of occasions on which the "color" of this field changed from some other value to "red_low".
yellow_lo_limit	32-bit floating-point	Value of the low "yellow" limit.
yellow_lo_cnt	32-bit integer	Count of values greater than the low "red" limit but less than the low "yellow" limit. This is a "Warning" condition.
to_yellow_lo	32-bit integer	Count of occasions on which the "color" of this field changed from some other value to "yellow_low".
green_cnt	32-bit integer	Count of values greater than the low "yellow" limit but less than the high "yellow" limit.
to_green	32-bit integer	Count of occasions on which the "color" of this field changed from some other value to "green".
yellow_hi_limit	32-bit floating-point	Value of the high "yellow" limit.
yellow_hi_cnt	32-bit integer	Count of values greater than the high "yellow" limit but less than the high "red" limit. This is a "Warning" condition.
to_yellow_hi	32-bit integer	Count of occasions on which the "color" of this field changed from some other value to "yellow_high".
red_hi_limit	32-bit floating-point	Value of the high "red" limit.
red_hi_cnt	32-bit integer	Count of values greater than the high "red" limit. This is an "Alarm" condition.
to_red_hi	32-bit integer	Count of occasions on which the "color" of this field changed from some other value to "red_high".
missing	8-bit integer	Missing limits flags. Bit 0 (LSB) is 1 when yellow low limit (yellow_lo_limit) is missing; Bit 1 is high when yellow high limit is missing; Bit 2 is 1 when red low limit is missing; Bit 3 is 1 when red high limit is missing; Other bits unused set to 0.

## 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](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
```

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```
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.

---

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

---

Step-by-step instructions how to download, install and execute ncdump commands.

(from [http://nsidc.org/data/hdfeos/hdf\\_to\\_ascii.html#unix/linux](http://nsidc.org/data/hdfeos/hdf_to_ascii.html#unix/linux))

### UNIX/Linux Users

Download HDF Libraries from The HDF Group Web Site

\*\*Note that HDFgroup may change its web page from time to time and the URLs below are not 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](http://ftp.hdfgroup.org/HDF/HDF_Current/bin). ([ftp://ftp.hdfgroup.org/HDF/HDF\\_Current/bin](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
```

## AIRS L1B Visible/NIR Calibrated Radiance Data

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](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:

<code>list</code>	lists contents of files in <filelist>
<code>dumpsd</code>	displays data of SDSs in <filelist>
<code>dumpvd</code>	displays data of vdatas in <filelist>.
<code>dumpvg</code>	displays data of vgroups in <filelist>.
<code>dumpri</code>	displays data of RIs in <filelist>.
<code>dumpgr</code>	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](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

Users, 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](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](http://disc.gsfc.nasa.gov/AIRS/documentation/v5_docs/AIRS_V5_Release_User_Docs/FORTRAN_C_READERS.tar.gz))

If you wish to program yourself, the HDFEOS programming model for accessing a swath data set through the swath (SW) interface is as follows:

- (1) Open the file and obtain a file id from a file name.
- (2) Open a swath data set by obtaining a swath id from a swath name.
- (3) Perform desired operations on the data set.
- (4) Close the swath data set by disposing of the swath id.
- (5) Terminate swath access to the file by disposing of the file id.

A complete list of swath interface routines is summarized in the next two pages. To read an HDFEOS data file, access, basic I/O and inquiry routines are of particular interest.

## Summary of HDF-EOS Swath Interface

Category	Routine Name		Description
	C	FORTRAN	
Access	SWopen	swopen	opens or creates HDF file in order to create, read, or write a swath
	SWcreate	swcreate	creates a swath within the file
	SWattach	swattach	attaches to an existing swath within the file
	SWdetach	swdetach	detaches from swath interface
	SWclose	swclose	closes file
Definition	SWdefdim	swdefdim	defines a new dimension within the swath
	SWdefdimmap	swdefmap	defines the mapping between the geolocation and data dimensions
	SWdefidxmap	swdefimap	defines a non-regular mapping between the geolocation and data dimension
	SWdefgeofield	swdefgfld	defines a new geolocation field within the swath
	SWdefdatafield	swdefdfld	defines a new data field within the swath
	SWdefprofile		defines the profile data structure within the swath
	SWdefcomp	swdefcomp	defines a field compression scheme
	SWwritegeometa	swwrgmeta	writes field metadata for an existing swath geolocation field
	SWwritadatameta	swwrdmeta	writes field metadata for an existing swath data field
Basic I/O	SWwritefield	swwrfld	writes data to a swath field
	SWreadfield	swrdfld	reads data from a swath field.
	SWwriteprofile		writes data to the profile
	SWreadprofile		reads data from the profile
	SWwriteattr	swwrattr	writes/updates attribute in a swath
	SWreadattr	swrdattr	reads attribute from a swath
	SWwritegrpattr	swwrgattr	writes/updates attribute as a swath
	SWreadgrpattr	swrdgattr	reads group attribute from a swath
	SWwritelocatrr	swwrlattr	writes/updates local attribute in a swath
	SWreadlocattr	swrdlattr	reads local attribute from a swath
	SWsetfillvalue	swsetfill	sets fill value for the specified field
SWgetfillvalue	swgetfill	retrieves fill value for the specified field	
Inquiry	SWinqdims	swinqdims	retrieves information about dimensions defined in swath
	SWinqmaps	swinqmaps	retrieves information about the geolocation relations defined
	SWinqidxmaps	swinqimaps	retrieves information about the indexed geolocation/data mappings defined
	SWinqgeofields	swinqgflds	retrieves information about the geolocation fields defined
	SWinqdatafields	swinqdflds	retrieves information about the data fields defined
	SWinqattr	swinqattr	retrieves number and names of attributes defined
	SWinqgrpattr	swinqgattr	retrieves number and names of group attributes defined
	SWinqlocattr	swinqlattr	retrieves number and names of local attributes defined
	SWnentries	swnentries	returns number of entries and descriptive string buffer size for a specified entity
	SWdiminfo	swdiminfo	retrieve size of specified dimension
	SWgrpattrinfo	swgattrinfo	retrieves information about swath group attributes
SWlocattrinfo	swlattrinfo	returns information about swath local attributes	

### Summary of HDF-EOS Swath Interface

Category	Routine Name		Description
	C	FORTTRAN	
	SWmapinfo	swmapinfo	retrieve offset and increment of specified geolocation mapping
	SWidxmapinfo	swimapinfo	retrieve offset and increment of specified geolocation mapping
	SWattrinfo	swattrinfo	returns information about swath attributes
	SWfieldinfo	swfldinfo	retrieve information about a specific geolocation or data field
	SWcompinfo	swcompinfo	retrieve compression information about a field
	SWingswath	swingswath	retrieves number and names of swaths in file
	SWregionindex	swregidx	returns information about the swath region ID
	SWupdateidxmap	swupimap	update map index for a specified region
Subset	SWgeomapinfo	swgmapinfo	retrieves type of dimension mapping when first dimension is geodim
	SWdefboxregion	swdefboxreg	define region of interest by latitude/longitude
	SWregioninfo	swreginfo	returns information about defined region
	SWextractregion	swextreg	read a region of interest from a field
	SWdeftimeperiod	swdeftmeper	define a time period of interest
	SWperiodinfo	swperinfo	retuns information about a defined time period
	SWextractperiod	swextper	extract a defined time period
	SWdefvrtregion	swdefvrtreg	define a region of interest by vertical field
	SWdupregion	swdupreg	duplicate a region or time period
SWdefscanregion		define region of interest based on range of scans	

## 5. Data Services

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### AIRS File Subsetting Service

Users can limit number of files for download by specifying appropriate spatial and temporal constraints in search engines like Mirador (<http://mirador.gsfc.nasa.gov>). The total download size can be further reduced by choosing a subset of variables, channels within each file through the subsetting service. AIRS file subsetting service is provided as a part of the data ordering process through the Mirador search engine. The table below shows the available subsetting options for AIRS Level-1B and Level-2 products.

([http://disc.sci.gsfc.nasa.gov/AIRS/data\\_access.shtml](http://disc.sci.gsfc.nasa.gov/AIRS/data_access.shtml))

Product Name	Variable	Channel	Spatial
AIRIBRAD		√	
AIRABRAD		√	
<b>AIRVBRAD</b>		√	
AIRXBCAL	√	√	√
AIRX2RET / AIRH2RET	√		
AIRI2CCF		√	
AIRX2SUP / AIRH2SUP	√		

Direct data access via FTP available at

**server:** [airscal1u.ecs.nasa.gov](ftp://airscal1u.ecs.nasa.gov) (odd year), [airscal2u.ecs.nasa.gov](ftp://airscal2u.ecs.nasa.gov) (even year)

**directory:** /data/s4pa/Aqua\_AIRS\_Level1

For NRT product,

**server:** [airscal1u.ecs.nasa.gov](ftp://airscal1u.ecs.nasa.gov)

**directory:** /data/s4pa/Aqua\_AIRS\_NearRealTime

## 6. Data Interpretation and Screening

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### 6.1 Quality Assurance

The properties of the 2378 AIRS instrument detectors are individually listed in self-documenting text files. Some properties of the channels change slowly with time or discontinuously whenever the instrument is warmed by a spacecraft safety shutdown or in a defrost cycle. Whenever this occurs, a recalibration exercise is performed and a new channel properties file is created. Thus a series of these files will result. The L1B PGE must use the proper one (chosen by date of properties file and date of data) for initial processing and reprocessing.

The file names contain a date, identifying the first date for which they are valid (and supersede a calibration properties file and channel properties file containing an earlier date). As of this release, there are six files of each type covering the time period from 8/30/02 to the present. Text versions are provided as ancillary files to this document:

Calibration Properties Files
L1B.cal_prop.2002.08.30.v9.5.0.txt
L1B.cal_prop.2002.09.17. v9.5.0.txt
L1B.cal_prop.2002.10.22. v9.5.0.txt
L1B.cal_prop.2003.01.10. v9.5.0.txt
L1B.cal_prop.2003.11.19. v9.5.0.txt
L1B.cal_prop.2005.03.01. v9.5.0.txt

Channel Properties Files
L2.chan_prop.2002.08.30.v9.5.1.txt
L2.chan_prop.2002.09.17. v9.5.1.txt
L2.chan_prop.2002.10.22. v9.5.1.txt
L2.chan_prop.2003.01.10. v9.5.1.txt
L2.chan_prop.2003.11.19. v9.5.1.txt
L2.chan_prop.2005.03.01. v9.5.1.txt

We recommend users choosing L1B radiances for their research use the **calibration properties files** rather than the channel properties files. The information contained in the former set has been expanded with the user in mind and will be of greater utility for selecting channels. The latter set is provided for continuity and its primary function is to support the Level 2 software. We are planning to phase out the channel properties files in later releases. Both sets of files include a documenting header describing their contents.

The calibration properties files provide the quality indicators on a per-channel basis. Key indicators are the frequency centroids and widths, NE<sub>T</sub> at 250 K and 300 K, spatial centroids, **AB-weight**, **Spec\_qual**, **n3sigma** and **npops**. We recommend that users filter channels by requiring that **Spec\_qual** = 1 (or both 1 and 2) and **npops** ≤ 1 and **NE<sub>dt250</sub>** ≤ 1 K. Users may

work out an effective NEdT for any scene temperature from the values quoted at 250 K and 300 K. They may also choose to further filter channels by thresholding on **n3sigma**.

The L1B AIRS Radiance Product files contain dynamic quality indicators, on-the-fly estimates of noise and indicators of abnormal behavior by the instrument or algorithms.

### Evaluate Candidate Channel Spectrally

- Check the **Spec\_qual** field in appropriate (by date) calibration properties file and avoid using channels for which **Spec\_qual** > 2. A more rigorous test is to require that **Spec\_qual** = 1.

### Evaluate Candidate Channel Radiometrically

- Check the NEdT250 field in appropriate (by date) calibration properties file and avoid using channels for which **NedT250** > 1 K
- Check the **npops** field in the appropriate (by date) calibration properties file and avoid using channels for which **npops** > 1.
- Pick a noise limit and filter out channels exceeding it using dynamic **Min\_NEdT250** and **Max\_NEdT250**.
- Exclude channels having nonzero **CalChanSummary** (a 2378 element attribute in the L1B radiance granules). A zero means the channel was well calibrated for all scanlines in the granule.

### Evaluate Candidate Channel Spatially

If sensitivity to channel co-registration is a concern:

- Check the X- and Y- centroid fields in the appropriate (by date) calibration properties and avoid using channels with absolute values greater than 0.25 degree, or
- Use the **Sceneinhomogeneous** flag, the **Rdiff\_swindow** and **Rdiff\_lwindow** flags and/or the radiances themselves to restrict data selection to uniform scenes where co-registration is not an issue. All flags are full swath fields, i.e. there is a value for each of the 90x135 AIRS footprints in the L1B radiance granule.

### Additional Per-Scan-Per-Channel Quality Checks

The AIRS L1B product contains a per-scan field named "**CalFlag**". Users should avoid using any channel for any scan in which the "**offset problem**" or "**gain problem**", or "**pop detected**" bits are set (bits 6, 5, and 4 respectively where bit 0 is LSB). Bit 0, "**cold scene noise**", and bit 1, "**telemetry out of limit condition**", indicates conditions that can potentially impact data quality. Users who require pristine data should discard any data in which either of these bits is set.

### Additional Per-Field-of-View Quality Checks

Before using any AIRS L1B radiance, check the value of the corresponding "**state**" to ensure that it is equal to zero. There is one "**state**" value per field-of-view (FOV), and it is valid for all 2378 channels in that FOV. The "**state**" values and their meaning are:

## AIRS L1B Visible/NIR Calibrated Radiance Data

State Valid	State Value Meaning	Meaning
Process	0	normal data
Special	1	instrument in special calibration mode when these data were taken (e.g., staring at nadir)
Erroneous	2	data known bad (e.g., instrument in safe mode)
Missing	3	data are missing

### Additional Per-Channel Quality Checks

Individual channel readings ("radiance") must be checked for the flag bad value of -9999.0. A channel reading is set to this value only when no radiance can be calculated; questionable or suspect values are indicated only by QA fields.

Note that small negative radiances for shortwave channels (2000 to 2700  $\text{cm}^{-1}$ ) are rare, but valid. These negative radiances values are due to instrument noise, and occur when the scene temperatures drop below 190K, for example, over very high cloud or very cold surface.

### Advanced Quality Checks

Each scan contains a "**glintlat**" and "**glintlon**" giving the location of the solar glint center at the time in the middle of that scan. Users can use these or the per-field-of-view **sun\_glint\_distance** to check for possibility of solar glint contamination.

Infrared glints can occur over clouds as well as water and can extend up to several hundred km. Note that there are two spectral SRF centroids listed: **nominal\_freq** and **spectral\_freq**. Ignore **spectral\_freq** and **spectral\_freq\_unc**. These latter two fields are instantaneous estimates and therefore noisy. They should not be relied upon as QA indicators.

Detailed information on algorithm, calibration, and error estimation is documented in "Algorithm Theoretical Bases Document"

([http://eosps0.gsfc.nasa.gov/eos\\_homepage/for\\_scientists/atbd/docs/AIRS/AIRS\\_L1B\\_ATBD\\_Part\\_1.pdf](http://eosps0.gsfc.nasa.gov/eos_homepage/for_scientists/atbd/docs/AIRS/AIRS_L1B_ATBD_Part_1.pdf))

Also, please refer to the Advanced Theoretical Basis Document (ATBD) for AIRS Full Validation, [AIRS Validation Plan](#)

([http://eosps0.gsfc.nasa.gov/eos\\_homepage/for\\_scientists/atbd/docs/AIRS/AIRSVAlP2doc.pdf](http://eosps0.gsfc.nasa.gov/eos_homepage/for_scientists/atbd/docs/AIRS/AIRSVAlP2doc.pdf))

A report on the status of V5 calibration and validation is provided in the document:

V5\_CalVal\_Status\_Summary.pdf

([http://disc.sci.gsfc.nasa.gov/AIRS/documentation/v5\\_docs/AIRS\\_V5\\_Release\\_User\\_Docs/V5\\_CalVal\\_Status\\_Summary.pdf](http://disc.sci.gsfc.nasa.gov/AIRS/documentation/v5_docs/AIRS_V5_Release_User_Docs/V5_CalVal_Status_Summary.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](http://disc.sci.gsfc.nasa.gov/AIRS/documentation/v5_docs/AIRS_V5_Release_User_Docs/V5_Retrieval_Flow.pdf)) document.

## 7. More Information

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### 7.1 Web resources for AIRS data users:

#### NASA/JPL:

- AIRS Project Web Site: <http://airs.jpl.nasa.gov/>
- Ask AIRS Science Questions: <http://airs.jpl.nasa.gov/AskAirs/>
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#### NASA/GSFC:

- AIRS Data Support Main Page: <http://disc.sci.gsfc.nasa.gov/AIRS/>
- AIRS Data Access: [http://disc.sci.gsfc.nasa.gov/AIRS/data\\_access.shtml](http://disc.sci.gsfc.nasa.gov/AIRS/data_access.shtml)
- AIRS Documentation: <http://disc.sci.gsfc.nasa.gov/AIRS/documentation.shtml>
- AIRS Products: [http://disc.sci.gsfc.nasa.gov/AIRS/data\\_products.shtml](http://disc.sci.gsfc.nasa.gov/AIRS/data_products.shtml)

Data can also be obtained from Giovanni (online visualization and analysis tool):  
<http://acdisc.sci.gsfc.nasa.gov/Giovanni/airs/>

### 7.2 Point of Contact

<b>URL</b>	<a href="http://disc.gsfc.nasa.gov/">http://disc.gsfc.nasa.gov/</a>	
<b>Contact</b>	Name	GES DISC HELP DESK SUPPORT GROUP
	Email	<a href="mailto:help-disc@listserv.gsfc.nasa.gov">help-disc@listserv.gsfc.nasa.gov</a>
	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

## 8. Acronyms

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**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