README Document for

AIRS Level-1B Version 5
IR Calibrated Radiance Products:

AIRIBRAD, AIRIBRAD_NRT,

AIRIBQAP, AIRIBQAP_NRT

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Revision History

Revision Date	***Changes***	***Author***
11/27	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 AIRIBQAP	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 1B Infrared Radiance Products (**AIRIBRAD**) which contain calibrated and geolocated radiance in milliWatts/$m^2 \cdot cm^{-1} \cdot$steradian. The corresponding **AIRIBQAP** 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). **AIRIBRAD_NRT** and **AIRIBQAP_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.

The data set is generated from AIRS level 1A digital numbers (DN) and contains 2378 infrared channels in the 3.74 to 15.4 µm 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 infrared measurements, an individual scene consists of 135 scanlines containing 90 cross-track footprints. Thus, there is a total of 135 x 90 = 12,150 footprints per AIRS IR scene.

AIRS employs a 49.5 degree cross-track scanning with a 1.1 degree instantaneous field of view (IFOV) to provide twice daily coverage of essentially the entire globe in a 1:30 PM sun synchronous orbit. Combined with the passive microwave measurements from the AMSU-A (http://disc.sci.gsfc.nasa.gov/AIRS/documentation/amsu_instrument_guide.shtml) and HSB (http://disc.sci.gsfc.nasa.gov/AIRS/documentation/hsb_instrument_guide.shtmlinstruments) aboard the same platform, the AIRS calibrated radiances are used primarily to retrieve vertical profiles of temperature and humidity.

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

Table 1. Basic characteristics of the AIRIBRAD data.

Latitude Range	-90° to 90°N
Longitude extent	-180° to 180°E
horizontal resolution	13 km at nadir 41 km x 21.4 km extreme
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 (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.

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.

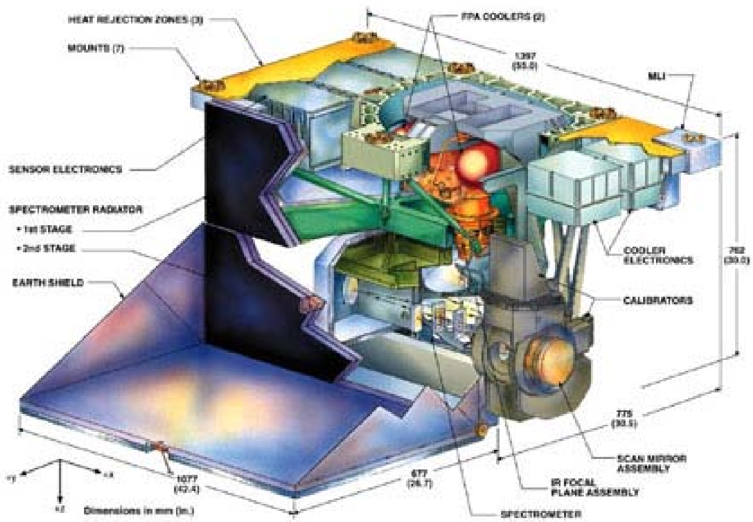

Figure 1. AIRS instrument cutaway drawing.

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 2. 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	λ/Δλ > 1200 nominal
Spectral Resolution	Δλ/2
Spectral Sampling	±1 Δλ
Integrated Response (95%)	0.05 Δλ 24 hours
Wavelength Stability	0.01 Δλ
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

1.4 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.

AIRIBRAD NRT products are also 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 AIRIACAL for the case of **AIRIBRAD**). 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**
L1B VIS radiances	AIRVBRAD	21 MB
L1B AIRS QA	**AIRIBQAP**	**5.6 MB**
L1B VIS QA	AIRVBQAP	1.1 MB

The user is encouraged to read the documentation describing the Level 1B Algorithm Theoretical Basis Document for Infrared Spectrometer for further details. (http://eospso.gsfc.nasa.gov/eos_homepage/for_scientists/atbd/docs/AIRS/AIRS_L1B_ATBD_Part_1.pdf)

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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) 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 IR Radiance	3%*	<0.2%	N/A	VAL5

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 IR Liens
Per-granule measurements of spectral parameters (spectral_freq, spec_shift_upwell, etc.) and noise (NeN) are not stable enough for use as single granule measurements. Either use static values from channel properties files or smooth these measurements over longer time periods

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

2.1 File naming convention

The Level-1 B AIRS IR Radiance (AIRIBRAD**)** files are named in accordance to the following convention:

AIRS.*yyyy***.***mm***.***dd***.***ggg***.L1B.AIRS_Rad.v***m***.***m***.***r***.***b***.***productionTimeStamp***.hdf**
AIRS.*yyyy***.***mm***.***dd***.***ggg***.L1B.AIRS_QaSub.v***m***.***m***.***r***.***b***.***productionTimeStamp***.hdf**

`For example:`
`AIRS.2007.04.28.044.L1B.AIRS_Rad.v5.0.0.0.G07233155526.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
- **AIRS_Rad=** string defining the product file type (AIRS IR Radiation product)
- **AIRS_QaSub=** string defining the product file type (AIRS IR 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.

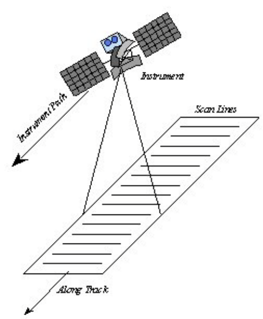
2.2 File Format

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 AIRIBRAD 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 AIRIBRAD) 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

- CalGranSummary
  Bit field that is a bitwise OR of CalScanSummary. Zero means that all
  channels with ExcludedChans < 3 were well calibrated in the entire
  granule, dimension (1)

The per-granule data 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)
- ExcludedChans

Bit field (AB_state from the channel properties file) that indicates A/B detector weights and radiometric quality assessment. Should require value to be less than 3, dimension (2378)

- NeN

  Noise equivalent radiance for each channel for an assumed 250 K scene (milliWatts/m2/cm-1/steradian), dimension (2378)
- nominal_freq

  nominal frequencies of each channel (cm-1), USE THIS FOR FREQUENCIES, dimension (2378)
- spectral_freq

  calculated frequencies of each channel (cm^{-1}), noisy since determined using single granule, dimension (2378)
- spectral_freq_unc

  uncertainty in calculated frequencies(cm^{-1}), noisy since determined using single granule, dimension (2378)

The along-track data fields

- CalFlag

  Bit field by channel for each scanline. Zero means the channel was well calibrated, dimension (2378,135)
- CalScanSummary

  Bit field that is a bitwise OR over the “good” channel list (i.e., channels with **ExcludedChans** < 2). Zero means that all such channels were well calibrated for a scanline, dimension (135)

The swath data fields

- radiances

  calibrated, geolocated channel-by-channel AIRS observed infrared spectra (milliWatts/m2/cm-1/steradian), dimension (2378,90,135)
- 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)
- Sceneinhomogeneous

  flag using band-overlap detectors which is set non-zero if the scene is inhomogeneous as determined by Rdiff_swindow, Rdiff_lwindow or Rdiff_strat, dimension (90,135)
- Rdiff_swindow

radiance difference in the 2560 cm-1 window region, used to warn of possible errors caused by scene non-uniformity and misalignment of the beams (milliWatts/m2/cm-1/steradian), dimension (90,135)

- Rdiff_lwindow
  radiance difference in the 850 cm-1 window region, used to warn of possible errors caused by scene non-uniformity and misalignment of the beams (milliWatts/m2/cm-1/steradian), dimension (90,135)

3. Data Contents

Described below are all the parameters contained within an AIRS Version 5 Level-1B AIRS Radiance Product file (AIRIBRAD). For parameter lists of AIRIBQAP, see File Descriptions for Released Products.

3.1 Dimensions

These fields define all dimensions that can be used for HDF-EOS swath fields.

The names "GeoTrack" and "GeoXTrack" have a special meaning for this document: "Cross-Track" data fields have a hidden dimension of "GeoXTrack"; "Along-Track" data fields have a hidden dimension of "GeoTrack"; "Full Swath" data fields have hidden dimensions of both "GeoTrack" and "GeoXTrack".

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)
CalXTrack	6	Dimension "across" track for calibration footprint positions. Same as number of calibration footprints per scanline. (NUM_FOOTPRINTS_AIRS_CALIB) (Footprints are ordered: 1-4: spaceviews (ports 3, 4, 1, 2); 5: blackbody radiometric calibration source; 6: spectral/photometric calibration sources)
SpaceXTrack	4	Dimension "across" track for spaceview calibration footprint positions in order of observation time. (NUM_FOOTPRINTS_AIRS_SPACE)
BBXTrack	1	Dimension "across" track for blackbody calibration footprint positions in order of observation time. (NUM_FOOTPRINTS_AIRS_BB)
Channel	2378	Dimension of channel array (Channels are generally in order of increasing wavenumber, but because frequencies can vary and because all detectors from a physical array of detector elements (a "module") are always grouped together there are sometimes small reversals in frequency order where modules overlap.)
MaxRefChannel	100	Maximum number of radiometric reference channels. "RefChannels" lists the channels used.
MaxFeaturesUpwell	35	Maximum number of spectral features in upwelling radiances used for spectral calibration
MaxFeaturesPary	17	Maximum number of spectral features in parylene radiances used for spectral calibration

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

3.3 Attributes

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

Name	Type	Explanation
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 ("AIRS")
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)
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 (subsatellite 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 (subsatellite 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 (subsatellite 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 (subsatellite 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 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_moongeoqa	16-bit integer	Number of scans with problems in moongeoqa
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)
CalGranSummary	8-bit unsigned integer	Bit field. Bitwise OR of CalChanSummary, over all channels with ExcludedChans < 3. Zero means all good channels were well calibrated, for all scanlines. Bit 7 (MSB): scene over/underflow; Bit 6: (value 64) anomaly in offset calculation; Bit 5: (value 32) anomaly in gain calculation; Bit 4: (value 16) pop detected; Bit 3: (value 8) noise out of bounds; Bit 2: (value 4) anomaly in spectral calibration; Bit 1: (value 2) Telemetry; Bit 0: (LSB, value 1) unused (reserved);
DCR_scan	16-bit integer	Scanline number following (first) DC-Restore. 0 for no DC-Restore
input_bb_temp	Limited Engineering Struct (see below)	Input statistics on Blackbody temperature
input_bb_temp1	Limited Engineering Struct (see below)	Input statistics on Blackbody temperature 1A (CaBbTempV1A or CaBbTempV1B, as active)
input_bb_temp2	Limited Engineering Struct (see below)	Input statistics on Blackbody temperature 2 (CaBbTempV2A or CaBbTempV2B, as active)
input_bb_temp3	Limited Engineering Struct (see below)	Input statistics on Blackbody temperature 3 (CaBbTemp3, active A or B)
input_bb_temp4	Limited Engineering Struct (see below)	Input statistics on Blackbody temperature4 (CaBbTemp4, active A or B)
input_spec_temp	Limited Engineering Struct (see below)	Input statistics on Spectrometer temperature
input_ir_det_temp	Limited Engineering Struct (see	Input statistics on IR detector temperature

	below)	
input_grating_temp_1	Limited Engineering Struct (see below)	Input statistics on Grating temperature 1 (SpGratngTemp1, active A or B)
input_grating_temp_2	Limited Engineering Struct (see below)	Input statistics on Grating temperature 2 (SpGratngTemp2, active A or B)
input_entr_filt_temp	Limited Engineering Struct (see below)	Input statistics on the entrance filter temperature (SpEntFiltTmp, active A or B)
input_opt_bench_temp_2	Limited Engineering Struct (see below)	Input statistics on optical bench temperature 2 (SpOptBnchTmp2, active A or B)
input_opt_bench_temp_3	Limited Engineering Struct (see below)	Input statistics on optical bench temperature 3 (SpOptBnchTmp3, active A or B)
input_scan_mirror_temp	Limited Engineering Struct (see below)	Input statistics on scan mirror housing temperature
input_chopper_phase_err	Limited Engineering Struct (see below)	Input statistics on chopper phase error voltage (ChPhaseErrVA or ChPhaseErrVB, as active)
PopCount	32-bit integer	Number of popcorn events within granule, i.e. number of times than an AIRS channel used in the Level 2 retrieval has suffered a sudden discontinuity in dark current
NumRefChannels	32-bit integer	The number of channels reported in MaxRefChannel arrays
Rdiff_swindow_M1a_chan	16-bit integer	Array M1a channel used as one reference in calculating Rdiff_swindow. (index into radiance & frequency arrays 1...2378)
Rdiff_swindow_M2a_chan	16-bit integer	Array M2a channel used as one reference in calculating Rdiff_swindow. (index into radiance & frequency arrays 1...2378)
Rdiff_lwindow_M8_chan	16-bit integer	Array M8 channel used as one reference in calculating Rdiff_lwindow. (index into radiance & frequency arrays 1...2378)
Rdiff_lwindow_M9_chan	16-bit integer	Array M9 channel used as one reference in calculating Rdiff_lwindow. (index into radiance & frequency arrays 1...2378)
CF_Version	string of 8-bit characters	Cloud Filter Version Identification. Identifies the set of thresholds used in determination of spectral_clear_indicator.
NumSaturatedFOVs	16-bit unsigned integer	Number of scene fields-of-view (out of a nominal 1350) in which the downlinked counts overflowed.
NumUnderflowFOVs	16-bit unsigned integer	Number of scene fields-of-view (out of a nominal 1350) in which the downlinked counts underflowed.
NumCalFOVsOutOfBounds	16-bit unsigned integer	Number of calibration fields-of-view (out of a nominal 810) in which the downlinked counts underflowed or overflowed.
NumSO2FOVs	16-bit	Number of fields-of-view (out of a nominal 1350) with a signifcant SO2

	unsigned integer	concentration based on the value of BT_diff_SO2.
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)
spectral_TAI	64-bit floating-point	TAI time of (first) Spectral calibration. (floating-point elapsed seconds since start of 1993) 0 for no Spectral calibration occurred in this granule.
spec_shift_upwell	32-bit floating-point	Focal plane shift calculated in grating model fit to upwelling radiances (microns)
spec_shift_unc_upwell	32-bit floating-point	Uncertainty of the focal plane shift calculated in the grating model fit to upwelling radiances (microns)
spec_fl_upwell	32-bit floating-point	Focal length calculated in grating model fit to upwelling radiances (microns)
spec_fl_unc_upwell	32-bit floating-point	Uncertainty of focal length calculated in grating model fit to upwelling radiances (microns)
SpectralFeaturesUpwell	32-bit integer	The actual number of upwelling features for MaxFeaturesUpwell-sized arrays
spec_iter_upwell	16-bit integer	Number of amoeba iterations to fit the grating model to upwelling radiance feature positions
spec_clim_select	16-bit integer	Number of the climatology to which the upwelling features were fitted
spec_shift_pary	32-bit floating-point	Focal plane shift calculated in grating model fit to parylene radiances (microns)
spec_shift_unc_pary	32-bit floating-point	Uncertainty of the focal plane shift calculated in grating model fit to parylene radiances (microns)
spec_fl_pary	32-bit floating-point	Focal length calculated in grating model fit to parylene radiances (microns)
spec_fl_unc_pary	32-bit floating-point	Uncertainty of focal length calculated in grating model fit to parylene radiances (microns)
SpectralFeaturesPary	32-bit integer	The actual number of parylene features for MaxFeaturesPary-sized arrays
spec_iter_pary	16-bit integer	Number of amoeba iterations in fit the grating model to parylene radiance feature positions
DCRCount	32-bit integer	Number of times a Direct Current Restore was executed for any module

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
CalChanSummary	8-bit unsigned integer	Channel (= 2378)	Bit field. Bitwise OR of CalFlag, by channel, over all scanlines. Noise threshold and spectral quality added. Zero means the channel was well calibrated for all scanlines Bit 7 (MSB): scene over/underflow; Bit 6: (value 64) anomaly in offset calculation; Bit 5: (value 32) anomaly in gain calculation; Bit 4: (value 16) pop detected; Bit 3: (value 8) noise out of bounds; Bit 2: (value 4) anomaly in spectral calibration; Bit 1: (value 2) Telemetry;

			Bit 0: (LSB, value 1) unused (reserved);
ExcludedChans	8-bit unsigned integer	Channel (= 2378)	An integer 0-6, indicating A/B detector weights. Used in L1B processing. 0 - A weight = B weight. Probably better that channels with state > 2; 1 - A-side only. Probably better that channels with state > 2; 2 - B-side only. Probably better that channels with state > 2; 3 - A weight = B weight. Probably better than channels with state = 6; 4 - A-side only. Probably better than channels with state = 6; 5 - B-side only. Probably better than channels with state = 6; 6 - A weight = B weight.
NeN	32-bit floating-point	Channel (= 2378)	Noise-equivalent Radiance (radiance units) for an assumed 250K scene
input_scene_counts	Limited Engineering Struct (see below)	Channel (= 2378)	Input statistics on scene data numbers
input_space_counts	Limited Engineering Struct (see below)	SpaceXTrack (= 4) * Channel (= 2378)	Input statistics on spaceview data numbers
input_space_signals	Limited Engineering Struct (see below)	SpaceXTrack (= 4) * Channel (= 2378)	Input statistics on spaceview signals (data numbers with offset subtracted)
input_space_diffs	Unlimited Engineering Struct (see below)	SpaceXTrack (= 4) * Channel (= 2378)	Statistics on differences between corresponding space views, for consecutive scanlines
input_bb_counts	Limited Engineering Struct (see below)	Channel (= 2378)	Input statistics on blackbody calibration data numbers
input_bb_signals	Limited Engineering Struct (see below)	Channel (= 2378)	Input statistics on blackbody calibration signals (data numbers with offset subtracted)
input_spec_counts	Limited Engineering Struct (see below)	Channel (= 2378)	Input statistics on spectral calibration data numbers
offset_stats	Unlimited Engineering Struct (see below)	Channel (= 2378)	Statistics on offsets as of first spaceview of each scan
gain_stats	Unlimited Engineering Struct (see below)	Channel (= 2378)	Statistics on gains (radiance units / count)
rad_stats	Unlimited Engineering Struct (see below)	Channel (= 2378)	Statistics on radiances (radiance units)
Gain	32-bit floating-point	Channel (= 2378)	Number of radiance units per count
RefChannels	32-bit integer	MaxRefChannel (= 100)	The 1-based indexes of channels reported in MaxRefChannel arrays. Entries beyon NumRefChannels are set to -1.
rad_scan_stats	Unlimited Engineering Struct (see below)	GeoXTrack (= 90) * MaxRefChannel (= 100)	Statistics on scan angle dependence of radiances
nominal_freq	32-bit floating-point	Channel (= 2378)	Nominal frequencies (cm**-1) of each channel
spectral_freq	32-bit floating-point	Channel (= 2378)	Dynamic estimate of frequency associated with each channel (cm**-1). Note: This is a noisy estimate because there is very limited data in a single 6-minute granule. Designed for use only in aggregation to monitor instrument status. Use nominal_freq instead

			when analyzing data.
spectral_freq_unc	32-bit floating-point	Channel (= 2378)	a signed estimate of the spectral frequency uncertainty (positive means estimated frequencies are likely too high)
spec_feature_shifts_upwell	32-bit floating-point	MaxFeaturesUpwell (= 35)	Spectral shift seen for each upwelling feature, in microns at the focal plane
spec_feature_corr_upwell	32-bit floating-point	MaxFeaturesUpwell (= 35)	Maximum correlation seen for each upwelling feature (0.0 ... 1.0)
spec_feature_sharp_upwell	32-bit floating-point	MaxFeaturesUpwell (= 35)	Quadratic coefficient in fit to correlation for each upwelling feature
spec_feature_resid_upwell	32-bit floating-point	MaxFeaturesUpwell (= 35)	Fit residual for each upwelling feature (wavenumbers)
spec_feature_contrast_stats	Limited Engineering Struct (see below)	MaxFeaturesUpwell (= 35)	Statistics on the spectral contrasts for each of the upwelling features, for each of the scene footprints considered for spectral calibration
spec_feature_shifts_pary	32-bit floating-point	MaxFeaturesPary (= 17)	Spectral shift seen for each parylene feature, in microns at the focal plane
spec_feature_corr_pary	32-bit floating-point	MaxFeaturesPary (= 17)	Maximum correlation seen for each parylene feature (0.0 ... 1.0)
spec_feature_sharp_pary	32-bit floating-point	MaxFeaturesPary (= 17)	Quadratic coefficient in fit to correlation for each parylene feature
spec_feature_resid_pary	32-bit floating-point	MaxFeaturesPary (= 17)	Fit residual for each parylene feature (wavenumbers)
ave_pary_spectrum	32-bit floating-point	Channel (= 2378)	The average parylene spectrum (over good scanlines), in milliWatts/m**2/cm**-1/steradian

3.5 Along-Track Data Fields

These fields appear once per scanline (GeoTrack times).

Name	Type	Extra Dimensions	Explanation
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	Satellite Geolocation QA flags: Bit 0: (LSB, value 1) bad input value; Bit 1: (value 2) PGS_TD_TAItoUTC() gave PGSTD_E_NO_LEAP_SECS; Bit 2: (value 4) PGS_TD_TAItoUTC() 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_ECItoECR() gave PGSCSC_W_BAD_TRANSFORM_VALUE; Bit 14: (value 16384) PGS_CSC_ECItoECR() gave PGSCSC_E_BAD_ARRAY_SIZE; Bit 15: (value 32768) PGS_CSC_ECItoECR() gave PGSTD_E_NO_LEAP_SECS; Bit 16: (value 65536) PGS_CSC_ECItoECR() gave PGSTD_E_TIME_FMT_ERROR; Bit 17: (value 131072) PGS_CSC_ECItoECR() gave PGSTD_E_TIME_VALUE_ERROR; Bit 18: unused (set to zero); Bit 19: (value 524288) PGS_CSC_ECItoECR() gave PGSTD_E_NO_UT1_VALUE; Bit 20:(value 1048576) PGS_CSC_ECItoECR() 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; Bit 23: (value 8388608) PGS_CSC_ECRtoGEO() gave PGSCSC_W_SPHERE_BODY; Bit 24: (value 16777216) PGS_CSC_ECRtoGEO() gave PGSCSC_W_LARGE_FLATTENING; Bit 25: (value 33554432) PGS_CSC_ECRtoGEO() gave PGSCSC_W_DEFAULT_EARTH_MODEL; Bit 26: (value 67108864) PGS_CSC_ECRtoGEO() gave PGSCSC_E_BAD_EARTH_MODEL; Bit 27: (value 134217728) PGS_CSC_ECRtoGEO() gave PGS_E_TOOLKIT; Bit 28-31: not used
glintgeoqa	16-bit unsigned integer	None	Glint Geolocation QA flags: Bit 0: (LSB, value 1) bad input value; Bit 1: (value 2) glint location in Earth's shadow (Normal for night FOVs); Bit 2: (value 4) glint calculation not converging; Bit 3: (value 8) glint location sun vs. satellite zenith mismatch; Bit 4: (value 16) glint location sun vs. satellite azimuth mismatch; Bit 5: (value 32) bad glint location; Bit 6: (value 64) PGS_CSC_ZenithAzimuth() gave any 'W' class return code; Bit 7: (value 128) PGS_CSC_ZenithAzimuth() gave any 'E' class return code; Bit 8: (value 256) PGS_CBP_Earth_CB_Vector() gave any 'W' class return code; Bit 9: (value 512) PGS_CBP_Earth_CB_Vector() gave any 'E' class return code; Bit 10: (value 1024) PGS_CSC_ECItoECR() gave any 'W' class return code except PGSCSC_W_PREDICTED_UT1 (for Glint); Bit 11: (value 2048) PGS_CSC_ECItoECR() gave any 'E' class return code (for Glint); Bit 12: (value 4096) PGS_CSC_ECRtoGEO() gave any 'W' class return code (for Glint);

			Bit 13: (value 8192) PGS_CSC_ECRtoGEO() gave any 'E' class return code (for Glint); Bit 14: (value 16384) PGS_CSC_ECItoECR() gave any 'W' class return code except PGSCSC_W_PREDICTED_UT1 ; Bit 15: (value 32768) PGS_CSC_ECItoECR() gave any 'E' class return code
moongeoqa	16-bit unsigned integer	None	Moon Geolocation QA flags: Bit 0: (LSB, value 1) bad input value; Bit 1: (value 2) PGS_TD_TAItoUTC() gave PGSTD_E_NO_LEAP_SECS; Bit 2: (value 4) PGS_TD_TAItoUTC() gave PGS_E_TOOLKIT; Bit 3: (value 8) PGS_CBP_Sat_CB_Vector() gave PGSCSC_W_BELOW_SURFACE; Bit 4: (value 16) PGS_CBP_Sat_CB_Vector() gave PGSCBP_W_BAD_CB_VECTOR; Bit 5: (value 32) PGS_CBP_Sat_CB_Vector() gave PGSCBP_E_BAD_ARRAY_SIZE; Bit 6: (value 64) PGS_CBP_Sat_CB_Vector() gave PGSCBP_E_INVALID_CB_ID; Bit 7: (value 128) PGS_CBP_Sat_CB_Vector() gave PGSMEM_E_NO_MEMORY; Bit 8: (value 256) PGS_CBP_Sat_CB_Vector() gave PGSCBP_E_UNABLE_TO_OPEN_FILE; Bit 9: (value 512) PGS_CBP_Sat_CB_Vector() gave PGSTD_E_BAD_INITIAL_TIME; Bit 10: (value 1024) PGS_CBP_Sat_CB_Vector() gave PGSCBP_E_TIME_OUT_OF_RANGE; Bit 11: (value 2048) PGS_CBP_Sat_CB_Vector() gave PGSTD_E_SC_TAG_UNKNOWN; Bit 12: (value 4096) PGS_CBP_Sat_CB_Vector() gave 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)
CalScanSummary	8-bit unsigned integer	None	Bit field. Bitwise OR of CalFlag over the all channels with ExcludedChans < 3. Zero means all "good" channels were well calibrated for this scanline Bit 7 (MSB): scene over/underflow; Bit 6: (value 64) anomaly in offset calculation; Bit 5: (value 32) anomaly in gain calculation; Bit 4: (value 16) pop detected; Bit 3: (value 8) DCR Occurred; Bit 2: (value 4) Moon in View; Bit 1: (value 2) telemetry out of limit condition; Bit 0: (LSB, value 1) cold scene noise
CalFlag	8-bit unsigned integer	Channel (= 2378)	Bit field, by channel, for the current scanline. Zero means the channel was well calibrated, for this scanline. Bit 7 (MSB): scene over/underflow;

			Bit 6: (value 64) anomaly in offset calculation; Bit 5: (value 32) anomaly in gain calculation; Bit 4: (value 16) pop detected; Bit 3: (value 8) DCR Occurred; Bit 2: (value 4) Moon in View; Bit 1: (value 2) telemetry out of limit condition; Bit 0: (LSB, value 1) cold scene noise
SpaceViewDelta	32-bit floating-point	Channel (= 2378)	The median of the four spaceviews immediately following the Earth views in the scanline, minus the median of the spaceviews immediately preceding the Earth views in the scanline (also the magnitude of a "pop" in this scanline, when the "pop detected" bit is set in CalFlag.) (data numbers)
spaceview_selection	8-bit unsigned integer	None	Indicates which footprints were included for this scan. Each bit is high when the corresponding space view is used in the spaceview offset calculation. (See L1B Processing Requirements, section 6.2); LSB is first space view.
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
EDCBOARD	16-bit unsigned integer	None	EDC A/B Powered on Indicator:; 0: Both sides off; 1: Side A; 2: Side B; 3: Invalid; 65534: No value downlinked

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 (= 2378)	Radiances for each channel in milliWatts/m**2/cm**-1/steradian
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_TAItoUTC() gave PGSTD_E_NO_LEAP_SECS; Bit 2: (value 4) PGS_TD_TAItoUTC() 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; Bit 19: (value 524288) PGS_CSC_GetFOV_Pixel() gave PGS_E_TOOLKIT; Bit 20: (value 1048576) PGS_CSC_GetFOV_Pixel() gave PGSEPH_E_BAD_EPHEM_FILE_HDR; Bit 21: (value 2097152) PGS_CSC_GetFOV_Pixel() gave PGSEPH_E_NO_SC_EPHEM_FILE; Bit 22-31: not used
zengeoqa	16-bit unsigned integer	None	Satellite zenith Geolocation QA flags: Bit 0: (LSB, value 1) (Spacecraft) bad input value; Bit 1: (value 2) PGS_CSC_ZenithAzimuth(S/C) gave PGSCSC_W_BELOW_HORIZON; Bit 2: (value 4) PGS_CSC_ZenithAzimuth(S/C) gave PGSCSC_W_UNDEFINED_AZIMUTH; Bit 3: (value 8) PGS_CSC_ZenithAzimuth(S/C) gave PGSCSC_W_NO_REFRACTION; Bit 4: (value 16) PGS_CSC_ZenithAzimuth(S/C) gave PGSCSC_E_INVALID_VECTAG; Bit 5: (value 32) PGS_CSC_ZenithAzimuth(S/C) gave PGSCSC_E_LOOK_PT_ALTIT_RANGE; Bit 6: (value 64) PGS_CSC_ZenithAzimuth(S/C) gave PGSCSC_E_ZERO_INPUT_VECTOR; Bit 7: (value 128) PGS_CSC_ZenithAzimuth(S/C) gave PGS_E_TOOLKIT; Bit 8: (value 256) (Sun) bad input value; 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); Bit 10: (value 1024) PGS_CSC_ZenithAzimuth(Sun) gave PGSCSC_W_UNDEFINED_AZIMUTH; Bit 11: (value 2048) PGS_CSC_ZenithAzimuth(Sun) gave PGSCSC_W_NO_REFRACTION; Bit 12: (value 4096) PGS_CSC_ZenithAzimuth(Sun) gave PGSCSC_E_INVALID_VECTAG; Bit 13: (value 8192) PGS_CSC_ZenithAzimuth(Sun) gave PGSCSC_E_LOOK_PT_ALTIT_RANGE; Bit 14: (value 16384) PGS_CSC_ZenithAzimuth(Sun) gave PGSCSC_E_ZERO_INPUT_VECTOR; Bit 15: (value 32768) PGS_CSC_ZenithAzimuth(Sun) gave PGS_E_TOOLKIT
demgeoqa	16-bit unsigned integer	None	Digital Elevation Model (DEM) Geolocation QA flags: Bit 0: (LSB, value 1) bad input value; Bit 1: (value 2) Could not allocate memory; Bit 2: (value 4) Too close to North or South pole. Excluded. (This is not an error condition - a different model is used);

			Bit 3: (value 8) Layer resolution incompatibility. Excluded; Bit 4: (value 16) Any DEM Routine (elev) gave PGSDEM_E_IMPROPER_TAG; Bit 5: (value 32) Any DEM Routine (elev) gave PGSDEM_E_CANNOT_ACCESS_DATA; Bit 6: (value 64) Any DEM Routine (land/water) gave PGSDEM_E_IMPROPER_TAG; Bit 7: (value 128) Any DEM Routine (land/water) gave PGSDEM_E_CANNOT_ACCESS_DATA; Bit 8: (value 256) Reserved for future layers; Bit 9: (value 512) Reserved for future layers; Bit 10: (value 1024) PGS_DEM_GetRegion(elev) gave PGSDEM_M_FILLVALUE_INCLUDED; Bit 11: (value 2048) PGS_DEM_GetRegion(land/water) gave PGSDEM_M_FILLVALUE_INCLUDED; Bit 12: (value 4096) Reserved for future layers; 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
Rdiff_swindow	32-bit floating-point	None	Radiance difference in the 2560 cm**-1 window region used to warn of possible errors caused by scene non-uniformity and misalignment of the beams: radiance(Rdiff_swindow_M1a_chan) - radiance(Rdiff_swindow_M2a_chan). (radiance units)
Rdiff_lwindow	32-bit floating-	None	Radiance difference in the longwave window(850 cm**-1) used to warn of possible errors caused by scene non-uniformity and misalignment of the

	point		beams: radiance(Rdiff_lwindow_M8_chan) - radiance(Rdiff_lwindow_M9_chan). (radiance units)
SceneInhomogeneous	8-bit unsigned integer	None	Threshold test for scene inhomogeneity, using band-overlap detectors (bit fields).; Bit 7 (MSB, value 128): scene is inhomogeneous, as determined by the Rdiff_swindow threshold. For v5.0 the test is abs(Rdiff_swindow) > 5 * sqrt(NeN(Rdiff_swindow_M1a_chan)^2 + NeN(Rdiff_swindow_M2a_chan)); Bit 6 (value 64): scene is inhomogeneous, as determined by the Rdiff_lwindow threshold. For v5.0 the test is abs(Rdiff_lwindow) > 5 * sqrt(NeN(Rdiff_lwindow_M8_chan)^2 + NeN(Rdiff_lwindow_M9_chan)); Bits 5-0: unused (reserved)
dust_flag	16-bit integer	None	Flag telling whether dust was detected in this scene; 1: Dust detected; 0: Dust not detected; -1: Dust test not valid because of land; -2: Dust test not valid because of high latitude; -3: Dust test not valid because of suspected cloud; -4: Dust test not valid because of bad input data
dust_score	16-bit integer	None	Dust score. Each bit results from a different test comparing radiances. Higher scores indicate more certainty of dust present. Dust probable when score is over 380. Not valid when dust_flag is negative.
spectral_clear_indicator	16-bit integer	None	Flag telling whether scene was flagged as clear by a spectral filter. Only ocean filter is validated; 2: Ocean test applied and scene identified as clear; 1: Ocean test applied and scene not identified as clear; 0: Calculation could not be completed. Possibly some inputs were missing or FOV is on coast or on the edge of a scan or granule; -1: Unvalidated land test applied and scene not identified as clear; -2: Unvalidated land test applied and scene identified as clear
BT_diff_SO2	32-bit floating-point	None	Brightness temperature difference Tb(1361.44 cm-1) - Tb(1433.06 cm-1) used as an indicator of SO2 release from volcanoes. Values under -6 K have likely volcanic SO2. (Kelvins)

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: 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 occassions 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

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.

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/linx)

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. (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 Services

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)

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

Direct data access via FTP available at

server: airscal1u.ecs.nasa.gov (odd year), airscal2u.ecs.nasa.gov (even year)
directory: /data/s4pa/Aqua_AIRS_Level1

For NRT product,

server: airscal1u.ecs.nasa.gov
diretory: /data/s4pa/Aqua_AIRS_NearRealTime

6. Data Interpretation and Screening

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, NEdT 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 **NEdt250** ≤ 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**" valids and their meaning are:

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 ("radiances") 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 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://eospso.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://eospso.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)

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.

7. More Information

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/
-

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
- AIRS Documentation: http://disc.sci.gsfc.nasa.gov/AIRS/documentation.shtml
- AIRS Products: 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

URL	http://disc.gsfc.nasa.gov/	
Contact	Name	GES DISC HELP DESK SUPPORT GROUP
	Email	help-disc@listserv.gsfc.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

8. 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