AIRS/AMSU/HSB Version 6 Data Release User Guide

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Submit Questions to:
http://airs.jpl.nasa.gov/AskAirs

Table of Contents

Table of Figures

1 Introduction

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 Aqua spacecraft orbit is polar sun-synchronous with a nominal altitude of 705 km and an orbital period of 98.8 minutes. The repeat cycle period is 233 orbits (16 days) with a ground track repeatability of +/- 20 km. The platform equatorial crossing local times are 1:30 in the morning (descending) and 1:30 in the afternoon (ascending). Aqua orbital track information may be found at the URL:

http://www.ssec.wisc.edu/datacenter/aqua/

Aqua overpass prediction may be secured at the URL:

http://www-air.larc.nasa.gov/tools/predict.htm

Operational L1B, L2 and L3 Products of the AIRS/AMSU/HSB instrument suite on the EOS Aqua spacecraft are available for use by the general public. They can be accessed on the web at the URL:

http://disc.sci.gsfc.nasa.gov/AIRS/data-holdings/by-data-product-v6/data_products.shtml

Daily maps showing the location of AIRS granules are available at the URL

http://disc.sci.gsfc.nasa.gov/daac-bin/airs/airs_gallery.pl

The full V6 User Documentation may be accessed at the URL:

http://disc.sci.gsfc.nasa.gov/AIRS/documentation

The Level 2 data are in the standard HDF-EOS V4 swath format. The Level 3 data are in the standard HDF-EOS V4 grid format. See the NCSA HDF 4.2 Reference URL:

http://www.hdfgroup.org/products/hdf4/

and the HDF-EOS Tools and Information URL:

http://hdfeos.org/

All data are released to the public. However, the state of product validation depends upon surface type, latitude and product type. Please read the V6 Disclaimer and early validation results reported in the test report:

http://disc.sci.gsfc.nasa.gov/AIRS/documentation/v6_docs/v6releasedocs-1/V6_Data_Disclaimer.pdf

http://disc.sci.gsfc.nasa.gov/AIRS/documentation/v6_docs/v6releasedocs-1/V6_L2_Performance_and_Test_Report.pdf

The L1B data product includes geolocated, calibrated observed microwave, infrared and visible/near infrared radiances, as well as Quality Assessment (QA) data. The radiances are well calibrated; however, not all QA data have been validated. Each product granule contains 6 minutes of data. Thus there are 240 granules of each L1B product produced every day.

The L2 data product includes geolocated, calibrated cloud-cleared radiances and 2-dimensional and 3-dimensional retrieved physical quantities (e.g., surface properties and temperature, moisture, ozone, carbon monoxide and methane profiles throughout the atmosphere). Each product granule contains 6 minutes of data. Thus there are 240 granules of each L2 product produced every day.

The L3 data are created from the L2 data product by binning them in 1°x1° grids. There are three products: daily, 8-day and monthly. Each product provides separate ascending (daytime) and descending (nighttime) binned data sets.

A complete description of the contents of the product files may be found in the companion document titled “AIRS Version 6 Files Description”:

http://disc.sci.gsfc.nasa.gov/AIRS/documentation/v6_docs/v6releasedocs-1/V6_Released_Processing_File_Description.pdf

The document provides for each product:

- Dimensions for use in HDF-EOS swath fields (name, value, explanation)
- Geolocation fields (name, explanation)
- Attributes (name, type, extra dimensions, explanation)
- Along-track data fields (name, type, extra dimensions, explanation)
- Swath data fields (name, type, extra dimensions, explanation)

- Special AIRS types for engineering data fields (name, type, explanation)

It also provides the product file naming and local granule identification (LGID) conventions used in the identifier portion of the EOSDIS Core System (ECS) and a table of all current Science and Engineering products (L1A, L1B, L2 and L3).

Descriptions of the L2 and L3 data products provided in that document as well as instrument and data features provided here are limited to the V6 released data set. Descriptions of the L1A and L1B data products provided in that document are for V5. The L1A and L1B products remain at V5 because the algorithms that create them are unchanged as of the V6 release. For additional information, please consult the AIRS public web site:

http://airs.jpl.nasa.gov

Questions may also be submitted at the AskAIRS link there:

http://airs.jpl.nasa.gov/AskAirs

AIRS data users may register at the following URL

http://airs.jpl.nasa.gov/DataRegistration/data/

to receive periodical announcements of data features that may impact their research and an occasional newsletter.

Additional information may be accessed at the following web sites:

AIRS Data Support at the Goddard Earth Sciences Data and Information Services Center (GES DISC):

http://disc.sci.gsfc.nasa.gov/AIRS

AIRS Theoretical Basis Documents (ATBD):

http://eospso.gsfc.nasa.gov/eos_homepage/for_scientists/atbd/viewInstrument.php?instrument=22

The version numbers that appear in the V6 AIRS Product Files are slightly different, depending upon the product due to a staged delivery of processing code to the GES DISC. They are:

- **All Level 1B Products**: v5.0.0.0 (with one exception, V5.0.21.0 the break being in AIRS L1B products on 21 Jan 2012)
- **Level 1B Calibration Subset Product**: v5.0.16.0 (will be superseded by V6.0.x at some point in the future)
- **Level 2 Products**:
  v6.0.7.0 for AIRS+AMSU and AIRS-Only (standard, support and cloud-cleared radiances)
  V6.0.x for AIRS+AMSU+HSB (standard, support and cloud-cleared radiances)
  V6.x for CO2 products
- **Level 3 Products**:
  V6.0.9.0 for AIRS+AMSU and AIRS-Only (standard, support and quantized products)
  V6.0.x for AIRS+AMSU+HSB (standard, support and quantized products)
  (V6.x for CO2 products)

1.1 SIGNIFICANT CHANGES FROM V5 TO V6

A complete listing of the noteworthy changes from V5 to V6 is provided in the document:

http://disc.sci.gsfc.nasa.gov/AIRS/documentation/v6_docs/v6releasedocs-1/V6_Changes_from_V5.pdf

The following are the most visible to the user:

1.1.1 Trend Reduction

V5 had spurious cooling trends in tropospheric temperature as well as spurious trends in cloudiness and yield. These were mostly caused by unaccounted-for changes in CO_2, N_2O, and instrument frequencies. These trends are nearly eliminated in V6.

1.1.2 Profiles Provided at Pressure Levels

In the V6 release, all retrieved profiles are given as level quantities, while the earlier layer quantities continue to be available. Please read the Level 2 Product User Guide for details on all L2 products.

http://disc.sci.gsfc.nasa.gov/AIRS/documentation/v6_docs/v6releasedocs-1/V6_L2_Product_User_Guide.pdf

1.1.3 Improved Quality Indicators and Error Estimates

In the V6 release, all retrieved quantities have quality indicators. Please read the Level 2 Quality Control and Error Estimation documentation for a description of these indicators and how they are set.

http://disc.sci.gsfc.nasa.gov/AIRS/documentation/v6_docs/v6releasedocs-1/V6_L2_Quality_Control_and_Error_Estimation.pdf

The V6 yields are increased and the error estimate improved.

1.1.4 Improved Outgoing Longwave Radiation

The OLR calculation has been updated and products are now provided at AIRS spot resolution as well as AMSU FOV esolution. A new spectral OLR reported in 16 bands is provided in the L2 Support Product.

1.1.5 New Thermodynamic/Ice Cloud Products

Four primary new cloud products are provided in the L2 Support Product: cloud thermodynamic phase, ice cloud optical thickness, ice cloud effective diameter, and effective ice cloud top temperature.

1.1.6 New Boundary Layer Height Product

The pressure at the top of the planetary boundary layer and associated quality control are reported in the L2 Support Product at the resolution of the AMSU FOV. The vertical positioning of thermodynamic profile gradients are used to locate the top of the PBL.

2 Instrument Description and Status

2.1 Overview

The AIRS/AMSU/HSB instrument suite has been constructed to obtain atmospheric temperature profiles to an accuracy of 1 K for every 1 km layer in the troposphere and an accuracy of 1 K for every 4 km layer in the stratosphere up to an altitude of 40 km. The temperature profile accuracy in the troposphere matches that achieved by radiosondes launched from ground stations. The advantage of the AIRS suite in orbit is the provision of rapid global coverage; radiosonde coverage of the Earth's oceans is practically nonexistent. In conjunction with the temperature profiles, the AIRS instrument suite obtains humidity profiles to an accuracy of 10% in 2 km layers in the lower troposphere and an accuracy of ~50% in the upper troposphere. It also provides integrated column burden for several trace gases.

Summary descriptions of the instruments are available at the URLs:

http://airs.jpl.nasa.gov/instrument/how_AIRS_works/
http://disc.sci.gsfc.nasa.gov/AIRS/additional/instruments.shtml

2.2 Description of Instruments

2.2.1 AIRS

AIRS is a continuously operating cross-track scanning sounder, consisting of a telescope that feeds an echelle spectrometer. The AIRS infrared spectrometer acquires 2378 spectral samples at resolutions, $\lambda/\Delta\lambda$, ranging from 1086 to 1570, in three bands: 3.74 μm to 4.61 μm, 6.20 μm to 8.22 μm, and 8.8 μm to 15.4 μm. The spatial footprint of the infrared channels is 1.1° in diameter, which corresponds to about 15x15 km in the nadir.

During each scan, the rotating external mirror scans the underlying Earth scene from 49° on one side of the nadir to 49° on the other side, in 90 integration periods, and provides two views of dark space (one before and one after the Earth scene), one view of an internal radiometric calibration target, and one view of an internal spectral calibration target. Thus each scan produces 94 sets of measurements (90 earth scenes and 4 calibrations). The scan is repeated every 8/3 seconds. The downlink data rate from the AIRS instrument is 1.2 Mbit/sec.

The IR focal plane is cooled to about 58 K by a Stirling/pulse tube cryocooler. The scan antenna operates at approximately 265 K due to radiative coupling to the Earth and space and to the 150 K IR spectrometer. Cooling of the IR optics and detectors is necessary to achieve the required instrument sensitivity.

2.2.1.1 AIRS IR channel characteristics

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 24 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. Here are example names for the first two and (currently) last two files of each set:

Example Calibration Properties Files
L1B.cal_prop.2002.08.30.v9.5.0.anc
L1B.cal_prop.2002.09.17.v9.5.0.anc
…
…
L1B.cal_prop.2012.01.21.v9.5.0.anc
L1B.cal_prop.2012.07.01.v9.5.0.anc

Example Channel Properties Files
L2.chan_prop.2002.08.30.v9.5.3.anc
L2.chan_prop.2002.09.17.v9.5.3.anc
…
…
L2.chan_prop.2012.01.21.v9.5.3.anc
L2.chan_prop.2012.07.01.v9.5.3.anc

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.

2.2.1.2 AIRS Instrument state

Instrument is in nominal science mode (instrument flag **OpMode** = 'Operate')
The quality of the calibration is judged to be good

2.2.1.3 Radiometric calibration

Refer to papers:

Aumann, H. H., M.T. Chahine and D. Barron (2003), Sea Surface Temperature Measurements with AIRS: RTG.SST Comparison, Proc. SPIE Vol.5151, pp.252-260, San Diego.

Aumann, H. H., D. Gregorich and D. Barron (2004), Spectral Cloud-screening of AIRS data: Non Polar Ocean, Proc. SPIE 49th Annual Meeting on Optical Science and Technology, , Denver Colorado 5548-42

Aumann, H.H., D. Gregorich, S. Gaiser and M. T. Chahine (2004), Application of Atmospheric Infrared Sounder (AIRS) Data to Climate Research, Proc. SPIE 5570 Las Palomas, Spain.

Aumann H. H., S. Broberg, D. Elliott, S. Gaiser, D. Gregorich (2006), "Three years of Atmospheric Infrared Sounder radiometric calibration validation using sea surface temperatures", J. Geophys. Res., 111, D16S90, doi:10.1029/2005JD006822.

DeSouza-Machado S. G., L. L. Strow, S. E. Hannon, H. E. Motteler, M. Lopez-Puertas, B. Funke, D. P. Edwards (2007), Fast forward radiative transfer modeling of 4.3 μ m nonlocal thermodynamic equilibrium effects for infrared temperature sounders, Geophys. Res. Lett., 34, L01802, doi:10.1029/2006GL026684.

Hagan, D. and P. Minnett (2003), AIRS radiance validation over ocean from sea surface temperature measurements, IEEE Transactions on Geosciences and Remote Sensing, pp 432-441, 41.

Huang X., Y. L. Yung (2005), Spatial and spectral variability of the outgoing thermal IR spectra from AIRS: A case study of July 2003, J. Geophys. Res., 110, D12102, doi:10.1029/2004JD005530.

Kahn, B. H., E. Fishbein, S. Nasiri, A. Eldering, E. J. Fetzer, M.J. Garay, S-Y Lee, (2007), The radiative consistency of Atmospheric Infrared Sounder and Moderate Resolution Imaging Spectroradiometer cloud retreivals, JGR, 11, D09201, doi: 10.1029/2006JD007486.

Pagano, T.S., Aumann, H.H., Hagan, D.E., and Overoye, K. (2003), Prelaunch and In-Flight Radiometric calibration of the Atmospheric infrared Sounder (AIRS), IEEE Transactions on Geosciences and Remote Sensing, pp 265-273, 41.

Tobin D. C., et al. (2006), Radiometric and spectral validation of Atmospheric Infrared Sounder observations with the aircraft-based Scanning High-Resolution Interferometer Sounder, J. Geophys. Res., 111, D09S02, doi:10.1029/2005JD006094.

Tobin D. C., H. E. Revercomb, R. O. Knuteson, B. M. Lesht, L. L. Strow, S. E. Hannon, W. F. Feltz, L. A. Moy, E. J. Fetzer, T. S. Cress (2006), Atmospheric Radiation Measurement site atmospheric state best estimates for Atmospheric Infrared Sounder temperature and water vapor retrieval validation, J. Geophys. Res., 111, D09S14, doi:10.1029/2005JD006103.

Tobin D. C., H. E. Revercomb, C. C. Moeller, T. S. Pagano (2006), Use of Atmospheric Infrared Sounder high-spectral resolution spectra to assess the calibration of Moderate resolution Imaging Spectroradiometer on EOS Aqua, J. Geophys. Res., 111, D09S05, doi:10.1029/2005JD006095.

Walden V. P., W. L. Roth, R. S. Stone, B. Halter (2006), Radiometric validation of the Atmospheric Infrared Sounder over the Antarctic Plateau, J. Geophys. Res., 111, D09S03, doi:10.1029/2005JD006357.

2.2.1.4 AIRS Spectral Calibration

Refer to papers:

Gaiser, S. L., H. H. Aumann, L. L. Strow, S. E. Hannon, and M. Weiler (2003), In-flight spectral calibration of the atmospheric infrared sounder (AIRS), IEEE Trans. Geosci. Remote Sensing, 41, pp. 287-297.

Strow, L.L., S.E. Hannon, M. Weiler, K. Overoye, S.L. Gaiser, H.H. Aumann, (2003), Prelaunch spectral calibration of the atmospheric infrared sounder (AIRS), IEEE Trans Geosci Remote Sensing 41, (2): 274.

Strow L. L., S. E. Hannon, S. De-Souza Machado, H. E. Motteler, D. C. Tobin (2006), Validation of the Atmospheric Infrared Sounder radiative transfer algorithm, J. Geophys. Res., 111, D09S06, doi:10.1029/2005JD006146.

Tobin D. C., et al. (2006), Radiometric and spectral validation of Atmospheric Infrared Sounder observations with the aircraft-based Scanning High-Resolution Interferometer Sounder, J. Geophys. Res., 111, D09S02, doi:10.1029/2005JD006094.

Weiler, M.H., L. Strow, S. Gaiser, R. Schindler, K. Overoye, and H.H. Aumann (2001), Spectral Test and Calibration of the Atmospheric Infrared Sounder (AIRS) presented at the SPIE International Symposium on Optical Science andTechnology, Vol. 4483, San Diego, CA, 29 July-3 August, 2001.

2.2.1.5 AIRS Spatial Calibration

Refer to paper:

Gregorich, D. T. and H. H. Aumann (2003), Verification of AIRS Boresight Accuracy Using Coastline Detection, IEEE Trans. Geosci. Remote Sensing, vol. 41, pp. 298-302.

2.2.2 Visible/NIR

The Visible/Near-IR (VIS/NIR) photometer contains four spectral bands, each with nine pixels along track, with a 0.185 degree instantaneous field-of-view (FOV). It is boresighted to the IR spectrometer to allow simultaneous measurements of the visible and infrared scene. The VIS/NIR photometer uses optical filters to define four spectral bands in the 400 nm to 1000 nm region. The VIS/NIR detectors are not cooled and operate in the 293 K to 300 K ambient temperature range of the instrument housing. The spatial resolution at nadir is 2.3 km. The primary function of the AIRS VIS/NIR channels is to provide diagnostic support to the infrared retrievals: setting flags that warn of the presence of low-clouds or highly variable surface features within the infrared FOV. The approximate spectral responses of the four near-IR channels are shown in Figure 1.

2.2.2.1 Visible/NIR Instrument state

Instrument is in nominal science mode (instrument flag **OpMode** = ‘Operate’)

2.2.2.2 Visible/NIR Radiometric calibration and Channel Characteristics

Refer to paper:

Gautier, C., Y. Shiren, L. L. Strow and M. D. Hofstadter (2003), AIRS vis/near IR instrument, IEEE Trans. Geosci. Remote Sensing, vol. 41, pp. 330-342, Feb. 2003

The Vis/NIR L1B radiances have been calibrated and validated by vicarious calibration. Unpublished field data confirms the radiances are valid to the quoted accuracy: 11% for Channel #1 and 7% for Channels #2, 3 and 4. This accuracy does not apply to the first few samples of Channel #4 in each scanline. These data have anomalously low values as reported in the accompanying disclaimer file.

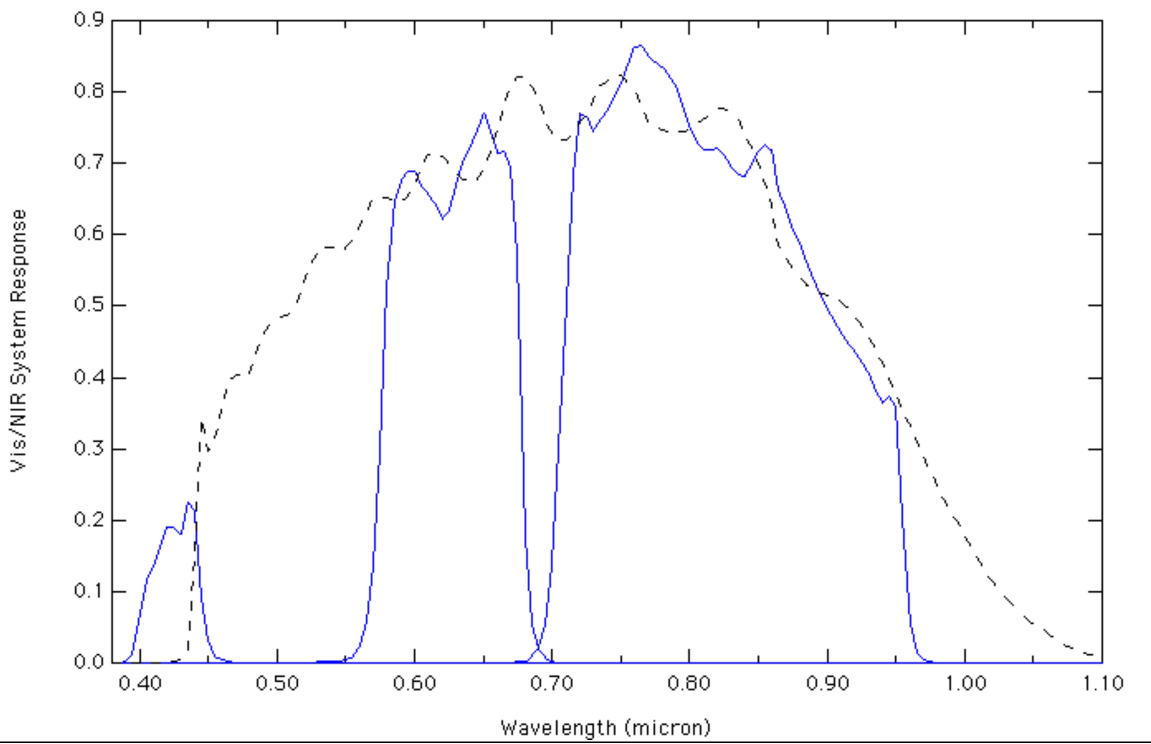

Figure 1: The approximate spectral response of the four VIS/NIR channels. The three solid curves are, from left to right, Channels 1, 2, and 3. The dashed curve is the response of Channel 4.

Channel 1 (0.40 to 0.44 µm) is designed to be most sensitive to aerosols. Channels 2 (0.58 to 0.68 µm) and 3 (0.71 to 0.92 µm) approximate the response of AVHRR channels 1 and 2, respectively, and are particularly useful for surface studies. (AVHRR is an imaging instrument currently carried by NOAA polar orbiting satellites.) Channel 4 has a broadband response (0.49 to 0.94 µm) for energy balance studies.

2.2.2.3 Visible/NIR Pointing

Validation of the Vis/NIR pointing has not been done, but initial comparisons to other satellite data (Terra MISR and Aqua MODIS instruments) suggests it is accurate to within 0.3 degrees (corresponding to 4 km at nadir).

Note: To reduce the data volume, not every VIS/NIR pixel is geolocated. Instead, only the four “corner pixels” of the 9x8 grouping associated with each IR footprint are geolocated. (A bi-linear interpolation can be used to locate the remaining pixels.) In the data files, four-element arrays called “**cornerlats**” and “**cornerlons**” carry this information. The first array element is the upper-left pixel

when viewing an image aligned with “up” being North. The second element is the upper-right pixel. The third and fourth elements refer to the lower-left and lower-right pixels, respectively.

2.2.3 AMSU-A

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

2.2.3.1 AMSU-A Instrument state

Instrument is in nominal science mode and both AMSU modules are in the optimal space view position.

- On 11/16/2004 at 13:21:19 UT all of the AMSU-A2 temperature read outs except the warm load temperatures showed a sudden and simultaneous increase in noise. Subsequent analyses indicate that failure of a compensation capacitor in the reference voltage amplifier is the most probable cause. This will have a negligible effect on science products because RF shelf temperature enters into the calibration in a small second-order term. At the same time, however, the warm load temperature appeared to undergo a decrease of 0.15 K. Analysis continues to determine whether the warm load temperature offset continued. If so, the DN to EU conversion in the calibration algorithm will require modification.
- AMSU channel 4 failed 1 October 2007
    - Radiances useful until mid-2007
- AMSU channel 5 progressively degraded beginning January 2010
    - Noise level of 0.5 K in January 2010
    - Noise level of 1.0 K in February 2011

  - Noise level of 2.0 K in February 2012 and sharply increased thereafter
- AMSU channel 7 exhibits abnormal noise levels
  - Noise level is about 5x NEdT on the average, but varies substantially
  - The added noise is not random; probable cause is spacecraft transmitter interference
  - The underlying random noise (NEdT) is within specs
  - Channel 7 should not be used until this systematic noise can be removed
- AMSU channel 6 exhibits some of the same noise characteristics as channel 7, however
  - Added noise level is a fraction of NEdT; overall level still meets specs
  - Use channel 6 with confidence
- AMSU channel 9 radiometer counts exhibit sudden, large change (~0.1%) recovering suddenly or gradually after 1-3 minutes; typically appears once or a few times per day, possibly clustered; no other channels affected
  - The phenomenon is being characterized; cause as yet unknown
  - Negligible effect in most cases; use channel 9 with confidence

2.2.3.2 AMSU-A Radiometric calibration

The data have been reprocessed with the current best calibration algorithm and calibration parameters. Calibration accuracy is estimated to be on the order of 1 K. Radiometric sensitivity is better than requirements – see AMSU-A channel characteristics table, below.

The quality of the calibration is judged to be good, but at present there are substantial scan biases. Modeling of the sidelobe pickup is under way to correct these scan biases.

Channel 7 has additional correlated noise, and should be avoided in applications that use single measurements, such as comparisons with collocated soundings. It may be used in applications in which some averaging is done (i.e. gridding/binning or regional averages).

Channel 6 exhibits additional correlated noise; similar to channel 7 but much smaller.

Channel 9 exhibits occasional popping, i.e. the calibration counts suddenly drop and then quickly recover. This typically occurs no more than once per orbit.

Channel 14 may have correlated noise, but it is minor.

2.2.3.3 AMSU-A Preliminary Pointing Analysis using Coastlines

Valid for channels 1, 2, 3, 15 (window channels)
Pitch error < 10% of FOV (< 4 km at nadir)
Roll Error estimated to be less than 20% of FOV
Yaw error estimated to be less than 30% of FOV at swath edge

2.2.3.4 AMSU-A channel characteristics at launch

Ch #	Module	Center freq [MHz]	Stability [MHz]	Bandwidth [MHz]	On-Orbit NEdT [K]	T/V NEdT [K]	Pol
1	A2	23800	±10	1x270	0.17	0.17	V
2	A2	31400	±10	1x180	0.19	0.25	V
3	A1	50300	±10	1x160	0.21	0.25	V
4	A1	52800	±5	1x380	0.12	0.14	V
5	A1	53596±115	±5	2x170	0.16	0.19	H
6	A1	54400	±5	1x380	0.21	0.17	H
7	A1	54940	±5	1x380	0.21	0.14	V
8	A1	55500	±10	1x310	0.14	0.16	H
9	A1	[f_0]=57290.344	±0.5	1x310	0.14	0.16	H
10	A1	f_0±217	±0.5	2x77	0.19	0.22	H
11	A1	f_0±322.4±48	±1.2	4x35	0.22	0.24	H
12	A1	f_0±322.4±22	±1.2	4x16	0.31	0.36	H
13	A1	f_0±322.4±10	±0.5	4x8	0.43	0.50	H
14	A1	f_0±322.4±4.5	±0.5	4x3	0.71	0.81	H
15	A1	89000	±130	1x2000	0.10	0.12	V

2.2.4 HSB

The Humidity Sounder for Brazil (HSB) is a 4-channel microwave moisture sounder implemented as a single module. Three channels are located near 183 GHz, while the fourth is a window channel at 150 GHz. Physically HSB is identical to AMSU-B, which is operated by NOAA on its most recent POES satellites, but HSB lacks the fifth channel (89 GHz) of AMSU-B. Like AIRS, HSB is a cross-track scanner, and it has only one parabolic scan antenna. Its scan speed as well as its footprints is similar to AIRS (three scans per 8 seconds and about 15 km at nadir, respectively). There is therefore one HSB footprint per AIRS footprint.

HSB ceased operation on February 5, 2003 due to a failure in the mirror scan motor electronics.

2.2.4.1 HSB Instrument state

Instrument failed Feb 5, 2003. An anomaly investigation team has concluded that the most likely failure cause was a bad connection or solder joint in the motor drive electronics commutation circuit. The symptoms seen on orbit were replicated on an engineering model.

2.2.4.2 Radiometric calibration

The data have been reprocessed with the current best calibration algorithm and calibration parameters. Calibration accuracy is estimated to be on the order of 1 K. Radiometric sensitivity is better than requirements – see HSB channel characteristics table, below.

The quality of the calibration is judged to be good, but at present there are substantial scan biases. Modeling of the sidelobe pickup is under way to correct these scan biases.

L1B data contain fields named “**antenna_temp**” and “**brightness_temp**”. Both are well calibrated and without sidelobe correction in this release. The **brightness_temp** data field may include sidelobe correction in a future release. In this release the two fields are identical.

2.2.4.3 HSB Preliminary Pointing Analysis using Coastlines

Valid for channel 2 (window channel)
Pitch error < 10% of FOV (< 1.5 km at nadir)
Roll Error estimated to be less than 20% of FOV
Yaw error estimated to be less than 30% of FOV at swath edge

Refer to paper:

Lambrigtsen, B. H., and R. V. Calheiros (2003), The humidity sounder for Brazil--an international partnership, IEEE Trans. Geosci. and Remote Sensing, 41, 2, pp 352-361.

2.2.4.4 HSB channel characteristics

Ch #	Center freq [MHz]	Stability [MHz]	Bandwidth [MHz]	On-Orbit NEdT[K]	T/V NEdT [K]	Pol
1	AMSU-B channel 1 was not implemented for HSB					
2	150000	±100	2x1000	0.58	0.68	V
3	183310±1000	±50	2x500	0.55	0.57	V
4	183310±3000	±70	2x1000	0.35	0.39	V
5	183310±7000	±70	2x2000	0.28	0.30	V

2.2.5 Relation of Fields of View of AIRS/AMSU/HSB

There are nominally 240 Level 1B and 240 Level 2 granules of 6-minute duration generated each day. The orbital repeat cycle is 16 days, but orbital maintenance maneuvers can shift granules along orbits by a small fraction of a granule. Maps showing the locations of granules are generated daily and available for download at the URL

http://disc.sci.gsfc.nasa.gov/daac-bin/airs/airs_gallery.pl

Example maps for 2/1/2013 are shown in Figure 2:

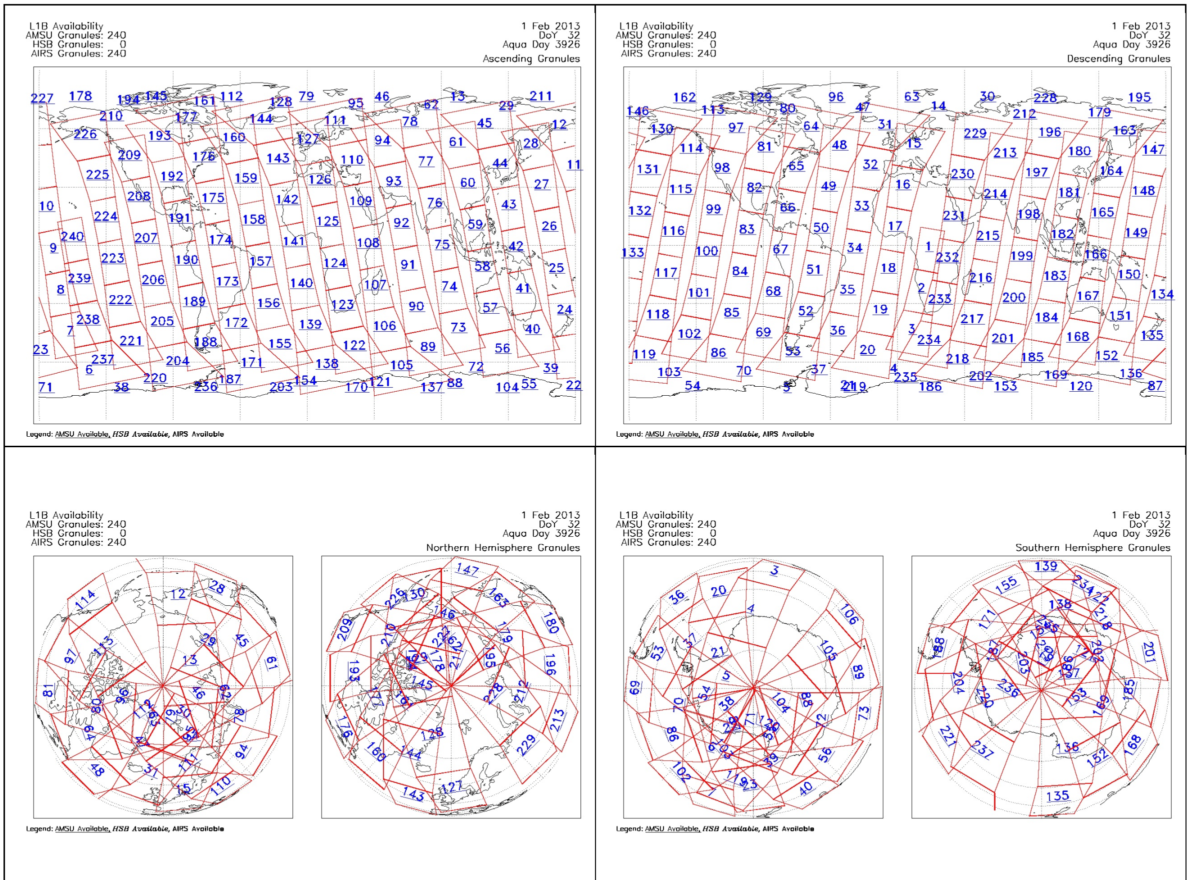

Figure 2: AIRS/AMSU/HSB Granules for February 1, 2013
top left: ascending granules top right: descending granules
bottom left: Arctic granules bottom right: Antarctic granules

A granule of data contains 45 scansets, corresponding to 45 cross-track scans of the AMSU-A mirror. The AMSU-A radiance data sampled in a scanset are

combined to create integrated radiances for 30 contiguous AMSU-A FOVs. An integration encompasses the time required for the mirror to sweep through an AMSU-A instantaneous FOV. Figure 3 illustrates the retrieval FOV pattern over Southern California that make up Granule 209 of AIRS/AMSU/HSB products on September 6, 2002.

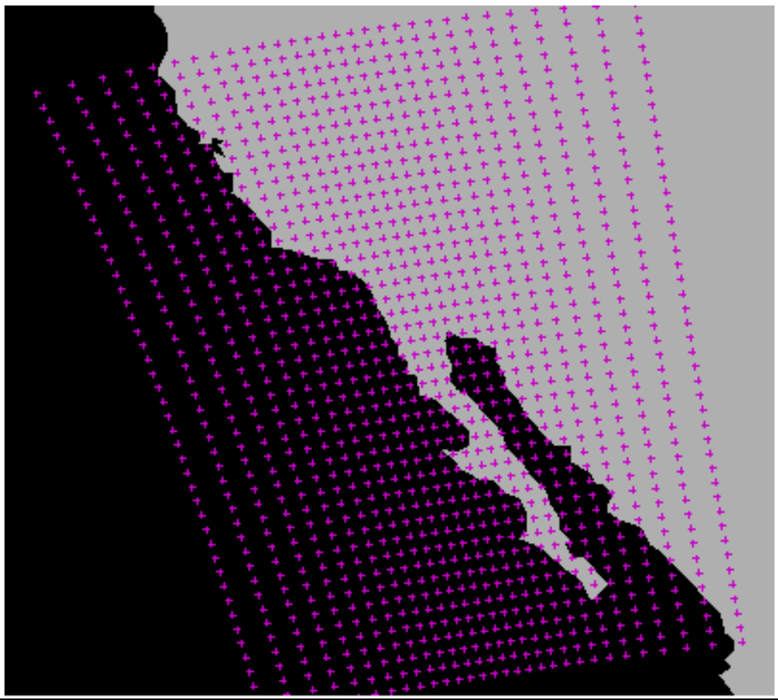

Figure 3: AIRS/AMSU/HSB Footprint Pattern Sept 6, 2002; Granule 209

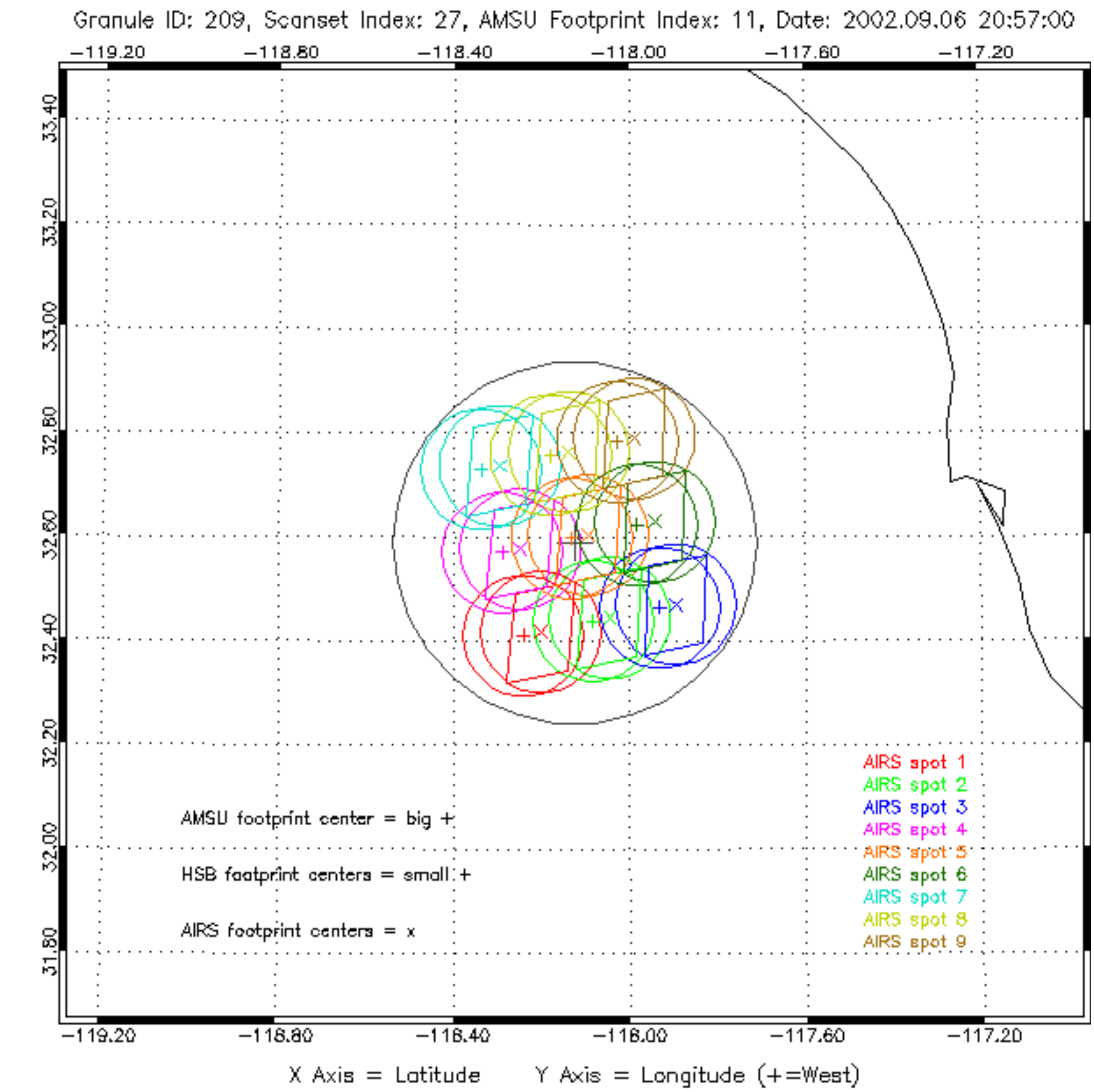

Figure 4: AIRS/AMSU/HSB Footprint Pattern
Sept 6, 2002; Granule 209; Scanset 27; Footprint 11
central (lat,lon) = (32.6°, -118.1°)

An AMSU-A FOV encompasses 9 AIRS FOVs (arranged in a 3x3 matrix) and 9 HSB FOVs (arranged in a 3x3 matrix). Each AIRS footprint encompasses 72 Vis/NIR pixels (arranged in a 9x8 rectangular array). This arrangement is illustrated in Figure 3, which was produced from the geolocation information contained within Granule 209 of data taken September 6, 2002, just off the coast of Southern California. The association shown comprises those data which are combined into a retrieval field-of-view located in the 11 th AMSU-A FOV of the 27th AMSU-A scanset. The large circle represents the 3.3 deg instantaneous

FOV of an AMSU-A observation. The smaller colored circles represent the 1.1 deg instantaneous FOVs of the associated arrays of AIRS and HSB observations. The colored rectangles represent the areas covered by the associated arrays of VIS/NIR pixels.

Since granule 209 is an ascending (daytime) granule, the spacecraft track tends toward the northwest. The scan direction as seen by an observer sitting on the spacecraft and facing the direction of motion is left to right. Thus the scan direction on the Earth for this granule is also left to right in this figure.

Within each scanset are three scanlines, corresponding to 3 cross-track scans of the AIRS and HSB mirrors. The AIRS and HSB radiance data sampled in each scanline are combined to create integrated radiances for 90 AIRS and 90 HSB footprints.

The VIS/NIR instrument has an array of 9 detectors arranged along the spacecraft track direction that look at the AIRS mirror. Sampling and integration are arranged so that there are 8 cross-track samples of each VIS/NIR detector as the mirror sweeps through one AIRS instantaneous FOV.

3 AIRS Science Processing System

3.1 System Overview

The AIRS Science Processing System (SPS) is a collection of programs, or Product Generation Executives (PGEs), used to process AIRS Science Data. These PGEs process raw, low level AIRS Infrared (AIRS), AIRS Visible (VIS), AMSU, and HSB instrument data to obtain temperature and humidity profiles.

AIRS PGEs can be grouped into four distinct processing phases for processing: Level 1A, Level 1B, Level 2 and Level 3. Each consecutive processing phase yields a higher-level data product. Levels 1A and 1B result in calibrated, geolocated radiance products. Level 2 processing derives temperature and humidity profiles, and cloud and surface properties. Level 3 produces gridded ascending and descending products from the Level 2 products averaged daily, over 8-day periods and for each calendar month. In addition to the standard processing PGEs, there is a radiosonde matchup PGE which collects and associates all AIRS products derived within 100 km and 3 hours of ADP operational upper air radiosonde launches reported in the National Centers for Environmental Prediction (NCEP) quality controlled final observation data files (PREPQC). Figure 5 is a diagram illustrating the processing flow of the AIRS Science Processing System through Level 2.

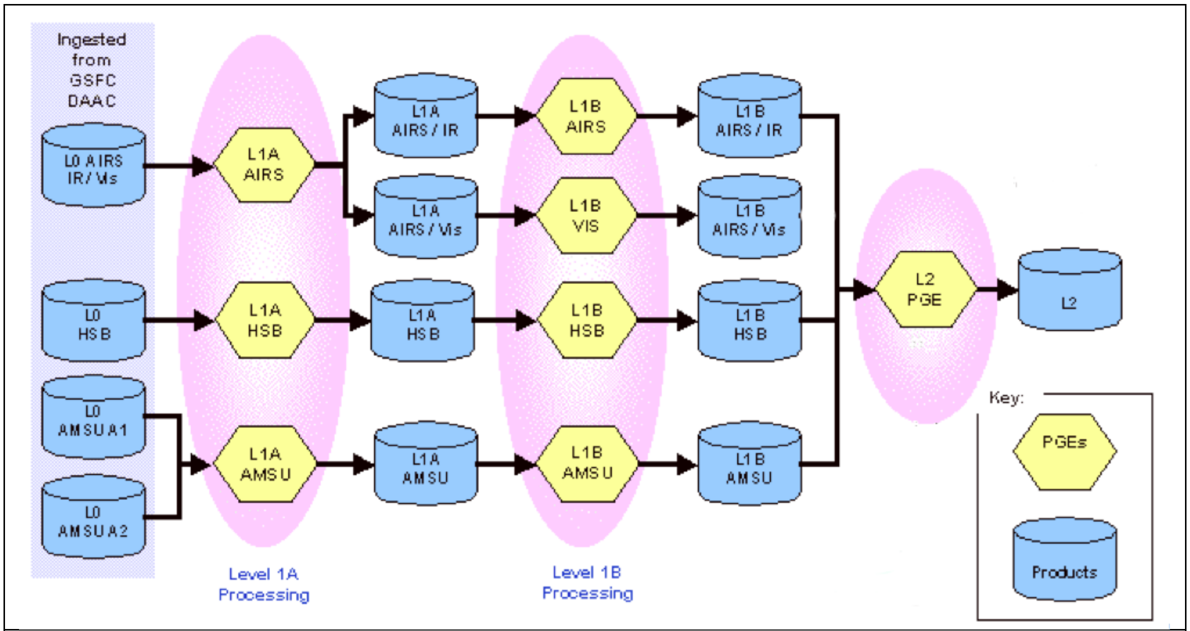

Figure 5: AIRS-Suite Science Processing System Processing Flow through L2

3.2 Data Processing –Version 6

The V6 Release Science Processing Software (SPS) provided to the Goddard Earth Sciences (GES) Data and Information Services Center (DISC) for L2

Product Generation is version 6.0.7.0 for Level 1 and Level 2 PGEs and version 6.0.9.0 for Level 3 PGEs. V6 represents the best refinement of all Level 1A, Level 1B Level 2 and Level 3 PGEs as of January 2013. It contains working versions of all Level 1A, Level 1B, Level 2 and Level 3 software modules. Specific features and characteristics of V6 are described in other sections of this documentation. For a complete description of the data product files and the ancillary static and dynamic inputs to the various PGEs see:

http://disc.sci.gsfc.nasa.gov/AIRS/documentation/v6_docs/v6releasedocs-1/V6_Released_Processing_File_Description.pdf

Note: The L1B radiances will NOT be reprocessed in V6. The algorithm has remained unchanged, and so radiances are still V5.0.x.0. L1B products prior to 21 Jan 2012 are V5.0.0.0 and since that date are V5.0.21.0. The difference results from gain table changes that recovered almost 100 “dead” channels that had been impacted by radiation hits over the life of the mission to date.

We expect the L1B radiances to be reprocessed in a subsequent release some years in the future. The Level 2 and Level 3 software continues to be refined, and JPL plans to continue to upgrade these PGEs periodically, delivering updated code modules to the GES DISC to support public release of their products.

3.3 Level-1A Processing

AIRS data processing begins with receipt of Level 0 data from the Earth Observing System (EOS) Data and Operations System (EDOS). When Level 0 data are received, Level 1A PGEs are scheduled. The Level 1A PGEs perform basic house keeping tasks such as ensuring that all the Level 0 data are present and ordering the data into time of observation synchronization. Once the Level 0 data are organized, algorithms perform geolocation refinement and conversion of raw Data Numbers to Engineering Units (DN to EU). Finally, the level 1A data are collected into granules of data (six minutes of instrument data) and are forwarded to Level 1B PGEs for further processing.

3.4 Level-1B Processing

Level 1B PGEs receive 240 granules of AIRS-suite (AIRS IR, AIRS VIS, AMSU and HSB) Level 1A 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 per day.

Level 1B PGEs produce 240 granules per day 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:

Data Set	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

Figure 6 shows the nominal weighting function profiles as a function of pressure for the 15 AMSU channels.

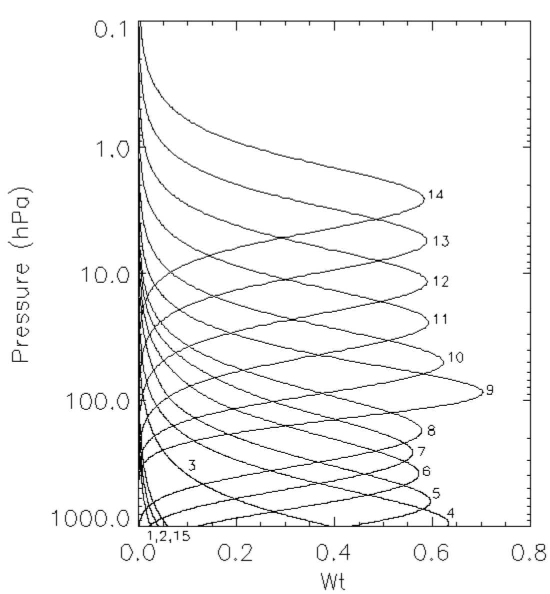

Figure 6: Nominal weighting functions for the AMSU channels

Figure 7 on the following page shows the combined AMSU and HSB spectra for the example AMSU FOV first introduced in Figure 3. Channel number is shown along the vertical axes (AMSU to the left and HSB to the right), and the horizontal axis represents brightness temperature. The AMSU temperature sounding channels (3-14) are connected with line segments and that plot can be viewed as a rudimentary representation of the temperature profile. The lowest channel is affected by the surface, however, which depresses the brightness temperature relative to the atmospheric temperature for this oceanic FOV.

AMSU channels 1, 2 and 15 are plotted separately as bars, since they are window channels that are primarily influenced by the surface brightness (i.e. the product of surface temperature and emissivity). Ocean emissivity is very low for channels 1 and 2, which causes very low brightness temperatures, even though the SST is relatively high. Channel 1 is warmer than channel 2 because it is affected by water vapor and clouds, which elevates the brightness temperature over the "cold" ocean background. Channel 15 is warmer still, due to a higher emissivity as well as higher sensitivity to both water vapor and clouds.

HSB has 4 channels and 9 FOVs within the single AMSU FOV, resulting in the 9 line plots shown to the right. The vertical order of the channels reflects the order of the peak in the weighting function rather than the serial channel number. These channels essentially reflect the atmospheric temperature near the peaks of the water vapor/liquid weighting functions. The lowest channel (#2) peaks near the surface (but is slightly "cooler" than the surface due to the emissivity). The highest channel (#3), which is too opaque to have much influence from the surface, has a brightness temperature somewhere between AMSU channels 4 and 5, which suggests it peaks at perhaps 850 mb. The spread between the 9 plots suggests there is some (but not much) variability in water vapor and liquid water.

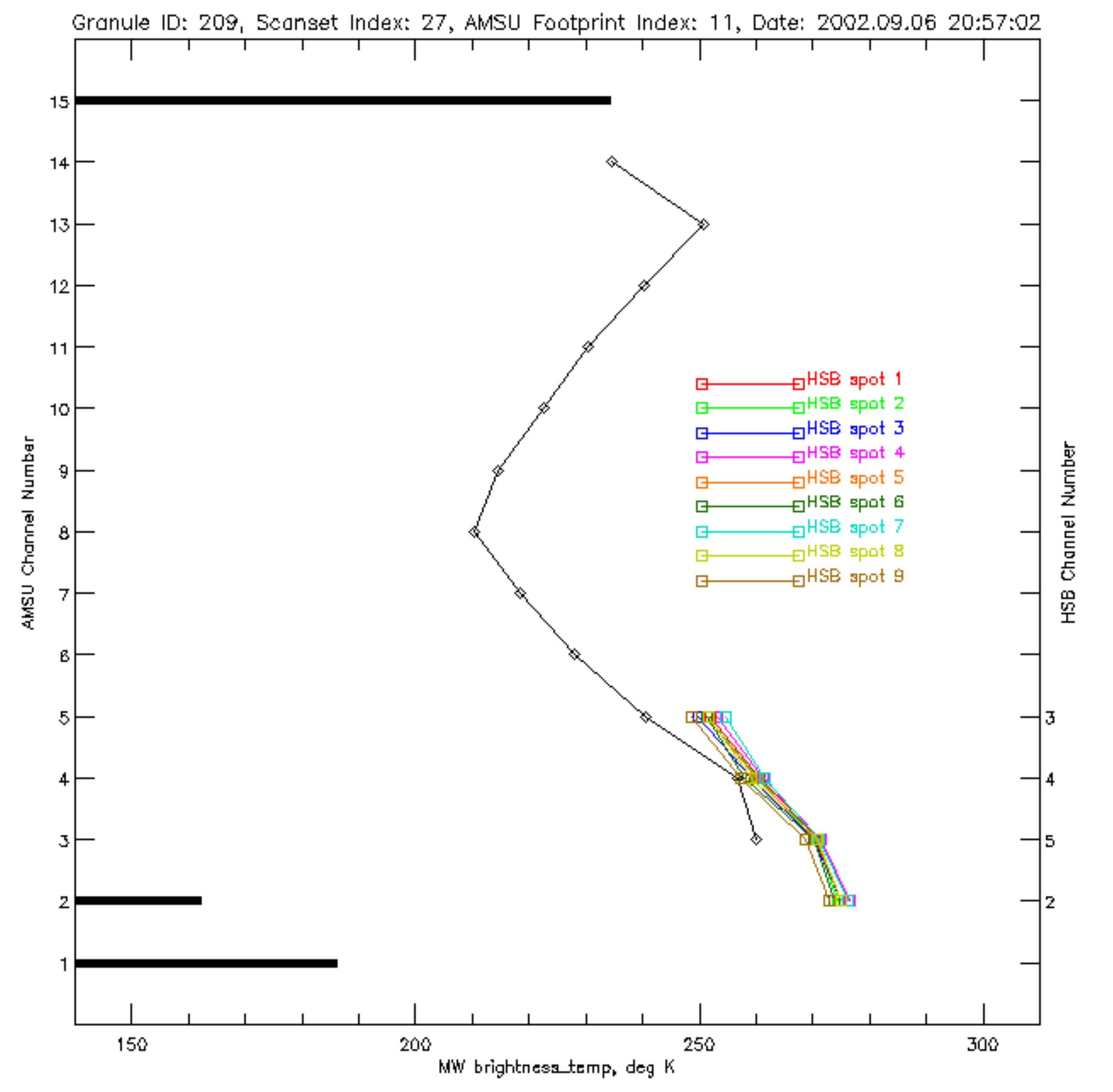

Figure 7: Level 1B Microwave Radiances (AMSU-A and HSB)
Sept 6, 2002; Granule 209; Scanset 27; Footprint 11

Figure 8 shows the infrared Level 1B radiance spectra (AIRS) from the example FOV, which contains 9 AIRS spots. These data are contained in the L1B AIRS Radiance Product.

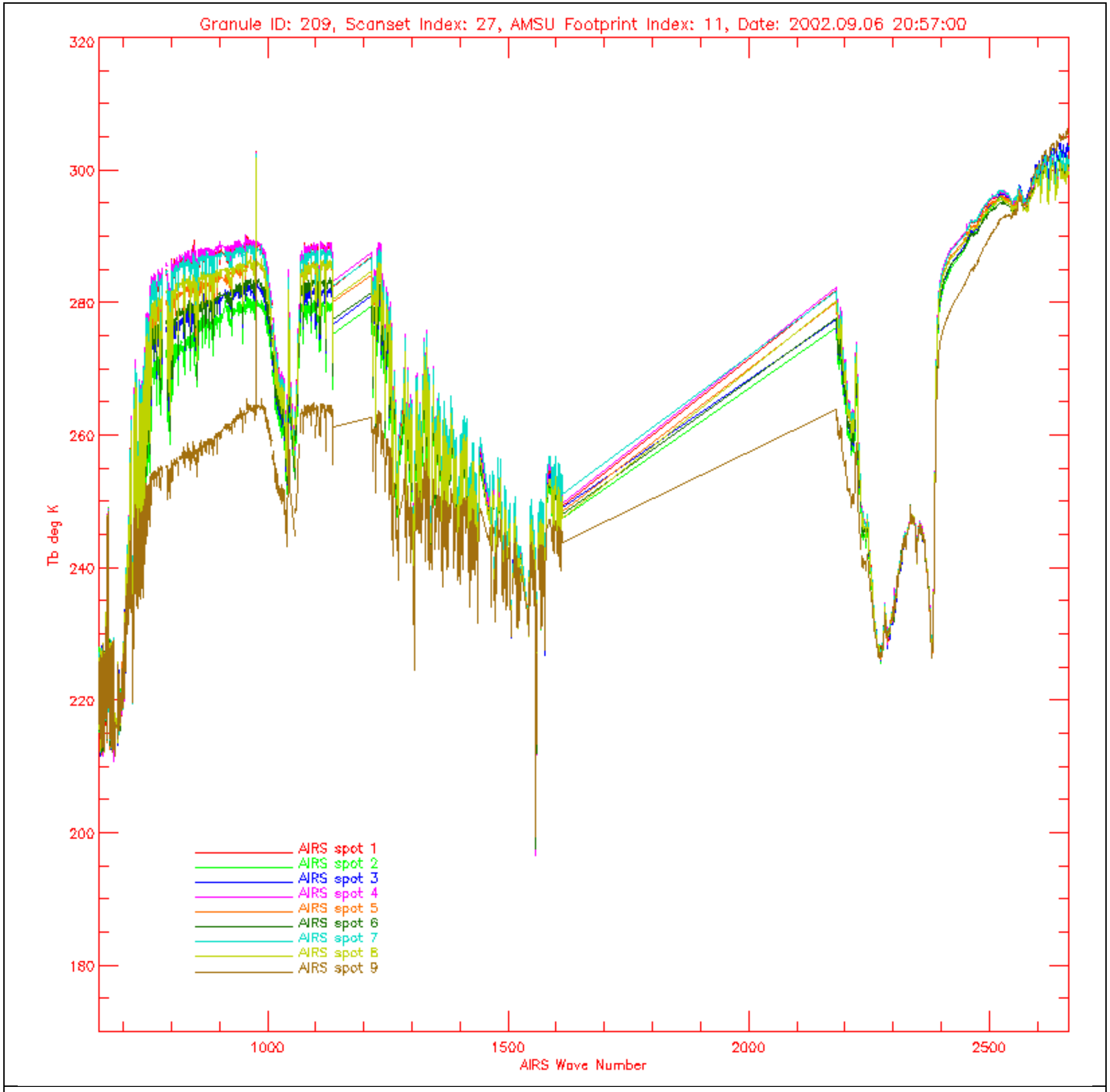

Figure 8: Level 1B Infrared Radiance Spectra (AIRS)
Sept 6, 2002; Granule 209; Scanset 27; Footprint 11

The brightness temperature in the 900 cm^{-1} region varies from around 260K to just under 290K. The AMSU footprint is over ocean and relatively uniform with the exception of cloud properties. Thus the variability of brightness temperature is mostly due to the effect of clouds. Cloud-clearing in the Level 2 retrieval estimates the clear column radiance from the cloud radiances by extrapolation. Note the slope of the coldest spectrum (color-coded brown) in the 900 cm^{-1} region. Since cloud tops tend to be colder than the surface, this is most likely the

cloudiest of the nine AIRS footprints. The slope is one of the signatures of cirrus clouds. This spectrum appears to reflect more solar radiance than other AIRS spectra (i.e., higher brightness temperature in 2600 cm^{-1} region).

A Validation Report for V6 data is currently under preparation and will be published after the V6 data products become publicly available. A V5 Validation Report, summarizing relevant publications, is also being prepared. Early V6 validation results are partially summarized in

http://disc.sci.gsfc.nasa.gov/AIRS/documentation/v6_docs/v6releasedocs-1/V6_L2_Performance_and_Test_Report.pdf

This is a brief summary of some of those results. V6 product yields (fraction of useful retrievals) are higher, especially near land surface. The V6 retrieved product uncertainties are generally smaller than those of V5 products. A spurious, long-term cooling trend in temperature profiles, first noted by Divakarla et al. (2006), has been reduced by an order of magnitude. Surface properties over both land and ocean are more realistic compared to in situ observation, as are near-surface profiles of temperature and water vapor in preliminary comparisons to radiosondes. Trace gas amounts are also more realistic in comparison to in situ and satellite data sources. Cloud top properties from V6 compare better against CloudSat/CALIPSO observations than do those from V5.

The visible/near infrared data provide diagnostic support to the infrared retrievals as well as several research products. The field of radiances from the four channels can be combined to produce a low-resolution false color image of a granule. On the following page, Figure 9 is an example. It shows a false color image of the entire granule from which the data of Figures 5 and 7 were taken.

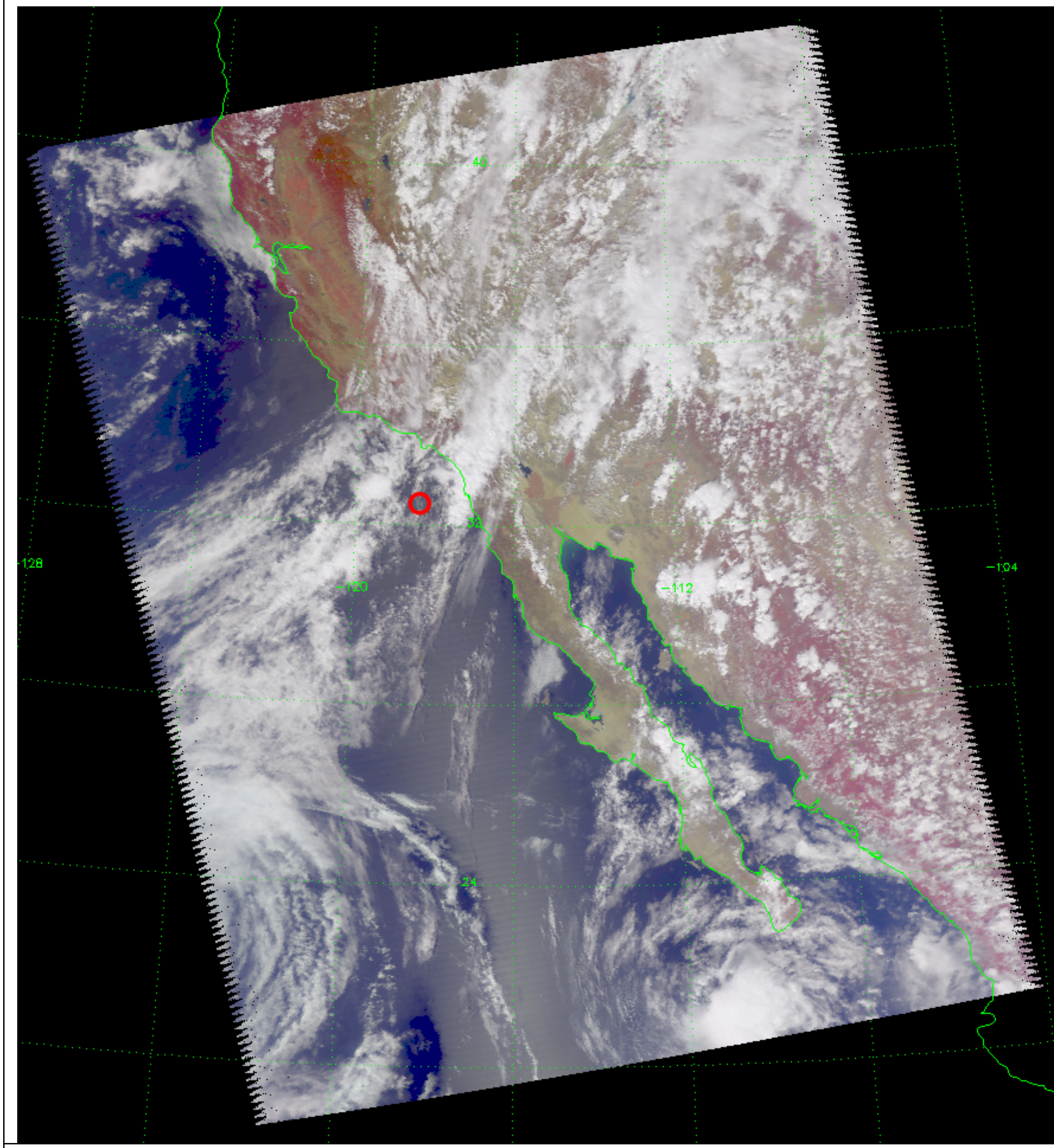

Figure 9: false color image of Sept 6, 2002 Granule 209 constructed from Vis/NIR radiances red circle outlines example FOV; interior is approximate size of FOV

3.5 Level-2 Processing

The single Level 2 PGE reads Level 1B AIRS IR data and optionally corresponding Level 1B data granules from other AIRS-suite instruments (AMSU and HSB), the surface pressure from the NCEP forecasts and a digital elevation map. The steps in the retrieval flow are shown in the document:

http://disc.sci.gsfc.nasa.gov/AIRS/documentation/v6_docs/v6releasedocs-1/V6_Retrieval_Flow.pdf

Depending upon the results of tests applied at each stage of the retrieval flow, the resulting Level 2 product may be one of several possibilities. Refer to the two documents:

http://disc.sci.gsfc.nasa.gov/AIRS/documentation/v6_docs/v6releasedocs-1/V6_L2_Product_User_Guide.pdf

http://disc.sci.gsfc.nasa.gov/AIRS/documentation/v6_docs/v6releasedocs-1/V6_L2_Quality_Control_and_Error_Estimation.pdf

Level 2 produces 240 granules of each of the following AIRS products:

Data Set	Granule Size	Short Name AIRS+AMSU	Short Name AIRS Only	Short Name AIRS+AMSU+HSB
L2 Cloud-cleared radiances	10 MB	AIRI2CCF	AIRS2CCF	AIRH2CCF
L2 Standard Product	5.4 MB	AIRX2RET	AIRSRET	AIRH2RET
L2 Support Product	20 MB	AIRX2SUP	AIRS2SUP	AIRH2SUP

Each granule contains the data fields from 1350 retrievals laid out in an array of dimension 30x45, corresponding to the 30 AMSU footprints (cross-track) in each of 45 scansets (along-track).

3.6 Level-3 Processing

Level 3 products are statistical summaries of geophysical parameters that have been spatially and temporally re-sampled from lower level data products (e.g., Level 2 data). Due to re-sampling and selecting a reduced set of reporting parameters, Level 3 datasets are substantially smaller than the lower level source products from which they are derived. Thus, Level 3 products can be used without a great deal of overhead in terms of data handling.

AIRS Level 3 products are a direct representation of the lower level datasets; the underlying geophysical values are retained in Level 3. In addition, standard deviations, extrema, counts and (sometimes) error estimates are carried forth in the AIRS Level 3 products as well as the mean value per grid cell.

The daily Level 3 standard product PGE reads Level 2 standard product data granules. The daily Level 3 support product PGE reads Level 2 standard and support product data granules. The input Level 2 data are filtered according to associated quality indicators described in:

http://disc.sci.gsfc.nasa.gov/AIRS/documentation/v6_docs/v6releasedocs-1/V6_L2_Product_User_Guide.pdf

http://disc.sci.gsfc.nasa.gov/AIRS/documentation/v6_docs/v6releasedocs-1/V6_L2_Quality_Control_and_Error_Estimation.pdf

Level 3 files contain geophysical parameters that have been averaged and binned into 1°x1° grid cells. Grid maps correspond to -180.0° to +180.0° longitude and -90.0° to +90.0° latitude. For each grid map of 4-byte floating-point mean values there is a corresponding 4-byte floating-point map of standard deviation and a 2-byte integer grid map of counts. The counts map provides the user with the number of points per bin that were included in the mean and can be used to generate multi-day maps from the daily gridded products. For some geophysical parameters, we include maps of error estimates. The error estimates are binned from the Level 2 error estimate values as sums of squares.

AIRS Level 3 data products consist of three "types" of product, daily, 8-day (one-half of the Aqua orbit repeat cycle), and monthly (calendar). Each of the three Level 3 data products is separated into ascending and descending portions of the orbit, where “ascending or descending” refers to the direction of the sub-satellite point in the satellite track at the equatorial crossing. The ascending direction of movement is from Southern Hemisphere to Northern Hemisphere; the descending direction of movement is from Northern Hemisphere to Southern Hemisphere. Outside of the polar zones, these correspond respectively to daytime and nighttime. Spatial resolution for all standard Level 3 products is 1°x1° where each grid cell is bounded by latitude and longitude lines. Figure 10

is a high level flow diagram of the AIRS standard Level 3 processing, showing the production of the daily and multi-day products.

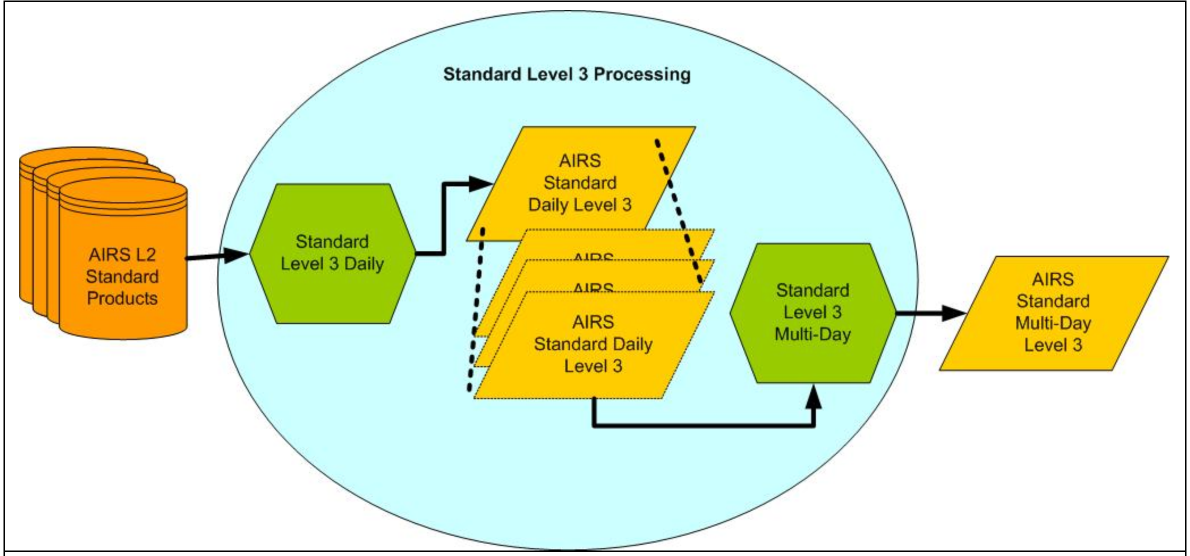

Figure 10: High Level Flow Diagram of AIRS Standard Level 3 Processing

The daily and multi-day Level 3 PGEs produce the following AIRS products:

Data Set	Short Name	Granule Size
L3 standard daily product	AIRX3STD	~70 MB
L3 8-day standard product	AIRX3ST8	~103 MB
L3 monthly standard product	AIRX3STM	~105 MB

The daily Level 3 products will have gores between the satellite paths where there is no coverage for that day. The 8-day Level 3 products may have missing data due to data dropouts. Monthly Level 3 products will likely contain complete global coverage without gores and with little missing data.

The AIRS Level 3 Daily Product is time-continuous from east to west and encompasses all ascending or descending orbits in 24-hour temporal period. AIRS Level 3 data begin just West of the dateline and end just East of the dateline. This is done to prevent data points that are 24 hours apart from being averaged within the same grid cell.

4 V6 Release Data Information

4.1 Data Disclaimer and Quick Start Quality Assurance

4.1.1 Data Disclaimer

The accompanying file:

http://disc.sci.gsfc.nasa.gov/AIRS/documentation/v6_docs/v6releasedocs-1/V6_Data_Disclaimer.pdf

provides information which affects the availability of data for ordering (i.e., may be unavailable due to instrument outage or spacecraft maneuvering). It also lists the known liens against each instrument.

4.1.2 Quick Start Quality Assurance

The accompanying file:

http://disc.sci.gsfc.nasa.gov/AIRS/documentation/v5_docs/AIRS_V5_Release_User_Docs/V5_L1B_QA_QuickStart.pdf

is a guide to the most basic L1B AIRS/AMSU/HSB quality assurance (QA) parameters that a novice user of AIRS/AMSU/HSB data should access to judge L1B Radiance Product quality.

Please refer to the L2 Quality Control and Error Estimation Documentation for a description of the various quality indicators and how they are set:

http://disc.sci.gsfc.nasa.gov/AIRS/documentation/v6_docs/v6releasedocs-1/V6_L2_Quality_Control_and_Error_Estimation.pdf

Data Products

The following is a quick guide to the contents of the data products that we believe are of greatest interest to the user.

4.1.3 L1B AMSU Radiance Product

See

http://disc.sci.gsfc.nasa.gov/AIRS/documentation/v6_docs/v6releasedocs-1/V6_Released_Processing_File_Description.pdf

for a complete description. Please note that values of -9999 (if integer) and -9999.0 (if floating) denote invalid data.

The geolocation data fields of immediate interest to the user are:

- **Latitude**
  AMSU footprint boresight geodetic latitude
  (degrees North, -90->+90), dimension (30,45)
- **Longitude**
  AMSU footprint boresight geodetic longitude
  (degrees East, -180->+180), dimension (30,45)

The per-granule data fields of immediate interest to the user are:

- **center_freq**
  channel center frequency (GHz), dimension (15)
- **IF_offset_1**
  offset of first intermediate frequency stage (MHz)
  (zero for no mixing), dimension (15)
- **IF_offset_2**
  offset of second intermediate frequency stage (MHz)
  (zero for no second mixing), dimension (15)
- **Bandwidth**
  bandwidth of sum of 1,2 or 4 channels (MHz),
  dimension (15)
- **NeDT**
  instrument noise level estimated from warm count scatter (15)

The along-track data fields of immediate interest to the user are:

- **qa_scanline**
  Bit field for each scanline (bit 0 set if sun glint in scanline; bit 1 set if costal crossing in scanline, bit 2 set if some channels had excessive NeDT estimated), dimension (45)
- **qa_channel**
  Bit field by channel for each scanline (bit 0 set if all space view counts bad; bit 1 set if space view counts marginal; bit 2 set if space view counts could not be smoothed; bit 3 set if all blackbody counts bad; bit 4 set if blackbody counts marginal; bit 5 set if blackbody counts could not be smoothed; bit 6 set if unable to calculate calibration coefficients; bit 7 set if excessive NeDT estimated), dimension (15,45)

The swath data fields of immediate interest to user are:

- **antenna_temp**
  calibrated, geolocated channel-by-channel AMSU observed raw antenna temperature (K), dimension (15,30,45)
- **brightness_temp**
  calibrated, geolocated channel-by-channel AMSU sidelobe-corrected antenna temperature (K), dimension (15,30,45)
- **brightness_temp_err**
  error estimate for brightness_temp (K), dimension (15,30,45)
- **landFrac**
  fraction of AMSU footprint that is land (0.0 -> 1.0),
  dimension (30,45)
- **landFrac_err**
  error estimate for landFrac, dimension (30,45)

4.1.4 L1B HSB Radiance Product

See

http://disc.sci.gsfc.nasa.gov/AIRS/documentation/v6_docs/v6releasedocs-1/V6_Released_Processing_File_Description.pdf

for a complete description. Please note that values of -9999 (if integer) and -9999.0 (if floating) denote invalid data.

The geolocation data fields of immediate interest to the user are:

- **Latitude**
  HSB spot boresight geodetic latitude
  (degrees North, -90->+90), dimension (90,135)
- **Longitude**
  HSB spot boresight geodetic longitude
  (degrees East, -180->+180), dimension (90,135)

The per-granule data fields of immediate interest to the user are:

- **center_freq**
  channel center frequency (GHz), dimension (5)
- **IF_offset_1**
  offset of first intermediate frequency stage (MHz)
  (zero for no mixing), dimension (5)
- **IF_offset_2**
  offset of second intermediate frequency stage (MHz)
  (zero for no second mixing), dimension (5)
- **Bandwidth**
  bandwidth of sum of 1,2 or 4 channels (MHz),
  dimension (5)
- **NeDT**
  instrument noise level estimated from warm count scatter (5)

The along-track data fields of immediate interest to the user are:

- **qa_scanline**
  Bit field for each scanline (bit 0 set if sun glint in scanline; bit 1 set if costal crossing in scanline, bit 2 set if some channels had excessive NeDT estimated; bit 3 set if near sidelobe correction applied), dimension (135)
- **qa_receiver**
  Receiver bit field for each scanline (bit 0 set if calibration was not derived due to instrument mode in scanline; bit 1 set if calibration was not derived due to bad or missing PRT values in scanline, bit 2 set if scanline was calibrated but the Moon was in the space view; bit 3 set if scanline was calibrated but there was a space view scan position error; bit 4 set if scanline was calibrated but there was a blackbody view scan position error; bit 5 set if scanline was calibrated but some PRT values were bad or marginal; bit 6 set if scanline calibrated but there was a data gap; bit 7 set if some channels were not calibrated), dimension (135)
- **qa_channel**
  Bit field by channel for each scanline (bit 0 set if all space view counts bad; bit 1 set if space view counts marginal; bit 2 set if space view counts could not be smoothed; bit 3 set if all blackbody counts bad; bit 4 set if blackbody counts marginal; bit 5 set if blackbody counts could not be smoothed; bit 6 set if most recent calibration coefficients used; bit 7 set if excessive NeDT estimated), dimension (15,135)

The swath data fields of immediate interest to user are:

- **antenna_temp**
  calibrated, geolocated channel-by-channel HSB observed raw antenna temperature (K), dimension (5,90,135)
- **brightness_temp**
  calibrated, geolocated channel-by-channel HSB sidelobe-corrected antenna temperature (K). No sidelobe correction applied in V6, so set equal to **antenna_temp**, dimension (5,90,135)
- **brightness_temp_err**
  error estimate for brightness_temp (K), do not use since no sidelobe correction applied in V6, dimension (5,90,135)
- **landFrac**
  fraction of HSB spot that is land (0.0 -> 1.0), dimension (90,135)
- **landFrac_err**
  error estimate for landFrac, dimension (90,135)

4.1.5 L1B AIRS Radiance Product

See

http://disc.sci.gsfc.nasa.gov/AIRS/documentation/v6_docs/v6releasedocs-1/V6_Released_Processing_File_Description.pdf

for a complete description. Please note that values of -9999 (if integer) and -9999.0 (if floating) denote invalid data.

Users should consult the appropriate (by date) Calibration Properties File. The channel properties files are named

L1B.cal_prop.yyyy.mm.dd.v9.5.0.anc

Here, **yyyy.mm.dd** is the year, month and day of month (i.e., 2005.03.01) on which the calibration properties file supersedes the previous version. The file provides 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**. Refer to the following documents for additional quality assurance information:

http://disc.sci.gsfc.nasa.gov/AIRS/documentation/v5_docs/AIRS_V5_Release_User_Docs/V5_L1B_QA_QuickStart.pdf

http://disc.sci.gsfc.nasa.gov/AIRS/documentation/v6_docs/v6releasedocs-1/V6_L2_Quality_Control_and_Error_Estimation.pdf

http://disc.sci.gsfc.nasa.gov/AIRS/documentation/v6_docs/v6releasedocs-1/V6_Released_Processing_File_Description.pdf

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.

SUGGESTION TO USERS FOR CHOOSING CHANNELS TO USE IN RESEARCH:

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.

The geolocation data fields of immediate interest to the user are:

- **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)

The attribute of immediate interest to the user are:

- **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 of immediate interest to the user are:

- **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/m^2/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 of immediate interest to the user are:

- **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 of immediate interest to user are:

- **radiances**
  calibrated, geolocated channel-by-channel AIRS observed infrared spectra (milliWatts/m^2/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/m^2/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/m^2/cm^{-1}/steradian),
  dimension (90,135)

4.1.6 L1B Visible/NIR Radiance Product

See

http://disc.sci.gsfc.nasa.gov/AIRS/documentation/v6_docs/v6releasedocs-1/V6_Released_Processing_File_Description.pdf

for a complete description. Please note that values of -9999 (if integer) and -9999.0 (if floating) denote invalid data.

The geolocation data fields of immediate interest to the user are:

- **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)

The attributes of immediate interest to the user are:

- **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 of immediate interest to the user are:

- **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 of immediate interest to the user are:

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

The swath data fields of immediate interest to user are:

- **radiances**
  calibrated, geolocated channel-by-channel radiances for each channel (Watts/m^2/micron/steradian), dimension (8,9,4,90,135)
- **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)

4.1.7 L2 Standard Product

See

http://disc.sci.gsfc.nasa.gov/AIRS/documentation/v6_docs/v6releasedocs-1/V6_Released_Processing_File_Description.pdf

for a complete description. Please note that values of -9999 (if integer) and -9999.0 (if floating) denote invalid data.

Please read the document that discusses the finer points of AIRS products defined on levels, layers, trapezoids, TOA and surface.

http://disc.sci.gsfc.nasa.gov/AIRS/documentation/v6_docs/v6releasedocs-1/V6_L2_Levels_Layers_Trapezoids.pdf

Please refer to the L2 Quality Control and Error Estimation documentation for a description of the various quality indicators and how they are set.

http://disc.sci.gsfc.nasa.gov/AIRS/documentation/v6_docs/v6releasedocs-1/V6_L2_Quality_Control_and_Error_Estimation.pdf

The geolocation data fields of immediate interest to the user are:

- **Latitude**
  FOV boresight geodetic latitude
  (degrees North, -90->+90), dimension (30,45)
- **Longitude**
  FOV boresight geodetic longitude
  (degrees East, -180->+180), dimension (30,45)

The per-granule data fields of immediate interest to the user are:

- **pressStd**
  standard pressure (mb) for each of 28 levels in atmosphere associated with temperature, moisture and ozone profiles. **The array order is from the surface upward, in conformance with WMO standard**. Note that topography may place some of these levels below the surface, dimension (28)
- **MWHingeSurfFreqGHz**
  frequencies in GHz for MW Surface parameters, dimension (7)

The swath data fields of immediate interest to the user are:

See the extensive discussion in

http://disc.sci.gsfc.nasa.gov/AIRS/documentation/v6_docs/v6releasedocs-1/V6_L2_Product_User_Guide.pdf

4.1.8 L2 Cloud-Cleared Radiance Product

See
http://disc.sci.gsfc.nasa.gov/AIRS/documentation/v6_docs/v6releasedocs-1/V6_Released_Processing_File_Description.pdf

for a complete description. Please note that values of -9999 (if integer) and -9999.0 (if floating) denote invalid data.

SUGGESTION TO USERS FOR CHOOSING DATA TO USE IN RESEARCH:

Evaluate candidate channel as described for AIRS L1B Radiance Product

Evaluate Qual_CC_Rad for FOV

- Researchers should use radiances only from FOVs in which **Qual_CC_Rad** = 0
- FOVs in which **Qual_CC_Rad** = 1 may be sufficiently accurate for statistical studies, but results should be carefully checked
- FOVs in which **Qual_CC_Rad** = 2 must be avoided

The geolocation data fields of immediate interest to the user are:

- **Latitude**
  FOV boresight geodetic latitude
  (degrees North, -90->+90), dimension (30,45)
- **Longitude**
  FOV boresight geodetic longitude
  (degrees East, -180->+180), dimension (30,45)

The attribute of immediate interest to the user are:

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

The per-granule data fields of immediate interest to the user are:

- **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 that indicates A/B detector weights,
  dimension (2378)
- **NeN**
  Noise equivalent radiance for each channel for an assumed 250 K scene (milliWatts/m^2/cm^{-1}/steradian), dimension (2378)
- **nominal_freq**
  nominal frequencies of each channel (cm^{-1}),
  dimension (2378)
- **NeN_L1B**
  Level 1B noise equivalent radiances for an assumed 250 K scene. Note that effective noise on cloud-cleared radiances will be modified (milliWatts/m^2/cm^{-1}/steradian), dimension (2378)

The along-track data fields of immediate interest to the user are:

- **CalFlag**
  Bit field by channel for each scanline. Zero means the channel was well calibrated, dimension (2378,45)
- **CalScanSummary**
  Bit field that is a bitwise OR over the good channel list (i.e., channels not in ExcludedChans). Zero means that all "good" channels were well calibrated for a scanline, dimension (45)

The swath data fields of immediate interest to user are:

- **Qual_CC_Rad**
  overall quality flag for cloud-cleared radiances. 0 indicates highest quality; 1 indicates good quality; 2 means do not use, dimension (30,45)
- **radiances**
  cloud-cleared channel-by-channel observed infrared spectra that would have been observed over FOV in absence of clouds (milliWatts/m^2/cm^{-1}/steradian), dimension (2378,30,45)
- **radiance_err**
  error estimate for radiances (milliWatts/m^2/cm^{-1}/steradian), dimension (2378,30,45)
- **CldClearParam**
  cloud-clearing parameter eta, dimension (3,3,30,45)
- **landFrac**
  fraction of FOV that is land (0.0 -> 1.0), dimension (30,45)
- **landFrac_err**
  error estimate for landFrac, dimension (30,45)
- **sun_glint_distance**
  distance from FOV 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 (30,45)
- **solzen**
  solar zenith angle (degrees, 0->180; daytime if < 85), dimension (30,45)
- **scanang**
  scanning angle of AIRS instrument with respect to the spacecraft for this FOV, negative at start of scan and zero at nadir (degrees, -180->180), dimension (30,45)

Figure 11 shows the AIRS Level 2 cloud-cleared radiance spectrum (**radiances**) from the example FOV converted to brightness temperature. These data contained in the L2 Cloud-Cleared Radiance Product.

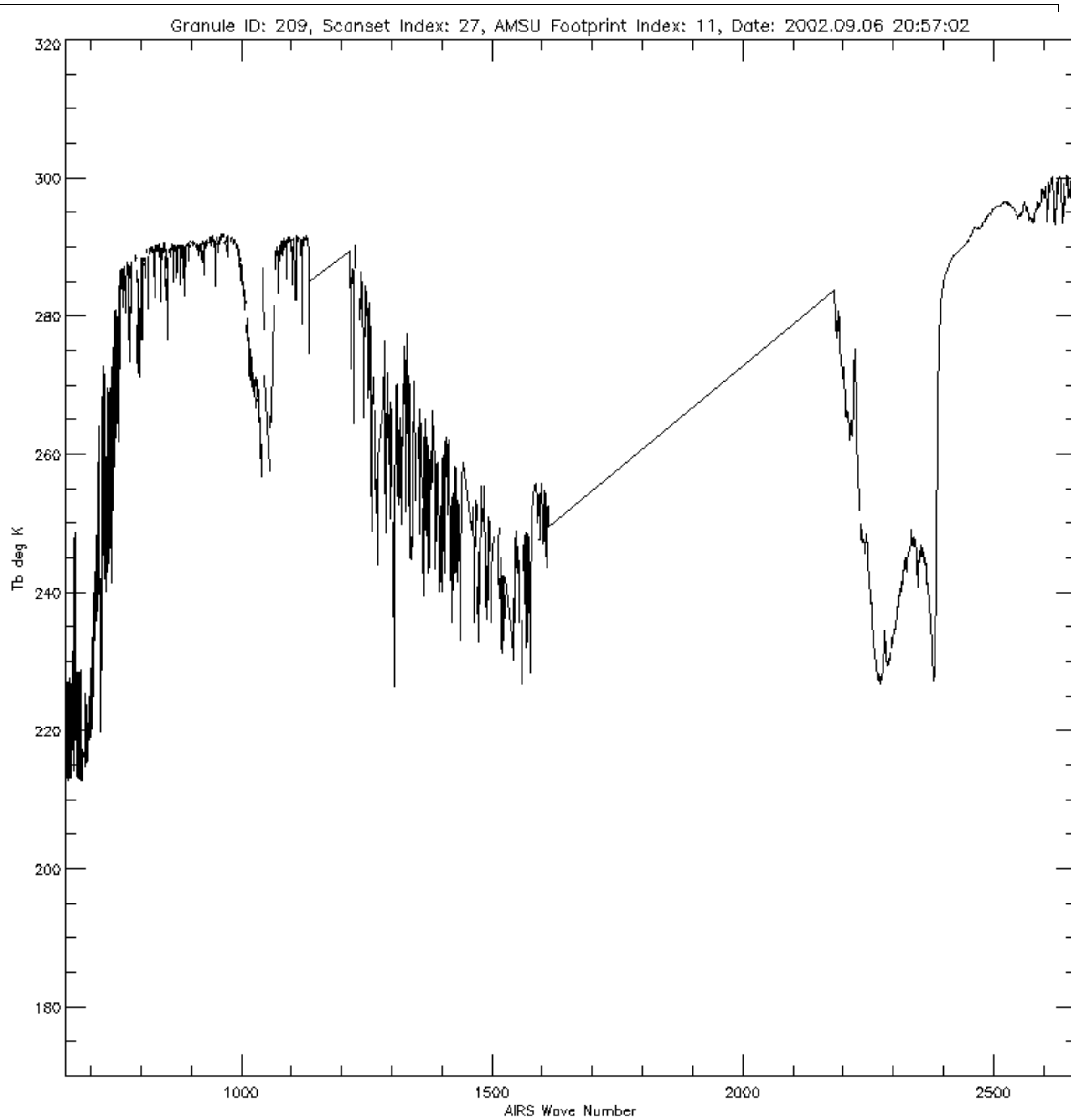

Figure 11: Level 2 Cloud-Cleared Infrared Radiance Spectrum (AIRS)
Sept 6, 2002; Granule 209; Scanset 27; Footprint 11

Figure 12 illustrates the magnitude of the difference between the final Level 2 cloud-cleared radiance spectrum reported for the example FOV and the nine observed L1B AIRS radiance spectra. The bulk of this difference is due to the effect of clouds, which is removed during the Level 2 processing. The cloudiest AIRS footprint was spot #9 (color-coded in Figures 3,5,7 and 10 by brown). The least cloudy was spot #4 (color-coded in Figures 3,5,7 and 10 by magenta).

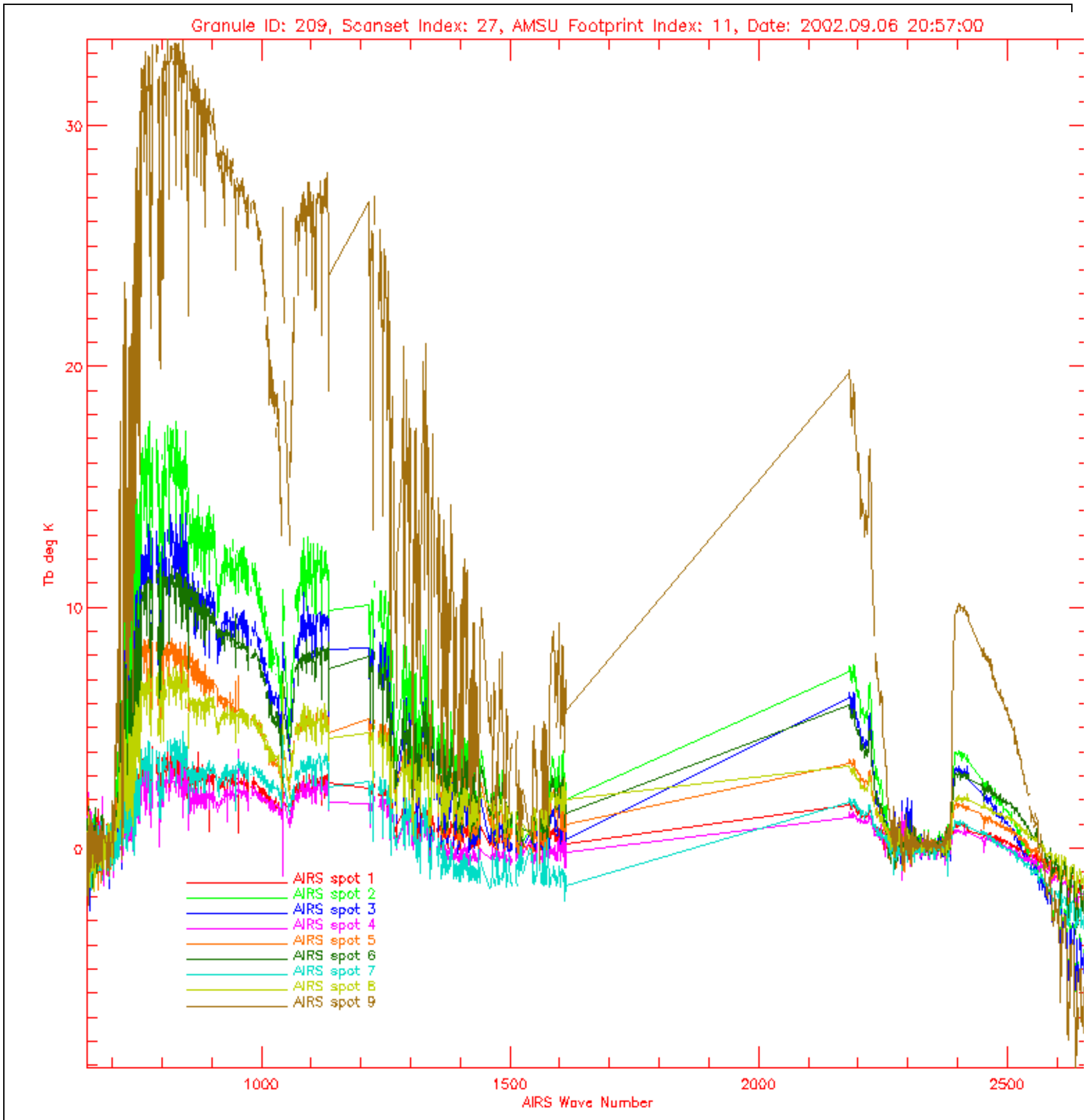

Figure 12: (L2 Cloud-Cleared Spectrum – L1B Observed Spectra)
Sept 6, 2002; Granule 209; Scanset 27; Footprint 11

4.1.9 L2 Support Product

See

http://disc.sci.gsfc.nasa.gov/AIRS/documentation/v6_docs/v6releasedocs-1/V6_Released_Processing_File_Description.pdf

for a complete description. Please note that values of -9999 (if integer) and -9999.0 (if floating) denote invalid data.

General users are urged to order the L2 Standard Product. The L2 Support Product is intended for the knowledgeable, experienced user of AIRS products. It contains high-resolution profiles to be used for computation of radiances, as-yet unimplemented research products and various parameters and intermediate results used to evaluate and track the progress of the retrieval algorithm.

Please read the document that discusses the finer points of AIRS products defined on levels, layers, trapezoids, TOA and surface:

http://disc.sci.gsfc.nasa.gov/AIRS/documentation/v6_docs/v6releasedocs-1/V6_L2_Levels_Layers_Trapezoids.pdf

The geolocation data fields of immediate interest to the user are:

- **Latitude**
  FOV boresight geodetic latitude
  (degrees North, -90->+90), dimension (30,45)
- **Longitude**
  FOV boresight geodetic longitude
  (degrees East, -180->+180), dimension (30,45)

The per-granule data fields of immediate interest to the user are:

- **pressSupp**
  support pressure (mb) for each of 100 levels in atmosphere associated with temperature, moisture and ozone profiles. **The array order is from the top of atmosphere downward**. This is the reverse of **pressStd** ordering. Note that topography may place some of these levels below the surface, dimension (100)

The swath data fields that are not part of the L2 Standard Product and may be of interest to the user are:

- **PsurfStd**
  first guess surface pressure, interpolated from forecast and mean topography of FOV (mb), dimension (30,45)
- **nSurfSup**
  index of first pressure level above the mean surface (90, …, 100), dimension (30,45)
- **TAirSup**
  retrieved atmospheric temperature profile (K) at the **pressSupp** pressures. Array values below the surface (index < **nSurfStd**) are not physically meaningful. In particular, the first level below the surface contains an extrapolated value. Always check **nSurfSup** to identify where extrapolated values begin. The surface value (at **PsurfStd**) must be calculated by interpolating in the log(pressure) domain between this value and the value in the next level up (index = **nSurfSup**-1),
  dimension (100,30,45)
- **TAirMWOnly**
  MW-only retrieved atmospheric temperature profile (K),
  dimension (100,30,45)
- **H2OCDSup**
  Retrieved layer column water vapor (molecules/cm^{-2}). The layer corresponding to value **H2OCDSup**(index) is bounded by **pressSupp**(index) at the bottom and **pressSupp**(index-1) at the top. Array values below the surface (index < **nSurfStd**) are not physically meaningful. In particular, the first level below the surface contains an extrapolated value. Always check **nSurfSup** to identify where extrapolated values begin. The surface value (at **PsurfStd**) must be calculated by interpolating in the log(pressure) domain between this value and the value in the next level up (index = **nSurfSup**-1),
  dimension (100,30,45)
- **H2OCDMWOnly**
  layer-averaged MW-only retrieved column water vapor,
  dimension (100,30,45)
- **lwCDSup**
  Retrieved layer column cloud liquid water (molecules/cm^{-2}). The layer corresponding to value **lwCDSup**(index) is bounded by **pressSupp**(index) at the bottom and **pressSupp**(index-1) at the top. Array values below the surface (index < **nSurfStd**) are not physically meaningful. In particular, the first level below the surface contains an extrapolated value. Always check **nSurfSup** to identify where extrapolated values begin. The surface value (at **PsurfStd**) must be calculated by interpolating in the log(pressure) domain between this value

and the value in the next level up (index = **nSurfSup**-1), dimension (100,30,45)

- **O3CDSup**
  Retrieved layer column ozone (molecules/cm^{-2}). The layer corresponding to value **O3CDSup**(index) is bounded by **pressSupp**(index) at the bottom and **pressSupp**(index-1) at the top. Array values below the surface (index < **nSurfStd**) are not physically meaningful. In particular, the first level below the surface contains an extrapolated value. Always check **nSurfSup** to identify where extrapolated values begin. The surface value (at **PsurfStd**) must be calculated by interpolating in the log(pressure) domain between this value and the value in the next level up (index = **nSurfSup**-1), dimension (100,30,45)
- **O3_ave_kern**
  Averaging kernel for ozone retrieval, dimension (9,9)
- **COCDSup**
  Retrieved layer column carbon monoxide (molecules/cm^{-2}). The layer corresponding to value **COCDSup**(index) is bounded by **pressSupp**(index) at the bottom and **pressSupp**(index-1) at the top. Array values below the surface (index < **nSurfStd**) are not physically meaningful. In particular, the first level below the surface contains an extrapolated value. Always check **nSurfSup** to identify where extrapolated values begin. The surface value (at **PsurfStd**) must be calculated by interpolating in the log(pressure) domain between this value and the value in the next level up (index = **nSurfSup**-1), dimension (100,30,45)
- **CO_ave_kern**
  Averaging kernel for carbon monoxide retrieval, dimension (9,9)
- **CH4CDSup**
  Retrieved layer column methane (molecules/cm^{-2}). The layer corresponding to value**CH4CDSup**(index) is bounded by **pressSupp**(index) at the bottom and **pressSupp**(index-1) at the top. Array values below the surface (index < **nSurfStd**) are not physically meaningful. In particular, the first level below the surface contains an extrapolated value. Always check **nSurfSup** to identify where extrapolated values begin. The surface value (at **PsurfStd**) must be calculated by interpolating in the log(pressure) domain between this value and the value in the next level up (index = **nSurfSup**-1), dimension (100,30,45)
- **CH4_ave_kern_10func**
  Averaging kernel for methane retrieval, dimension (10,10)

4.1.10 Level 3 Data Products

See

http://disc.sci.gsfc.nasa.gov/AIRS/documentation/v6_docs/v6releasedocs-1/V6_Released_Processing_File_Description.pdf

for a complete description. Please note that values of -9999 (if integer) and -9999.0 (if floating) denote invalid data.

Read this document thoroughly as well:

http://disc.sci.gsfc.nasa.gov/AIRS/documentation/v6_docs/v6releasedocs-1/V6_L3_User_Guide.pdf

There are now 6 grids instead of 4. The two new "TqJoint" grids contain are the result of applying common filtering to the temperature and moisture products to identify profiles to be accumulated in the L3 gridding scheme. In addition, there are now moisture and trace gas level products as well as layer products in the grids. The six grids are:

Grid name	Tag	Description
location	None	Location information which is valid for all grids
ascending	_A	Information collected while the spacecraft is in the ascending part of its orbit. (Daytime data except near the poles.) Each field and level is individually quality controlled.
descending	_D	Information collected while the spacecraft is in the descending part of its orbit. (Nighttime data except near the poles.) Each field and level is individually quality controlled.
ascending_TqJoint	_TqJ_A	Information collected while the spacecraft is in the ascending part of its orbit. (Daytime data except near the poles.) Collective quality control is used across all fields and levels.
descending_TqJoint	_TqJ_D	Information collected while the spacecraft is in the descending part of its orbit. (Nighttime data except near the poles.) Collective quality control is used across all fields and levels.
ascending_MW_Only	_MW_A	Microwave information collected while the spacecraft is in the ascending part of its orbit. (Daytime data except near the poles.)
descending_MW_Only	_MW_D	Microwave information collected while the spacecraft is in the descending part of its orbit. (Nighttime data except near the poles.)

For example, the profile of relative humidity reported on levels (RelHum) exists in 6 flavors: **RelHum_A, RelHum_D, RelHum_TqJ_A, RelHum_TqJ_D, RelHum_MW_A** and **RelHum_MW_D**.

4.2 Sample Data Readers

Sample IDL, MATLAB, FORTRAN and C data readers are provided in the zipped files:

http://disc.sci.gsfc.nasa.gov/AIRS/documentation/v5_docs/AIRS_V5_Release_User_Docs/IDL_MATLAB_READERS.tar.gz

http://disc.sci.gsfc.nasa.gov/AIRS/documentation/v6_docs/v6releasedocs-1/FORTRAN_C_READERS.tar.gz

4.2.1 IDL-Based Data Readers

The AIRS Project releases to the broad scientific community sample data readers written in Interactive Data Language (IDL) to facilitate user community use of data products. IDL is an array-oriented data analysis and visualization environment developed and marketed by Research Systems, Incorporated (RSI) of Boulder, Colorado.

The user community must realize that the AIRS Project does not have the resources to support consultation on these readers. They are being provided as an aid to give the user community a leg up in using the data. There is no commitment to provide assistance to the broad user community beyond the release of these readers.

4.2.1.1 read_airs_swath.pro

The IDL procedure to read AIRS L1B and L2 Product files written in HDF-EOS swath format is provided in the file:

read_airs_swath.pro

FUNCTION NAME:

read_airs_swath.pro

USAGE:

status = read_airs_swath(filename, content_flag,buffer,[content_list=content_list],[swathname=swathname])

INPUT ARGUMENTS:

- **filename** - The fully qualified path to a Level 1B or Level 2 HDF-EOS swath data file.
- **content_flag** - An integer that specifies the type of data to be extracted, as follows:
  - 0 - an array of the names of all data swaths in the file.
  - 1 - names and values of specified swath's dimension parameters.
  - 2 - names and values of specified swath's attribute parameters.
  - 3 - names and values of specified swath's data field parameters,
  - 4 - an array of the data field names within a specified swath.
  - **content_list** [OPTIONAL] - An array of text strings which are the names of specific parameters that will extracted per the content flag choice (Choices 1-3 only). If content_list is left unspecified, the function will retrieve the content on ALL items in the category specified by the content_flag.
  - **swathname** [OPTIONAL] - A single text expression which is the exact name of the data swath to be extracted from the granule file. If swathname is left unspecified and there is only one data swath in a file, that swath will automatically be used.

HINT: Run this function with the content_flag=0 option first if you suspect that there are more than one data swath in a granule file. AIRS L1B and L2 Data Products have only one swath in each granule file.

OUTPUTS:

- standard sucess code, stored in **status** in the USAGE description above
  - 0 = success
  - -1 = failure.
- **buffer** - This is a general-purpose data buffer. When content_flag=0 or 4, "buffer' is a single text expression. When the other content_flag options are used, buffer is an IDL structure which has the results expressed as buffer.<item_name> and buffer.<item_value>. HINT: To query these results, type "help,buffer,/struct" after running this function.

HOW TO USE:

See README_Swath_Reader_IDL.txt

4.2.1.2 read_airs_grid.pro

The IDL procedure to read L3 Product files written in HDF-EOS grid format is provided in the file:

read_airs_grid.pro

FUNCTION NAME:

read_airs_grid.pro

USAGE:

status = read_airs_grid(filename, content_flag,buffer,[content_list=content_list],[gridname=gridname])

INPUT ARGUMENTS:

- **filename** - The fully qualified path to a Level 3 HDF-EOS grid data file.
- **content_flag** - An integer that specifies the type of data to be extracted, as follows:
  - 0 - an array of the names of all data grids in the file.
  - 1 - names and values of specified grid's dimension parameters.
  - 2 - names and values of specified grid's attribute parameters.
  - 3 - names and values of specified grid's data field parameters,
  - 4 - an array of the data field names within a specified grid.
  - **content_list** [OPTIONAL] - An array of text strings which are the names of specific parameters that will extracted per the content flag choice (Choices 1-3 only). If content_list is left unspecified, the function will retrieve the content on ALL items in the category specified by the content_flag.
  - **gridname** [OPTIONAL] - A single text expression which is the exact name of the data grid to be extracted from the granule file. If gridname is left unspecified and there is only one data grid in a file, that grid will automatically be used.

HINT: Run this function with the content_flag=0 option first if you suspect that there are more than one data grid in a granule file. AIRS L3 Data Products have four swaths in each granule file.

OUTPUTS:

- standard sucess code, stored in **status** in the USAGE description above
  - 0 = success

  - -1 = failure.
- **buffer** - This is a general-purpose data buffer. When the content_flag=0 or 4, "buffer' is a single text expression. When the other content_flag options are used, buffer is an IDL structure which has the results expressed as buffer.<item_name> and buffer.<item_value>. HINT: To query these results, type "help,buffer,/struct" after running this function.

HOW TO USE:

See README_Grid_Reader_IDL.txt

4.2.2 MATLAB-Based Data Readers

The AIRS Project releases to the broad scientific community sample data readers written in MATLAB to facilitate user community use of data products. MATLAB is an array-oriented data analysis and visualization environment developed and marketed by The MathWorks of Natick, Massachusetts.

The user community must realize that the AIRS Project does not have the resources to support consultation on these readers. They are being provided as an aid to give the user community a leg up in using the data. There is no commitment to provide assistance to the broad user community beyond the release of these readers.

4.2.2.1 read_L12_swath_file.m

The MATLAB procedure to read L1B and L2 Product files written in HDF-EOS swath format is provided in the file:

read_airs_swath.m

FUNCTION NAME:

read_airs_swath.m

USAGE:

buffer = read_airs_swath(filename, content_flag,[content_list],[swathname])

INPUT ARGUMENTS:

- **filename** - The fully qualified path to a Level 1B or Level 2 HDF-EOS swath data file.
- **content_flag** - An integer that specifies the type of data to be extracted, as follows:
  - 0 - an array of the names of all data swaths in the file.
  - 1 - names and values of specified swath's dimension parameters.
  - 2 - names and values of specified swath's attribute parameters.
  - 3 - names and values of specified swath's data field parameters,
  - 4 - an array of the data field names within a specified swath.
  - **content_list** [OPTIONAL] - A cell array of text strings which are the names of specific parameters that will extracted per the content flag choice (Choices 1-3 only). If content_list is left unspecified, the function will retrieve the content on ALL items in the category specified by the content_flag.
  - **swathname** [OPTIONAL] - A single text expression which is the exact name of the data swath to be extracted from the granule file. If swathname is left unspecified and there is only one data swath in a file, that swath will automatically be used.

HINT: Run this function with the content_flag=0 option first if you suspect that there are more than one data swath in a granule file. AIRS L1B and L2 Data Products have only one swath in each granule file.

OUTPUTS:

- **buffer** - This is a general-purpose data buffer. When the content_flag=0 or 4, "buffer' is a comma-delimited text string showing the names of the swaths present in the granule file. When the other content_flag options are used, buffer is a MATLAB data structure in which the results are expressed as buffer.<item_name> and buffer.<item_value>. HINT: To query these results, type "buffer" after running this function.

HOW TO USE:

See README_Swath_Reader_MATLAB.txt

4.2.2.2 read_airs_grid.m

The MATLAB procedure to read L3 Product files written in HDF-EOS grid format is provided in the file:

read_airs_grid.m

FUNCTION NAME:

read_airs_grid.m

USAGE:

buffer = read_airs_grid(filename, content_flag,[content_list],[gridname])

INPUT ARGUMENTS:

- **filename** - The fully qualified path to a Level 3 HDF-EOS grid data file.
- **content_flag** - An integer that specifies the type of data to be extracted, as follows:
  - 0 - an array of the names of all data grids in the file.
  - 1 - names and values of specified grid's dimension parameters.
  - 2 - names and values of specified grid's attribute parameters.
  - 3 - names and values of specified grid's data field parameters,
  - 4 - an array of the data field names within a specified grid.
  - **content_list** [OPTIONAL] - A cell array of text strings which are the names of specific parameters that will extracted per the content flag choice (Choices 1-3 only). If content_list is left unspecified, the function will retrieve the content on ALL items in the category specified by the content_flag.
  - **swathname** [OPTIONAL] - A single text expression which is the exact name of the data grid to be extracted from the granule file. If gridname is left unspecified and there is only one data grid in a file, that grid will automatically be used.

HINT: Run this function with the content_flag=0 option first if you suspect that there are more than one data grid in a granule file. AIRS L3 Data Products have four swaths in each granule file.

OUTPUTS:

- **buffer** - This is a general-purpose data buffer. When the content_flag=0 or 4, "buffer' is a comma-delimited text string showing the names of the grids present in the granule file. When the other content_flag options are used, buffer is a MATLAB data structure in which the results are

expressed as buffer.<item_name> and buffer.<item_value>. HINT: To query these results, type "buffer" after running this function.

HOW TO USE:

See README_Grid_Reader_MATLAB.txt

4.2.3 FORTRAN and C Data Readers

The AIRS Project releases to the broad scientific community sample data readers written in FORTRAN and C to facilitate user community use of data products.

The user community must realize that the AIRS Project does not have the resources to support consultation on these readers. They are being provided as an aid to give the user community a leg up in using the data. There is no commitment to provide assistance to the broad user community beyond the release of these readers.

Note that AIRS products are in HDF4 format. To use the FORTRAN and C readers, the user must also download the HDF-EOS2 Library builty on HDF4. The URL where this library may be accessed is:

http://hdfeos.net/software.php#PGS_Toolkit

SUMMARY OF MODULES:

See README_FORTRAN_C.txt

Examples input and output are included.

5 Acronyms

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