AIRS Level 2 Status

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Abstract: *The AIRS Team Leader Facility at JPL is developing software to process AIRS data. The software will be run at NASA GSFC DAAC in Greenbelt Maryland. The retrieval algorithm, which generates atmospheric and surface parameters from radiance products, is called the Unified Team Algorithm. Many science team members are responsible for various parts of the retrieval algorithm. They test their software at their home institution and integrate it into the AIRS level 2 software.*

The AIRS project has the goal of temperature retrieval accuracy of 1K in 1 km thick layers in the troposphere. For water vapor profiles, the accuracy goal is 10% relative accuracy in 2 km thick layers in the troposphere. We are also planning to retrieve surface and cloud parameters as well as minor gases like O_3 and CO.

The Atmospheric InfraRed Sounder (AIRS) is a facility instrument on NASA's second EOS satellite called Aqua. The satellite was launched in early May 2002 into 1:30 PM descending sun-synchronous orbit. AIRS is designed to measure atmospheric temperature and water vapor profiles and works with two passive microwave sounders, AMSU-A and HSB. The details of the sounding instrument suite and the science objectives can be found in H. H. Aumann, et al[1].

The AIRS Science Team is responsible for algorithms to process AIRS sounding suite. Table 1 lists science team members and their roles in the retrieval algorithm.

Team Member	Level 2 Role
P Rosenkranz	MW Only retrieval algorithm MW Rapid Transmittance Algorithm
C Gautier	VIS/NIR cloud algorithm
L Strow	AIRS Rapid Transmittance Algorithm
L McMillin	Brightness Temperature Bias Correction Local Angle Correction
M Goldberg	Initial Regression Retrieval Algorithm
J Susskind	Final Physical Retrieval Algorithm and Cloud Clearing Algorithm

Table 1. Roles of AIRS Science Team Members

The AIRS team at JPL combines these algorithms into the "Unified Team Algorithm" and delivers operational software to the Goddard DAAC for use in operational data processing. Figure 1 outlines data and algorithm flow in the Level 2 software. JPL is also responsible for developing other algorithms not supplied by the science team.

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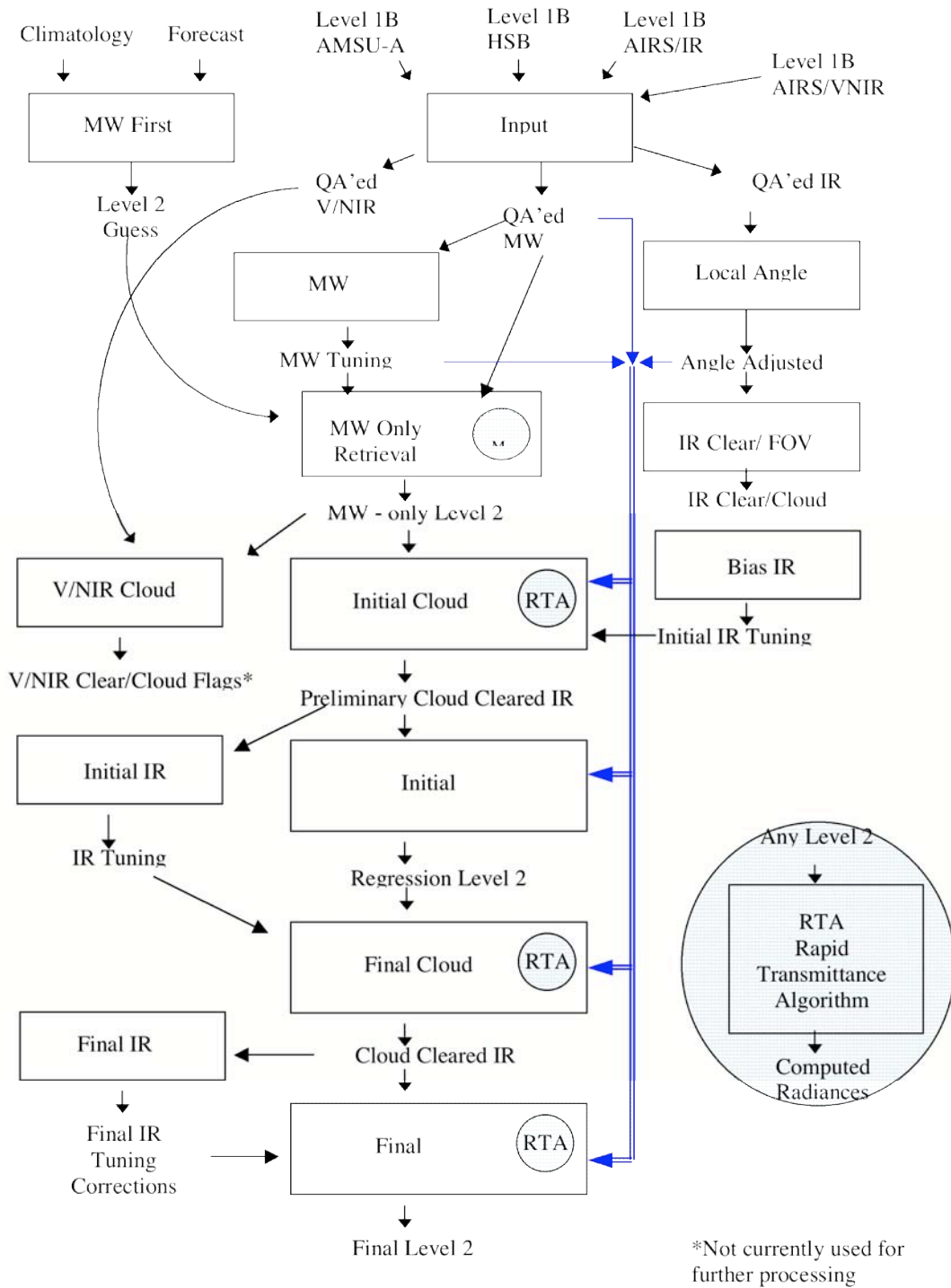
Figure 1. AIRS Level 2 Data Flow

Figures 2 through 6 show a sample AIRS spectrum over tropical ocean, highlighting channels used by the physical retrieval algorithm.   The initial regression uses the majority of the AIRS channels. Figure 2 covers the whole AIRS spectral range, while other figures cover interesting spectral regions.   In the figures blue asterisks denote channels used in temperature sounding, green asterisks denote water vapor sounding channels, and red asterisks are channels used in surface retrieval.   The channels used in ozone, methane and CO retrievals are marked with cyan, magenta and yellow asterisks, respectively.
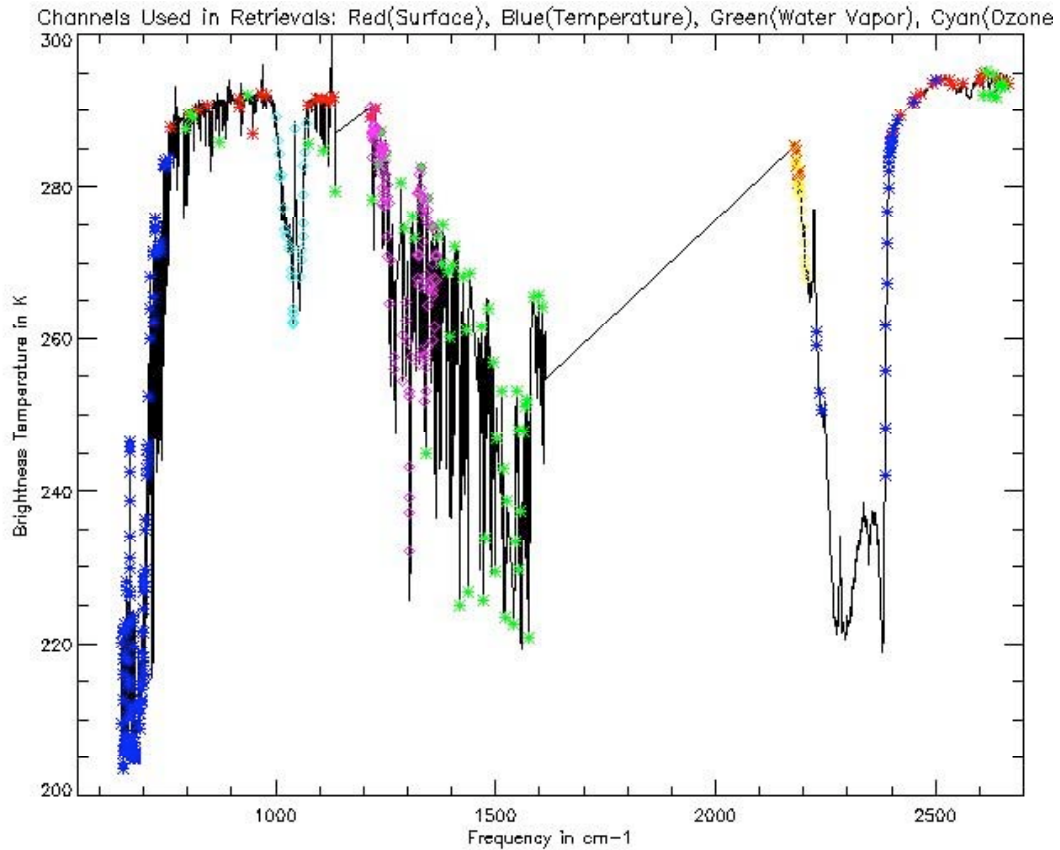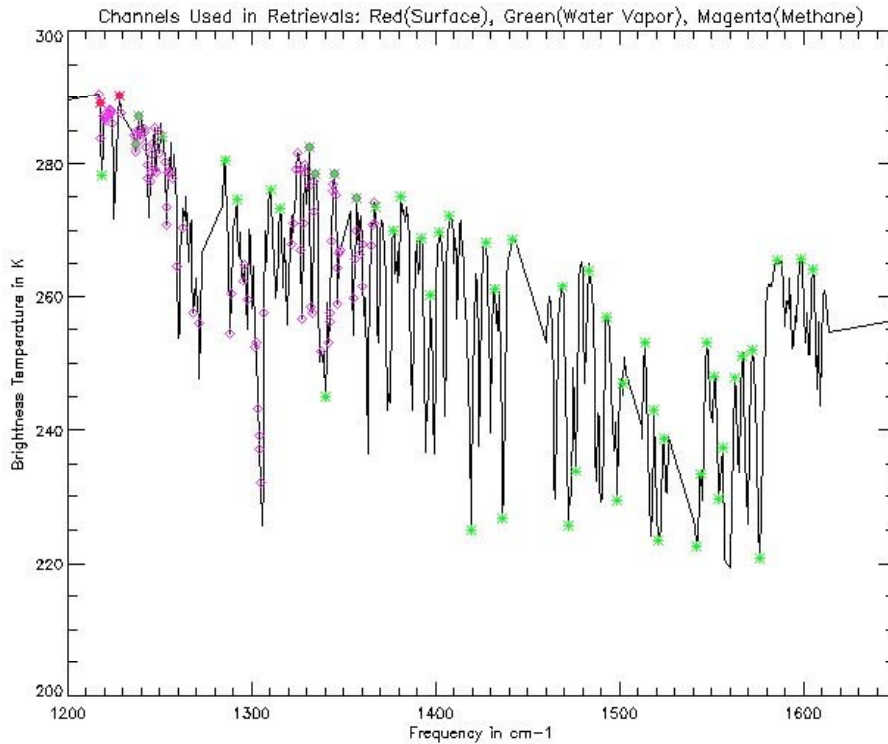

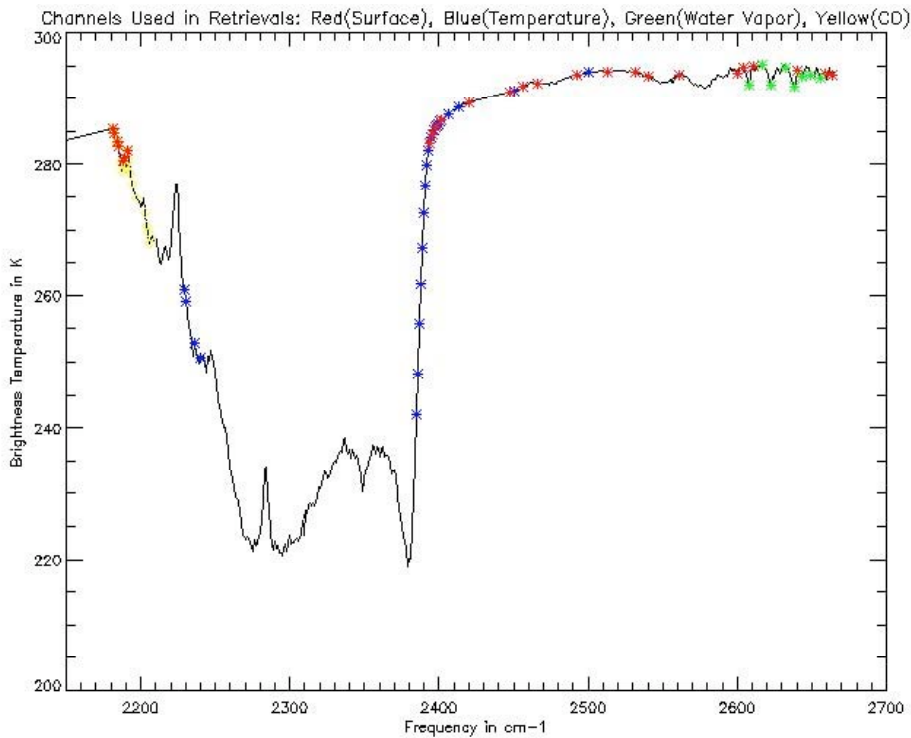**Figure 2. AIRS Spectrum for US Standard Atmosphere**
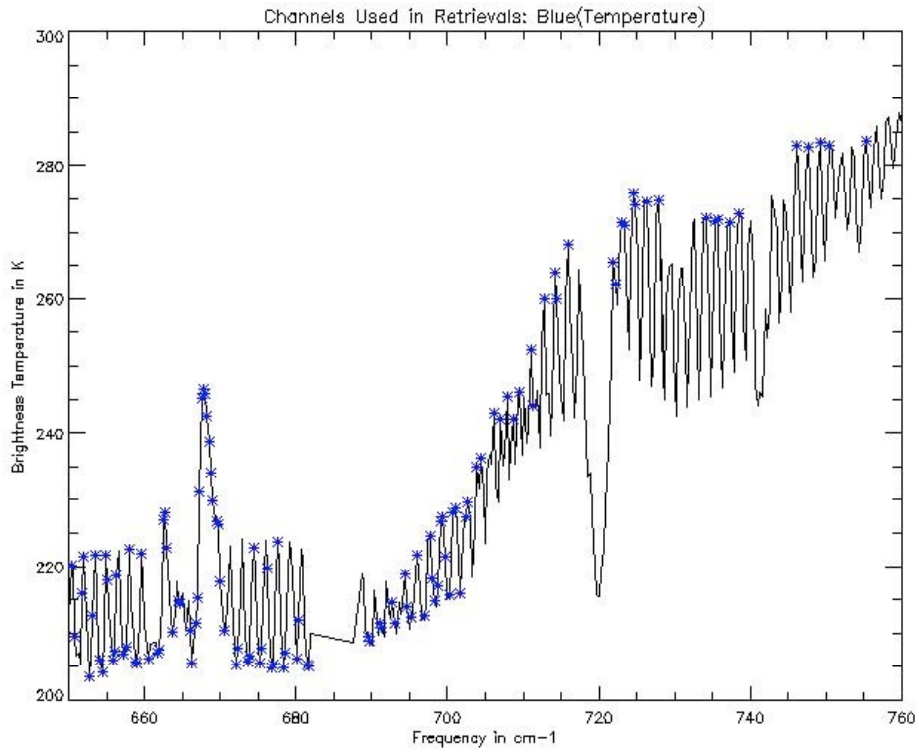
Figure 3. 16 micron CO2 Channels
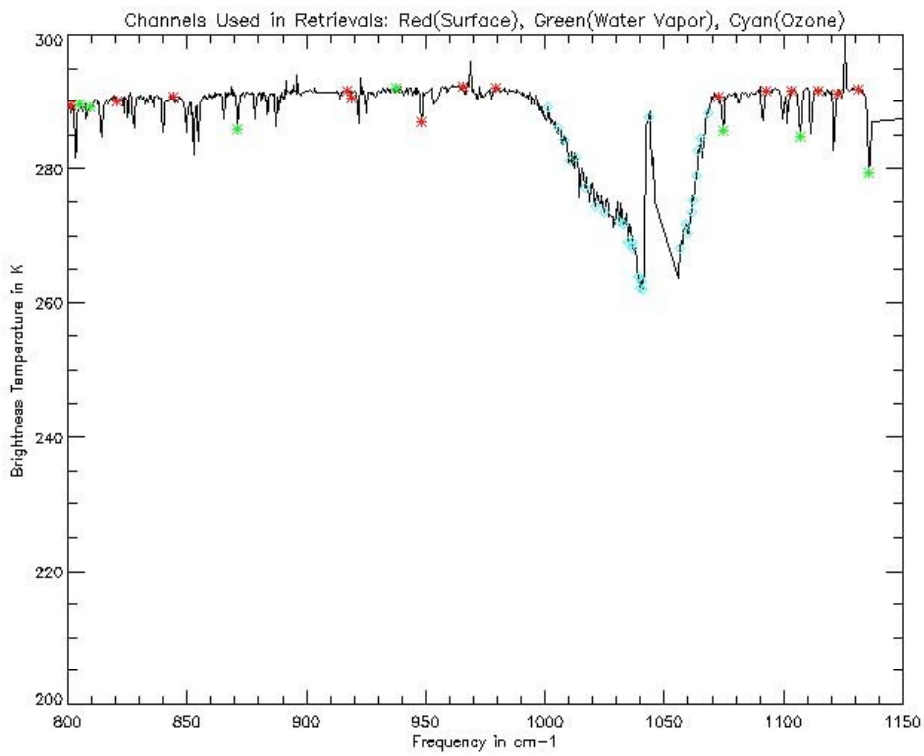
**Figure 4. Longwave Window Channels**

Figure 5. Water Band Channels

Figure 6. Shortwave Channels

Figure 7 shows the weighting functions of the AIRS channels used in temperature sounding. Most of these channels are in the 14 to 16 micron CO_2 band. Only a few channels in the 4.3 micron CO_2 band are used in the temperature sounding because of non-LTE behavior of the 4.3 micron CO_2 channels. It is worth noting that the highest peak of the weighting functions is near 2 mb, with a significant tail going well above 0.5 mb.
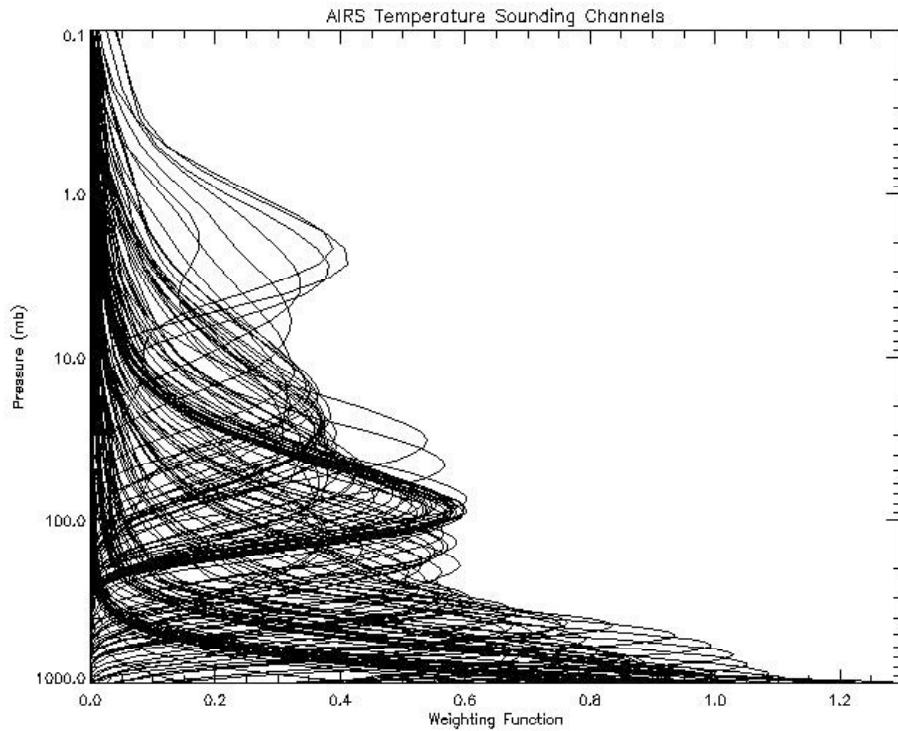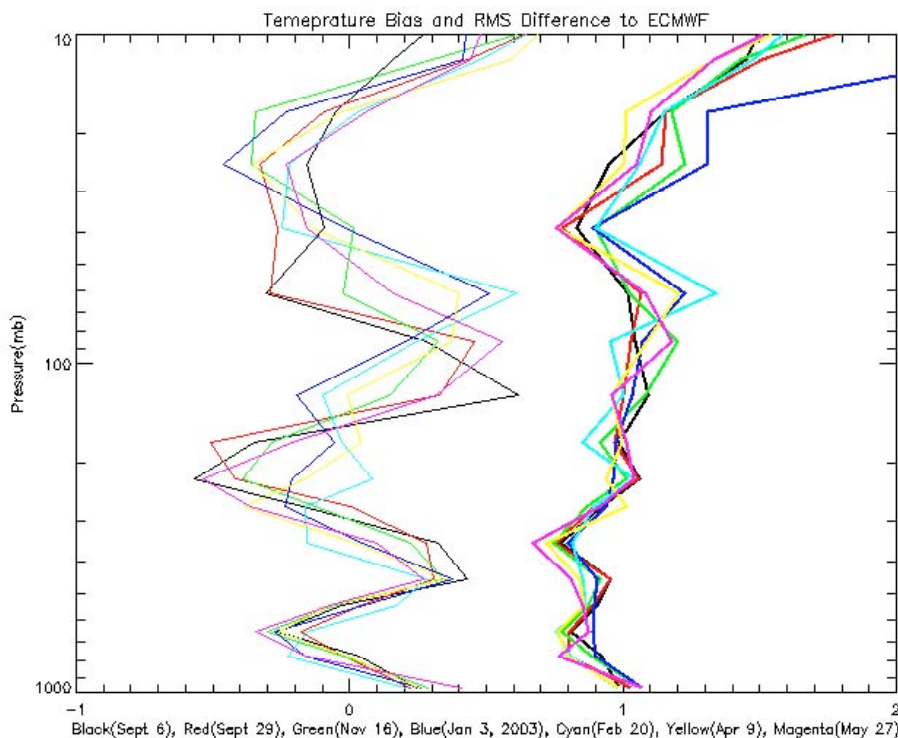
Figure 7. Weighting Functions of Temperature Sounding Channels
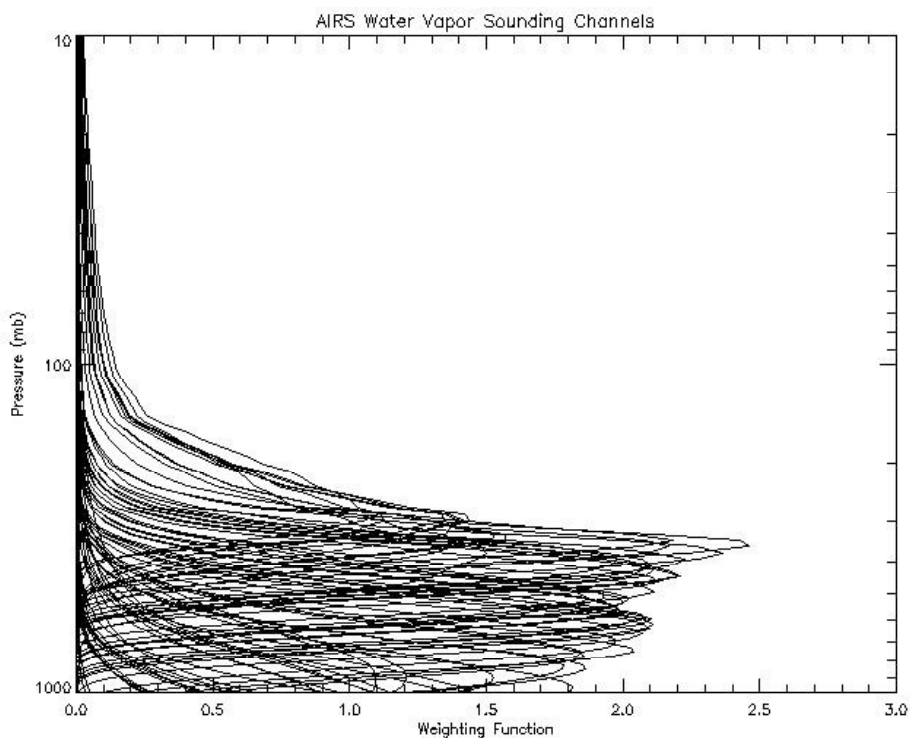
Figure 8. Weighting Functions of Water Vapor Sounding Channels

Figure 8 has the weighting functions of water vapor channels. The highest peak of the weighting functions of these channels is near 300 mb. The significant contributions from above 200 mb give confidence that upper tropospheric water vapor can be retrieved accurately.

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The AIRS project has selected "focus days" to study retrieval statistics compared to ECMWF analysis.   The focus days are generally chosen every 48 days to have identical orbit patterns. The Aqua spacecraft has a 16-day orbit cycle.   Figure 9 shows the biases and the RMS differences of AIRS v3.1.9 retrievals vs. ECMWF analysis for 7 focus days between September 6, 2002 and May 27, 2003.   Version 3.1.9 AIRS retrieval software is currently being evaluated in the NOAA NESDIS near-real-time production system. Note that the statistics are very stable without updates to software or tables.   The same bias correction is used throughout the year.

Temeprature Bias and RMS Difference to ECMWF

Black(Sept 6), Red(Sept 29), Green(Nov 16), Blue(Jan 3, 2003), Cyan(Feb 20), Yellow(Apr 9), Magenta(May 27)

**Figure 9. Bias and RMS with respect to ECMWF Analysis**

AIRS retrieval software version v3.0.9 was sent to Goddard DAAC, along with a validation report, E. Fetzer[1].   Goddard DAAC has processed level 2 data with this version since August 2003.   Level 1B AIRS data has been publicly available since April 2003.   Old data since September 2002 will also be processed soon with the latest software and released.   All data processed at GDAAC can be accessed through their web page http://daac.gsfc.nasa.gov/atmodyn/airs/   This web page also has a good set of documents for AIRS data users.   Any questions regarding AIRS data can be directed to the AIRS Dynamics Data Support Team at the above web site, or to Edward Olsen at the AIRS project, Edward.Olsen@jpl.nasa.gov.

The level 2 processing software produces three sets of output files, described in table 2.   In accordance with EOS policy, most AIRS data files are in HDF-EOS swath.   One set of files is written for each 6 minutes worth of data, producing 240 granules of data for each day. Detailed description of the files and the parameters in the files can be found in the above GDAAC Atmospheric Dynamics web site.   Most of the parameters in these files are at AMSU-A spatial resolution, 45 km at nadir.   Some exceptions, including cloud parameters, are produced at AIRS resolution, 15 km at nadir.

| File Type	Short Description
Level 2 Standard	Standard, or core, products including $T(p)$, $q(p)$, $O_3(p)$, T_s. Profile data in standard levels that are adopted from WMO levels. Cloud parameters.
Level 2 Support	Research products and other intermediate products. Profiles at 100 fine levels chosen for forward algorithm. Contains data needed to compute radiances accurately.
Cloud Cleared Radiances	Radiances that would have been observed if the FOV was clear. Available only where combined IR/MW algorithm succeeds.

Table 2. AIRS Level-2 File Description

AIRS Level 2 software program also produces browse products, simple grids of selected parameters for use in ordering data from EOSDIS. These daily browse products can be averaged to produce monthly means. The following figures are monthly means for January 2003.
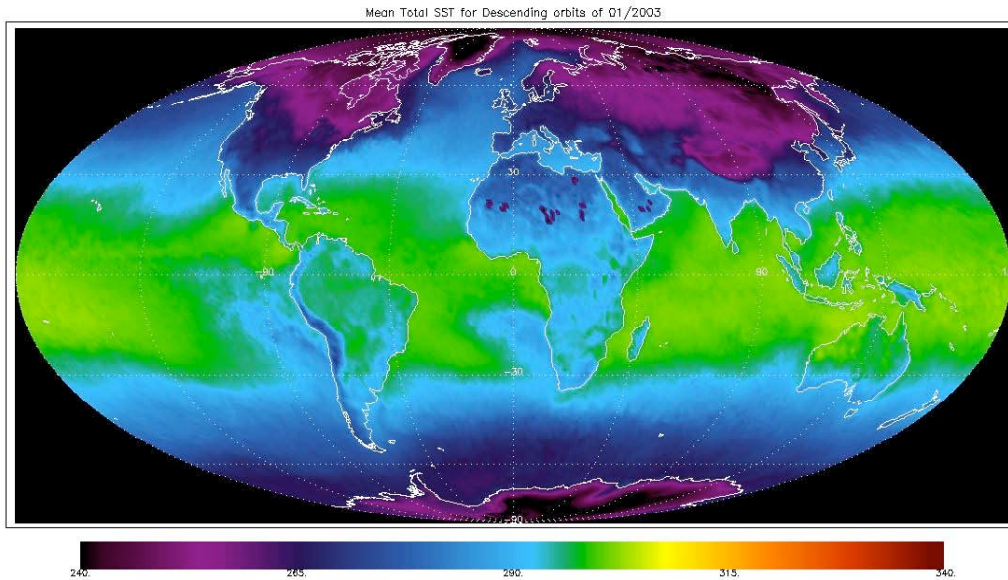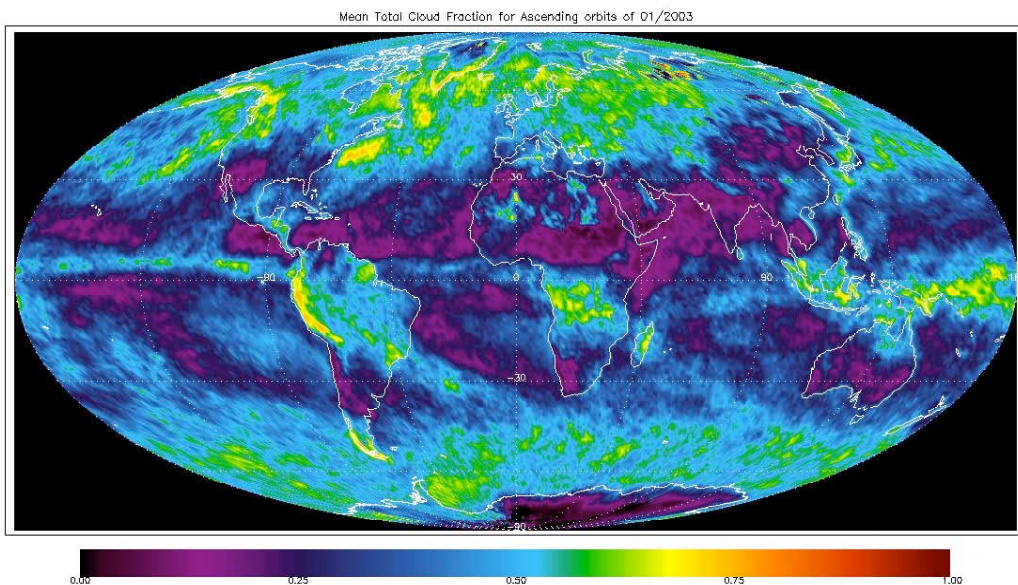

**Figure 10. Monthly Mean Skin Temperature
Descending Orbits for January 2003**
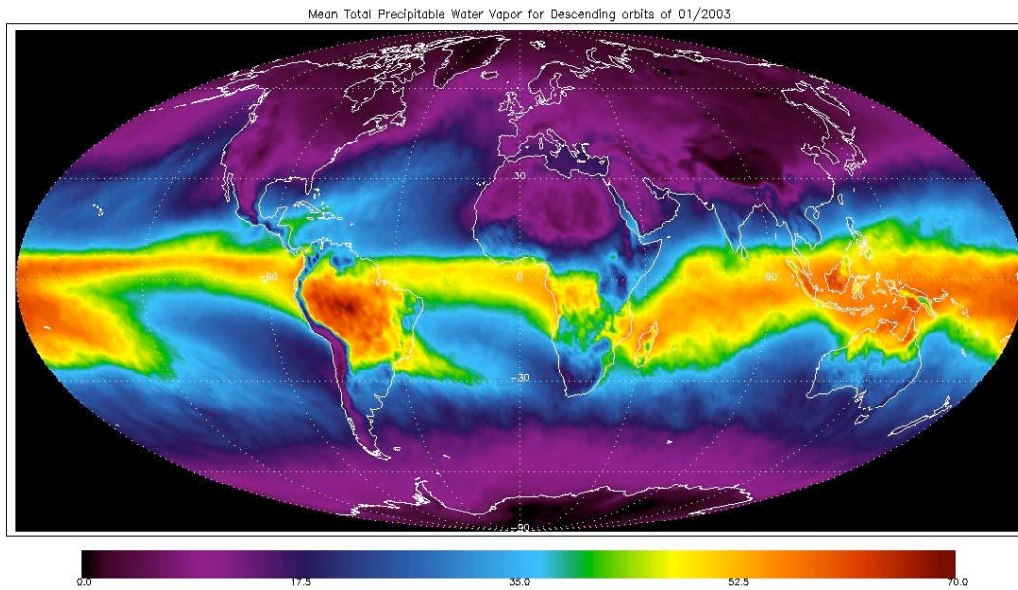
**Figure 11. Monthly Mean Total Precipitable Water Vapor
Descending Orbits for January 2003**

**Figure 12. Monthly Mean Effective Cloud Fraction
Ascending Orbits for January 2003**

References:
H. H. Aumann et al, "AIRS/AMSU/HSB on the Aqua Mission: Design, science objectives, data products, ad processing systems," IEEE Trans. Geosci. Remote Sensing, vol 41, pp 253-264, Feb 2003.

E. Fetzer (editor), "AIRS/AMSU/HSB Validation Report for Version 3.0 Data Release", August 2003.   Electronic copy of the report can be found from GDAAC as http://daac.gsfc.nasa.gov/atmodyn/airs/guide/airs_l2/V3.0_Validation_Report.pdf.

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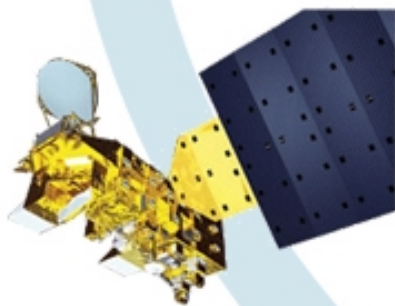
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