AIRS/AMSU/HSB Version 4.0 Level 3 Quick Start

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December, 2005
Version 1.0

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Introduction

Release V4.0 includes a Level 3 gridded product, derived from the Level 2 swath product. The Level 2 Quality Flags control which of the Level 2 Product data are combined to create the Level 3 Product. It is important that the user of Level 3 Products become familiar with these quality flags, and we urge the user to read the Level 2 Quality Flags Quick Start documentation for a description of these flags.

V4.0_L2_QualFlag_QuickStart.pdf

There are three AIRS Level 3 data products: daily, 8-day (one-half of the Aqua orbit repeat cycle), and monthly (calendar). The multi-day products are simply the arithmetic mean weighted by the counts of the daily data combined in each grid box. Each product is separated into ascending and descending portion 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, with an equatorial crossing time of 1:30 PM local time; the descending direction of movement is from Northern Hemisphere to Southern Hemisphere, with an equatorial crossing time of 1:30 AM local time. Outside of the polar zones, these correspond respectively to daytime and nighttime.

Each Level 3 daily product contains information for a temporal period of 24 hours for either the descending (equatorial crossing North to South @1:30 AM local time) or ascending (equatorial crossing South to North @1:30 PM local time) orbit rather than midnight-to-midnight (e.g., AIRS Browse products). The data starts at the international dateline and progresses westward (as do the subsequent orbits of the satellite) so that neighboring gridded cells of data are no more than a swath of time apart (about 90 minutes). The two parts of a scan line that crosses the dateline will be included in separate data sets, according to the appropriate date. This ensures that data points in a grid box are always coincident in time. If the data were gridded using the same time-span as the AIRS Browse products, the start of the day and the end of the day could be in the same grid cell, producing an artificial time discontinuity across the image. The edge of the AIRS Level 3 gridded cells is at the date line (the 180E/W longitude boundary). When plotted, this produces a map with 0 degrees longitude in the center of the image unless the bins are reordered. This method is preferred because the left (West) side of the image and the right (East) side of the image contain data farthest apart in time. The gridding scheme used by AIRS is the same as used by TOVS Pathfinder to create Level 3 products.

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 or no missing data.

Level 3 files contain geophysical parameters that have been averaged and binned into 1°x1° grid cells. Grid maps coordinates range from -180.0° to +180.0° in longitude and from -90.0° to +90.0° in 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 custom multi-day maps from the daily gridded products. The complete description of the contents of the AIRS Level 3 Product is available in Appendix A3 of

V4_Release_Proc_FileDesc.pdf

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

Example Global Images Created from Level 3 Products

The three images below are example global images created from the Daily, 8-day, and monthly Level 3 ascending total water vapor product.

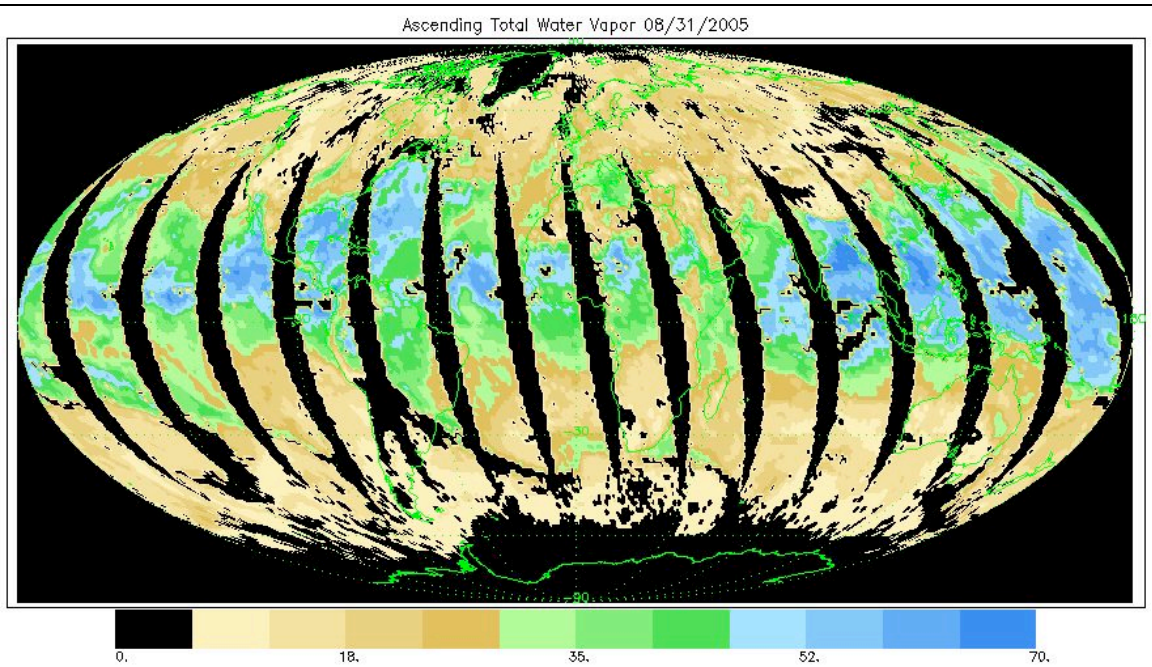

Figure 1. Image of ascending daily total water vapor product for 8/31/05. Color bar units are millimeters of precipitable water vapor. The gores between orbits are apparent, as well as gaps due to lack of retrievals that passed the water vapor quality factor.

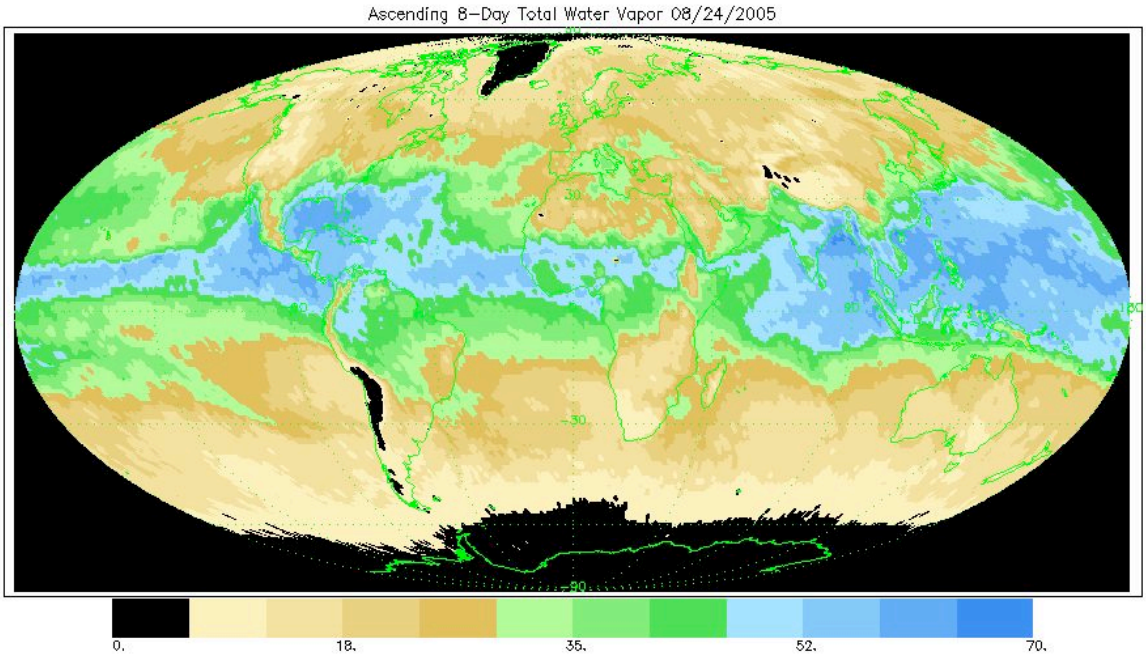

Figure 2. Image of ascending 8-day total water vapor product for 8/24/05 through 8/31/05. Color bar units are millimeters of precipitable water vapor. The gores between orbits are now filled. Only areas in which data are missing are those where retrievals consistently fail water vapor quality check. These are primarily over snow and ice fields or Greenland, the Andes, the Himalayas and Antarctica and its surrounding oceanic winter-ice.

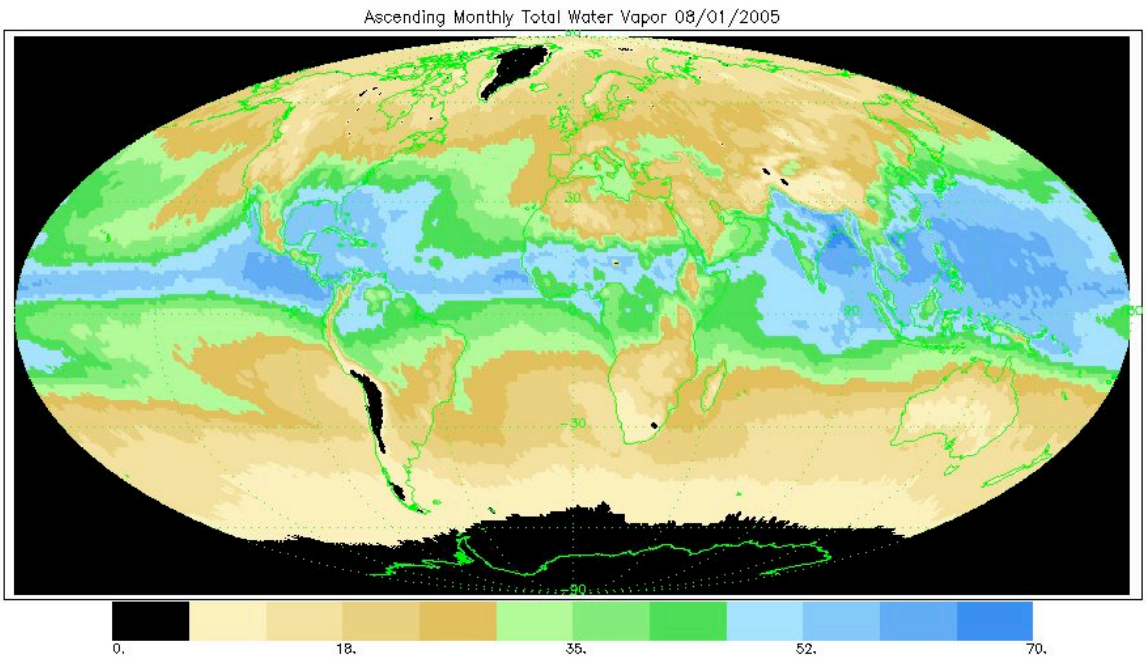

Figure 3. Image of ascending monthly total water vapor product for August, 2005. Color bar units are millimeters of precipitable water vapor. Only areas in which data are missing are those where retrievals consistently fail water vapor quality check. These are primarily over snow and ice fields or Greenland, the Andes, the Himalayas and Antarctica and its surrounding oceanic winter-ice.

Level 3 Data Field Precision

The Level 3 data files are rounded to a precision that is dependent upon the retrieved quantity and compressed using the HDF-EOS compression technique deflate. When read using tools employing the HDF library the data are automatically decompressed transparent to the user.

The following table lists the precision for each field in the Level 3 products. All numbers are for daily products. Multi-day and monthly will have 3 additional bits (1 additional digit) for all fields except standard deviations.

Field Name	Bits	Digits	Low value	High value
TotCldLiqH2O	11	3.3	3 +/- .001 x E-5	10 +/- 0.004
TotH2OVap	11	3.3	.05 +/- .000015	200 +/- 0.06
TotO3	8	2.4	80 +/- .25	1300 +/- 4
SurfAirTemp	13	3.9	200 +/- .015	350 +/- 0.03
SurfSkinTemp	13	3.9	200 +/- .015	350 +/- 0.03
SurfPres	11	3.3	500 +/- .13	1000 +/- 0.25
OLR	11	3.3	200 +/- .06	300 +/- 0.13
ClrOLR	11	3.3	200 +/- .06	300 +/- 0.13
EmisIR	8	2.4	0.8 +/- .002	1 +/- 0.003
GPHeight	*	0-5	100 +/- 0.5	65000 +/- 0.5
CloudFrc	8	2.4	.01 +/- .00003	1 +/- 0.002
CloudTopPress	8	2.4	100 +/- .25	1000 +/- 2
RelHumid	8	2.4	1 +/- .004	100 +/- 0.25
H2OVapMMR	8	2.4	5 +/- .012 x E-5	50 +/- 0.13
Temperature	13	3.9	200 +/- .015	350 +/- 0.03
CloudFrcVis	8	2.4	.01 +/- .00003	1 +/- .003
TotH2OVap_MW	11	3.3	.05 +/- .000015	200 +/- 0.06
EmisMW_MW	8	2.4	.3 +/- .001	0.9 +/- .002
GPHeight_MW	*	0-5	100 +/- 1.0	65000 +/- 1.0
Temperature_MW	12	3.6	200 +/- .03	350 +/- .06
Any standard deviation	6	1.8	1 +/- 0.03	1000 +/- 16

(*) GP_Height uses a different scheme. It is scaled to the nearest meter for all ranges. GP_Height_MW is to the nearest 2 meters.

Disclaimer and Caveats for Level 3 Data Products

The user is advised to read the full disclaimer documentation for the Version 4 Data Products Release:

V4.0_Data_Disclaimer.pdf

Validation

Although the Level 3 data products are global, they are composed of Level 2 data products that have been validated for non-polar latitudes (between 50° South and 50° North). Some products have been validated over both land and ocean, while others are validated only over ocean. No products have been validated over ice and snow on land or ocean. It is important that the user read the Version 4 Validation Report to understand the validation limits for each product:

V4.0_Validation_Report.pdf

The table below is provided for convenient reference to indicate status of validation of Level 2 products combined to create Level 3 products. Level 3 data whose geospatial location is outside of the corresponding Level 2 data validation regions should not be used for research.

Status of Validation for AIRS Version 4.0 Level 2 Data Products				
Parameter	Non-Polar|lat| ≤ 50°, no ice or snow cover			
	Land		Ocean	
	Day	Night	Day	Night
Cloud-Cleared Radiances		Validated	Validated	Validated
TsurfStd			Validated	Validated
emisIRStd				
OLR				
TairStd	Validated[1]	Validated[1]	Validated[1]	Validated[1]
H2OMMRStd	Validated[1]	Validated[1]	Validated[1]	Validated[1]
totH2OStd	Validated[2]	Validated[2]	Validated	Validated
O3VMRStd				
totO3Std	Validated[2]	Validated[2]	Validated	Validated
PCldTopStd			Validated	Validated
CldFrcStd			Validated	Validated

[1]Retrievals exhibit greater uncertainty at altitude < 3 km for these profile quantities (i.e., users should be cognizant of quality flag, Qual_Temp_Profile_Bot)
[2]Known large positive biases over desert surfaces
[3]Not Validated In V4

In addition, a set of field and height-dependent quality flags tied to the Level 2 data products have been applied to select which of those data are included in the Level 3 data products. The possible values of these flags are 0, 1 and 2. Level 2 data whose corresponding flag is set to 2 are not included in the Level 3 product.

We caution the user to use Level 3 data products outside the bounds of validation with caution. The data are not publication quality. The AIRS Project decided before launch that all data products would be released as an aid to researchers instead of suppressing nonvalidated data products.

Caveats

Application of Quality Flags Creates Unequal Numbers of Samples within Profiles and among Retrieved Parameters

The Level 3 products are assembled from Level 2 products that have been filtered using their respective quality flags. Please refer to the document

V4.0_L2_QualFlag_QuickStart.pdf

for a complete description of the Level 2 quality flags. Quality control is applied to each data point entering the gridding algorithm both for different parameters and at different levels in the atmosphere for a profile. Therefore the number of samples combined to create the averages varies between parameters and levels in the atmosphere. A result is that profiles will contain different numbers of samples as a function of altitude. There will be a greater number of samples (greater yield) included in the TairStd profiles at higher altitudes due to filtering over three broad pressure regimes using Qual_Temp_Profile_Top, Qual_Temp_Profile_Mid and Qual_Temp_Profile_Bot. At any particular layer, there will usually be fewer moisture samples than temperature samples because Qual_H2O is applied in addition to the relevant temperature profile quality flag. There will be FOVs containing moisture profiles in which there are layers containing no valid samples but whose associated levels of the temperature profile contain significant numbers of valid temperature samples. Surface fields are filtered using Qual_Surf, the most restrictive of the quality flags. In all cases, a sample is included if the applied quality flags are either 0 or 1.

We provide the count of samples, but this does not characterize sampling biases, which result from the measuring system. For example, parameters that are correlated with cloudiness, e.g. cloud properties and water vapor mass mixing ratio, have sampling biases which are currently not well characterized. The problem is complicated because the bias is height and species dependent within a grid box. Water vapor generally has the least restricted quality control applied; hence water vapor associated with less reliable temperature is often included in the averaging despite the fact that its corresponding temperature is not. The rationale for looser quality control on water vapor is that this parameter is sufficiently poorly characterized that a low quality measurement of water vapor is better than none. The loss of sensitivity from clouds is not only dependent upon cloud amount, but depends upon correlations between clouds at different levels that are not characterized by cloud amount alone. Thus you cannot use total cloudiness in a grid box to further quality control the products. At this time we do not recommend analyses be carried out which depend upon correlations between temperature and water vapor fields owing to the field and height dependent quality control used in these products.

Topography Creates Unequal Numbers of Samples within Profiles

Binning vertical profile data over a spatial area containing topography is always problematical. Some samples in a bin may cover a footprint of low altitude topography while others in the same bin may cover a footprint of high altitude topography. This affects the number of samples as a function of altitude of the temperature profile. For example, the number samples falling within an ascending bin, TotalCounts_A, is the maximum number of entries which may be used in determining the average air temperature, Temperature_A, as some point in the vertical profile. Over topography, the count of samples actually included in the calculation at a particular level, Temperature_A_ct, may drop rapidly to zero as the profile approaches the 1000mb level due to intervening topography.

Digitization Effect due to Compression by Rounding

A user who combines data over a time interval to create a histogram of the number of occurrences of a given value of water vapor in the 500-600mb layer will see a high-frequency oscillation. This is a digitization effect due to the compression of the Level 3 data by rounding to shrink the product file size. The precision of H2OMMR is 8 bits in the mantissa. This is equivalent to 2 /2 significant digits. The effective bin size is ~1/256 of whatever the value is for the given cell. The user has two options to avoid creating a histogram that shows this beating. The first is to make the histogram bin size much larger than the effective bin size. The second is to make the histogram bin size much smaller, but then only display the non-empty bins.

Relative Humidity Calculation Results in Dry Bias

The Level 3 relative humidity is currently computed using the Level 2 specific humidity profile (H2OMMRStd, a layer quantity) and the Level 2 air temperature profile (TAIRStd, a level quantity). As described in the ancillary document

AIRS_L2_levels_and_layers.pdf

layer quantities are the mean for a layer whose bottom boundary is the pressure level at which they are reported and whose top boundary is the pressure level immediately above. In the troposphere, where temperature usually decreases with altitude, this results in a dry bias.

Integrating the Layer Mixing Ratios in H2OVapMMR yield a value smaller than TotH2Ovap

The Level 3 profiles assume the atmosphere extends downward all the way to 1000mb. The Level 3 total water vapor values does not make this assumption. Profiles can extend below the surface, and the user can partially correct for this by using topography to remove from sums of H2OVapMMR layers and fractions of layers that are below the surface. Unfortunately, specific humidity is not constant throughout the vertical extent of a layer so the correction cannot be exact. The user might believe that he is safe over the ocean. However, if the surface pressure is less than 1000mb and the Level 3 bin is over the ocean, the bottom layer should appear to have more water vapor than is really there because it will extend below the surface.