



Abstract The Atmospheric Infrared Sounder (AIRS) sounding system is a suite of infrared and microwave instruments flown as part of NASA's Earth Observing system (EOS) on board the Aqua platform. The AIRS dataset provides a global view of Earth processes at a finer vertical resolution than ever before. However, analysis of the AIRS data is a daunting task given the sheer volume and complexity of the data. The volume of data produced by the EOS project is unprecedented; the AIRS project alone will produce multi-terabytes of data over the lifetime of the mission. We describe the development of AIRS Level 3 data products that will help to alleviate problems of access and usability.

Keywords: global analysis, climate studies, gridded data, data reduction

Introduction

Motivation

- AIRS Level 3 algorithm and product development is driven by the need for global analysis of AIRS data for weather and climate studies
- to promote the wide use of AIRS datasets by providing easy-to-use, quantitative gridded data products for inter-disciplinary science.

Objective

- To provide a consistent, standard global AIRS data set of relatively low volume to aid in research and data discovery.

Research applications

- Numerical Weather Prediction
- Atmospheric dynamics
- Climate variability and change
- Hydrologic cycle
- Variability, trends

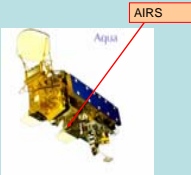


Orbital and instrument characteristics

- Polar, sun-synchronous orbit
- 705 km nominal altitude
- 98.2° inclination
- 233 orbit (16 day) repeat cycle.
- 1:30 A.M. and P.M. equatorial crossing times.

AIRS Instrument Facts and Characteristics

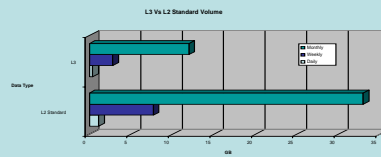
- High-spectral resolution, grating multispectral infrared sounder operated in a cross-track scanning mode with AMSU-A and HSB for all weather capability
- Measures the Earth's outgoing radiation at 0.4 to 1.0 μm and 3.7 to 15.4 μm .
- 1 K temperature retrieval accuracy per 1 km layer in the troposphere.
- 0.05 emissivity accuracy.
- Array grating spectrometer (3.74 to 15.4 μm), with a spectral resolution of 1200 ($\lambda/\Delta\lambda$)



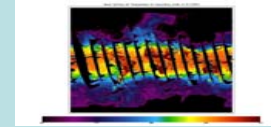
AIRS Level 3 Products

Level 3 products

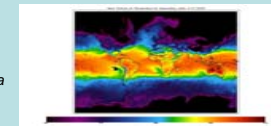
- Are composed of geophysical parameters that have been spatially and temporally re-sampled from Level 2 data products. Due to re-sampling and selecting a reduced set of reporting parameters, Level 3 datasets are substantially smaller than the lower level source products from which they are derived.
- Low overhead in terms of data handling
- Created directly from the geophysical parameters, no additional parameters are derived
- Two types of L3 planned
 - Standard (Fall 2004)
 - means, standard deviation, counts
 - 1' x 1' spatial resolution
 - Daily, 8-day (one half the AIRS repeat cycle), monthly temporal resolution
 - Quantization (Future release)
 - Statistical summaries of lower level data
 - 5' spatial resolution
 - Pentad (5-day), monthly temporal resolution



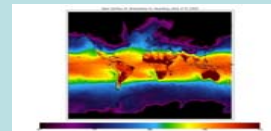
Daily L3 Standard Product sample coverage. "Complex" data, leaves in gores between satellite tracks.



8-Day L3 Standard Product sample. "Moderate" data, no gores, some data dropouts.



Monthly L3 Standard Product sample. "Simple" data, no gores, complete coverage.



Level 3 Data Product Development Issues

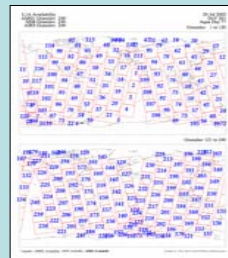
- Uncompressed binary HDF-EOS files are on the order of 153 MB/daily file.
- Defeats the purpose of Level 3.
- Solution
 - HDF-EOS offers three internal lossless compression methods that are transparent to the end-user and have shown good results.
 - Run Length Encoding (RLE)
 - Skipping Huffman
 - Deflate (Gzip)
 - Level of compression can be adjusted with an integer flag (1-9)
 - Comparisons of HDF internal compression methods show that 'Deflate' (compression parameter = 5) gives the best results with little impact on I/O throughput.
- Additional file size reduction needed while maintaining ease of use and transparency to the user.
- Solution
 - Precision reduction
 - Use only significant bits and round so that lower bits will be zero.
 - Significance of AIRS product fields is limited to 1%, so the lower fields are filled with uncorrelated instrument and computational noise
 - Makes AIRS data more compressible while maintaining the ease-of-use of floating-point notation.

AIRS Level 2 Data Products

Level 2 products

- AIRS data are organized in terms of data levels as defined by the Committee on Data Management, Archiving and Computing (CODMAC) as shown in the table below.

CODMAC Data Levels	
Level	Description
0	Reconstructed unprocessed instrument/payload data at full resolution; raw engineering measurements.
1A	Reconstructed uncalibrated instrument data at full resolution, time-referenced, and annotated with ancillary information, computed and appended, but not applied, to the Level 0, processed tracking data.
1B	Calibrated Level 1A
2	Derived geophysical variables at the same resolution and location as the Level 1 source data.
3	Variables mapped on uniform space-time grid scales, usually with some completeness and consistency.

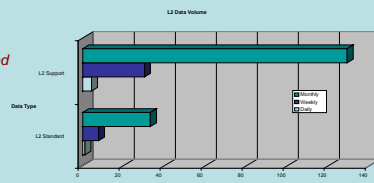


Example of AIRS daily coverage. Ascending and descending orbits combine for global coverage. Each square represents a single AIRS Level 2 file (granule).

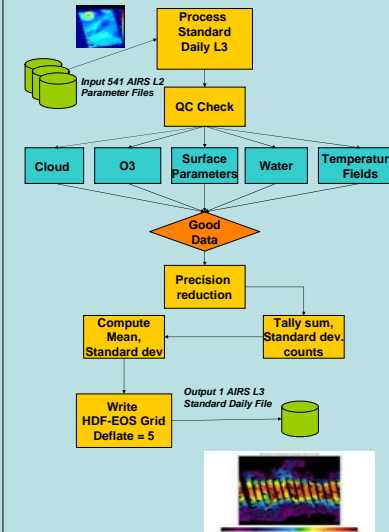
AIRS derived geophysical parameters (Level 2)

- Atmospheric temperature profiles with and average layer accuracy of 1K in 1 km thick layers in the troposphere and 1K in 4 km layers in the stratosphere.
- Land surface temperature, sea surface temperature, IR spectral surface emissivity
- Humidity profiles of 2 km resolution and total precipitable water vapor
- Fractional cloud cover, cloud spectral infrared emissivity, cloud top pressure and temperature
- Total ozone column density and column density in atmospheric layers.
- Trace gas column densities.

- All Level 2 products, except cloud fraction are produced at the AMSU-A footprint resolution (45 km at nadir), cloud fraction is on the AIRS IFOV, or 15 km at nadir.
- Level 2 files range in size from 4.7 (L2 Standard core products) to 18 MB (L2 Research support products), with each file containing about 6 minutes of satellite coverage data, for a total of 240 files per day per instrument per processing level.



AIRS Standard Daily L3 Processing High Level Overview



AIRS Standard Multi-Day Standard L3 Processing High Level Overview

