Distribution of Hyperspectral Radiances to Numerical Weather Prediction Centers

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Abstract

The near real-time AIRS processing and distribution system has been operational at NOAA/NESDIS/STAR since October 2002. The AIRS radiances are operational at a number of Numerical Weather Prediction (NWP) Centers . The initial radiances distributed were the center field of view (FOV) of the nine FOVs within a golf ball. Since the NWP centers assimilate clear radiances, this choice of FOV was non-optimal for distribution. To tailor to the needs of the users, the determination of the FOV to distribute was changed to the warmest FOV within a golf ball (using a window channel for the warmest determination). This warmest FOV dataset is currently being operationally distributed. A test dataset is being produced that contains the clearest AIRS golf ball FOV by using MODIS data. This dataset may become operational if deemed more suitable than the warmest FOV dataset.

The AIRS near real-time operational system is the baseline for the design and development of the IASI and then CrIS near real-time processing and distribution systems. The IASI system will be distributing subset radiances to the NWP within the United States while the CrIS system will distribute the near real-time radiances to the same customers as AIRS. The products and similarities of all three systems will be discussed and presented.

Instruments

AIRS

A cooled grating array IR spectrometer.

17 arrays with 2378 spectral channels (649– 1135 cm^{-1}, 1217–1613 cm^{-1}, 2169-2674 cm^{-1}).

Gaussian spectral resolution: 0.5–2.25 cm^{-1}.

Primary products: radiances, and retrieval products such as temperature profiles, moisture profiles, and ozone.

IASI

Fourier Transform Spectrometer (Michelson Interferometer).

Spectral range: 645 - 2760 cm^{-1} in three bands.

Constant sample spectral interval: 0.25cm^{-1} → 8461 channels.

Apodized spectral resolution: 0.5 cm^{-1}.

Primary products from NOAA: subset radiances and trace gas retrieval products.

CrIS

Fourier Transform Spectrometer (Michelson Interferometer).

1305 Channels

Spectral range: 650 – 1095 cm^{-1}, 1210 -1750 cm^{-1}, 2155-2550 cm^{-1}.

Unapodized spectral resolution: 0.625 cm^{-1}, 1.25 cm^{-1}, 2.5 cm^{-1}.

Primary products from NOAA: radiances, retrieval products such as temperature profiles, water vapor profiles, ozone profiles and trace gas profiles.

AIRS Processing Milestones at NOAA

- May 4, 2002 – AQUA Launched
- August 7, 2002 – Received Level 0 to Level 1B processing package from JPL.
- August 21, 2002 – delivery of "first look" thinned radiance products to NWP centers, July 20th 2002 data.
- October 9, 2002 – routine distribution of thinned Level 1B radiance products to NWP centers.
- January 22, 2003 – Visible cloud fraction and top of atmosphere albedos have been added to the thinned data sets.
- July 1, 2003 – AIRS Level 2 becomes operational at NOAA.
- September 11, 2003 – HSB processing and distribution is turned off.
- September 16, 2003 – AIRS reconstructed radiances for 324 channels are available on the NOAA server in BUFR format.
- October 3, 2005 – Warmest FOV replaces the center FOV distribution.

Decisions for Hyperspectral BUFR Files

- Radiance Files: Should we be using a table 8 descriptor to determine the difference between radiances, reconstructed radiance, and cloud cleared radiances? Should it be in the file name?
- Level 2 Files: Should the Level 2 products each have their own file or should all the Level 2 products be in their own file?

IASI Simulation Milestones at NOAA

- August 2004: Began IASI development.
- February 2005: Started running IASI simulation system.
- October 2005: Started distributing simulated IASI level 1C BUFR files (Subsets and RR) on AIRS data server.
- August 2005: August 2006: Started producing Level 2 NOAA Unique products (profiles and CCR) in NetCDF format.
- February 2006: Began development of the IASI/AVHRR NOAA Unique products system.

AIRS and IASI as Preparation for CrIS

- CrIS/ATMS simulation system that is currently being developed is based upon both the IASI/AMSU/MHS simulation system and the AIRS/AMSU/HSB simulation system.
- As with AIRS and IASI, we will be distributing simulated CrIS BUFR files. These will be available to current AIRS and IASI data users.
- Much of the system management design, data subsetter and software utilities developed for AIRS, and then for IASI, are being used for the CrIS/ATMS system.
- Simulated CrIS data will be available in the summer of 2007.
- The CrIS BUFR format will be based upon the IASI BUFR format.

Products in BUFR Format for Distribution	AIRS	IASI (Simulated)	CrIS	AIRS and MODIS	IASI and AVHRR	CrIS and VIIRS
Level 1B/L1C Subset Radiances	281 and 324 channels containing the warmest FOV from each golfball	616* channels containing the warmest FOV for an IASI FOR	~350 channels containing the warmest FOV from each golfball	281 and 324 channels containing the clearest FOV from each golfball	616* channels containing the clearest FOV for an IASI FOR	~350 channels containing the clearest FOV from each golfball
Principal Components	200 Principal Components representing 1688 channels for the warmest FOV from each golball	200 Principal Components representing 8461 channels for the warmest FOV each IASI FOR	200 Principal Components representing 2200 channels for the warmest FOV from each golfball	Not Applicable	Not Applicable	Not Applicable
Level 1B/1C Reconstructed Radiances	281 and 324 channels containing the warmest FOV from each golfball	616* channels containing the warmest FOV for each IASI FOR	~350 channels containing the warmest FOV from each golfball	281 and 324 channels containing the clearest FOV from each golfball	616* channels containing the clearest FOV for an IASI FOR	~350 channels containing the clearest FOV from each golfball
Cloud Cleared Radiances	281 and 324 channels containing one FOV for each golfball	616* channels containing one FOV for an IASI FOR	~350 channels containing one FOV for each golfball	281 and 324 channels containing one FOV from each golfball	616* channels containing one FOV for an IASI FOR	~350 channels containing one FOV from each golfball
Level 2 Products	Full Resolution Temperature, Water Vapor, Ozone and Trace Gas Retrievals	Full Resolution Trace Gas Retrievals	Full Resolution Temperature, Water Vapor, Ozone and Trace Gas Retrievals	Full Resolution Temperature, Water Vapor, Ozone and Trace Gas Retrievals	Full Resolution Trace Gas Retrievals	Full Resolution Temperature, Water Vapor, Ozone and Trace Gas Retrievals

LEGEND

- **Currently being distributed**
- **Currently available in test mode**
- **Will be available in test mode by the end of the year**
- **Currently working on**
- **Will be working on within the next year**

Possible Variables in the CrIS/ATMS Level 2 BUFR file for Distribution

Air Temperature (100 levels)	Rain Rate	Cloud Top Pressure
Layer Column Liquid Water (100 layers)	Total Water	Cloud Top Temperature
Layer Column Water Vapor (100 layers)	Total Ozone	Cloud Infrared Emissivity
Layer Column Carbon Monoxide (100 layers)	Surface Air Temperature	Cloud Infrared Reflectivity
Layer Column Methane (100 layers)	Surface Skin Temperature	Clear Field of View Flag
Standard Air Temperature (28 levels)	Microwave Surface Class	Microwave Surface Emissivity
Water Vapor Mass Mixing Ratio (28 layers)	Outgoing Longwave Radiation	Infrared Surface Emissivity
Ozone Volume Mass Mixing Ratio (28 layers)	Clear Outgoing Longwave Radiation	Infrared Surface Reflectivity
Column Averaged Carbon Dioxide	Cloud Fraction	Water Vapor Saturation Mass Mixing Ration (28 layers)

Microwave Products

- AQUA: AMSU and HSB full resolution BUFR files have been available since launch
- METOP: AMSU and MHS full resolution BUFR files will be available via the same path as the current NOAA microwave BUFR files.
- NPOESS: ATMS full resolution BUFR files will be made available.

Lack of Pictures?

- Both a near real-time visualization system and an offline validation system have been set up for AIRS and IASI. For more information on these system, please see the following poster:

An Integrated Web-base Visualization System for Monitoring and Validation of the Products from Hyper-spectral Instruments (L. Zhou et al.)

International TOVS Study Conference, 15th, ITSC-15, Maratea,Italy, 4-10 October 2006
Madison, WI, University of Wisconsin-Madison, Space Science and Engineering Center, Cooperative Institute for Meteorological Satellite Studies, 2006.