JP1.13 A NEAR-REALTIME AIRS PROCESSING, DISTRIBUTION, AND VISUALIZATION SYSTEM

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1. INTRODUCTION

The AQUA satellite, launched on May 4, 2002, contains a suite of six instruments. Three of the instruments were designed to work as a tightly integrated remote sensing system that will be used to create three-dimensional maps of temperature, humidity and clouds with unprecedented accuracy. The Atmospheric Infrared Sounder (AIRS), a grating spectrometer resolving 2378 channels with a high spectral resolution, is used in conjunction with the Advanced Microwave Sounding Unit (AMSU) and the Humidity Sounder for Brazil (HSB) to produce the global three dimensional maps. For the AIRS/AMSU/HSB suite to have an impact on numerical weather prediction (NWP) models, their calibrated and navigated radiances and brightness temperatures have to be received at the NWP centers in near real-time (generally within 3 hours). NOAA/NESDIS has developed and implemented a system to process the AIRS, AMSU, and HSB data and to distribute it to the NWP centers in a timely fashion. This system is the result of collaboration between NOAA/NESDIS/ORA and the following organizations: NOAA/NESDIS/OSDPD, IPO, NASA/JPL, NASA/ESDIS, UMBC, MIT, and the global Numerical Weather Prediction Centers.

2. FRAMEWORK

The AIRS/AMSU/HSB data is being processed using a 32 CPU SGI Origin 3400. The near real-time AIRS processing system is built using Perl and kshell scripts for the top level programs which control the data flow. The system was designed with the ability to process and distribute the satellite data as quickly as possible to meet the distribution time requirements. The scripts are written to handle every processing step as an independent process for each instrument, creating a flag file upon completion. The flag file is the trigger for the next level of processing. The processing steps include: raw data to Level 0 format, Level 0 to Level 1A format, Level 1A to Level 1B format, Level 1B format to the subset, distributable data files, and Level 1B to Level 2 science products.

3. DATA PREPARATION

NOAA/NESDIS/ORA receives the raw data files from the EOS Data and Operations System (EDOS) at GSFC in Rate Buffered Data (RBD) format. A file is received for each Application Process Identifier (APID) for every AQUA orbit. There are 8 APID files for AIRS, 8 APID files for AMSU, 1 APID file for HSB, and 1 APID file for the Ground Based Attitude Data (GBAD) per orbit. These orbital files are split into 6 minutes of data called granules to enable simultaneous processing. This program also converts the RBD format to Production Data Set (PDS) format for each APID, the required format for the Level 0 PGS Toolkit data processing. The GBAD 1 second PDS data is then converted into DAAC L0 format that is also required by the PGS Toolkit. The GBAD converter has been supplied by the Direct Readout Lab at NASA/GSFC.

4. DATA PROCESSING

The instrument data for each granule is not processed until all the required APID data files exist in PDS format along with the attitude and ephemeris files in DAAC L0 format. When all the files and data exist, a Product Control File (PCF) is created for each instrument run. The PCF file contains a list of the input files needed for the Level 0 to Level 1A conversion. After the PCF file is created, the JPL AIRS Processing Package is run to convert the instrument data to the Level 1A and then to the Level 1B format, calibrated and navigated radiances and brightness temperatures. Once the Level 1B data exists, then the JPL AIRS Processing Package is run to create the Level 2 scientific products that include the temperature, water vapor and ozone retrievals.

5. DATA SUBSETTING AND DISTRIBUTION

The Level 1B AIRS data uses 35 GB of disk space on a daily basis. To enable data distribution to the NWP centers on a timely basis, the AIRS data had to be decimated both spatially and spectrally and reformatted according to the NWP requirements. The AIRS/AMSU/HSB data is designed to overlap on the ground such that nine AIRS and nine HSB footprints overlap one AMSU footprint, a golf ball data set (Fig. 1). To decimate the data, we spectrally subset the channels to only include AIRS data which are used to calculate the temperature, water vapor, ozone and trace gas retrievals. This data set contains 324 AIRS channels along with all 15 AMSU channels and the 4 HSB channels. Spatially, the center AIRS and HSB

field of view (FOV) was saved for each golf ball where every other golf ball was saved. Therefore, the granule data was decimated by a factor of 130 and written into BUFR (Binary Universal Format for the Representation of Data) format for easy distribution to the NWP centers. A second file is created which contains the opposite golf ball data so that the two files contain full golf ball coverage. A file containing all nine FOVs for every other golf ball using the 324 channel data set is also being created for use by the Goddard Data Assimilation Office (DAO). A third and fourth BUFR file contains the full resolution AMSU and HSB data. The full AIRS spectra at the same decimated spatial resolution is compressed using principal component analysis (PCA) (Goldberg et. al.) and is provided in a separate BUFR file. The PCA BUFR file contains 200 principal component scores from which the complete AIRS spectra can be reconstructed.

These BUFR files are distributed to the NWP centers via two avenues. The files are sent to NOAA CEMSCS where they are pushed along the dedicated Washington-Bracknell high speed link to the UK Met Office. The BUFR files are also stored on the CEMSCS machines for pick up by NCEP and CMC. NOAA has a separate server that we use as a mirror site where the DAO gets the data and the NWP centers can get the BUFR files if there are any problems with the CEMSCS distribution system.

6. PRODUCTS

The products from the AIRS/AMSU/HSB instruments that are created at the NOAA site are: JPL AIRS Processing Package Level 2 products (temperature profile, water vapor profiles, ozone profiles, and surface skin temperature), collocations with other data types, and global grids of the Level 1B radiances/brightness temperature and the Level 2 products. The collocations were designed to match AIRS data with a latitude and longitude given a time separation. They were designed this way to give the AIRS/AMSU/HSB data in golf ball format to any group doing validation work. The global grids are created for internal monitoring and research. The Level 1B and Level 2 AIRS suite data are sub sampled onto these grids to enable global data viewing and manipulation.

7. VISUALIZATION

NOAA/NESDIS/ORA has two software packages which are used to view the AIRS data. GrADS is used to view the data in global grid format and ION (IDL on the net), a web base IDL (the Interactive Data Language) software package, is used to view the data in near real-time. The global grids have a two degree latitude and one half degree longitude resolution and contain the AIRS/AMSU/HSB Level 1B and Level 2 sub sampled data, the NCEP Aviation forecast model data and the ECMWF global model data (Fig 2.). The GrADS package enables quick viewing of the various types of data: radiances/brightness temperatures for each channel, land or ocean only data, and/or the temperature at each pressure level over the globe. The program also has zoom capabilities and has the interactive capability of looking at the AIRS data spectrum for each grid point. Cloud tests have been added to the program to show the cloud amount as different test and thresholds are applied to the Level 1B data.

The near real-time data can be viewed on the internet using ION/IDL (Fig. 3). The granule data has been taken out of its original format and placed in individual files, one file per channel. Each channel file has an associated latitude and longitude file for the geo-location. The data has been separated in this manner to enable quick viewing of the data over the internet. The granule images can be combined to create global images. The AIRS spectrum can be view for each footprint and the associated computed atmospheric temperature profile can be viewed for every golf ball.

8. SUMMARY

A near real-time AIRS processing, distribution, and visualization system has been developed and implemented at NOAA/NESDIS. The AQUA data is received in pipeline form directly from EDOS. This Level-0 data is reformatted, organized and then staged for Level-1B and Level-2 processing. The AIRS, AMSU, and HSB Level-1B radiances and brightness temperatures are sub sampled, spatially and spectrally, and delivered to NWP centers in BUFR format within the given time requirement. The radiances and brightness temperatures, along with the Level-2 retrievals and science products, are matched to radiosondes and other instrument data and delivered to multiple scientific groups, including ORA. A full feature, highly interactive web based visualization system has been developed to both monitor the data processing stages and to view the most recent data that has been processed, as well as the global climatology.

9. REFERENCES

Goldberg, M. D., W. Wolf, Y. Qu, and L. Zhou, 2001: Operational Processing and Distribution of AIRS. *Proc 11th International ATOVS Study Conference, 113-122.*

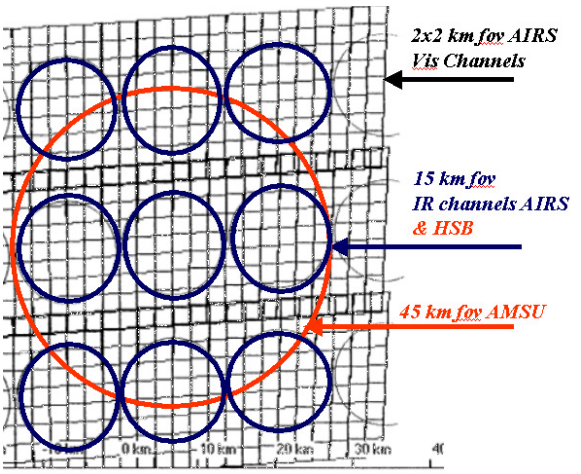

Figure1. An overlay of the AIRS, AMSU, and HSB footprints displaying the golf ball format.

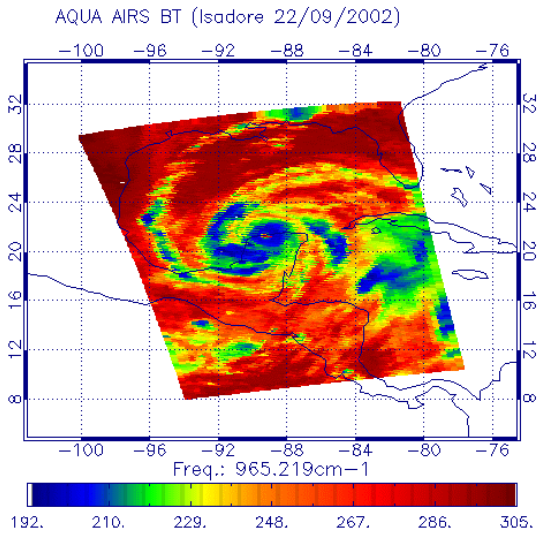

Figure 3. AIRS granule data showing hurricane Isadore viewed using the ION/IDL package.

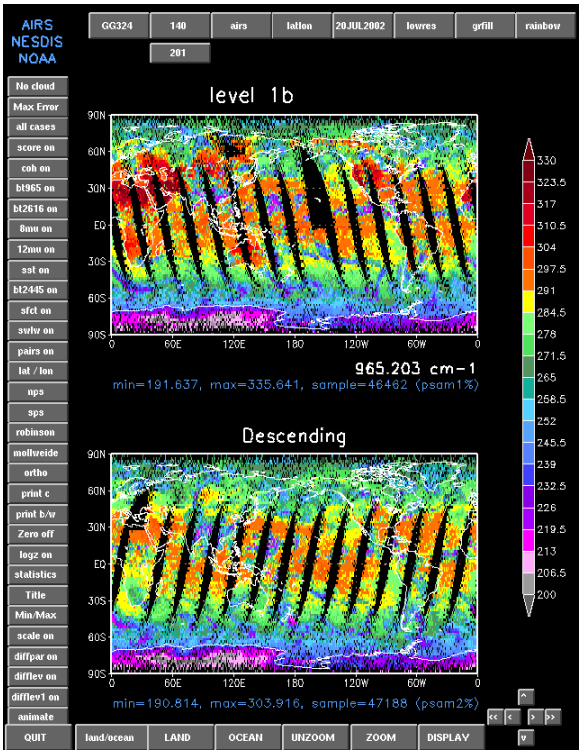

Figure 2. AIRS global grid data for September 22, 2002