CGMS

REPORT ON COMMUNITY DIRECT BROADCAST PROCESSING SOFTWARE PACKAGES

In response to CGMS Recommendation 36.16: The community software packages (i.e. AAPP, IAPP, IMAPP) have been essential in the use of ATOVS, IASI, AIRS and MODIS data by the meteorological community, especially for those who rely on the use of real-time direct broadcast data. The group encouraged satellite agencies to continue to support these packages for existing missions and to develop and release processing software packages (e.g. IPOPP) as soon as practicable before launch of all future missions.

This report overviews these processing packages to highlight their functions for the benefit of users and to document the software status and issues. It also provides the updates and distribution information. It is critical for any interested users to join the user group to ensure that the latest announcements are received by users in a timely fashion.

REPORT ON COMMUNITY DIRECT BROADCAST PROCESSING SOFTWARE PACKAGES
Hung-Lung Allen Huang

INTRODUCTION

Polar orbiting Meteorological satellite data, acquired from NOAA's meteorological satellite, NASA's Earth Observing spacecraft Terra and Aqua and Metop via direct broadcast, continues to support a wide range of meteorological and environmental monitoring and research applications.

To date, more than a few hundred direct broadcast ground stations have been installed around the world, with the purpose of receiving direct broadcast data in real-time from the aforementioned spacecrafts. The resulting images and geophysical products are providing immediate information to government, education, defense, and private sector operations worldwide.

The International MODIS/AIRS Processing Package (IMAPP) is a collection of software programs which facilitate any ground station capable of receiving Terra or Aqua direct broadcast data to process the raw data from Level 0 (raw instrument packets) to Level 1B (calibrated geolocated radiances), and to a selection of Level 2 products (geophysical parameters). Supported instruments include MODIS, AIRS, AMSU, HSB, and AMSR-E.

Recently, IMAPP has expanded its goal to build the capability of real-time product utilization and applications. Two major efforts are the real-time distribution of IMAPP products via a seamless interface with United States' National Weather Service (AWIPS), and the real-time data assimilation of MODIS products into regional weather forecast models.

Similarly, IAPP (International ATOVS Processing Package) and AAPP (ATOVS and AVHRR Pre-Processing Package) are processing packages that enable direct broadcast data users to process data into geo-calibrated and navigated Level 1 data from Level 0 raw data. IAPP uses Level 1-D data output from AAPP to provide Level 1 to Level 2 functions, wherein a set of common and useful atmospheric products can also be generated.

In summary AAPP is a "pre-processing" package since it only produces Level 1 data. IAPP has been designed to work with the HIRS Level 1-D output file that is produced by the AAPP. IMAPP belong to "processing" package category since it produces both Level 1 and Level 2 products. AAPP, IAPP and IMAPP are the backbone of the processing software that enable users to process in real-time local area environmental polar-orbiting satellite data including the infrared, microwave and visible sensors of AVHRR, HIRS, AMSU-A, AMSU-B, MHS, IASI, AIRS, MODIS, AMSR-E.

It is critical to users that the international satellite agencies, or their affiliates, continue to maintain these packages for existing sensor systems and to develop new processing capabilities for planned future missions such as NPP/NPOESS of United States, METOP series of Europe, and FY polar series of China, and other sustained polar orbiting satellite mission series. Without these packages hundreds of direct broadcast ground stations around the world, who have invested significant receiving and computing resources, will find it difficult to continue operating and to fulfill their roles in providing environmental monitoring, weather forecasting and many other services which are heavily reliant on daily data and products efficiently generated by these processing packages.

Overview

1.   IAPP

1.1   IAPP DESCRIPTION

The International ATOVS Processing Package (IAPP) has been developed to retrieve atmospheric temperature and moisture profiles, total ozone (and other parameters), in both clear and cloudy atmospheres, from ATOVS radiance measurements. The IAPP algorithm, which operates on NOAA-15 and later data, retrieves the parameters in 4 steps, viz: 1) cloud detection and removal; 2) bias adjustment; 3) regression retrieval; and 4) nonlinear iterative physical retrieval.

For information on the IAPP, and to download free of charge, go to:
http://cimss.ssec.wisc.edu/opsats/polar/iapp/iapp_info.htm

1.2   IAPP PURPOSE AND SCOPE

The IAPP can use radiances from HIRS-3, AMSU-A, and AMSU-B on the NOAA-15 through NOAA-18 spacecraft, preprocessed into the AAPP level 1-D format, for retrieval of atmospheric parameters.

The IAPP source code and supporting fixed datasets have been bundled as Open Source in accordance with the terms of the GNU General Public License agreement http://www.gnu.org/licenses/licenses.html - GPL and is freely available.

Feedback from users on the performance of the system, as well as any problems encountered during installation or execution, is encouraged. The IAPP technical contact is Hal Woolf of CIMSS, University of Wisconsin-Madison: mailto:hal.woolf@ssec.wisc.edu.

2.   AAPP

2.1   AAPP DESCRIPTION

The AAPP (ATOVS and AVHRR Pre-processing Package) is a software package for the processing of sounder and imager data from the NOAA and METOP series of weather satellites. The package is intended for the ingestion and the pre-processing tasks of received HRPT or AHRPT data, up to the retrieval of the satellite brightness temperatures. It can be used to process:

- ATOVS (HIRS, AMSU-A, AMSU-B) and AVHRR data from NOAA15, NOAA16 and NOAA17
- ATOVS (HIRS, AMSU-A, MHS) and AVHRR data from NOAA-18 and NOAA-N'
- TOVS (HIRS, MSU) and AVHRR data from NOAA satellites prior to NOAA15
- ATOVS (HIRS, AMSU-A, MHS), AVHRR and IASI data from the METOP satellites

AAPP was developed by a number of European meteorological organizations (Météo France, UK Met Office, ECMWF, KNMI,...), and is now maintained as a deliverable of the EUMETSAT NWP SAF.

2.2   AAPP PURPOSE AND SCOPE

AAPP contains software for the processing of raw HRPT data (level 0) successively to:

  Level 1a: separated data for each instrument.

☐*Level 1b:* geo-referenced and calibrated data (reversible: calibration coefficients are separated from raw data).

☐*Level 1c:* geo-referenced and calibrated temperatures and albedo (non-reversible: calibration coefficients are applied to numerical data).

☐*Level 1d:* mapped and filtered data (cloud mask).

Levels 1a, 1b, 1c and 1d are internationally agreed data formats.

AAPP contains modules for decommutation, navigation, calibration, pre-processing, mapping to a common instrument grid, and AVHRR cloud-masking.

For NOAA satellites, Figure 2.1 is a schematic showing the data processing sequence through the different levels, and the data files that are used at the different stages, of ATOVS and AVHRR processing. For pre-NOAA15 satellites, MSU files are used in place of AMSU-A and AMSU-B, and a separate MSU calibration module is incorporated.
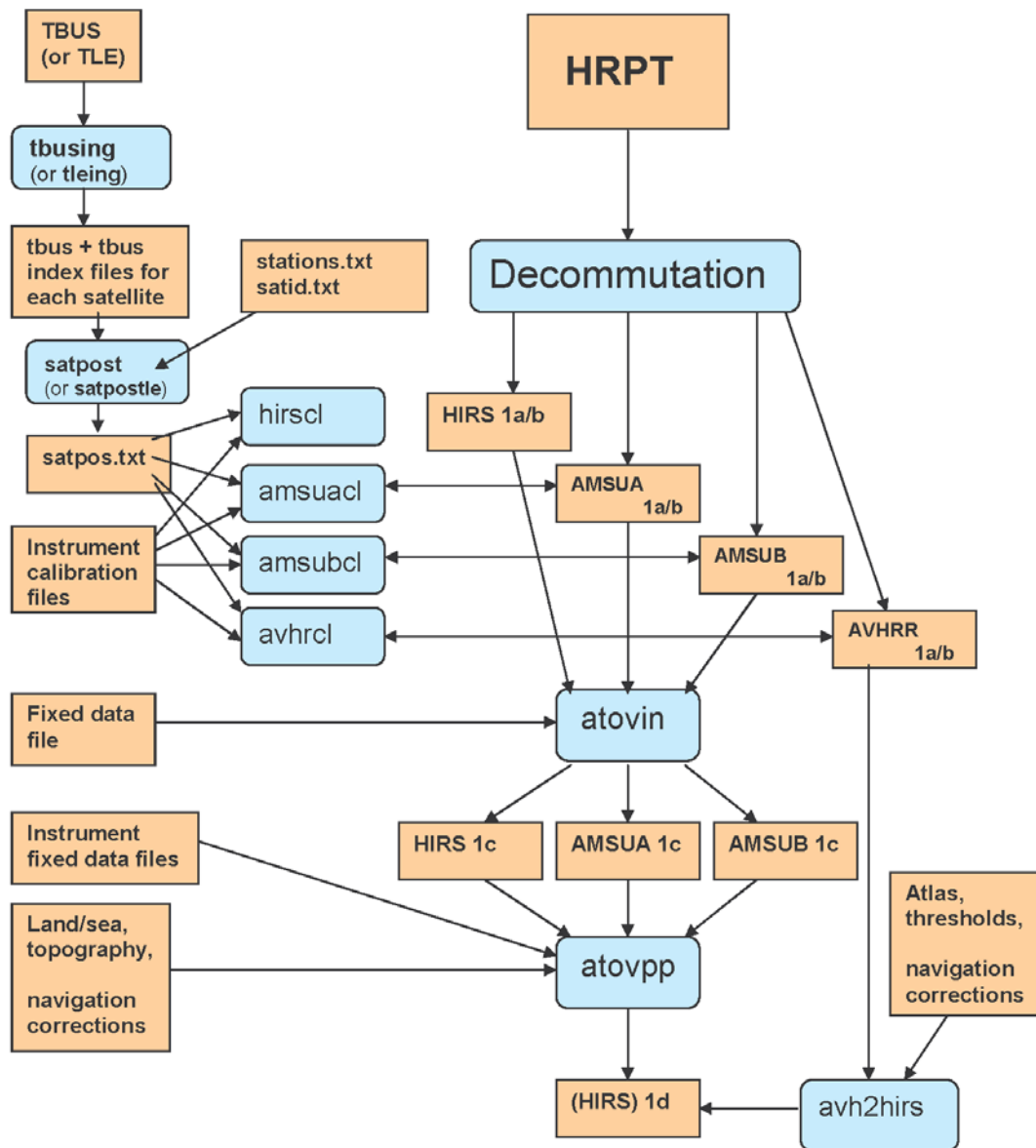

Figure 2.1 AAPP processing chain.

In the case of the METOP satellites, AAPP accepts ATOVS and AVHRR data in so-called "PFS Level 0" format, in which there is one file per instrument. There is therefore no decommutation task for METOP. Instead tools are provided to convert PFS Level 0 to standard AAPP Level 1a format, which can be processed as for the NOAA satellites.

The data for the IASI instrument on METOP are processed to Level 1c by a separate program, called OPS-LRS (Operational Software – Local Reception Station). For details on the interfaces, see the AAPP v6 Top Level Design document, NWPSAF-MO-DS-011.

3. IMAPP

3.1 IMAPP DESCRIPTION

The objectives for IMAPP are:
  A. To develop a software package for international distribution which allows any ground station capable of receiving EOS direct broadcast data to produce a suite of geophysical products in near real-time (within 1 hour of satellite overpass).
  B. By providing a software package to process MODIS and AIRS data, to directly involve the international community in the use and validation of EOS data sets.
  C. Using data from the UW/SSEC X-band antenna, generate near real-time MODIS/AIRS products over the central and eastern United States for distribution via the World Wide Web.
  D. Implement synergistic retrieval algorithms that combine high spatial resolution MODIS data with high spectral resolution AIRS data.

3.2 IMAPP PURPOSE and SCOPE

The IMAPP allows ground stations capable of receiving EOS direct broadcast to create the following products:

- MODIS Level 2 geophysical products (Terra and Aqua)

    o MODIS cloud mask (MOD35)

    o MODIS cloud top properties (MOD06CT)

    o MODIS atmospheric profiles, precipitable water and stability indices (MOD07)

    o MODIS aerosol product (MOD04)

    o MODIS Sea Surface Temperatures (IMAPP product)

    o MODIS Near Infrared Water Vapor product (IMAPP product)

- AIRS/AMSU/HSB Level 1 calibrated and geolocated radiances (Aqua)

- AIRS/AMSU/HSB Level 2

    o JPL DAAC Product

    o Single Field-of-View Product (IMAPP product)

- AMSR-E Level 1 calibrated and geolocation radiances (Aqua)

- AMSR-E Level 2 geophysical products (Aqua)

    o AMSR-E Rain Rate

    o AMSR-E Soil Moisture

    o AMSR-E Snow Water Equivalent

IMAPP is derived from the operational EOS processing software developed at NASA GSFC and JPL, and has been modified to be compatible with direct broadcast data. The main differences between IMAPP and the operational software are,

- portability,

- wherever possible, the reliance on toolkits has been eliminated,

- the IMAPP processing environment is greatly simplified,

- satellite overpasses of arbitrary size may be processed.

IMAPP can be downloaded from http://cimss.ssec.wisc.edu/imapp/ under the terms of the GNU General Public License agreement http://www.gnu.org/licenses/licenses.html - GPL and is freely available.

In addition, many useful functions are also developed and distributed for:

- **AIRS Level 1B HDFEOS to BUFR Utility**

    This package consists of software that will convert AIRS Level 1B Radiance HDFEOS files (AIRS.2009.02.06.176.L1B.AIRS_Rad.v5***.hdf) into Binary Universal Form for the Representation (BUFR) format for meteorological data. The output consists of selected channels at full spatial resolution. The software defaults to selecting the standard 324-channel set, but users can substitute their own channel selection should they prefer.

    This software encodes AIRS Level 1b files into BUFR using the same BUFR template that is used in the NOAA/NESDIS near real-time processing, (see http://www.star.nesdis.noaa.gov/smcd/spb/iosspdt/iosspdt.php).

    This software was written by Nigel Atkinson, Met Office, Exeter, UK.

- **AIRS Utility Release: MODIS/AIRS collocation, AIRS Cloud Mask, UWAIRS Single FOV retrieval package**

    This direct broadcast software package was created by Elisabeth Weisz at the University of Wisconsin-Madison. It contains software that will create the above products from input AIRS Level 1B Radiance files and Direct Broadcast MODIS Geolocation and cloud mask files:

    o MODIS/AIRS collocations as described in Nagle, Frederick W. and Robert E. Holz, 2009: Computationally Efficient Methods of Collocating Satellite, Aircraft, and Ground Observations. Accepted to the J. of Atmos. and Ocean Tech.

    o AIRS cloud mask using collocated MODIS cloud mask pixels.

o AIRS single field-of-view retrievals of temperature, moisture, ozone, surface emissivity and cloud top pressure.

The AIRS utility package includes scripts that can be run independently, or as part of the main processing script which calls the collocation, cloud mask and retrieval software in a processing chain. MODIS geolocation and cloud mask files are required as part of this processing. NOTE: This collocation will work only for Direct Broadcast full MODIS passes ONLY. It will not work correctly on standard DAAC 5 minute MODIS granules.

Several changes have been made to the UW AIRS single FOV regression retrieval. It is now valid under all-sky (clear and cloudy) conditions. Regression coefficients have been calculated using the latest version of the SARTA forward model (v1.07 as of Jan 2008, see http://asl.umbc.edu/pub/packages/sarta.html). Surface emissivities are retrieved as 6 emissivity eigenvector coefficients, and then converted to full spectrum (2378 AIRS channels). This is done under clear-skies conditions only. Cloud-top pressure (ctp) is now retrieved, as are quality flags based on retrieved cloud optical thickness (cot). The quality flag is a measure of cloudiness, and therefore at the same time a measure of the reliability of the retrieval results. Possible values are:

o 0=clear

o 1=thin clouds (cot < 0.5)

o 2=medium clouds(0.5 < cot < 1)

o 3=thick clouds (1 < cot < 1.5)

o 4=opaque clouds (cot > 1.5)

o 5=bad cloud top retrieval (i.e., cloud top retrieval above 90 hPa)

More information is provided in the release README file that is included with the package.

- **DB Google Earth True Color Imagery Software**

Direct Broadcast Google Earth (DBGE) is a software package that uses Terra or Aqua MODIS Level 1B 1km, 500m, 250m and geolocation files as input to create true color imagery in a format which is compatible with the Google Earth geobrowser. To obtain the free Google Earth software, please visit: http://earth.google.com/.

The requirements are:

- An Intel Linux computer (32 or 64 bit)

- IDL 6.0 or higher

- ImageMagick

Level 1B files created by MODISL1DB (http://oceancolor.gsfc.nasa.gov/seadas/modisl1db/) or SeaDAS (http://oceancolor.gsfc.nasa.gov/seadas/) are compatible with DBGE as well as files created at the NASA MODIS LAADS archive (http://ladsweb.nascom.nasa.gov/data/).

DBGE reads MODIS Level 1B image and geolocation data, and creates tiled MODIS true color images at 250 meter resolution, along with Keyhole Markup Language (KML) files

which allow the imagery to be displayed in Google Earth. To make the MODIS images and KML files viewable on the Internet, a web server is required where the images and KML files can be stored. It does not have to be the same system where you run DBGE. Any computer which runs a web server (even a Windows computer) may be used to serve the images to Google Earth.

For an example of a real-time web page containing 250m true color images along with the option to view them in Google Earth, please see the University of Wisconsin Direct Broadcast MODIS today web page: http://ge.ssec.wisc.edu/modis-today/.

For more information on this release, please see the top level README file that accompanies the software at: http://cimss.ssec.wisc.edu/imapp/download/.

- **DBCRAS Numerical Weather Prediction Forecast Model**

This is the first release of software that produces 48 km Numerical Weather Prediction (NWP) 72 hour forecast fields, using MODIS IMAPP Level 2 Total Precipitable Water (TPW), Cloud Top Pressure and Cloud Fraction as part of the assimilation to improve the depiction of clouds and moisture in the model. A version of CRAS that assimilates geostationary satellite products has been in use by some US National Weather Service forecasters for the last 2 years. Of most interest is the improved cloud and moisture physics that allow realistic depictions of forecast infrared satellite imagery.

The installation of the software begins with a one time set-up to define the domain centered on your DB antenna site. The forecast can then be executed twice per day at the synoptic times of 00 and 12 UTC. This execution can begin either by typing in a Unix shell script manually, or by using the Unix utility cron scheduler. The output is meteorological parameters, including forecast satellite imagery of water vapor (6.7 micron) and IR window (11 micron) brightness temperatures, at 48 km resolution every 3 hours out to 72 hours.

This is a Linux-only release and requires a reliable and efficient internet connection. Approximately 500MB of dynamic ancillary data must be downloaded from the IMAPP ancillary data ftp site (ftp://ftp.ssec.wisc.edu/pub/eosdb/ancillary) per DBCRAS model execution. It requires ~250MB of memory. The output file is in grib2 format, the WMO standard for grids. Product animations are created automatically using McIDAS-X (see below) and ImageMagick (http://www.imagemagick.org/script/index.php). Should ImageMagick not be installed, the software will still create individual static product images for each forecast time period.

McIDAS-X (http://www.ssec.wisc.edu/mcidas/software/about_mcidas.html) binaries are included as part of the release and will automatically create forecast product images and animations upon completion of the model run. This software cannot be redistributed or repackaged without authorization from SSEC (please contact the McIDAS Help Desk). Example forecast field animations images that were created by this imaging software, using the automated script included with the release, can be viewed from this ftp site: ftp://ftp.ssec.wisc.edu/pub/kathys/DBCRAS_examples/.

Also included as part of this release, are instructions on how to visualize the DBCRAS output grib2 files using McIDAS-V (Displaying_DBCRAS_In_McIDAS-V.pdf).

McIDAS-V is a free, open source, visualization and data analysis software package that is the next generation in SSEC's 35-year history of sophisticated McIDAS software packages. McIDAS-V displays weather satellite (including hyperspectral data) and other geophysical data in 2- and 3-dimensions. More information about McIDAS-V can be found at the McIDAS-V web site: http://www.ssec.wisc.edu/mcidas/software/v/.

Finally, more details about the release, including installation instructions and CRAS model references can be found in the DBCRAS README file at the download site: http://cimss.ssec.wisc.edu/imapp/download/.

3.3 Improved timeliness of our own direct broadcast system and product distribution

Many users of SSEC DB data express the desire to receive our products as quickly as possible. In an effort to improve the product generation and distribution times, we have purchased 4 more Sun Opteron computers to serve as nodes for the UW direct broadcast Linux cluster. The cluster now has a head node with 4 CPU cores and 8 computes nodes, each with 4 CPU cores. Thus the cluster is able to run 32 processing jobs simultaneously on the compute nodes (compared to 12 previously). This has greatly increased our capacity to run a wide range of DB applications. In particular, it has allowed us to routinely process two satellite passes simultaneously (one from Terra, one from Aqua). The data flow diagram in Figure 3.3.1 shows a simplified view of the complete DB processing system at SSEC.
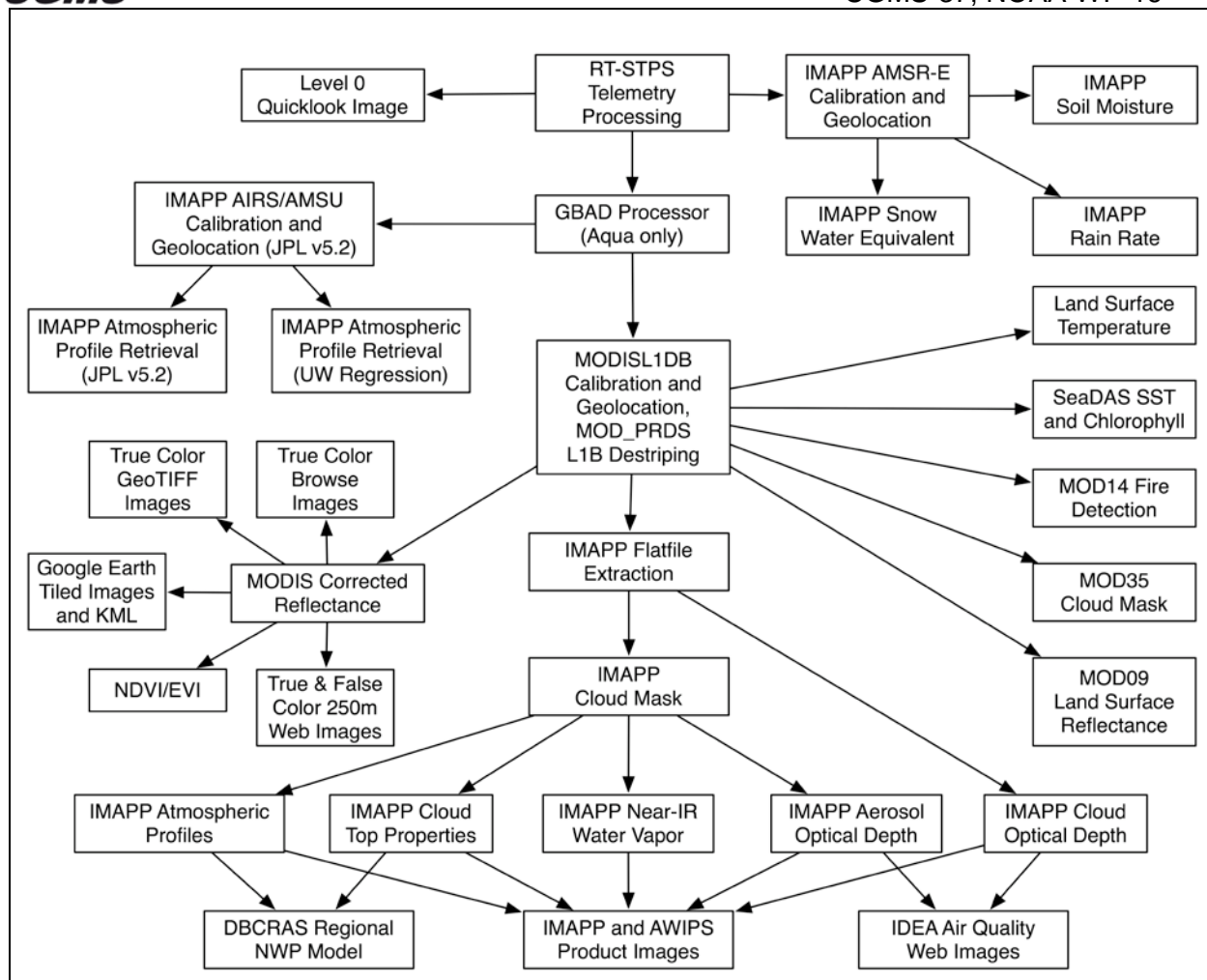
Figure 3.3.1: SSEC DB Processing System Data Flow

In addition, modifications to our processing scripts have relieved some congestion on the head node, which has also helped to improved product delivery rates. We are now able to process large MODIS overpasses (> 10 minutes) from Level 0 to all Level 1 and Level 2 products in less than 60 minutes following the end of satellite overpass acquisition.

SSEC also procured and installed a new X-band receiver and acquisition computer from SeaSpace Corp. to replace the original receiver, which failed in April 2008. The new receiver and computer were installed in August 2008, and have been operating reliably since. During the period when our receiver was not functioning, we implemented an ingest system to bring in MODIS Level 0 data from other direct broadcast sites in the US, including NASA GSFC, Univ. of South Florida, Univ. of Texas-Austin, and USFS RSAC Salt Lake City.

3.4   Increased use of IMAPP direct broadcast products by the National Weather Service of United States

Distribution of MODIS data and data products used by National Weather Service forecasters (NWS) in AWIPS has steadily increased since we began distributing direct broadcast data to them in June 2006. As far as we know, UW-Madison MODIS data is the first polar orbiting data that has ever been used by the NWS forecasters in AWIPS. The keys to success of the effort are:

- Running AWIPS locally to be able to understand the system and test products prior to dissemination to NWS offices.
- Timeliness and reliability of the products. All MODIS products are inserted through LDM and can be picked up by the forecast offices within 1 hour 15 minutes of the beginning time of the overpass.
- Visits to the NWS forecast offices to understand their needs and provide detailed information about the products. So far, UW personnel have visited the Sullivan, Wisconsin, La Crosse, Wisconsin, Green Bay Wisconsin forecast offices and the Central Region headquarters in Kansas City, Kansas.
- UW has on-site Virtual Institute for Satellite Integration Training (VISIT) teachers who developed a MODIS in AWIPS Teletraining Module. This is an official NESDIS and NWS project whose mission is to accelerate the transfer of research results based on atmospheric remote sensing data into NWS operations via distance education. As of March 2008, 27 VISIT MODIS distance training lessons have been held with a total of 49 NWS offices participating (see Figure 3.4.1). This has helped to introduce the products and demonstrate how they may complement and enhance the satellite products already received from GOES.

As of December 2008, 25 NWS offices across the country are receiving MODIS IMAPP products from our direct broadcast antenna. Among these sites is the Space Meteorology Group that provides forecasts for the Space Shuttle missions. For a graphical display of the sites, please see Figure 3.4.2.
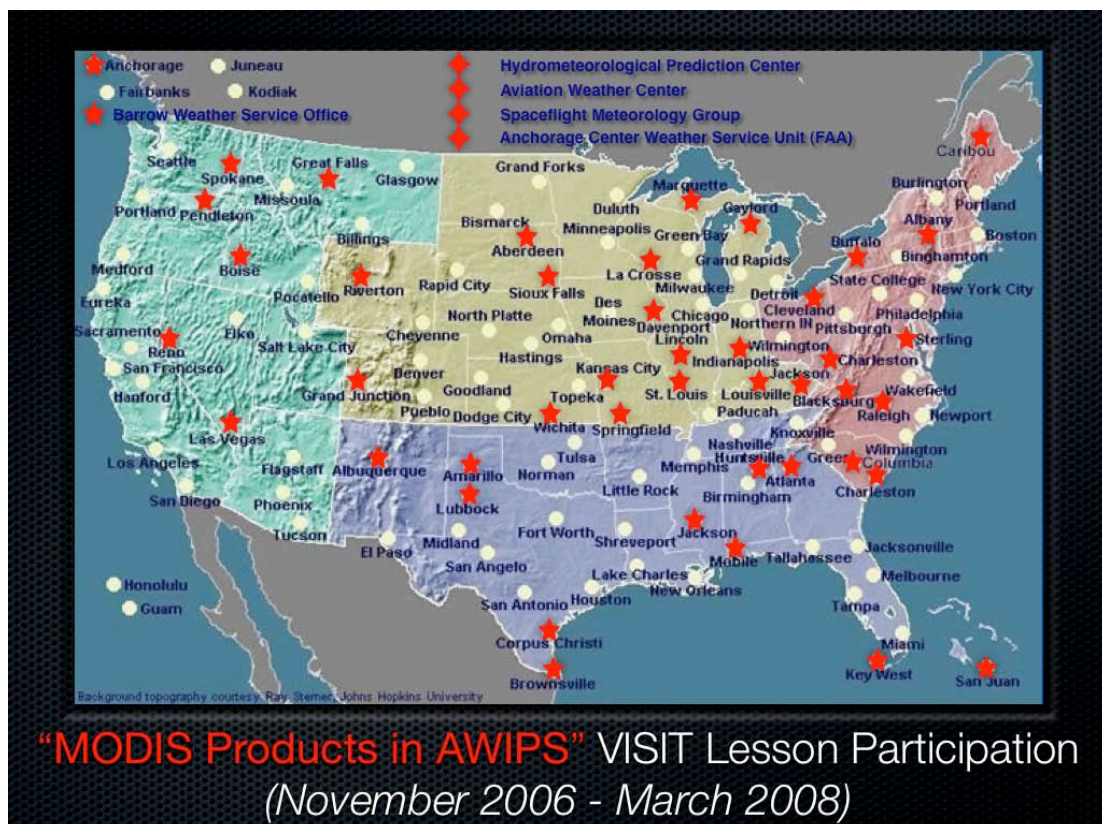

Figure 3.4.1: List of NWS sites that have participated in the MODIS Products in AWIPS teletraining sessions.
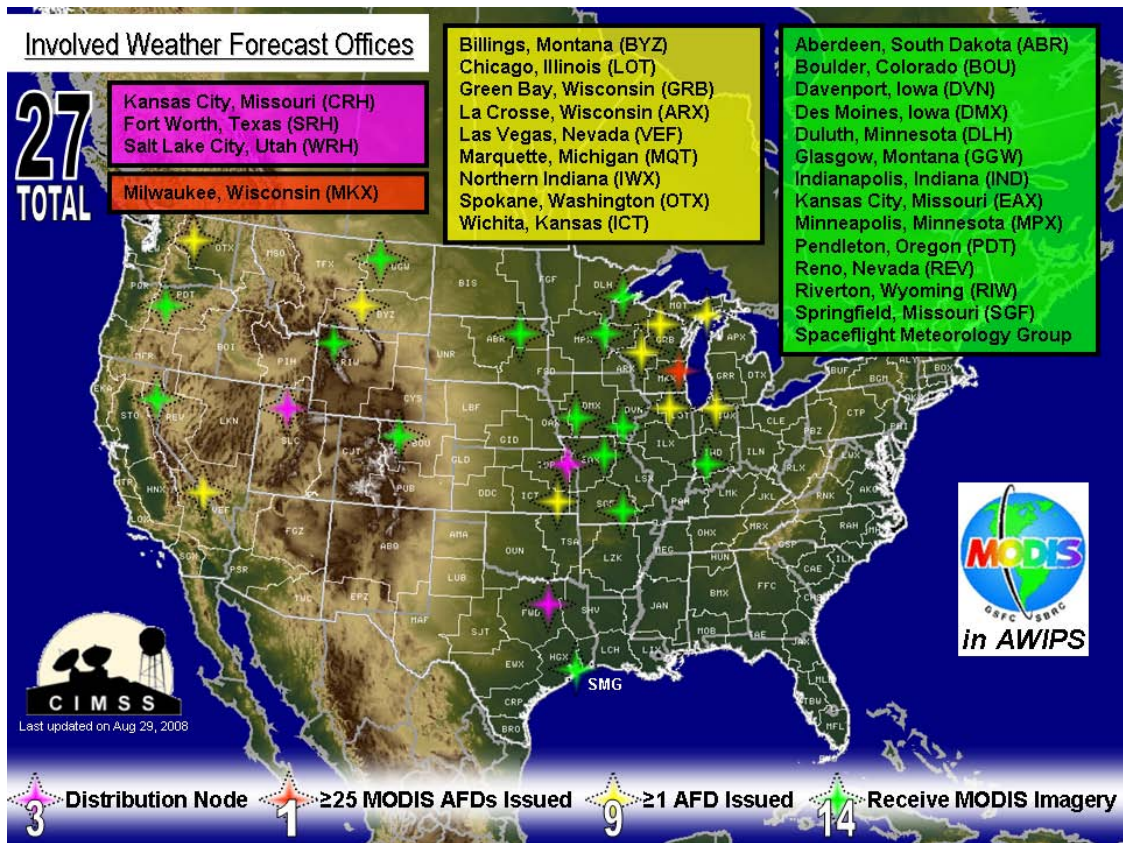
Figure 3.4.2: NWS sites that are now receiving MODIS data from UW direct broadcast.

Validation has been done to confirm that the MODIS products in AWIPS are useful to NWS forecasters. Online surveys with questions regarding the utility of MODIS products were given to four NWS offices (KMKE, KRIW, KARX and KDVN), with 20 forecasters participating. 75% of the respondents rated the products as either very useful or useful, with only 10% rating them as not useful. MODIS Sea Surface Temperature (SST) and Total Precipitable Water Vapor parameters were considered to be the most useful IMAPP products. But perhaps the best indication that the products are useful, is that they have been mentioned by NWS forecasters a total of 69 times in their Area Forecast Discussions (AFDs). These text write-ups describe the reasons behind the forecast decisions that are made. An example of a recent AFD that mentions the MODIS IMAPP SST product is displayed below:

```
000
FXUS63 KMKX 162001
AFDMKX

AREA FORECAST DISCUSSION
NATIONAL WEATHER SERVICE MILWAUKEE/SULLIVAN WI
300 PM CDT THU OCT 16 2008

.SHORT TERM...TNGT THROUGH SUNDAY.
FOCUS ON THREAT OF LIGHT PRECIPITATION FRIDAY INTO FRIDAY EVENING
AND AGAIN ON SUNDAY.  EXPECT TEMPERATURES TO DROP OFF RAPIDLY LATE
THIS AFTERNOON THROUGH THE EVENING AS WINDS DECOUPLE IN LOWEST FEW
HUNDRED FEET.  LATEST MODIS IMAGERY INDICATING SEA SURFACE
TEMPERATURES GENERALLY IN THE UPPER 50S WITH A FEW AREAS OF LOWER
50S OFF THE SHEBOYGAN COUNTY COASTLINE.  EXPECT LIGHT WINDS TO
REMAIN ONSHORE THROUGH THE NIGHT...TEMPERING OVERNIGHT LOWS.
HOWEVER WITH WINDS DECOUPLING WL LIKELY SEE KSBM AND KENW AND OTHER
LOW AREAS DROP 3 TO 6 DEGREES BELOW COLDEST GUIDANCE.  NOT EXPECTING
MID/HIGH LEVEL CLOUDINESS TO PUSH INTO WESTERN AREAS UNTIL AFTER
MIDNIGHT ALLOWING TEMPERATURES TO LEVEL OFF.  CLOUDS WILL HOLD OFF
UNTIL LATE IN THE EAST SO NON-DIURNAL TREND MINIMAL.
```

In this case, the forecaster (Hentz) is using the MODIS SST product to help forecast low temperatures near the Lake Michigan coastline with light onshore winds.

3.5 Release of DBCRAS NWP globally configurable model that utilizes MODIS IMAPP products in the assimilation

On December 3, 2008 UW released the International MODIS/AIRS Processing Package (IMAPP) Direct Broadcast CIMSS Regional Assimilation System (DBCRAS) software package. This version of the CRAS has been modified to use Aqua and Terra IMAPP MODIS mod07.hdf (atmospheric profiles) and mod06ct.hdf (cloud top properties) products to improve the depiction of clouds and moisture in the Global Forecast System (GFS) grid fields. The CRAS model is now used by some US National Weather Service forecasters in AWIPS.

Example forecast field animations from selected global locations can be viewed from this site: ftp://ftp.ssec.wisc.edu/pub/kathys/DBCRAS_examples/

This unique software is expected to assist sites globally who may not have access to NWP; especially NWP that is centered on their region of interest. In addition, the improved cloud and moisture physics in the model itself, and the improvements gained through the assimilation of IMAPP MODIS products, have been shown to result in realistic forecasts of satellite imagery. An example of a single output product image from the UW real-time DBCRAS web site, http://cimss.ssec.wisc.edu/~kathys/dbcras/, is shown in Figure 3.5.1. This image was generated automatically using the McIDAS-X binaries that are included as part of the IMAPP DBCRAS software package release.
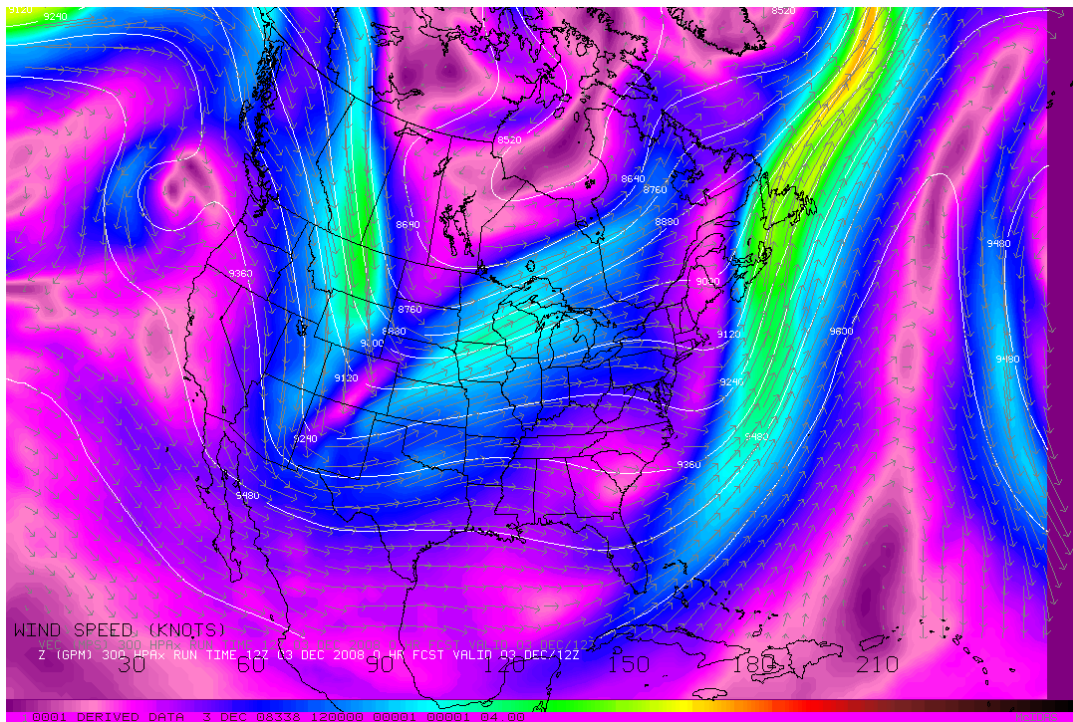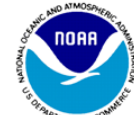
Figure 3.5.1: DB CRAS 300 hPa forecast of winds and heights from the 12 UTC 3 December 2008 model run centered on the UW X-band antenna site.

Figure 3.5.2: DBCRAS has been routinely producing real-time regional forecasts in 6 real-time sites and has been tested in 8 test sites around the world. *DBCRAS is MODIS retrieval ready and can be configured any where in the world.*

4. IPOPP

4.1 IPOPP DESCRIPTION

The international Polar Orbiter Processing Package (IPOPP) is a software package that will enable the direct broadcast (DB) user community and other meteorological users to smoothly transition from EOS to NPOESS. IPOPP is to US government sanctioned algorithms to enable the world wide community to process, visualize, and evaluate NPOESS Sensor and Environmental Data Records (starting with MODIS and NPP missions).

4.2 IPOPP PURPOSE and SCOPE

IPOPP is to facilitate the international direct broadcast community's continuous involvement in algorithm development for NPP/NPOESS:

- By providing mission continuity from EOS to NPOESS.
- By participating in NPP calibration/validation activities.
- By enabling regional application development.

IPOPP also provides software to generate Environmental Data Records (Level 2) in near real-time from direct broadcast of EOS to NPOESS High Rate Data and NPOESS Low Rate Data. It's characteristics are:

- Open source (GPL)
- Freely available (no COTS licenses required)
- Easy to install & run
- Multi-platform (e.g., Linux, Solaris, OS X), Linux initial OS
- Data formats - HDF 4 EOS (MODIS), HDF5 (NPP and NPOESS)
- Self-contained, modular
- Uses consistent and up-to-date calibration look-up tables
- Leverages legacy software development lessons learned (from IMAPP)
- Build on NPP In-Situ Ground Station (NISGS) foundation

IPOPP contains software to process and generate products from sensors of:

- VIIRS,
- OMPS,
- CrIS and
- ATMS

Figure 4.1 describes the overall responsibility and partnership among IPO/NOAA, DRL/NASA and CIMSS UW-Madison. In addition to sensor processing algorithms, the utility programs required for conducting calibration, validation, analysis and visualization will also be developed. The education and training components of IPOPP (under Supports and Services) will also be the highlight of this program.
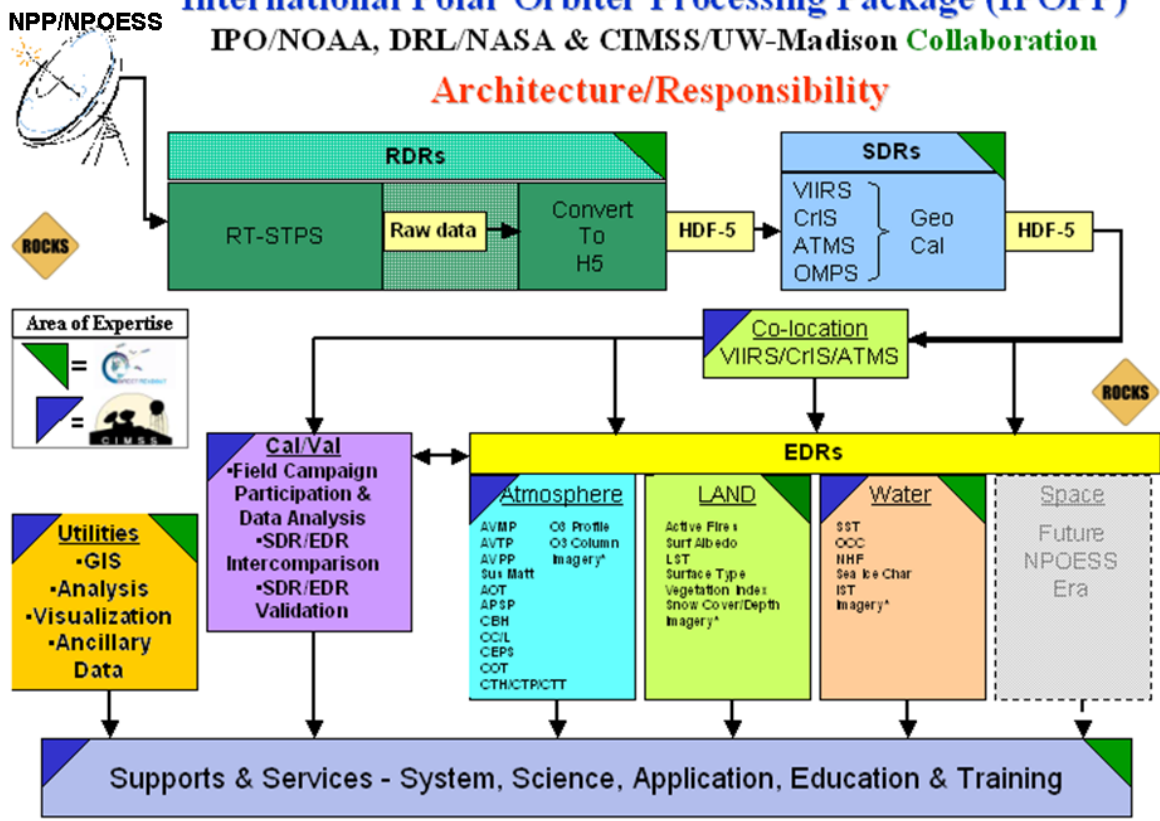
Figure 4.1: Architecture and responsibility of International Polar Orbiter Processing Package (IPOPP) – a partnership among IPO/NOAA, DRL/NASA and SSEC/UW-Madison.

5.   SUMMARY

This report is written in response to CGMS recommendation that the community software packages (i.e. AAPP, IAPP, IMAPP) have been essential in the use of AVHRR, ATOVS, IASI, AIRS and MODIS data by the meteorological community.

The group encouraged satellite agencies to continue to support these packages for existing missions and to develop and release processing software packages (e.g. IPOPP) as soon as practicable before the launch of all the future missions.