

Progress Report for NASA Grant NNX08AG88G
Reporting Period: 1/28/2008 to 1/27/2011

**International MODIS/AIRS Processing Package (IMAPP) Maintenance, Support
and Multisensor Product Development for Terra and Aqua Direct Broadcast Users**

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Final Report for NASA Grant NNX08AG88G
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Introduction

Data acquired from NASA's Earth Observing spacecraft, Terra and Aqua, via direct broadcast, continues to support a wide range of environmental monitoring and research applications. To date, more than 200 ground stations have been installed worldwide for the purpose of receiving direct broadcast data in real-time from these spacecraft. The resulting images and geophysical products are providing immediate information to government, education, defense, and private sector concerns in the United States and around the world.

The International MODIS/AIRS Processing Package (IMAPP) is a collection of software which allows 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 and geolocated radiances), and to a selection of Level 2 products (geophysical products). Supported instruments include MODIS, AIRS, AMSU, HSB, and AMSR-E.

Throughout the reporting period IMAPP has continued to build upon the successes of the past few years by not only continuing the delivery of real-time satellite data products to an expanded number of users, but by also making milestone releases of new and improved AIRS single FOV retrievals, MODIS and AIRS collocation, a virtual appliance that allow user to install and run IMAPP (with an installation time of just 10 minutes) under Windows, Linux, and Apple OS X operating systems, and the MODIS DB birectional reflectance distribution function. Starting with the launch of the new IMAPP web site in 2007 through January 2011, IMAPP has recorded more than 900 registered users from 63 countries and supporting 11 real-time government and academic institutes, and has provided more than 50 NWS offices real-time MODIS images and products. IMAPP team members have conducted 8 DB training workshops on 5 continents and are continuing efforts to update and support a real-time DB Data Assimilation System (DBCRAS) as well as developing an air quality forecast system for public release. The profound impact of NASA supported IMAPP and its expanded direct broadcast activities have consistently merited its continued support to facilitate EOS DB users to continue exploring new products and applications in preparation for NPP and JPSS.

Highlights in the Last Year

The highlights, listed briefly below, demonstrate that the IMAPP team has successfully carried out the planned tasks and moreover, significant accomplishments beyond those proposed.

- 1. December 7, 2009** ([DB Google Earth Software Package Version 1.2 Release](#)). Update to the software package that creates 250m true color imagery from direct broadcast or NASA DAAC MODIS data that is compatible with the Google Earth geobrowser.
- 2. December 16, 2009** ([AIRS/MODIS Collocation, AIRS Cloud Mask and Single FOV Retrieval Package v1.1 Release](#)). Update to the University of Wisconsin-Madison software utilities package for AIRS and MODIS that creates a collocated MODIS/AIRS file, performs an AIRS cloud mask using the MODIS cloud mask, and produces single-pixel AIRS retrievals of temperature, moisture, ozone and surface emissivity under all sky conditions.
- 3. May 17, 2010** ([IMAPP Virtual Appliance Version 1.0 Release](#)). First release of a stand-alone processing system for MODIS, AIRS and AMSR-E data that can be installed for all major small computer operating systems.
- 4. June 21, 2010** ([MODIS Direct Broadcast Bidirectional Reflectance Distribution Function v1.0 Release](#)). First release of a software package that takes MODIS L1B geolocation (MOD03) and L2 surface reflectance (MOD09_L2) files as input, and creates gridded L2G surface reflectance and nadir Bidirectional Reflectance Distribution Function (BRDF)-Adjusted Reflectances as output.
- 5. August 24, 2010** ([AIRS L1B HDFEOS to BUFR Software Utility v1.2 Release](#)). Update to the software utility package (written by Nigel Atkinson of the UK Met. Office) that converts standard HDFEOS AIRS L1B radiances into BUFR format. This update allows the user to include AMSU sensor brightness temperatures in the AIRS BUFR output file.
- 6.** UW IMAPP team members have collectively presented more than 22 lectures and presentations about IMAPP, its related products, applications and processing system.
- 7.** In addition to the above, IMAPP has also been implemented as part of the end-to-end Terra/Aqua data acquisition, processing and application turn-key system. Such a system has been installed and, within 24 hours, was producing real-time MODIS, AIRS, AMSR-E products and, additionally, MODIS cloud, precipitable water and aerosol products were assimilated into the regional short term forecast weather and air quality model.

A.1 MODIS Activities

UW continues to foster and facilitate the use of EOS Aqua and Terra Satellites for a variety of global applications by providing utilitarian software where high resolution, high quality and timeliness of data are vital. The main efforts of this work focused on supporting an increase in the use of the IMAPP software globally, growing the use of the IMAPP products by the US National Weather Service, release of a cross-platform stand alone Terra and Aqua processing system, first release of an MODIS Land Tiled modeled reflectance product (BRDF), updates to a previous package for creating 250 m resolution true color image compatible with Google Earth, an improvement to our local MODIS reprojection tool, and a completed and installed prototype Air Quality Forecasting software package.

a) Support an ever increasing global user base

The global use of IMAPP software continues to increase. The UW continues to support the DB user community with software and real time distribution of data and products generated from our own local direct broadcast antenna. The IMAPP download page now has over 900 registrants from around the world; an increase of 300 in the last year alone, representing 63 different countries, which is more than 30% of the world total. Table 1 displays a list of countries with at least one registered IMAPP user.

Table 1: List of countries of registrants from the International MODIS/AIRS Processing Package (IMAPP) (63 total) download page.

Italy	Mexico
Argentina	Hungary
Brazil	Belgium
Kazakhstan	Norway
Ukraine	Venezuela
Indonesia	Sri Lanka
China	France
Denmark	Russia
South Africa	Vietnam
Taiwan	Mongolia
Japan	Turkey
Morocco	South Korea
Iran	United Arab Emirates
Singapore	Lithuania
India	United States
Germany	Thailand
United Kingdom	Romania
Australia	Malaysia
Czech Republic	Algeria
Canada	Reunion
Spain	Austria

Chile	Finland
Pakistan	Czech Republic
Nepal	New Zealand
Portugal	Guatemala
Poland	Uruguay
Saudi Arabia	Israel
El Salvador	Azerbaijan
Colômbia	Cuba
Serbia	Kuwait
Kenya	Syria
Oman	

Figure 1 provides a graphical portrait of the global IMAPP community. Any user who downloaded at least one IMAPP software package was included in the image. The reach of IMAPP includes such obscure regions as French Polynesia, Reunion Island and McMurdo, Antarctica.

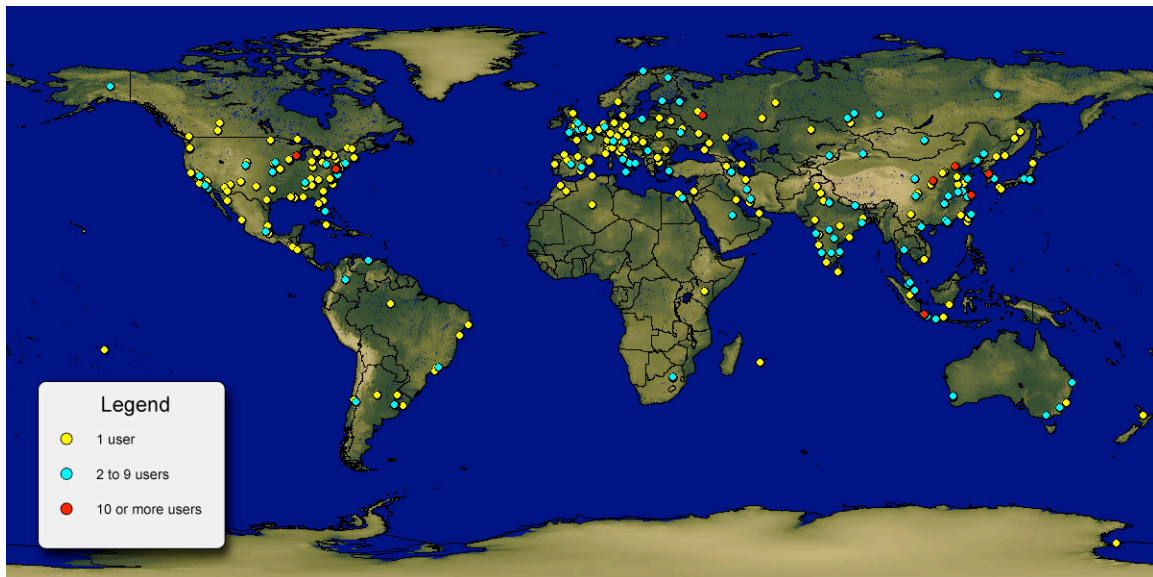


Figure 1. Graphical display of the IMAPP user community. This map includes all users who downloaded at least one IMAPP software package since the launch of the new IMAPP web page in 2007.

Global expansion and use of the Aqua and Terra direct broadcast data are a direct result of the high quality of the data coupled with the free distribution of the software. A couple of examples of global data users follows.

An antenna system in Budapest, Hungary, partially operated by the Meteorological Department at [Eötvös Loránd University](http://www.ott.vinc.hu), is supported by IMAPP software. The relationship between the Meteorological Department and UW Madison SSEC began when a Hungarian graduate student, Aniko Kern, attended a 2007 Remote Sensing Workshop partially funded by IMAPP in the Italian city of Benevento. Since that time, we have worked together to publish a paper validating the IMAPP atmospheric water

vapor retrievals (Aniko Kern, Judit Bartholy, Eva E. Borbas, Zoltan Barcza, Rita Pongracz, Csaba Ferencz, Estimation of vertically integrated water vapor in Hungary using MODIS imagery, *Advances in Space Research*, Volume 41, Issue 11, 2008, Pages 1933-1945, ISSN 0273-1177, DOI: 10.1016/j.asr.2007.06.048) as well as receiving help from Ms. Kern in evaluating beta versions of the IMAPP software. This relationship has been invaluable to us by providing suggestions and feedback which improves the final versions of the products to the whole user community. Since the Hungarian University has limited funds to process and use the data, IMAPP provides a way for the Department to produce quality products with limited resources.

An example of the Bidirectional Reflectance Distribution Function (BRDF) true color image produced using IMAPP software from data acquired in real time in Hungary, is displayed in Figure 2.

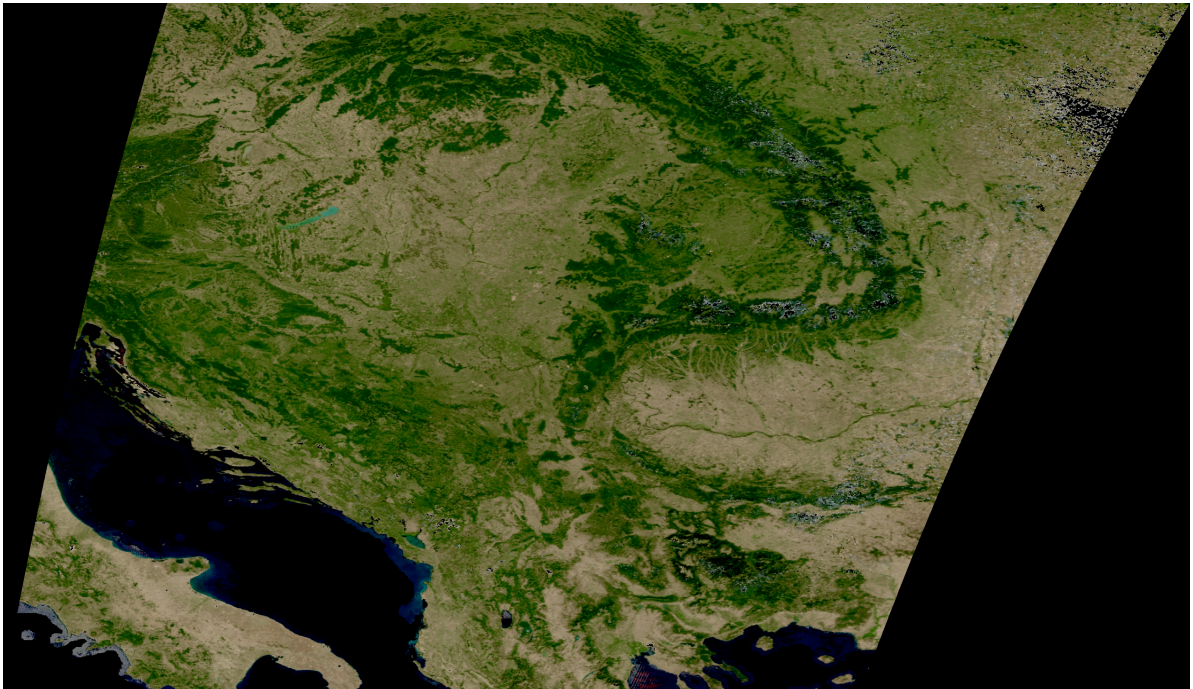


Figure 2. BRDF true color composite of 3 days of data acquired and processed using IMAPP software from the X-band antenna located at [Eötvös Loránd University](#) in Budapest Hungary. The data was collected in July of 2007.

The Instituto Nacional de Pesquisas Espaciais/Centro de Previsão de Tempo e Estudos Climáticos (INPE/CPTEC), the Brazilian Space Agency Center for Weather and Climate Prediction uses IMAPP retrievals extensively for weather forecasting and data assimilation. Dr. Simone Costa, of CPTEC, compared and validated the IMAPP AIRS Level 2 product with IASI during a stint as a visiting scientist at the UK MET office in 2010. Her results were published in a EUMETSAT NWP SAF Visiting Scientist mission report, titled “Comparison of CPTEC AIRS L2: intercomparison and validation with Met Office IASI L2 intercomparison and validation”.

Her results point to the AIRS IMAPP Level 2 retrievals showing better vertical temperature profile structure when compared to radiosondes, than the UK MET Office AIRS 1D-var technique for the limited number of cases that were included in the study. The AIRS 1D-Var technique tended to provide more structure in the moisture profile. Figure 3 is a copy of one of the figures in the UK MET Office report.

Figure 1 – Temperature vertical profiles from IMAPP (AIRS) and radiosonde.

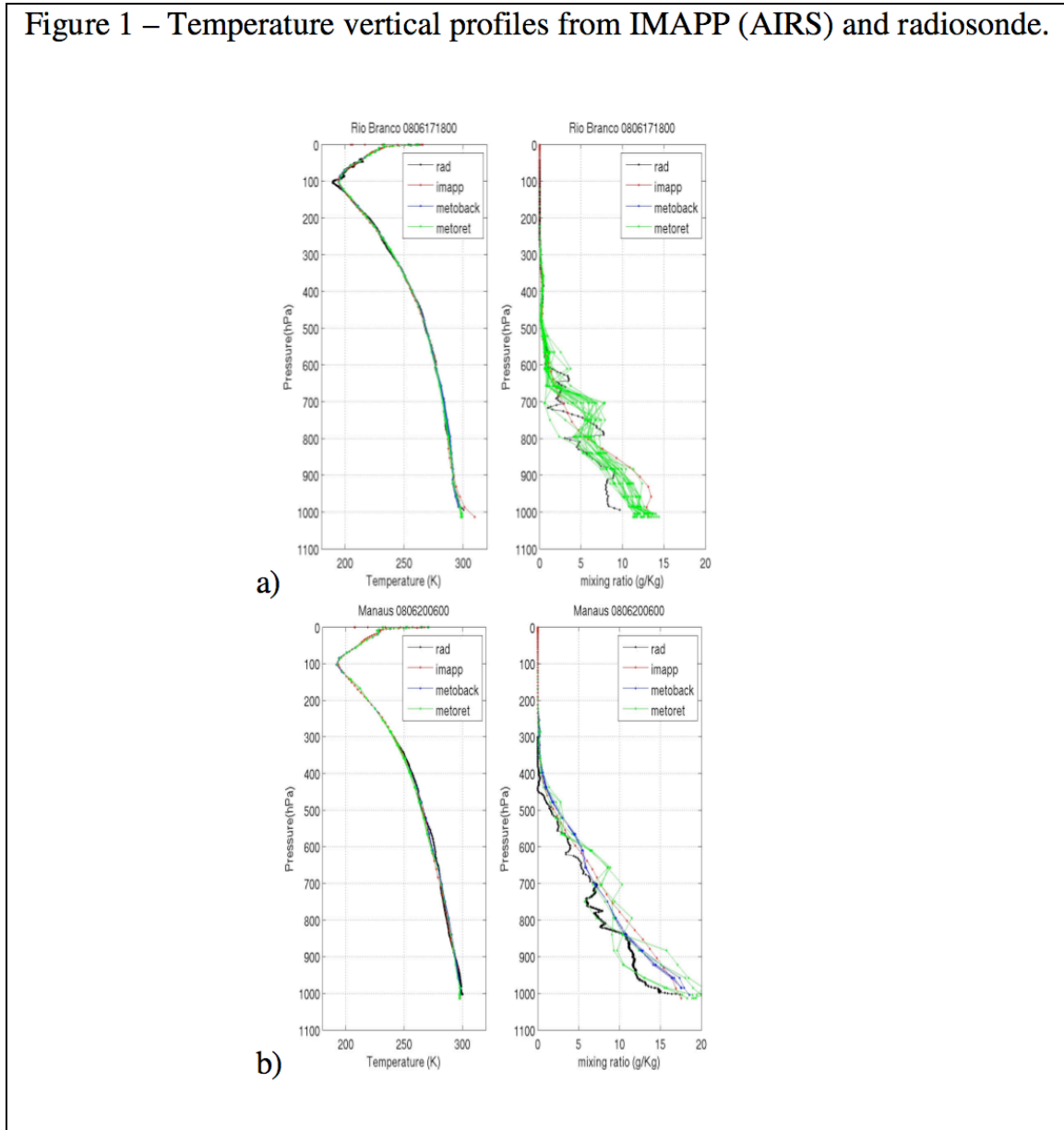


Figure 3. Copy of Figure 1 from the EUMETSAT NWP SAF Visiting Scientist mission report number NWPSAF-MO-VS-041, which shows a comparison between two temperature and moisture retrievals from radiosondes, IMAPP AIRS Level 2, and AIRS UK MET Office 1D-var retrievals.

Other groups using the MODIS data for scientific evaluation include researchers from the KN Toosi University of Technology, Tehran, Iran who were attempting to improve the

local retrievals of the MODIS Atmospheric Profiles Product (MOD07) in IMAPP by using local radiosonde mean values and local land surface temperatures. Another group consisting of two groups of researchers from two Universities in Spain, developed an improved cloud classification scheme from locally received MODIS Terra and AIRS Aqua IMAPP data combined with Meteosat Second Generation (MSG) geostationary satellite data.

b) Support of the National Weather Service Forecasters

Use of the IMAPP MODIS products generated from our DB antenna data and distributed to the National Weather Service (NWS) field offices continues to increase. The total number of Forecast Offices that are supported has now reached 46, including the 4 US regional offices of Bohemia, New York (East Region Headquarters), Kansas City, Missouri (Central Region Headquarters), Fort Worth, Texas (Southern Region Headquarters) and Salt Lake City, Utah (Western Region Headquarters). Figure 4 shows the current distribution of supported forecast offices, and the office names. The gap in the Southeastern United States are offices that are supported by the NASA Short-term Prediction Research and Transition Center (SPoRT); however the MODIS data and products they supply are from SSEC antenna data and include some IMAPP products.

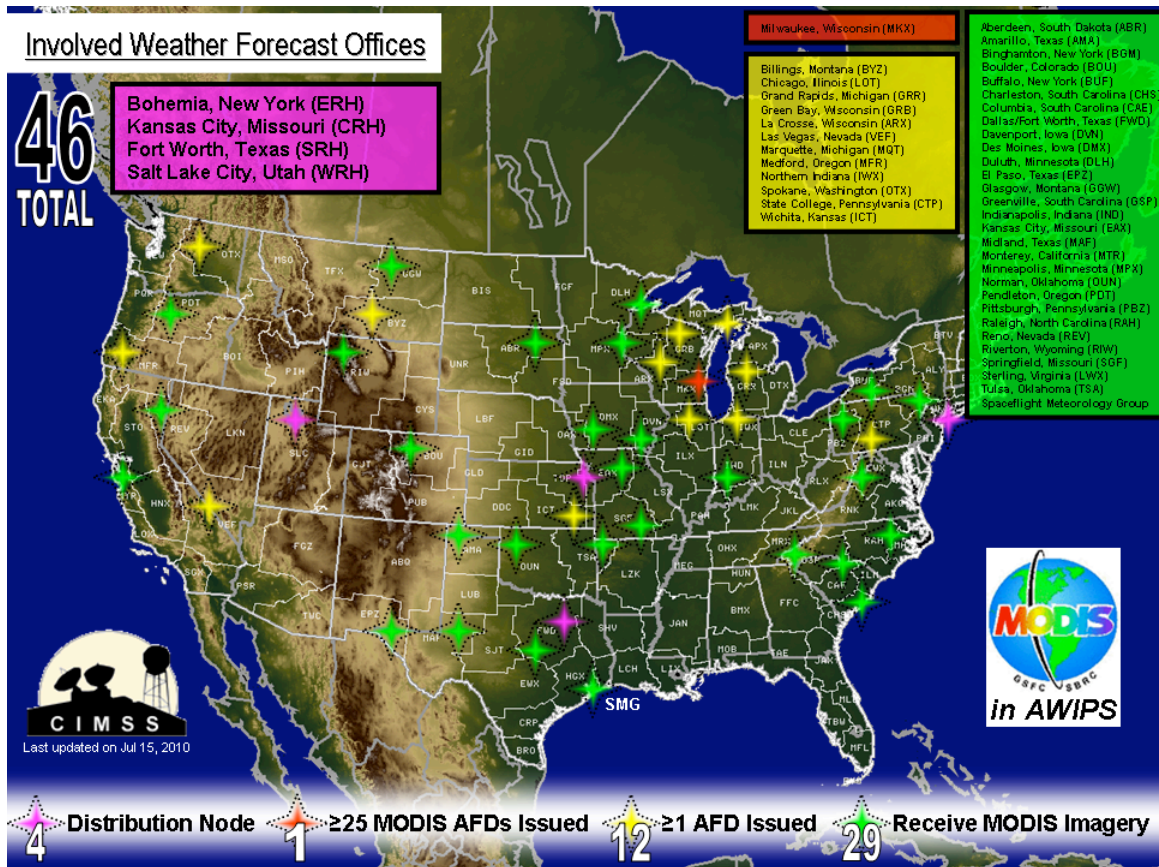


Figure 4. Graphical distribution of NWS offices that receive MODIS IMAPP products distributed by the UW from DB data acquired and processed in real time at SSEC.

We continue to ensure that these products are useful as decision making tools for the NWS. Scott Bachmeier, of SSEC, created and has provided the Virtual Institute for Satellite Integration Training (VISIT) teletraining lesson "MODIS products in AWIPS" for NWS forecasters since 2006. In addition, we continue to track the number of times the MODIS products are mentioned as a decision making tool in the forecaster Area Forecast Discussions (AFDs). Figure 5 is a chart showing the steady increase in the number of times MODIS products have been referenced in the AFD's. The total number since we began supplying the data now stands at 192. A couple of recent examples follows:

**AREA FORECAST DISCUSSION
NATIONAL WEATHER SERVICE RALEIGH NC
735 PM EDT FRI OCT 22 2010**

.SYNOPSIS...

COOL HIGH PRESSURE WILL BUILD DIRECTLY OVER NORTH CAROLINA TONIGHT...THEN SHIFT OFFSHORE AND RESULT IN A WARMER SOUTHWESTERLY FLOW SATURDAY INTO NEXT WEEK.

...

.AVIATION /00Z SATURDAY THROUGH WEDNESDAY/...
AS OF 735 PM FRIDAY...

VFR CONDITIONS THROUGH THE 24 HR PERIOD. HIGH PRESSURE TO THE WEST WILL SLIDE OVERHEAD TONIGHT LEADING TO CLEAR SKIES AND NEAR CALM WINDS. WITH NORTHWESTERLY FLOW ALOFT.... **A FEW RIPPLES IN WATER VAPOR IMAGERY FROM A MODIS SATELLITE PASS SUGGESTS SOME LIGHT CLEAR AIR TURBULENCE POSSIBLE...BUT OTHERWISE GOOD AVIATION WEATHER IN STORE.** AS THE HIGH MOVES FURTHER EAST ON SATURDAY...LIGHT SOUTHWESTERLY WINDS WILL DEVELOP...BUT SKIES WILL REMAIN CLEAR.

**AREA FORECAST DISCUSSION
NATIONAL WEATHER SERVICE MILWAUKEE/SULLIVAN WI
307 PM CDT TUE OCT 12 2010**

.SHORT TERM...

TONIGHT...FORECAST CONFIDENCE MEDIUM.

...

SATURDAY THROUGH SUNDAY...FORECAST CONFIDENCE MEDIUM.

UPPER LEVEL FLOW WILL THEN TRANSITION TO A MORE ZONAL PATTERN FOR THE WEEKEND INTO NEXT WEEK. WARM AIR ADVECTION WITH THE SOUTHERLY RETURN FLOW AROUND THE HIGH WILL BRING 850MB TEMPS OF 11 TO 13C INTO FAR SOUTHERN WI BY SAT AFTERNOON. TEMPS

SHOULD RISE INTO THE UPPER 60S/LOW 70S. A WEAK TROUGH EXTENDING FROM A SFC AND UPPER LOW NEAR HUDSON BAY WILL CROSS WI SAT NIGHT...AND THEN NORTH TO NORTHEAST WINDS WILL BRING COOLER AIR TO THE CWA ON SUN AS SFC HIGH PRESSURE SCOOTs ACROSS NORTHERN MN AND LAKE SUPERIOR. 850MB TEMPS WILL MODERATE TO THE 8 TO 10C RANGE ON SUN...AND HIGH TEMPS SHOULD THEN BE IN THE LOWER 60S.

MODIS SHOWED LAKE TEMPS IN THE UPPER 50S TO AROUND 60 TODAY. IF THESE TEMPS PERSIST THROUGH THE WEEKEND AND MAX TEMPS ARE EXPECTED AROUND 60 NEAR THE LAKE...THEN LAKE CLOUDS SHOULD NOT BE A CONCERN WITH THE EASTERLY WINDS OFF THE LAKE.

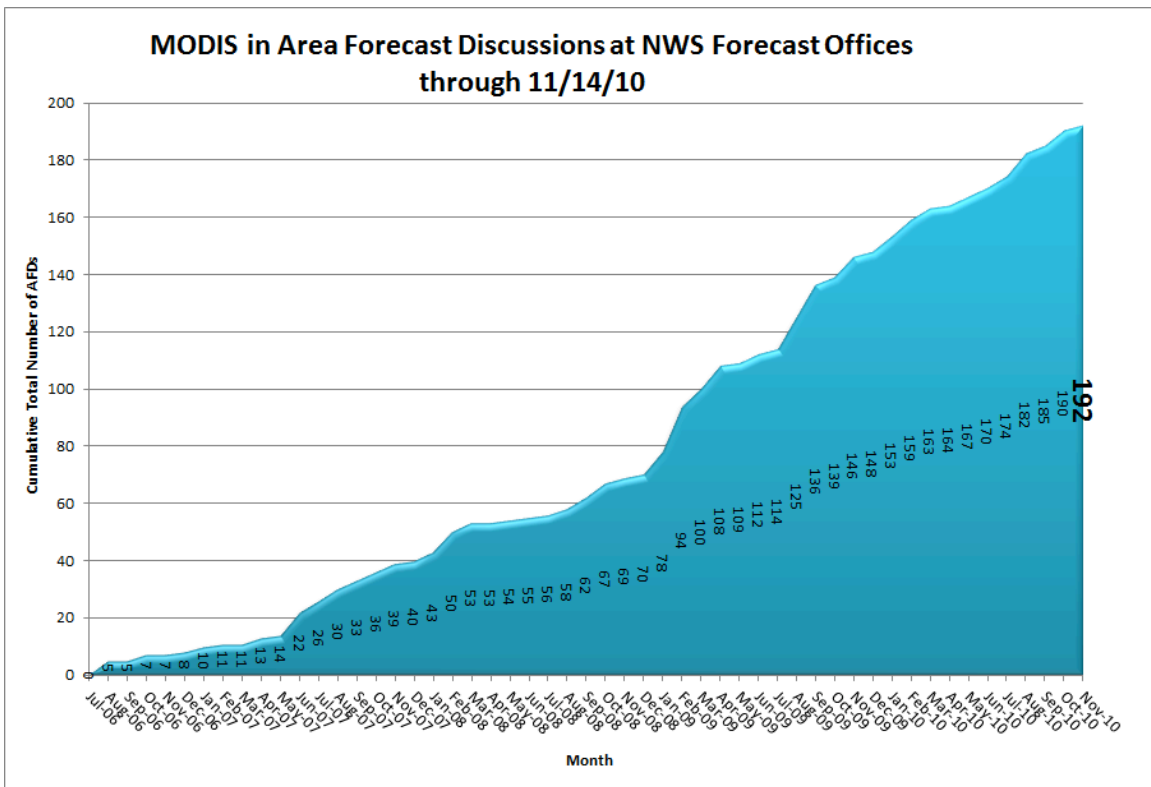


Figure 5. Chart showing the progression in the use of MODIS IMAPP products by NWS forecasters, as quantified by the number of times MODIS products appear in the forecast Area Forecast Discussions as a decision making tool. The total now stands at 192 since the inception of the distribution in 2006.

The effort to support MODIS data and IMAPP products in AWIPS is being partially funded by the GOES proving ground as a way to prepare the forecasters for the spectral bands and data resolutions that they will see with the future GOES Advanced Baseline Imager scheduled to be launched in December 2015.

c) Release of a stand alone Aqua and Terra Processing System

Liam Gumley provided the DB user community with a stand alone, multi-platform processing system for Aqua and Terra called the IMAPP Virtual Appliance, which was released in May, 2010. It is a system for processing DB MODIS, AIRS and AMSR-E data implemented in the form of a VMware virtual machine that is easy to install and run on platforms including:

- Microsoft Windows (XP, Vista, 7)
- Intel Linux
- Apple OS X

The system makes it easier for users to process Aqua and Terra data using all of the free DB software packages that currently exist. The features of the Virtual Appliance include:

- Can be installed, configured, and be ready to start processing data within 10 minutes of completing download.
- Designed to be easy to modify, maintain, and upgrade.
- Features the latest versions of all available Terra and Aqua DB processing packages including MODISL1DB v1.6, IMAPP MODIS v2.1, and SeaDAS 6.1. It is preconfigured with MODIS Level 1 and IMAPP Atmosphere software installed and ready to run.
- Other DB processing packages can be added (or removed) by editing one configuration file, and then running an installer script.
- Highly reliable and fault tolerant, and is fast and efficient on modest computer hardware.
- Supports automated ingest and processing of Level-0 PDS files from a local directory or a remote anonymous FTP site.
- Implemented entirely in bash scripts (<2200 lines). All bash scripts are extensively commented, and are designed to make it easy to add your own local DB processing software.
- Based on 10 years of experience with three generations of Terra and Aqua processing systems at SSEC, where more than 25,000 Terra and Aqua passes have been acquired and processed in real time.
- Uses only freely available software, and is licensed under the terms of the GNU GPL.

The supported products and processing software are:

MODIS Level 1B Products (created by MODISL1DB from the NASA Ocean Biology Processing Group)

- Level 0 quicklook images (visible and infrared, in sensor projection) in JPEG format
- Level 1B 1KM, HKM, and QKM radiances and Geolocation

- Destriping corrections for MODIS Level 1B 1KM radiances

MODIS Atmosphere Level 2 Products (created by IMAPP from the University of Wisconsin-Madison)

- Cloud Mask
- Cloud Top Pressure
- Cloud Optical Depth and Effective Radius
- Aerosol Optical Depth
- Temperature and Water Vapor Profiles
- Total Column Precipitable Water Vapor (Infrared, Day/Night)
- Total Column Ozone
- Total Column Precipitable Water Vapor (Near-Infrared, Day only)
- Level 2 browse images for all Atmosphere Products

MODIS Land Products (created by Land Algorithms from the NASA Direct Readout Laboratory)

- Corrected Reflectance 1KM, HKM, QKM
- Fire Detection
- Land Surface Temperature (LST)
- Normalized Difference Vegetation Index (NDVI)
- Enhanced Vegetation Index (EVI)
- Land Surface Reflectance

MODIS Ocean Products (created by SeaDAS from the NASA Ocean Biology Processing Group)

- Chlorophyll-A Concentration
- Sea Surface Temperature (SST)

MODIS Images (created by HDFLook from Univ. of Lille) in GeoTIFF and JPEG format

- Level 1B browse images (visible, infrared, true color)
- Level 2 Land browse images (NDVI, LST)
- MODIS Level 2 Ocean browse images (Chlorophyll-A, SST)

MODIS Google Earth KML (created by DBGE from the Univ. of Wisconsin-Madison)

- 250 meter resolution true color JPEG images and KML

AIRS Level 1 and Level 2 (created by AIRS IMAPP from NASA JPL)

- Level 1B data (including AIRS IR, AIRS VIS, and AMSU)
- Level 2 retrievals of temperature and moisture

AMSR-E Level 1 and Level 2 (created by AMSR-E IMAPP from Univ. of Wisconsin-Madison)

- Geolocated and calibrated antenna temperatures
- Rain rate
- Soil moisture

- Snow water equivalence

The importance of this package to the DB community cannot be stressed enough. It allows “one stop shopping” for all of the free software packages, does not require external proprietary software, is configurable, includes browse image creation, and is supported for Windows, which represents a very large user base across the world.

The system was installed and working in a day in Shanghai, China, at East China Normal University (ECNU). Figure 6 is a example of some of the browse images that were created from the first day’s products generated at ECNU by the IMAPP VA.

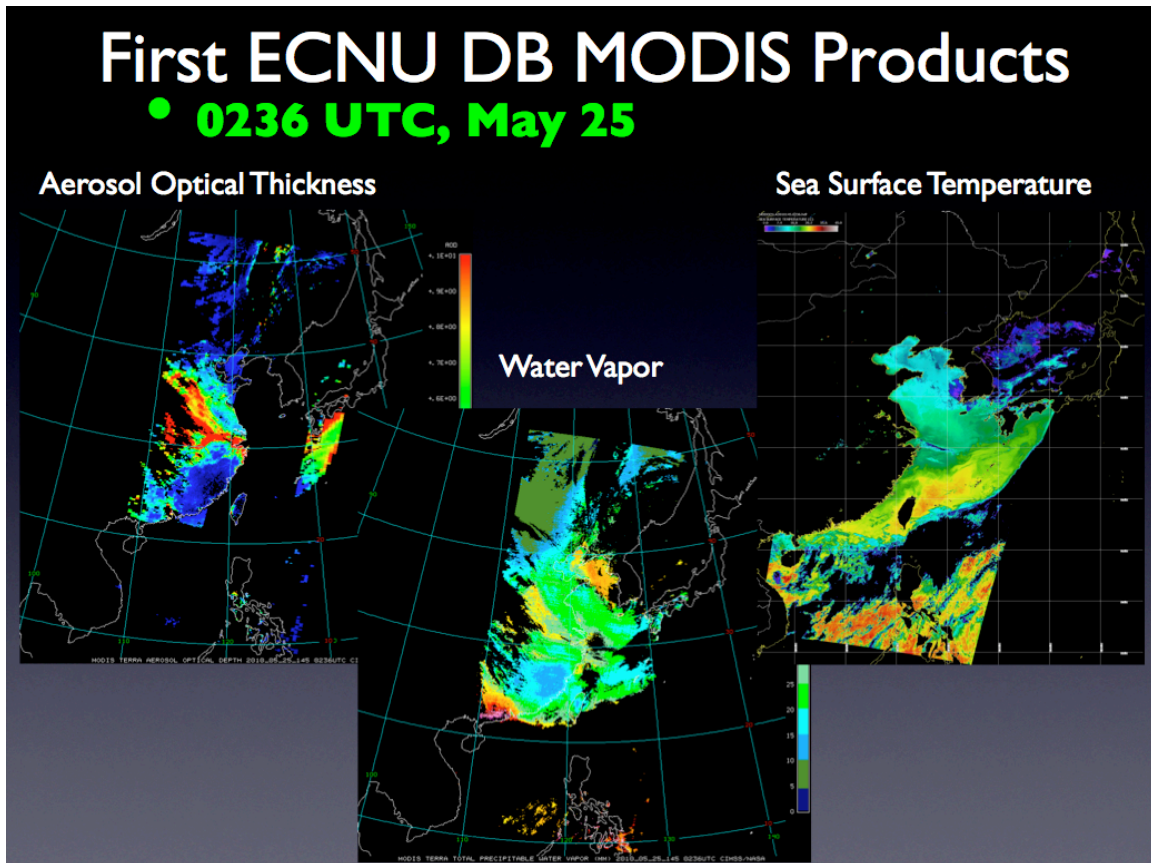


Figure 6. Browse images of MODIS products generated by the IMAPP VA installed at East China Normal University in Shanghai, China.

d) Release of a DB MODIS Bidirectional Reflectance Function Distribution (BRDF) Package

In cooperation with Boston University, UW released an IMAPP package that can generate multi-day Bidirectional Reflectance Function Distribution Function (BRDF) products (MOD43) from MODIS DB or MODIS LAADS archive data sets. The release took place on 21 June 2010. This release required significant coordination between Dr. Crystal Schaaf and Dr. Yanmin Shuai of Boston University and UW to ensure that the package worked properly for DB data. The packaging of the BRDF software was complicated by these factors:

- Output products are on the MODIS Land Team Sinusoidal Grid Tiles.
- Two step processing
 - Daily Aqua and Terra surface reflectance processing on an L2G grid for each tile.
 - Rolling 16 day composites of the daily L2G files to produce tiled BRDF HDF fields.

The resultant package is driven by a main perl script, which allows the user to choose to process all tiles covered by their DB data, or to choose a subset. The software also allows users to select the number of days they wish to composite (default is 16 days). It can operate on the unix cron scheduler to execute at the same time each day, and the package allows the user to choose to generate both a GeoTIFF as well as a .jpg image of the composited 1km BRDF true color image.

Since the MODIS BRDF feeds into all of the remainder of the MODIS land products, the release of this package opens the door for other MODIS land products to be included in the DB products suite. In addition, the high resolution true color images that can be generated from this product are stunning. Figure 7 is an example of a recent MODIS BRDF modeled reflectance true color image composite generated from our own antenna automatically using the IMAPP BRDF software package. The composite includes 20 different tiles.

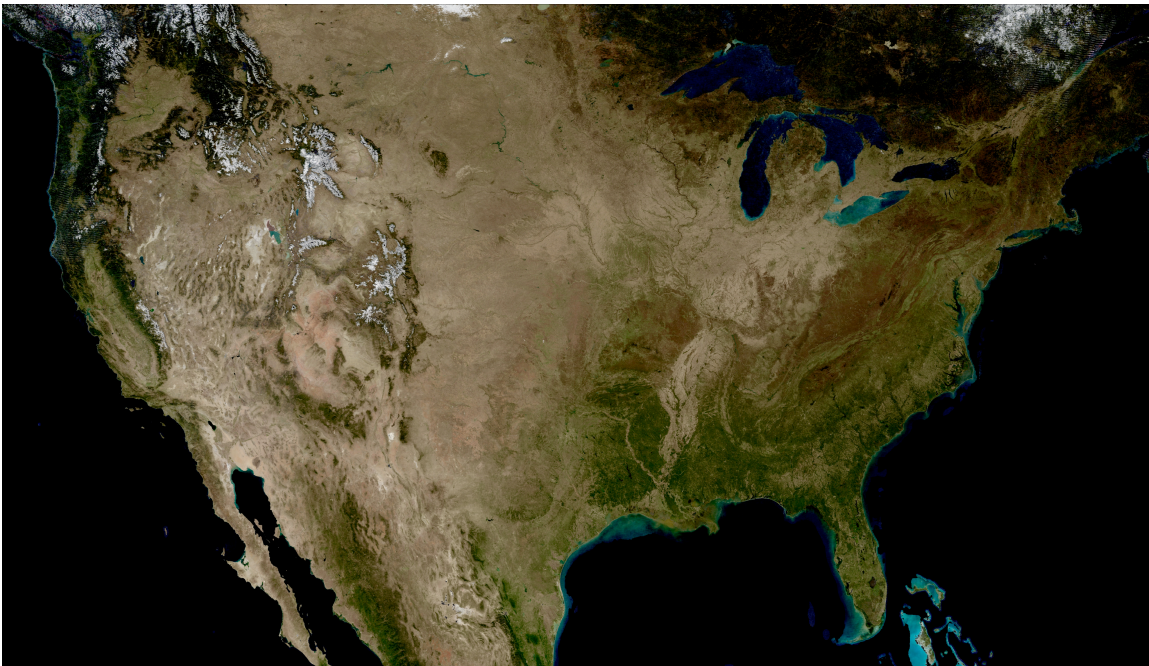


Figure 7. MODIS 1 km true color image generated using the IMAPP BRDF modeled reflectances collected for 16 days (28 October through 13 November 2010) from the Aqua and Terra DB antenna at SSEC.

e) Release of updated DB Google Earth (DBGE) Package

An update to the MODIS DBGE package that creates true color images and Keyhole Markup Language (KML) at 250 m resolution was released in December 2009. The software creates images and KML that can be displayed in the Google Earth Geobrowser, from DB or LAADS archive L1B MODIS files.

This package contains several changes to the original [DBGE version 1.1](#) that was released in January 2009. These changes include:

- IDL is no longer required to run DBGE. The freely available IDL clone "Fawltly Language" is now used by default to run the IDL portions of the DBGE package.
- KML files created by DBGE are now identified by satellite, date, and last update time when displayed in Google Earth (web server is required).
- The end user can add a logo image to be displayed in Google Earth (web server is required).
- Reduced the verbosity of log output from `process_granule.bash`. However, the user can enable verbose output by changing an environment variable in `dbge_env.bash` or `dbge_env.csh`.
- Increased the brightness of the MODIS true color images for better display of dark regions on monitors with a default gamma of 2.2.

f) Improved MODIS product reprojection tool

The local visualization tool used to reproject MODIS products for display in AWIPS was updated to improve the handling of the pixel overlap that occurs at the end portion of each earth scan. When products were originally displayed using Man-computer Interactive Data Access System (McIDAS) servers, some residual waviness in at the edge of the scans appeared due to the way this "bow tie" effect was handled in the software. The servers have all been updated now, to use the official MODIS Swath Reprojection Tool (MRT-Swath). The result of this are improved displays of the data for use by the National Weather Service Forecasters. Figure 8 depicts two side-by-side images of an IMAPP MODIS Sea Surface Temperature product. The left image is created using the original MODIS reprojection tool, the right is the new image created in McIDAS which uses the MRT-Swath utility. Note the improved level of detail that can be resolved in the image created with the new server.

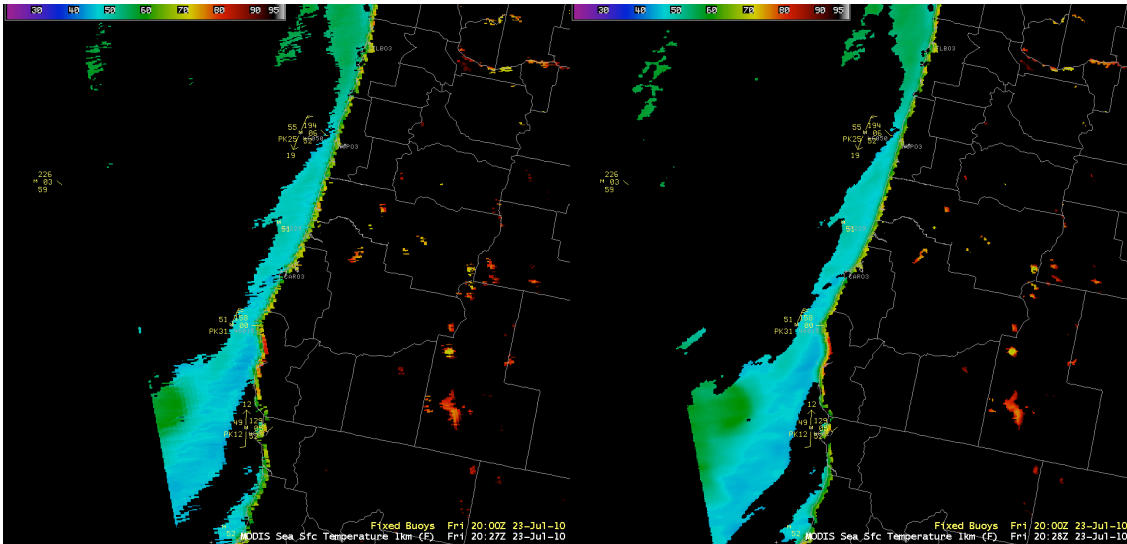


Figure 8. IMAPP MODIS Sea Surface Temperature (SST) images as displayed in AWIPS from 23 July 2010 covering the Northwest Coast of the United States. The left image was produced using the original McIDAS servers; the right side using the new server with improved handling of the scan overlap region.

g) Launch of the IMAPP Forum

UW launched the IMAPP Forum in June 2010 as a means to facilitate communications between the IMAPP user community and the software developers. Our goal is to encourage interaction between the members of the Terra/Aqua direct broadcast community in general, and IMAPP users in particular. The forum has been added to the Navigation Bar on the IMAPP web page, which leads to this page:

<https://forums.ssec.wisc.edu/viewforum.php?f=3>

The forum is a place where the IMAPP user community can:

- interact with the IMAPP team at SSEC
- interact with other IMAPP users
- report problems with IMAPP or other DB applications
- share tips, tricks, or advice on how to run IMAPP or other DB applications
- share examples of interesting images or products created at any DB site

There have been some good communication with users, including a emails exchanged concerning a problem with a new location for a leapsec file that is required to create MODIS L1B data.

h) Prototype Configurable Air Quality Forecasting Tool Completed

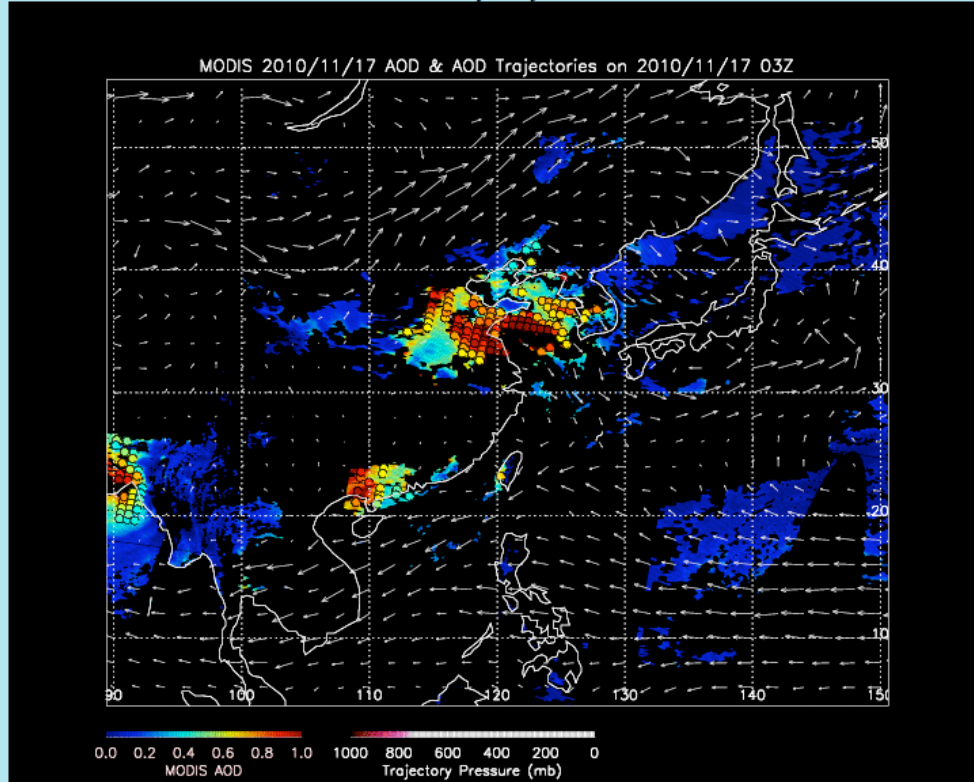
The first test version of the Infusing Satellite Data into Environmental Applications – International (IDEA-I) software applications package was installed at East China Normal University (ECNU). This package uses the IMAPP MODIS Terra Aerosol Optical Depth

(AOD) product (part of MOD04) to define regions of high aerosol loading. Any pixel in the daily Terra passes where the AOD is observed to be greater than 0.4, a trajectory is initialized and a 48 hour trajectory forecast is created showing the progression in the locations and height of the aerosols in the user domain. The domain is configurable in that the user defines the center point and the extent of the area covered.

The original IDEA project was started in the US as a partnership between NASA, NOAA and the EPA to improve air quality assessment, management and prediction by infusing NASA satellite measurements into analyses for public benefit. The original trajectory software was created by a team of NASA Langley Scientists, lead by Dr. Bradley Pierce. The operational test phase of IDEA was moved to UW because of how quickly we could produce the data from our DB antenna, and because of the CONUS coverage that we could provide. The operational test phase was extremely successful, and eventually transferred to NOAA operations. The success of the project led to the desire to make the software portable and available to the global direct broadcast community in the form of a package called IDEA-I.

The objective of IDEA-I is to develop an open source, portable version IDEA for use by the international air quality forecasting community. The concept was demonstrated for real-time aerosol forecasting conducted during the 2010 Shanghai World Exposition, and the Korea Meteorological Administration (KMA) Asian Dust Research Laboratory. It was converted into a stand alone package with the help of Dr. Pierce, who is now a NOAA employee working at the UW, and installed at ECNU. The package includes PHP that can be used by a web server to serve the data and display the trajectory forecasts as controllable animations through a simple web site. The entire package is expected to be released as part of IMAPP in the first quarter of 2011. Figure 9 is a screen capture of the front page of the ECNU IDEA-I real-time web site.

Forward Trajectory Forecast



[View Latest](#)

This web site is to be used for real-time aerosol air quality forecasting. The background basemap is the daily Terra MODIS Aerosol Optical Depth product (MOD04), which is used to initialize trajectories which show where the aerosol is expected to move in the next ~ 48 hours. The products are derived from MODIS data acquired and processed at East China Normal University in Shanghai, China.

The objective of IDEA-I is to develop an open source, portable version of Infusing satellite Data into Environmental air quality Applications (IDEA) [Al-Saadi, et al., 2005] a satellite based aerosol forecasting, visualization, and data synthesis tool for use by the international air quality forecasting community.

[More »](#)

Last updated: 19 October 2010



Figure 9. Screen capture of the ECNU IDEA-I real time air quality monitoring home page. The PHP used to create the web site is included as part of the IMAPP IDEA-I software package.

i) Estimation of sediment concentrations in coastal waters with MODIS

James Davies and Colleen Mouw continue the work to develop a stable algorithm to derive Suspended Sediment Concentration (SSC) from MODIS direct broadcast data, with the intent of creating an IMAPP stand alone package for distribution.

Coastal waters are often characterized by significant concentrations of suspended sediments sourced from fluvial outflows and/or seabed re-suspension. In these case-2 waters, optically active constituents vary independently of each other. However, radiative transfer numerical simulations revealed that, beyond wavelengths of about 800nm, significant variations in the remote sensing reflectance (Rrs) were primarily associated with changes in mineral suspended sediment concentration. This suggests that the MODIS 250m resolution band centered at 859nm could be a useful probe of sediment concentration in case-2 waters and without the complication of retrieving other optically active constituents. Our results indicate that the SWIR atmospheric correction provided with SeaDAS is quite suitable for ocean sediment mapping using the retrieved remote sensing reflectance in the 250m resolution 859nm MODIS band. However, at high sediment loads, the 1240nm band can itself be influenced by the suspended sediment and its utility for atmospheric correction thus compromised. A simple water optical model extended to include the 1240nm band, and with appropriate sediment optical properties, permits a simple adjustment to be made to this band's reflectance input to SeaDAS. This leads to retrieval of more plausible atmospheric aerosol types and abundances over bright water and to increased estimates of 859nm Rrs and sediment concentration. Figure 10 is an example of the difficulties in retrieving ocean and atmospheric properties in regions of high SSC concentrations.

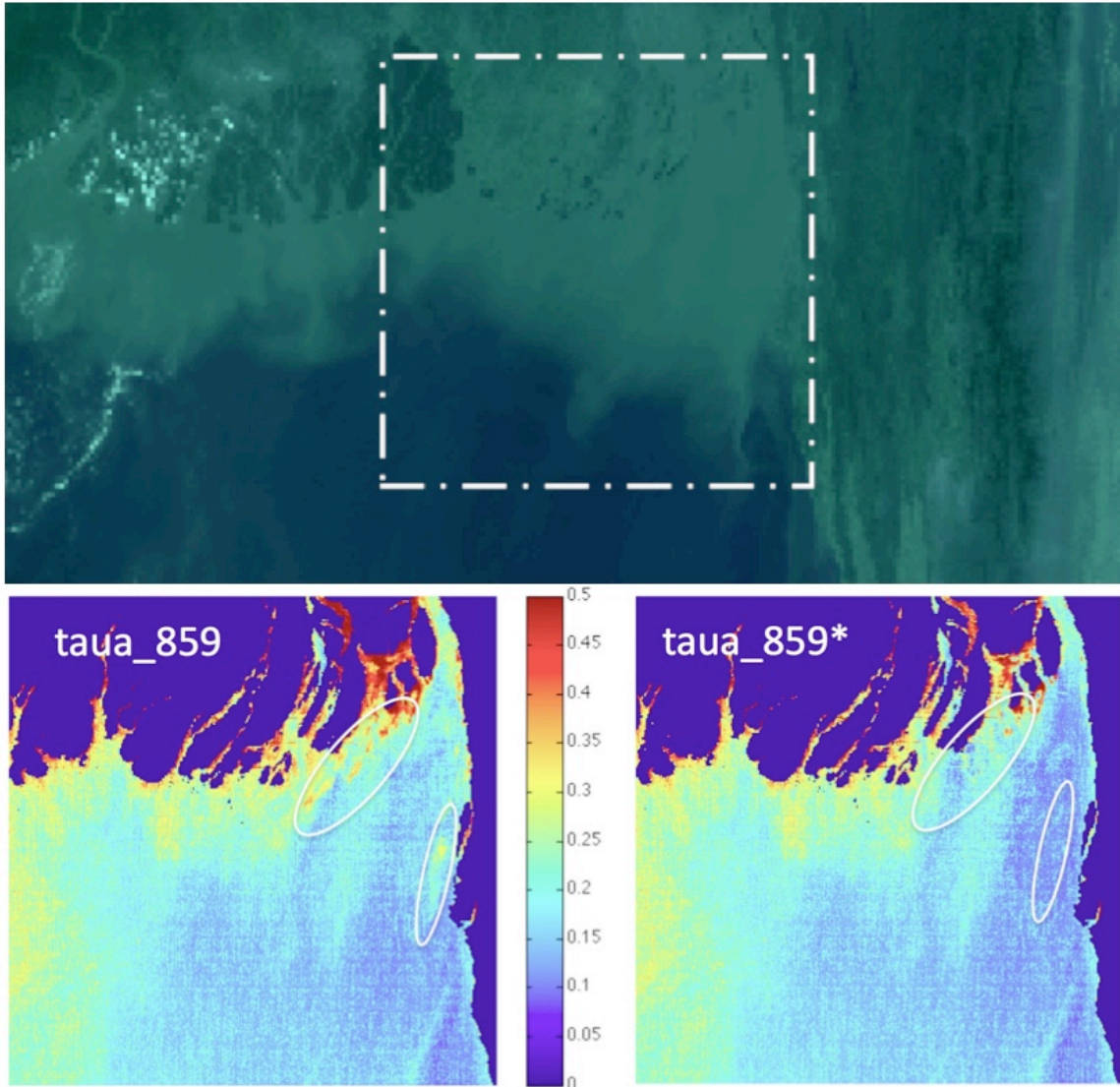


Figure 10. Terra MODIS false color image of the Bay of Bengal (top) showing a region of interest (ROI) centered on the outflow from the Ganges delta. This MODIS scene is for 15 February 2009. The ROI appears to comprise both high and moderate-to-low sediment concentration regions and is essentially glint-free. The aerosol optical depth at 859nm is shown at bottom, as retrieved using the SeaDAS SWIR correction (left) and after correction for non-zero 1240nm water reflectance (right). Within the two sub-regions (marked by white oblique ellipses) we observe high retrieved aerosol optical depths in the SeaDAS SWIR corrected image that seem to covary with high ocean sediment concentration. Ocean sediment features observable 1240nm image (and not discernible at 2130nm) are responsible for an aerosol misclassification and over-estimated aerosol optical depth. A model-based adjustment to the 1240nm water reflectance can assist to reduce this error.

A.2 AIRS Activities

a) Release of AIRS/MODIS Collocation, AIRS Cloud Mask and Single FOV Retrieval Software Package v1.2 Software Package

In December 2009, UW released an update to the AIRS utility package that was originally released in March of 2009. It contains software that will allow a user to create an output file containing MODIS/AIRS collocations, an AIRS cloud mask based upon the collocated MODIS cloud mask pixels and then execute an AIRS retrieval algorithm at single field-of-view in all sky conditions using the AIRS cloud mask as input.

Changes to the package include:

- The collocation software has been rewritten in C++ by Greg Quinn. The collocation algorithm has not changed. Please see:

Nagle, Frederick W. and Robert E. Holz, 2009: Computationally Efficient Methods of Collocating Satellite, Aircraft, and Ground Observations. *J. of Atmos. and Ocean Tech.*, Volume 26, Issue 8, pp. 1585-1595.

- The collocation `airsmodhdf.exe` executable has been replaced by the `airsmod_static` executable, and the arguments to it are:

```
airsmod_static airsfile modis_geo_file output_file
```

- You can now use either direct broadcast MODIS geolocation and cloud mask files (files that cover the same usable data orbit as AIRS) using the IMAPP naming conventions `a1.yyddd.hhmm.geo.hdf` and `a1.yyddd.hhmm.mod35.hdf` or the 2 to 3 DAAC/MODAPS 5 minute granule segments that coincide with the AIRS data with naming conventions

```
MYD03.AYYYYDDD.HHMM.005.yyyydddhhmmss.hdf and  
MYD35_L2.AYYYYDDD.HHMM.005.yyyydddhhmmss.hdf.
```

- There is a new argument to the main run script "MODE" that lets the program know whether you are processing Direct Broadcast MODIS data segments (passes of arbitrary size using the IMAPP naming conventions) or NASA archive 5 minute segments.

```
RUN_AIRS_UTILS_RTV.scr MODE AIRSL1BFILENAME OUTDIR
```

```
MODE is either 1 or 2
```

```
1 = Direct Broadcast MODIS files (naming convention a1...)
```

```
2 = MODAPS Archive 5 minute files (naming convention MYD..)
```

- Two new scripts have been written to run the collocation and cloud mask on the 5 minute MODIS granules (there will be either 2 or 3 files per 6 minute AIRS L1B file)

run_5min_collocation_and_cfrac.scr and get_5Min_myd03.scr

b) Update to AIRS L1B HDFEOS to BUFR Format Utility Software Package

Acting upon a request from the Australian Bureau of Meteorology (BOM), UW teamed with the UK MET Office, Exeter, UK, to release an update of the IMAPP utility software package that converts AIRS L1B HDFEOS radiance files into Binary Universal Form for the Representation of meteorological data (BUFR) format files. The BUFR file format is one that is commonly used by Met offices for data assimilation into numerical weather prediction models. The software was updated to add the capability of reading Advanced Microwave Sounding Unit (AMSU) HDFEOS files (AIRS.2009.02.06.176.L1B.AMSU_Rad.v5***.hdf) and to include co-located AMSU temperatures in the AIRS BUFR output.

c) Work toward AIRS synergistic cloudy retrievals

Elisabeth Weisz continues to work on improving the UW IMAPP AIRS synergistic retrievals under cloudy conditions. A new method (dual regression with cloud stratification) will be implemented into the IMAPP AIRS package as soon as testing and validation are conducted by using the operational V5 AIRS product, current GOES sounder products, radiosondes, CALIPSO and CloudSat products.

A.3 AMSR-E Activities

Little progress was made during the last year in resolving the problems with the IMAPP AMSR-E L1B processing package. The L1B package was originally provided by Remote Sensing System (RSS), but the company has now ceased support of it. This has led to serious degradation of the calibration and navigation of the IMAPP AMSR-E products.

The best solution seems to be to write a stand alone non-JAXA version of the L1A software. This will be a big effort, especially considering the fact that we do not have a microwave remote sensing scientist at SSEC. We continue to try and find the best option to resolve this problem given our personnel and resources.

B.1 Real-time Data Customers

UW SSEC continued to provide real-time Terra and Aqua products to a number of customers in the US. The reliability and timeliness of products from the SSEC reception and processing system enabled these customers to make use of EOS products in near real-time. A list of current real-time data customers is shown below:

US National Weather Service
Central, Western, Eastern and Southern Regions (AWIPS)

NWS Space Flight Meteorology Group
<http://www.srh.noaa.gov/smg>

Naval Research Laboratory Monterey
http://www.nrlmry.navy.mil/nexsat_pages/nexsat_home.html

NASA/MSFC Short-term Prediction Research and Transition Center
<http://weather.msfc.nasa.gov/sport/>

NOAA CoastWatch Great Lakes Node
http://coastwatch.glerl.noaa.gov/modis/region_map.html

WisconsinView
<http://www.wisconsinview.org/>

UMBC US Air Quality Blog
<http://alg.umbc.edu/usaq/>

Canadian Ice Service
<http://ice-glaces.ec.gc.ca/>

Real-Time Images for PDAs
<http://www.ssec.wisc.edu/data/paw/>

MODIS Today website
<http://ge.ssec.wisc.edu/modis-today/>

Weather Underground
<http://www.wunderground.com/blog/Rainman32>

United States Forest Service
<http://activefiremaps.fs.fed.us/imagery.php>

Conference/Invited Presentations and Lectures

Kathleen Strabala gave a talk at the MODIS/VIIRS Science Team Meeting Plenary Session, held in Washington, DC, January 2010 entitled: [The Global Impact of MODIS Direct Broadcast Atmosphere Products](#).

James Davies presented a poster at the AGU 2010 Ocean Sciences Meeting, held in Portland, Oregon, 20-26 February 2010 entitled: Atmospheric correction of MODIS observations in the coastal zone for suspended sediment concentration retrievals.

Elisabeth Weisz gave a talk at the International TOVS Study Conference 17 in Monterey, CA in April entitled: [Updates to the IMAPP AIRS Utility Software](#).

Liam Gumley presented a poster at the International TOVS Study Conference 17 in Monterey, CA in April entitled: Virtual Appliance for Terra, Aqua, Metop, and POES Direct Broadcast Processing.

Kathleen Strabala presented a poster at the International TOVS Study Conference 17 in Monterey, CA in April entitled: [IMAPP: Promoting the Knowledge and Use of Remote Sensing Data](#).

Kathleen Strabala gave a talk at the Sea Space 19th International Remote Sensing Conference, held in Kahuku, Hawaii, in August entitled: [University of Wisconsin Direct Broadcast Activities](#).

Liam Gumley gave a talk at the 15th Australasian Remote Sensing and Photogrammetry Conference (ARSPC-15), held in Darwin, Australia, 20 September, 2010 entitled: The IMAPP Virtual Appliance.

Liam Gumley was the Keynote Speaker at the AmericaView meeting, held in Madison, Wisconsin, in October. The title of his talk was: Real-time Imaging of the Earth Using Terra/Aqua MODIS Today and NPP/JPSS VIIRS in the Future.

Kathleen Strabala presented a poster at the AmericaView meeting, held in Madison, Wisconsin, in October entitled: Daily 1km MODIS True Color Images.

Elisabeth Weisz gave a talk at the First Asia/Oceania Meteorological Satellites Users Conference, Beijing, China, Nov 1-2, entitled: Hyperspectral Infrared Sounding Algorithm Development, Product Evaluation and Applications.

Kathleen Strabala gave an invited talk at the 91st Annual Meeting of the AMS in Seattle, Washington, 26 January 2011, entitled: [The Global Impact of Polar Orbiter Direct Broadcast Data](#).

Allen Huang has given following DB related presentations and lectures:

Recent Advancement of Direct Broadcast Data Acquisition, Processing, Applications and Distributions and Overview of International (A)TOVS Working Group (ITWG) Activities and its Role in Coordinating Standardization and Optimal Use of Weather Satellite Information World Meteorological Organization (WMO), Geneva, Switzerland, February 2010.

Ground Processing Systems: LEOCAT/GEOCAT/DBPS/DBVM, National Satellite Meteorological Center, China Meteorological Administration, Beijing China. March, 2010.

Prospect of Remote Sensing End-to-End Processing and Application System, National Satellite Meteorological Center, China Meteorological Administration, Beijing China, April, 2010.

Towards Optimized Utilization of Meteorological Satellite Assets: Better World with Satellite Remote Sensing, National Satellite Meteorological Center, China Meteorological Administration, Beijing China. April, 2010.

Building a Campus-wide Remote Sensing Infrastructure for Education, Research and Interdisciplinary Applications, Part 1: An End-to-End Environmental Satellite Receiving, processing and Distribution Data Center, East China Normal University, Shanghai, China, May 2010.

Recent Advances in Direct Broadcast Remote Sensing Science and Applications, Atmospheric and Environmental Remote Sensing Data Processing and Utilization VI: Readiness for GEOSS IV, SPIE, San Diego, CA, August, 2010.

The Development of a Turn-Key Direct Broadcast End-to-End System. Remote Sensing System Engineering III, SPIE, San Diego, CA, August 2010.

Real-Time Remote Sensing of Environment Monitoring and Forecasting: The Development and Demonstration of the Innovated Processing and Modeling System. Beijing Normal University Beijing, China, August 2010.

Direct Broadcast Data Access, Processing and Utilization: The Development of Processing Packages and an End-to-End System, 2010 EUMETSAT Meteorological Satellite Conference, Cordoba, Spain, September 2010.

Polar Orbiting Weather Satellite Proving Ground: Facilitating Broad and Optimal Use of Global Direct Broadcast Data, 91st Annual Meeting of the AMS in Seattle, Washington, 26 January 2011.

Peer-reviewed Publications

Zhang, Hong, Huang, Hung-Lung, Lim, Agnes, Holz, Robert, Dutcher, Steve, Nagle, Fred, Gumley, Liam, Wang, Jinnian, Shi, Runhe, and Gao, Wei: 2010. Analysis and characterization of the synergistic AIRS and MODIS cloud-cleared radiances, *Frontiers of Earth Science in China*, Vol. 4, No. 3, pp. 363-373.

E. Weisz, W. P. Menzel, R. Frey, E. Borbas, 2010: "An approach for Merging high Spectral Resolution Sounder Data with Spatial Resolution Imager Data to infer Cloud Cover Properties", submitted to the *Journal of Applied Meteorology and Climatology*.

IMAPP related Peer-reviewed Publications for 2010

Rahimzadegan, M. and Mobasheri, M. R., An attempt for improving MODIS atmospheric temperature profiles products in clear sky. *Meteorological Applications*, n/a. doi: 10.1002/met.221

Casanova, C.; Romo, A.; Hernández, E.; Casanova, J. L.. "Operational cloud classification for the Iberian Peninsula using Meteosat Second Generation and AQUA-AIRS image fusion", *International Journal of Remote Sensing*, 31.1, Nov. 2010.