International MODIS/AIRS Processing Package (IMAPP) Products and Applications

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International MODIS/AIRS Processing Package (IMAPP)

Builds upon our previous experience with
• ITPP (International TOVS Processing Package) since 1983
• IAPP (International ATOVS Processing Package) since 1998

Purpose:
• The intention in developing IMAPP for processing direct broadcast MODIS and AIRS data is to help foster the rapid improvement of retrieval algorithms and other applications of EOS data in a variety of global weather, process studies, and climate applications, just as the ITPP and IAPP have done for TOVS and ATOVS data.

Available from:
http://cimss.ssec.wisc.edu/~gumley/IMAPP/
International MODIS/AIRS Processing Package

Goal: Transform direct broadcast Level-0 data to calibrated & geolocated radiances (Level-1B) and science data products (Level-2).

Features:
• Ported to a range of platforms (IRIX, SunOS, AIX, HPUX, Linux),
• The only required tool kit is NCSA HDF4,
• Processing environment is greatly simplified,
• Passes of arbitrary size may be processed,
• Available at no cost; licensed under GNU GPL
• Funded by NASA (250K/yr 01-03, 350K/yr 03-06)

Available from:
http://cimss.ssec.wisc.edu/~gumley/IMAPP/
Launched: Dec. 18, 1999
10:30 am ascending
ASTER: Hi-res imager
CERES: Broadband scanner
MISR: Multi-view imager
MODIS: Multispectral imager
MOPITT: Limb sounder
Aqua

Launched: May 4, 2002
1:30 pm descending
AIRS: Infrared sounder
AMSR-E: Microwave scanner
AMSU: Microwave scanner
CERES: Broadband scanner
HSB: Microwave sounder
MODIS: Multispectral imager
MODIS, AIRS, AMSU, HSB are included in IMAPP

**AIRS - Atmospheric Infrared Sounder**

**Measurements:**
- Atmospheric temperature and humidity
- Land and sea surface temperatures
- Cloud properties
- Radiative energy flux

**Properties:**
- Measures simultaneously in more than 2,300 spectral channels in the range of 0.4 to 1.7 µm and 3.4 to 15.4 µm
- Sponsor: NASA JPL
- Developer: Lockheed Martin
- URL: http://www-airs.jpl.nasa.gov/

**AMSR/E - Advanced Microwave Scanning Radiometer - EOS**

**Measurements:**
- Cloud properties; radiative energy flux; precipitation; land surface wetness; sea ice; snow cover; sea surface temp.; sea surface wind fields

**Properties:**
- Views in 12 channels at six discrete frequencies in the range of 6.9 to 89 GHz
- Sponsor: NASDA of Japan
- Developer: Mitsubishi Electric Corporation
- URL: http://wwwghcc.msfc.nasa.gov/AMSR

**AMSU - Advanced Microwave Sounding Unit**

**Measurements:**
- Atmospheric temperature and humidity

**Properties:**
- Senses in 15 discrete channels in the range of 50 to 89 GHz
- Sponsor: NASA GSFC
- Developer: Aerojet
- URL: http://www.aerojet.com/Weapon_Systems/Earth_Sensing/AMSU/
- New AMSU info URL: http://orbit-net.nesdis.noaa.gov/crad/st/amsuclimat

**HSB - Humidity Sounder for Brazil**

**Measurements:**
- Atmospheric humidity

**Properties:**
- Measures in 5 discrete channels in the range of 150 to 183 MHz
- Sponsor: Instituto Nacional de Pesquisas Espaciais (INPE), Brazil
- Developer: Matra Marconi Space

**CERES - Clouds and the Earth's Radiant Energy System**

**Measurements:**
- Radiative energy flux

**Properties:**
- Two sensor, one scanning cross track, the other scanning azimuthally view in three channels per scanner: shortwave (0.3 to 5 µm), longwave (8 to 12 µm), and "total" (0.3 to > 50 µm)
- Sponsor: NASA LaRC
- Developer: TRW Space & Electronics Group

**MODIS - Moderate Resolution Imaging Spectroradiometer**

**Measurements:**
- Cloud properties; radiative energy flux; aerosol properties; land cover and land use change; vegetation dynamics; land surface temperature; fire occurrence; volcanic effects; sea surface temperature; ocean color; snow cover; atmospheric temperature and humidity; sea ice

**Properties:**
- Views in 36 spectral bands from 0.4 to 14 µm
- Sponsor: NASA GSFC
- Developer: Raytheon (Santa Barbara Remote Sensing)
- URL: http://ltpwww.gsfc.nasa.gov/MODIS

**CERES will not be included in IMAPP**

**Instruments On Board Aqua**
Current IMAPP Status

**MODIS products**
- calibration, geolocation (L1B)
- cloud mask
- cloud properties (height, temperature, emissivity, phase)
- atmospheric profiles (T, q, tpw, total ozone, stability indices)
- sea surface temperatures
- aerosol optical depth

**MODIS utilities**
- destriping band 26 (correct for band 5 spectral leak)
- Creating true color images tutorial

**AIRS products**
- AIRS/AMSU/HSB Level 1 (with JPL)
- AIRS Level 2 profiles in testing (both single pixel and 3x3)

**AMSR-E products**
- RSS L1B software has been successfully tested – released soon
Local Applications
EOS Direct Broadcast Groundstation

TeraScan SX-EOS 4.4 m antenna: First data acquired 2000/08/18

Overpass prediction 2000/10/13
# Terra - December 02, 2001

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Information current as of December 4, 2001 16:30:55 UTC

[Orbital Tracks](http://eosdb.ssec.wisc.edu/modisdirect/) | [Download Data](http://eosdb.ssec.wisc.edu/modisdirect/) | [X-Band Antenna](http://eosdb.ssec.wisc.edu/modisdirect/) | [About MODIS](http://eosdb.ssec.wisc.edu/modisdirect/) | [Contact Us](http://eosdb.ssec.wisc.edu/modisdirect/) | [SSEC Home](http://eosdb.ssec.wisc.edu/modisdirect/)
CIMSS Near-Real Time IMAPP automated processing

Applications:

• MODIS L1B and science product validation
• Testing of MODIS operational product changes
• Quick look images for identifying regions of spectral or meteorological interest
• Support for field experiments
• Public Service
• Channel simulation for future instruments (Advanced Baseline Imager - 2012)

http://cimss.ssec.wisc.edu/goes/abi/airs_broadcast/aniairs.html
IMAPP
Terra/Aqua
MODIS
Level 2
Products

Automatic
Production at
SSEC
Northern Wisconsin    10 October 2003
Simulated Advanced Baseline Imager (ABI) 3.9 micron Brightness Temperature from AIRS UW Direct Broadcast IMAPP Real time product

Aqua 8 September 2003 20:21 UTC
IMAPP AIRS RTV vs. ECMWF vs. Operational RTV:

Temperature [K] at 500 mbar

IMAPP AIRS RTV

ECMWF ANL
Interpolated to AIRS grid

Operational AIRS RTV
• available on AMSU footprint (=3x3 AIRS FOVs) only
• missing areas → retrieval not successful or not validated yet

With Cloudmask
AMSR-E 89.0A GHz
horizontal polarization

Antenna temperature (K)
Global Applications
Global MODIS IMAPP Community

Applications — based upon sample of responses to IMAPP survey:

• Hartbeeshoek, South Africa - CSIR Satellite Application Centre - MODIS Level 1B used for generation of surface reflectance, NDVI, BRDF, LST, SST

• Plymouth, United Kingdom - Plymouth Marine Laboratory - MODIS Level 1 and Level 2 cloud product, cloud mask, and atmospheric profiles products used as a deliverable for the EC funded CLOUDMAP2 project which finished in January 2004

• Taiwan, ROC - Center for Space and Remote Sensing Research, National Central University - MODIS Level 1 and Level 2 products used for studying atmospheric temperature, ozonosphere, sea surface temperature, chlorophyll, ocean color, vegetation indices and forest fires
Global MODIS IMAPP Applications Continued

- **Sao Paolo, Brazil** - National Institute for Space Research – INPE - MODIS Level 1B used to serve INPE/CPTEC, IBAMA and other Governmental institutions.

- **Missoula, Montana** - US Forest Service - MODIS Level 1B and eventually aerosol product used for fire monitoring.

- **Alice Springs, Canberra and Hobart, Australia** - Australian Centre for Remote Sensing - IMAPP MODIS Level 1 and, in test right now, Level 2 cloud mask and cloud properties. These products are being utilized in various environmental applications.
Global MODIS IMAPP Applications Continued

• **Chinese Academy of Science** - Institute of Geography and Resources Research, MODIS Level 1 and Level 2 products used for a variety of applications

• **Tromso, Norway** - Kongsburg Satellite Services - MODIS Level 1 and Level 2 products distributed with ground stations worldwide for a variety of environmental applications

• **Moscow, Russia** - ScanEx Research and Development Center - MODIS Level 1, and Level 2 cloud mask and SST used for a wide range of land and sea surface monitoring tasks

• **Sioux Falls, South Dakota, USA** - EROS Data Center - MODIS Level 1 products are reprojected for users on the AmericaView project, a national and state partnership to enable remote sensing education, training, and applications
Use IMAPP MODIS cloudmask as a means of choosing scenes for users.
Global MODIS IMAPP Community

continued:

- Many, many MODIS applications in China
  
  Wenjian ZHANG presented many of these at last International EOS DB meeting – 17-20 November 2003
  
  - Cloud and aerosol applications
  
  - Disaster monitoring (Floods and Fires)
  
  - Snow and ice monitoring
  
  - Others

How Many IMAPP users are there?

- Not sure, software is free without registration – but know that it is used on every continent – including Antarctica.
MODIS view of Shanghai

The 3 channel composition image of ch1/ch4/ch3. The blue arrow points Shanghai city district.
Other known IMAPP applications:

• Providing USA Weather Service forecasters with near real-time high spatial resolution imagery and products (NASA SPORT).

• Water quality monitoring - University of Wisconsin

• Aiding the Canadian Ice Service in monitoring the amount of ice on Hudson Bay for shipping concerns.

• Providing MODIS Aerosol and Cloud data for Infusing Satellite Data into Environmental Applications (IDEA) project to aid in Air Quality Forecasts by the US EPA.

Other known users:

• Naval Research Laboratory, Monterey, California, USA
• Satellite Services Division, NOAA/NESDIS, USA
• Atmospheric and Environmental Research, Inc, Lexington Massachusetts, USA
• Upper Midwest Aerospace Consortium, University of North Dakota, USA
• National Center for Environmental Prediction (NCEP), NOAA, USA
• MODIS Snow and Sea Ice Global Mapping Project, NASA/GSFC, USA
http://www.ghcc.msfc.nasa.gov/sport/sport_featured.html
Latest Forecast Discussion - May 27, 2004

MODIS AOD over continental US shows relatively low aerosol loading with moderate AOD plume exiting the mid-Atlantic Coast. Region of moderate PM2.5 AQI in Midwestern AIRNow data is obscured by clouds.

Moderate (~0.4) MODIS AOD in south-central US forecasted to be advected towards Virginia and Carolinias on 05/28 with rapid advection off the South-eastern coast by 05/29. Possibility of recirculation of aerosol loading off the coast associated with high pressure system over Florida.

http://idea.ssec.wisc.edu

Forecast Trajectories for MODIS Aerosol Optical Depth, Cloud Optical Thickness and 48 hour Air Parcel

Regional Summary Plots of MODIS Aerosol Optical Depth and Cloud Optical Thickness
Water quality in Green Bay: summer 2001

Enhanced true-color MODIS images: bands 1 (red), 4 (green), and 3 (blue)

Chlorophyll a concentration, derived from MODIS data:

Total suspended solids, derived from MODIS data:

Water clarity (Secchi disk transparency), derived from MODIS data:
Future IMAPP applications

**AIRS Sounding System Software:**

- L2 retrieval products – *First release in November*
  - T/q retrievals, Total Precipitable Water Vapor
  - Single pixel and 3x3 fov
- Cloud Detection
- Cloud Properties (Height, Emissivity)
- Cloud Liquid Water
- AMSU Precipitation
- Combined MODIS/AIRS products

**MODIS L2 products:**

- Aerosol Optical Depth – *First release in September*
- Surface Reflectance
- Suspended Sediment Concentration
- Cloud Optical Properties
- Scene Classification
- Snow Cover/Lake Ice
- Ocean Color
Future IMAPP applications (Continued)

**AMSR-E:**
- Soil Moisture
- Precipitation

**Utilities:**
- Utility to visualize L1B and L2 IMAPP products
  - hydra
  - Utilities to share data with other users
    - DODS server
    - ADDE server
- Utilities to collocate MODIS/AIRS pixels
- Corrected reflectance tutorial
- Guide to converting IMAPP L1B format to DAAC format

**Workshops:**
- More IMAPP remote sensing workshops planned
AIRS Clear Flag from MODIS cloud mask
Summary

• IMAPP is providing the international community with the means to process Terra MODIS and Aqua MODIS and AIRS data independently. Level 2 MODIS products are being used for a variety of applications internationally.

• MODIS, AIRS L1B and a subset of MODIS L2 algorithms are available today.

• Additional MODIS and AIRS L2 products are under development, including MODIS surface reflectance product and AIRS/MODIS collocated combined products

• AMSR-E L1B software package will be released soon.

• We intend to follow on from Terra and Aqua to NPP and NPOESS.
**IMAPP AMSR-E Processing**

*Goal:*
Release freely available package for processing AMSR-E from Level 0 to Level 1B initially, followed by Level 2 in future.

*Status:*
- RSS has delivered AMSR-E L1B package to SSEC in source form
- Output format is flat binary, arbitrary overpass size
- SSEC has been running beta version in near real-time
- SSEC has been developing these Level 2 products for testing in DB:
  - Soil moisture
  - Precipitation

*Schedule:*
L1B released by the end of the year.
Level 2 products in the beginning of 2005.