



International MODIS/AIRS Processing Package (IMAPP)

NASA International MODIS/AIRS Processing Package
(IMAPP): Current Status and Future Plans
Where do we go from here?

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Collaborations



- UW SSEC
- NOAA/STAR
- Boston University
- NASA Goddard Space Flight Center
- Institut für Weltraumwissenschaften, Freie Universität, Berlin, Germany
- German Weather Service (DWD)
- NASA Langley
- NASA SPoRT
- Met Office
- NWS
- Taiwan Central Weather Bureau, Taipei
- Australian Bureau of Meteorology
- Eötvös Loránd University, Budapest, Hungary
- East China Normal University, Shanghai, China
- GINA Alaska
- EUMETSAT
- BMKG, Indonesian Agency for Meteorology, Climatology and Geophysics
- CSIR South Africa
- INPE/CPTEC Brazil
- Jet Propulsion Lab (JPL)



What is IMAPP?

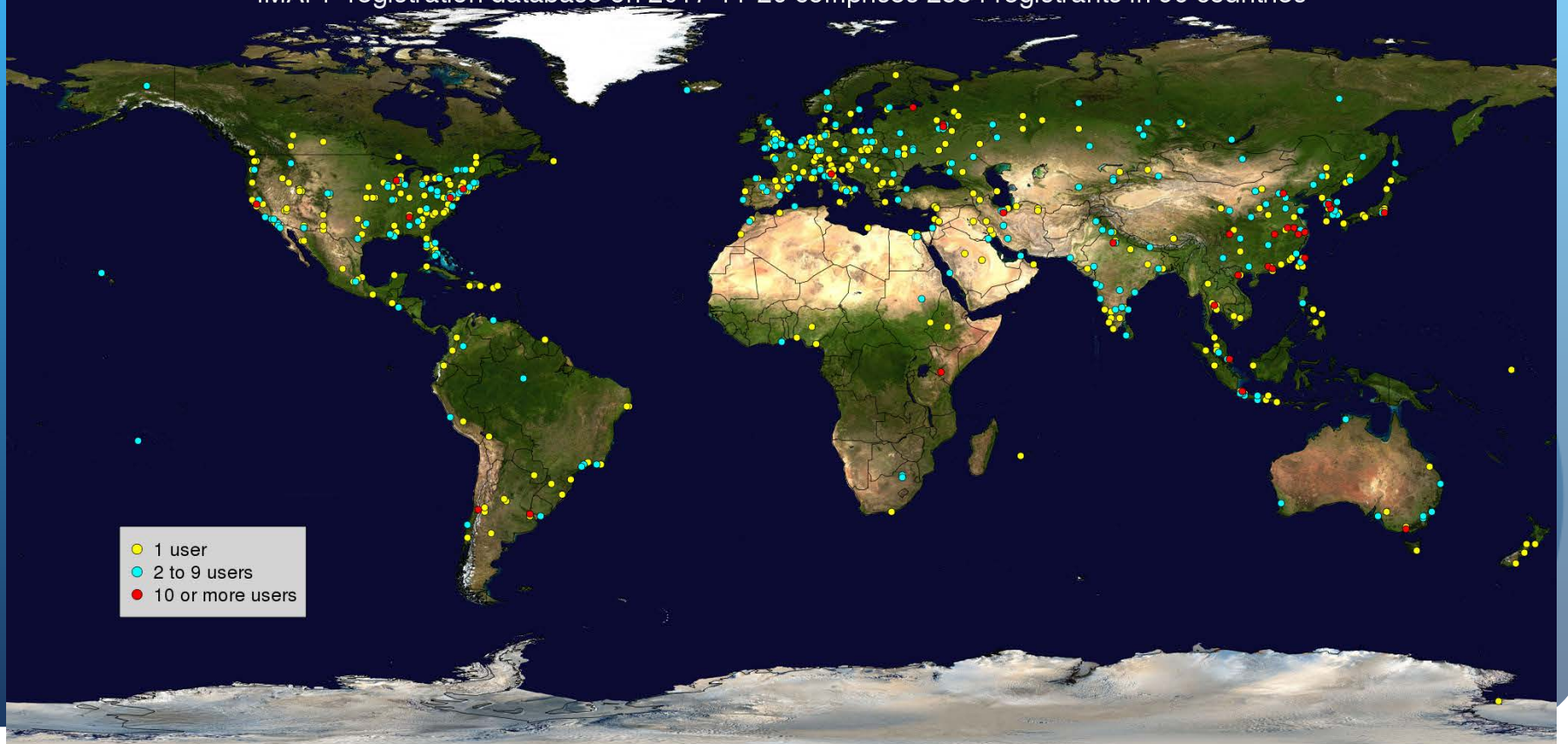
- The International MODIS/AIRS Processing Package is a collection of software systems for processing direct broadcast data from NASA Aqua and Terra satellites.
- The primary goal of IMAPP is to facilitate and promote the use of Level 1 and Level 2 products for local environmental applications.
- Funding is supplied by NASA.



IMAPP Registrants



IMAPP registration database on 2017-11-26 comprises 2554 registrants in 96 countries





The International MODIS/AIRS Processing Package (IMAPP) allows ground stations capable of receiving direct broadcast data from the NASA Terra and Aqua spacecraft to create a suite of products from MODIS, AIRS, AMSU, and AMSR-E. The IMAPP software is freely available, and is supported on Intel Linux host platforms.

IMAPP is also available as a Virtual Appliance for Windows, OS X, and Linux, offering a complete processing system for direct broadcast atmosphere, land, and ocean products from Terra and Aqua.

MODIS products (Terra and Aqua)

Atmosphere and Polar Products

- Cloud mask
- Cloud top pressure and temperature
- Cloud effective radius and cloud optical thickness
- Temperature and moisture profiles
- Total precipitable water
- Stability indices
- Aerosol optical depth (3km and 10km)
- Ice Surface Temperature
- Snow Mask
- Ice Cover and Ice Concentration
- Inversion Strength and Inversion Depth

[Learn more ...](#)

Land Products

- Land surface reflectance
[Learn more ...](#)
- Nadir BRDF-adjusted reflectance
[Learn more ...](#)

Image Products

- True color GeoTIFF and KML
[Learn more ...](#)
- MODIS and VIIRS L1B and True Color GeoTIFF
[Learn more ...](#)

AIRS and AMSU Products (Aqua)

Sensor Products

- Calibrated and geolocated radiances and reflectances (AIRS)
- Calibrated and geolocated antenna temperatures (AMSU)

NWP Products

The Direct Broadcast CIMSS Regional Assimilation System (DBCRAAS) is a regional numerical weather prediction model that assimilates MODIS products in real time and creates forecasts up to 72 hours at 48 km and 16 km resolution.

[Learn more ...](#)

GeoTIFF Web Mapping Service (WMS) MODIS Display Tool

This package provides users with the capability to display and share GeoTIFF products through a web browser in a Google Maps interface. It is designed specifically for display of MODIS and VIIRS default GeoTIFF files created by the Polar2Grid reprojection software package. It is distributed as a virtual machine (VM).

[Learn more ...](#)

Aviation/Severe Weather Forecast Products

- The IMAPP Overshooting Tops (OT) software package identifies regions of MODIS data that contain convective cloud tops that have broken through the tropopause into the lower stratosphere because of a strong updraft. Convective storms with OTs have the potential to produce severe weather at the ground (heavy rain, damaging winds, hail and tornadoes) as well as aviation hazards including lightning and turbulence.

What's New

- MODIS/VIIRS Polar2Grid Reprojection Software v2.1
- MODIS/VIIRS AerosolAir Quality Forecast Software v1.2
- MODIS Infrared Band Destripping Software v1.3
- MODIS Aerosol Visibility and Fog/Low Stratus Aviation Weather Hazard Software v1.0
- MODIS/AIRS HYDRA2 Multispectral Data Analysis Toolkit v2.0
- MODIS Overshooting Tops Aviation Weather Hazard Software v1.1
- MODIS DB Processing System Virtual Appliance v2.0





Suite of Products



MODIS Products (Terra and Aqua)

- **Atmosphere Group Collect 6.0 - MODIS Science Team Software**
 - Cloud mask (MOD35)
 - Cloud top pressure and temperature (MOD06CT)
 - Cloud effective radius and cloud optical thickness (MOD06OD)
 - Temperature and moisture profiles (MOD07)
 - Total precipitable water (MOD07)
 - Stability indices (MOD07)
 - Aerosol optical depth (3km and 10km) (MOD04)
 - Bright Target Aerosol Optical Depth (Deep Blue) (MOD04)
- **Polar Products from Jeff Key (NOAA Cryosphere Scientist)**
 - Ice Surface Temperature
 - Snow Mask
 - Ice Cover and Ice Concentration
 - Inversion Strength and Inversion Depth



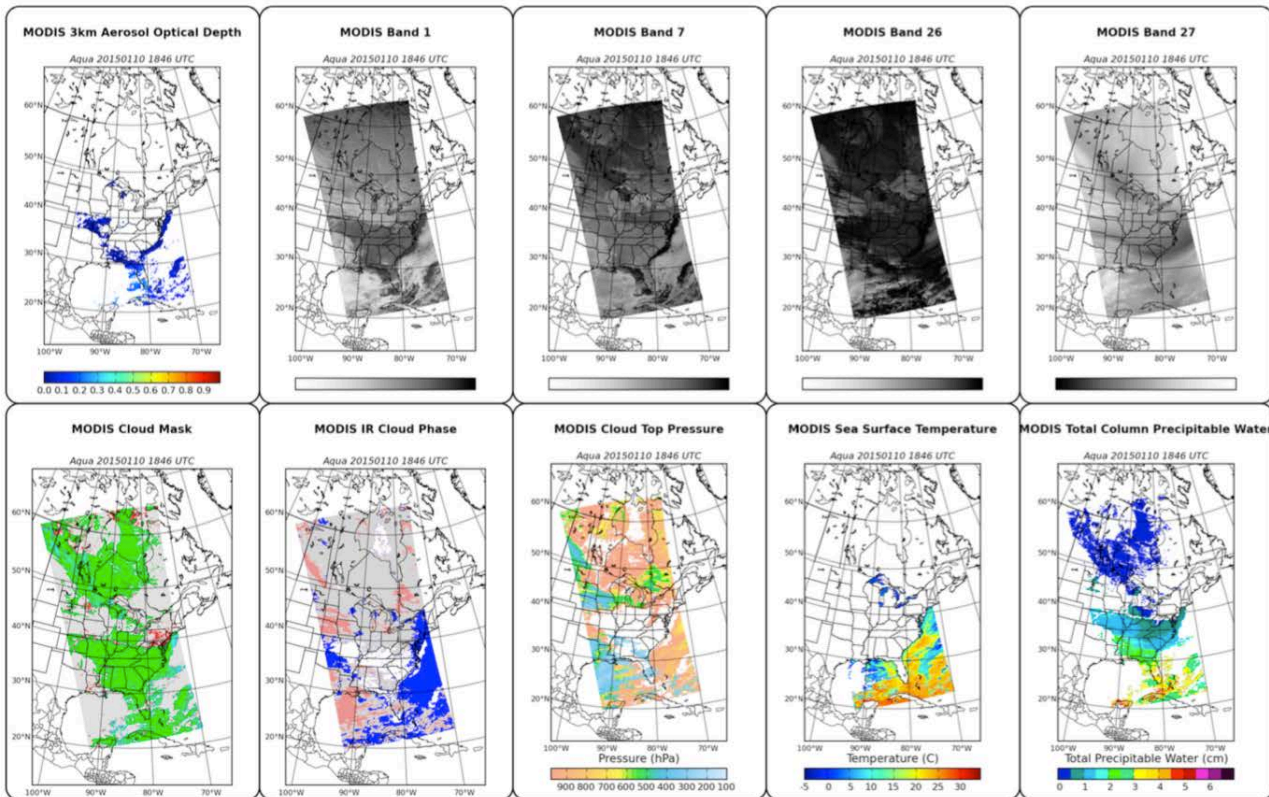
New MODIS Atmosphere Product Software



- MODIS NASA LAADS Archive Atmosphere Collect 6.1 software has been obtained and ported for Direct Broadcast use
- This code is specifically designed for use with Collect 6.1 Level 1B inputs
- Therefore, it has not been released yet because the Level 1B software has not been ported by the NASA Ocean Biology Group
- The Level 2 products will be released after the Level 1B 6.1 software is available to the DB community



IMAPP MODIS Level 2 Products





Suite of Products



MODIS Land Products (Terra and Aqua)

- MODIS Surface Reflectance (MOD09)
- Nadir Bidirectional Reflectance Distribution Function (BRDF) MCD43
- Working with Crystal Schaaf

MODIS Image Products

- Polar2Grid reprojection software - David Hoes
- True Color Reprojection for Display in Google Earth (DB Google Earth) - Full Resolution

AIRS and AMSU Products (Aqua) from NASA Jet Propulsion Lab (JPL) Version 5.0.22

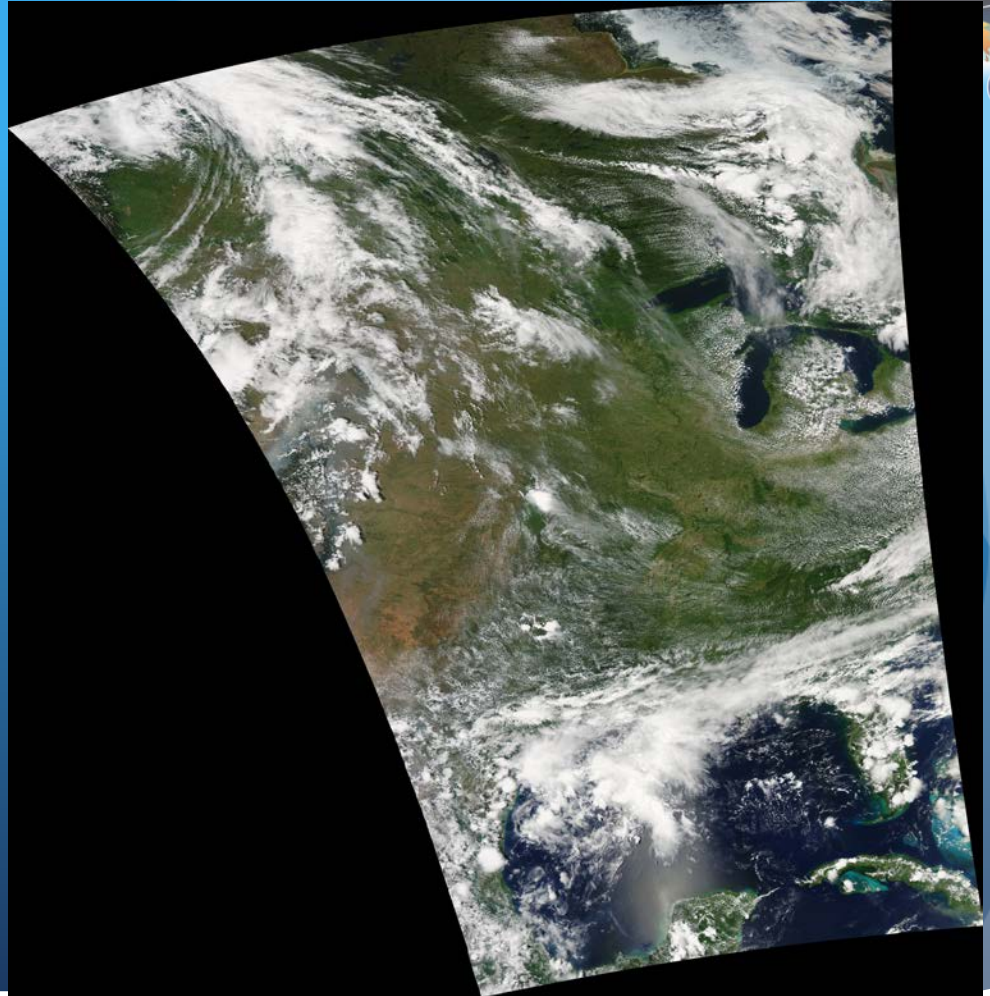
- Calibrated and geolocated radiances (AIRS)
- Calibrated and geolocated antenna temperatures (AMSU)



Polar2Grid

Easy to use interface to create
high quality polar orbiter
satellite data rejections

```
polar2grid.sh crefl gtiff -f <dir>
```





Involved Weather Forecast Offices

59
TOTAL

Bohemia, New York (ERH)
Kansas City, Missouri (CRH)
Fort Worth, Texas (SRH)
Salt Lake City, Utah (WRH)

Milwaukee, Wisconsin (MPX)

Billings, Montana (BYZ)
Buffalo, New York (BUF)
Charleston, South Carolina (CHS)
Chicago, Illinois (LOT)
Eureka, California (EKA)
Glasgow, Montana (GGW)
Grand Rapids, Michigan (GRR)
Green Bay, Wisconsin (GRB)
La Crosse, Wisconsin (ARX)
Las Vegas, Nevada (VEF)
Marquette, Michigan (MQT)
Medford, Oregon (MFR)
Minneapolis, Minnesota (MPX)
Northern Indiana (IWX)
Phoenix, Arizona (PSR)
Raleigh, North Carolina (RAH)
Salt Lake City, Utah (SLC)
San Diego, California (SGX)
Spokane, Washington (OTX)
State College, Pennsylvania (CTP)
Wichita, Kansas (ICT)

Aberdeen, South Dakota (ABR)
Amarillo, Texas (AMA)
Binghamton, New York (BGM)
Blacksburg, Virginia (RNK)
Boulder, Colorado (BOU)
Burlington, Vermont (BTV)
Cleveland, Ohio (CLE)
Columbia, South Carolina (CAE)
Dallas/Fort Worth, Texas (FWD)
Davenport, Iowa (DWN)
Des Moines, Iowa (DMX)
Duluth, Minnesota (DLH)
El Paso, Texas (EPZ)
Greenville, South Carolina (GSP)
Indianapolis, Indiana (IND)
Kansas City, Missouri (EAX)
Lincoln, Illinois (ILX)
Lubbock, Texas (LUB)
Memphis, Tennessee (MEG)
Midland, Texas (MAF)
Monterey, California (MTR)
Newport, North Carolina (MXX)
Norman, Oklahoma (OUN)
Pendleton, Oregon (PDT)
Philadelphia, Pennsylvania (PHI)
Pittsburgh, Pennsylvania (PBZ)
Reno, Nevada (REV)
Riverton, Wyoming (RIW)
Springfield, Missouri (SGF)
Sterling, Virginia (LWX)
Topeka, Kansas (TOP)
Tulsa, Oklahoma (TSA)
Spaceflight Meteorology Group



4 Distribution Node 1 ≥250 MODIS AFDs Issued 21 ≥1 AFD Issued 33 Receive MODIS Imagery



Suite of Products



AIRS and AMSU Products (Aqua)

- 3x3 AIRS FOV retrievals - JPL (Collect 6.0.12)
- UW Dual Regression single FOV retrievals (AIRS, CrIS, IASI)
- Collocated AIRS/MODIS FOVs

AMSR-E Products

- Calibrated and Geolocated Antenna Temperatures
- Rain Rate
- Soil Moisture
- Snow Water Equivalent



Suite of Products



HYDRA2 Multispectral Data Analysis Toolkit

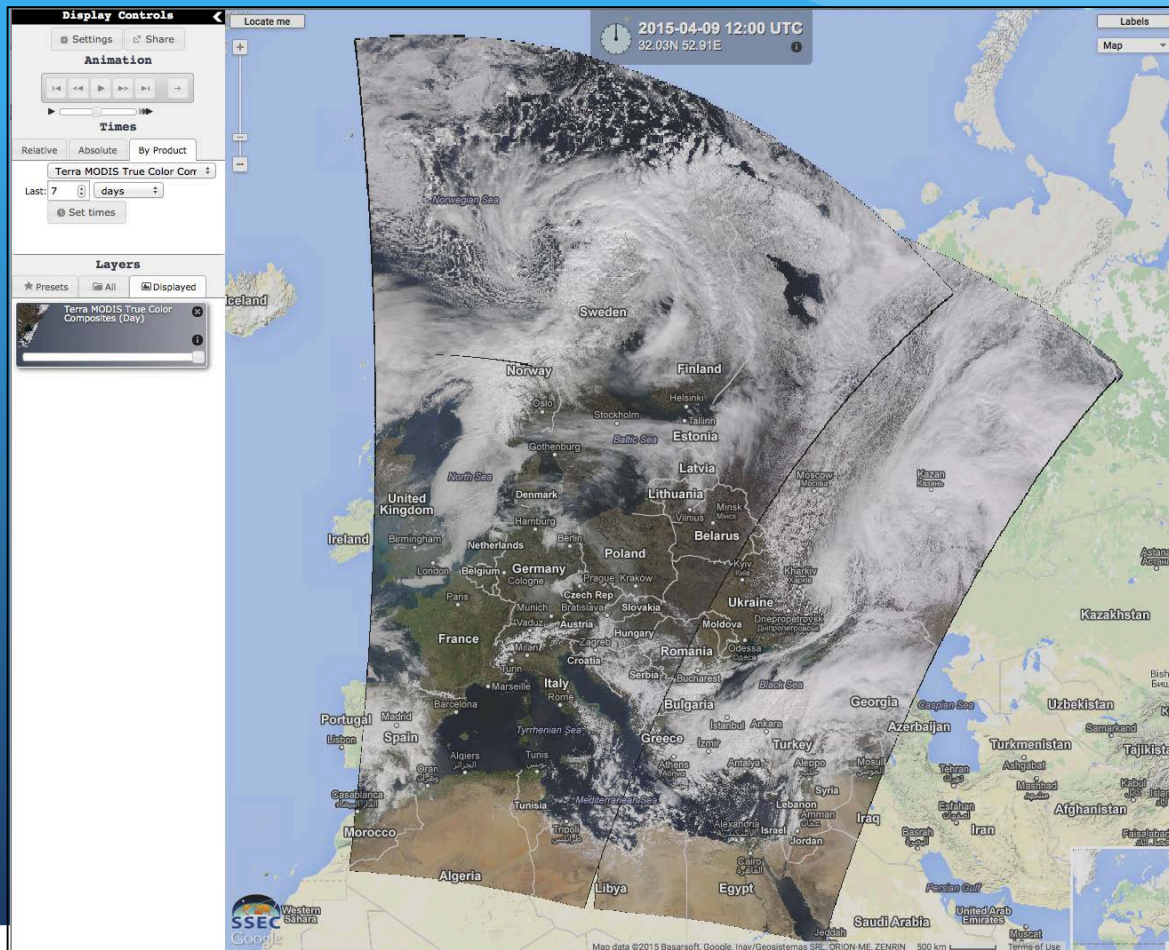
Web Mapping Service (WMS) for display of local GeoTIFFs created by Polar2Grid

Numerical Weather Prediction (NWP) Model DBCRAS

- Direct Broadcast CIMSS Regional Assimilation system (DBCRA5).
- Globally configurable NWP at 48 km resolution
- Nested grid at 16 km.
- 72 hour forecast of gridded meteorological fields.
- Assimilates MODIS Cloud (MOD06) and Moisture (MOD07) Retrievals to improve initial conditions in the model.
- Output includes forecast IR and Water Vapor Satellite Imagery.

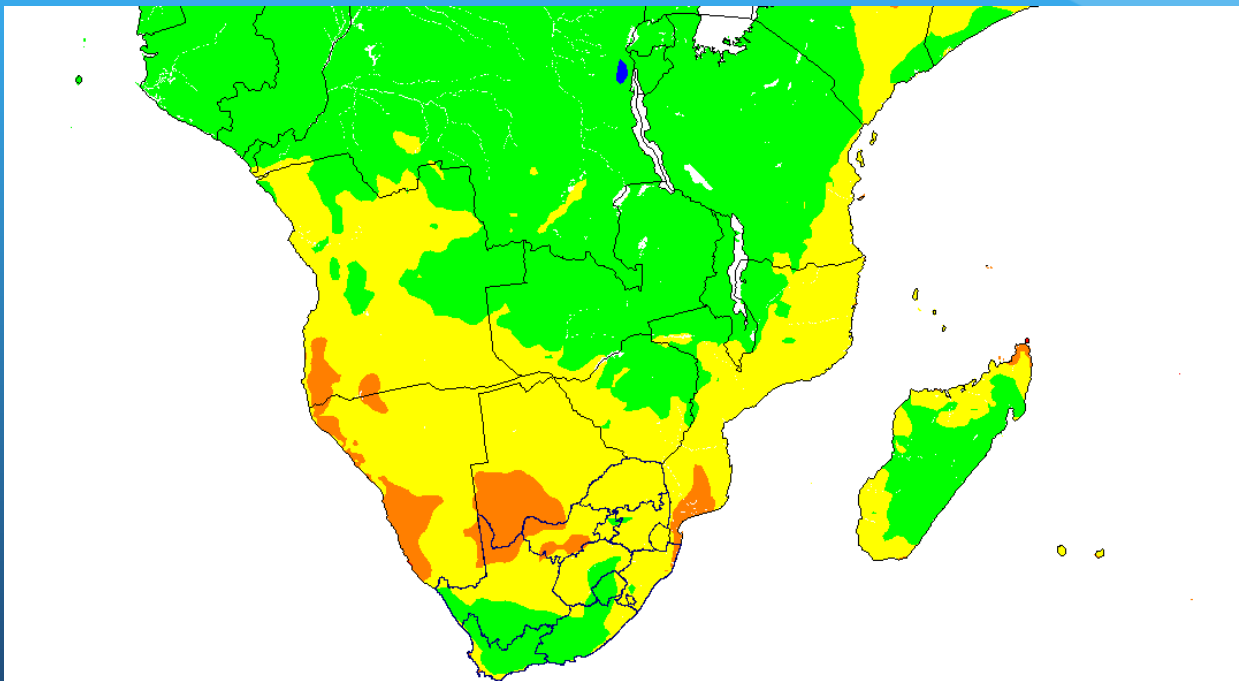


IMAPP wms





DBCRCAS South Africa Domain



FIRE DANGER INDEX (FDI)
SSEC DBCRCAS

22 JUN 17 12UTC

LOW

MODERATE

DANGEROUS

VERY
DANGEROUS

EXTREMELY
DANGEROUS



Suite of Products



Overshooting Tops Aviation Hazard Software

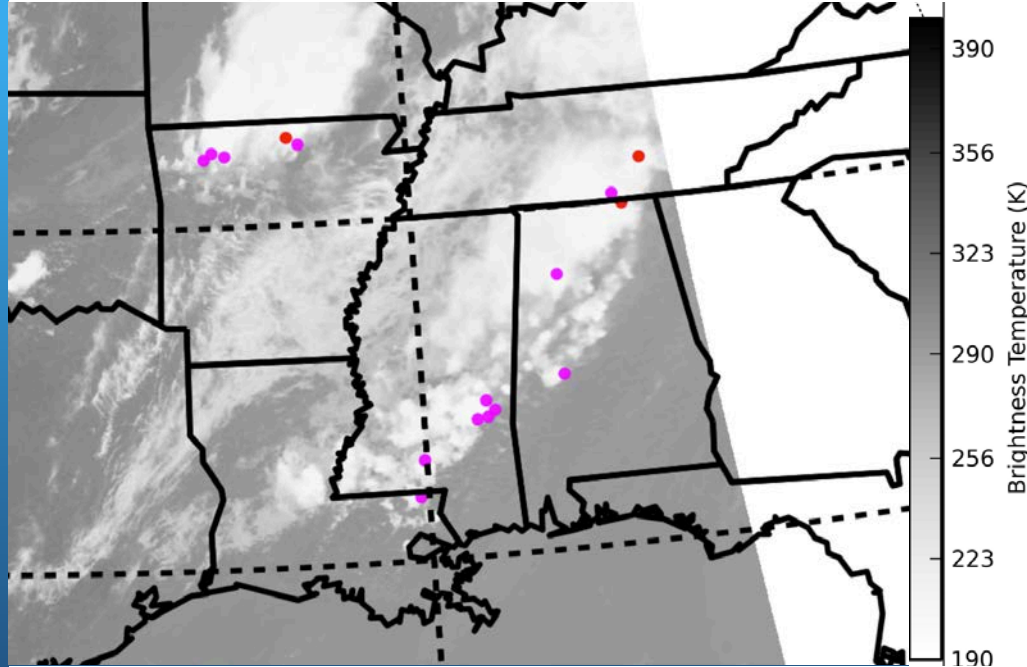
- Identifies potentially dangerous convection that protrudes into the stratosphere.
- Using NASA Scientist Dr. Kris Bedka algorithm applied to IR bands.
- Creates output product images that include areal coverage of danger of lightning and turbulence.

Infusing satellite Data into Environmental Applications - International (IDEA-I)

- Globally configurable package for Air Quality Forecasters
- MODIS Aerosol Pollution forecast trajectories, using MOD04 products with web interface and control of animations.
- AIRS Stratospheric Ozone intrusions trajectories, using AIRS upper tropospheric ozone retrievals with web interface and control of animations.



Lightning Risk: 2017-06-23 at 19:41 UTC



70 65 50 35

Lightning Risk within 10 km of overshooting top (%)

IMAPP
Overshooting
Top Lightning
Risk Image
Product



Suite of Products

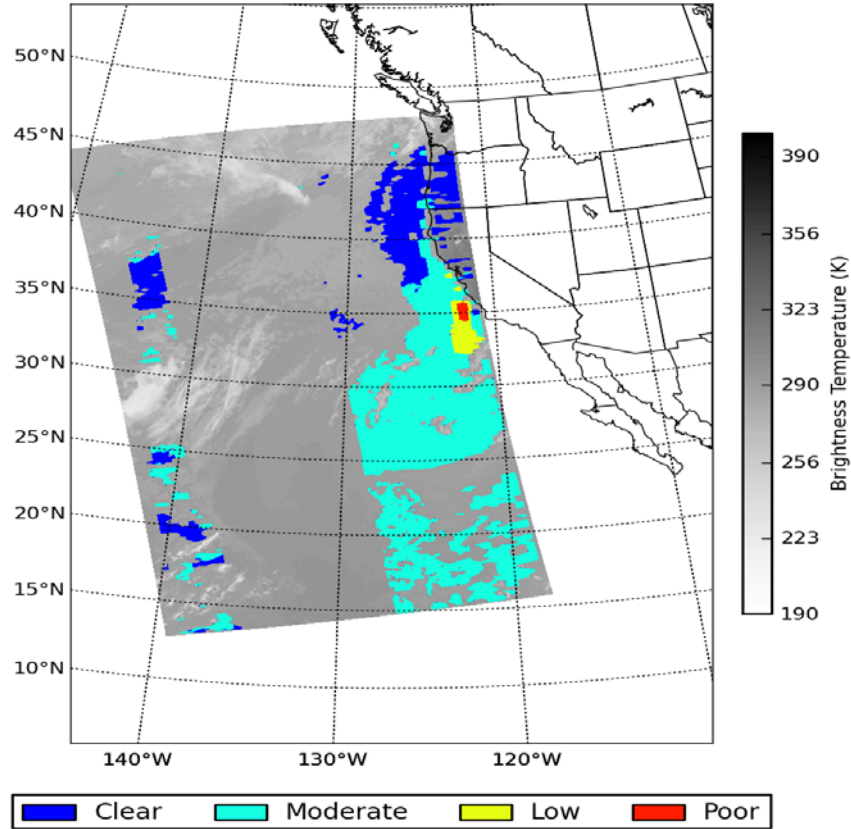


Visibility Products - Aviation Applications

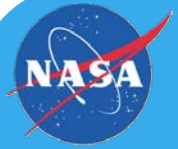
- Aerosol Visibility Product - Brad Pierce - NOAA/STAR
- Fog/Low Status Product
 - Aviation Visibility output products - Software provided by Michael Pavolonis -NOAA/STAR



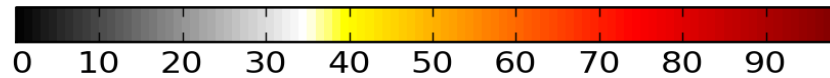
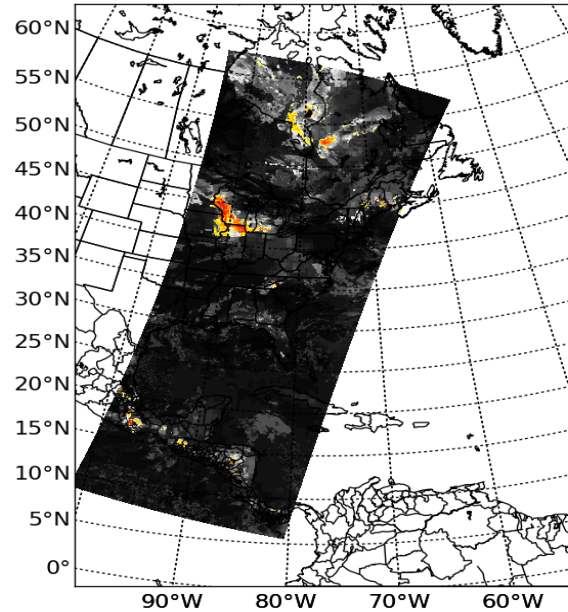
Aerosol Visibility: 2016-06-21 at 22:01 UTC



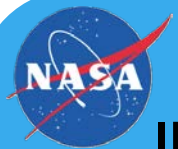
Brunner, J., R. B. Pierce, and A. Lenzen, "Development and validation of satellite-based estimates of surface visibility", *Atmos. Meas. Tech.*, 9, 409-422, 2016.



LIFR fog probability: 2016-06-23 at 07:27 UTC



MODIS Fog and Low Stratus Product



Suite of Products



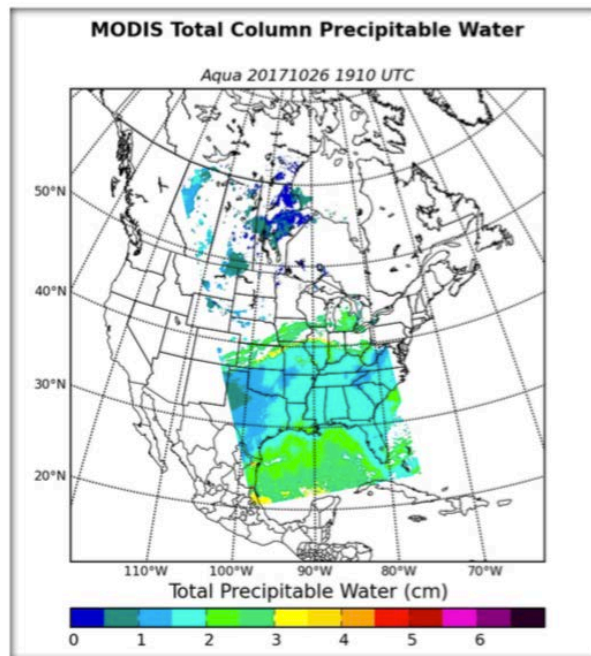
IMAPP Virtual Appliance

- A complete free Aqua and Terra DB processing system (Level 0 to Level 2 products plus quicklooks) in the form of a Virtual Appliance which can be installed and run on:
 - Microsoft Windows (10, 7, Vista, XP; 64 bit)
 - Intel Linux
 - Apple OS X (10.6 or higher)
- Uses most of the freely available software that is available from IMAPP, SeaDAS and NASA DRL
- Easy to install and run full-featured processing system Level 0 - Level 2 plus browse images



IMAPP Virtual Appliance Version 3.0

User's Guide



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November 3, 2017



IMAPP Training Workshops



Global Direct Broadcast Application Workshops



- Promote the local use of satellite data
 - Lectures and hands-on labs determined by student interest/needs
 - Lectures, labs, data and software freely distributed

<http://cimss.ssec.wisc.edu/dbs>

- How can the data inform decision making?
 - Remote sensing complemented by local knowledge
- Encourages international collaborations both between NASA/global science community as well as and community to community
- Teach the principles of remote sensing to foster the next generation of scientists



Timeline of DB Training Courses



- 2004 - Nanjing, China
- 2004 - Perth, Australia
- 2005 - Taipei, Taiwan
- 2005 - Beijing, China
- 2006 - Andenes, Norway
- 2006 - Pretoria, South Africa
- 2007 - Cachoeira Paulista, Brazil as part of **GEOSS**
- 2009 - Stellenbosch University, South Africa
 - IGARSS Short Course 4: MODIS direct broadcast data for enhanced forecasting and real-time environmental decision making**
- 2011 - June - Shanghai, China
- 2011 - September - Indonesia
 - WMO Region V Training workshop on satellite applications for meteorology and climatology**
- 2013 - September - Honolulu, Hawaii
 - Hawaii VIIRS / MODIS Direct Broadcast Applications Workshop**
- 2015 - February - Miami, Florida
 - AOML Miami VIIRS / MODIS Direct Broadcast Applications Workshop**
- 2016 - April - Mayaguez, Puerto Rico
 - Mayaguez Direct Broadcast Applications Workshop - NOAA CREST**
- 2016 - October - Korea as part of the 7th Asia/Oceania Meteorological Satellite Users' Conference (AOMSUC-7)
- 2016 - November - University of Moscow, Russia
- 2017 - June - Hampton University, Virginia, USA



Hampton University Direct Broadcast Applications Workshop 6-9 June 2017





Hampton University Satellite Direct Broadcast Workshop: Polar Orbiter Satellites in Support of Real-Time Environmental Applications



Location: Hampton University, Virginia
Date: 6-9 June 2017

Workshop Agenda

Day One Polar Orbiter Imager Sensors - including MODIS and VIIRS
6 June 2017 Kathy Strabala and Jessica Braun

9:00 AM – 12:00 PM Lecture: Introduction to Polar-Orbiting Satellites and Sensors

- Properties of Polar-Orbiting Satellite sensors
- Bowtie effects and data aggregation
- SDR and Level 1B products and formats
- Software for visualization of SDRs and Level 1B files
- Overview of Direct Broadcast system at Hampton University
- Overview of Software for SDR and L1B file generation
- CSPP – Community Satellite Processing Package

Noon – 1:00 PM Group Lunch and Loading of Lab Data onto Laptops

1:00 PM – 5:00 PM Lab Session: Exploring MODIS and VIIRS L1B data in Hydra

- Learning Hydra
- Exploring S-NPP SDR and MODIS L1B using direct broadcast data
- Exploring VIIRS Day/Night Band Capabilities.





Funding

- 3 year cycle ended 6 June 2017
- Cost extension provided through November 4, 2017
- New NASA ROSES amendment includes real time algorithms for Aqua, Terra and S-NPP
- Awaiting ROSES award announcements to see if IMAPP will continue



NASA ROSES Proposal



- Addition of support NASA Science Investigator-led Processing Systems (SIPS) algorithms for S-NPP and JPSS-1
 - Combined VIIRS/CrIS cloud top pressure and cloud phase
 - Combined VIIRS/NUCAPS clear sky total precipitable water vapor
 - VIIRS Level 2 cloud data records, including cloud mask and cloud microphysical properties
 - VIIRS deep blue arid and semi-arid aerosol retrievals.
 - VIIRS/MODIS dark target aerosol retrievals.
- Expansion of Aviation Products - Kris Bedka
 - NASA Langley Overshooting Tops for VIIRS
 - Aircraft engine icing
- Others
 - Replace DBCRAS NWP model with WRF
 - Update to IDEA-I using high spatial resolution trajectory model
 - More Direct Broadcast Workshops!
 - Leads to numerous long-lasting collaborations



Questions?

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