



# LAND AND VEGETATION DIRECT READOUT WORKSHOP

## IPOPP Implementation at the USDA Forest Service

Brad Quayle  
USDA Forest Service  
Remote Sensing Applications Center (RSAC)

Direct Readout Land/Vegetation Workshop

Mexico City, Mexico  
October 10 & 11, 2007



# USDA Forest Service Organization



- National Headquarters in Washington, DC
- 9 Regional Offices
- National Forest System
  - ◆ 155 National Forests and 20 National Grasslands
    - 600 Ranger Districts
  - ◆ 78 million hectares in CONUS, AK and PR
- Research
  - ◆ 7 stations
  - ◆ 50 field offices
- State and Private Forestry
  - ◆ Fire & Aviation
  - ◆ Forest Health Protection
- International Programs





# Remote Sensing Applications Center (RSAC)

- National Technical Center
- Detached Washington Office unit of Engineering staff
- Located in Salt Lake City, Utah
- *Mission:* Provide national assistance to agency field units in applying the most advanced geospatial technology toward improved monitoring and mapping of natural resources



# Forest Service MODIS Active Fire Mapping Program

USDA FOREST SERVICE REMOTE SENSING APPLICATIONS CENTER

## MODIS Active Fire Mapping Program

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Fire locations are based on data provided by the National Interagency Fire Center and are subject to change. Move your mouse over the fire indicators or click to see additional information (popups required).

### Large Incidents - September 04, 2007

Legend:

- Wildland Fire - IMT1
- Wildland Fire - IMT2
- Wildland Fire - Other
- WFU Fire

1 LAZY	12 GROUSE	23 FOREST GROVE	34 AHORN
2 YOLLA BOLLY COMPLEX	13 NORTH	24 KRASSEL COMPLEX	35 SAWMILL COMPLEX
3 GW FIRE	14 GRAYS CREEK	25 BRIDGE	36 ROMBO MOUNTAIN
4 LICK	15 BUTLER	26 SHOWER BATH COMPLEX	37 FOOL CREEK
5 QUIEN	16 ROSE CREEK	27 BITTERROOT FIRE USE COMPLEX	38 PATTENGAIL CREEK
6 MOONLIGHT	17 EAST ZONE COMPLEX	28 CASTLE ROCK	39 CONGER CREEK
7 DOMKE LAKE COMPLEX	18 CHIEF PARRISH	29 CORPORAL	40 SWEETWATER
8 BIG BASIN COMPLEX	19 RATTLESNAKE	30 CONFLUENCE COMPLEX	41 WH COMPLEX
9 SOUTH OMAK LAKE	20 CASCADE COMPLEX	31 JOCKO LAKES	42 CHOUTEAU CO. ASST.
10 OTTER CREEK	21 BH	32 MIDDLE MOUNTAIN	43 NORTHEND COMPLEX
11 FAIRMONT	22 CHIPPY CREEK	33 RAT CREEK	

View Printable Map View High Resolution Map Definition of Map Terms Download KMZ File Select a Fire Go

### News

Posted August 18, 2007

Terra MODIS direct broadcast update: On August 16th, NASA successfully restored Terra's X band direct broadcast capability that had been unavailable since August 3rd. All geospatial data, mapping and analysis products provided on this website are again utilizing MODIS data from Terra in near real-time via direct broadcast. Aqua MODIS direct broadcast was not affected by this outage and the MODIS Active Fire Mapping program continues to utilize near real-time Aqua MODIS data collected via direct broadcast.

These fire information products were compiled at the USDA Forest Service (USFS) Remote Sensing Applications Center in cooperation with...

RSAC  
Remote Sensing Applications Center  
2222 W. 2300 South  
Salt Lake City, UT  
84119 - 2020  
voice: (801) 975-3737  
fax: (801) 975-3478



- Operational wildland fire detection & monitoring
- Direct readout-based
- United States & Canada
- Near real-time maps, data and imagery



**Rapid Response**



<http://activefiremaps.fs.fed.us>



# Forest Service Direct Readout Issues

- Maintenance of existing direct readout algorithms/products
- Integration of new direct readout algorithms/products
- EOS to NPP transition

# International Polar Orbiter Processing Package

- Direct readout processing environment
  - ◆ Process, visualize and evaluate:
    - NPP/NPOESS SDRs & EDRs
    - Terra/Aqua L1A/B & L2 products
- Built on the NISGS framework
  - ◆ Modular components; scaleable
- Algorithms
  - ◆ Latest land, ocean & atmosphere algorithms for direct readout environment
- IPOPP Development
  - ◆ NASA Direct Readout Laboratory
  - ◆ NOAA Integrated Program Office
  - ◆ University of Wisconsin - Cooperative Institute of Meteorological Satellite Studies



# IPOPP Alpha Test Program

- RSAC is one of 4 Alpha Testers for IPOPP



# IPOPP Alpha Test - Roles/Responsibilities

## NASA Direct Readout Lab (DRL)

- Alpha release version of IPOPP
  - ◆ Core NISGS/IPOPP modules and associated technologies
  - ◆ MODIS land, atmosphere and ocean direct readout algorithms
- Implement feedback into IPOPP development

## RSAC

- Test/evaluate IPOPP in live direct readout environment
  - ◆ Generate products for use and distribution
  - ◆ Provide feedback to DRL
    - Software
    - System performance
    - Products
    - Documentation



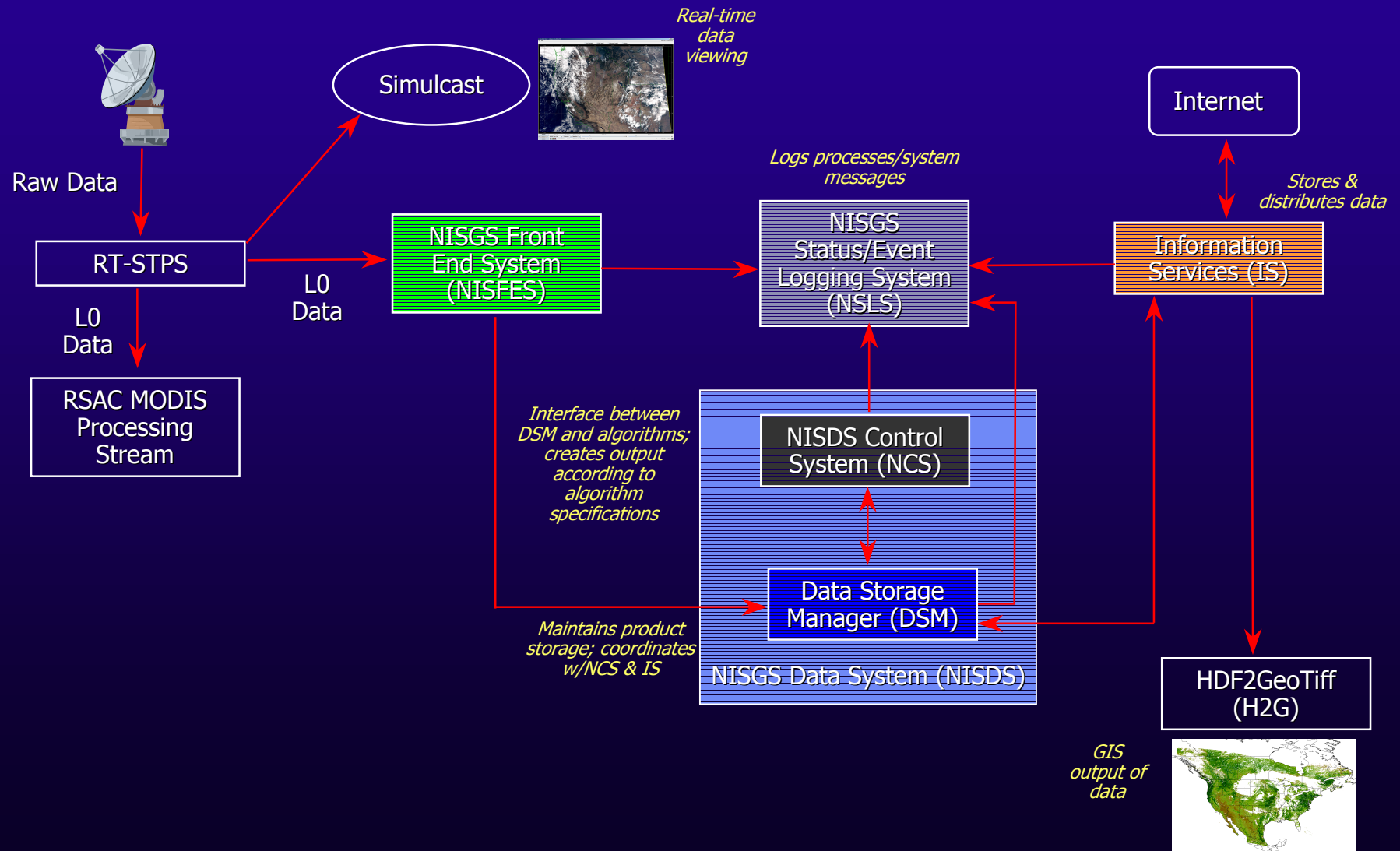
# RSAC IPOPP Alpha Test - Server

- Rack-Mounted 4U Server
  - ◆ 2.2GHz dual AMD Opteron processors, dual core
  - ◆ 8 GB RAM
  - ◆ Linux OS; FC 6
  - ◆ Implemented at RSAC on June 19, 2007



# IPOPP Alpha Test - Processing Configuration

Based on NISGS framework...



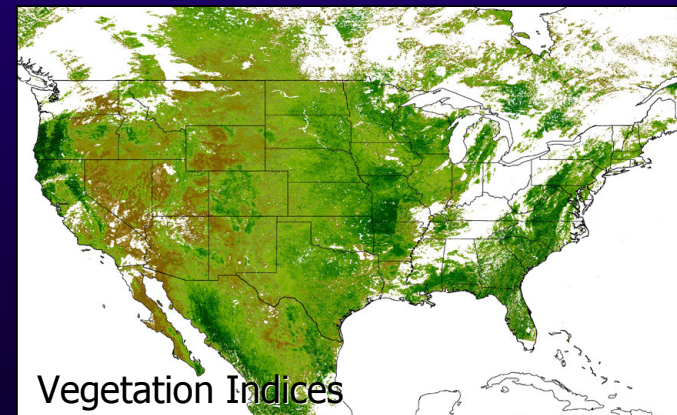
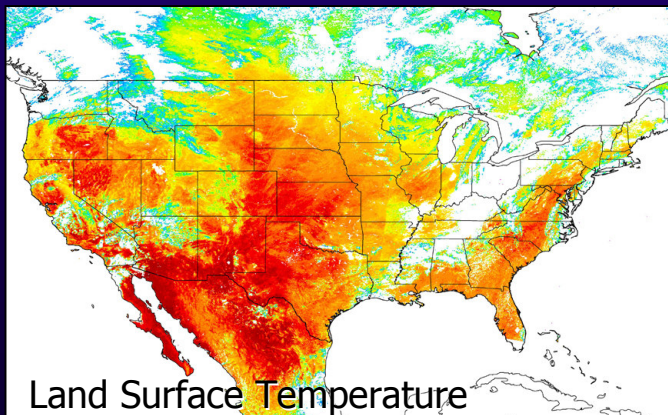
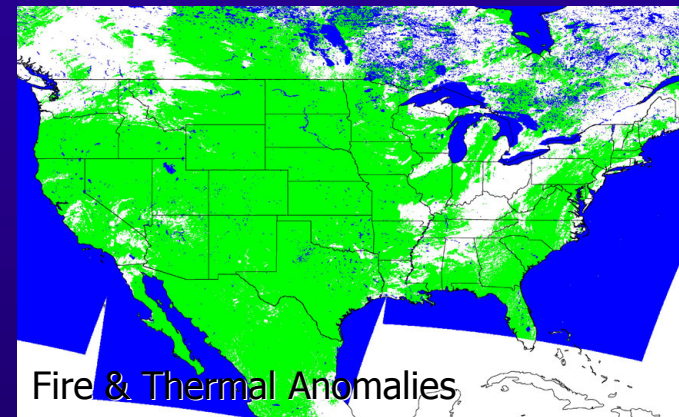
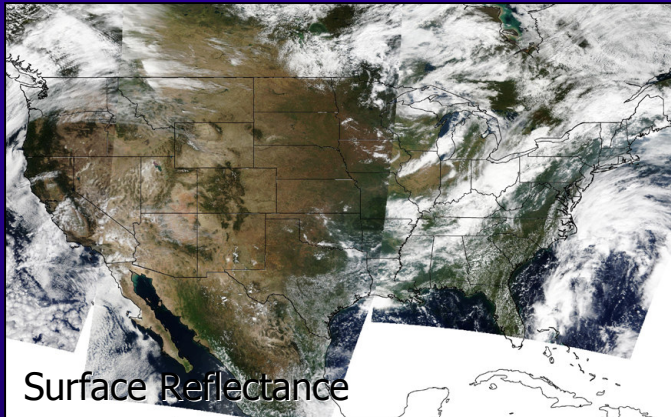


# IPOPP Alpha Test - Science Processing Algorithms

- Using latest Collection 5 (C5) MODIS science algorithms for direct readout environment
  - ◆ Land (4) – MODIS Rapid Response System
  - ◆ Atmosphere (5) – International MODIS/AIRS Processing Package (IMAPP)
  - ◆ Ocean (2) – SeaWiFS Data Analysis System (SeaDAS)
- Science Processing Algorithm (SPA) wrappers
  - ◆ Common command and execution interface
  - ◆ Algorithm customization
  - ◆ Standardization for algorithm updates; prototyping
- Ancillary/auxiliary data dependencies are maintained by NISGS/IPOPP

# IPOPP Alpha Test – SPA Products

## Land Discipline

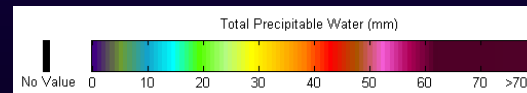
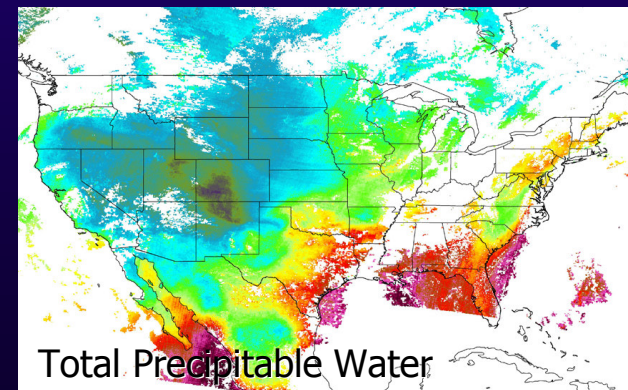
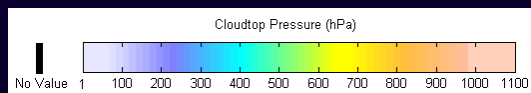
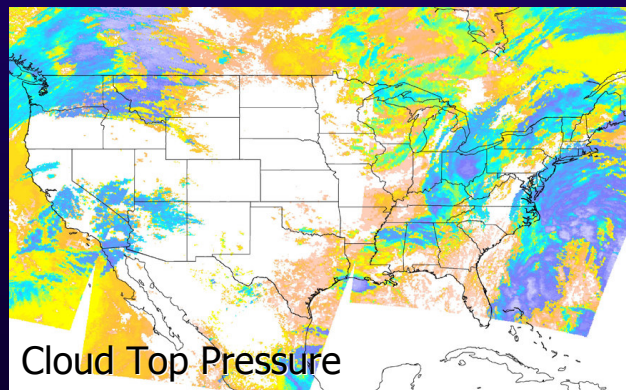
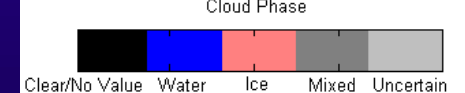
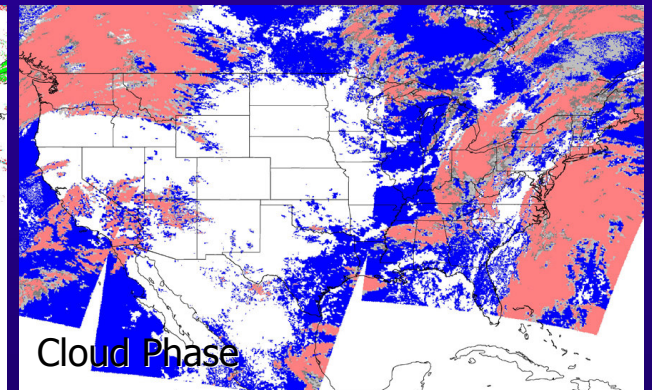
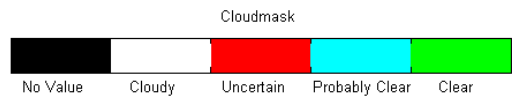
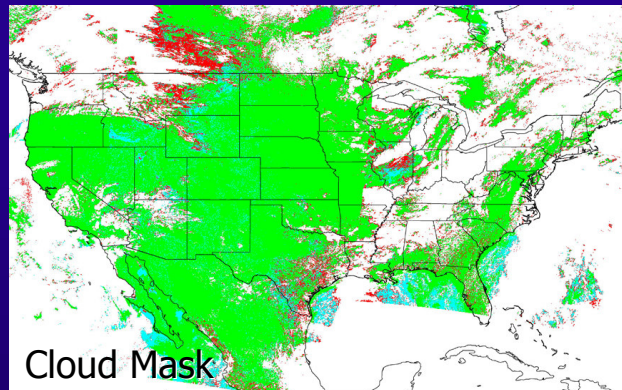
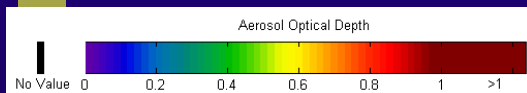
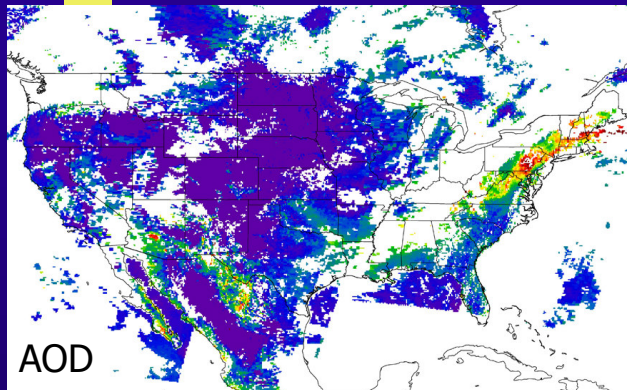


Snow/Ice product coming soon...<sup>NDVI</sup>



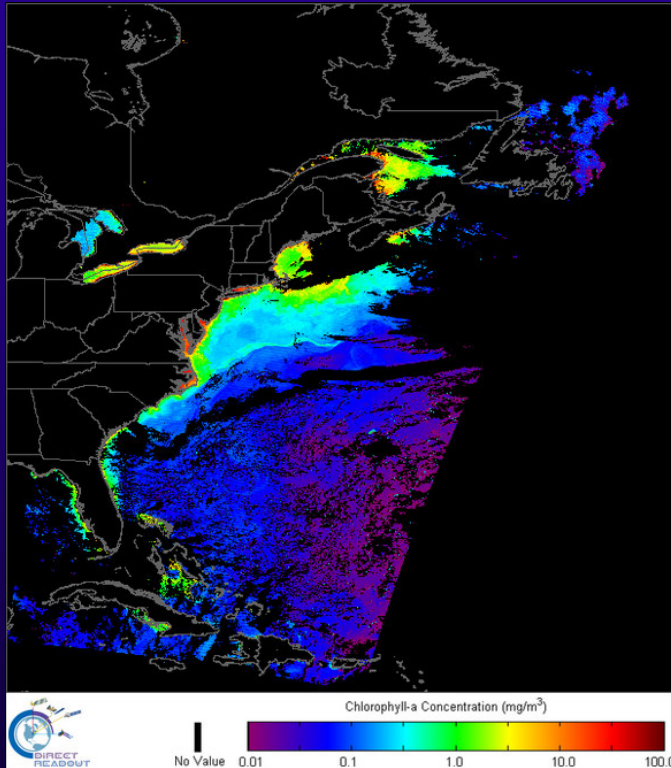
# IPOPP Alpha Test - SPA Products

## Atmosphere Discipline

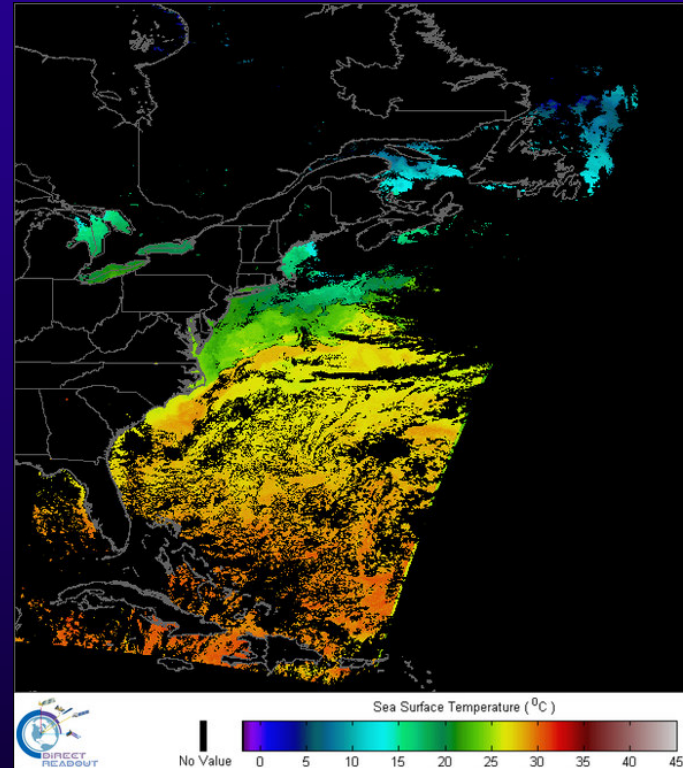


# IPOPP Alpha Test - SPA Products

## Ocean Discipline



Chlorophyll-a Concentration



Sea Surface Temperature

Not tested by RSAC...

# IPOPP Alpha Test - Product Output

- Products generated for entire L0 swath
- Output formats
  - ◆ HDF4
    - Standard output format for L2 products
    - Science data sets (SDS) layers for each L2 product
  - ◆ GeoTiff
    - Output using HDF2GeoTiff utility (H2G)
    - Single SDS for each GeoTiff (multi-band output is possible)
    - Geolocated with color map and metadata
    - Projection: Geographic decimal degrees; WGS84 datum/spheroid
- Compatibility
  - ◆ GeoTiff format imports readily or can be used directly in Forest Service enterprise geospatial applications
    - Leica Geosystems Imagine 9.x
    - ESRI ArcGIS 9.x



# IPOPP Alpha Test - Product Output

- Metadata

- ◆ Generated for each product; XML format
- ◆ Generated at each level of processing
  - Processing lineage for each level is captured
  - Aggregate with supplementary metadata information to generate FGDC compliant metadata to meet Forest Service requirements

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  <productType description="MOD014 Fire Detection" is_directory="gsfcd/terra/modis/level2" level="2"
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    <los>2007-09-26 05:12:19</los>
  </pass>
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  <stopTime>2007-09-26 05:12:19</stopTime>
  <creation>2007-09-27 01:30:06</creation>
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  <algorithm>fire-geotiff</algorithm>
  <algorithmVersion>FIRE GEO</algorithmVersion>
  <centerLatitude>40.8073</centerLatitude>
  <centerLongitude>-112.415</centerLongitude>
  <northLatitude>18.2897</northLatitude>
  <southLatitude>63.325</southLatitude>
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  <westLongitude>-135.163</westLongitude>
  <resources>
    <resource id="47067" path="gsfcd/terra/modis/level2/MOD014.07269050038.tif" rkey="DATA"/>
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  <ancestors>
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  <westLongitude>-135.163</westLongitude>
```

## L2 product metadata

### MOD14.07269050038.tif

#### Metadata:

- Identification\_Information
- Data\_Quality\_Information
- Spatial\_Data\_Organization\_Information
- Spatial\_Reference\_Information
- Entity\_and\_Attribute\_Information
- Distribution\_Information
- Metadata\_Reference\_Information

## FGDC metadata

#### Identification\_Information:

Citation:  
Originator: USDA Forest Service  
Publication\_Date: 9/26/2007  
Title:  
MOD14.07269050038.tif  
Geospatial\_Data\_Presentation\_Form: remote-sensing image  
Online\_Linkage: <http://CIBAM04FRFC/Name=014.07269050038.tif>  
Description:  
Abstract:  
Terra MODIS MOD14 Fire and Thermal Anomalies data  
Purpose:  
General Use  
Time\_Period\_of\_Content:  
Time\_Period\_Information:  
Single\_Date/Time:  
Calendar\_Date: 9/26/2007  
Time\_of\_Day: 0500 UTC  
Currentness\_Reference:  
ground condition  
Status:  
Progress: Complete  
Maintenance\_and\_Update\_Frequency: None planned  
Spatial\_Domain:  
Bounding\_Coordinates:  
West\_Bounding\_Coordinate: -134.523270  
East\_Bounding\_Coordinate: -89.746626  
North\_Bounding\_Coordinate: 62.850410  
South\_Bounding\_Coordinate: 18.923893

#### Keywords:

Theme:  
Theme\_Keyword: Fire  
Theme\_Keyword: Thermal Anomaly  
Theme\_Keyword: MODIS

#### Entity and Attribute\_Information:

Detailed\_Description:  
Entity\_Type:  
Entity\_Type\_Label: Fire Mask  
Attribute:  
Attribute\_Label: ObjectID  
Attribute\_Definition:  
Internal feature number  
Attribute\_Definition\_Source:  
ESRI  
Attribute\_Domain\_Values:  
Enumerated\_Domain:  
Enumerated\_Domain\_Value: 0  
Enumerated\_Domain\_Value\_Definition:  
Not Processed (missing data)  
Enumerated\_Domain:  
Enumerated\_Domain\_Value: 1  
Enumerated\_Domain\_Value\_Definition:  
Not Processed (obsolete)  
Enumerated\_Domain:  
Enumerated\_Domain\_Value: 2  
Enumerated\_Domain\_Value\_Definition:  
Not Processed (other reason)  
Enumerated\_Domain:  
Enumerated\_Domain\_Value: 3  
Enumerated\_Domain\_Value\_Definition:  
Water  
Enumerated\_Domain:  
Enumerated\_Domain\_Value: 4  
Enumerated\_Domain\_Value\_Definition:  
Cloud  
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Enumerated\_Domain\_Value: 5  
Enumerated\_Domain\_Value\_Definition:  
No Fire  
Enumerated\_Domain:  
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Unknown  
Enumerated\_Domain:  
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Enumerated\_Domain\_Value\_Definition:  
Fire (low confidence)  
Enumerated\_Domain:

# RSAC IPOPP Alpha Test - System Performance

## Testing Time Period

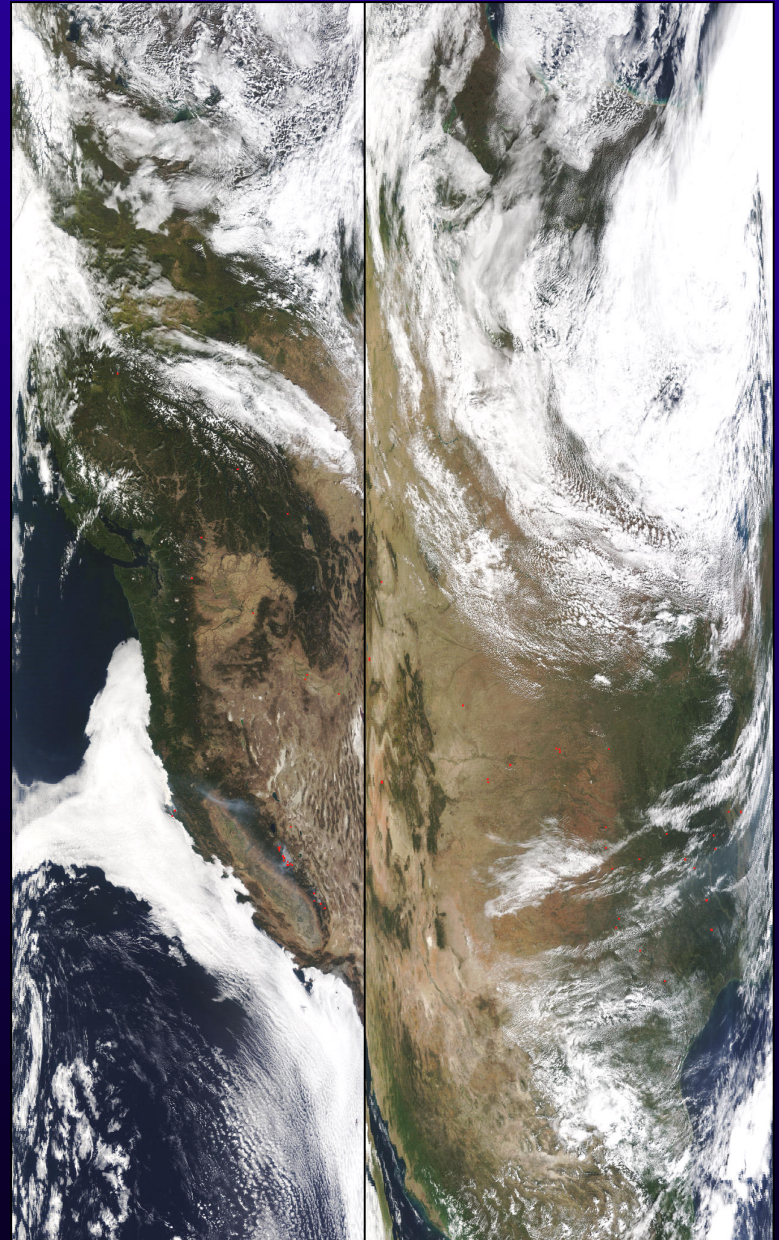
- Processed data on 91 days between June 19, 2007 – October 5, 2007

## Data Ingest

- 695 Terra/Aqua L0 swath granules

## Product Generation Rate

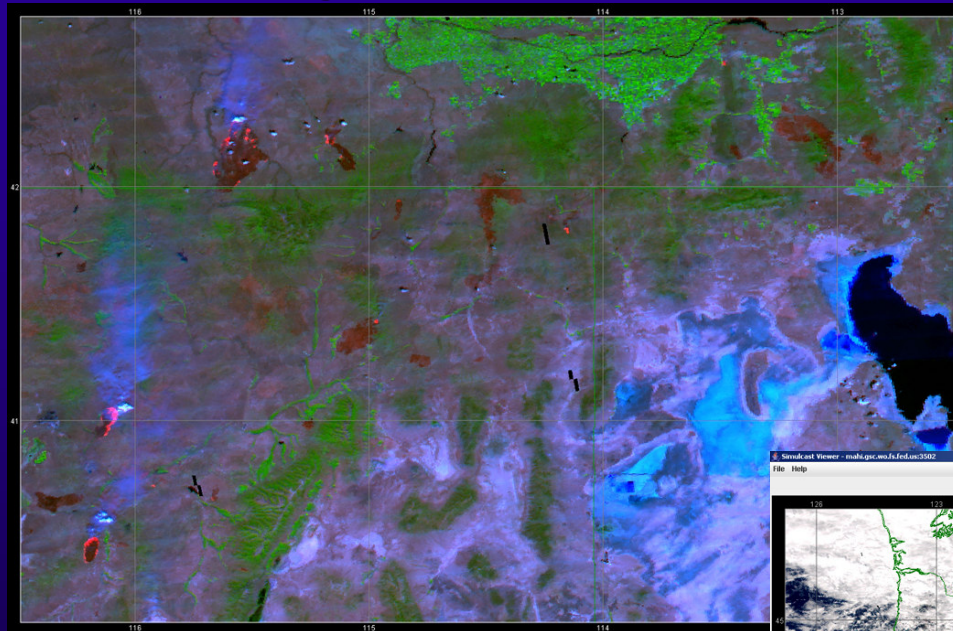
- <1 hour to generate all L2 products from an ~1GB L0 swath (~12-14 minute swath)





# RSAC IPOPP Alpha Test - Simulcast

NRT viewing of direct readout data on a map base

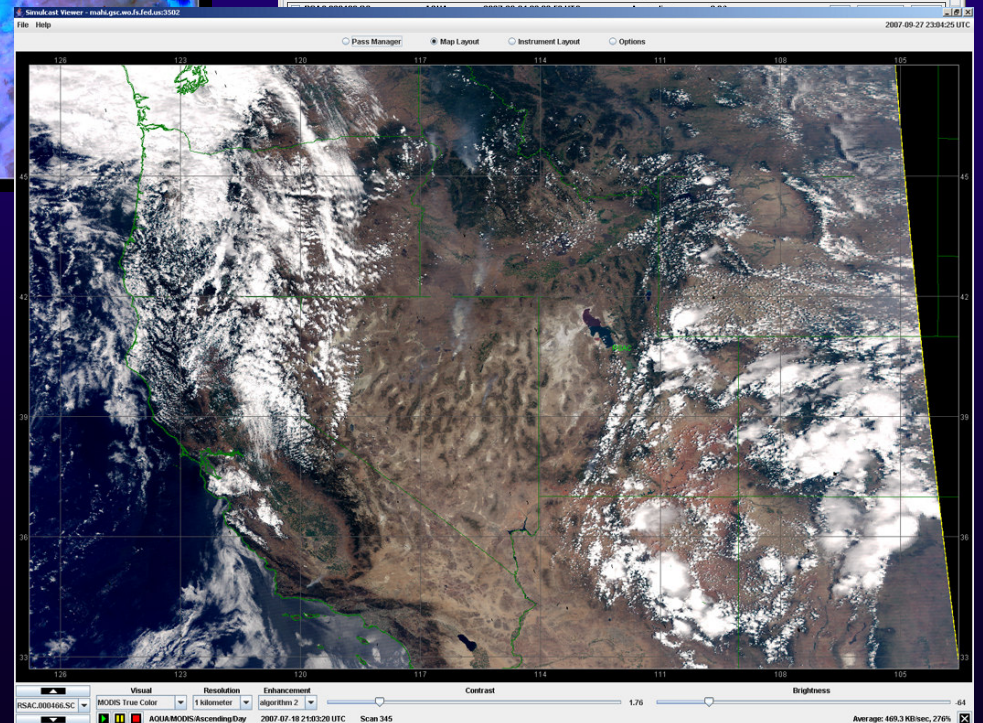


Simulcast Viewer - mahigsc.wu.fs.fed.us:3502					
File Help					
Pass Manager Map Layout Instrument Layout Options					
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RSAC.000424.SC	AQUA	2007-09-23 08:42:09 UTC	Descending	11:09	Map Instrument Details
USDAFS.RSAC	MODIS	2007-09-23 08:53:18 UTC	Night	454	Map Instrument Details
RSAC.000425.SC	AQUA	2007-09-23 10:20:08 UTC	Descending	10:29	Map Instrument Details
USDAFS.RSAC	MODIS	2007-09-23 10:30:38 UTC	Night	428	Map Instrument Details
RSAC.000426.SC	TERRA	2007-09-23 16:33:48 UTC	Descending	2:20	Map Instrument Details
USDAFS.RSAC	MODIS	2007-09-23 16:36:08 UTC	Day	96	Map Instrument Details
RSAC.000427.SC	TERRA	2007-09-23 18:07:49 UTC	Descending	11:29	Map Instrument Details
USDAFS.RSAC	MODIS	2007-09-23 18:18:19 UTC	Day	439	Map Instrument Details
RSAC.000428.SC	TERRA	2007-09-23 19:46:26 UTC	Descending	8:20	Map Instrument Details
USDAFS.RSAC	MODIS	2007-09-23 19:54:49 UTC	Day	330	Map Instrument Details
RSAC.000429.SC	AQUA	2007-09-23 21:25:58 UTC	Ascending	7:46	Map Instrument Details
USDAFS.RSAC	MODIS	2007-09-23 21:33:45 UTC	Day	317	Map Instrument Details
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USDAFS.RSAC	MODIS	2007-09-24 07:55:18 UTC	Night	249	Map Instrument Details
RSAC.000434.SC	AQUA	2007-09-24 09:24:48 UTC	Descending	11:40	Map Instrument Details
USDAFS.RSAC	MODIS	2007-09-24 09:30:29 UTC	Night	475	Map Instrument Details
RSAC.000435.SC	AQUA	2007-09-24 11:04:09 UTC	Descending	6:59	Map Instrument Details
USDAFS.RSAC	MODIS	2007-09-24 11:11:08 UTC	Night	285	Map Instrument Details
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USDAFS.RSAC	MODIS	2007-09-24 17:23:09 UTC	Day	401	Map Instrument Details
RSAC.000437.SC	TERRA	2007-09-24 18:58:29 UTC	Descending	11:19	Map Instrument Details
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Simulcast server hosted by RSAC; available to USFS and BLM users.

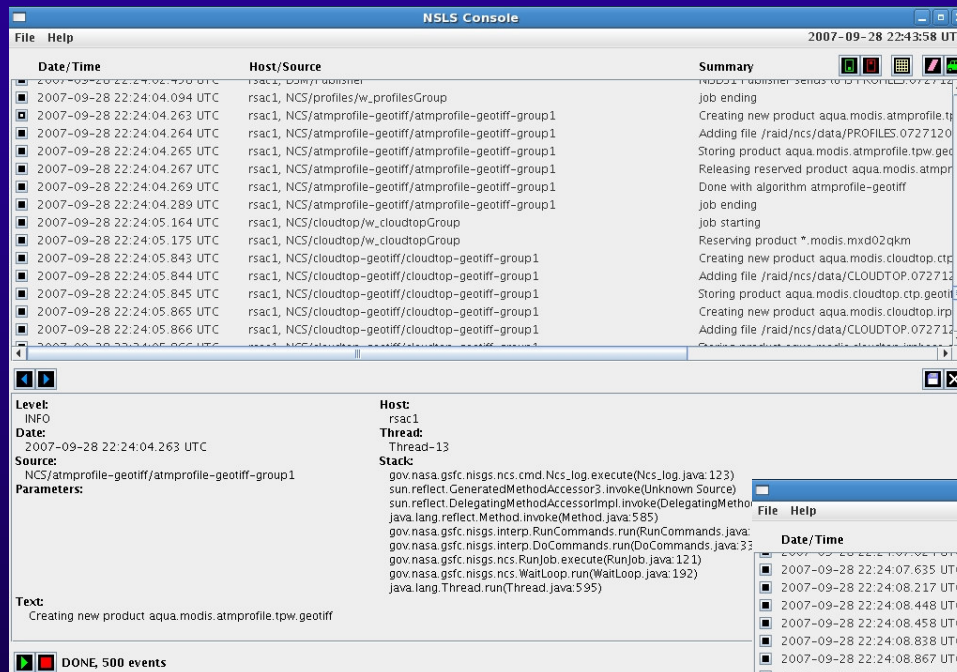
Used at RSAC to review acquisitions in NRT.

Also used by fire managers; air quality specialists.



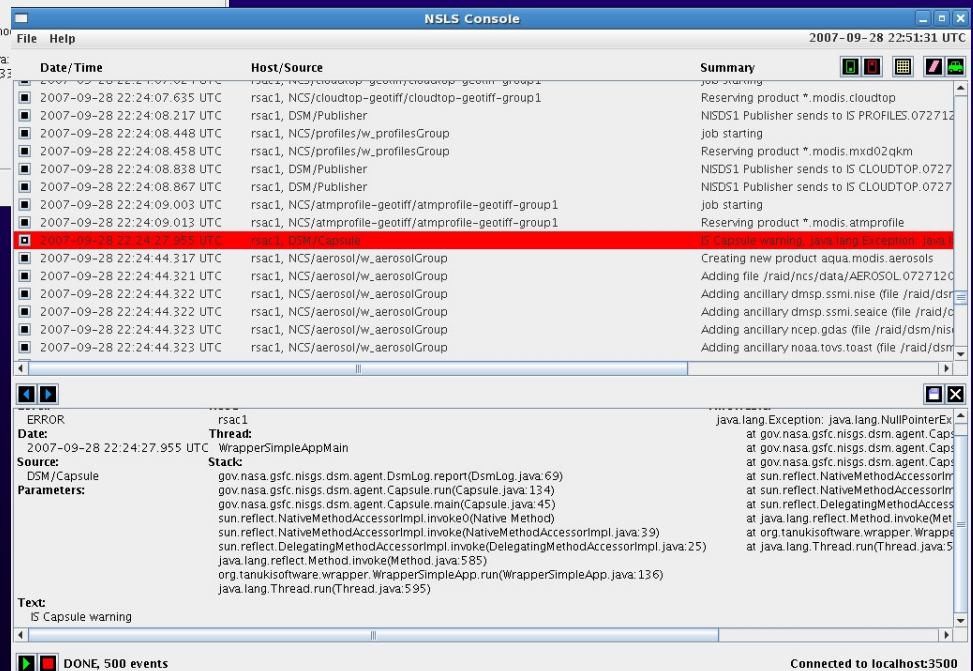
# RSAC IPOPP Alpha Test - NSLS

## NISGS Status/Event Logging System (NSLS)



Logs all status and event messages from processing system

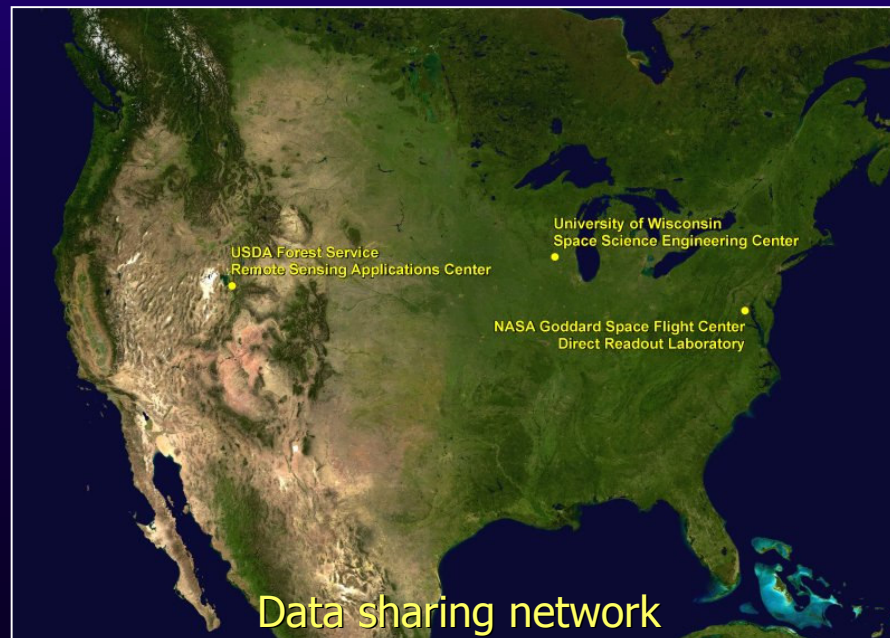
Used during Alpha testing to monitor all system processes; troubleshooting





# RSAC IPOPP Alpha Test – Looking Forward

- Additional testing/feedback
- Increase data processing volume
  - ◆ CONUS coverage with additional ground station data
- Evaluate integration of new algorithms of utility to Forest Service
- Data product distribution
- Data integration into relevant Forest Service applications



# IPOPP Product Distribution By RSAC

## Product Website – Unrestricted Access

Products

RSAC Level 0  
data

[Home](#)  
**Recent Products**  
[Latest Aqua and Terra Passes](#)  
**Land Products**  
[Fire and Thermal Anomalies](#)  
[Land Surface Temperature](#)  
[Surface Reflectance](#)  
[Vegetation Indices](#)  
**Atmosphere Products**  
[Aerosol Optical Depth](#)  
[Atmosphere Profiles \(TPW\)](#)  
[Cloud Mask](#)  
[Cloud Top IR Phase](#)  
[Cloud Top Properties](#)  
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**Related Technologies**  
[RTSTPS](#)  
[Simulcast](#)  
**Links**  
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[NASA Direct Readout Lab](#)  
[MODIS](#)  
[Terra](#)  
[Aqua](#)

### USDA Forest Service RSAC Direct Readout Data Products

The USDA Forest Service Remote Sensing Applications Center (RSAC) Direct Readout Portal provides access to high temporal, moderate resolution imagery, and derivative land, atmosphere and ocean data products. The objective of this program is to provide timely science data products and information to aid resource management and environmental monitoring by the Forest Service and other federal/state resource management agencies.



Direct readout data are utilized by this program and collected in near real-time from selected satellite sensors. RSAC operates an X-band antenna at its ground station facilities in Salt Lake City, Utah and currently collects MODIS direct broadcast data directly from both the Terra and Aqua satellite platforms. Additional near real-time data from other North American ground stations are also compiled and integrated at the RSAC facility. These data are made available as part of a [data sharing network](#) between participating ground stations. Together, this network facilitates comprehensive coverage of the continental United States, southern Canada and northern Mexico.



Level 2 MODIS data products provided on this website are generated at RSAC using the [International Polar Orbiting Processing Package \(IPOPP\)](#). IPOPP is a direct readout data processing package sponsored by the [NPOESS Integrated Program Office \(IPO\)](#). IPOPP software is an evolution of the NASA/GSFC [NPOESS Preparatory Project \(NPP\)](#), NPP In-Situ Ground Station (NISGS) processing framework, International MODIS/AIRS Processing Package (IMAPP) (Atmospheres) and SeaWiFS Data Analysis System (SeaDAS) (Oceans) packages, and the MODIS Land Rapid Response (Land) algorithms. The IPO, NASA Direct Readout Laboratory (DRL), and the Cooperative Institute of Meteorological Satellite Studies (CIMSS) of the University of Wisconsin are collaborating to develop the package. The IPOPP package uses the latest Science Processing Algorithms (SPAs) and related technologies to facilitate the processing, visualization and evaluation of direct readout data. IPOPP is designed to be the primary direct readout processing package for the National Polar-orbiting Operational Environmental Satellite System and NPOESS Preparatory Project sensor and Environmental Data Records (EDRs), in particular for the [VIIRS](#), [ATMS](#), and [CrIS](#). It also supports current Earth Observing System (EOS) MODIS image and data products and will facilitate the transition to the NPOESS era.



  
**Remote Sensing Applications Center**  
2222 W. 2300 South  
Salt Lake City, UT  
84119 - 2020  
voice: (801) 975-3750  
fax: (801) 975-3476  
  
  
  
  
  
  
National Aeronautics and Space Administration

<http://svinetfc6.fs.fed.us/directreadout>

# IPOPP Product Distribution By RSAC

## Product Website – Unrestricted Access

[Home](#)

### Recent Products

[Latest Aqua and Terra Passes](#)

### Land Products

[Fire and Thermal Anomalies](#)  
[Land Surface Temperature](#)  
[Surface Reflectance](#)  
[Vegetation Indices](#)

### Atmosphere Products

[Aerosol Optical Depth](#)  
[Atmosphere Profiles \(TPW\)](#)  
[Cloud Mask](#)  
[Cloud Top IR Phase](#)  
[Cloud Top Properties](#)

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### Related Technologies

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### Remote Sensing Applications Center

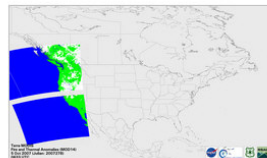
2222 W. 2300 South  
Salt Lake City, UT  
84119 - 2020  
voice: (801) 975-3750  
fax: (801) 975-3478



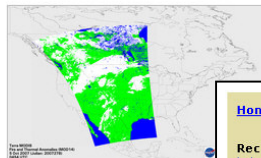
National Aeronautics and Space Administration

### Fire and Thermal Anomalies ([product description](#))

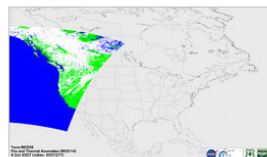
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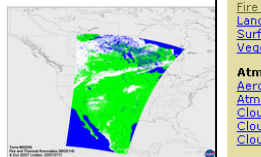
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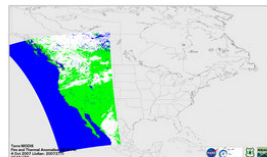
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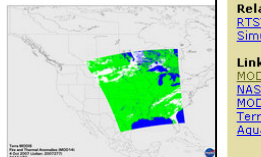
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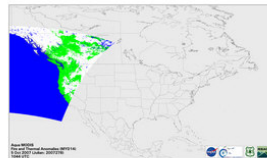


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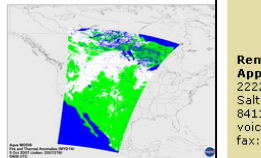


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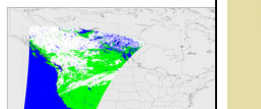
#### AQUA



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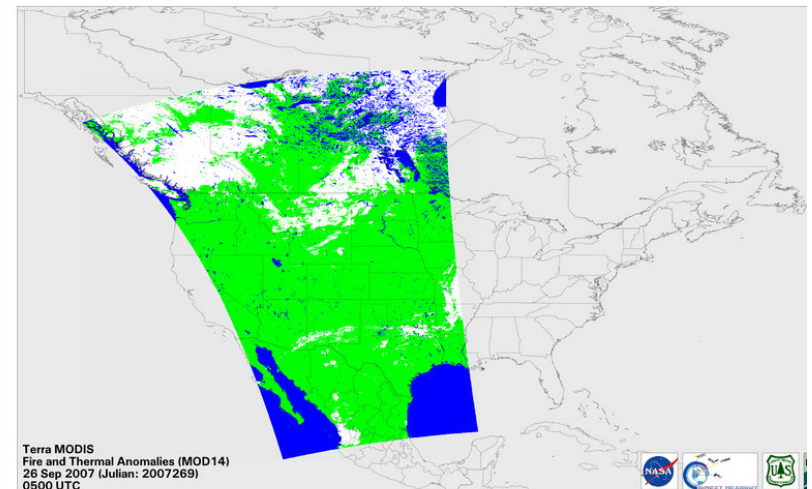


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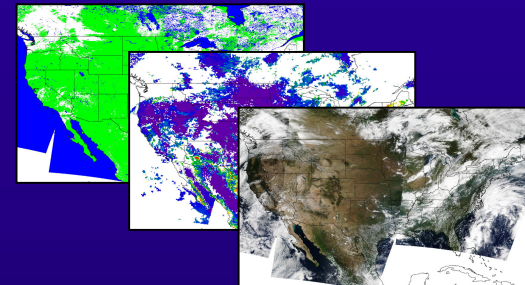
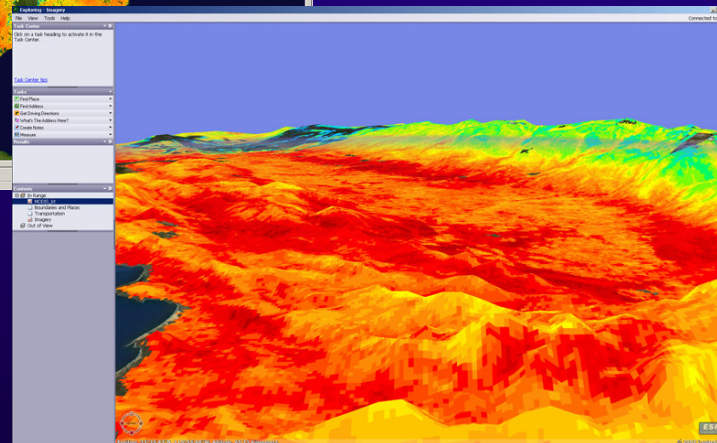
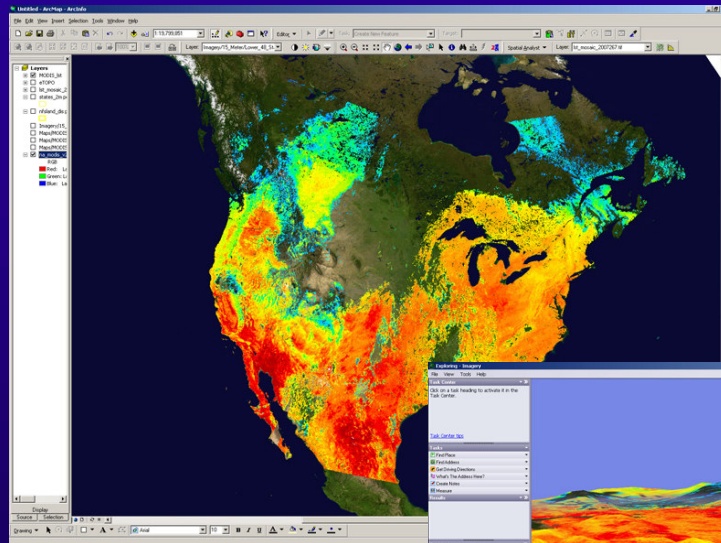
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# IPOPP Product Distribution By RSAC

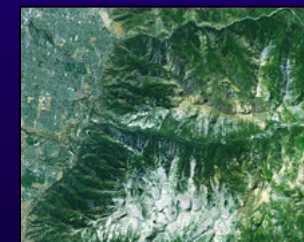
## Enterprise Data Services – USFS access only



Daily  
MODIS  
IPOPP  
Products



MODIS  
Blue  
Marble



15 meter pan-  
sharpened  
Landsat



1-2 meter  
digital  
ortho  
photos

Instant access to local/regional/national  
scale imagery for CONUS via GIS client

No need to download data

Integrate with other geospatial data

2D/3D visualization

USFS corporate image datasets



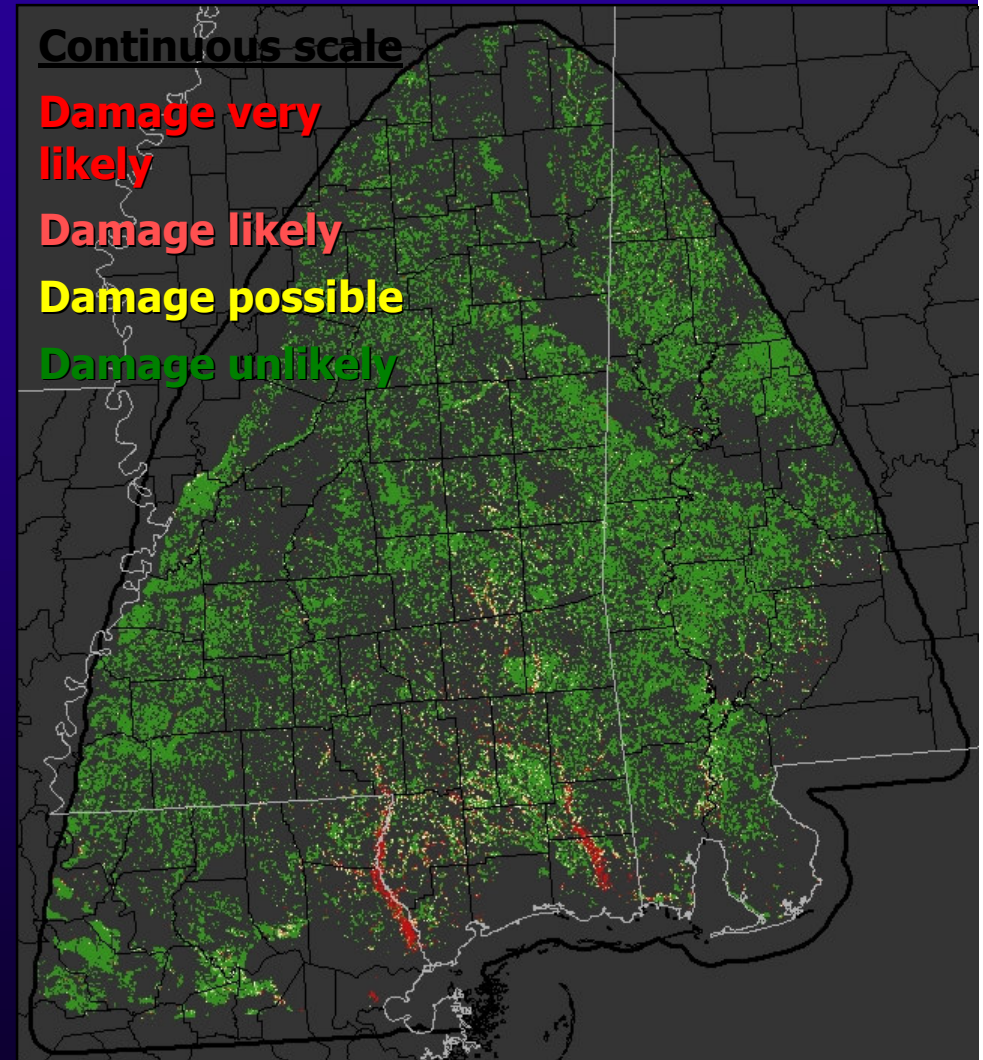
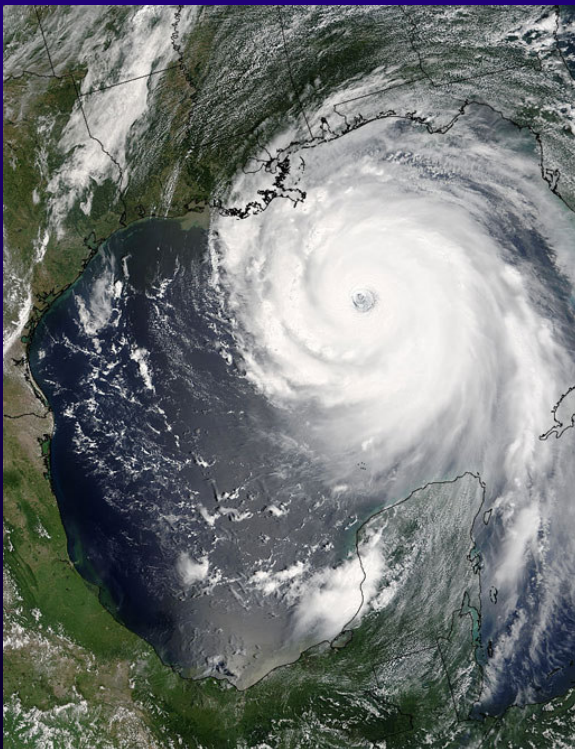
# Example USFS Applications of IPOPP Products

Both time-sensitive & routine applications...

- Wildland Fire
  - ◆ Fire detection and monitoring
  - ◆ Burn area mapping/assessment
  - ◆ Fire risk/forecasting assessments
- Monitoring
  - ◆ Ecosystem disturbance/Post-catastrophic event damage assessment
  - ◆ Vegetation recovery
  - ◆ Air quality
  - ◆ Range management
- Enterprise Data Services/Applications
  - ◆ USFS data server/data visualization services
  - ◆ USDA/USFS decision support applications

# Example - Post Catastrophic Event Rapid Assessment

- Forest Service “rapid response toolkit”
- Approximate estimates of forest damage and its costs within days of a catastrophic event

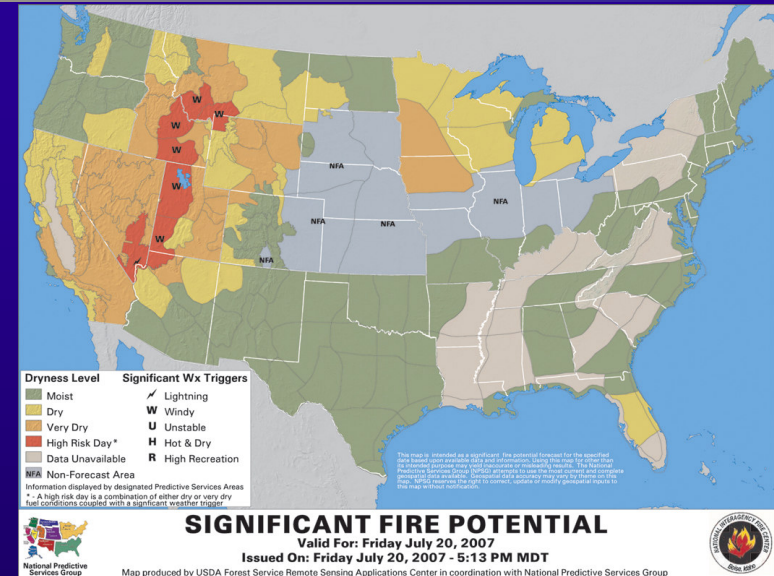
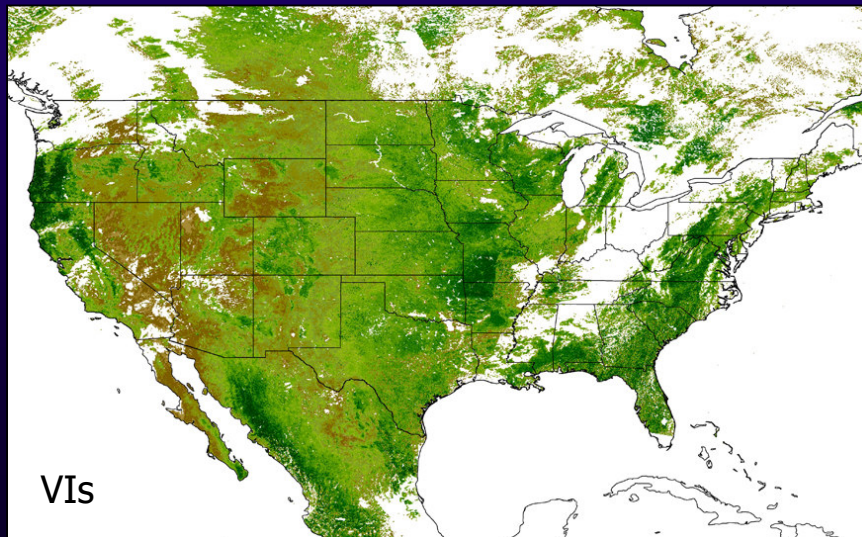


Damage likelihood of forested areas produced using data available 3 days after hurricane Katrina.

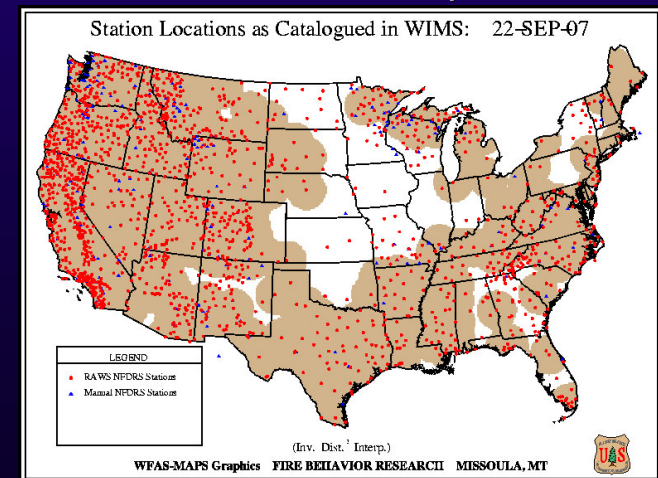


# Example – Predictive Services Fire Forecasting

- Forecast nationwide, daily probability of large fire occurrence within PSAs over a 7-day period
- Variables:
  - ♦ Fuel moisture
  - ♦ Ignition triggers
  - ♦ Resource availability
- Fuel moisture currently based on Wx station indices



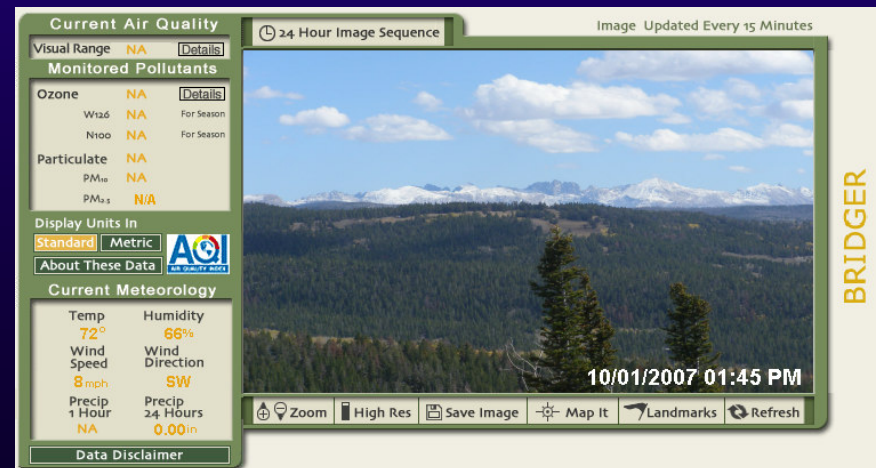
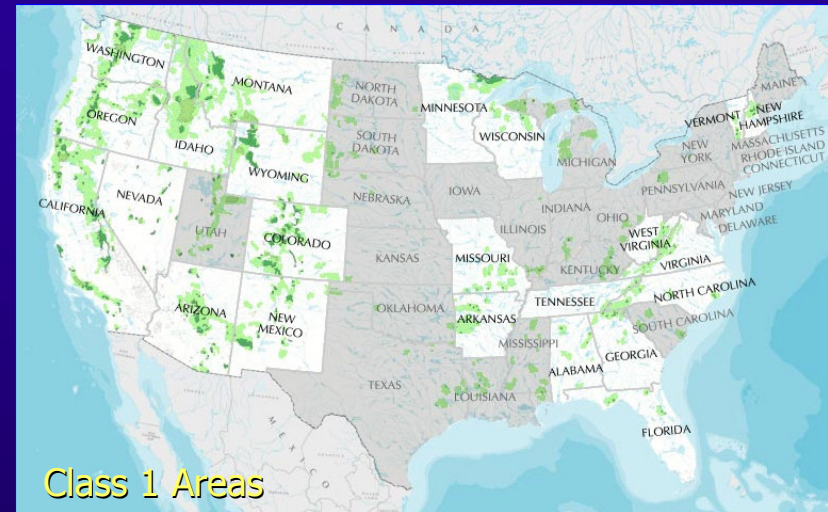
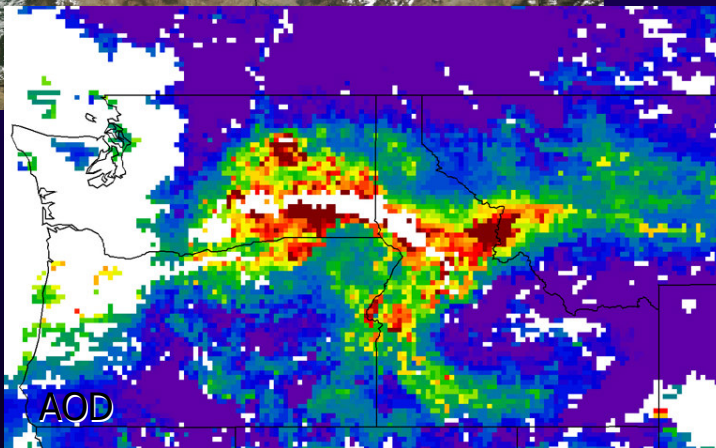
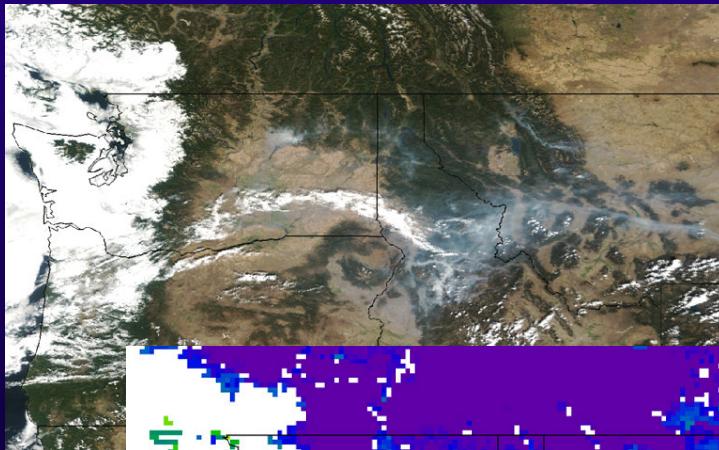
July 20, 2007 Significant Fire Forecast – Day 1



National Fire Danger Rating System  
Wx Stations

# Example – Air Quality Monitoring

- Forest Service closely monitors air quality for Class 1 areas, population centers, etc.
- Real time air quality data (visibility, particulate matter) is collected at Forest Service monitoring sites



USFS real time air quality monitor site



# IPOPP Alpha Test - Conclusion/Summary

- Modular, scaleable processing framework
  - ◆ Direct readout processing “a la carte”
- Facilitates implementation of algorithms in the DR environment
  - ◆ Provides standardized framework for updating existing algorithms and implementation of new algorithms
    - EOS and NPP
- Access to suite of latest DR products will facilitate multi-disciplinary needs/applications within the Forest Service
- “GIS ready” output with metadata
  - ◆ Facilitate use by users
  - ◆ Compatible with Forest Service applications and data services
- Ancillary tools for monitoring system/processes and visualizing data

## **Additional Information**

### **USDA Forest Service Remote Sensing Applications Center**

<http://www.fs.fed.us/enq/rsac>

### **USDA Forest Service RSAC Direct Readout Product Portal**

<http://svinetfc6.fs.fed.us/directreadout>

### **NASA GSFC IPOPP and Alpha Test Program**

<http://directreadout.gsfc.nasa.gov/index.cfm?section=technology&page=IPOPP>