USDA Forest Service Remote Sensing Applications Center Update

Brad Quayle

Rapid Disturbance Assessment and Services Program
USDA Forest Service
Remote Sensing Applications Center

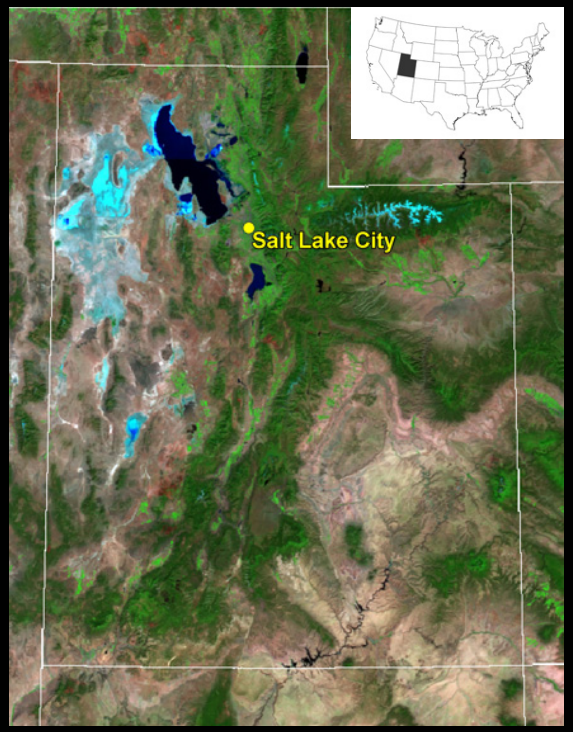
NASA Wildfires Program Review Meeting
Boise, Idaho
March 2, 2016

USDA Forest Service, Remote Sensing Applications Center,
FSWeb: http://fsweb.rsac.fs.fed.us
WWW: http://www.fs.fed.us/eng/rsac

Aqua MODIS – September 19, 2014

Remote Sensing Applications Center (RSAC)

- National Forest System Deputy Area; Engineering Staff
- National Technical Center
- *Mission:* Provide assistance to agency units and national program partners in applying the most advanced remote sensing/geospatial technologies for improved mapping and monitoring of natural resources.



RSAC Organization

- Center Director – Vacant
- 4 Program areas:
  - Enterprise Data & Services (EDS)
    - Dave Vanderzanden
  - Remote Sensing Evaluation, Application & Training (RSEAT)
    - Haans Fisk
  - Resource Mapping, Inventory & Monitoring (RMIM)
    - Kevin Megown
  - Rapid Disturbance Assessment & Services (RDAS)
    - Brad Quayle
- 10 federal FTEs, ~50 contract staff
  - A blend of highly skilled technical staff - remote sensing, image processing, GIS, IT, and natural resource management

Significant Ongoing RSAC Events

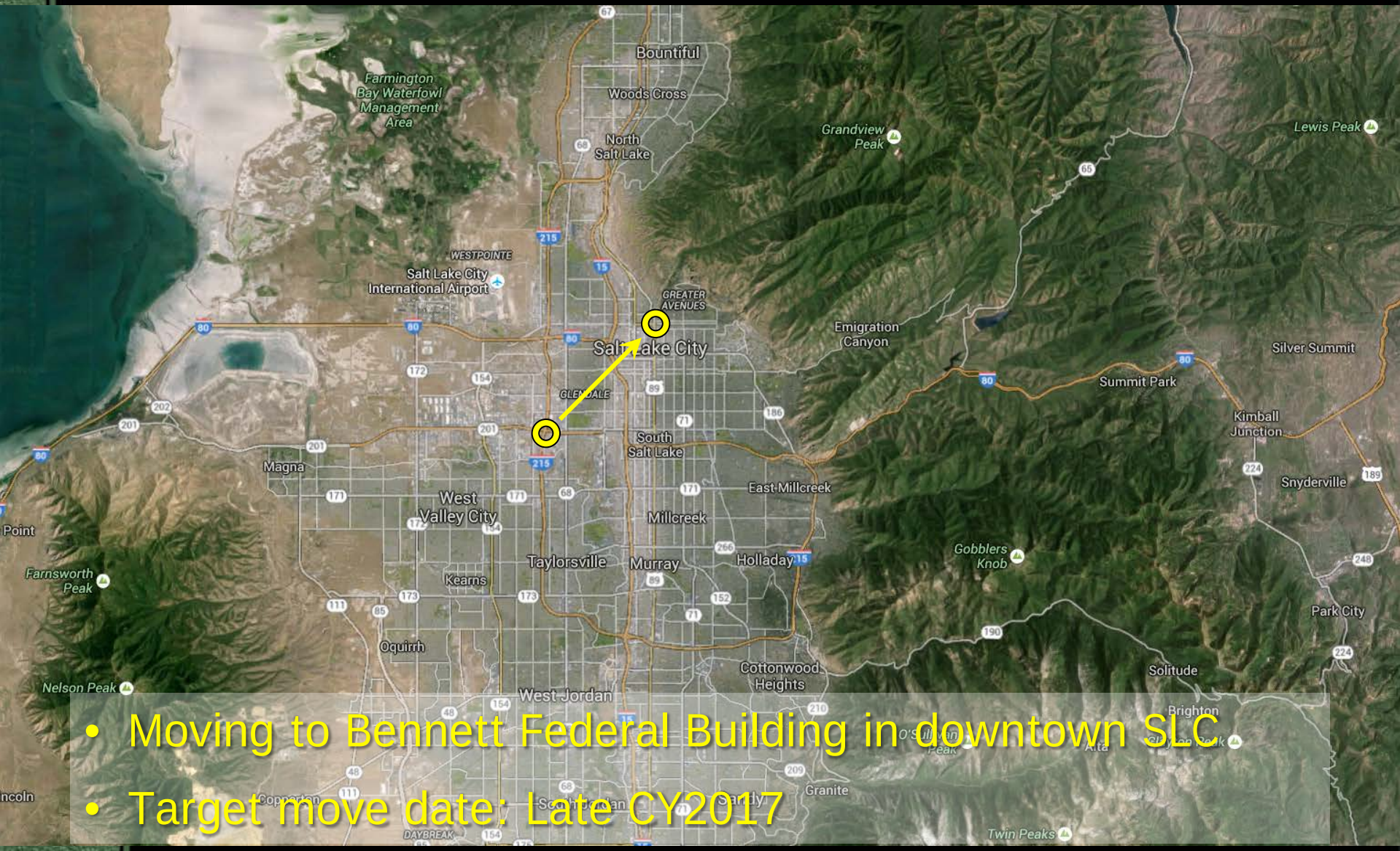
RSAC and GSTC Integration

RSAC + GSTC = Geospatial Technology and Applications Center (GTAC)

- Integration planning activities ongoing the past two years
- Approval by NFS leadership is pending
- Likely to become official in CY2016
- Existing RSAC program areas will remain largely intact

Significant Ongoing RSAC Events

RSAC/GSTC Relocation



- Moving to Bennett Federal Building in downtown SLC
- Target move date: Late CY2017

RSAC Support to Interagency Fire Management

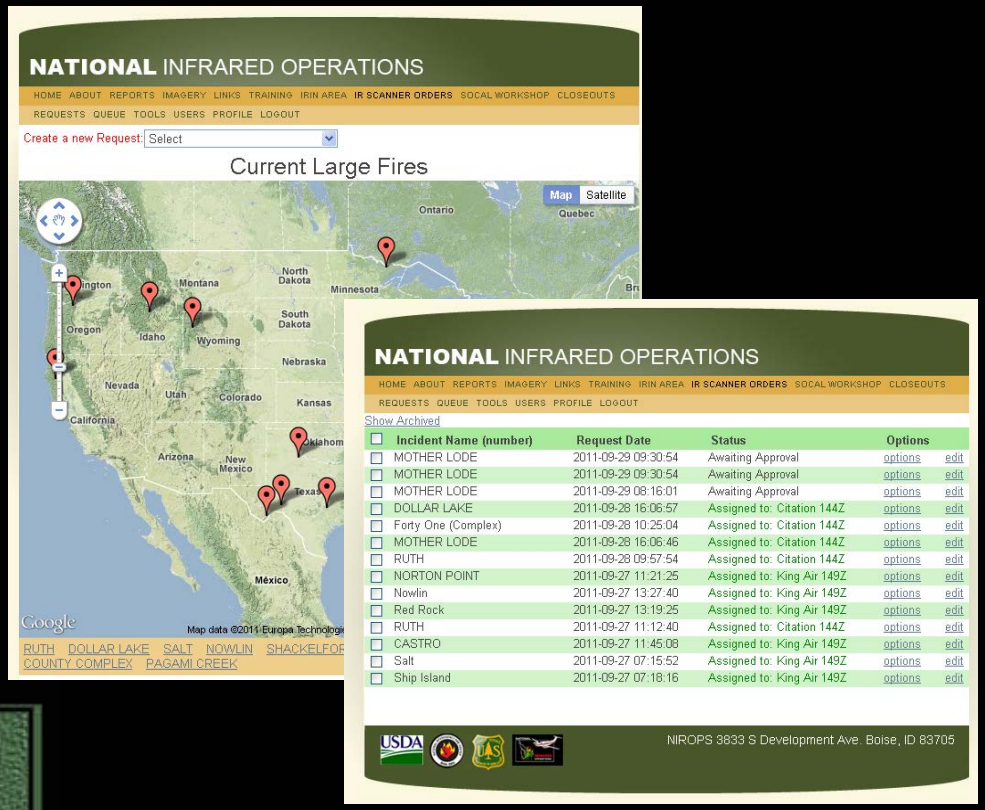
RDAS program provides remote sensing/geospatial support to all phases of fire management

Wildfire Management Phase	Functions	Activities
Preparedness	Fire intelligence and fire risk assessment	National Interagency Coordination Center Support
		Predictive Services Program Support
Detection and Response	Strategic and tactical fire detection, monitoring & mapping	Tactical Fire Mapping Support
		UAS Technology Evaluation/ Integration
		Active Fire Mapping/Satellite DR Operations
Post-Fire Assessment	Burn severity mapping & characterization	Burned Area Emergency Response (BAER) Support
		Reforestation Planning & Prioritization Support
		Monitoring Trends in Burn Severity (MTBS)

Tactical Scale Fire Mapping Support

(http://nirops.fs.fed.us)

- "NIROPS" - National Infrared Operations Unit
- Provides daily high resolution airborne IR imaging
- Facilitates fire detection/mapping products to support incident command operations

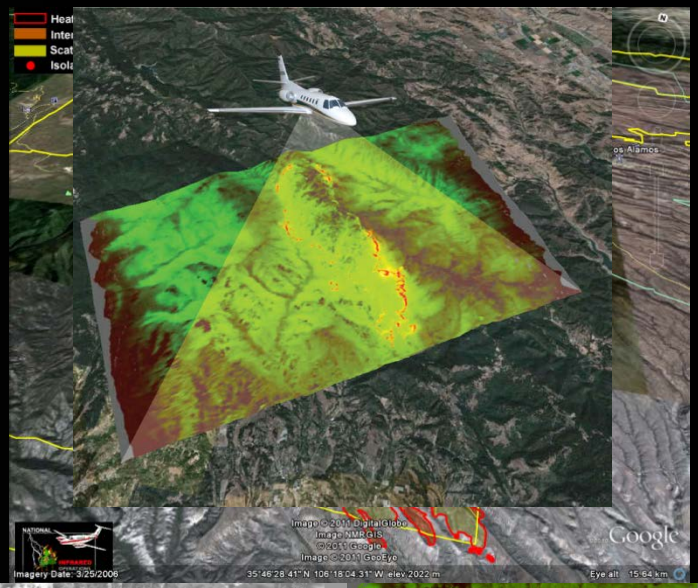


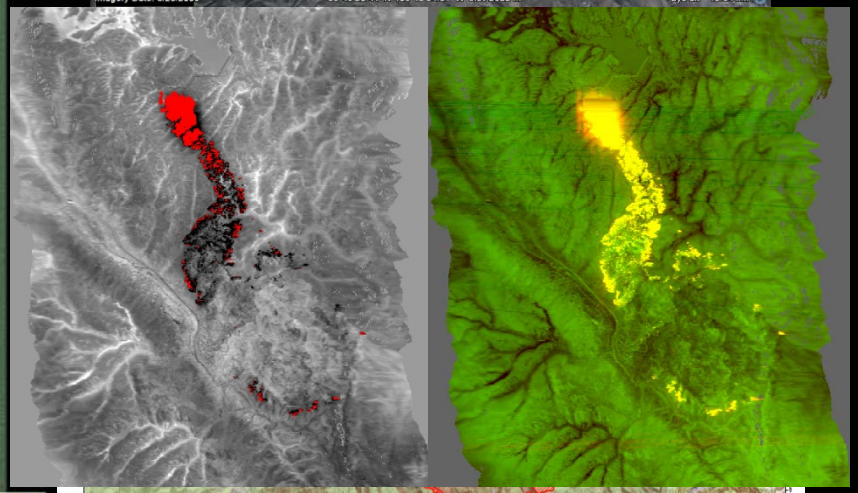
RSAC Support Functions:

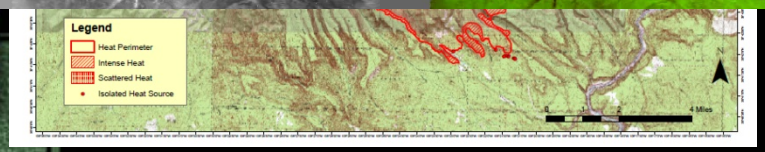
- Maintenance
  - NIROPS website
  - IR ordering system
  - Operations Users Guide
  - IR Vendor listing
- PHOENIX sensor tech support
- Technology evaluation
- IRIN incident support
- IRIN training

Tactical Scale Fire Mapping Support

(http://nirops.fs.fed.us)



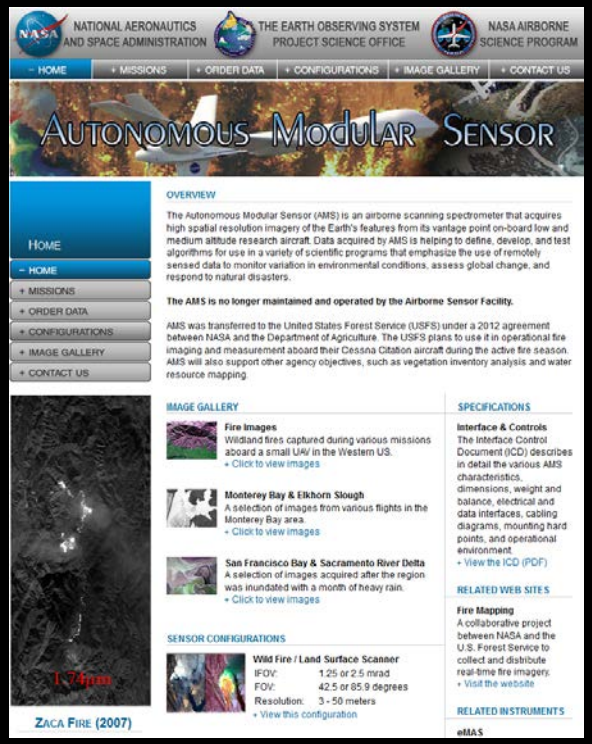


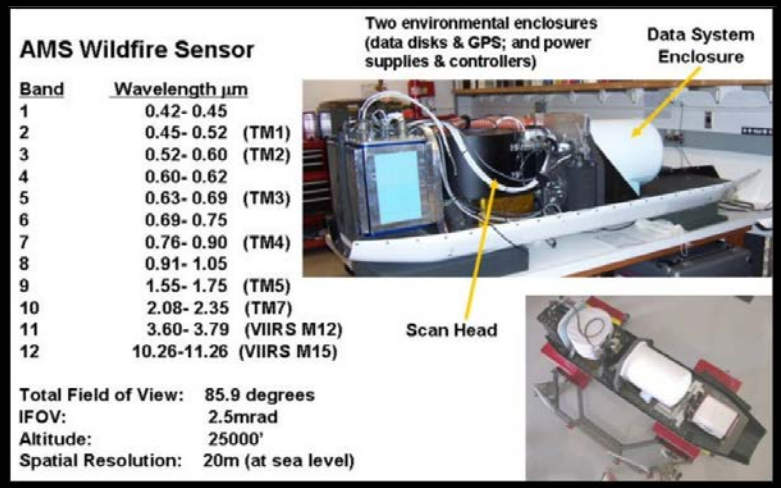


- Airborne PHOENIX imagery acquired by two agency aircraft
- Imagery is pre-processed in flight and downloaded directly to ground for interpretation by IRINs
- High resolution, daily fire map products provided by 6:00 AM
- Products delineate fire perimeter and active fire areas

Autonomous Modular Sensor (AMS)

- 16 band multispectral scanner
- Multi-mission capability
- Developed by NASA Ames and UC Santa Cruz
- Used extensively since 2006 for wildfire mapping & Cal/Val activities
  - Western States Fire Missions
  - Targeted active fire/post-fire incident support
  - USFS tactical fire support operations





AMS Timeline

AMS integrated on Altair; flies Esperanza Fire, Oct 2006

AMS flies No. CA Lightning Storm Wildfires, Summer 2008

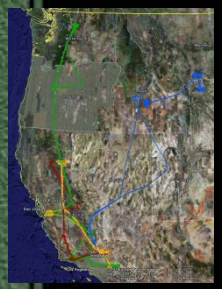
AMS flies Station Fire Post-Fire Assessment, Nov 2009

AMS Integrated on NASA B200 KA, December 2010

First Test Flight Data From AMS on Citation, March 2013

2006 2007 2008 2009 2010 2011 2012 2013

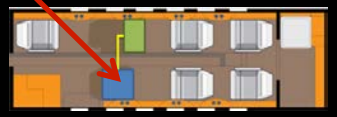
AMS integrated on Ikhana; flies four Western States Fire Missions covering eight states and +20 fires, summer 2007



AMS flies So. CA Firestorm missions; Oct. 2007

AMS flies Los Conches NM Wildfire & 2 So. CA Wildfires

AMS Integrated on USFS Citation jet (144Z)



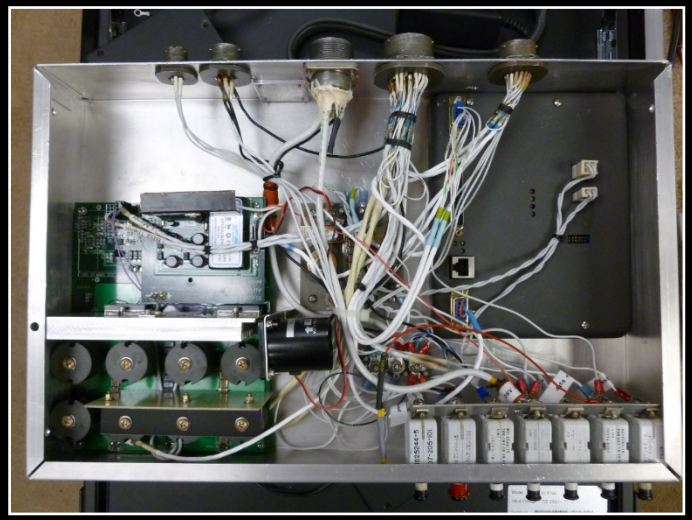
Courtesy of V. Ambrosia

2014-2015 AMS Testing/Integration Activities

- Collaborative effort on a limited budget!!!
  - NIFC/NIICD IR Branch, R4 F&AM, NASA Ames, RSAC
- Schedule
  - Typically conduct annual test flights from March through late May
- Missions
  - 15 target areas flown
    - Rx fires
    - Post-fire areas
    - Forest areas affected by pests/pathogens
  - Two 2014 wildfire incidents (multiple days)
- Significant test objectives/goals
  - Forest Service IR technician training
  - Refinement of onboard processing (OBP) system for NRT data production/delivery
  - Remote command and control of sensor from the ground

Winter 2015/2016 AMS "Overhaul"

- Collaboration between NIFC/ NIICD IR Branch and NASA Ames
  - New 19" rack/operator console
  - New UAVSys and LinkMod computers
  - New 12V rack mounted power supply
  - New WiFi router
  - New card cage for data acquisition unit, new computers, CPU power supply & related equipment
  - New cooling system for rack equipment
  - Etc., etc.



AMS Integration Support Contract

- 5 year IDIQ Contract
  - August 2015 - 2020
- Year 1 Tasks (primarily OBP enhancements & technical support activities)
  - Provide AMS Testing/Integration Mission Support
  - Implement AMS Algorithm Refinements/Updates
  - Implement Improved Histogram Matching/Tone Balancing for Mosaic Products
  - Enhance/Support AMS System & FS AirCell Integration
  - Implement AMS System Navigation/Flight Data Display
  - Develop and Implement AMS Boresight Process Automation
  - Develop/Maintain AMS Technical/Software Documentation
  - Provide Consultation and Technology Transfer

AMS Wildland Fire Support

- Signal Fire, NM
  - Gila NF
  - NE of Silver City, NM
  - ~5,400 acres
  - Type 2 IMT assigned
- Acquired AMS data on three nights
  - May 12, 13 & 14, 2014

Signal Fire – May 12, 2014

- AMS Night Fire Product
- Bands 11, 12 for hot spots
- Band 12 visual image
- NIROPS PI product overlay

2016 AMS Testing/Integration Activities

- Schedule
  - Installation delayed until early April in 2016
    - Accommodate upgrade/maintenance schedule for 144Z and AMS readiness after “overhaul”
- Missions
  - Local evaluation missions (UT/ID)
  - Wildfire missions, if possible and as schedule permits
- Significant test objectives/goals
  - Additional Forest Service IR technician training
  - Further testing of remote command and control of sensor from the ground
    - Address issues with simultaneous C/C and transfer of NRT products

Identifying a USFS Platform for AMS

- 3rd Aircraft Proposal (N182Z)
  - Submitted to F&AM in 2015
    - Coordination with R8 and WO F&AM
  - FS Fire Imaging Technology Working Group developing requirements to ensure multi-mission capability
    - Sensor port/pod installation
    - AirCell system installation
  - Potential mission scope
    - Tactical fire support "surge" aircraft; daytime fire missions
    - Post-fire/post-storm assessment
    - Forest health monitoring
    - Cal/Val of satellite products

Multi-Mission Platform Proposal

March 2015, V4

A Proposal Submitted to US Forest Service
Fire and Aviation Management

Prepared By:

/S/_____
National Remote Sensing Program Manager
WO ENG/GMO, USDA Forest Service

Approved By:

/S/_____
Deputy Director
WO F&AM, USDA Forest Service

RSAC X-Band Direct Readout Ground Station

Location:

- Salt Lake City, Utah; 111.949° W 40.722° N
- Future location TBD; options are currently being evaluated

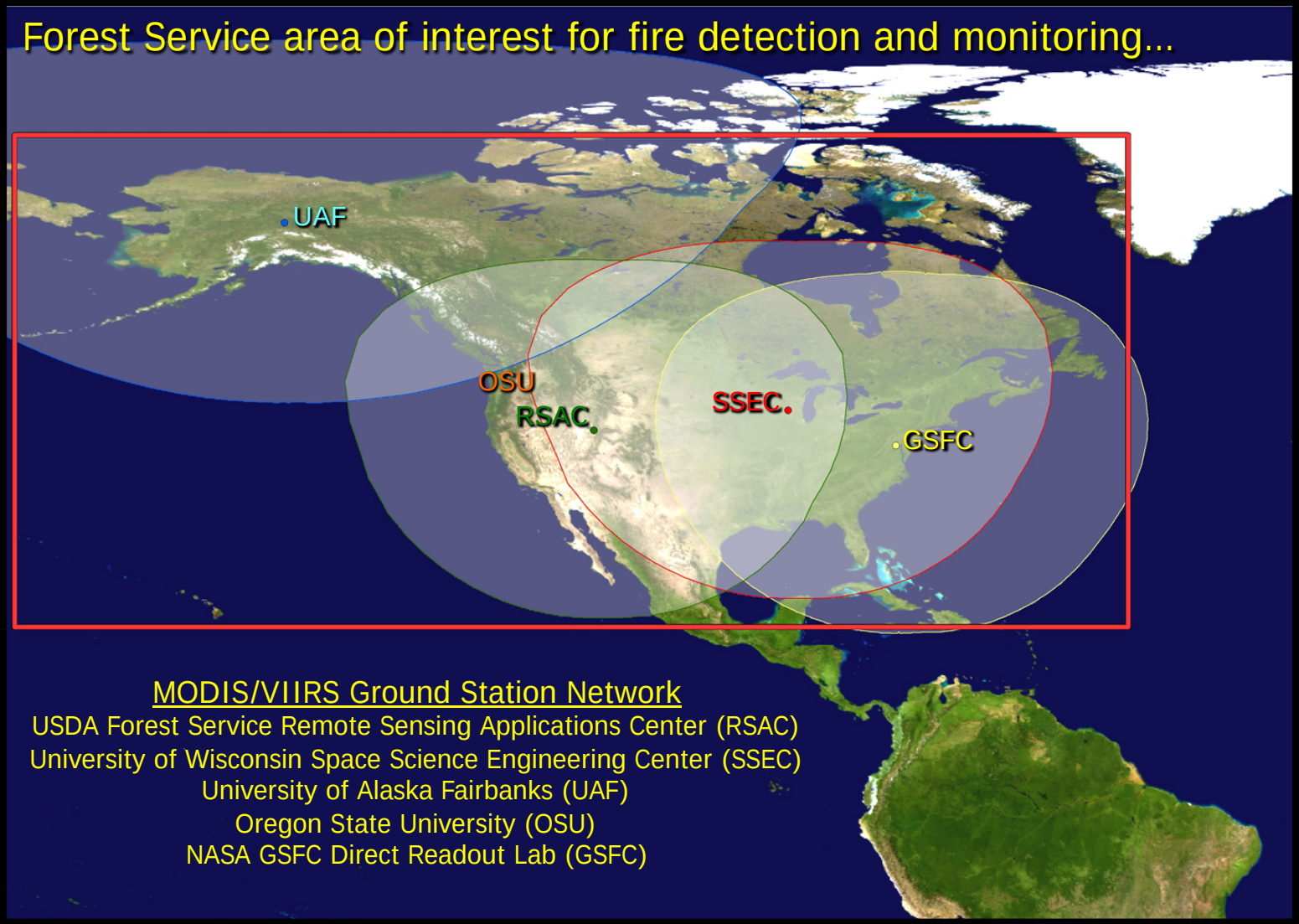
History:

- Daily MODIS direct broadcast data collection since 2002
- Daily VIIRS direct broadcast data collection since 2012

Antenna:

- 2.4 meter X-band (7.5 to 8.5 GHz) antenna; 3-axis SeaTel Model 9497A-7
- 3.7 meter diameter radome enclosure

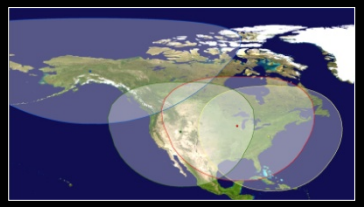
AFM Direct Readout Network



NASA LANCE/FIRMS provides global MODIS & VIIRS coverage; backs up ground station network

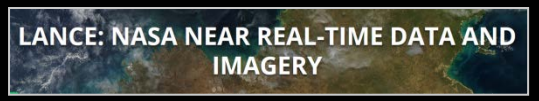
RSAC MODIS/VIIRS NRT Data Processing

MODIS/VIIRS Direct Readout
Ground Station Network

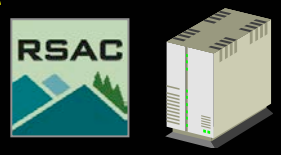


Selected
MODIS L0/L2 & VIIRS RDR/EDR Data
(~30 minutes after acquisition)

Low Latency NASA MODIS
Data Stream



L0 data & L2 Data (every
15 minutes)
(VIIRS data is beginning to
be integrated in LANCE)

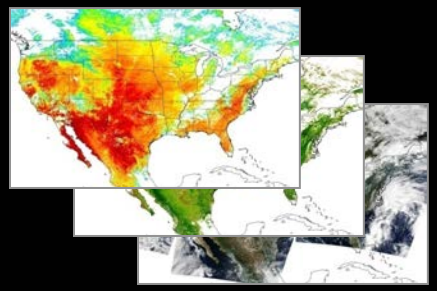


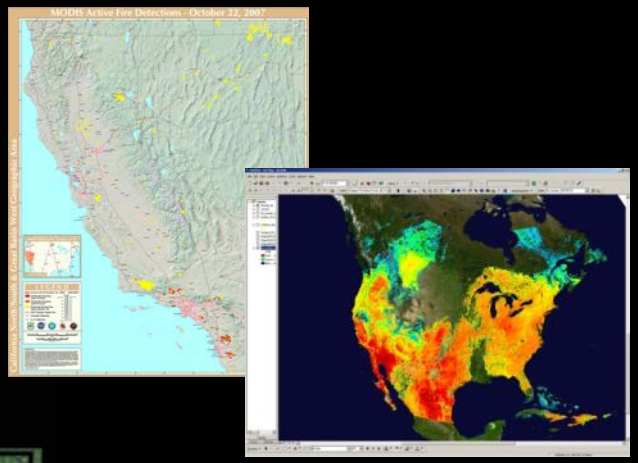
USFS-RSAC IPOPP
Processing System(s)

NASA International Polar Orbiter
Processing Package (IPOPP)

- Provided by NASA Direct Readout Lab
- MODIS L0, L1 and L2 products
- VIIRS RDR, SDR and EDR products
- Based on latest science processing algorithms (SPAs) from NASA

L2/EDR Product
Stream for U.S.
and Canada



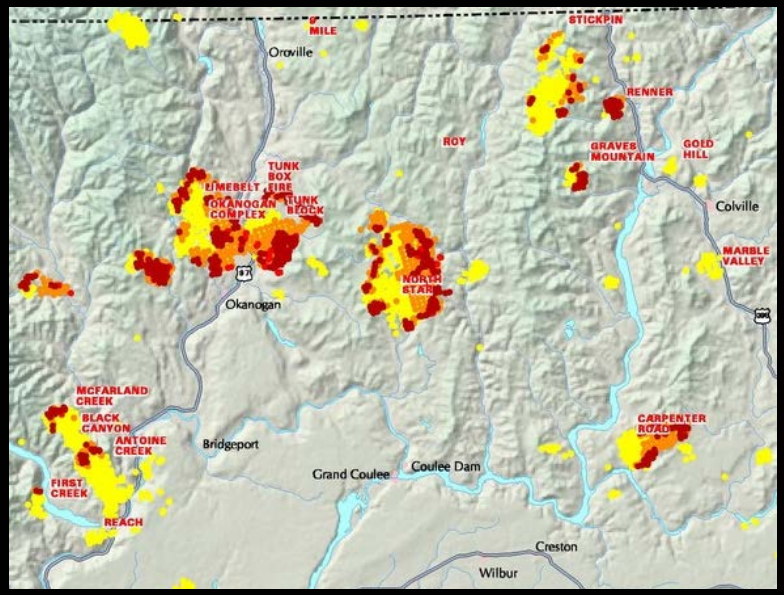


Value-added Mapping/Visualization, Data
& Analysis Products

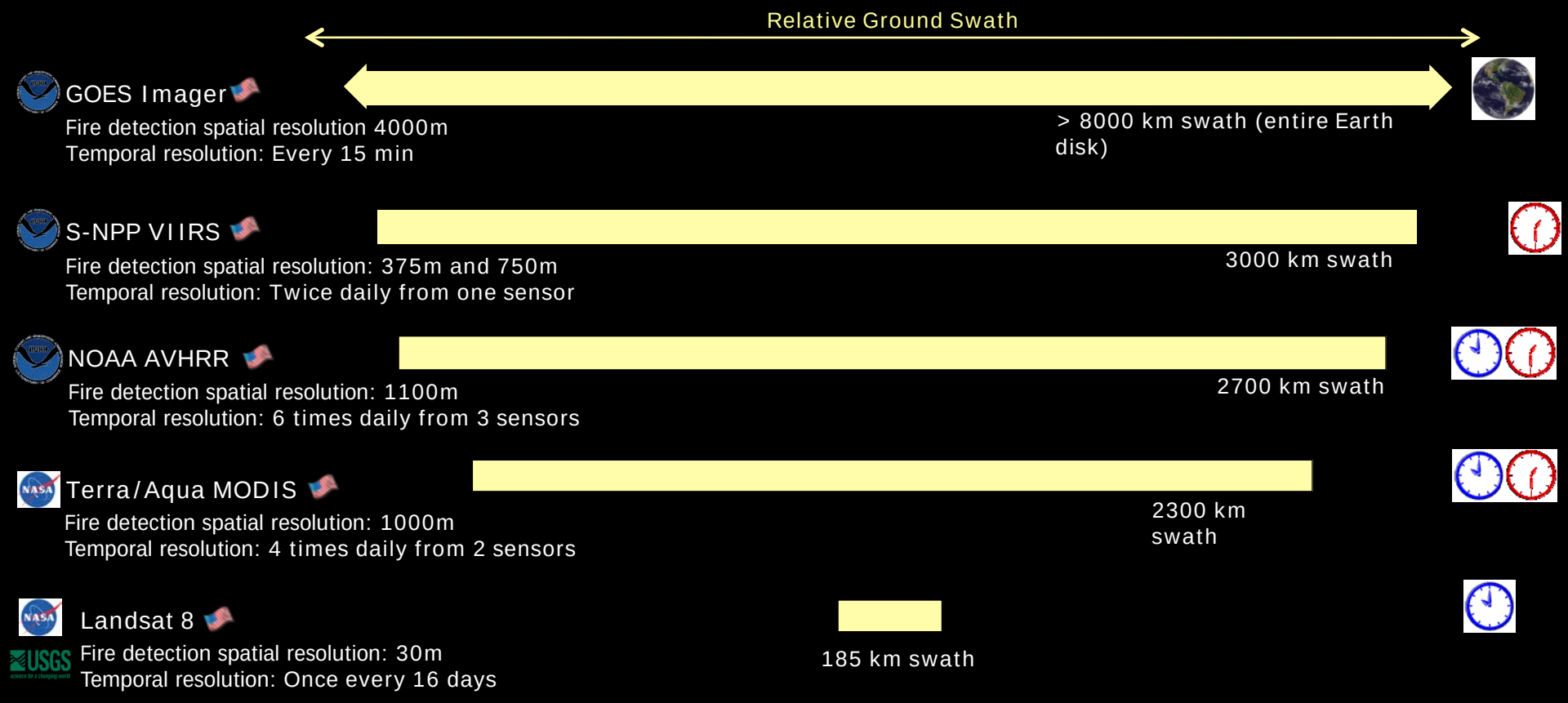
Active Fire Mapping (AFM) Program

(http://activefiremaps.fs.fed.us)

- Implemented at RSAC in 2001
  - In coordination w/NASA & mission science teams
- Operational near real-time (NRT) satellite data/mapping/visualization products for strategic wildfire management
  - "Value-added" products
  - All lands and ownerships in U.S. and Canada
- Facilitates situational awareness and wildfire decision support
  - Prioritize allocation of fire suppression assets
  - Focus tactical airborne reconnaissance assets
  - Key data input to several fire-related operational applications



Satellites/Sensors Used by AFM

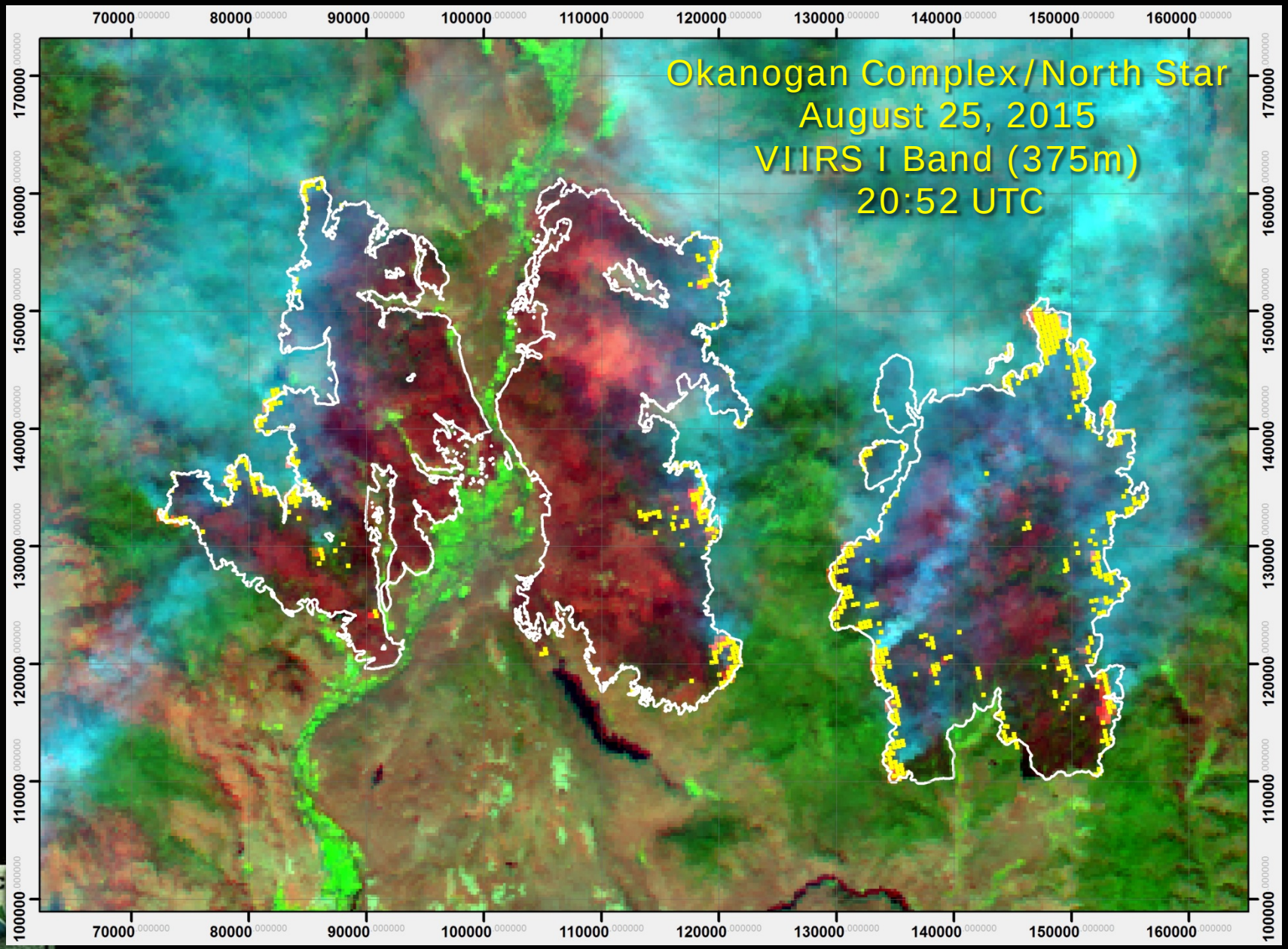


- MODIS is the only available sensor designed with consideration for active fire detection and characterization
- Advent of loss of Terra MODIS impacts long term diurnal fire detection/monitoring continuity available to fire community the past 16 years

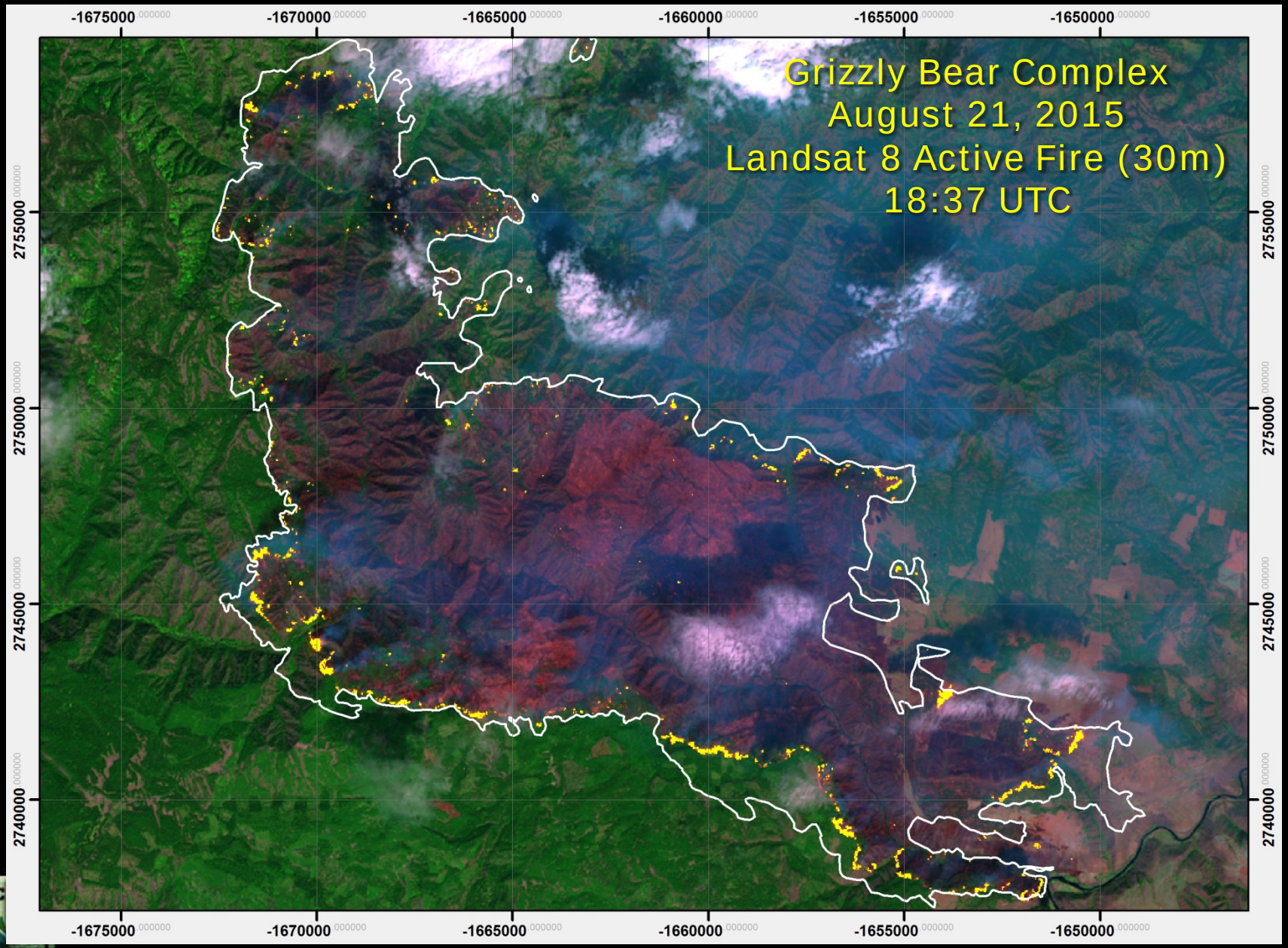
2014-2015 NASA Research to Operations Activities Benefiting AFM and End Users

- Conducted through support by NASA & USGS
  - NASA Applied Sciences Program
  - Project PIs W. Schroeder & J. Coen
  - NASA Direct Readout Lab
  - USGS EROS Data Center
- Integration of active fire detection algorithms and output products in RSAC NRT environment
  - VIIRS-AF 750m (2014)
    - NASA SPA based on MODIS C6 Active Fire Product
    - Provides fire characterization continuity with MODIS products
  - VIIRS 375m I-Band (2014)
  - Landsat 8 30m (2014)
    - Daily Landsat 8 acquisitions for North America pulled from EROS
- VIIRS 375m I-Band SPA integrated into NASA IPOPP (2015/2016)
  - Accessibility to the global DR community

MODIS/VIIRS Active Fire Product Examples



Landsat Active Fire Product Examples



Emerging Satellites/Sensors of Interest to AFM

Relative Ground Swath

GOES R/S ABI

Fire detection spatial resolution **2000m**
Temporal resolution: **Every 5 min**

> 8000 km swath (entire Earth disk)

JPSS VIIRS

Fire detection spatial resolution: **375m and 750m**
Temporal resolution: **Twice daily from one sensor**

3000 km swath

esa **Sentinel 3A/3B - SLSTR**

Fire detection spatial resolution: **1000m**
Temporal resolution: **Once daily from one sensor**

1675 km swath

GCOM-C - SGLI

Fire detection spatial resolution: **500m**
Temporal resolution: **Once every 1-2 days from one sensor**

1400 km swath

esa **Sentinel 2A/2B - MSI**

Fire detection spatial resolution: **20m**
Temporal resolution: **Once every 5 days (or less) from 2 sensors**

290 km swath

- GOES-R/S will provide enhanced, persistent fire detection and monitoring capabilities
- GOES-R launch date: October 2016
- JPSS-1, 2, 3 & 4 launch dates: March 2017, 2021, 2026 and 2031
- Sentinel 3A/3B launch dates: February 2016 and late 2017
- GCOM-C launch dates: 2016, 2018 & 2022
- Sentinel 2A/2B launch dates: June 2015 and late 2016
- Collectively, Landsat and Sentinel 2 can potentially provide 20-30m fire detection coverage on a 1-2 day basis

Geostationary

Morning Orbit

Afternoon Orbit

USFS RSAC/USGS EROS Satellite-Based Burn Severity Mapping Programs – A Primer

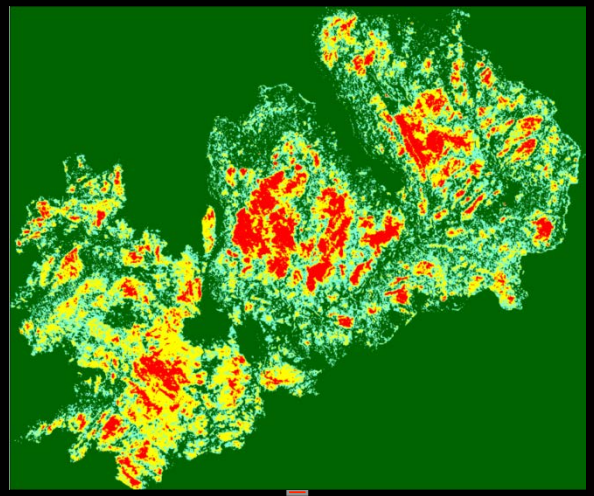
RSAC/EROS Program (Objectives & Specifications)	Time of Assessment Since Fire
Burned Area Emergency Response Imagery Support – Where are the hazards and how can they be mitigated? – Assessment of fire effects on soils/watershed hydrologic function – Conducted on USFS and DOI agency lands	Immediately (Emergency Assessment)
Rapid Assessment of Vegetation Condition after Wildfire – How do we determine the best way to restore damaged forests? – Assessment and characterization of post-fire forest conditions – Conducted on USFS lands only	Approximately one month (Initial Assessment)
Monitoring Trends in Burn Severity – How effective are our fire management policies? – Multi-decadal mapping of the location, extent and ecological burn severity of all large fires – Conducted on all lands: federal, state and private	Up to 1 year (Initial/Extended Assessment)

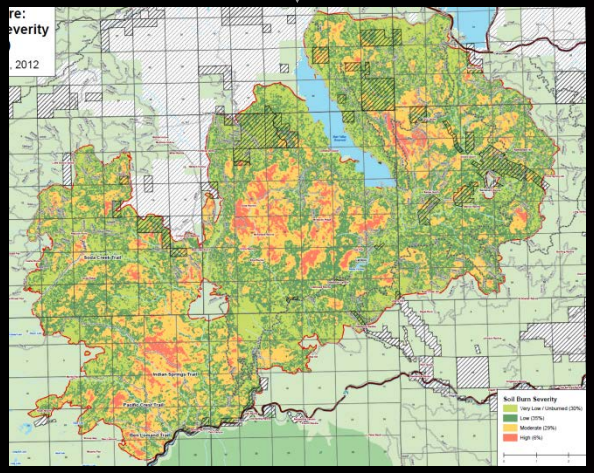
Burned Area Emergency Response Support

(http://www.fs.fed.us/eng/rsac/baer)

- Provide rapid delivery of imagery and derived products to Forest Service BAER teams
  - Conducted on fires exceeding thresholds for size, severity and/or soil resource damage
  - Burned Area Reflectance Classification (BARC), preliminary vegetation burn severity, based on dNBR/dNDVI assessment
  - BAER teams use BARC with field observations and other spatial data to generate a soil burn severity map
  - Soil burn severity map used to target and mitigate hazards to life and property
- Imagery and data products available within 24 hours of image acquisition
- 2015: 94 fires/1.9 million acres
- 2001 - 2015: 1,100 fires/23 million acres

BARC



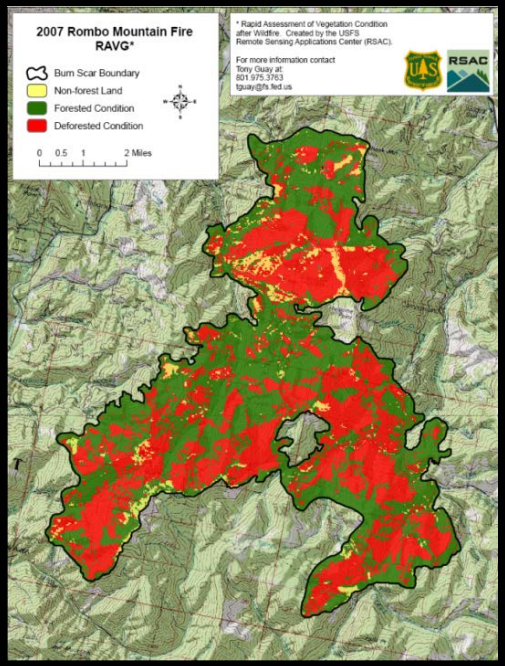


Soil Burn Severity

Rapid Assessment of Vegetation Condition after Wildfire

(http://www.fs.fed.us/postfirevegcondition)

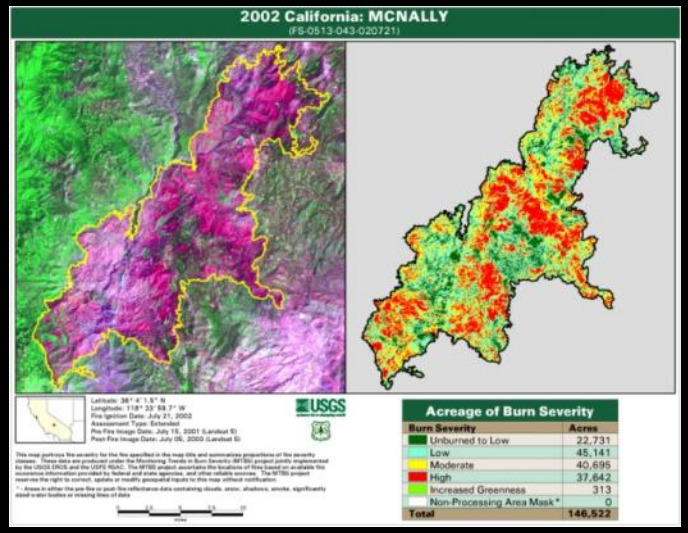
- Provide Landsat imagery and derived products characterizing fire effects on forest resources to silviculturists
  - Conducted on fires where > 1,000 acres of NFS forested land is affected
  - Assessment based on RdNBR – a variant of dNBR - to derive post-fire forest condition layers
    - Burn severity
    - % basal area loss
    - % canopy cover loss
  - Silviculturists use as decision support to identify and prioritize land suitable for reforestation
- 2015: 79 fires/1.4 million acres
- 2007 – 2015: 550 fires/13.5 million acres

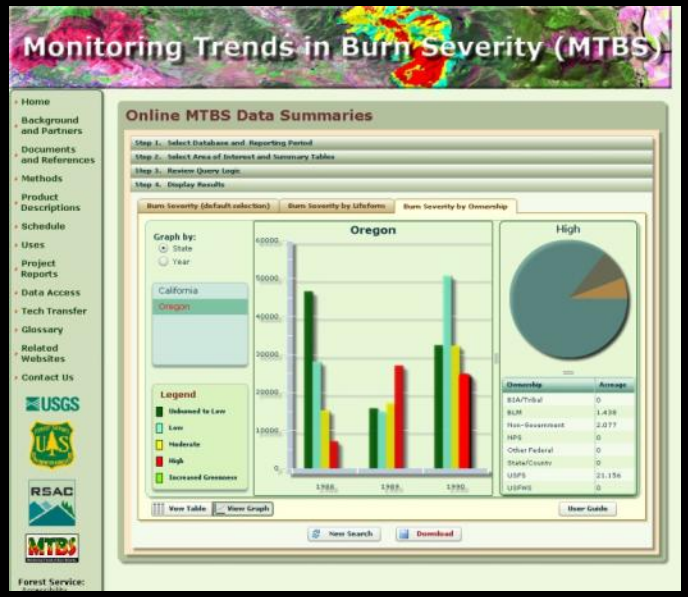


Monitoring Trends in Burn Severity

(http://www.mtbs.gov)

- Provide imagery and derived products for all large fires
  - Provided for fires > 1,000 acres in western U.S.; > 500 acres in eastern U.S.
  - Post-fire extent and burn severity layers based on dNBR assessment
  - Products are used to support:
    - Assessment of fire/severity trends
    - Assess effectiveness of national fire management policies
    - Land cover product updates
    - Resource management and monitoring activities





- Remaining 2014 fires completed; 2015 fire mapping in process
- 1984 – 2014: 19,200 fires/144 million acres

Annual 1 Day Post-Fire Training Webinars

- Burned Area Emergency Response Imagery Support
  - “Using the BARC for BAER Support”
  - March 22, 2016
- Rapid Assessment of Vegetation Condition after Wildfire
  - “Using RAVG Data for Reforestation Assessments”
  - March 29, 2016
- Monitoring Trends in Burn Severity
  - “Understanding & Using Monitoring Trends in Burn Severity Data”
  - April 5, 2016

Comments/Questions?

Brad Quayle
801-975-3737
bquayle@fs.fed.us