



Wildfire Support Remote Sensing Technology: Gaps & Opportunities

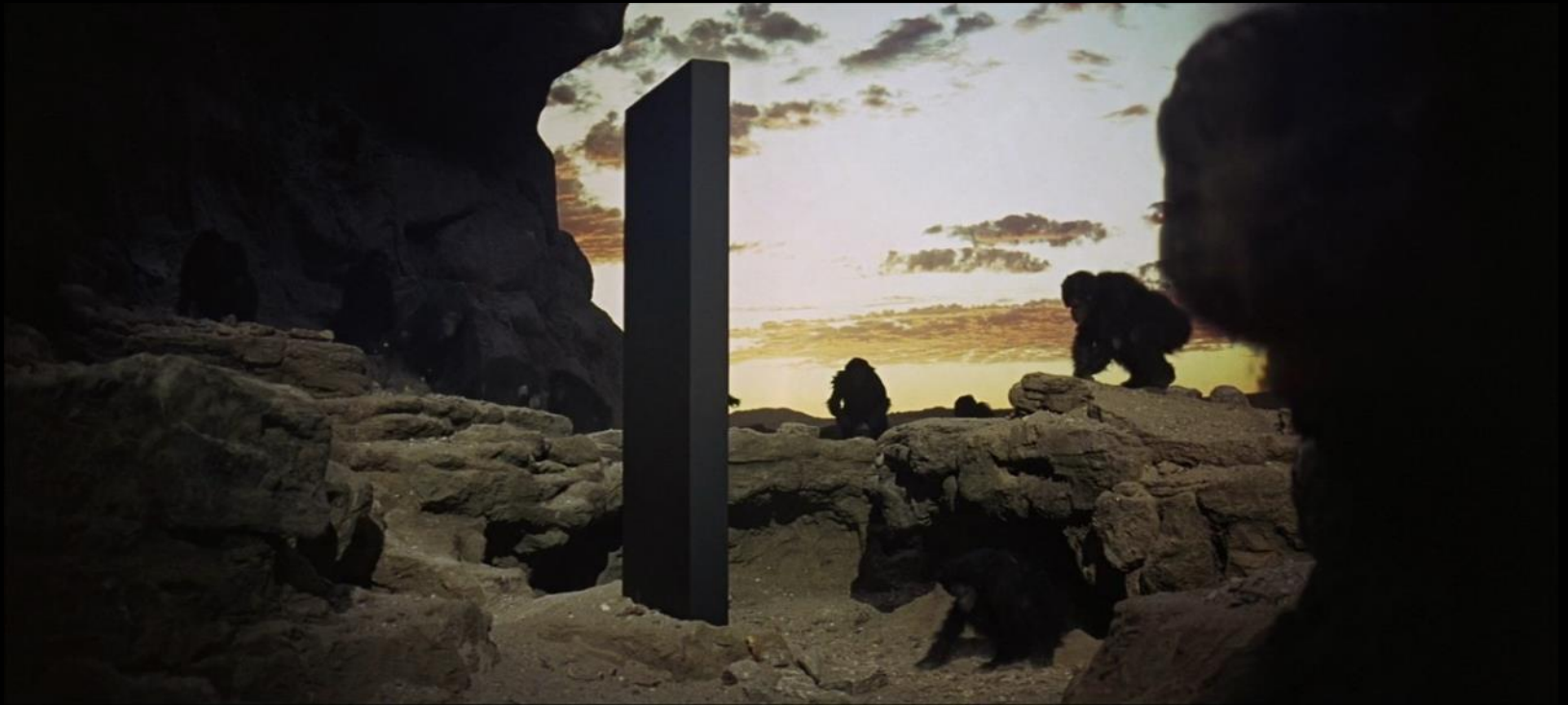
SDR – Wildland Fire S&T Task Force
June 2014

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USDA Forest Service



Technology – New Capabilites New Challenges



Google Earth – First Look 2004



Technology and Wildfire

- Wildfires
 - Do response teams have sufficient tactical information to effectively and safely manage the incident?
 - Work with fire management teams to identify gaps.
- Technology
 - What is the role of RS technology in disasters/wildfire?
 - Current RS capabilities: what do we currently bring to the fight?
 - Can remote sensing technology be better applied to assist in decision-making, increase safety, and reduce losses?
 - Are there underutilized technologies (identify opportunities)?
 - New Sensors
 - Unmanned Aircraft Systems
 - Crowd Sourcing?



Wildland Fires - Requirements

What Information is Needed?

- Fire detection and reporting / where are the starts?
- Fuel information – what is available to burn?
- Weather - what are the current and predicted conditions?
 - Need good forecasting
 - And real time, high granularity weather information during event.
- Where is the active fire / what is the behavior?
 - Fire perimeter and active fire fronts
 - Where the fire has been (the black)
 - Lines of containment
- Where are the firefighters? Assets at risk? People at risk?

Update frequency? Data accuracy?



Wildland Fires - Technology (RS)

Platforms

- Satellites
- Manned aircraft
- Unmanned aircraft

Sensors

- Thermal Sensors
- Weather Sensors

Data Telemetry Capabilities

- Aircell Internet capability
- UAS radio repeaters

Decision Support Tools – Intelligent mission management technologies which take in data, analyze and then display the appropriate data to decision makers.



Technology - Sensors and Platforms

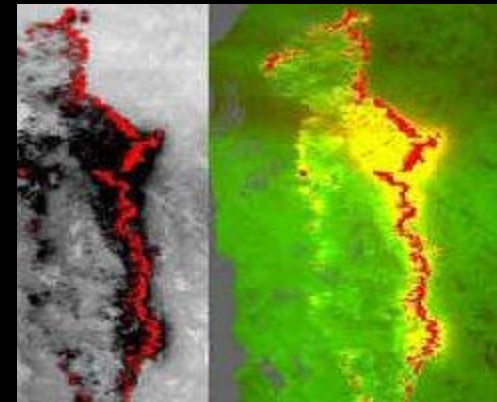
- **Satellite**

- MODIS
- Landsat
- NTM
- *Other*



- **Airborne**

- Phoenix
- Various (vendors)
- **Unmanned Airborne Systems:
Ikhana / Global Hawk / Others*



- **Other**

- Firehawk (active fire mapping)
- **Hawkeye (fire detection & alerting)*

Airborne Fire Mapping (Manned)

- National Infrared Operations - "NIROPS"
- Large scale tactical fire detection/mapping to support incident command operations
- Continuous operational deployment since 1967 (47 years)



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



NIROPS Assets

149Z

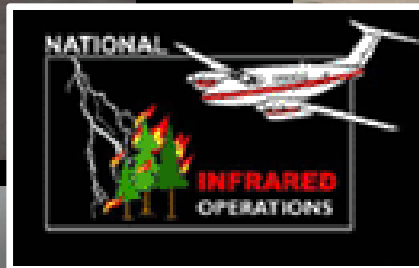


King Air 200B

144Z



Citation Bravo



Sensor Pod

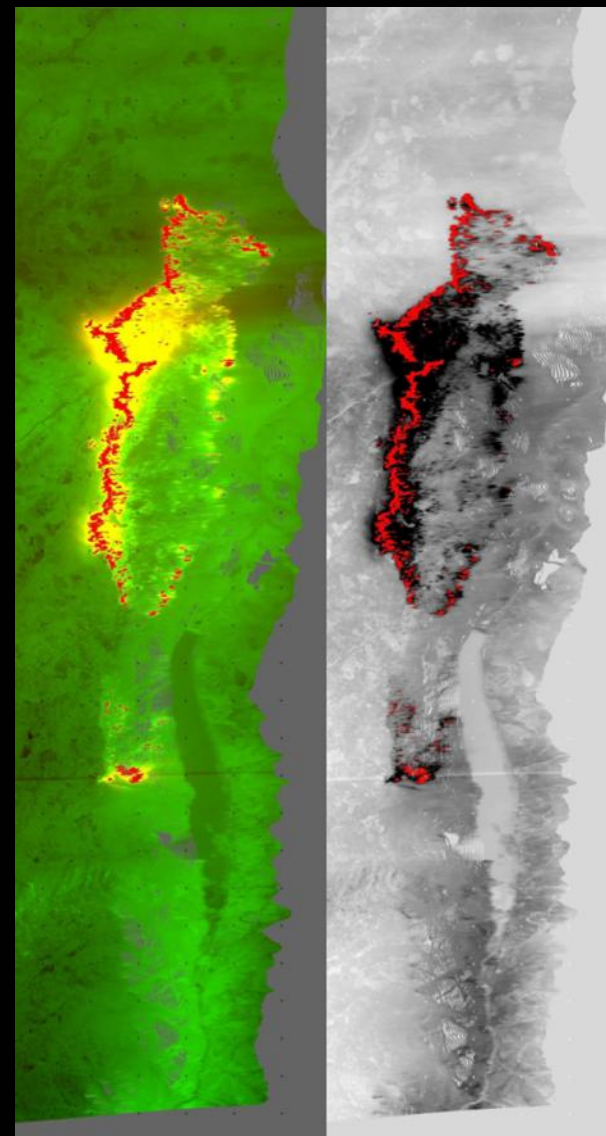


Phoenix Line
Scanner

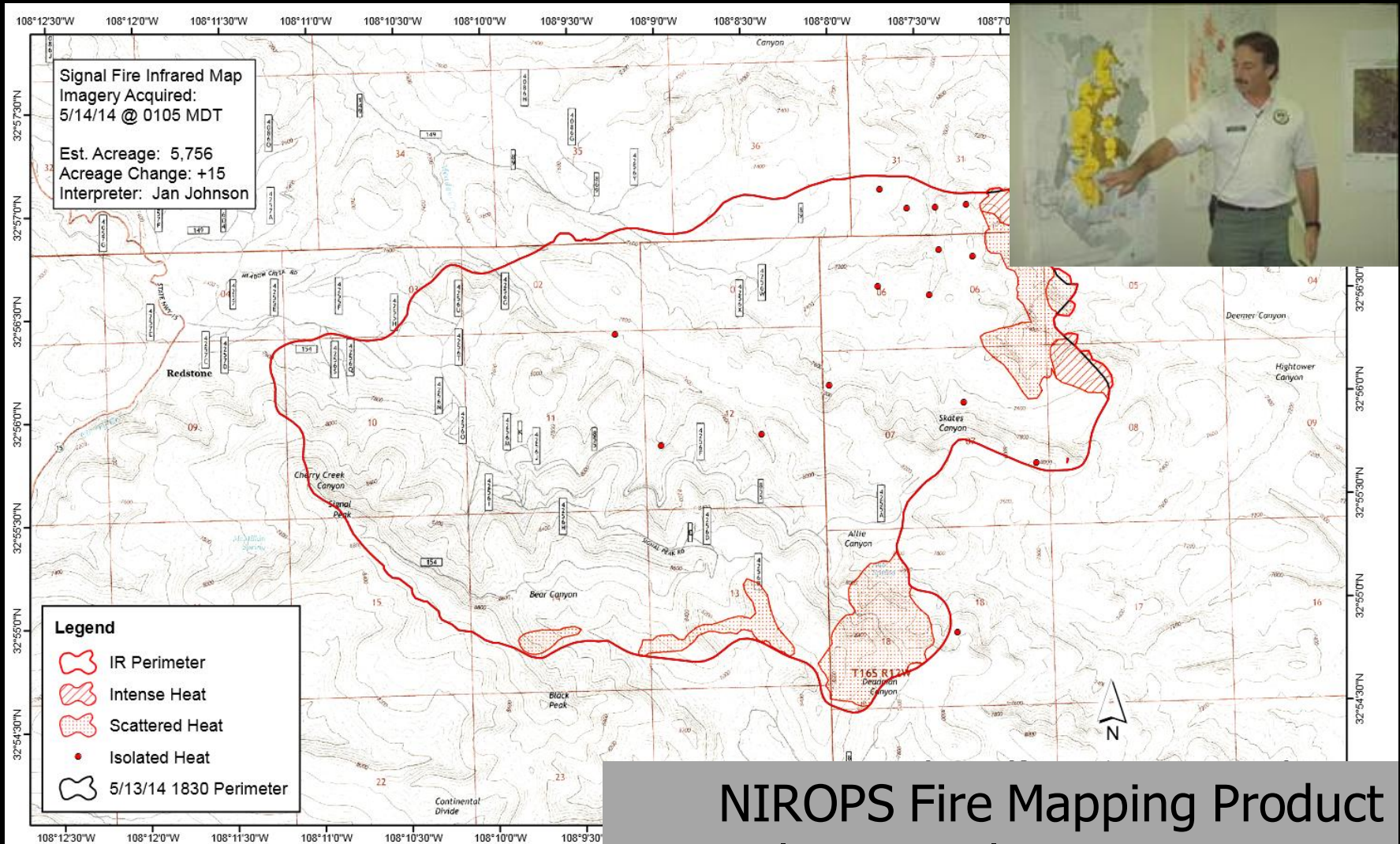


Phoenix Sensor Thermal Imagery

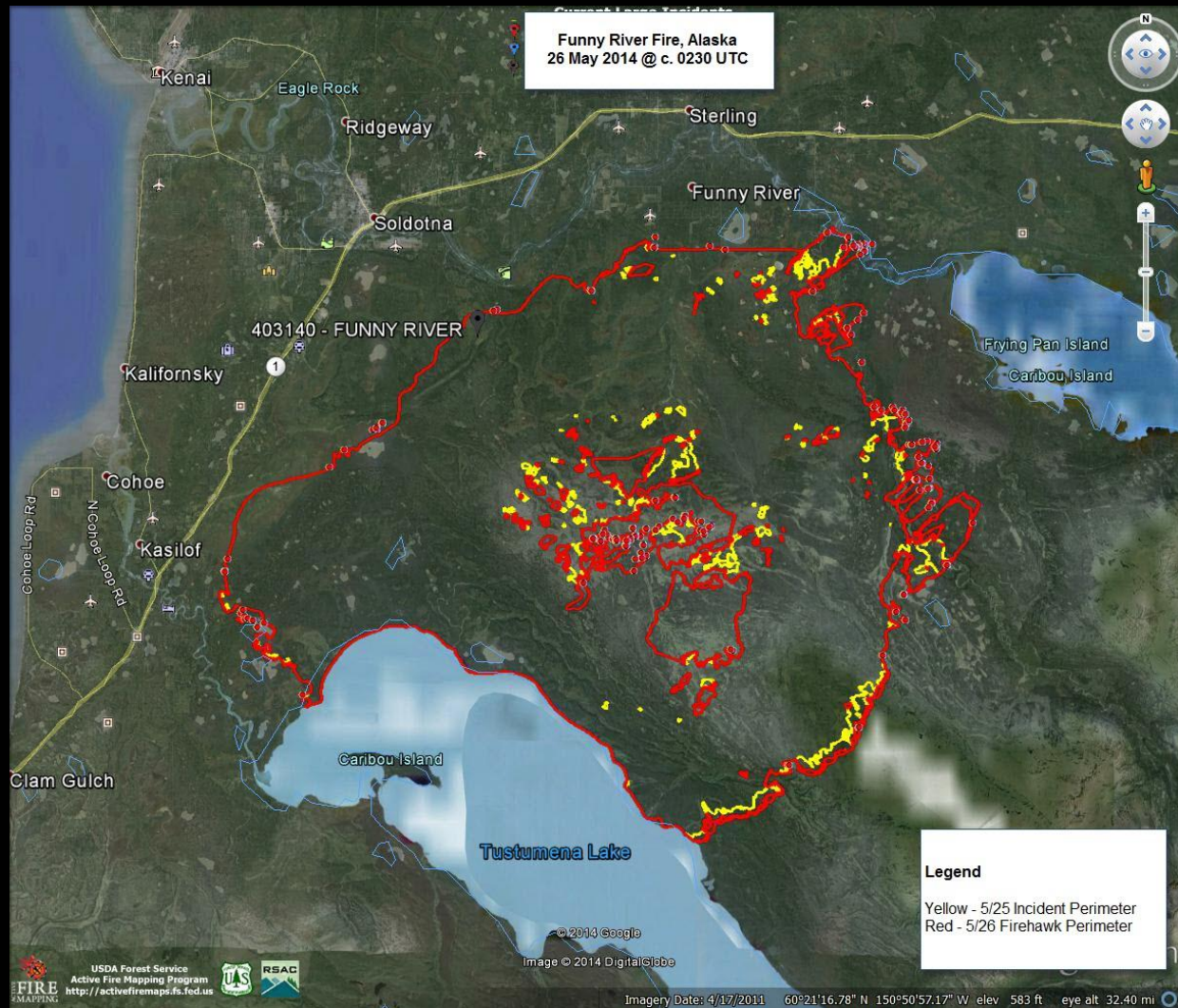
- 8-bit (0-255) imagery
 - 255 pixel tagged red
- 3.5-meter pixels at nadir at 10,000 ft. AGL
- The detection threshold at 10,000 ft. AGL is 8" .
- Nominal swath width of 6 miles at 10,000 ft. AGL



Active-Fire Mapping Products



Active-Fire Mapping Products

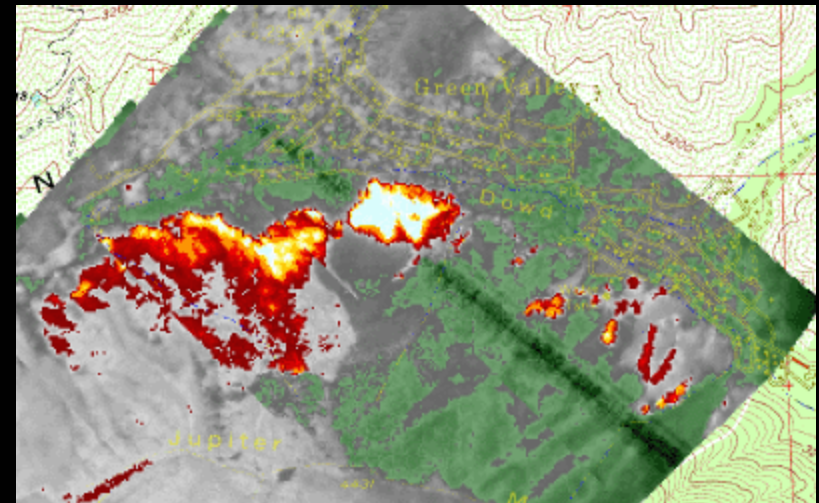


Funny River Fire – Kenai Alaska



Firemapper

- Pacific Southwest Research Station
- Small, well-tested thermal imaging system
- Good for small area fires



Firemapper 2

Commercial IR Vendors & Military

- Few qualified vendors
- Not always available
- Cost significantly more than the NIROPS aircraft

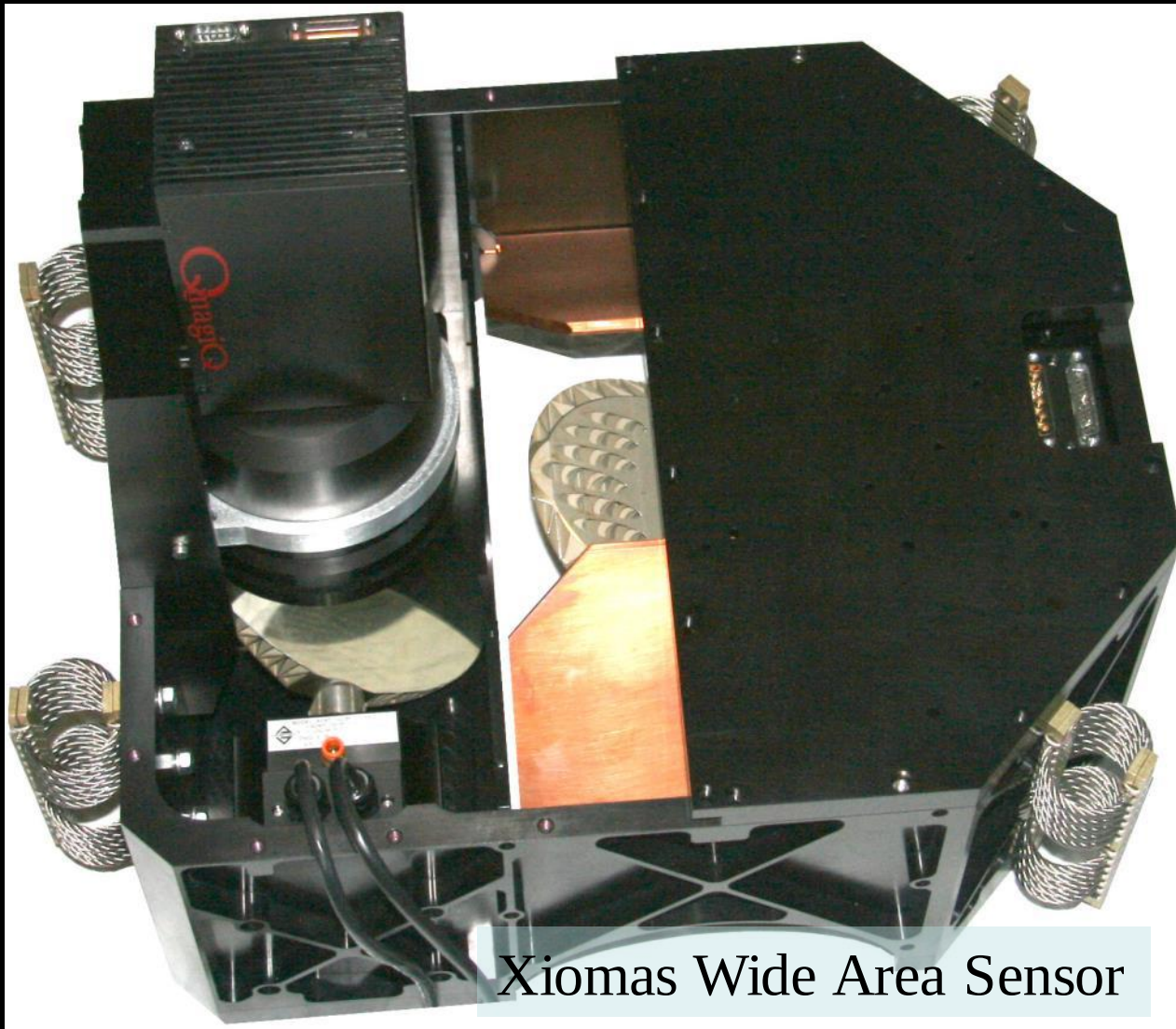


Contract IR Aircraft

**ANG /
NORTHCOM**



New Fire Mapping Sensors



Xiomax Wide Area Sensor

Hawkeye – Fire Detection & Alerting

- Hawkeye leverages national systems for fire detection and alerting. In trial phase over past 2 fire seasons.
- Hawkeye has demonstrated a fire alert process with manual downgrade and dissemination of tipoff information.
- Hawkeye fire alerts have demonstrated a low false alarm rate, and proven “early detection capability”.
- Future capability may include automated fire detection and false alarm de-confliction based on the fusion of many divergent sources.
- All forensic case studies were very positive for Hawkeye fire alerts (i.e., good correlation between detections and actual fires in study areas).
- Hawkeye can support active fire monitoring, but additional requirements will require additional development work.



Technology – Unmanned Aircraft Systems

A menagerie of UAVs

As drones go domestic, both the models and the missions are multiplying.



PREDATOR

Used by: DHS, NASA
Used for: Border patrol and wildfire mapping.



BAT

Used by: USDA
Used for: Digital imagery to monitor rangeland vegetation.

GLOBAL HAWK

Used by: NASA
Used for: Tracking hurricanes and studying signs of climate change.



DRAGON EYE

Used by: NASA
Used for: Aerial mapping and in situ gas sampling.



RAVEN

Used by: DOE, USGS, NASA
Used for: Monitoring land change, wildfire mapping and general research.



T-HAWK

Used by: USGS
Used for: Monitoring Fukushima radiation emissions and environmental mapping.



Forest Service UAS Strategy

- Augment, NOT replace, our manned aircraft
- Work with partners to identify niche applications that are underserved by current technology
- Keep the approach simple; work on doing one thing well before adding additional capabilities
- Provide unified systems that are affordable



UAS Application Areas

- Wildfire
 - Near real-time, high resolution fire detection and characterization
 - Tactical scale imagery and geospatial mapping/visualization products
 - Communications link/relay
- Resource Management
 - General remote sensing – hi res imagery, LiDAR and others....
 - Forest inventory
 - Resource mapping (fuels, forest health, etc.)
 - Rangeland Monitoring (grazing permits)
- Law Enforcement & Investigations
 - Surveillance
 - Detection/mapping of illegal activities



Possible UAS Fire Applications

WILDFIRE & DISASTER SAFETY & RISK REDUCTION

REAL-TIME EVENT-COMMUNICATIONS

- DATAKOM
- VOICE-RE, CELL, TEXT
- ASSET TRACKING
- VEHICLE COMMAND & CONTROL

REAL-TIME EVENT-DATA

- ON-SITE WITHIN 1 HOUR
- MEASURE HOT SPOTS & FIRE FRONT
 - INTENSITY OF FIRE
 - MOVEMENT & RATE OF SPREAD
 - WEATHER & TEMP CONDITIONS
 - FUEL MOISTURE
 - AIR QUALITY
- REALTIME DATA TRANSFER
- REMOTELY OPERATED

SAFETY & RISK REDUCTION

"INITIAL ASSESSMENT"

- FAST RESPONSE TO EVENT
- COLOR & THERMAL VIDEO
- 1-HOUR DURATION

"LOITERING & STAKING"

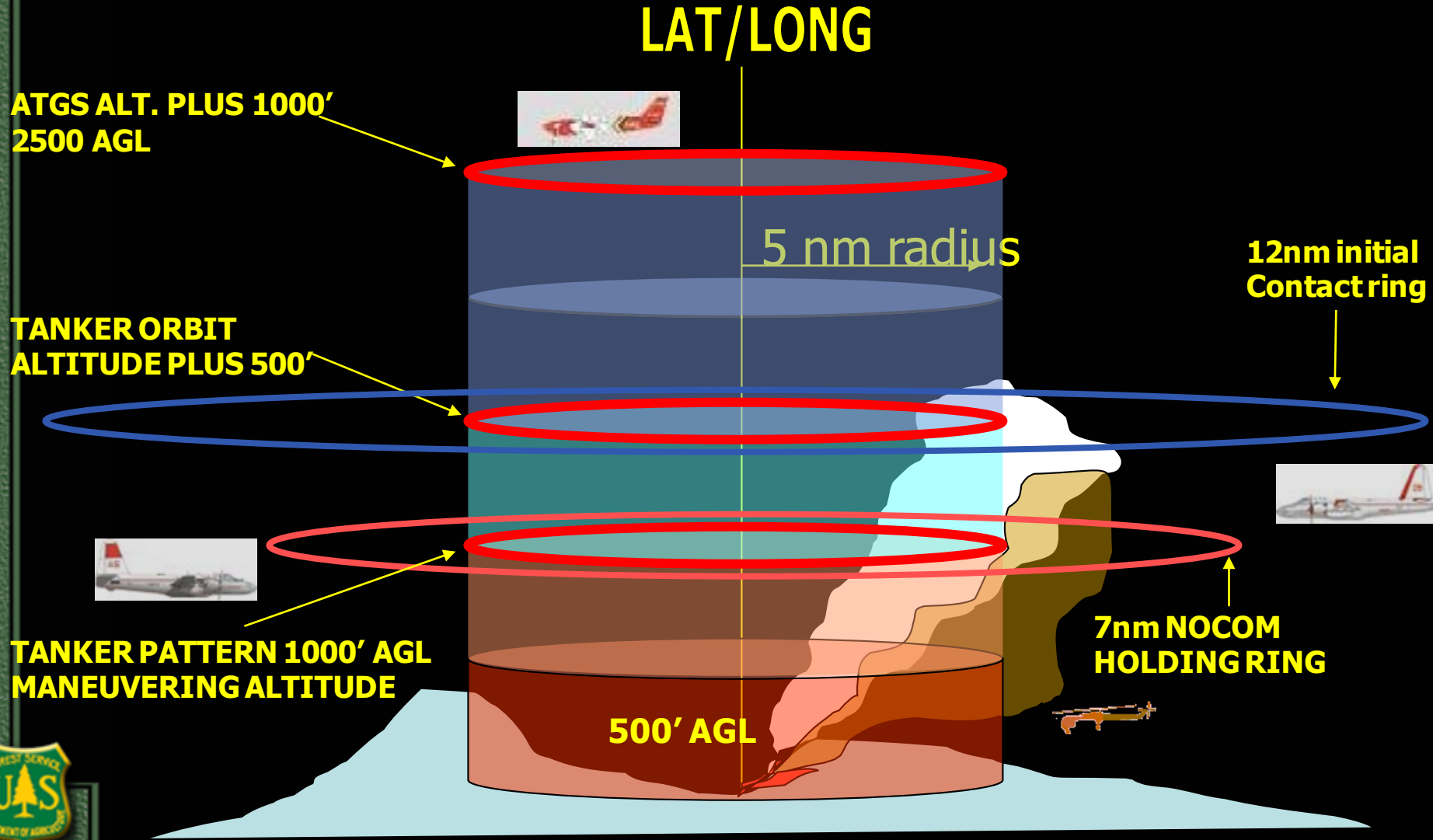
- 1-8 HOUR DURATION
- THERMAL IMAGING
- FIRE DETECTION

"FIXED-WING RETARDANT"

- 500 MILE RANGE
- 300 KNOTS
- 6-76'S TOLL
- HEAVY TURBULENCE
- PAYLOAD 500-3000 GALLONS
- FORMATION FLYING
- AUTONOMY
- 100-10,000 FT

Fire Traffic Area (FTA) Environment

After obtaining a COA, there are additional challenges to using UAS on wildfires...



Two Track Approach to Evaluating UAS

Large Platforms



Small Platforms



Small UAS – Looking Ahead

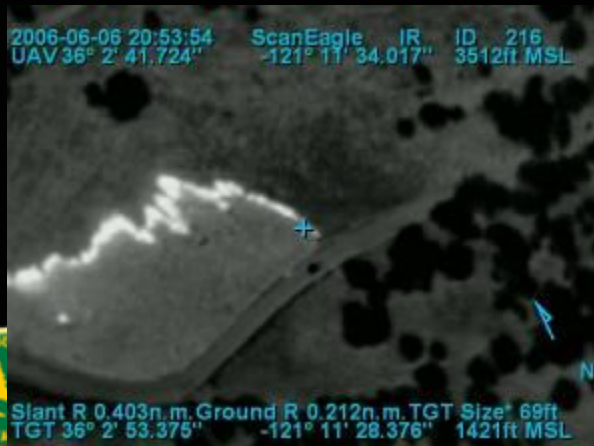
Desired Features

- Fully autonomous takeoff and landing
- Operable from small, unimproved locations!!
- Man or light truck portable
- Capable imaging systems and guidance systems
- VTOL Preferred



UAS Fire Products

Near real-time full motion video of active fire areas



Large UAS

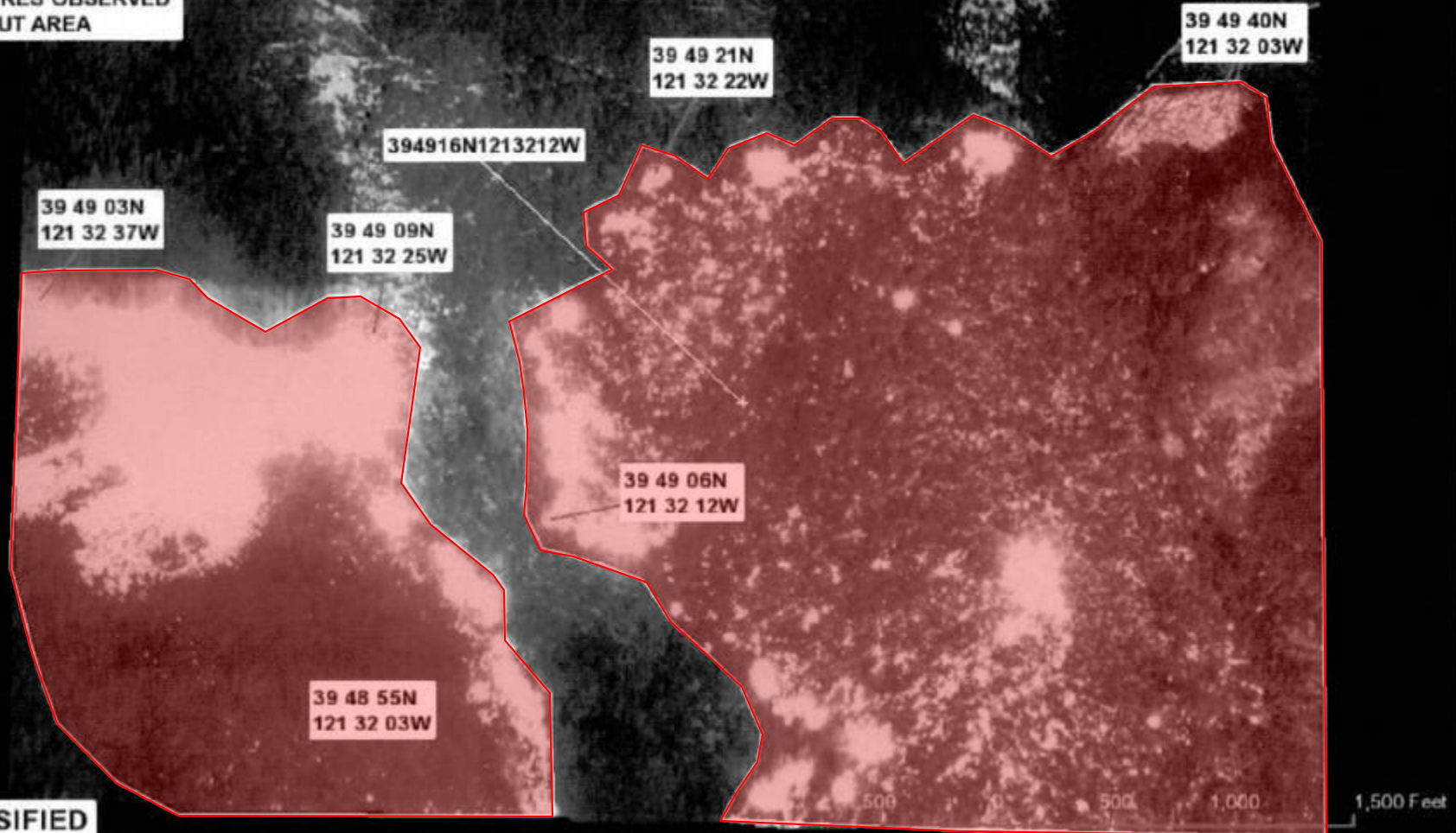


Global Hawk Thermal Image

LOCATION: FIRE COMPLEX, US
GEO: 394916N1213212W
DOI: 27JUN08/TIME: 1000L

UNCLASSIFIED

MULTIPLE FIRES OBSERVED
THROUGHOUT AREA



UNCLASSIFIED



Thoughts on UAS and Wildfire

- Integrating UAS into fire operations is complicated, but not impossible
- UAS augments manned aircraft capacity
 - Expands the “tool kit”
 - Transfer of technologies
- It’s also about the mission objective, the sensor and related technologies
 - Sensor characteristics
 - Data and products
 - Communications; Delivery and dissemination of data/products
- Data and intelligence derived using UAS can potentially increase the safety and effectiveness of firefighters



Active Fire Mapping Program

- The USDA Forest Service Active Fire Mapping (AFM) program provides critical, timely, and comprehensive imagery and fire geospatial data products for the wildfire management community and the public at large.
- The AFM fire locations are produced by an operational, satellite-based fire detection and monitoring program managed by the Remote Sensing Applications Center (RSAC) in Salt Lake City, Utah.

USDA FOREST SERVICE REMOTE SENSING APPLICATIONS CENTER

Fire Detection Maps

Current Large Fires (Home)
Fire Detection Maps
Interactive Fire Detection Viewer
MODIS Satellite Imagery
VIIRS Satellite Imagery
Fire Detection GIS Data
Fire Data in Google Earth
Fire Data Web Services
Latest Detected Fire Activity
Burn Scar Data
Other MODIS Products
Frequently Asked Questions
About Active Fire Maps

MODIS VIIRS AVHRR GOES

California N/S & Great Basin West (CA, NV)

This map depicts fire activity as detected by MODIS over the last 6, 12 and 24 hours since 7 AM MDT on 6/16/2014, and cumulative fire activity detected since the beginning of the calendar year.

Current Map	
	PDF Map 3.1 MB
	Image Map 1.9 MB

Archived Maps	
	View Archive

Back

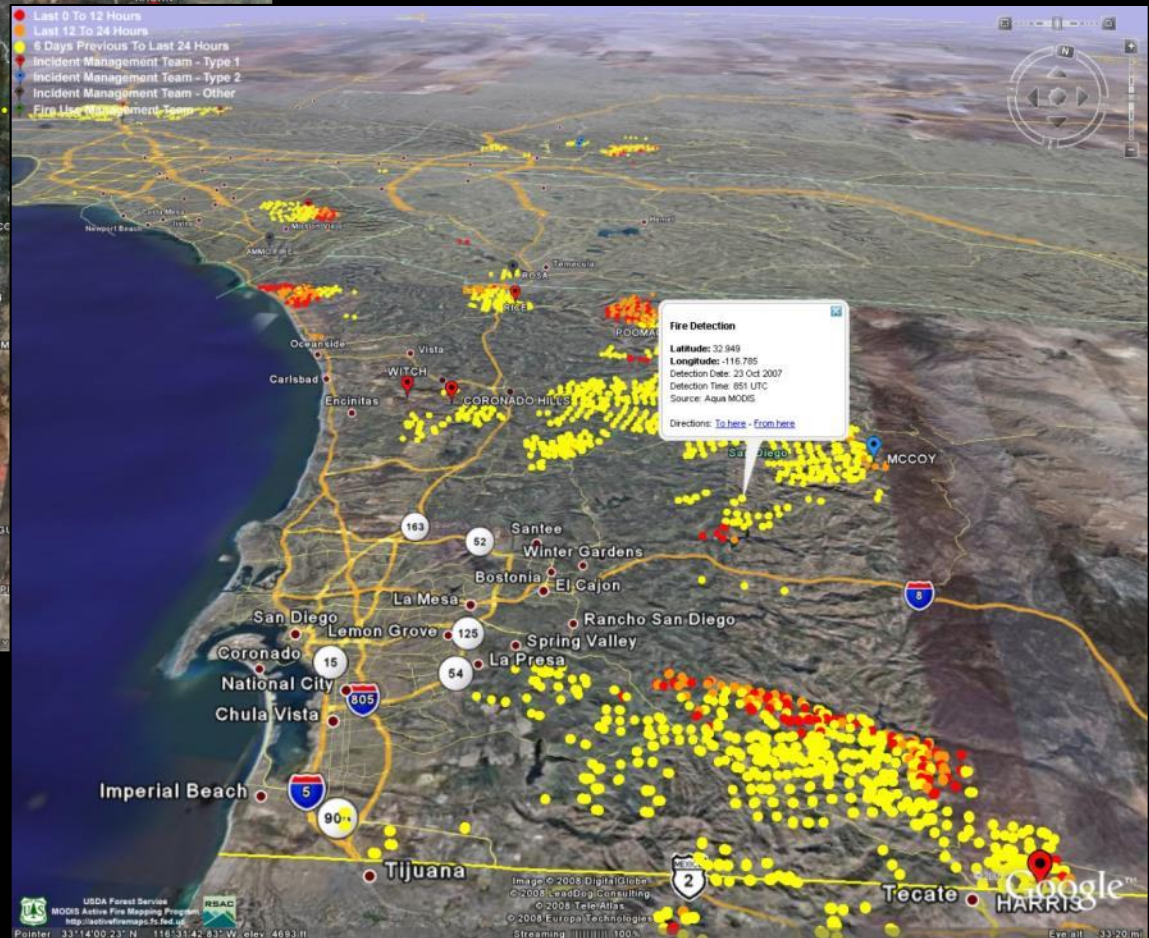
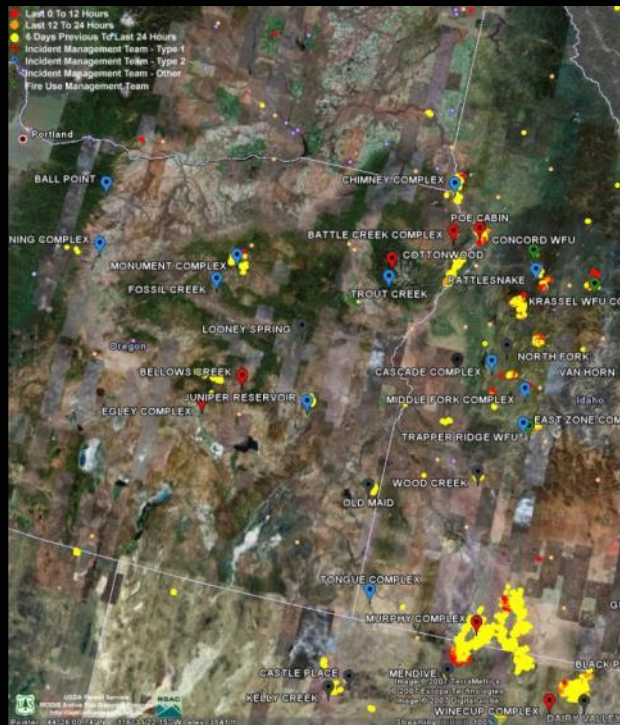
RSAC
Remote Sensing Applications Center
2222 West 2300 South
Salt Lake City, UT 84119 - 2020
voice: (801) 975-0737
fax: (801) 975-3478

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

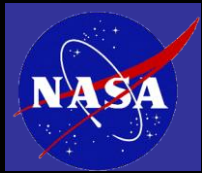
Feedback | Governance | Privacy Policy



Google Earth - Common Decision Environment (CDE)



Wildfire Research and Applications Partnership (WRAP)



NASA Sun-Earth Systems Directorate, Applied Sciences Program

Collaborators

- NASA-Ames Research Center (ARC)
- USDA – Forest Service
- Remote Sensing Applications Center (RSAC)
- National Interagency Fire Center (NIFC)



Tactical Fire Remote Sensing Advisory Committee (TFRSAC)

Mission: Ensure that the WRAP program is supporting the firefighter's technology needs. Identify "gaps & opportunities"; transfer capable technology and development applications to the Field.

Membership: Stakeholders from NASA, USDA Forest Service, DOI Bureau of Land Management, Universities, and including Firefighters from 3 nations, with expertise in fire detection/mapping, aviation, communications, and ground operations.

Next meeting: October 22 -23 / Reno NV



Technology and Disasters

Closing Caveats

- Over-reliance on technology may:
 - create a false sense of security
 - create vulnerabilities and
 - dull common sense in dangerous situations
- Technology can not make all of us safe all the time.





Comments/Questions?



Contact Information

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2007-2009 Western States Fire Mission

- NASA/USFS collaboration via Wildfire Research Applications Partnership (WRAP)
- Missions conducted using NASA Ikhana UAS
 - Standard MQ-9 Predator B/Reaper w/o skyball
- Mission Plan:
 - One LE mission/week
 - 4-5 missions/summer
- Mission Durations:
 - ~20+ hours
- Flight Altitude Operations:
 - FL230 (23,000 feet MSL)



Results:

- 18 missions
- 81 Fires
- Traversed 8 western states
- Over 120 operational hours in the National Airspace



Global Hawk Imagery

