J1G.6 **MONITORING WILDLAND FIRE ACTIVITY ON A NATIONAL-SCALE WITH MODIS IMAGERY.**

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1. INTRODUCTION

Wildfires burn millions of acres of land annually in the United States. Wildfire managers at regional coordination centers and the National Interagency Fire Center (NIFC) allocate resources for the control and suppression of large wildfire incidents. Strategic planning decisions for wildfire management and resource allocation can be augmented by the knowledge of the degree and distribution of fire activity over large geographic areas. The detection and monitoring of wildfires using remote sensing technologies can facilitate this knowledge; however, not all wildland fires can be effectively detected and monitored daily at a regional and national level using traditional airborne and satellite remote sensing platforms.

In an effort to provide the location of currently active fires, the USDA Forest Service Remote Sensing Application Center (RSAC) collaborated with NASA Goddard Space Flight Center (GSFC) and the University of Maryland to develop a system that uses MODIS satellite imagery to produce daily active fire maps, detection data, imagery and associated fire information products for the entire United States.

These MODIS-derived products provide an understanding of the current wildfire situation in a geospatial context for wildfire managers, the interagency fire community and the general public. This service has been provided on a daily basis since July 4, 2001.

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2. MAPPING FIRES WITH MODIS

The Moderate Resolution Imaging Spectroradiometer (MODIS) is a sensor on board two recently launched NASA Earth Observation System (EOS) satellites – TERRA and AQUA. TERRA was launched in December 1999 and AQUA was launched in May 2002. Both platforms are polar orbiting satellites. The TERRA satellite follows a descending polar orbit crossing the equator at approximately 10:30 AM local time. AQUA follows an ascending polar orbit crossing the equator at 1:30 PM local time.

MODIS detects a broad spectral range of electromagnetic energy in 36 bands ranging from the visible to thermal infrared wavelengths and takes measurements at three nested spatial resolutions (250 meters, 500 meters and 1000 meters). Each MODIS sensor has a wide 2,330-kilometer field of view (Figure 1) that enables it to collect image data over nearly the entire globe twice daily—one daytime and one nighttime observation approximately 12 hours apart.

Figure 1 - An example of the extent of MODIS swath data over the western United States.

Fire detections are gleaned using MODIS' thermal bands that are collected at 1000-meter resolution on both daytime and nighttime observations. Together, the MODIS sensors on board TERRA and AQUA provide a total of at least 4 daily thermal observations of any location in the middle and high latitudes of the globe.

In an effort to take advantage of the capabilities of MODIS for fire detection and monitoring, RSAC, GSFC and the University of Maryland collaborate to provide a system that facilitates 1) the rapid acquisition and processing of MODIS imagery, and 2) the immediate compilation and delivery of derived geospatial products to users.

The system utilizes MODIS data for the western two thirds of the United States acquired in real time by RSAC's MODIS Direct Broadcast Receiving station in Salt Lake City, Utah (Figure 2). MODIS data for the eastern United States and Alaska is acquired in near real time (within 4-6 hours of acquisition) via the Goddard Space Flight Center MODIS data stream. Both TERRA and AQUA MODIS data for the daytime and nighttime overpasses are collected at both facilities. Utilizing data collected at RSAC's Direct Broadcast facility provides TERRA and AQUA MODIS data within an hour of acquisition resulting in timely information to users during the western United States fire season.

Figure 2 - RSAC MODIS Direct Broadcast Receiving Station in Salt Lake City, Utah.

MODIS imagery is continually acquired and processed at GSFC and RSAC. Fire detections are identified using the MODLand Rapid Response System designed by GSFC and the University of Maryland. The fire detection algorithm is documented in the MOD14 Users Guide (Giglio et al; 2000). Several environmental factors may limit the ability of MODIS to detect fires: 1) cloud cover, 2) fire size and temperature, and 3) fire location on the terrain. Raw fire detection data from GSFC and RSAC are subsequently compiled and processed at RSAC to create fire GIS data layers.

3. MODIS ACTIVE FIRE PRODUCTS

RSAC utilizes MODIS-derived fire detections and MODIS imagery to produce daily geospatial fire products and related fire information. These products include:

1. *MODIS Active Fire Maps* - Poster-sized maps covering the entire United States that depict active fire detections within the last 24 hours and the cumulative extent of previous detections in conjunction with other cartographic data. Twenty maps are compiled three times daily which coincide with geographic areas designated by the wildland fire agencies (Figures 3 and 4).

2. *MODIS Current Detection Information* - Detailed geospatial information for all MODIS detections nationwide within the last 24 hours. Information includes time of detection and coordinates as well as other relevant data for each detection (state, county, National Forest, nearest populated place, etc.),

3. *MODIS Fire Detection GIS Data* - Annual GIS layers of the cumulative United States MODIS fire detections. Data sets are available for each year dating back to year 2001. The current year's data is updated daily. Each annual GIS layer contains the centroids of the 1KM fire detections populated with pertinent attributes.

4. *MODIS Swath Quicklook Imagery* - JPG Quicklook images at multiple resolutions of AQUA and TERRA MODIS swath data collected by RSAC on a daily basis.

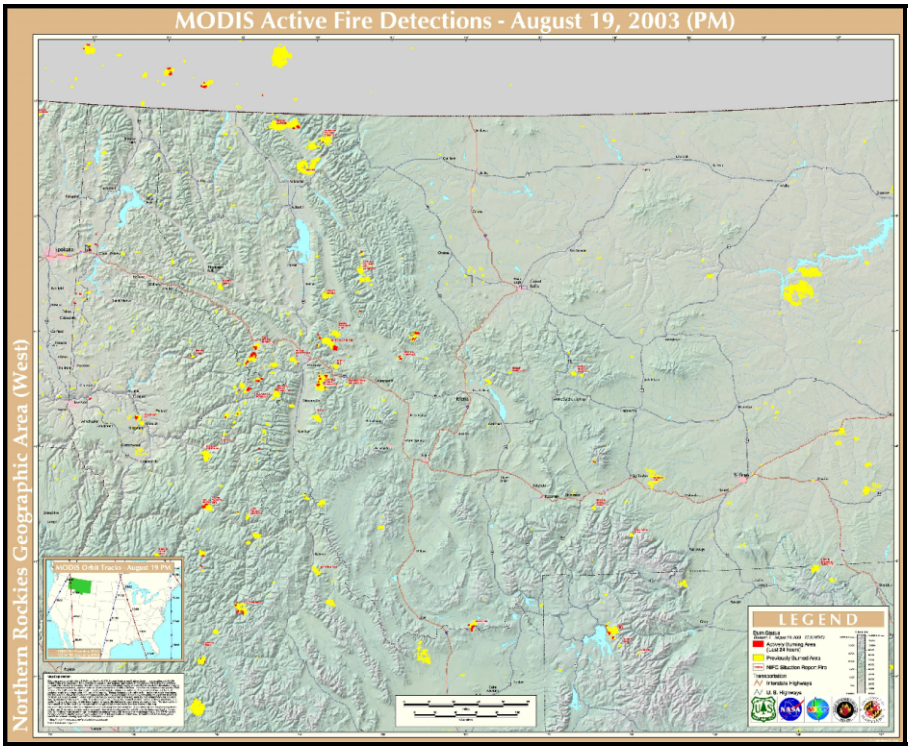

Figure 3 - An August 19, 2003 MODIS Active Fire Map for the Northern Rockies Geographic Area.

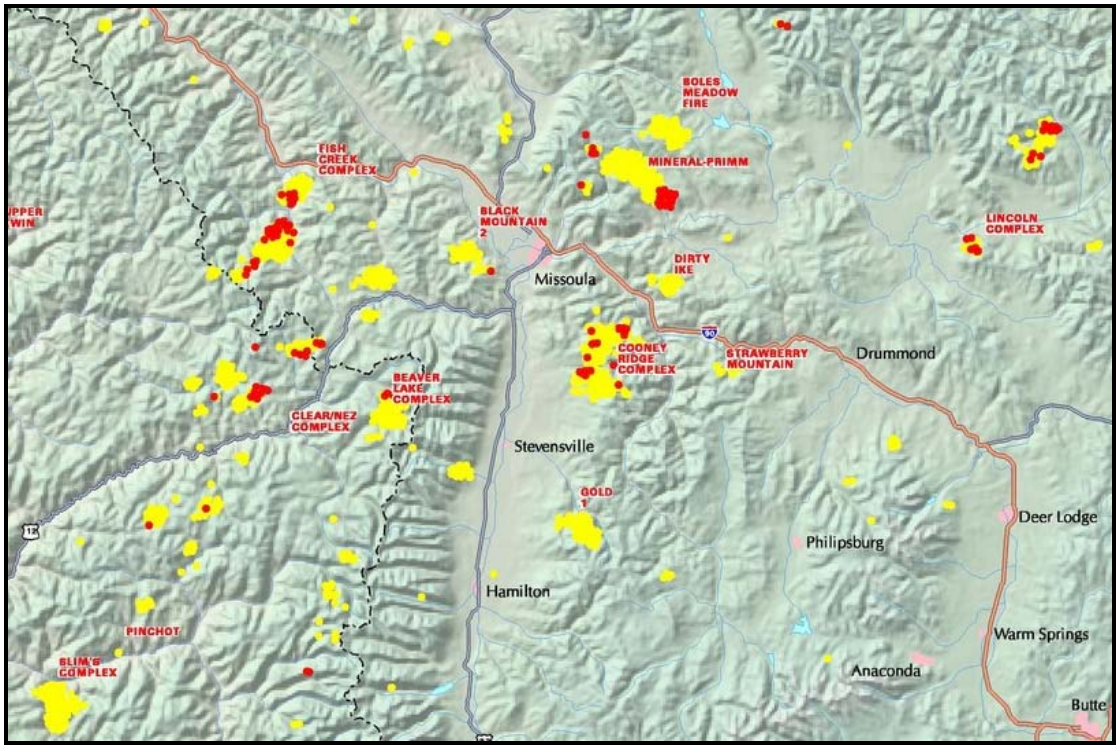

Figure 4 - A zoomed view of the August 19, 2002 Active Fire Map in the vicinity of Missoula, Montana. Red areas are MODIS fire detections in the last 24 hours; yellow areas are detections previous to the last 24 hours. Large incident names are labelled.

5. *MODIS Fire Subsets* - Georeferenced multispectral MODIS imagery subsets of current large fires in the western United States. Subsets are updated daily and are available for download as 3 band true- and false-color composite GeoTiffs. Seven band generic binary data is also provided (Figures 5 and 6).

Figure 5 - An example of True-color composite MODIS GeoTiff data (Bands 1, 4 and 3) of the Flathead and Bitterroot Valleys in Montana. Image acquired August 19, 2003.

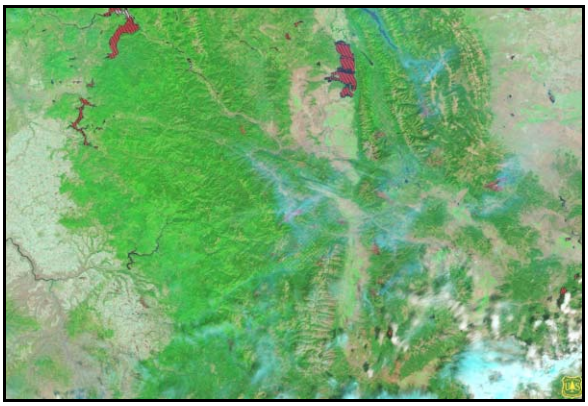

Figure 6 - An example of a False-color composite MODIS GeoTiff data (Bands 7, 2 and 1) of the Flathead and Bitterroot Valleys in Montana. Image acquired August 19, 2003.

6. *Current Fire Information* – Interactive MODIS fire detection mapping application for current large fires. Mapping data and detailed fire information and statistics for each incident are provided.

All products are available for download from RSAC's Active Fire Mapping Program website (http://activefiremaps.fs.fed.us).

4. CONCLUSION

The MODIS Active Fire Mapping Program is a cooperative effort of the USDA Forest Service Remote Sensing Application Center, NASA Goddard Space Flight Center and the University of Maryland Department of Geography. Additional support is also provided by the National Interagency Fire Center and the USDA Forest Service Fire Sciences Laboratory.

The MODIS Active Fire Mapping Program has provided active fire mapping products daily since July 4, 2001. The program integrates remote sensing, GIS and Internet technologies to provide MODIS imagery, detection data, active fire maps and other fire-related geospatial data rapidly and reliably.

The active fire maps are intended for strategic planning by wildfire managers at the regional and national level, not tactical planning at the incident level. MODIS imagery and fire detection GIS data are also intended not only for strategic planning and assessments, but also analysis at the appropriate scale.

5. REFERENCES

Giglio, L., Justice, C., Korontzi, S., Owens, J. and Roy, D. (October, 2000). MODIS Fire Products Users Guide (MOD14). <http://modis-fire.gsfc.nasa.gov/products/usersguide.asp>.