

Systematic Mapping of the Location, Extent and Severity of Fires in The United States

MTBS - The Monitoring Trends in
Burn Severity Project



MTBS Project Background (1/2)

- Consistently map the location, extent and burn severity of large fires on all lands in the United States from 1984 and 2010
 - > 1,000 acres in the western United States
 - > 500 acres in the eastern United States
- Initiated in FY 2006
- Sponsored by the interagency Wildland Fire Leadership Council (WFLC)
 - One element of a strategy monitoring the effectiveness of NFP and HFRA
 - Provide an information base to synoptically assess environmental impacts and trends
 - Required for all lands in CONUS, AK, HI and PR



MTBS Project Background (2/2)

- GAO recommendation that land management agencies develop and implement comprehensive burn severity assessments
 - Provide consistent and comprehensive data characterizing wildfire effects to land managers and the scientific community
- Jointly implemented by USFS RSAC and USGS EROS
 - Equal funding from USDA-FS and DOI



MTBS and Burn Severity

Burn Severity:

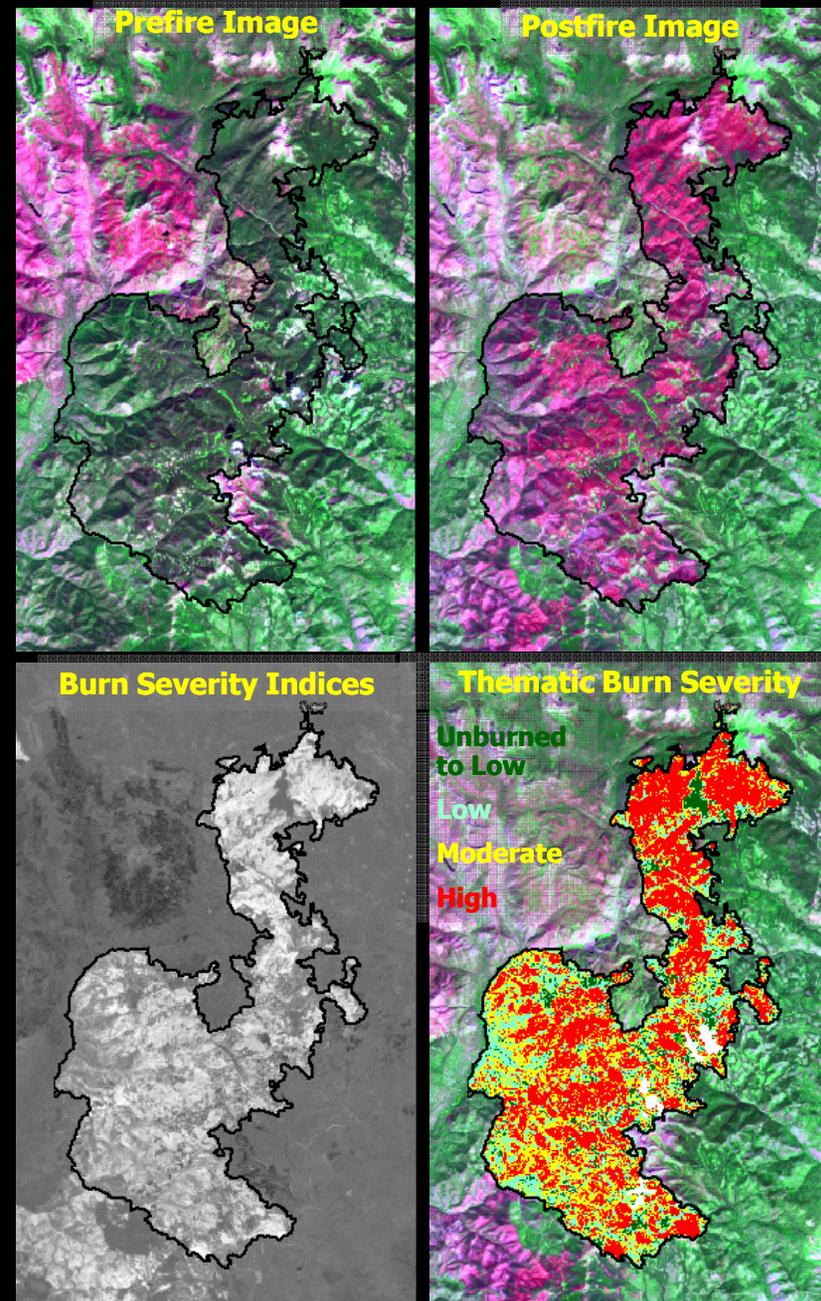
- ...relates to detectable changes in living and non-living biomass, fire by-products (ash) and soil exposure
- ...is a composite of first order effects and second order effects that arise within one growing season
- ...occurs on a gradient or ordinal scale
- ..is a mosaic of effects that occur within a fire area
- ..is "mappable" using remote sensing and change detection methods



MTBS Geospatial Products

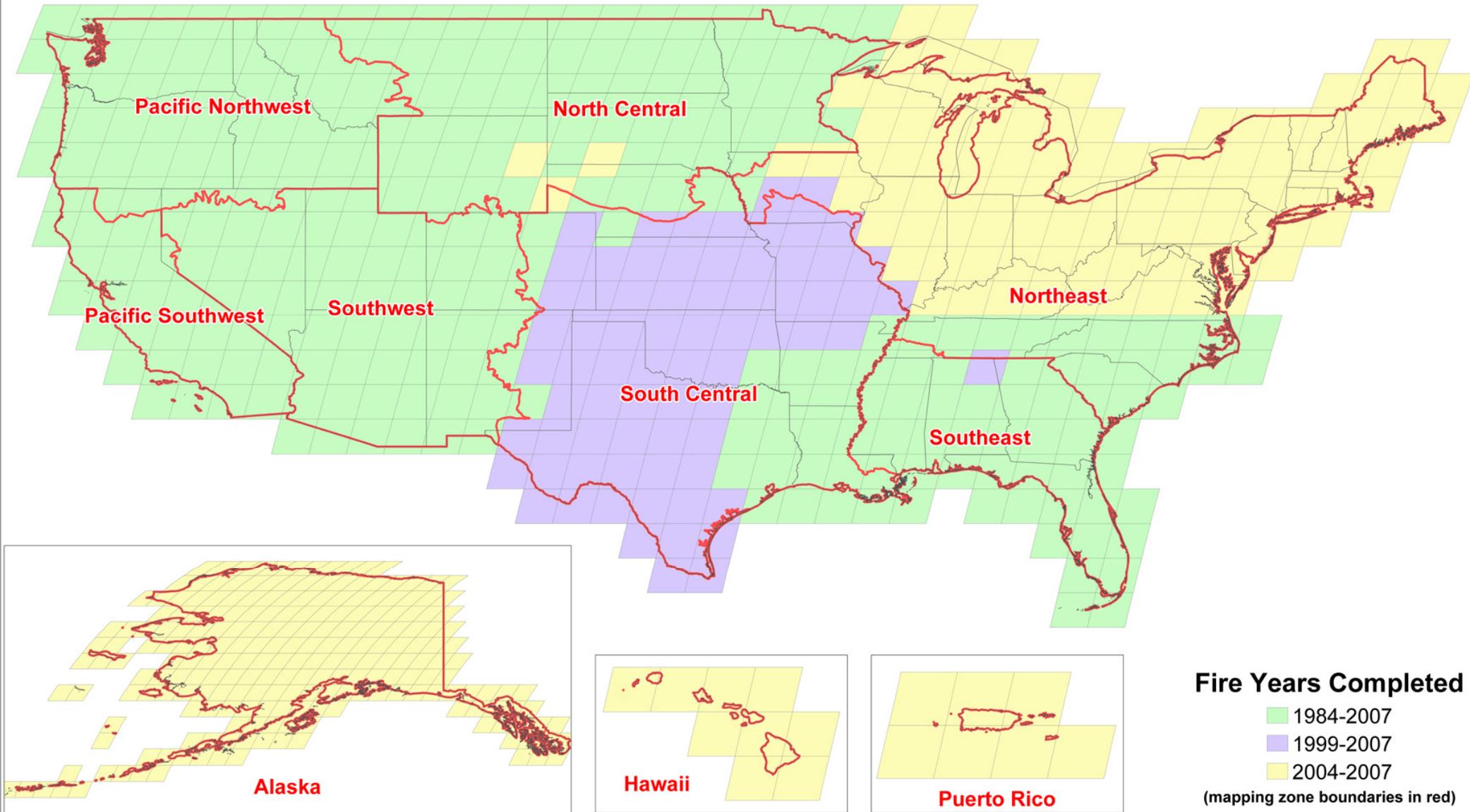
Fire Level Datasets

- Available at <http://www.mtbs.gov/dataaccess.html>
- Pre/Post-fire Landsat imagery
 - Bands 1-5, 7
- Burn scar boundary
 - Vector delineation of burned area extent based on image analysis
- Continuous burn severity indices
 - dNBR/RdNBR
- Thematic burn severity data
 - 6 classes (unburned to low, low, moderate, high, increased vegetation response, non-mappable areas)
- Metadata
- Expanded Landsat MRLC archive
 - 10,000+ scenes
 - Thousands more scenes to be added
 - See <http://glovis.usgs.gov>



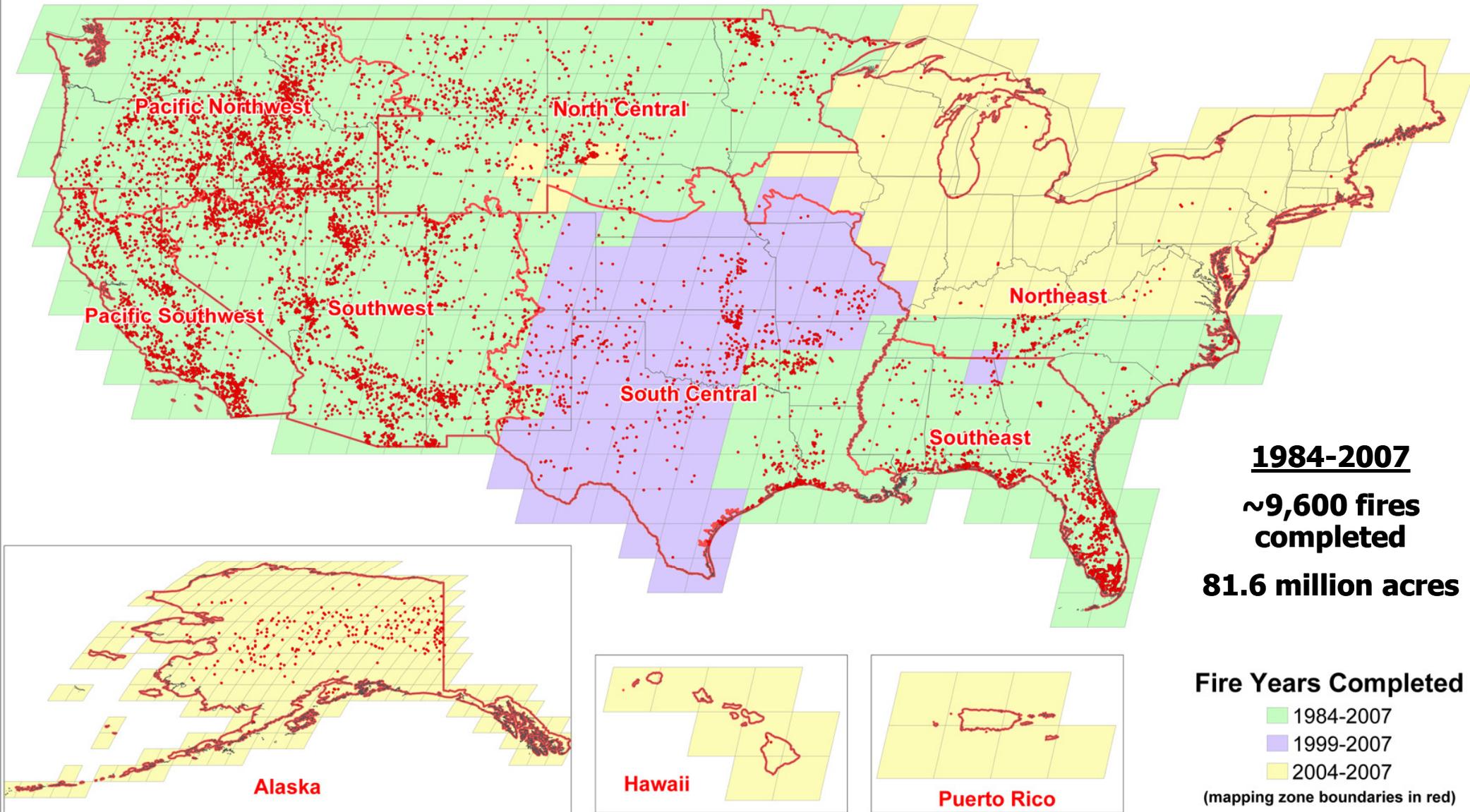
MTBS Production Status

MTBS Mapping Status By Landsat P/R
(August, 2009)



MTBS Production Status

MTBS Mapping Status By Landsat P/R (August, 2009)



MTBS Methods

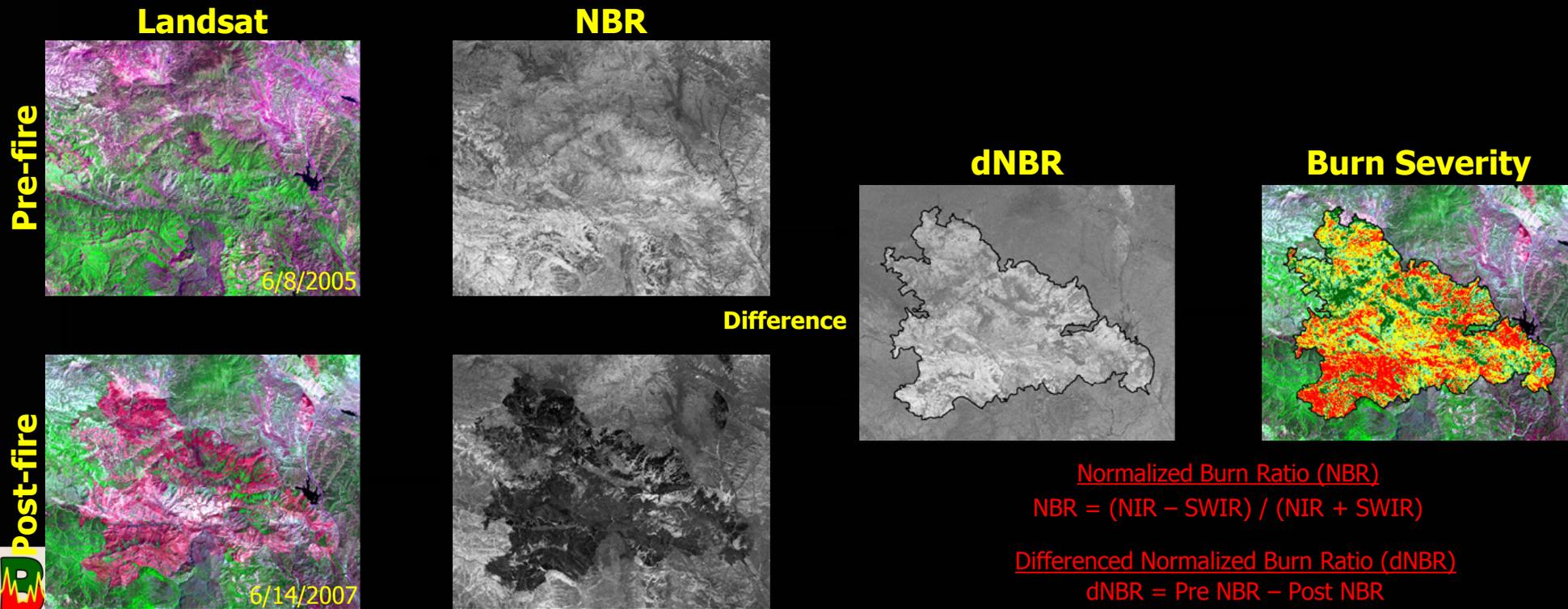
Burn scar and burn severity products are based on Landsat TM/ETM data and the differenced Normalized Burn Ratio (dNBR) approach

$$\begin{aligned} \text{NBR} &= (\text{NIR} - \text{Mid IR}) / (\text{NIR} + \text{Mid IR}) \\ \text{dNBR} &= \text{pre NBR} - \text{post NBR} \end{aligned}$$

- Mature science established in the literature
 - Lopez-Garcia and Caselles, 1991; Brewer et al., 2005; Cocke et al., 2005; others
- Operational precedent
 - Implemented by Key and Benson for development of NPS fire atlases
 - USFS/DOI BAER Programs
- Landsat TM/ETM data record
 - Consistent data record spanning ecologically and possibly climatically significant time frame
- Resolution synergy
 - Spatial and spectral resolutions comparable to other national scale data

MTBS Fire Mapping Methods Overview

- Compile a single MTBS fire occurrence database (FOD) from existing data sources
- Based on FOD and prescribed assessment strategy, select pre and post-fire Landsat scenes
- Landsat TM/ETM+ data ordered and acquired from EROS
- Analysts perform necessary image pre-processing, image differencing, burned scar delineation and threshold dNBR images into burn severity classes
- Metadata, map products, burn severity data analysis and summary, and reporting

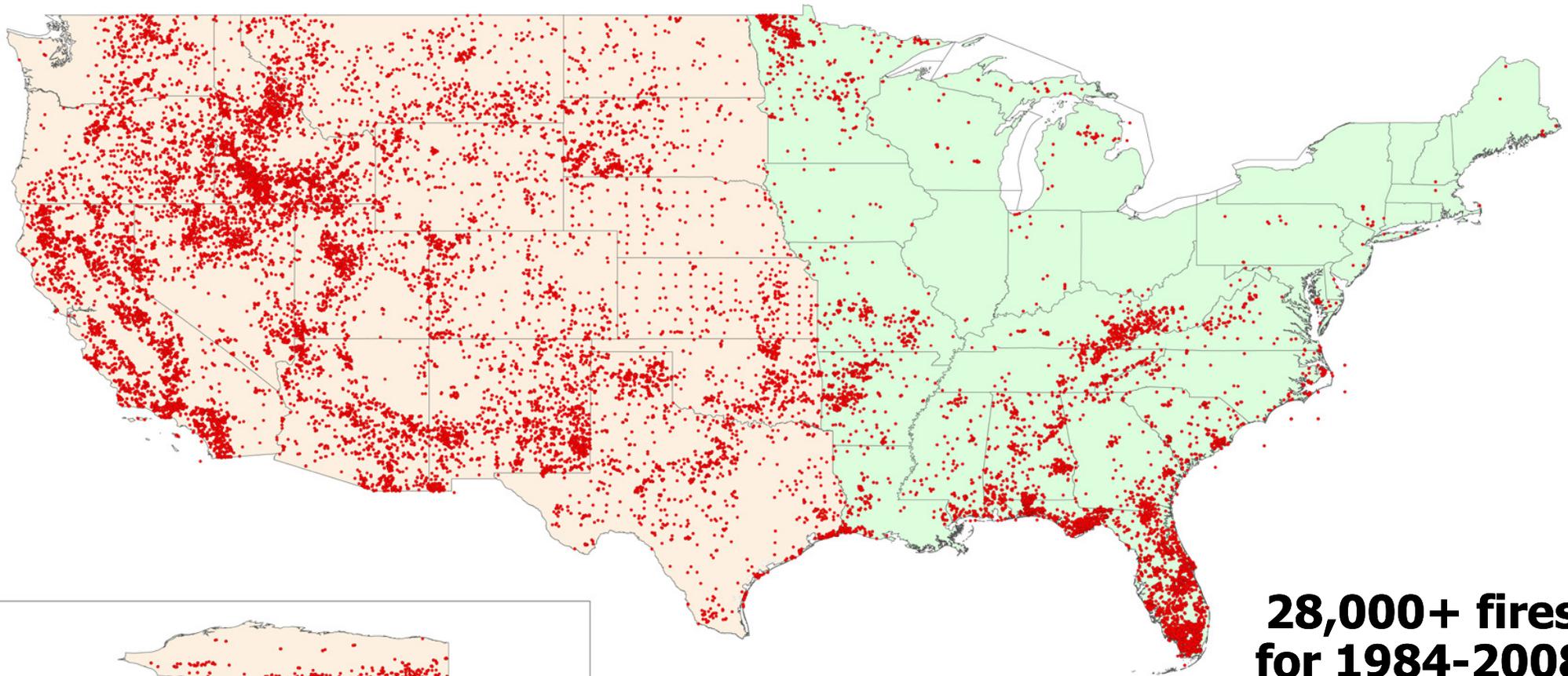


MTBS Methods- Source Fire Occurrence Data

- Compile from existing fire occurrence databases
 - Federal fire history database
 - Compiled from ICS209 database
 - Most state fire databases
 - Other related databases (NASF, NFPORS, etc)
- 28,000+ MTBS fire records for years 1984 - 2008
 - Numerous duplicates and spatial anomalies
- Standardize to address format and content variability
 - Core fire data harvested (fire name, fire size, database id, ignition date, containment date, out date)
 - Unique MTBS id assigned; links to database of origin
- Discovered fires on Landsat imagery are added to database

MTBS Fire Occurrence Locations

Fire Occurrence Locations Provided By Federal, State Agencies and Other Organizations
(1984-2008)



**28,000+ fires
for 1984-2008**

MTBS East/West Regions
East U.S. (Fires > 500 ac)
West U.S. (Fires > 1,000 ac)

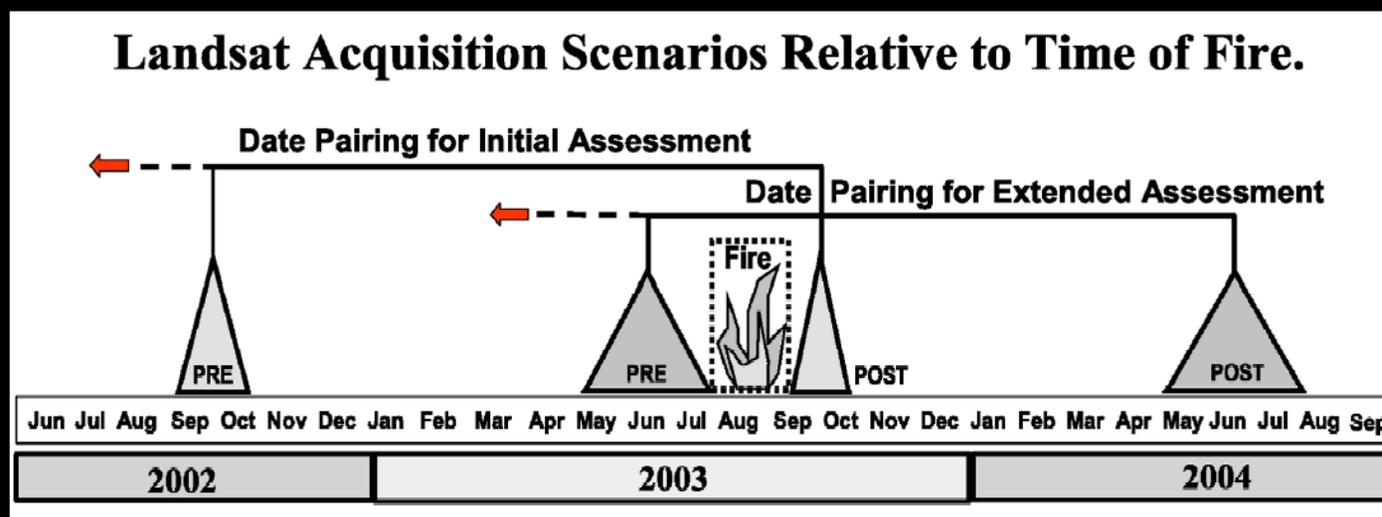
Alaska

Hawaii

Puerto Rico

MTBS Methods – Assessment Strategy

- Based on fire type
 - Extended Assessment (EA)
 - Severity based on post-fire assessment at peak of green of next growing season
 - Forests/shrublands
 - Initial Assessment (IA)
 - Severity based on immediate post-fire assessment
 - Grasslands/shrublands
 - “Single Scene” Assessment
 - Lack of suitable pre-fire imagery or other factors; use post-fire NBR
 - Conducted on a limited basis (EAs and IAs)



MTBS Methods – Landsat Scene Selection

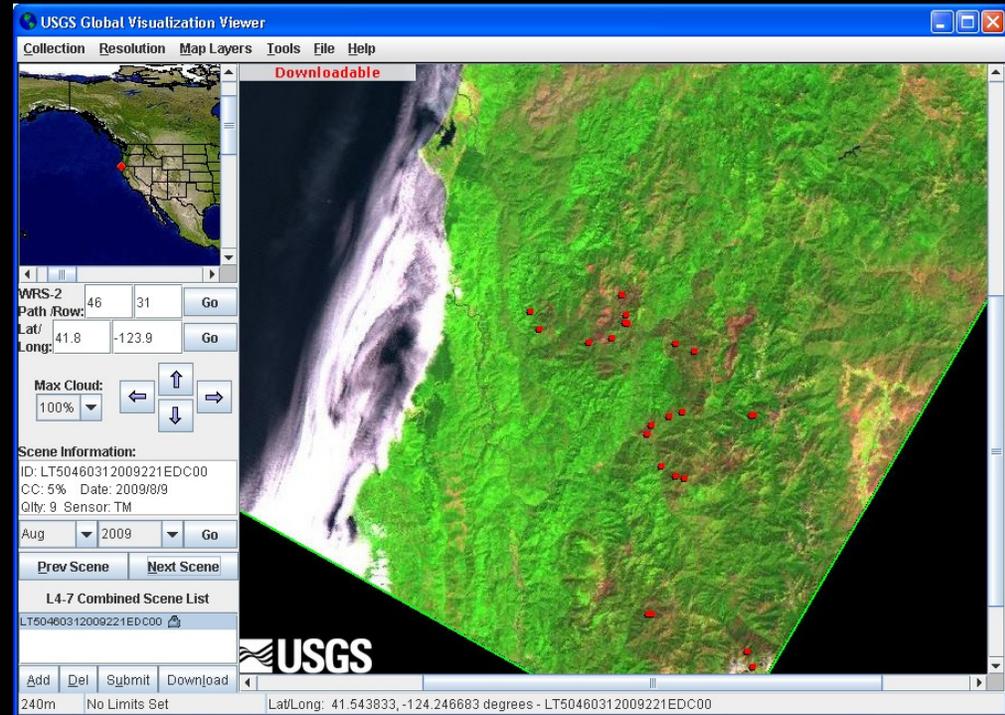
- Scene selection based on assessment strategy
 - Variables: fire location/date, cloud-free availability, and optimal seasonality
- USGS Global Visualization Browser (GloVis)
 - <http://glovis.usgs.gov>
 - Review browse images for Landsat data record
 - MTBS driven enhancements include:
 - Input and overlay of user supplied shape files
 - Annual NDVI/land cover summary graphs by path/row
- MTBS scene selection tool
 - Database application containing MTBS fire occurrence data and Landsat metadata
 - Select/record fire type, selected scenes, etc.

GloVis Scene Selection Process

GloVis NDVI trend summaries by land cover type and P/R



GloVis viewer w/targeted MTBS fire locations



The screenshot shows the 'MTBS_MASTER_Form_v2' web form. It includes fields for Year (2008), Fire ID (FS-0611-014-20080816), and Geographic Region (CONUS). A table lists scene parameters: PreScene (5046031000821910), Initial Scene, and Extended Scene (5046031000922110). The form also has dropdowns for Fire Type (Evergreen Forest), Assessment Type (Extended), and Visible Burn Scar (Yes). Buttons for 'Duplicate', 'Primary', and 'Assign Duplicates To This Fire ID' are present. A 'Notes' section is at the bottom.

MTBS scene selection tool records selection parameters for each fire

Image orders submitted to EROS through GloVis interface



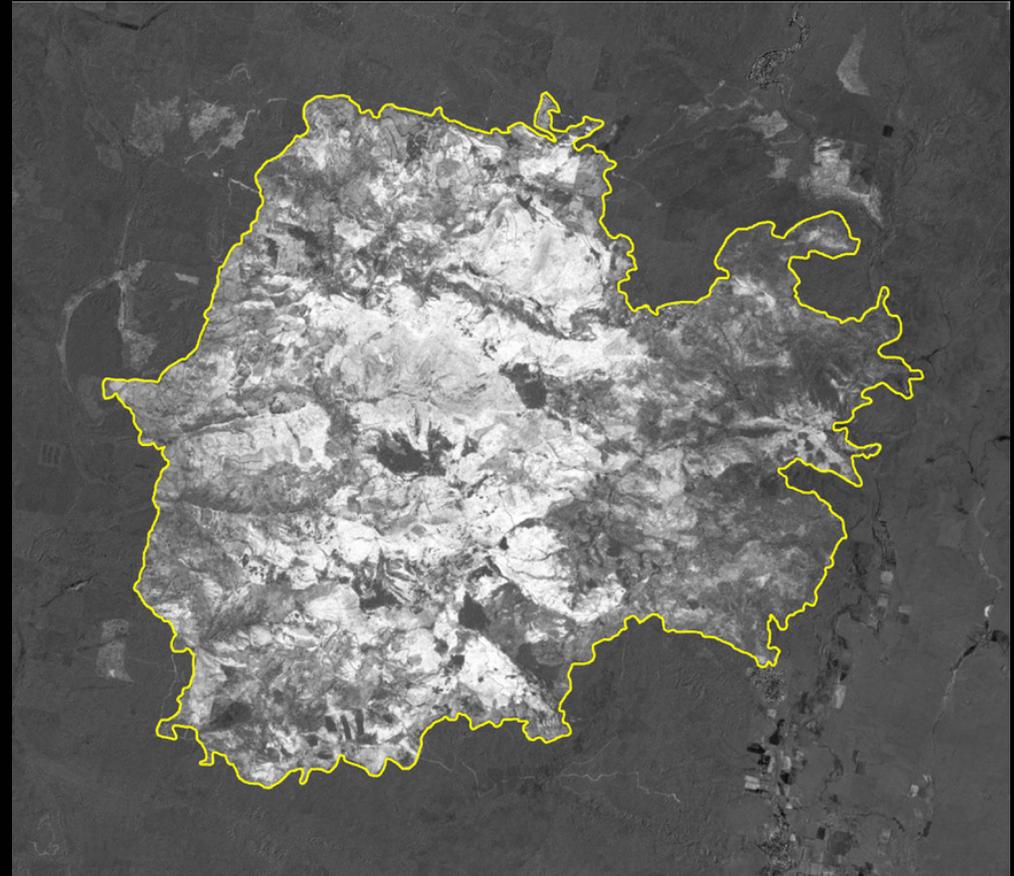
MTBS Methods – Landsat Data Processing

- Data are processed using Level 1 Product Generation System (LPGS) at EROS
 - Level 1T product (terrain corrected)
 - UTM projection
- LPGS images are downloaded and pre-processed to create an “MRLC-like” product
 - Calibrate to At-Satellite reflectance
 - Reproject to Albers Equal Area
 - Derive full scene NBR image
- Prepare Landsat imagery and derivatives used in fire-level mapping
 - Generate full scene dNBR image from NBR pairs
 - Subset pre/post-fire reflectance, dNBR images to extent of fire
 - Generate RdNBR

MTBS Methods – Burn Scar Delineation

- Goal is to utilize a consistent method and data to derive perimeters
- Perimeters digitized using dNBR and reflectance data
- Scale of delineation: 1:24,000 to 1:50,000
- Incident perimeters do not directly affect delineation
- Perimeter confidence levels included as feature level metadata

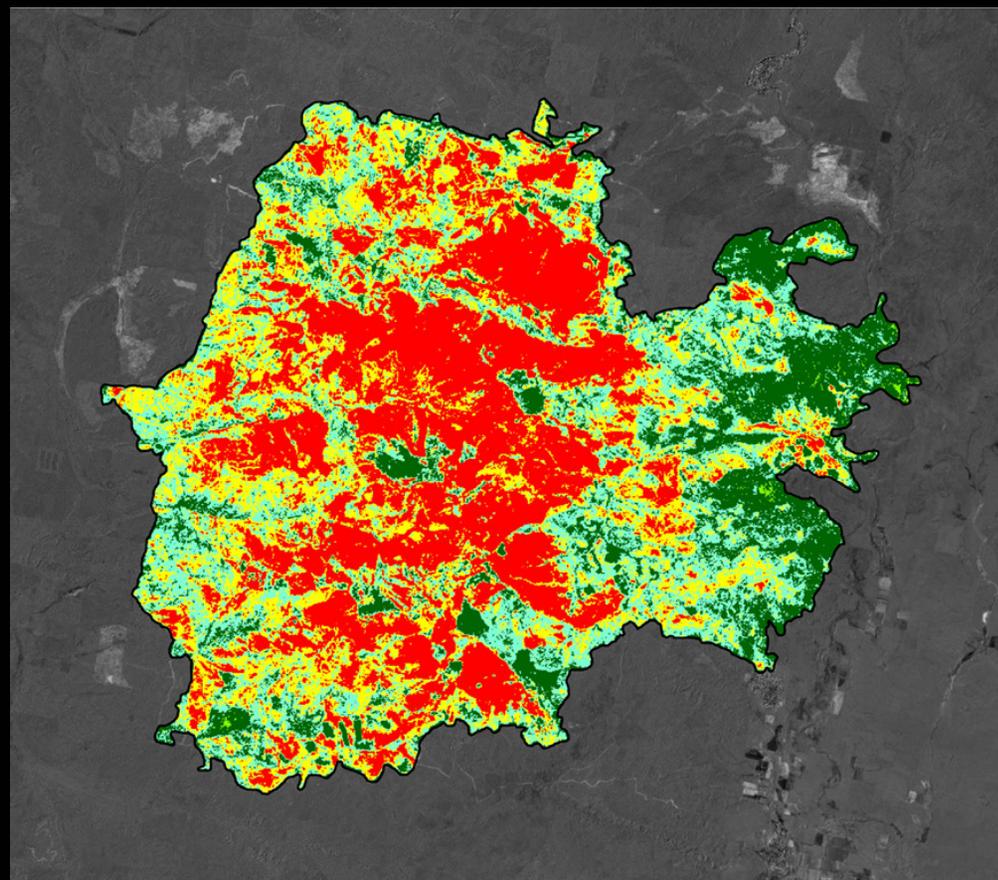
2007 Chippy Creek Fire (western Montana)



MTBS Methods - Burn Severity Mapping

- dNBR images are interpreted to derive 5 severity classes
- Analysts use knowledge of site ecology, and knowledge of fire behavior and effects in given ecological settings, as guidance for choosing severity thresholds
- Composite Burn Index (CBI) thresholds applied where available
- Analysts also have access to advice and feedback from regional experts

2007 Chippy Creek Fire (western Montana)



- Unburned to Low
- Low
- Moderate
- High
- Increased Response
- Non-mapping Area

MTBS Project Challenges and Limitations

- FOD accuracy/completeness
 - Erroneous locations
 - Incorrect acreage reports
 - Source database revisions/updates
- Landsat data continuity/quality
 - Investigating alternative sensors in case of data gap
 - L7 SLC-off data
- Limitations of sensor characteristics
 - Detection of low intensity/understory fire areas
- Ability of NBR/dNBR to characterize fire effects
 - Adaptability to wide range of biophysical settings
 - Pre-fire/post-fire reflectance data provided by MTBS to facilitate application of other methods

MTBS Project Challenges and Limitations

- Consistency in thresholding severity classes
 - Feedback from regional experts
 - MTBS internal calibration
 - Apply regional threshold models calibrated using plot data
- Assessment timing relative to burn scar delineation and severity characterization
 - Challenges to obtaining appropriate imagery (cloud cover, lack of data coverage, etc.)
 - Post-fire management activities
- Inclusion of “small” fires (< 500 and < 1,000 acre fires)
 - Significant costs involved to capture these additional fires
 - ~5% of the fire occurrences and ~95% of burned area is captured by MTBS

MTBS – Looking Forward

- Production continues
 - 2008 nationwide fire mapping started
 - Completion of historical fire mapping in South Central mapping zone later this year
 - Start historical fire mapping in Alaska, Hawaii and Northeast mapping zones in FY10
 - Plans for MTBS annual maintenance and update for years 2011+
- Cal/Val efforts
 - Field trip to several fires in TN and NC in September 2009
- Technology transfer
 - Tutorials/training modules coming soon to MTBS project website
 - MTBS workshop at Association for Fire Ecology Conference in November 2009



MTBS Contact Information

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<http://www.mtbs.gov>

