Welcome to Techniques for Wildfire Detection and Monitoring

We will begin promptly at 10:00 EDT (UTC-4)

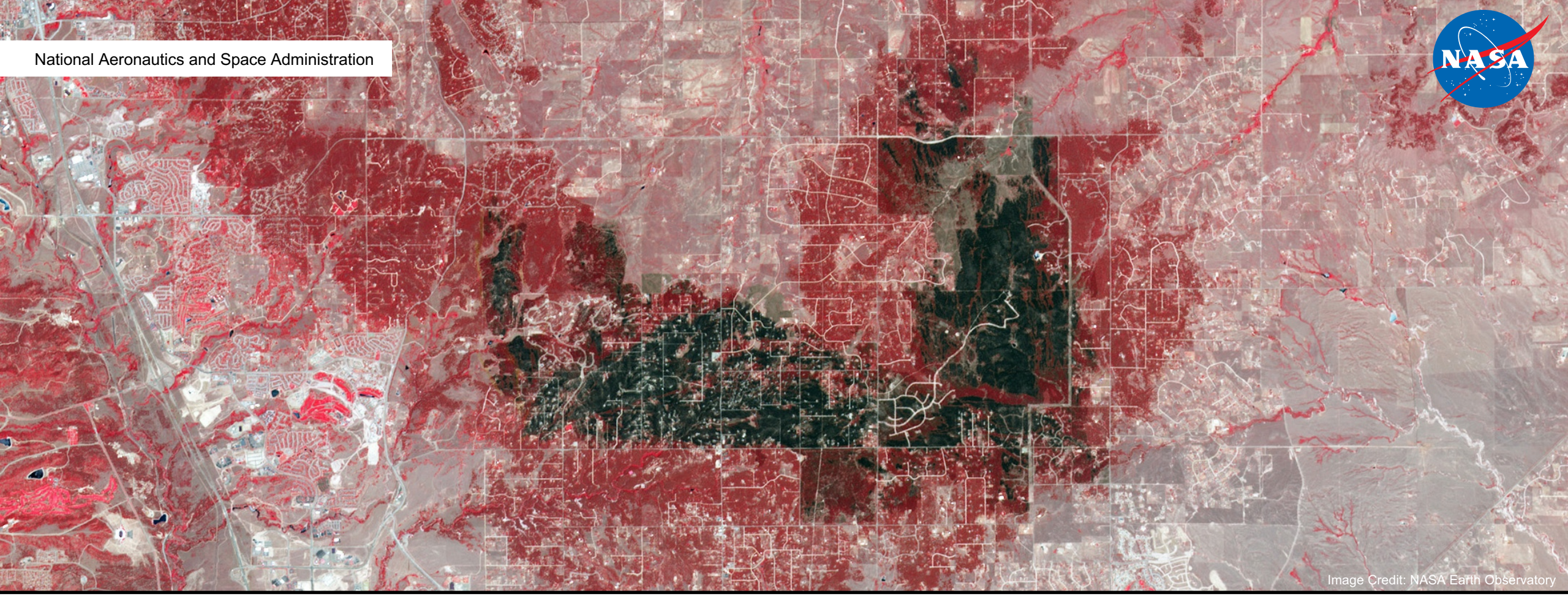
Course Format:

- Two, two hour sessions
- Sessions will be held on July 12 and 19, 2018
- All attendees will be muted automatically upon entry
- This session will be recorded and made available to you within two days

Please be sure you have completed the prerequisites on the training website:

https://arset.gsfc.nasa.gov/land/webinars/adv-wildfire-2018

National Aeronautics and Space Administration



Using the Fire Mapping Tool to Map Fires

Josh Picotte — ASRC Federal InuTeq LLC, Contractor to the U.S. Geological Survey (USGS), Earth Resources Observation and Science (EROS) Center, Contract Number G13PC00028

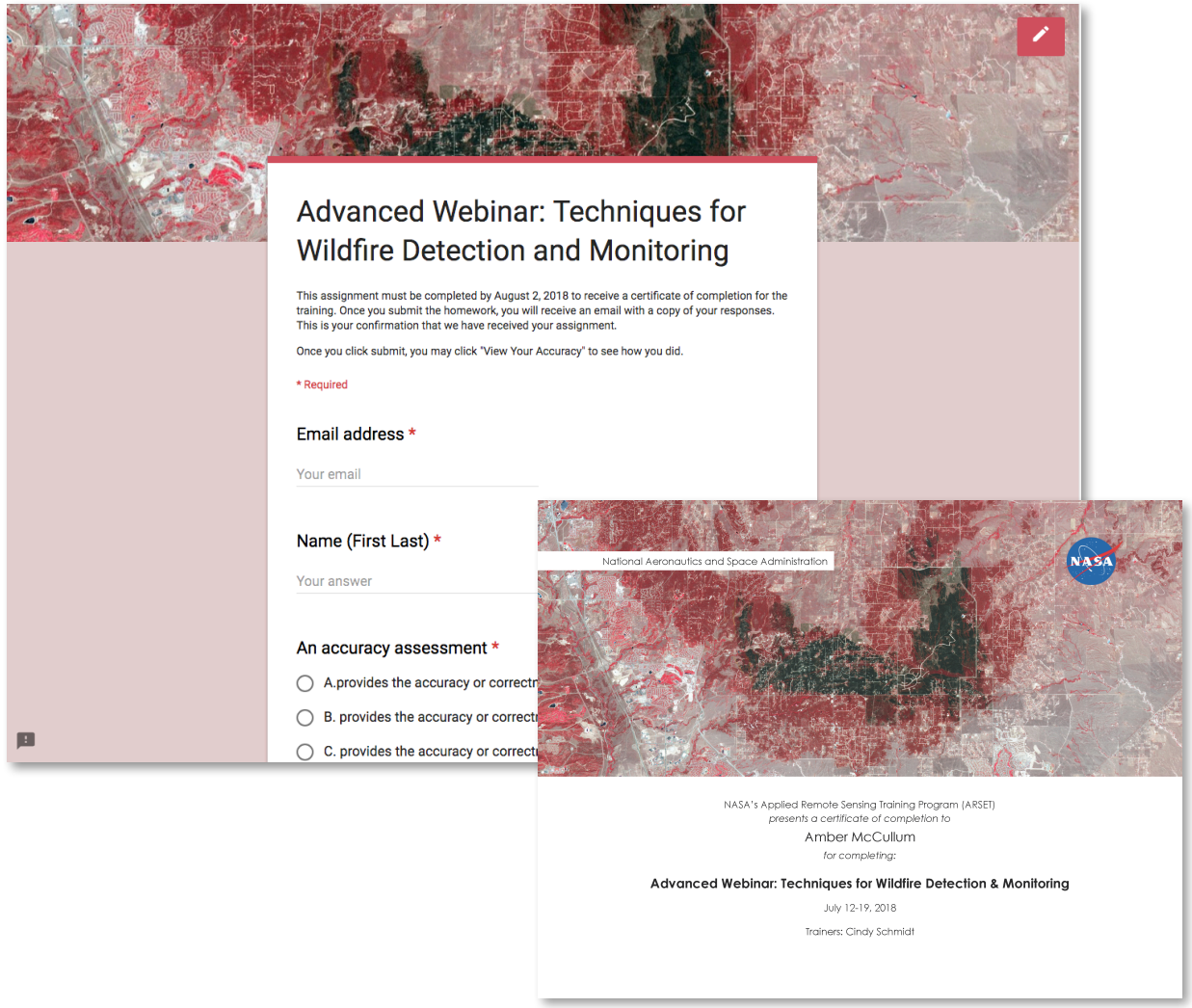
7/12/2018

Course Structure

- Two 2-hour sessions on July 12 and 19, 2018
  - Session A: 10:00-12:00 EDT (UTC-4)
  - Session B: 18:00-20:00 EDT (UTC-4)
  - Please only sign up for and attend one session
- Guest speaker, Josh Picotte with the USGS EROS/ASRC Federal InuTeq
- Webinar recordings, PowerPoint presentations, and the homework assignment can be found after each session at:
  - https://arset.gsfc.nasa.gov/land/webinars/adv-wildfire-2018
  - Q&A: Following each lecture and/or by email
    - cynthia.l.schmidt@nasa.gov, or
    - amberjean.mccullum@nasa.gov

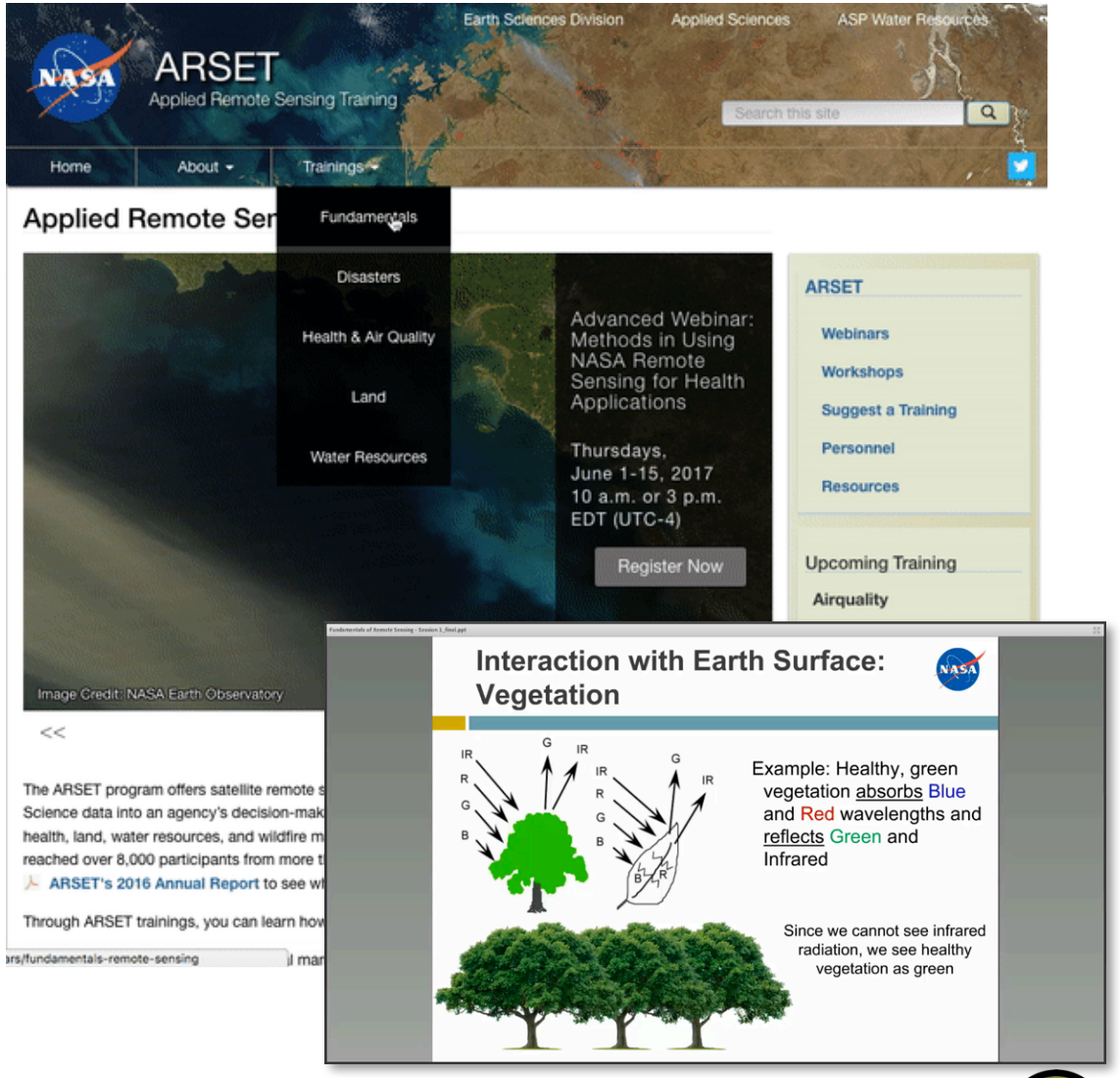
Homework and Certificates

- Homework
  - One homework assignment
  - Answers must be submitted via Google Forms
- Certificate of Completion:
  - Attend sessions from both weeks
  - Complete the homework assignment by the deadline (access from ARSET website)
    - HW Deadline: August 2nd
  - You will receive certificates approx. two months after the completion of the course from: marines.martins@ssaihq.com



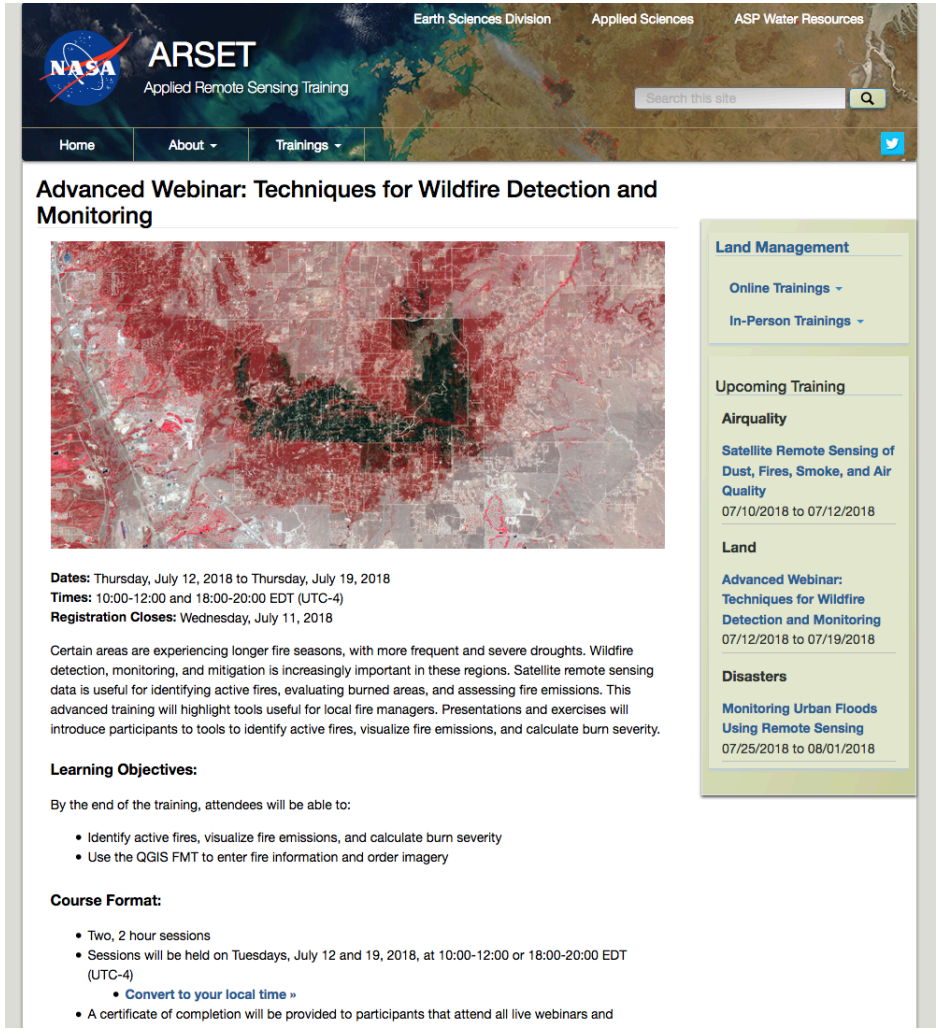
Prerequisites

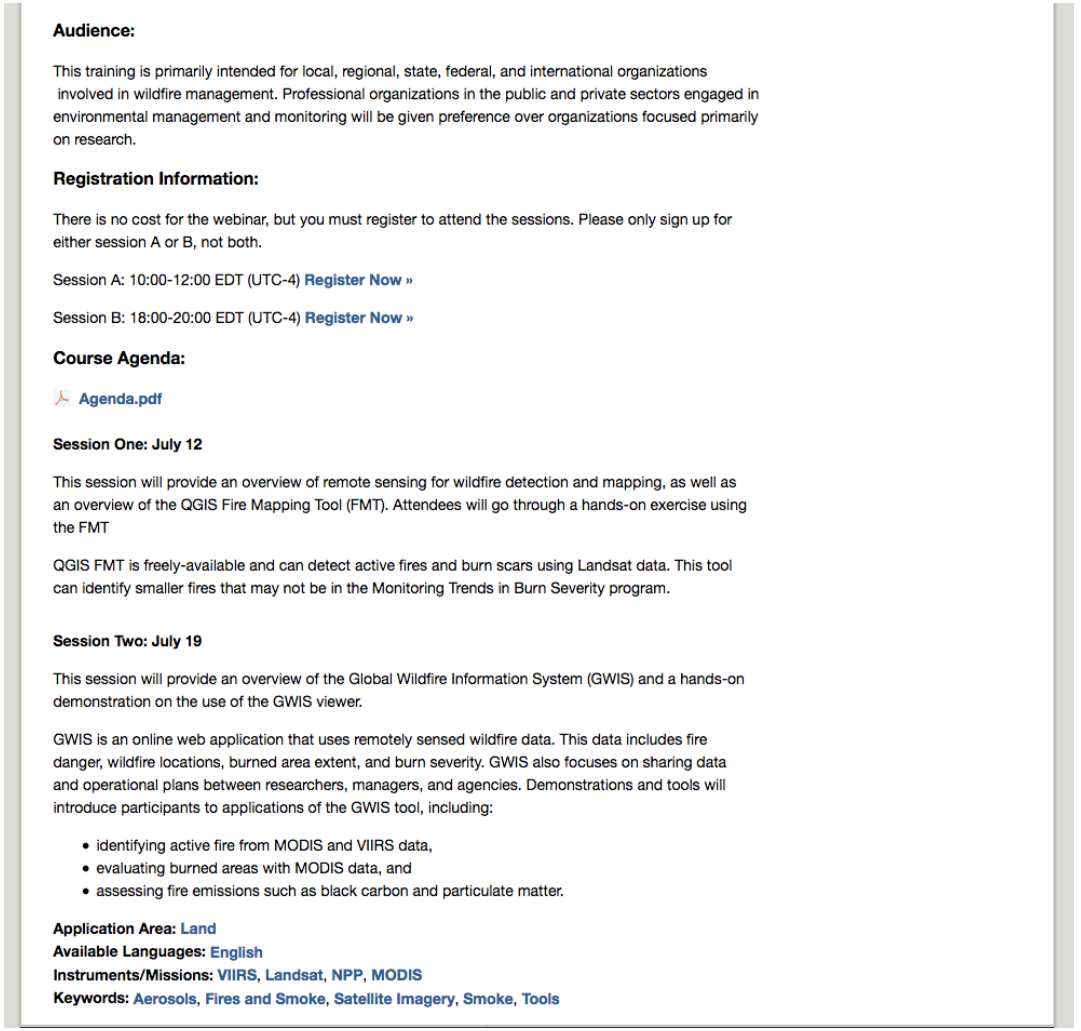
- Fundamentals of Remote Sensing
  - Sessions 1 and 2A (Land)
  - On demand webinar, available anytime
  - http://arset.gsfc.nasa.gov/webinars/fundamentals-remote-sensing
- Download and install QGIS and all accompanying software
  - Use this exercise for help: Downloading and Installing QGIS
  - We strongly recommend you open QGIS and ensure the software is working prior to starting the webinar



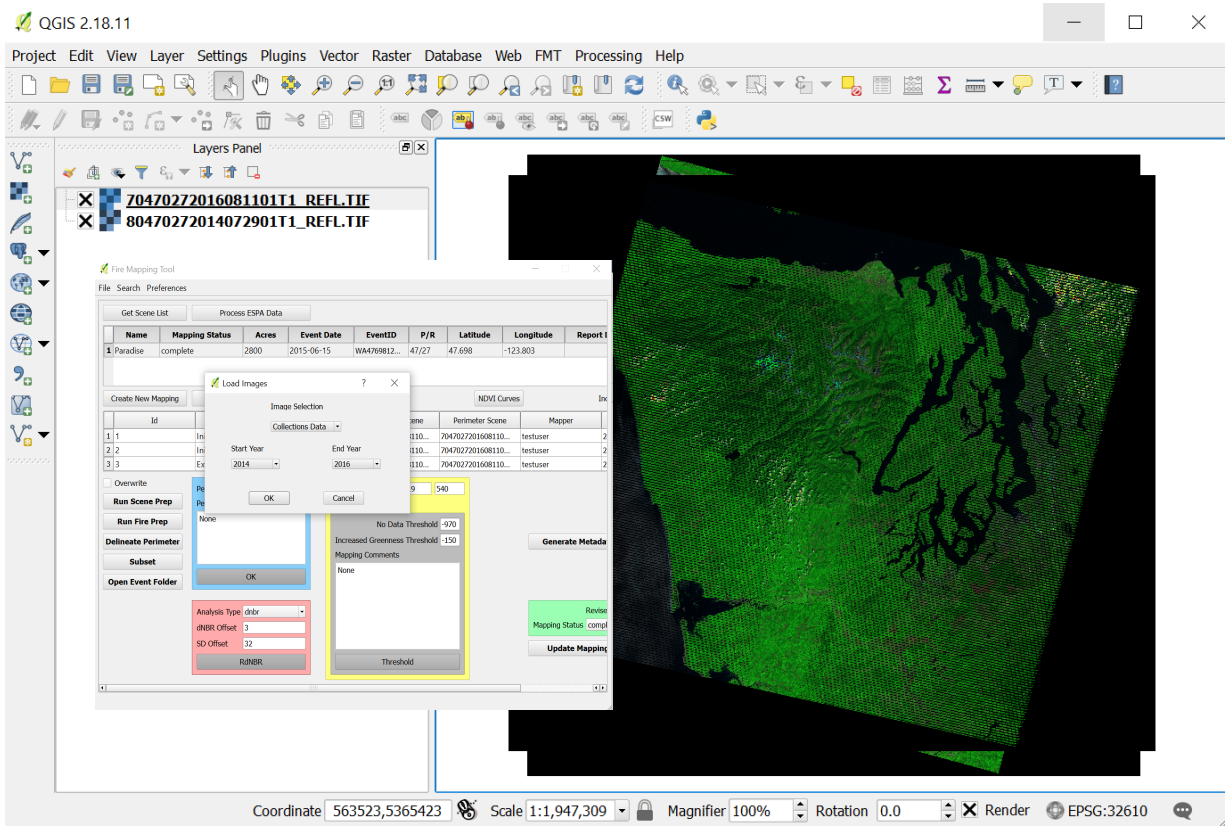
Accessing Course Materials

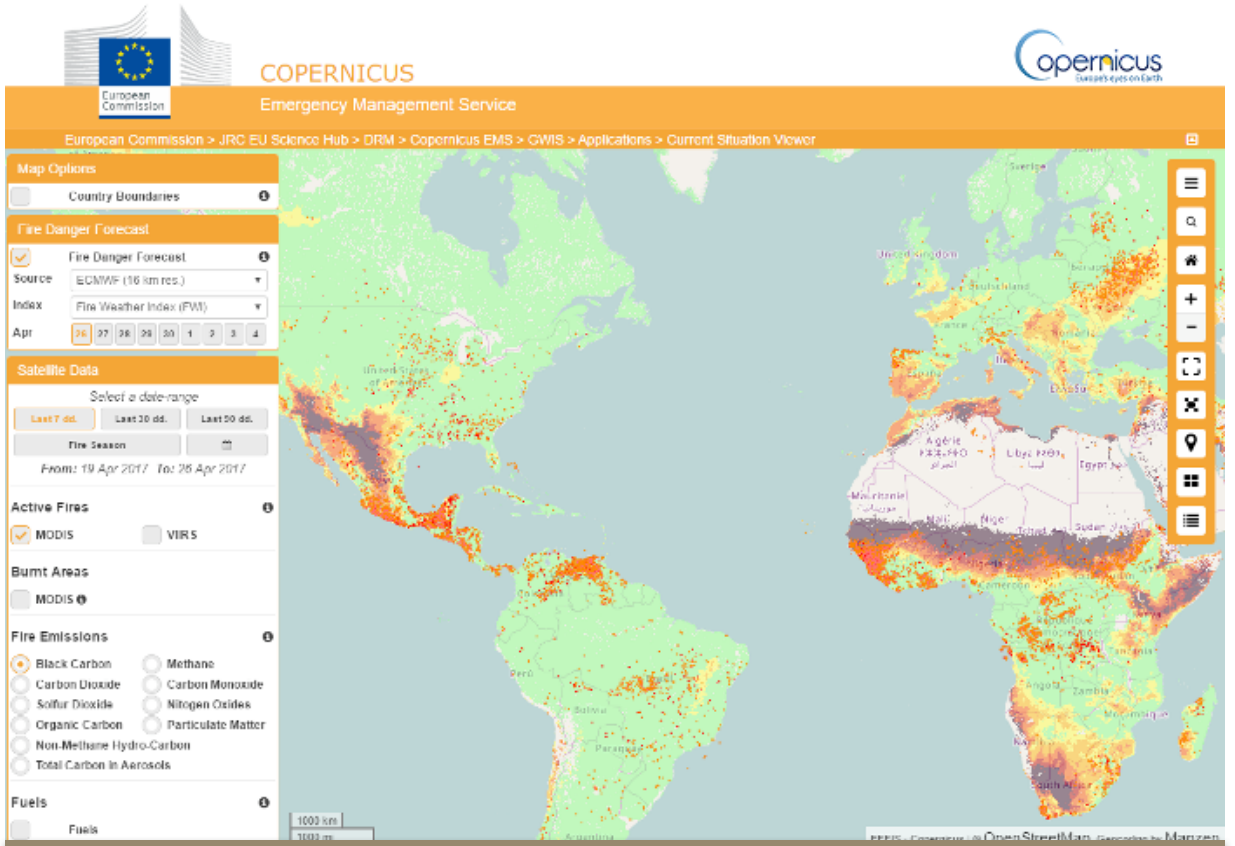
https://arset.gsfc.nasa.gov/land/webinars/adv-wildfire-2018





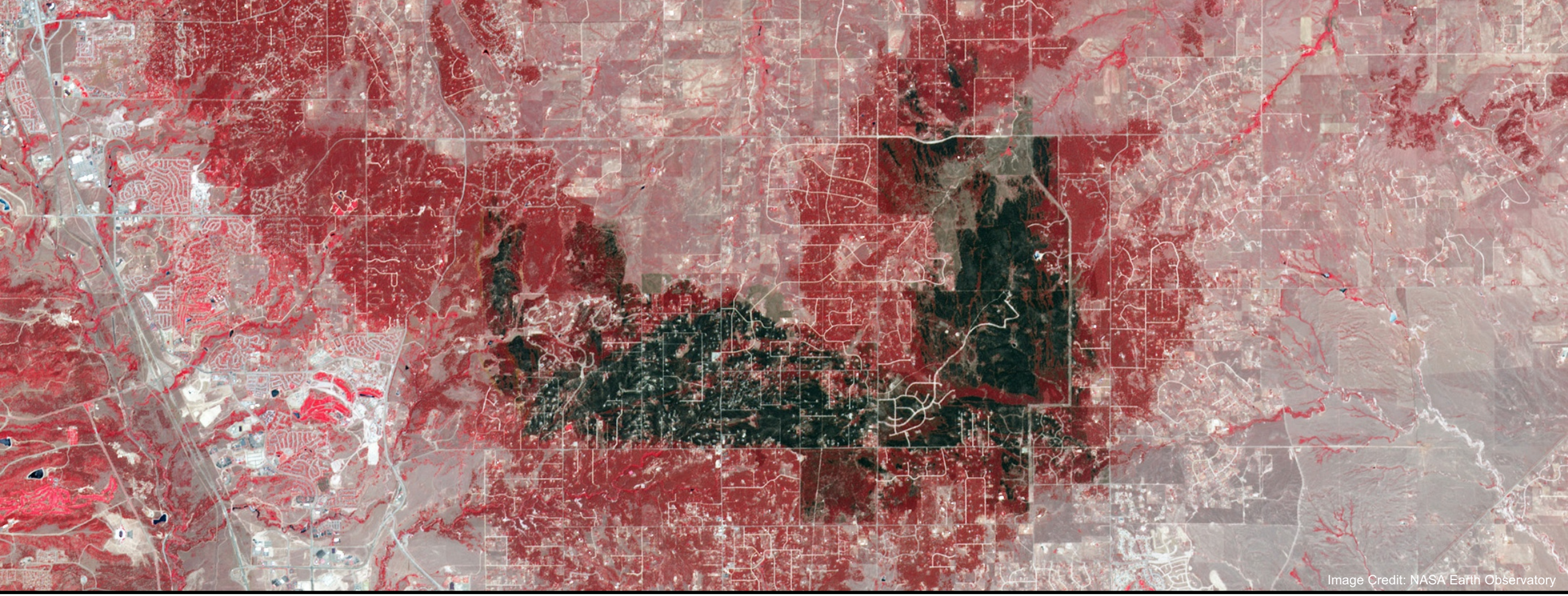
Course Outline





Session 1: Overview of the QGIS Fire Mapping Tool (FMT)

Session 2: Overview of the Global Wildfires Information System (GWIS)

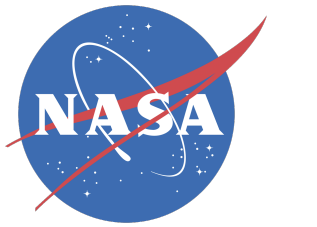


Guest Speaker: Josh Picotte

Special Thanks To:

- USGS
  - Earth Resources and Observation and Science (EROS) Center, Sioux Falls SD
  - Retired Project Lead: Stephen Howard
  - Tool Developers: Cheryl Holen and Karthik Vanumamalai

- NASA Applied Sciences Program- Wildfires: Project NNH12AU71I



Agenda

- Burn Severity Background
- Introduction of Remote Sensing of Burn Severity
- Landsat Background
- Introduction to the Burn Severity Mapping Process
- Landsat Image Pairing Considerations
- Introduction to the Fire Mapping Tool

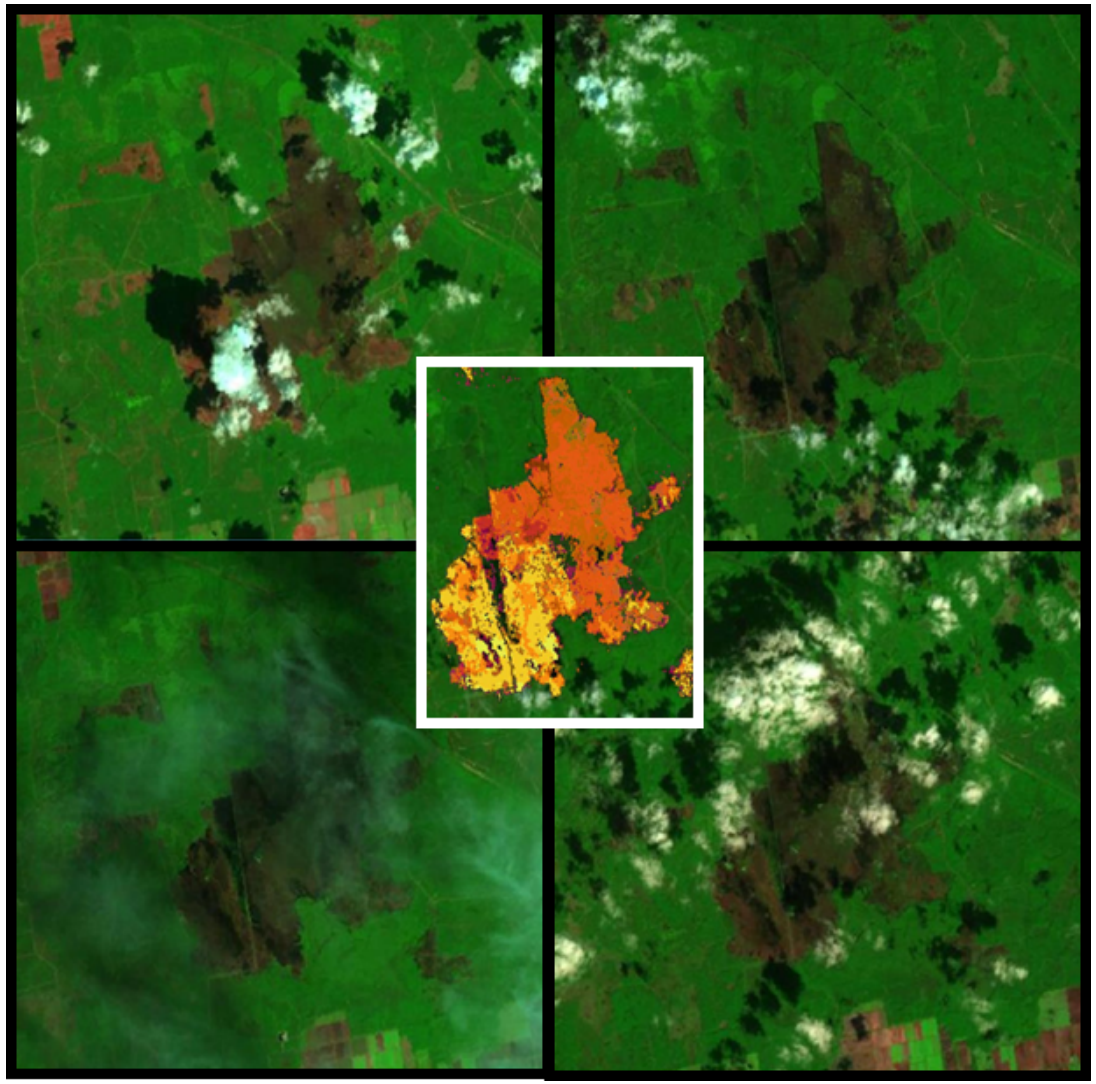


Image Credit: Josh Picotte

Fire Intensity

- The amount of energy or heat release per unit time or area and encompasses several specific types of fire intensity measures
- Byram (1959): "The rate of energy or heat release per unit time, per unit length of fire front, regardless of its depth."

Byram, G.M. 1959. Combustion of forest fuels. In: Davis, K.P. (ed.). Forest fire: control and use. McGraw-Hill, New York. p. 61-89. Photo Courtesy of NPS

Fire (Burn) Severity

- The effect of a fire on ecosystem properties, often defined by the degree of mortality of vegetation
- Degree to which a site has been altered or disrupted by fire; loosely, a product of fire intensity and residence time

Image Credit: USDA Forest Service Gen. Tech. Rep. RMRS-GTR-243. 2010

Soil Burn Severity

- The fire-induced changes in physical, chemical, and biological soil properties that impact hydrological and biological soil functions

Photo Courtesy of Stefan Doerr

Example in Pictures

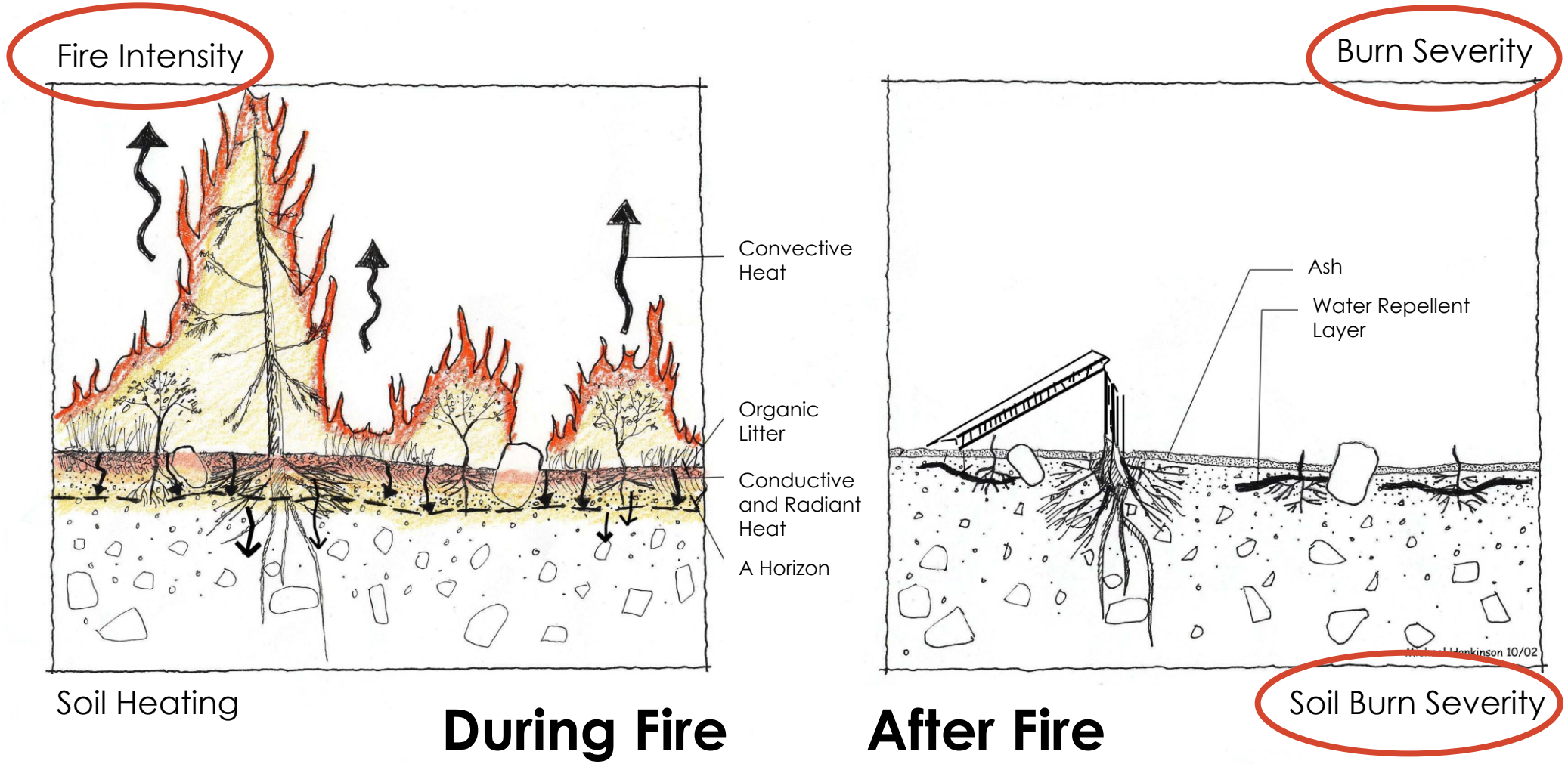


Image: USDA Forest Service Gen. Tech. Rep. RMRS-GTR-243. 2010

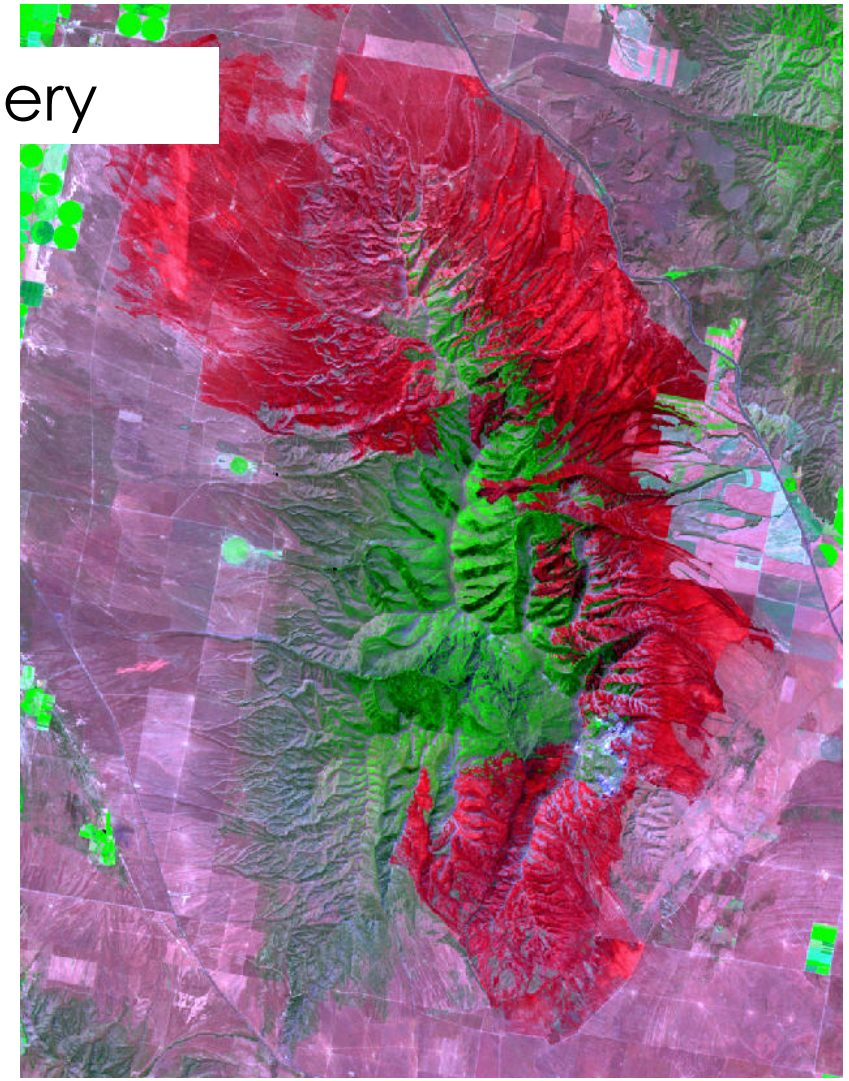
Field Perspective

- Ground-based severity assessments:
  - Composite Burn Index (CBI)
  - Hiking through and observing burn scar mosaic
  - Water repellency tests

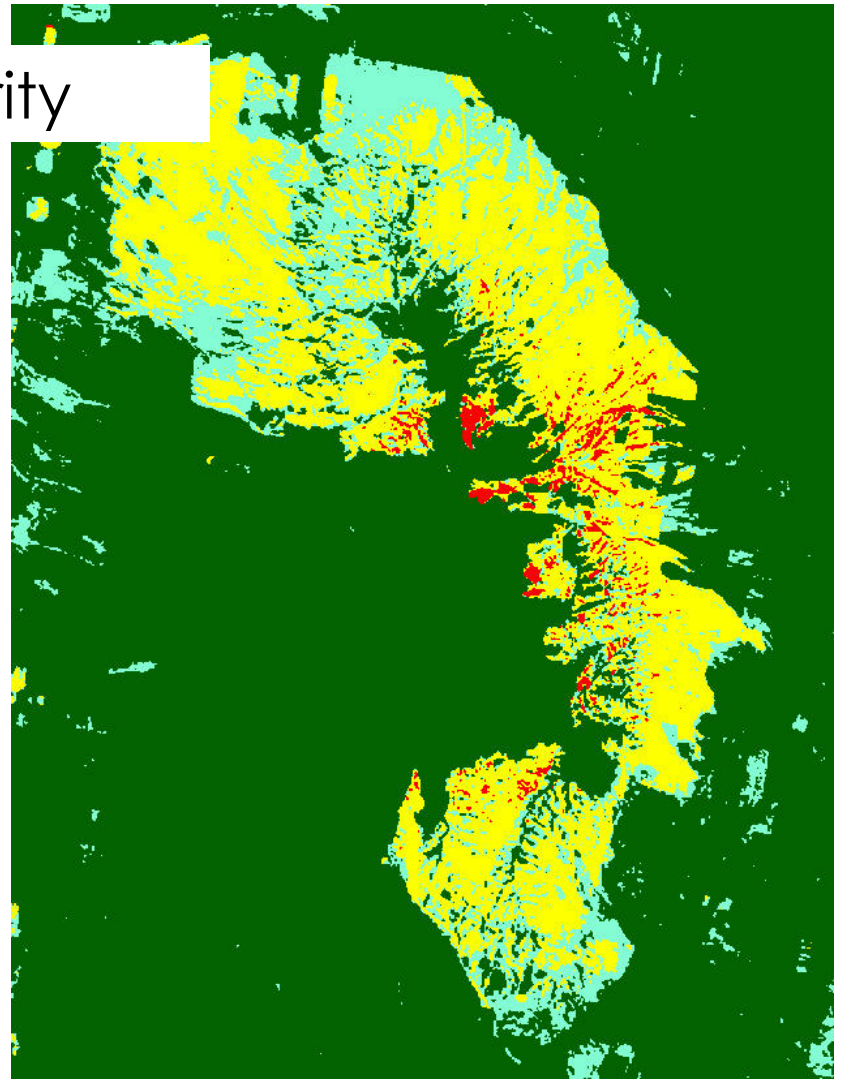
Images: USDA Forest Service Gen. Tech. Rep. RMRS-GTR-243. 2010

Satellite Perspective

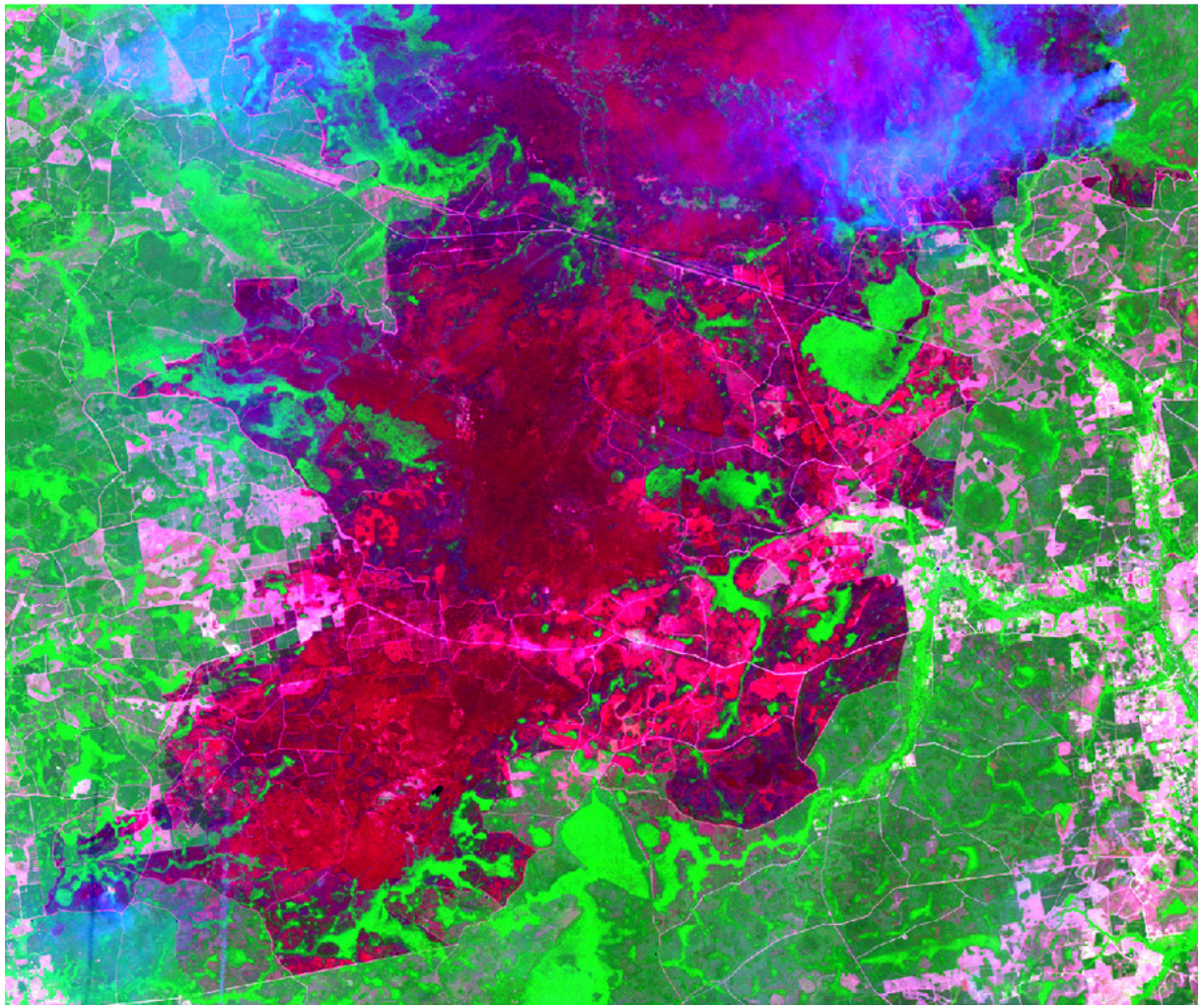
Imagery



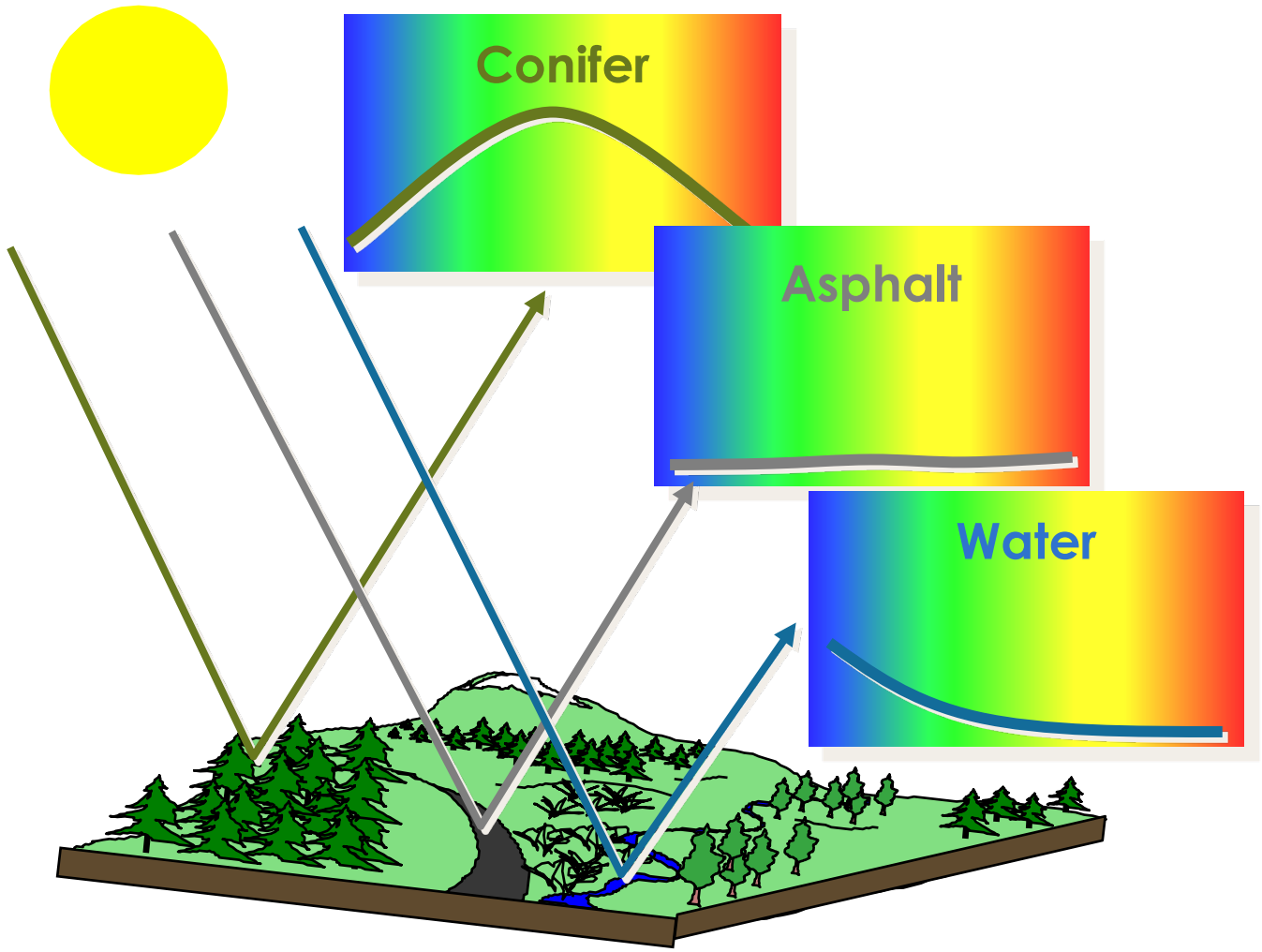
Severity



Connecting the Dots

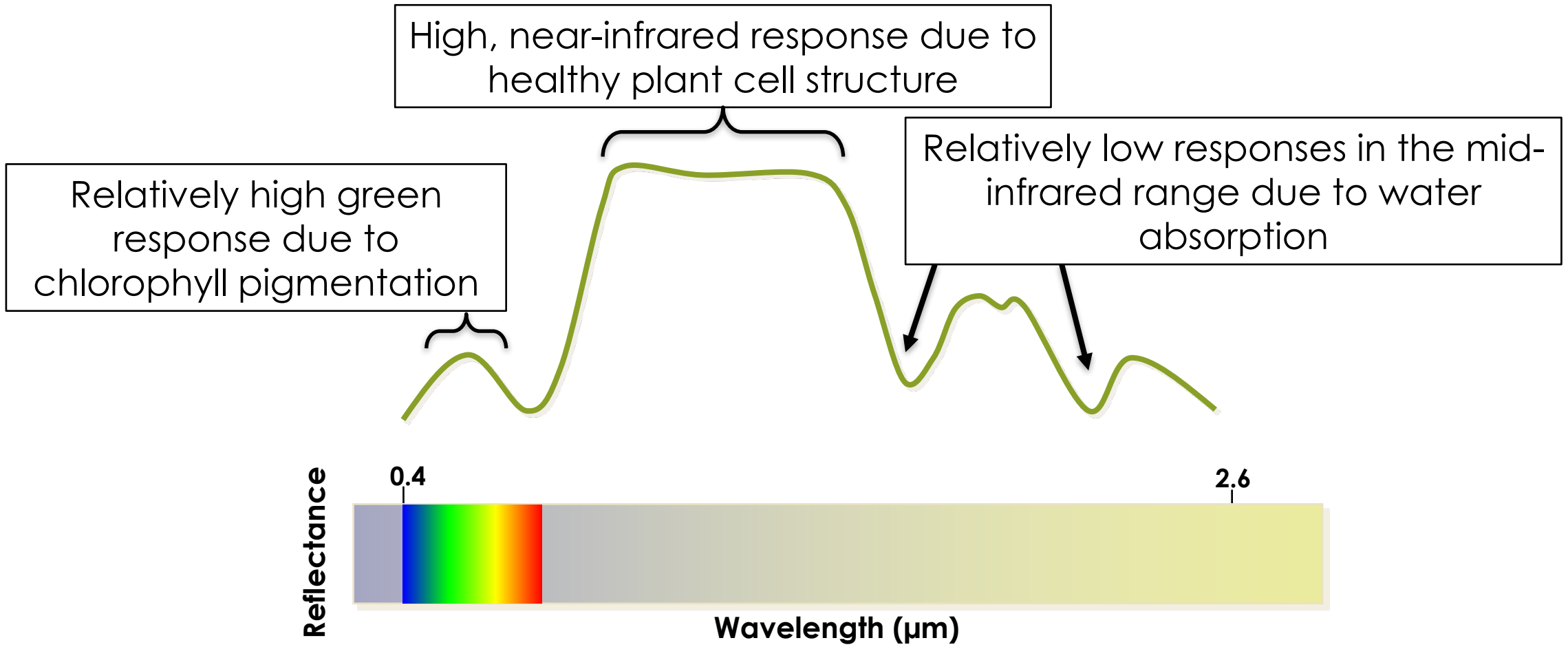


Remote Sensing and Electromagnetic Energy



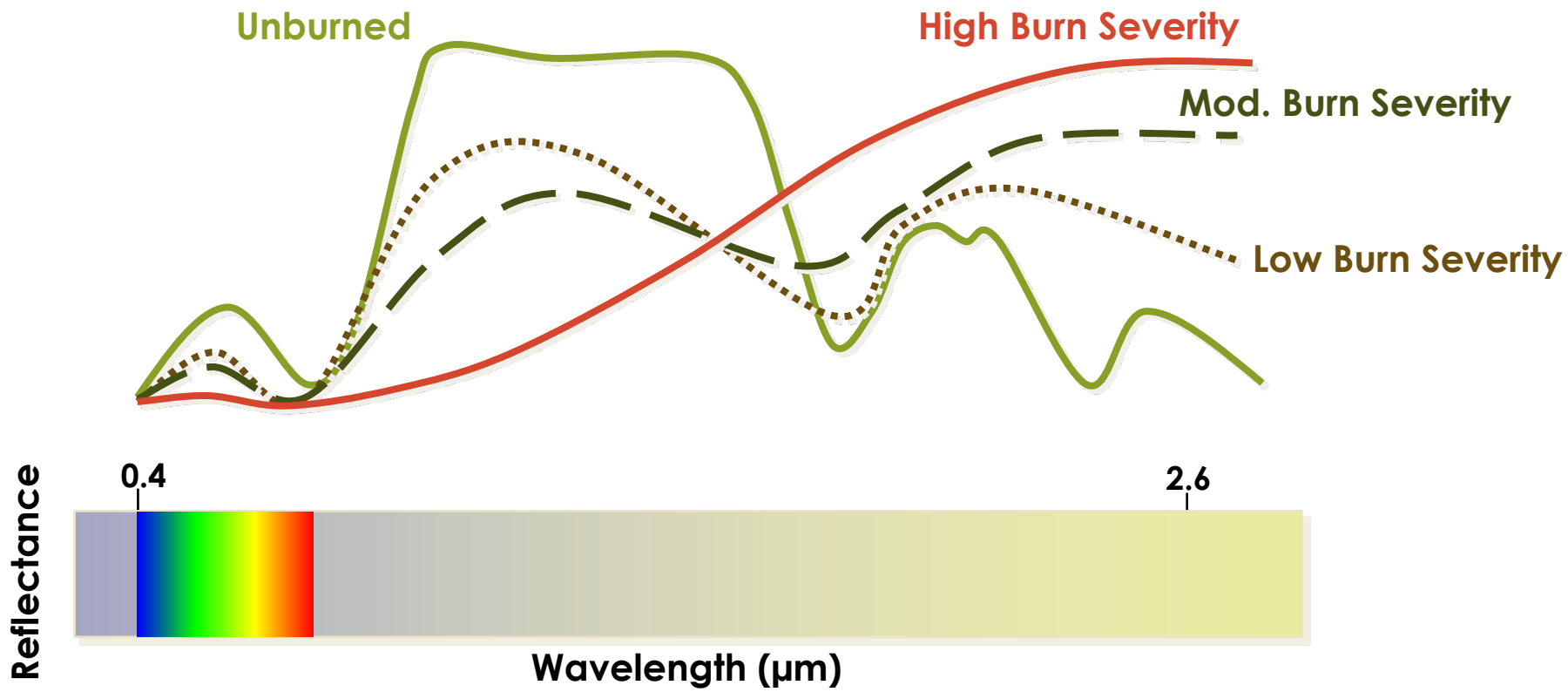
Response to Electromagnetic Energy

Spectral response curve of typical vegetation from 0.4 to 2.6 µm



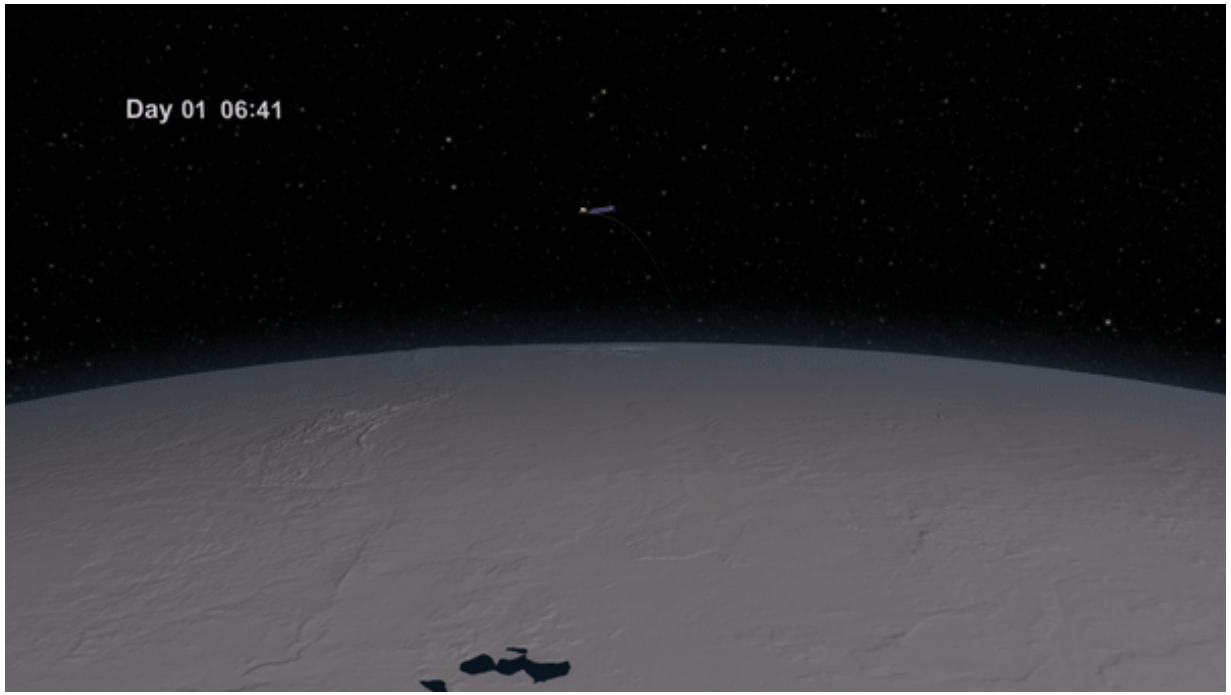
Healthy Vegetation vs. Burned Areas

Exploiting Spectral Response Curves



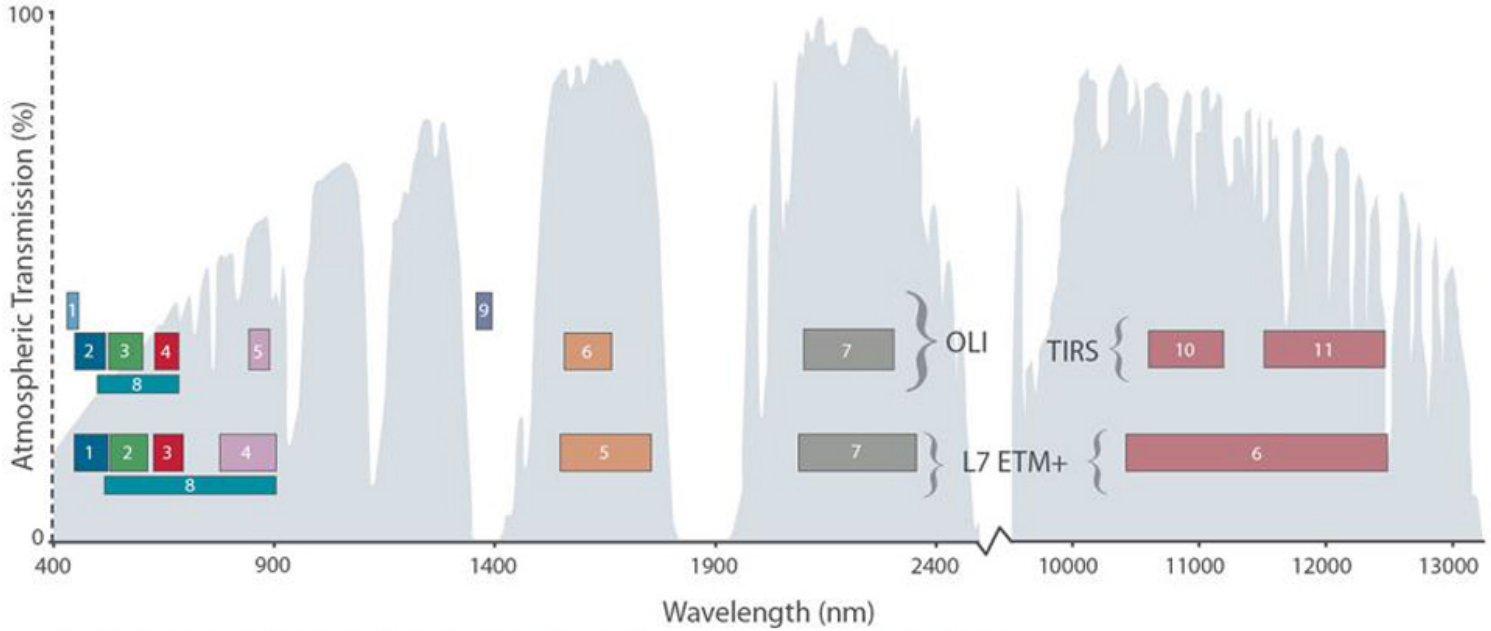
Important Satellite Sensor Properties

- Spatial Properties
  - Resolution
    - How small of an object can we see?
  - Extent
    - How large of an area is covered?
- Revisit time
  - How often can we see the same area?
- Spectral sensitivity
  - How many "colors" can we see?



Landsat Background

- Landsat 5 Thematic Mapper (TM)
  - 1984-2011
  - 7 bands
- Landsat 7 Enhanced Thematic Mapper (ETM+)
  - 1999-present
  - 8 bands
- Landsat 8 Operational Land Imager (OLI)
  - 2013-present
  - 11 bands
- 30 m resolution



Bandpass wavelengths for Landsat 8 OLI and TIRS sensor, compared to Landsat 7 ETM+ sensor

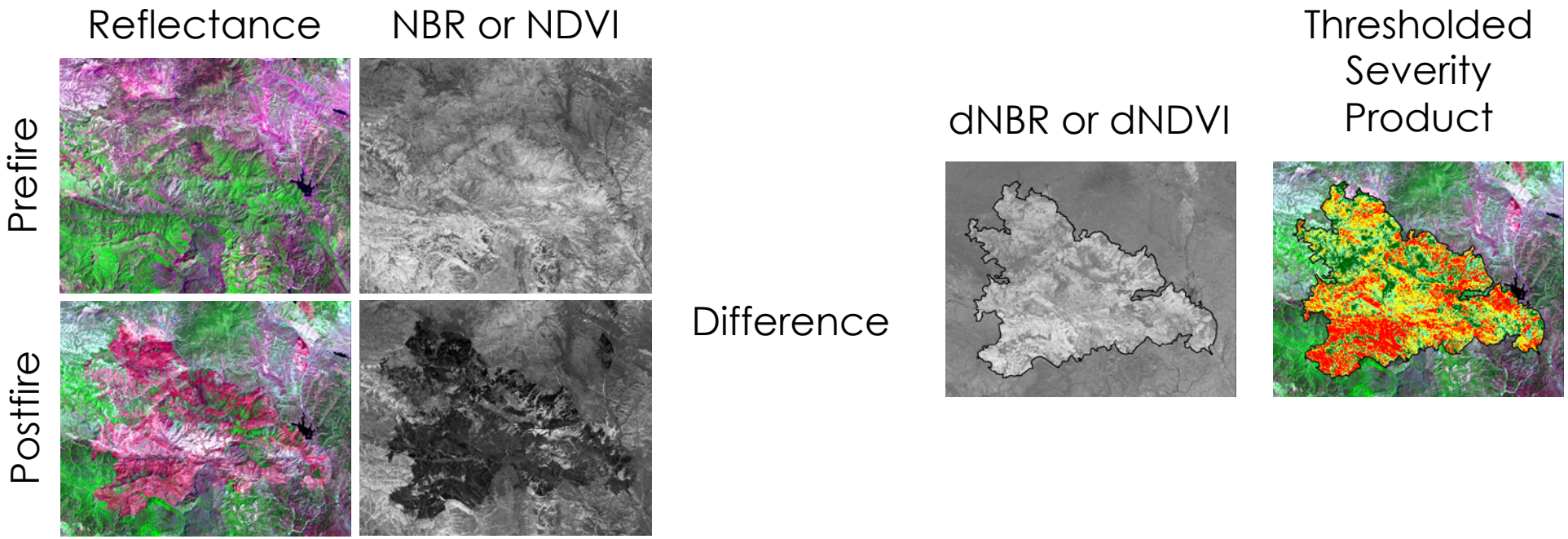
Note: atmospheric transmission values for this graphic were calculated using MODTRAN for a summertime mid-latitude hazy atmosphere (circa 5 km visibility).

Burn Severity Mapping

Image processing methods depend on which sensor is used. For this application, we used Landsat data.

NBR *(Normalized Burn Ratio)*
NBR = (NIR-SWIR) / (NIR + SWIR)
dNBR = Prefire NBR – Postfire NBR

NDVI *(Normalized Difference Vegetation Index)*
NDVI = (NIR – RED) / (NIR + RED)
dNDVI = Prefire NDVI = Postfire NDVI



Relativized Differenced Normalized Burn Ratio (RdNBR)

- Variant of dNBR; removes bias associated with pre-fire vegetation condition
  - Developed by Miller and Thode 2007*
  - Example: Low density vegetation in prefire image experiences complete burn
    - i.e., a stand-replacing fire
  - RdNBR measures relative change of vegetation within the pixel: 100% change in vegetation: RdNBR is high

dNBR & RdNBR

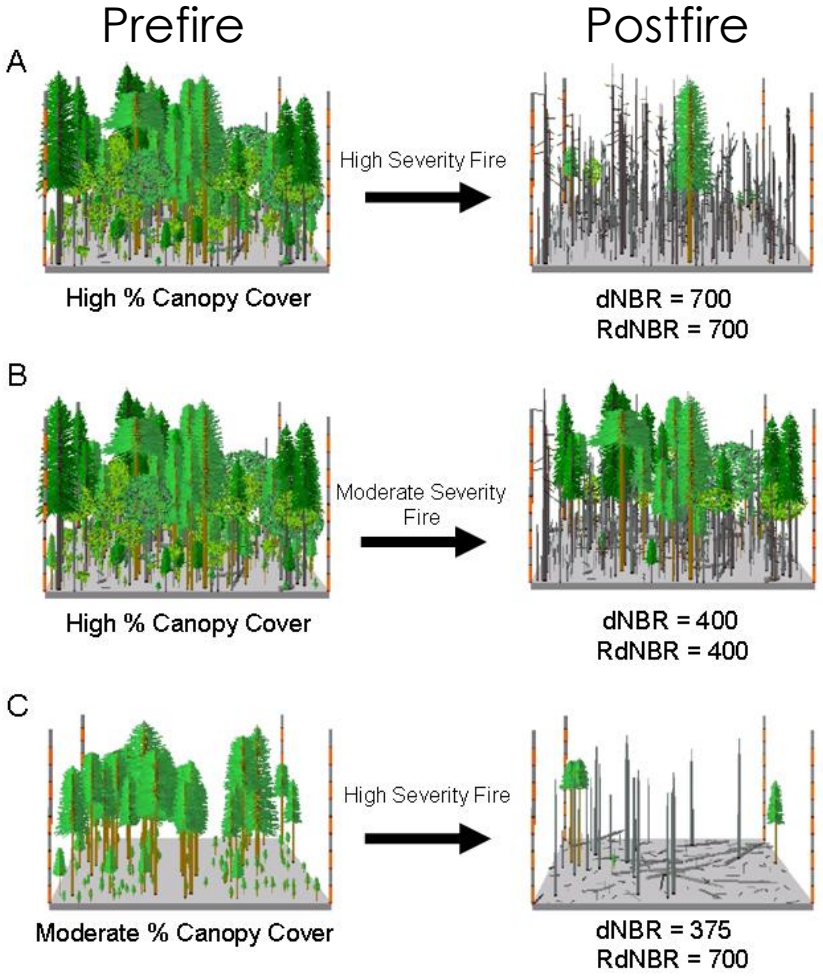


Image Credit: Remote Sensing of the Environment; 109, 66-80 (July 12, 2007)

Image Pairing Considerations

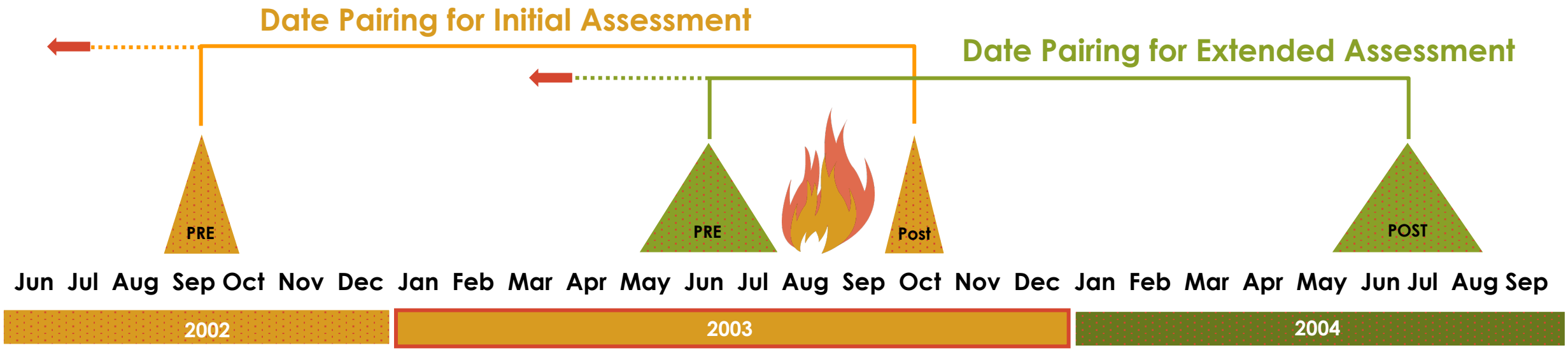
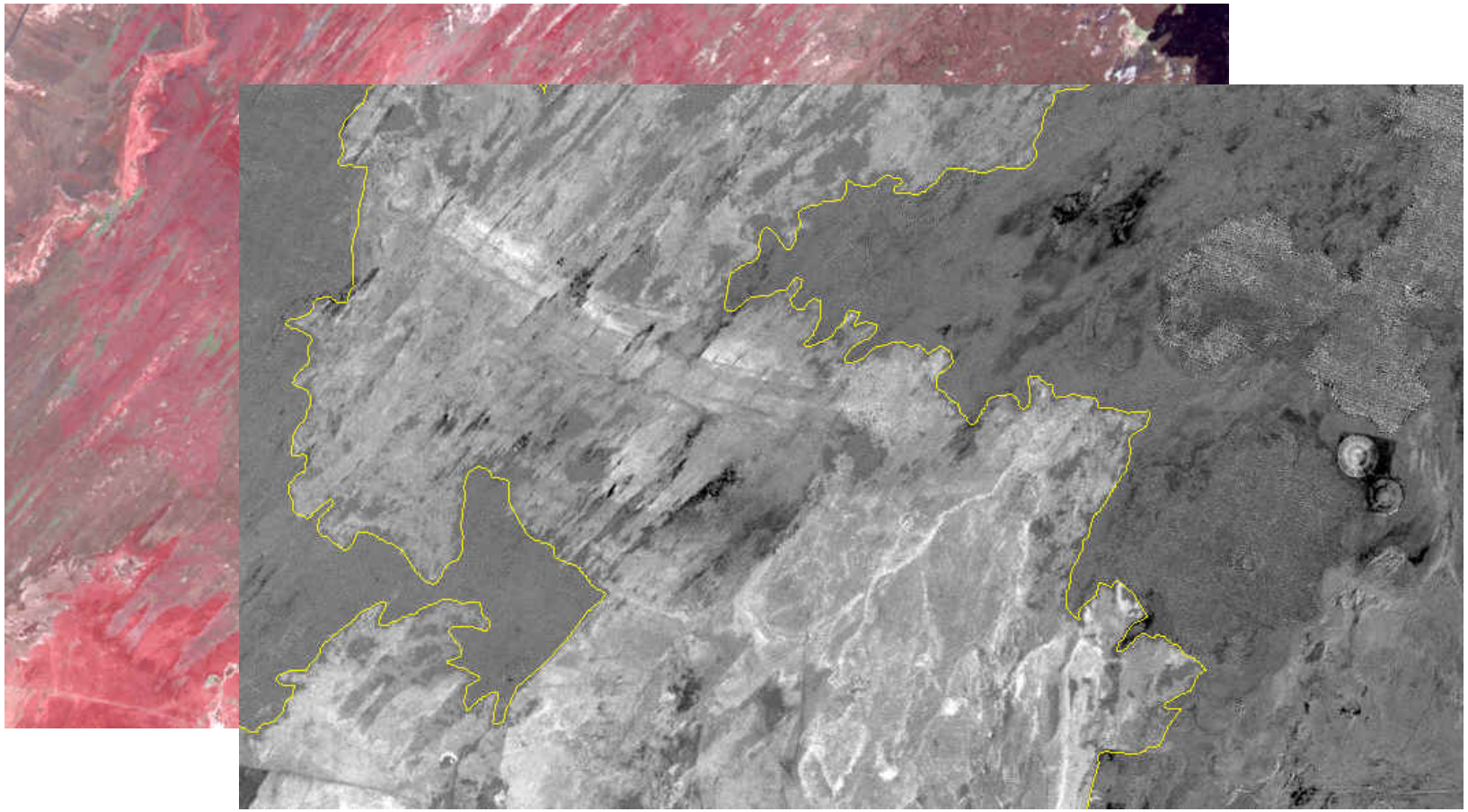


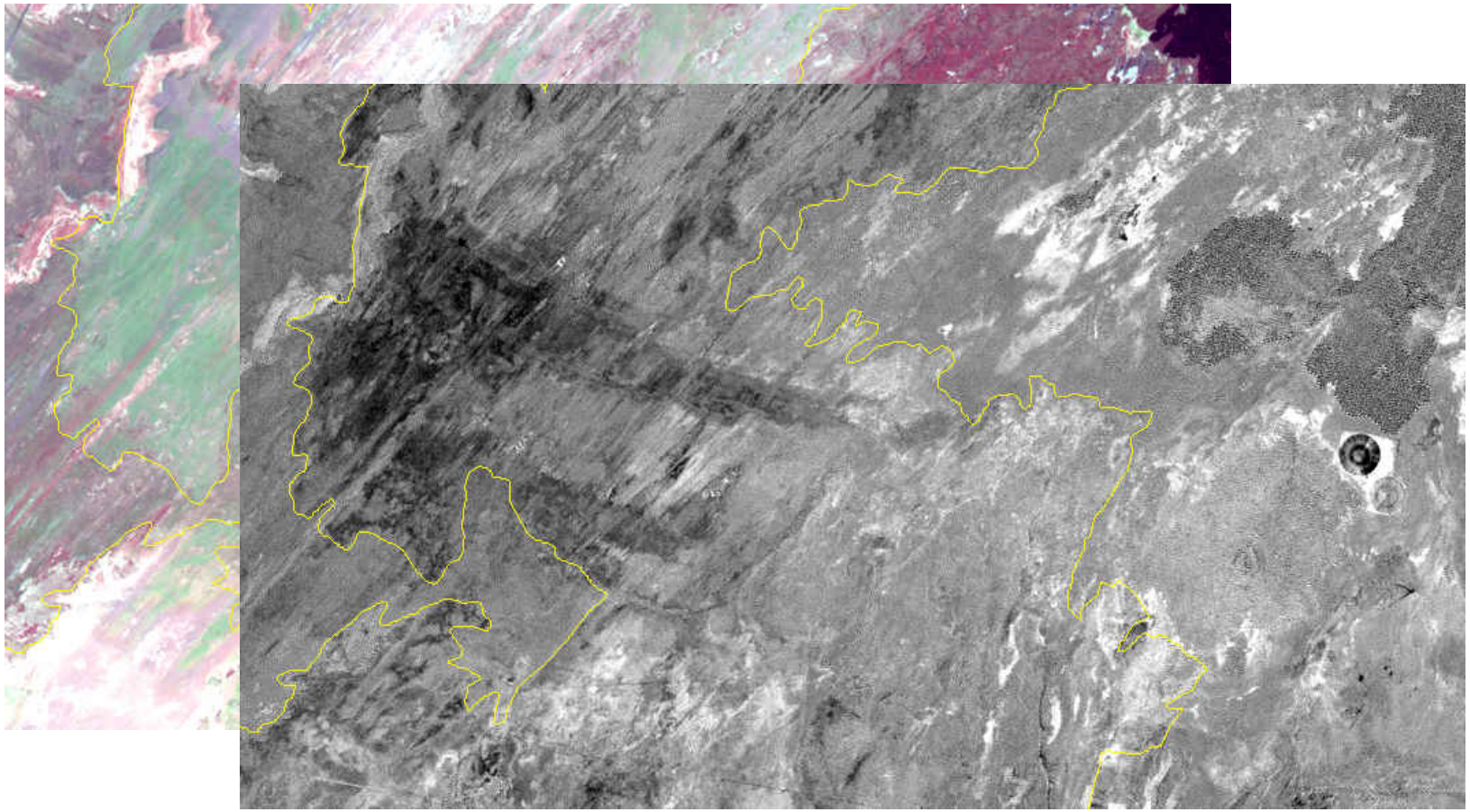
Image Credit: Carl Key, 2006

Assessment Strategy: Initial Assessment



Fire date: July 6, 2007
Postfire Image Date: July 27, 2007

Assessment Strategy: Extended Assessment



Fire date: July 6, 2007
Postfire Image Date: July 27, 2007

Landsat Scene Pairs (dNBR) Should…

Pre-Fire NBR
07/10/1999

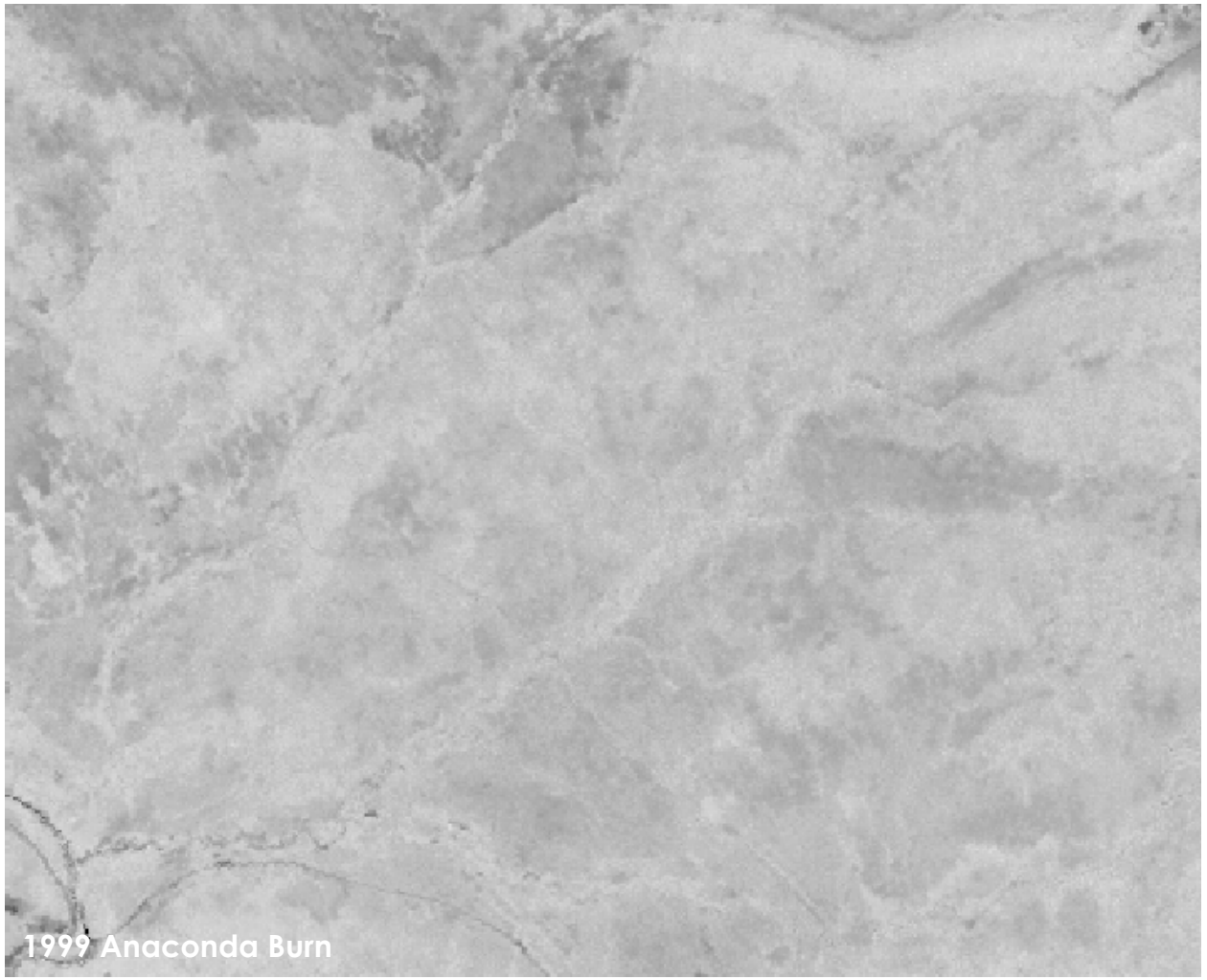


Image Credit: Carl Key

Landsat Scene Pairs (dNBR) Should…

Pre-Fire NBR
07/10/1999

Post-Fire NBR
06/25/2000

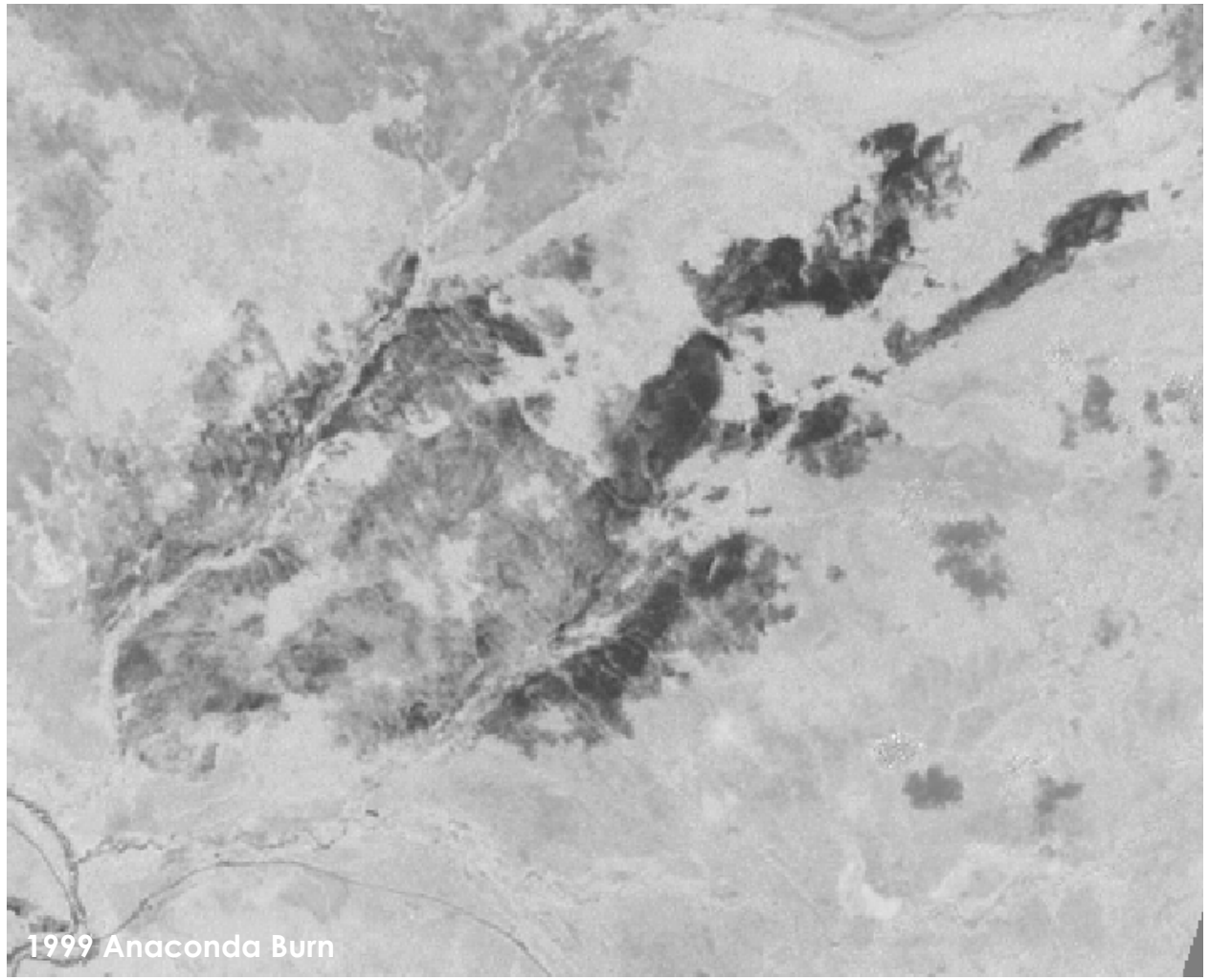


Image Credit: Carl Key

Landsat Scene Pairs (dNBR) Should…

Pre-Fire NBR
07/10/1999

Post-Fire NBR
06/25/2000

dNBR
07/10/99 - 06/25/2000

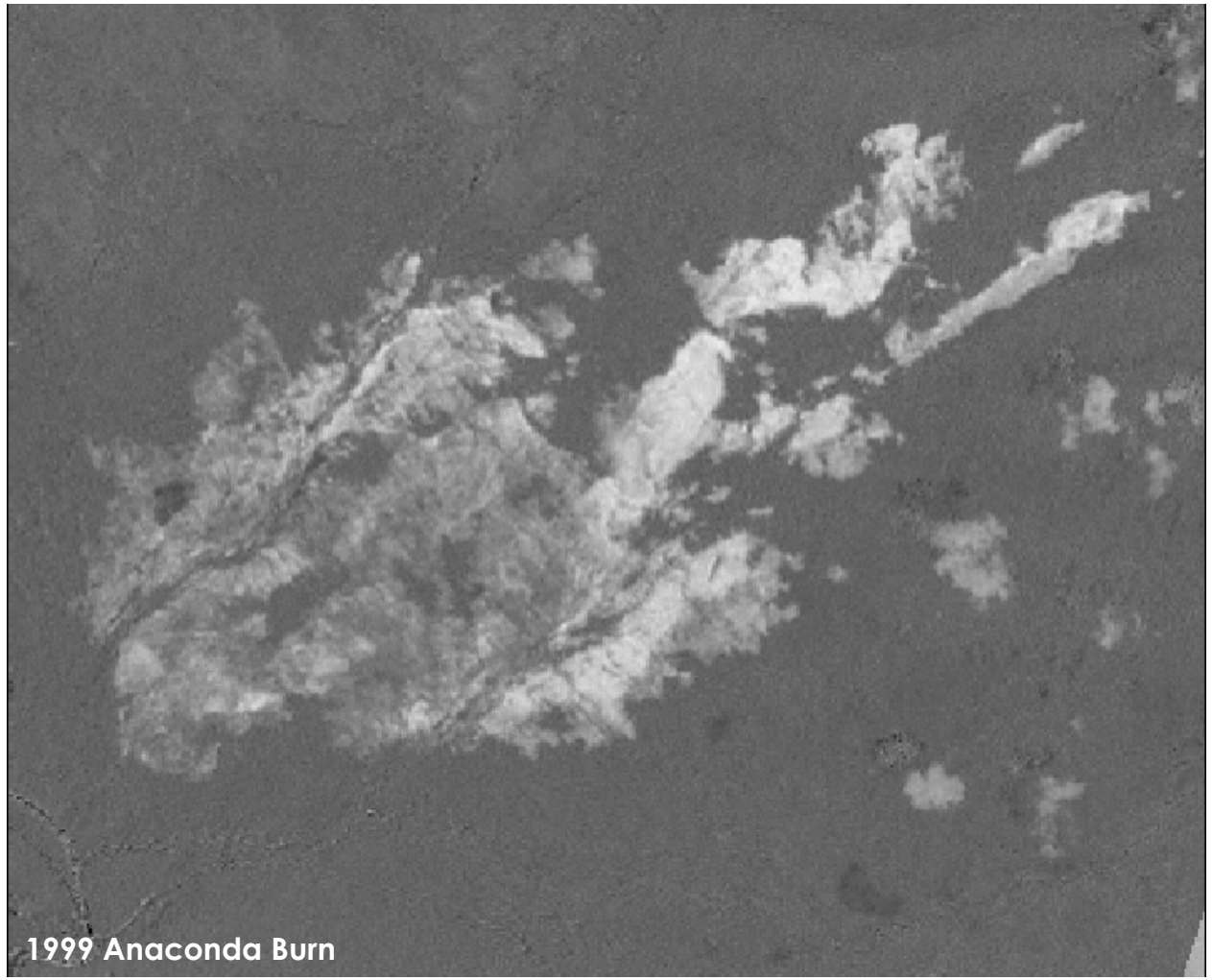
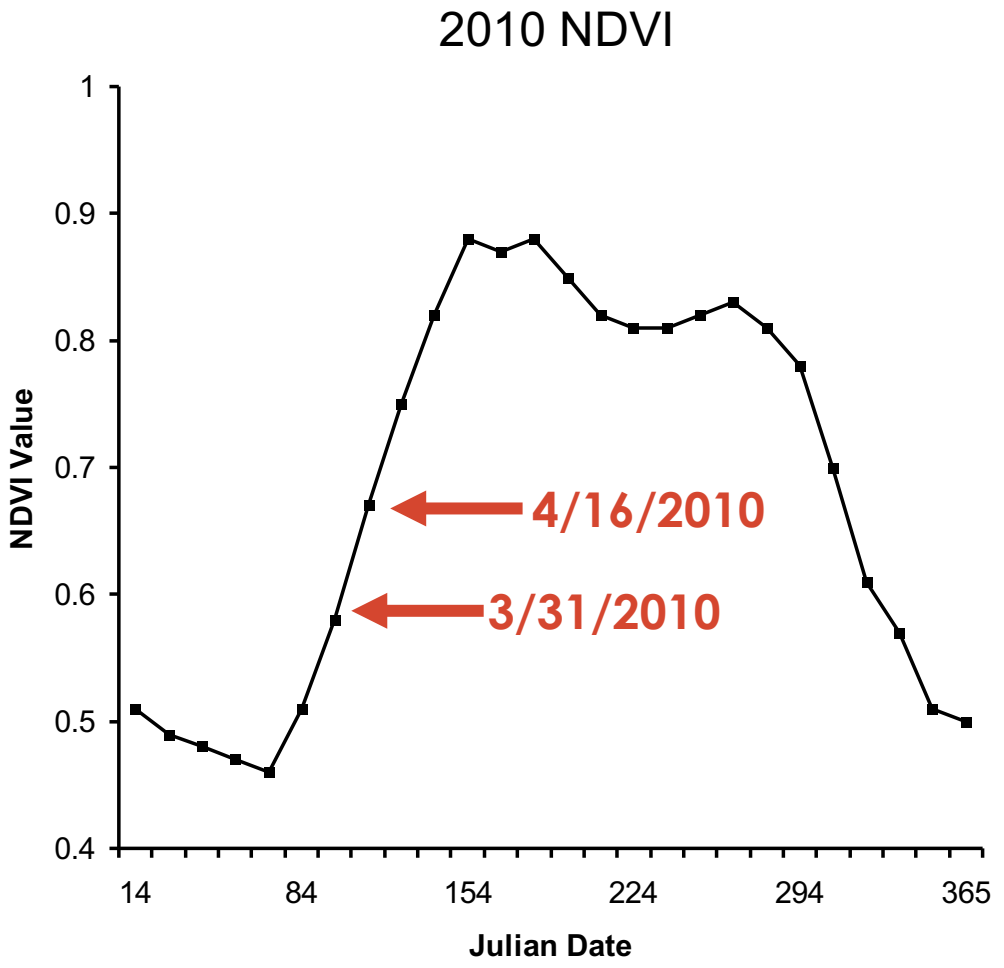


Image Credit: Carl Key

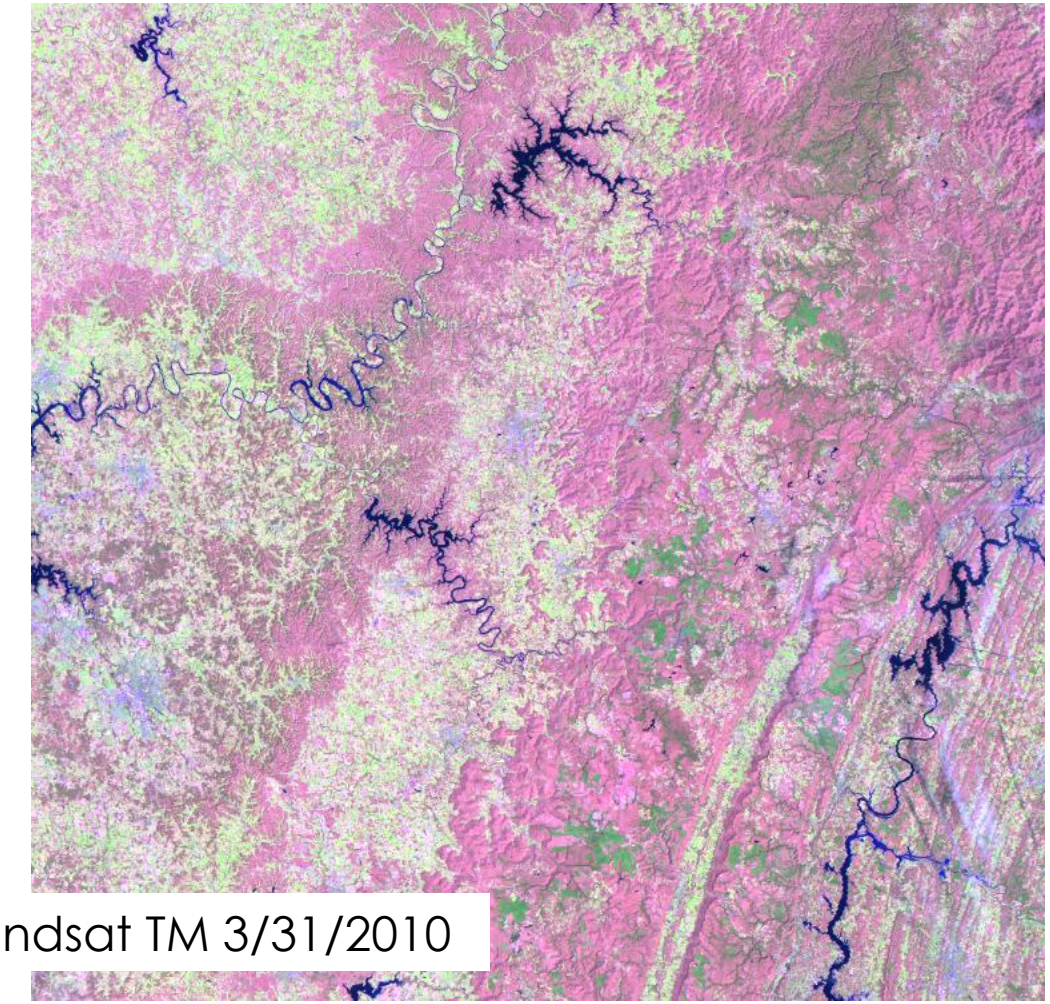
…Have Limited Between-Scene Seasonal Variation

Path 20
Row 35

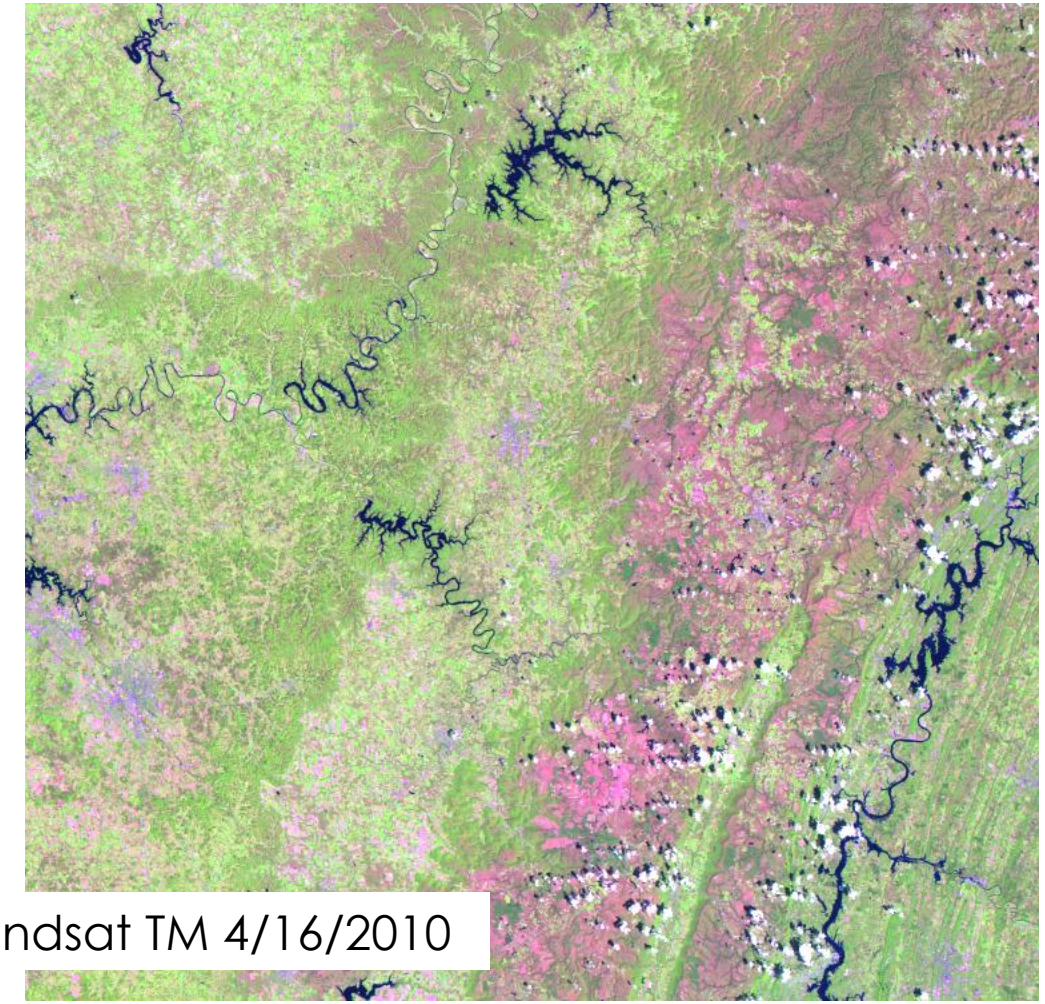


…Have Limited Between-Scene Seasonal Variation

Path 20 Row 35

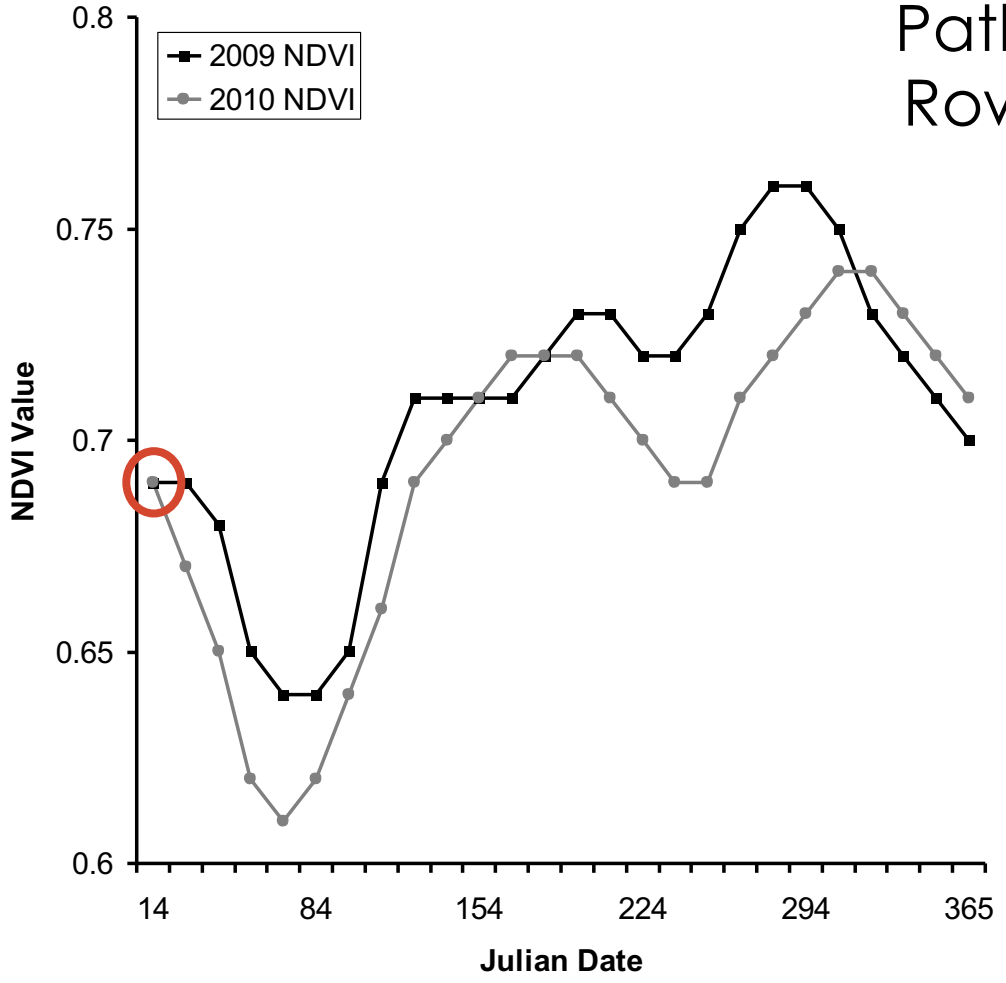


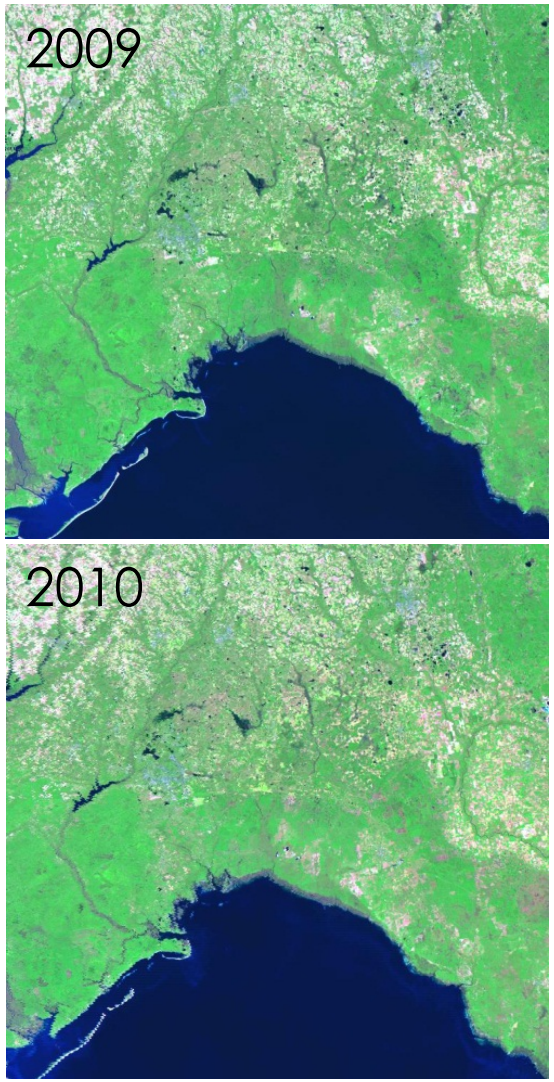
Landsat TM 3/31/2010



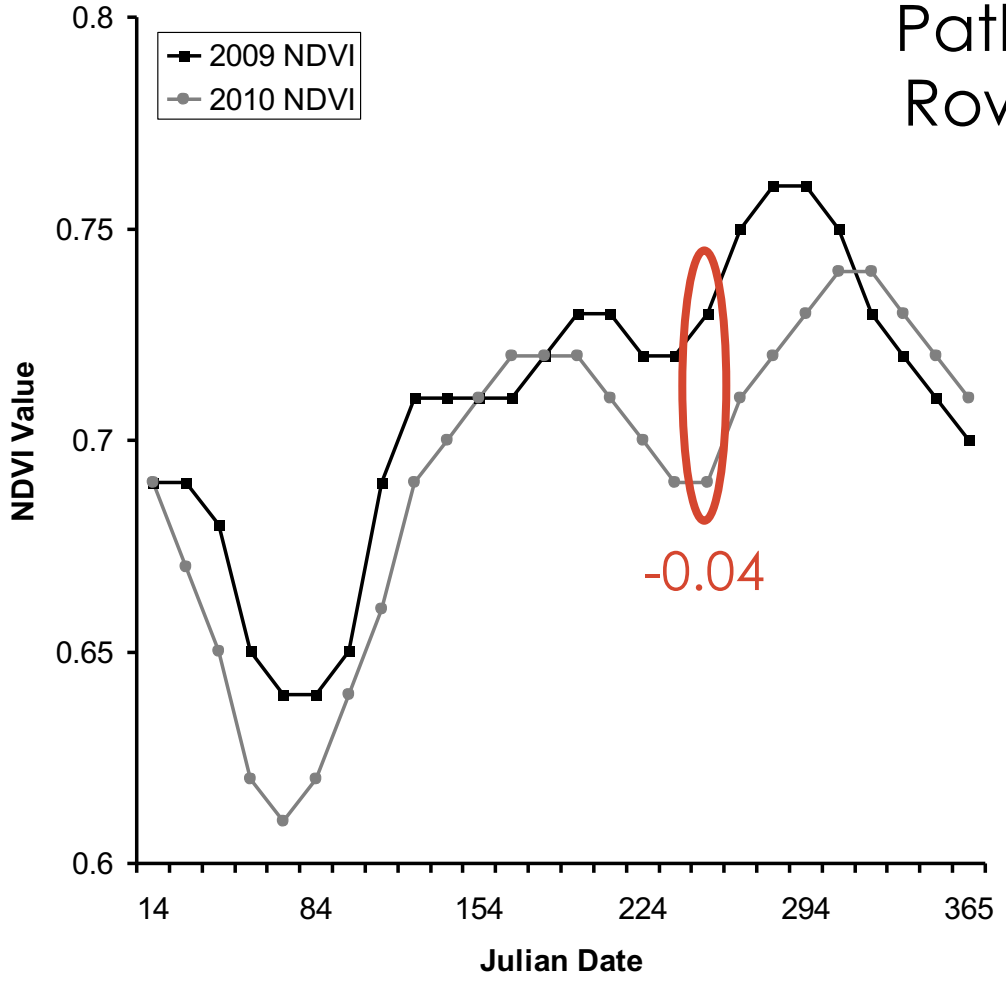
Landsat TM 4/16/2010

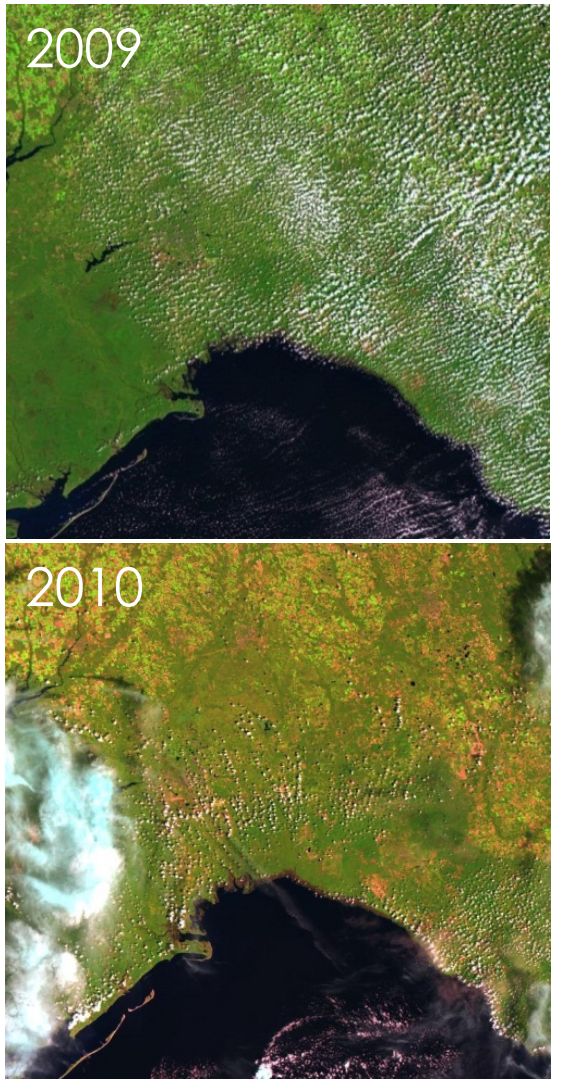
…Only Exhibit Small Between-Scene Changes in Greenness



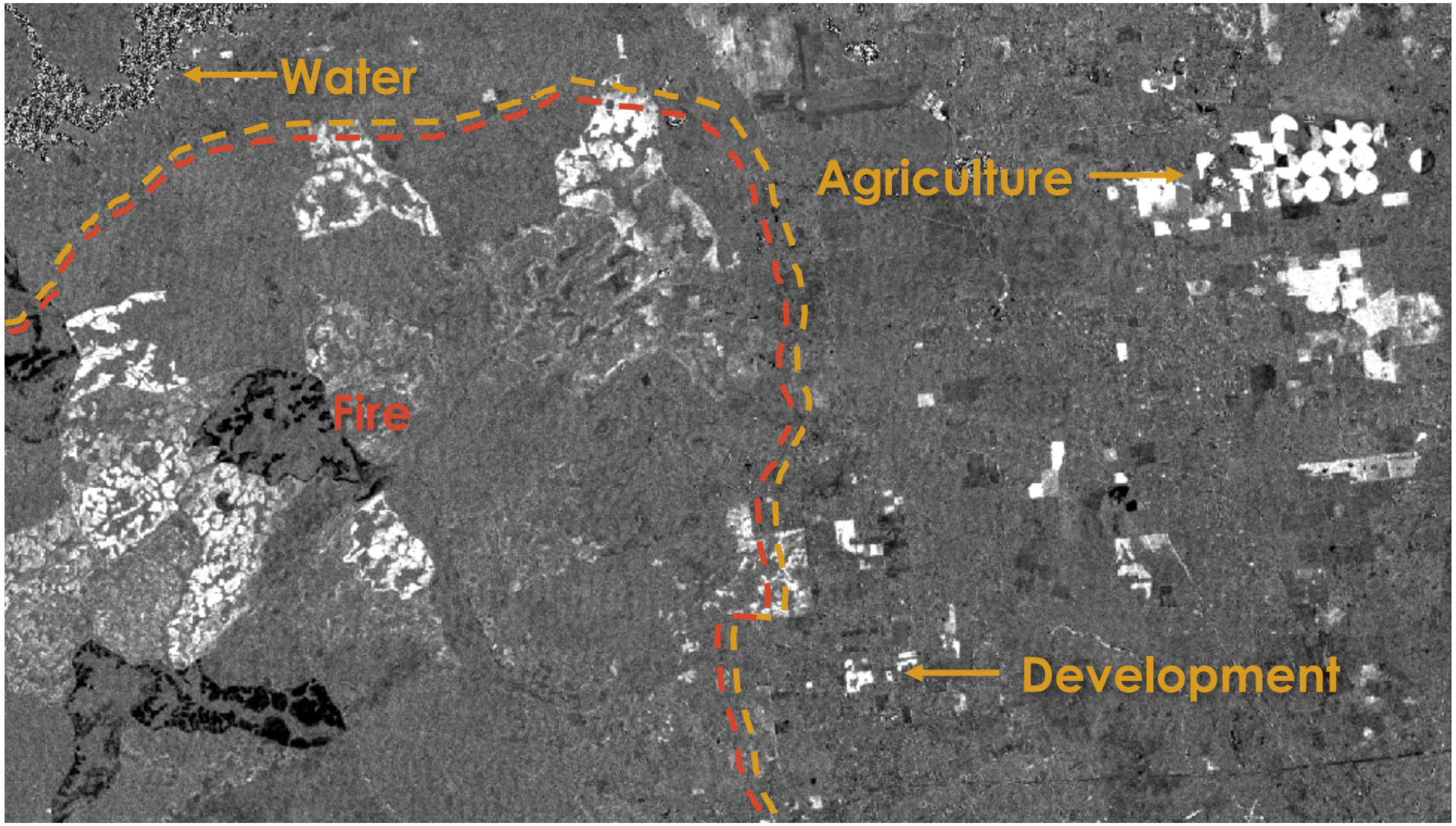


…Only Exhibit Small Between-Scene Changes in Greenness

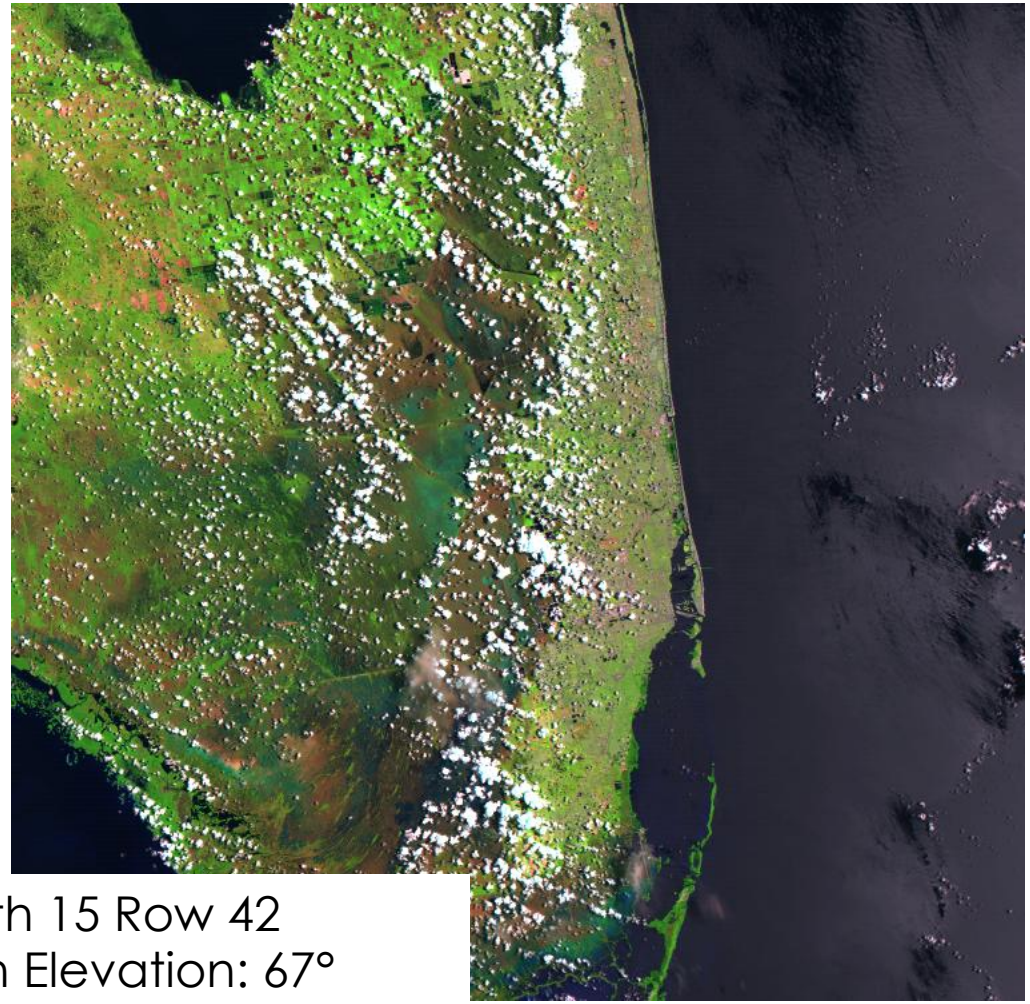




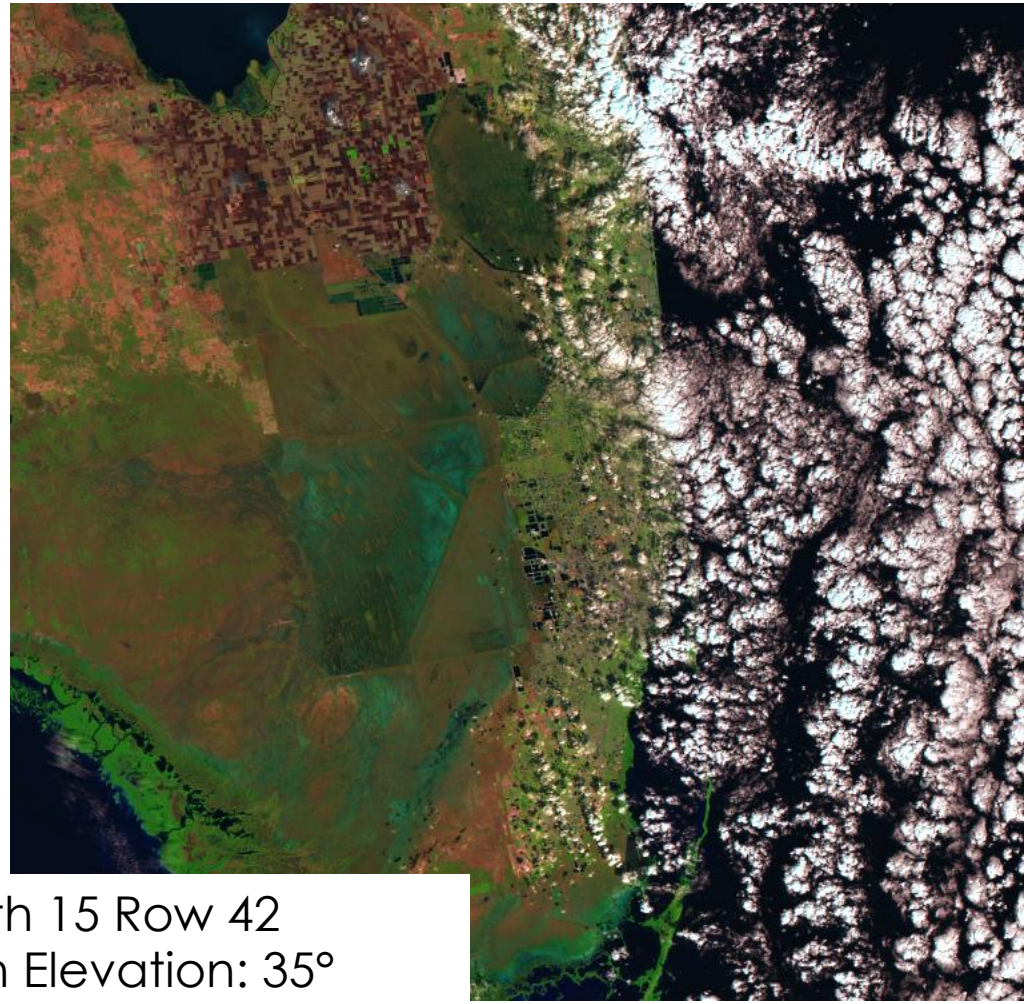
..Not Exhibit Between-Scene Landcover Changes



…Have Similar Reflectance Brightness

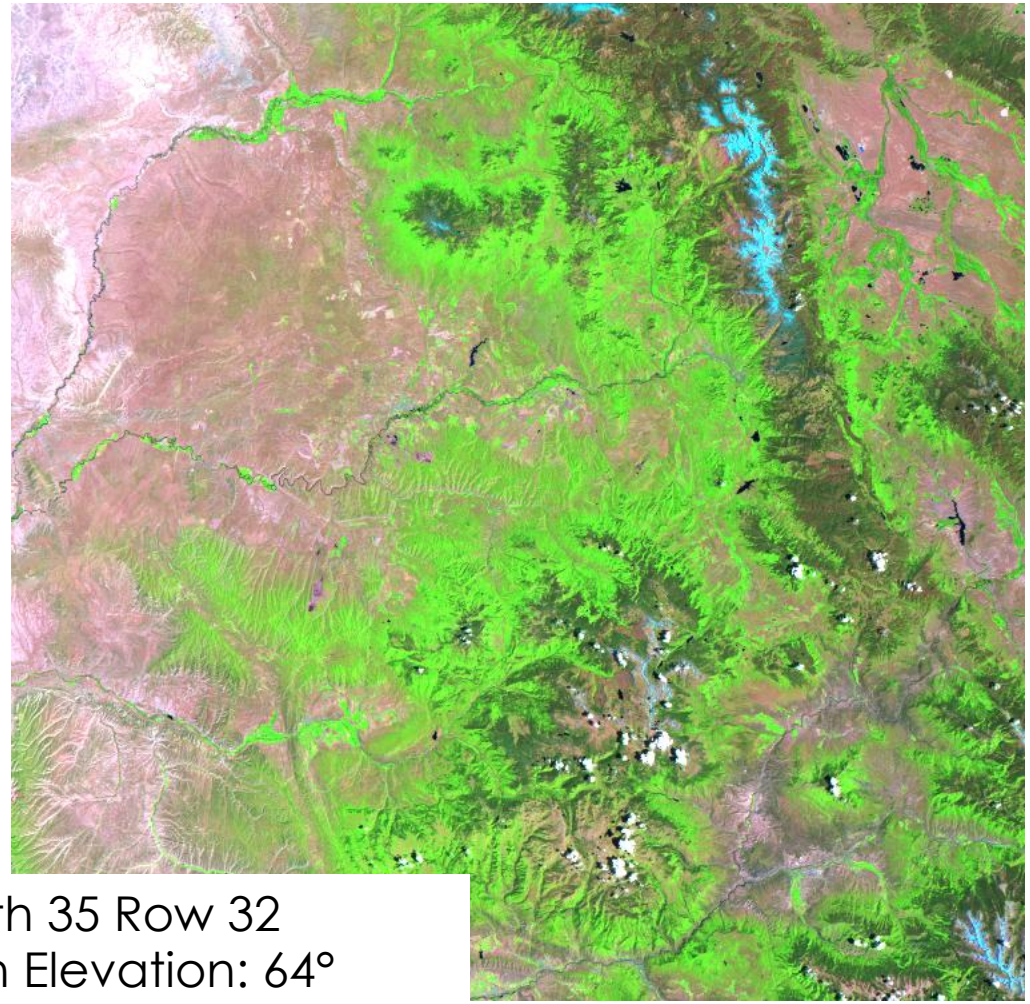


Path 15 Row 42
Sun Elevation: 67°
Sun Azimuth: 91°

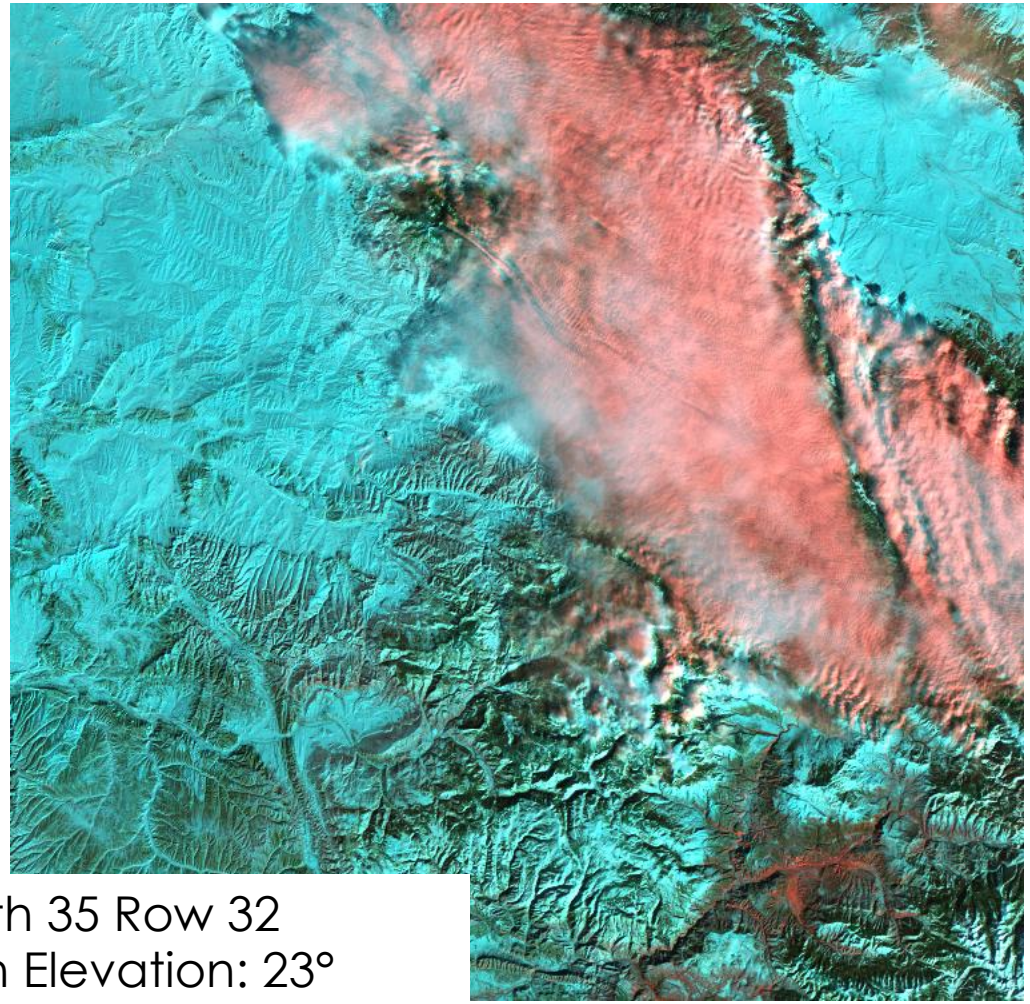


Path 15 Row 42
Sun Elevation: 35°
Sun Azimuth: 151°

…Have Similar Reflectance Brightness

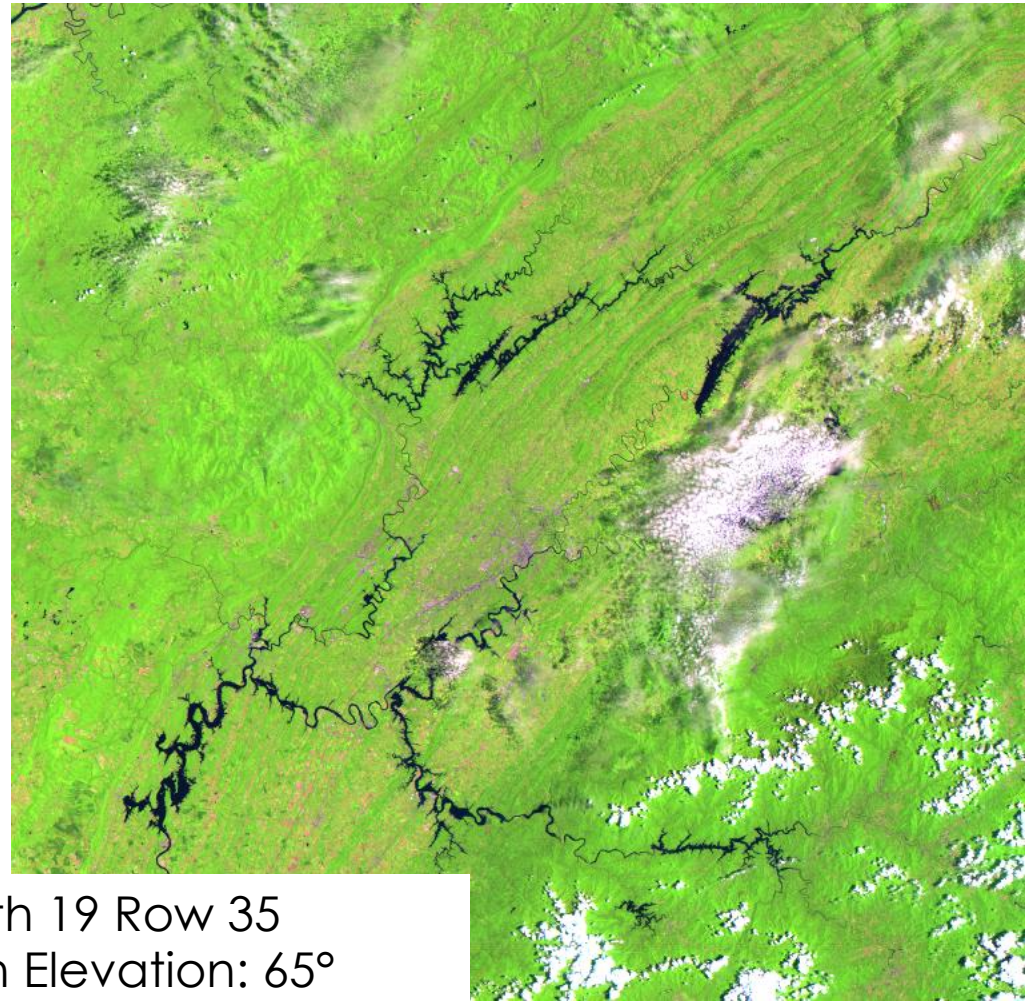


Path 35 Row 32
Sun Elevation: 64°
Sun Azimuth: 124°

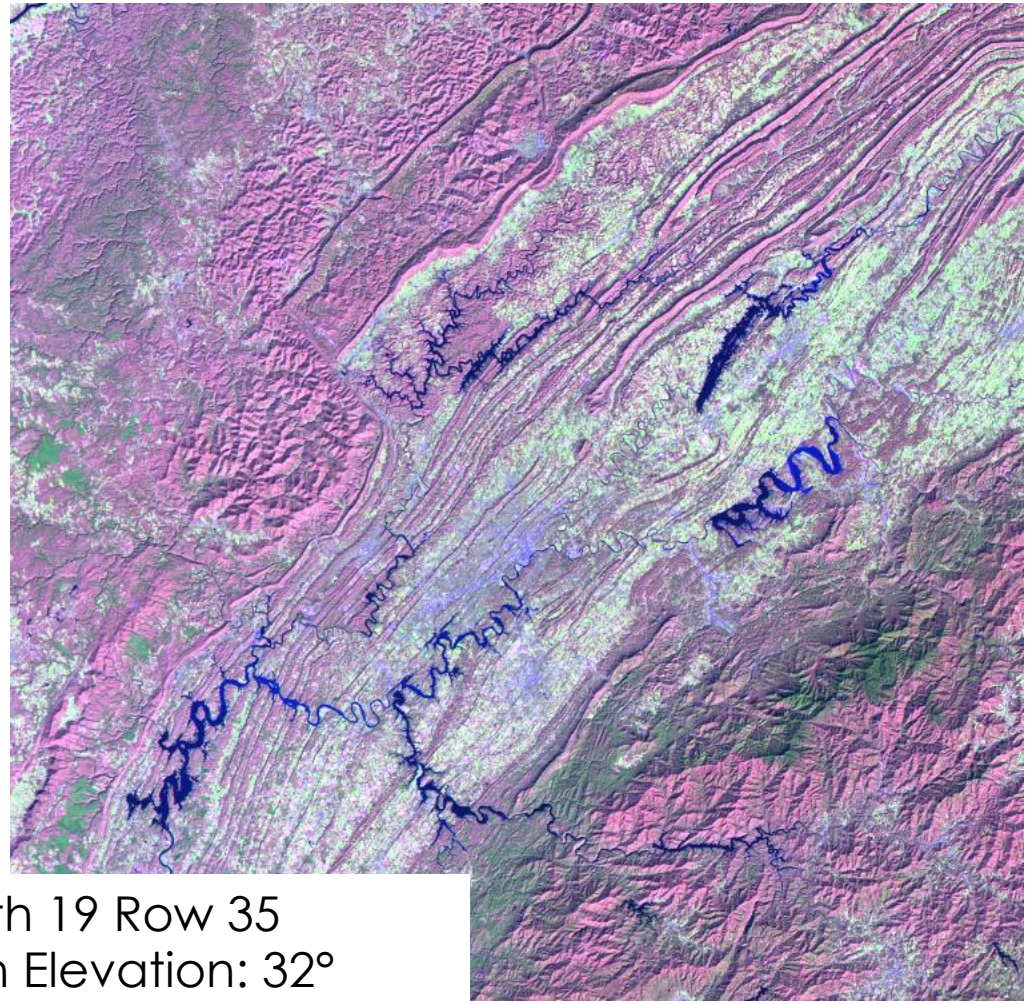


Path 35 Row 32
Sun Elevation: 23°
Sun Azimuth: 156°

…Have Similar Reflectance Brightness

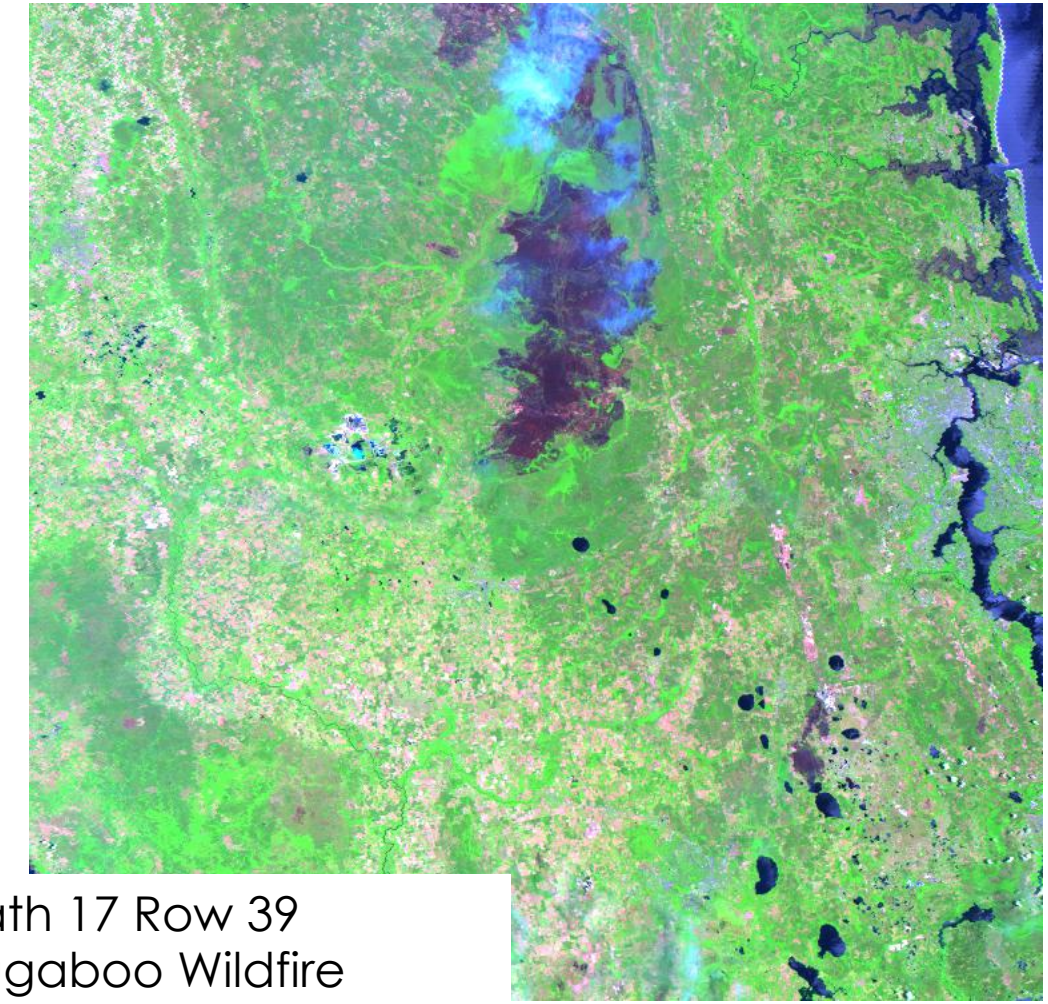


Path 19 Row 35
Sun Elevation: 65°
Sun Azimuth: 114°



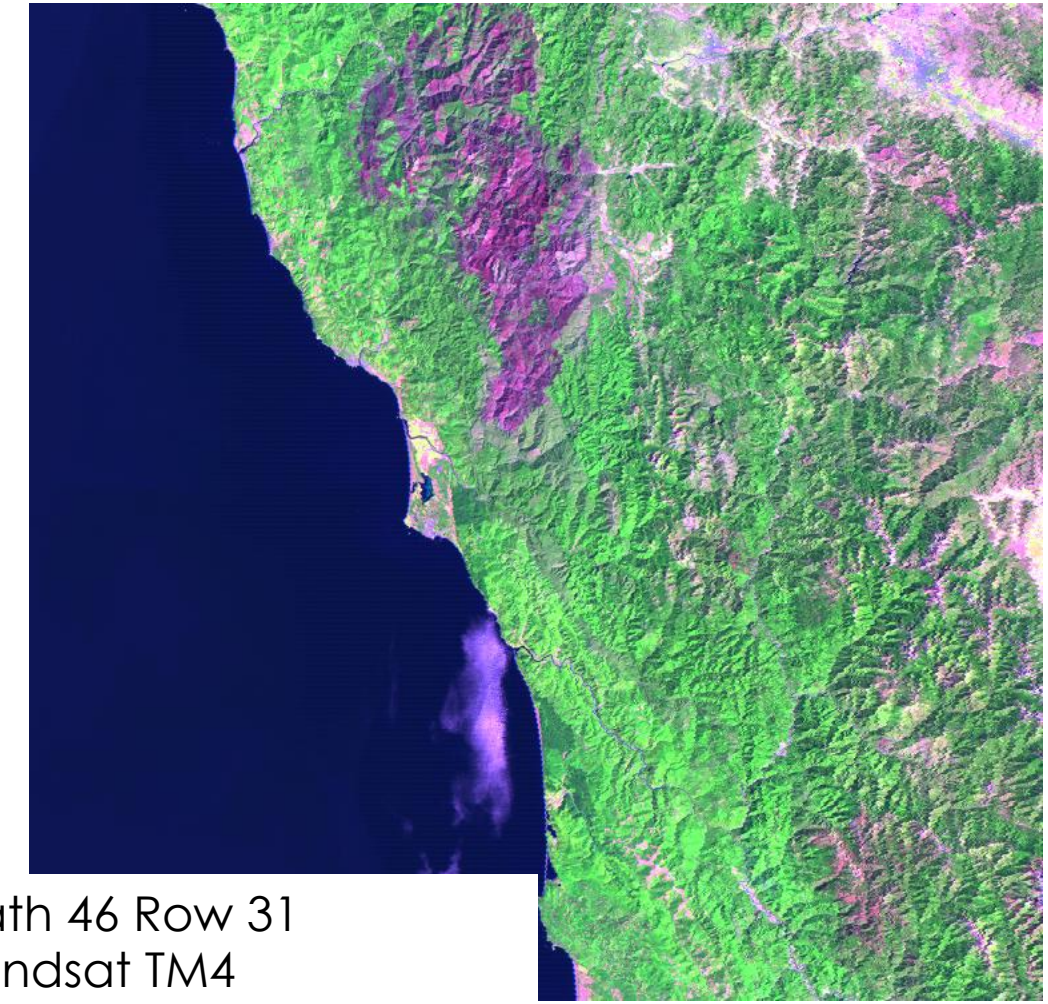
Path 19 Row 35
Sun Elevation: 32°
Sun Azimuth: 158°

Postfire and Prefire Landsat Scenes Should…



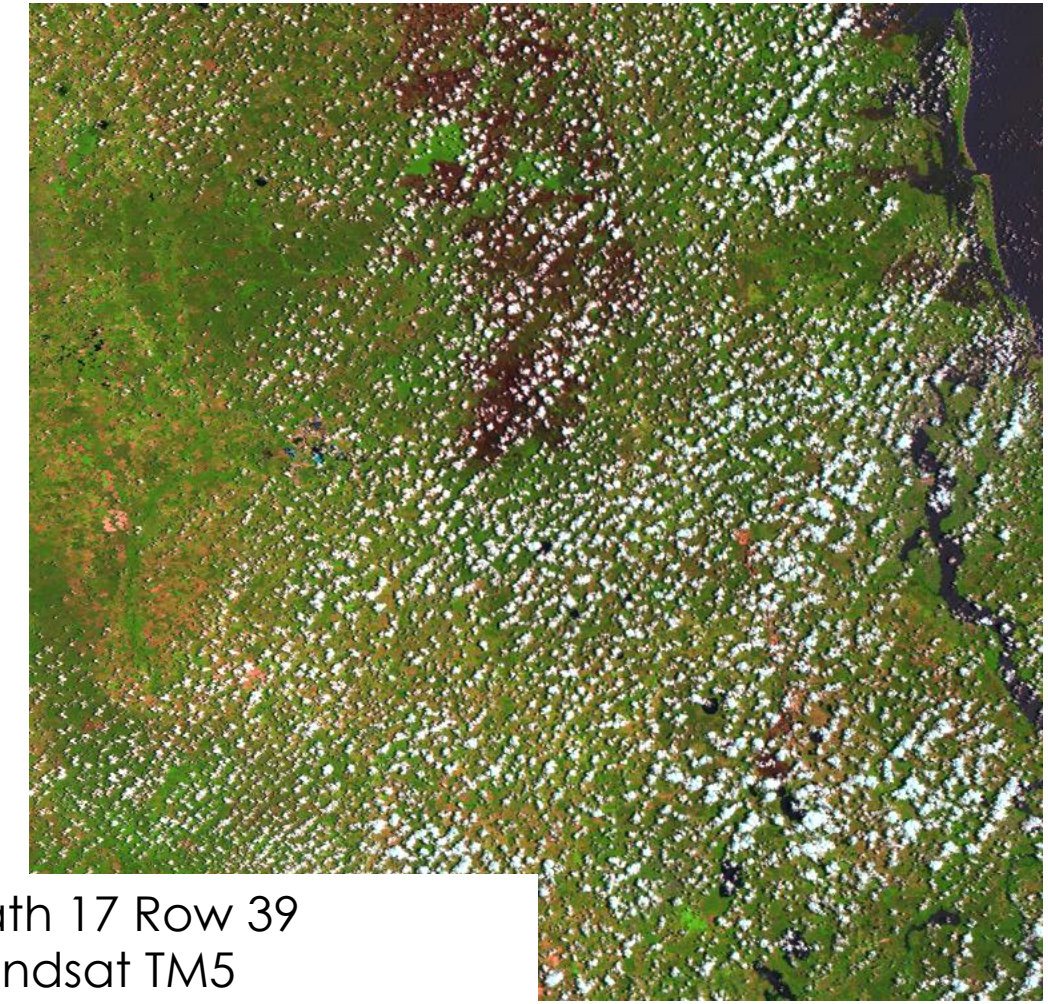
Path 17 Row 39
Bugaboo Wildfire
Image Date: 5/21/2007

…Be Cloud Free



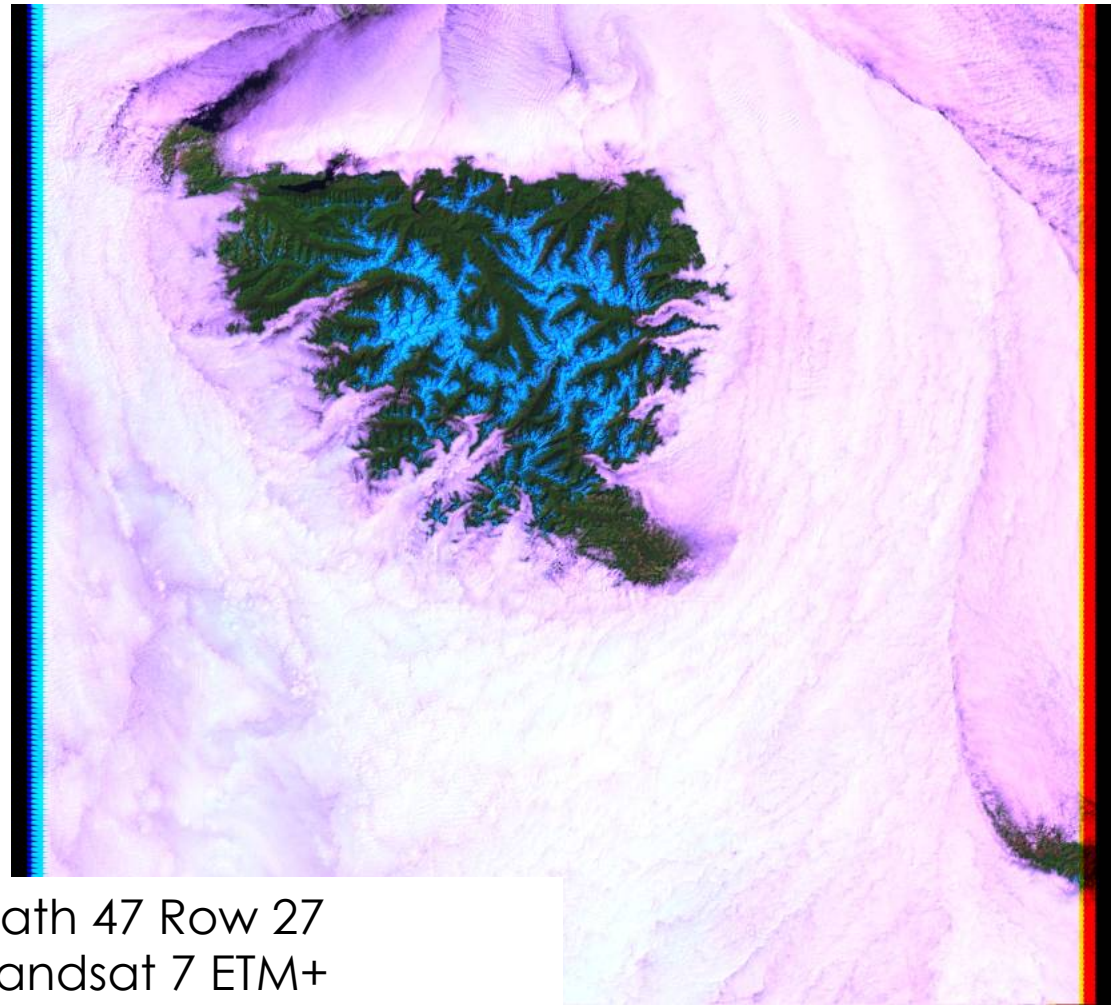
Path 46 Row 31
Landsat TM4
Image Date: 09/23/2002

…Be Cloud Free



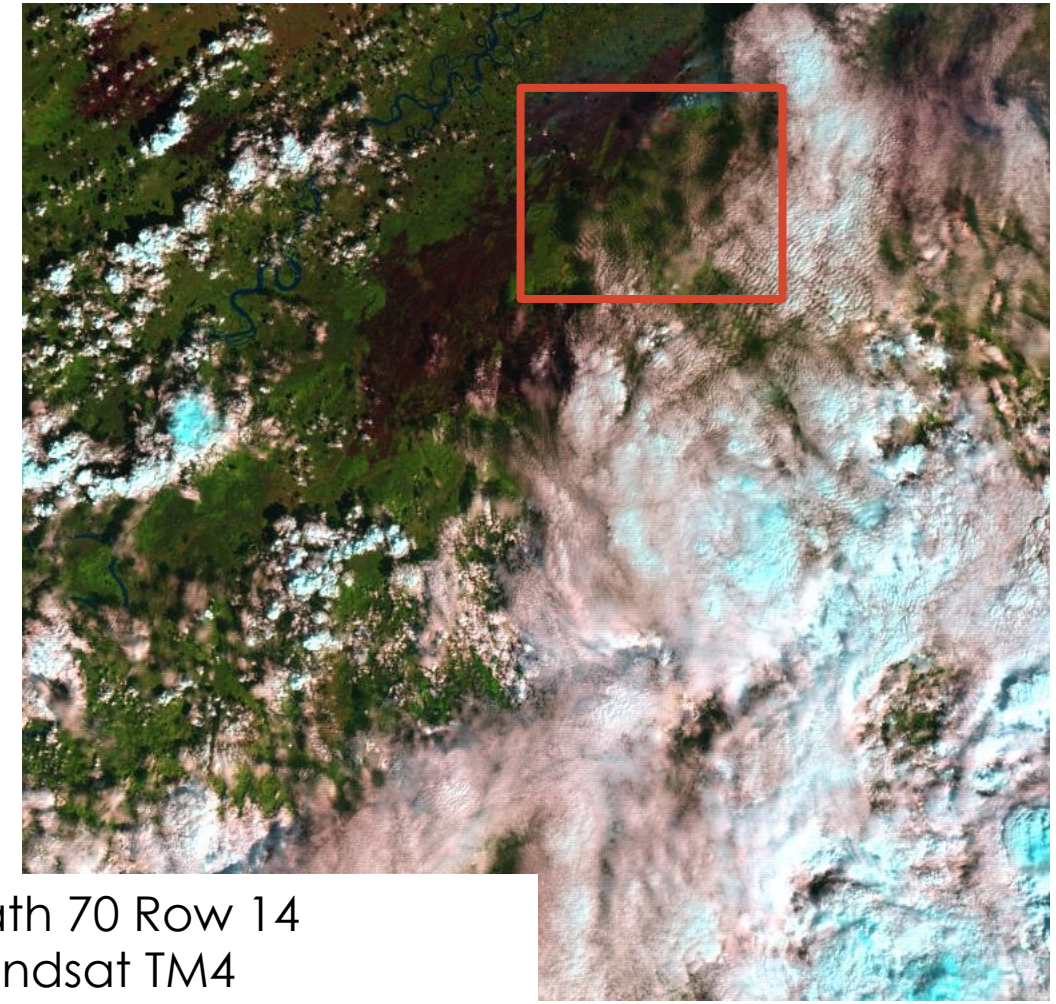
Path 17 Row 39
Landsat TM5
Image Date: 06/22/2007

…Be Cloud Free



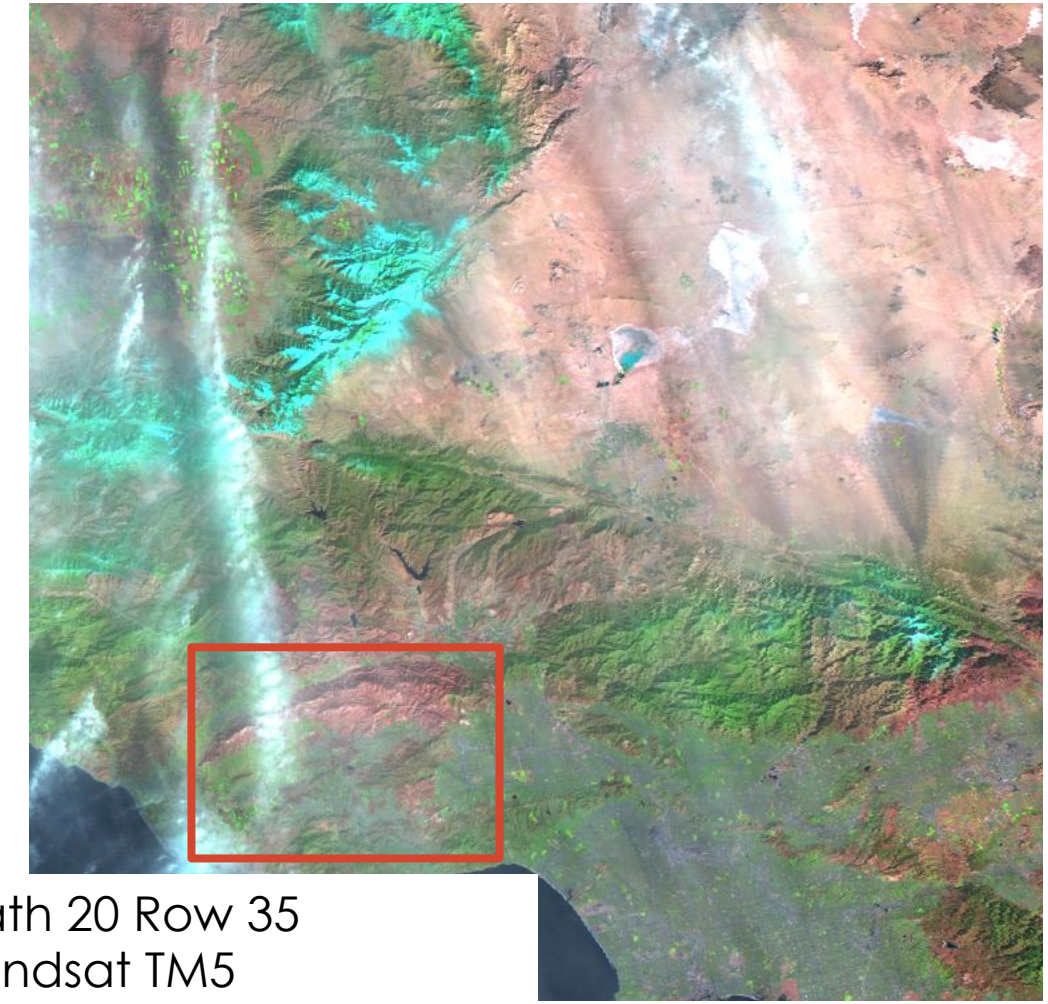
Path 47 Row 27
Landsat 7 ETM+
Image Date: 05/01/2002

…Be Cloud Free



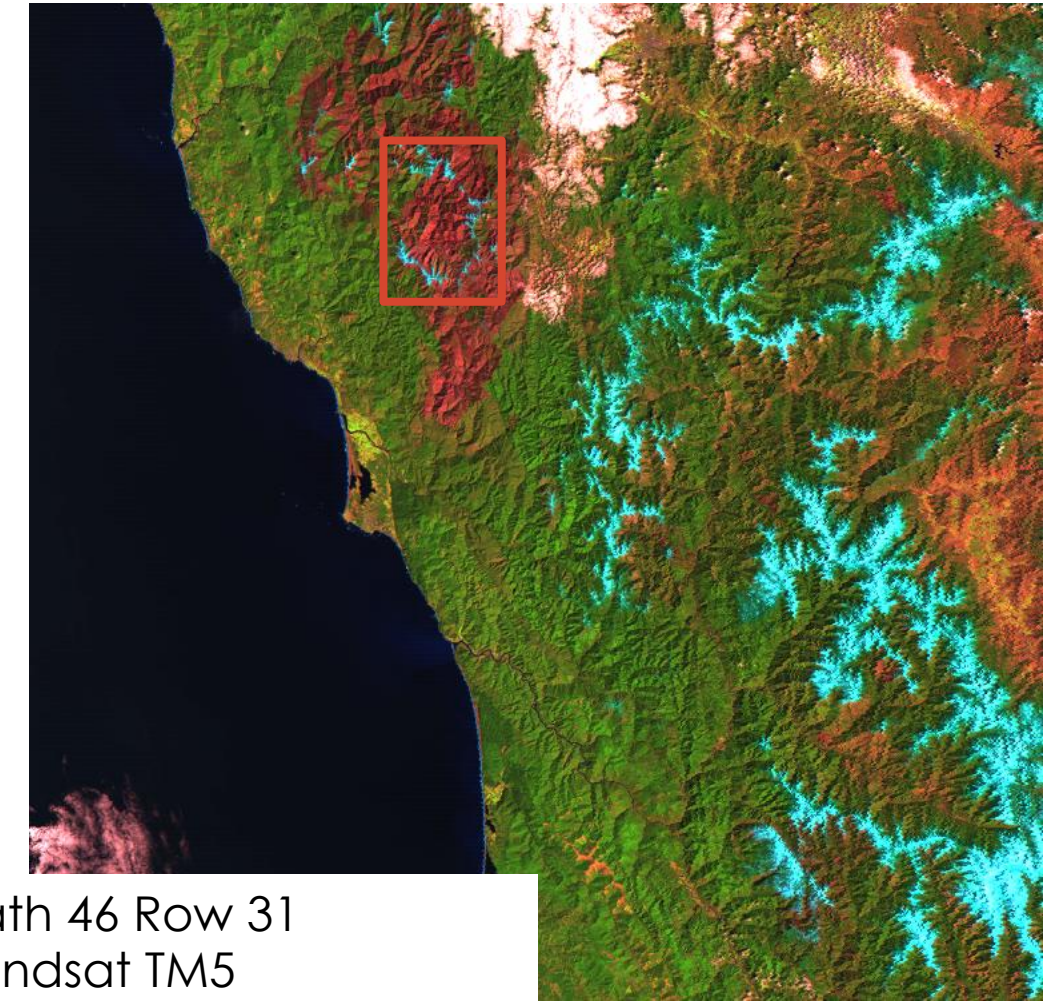
Path 70 Row 14
Landsat TM4
Image Date: 07/30/1988

…Contain Limited Haze



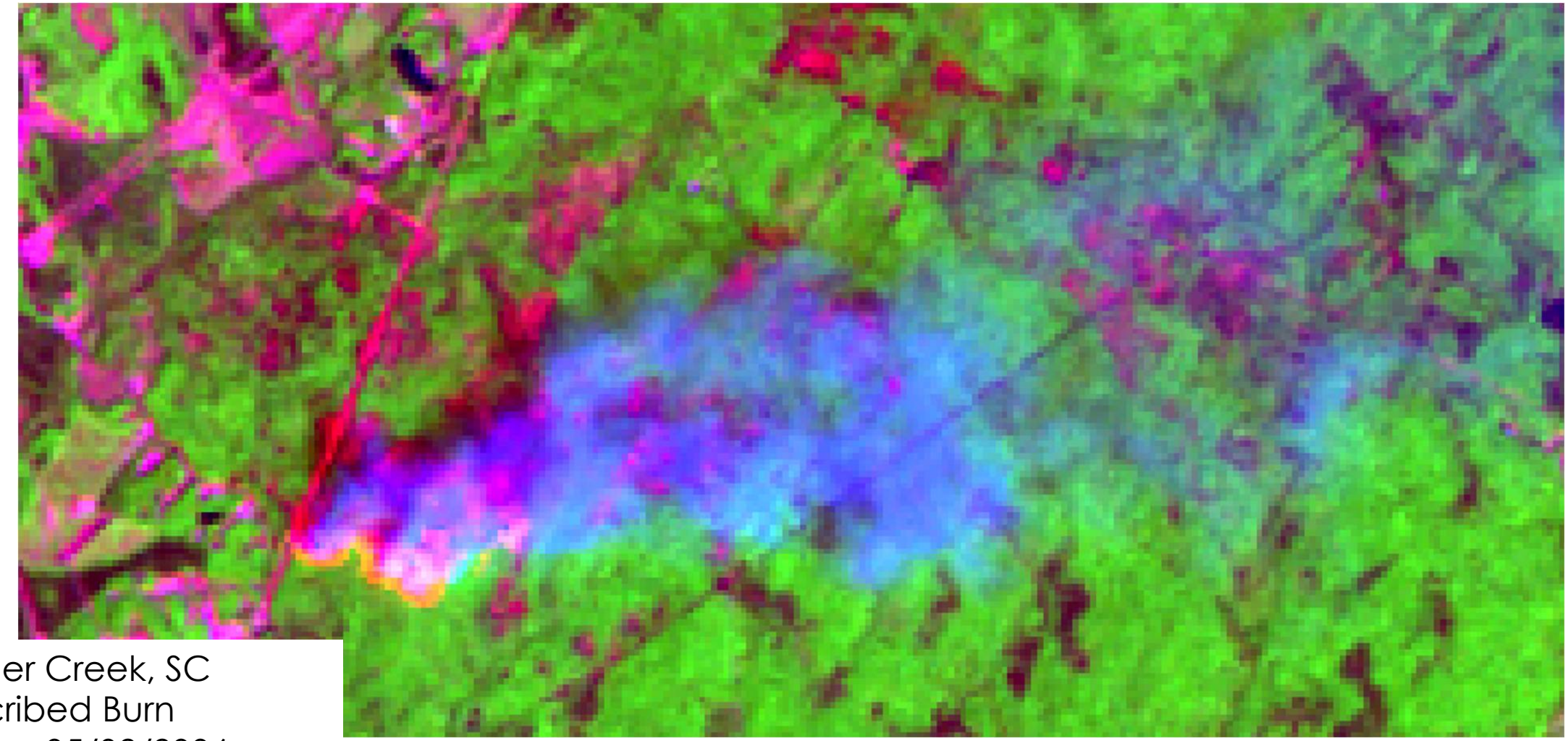
Path 20 Row 35
Landsat TM5
Image Date: 12/12/2003

…Have No Snow Within the Fire Perimeter



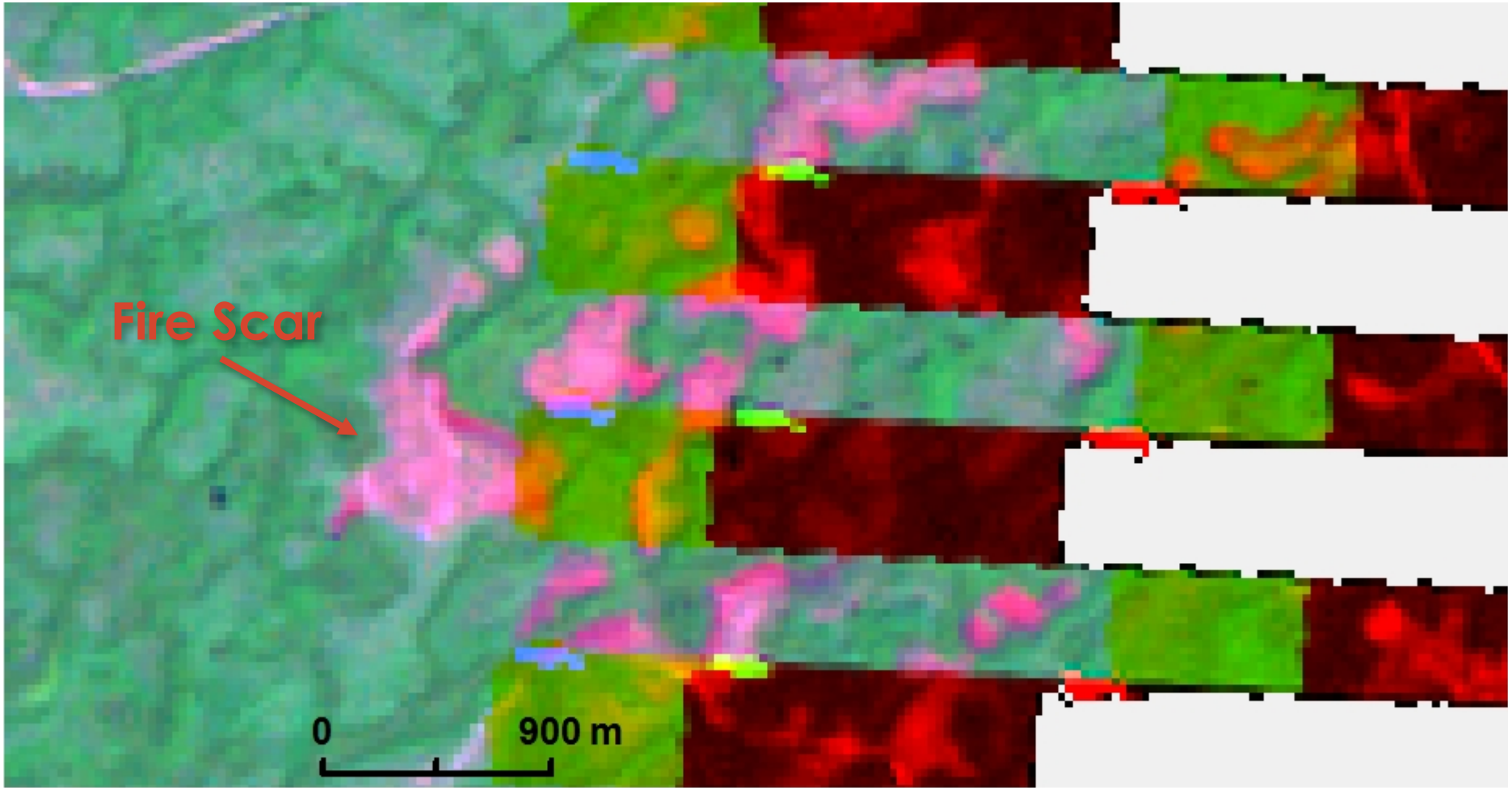
Path 46 Row 31
Landsat TM5
Image Date: 03/18/2003

…Contain No Active Burning Within the Fire Perimeter

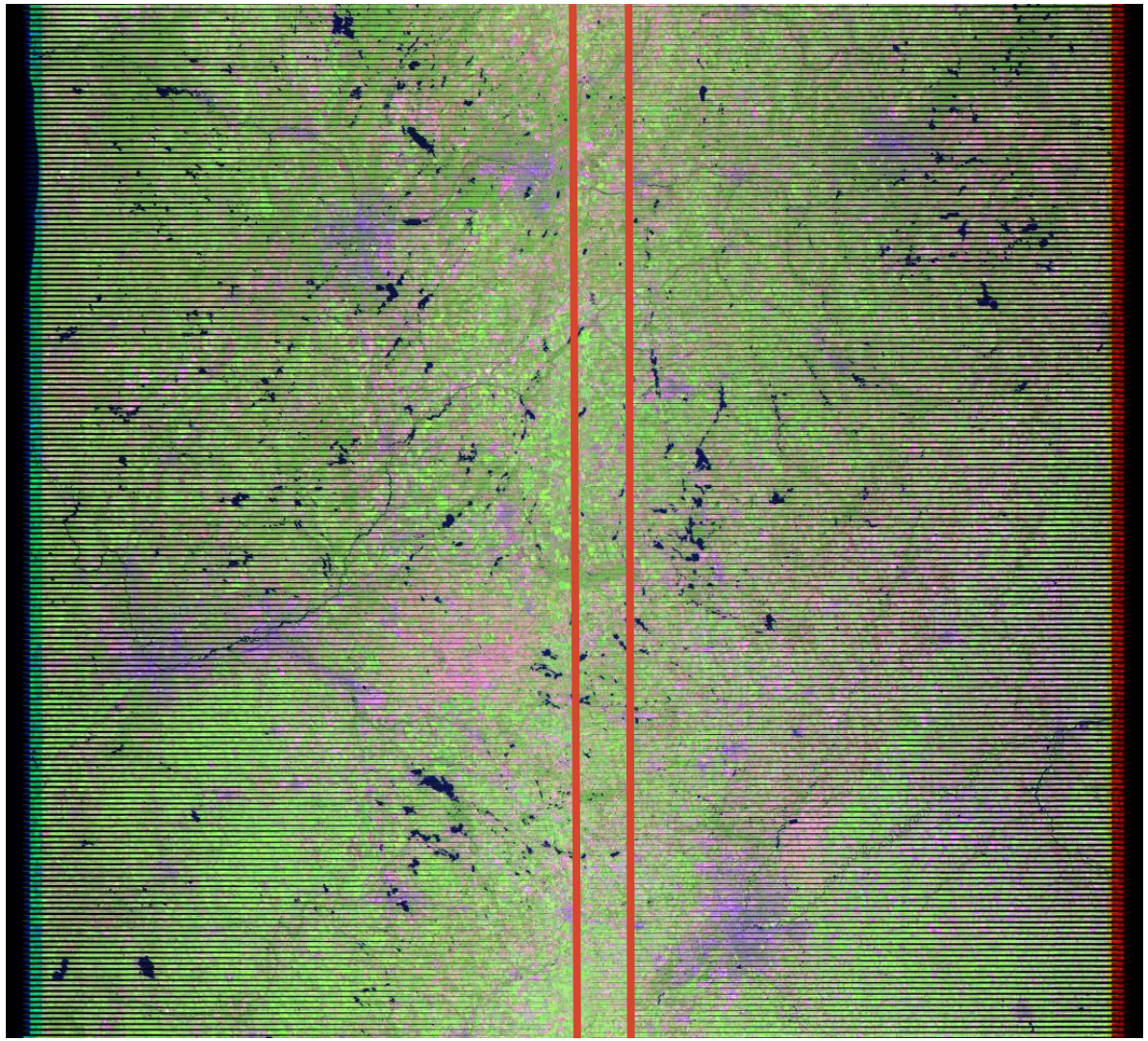


Gamer Creek, SC
Prescribed Burn
Image: 05/02/2006

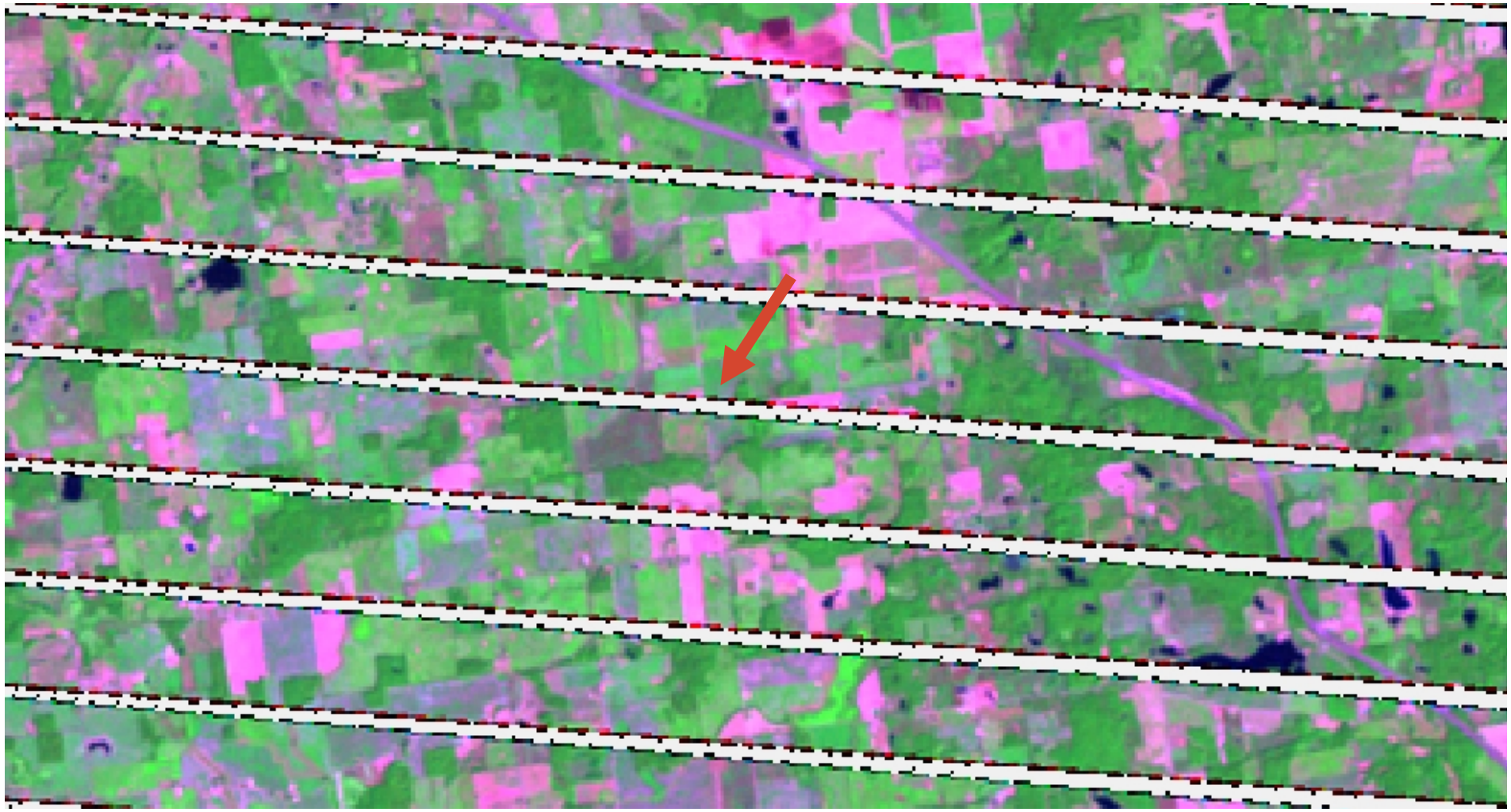
…Not Contain the Fire Perimeter Near the Scene Edge



...Not Have Scan Lines Within the Fire Perimeter



...Not Have Scan Lines Within the Fire Perimeter



Development of Fire Mapping Tool (FMT)

Problem: Most Small Fires (<10 ha) Are Unmapped

Monitoring Trends in Burn Severity (MTBS)
Versus NIFT Percentage of Fires Mapped

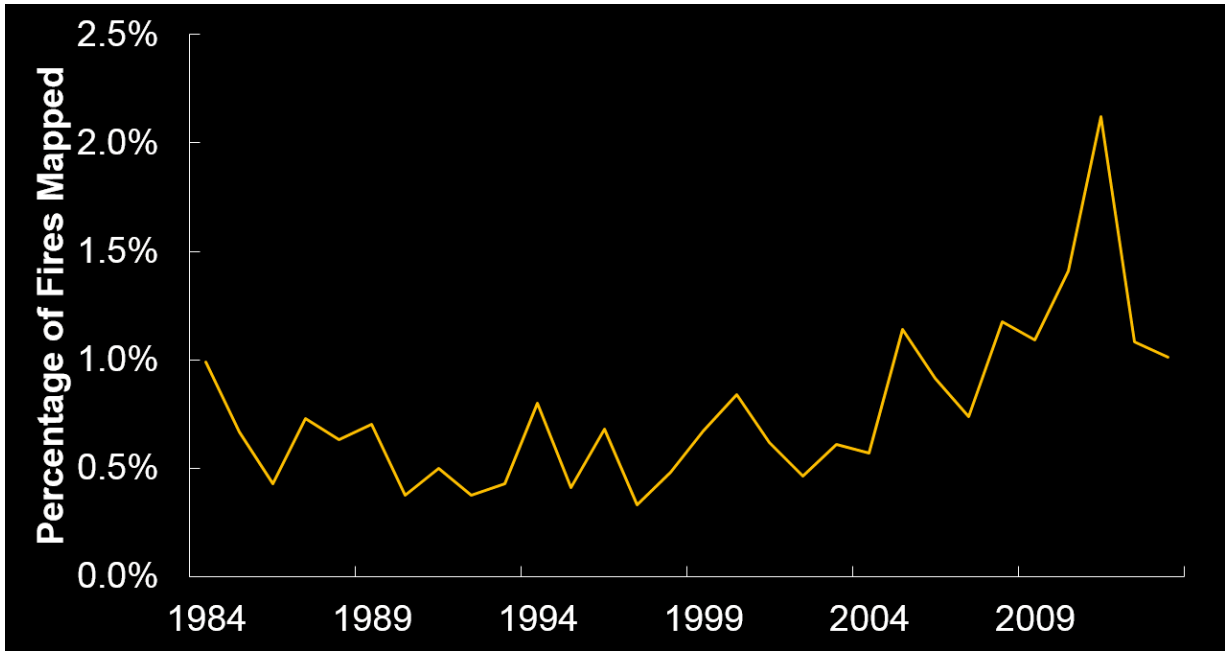
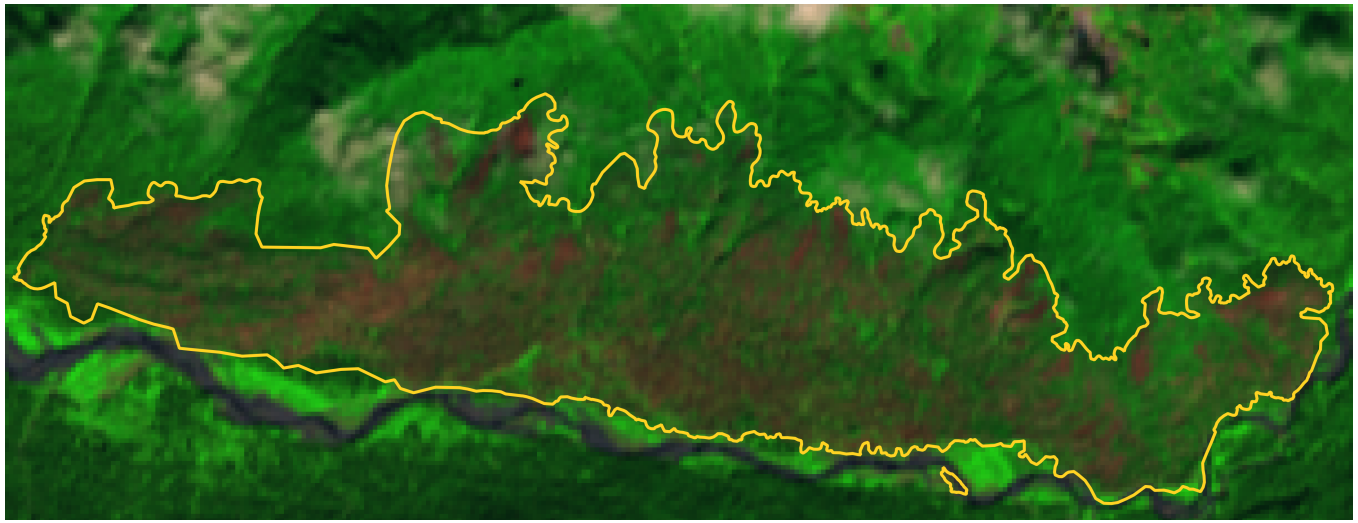


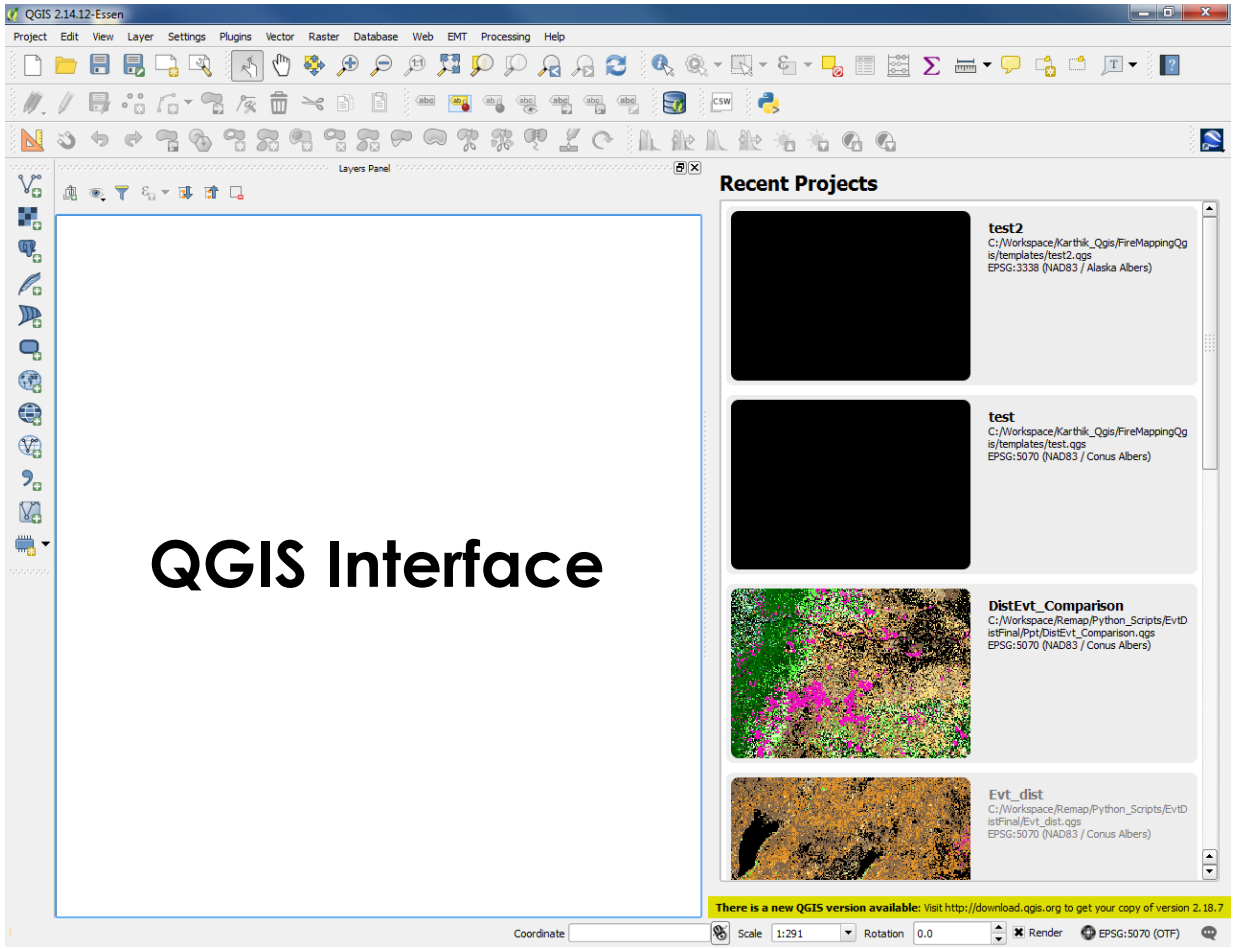
Image Credit (Right): NIFC Data Source: http://www.nifc.gov/fireInfo/fireInfo_statistics.html

Fire Mapping Tool (FMT) Project Goal

- Create tools to more accurately map burn perimeters and severity with Landsat imagery, and use a similar methodology to the Monitoring Trends in Burn Severity (MTBS) Project

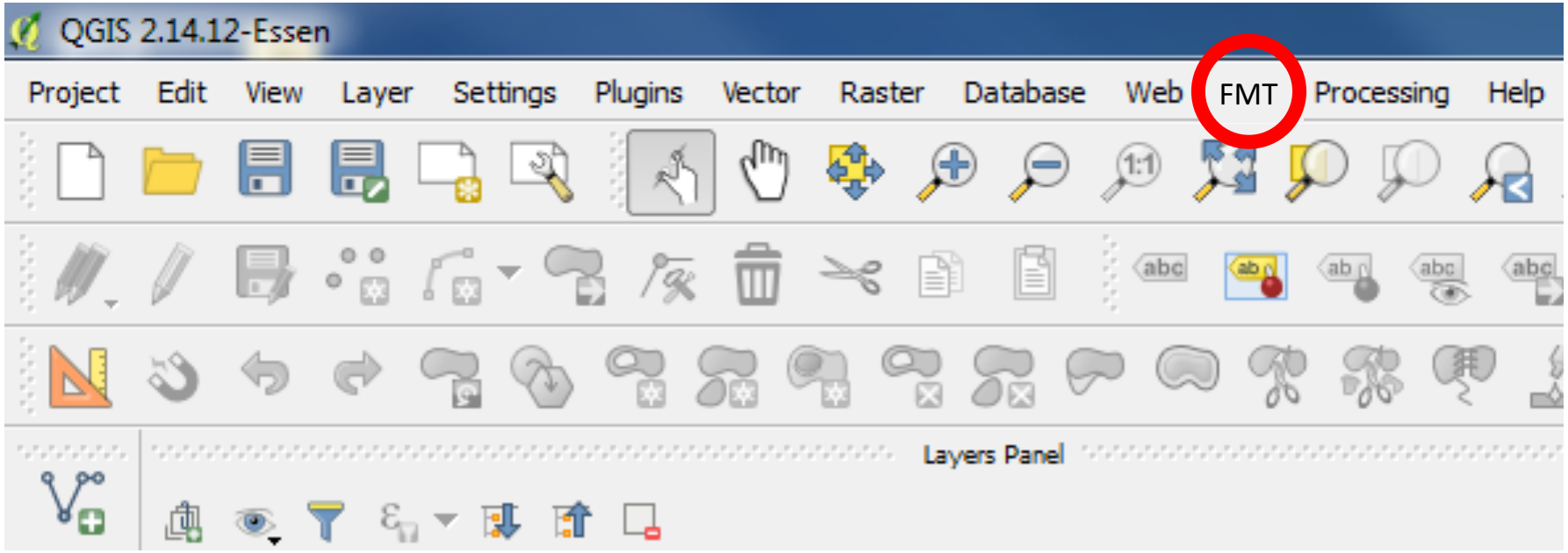


QGIS Background



http://www.qgis.org/en/site/

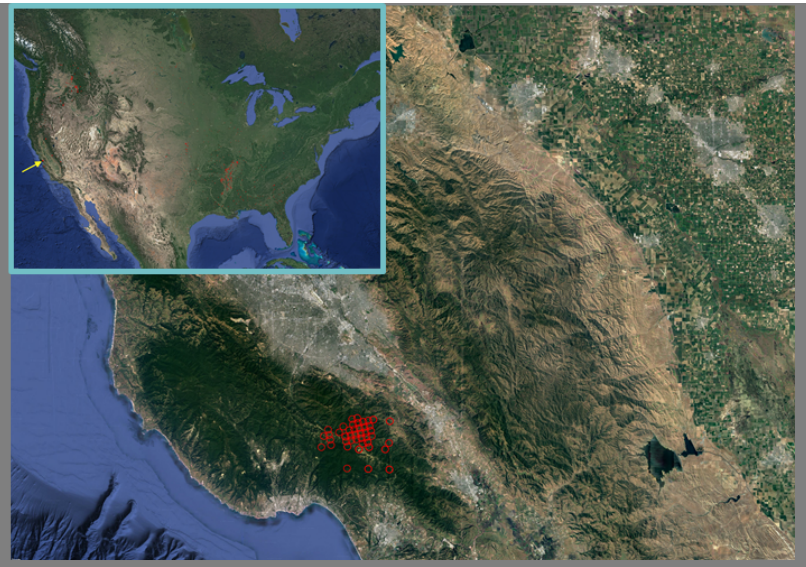
QGIS Fire Mapping Tool (FMT)



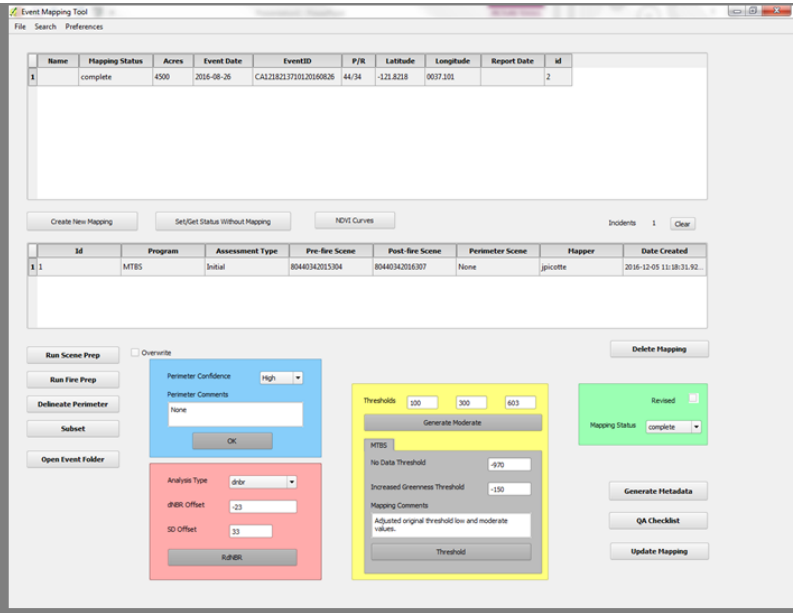
FMT's Functionality

- Processes Landsat Imagery ordered from https://espa.cr.usgs.gov/
- Creates dNBR images
- Builds fire perimeter and masking vector files (i.e. shapefiles)
- Calculates RdNBR offset and subsequently outputs a RdNBR image
- Suggests potential low, moderate, and high burn severity thresholds
- Creates thresholded burn severity product
- Outputs metadata
- All user entered information is databased within a Spatialite database
- Additional documentation available from https://mtbs.gov/qgis-fire-mapping-tool

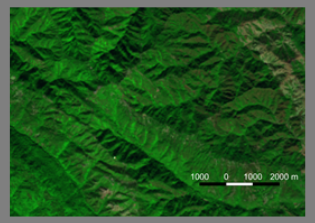
QGIS FMT Processing Outline

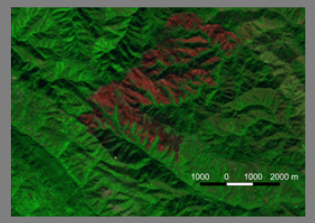


Step 1: Identify a fire using sensor detections or another data source

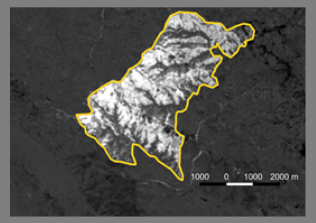


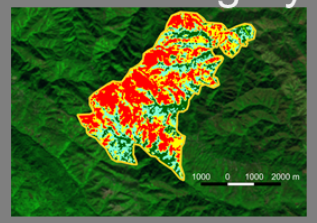
Step 2: Use QGIS tool to enter fire information and order imagery





Step 3: Identify pre- (left) and post- (right) fire Landsat Scenes

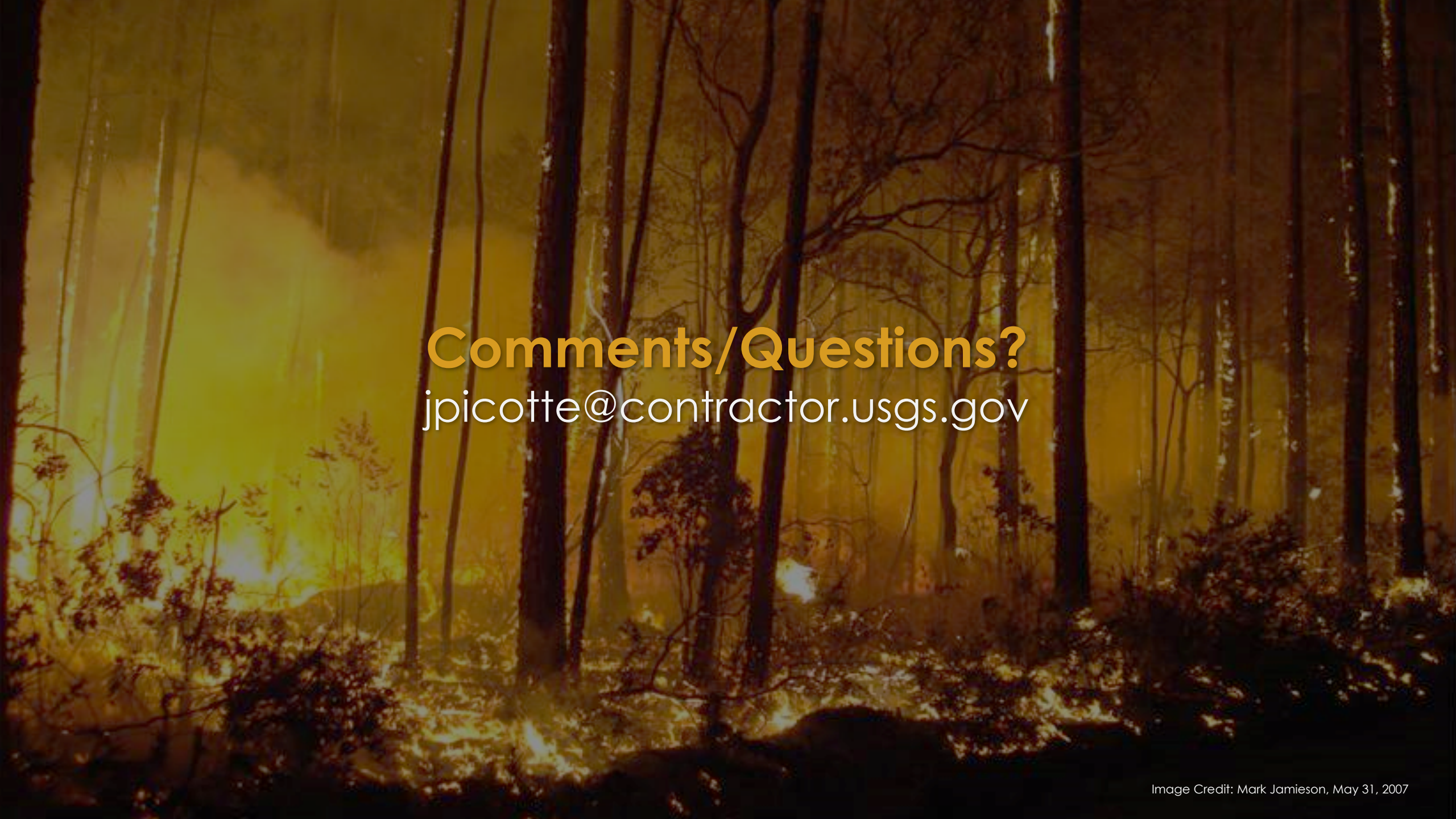


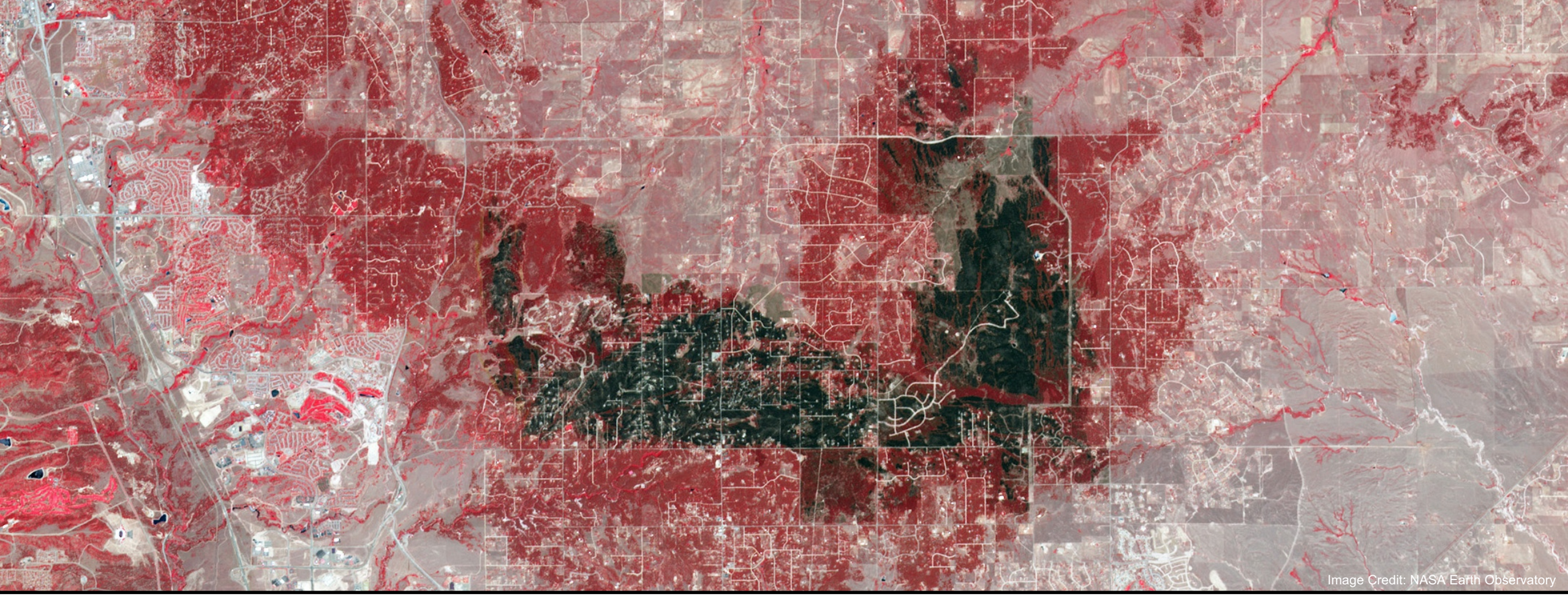


Step 4: Map fire perimeter and burn severity

Conclusions

- Remote sensing of burn severity is possible
- On the ground burn severity information can help calibrate remotely sensed burn severity estimates
- Pre- and post-fire image characteristics are important
  - Initial versus extend assessment
  - Seasonal variation
  - Phenological variation
  - Be aware of potential image anomalies
- The FMT:
  - can use Landsat 5, 7, and 8 images
  - assist in the mapping of burn severity
- Demonstration of FMT tool


Comments/Questions?
jpicotte@contractor.usgs.gov
Image Credit: Mark Jamieson, May 31, 2007

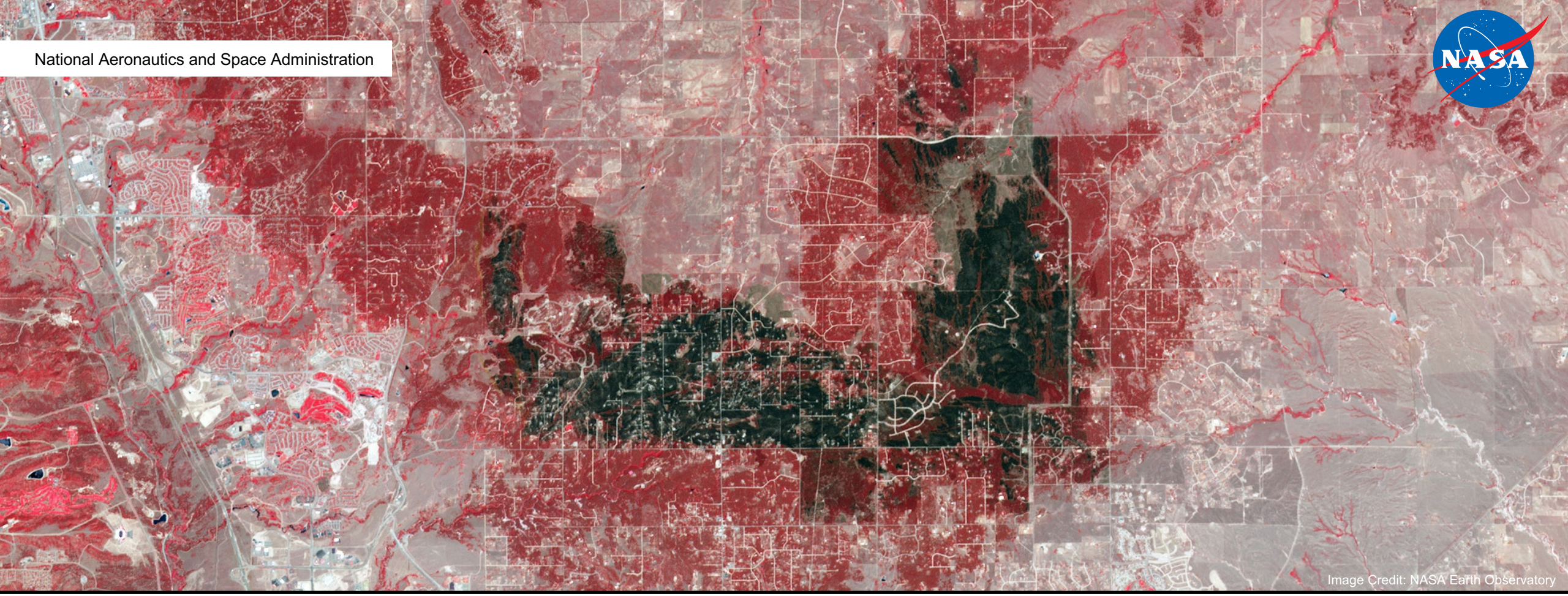


FMT Exercise

Contacts

- ARSET Land Management & Wildfire Contacts
  - Cynthia Schmidt: Cynthia.L.Schmidt@nasa.gov
  - Amber McCullum: AmberJean.Mccullum@nasa.gov
- General ARSET Inquiries
  - Ana Prados: aprados@umbc.edu
- ARSET Website:
  - http://arset.gsfc.nasa.gov

National Aeronautics and Space Administration



Thank You

Next Week: Global Wildfire Information System (GWIS)

07/19/2018

Cindy Schmidt and Amber McCullum

Question and Answer Session

Please type your questions in the Question Box

You can also type your name, location, organization, and email address to connect with your fellow land remote sensing professionals