

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>



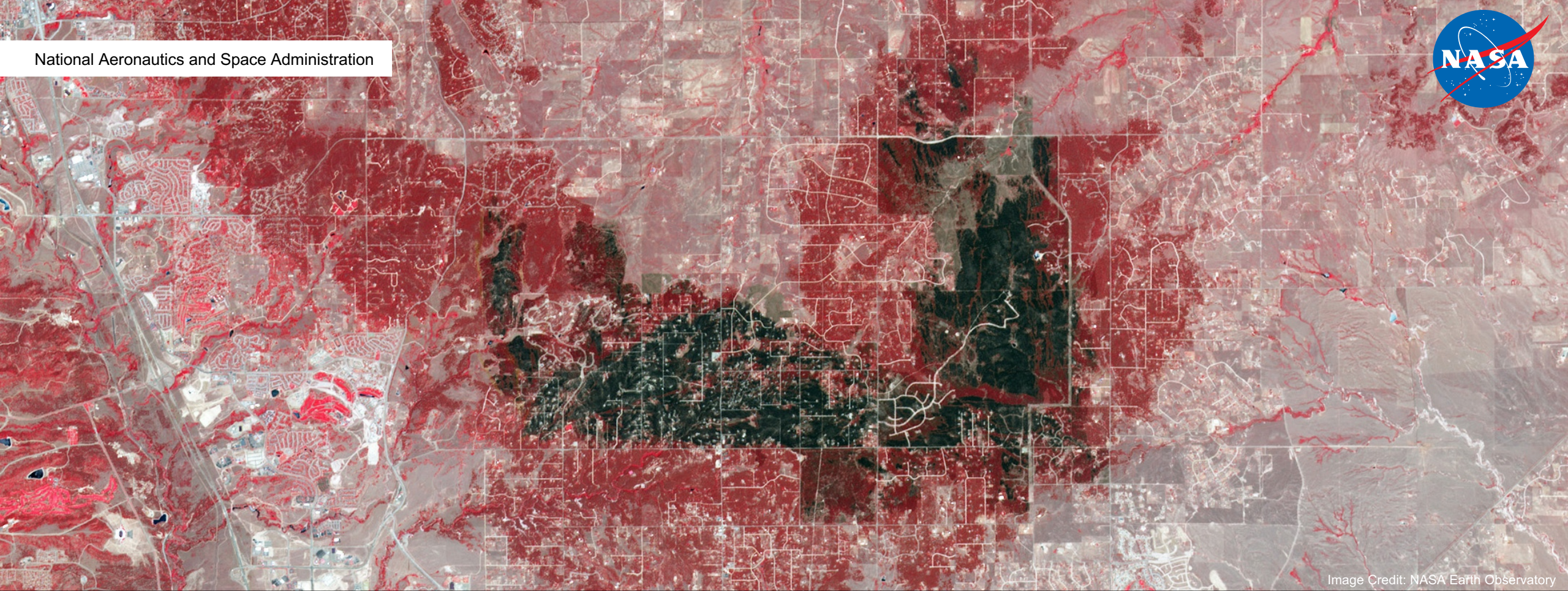
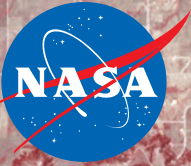


Image Credit: NASA Earth Observatory



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

Advanced Webinar: Techniques for Wildfire Detection and Monitoring

This assignment must be completed by August 2, 2018 to receive a certificate of completion for the training. Once you submit the homework, you will receive an email with a copy of your responses. This is your confirmation that we have received your assignment.

Once you click submit, you may click "View Your Accuracy" to see how you did.

*** Required**

Email address *

Your email

Name (First Last) *

Your answer

An accuracy assessment *

A. provides the accuracy or correctness

B. provides the accuracy or correctness

C. provides the accuracy or correctness

NASA's Applied Remote Sensing Training Program (ARSET) presents a certificate of completion to
Amber McCullum
for completing:
Advanced Webinar: Techniques for Wildfire Detection & Monitoring
July 12-19, 2018
Trainers: Cindy Schmidt



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

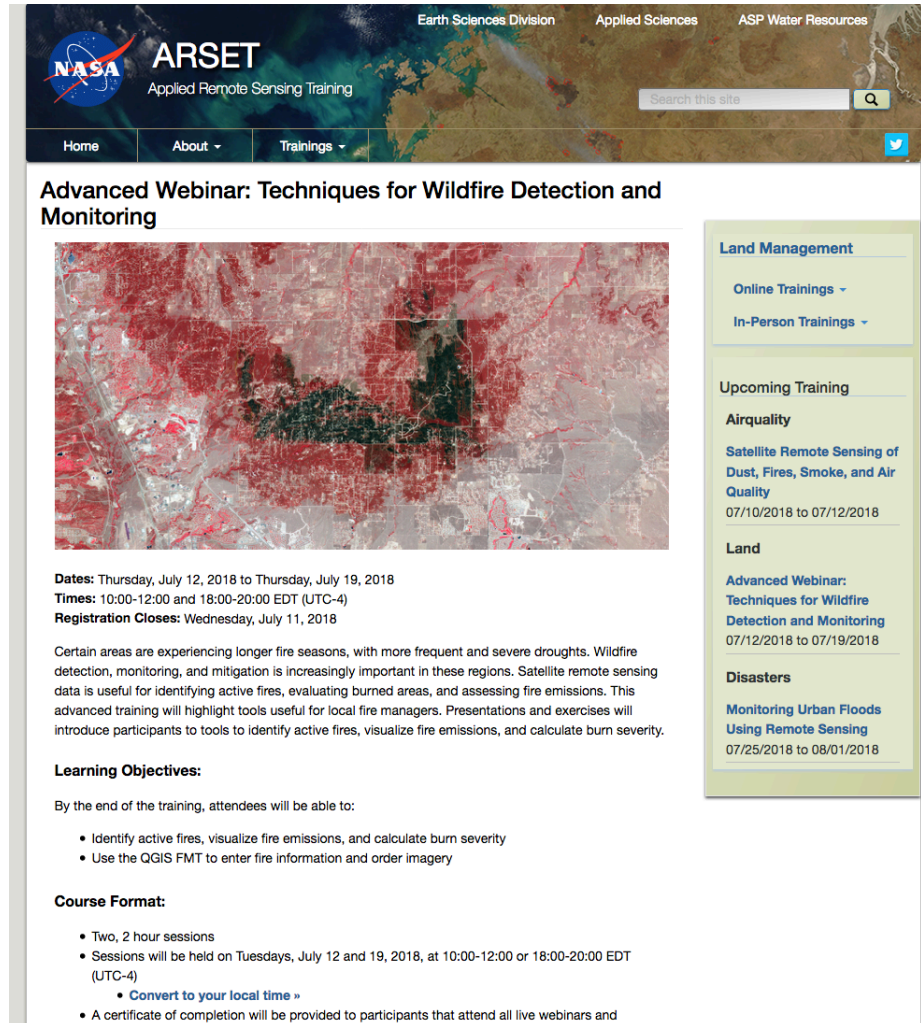
The image shows a screenshot of the ARSET (Applied Remote Sensing Training) website. The top navigation bar includes the NASA logo, 'ARSET Applied Remote Sensing Training', and links for 'Earth Sciences Division', 'Applied Sciences', and 'ASP Water Resources'. A search bar is present on the right. Below the navigation, there are tabs for 'Home', 'About', and 'Trainings'. The main content area features a large image of Earth from space with a dark overlay containing a menu with options: 'Fundamentals', 'Disasters', 'Health & Air Quality', 'Land', and 'Water Resources'. To the right of this menu, there is a promotional box for an 'Advanced Webinar: Methods in Using NASA Remote Sensing for Health Applications' scheduled for Thursdays, June 1-15, 2017, from 10 a.m. to 3 p.m. EDT (UTC-4), with a 'Register Now' button. Further right is a sidebar with 'ARSET' branding and links for 'Webinars', 'Workshops', 'Suggest a Training', 'Personnel', and 'Resources'. Below this is a section for 'Upcoming Training' with 'Airquality' listed.

Overlaid on the bottom right of the website screenshot is a slide titled 'Interaction with Earth Surface: Vegetation'. The slide features a diagram showing a tree with arrows representing radiation: 'G' (Green) and 'IR' (Infrared) are shown as outgoing radiation from the tree, while 'R' (Red) and 'B' (Blue) are shown as incoming radiation. A second diagram shows a tree with 'IR' and 'G' arrows, and a text box stating: 'Example: Healthy, green vegetation absorbs Blue and Red wavelengths and reflects Green and Infrared'. Below this, another text box says: 'Since we cannot see infrared radiation, we see healthy vegetation as green'. The slide also includes a photograph of a row of green trees at the bottom.



Accessing Course Materials

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



The screenshot shows the ARSET (Applied Remote Sensing Training) website. The header includes the NASA logo, the text 'ARSET Applied Remote Sensing Training', and navigation links for 'Home', 'About', and 'Trainings'. The main content area features a satellite image of a wildfire-affected region. To the right of the image is a sidebar with categories: 'Land Management' (with sub-links for 'Online Trainings' and 'In-Person Trainings'), 'Upcoming Training' (listing 'Airquality' and 'Satellite Remote Sensing of Dust, Fires, Smoke, and Air Quality' for 07/10/2018 to 07/12/2018), 'Land' (listing 'Advanced Webinar: Techniques for Wildfire Detection and Monitoring' for 07/12/2018 to 07/19/2018), and 'Disasters' (listing 'Monitoring Urban Floods Using Remote Sensing' for 07/25/2018 to 08/01/2018).

Advanced Webinar: Techniques for Wildfire Detection and Monitoring

Dates: Thursday, July 12, 2018 to Thursday, July 19, 2018
Times: 10:00-12:00 and 18:00-20:00 EDT (UTC-4)
Registration Closes: Wednesday, July 11, 2018

Certain areas are experiencing longer fire seasons, with more frequent and severe droughts. Wildfire detection, monitoring, and mitigation is increasingly important in these regions. Satellite remote sensing data is useful for identifying active fires, evaluating burned areas, and assessing fire emissions. This advanced training will highlight tools useful for local fire managers. Presentations and exercises will introduce participants to tools to identify active fires, visualize fire emissions, and calculate burn severity.

Learning Objectives:

By the end of the training, attendees will be able to:

- Identify active fires, visualize fire emissions, and calculate burn severity
- Use the QGIS FMT to enter fire information and order imagery

Course Format:

- Two, 2 hour sessions
- Sessions will be held on Tuesdays, July 12 and 19, 2018, at 10:00-12:00 or 18:00-20:00 EDT (UTC-4)
 - [Convert to your local time](#)
- A certificate of completion will be provided to participants that attend all live webinars and

Audience:

This training is primarily intended for local, regional, state, federal, and international organizations involved in wildfire management. Professional organizations in the public and private sectors engaged in environmental management and monitoring will be given preference over organizations focused primarily on research.

Registration Information:

There is no cost for the webinar, but you must register to attend the sessions. Please only sign up for either session A or B, not both.

Session A: 10:00-12:00 EDT (UTC-4) [Register Now](#) »

Session B: 18:00-20:00 EDT (UTC-4) [Register Now](#) »

Course Agenda:

[Agenda.pdf](#)

Session One: July 12

This session will provide an overview of remote sensing for wildfire detection and mapping, as well as an overview of the QGIS Fire Mapping Tool (FMT). Attendees will go through a hands-on exercise using the FMT

QGIS FMT is freely-available and can detect active fires and burn scars using Landsat data. This tool can identify smaller fires that may not be in the Monitoring Trends in Burn Severity program.

Session Two: July 19

This session will provide an overview of the Global Wildfire Information System (GWIS) and a hands-on demonstration on the use of the GWIS viewer.

GWIS is an online web application that uses remotely sensed wildfire data. This data includes fire danger, wildfire locations, burned area extent, and burn severity. GWIS also focuses on sharing data and operational plans between researchers, managers, and agencies. Demonstrations and tools will introduce participants to applications of the GWIS tool, including:

- identifying active fire from MODIS and VIIRS data,
- evaluating burned areas with MODIS data, and
- assessing fire emissions such as black carbon and particulate matter.

Application Area: [Land](#)

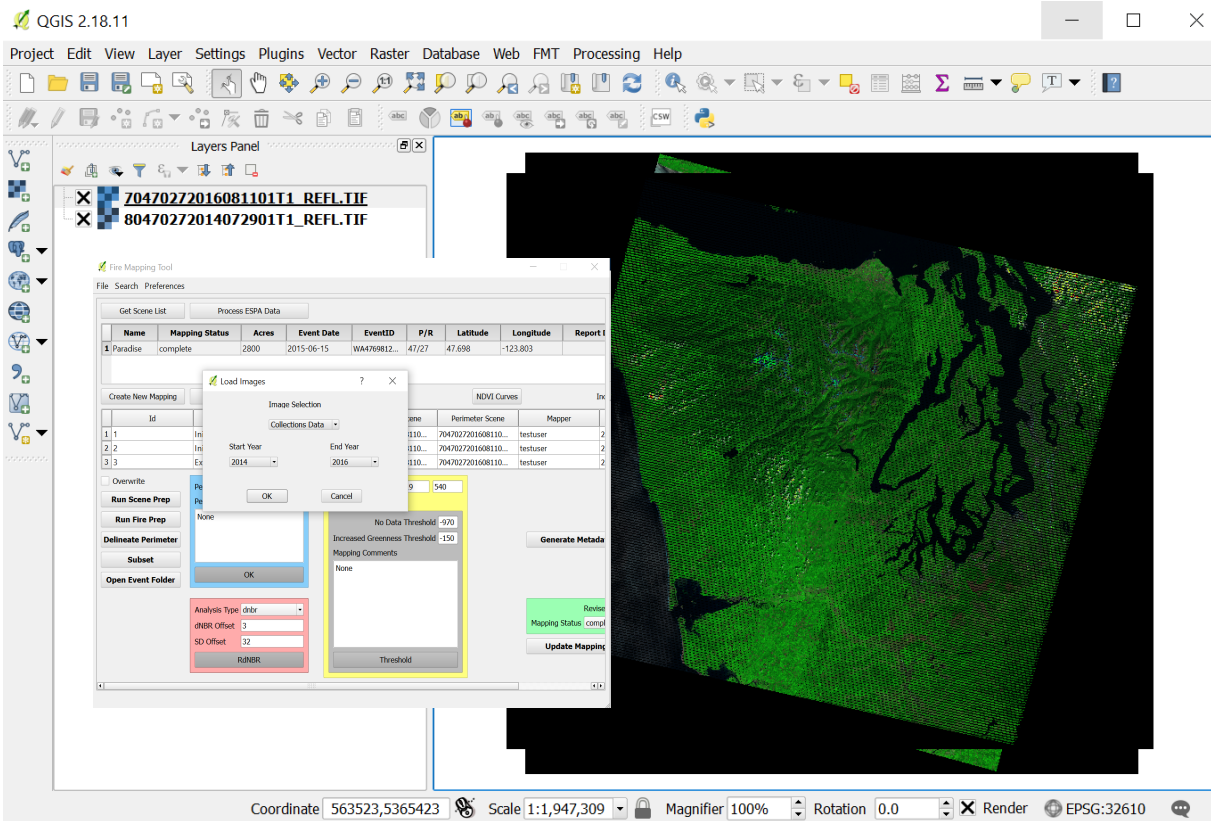
Available Languages: [English](#)

Instruments/Missions: [VIIRS](#), [Landsat](#), [NPP](#), [MODIS](#)

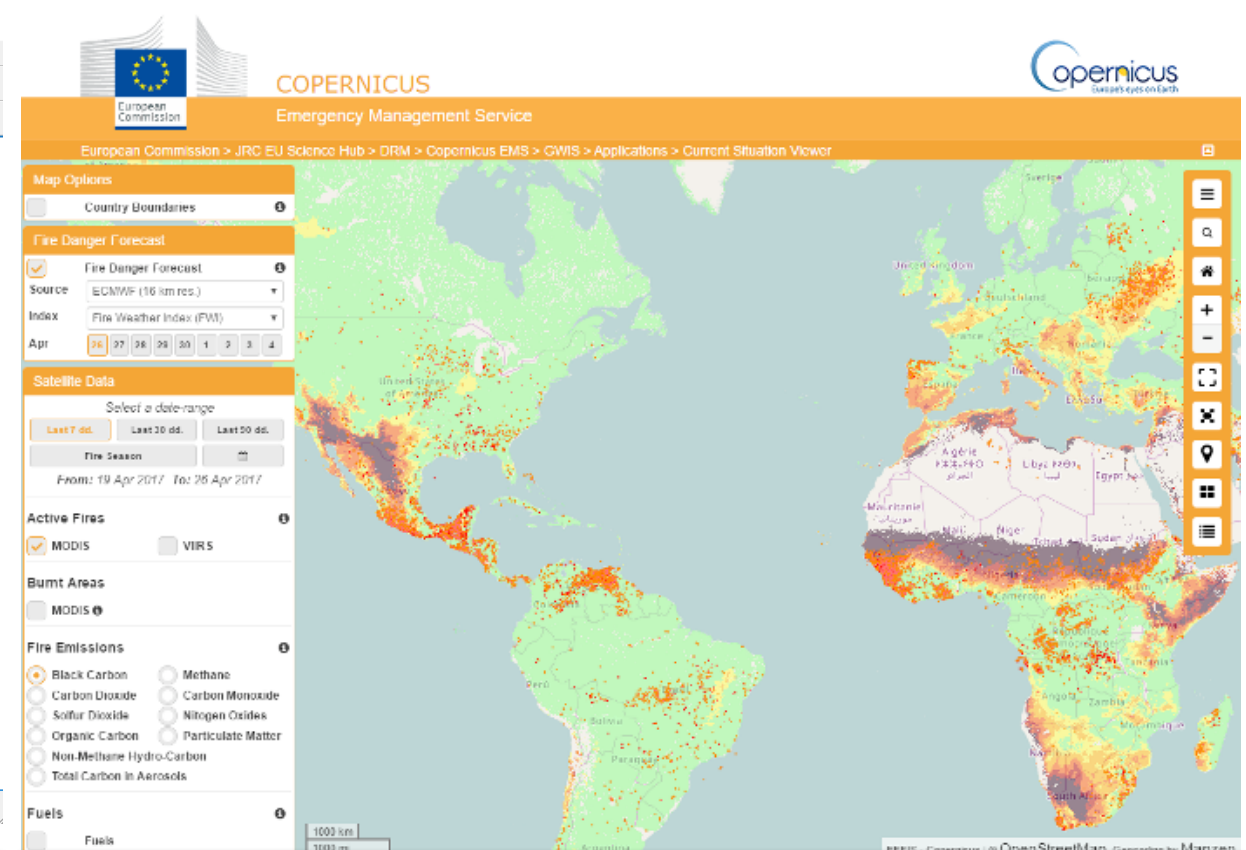
Keywords: [Aerosols](#), [Fires and Smoke](#), [Satellite Imagery](#), [Smoke](#), [Tools](#)



Course Outline



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



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



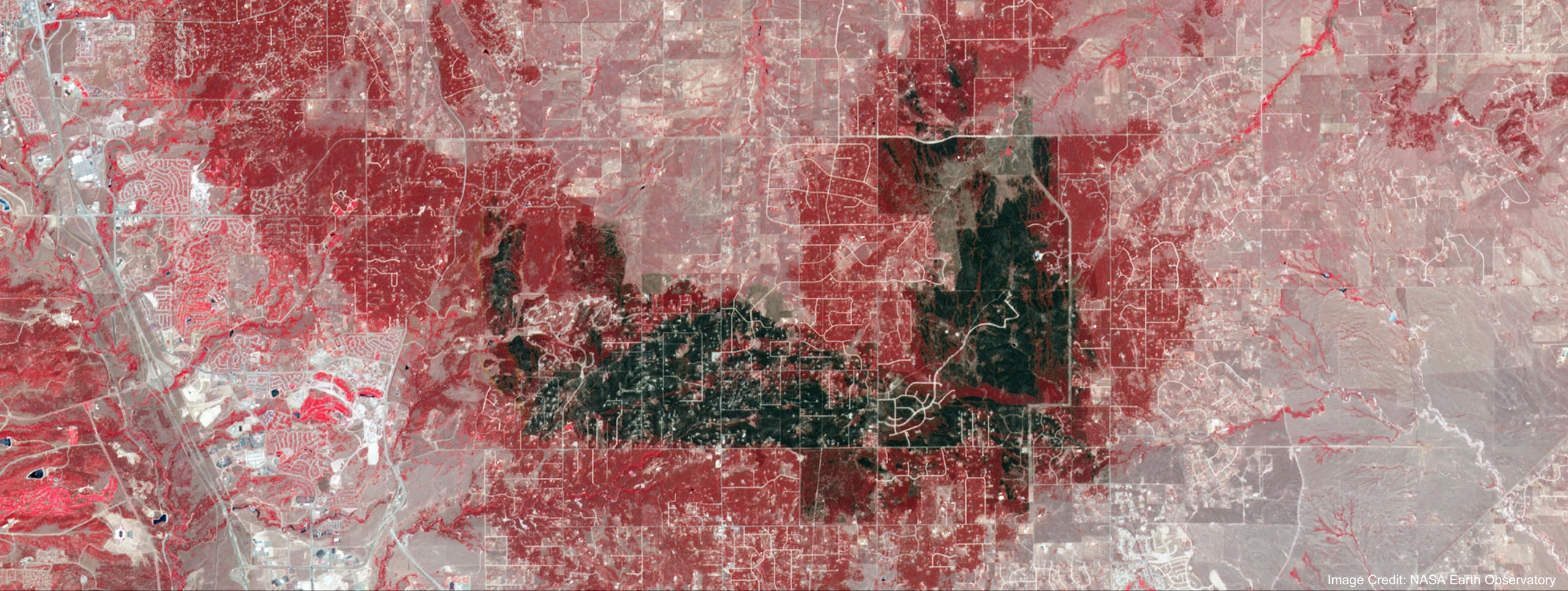
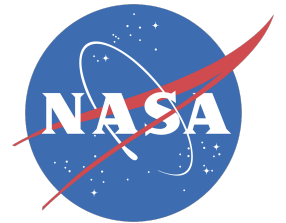


Image Credit: NASA Earth Observatory

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 NNH12AU711



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

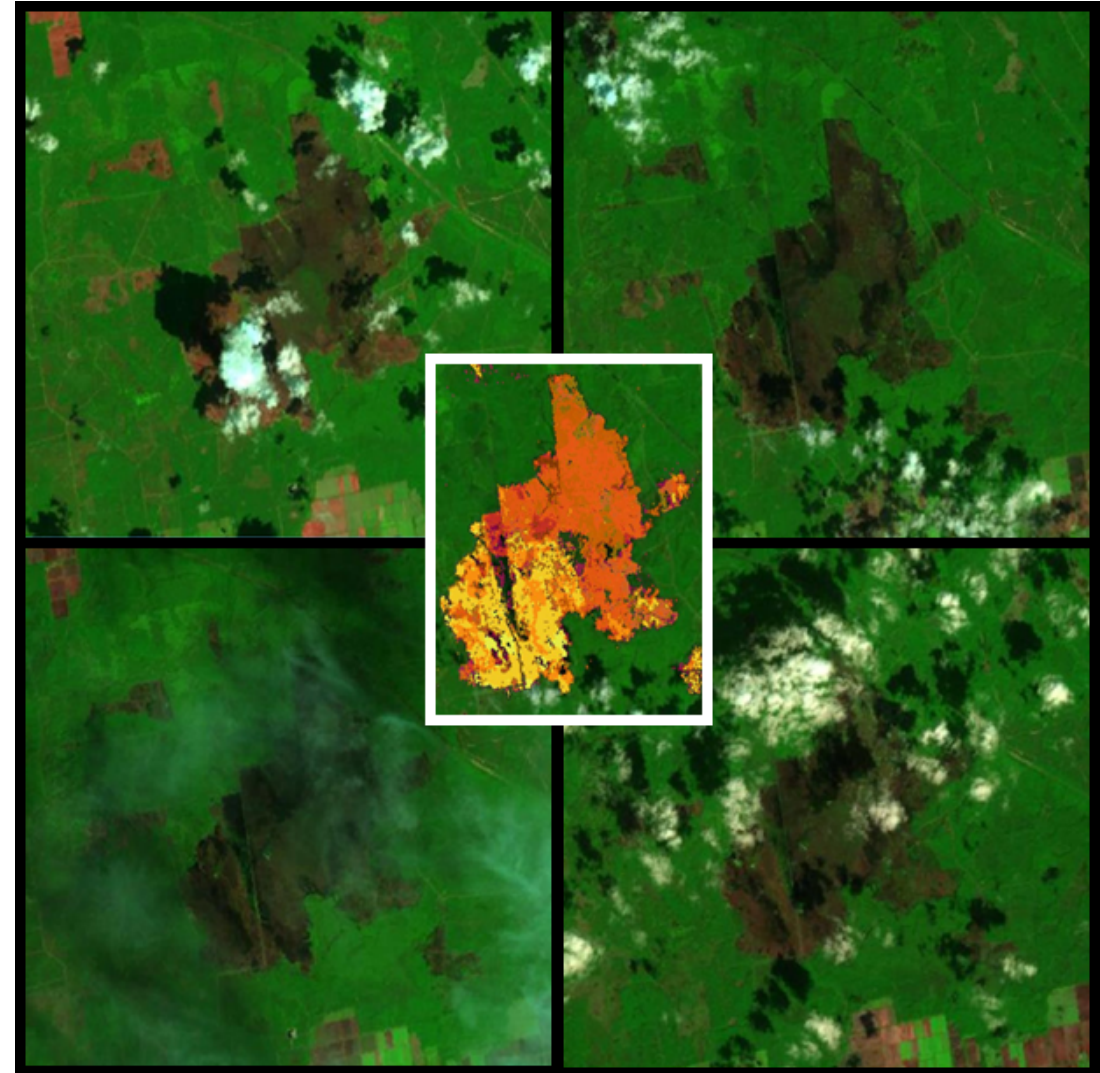


Image Credit: Josh Picotte



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

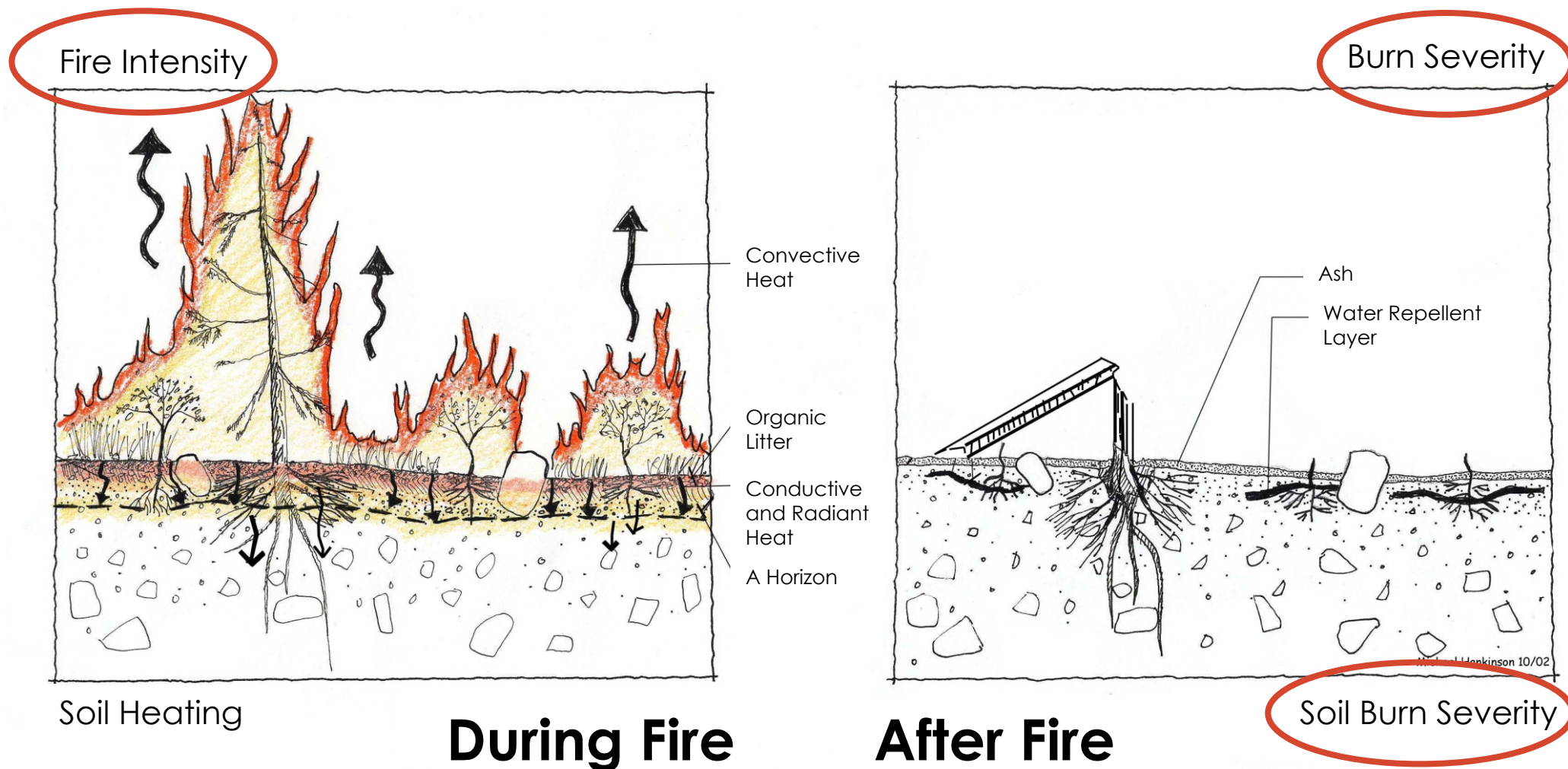


Image: USDA Forest Service Gen. Tech. Rep. RMRS-GTR-243. 2010



Field Perspective

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

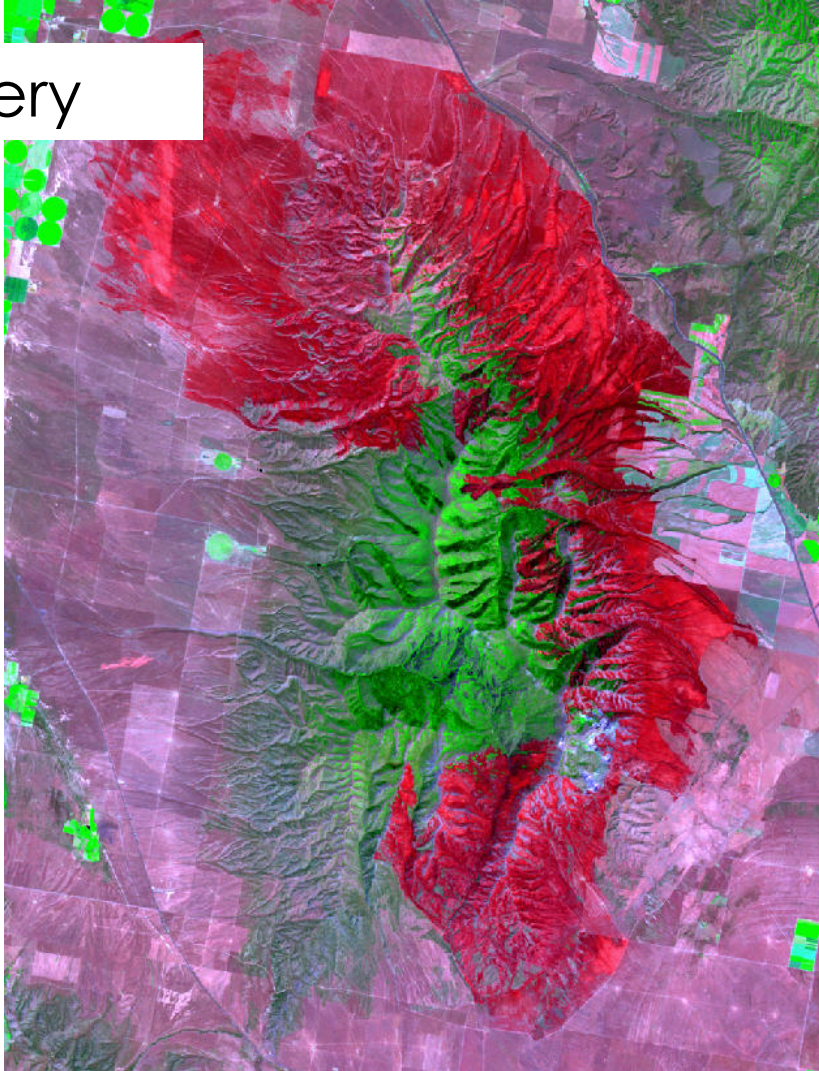


Images: USDA Forest Service Gen. Tech. Rep. RMRS-GTR-243, 2010

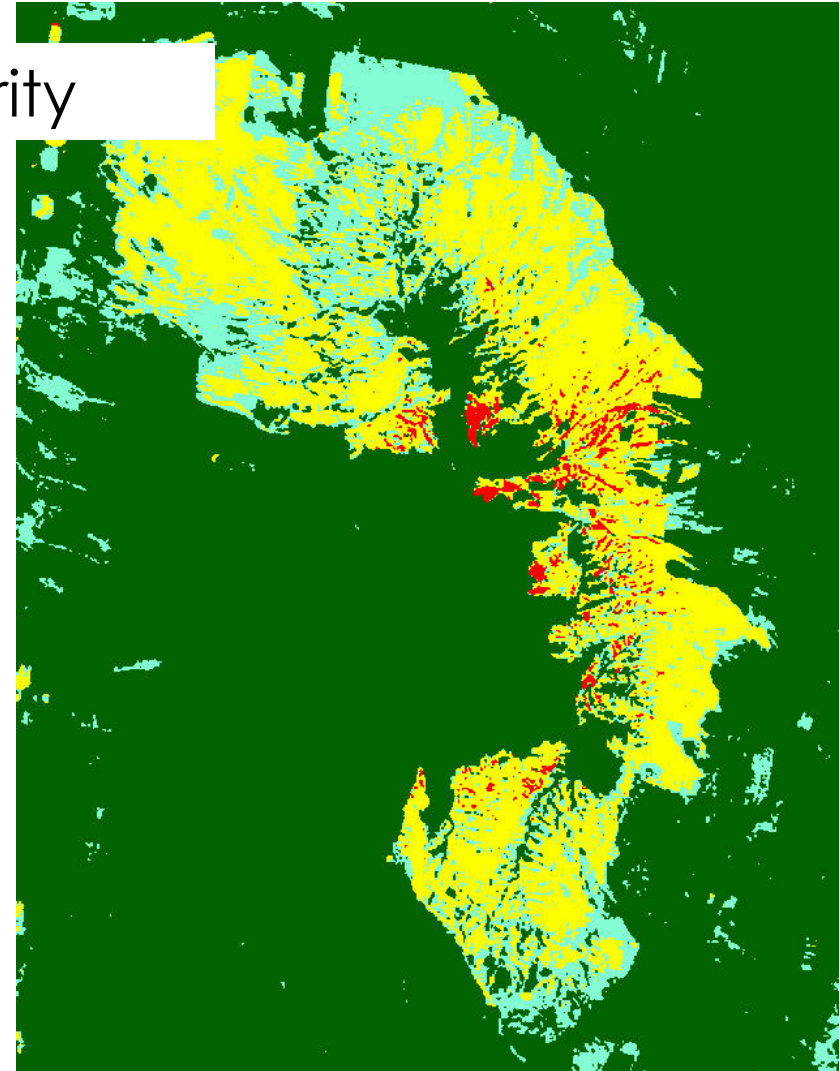


Satellite Perspective

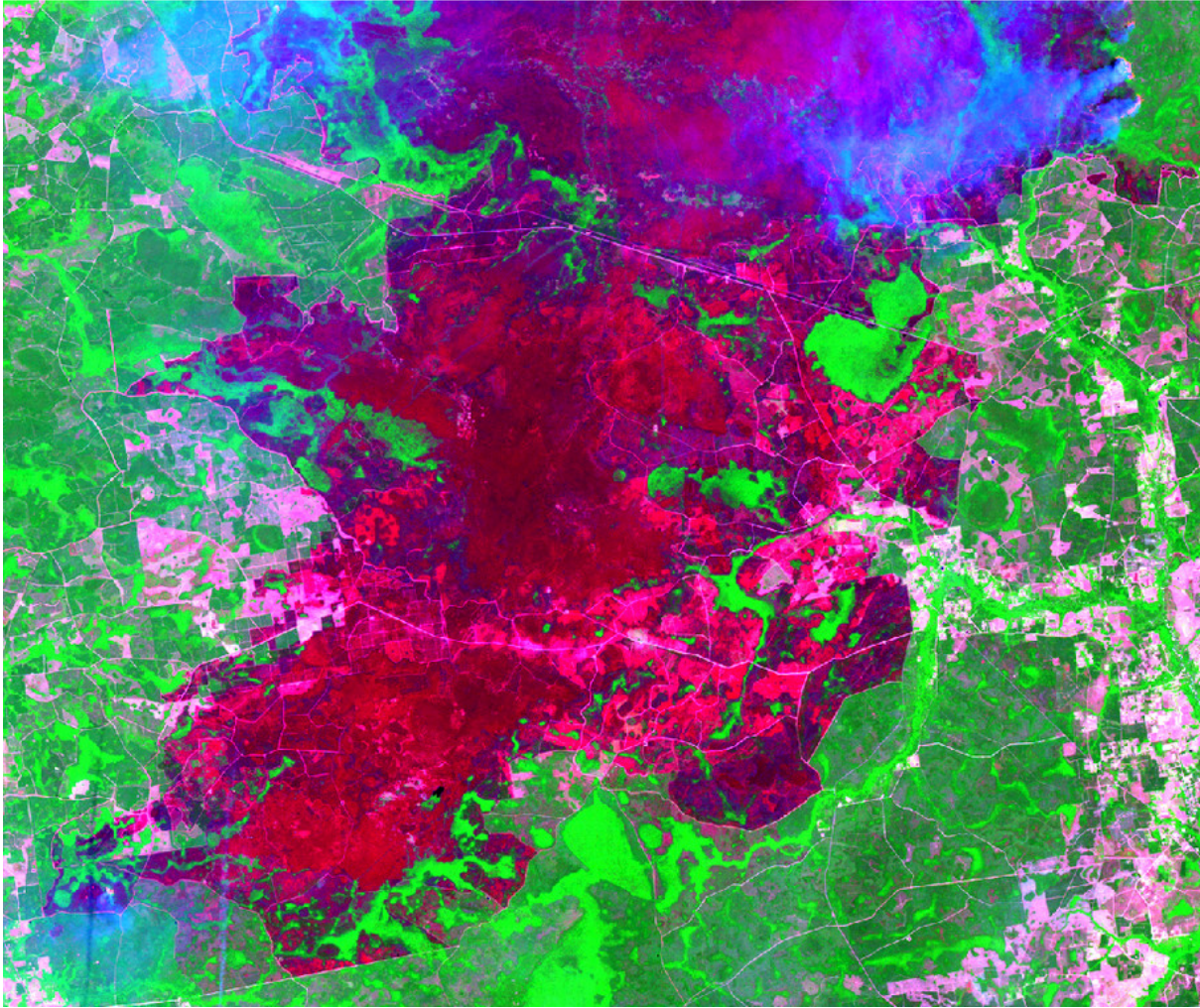
Imagery



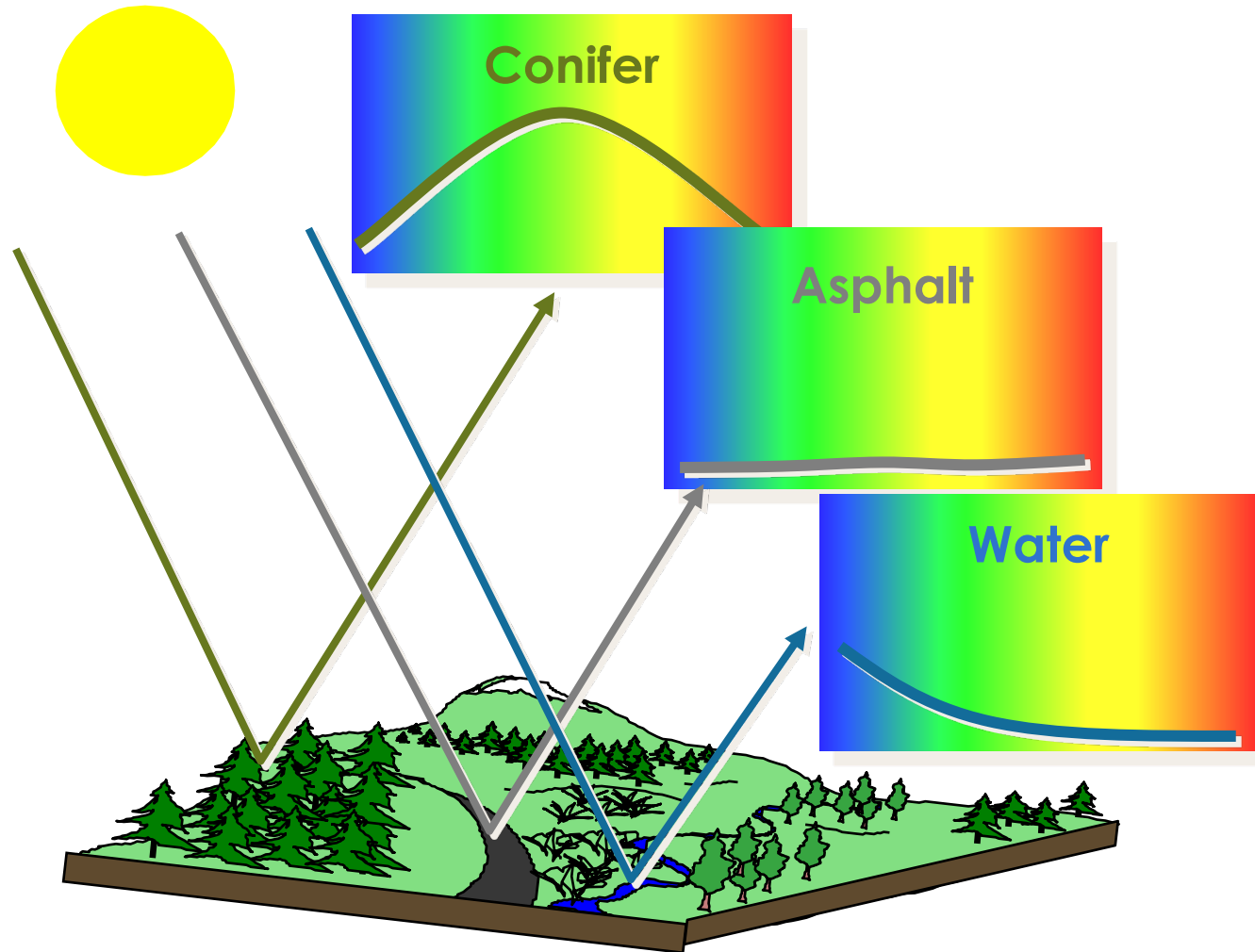
Severity



Connecting the Dots

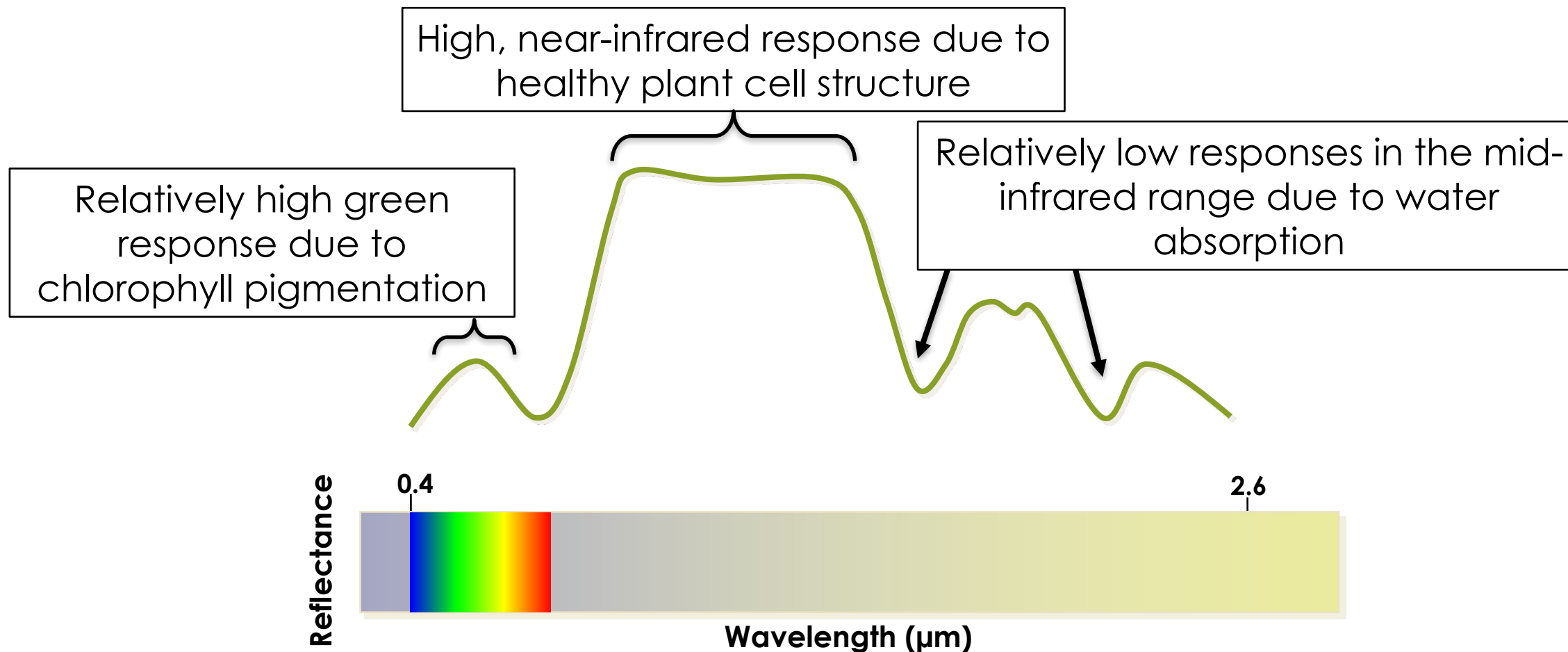


Remote Sensing and Electromagnetic Energy



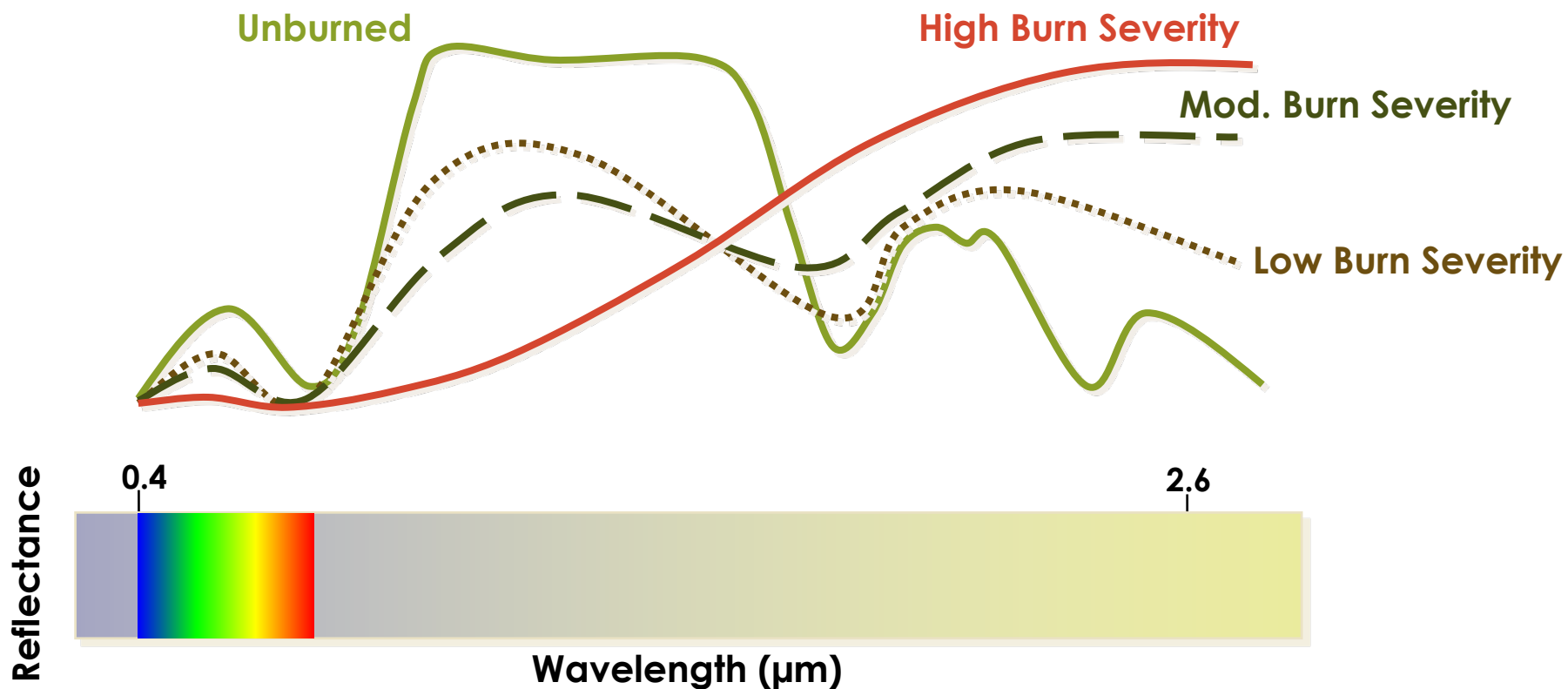
Response to Electromagnetic Energy

Spectral response curve of typical vegetation from 0.4 to 2.6 μm



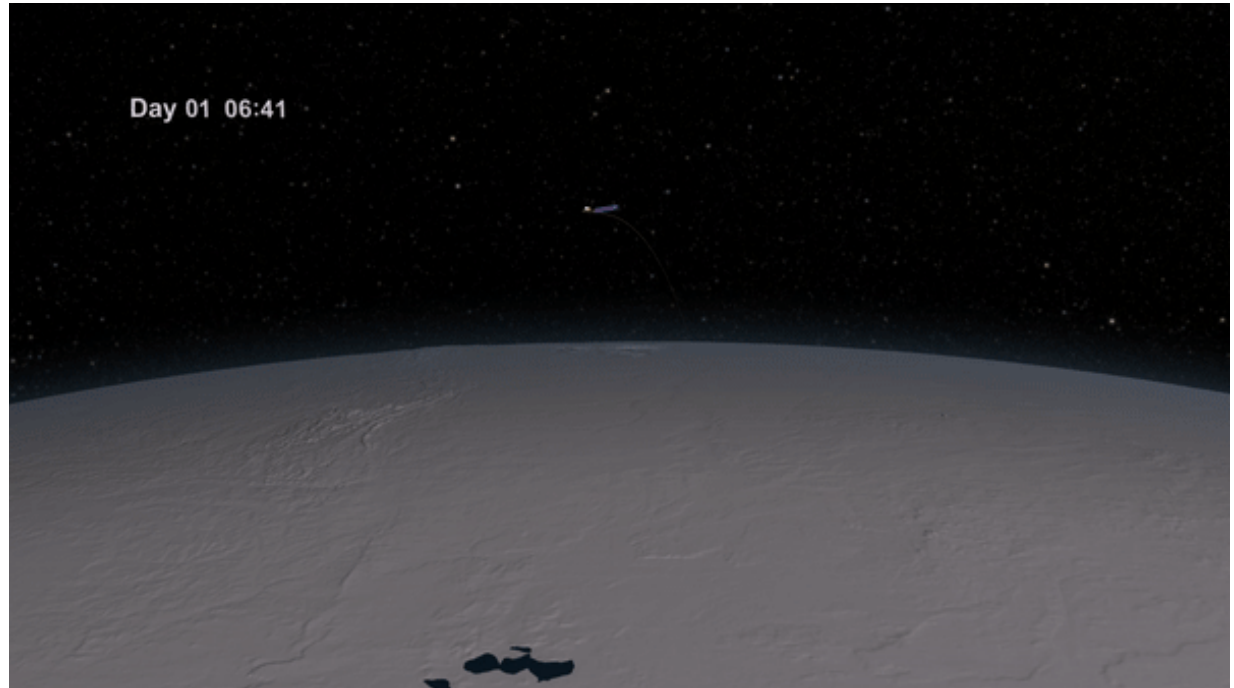
Healthy Vegetation vs. Burned Areas

Exploiting Spectral Response Curves



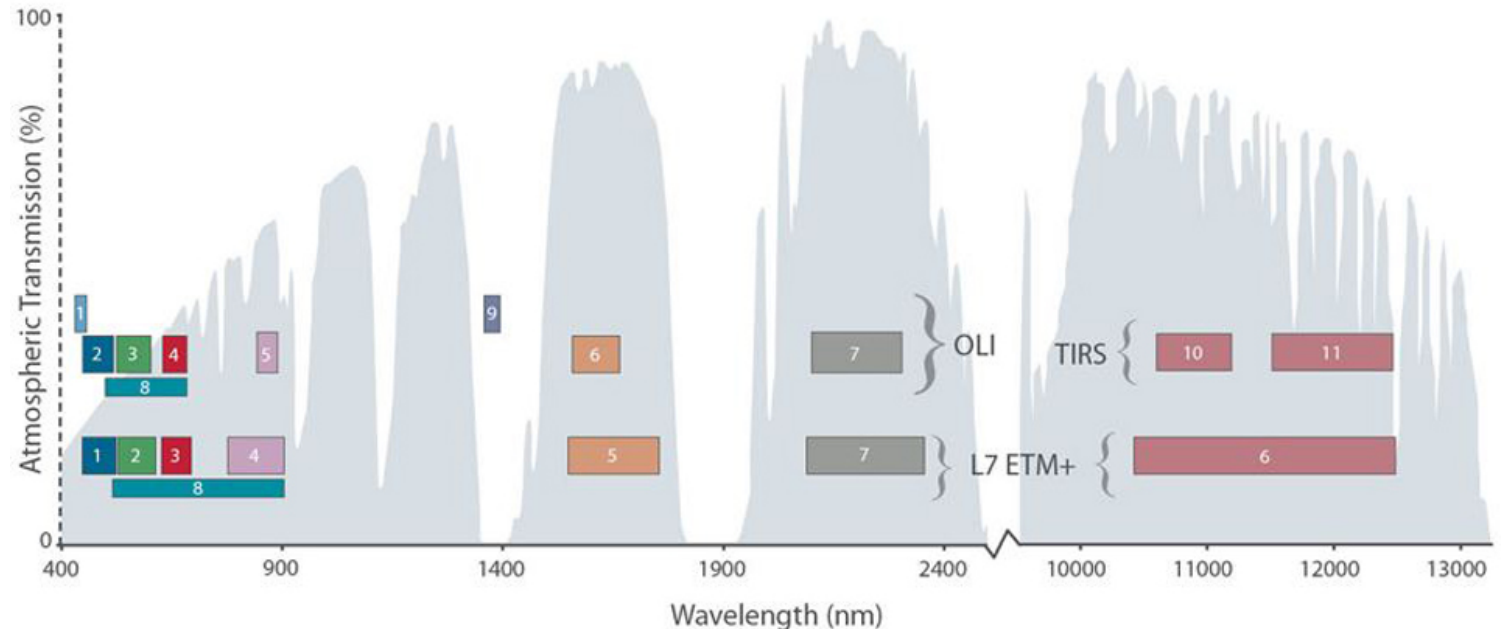
Important Satellite Sensor Properties

- 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*)

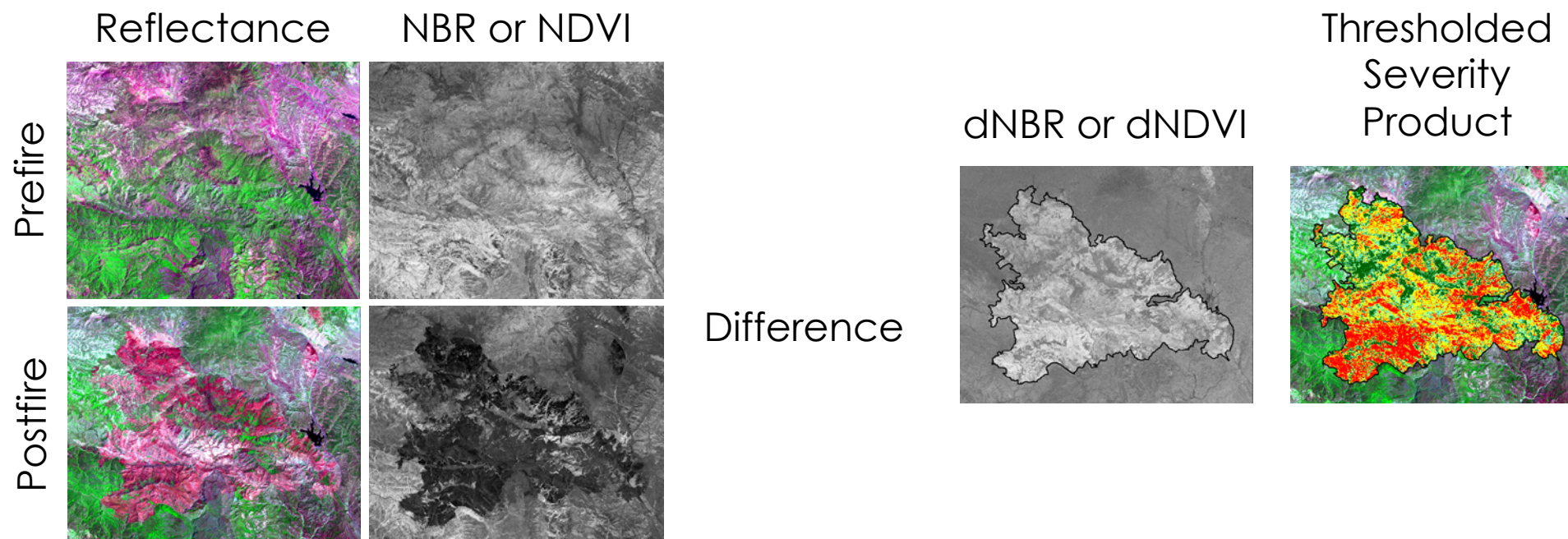
$$\text{NBR} = (\text{NIR} - \text{SWIR}) / (\text{NIR} + \text{SWIR})$$

$$\text{dNBR} = \text{Prefire NBR} - \text{Postfire NBR}$$

NDVI (*Normalized Difference Vegetation Index*)

$$\text{NDVI} = (\text{NIR} - \text{RED}) / (\text{NIR} + \text{RED})$$

$$\text{dNDVI} = \text{Prefire NDVI} - \text{Postfire NDVI}$$



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

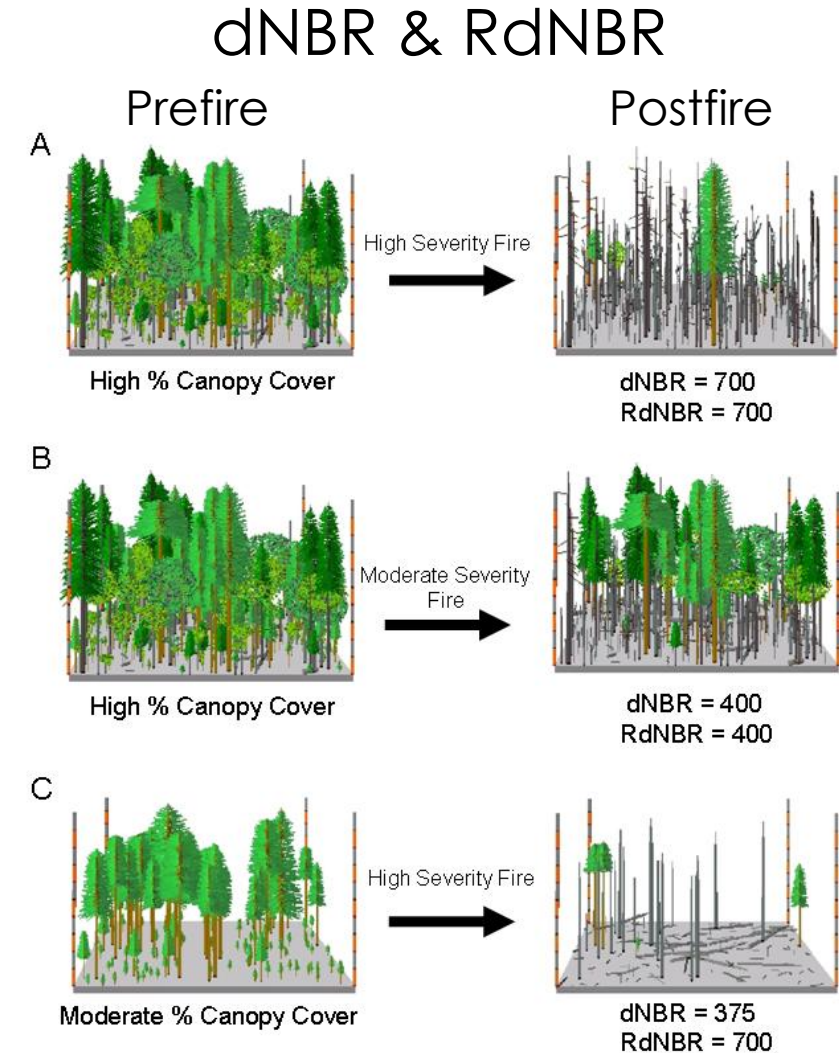


Image Credit: Remote Sensing of the Environment; 109, 66-80 (July 12, 2007)



Image Pairing Considerations

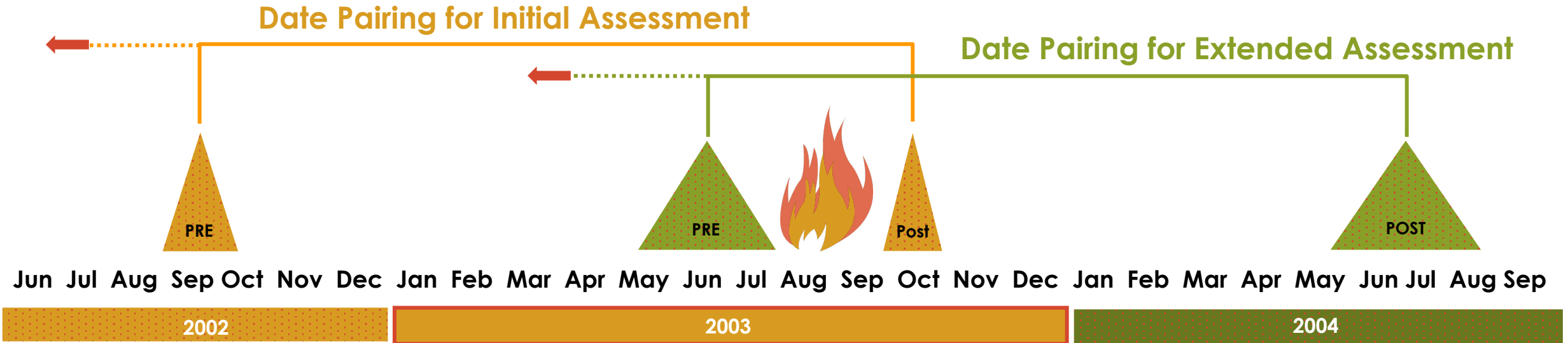
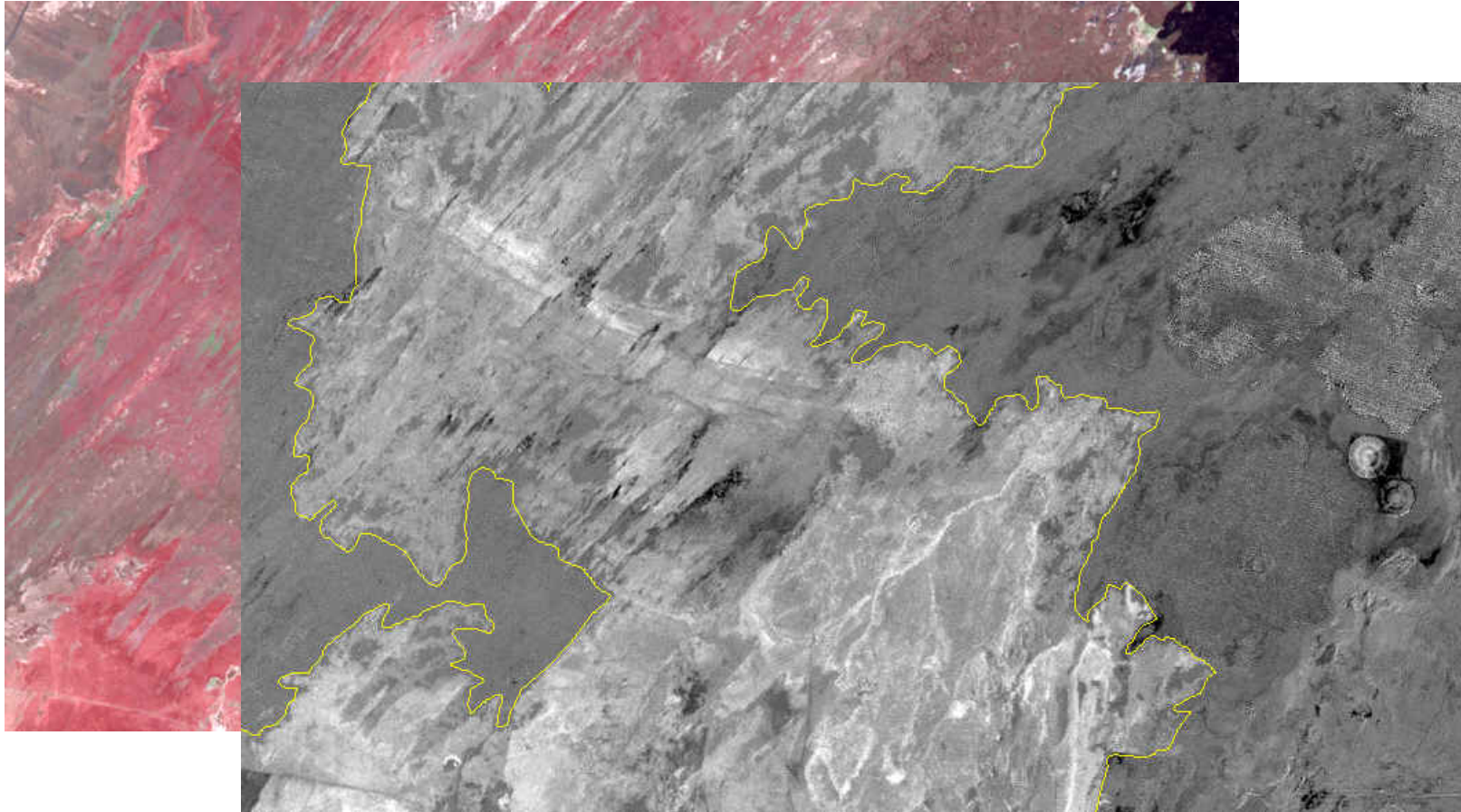


Image Credit: Carl Key, 2006



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



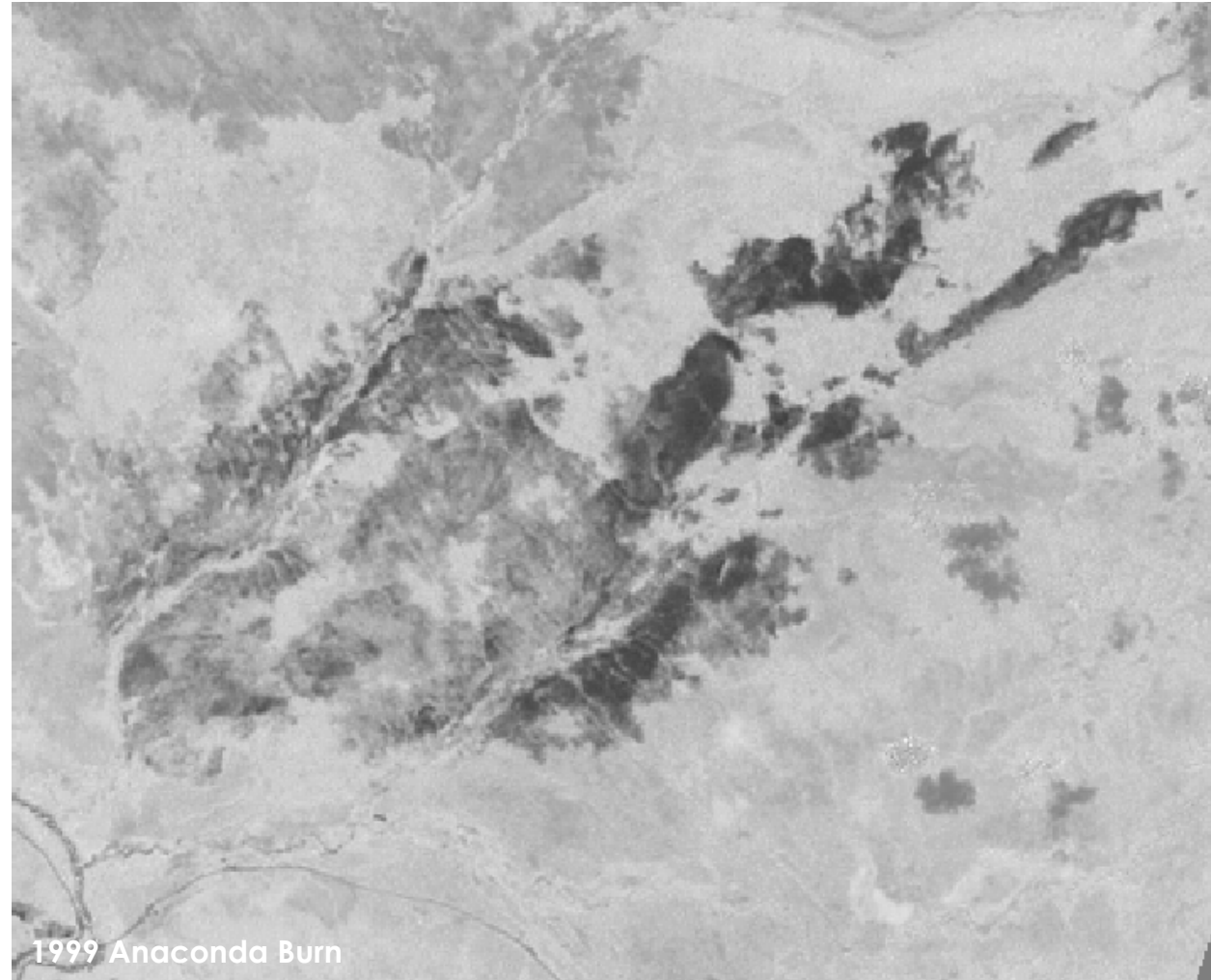
Image Credit: Carl Key



Landsat Scene Pairs (dNBR) Should...

Pre-Fire NBR
07/10/1999

Post-Fire NBR
06/25/2000



1999 Anaconda Burn

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

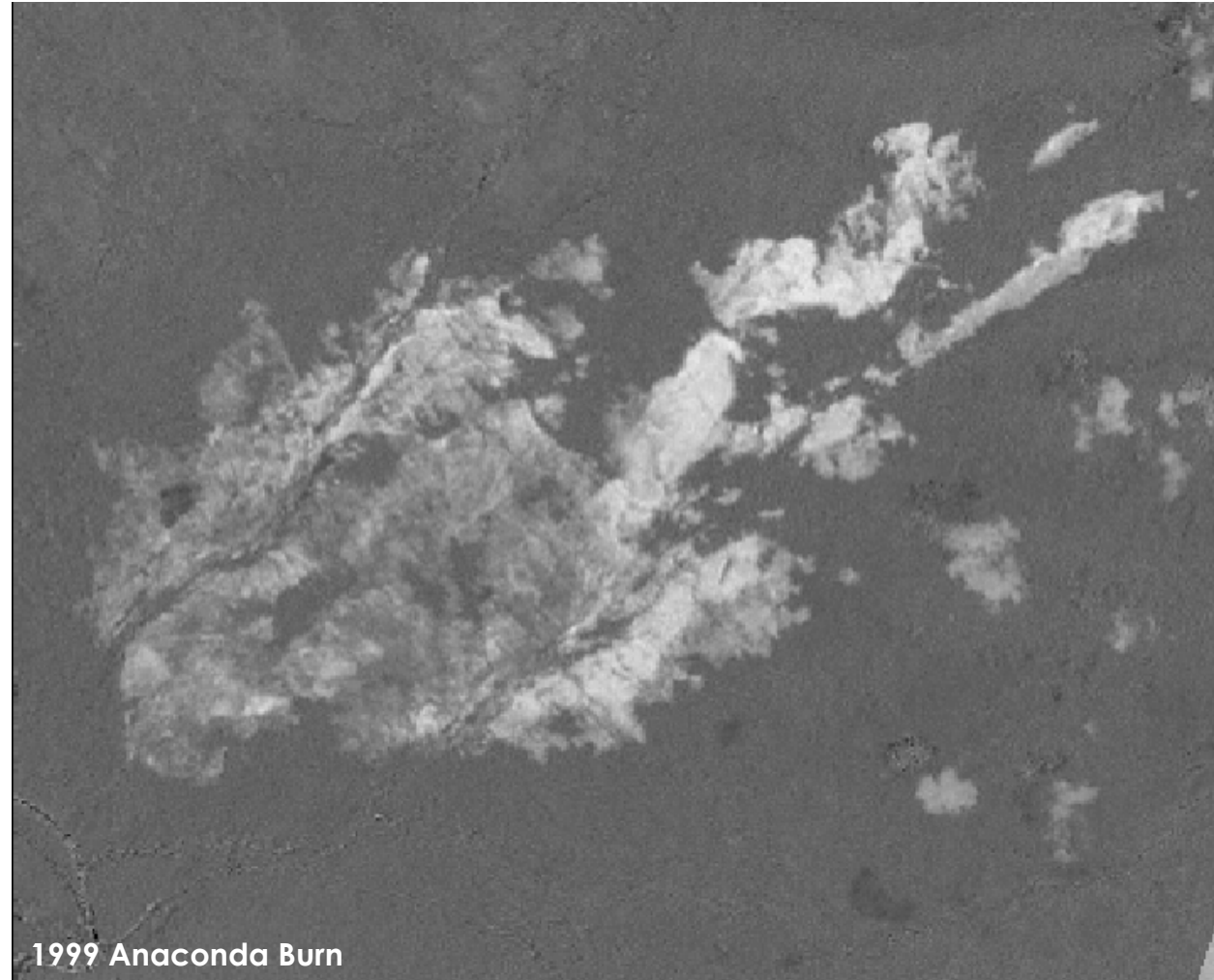
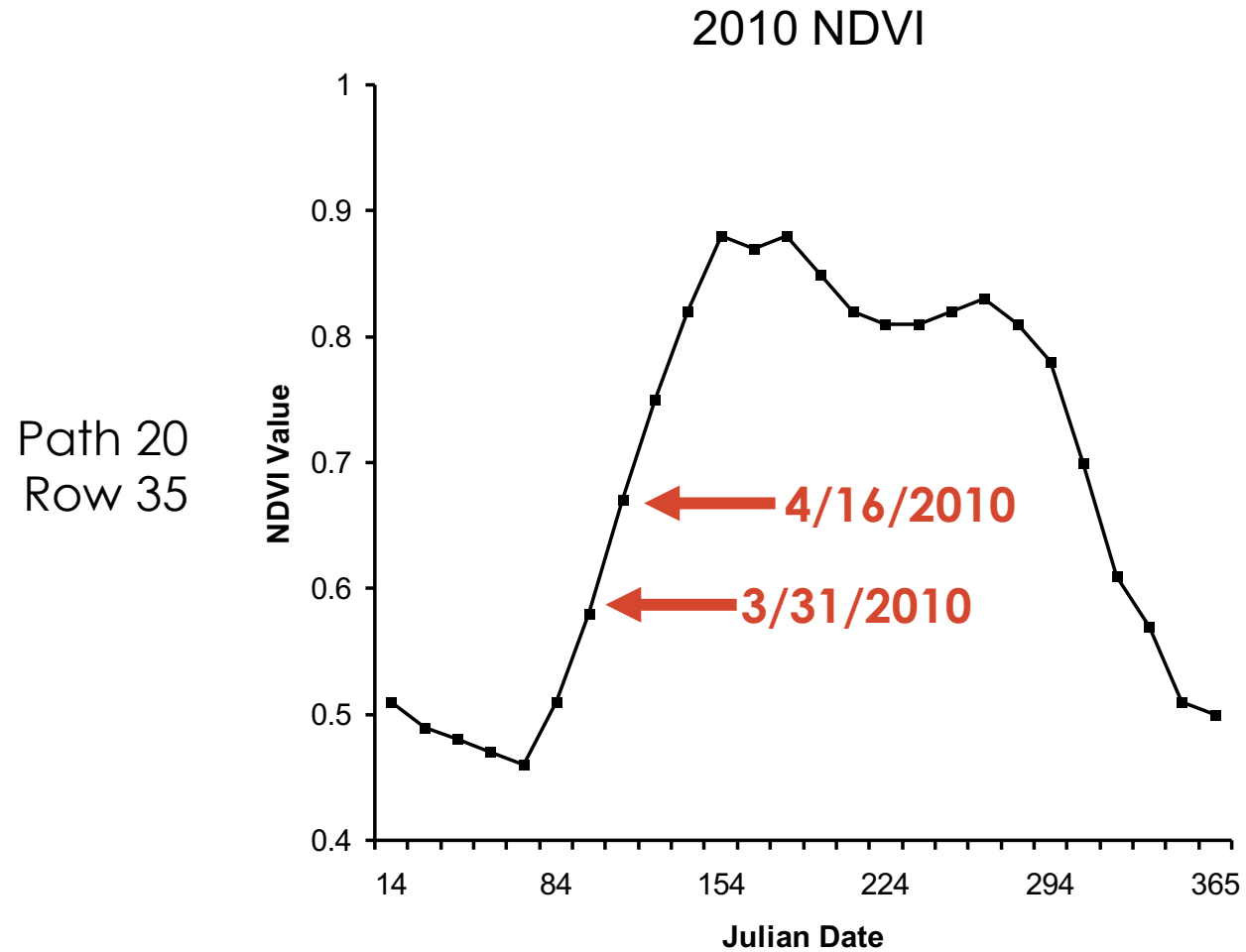


Image Credit: Carl Key

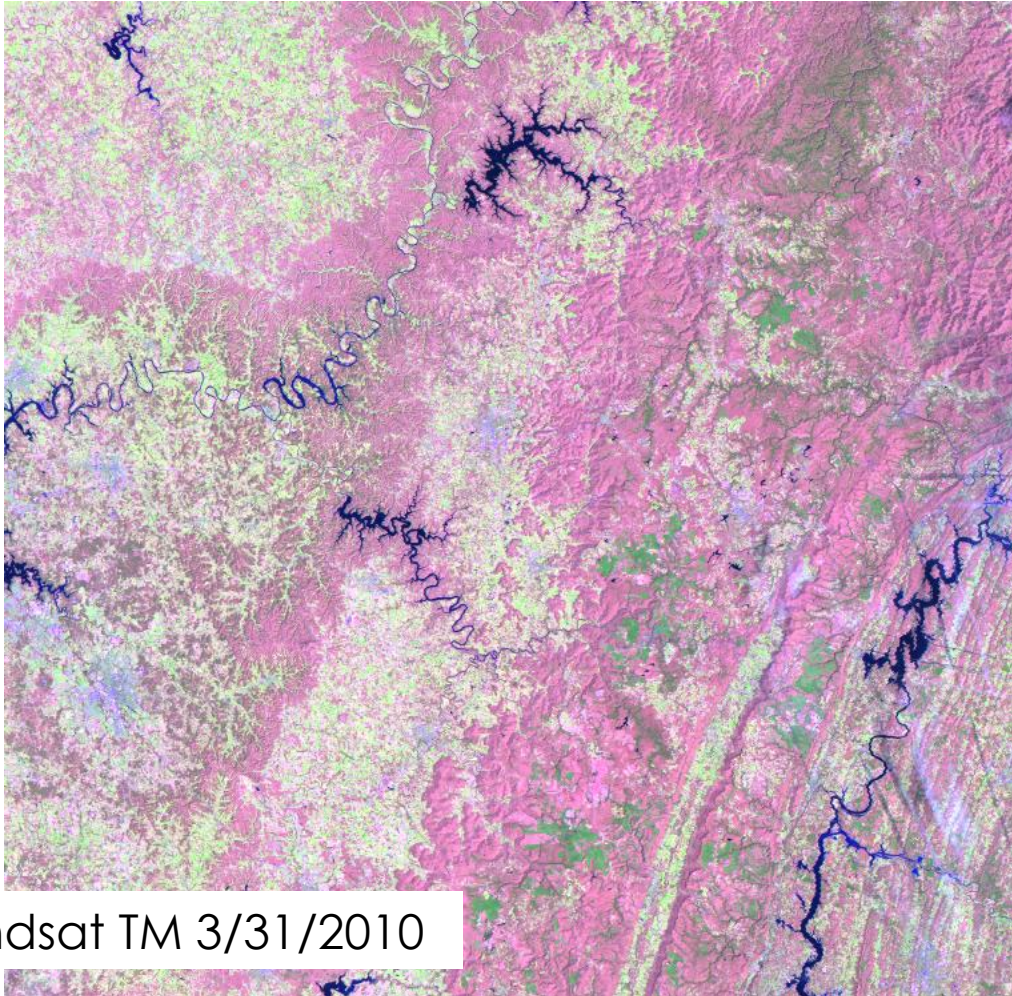


...Have Limited Between-Scene Seasonal Variation

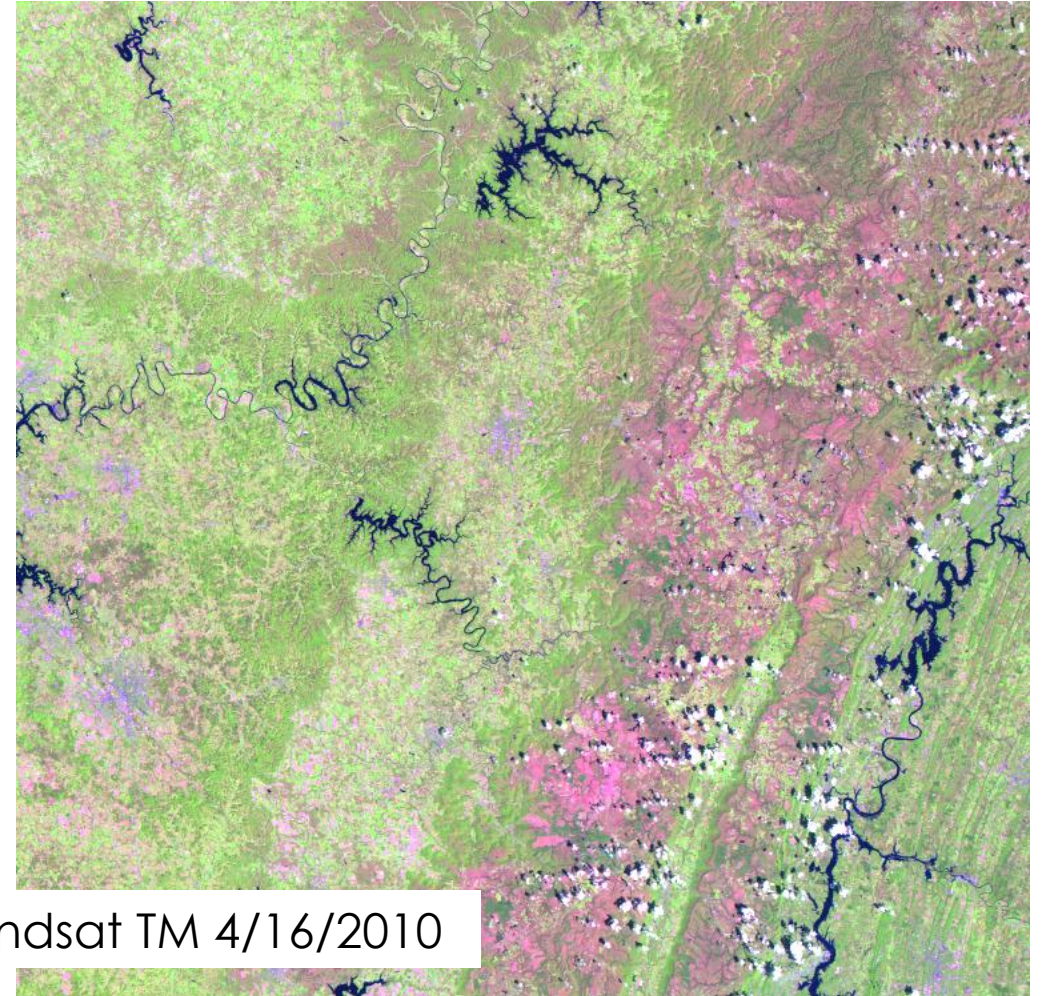


...Have Limited Between-Scene Seasonal Variation

Path 20 Row 35



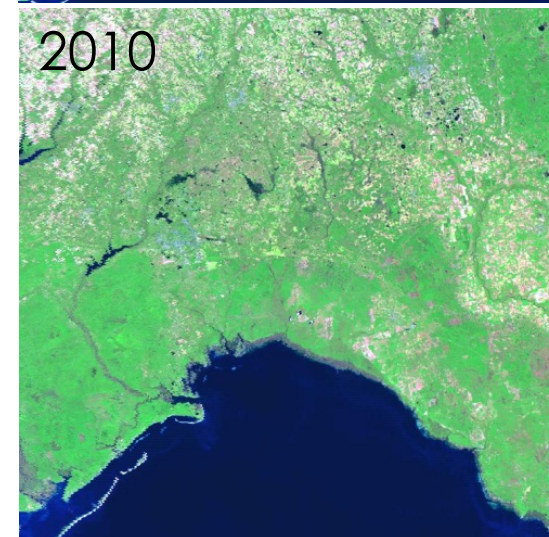
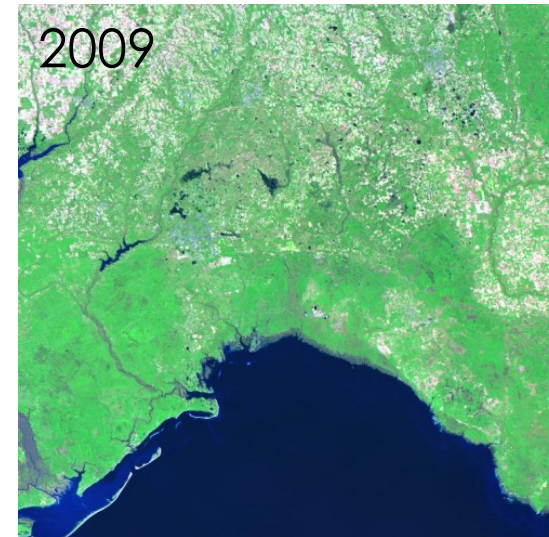
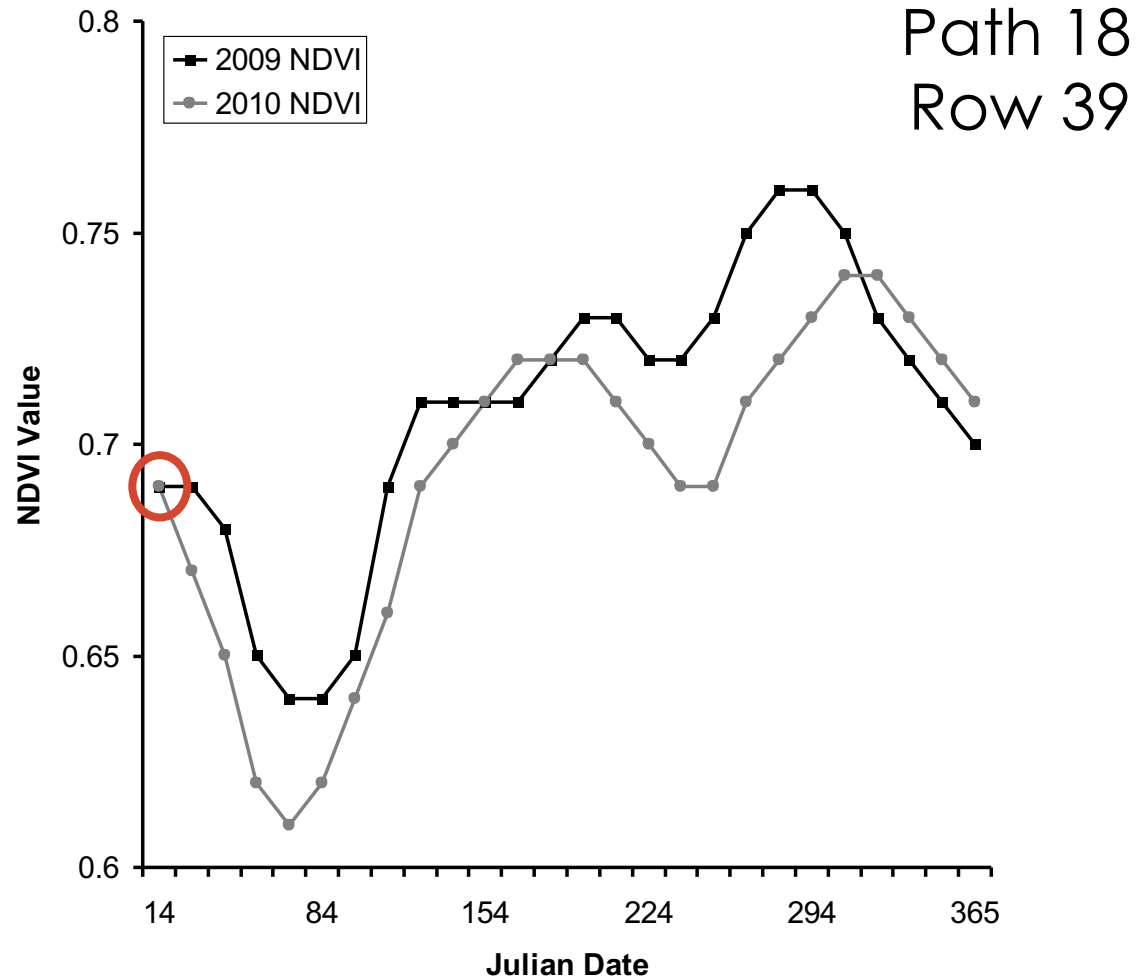
Landsat TM 3/31/2010



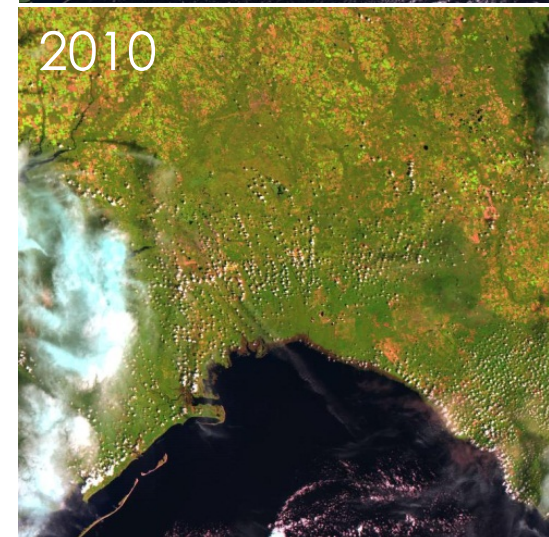
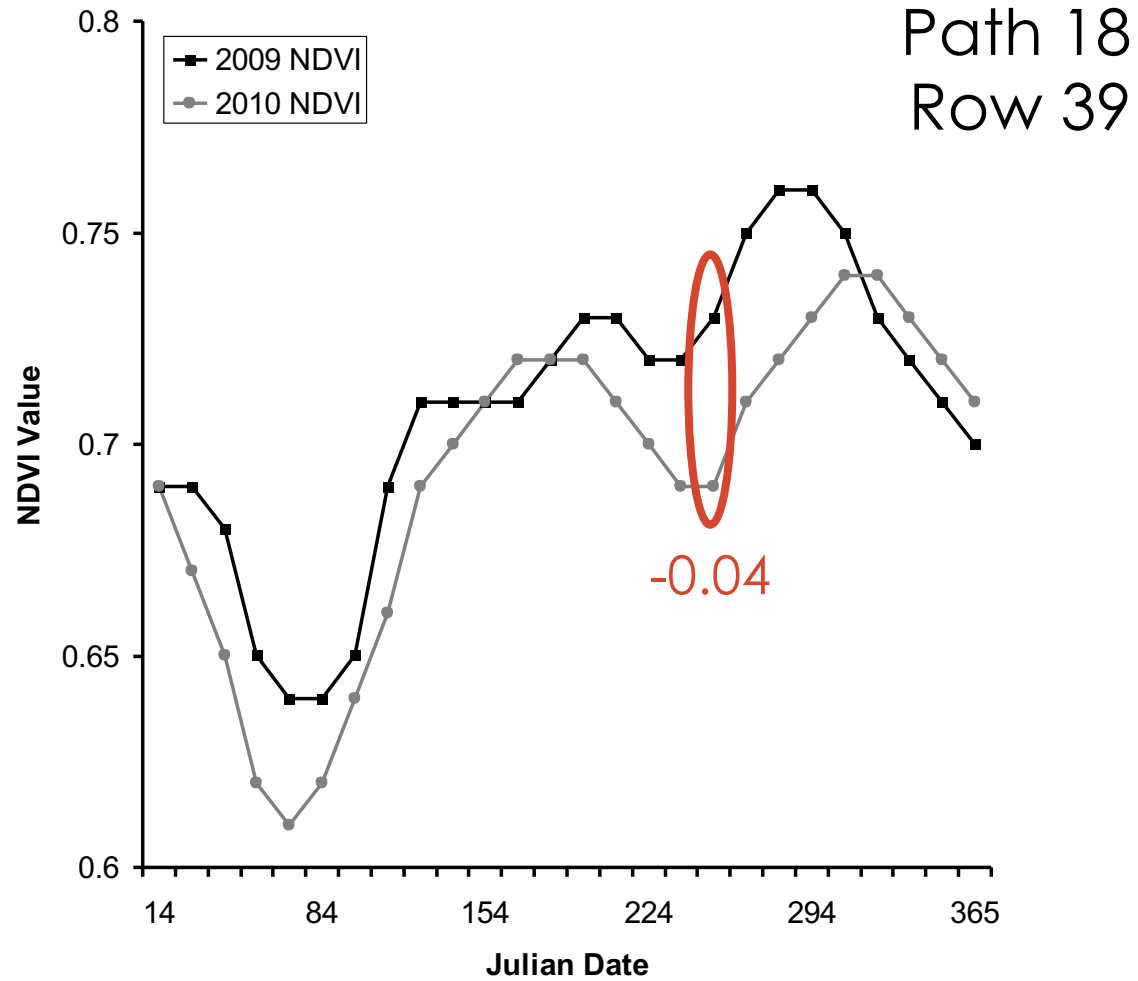
Landsat TM 4/16/2010



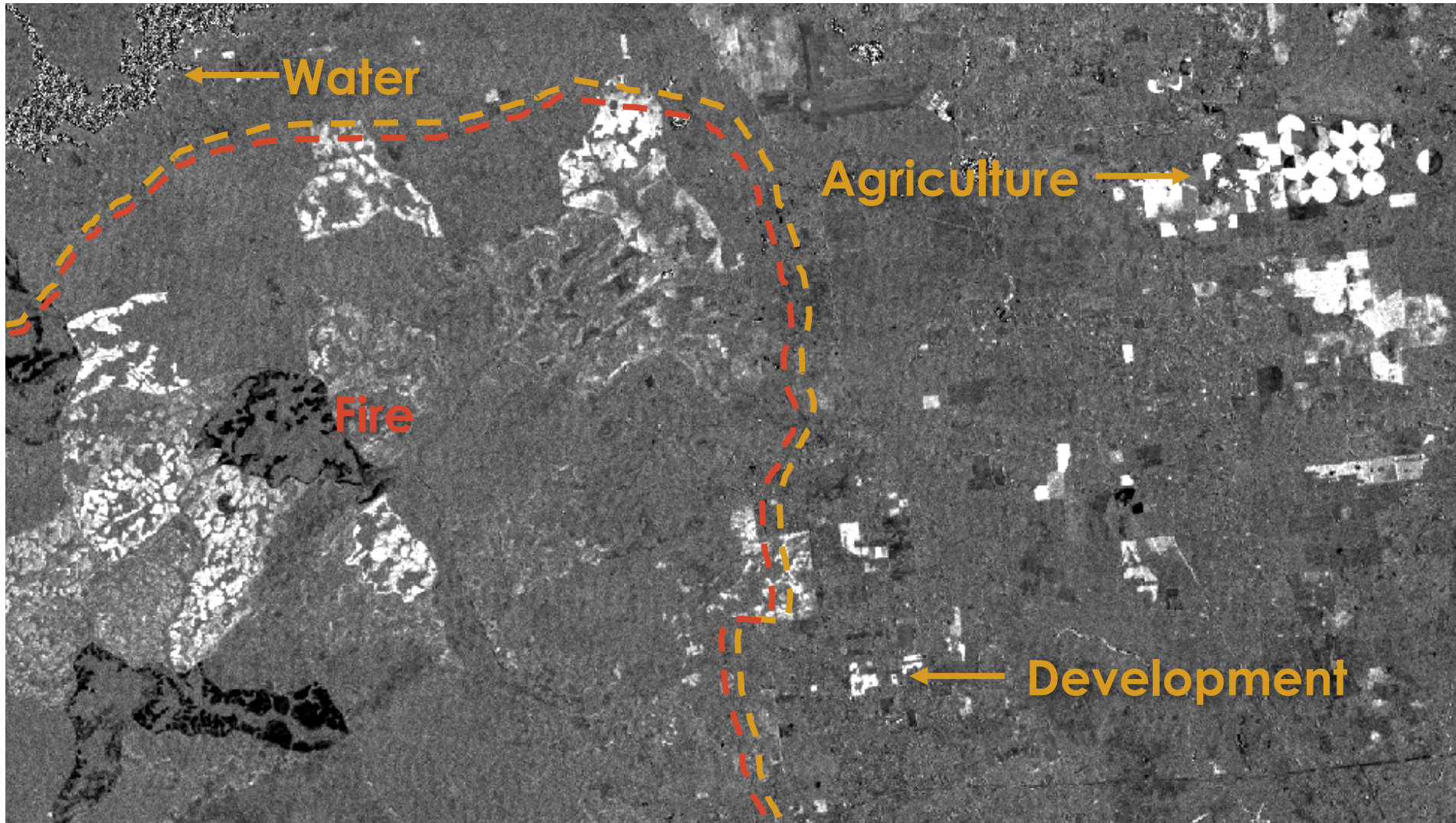
...Only Exhibit Small Between-Scene Changes in Greenness



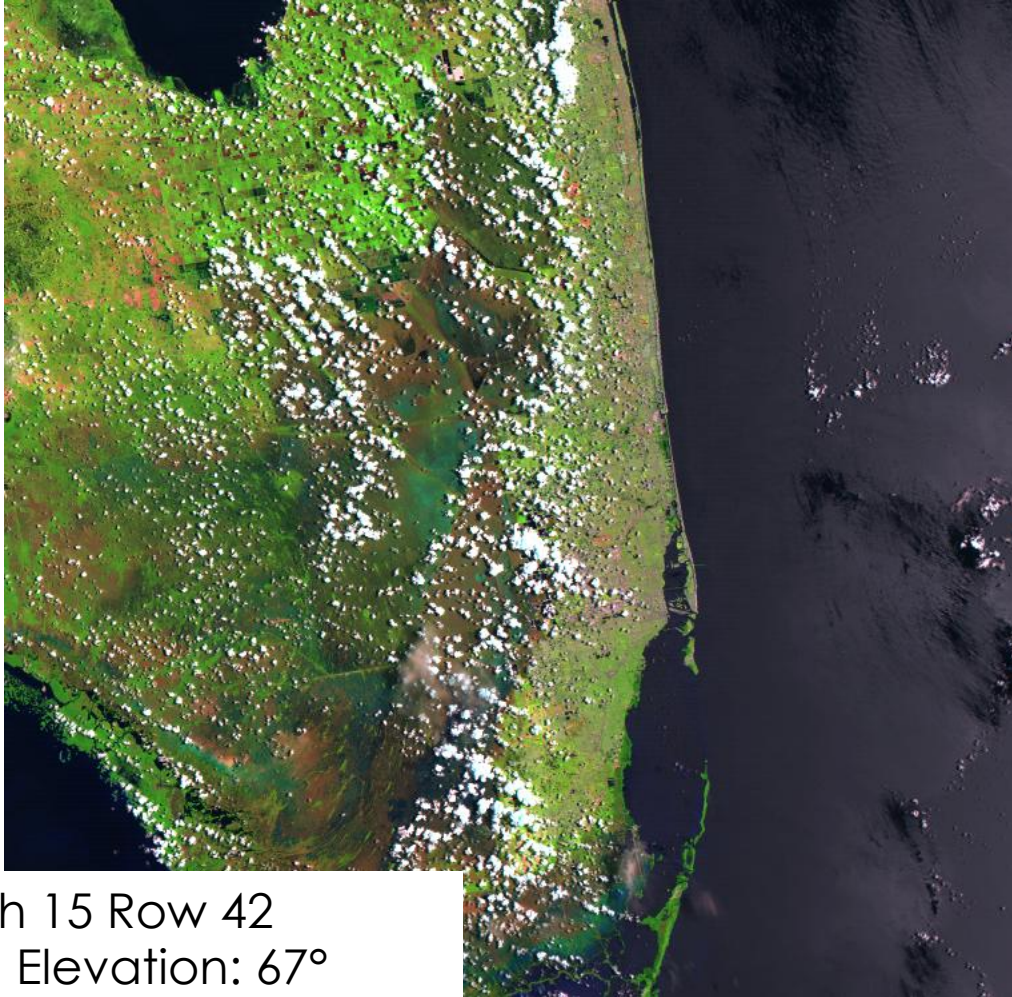
...Only Exhibit Small Between-Scene Changes in Greenness



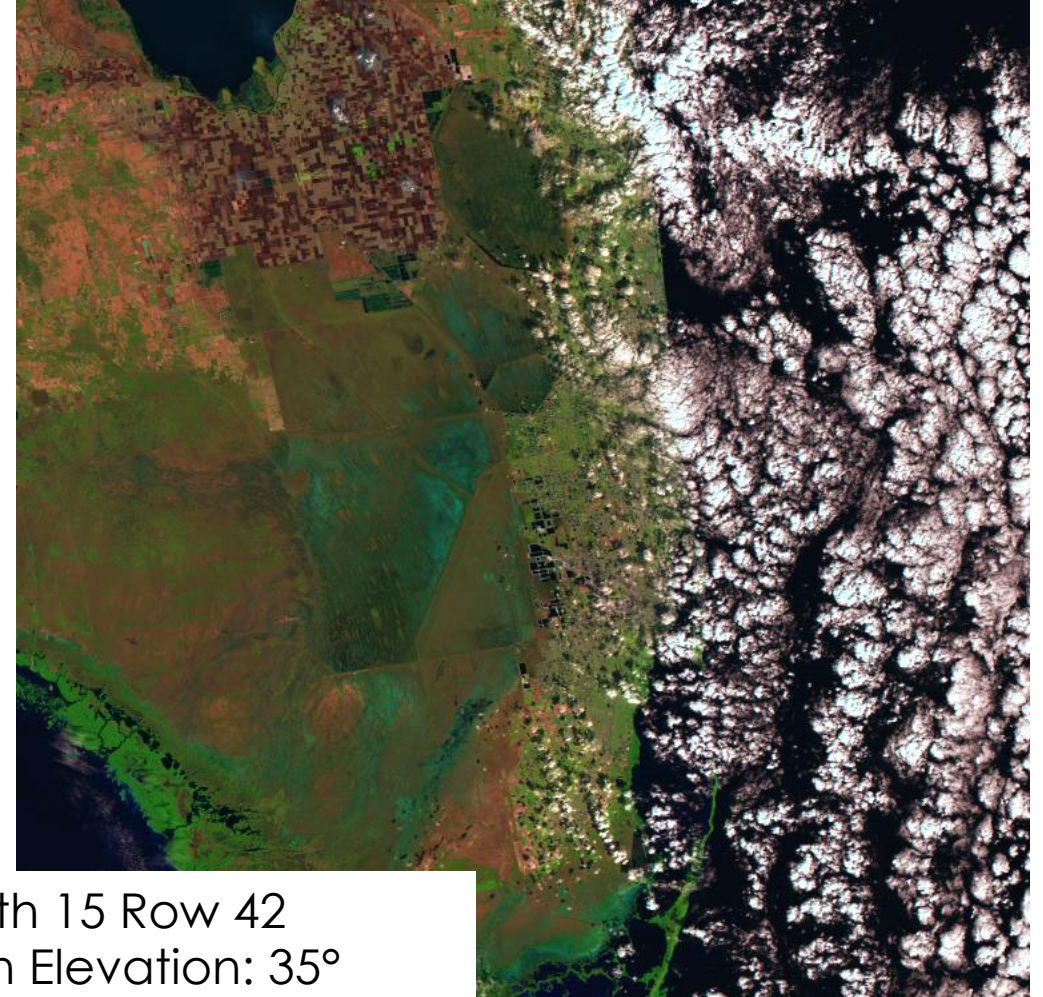
..Not Exhibit Between-Scene Landcover Changes



...Have Similar Reflectance Brightness



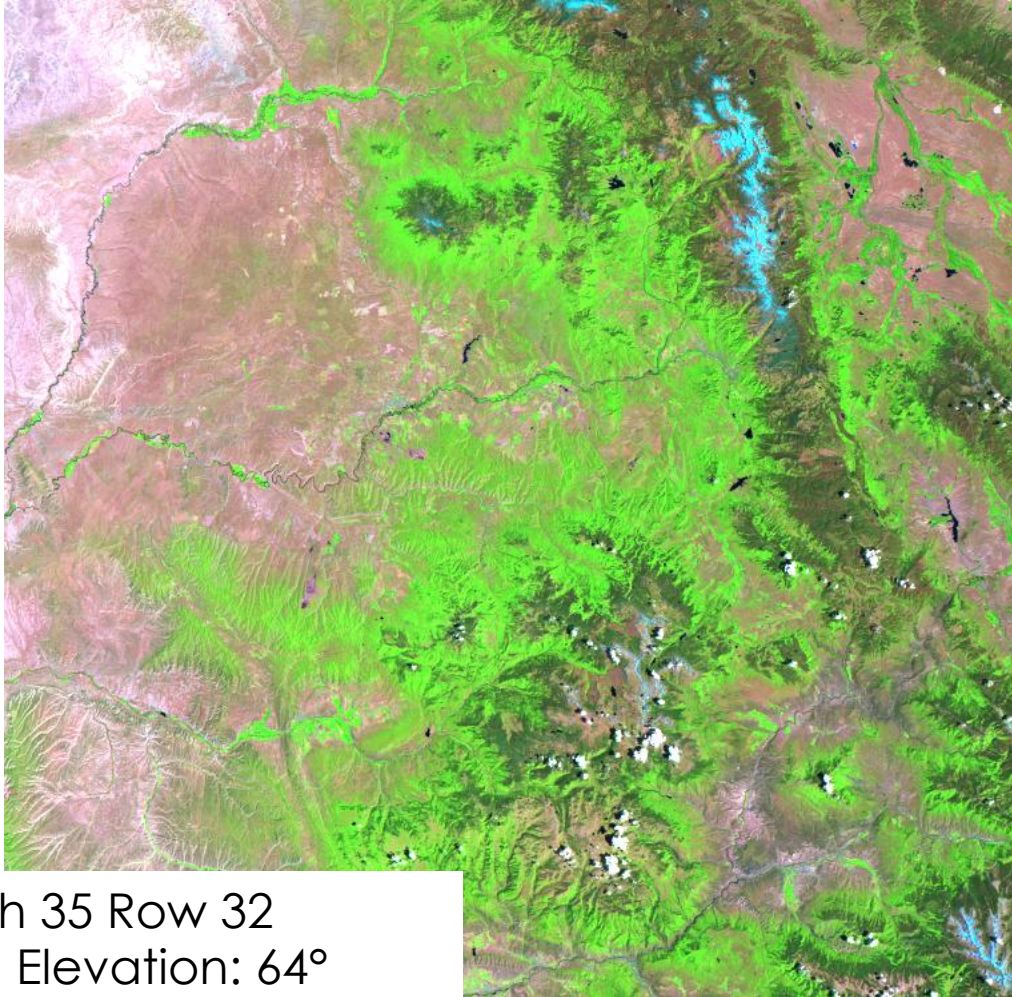
Path 15 Row 42
Sun Elevation: 67°
Sun Azimuth: 91°



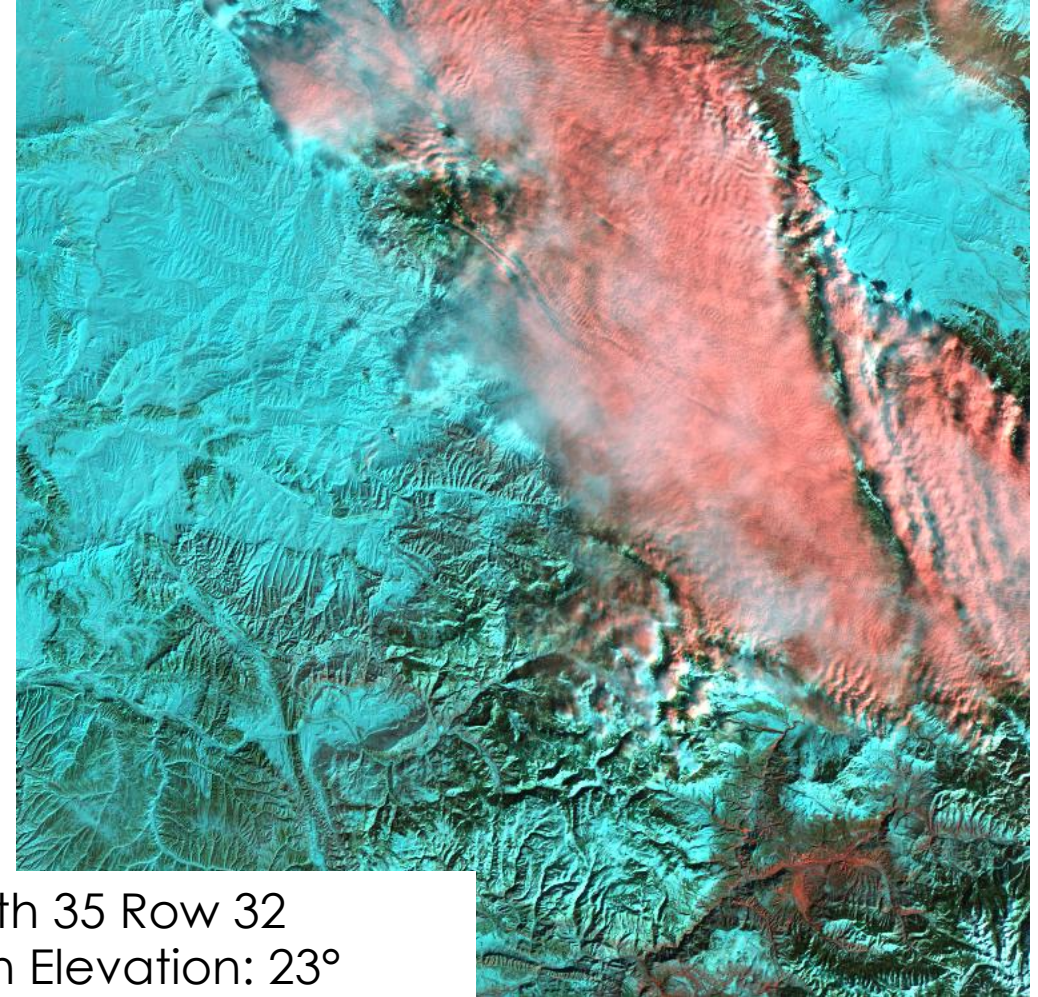
Path 15 Row 42
Sun Elevation: 35°
Sun Azimuth: 151°



...Have Similar Reflectance Brightness



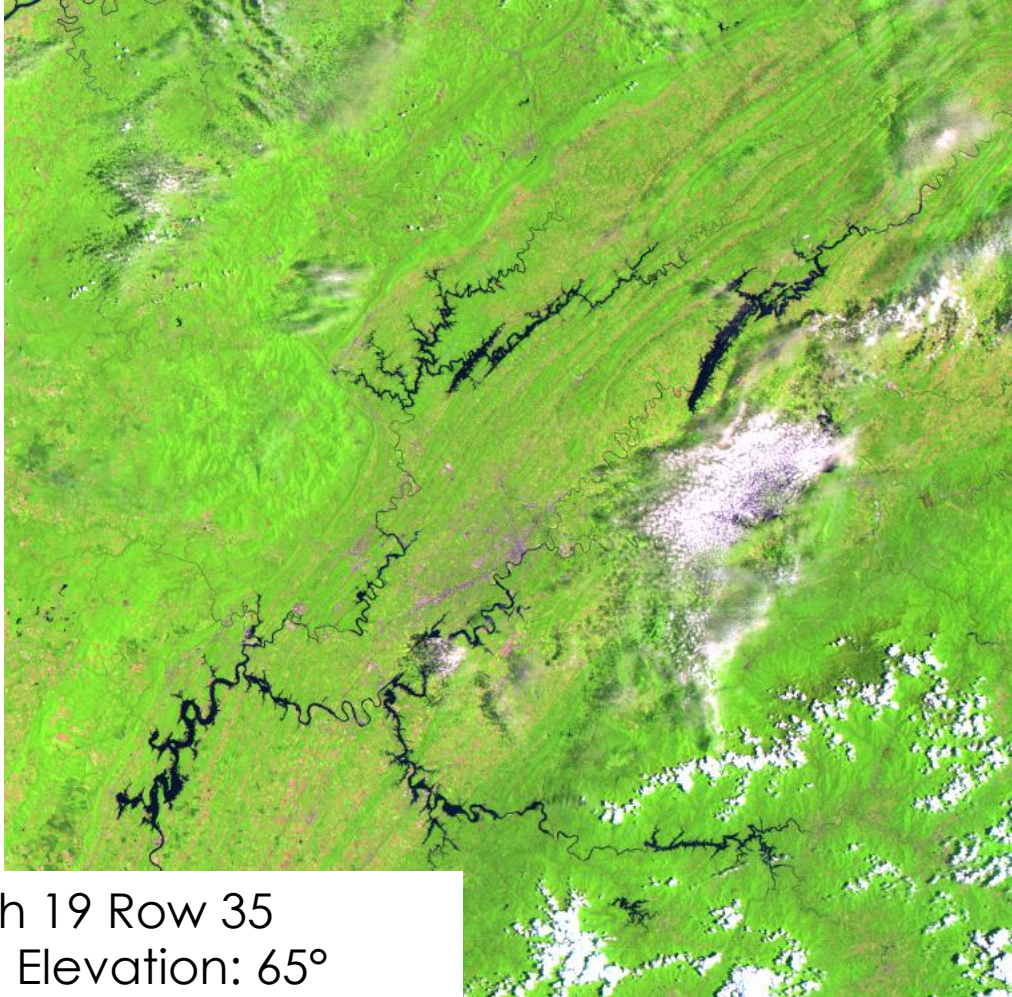
Path 35 Row 32
Sun Elevation: 64°
Sun Azimuth: 124°



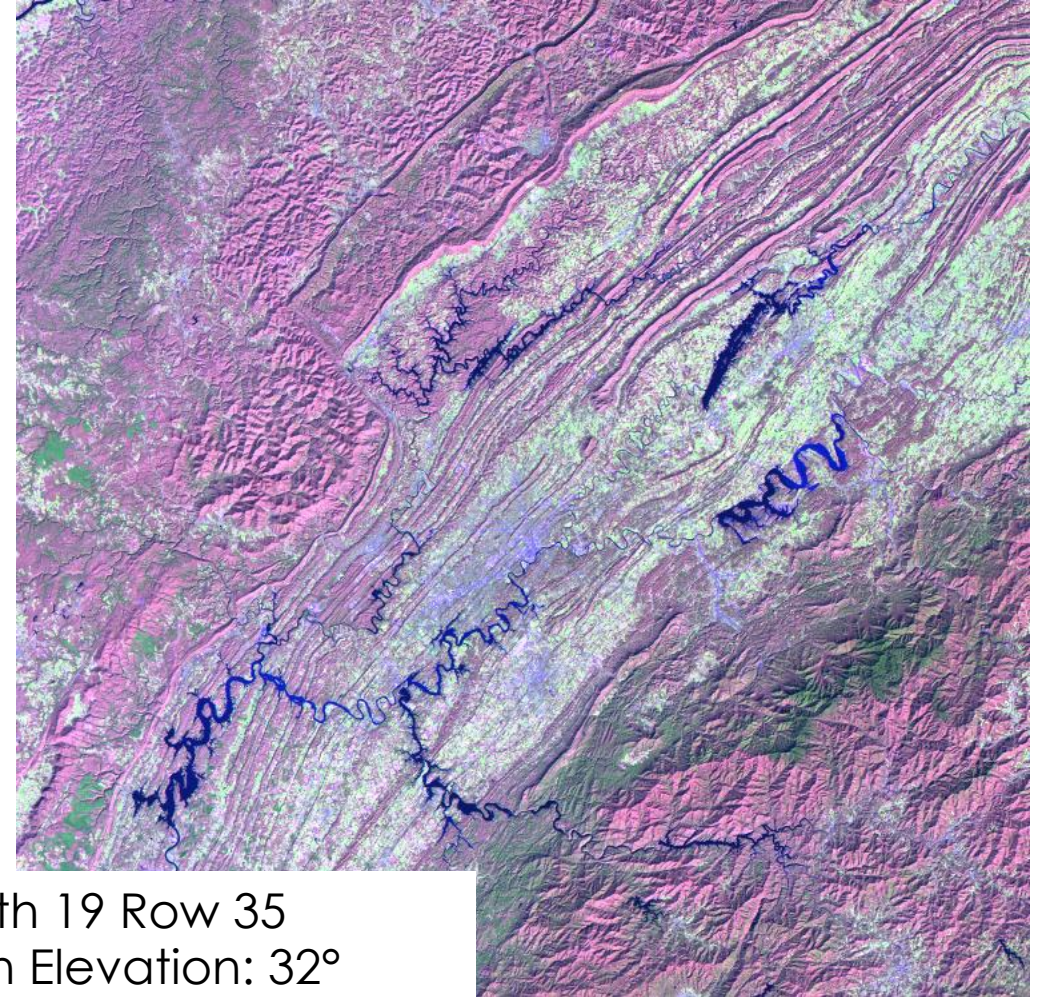
Path 35 Row 32
Sun Elevation: 23°
Sun Azimuth: 156°



...Have Similar Reflectance Brightness



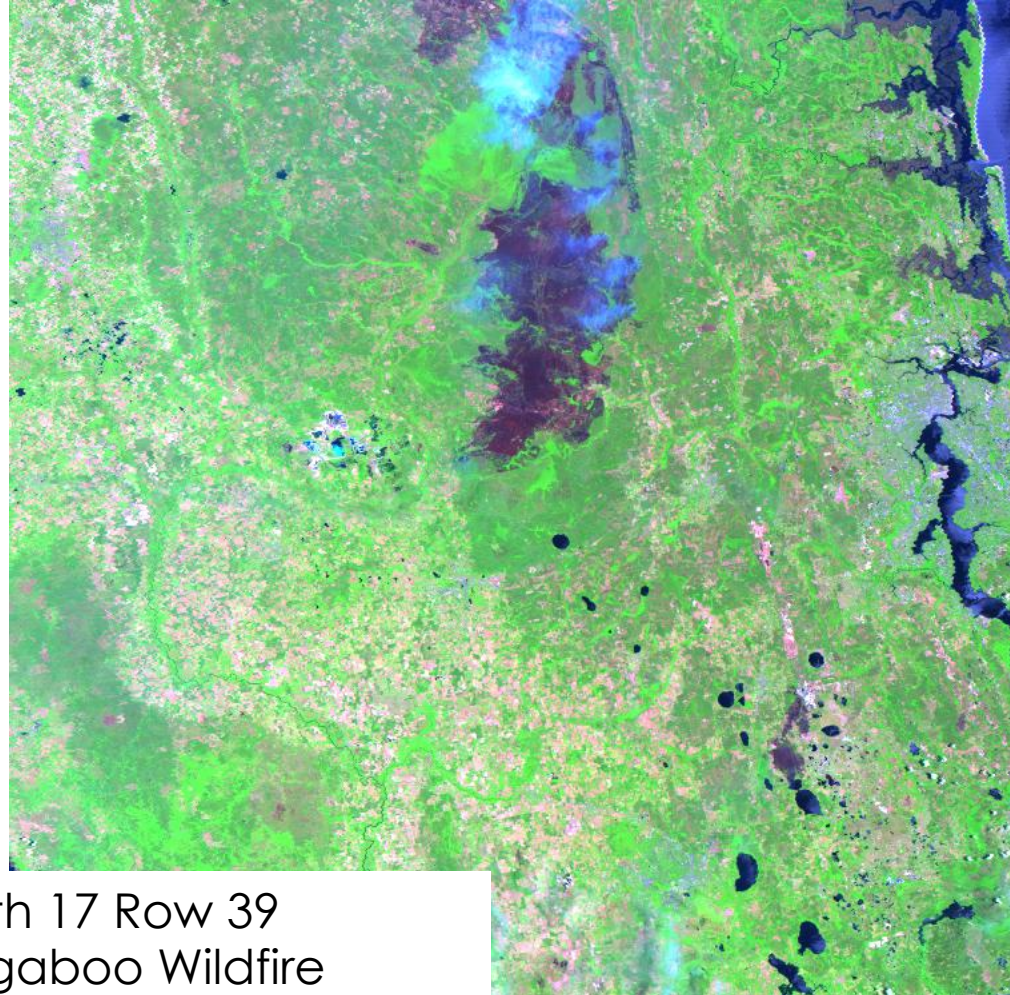
Path 19 Row 35
Sun Elevation: 65°
Sun Azimuth: 114°



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



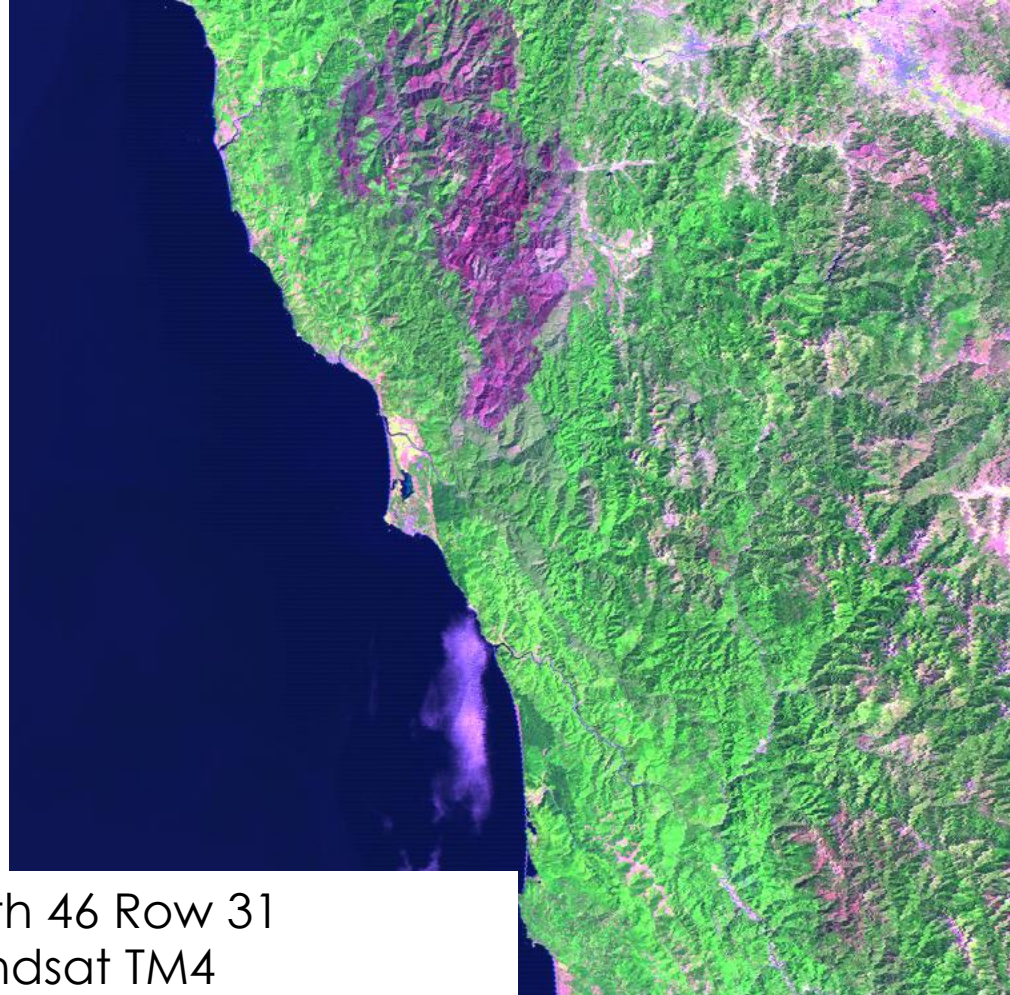
Postfire and Prefire Landsat Scenes Should...



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



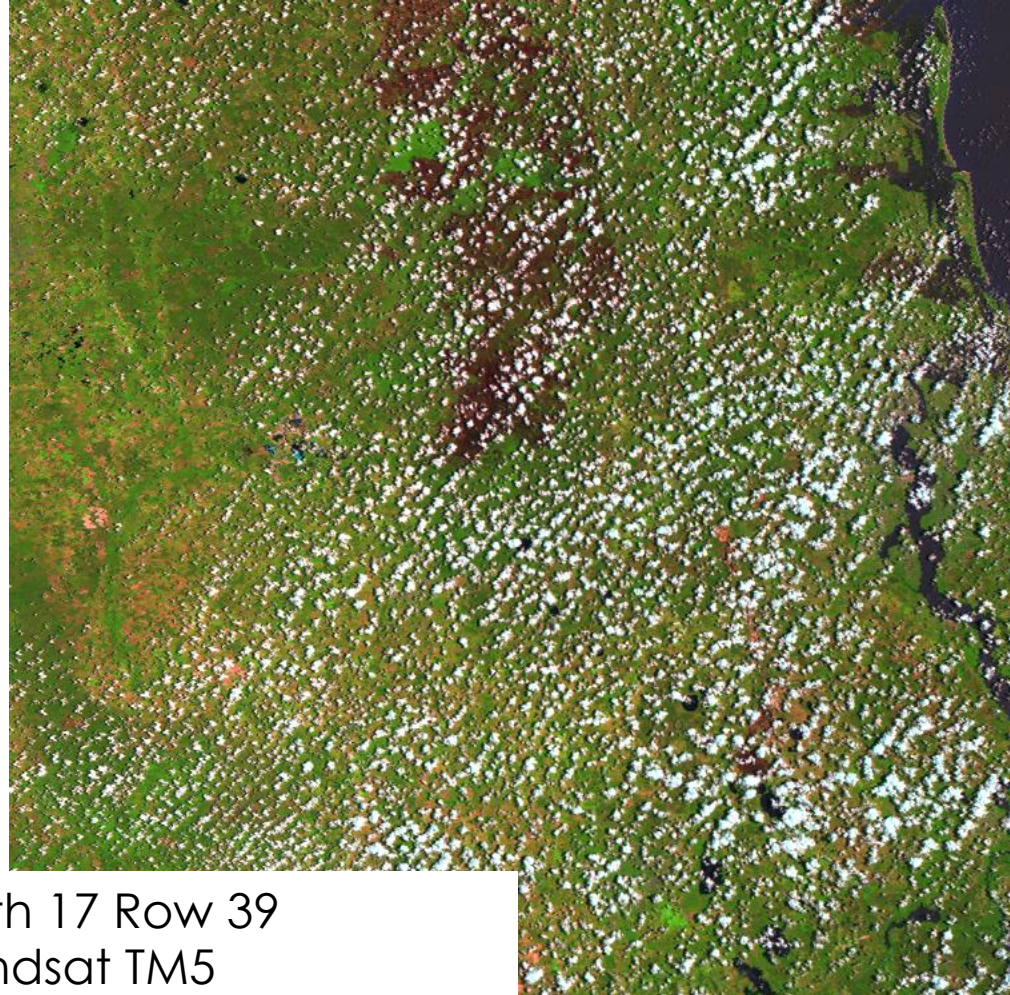
...Be Cloud Free



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



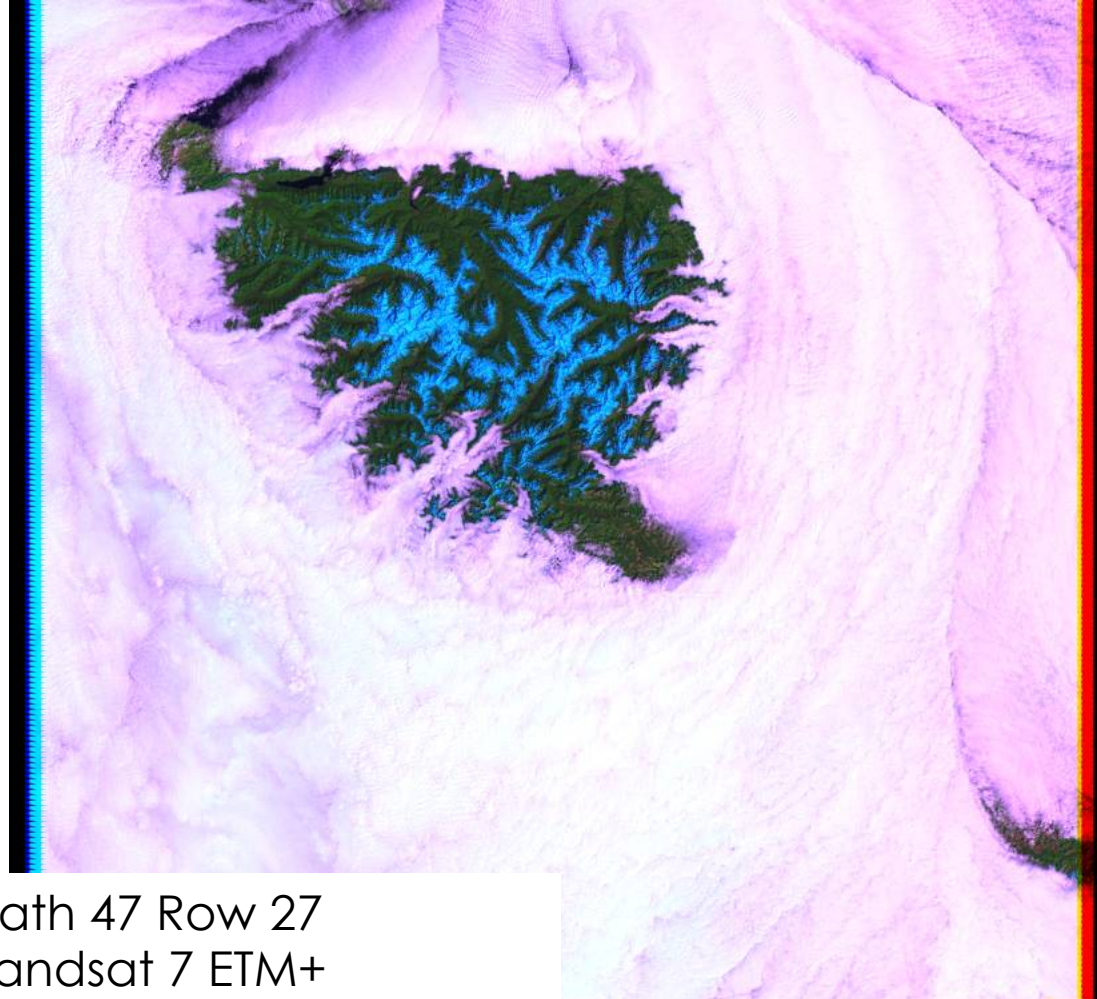
...Be Cloud Free



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



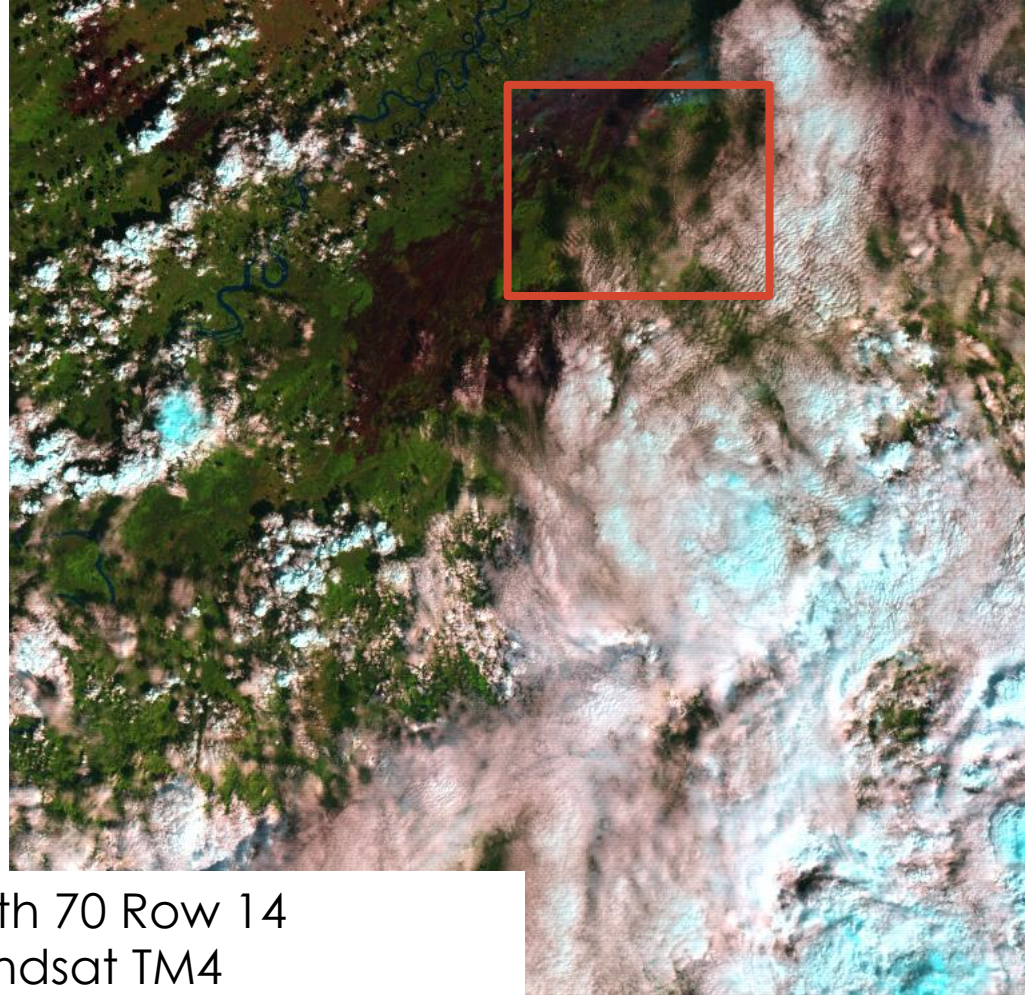
...Be Cloud Free



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



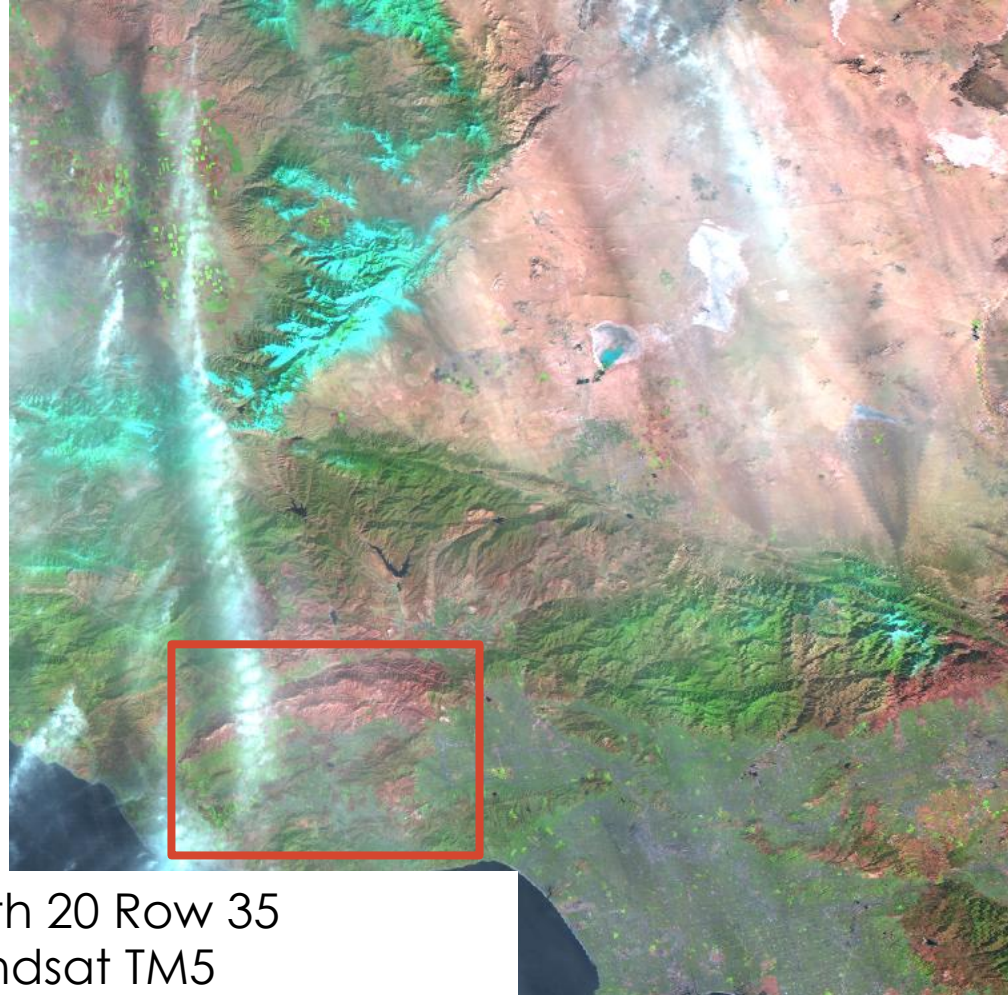
...Be Cloud Free



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



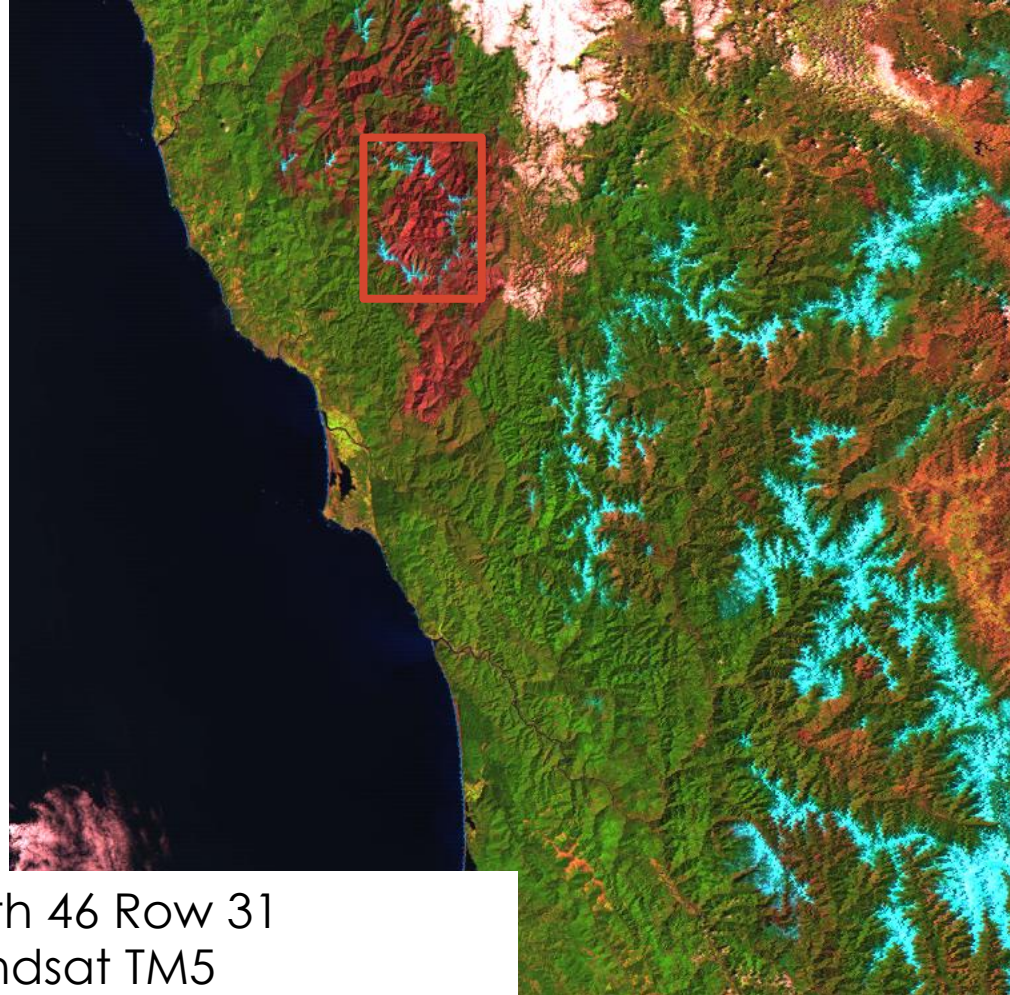
...Contain Limited Haze



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



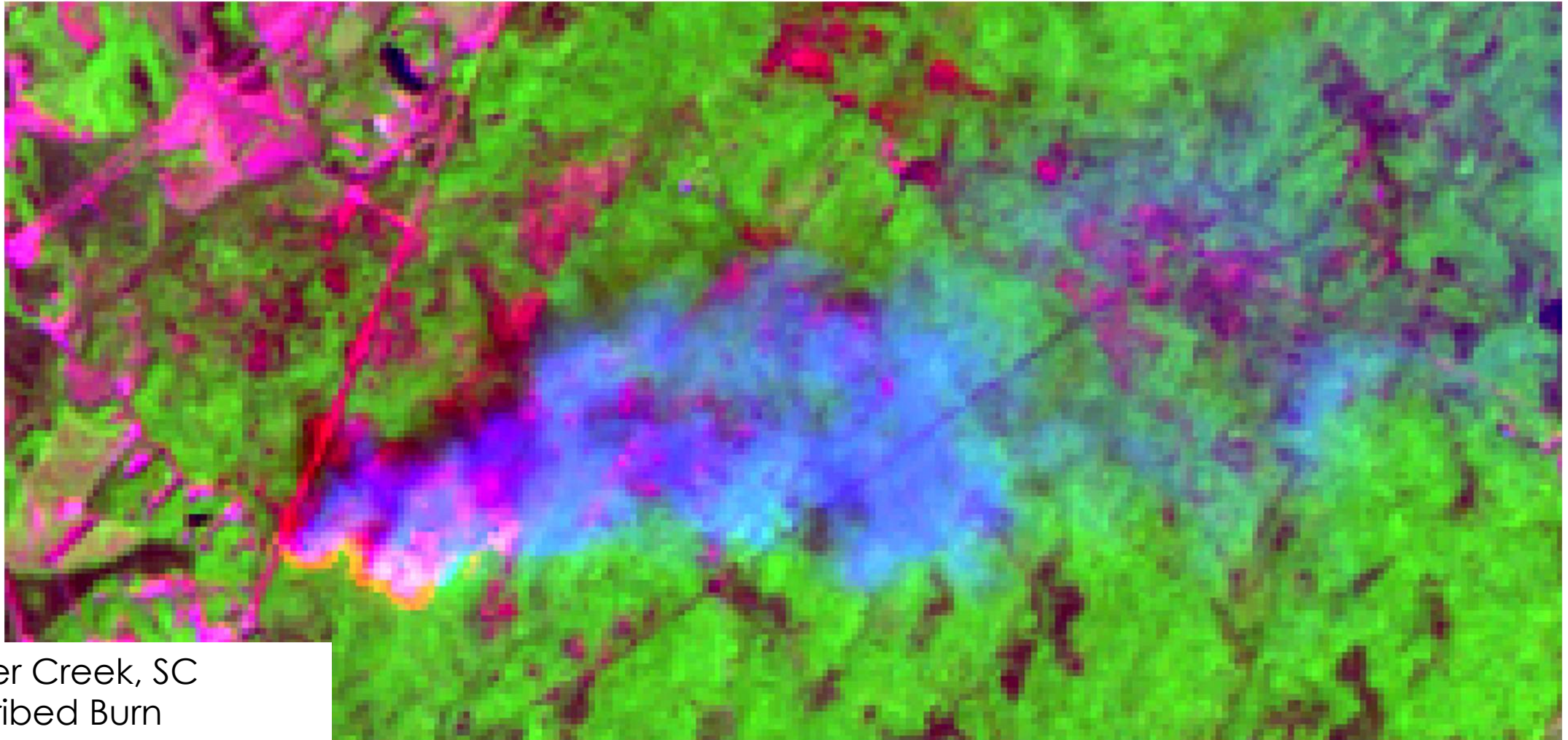
...Have No Snow Within the Fire Perimeter



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



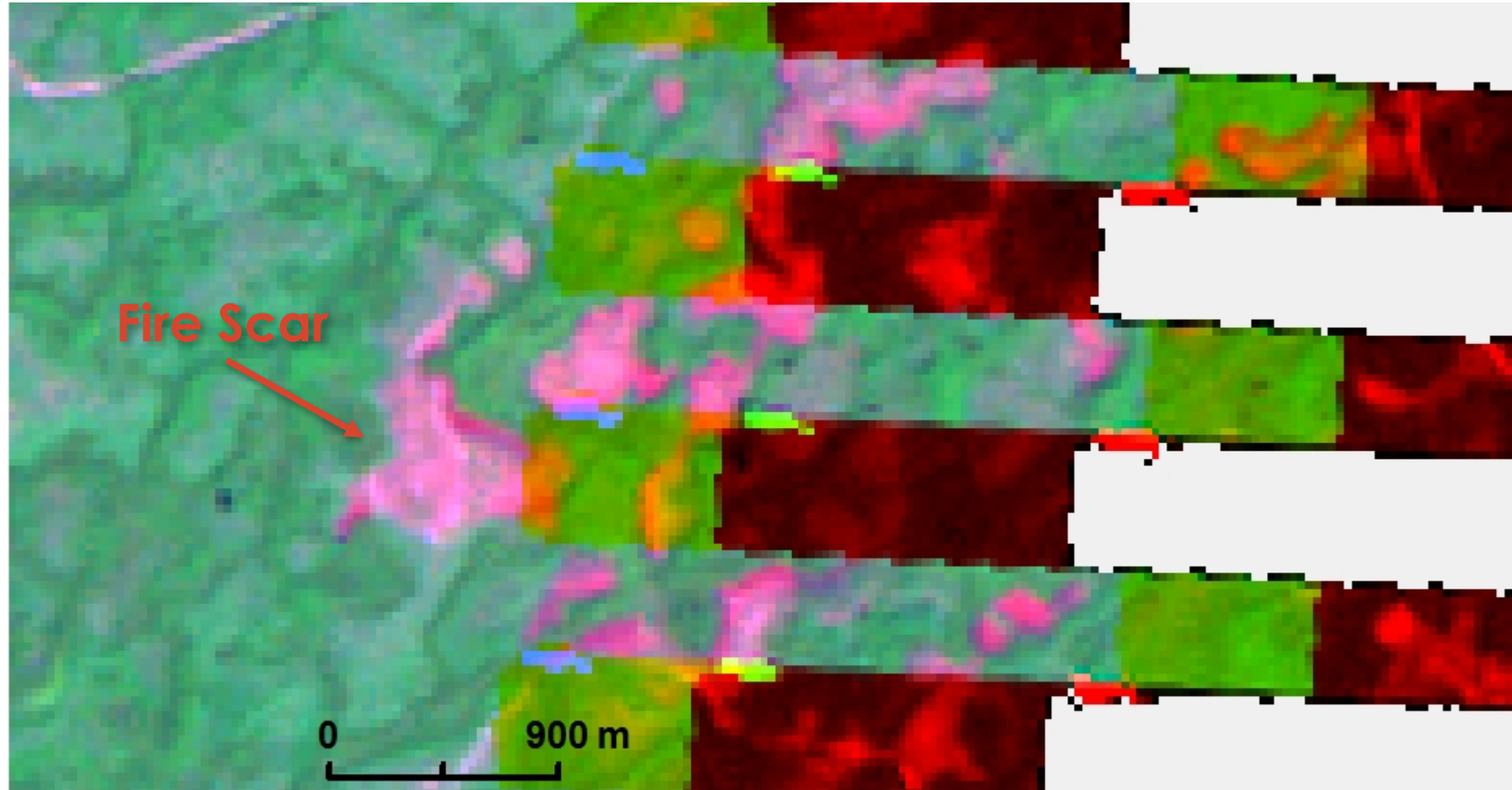
...Contain No Active Burning Within the Fire Perimeter



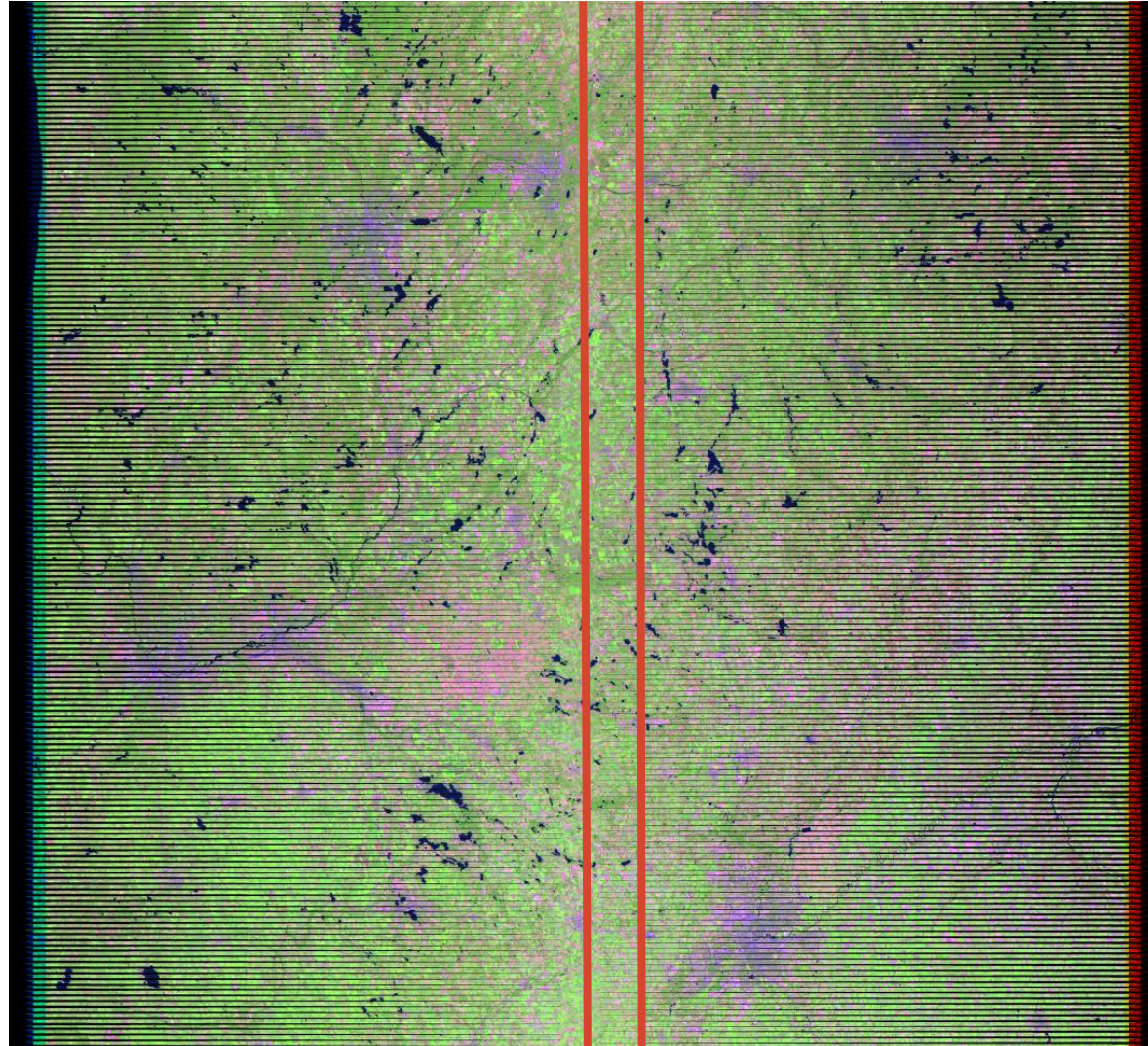
Gamer Creek, SC
Prescribed Burn
Image: 05/02/2006



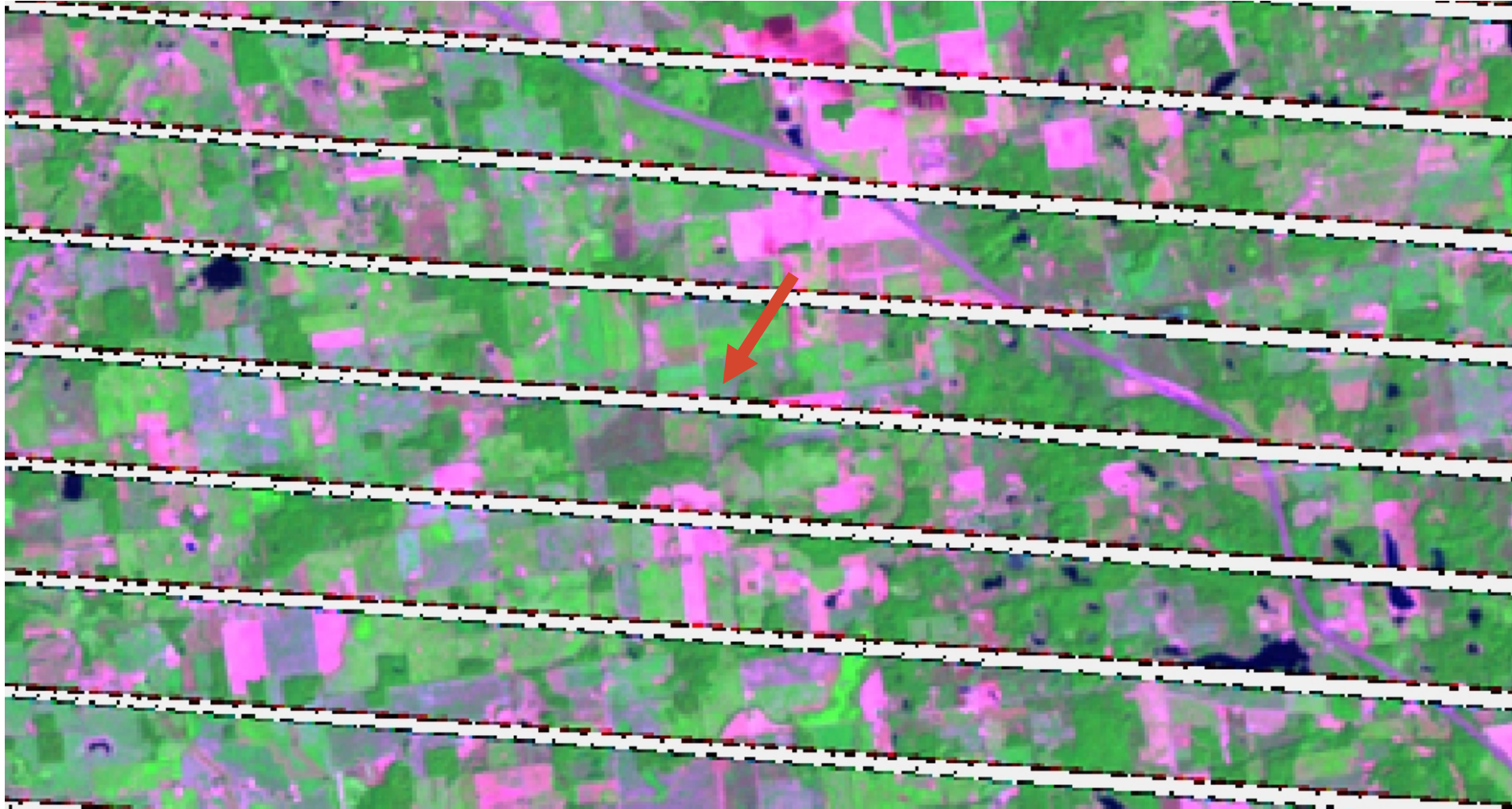
...Not Contain the Fire Perimeter Near the Scene Edge



...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

2016 Fires



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

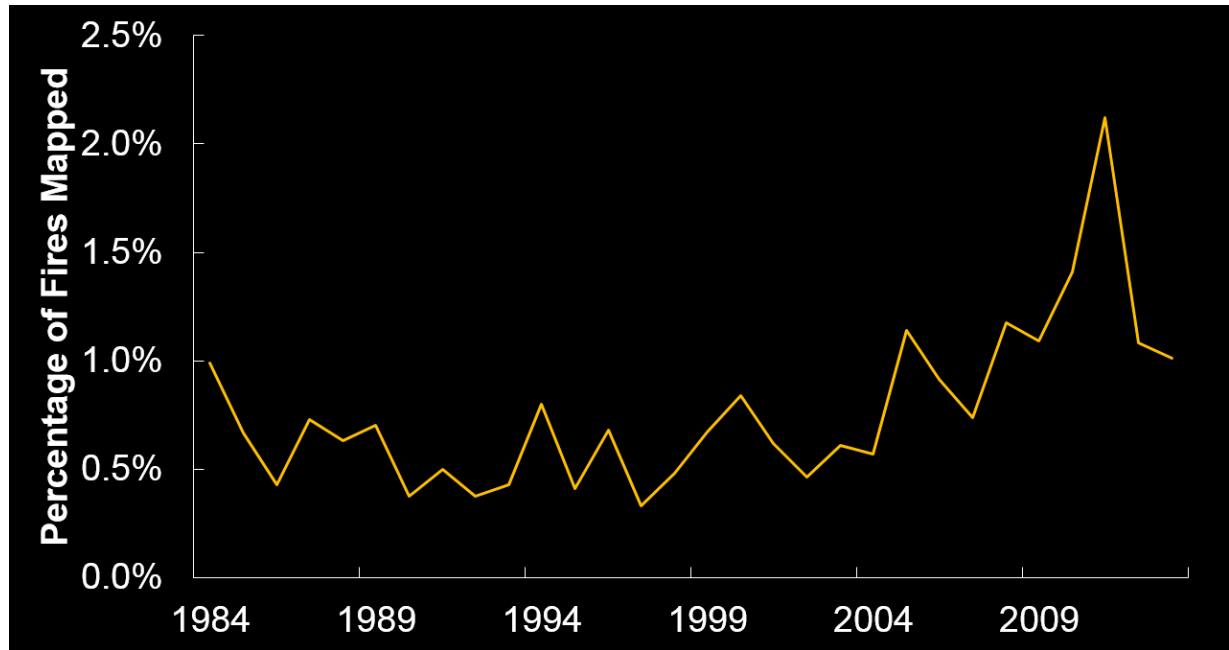
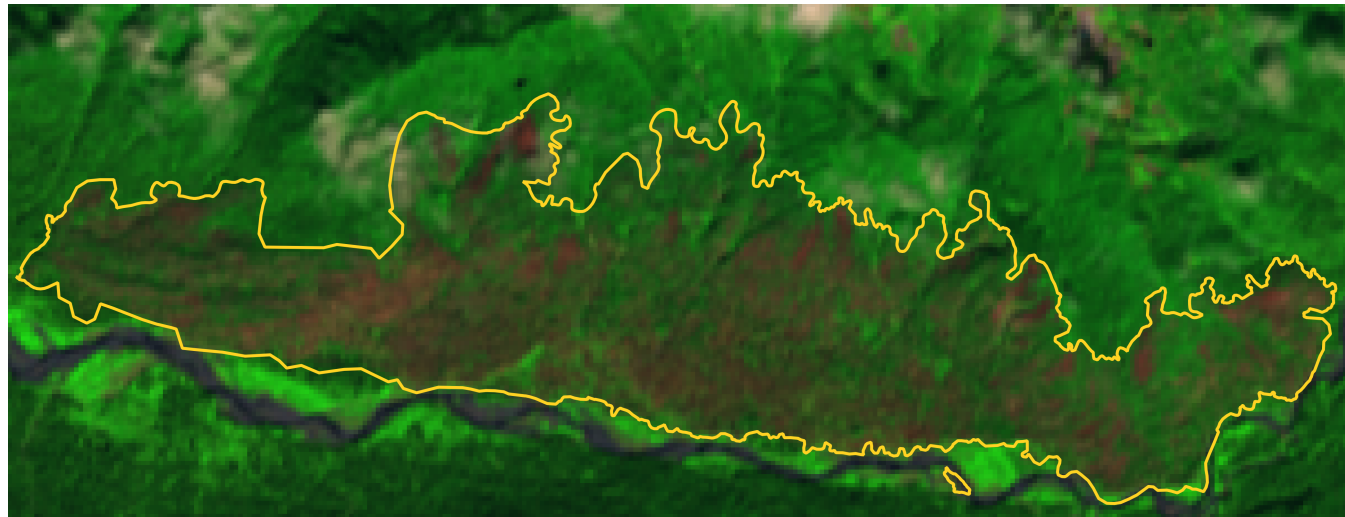


Image Credit (Right): NIFC Data Source: http://www.nifc.gov/fireInfo/fireInfo_statistics.html

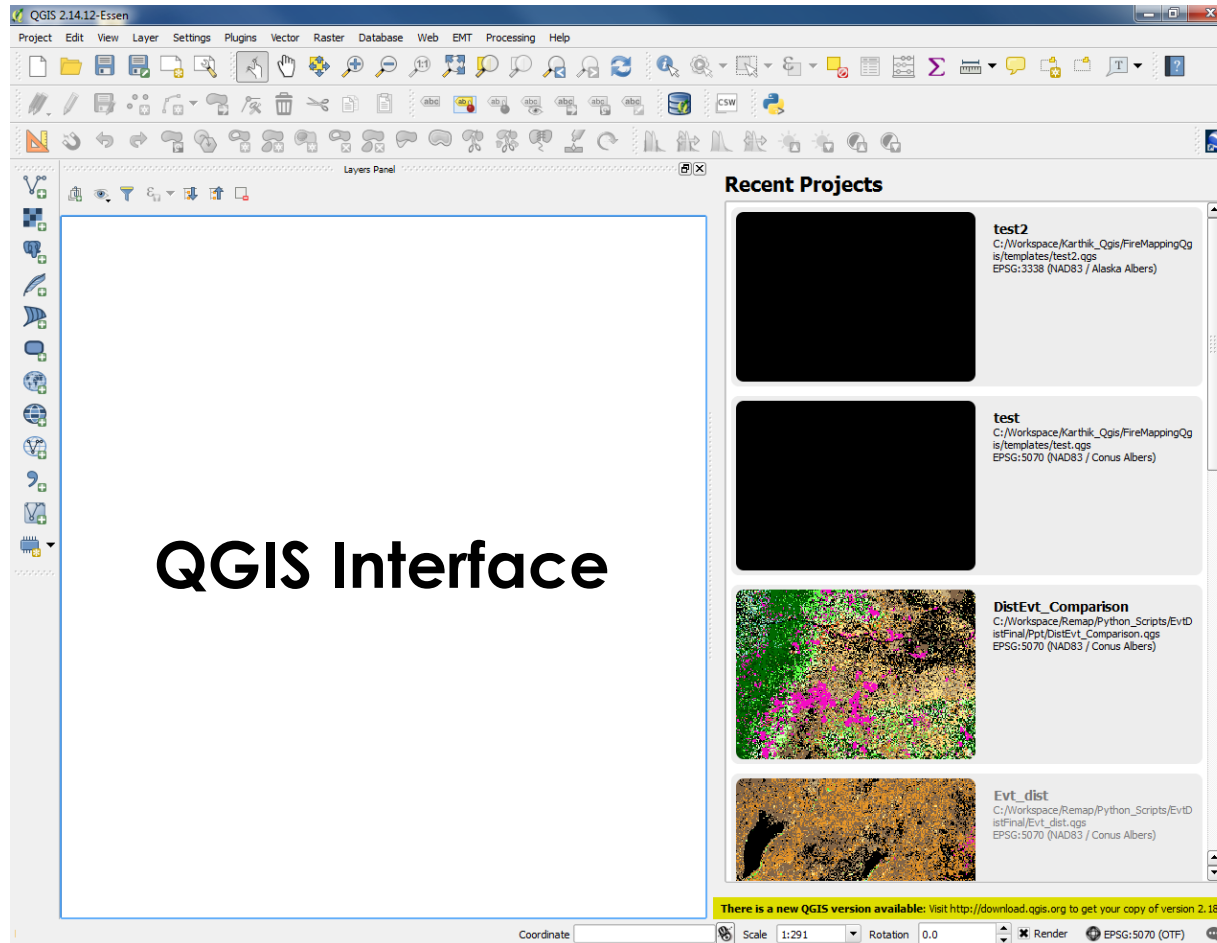


Fire Mapping Tool (FMT) Project Goal

- 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



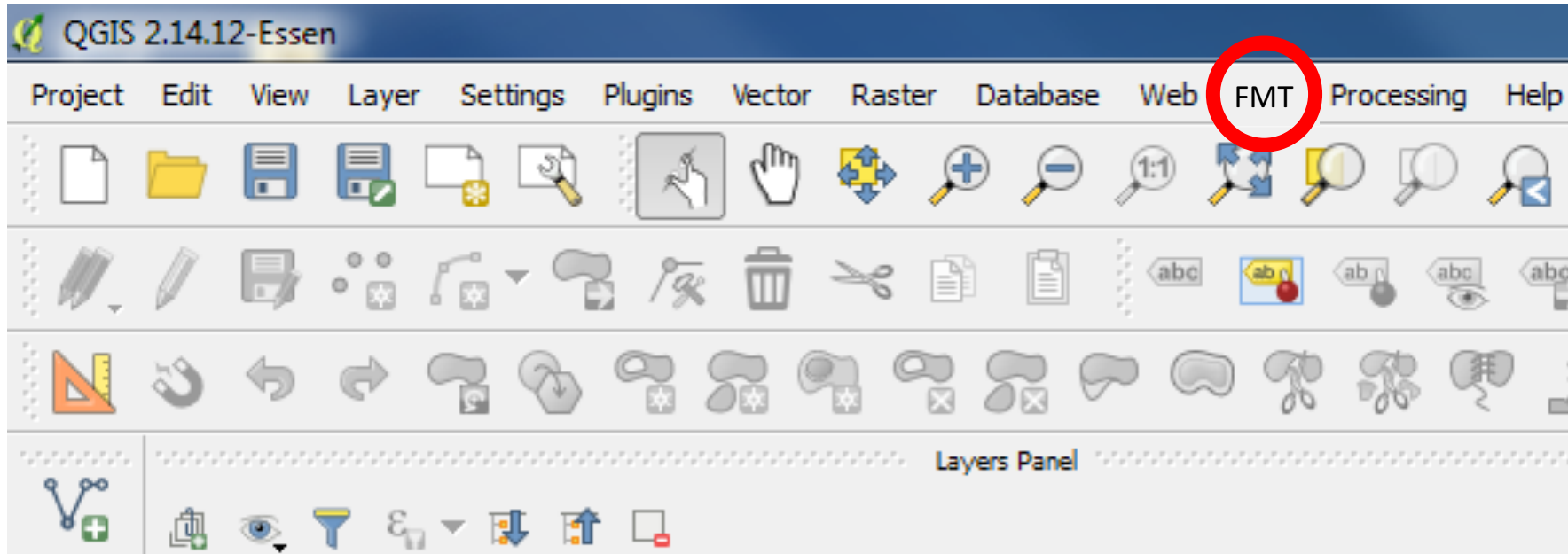
QGIS Background



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



QGIS Fire Mapping Tool (FMT)

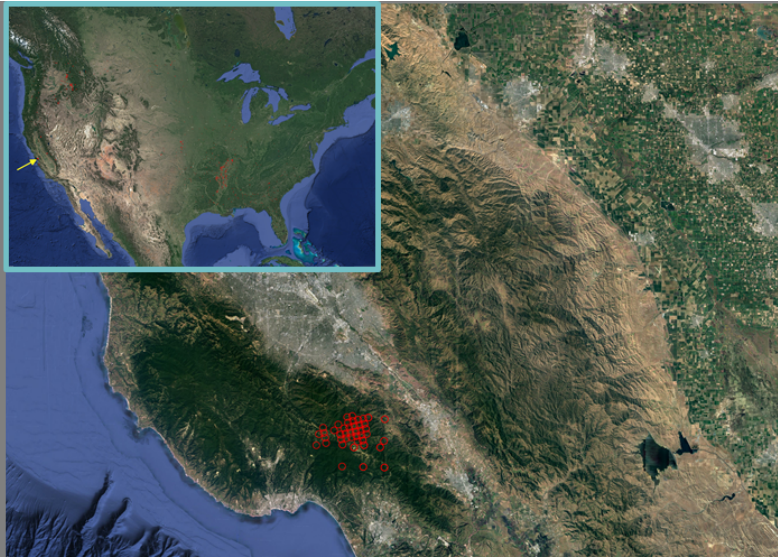


FMT's Functionality

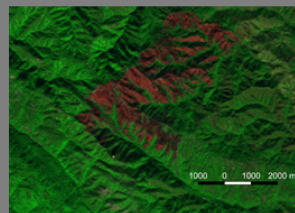
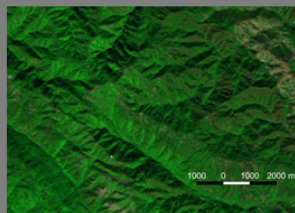
- Processes Landsat Imagery ordered from <https://espa.cr.usgs.gov/>
- Creates dNBR images
- Builds fire perimeter and masking vector files (i.e. shapefiles)
- Calculates RdNBR offset and subsequently outputs a RdNBR image
- Suggests potential low, moderate, and high burn severity thresholds
- Creates 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>



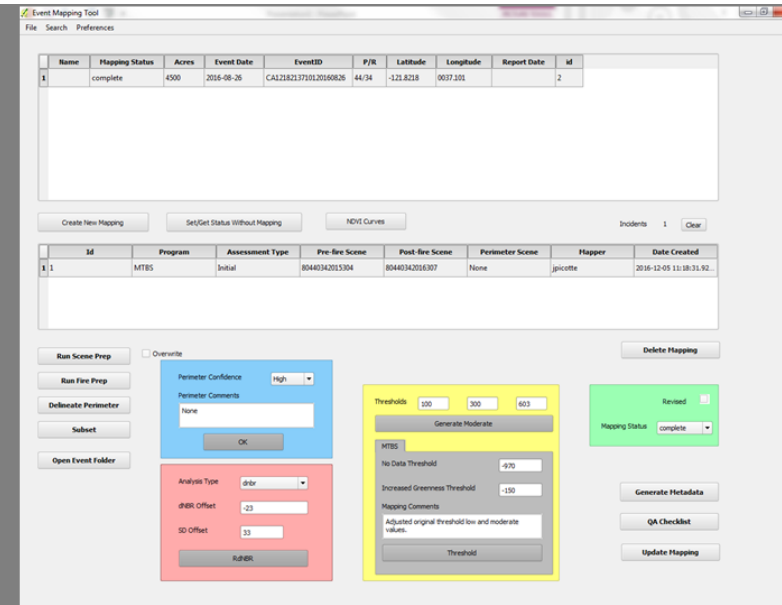
QGIS FMT Processing Outline



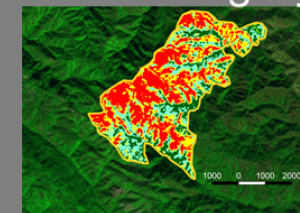
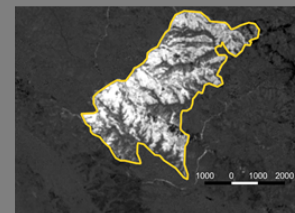
Step 1: Identify a fire using sensor detections or another data source



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



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



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

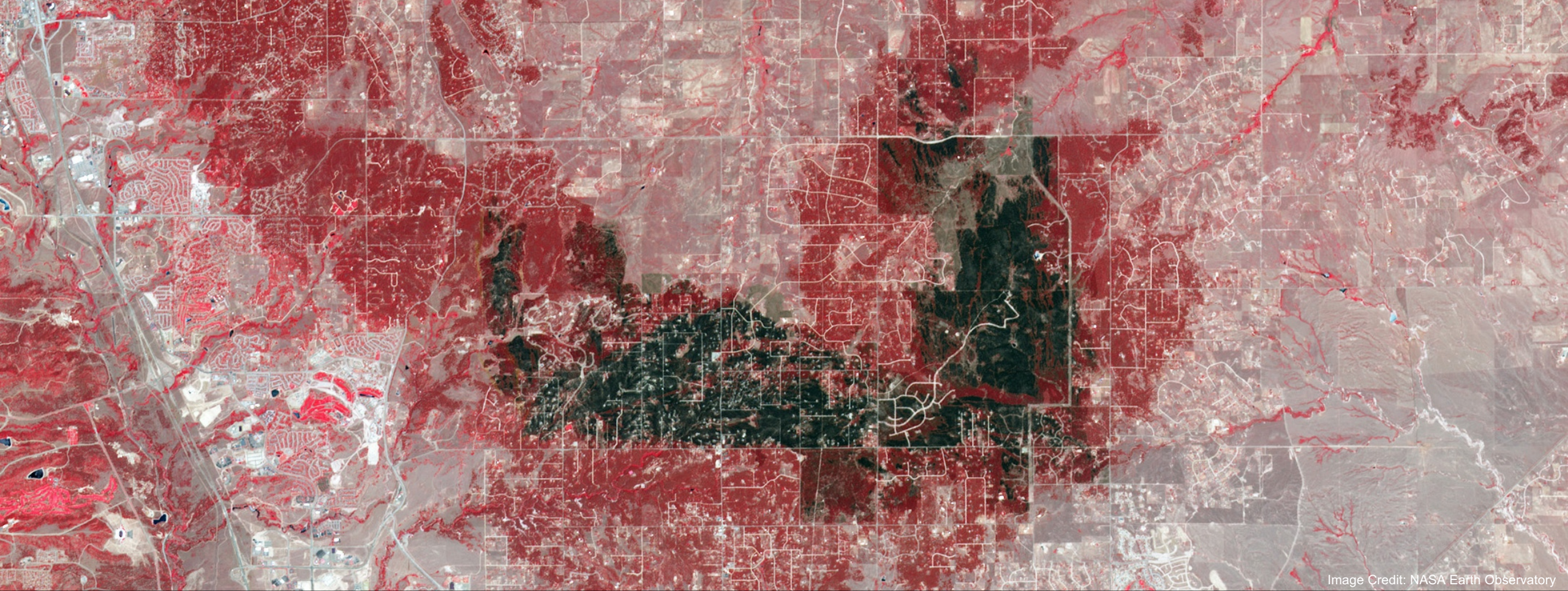


Image Credit: NASA Earth Observatory

FMT Exercise

Contacts

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- ARSET Website:
 - <http://arset.gsfc.nasa.gov>



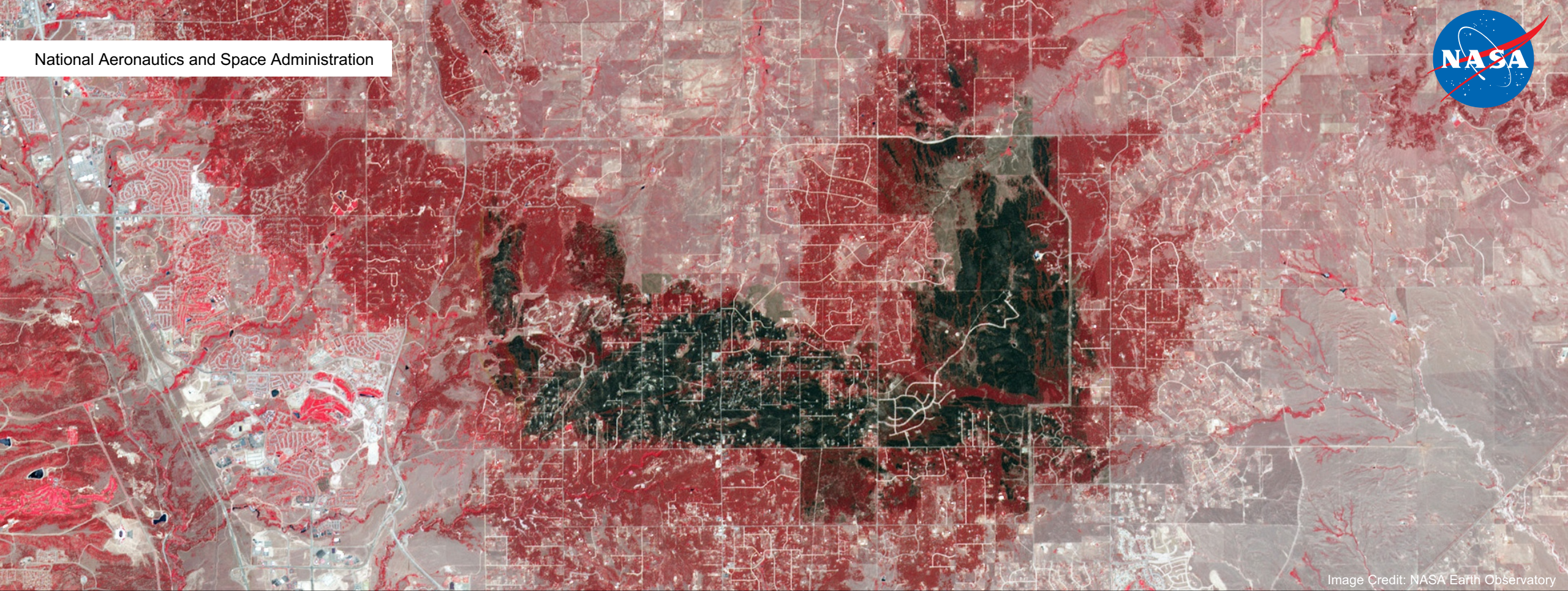
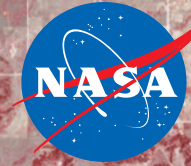


Image Credit: NASA Earth Observatory



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

