

# Evaluation of High Resolution Data for LCLUC Science

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**Project Title:** Commercial satellite data evaluation for burned area mapping & validation of Landsat-8 Sentinel-2 African burned area product



Department of Geography,  
Environment, and Spatial Sciences  
MICHIGAN STATE UNIVERSITY



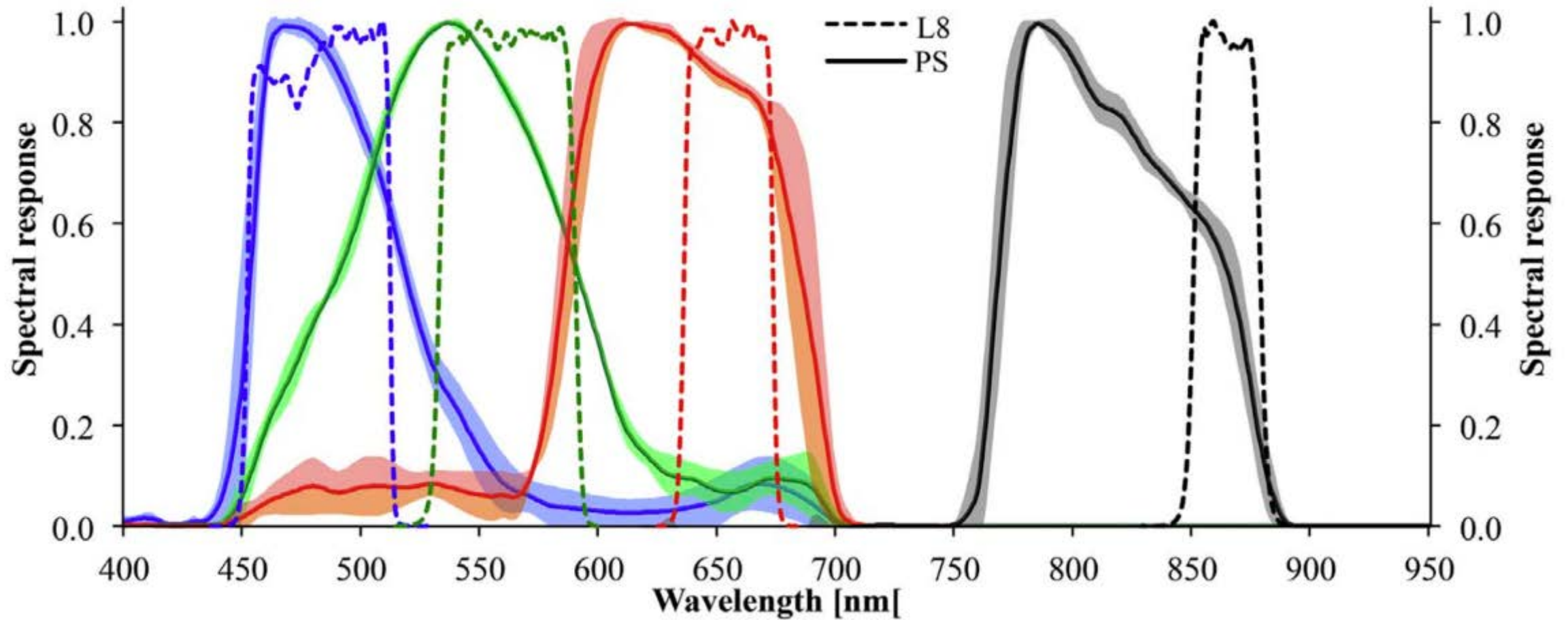
## Study Regions

Russia	68.2 × 68.2 km
Zambia	53.3 × 42.2 km
CA	45.0 × 28.5 km

## Data download status

Russia	- Planet 4-band surface reflectance (4.8 GB)
Zambia	- Planet 4-band surface reflectance (4.2 GB)
CA	- Planet 4-band surface reflectance (2.7 GB) - Worldview 3 (8.2 GB)

# PLANET 3 m B / G / R / NIR (high temporal coverage)



# Planet Explorer GUI: easy and intuitive

The screenshot displays the Planet Explorer interface for South Africa. The search filters are set to "Daily Imagery - Aggregate of image captures". The filters include:

- Cloud cover: 0 - 40 %
- Area coverage: 10 - 100 %
- Source: 1 source
- All filters >

The selected filters are:

- 4-band PlanetScope scene
- 3-band PlanetScope scene
- RapidEye ortho tile
- Sentinel-2 tiles
- PlanetScope ortho tile
- Landsat 8 scenes

The search results are sorted by "Most recent" and show the following items:

Date	Scene Type	Area Coverage	Items
May 7, 2017	4-band PlanetScope scene (3 m)	25 %	92
May 5, 2017	4-band PlanetScope scene (3 m)	14 %	36
May 3, 2017	4-band PlanetScope scene (3 m)	23 %	75
May 2, 2017	4-band PlanetScope scene (3 m)	22 %	113

The map shows a satellite view of South Africa with various cities and regions labeled, including Northam, Lebotwane, Moretele, Jerecho, Madidi, Rustenburg, and Cullinan. A timeline at the bottom indicates the date range from May 20 to May 31, 2017.

9 PLANET images in the same orbit

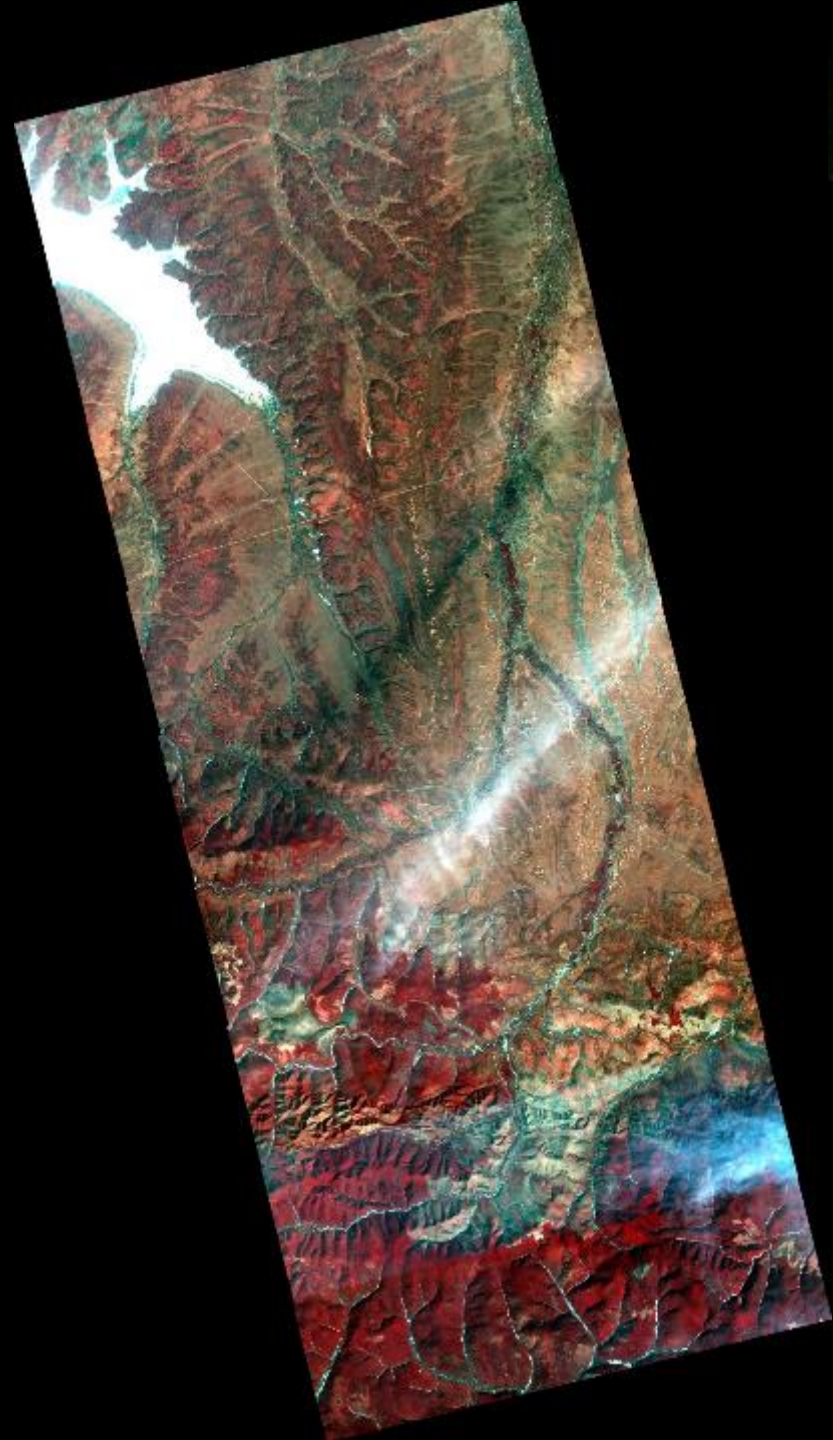
each  $8500 \times 4500$  3m pixels  
( $25.5 \times 13.5$  km)

False color surface reflectance  
(820 nm, 630 nm, 545 nm)

Russia

$54.31^\circ\text{N}$ ,  $127.78^\circ\text{E}$

May 4 2018



9 PLANET images in the same orbit

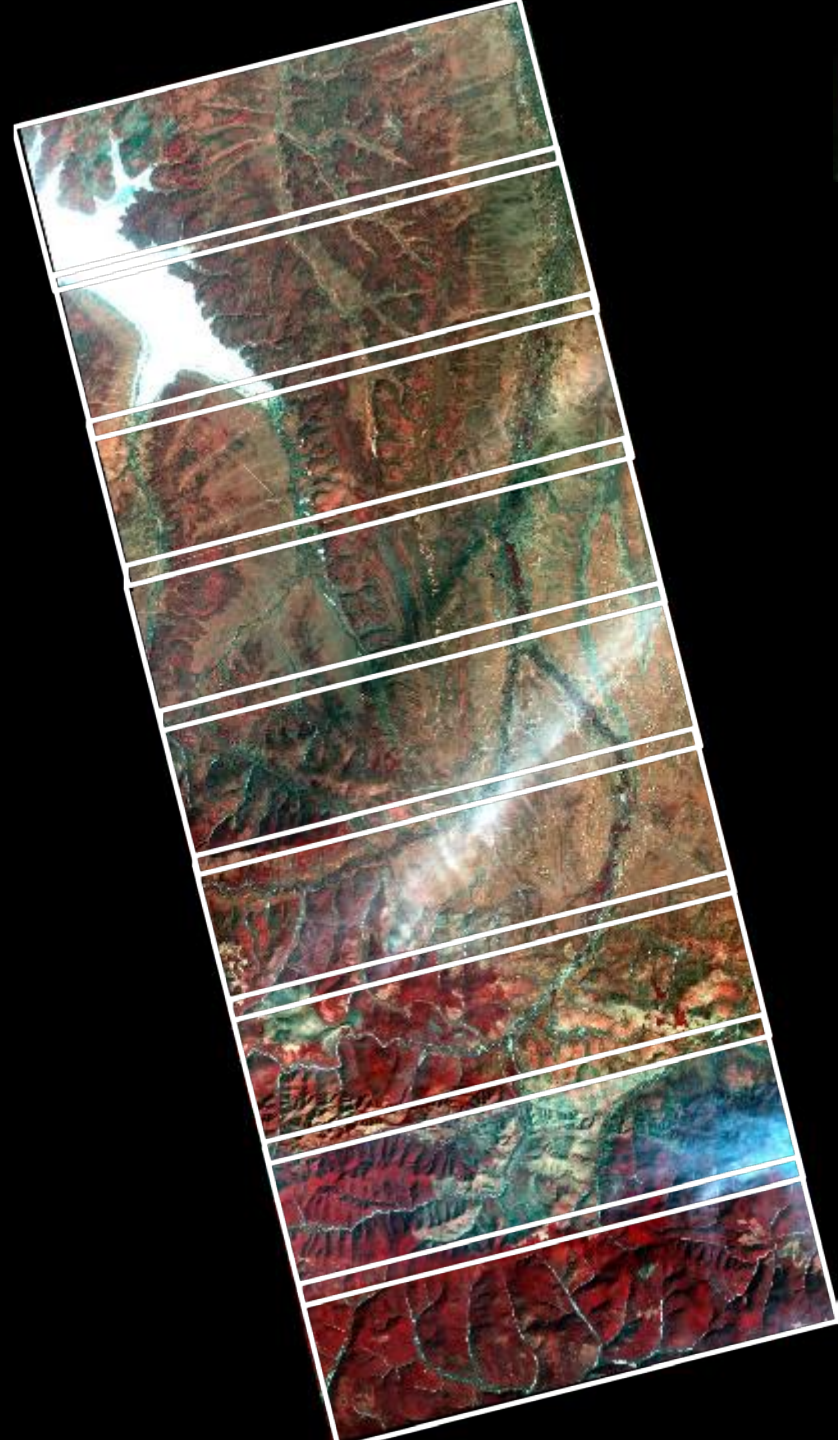
each  $8500 \times 4500$  3m pixels  
( $25.5 \times 13.5$  km)

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each  $8500 \times 4500$  3m pixels  
( $25.5 \times 13.5$  km)

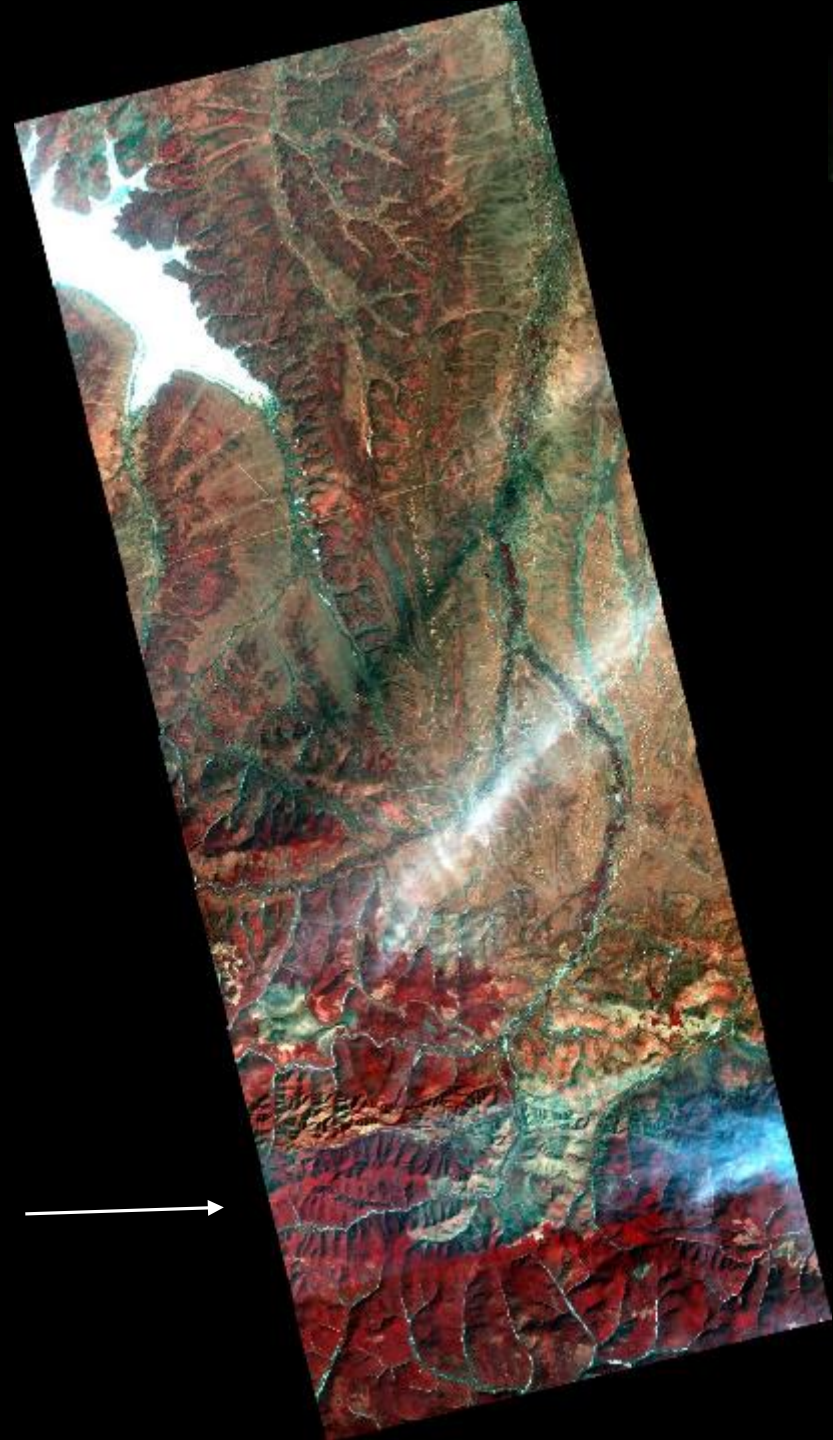
False color surface reflectance  
(820 nm, 630 nm, 545 nm)

Russia

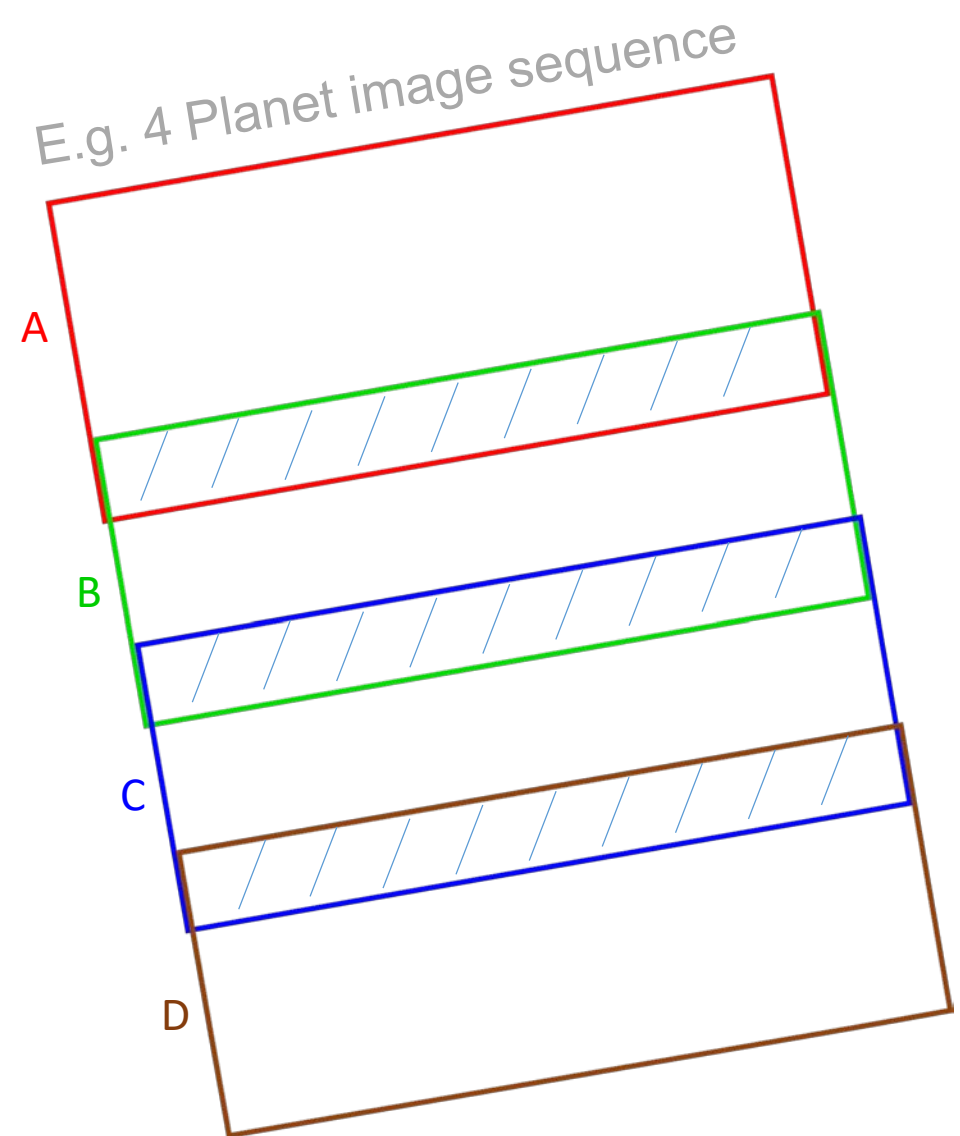
$54.31^\circ\text{N}$ ,  $127.78^\circ\text{E}$

May 4 2018

**ISSUE:** between image  
atmospheric correction  
discontinuities (particularly  
problematic over high AOD  
e.g., smoke from fires)



# Developed a reflectance normalization least-squares-adjustment (LSA) approach



- Loop **control image** over sequence {A, B, C, D}

Solve (*gain*, *bias*) for each image

minimize, by LSA, residuals  $\Delta$  of all  $i = 1 \dots n$  overlapping pixels among all the image pairs :

$$\Delta_i = (\rho_i^j \cdot \text{gain}^j + \text{bias}^j) - (\rho_i^k \cdot \text{gain}^k + \text{bias}^k)$$

image  $j = \{A, B, C, D\}$

image  $k = \neq j$  and  $\in \{A, B, C, D\}$

$\text{gain}^{\text{control image}} = 1$

$\text{bias}^{\text{control image}} = 0$

$$D^{\text{control}} = \sum_{m \in \{A, B, C, D\}} ((\rho_i^m \cdot \text{gain}^m + \text{bias}^m) - \rho_i^m) / n$$

- Select the **control image** that provides the smallest  $D^{\text{control}}$  then apply corresponding image (*gain*, *bias*) values to the images



2 PLANET images in the same orbit

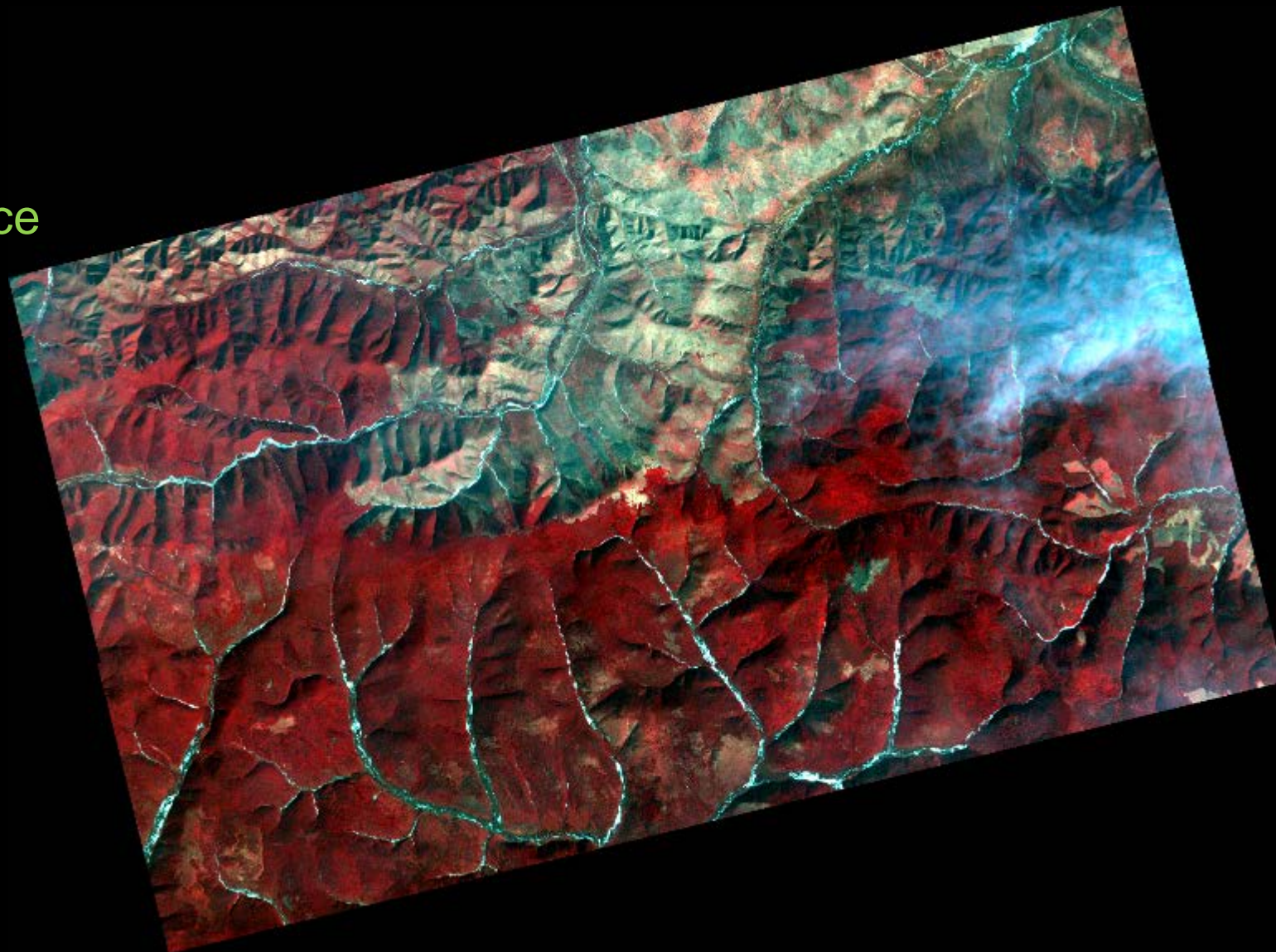
each  $8500 \times 4500$  3m pixels  
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False color surface reflectance  
(820 nm, 630 nm, 545 nm)

Russia

$54.31^\circ\text{N}$ ,  $127.78^\circ\text{E}$

May 4 2018

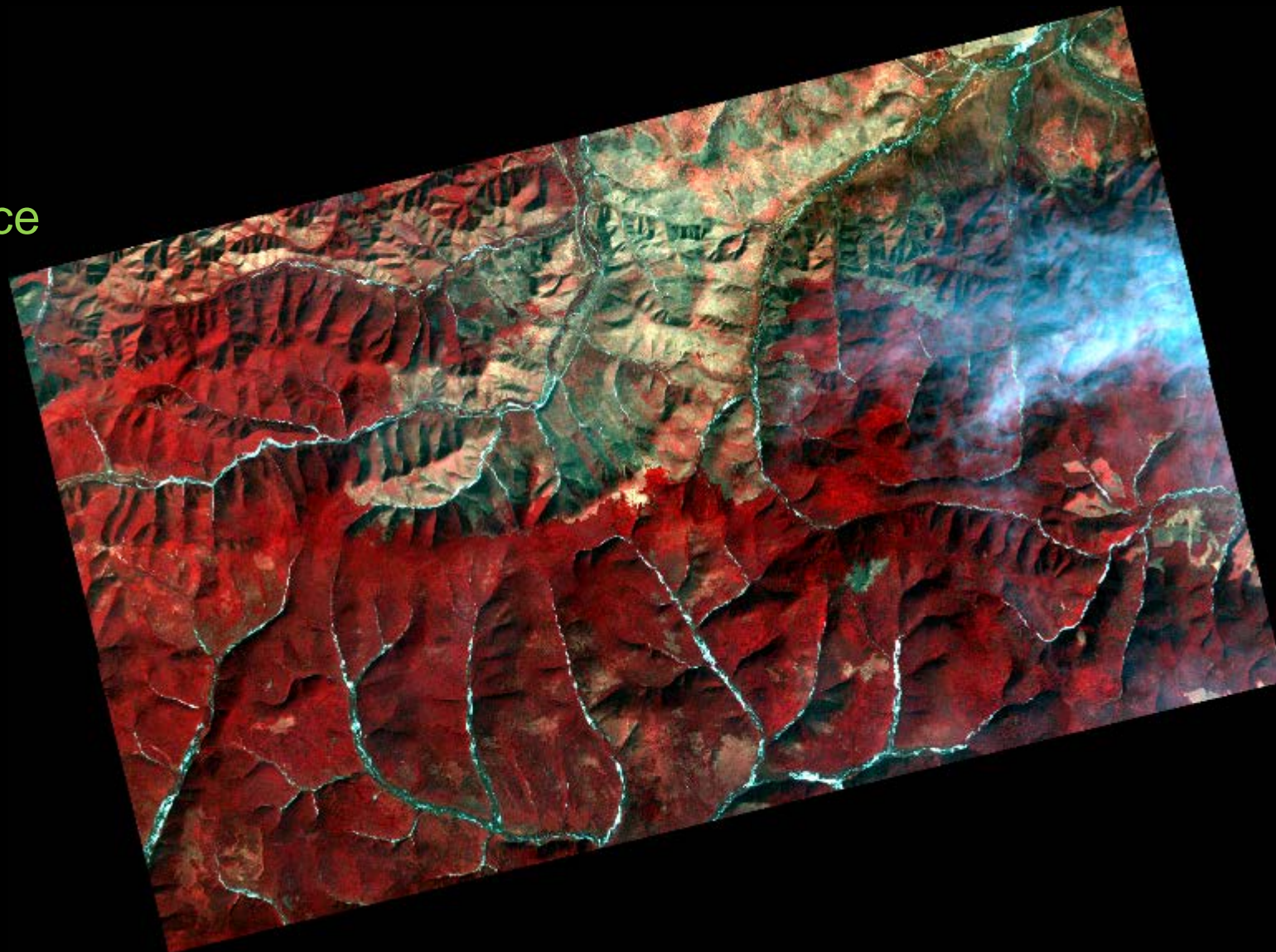


2 PLANET images in the same orbit

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( $25.5 \times 13.5$  km)

False color surface reflectance  
(820 nm, 630 nm, 545 nm)

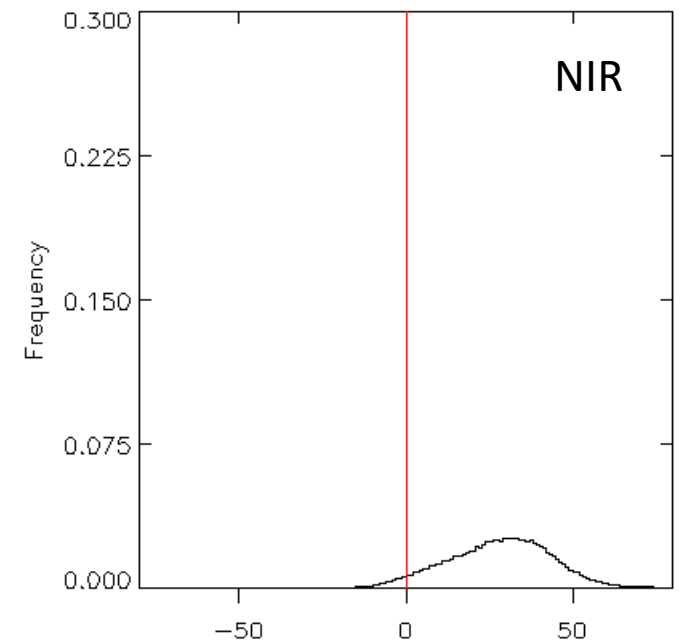
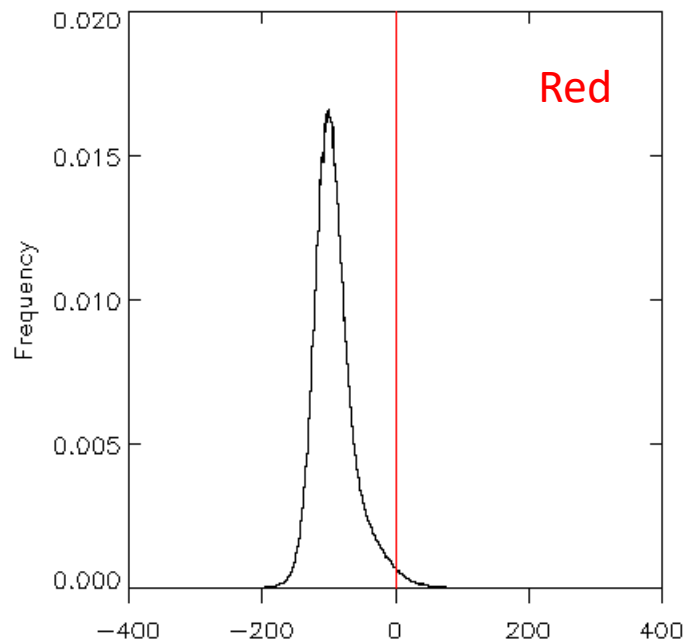
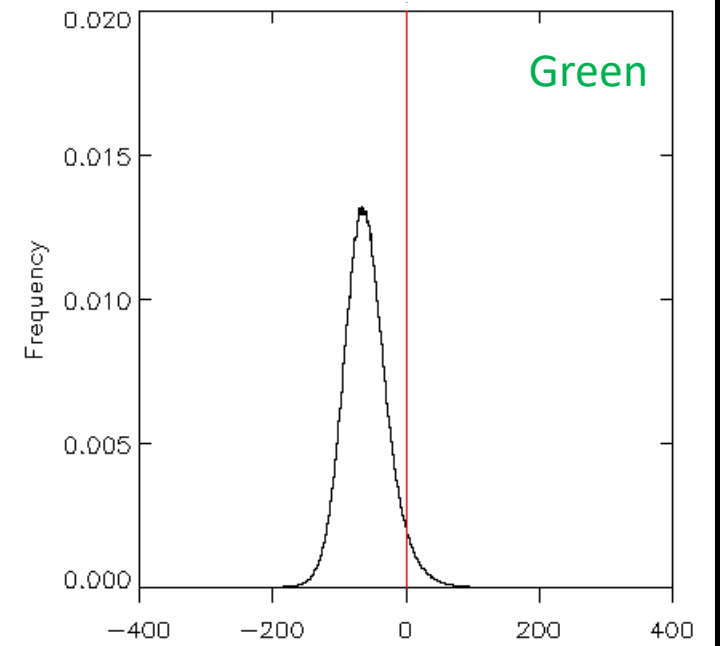
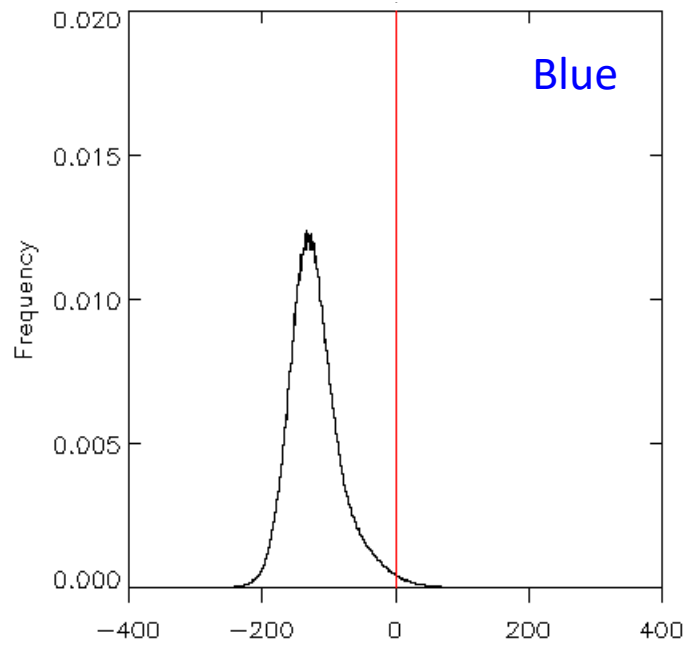
Russia  
 $54.31^\circ\text{N}$ ,  $127.78^\circ\text{E}$   
May 4 2018



After Normalization

# Histograms of surface reflectance differences in the PLANET Image overlap regions

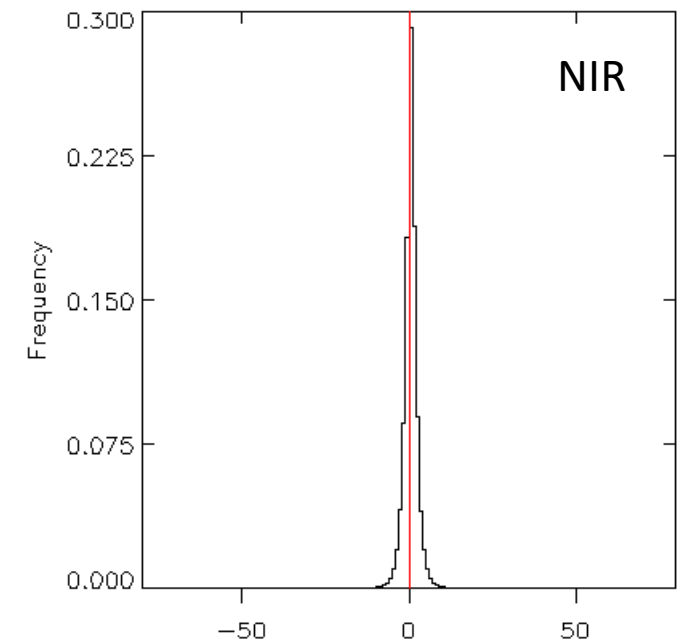
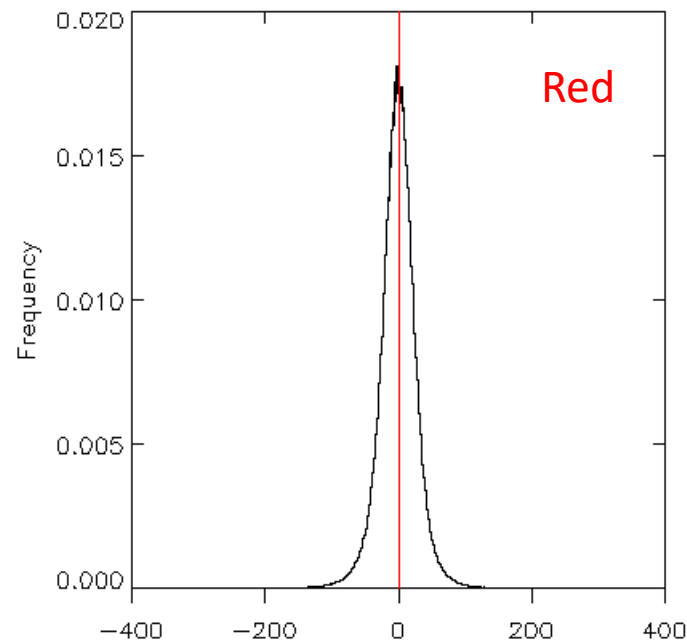
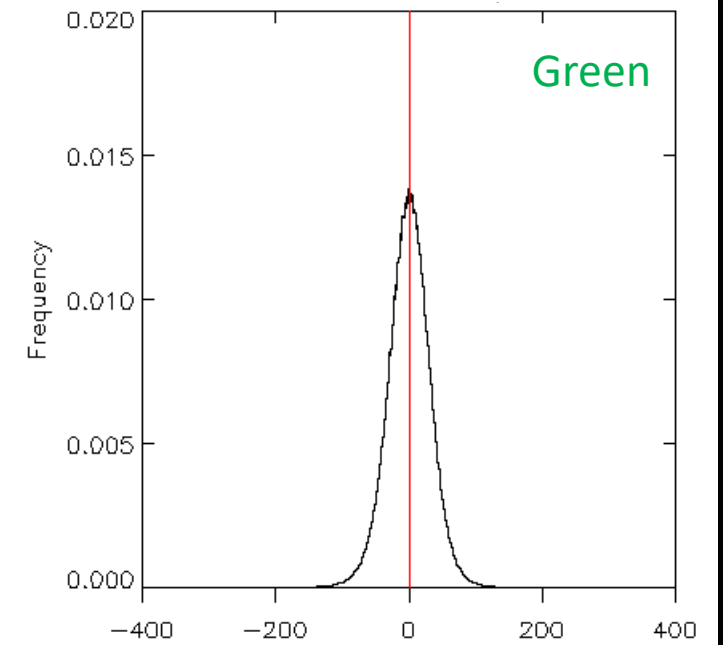
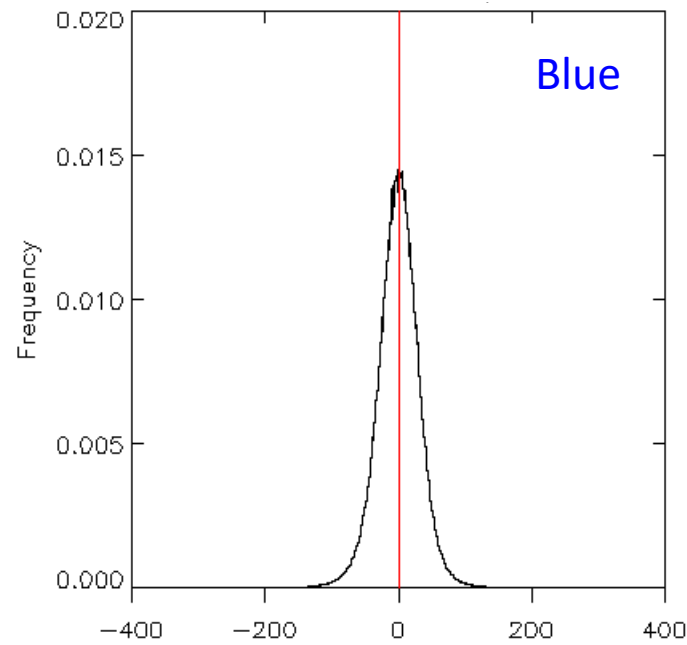
( $\times 10,000$ )



Histograms of  
surface reflectance  
differences in the  
PLANET  
Image overlap  
regions

( $\times 10,000$ )

After Normalization



9 PLANET images in the same orbit

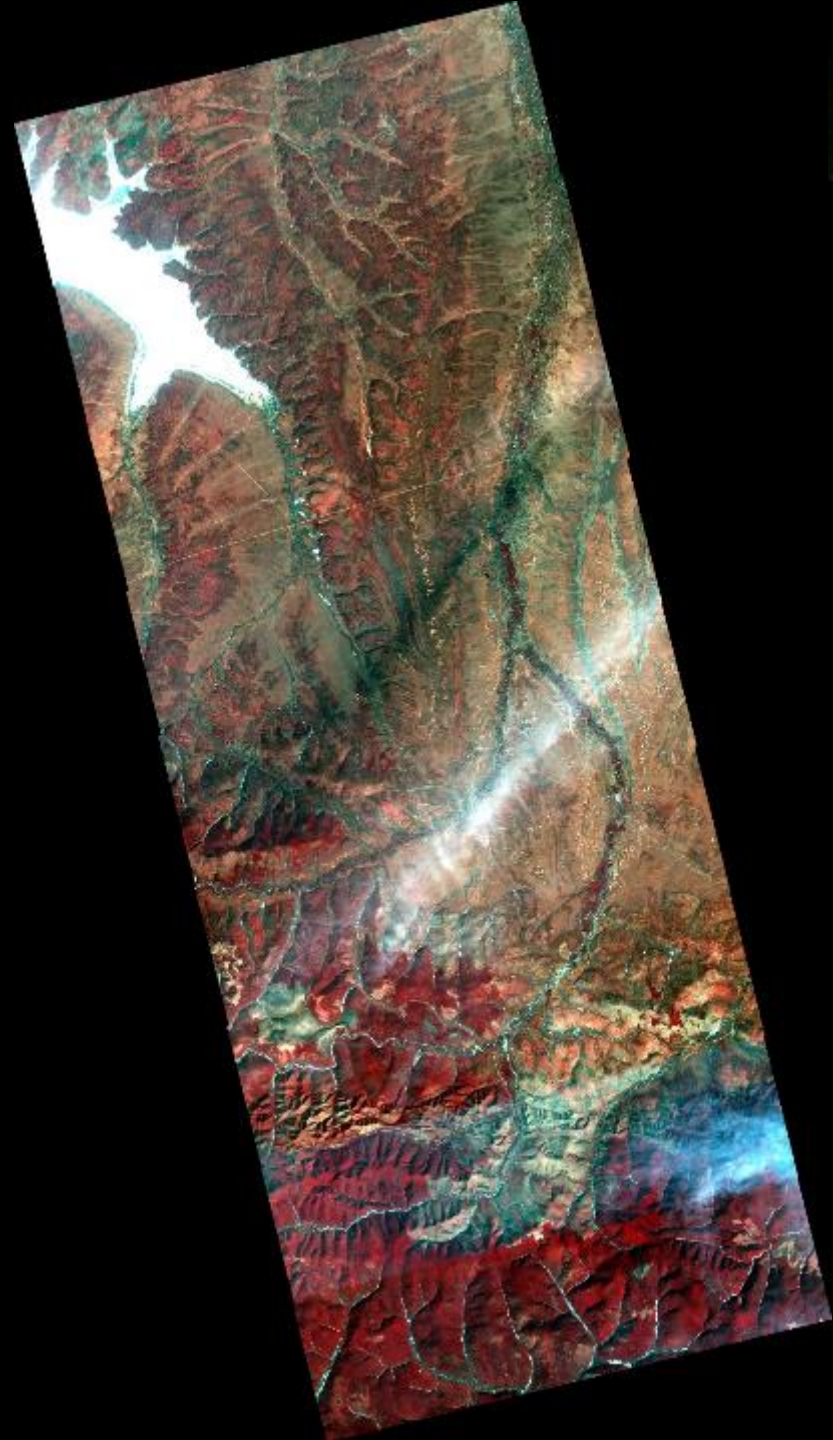
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May 4 2018

After Normalization





# 4 PLANET images

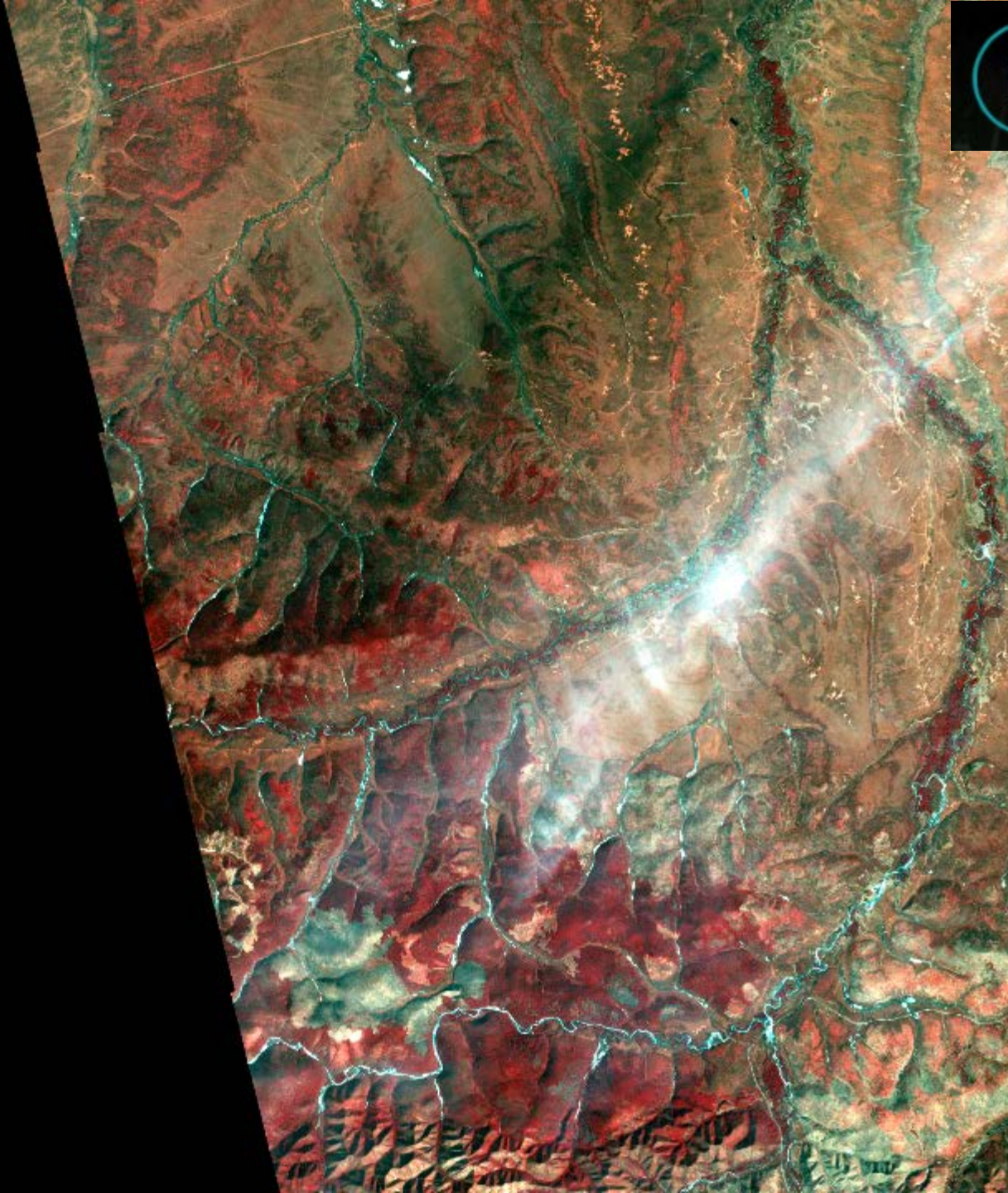
May 4 2018

Russia

False color surface reflectance  
(820 nm, 630 nm, 545 nm)

 Burned training

 Unburned training

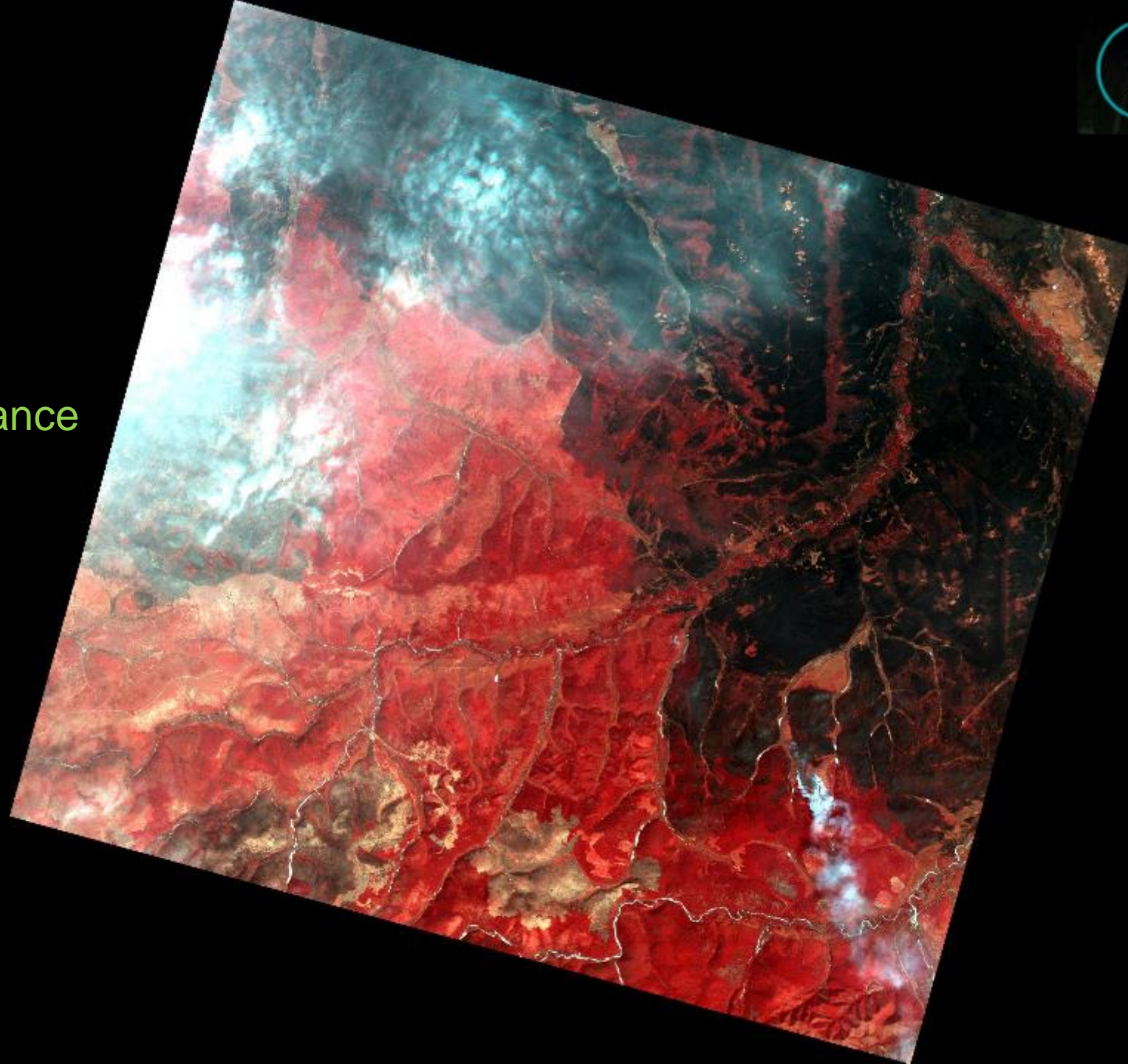



## 3 PLANET images


May 16 2018

Russia

False color surface reflectance  
(820 nm, 630 nm, 545 nm)



 Burned training

 Unburned training

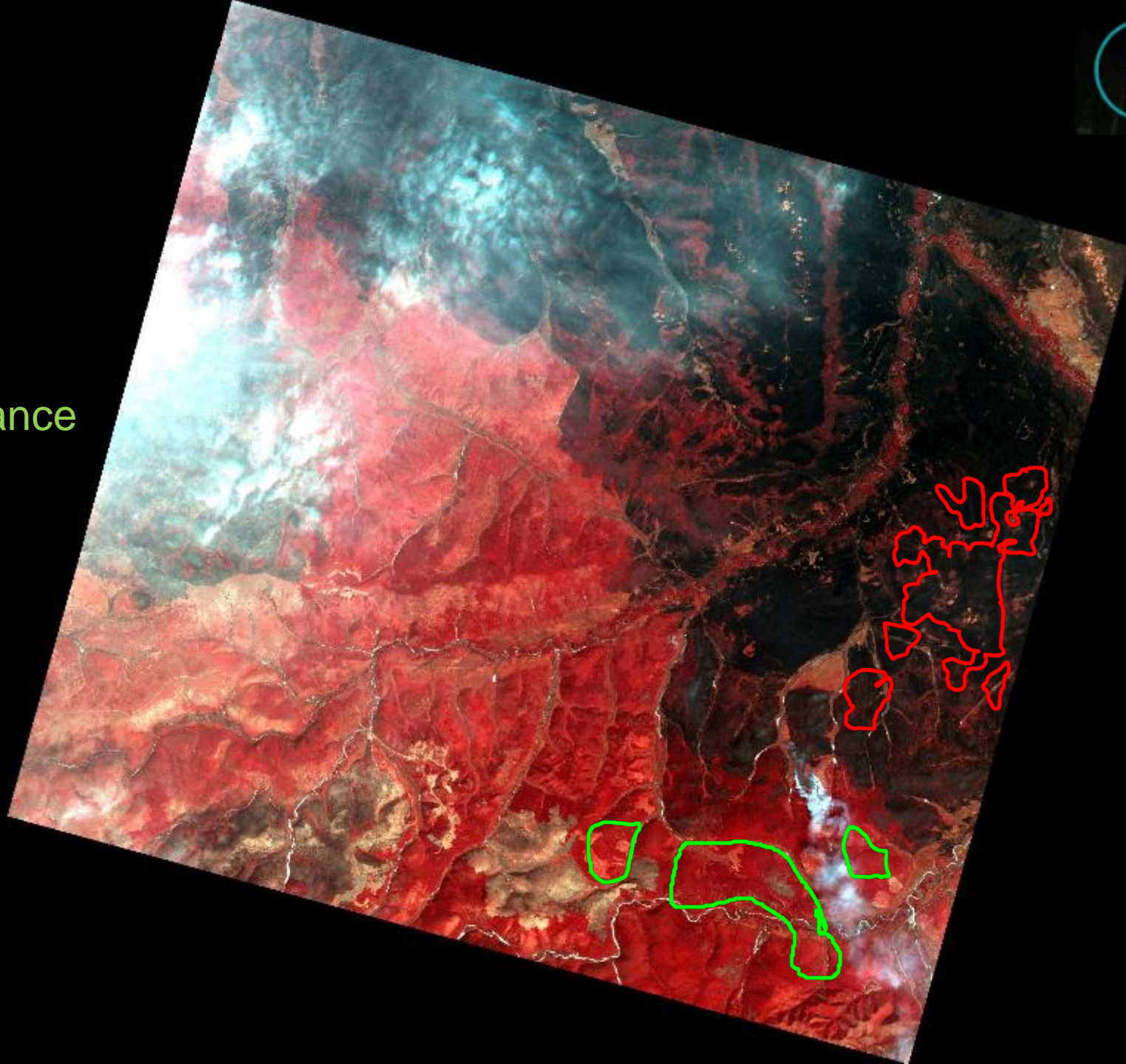



# 3 PLANET images


May 16 2018

Russia

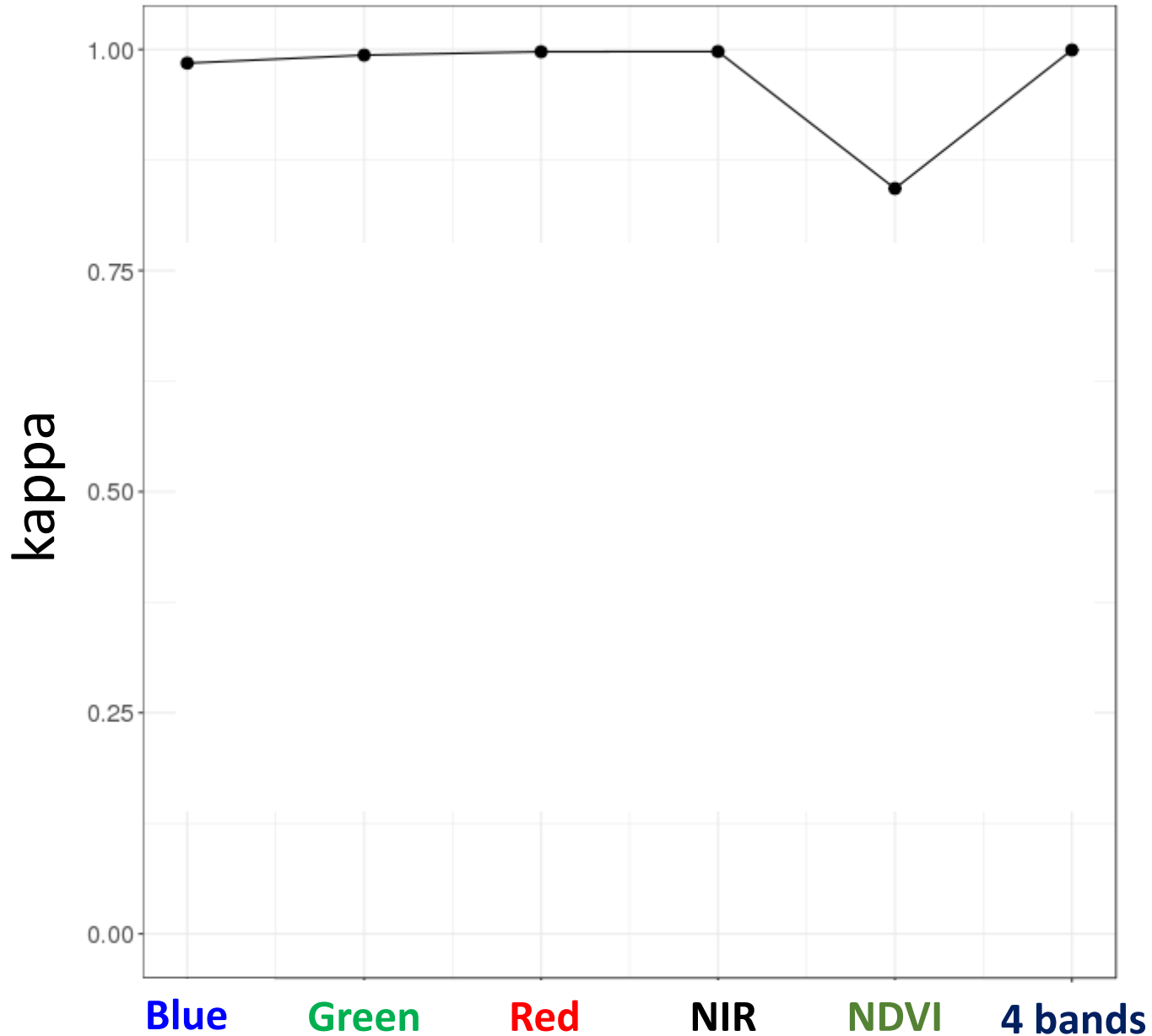
False color surface reflectance  
(820 nm, 630 nm, 545 nm)



 Burned training

 Unburned training

# PLANET band non-parametric separability analysis

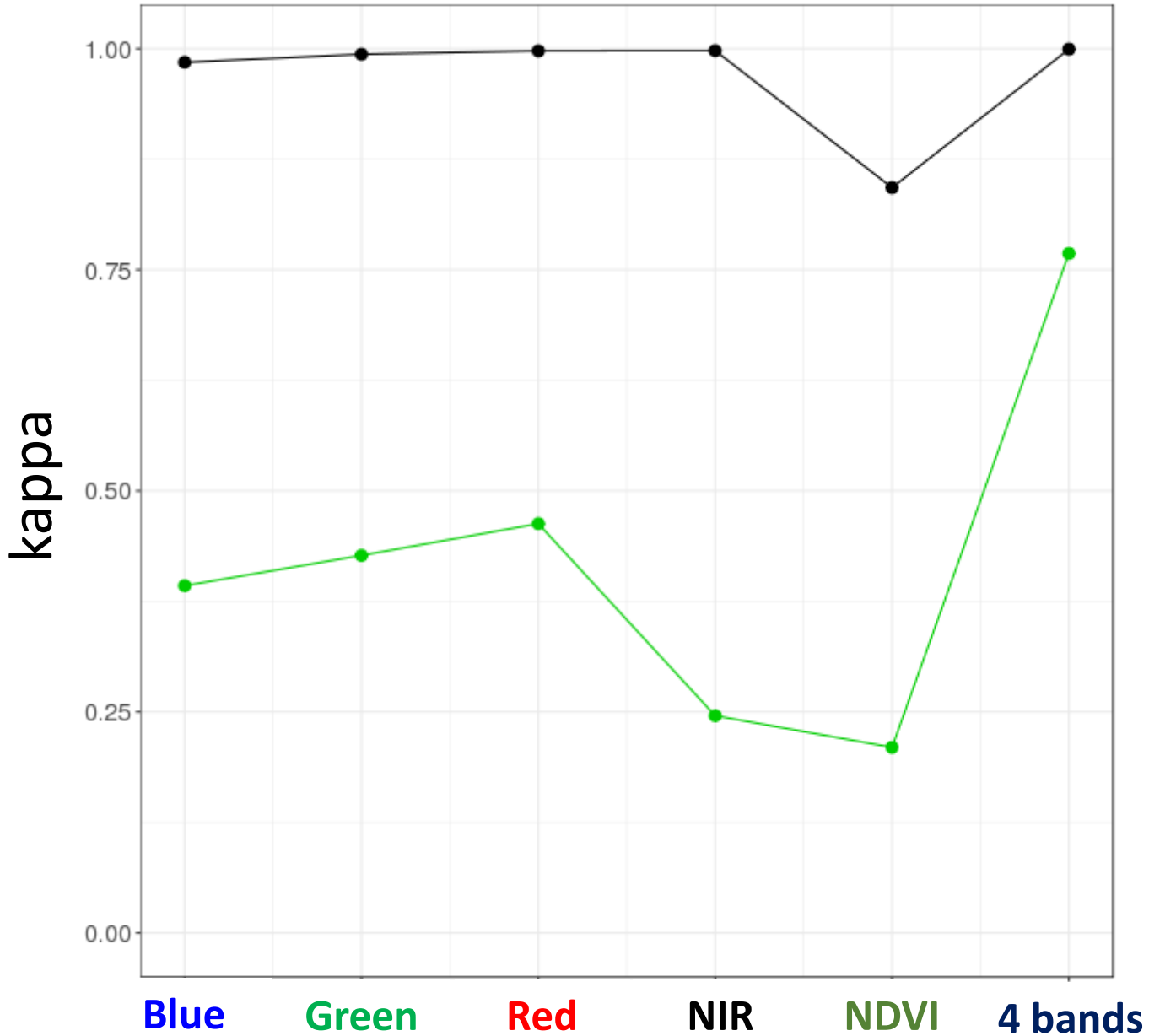


**May 4<sup>th</sup> unburned -> May 16<sup>th</sup> 2018 burned**

Huang et al. 2016

- 200 decision trees grown
- each time using 20% of the training samples selected randomly with replacement
- remaining “out-of-bag” 80% classified

# PLANET band non-parametric separability analysis



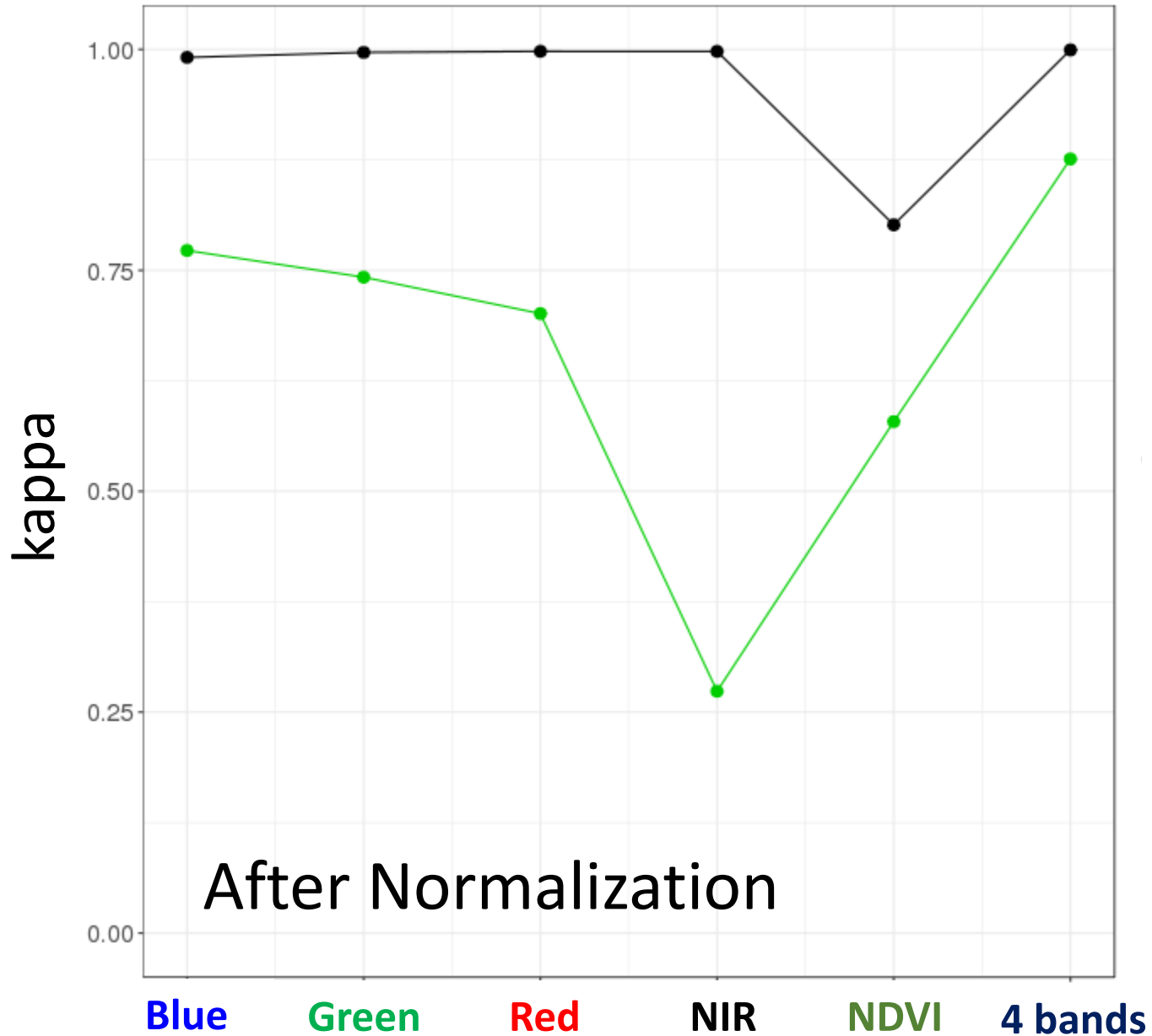
**May 4<sup>th</sup> unburned -> May 16<sup>th</sup> 2018 burned**

**May 4<sup>th</sup> unburned -> May 16<sup>th</sup> 2018 unburned**

Huang et al. 2016

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# PLANET band non-parametric separability analysis



**May 4<sup>th</sup> unburned -> May 16<sup>th</sup> 2018 burned**

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Huang et al. 2016

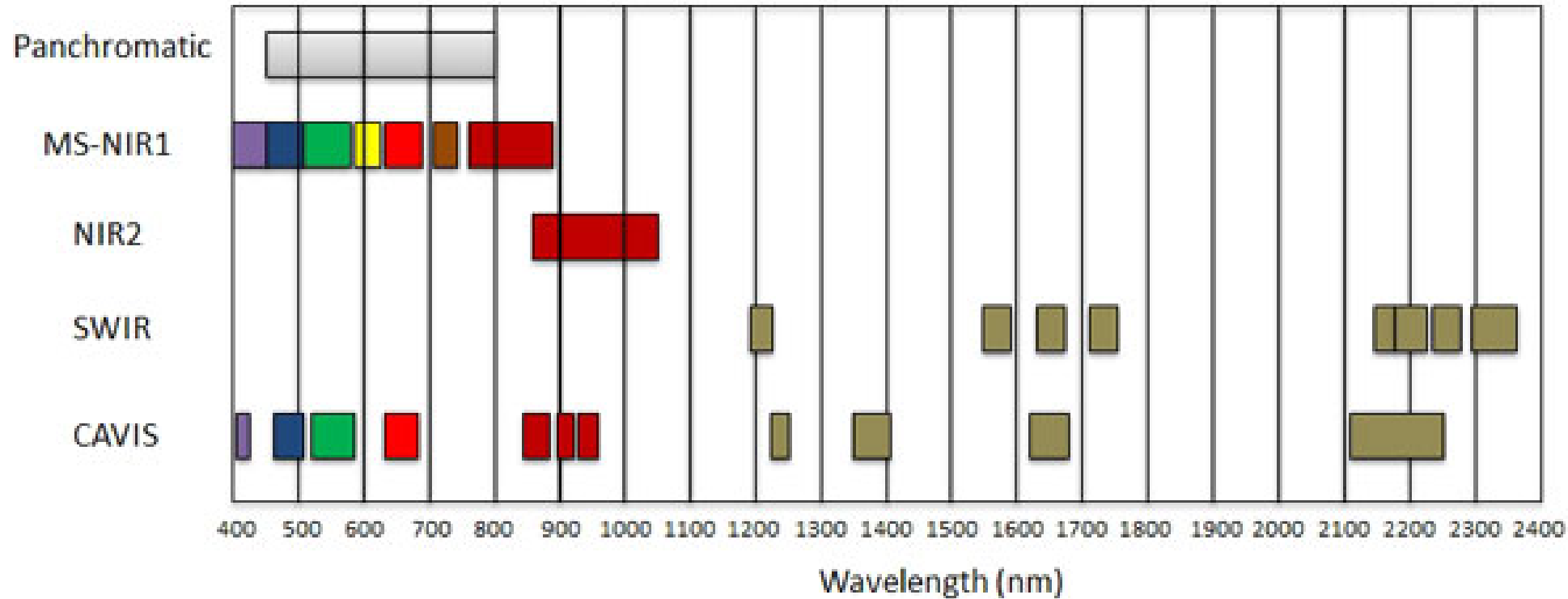
- 200 decision trees grown
- each time using 20% of the training samples selected randomly with replacement
- remaining “out-of-bag” 80% classified

# World View 3

VIS 1.24 m

NIR 1.24 m

SWIR 3.7 m (not orthorectified) 7.5 m (orthorectified) <- useful for burned area mapping with NIR



# World View 3

NASA CAD access: ! easy && ! intuitive

NASA National Aeronautics and Space Administration Goddard Space Flight Center Sciences and Exploration

## NGA Commercial Archive Data

Access to High-Resolution Data for NASA Earth Science Investigators

Home Login Register Forgot Password

### Welcome - About this Site

The National Geospatial-Intelligence Agency (NGA), in partnership with the Civil Applications Committee (CAC), of which NASA is a member, provides access to its immense archive of unclassified commercial high-resolution satellite data to non-DOD government agencies under terms of its NextView contract.

The NextView contract (see slide at left for details) stipulates that the data can be used by all branches, departments, and offices of the U.S. Government. With appropriate approval and acknowledgement, the data can also be shared with NGO's, state/local governments, Intergovernmental agencies, as well as universities, and foreign governments if the use is in support of U.S. government interests. Goddard Space Flight Center has been tasked with providing an interface to these data for NASA-funded investigations.

After registering and logging in, you can submit data request parameters that we use to search for high-resolution commercial satellite data on limited-access NGA interfaces. Details about each of the sensors and their available coverage are also provided here. This site does not directly link to active searching. Search request information is submitted via the web site and the NGA discovery tools are used by our staff to satisfy requests.

### Links

Search vendor archives and other data discovery tools

- [DigitalGlobe ImageFinder](#)
- [DataDoors](#)

Responsible NASA Official : Chris Neigh  
Web Curator: Jaime Nickeson

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Page Last Updated: 11/20/2018

Jamie and the NASA CAD team are *great* but

– not able to interactively browse archive contents (“human in the loop” email process)

- slow to find WV3 data where we have contemporaneous PLANET data
- some WV3 spectral bands not in the NASA CAD archive

# World View 3

1.24 m NIR (948 nm)

**ISSUE:** many WV3 images over burned locations are not orthorectified

Los Padres National Forest  
California  
December 7 2017



# World View 3

1.24 m NIR (948 nm)

Orthorectified using 1/3 arc-sec  
(~10 m) USGS 3D Elevation  
Program (3DEP) DEM

**ISSUE:** high res. DEM  
unavailable outside US

Los Padres National Forest  
California  
December 7 2017



1100 × 950 pixels



# World View 3

1.24 m NIR (948 nm)



1300 × 1300  
1.6 × 1.6 km

Los Padres National Forest  
California  
December 7 2017

3719 × 6461

# World View 3

1.24 m NIR (948 nm)

Burned areas

Active fire



Los Padres National Forest  
California  
December 7 2017

1300 × 1300

1.6 × 1.6 km

# World View 3

3.7 m SWIR  
(1210, 1570, 1660 nm)

Resampled to  
1.24 m

**ISSUE:** SWIR bands lower spatial resolution & not well aligned with other bands



1300 × 1300

1.6 × 1.6 km

Los Padres National Forest  
California  
December 7 2017

# World View 3

3.7 m SWIR  
(1210, 1570, 1660 nm)  
Pansharpened and  
coregistered to  
1.24 m



Los Padres National Forest  
California  
December 7 2017

1300 × 1300

1.6 × 1.6 km

# World View 3

1.24 m NIR (948 nm)



Los Padres National Forest  
California  
December 7 2017

1300 × 1300

1.6 × 1.6 km

Planet

3 m NIR (948 nm)

December 4 2017

Los Padres National Forest  
California



537 × 537

1.6 × 1.6 km

# World View 3

1.24 m NIR (948 nm)

December 7 2017



Los Padres National Forest  
California

1300 x 1300

1.6 x 1.6 km

Planet

3 m NIR (948 nm)

December 18 2017

Los Padres National Forest  
California



537 × 537

1.6 × 1.6 km



# Summary: Commercial satellite data evaluation for burned area mapping & validation of Landsat-8 Sentinel-2 African burned area product

## Plan to use

- PLANET 3m VIS and NIR (near daily)
- World View 3 1.24 m NIR (less frequent)  
1.24 m pansharpened SWIR (less frequent)

## Issues

- PLANET among image atmospheric correction discontinuities (developed a normalization solution)
- World View 3
  - ordering vis NASA CAD cumbersome
  - orthorectification unlikely to be reliable where no high res. DEM
  - SWIR band coregistration and panshaping needed (developed a solution)

See our MuSLI Talk Thursday 10.50-11.10 am for PLANET validation examples