Where are the Missing Burned Areas?

Global Hotspots of Burned Area - A Multiresolution Analysis

David Roy [a, b], Haiyan Huang [a], Luigi Boschetti [c], Hugo De Lemos [a], Louis Giglio [d]

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[b] Department of Geography, Environment, and Spatial Sciences, Michigan State University

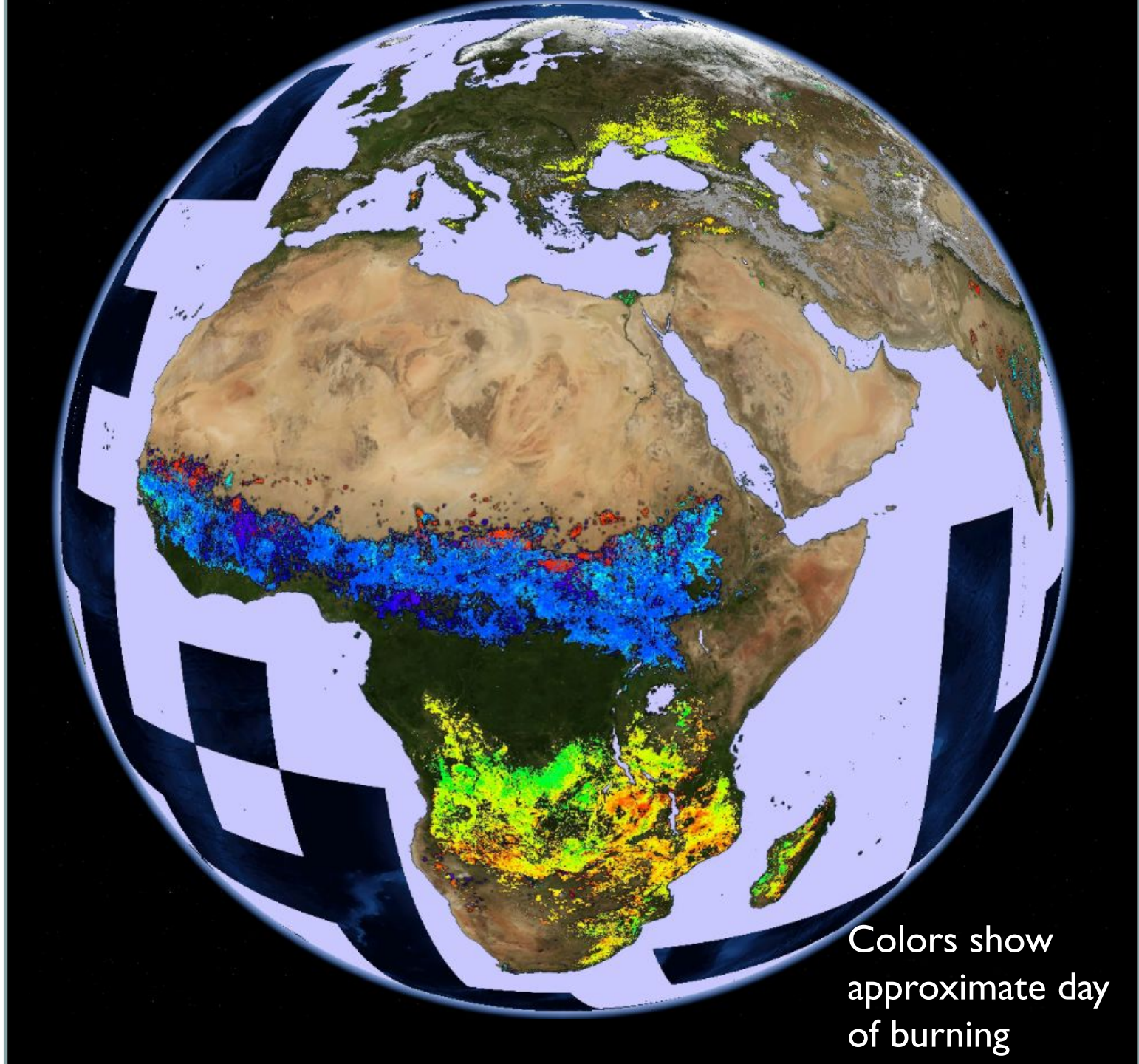
[c] College of Natural Resources, University of Idaho

[d] Department of Geographical Sciences, University of Maryland, College Park

NASA LCLUC Science Team Meeting, May 8-12th, College Park, MD, USA

The definitive global burned area record:

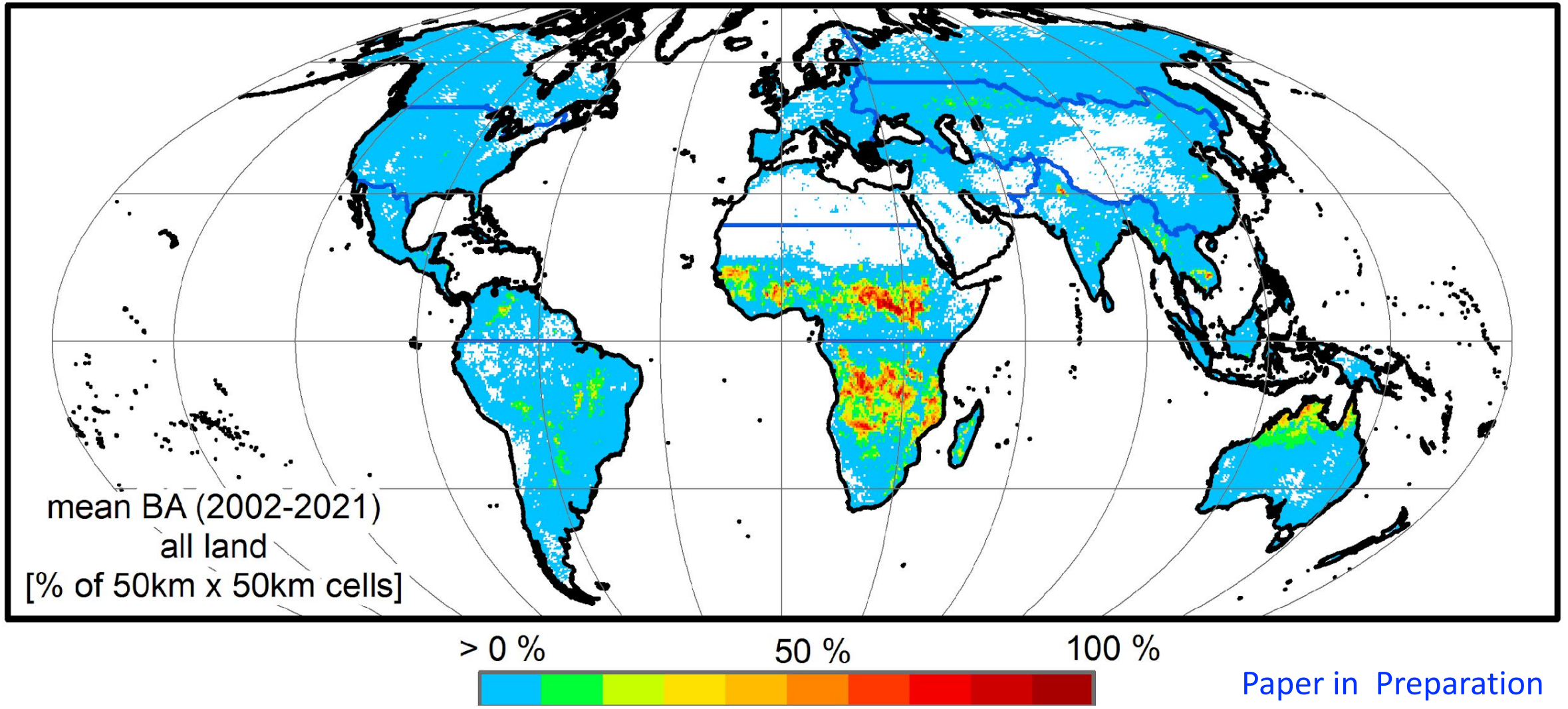
NASA MODIS 500m burned area product



Giglio, Boschetti, Roy, Humber, Justice, 2018, *RSE*

Mean Burned Area mapped by NASA MODIS 500m product for 2002-2021

on average 2.7 % of the land surface reported as burned each year



Paper in Preparation

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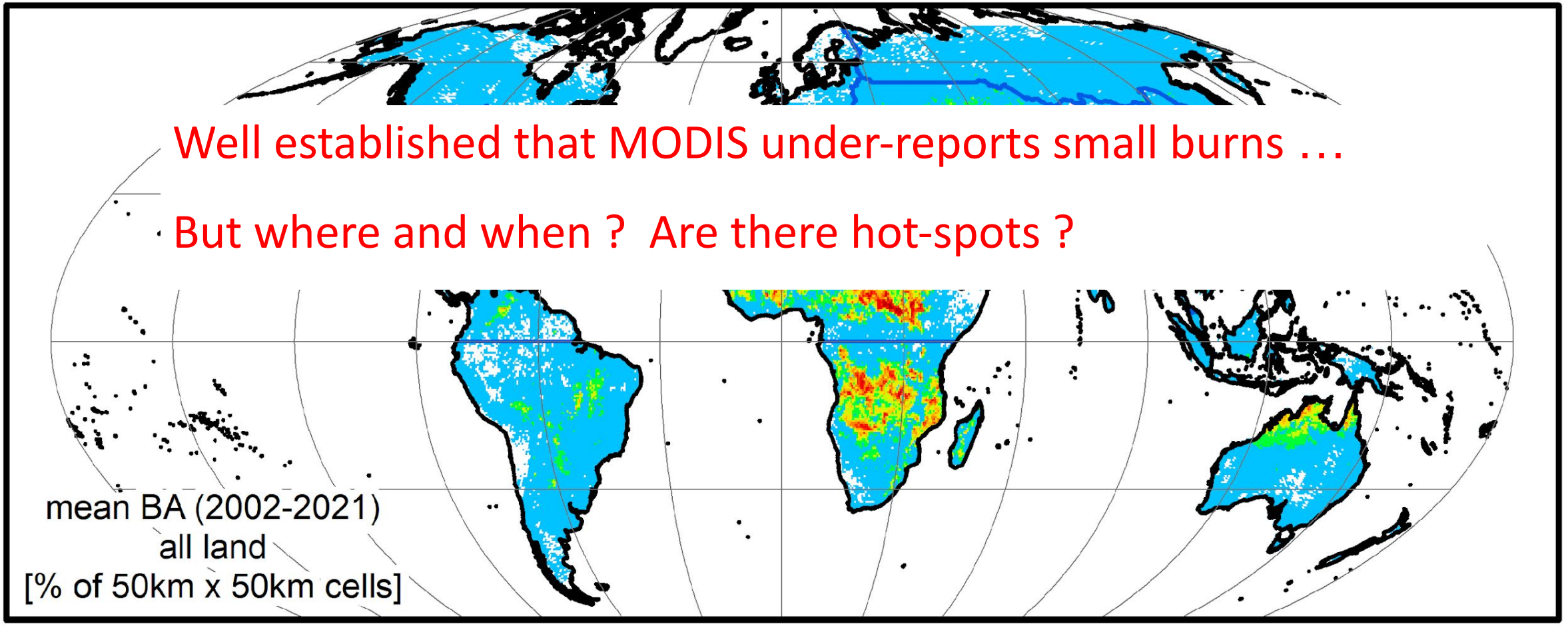


Paper in Preparation

Under-reporting example

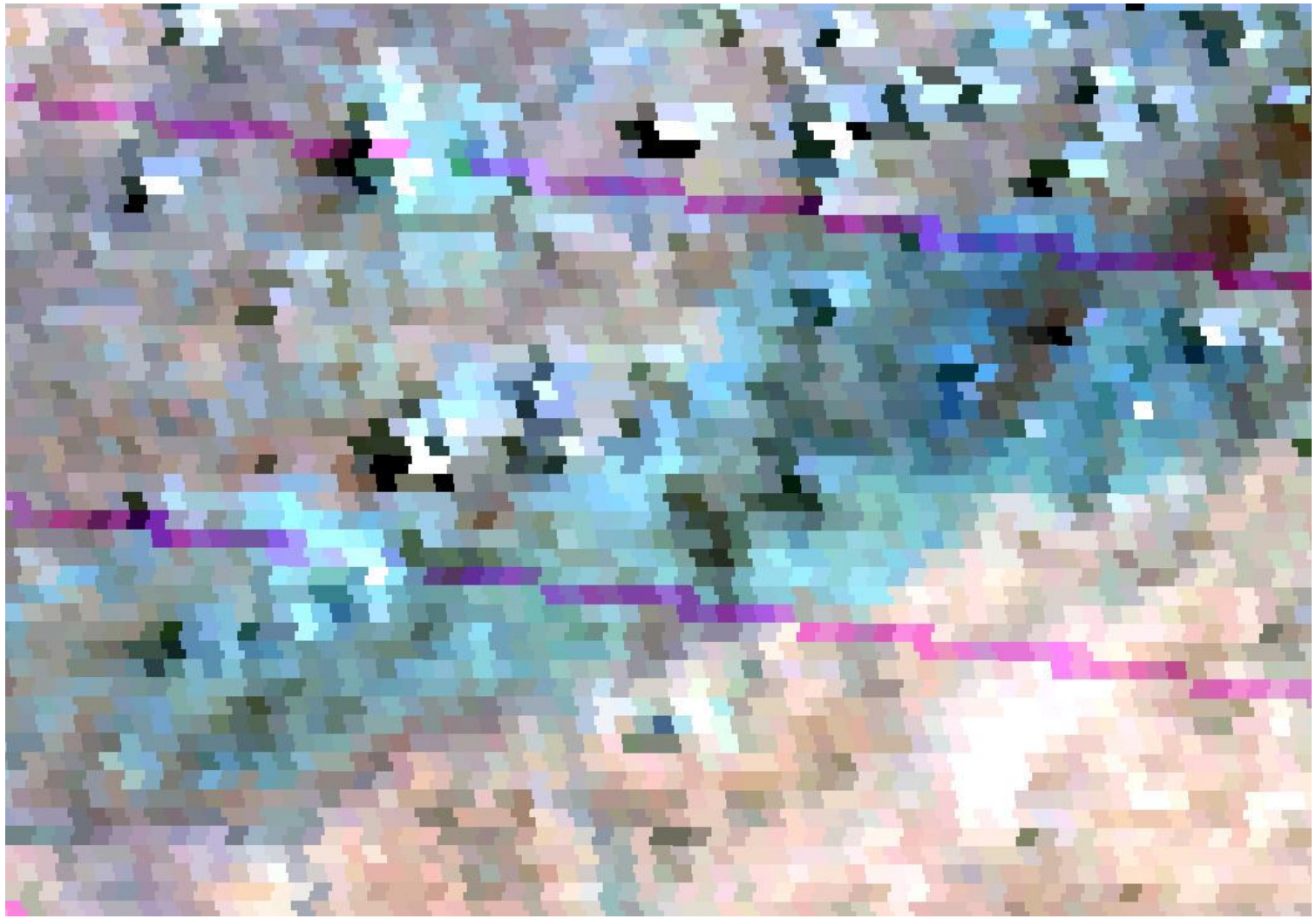
August 24th 2001

Road North to the Chimaliro forest reserve, Malawi

miombo woodland reserve - the hilly area on the horizon

September 26th 2001, Chimaliro forest reserve

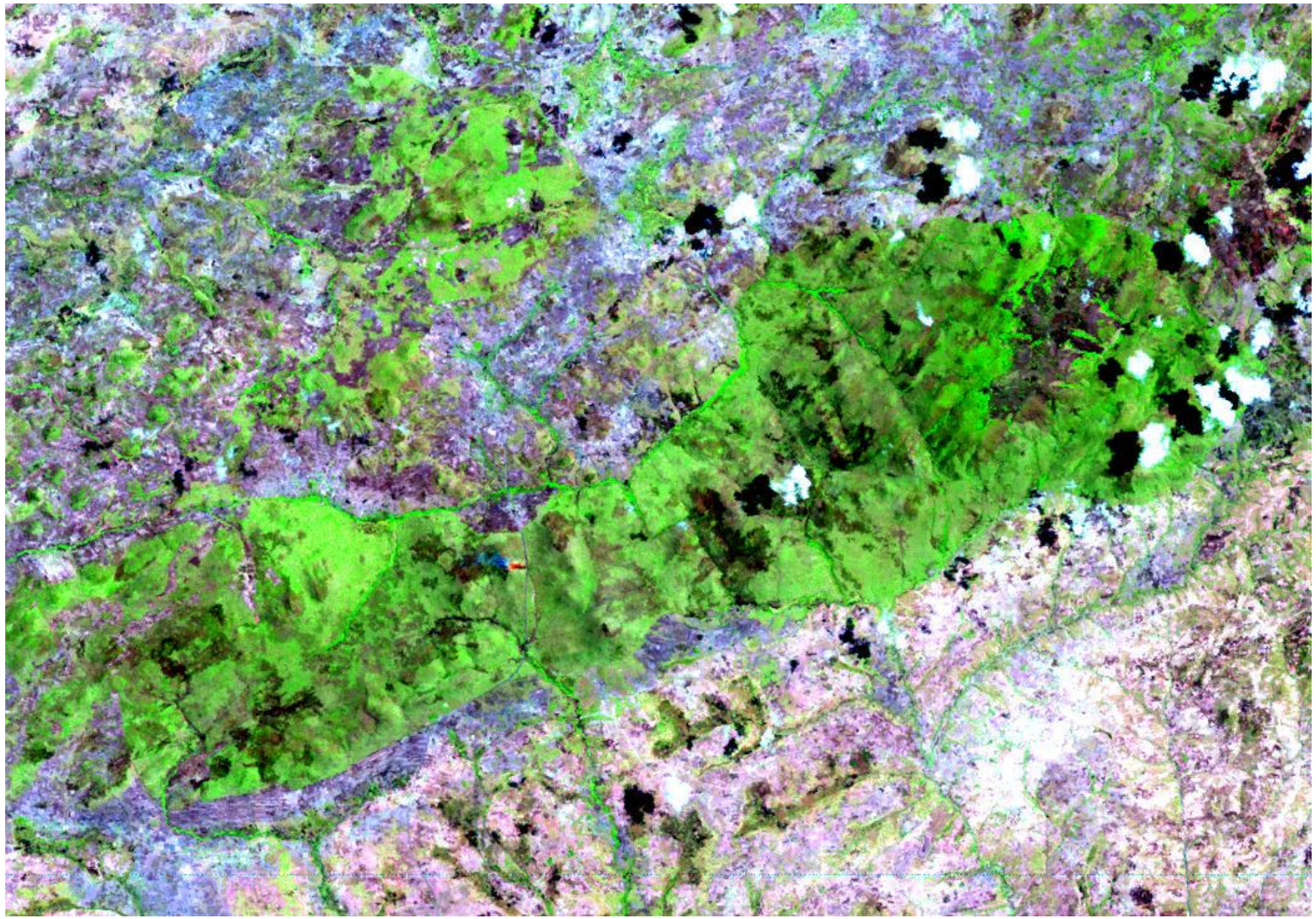
MODIS 500 m pixels (1.65μm, 1.24μm, 0.86μm)



31km x 23km

September 26th 2001, Chimaliro forest reserve

Landsat 30 m pixels (1.65μm, 0.82μm, 0.66μm)



31km x 23km

Quantifying small burns is rather important for applications and science !

JOURNAL OF GEOPHYSICAL RESEARCH
Biogeosciences
AN AGU JOURNAL

JGR

Global burned area and biomass burning emissions from small fires

J. T. Randerson ✉, Y. Chen, G. R. van der Werf, B. M. Rogers, D. C. Morton

First published: 11 December 2012

"Accounting for small fires increased total global burned area by ~35%,

but a formal quantification of uncertainties was not possible … "

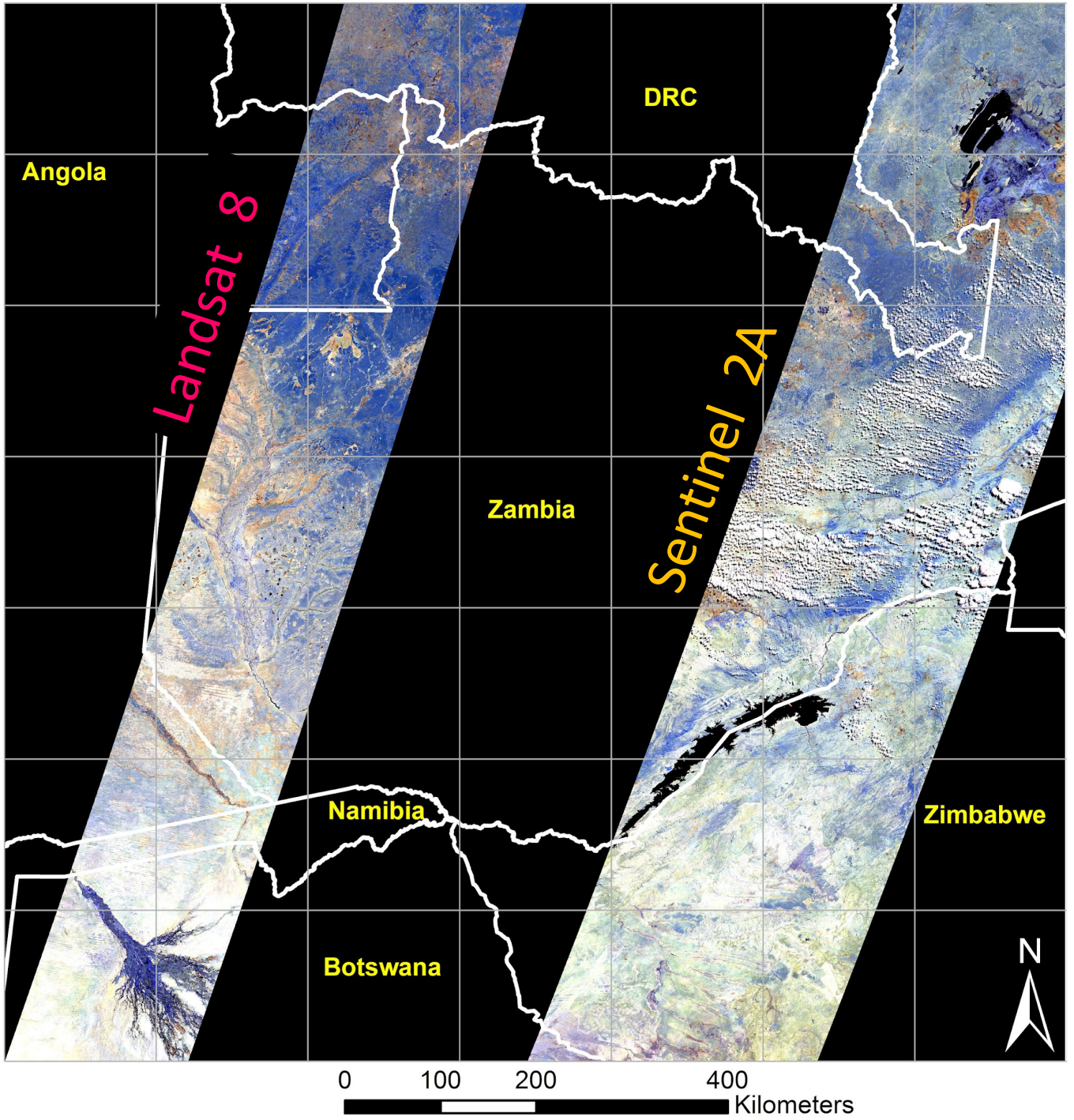
Under our previous NASA LCLUC funding:

Africa 30 m
NASA Harmonized Landsat Sentinel-2 (HLS)
Burned Area Product Generation

Roy, Huang, et al. 2019, Landsat-8 and Sentinel-2 burned area mapping - a combined sensor multi-temporal change detection approach, *RSE*, 231, 111254.

Landsat 8 and Sentinel S2

same day

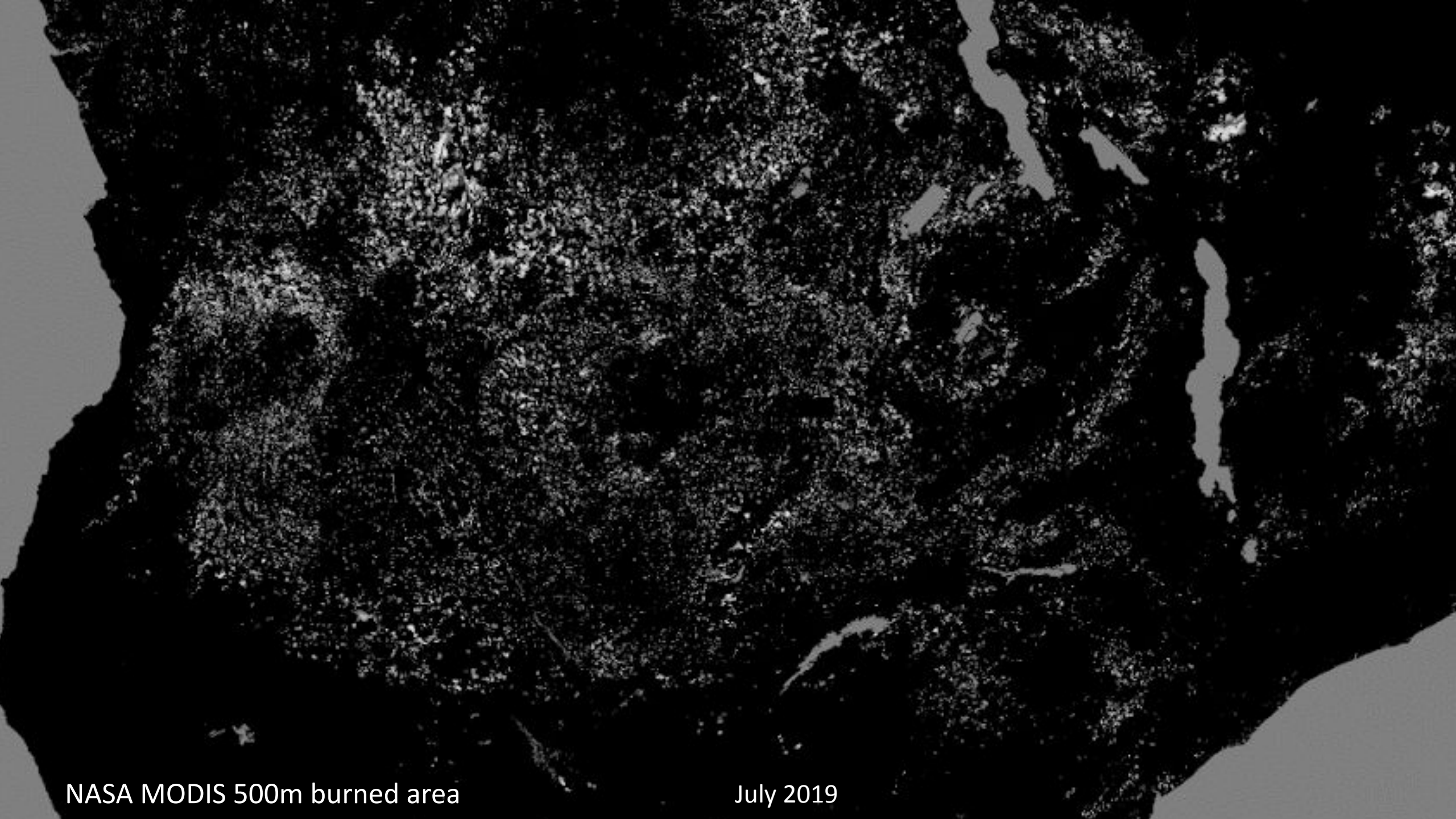


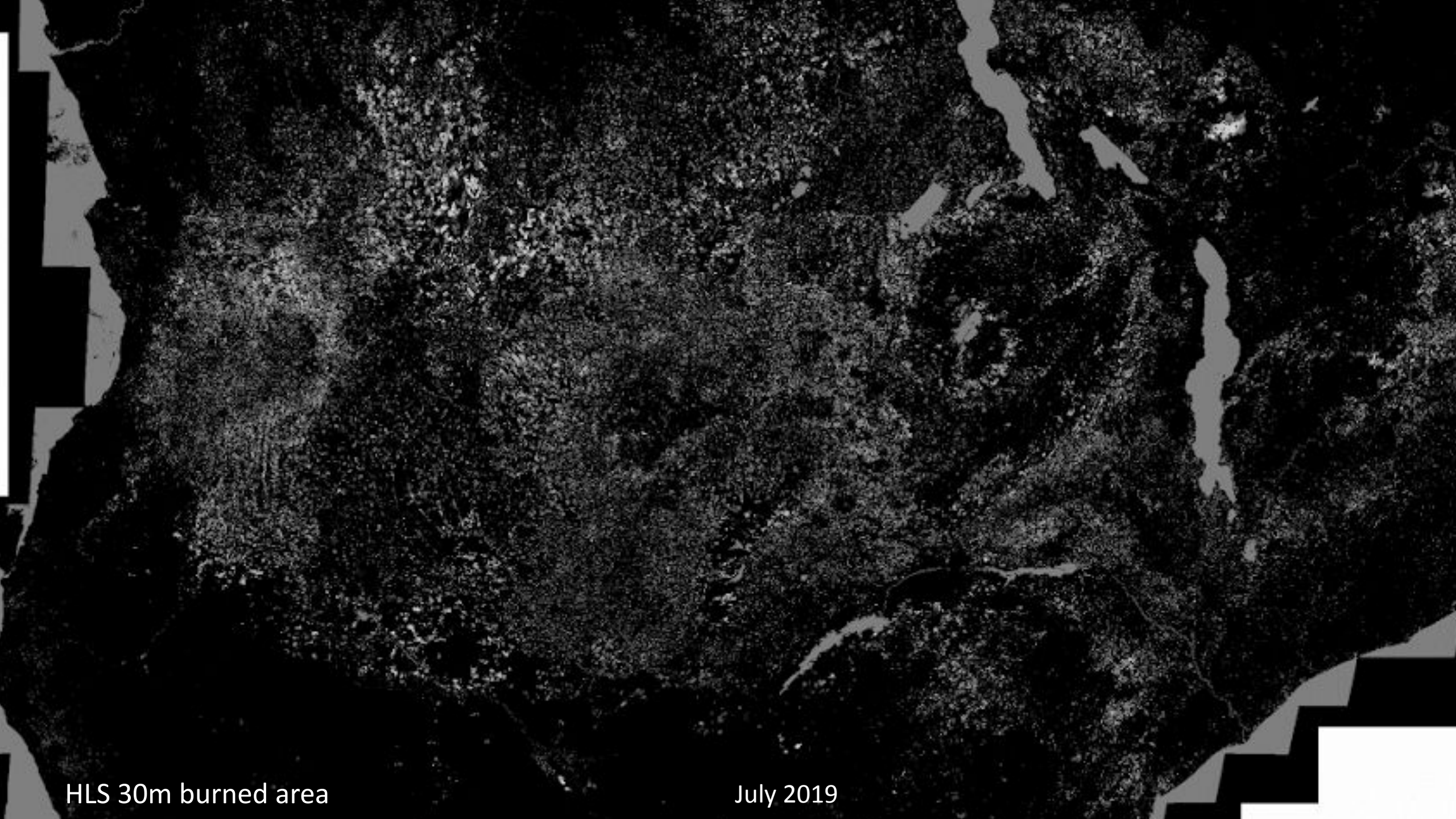
Harmonized Landsat Sentinel-2

Home | Algorithms | Products Description | Test Sites | Data | QA | Documents | News

- 30 m gridded
- atmospherically corrected
- near-global coverage
- global median revisit 3 days

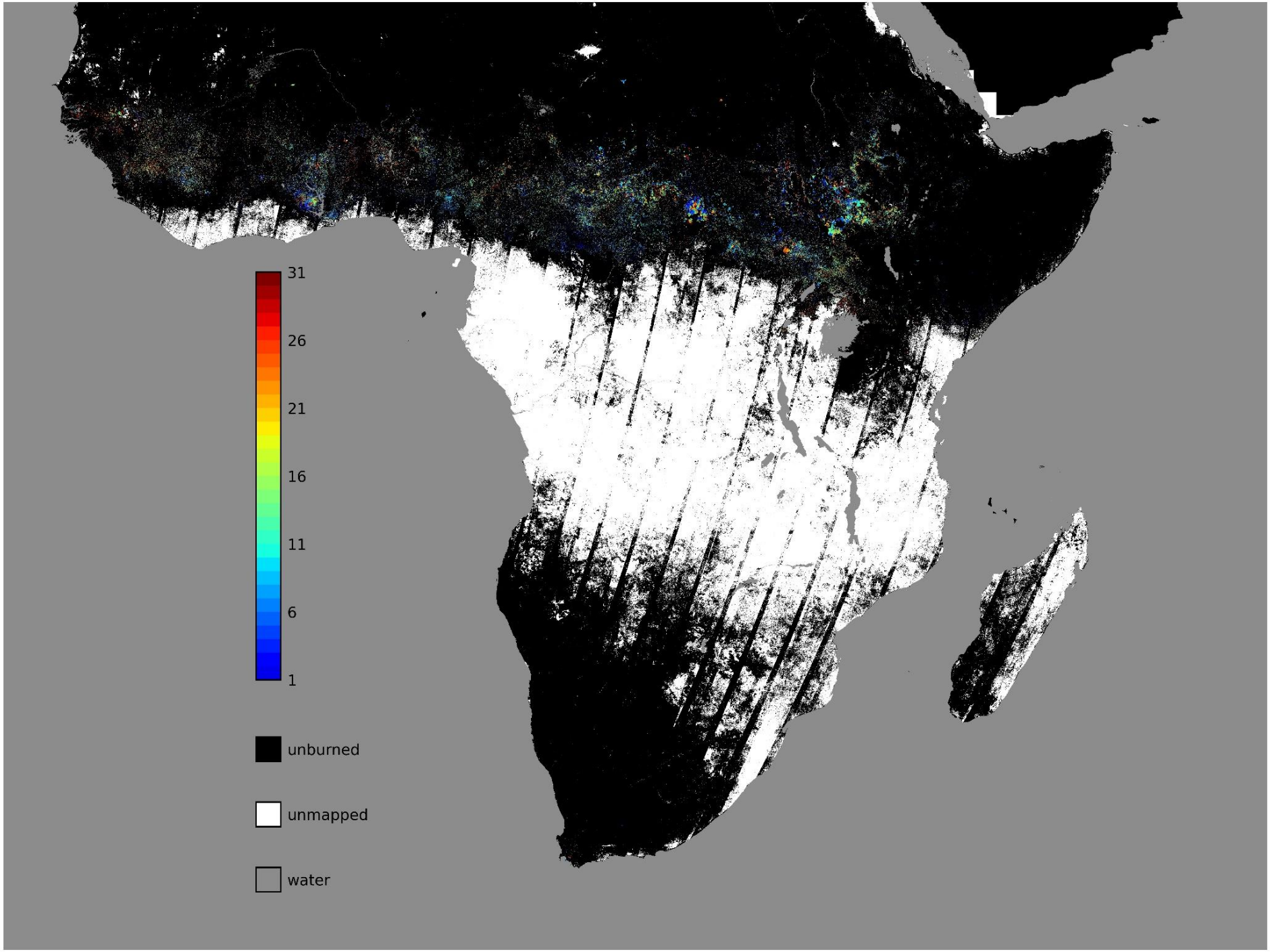
New opportunity for monitoring land surface change at scales where human activity is discernable


NASA MODIS 500m burned area
July 2019


HLS 30m burned area
July 2019

Sentinel-2 &
Landsat-8 30 m
Burned Area

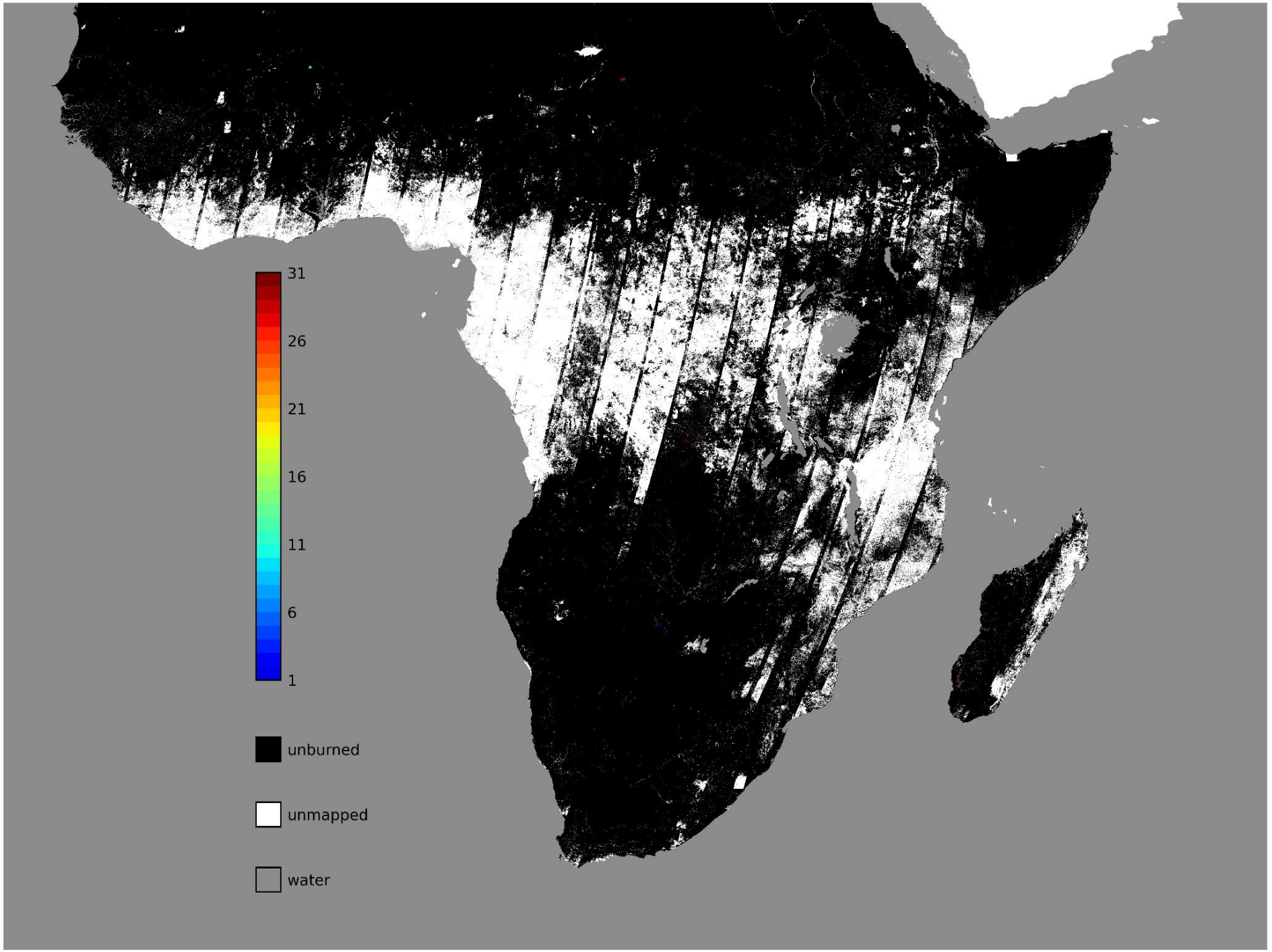
Jan 2019



2861
109 x 109 km
HLS tiles

Sentinel-2 &
Landsat-8 30 m
Burned Area

Apr 2019



2861
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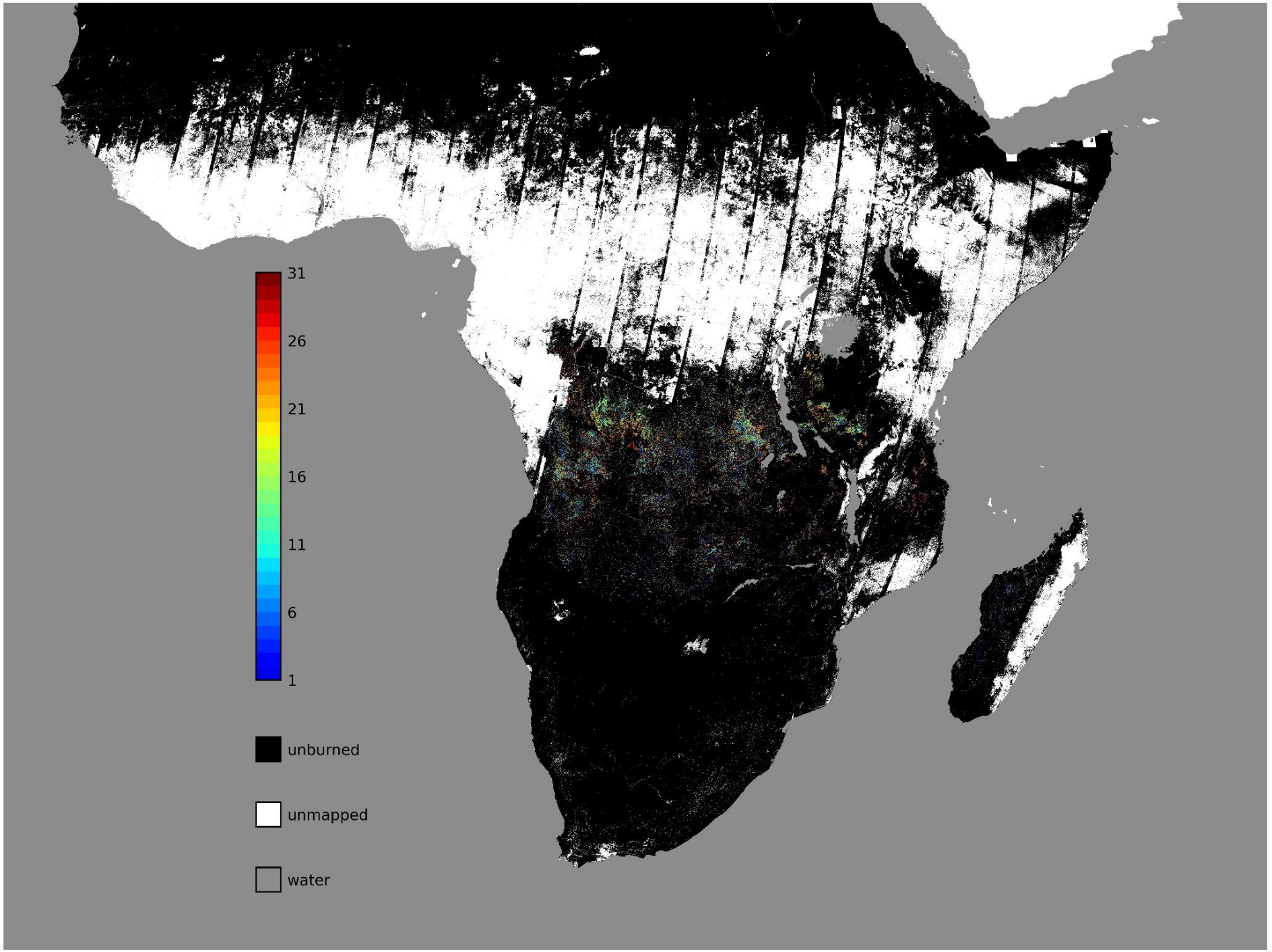
Sentinel-2 &
Landsat-8 30 m
Burned Area

June 2019



2861
109 x 109 km
HLS tiles

Sentinel-2 &
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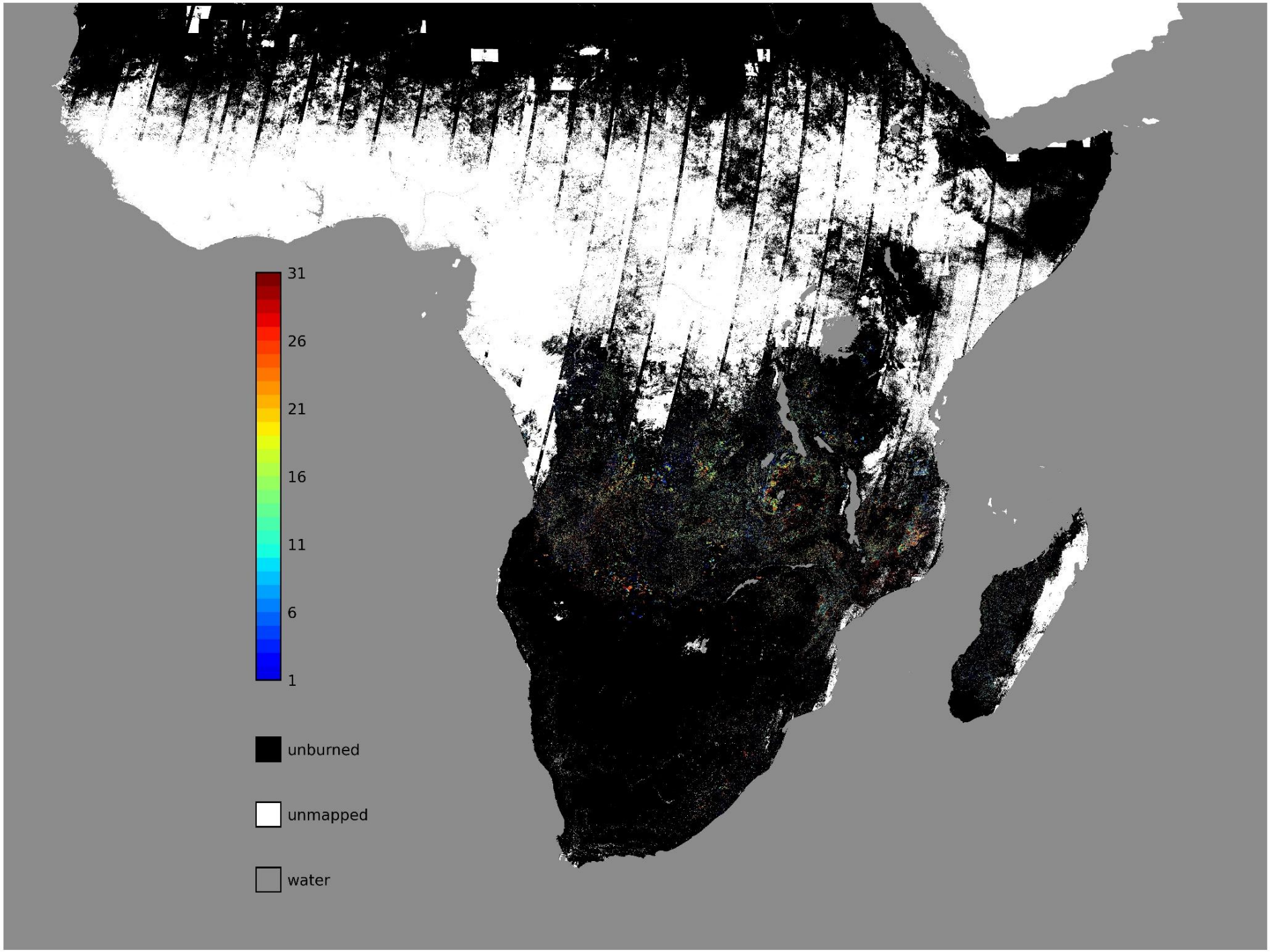
Burned Area

Aug 2019



2861
109 x 109 km
HLS tiles

Where are the Missing Burned Areas?
Global Hotspots of Burned Area - A Multiresolution Analysis

- **Task #1** Identify global hot-spots of burned areas, specifically where the burns are missing at MODIS 500 m resolution.
- **Task #2** Map the burned area in the identified hot-spots at 30 m resolution.
- **Task #3** Validate the 30 m burned area hot-spot mapping results using contemporaneous 3m PlanetScope data.
- **Task #4** Provide the hot-spot 30 m burned area maps and 3 m PlanetScope validation data to the public.
- **Task #5** Quantify the global MODIS 500 m burned area product underestimation due to its omission of small burns.

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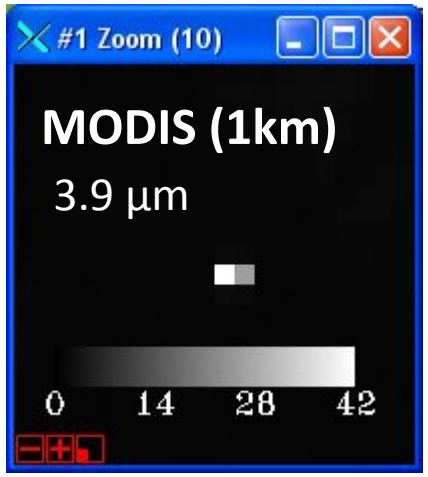
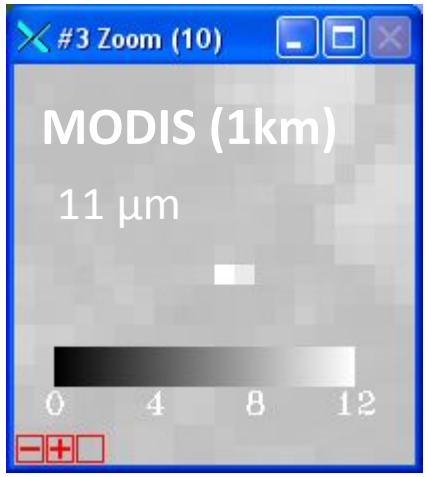
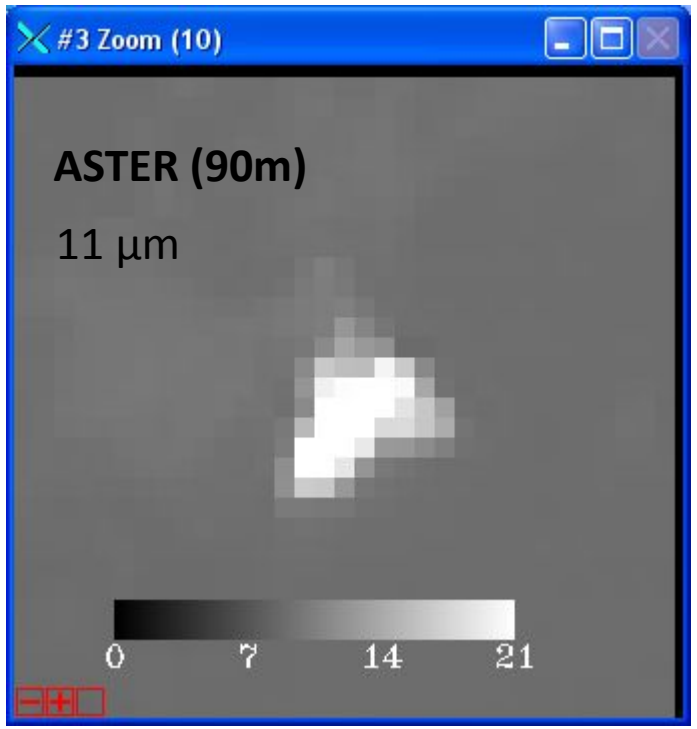
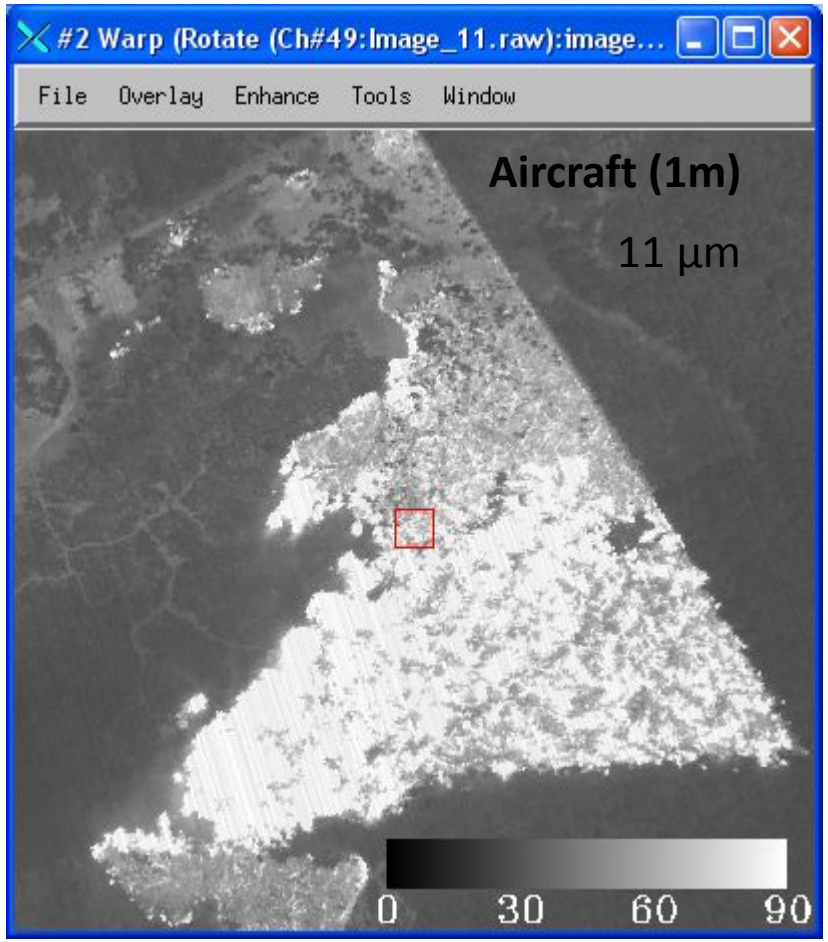




radiance [W m^{-2} um^{-1} sr^{-1}]



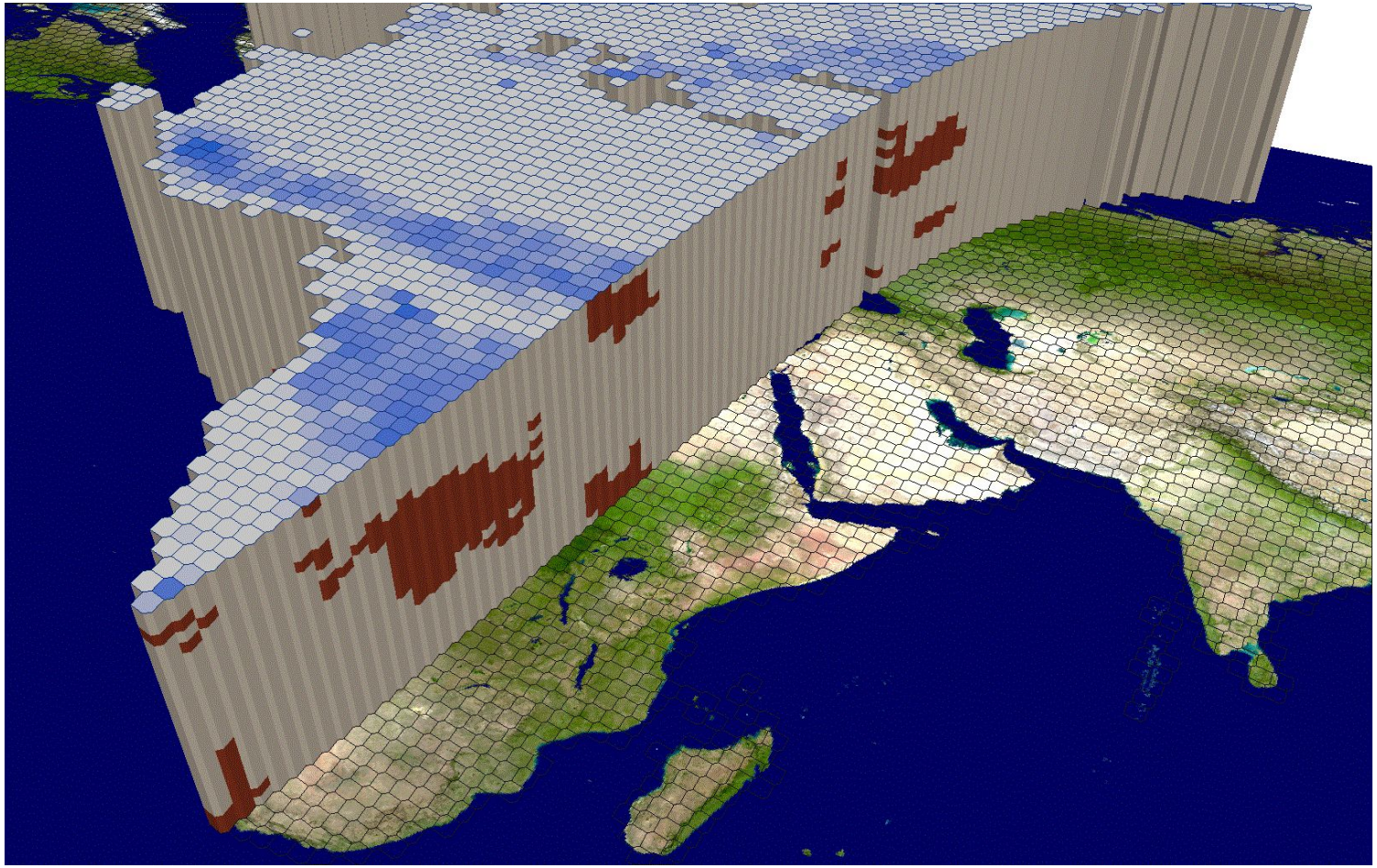
Well established that thermal λ active fire detection algorithms can detect small fires not apparent in reflective λ data



uncalibrated raw counts

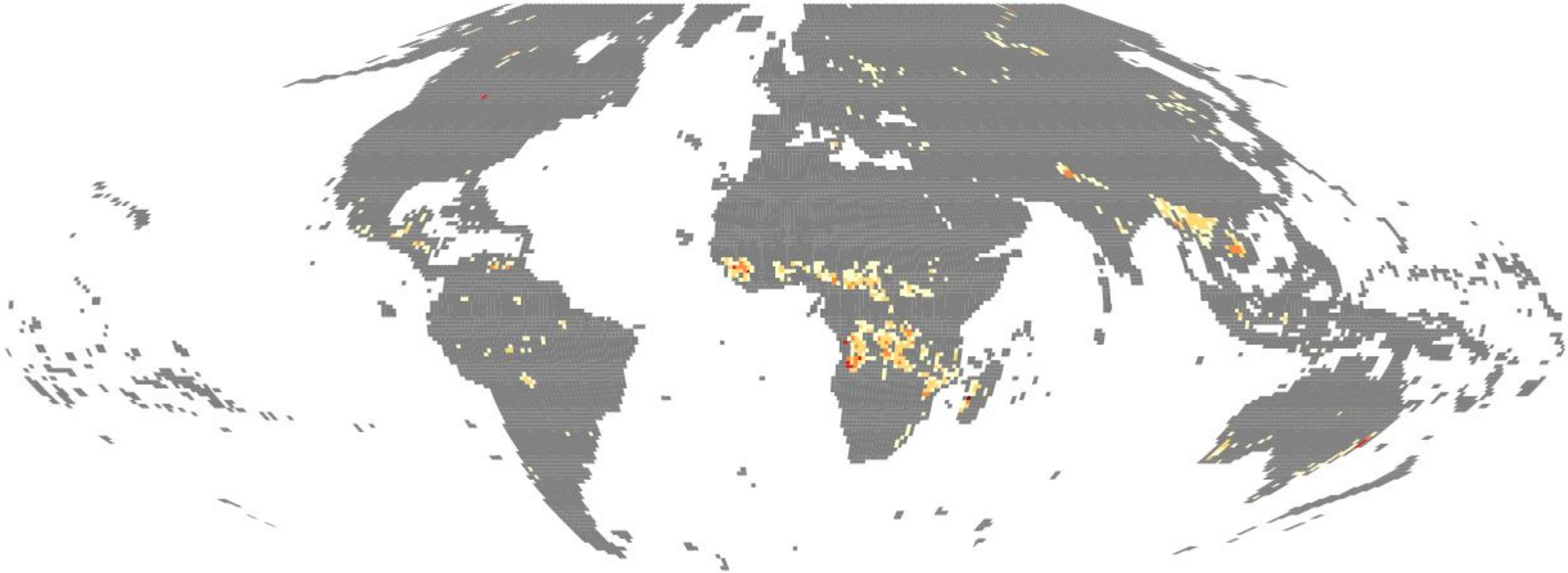
Roraima,
Brazil, Jan. 28 2003

Hot-spot selection approach



- Spatial stratification
  - HLS 109 x 109 km tile grid
  - 7 biome global map
- Temporal stratification
  - calendar months

- Rank the HLS tiles in each month by the proportion of VIIRS 375 m active fire detections occurring outside 500 m MODIS burned areas

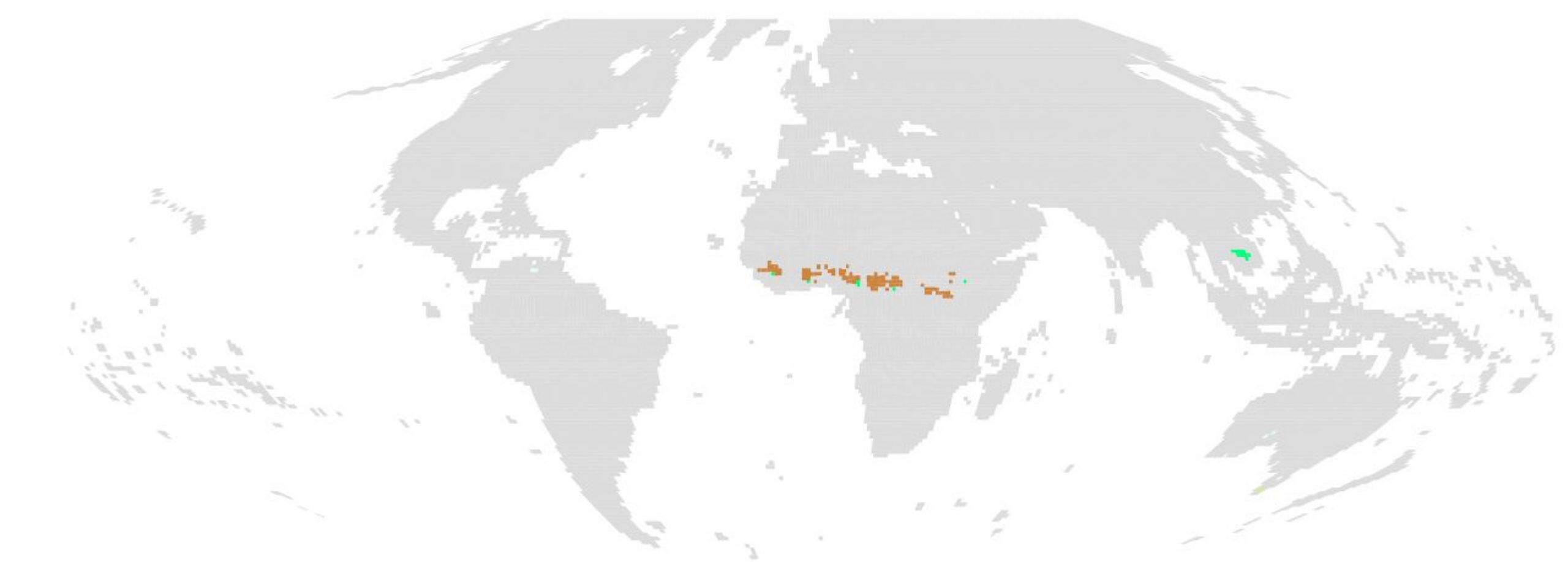


Count

0
1
2
3
4
5

All 12 months of 2019

Top 1000 hot-spots with greatest incidence of VIIRS 375 m active fire detections outside of MODIS 500 m burned areas (different number selected per biome using a biome area proportional allocation)

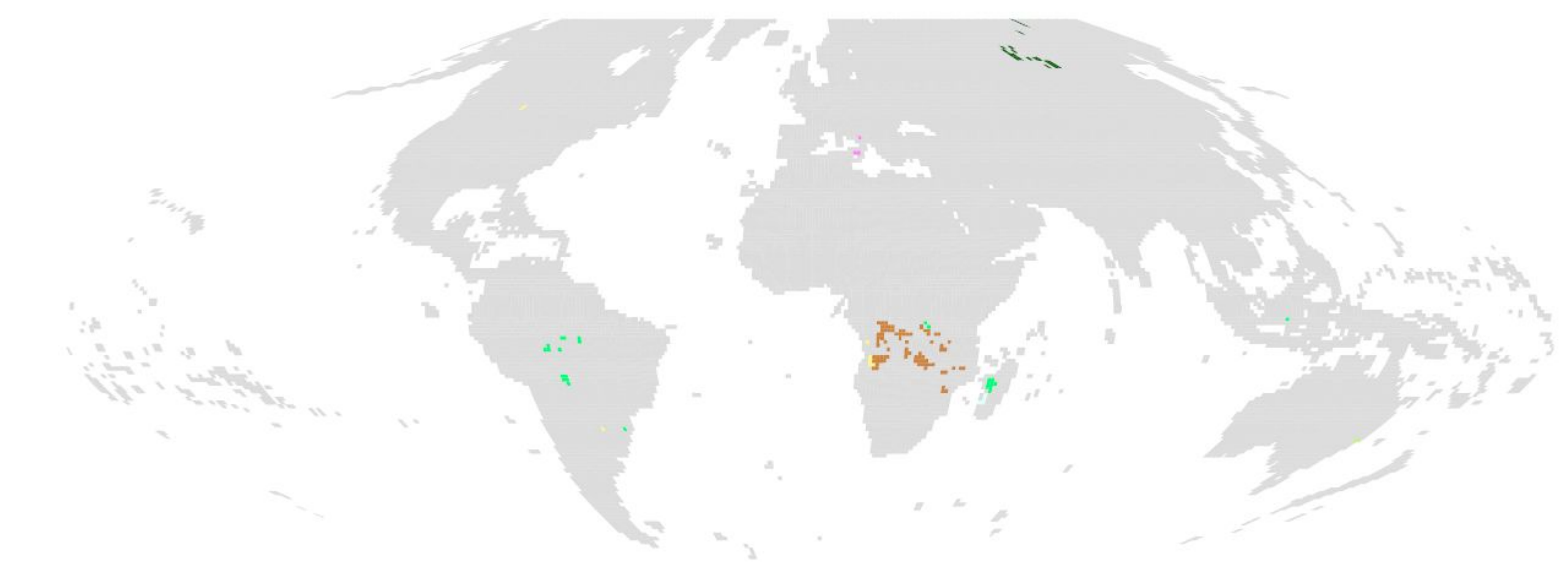


Biome

- tropical_forest , 15
- temperate_forest , 1
- boreal_forest , 0
- tropical_savannah , 90
- temperate_savannah , 0
- mediterranean , 0
- deserts_and_xeric_shrublands , 4

January 2019

Of the 1000 the top 110 hot-spots with greatest incidence of VIIRS 375 m active fire detections outside of MODIS 500 m burned areas

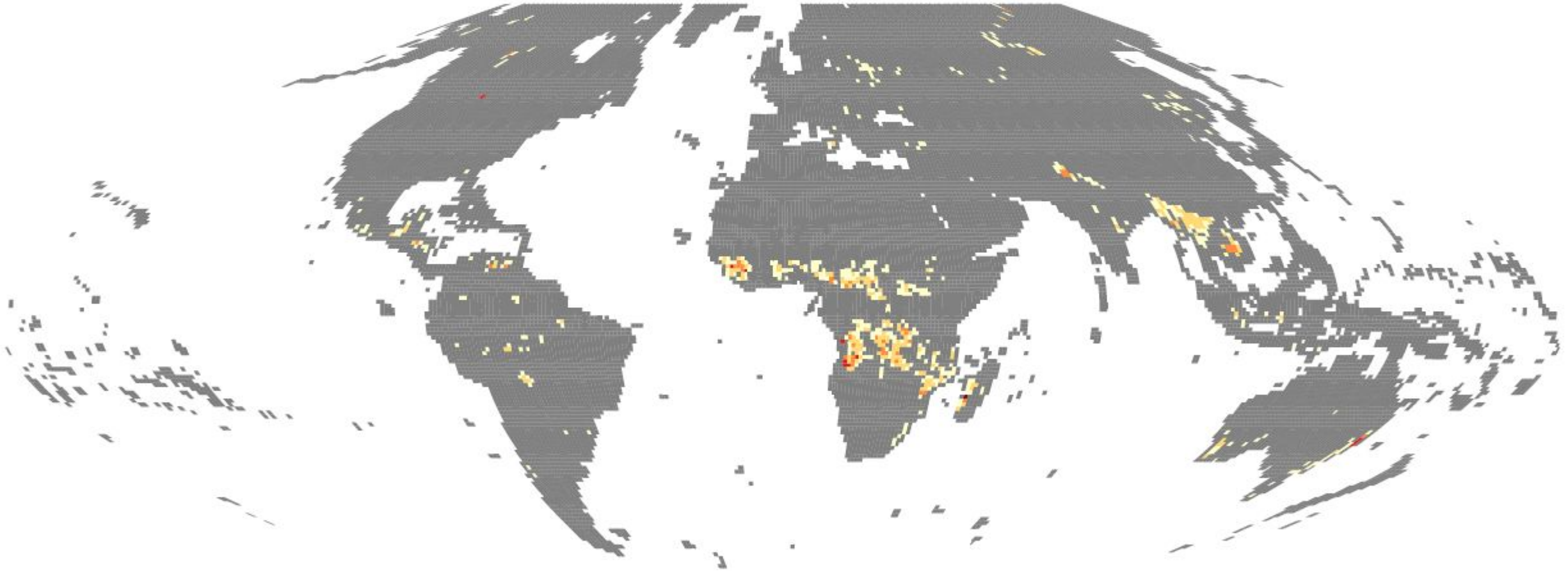


Biome

- tropical_forest , 25
- temperate_forest , 1
- boreal_forest , 19
- tropical_savannah , 77
- temperate_savannah , 7
- mediterranean , 3
- deserts_and_xeric_shrublands , 4

August 2019

Of the 1000 the top 136 hot-spots with greatest incidence of VIIRS 375 m active fire detections outside of MODIS 500 m burned areas



- We have generated monthly ranked hot-spot lists with 1000s of entries per month (as there are >18,000 HLS land tiles)
- Final ones used (for Tasks #2-5) depend on HLS and PlanetScope availability

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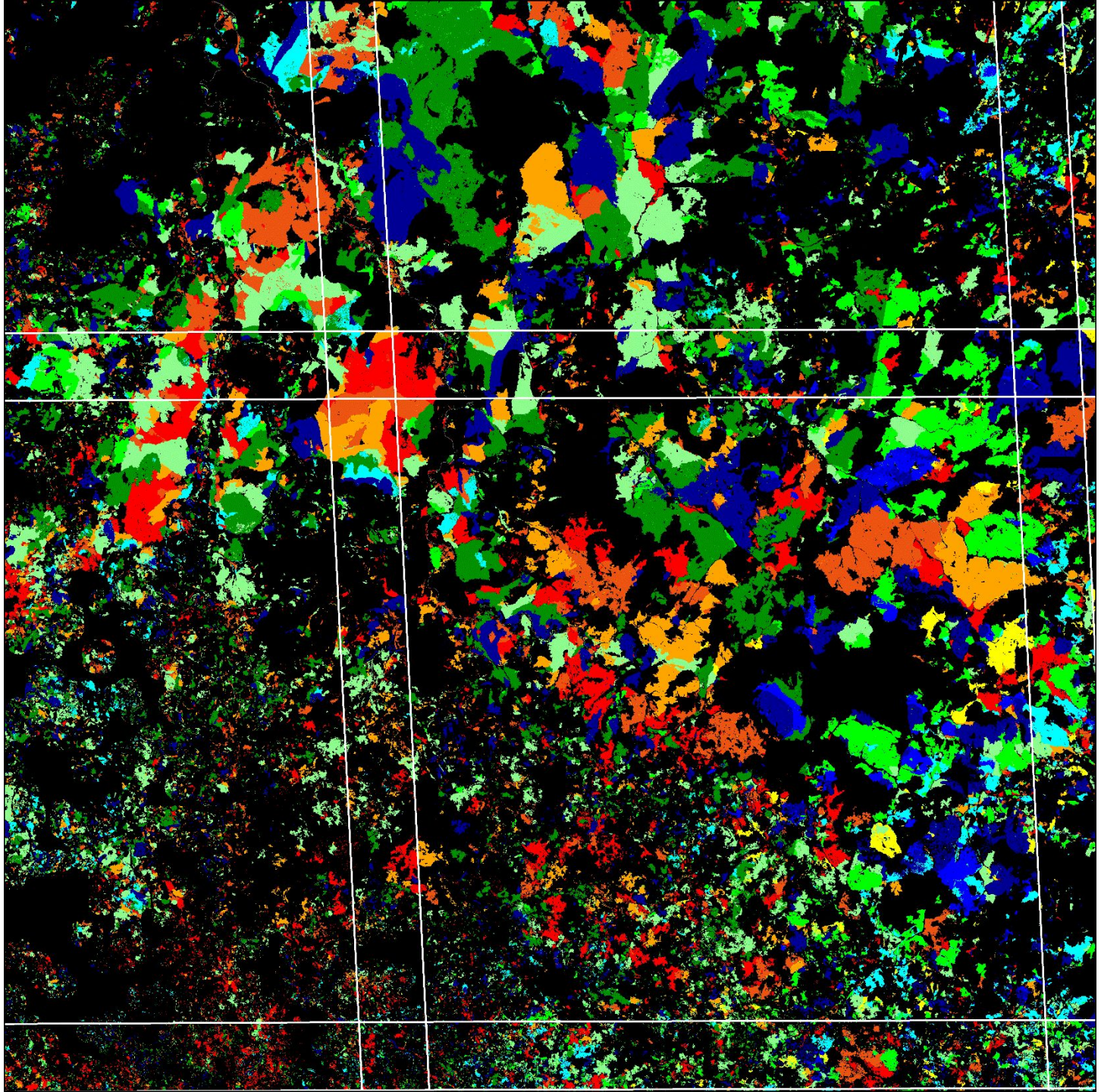
HLS 30 m
burned area



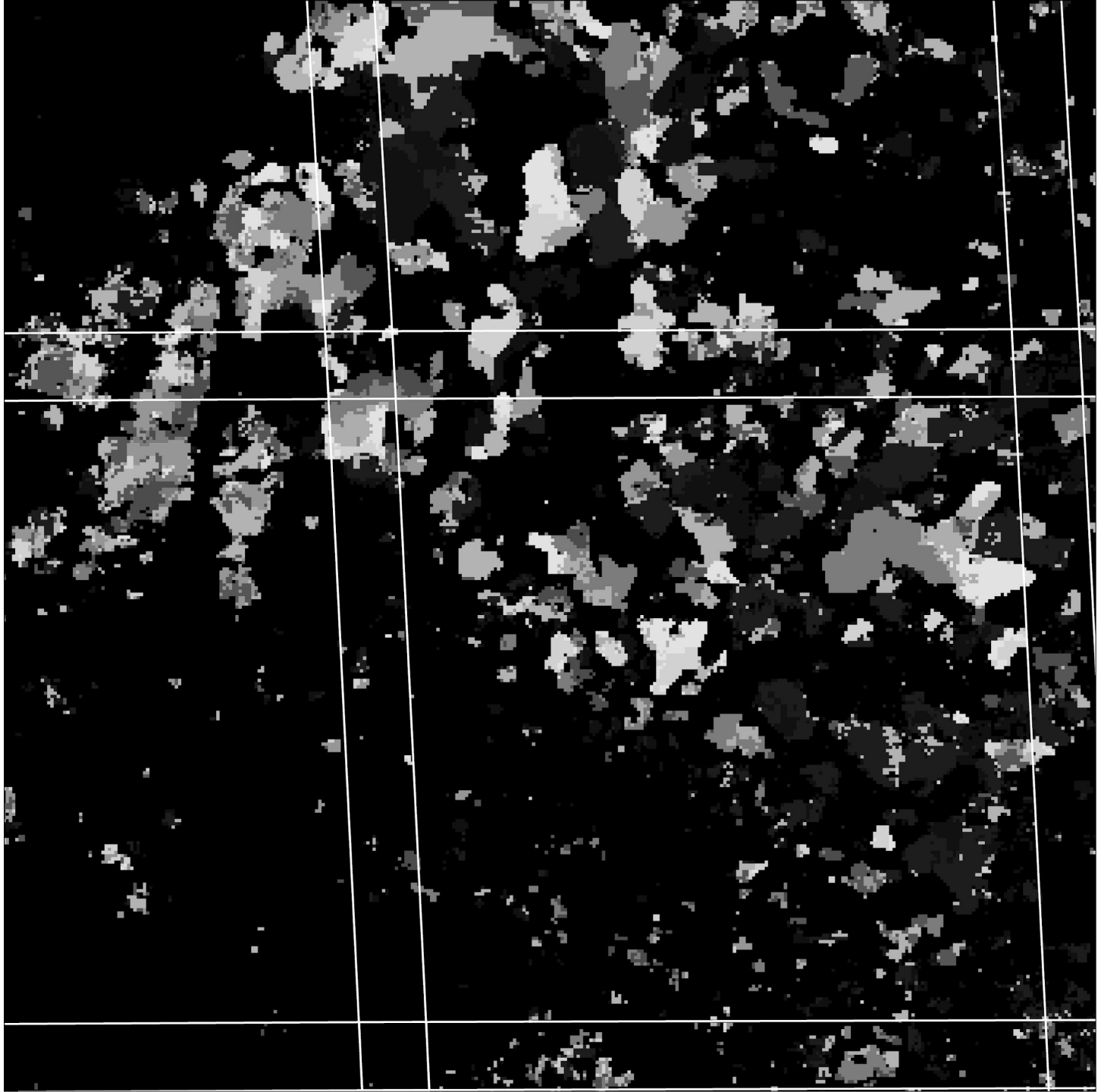
Example selected hot-spot tile

Jan 2019

109 x 109 km HLS tiles

center at 6.70°N, 18.77°E

MODIS 500 m
burned area



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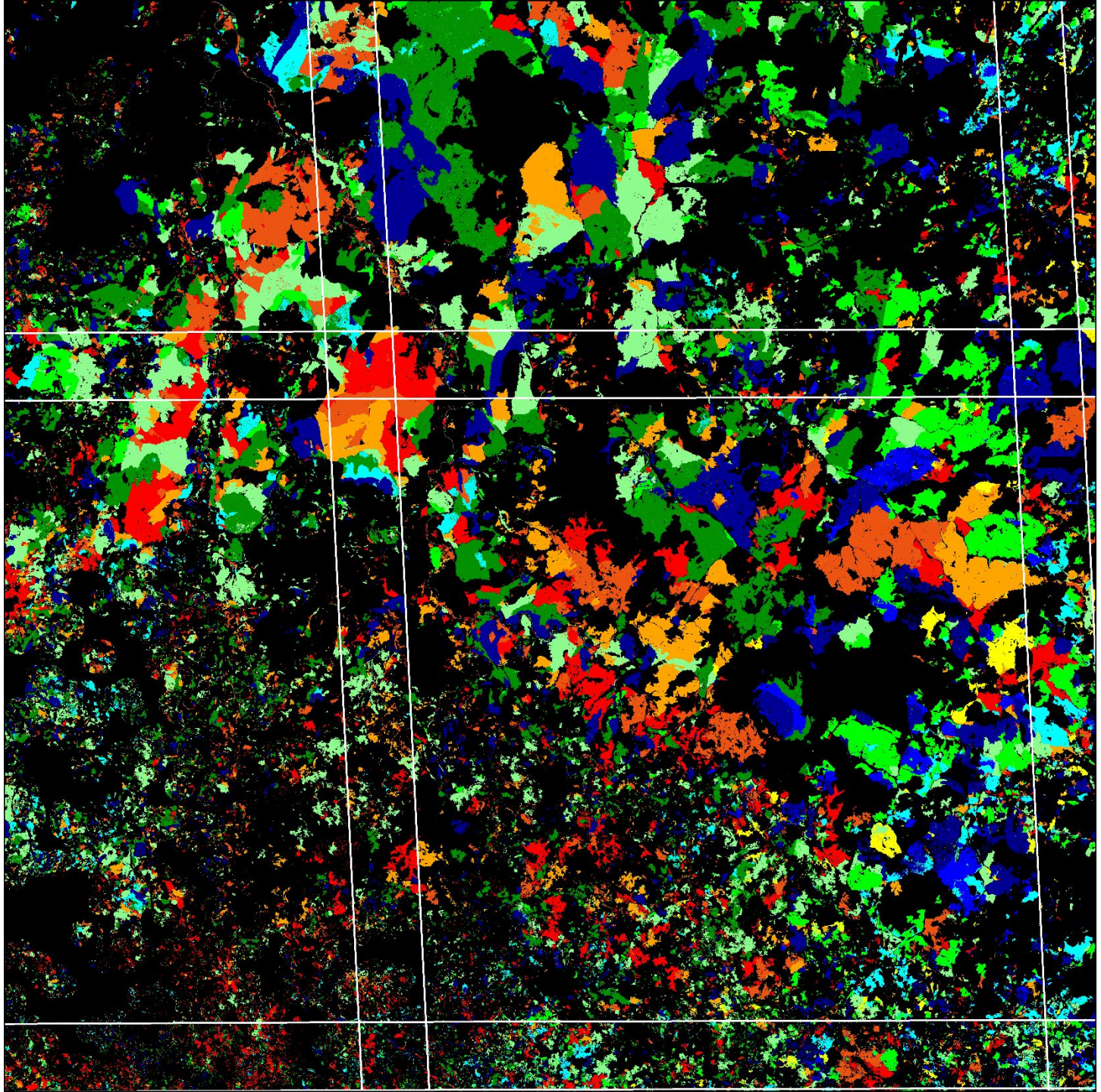

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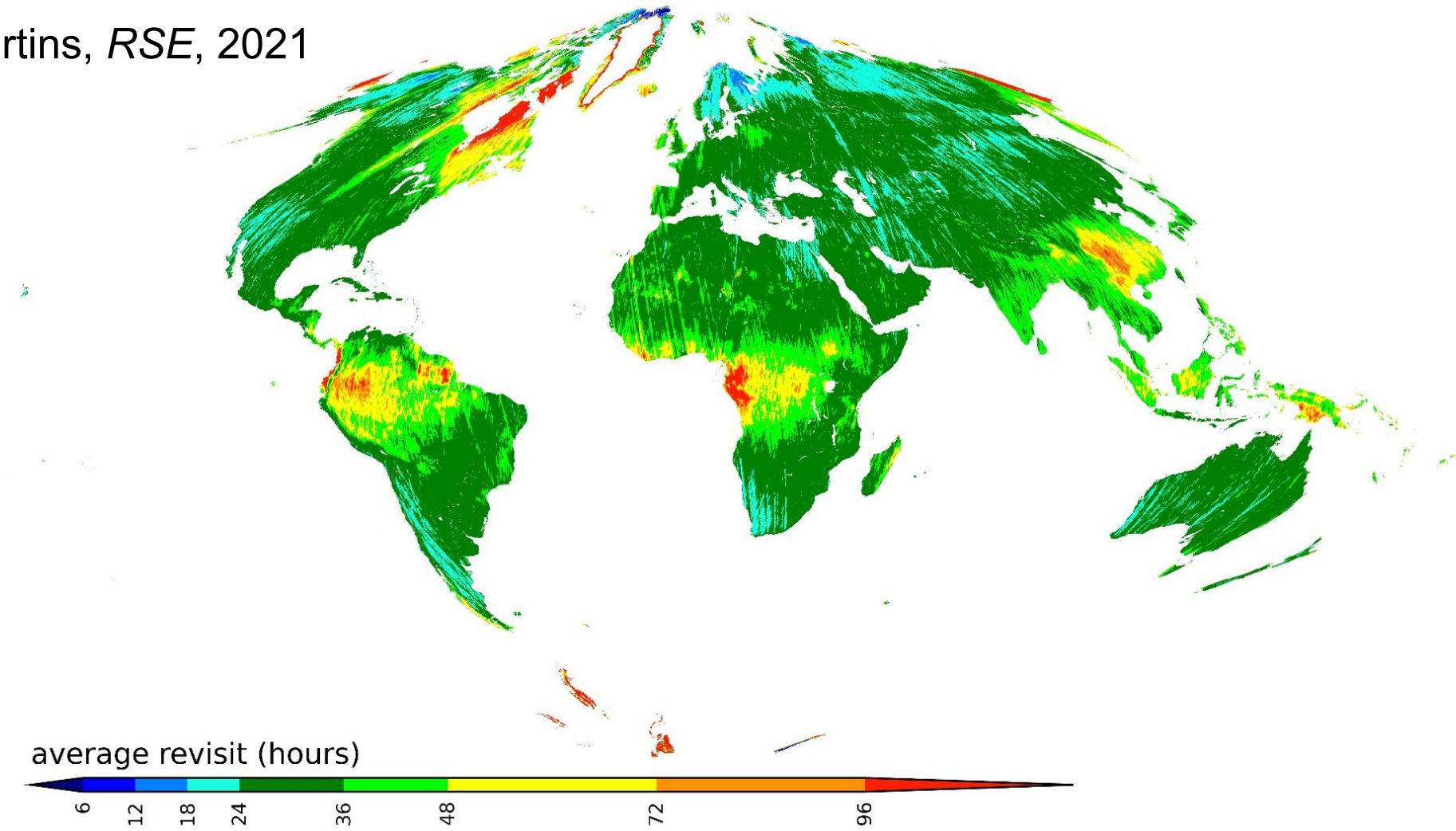
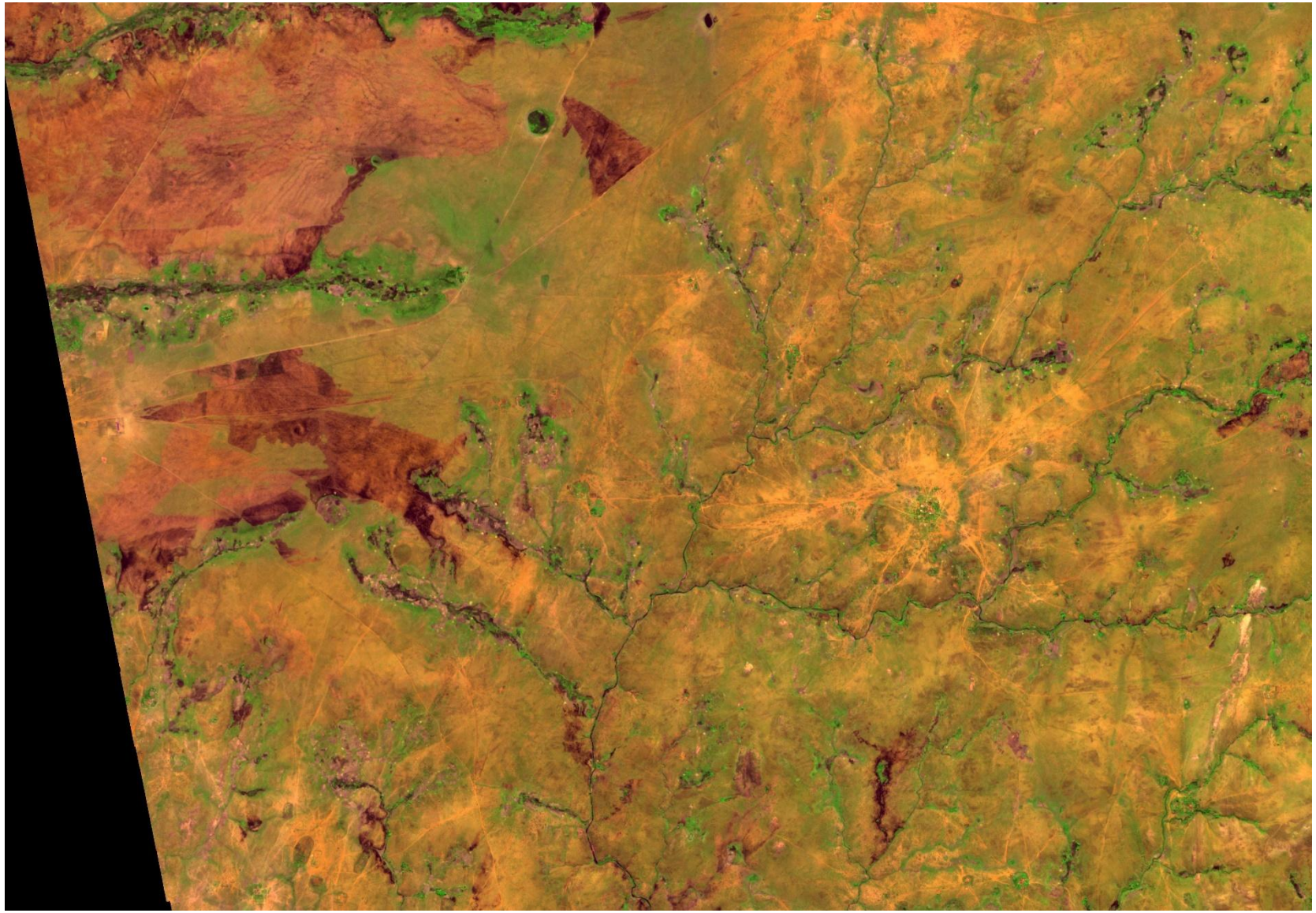
PlanetScope constellation average revisit interval analysis

- ~200 sensors
- ~3m
- blue / green / red / NIR λ

Roy, Huang, Houborg, Martins, *RSE*, 2021

Global median PlanetScope revisit **30.3 hours !**





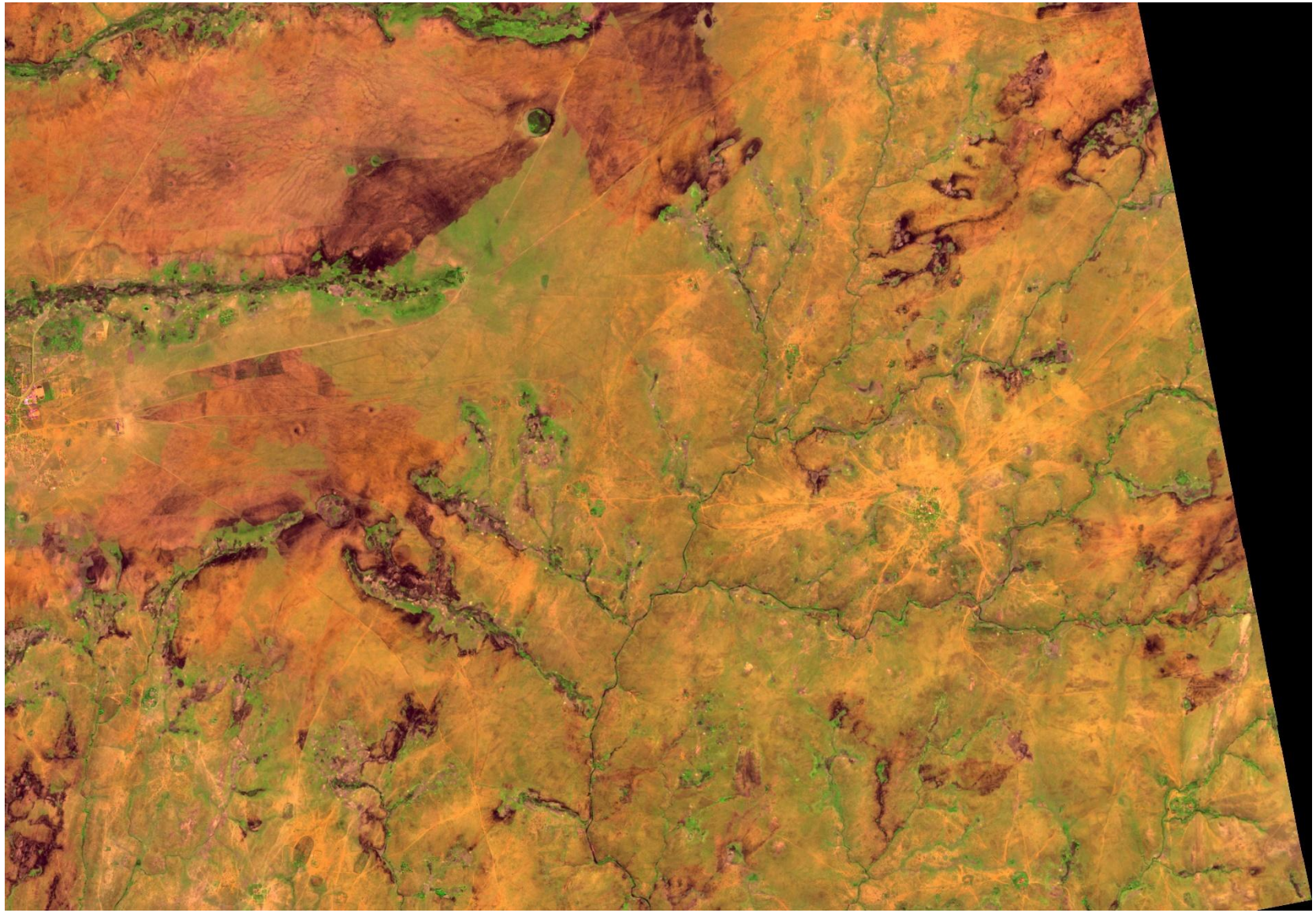
630 nm
820 nm
545 nm

surface reflectance

July 12nd 2019

Isalo National Park
Madagascar

15.4 × 10.7 km
5134× 3568 3 m pixels



630 nm
820 nm
545 nm

surface reflectance

July 16th 2019

Isalo National Park
Madagascar

15.4 × 10.7 km
5134× 3568 3 m pixels

Used Landsat-8 two date image pairs interpreted into burned, unburned, and unmapped classes

(Landsat-8 interpreted data used previously to validate the MODIS burned area product)

for transfer learning to PlanetScope

ELSEVIER

Remote Sensing of Environment

Volume 280, October 2022, 113203

Deep learning high resolution burned area mapping by transfer learning from Landsat-8 to PlanetScope

V.S. Martins [a], D.P. Roy [a, b], H. Huang [a], L. Boschetti [c], H.K. Zhang [d], L. Yan [a]

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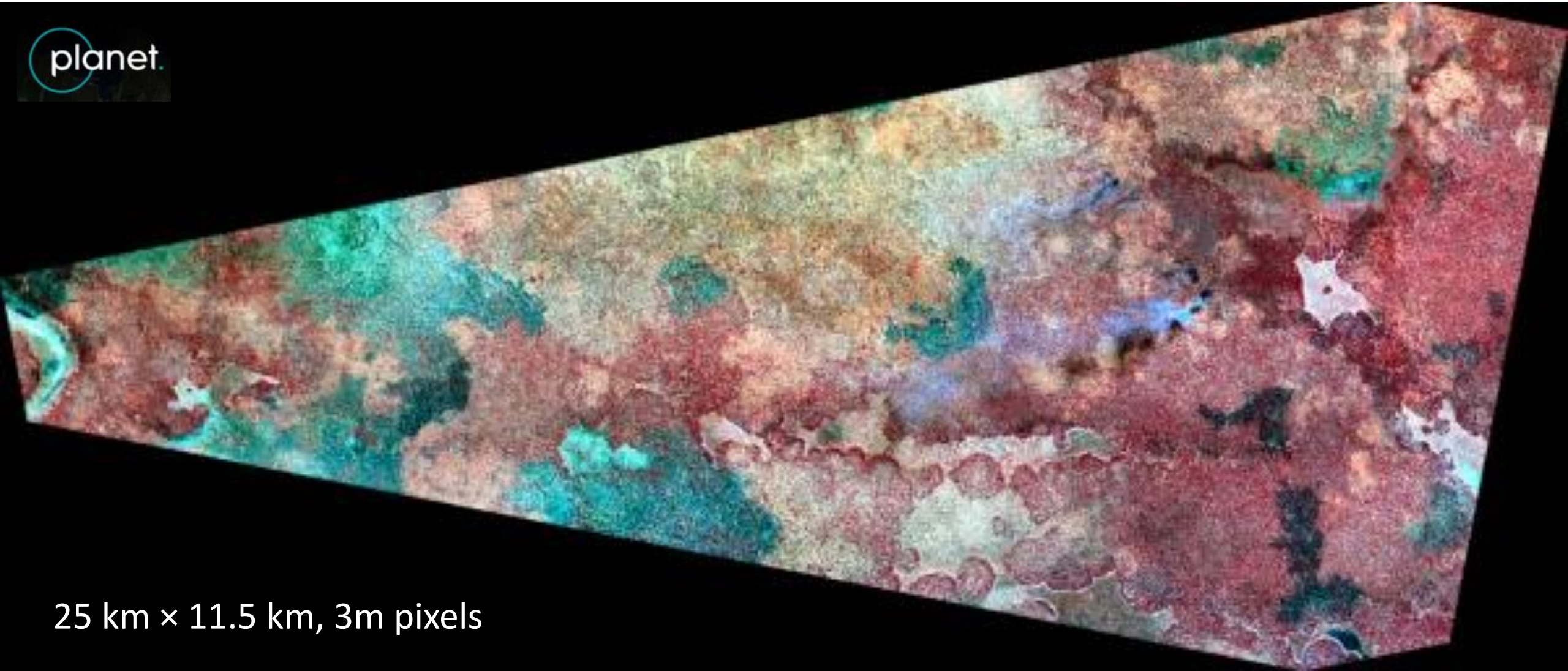
https://doi.org/10.1016/j.rse.2022.113203

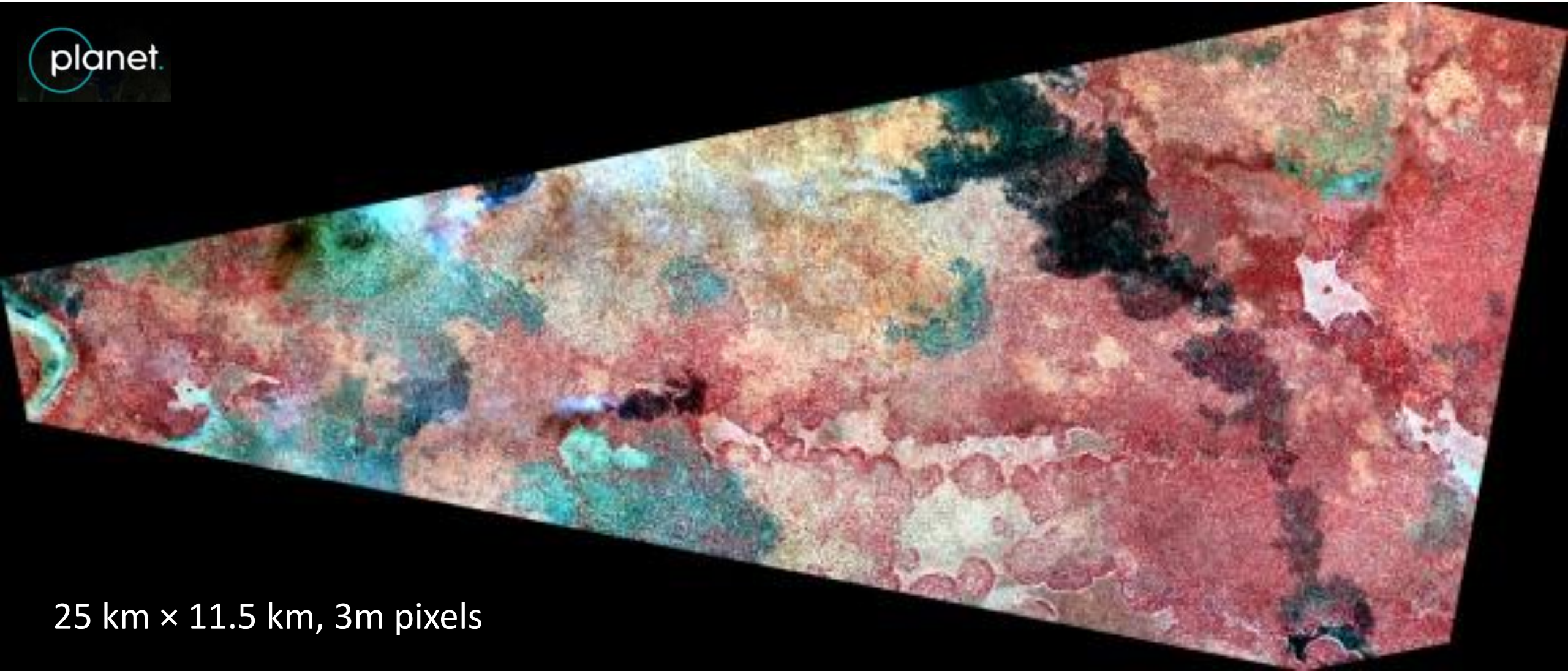
Highlights

- PlanetScope two-date 3 m burned area deep learning classification.
- Transfer learning with pre-existing Landsat-8 derived burned area reference data.
- Results for 659 radiometrically normalized PlanetScope image pairs across Africa.
- Classification with 12% 3 m burn omission and commission errors.
- Commission and omission errors largely compensate at 30 m resolution.

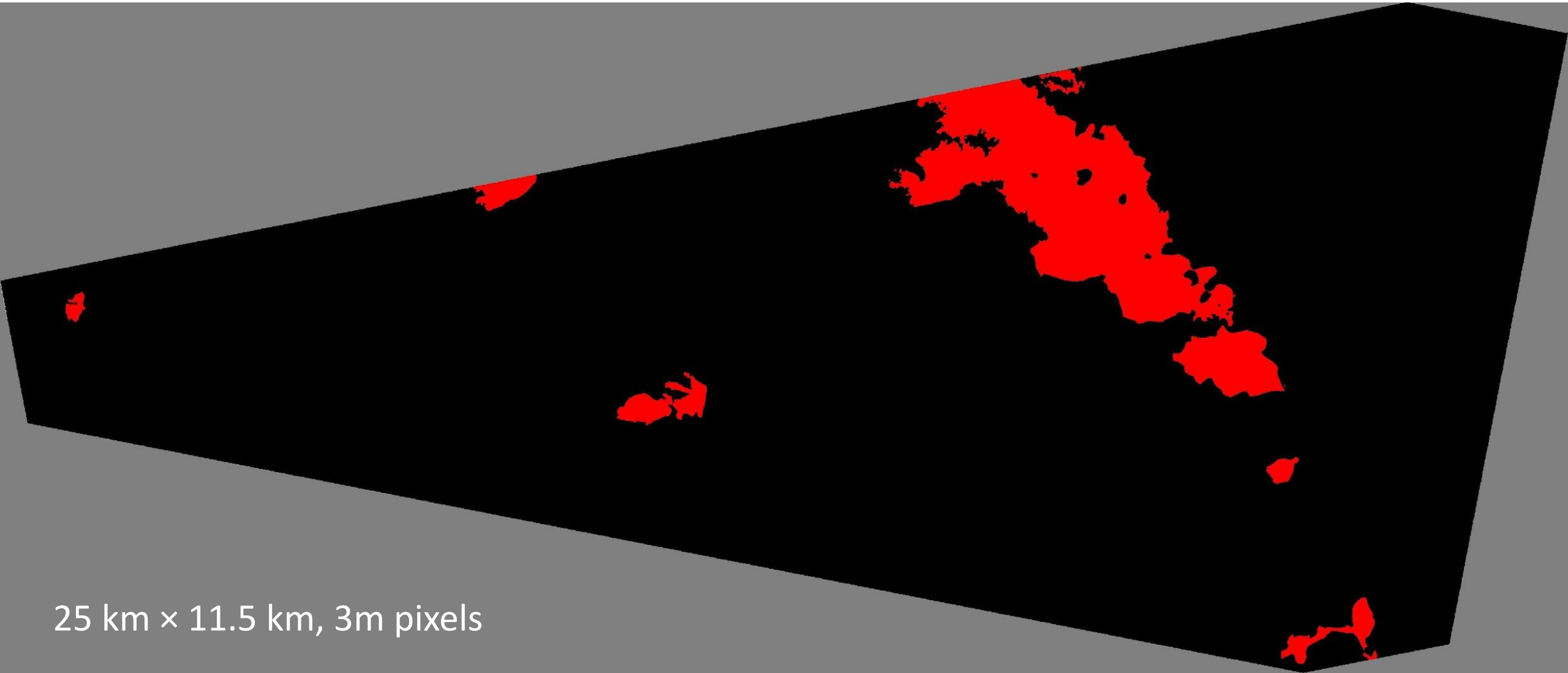
PlanetScope 2019 July 5th



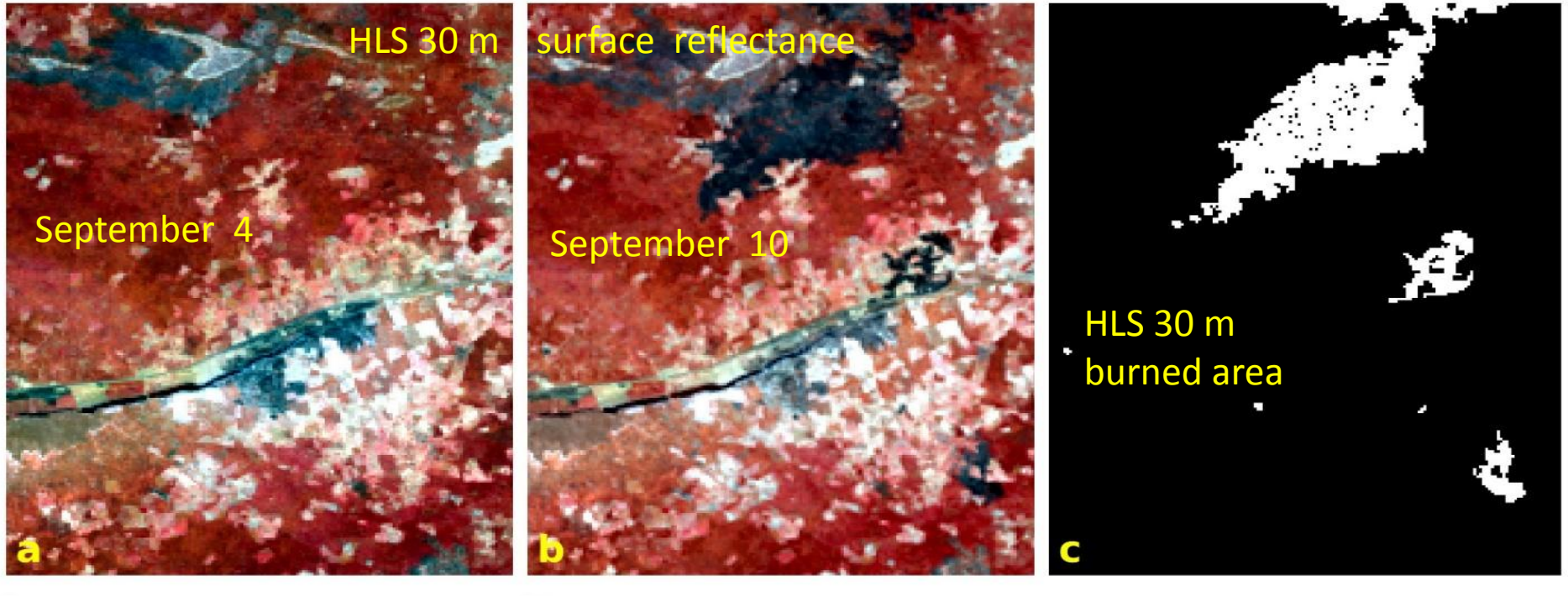
PlanetScope 2019 July 6th



Deep learning burned area classification

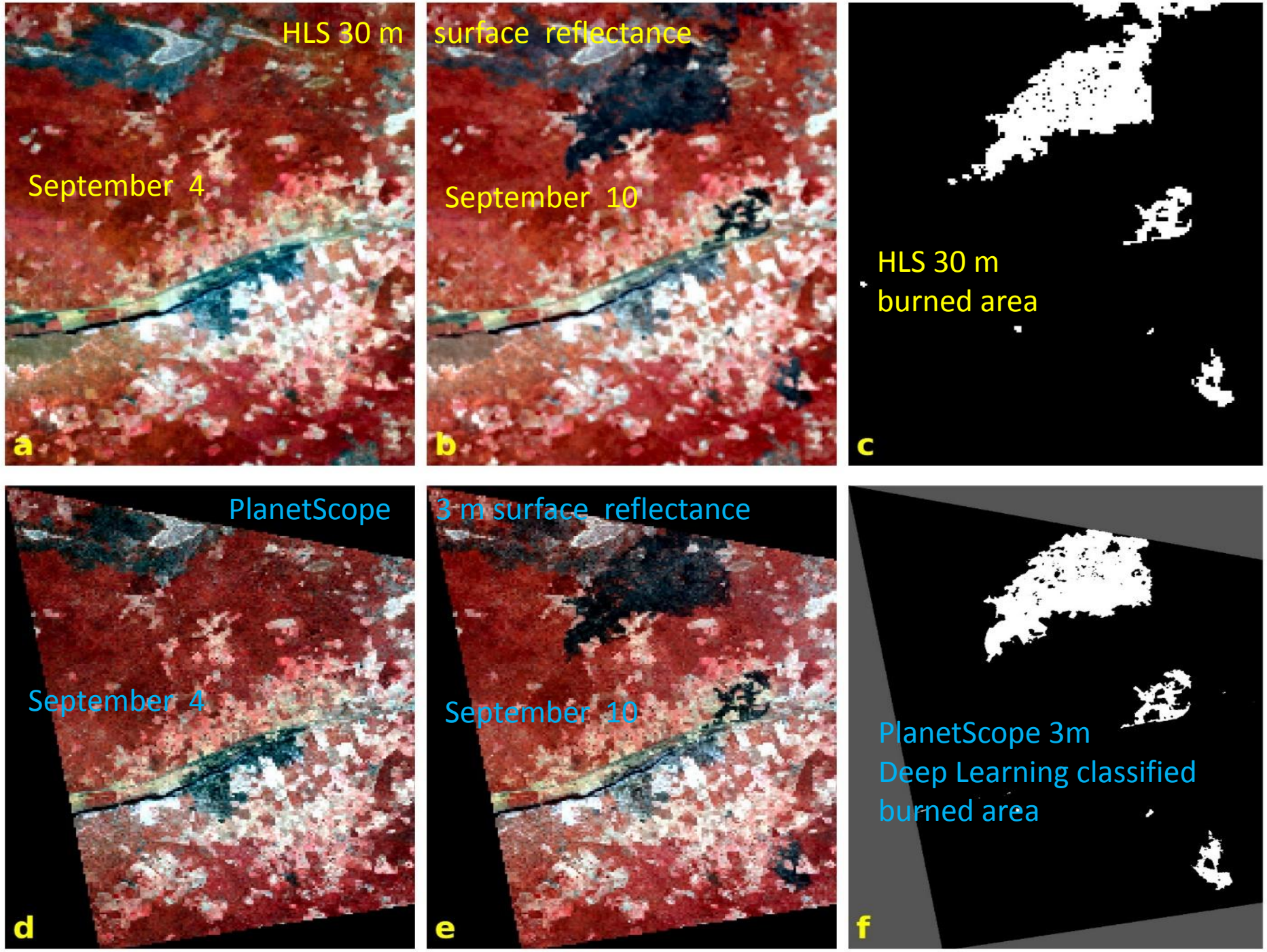


Detailed HLS burned area validation example



6.9 x 5.3 km
Moxico province, Angola

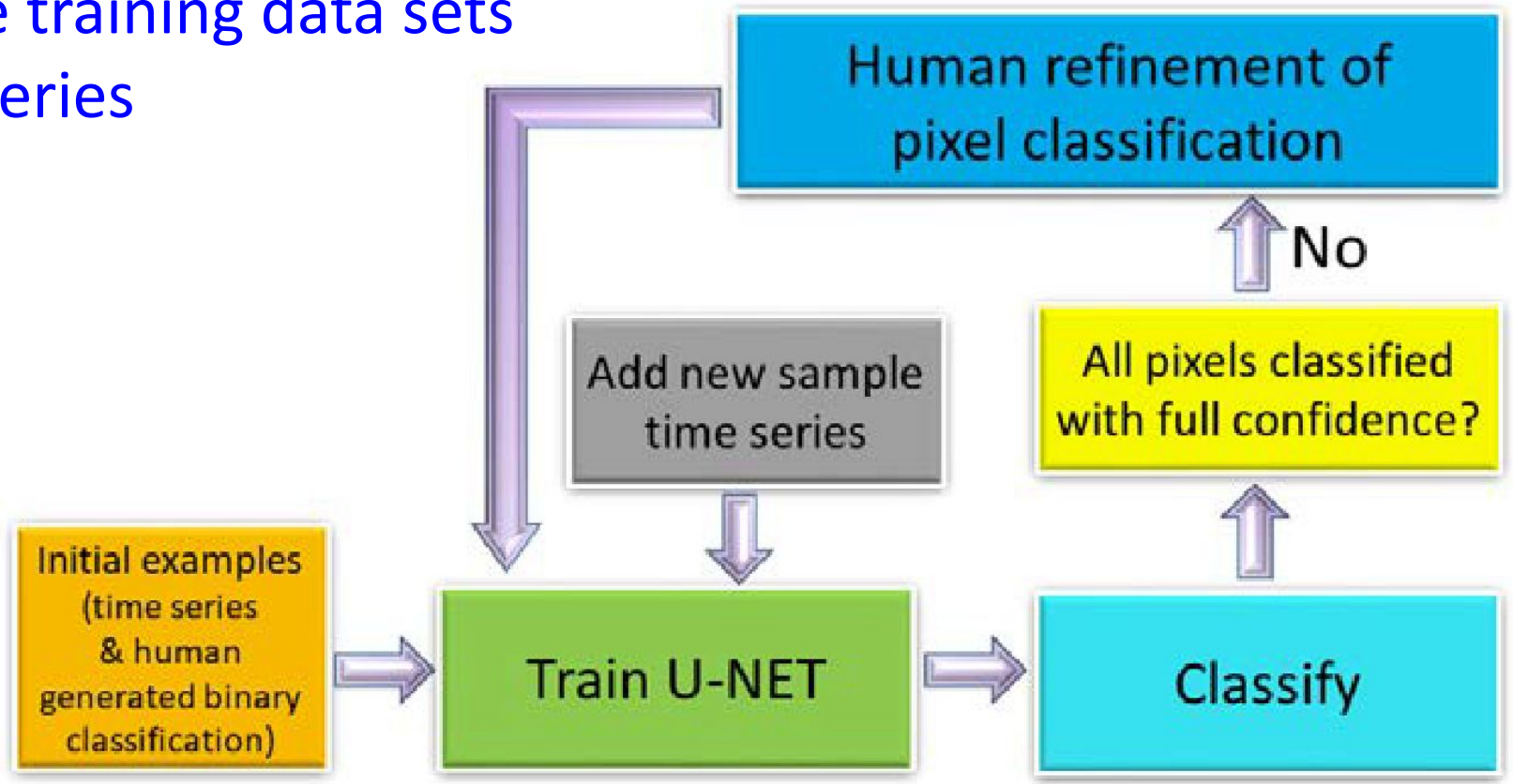
Detailed HLS burned area validation example



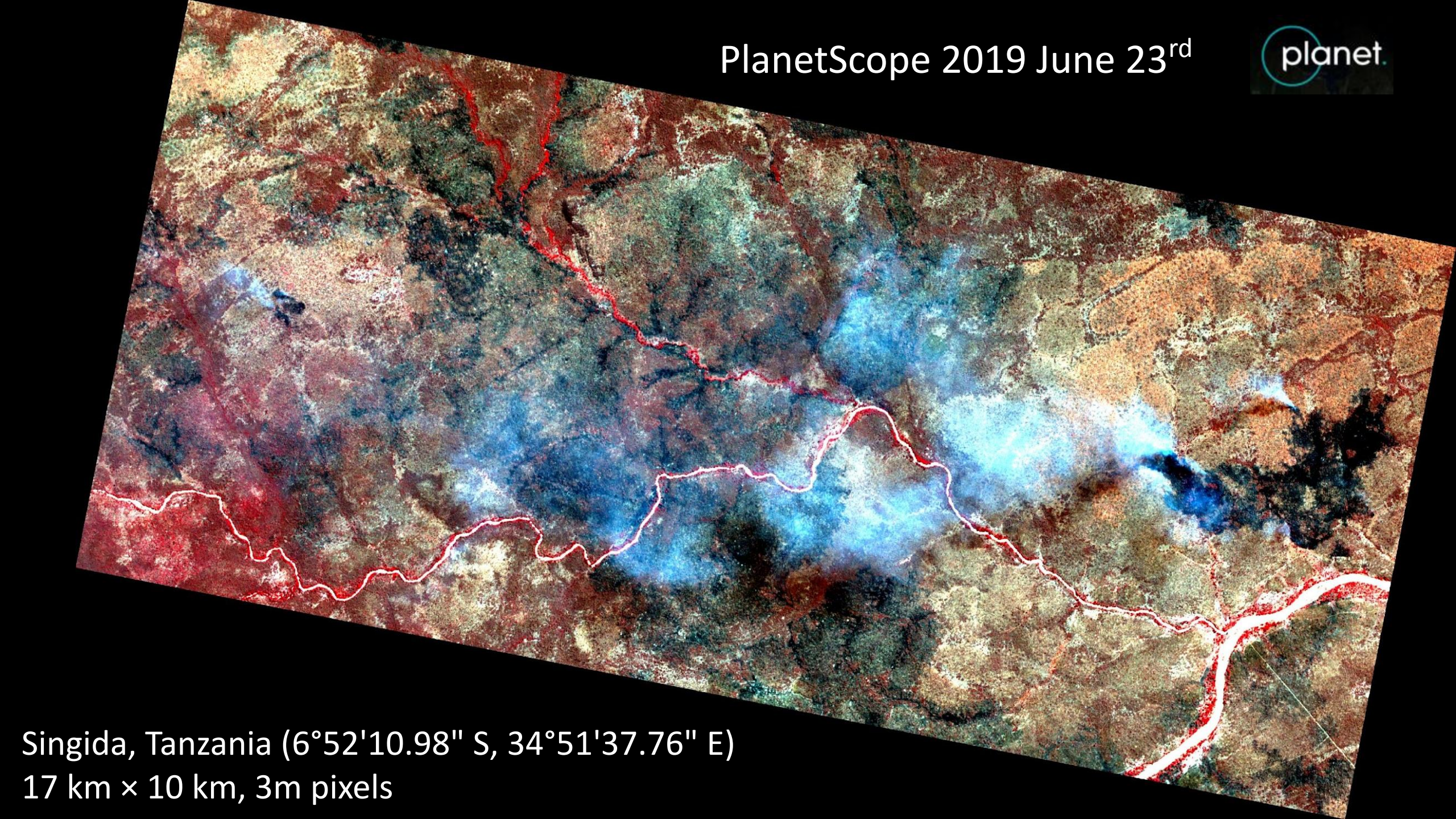
6.9 x 5.3 km
Moxico
province,
Angola

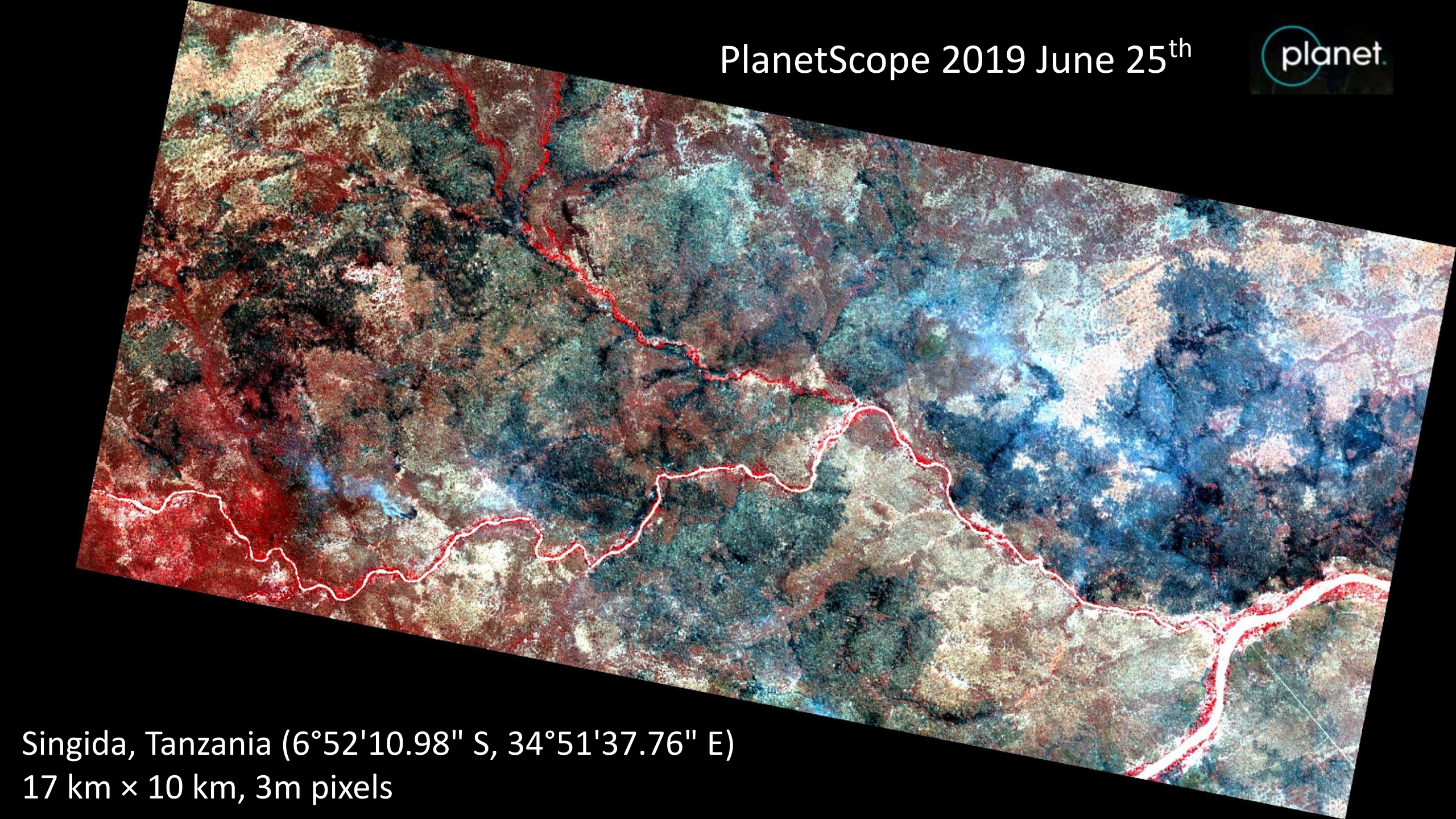
This year we updated the Deep Learning Model with active learning derived training data

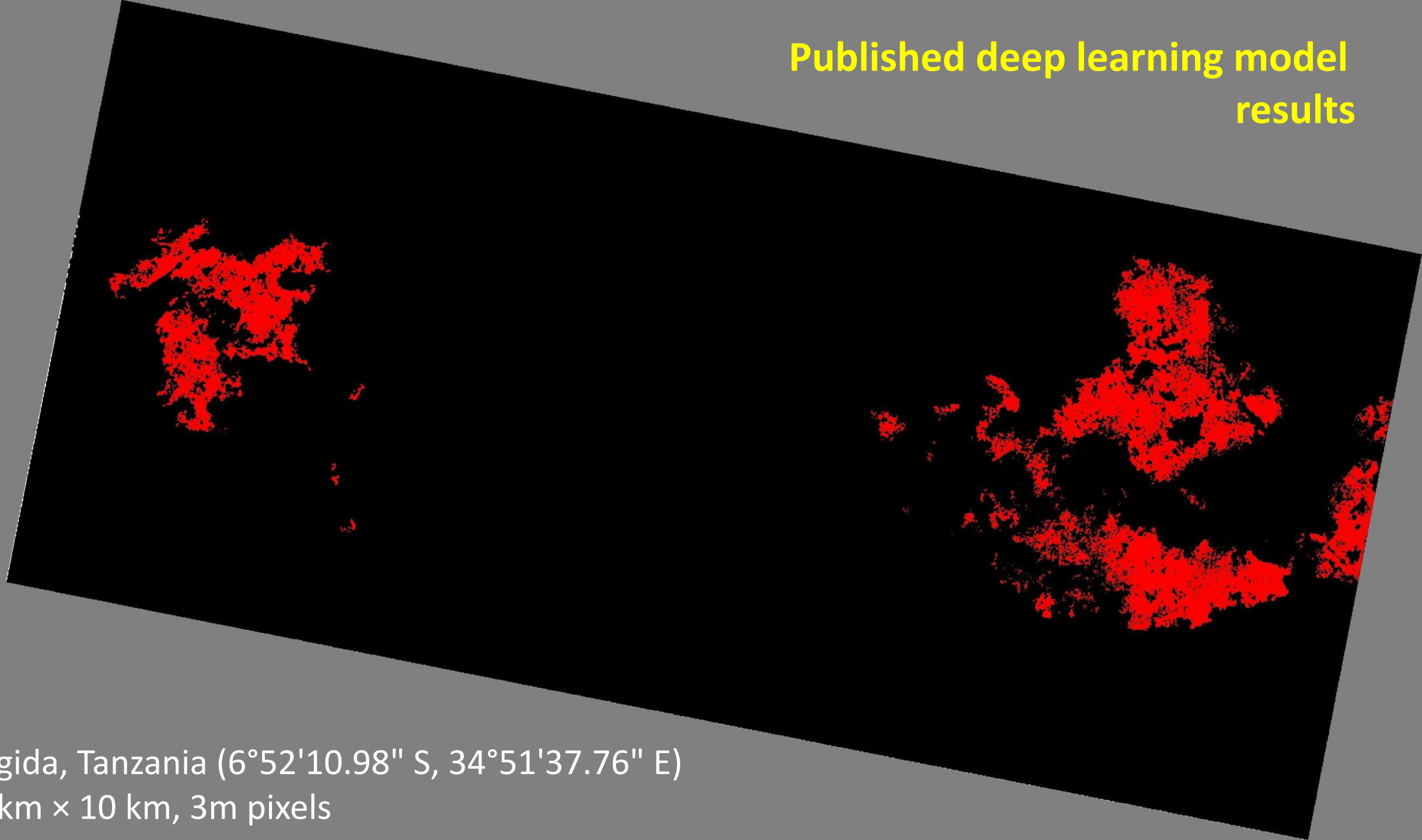
Use active learning / deep learning
to efficiently derive large training data sets
from PlanetScope time series



NASA ACCESS


PlanetScope 2019 June 23rd
planet
Singida, Tanzania (6°52'10.98" S, 34°51'37.76" E)
17 km × 10 km, 3m pixels


PlanetScope 2019 June 25th
planet
Singida, Tanzania (6°52'10.98" S, 34°51'37.76" E)
17 km × 10 km, 3m pixels



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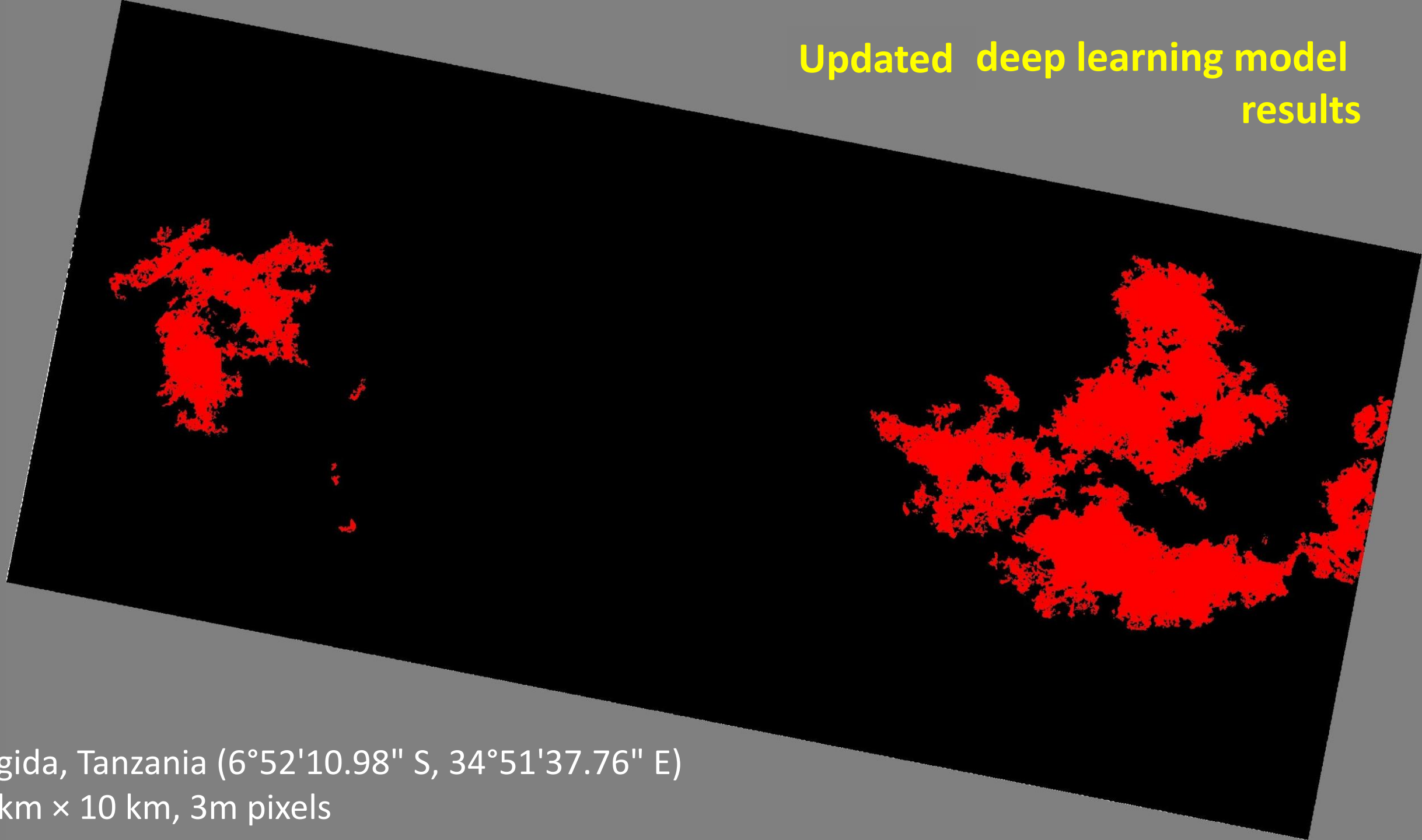

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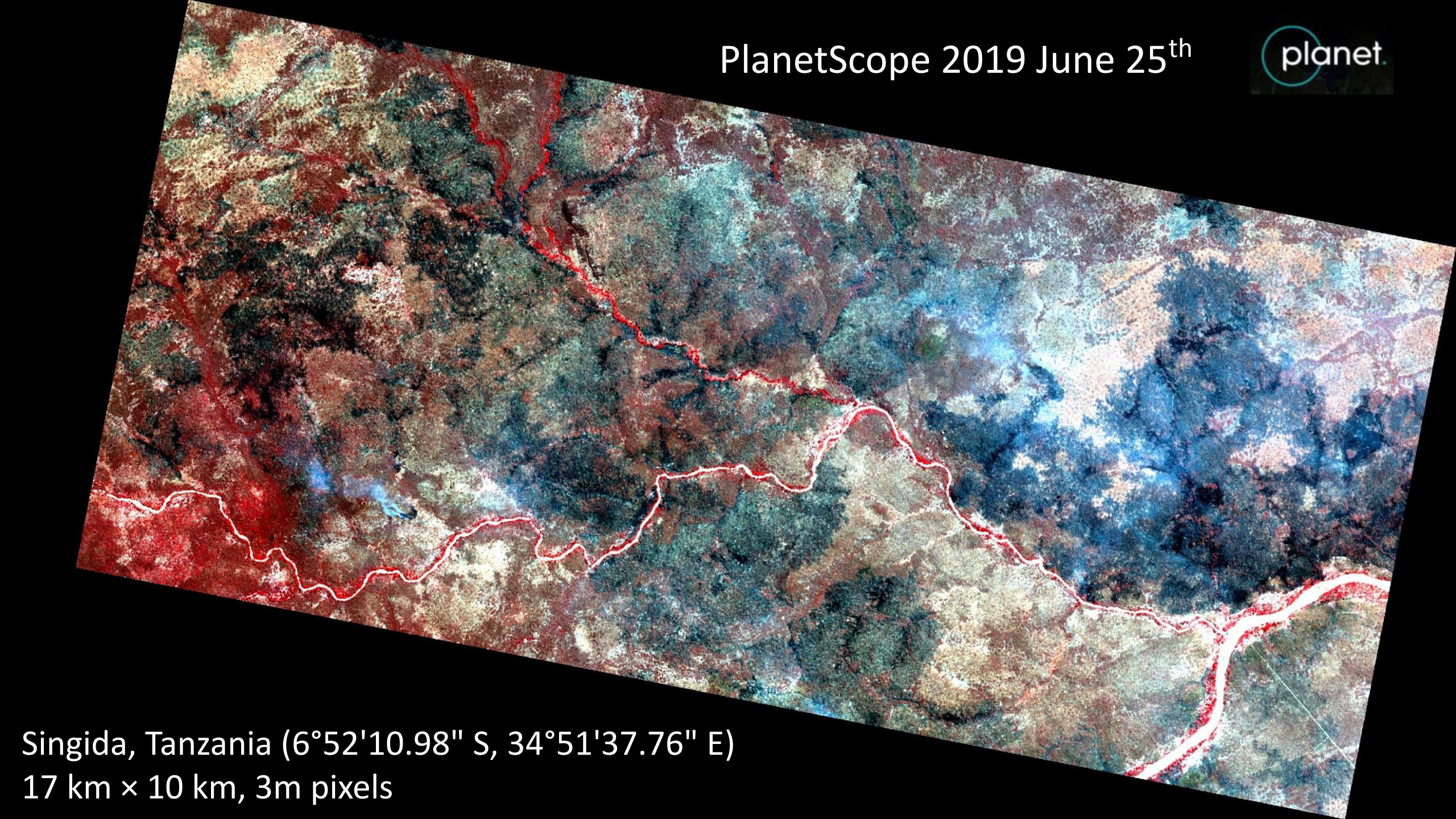
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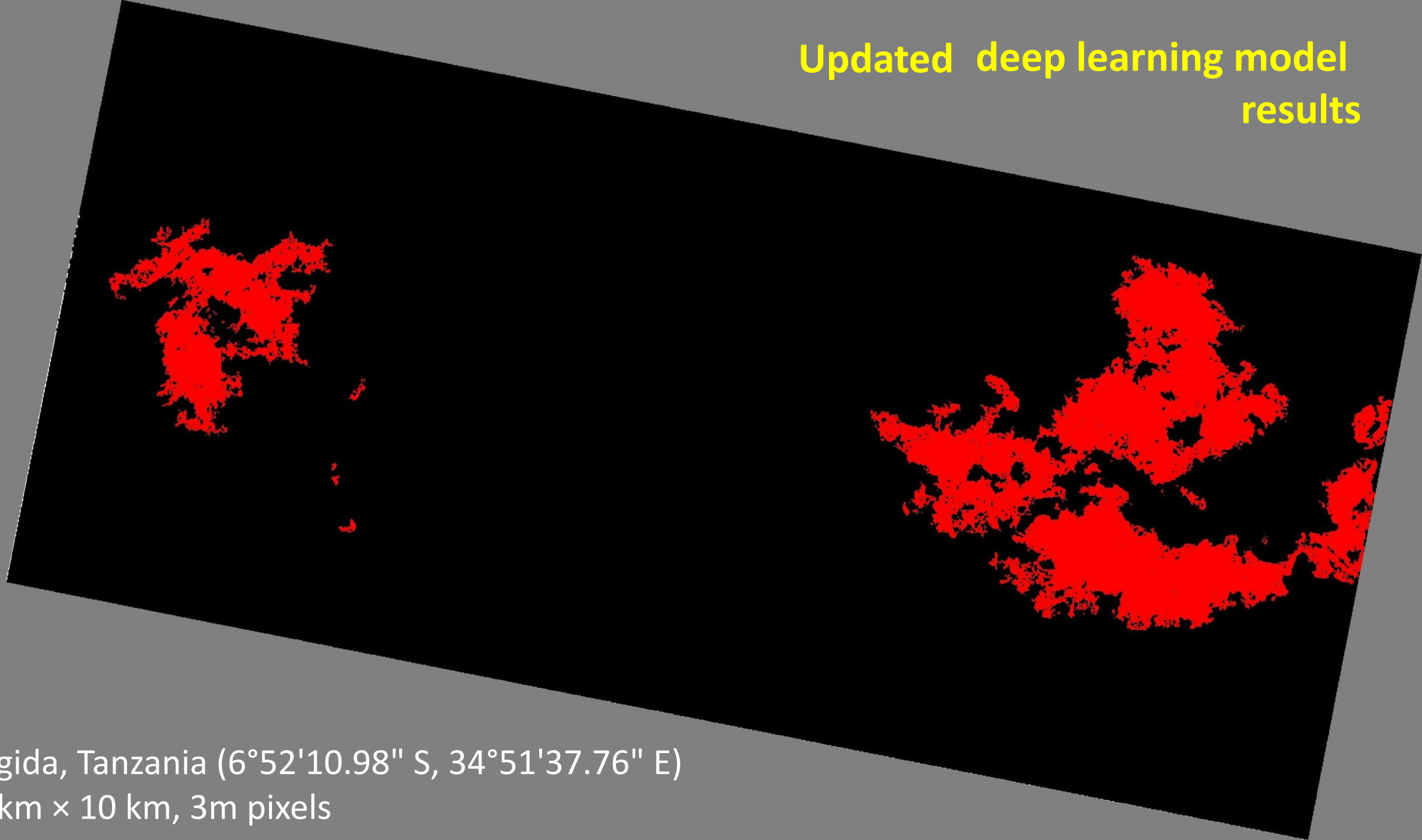

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- **Task #1** Identify global hot-spots of burned areas, specifically where the burns are missing at MODIS 500 m resolution. **Done**

- **Task #2** Map the burned area in the identified hot-spots at 30 m resolution. **Capability Done**

- **Task #3** Validate the 30 m burned area hot-spot mapping results using contemporaneous 3m PlanetScope data. **Capability Done**

- **Task #4** Provide the hot-spot 30 m burned area maps and 3 m PlanetScope validation data to the public.

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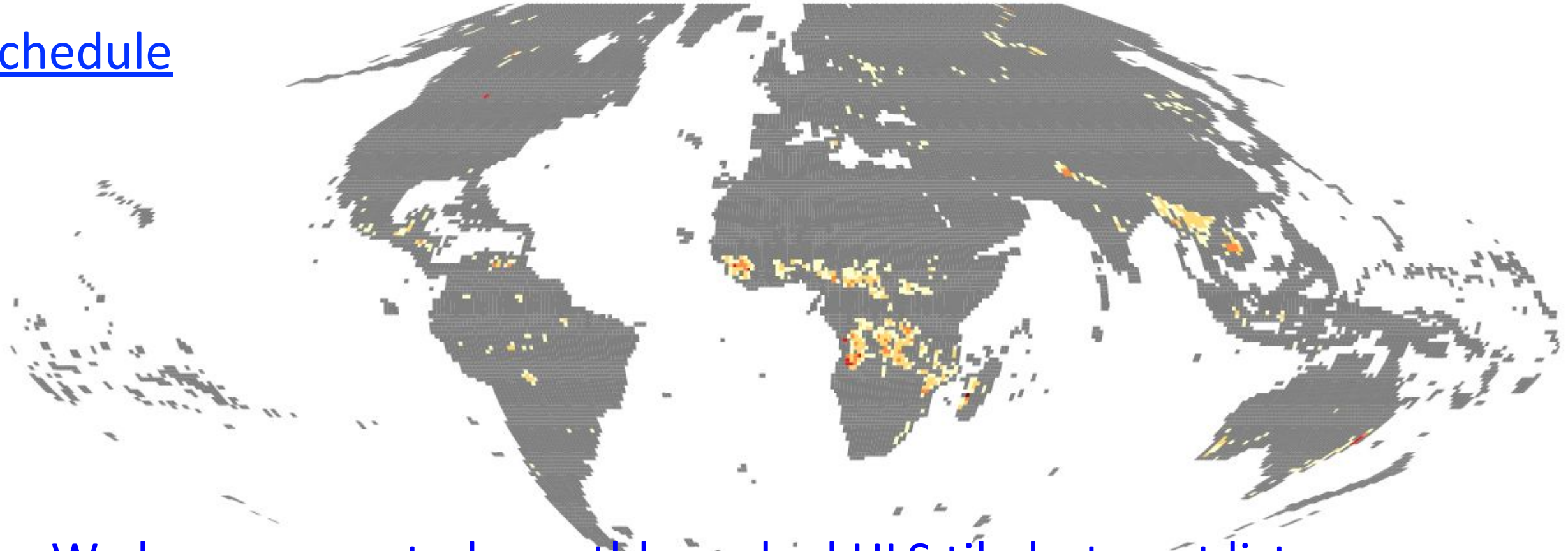
Schedule



- We have generated monthly ranked HLS tile hot-spot lists
- Currently searching through the entries considering the highest ranked (i.e. greatest incidence of VIIRS 375 m active fire detections outside of MODIS 500 m burned areas) to find locations where both HLS and PlanetScope imagery are available

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- **Task #5** Quantify the global MODIS 500 m burned area product underestimation due to its omission of small burns. **Exciting pay-off**

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THANKS

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