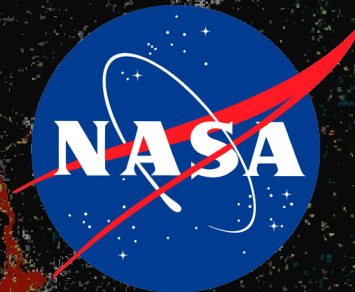


DIST-ALERT: Mapping Near Real-Time Vegetation Extent and Loss Based on Harmonized Landsat and Sentinel-2 data

Matthew Hansen, Amy Pickens, Zhen Song,
Andre Lima, Andrew Poulson, Antoine Baggett

University of Maryland, College Park

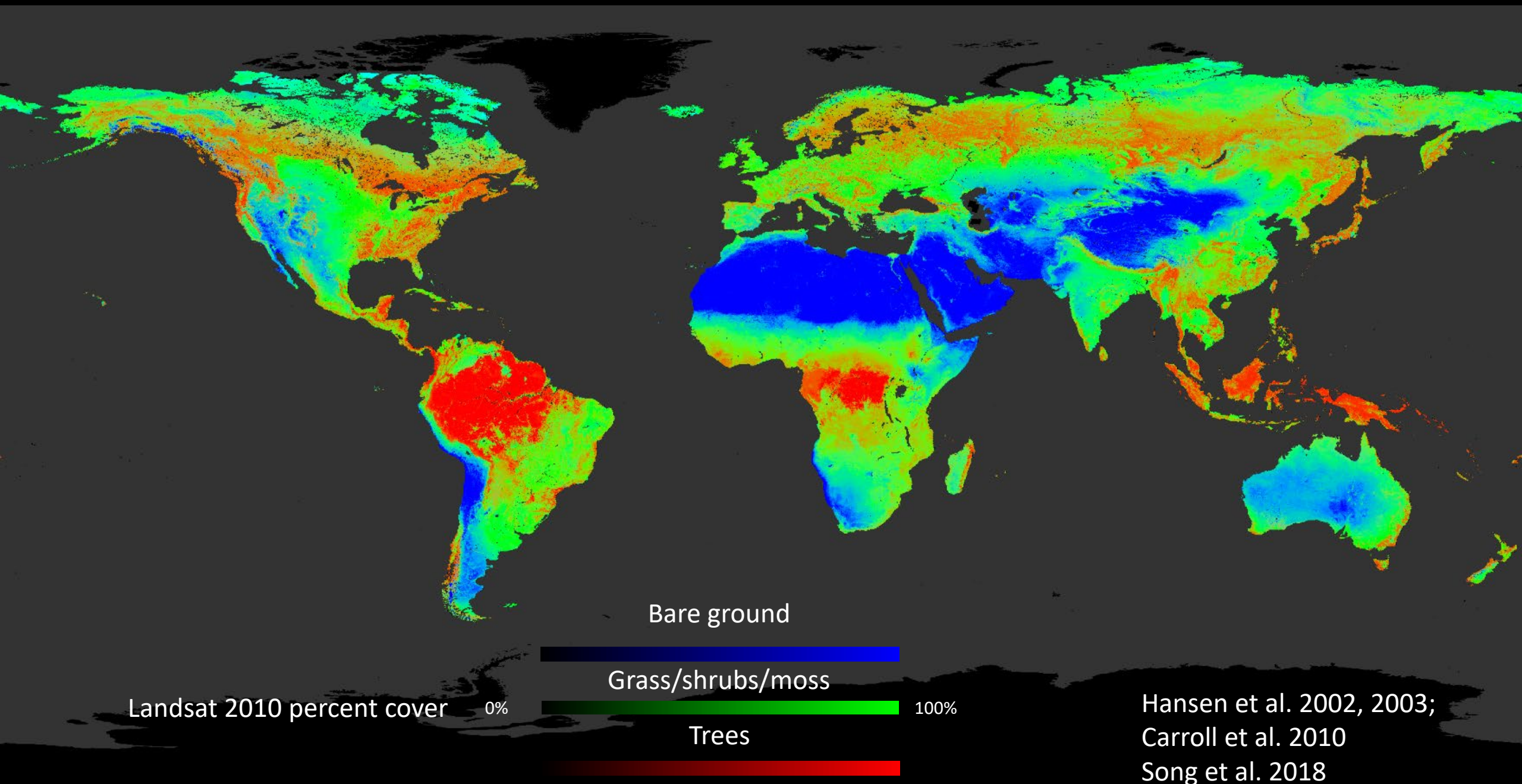


DIST-ALERT

- Tracks disturbances globally
 - Primary algorithm: Vegetation loss using time-series of fraction vegetation cover
 - Secondary algorithm: General spectral anomalies
- Employs Harmonized Landsat Sentinel-2 (HLS) data
 - 4 sensors: Landsat 8, Landsat 9, Sentinel-2A, Sentinel-2B
 - Revisit rate of ~2-3 days
 - 30 m
- Runs hourly as new data become available



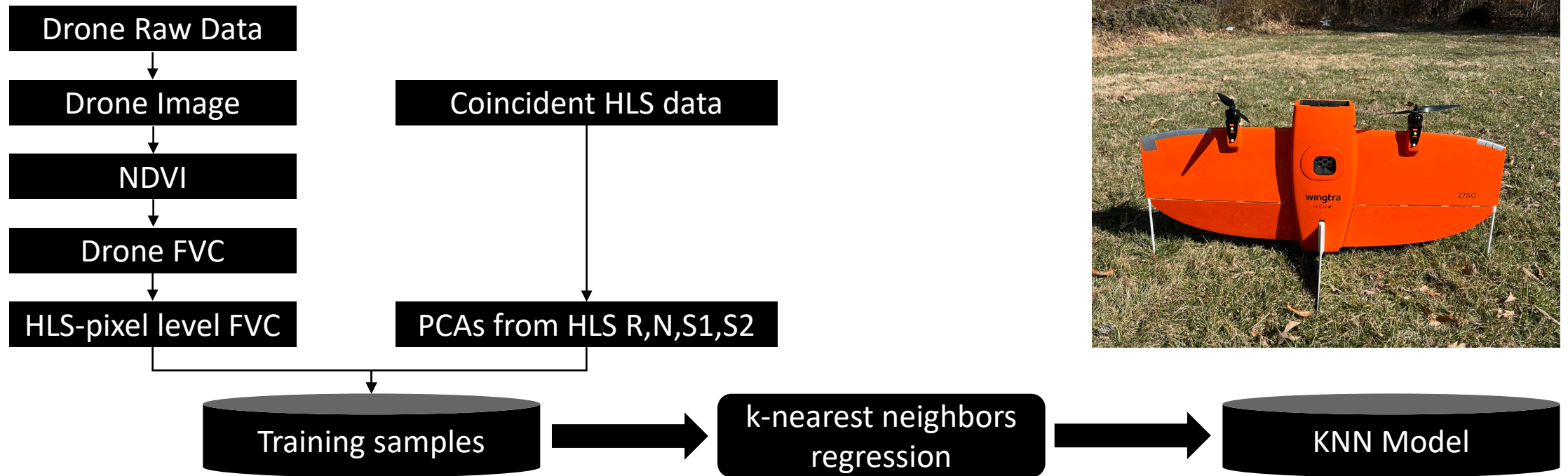
History - Vegetation Continuous Fields



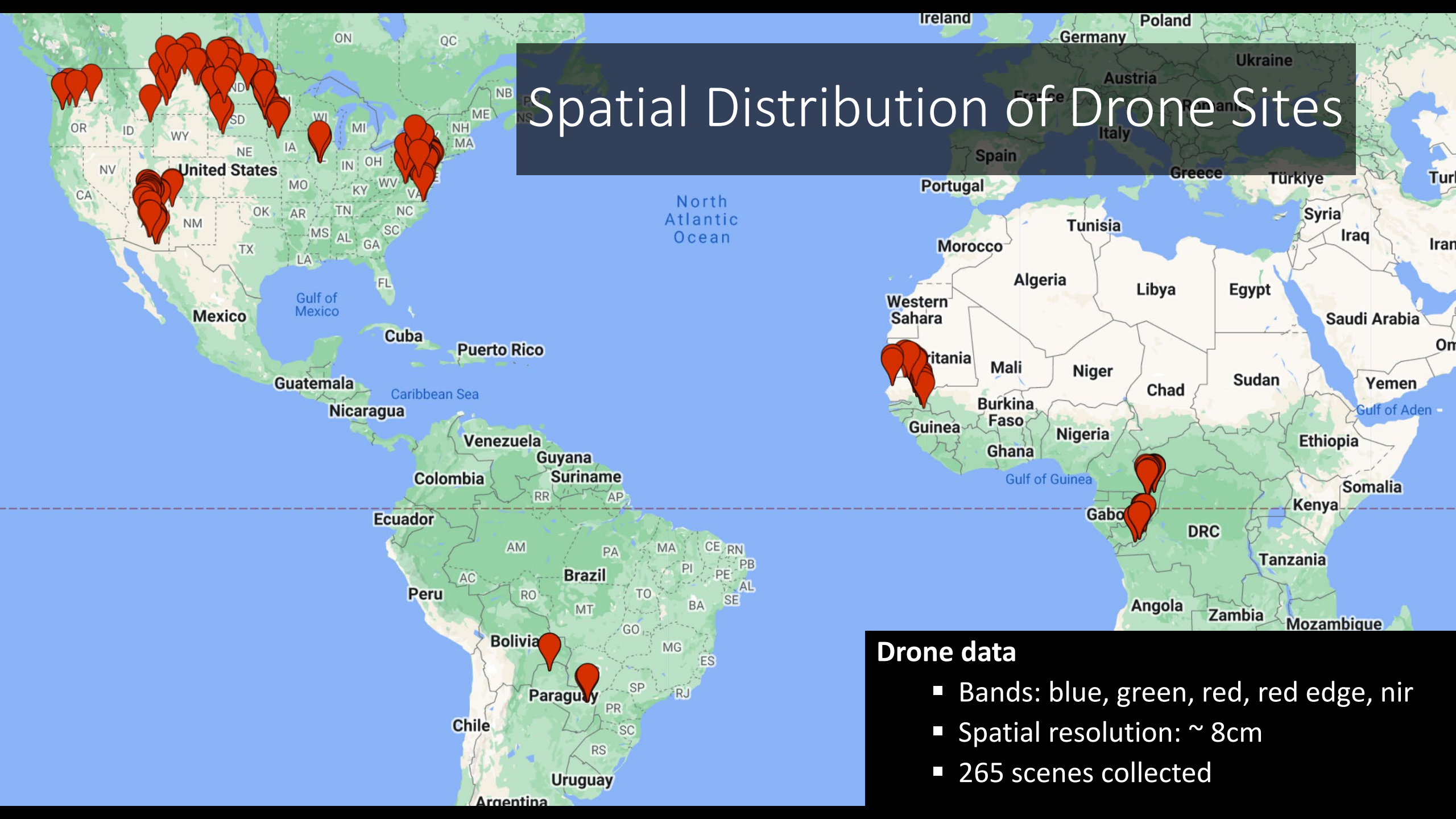
Hansen et al. 2002, 2003;
Carroll et al. 2010
Song et al. 2018

Algorithm Overview

- Collect drone data across many biomes
- Calculate FVC from drone images and aggregated to HLS-pixel scale
- Covert four bands of coincident HLS data to 3 Principal Components through PCA
- Build turn-key k-nearest neighbors (KNN) model and apply model to every HLS tile



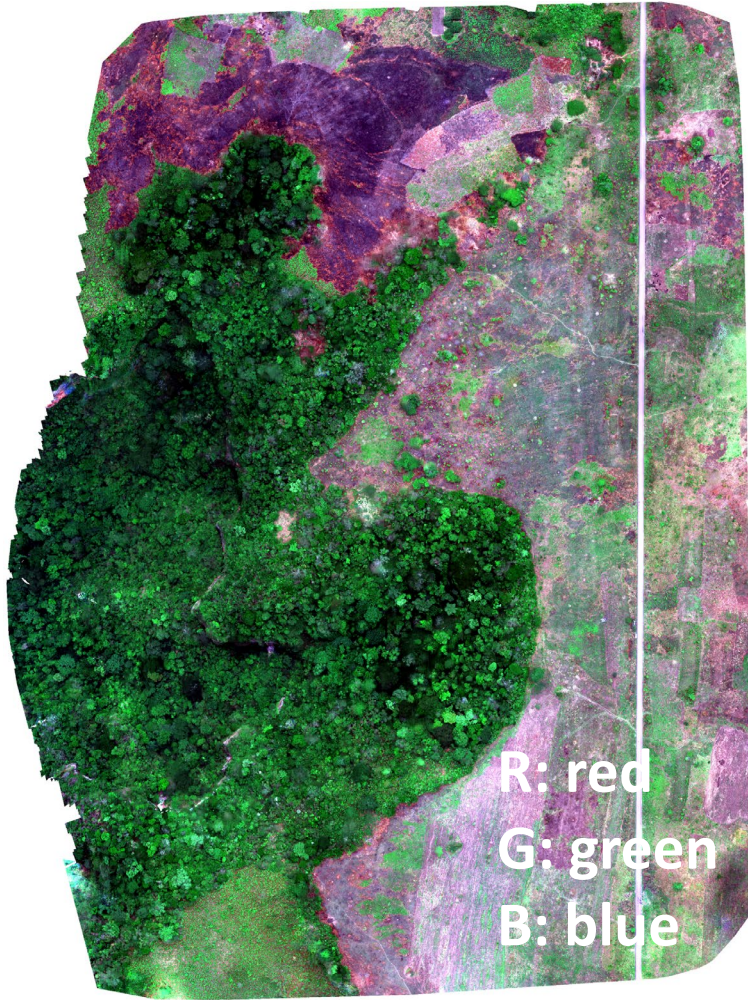
Spatial Distribution of Drone Sites



Drone data

- Bands: blue, green, red, red edge, nir
- Spatial resolution: ~ 8cm
- 265 scenes collected

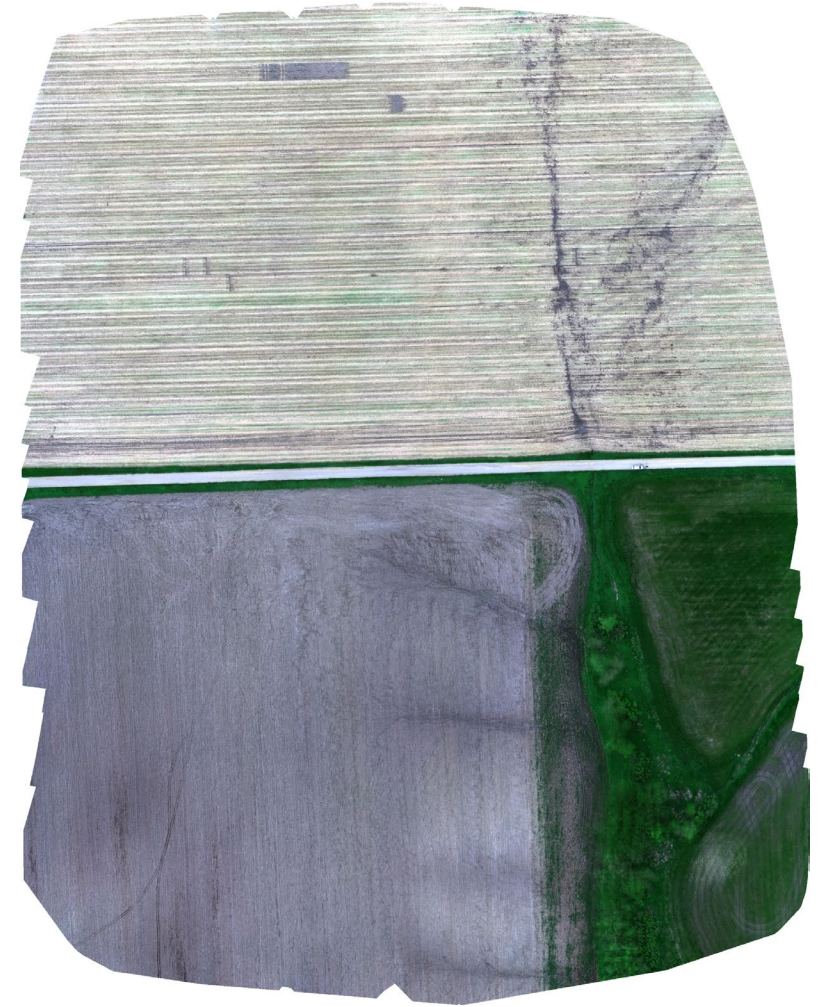
Drone image examples: various vegetation types



Fire impact, Republic of Congo (ROC)

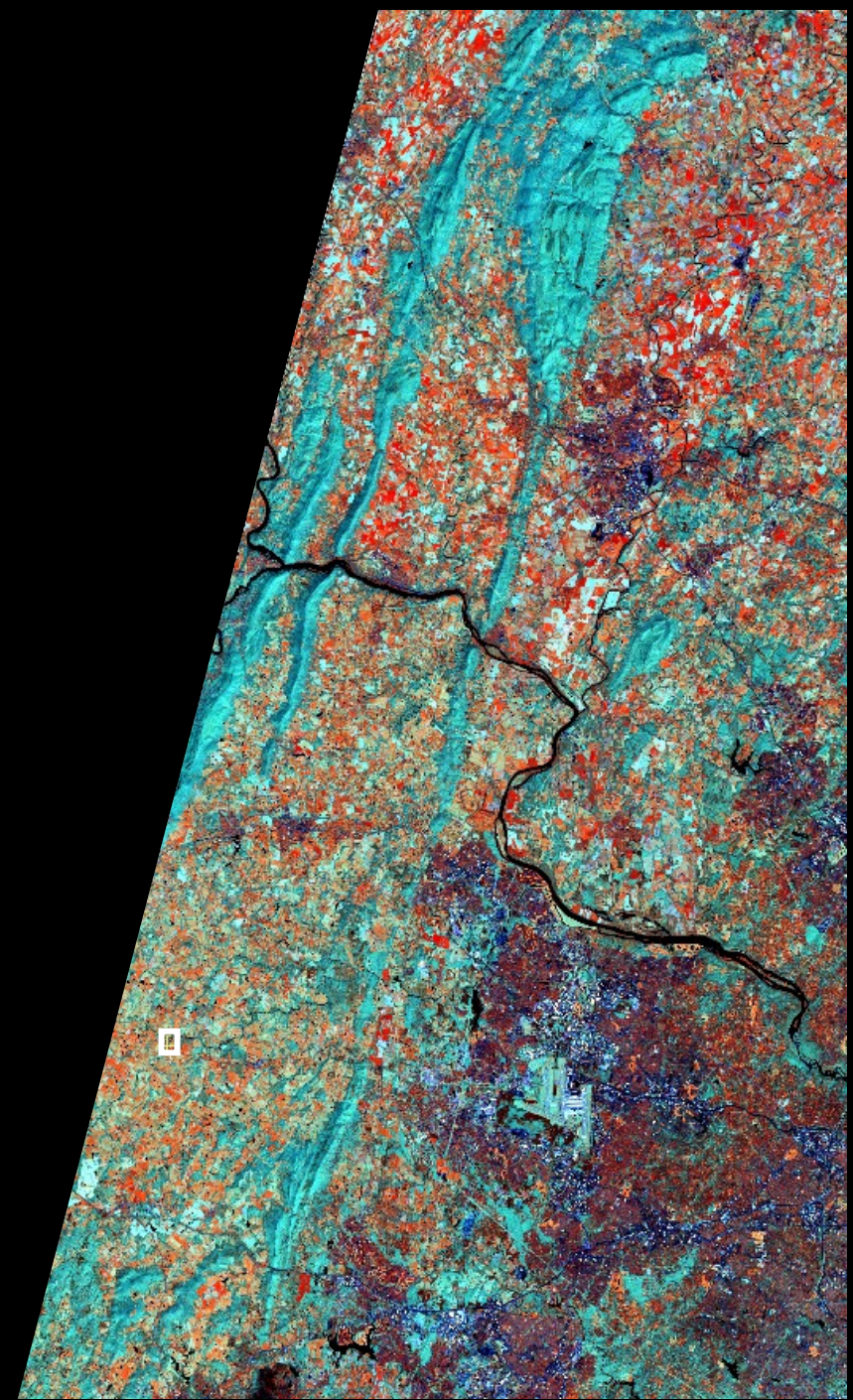


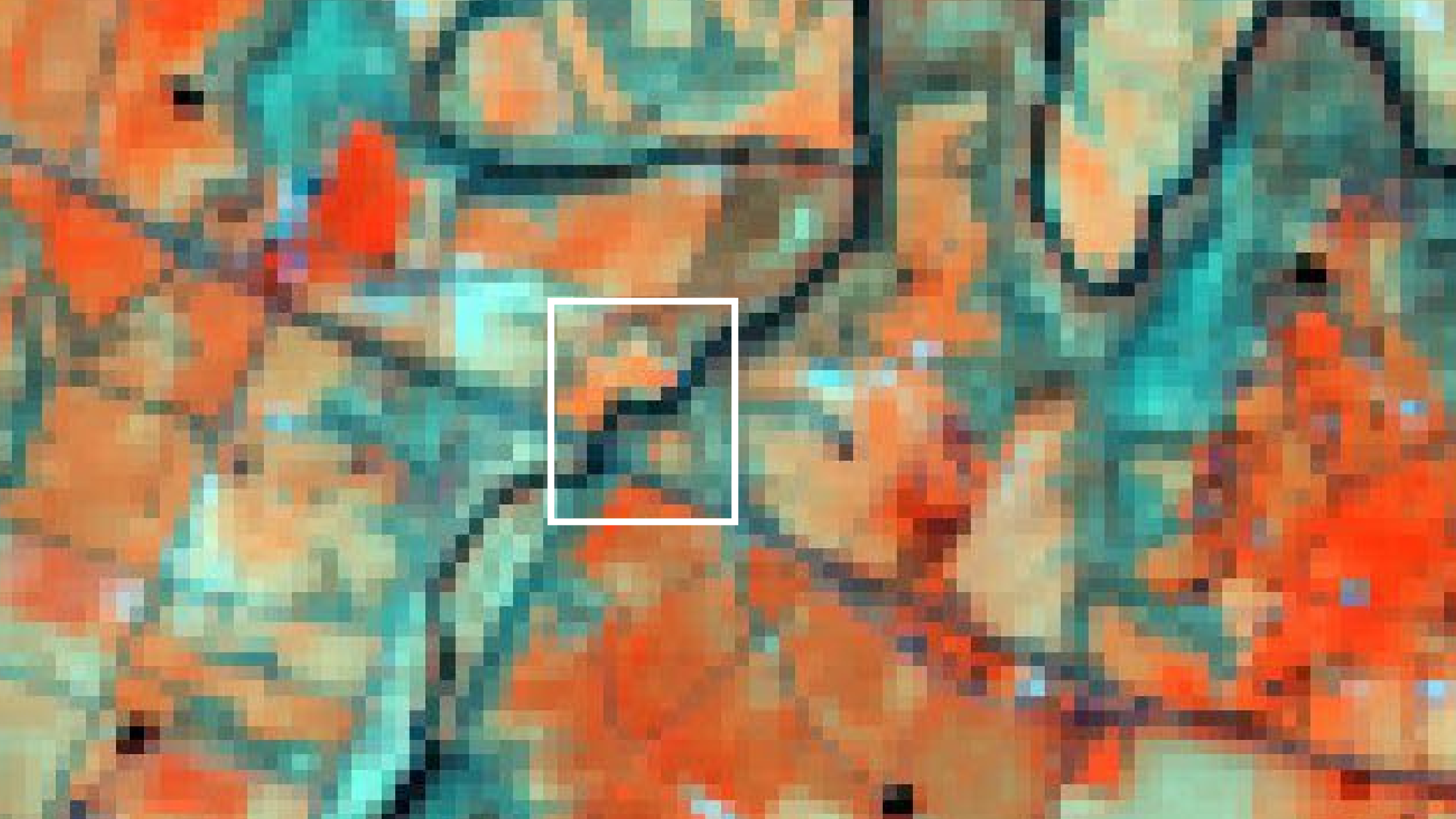
Diverse tree species and selective logging, ROC

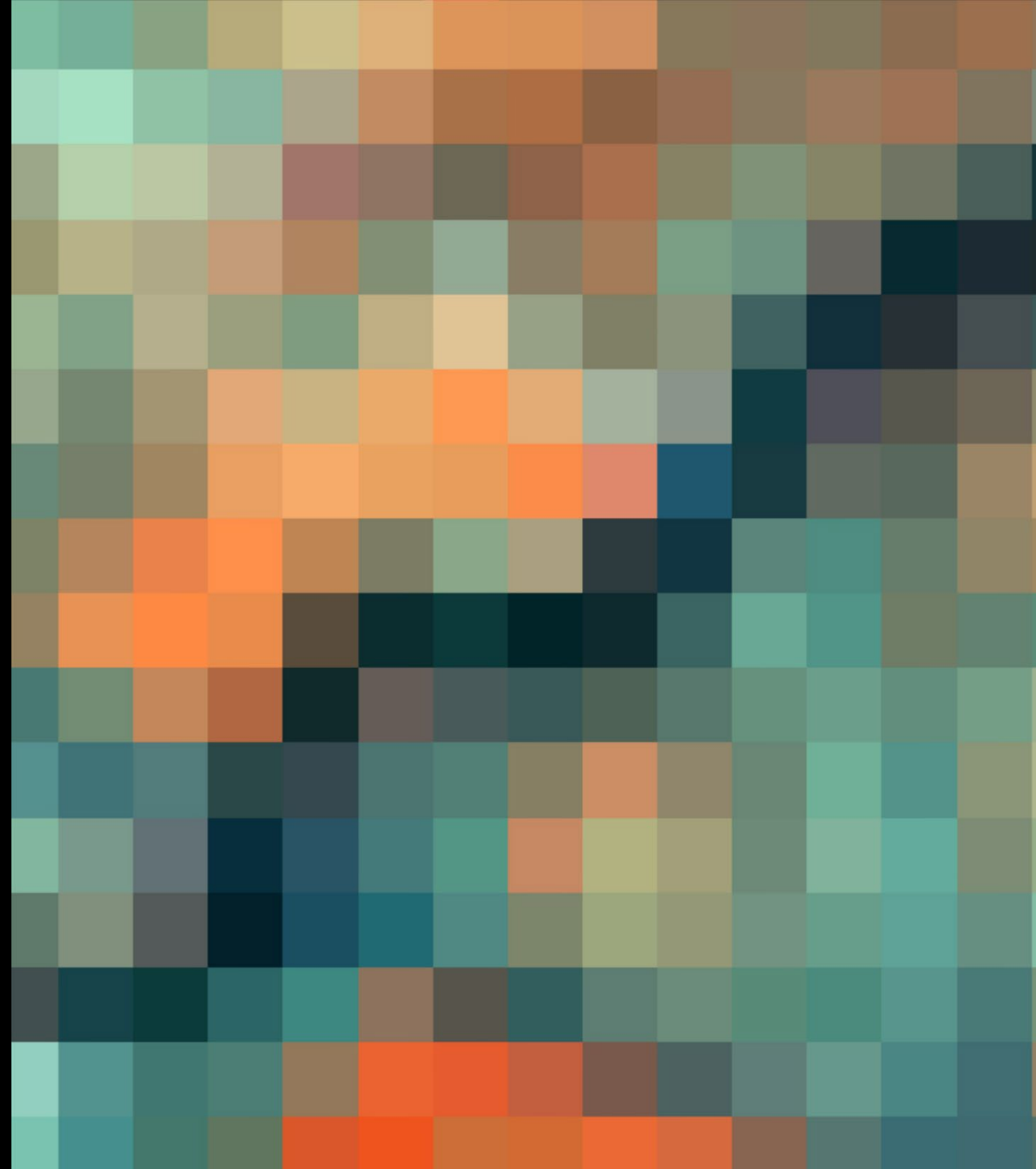


Growing and harvested cropland, US

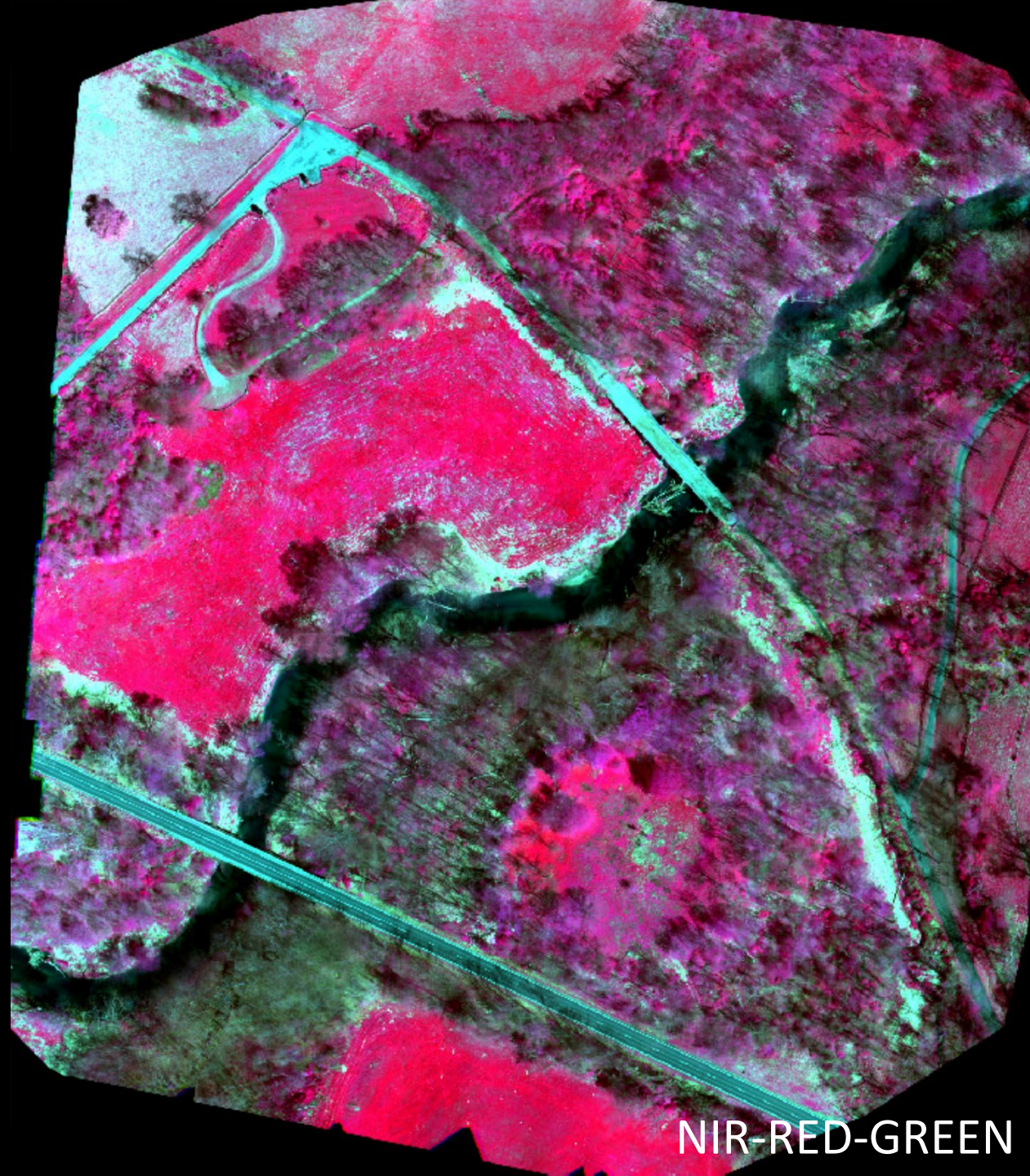
HLS tile of Sentinel 2
image of April 20, 2022







Battle of Upperville
Historic Park, VA

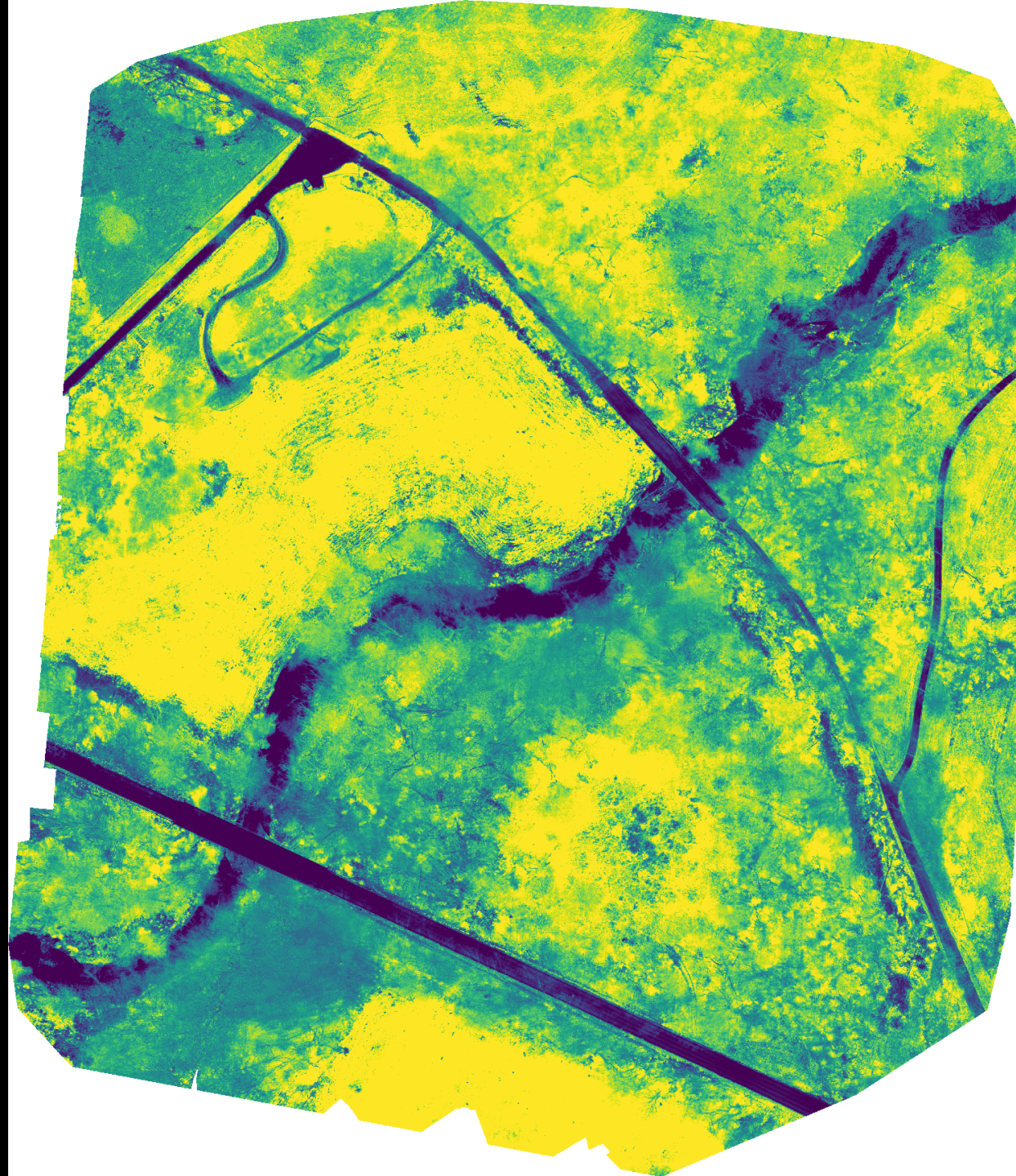
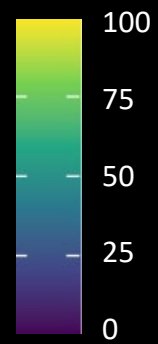


April 22, 2022
drone image

NIR-RED-GREEN

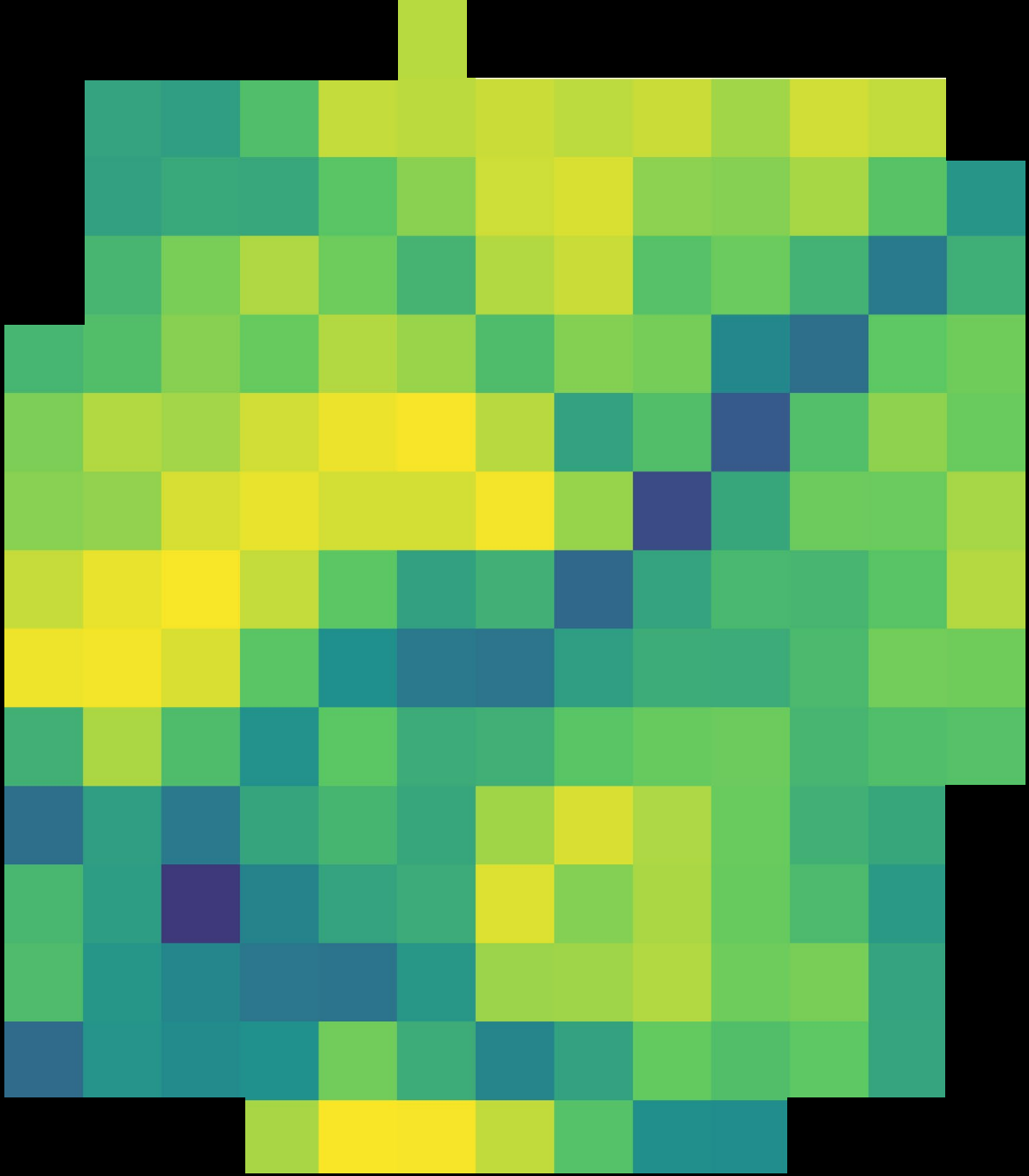
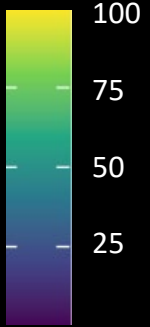
Battle of Upperville Historic Park, VA

Drone FVC(%)

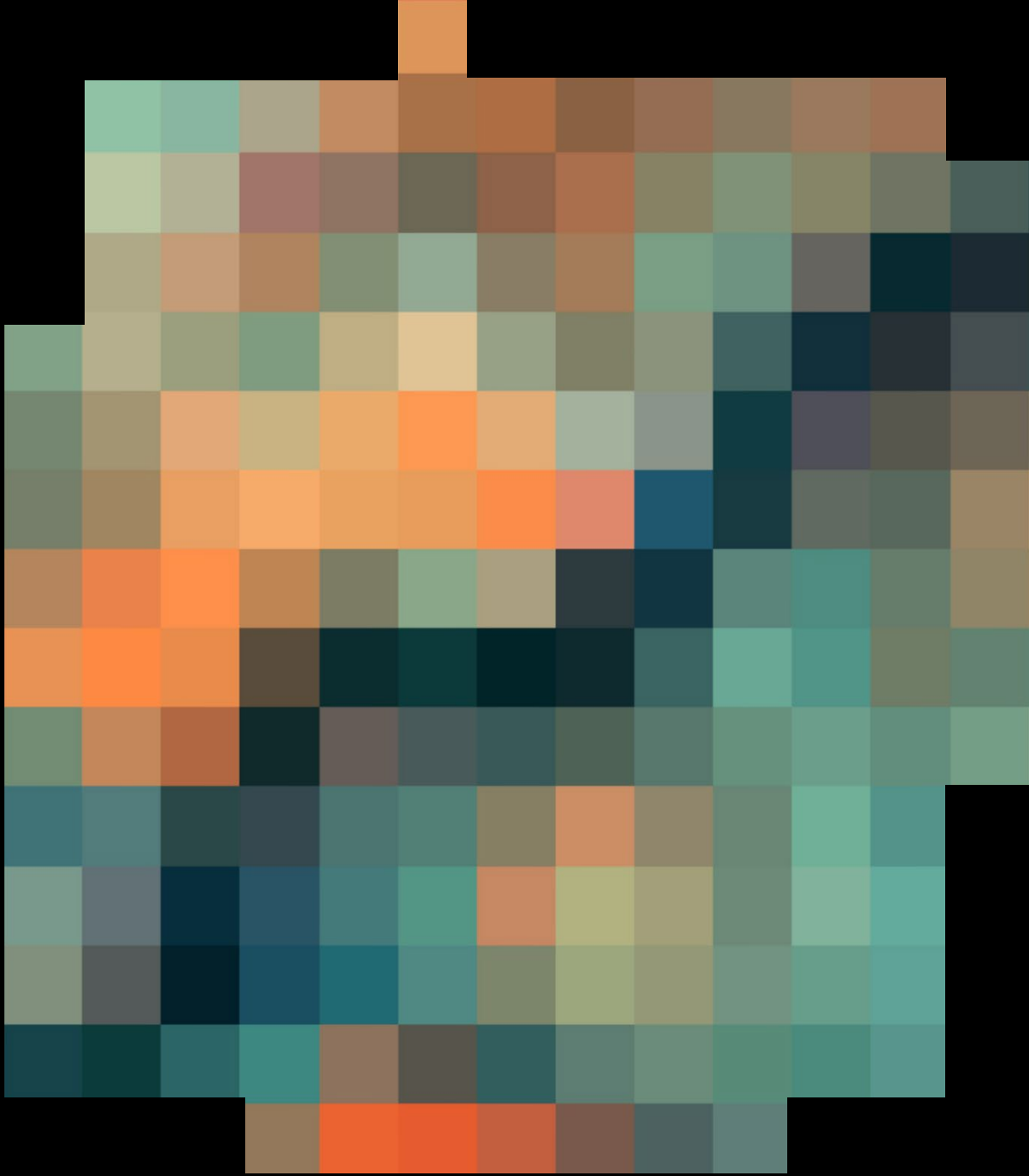


Battle of Upperville Historic Park, VA

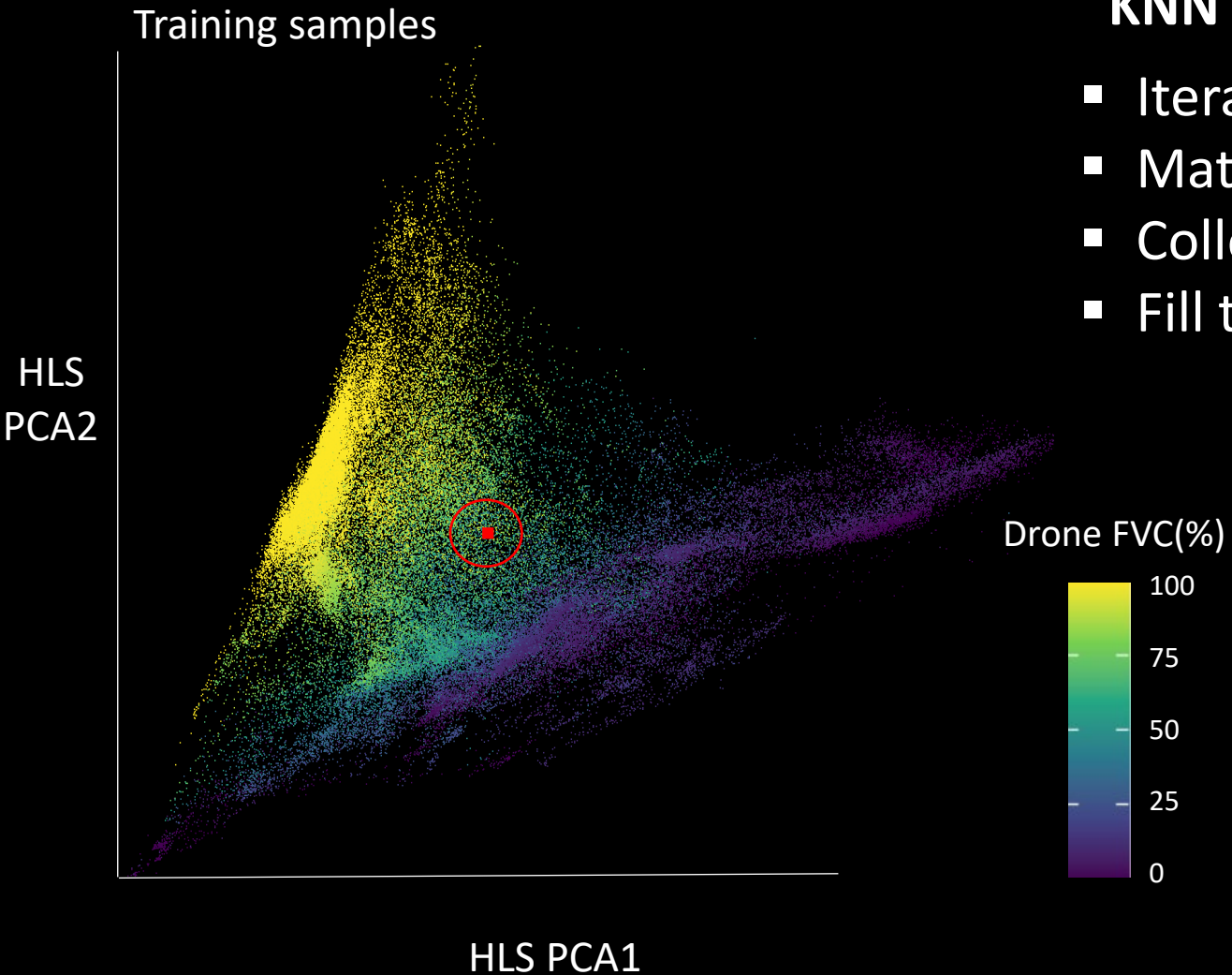
Drone FVC(%)



HLS tile of
Sentinel 2 image
of April 20, 2022



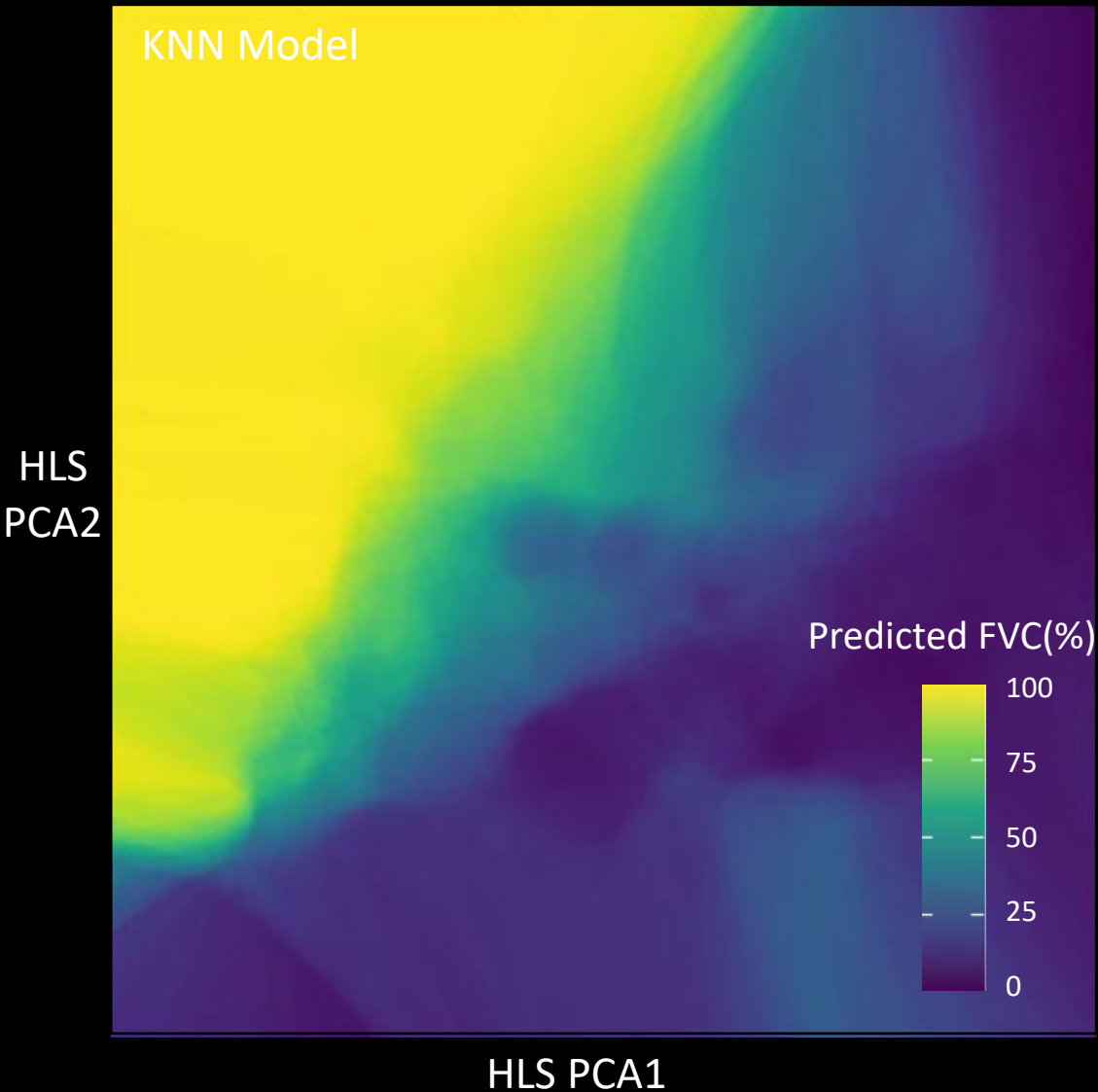
Training samples and KNN model



KNN model:

- Iterate to collect representative land cover/use
- Match drone data with coincident HLS data
- Collect 85K+ sample pixels from 265 drone images
- Fill the feature space by training samples

Training data and KNN model



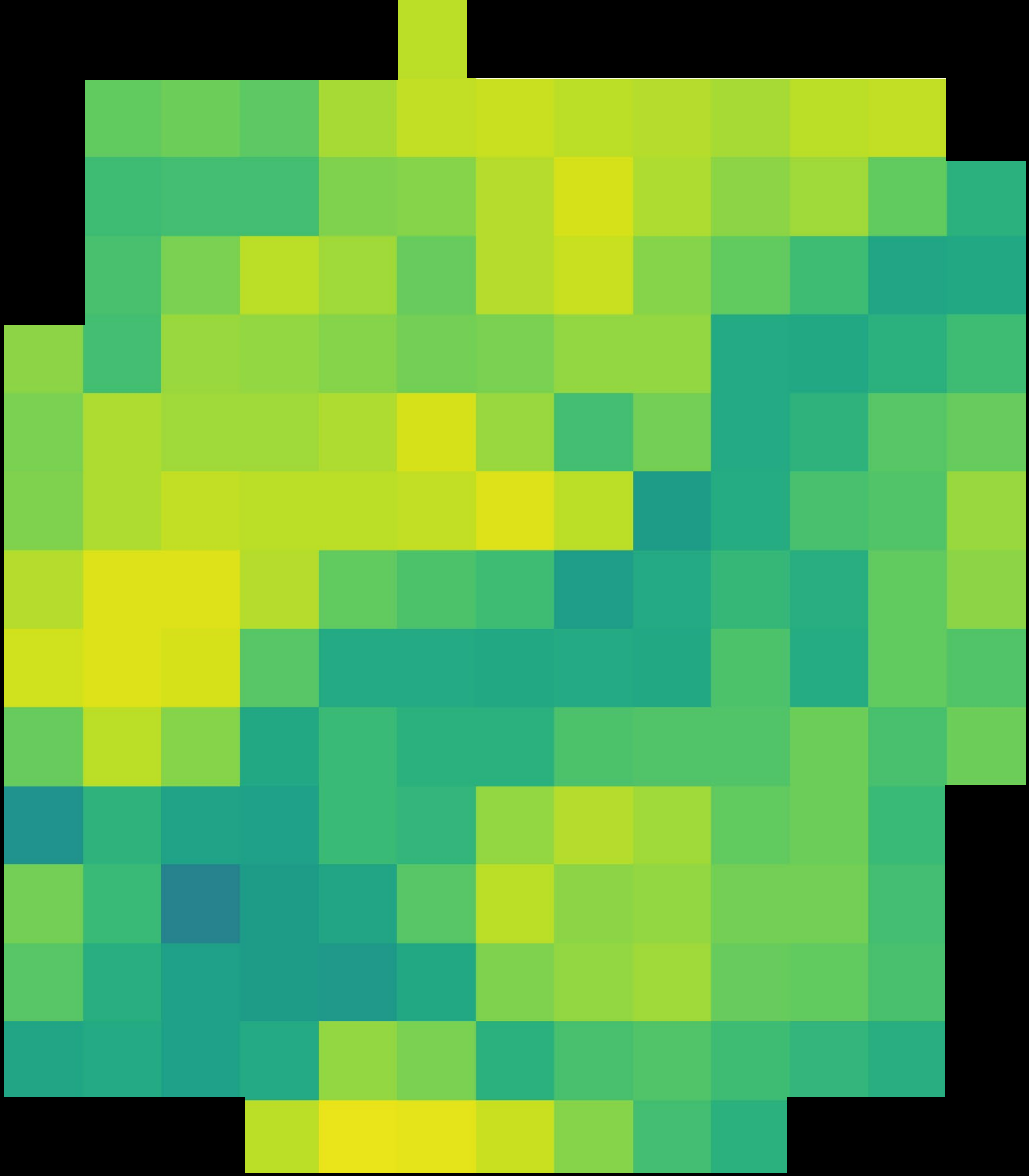
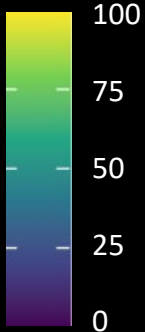
KNN model

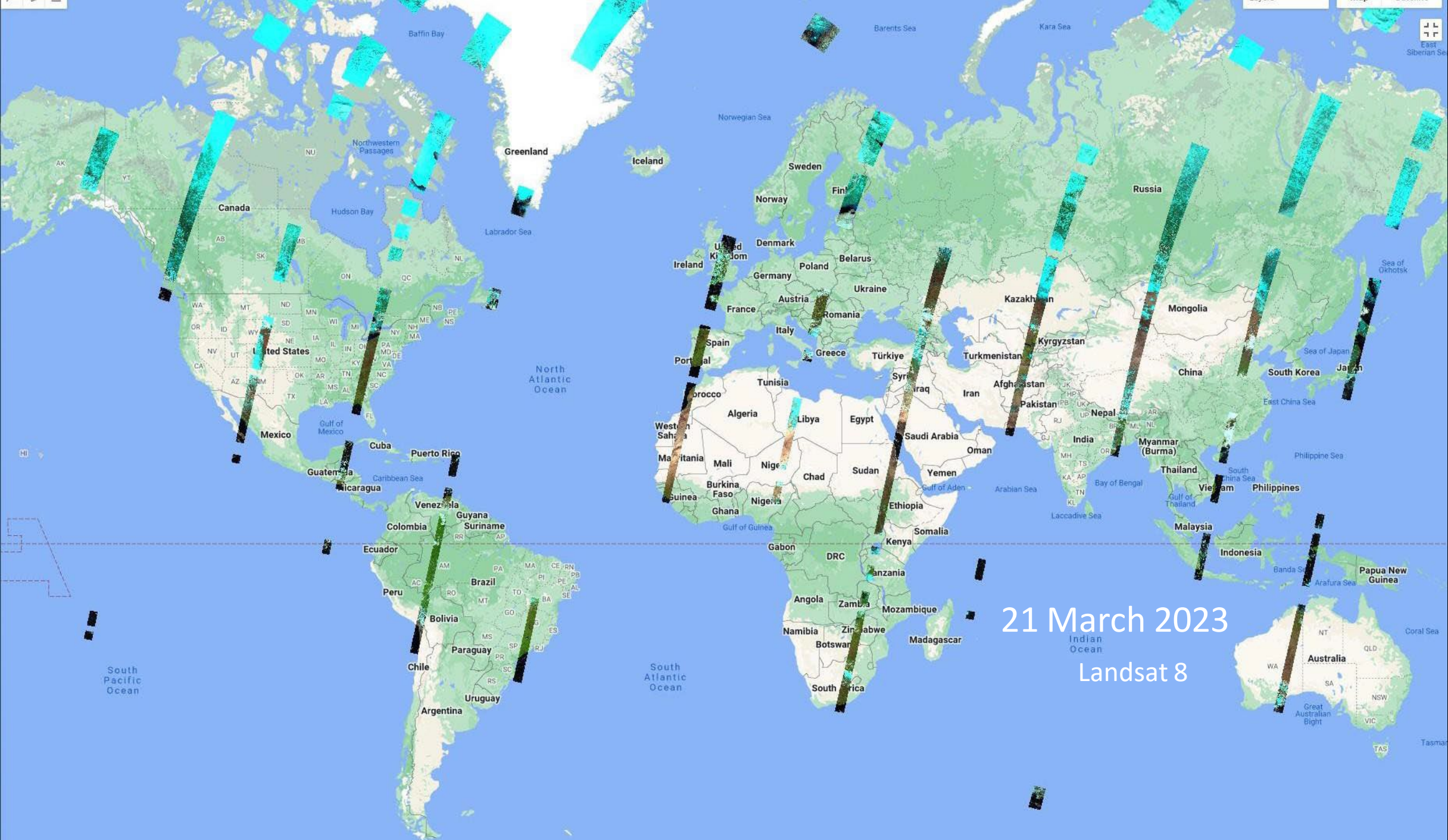
KNN model:

- Iterate to collect representative land cover/use
- Match drone data with coincident HLS data
- Collect 85K+ sample pixels from 265 drone images
- Fill the feature space by training samples
- Build KNN model and predict the FVC at global scale

Battle of Upperville Historic Park, VA

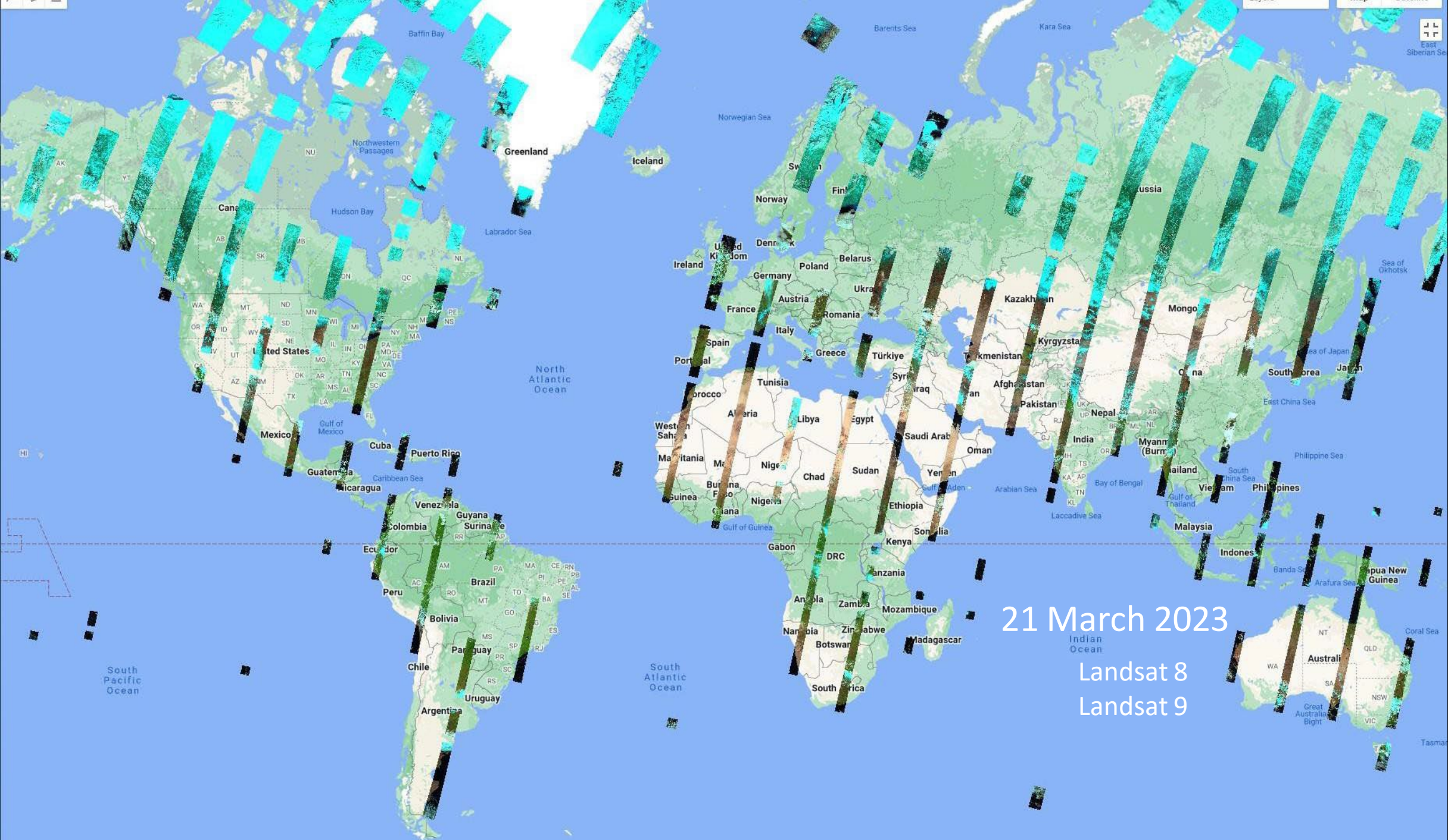
Predicted FVC(%)





21 March 2023

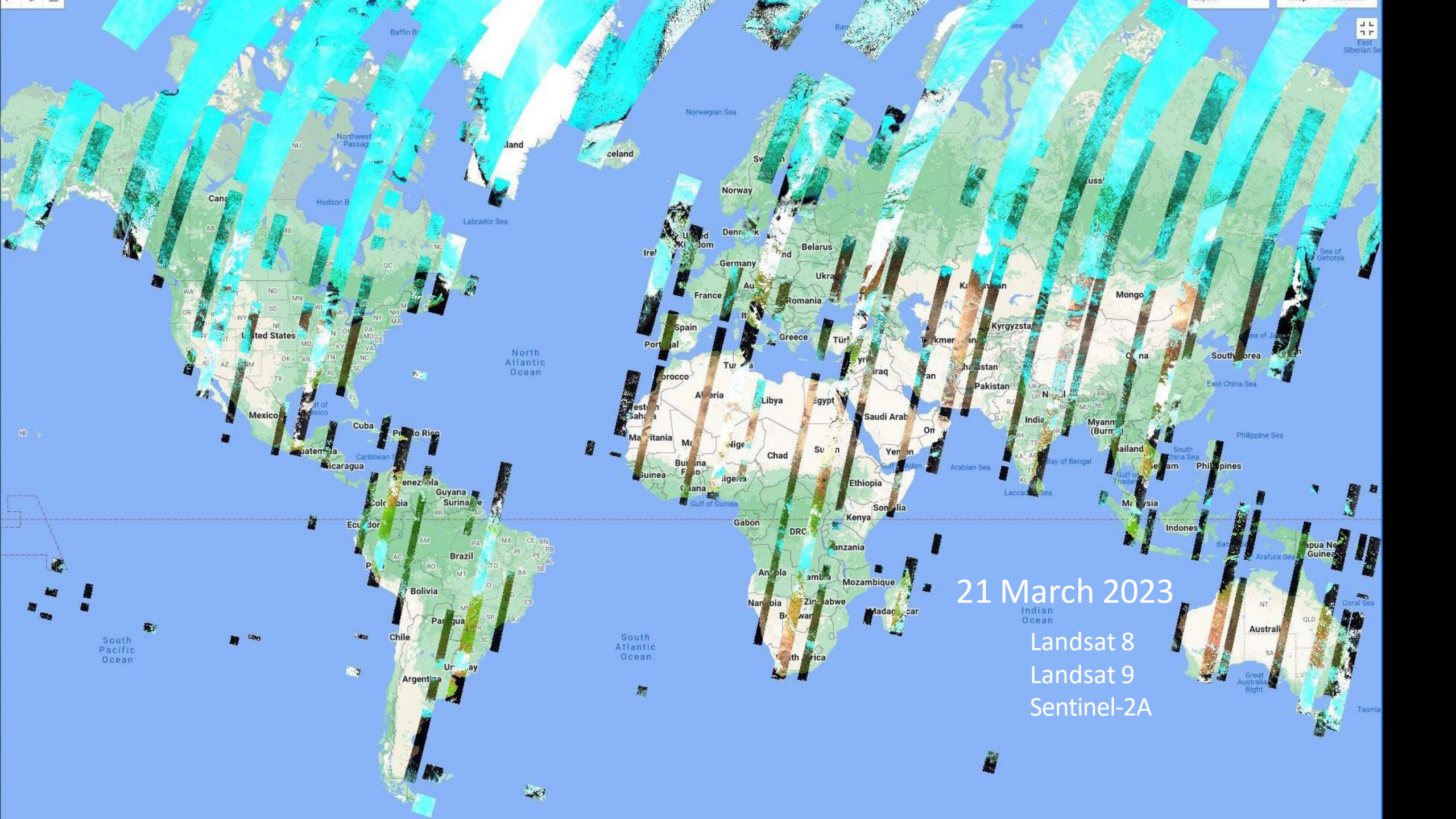
Landsat 8



21 March 2023

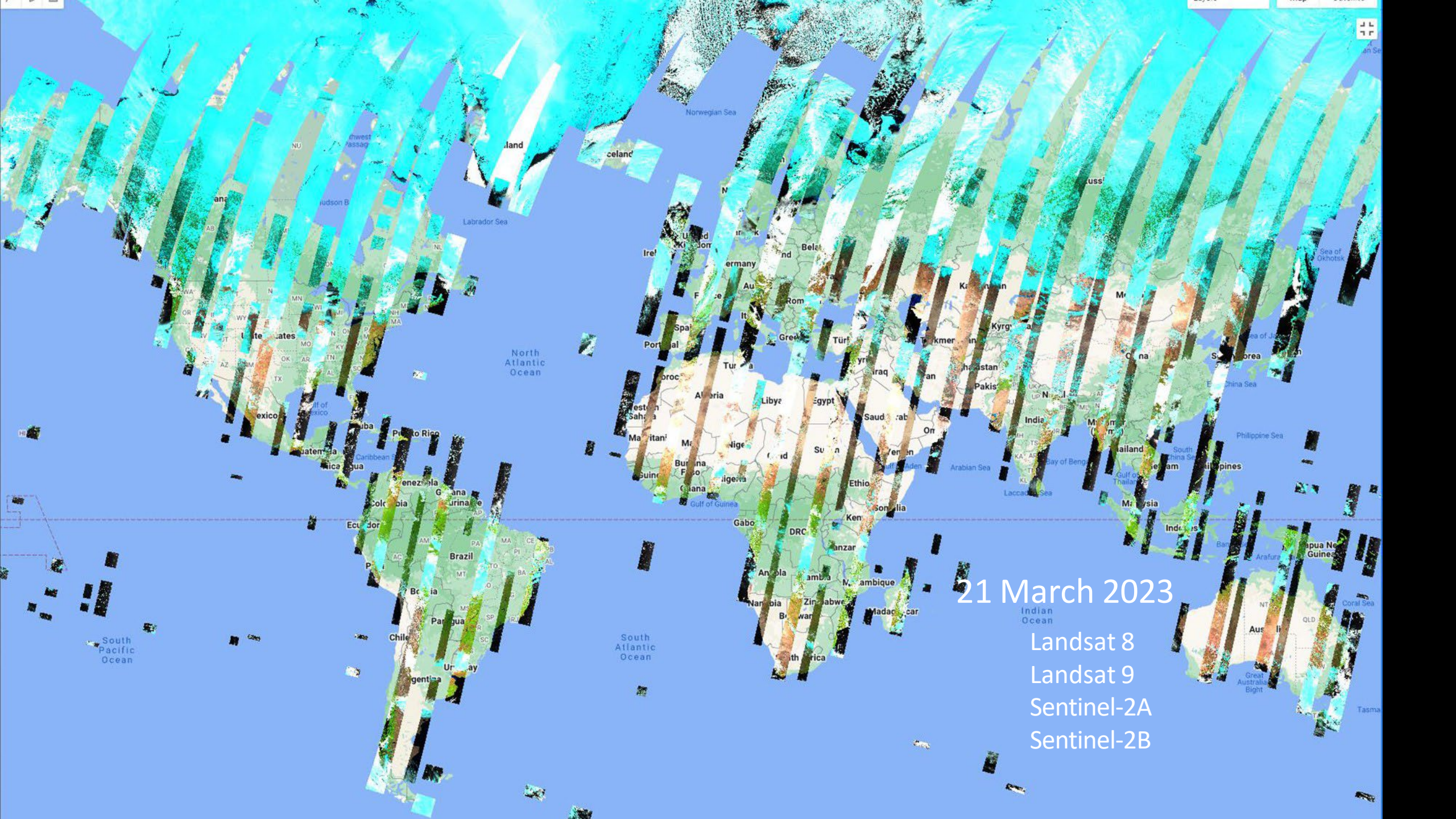
Landsat 8
Landsat 9





21 March 2023

Landsat 8
Landsat 9
Sentinel-2A

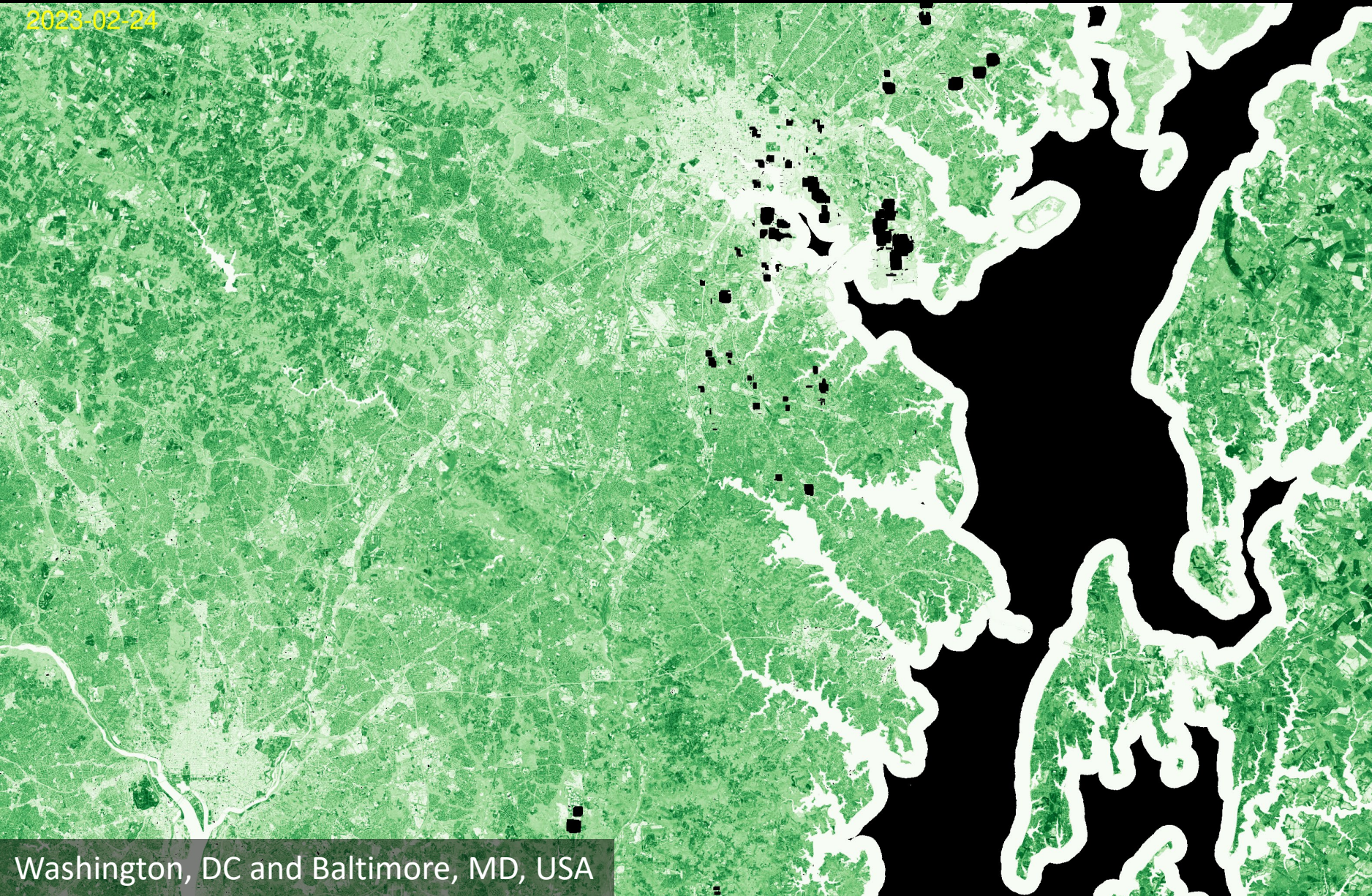


21 March 2023

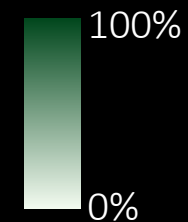
Landsat 8
Landsat 9
Sentinel-2A
Sentinel-2B

Fractional vegetation mapping

2023-02-24



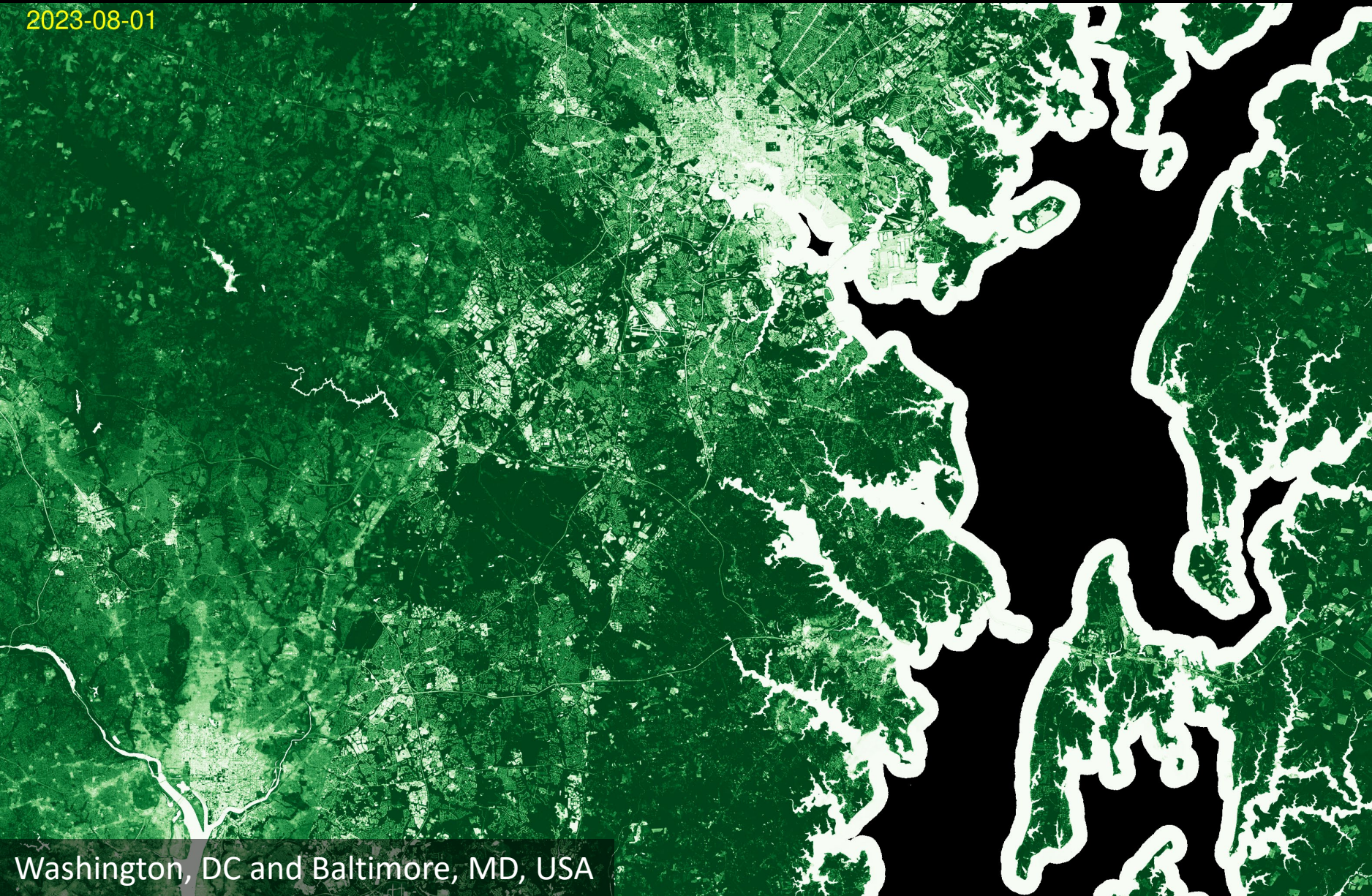
Vegetation cover percent is mapped per HLS pixel, defined as the amount of skylight orthogonal to the surface that is intercepted by vegetation.



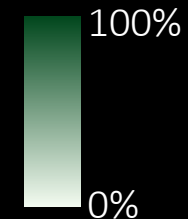
Washington, DC and Baltimore, MD, USA

Fractional vegetation mapping

2023-08-01

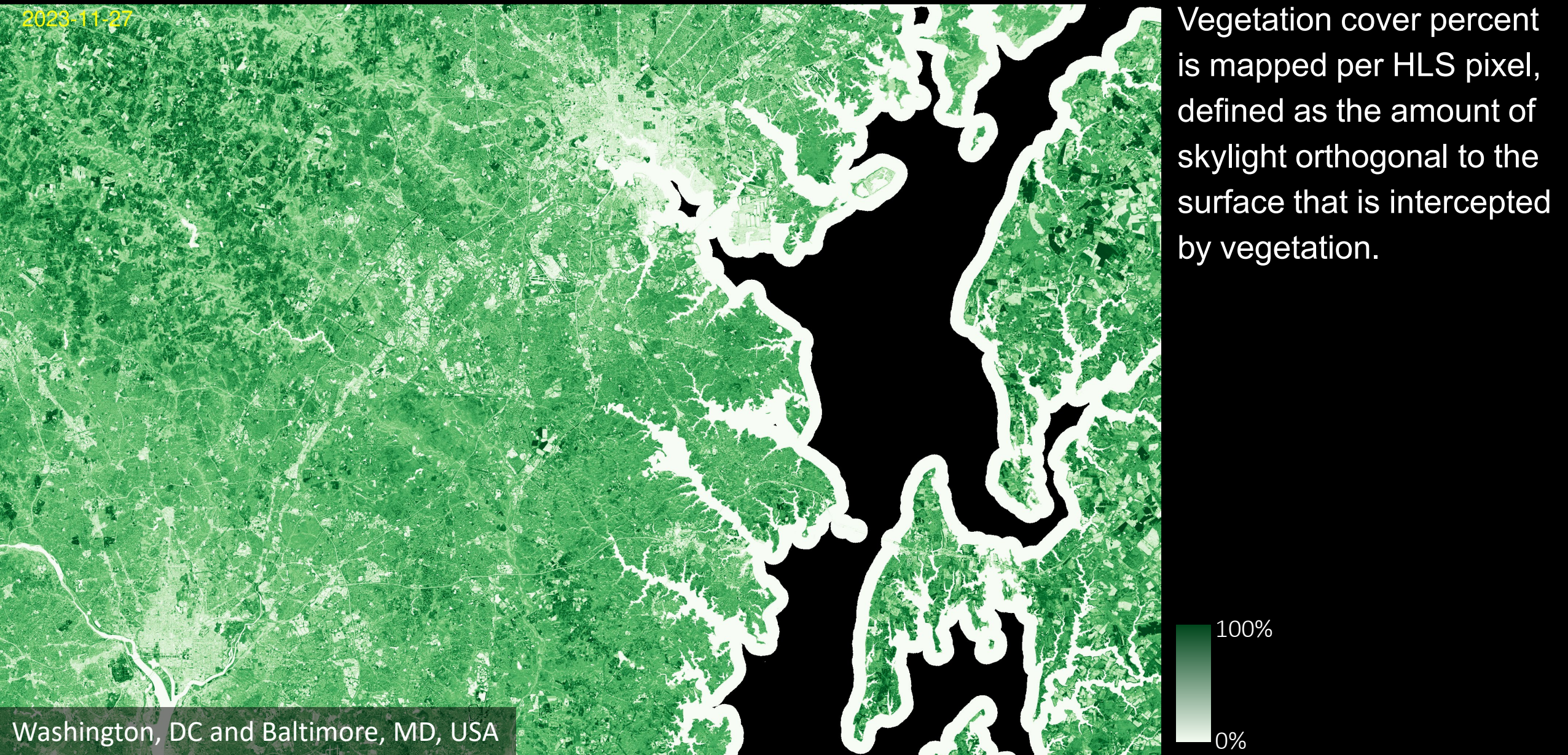


Vegetation cover percent is mapped per HLS pixel, defined as the amount of skylight orthogonal to the surface that is intercepted by vegetation.



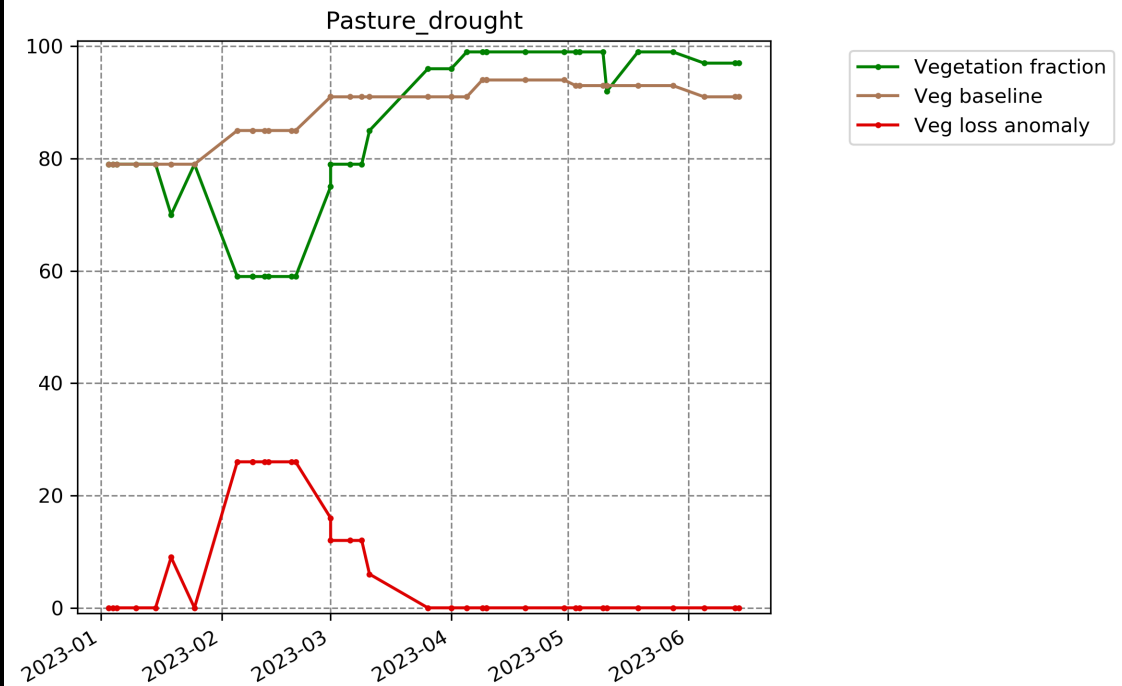
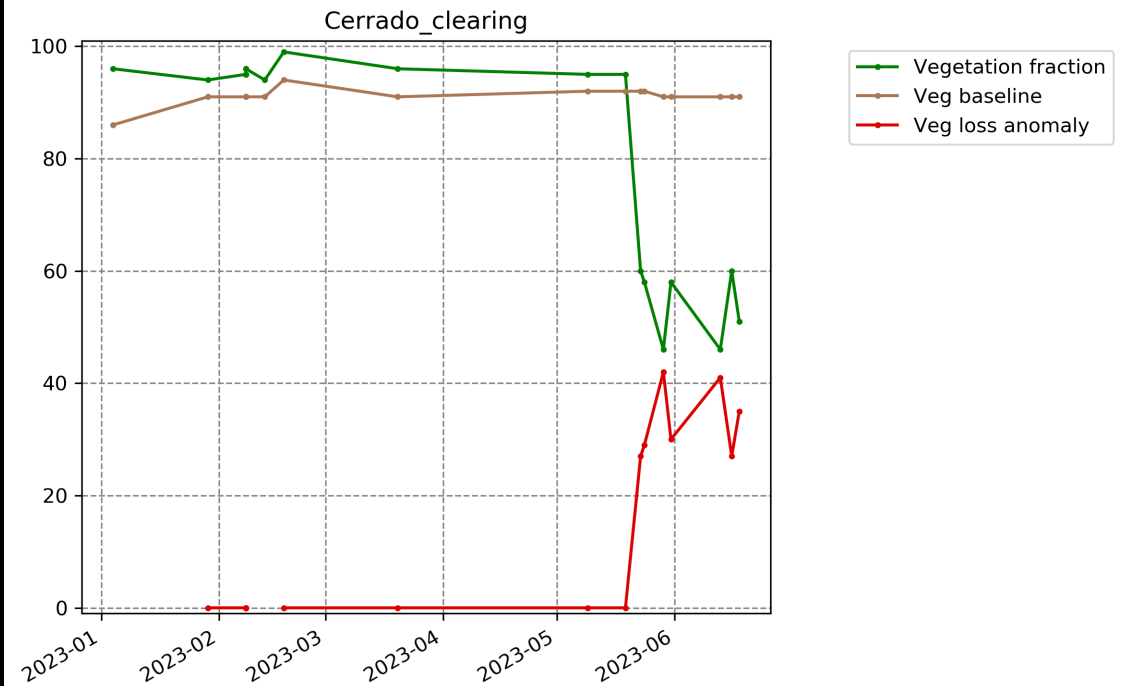
Washington, DC and Baltimore, MD, USA

Fractional vegetation mapping



Vegetation Change Monitoring (DIST-ALERT Product)

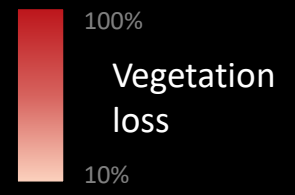
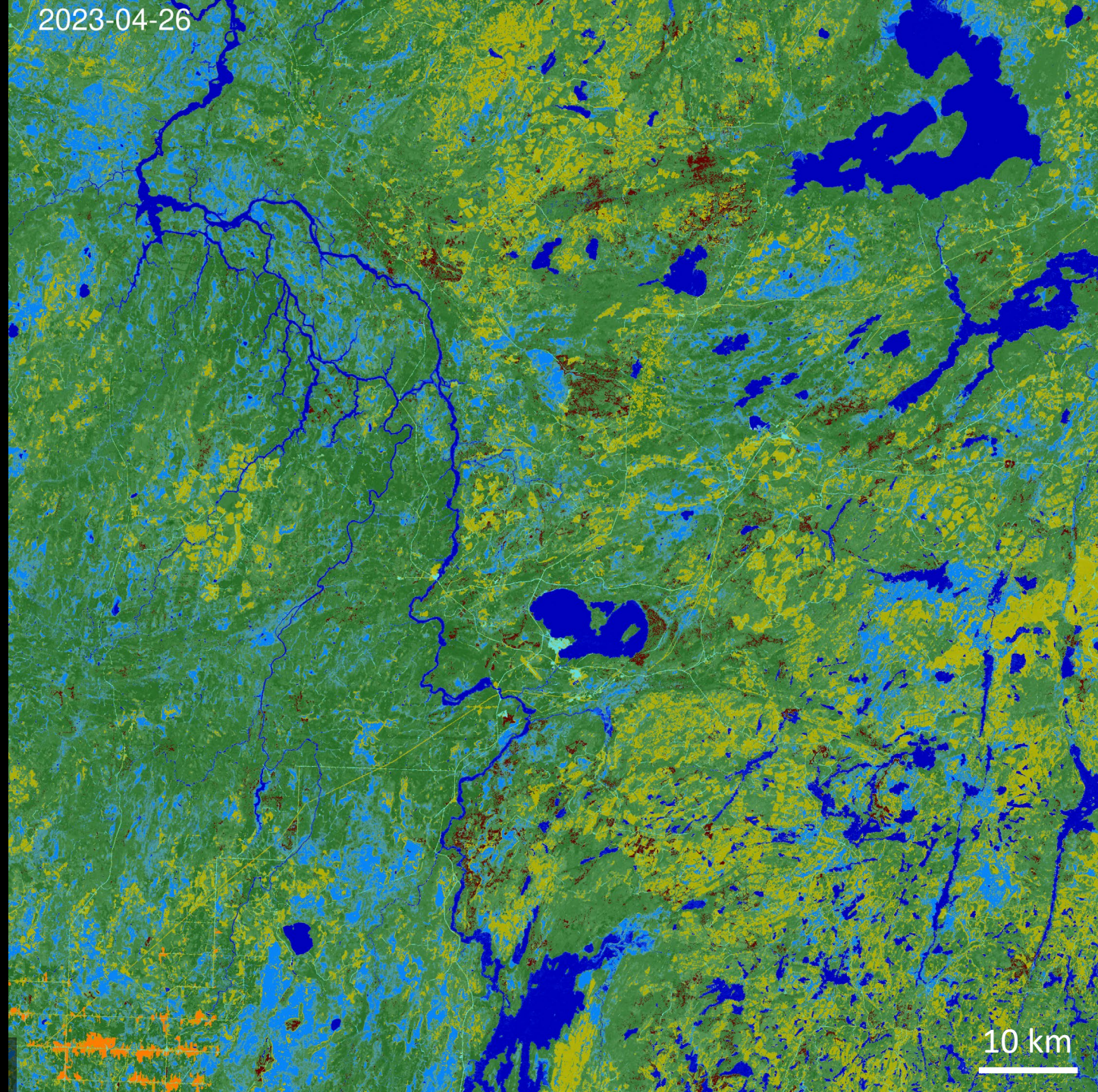
- Near real-time **vegetation fraction** is compared to a **seasonal baseline**
 - The baseline is the *minimum* of the *three previous years* of HLS-based vegetation cover within a seasonal window of ± 15 days
- Disturbance is monitored by tracking **vegetation fraction anomalies** through time



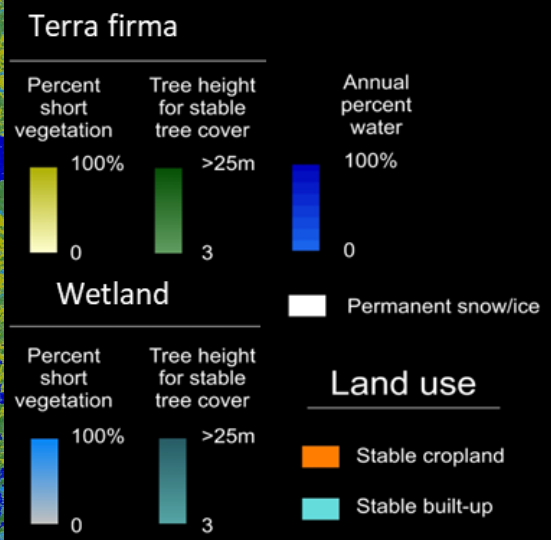


Fire

North Atlantic Ocean

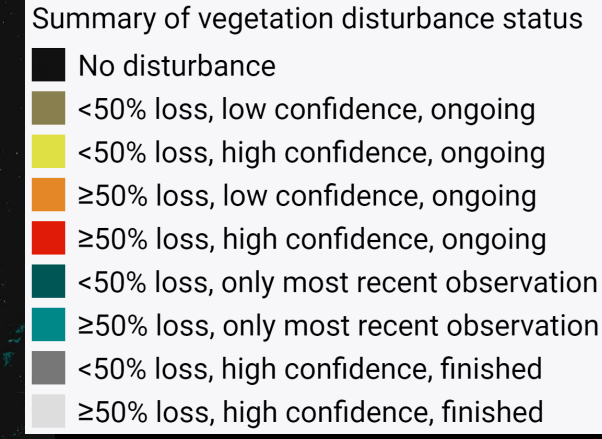
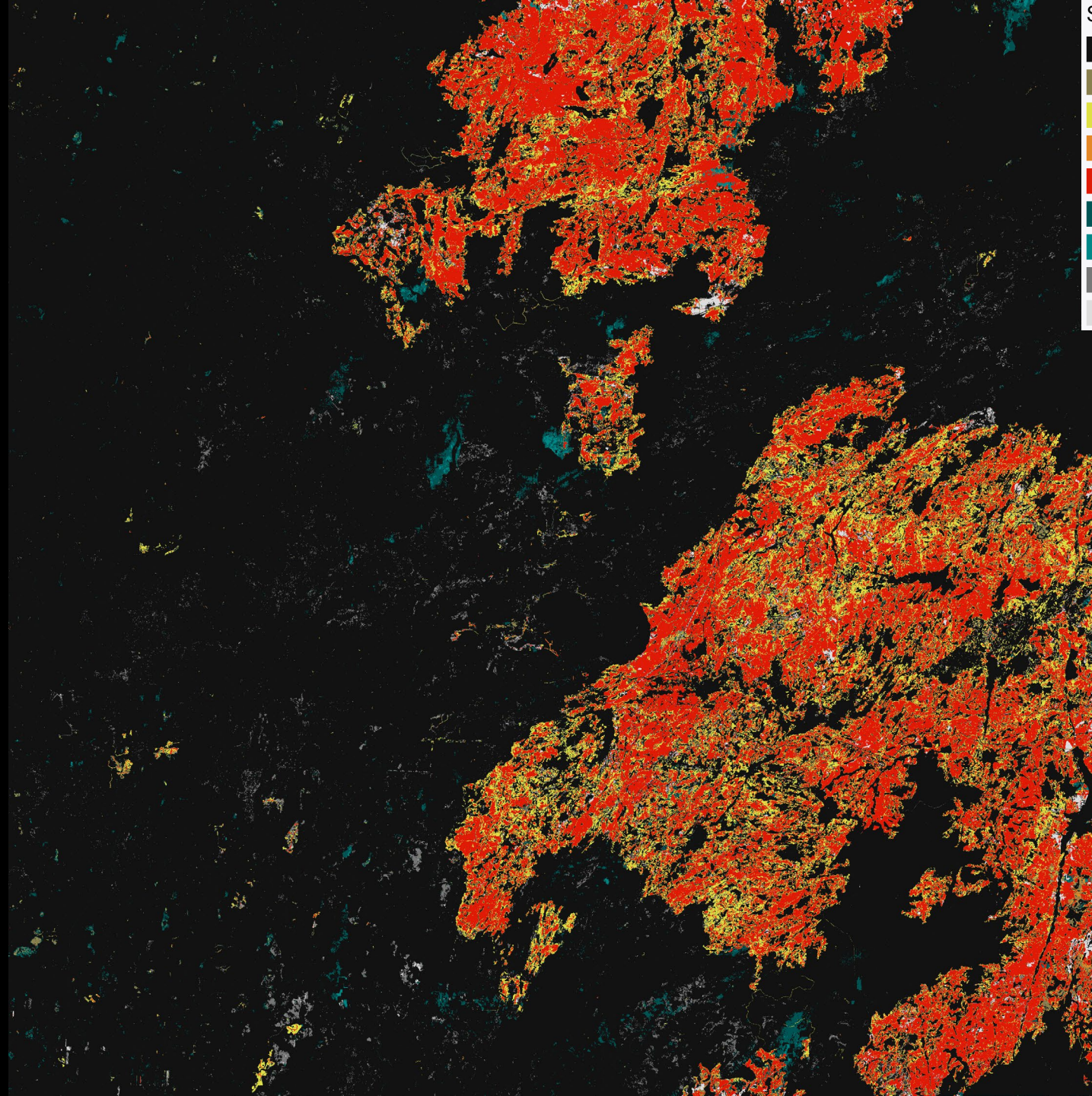


Potapov et al. The Global 2000-2020 Land Cover and Land Use Change Dataset Derived From the Landsat Archive: First Results. *Frontiers in Remote Sensing* <https://www.frontiersin.org/articles/10.3389/frsen.2022.856903>



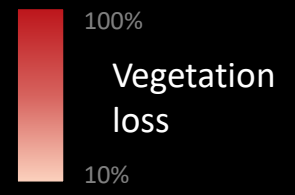
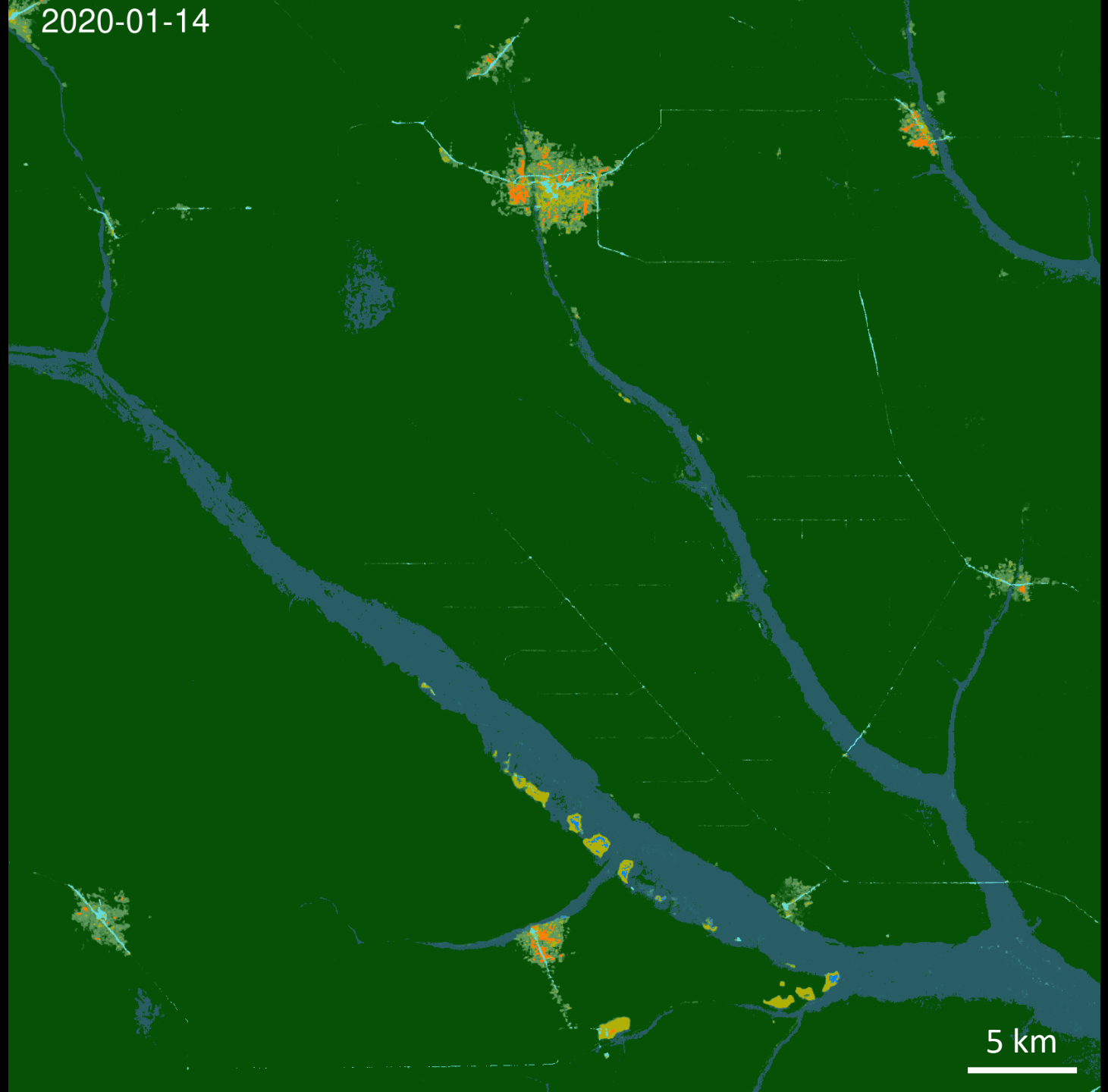
10 km

DIST-ALERT



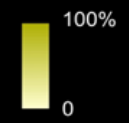
Logging



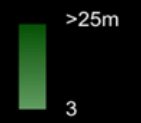


Terra firma

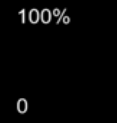
Percent short vegetation



Tree height for stable tree cover

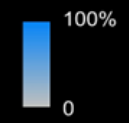


Annual percent water

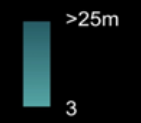


Wetland

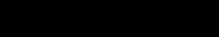
Percent short vegetation



Tree height for stable tree cover



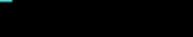
Permanent snow/ice



Land use

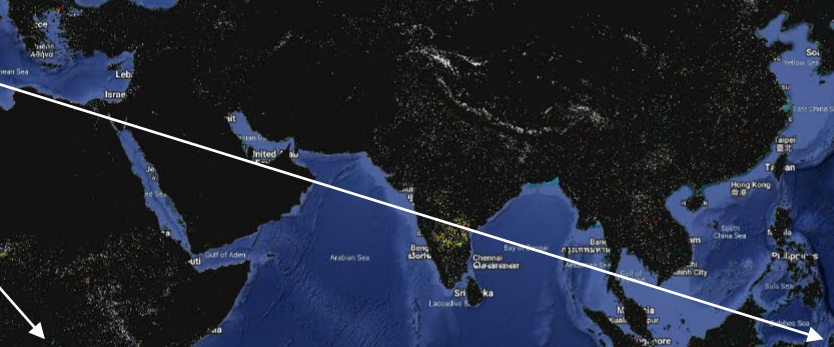
Stable cropland

Stable built-up

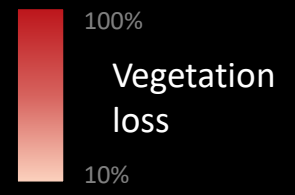
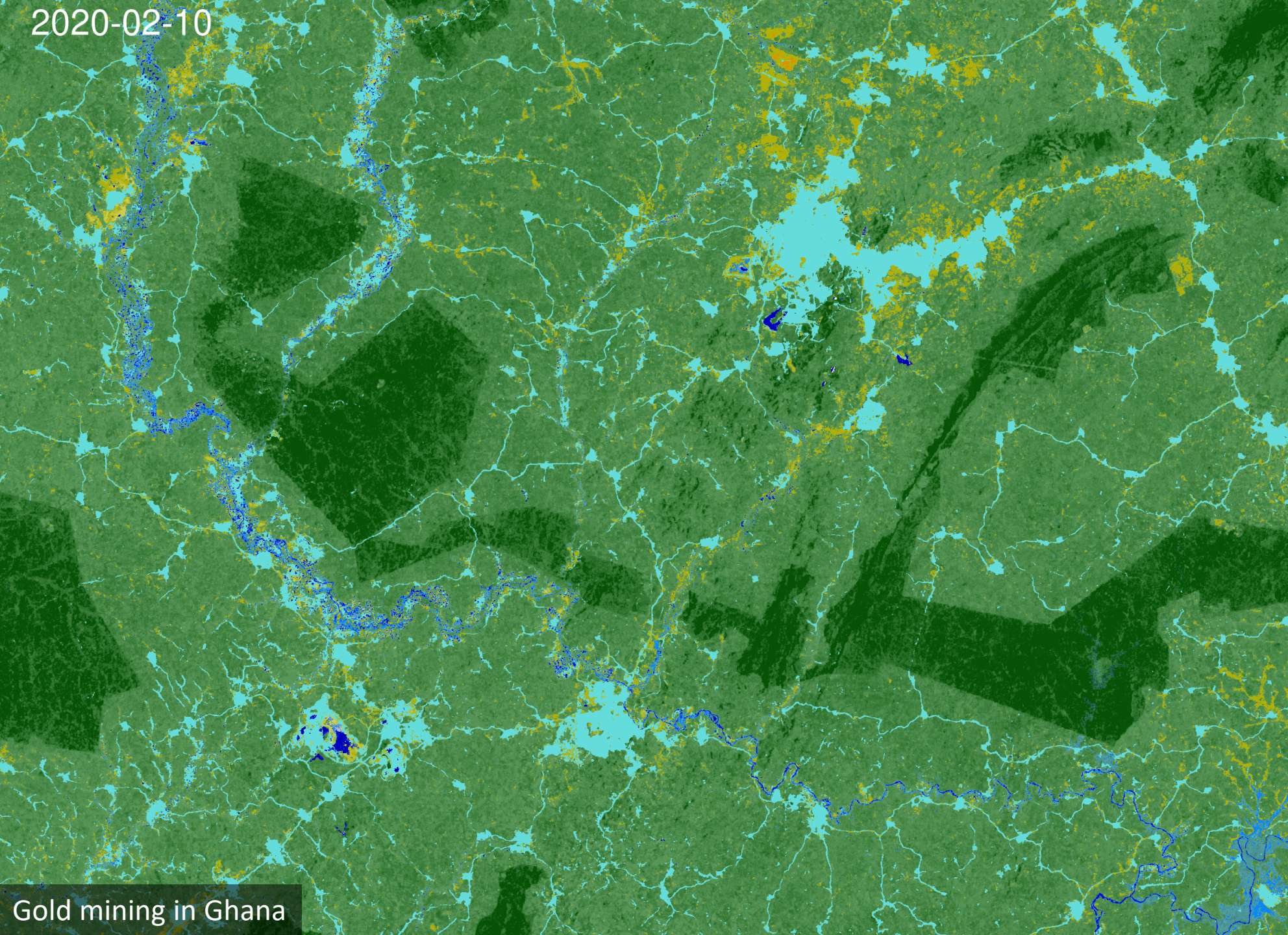


5 km

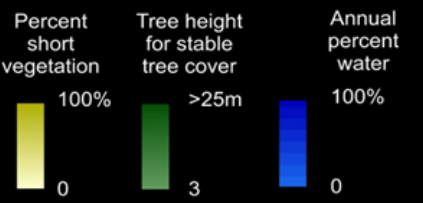
Mining



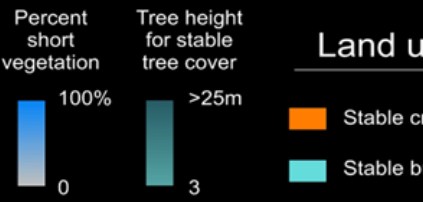
2020-02-10



Terra firma



Wetland

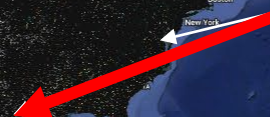


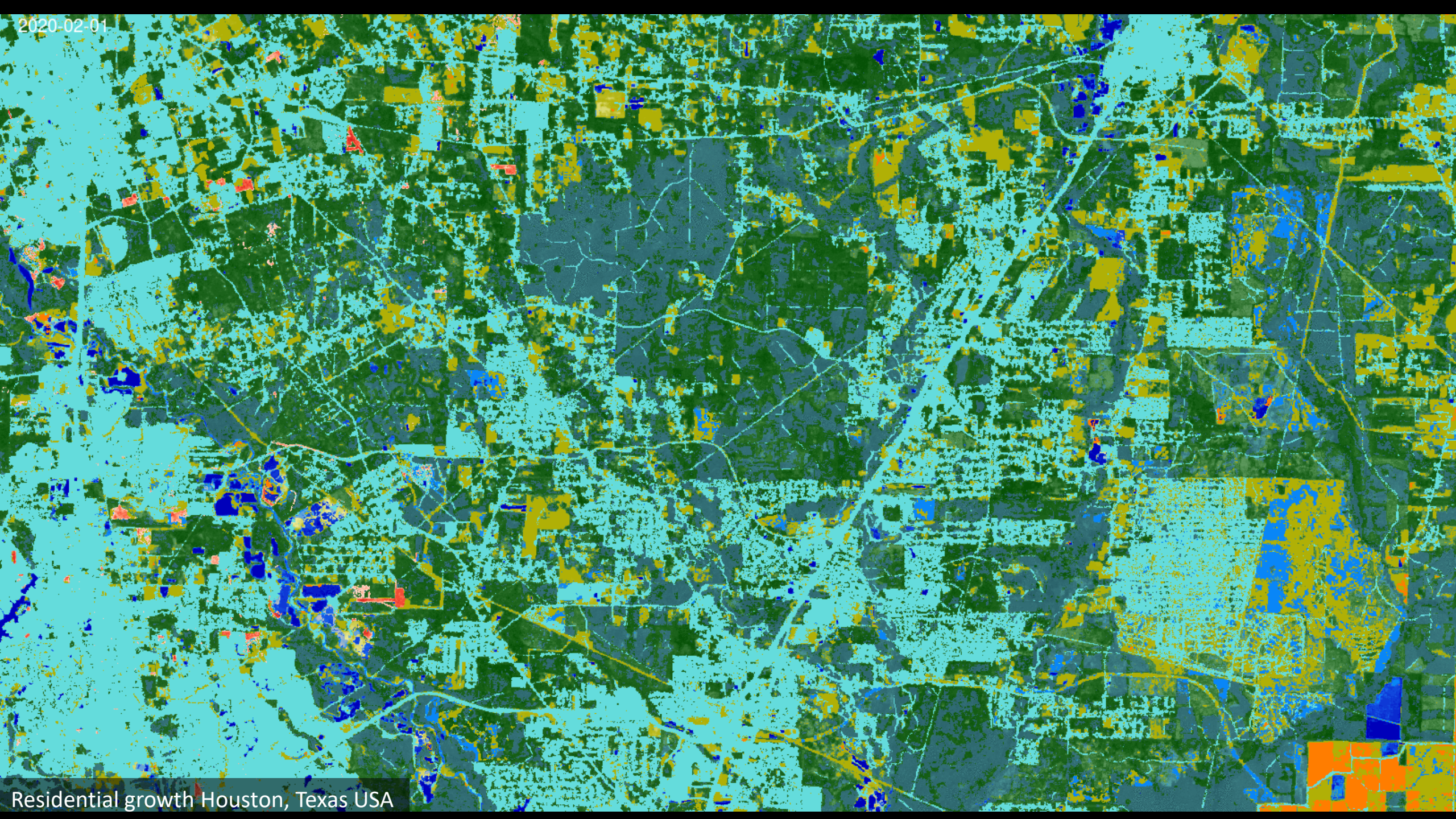
Permanent snow/ice

Gold mining in Ghana



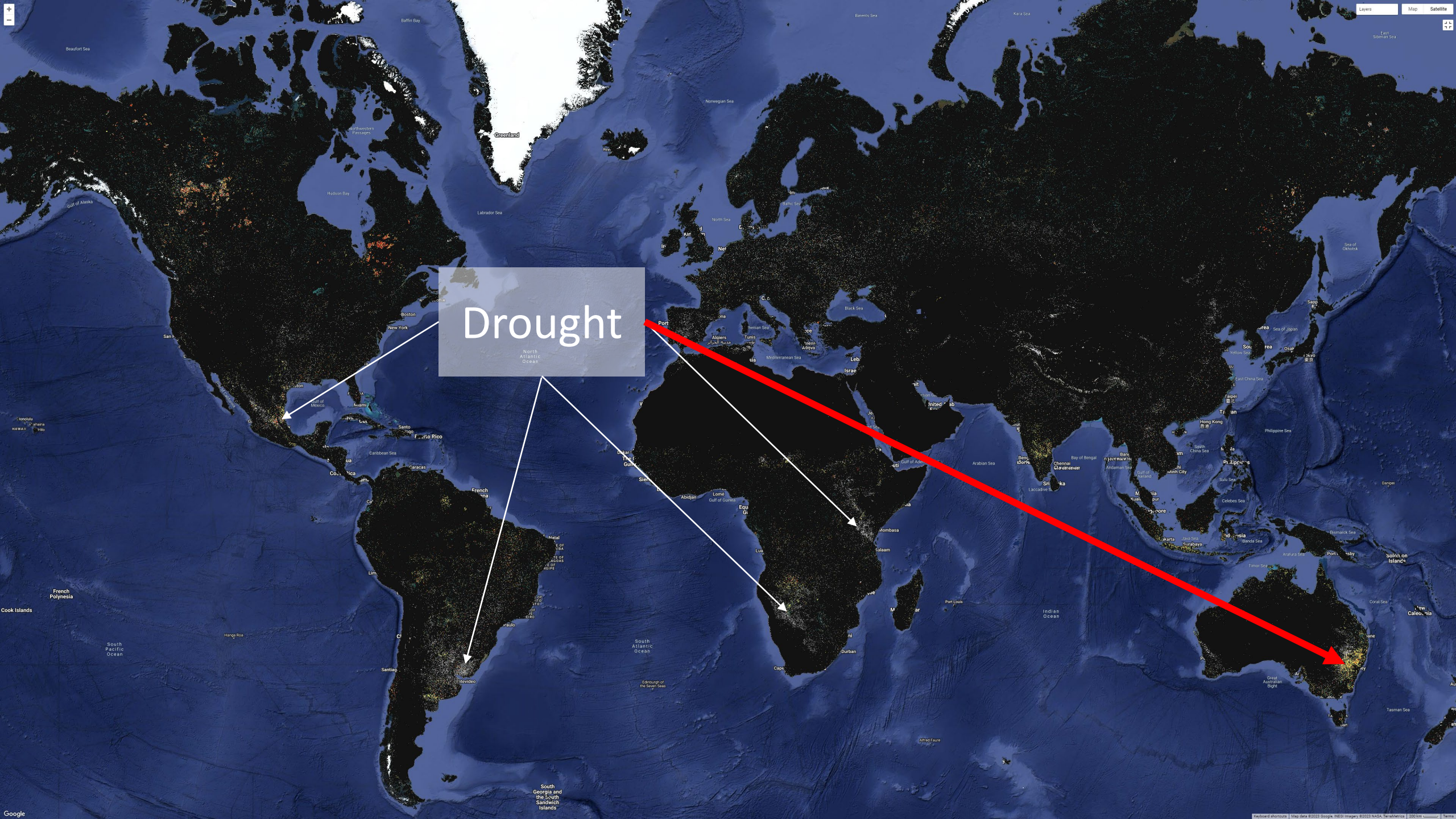
Urban expansion





2020-02-01

Residential growth Houston, Texas USA



Drought

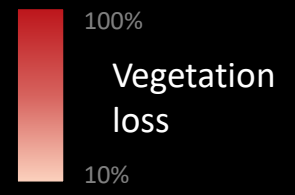
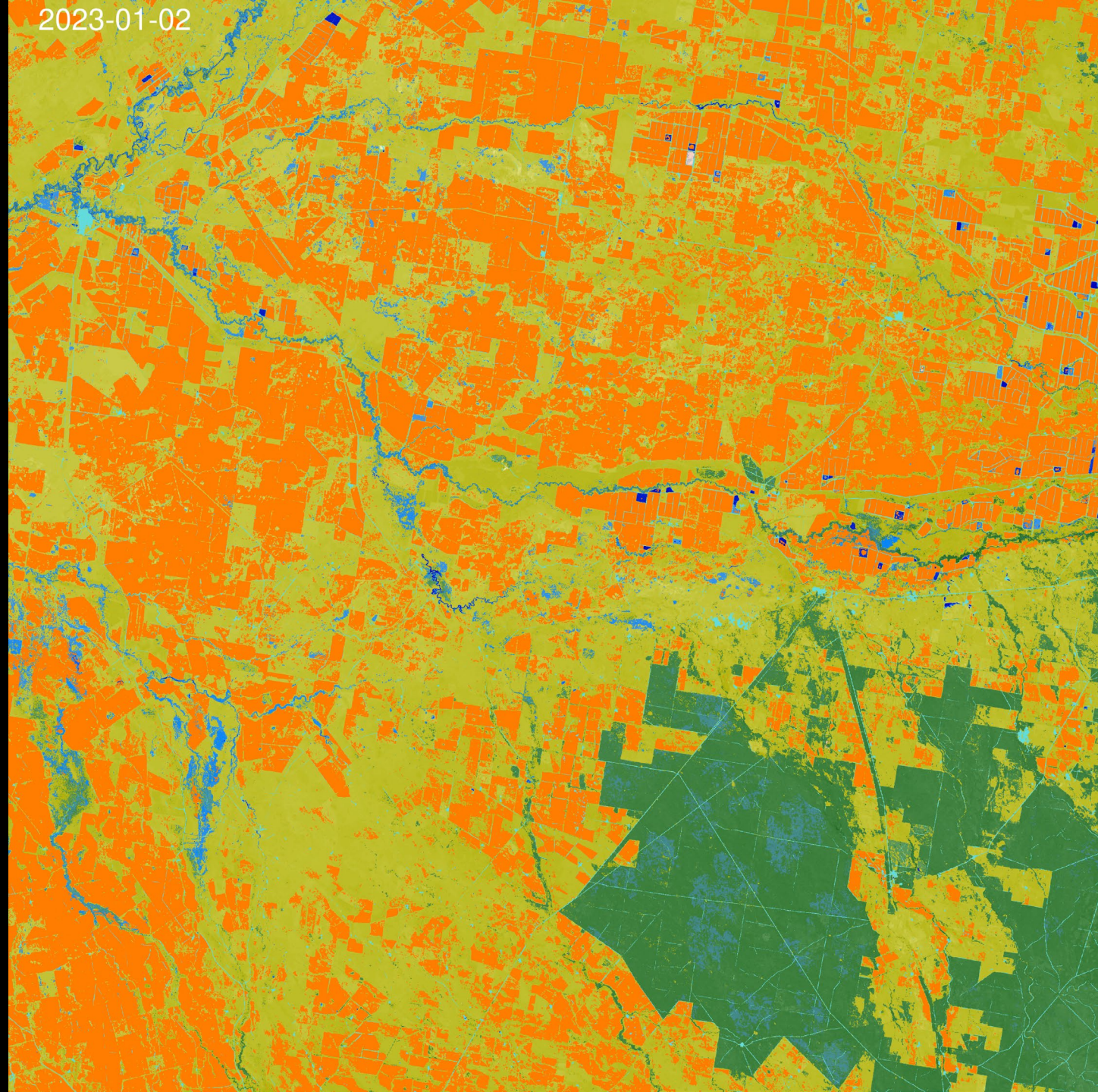
North America

South America

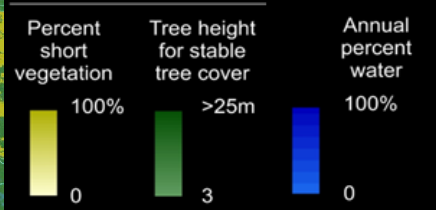
Africa

Australia

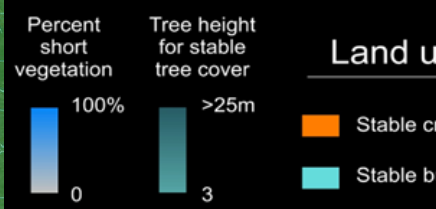
2023-01-02



Terra firma



Wetland

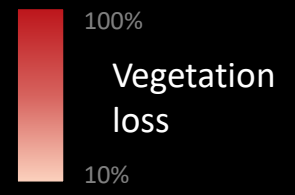
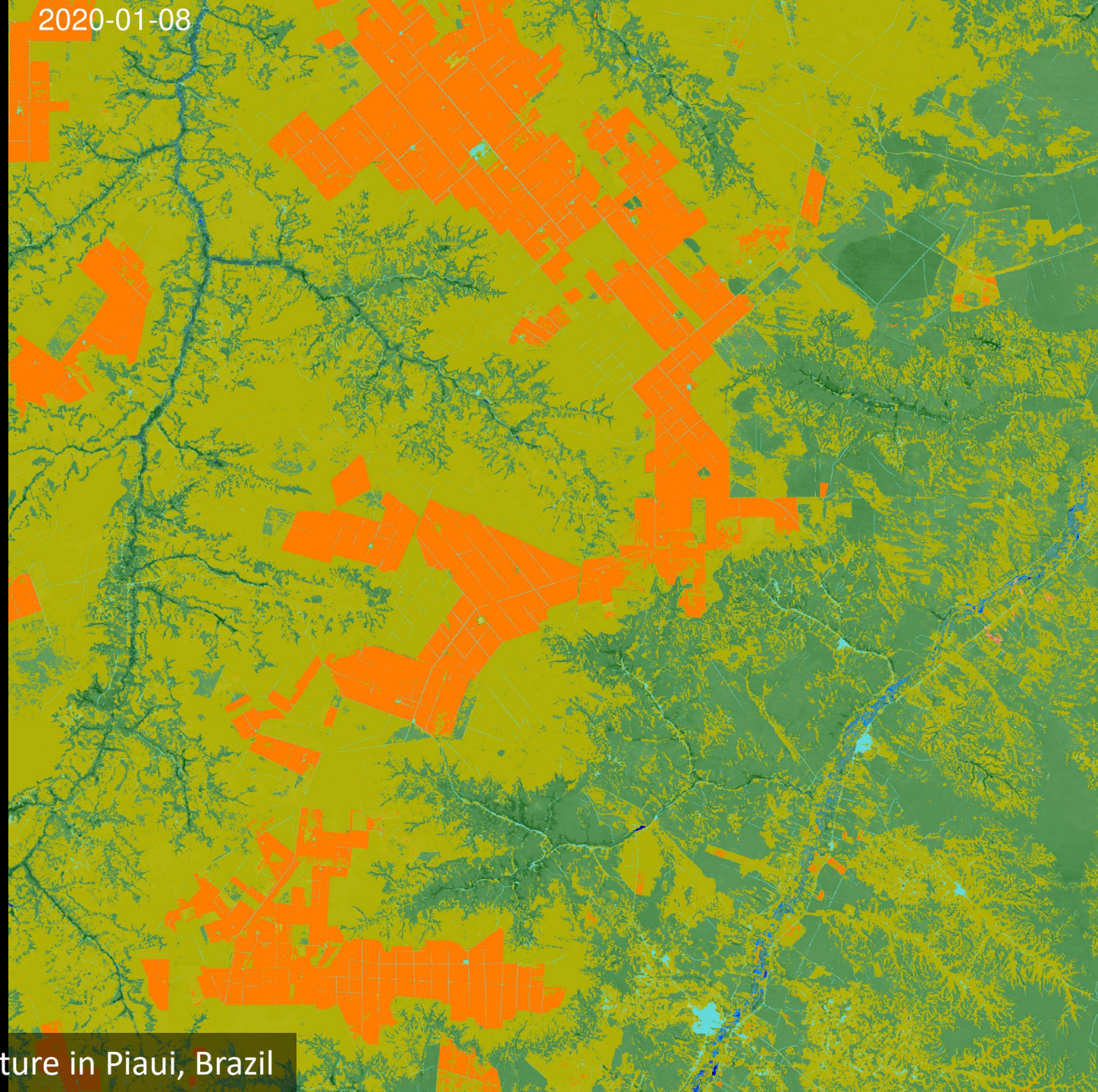




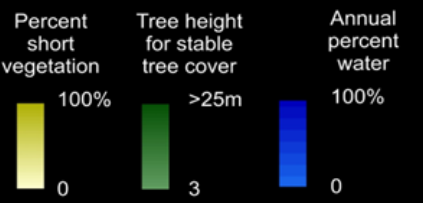
Conversion
of natural
land



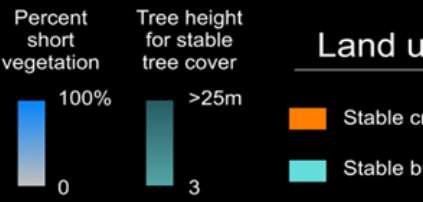
2020-01-08



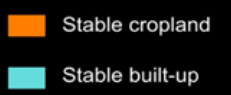
Terra firma



Wetland

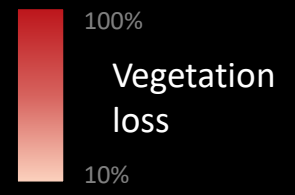
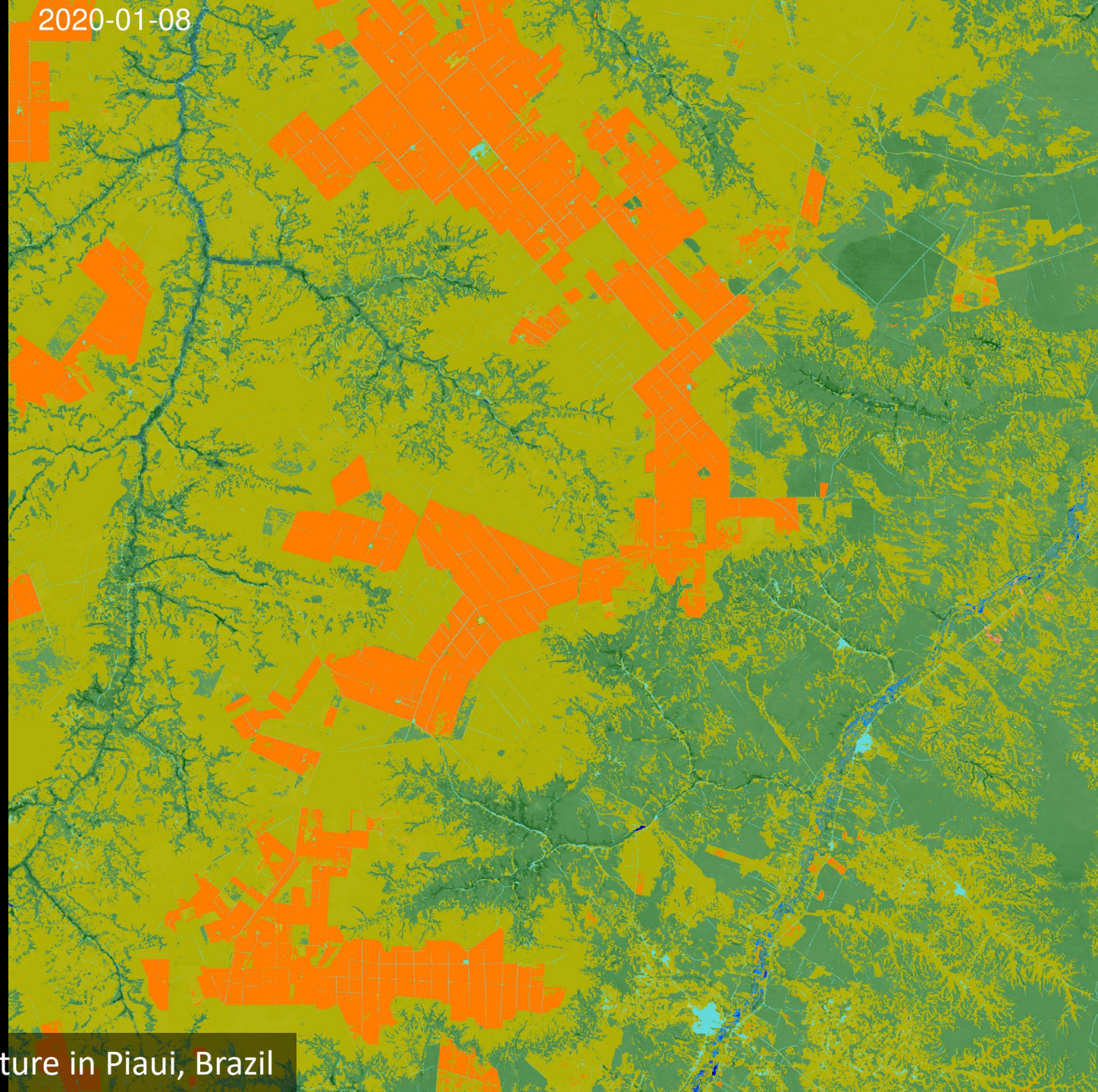


Land use



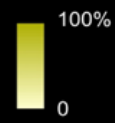
Cerrado clearing for agriculture in Piaui, Brazil

2020-01-08

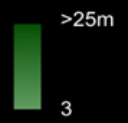


Terra firma

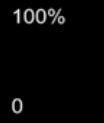
Percent short vegetation



Tree height for stable tree cover

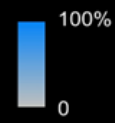


Annual percent water

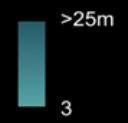


Wetland

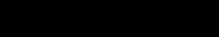
Percent short vegetation



Tree height for stable tree cover

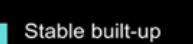


Permanent snow/ice

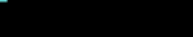


Land use

Stable cropland





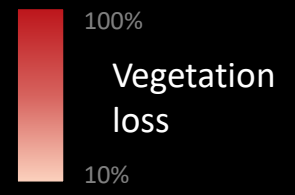
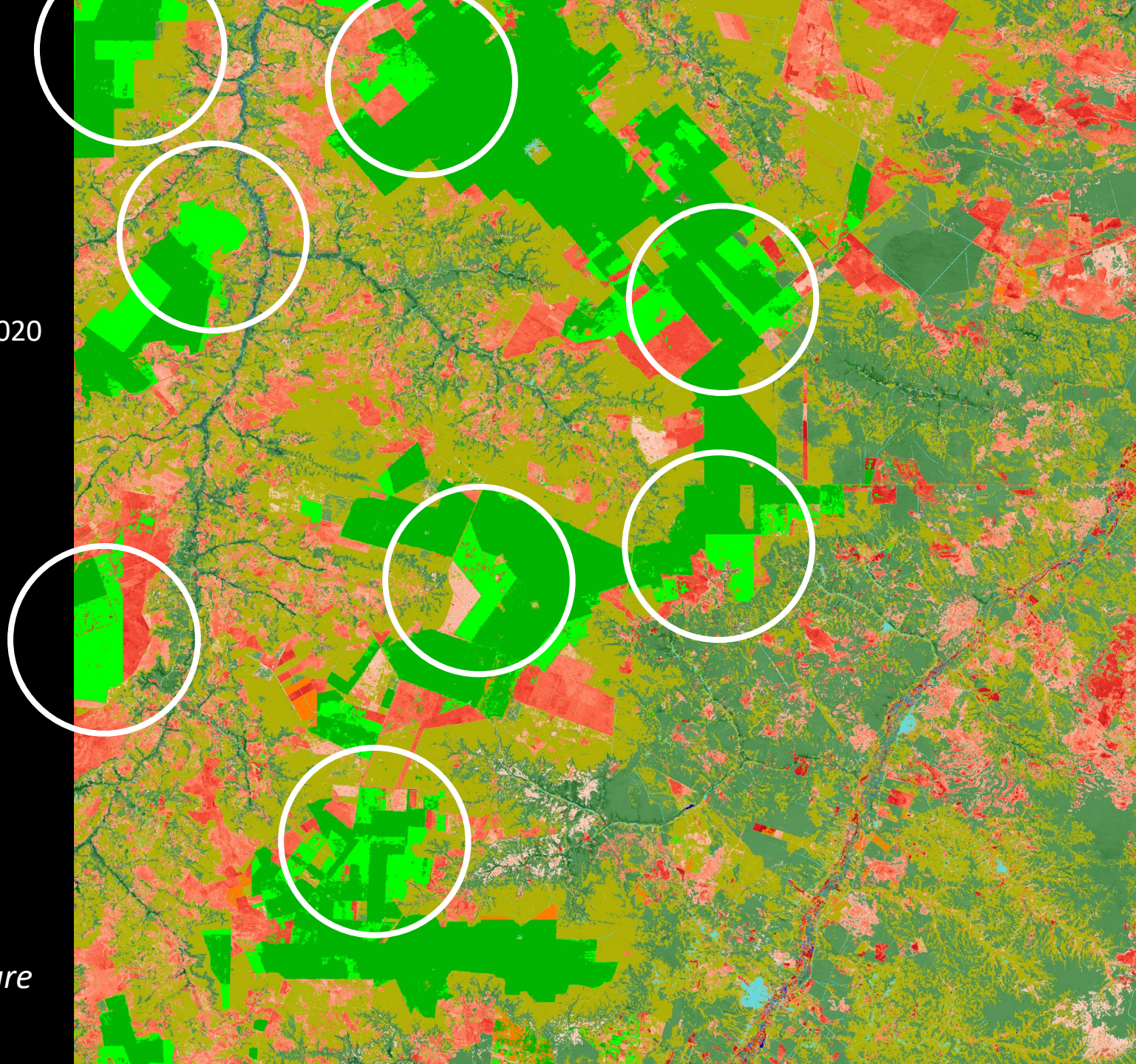
Stable built-up



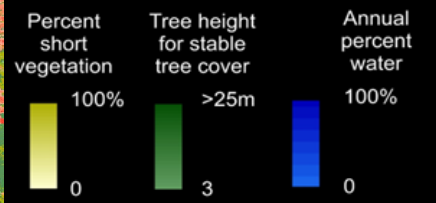
Cerrado clearing for agriculture in Piauí, Brazil

DIST-ALERT

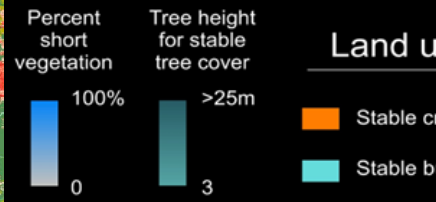
 New soybean since 2020
 Soybean established before 2020



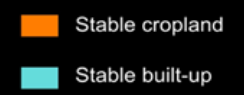
Terra firma



Wetland



Land use



Song et al., 2021, *Nature Sustainability*

Landslides



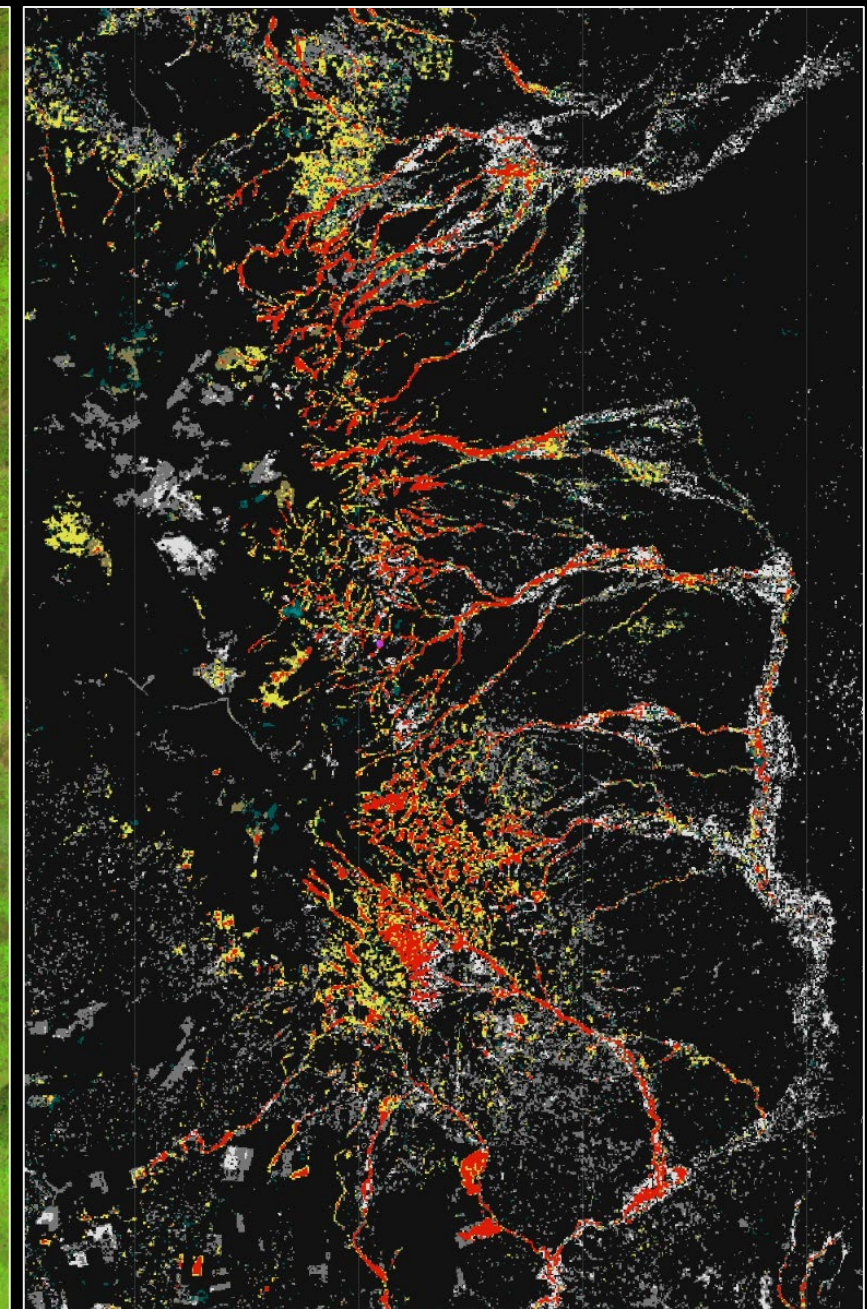
Cyclone Freddy Brings Mudslides and Floods, Leaving Nearly 200 Dead in Malawi

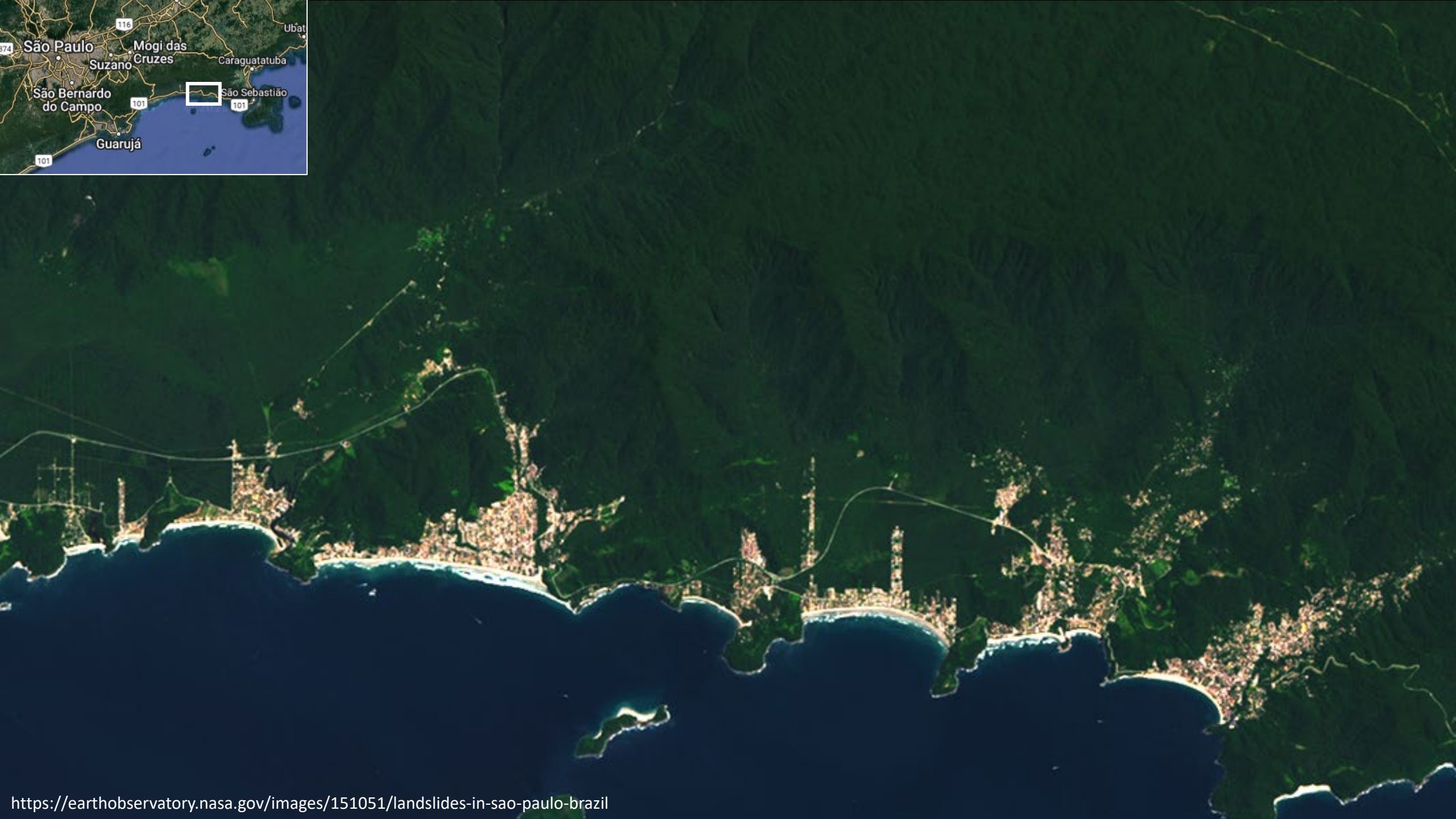


<https://www.nytimes.com/2023/03/14/world/africa/cyclone-freddy-malawi-mudslides-flooding.html>



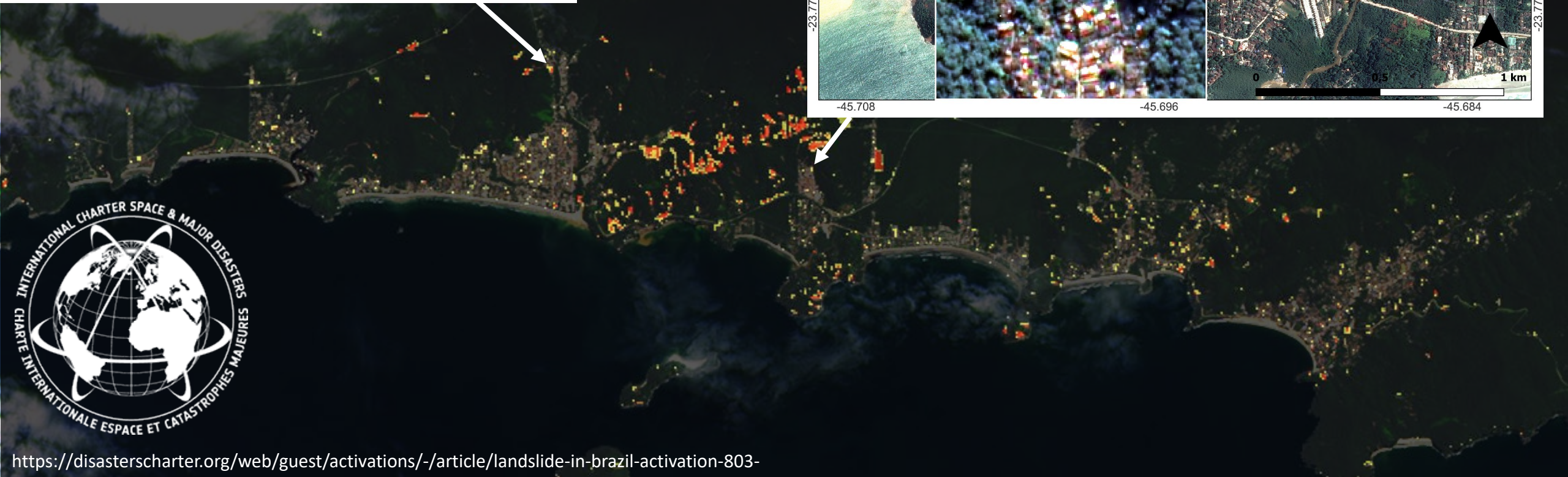
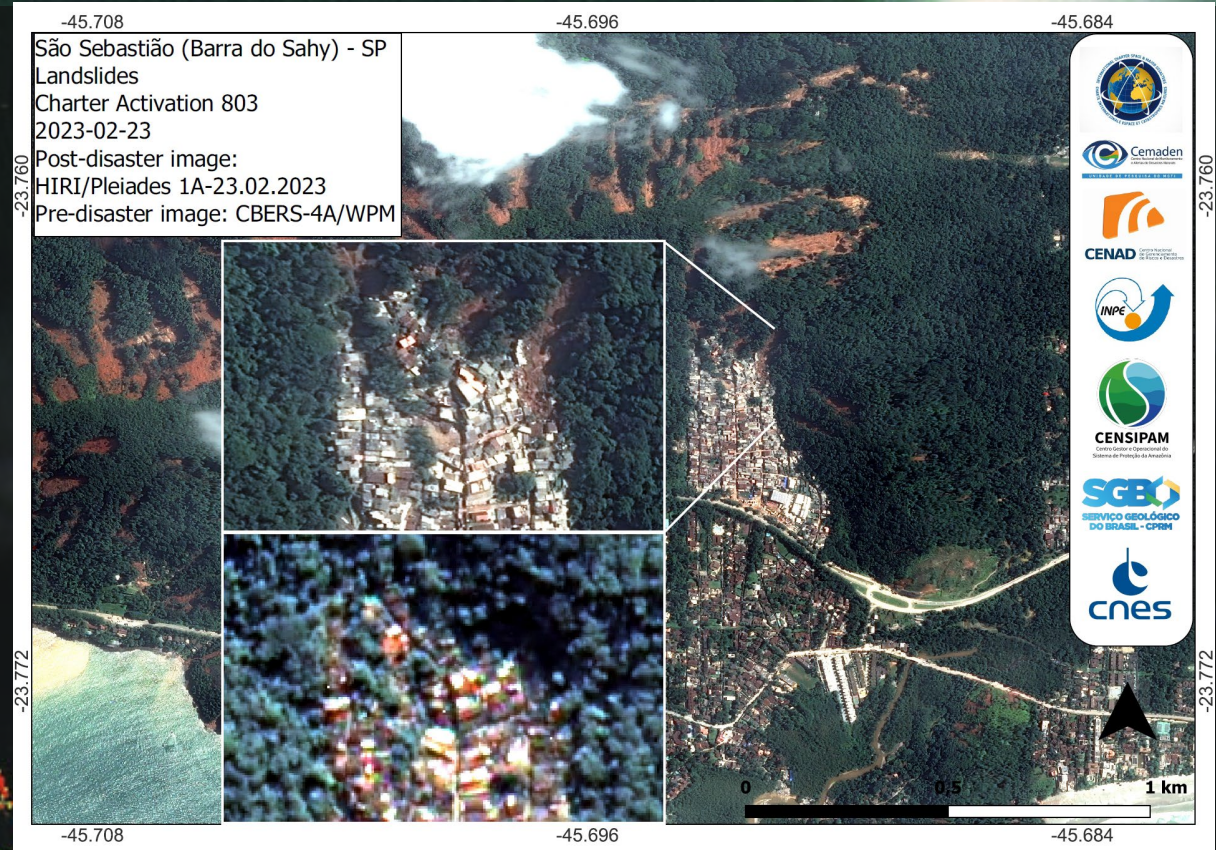
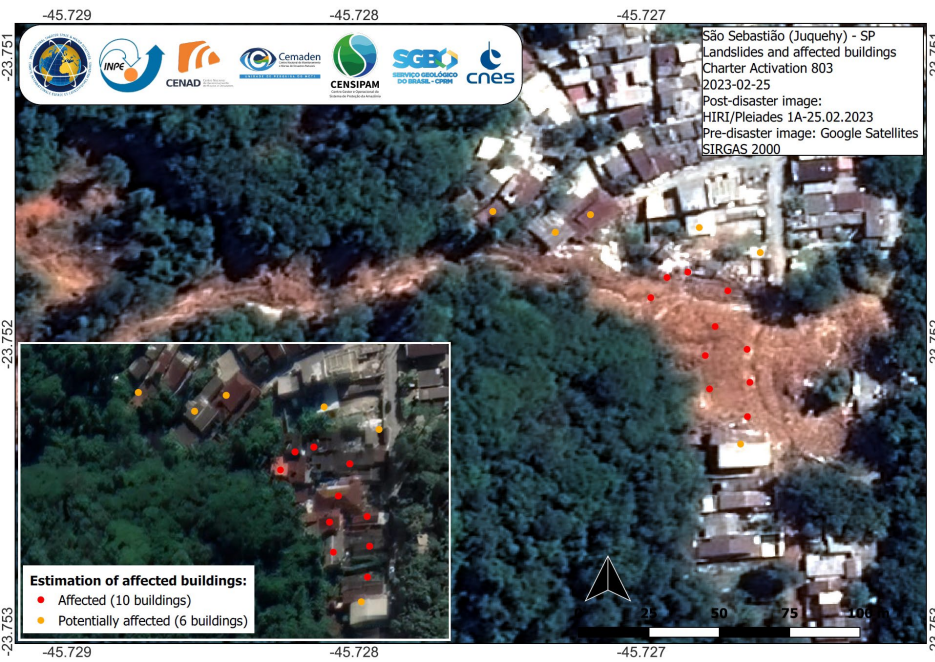
<https://blogs.agu.org/landslideblog/2023/03/20/mtauchira-1/>





"Parts of the state saw more than 680 millimeters (26 inches) in a single day, exceeding the 24-hour rainfall record in some of the affected areas."

Landslides



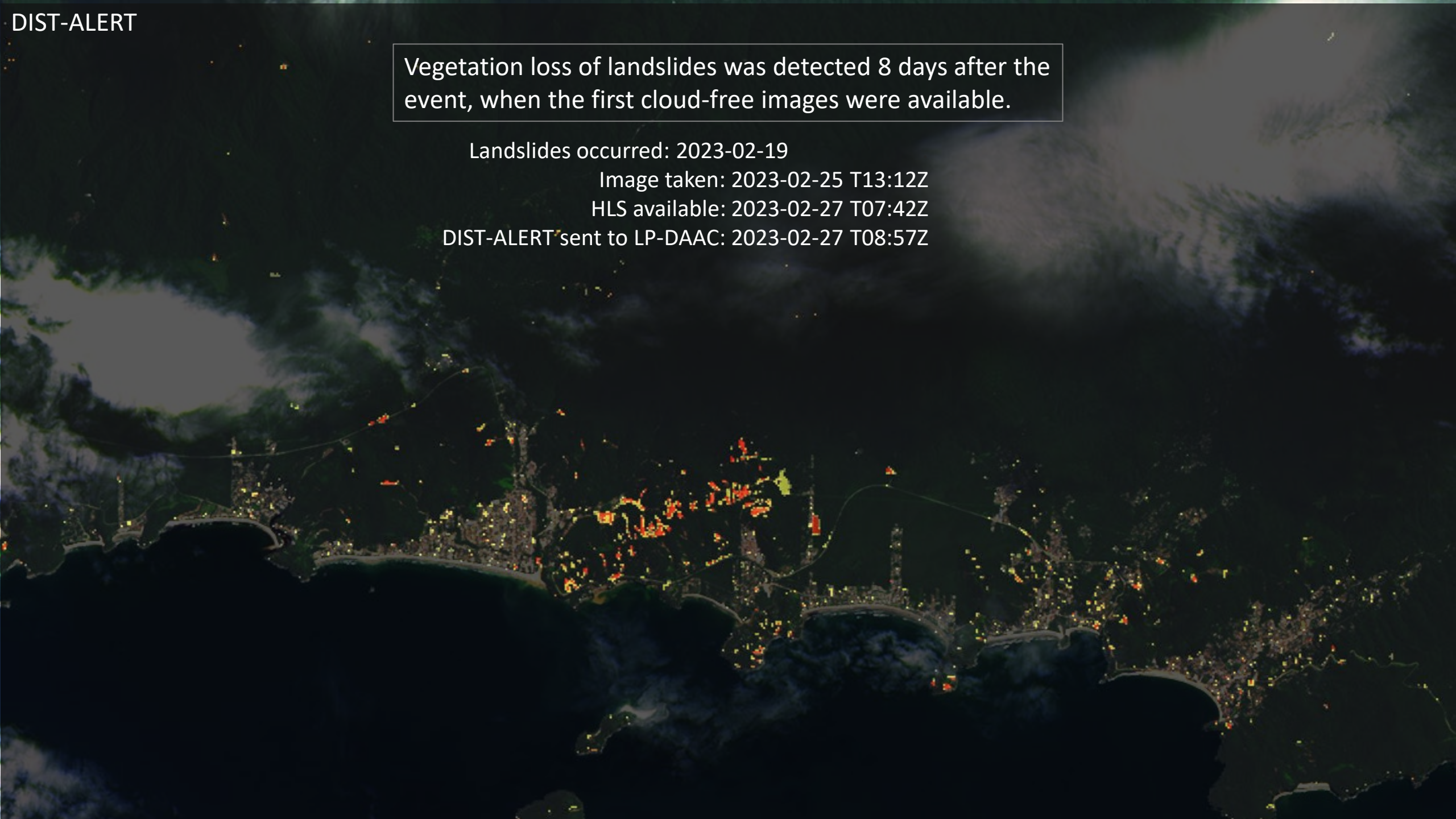
Vegetation loss of landslides was detected 8 days after the event, when the first cloud-free images were available.

Landslides occurred: 2023-02-19

Image taken: 2023-02-25 T13:12Z

HLS available: 2023-02-27 T07:42Z

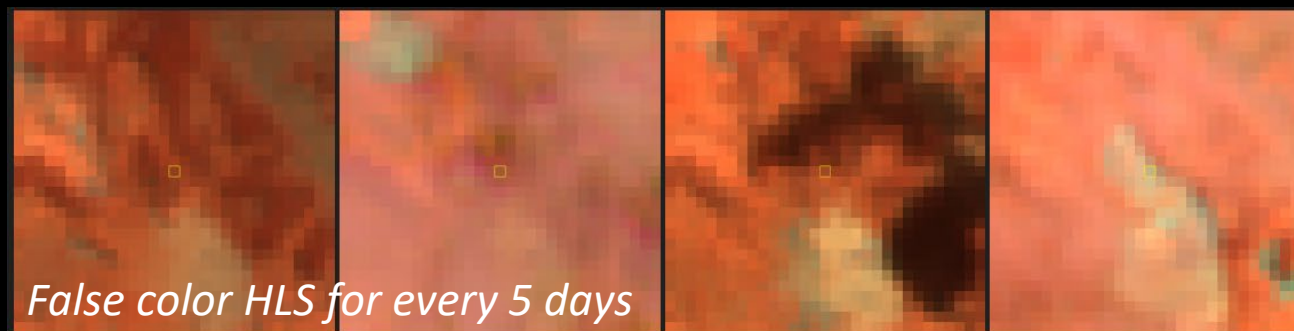
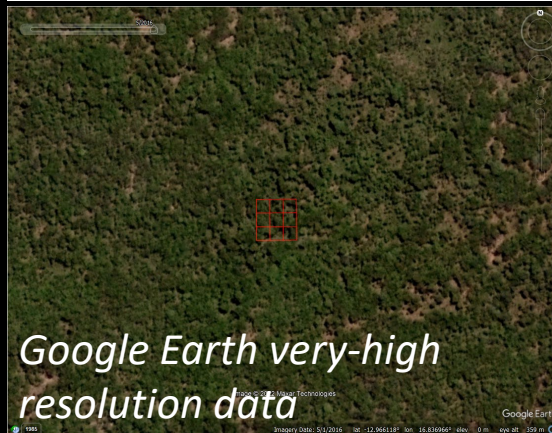
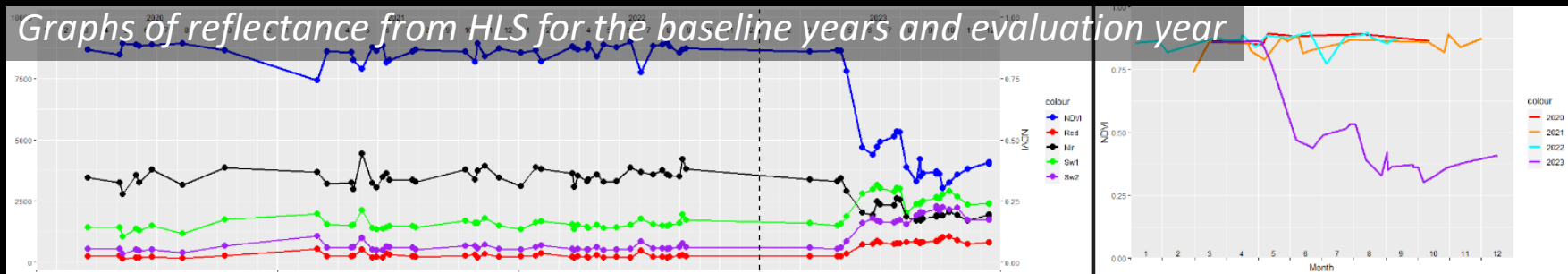
DIST-ALERT sent to LP-DAAC: 2023-02-27 T08:57Z



Validation

We evaluated the performance of DIST-ALERT over a full year with global stratified random sample

- Created strata based on:
 - the DIST-ALERT product over the evaluation year to identify likely areas of vegetation loss and other change
 - 2020 land cover plus recent forest loss
- Labeled the magnitude of vegetation loss or other change relative to three previous years for every 5 days

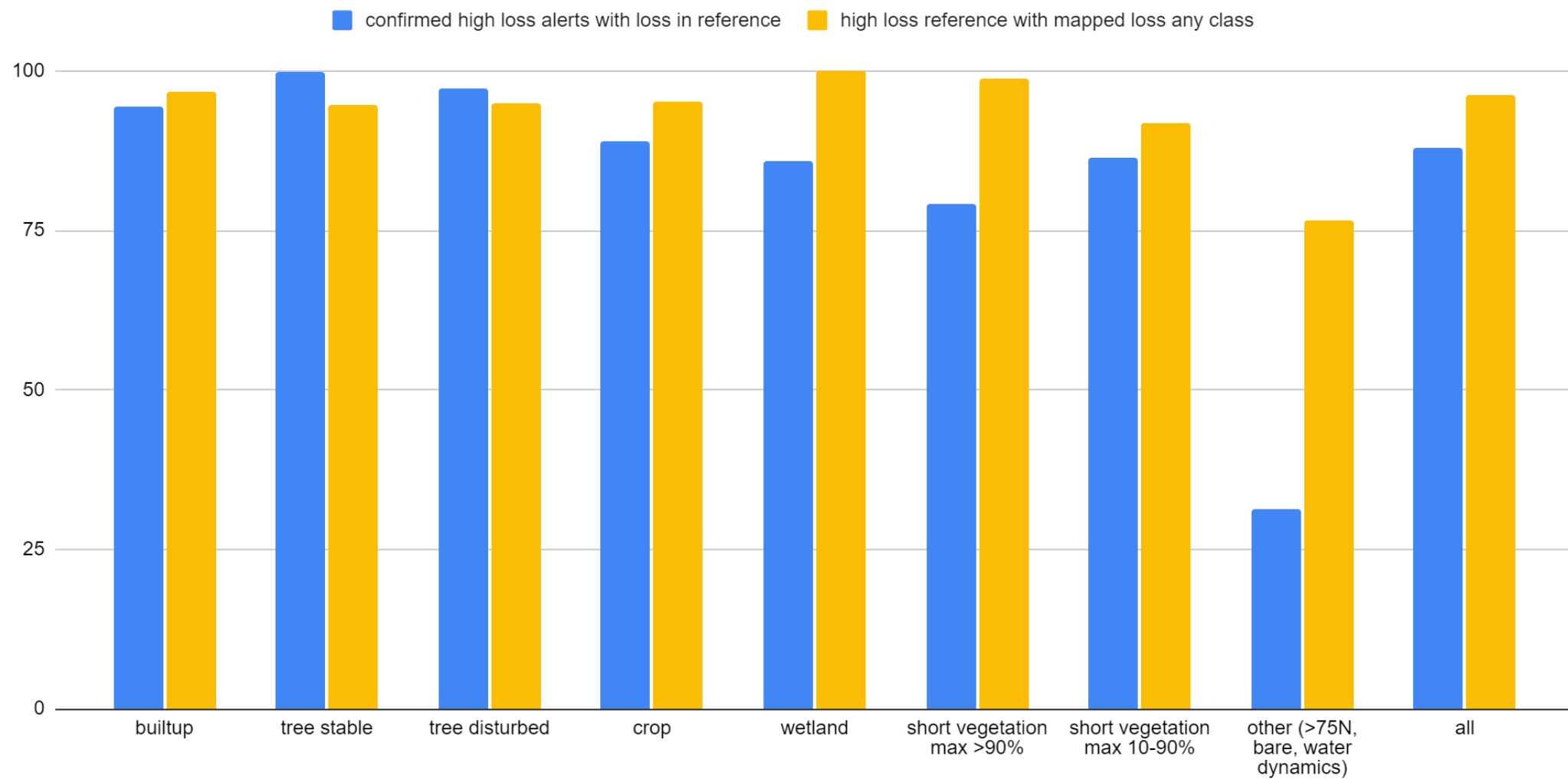


2023-07-17	
No change	
Veg loss minority	Other change minority
Veg loss majority	Other change majority
Veg loss total	Other change total
No/bad observation	

Accuracy for tree cover

- Stable tree cover
 - 99.7% of **confirmed high loss alerts** were true loss (92.2% of **provisional** and above, 86.0% of **first** and above)
 - Alerts in any of the classes correspond to 94.8% of the high loss identified in the reference data (low reference loss often due to extended leaf off conditions)
- Tree cover in 2020 with loss 2001-2022 (mostly tree cover, plus recent loss)
 - 97.4% of **confirmed high loss alerts** were true loss (91.0% of **provisional** and above, 61.9% of **first** and above)
 - Alerts in any of the classes correspond to 94.9% of the high loss identified in the reference data

Accuracy



Status and next steps

- Improved validated release of DIST-ALERT (V1) released March 14, 2024
- Operationally produced the provisional release of DIST-ALERT (V0) Feb 2023 to Feb 2024
- Land cover specific validation to provide accuracy for forests, cropland, other short vegetation, and urban areas





OPERA_L3_DIST-ALERT-HLS_V1 v001

OPERA Land Surface Disturbance Alert from Harmonized Landsat Sentinel-2 product (Version 1)

PI: Observational Products for End-Users from Remote Sensing Analysis (OPERA),
Development Organization: University of Maryland (UMD) – Dr. Matt Hansen

Cloud icon

- DOCUMENTATION
- USING THE DATA
- ACCESS DATA
- CITATION
- RELATED PRODUCTS

Homepage / Data / Search Data Catalog / OPERA_L3_DIST-ALERT-HLS_V1v001

https://lpdaac.usgs.gov/products/opera_l3_dist-alert-hls_v1v001/

Description

The Observational Products for End-Users from Remote Sensing Analysis (OPERA) Land Surface Disturbance Alert from Harmonized Landsat Sentinel-2 (HLS) product Version 1 maps vegetation disturbance alerts that are derived from data collected by Landsat 8 and Landsat 9 Operational Land Imager (OLI) and Sentinel 2A