Eastern Forest Environmental Threat Assessment Center

USDA Forest Service, Southern Research Station, Asheville, NC

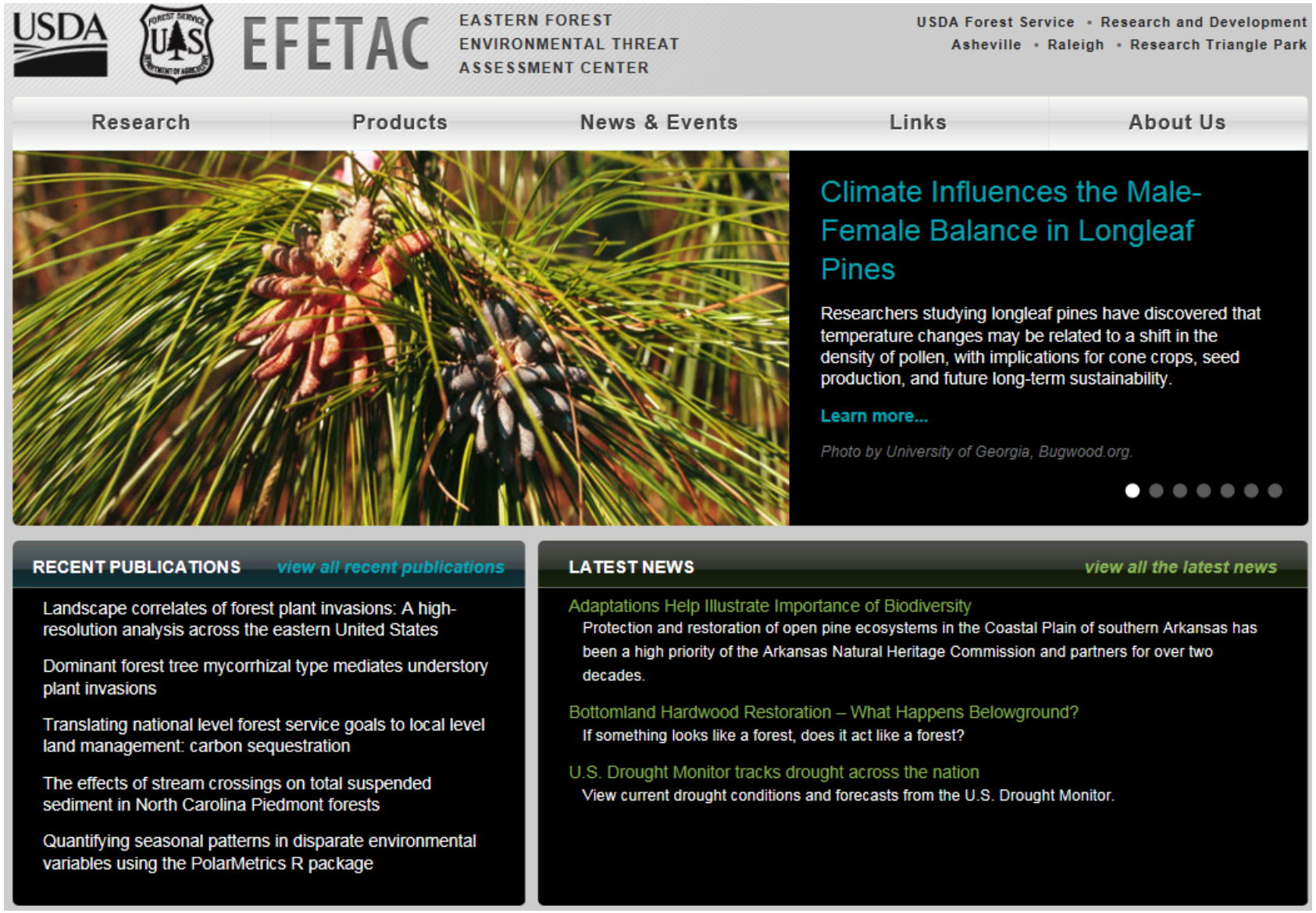
1. **Introduction**
2. ***ForWarn* II**
3. **Disturbance Assessments** (S2)
   - **SPB/IPS Host Mapping (GA)**
   - **Puerto Rico, Hurricane Maria**
   - **Florida, Hurricane Irma**
4. **Expectations Going Forward**

Photo by Paul Merten, Entomologist, Forest Service

2018 SGSF GIS Committee Annual Meeting

February 12-16, 2018 Mobile, AL

https://forestthreats.org



https://forwarn.forestthreats.org

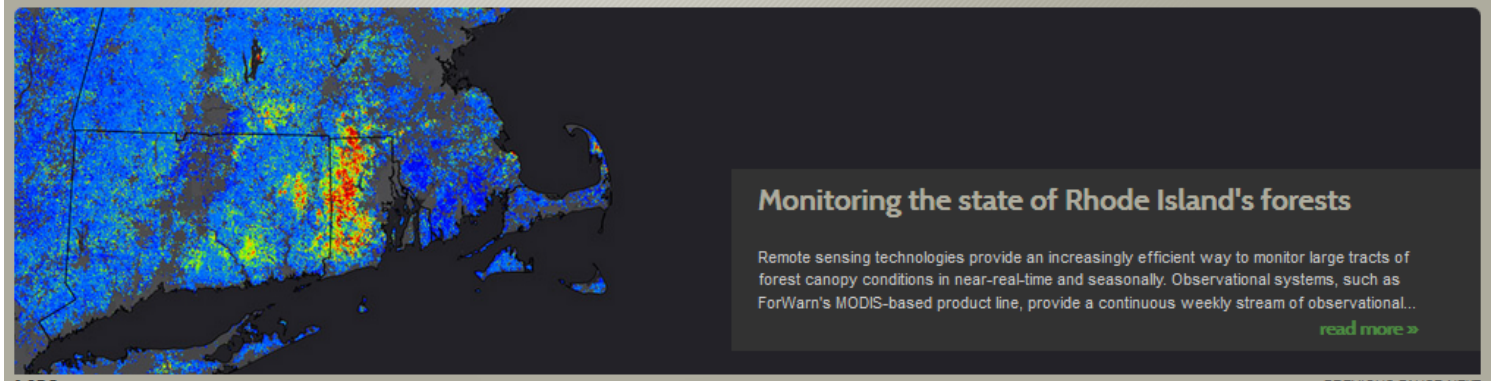
ForWarn

Satellite-Based Change Recognition and Tracking

CONTACT US

SEARCH

Home | Overview | Highlights | Products | Support



Monitoring the state of Rhode Island's forests

Remote sensing technologies provide an increasingly efficient way to monitor large tracts of forest canopy conditions in near-real-time and seasonally. Observational systems, such as ForWarn's MODIS-based product line, provide a continuous weekly stream of observational...

read more »

3 OF 7 PREVIOUS PAUSE NEXT

Get Started

ForWarn provides near-real-time tracking of vegetation changes across landscapes in the United States. Useful for both monitoring disturbance events as well as year-to-year variability, derived products can also be used to develop insights into seasonal and inter-annual dynamics.

» Introduction to ForWarn

» Data Access

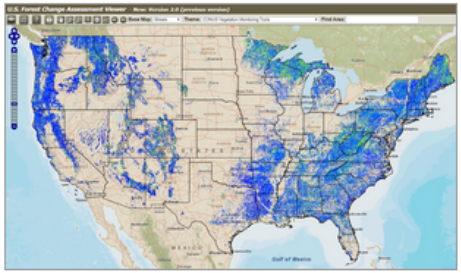
» Sign up for updates

» Contact Us

Forest Change Assessment Viewer

The Forest Change Assessment Viewer provides a vegetation change recognition and tracking system for *ForWarn* that uses high-frequency, moderate resolution satellite data.

FORWARN Viewer



Recent News

ForWarn featured in NASA Earth Observatory

11/18/2016 - 11:03 Sap-sucking insects called hemlock woolly adelgids are draining the life from a common evergreen tree in the eastern United States. Once the non-native bugs become well-established, the consequences...

Featured in Compass Magazine: Here Today or Here to Stay?

09/22/2016 - 09:47 Some disturbances come and go, leaving forests no worse for the wear. Hailstorms, insect defoliations, and light prescribed fires, for example, commonly occur early in the growing season, but,...

ForWarn data on Okefenokee National Wildlife Refuge presented at Texas fire conference

11/23/2015 - 13:49 ForWarn team members attended the 2015 Association for Fire Ecology Meeting in San Antonio, TX in November 2015 to present research on long-term monitoring based on ForWarn's NDVI products. You can...

more news »

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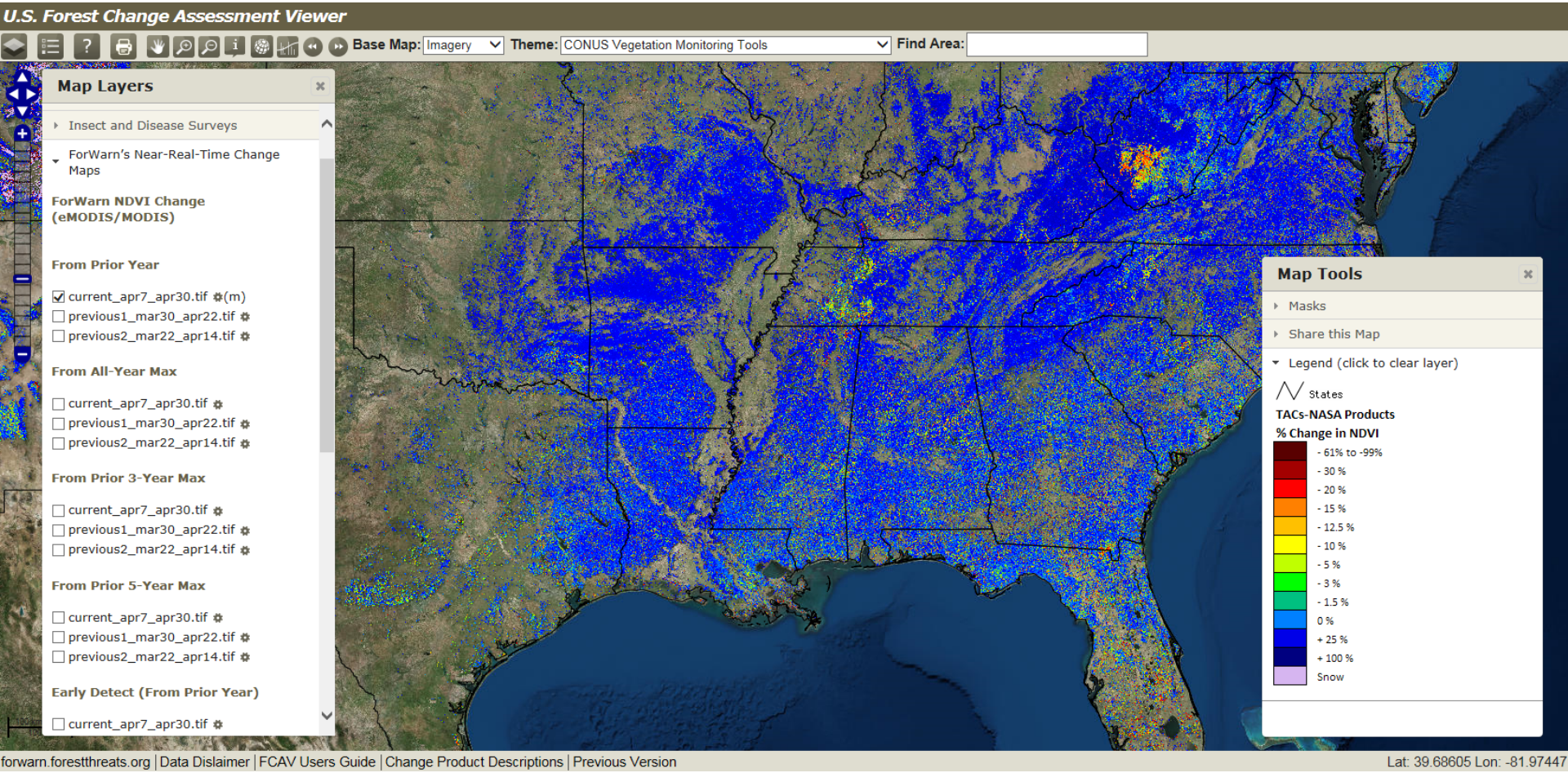
ForWarn

https://forwarn.forestthreats.org/fcav2

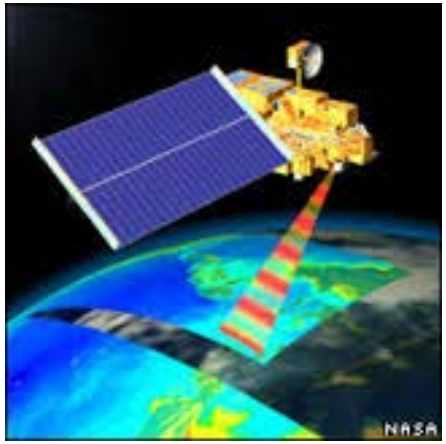


***ForWarn* point of contact**

Bill Christie, Eastern Forest Environmental Threat Assessment Center

wchristie@fs.fed.us 828.257.4370

ForWarn's Context



strategic

tactical

- The *ForWarn* System covers essentially 100% of the forests within the lower 48 United States every 8 days
- **Tier 1: Strategic** – The *ForWarn* system routinely monitors wide areas at coarse resolution, repeated frequently – it produces alerts or warnings that forest vegetation at particular locations may be affected by forest threats
- **Tier 2: Tactical** – Airborne overflights and ground inspections of areas of potential interest – Insect and Disease Surveys (IDS) monitoring – to determine if such warnings are confirmed and become alarms
- The two tiers are complementary:
  - *Tier 1 can be used to optimally direct the labor-intensive efforts of Tier 2, which are limited in coverage and frequency*
- The two different systems can support each other well

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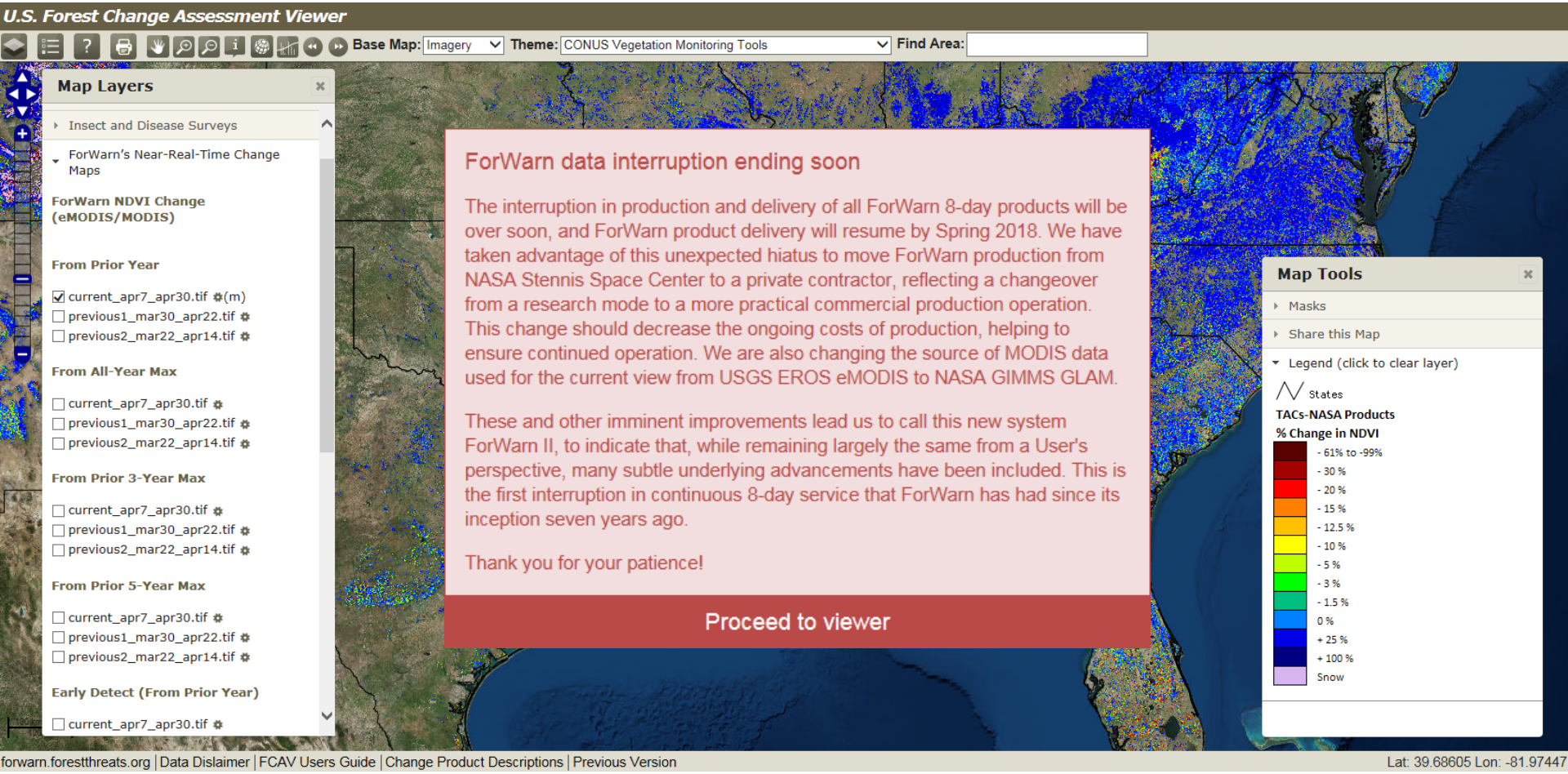
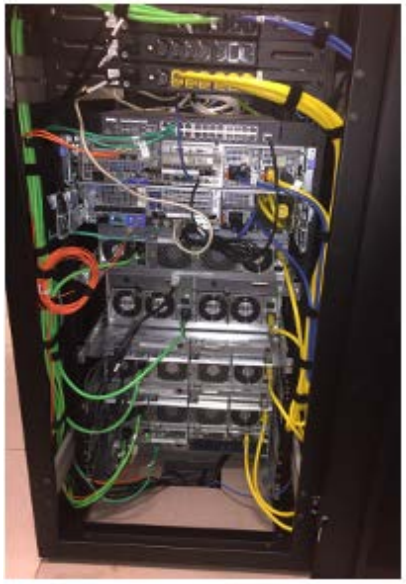
https://forwarn.forestthreats.org/fcav2



ForWarn II Server
at ERC Asheville



Background

- Our long-term partner, **NASA Stennis Space Center was no longer allowed to perform "Applied Science" work**
- This forced a *ForWarn* interruption and an "opportunity" for changes
- Our three *ForWarn* NASA colleagues transferred to **Leidos**, a nationally-known consulting and subcontracting company, assuring continuity
- EFETAC established a new sole-source contract with Leidos for *ForWarn* production and development
- Moved *ForWarn* server computers to Asheville, NC
- Moving from a more Research-oriented environment to a more Production-oriented environment, with an associated reduction in production costs
- Ultimately plan to move Production to virtual "Cloud Computing" - More Sustainable for the Future

A New Name: *ForWarn* II

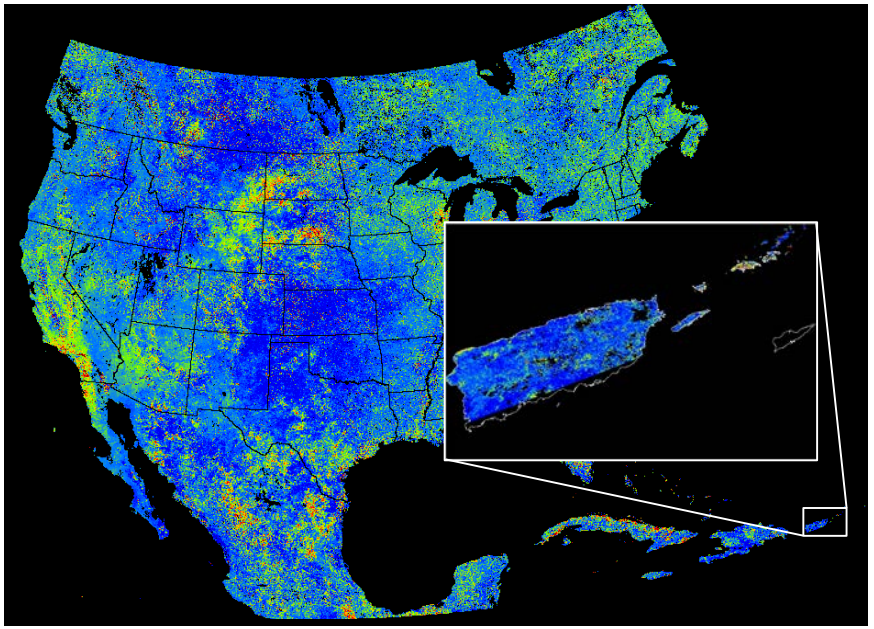
What Changed?

'kinda the same, but kinda different'

- No longer using expedited-MODIS from USGS EROS Data Center – current view imagery has switched over to using **NASA Goddard GIMMS/GLAM** (*Global Inventory Modeling and Mapping Studies/GLobal Agricultural Monitoring*)
- EFETAC, Leidos, UNCA-NEMAC, and Oak Ridge National Lab remain active partners
- *Forwarn* II production tests and evaluations are underway now
- Hope to be up and running by the beginning of the 2018 growing season

Few changes from the *ForWarn* User's perspective:

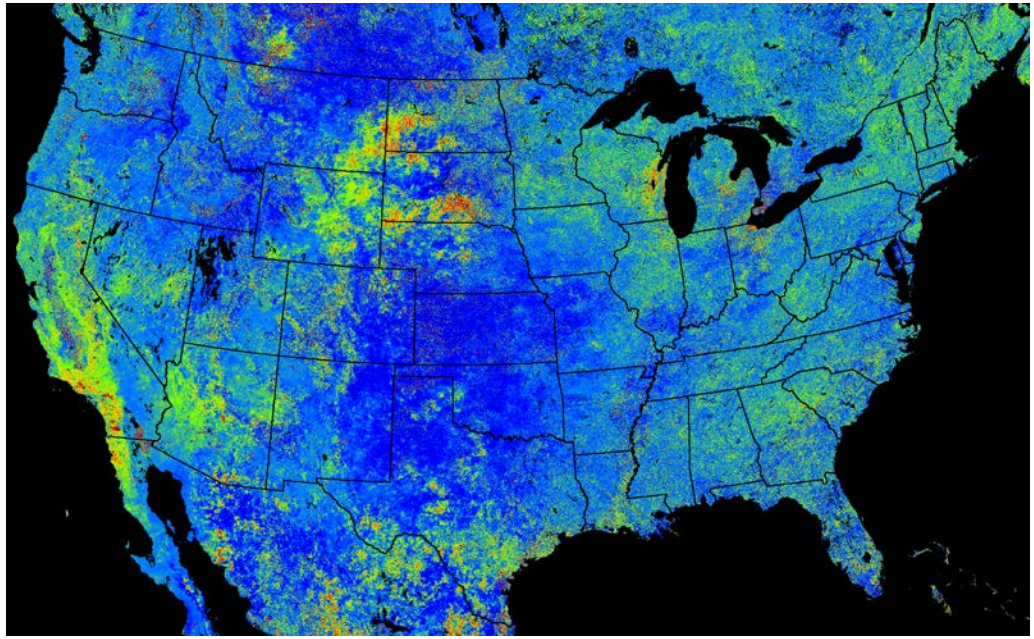
- Same *ForWarn* Viewer
- Same *ForWarn* Algorithm
- Cross-border view, incl. PR-VI
- **Evaluating a new product…**



The ‘Square Root’ Product

Standard, NDVI ‘Percent Change’ Algorithm: (Current - Baseline)/Baseline

- This Ratio implicitly assumes that greener vegetation can withstand a greater decrease in NDVI
- The Denominator drags down the impact of decreasing NDVI
- The same absolute decrease in NDVI will show less change in the *ForWarn* map within really green vegetation, and will show more change within less green vegetation
- Grasses, herbs and shrubs are hyper-sensitive to disturbance, while tree responses are muted (especially evergreens)



- Take the ‘square root’ of the denominator instead
- **RESULT - trees retain their relative sensitivity to even minor NDVI drops, while grasses, herbs and shrubs have more muted responses**

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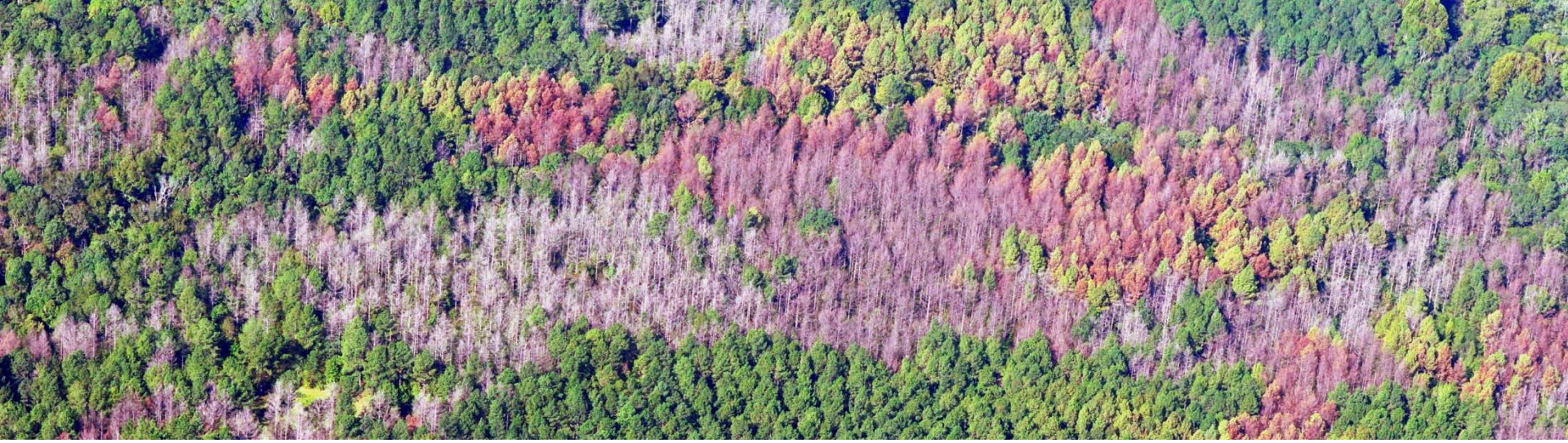
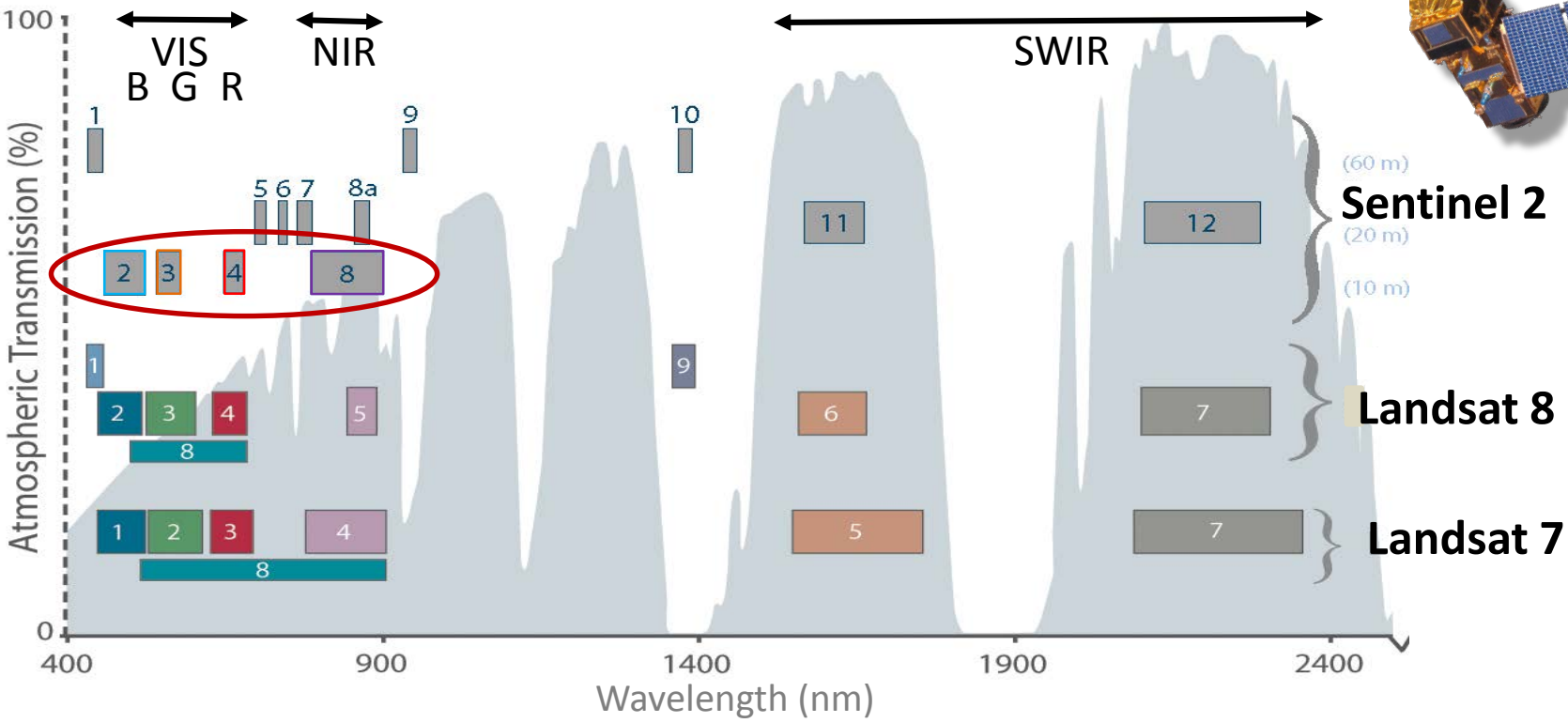
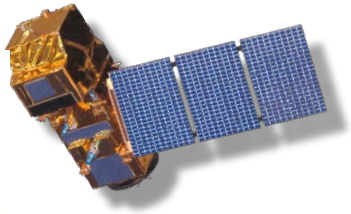


Use of Sentinel-2 10m imagery in SPB/Ips Mapping

1. *Manual Image Interpretation*
2. *Percent Change in NDVI*
3. *Host Map Differencing*

Why Sentinel-2?





Satellite, Instrument	Spatial resolution	Temporal resolution	Historical Availability	Source
Sentinel-2a/b, MSI	**10m** (20m)	**5 day** (both)	Jun 2015 -	Euro. Space Agency
Landsat 8, OLI Landsat 7, ETM+ Landsat 5, TM, MSS	30m (15m) 30m (15m) 30m (15m)	8 to 16 day (with both)	2013 - 1999 - … 1984-2012	US NASA
Terra/Aqua, MODIS	500m (250m)	2 passes/day	2000 -	US NASA

What does a 10m spatial resolution tell us?

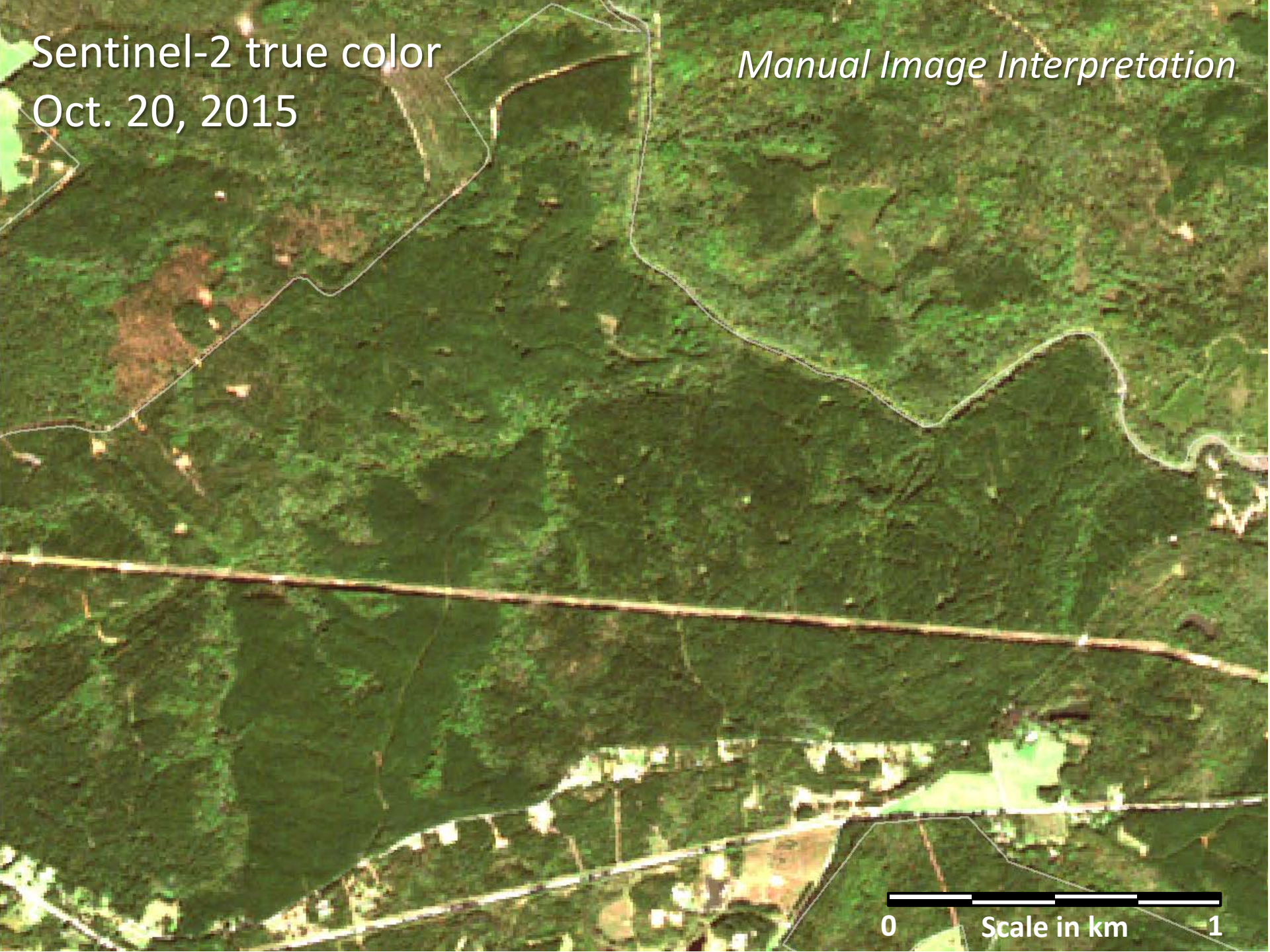
Plantation pine and hardwoods – Oconee National Forest, GA

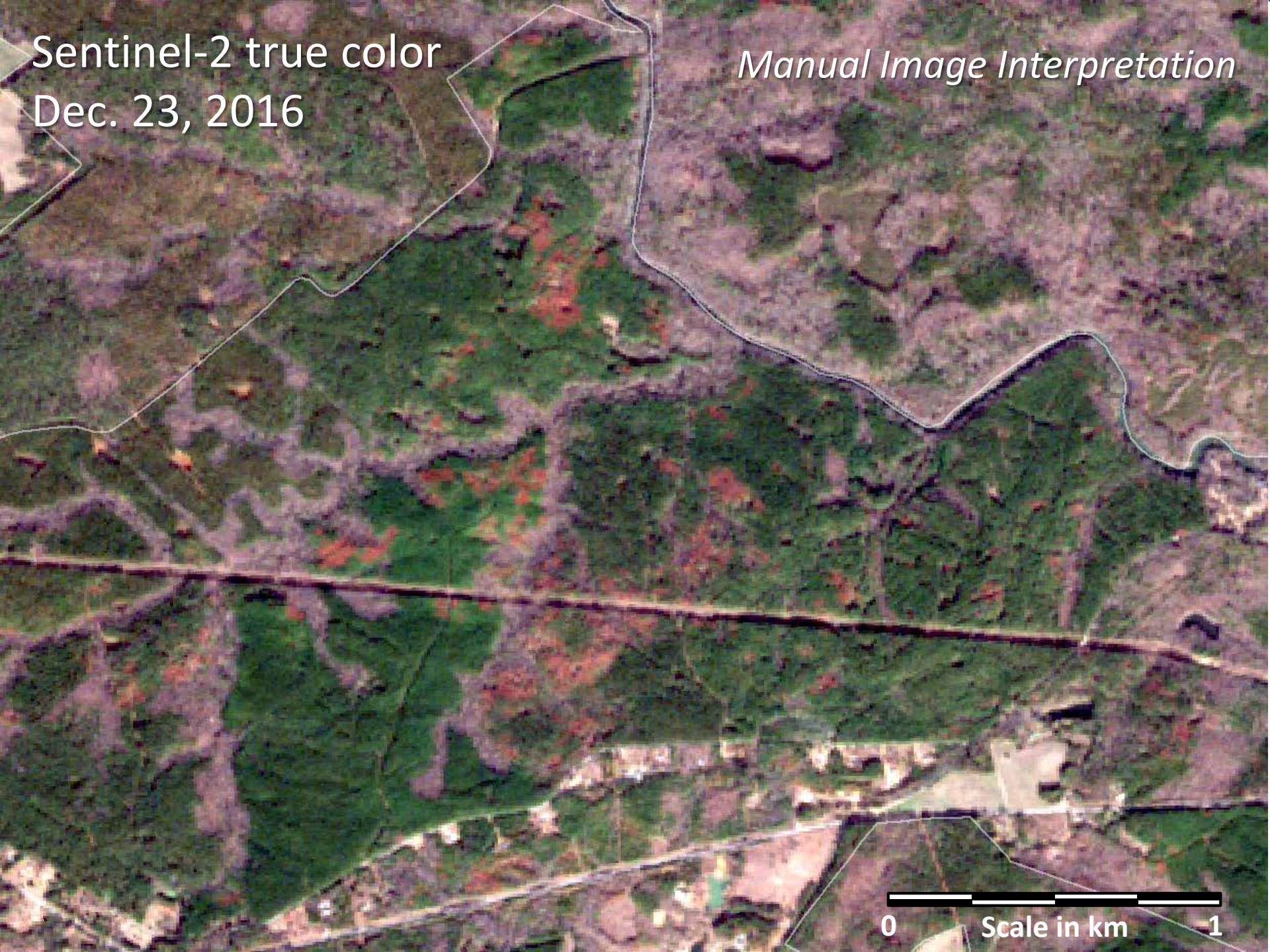
Typically-used spatial resolutions of Sentinel-2 (10m) compared to Landsat (30m)

Key monitoring question:

- Can we capture and map progressive mortality as it unfolds?

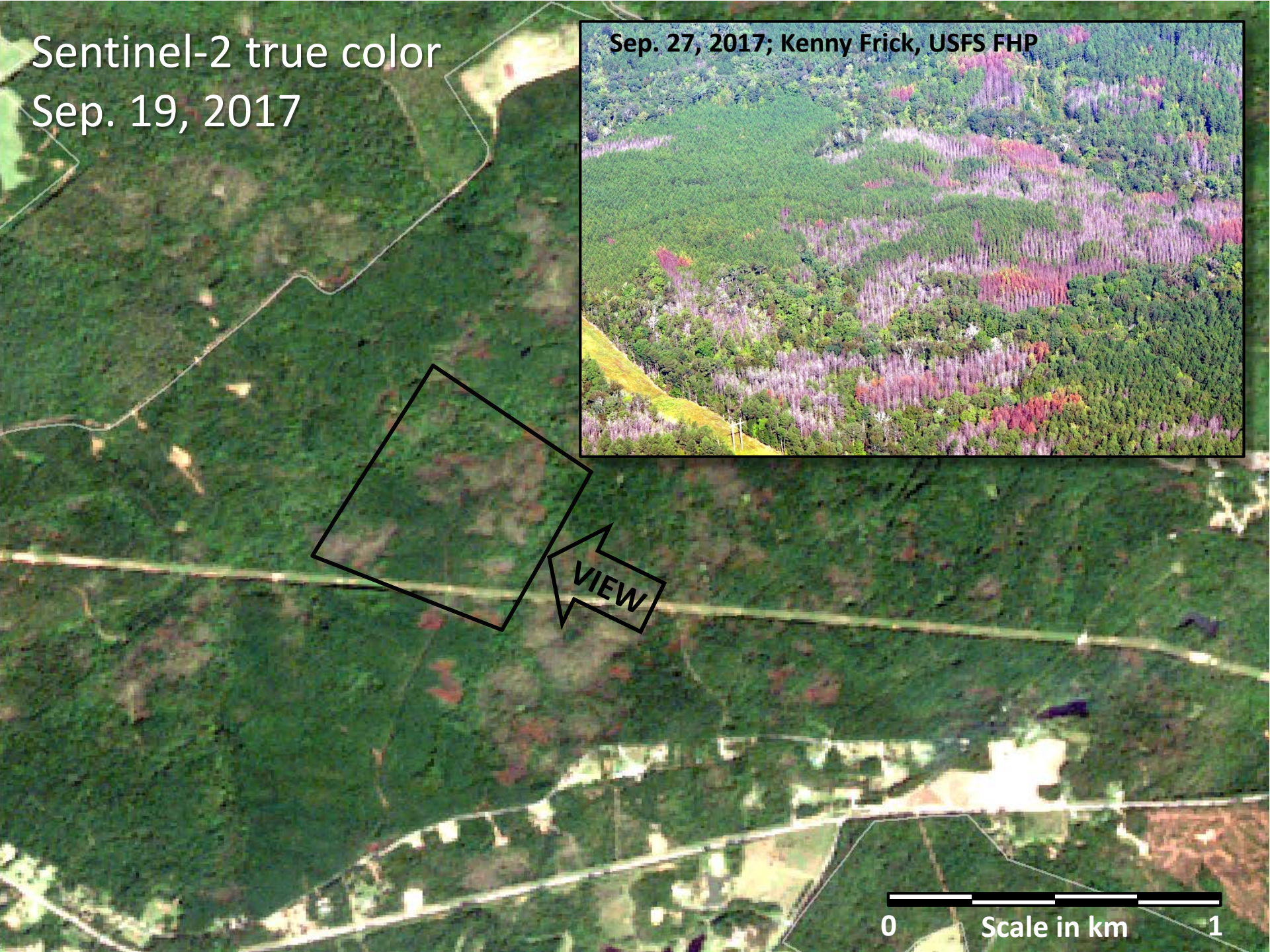
Southern pine beetles, Oconee NF, GA


Sentinel-2 true color
Oct. 20, 2015
Manual Image Interpretation
0
Scale in km
1

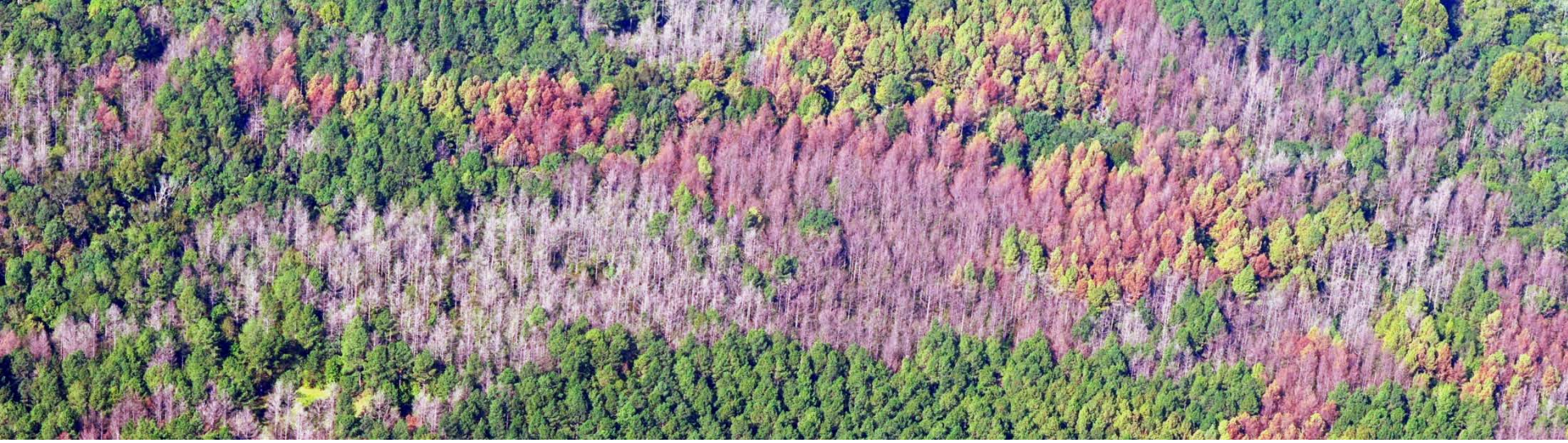

Sentinel-2 true color
Dec. 23, 2016
Manual Image Interpretation
0
Scale in km
1


Sentinel-2 true color
May 2, 2017
Manual Image Interpretation
0
Scale in km
1


Sentinel-2 true color
Sep. 19, 2017
Manual Image Interpretation
0
Scale in km
1


Sentinel-2 true color
Sep. 19, 2017
Sep. 27, 2017; Kenny Frick, USFS FHP
VIEW
0
Scale in km
1


Sentinel-2 true color
Jan. 2, 2018
Manual Image Interpretation
0
Scale in km
1



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1. *Manual Image Interpretation*
2. ***Percent Change in NDVI***
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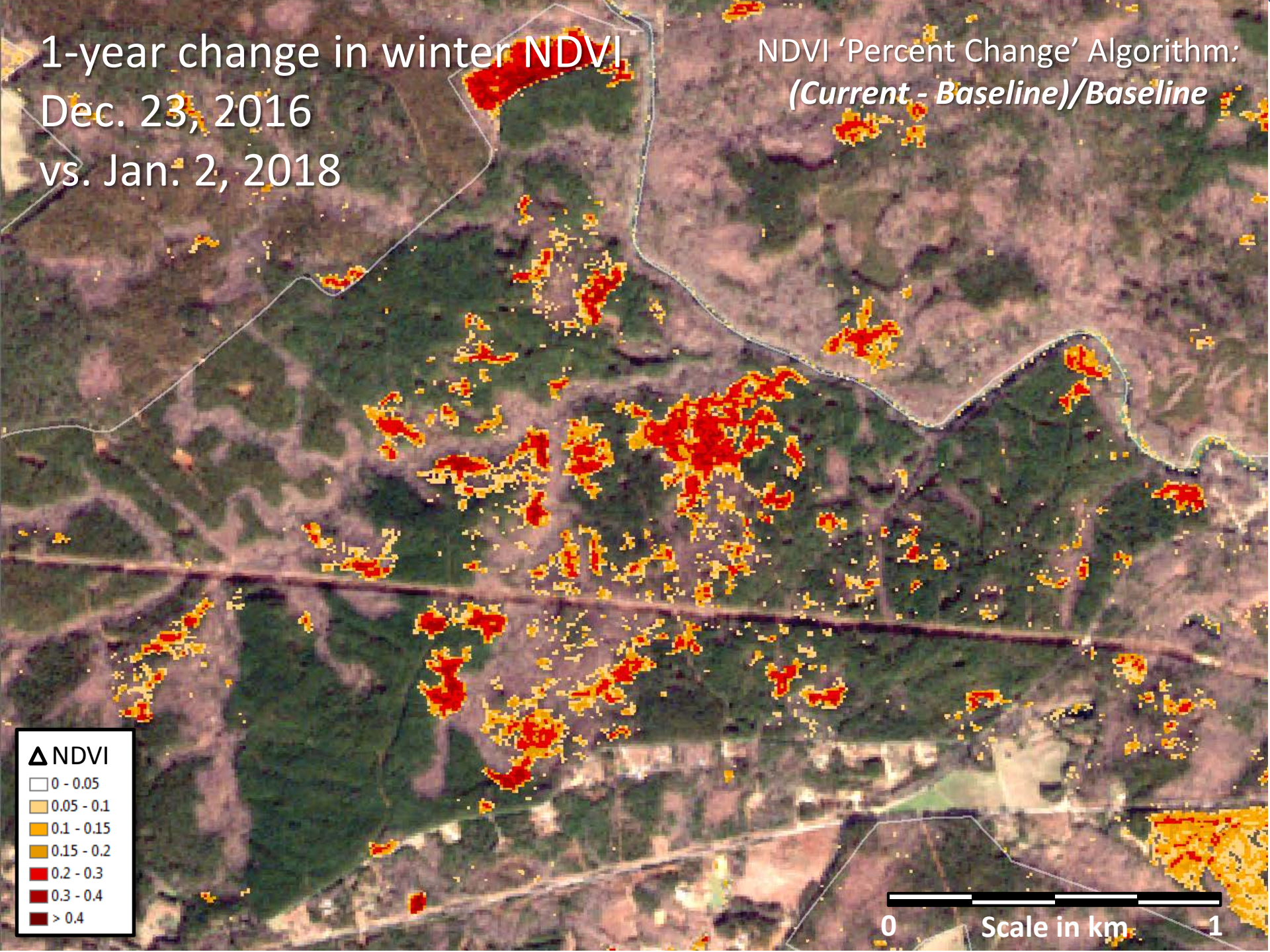
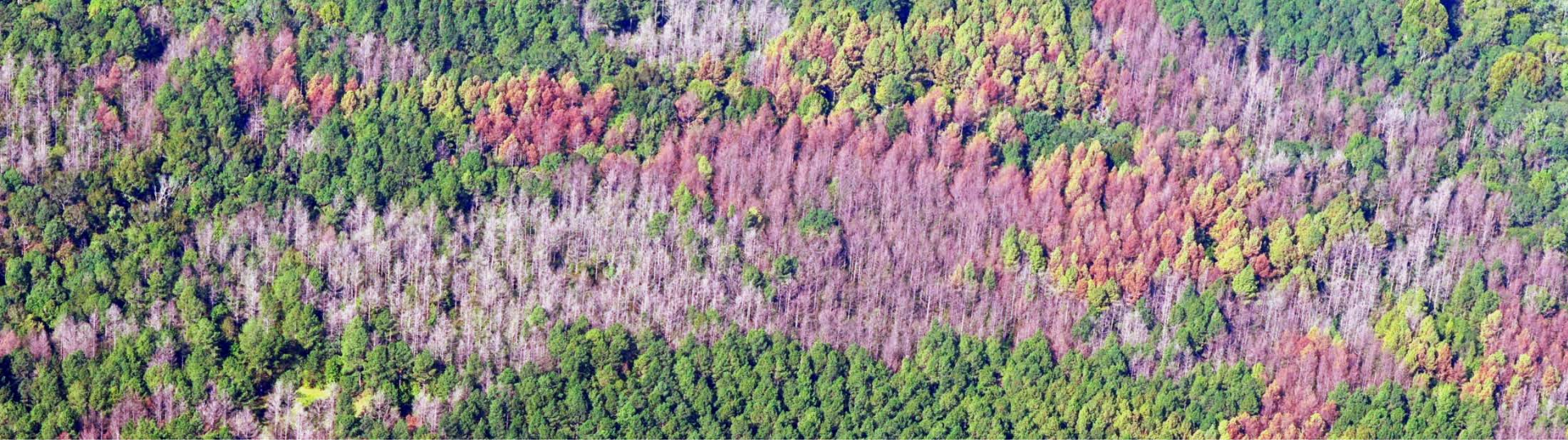

1-year change in winter NDVI
Dec. 23, 2016
vs. Jan. 2, 2018
NDVI 'Percent Change' Algorithm:
(Current - Baseline)/Baseline
ΔNDVI
0 - 0.05
0.05 - 0.1
0.1 - 0.15
0.15 - 0.2
0.2 - 0.3
0.3 - 0.4
> 0.4
0
Scale in km
1



Use of Sentinel-2 10m imagery in SPB/Ips Mapping

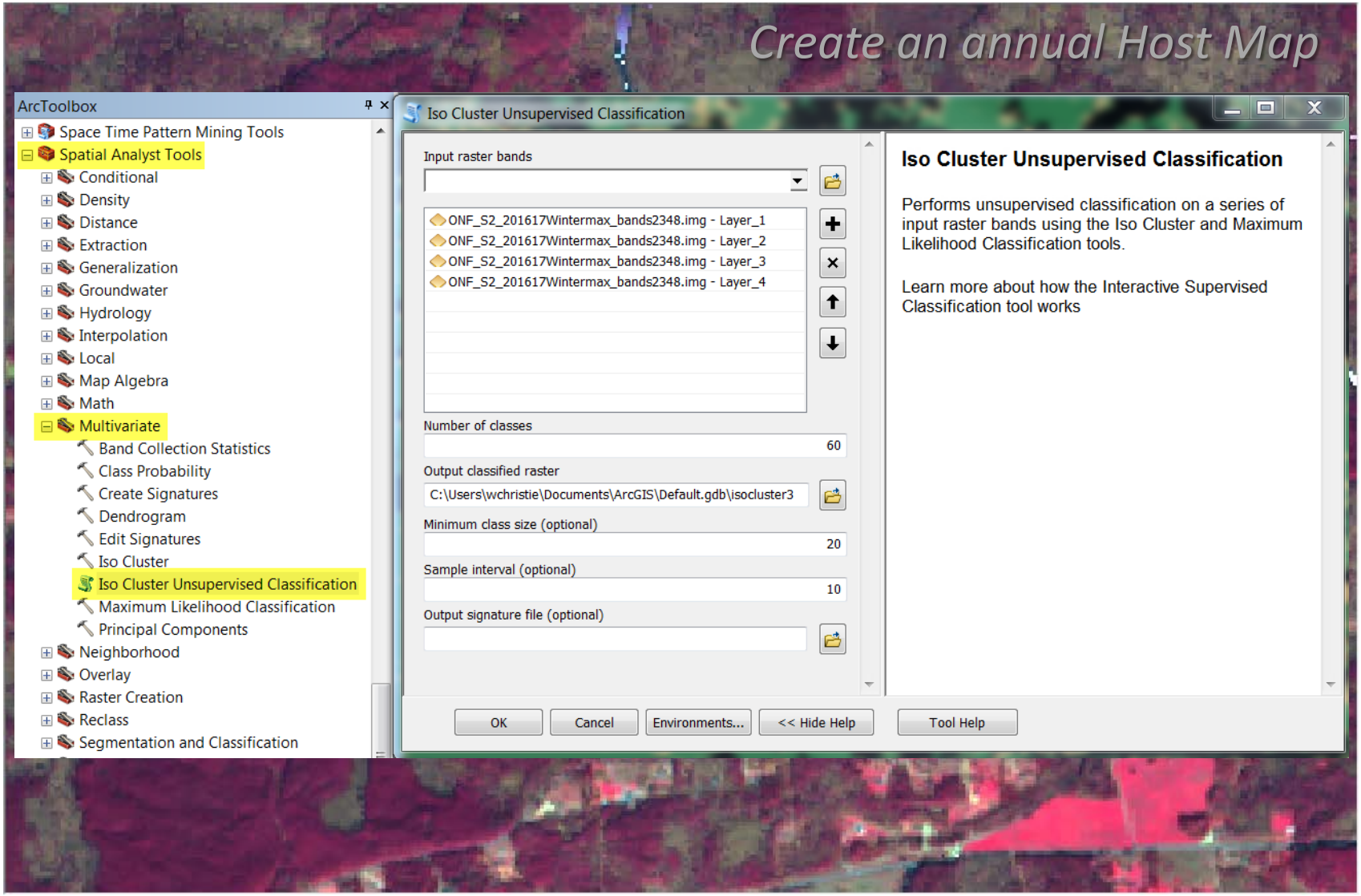
1. *Manual Image Interpretation*
2. *Percent Change in NDVI*
3. ***Host Map Differencing***

Sentinel-2 CIR 843rgb

Winter NDVI-max composite: 11/15/2016 – 02/28/2017

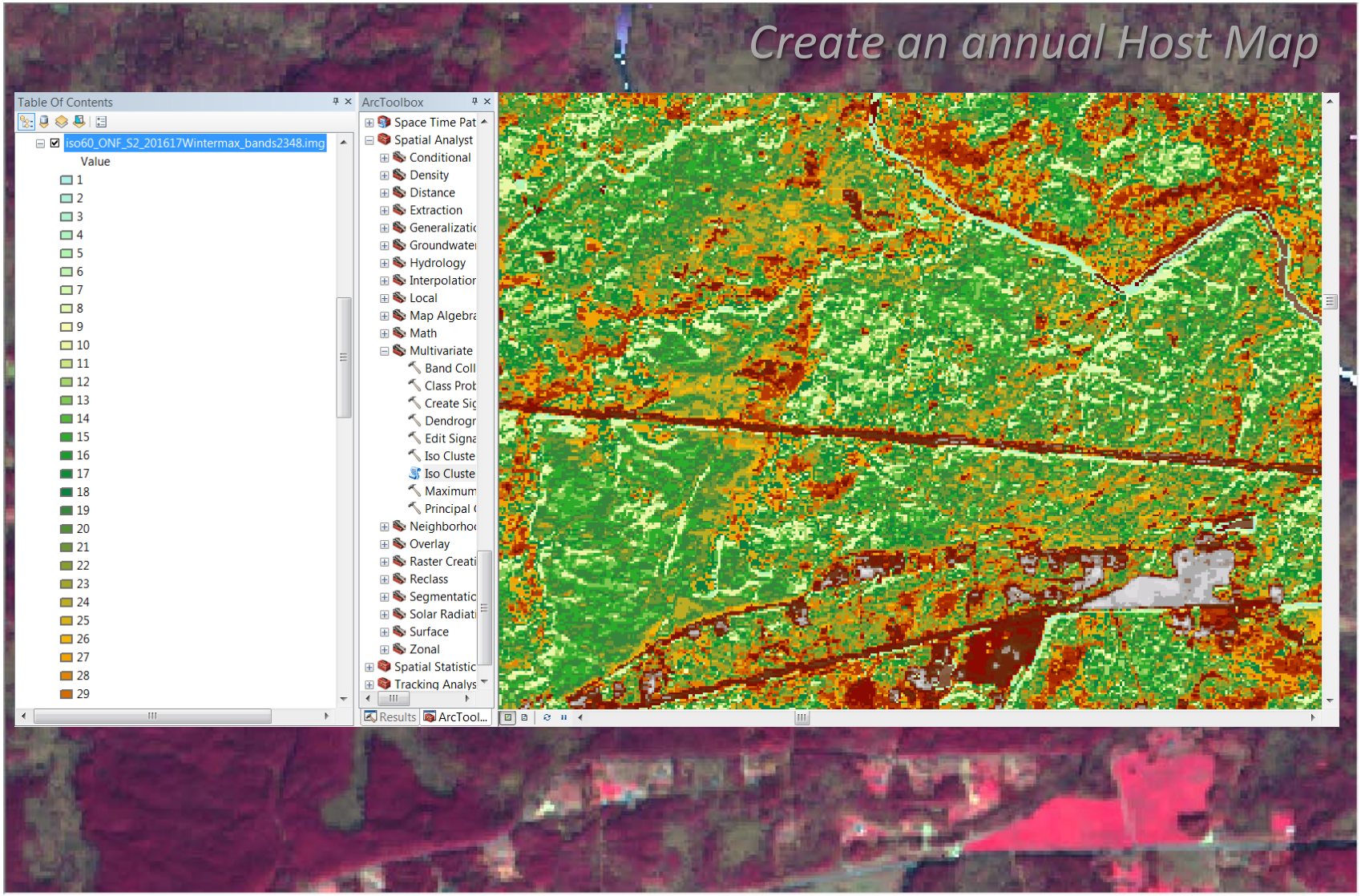
Unsupervised Classification

Clustering to create evergreen binary mask for winter, 2017



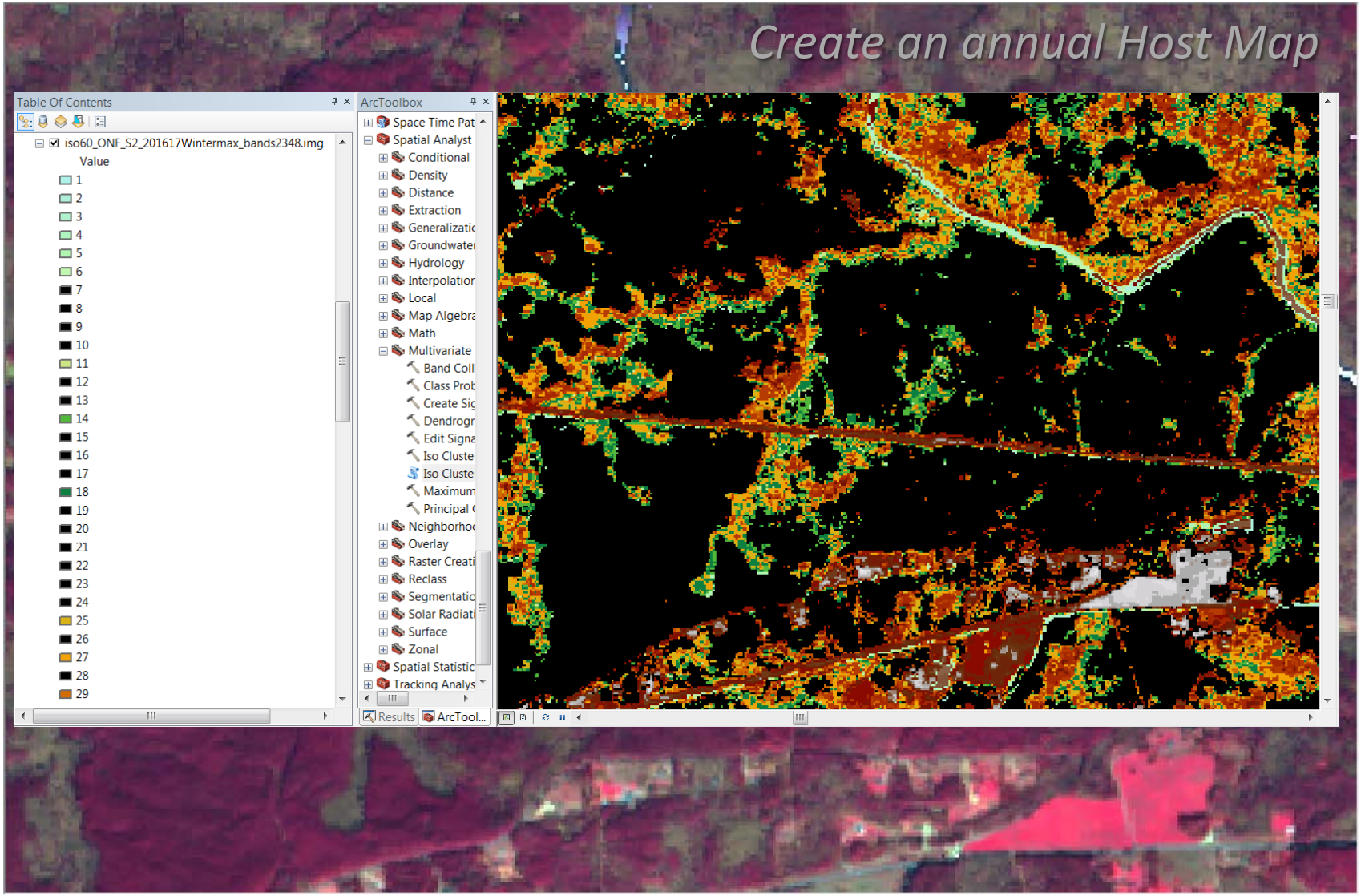
Unsupervised Classification

Clustering to create evergreen binary mask for winter, 2017



Unsupervised Classification

Clustering to create evergreen binary mask for winter, 2017



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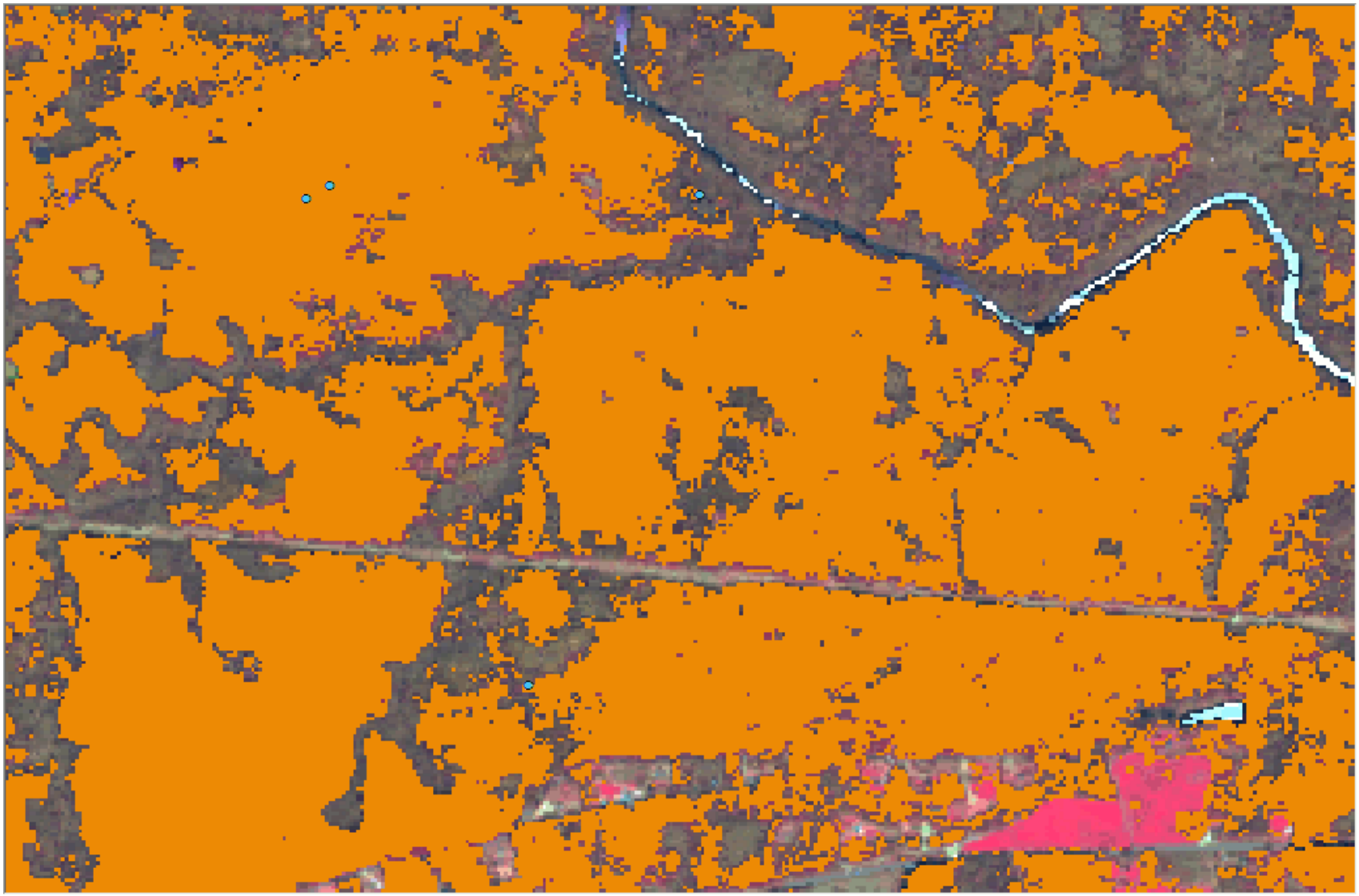
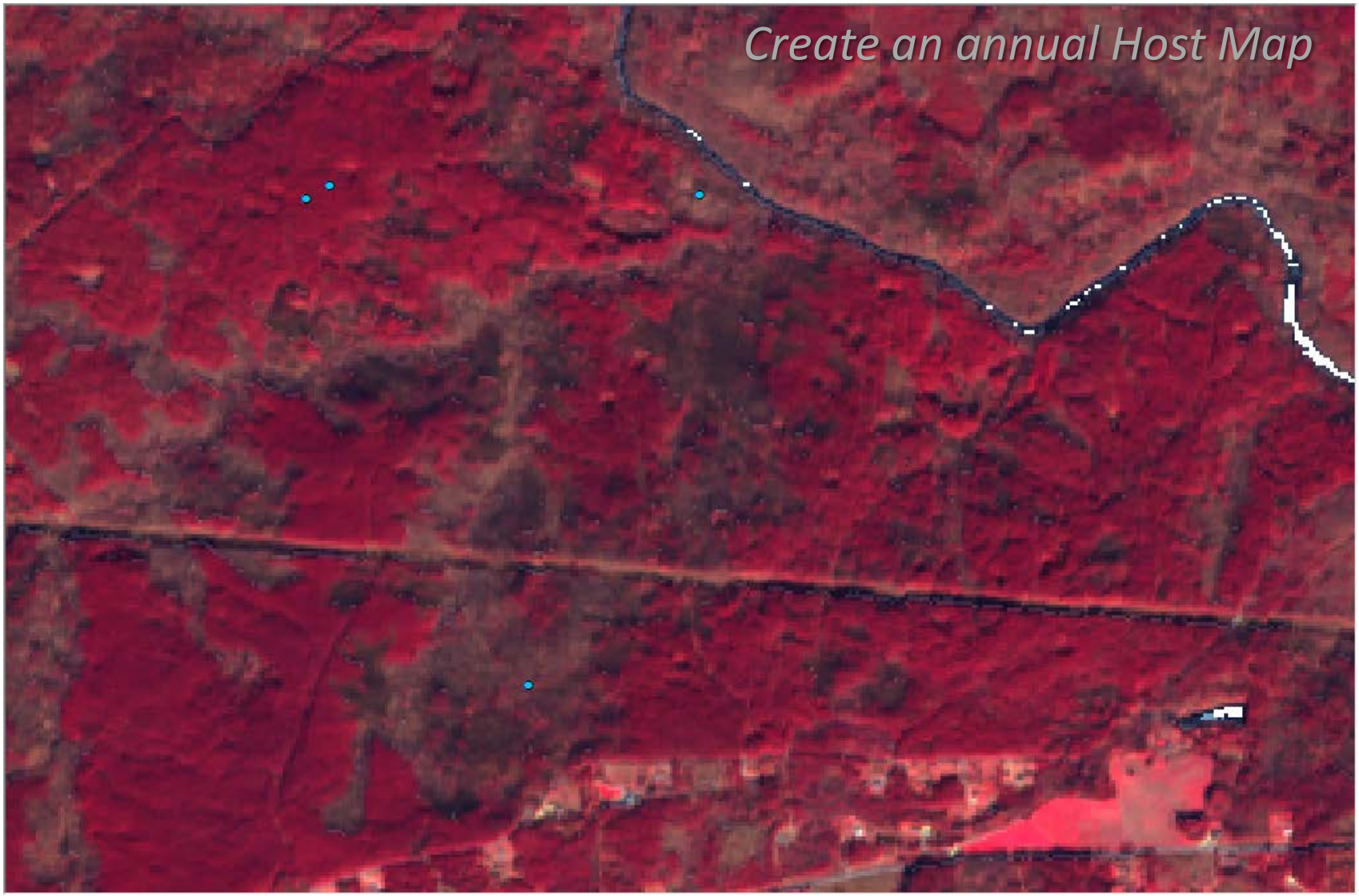


Sentinel-2 CIR 843rgb

Winter NDVI-max composite: 11/15/2017 – 02/28/2018



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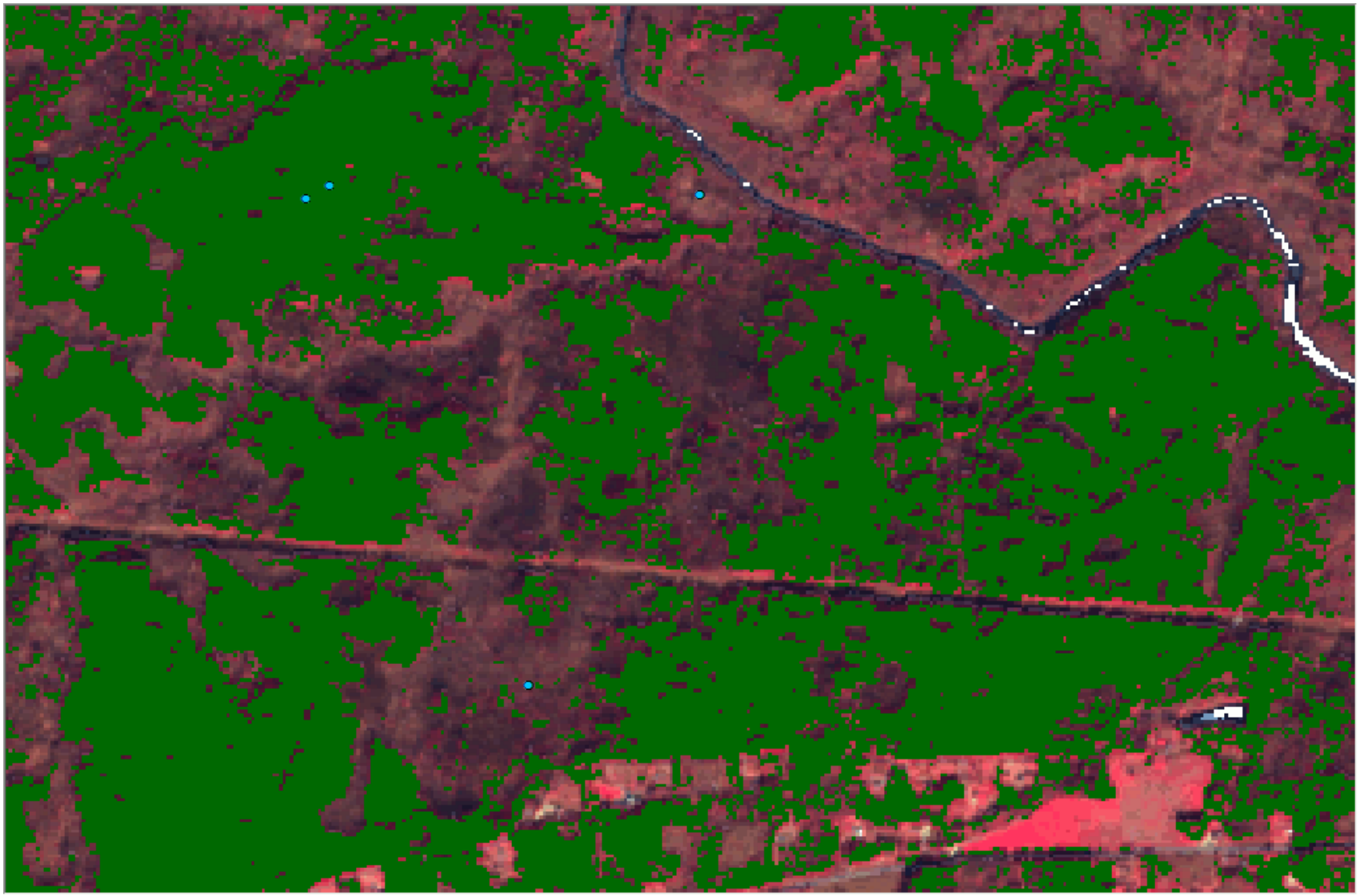
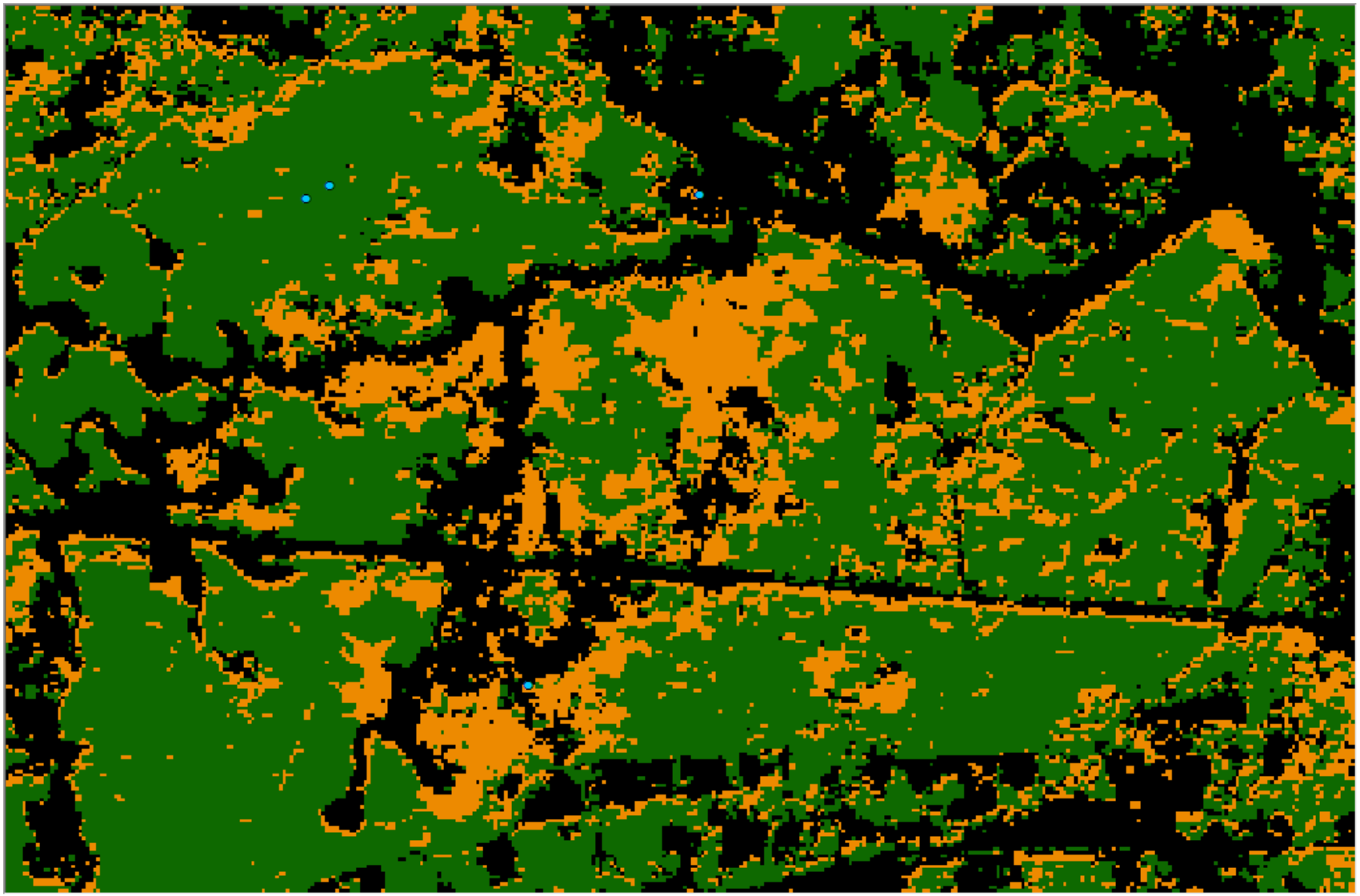


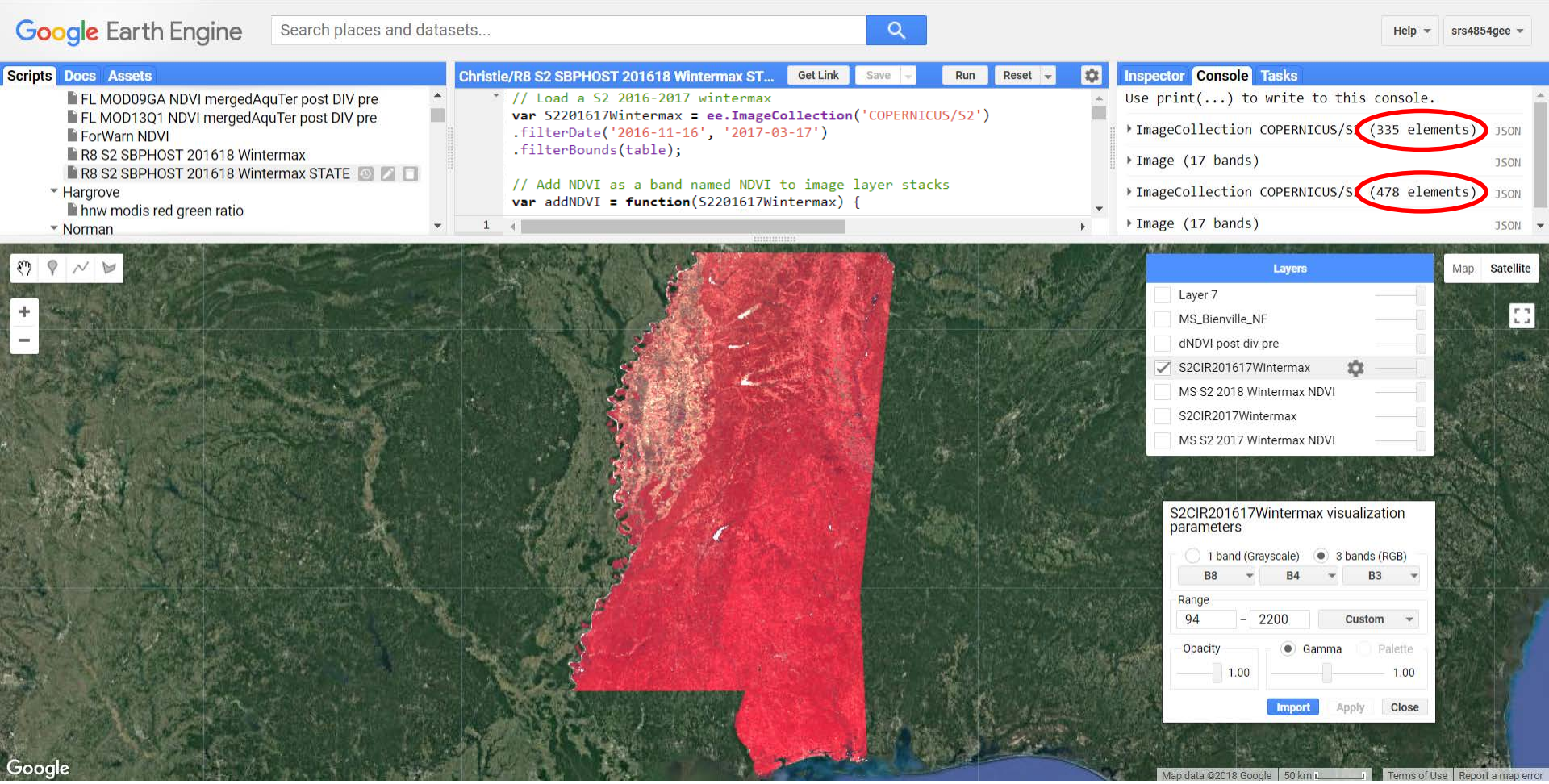
Differencing annual Host Maps

Pine beetle mortality and logging during 2017 (orange)



Benchmark Example

Statewide dNDVI Calculation from Annual Composites



Run Times:

- create 2017 and 2018 statewide winter max-NDVI composite, calculate dNDVI and draw it – 2 sec.
- download the dNDVI result to your Google Drive – 27 min; file size to download from Drive – 5.8GB

Can we get more accurate and efficient answers with multi-date compositing?

That depends.

Image stack

Approaches for period compositing

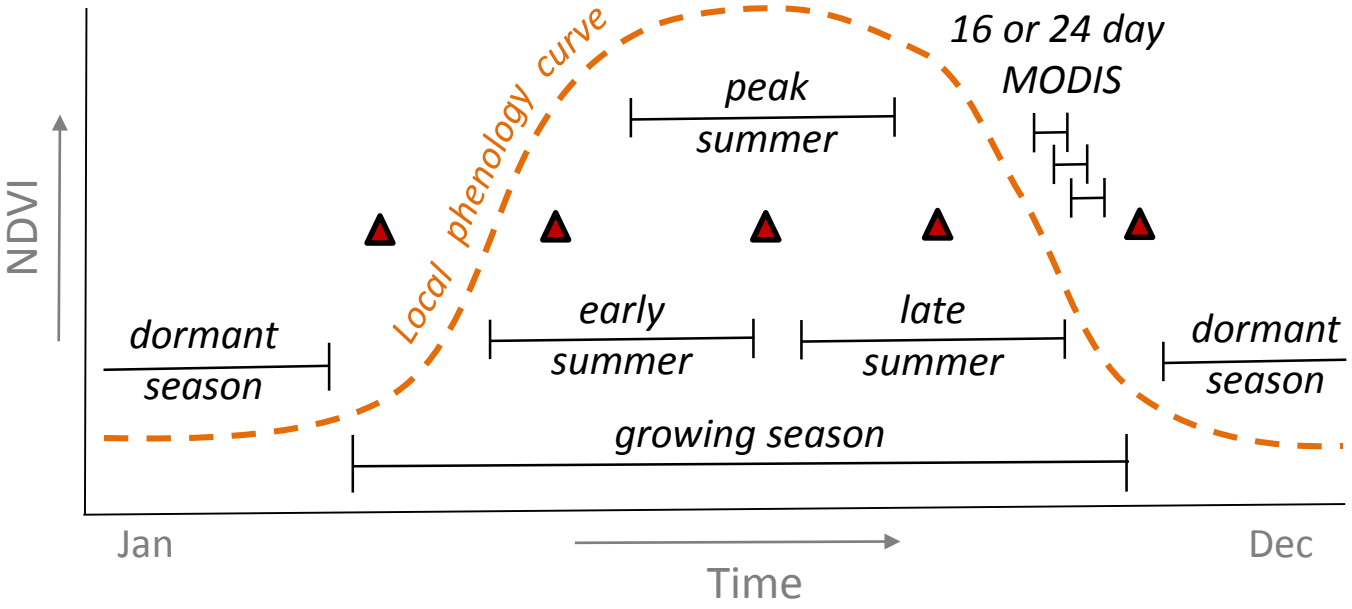
Best quality?

Highest NDVI?

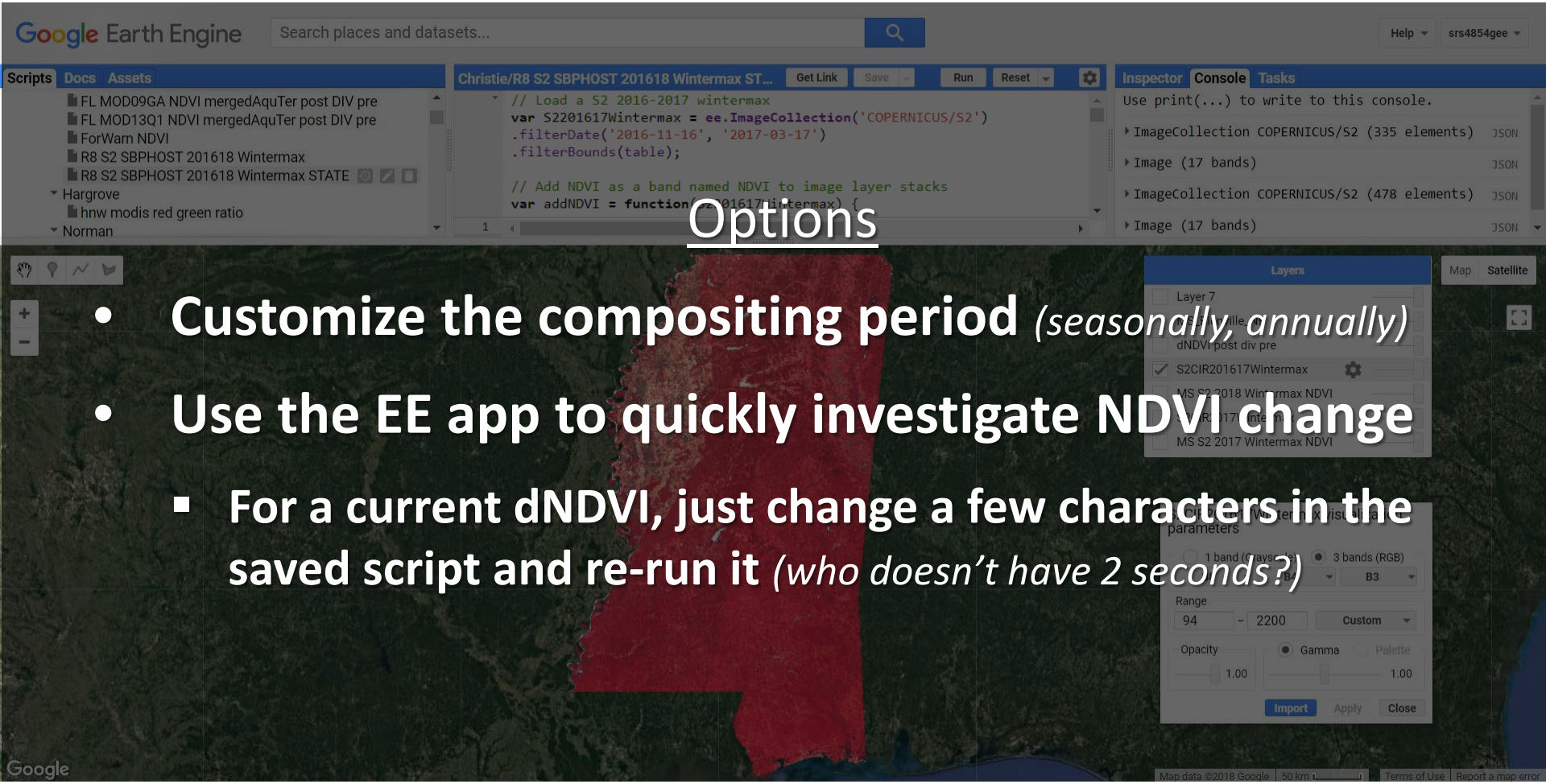
Most recent?

Composites provide "window-resolution" answers:

▲ This can be problematic when a disturbance or rapid recovery occurs at different times during a long composited window.



Earth Engine Example Using 10m Sentinel2
Statewide dNDVI Calculation from Annual Composites

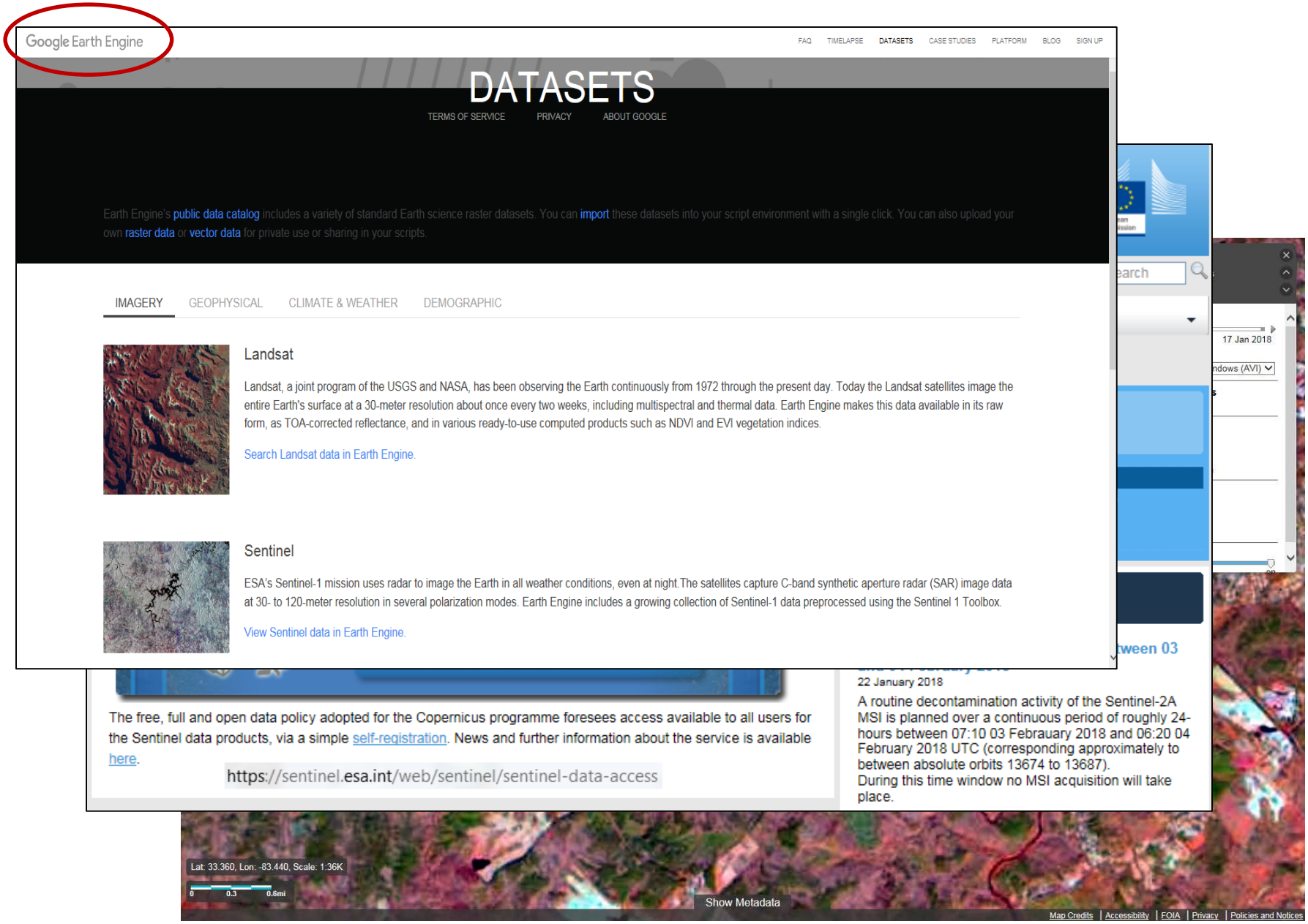


- **Customize the compositing period** *(seasonally, annually)*
- **Use the EE app to quickly investigate NDVI change**
  - **For a current dNDVI, just change a few characters in the saved script and re-run it** *(who doesn't have 2 seconds?)*

Run Times:

- create 2017 and 2018 statewide winter max-NDVI composite, calculate change and draw dNDVI – 2 sec.
- download the dNDVI result from EE to Google Drive – 27 min.; then from Drive to local – 5.8GB

Sources for Sentinel 2 imagery



Sources for Sentinel 2 imagery

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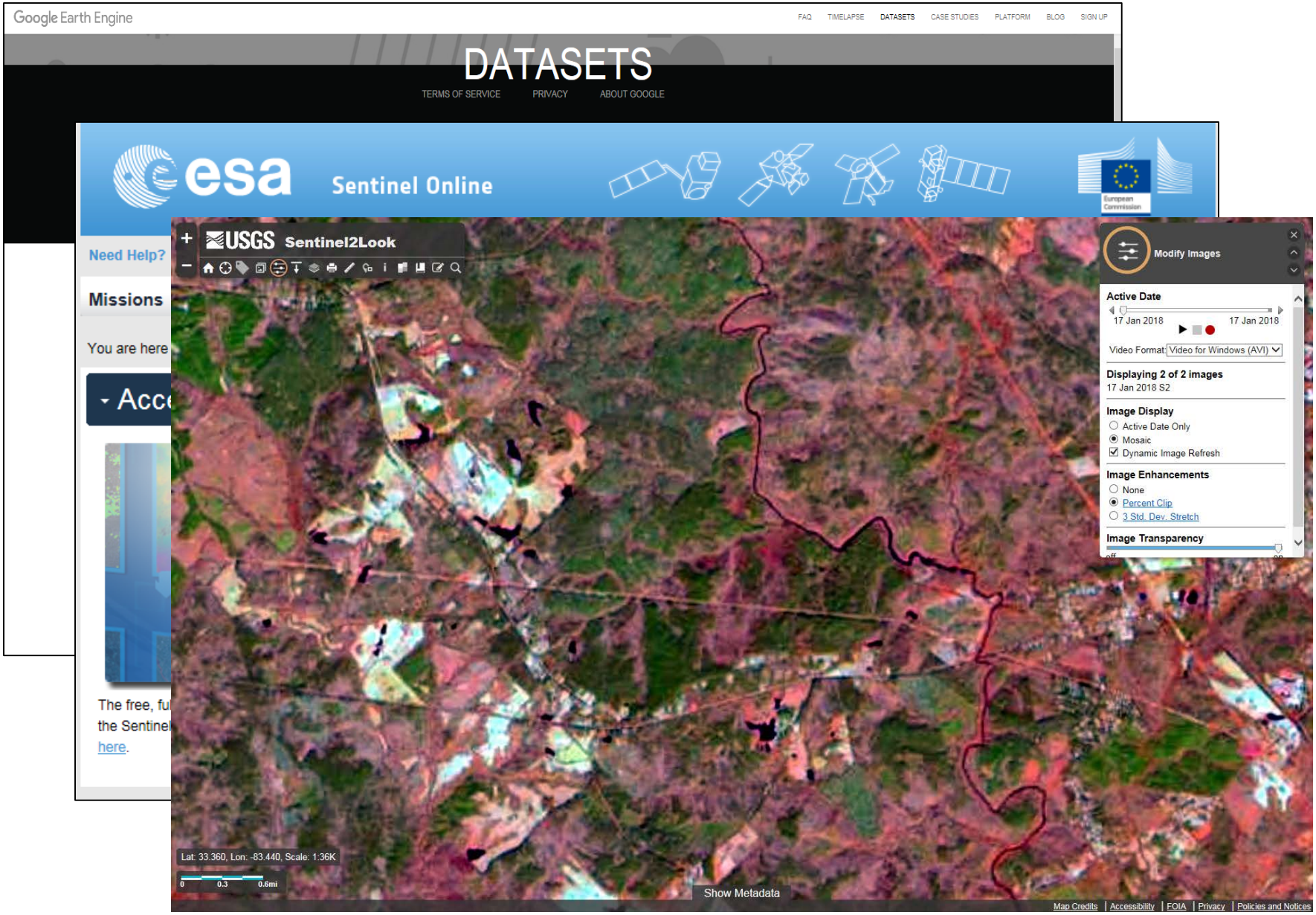

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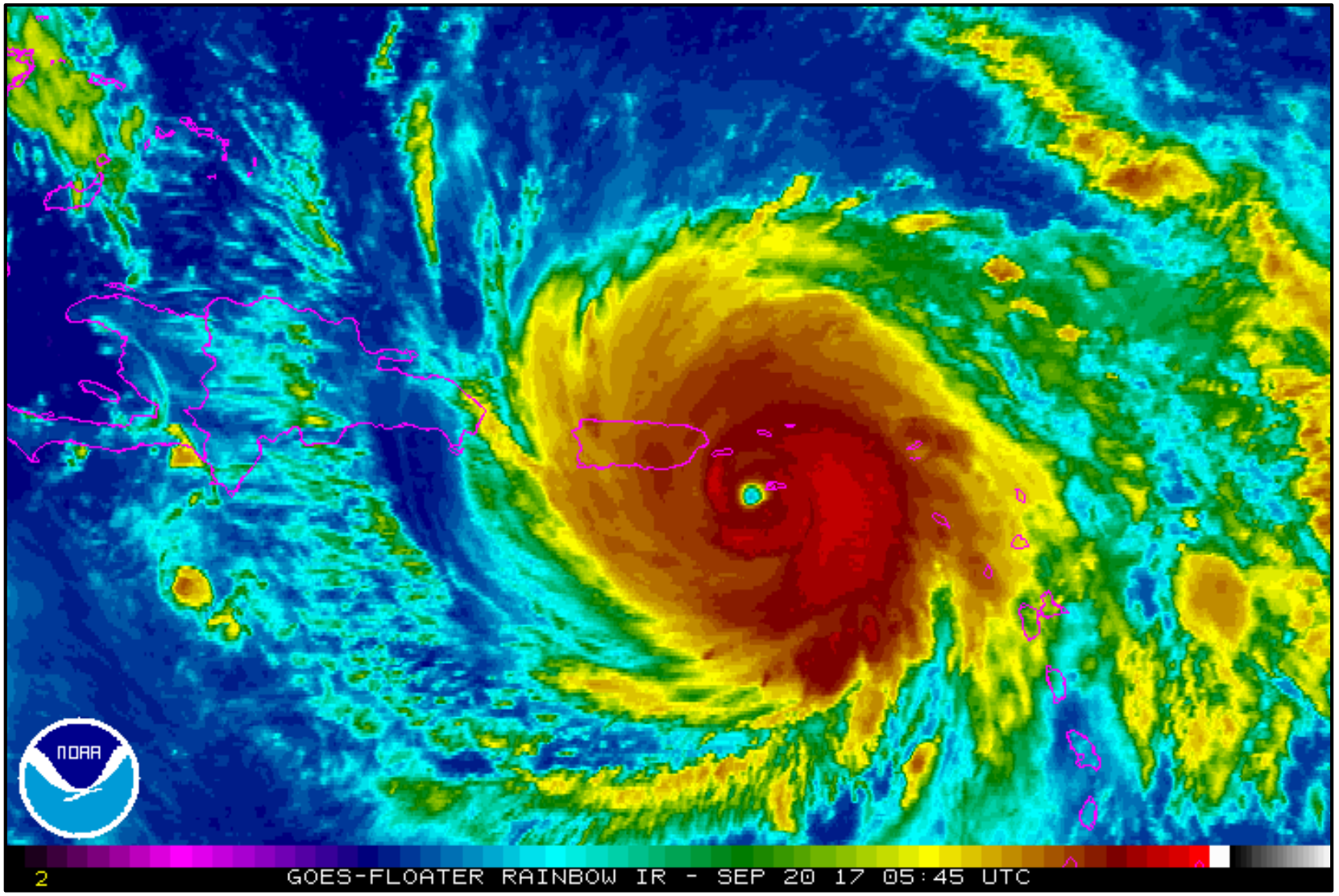
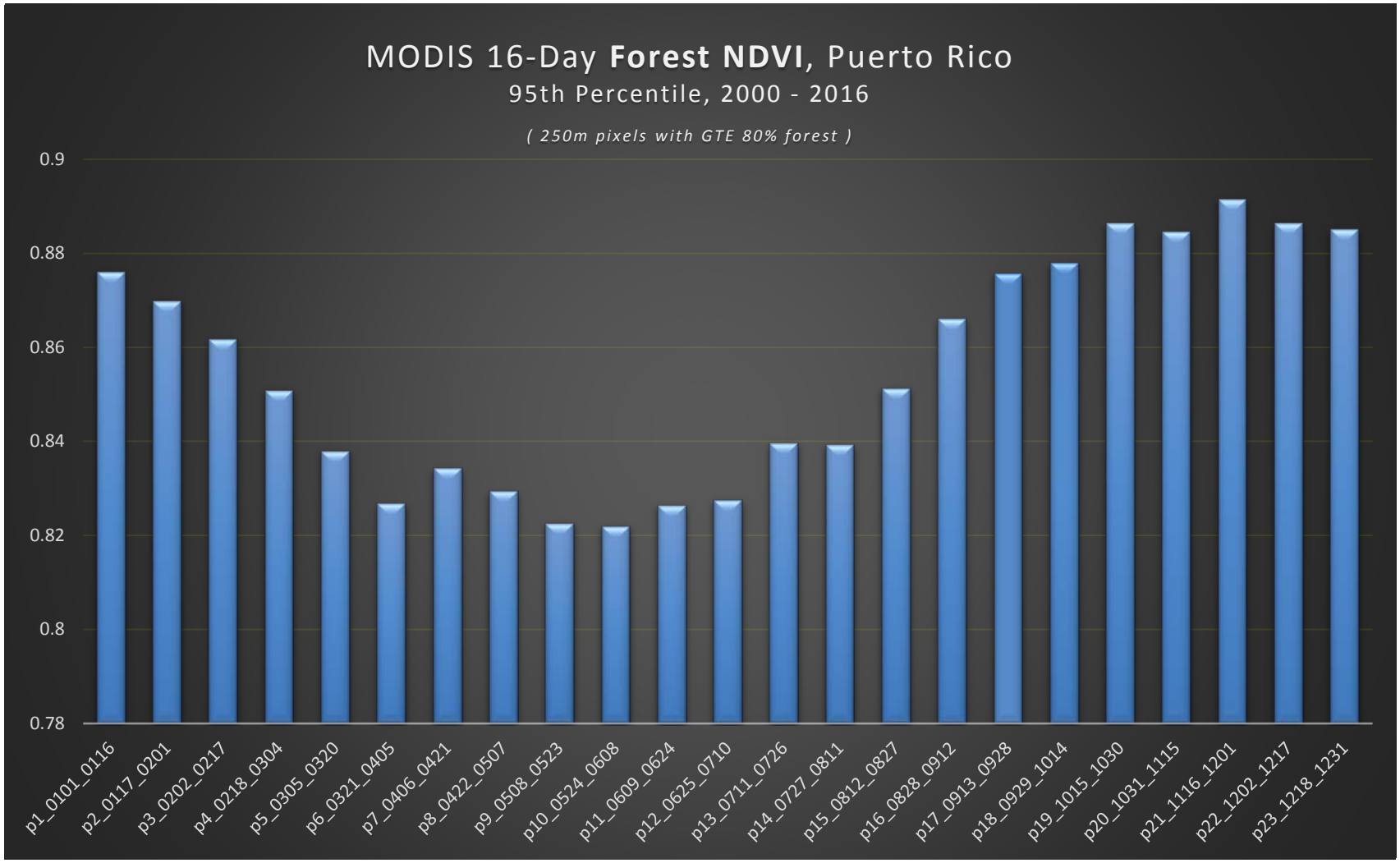
Hurricane Maria traversed Puerto Rico on Sep. 20, 2017

with 110-155 mph eye-winds



El Yunque National Forest

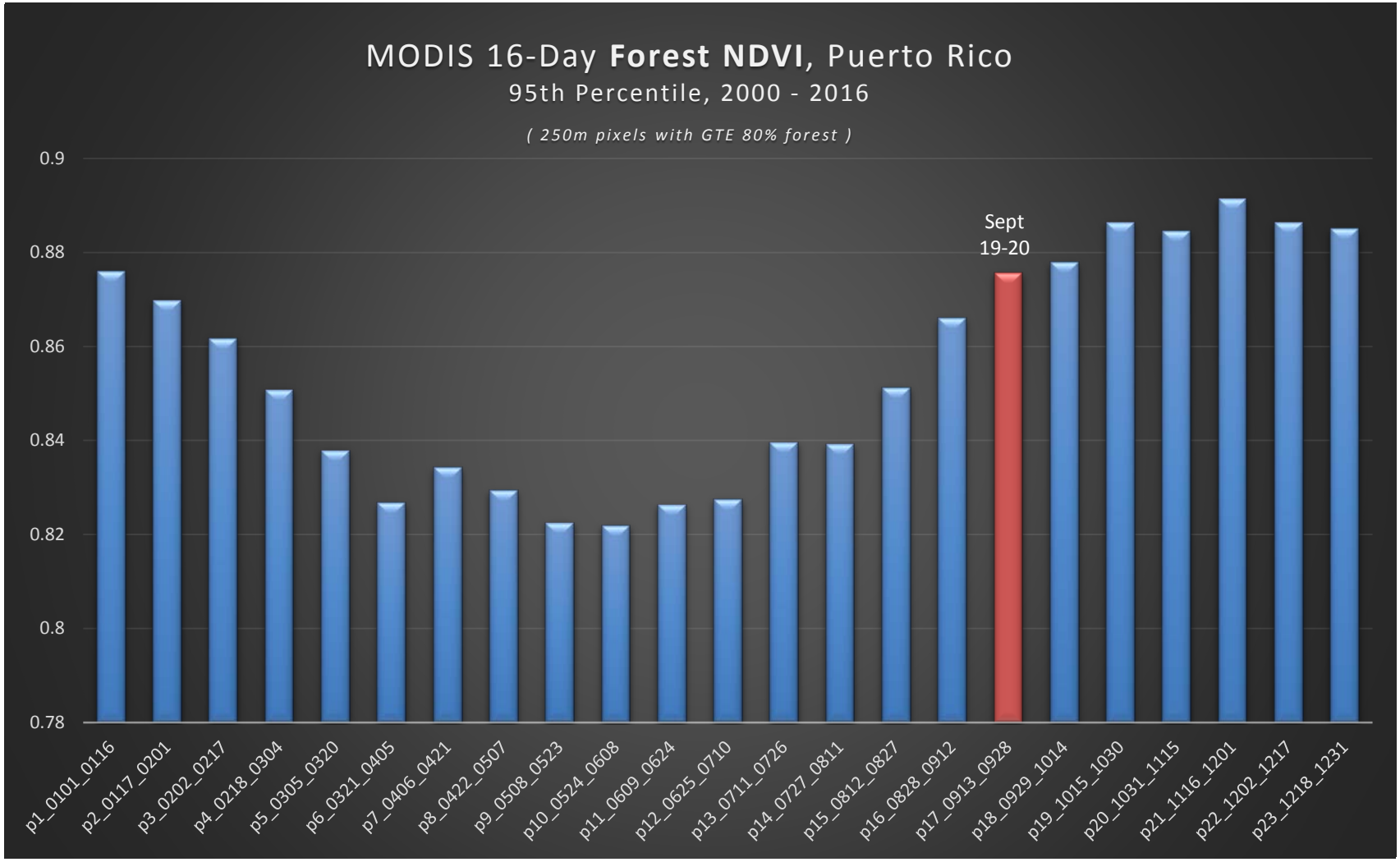
What is the Phenology of Tropical Forests in Puerto Rico?



Jan. July Dec.

Determining the pre- and post-disturbance compositing date-range

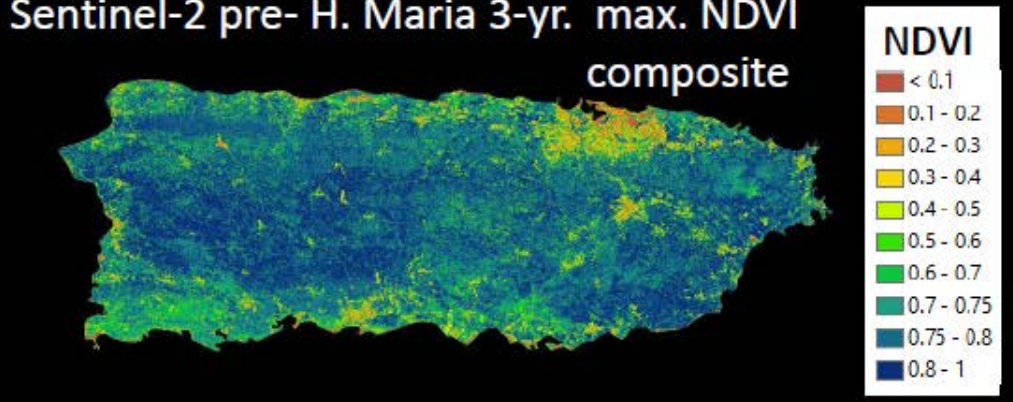
(contextualized within the annual phenological curve)

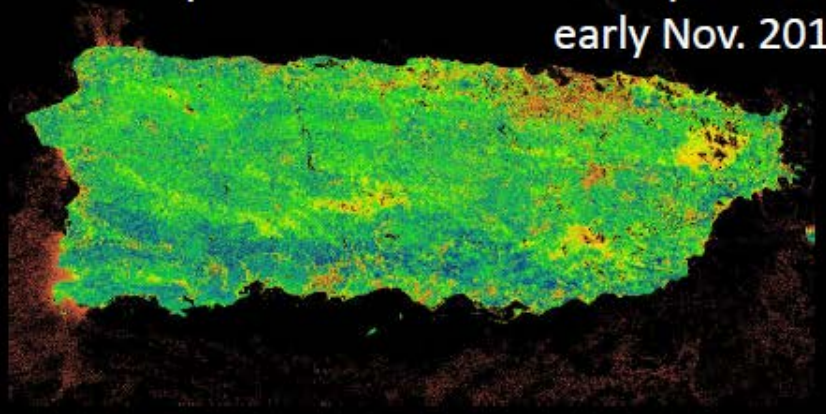


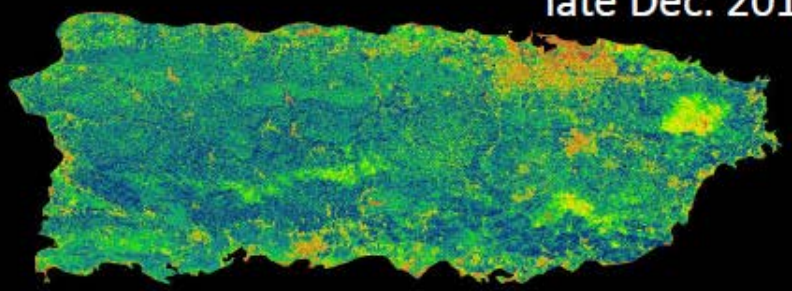

Sentinel-2 true color 10-20-2017


Sentinel-2 true color 10-25-2017


Sentinel-2 true color 11-04-2017


Sentinel-2 pre- H. Maria 3-yr. max. NDVI composite
NDVI
< 0.1
0.1 - 0.2
0.2 - 0.3
0.3 - 0.4
0.4 - 0.5
0.5 - 0.6
0.6 - 0.7
0.7 - 0.75
0.75 - 0.8
0.8 - 1

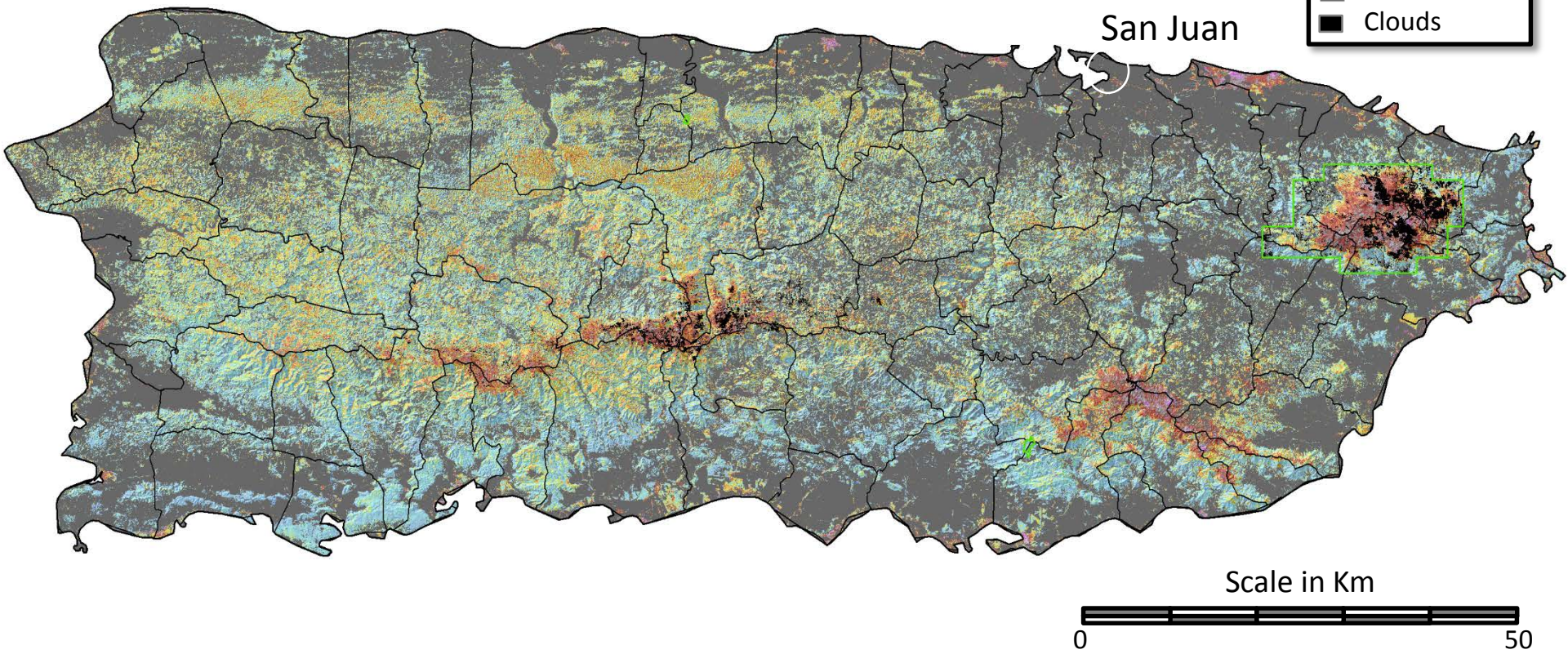

Sentinel-2 post–H. Maria NDVI composite through early Nov. 2017


Sentinel-2 post H. Maria NDVI composite through late Dec. 2017

Change in forest NDVI after Hurricane Maria using Sentinel-2 composites and Google Earth Engine cloud computing

Pre: 3-year max. baseline

Post: Sep 25-Dec. 31, 2017



Eastern Forest Environmental Threat Assessment Center

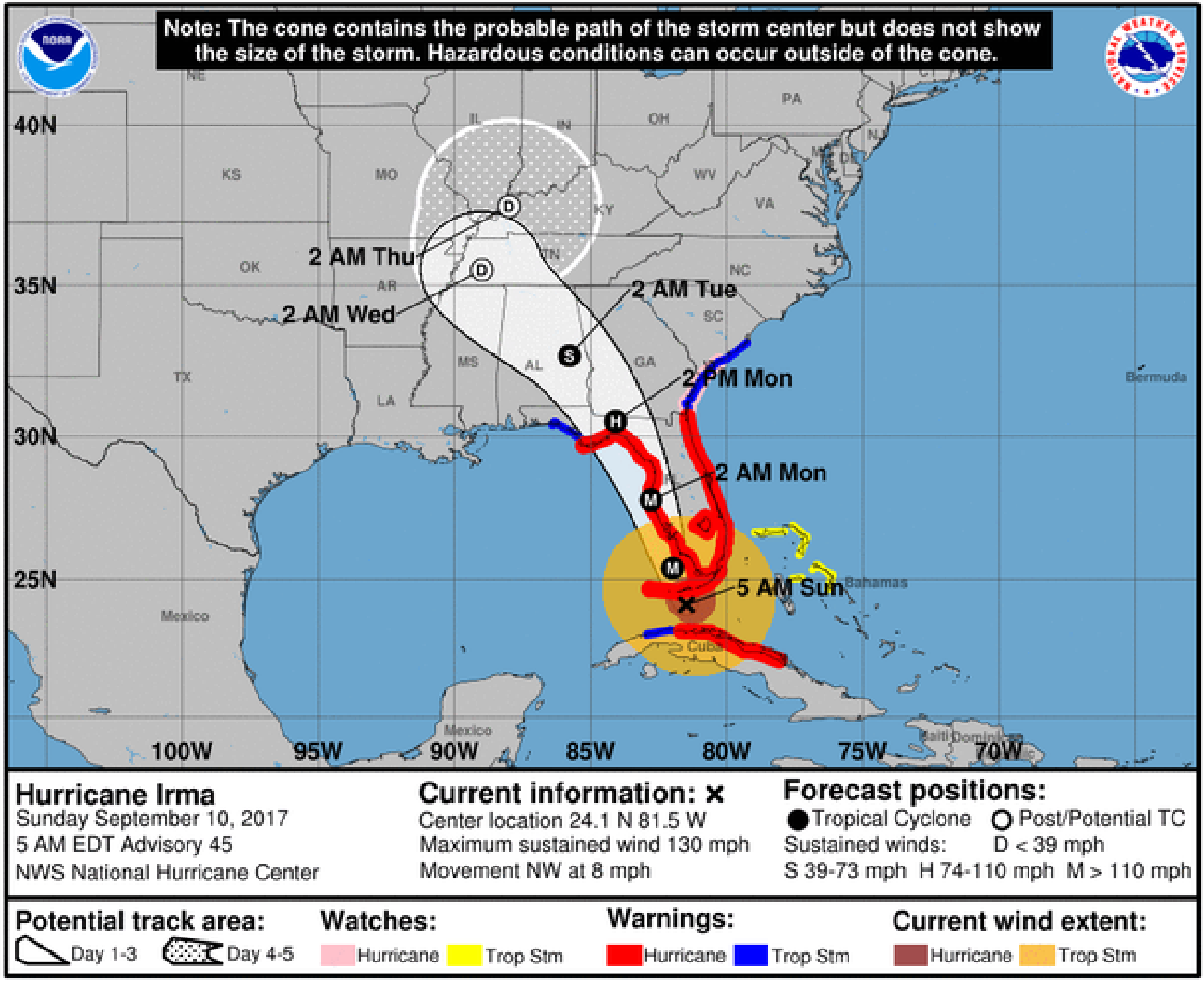
USDA Forest Service, Southern Research Station, Asheville, NC

1. Introduction
2. *ForWarn* II
3. **Disturbance Assessments** (S2)
   - SPB/IPS Host Mapping (GA)
   - Puerto Rico, Hurricane Maria
   - Florida, Hurricane Irma
4. **Expectations Going Forward**

Photo by Paul Merten, Entomologist, Forest Service

2018 SGSF GIS Committee Annual Meeting

February 12-16, 2018 Mobile, AL



Hurricane Irma
Sunday September 10, 2017
5 AM EDT Advisory 45
NWS National Hurricane Center

Current information: ×
Center location 24.1 N 81.5 W
Maximum sustained wind 130 mph
Movement NW at 8 mph

Forecast positions:
● Tropical Cyclone ○ Post/Potential TC
Sustained winds: D < 39 mph
S 39-73 mph H 74-110 mph M > 110 mph

Potential track area: Day 1-3, Day 4-5

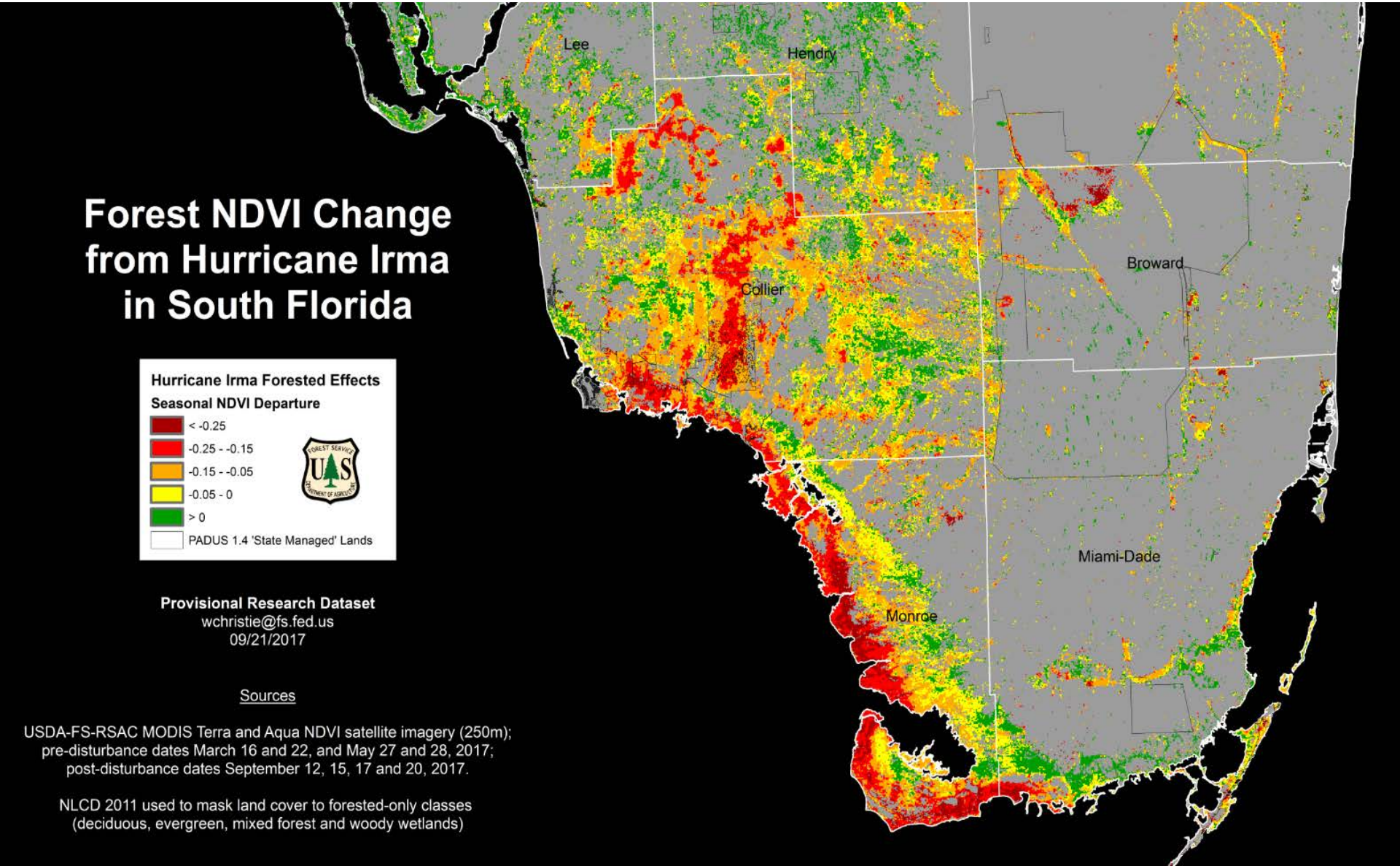
Watches: Hurricane, Trop Stm

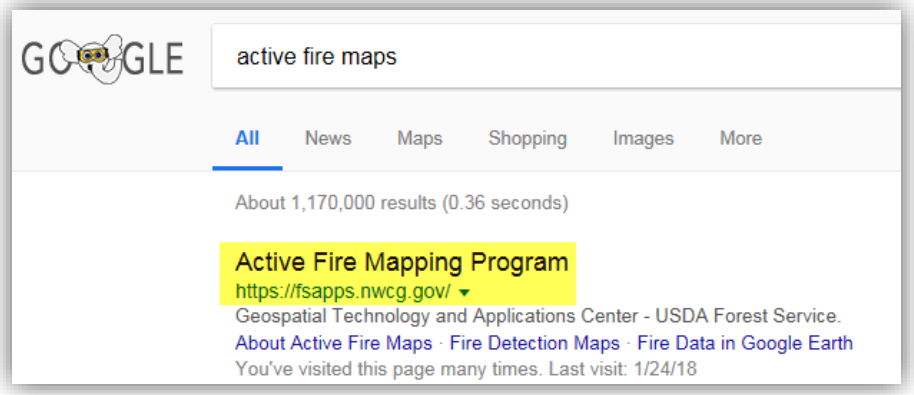
Warnings: Hurricane, Trop Stm

Current wind extent: Hurricane, Trop Stm

Delta-NDVI using Forest Service GTAC MODIS Imagery

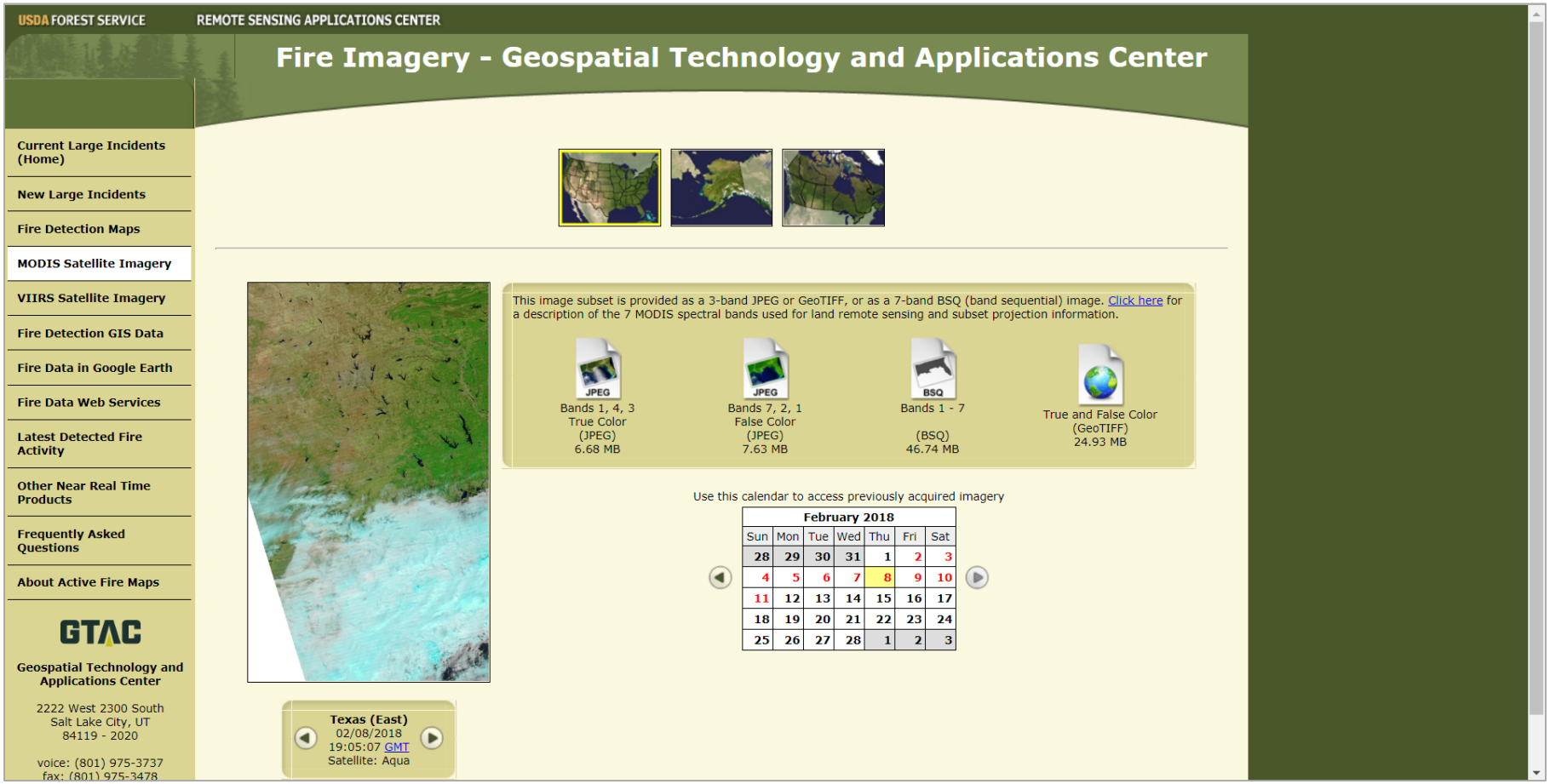
when time is of the essence, availability on, or the day after a disturbance





2x Daily MODIS Availability

for time-critical mapping



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ForWarn II

- **Back-fill all change products where we left off in 2017**
- **Resolve the addition of the new 'SQRT' product(s) into *The Forest Change Assessment Viewer***
- **Be operational for the beginning of the 2018 growing season**

SPB/Ips

- **Explore production of annual host maps for the SGSF region**
- **Explore production of annual host map change products**
- **Refine Sentinel 2 image processing methods in an effort to (1) identify outbreaks and (2) map the progression, mortality stages of active SPB/Ips occurrences**

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Questions?

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