





<https://forestthreats.org>



EASTERN FOREST  
ENVIRONMENTAL THREAT  
ASSESSMENT CENTER

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### Burning Forests Impact Water Supplies

After a wildland fire burns away vegetation, rivers may rise. This could provide some relief for water supplies in drought-stricken areas, but there are trade-offs, according to a new study led by Center scientists.

[Learn more...](#)

*Photo by Erich Vallery, USDA Forest Service, Bugwood.org.*

RECENT PUBLICATIONS [view all recent publications](#)

Drought and thinning have limited impacts on evapotranspiration in a managed pine plantation on the southeastern United States coastal plain

Noteworthy bird records from northeastern Peru reveal connectivity and isolation in the western Amazonian avifauna

Implications of upstream flow availability for watershed surface water supply across the conterminous United States

Regional evapotranspiration from an image-based implementation of the Surface Temperature Initiated Closure (STIC1.2) model and its validation across an aridity gradient in the conterminous US

Least tern (*Sternula antillarum*) population response to water levels on Cheyenne River and Oahe Reservoir, South Dakota, USA

LATEST NEWS [view all the latest news](#)

**USDA Deputy Under Secretary promotes environmental justice goals**  
Today, environmental justice at USDA refers to meeting the needs of underserved communities by reducing disparate environmental burdens, removing barriers to participation in decision making, and increasing access to environmental benefits that help make all communities safe, vibrant and healthy places to live and work.

**Reptiles and Amphibians Unharmed by Prescribed Fires in Early Growing Season**  
Amphibians and reptiles tend to be most active during the spring and summer, when it's warmer. A recent study compared how they respond to prescribed fires conducted during the growing season – when vegetation is actively growing – versus those in dormant season months.

**Agroforestry Strategies for Landowners**  
Two recent USDA Forest Service publications focus on agroforestry practices.

## Data & Tools

Comparative Risk Assessment Framework and Tools (CRAFT)

Forecasts of Climate-Associated Shifts in Tree Species (ForeCASTS)

**ForWarn II**

Landscape Dynamics Assessment Tool (LandAT)

Template for Assessing Climate Change Impacts and Management Options (TACCIMO)

Water Supply Stress Index (WaSSI)



"Praemonitus Praemunitus"

# ForWarn II

Satellite-Based Change Recognition and Tracking



- A **national-scale near real-time** satellite-based recognition and tracking system for all land cover disturbances
- "Officially" rolled-out in 2012, but has actually been operating since January 2010
- **ForWarn** covers the entire lower 48 United States
- Generates new potential **disturbance maps every 8 days**, even throughout the winter
- Detects most types of regional and local land cover disturbances
  - insects, diseases, wildfires, ice and frost damage, tornadoes, hurricanes, blowdowns, harvest, urbanization, seasonal timing and drought. and landslides
- 231 meter native resolution map cells (13-acre minimum mapping unit)
  - It is not necessary for an entire forested pixel to be disturbed for disturbance to be detected



# ForWarn's Context



**ForWarn II**

- **Strategic** – The *ForWarn II* 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 1 can be used to optimally direct the labor-intensive efforts of Tier 2, which are limited in coverage and frequency*



**Insect and Disease Surveys**

- **Tactical** – Airborne overflights and ground inspections of areas of potential interest are visited to determine if such warnings are confirmed and become alarms

*The two tiers are complementary and support each other*

Gulf of  
Mexico

# How Does *ForWarn* Work?

- Based on a simple comparison between current greenness vs. historical greenness (NDVI)
- We develop this historical greenness from the 16-year historical MODIS satellite record
- The comparison is both spatially and temporally explicit – compares during the same 24-day window and for the same MODIS pixel location

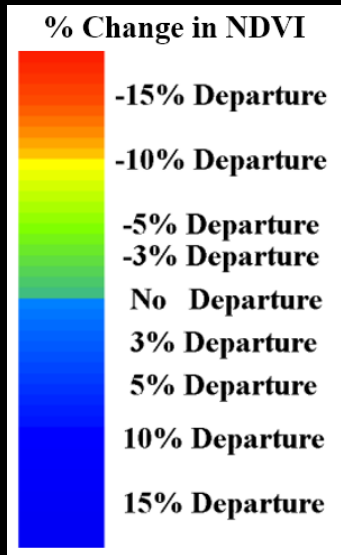
- If the current NDVI value is less than 100% of the baseline used =

**Potential Disturbances** shown as **Greens**, **Yellows**, and **Reds**

- If the current NDVI value is greater than 100% of baseline used =

**Vegetation Regrowth, Recovery or Normalcy** shown as **Blues**

- Only shows a Disturbance if it affects the plants - and to the degree that it affects the plants
- When first opening the 'Forest Change Assessment Viewer', only forested areas are shown by default, but ***ForWarn*** detects disturbances in all NLCD-based land use and land cover classes, including agricultural crops and rangeland forage (see the new "Masking" tool)





# ForWarn II Products

(6) annually-based disturbance maps every 8 days (**emphasizing age and magnitude**)

## Annually-based Products

1. 1yr baseline '**Early Detect**' (NDVI max, 8 day composite)
2. 1yr baseline (NDVI max, 24 day composite)
3. 3yr baseline (NDVI max , 24 day composite)
4. 5yr baseline (90<sup>th</sup> percentile , 24 day composite)
5. 10yr baseline (90<sup>th</sup> percentile , 24 day composite)
6. All-year baseline (NDVI median , 24 day composite)

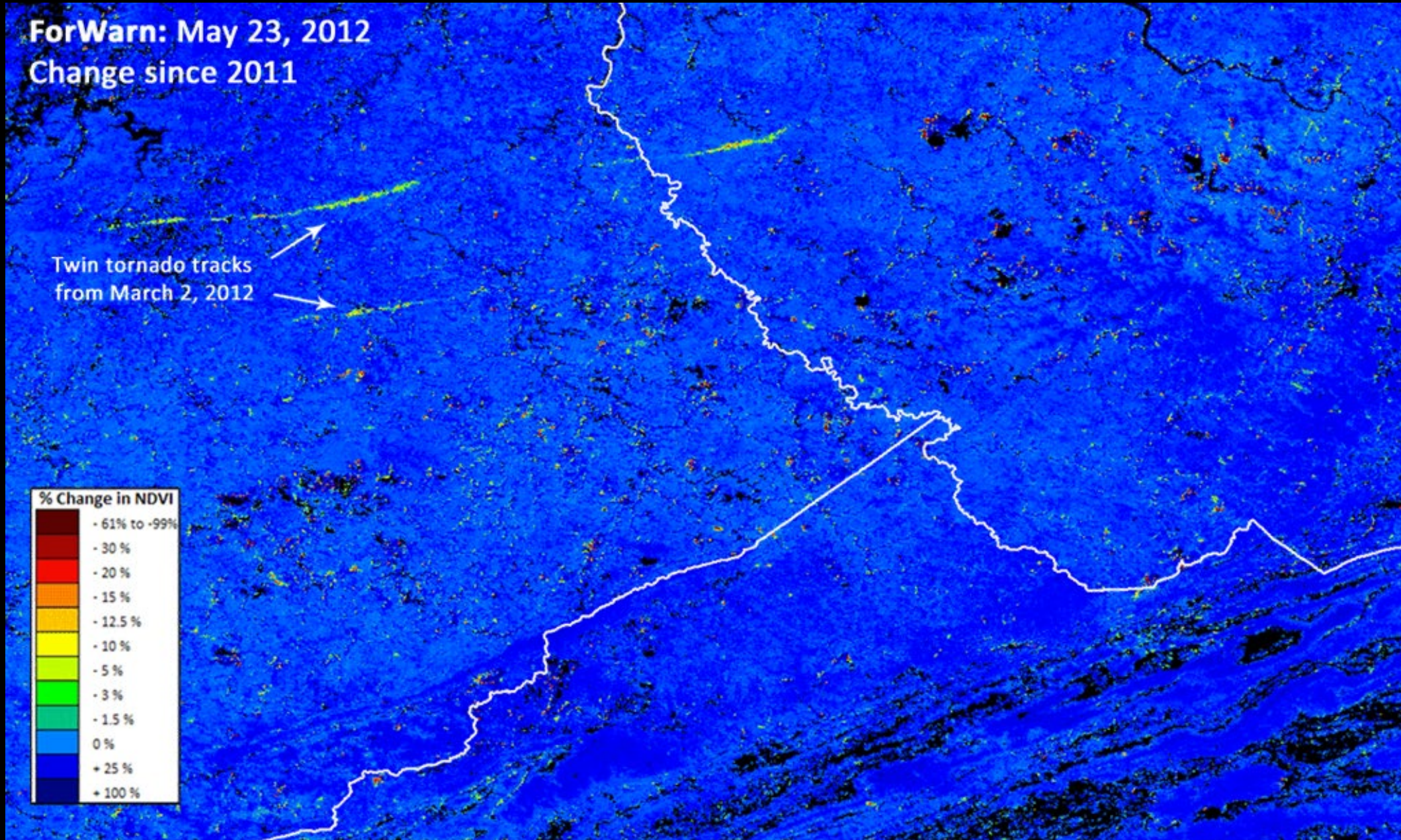
(4) intra-annual disturbance products during the growing season (**emphasizing persistence**)

## Intra-Annual Duration

1. 6-period Duration, May 8 – June 17 (for western U.S.)
2. 6-period Duration, June 24 – Aug 4
3. 6-period Duration, Aug 12 – Sept 21
4. 12-period Duration, June 24 – Sept 21

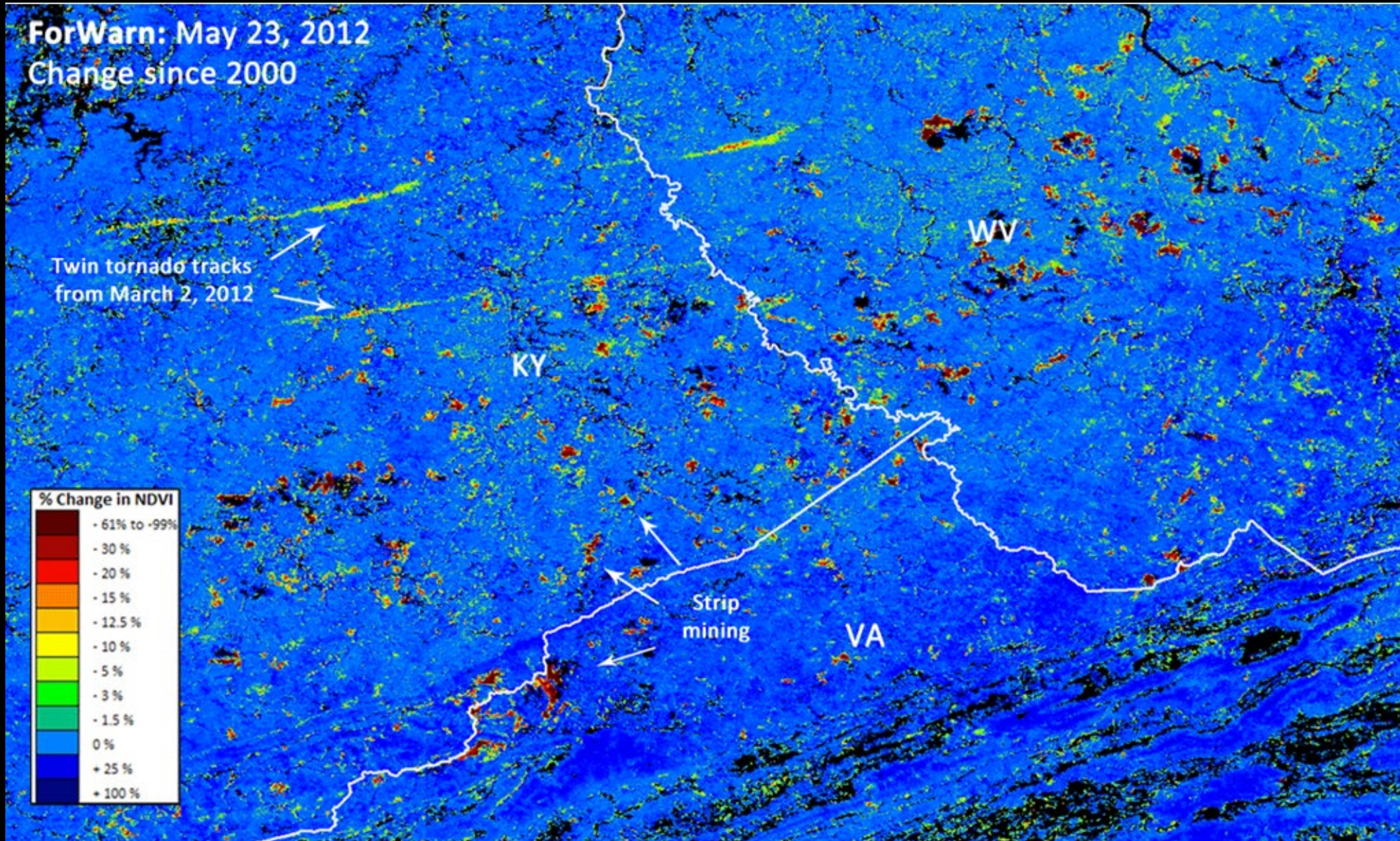


## ForWarn 1yr baseline vs. All-year baseline





## ForWarn 1yr baseline vs. All-year baseline

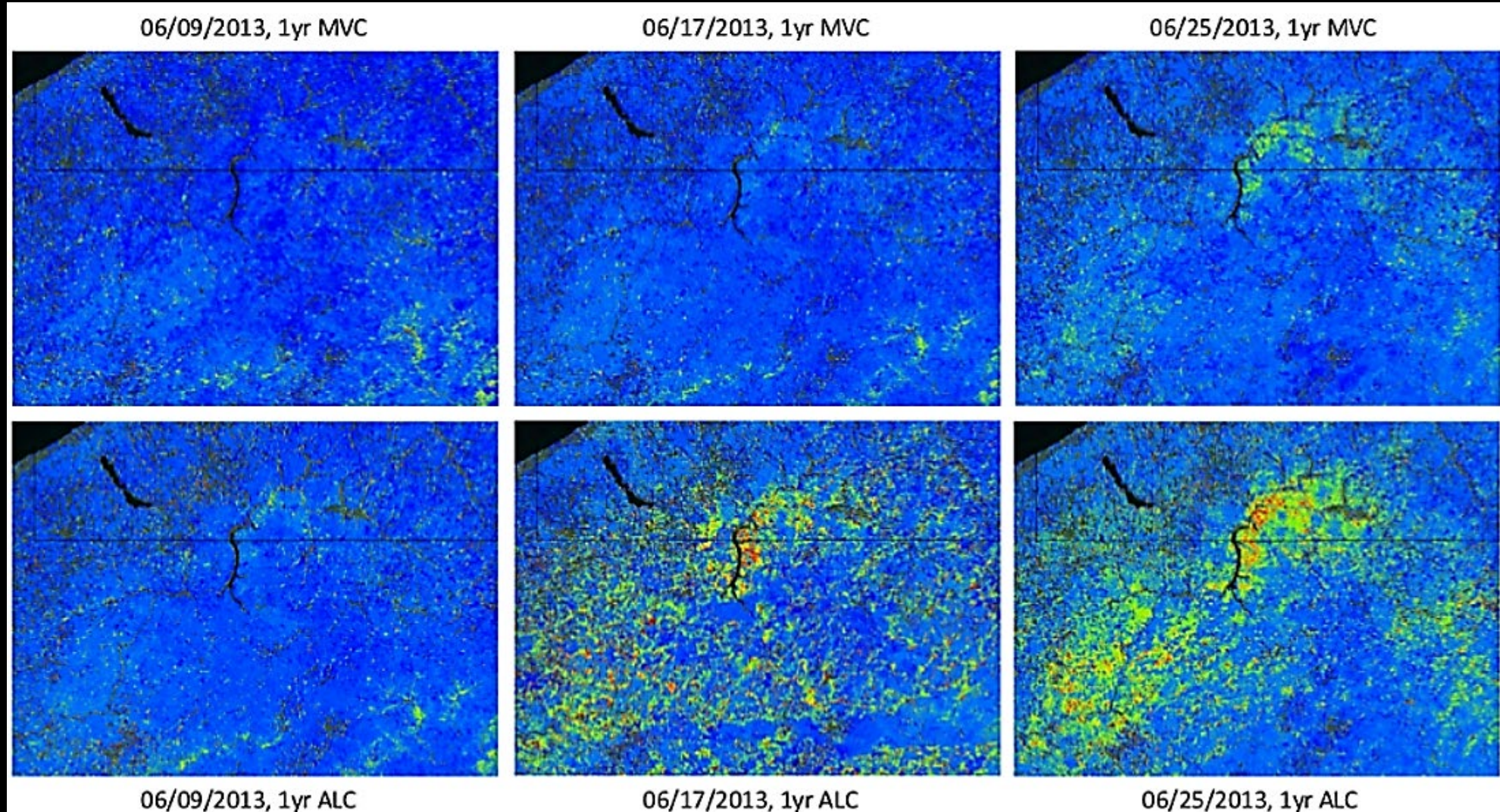




# ForWarn 1yr Baseline 'Standard' Product vs. 1yr Baseline 'Early Detect' Product



2013 Gypsy Moth Defoliation, Allegheny NF, PA-NY



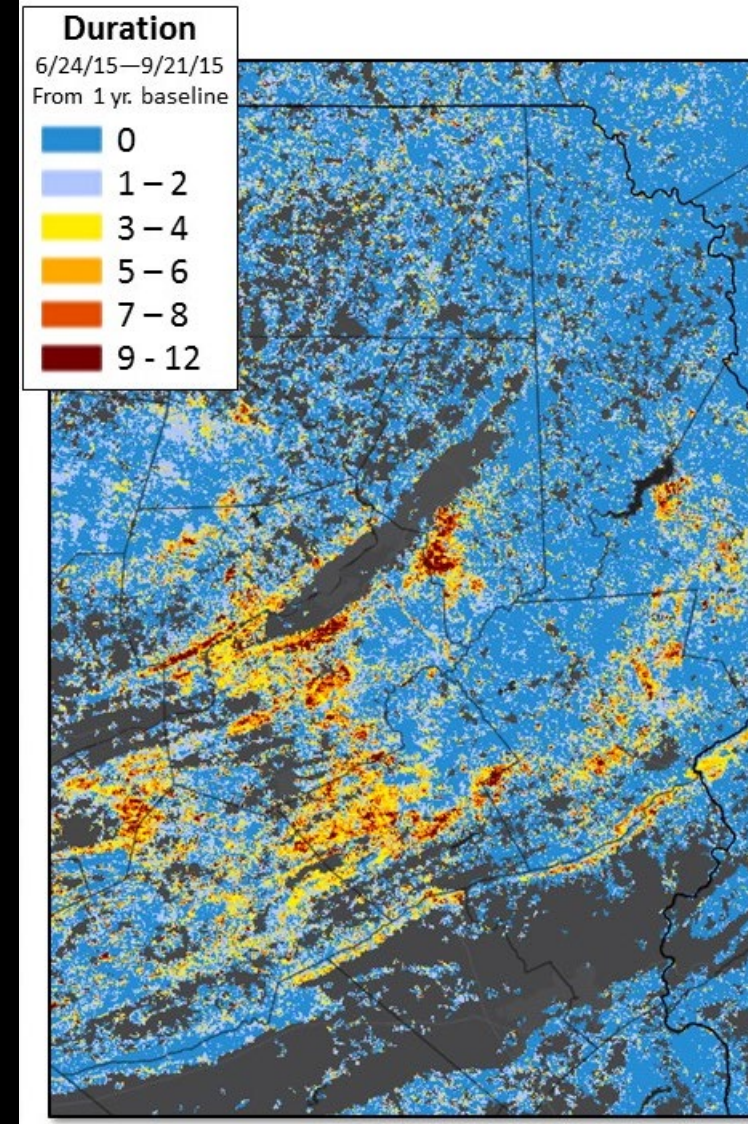
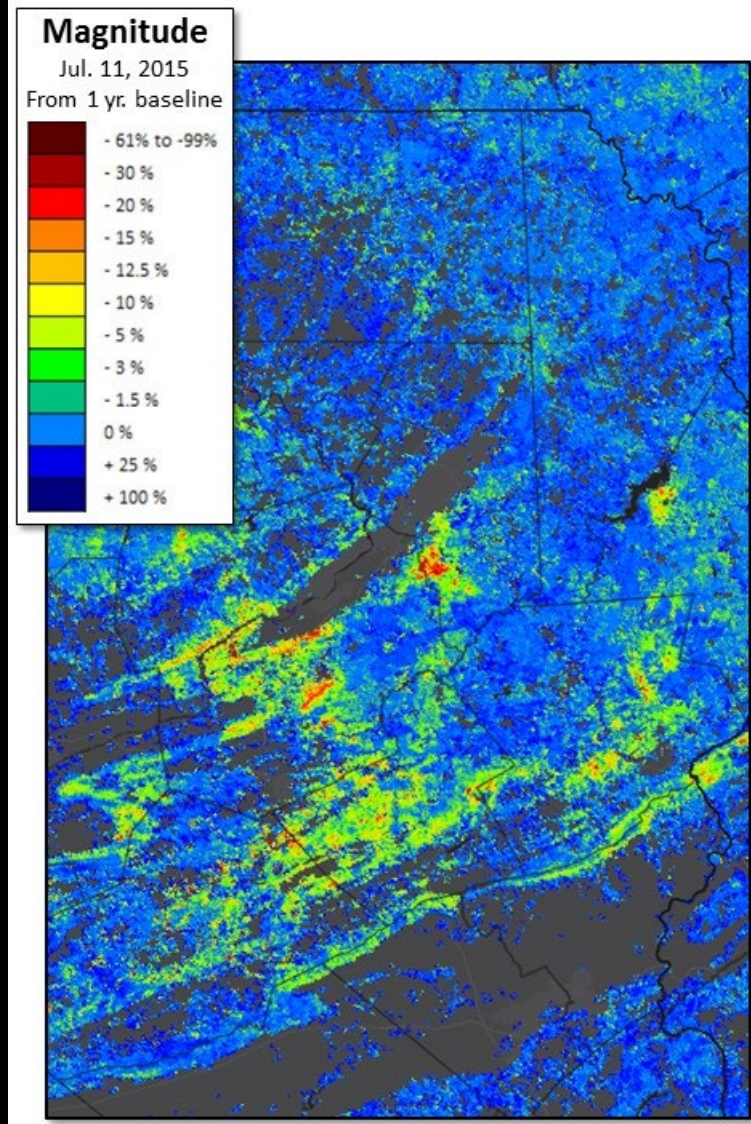
*The 'Early Detect' product dramatically reduces **ForWarn** detection speeds, allowing the detection of disturbances in as few as one 8-day period*



# Tracking Gypsy Moth emergence and severity with magnitude and duration (PA, 2016)



Static images  
produced every  
8-days



(6) or (12)  
Consecutive  
image dates are  
summarized  
within the  
growing season  
for these  
timeframes:

6-period Duration  
**May 8 – June 17**

6-period Duration  
**June 24 – Aug 4**

6-period Duration  
**Aug 12 – Sept 21**

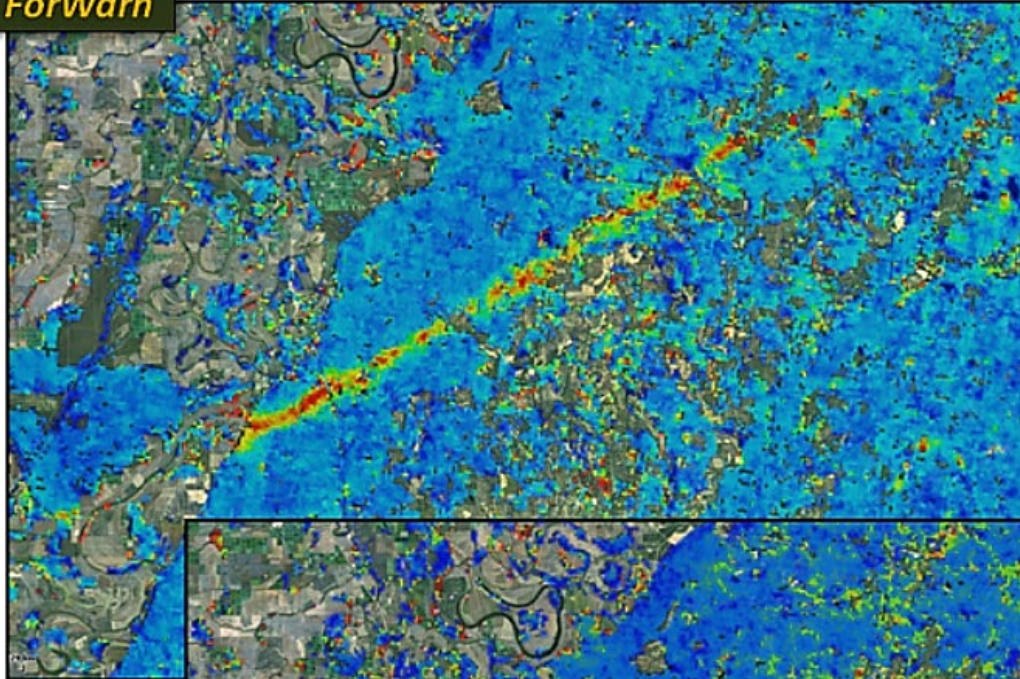
12-period Duration  
**June 24 – Sept 21**

*ForWarn's* Seasonal Duration products help discriminate ephemeral from persistent impacts

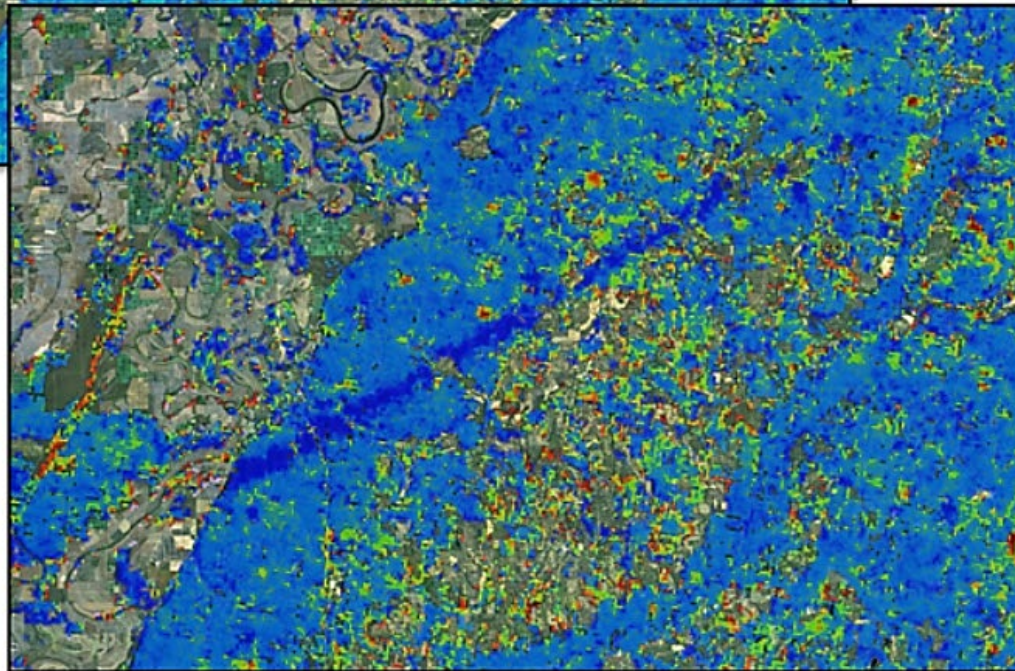


# Positive NDVI Departure = Vegetative Recovery / Re-Growth

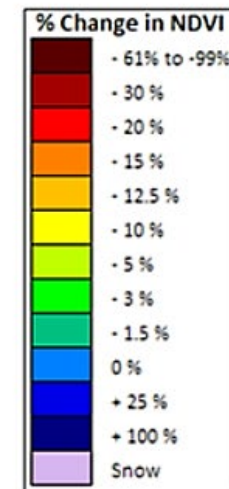
**ForWarn**



June 17, 2010  
compared to 2009



June 17, 2011  
compared to 2010



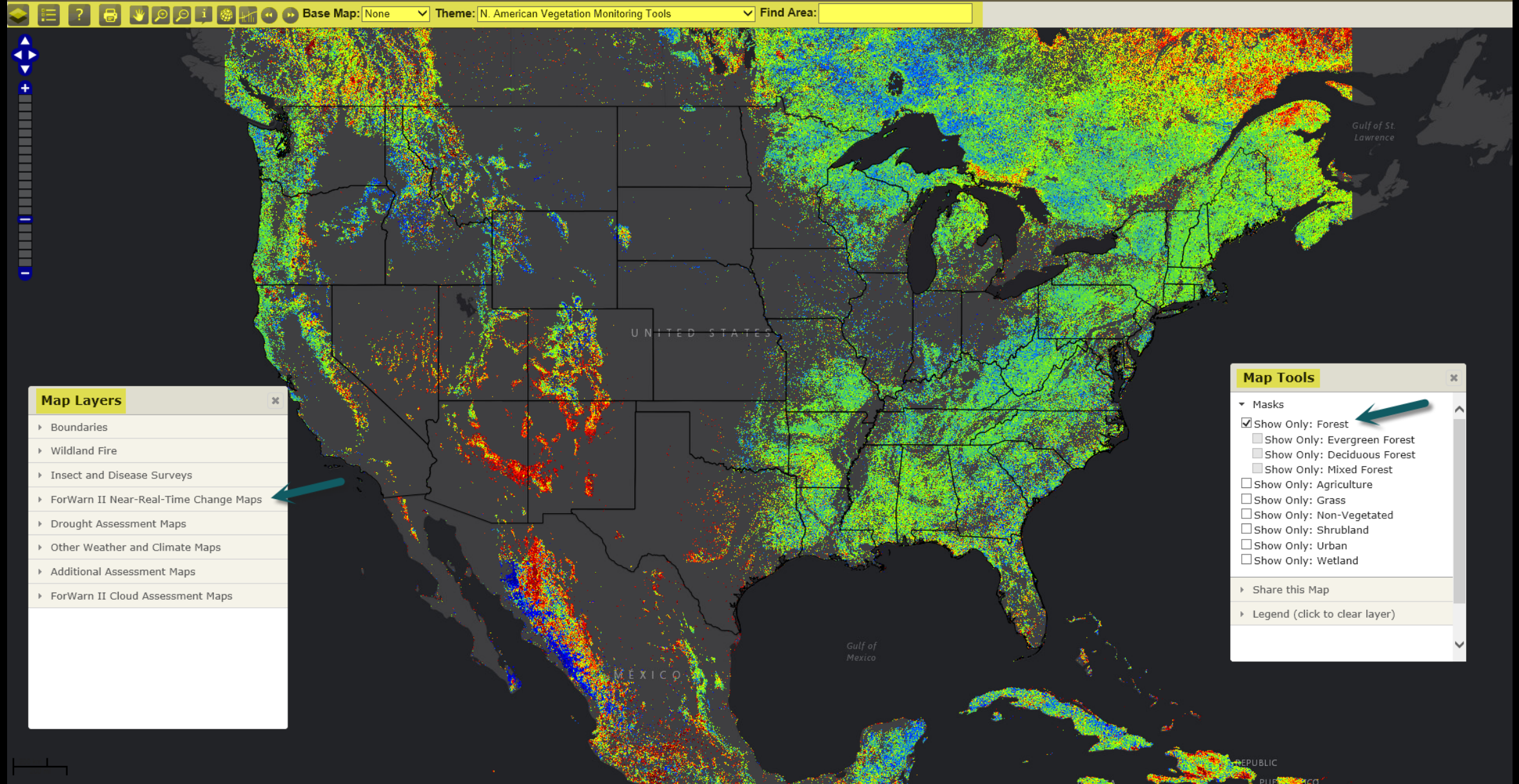
Relative to a 1-year baseline, forest vegetation is re-growing within the Yazoo, MS tornado track. **ForWarn** can easily track such recovery, and the variability in the rate of recovery.



# ForWarn's Forest Change Assessment Viewer (forwarn.forestthreats.org/fcav2)



## U.S. Forest Change Assessment Viewer

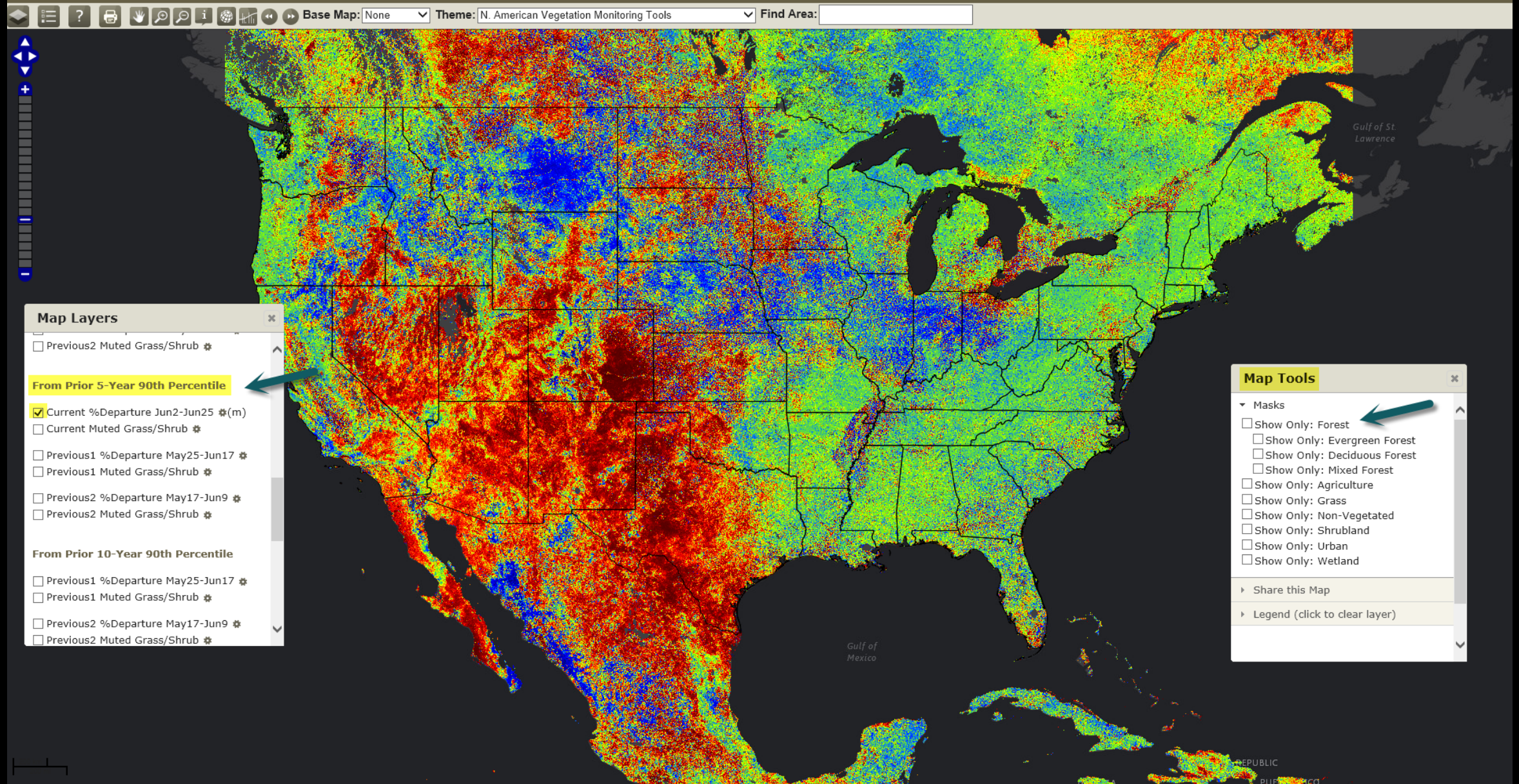




# Forest Change Assessment Viewer (FCAV): 5yr '90<sup>th</sup> percentile' (unmasked)



## U.S. Forest Change Assessment Viewer





# FCAV Feature: “Share this Map” (share potential disturbances with your colleagues)



U.S. Forest Change Assessment Viewer

Base Map: USA Topo Theme: Archived Near-Real-Time Change Maps (MODIS NDVI) Find Area:

## Share this Map

Copy and email this URL to a colleague. The Viewer will open and display the exact extent and layers from which it was created.

### Map Tools

Masks

#### Share this Map

[https://forwarn.forestthreats.org/fcav2/?theme=MODIS\\_Forest\\_Change\\_Products&layers=FW\\_20170609\\_1YR\\_LEGACY,AAB&mask=Forest&alpha=0.33,1&acqp=G04&basemap=USA\\_Topo&extent=-9312639,278981,4251106,4474964,-9275949,5054042,4269604,2083414](https://forwarn.forestthreats.org/fcav2/?theme=MODIS_Forest_Change_Products&layers=FW_20170609_1YR_LEGACY,AAB&mask=Forest&alpha=0.33,1&acqp=G04&basemap=USA_Topo&extent=-9312639,278981,4251106,4474964,-9275949,5054042,4269604,2083414)

Legend (click to clear layer)

## Share this Map URL

Create a bookmark in your browser to quickly return to, and monitor your area of interest, pre-loaded with the change product and layers of your choice

20170609

Transparency: 67 %

Map Layers

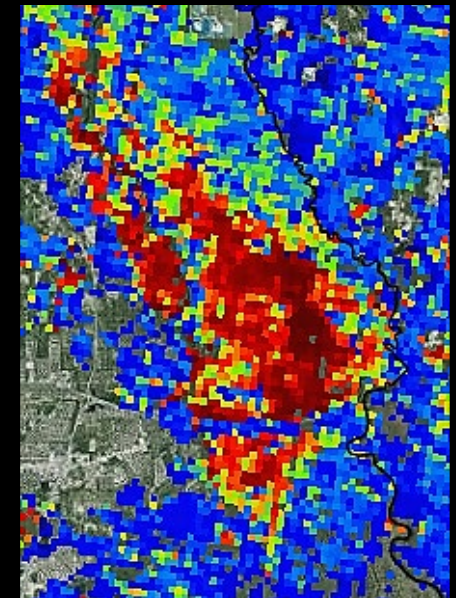
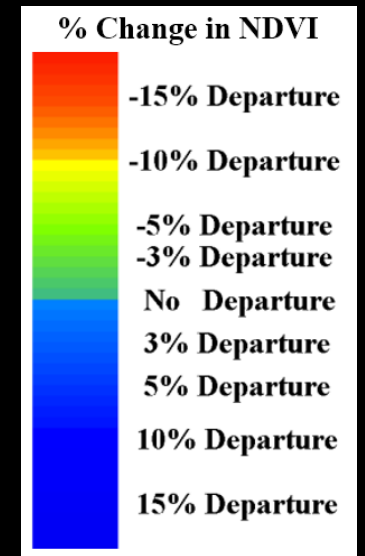
- ☐ 20170609
- ☐ 20170601
- ☐ 20170601
- ☐ 20170601
- ☐ 20170703 \*
- ☐ 20170625 \*
- ☐ 20170617 \*
- ☒ 20170609 \*(m)
- ☐ 20170601 \*
- ☐ 20170524 \*
- ☐ 20170516 \*
- ☐ 20170508 \*
- ☐ 20170430 \*
- ☐ 20170422 \*
- ☐ 20170414 \*
- ☐ 20170406 \*
- ☐ 20170329 \*
- ☐ 20170321 \*
- ☐ 20170313 \*



# Identifying and Interpreting NDVI Change

locate – characterize – assess

- **Site and situation?**
  - Land Use / Land Cover type (image base map, masks, veg maps)
  - Topographic position (elevation, slope, aspect, wet/dry, amount of LULC mix)
- *What is the **character** of the NDVI departure?*
  - Progression speed (toggle 3 most recent, fast/slow, on/off = clouds)
  - Severity and Duration (pos/neg, high/low, persistence – long/short)
  - Spatial extent (regional, large area or localized)
  - Pattern and shape (scattered, contiguous, target-like, linearity)
  - Edges (well defined or bulls-eye – trails-off showing less departure)
  - Seasonality (spring, fall, snow, frost effects)



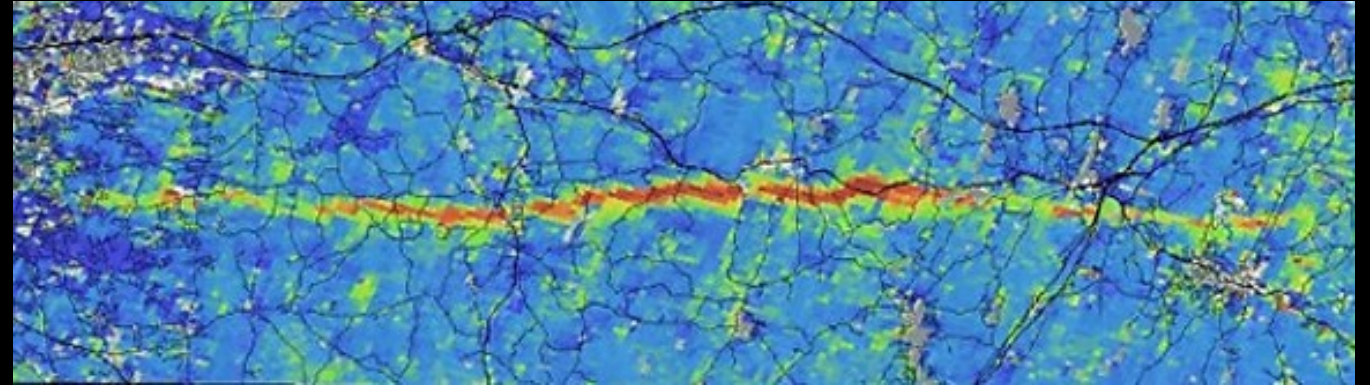


# Examples of forest disturbance, or recovery, seen in the *ForWarn* forest change images

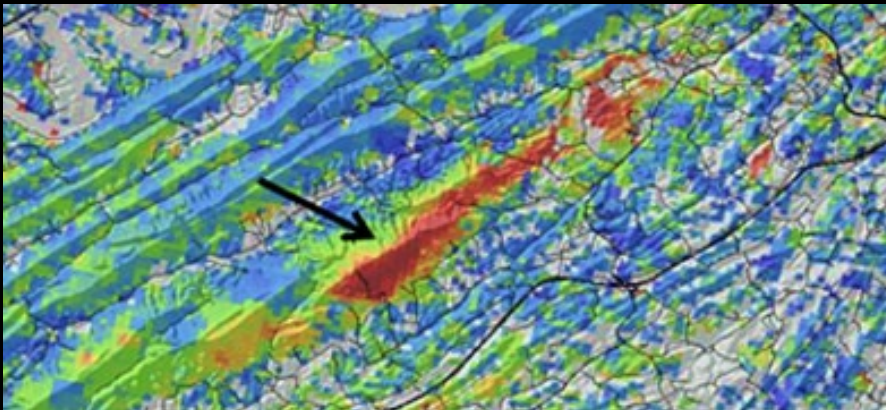
## Natural Disturbance

### Severe weather (tornadoes, wind, hail, ice)

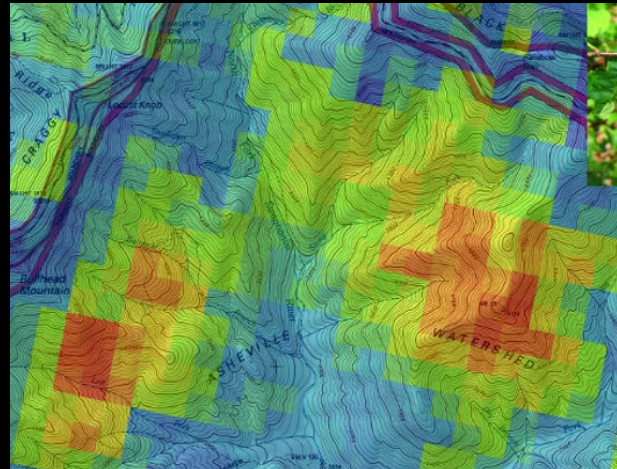
Drought and flood events  
Insects and disease outbreaks  
Early/late – spring/fall timing  
Snow  
Wildfire events



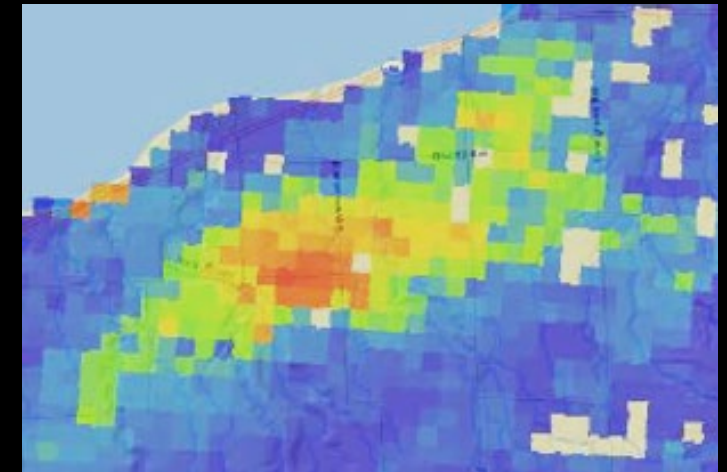
Tornado (MA)



Severe Wind, Leaf Stripping (TN)



Hail Damage (NC)



Severe Weather (MI)



# Examples of forest disturbance, or recovery, seen in the *ForWarn* forest change images

## Natural Disturbance

Severe weather (tornadoes, wind, hail, ice)

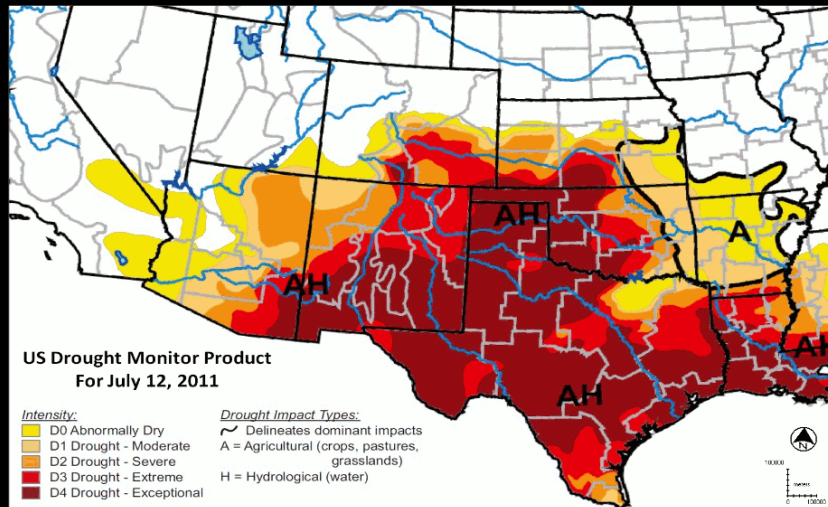
### **Drought and flood events**

Insects and disease outbreaks

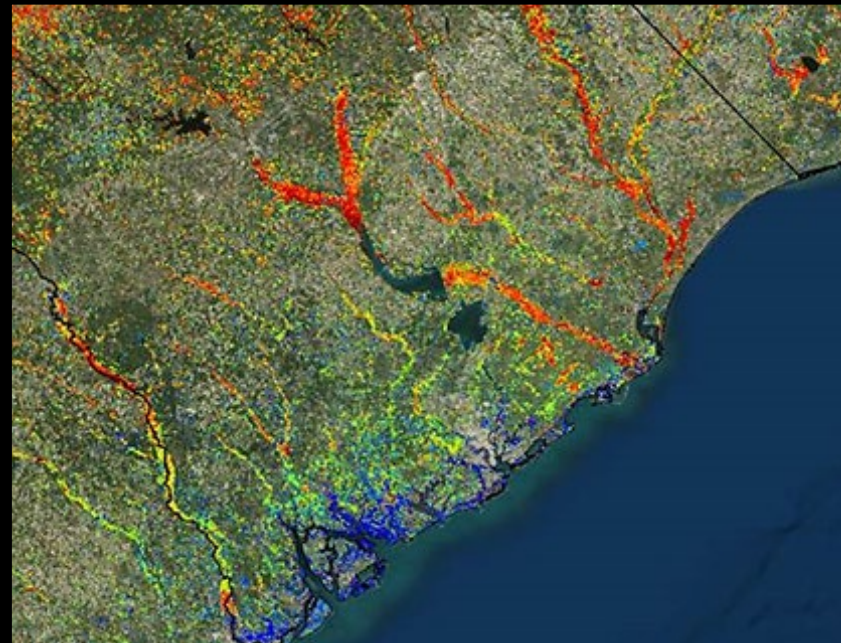
Early/late – spring/fall timing

Snow

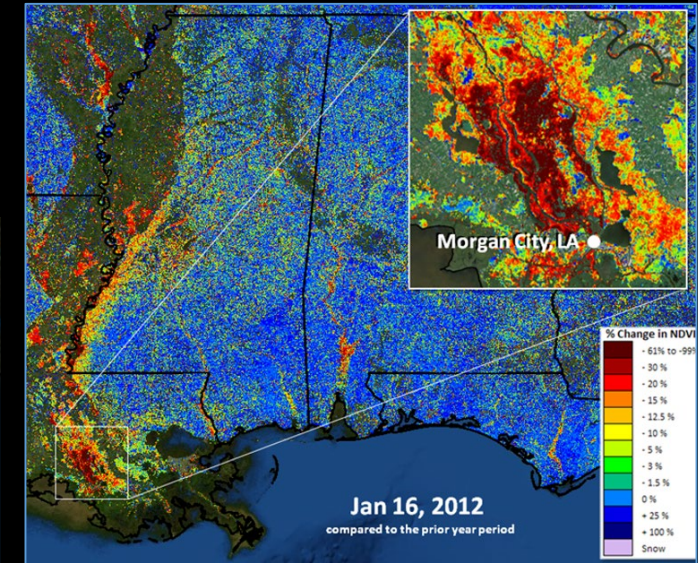
Wildfire events



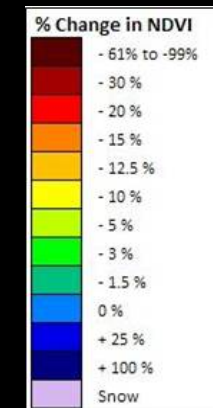
Texas Drought Monitor Comparison, 2011



Bottomland Hardwood Flooding (SC)



Flooding (Atchafalaya Basin, LA)





# Examples of forest disturbance, or recovery, seen in the *ForWarn* forest change images

## Natural Disturbance

Severe weather (tornadoes, wind, hail, ice)

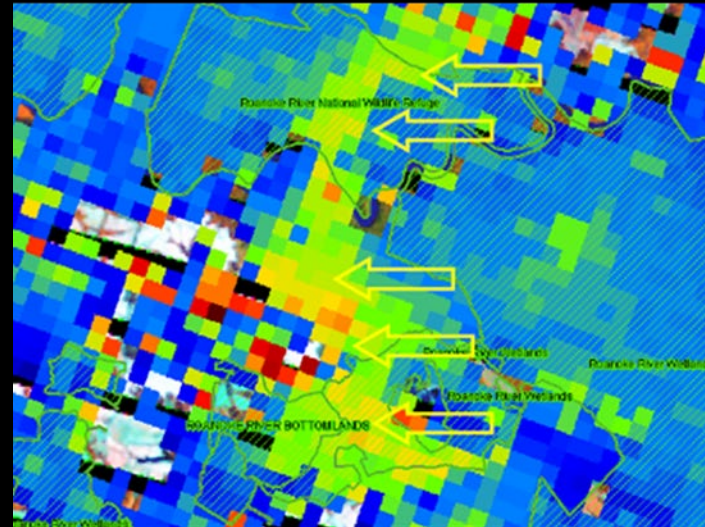
Drought and flood events

**Insects and disease outbreaks**

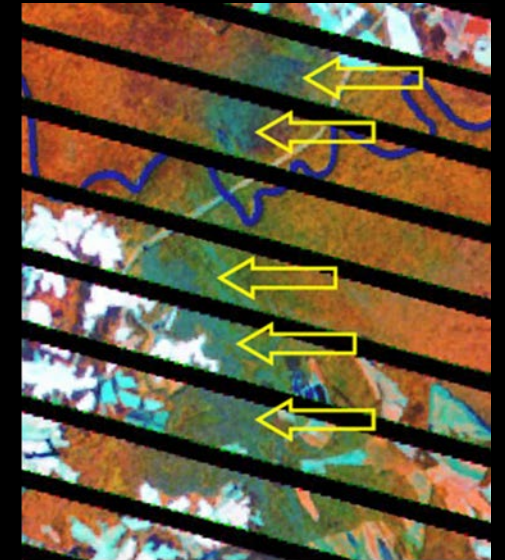
Early/late – spring/fall timing

Snow

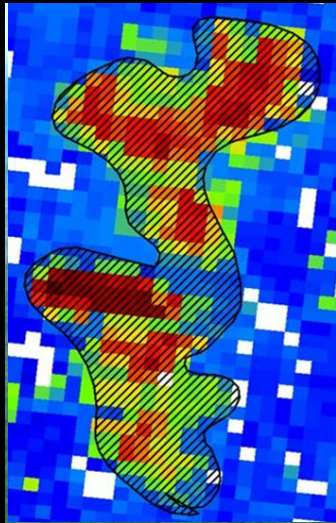
Wildfire events



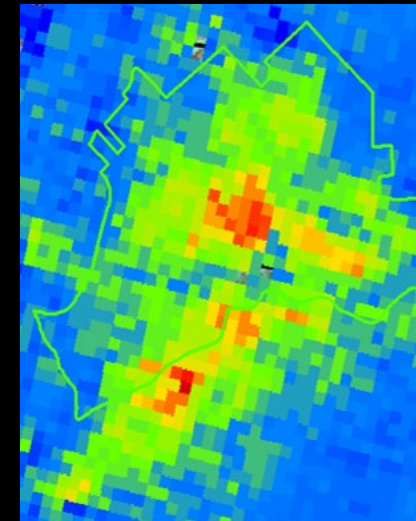
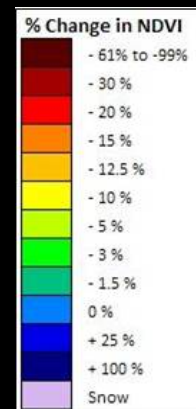
Forest Tent Caterpillar (NC)



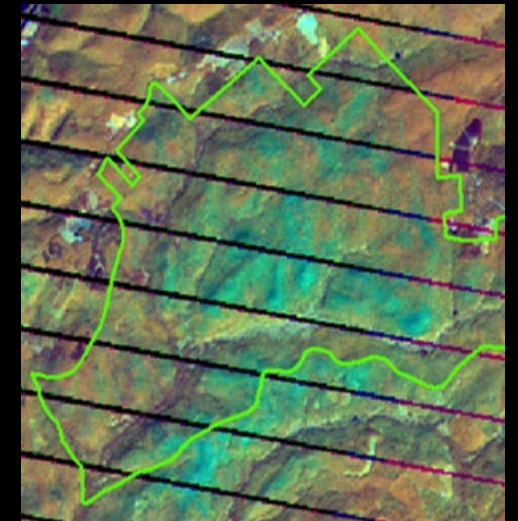
Landsat



Forest Tent Caterpillar (LA/MS)



Fall Webworm (PA)



Landsat



# Examples of forest disturbance, or recovery, seen in the *ForWarn* forest change images

## Natural Disturbance

Severe weather (tornadoes, wind, hail, ice)

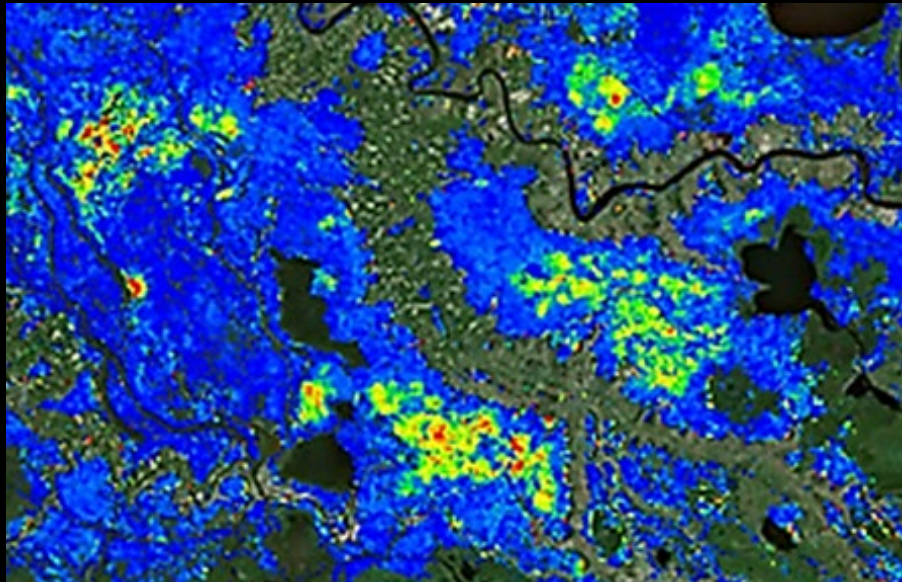
Drought and flood events

**Insects and disease outbreaks**

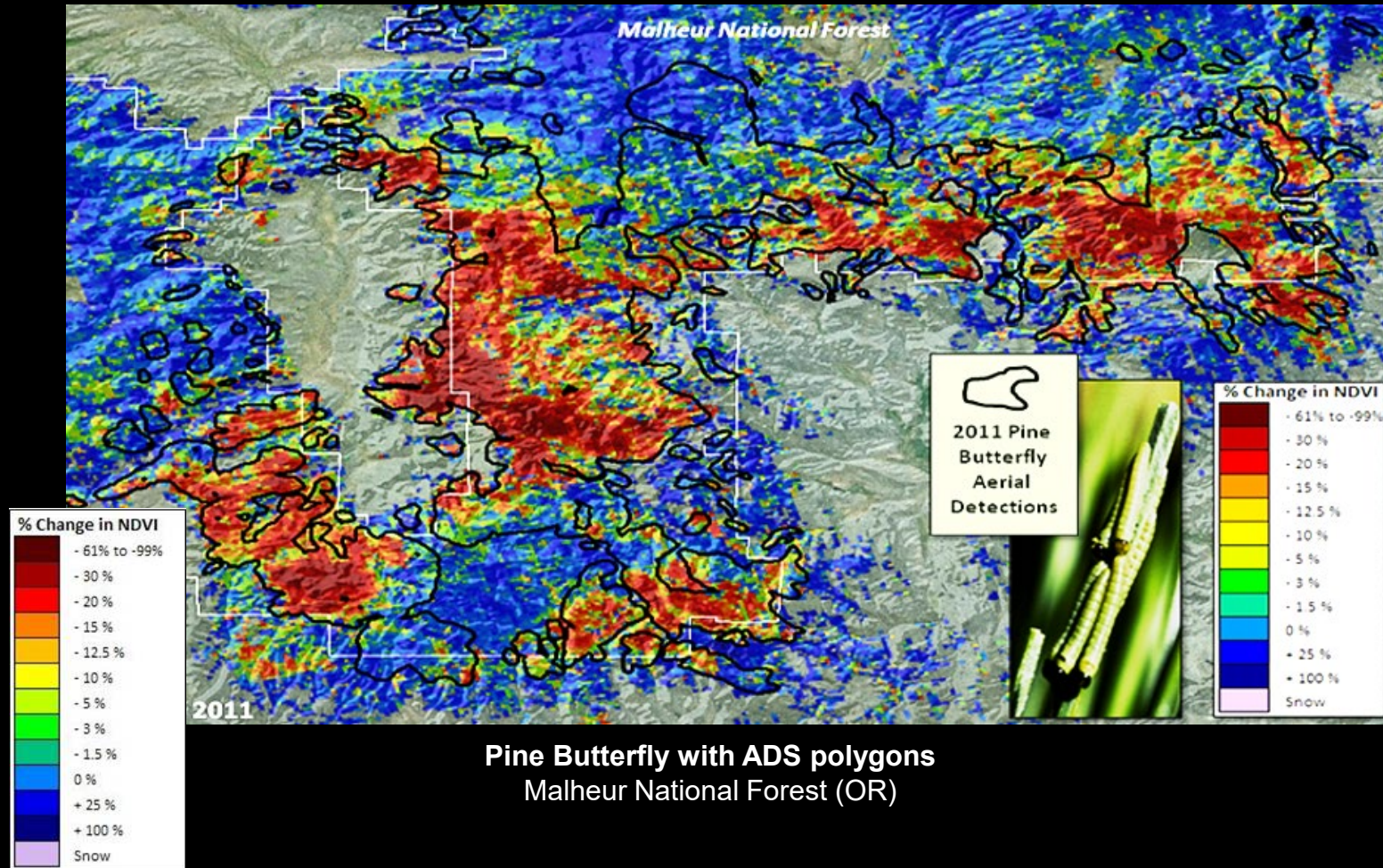
Early/late – spring/fall timing

Snow

Wildfire events



Cypress Leaf roller – Forest Tent Caterpillar (LA)



Pine Butterfly with ADS polygons  
Malheur National Forest (OR)



# Examples of forest disturbance, or recovery, seen in the *ForWarn* forest change images

## Natural Disturbance

Severe weather (tornadoes, wind, hail, ice)

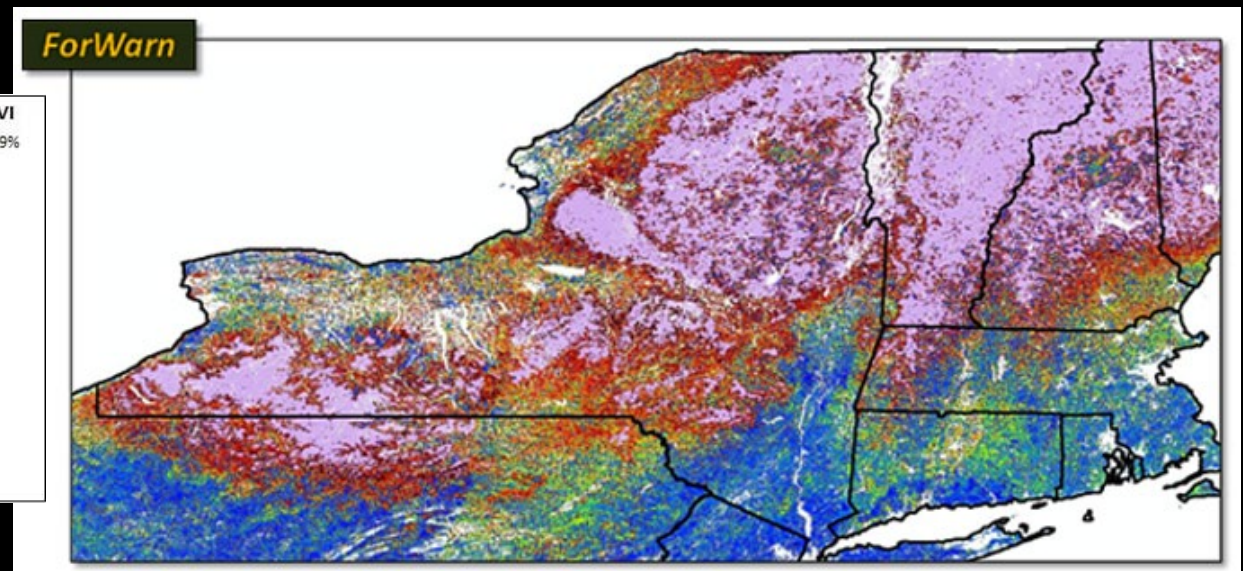
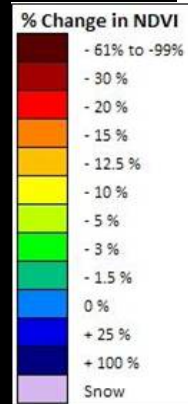
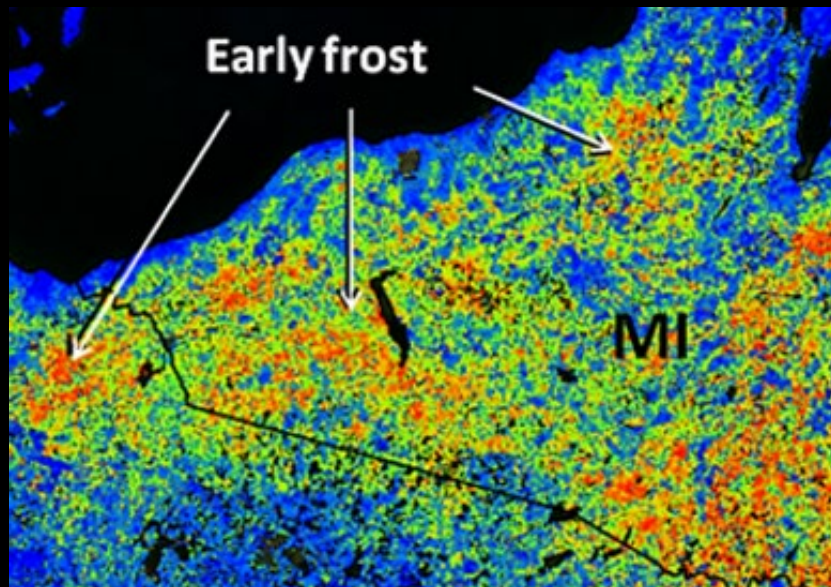
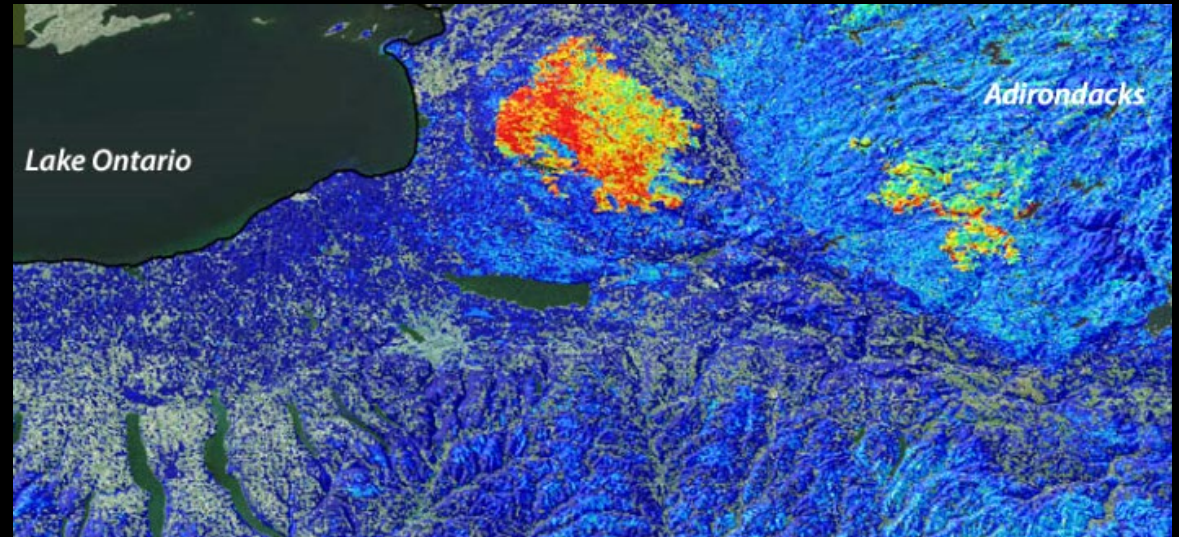
Drought and flood events

Insects and disease outbreaks

**Early/late – spring/fall timing**

**Snow, frost**

Wildfire events





# Examples of forest disturbance, or recovery, seen in the *ForWarn* forest change images

## Natural Disturbance

Severe weather (tornadoes, wind, hail, ice)

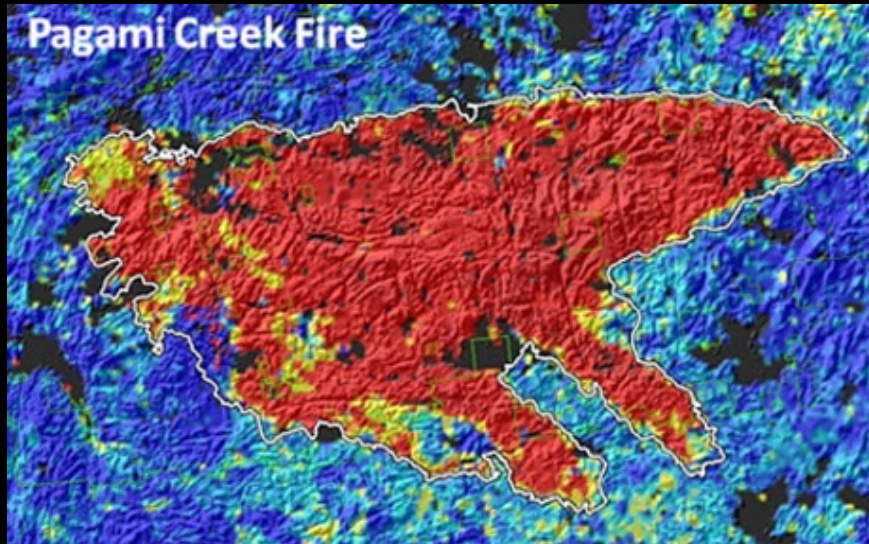
Drought and flood events

Insects and disease outbreaks

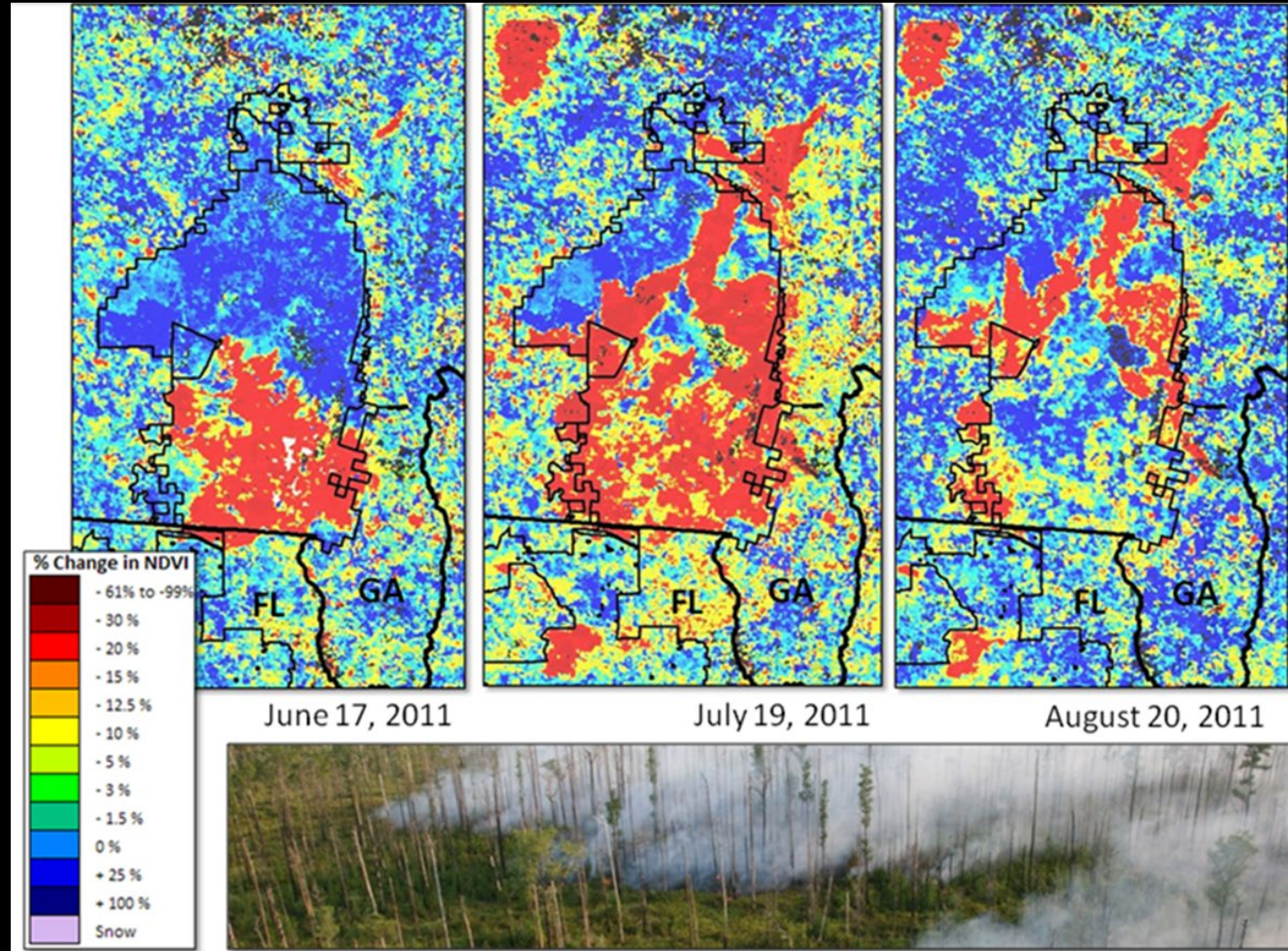
Early/late – spring/fall timing

Snow

## Wildfire events



Okefenokee Swamp (GA)





# Examples of forest disturbance, or recovery, seen in the *ForWarn* forest change images

## Natural Disturbance

Severe weather (tornadoes, wind, hail, ice)

Drought and flood events

Insects and disease outbreaks

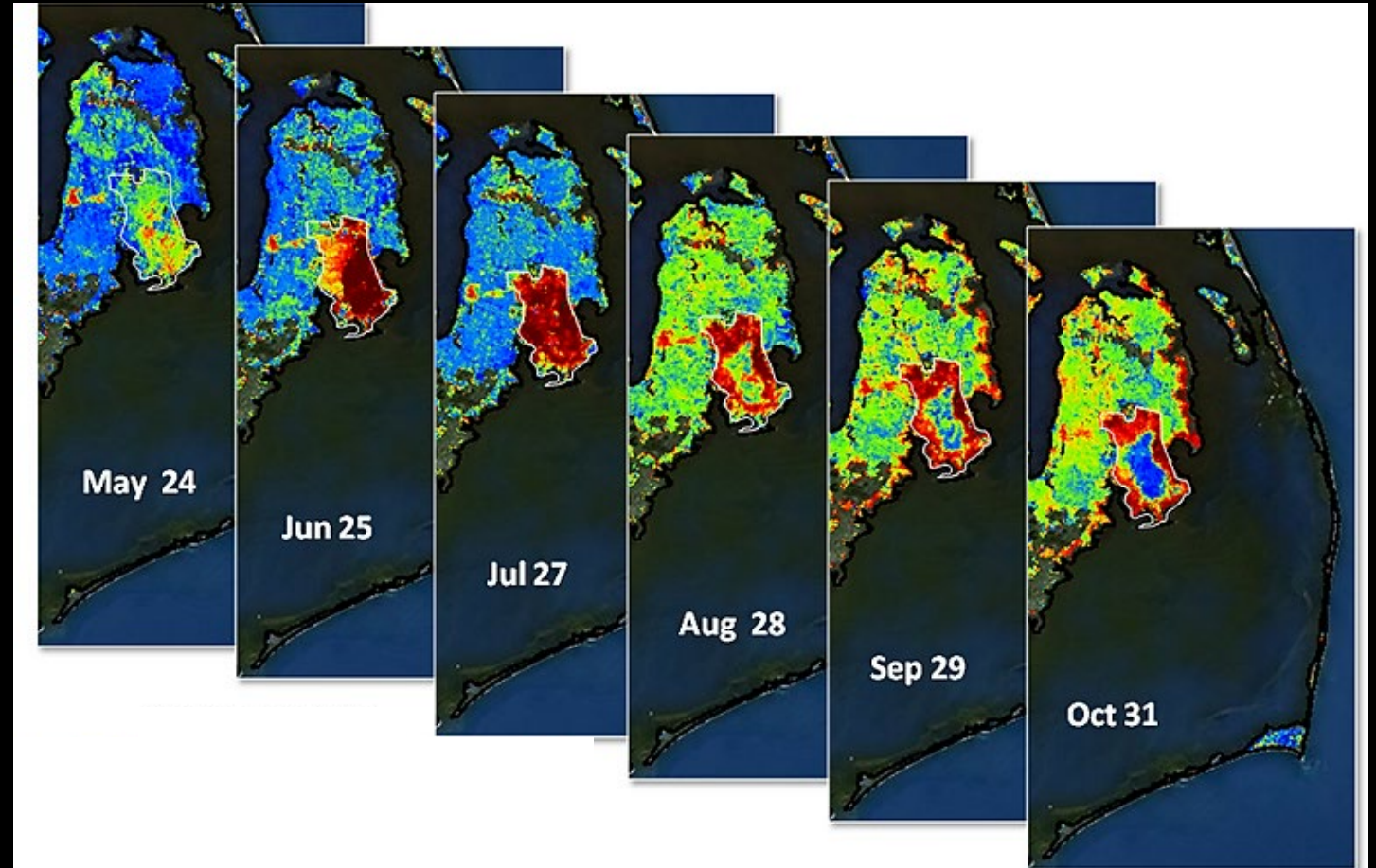
Early/late – spring/fall timing

Snow

### **Wildfire events**

*Forest disturbance events often display degrees of severity. Variation in rates of recovery can relate to vegetative resilience.*

Pains Bay Wildfire (NC)





# Examples of forest disturbance, or recovery, seen in the *ForWarn* forest change images

## Anthropogenic Disturbance

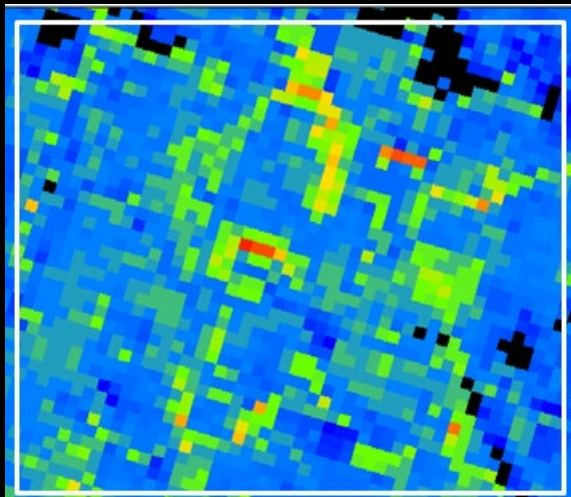
Forest Fragmentation, conversion and urban sprawl

Forest clear cutting, Rx and silvicultural operations

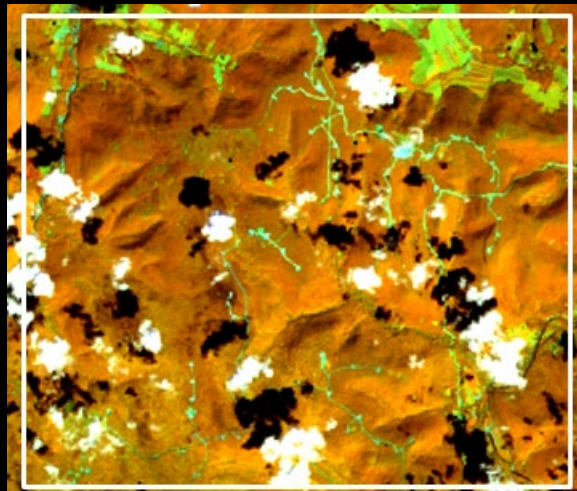
Mining, oil and gas activities

Climate variability

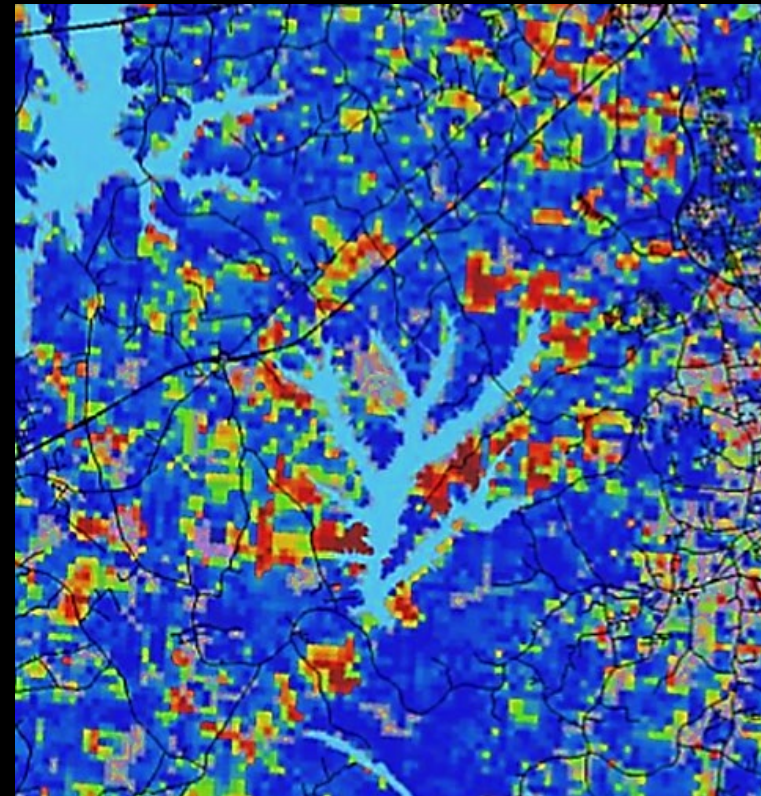
Arson wildfire



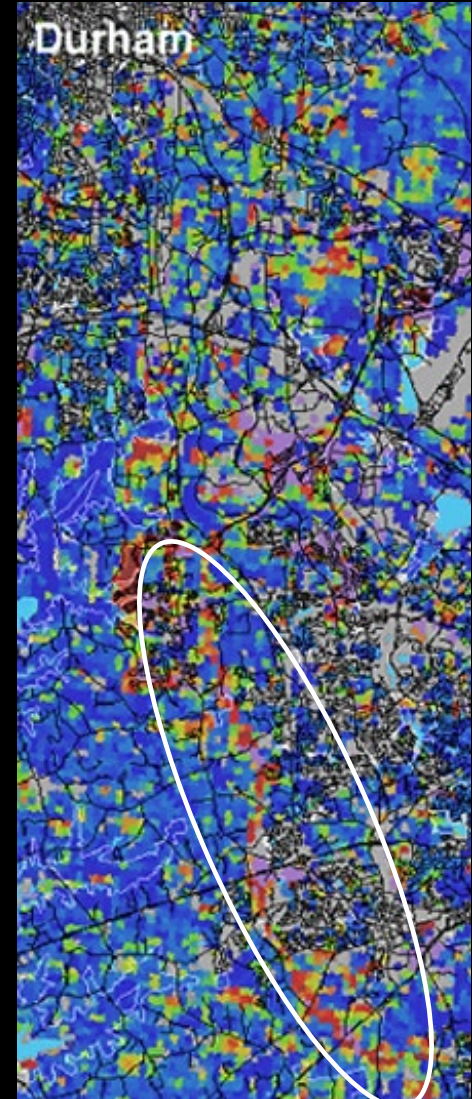
Oil and gas well construction (PA)



Landsat



Forest management (NC)



Road construction (NC)

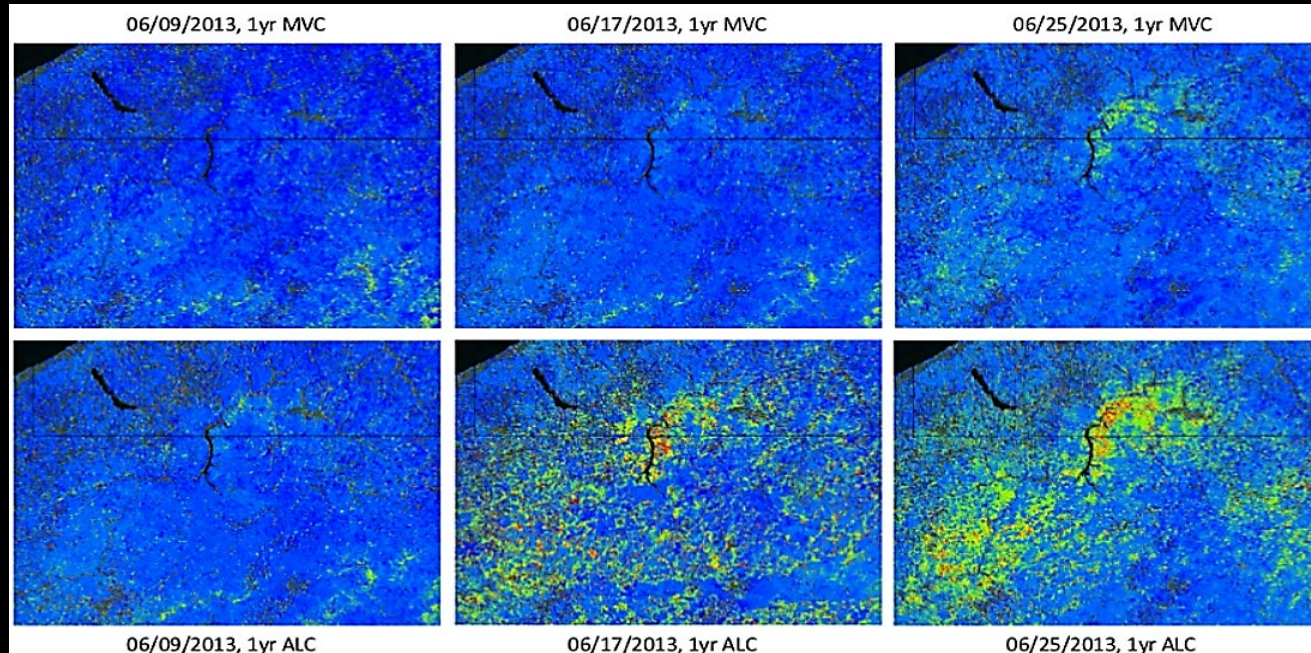


# Application Limitations

## Detection Delay

*24-day detection delay in the 'max-NDVI' standard products, except...*

*ForWarn 1yr Baseline 'Standard' Product vs. 1yr Baseline 'Early Detect' Product*



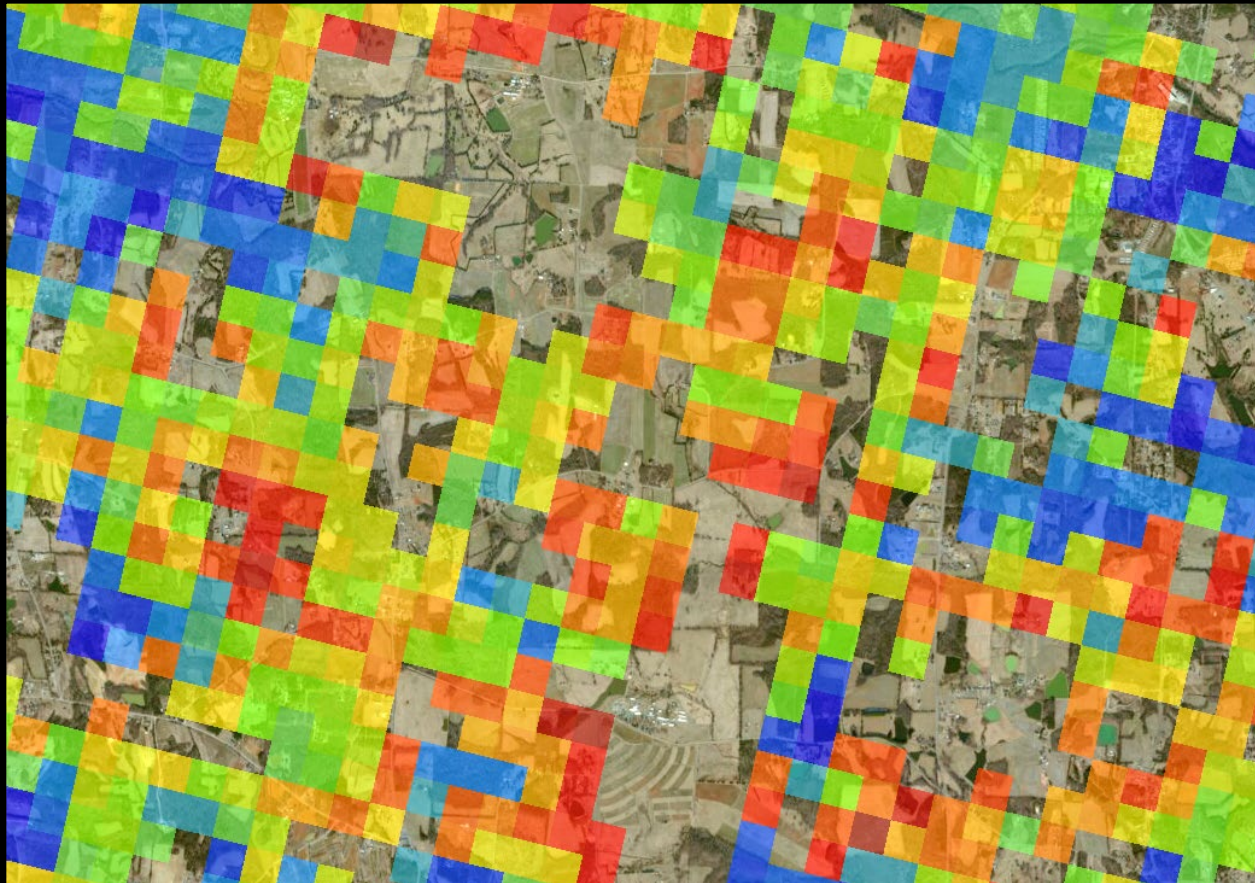
*The 'Early Detect' product dramatically reduces **ForWarn** detection speeds, allowing the detection of disturbances in as few as one 8-day period*



# Application Limitations

## 'Edge-of-the-mask'

*low density, mixed composition forest  
pixels are subject to show drought*



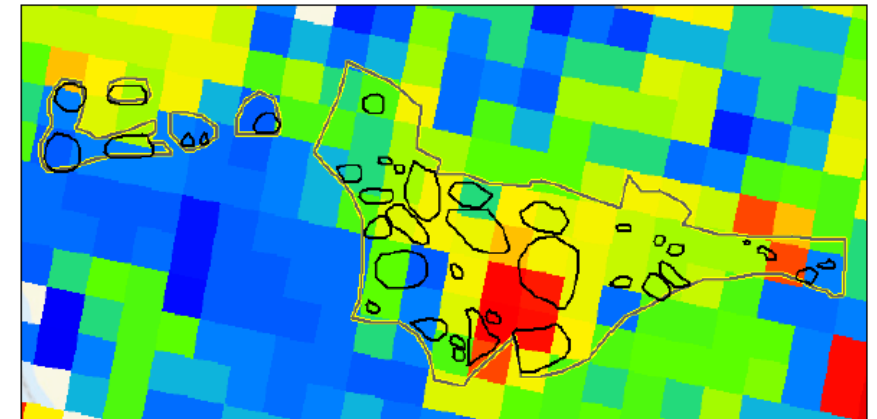
## Spatial Resolution

*SPB / IPS have been difficult to detect*

08/14/2012  
Landsat 453



08/19/2012  
ForWarn 11yr





## ForWarn

Satellite-Based Change Recognition and Tracking

CONTACT US

SEARCH

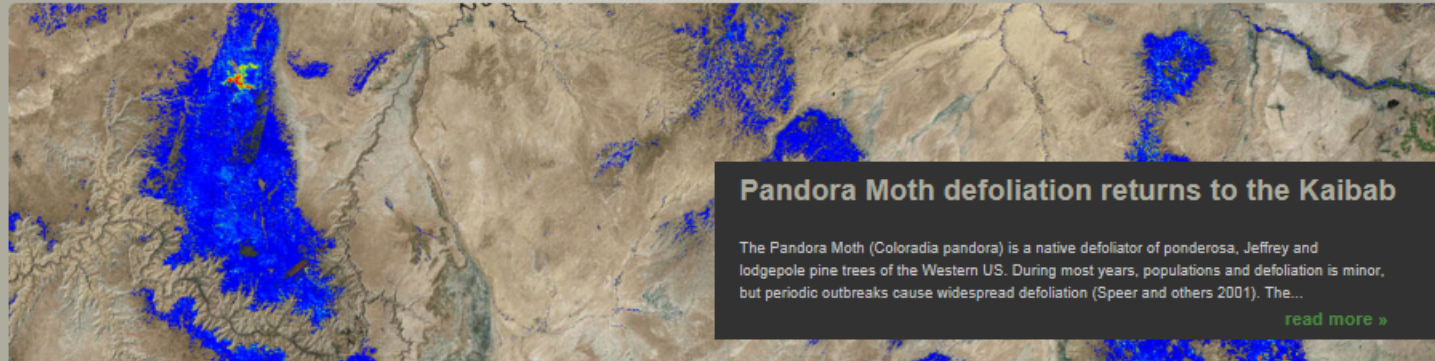
Home

Overview

Highlights

Products

Support



### Pandora Moth defoliation returns to the Kaibab

The Pandora Moth (*Coloradia pandora*) is a native defoliator of ponderosa, Jeffrey and lodgepole pine trees of the Western US. During most years, populations and defoliation is minor, but periodic outbreaks cause widespread defoliation (Speer and others 2001). The...

[read more »](#)

2 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](#)

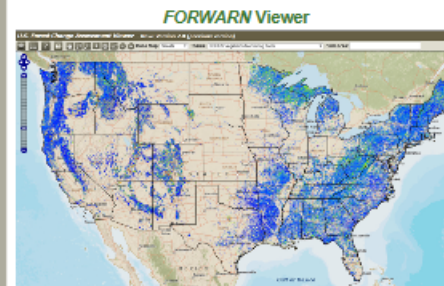
» [Data Access](#)

» [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.



### Recent News

#### [ForWarn featured in NASA Earth Observatory](#)

11/16/2016 - 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 »](#)



# ArcGIS Online – An alternate delivery platform for ForWarn II change imagery



Home Gallery Map Scene Groups Content Organization

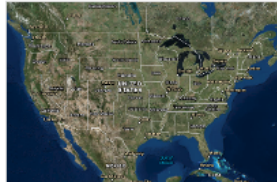


William ▾

forwarn

## Forest Change using MODIS, (3) most recent 8-day periods

Overview



★ Remove from Favorites

Near-real-time percent NDVI change from MODIS, every 8-days, always the (3) most recent 8-day period's NDVI change image using the 1yr NDVI-max baseline, multiple masks by LULC class.

Web Map by [USFSSouthResearchStation](#)

Created: Aug 3, 2018 Updated: Aug 3, 2018 View Count: 47

### Description

Welcome to ForWarn III!

ForWarn II has enhanced sensitivity, now showing even slight disturbances earlier than ever before, and now covers a larger geographic area.

ForWarn II is mostly the same system with which you're already familiar, but now has a totally new production system that offers some exciting new capabilities, including some new products designed for specialized purposes. For example, disturbances within grasses, shrubs and other shallow-rooted vegetation can sometimes dominate the disturbance signal seen in ForWarn maps, particularly in the Western United States. Almost every ForWarn II disturbance map now has a "Muted Grass/Shrub" companion product that concentrates on the disturbance responses of trees, reserving more of the dynamic range in the maps for showing forest impacts.

Most new ForWarn II products are already available for the entire MODIS period starting in 2003 to present. Most of the data viewer features, like the Share-This-Map, the NDVI graphing tool, and the PestProximity tools, will still work just as always. Documentation is still being developed, so please pardon our virtual dust as we continue to carry these improvements throughout the entire Forest Change Assessment Viewer 2 and the ForWarn II website. Enjoy the new features, and we welcome your feedback!

For more information about ForWarn II - <https://forwarn.forestthreats.org/>

Open in Map Viewer

Open in ArcGIS Desktop

Create Web App ▾

Share

### Details

Size: 8 KB



Owner

Change Owner



USFSSouthResearchStation

### Categories

Weather and Climate

Forest Management

Fire and Aviation

Ecosystems

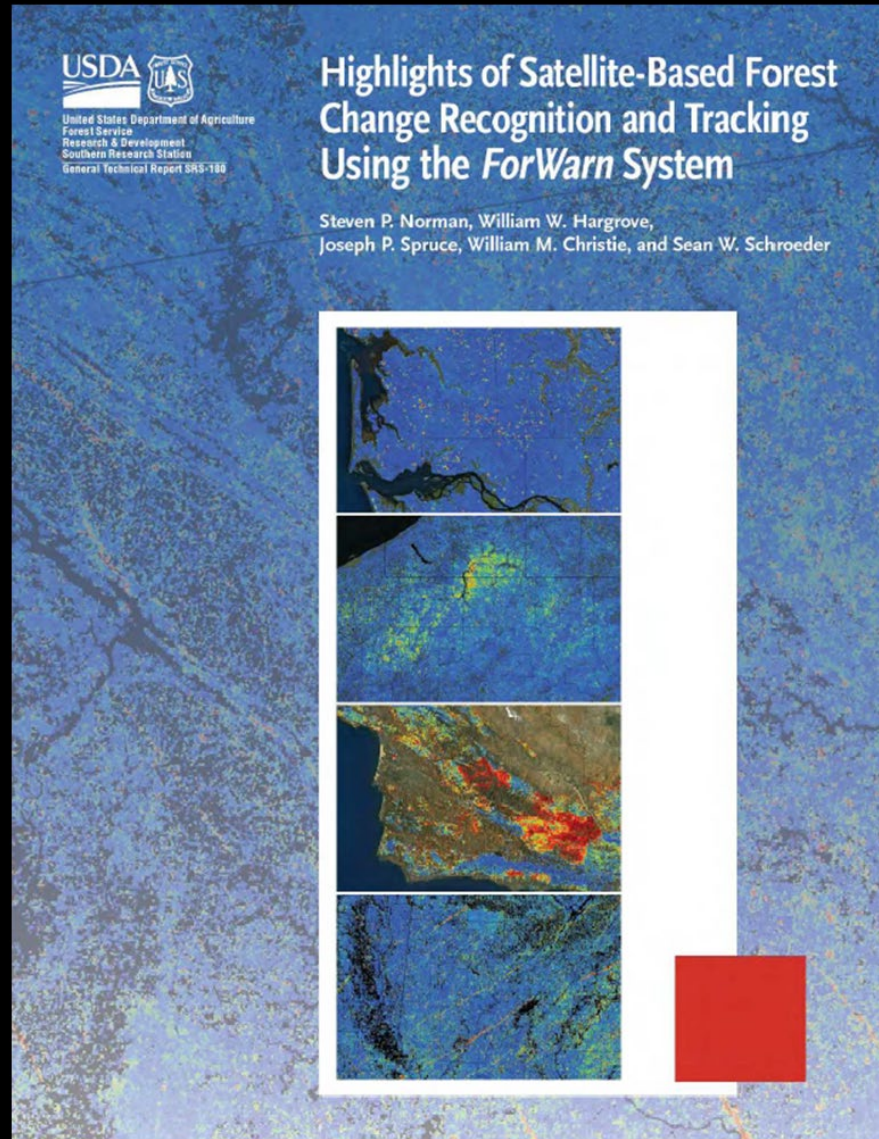
Vegetation

### Tags

Requires an ESRI ArcGIS Online account



# ForWarn General Technical Report





**U.S. FOREST SERVICE**  
Caring for the land and serving people  
United States Department of Agriculture

**Southern  
Research Station**

Sarah Farmer, Multimedia Information Specialist

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SRS Publications Highlights of satellite-based forest change recognition and tracking using the ForWarn Sys...

### Highlights of satellite-based forest change recognition and tracking using the ForWarn System

**Author(s):** Norman, Steven P.; Hargrove, William W.; Spruce, Joseph P.; Christie, William M.; Schroeder, Sean W.

**Date:** 2013

**Source:** Gen. Tech. Rep. SRS-GTR-180. Asheville, NC: USDA-Forest Service, Southern Research Station. 30 p.

**Station ID:** GTR-SRS-180

**Abstract**

For a higher resolution version of this file, please use the following link:  
[www.geobabble.org](http://www.geobabble.org)

Satellite-based remote sensing can assist forest managers with their need to recognize disturbances and track recovery. Despite the long standing availability of raw imagery, the systematic delivery of spatially continuous, ready-to-use, processed products has evaded us until recently. The web-based ForWarn system moves us a step forward by generating forest change maps at high frequency in a format that is usable to forest managers, planners, and the public. The ForWarn system shows change in the Normalized Difference Vegetation Index derived from moderate resolution imagery according to a range of baseline normals. Expectations of normal derive from previously observed changes in seasonal leaf phenology; this adjustment is critical for forests dominated by deciduous vegetation that vary in greenness through the year. After these seasonal adjustments are made behind the scene, the remaining forest change that ForWarn users see may result from an array of climatic and disturbance causes. These include insects and disease, wildland fire, wind, hail, human development, drought, or variation in the timing of spring and fall. This publication outlines the data and methods that underlie this technology, and provides examples that illustrate selected capabilities of this system for coarse-scale forest monitoring.

**Citation:** Norman, Steven P.; Hargrove, William W.; Spruce, Joseph P.; Christie, William M.; Schroeder, Sean W. 2013. Highlights of satellite-based forest change recognition and tracking using the ForWarn System. Gen. Tech. Rep. SRS-GTR-180. Asheville, NC: USDA-Forest Service, Southern Research Station. 30 p.

Download (PDF; 7.73 MB)

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[http://www.srs.fs.fed.us/pubs/gtr/gtr\\_srs180.pdf](http://www.srs.fs.fed.us/pubs/gtr/gtr_srs180.pdf)



*"Praemonitus Praemunitus"*

# ***ForWarn II***

*Satellite-Based Change Recognition and Tracking*

**EASTERN THREAT CENTER:** <https://forestthreats.org/>

***ForWarn Website:*** <https://forwarn.forestthreats.org>

**Forest Change Assessment Viewer:** <https://forwarn.forestthreats.org/fcav2>

**Bill Christie, GIS / RS Analyst:** [william.m.christie@usda.org](mailto:william.m.christie@usda.org)



*"Praemonitus Praemunitus"*

## **ForWarn II**

*Satellite-Based Change Recognition and Tracking*

- New Products every 8-days
- Landscape-scale analyses (231m)
  - Hurricane Damage
  - Wildfire
  - Drought affects
  - Regional Phenological Departure
  - Western Pine Beetle Mapping
  - Eastern Gypsy Moth, Forest Tent Caterpillar and Cypress Leaf Roller
- [ForWarn.forestthreats.org](http://ForWarn.forestthreats.org)



- Cloud-based processing using Google Earth Engine and Sentinel-2 satellite imagery
- Tree Canopy Resolution (10m)
  - Forest Disturbance (view topographic effects)
  - SPB/Ips resolution
  - Patchy fire effects
  - Informal R8 Workshop Fall 2019
- [HiForm.org](http://HiForm.org)