Monitoring Regional Forest Disturbances across the US with Near Real Time MODIS NDVI Products included in the ForWarn Forest Threat Early Warning System

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Introduction

- U.S. forests occupy ~1/3 of total land area (~304 million ha)
- Since 2000, a growing number of regionally evident forest disturbances have occurred due to abiotic and biotic agents
- Regional forest disturbances can threaten human life and property, bio-diversity and water supplies
- Timely regional forest disturbance monitoring products are needed to aid forest health management work
- Near Real Time (NRT) twice daily MODIS NDVI data provide a means to monitor U.S. regional forest disturbances every 8 days
- Since 2010, these NRT forest change products have been produced and posted on the US Forest Service ForWarn Early Warning System for Forest Threats

U.S. ForWarn System for Regional Forest Disturbance Monitoring

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http://forwarn.forestthreats.org

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ForWarn

Satellite-Based Change Recognition and Tracking

USGS OAK RIDGE National Laboratory

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Monitoring Gypsy Moth defoliation in near real time

By late 2012, forest health monitors in western New York and Pennsylvania knew that they were about to experience a severe outbreak of the non-native Gypsy Moth. Surveys showed an unusually high density of egg masses on the branches and trunks of...

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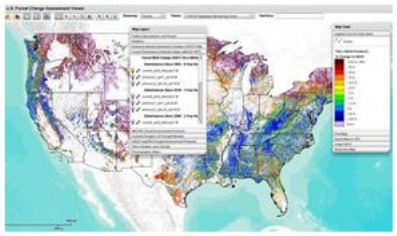
What is ForWarn?

ForWarn is a satellite-based forest disturbance monitoring system for the conterminous United States. It delivers new forest change products every eight days and provides tools for attributing abnormalities to insects, disease, wildfire, storms, human development or unusual weather. Archived data provide disturbance tracking across all lands since 2000. Interactive maps are accessible via the Forest Change Assessment Viewer. Read more about ForWarn here.



Recent News

ForWarn highlights report published

09/06/2013 - 07:59 A Forest Service General Technical Report highlighting detections made by the ForWarn system is available online. See here...

GTR_SRS180LARGE.PDF

ForWarn awarded NASA Group Achievement Award

07/08/2013 - 08:01 The ForWarn development team was awarded the *NASA Group Achievement Award* in recognition for creating the first near real-time forest threat early warning system...

more news »

Background on ForWarn

- ForWarn is an on-line geospatial data analysis tool for detecting and tracking regionally evident forest disturbances in the U.S.
- Collaboration of USFS, NASA, ORNL, and the USGS
- Developed per mandate of the 2003 Healthy Forest Restoration Act
- Uses 250m MODIS satellite NDVI data products to compare current vegetation canopy greenness to a given historical baseline
- Provides a suite of nationwide NRT forest change products, refreshed every 8 days

U.S Forest Change Assessment Viewer (FCAV) Resident to ForWarn

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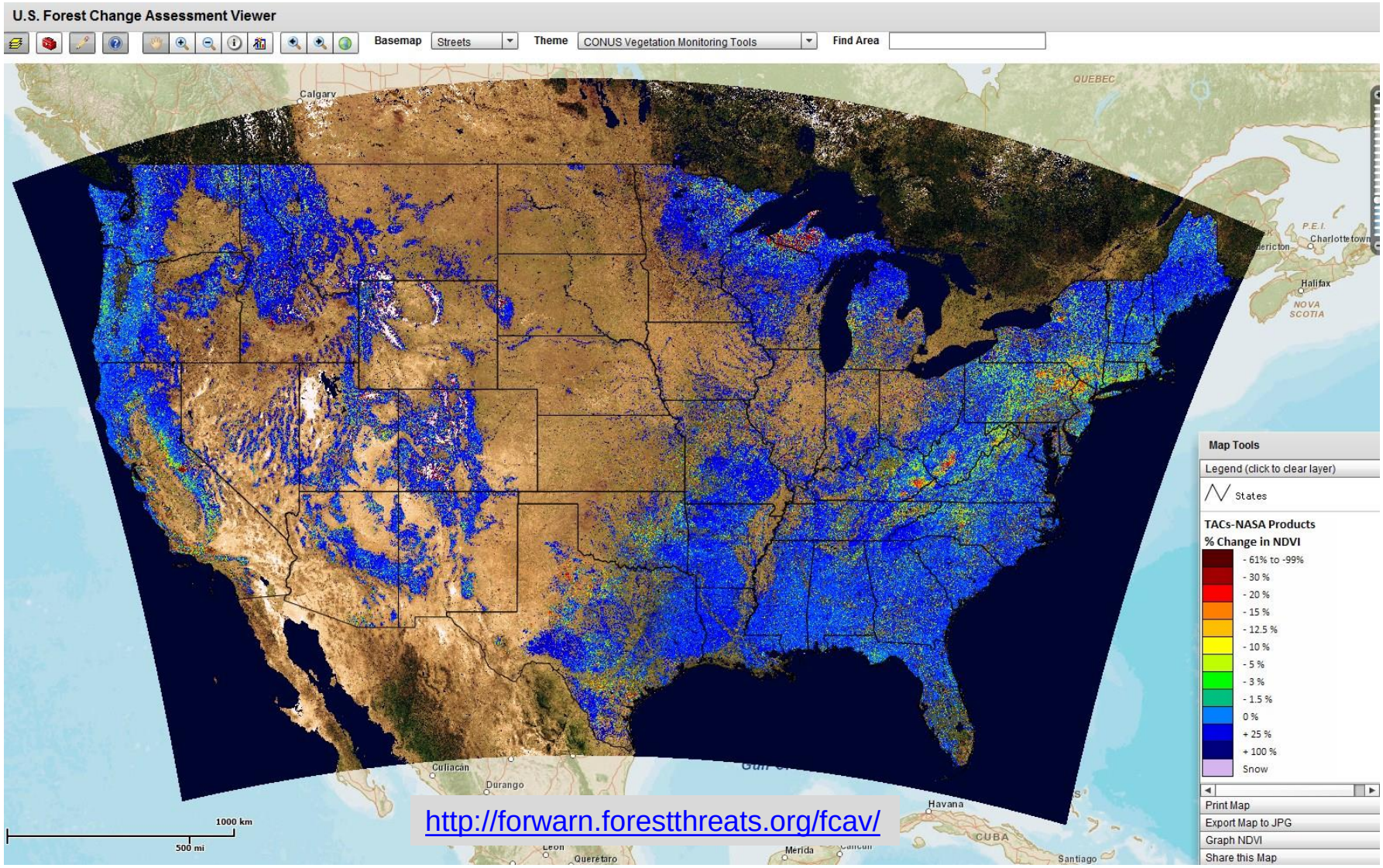
2013 Forest % NDVI Change versus Previous Year for October 24 - November 16



Process for Computing ForWarn's MODIS NDVI Change Products

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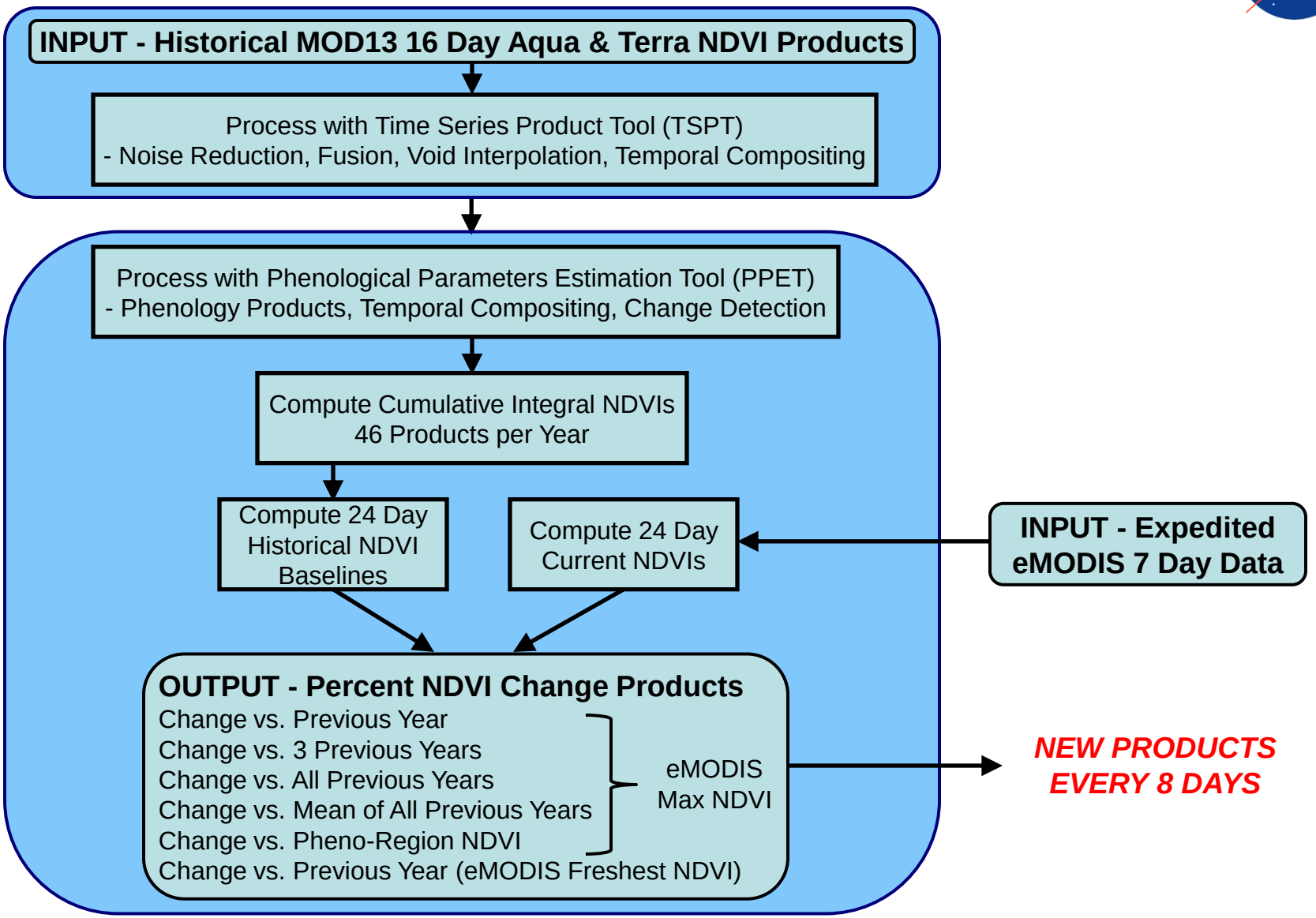

Complexities in Monitoring Regional Forest Disturbances

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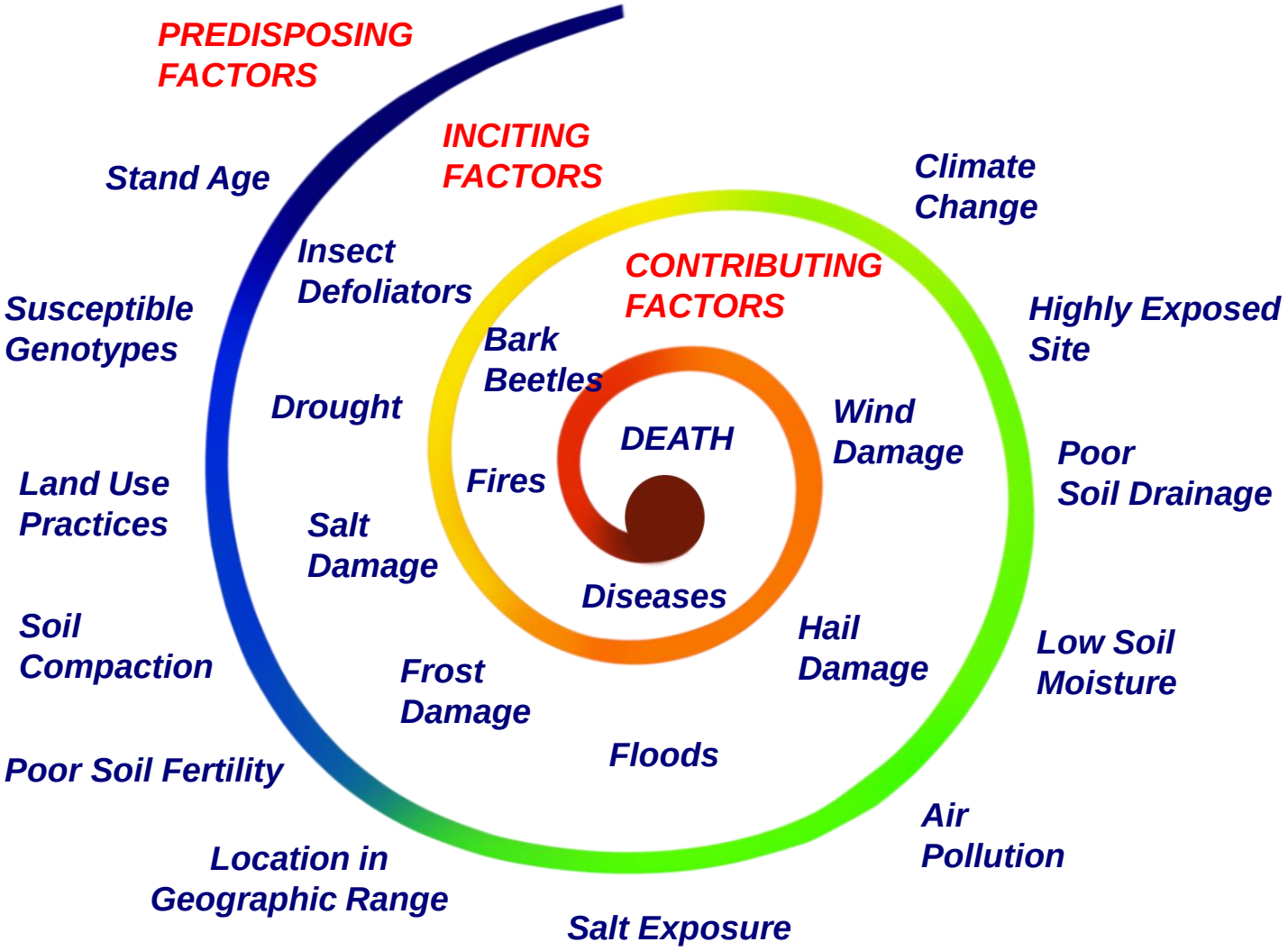
Graphic below based on Manion (1981) Forest Decline Spiral Model



Series 1 – Examples of ForWarn NDVI Change Products with Regional Abiotic Forest Disturbances

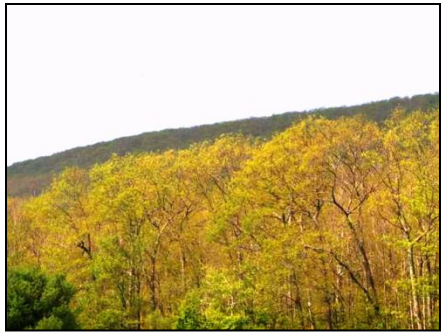
2013 Drought in Sierra Foothills, California

Source: USFS

2013 Rim Fire in Sierra Nevada Mountains, CA

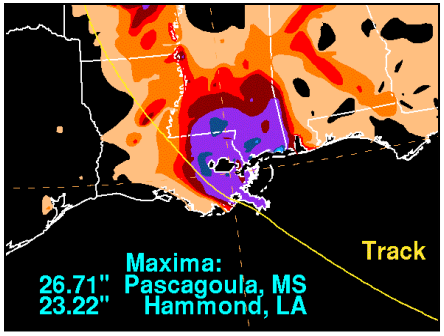
Source: USFS

2013 Hail Storm at CT, MA, and NY State Border



Source: USFS

2012 Hurricane Isaac in Southeastern Louisiana



Source: NOAA

Drought Impacts in California's Sierra Foothills

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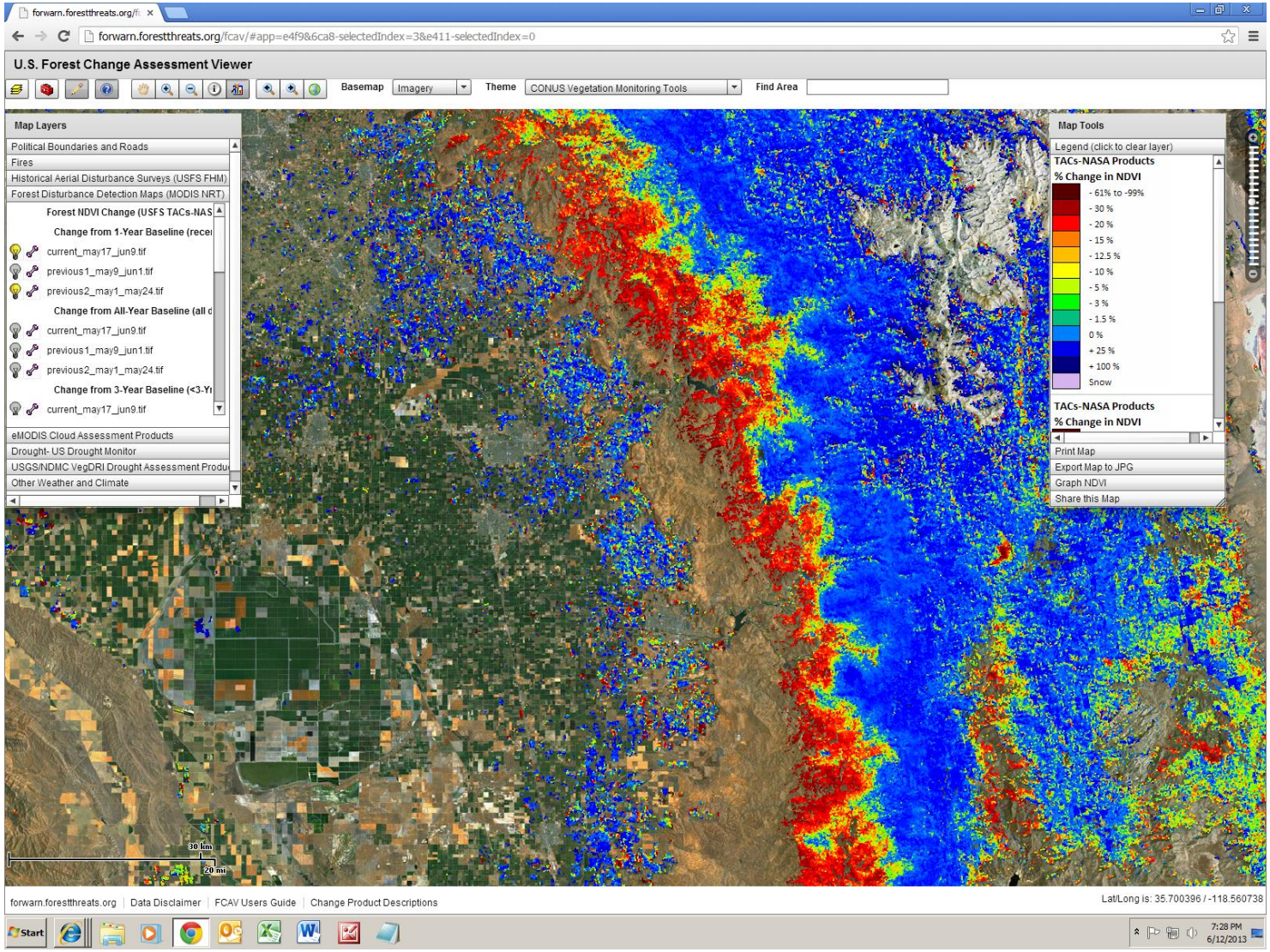
ForWarn products (e.g., for date ending 6/9/2013) showed drought impacts before the Rim Fire



Impacts from Rim Fire in California's Sierra Nevada Mountains

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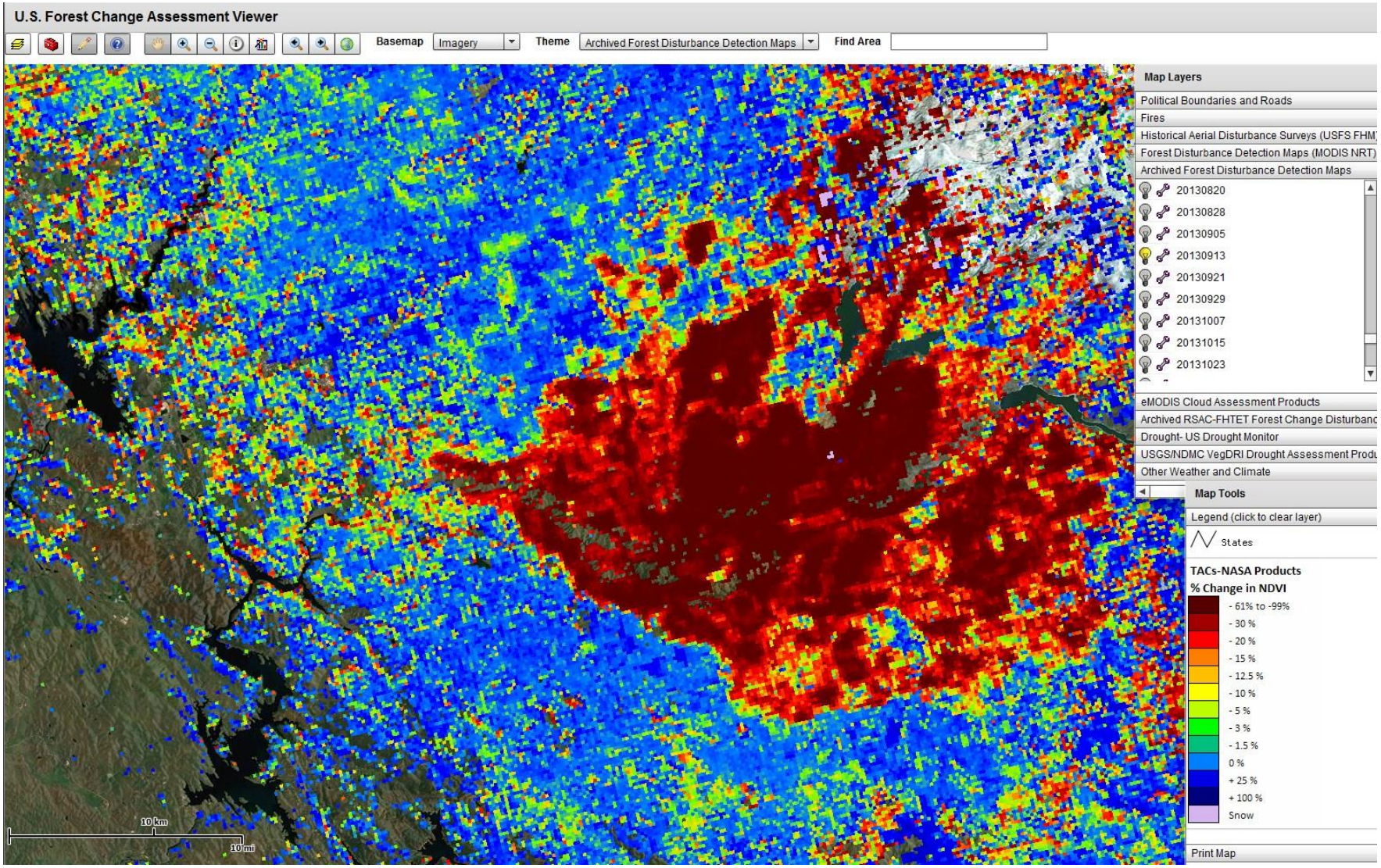
A ForWarn product for date ending 9/13/2013 gave the first available look at the fire scar



Hail Storm Impacts to Area in Southern New England

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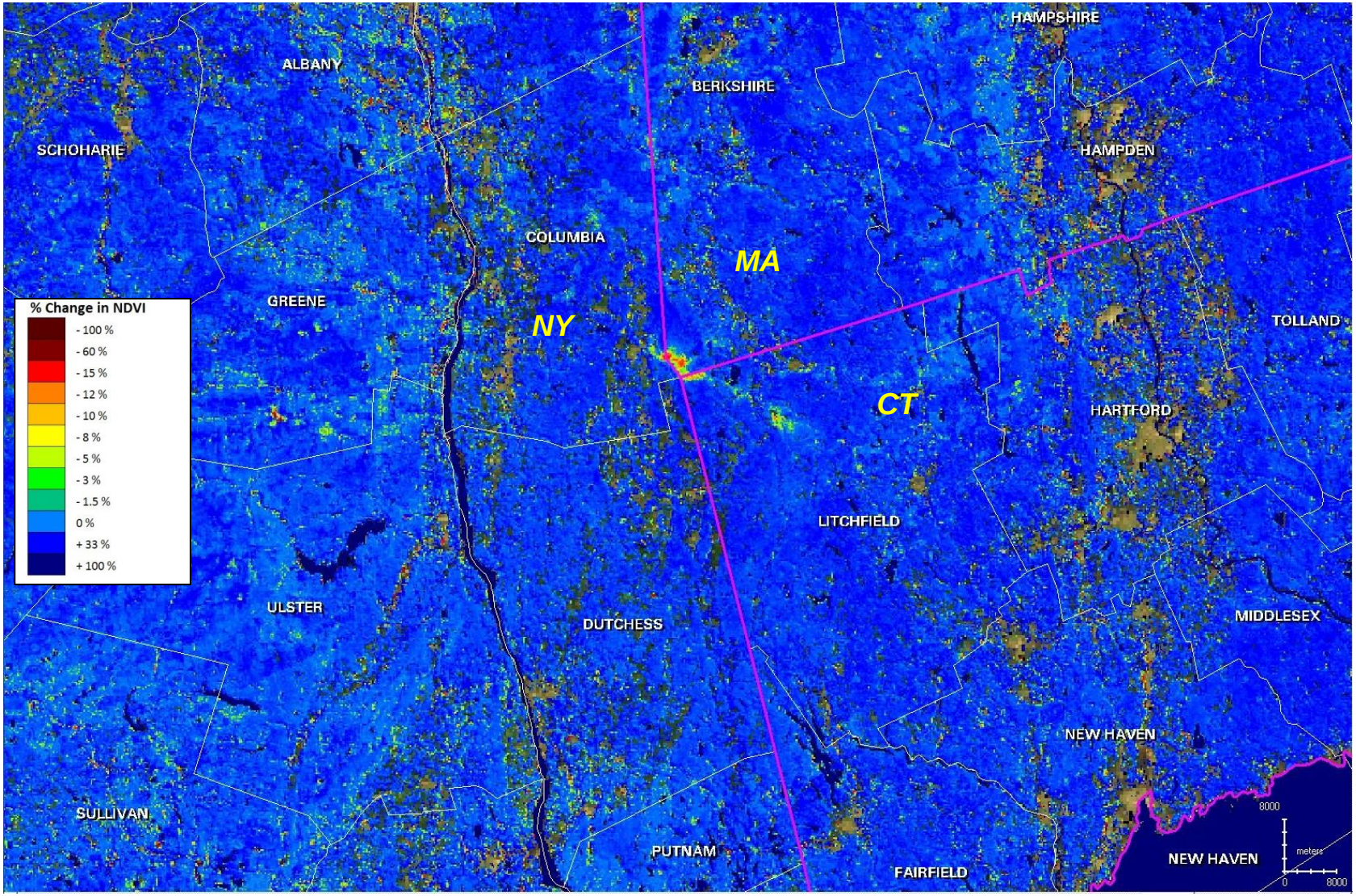
A ForWarn product for date ending 6/8/2013 gave first indication of hail damage (field checked)



MODIS Views of 2012 Hurricane Isaac's Impact on Coastal Louisiana

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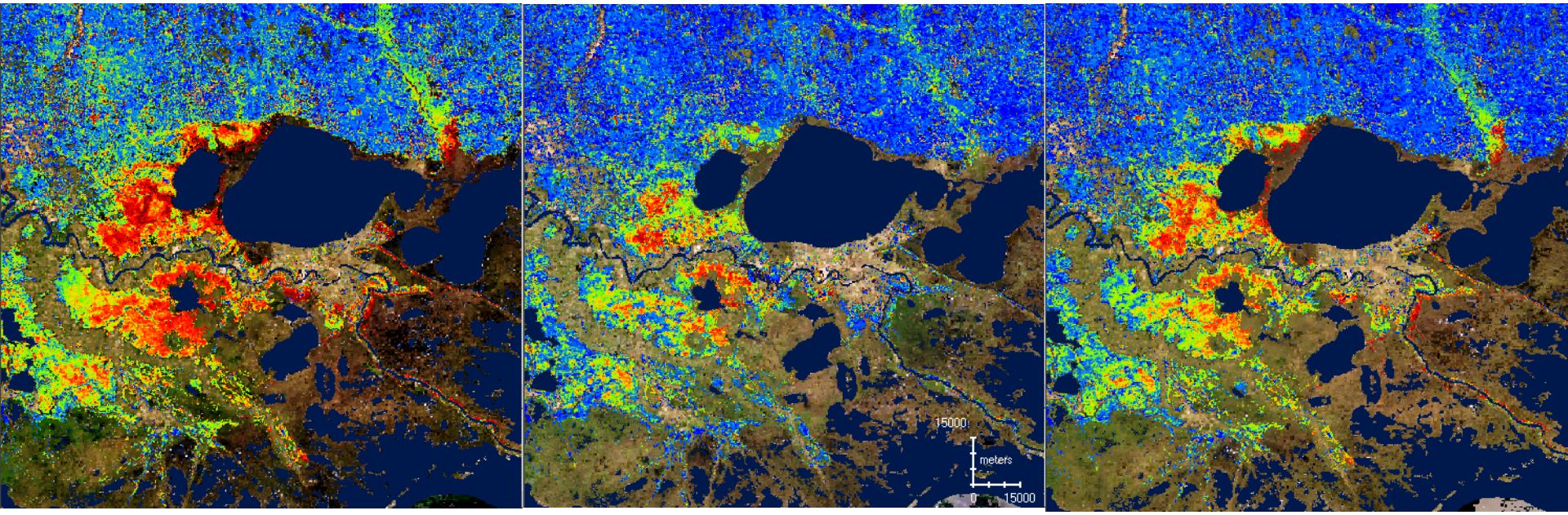
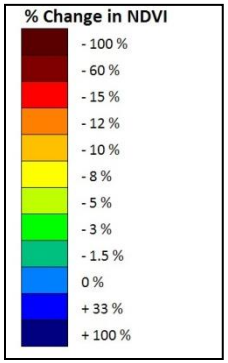
Forest Change 2012 versus 2011
ALC NDVI Method for 8/20 – 9/12/12

Forest Change 2012 versus 2011
Max NDVI Method for 8/20 - 9/12/12

Forest Change 2012 versus 2011
Max NDVI Method for 8/28 – 9/20/12





Hurricane Isaac hit Louisiana on August 28-29, 2012

ALC = Adaptive Length Compositing. It's use enables a fresher NDVI than the Max NDVI.
The ALC NDVI product showed more NDVI drops than the Max NDVI product for 9/12/12
The NDVI drops on the ALC map are related to the improved product freshness
The Max NVDI product for 9/20/12 showed more defoliation than the one for 9/12/12
The ALC 9/12/12 detects disturbance 8 days earlier than the Max NDVI result for 9/20/12

Series 2 – Examples of ForWarn MODIS Change Products Showing Regionally Evident Biotic Forest Disturbances

2013 Swamp Forest Defoliation in Coastal LA from 2 Caterpillar Species

Source: LSU

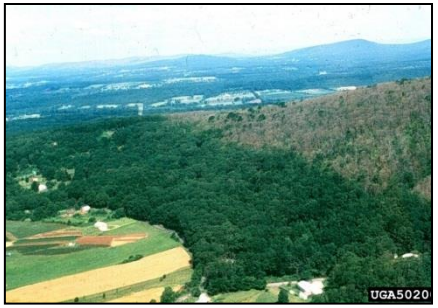
Recent Spruce Beetle Mortality in Southern Colorado

Source: CSU

2013 Pine Forest Defoliation in AZ due to Pandora Moths

Source: USFS

2013 Hardwood Forest Defoliation in NY and PA from Gypsy Moths



Source: PA DCNR

2013 Swamp Forest Defoliation in Southeastern Louisiana

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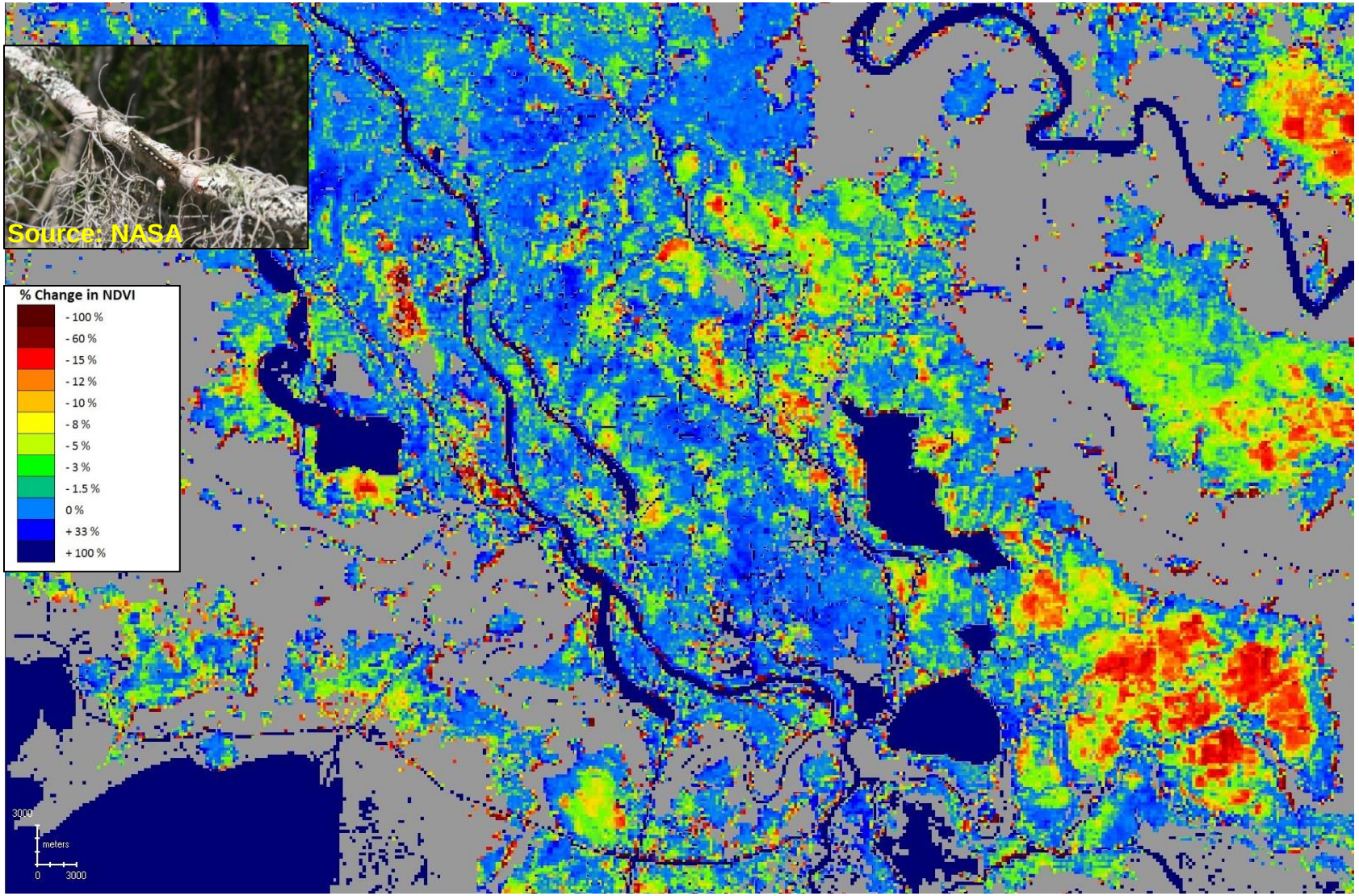
A ForWarn product for 4/22/2013 gave earliest detection of an annual defoliation event



2010 Spruce Beetle Mortality in Southern Colorado

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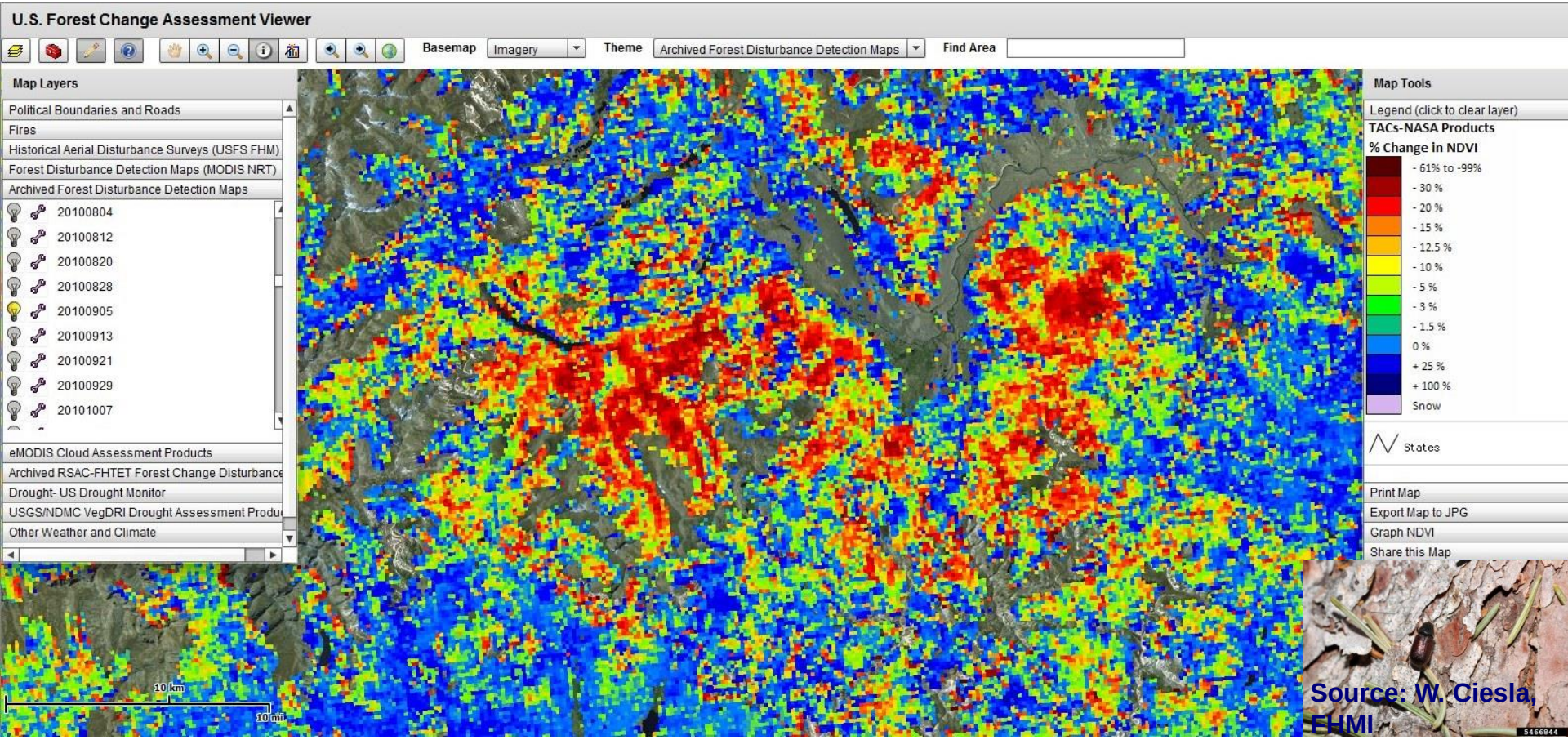
Hot spots on this 3 year change product for 9/5/2010 depict mostly spruce beetle damage



2010 Spruce Beetle Mortality in Southern Colorado – Aerial Surveys

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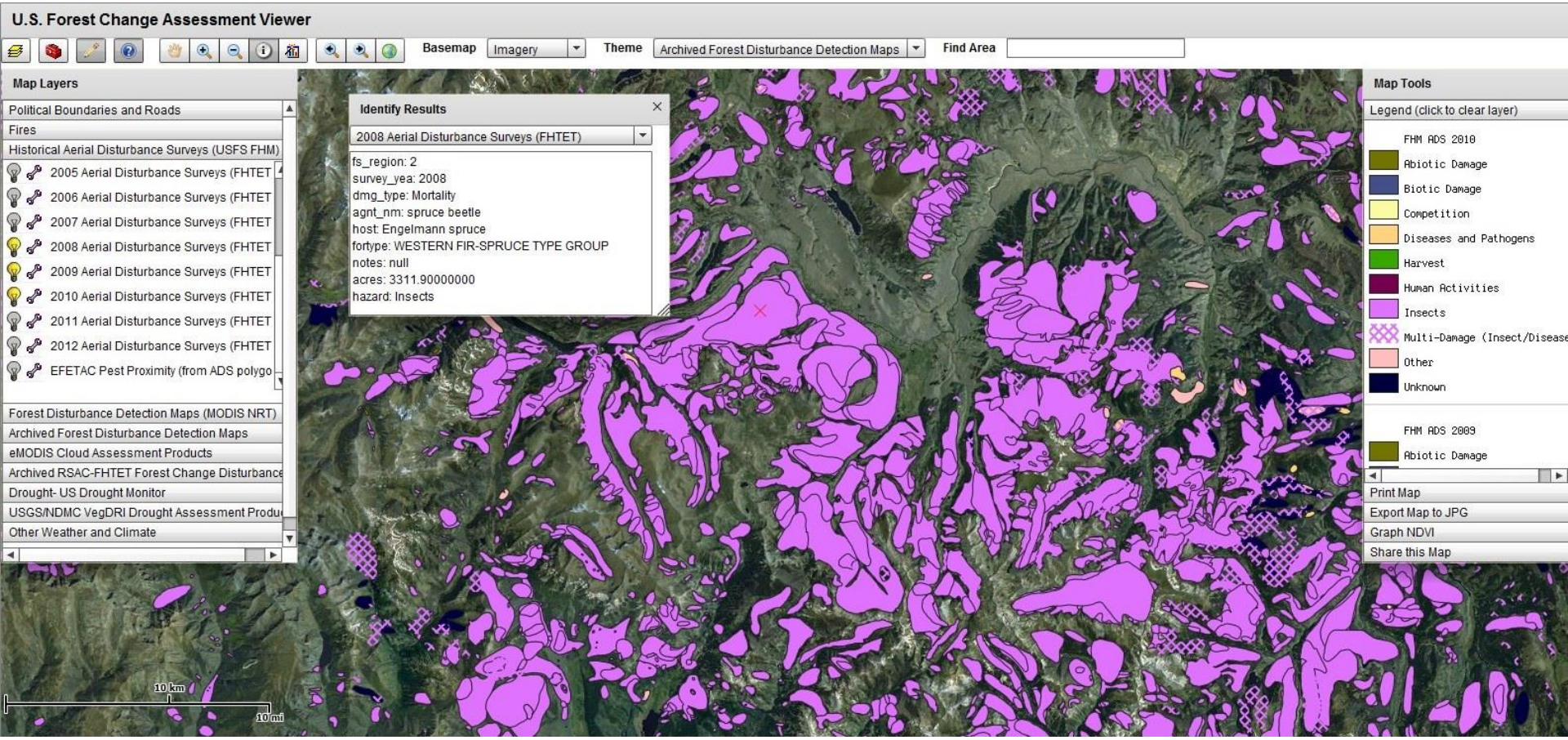
Aerial disturbance surveys for 2008-2010 also show extensive spruce beetle damage



2010 Spruce Beetle Mortality Area – Landfire Land Cover Map

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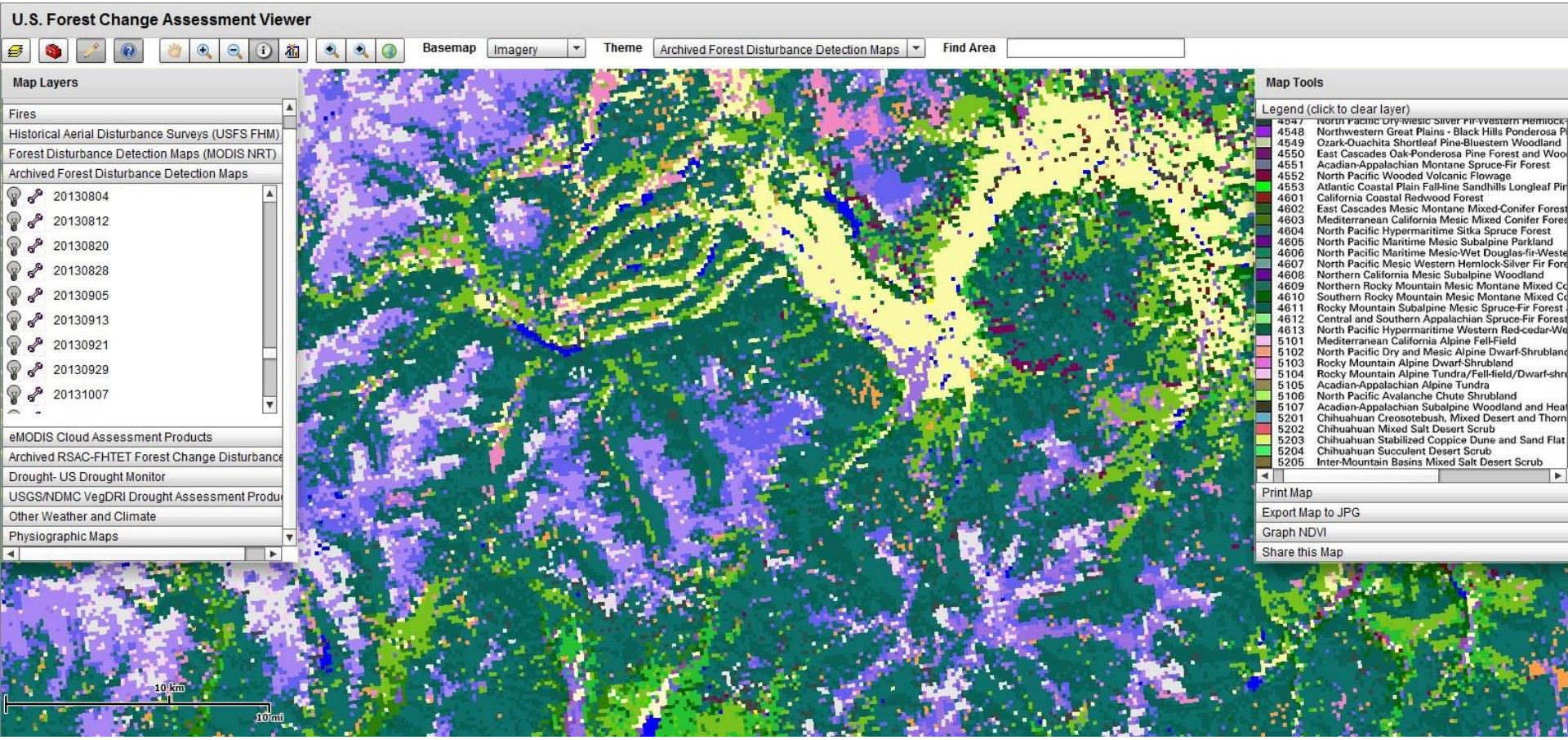
Most of the disturbance in the observed area is occurring in spruce-fir forests (teal green tones)



2013 Spruce Beetle Mortality and Fire Damage in Southern Colorado

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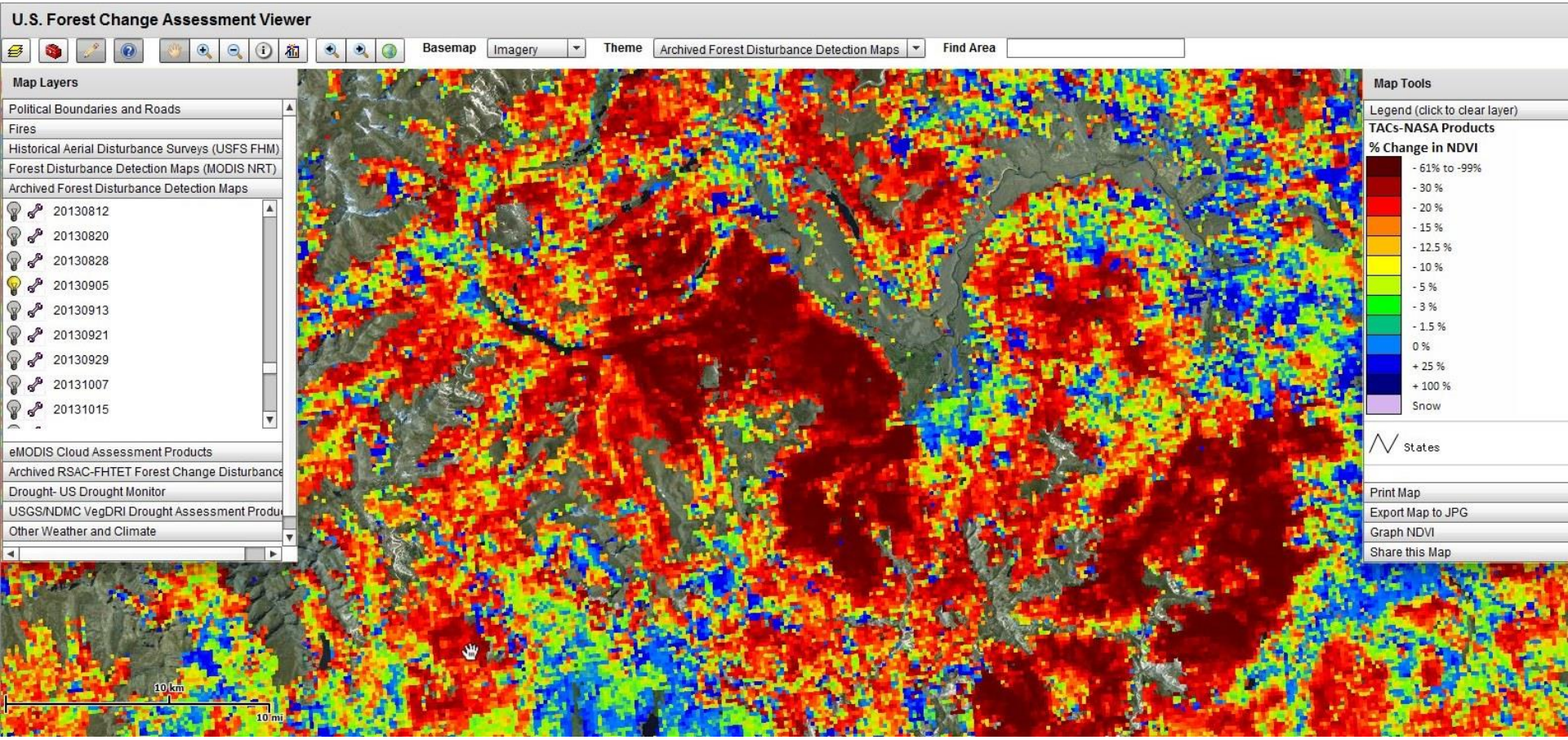
Hot spots on this all previous years change product for 9/5/2013 show spruce beetle and fire damage



Burn Perimeter of 2013 West Fork Fire Complex in Southern Colorado

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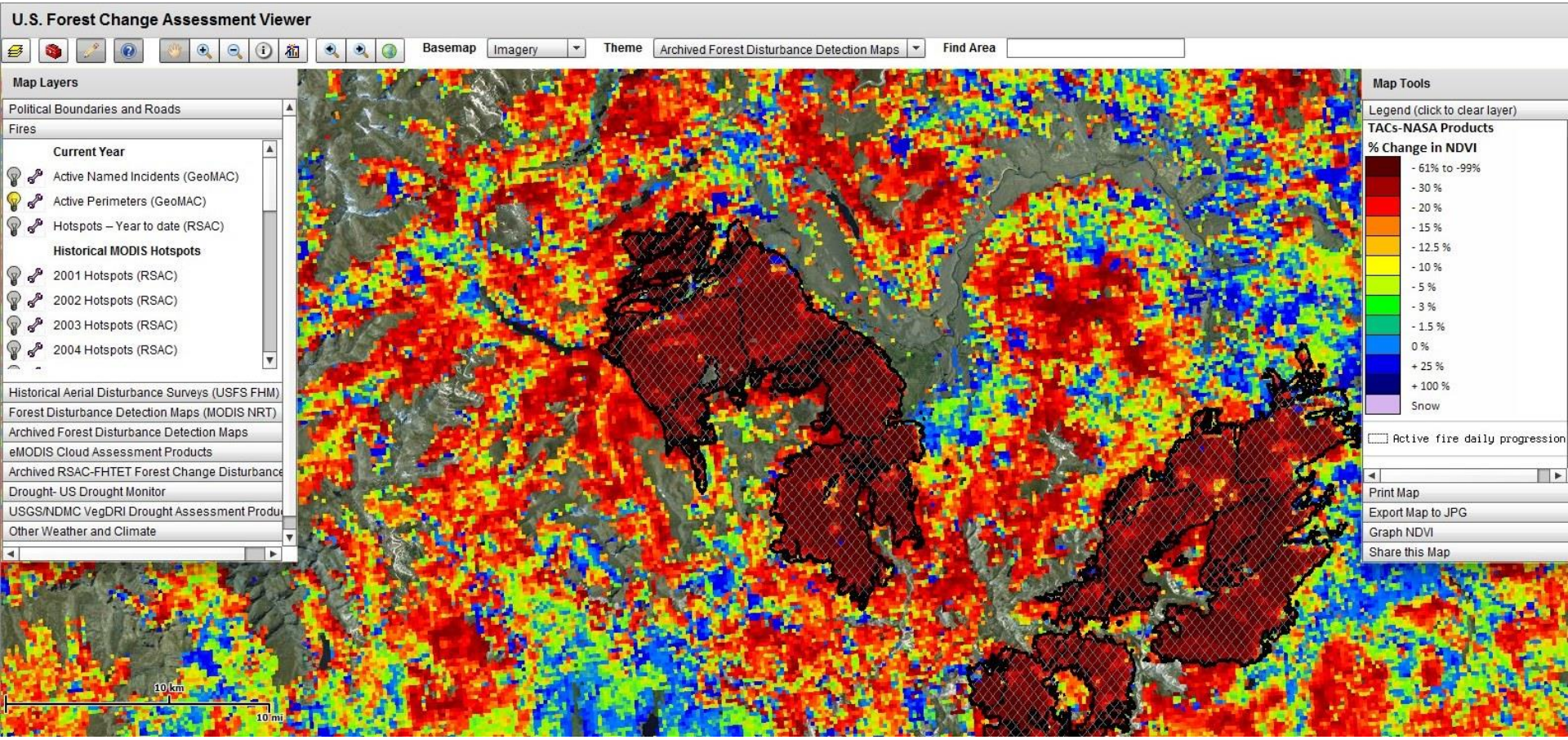
Same base image as previous slide with fire perimeter map overlain



2004-2012 Aerial Disturbance Surveys for Southern Colorado

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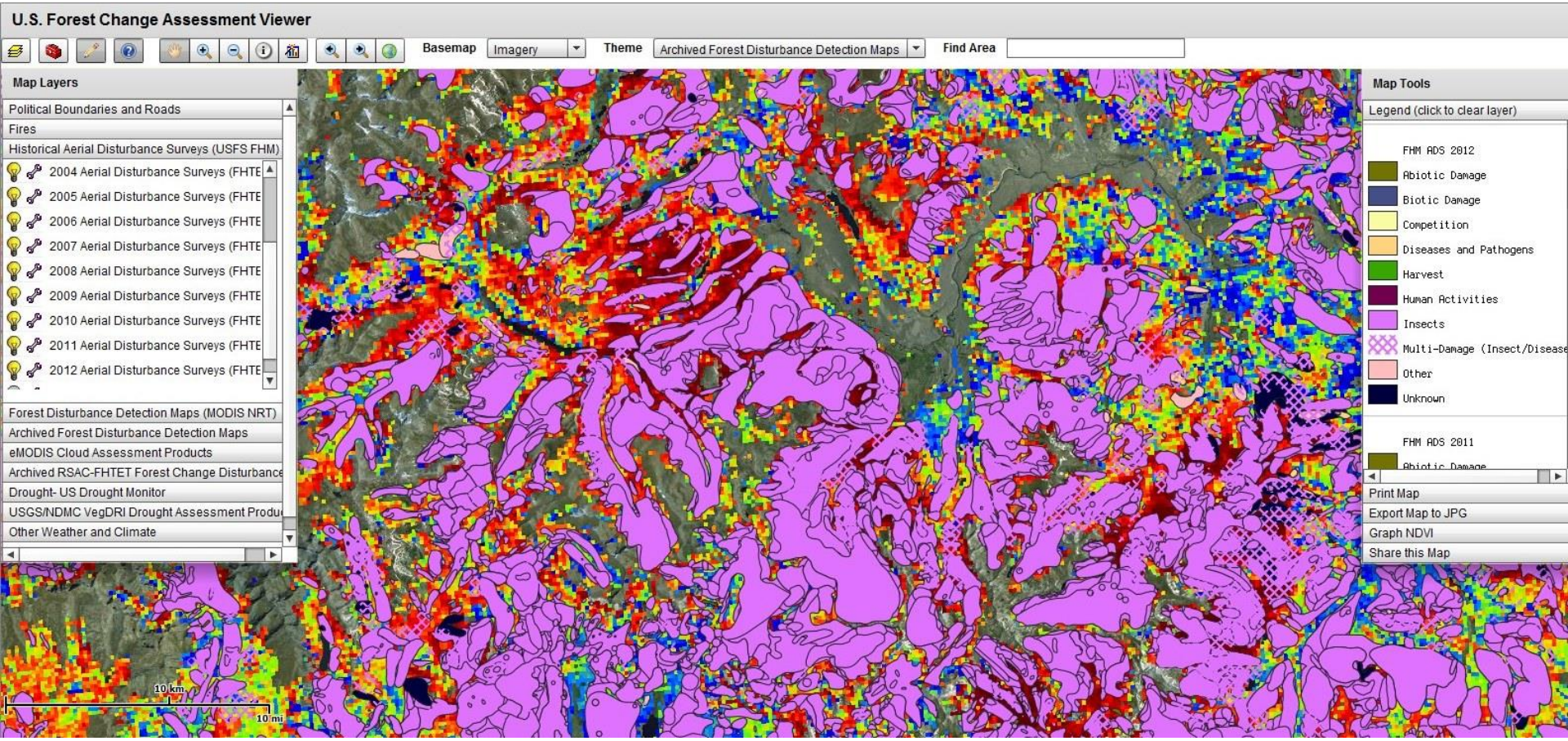
Same base image as previous slide with 2004-2012 aerial disturbance surveys (2013 aerial survey not yet available)



2013 Pine Forest Defoliation in Arizona from Pandora Moth Caterpillars

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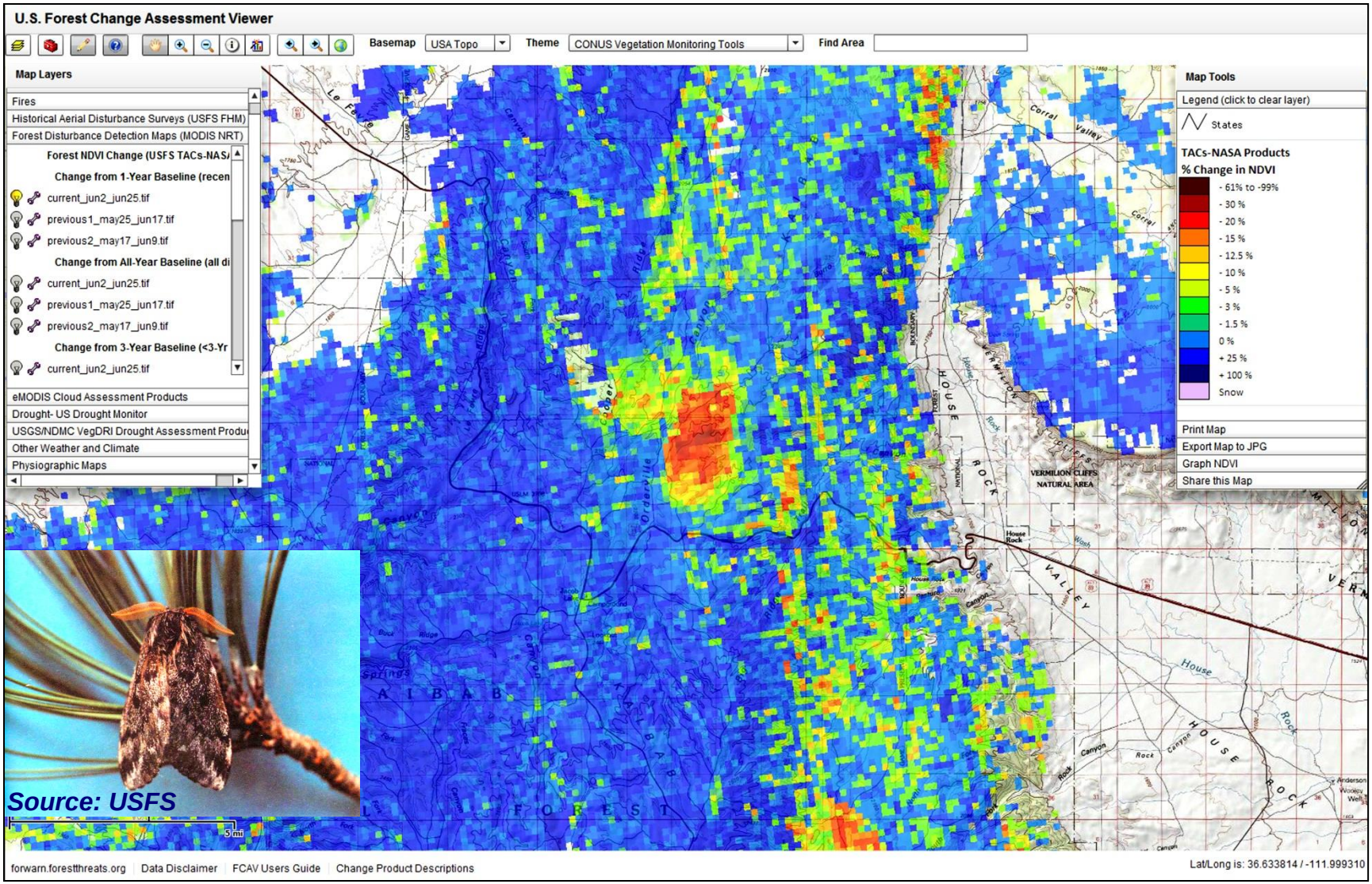
Red area in center on ForWarn product for 6/25/2013 was field verified as Pandora moth damage



2013 Hardwood Defoliation in PA and NY State from Gypsy Moth Outbreak

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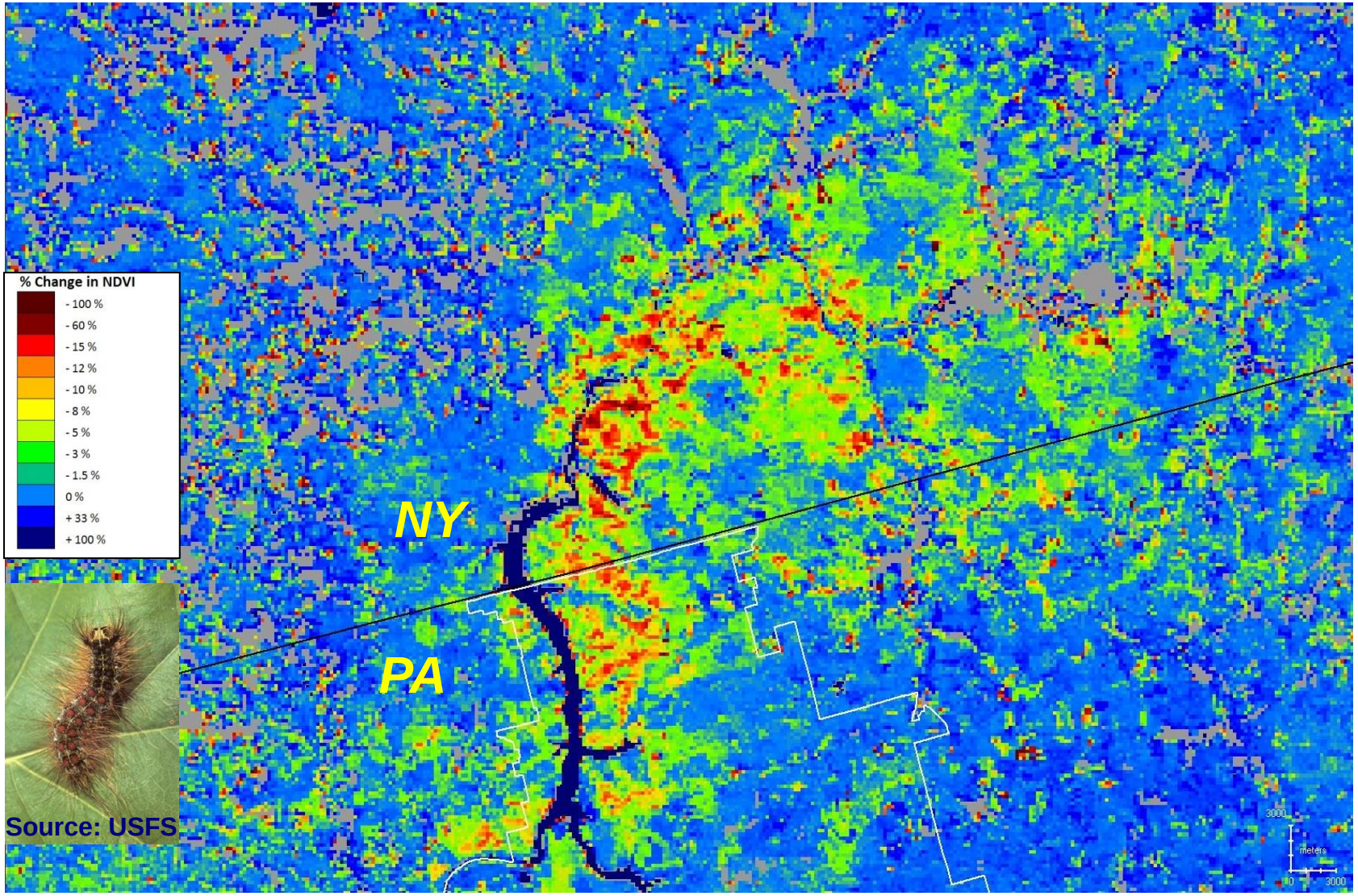
Hotter colors on ForWarn product for 6/25/2013 was field verified as gypsy moth defoliation

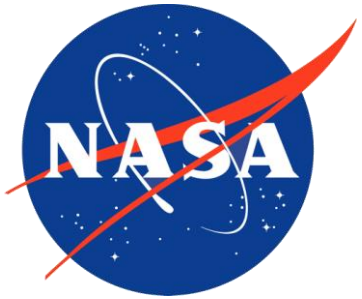


Comments on Example Results

- NRT MODIS NDVI forest change products enabled detection of multiple regional forest disturbance events
  - *Including abiotic, biotic, and anthropogenic disturbances in multiple forest types and locations*
  - *New disturbances were best detected using the previous year NDVI as the baseline*
  - *Multiyear disturbance events were best assessed using all three previous year NDVI baselines (previous 1, 3 and all years)*
  - *The "freshest" (ALC) NDVI change product usually detected events 1 week earlier than the other products*
- Disturbance detections were checked using news accounts, aerial surveys, Landsat data, and fire maps
- ForWarn disturbance detection results were conveyed to Federal and State forest health monitoring community

Conclusions

- Since 2010, NRT MODIS % NDVI change products have been produced for the U.S. every 8 days, usually posted on ForWarn 1-2 days after the last collection date
- ForWarn disturbance detection products require use of daily data from both MODIS Aqua and Terra
- Future work
  - *Expand ForWarn change products to include all land areas*
  - *Development of damage agent attribution capabilities*
  - *Develop means to process and integrate VIIRS data*
- For more information, email: joseph.p.spruce@nasa.gov
- Other ForWarn related AGU talks on Friday:
  - *Hargrove et al. - 11:20 am - IN52A in Moscone West 2010*
  - *Hoffman et al. - 12:05 pm – B52D in Moscone West 2004*



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