



# Role of MODIS Vegetation Phenology Products in the U.S. ForWarn Early Warning System for Forest Threats

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# Introduction



- U.S. forests occupy ~751 million acres (~1/3 of total land)
- Several abiotic and biotic damage agents disturb, damage, kill, and/or threaten these forests
- Regionally extensive forest disturbances can also threaten human life and property, bio-diversity and water supplies
- Timely regional forest disturbance monitoring products are needed to aid forest health management work at finer scales
- Daily MODIS data provide a means to monitor regional forest disturbances on a weekly basis, leveraging vegetation phenology
- In response, the USFS and NASA began collaborating in 2006 to develop a Near Real Time (NRT) forest monitoring capability, based on MODIS NDVI data, as part of a national forest threat Early Warning System (EWS)

# U.S. ForWarn System for Regional Forest Disturbance Monitoring

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<http://forwarn.forestthreats.org>

The screenshot shows the ForWarn website interface. At the top, there is a navigation bar with the text "FW Home | ForWarn" and a search box. Below the navigation bar is the main header area featuring the "ForWarn" logo, the tagline "Satellite-Based Change Recognition and Tracking", and logos for the USDA Forest Service, NASA, USGS, and Oak Ridge National Laboratory. A horizontal menu contains links for Home, Overview, News, Highlights, Data, and Support. The main content area is dominated by a large satellite image of a forest with a dark overlay. To the right of the image is a text box titled "Tornadoes scar the South" with a "read more" link. Below this is a "What is ForWarn?" section with a brief description and a link to a "Forest Change Assessment Viewer" which is accompanied by a small map of the United States. To the right of the "What is ForWarn?" section is a "Recent News" section with two news items, each with a date and a "more news" link. At the bottom of the page is a footer with various links including "USDA Forest Service", "EFETAC", "WWETAC", "Policies and Links", "Privacy Policy", "Accessibility Statement", "FOIA", "Non-discrimination Statement", "White House", "usa.gov", and "Log In".

# What is ForWarn?



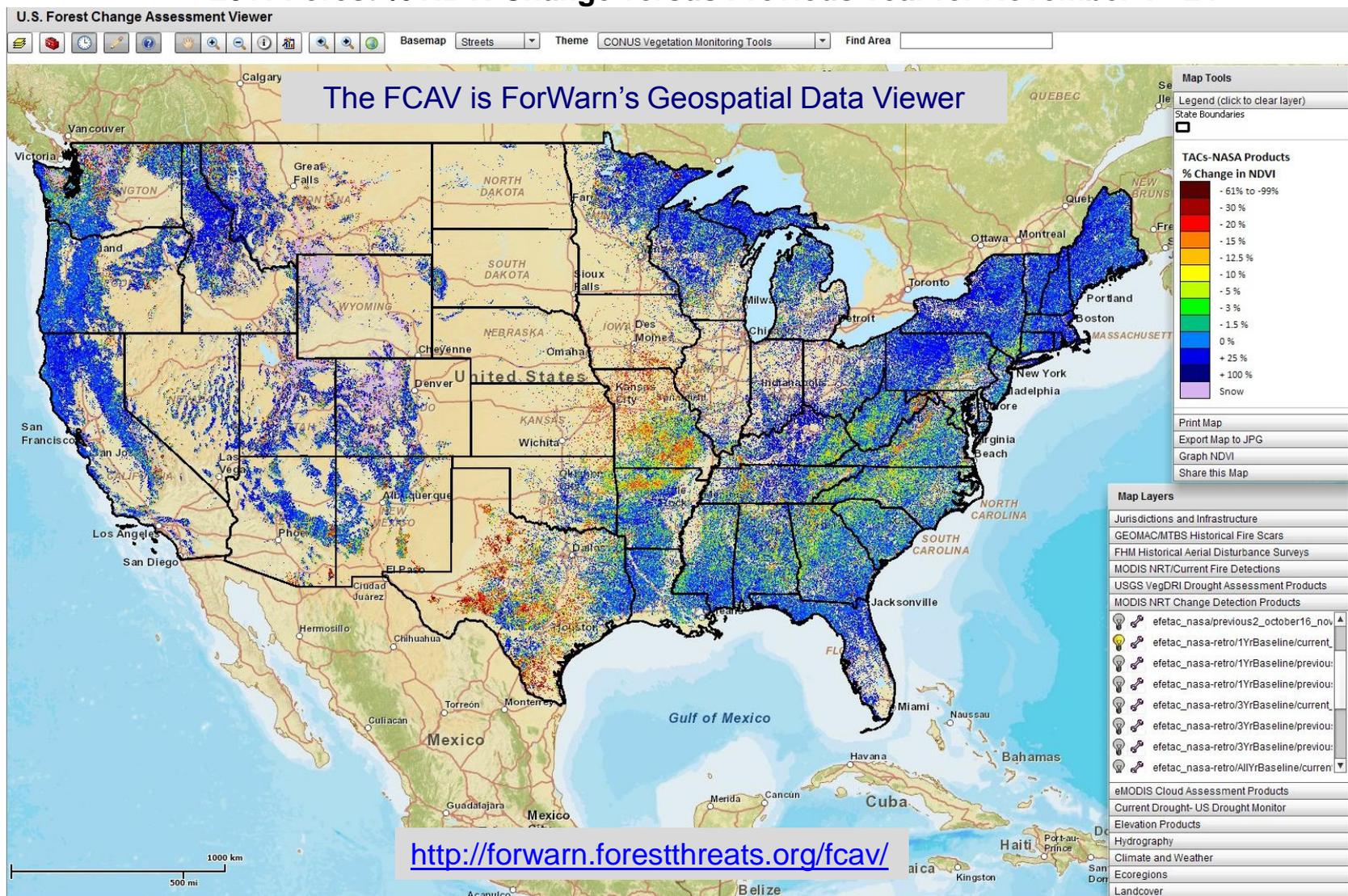
- ForWarn is an on-line geospatial data analysis tool for detecting and tracking regionally evident forest disturbances in the U.S.
- Developed by the US Forest Service in collaboration with NASA, ORNL, and the USGS per mandate of the Healthy Forest Restoration Act
- Uses 250m MODIS satellite NDVI data products to detect changes in vegetation canopy greenness that are anomalous in terms of normal phenology
- Includes a suite of annual MODIS NDVI phenology products and near real time forest change products derived from these products

# U.S Forest Change Assessment Viewer (FCAV) - New Products Every 8 Days

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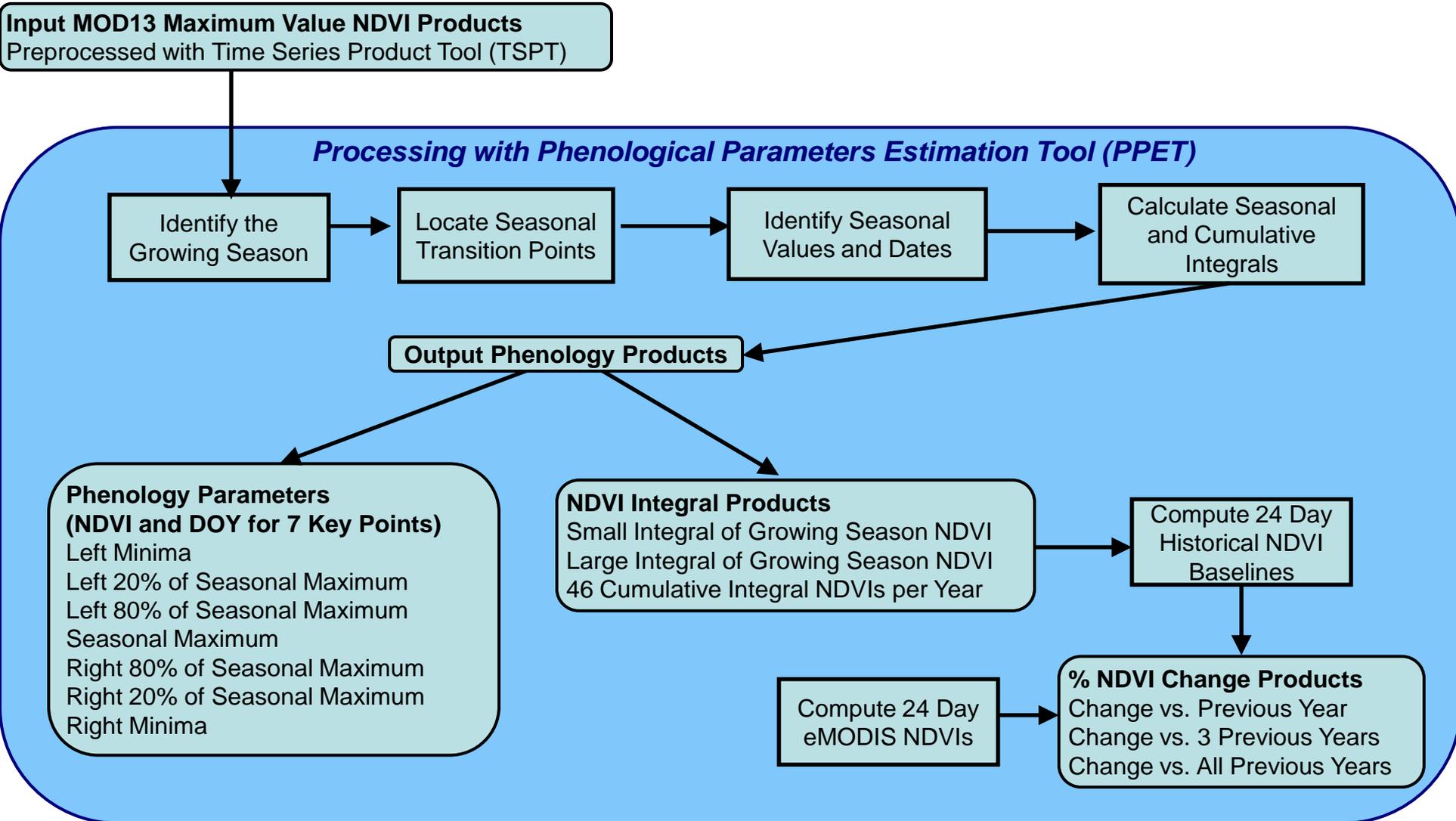


## 2011 Forest % NDVI Change versus Previous Year for November 1 - 24



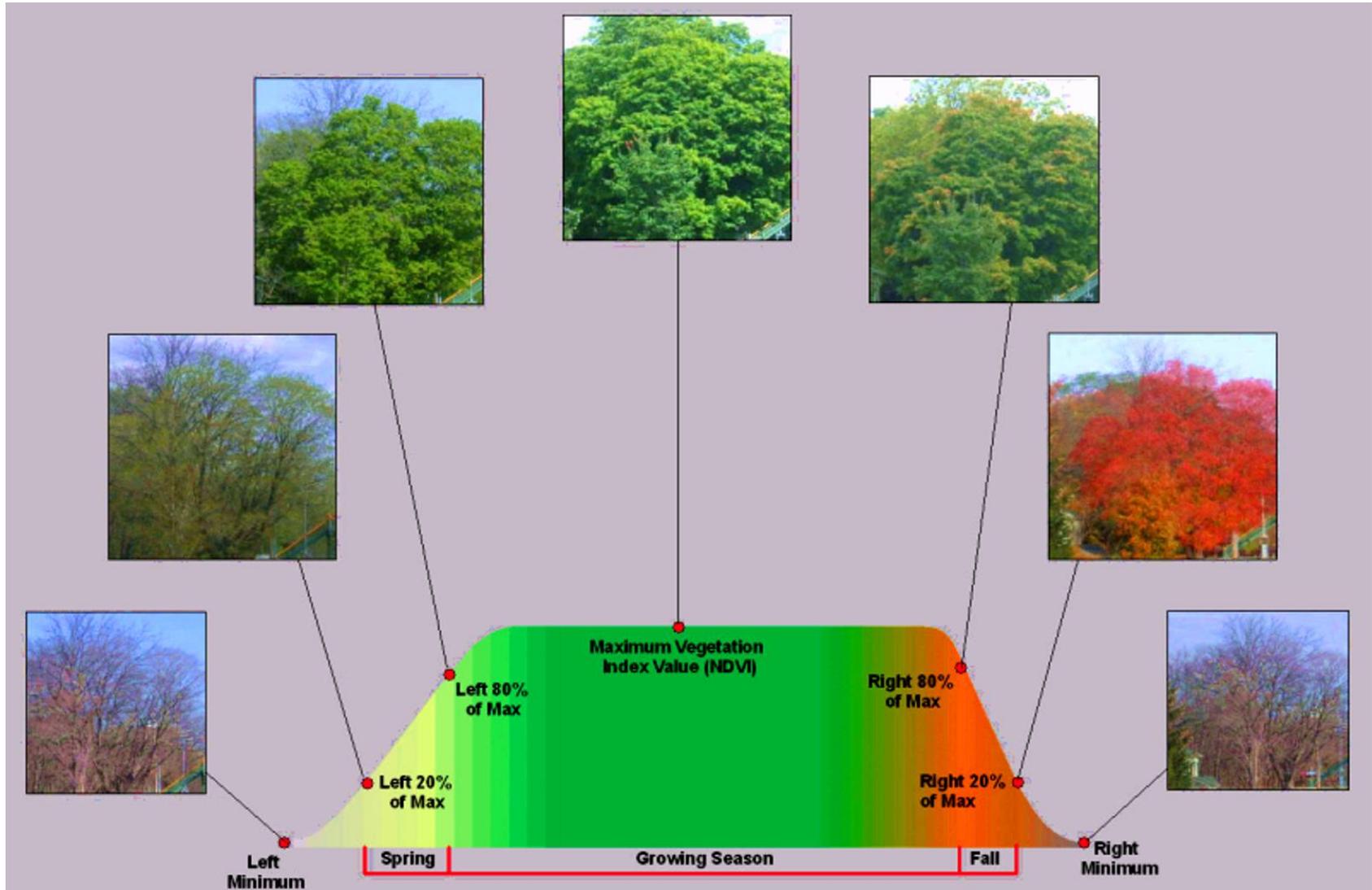
# Process for Computing ForWarn MODIS NDVI Phenology Products

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# Seasonal States of Individual Tree Compared to Phenology Parameters

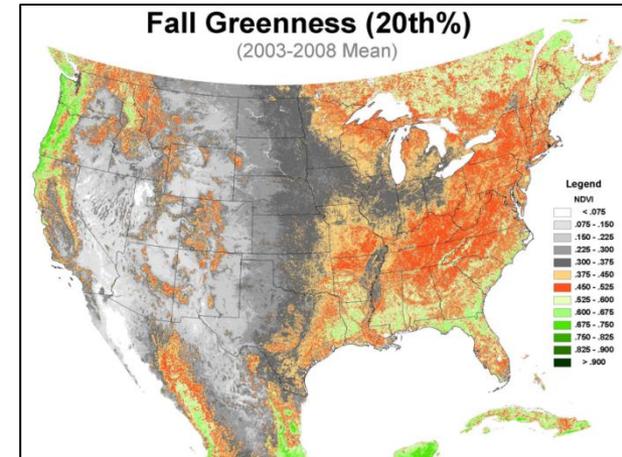
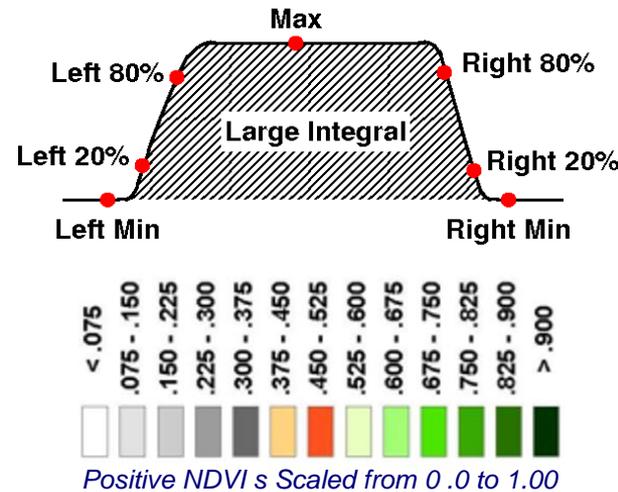
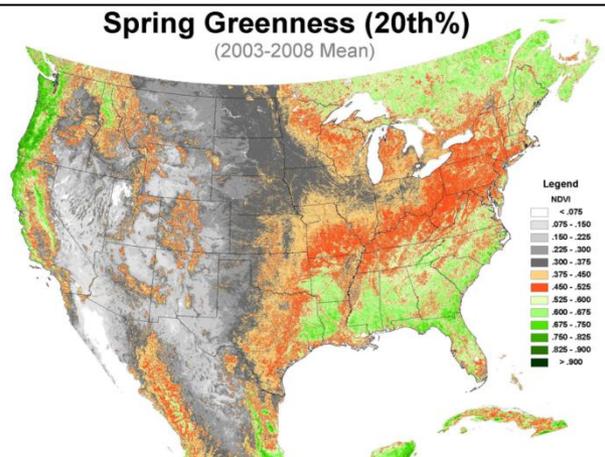
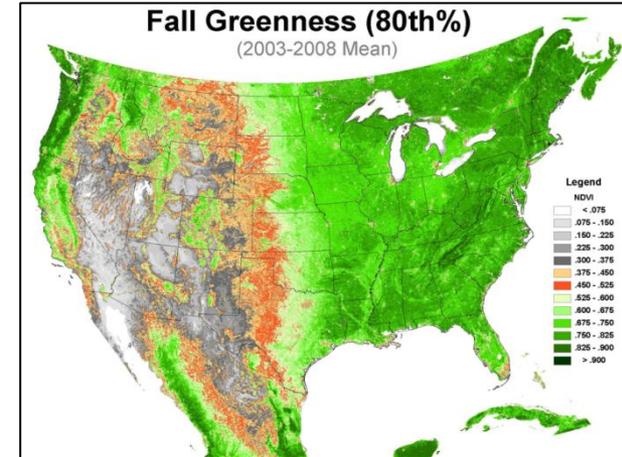
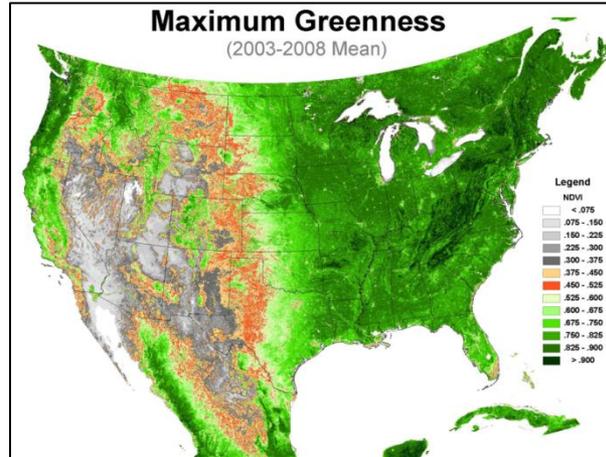
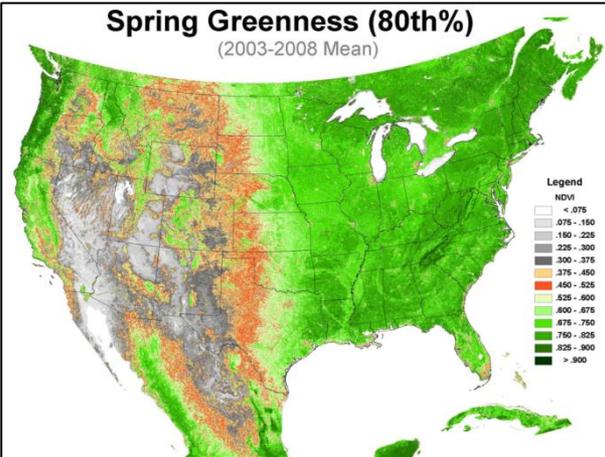
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# Example MODIS Phenology Products



CONUS Historical NDVI Phenology Products for 2000 – 2011



# Series 1 – Examples of ForWarn MODIS Change Products With Regionally Evident Abiotic Forest Disturbances

*2011 Tornadoes  
in Alabama and Mississippi*



Source: NOAA

*2012 High Park Fire in  
Colorado Front Range*



Source: NASA

*2012 Hail Damage  
Asheville Watershed, NC*



Source: USFS

*2011 Drought in Texas,  
and Adjacent States*



Source: NOAA

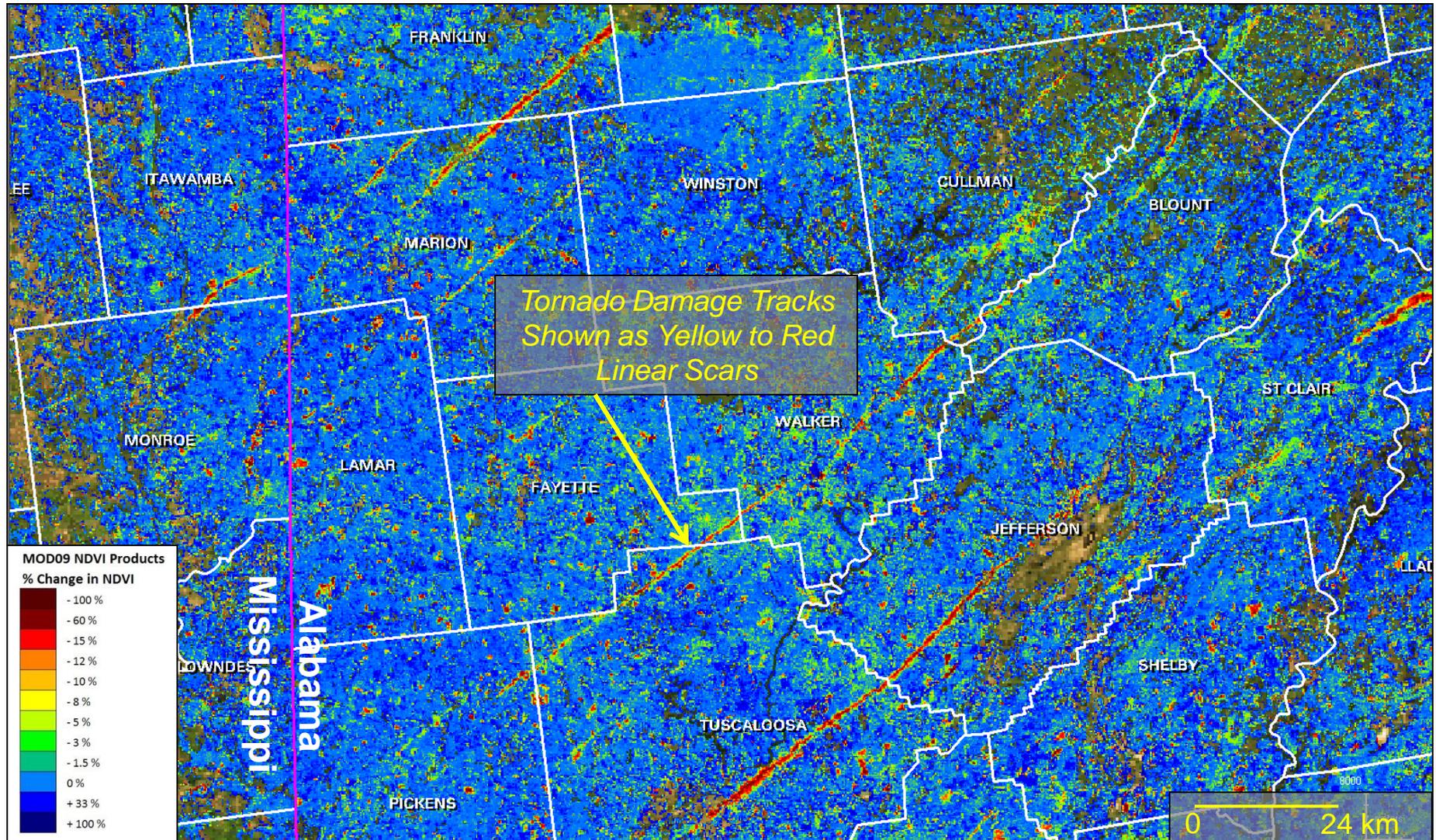
# MODIS View of April 27, 2011

## Tornadoes in Mississippi and Alabama

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Forest %NDVI Change for May 1-24, 2011 versus 2010 – Counties in White

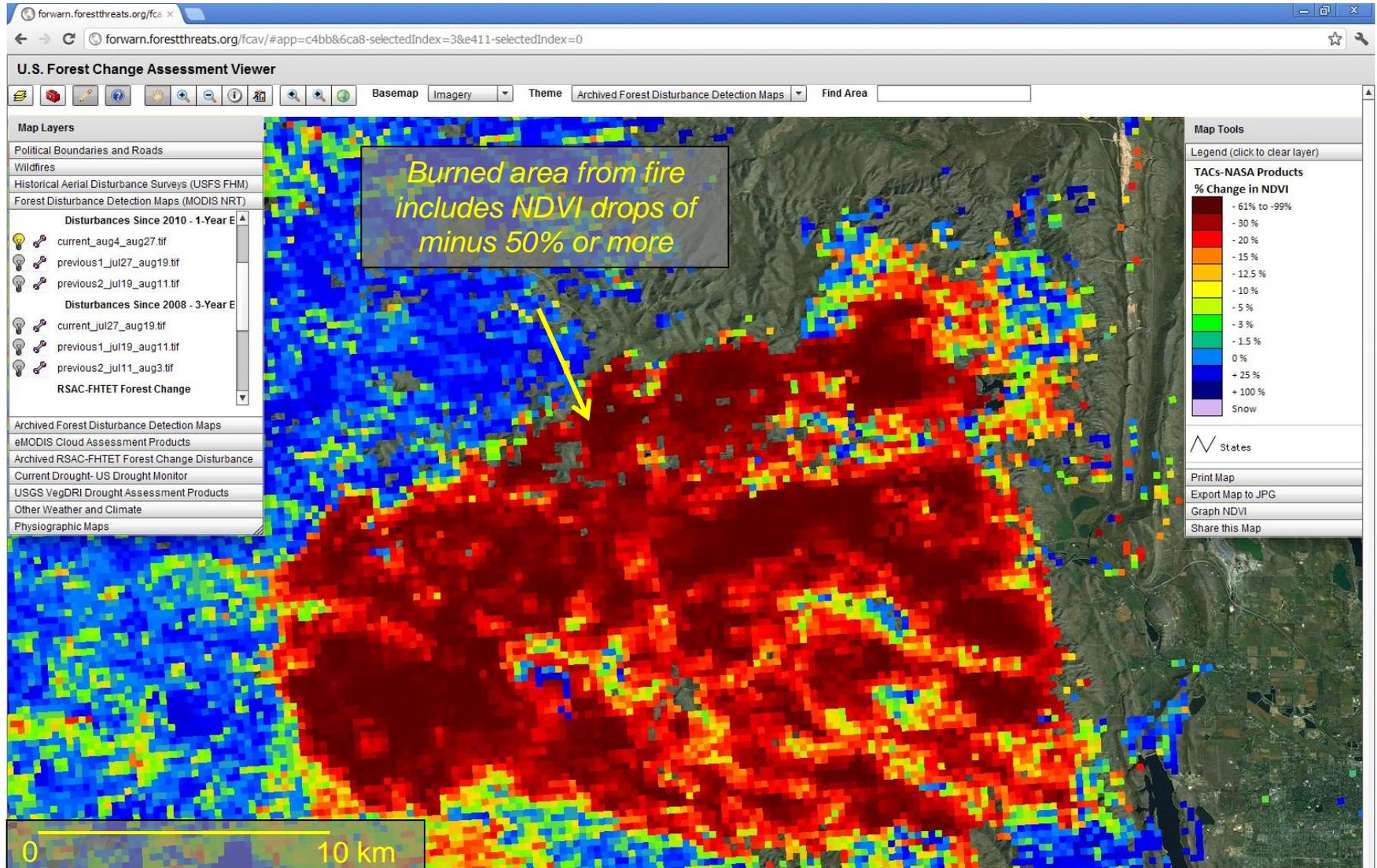


# MODIS View of 2012 High Park Fire in Colorado Front Range



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Forest % NDVI Change for August 4 – 27, 2012 versus 2011



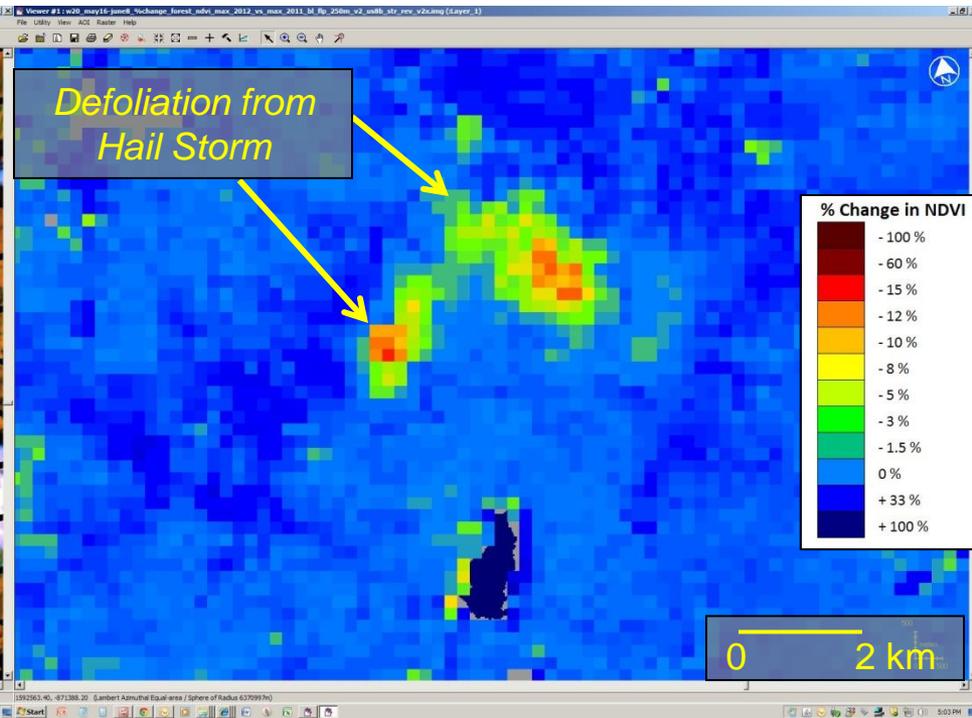
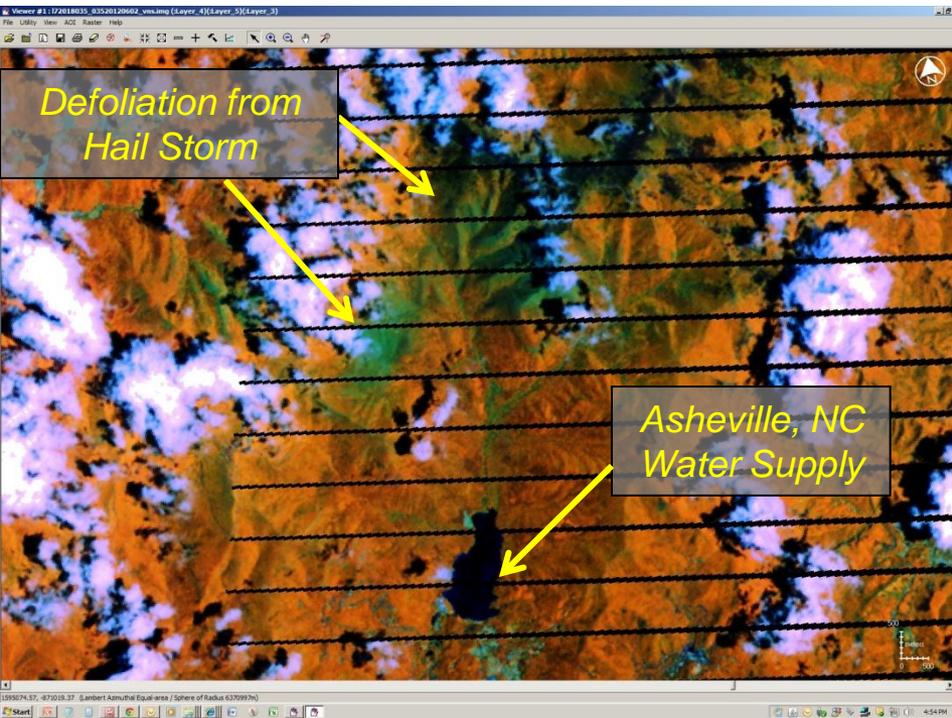
# MODIS View of 2012 Hail Damage to Asheville, North Carolina Watershed



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Landsat 7 False Color RGB from 6/2/2012

MODIS % NDVI Change for 5/16 to 6/8/2012 vs. 2011



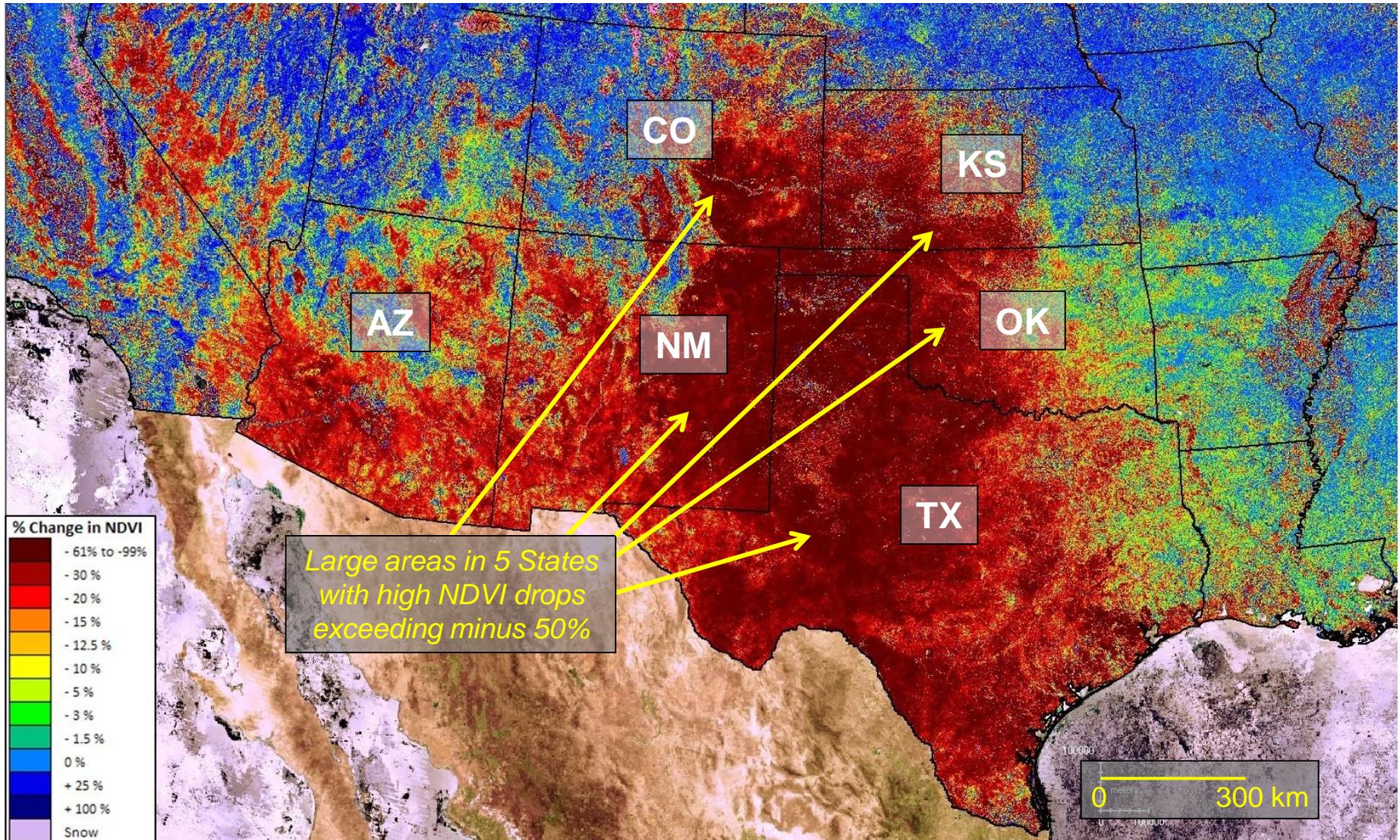
Area Field Checked 6/14/2012

# MODIS View of 2011 Drought in Southeastern U.S.



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Land %NDVI Change for June 18 through July 11 of 2011 versus 2003-2010



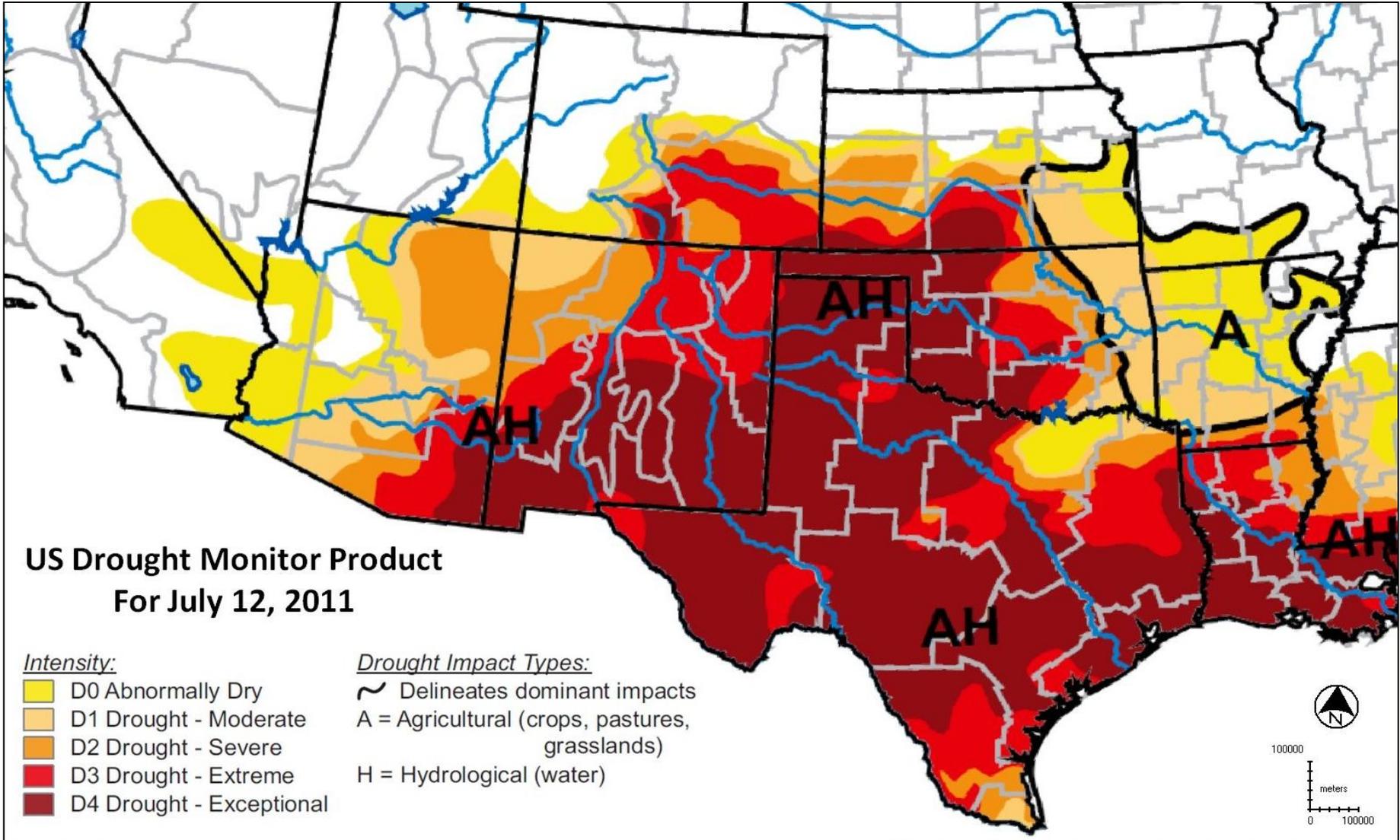
# U.S. Drought Monitor View of 2011

## Drought in Texas and Adjacent States

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U.S. Drought Monitor Product for July 12, 2011



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

*2012 Spring Defoliation in Louisiana Swamps from Caterpillars*



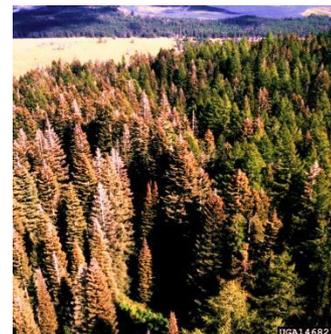
Source: LSU

*2012 Summer Spruce Beetle Mortality in Rio Grande NF of Colorado*



Source: CSU

*2011 Summer Budworm Defoliation in Washington State*



Source: USFS

*2011 Fall Defoliation in Pennsylvania From Fall Webworm*



Source: Texas FS

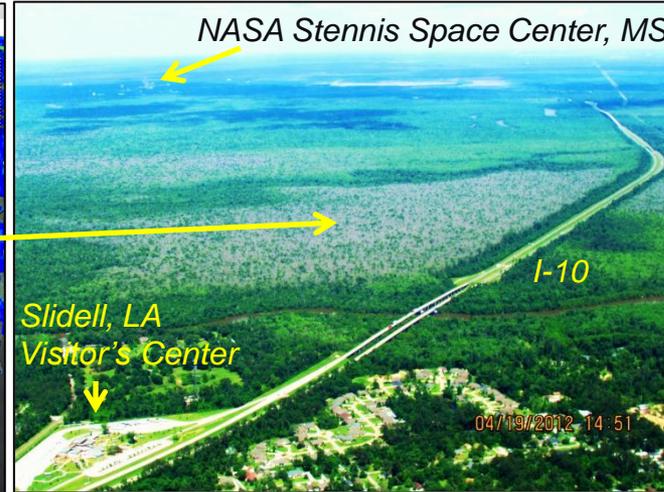
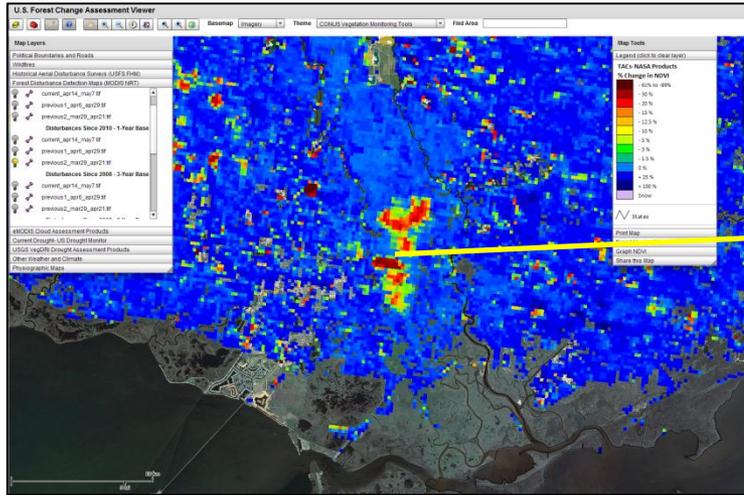
# MODIS View of 2012 Wetland Forest Defoliation in Coastal Louisiana



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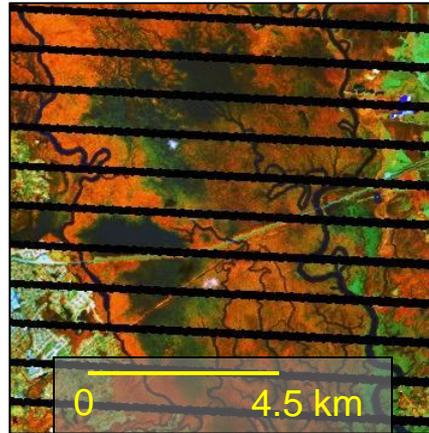
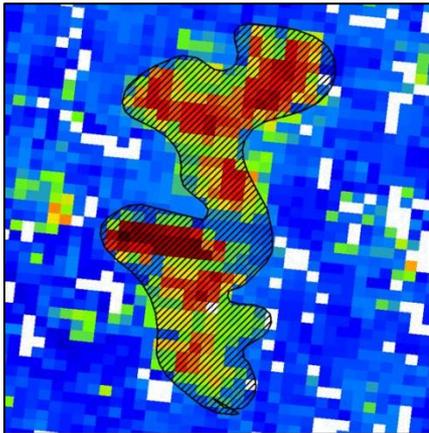
MODIS Forest % NDVI Change Product  
(Date Ending 4/21 for 2012 versus 2011)

Aerial Oblique Below Acquired by DAF  
(Days After Initial ForWarn Notification)



2012 MODIS Product with LDAF 2012  
Aerial Survey Polygon from 4/19/2012

Landsat False Color RGB Image from  
4/12/2012 (Healthy Forest Orange/Brown)



MODIS products showing locations of insect defoliated swamp forests – were used to aid aerial detection surveys by LDAF and the USFS



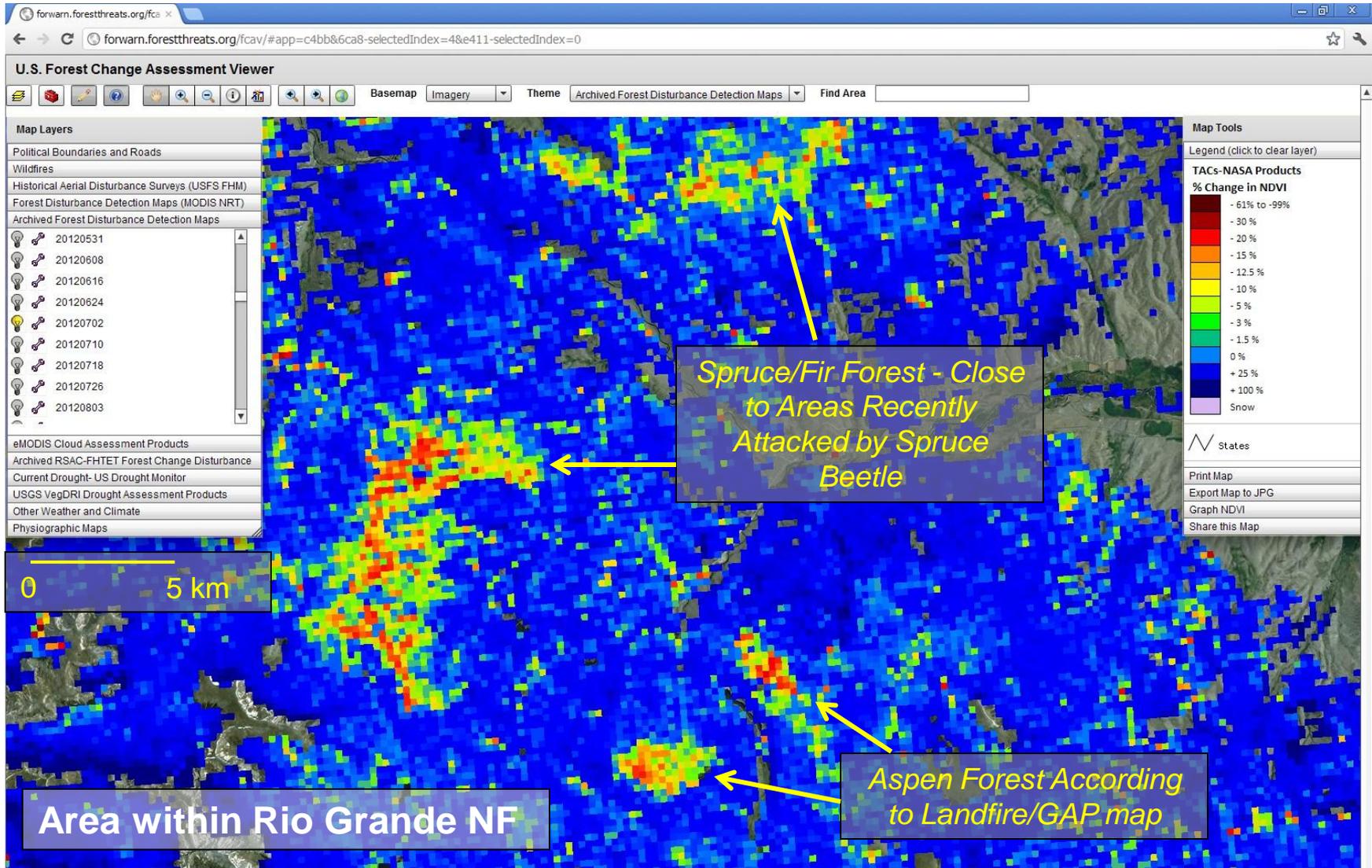
Above: Pearl River, LA photos of forest tent caterpillar and related tree defoliation acquired by NASA

# MODIS View of Potential New 2012 Spruce Beetle Mortality in Colorado

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Forest % NDVI Change for Date Ending July 2 of 2012 versus 2011

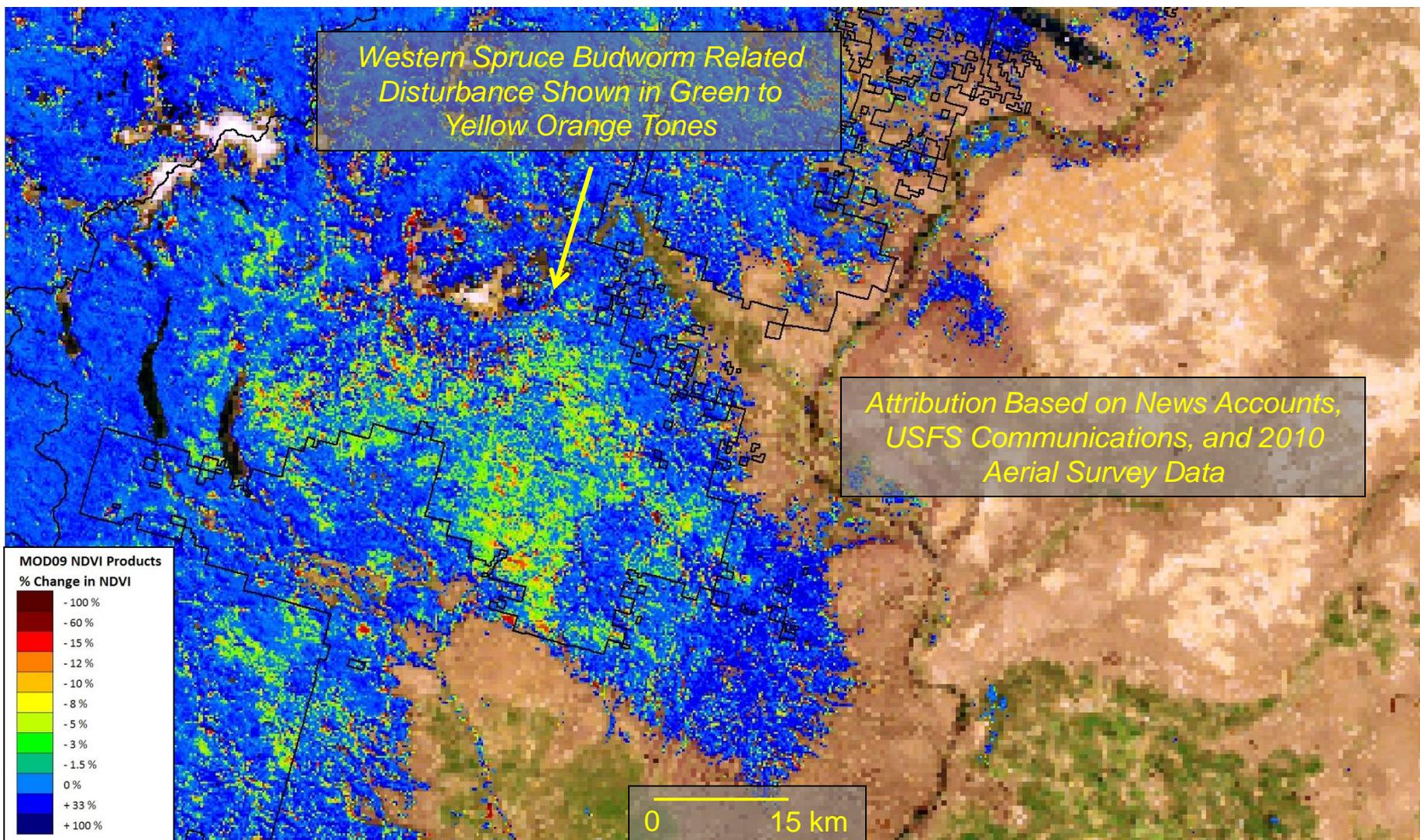


# 2011 MODIS View of Spruce Budworm Defoliation Area in Washington



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Forest %NDVI Change for 8/21 through 9/13 of 2011 versus 2008-2010 – National Forests in Black

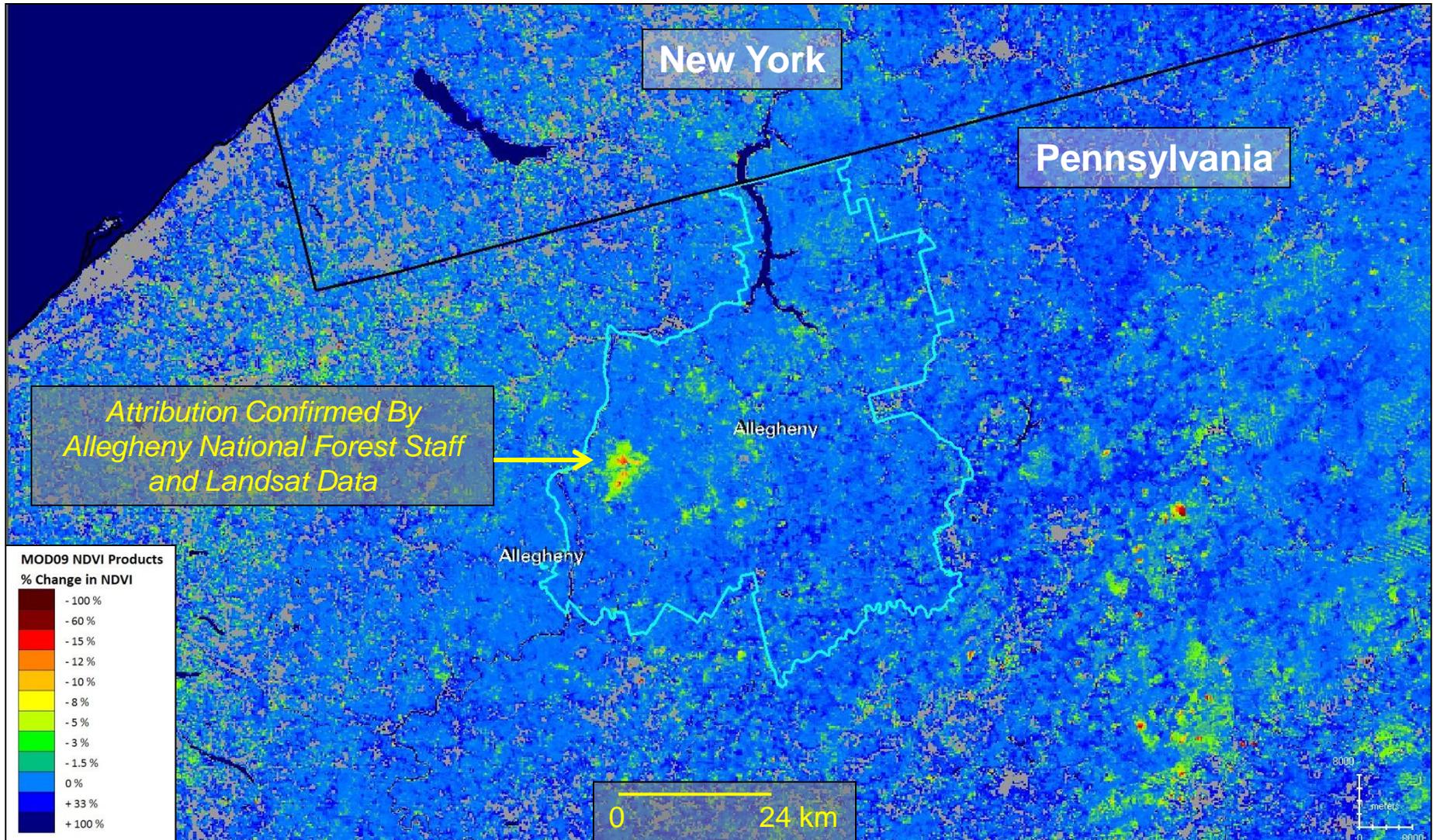


# MODIS View of 2011 Fall Webworm Defoliation in Pennsylvania



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Forest %NDVI Change for 8/21 through 9/13 of 2011 versus 2010 – National Forests in Cyan



# ForWarn NDVI Profile of Hemlock Woolly Adelgid Forest Mortality Area

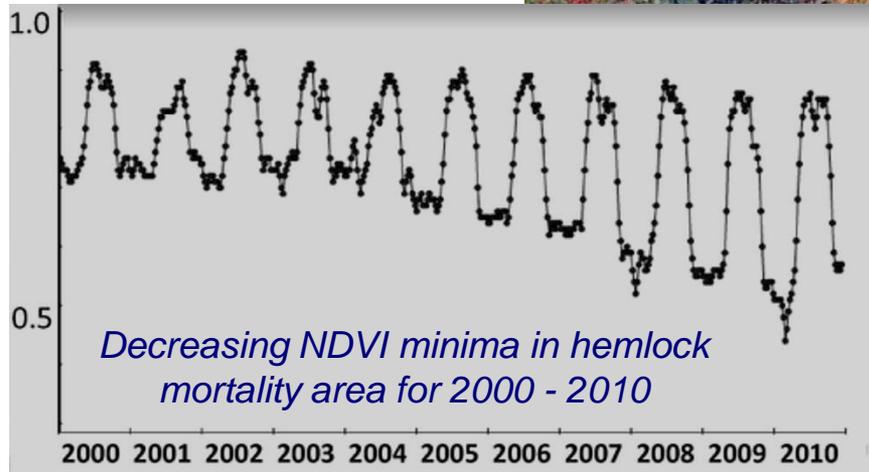
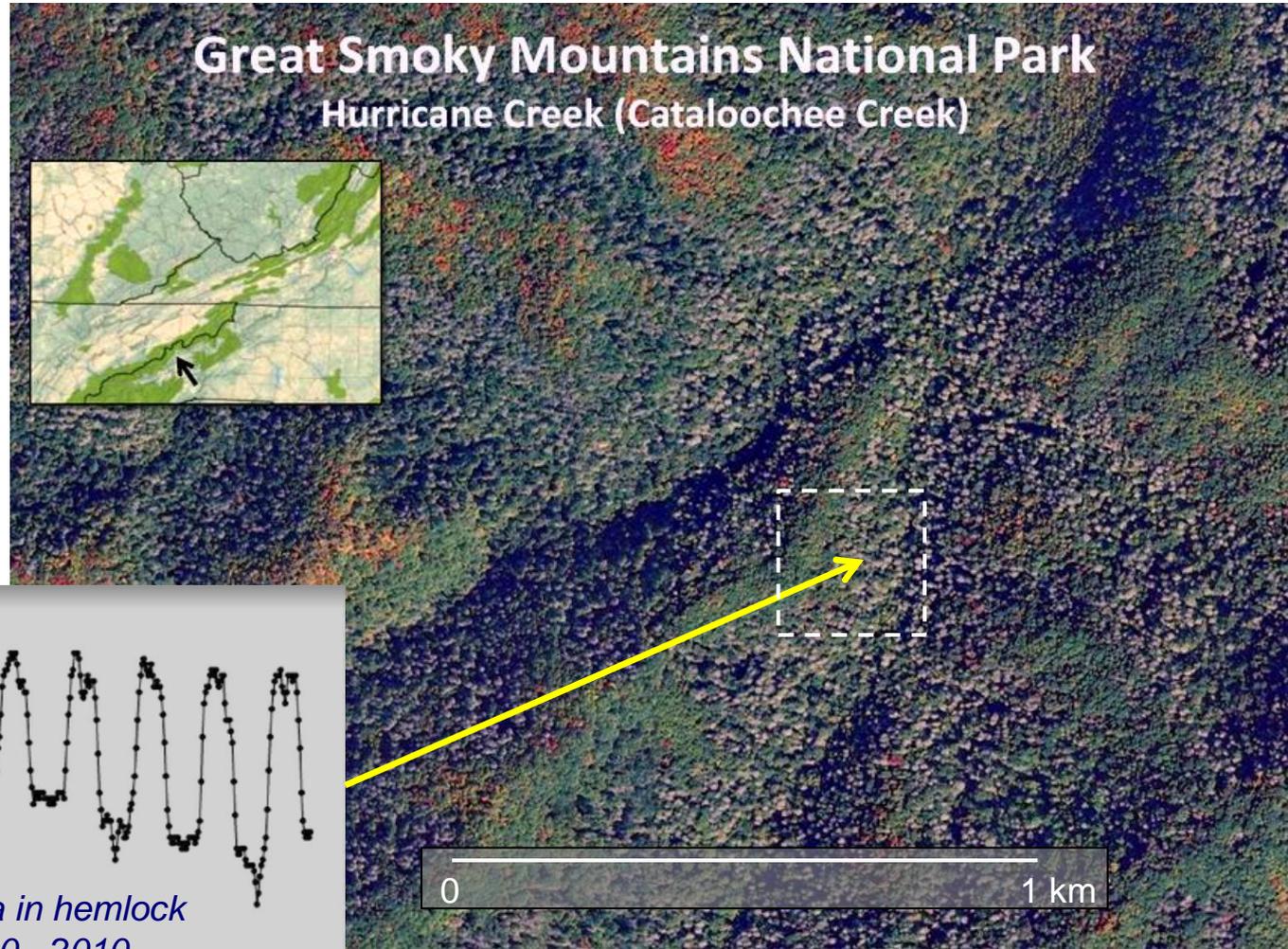
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*Oblique View of Hemlock Mortality*



Source: USFS



*Above – NAIP Aerial True Color Image*

# Comments on Example Results for 2011-2012



- NRT MODIS CONUS forest change products showed multiple regional forest disturbances
  - *Including abiotic, biotic, and anthropogenic disturbances in softwood, hardwood, and mixed wood forests*
  - *New disturbances were best detected using the previous year NDVI as the baseline*
  - *Multiyear disturbance events were best assessed using all three historical NDVI baselines (previous 1, 3 and all years)*
- Detected disturbances were assessed with news accounts, aerial disturbance survey, fire, and Landsat data
- 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 success requires use of daily MODIS satellite-based phenology data
- Future work
  - *Improving change product freshness and data quality*
  - *More retrospective forest change products*
  - *More product validation studies*
- For more information, email [joseph.p.spruce@nasa.gov](mailto:joseph.p.spruce@nasa.gov)
- Visit the ForWarn web site at: <http://forwarn.forestthreats.org>



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