Use of Current 2010 Forest Disturbance Monitoring Products for the Conterminous United States in Aiding a National Forest Threat Early Warning System

Joseph P. Spruce, William Hargrove, J. Gasser, J. Smoot, P. Kuper

This presentation discusses contributions of near real time (NRT) MODIS forest disturbance detection products for the conterminous United States to an emerging national forest threat early warning system (EWS). The latter is being developed by the USDA Forest Service's Eastern and Western Environmental Threat Centers with help from NASA Stennis Space Center and the Oak Ridge National Laboratory. Building off work done in 2009, this national and regional forest disturbance detection and viewing capability of the EWS employs NRT MODIS NDVI data from the USGS eMODIS group and historical NDVI data from standard MOD13 products. Disturbance detection products are being computed for 24 day composites that are refreshed every 8 days. Products for 2010 include 42 dates of the 24 day composites. For each compositing date, we computed % change in forest maximum NDVI products for 2010 with respect to each of three historical baselines of 2009, 2007-2009, and 2003-2009,. The three baselines enable one to view potential current, recent, and longer term forest disturbances. A rainbow color table was applied to each forest change product so that potential disturbances (NDVI drops) were identified in hot color tones and growth (NDVI gains) in cold color tones. Example products were provided to end-users responsible for forest health monitoring at the Federal and State levels. Large patches of potential forest disturbances were validated based on comparisons with available reference data, including Landsat and field survey data. Products were posted on two internet mapping systems for US Forest Service internal and collaborator use. MODIS forest disturbance detection products were computed and posted for use in as little as 1 day after the last input date of the compositing period. Such products were useful for aiding aerial disturbance detection surveys and for assessing disturbance persistence on both inter- and intra-annual scales. Multiple 2010 forest disturbance events were detected across the nation, including damage from ice storms, tornados, caterpillars, bark beetles, and wildfires. This effort enabled improved NRT forest disturbance monitoring capabilities for this nation-wide forest threat EWS.

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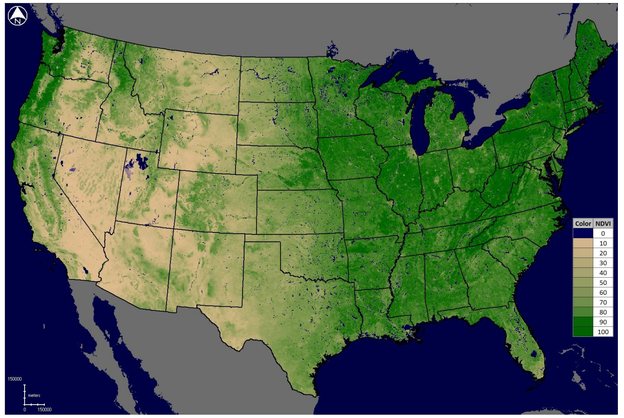

Figure 1. MODIS MOD13 maximum NDVI product for August 21 – September 13 of 2007-2009 baseline. Water areas shown here are from a USGS 2001 NLCD land cover product.

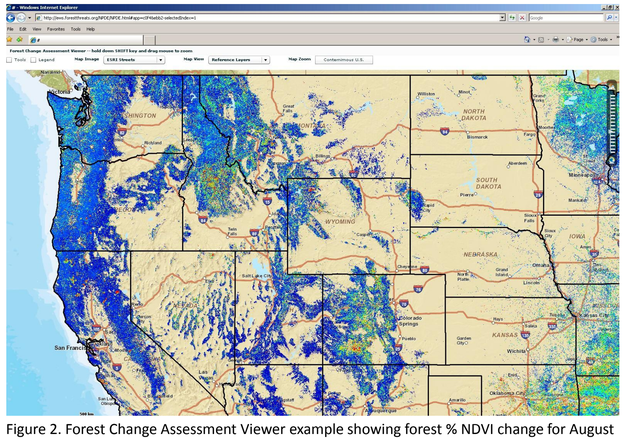

Figure 2. Forest Change Assessment Viewer example showing forest % NDVI change for August 21 - September 13 of 2010 versus 2007-2009 baseline. Hot colors show potential disturbances.

Introduction

- This poster regards use of near real time (NRT) 2010 MODIS forest disturbance detection products for aiding a national forest threat early warning system (EWS) being developed by the U.S. Forest Service (USFS) Threat Centers (Hargrove et al., 2009).
- Forests occur on approximately 747 million acres of the United States, representing almost a third of the entire U.S. land base.
- Such forests can be negatively impacted or threatened by disturbances from biotic and abiotic factors, some of which are associated with climate change (e.g., drought, fire, insect attacks).
- Current geospatial information on forest disturbances is a crucial component of this national forest threat EWS.
- Temporally processed daily MODIS satellite data was used in the EWS to monitor 2010 forest disturbances at broad regional to CONUS scales.
- The 2010 national forest disturbance detection products build upon previous work discussed by Hargrove et al. (2009).
- These products use USGS eMODIS expedited NDVI data for 2010 and historical MOD13 NDVI products for a comparative NDVI baseline.

Methods

- Employed MODIS data to compute near real time "weekly" % change in forest NDVI products, based on 24 day temporal composite products that are refreshed every 8 days.
- MODIS products were derived from temporal processing and fusion of MODIS Aqua and Terra NDVI.
- eMODIS NDVI data was used to compute current NDVI and MOD13 NDVI products were used to compute historical baselines.
- Historical baseline products were computed for 2009, 2007-2009 and 2003-2009 time frames (Figure 1).
- Computed % change in NDVI products for each 24 day analysis window, comparing current year NDVI to that from each baseline.
- Posted products in near real time on prototypical forest threat EWS tool: "Forest Change Assessment Viewer" (FCAV) – see http://ews.forestthreats.org/NPDE/NPDE.html (Figure 2).
- Also provided change products to USFS Forest Health Technology Enterprise Team to assist 2010 aerial disturbance detection surveys.
- Assessed apparent disturbances compared to available reference data (Landsat, aerial, and ground-based geospatial data). Acquired multiple NRT Landsat data sets to aid interpretation of MODIS NRT products.

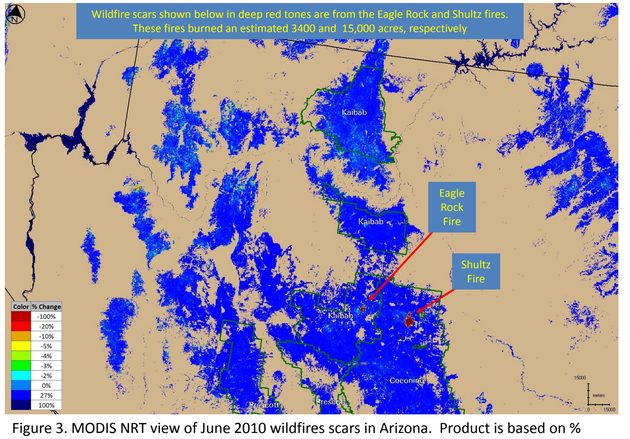

Figure 3. MODIS NRT view of June 2010 wildfires scars in Arizona. Product is based on % change in maximum NDVI from August 21 – September 13 of 2010 versus 2009 baseline.

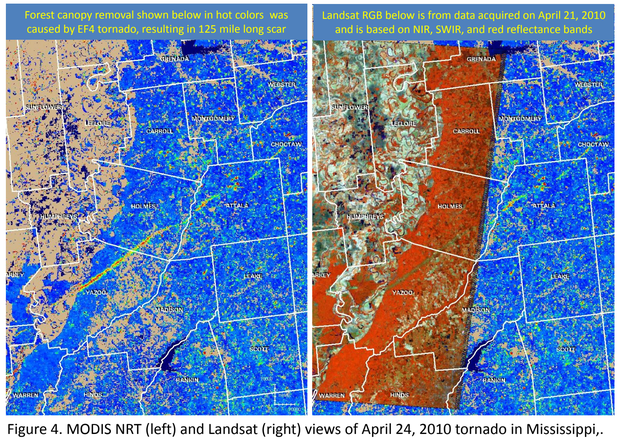

Figure 4. MODIS NRT (left) and Landsat (right) views of April 24, 2010 tornado in Mississippi,. MODIS % NDVI change product is from April 23 – May 16 of 2010 versus 2007-2009 baseline.

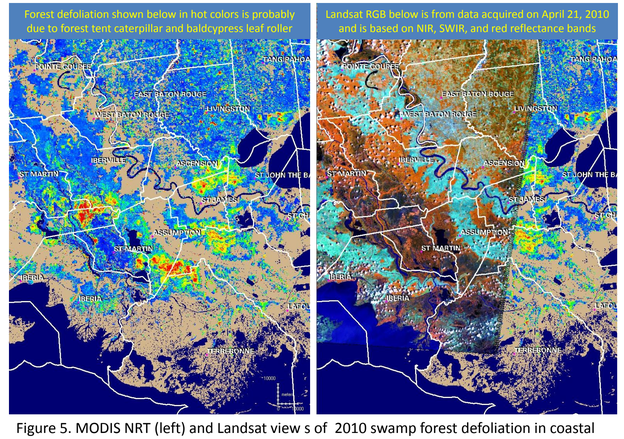

Figure 5. MODIS NRT (left) and Landsat view s of 2010 swamp forest defoliation in coastal Louisiana,. MODIS product - April 23 - May 16 of 2010 versus 2007-2009 baseline.

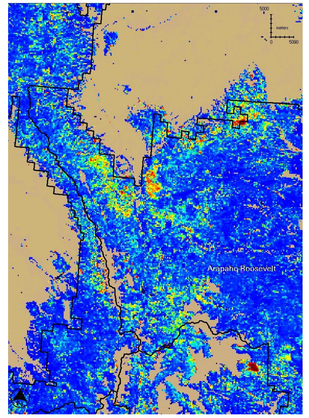

Figure 6. Colorado Front Range - % NDVI change for 8/13 – 9/5 of 2010 (2009 baseline).

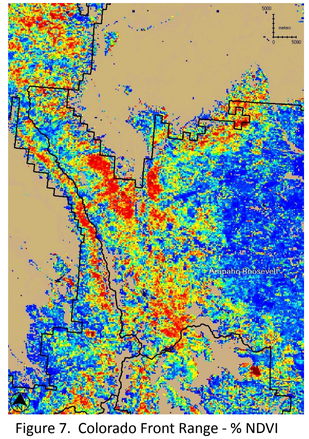

Figure 7. Colorado Front Range - % NDVI change for 8/13 - 9/5 of 2010 (2007 - 2009 baseline).

Results and Discussion

- MODIS-based NRT and other geospatial visualization products were posted each week on the EWS's FCAV that depicted regionally evident 2010 forest disturbances (e.g., damage from insects, storms, and fire).
- Computed forest change products from multiple baseline enabled many current, recent, and longer term disturbances to be assessed (Figures 3 – 10).
- More severe disturbance (e.g., mortality from fire and beetles) usually showed higher NDVI drops than ephemeral disturbance (e.g., caterpillar defoliation).
- The 24 day compositing period and the fusion of MODIS Aqua and Terra data help mitigate cloud contamination effects, though product sometimes showed false NDVI drops apparently due to frequent bad weather.
- The use of rainbow color tables on the % NDVI change products improved the visualization of regionally evident forest disturbances.
- Effective NRT regional products were computed for multiple terrains and landscapes , usually with low latencies of 1 -2 days after last collection date.

Conclusions and Future Work

- The results for 2010 indicate MODIS eMODIS and MOD13 products data can be processed into effective NRT regional forest disturbance detection products.
- The on-line posting of refreshed NRT geospatial products into FCAV aided the development of the EWS and was useful for testing the potential of this system.
- The MODIS NRT % change in forest NDVI products enabled regional forest disturbances to be viewed and assessed throughout the 2010 growing season.
- The products based on 3 baselines aided disturbance assessment, especially for multiyear events.
- Additional research is being done to assess whether MODIS phenology products such as these could be further applied to identify and quantify the areal extent of forest disturbance across CONUS.
- Future work will include efforts to further automate forest disturbance detection. GIS techniques will be used to assess disturbance persistence and the year in which a given disturbance initially occurred.
- These products also have potential for aiding climate change studies, such as research on forest mortality associated with prolonged drought.
- Several other MODIS phenological products are being assessed for aiding forest disturbance monitoring needs of the EWS, including cumulative NDVI products.

References

- Hargrove, William W., Joseph P. Spruce, Gerald E. Gasser, and Forrest M. Hoffman (2009). Toward a national early warning system for forest disturbances using remotely sensed canopy phenology. *Photogrammetric Engineering & Remote Sensing*, 75:1150-1156.

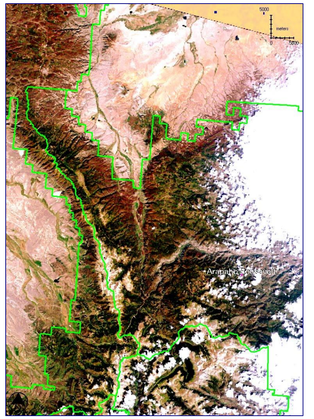

Figure 8. Colorado Front Range – Landsat true color view from 8/24/2010.

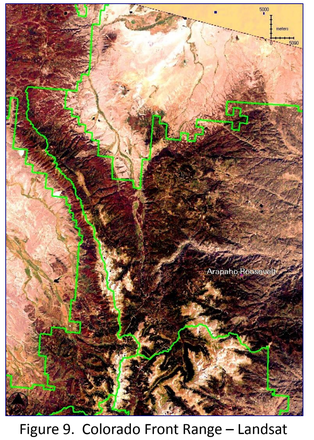

Figure 9. Colorado Front Range – Landsat true color view from 8/21/2009.

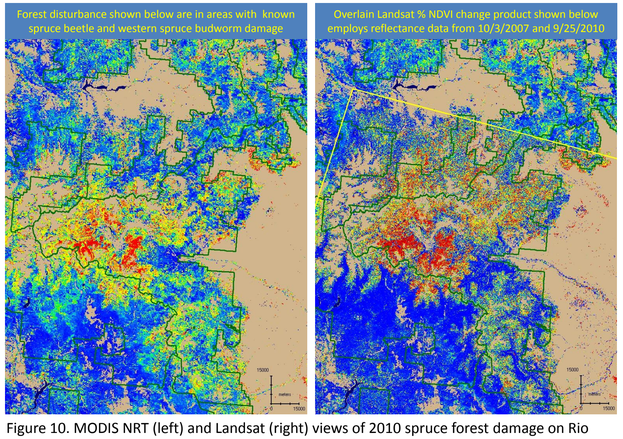

Figure 10. MODIS NRT (left) and Landsat (right) views of 2010 spruce forest damage on Rio Grande National Forest . MODIS view from 8/29 – 9/21 of 2010 versus 2007 - 2009 baseline.