Introduction

- 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).
- Temporally processed daily MODIS satellite data offers a potential means to monitor forest disturbances at broad regional to CONUS scales.
- Current geospatial information on forest disturbances is needed as part of a national forest threat Early Warning System (EWS) being developed by the U.S. Forest Service (USFS) Threat Centers (Hargrove et al., 2009).
- In response, a study was conducted by NASA and the USFS to assess the use of 250-meter MODIS NDVI products for the 2009 in-season detection of CONUS forest disturbances, based on MODIS time series data.
- The case study discussed here is a subset of the Forest Threat EWS work discussed by Hargrove et al. (2009).

This case study utilizes eMODIS expedited NDVI products for 2009 and historical MODIS NDVI products for a comparative NDVI baseline.

Methods

- Computed CONUS historical baseline from fused MODIS Aqua and Terra MOD13 maximum value NDVI for the June 10 - July 27 period of 2000-2008 (Figure 1).
- Composed CONUS 2009 maximum value NDVI for June 10 – July 27, using eMODIS atmospherically corrected products from USGS EDC – generated and revised during growing season as new products came available.
- Stacked 2009 and baseline NDVI products, developing 2-date RGB for forest disturbance visualization (Figure 2).
- Shared initial products with prospective end-users during growing season of 2009.
- Later calculated % change in NDVI product, comparing 2009 eMODIS NDVI to baseline NDVI (Figure 3).
- Also applied 2-date stack to compute preliminary CONUS forest disturbance classification product (Figure 4).
- Performed additional qualitative assessment of these products via comparisons with available reference data (USFS, Landsat, aerial, and other geospatial data) (Figures 5, 6, and 7).

Results and Discussion

- Produced multiple MODIS-based visualization products that depicted regionally evident forest disturbance patches associated with caterpillars, bark beetles, ice storms, wind storms, and wildfire.
- These products show forest disturbance but not the date in which the disturbance first occurred – this could be addressed with additional work.
- The % change in NDVI and the classification products clearly improved the visualization of changes in low NDVI forests, compared to the 2-date NDVI RGB.
- The classification product contains disturbance cluster classes that pertains to NDVI level and % change in NDVI. Severe disturbance (e.g., mortality) usually shows higher NDVI drops than ephemeral disturbance (e.g., caterpillar defoliation).
- The product may show false indications of NDVI drops when frequent bad weather occurs during the observed time frame. A potential example is Maine, where it was unusually cloudy during the early summer of 2009.

Conclusions and Future Work

- This case study shows the promise of computing current season forest disturbance detection products at regional to CONUS scales. Use of the eMODIS expedited product enabled a NRT CONUS forest disturbance detection product, a requirement for an eventual, operational forest threat EWS.
- The 2009 classification product from this study can be used to quantity the areal extent of forest disturbance across CONUS, although a quantitative accuracy assessment still needs to be completed. However, the results would not include disturbances that occurred after July 27, such as the Station Fire.
- While not shown here, the project also produced maximum NDVI products for the June 10 – July 27 period of each year of the 2000-2009 time frame. These products could be applied to compute forest change products on an annual basis. GIS could then be used to assess disturbance persistence. Such follow-on work could lead to attribution of year in which a disturbance occurred.
- These products (e.g., Figures 6 and 7) may also be useful for assessing forest change associated with climate change, such as carbon losses from bark beetle-induced forest mortality in the Western United States.
- Other MODIS phenological products are being assessed for aiding forest monitoring needs of the EWS, including cumulative NDVI products (Figure 10).

References


J. Spruce1; W. W. Hargrove2; G. Gasser3; J. C. Smoot2; P. Kuper1
1. Applied Sciences Dept., Science Systems & Applications, Inc., Stennis Space Center, MS, USA
2. Eastern Forest Environmental Threat Assessment Center, USDA Forest Service, Asheville, NC, USA
3. Lockheed Martin Civil Programs, Stennis Space Center, MS, USA

PDD: Joseph.P.Spruce@nasa.gov

Monitoring 2009 Forest Disturbance Across the Conterminous United States, Based on Near-Real Time and Historical MODIS 250 Meter NDVI Products