

Monitoring regional forest disturbances across the US with near real time MODIS NDVI products resident to the ForWarn Forest Threat Early Warning System

Authors: Joe Spruce, Bill Hargrove, Jerry Gasser, and Steve Norman

Forest threats across the US have become increasingly evident in recent years. Sometimes these have resulted in regionally evident disturbance progressions (e.g., from drought, bark beetle outbreaks, and wildfires) that can occur across multiyear durations and have resulted in extensive forest overstory mortality. In addition to stand replacement disturbances, other forests are subject to ephemeral, sometimes yearly defoliation from various insects and varying types and intensities of ephemeral damage from storms. Sometimes, after prolonged severe disturbance, signs of recovery in terms of Normalized Difference Vegetation Index (NDVI) can occur. The growing prominence and threat of forest disturbances in part have led to the formation and implementation of the 2003 Healthy Forest Restoration Act which mandated that national forest threat early warning system be developed and deployed. In response, the US Forest Service collaborated with NASA, DOE Oakridge National Laboratory, and the USGS Eros Data Center to build and roll-out the near real time ForWarn early warning system for monitoring regionally evident forest disturbances. Given the diversity of disturbance types, severities, and durations, ForWarn employs multiple historical baselines that are used with current NDVI to derive a suite of six forest change products that are refreshed every 8 days. ForWarn employs daily quarter kilometer MODIS NDVI data from the Aqua and Terra satellites, including MOD13 data for deriving historical baseline NDVIs and eMODIS 7 NDVI for compiling current NDVI. In doing so, the Time Series Product Tool and the Phenological Parameters Estimation Tool are used to temporally de-noise, fuse, and aggregate current and historical MODIS NDVIs into 24 day composites refreshed every 8 days with 46 dates of products per year. The 24 day compositing interval enables disturbances to be detected, while minimizing the frequency of residual atmospheric contamination. Forest change products are computed versus the previous 1, previous 3, and all previous years in the MODIS record for a given 24 day interval. Other “weekly” forest change products include one computed using an adaptive length compositing method for quicker detection of disturbances, two others that adjust for seasonal fluctuations in normal vegetation phenology (e.g., early versus late springs). This overall approach enables forest disturbance dynamics from a variety of regionally evident biotic and abiotic forest disturbances to be viewed and assessed through the calendar year. The change products are also being utilized for forest change trend analysis and for developing regional forest overstory mortality products. ForWarn’s forest change products are used to alert forest health specialists about new forest disturbances. Such alerts are also typically based on available Landsat, aerial, and ground data as well as communications with forest health specialists and previous experience. ForWarn products have been used to detect and track many types of regional disturbances to multiple forest types, including defoliation from caterpillars and severe storms, as well as mortality from both biotic and abiotic agents (e.g., bark beetles, drought, fire, anthropogenic clearing). ForWarn offers products that could be combined with other geospatial data on forest biomass to assess forest disturbance carbon impacts within the conterminous US.