

OPERA: Observational Products for End-Users from Remote Sensing Analysis

Land Surface Disturbance (DIST)

The Disturbance product (DIST) maps vegetation disturbance in near-real time using imagery from the orbiting Landsat-8 and Sentinel-2 A/B sensors. Vegetation disturbance is detected when vegetation cover decreases, or spectral variation is outside a historical norm. The product can identify logging activities in the depths of a dense rainforest, commercial or residential development as cities grow, or natural hazards such as landslides and lava flows.

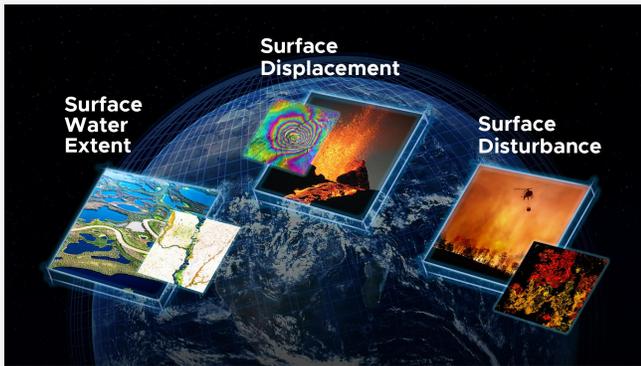
Tracking Vegetation

Whether it's monitoring the health of regional agriculture or finding the extent of a massively expanding fire, mapping vegetation loss is at the core of numerous environmental monitoring efforts. The near-global land disturbance product detects vegetation loss using the dense time-series of observations from Harmonized Landsat-8 and Sentinel-2 A/B (HLS) data. Using statistical machine learning, the DIST product identifies vegetation loss every 3-5 days, comparing the most recent acquisition to those in previous years, putting a dense stack of imagery squarely in perspective for disaster managers, policy makers, and scientists.



Figure: Dynamics that will be detected by the DIST algorithm; the right panel before and left, after. From top to bottom, open pit coal mining in southwest Indiana, commercial land use expansion in northern Virginia, conversion of secondary forest to cropland in northern Alabama, and loss of vegetation due to lava flow on Hawaii.

Comprehensive Products for Expansive Needs



Surface Water Extent: Firth River Yukon; **Credit:** USGS/John Jones. **Surface Displacement:** Lava boiling out of the Kilauea **Credit:** ASI/NASA/JPL-Caltech. **Surface Disturbance:** Firefighting helicopter. **Credit:** UMD/Google/USGS/NASA/Matthew Hansen.

The JPL OPERA project will develop and provide three product suites: (1) a near-global Dynamic Surface Water Extent Product (*DSWx*) from optical and synthetic aperture radar (SAR) data, (2) a near-global Land Surface Change Disturbance Product (*DIST*) from optical data, and (3) a North America Land Surface Displacement Product (*DISP*) from SAR data. Each of these products will be periodically updated to reflect a growing archive of regularly acquired data, thus supporting and informing hazard monitoring and disaster response efforts.

***Near-global:** all land-masses excluding Antarctica; **North America:** the United States (USA) and US Territories, Canada within 200 km of the US border, and all mainland countries from the southern US border up to and including Panama.

The Dynamics of Disturbance from a Constellation of Satellites

Alerts of land change are crucial for a variety of land monitoring efforts including:

(a) deforestation monitoring with the Real-Time System for Detection of Deforestation, (b) active fire monitoring with the NASA's Fire Information for Resource Management System, (c) food security with the Famine Early Warning System of USAID, and (d) Global Forest Watch's deforestation alerts globally.

The *DIST* product uses sophisticated statistical machine learning techniques to identify disturbances in vegetative cover from prior years by comparing each current HLS scene to a composite from previous years representing a lower bound of observed vegetation cover. The composite is derived from a small temporal window surrounding the date of the current HLS

scene to account for intra-annual variation. Anomalous vegetative cover loss is recorded and tracked over time. Repeated estimates of vegetation loss are used as a confidence measure in assigning loss in terms of magnitude and persistence. The algorithm may be used to track commercial and residential developments and mining from high-magnitude, long-lived loss dynamics, and selected logging and droughts in the case of low level, short-lived loss dynamics.

The *DIST* product leverages imagery from a constellation of orbiting optical sensors to detect disturbances every 3-5 days (*DIST-ALERT*). The *DIST-ALERT* product tracks land change data with each new acquisition from the optical constellation.

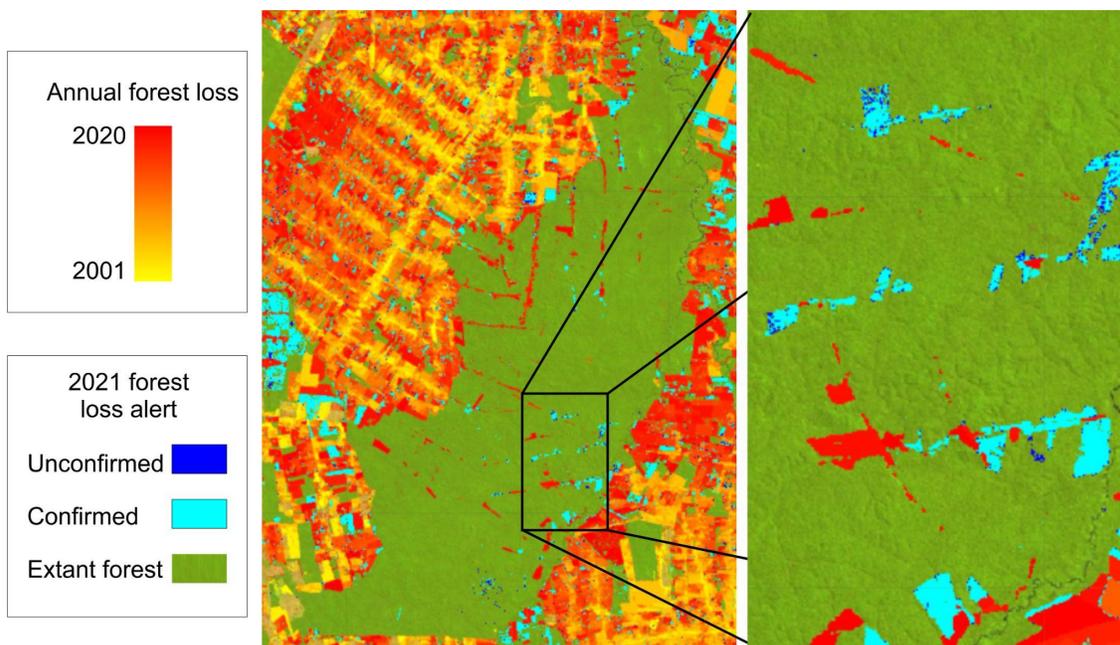
The product serves researchers, policy makers, and environmental managers who monitor vegetation dynamics in near real-time to track land-use expansion, resource extraction, and vegetation loss from

drought or landslides. Scientists interested in broader trends over larger spatial and temporal scales can leverage the DIST-ANNUAL data, a summary of annual confirmed disturbances from the DIST-ALERT product.

Example: Monitoring Deforestation in Brazilian Reserve

Governance of land use and tenure rights is an important issue in developing countries. In the example below, incursions into the Karipuna Indigenous Reserve in Rondonia, Brazil are documented. Such alert information may be used by authorities to interdict illegal clearing.

The Brazilian Space Agency pioneered deforestation alerts that served as a tool in reducing deforestation in Brazil from 2004 to 2012. Since then, deforestation clearings have increased as enforcement has waned.



Map showing DIST-ALERT disturbances for 2021 over a DIST-ANNUAL map of 2020. Provisional disturbances are in blue (i.e. disturbances that are first observed in 2021 acquisition), confirmed disturbances in cyan (i.e. disturbances that have been observed in multiple earlier acquisitions). Data from the Global Forest Watch product developed and implemented by OPERA team partner, University of Maryland Global Land and Analysis laboratory. Dates of first disturbance are recorded and indicated change delivered within days of observation. Annual confirmed summary forest disturbance is shown in yellow to red from 2001 through 2020.