National Aeronautics and Space Administration

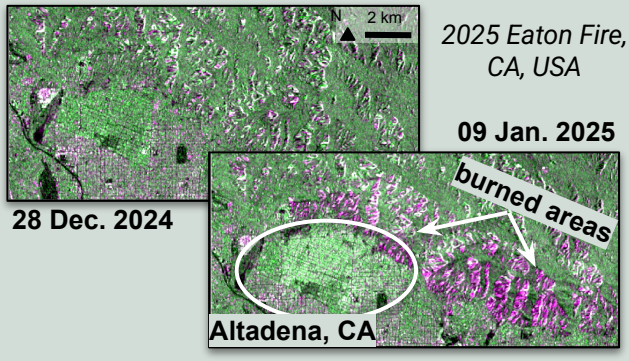
OPERA: Observational Products for End-Users from Remote Sensing Analysis

Surface Disturbance from Sentinel-1

Overview

The OPERA Surface Disturbance from Sentinel-1 (DIST-S1) product provides a consistent, near-global view of *generic disturbance*, on areas where radar backscatter measurements, derived from the input OPERA Radiometric Terrain-Corrected (RTC-S1) products, exhibit a statistically significant deviation from their normal baseline. DIST-S1 offers a powerful lens for observing a wide range of surface changes, from slower processes like forest loss or agricultural activity to rapid and extreme events such as wildfires, flooding, volcanic eruptions, landslides, earthquakes, including anthropogenic disturbances. Since it serves as a general disturbance indicator without direct attribution, users can combine DIST-S1 with expert knowledge and/or ancillary datasets to interpret the underlying causes and context of change. Unlike optical satellites, radar can see through clouds and operate day and night, enabling DIST-S1 to deliver a consistent detection of surface changes under all weather and lighting conditions.

How Radar Reveals Burned Areas After Fires



The false-color RGB visualization of OPERA RTC-S1 combines both co-polarized backscatter values (red and blue) with cross-polarized (green) to generate a color image from SAR data. In this false-color scale, vegetated areas appear green; urban and/or sparsely vegetated areas appear white/pink; calm water appears black.

Did you know? **The OPERA RTC-S1 products serve as the input for generating the higher-level DIST-S1 product.** RTC-S1 provides brightness-calibrated and terrain-corrected radar backscatter measurements that can capture subtle to extreme changes in surface properties, including those caused by wildfires. Such surface disturbances are automatically detected in the DIST-S1 product, where they appear as high-confidence disturbance pixels, enabling consistent tracking of the burned areas and over longer timescales, the observation of vegetation recovery.

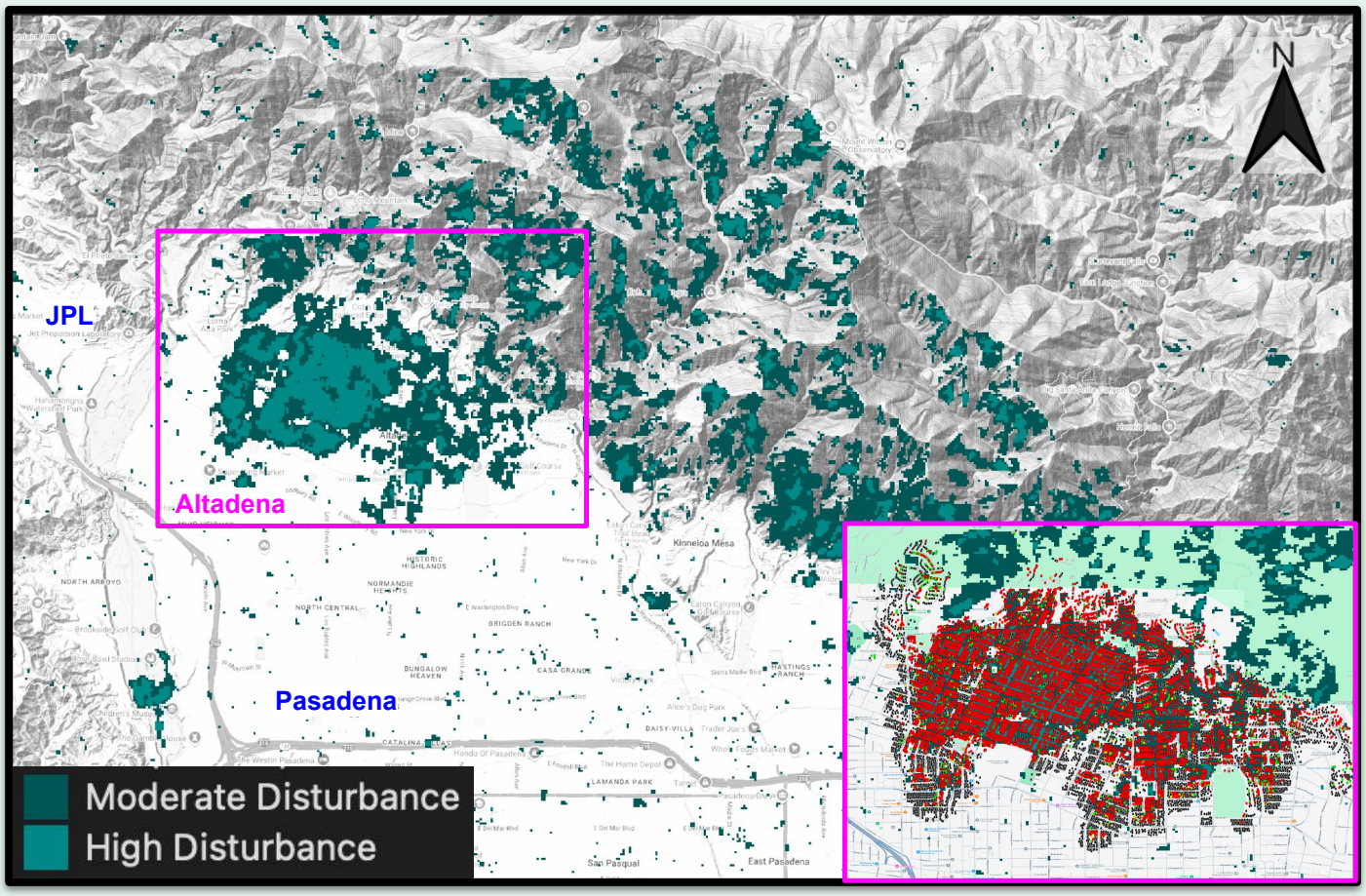
File Naming Convention:
OPERA_L3_DIST-ALERT-S1_<TileID>_<AcqDateTimeZ>_<ProdGenDateTimeZ>_<Sensor>_30_v<version>_<LayerName>.tif
Example:
OPERA_L3_DIST-ALERT-S1_T11SLT_20250121T015030Z_20250819T130204Z_S1_30_v0.1_GEN-DIST-STATUS.tif

Product details

File type: Cloud-Optimized GeoTIFF
Spatial reference: Military Grid Reference System (MGRS)
Resolution: 30-meter posting
Tile size: ~110 × 110 km (3600 × 3600 pixels)
Latency: Every 6-12 days (S1 A/C)
Distribution: ASF DAAC

What's Inside Each DIST-S1 Product?

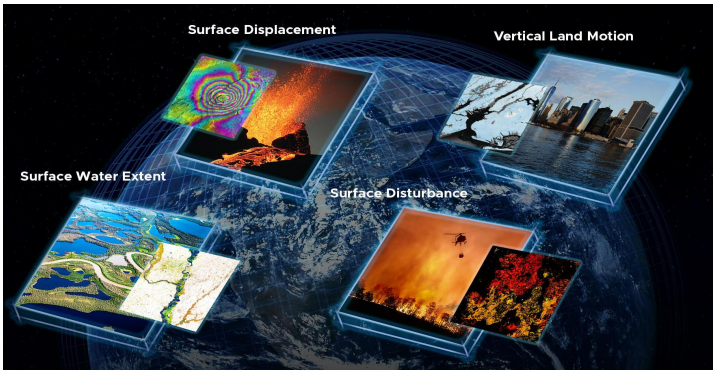
Disturbance Status – Indicates if a detected change is first, provisional, or confirmed, and confidence level (low, moderate, high).
Disturbance Latest Status – Highlights new changes detected from the most recent acquisition.
Anomaly Metrics– Transformer-derived disturbance metrics (Mahalanobis distance between latest image and baseline set).
Confidence, Duration, and Date Layers – Captures the reliability, persistence, and timing of detected surface changes.



DIST-S1 GEN-DIST-STATUS layer showing surface disturbance associated with the January 2025 Eaton Fire that impacted Altadena, California. *Inset*: the same layer overlaid with the CAL FIRE Damage Inspection database (red points), which identifies structures damaged or destroyed by wildland fire. *Basemap: Google Earth.*

DIST-S1 Example Use Cases:

- **Wildfire monitoring:** Track burned areas and vegetation recovery.
- **Flood impact assessment:** Identify zones affected during or after hurricanes.
- **Landslide:** Detect landslides in mountainous regions.
- **Deforestation tracking:** Spot new clearings or logging activity in forested landscapes.
- **Lava flow mapping:** Maps emplacement of lava flows during volcanic eruptions.
- **Infrastructure and urban change:** Observe construction, land development, and building damages following disasters.



The JPL-led OPERA project develops and provides four product suites. Clockwise starting from bottom left: ***Surface Water Extent:*** *Firth River Yukon;* ***Surface Displacement:*** *Lava fountaining at Kilauea volcano;* ***Vertical Land Motion:*** *Subsidence and uplift over New York City.* ***Surface Disturbance:*** *Firefighting helicopter.* ***Credit:*** *Hansen/UMD/Google/USGS/NASA.*

About the authors: The development of this product quick guide was led by Dr. Mary Grace Bato, Dr. Alexander Handwerger, and Dr. Talib Oliver Cabrera in collaboration with the OPERA DIST-S1 Algorithm Development and Project Science Teams.

National Aeronautics and Space Administration

Jet Propulsion Laboratory | California Institute of Technology | Pasadena, CA 91109
www.jpl.nasa.gov/go/opera

www.nasa.gov

CL#25-4400