**NASA DEVELOP National Program**

****NASA Jet Propulsion Laboratory

**Summer 2015**

**Short Title: California Disasters II**

**Subtitle:** A New Method for Providing Near-Real-Time Active-Fire and Post-Burn Support to Fire Responders Using Data Products Derived from NASA’s Uninhabited Aerial Vehicle Synthetic Aperture Radar (UAVSAR)

**VPS Title:** The Radar Games: Catching Fires

**Project Team & Partners**

**Project Team:**

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**Partner Organizations**

California Department of Forestry and Fire Protection (CAL FIRE), End-User, POCs: Chris Starnes, Deputy Chief, Operations Support, and Jana Luis, Division Chief, Predictive Services

US Forest Service Remote Sensing Activities Center, Boundary Organization, POC: Brad Quayle, Program Leader, Rapid Disturbance Assessment and Services Program

**Project Details**

**Applied Sciences National Applications Addressed:** Disasters

**Study Area:** California (CA)

**Study Period:** January 2009 - Present

**Earth Observations & Parameters**

Gulfstream III, UAVSAR - Polarimetric Synthetic Aperture Radar (PolSAR)

Landsat 5, TM - Normalized Burn Ratio (NBR)

Landsat 7, ETM+ - Normalized Burn Ratio (NBR)

Landsat 8, OLI - Normalized Burn Ratio (NBR)

**Ancillary Datasets Utilized**

* USGS National Land Cover Dataset (NLCD) - Land Cover Shapefiles
* USFS California Vegetation (CALVEG) Mapping Zones - Vegetation Cover Shapefiles
* CAL FIRE Fire Resource and Assessment Program (FRAP) website – wildfire acres burned, dates of incident, location, and perimeter shapefiles
* Wildland Fire Leadership Council (WFLC) Monitoring Trends in Burn Severity (MTBS) Individual Fire-Level Geospatial Data - fire perimeter shapefiles, soil burn severity maps, dNBR shapefiles

**Software Utilized**

ENVI – Image Enhancement of Landsat imagery

IDL – Polarimetric Decomposition of Radar Imagery

ArcGIS – Raster Manipulation/Analysis, Image Enhancement & Map Creation of Landsat dNBR and PolSAR imagery

Python – Batch downloading of PolSAR imagery, Converting PolSAR imagery to decibels (dB) & creation of Differenced cross-polarized amplitude (dCA) imagery

**Project Overview**

**80-100 Word Objectives Overview**

This project explored the viability of using polarimetric radar products from NASA’s airborne Uninhabited Aerial Vehicle Synthetic Aperture Radar (UAVSAR) instrument to provide near-real-time-map products to on-the-ground fire responders during active wildfires. The team processed UAVSAR data for a comprehensive list of moderate to large fires in California from 2009 to the present, and evaluated the effectiveness of radar to detect changes due to wildfires in different types of Californian vegetation and terrain. The UAVSAR differenced cross-polarized amplitude (dCA) data sets were compared with Landsat-derived differenced Normalized Burn Ratio (dNBR) data sets for preliminary validation.

**Abstract**

The need for efficient wildfire monitoring and assessment is paramount in California due to increasing ecological and economical losses caused by wildfire. The California Disasters II team at the Jet Propulsion Laboratory partnered with the California Department of Forestry and Fire Protection (CAL FIRE) and the US Forest Services Remote Sensing Activities Center (RSAC) to examine the potential of using radar-derived imagery from NASA’s Uninhabited Aerial Vehicle Synthetic Aperture Radar (UAVSAR) sensor for active fire assessment. Currently, remote sensing support for active fire response is limited to infrared-detecting satellites with relatively low spatial or temporal resolutions, or to airborne sensors that have limited availability and that may be interfered by cloud and smoke. The UAVSAR instrument mounted on NASA’s Gulfstream III plane, however, has a high spatial resolution of 5m, can be flown day or night, and can penetrate cloud and smoke. The team studied wildfires throughout California from 2009 to the present and analyzed the ability of the UAVSAR sensor to detect burn scars and classify burn severity using a simple method with minimal computational demands. The results showed that the UAVSAR sensor is capable of detecting changes in vegetation due to wildfires. This preliminary study suggests that polarimetric SAR has the potential to become a powerful tool for active fire response.

**Community Concerns**

* Destructive wildfires in California have increased in number and size within the last decade, exacerbated by severe drought conditions.
* Erratic fire behavior, smoky conditions and uneven terrain make accurately assessing the intensity of a fire and its growth-potential during an active burn difficult, but as the 2009 Station fire in the Los Angeles area showed, small fires can quickly grow to raging infernos when the fire severity potential is not accurately assessed.
* Currently, fire responders in California such as the California Department of Forestry and Fire Protection (CAL FIRE) are limited to visual assessments by ground or by air when responding to on-the-ground fires.
* Fire responders work long hours, often with no sleep, and require access to data products that are easy to understand, quickly accessible, and reliably accurate.

**Current Management Practices & Policies**

Current methods in remotely sensing fires involve the use of infrared spectral imagery. Airborne infrared sensors from the National Infrared Operations (NROPs) center in Boise, Idaho, can be requested for once-per-night flight scans of active fires. These flights result in thermal images that are interpreted by specialists and ready for fire responders by morning. Fire responders also use Moderate Resolution Imaging Spectroradiometer (MODIS) dNBR products with limited temporal and spatial resolution (1km, daily) for synoptic views during active fires. Higher spatial resolution (30 m) dNBR products derived from Landsat products are used by the Forest Service to create post-fire mitigation plans with low temporal resolution (16 days), but are of limited use during active fires.

**Decision Support Tools & Benefits**

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| **End-Product** | **Earth Observations Used** | **Benefit & Impact** |
| Comprehensive case study compilation and analysis of dCA and dNBR Images | Gulfstream III UAVSAR – HVHV Polarized imagery | Demonstrated potential to provide high resolution imagery of fire perimeters in near-real-time with data that can be captured any time of day or night with minimal processing, for active fire response decision making |

**Project Imagery**

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**Caption:** UAVSAR radar image of the burn scar from the Mint Fire in Los Angeles, CA, September 2011. Yellow indicates highest vegetative change; black indicates lowest. Image Credit: California Disasters II.

**Image:** 2015Sum\_JPL\_CADisastersII\_FInalImage.jpg