



# NASA ARMD

## Wildfire Management Workshop

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# Disclaimer



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# Classification

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# Wildland Fire Response – Critical Requirements



- Where is the Fire?
  - Direction, Spread, Speed, Intensity
  - Real Time Modeling-Like Tornado “Storm Tracks”
- Where are the Firefighters?
  - Personnel, Engines, Aircraft
- Where are the Values at Risk?
  - Homes, Business, Natural Resources, Critical Infrastructure
- Where are the people and how do they get out?
  - Can they understand how to get out?
- All in one Common Operating Picture Across Any Device



# Wildfires: A Devastating Threat to the Public, Infrastructure, and Resources





“Tree dies-offs of this magnitude are unprecedented and increase the risk of catastrophic wildfires that puts property and lives at risk.”

**Tom Vilsack**  
Secretary of Agriculture



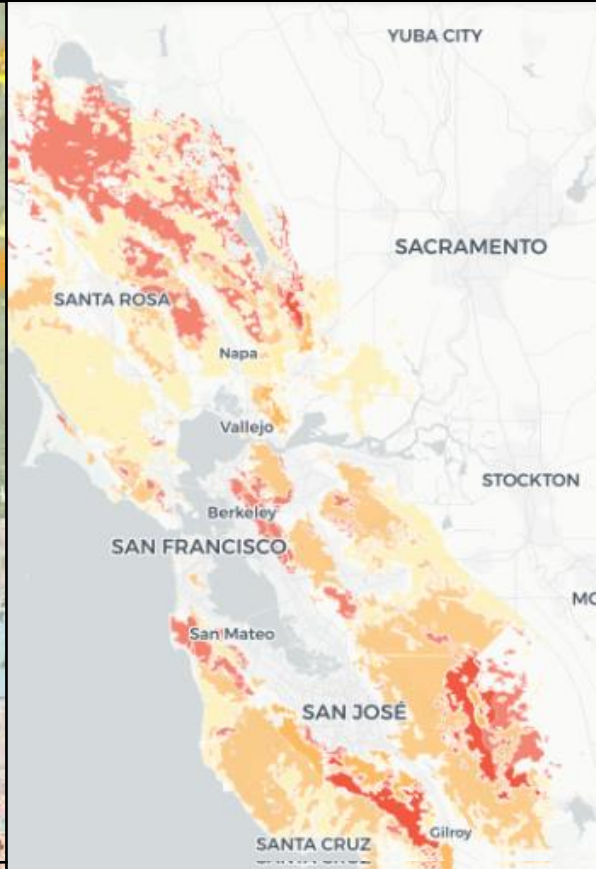
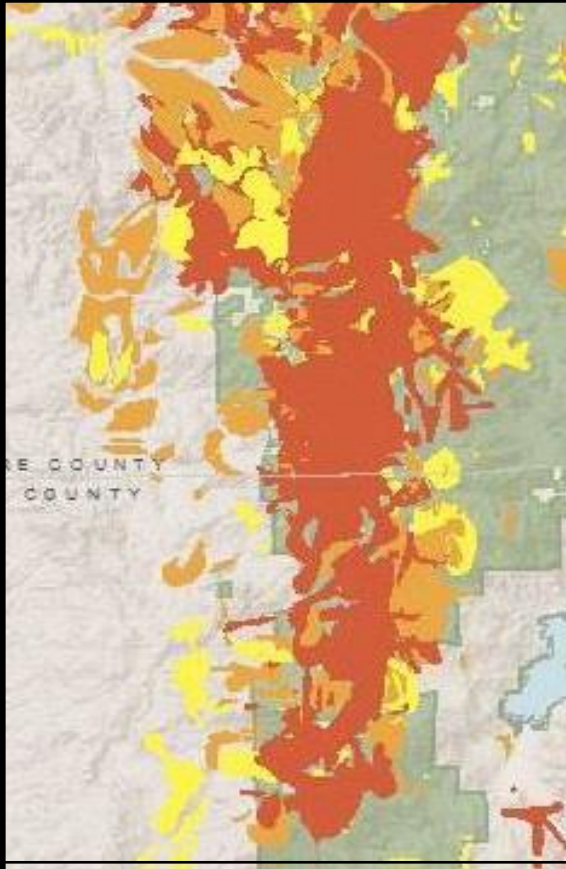
#StandingDead

<http://www.fs.usda.gov/CATreeMortality>





# Wildland-Urban Interface



***Wildfire does not recognize jurisdictional boundaries.***



# Tree Mortality



**102+ Million Dead Trees In California**



# Wildland Fire Operational Environment



























# Canyon Fire 2016

## Vandenberg AFB, CA



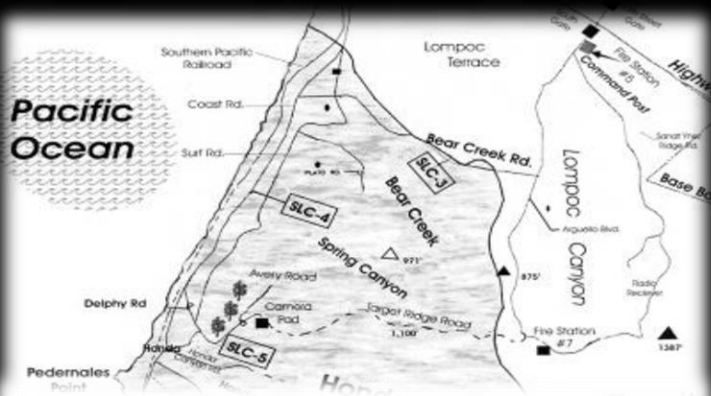
One Death FF Ryan Osler and Several Entrapments





# Honda Canyon Fire 1977

## Vandenberg AFB, CA



Col. Joseph Turner



Fire Chief Billy Bell



Asst. Chief Gene Cooper



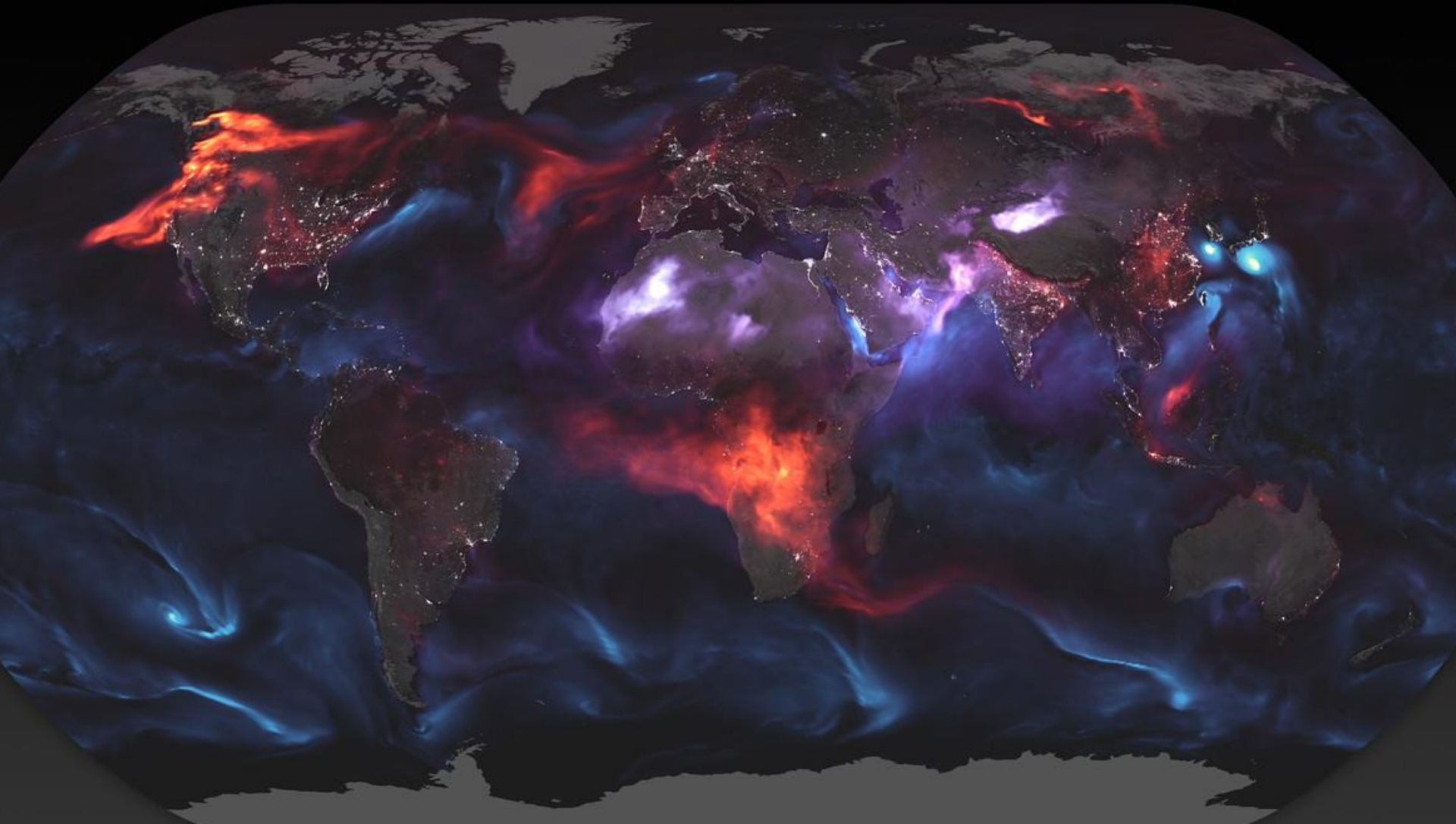
Dozer Op Clarence McCauley

Hot-Shots assemble for Backfire Operation.

Four Deaths and Eight Entrapments

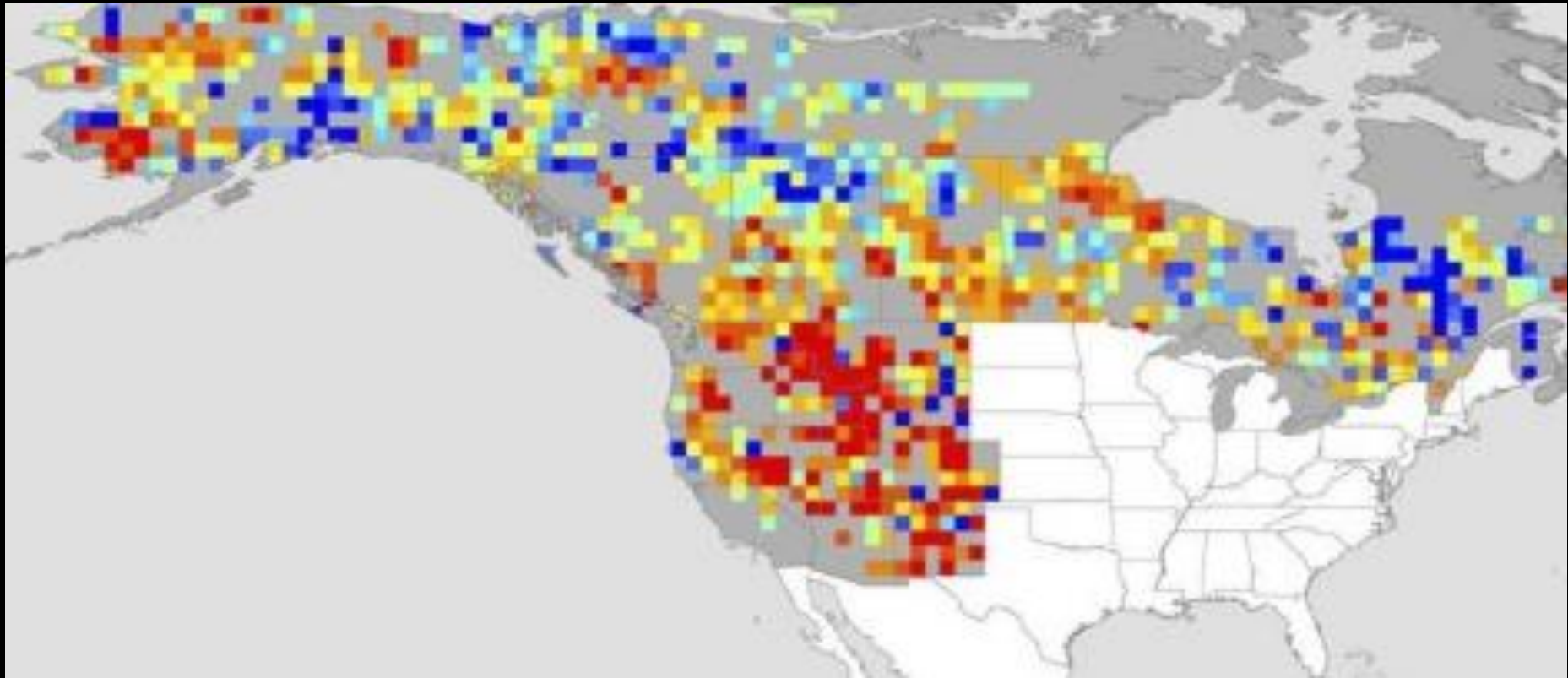


# "Fire Planet"





# Projection of Change to 2039



Projected change in annual area burned for the period 2010–2039, with red colors indicating areas with the greatest increase in area burned annually in wildfires, and dark blue the least. Credit: University of Arizona





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## What We Need For Wildfire Detection?



Near-Real Time IR wildfire detection, tracking, and projection is needed on the front lines of wildfire management in austere areas to respond to the wind-driven and fast moving wildfires.



# Cedar Progression



October 2003







# Cedar Fire Witness





# In 2019 We Asked Is it getting worse?



Two of the largest fires in California history within the last two years (17/18)



Six of the top 20 Most destructive Fires occurred in the last 2 years (17/18)

Eight in the last 5 years (2013-18)

Top 20 Largest California Wildfires

FIRE NAME (CAUSE)	DATE	COUNTY	ACRES	STRUCTURES	DEATHS
1 MENDOCINO COMPLEX* (Under Investigation)	July 2018	Colusa County, Lake County, Mendocino County & Glenn County	459,123	280	1
2 THOMAS (Under Investigation)	December 2017	Ventura & Santa Barbara	281,893	1,063	2
3 CEDAR (Human Related)	October 2003	San Diego	273,246	2,820	15
4 RUSH (Lightning)	August 2012	Lassen	271,911 CA / 43,666 NV	0	0
5 RIM (Human Related)	August 2013	Tuolumne	257,314	112	0
6 ZACA (Human Related)	July 2007	Santa Barbara	240,207	1	0
7 CARR (Human Related)	July 2018	Shasta County, Trinity County	229,651	1,604	7
8 MATILJA (Undetermined)	September 1932	Ventura	220,000	0	0
9 WITCH (Powerlines)	October 2007	San Diego	197,990	1,650	2
10 KLAMATH THEATER COMPLEX (Lightning)	June 2008	Siskiyou	192,038	0	2
11 MARBLE CONE (Lightning)	July 1977	Monterey	177,866	0	0
12 LAGUNA (POWERLINES)	September 1970	San Diego	175,425	382	5
13 BASIN COMPLEX (Lightning)	June 2008	Monterey	162,818	58	0
14 DAY FIRE (Human Related)	September 2006	Ventura	162,702	11	0
15 STATION (Human Related)	August 2009	Los Angeles	160,557	209	2
16 ROUGH (Lightning)	July 2015	Fresno	151,623	4	0
17 McNALLY (Human Related)	July 2002	Tulare	150,696	17	0
18 STANISLAUS COMPLEX (Lightning)	August 1987	Tuolumne	145,980	28	1
19 BIG BAR COMPLEX (Lightning)	August 1999	Trinity	140,948	0	0
20 HAPPY CAMP COMPLEX (Lightning)	August 2014	Siskiyou	134,056	6	0

Top 20 Most Destructive California Wildfires

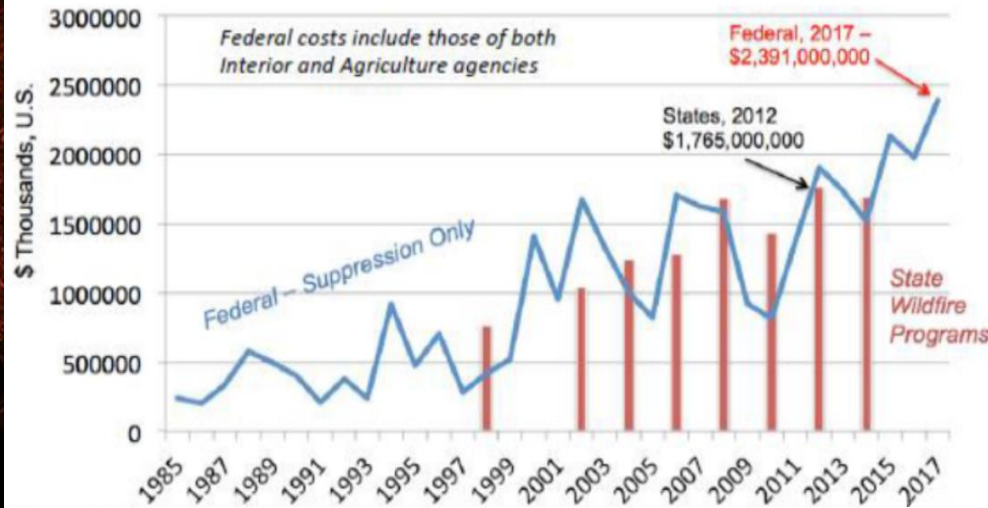
FIRE NAME (CAUSE)	DATE	COUNTY	ACRES	STRUCTURES	DEATHS
1 TUBBS (Under Investigation)	October 2017	Napa & Sonoma	36,807	5,636	22
2 TUNNEL - Oakland Hills (Rekindle)	October 1991	Alameda	1,600	2,900	25
3 CEDAR (Human Related)	October 2003	San Diego	273,246	2,820	15
4 VALLEY (Electrical)	September 2015	Lake, Napa & Sonoma	76,067	1,955	4
5 WITCH (Powerlines)	October 2007	San Diego	197,990	1,650	2
6 CARR* (Human Related)	July 2018	Shasta County, Trinity County	229,651	1,604	7
7 NUNS (Under Investigation)	October 2017	Sonoma	54,382	1,355	3
8 THOMAS (Under Investigation)	December 2017	Ventura & Santa Barbara	281,893	1,063	2
9 OLD (Human Related)	October 2003	San Bernardino	91,281	1,003	6
10 JONES (Undetermined)	October 1999	Shasta	28,200	954	1
11 BUTTE (Powerlines)	September 2015	Amador & Calaveras	70,868	921	2
12 ATLAS (Under Investigation)	October 2017	Napa & Solano	51,624	783	6
13 PAINT (Arson)	June 1990	Santa Barbara	4,900	641	1
14 FOUNTAIN (Arson)	August 1992	Shasta	63,960	636	0
15 SAYRE (Misc.)	November 2008	Los Angeles	11,262	604	0
16 CITY OF BERKELEY (Powerlines)	September 1923	Alameda	130	584	0
17 HARRIS (Under Investigation)	October 2007	San Diego	90,440	548	8
18 REDWOOD VALLEY (Under Investigation)	October 2017	Mendocino	36,523	546	9
19 BEL AIR (Undetermined)	November 1961	Los Angeles	6,090	484	0
20 LAGUNA (Arson)	October 1993	Orange	14,437	441	0



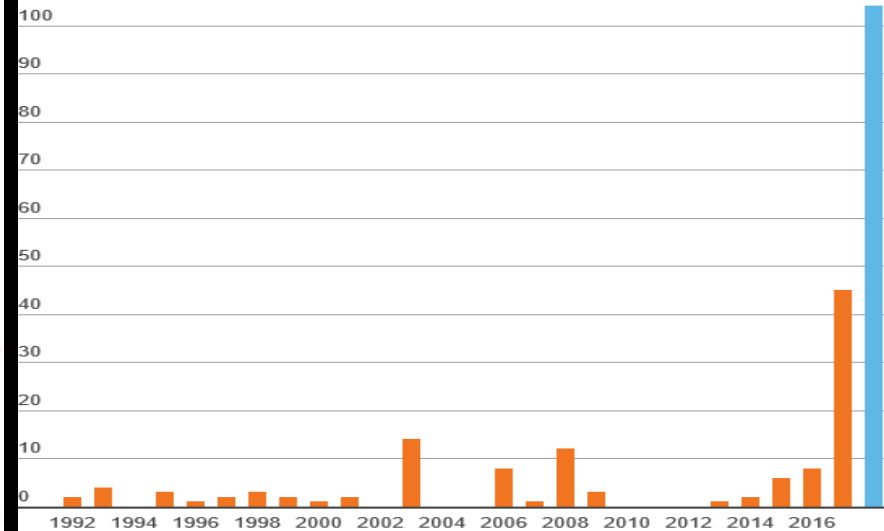
# Bottom Line- What does the Future Hold?



### Federal and State Firefighting Costs, 1985-2017



### Lives Lost in Wildfire in California 1992-2018



- Larger Wildfires
- More Loss of Life
- More Homes Destroyed in the WUI
- Soaring Public and Private Costs
- Critical Infrastructure Threatened
- Overlapping Fire Seasons – Fire Year





# Wildland Fire Response – What We Currently Have:



## Satellites

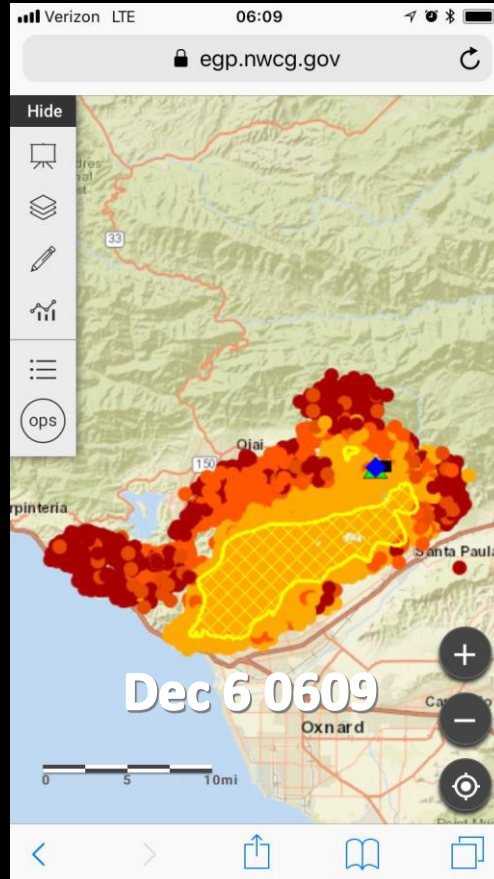
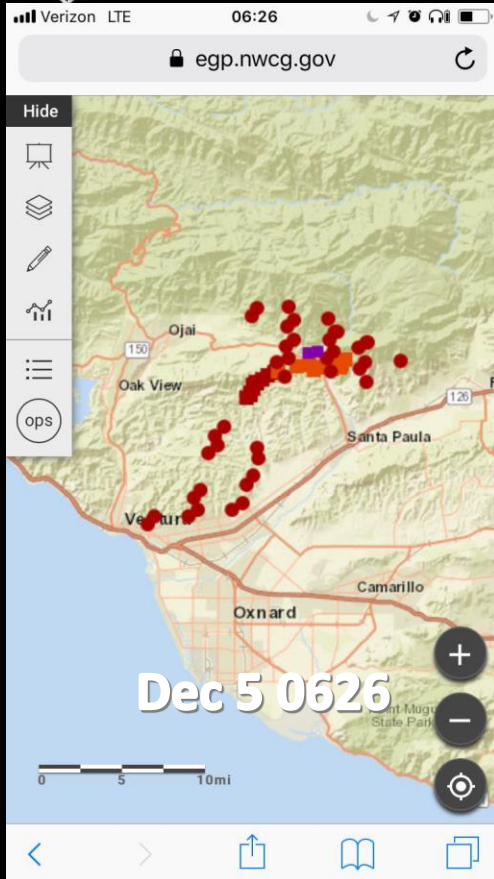
- MODIS/VIIRS (EGP)
  - 4 x images a day
- HAWKEYE/FIREFLY
  - ?
- FireGuard
  - Every 15 Mins

## Aircraft

- USFS AH-1 FireWatch Cobra
  - 2 x California
- USFS AA-51
  - 1 x SOCAL
- DRTI CO Multi-Msn AC
- NIROPS
  - 1 x Nationally
- Other Contracts



# MODIS & VIIRS



- Satellite-based fire detection
- Only 4 fire snapshots per day



# Thomas Wildfire

## Ventura, CA







# Thomas Wildfire

## Ventura, CA



Dec 4, 2017-Feb 28 2018  
281,893 Acres  
Structures Destroyed: 1,063  
Structures Damaged: 280

SKYMAP7



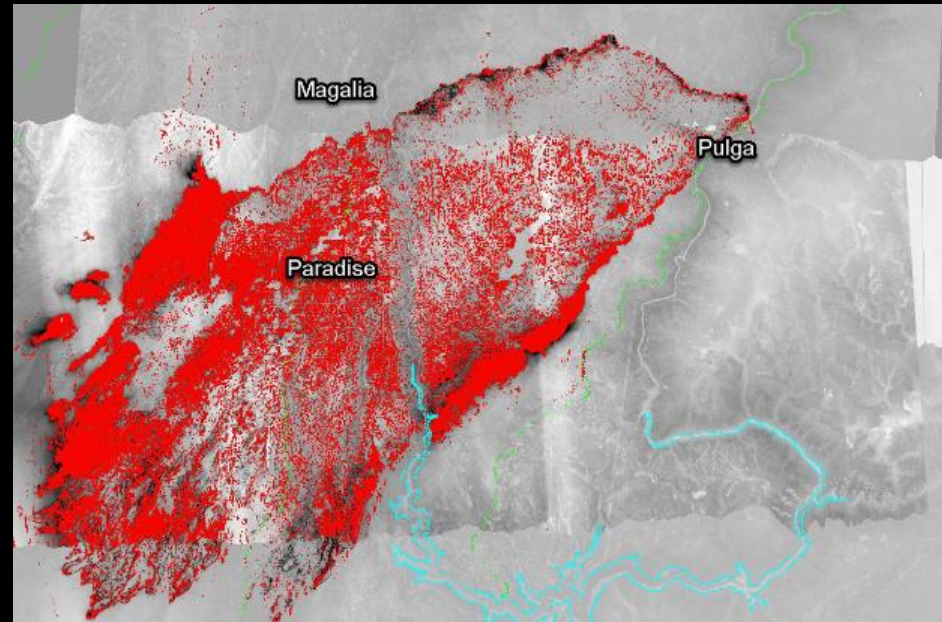


# NIROPS

## National Infrared Operations Program



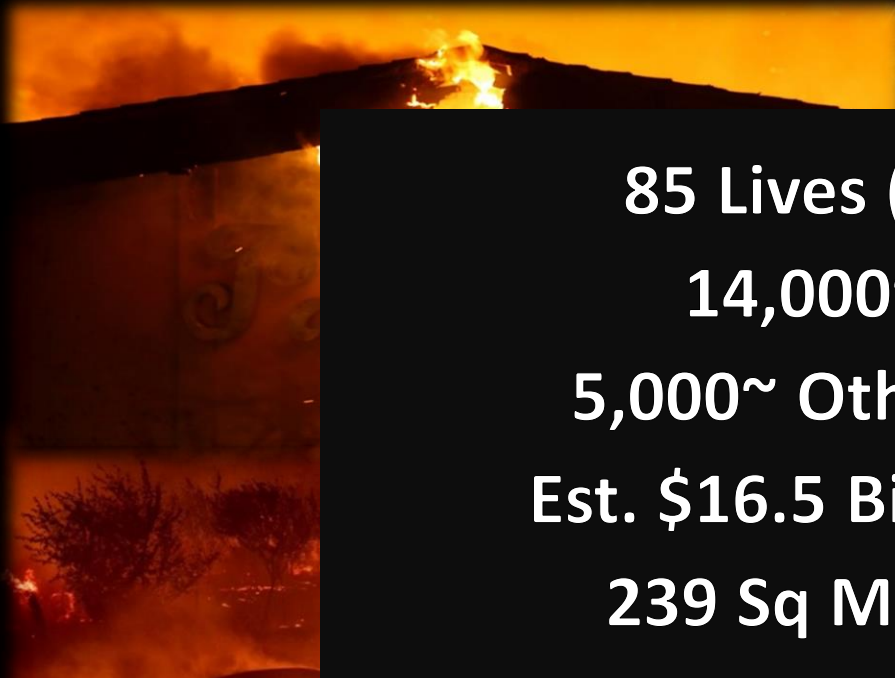
- Provides infrared images of fires from aerial platform
- Single nightly snapshot of fire perimeter
- 3 fulltime pilots
- 10 person IR tech team







# Camp Fire - Paradise, CA November 2018



Camp Fire  
Smoke from  
Paradise to San  
Francisco

**85 Lives (1 Missing)**  
**14,000~ Homes**  
**5,000~ Other Buildings**  
**Est. \$16.5 Billion in losses**  
**239 Sq Miles Burned**












# Firewatch Next Project (2018-?)



## LEGEND

	1530-1535 HRS – 25 ACRES
	1545-1550 HRS – 73 ACRES
	1600-1605 HRS – 22 ACRES
	1620-1625 HRS – 110 ACRES
	1715-1720 HRS – 155 ACRES

- DoD data
- Human manual interpretation and declassification
- Minimum processing time: 15 minutes
- High ongoing costs/high staffing levels





# USFS-CALGUARD-CALFIRE



## SPOT REPORT

FIRE GUARD DETECTION AND ASSESSMENT  
COMPILED FROM MULTIPLE SOURCES



Area estimate and graphical depiction is not actual fire perimeter. Acreage is not to be used for official reporting.

Serial: 20200610-8.8-2155

### What:

Lime

County: Ventura County

Lat: 34 27.2566

Lon: -118 47.2422

### Initial Detection:

06/10/2020 17:00

DPA: STATE

### Urban Proximity:

1.75 mi W of Santa Felicia Dam

### Weather:

72 F, 1 mph N, 9 mph Gust, 0% Cloud, 25% Hum

### Legend

When Detected

within 15 minutes

15-30 minutes

30-45 minutes

45 to 60 minutes

1 to 1 1/4 hours

1 1/4 to 1 1/2 hours

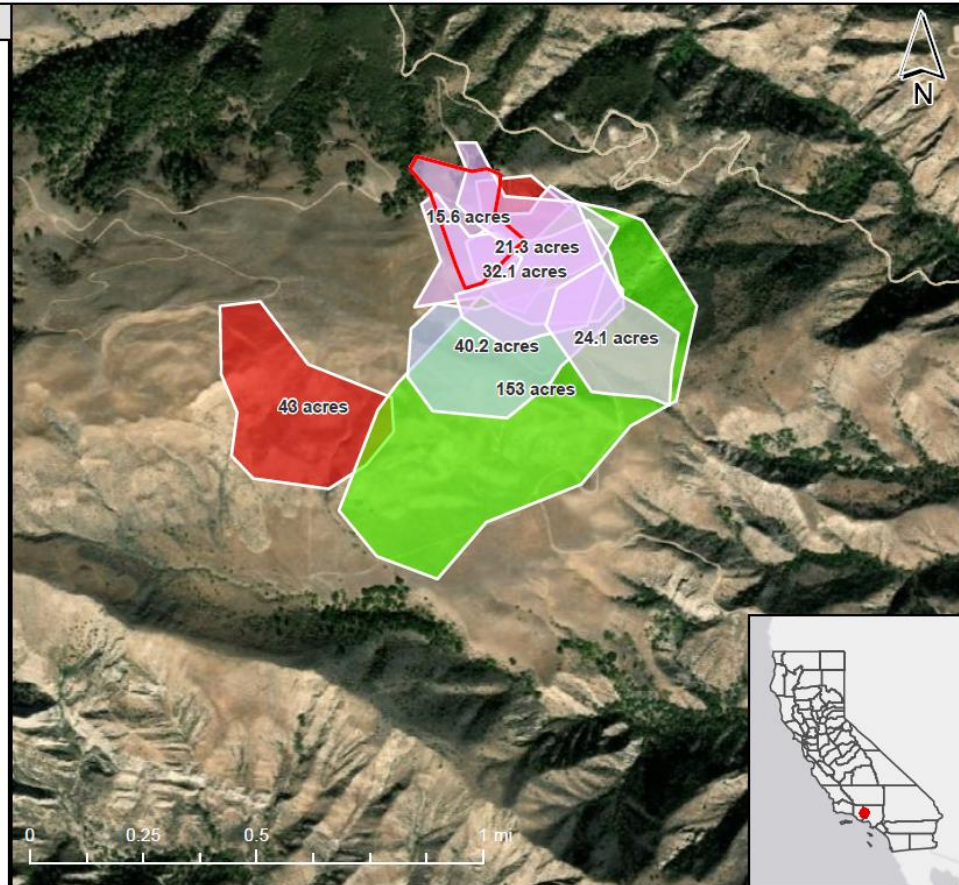
1 1/2 to 1 3/4 hours

1 3/4 to 2 hours

2 to 24 hours

More than 24 hours

First Detected



Comments: Split detection between base and ridge over past hour.

Time Stamp of Report:  
6/10/2020 10:05 PM





# Distributed Real Time Infra-red (DRTI)



- 1 x RC-26 block 25
  - MX-15 EO/IR sensor
  - VORTEX transmitter
  - RAMONA amplifier
  - 2 x pilots, 1 x sensor operator
  - 141 ARW (WAANG)
- 5 x ROVERs
  - L-3 SIR video receiver
  - Ruggedized laptops w/tailored software
  - PAS-23 Mini Thermal Monoculars
  - 124 FW (IDANG) and 194 RW (WAANG)





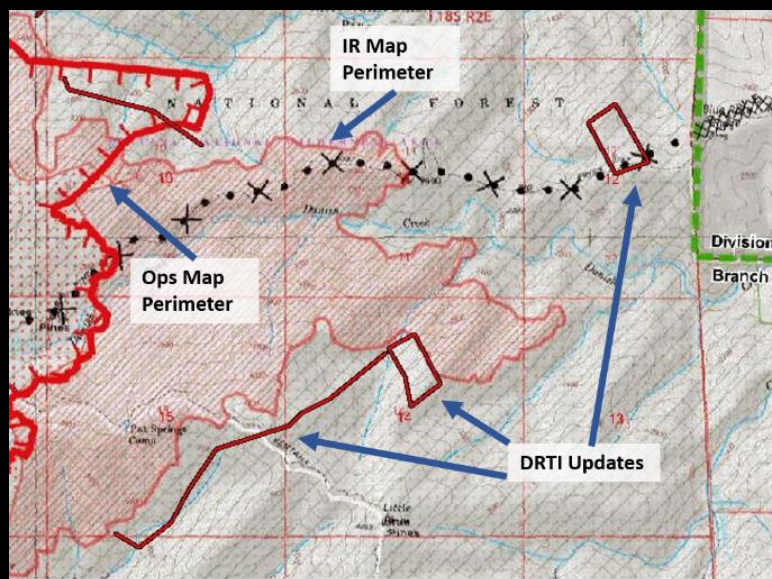




# Perimeter Data Example – From DRTI



*Soberanes Branch VIII using DRTI-provided perimeter maps delivered to their cell phone*



*DRTI updates drawn in real-time by aircrew and transmitted to ROVERs*



# Air Attack 51- Night Flying Air Attack



## Capabilities

- ❑ Recon fires visually
- ❑ Recon fires with IR
- ❑ Provide tactical assessment
- ❑ Monitor fire activity and behavior
- ❑ Supervise multiple aircraft over the fire
- ❑ Coordinate suppression actions
- ❑ Provide real-time intel to day and night Operations (transitional periods)







# Air Attack 51- Night Flying Air Attack



## Platform

- ▣ Twin Turbine Aero Commander
- ▣ 1 pilot
- ▣ 1 ATGS
- ▣ Tech Specialist as needed for complex fires

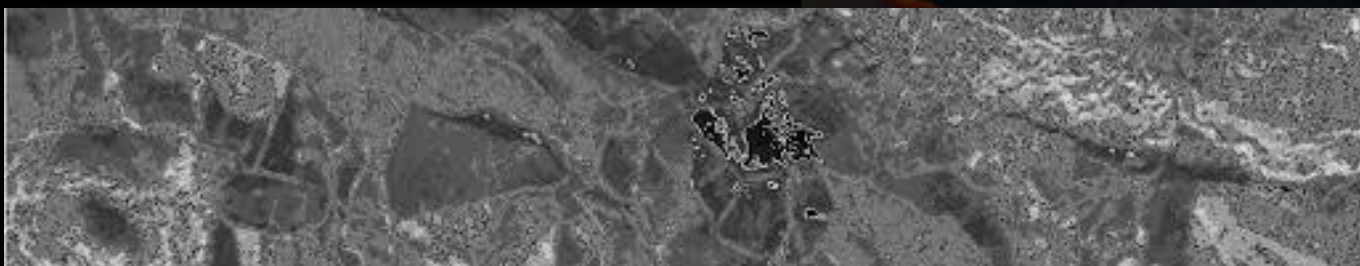




# FireWatch Cobra



- Former US Military Vietnam Era AH-1 “Cobra”
- Infrared and low-light sensors
- Real-time fire monitoring,
- GIS mapping,
- Real-time color video,
- Geo-referenced infrared,
- Infrared downlink



Phasing Out Due to ROI



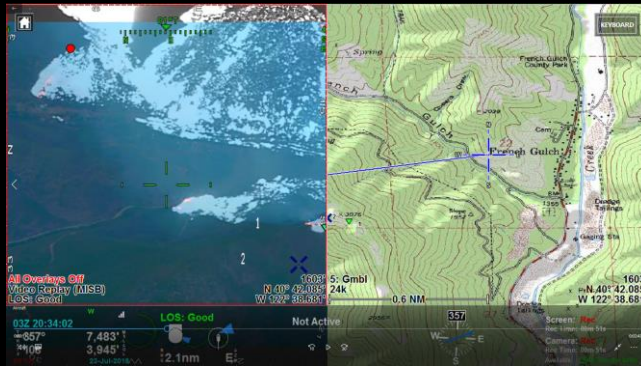
# Current Tools – Single Aircraft/Single Fire



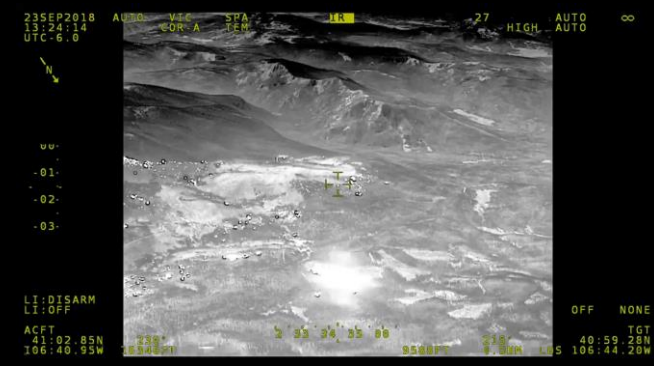
USFS Night Vision Air Attack—SOCAL Only



DRTI Natchez Wildfire



USFS Cobra Helo Firewatch IR

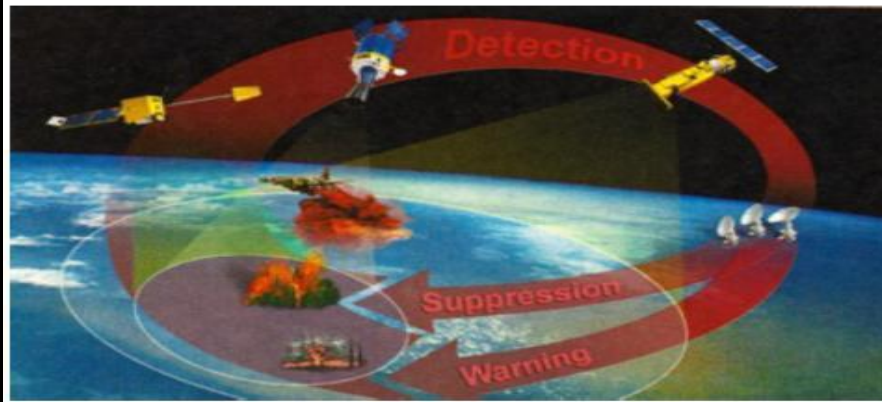


Colorado Multi-Mission Aircraft



# Firewatch / FADDS

- Beyond current capabilities of FireGuard
- DoD Existing Assets
- Automated Process
- Faster/More Accurate Results
- Lower Ongoing Costs/Staffing Levels
- Nationally Scalable



## Planned Satellite Components



DSP - Defense Support Program  
SBIRS - Space Based Infrared System



NOAA GOES - Geostationary Operational Environmental Satellite



NOAA POES - Polar Operational Environmental Satellite



NOAA-NASA-NIST Sumoi National Polar-Orbiting Partnership



NOAA-NASA JPSS - Joint Polar Satellite System (Nov 2017)



NASA EOS - Earth Observation System  
Terra (am), Aqua (pm)



DMSP - Defense Meteorological Satellite Program



EUMETSAT - MetOP - European Meteorological Operational Satellite





# Firewatch Next



- The US Space Force is currently launching the next generation of fire detection satellites

**SPACENEWS**

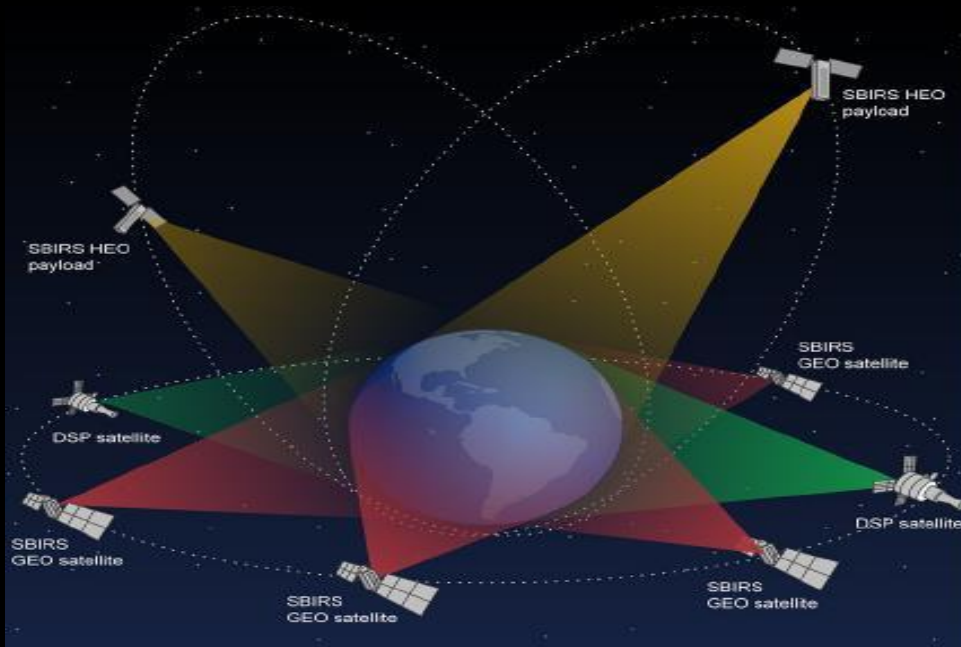
An open system for missile-warning satellite data is in the works but faces challenges

© by Sandra Erwin — February 1, 2021



Data from NASA's Landsat 8 was used to create this image of the Camp Fire as it burned near Paradise, Calif. Nov. 8, 2018. The U.S. Air Force provided data from its missile-warning overhead infrared sensor satellites to assist the U.S. Forest Service. Credit: NASA

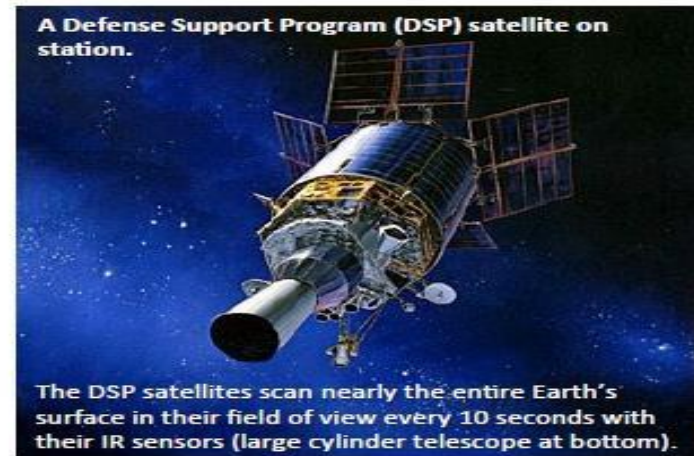
The U.S. Space Force wants an open platform to process and distribute data from missile-warning satellites.



The U.S. maintains a constellation of satellites equipped with IR sensors that continuously monitor the Earth to detect heat from missile and booster plumes against the Earth's background. The DSP satellites are positioned above the Earth's equator in geosynchronous orbit. The satellites orbit in synchrony with the rotation of the Earth, continuously monitoring ("staring at") their assigned part of the globe. The DSP satellites are being followed by the Space Based Infrared System (SBIRS), a mix of satellites in geosynchronous Earth orbit (GEO) and payloads in highly elliptical orbit (HEO). The SBIRS sensors are designed to perform a broader set of missions than the DSP IR sensor. They also collect with greater geographic precision. The ground-system data processing has also been greatly enhanced.

**An existing, unexploited Defense capability could provide wildland firefighters with continuously-available, real-time wildfire position and activity information. The U.S. ballistic missile early warning satellites (DSP, SBIRS) detect wildfires as well as missile launches with their infrared sensors. The satellites' wildfire detections are currently "falling to the floor" unused. The "dual-use" of the Defense satellites would have no impact on the satellites primary, vital Defense missile warning and surveillance mission.**

**A Defense Support Program (DSP) satellite on station.**



The DSP satellites scan nearly the entire Earth's surface in their field of view every 10 seconds with their IR sensors (large cylinder telescope at bottom).

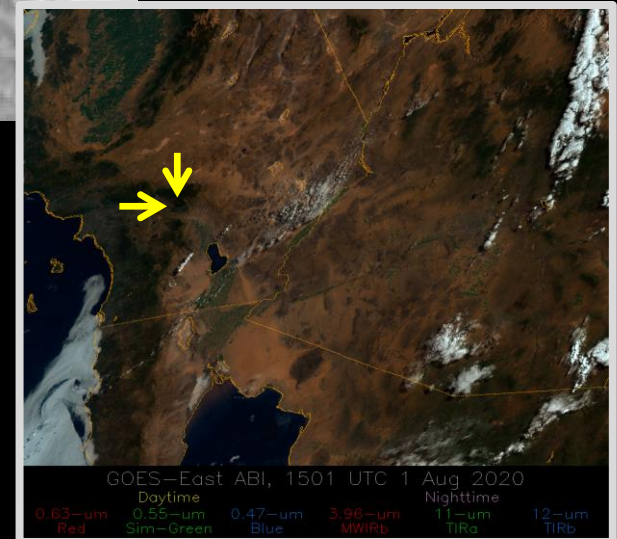
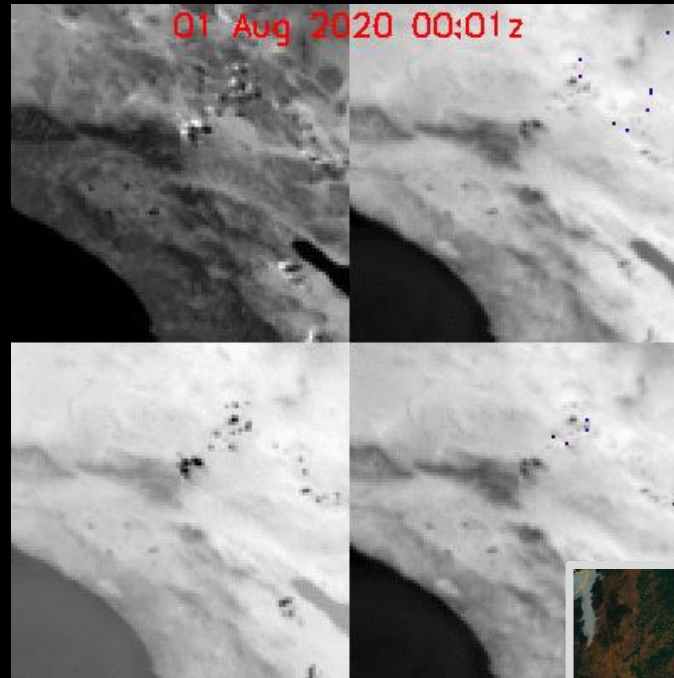
UNCLASS





# FADDS

- Fire Autonomous Detection & Dissemination System
- Apple Fire Detection in multi-IR-bands
- Multi-band IR ensure fire detection in different conditions, through clouds, dust, and from light or heat sources



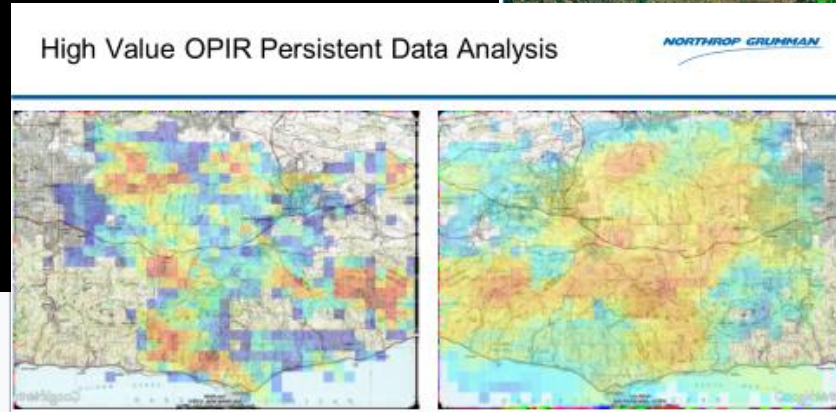
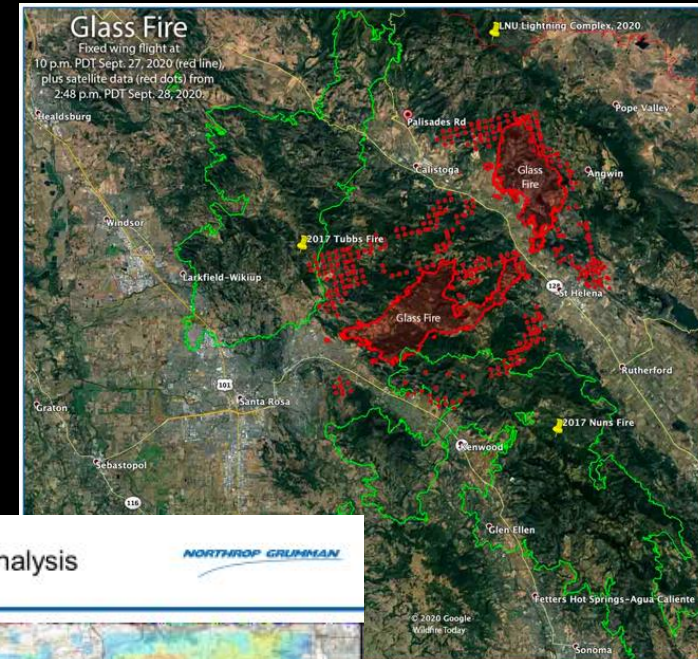


# Fire Watch Next

Data Fusion

Red = satellite

Green = fix winged



*Example Burn Duration (left) and Burn Intensity (right) products from the Woosley fire of 2018. Darker red color indicate longer duration/higher burn intensity, blue indicates less duration/lower intensity.*

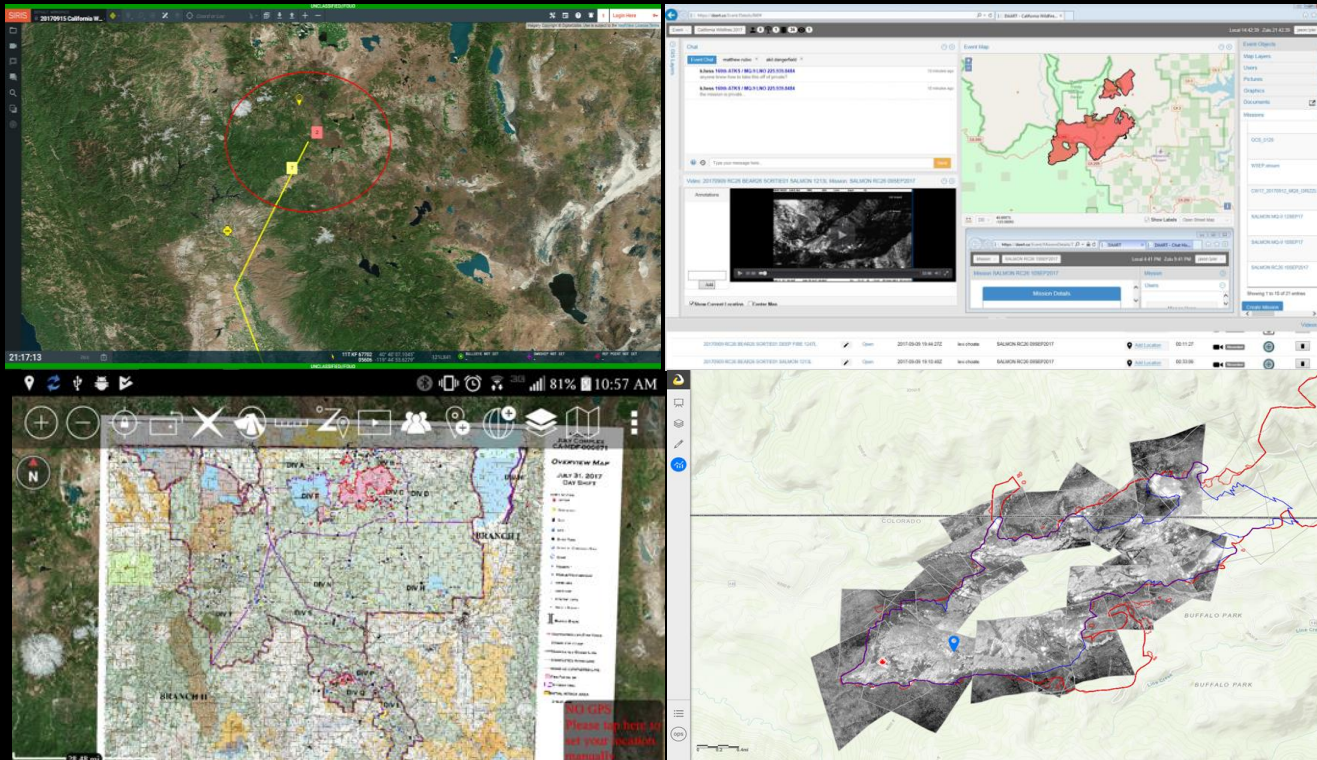
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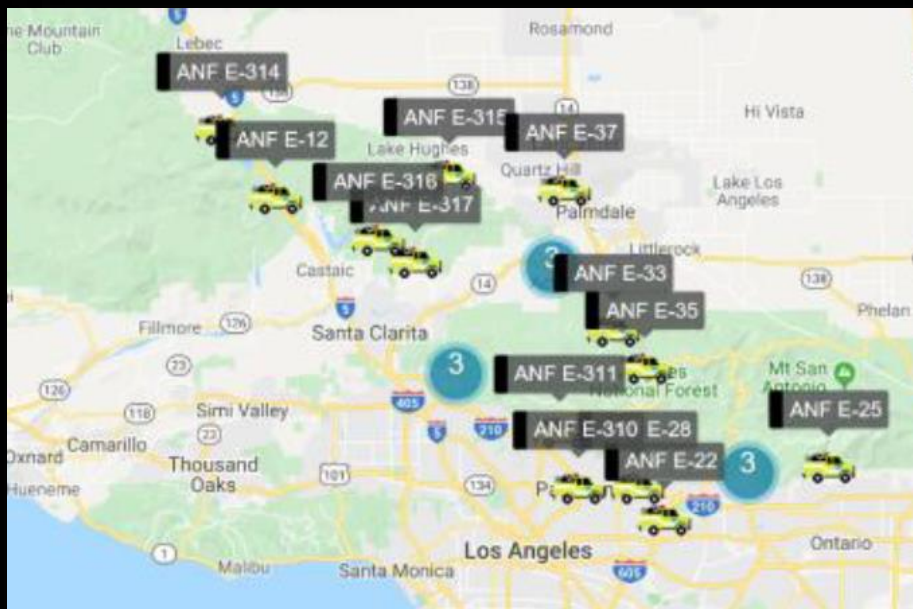
# The Future: SIRIS, DAART, ATAK and Other Synthesis Tools







# GPS Tracking





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# Future Autonomous Airtanker Concept



## Capabilities

- VSTOL-Very Short Take Off/Landing
- Rapid Reload (3,000 Gallons Min)
- Hoverfill Like A T1 Helo at a “dip sight”
- Transition to high speed for Initial Attack
- Night Flying-Takeoff, Land, and Refill
- Communicates with Air Attack and IC
- GPS Drops with various Coverage Levels
- Auto wind correct for Drops





Flooding



Arson

Terrorism

Drought

Constant EMS Demands

Mass Shootings

Pandemics

All Hazard Response

The new normal...





# Fire Workforce

## Resilience, Recovery and Mental Health

(In Addition To Crews Support Dispatch, Support and Leaders)









Questions?