High Performance Wireless Research and Education Network

A Wireless Safety and Education Network for Society and Science

http://hpwren.ucsd.edu/

HPWREN

UCSD

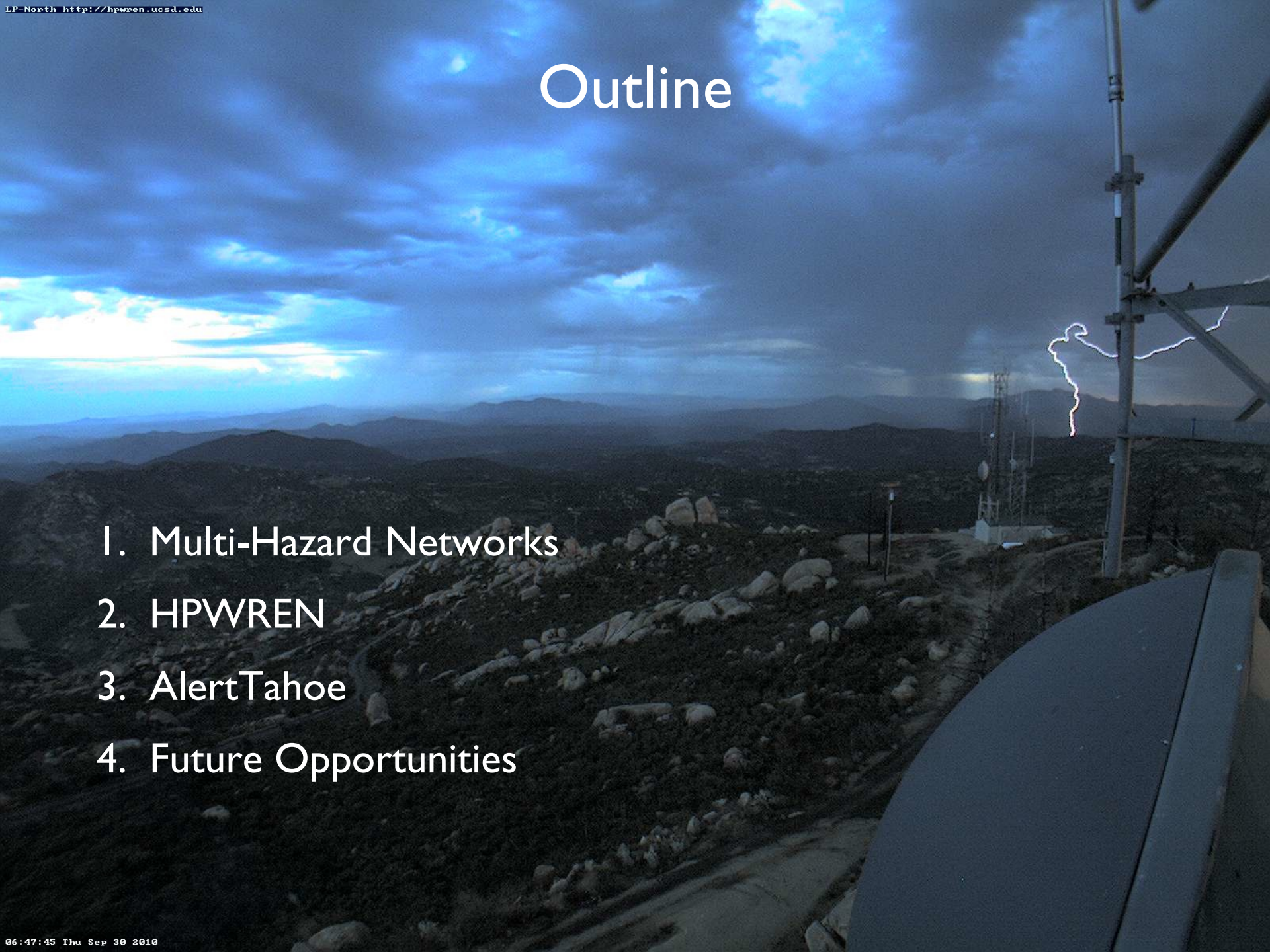
SDSC
SAN DIEGO SUPERCOMPUTER CENTER

SCRIPPS INSTITUTION OF OCEANOGRAPHY
UCSD

it²

SAN DIEGO STATE UNIVERSITY

NATIONAL SCIENCE FOUNDATION



Outline

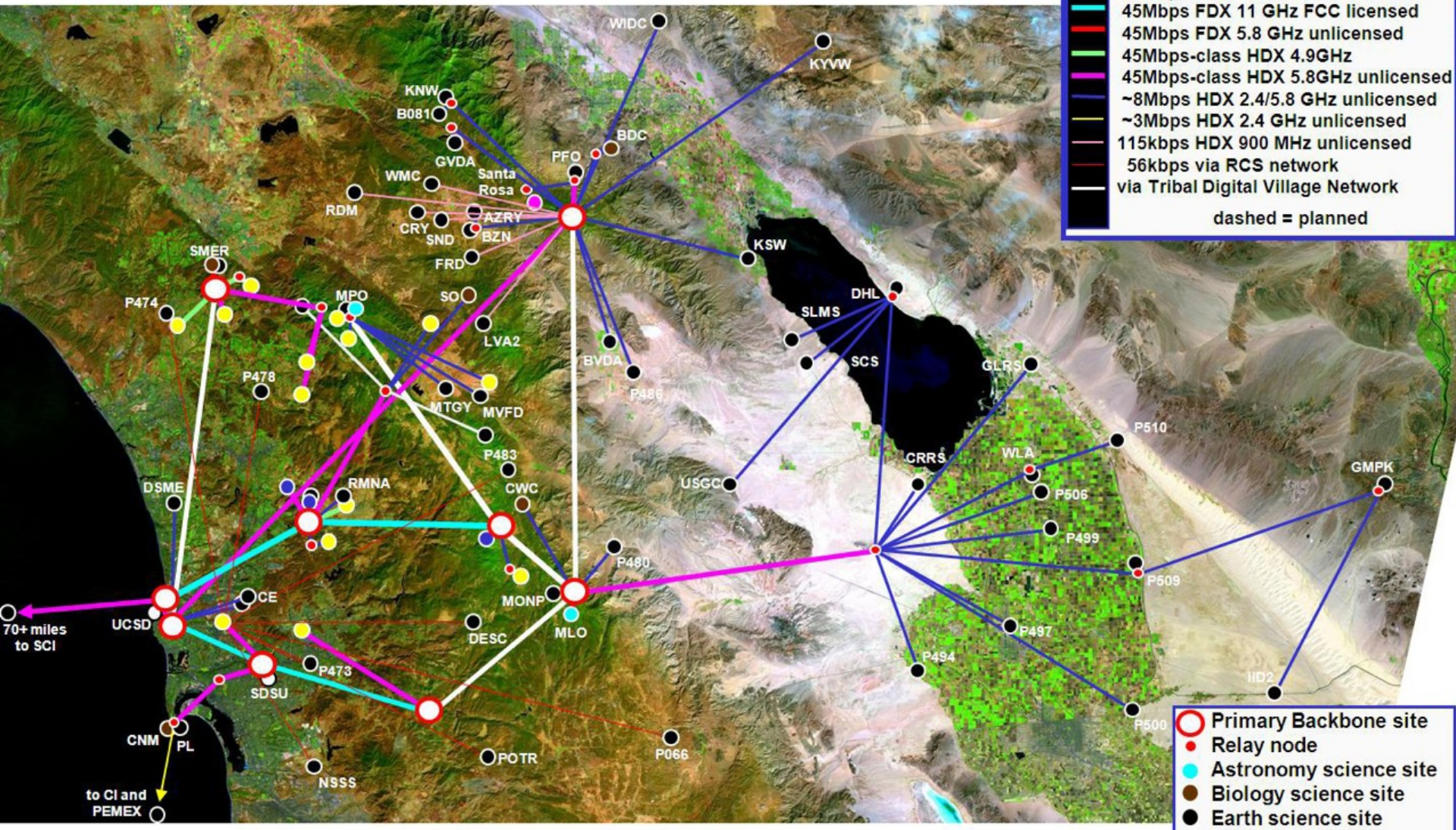
1. Multi-Hazard Networks
2. HPWREN
3. AlertTahoe
4. Future Opportunities

Multi-Hazard Networks

Environmental Sensor Networks

- Sensors in remote sites
- Communications
  - Internet accessible
- Real time
- Research networks
  - High quality data
- Public Safety networks
  - Reliable
  - Resilient

HPWREN topology – January 2015



Applied Network Research

http://anr.ucsd.edu

HPWREN Background

- Started in 2000 under National Science Foundation grant
- Largest stakeholders
  - Caltech - Mt Palomar Observatory
  - San Diego County fire fighting agencies
  - San Diego Gas and Electric
  - San Diego State University
  - Seismic Warning Systems, Inc.
  - UC San Diego
    - San Diego Supercomputer Center
    - California Institute for Telecommunications and Information Technology
    - Scripps Institution of Oceanography
- Shared resources
  - CalFire
  - San Diego Sheriff

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HPWREN Real Time Camera Imagery

- Fire detection
- Fire monitoring
- Fire perimeter mapping
- First used on the 2002 Pines fire in San Diego County
- Used on all major San Diego county wildfires since then
- Youtube animation videos posted for
  - 2003 Cedar Fire
  - 2006 Horse Fire
  - 2007 Harris and Witch Creek Fires
  - 2013 Chariot, DeLuz, Lyons, Mountain, and Silver Fires
  - 2014 Banner, Bernardo, Highway, Poinsettia, and Tomahawk Fires

14 May 2014: 9 Simultaneous Active Fires in San Diego County

San Diego County Red Mountain Fire Cameras

- Southeast (left) "Highway" Fire
- Southwest (center rear) "Poinsettia" Fire
- West (right) "Tomahawk" Fire

Mountain Fire near Idyllwild - July 2013

AlertTahoe

Access to Leverage Emergency information in Real Time

Multi-purpose, Integrated Hazard Platform

AlertTAHOE
Access to Leverage Emergency Information in Real Time.

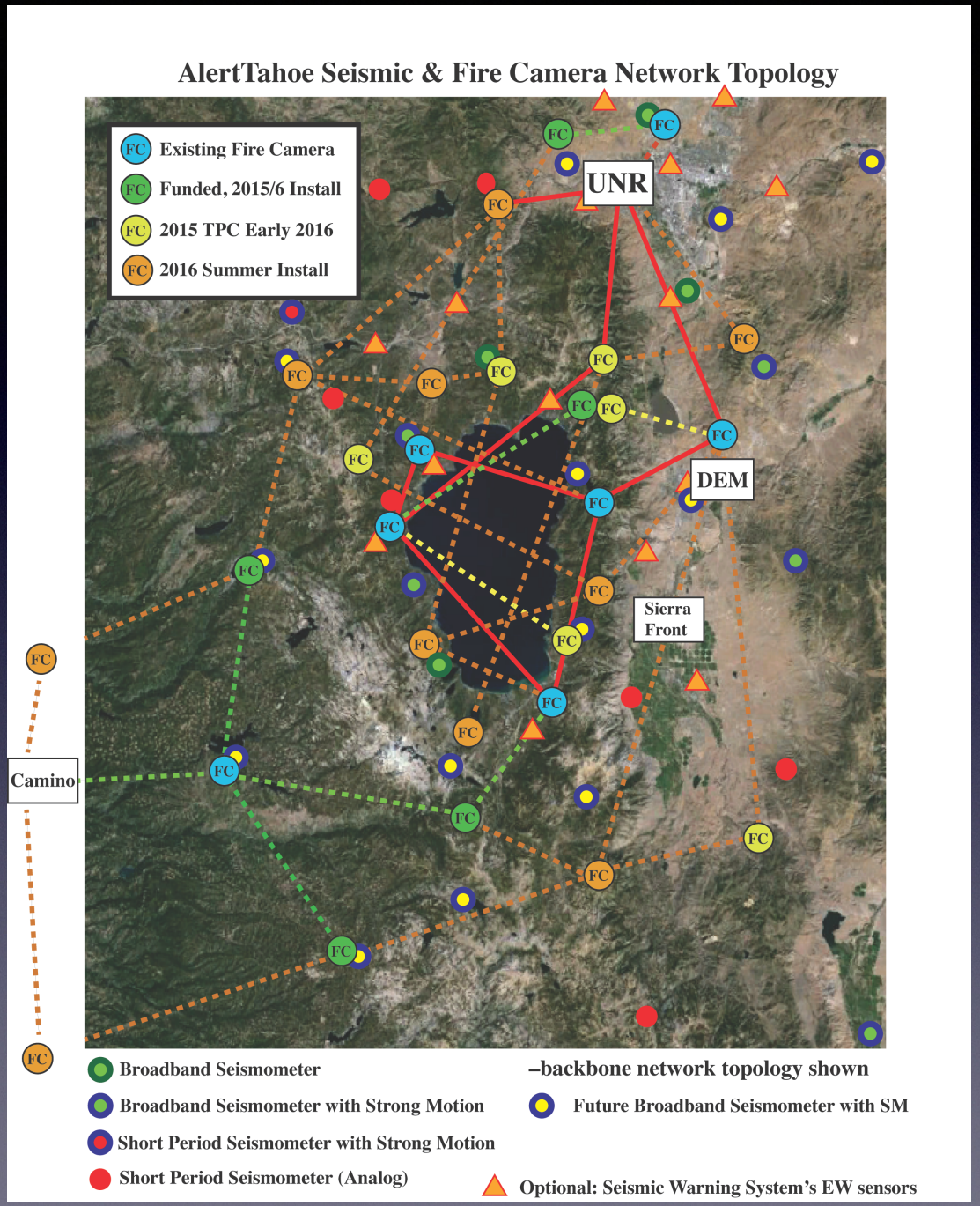
Fire

Earthquake

Flood

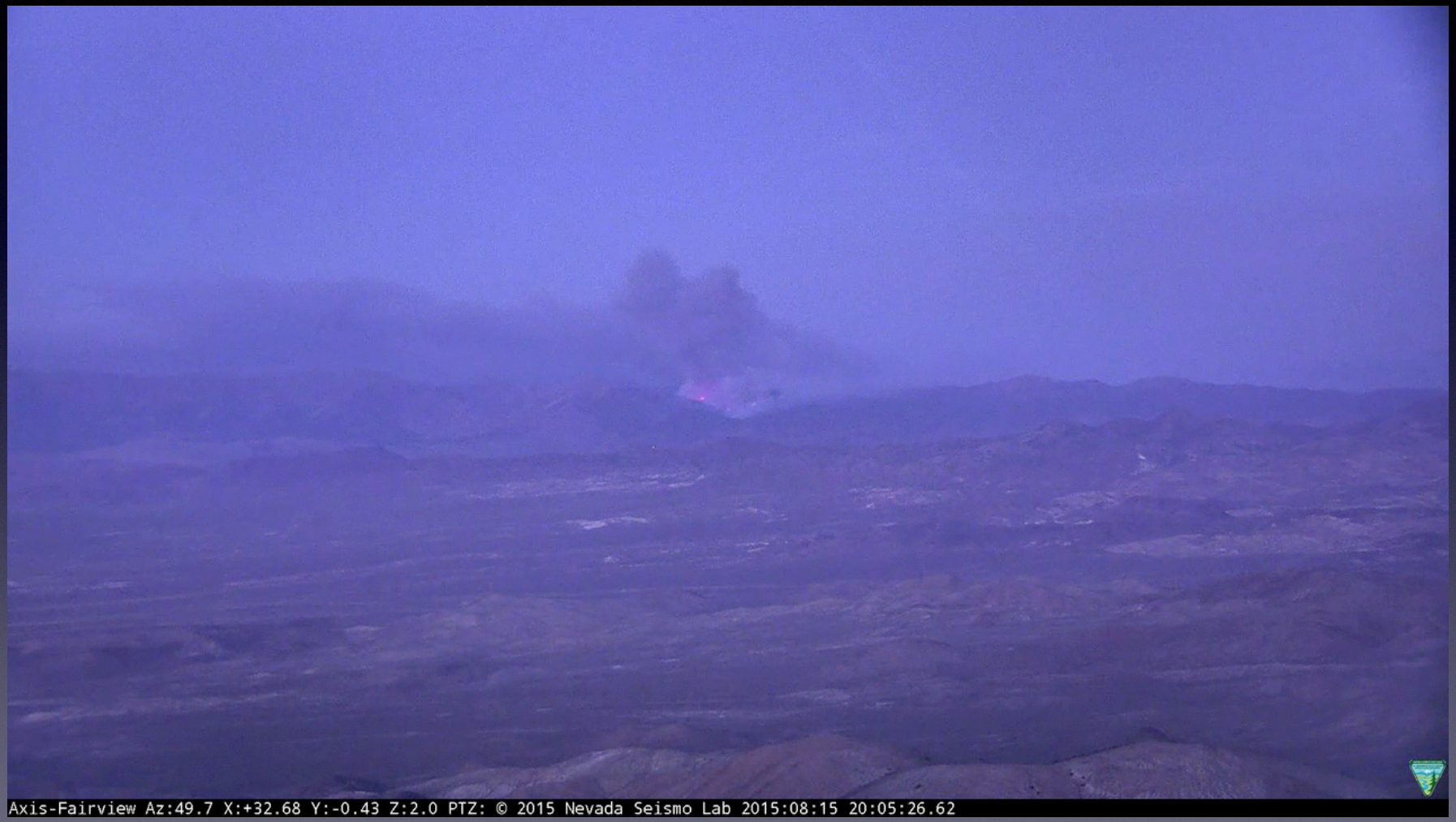
…it's the network and scalable!

AlertTahoe

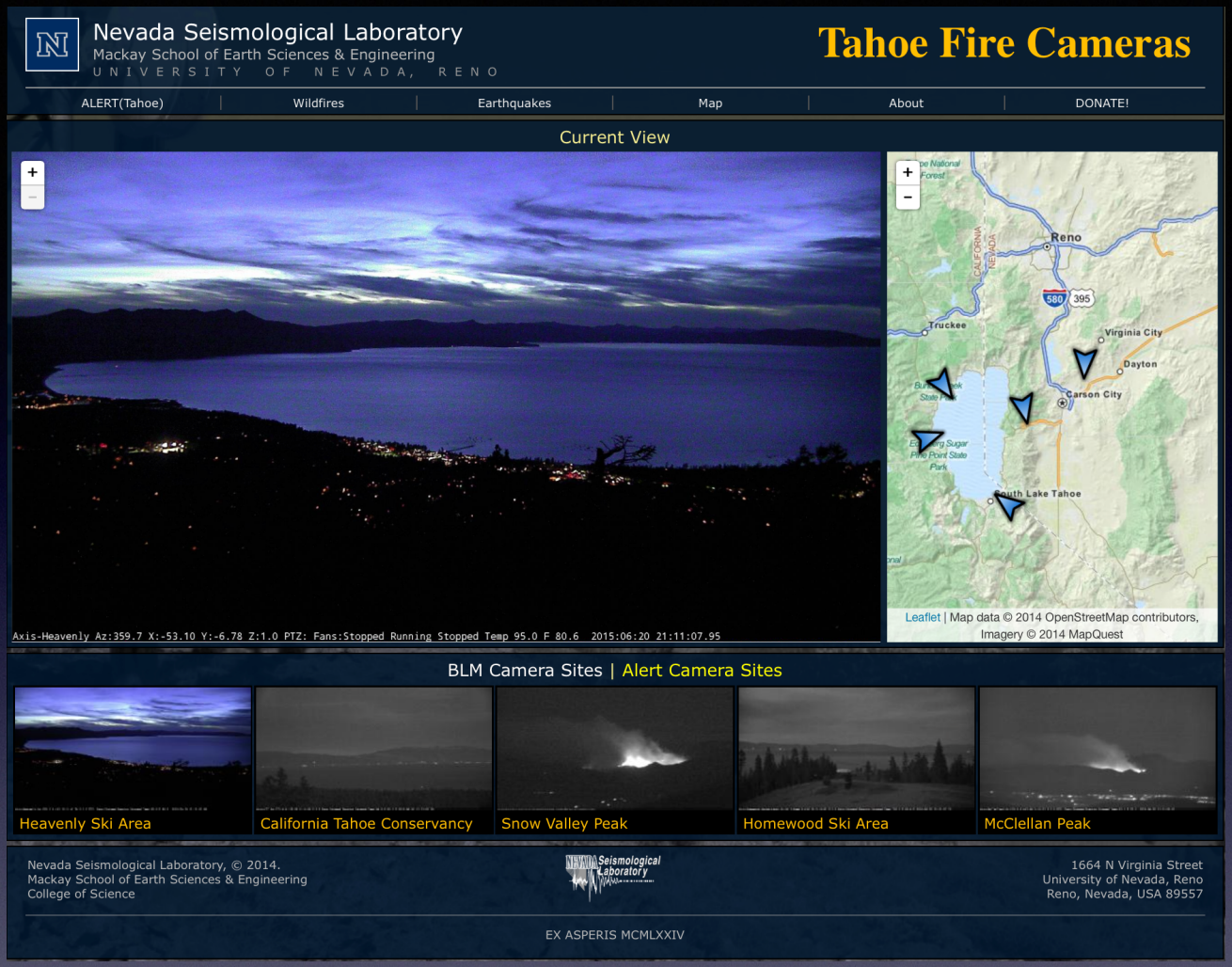


Multi-Hazard

Cold Springs Fire, Nevada, August 15th, 2015–2nd night



#progress



- Twitter public interface
- Proxy web interface
- Time-lapse interface ✓
- Lightening strike overlay ✓
- Machine vision, auto detect
- “10 gig E” web interface ✓
- Cloud-based, scalability
- Fire lat, long positioning ✓

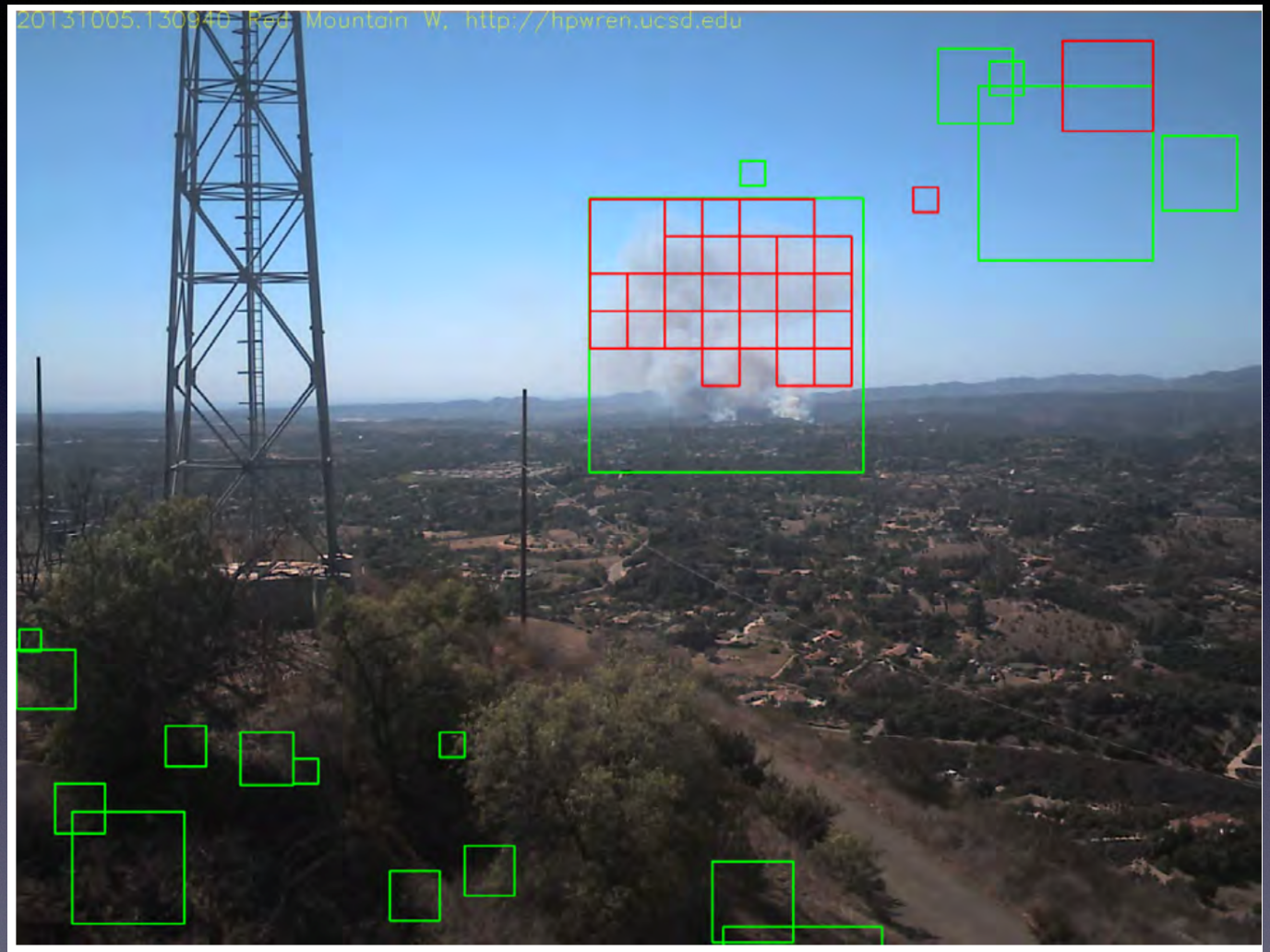
North Tahoe CTC Site

Solar Only Camera/
Seismometer Site

King Fire Sept. 17th, 2014

Near-IR band

Machine Vision Algorithm underway, Raul Rojas (UNR), Carl Pennypacker (LBL)

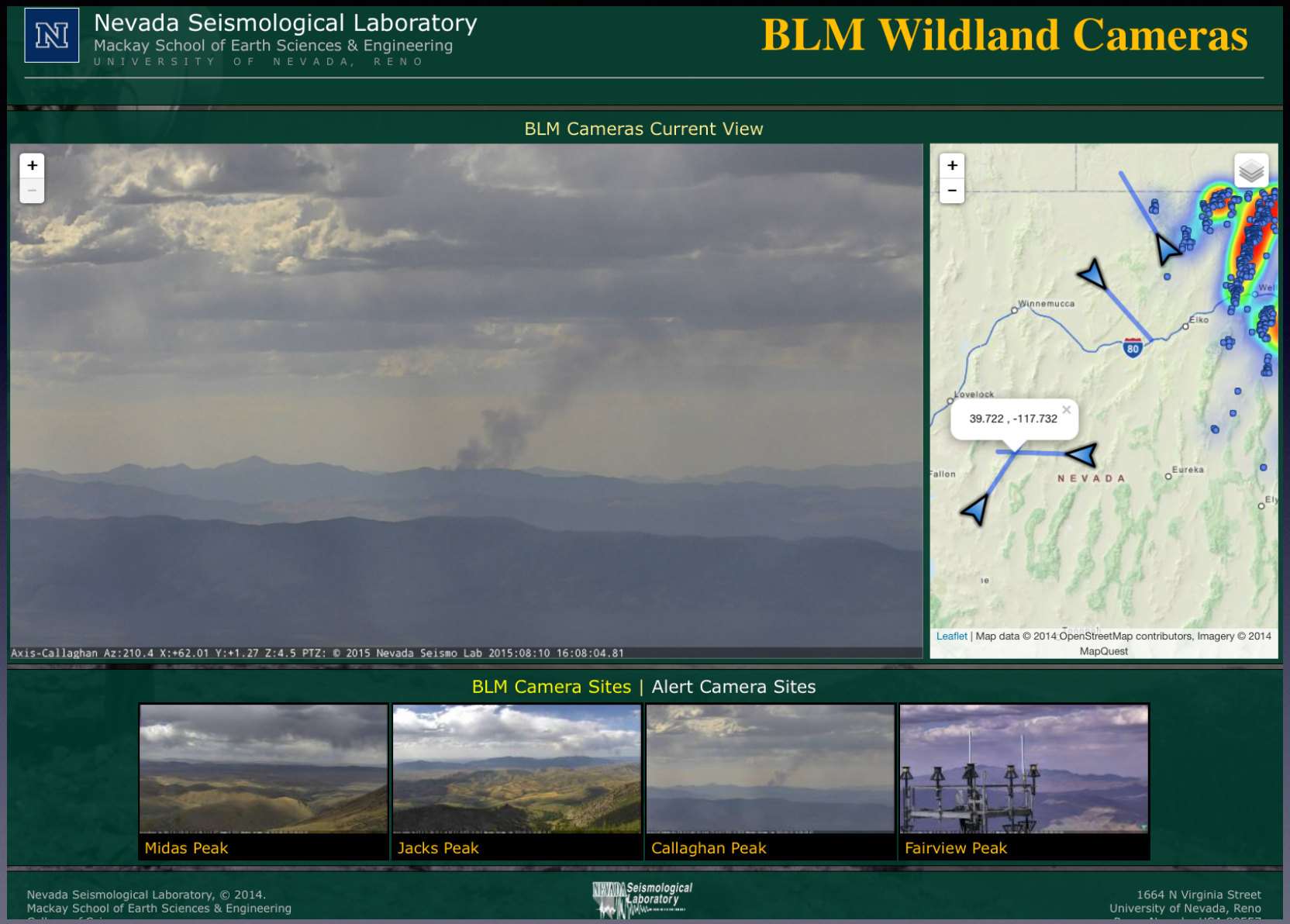


Classification using SIFT and bag of words **red channel only** (red boxes are the verified smoke regions

–pipeline implementation, planned 2017-18

Mountain Fire – SoCal

Callaghan Peak, August 10th, 2015



Towards an Integrated Cyberinfrastructure for Scalable Data-Driven Monitoring, Dynamic Prediction and Resilience of Wildfires

Ilkay Altintas[1], Jessica Block[2], Raymond de Callafon[3], Daniel Crawl[1], Charles Cowart[1], Amarnath Gupta[1], Mai Nguyen[1], Hans-Werner Braun[1], Jurgen Schulze[2], Michael Gollner[4], Arnaud Trouve[4] and Larry Smarr[2]

[1]San Diego Supercomputer Center, University of California San Diego, U.S.A.
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[3]Dept. of Mechanical and Aerospace Engineering, University of California San Diego, U.S.A.
[4]Fire Protection Engineering Dept., University of Maryland, U.S.A.

This work was supported mainly by NSF-1331615 under CI, Information Technology Research and SEES Hazards programs, and in part by NSF-112661, NSF-1062565 and NSF- 0941692.

UC San Diego

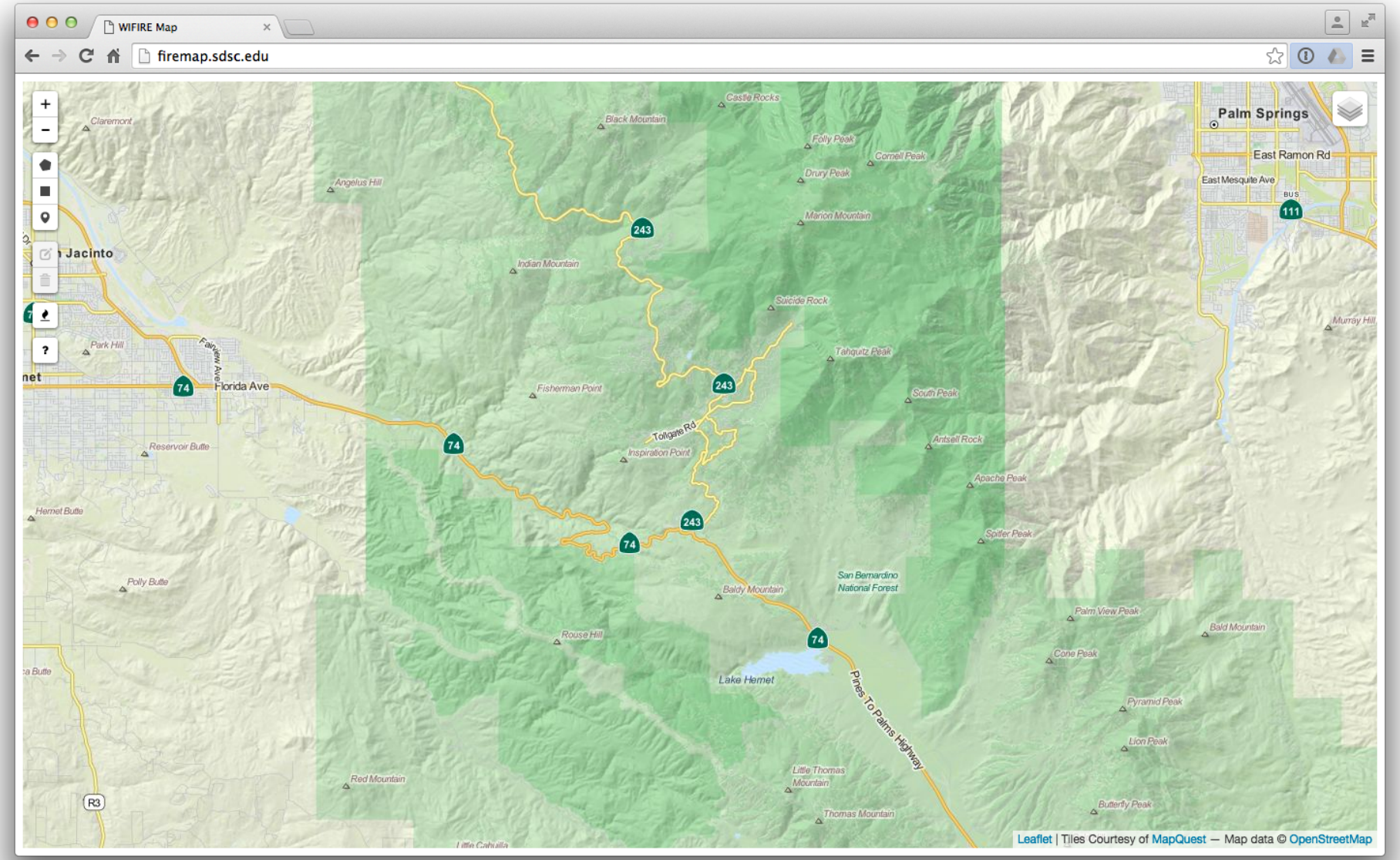
NSF

Use Case: Fire Growth

- *Goal*: Simulate fire growth in southern California
- Run FARSITE and Firefly
- Inputs:
  - Landscape (topography, fuel, etc.)
  - Weather (wind, temperature, humidity, etc.)
  - Ignition perimeter
- Outputs:
  - Fire perimeters
  - Intensity, flame length, spread rate, etc.

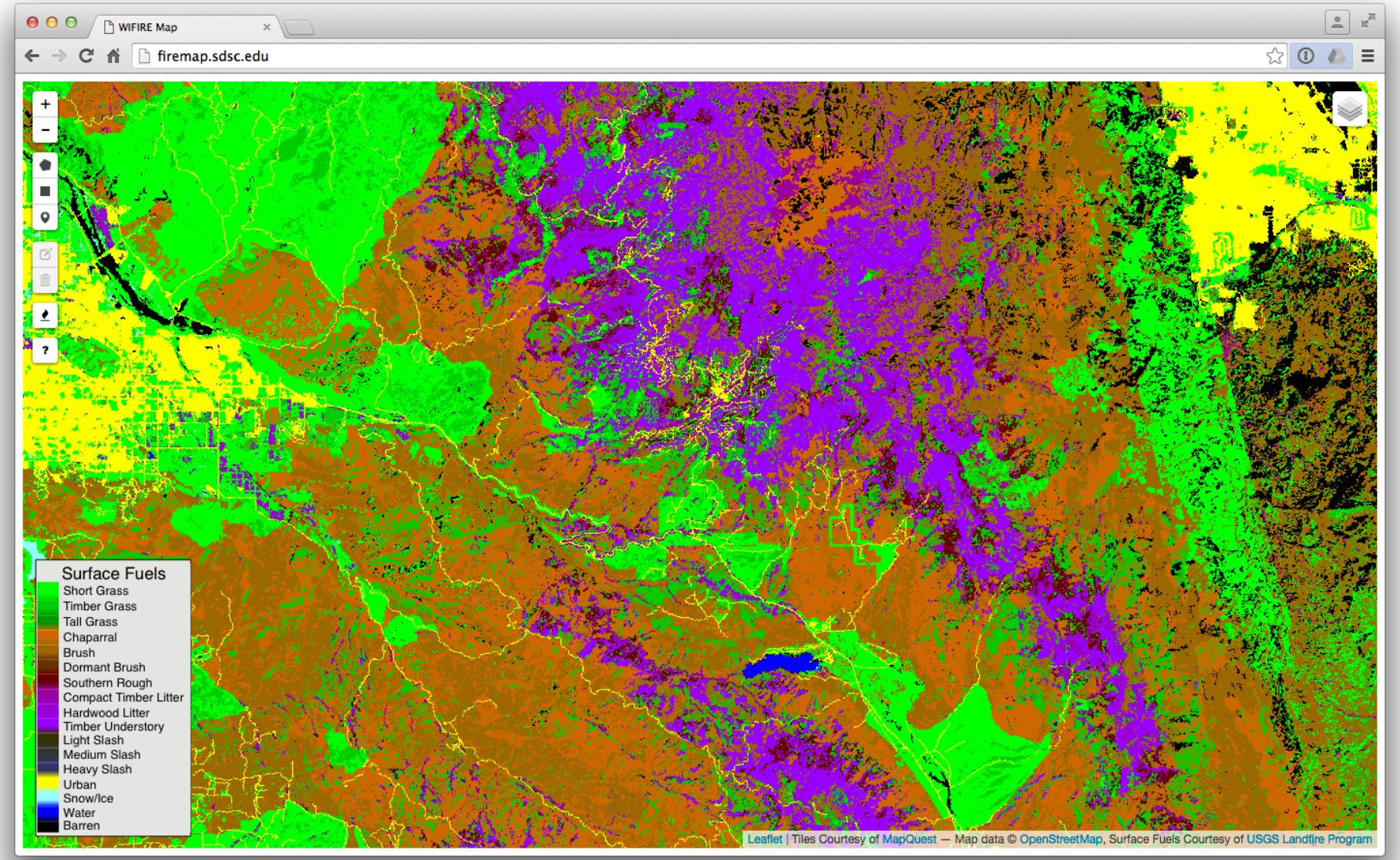
WIFIRE is funded by
NSF 1331615

Use Case: Fire Growth



WIFIRE is funded by
NSF 1331615

Surface Fuels



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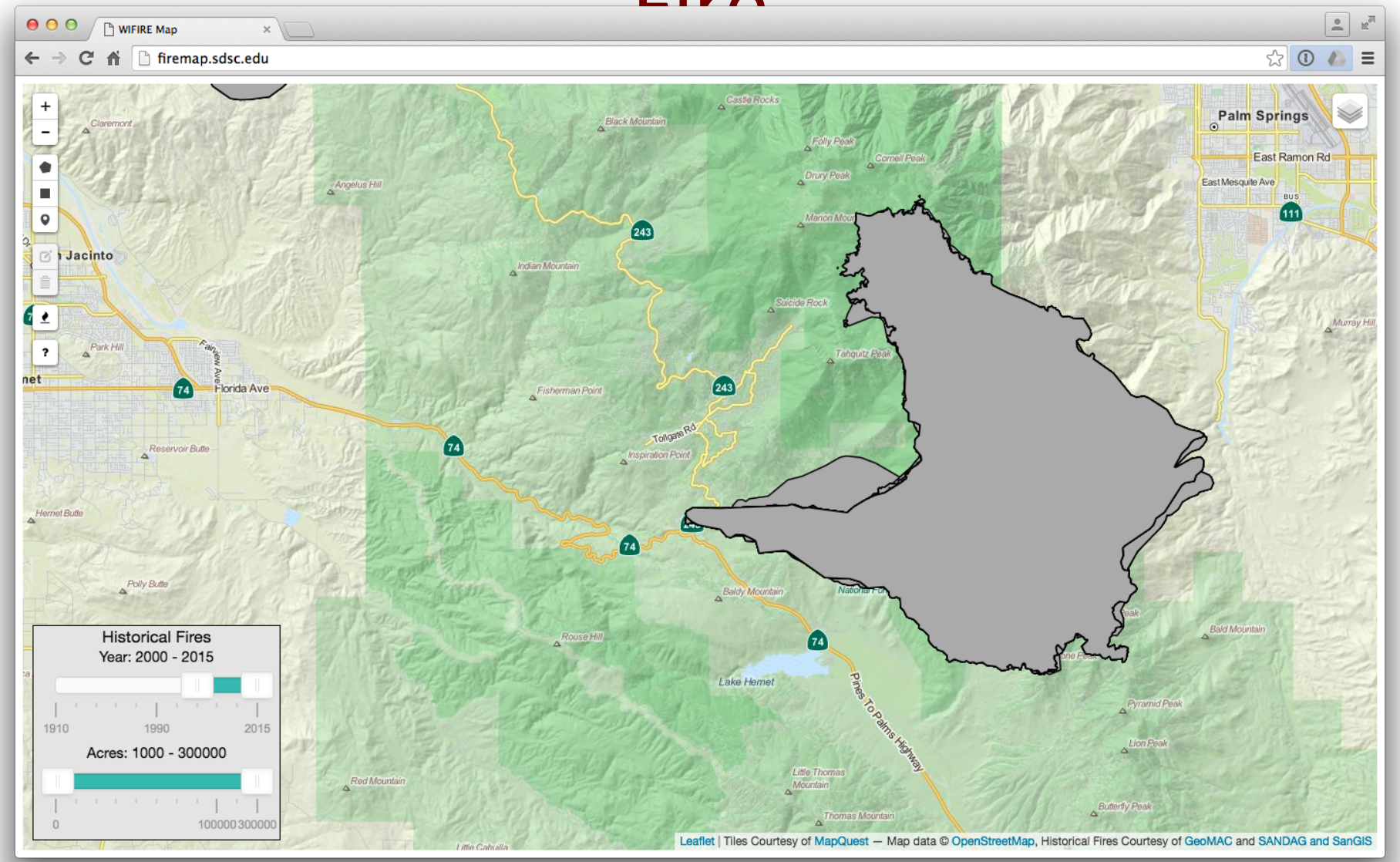
Historical Fires - 2013 Mountain Fire



WIFIRE is funded by
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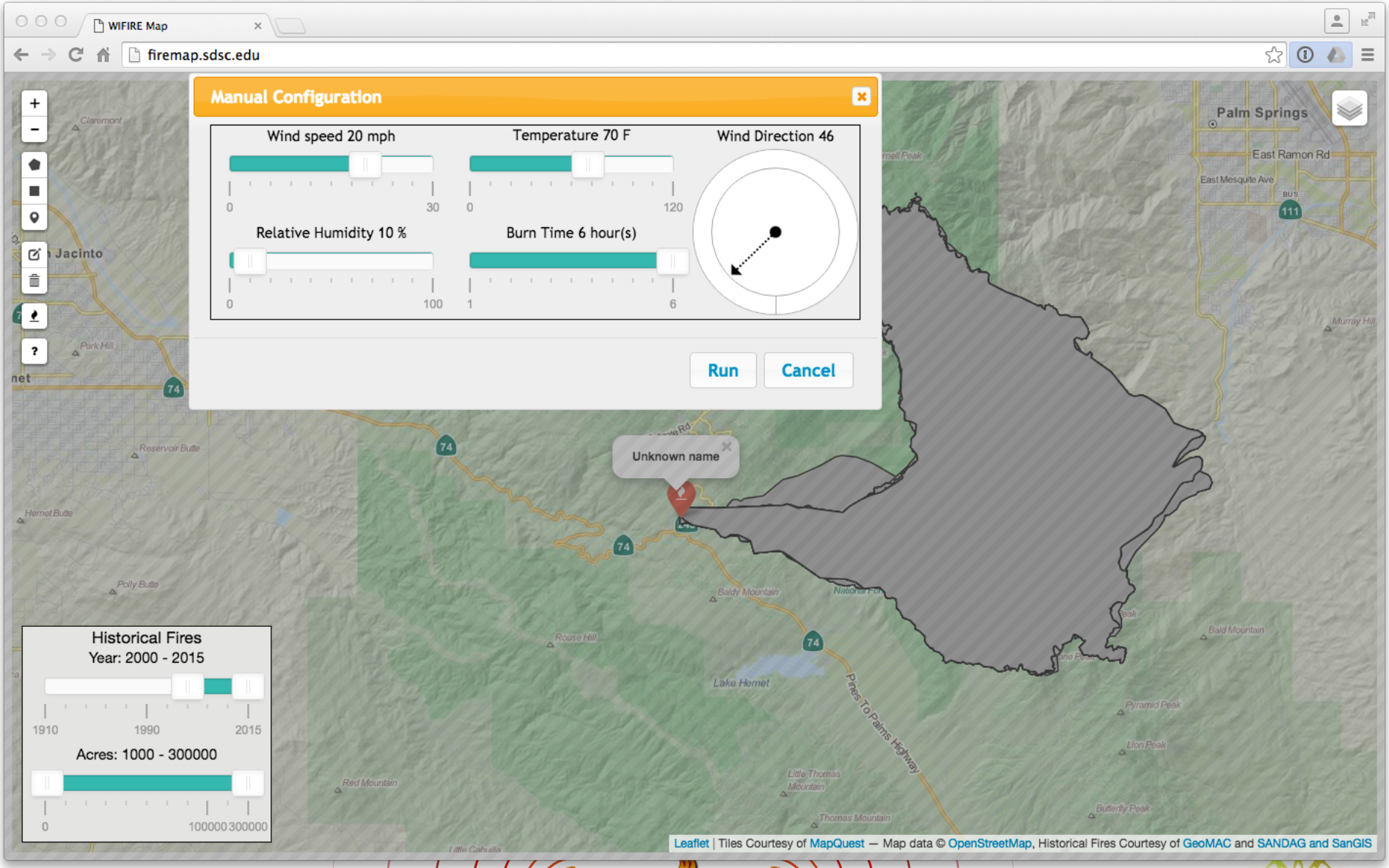
Santa Ana Condition Parameters



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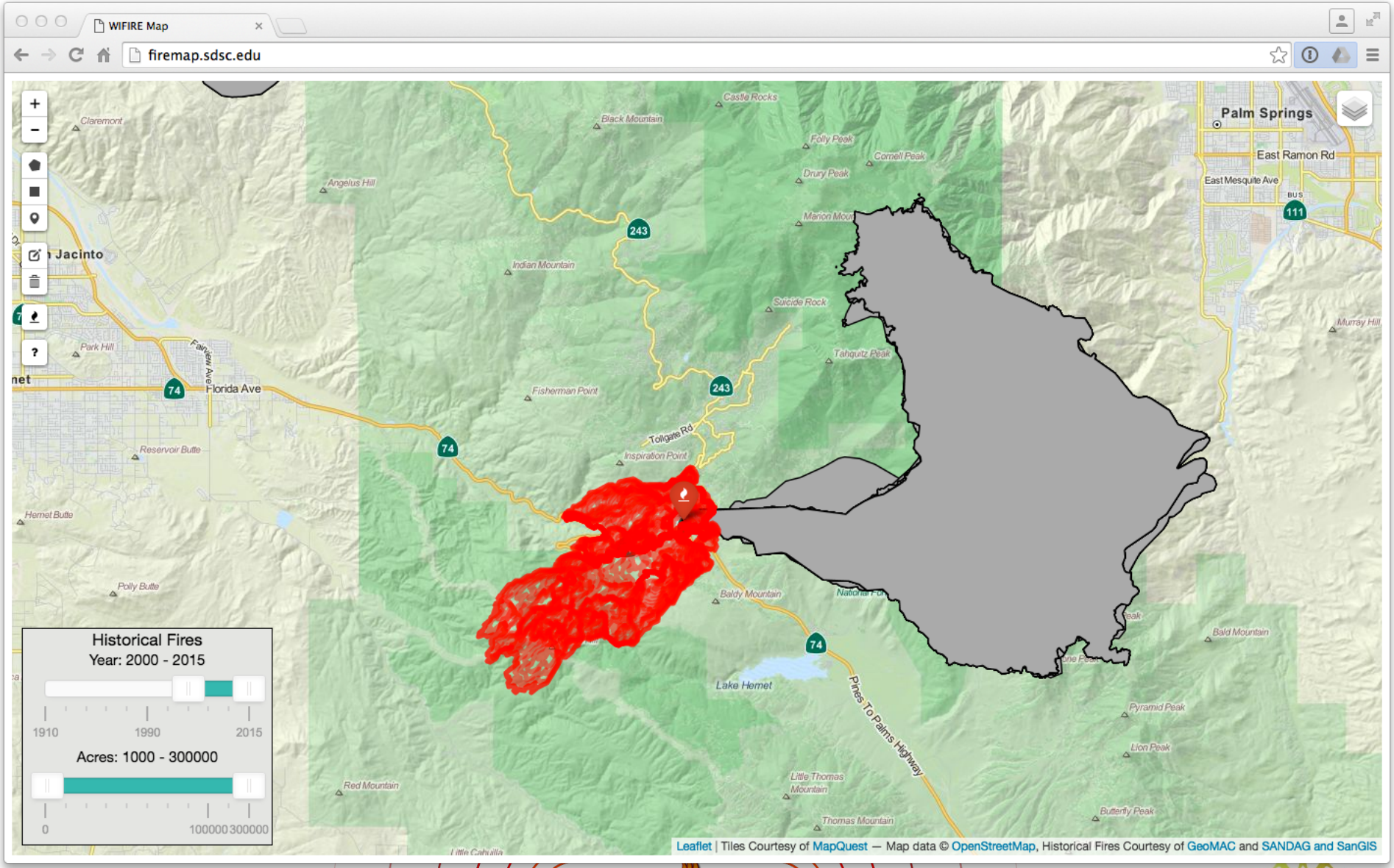
Fire Growth Model- 6 Hour Burn



WIFIRE is funded by
NSF 1331615

Santa Margarita River - December 28, 2004

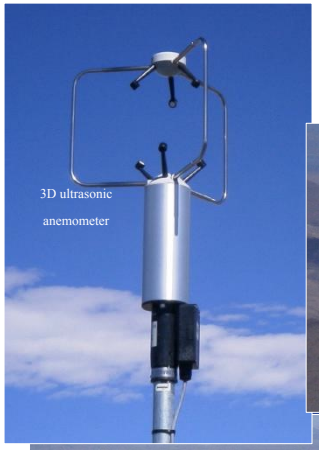
Santa Margarita River - February 25, 2003

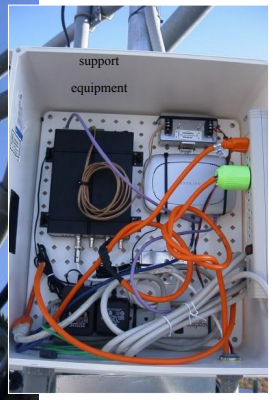
Multi-Hazard Networks

- Foundation is the network, not the sensor
- Microwave and fiber based communications
- Can attach any type of IP enabled sensor
- Greater bandwidth relative to cellular
  - requirement for fire camera networks
- Wide spread failure not associated with catastrophic events (i.e. cellular), or fiber damage
- Scalable, user determines failover paths

Biology/Ecology sciences

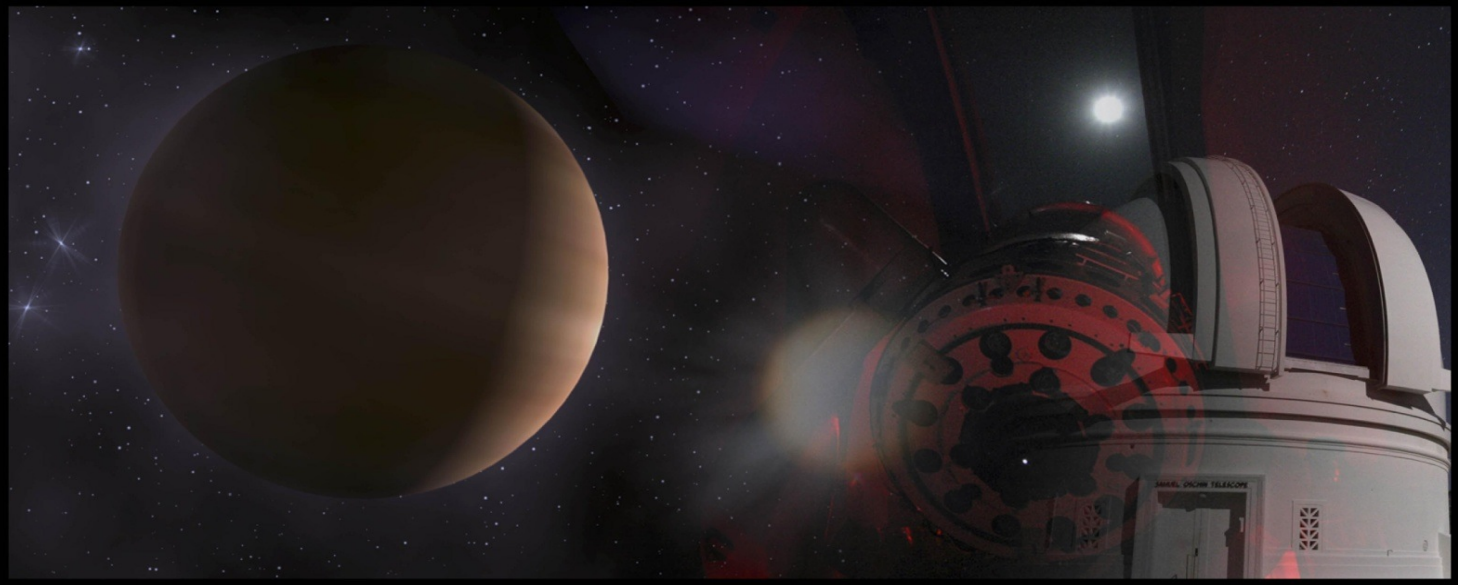
Mount Laguna sensor instrumentation





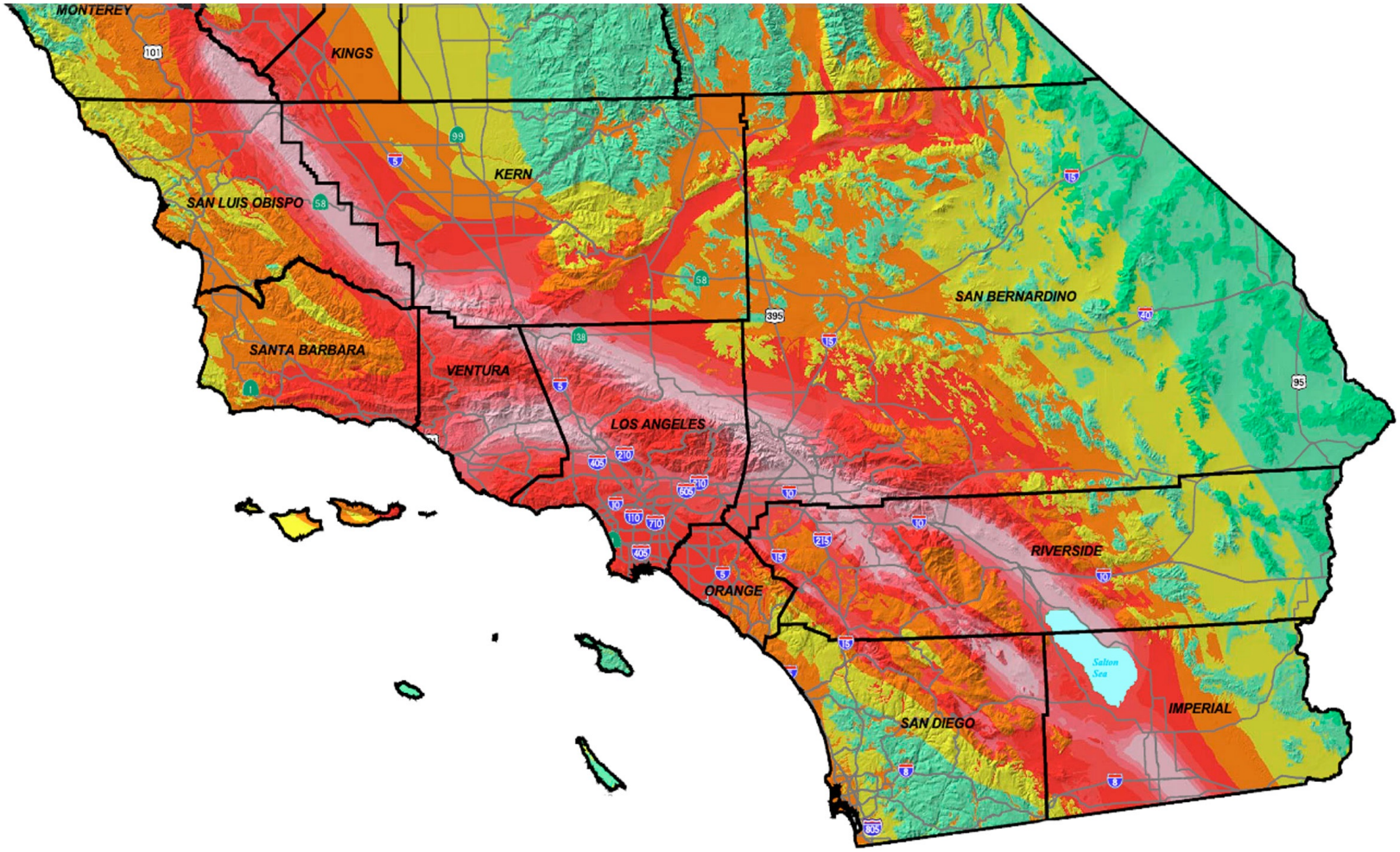
Research and New Discoveries

Palomar Observatory's automated and remotely operated telescopes, together with the availability of high speed wireless data connection via HPWREN (High Performance Wireless Research and Education Network) facilitate advanced astronomy science. It allows for long term studies and projects, high volumes of data that can be transferred and stored elsewhere, and enabling researchers to respond rapidly to real-time events from anywhere in the world. This is setting the stage for New Discoveries and a greater understanding of our Universe.

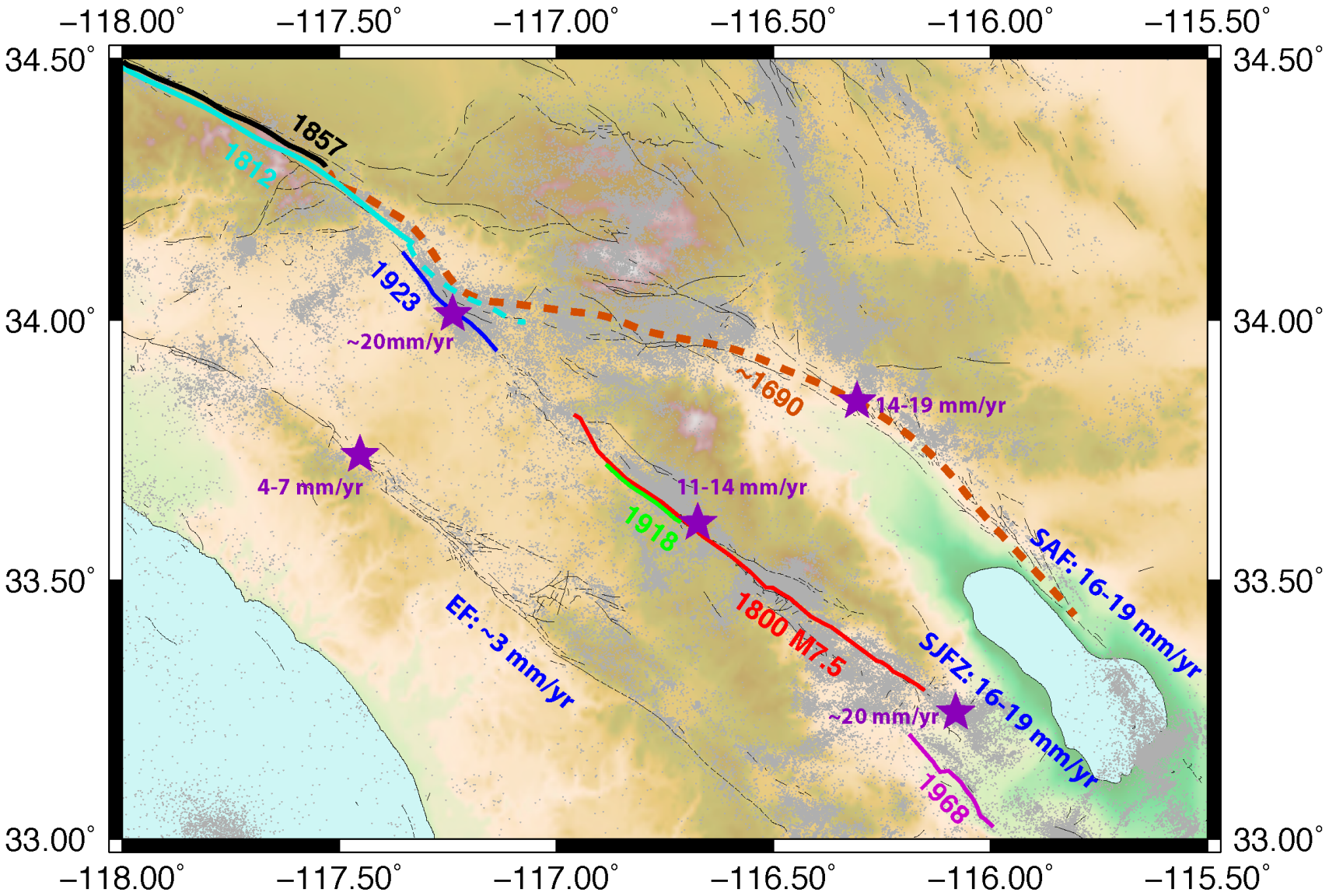


http://www.astro.caltech.edu/palomar/
http://hpwren.ucsd.edu/

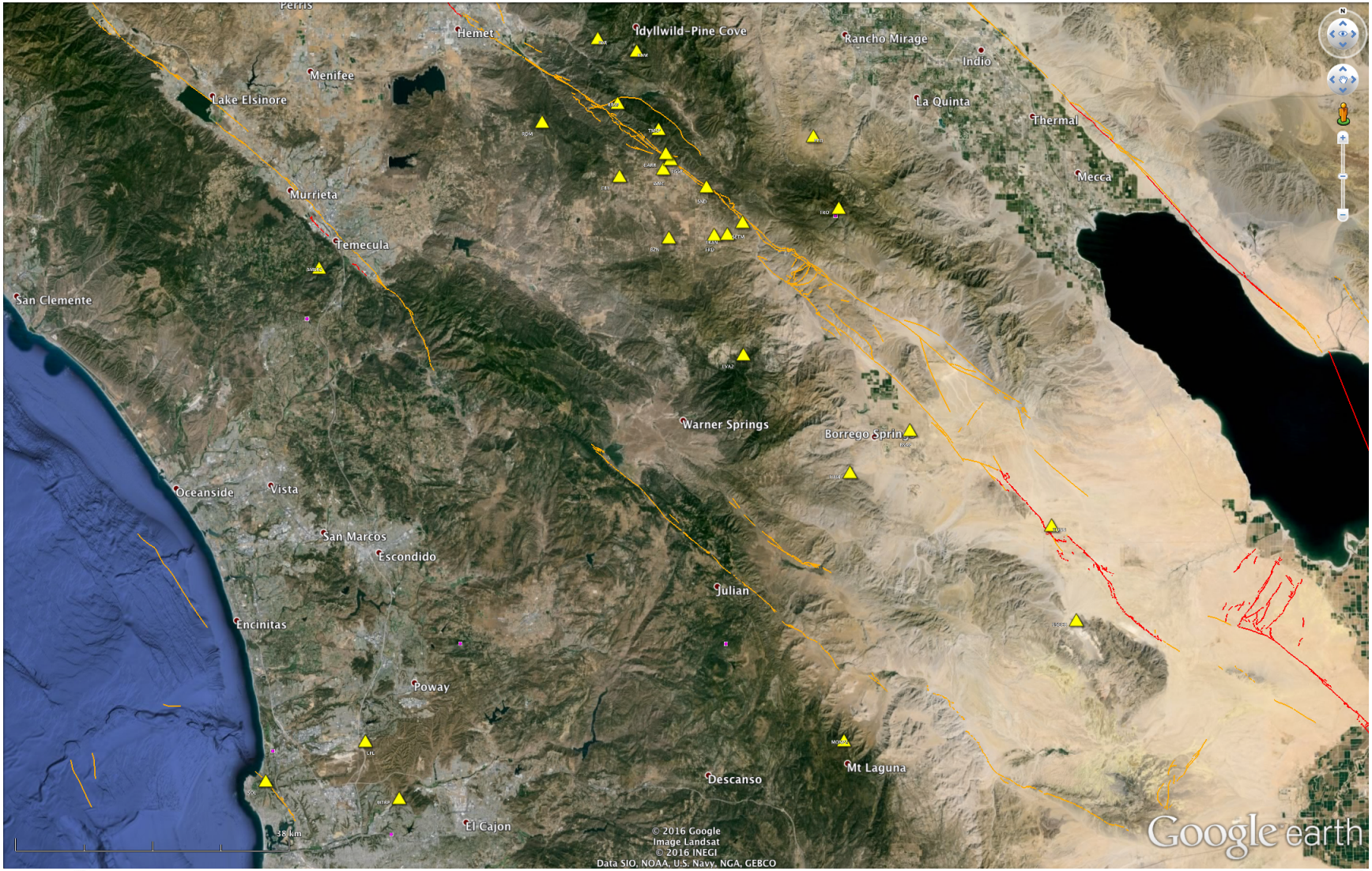
Potential for Significant Ground Shaking

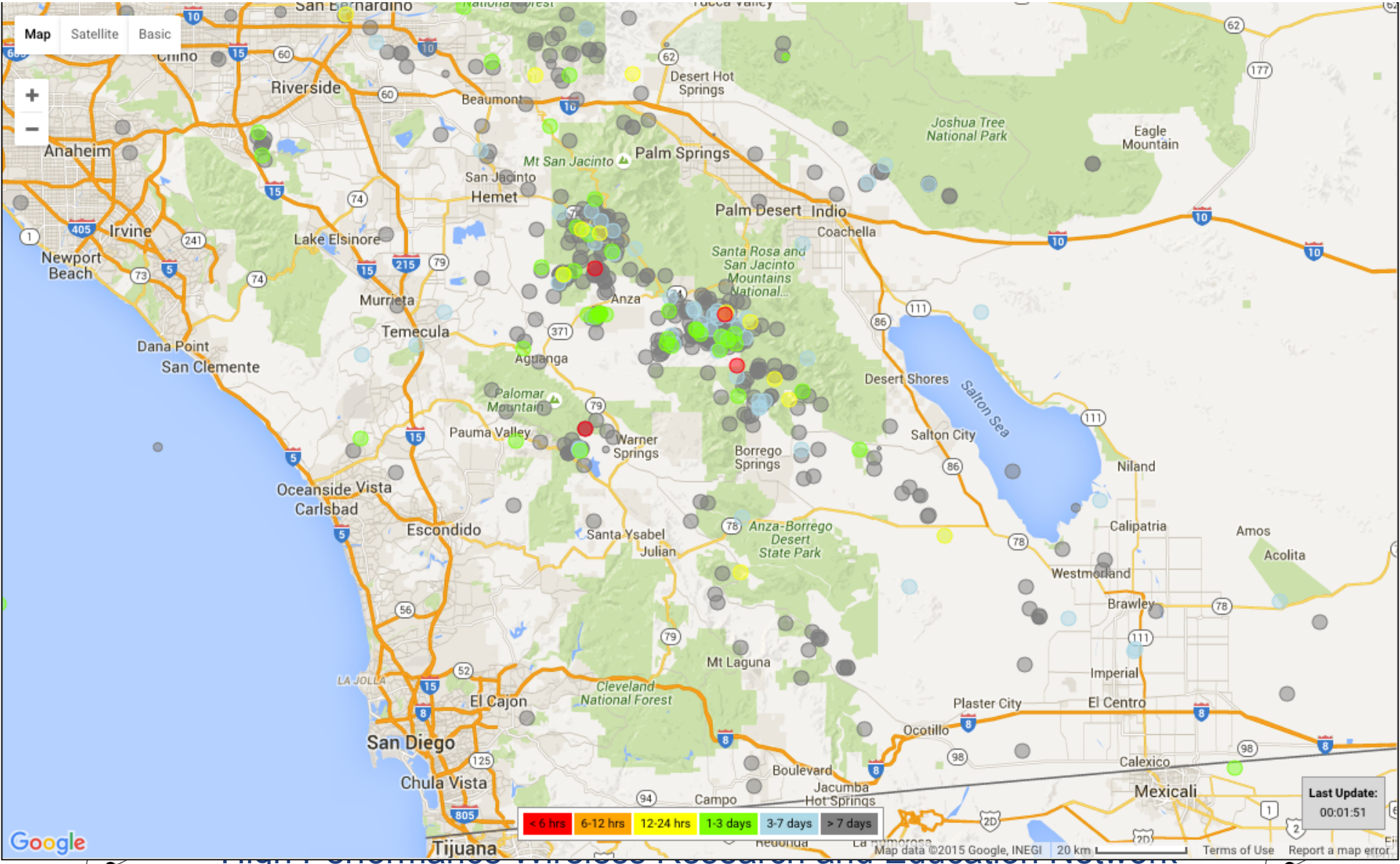


Southern California Major Surface Ruptures



ANZA Seismic Network




Map
Satellite
Basic
Riverside
Beaumont
Desert Hot Springs
Joshua Tree National Park
Eagle Mountain
Anaheim
Mt San Jacinto
Palm Springs
San Jacinto
Hemet
Palm Desert
Indio
Coachella
Irvine
Lake Elsinore
Newport Beach
Santa Rosa and San Jacinto Mountains National...
Murrieta
Anza
Temecula
Dana Point
San Clemente
Aguanga
Desert Shores
Salton Sea
Palomar Mountain
Pauma Valley
Warner Springs
Borrego Springs
Salton City
Niland
Oceanside
Vista
Carlsbad
Escondido
Santa Ysabel
Julian
Anza-Borrego Desert State Park
Calipatria
Amos
Acolita
Westmorland
Brawley
Mt Laguna
Imperial
LA JOLLA
El Cajon
Cleveland National Forest
Plaster City
El Centro
Ocotillo
San Diego
Calexico
Boulevard
Jacumba Hot Springs
Chula Vista
Campo
Mexicali
Tijuana
< 6 hrs
6-12 hrs
12-24 hrs
1-3 days
3-7 days
> 7 days
Last Update:
00:01:51
Google
Map data ©2015 Google, INEGI
20 km
Terms of Use
Report a map error

Earthquake Early Warning Basics

1 In an earthquake, a rupturing fault sends out different types of waves. The fast-moving P-wave is first to arrive, but damage is caused by the slower S-waves and later-arriving surface waves.

2 Sensors detect the P-wave and immediately transmit data to an earthquake alert center where the location and size of the quake are determined and updated as more data become available.

3 A message from the alert center is immediately transmitted to your computer or mobile phone, which calculates the expected intensity and arrival time of shaking at your location.

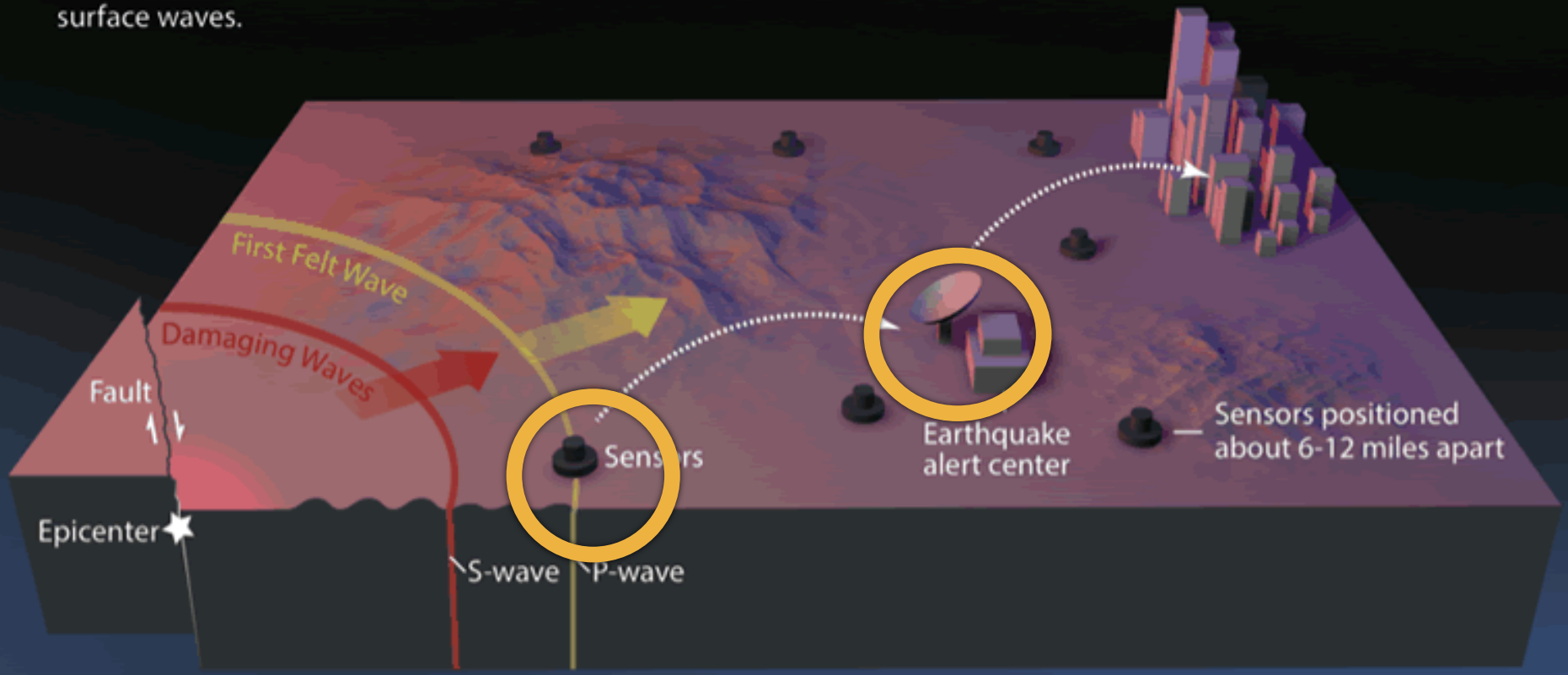


Image created by USGS

Benefits of HPWREN and AlertTahoe

- Networking platform for multi-hazard sensor applications
  - Wild fires — Cameras, met sensors
  - Extreme weather — Cameras, met sensors
  - Earthquakes — Seismic sensors, GPS
- Provides early intel on fires
  - Allows faster and more effective response
    - Smaller fires
    - Better use of resources
    - Minimizes costs
  - Fire Detection algorithms (UNR, UC Berkeley)
- National Weather Service uses cameras for daily/hourly weather updates
  - Extreme weather events
  - Smoke prediction
  - Health warnings
- Dedicated Secure Internet
- Chamber of Commerce mode
  - Views of weather and recreational areas
- Real-time public access to information
- Real-time aid in command decision making

Path Forward

- Can Earthquake Early Warning/Alert Systems evolve from "one trick pony" networks standing guard for the generational event?
- Microwave-based Multi-Hazard Networks
  - have more constituents
  - lower overall costs to build/run due to sharing of infrastructure
  - are constantly tested
  - pay for themselves in a couple years (thanks to fire)
  - can attach any type of IP enabled sensor
  - access to remote environments
- Cellular technologies are still unproven during catastrophic events and have a poor performance in terms of blocks of downtime. Good for diversity, bad as core technology. Wide spread failure not associated with catastrophic events (i.e. cellular), or fiber damage

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