Meteorology and Weather Associated with Extreme Wildfire in California

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FireWeatherLab

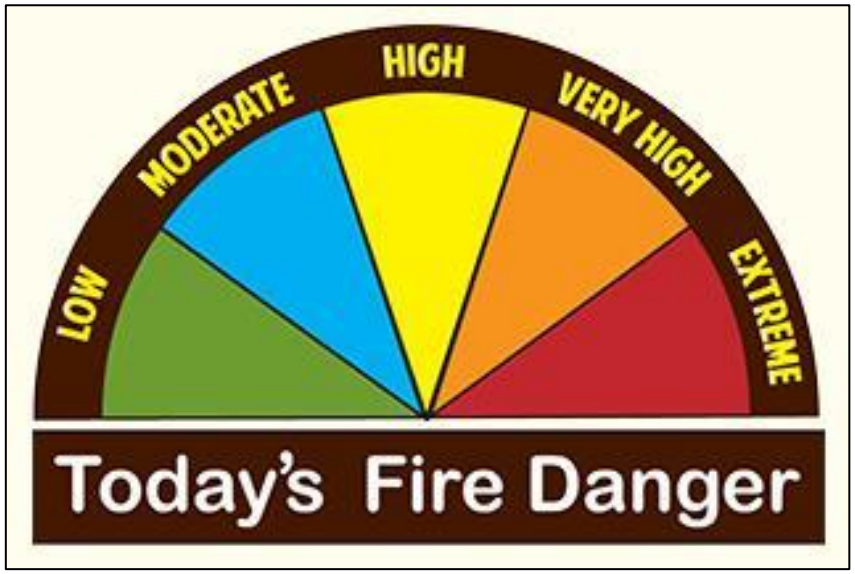
Fire Weather Research Laboratory San José State University

- Established in 2007
- Only Academic Fire Weather Program in US.
- Research on extreme fire behavior, fire weather, fire danger.
- Teach classes in Wildfire Science, Fire Weather, Advanced Fire Behavior.
- All SJSU team members maintain Fire-line Qualifications through CAL FIRE and US Forest Service. Only meteorological team in US listed in ROSS.

Funding sources

The Fire Environment

What is Fire Danger?



National Fire Danger Rating System

Forecast Fire Danger Class: 11-SEP-19

LEGEND

- Reporting Weather Stations
- Low
- Moderate
- High
- Very High
- Extreme
- Water

(Inv. Dist.^{2} Interp.)

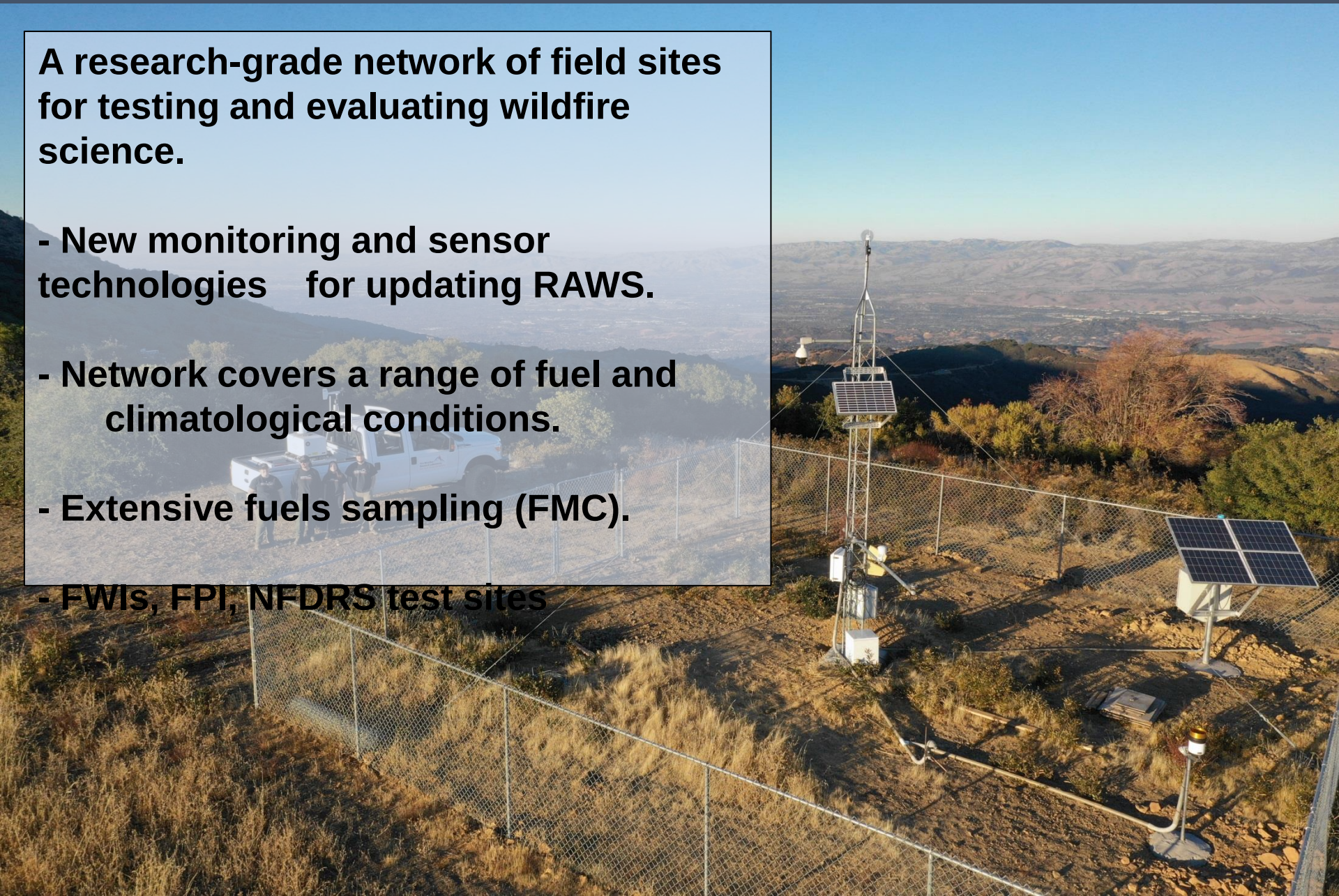
WFAS-MAPS Graphics FIRE BEHAVIOR RESEARCH MISSOULA, MT

Standard Fire Weather Networks

Surface weather station networks

- Used for Calculating Fire Danger Rating.
- Generally, data are hourly from the RAWS network.

Network of Fire Weather Research Field Sites



A research-grade network of field sites for testing and evaluating wildfire science.

- New monitoring and sensor technologies for updating RAWS.

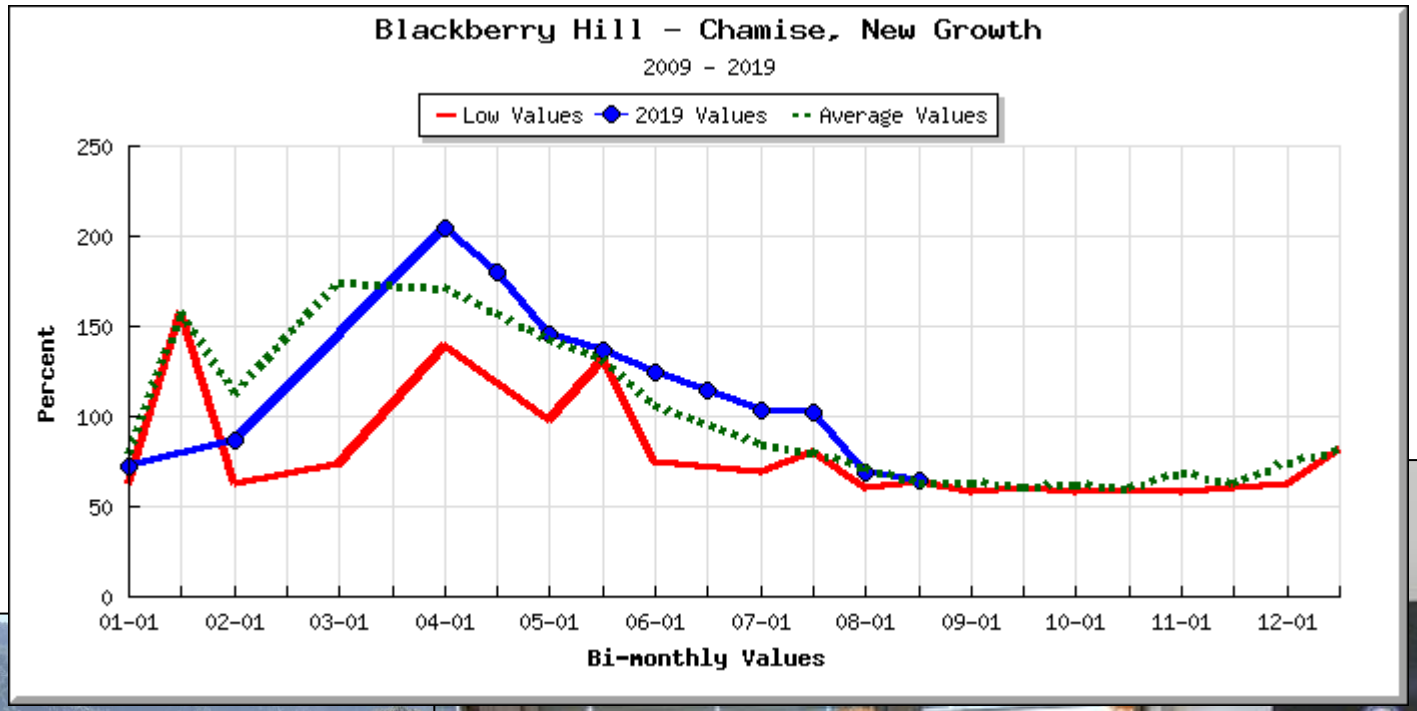
- Network covers a range of fuel and climatological conditions.

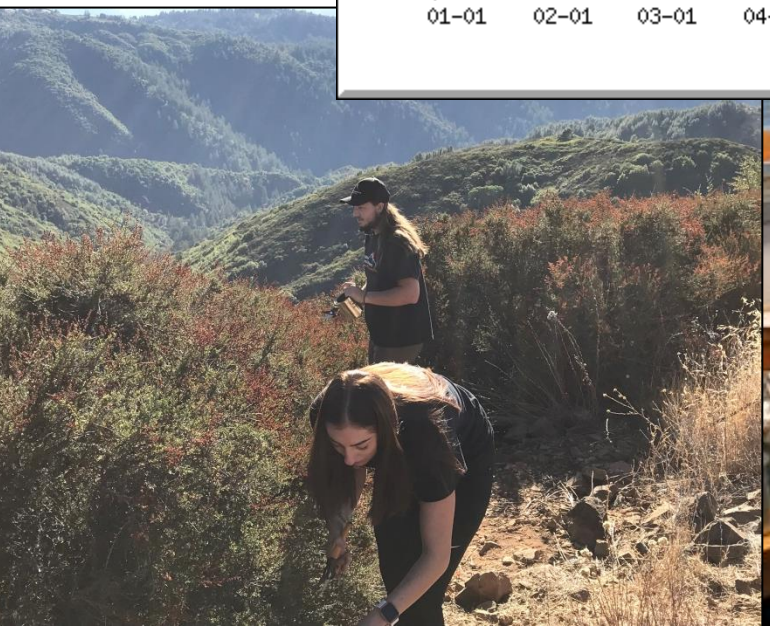
- Extensive fuels sampling (FMC).

- FWIs, FPI, NFDRS test sites

Live Fuel Moisture Content (FMC)

Raito of water content to plant material





The Diablo Wind of Northern California: Climatology and Numerical Simulations

Carrie Bowers (2018)

Climatology Methods

Diablo Wind Criteria

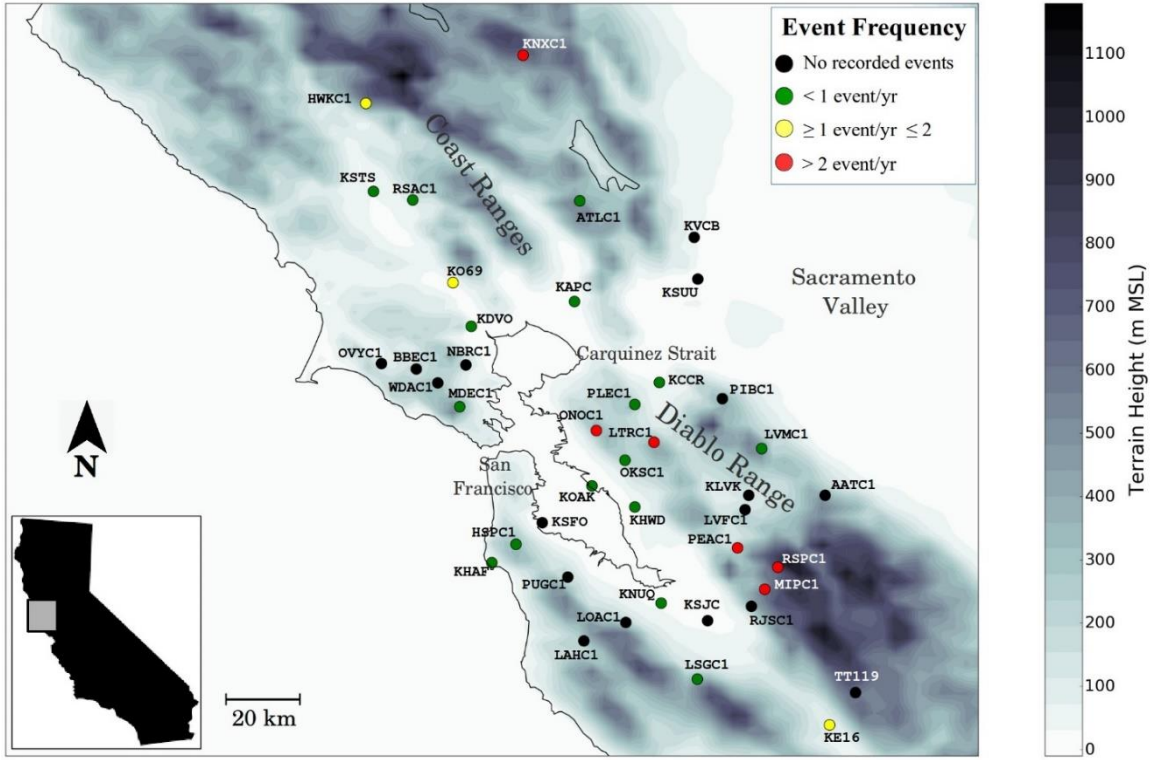
- Sustained winds **6 m s^{-1}** or greater from NE
- Persisting 6+ hours
- Min **RH ≤ 20%**
- 4+ stations impacted

17-year climatology

- 42 NWS stations and RAWS initially
- 18 stations with 14-17 yrs data and 2 or more events
- Monthly avg live fuel moisture from 3 sites (old and new)

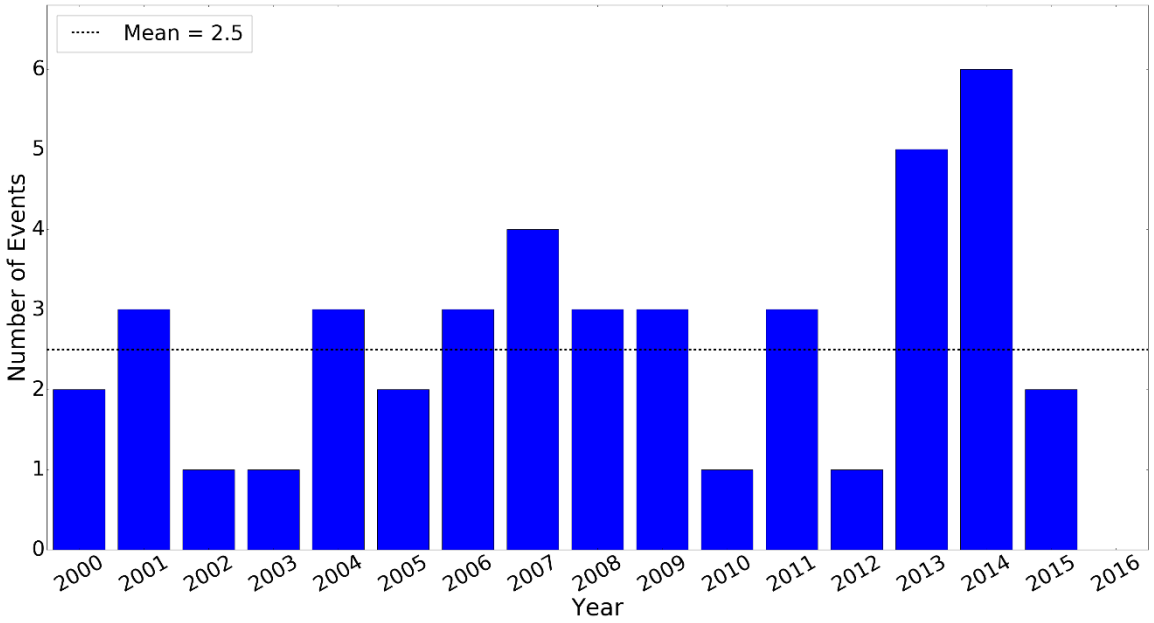
Synoptic Composite

- 43 events
- 32 km NARR at closest hour to time of max wind speed

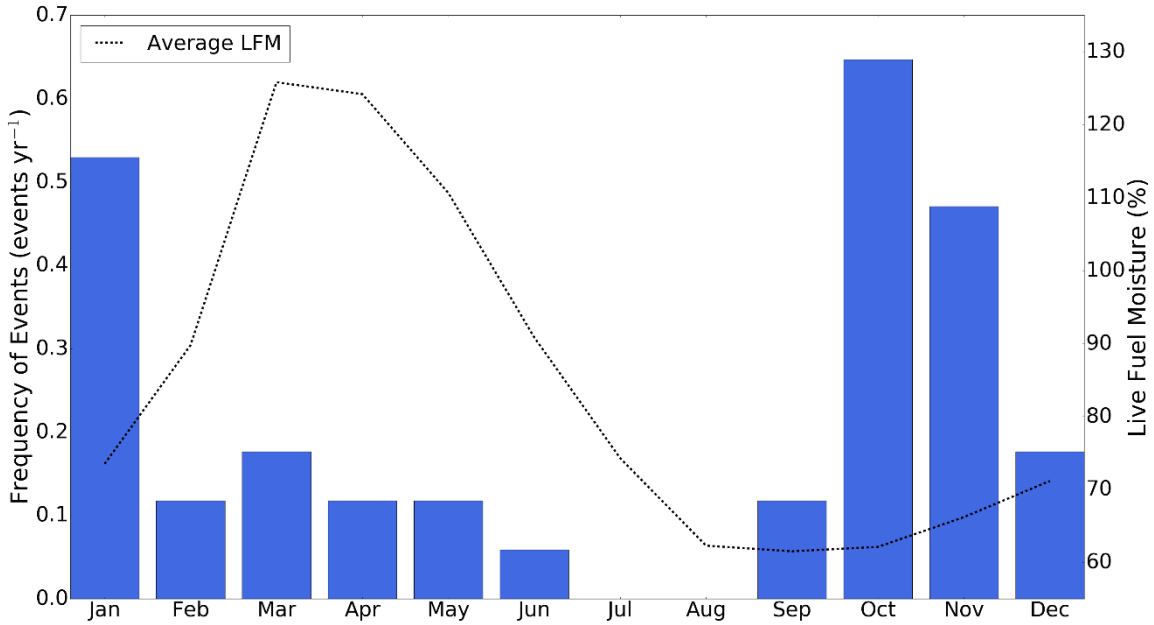


Event Frequency

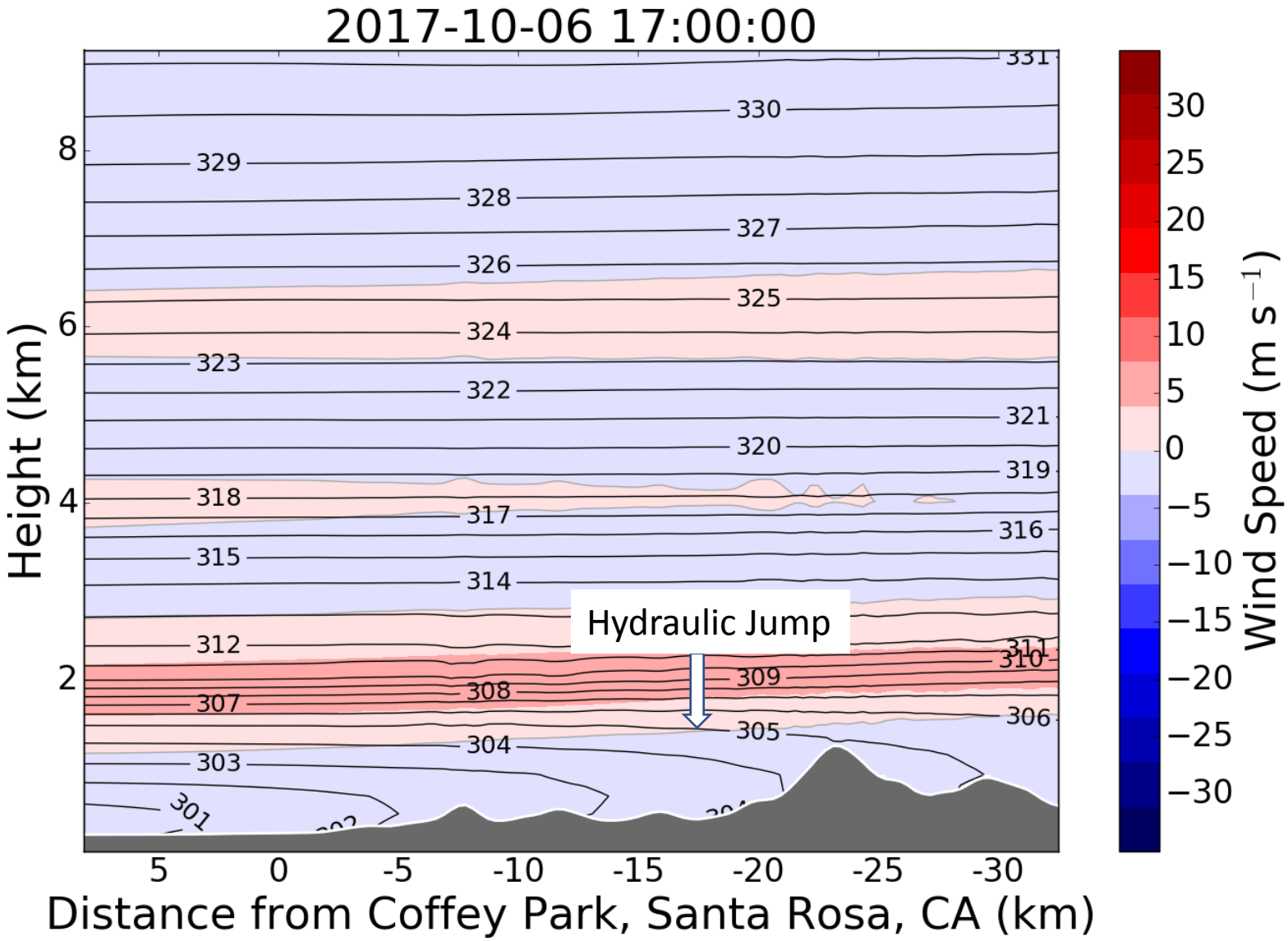
- 2.5 events/yr on average
- 6 events in 2014
- No recorded events in 2016



- October has highest frequency
  - minimum fuel moisture
- Very infrequent in summer

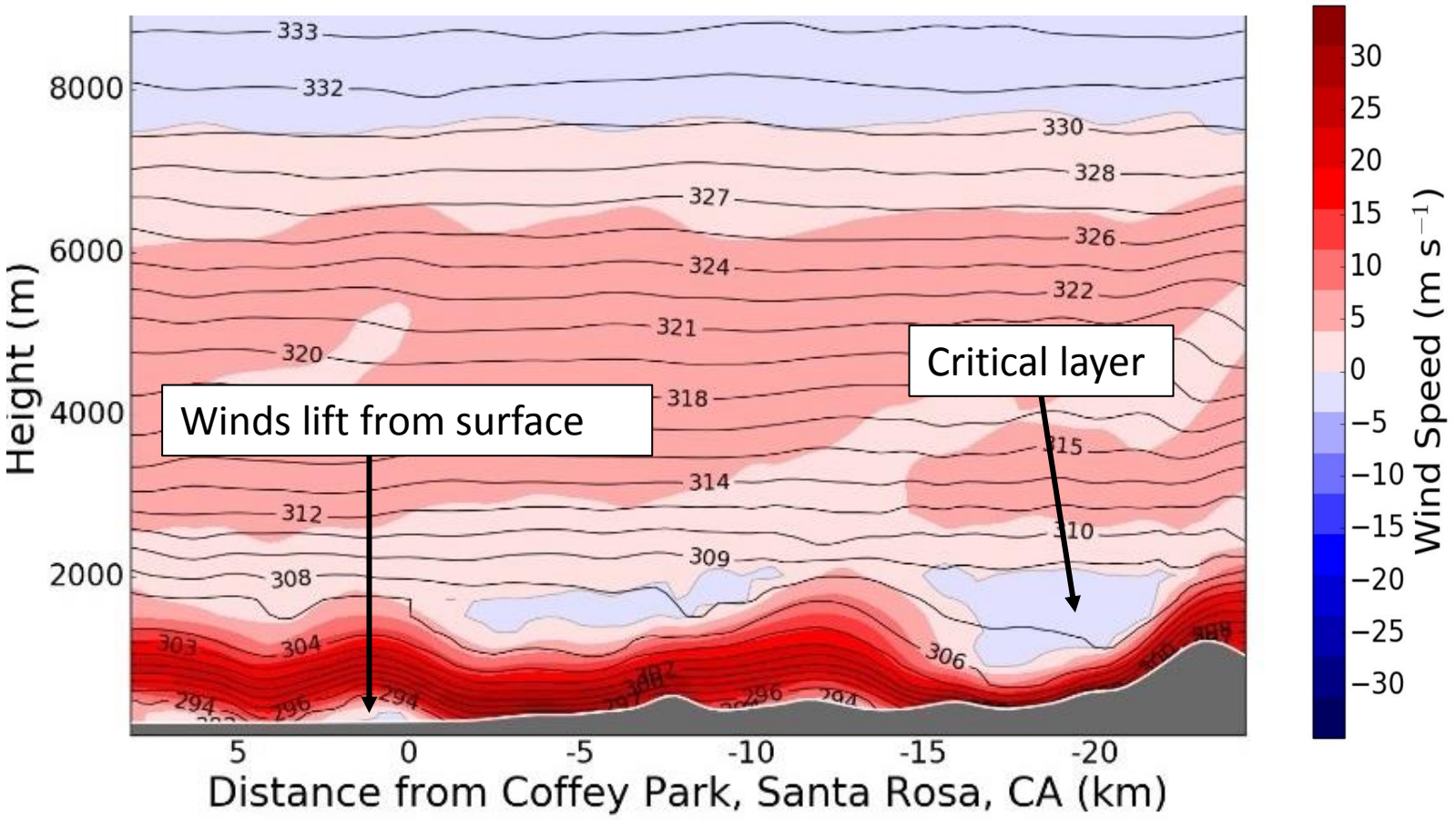


Numerical Simulation of Diablo Winds during the Tubbs Fire



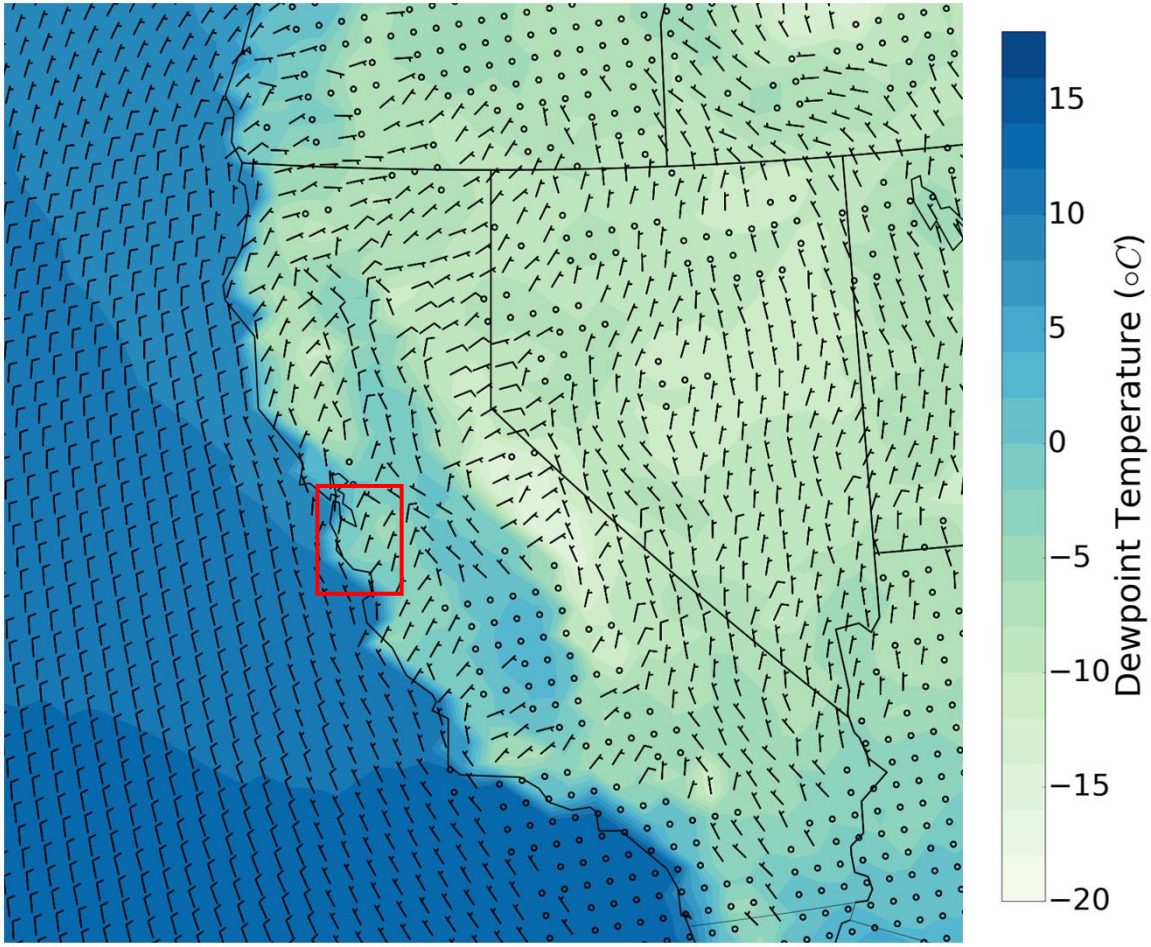
Numerical Simulation of Diablo Wind Event during Tubbs Fire

2017-10-09 0300 PDT



- 3AM is time when fire spread stopped spreading at Coffee Park

Synoptic Composite

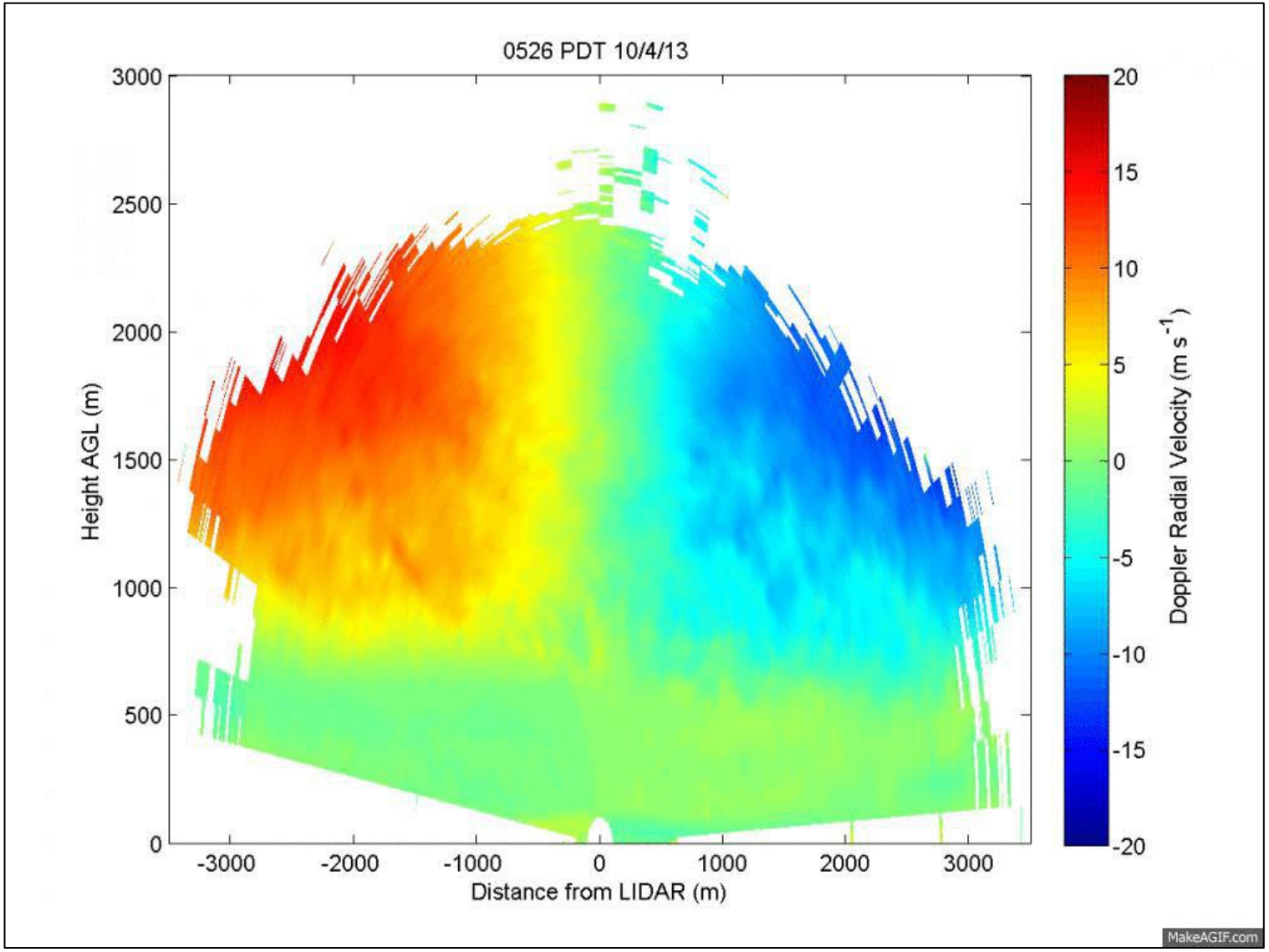


Composite winds and dewpoint temperature

- 43 events
- NARR data at closest hour to time of maximum wind speed

Rapid Onset of Downslope Wind Events

Surface weather conditions during Santa Ana wind, Oxnard

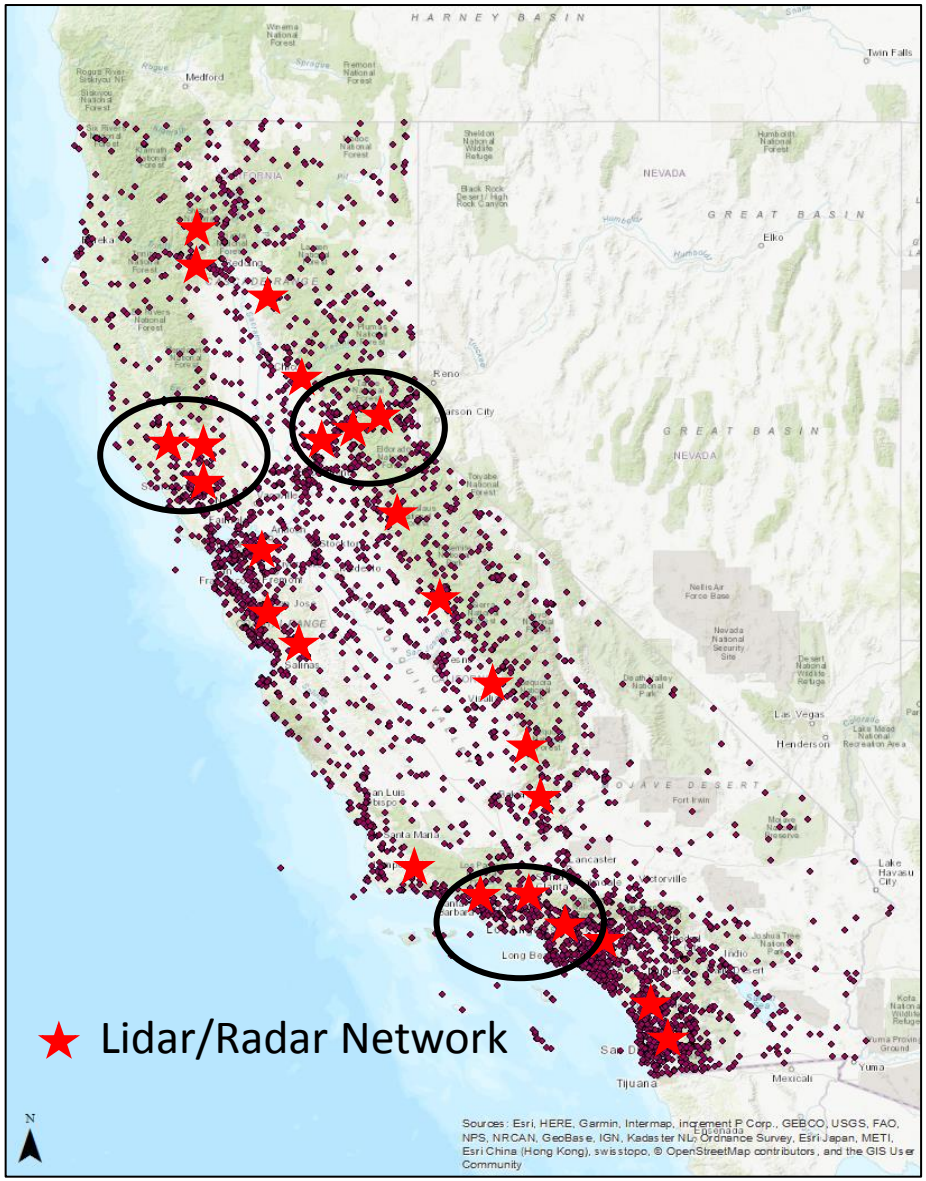


Network of Vertical Profiling Doppler Lidars

Profiling Network for Extreme Fire Weather Monitoring

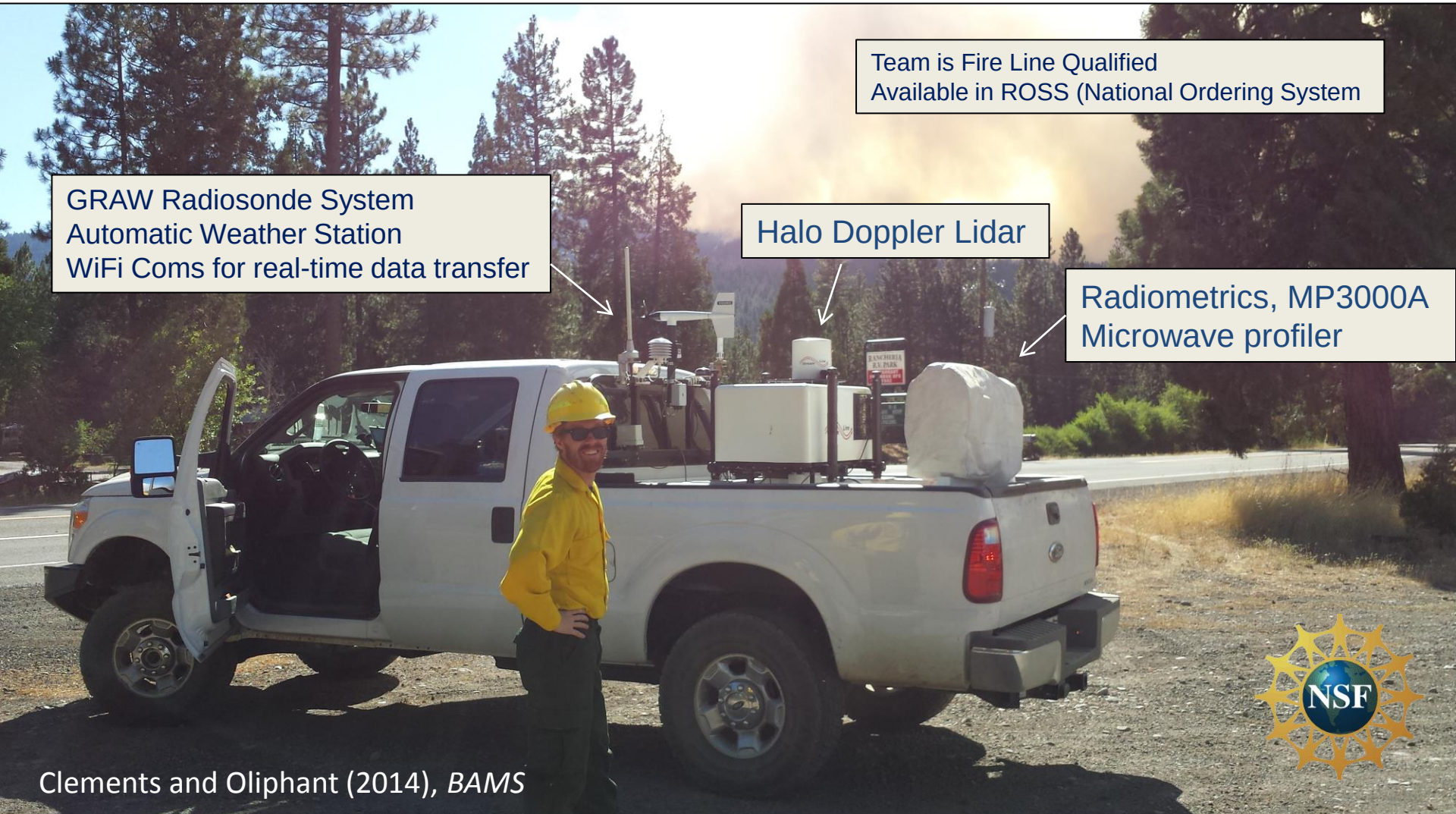
- **Wind profiles up to 6 km (~ 3 miles)**
- **High-frequency: every 2 seconds**
- **Data integration into weather prediction models.**

Doppler Lidar and Radars



California State University-Mobile Atmospheric Profiling System (CSU-MAPS)

Platform optimized for rapid deployment and wildfire research.



Clements and Oliphant (2014), *BAMS*

SJSU Wildfire and Cloud Doppler Radar

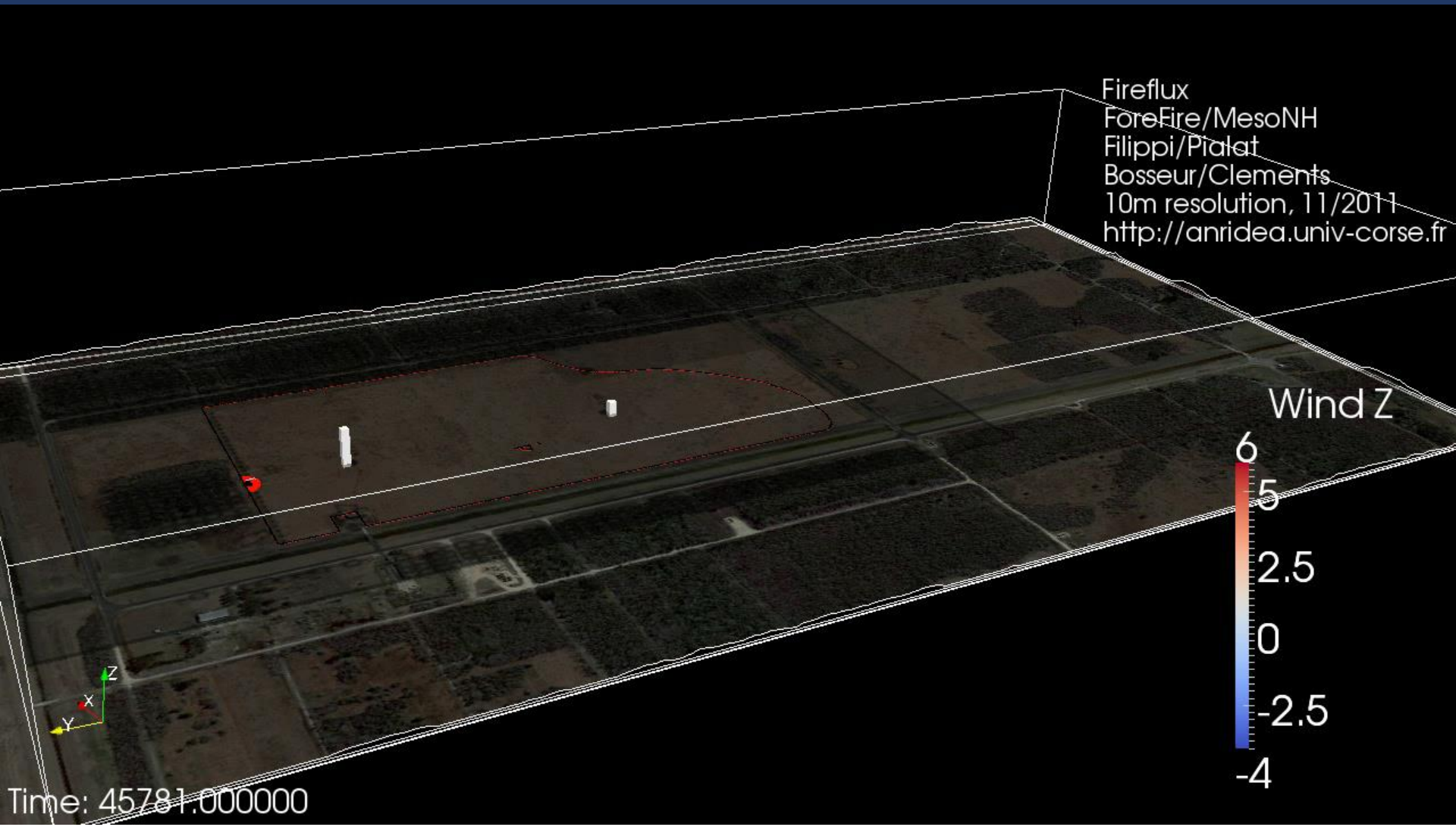
(Scanning Ka-band Polarimetric Doppler Radar)

Parameter	Specification
Frequency	35.61 GHz (short pulse) / 35.67 GHz (chirp waveform)
Transmitter power	10 W, 25% duty cycle max.
Antenna diameter	1.82 m
Antenna Polarization	Tx: alternating V/H pol Rx: simultaneous V/H pol
Beamwidth	0.32° typical
LNA Noise Figure (typical)	2.8 dB
Radiometer bandwidth	100 MHz
Radar data products	dBZ_V, dBZ_H, LDR, ZDR, ρ_{hv}, ρ_{xh}, K_{dp} power spectra: VV, HH, HV, HH; velocity and spectral width. Dual PRI velocity for alias unwrapping
Radiometer data	Calibrated brightness temperature on horizontally polarized channel

- 0.3° beamwidth
- 30 km range
- 7.5 m resolution
- 20° s^{-1} scan rate

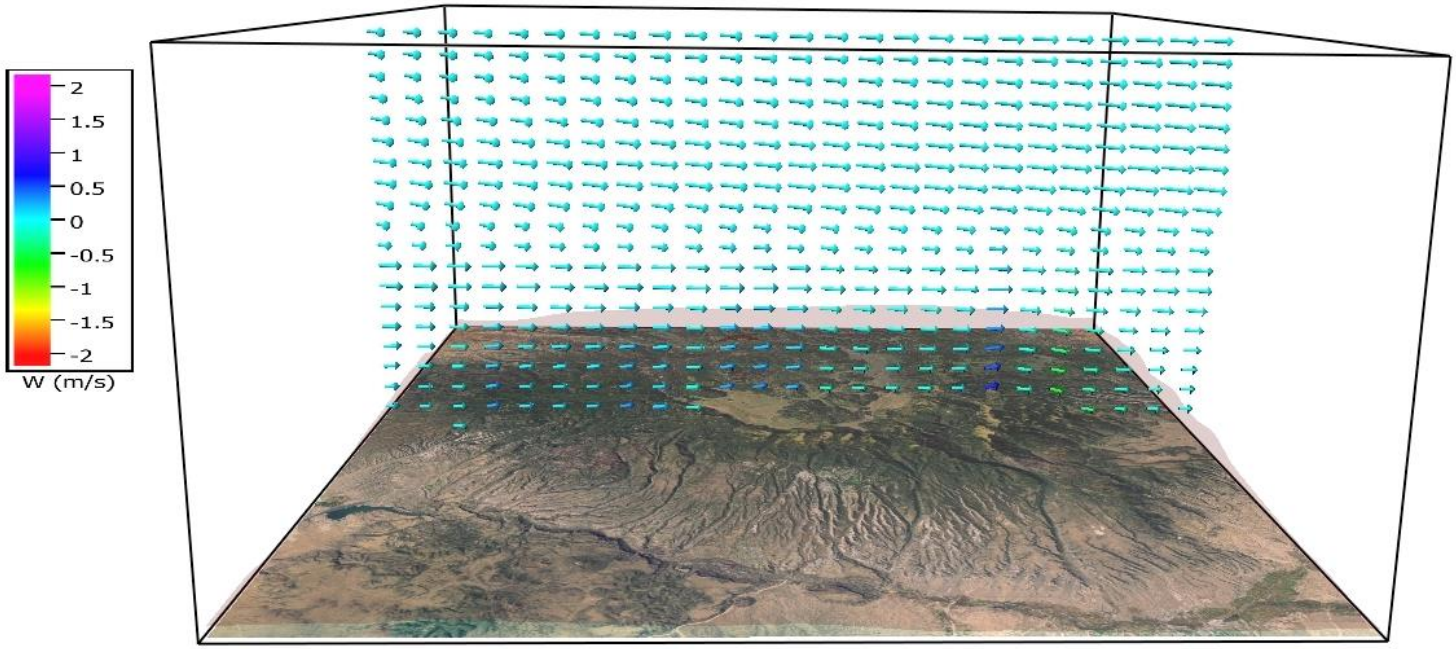
Coupled Fire-Atmosphere Model Simulation of Grass Fire

ForeFire/MesoNH Model (Filippi et al. 2013)



WRF-SFIRE simulations of Las Conchas Fire, 2011

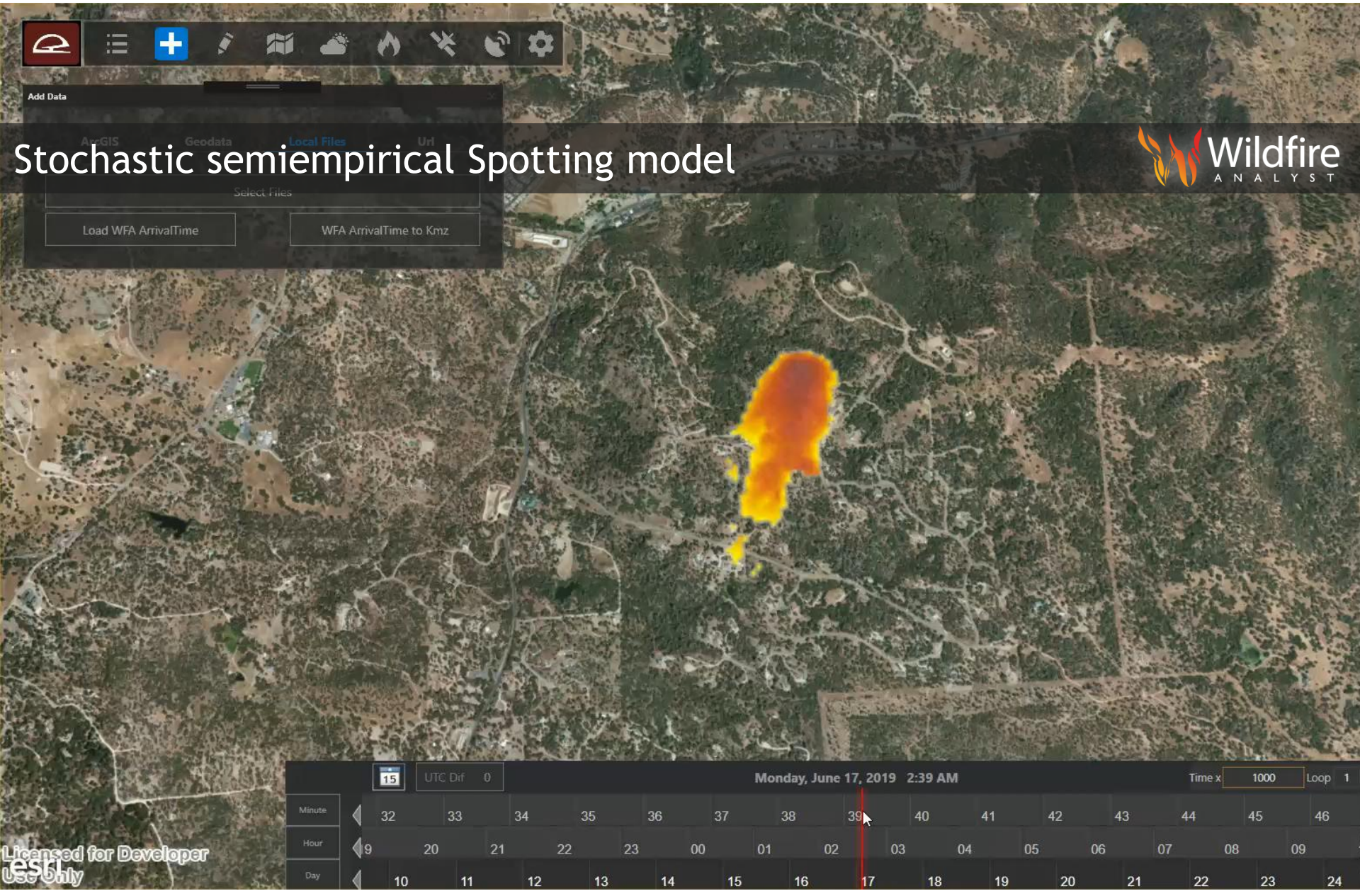
- Larger domain models are used in real-time for modeling active wildfire incidents.
- Weather and Research Forecast Model (real-time weather prediction model).
- WRF is coupled to fire spread code (Rothermel / Balbi) and air chemistry model to predict fire spread and smoke impacts.
- Current state of models **don't** account for **ember generation** and **spotting**.



Courtesy of Adam Kochanski
(University of Utah)

technosylva

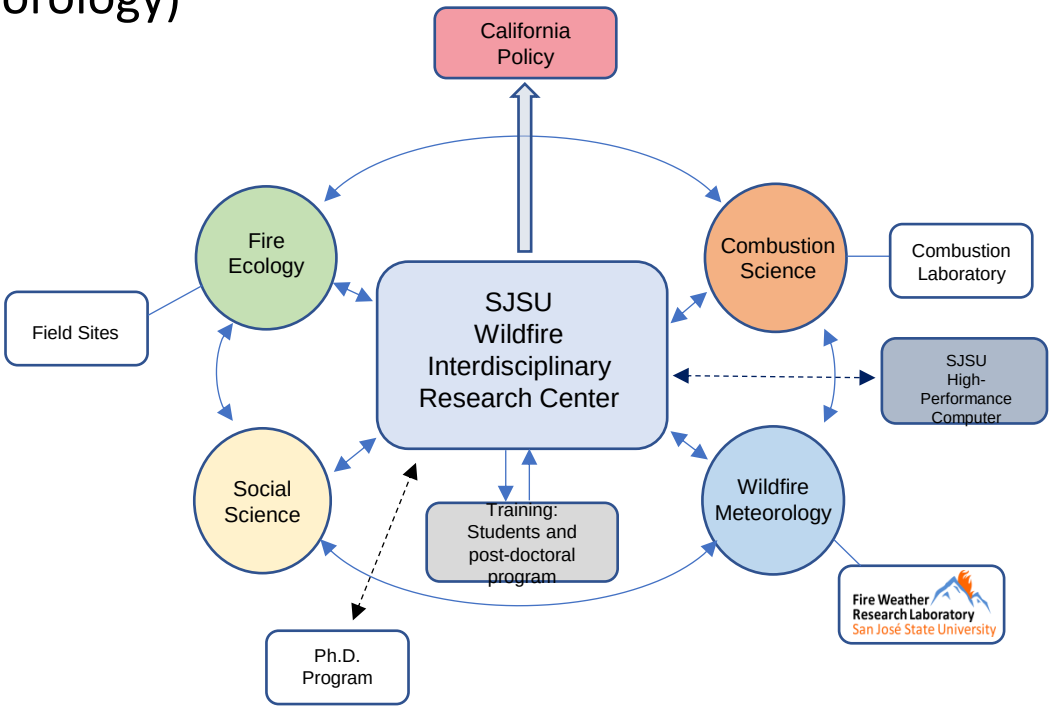
Courtesy of Joaquin Ramirez,PhD



Wildfire Interdisciplinary Research Center
San José State University

5 New Tenure-Track faculty positions / Cluster Hire:

1. Fire Ecologist (Biology)
2. Social Scientist-Wildfire Policy (Env. Studies)
3. Wildfire Combustion Engineering (Mech. Eng.)
4. Fire Behavior / Fire-Atmosphere Modeling (Meteorology)
5. Wildfire Remote Sensing (Meteorology)



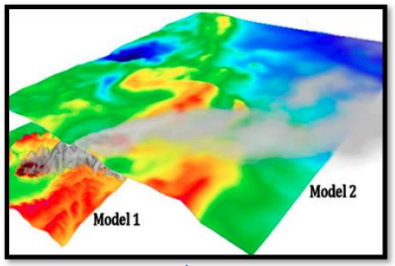
Conceptual Model for Rapid-Response Real-time Data System for Wildfire Prediction

Tactical Aircraft, 0V-10A
(**IR Fire Mapping**)

Satellite Communications

Data transmit

Coupled Wildfire-Weather
Prediction System



SJSU
High-Performance
Computing System

Dissemination
Public, Fire Fighters and
Incident Management Team

Suppression Aircraft
S-2T, VLAT (**Weather Data**)

SJSU Mobile Monitoring Assets
(Doppler Lidar / Radar)

Thank you!

www.fireweather.org

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