Meteorological Perspectives on Fire Potential and Extreme Fire Weather in California

Craig B. Clements

Fire Weather Research Laboratory
Department of Meteorology and Climate Science
San José State University
San José, CA

Contact:
craig.clements@sjsu.edu

fireweather.org
FireWeatherLab

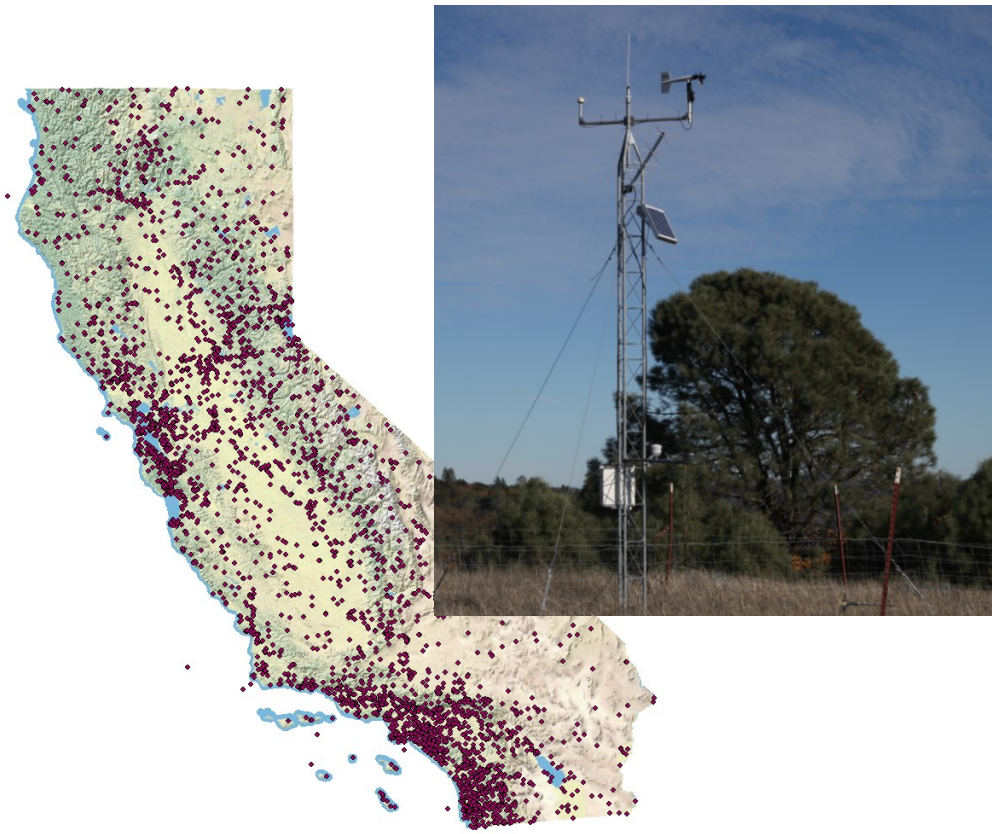
Fire Environment Triangle

Standard Fire Weather Networks

Surface weather station networks

- Used for Calculating Fire Danger Rating.

- The utilities are investing in advanced surface networks for fire risk and fire danger forecasting.



Live Fuel Moisture Monitoring

- **Ground truth**
- **Requires manual sampling**
- **Labor intensive**
- **Laboratory equipment**
- **Bi-monthly, multiple sites**
- **Variability based on site characteristics**
- **Live to dead ration needed**

SJSU Students, Santa Cruz Mountains, Nov 2018

New live fuel moisture models in SAWTI and NFDRS-2016

Large Fire Potential

- Santa Ana Wildfire Threat Index (SAWTI) (Rolinski et el. 2016)

$$\mathbf{LFP = 0.001 \times WS^2 \times D_d \times FMC}$$

- Using the weather portion of the index

(Large Fire Potential – weather [LFP_w])

- Autumn wildfires associated with strong winds and higher dewpoint depressions in Southern California, therefore those are the sole variables examined in this portion of the SAWTI.

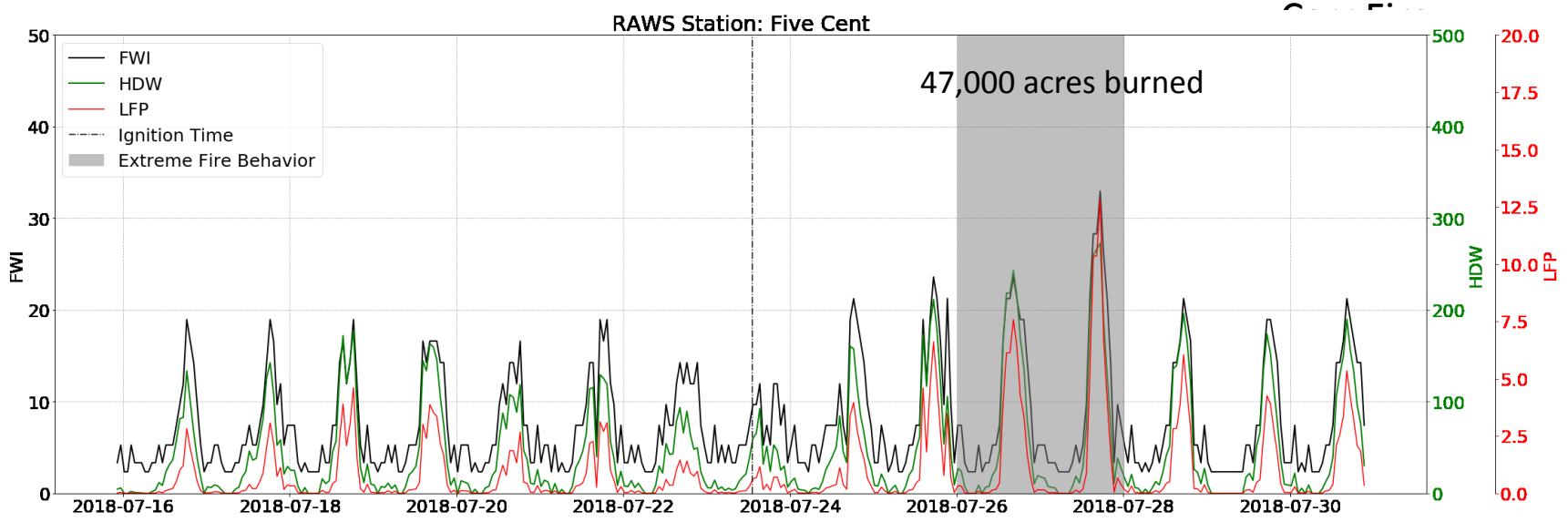
$$\mathbf{LFP_w = 0.001 \times WS^2 \times D_d}$$

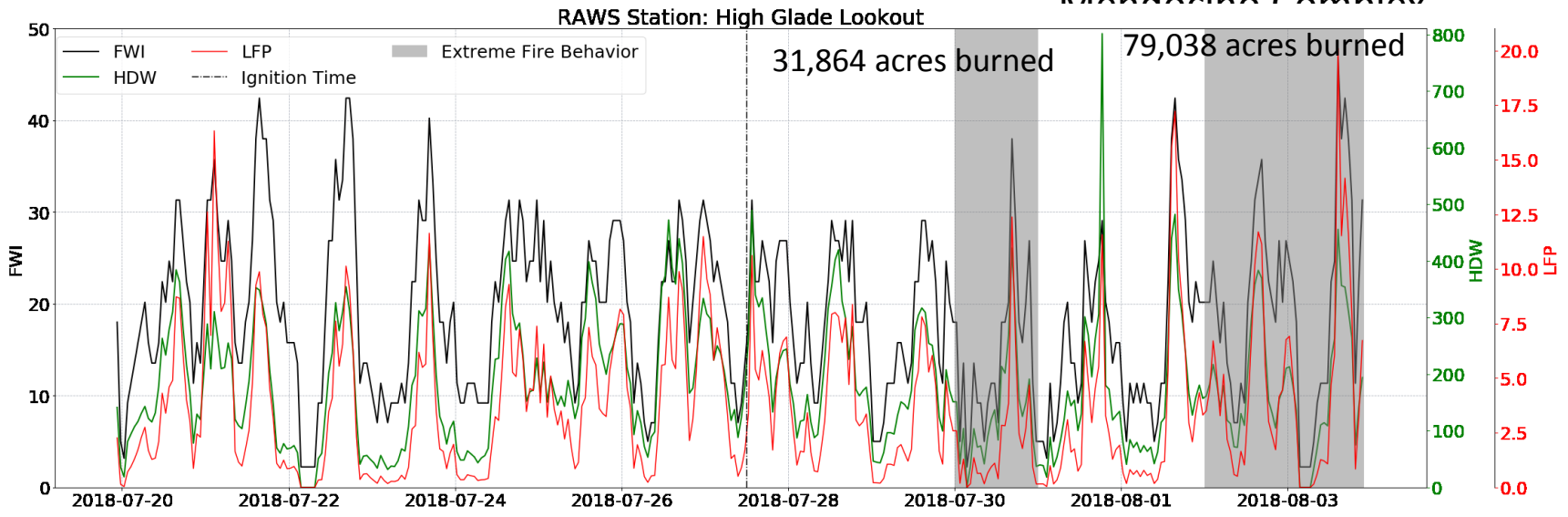
where

WS = Sustained Wind Speed

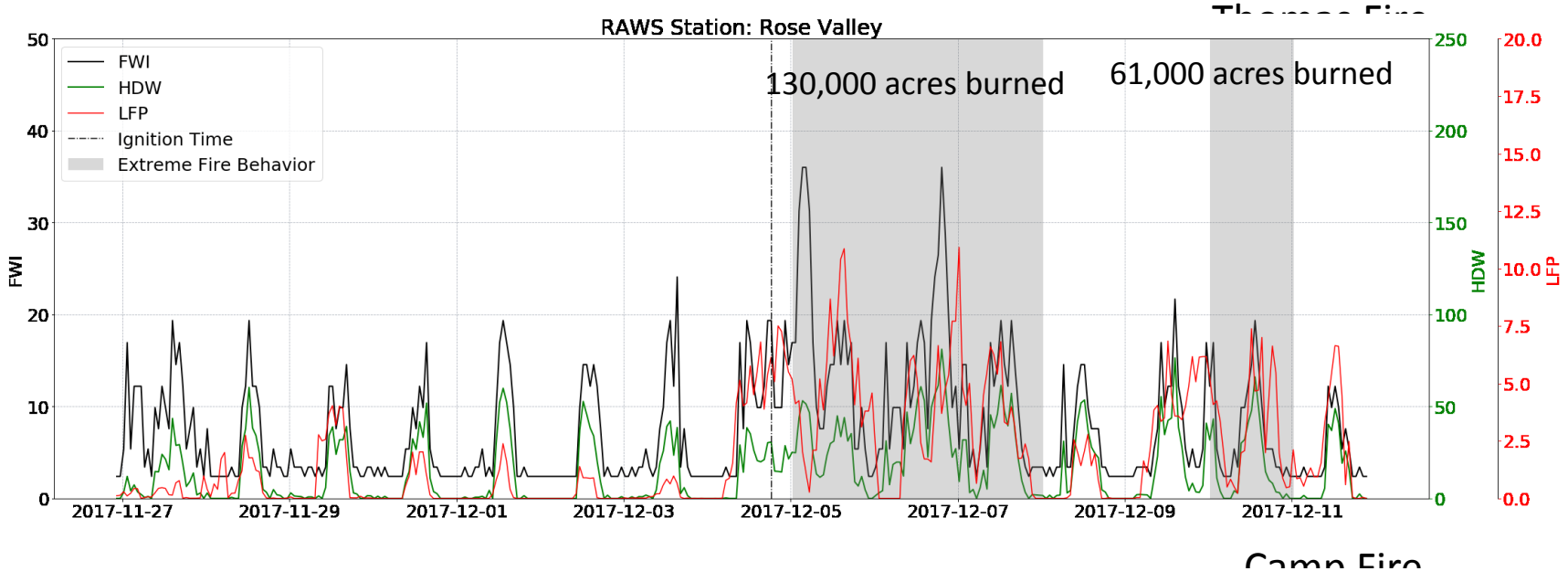
D_d is the dewpoint depression

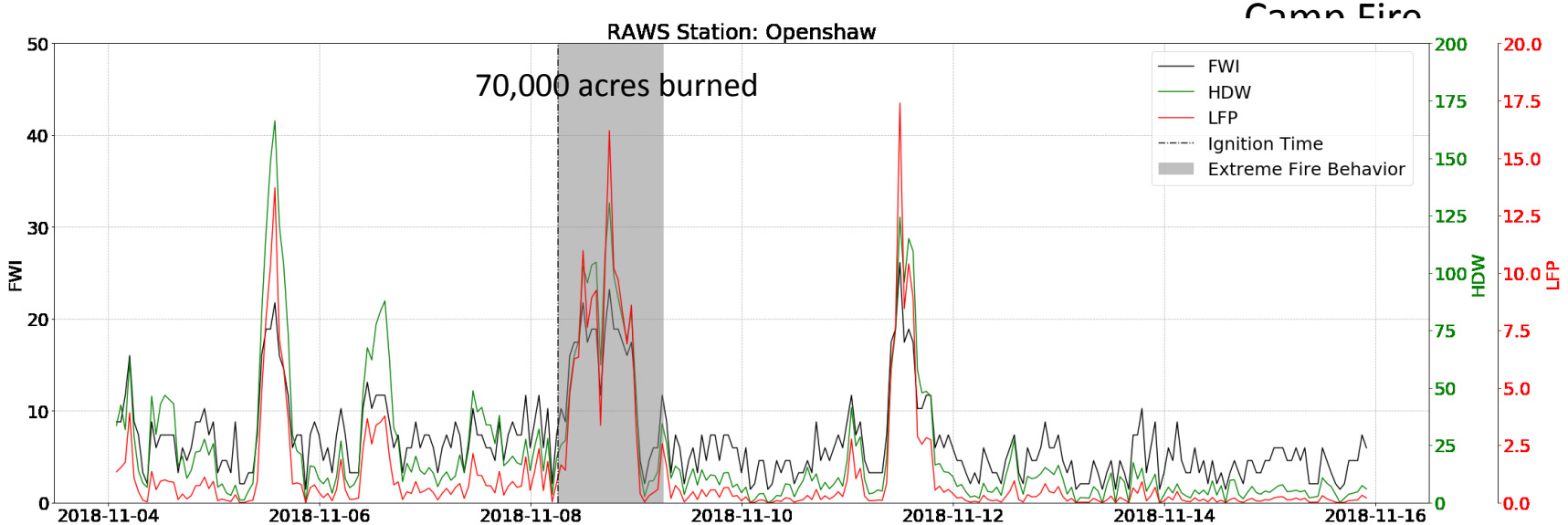
Index Performance for Fuel-Driven Fires





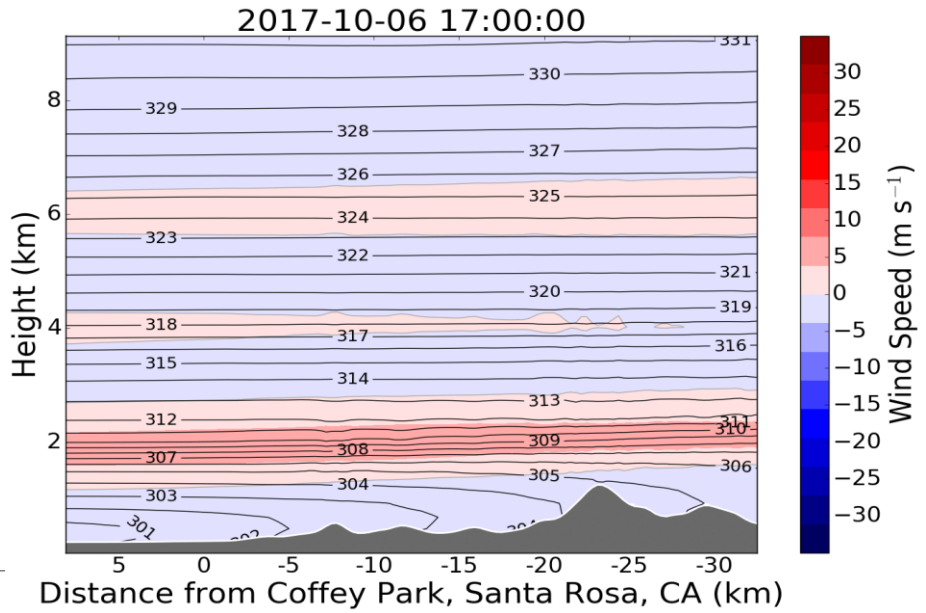
Index Performance for Wind-Driven Fires



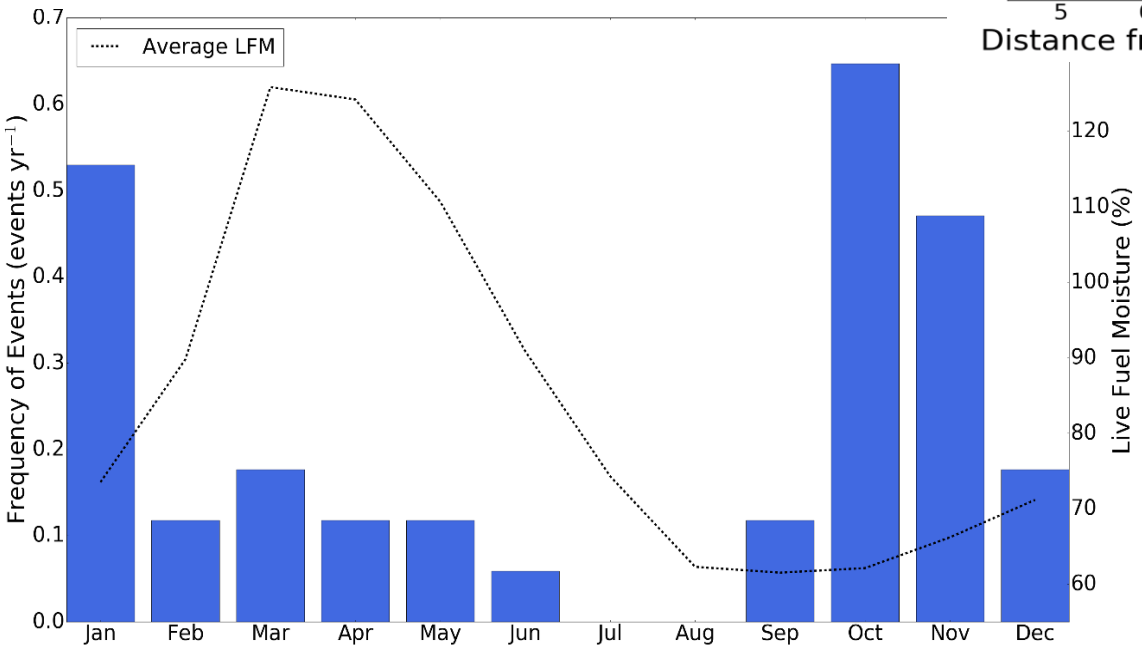


Diablo Winds of Northern California

- 2.5 events/year on average
- October greatest frequency
  - minimum live FMC
- Infrequent during summer



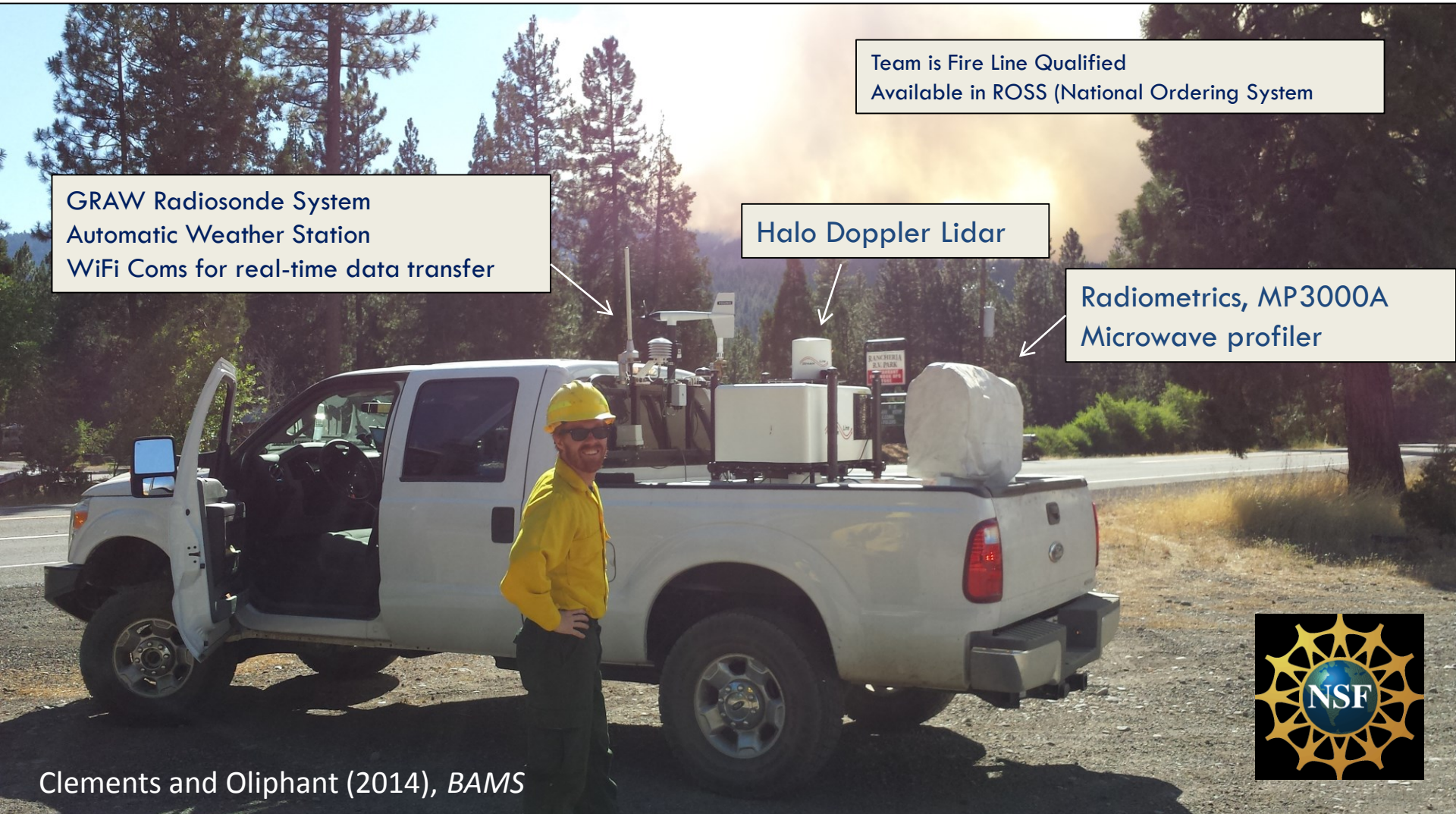
Frequency of Diablo Wind Events



Bowers (2018)

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

Platform optimized for rapid deployment and wildfire research.

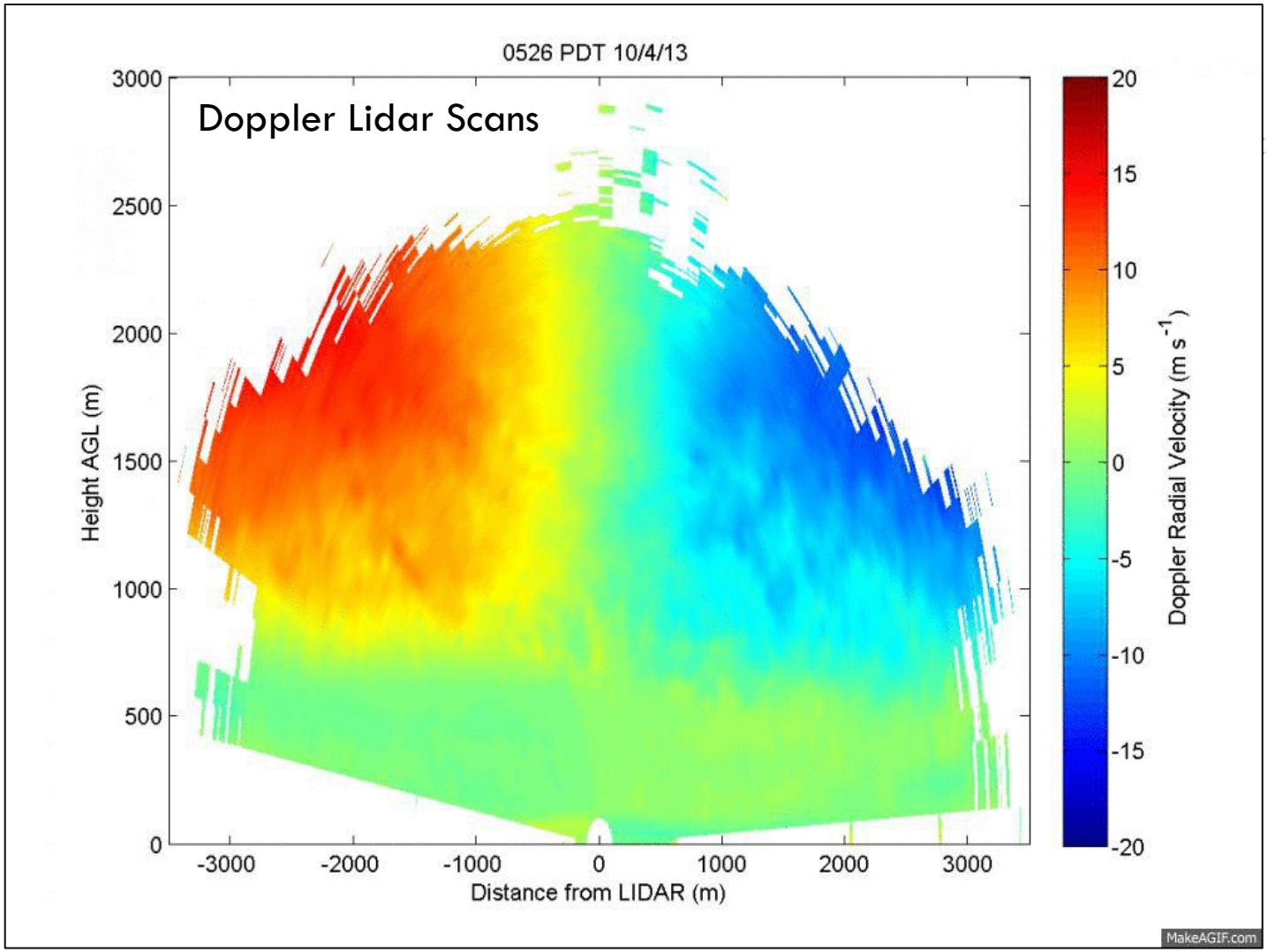


Clements and Oliphant (2014), *BAMS*

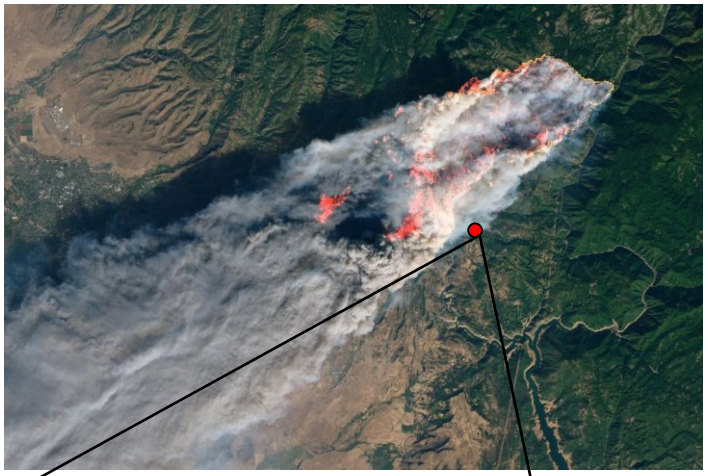
Marine Layer Impacts on Fire Behavior

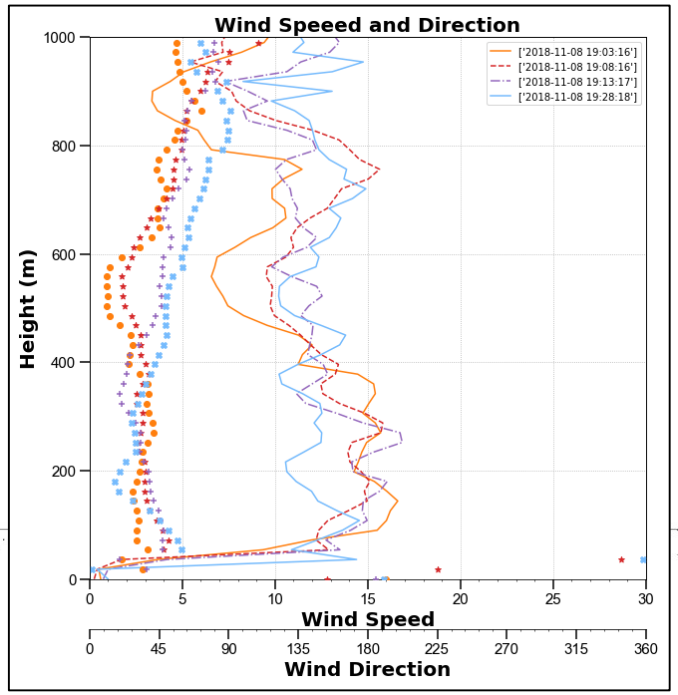
Rapid Onset of Downslope Wind Events

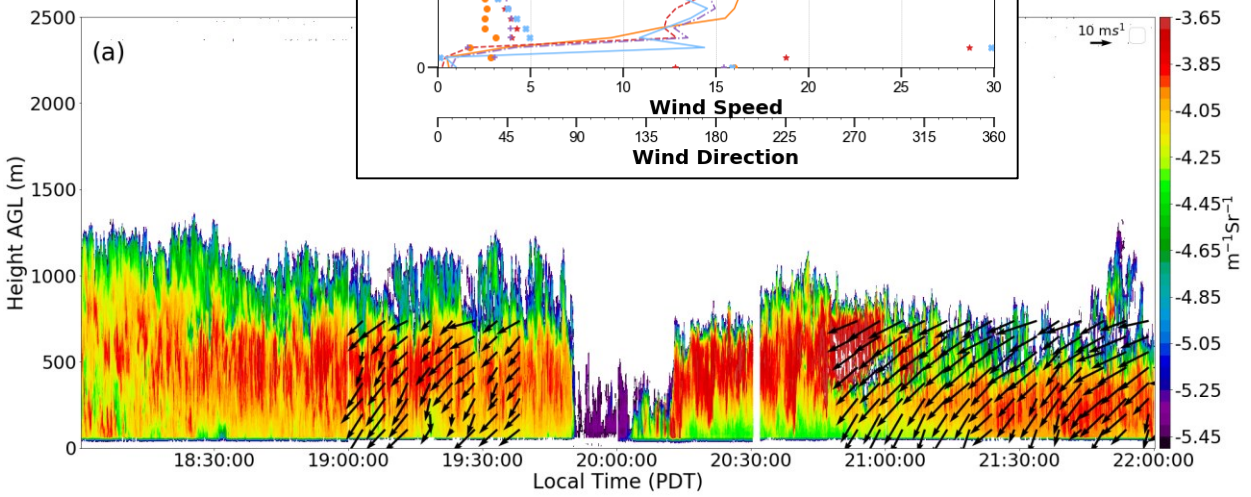
Surface weather conditions during Santa Ana wind, Oxnard



Camp Fire: Observations of Winds by Doppler Lidar

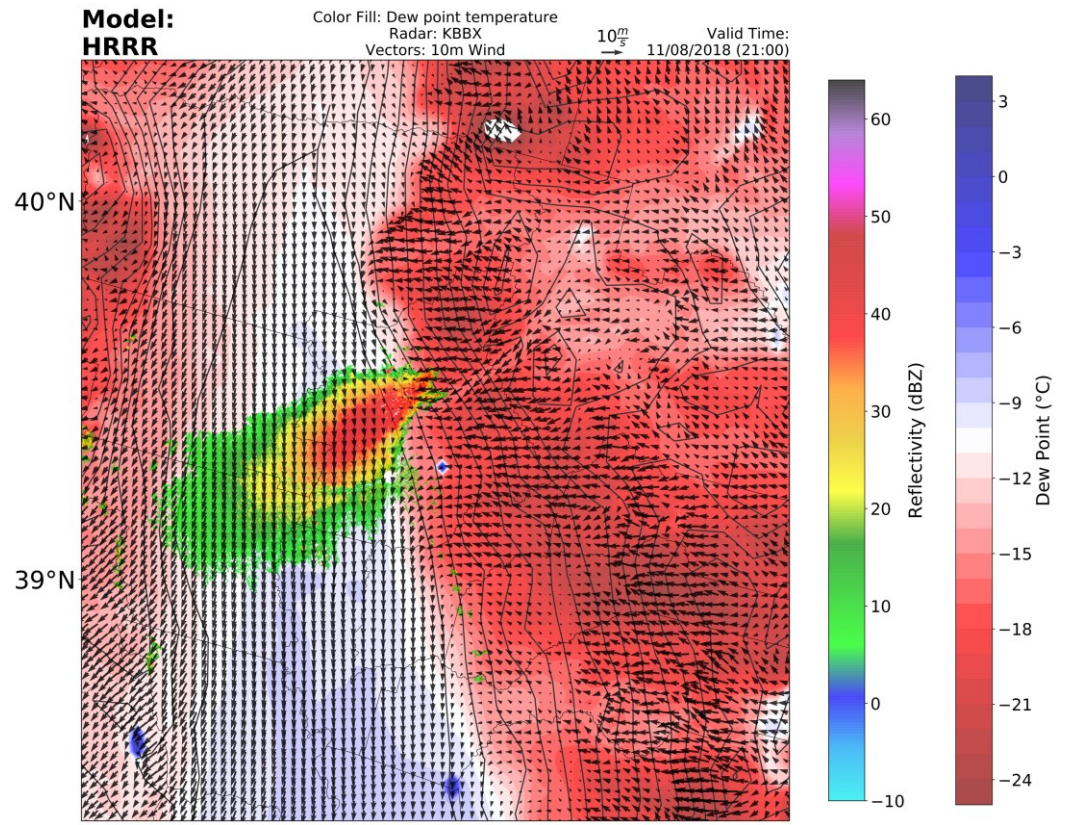




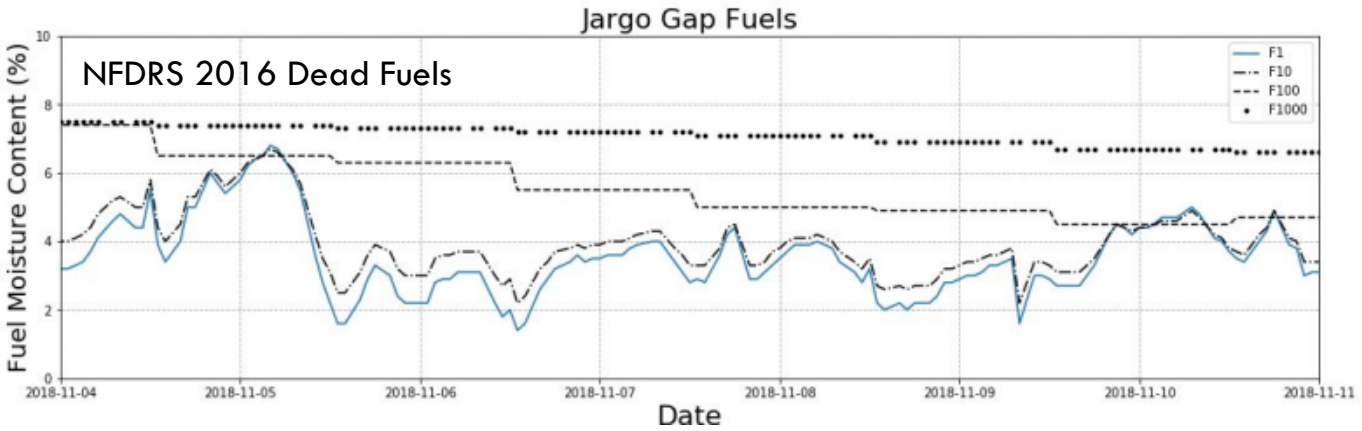


- Wind-driven fire
- Smoke remains within 1-1.5 km AGL
- Vertical profile indicates winds above the ground much stronger than at surface.

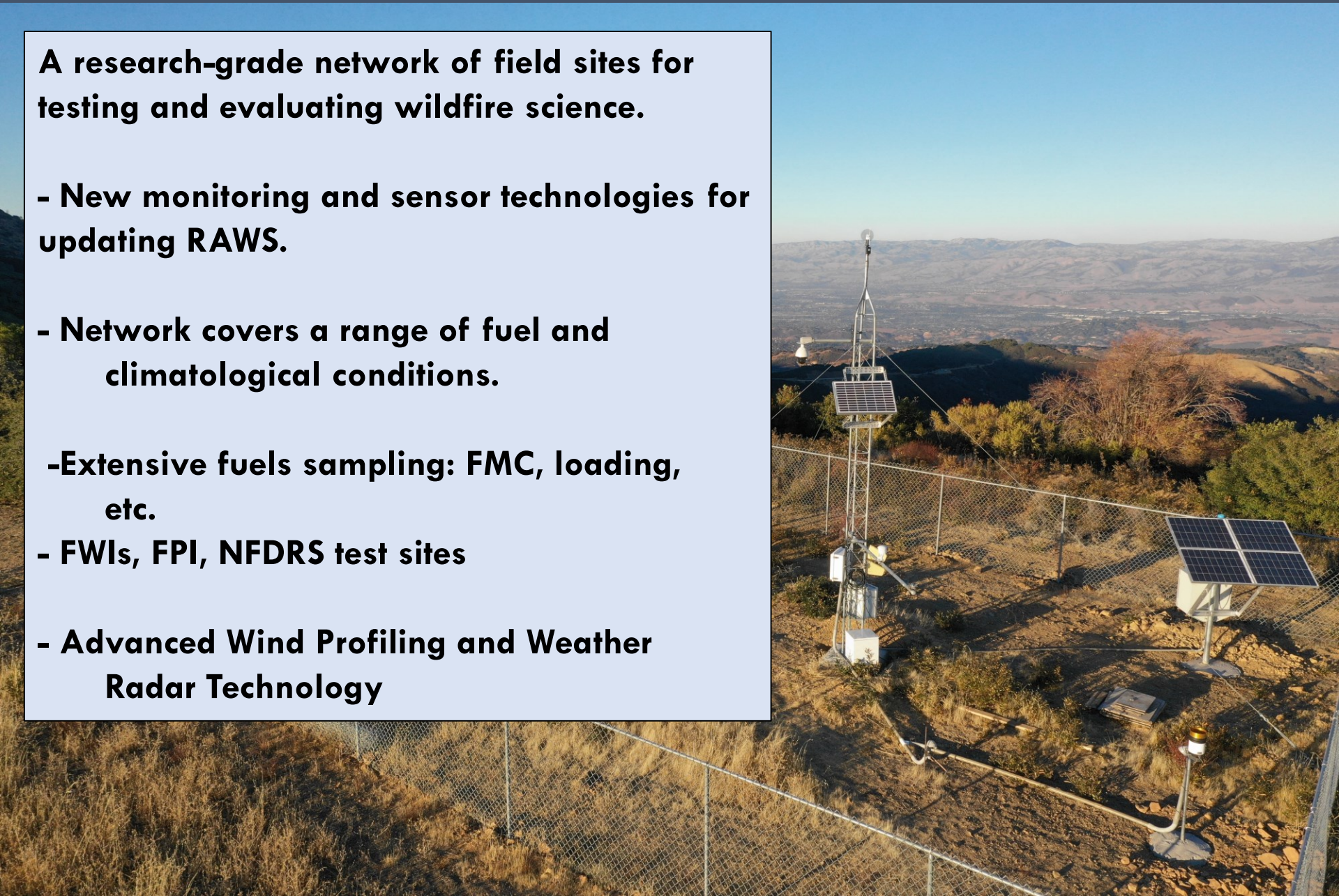
Camp Fire: Meteorological Conditions and Fuels



- Critical FMC: 4-7%
- Strong downslope and gap winds
- Ambient RH = 14%
- Indices dominated by wind



SJSU 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, loading, etc.

- FWIs, FPI, NFDRS test sites

- Advanced Wind Profiling and Weather Radar Technology

Summary

- **Large Fire Potential**
  - Correlates well with the large wind-driven events
  - Does not explain unprecedented extreme fire behavior
  - Other indices work as well for non-wind events.
  - Relationship between FPI and spotting not understood.
- **Live Fuel Moisture monitoring**
  - Critical for fire danger and Large Fire Potential
  - Largest fires are associated with critical LFM content
  - Live to dead fuel ratio needed
- **SJSU Fire Weather Research Network**
  - Testing new technologies.
  - Consistent fuels sampling, fuel ratios, moisture, loading
  - Vertical wind profiling and weather radar for wildfire
  - Evaluating next-generation fire prediction systems.