



WPI

Building a Resilient Society in Response to Wildfires

Albert Simeoni

Professor and Department Head
Fire Protection Engineering

asimeoni@wpi.edu

(508) 831-6333

www.wpi.edu/academics/departments/fire-protection-engineering

Building a Resilient Society in Response to Wildfires



WPI

The Context

Fire impact is growing because of:

- Climate Change (including wet years)
- Urban Sprawl / population growth (exposure, ignitions)
- Structures and communities vulnerability to fires



Different aspects to consider: the wildland fires, the spread mechanisms, and the structures

Building a Resilient Society in Response to Wildfires



WPI

Wildland Fires and Related Issues

- Multiple ignitions
- Extreme fire behavior
 - Elevated rate of spread
 - Higher heat fluxes
 - Ember showers
 - Merging fires
 - Fire whirls
- Safety
- Smoke
- Influence on evacuation



Building a Resilient Society in Response to Wildfires



WPI

The Spread Mechanisms

- Convective transfer / Flame contact
- Radiative transfer
- Firebrands
- Can be vegetation-to-structure or structure-to-structure
- Complex interaction between topography, wind, vegetation and structures
 - WUI and community geometry channeling wind, flames, and firebrands
 - Spread corridors exist through communities



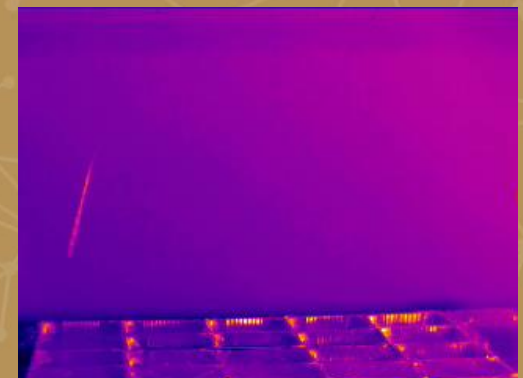
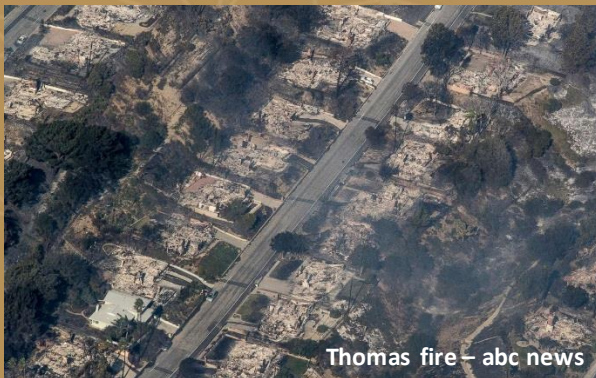
Building a Resilient Society in Response to Wildfires



WPI

The Structures

- 38% of new home construction in Western US is in WUI areas
- Enormous growth in the last 50 years in Greece (tourism, second homes, population concentration in the Mediterranean region)
- Whole areas are wiped out
- Fires often transition from wildland fires to urban / suburban fires
- Ornamental vegetation can be left almost untouched



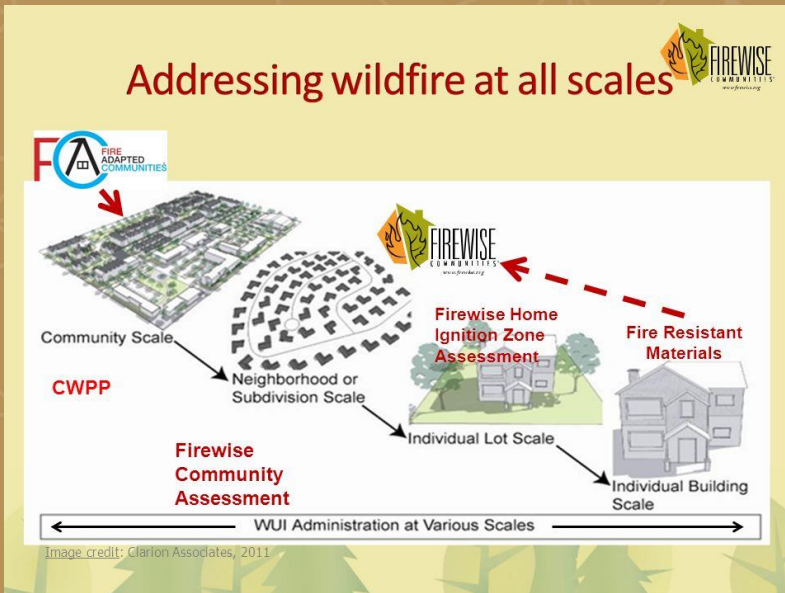
Building a Resilient Society in Response to Wildfires



WPI

The Structures

- Community design:
 - Fire can spread from structure to structure resulting in a large domino effect
 - Sometimes, the interaction between fire, burning vegetation and burning structures can be very complex
 - Design can be assessed / improved at different scales



Building a Resilient Society in Response to Wildfires



WPI

Building resilience

- *Community design:*
 - Fire spreads in heterogeneous ways
 - Design can be used to leverage this aspect for protection purposes



Tubbs fire



North-Corsica fire



Mati fire

Building a Resilient Society in Response to Wildfires



WPI

Building resilience

- *Public education:*
 - Property maintenance
 - Evacuation



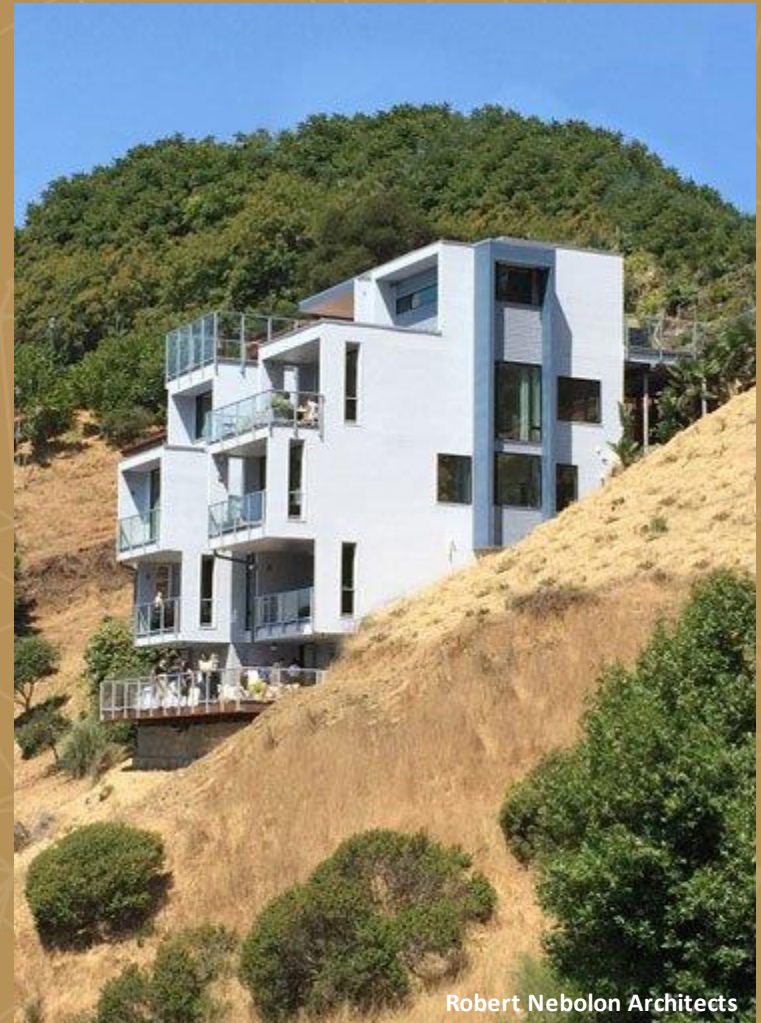
Building a Resilient Society in Response to Wildfires



WPI

Building resilience

- *Training and Education:*
 - Inspectors / enforcers
 - Architects / designers
 - Engineers
 - Researchers



Building a Resilient Society in Response to Wildfires



WPI

Building resilience

- *First responders:*
 - Safety
 - Evacuation
 - Decision support systems



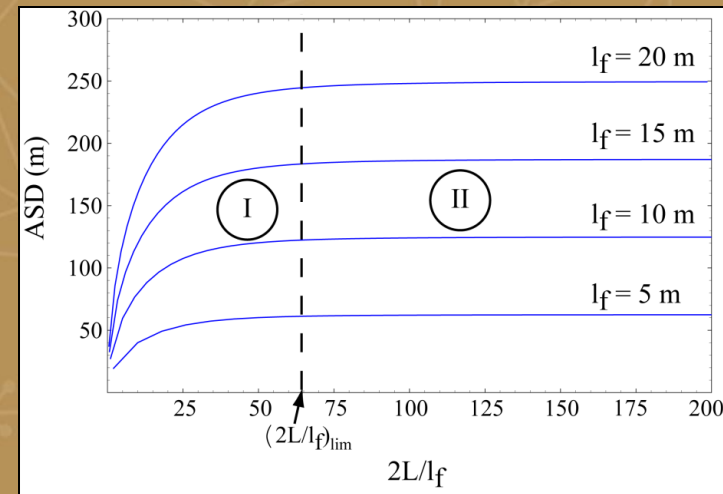
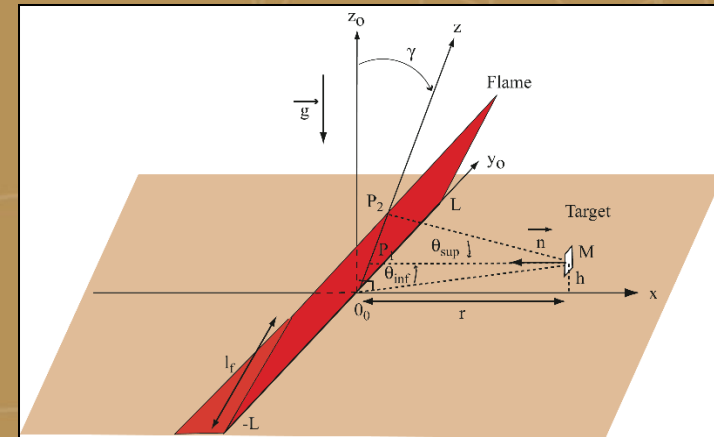
JRC Scientific and Technical Reports

Recent Forest Fire Related Accidents in Europe

Domingos Xavier Viegas (Editor)

EUR 24121 EN - 2009

JRC EUROPEAN COMMISSION ies



Building a Resilient Society in Response to Wildfires



WPI

Building resilience

- *Research:*
 - Extreme fire behavior
 - Fire impact
 - Design solution at the wildland-urban interface
 - Codes and Standards
 - Decision support systems
 - Firefighter safety

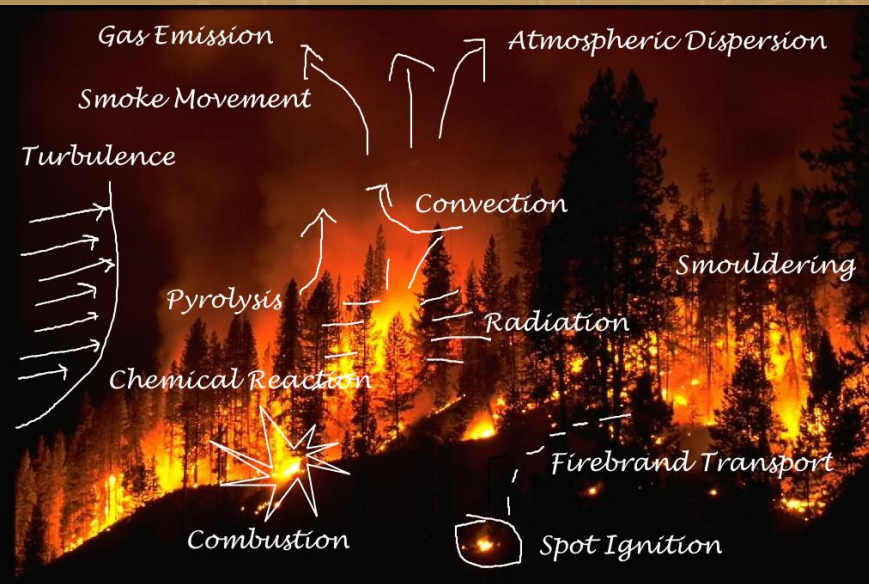


Building a Resilient Society in Response to Wildfires



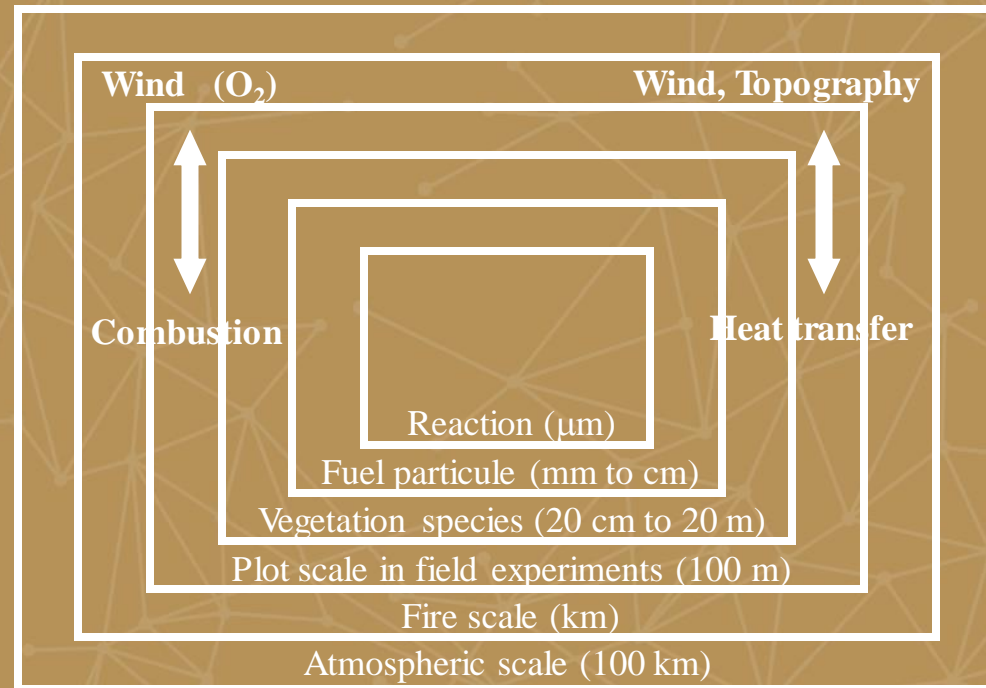
WPI

The complexity of modeling



Time Scales

Space Scales



Building a Resilient Society in Response to Wildfires



WPI



Building a Resilient Society in Response to Wildfires



WPI



Building a Resilient Society in Response to Wildfires



WPI

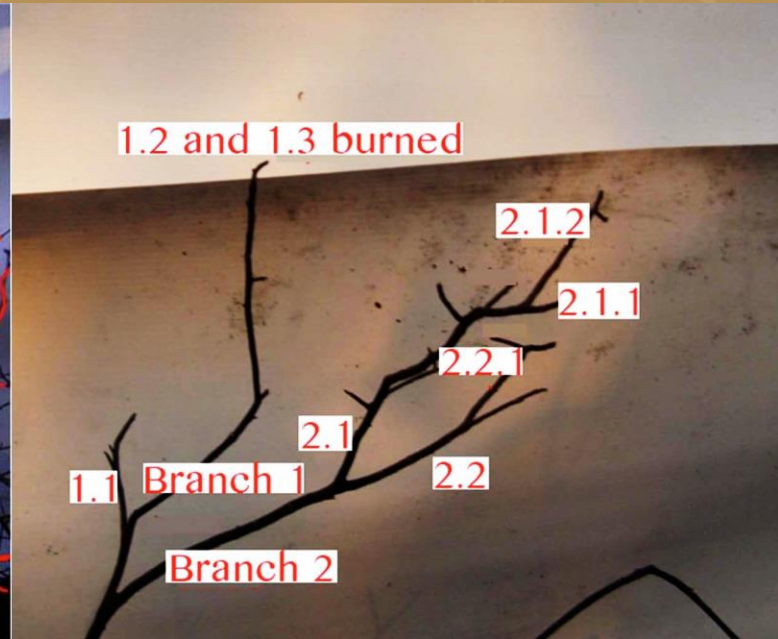
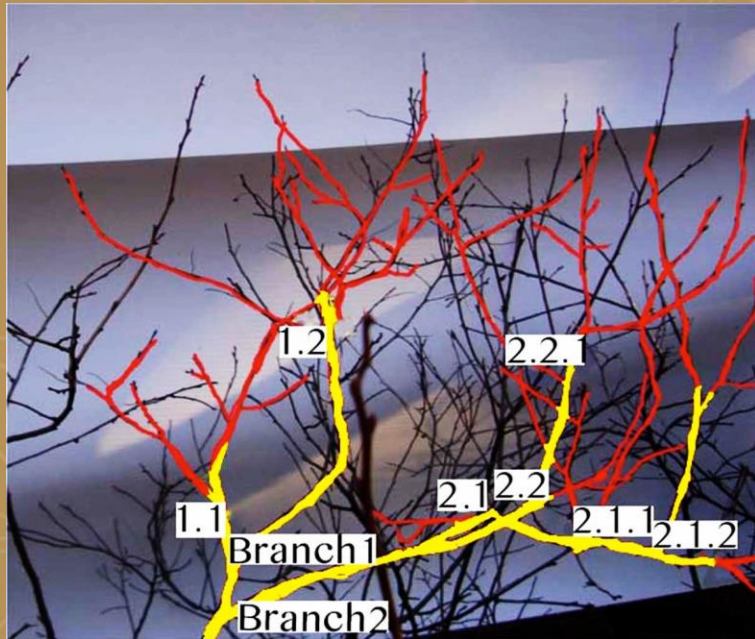
- Fuel consumption is a function of fire dynamics
- Difficult to differentiate what was burned during the fire / after the fire



Building a Resilient Society in Response to Wildfires



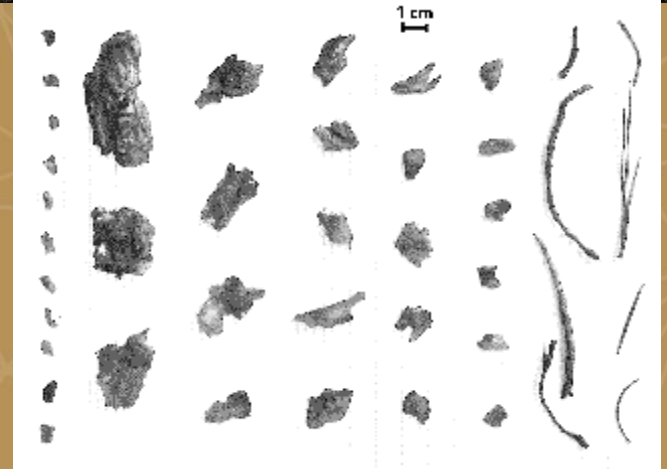
WPI



Building a Resilient Society in Response to Wildfires



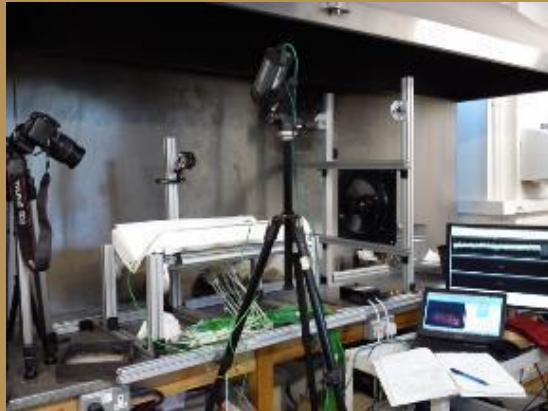
WPI



Building a Resilient Society in Response to Wildfires



WPI



Experimental conditions

- Wind
- Wood material
- Amount of firebrands
- Size and material of firebrands
- Wedge angle
- Tilt angle
- Sample gap



Flaming ignition occurs after hole through sample

Flaming occurs on back face of sample



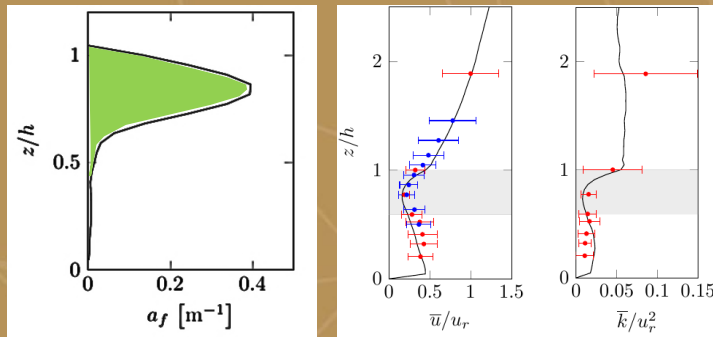
Building a Resilient Society in Response to Wildfires



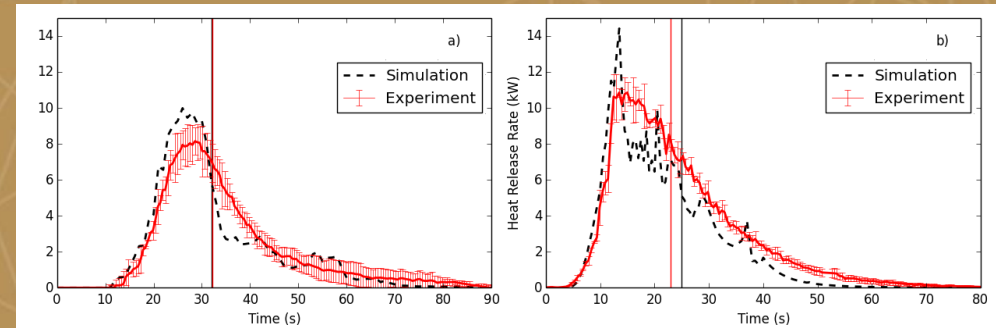
WPI

Understanding the different scales

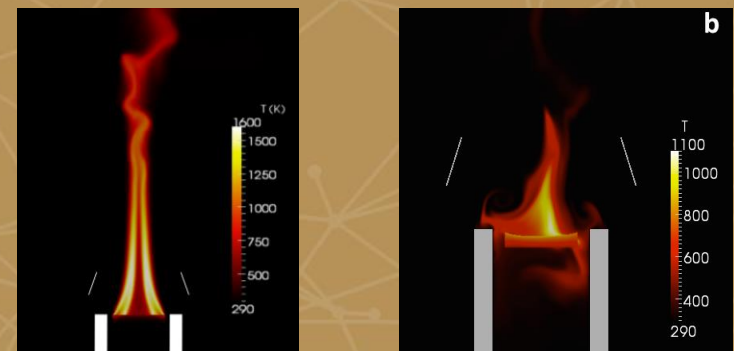
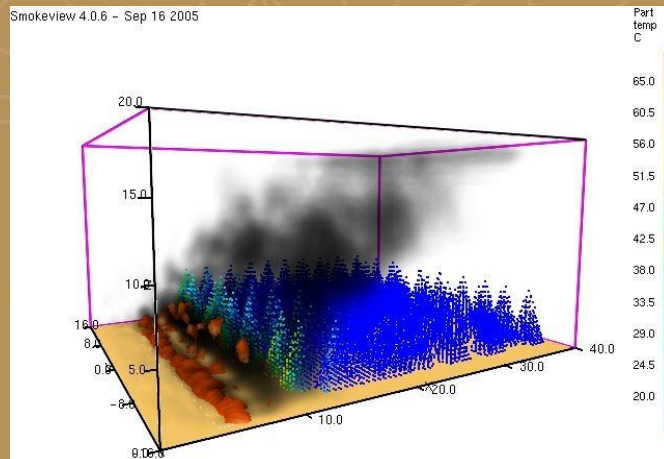
Drag Forces in the forest



Burning dynamics



Heat Release Rate

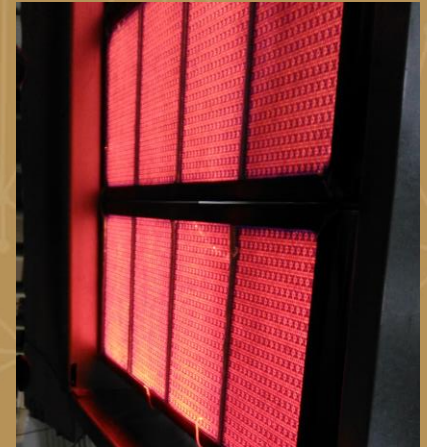
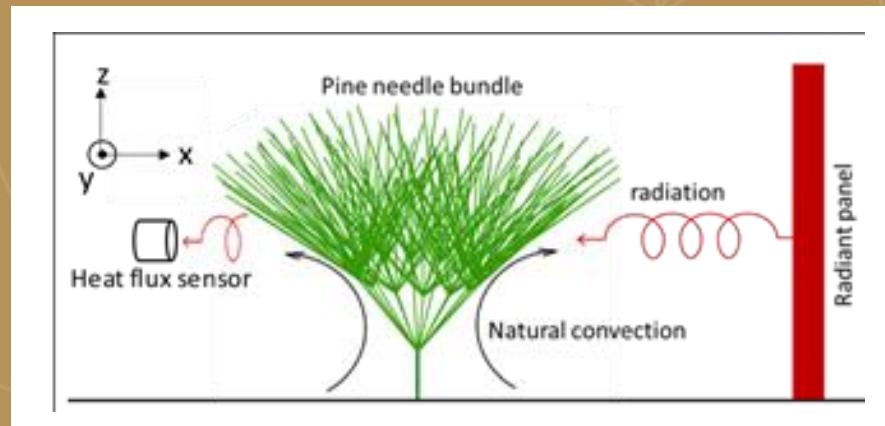


Temperature Distribution

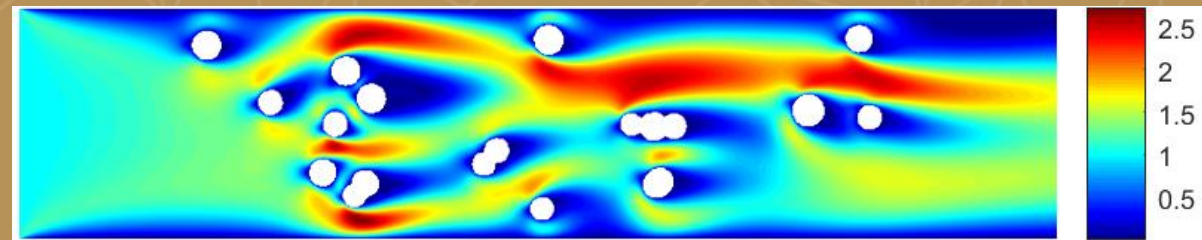
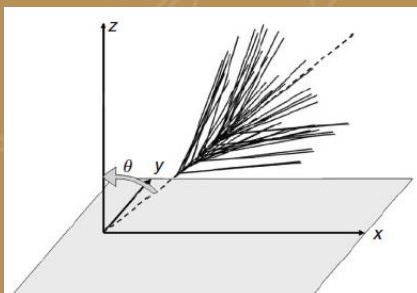
Building a Resilient Society in Response to Wildfires



WPI



*Radiant Panel Experiment
(absorption by vegetation)*



*Lattice Boltzmann Method
(Drag forces and convection)*

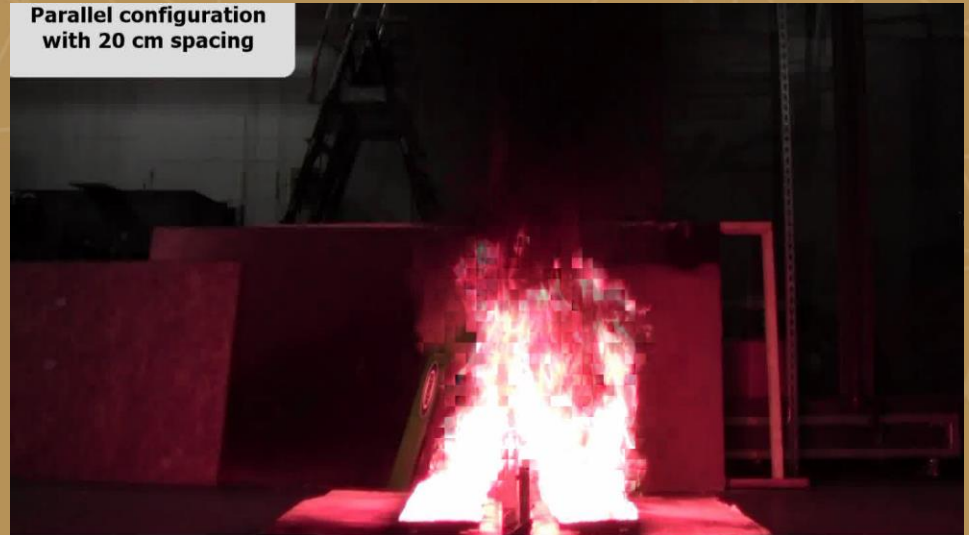
Building a Resilient Society in Response to Wildfires



WPI



Parallel configuration with 20 cm spacing



Building a Resilient Society in Response to Wildfires



WPI

