RxCADRE III

Fine Scale Fire Behavior

ATHENS FIRE LAB: Ben Hornsby, Louise Loudermilk, Christie Stegall, Evelyn Wenk, Dexter Strother, Mac Callaham

Bret Butler, Dan Jimenez, Matt Dickinson, Bob Kremens

Carl Seilstad, Eric Rowell, Casey Teske…

CFDS
CENTER FOR FOREST DISTURBANCE SCIENCE

JOINT FIRE SCIENCE PROGRAM

RxCADRE I

Goals for R_xCADRE III

- Record High Resolution ($25mm^2$-$10cm^2$) Fire Radiative Flux Density (FRFD)
- Measure FRFD coincident with FBPs, Dual Band Radiometers, UAV's, Satellite
- Link fine scale fuels data with fine scale FRFD data
- Backup UAVs (Boom Lift)
- Fire Effects (!)

Instrument

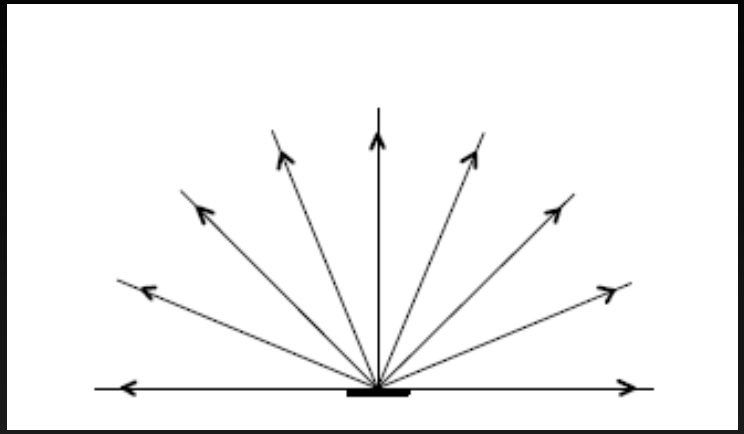
- FLIR Thermal Imaging Systems
  - Sensor measures near IR (7.3-13μm)
  - 640x480, 320x480, 320x240 pixel microbolometer
  - Recorded data at 1 Hz or .25 Hz
  - Sensitivity: 0.06°C, Accuracy 2%
  - Range 300°-1500°C

Using Temperature to Estimate Heat Flux

- Radiant Flux Density:

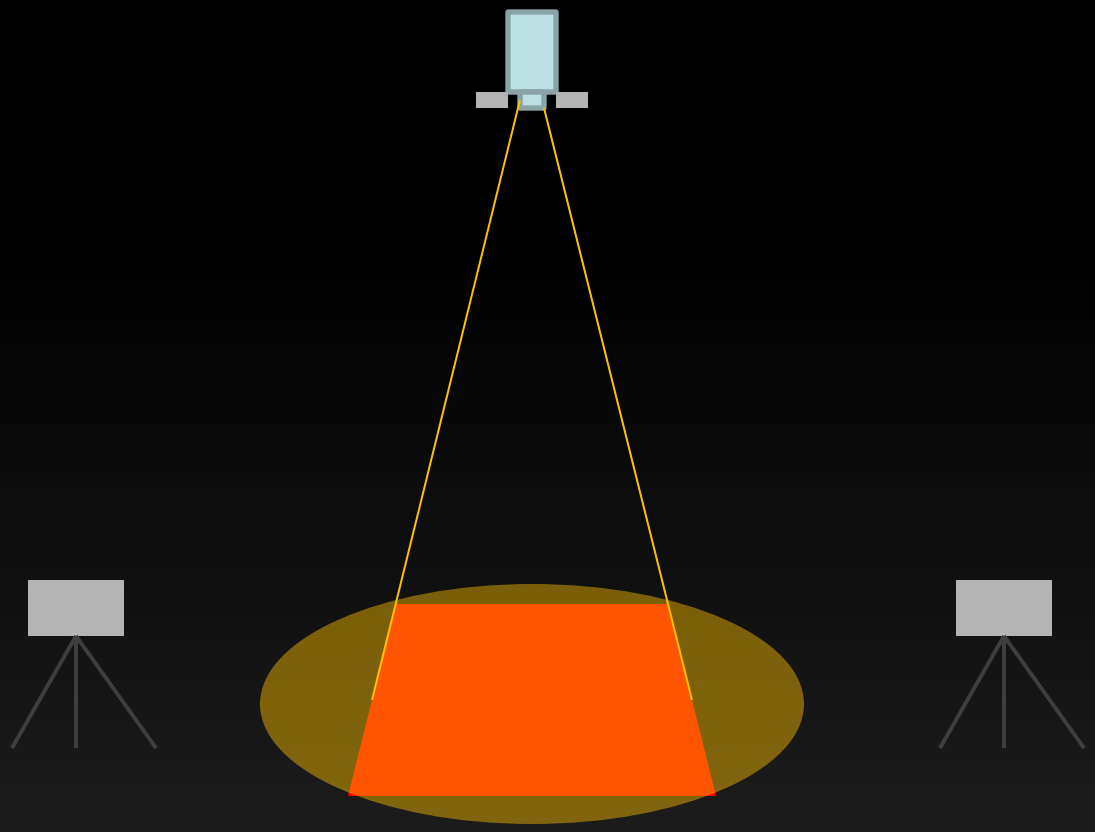
$$J^{*}=\varepsilon\sigma T^{4} \ (Wm^{-2})$$

  - Where ε=emissivity, σ=Stefan–Boltzmann Constant, T= Kelvin



Boom Lift

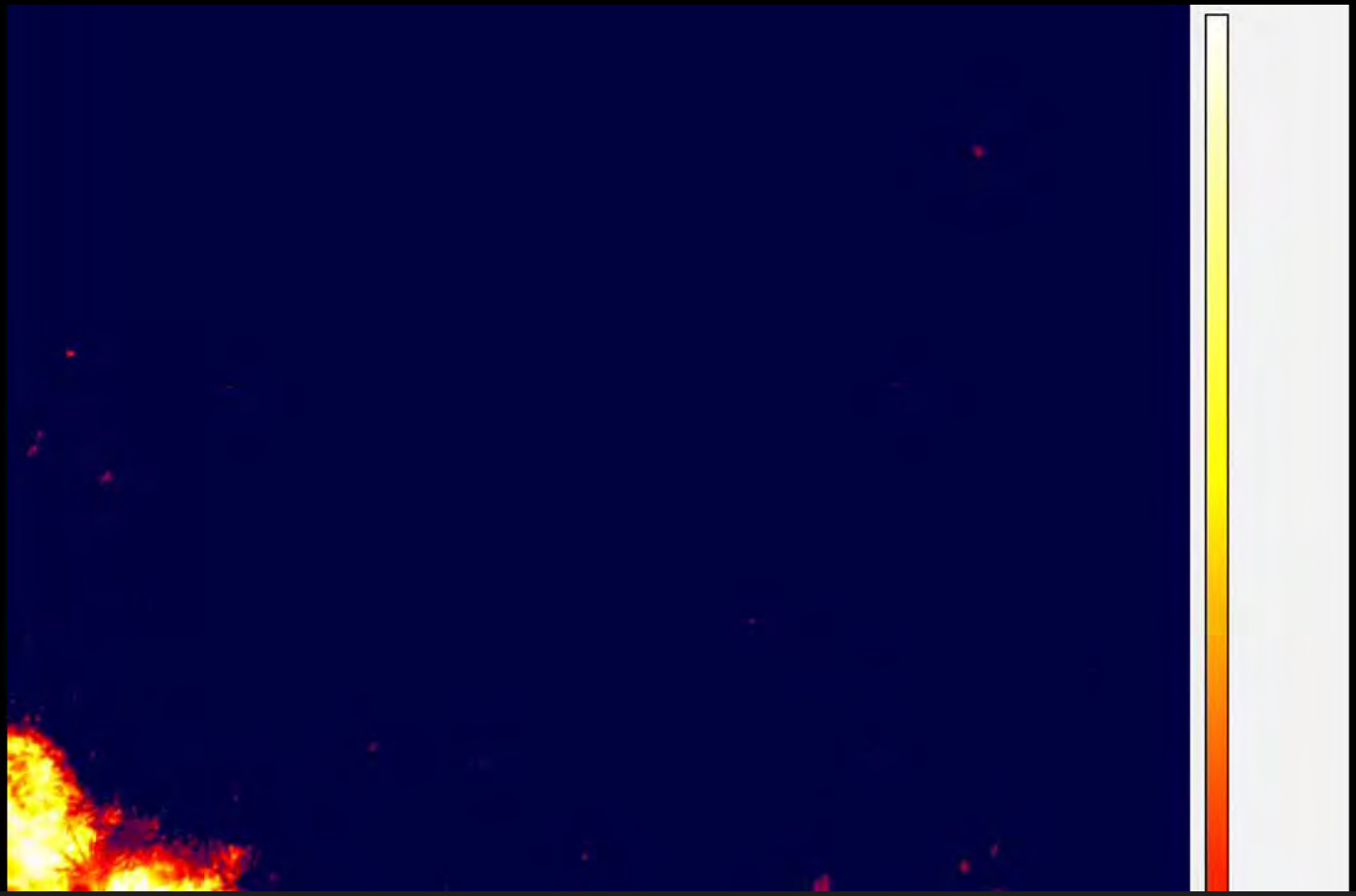
HIP



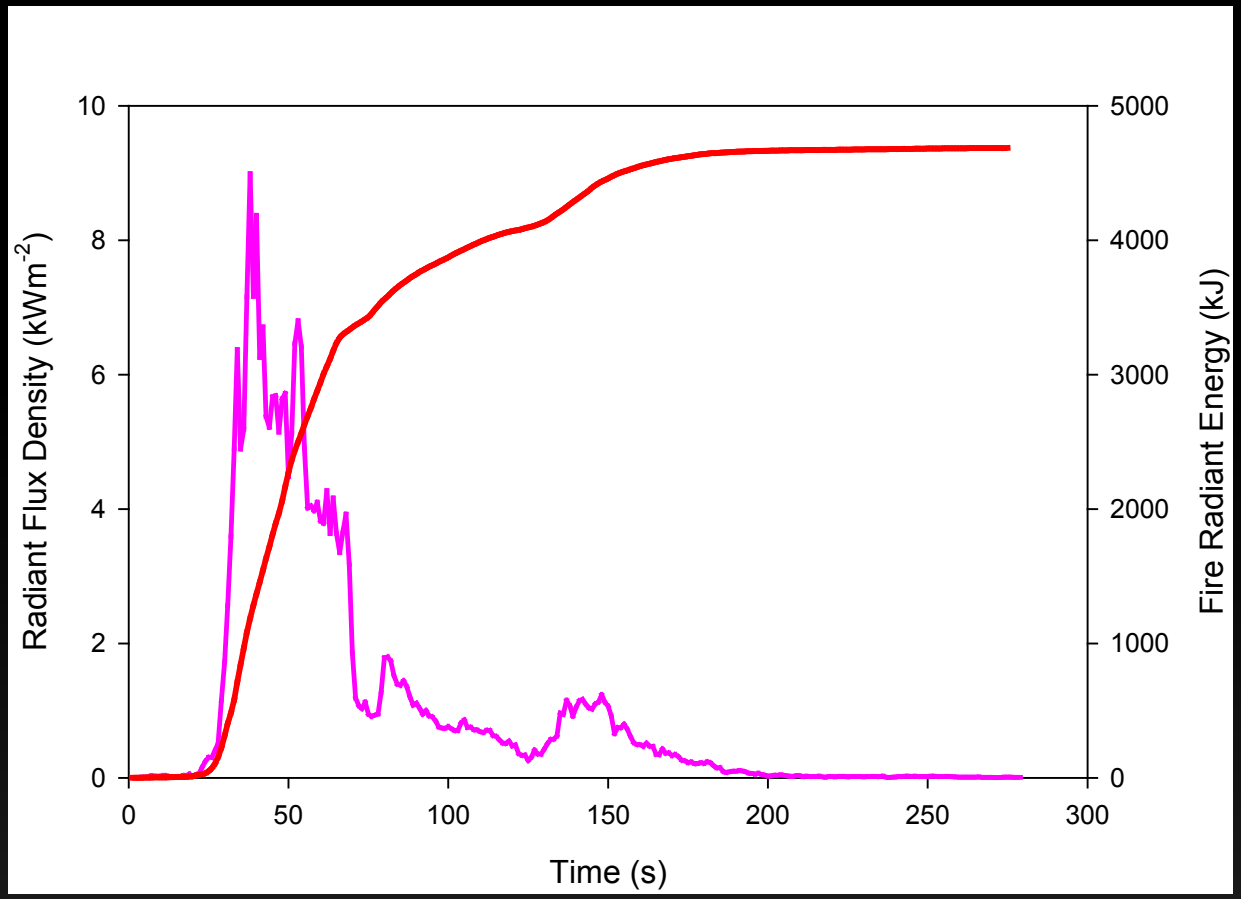
Tall Infrared Tripod System

- X,Y,Z IR radiant flux density
- RGB digital imagery, (pre-fire still, movies)
- Dual-band Radiometer (Radiant Flux Density)


LIVE OAK CREEK
L2G
L2F
L1G
HIP 1
HIP 2
HIP 3
HIP 2
HIP 2
HIP 1
S3
S4
S5
S7
S8
S9
675
677
681
660
658
659
685
687
743
253
279
646
235
B-144
660
713
234



Summary Data

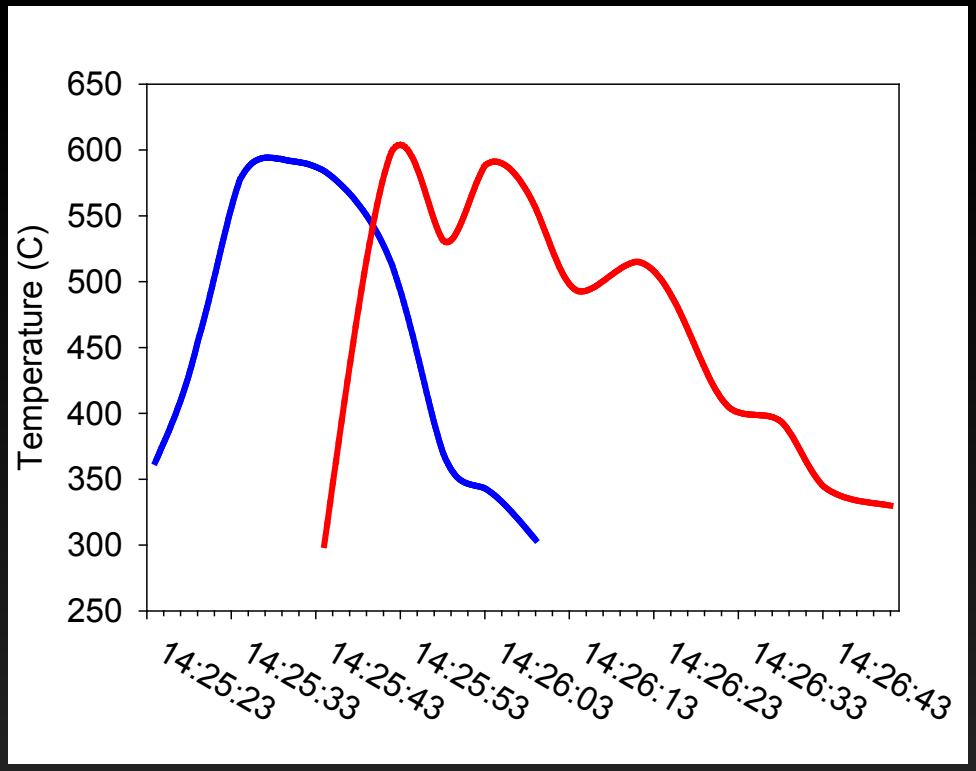


Rate of Spread

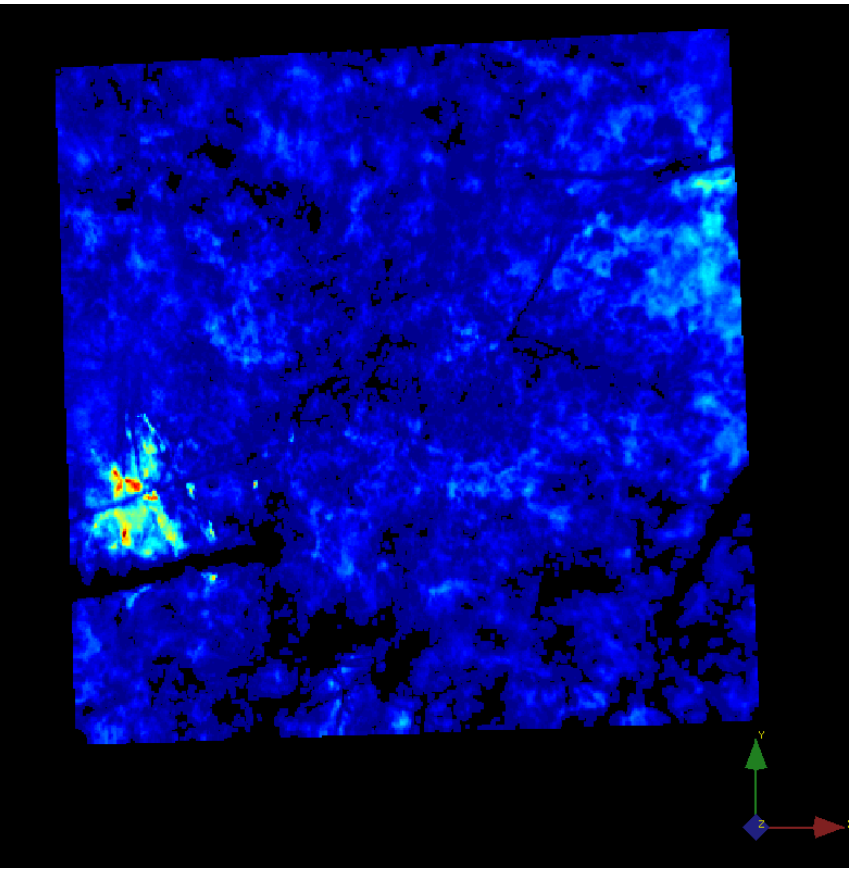
Blue= Point 1, Red = Point 2

Distance = 7 m

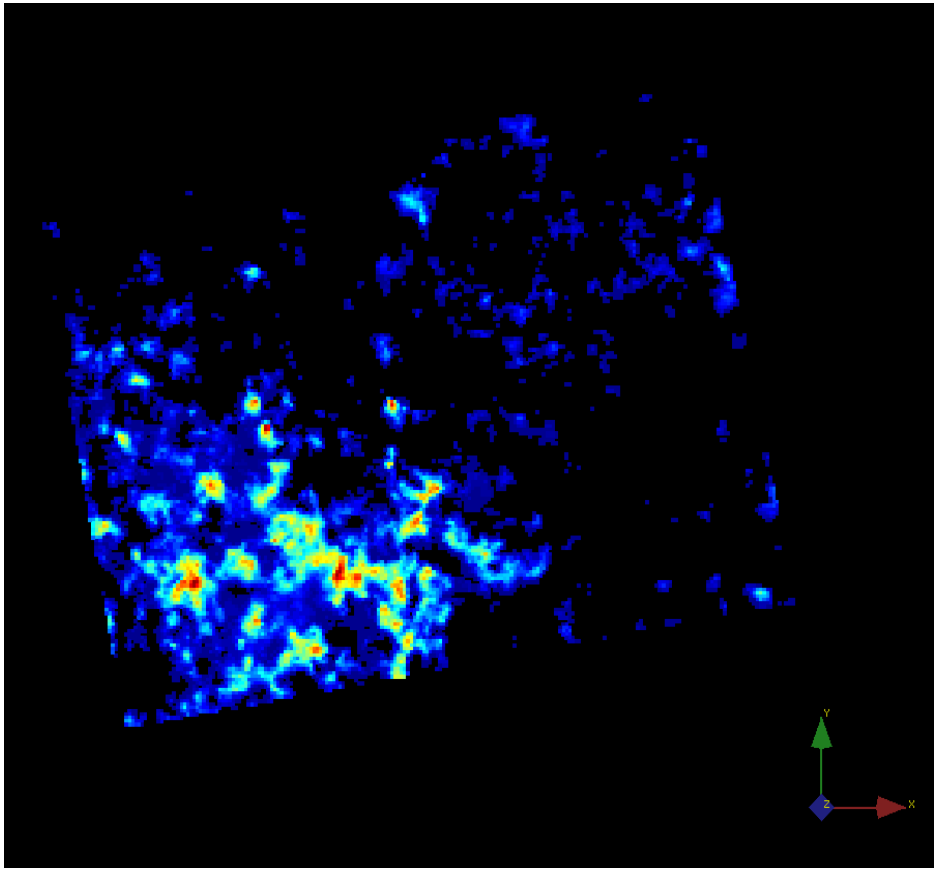
0.23 ms^{-1} (41 Ch h^{-1})



L2F (Forest)



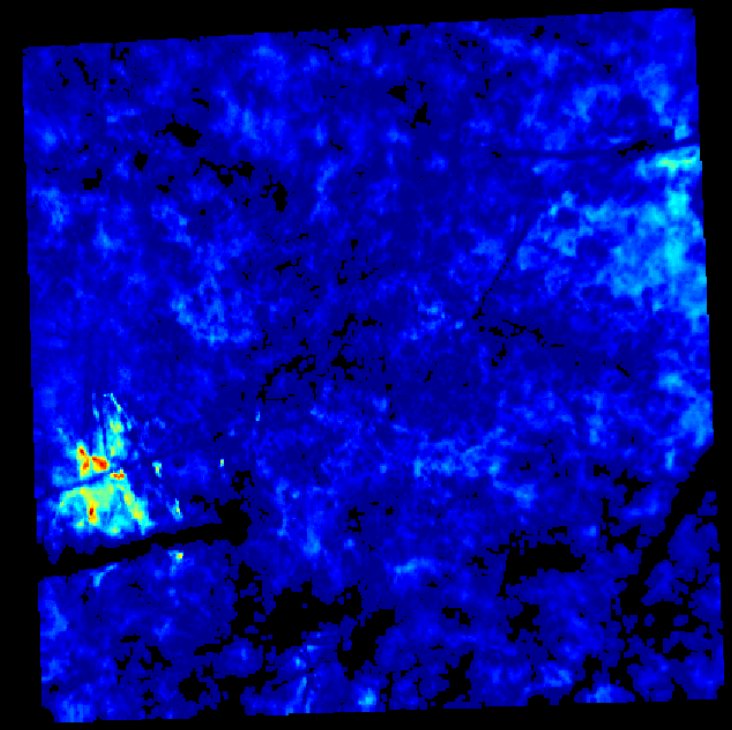
S5 (sparse grass)

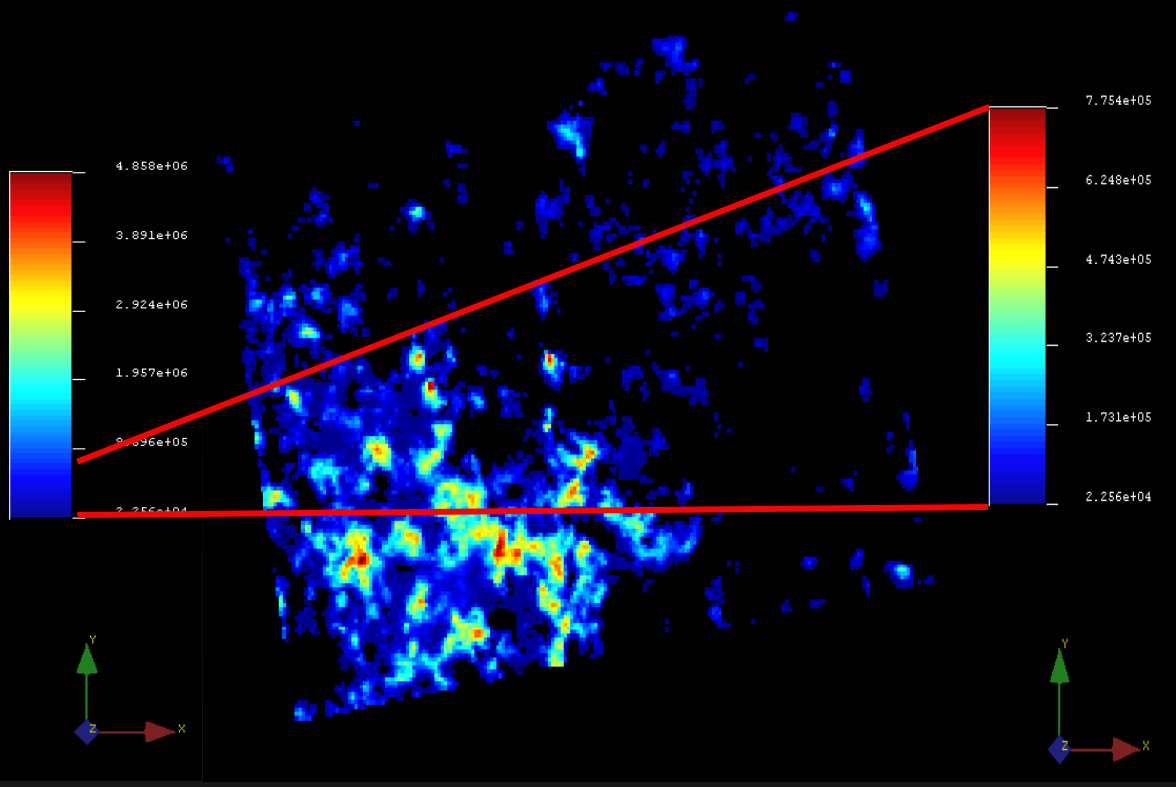


Energy Release (J)

L2F (Forest)

S5 (Grass)

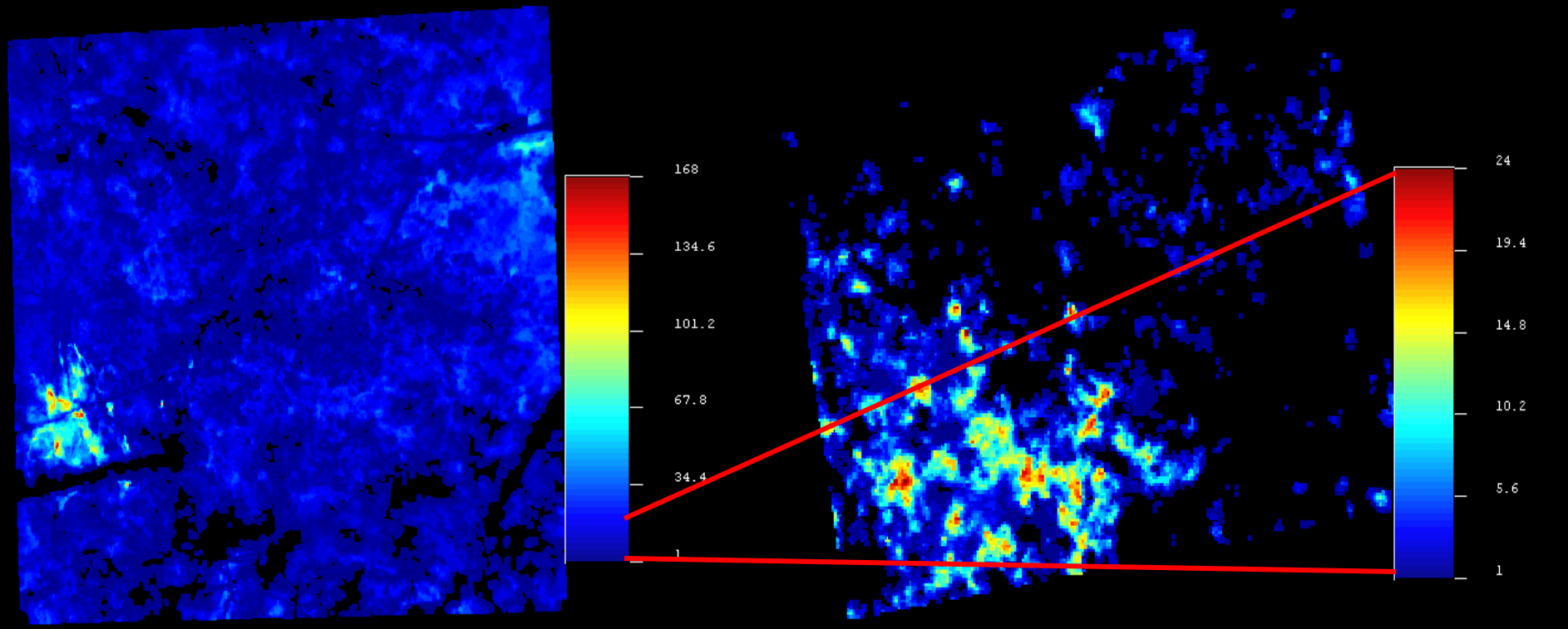




Scale difference in energy release (J)

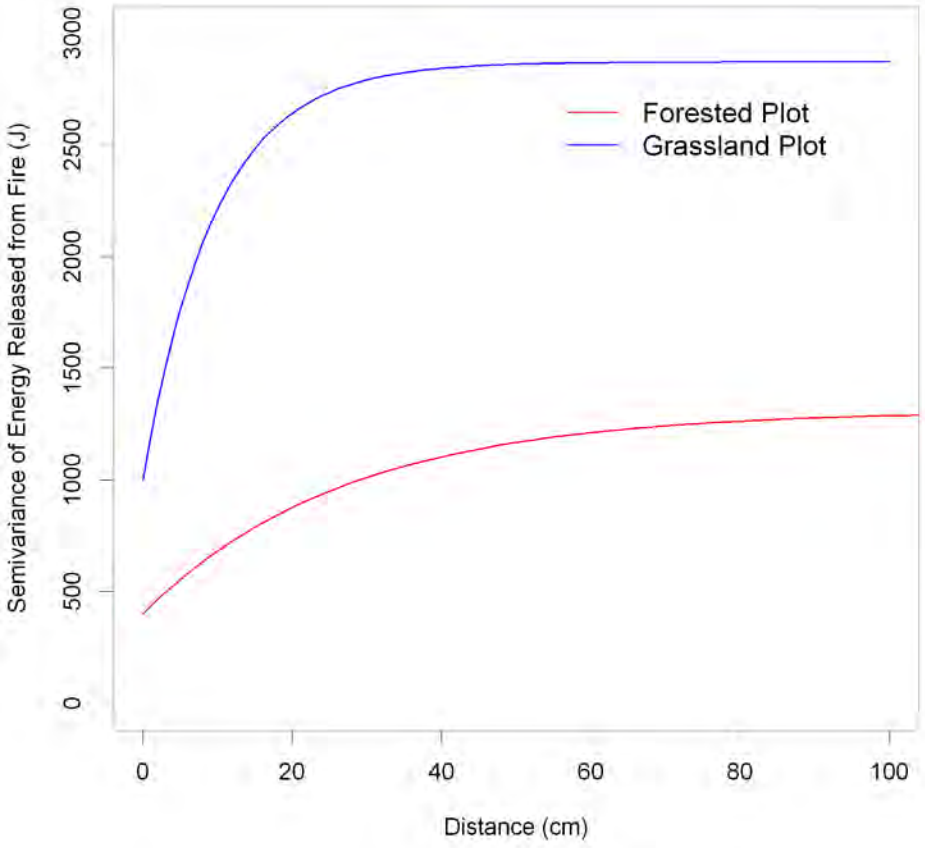
Forested Plot

Grassland Plot

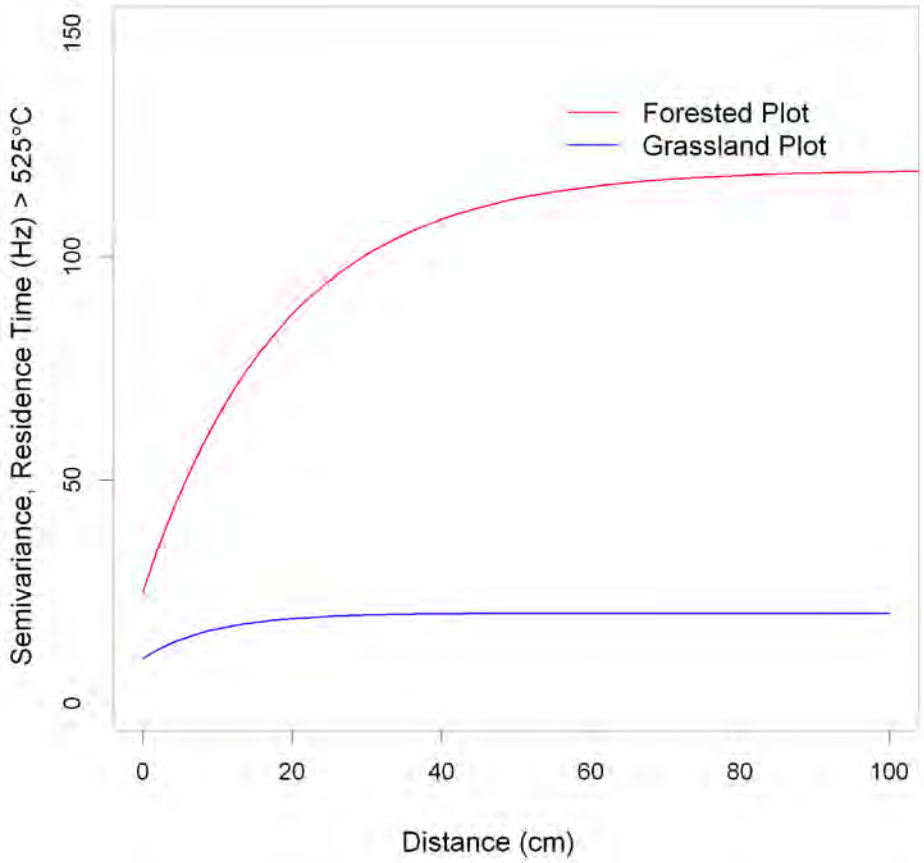


Residence Time (Seconds above 525 C)

Energy Release



Residence Time

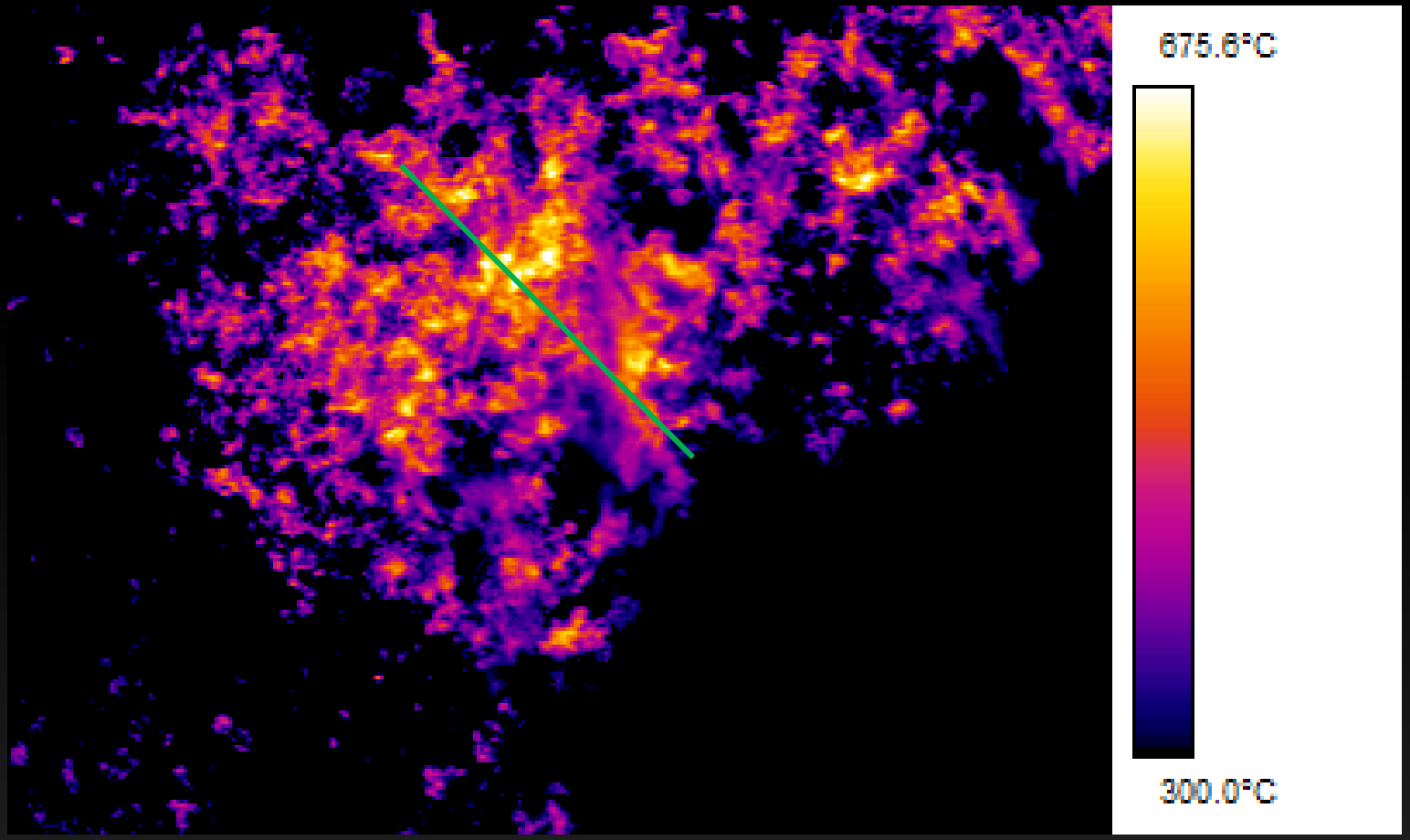


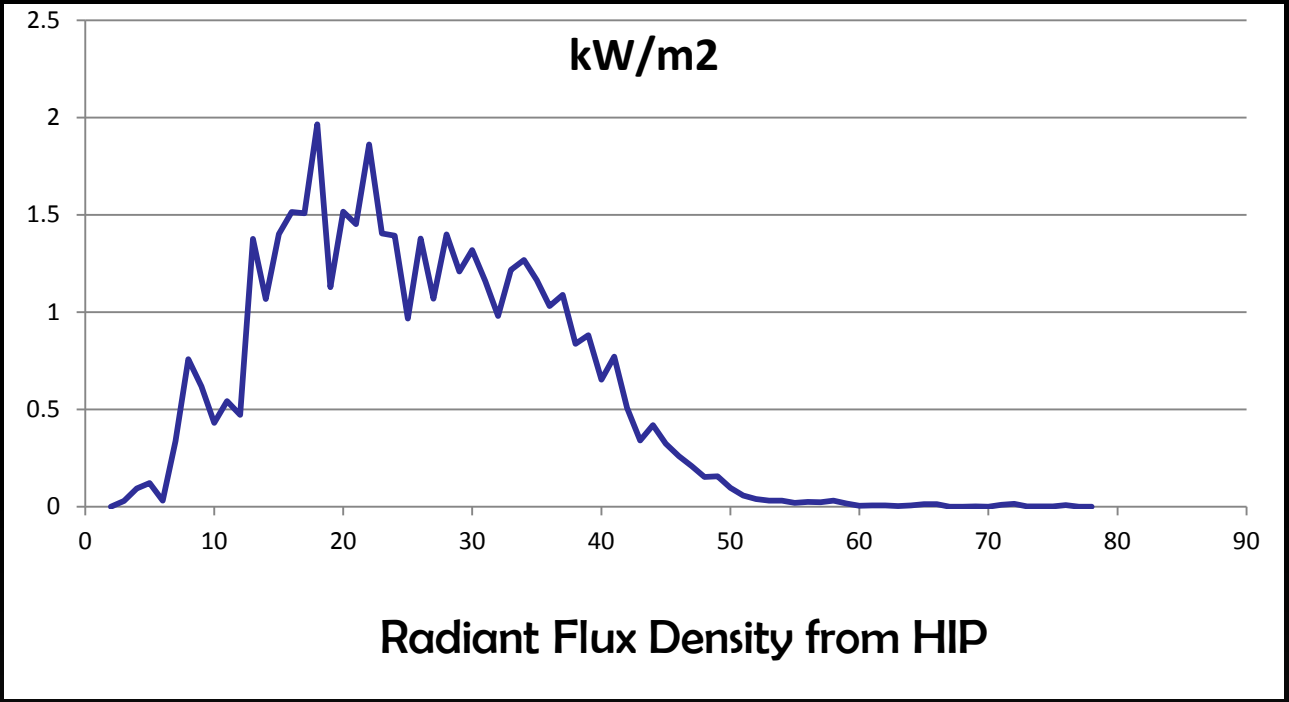
The Great S5 Megawatt Controversy

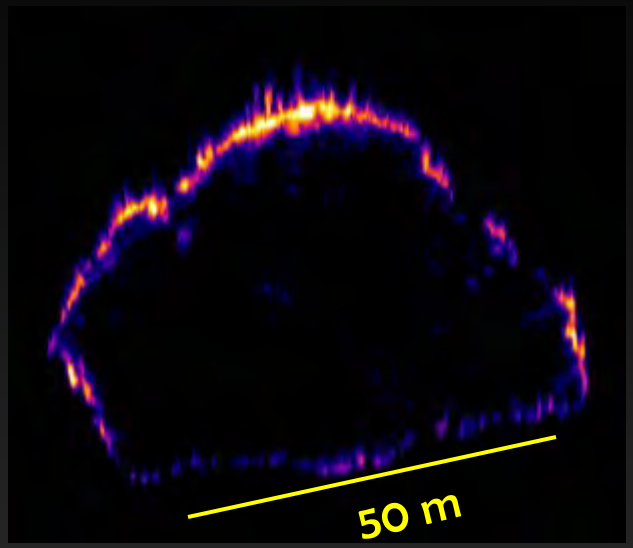
- Discrepancy between UAV, Satellite, and Boom Measurements
- Radiant Flux estimates ranging from 0.3 to 22 MW
- I was embarrassed to be at the 0.3 end.

Flame Depth

Flame Depth





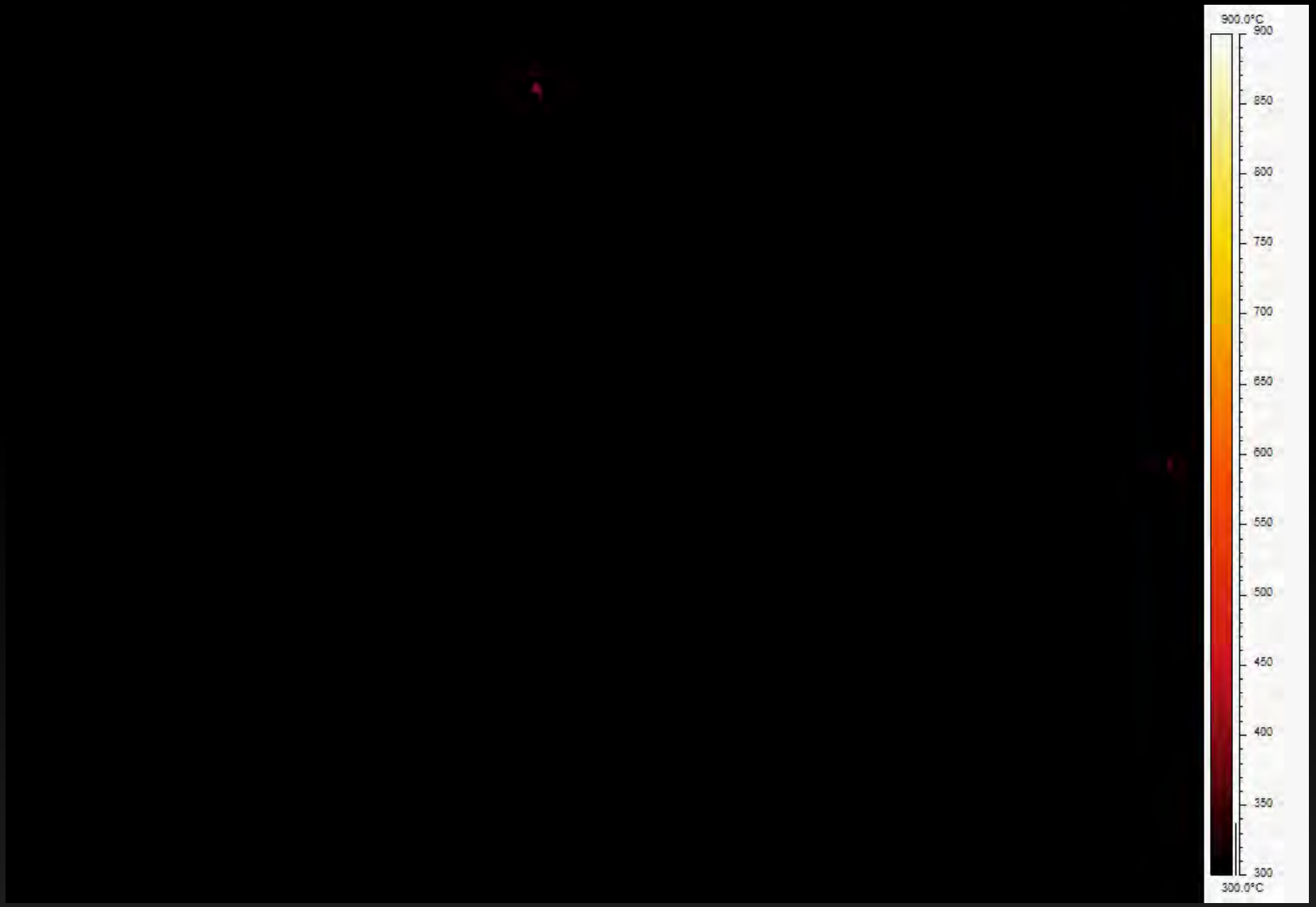


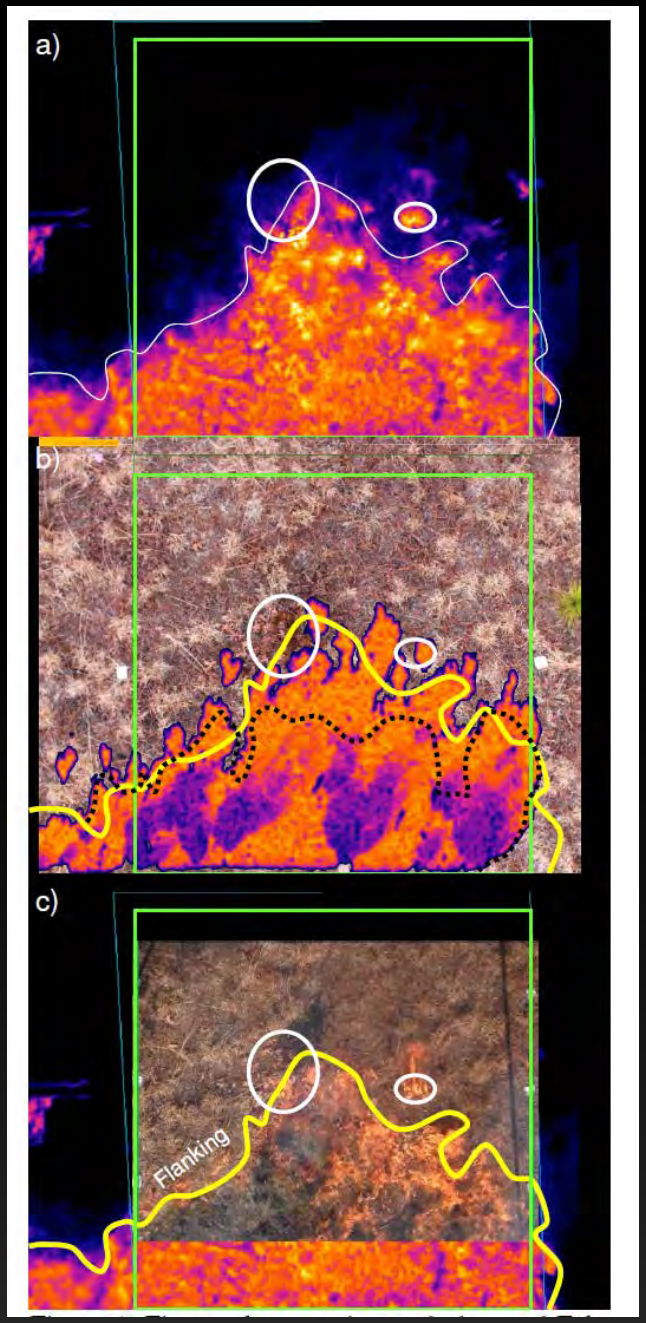
260m fireline

2 m flame depth

1.5 kWm^{-2}

~0.8 MW


900.0°C
900
850
800
750
700
650
600
550
500
450
400
350
300
300.0°C

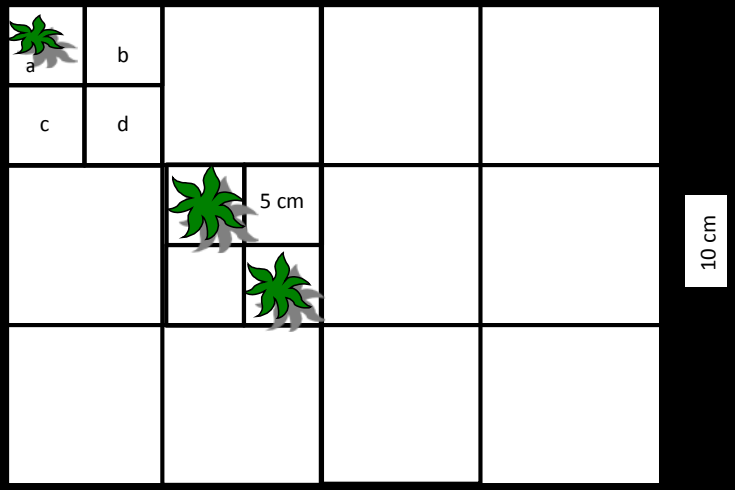


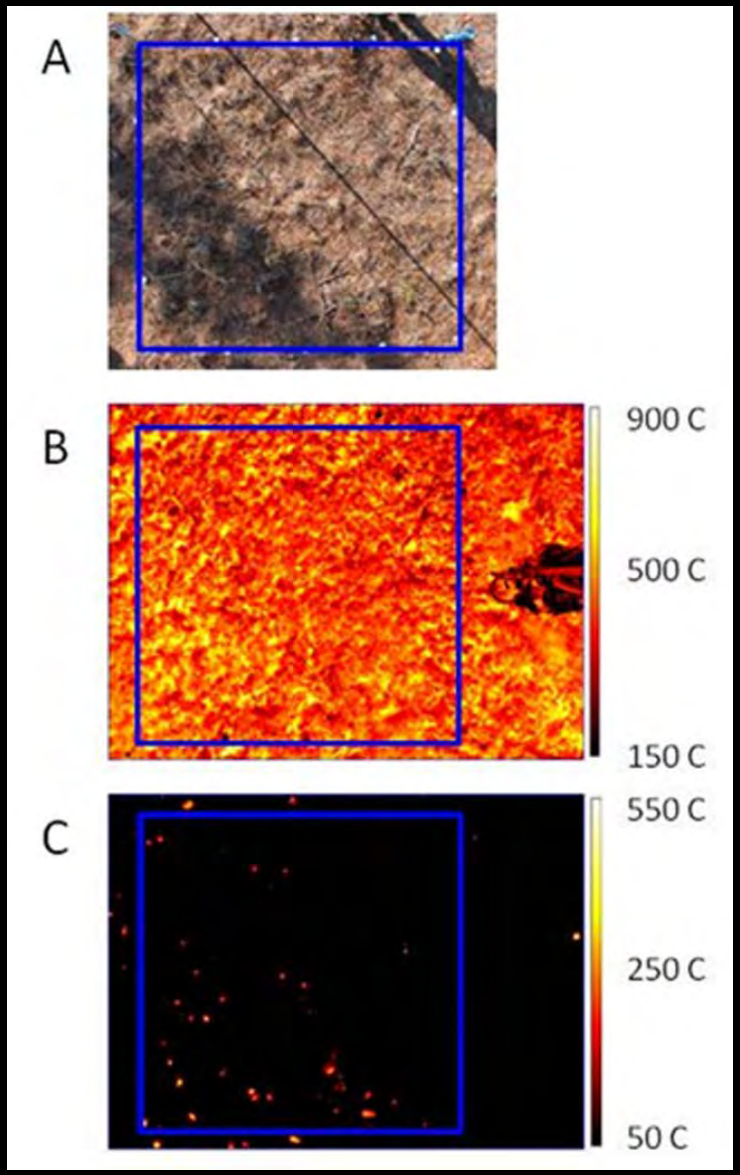
Real Data

Rabbit Rules Run

Visual Image Overlaid on IR

Fine Scale Spatial Studies





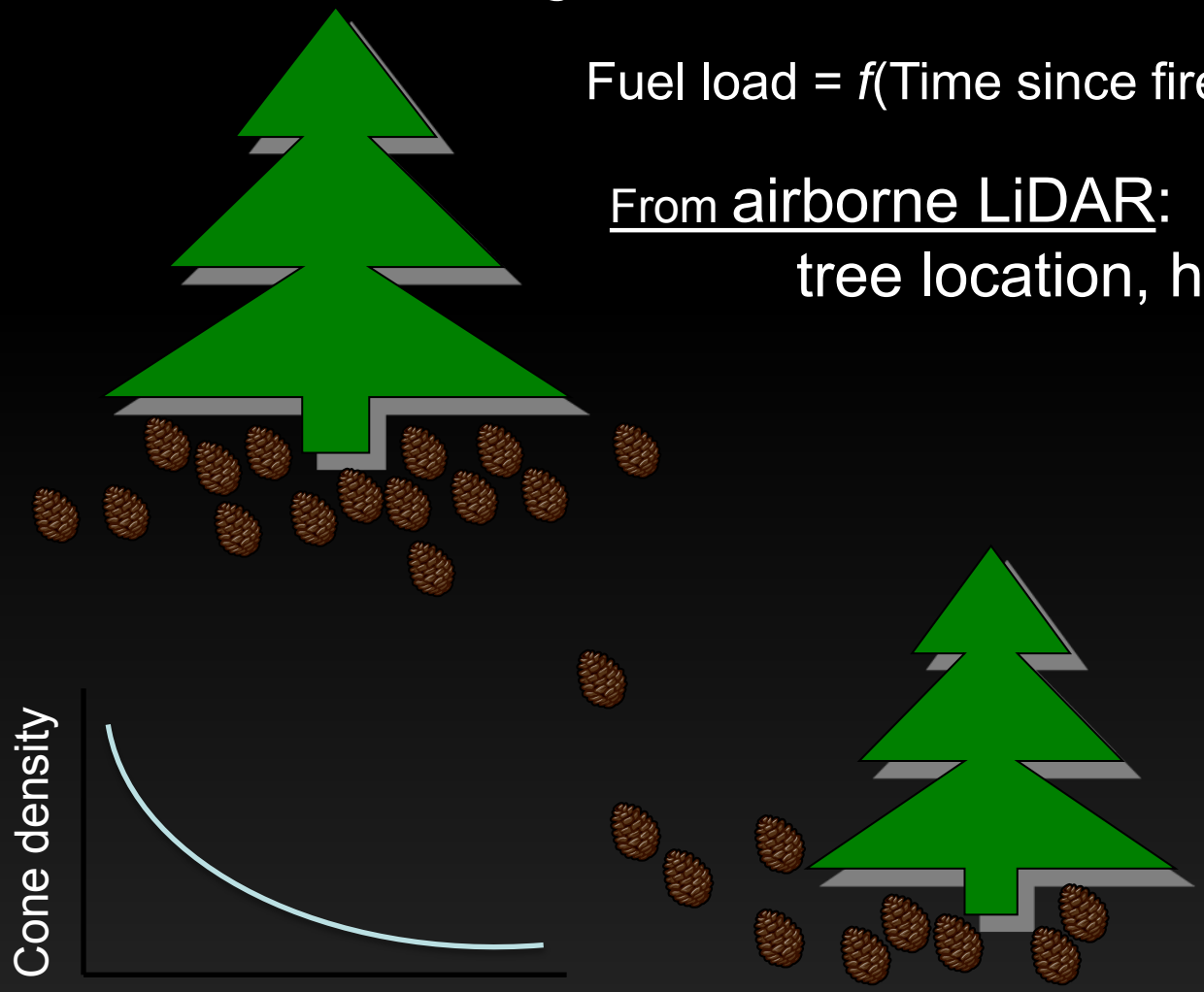
Coarse Scale Spatial Studies:

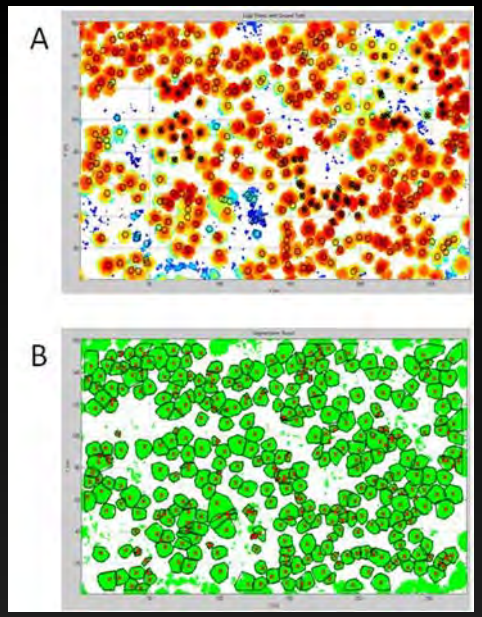
Moving from micro to meso to macro:

Fuel load = *f*(Time since fire, overstory canopy)

From airborne LiDAR:

tree location, height, crown diameter





Synthesis

- Link maps with spatial probabilistic models
  - Landscape ✓, Rabbit Rules ✓, forest dynamics ✓, community assembly (3 years)
- Use to examine management scenarios
  - logging, burn interval, invasive species, etc.