Experimental investigation of the role of fuel load, fuel structure, and environmental conditions on low-intensity prescribed fires

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Michael Gallagher, Kenneth Clark, Nicholas Skowronski
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Acknowledgements

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Particle-scale experimentation

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Wind tunnel fire experiments

University of Notre Dame

Prof. Seong-kyun Im
Design of laboratory flame-flow experiments

Giovanni Di Christina
Wind Tunnel Flow Experiments

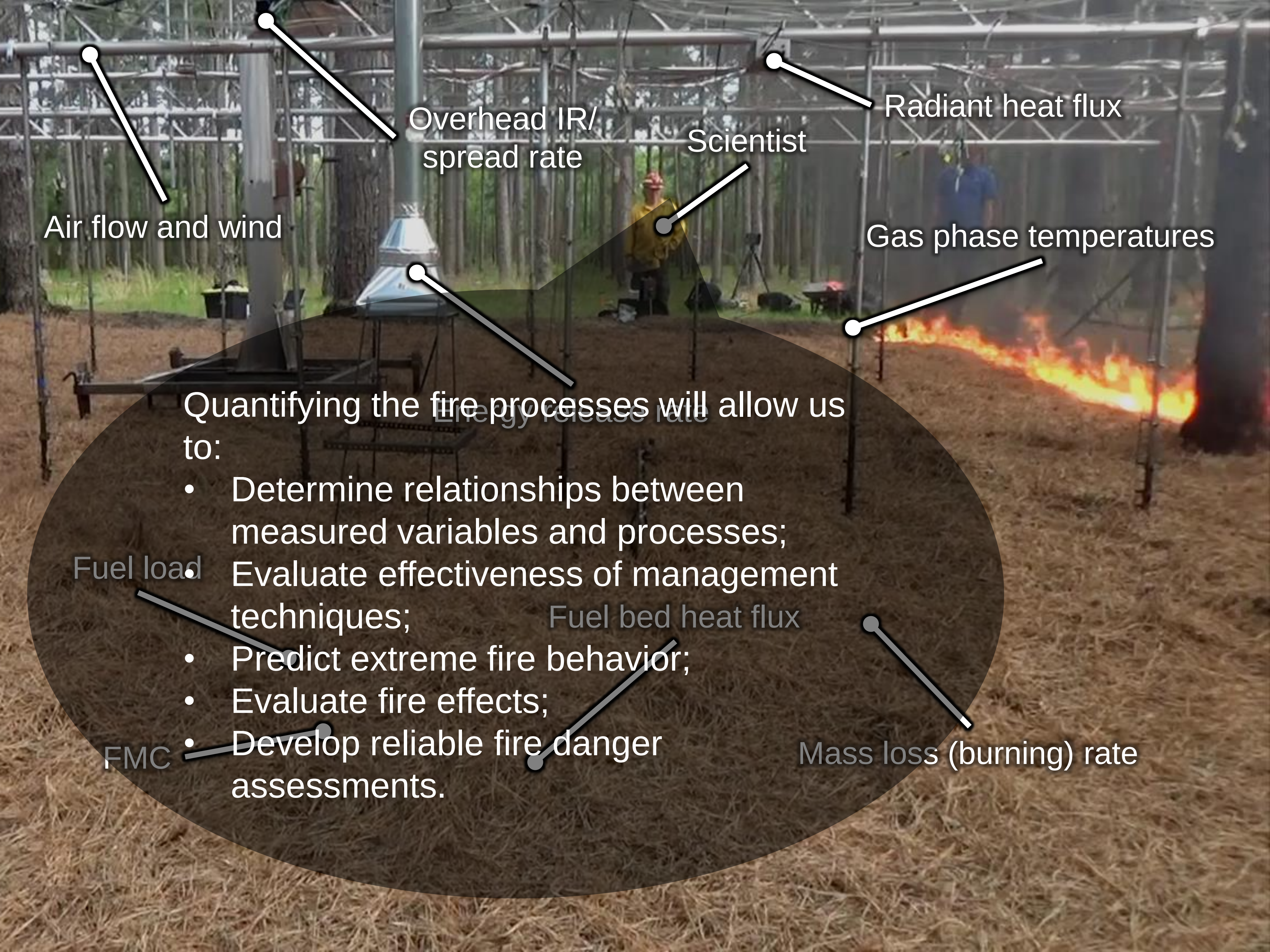
Rochester Institute of Technology

Dr. Robert Kremens
Design and engineering of sampling equipment.

Tall Timbers Research Station

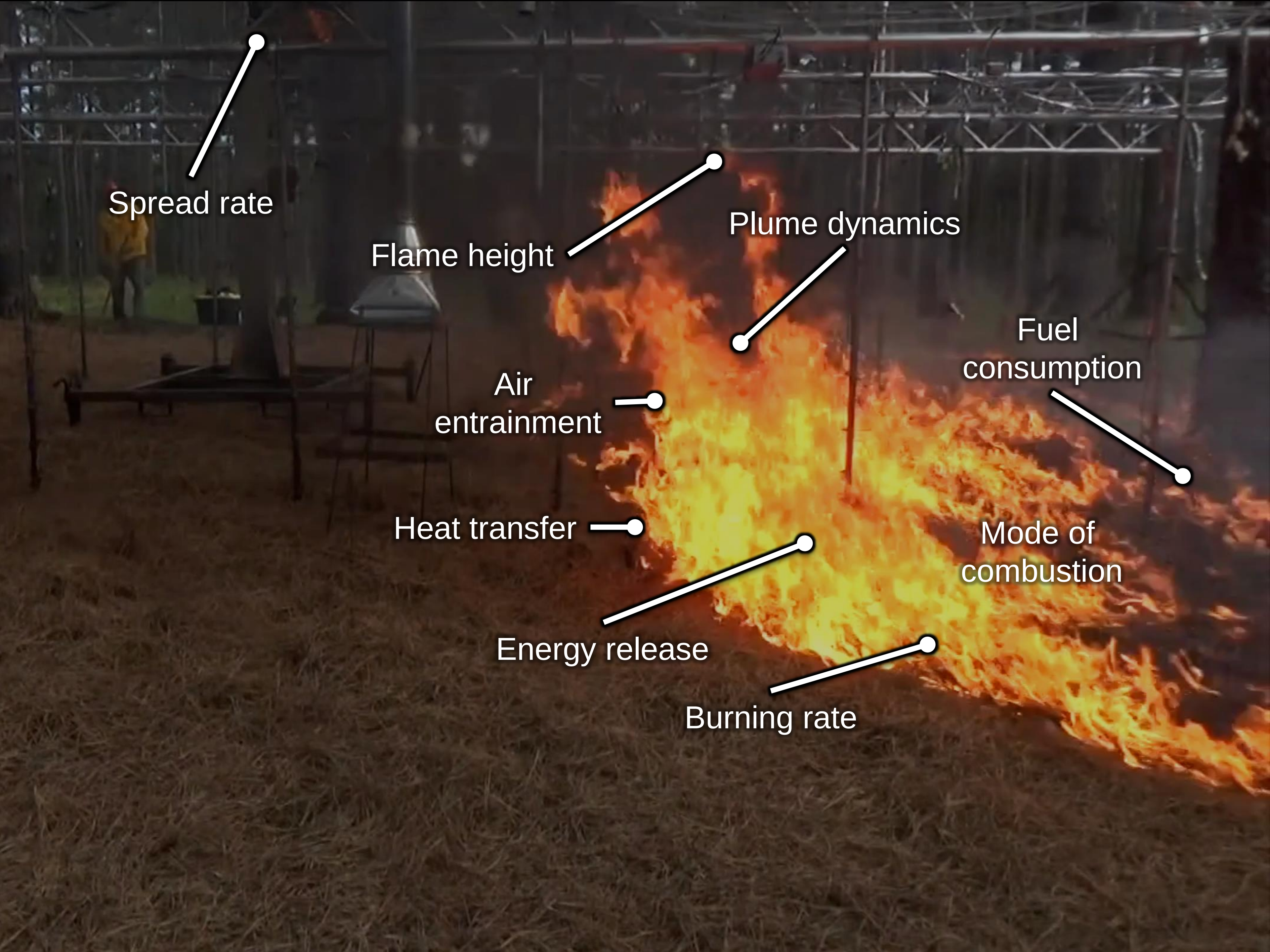
Lexi Everland
Field Technician Silas Little

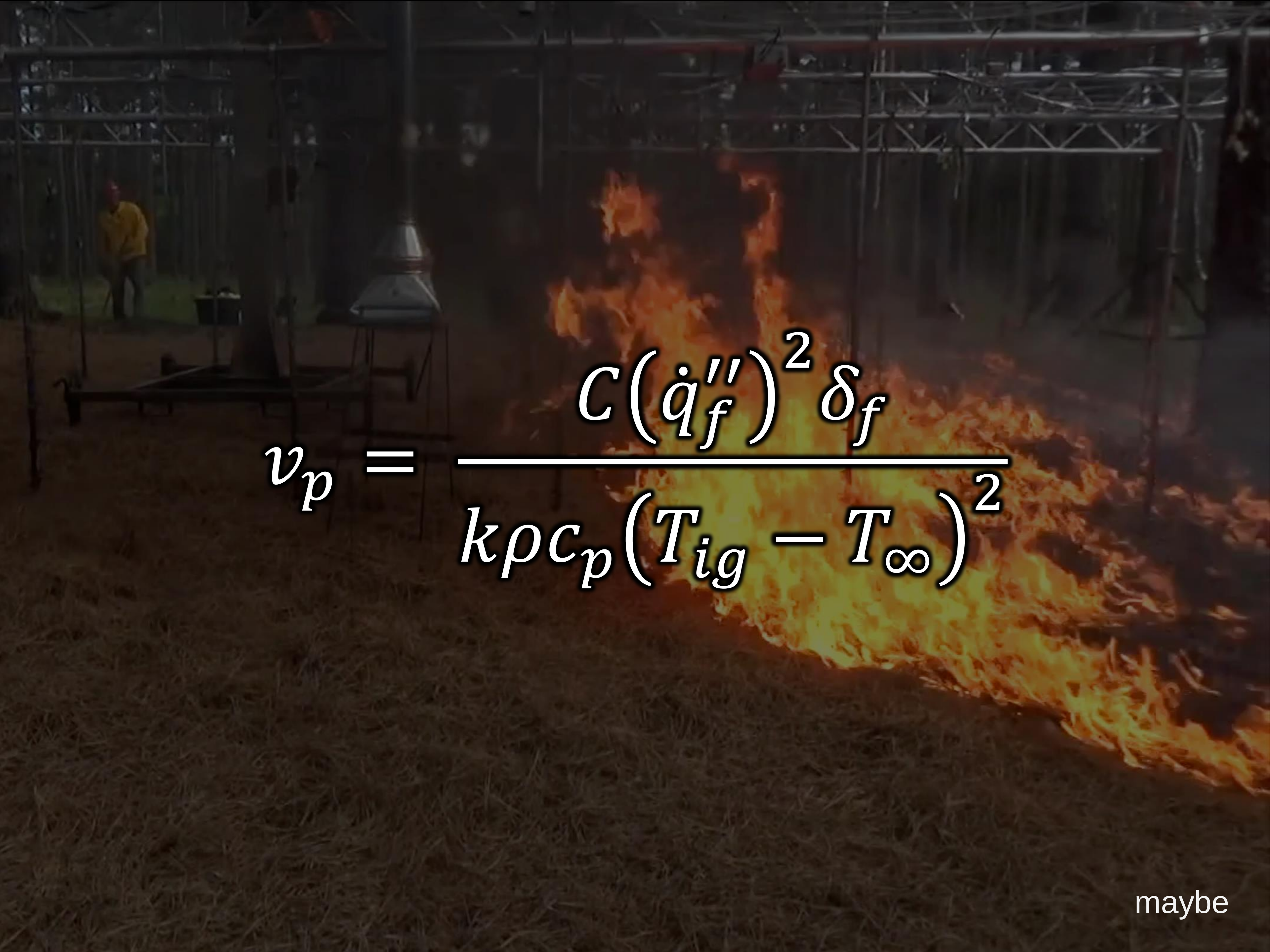

Scientists
Important tools



Quantifying the fire processes will allow us to:

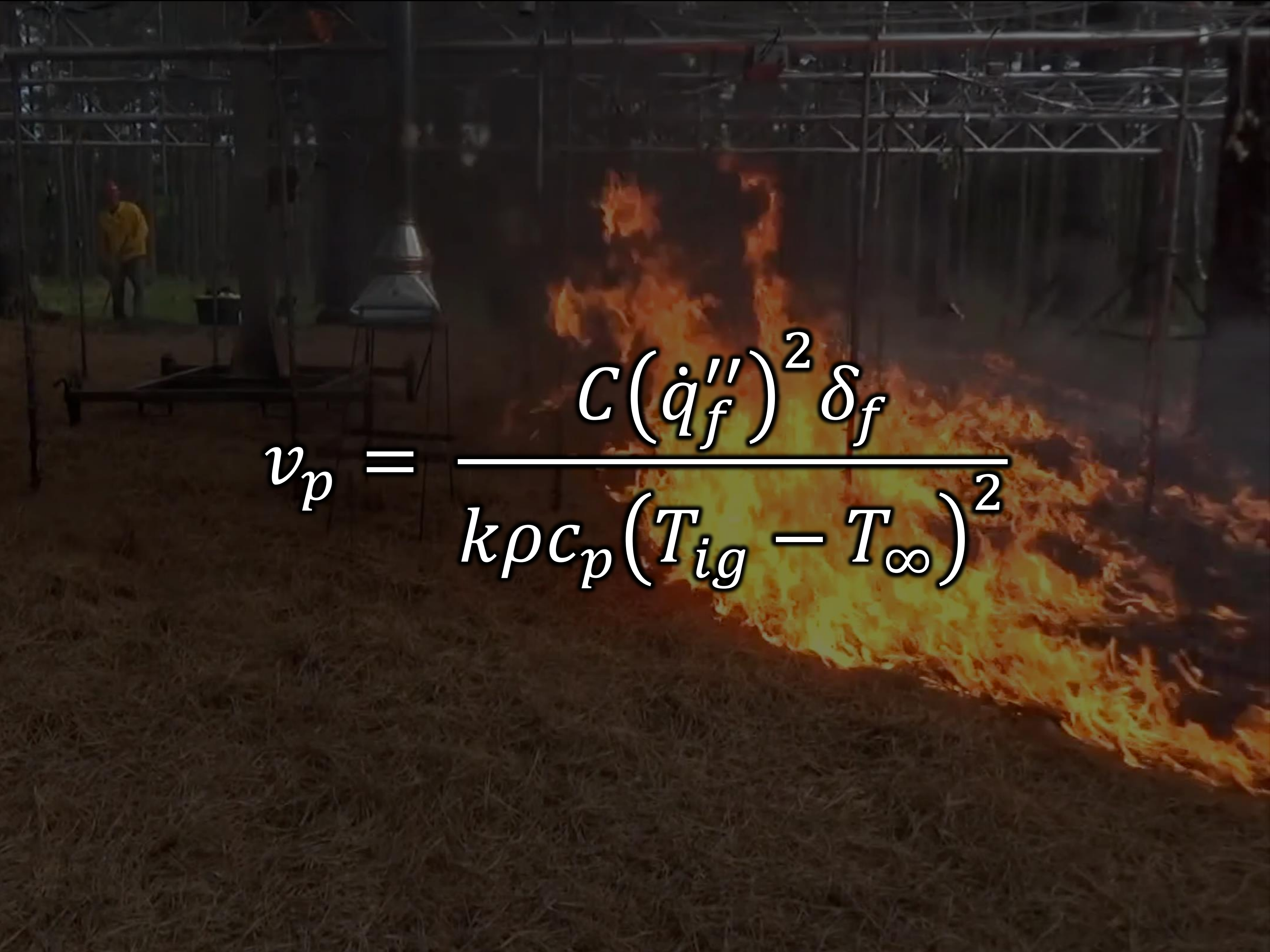
- Determine relationships between measured variables and processes;
- Evaluate effectiveness of management techniques;
- Predict extreme fire behavior;
- Evaluate fire effects;
- Develop reliable fire danger assessments.


Spread rate
Flame height
Plume dynamics
Fuel consumption
Air entrainment
Heat transfer
Mode of combustion
Energy release
Burning rate



$$v_p = \frac{C\left(\dot{q}_f''\right)^2 \delta_f}{k\rho c_p\left(T_{ig} - T_\infty\right)^2}$$

maybe



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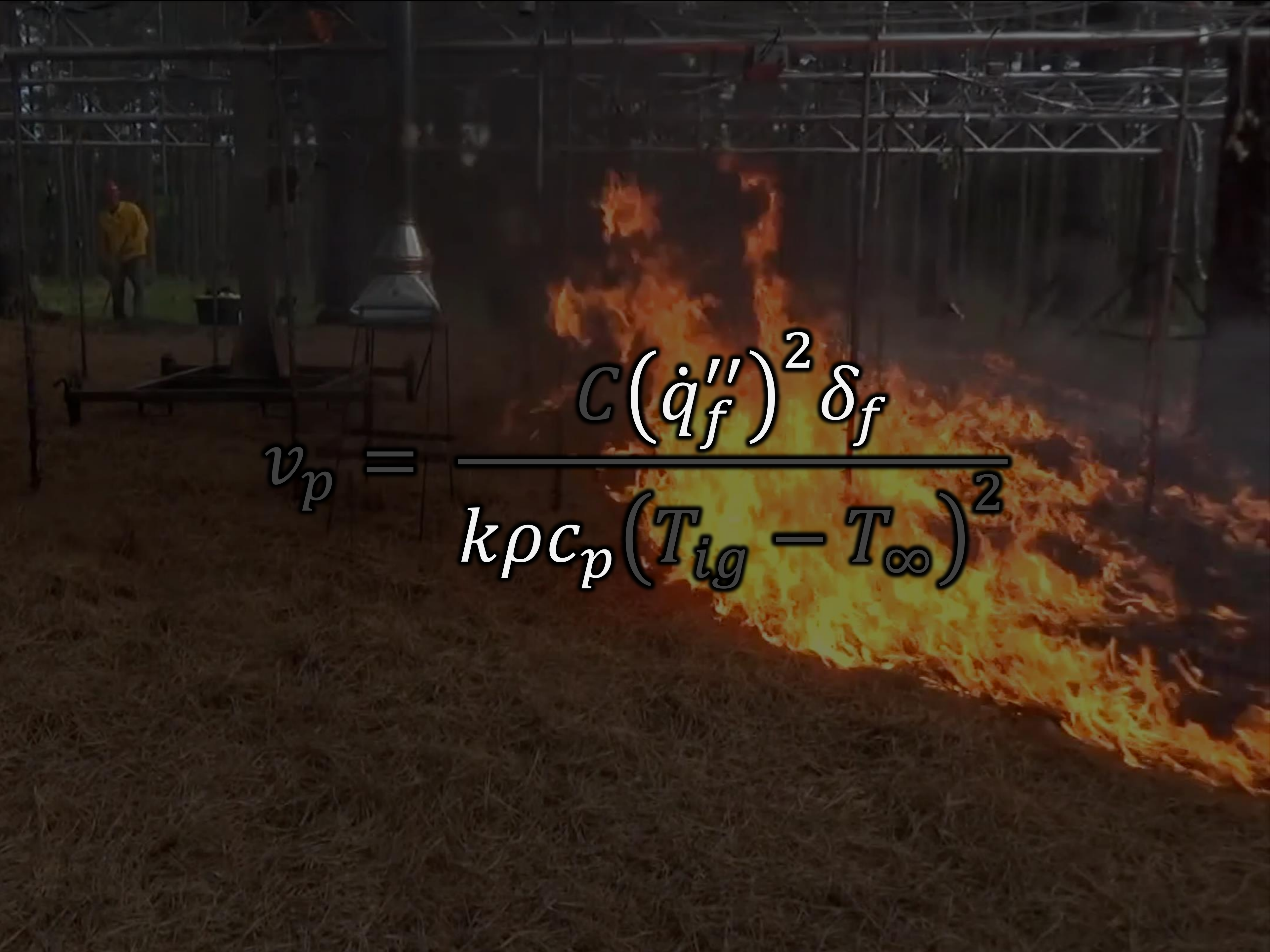

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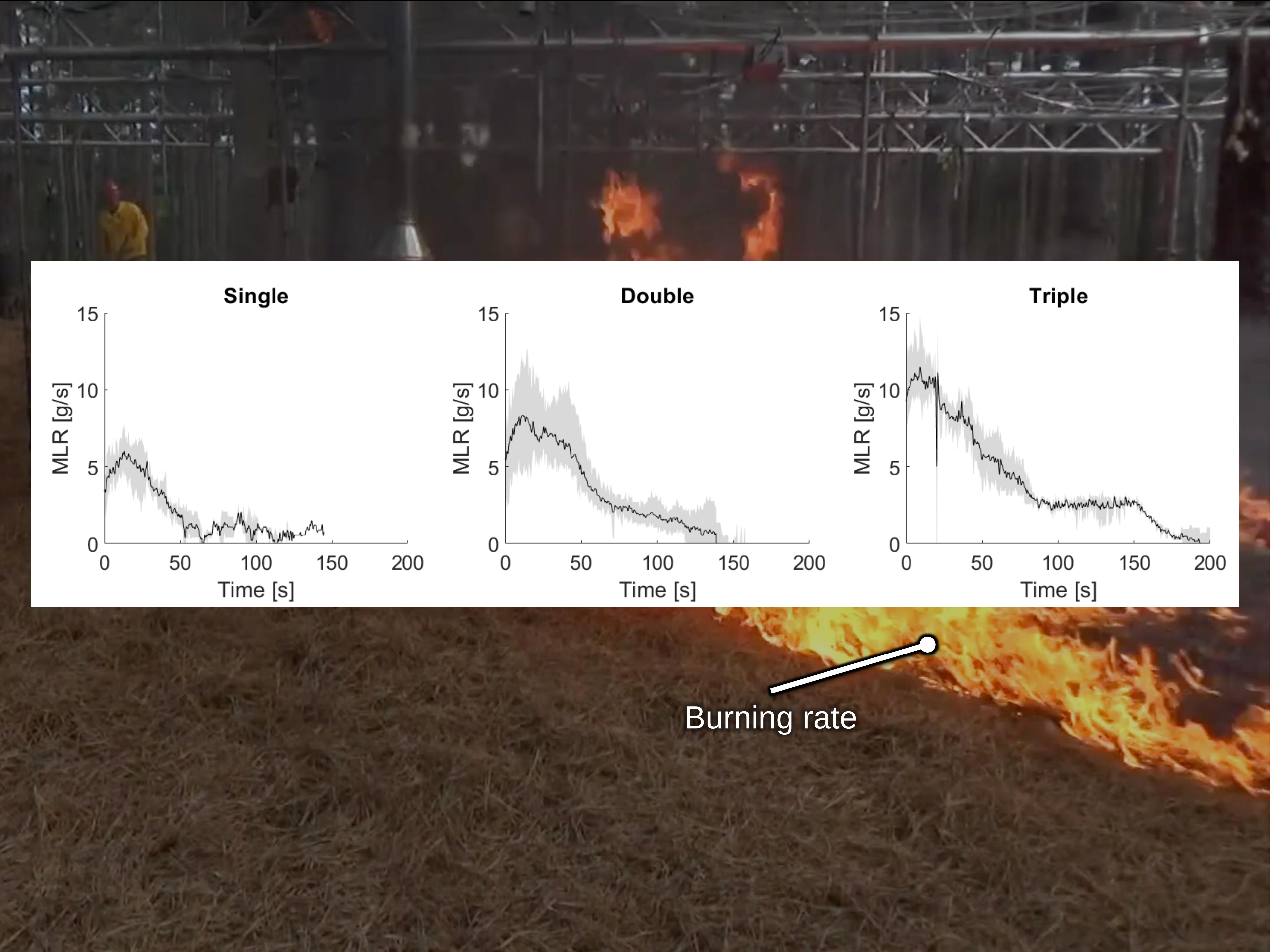
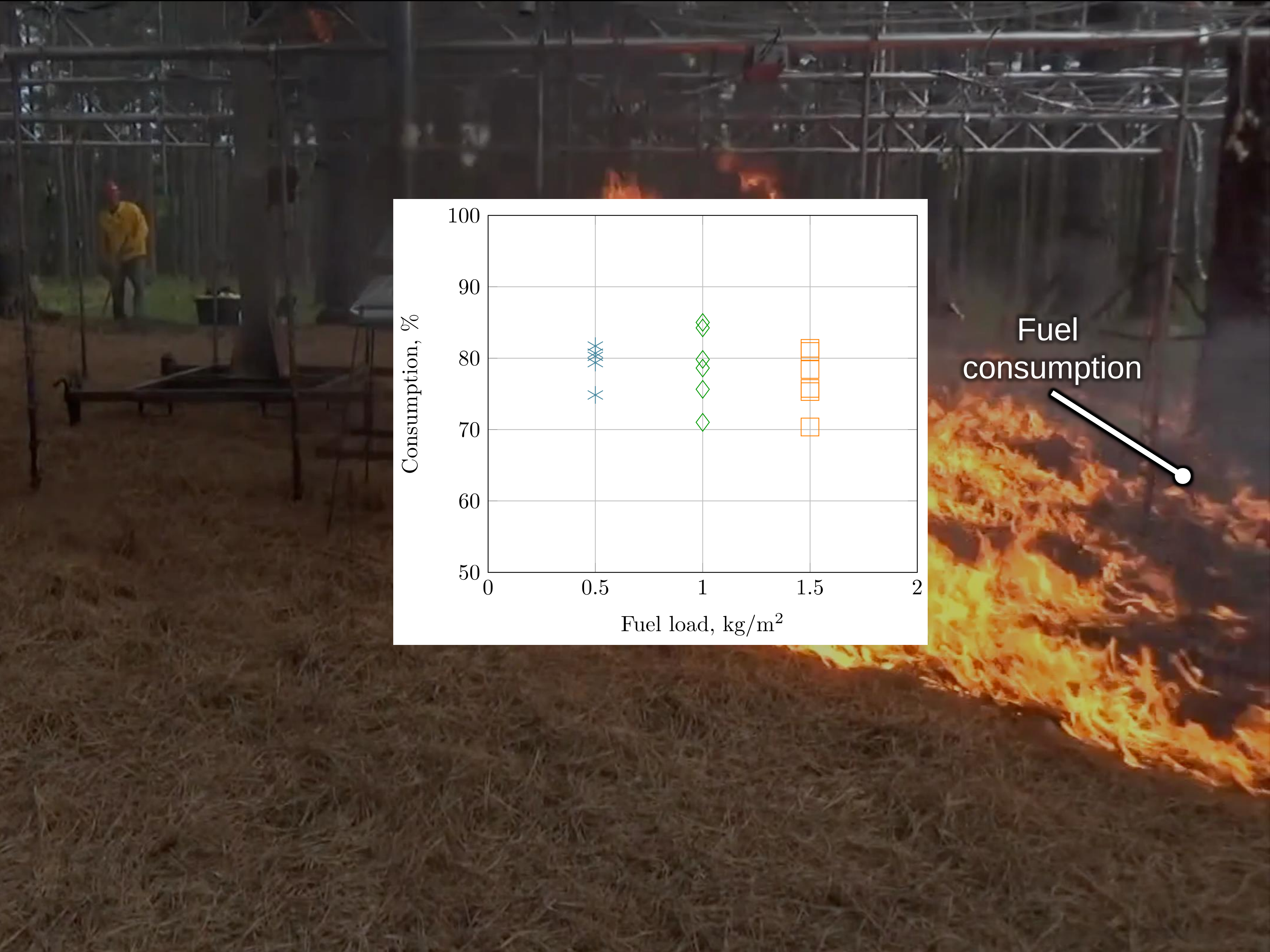
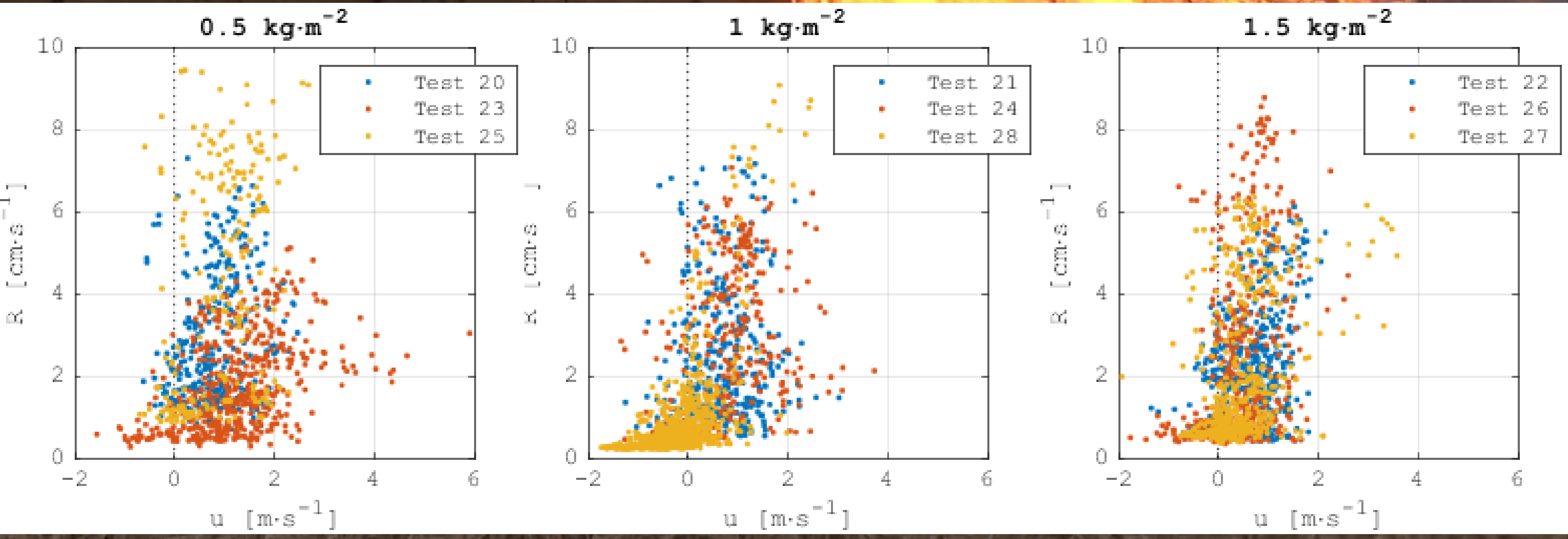

Single
Double
Triple
MLR [g/s]
Time [s]
0
5
10
15
0
50
100
150
200
Burning rate

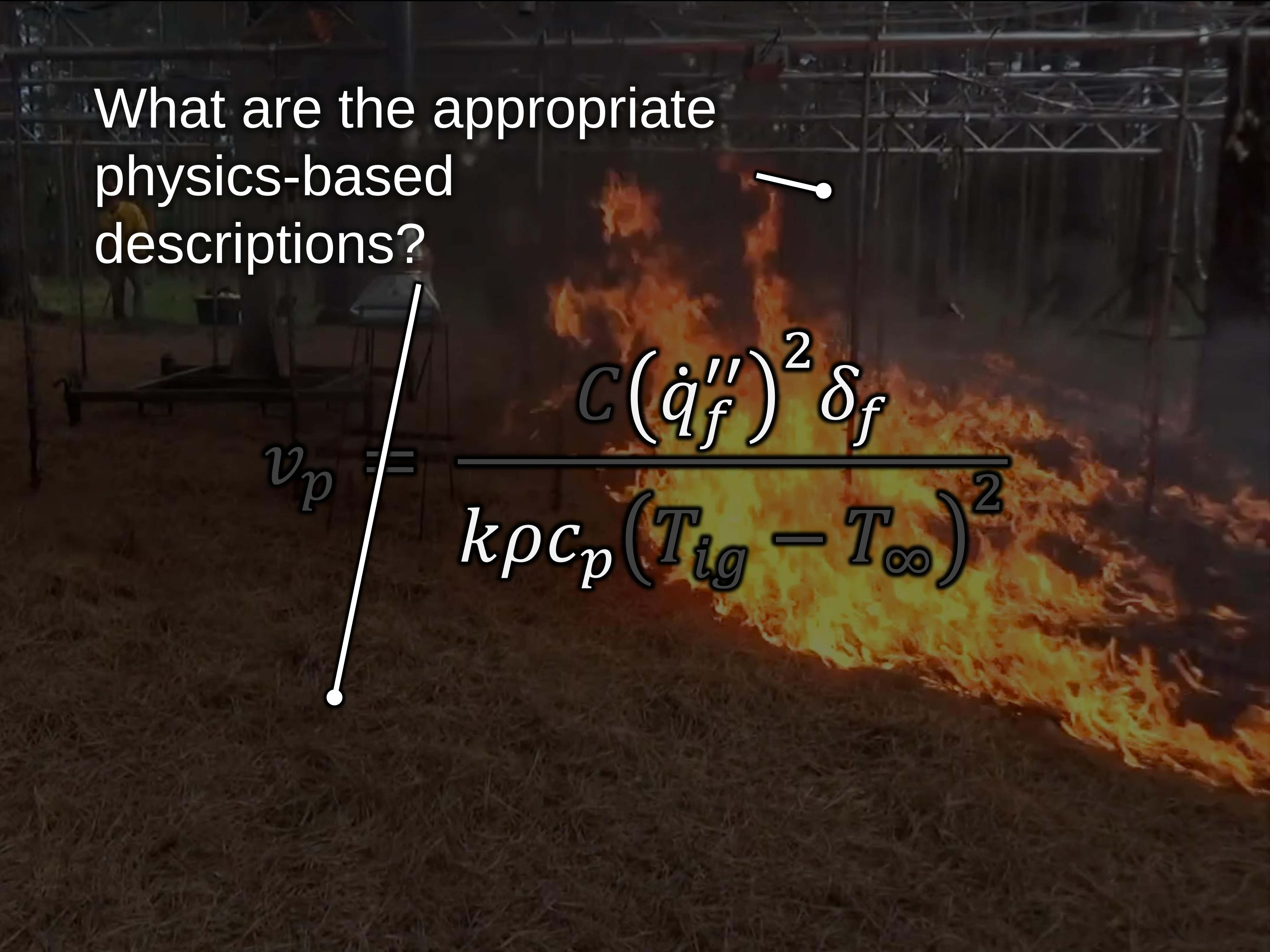

Flame height
120
100
80
60
40
20
0
h_f [cm]
single
double
triple
0
0.5
1
1.5
2
fuel load [kg·m^{-2}]


100
90
80
70
60
50
0
0.5
1
1.5
2
Consumption, %
Fuel load, kg/m²
Fuel
consumption


Spread rate
100
80
60
40
20
0
t_r [s]
0
0.5
1
1.5
2
fuel load [kg·m^-2]
single
double
triple

Fuel load, kg/m²	Spread rate, cm/s
0.5	4.5 ± 3.4
1.0	3.6 ± 3.0
1.5	3.9 ± 3.0





What are the appropriate physics-based descriptions?

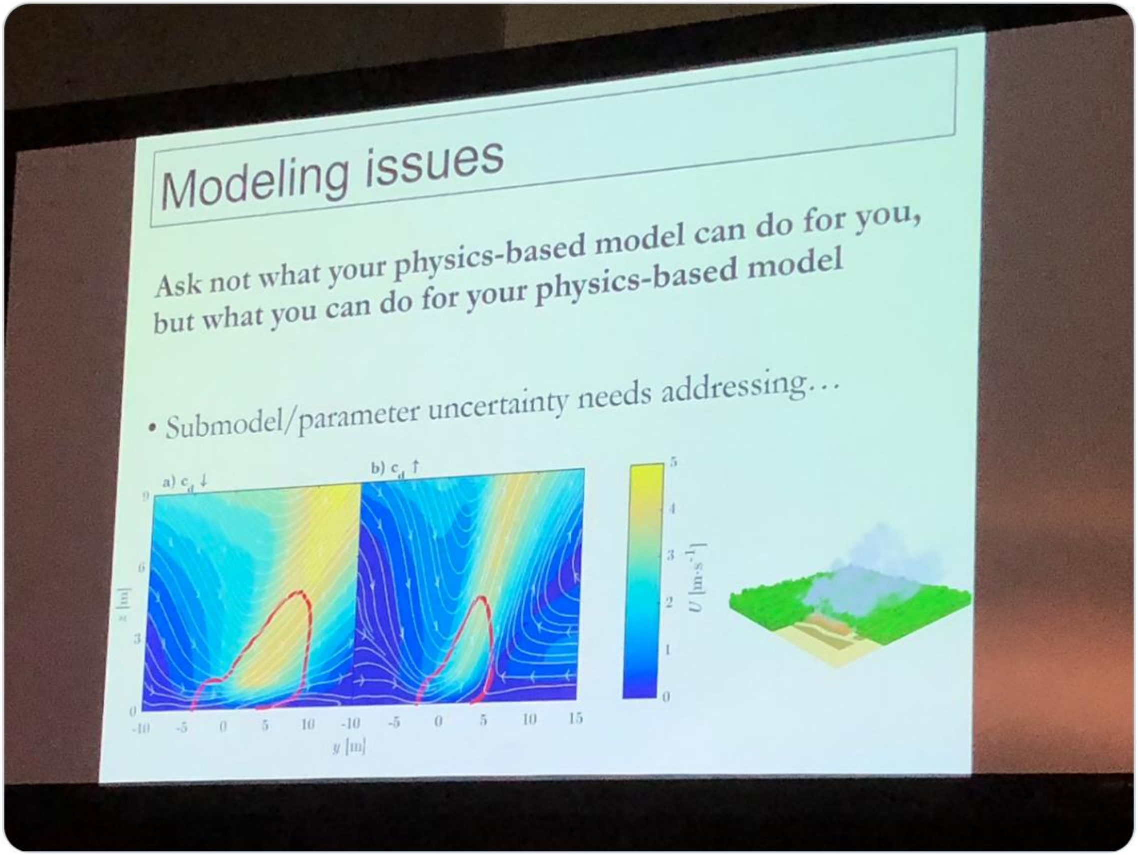
$$v_p = \frac{C\left(\dot{q}''_f\right)^2 \delta_f}{k\rho c_p\left(T_{ig} - T_\infty\right)^2}$$

Summary

- Current methods of measuring fuels and weather are simple…
- But we don't know how to express these in terms that can be related to fire spread phenomena…
- Quantification of the combustion processes will allow identification of fuel characteristics and meteorological conditions that are important
- This will allow prediction (extrapolation) of fire behavior, effects and dangers under relevant conditions.

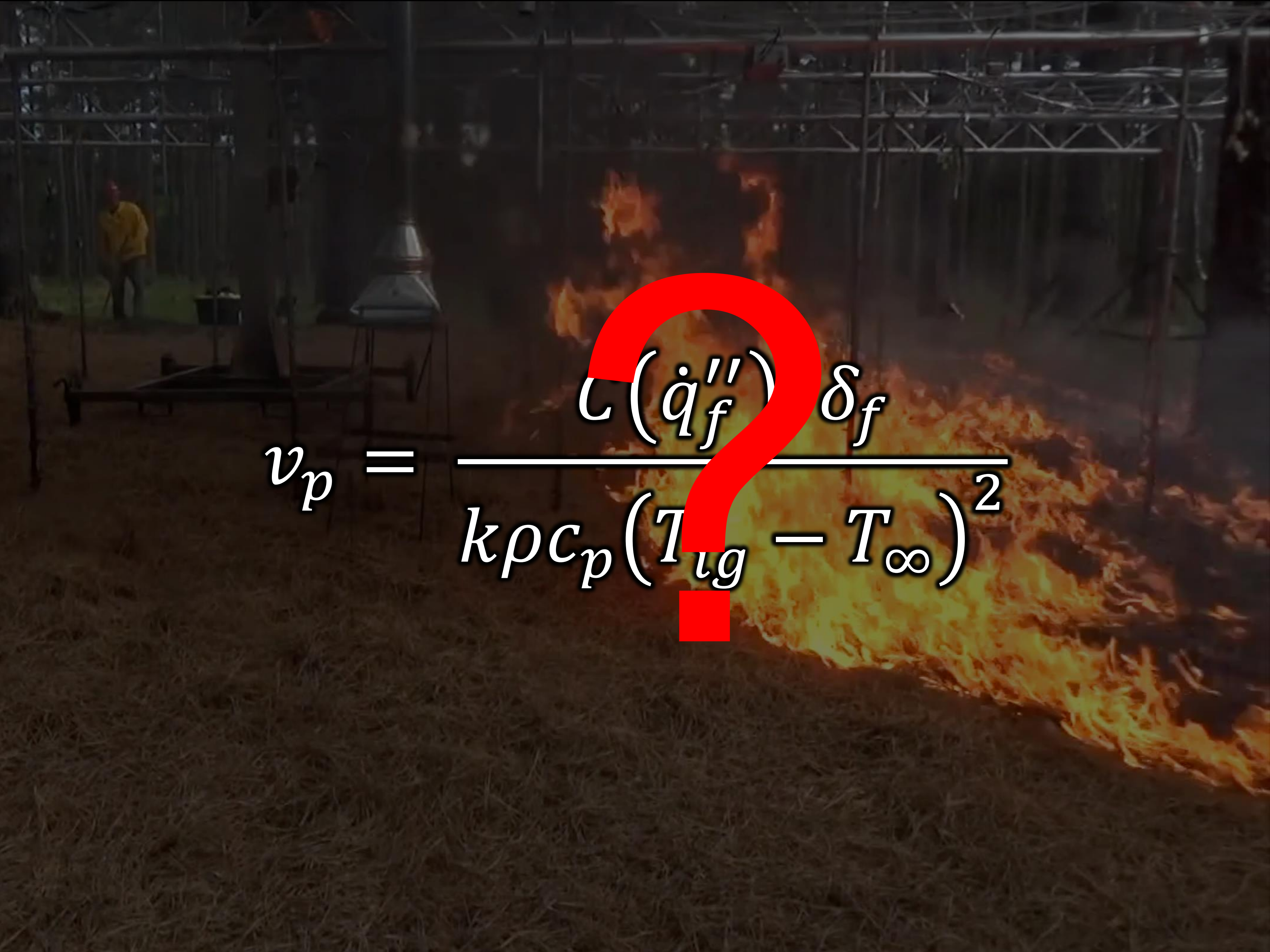
Michael Gollner
@gollnerfire

Nice quote

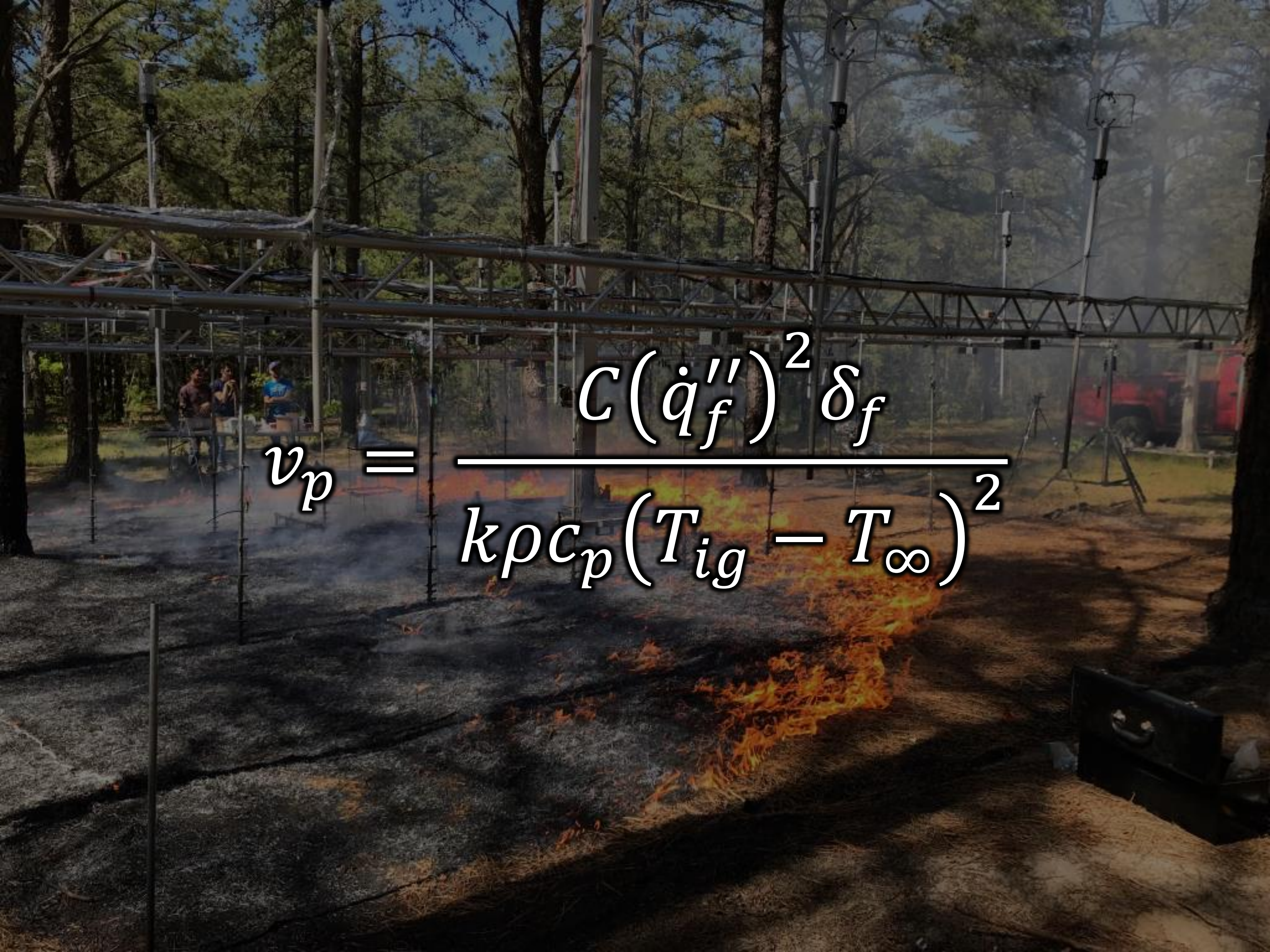


Paulo Fernandes @FireLab_UTAD · Dec 13, 2018
Replying to @gollnerfire
You mean making it somewhat empirical?

1



$$v_p = \frac{C\left(\dot{q}''_f\right)\delta_f}{k\rho c_p\left(T_{ig} - T_\infty\right)^2}$$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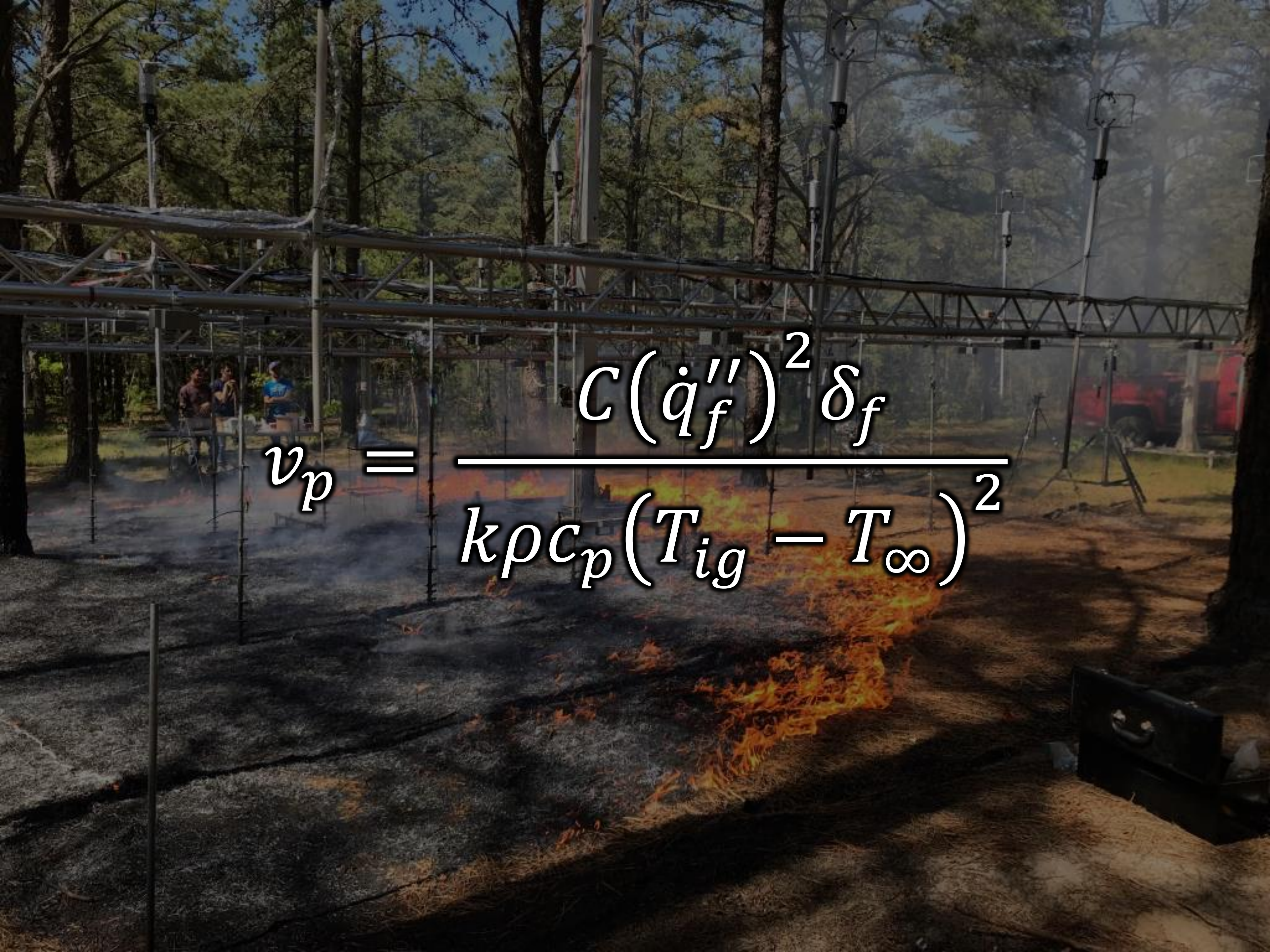

$$v_p = \frac{C\left(\dot{q}_f''\right)^2 \delta_f}{k\rho c_p\left(T_{ig} - T_\infty\right)^2}$$


Overhead IR/
spread rate
Air flow and wind
Scientists
Radiant heat flux
Gas phase temperatures
Energy release rate
Fuel load
Mass loss (burning) rate
FMC
Important tools


Solar flux
Plume dynamics
Heat transfer
Fuel load
Combustion mode
Air entrainment
Fuel structure
Ambient wind

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