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Title: Influence of topography and vegetation heterogeneity on wildfire in Earth System Models

Author(s): Oliveto, Julia Andre

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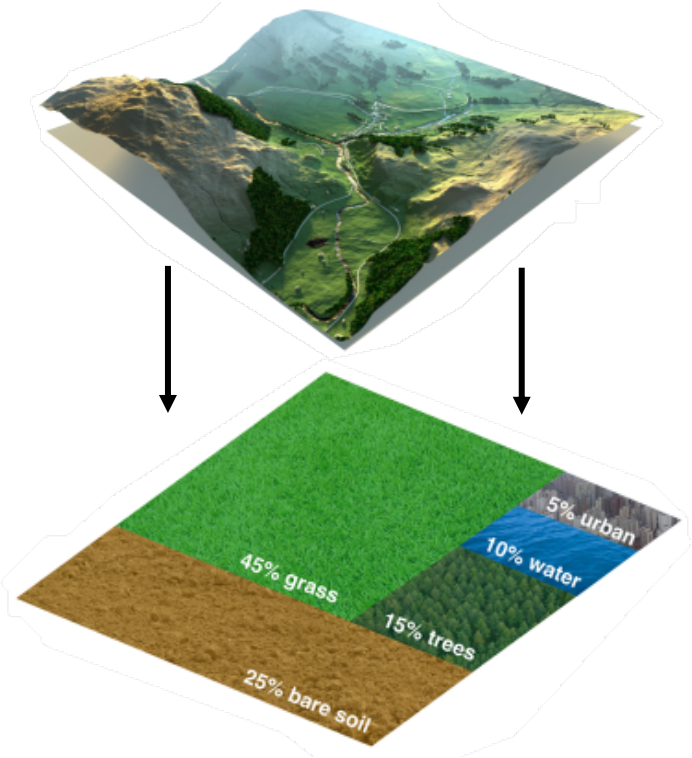
# Influence of topography and vegetation heterogeneity on wildfire in Earth System Models

Julia Oliveto

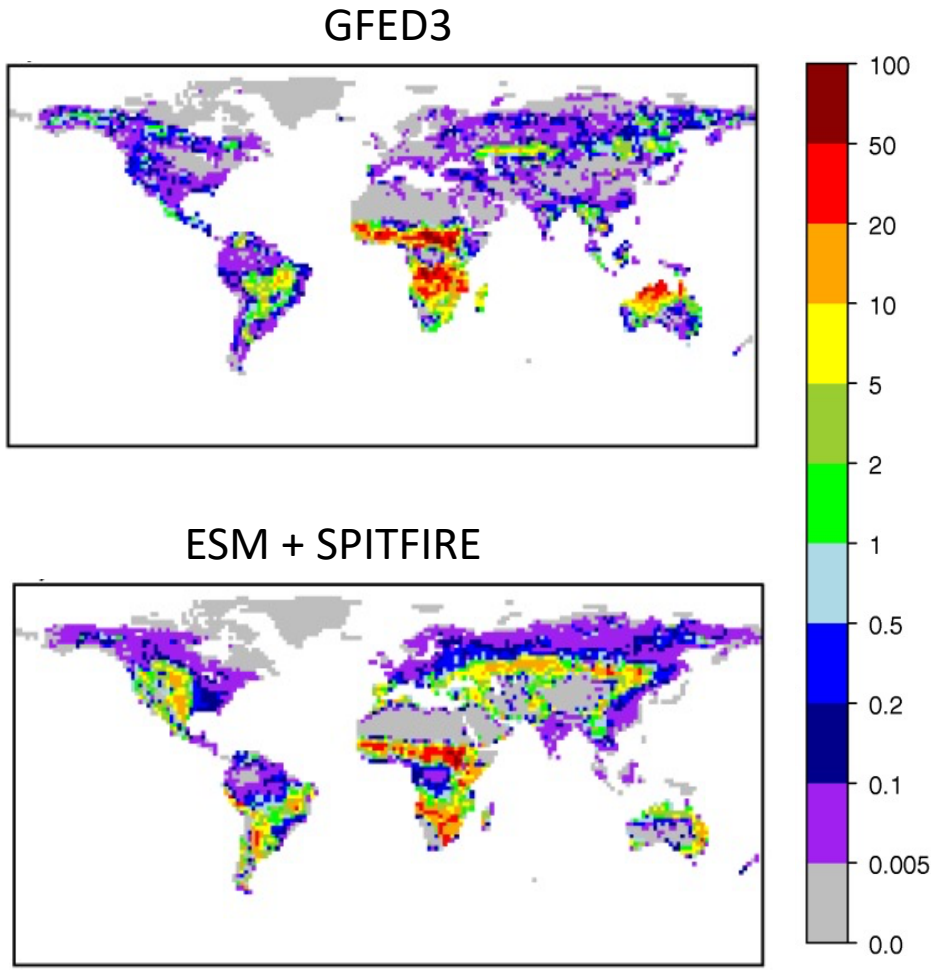
LANL PI: Alex Jonko

FSU Advisor: Neda Yaghoobian

# Motivation - Earth System Models (ESMs) and SPITFIRE

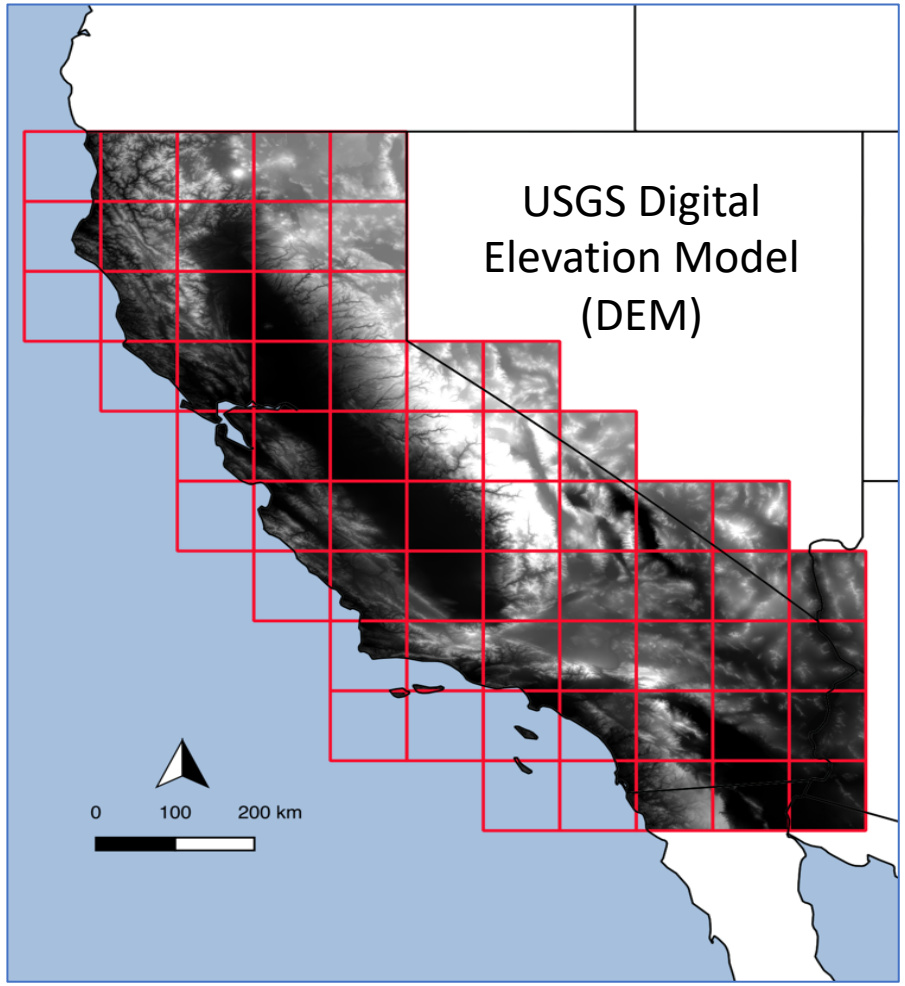


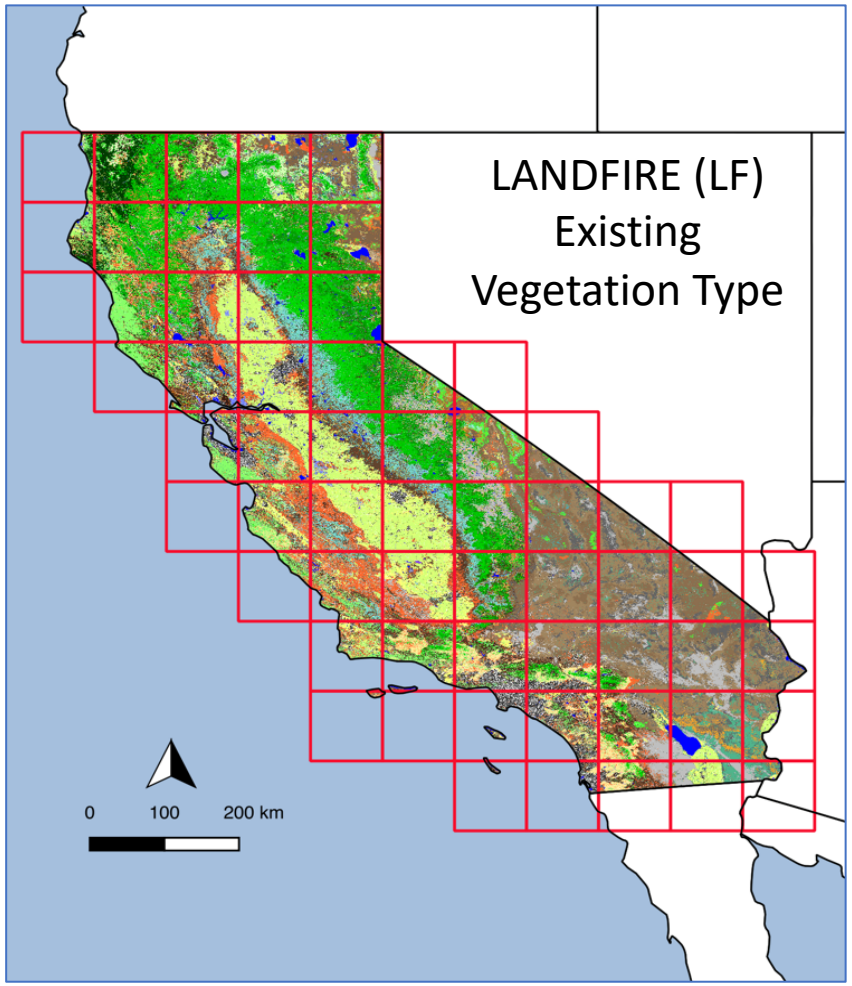

- Considers no sub-grid topography
- SPITFIRE uses Rothermel fire spread model




Burned fraction averaged over the years 1997–2005[1]

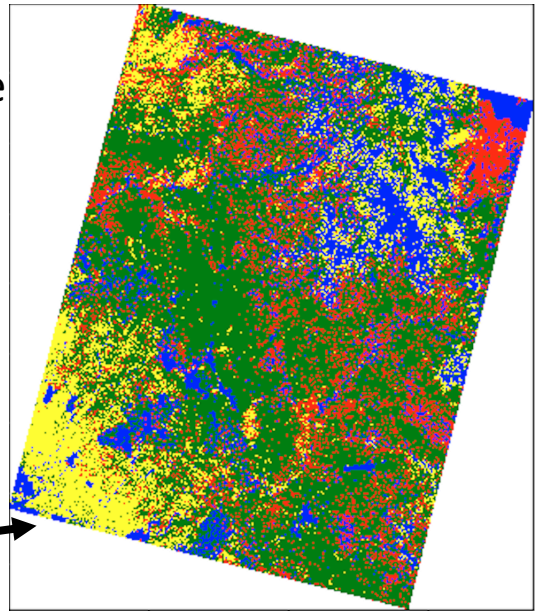
# Project Overview

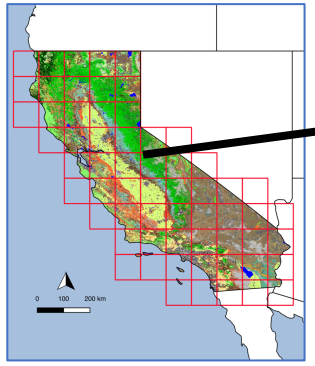


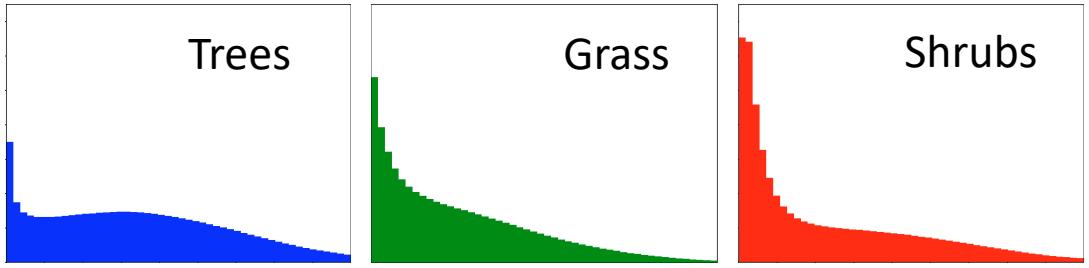
## (1) LF Reclassified Vegetation Types:

Non-burnable
Trees
Grass
Shrubs

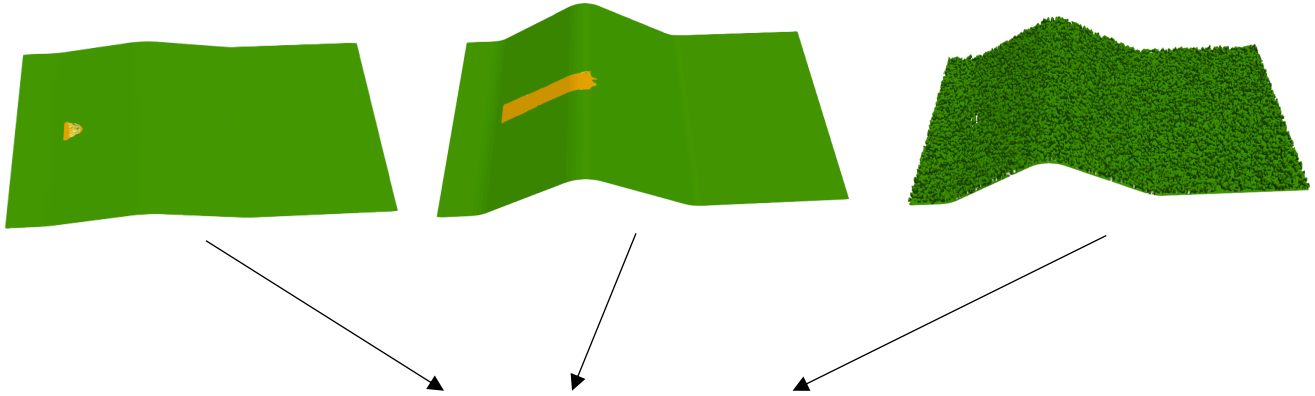




## (2) Slope, LF Vegetation Cover %, Height Distributions of Reclassified Tiles:

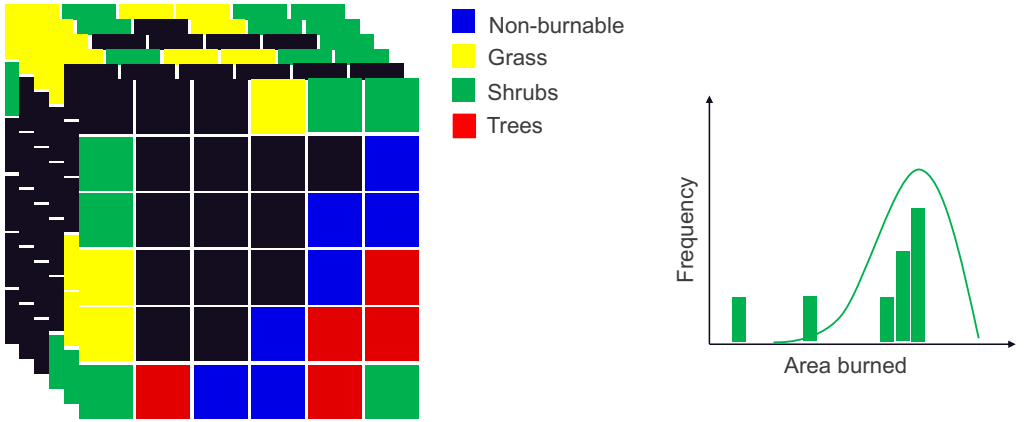



## (3) FIRETEC Simulations & Response Function



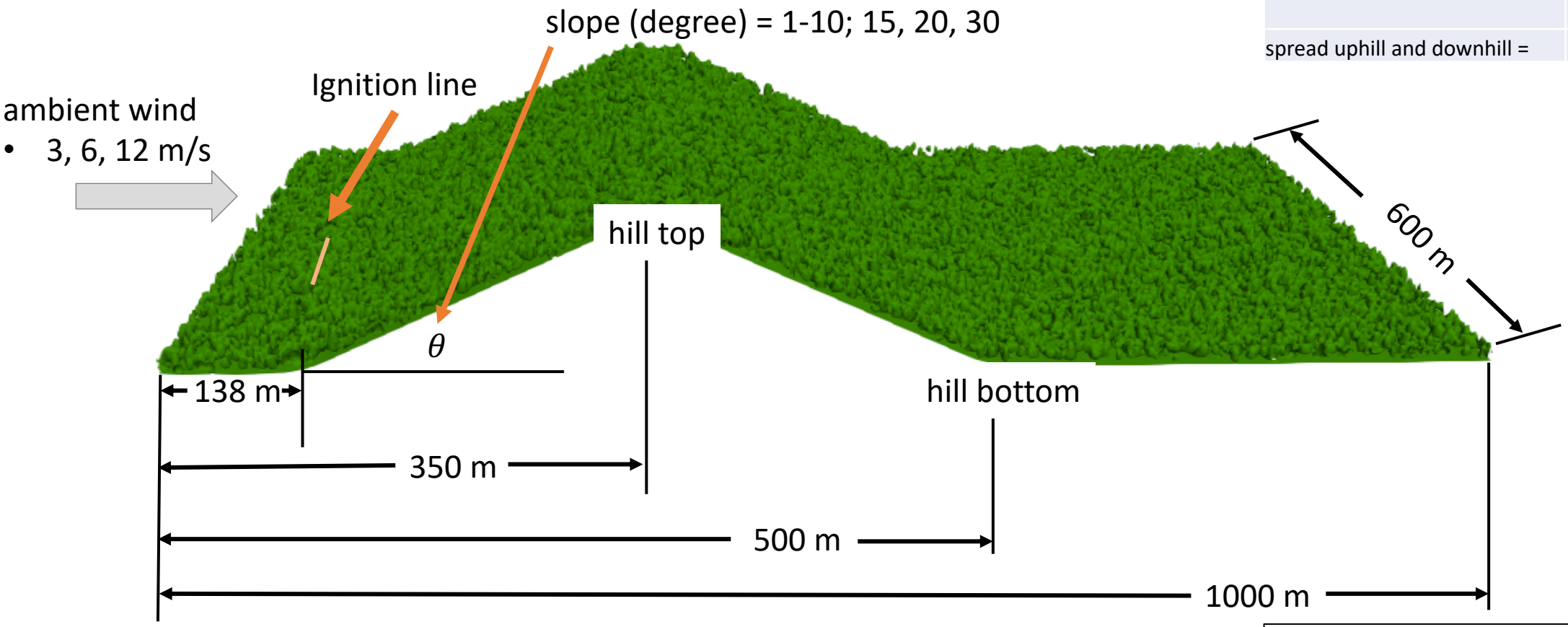
| | |
|---|---|
| no spread up or downhill = | 0,0 |
| | |
| spread uphill not downhill = | 1,0 |
| | |
| spread uphill and downhill = | 1,1 |

## (4) FIRETEC Response Application



# FIRETEC Simulations

| EX: | | |
|---|---|---|
| no spread up or downhill = | | 0,0 |
| | | |
| spread uphill not downhill = | | 1,0 |
| | | |
| spread uphill and downhill = | | 1,1 |




Specific Grass Suite Parameters:

- Height = 0.3 m
- Fuel load = 0.5 kg/m^3
- Fuel moistures = 5, 10, 15, 20%

# FIRETEC Results : Grass

| | |
|---|---|
| no spread up or downhill = | 0,0 |
| spread uphill not downhill = | 1,0 |
| spread uphill and downhill = | 1,1 |

**Wind = 3 m/s**

| slope / FM | 5% | 10% | 15% | 25% |
|---|---|---|---|---|
| 1 | 1,1 | 1,0 | 1,0 | 0,0 |
| 2 | 1,1 | 1,0 | 1,0 | 0,0 |
| 3 | 1,1 | 1,1 | 1,0 | 0,0 |
| 4 | 1,1 | 1,0 | 1,0 | 0,0 |
| 5 | 1,1 | 1,1 | 1,0 | 1,0 |
| 6 | 1,1 | 1,0 | 1,0 | 1,0 |
| 7 | 1,1 | 1,1 | 1,0 | 1,0 |
| 8 | 1,1 | 1,0 | 1,0 | 1,0 |
| 9 | 1,1 | 1,0 | 1,0 | 1,0 |
| 10 | 1,1 | 1,0 | 1,0 | 1,0 |
| 15 | 1,0 | 1,0 | 1,0 | 1,0 |
| 20 | 1,0 | 1,0 | 1,0 | 1,0 |
| 30 | 1,0 | 1,0 | 1,0 | 1,0 |

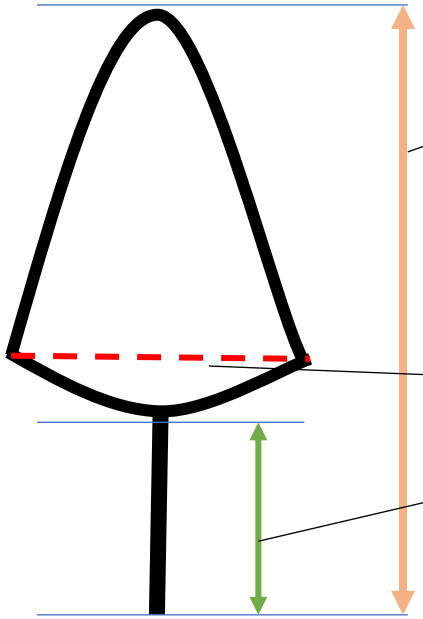
**Wind = 6 m/s**

| slope / FM | 5% | 10% | 15% | 25% |
|---|---|---|---|---|
| 1 | 1,1 | 1,1 | 1,1 | 1,1 |
| 2 | 1,1 | 1,1 | 1,1 | 1,1 |
| 3 | 1,1 | 1,1 | 1,1 | 1,1 |
| 4 | 1,1 | 1,1 | 1,1 | 1,1 |
| 5 | 1,1 | 1,1 | 1,1 | 1,1 |
| 6 | 1,1 | 1,1 | 1,1 | 1,1 |
| 7 | 1,1 | 1,1 | 1,1 | 1,1 |
| 8 | 1,1 | 1,1 | 1,1 | 1,1 |
| 9 | 1,1 | 1,1 | 1,1 | 1,1 |
| 10 | 1,1 | 1,1 | 1,1 | 1,1 |
| 15 | 1,1 | 1,1 | 1,1 | 1,1 |
| 20 | 1,1 | 1,1 | 1,1 | 1,0 |
| 30 | 1,0 | 1,0 | 1,1 | 0,0 |

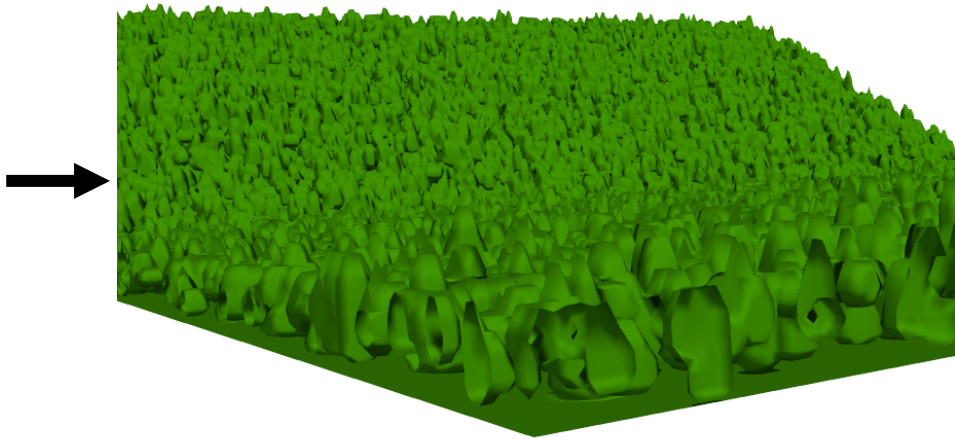
**Wind = 12 m/s**

| slope / FM | 5% | 10% | 15% | 25% |
|---|---|---|---|---|
| 1 | 1,1 | 1,1 | 1,1 | 1,1 |
| 2 | 1,1 | 1,1 | 1,1 | 1,1 |
| 3 | 1,1 | 1,1 | 1,1 | 1,1 |
| 4 | 1,1 | 1,1 | 1,1 | 1,1 |
| 5 | 1,1 | 1,1 | 1,1 | 1,1 |
| 6 | 1,1 | 1,1 | 1,1 | 1,1 |
| 7 | 1,1 | 1,1 | 1,1 | 1,1 |
| 8 | 1,1 | 1,1 | 1,1 | 1,1 |
| 9 | 1,1 | 1,1 | 1,1 | 1,1 |
| 10 | 1,1 | 1,1 | 1,1 | 1,1 |
| 15 | 1,1 | 1,1 | 1,1 | 1,1 |
| 20 | 1,1 | 1,1 | 1,1 | 1,1 |
| 30 | 1,1 | 1,0 | 1,0 | 1,0 |

# Fuel Bed Creation : Trees & Shrubs



| | TREES | SHRUBS |
|---|---|---|
| **LANDFIRE** | | |
| Average Height (m) | 13 +/- 6 | 1 +/- 0.5 |
| Cover (%) | 49 | 41 |
| Species | Ponderosa Pine | Chaparral |
| **Downscaled Live Fuel Moisture Content (%)** | 80, 85, 90, 95 | 65,70, 75, 85 |
| **Linn, et al** | | |
| Crown diameter (m) | 7.6 | 2.5 |
| Height to Live Crown (m) | 8.7 | 0.5 |
| Canopy Bulk Density (kg/m^3) | 0.24 | 1.25 |

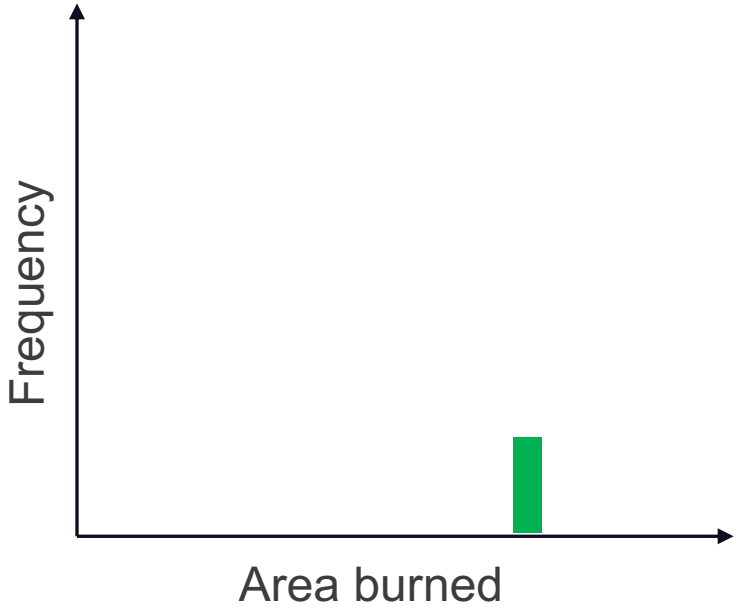


- Vary slope angle, fuel moisture, and ambient wind speed
- Setting homogenous grass layer at 5% fuel moisture; 0.3 m height
- Not considering litter

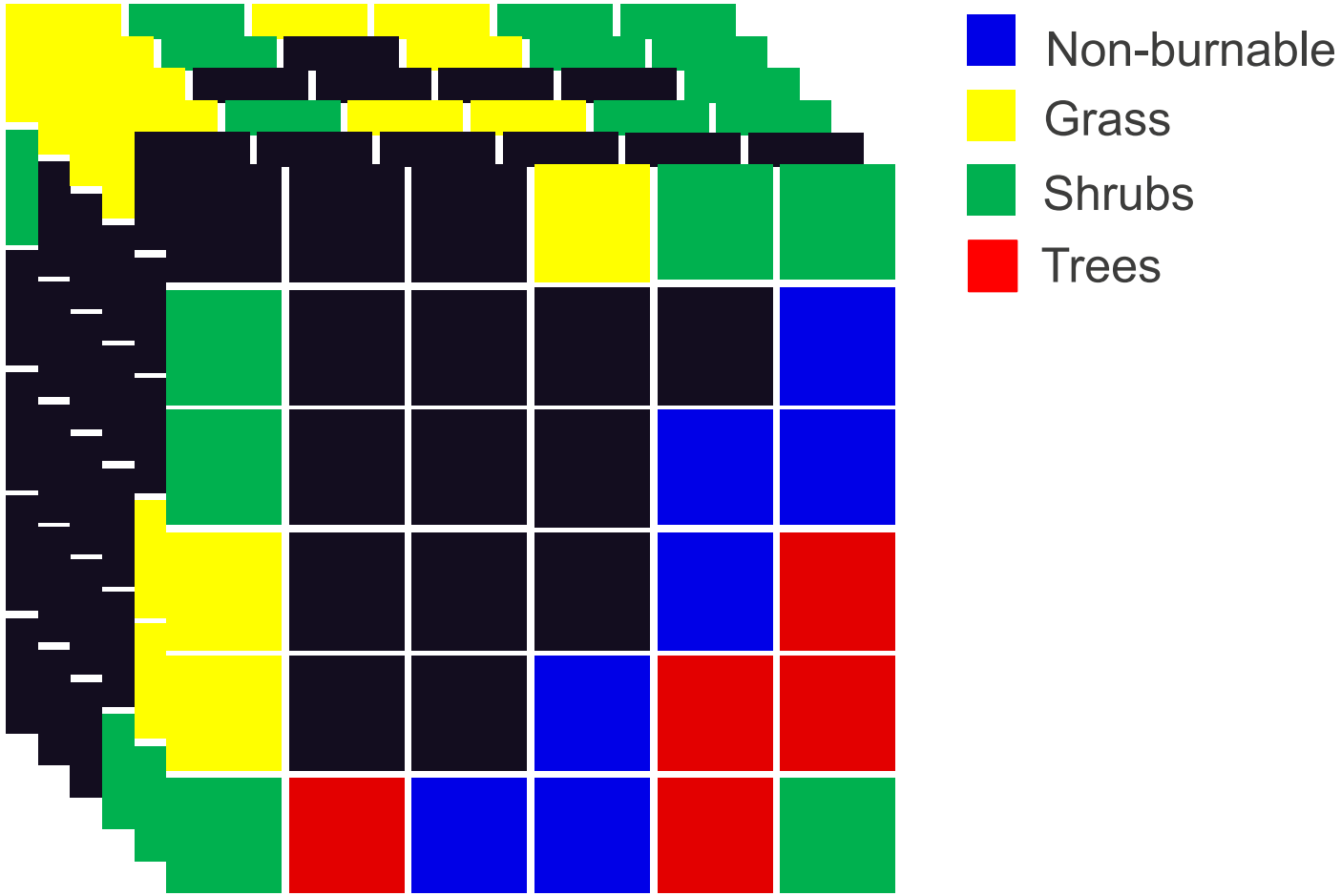
Linn, et al 2005 ; A numerical study of slope and fuel structure effects on coupled wildfire behavior

# Future Work: “The Gadget”


- Example: Ignite a cell that has a 20% slope, shrub: FIRETEC says: this cell burns completely, so it can spread to its burnable neighbors.
- Repeat this process on the neighboring cells until fire does not propagate



# Future Work: “The Gadget”




- Continue applying the response function over the cell varying ignition location and wind direction
- Record areas burned to create a distribution