Climate Change and Wildfire Extremes

Climate Change, Extreme Weather, And Southern California Floods

Dept. of Water Resources Workshop

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Applications Program
California Energy Commission
USDA Forest Service

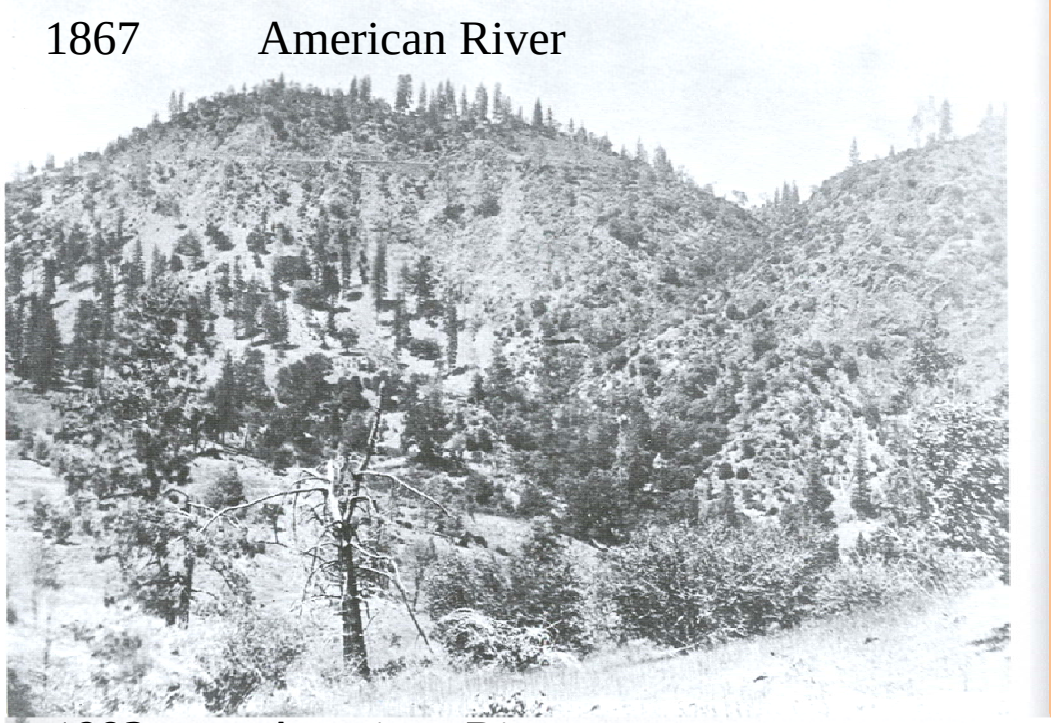
"Climate" describes a system with a set of possible outcomes

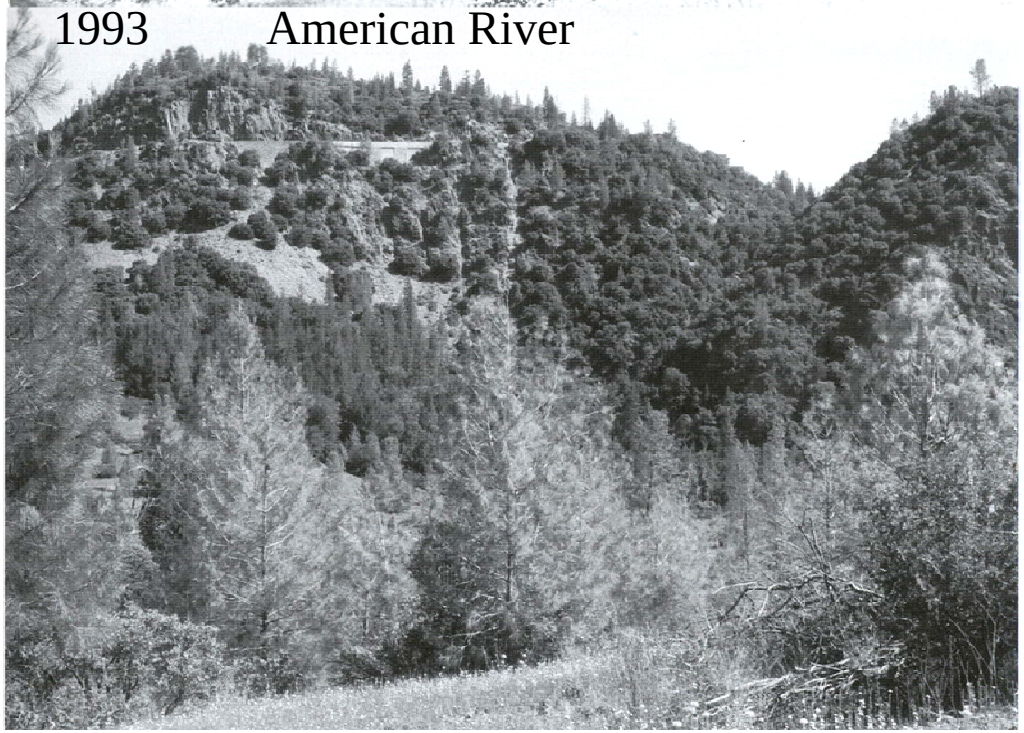
26
0
32
15
19
4
21

How we view the outcome depends on how we've placed our bets

Understory Fire Regimes

- Fire suppression has increased amount and connectivity of fuels
  - Unnatural increase in tree density
- Fire regime **has** changed
  - Fires are less frequent and more severe
  - Increased risk of severe fire





Fuel Treatments and Climate Change

- USFS implements fuel treatments to mitigate wildfire behavior in fuel-driven fires (not Santa Ana wind fires)
- In Southern California, 55% of area burned is due to fuel-driven fires
- Fuel treatments are currently designed to mitigate extreme fire behavior based on *historic* conditions

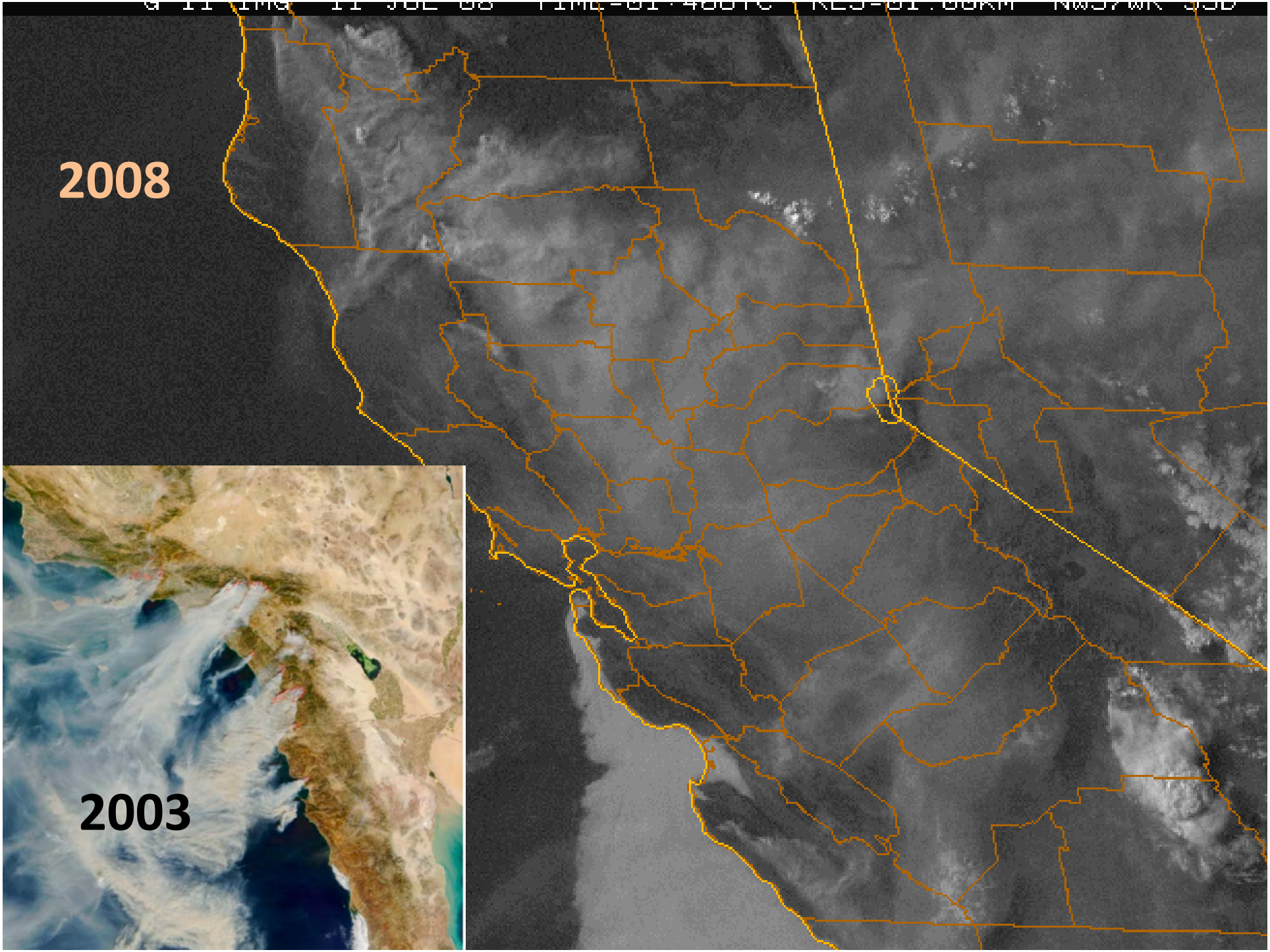
The Charlton-Chilao Fuel Treatment successfully mitigated the 2009 Station Fire outside of Los Angeles

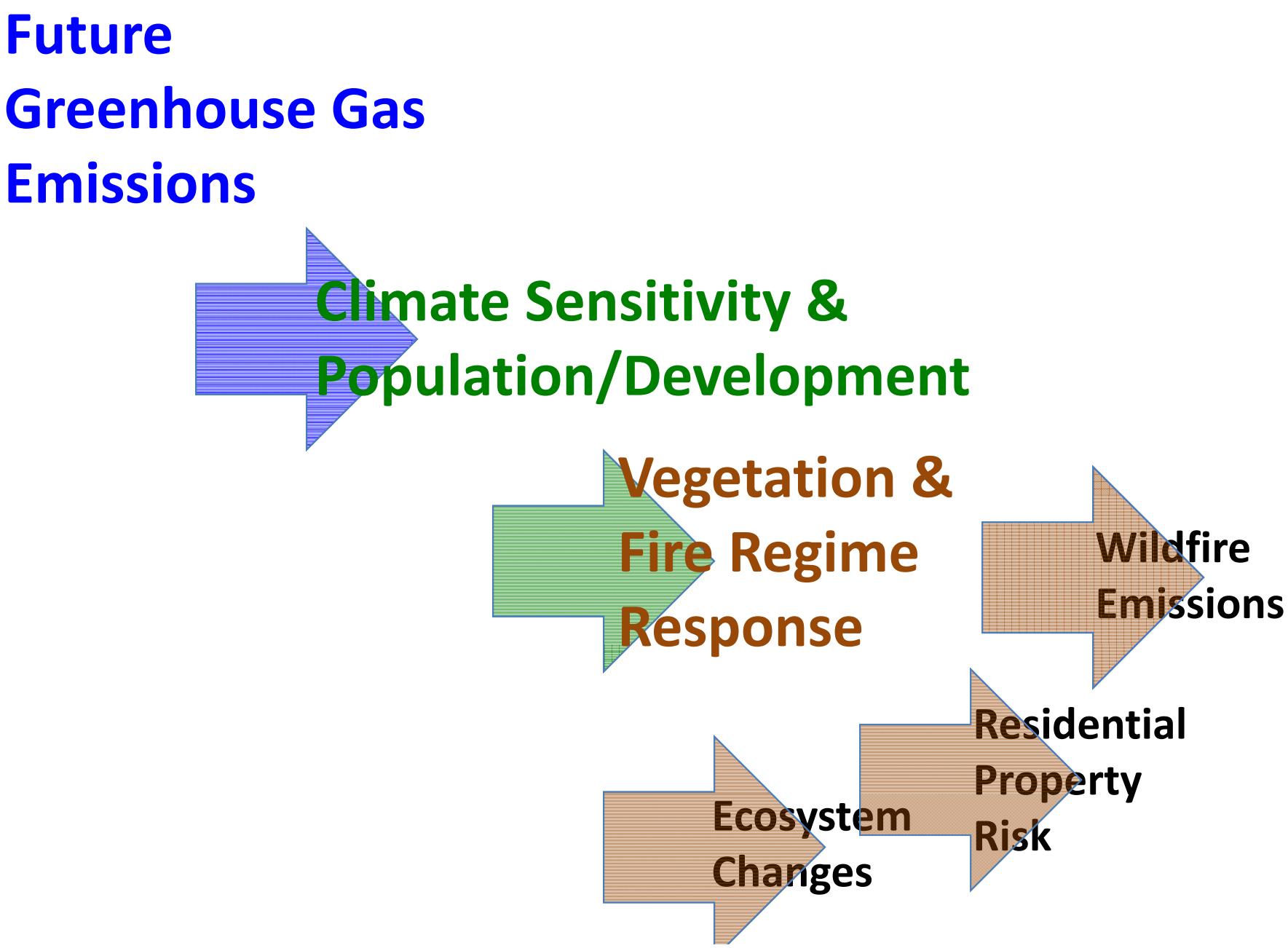
Kolden, Abatzoglou, Brown – DRI/CEFA; University of Idaho

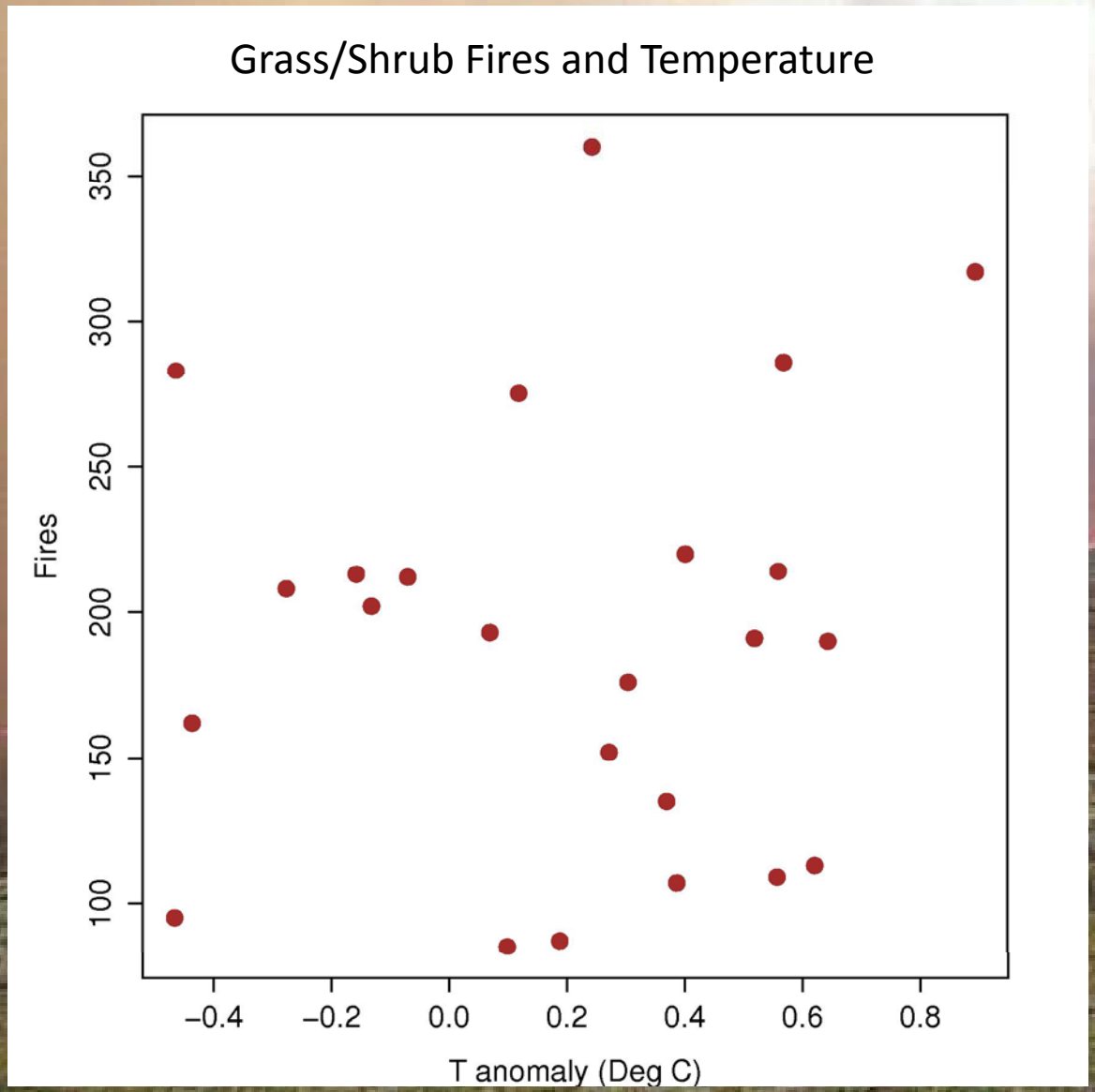
2002 Rodeo-Chediski Fires, AZ

- Burned in ponderosa pine during severe drought
- Prescribed fire, salvage logging in previous burns, and fuel reduction with slash removal **were effective** in reducing fire severity and spread, even with extreme weather.

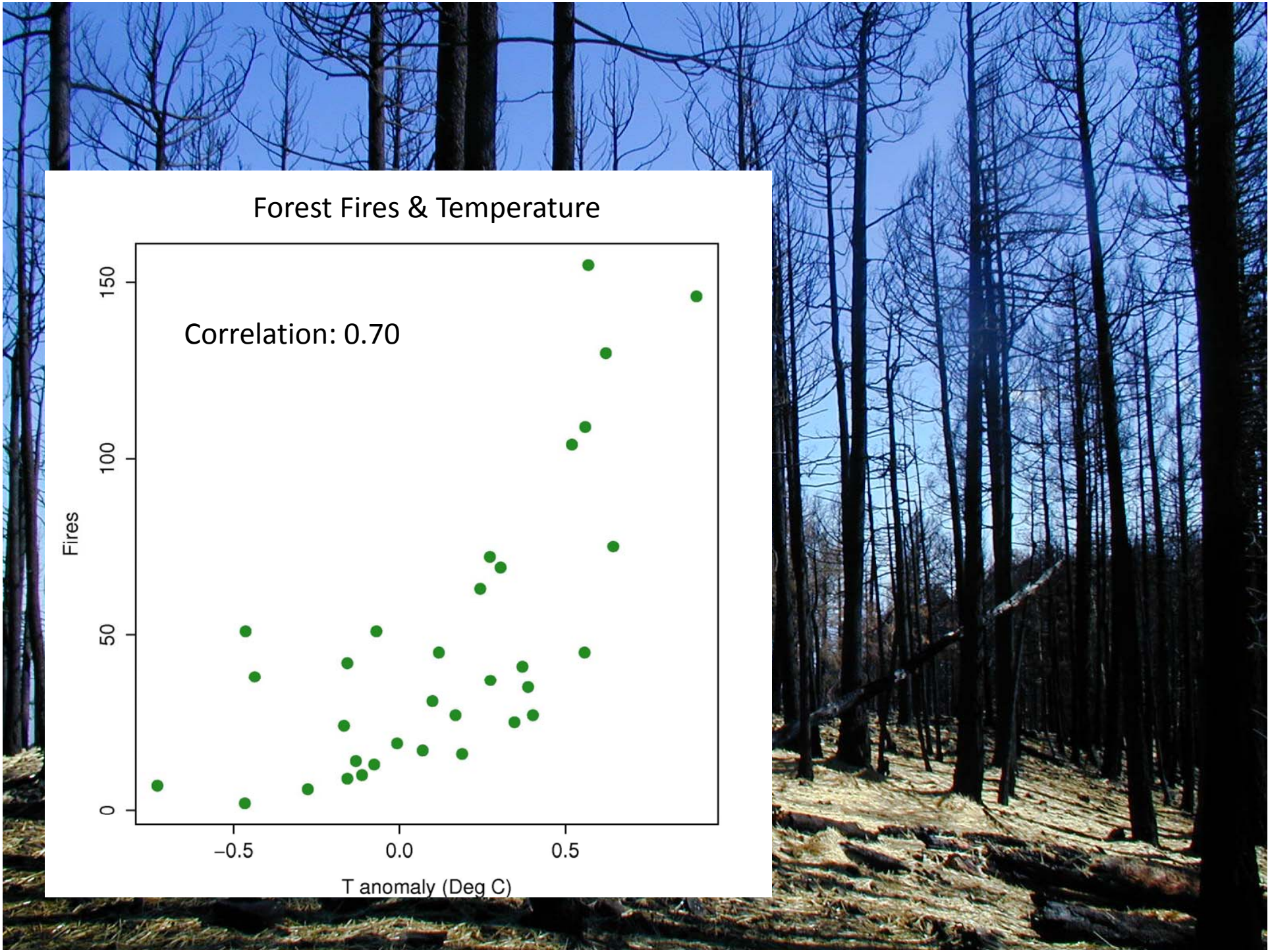
Both areas burned.


2008
2003

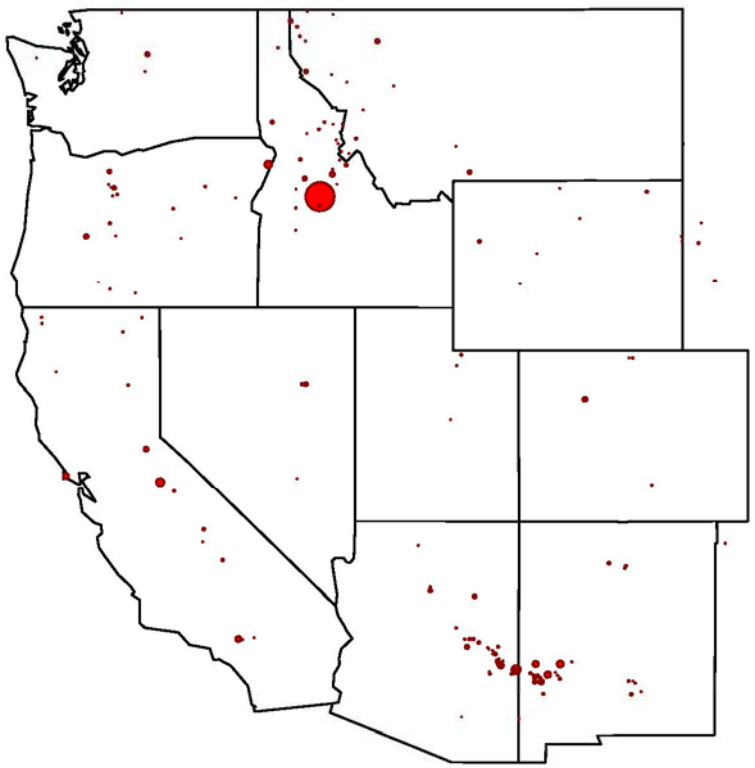

Future
Greenhouse Gas
Emissions
Climate Sensitivity &
Population/Development
Vegetation &
Fire Regime
Response
Wildfire
Emissions
Residential
Property
Risk
Ecosystem
Changes



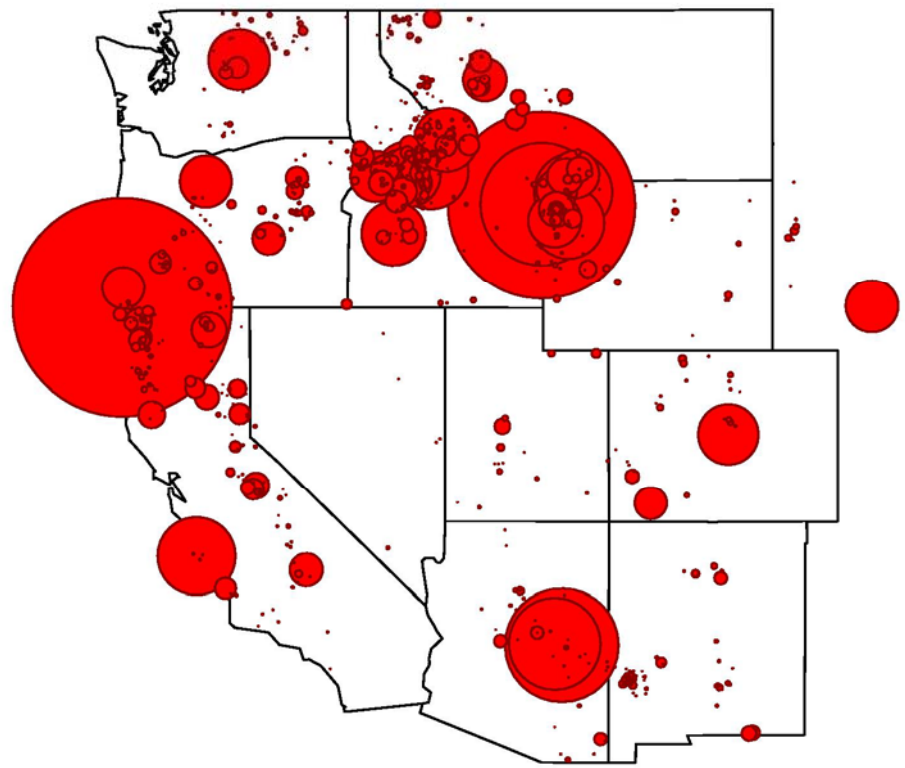
Correlation: 0.08


Forest Fires & Temperature
Correlation: 0.70
Fires
0
50
100
150
−0.5
0.0
0.5
T anomaly (Deg C)

Late Snowmelt Years

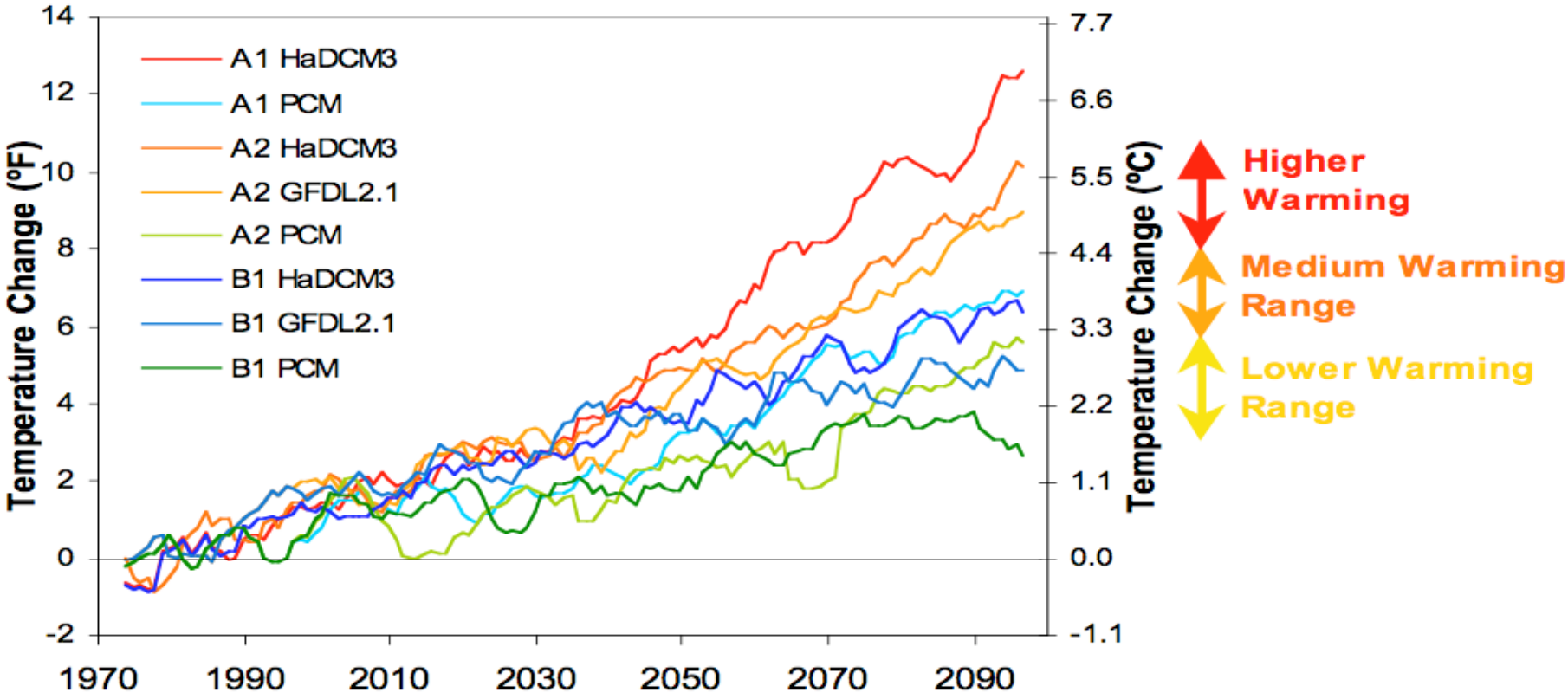


Early Snowmelt Years



1972 - 2003, NPS, USFS & BIA Fires over 1000 acres

Figure 4-2. Change in California Annual Average Daily Mean Temperature Relative to 1961-1990



Change in California annual mean temperature (°F and °C) by year from 1961 to 2100 relative to 1961–1990 average—7-year running mean.

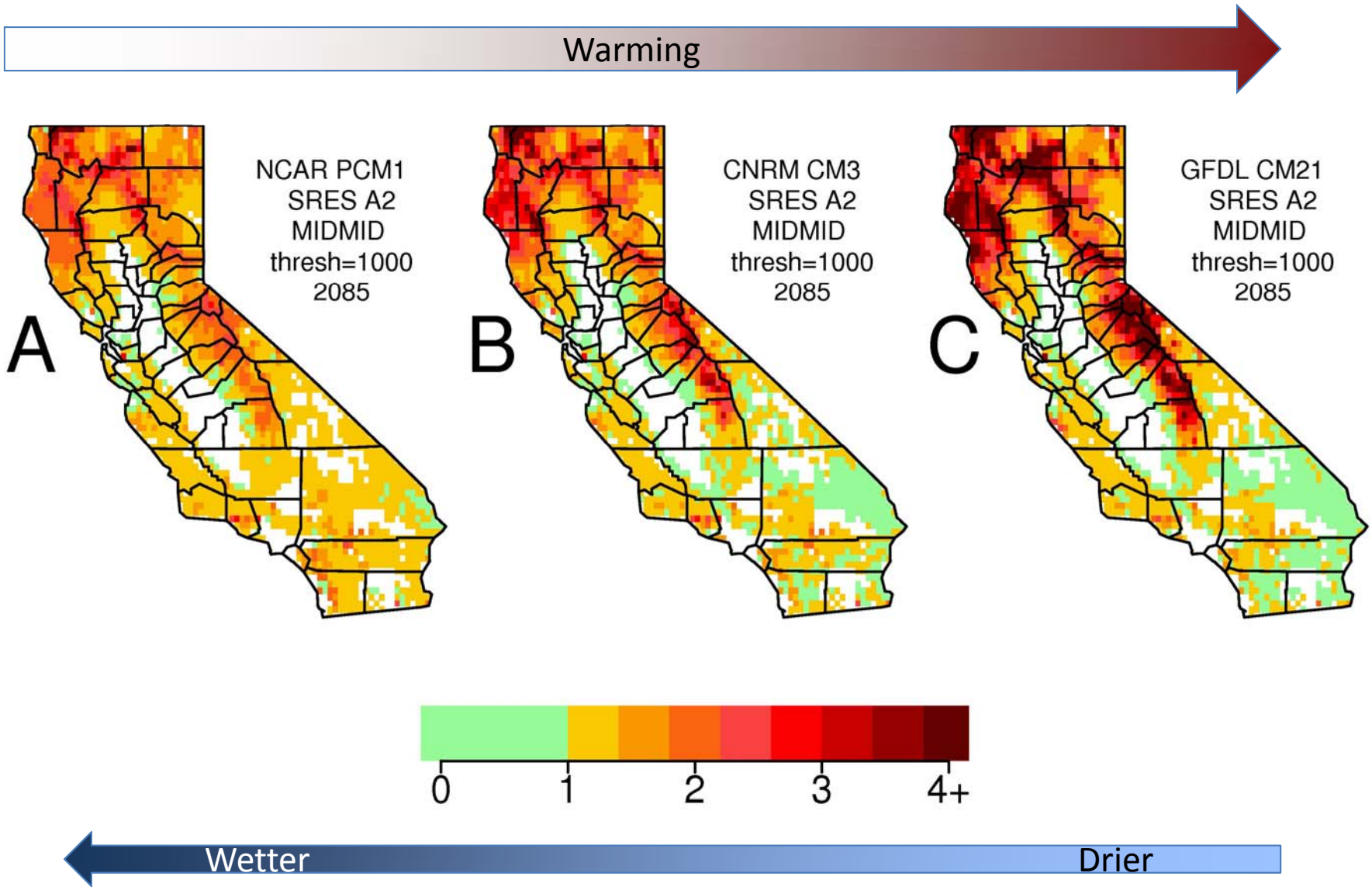
HadCM3 = Hadley Climate Model version 3

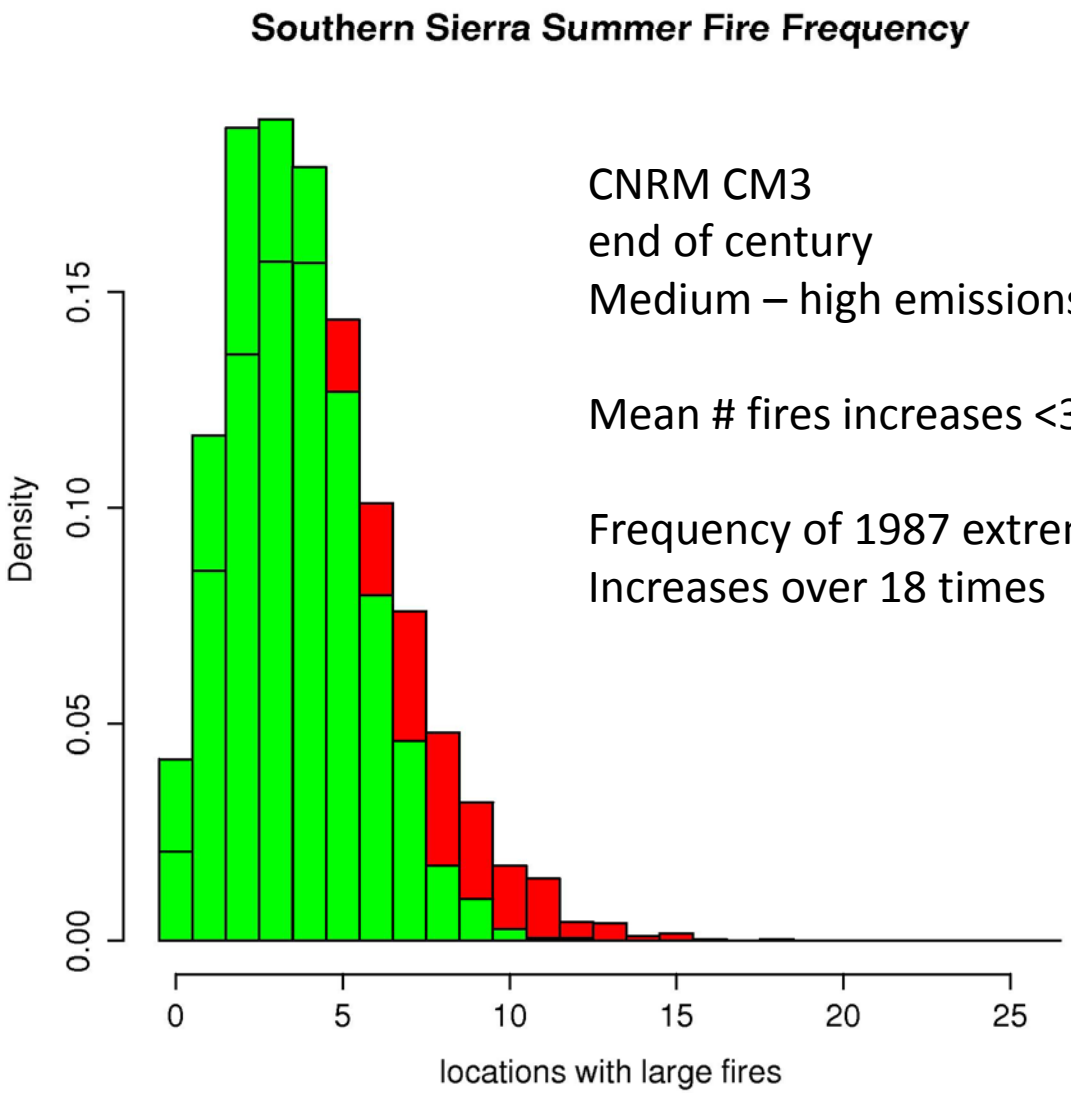
PCM = Parallel Climate Model

GFDL2.1 = Geophysical Fluid Dynamics Laboratory model 2.1

A1, A2, and B1 refer to global emission scenarios explained in Section 4. They are higher (A1), medium-high (A2), and lower (B1) emission scenarios.

Projected Changes in Burned Area

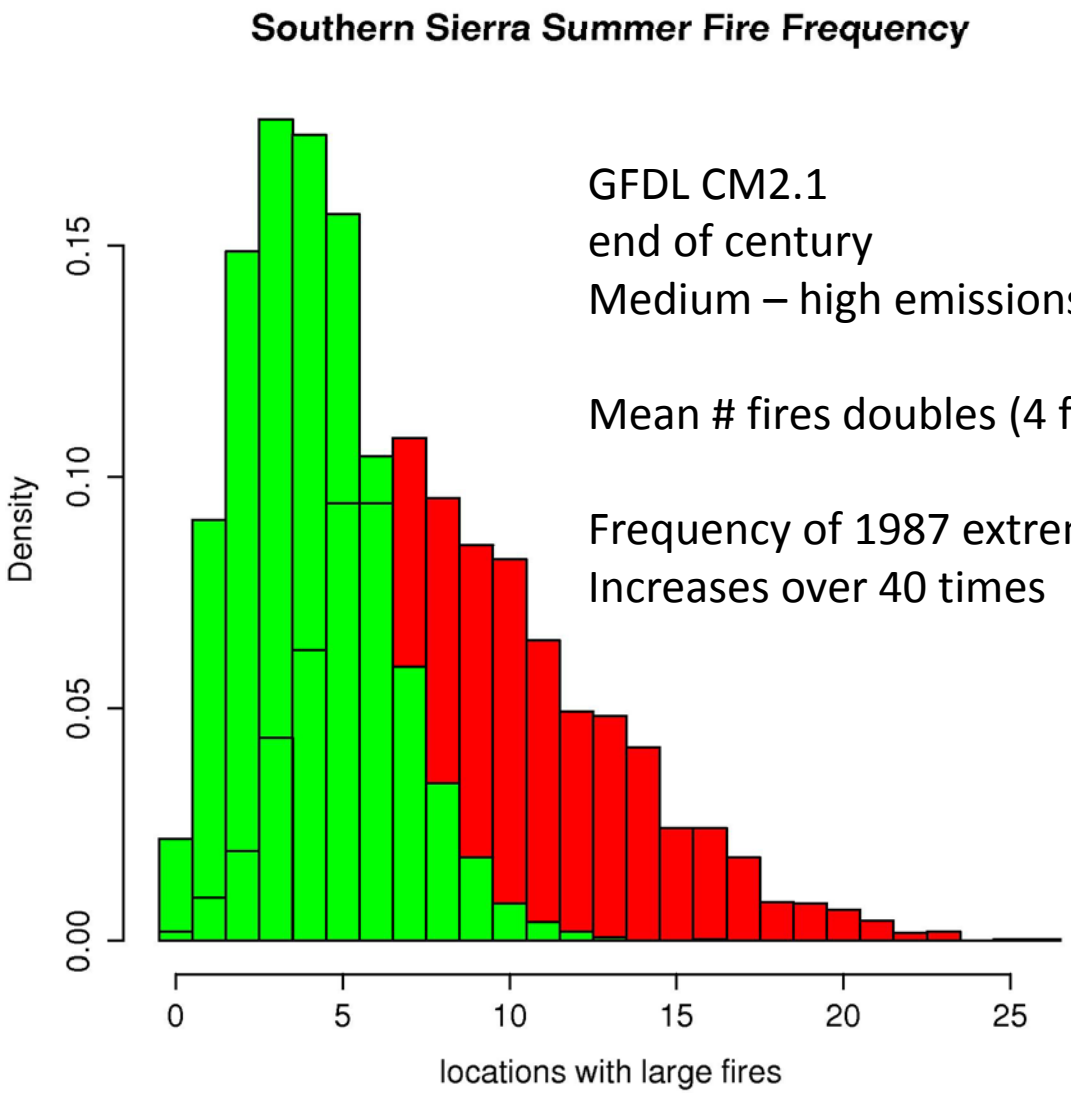




CNRM CM3
end of century
Medium – high emissions

Mean # fires increases <30% (1 fire/season)

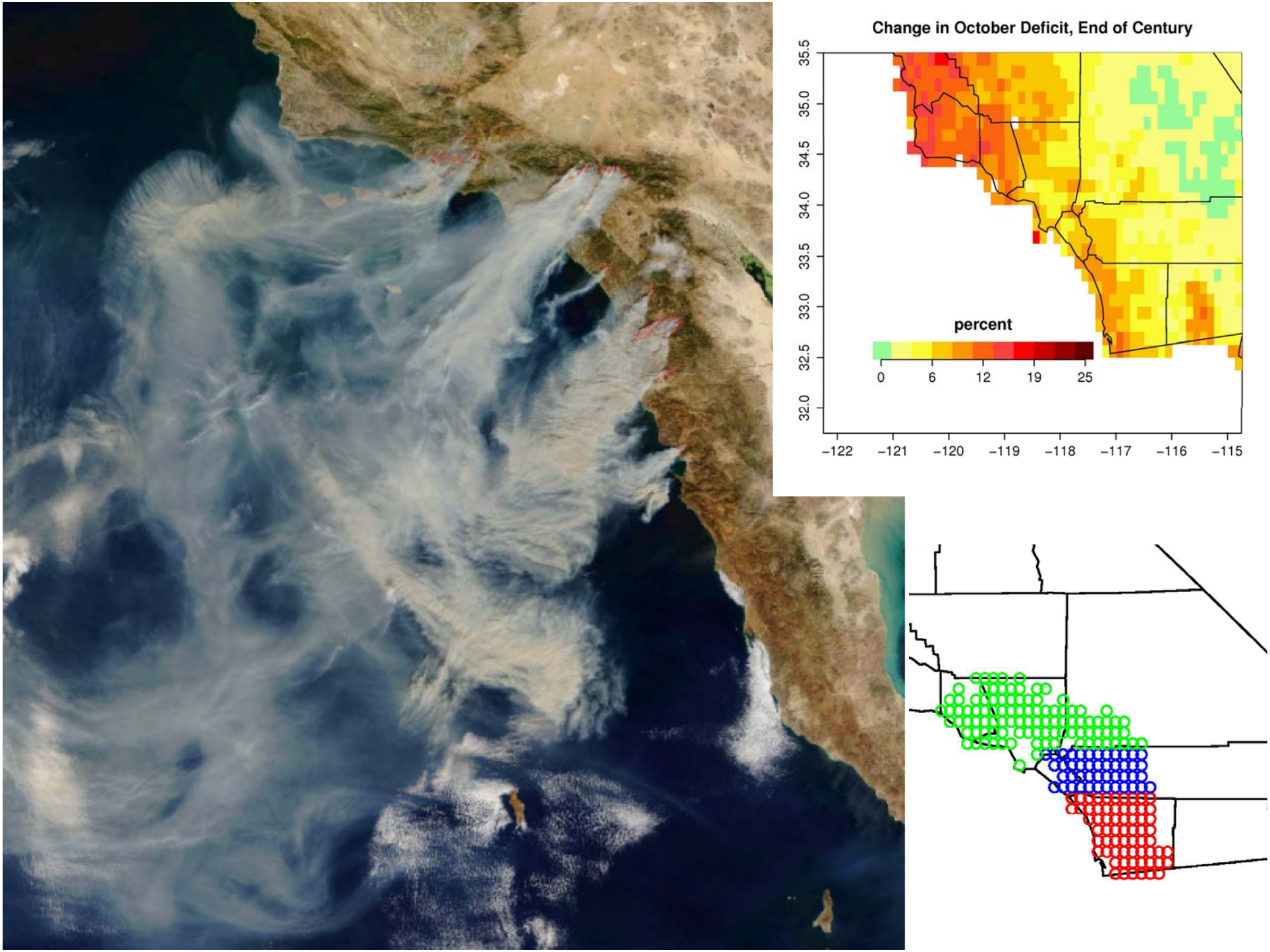
Frequency of 1987 extreme (11 fires)
Increases over 18 times

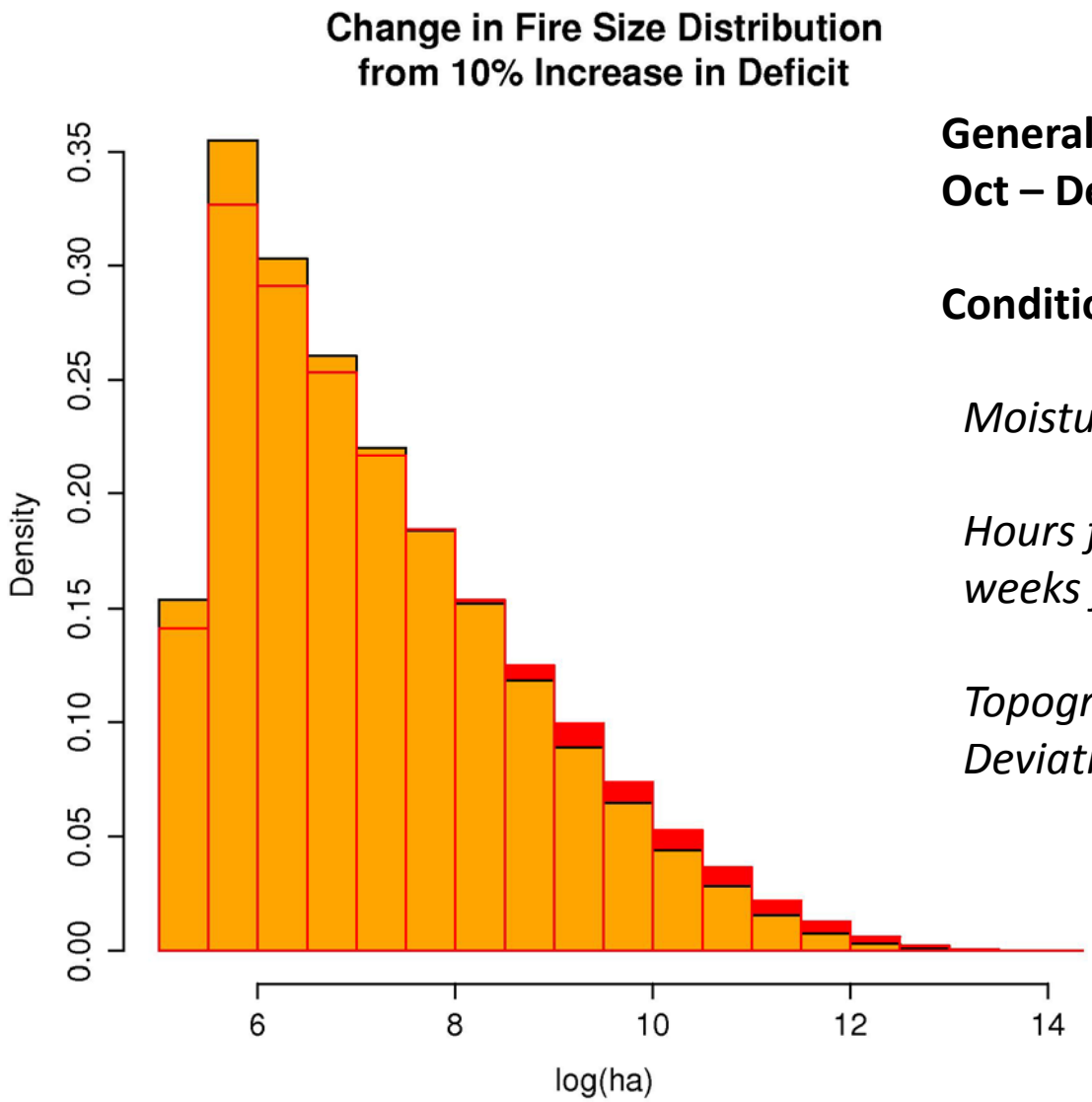


GFDL CM2.1
end of century
Medium – high emissions

Mean # fires doubles (4 fires/season)

Frequency of 1987 extreme (11 fires)
Increases over 40 times


Change in October Deficit, End of Century
35.5
35.0
34.5
34.0
33.5
33.0
32.5
32.0
−122
−121
−120
−119
−118
−117
−116
−115
percent
0
6
12
19
25



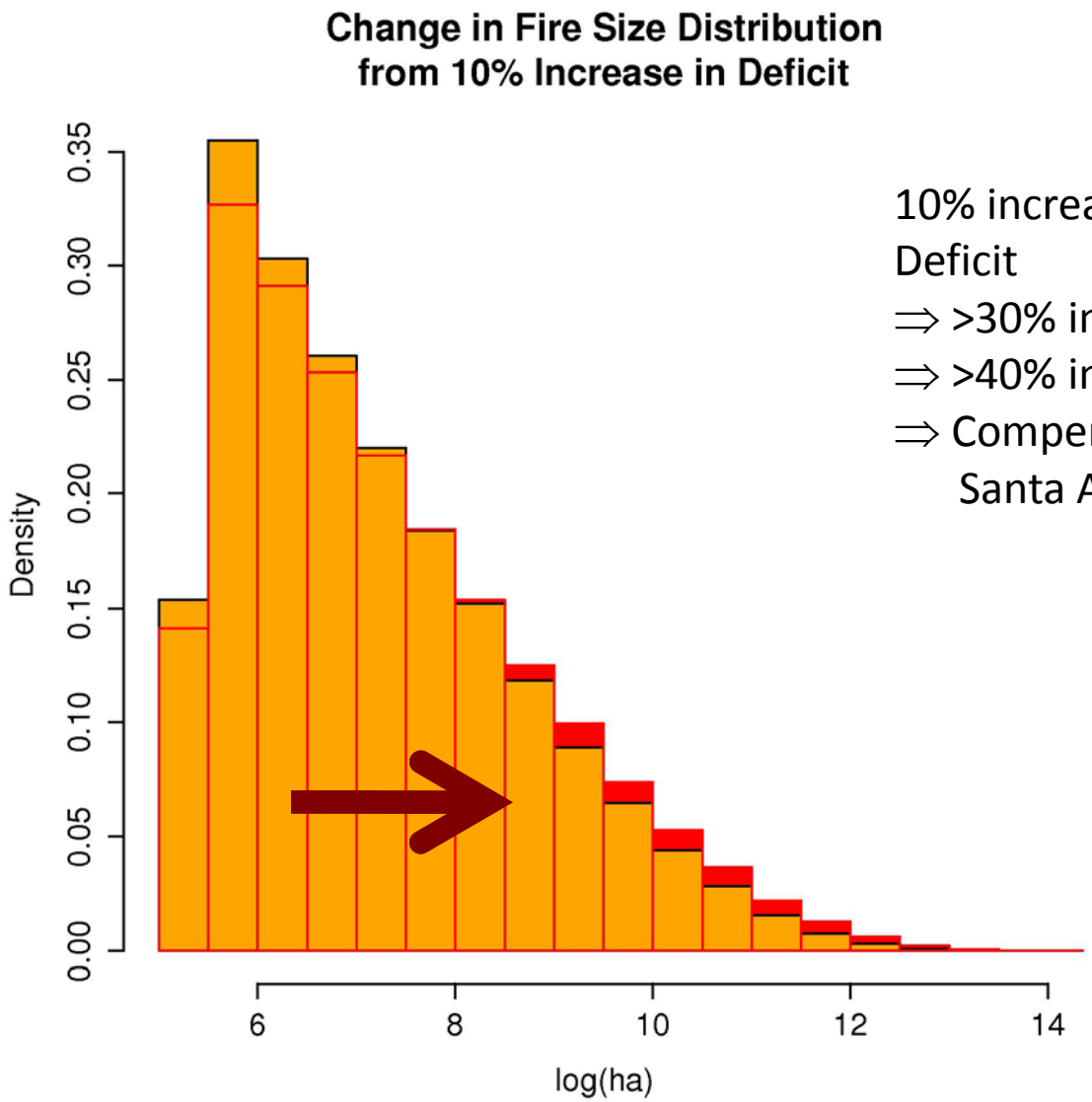
Generalized Pareto Distribution for Oct – Dec fire size

Conditional on:

Moisture deficit

Hours flagged as 'Santa Ana' over two weeks from date of fire ignition

Topography (Aspect and Standard Deviation of Elevation)



10% increase in October to December Deficit

⇒ >30% increase in average fire size

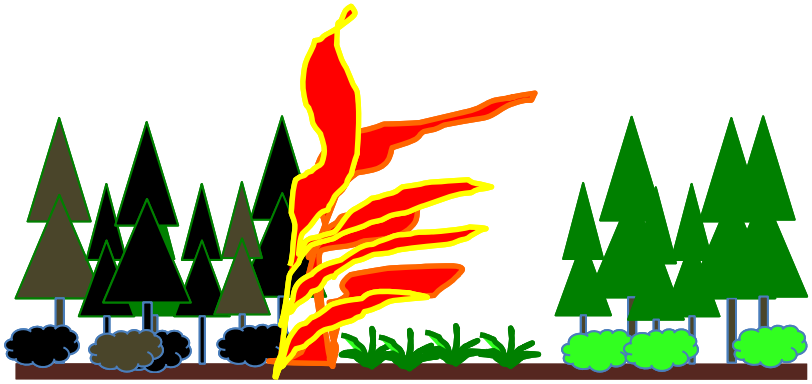
⇒ >40% increase in top 1% fire size

⇒ Compensating Change in hours of Santa Ana conditions required: -45%

How does climate change impact fuel treatment effectiveness in southern California?

- Climate change will increase future (mid-21st century) extreme fire conditions
  - Increased flame length and fireline intensity
- Current treatment strategies will not be sufficient to mitigate future fire behavior
- Fuel treatment effectiveness will improve with:
  - Larger, wider treatments
  - Lower tree/fuel density (remove more fuel)
  - More frequent maintenance

95th percentile flame length for historic period (1970-2000)



95th percentile flame length for mid-21st century (2040-2060)

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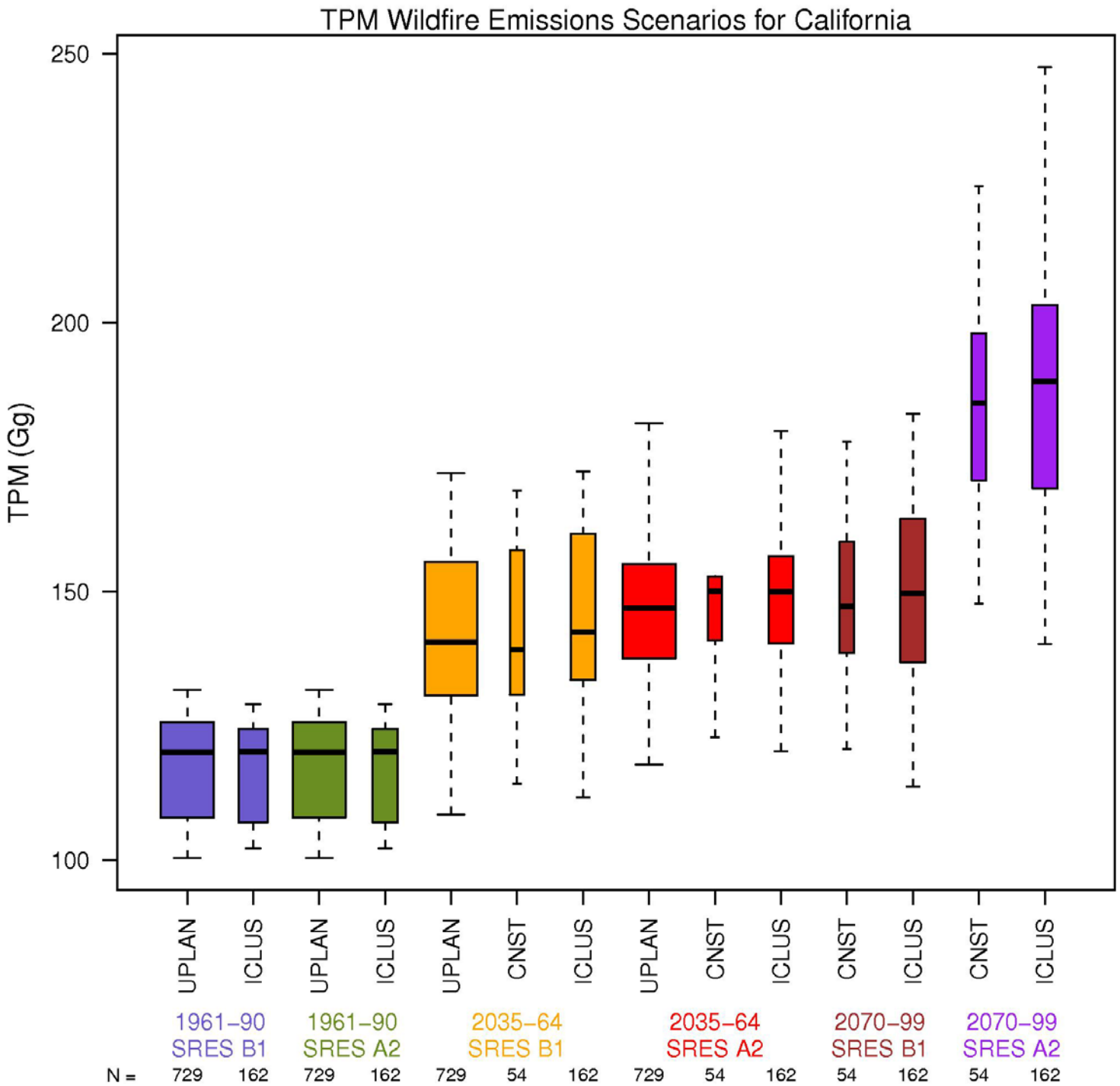
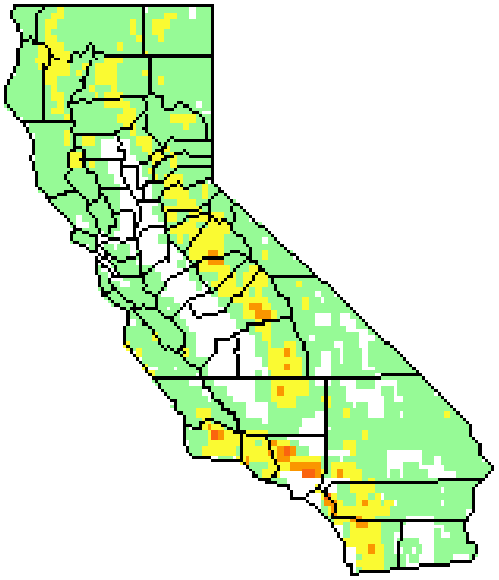
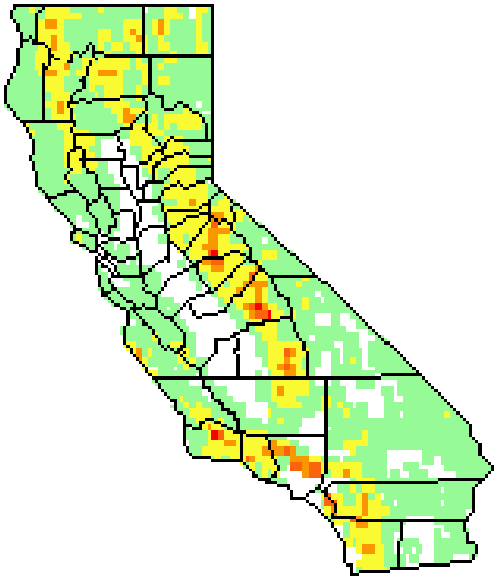

TPM Wildfire Emissions Scenarios for California
TPM (Gg)
250
200
150
100
UPLAN
ICLUS
UPLAN
ICLUS
UPLAN
CNST
ICLUS
UPLAN
CNST
ICLUS
CNST
ICLUS
CNST
ICLUS
1961–90
SRES B1
1961–90
SRES A2
2035–64
SRES B1
2035–64
SRES A2
2070–99
SRES B1
2070–99
SRES A2
N =
729
162
729
162
729
54
162
729
54
162
54
162
54
162

Average annual wildfire CO2 Emissions

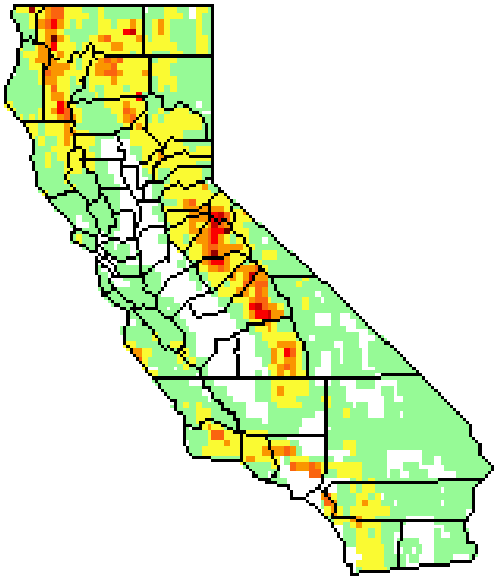
Historic

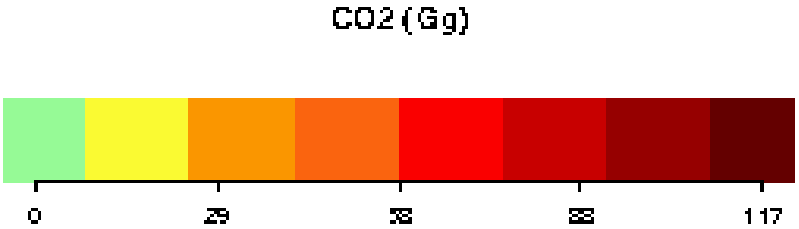


Low Warming

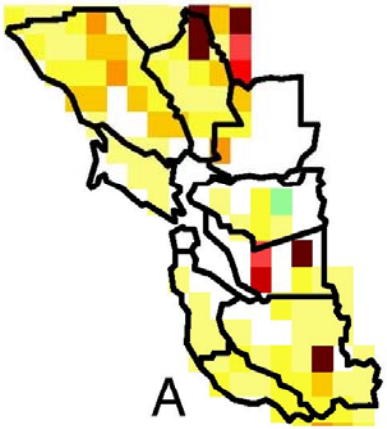


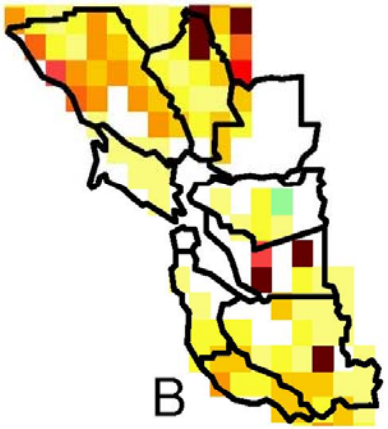
Moderate Warming





A:
low growth,
low climate,
low sprawl,
Low $ wui





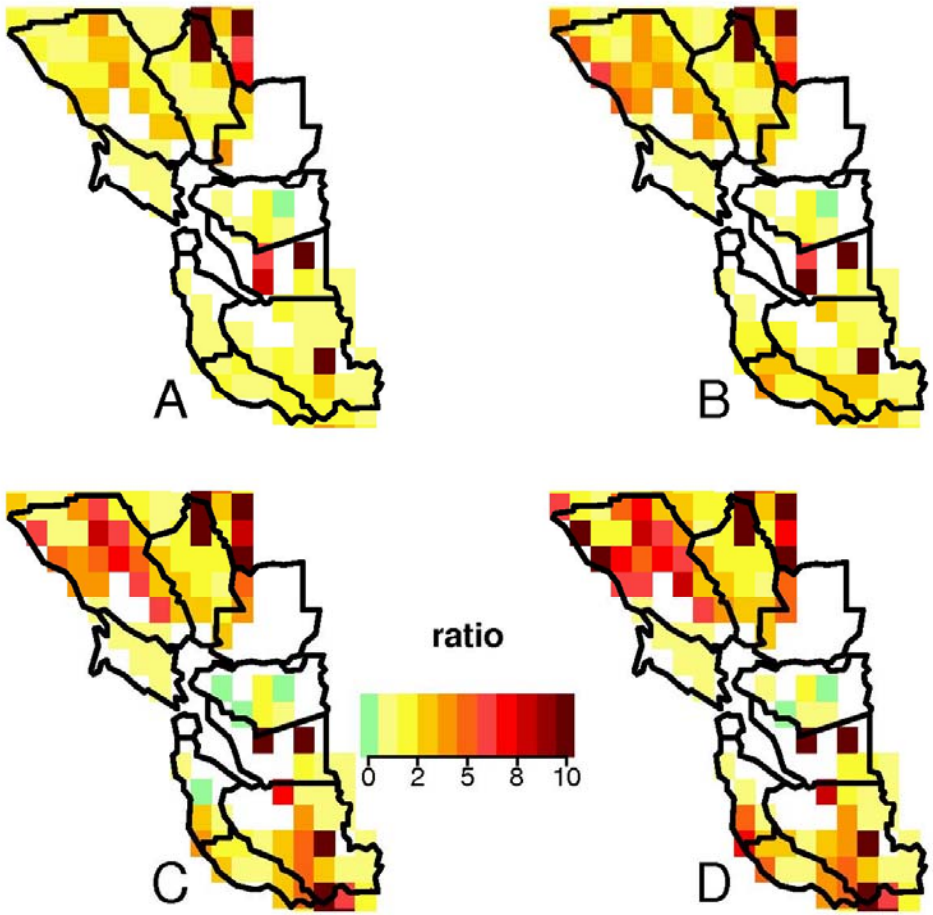
B:
low growth,
high climate,
low sprawl,
Low $ wui

A:
low growth,
low climate,
low sprawl,
Low $ wui

B:
low growth,
high climate,
low sprawl,
Low $ wui

C:
high growth,
low climate,
low sprawl,
low $ wui

D:
high growth,
high climate,
low sprawl,
low $ wui

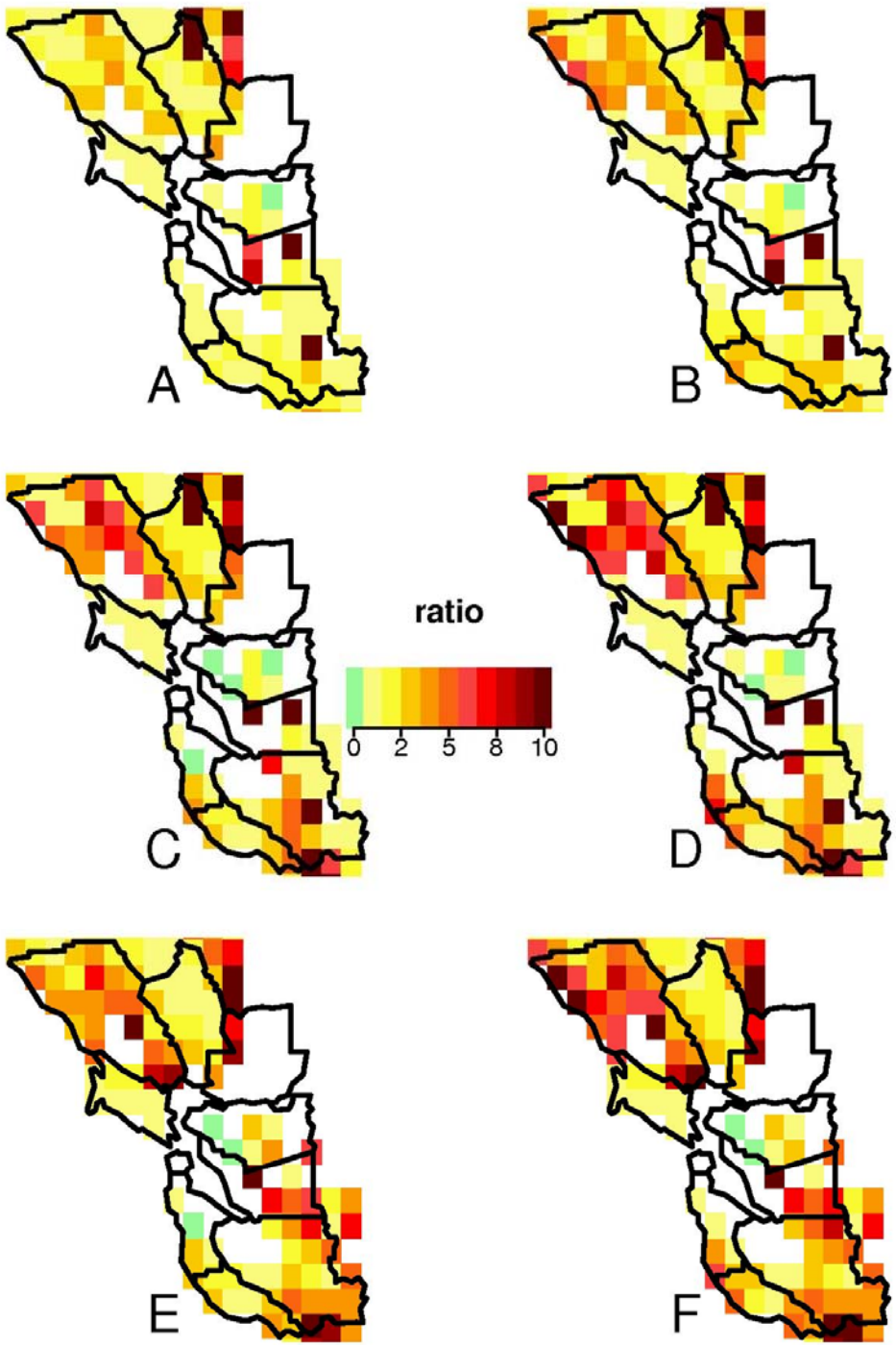


A:
low growth,
low climate,
low sprawl,
Low $ wui

B:
low growth,
high climate,
low sprawl,
Low $ wui

C:
high growth,
low climate,
low sprawl,
low $ wui

D:
high growth,
high climate,
low sprawl,
low $ wui

E:
high growth,
low climate,
high sprawl,
high $ wui

F:
high growth,
high climate,
high sprawl,
high $ wui