Developing new wildfire scenarios for the energy sector:
a proposed approach

27 February 2015, California Energy Commission, Sacramento, CA

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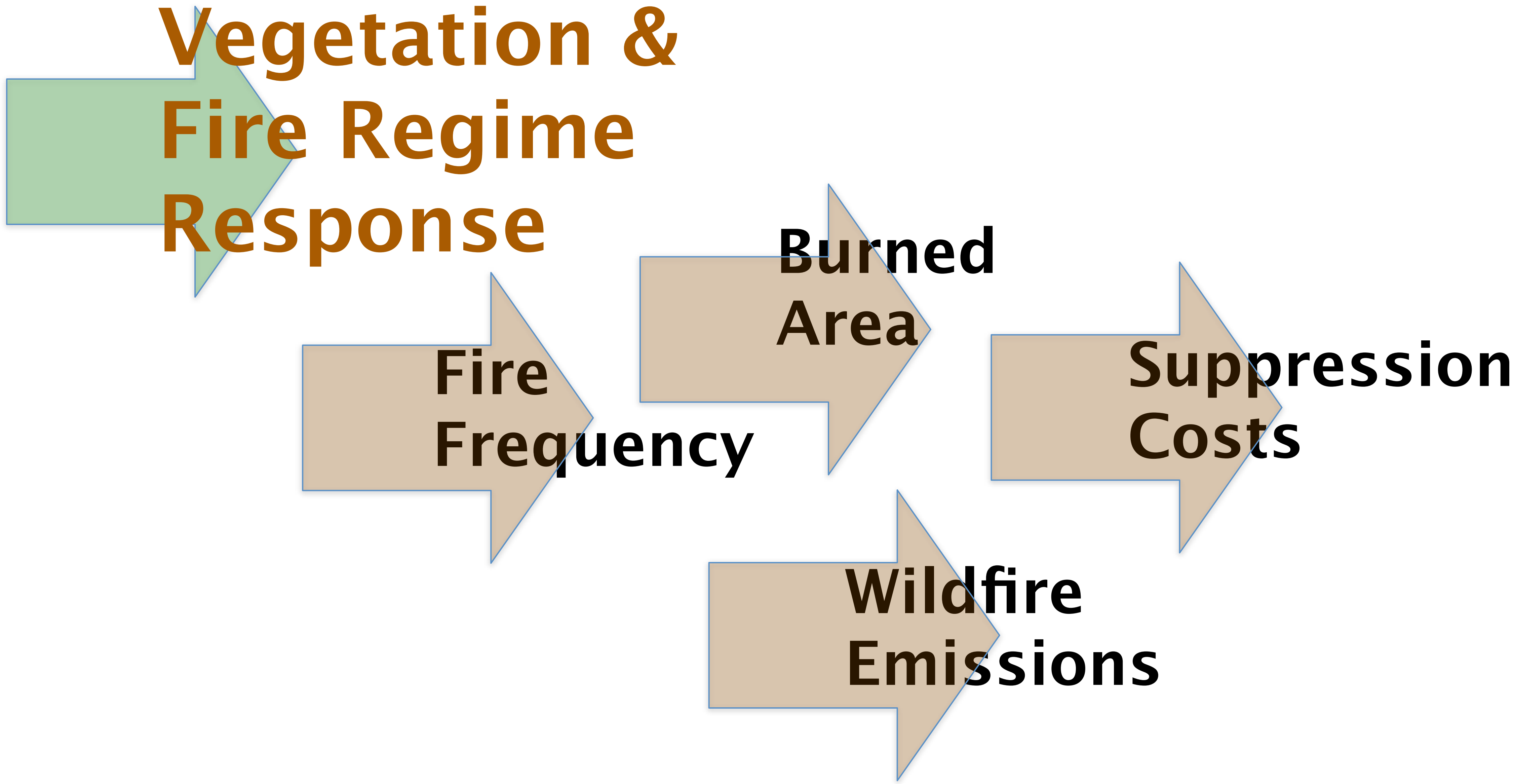
Climate Variability & Landsurface Characteristics



Probabilistic statistical modeling framework

Expected(Area) = P(fire | X) * N(fire | X) * Area(fire | X)

- P(fire | X) ← binomial
- N(fire | X) ← poisson
- Area(fire | X) ← generalized pareto

Probabilistic statistical modeling framework

Expected(Area) = P(fire | X) * N(fire | X) * Area(fire | X)

Expected(Costs) = f(Expected(Area), X)

Expected(Emissions) = Expected(Area) * g/Area

Probabilistic statistical modeling framework

P(fire | X) N(fire | X) Area(fire | X)

Fire Presence/ Absence	Conditional Fire Number	Conditional Burned Area
Logit Model	Poisson Lognormal	Generalized Pareto
Temperature Precipitation Moisture Deficit Topography FRCC** Ownership** (new: biomass/species	Temperature Precipitation Moisture Deficit Topography FRCC** Ownership** (new: biomass/species	Moisture Deficit Topography FRCC** (new: biomass/species
Grid/Month	Grid/Month/Presence	Grid/Month/Fire

Global Climate Models and Scenarios

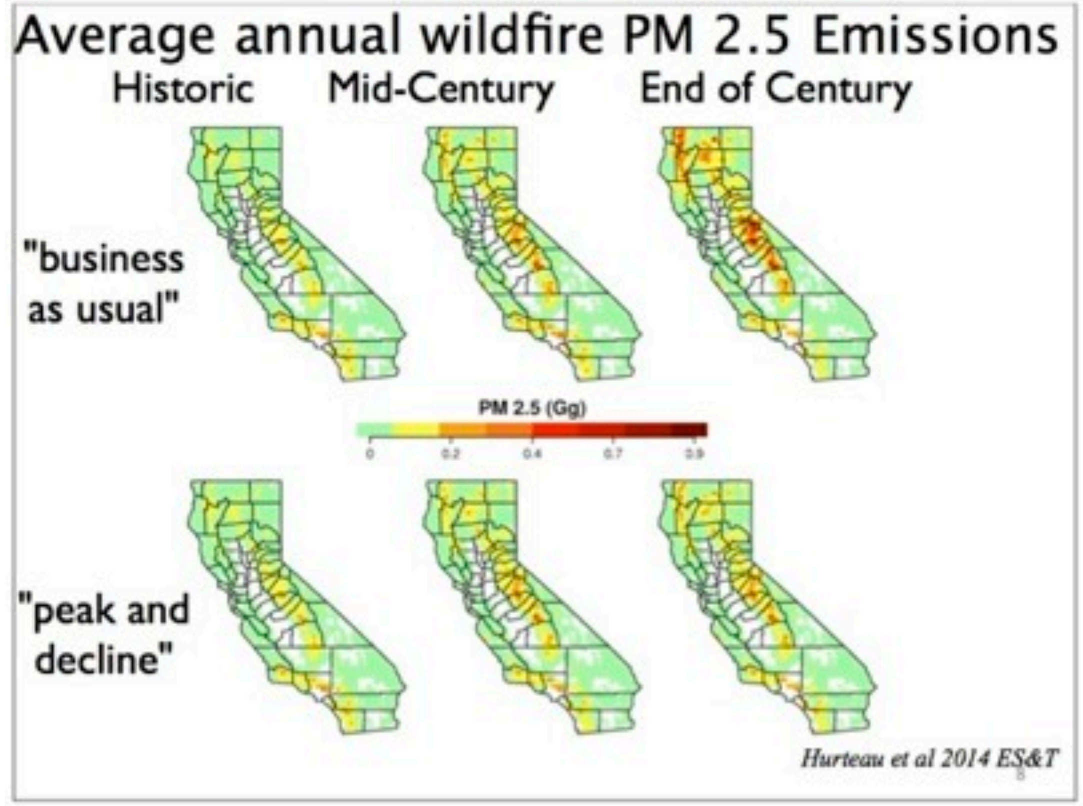
RCP 8.5 & 4.5

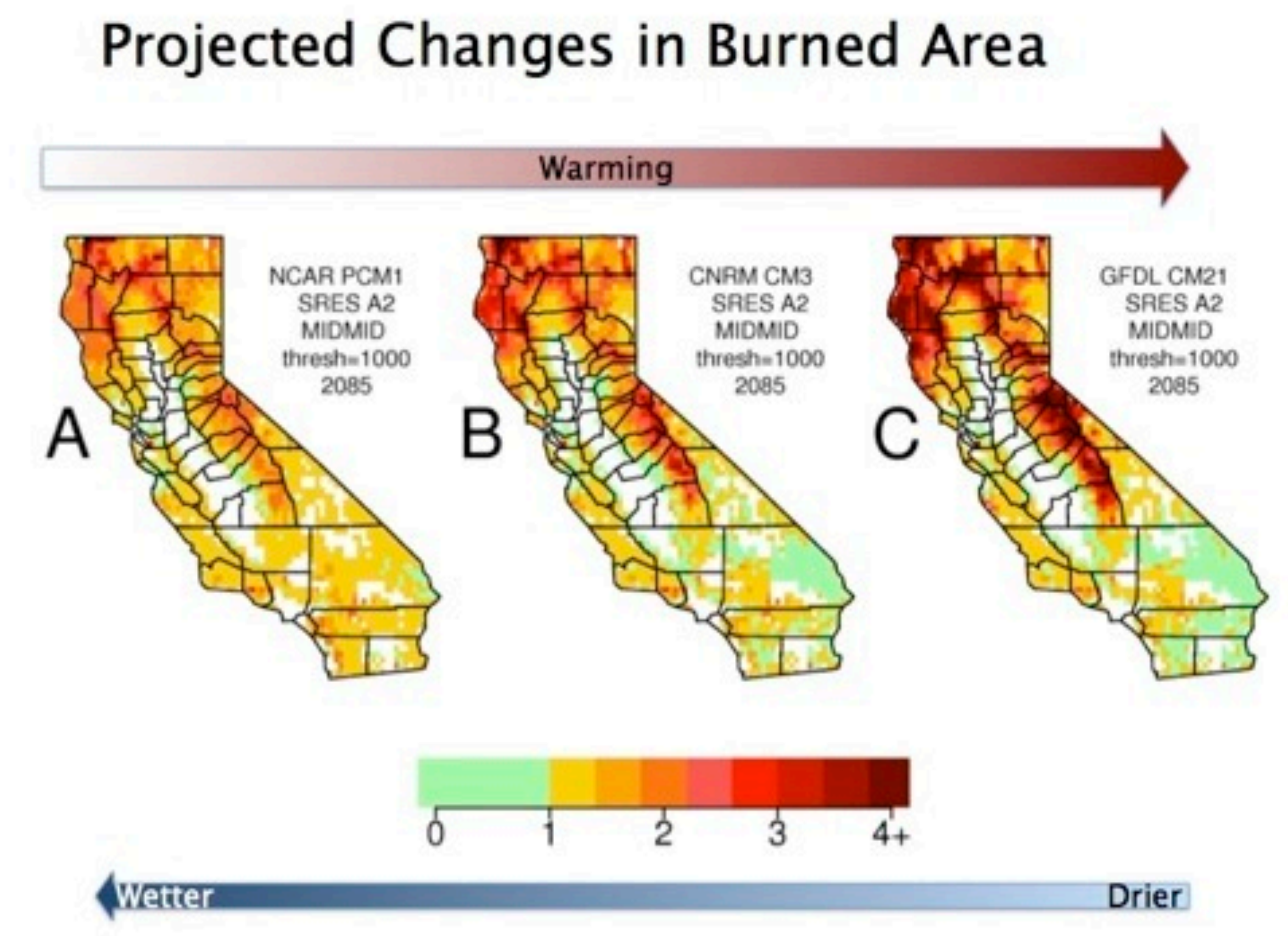
Range of GCMs

- to be selected in consultation with SIO, CEC, other stakeholders
- Important to capture the range of plausible climates,
- but also need to avoid using "too many" scenarios...
- there will be other scenario dimensions as well (demographic, fuels, vegetation, etc.)

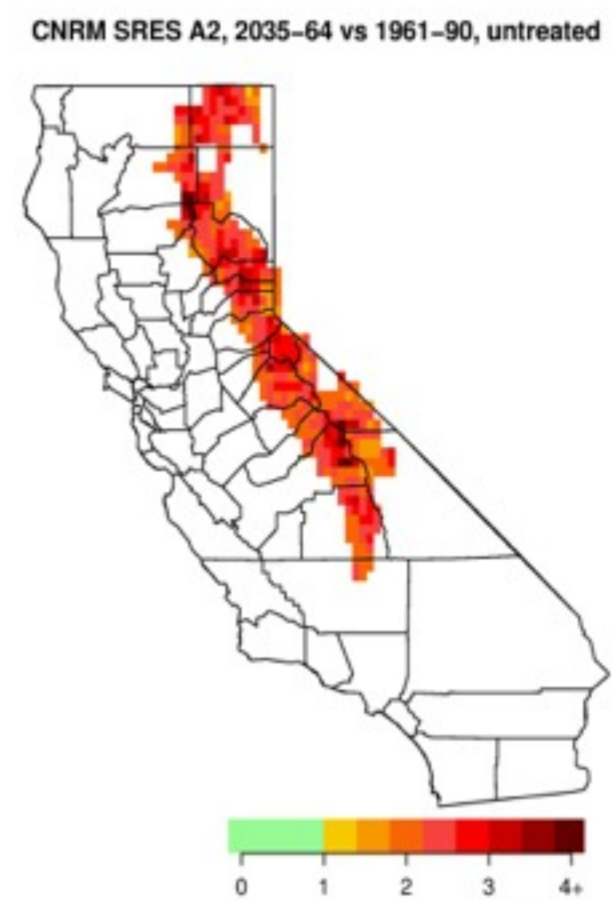
Output variables

- number of fires
- burned area
- emissions
- property risks





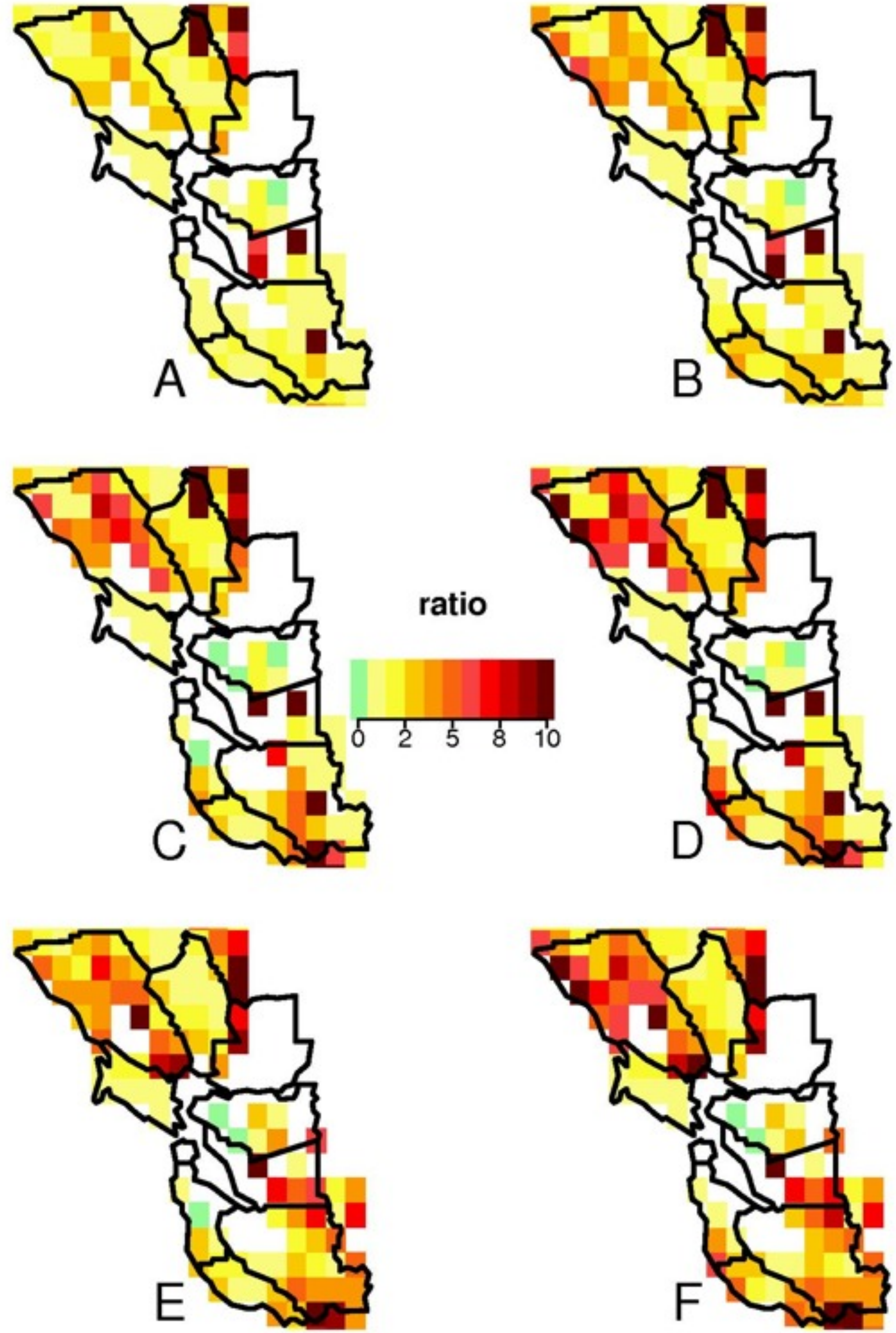
Westerling et al, Climatic Change 2011



Westerling et al, in preparation

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

Probabilistic statistical modeling framework

Original plan was 1/8 – degree, with 1/16 for selected areas/scenarios

However, 1/16 is what is currently available.

1/8 degree can't be created just by aggregating the 1/16 degree downscaled climate layers.

Working at both spatial scales has drawbacks: a different suite of models has to be estimated and tested for use with each spatial resolution.

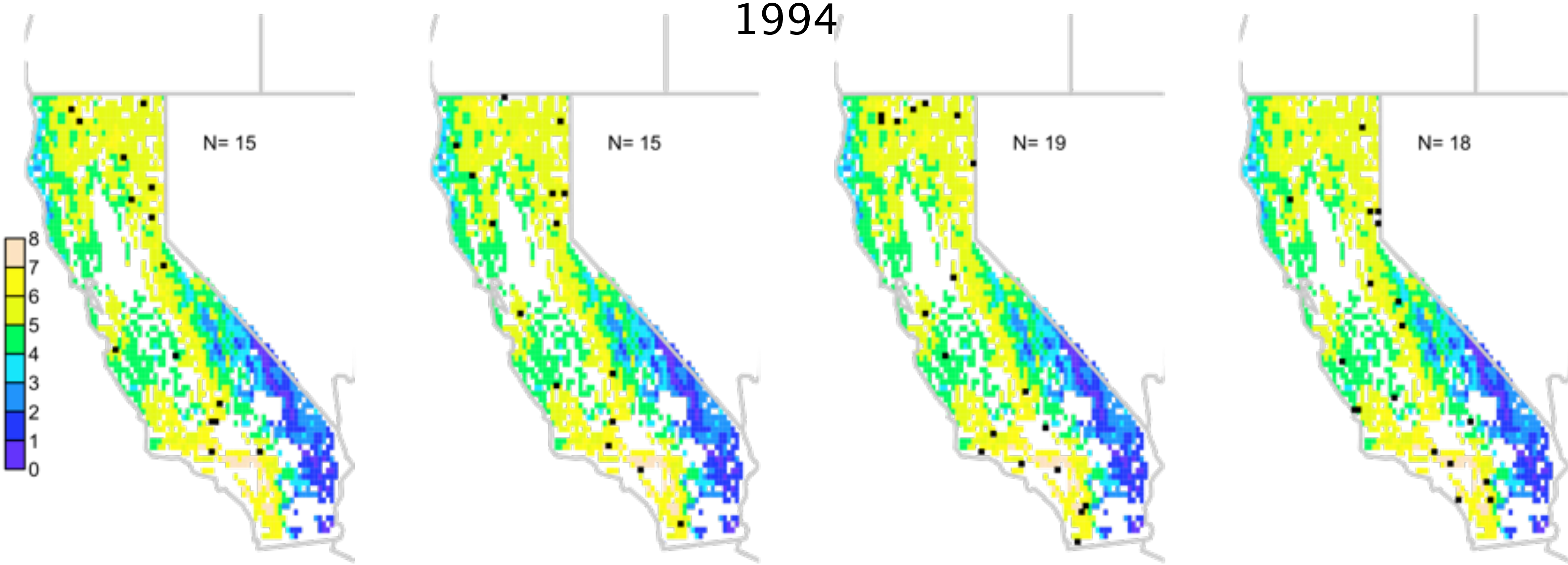
We could do all 1/16th degree, but this would likely require that we process fewer scenarios.

Stochastic simulations

Repeated random draws are made from fire presence, number and size distributions to simulate a range of outcomes possible for a given scenario.

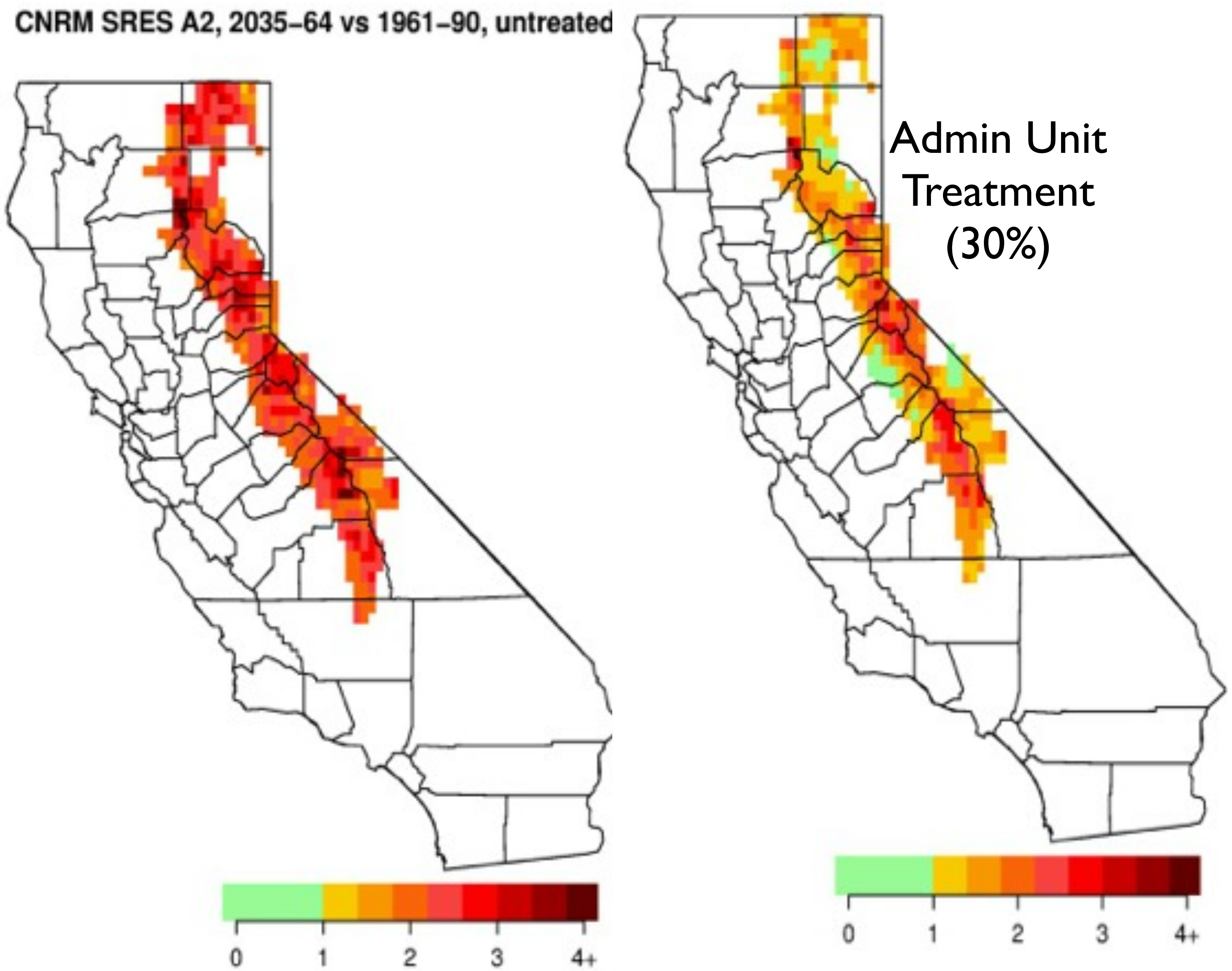
Large Fire Occurrence Forecasts: Simulation vs Observation

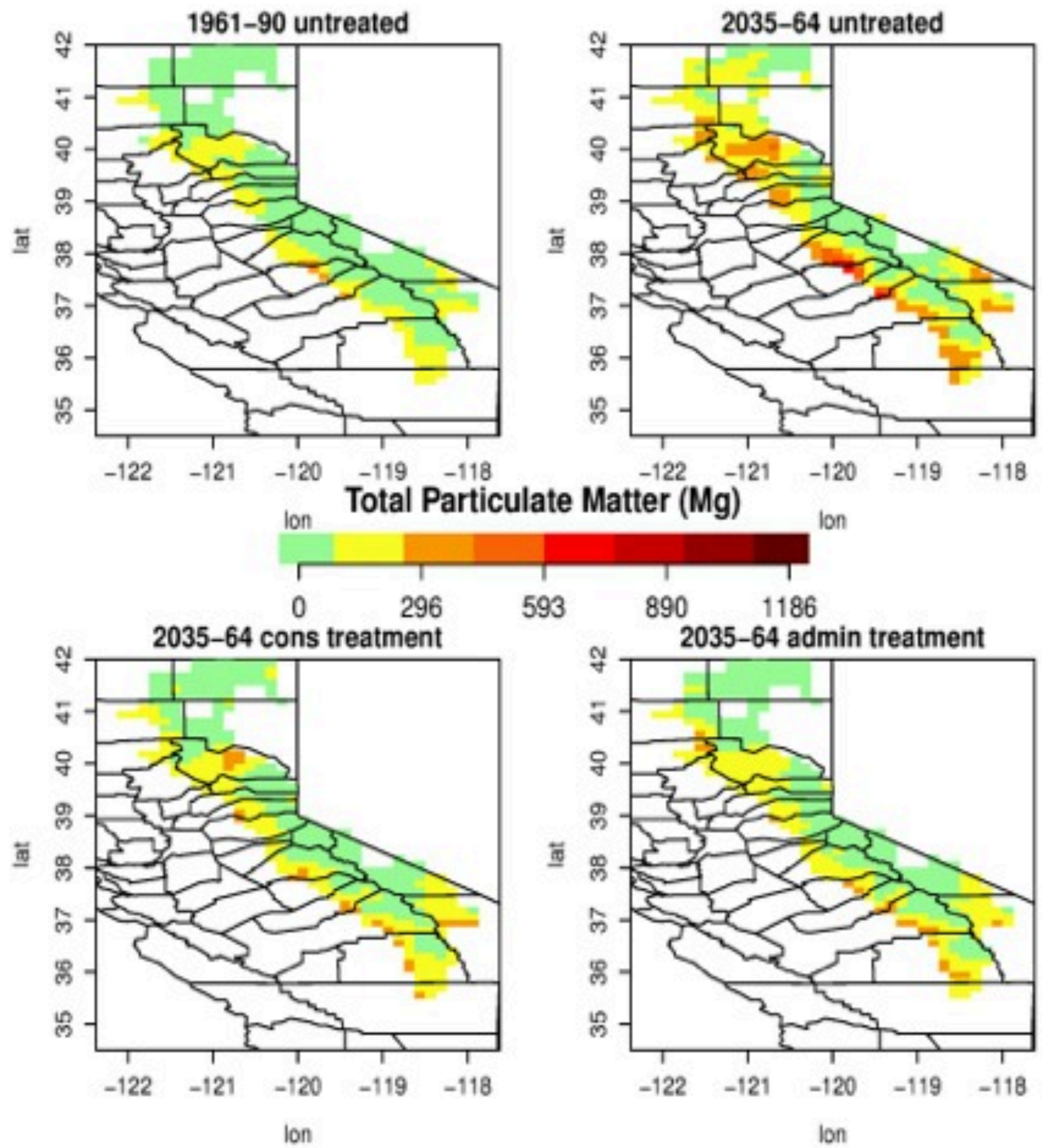
1994



Fuels Management Scenarios

- Forest service fuels scenarios for Sierra Nevada
- Fuels conditions affect fire size distributions





Population and Development Scenarios

Integrated Climate and Land Use Scenarios developed by EPA (ICLUS, US EPA 2009) based on the work of Theobald (2005)

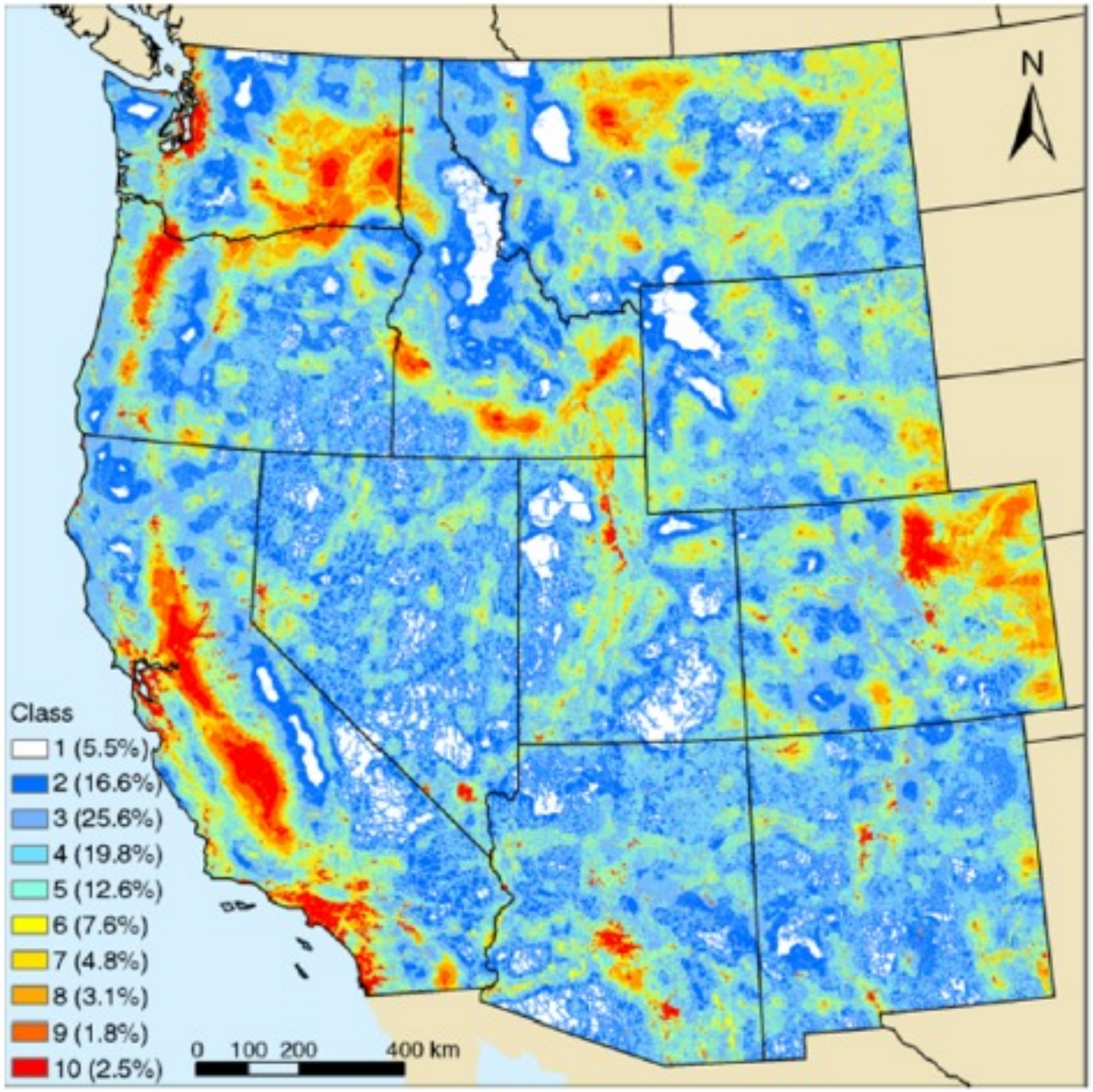
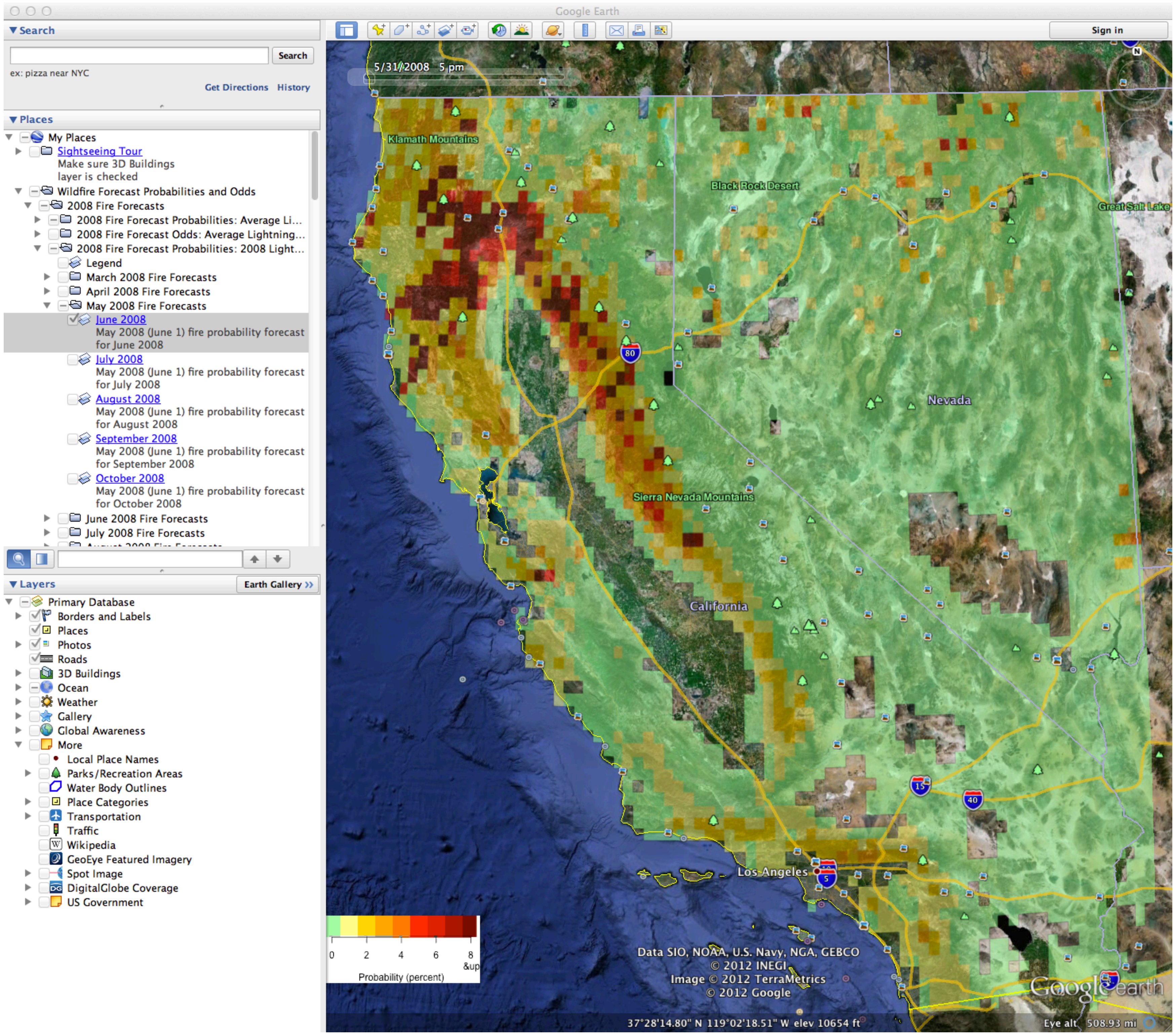


FIG. 3. The human footprint in the western United States in 2001. Human footprint intensity ranges from minimal (class 1, white) to high (class 10, red). The percentage of land covered by each human footprint class within the western United States is provided in parentheses as part of the figure key.

Data Formats and Dissemination

KMZ, RData binary formats, table data in flat files, etc.



Integrated wildfire–vegetation scenarios for coastal southern CA

Changes in vegetation, including spread of invasive species, in response to changing wildfire and climate, and feedbacks to wildfire characteristics

Example: type conversion following fire

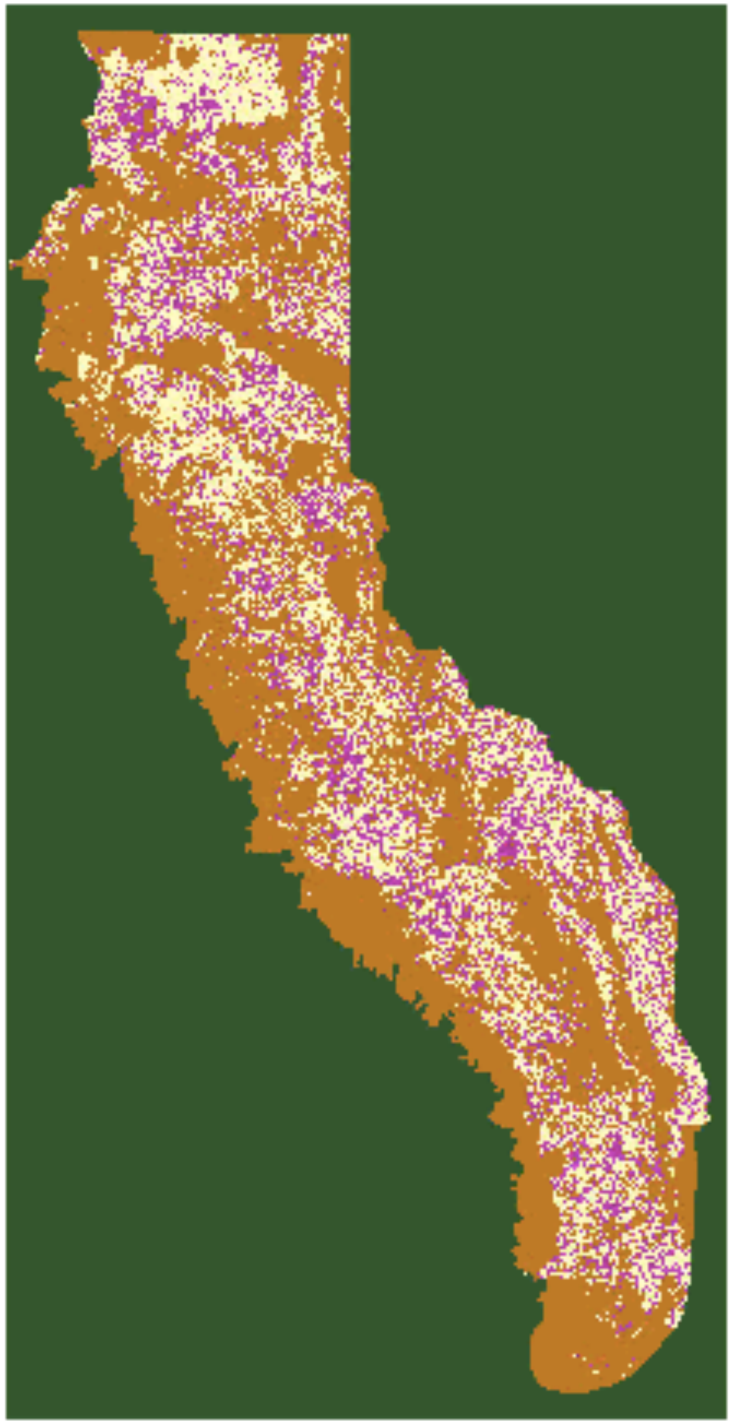
native shrubland

non-native invasive brome

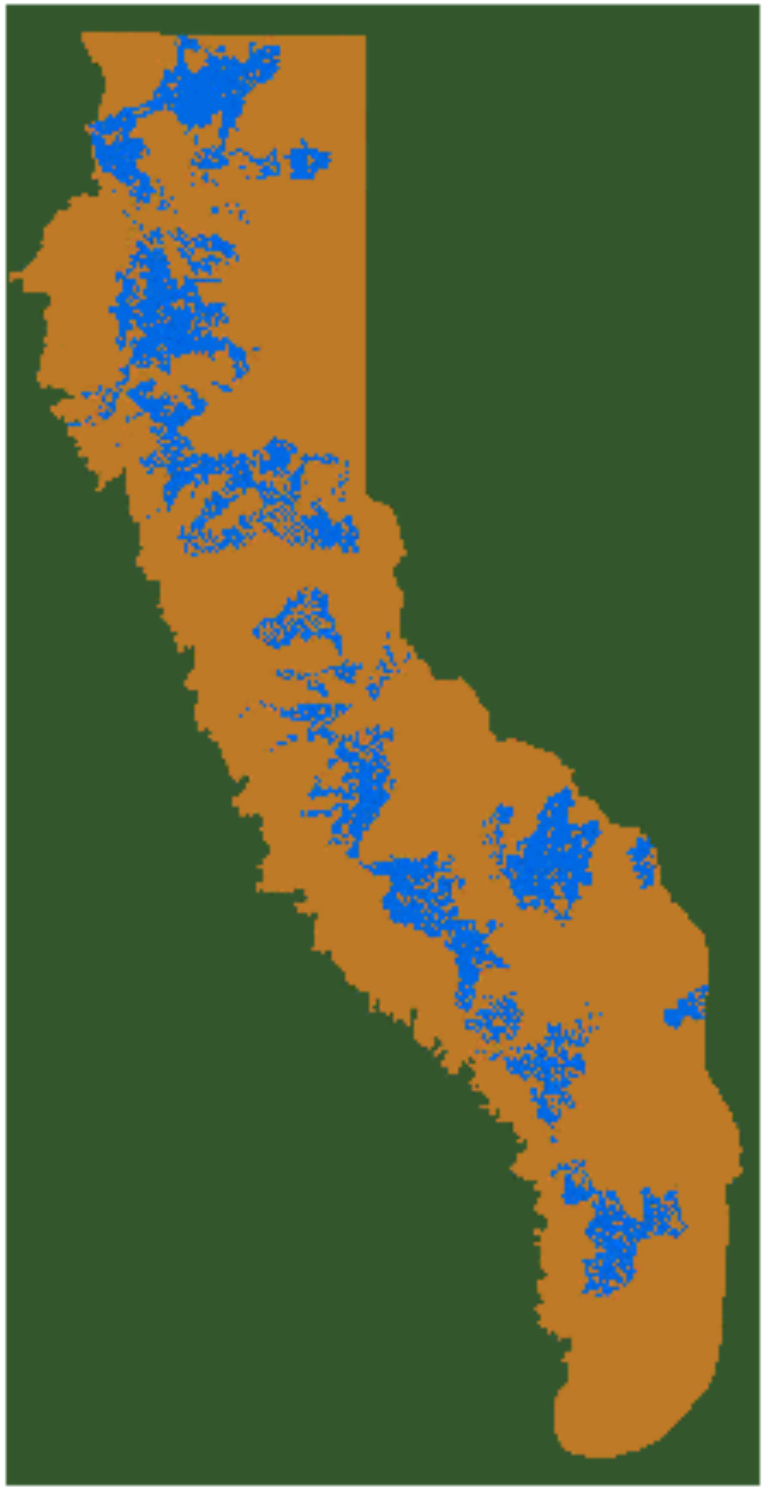
end of presentation

additional slides for question/ discussion period

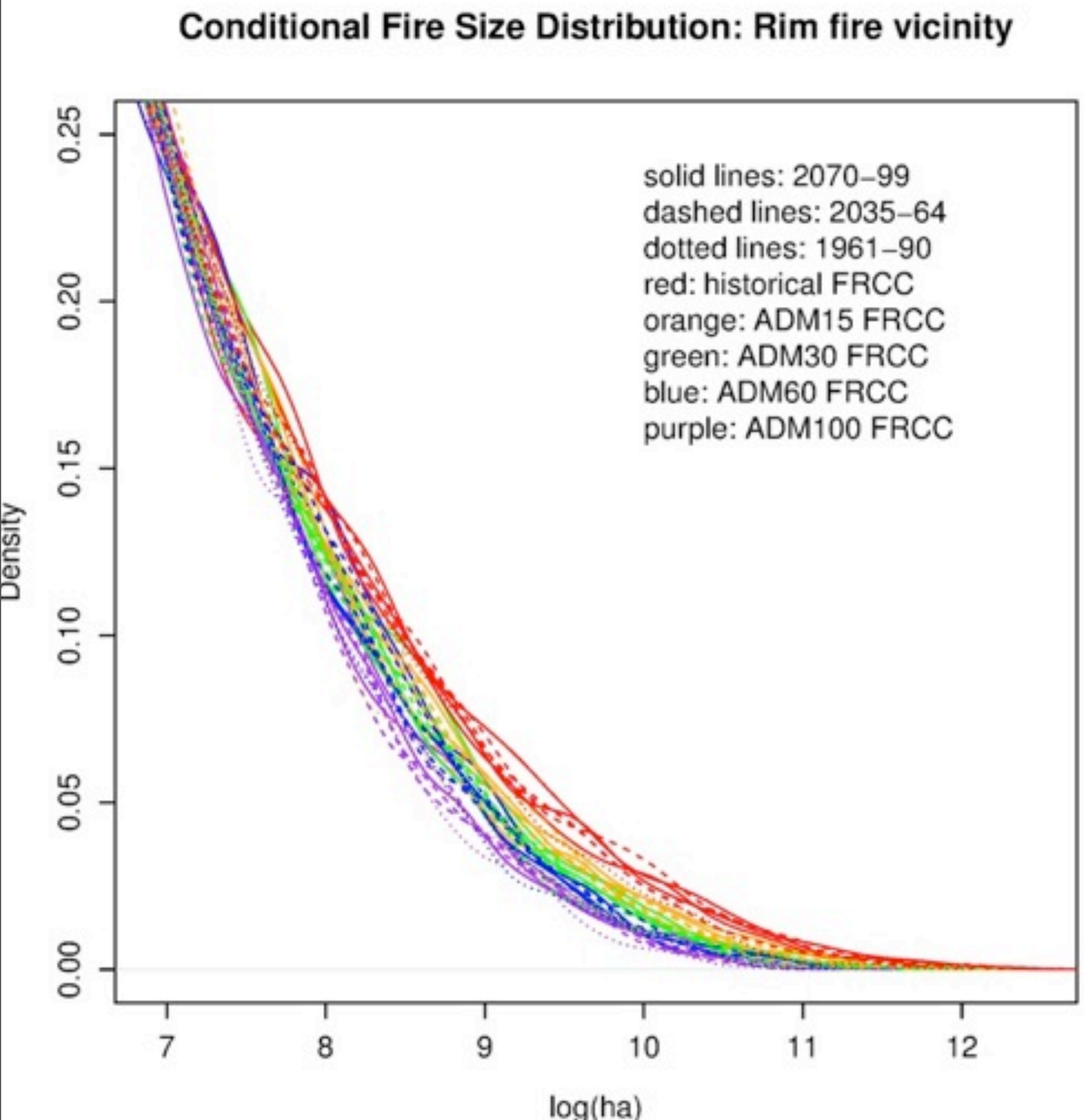
"30%" Treatment by Administrative Unit



"100%" Treatment by Conservation Objective



Provided by JoAnn Fites-Kaufman & April Brough USDA Forest Service, Region 5


Conditional Fire Size Distribution: Rim fire vicinity
solid lines: 2070–99
dashed lines: 2035–64
dotted lines: 1961–90
red: historical FRCC
orange: ADM15 FRCC
green: ADM30 FRCC
blue: ADM60 FRCC
purple: ADM100 FRCC
Density
0.00
0.05
0.10
0.15
0.20
0.25
7
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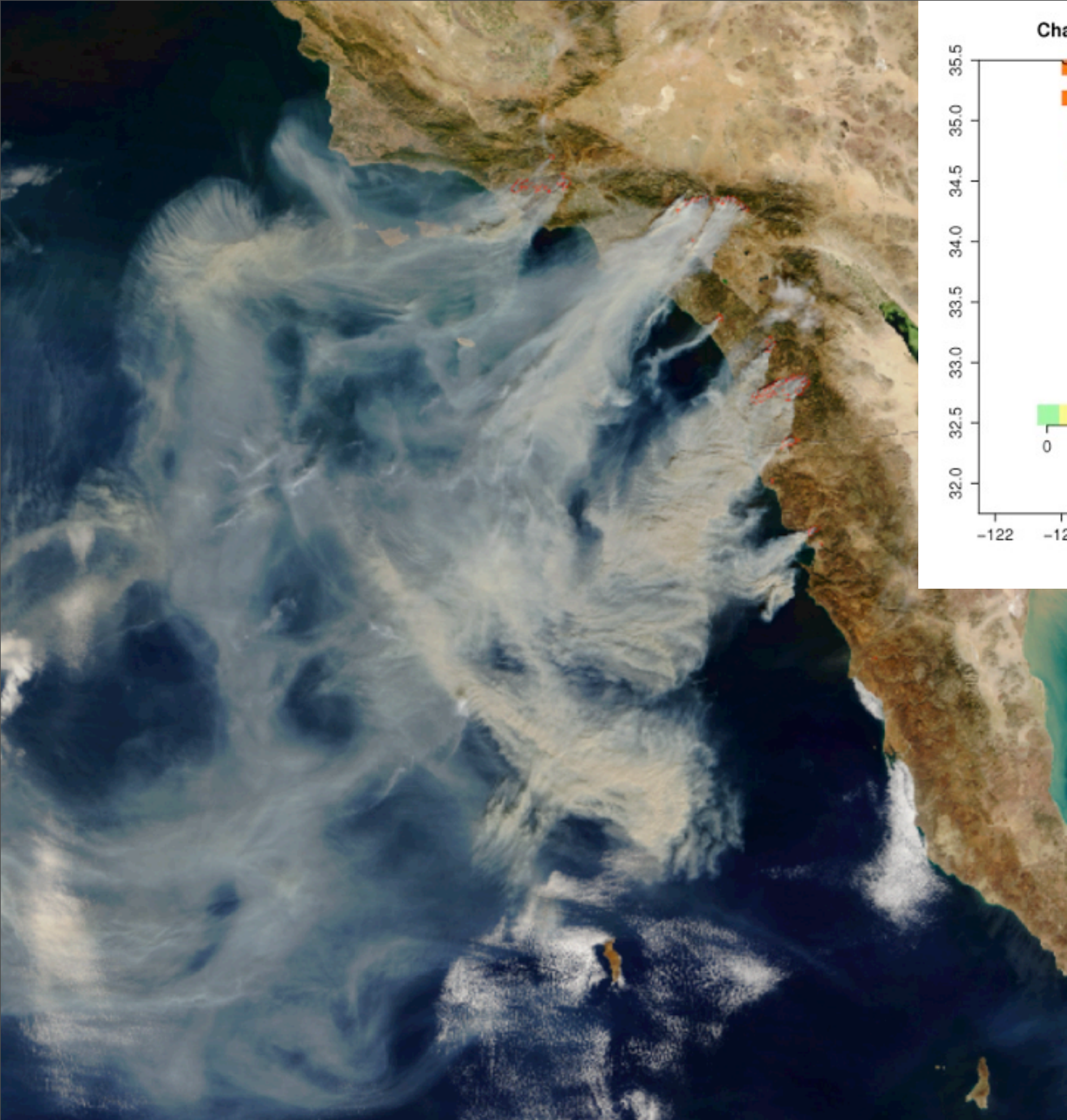
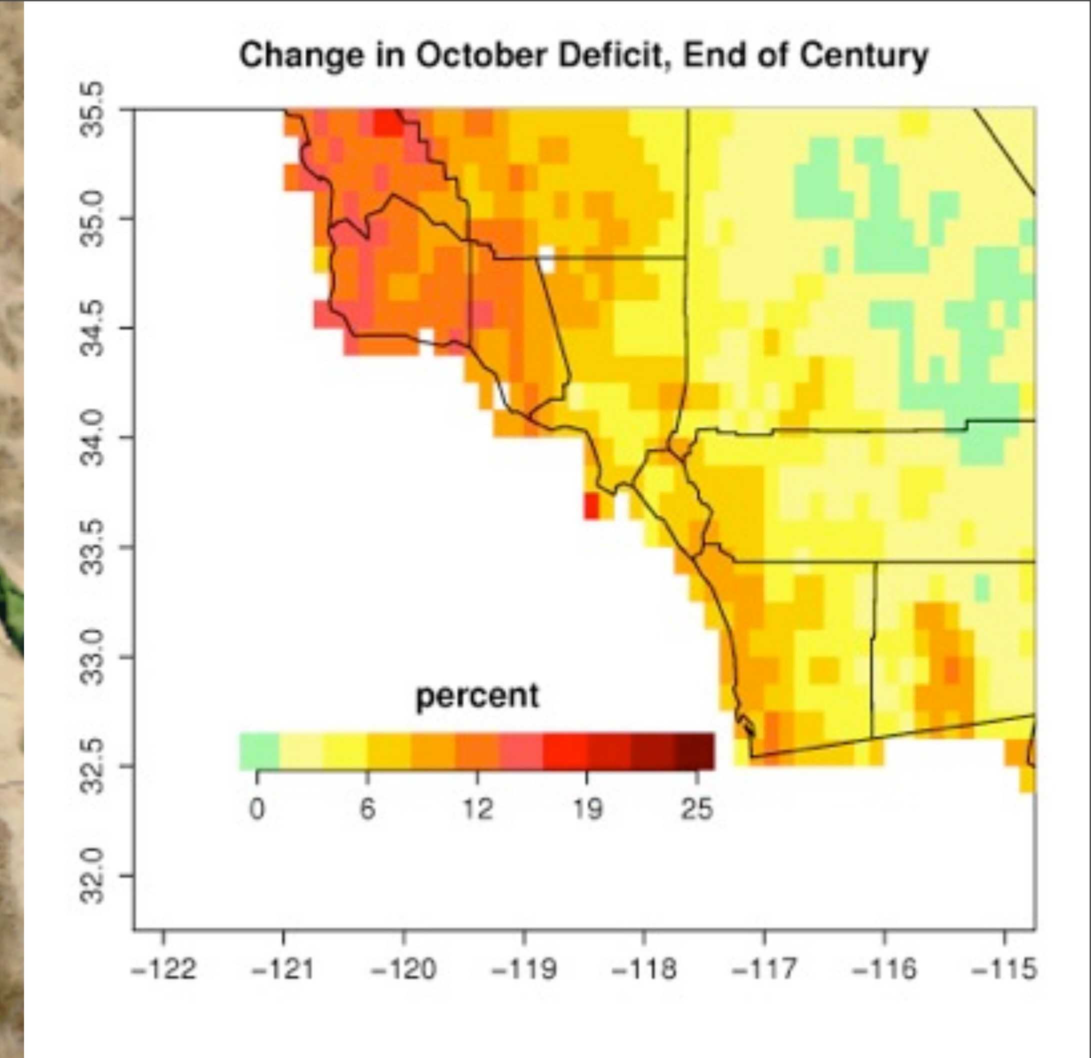
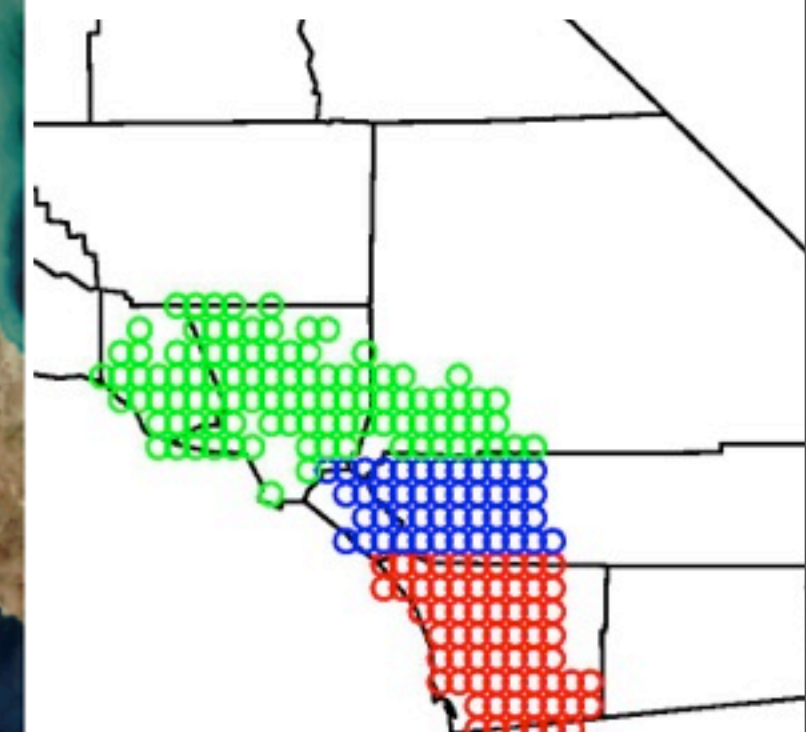
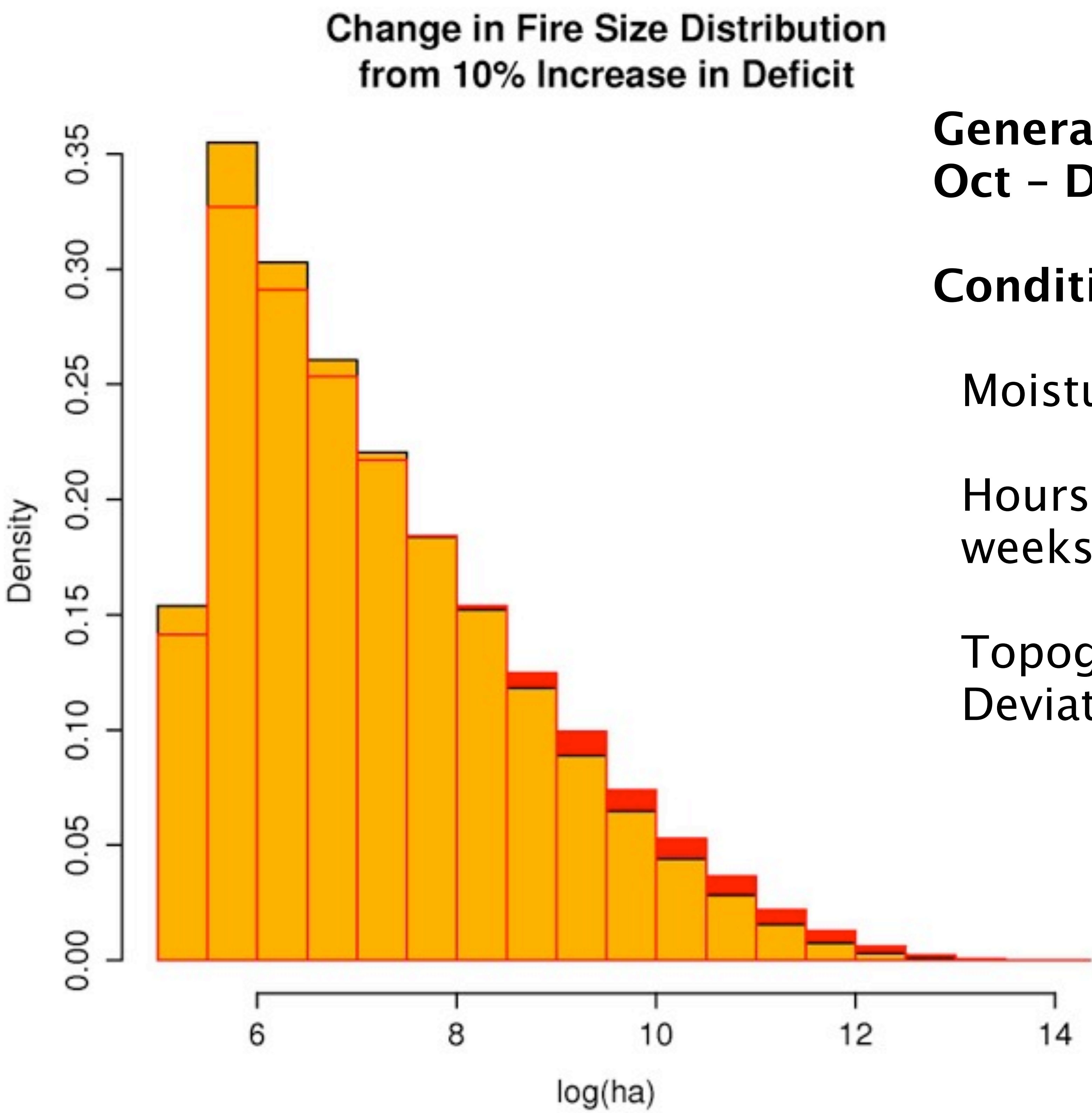
11
12
log(ha)




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





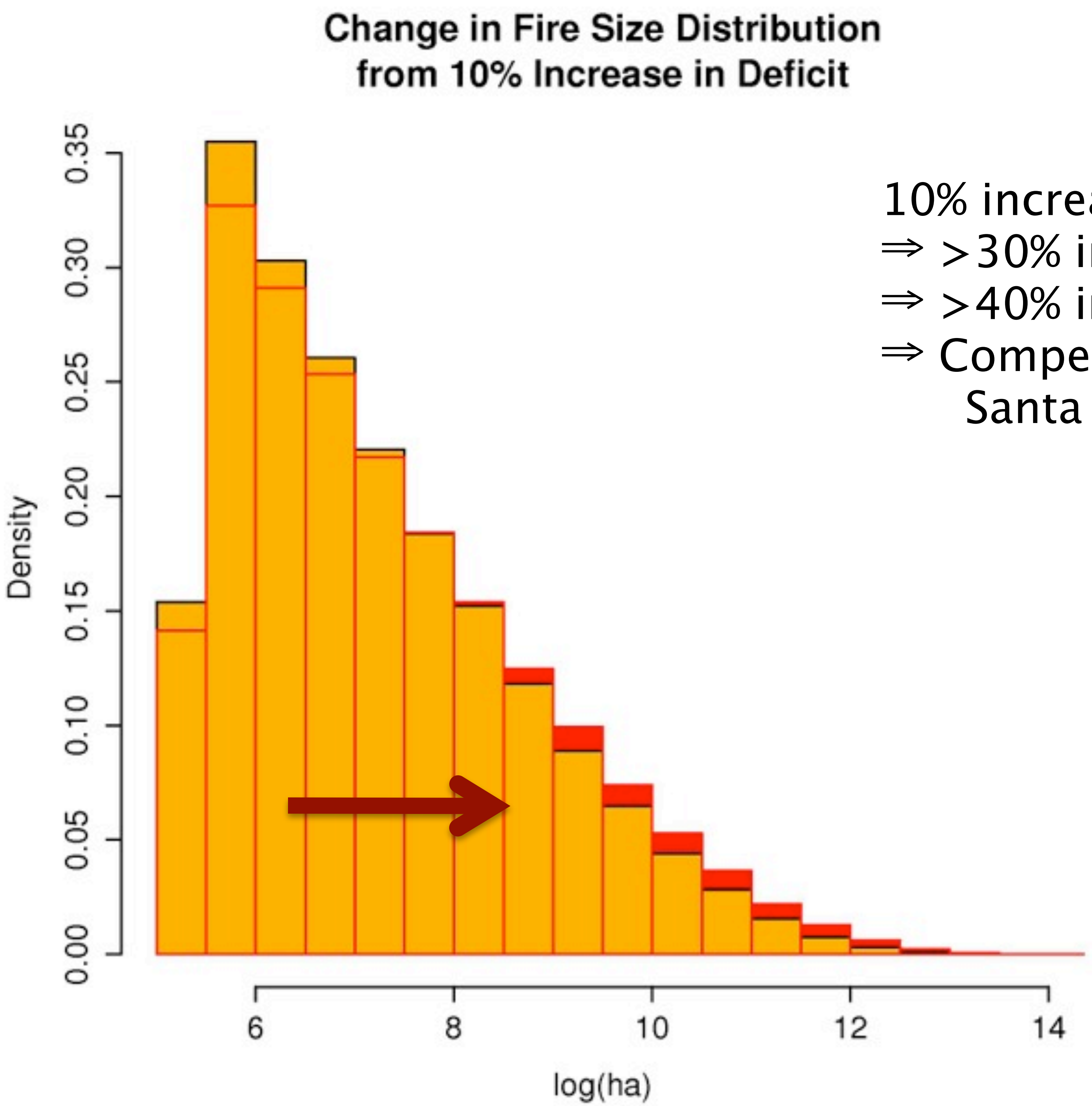
Generalized Pareto Distribution for Oct – Dec fire size

Conditional on:

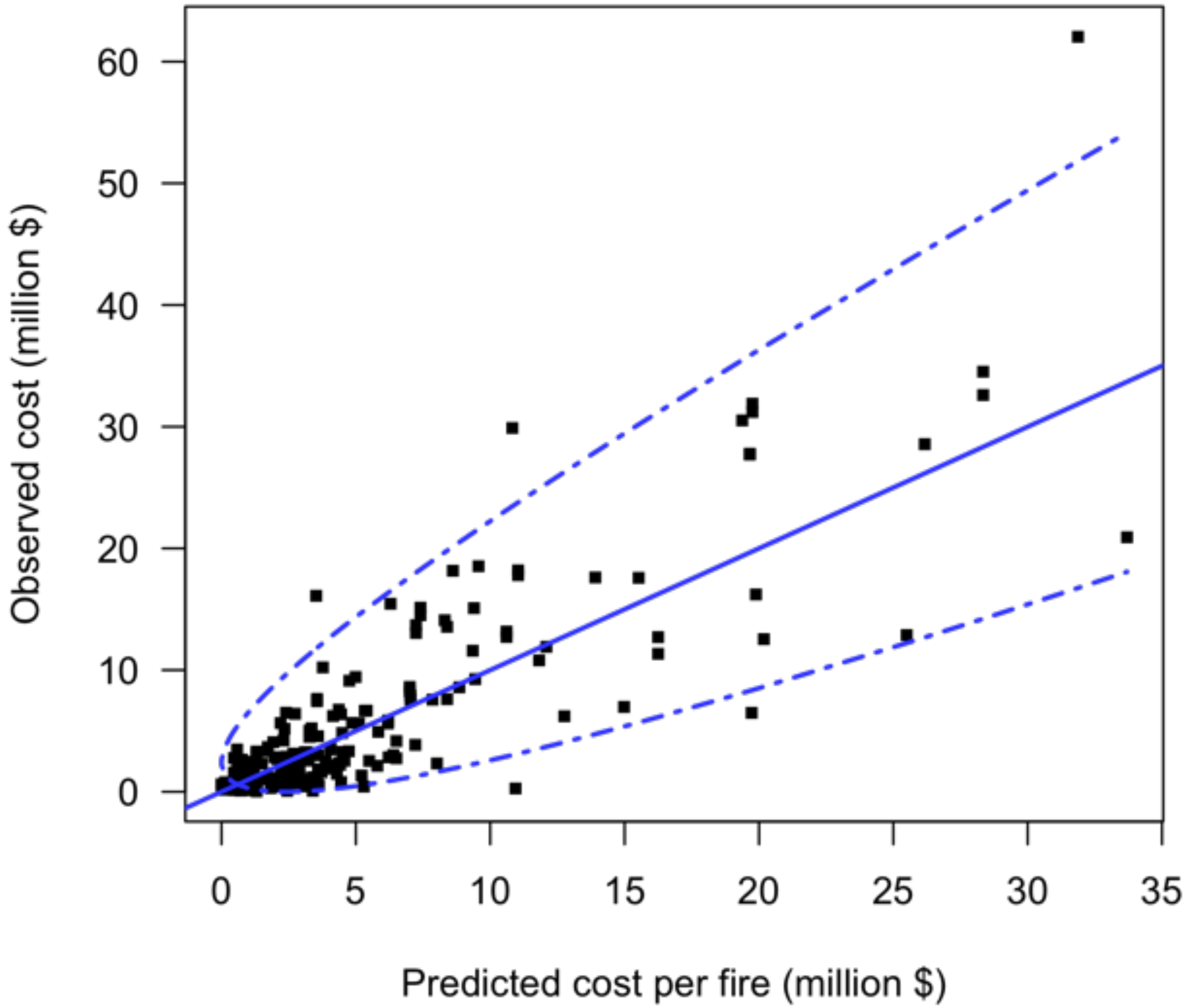
Moisture deficit

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

Topography (Aspect and Standard Deviation of Elevation)



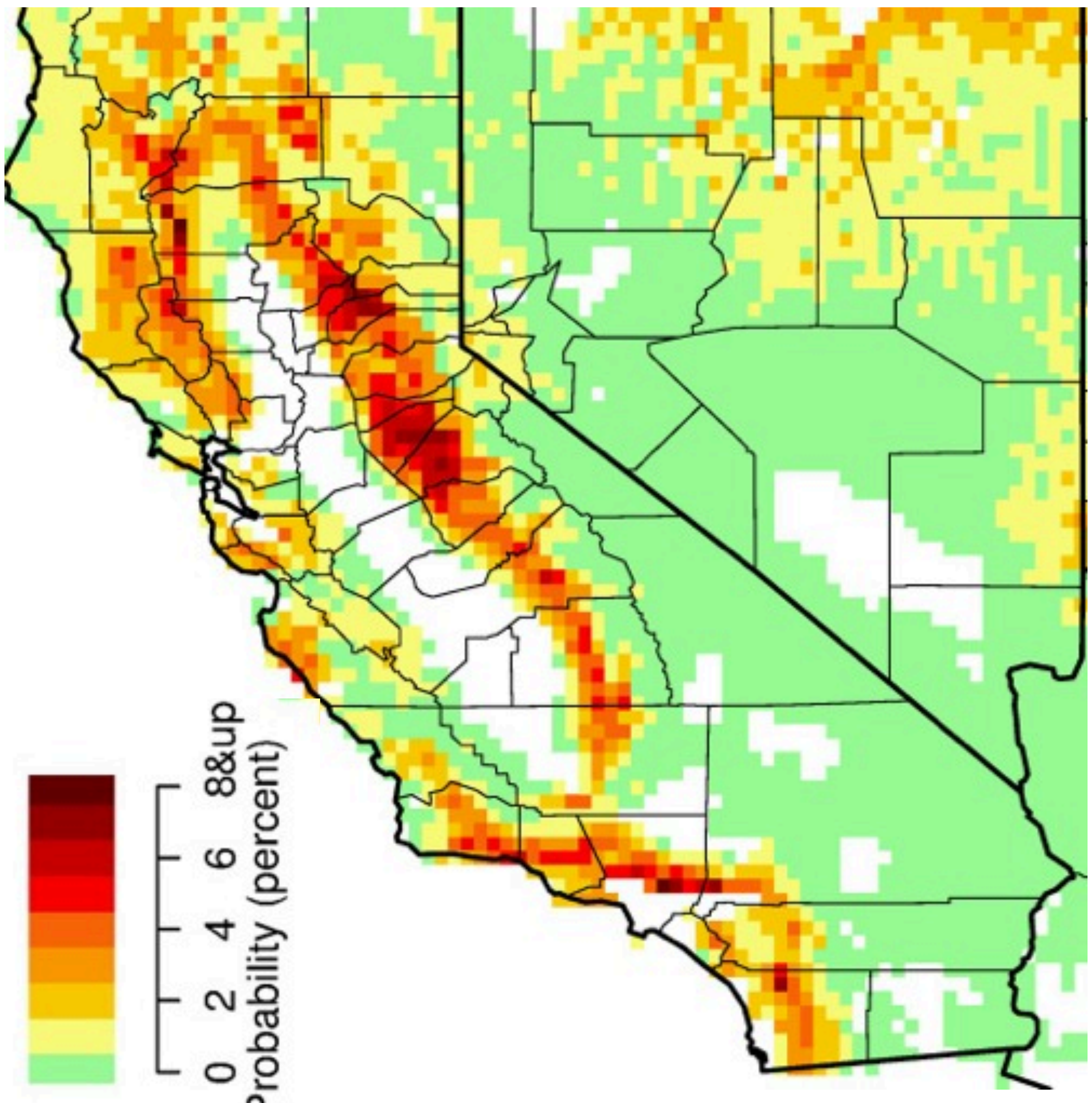
10% increase in October to December Deficit
⇒ >30% increase in average fire size
⇒ >40% increase in top 1% fire size
⇒ Compensating Change in hours of
Santa Ana conditions required: -45%



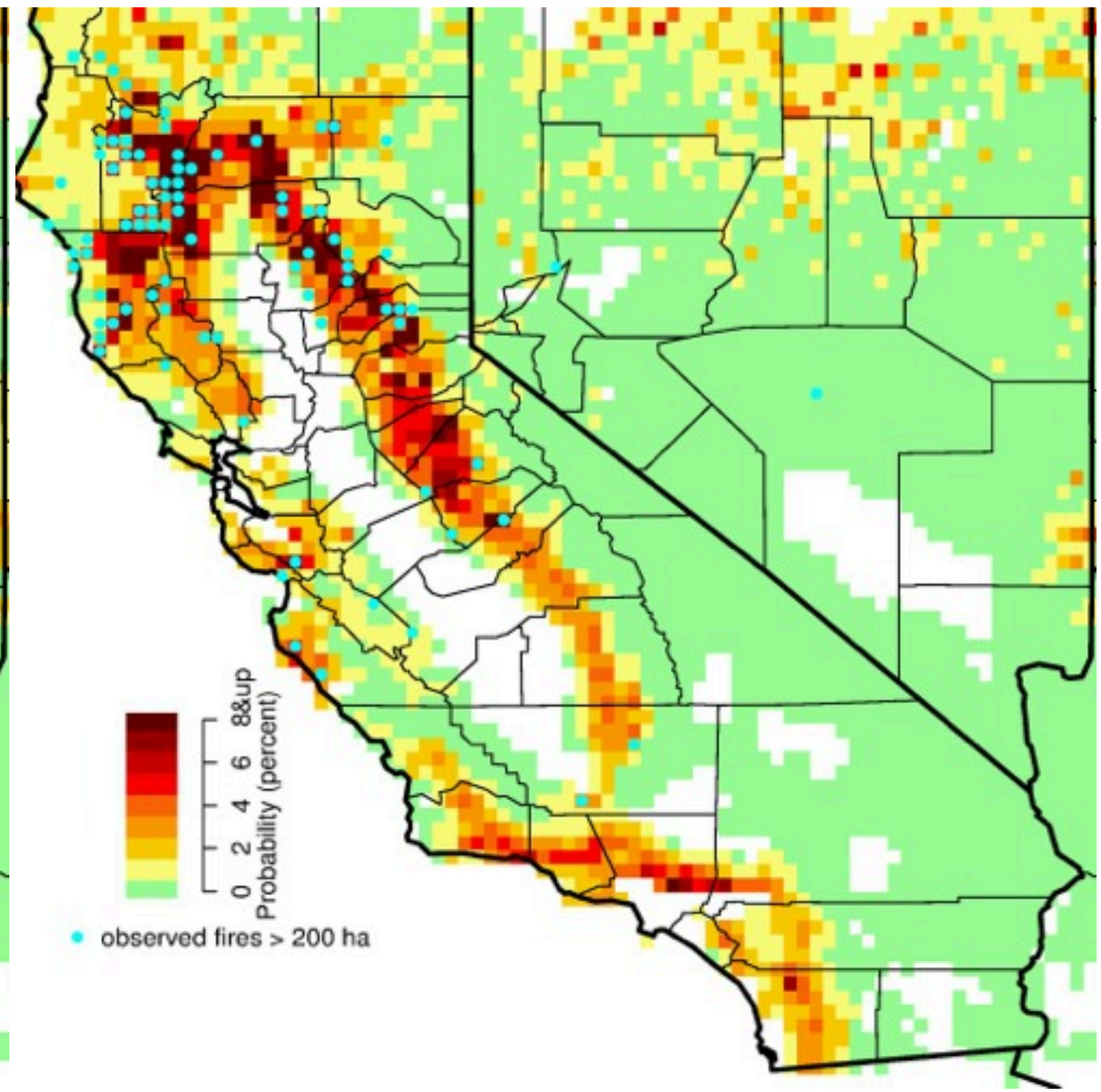
Observed versus predicted costs per fire based on fire size, elevation STD and vegetation (% forest). The dashed lines are the approximate 95% confidence bounds for expected costs under the model.

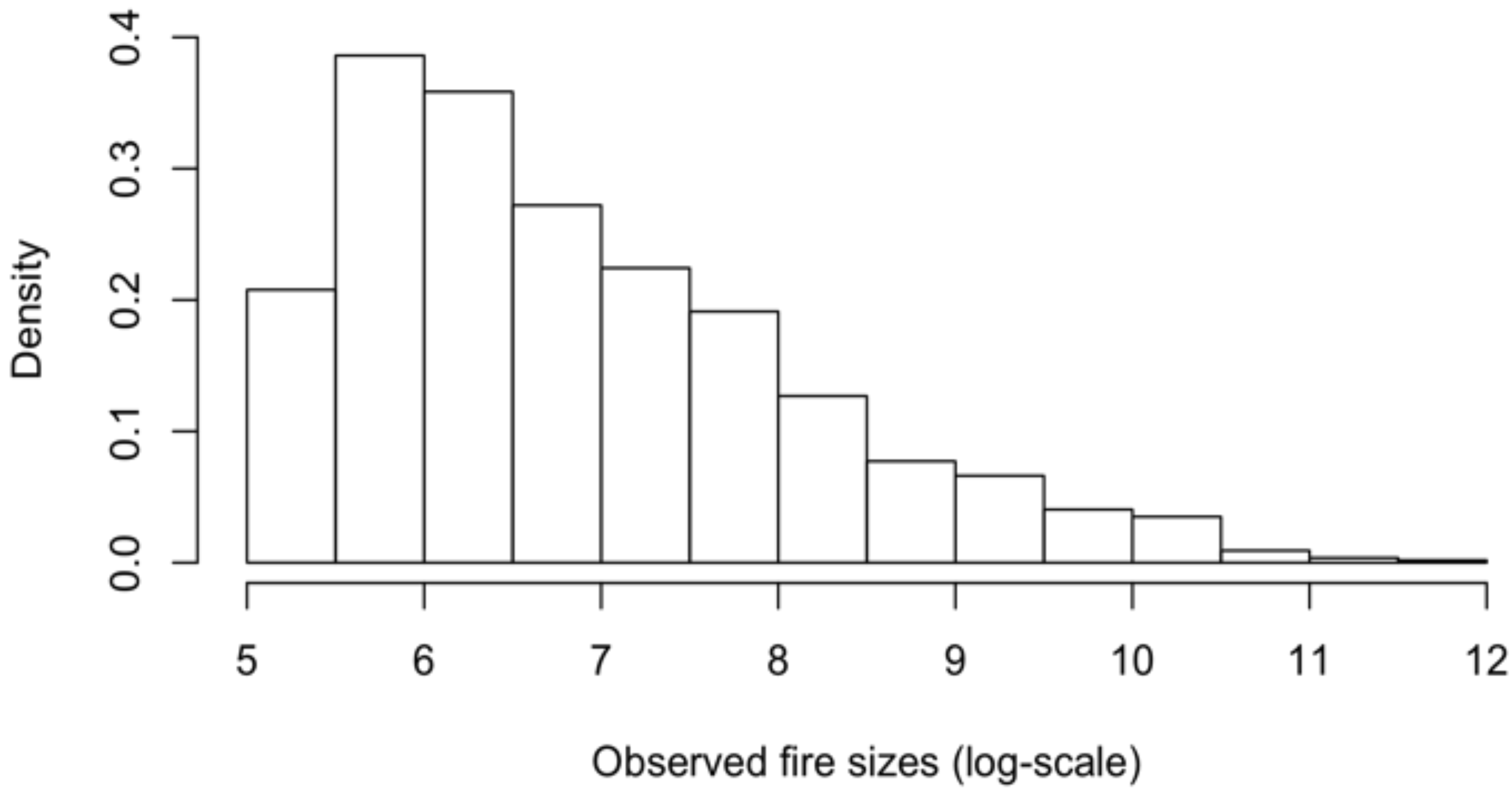
July 1 forecast of June 2008 large fire occurrence prob.

with Mean June lightning



with June 2008 lightning




Density
0.0
0.1
0.2
0.3
0.4
5
6
7
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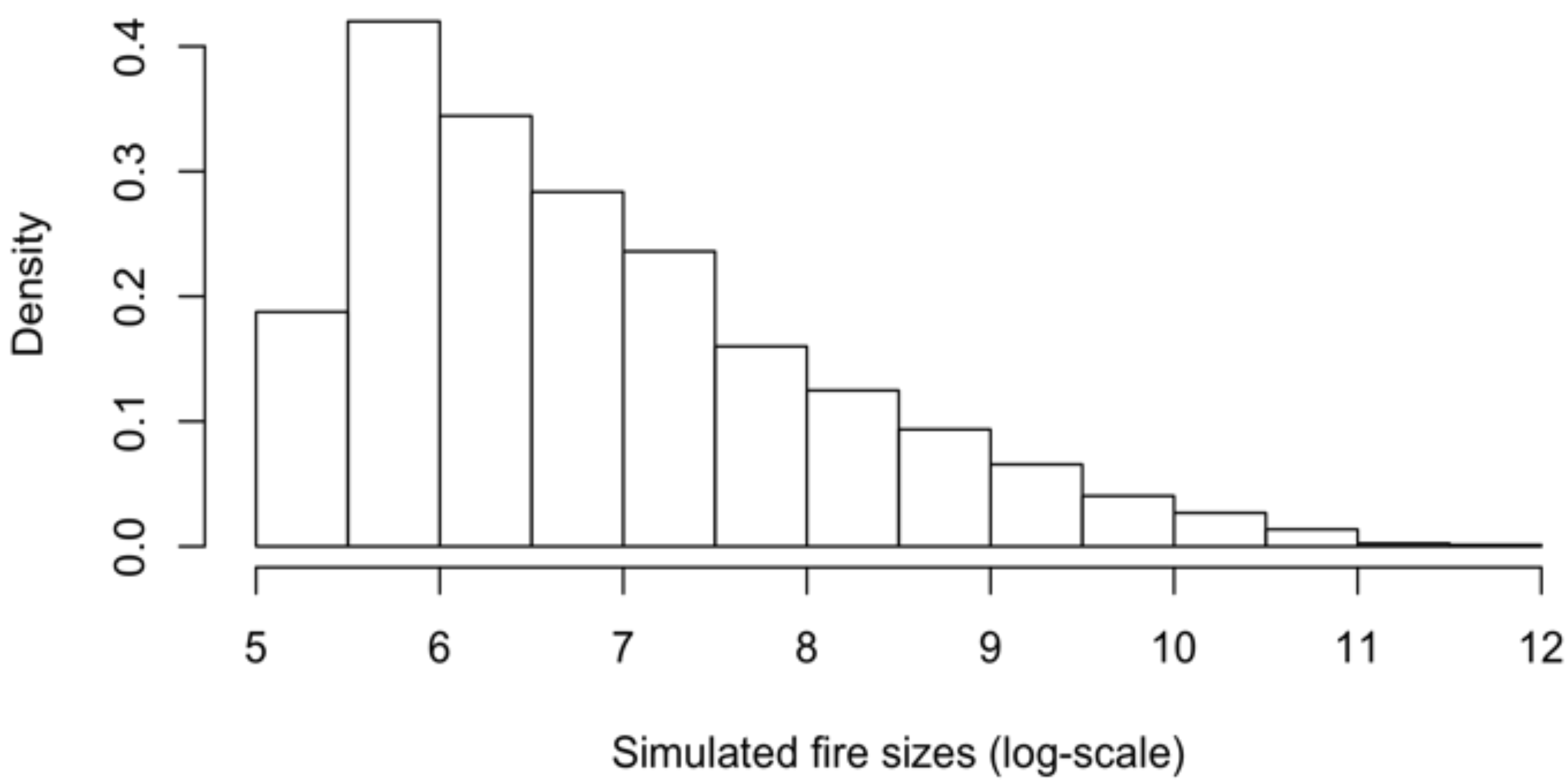
12
Observed fire sizes (log-scale)


Density
0.0
0.1
0.2
0.3
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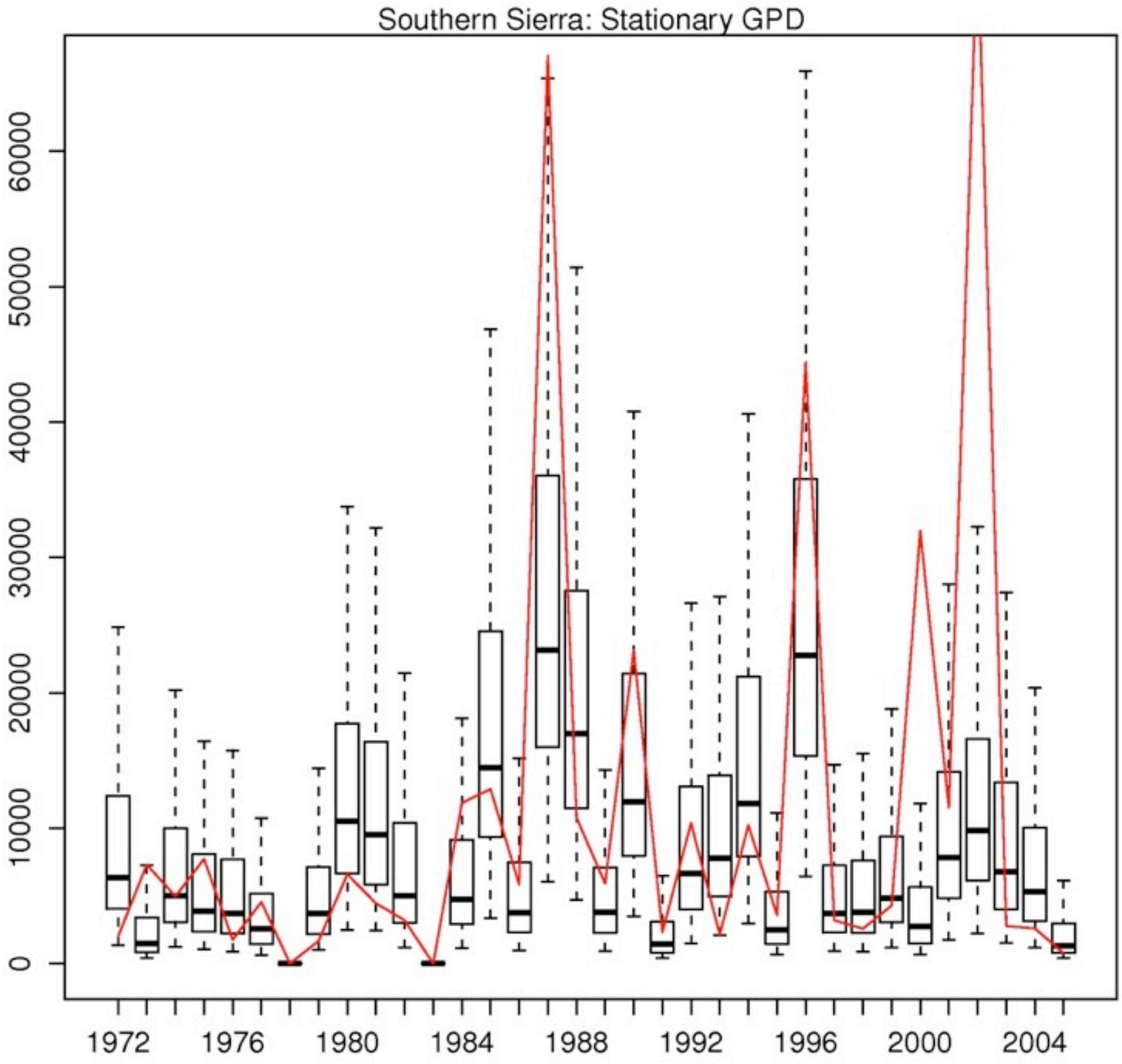
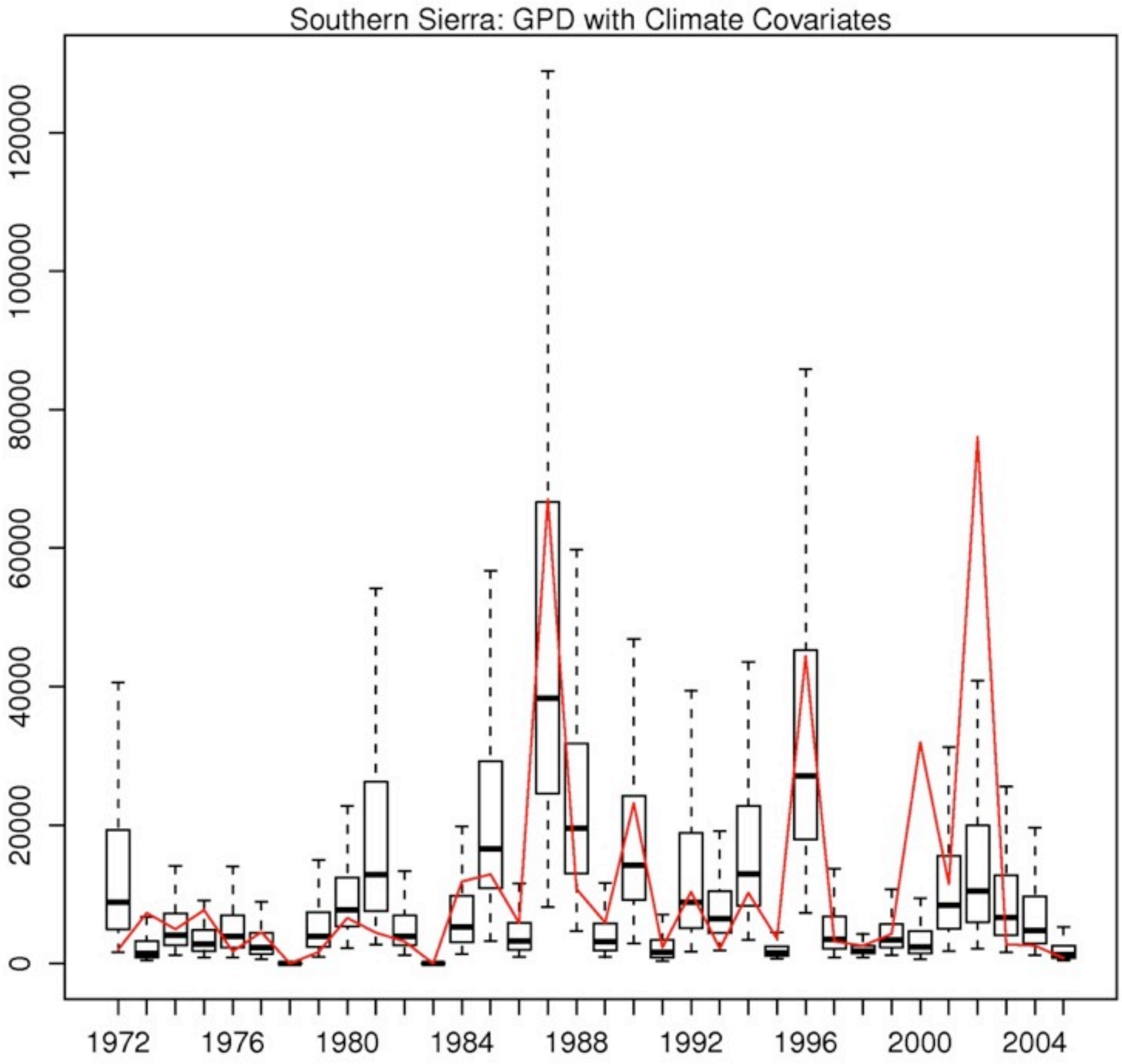
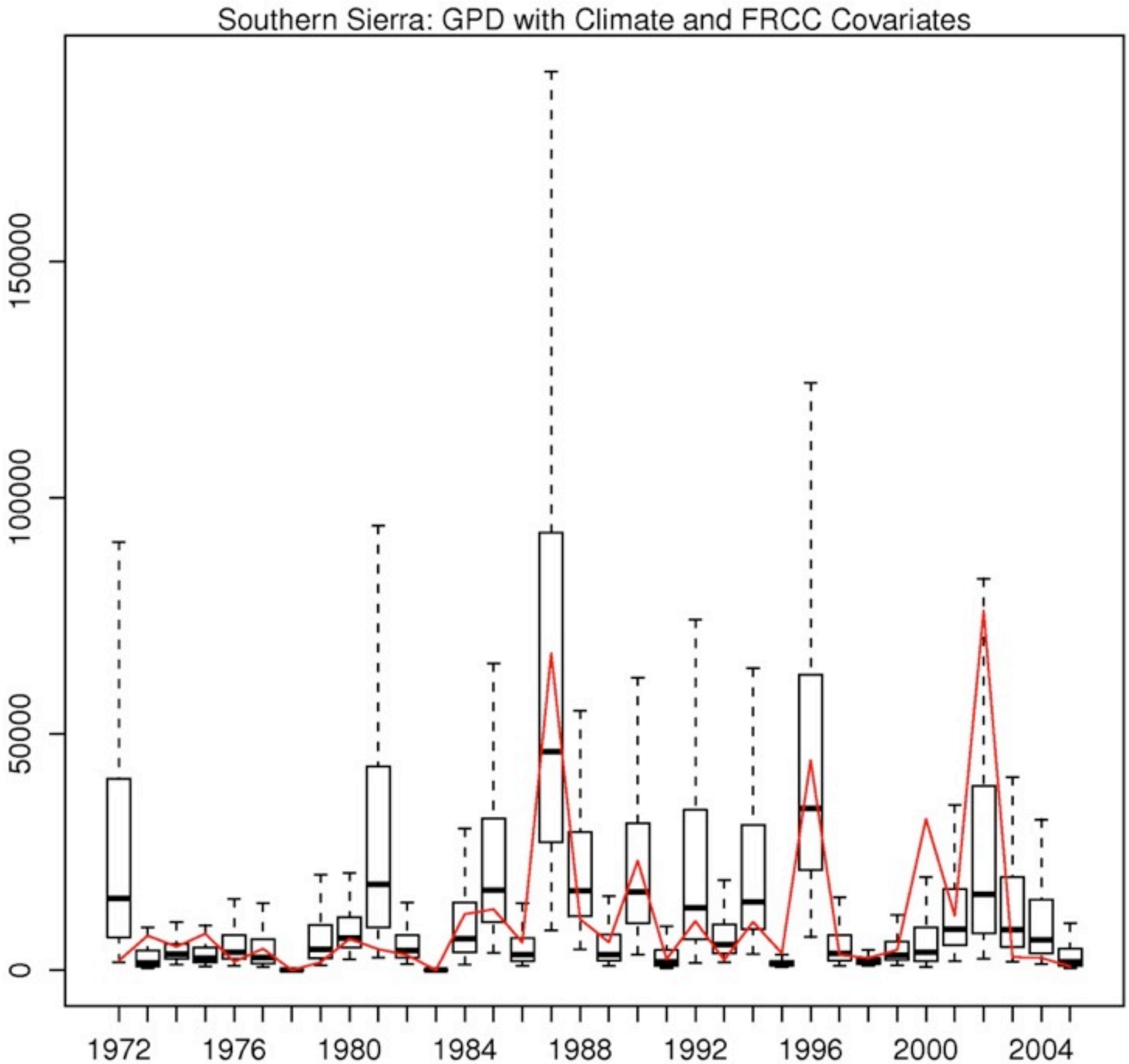
Simulated fire sizes (log-scale)

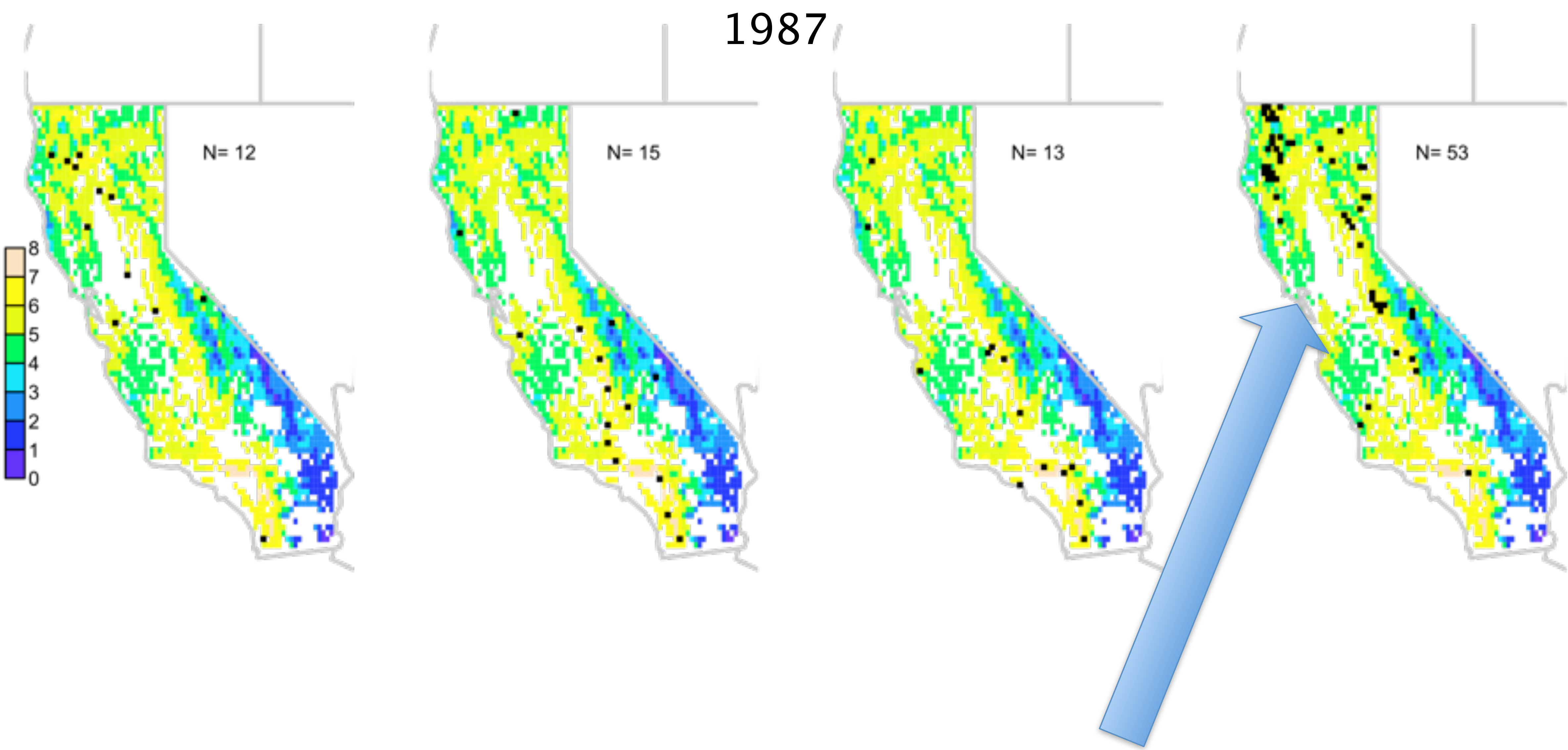


Southern Sierra: Stationary GPD
0
10000
20000
30000
40000
50000
60000
1972
1976
1980
1984
1988
1992
1996
2000
2004

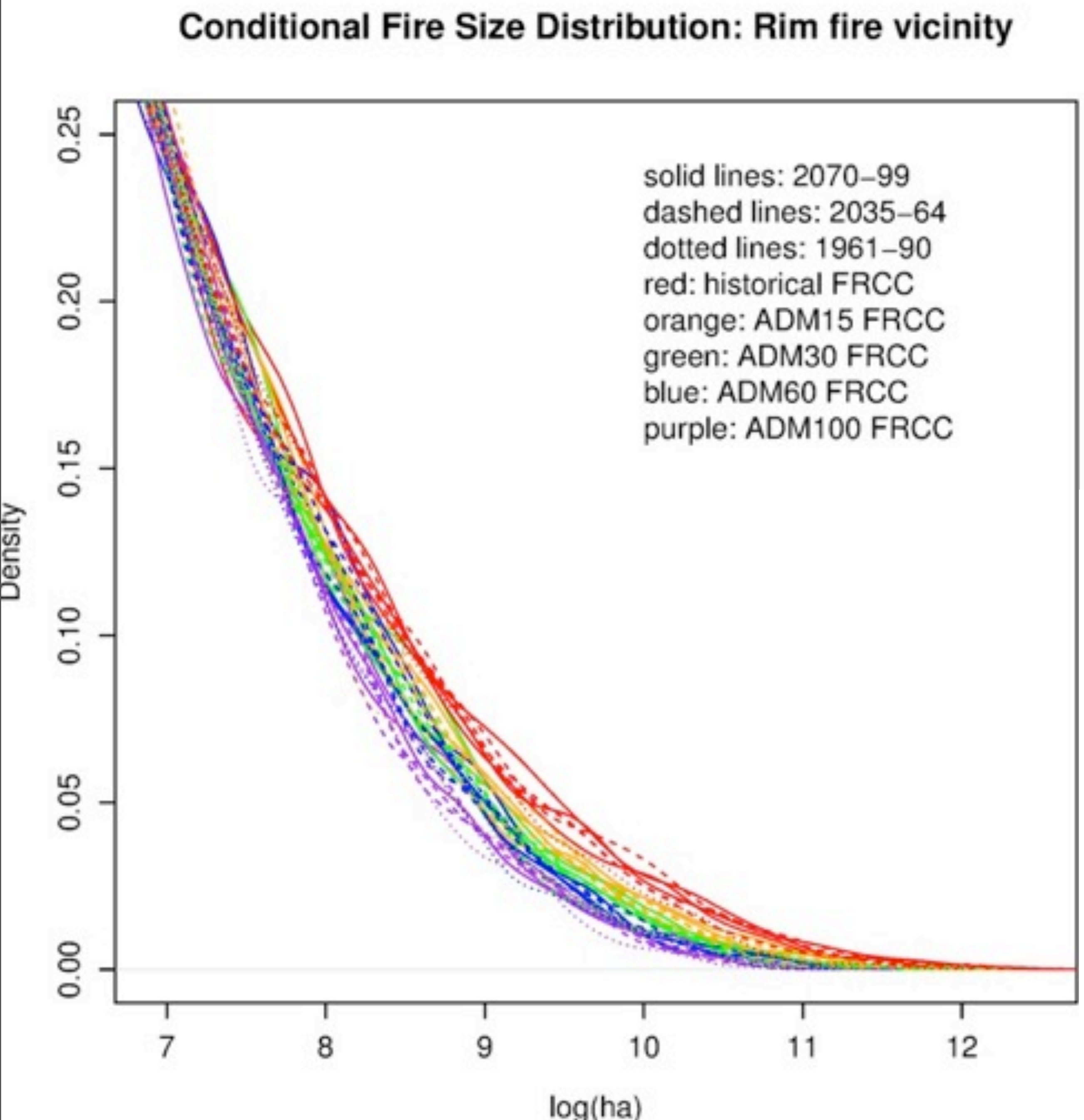

Southern Sierra: GPD with Climate Covariates
0
20000
40000
60000
80000
100000
120000
1972
1976
1980
1984
1988
1992
1996
2000
2004


Southern Sierra: GPD with Climate and FRCC Covariates
0
50000
100000
150000
1972
1976
1980
1984
1988
1992
1996
2000
2004

Large Fire Occurrence Forecasts: Simulation vs Observation



Clustered lightning ignitions observed in Northern CA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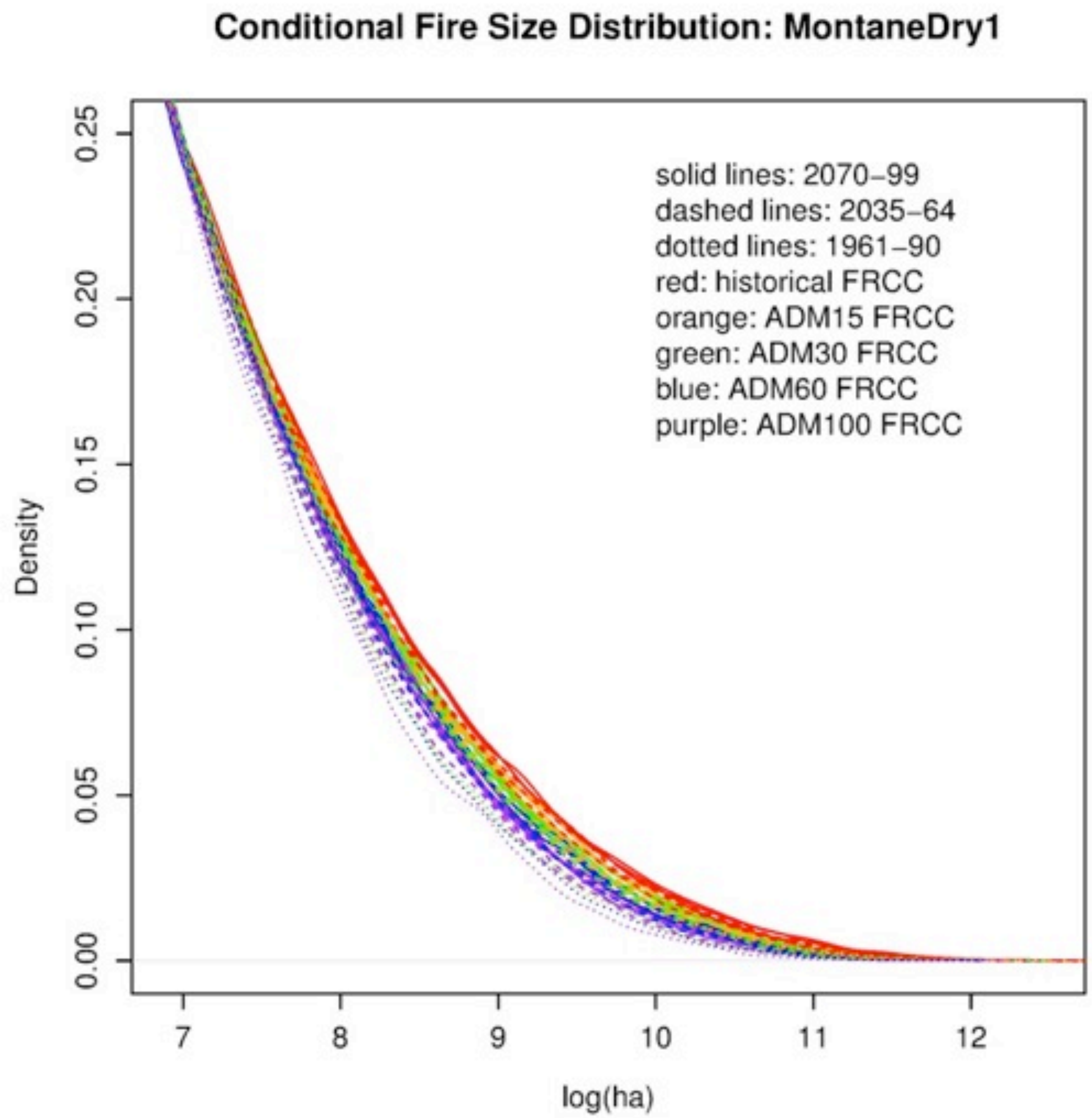
Conditional Fire Size Distribution: MontaneDry1
solid lines: 2070–99
dashed lines: 2035–64
dotted lines: 1961–90
red: historical FRCC
orange: ADM15 FRCC
green: ADM30 FRCC
blue: ADM60 FRCC
purple: ADM100 FRCC
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