Wildfire Risk Projections for California:

*examples from recent work and outstanding issues**

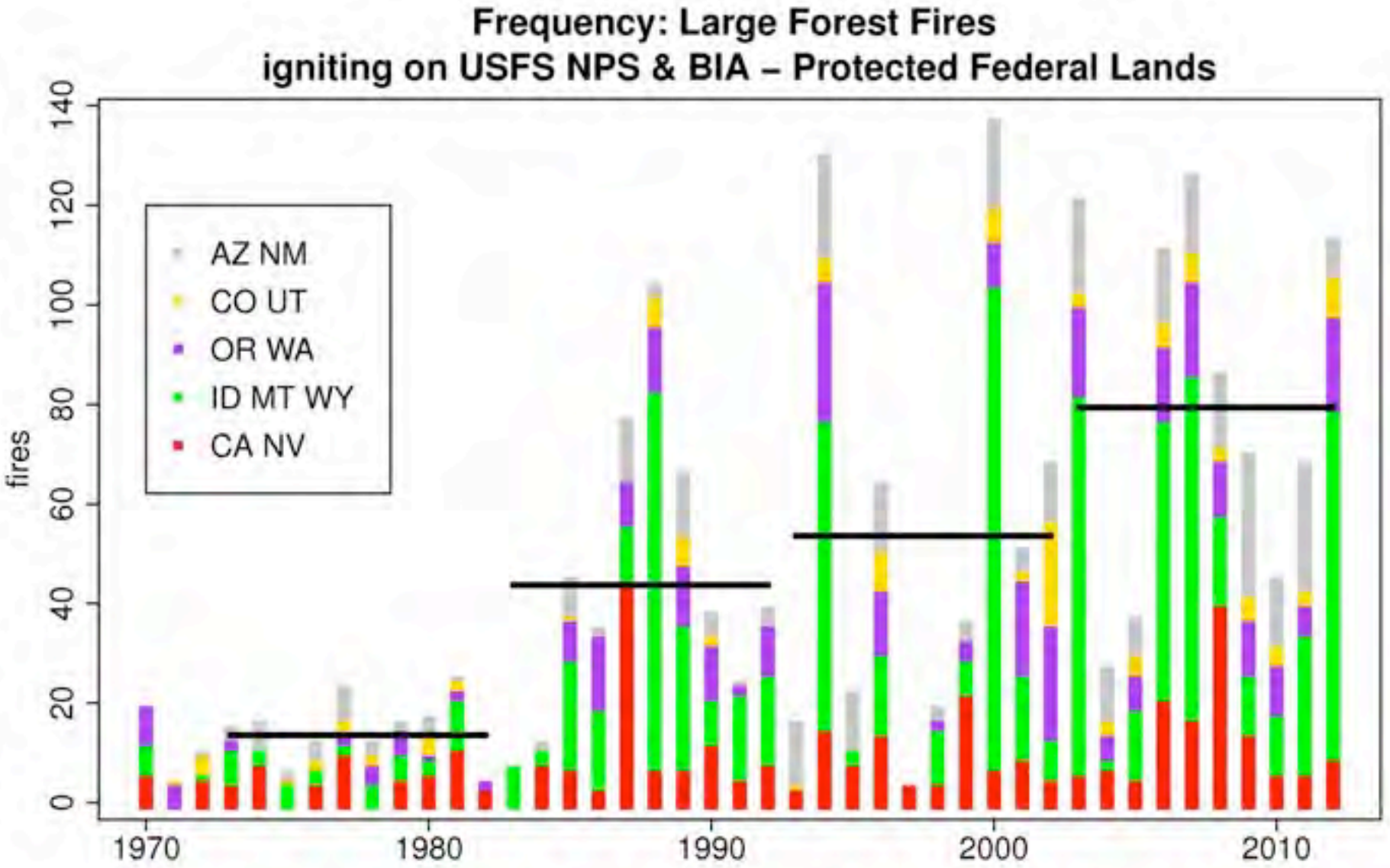
Public Health Work Group Panel "Wildfire and Health in a Changing Climate"

July 22, 2014

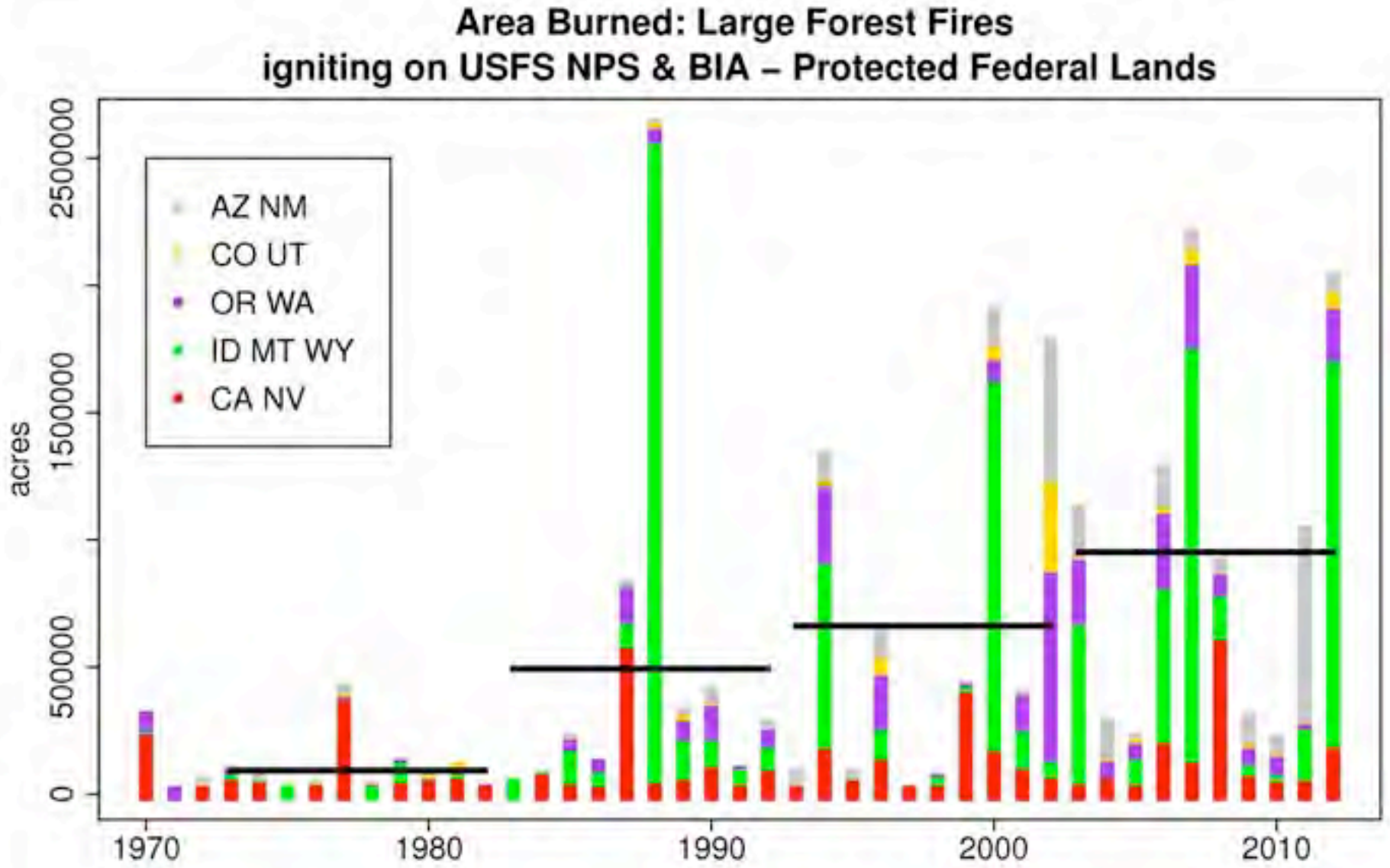
LeRoy Westerling, UC Merced

**i.e. wildfire research smorgasbord*

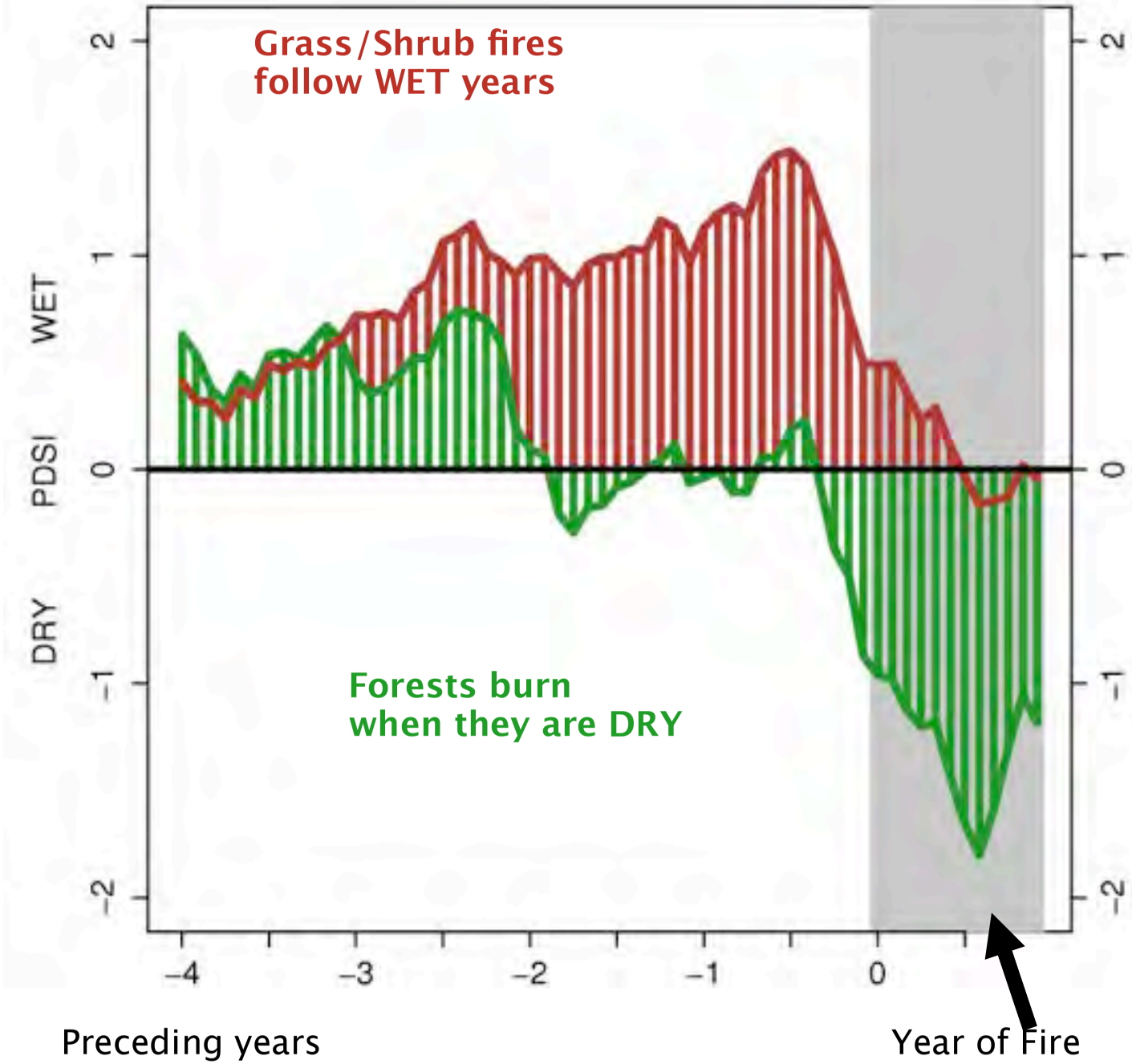
Photo: Rim Fire 2013 - source: NASA

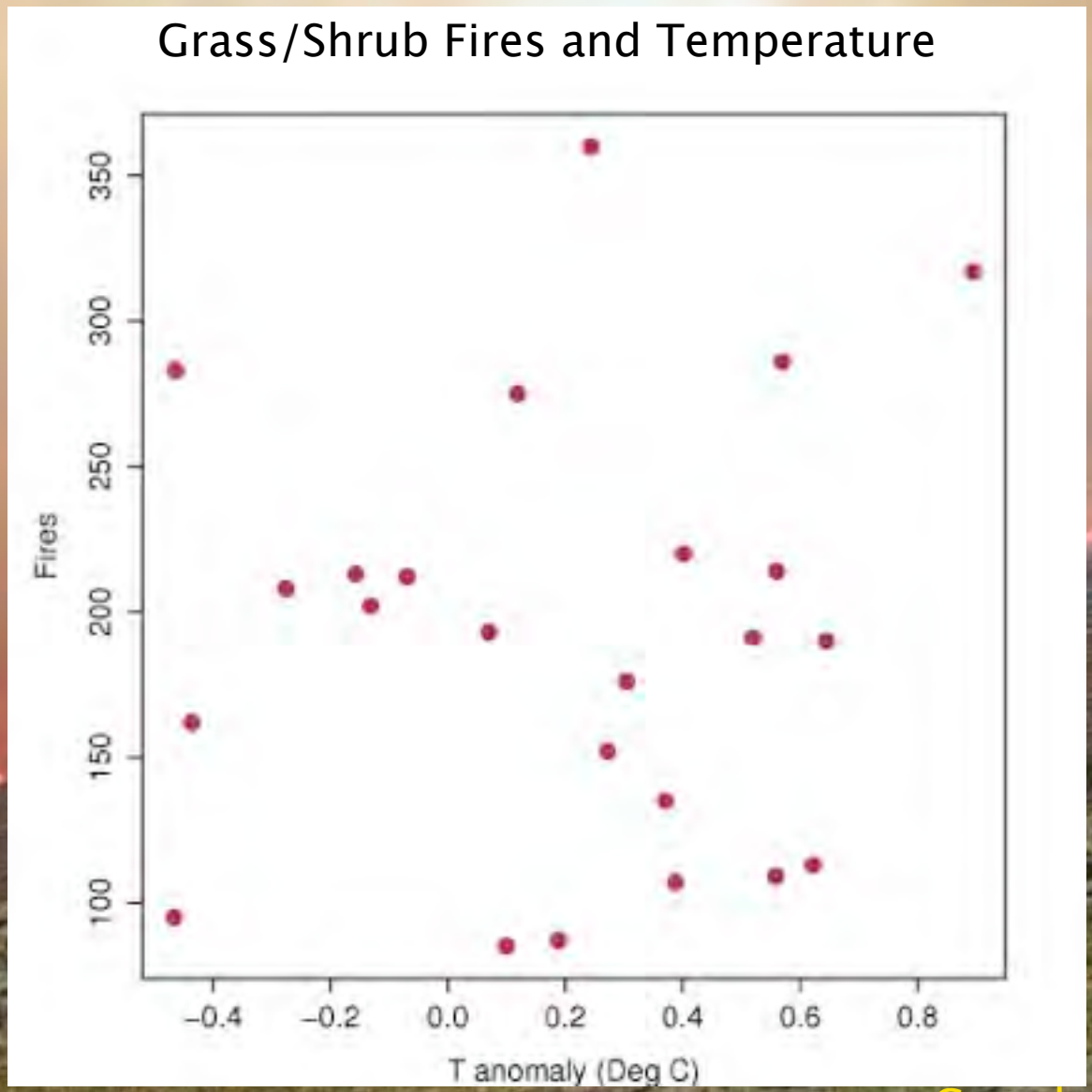


Westerling, unpublished data

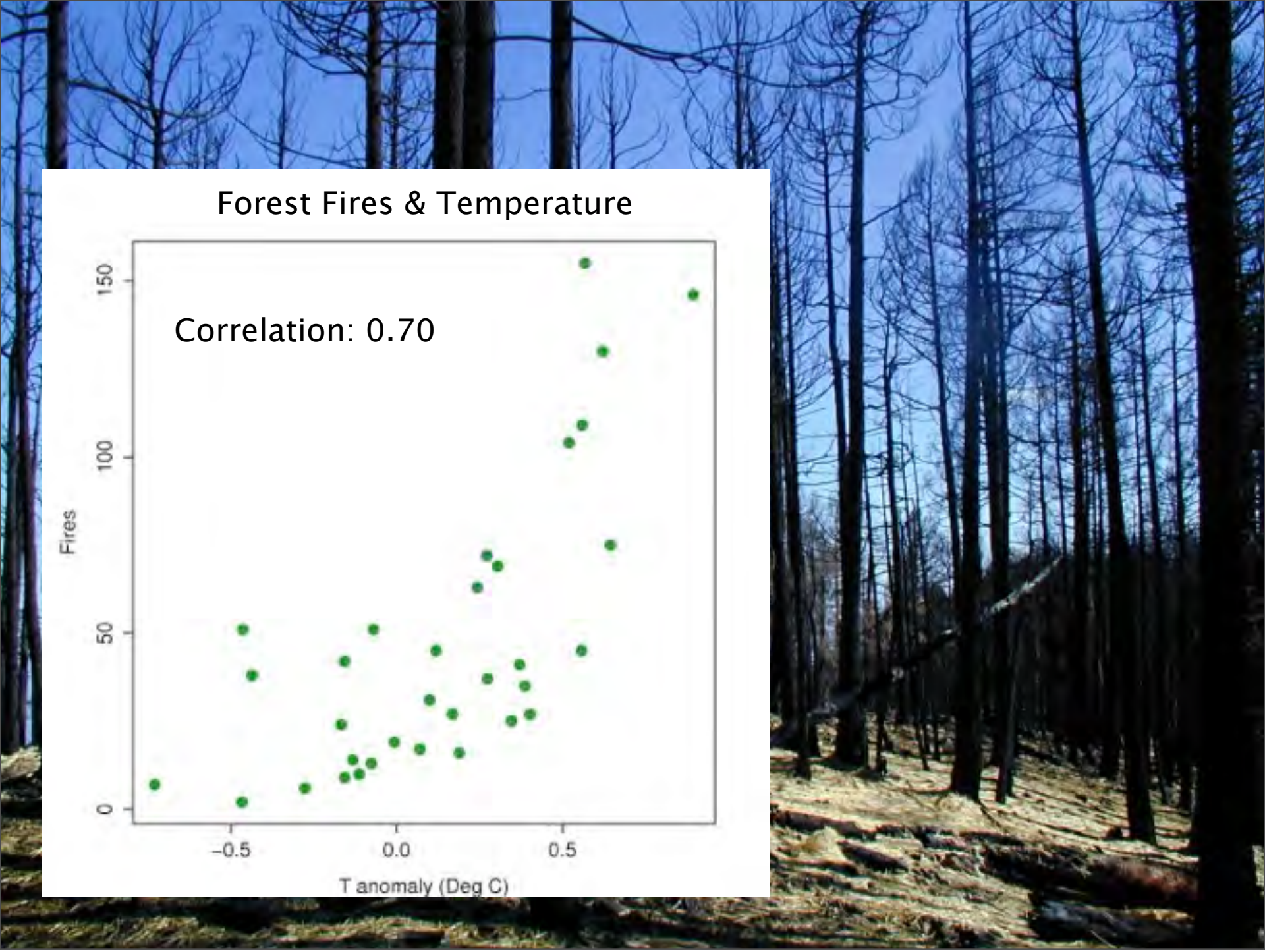


Westerling, unpublished data


Grass/Shrub fires
follow WET years
Forests burn
when they are DRY
WET
PDSI
DRY
2
1
0
−1
−2
−4
−3
−2
−1
0
Preceding years
Year of Fire

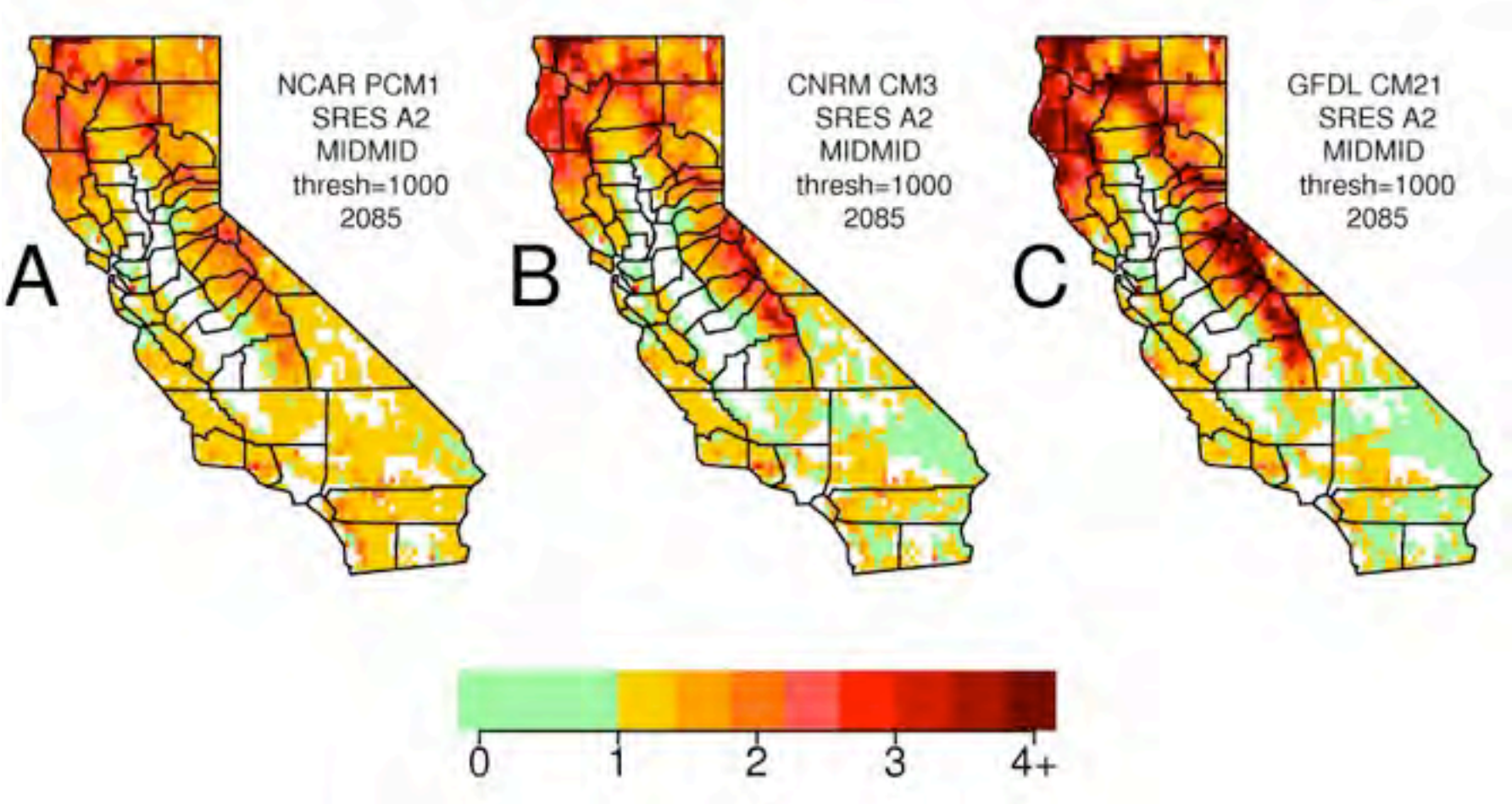


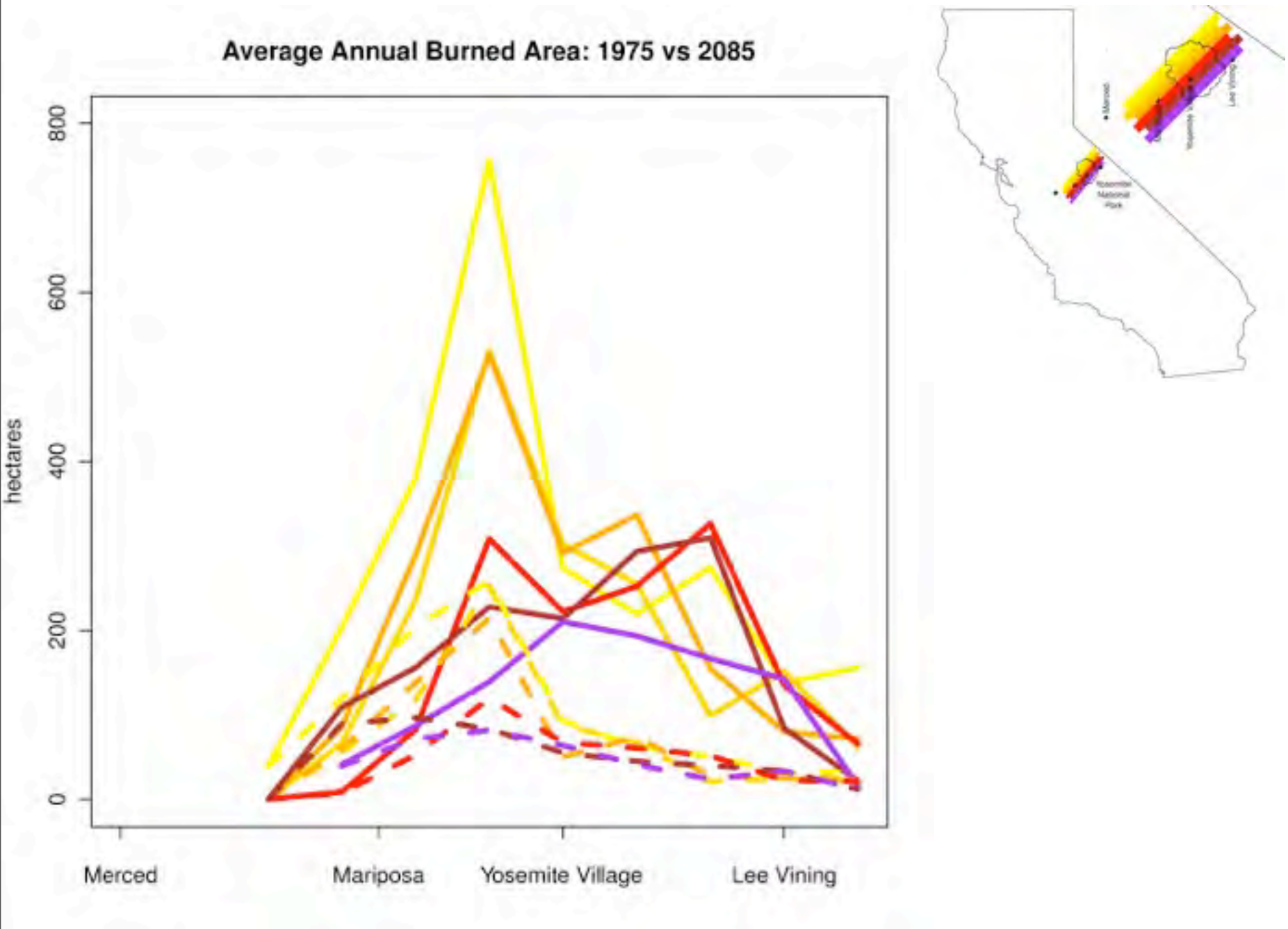
Correlation: 0.08

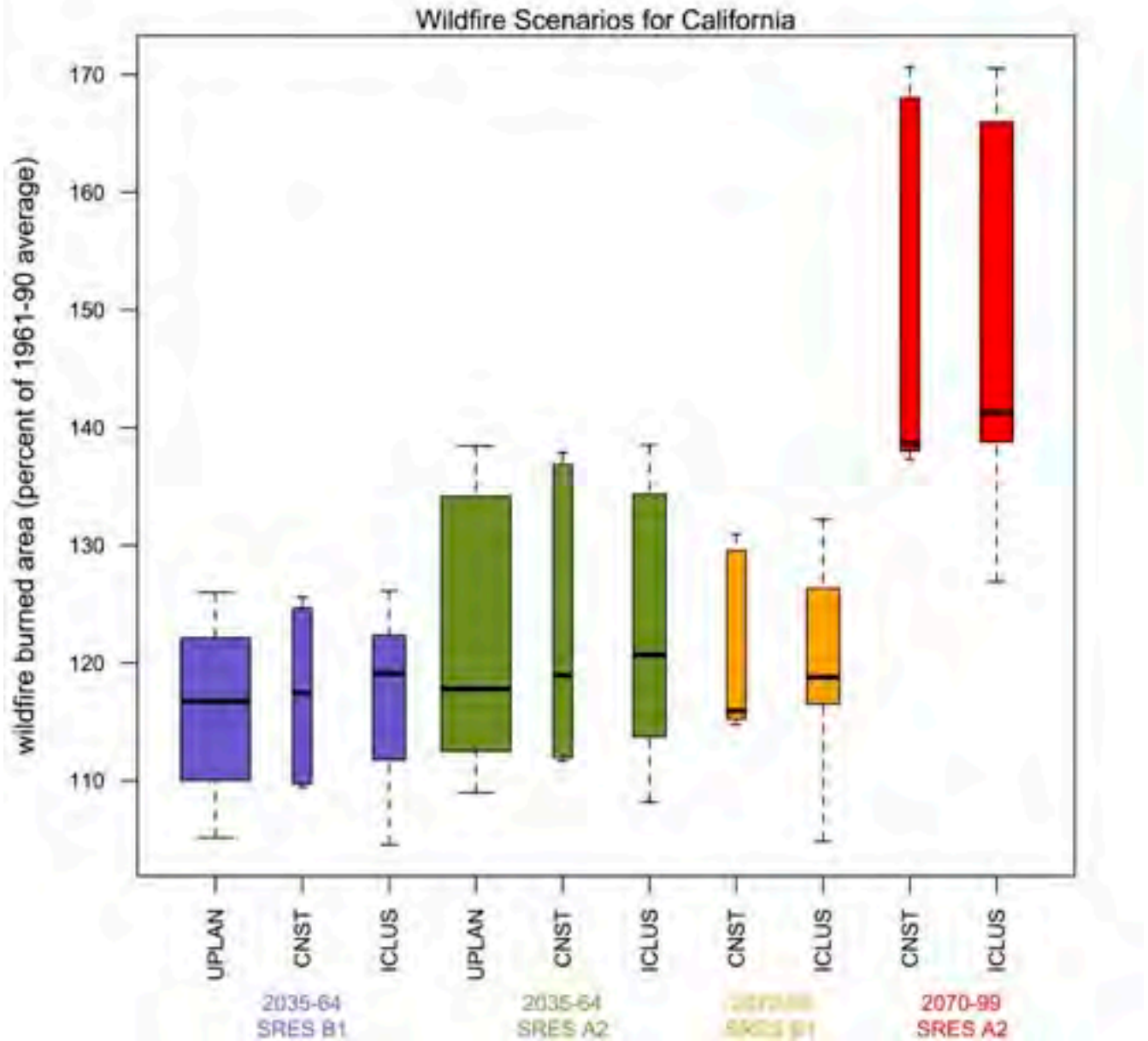

Forest Fires & Temperature
Correlation: 0.70
Fires
0
50
100
150
−0.5
0.0
0.5
T anomaly (Deg C)

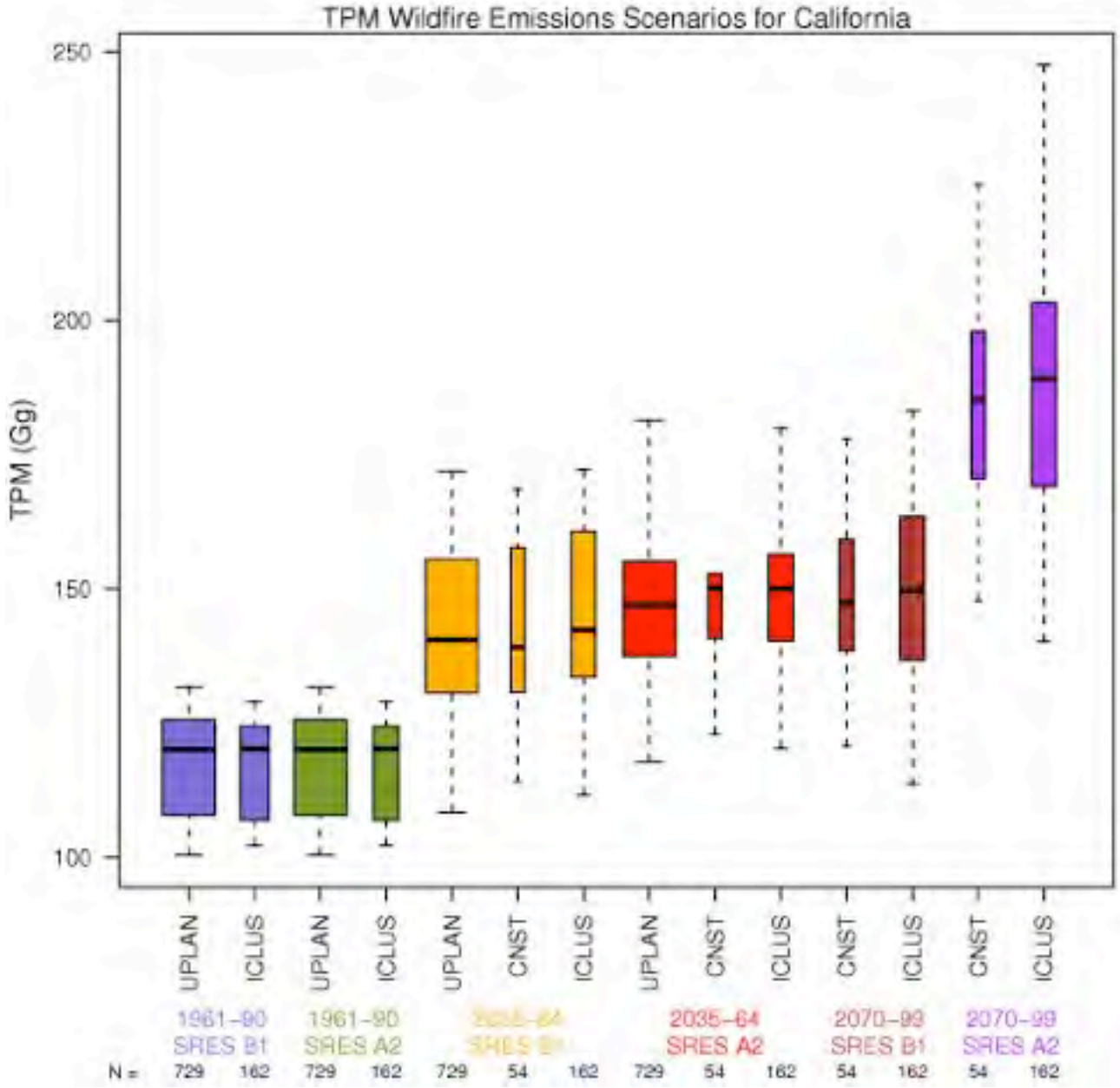
Early Spring
1972 - 2012

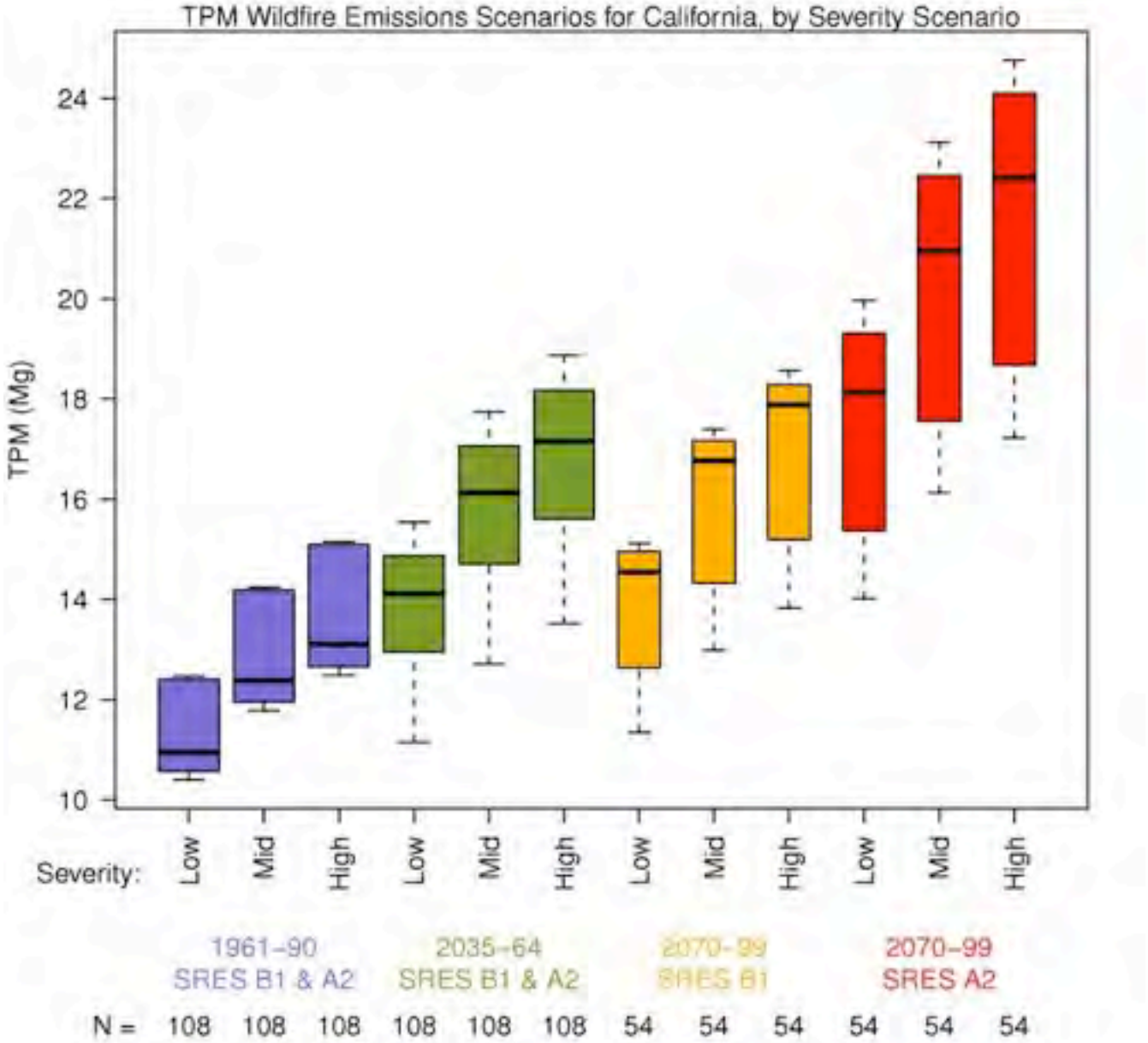
Late Spring
1972 - 2012


A
NCAR PCM1
SRES A2
MIDMID
thresh=1000
2085
B
CNRM CM3
SRES A2
MIDMID
thresh=1000
2085
C
GFDL CM21
SRES A2
MIDMID
thresh=1000
2085
0
1
2
3
4+

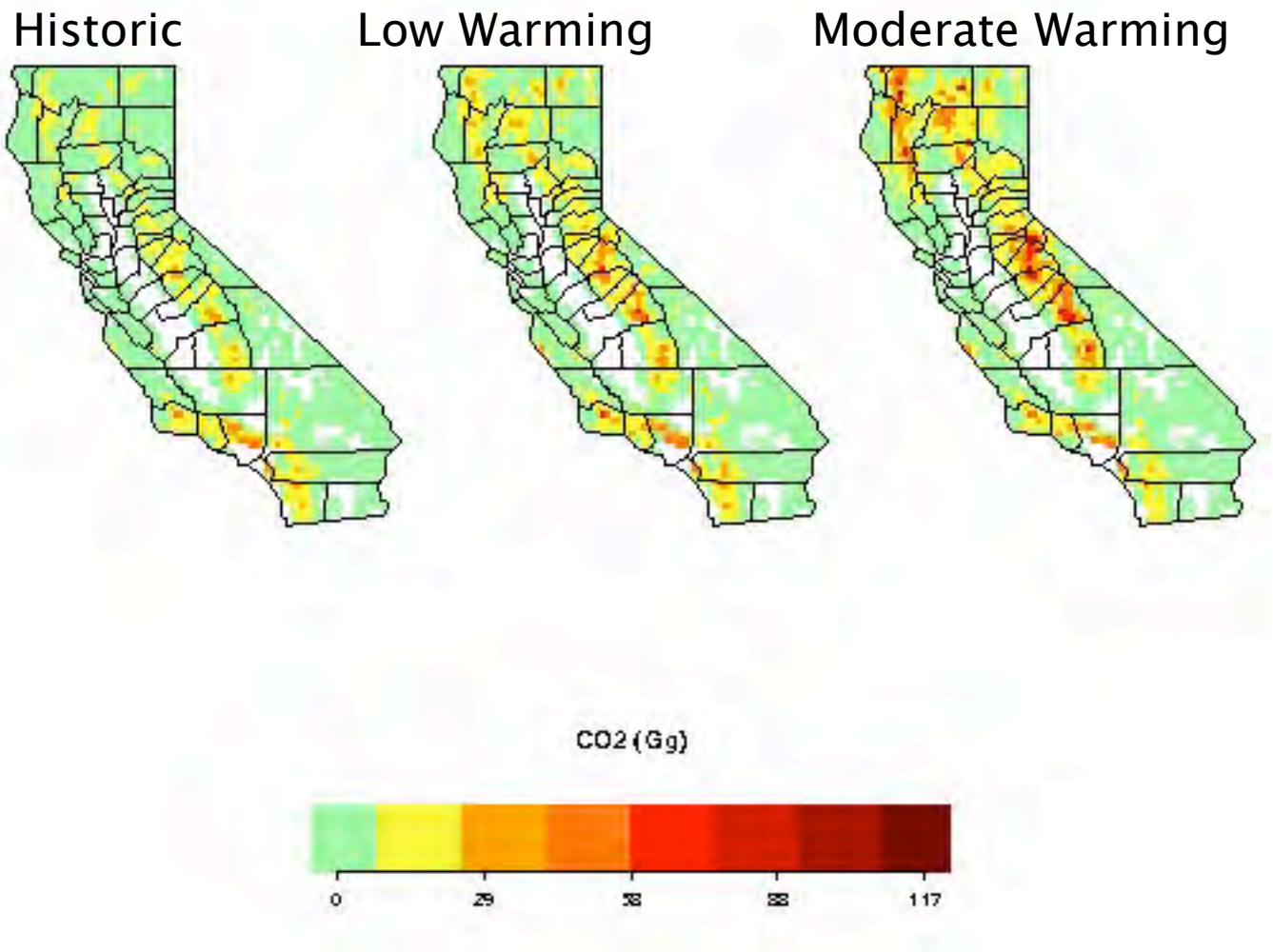

Average Annual Burned Area: 1975 vs 2085
hectares
0
200
400
600
800
Merced
Mariposa
Yosemite Village
Lee Vining


Wildfire Scenarios for California
wildfire burned area (percent of 1961-90 average)
170
160
150
140
130
120
110
UPLAN
CNST
ICLUS
UPLAN
CNST
ICLUS
CNST
ICLUS
CNST
ICLUS
2035-64
SRES B1
2035-64
SRES A2
2070-99
SRES A2


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

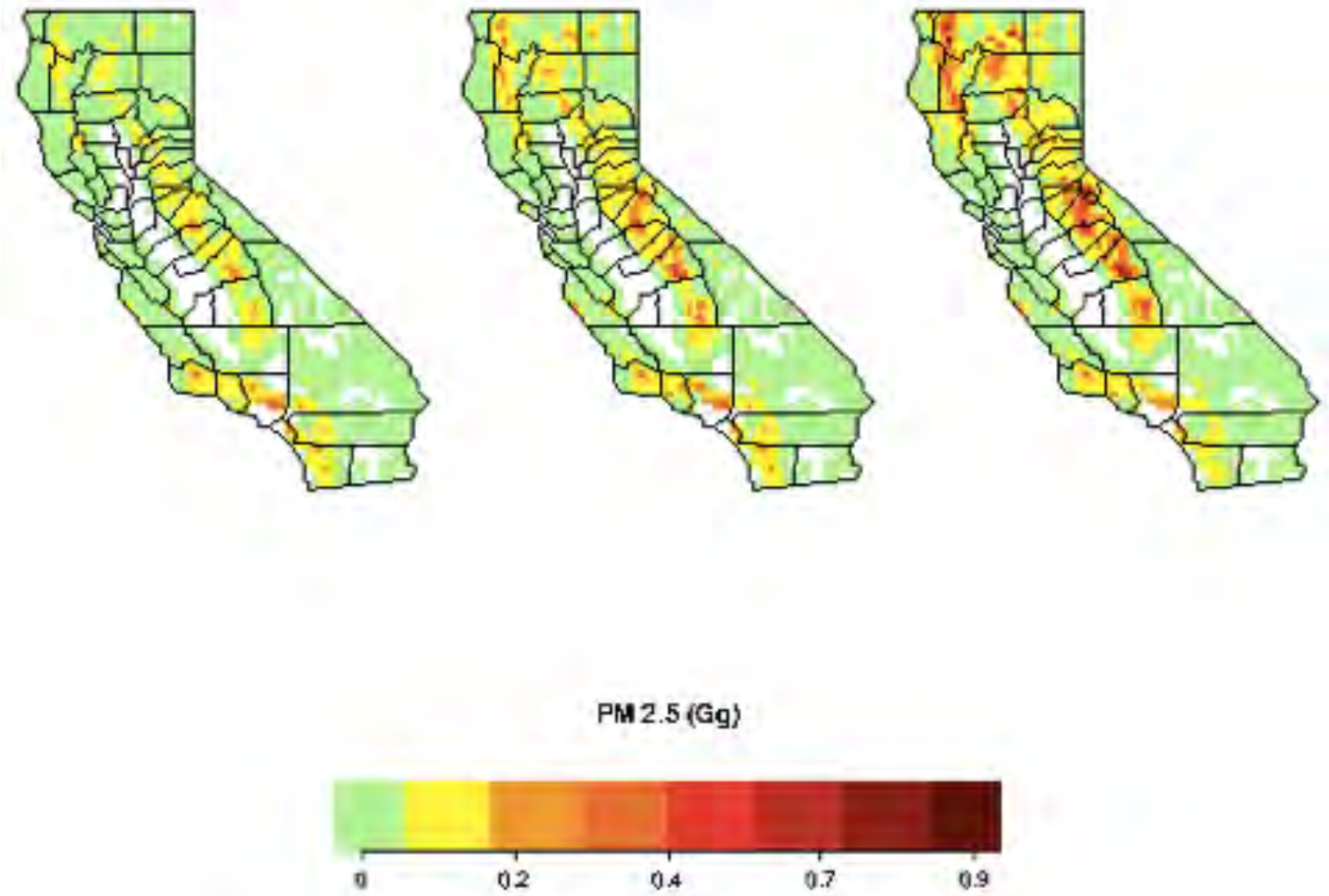

TPM Wildfire Emissions Scenarios for California, by Severity Scenario
TPM (Mg)
24
22
20
18
16
14
12
10
Severity:
Low
Mid
High
Low
Mid
High
Low
Mid
High
Low
Mid
High
1961–90
SRES B1 & A2
2035–64
SRES B1 & A2
2070–99
SRES B1
2070–99
SRES A2
N =
108
108
108
108
108
108
54
54
54
54
54
54

Average annual CO2 Emissions from wildfire



Average annual wildfire PM 2.5 Emissions

Historic Low Warming Moderate Warming



Slide 7

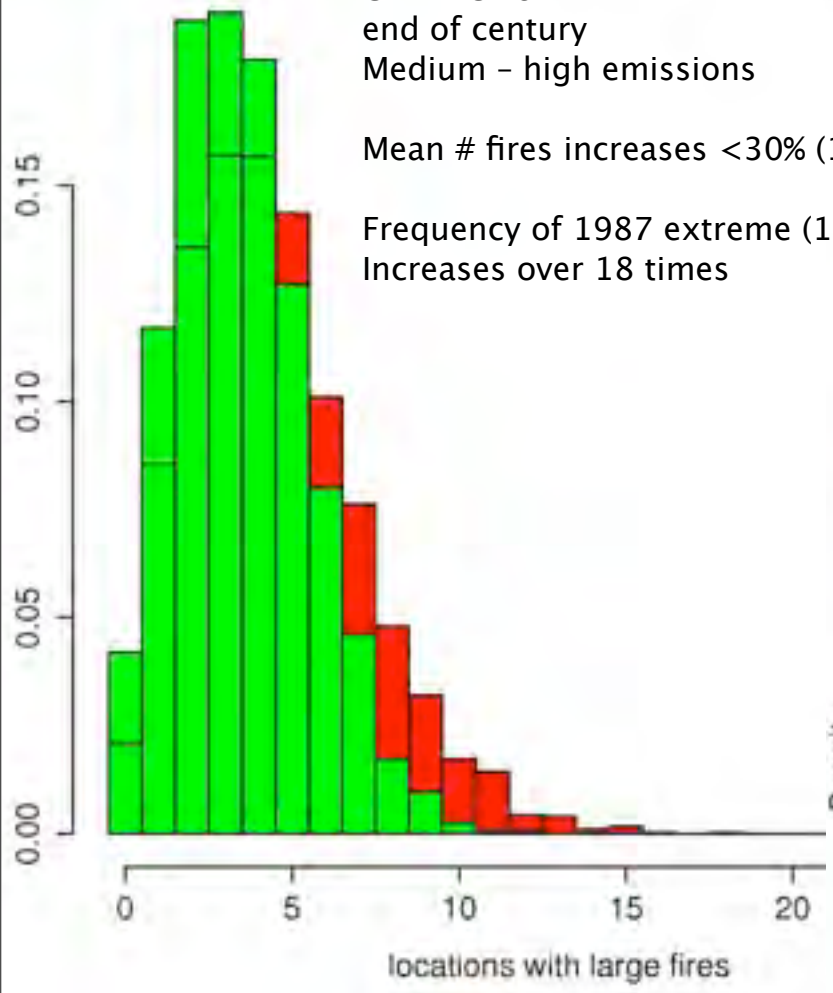
Hurteau et al, 2014

Southern Sierra Summer Fire Frequency

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

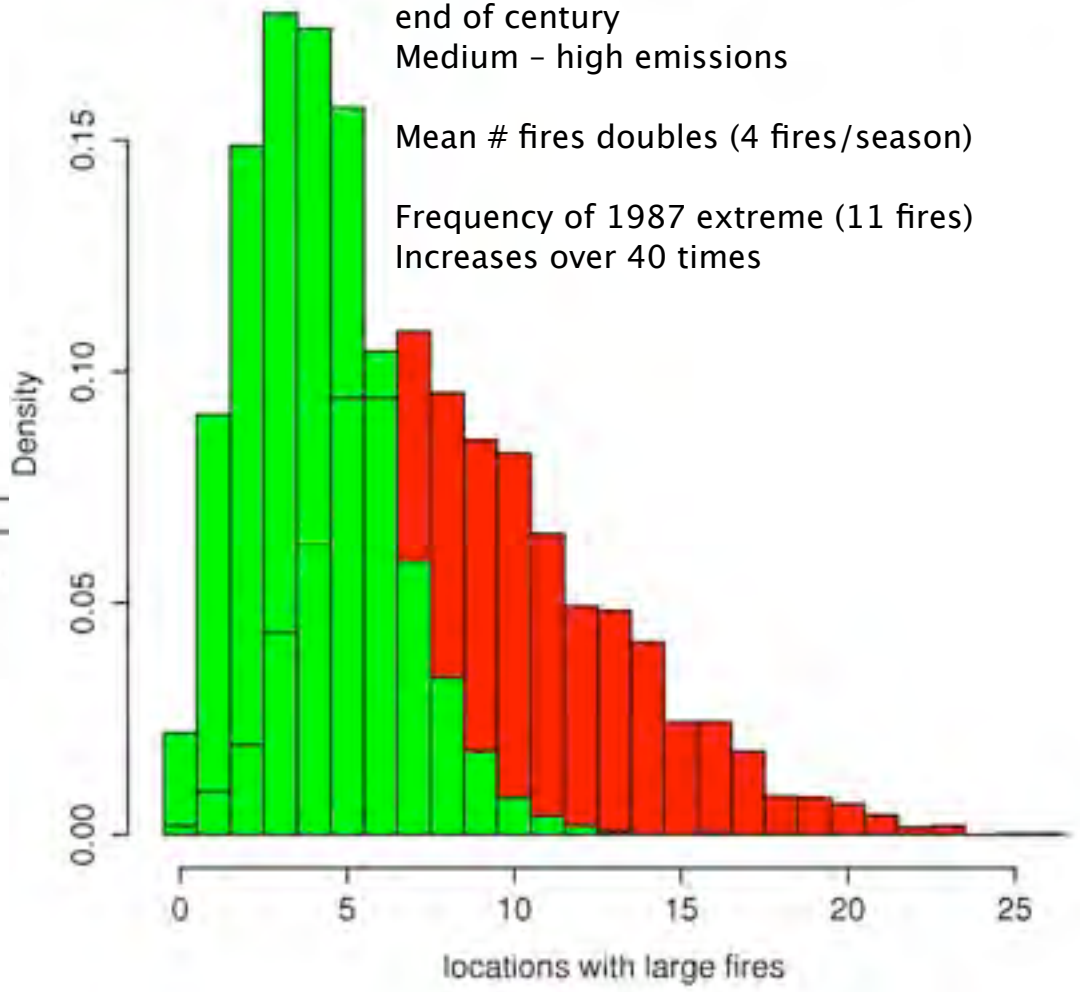


Southern Sierra Summer Fire Frequency

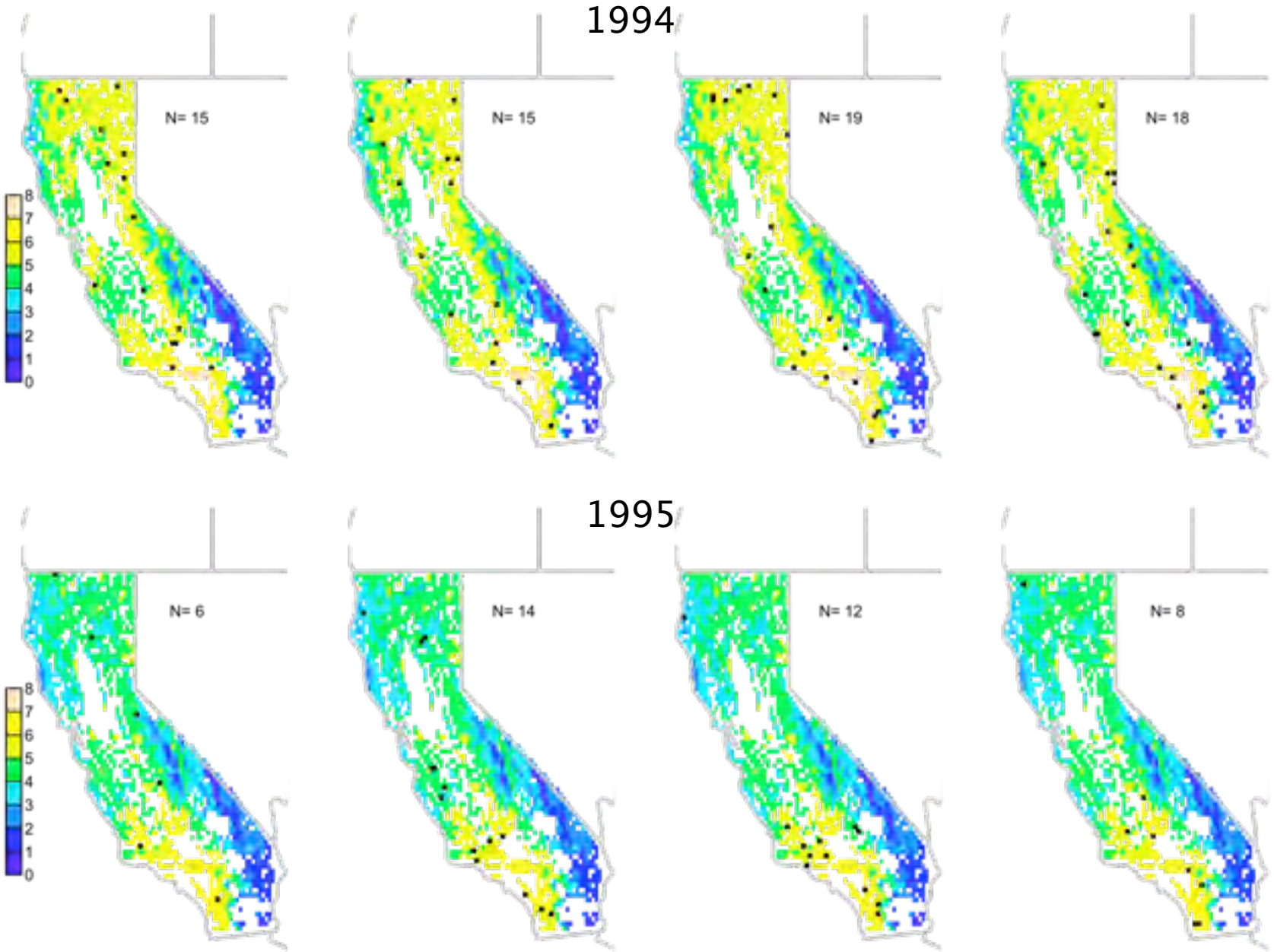
GFDL CM2.1
end of century
Medium – high emissions

Mean # fires doubles (4 fires/season)

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

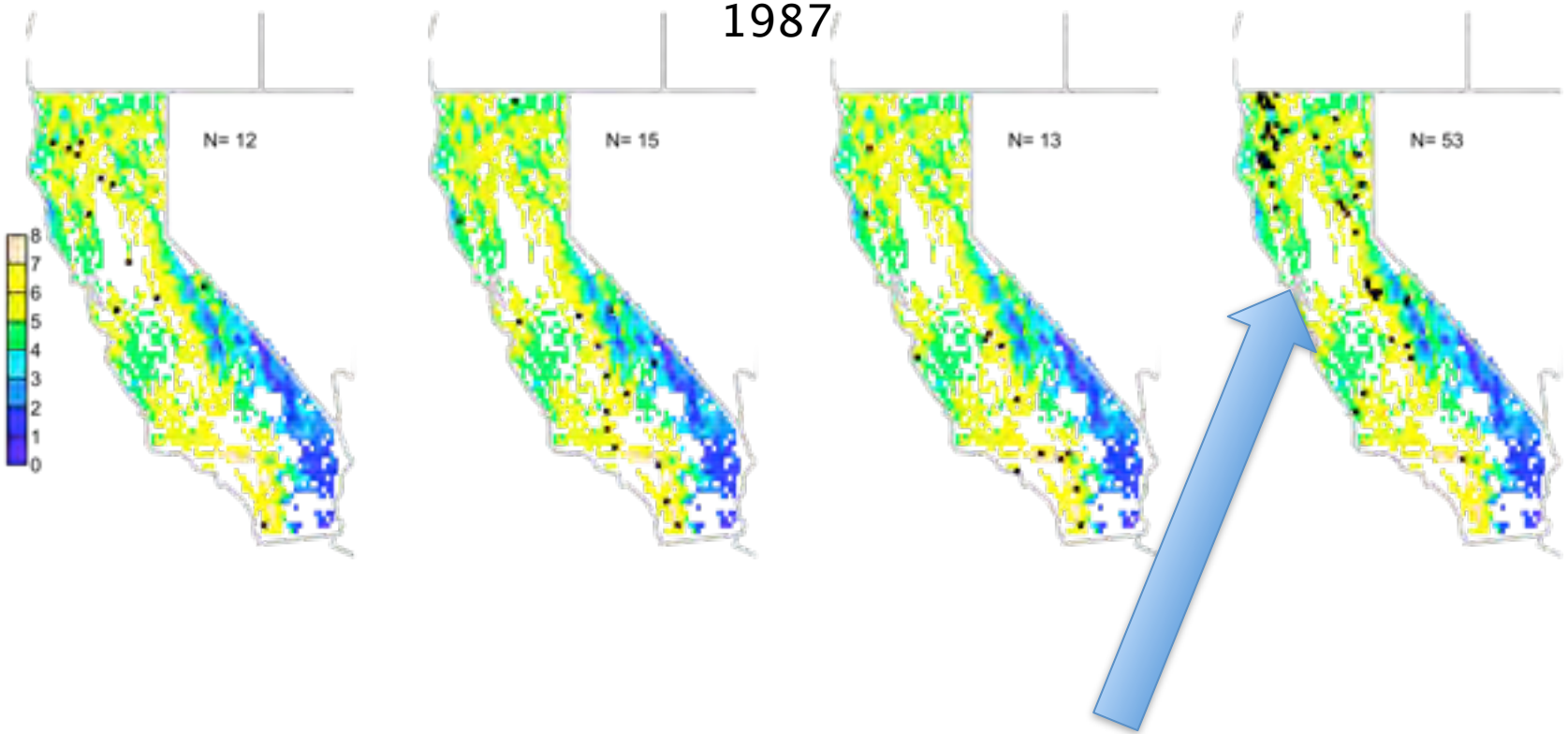


Large Fire Occurrence Forecasts: Simulation vs Observation



Large Fire Occurrence Forecasts: Simulation vs Observation

1987

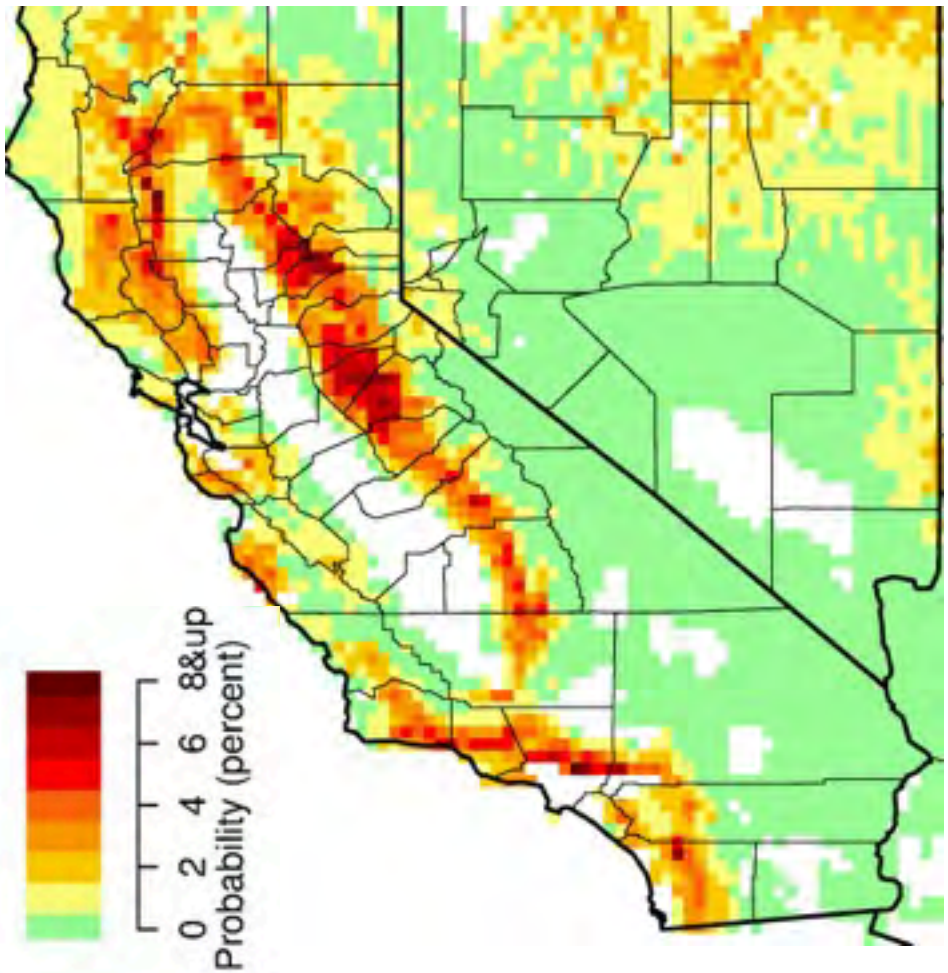


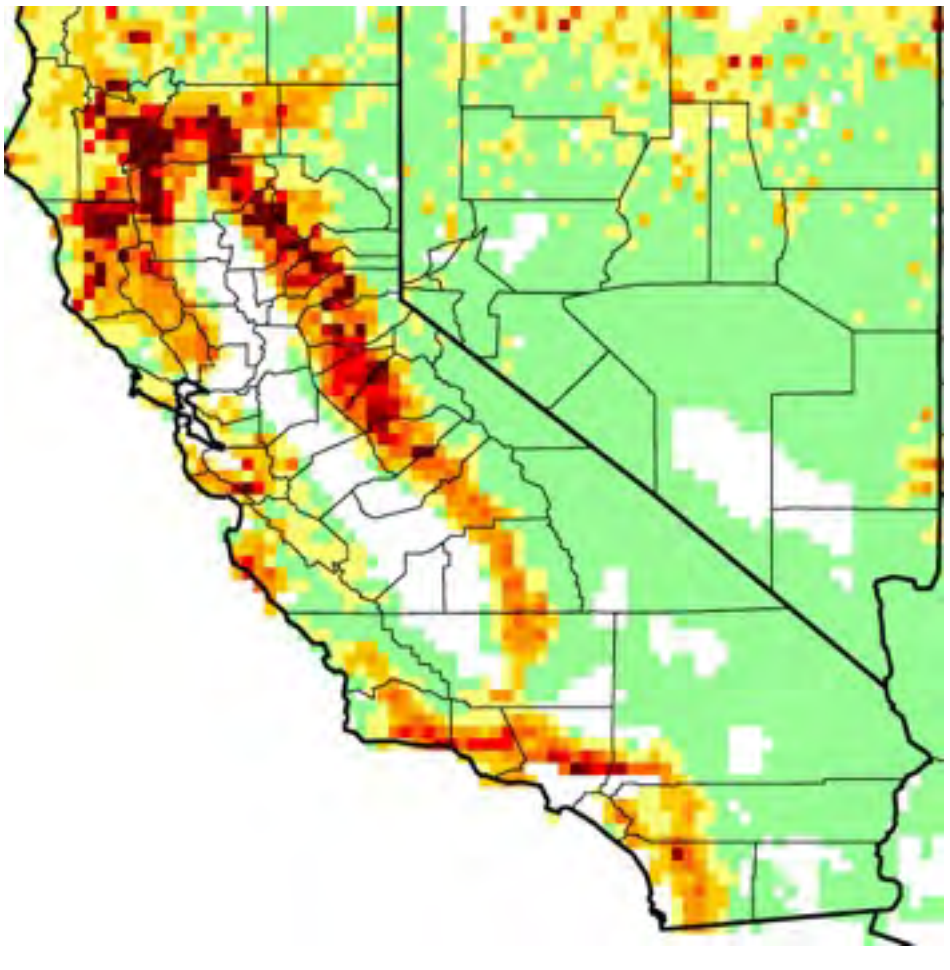
Clustered lightning ignitions observed in Northern CA

June 1 forecast of June 2008 large fire occurrence prob.

with Mean June lightning

with June 2008 lightning

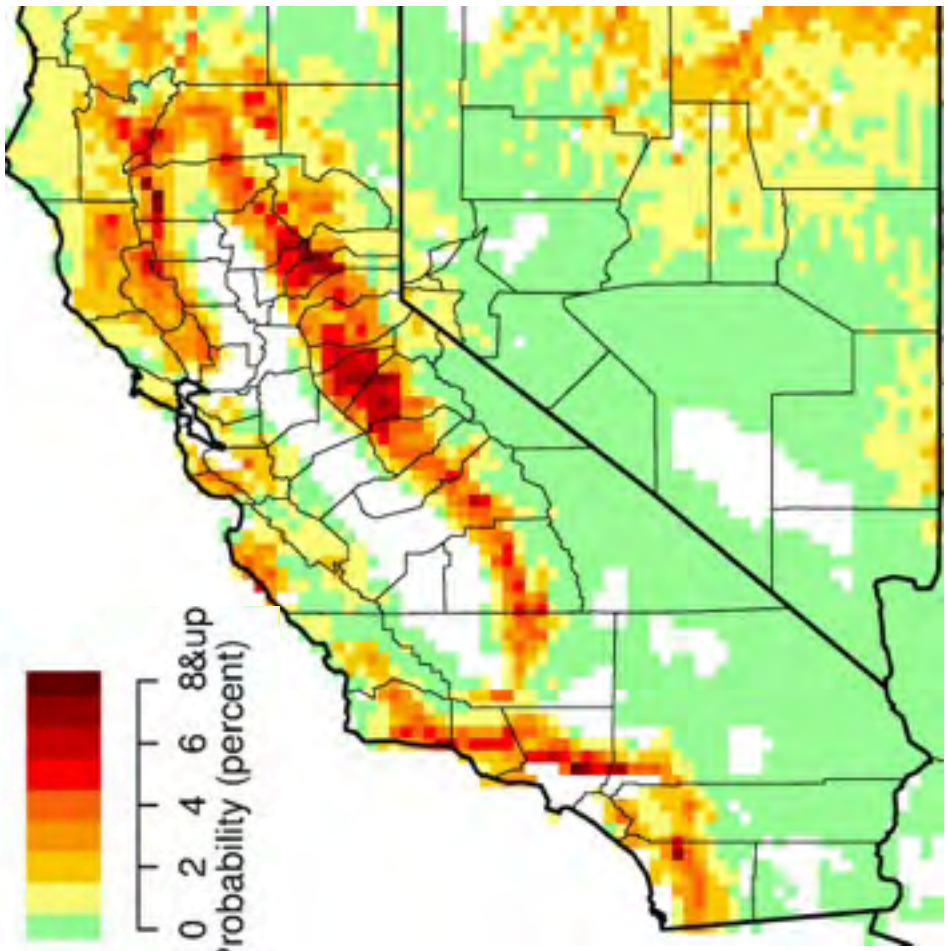


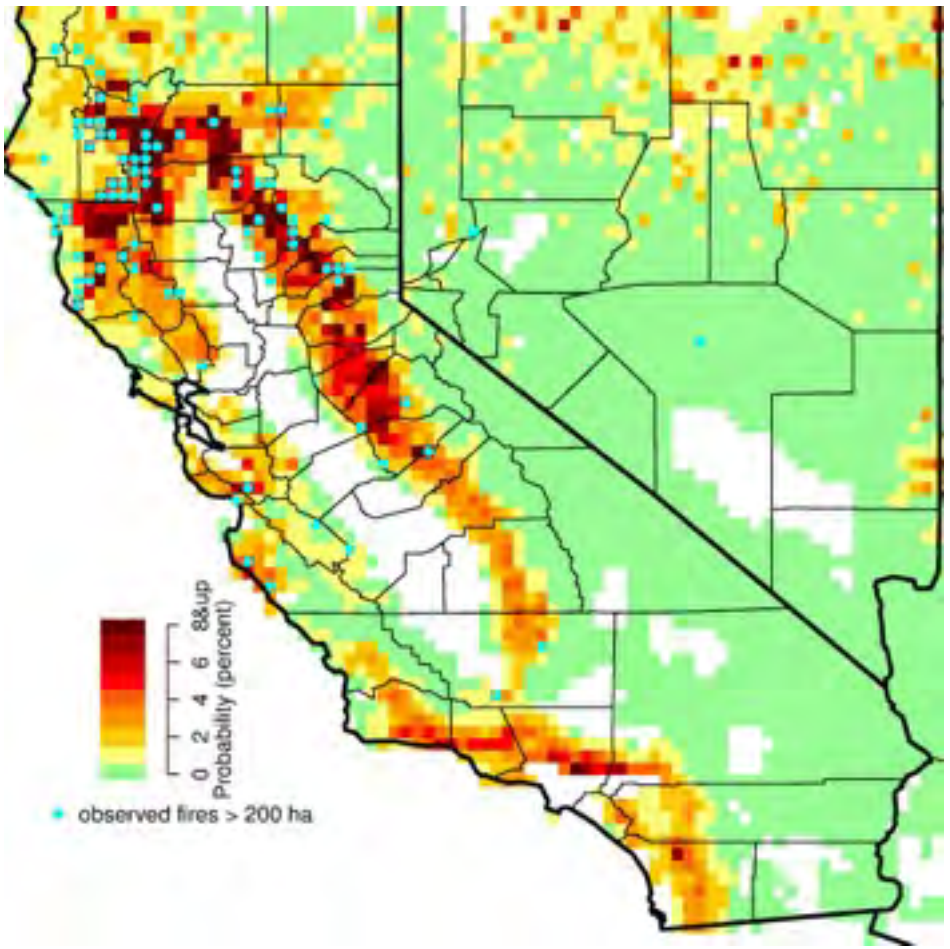


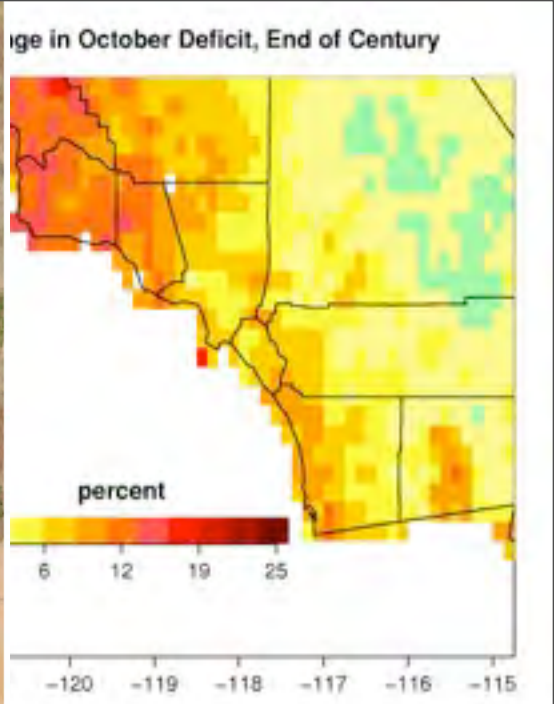
July 1 forecast of June 2008 large fire occurrence prob.

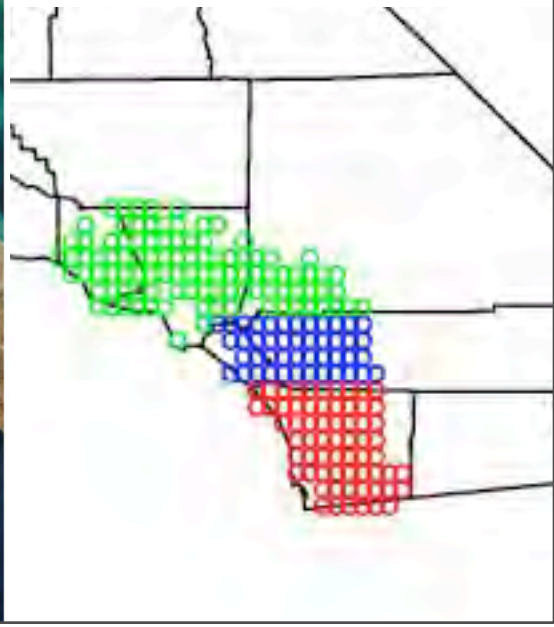
with Mean June lightning

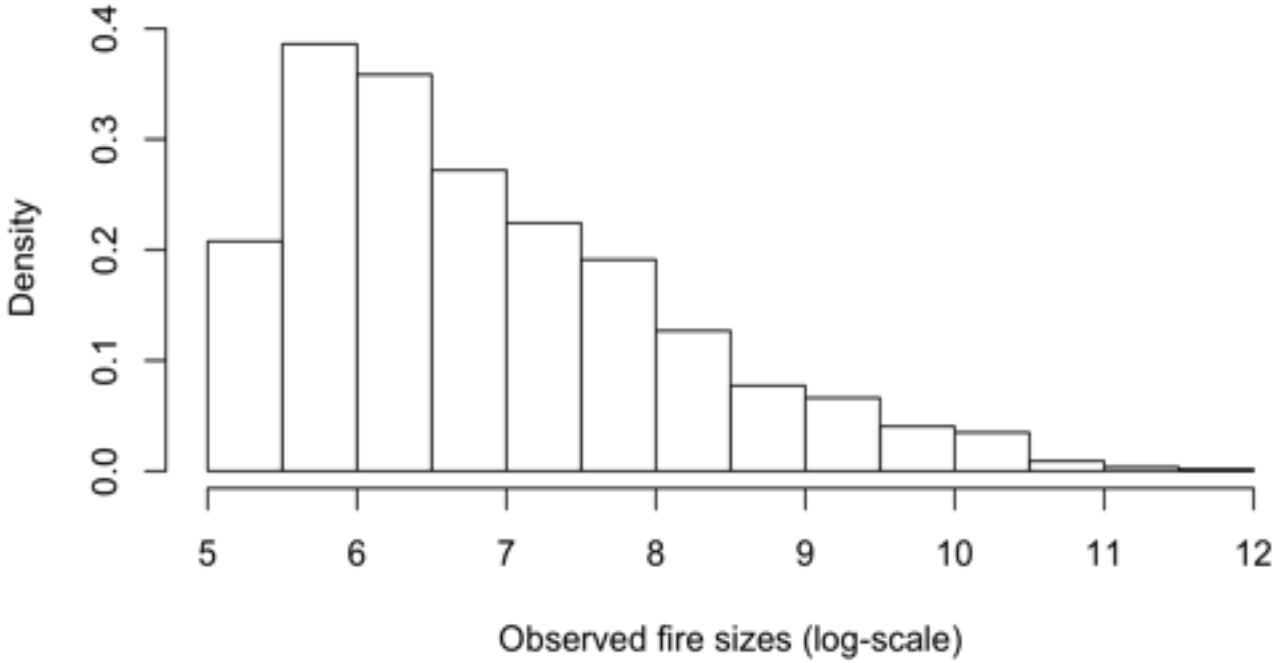
with June 2008 lightning

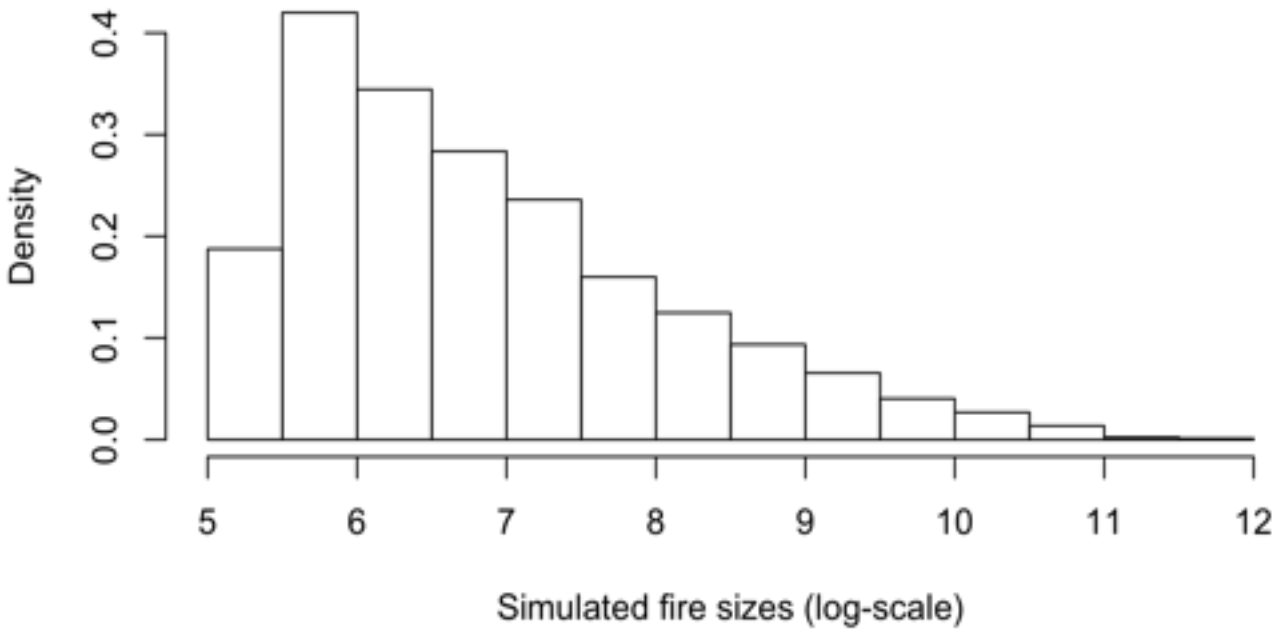


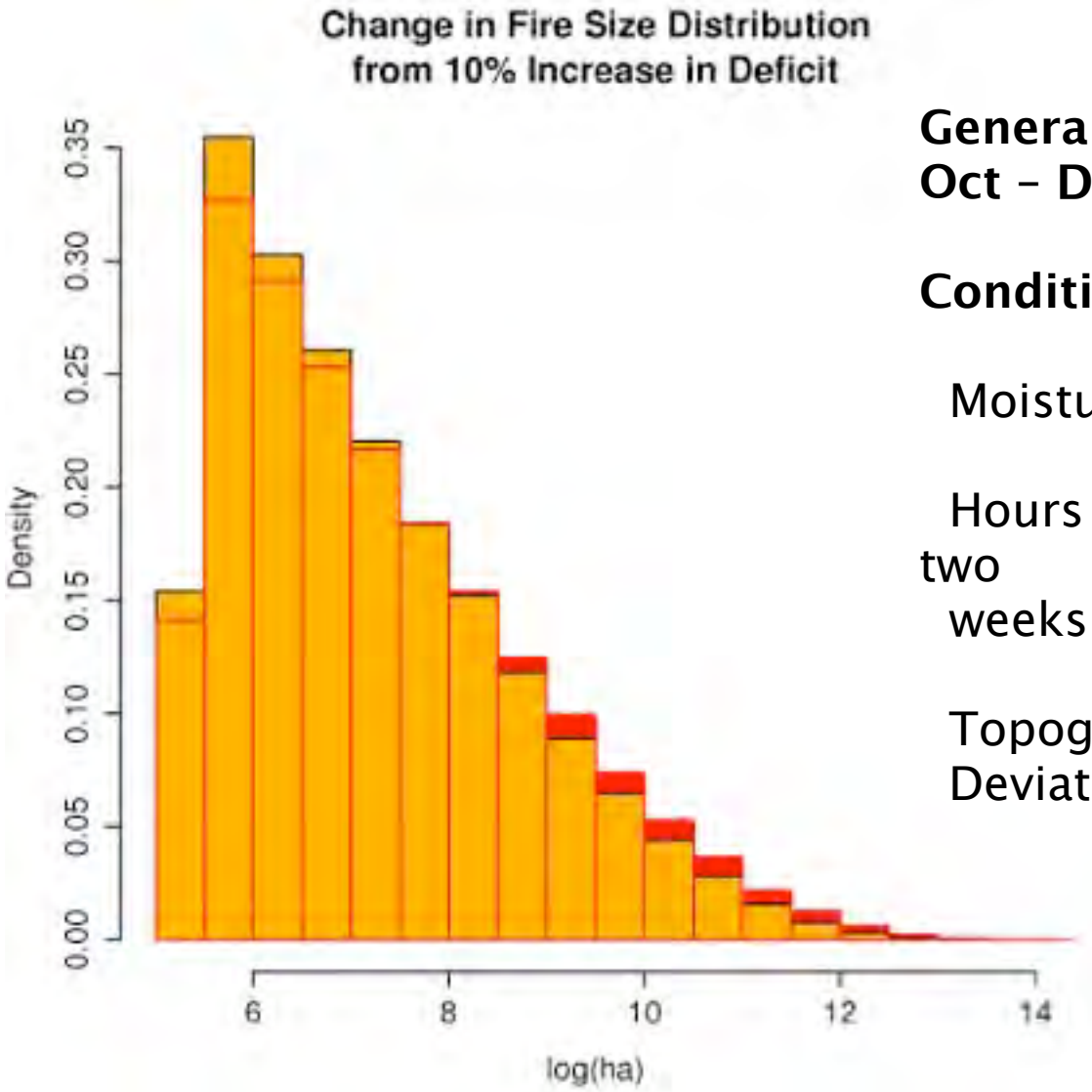



ge in October Deficit, End of Century
percent
6
12
19
25
−120
−119
−118
−117
−116
−115




Density
0.0
0.1
0.2
0.3
0.4
5
6
7
8
9
10
11
12
Observed fire sizes (log-scale)


Density
0.0
0.1
0.2
0.3
0.4
5
6
7
8
9
10
11
12
Simulated fire sizes (log-scale)



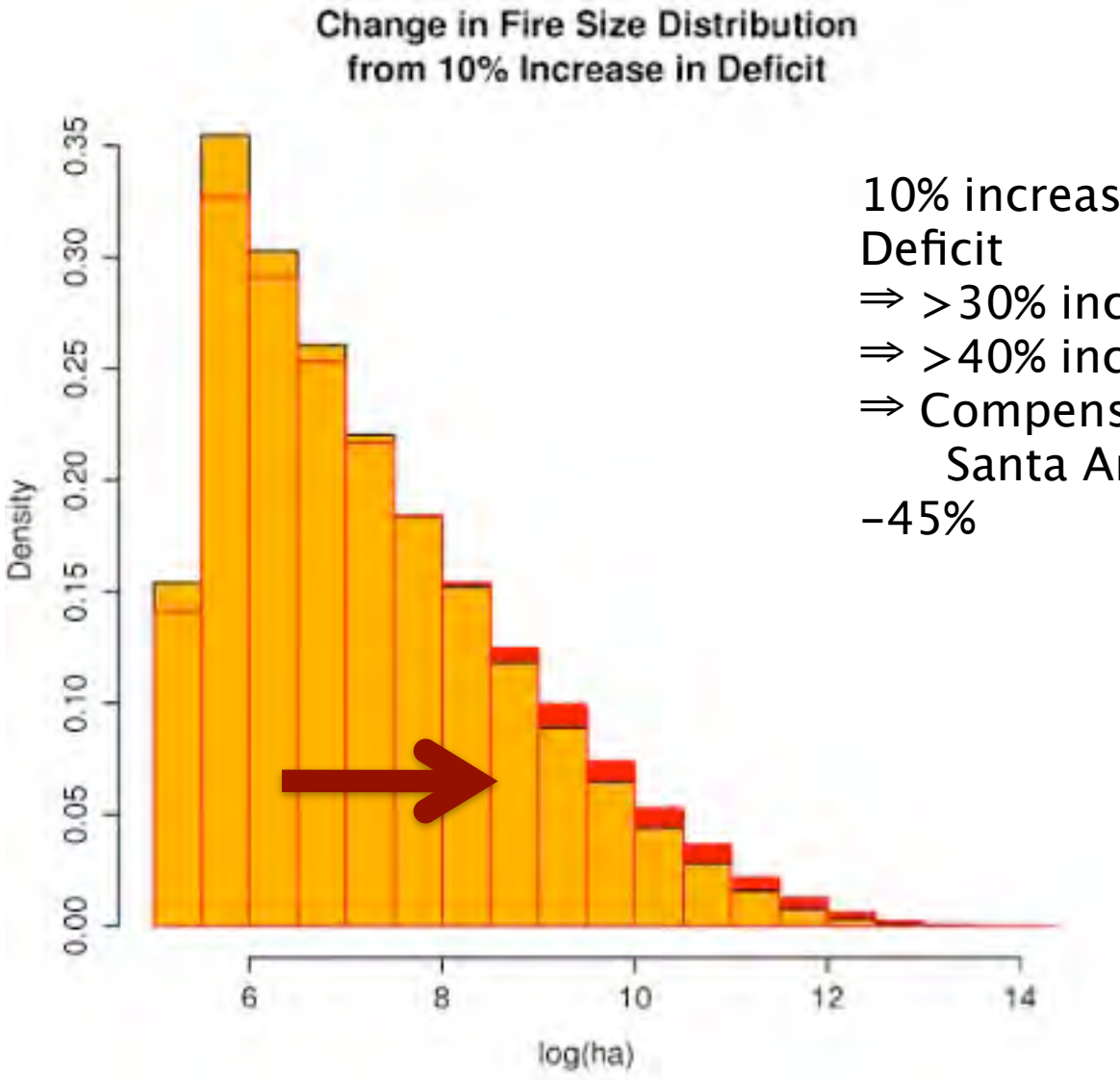
Generalized Pareto Distribution for Oct – Dec fire size

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

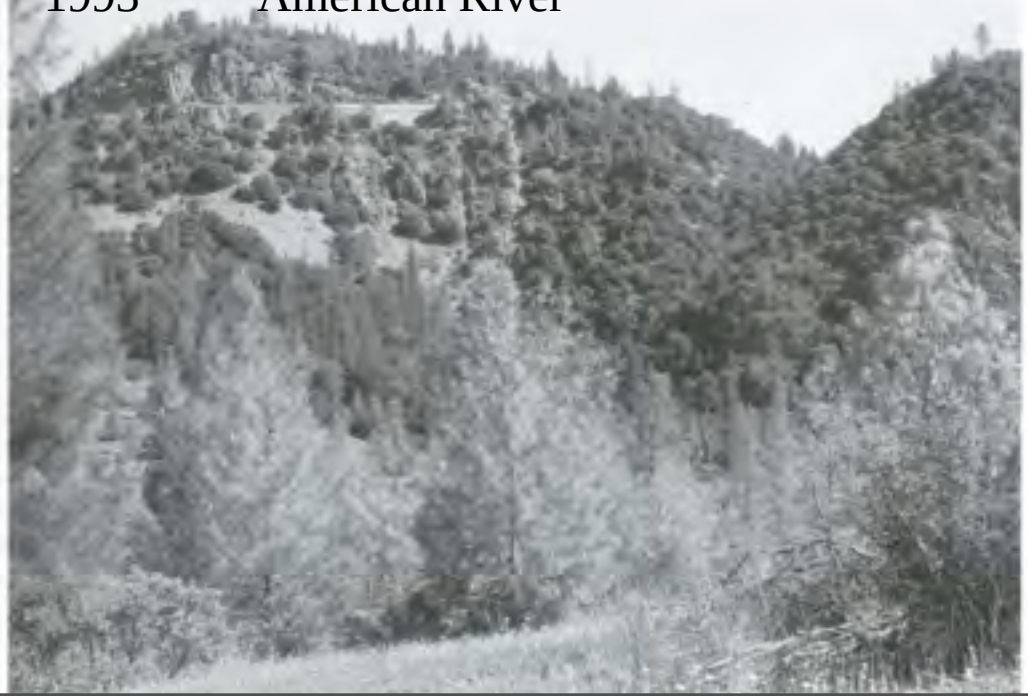
⇒ Compensating Change in hours of Santa Ana conditions required: -45%

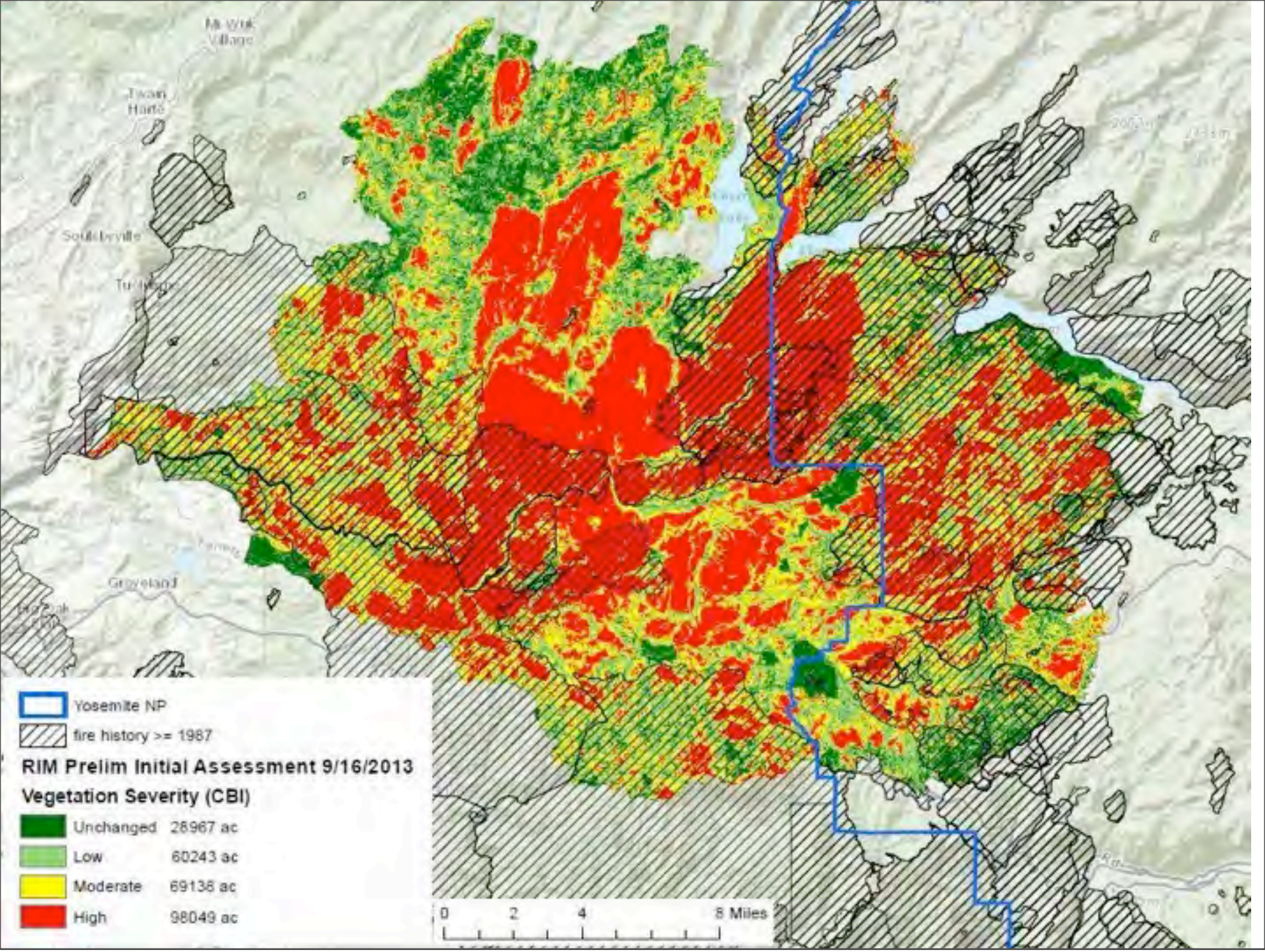
Understory Fire Regimes

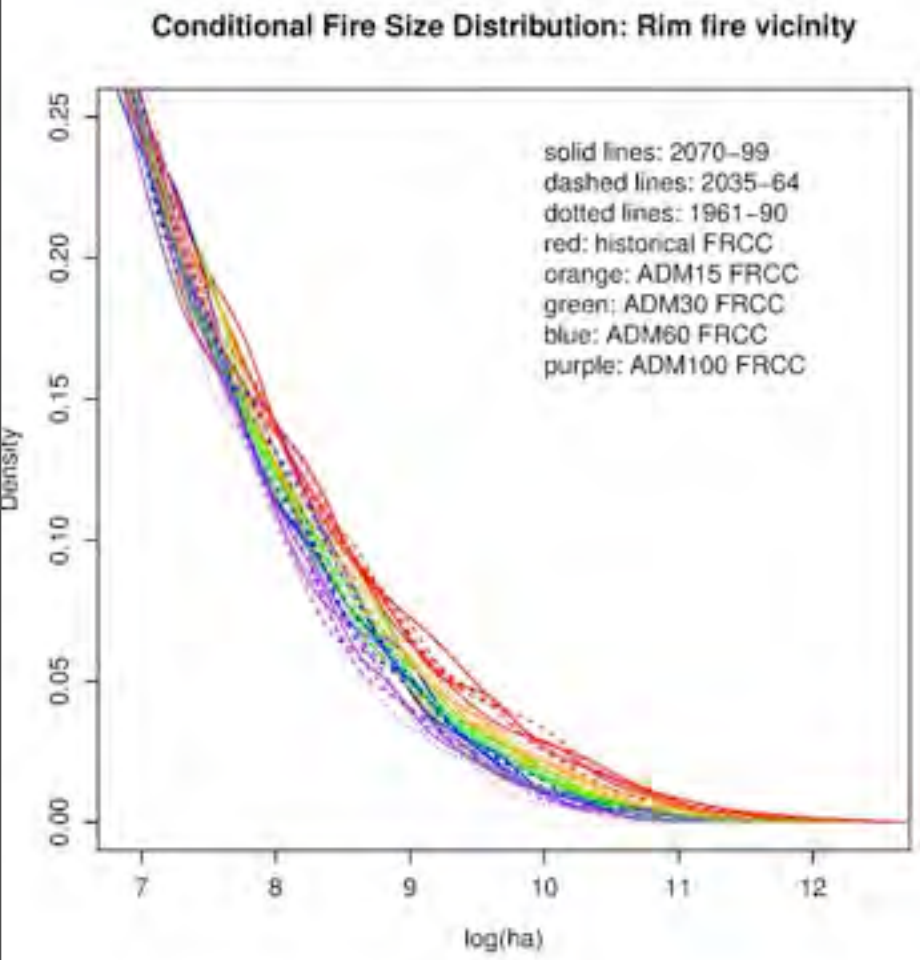
- Fire suppression has increased amount and connectivity of fuels
  - Unnatural increase in tree density
- Fire regime **has** changed
  - Fires are less frequent and more severe
  - Increased risk of

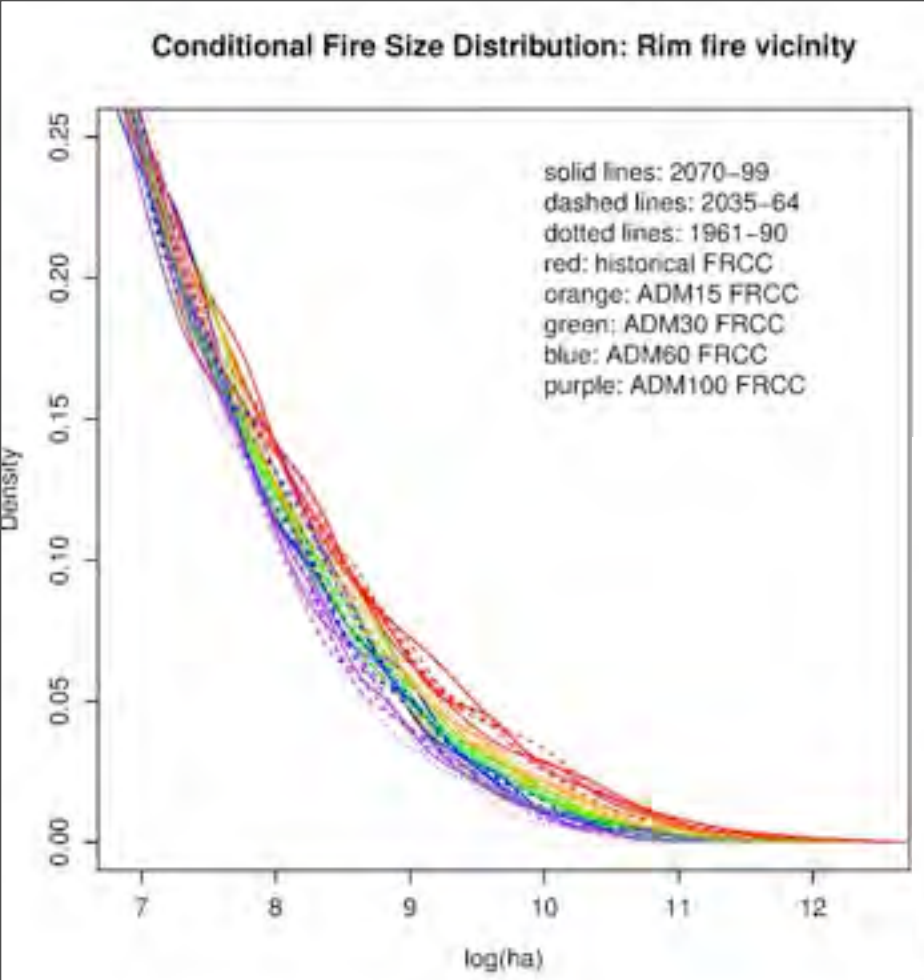
1867 American River

1993 American River




Yosemite NP
fire history >= 1987
RIM Prelim Initial Assessment 9/16/2013
Vegetation Severity (CBI)
Unchanged 26967 ac
Low 60243 ac
Moderate 69136 ac
High 98049 ac
0 2 4 8 Miles


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
8
9
10
11
12
log(ha)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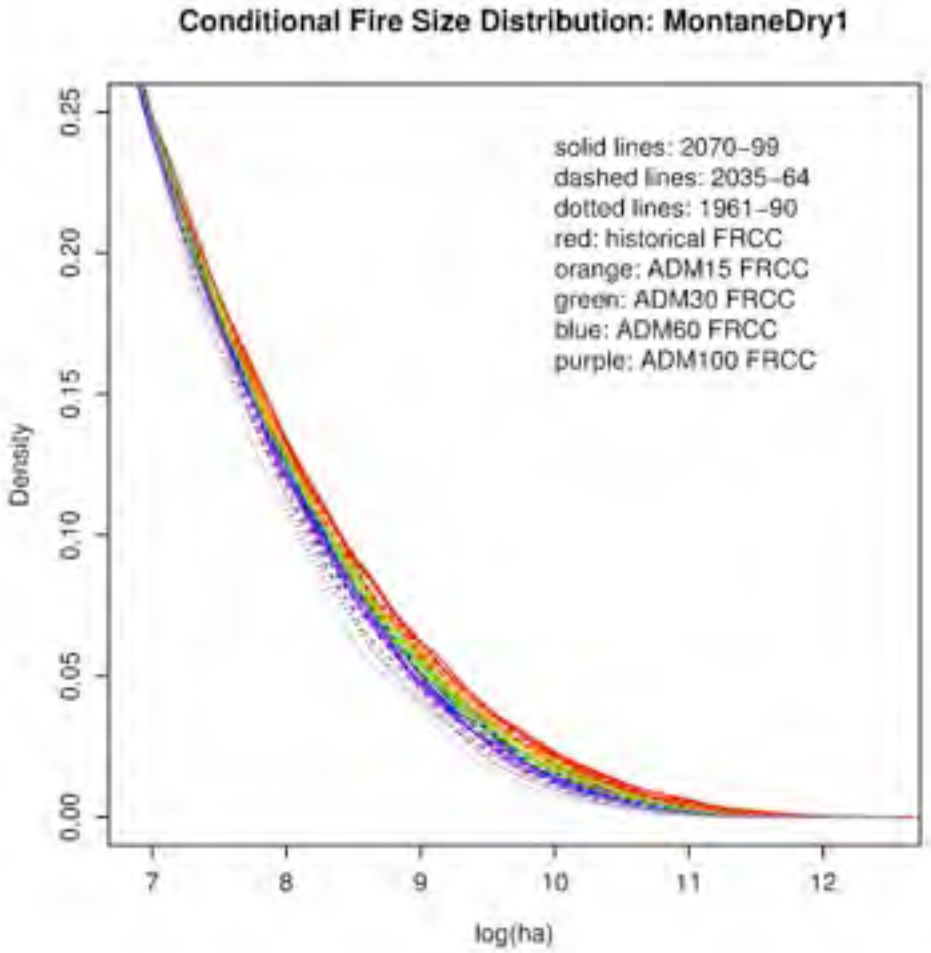
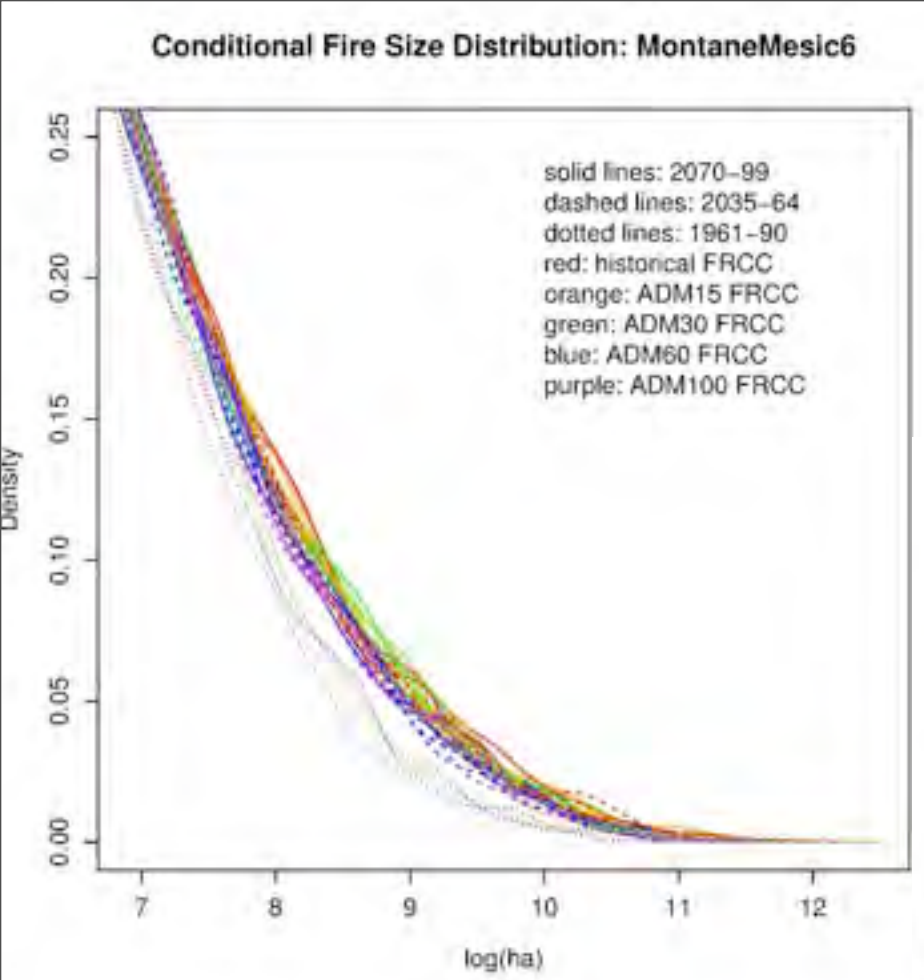
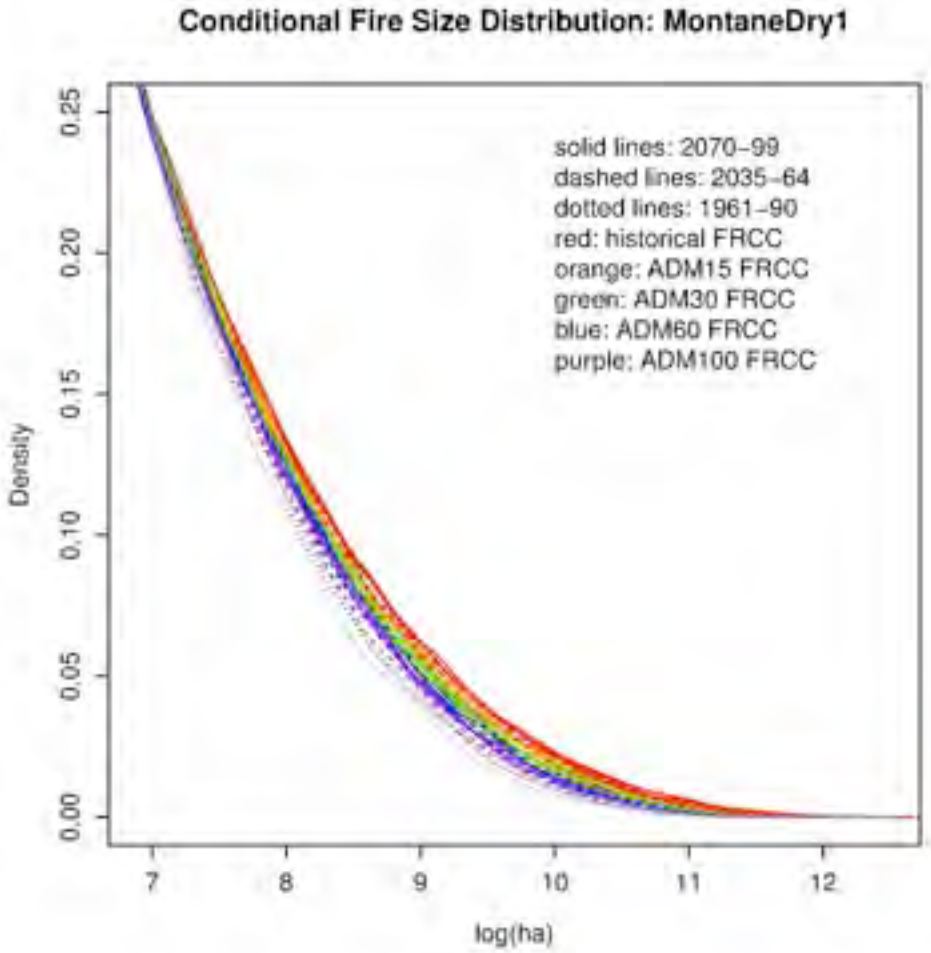
orange: ADM15 FRCC
green: ADM30 FRCC
blue: ADM60 FRCC
purple: ADM100 FRCC
Density
0.00
0.05
0.10
0.15
0.20
0.25
7
8
9
10
11
12
log(ha)


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
Density
0.00
0.05
0.10
0.15
0.20
0.25
7
8
9
10
11
12
log(ha)


Conditional Fire Size Distribution: MontaneMesic6
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
8
9
10
11
12
log(ha)


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
Density
0.00
0.05
0.10
0.15
0.20
0.25
7
8
9
10
11
12
log(ha)