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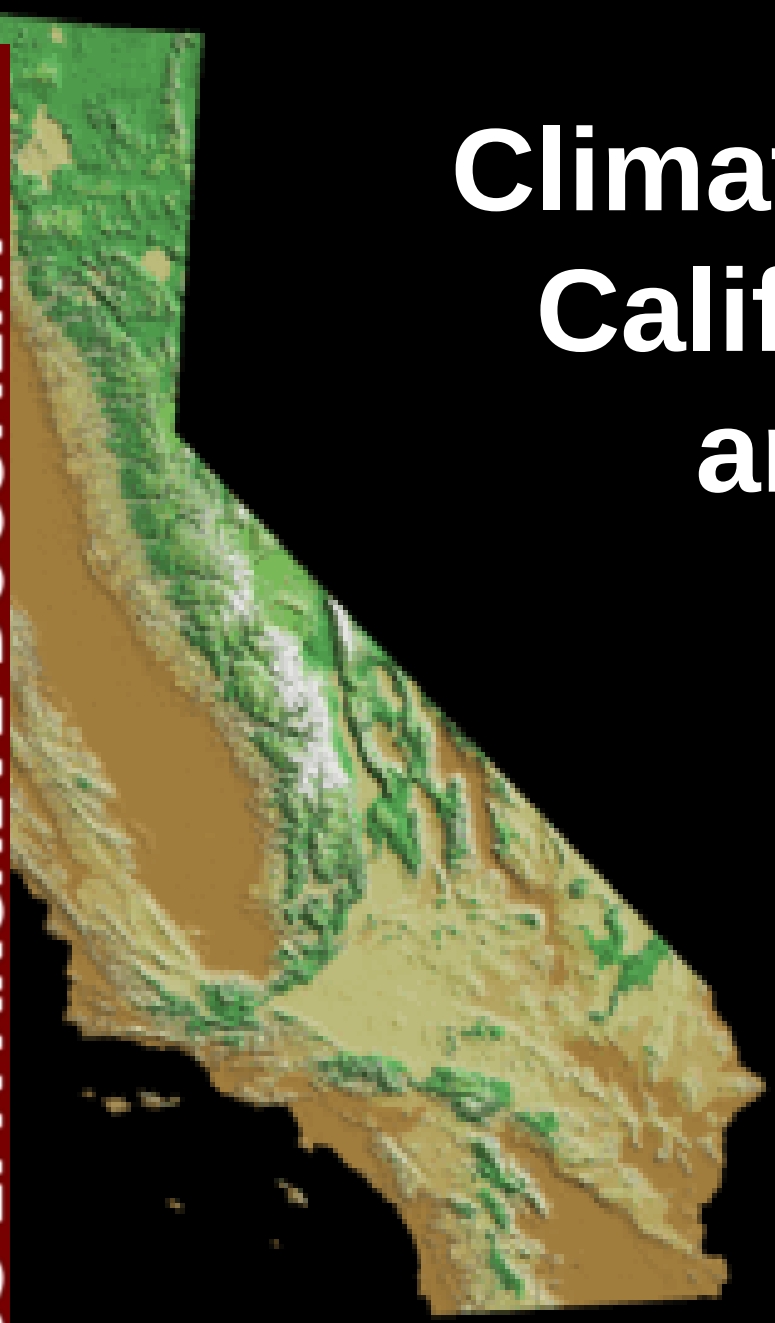
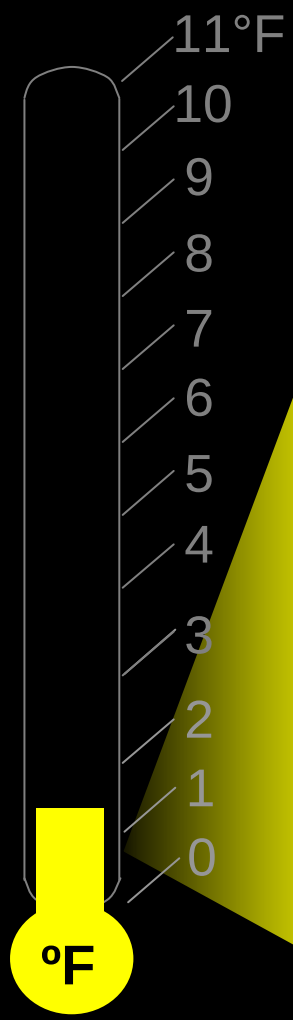


Climate Change and Air Qual
California Research Finding
and Policy Implications

Bart E. Croes, P.E., Chief
Research Division

California Air Resources Board

California Climate Impacts
over the past 100 years



1.3ºF (0.7°C) high
temperatures

7 inch sea level r

12% decrease in fra
of runoff between A
and July

snowmelt and spr
blooms advance
2 days/decade since

4-fold increase in wi
frequency (over 34 y

Lyell Glacier

Yosemite National Park

1903

2003

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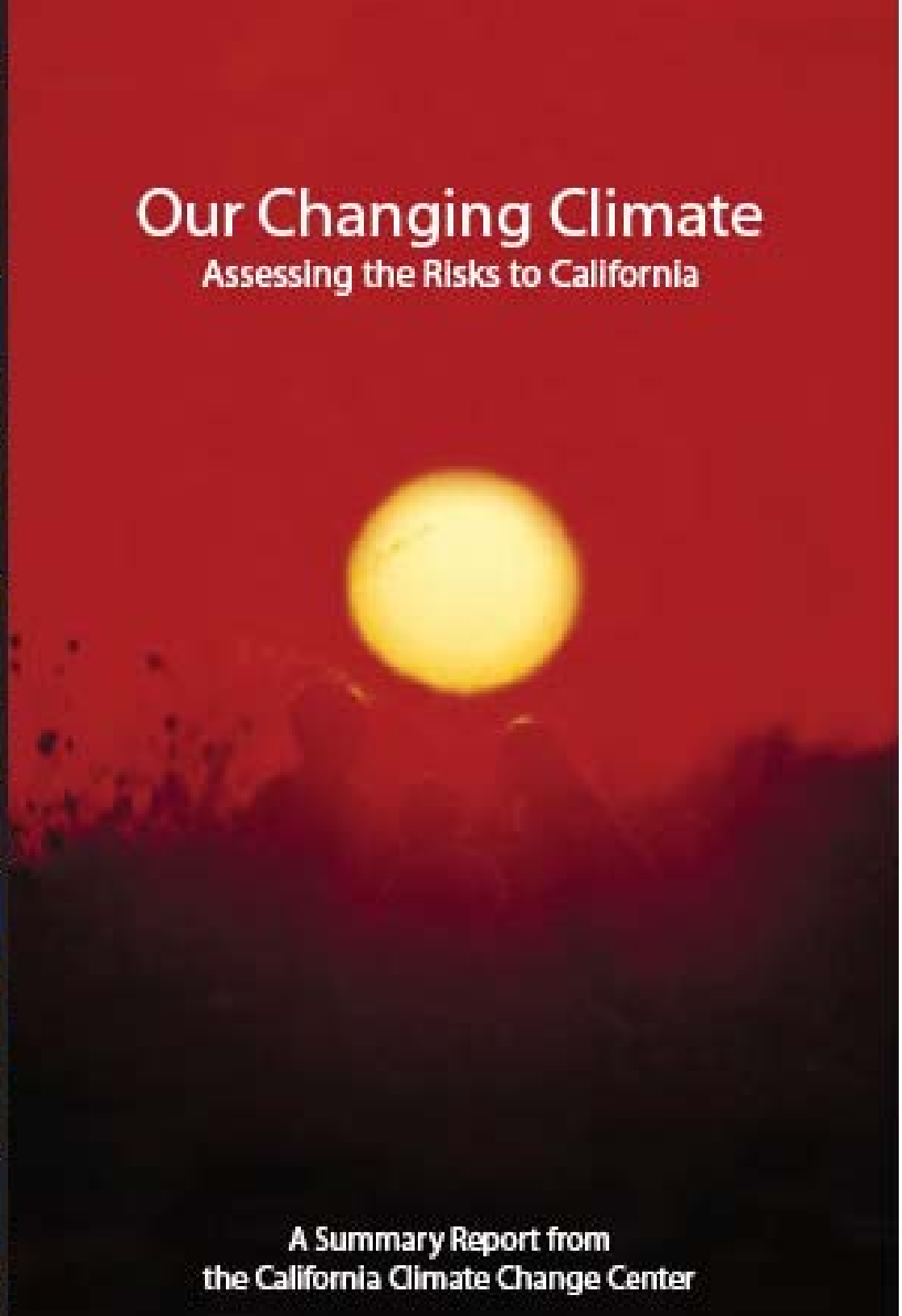
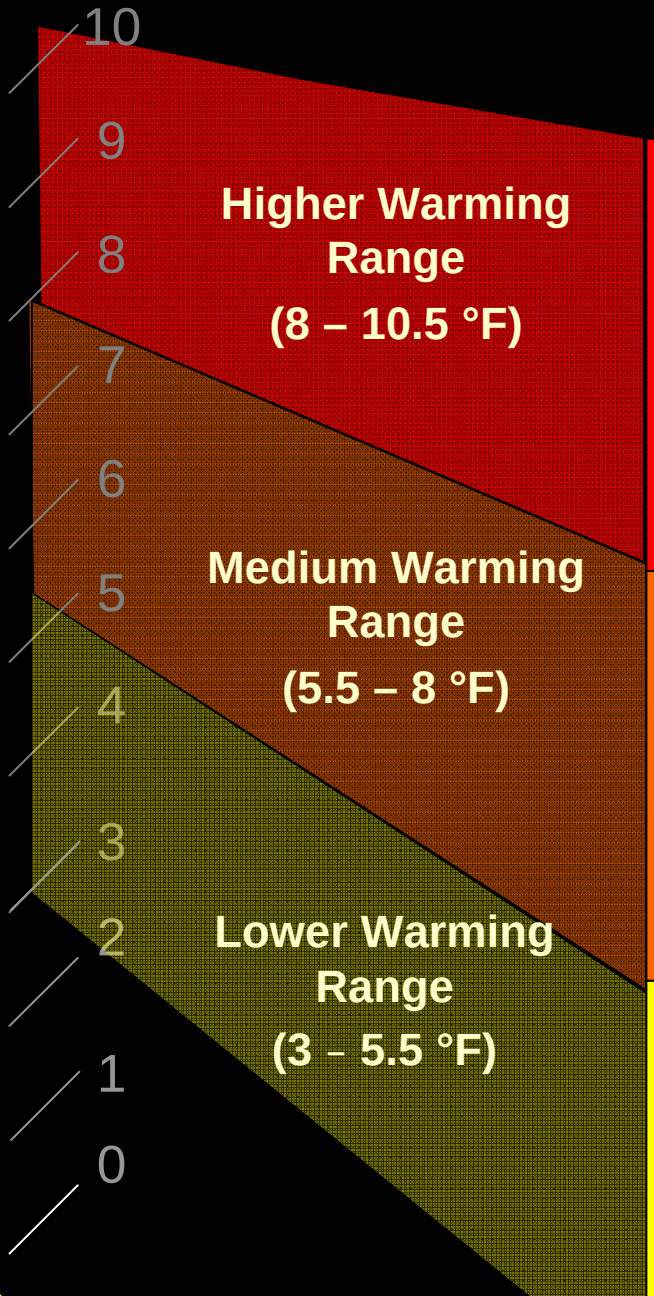


California Clim
Change Scenar
Assessment

Governor Schwarzene
June 2005 Executive
commissioned thi
peer-reviewed Clim
Assessment (release
March 2006), whic
investigated potential
change impacts a
provided key scientific
to California's landm
greenhouse gas redu
legislation, Assembly

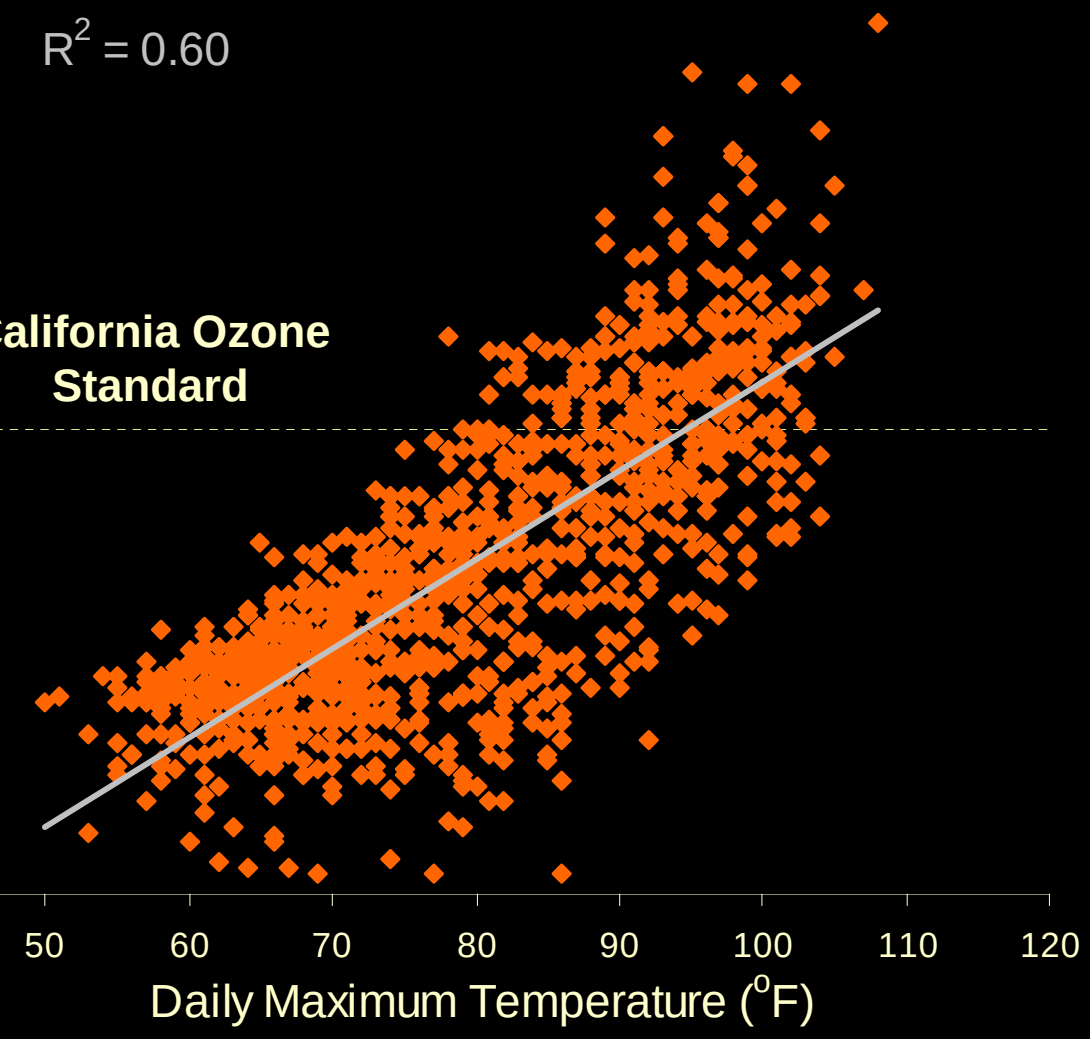
(as compared with 1961-1990)



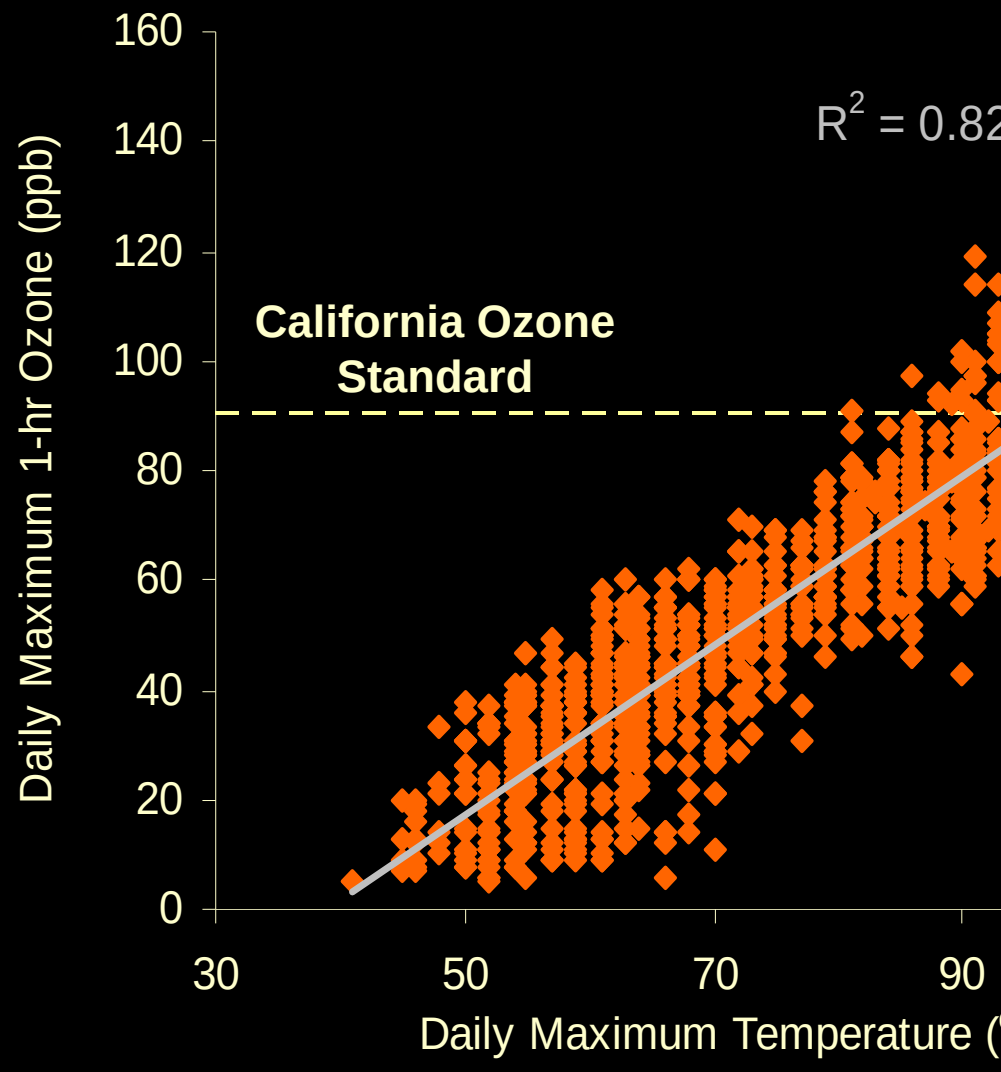
Sierra Snowpack	Sea Level	Energy Demand
↓ 90% loss	↑ 22-30”	↑ 20%
↓ 70-80% loss	↑ 14-22”	↑ 10%
↓ 30-60% loss	↑ 6-14”	↑ 3-6%

Implications of Climate Change for Air Quality

Ozone versus Temperature

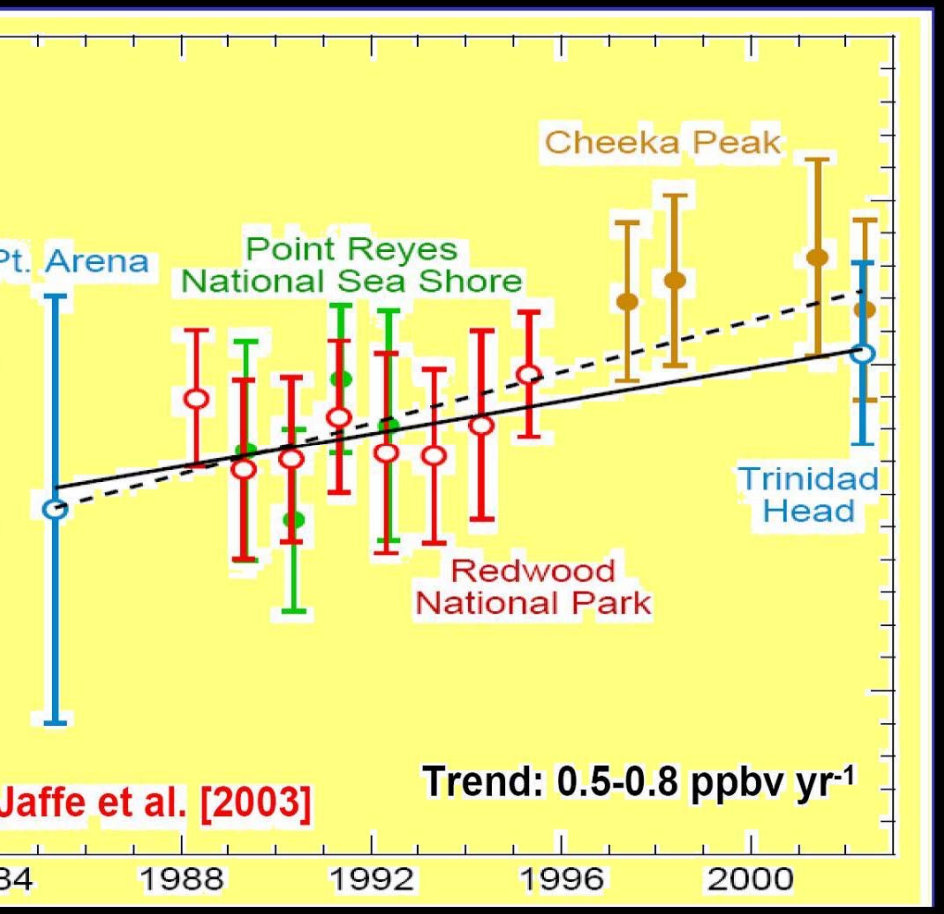


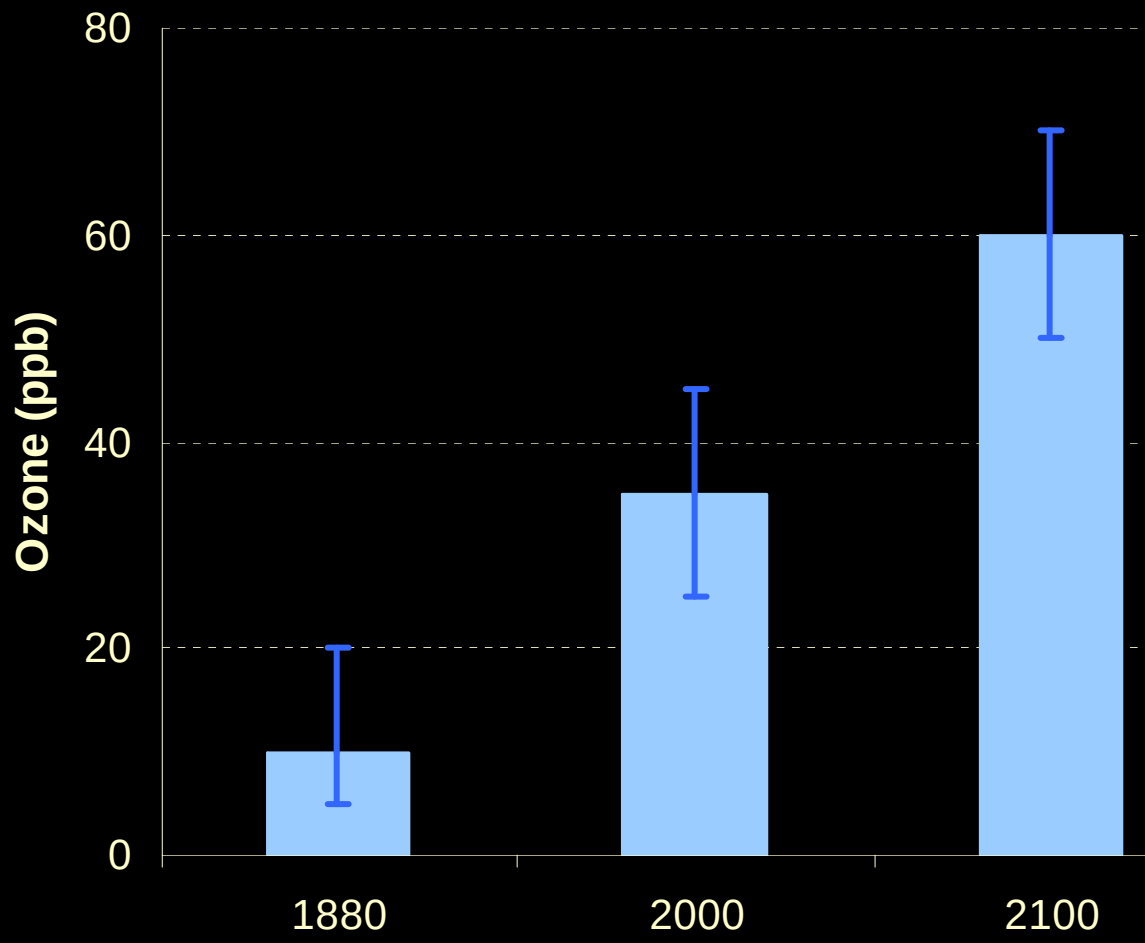
Riverside, 2003-2005



Fresno, 2003-2005

Increase in Background Ozone



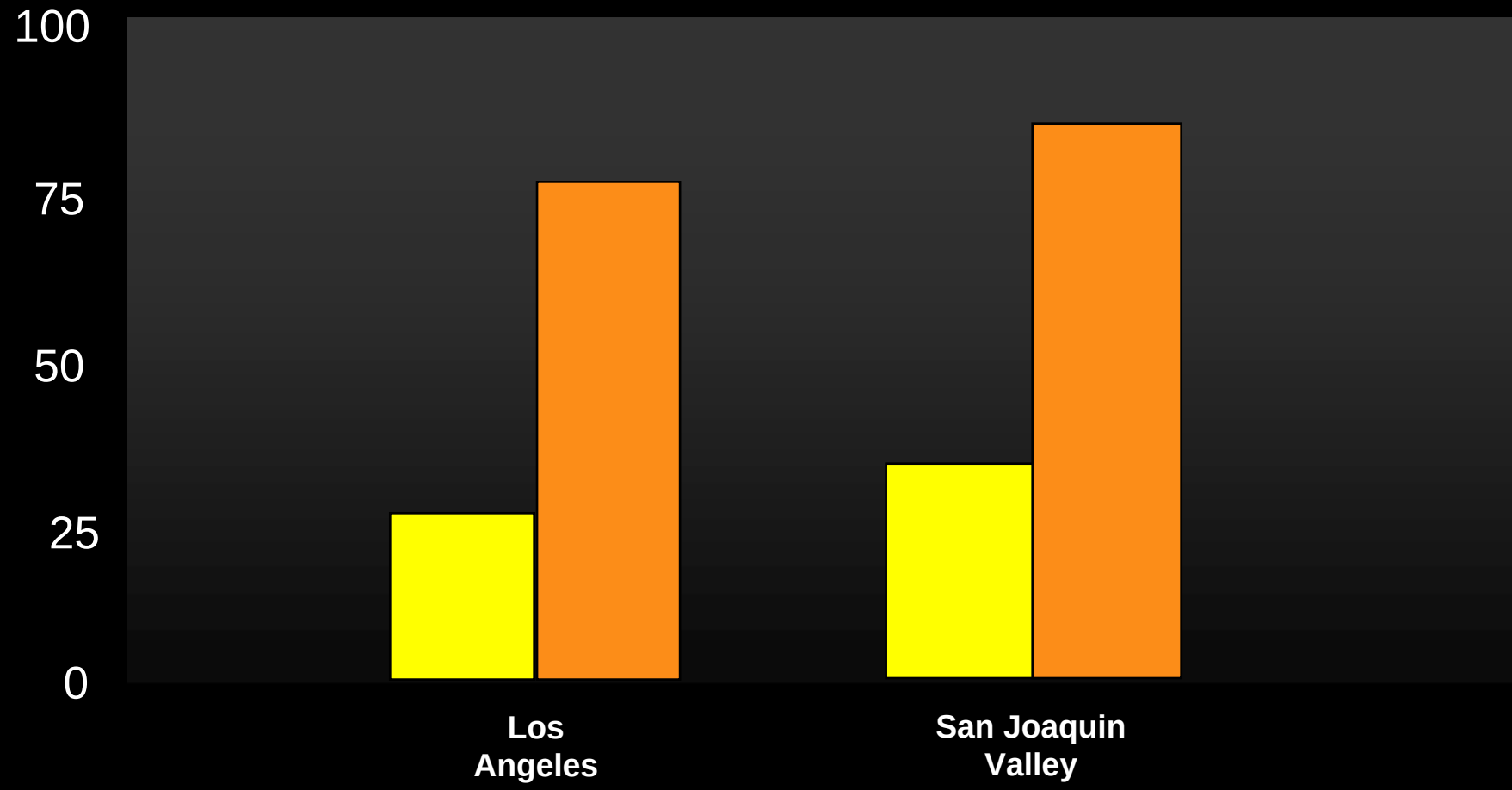


bserved trends in
ckground ozone levels in
lifornia (Jaffe et al., 2003)

Background ozone levels i
the Northern Hemisphere
(Vingarzan et al., 2004)

jected Episodic Response to Clim

days per year > 90 ppb ozone

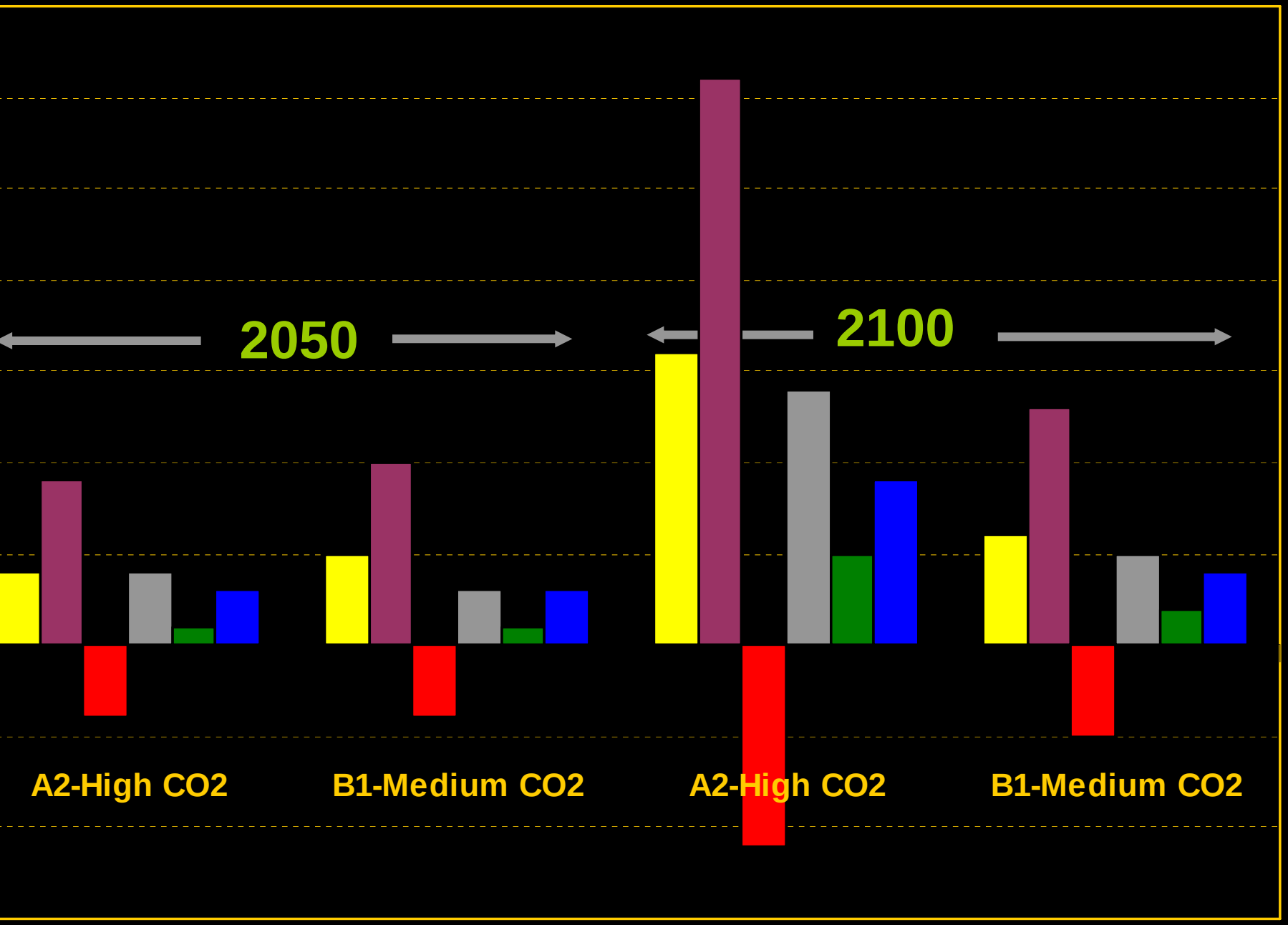


Lower Warming Range (3 – 5.5 ºF)

Medium Warming Range (5.5 – 8 ºF)

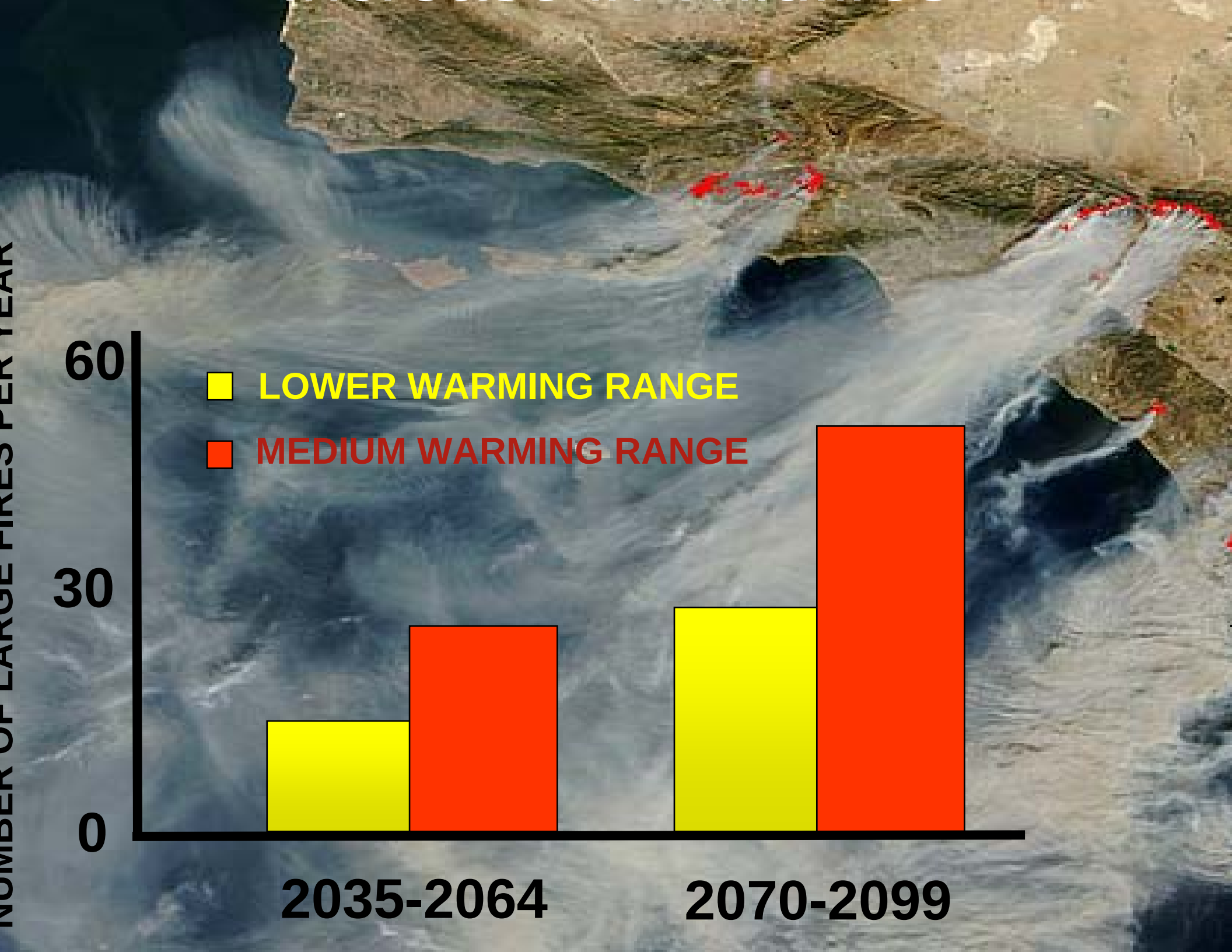
Increasing GHG Emissions

Motor Vehicle Emissions

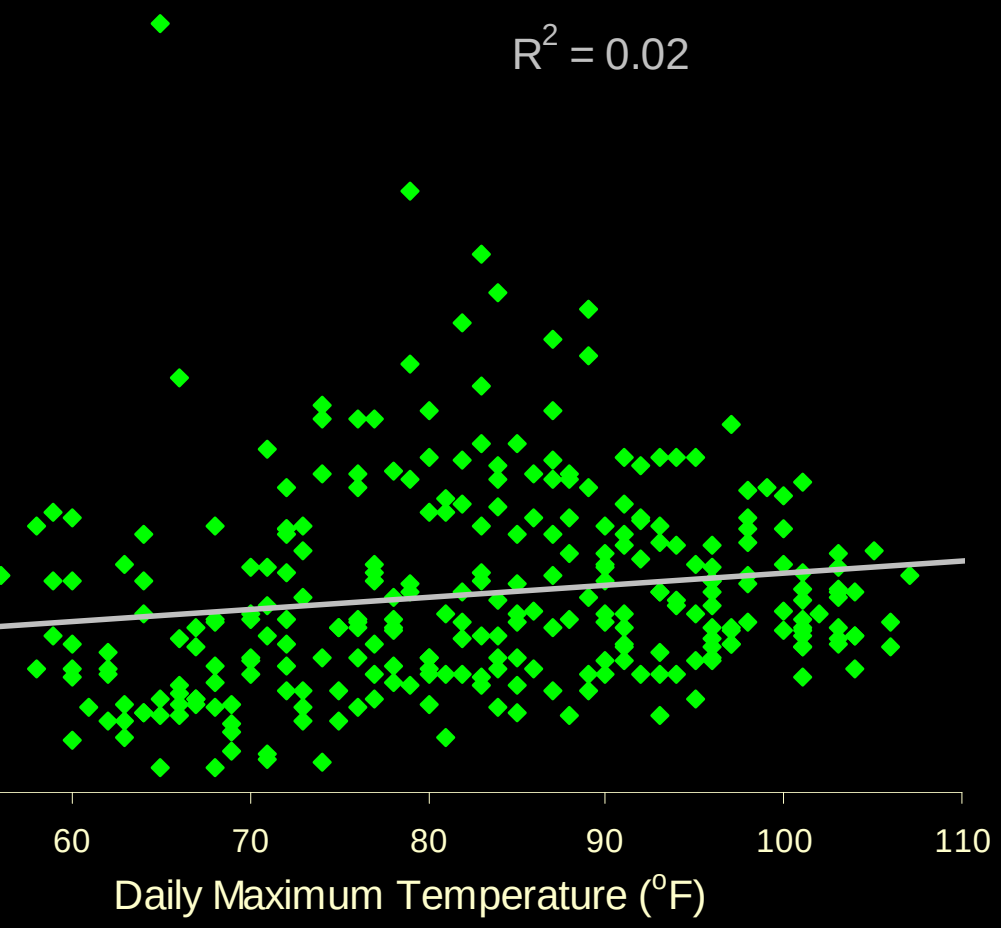


Future cl
in vehicl
populatio
technolo
activity r
consider

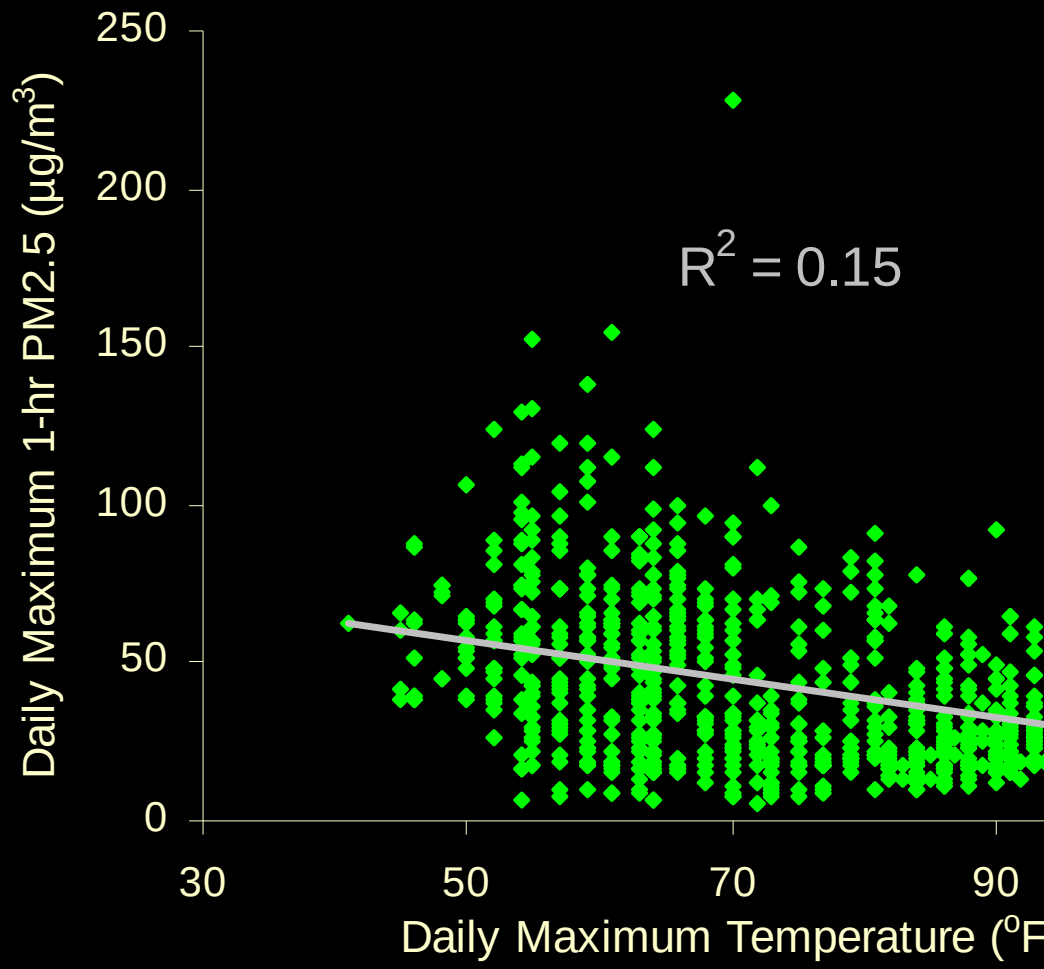
Total ROG | Evaporative ROG | NOx | CO | CH4 | CO2


NUMBER OF LARGE FIRES PER YEAR
60
30
0
LOWER WARMING RANGE
MEDIUM WARMING RANGE
2035-2064
2070-2099

PM2.5 versus Temperature



Riverside, 2003-2005



Fresno, 2003-2005

Ongoing Research

2008 Scenario Analysis

Economic Analysis

Costs of unmitigated impacts, adaptation, and mitigation

Socioeconomic Considerations

Projections of changes in population and demography

Effects on environmental justice communities

Air Quality Projections

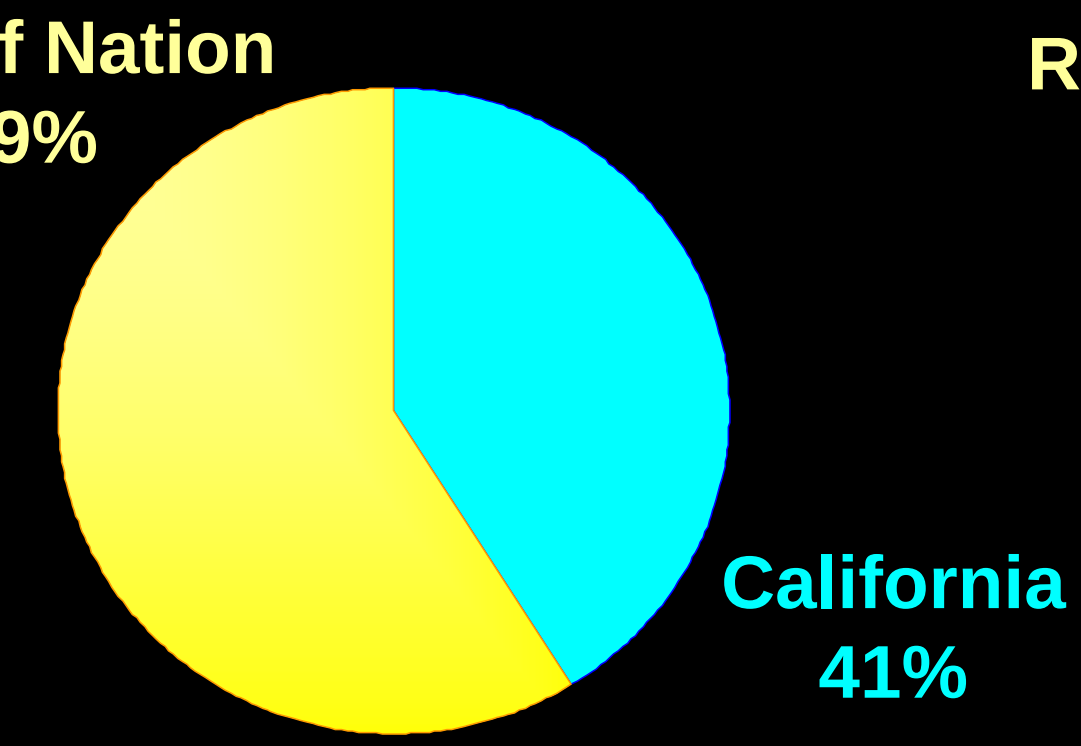
2050 ozone and PM2.5 for central and southern Californi

Include changes in inversion frequency, emission effects

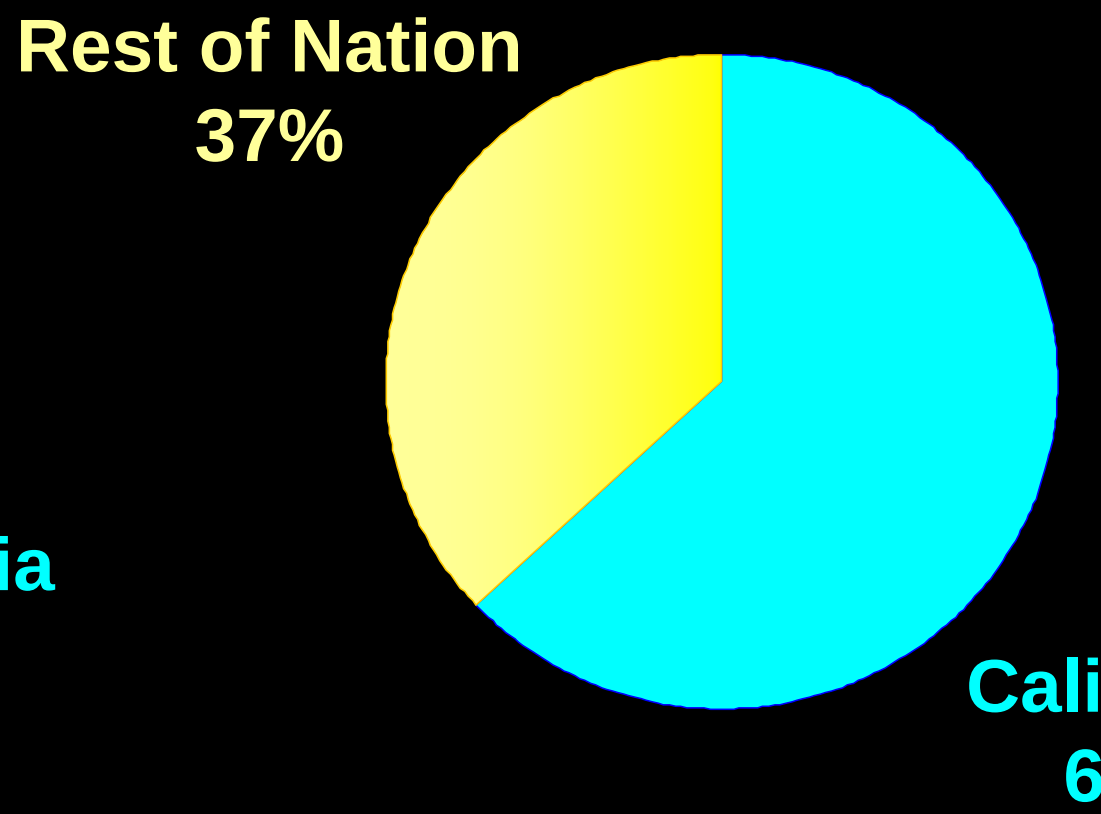
antify increased death and disease due to “climate pena

California's Disproportionate Air Pollution Exposure

8-Hour Ozone
(NAAQS = 80 ppb)



Annual PM2.5
(NAAQS = 15 µg/m³)



Air Pollution and Premature Death

Bounding Estimates for California, 2005

Pollutant	Annual Deaths*
PM2.5	13,000 to 22,000
PM10	1000 to 2000
Ozone	800
Toxic Air Contaminants	400

SIP Considerations

Limitations

Time frames do not match

imate change tools not accurate for planning horiz

Opportunities

dd temperature sensitivity to air quality models run

Estimate air pollutant co-benefits of greenhouse ga
reduction measures

on-Kyoto Climate Forcers in Californ

Preliminary Calculations

Climate Forcer	$MMTCO_2E$	2005-2020 Change[a]
oto (CO_2, CH_4, N_2O, HFC, PFC, SF_6)	500	-15%
Ozone (CO, VOC, NO_X)	-5 – 25	-30%
Diesel PM	15 – 35	-85%[b]
Other PM	unknown	--
Montreal (CFC, HCFC)	40 – 100	unknown

O_2 etc.: AB 32 target. CO, ROG, NO_X: CARB emission inventory for rules already adopted

Summary

California already affected by climate change

uture warming threatens public health, water suppl
and agriculture

imate change makes ozone standards more difficu
attain and maintain – overall impact on PM2.5 an
PM10 is unclear

Air quality controls will have some climate change
benefits – especially diesel PM reductions