Impacts of Climate Change on California

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

California Air Resources Board

California Environmental Protection Agency

California Climate Impacts
over the past 100 years

1.3ºF (0.7℃) higher temperatures

7 inch sea level rise

12% decrease in fraction of runoff between April and July

snowmelt and spring blooms advanced 2 days/decade since 1955

4-fold increase in wildfire frequency (over 34 years)

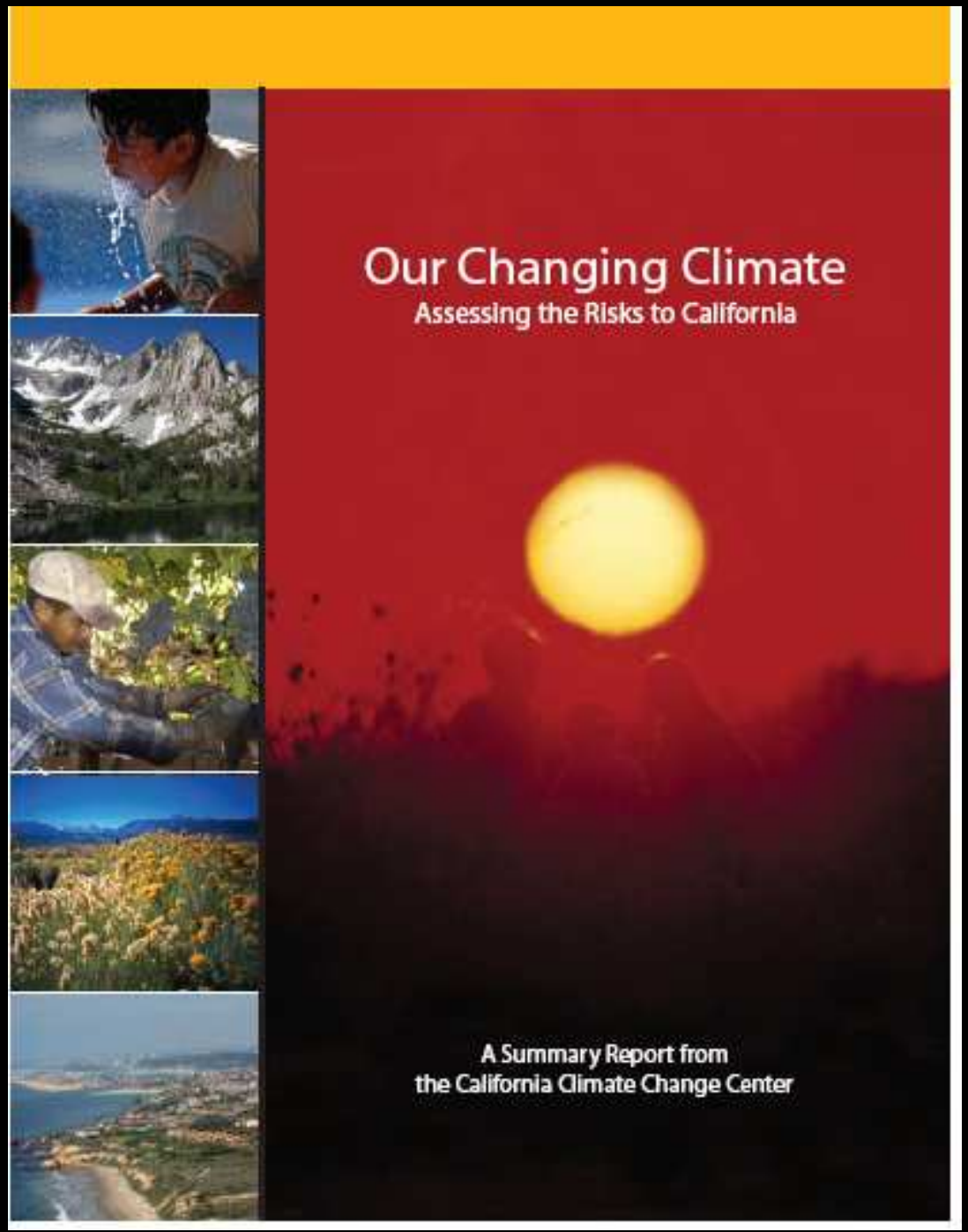
Cal/EPA-OEHHA, “Environmental Protection Indicators for California” (2002)
www.oehha.ca.gov/multimedia/epic/Epicreport.html
Westerling et al., “Warming and Earlier Spring Increase Western U.S. Forest Wildfire Activity”, *Science* (2006)

Lyell Glacier

Yosemite National Park

1903

2003

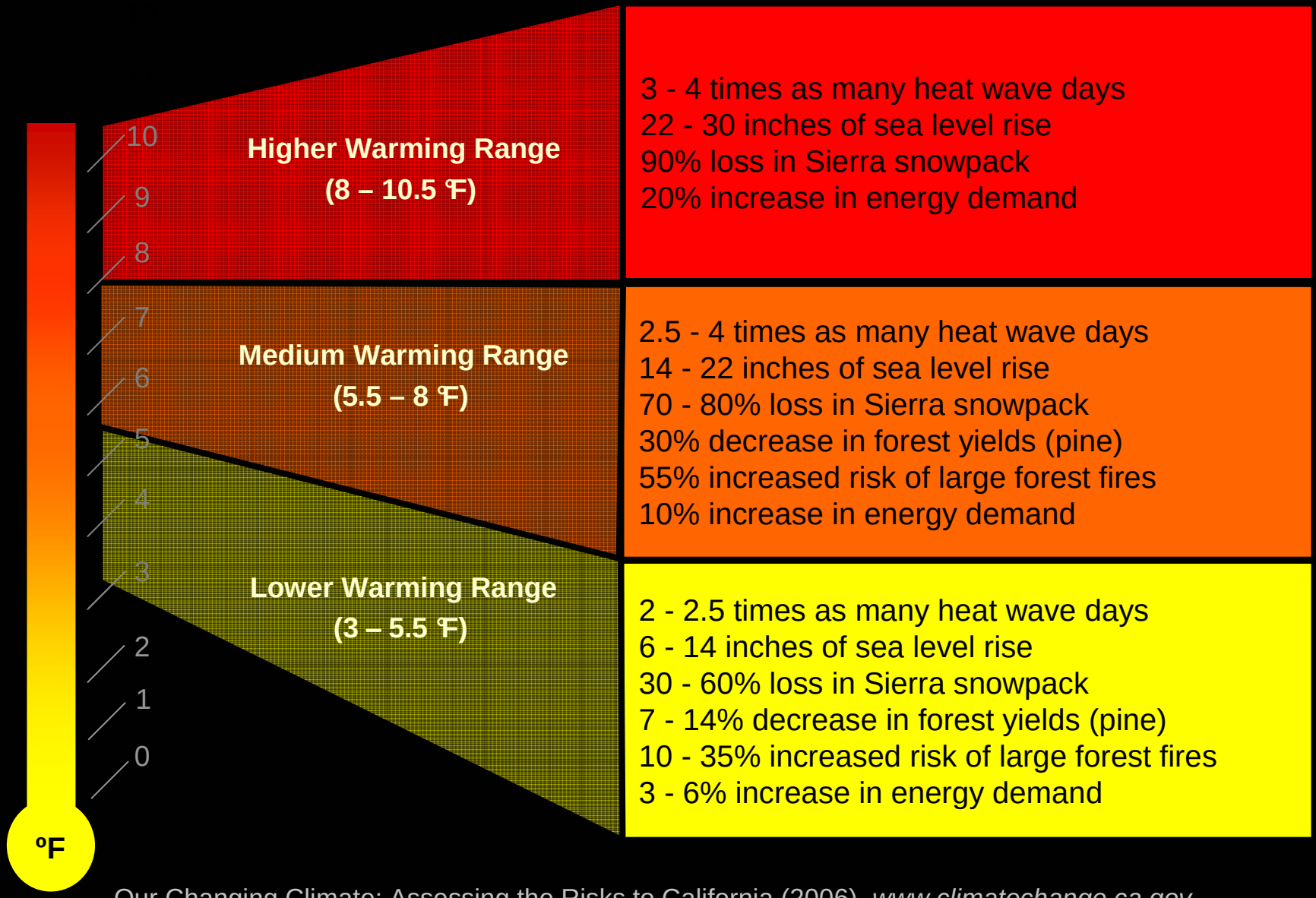


California Climate Change Scenarios Assessment

Governor Schwarzenegger's June 2005 Executive Order commissioned this peer-reviewed Climate Assessment (released in March 2006), which investigated potential climate change impacts and provided key scientific input to California's landmark greenhouse gas reduction legislation, Assembly Bill 32

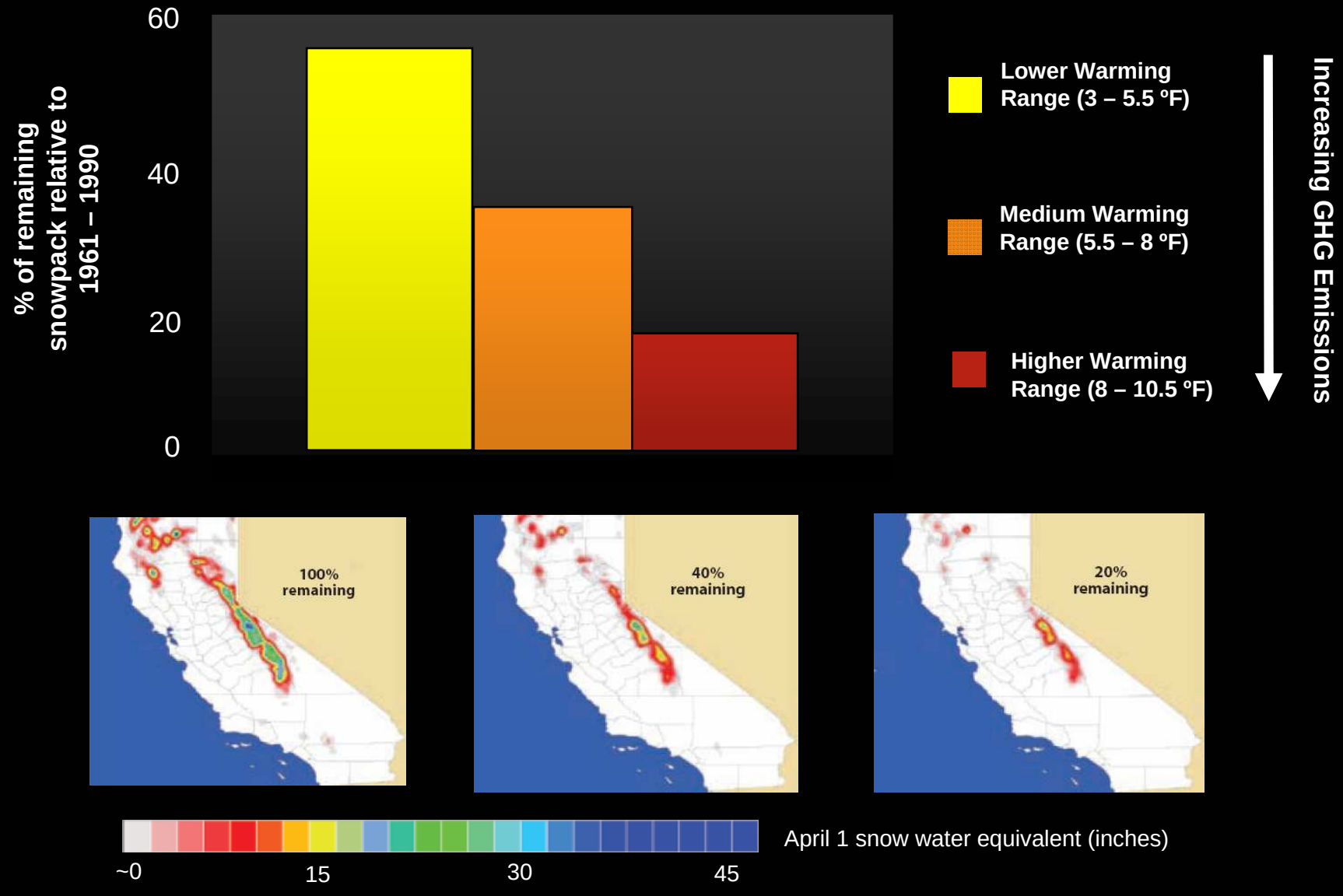
www.climatechange.ca.gov

Projected Climate Impacts on California, 2070-2099
(as compared with 1961-1990)



Our Changing Climate: Assessing the Risks to California (2006), *www.climatechange.ca.gov*

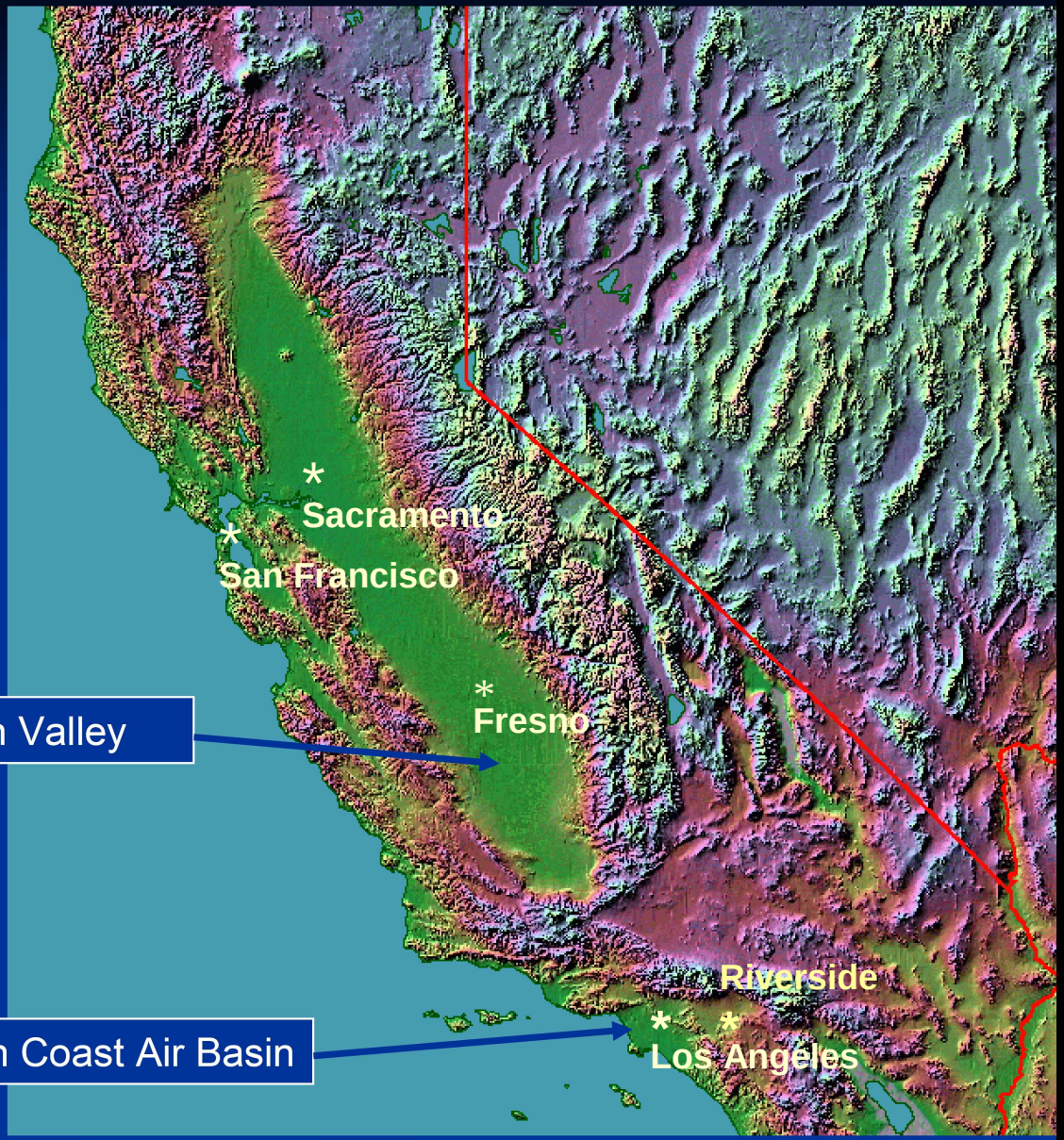
Decrease in Sierra Nevada Snowpack



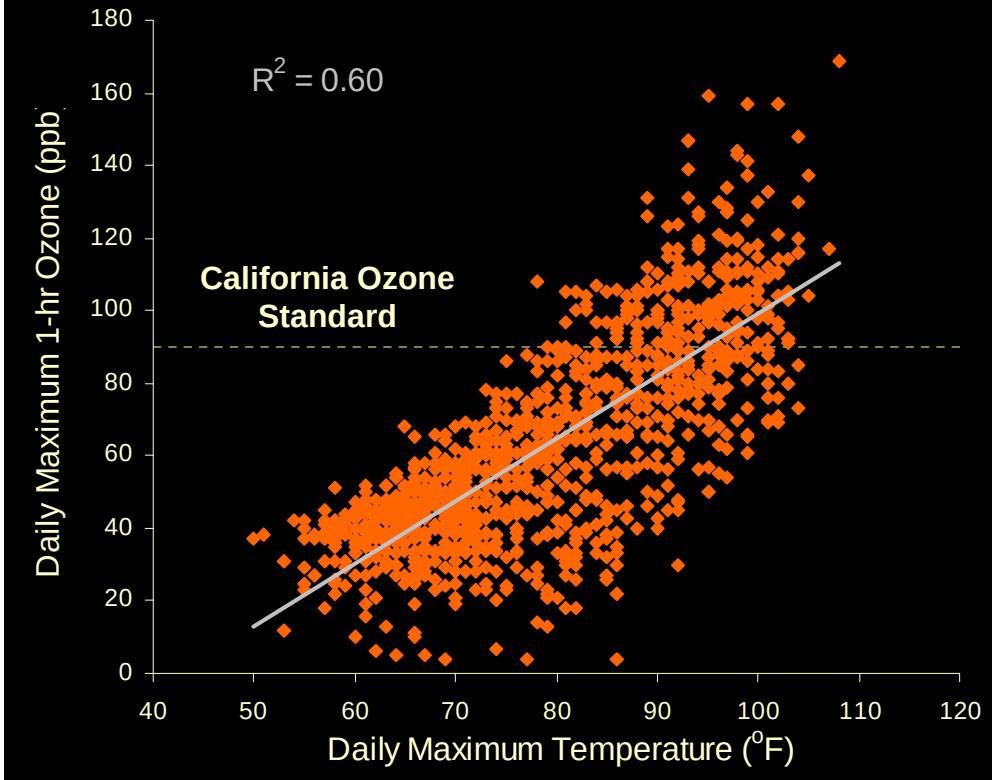
Our Changing Climate: Assessing the Risks to California (2006), *www.climatechange.ca.gov*

Implications of Climate Change for Air Quality

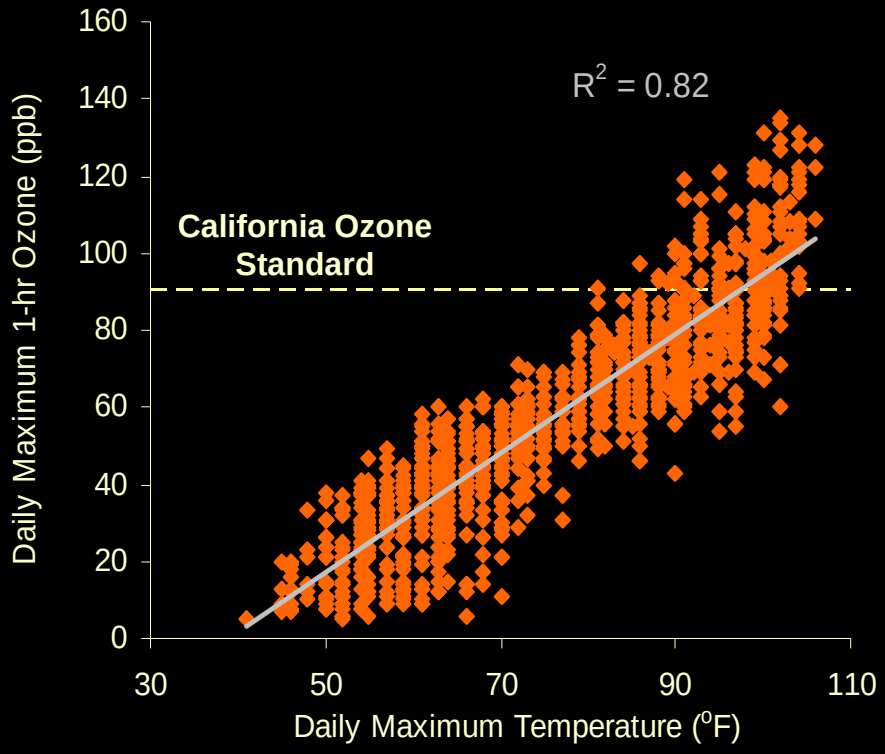
California's Major Air Basins



Ozone versus Temperature



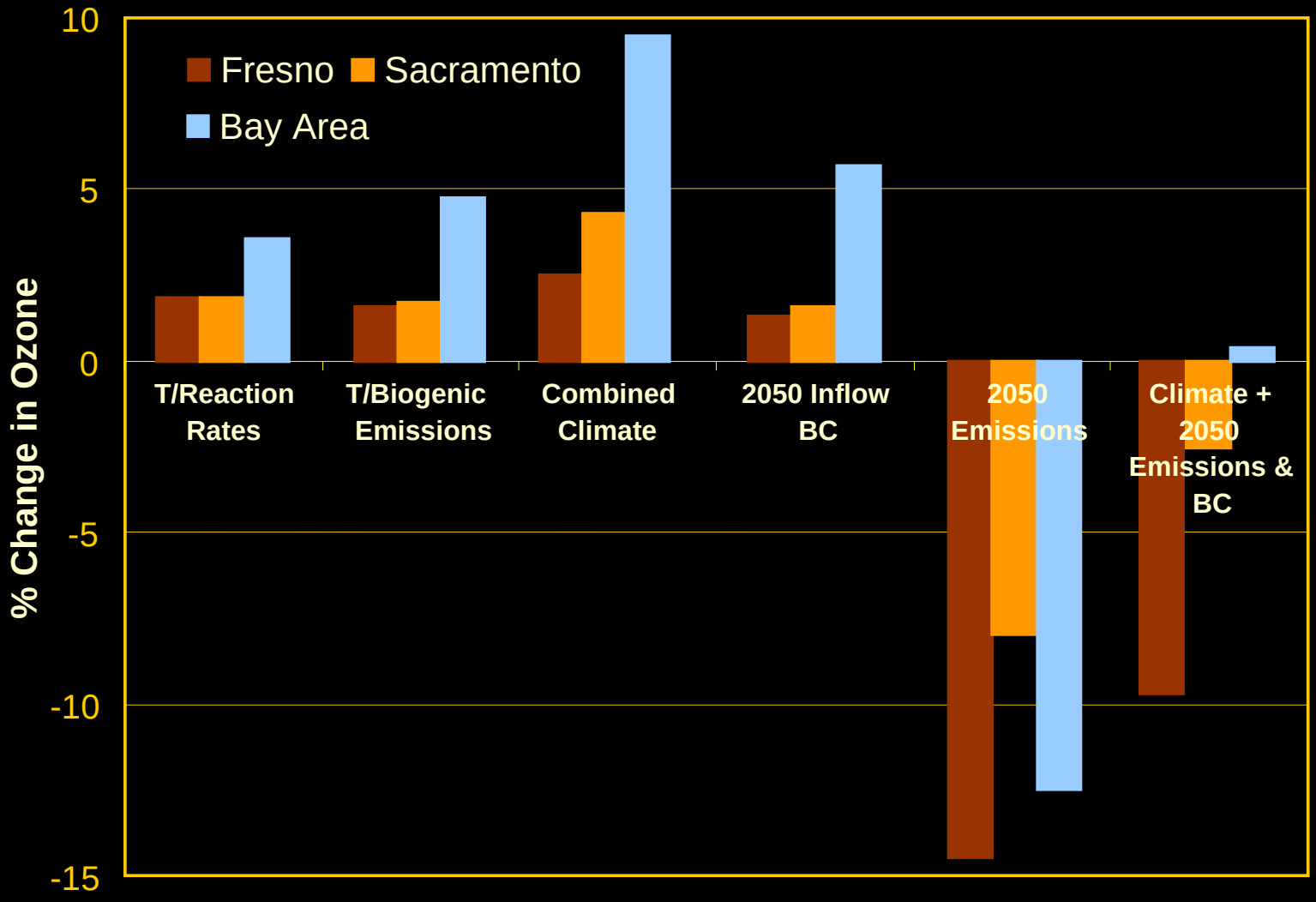
Riverside, 2003-2005



Fresno, 2003-2005

Projected Ozone Response to Climate

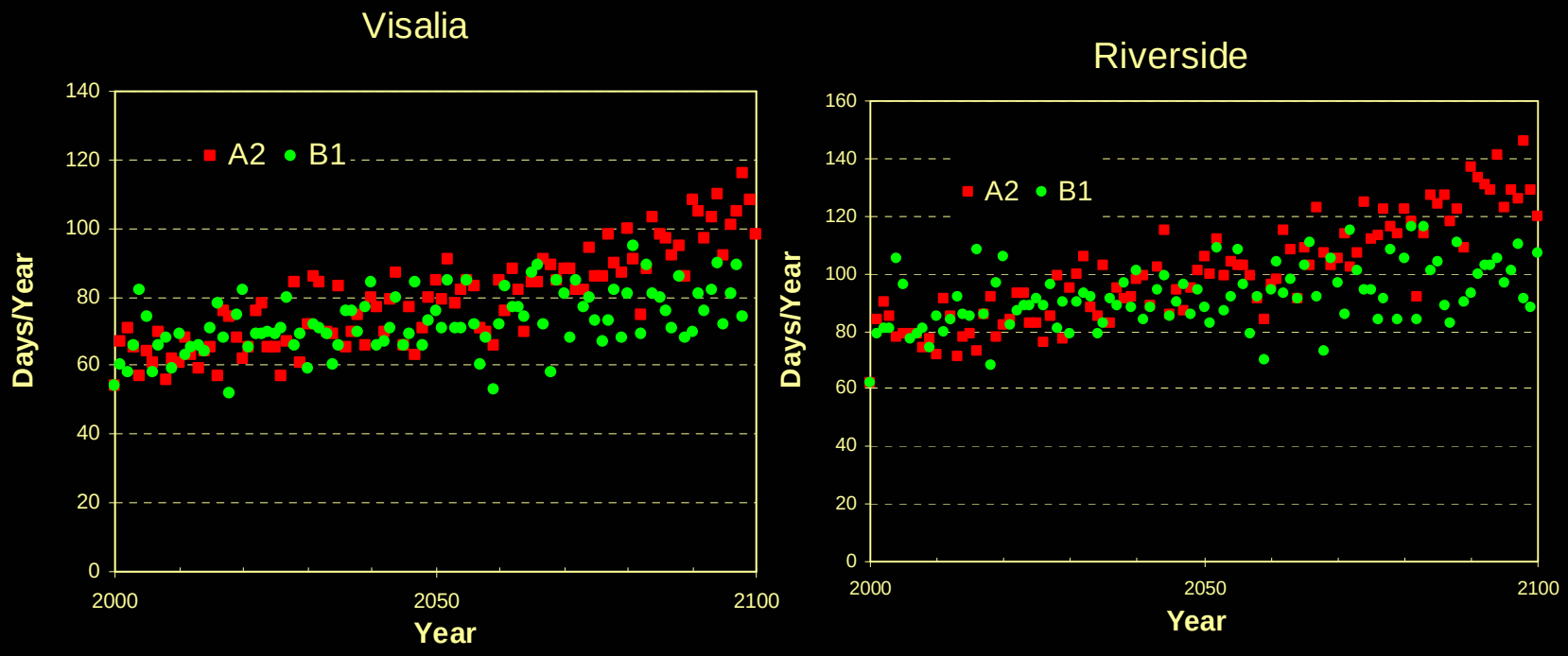
Central California, 2050



Steiner et al., "Influence of future climate and emissions on regional air quality in California", *JGR* (2006)

Projected Episode Response to Climate

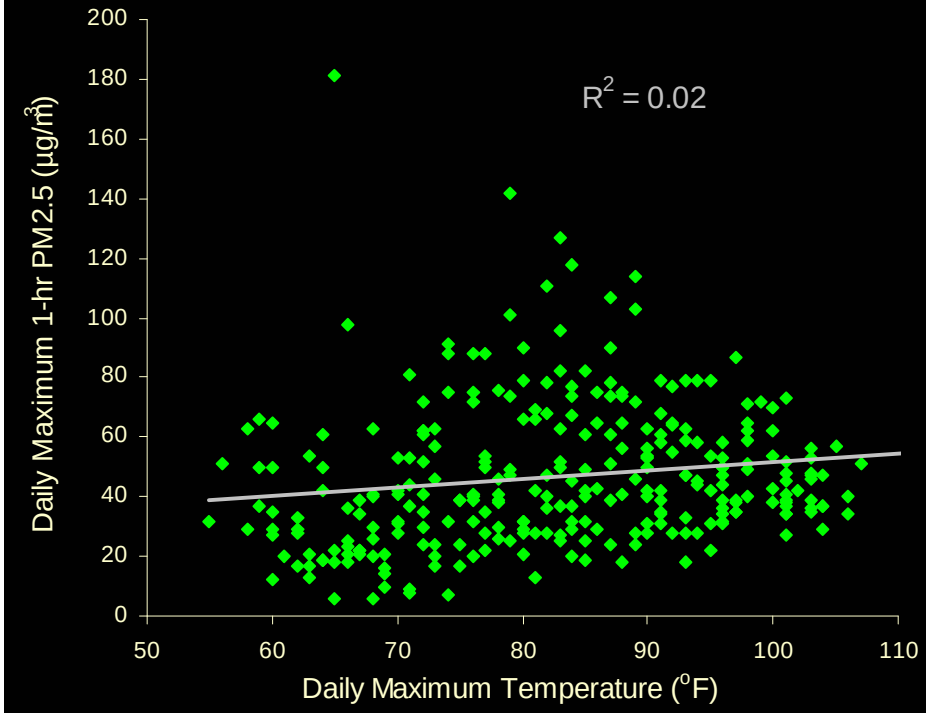
days per year > 90 ppb ozone



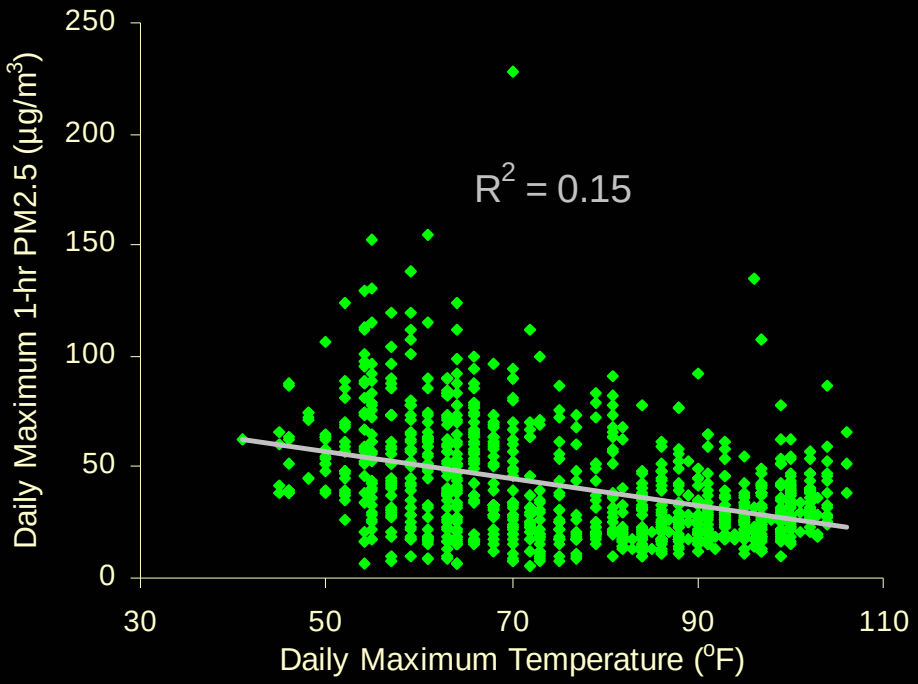
Stagnation events related to temperatures aloft. All other factors assumed to remain stay constant while global emissions follow IPCC projections A2 and B1.

Kleeman and Cayan, “Impact of Climate Change on Meteorology and Regional Air Quality In California”, Interim Report to CARB (2006)

PM2.5 versus Temperature



Riverside, 2003-2005



Fresno, 2003-2005

Projected PM2.5 Response to Climate

South Coast Air Basin

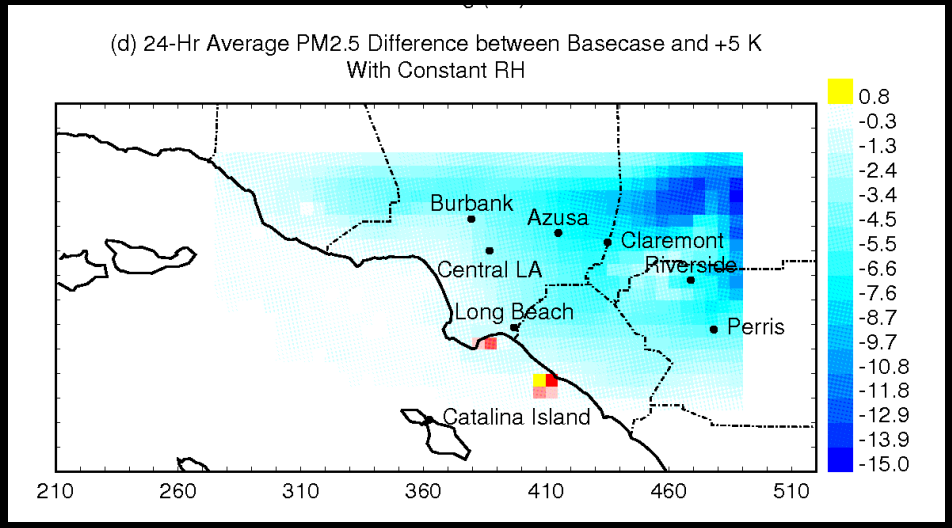
Base-case episode features

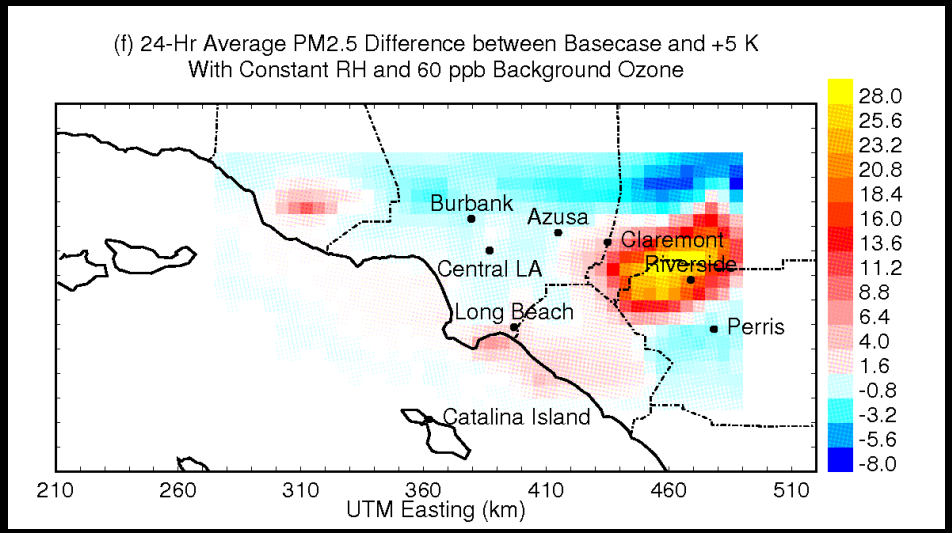
September 25, 1996 (125 µg/m^3)
Elevated temperature inversion
Cool nights, warm days

Sensitivity study

Limitations: No accounting of future controls or the effect of temperature on emissions and meteorology

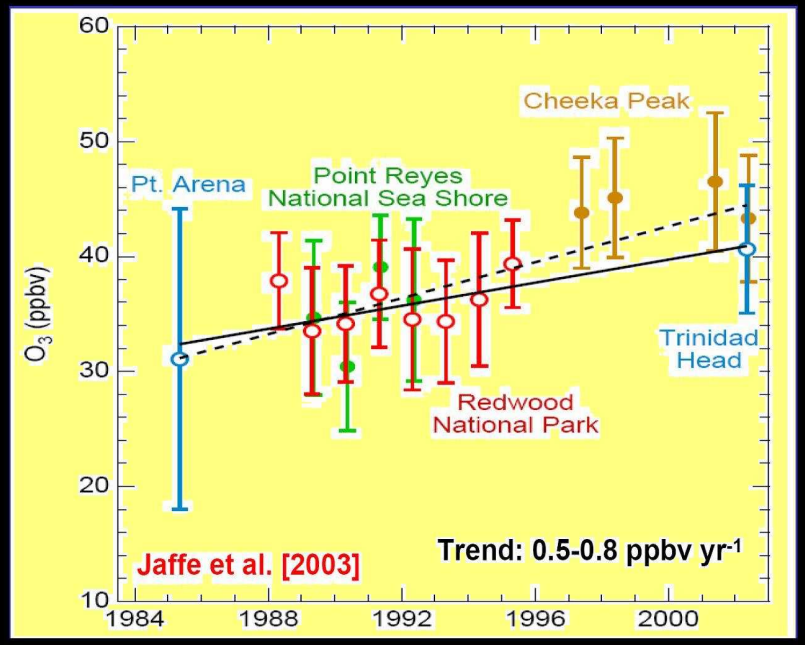
1. Increase temperature by +5℃, constant relative humidity
2. Also increase background ozone to 60 ppb



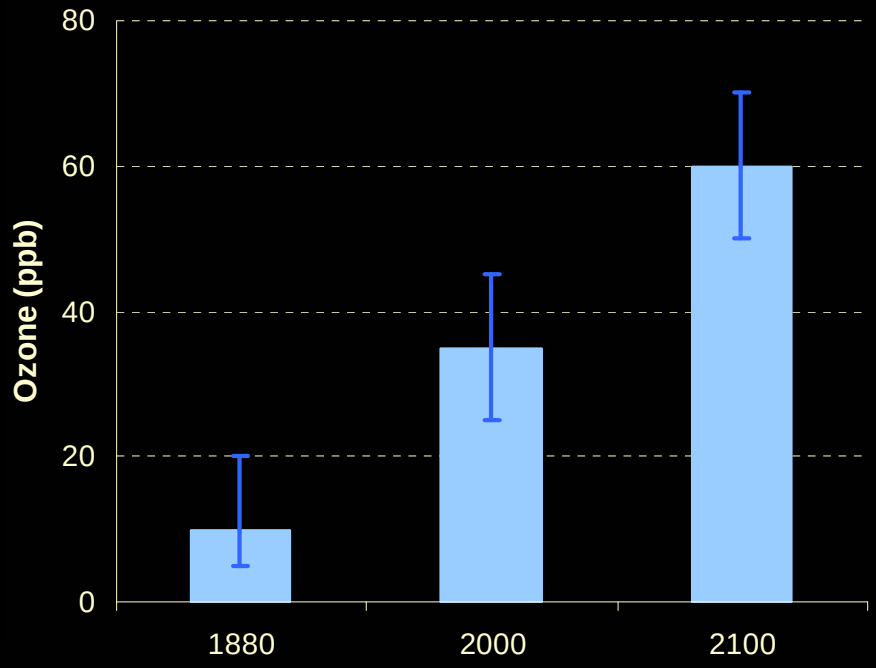


Kleeman, "A Preliminary Assessment of the Sensitivity of Air Quality in California to Global Change", *Climatic Change*, in review.

Increase in Background Ozone



Observed trends in background ozone levels in California (Jaffe et al., 2003)



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

Non-Kyoto Climate Forcers in California

Preliminary Calculations

Climate Forcer	100-year Global Warming Potential[a]	MMT[b] (2005)	MMTCO_2E	2005-2020 Change[c]
CO_2, CH_4, N_2O, HFC, PFC, SF_6	1 – 23,900	--	**500**	-15%
CO	1.0 – 3.0	4.56	**5 – 15**	-36%
ROG	1.1 – 6.2	0.81	**1 – 5**	-18%
NO_X	-10 – 5	1.07	**-10 – 5**	-32%
Diesel PM	500 – 1,200	0.029	**15 – 35**	-85%[d]
Other PM	unknown	--	**likely negative**	--
CFC, HCFC	100 – 10,000	0.014	**10 – 100**	unknown

[a] Fossil fuel soot GWP range from Hansen et al. (2007) and Jacobson (2005), all others from IPCC
[b] CFC and HCFC estimate from USEPA Vintaging model, all others from CARB emission inventory
[c] CO_2 etc.: AB 32 target. CO, ROG, NO_X: CARB emission inventory for rules already adopted.
[d] Diesel PM: 2000 to 2020 Diesel Risk Reduction Plan target.

Summary

California already affected by climate change

Future warming threatens public health, water supply, and agriculture

Climate change makes ozone standards more difficult to attain and maintain – overall impact on PM2.5 and PM10 is unclear

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