

Southern California's Future – Warmer, Drier and Wetter

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thanks David Pierce, Julie Kalansky SIO

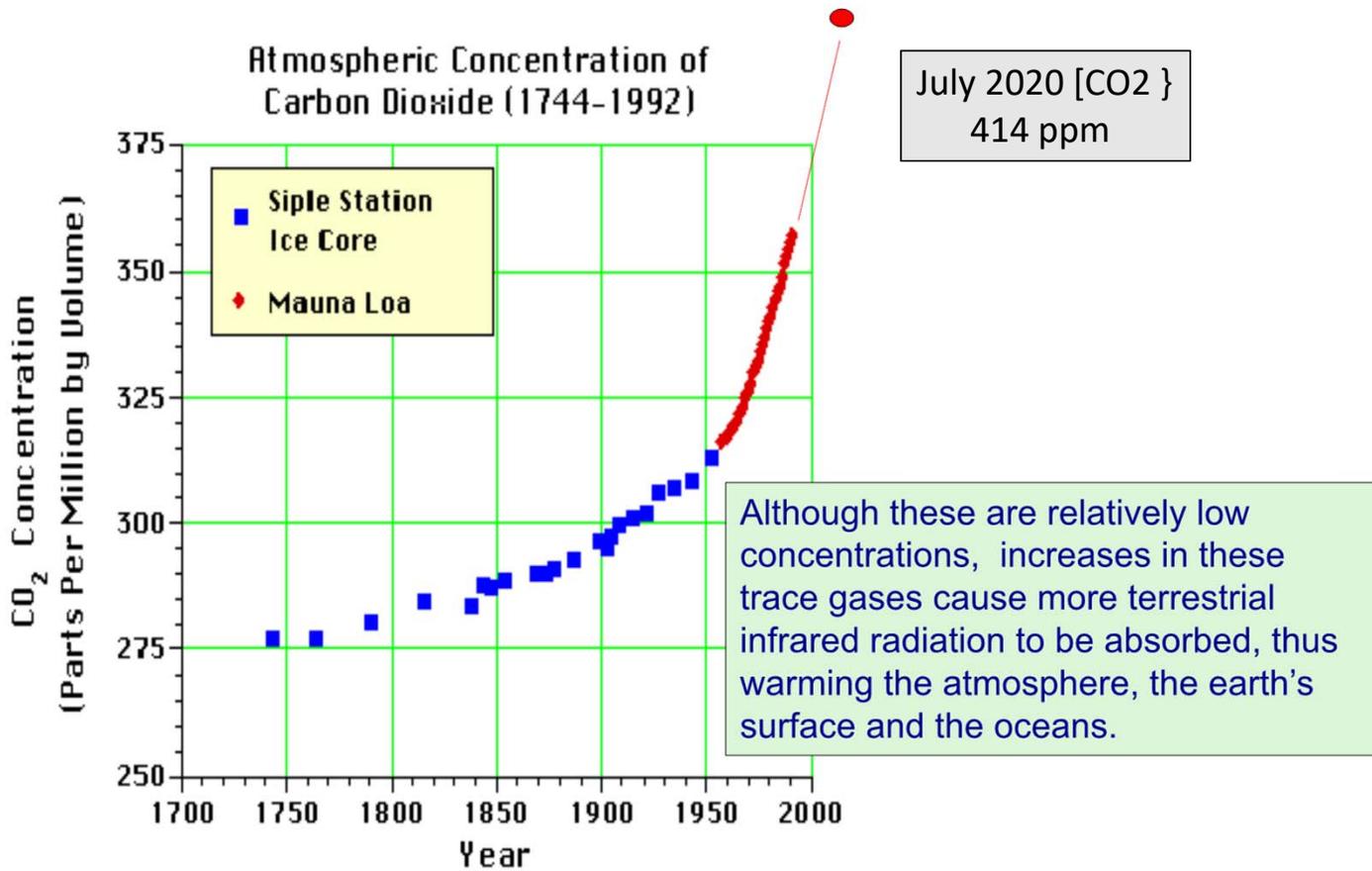
Sponsors:

California Energy Commission (CEC)
NOAA via CNAP RISA
USGS/DOI via SW Climate Science Center
U.S. Department of Energy



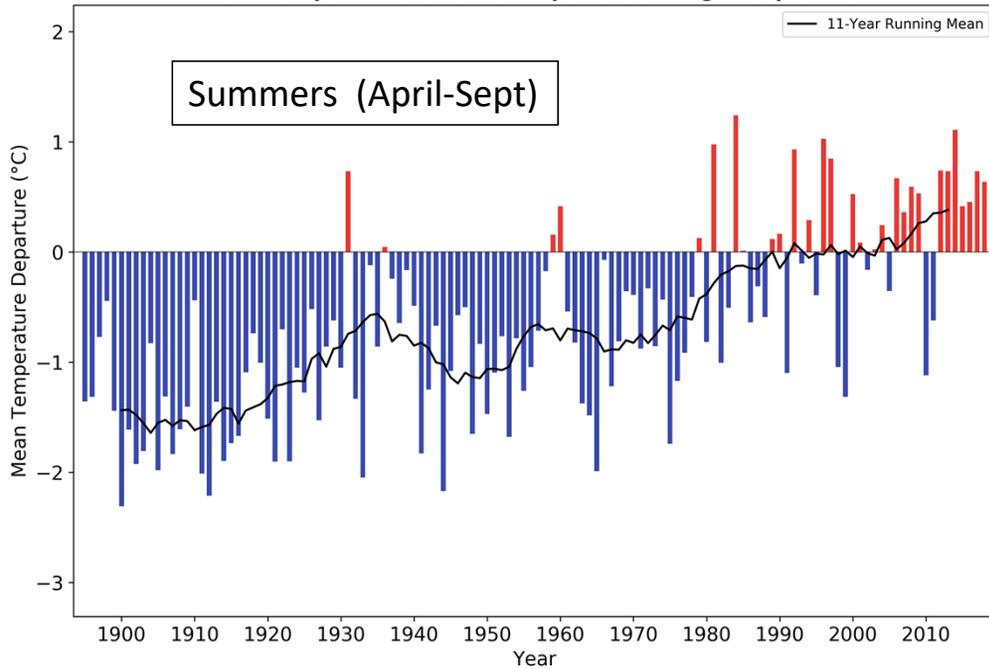
Greenhouse Gases increasing rapidly

Humans have altered the atmospheric composition during the industrial era



South Coast (Hydro Region)

Mean Temperature for 6-month periods ending in September



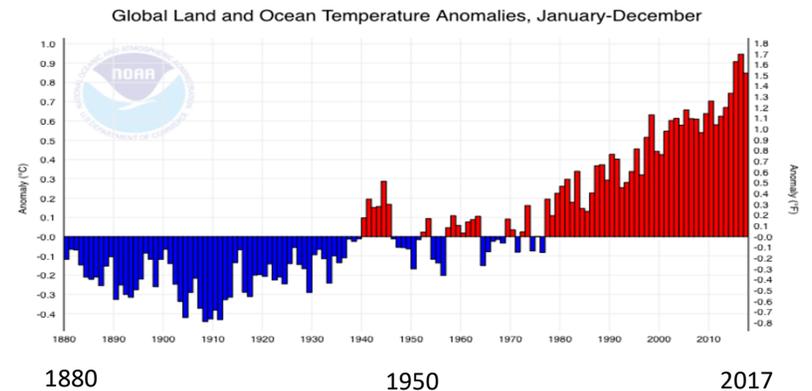
Summary Statistics

1981-2010 Normals: Mean: 20.0°C Median: 20.1°C
 Extremes: Warmest: 21.3°C (+1.2°C from Average), 1984
 Coldest: 17.7°C (-2.3°C from Average), 1900
 Most Recent Year: Apr 2018 - Sep 2018 | 20.6°C (+0.6°C) | Rank: 113 of 124
 (1 = Record Coldest, 124 = Record Warmest)

Observed temperatures Southern California

SoCal has warmed along with western U.S. and world natural variability and probably anthropogenic causes
 Southern California has been warmer since 1977
 since 2014 has been exceptionally warm

Global Surface Temperature

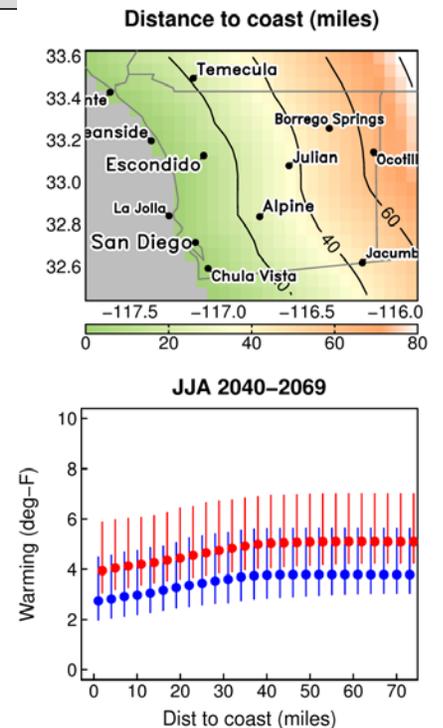
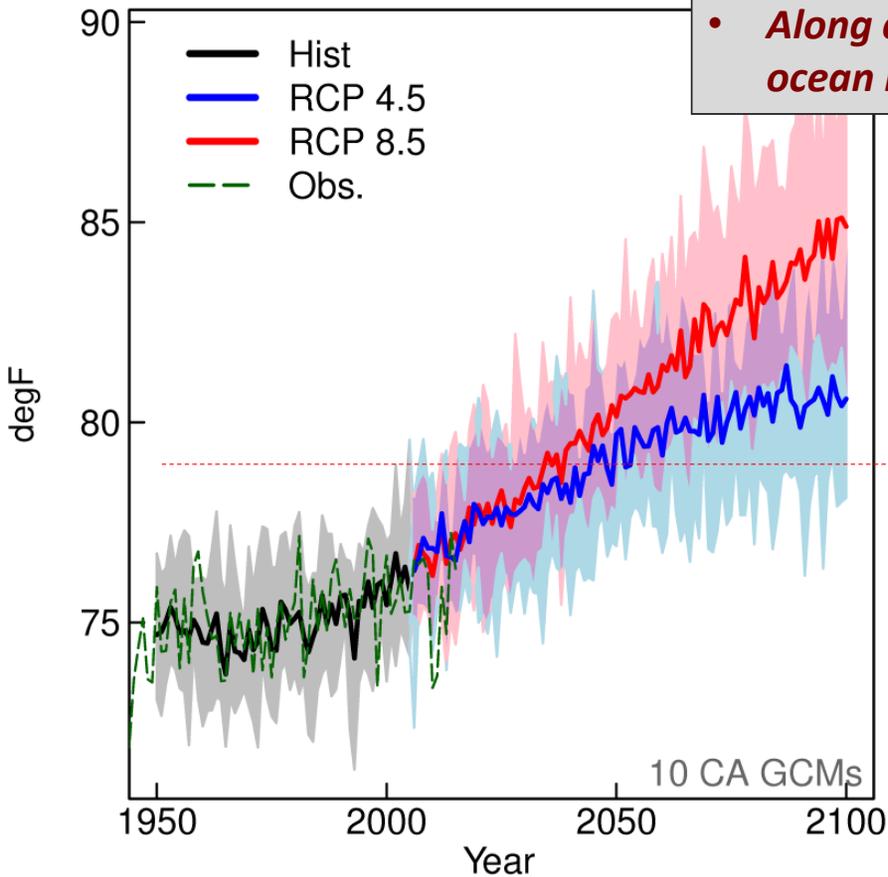


San Diego County

Tmax Annual

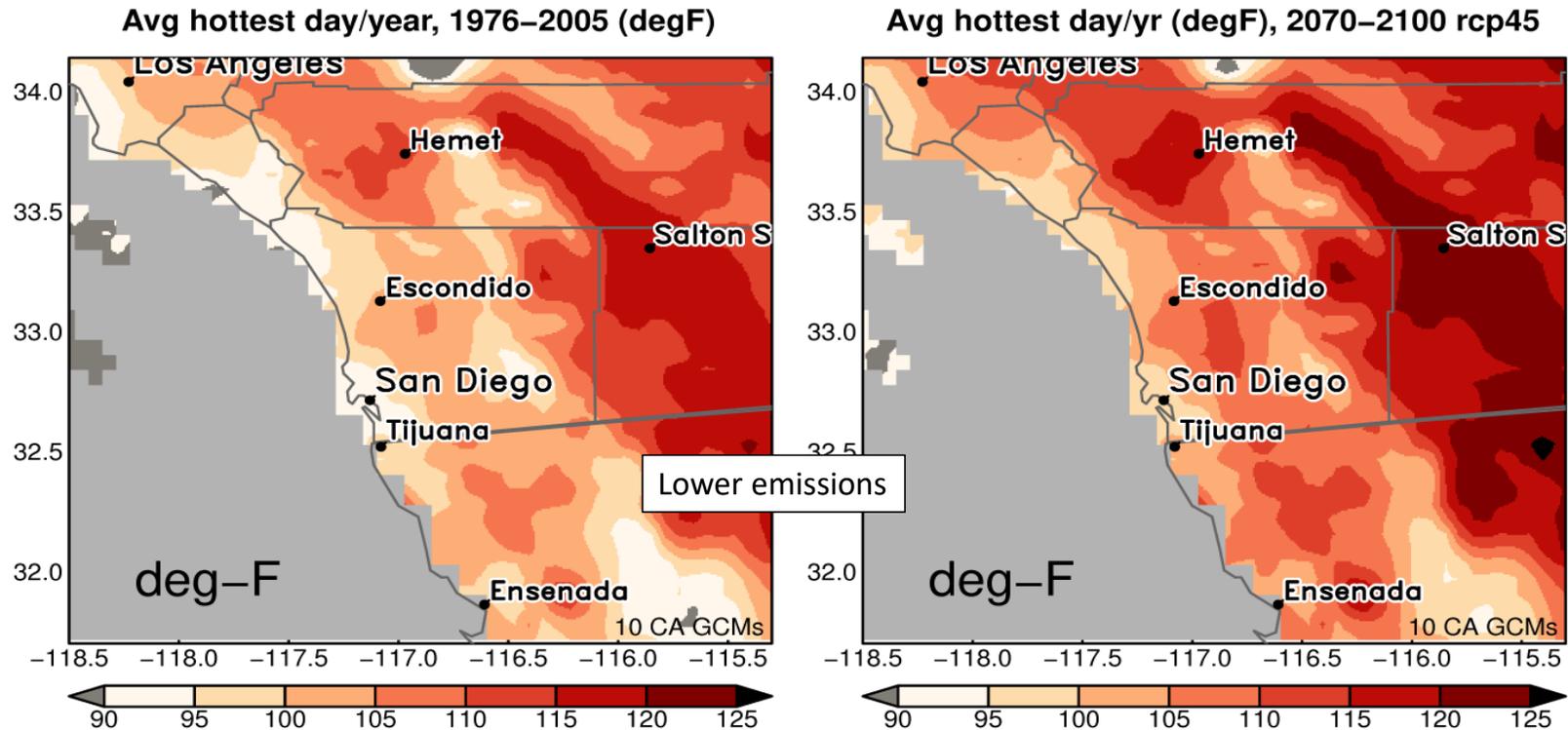
climate model projected WARMING is ***SUBSTANTIAL***

- *Due to greenhouse gas build-up we are already warming and committed to more warming*
- *amount of warming in future depends on greenhouse gas emissions*
- *Along coastal margin, warming will likely be less than inland because ocean buffers temperature rise*

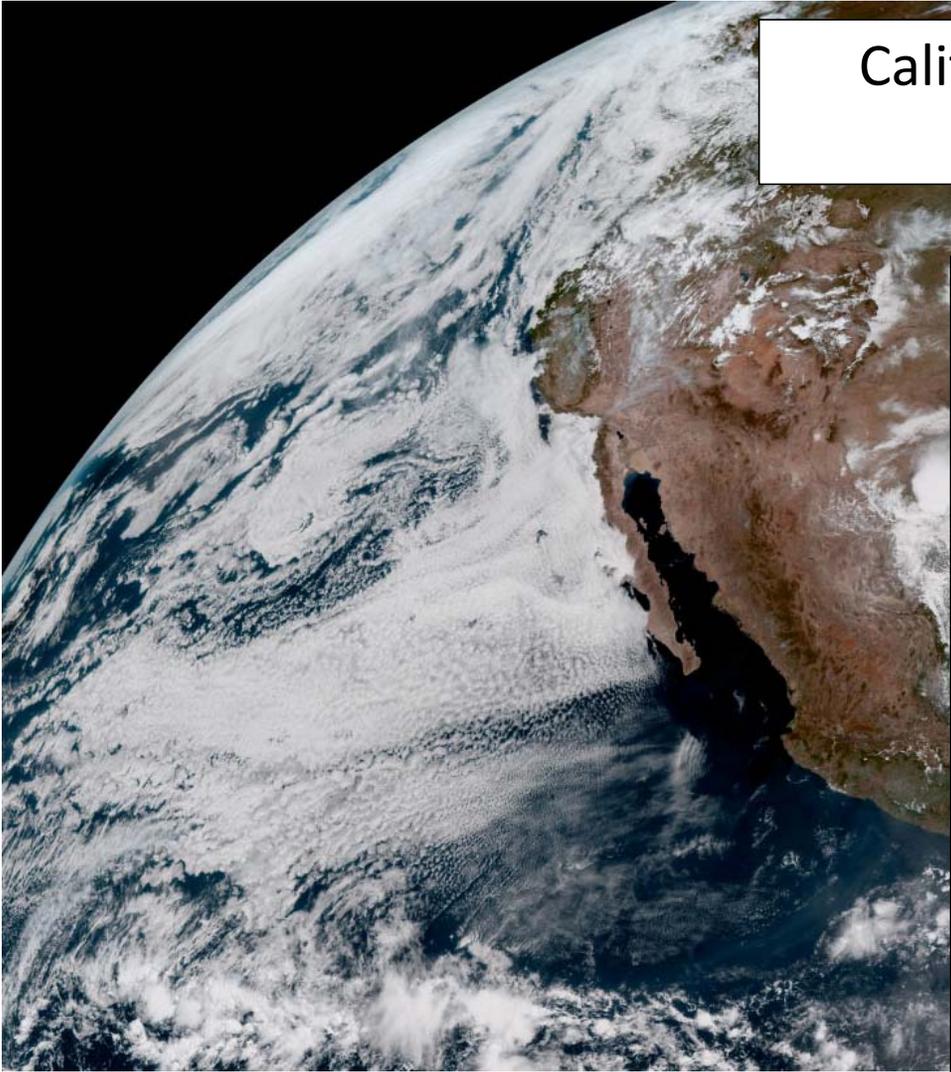


Projected Hotter Temperature Extremes

Change (deg F) Warmest day of the Year 2070-2100 vs. 1976-2005

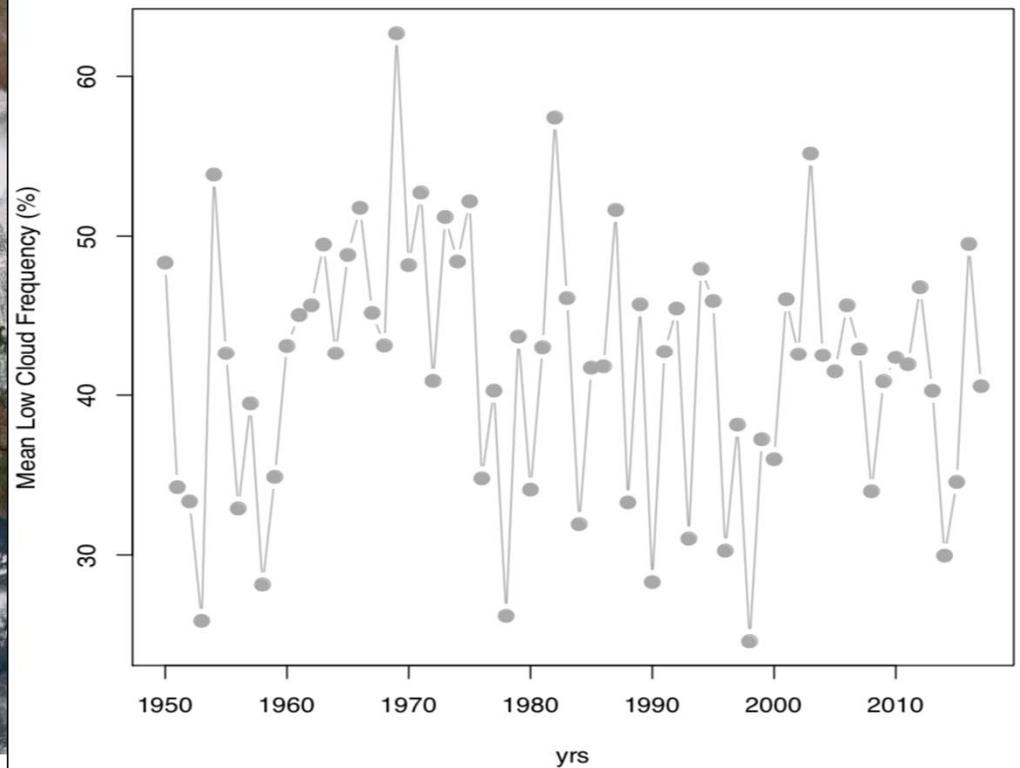


the duration and number of heat waves are also projected to increase
widespread consequences— e.g. health, energy and water demand, ecosystems

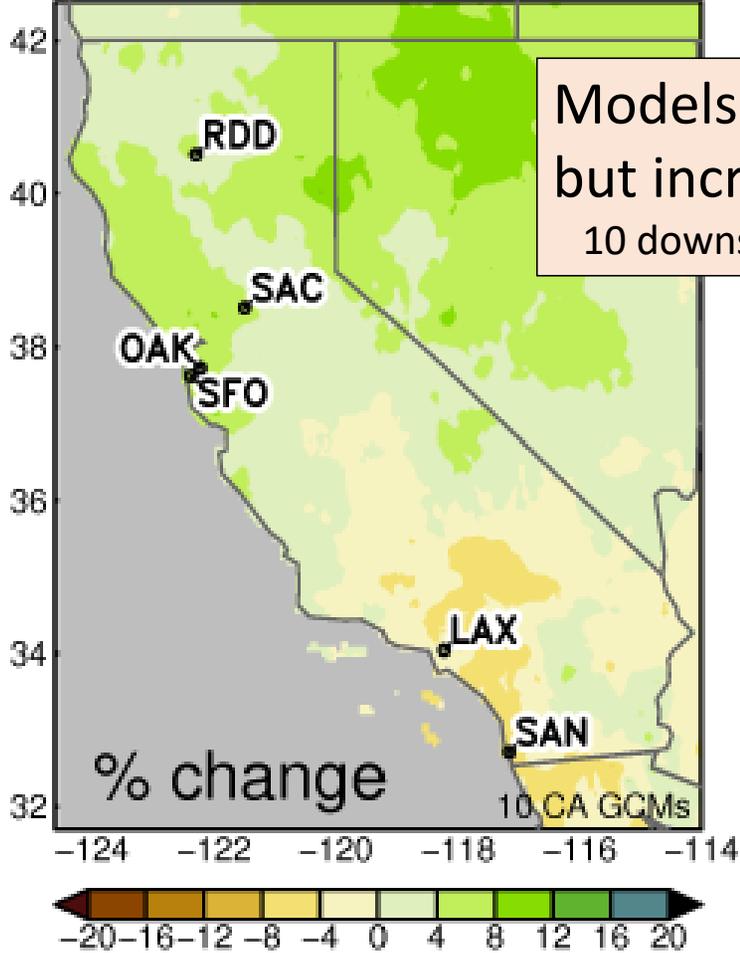


California's Coastal Clouds—highly variable Uncertain Changes

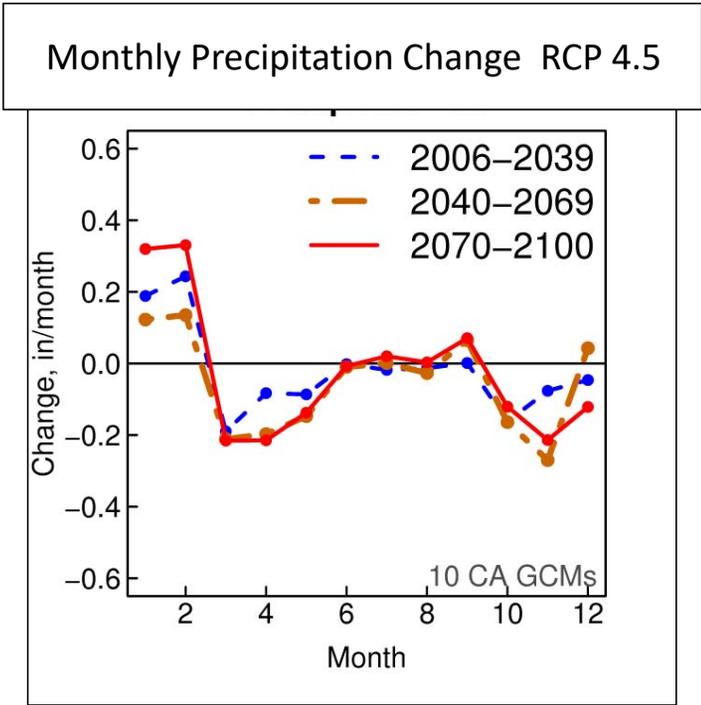
May & June Coastal Low Clouds/Fog at San Diego Airport



yearly avg precip change by 2040–2069 rcp45

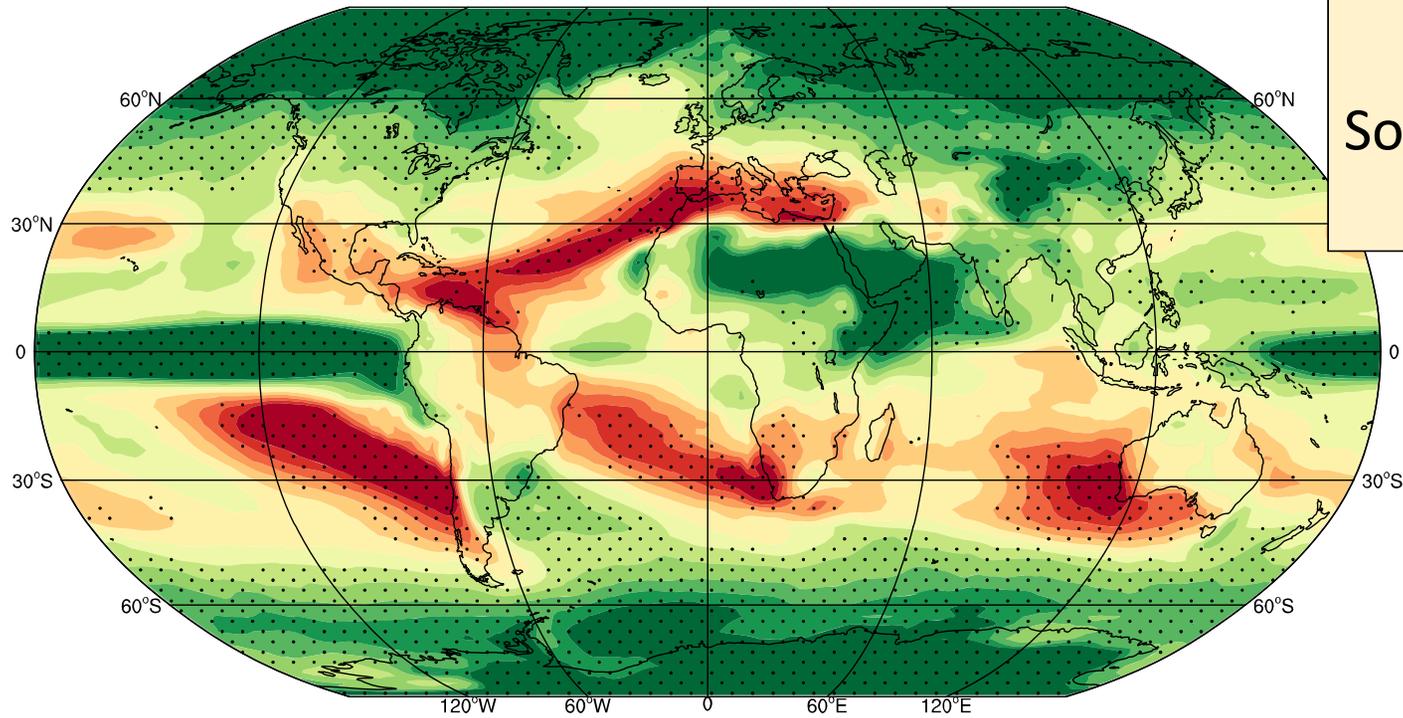


Models project little change in annual precipitation but increase in winter and decrease in spring and fall
 10 downscaled GCMs RCP 4.5 (map) and RCPs 4.5 and 8.5 (line plot)



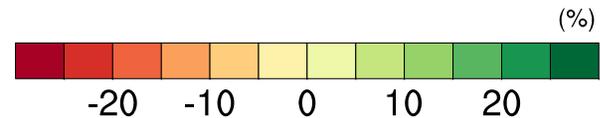
Precipitation Regime Change

global models indicate:
Northern California may become wetter,
Southern California may become drier

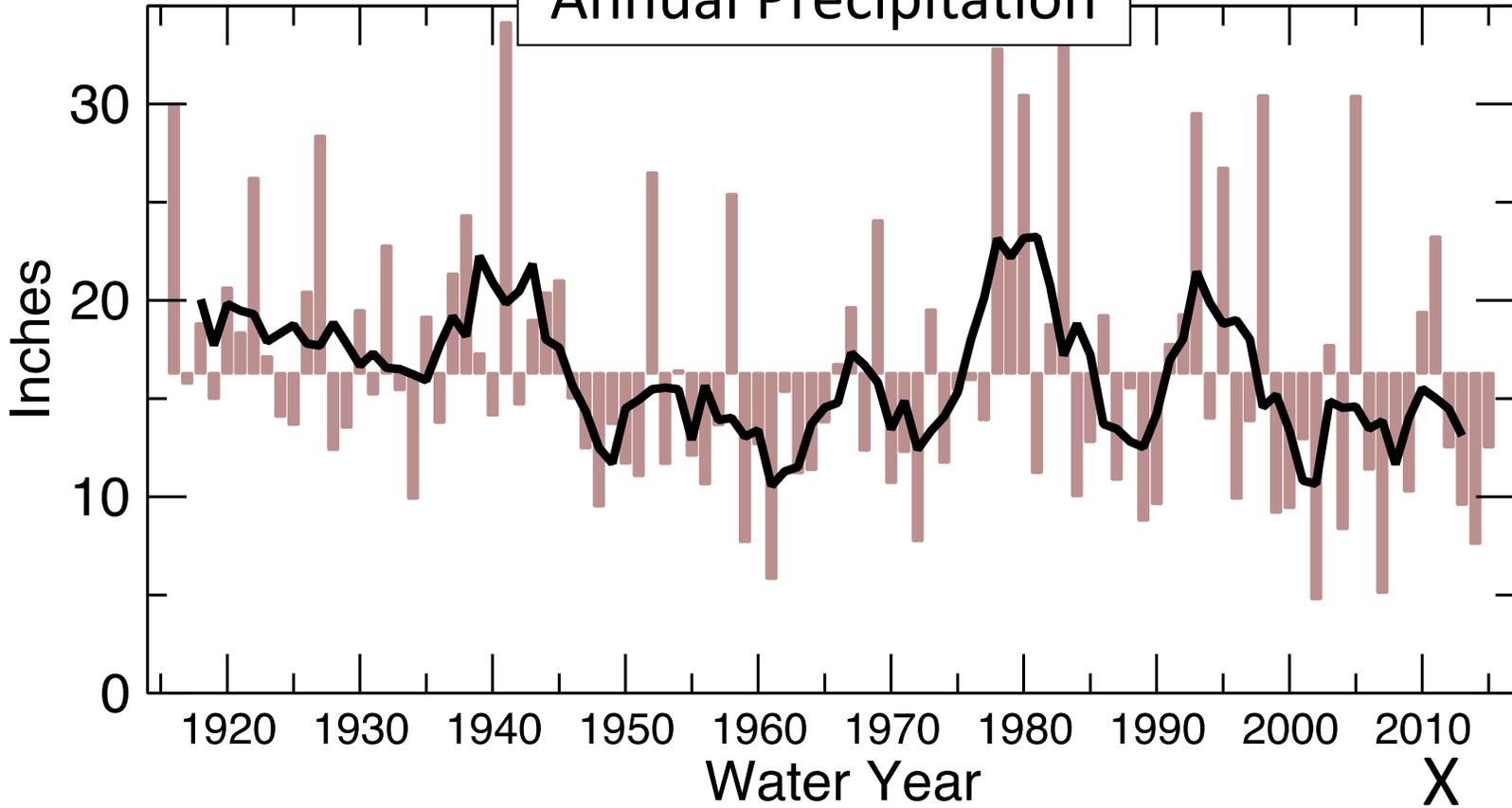


Late 21st century – late 20th century
Annual precipitation change

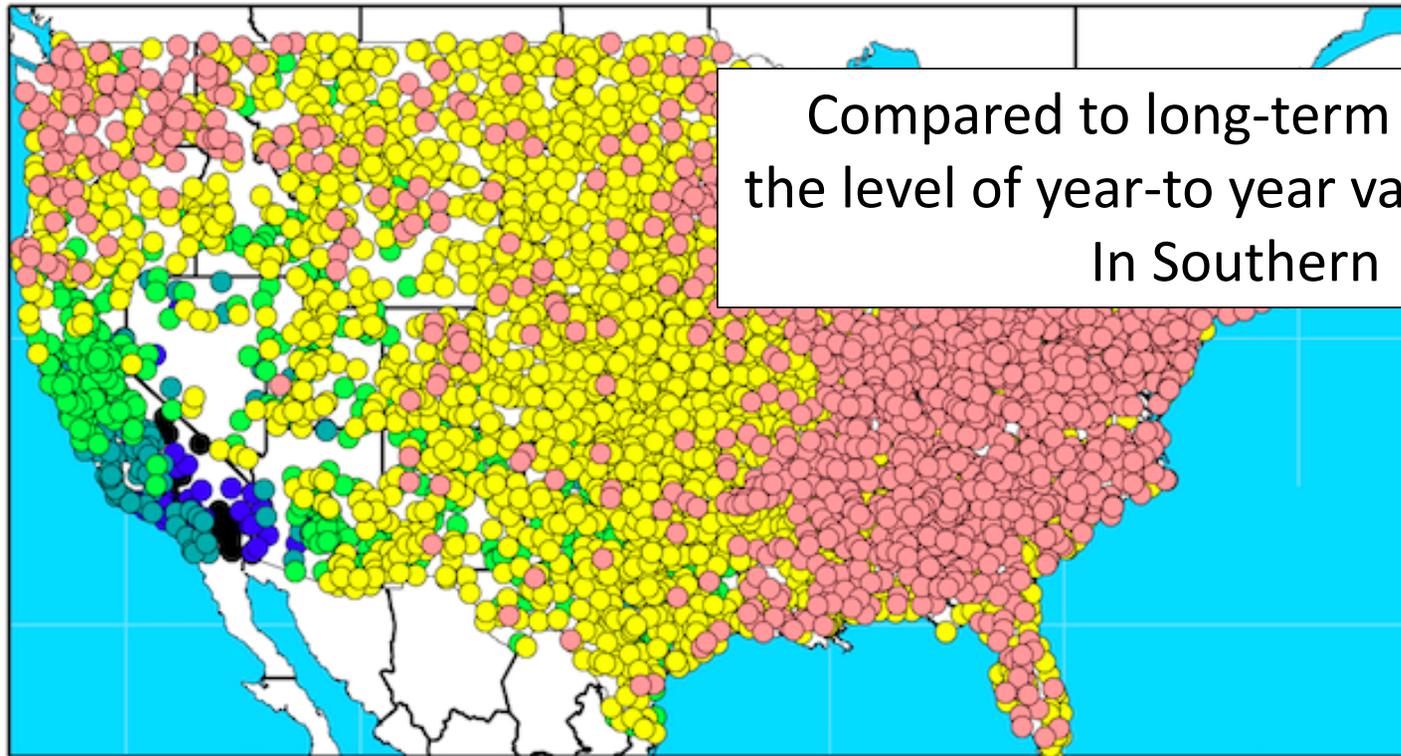
Polade, S.D., D.W. Pierce, D.R. Cayan, A. Gershunov and M.D. Dettinger, 2014: The key role of dry days in changing regional climate and precipitation regimes. *Nature Scientific Reports* 4, 4364; DOI:10.1038/srep04364.



San Diego County's Annual Precipitation



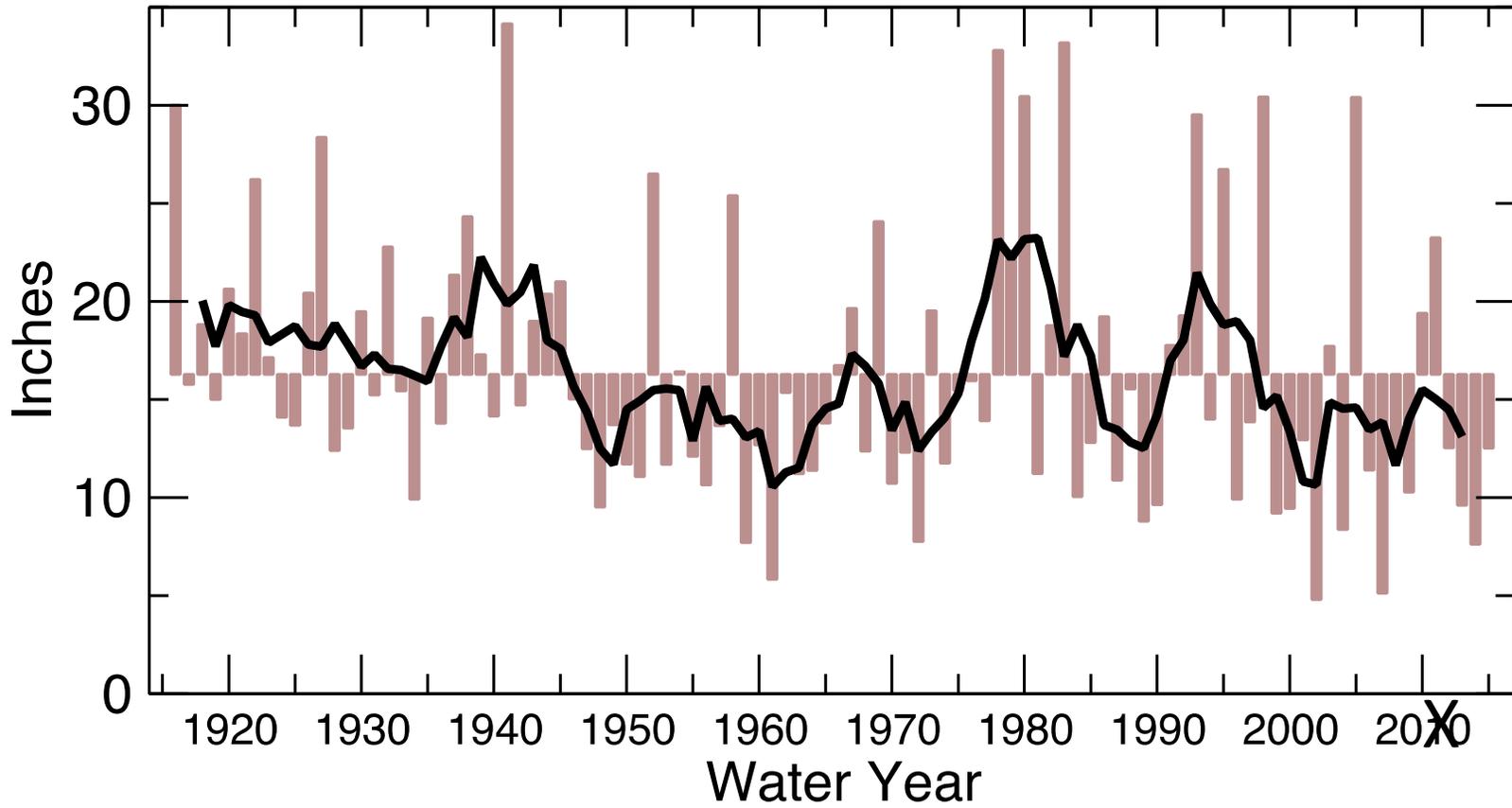
COEFFICIENTS OF VARIATION OF TOTAL PRECIPITATION, WY 1951-2008



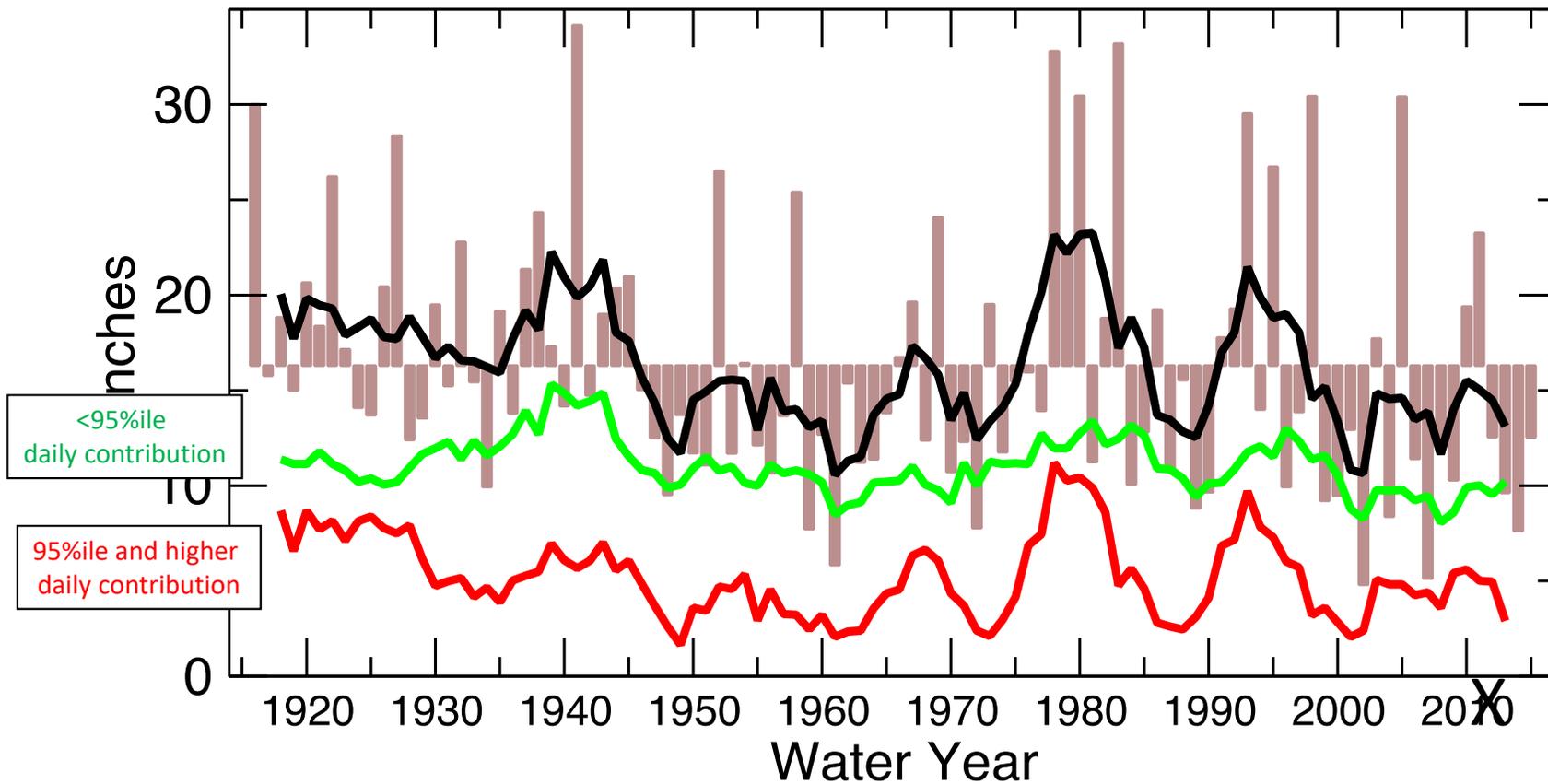
fraction



San Diego County's Annual Precipitation



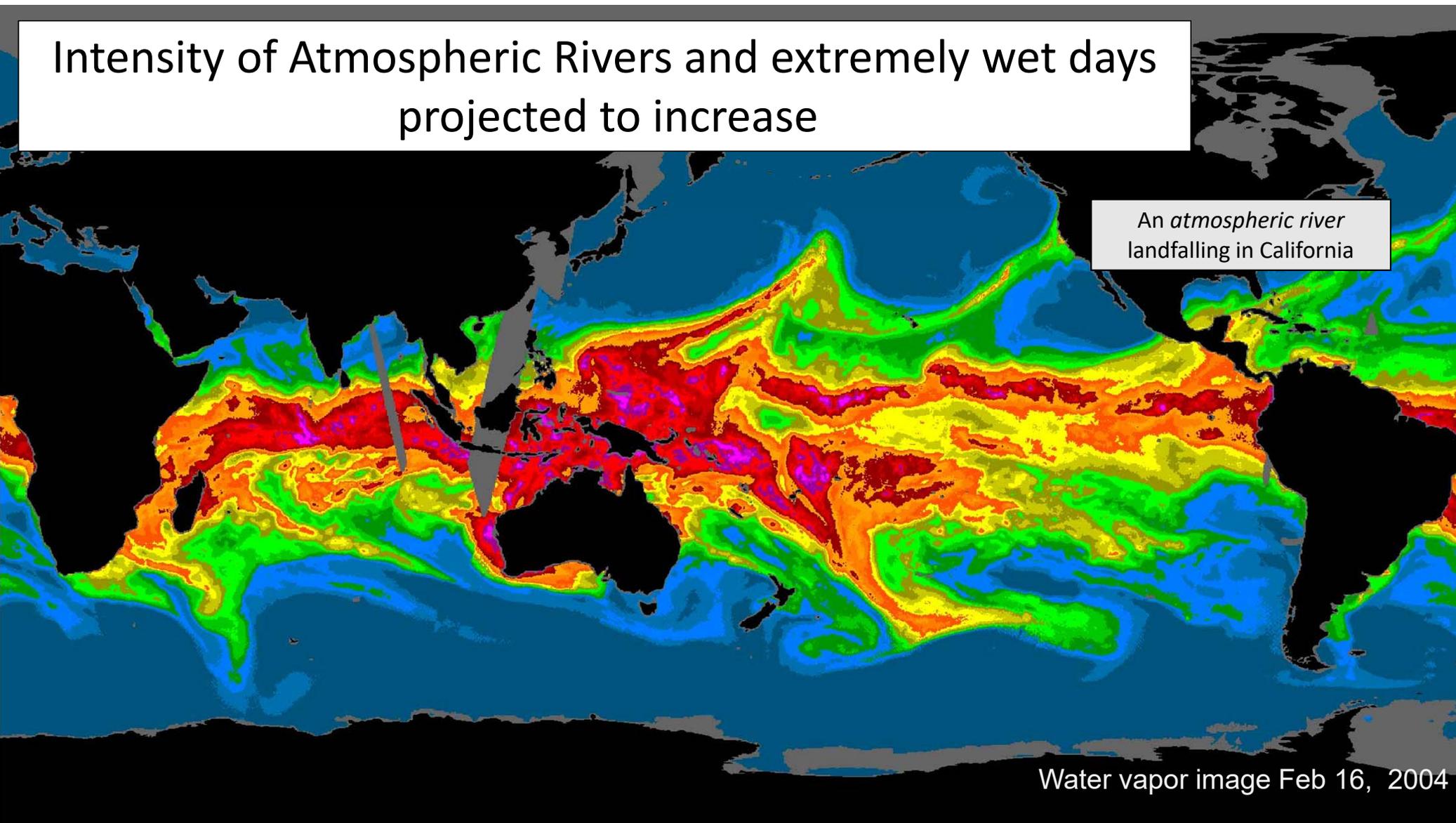
San Diego County's Annual Precipitation
variability is driven by contributions from **heavy** daily rains



Intensity of Atmospheric Rivers and extremely wet days projected to increase

An atmospheric river landfalling in California

Water vapor image Feb 16, 2004



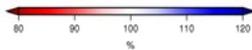
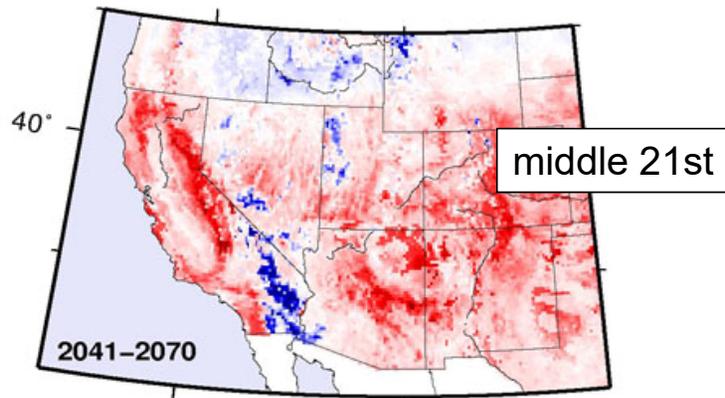
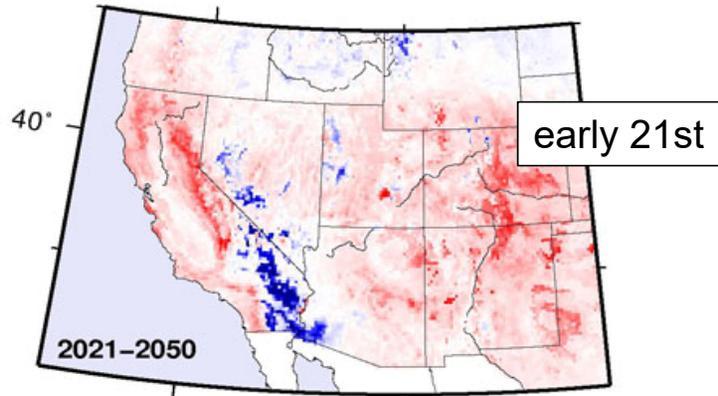


*drought outline on Lake Mead, still dropping, 73
% of normal inflow now expected*

photo and comment by Kelly Redmond 2/21/2015

median june 1 soil moisture
percent of historical (1971–2000) BCSD

16 SRESA2



Drier Summer Landscapes
increased warming and diminished snow
causes successively greater soil drying
throughout 21st Century

(this picture could change somewhat under more recent CMIP5 simulations)



Santa Ana winds may decline somewhat in future decades but longer, warmer dry season would heighten wildfire threat

Summary and Conclusions

Climate change is happening now

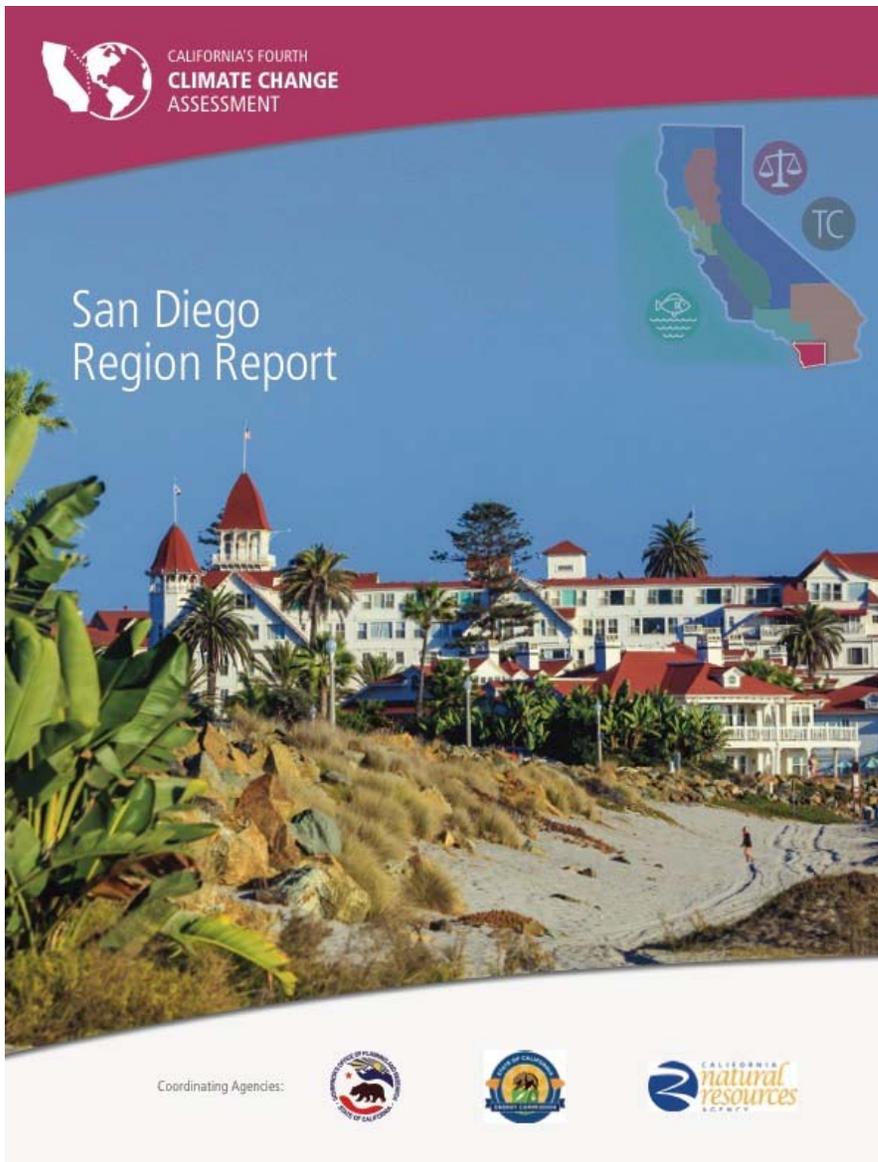
Future change substantial; avoiding the worst depends on society's ability to reduce emissions

Climate Change exacerbates extremes

Changes in water cycle -- more volatility from drought to floods

Community Resilience involves preparing and adapting across sectors:
public health, energy, transportation, land use, emergency management,
ecosystems, oceans and coasts, agriculture, and water

Keep Records! Monitor weather, climate, impacts -- Information is Power



California Fourth Climate Change Assessment
Provides several regional reports that assess impacts,
Challenges, ongoing adaptation strategies

more information:

<https://scripps.ucsd.edu/programs/cnap/> or

dcayan@ucsd.edu

“bend the curve”

[https://universityofcalifornia.edu/sites/default/files/Bending the Curve F5 spreads.pdf](https://universityofcalifornia.edu/sites/default/files/Bending_the_Curve_F5_spreads.pdf)