

# Impact of Climate Change on California

Presented to  
Sierra Club - Loma Prieta Chapter

**10 October 2018**

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[Securethefuture2100.org](http://Securethefuture2100.org)

**Our Goal is to Support Elected Officials and to Inform the Public on Climate Issues**

2100

# Climate Discussion Points

- **Rising Temperatures**
- **Precipitation and Drought**
- **Impact to Commerce, Environment, and Public Health**
- **Sea Level Rise (SLR)**
- **Summary**
- **Recommendations**
- **How You Can Help Fight Climate Change**
- **Supporting Information**
  - **Scenario Used for Sea Level Rise**
  - **References**
- **Suggested Reading and Videos**

# 2016-2017 US Climate Disaster Costs

## Estimated Cost to California:

- 2016-2017 Wild Fires: Over \$20B
- 2018 Wild Fires: TBD
- 2016-2017 Drought: \$2B

## Storms Throughout US during 2016-2018:

- Hurricane Irma: \$51B
- Hurricane Maria: \$92B
- Hurricane Harvey: \$128B
- Hurricane Florence: TBD
- Hurricane Michael: TBD

Hurricane Irma  
September 2016

**Total Cost for US: \$306B**

**Total Lives Lost  
in US: > 3,000**



# U.S. 2017 Billion-Dollar Weather and Climate Disasters



This map denotes the approximate location for each of the 18 billion-dollar weather and climate disasters that impacted the United States during 2017.

# Scenarios for Temperature / Sea Level Rise by 2100

## Temperature Rise (Global Average): 8°F

- No cuts in CO<sub>2</sub> emissions - “Business as usual” use of fossil fuels
- Does NOT meet Paris Climate Agreement

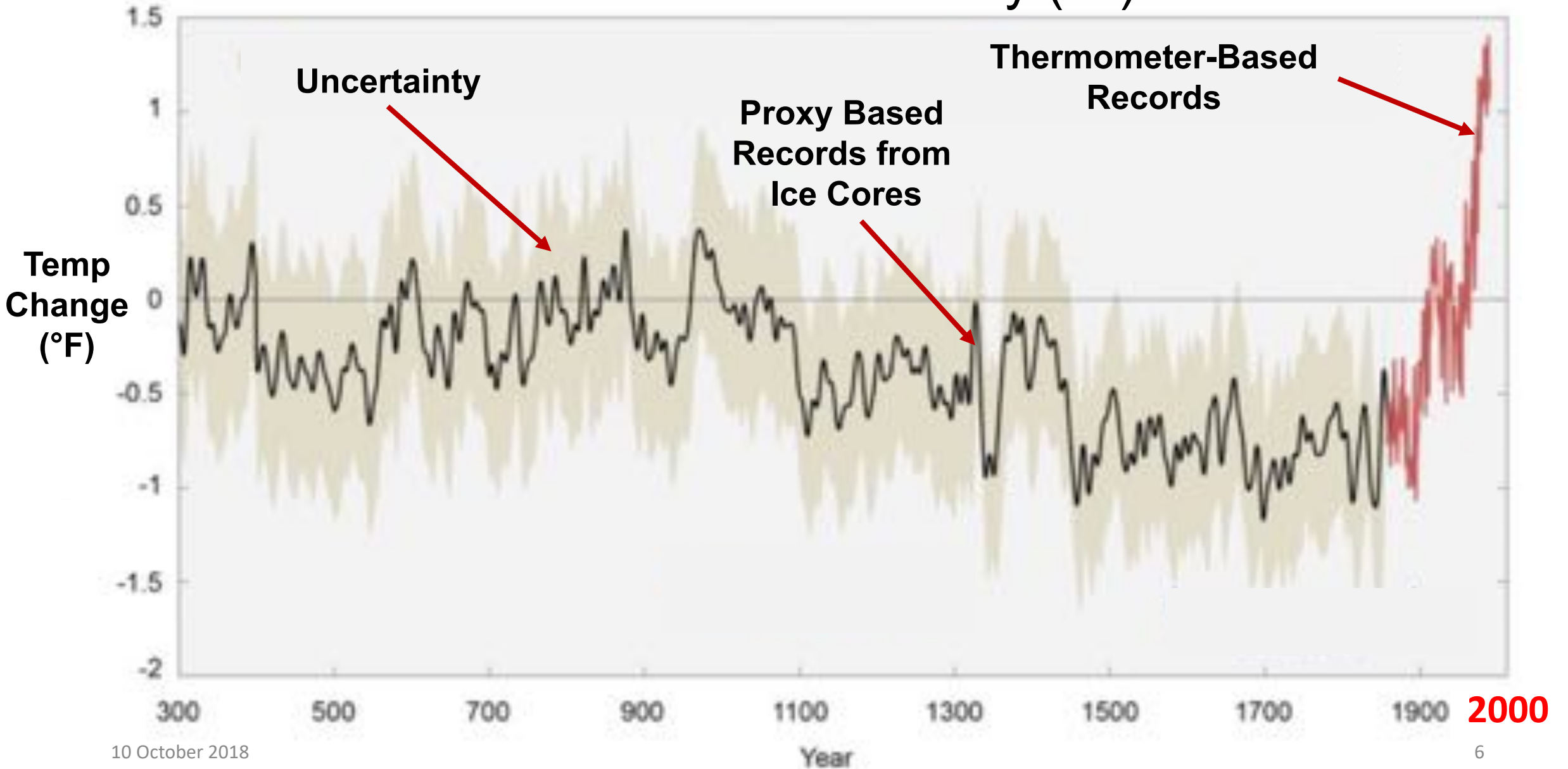
## Total Sea Level Rise (CA Average): 8.8 ft

- 6 ft from Sea Level Rise
- 2.8 ft from major storm surges and floods

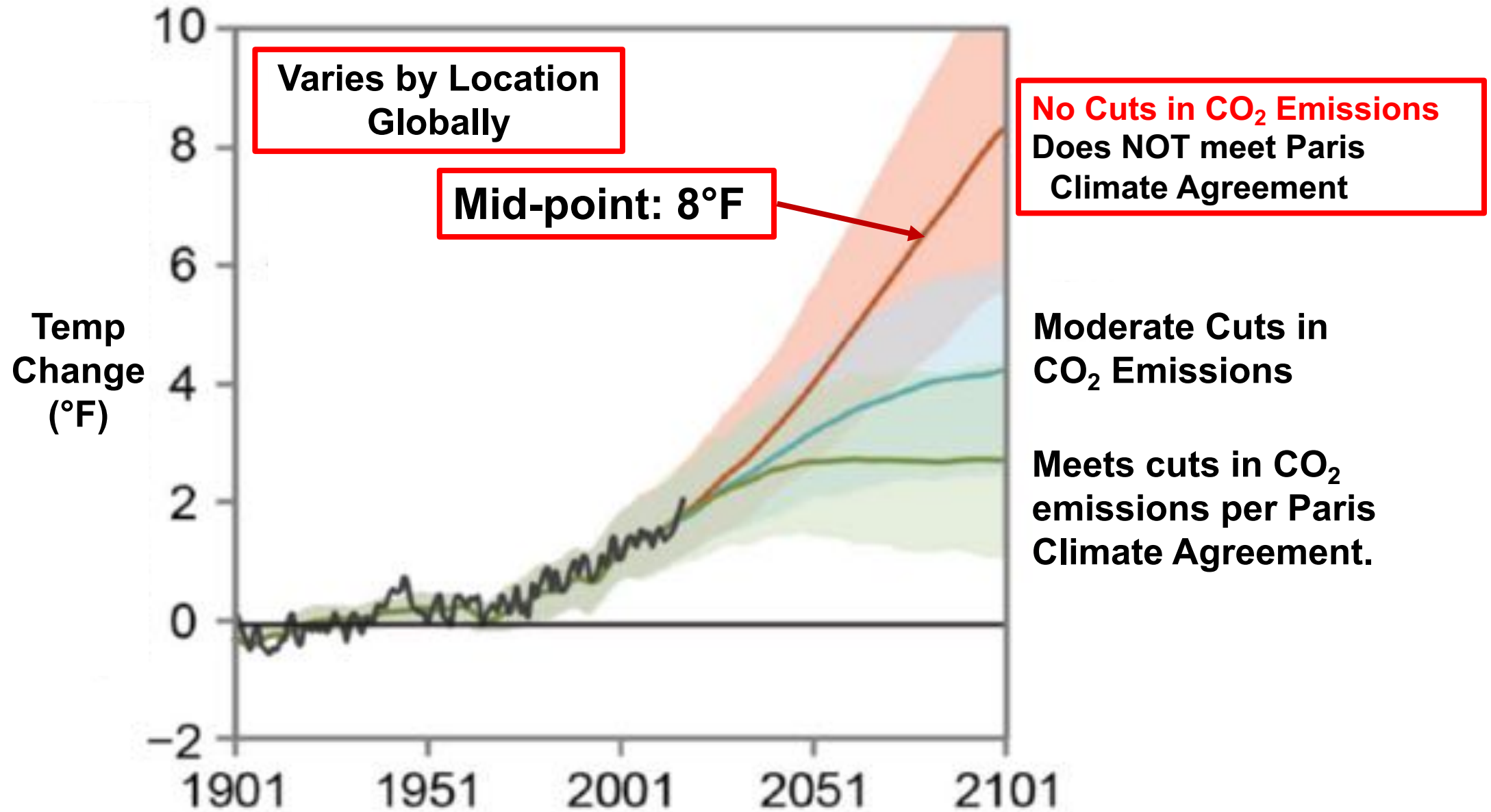
Temperature and sea level rise estimates based on peer-reviewed science publications

See References Section for sources used to define temperature and sea level rise scenarios

# Changes in Temperature for Northern Hemisphere From Year 300 to Today (°F)

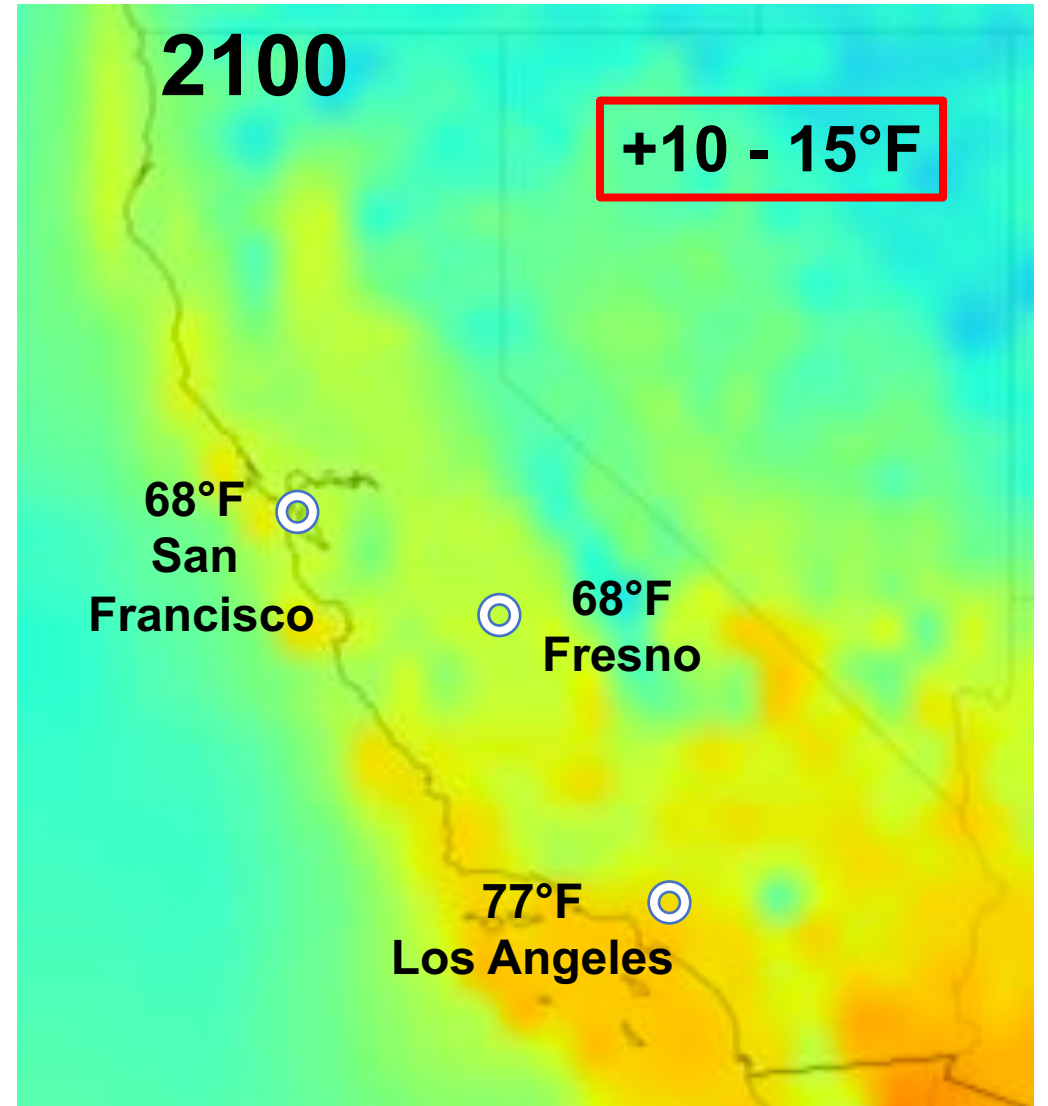
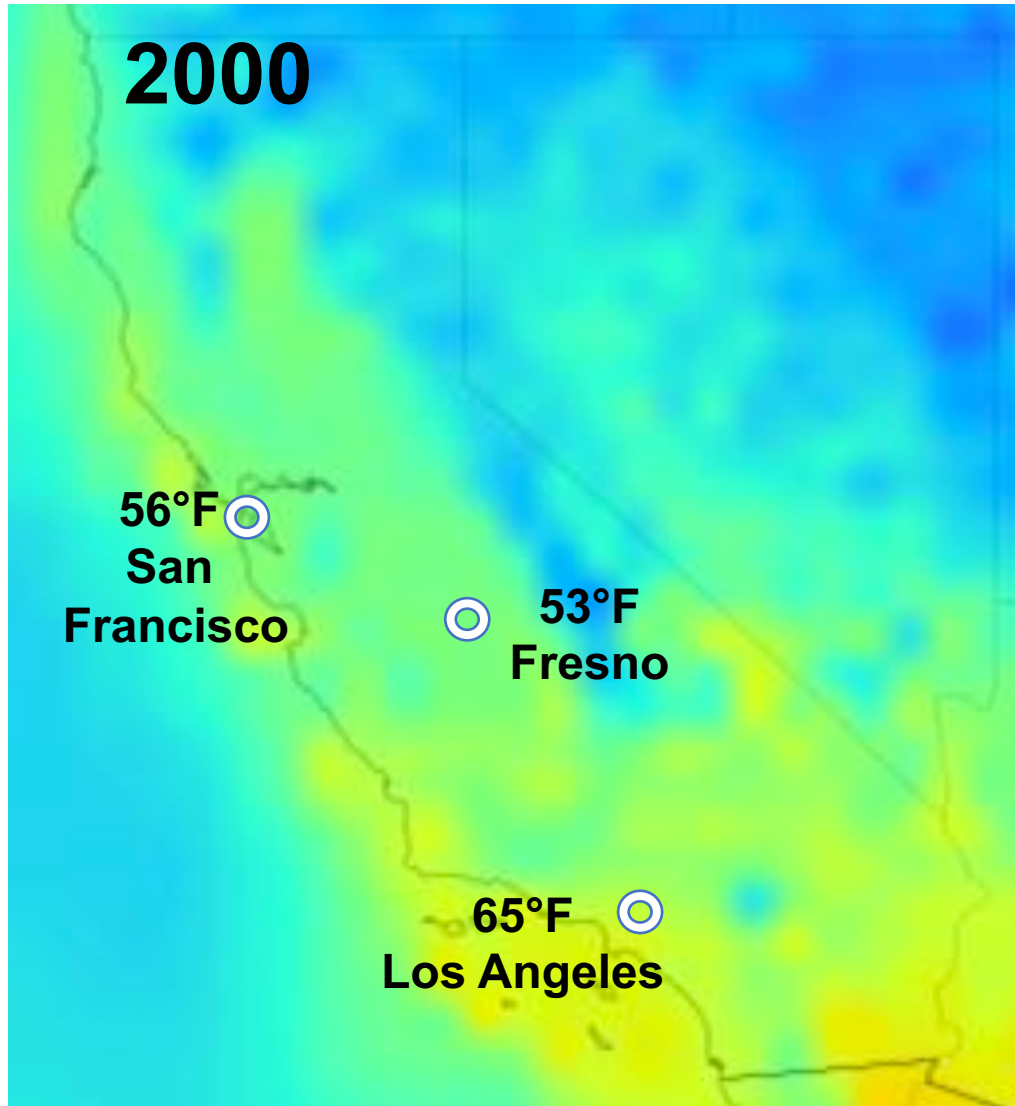


# Projected Average Global Temperatures



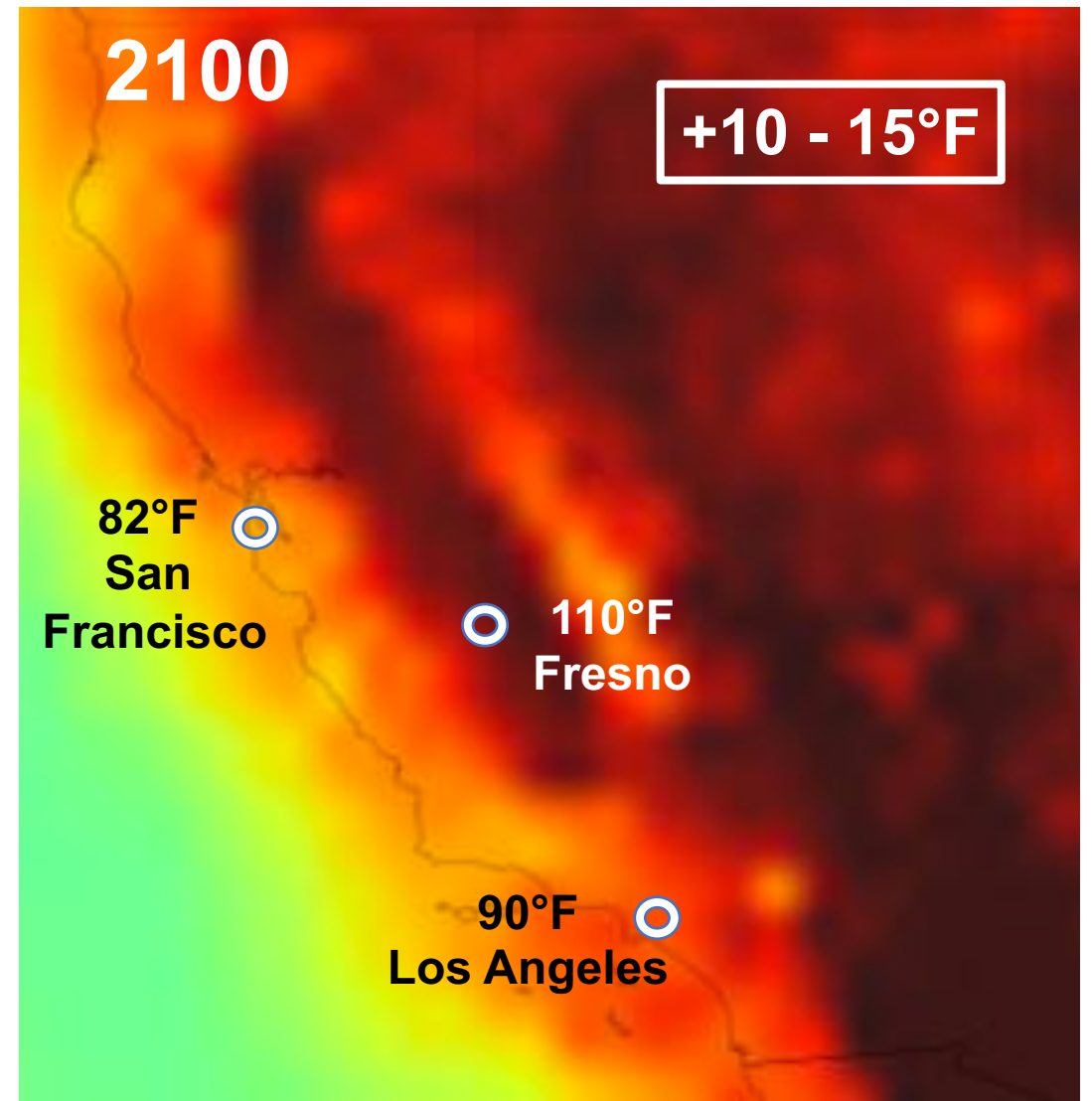
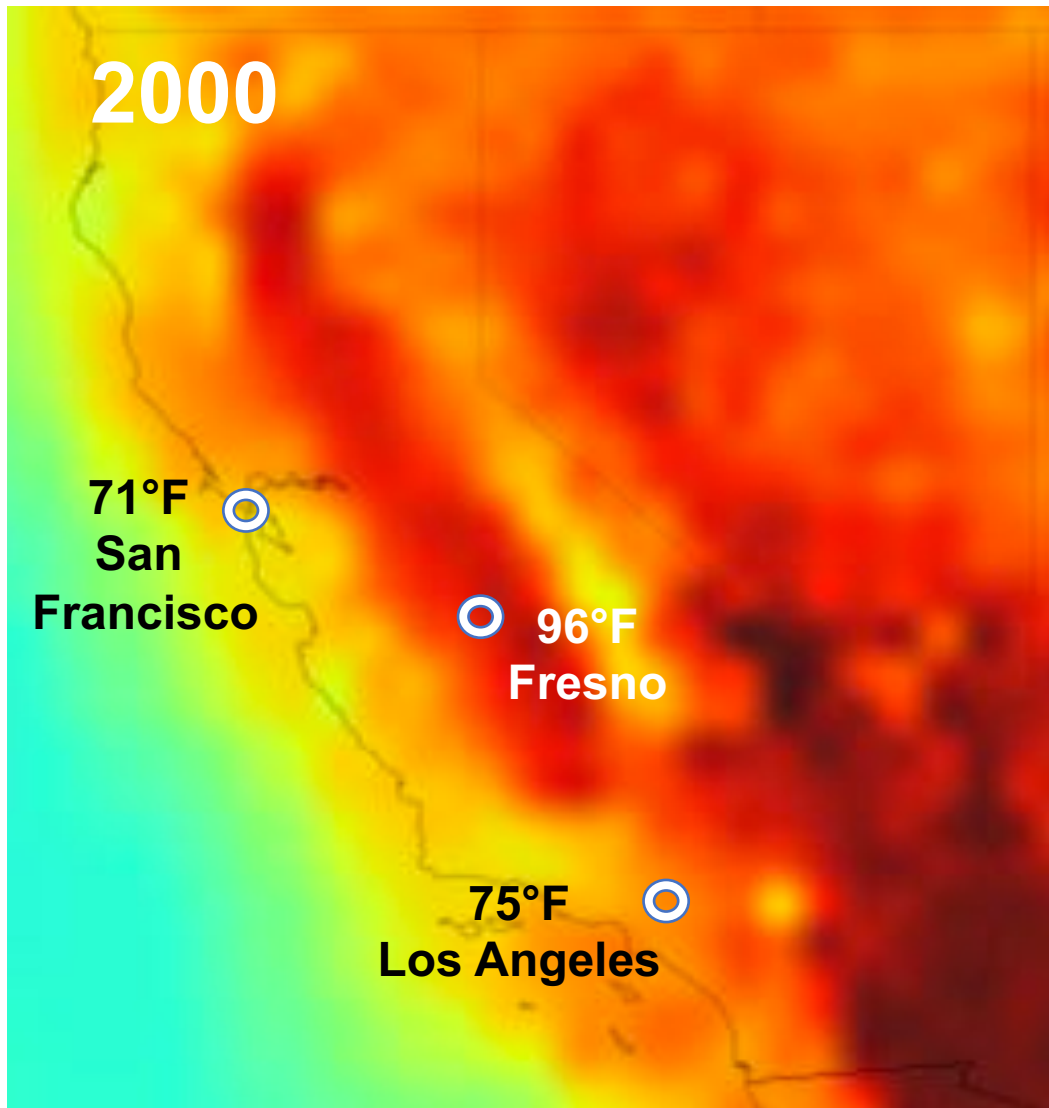


# January California Temperatures (Average Daily High)





# July California Temperatures (Average Daily High)



# Precipitation and Drought

- **How Global Temperature Rise Effects Storms**
  - **Frequency**
  - **Intensity**
  - **Shifting Geographic Distribution**
  - **Timing**
- **How Global Temperature Rise Effects Snow Pack**
  - **Water Content**
  - **Snow Pack Volume**
  - **Timing of First melt**
  - **Longevity of Melt**
  - **Snow Pack Carryover**

# Change in Precipitation by 2100

## Winter

Northern:  
Increase of  
10 - 20%

More  
precipitation  
shifts to Winter

Southern:  
Slight Increase  
From Normal

## Spring

Northern:  
Slightly Less  
Than Normal

Southern:  
Decrease of  
10-20%

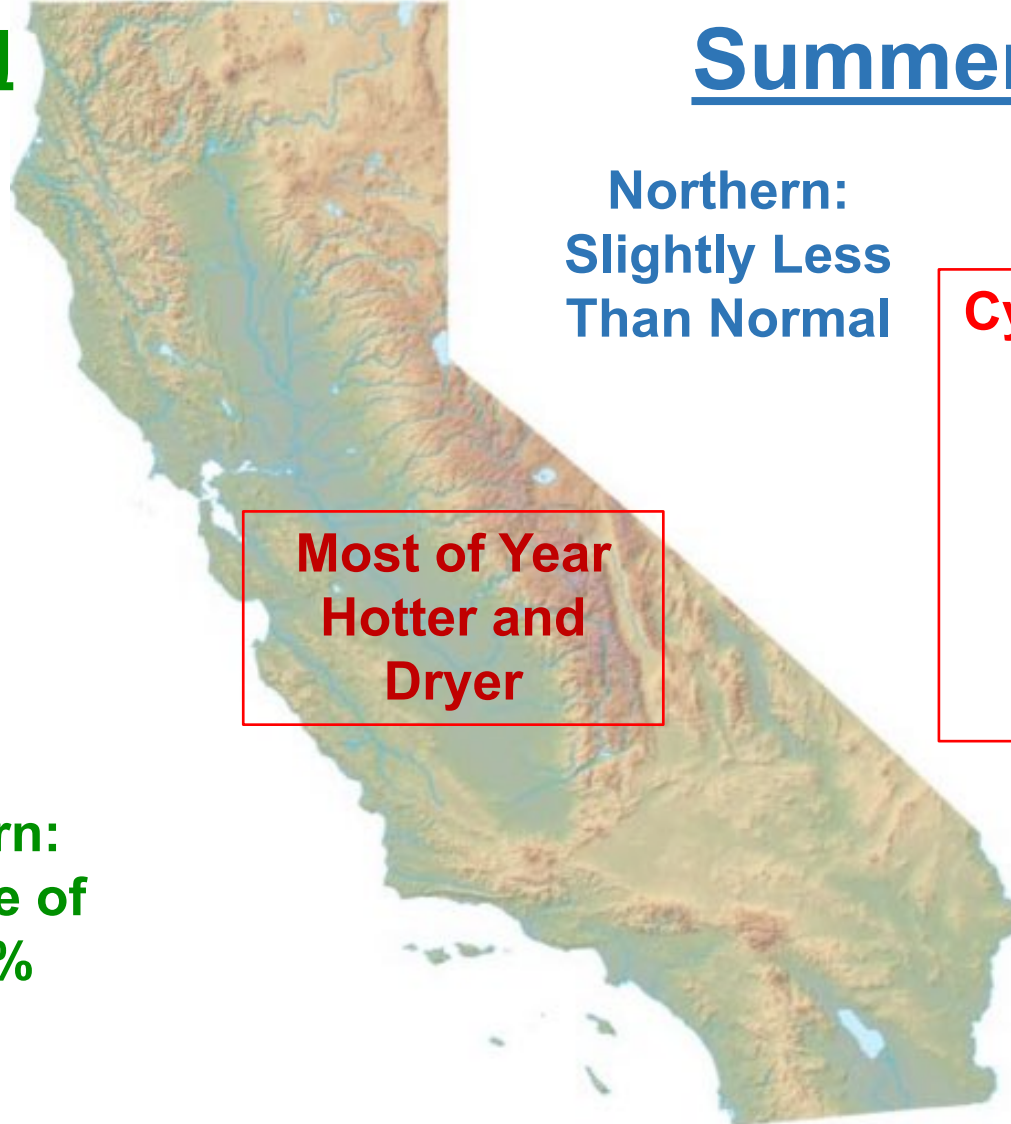
## Summer and Fall

Northern:  
Slightly Less  
Than Normal

Cycle of Increase severity  
of droughts  
Followed by  
Increase in Severity of  
seasonal Pacific  
Atmospheric Rivers  
Storm

Southern:  
Slightly Less  
Than Normal

Most of Year  
Hotter and  
Drier

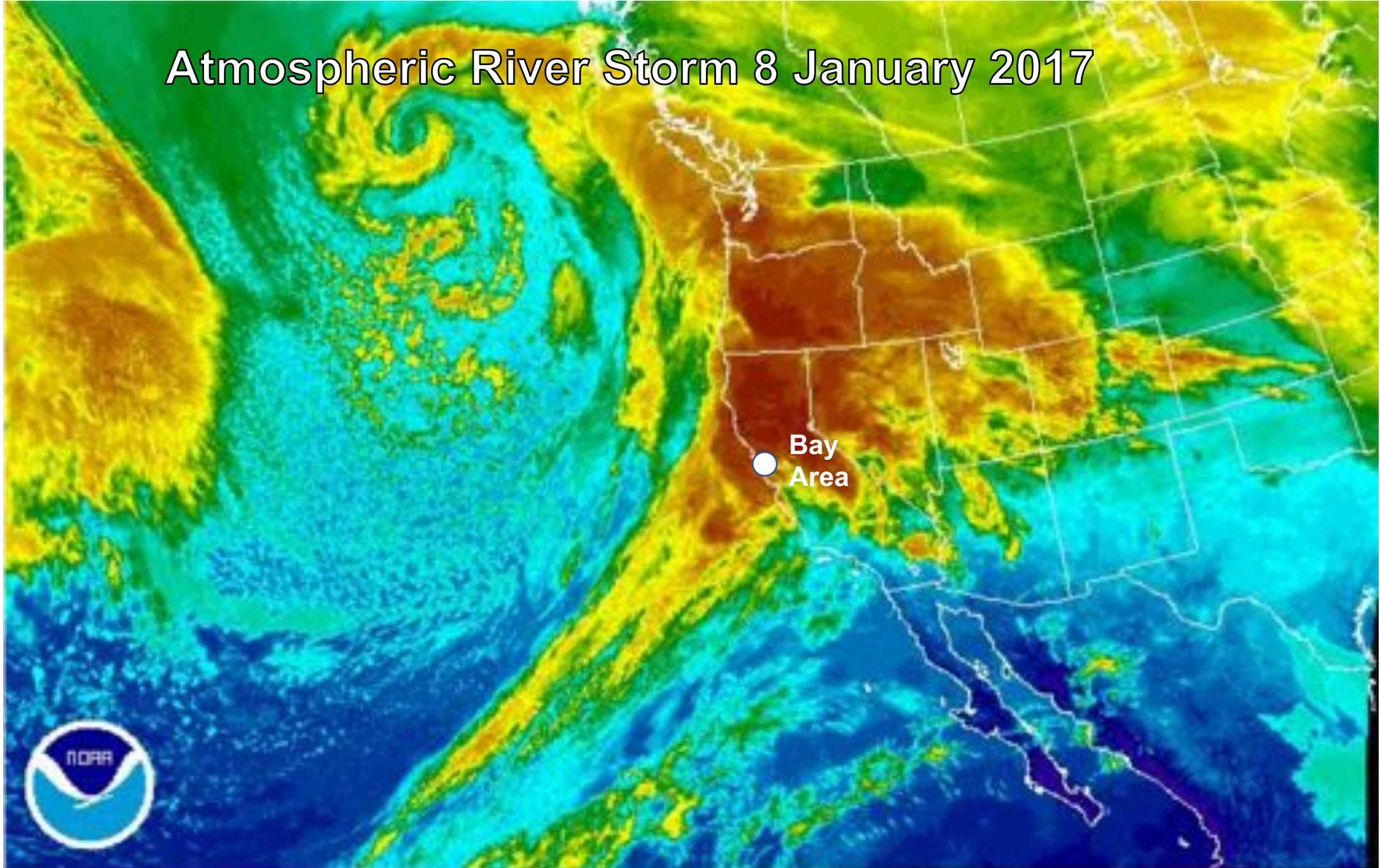


# Major Rivers and Drainage System





# Atmospheric River Storm 8 January 2017



10 October 2018

GOES-WEST RAINBOW IR CH. 4 - JAN 8 17 17:00 UTC

13



# Atmospheric River Storms: The Good, The Bad, The Ugly

## *The Good*

Provides ~30-50% of  
current total precipitation  
for California.

Will our dams, reservoirs,  
sea walls, and levees be  
compromised?  
Impact to life, property,  
infrastructure?

## *The Bad*

Warmer Air holds more Water:  
4 - 7% increase moisture for every 1°F rise  
in atmospheric temperature.  
Future storms will be  
much more intense and more frequent

## *The Ugly!*

40 days of massive  
Atmospheric River Storms  
Flooded Sacramento and  
Central Valley up to 10-30 ft  
during winter of 1861-1862.  
Took 6 months to drain!

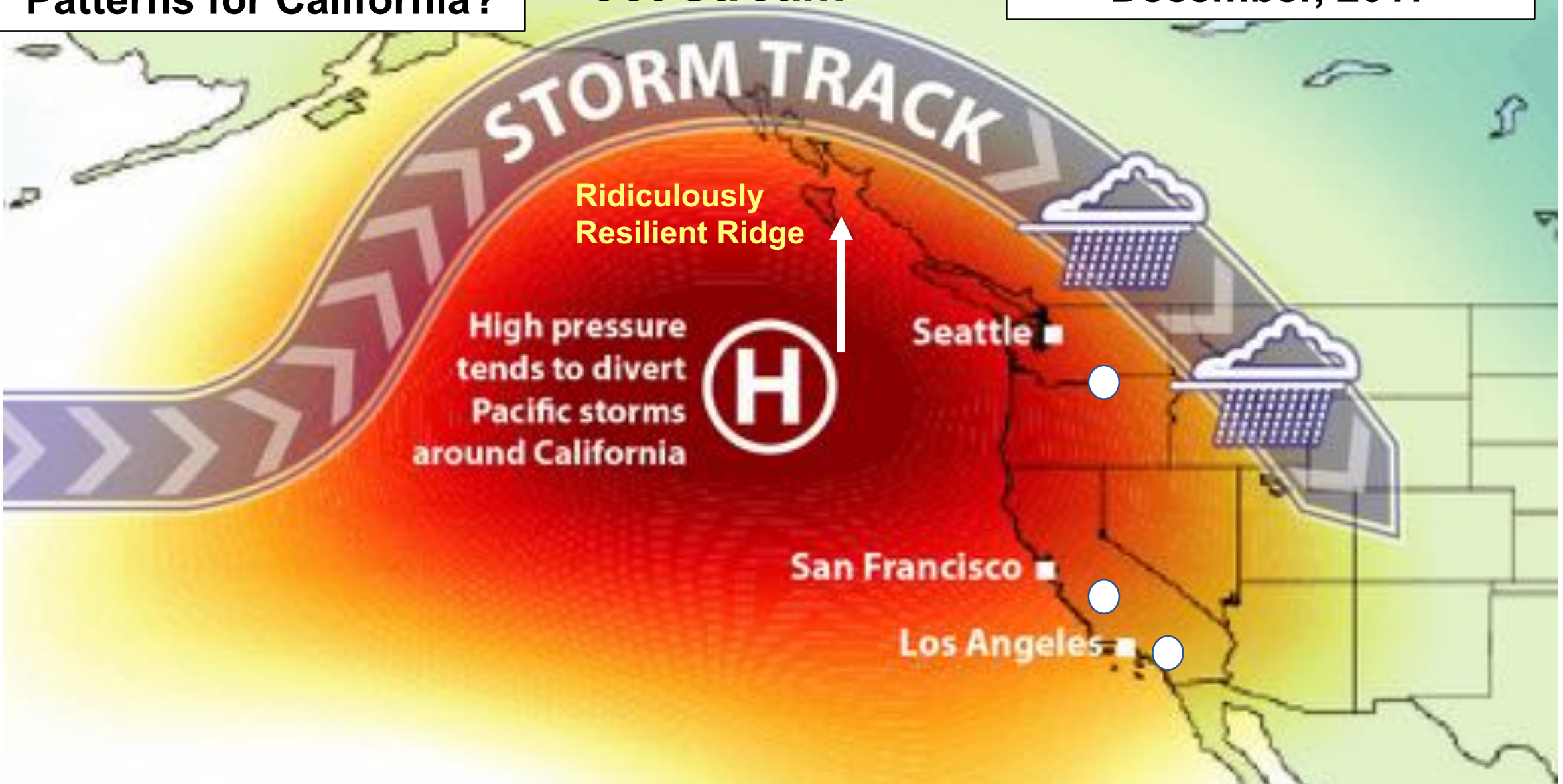
Probability of this event  
increases to once per 50  
years



# Shifting Future Weather Patterns for California?

## Jet Stream

December, 2017





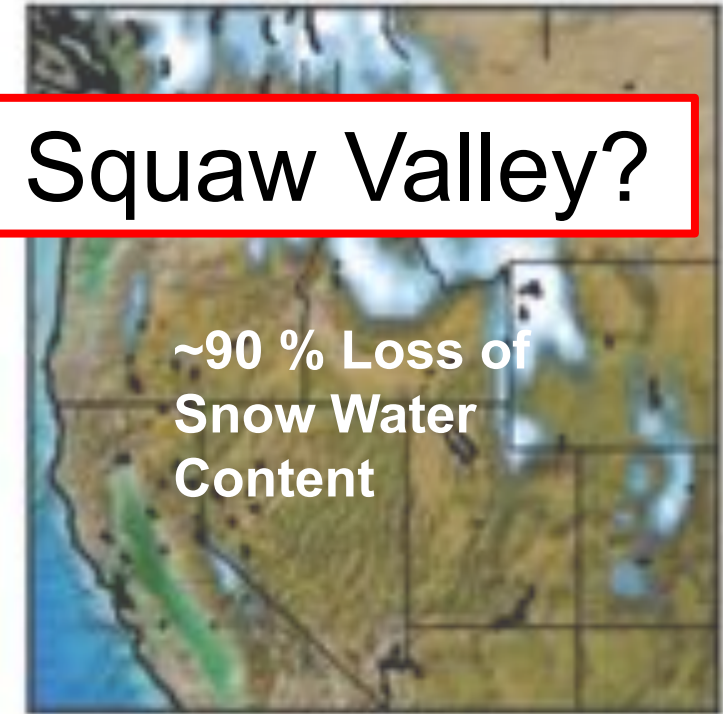
# Disappearing Winter Snow Pack

1980 - 2005

Mid 21st Century

End of Century

Will the Winter Olympics ever return to Squaw Valley?



More precipitation as rain - less snow

Results in immediate run-off rather than stored as snow



# Types of Drought

- **Meteorological Drought**  
Reduced rain and snow
- **Agricultural Drought**  
Soil moisture deficit for agriculture and forests
- **Hydrological Drought**  
Reduced Water Resources:  
Groundwater  
Snowpack  
Reservoirs and lakes  
Rivers and streams





# Potential of Droughts by 2100

## **Meteorological Drought (Reduced Precipitation)**

- Possible in Southern California
- Depends upon frequency of Ridiculously Resilient Ridge

## **Agricultural Drought in all of California (Reduced Soil Moisture)**

- Precipitation unlikely to replace moisture evaporation from warming soils
- Holding capacity reduced due to structural change of soil

## **Hydrological Drought in ALL of California (Reduced Water Resources)**

- “Chronic, long-duration Hydrological Drought is increasingly possible by the end of this century” (2017 *Climate Science Special Report: 4th National Climate Assessment*)



# Impact to Ecosystem

- **Modification of habitats**
- **Reduced number and displacement of native wildlife and plant species**
- **Impact to forests, wilderness, and wildlife areas**
- **Increase in soil instability and erosion**
  - > **Possible new Dust Bowl?**
- **Estuaries and salt marshes reduced by Sea Level Rise impacting fisheries**



**Conifer forests are being replaced by hardwood forests with temperature rise**

# Forests

**Loss of 102M trees during California's latest drought**

**Forest and rangelands cover over 80% of California.**

**Agricultural droughts impact lumber and forest industry:**

- **Forest industry is 3rd largest following Alaska and Oregon**
- **Jobs: 110,000**
- **Payroll: \$4.2B**
- **Sales Value: \$1.5B**



## Higher temperatures and drier soils:

- > Increased frequency, severity, and extent of wildfires

## Destabilizes soil:

- > Results in mudslides during rainy season (e.g., Santa Barbara area following wildfires)

## Post-fire results in bare ground:

- > Re-forestation takes decades to centuries

Much of 2018 Wine  
Grape Harvest  
- Smoke Damaged -



# Agriculture

Economic Value for All Agriculture in California: **\$80 - 100B**

Total jobs: **700,000**

**Only ~2% of California's economy!**

## **Wine Industry Alone \***

- Value: **\$47B (US: \$71B)**
- Jobs: **350,000**
- Wages: **\$17B**
- Tourism: **\$10B**
- Taxes Generated: **\$12B \*\***

**But Ranked #1 State for  
value of all agriculture  
commonities**

**Increased  
Desertification of  
Central Valley with  
temperature rise**

\* 2017 Direct and Indirect

\*\* Business and Consumer



# Energy

**60% increase  
demand by 2100  
with temperature  
rise**

- **Agriculture**
- **Household**
- **Commercial**
- **Cooling and Air Conditioning**
- **Electric vehicles**
- **State water distribution**  
**(20% of all energy used  
to distribute water)**



# Public Health: Dirty Air & Heat Waves

***Higher temperatures can increase risk of:***

**Los Angeles on  
a smoggy day**

- Dehydration
- Exhaustion
- Heat Stroke
- Night time heat retention in urban areas: heat waves

***Increased Smog Risk:***

- Promotes asthma and other respiratory illnesses

***Increased Smoke from Wildfires:***

- Promotes short and long term respiratory illnesses

**\* Low socioeconomic population is most vulnerable to all climate change-related public health issues**

# Public Health: Water and Food Borne Diseases

**Higher temperatures can accelerate the spread of water-borne diseases:**

- **Drinking contaminated water**
- **Eating seafood from contaminated water**
- **Eating produce irrigated by contaminated water**
- **Harmful algae blooms threatens aquatic organisms and food safety**

**Red Tide:  
Half Moon Bay,  
San Mateo Co.**



# Public Health: Vector-Borne Diseases

Warm, moist regions encourage establishment of vector-borne diseases including:

- Human Hantavirus
- Dengue Fever
- Lyme Disease
- Yellow Fever
- West Nile Virus
- Zika Virus
- Malaria
- Encephalitis
- Bubonic Plague





# Recreation

**Rising temperature impacts fish species diversity, and decreases fish populations**

**Recreational fisheries valued at \$2.4B (2011)**

**National Park System**  
**- \$2.9B Local Revenue**  
**- 29,000 Local Jobs**

**State Parks System**  
**- \$3.2B Local Revenue**

**Reductions in Sierra Nevada snowpack:**  
**Winter recreation -**  
**Value: \$1.4B (2011)**  
**24,000 workers**



# Sea Level Rise: The Race to Secure Our Coast

SPEED  
LIMIT  
35

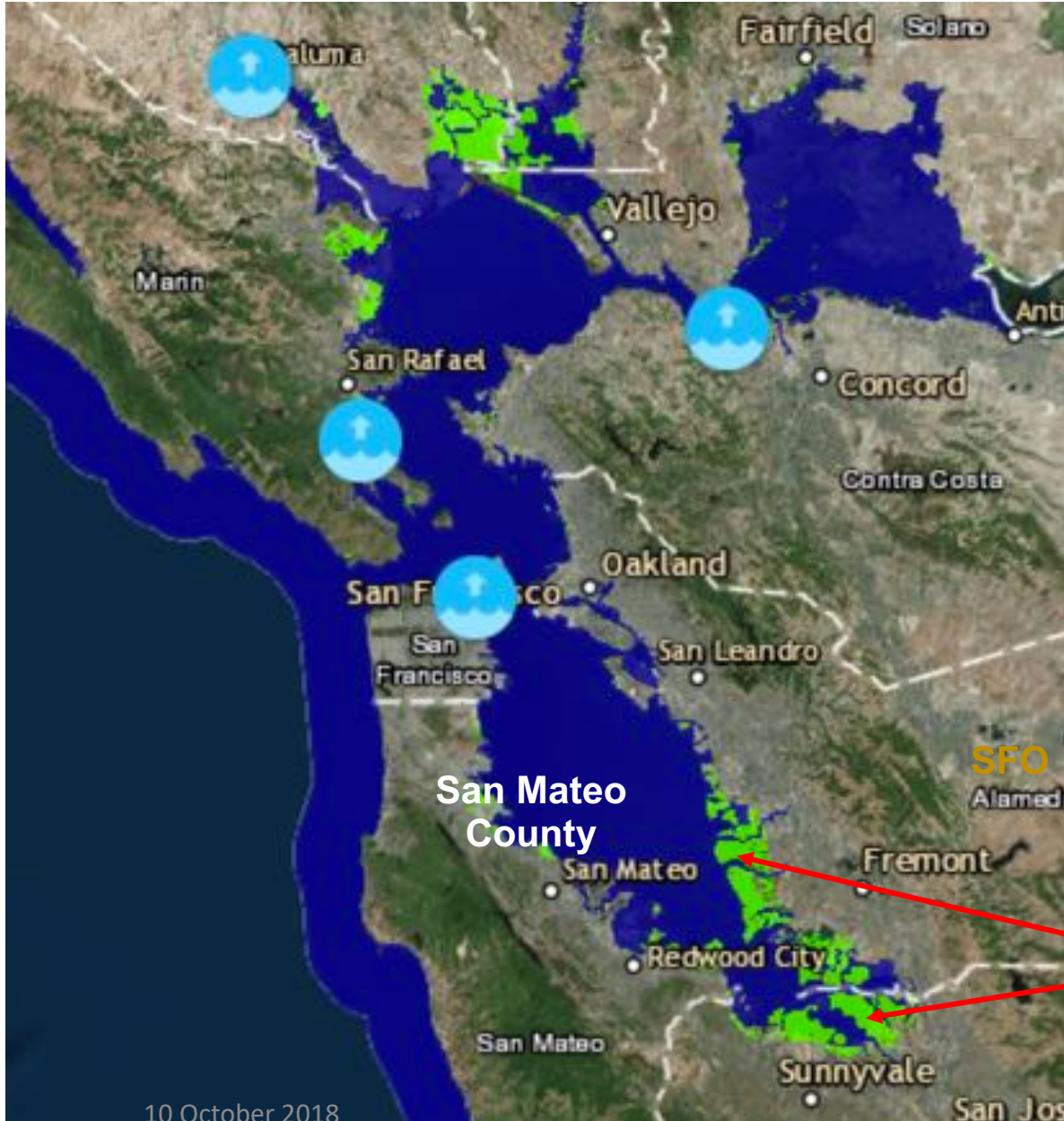


High Tide in  
Marin County

6 million Americans live within  
about 6 feet of the sea level

<https://www.sfgate.com/bayarea/article/King-tides-block-roads-cause-flooding-in-Marine-5973786.php>

# Current Sea Level - San Francisco Bay Area



**Northern California:**  
**Sustains most economic and infrastructure damage by 2100 from SLR and storm surge totaling 8.8 ft**

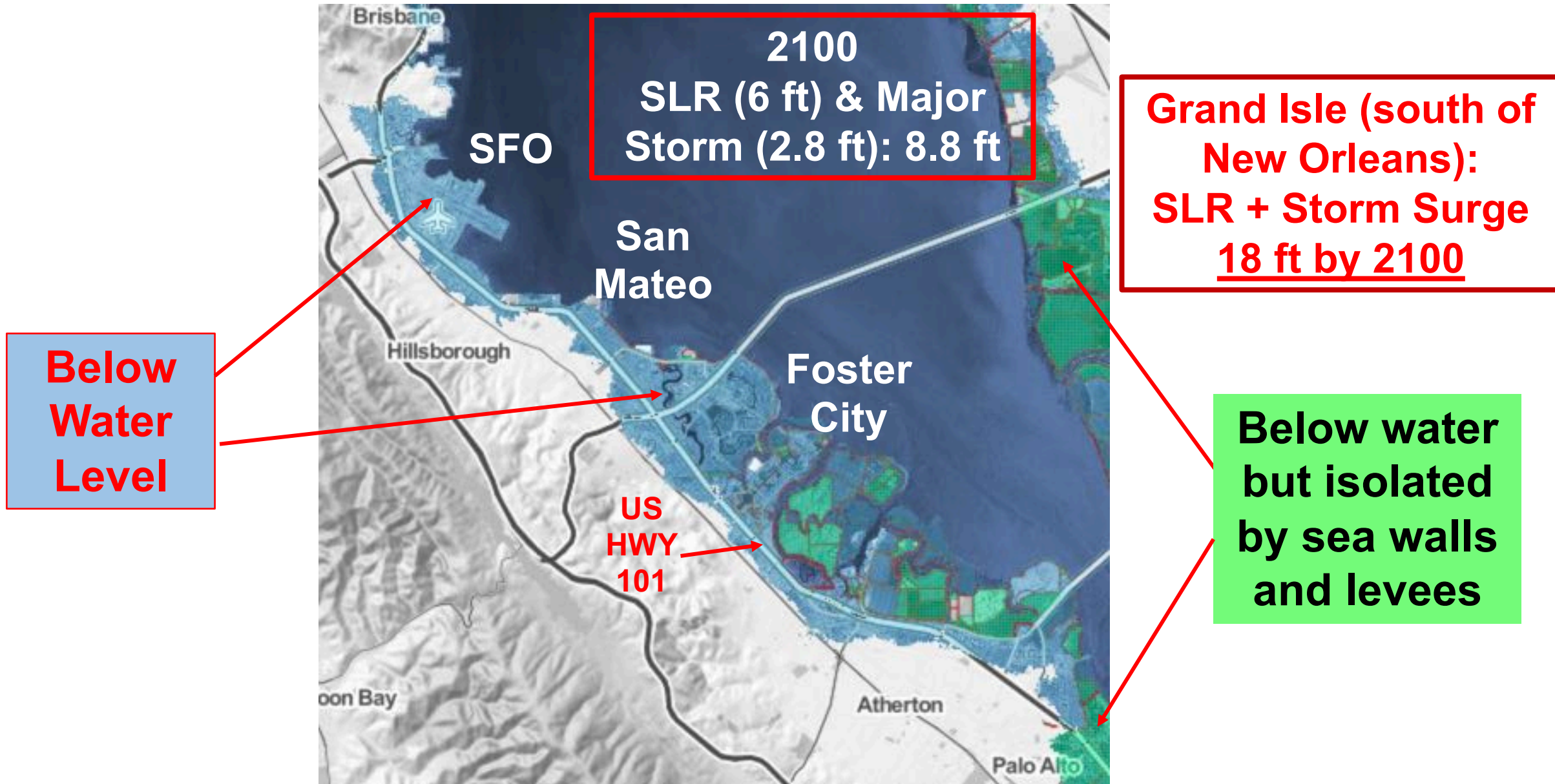
**Sea Level Rise for California will be higher than the Global average**

**Below water but isolated by sea walls and levees**

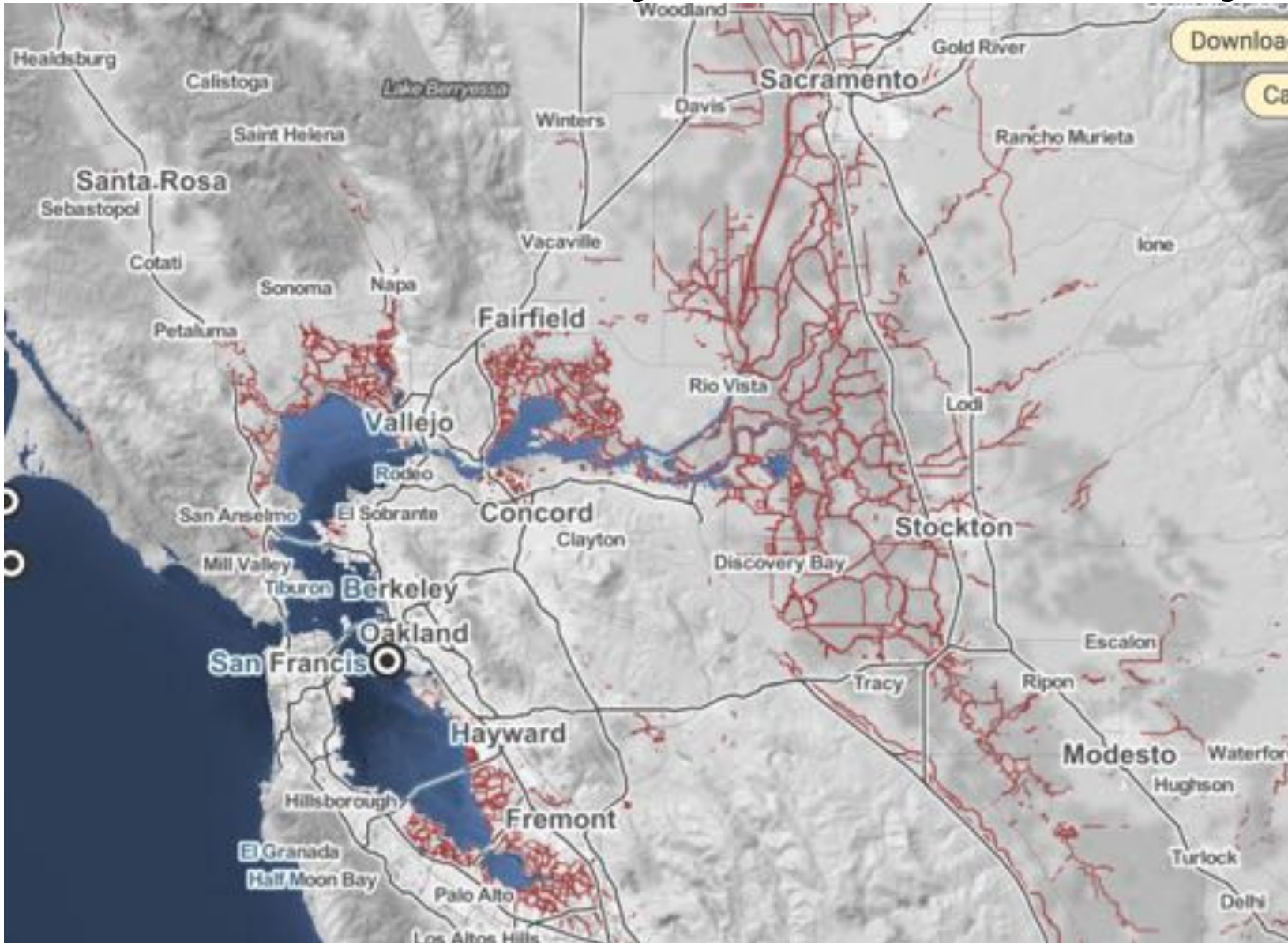
**Projected SLR of 32 ft by 2200 for No. Calif -- If climate change not mitigated by 2100**



# San Mateo County at Most Risk With Sea Level Rise by 2100



# Levee System: Reliability Uncertain



Approx. 14,000 miles of Federal, State, and private levees in California.

**What's their status?**

Recent Federal Funds awarded for upgrading.

**Lessons Learned:**  
Disastrous failure of levee system in Louisiana during Hurricane Katrina in 2005



# Impacts to California's Population and Infrastructure From SLR

2050 SLR (2 ft) & Moderate Storm (2 ft): 4 ft	2100 SLR (6 ft) & Major Storm (2.8 ft): 8.8 ft
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• Population at Risk*	213,000	777,000
• Land at Risk	310 sq miles	710 sq miles
• Buildings at Risk	91,000	322,000
• Property Value	\$54B	\$162B
• Roads & Highways	1,100 miles	4,000 miles
• International AP	SFO	SFO, Oakland
• Power Stations	8	34
• Oil Refineries	6	35
• Contamination Facil.	1,170	1,300

How do you  
move an Oil  
Refinery??

Economic  
Value Not Yet  
Assessed

\* Based on 2010 US Census  
Other data not projected to  
future dates: based on  
various government sources  
dated earlier than 2018.

## Saltwater intrusion of Coastal Aquifers

# Summary – California Impact by 2100

- **Projected Temperature Rise: Approx. 10 - 15°F**
- **Projected Sea Level Rise with major storms: Approx. 9 ft**
- **Increase risk of Agricultural Drought impacting food supply and forests**
- **Increase risk of Hydrological Drought impacting reliable water supply**
- **Increase severity and frequency of Atmospheric River Storms**
- **Drastic change in ecological habitats effects forests, agriculture, estuaries, etc.**
- **More frequent and intense wildfires, floods, mudslides**
- **Increased energy requirements for AC, electric vehicles, water distribution, etc.**
- **Impact on Public Health (especially low socioeconomic population)**
- **Projected Economic Impacts to many Sectors (agriculture, recreation, etc.) and infrastructure**



# Recommendations – Californians Need to Prepare for 2100 and Beyond

## Mitigation:

- **Greatly reduce use of fossil fuels to limit Climate Change.**

## Adaptation:

- **Insure integrity of levees and sea walls against Sea Level Rise**
  - **Need to accommodate shipping ports**
- **Plan for droughts and water management**
- **Plan for potential of major flooding from annual severe Atmospheric River Storms and once every 50 yr mega system**
- **Plan for impact of temperature rise to State's many sectors (agriculture, recreation, energy, etc.) and infrastructure**

# How You Can Help Fight Climate Change

Do what ever you are comfortable with

- **Learn more about climate change – this presentation is just a start**
  - **Check out our Suggested References page on our website**
- **Spread the word of what you have learned**
- **Support candidates that support climate related legislation**
- **Lobby for climate change legislation (see following slide)**
- **Participate in a future March for Science**
- **Join or participate with organizations that support climate change**
- **Donate**
- **Lower your carbon footprint (see following slide)**
  - **Reduce use of carbon based energy, services, and manufactured products**



# How You Can Help – Letter Writing Campaign

## Mitigation (preventative) Measures for Climate Change

- **Governor Executive Order B-48-18: Zero-Emission Vehicles**
  - <https://www.gov.ca.gov/2018/01/26/governor-brown-takes-action-to-increase-zero-emission-vehicles-fund-new-climate-investments/>
  - **\$2.5B infrastructure over 8 years**
  - **\$225M rebates (including low-income)**
- **AB1745: Clean Cars Act 2040**
  - <https://a19.asmdc.org/press-releases/20180103-assemblymember-ting-introduces-clean-cars-2040>
  - **All new car registrations must be ZEV by 2040**
- **SB100: Renewable Portfolio Standard**
  - <http://focus.senate.ca.gov/sb100/faqs>
  - **60% Retail Electricity by 2030**
  - **100% Retail Electricity by 2045**
- **AB 1030 Energy storage systems**
  - [https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill\\_id=201720180AB1030](https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201720180AB1030)
  - **Decentralize electric generation and locate the generation near where the electricity is used.**
  - **Establish a rebate program dedicated to energy storage and that carves out funding for low-income customers and disadvantaged**

# Reducing Your Carbon Footprint

## Resources

- **Natural Resources Defense Council: How You Can Help Fight Climate Change**  
<https://www.nrdc.org/stories/how-you-can-help-fight-climate-change>
- **The Nature Conservancy: Climate Change - How You Can Help**  
<https://www.nature.org/ourinitiatives/urgentissues/global-warming-climate-change/help/index.htm>
- **World Wildlife Fund: What You Can Do to Fight Climate Change**  
<https://www.worldwildlife.org/pages/what-you-can-do-to-fight-climate-change>
- **How to Reduce Your Carbon Footprint**  
<https://www.nytimes.com/guides/year-of-living-better/how-to-reduce-your-carbon-footprint?campaignId=7WWW8>



# Secure The Future 2100

What we do, Who we are

**Our Goal is to Support Elected Officials and to Inform the Public on Climate Issues.**

**We derive our information from highly regarded mainstream publications. Our reports are judiciously referenced to these sources.**

**Co-founders:**

**Stan Farkas, PhD - Retired NASA Project Manager \***

**Gary Latshaw, PhD - Retired Physics Professor**

**Phil Russell, PhD - Retired NASA Atmospheric Scientist**

**\* Point of Contact: [stan@securethefuture2100.org](mailto:stan@securethefuture2100.org)**

**Please visit our website for more information at:  
<https://securethefuture2100.org>**

# Supporting Information

- Technical Details on Scenario Used for Sea Level Rise
- References



# NOAA General Guidelines for Scenario Selection \*

Early stages of planning need to establish the conceptual linkage between sea level rise, the system(s) of interest [e.g., infrastructure, population], and the threat to those systems. Once a conceptual linkage is established, the next step is to “stress test” the system and the plans against different futures to assess potential risks. Scenarios, to be most useful, should delineate between policies or plans that succeed and those that fail..... For decisions involving long planning horizons and with a limited adaptive management capacity, the high degree of uncertainty in late-21st century GMSL rise looms large. **Failure to adequately account for low-probability, high-consequence outcomes significantly increases future risks and exposure. For many decisions, it is essential to assess worst-case scenarios, not only those assessed as the scientifically ‘likely’ to happen. For example, drawing on the references cited above, the following is suggested as a potential initial scenario selection strategy for decisions and planning processes for which *long-term* risk management is paramount:**

- Define a scientifically plausible upper-bound (which might be thought of as a worst-case or extreme scenario) as the amount of sea level rise that, while low probability, cannot be ruled out over the time horizon being considered. Use this upper-bound scenario as a guide for overall system risk and long-term adaptation strategies.
- Define a central estimate or mid-range scenario (given assumptions about greenhouse gas emissions and other major drivers). Use this scenario as baseline for shorter-term planning, such as setting initial adaptation plans for the next two decades. This scenario and the upper- bound scenario can together be thought of as providing a general planning envelope.

...Continuous monitoring of current sea level behaviors (trends and variability), along with improved scientific understanding of relevant climate-system processes and feedbacks, can then help identify the evolution of the system over time with respect to these mid-range and worst-case scenarios. Systematic assessments can determine current sea level rise (and risk) trajectories and when to implement more aggressive response options against the high-end scenario if adaptive management strategies are an option.....

\* GLOBAL AND REGIONAL SEA LEVEL RISE SCENARIOS FOR THE UNITED STATES; NOAA Technical Report NOS CO-OPS 083; pg 33  
<https://tidesandcurrents.noaa.gov/pub.html>

# Scenario Used for Sea Level Rise

Table 12.3. Interpretations of the Interagency GMSL rise scenarios

Scenario	Interpretation
Low	Continuing current rate of GMSL rise, as calculated since 1993 Low end of very likely range under RCP2.6
Intermediate-Low	Modest increase in rate Middle of likely range under RCP2.6 Low end of likely range under RCP4.5 Low end of very likely range under RCP8.5
Intermediate	High end of very likely range under RCP4.5 High end of likely range under RCP8.5 Middle of likely range under RCP4.5 when accounting for possible ice cliff instabilities
Intermediate-High	Slightly above high end of very likely range under RCP8.5 Middle of likely range under RCP8.5 when accounting for possible ice cliff instabilities
High	High end of very likely range under RCP8.5 when accounting for possible ice cliff instabilities
Extreme	Consistent with estimates of physically possible “worst case”

Scenario used (plus also accounting for a major storm) in running Surging Seas Risk Finder Model on Climate Central

[https://riskfinder.climatecentral.org/state/california.us?comparisonType=county&forecastName=With+extreme+flood&forecastType=NOAA2017\\_inthi\\_p50&level=9&stationNum=3&unit=ft](https://riskfinder.climatecentral.org/state/california.us?comparisonType=county&forecastName=With+extreme+flood&forecastType=NOAA2017_inthi_p50&level=9&stationNum=3&unit=ft)

Climate Science Special Report: Fourth National Climate Assessment, Volume I, Chapter 12: Sea Level Rise



# Scenario Used for Sea Level Rise

From Climate Central interactive model using NOAA Data from 2017

<https://riskfinder.climatecentral.org>

Sea level rise scenarios published by NOAA in 2017 (NOAA Technical Report NOS CO-OPS 083) for use in the 2018 U.S. National Climate Assessment. The amount of global mean sea level rise by 2100 (GMSL) defines each scenario. This tool gives corresponding local projections also provided by NOAA, which vary due to local factors such as rising or sinking land. Low, middle, and high sub-scenarios give a range of possible local outcomes (17th, 50th and 83rd percentiles) given each main scenario. Overall, lower emissions of heat-trapping pollution increase the chances for lower scenarios, and higher emissions point toward higher scenarios. The "Low" scenario assumes that sea level rise rates from the last 30 years continue unchanged, whereas the "Extreme" scenario assumes accelerated ice sheet loss in Antarctica.

Current report uses Intermediate high at the middle 50<sup>th</sup> percentile

Low (0.3 meters GMSL)

Sensitivity:  Low  Middle  High

Intermediate low (0.5 meters GMSL)

Sensitivity:  Low  Middle  High

Intermediate (1.0 meters GMSL)

Sensitivity:  Low  Middle  High

Intermediate high (1.5 meters GMSL)

Sensitivity:  Low  Middle  High

High (2.0 meters GMSL)

Sensitivity:  Low  Middle  High

Extreme (2.5 meters GMSL)

Sensitivity:  Low  Middle  High

# References (by Slide Title)

## 2016-2017 US Climate Disaster Costs

- <https://www.ncdc.noaa.gov/billions/events/US/1980-2017>

## U.S. 2017 Billion-Dollar Weather and Climate Disasters

- <https://www.climate.gov/news-features/blogs/beyond-data/2017-us-billion-dollar-weather-and-climate-disasters-historic-year>
- <https://gwtoday.gwu.edu/gw-researchers-2975-excess-deaths-linked-hurricane-maria>
- <https://www.cdc.gov/mmwr/volumes/67/wr/mm6730a5.htm>

## Scenarios for Temperature / Sea Level Rise by 2100

- United Nations Intergovernmental Panel on Climate Change Fifth Assessment Report, 2013  
<http://www.ipcc.ch/report/ar5/wg1/>
- Climate Science Special Report: Fourth National Climate Assessment, Volume I, Chapter 12: Sea Level Rise  
<https://science2017.globalchange.gov>
- NOAA Technical Report NOS CO-OPS 083: Global And Regional Sea Level Rise Scenarios For The United States, 2017  
<https://NOAA Technical Report NOS CO-OPS 083>
- Model from Surging Seas Risk finder developed by Climate Central using latest published data from NOAA and NASA and above publications  
[https://riskfinder.climatecentral.org/state/california.us?comparisonType=county&forecastName=With+extreme+flood&forecastType=NOAA2017\\_inthi\\_p50&level=9&stationNum=3&unit=ft](https://riskfinder.climatecentral.org/state/california.us?comparisonType=county&forecastName=With+extreme+flood&forecastType=NOAA2017_inthi_p50&level=9&stationNum=3&unit=ft)

## Changes in Temperature for Northern Hemisphere From Year 300 to Today (°F)

- Appendix 3: Climate Science Supplement. Climate Change Impacts in the United States: The Third National Climate Assessment  
<https://data.globalchange.gov/file/a2700bde-79f1-4ca6-844f-f8ad2bb46784>

## Projected Average Global Temperatures

- Climate Science Special Report: Fourth National Climate Assessment, Volume I, Chapter 6: Temperature Changes in the United States  
<https://science2017.globalchange.gov>



# References (Continued)

## July California Temperatures (Average Daily High)

- Estimates based on [climateinternational.org](http://climateinternational.org)

## Change in Precipitation by 2100

- <https://science2017.globalchange.gov/chapter/7/>
- <http://digital.olivesoftware.com/Olive/ODN/SanFranciscoChronicle/shared/ShowArticle.aspx?doc=HSFC%2F2018%2F04%2F24&entity=Ar00112&sk=3740A463&mode=text>
- <http://weatherwest.com/archives/6252>

## Projected Increased Frequency and Severity of Atmospheric River Storms

- <https://earthobservatory.nasa.gov/IOTD/view.php?id=89442&src=ve>
- <https://www.scientificamerican.com/article/global-warming-and-the-science-of-extreme-weather/>
- <https://www.scientificamerican.com/article/atmospheric-rivers-california-mega-flood-lessons-from-forgotten-catastrophe/>
- <http://digital.olivesoftware.com/Olive/ODN/SanFranciscoChronicle/shared/ShowArticle.aspx?doc=HSFC%2F2018%2F04%2F24&entity=Ar00112&sk=3740A463&mode=text>
- <http://weatherwest.com/archives/6252>

## Ridiculously Resilient Ridge

- <https://snowbrains.com/noaas-week-2-outlook-california-high-pressure-dry-conditions-return-to/>

## Disappearing Winter Snow Pack

- Climate Science Special Report: Fourth National Climate Assessment, Volume I, <https://science2017.globalchange.gov/chapter/8/>

## Types of Drought

- <https://www.livescience.com/21469-drought-definition.html>

# References (Continued)

## Potential of Droughts by 2100

- <https://nca2014.globalchange.gov/>
- <https://science2017.globalchange.gov/>

## Impact to Ecosystem

- The impact of climate change on California's ecosystem services  
<https://link.springer.com/article/10.1007/s10584-011-0313-4>

## Forests

- <http://calforests.org/resources/economic-benefit/>
- [http://www.pnas.org/content/101/34/12422.full?maxtoshow=&HITS=10&hits=10&RESULTFORMAT=&fulltext=heat-related+death&searchid=1093364423275\\_4087&stored\\_search=&FIRSTINDEX=0](http://www.pnas.org/content/101/34/12422.full?maxtoshow=&HITS=10&hits=10&RESULTFORMAT=&fulltext=heat-related+death&searchid=1093364423275_4087&stored_search=&FIRSTINDEX=0)

## Wildfires

- <https://www.climate.gov/news-features/event-tracker/winter-storm-brings-destructive-mudslides-california-january-2018>

## Agriculture

- California Department Of Food And Agriculture: 97 Years Protecting And Promoting Agriculture In The Golden State  
<https://www.cdffa.ca.gov/CDFA-History.html>
- National Impact of the Wine Industry: \$219.9 Billion  
<https://www.winesandvines.com/news/article/190064/National-Impact-of-the-Wine-Industry-219.9-Billion>
- The Economic Impact of Food and Beverage Processing in California  
<http://www.imperialvalleynews.com/index.php/news/california-news/3798-the-economic-impact-of-food-and-beverage-processing-in-california.html>

## Energy

- <http://large.stanford.edu/courses/2012/ph240/sperrin1/>
- <https://oag.ca.gov/environment/impact>



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## **Public Health: Dirty Air & Heat Waves**

- Health Effects of Ozone and Particle Pollution  
<http://www.lung.org/our-initiatives/healthy-air/sota/health-risks/>
- How Does a Heat Wave Affect the Human Body?  
<https://www.scientificamerican.com/article/heat-wave-health/>
- Climate and Human Health: Effects of Heat  
[https://www.niehs.nih.gov/research/programs/geh/climatechange/health\\_impacts/heat/index.cfm](https://www.niehs.nih.gov/research/programs/geh/climatechange/health_impacts/heat/index.cfm)

## **Public Health: Water and Food Borne Diseases**

- Climate and Human Health: Foodborne Diseases and Nutrition  
[https://www.niehs.nih.gov/research/programs/geh/climatechange/health\\_impacts/foodborne\\_diseases/index.cfm](https://www.niehs.nih.gov/research/programs/geh/climatechange/health_impacts/foodborne_diseases/index.cfm)
- Climate and Human Health: Waterborne Diseases  
[https://www.niehs.nih.gov/research/programs/geh/climatechange/health\\_impacts/waterborne\\_diseases/index.cfm](https://www.niehs.nih.gov/research/programs/geh/climatechange/health_impacts/waterborne_diseases/index.cfm)
- Climate Change and Harmful Algal Blooms  
<https://www.epa.gov/nutrientpollution/climate-change-and-harmful-algal-blooms>

## **Public Health: Vector-Borne Diseases**

- Climate and Human Health: Vectorborne and Zoonotic Diseases  
[https://www.niehs.nih.gov/research/programs/geh/climatechange/health\\_impacts/vectorborne/index.cfm](https://www.niehs.nih.gov/research/programs/geh/climatechange/health_impacts/vectorborne/index.cfm)

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## Recreation

- Visitor Spending Effects - Economic Contributions of National Park Visitor Spending  
<https://www.nps.gov/subjects/socialscience/vse.htm>
- State Park System Statistical Report: 2015-2016  
[https://www.parks.ca.gov/?page\\_id=23308](https://www.parks.ca.gov/?page_id=23308)
- Sportfishing in America: January 2013  
2011\_ASASportfishing\_in\_America\_Report\_January\_2013.pdf
- Climate Impacts on the Winter Tourism Econom in the United States  
<https://www.nrdc.org/sites/default/files/climate-impacts-winter-tourism-report.pdf>

## Current Sea Level - San Francisco Bay Area

- Climate Central  
<https://riskfinder.climatecentral.org/state/california.us>

## San Mateo County at Most Risk With Sea Level Rise by 2100

- Climate Central  
<https://riskfinder.climatecentral.org/state/california.us>

## Levee System: Reliability Uncertain

- Climate Central  
<https://riskfinder.climatecentral.org/state/california.us>
- ASCE Technical Council on Forensic Engineering (TCFE) : New Orleans Hurricane Katrina Levee Failures  
<https://eng-resources.uncc.edu/failurecasestudies/dam-failure-cases/new-orleans-hurricane-katrina-levee-failures/>

## Impacts to California's Population and Infrastructure From SLR

- Climate Central  
<https://riskfinder.climatecentral.org/state/california.us>



# Suggested Reading and Videos

- Secure The Future 2100: <https://securethefuture2100.org>
- Rising Tides: Climate Refugees in the Twenty-First Century - by John Tideshn R. Wennersten and Denise Robbins; 2017 A good non-technical read.
- The West without Water: What Past Floods, Droughts, and Other Climatic Clues Tell Us about Tomorrow - by B. Lynn Ingram and Frances Malamud-Roam; 2013
- "The Age of Consequences" 2016; obtain from Amazon ([https://www.amazon.com/dp/B06XFZ1GVG/ref=cm\\_sw\\_r\\_cp\\_ep\\_dp\\_4FcXzbH1WEC7J](https://www.amazon.com/dp/B06XFZ1GVG/ref=cm_sw_r_cp_ep_dp_4FcXzbH1WEC7J)) or itunes (<https://itunes.apple.com/us/movie/the-age-of-consequences/id1213578427>). It is about climate change and global security and coincidentally the movie and our South Asia report compliment each other covering the same or similar issues. And they, like us, target South Asia as the global hot spot.
- Decoding the Weather Machine: Discover how Earth's intricate climate system is changing - 2018 <http://www.pbs.org/wgbh/nova/earth/decoding-weather-machine.html>
- New York Times: Climate and Environment Section [https://www.nytimes.com/section/climate?action=click&contentCollection=science&region=navbar&module=collectionsnav&page\\_type=sectionfront&pgtype=sectionfront](https://www.nytimes.com/section/climate?action=click&contentCollection=science&region=navbar&module=collectionsnav&page_type=sectionfront&pgtype=sectionfront)
- Washington Post: Energy and Environment – Climate Change Section [https://www.washingtonpost.com/news/energy-environment/wp/category/climate-change/?utm\\_term=.523761b6487d](https://www.washingtonpost.com/news/energy-environment/wp/category/climate-change/?utm_term=.523761b6487d)
- NASA Global Climate Change: <https://climate.nasa.gov/>
- NOAA Climate: <http://www.noaa.gov/climate>