WATER TOMORROW

2020 Integrated Resources Plan

IRP Joint Workshop on Climate Change

Metropolitan Board of Directors and Member Agency Managers

May 25, 2021

Ed Means
Facilitator

- President of Means Consulting LLC
- 40 years in water in California
- Experienced facilitator on technical issues
  - Over 15 strategic plans
  - 8 scenario plans
  - Numerous expert panels
- Consultant since 1999 on numerous planning projects including scenario planning, resource plans, and strategic plans across the country
- Worked at Metropolitan from 1980-1998 including as Director of Resources during first MWD IRP

Workshop Logistics

Meeting Logistics

Objectives

Approach

Meeting Logistics

- Limited time – be succinct; focus on climate change issues
- Staff will consider all comments and questions as planning moves forward
- Staff will provide written guidance to process related questions
- Mute audio / turn off video unless talking
- Use the chat feature to submit questions <u>you haven't already submitted</u>
- The meeting is being recorded
- May also submit questions during meeting to: MWDIRP@mwdh2o.com

Workshop Objectives

- Gain familiarity of climate science for water resource planning
- Opportunity for workshop participants to pose questions to the panel of climate experts
- Feedback on charge questions on drivers of climate change
- Obtain expert feedback prompted by participant questions to improve quantification of scenarios

Workshop Approach

- Panel member discussion of charge questions related to climate change
- Panel member feedback on questions submitted by the Board and member agency managers in advance
- Panel member feedback for clarification or additional climate-related questions from Board members or member agency participants

Staff Presentation

Recap of Work Effort

Refinement Approach

Charge Questions for Workshop

Brief Recap of Work Efforts

- Preliminary scenario assumptions presented - October 2020
  - Initial assessment to illustrate potential for supply/demand ranges across scenarios and types of analytics available
- Joint Workshop on Demands - March 2021
  - Staff continuing to work with experts and incorporating feedback into the analysis
- Scenario Refinements – Ongoing
  - More robust modeling and evidence-based effort
  - Identify plausible supply/demand ranges across scenarios
  - Update “gap analysis”
  - Serves as the basis for identifying the actions needed to achieve 100 percent reliability for each scenario

How We Are Refining the Scenarios

- Collaborative Approach
  - Scenario refinements are grouped into three areas
    - Local Supply, Imported Supply and Demands
  - Engage with experts (demand and climate)
    - Contracted to help staff with technical support
    - Expanded to include Board and Member Agencies interaction

- Today's workshop focuses on climate change
  - Introduction to climate science
  - Going from global to local
  - Regional hydrologic changes
  - Climate and water demand
  - What do we plan for?

Panel Introductions

Dr. Heidi Roop

Dr. Julie Vano

Brad Udall

Heather Cooley

Dr. Heidi Roop

- Assistant Professor at the University of Minnesota, Department of Soil, Water and Climate.
- Ph.D in Geology from Victoria University of Wellington, M.S. in Geology from Northern Arizona University, and B.A. in Geology from Mount Holyoke College.
- Works to develop innovative ways to build bridges between theory and practice of science communication.
- Participated in research around the world from Greenland and Antarctica to the mountains of Vietnam and New Zealand.
- Holds Affiliate Assistant Professorship at University of Washington School of Public Health.
- Adjunct Researcher at Center of Science and Society at Victoria University of Wellington.
- Editor for the journal *Geoscience Communication.*

Dr. Julie Vano

- Research Director at Aspen Global Change Institute.
- Ph.D. in Civil and Environmental Engineering from University of Washington, M.S. in Land Resources from University of Wisconsin and B.A. in Biology, minors in Mathematics and Chemistry from Luther College.
- Focuses on connecting science and decision making, hydrology, water resource management, science policy, climate change adaptation, and system dynamics.
- Trainer for Water Utility Climate Alliance (WUCA) Resiliency Training to help water utilities build resilience to a changing climate.
- Lead and contributing author in reports for federal and state agencies, including Water Reliability in the West - 2021 SECURE Water Act Report.
- American Geophysical Union Science and Society Section President.

Brad Udall

- Senior Water and Climate Research Scientist at Colorado Water Institute, Colorado State University.
- M.B.A. from Colorado State University and B.S. in Environmental Engineering from Stanford University.
- Wide-ranging background in water and climate policy issues.
- Extensive writing on the impacts of climate change on water resources in American West, including:
  - Global Climate Change Impacts in the United States
  - Western Water Assessment's Climate Change in Colorado Report
- Awarded by California Department of Water Resources for work in facilitating interactions between water managers and scientists.
- Awarded by Department of Interior for work on groundbreaking 2007 EIS on Colorado River shortages and coordinated reservoir operations.

Heather Cooley

- Director of Research at the Pacific Institute.
- M.S. in Energy and Resources and B.S. in Molecular Environmental Biology from the University of California, Berkeley.
- Conducts and oversees research on water issues such as:
    - Sustainable water use and management
    - Connection between water and energy
    - Impacts of climate change on water resources
- Served on the California Commercial, Industrial, and Institutional Task Force.
- Currently serves on the California Urban Stakeholder Committee and the California Urban Water Conservations Council's Board of Directors.

Charge Questions

1. *What major components contribute to the range of future climate outcomes?*

2. *How do we apply global climate model outputs that examine climate change over a long timeframe to the shorter 25-year IRP planning horizon?*

3. *What approaches or methodologies do you recommend for quantifying how climate change (e.g., changing temperatures and precipitation) affect Southern California and its imported supply watersheds?*

4. *What models and downscaling techniques are available and appropriate for the relevant regions?*

Charge Questions Cont’d

5. *If the models and downscaling techniques differ for each region, how do we ensure internal consistency within the analysis?*

6. *What hydrologic changes are anticipated for the relevant regions?*

7. *What are the important underlying climate change drivers that influence demands, and how do they affect demands in each of the three major demand sectors (single family residential, multi-family residential, commercial/industrial)?*

8. *What other recommendations do you have for our planning?*

Part I:
Global Climate Change

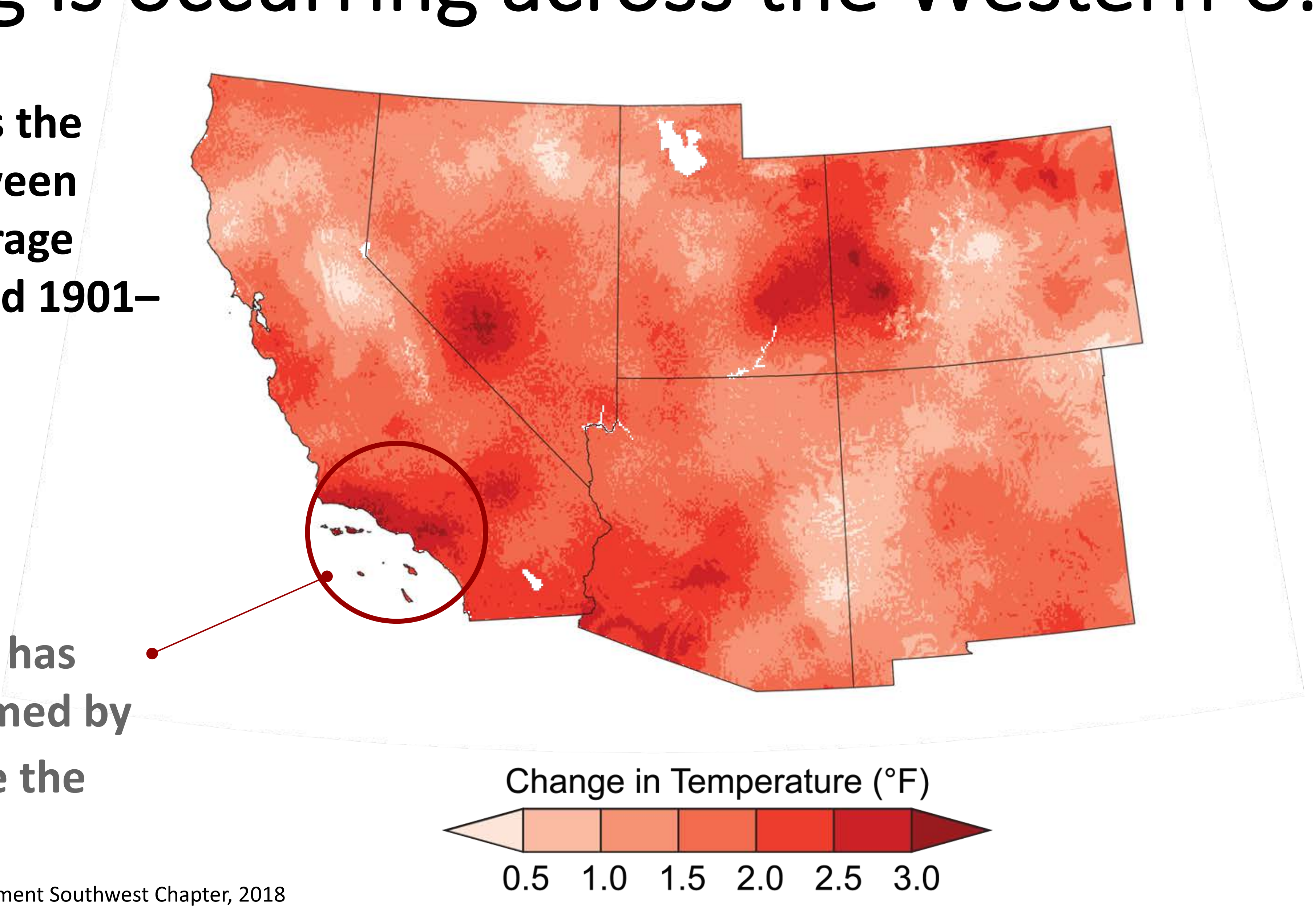
Dr. Heidi Roop

2.0°F of global warming since the late 1800's

Image & Data: NASA, 2021

Warming is occurring across the Western U.S.

This map shows the difference between 1986–2016 average temperature and 1901–1960 average temperature.



Southern CA has already warmed by ~3.0ºF since the early 1900s.

Source: 4th National Climate Assessment Southwest Chapter, 2018

This warming translates into impacts that matter for community well-being, ecosystems *and* water resources management.

Climate Change Context in CA

CALIFORNIA'S FOURTH **CLIMATE CHANGE** ASSESSMENT

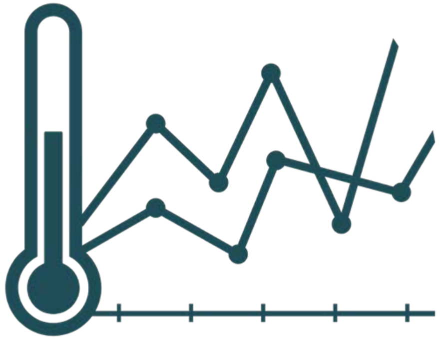
CLIMATE IMPACT	DIRECTION	SCIENTIFIC CONFIDENCE FOR FUTURE CHANGE
TEMPERATURE	WARMING ↗	Very High
SEA LEVELS	RISING ↗	Very High
SNOWPACK	DECLINING ↘	Very High
HEAVY PRECIPITATION EVENTS	INCREASING ↗	Medium-High
DROUGHT	INCREASING ↗	Medium-High
AREA BURNED BY WILDFIRE	INCREASING ↗	Medium High

Source: California's Fourth Climate Change Assessment, 2018

But, what is the actual range of outcomes?

Future climate impacts, and the ranges we can anticipate, are primarily determined by:

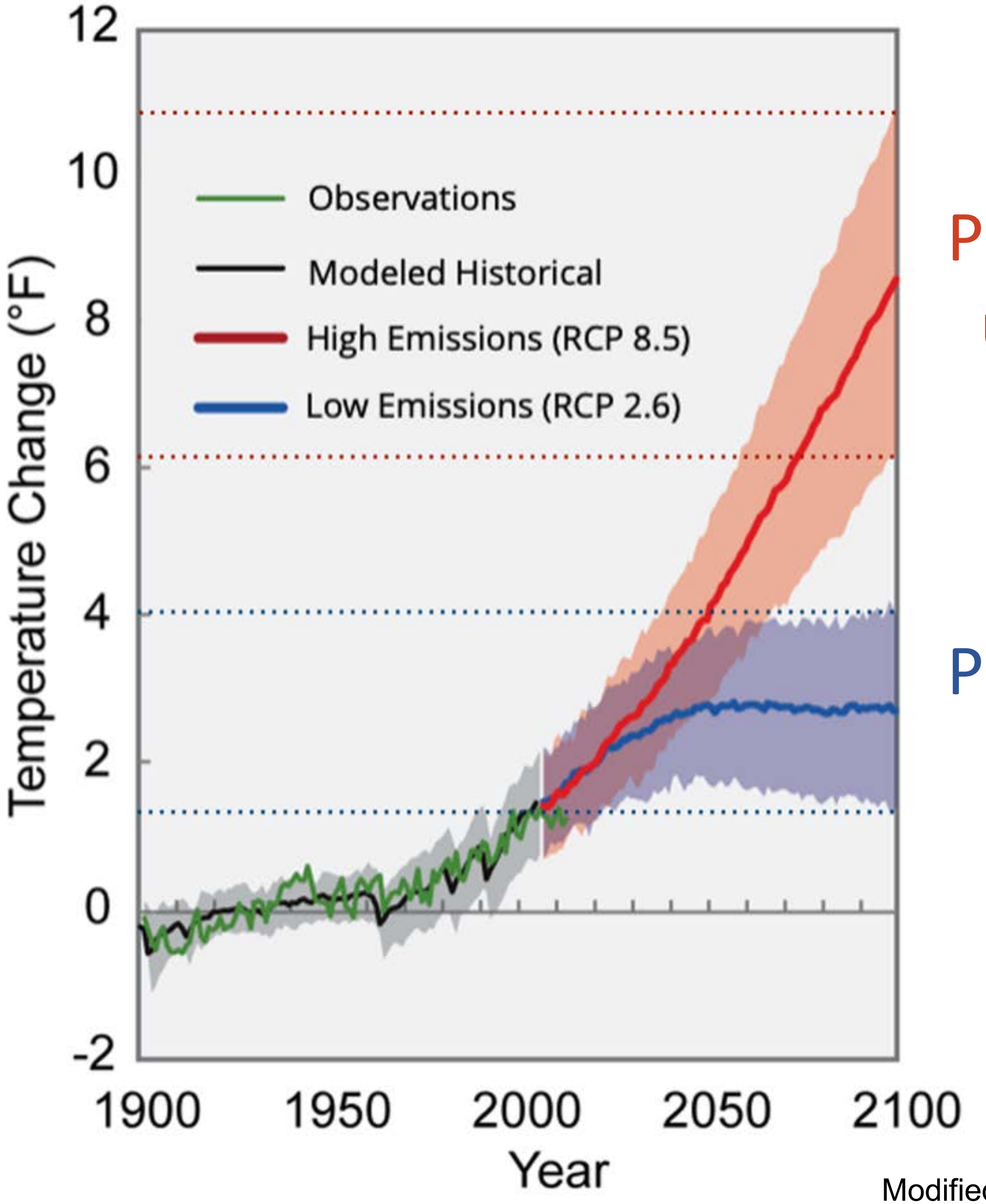
Human choices



Natural Variability

Physical process representations
(e.g. models, downscaling)

Human Choices: the principal driver of long-term warming is total emissions of CO_2



Projected warming under continued **HIGH emissions**

Projected warming under **LOW emissions**

RCP = Representative Concentration Pathway.

Modified from 3rd National Climate Assessment, 2014

Different outcomes for different emissions scenarios:

Temperature Change

If greenhouse gas emissions…	are reduced at a moderate rate…	then California will experience average daily high temperatures that are warmer than the historical average by…	**2.5°F** from 2006 to 2039.	**4.4°F** from 2040 to 2069.	**5.6°F** from 2070 to 2100.
	continue at current rates…		**2.7°F** from 2006 to 2039.	**5.8°F** from 2040 to 2069.	**8.8°F** from 2070 to 2100.

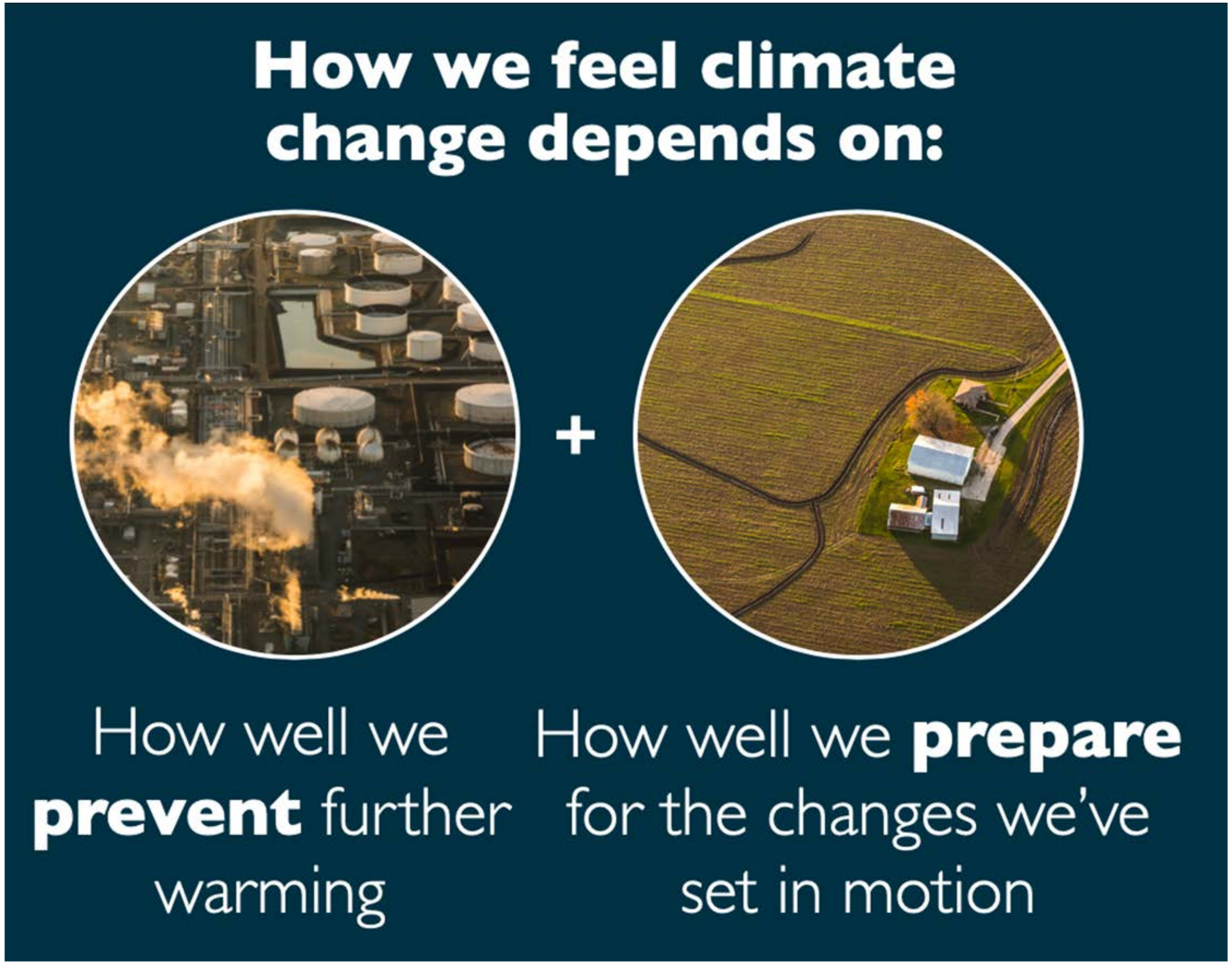
Change in snowpack

By 2050, the average water supply from snowpack is projected to decline to **2/3** from historical levels.

with no emissions reductions → Water from snowpack could fall to less than **1/3** of historical levels by 2100.

Source: California's Fourth Climate Change Assessment, 2018

Human Choices: planning and preparation



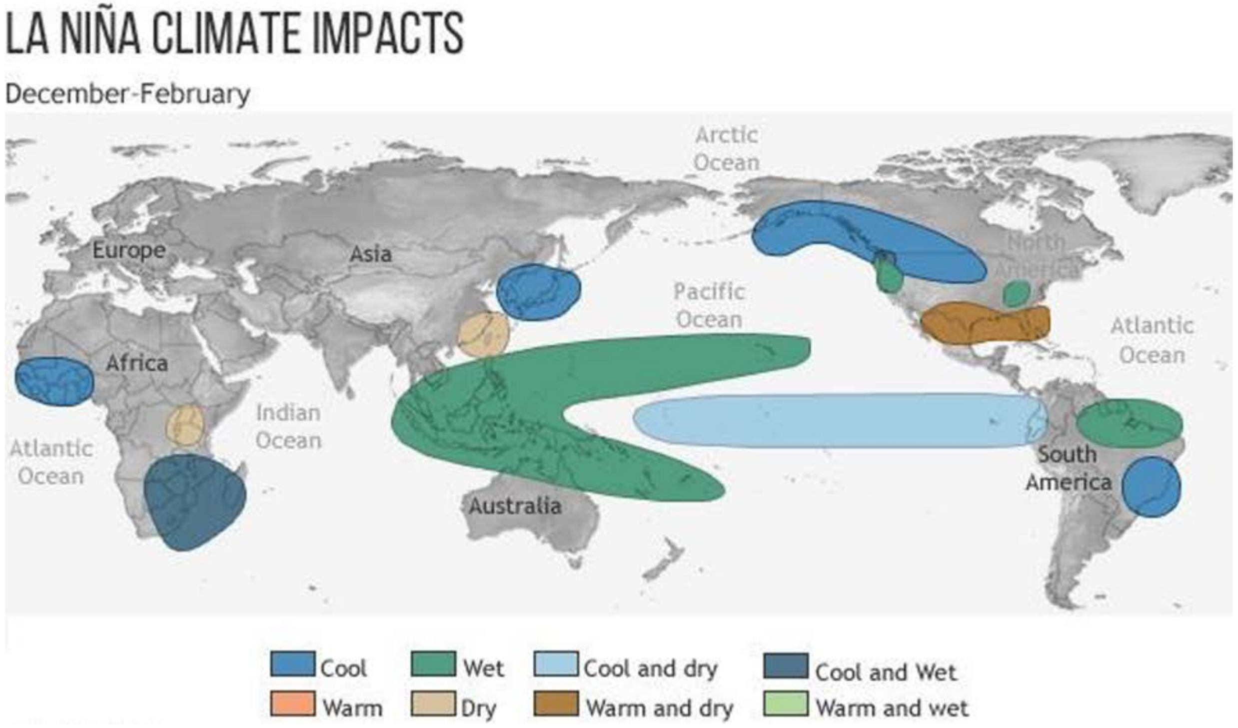
Graphic: Minnesota Climate Adaptation Partnership

Water supply and flood management practices need to be revised to account for our changing climate future.

Natural Variability:

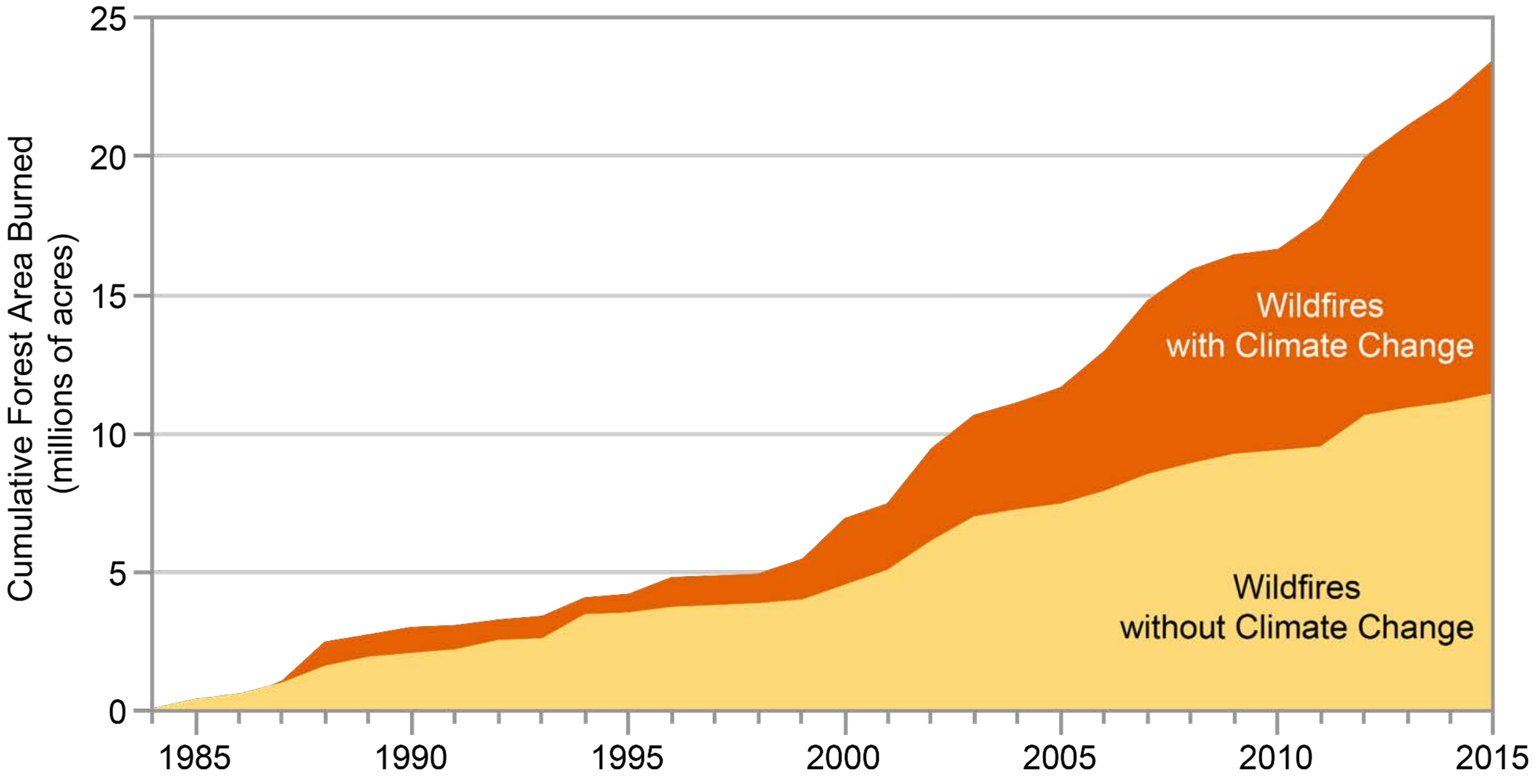
Natural variability is also influenced by processes internal to the climate system that arise, in part, from interactions between the atmosphere and ocean, such as El Niño/La Niña events.

Sun, volcanic eruptions, and changes in the orbit of the Earth around the sun exert an external control on climate variability.



Source: climate.gov; Roesch et al., 2006)

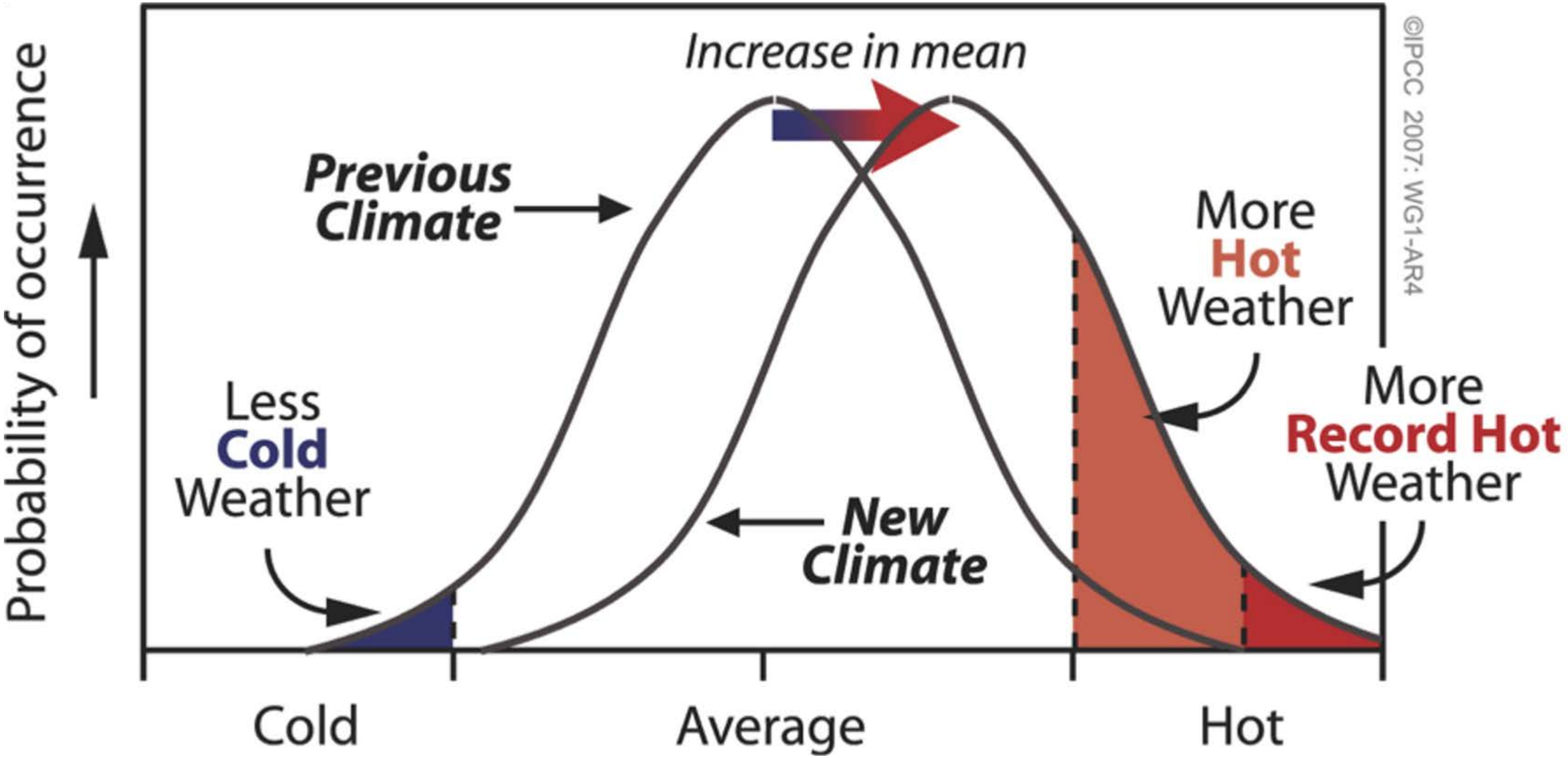
Natural Variability: Natural, Human & Climate Drivers



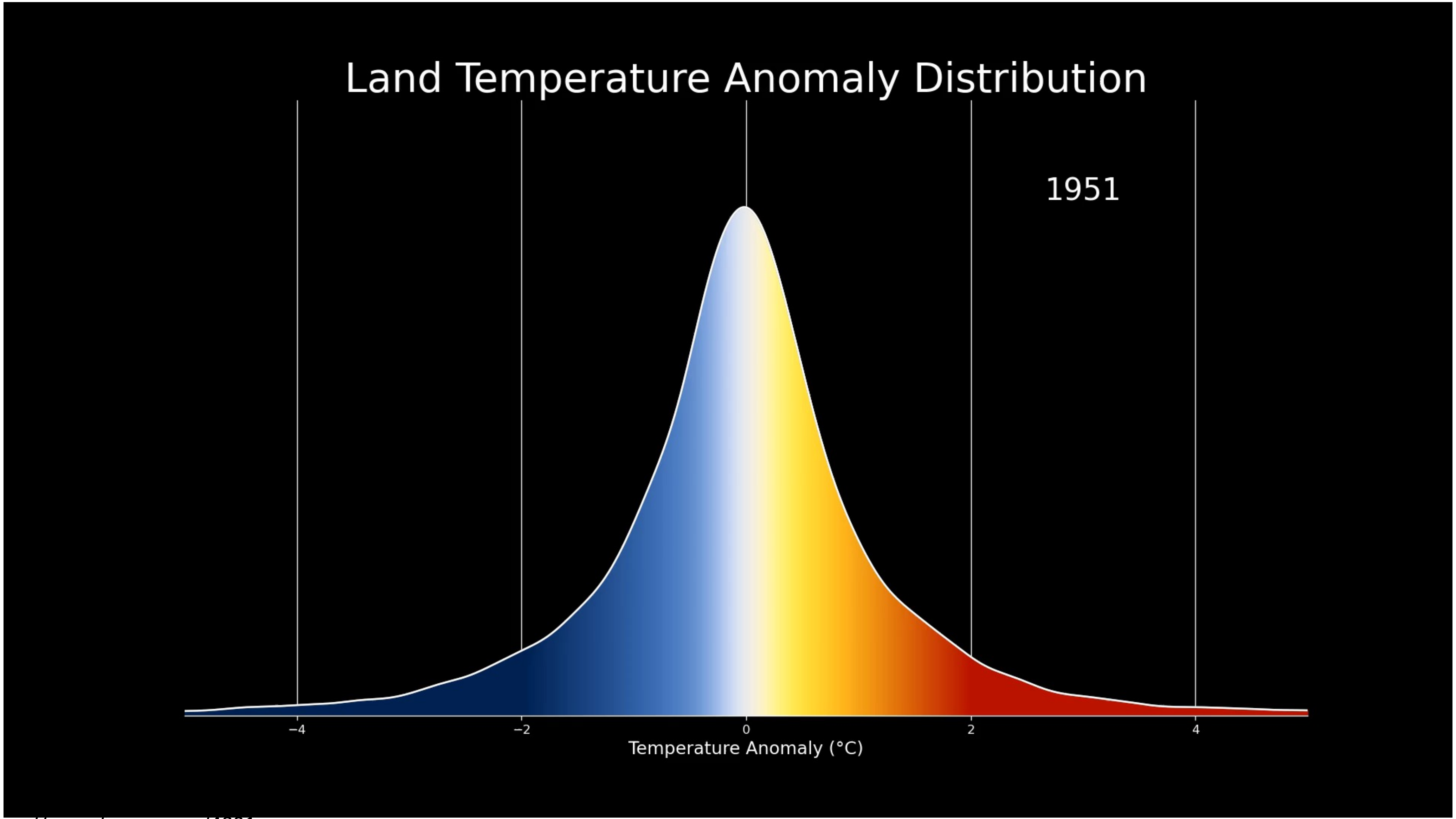
The cumulative forest area burned by wildfires has greatly increased between 1984 and 2015, with analyses estimating that the area burned by wildfire across the western United States over that period was **twice what would have burned had climate change not occurred**.

Source: 4th National Climate Assessment Southwest Chapter, 2018; Abatzoglou & Williams, 2016

Climate change induces a shift in means & extremes



NASA Animation



Source: NASA; https://svs.gsfc.nasa.gov/4891

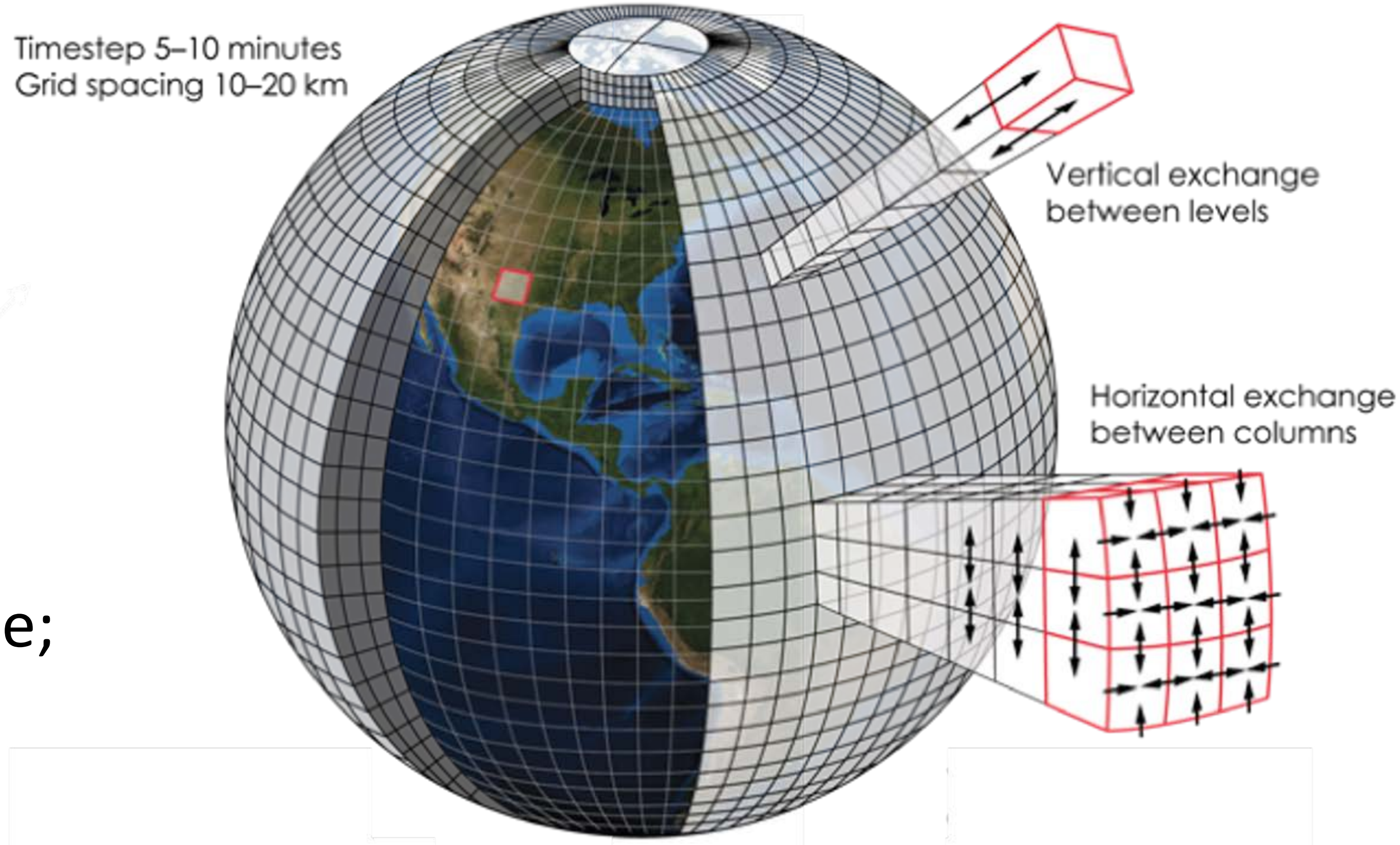
Physical Process Representations-

Do climate (and other) models actually "work"?

We don't have a crystal ball...

but, we do have useful tools in our toolbox...

Climate models provide critical information about our future climate



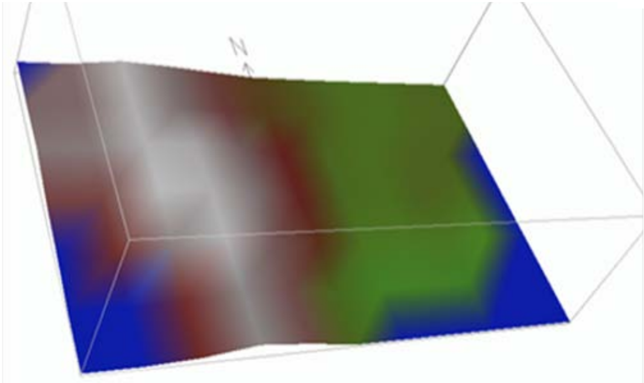
Climate Models

- Are the **best source of information** we have to understand future climate;
- Provide **projections**, not predictions;
- Have important **limitations & uncertainty**.

Image Modified from K. Cantner, AGI

Models can produce information at a range of scales and for different time periods & emissions scenarios.

Early 1990's models

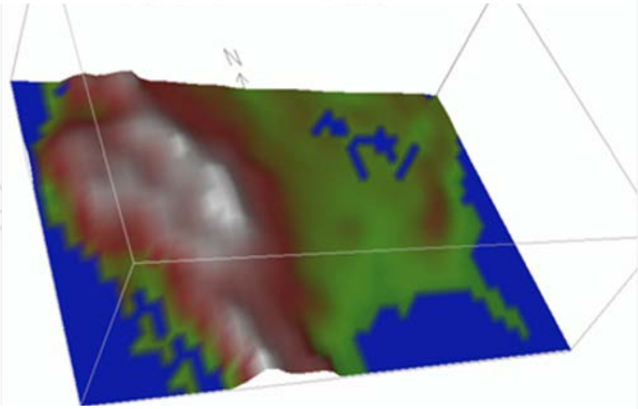


~250 miles

(400 km)

Downtown LA to Napa Valley

Coupled GCMs in 2006

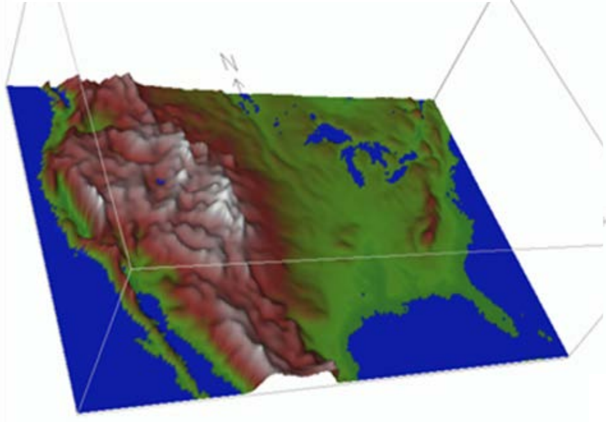


62 miles

(100 km)

Downtown LA to Oxnard

Regional Models

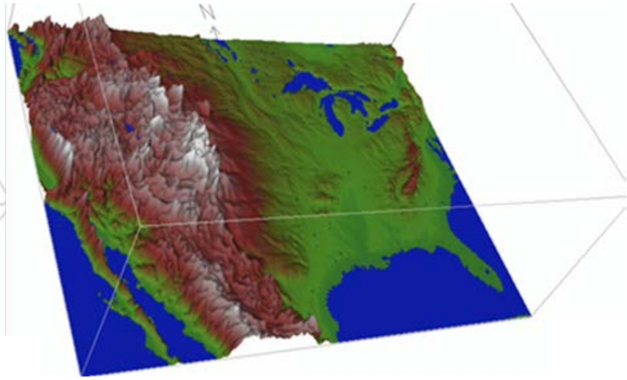


15.5 miles

(25 km)

Downtown LA to Santa Monica Pier

Future Global models (in 5-10 years)



6.2 miles

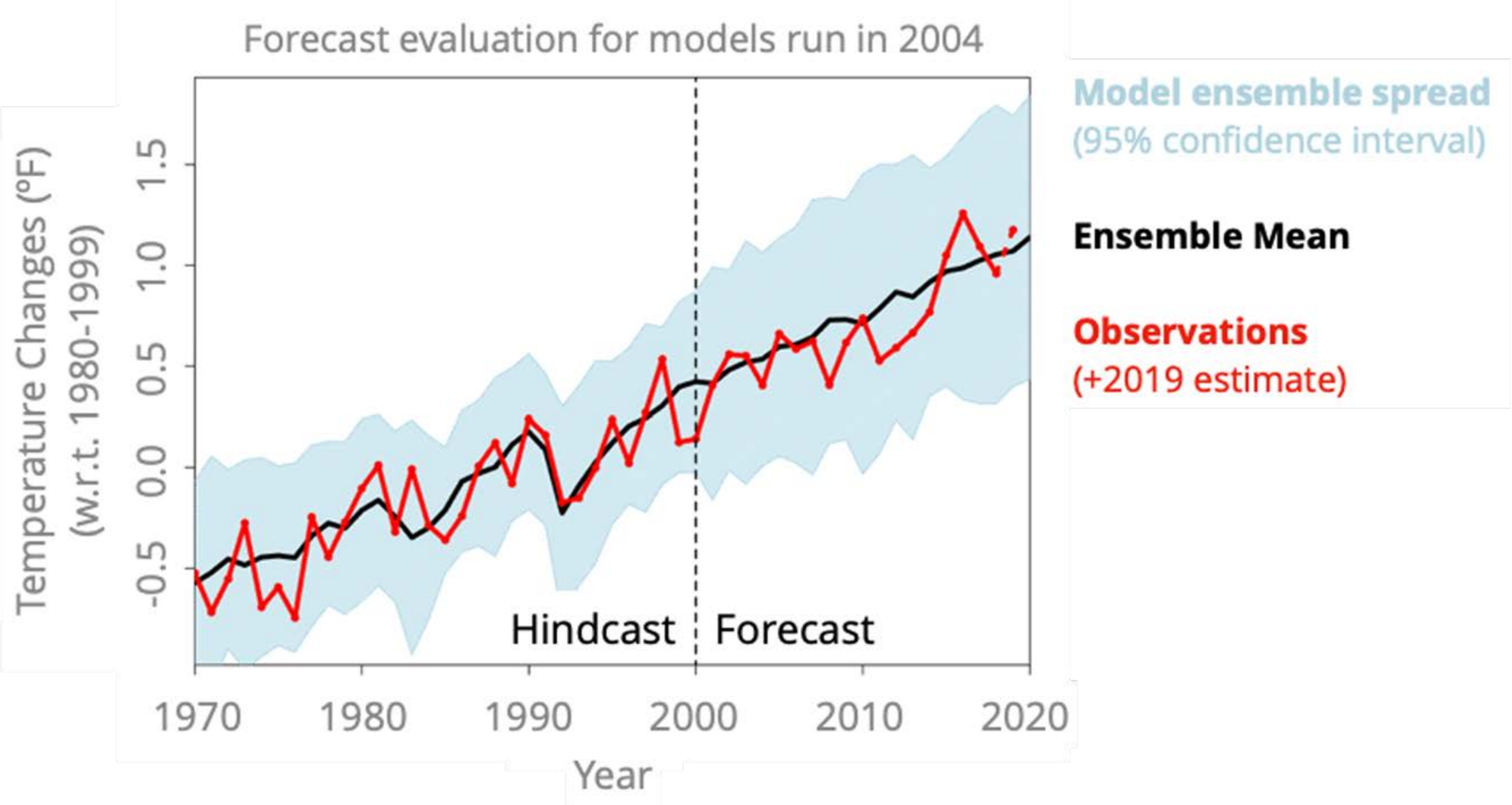
(10 km)

LA MWD Offices to LA Natural History Museum

Figure modified from NCAR

Have climate model projections been reliable?

Hindcasts: compare model predictions to recorded climate observations. If climate models are able to successfully *hindcast* past climate variables (e.g. temperature), this gives us more confidence in the model. *The physics of the model drive the change, rather than the historical data.*

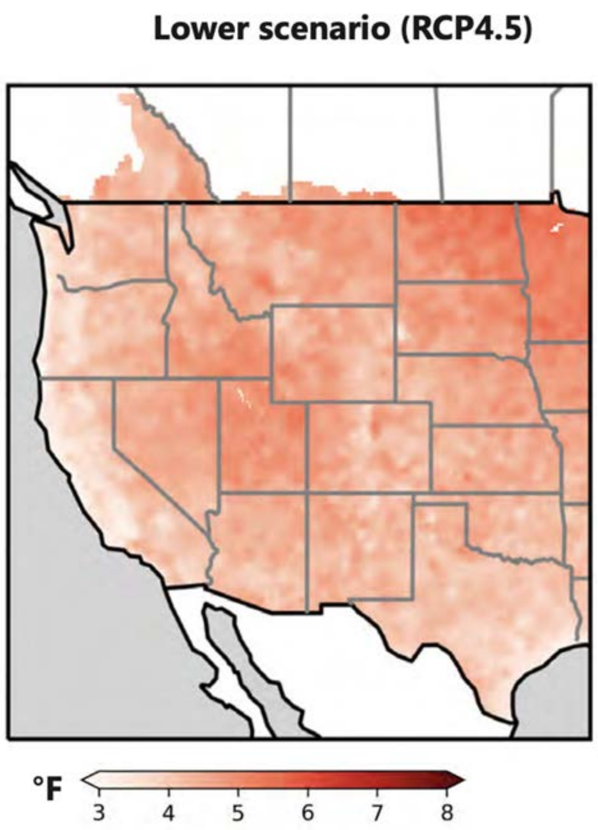


IPCC model projections from 2004 **compare well** with observed temperature change from 2004-2019

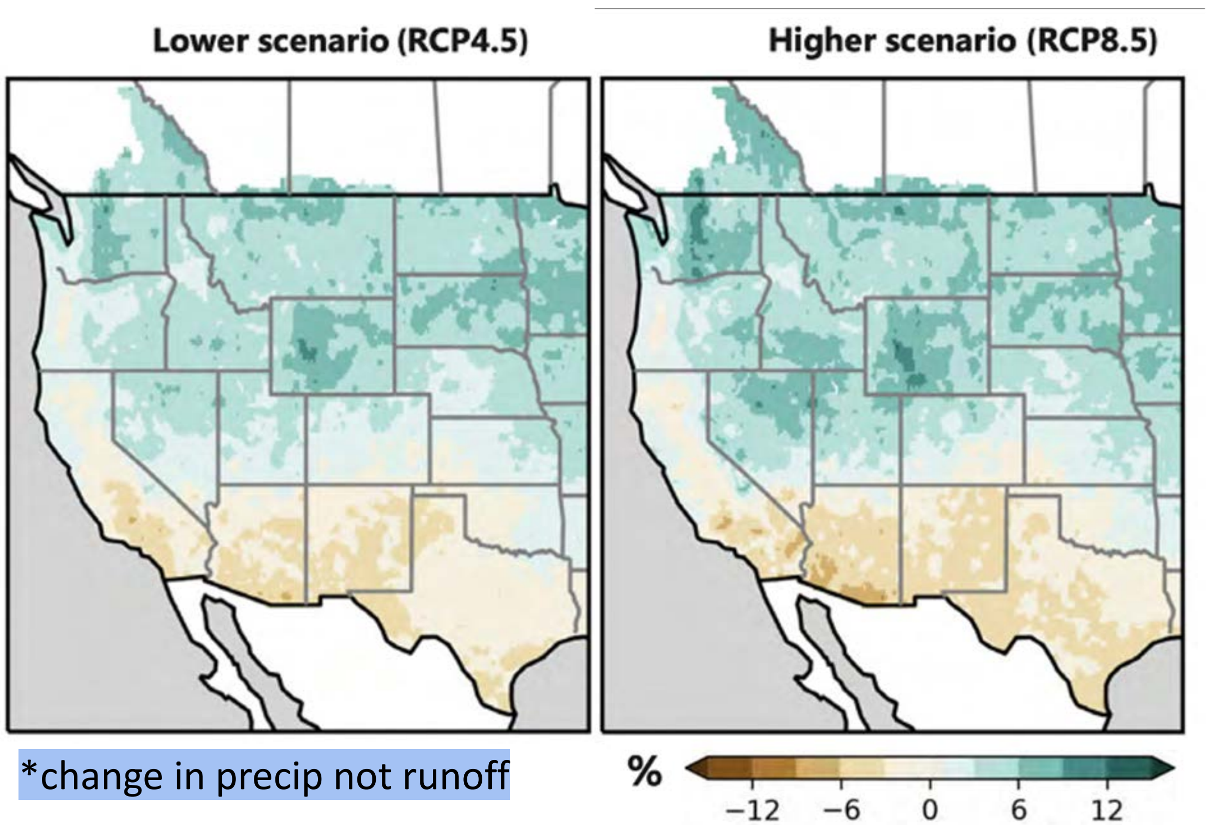
From NASA: https://climate.nasa.gov/news/2943/study-confirms-climate-models-are-getting-future-warming-projections-right/

Examples of projection data for 2040-2069

Temperature Projections



Precipitation Projections*



*change in precip not runoff

Maps show average change in temperature and precipitation across a two emissions scenarios for the period 2040 - 2069 relative to 1970 - 1999 using the **LO**calized **C**onstructed **A**nalogs (LOCA) downscaling approach.

These maps convey an average across 32 global climate models.

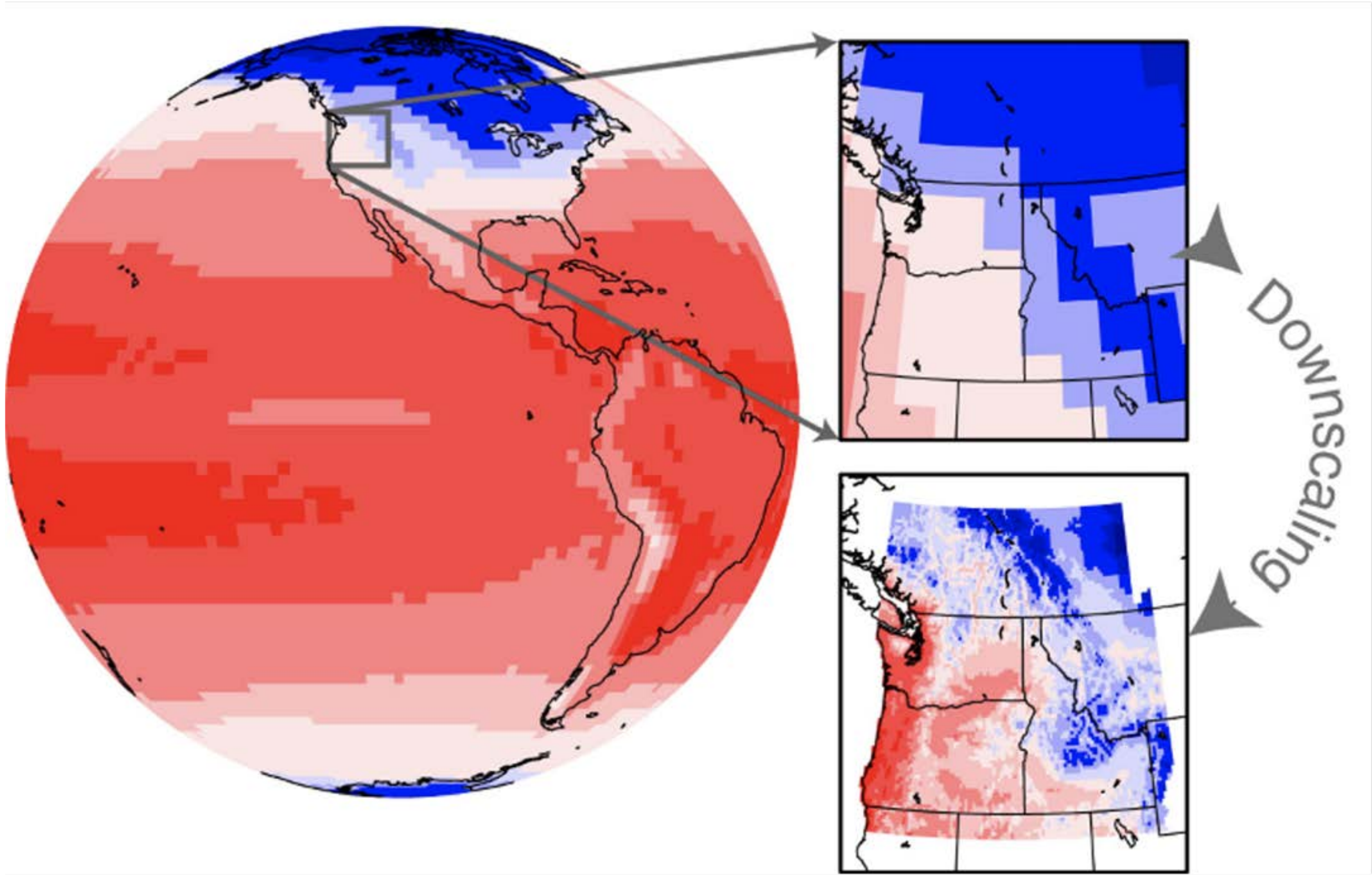
Source: Reclamation's 2021 SECURE Water Act

Part II:

Going from Global to Local

Dr. Julie Vano

Going from Global to Local

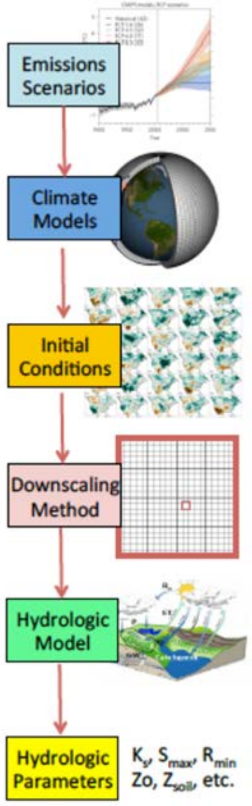


Translating global information for regional water management

Figure courtesy of UW Climate Impacts Group

Multiple Ways to Evaluate Future Changes

Climate impacts modeling chain



Clark et al. 2016; connect models in a chain

Stochastic hydrology

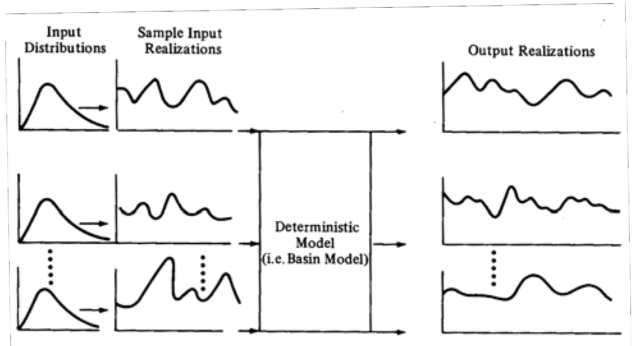
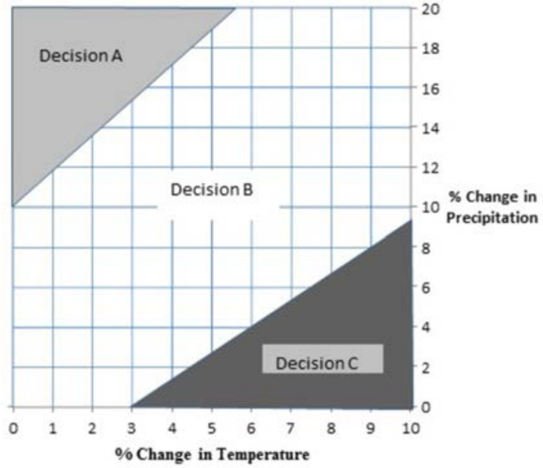


Figure 1.3 Concept of Monte Carlo experiments.

Bras and Rodriguez-Iturbe, 1985; generate synthetic timeseries using statics from the past

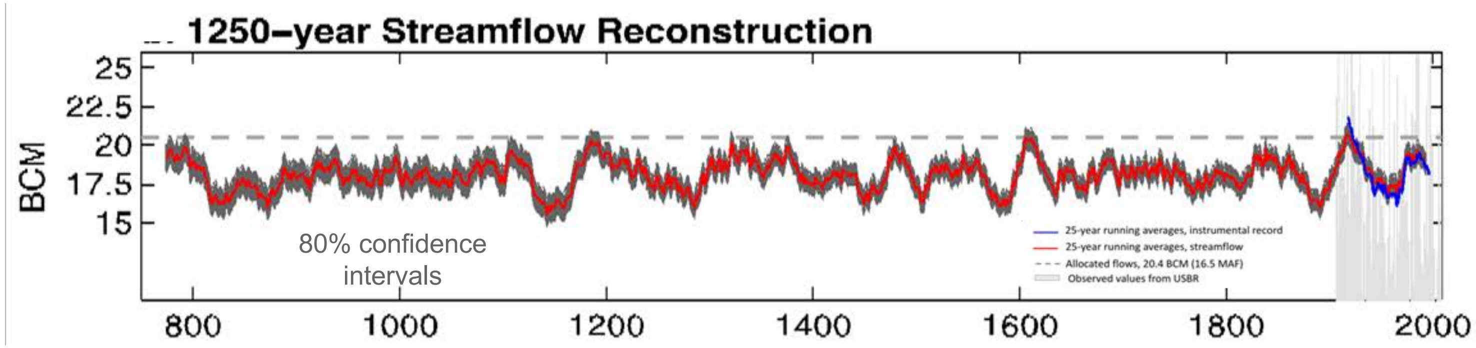
Climate-informed vulnerability analysis



Brown et al., WRR, 2016; explore system vulnerabilities with perturbations

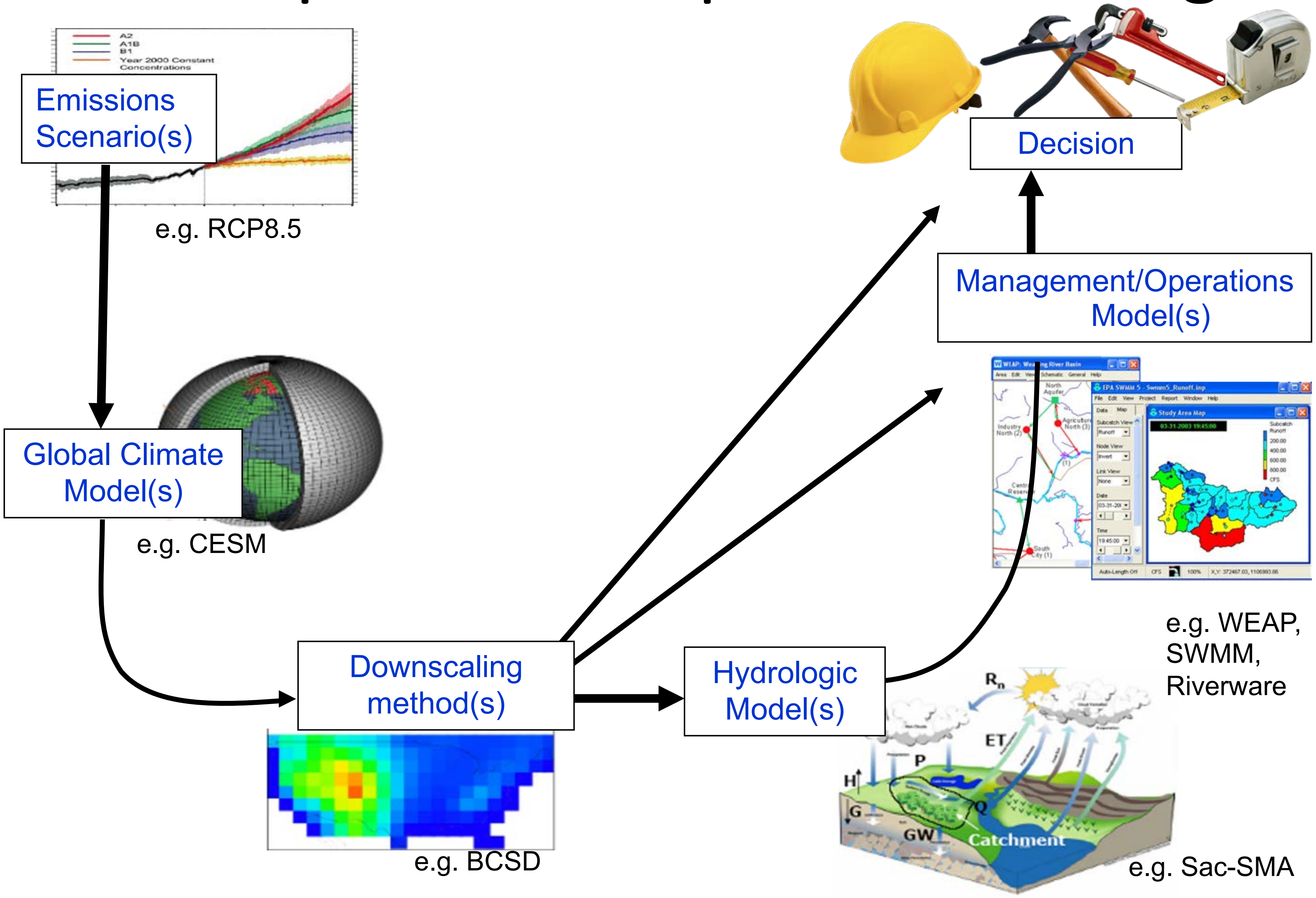
*and others

Paleoclimate studies



Vano et al., BAMS, 2016; generate timeseries using reconstructions of the distant past

Classic “Top-down” Impacts Modeling Chain

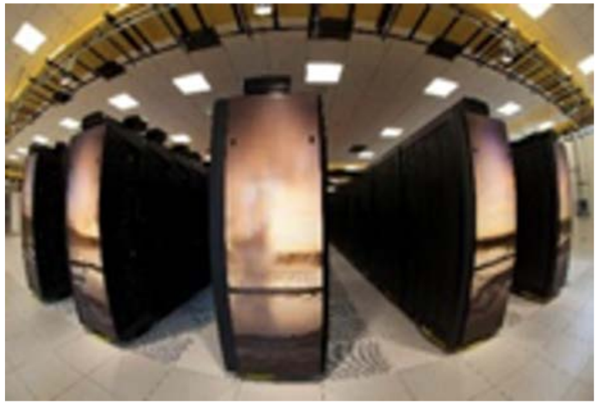


Downscaling methods

Ways to make global climate information more locally relevant

statistical methods (computationally efficient)

hybrid techniques



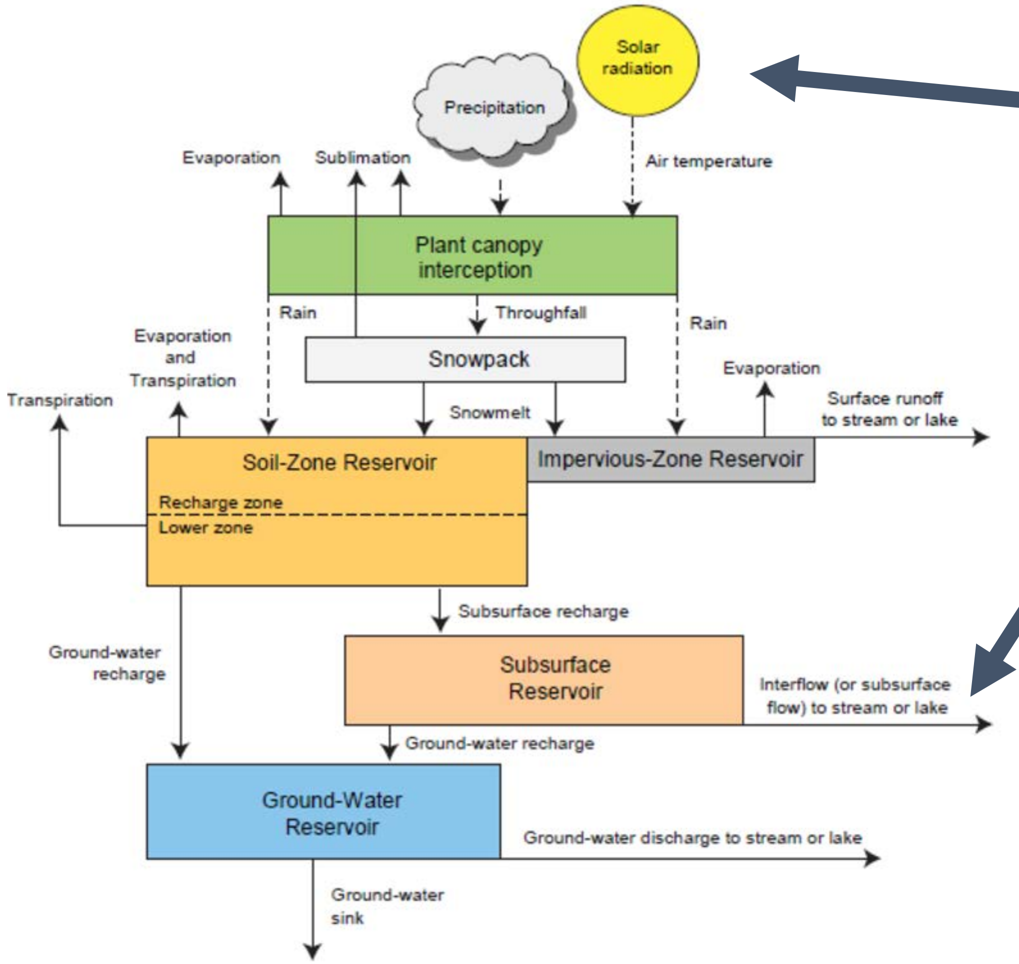
high-resolution regional climate models (captures local dynamics)

Increasing methodological complexity in downscaling methods

Tradeoffs:

- Physical realism vs. computational cost
- Single realization vs. ensemble
- Explicit physics/feedbacks vs. simplicity

Hydrologic models



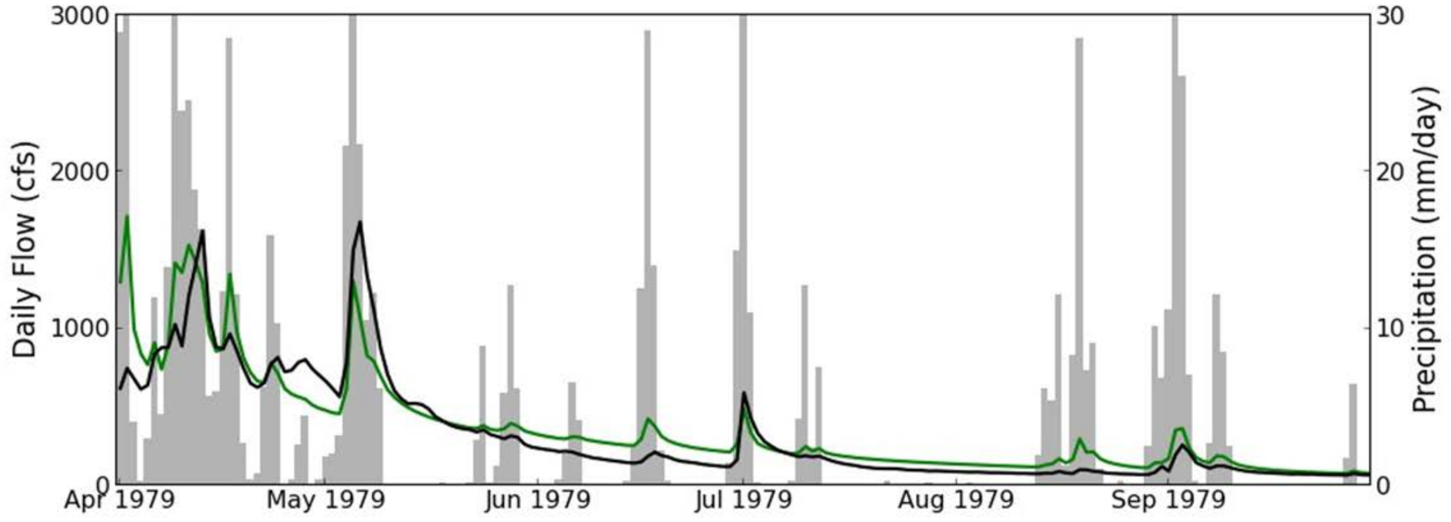
We have: precipitation, temperature, other atmospheric values

We want: streamflow (highs, lows), water demand from vegetation, water temperature

Hydrology models represent energy and water fluxes in watersheds, encapsulate our best understanding

Fill gaps since measurements unavailable in most places

Hydrologic models

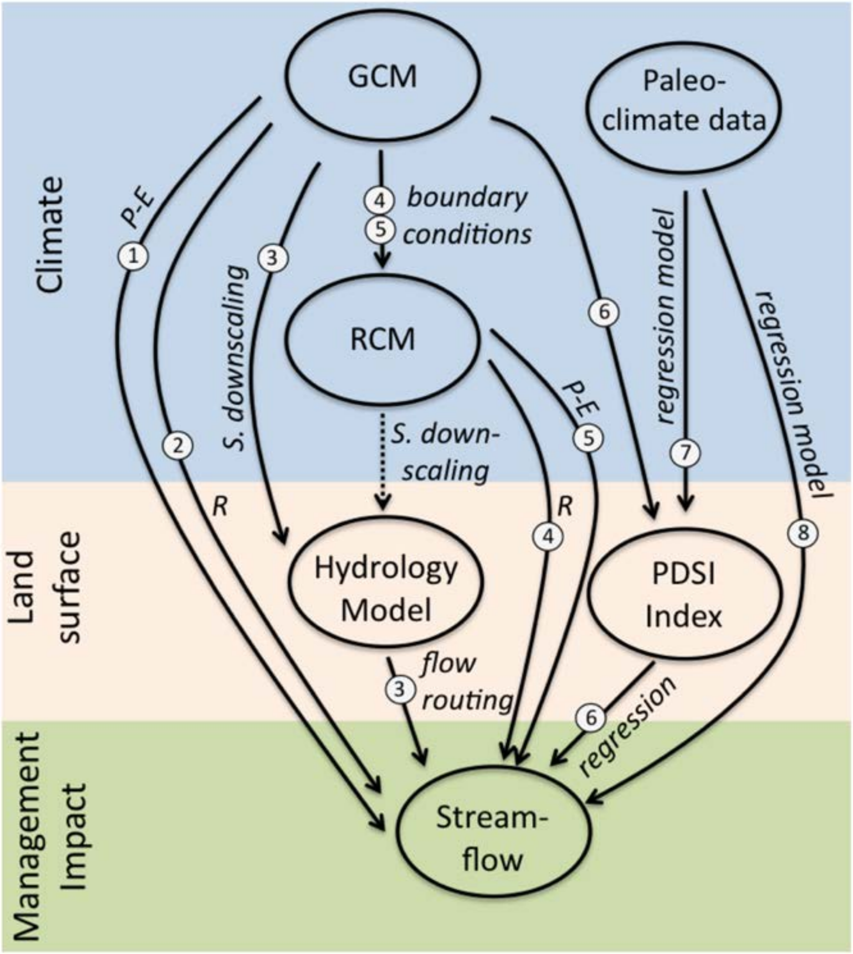


Without hydrologic model: only had gray bars (precipitation values) to estimate streamflow

With hydrologic model: able to use precipitation values to estimate streamflow, particular useful to understand future projections

PORTLAND WATER BUREAU
FROM FOREST TO FAUCET

Future projections or methods are not equal



Different: GCMs, emission scenarios, spatial resolution, hydrology, +

- Certain models and methods are more appropriate
- Certain spatial and temporal scales are more appropriate for certain questions
- Realize some questions may not be possible to answer with current knowledge
- Finer resolution in space and time is not necessarily better
  - Higher Resolution ≠ Higher Accuracy

Be a savvy consumer and remember…

Figure from Vano et al., BAMS, January 2014

No model is perfect

“The accuracy of streamflow simulations in natural catchments will always be limited by simplified model representations of the real world as well as the availability and quality of hydrologic measurements.” (Clark et al., WRR, 2008)

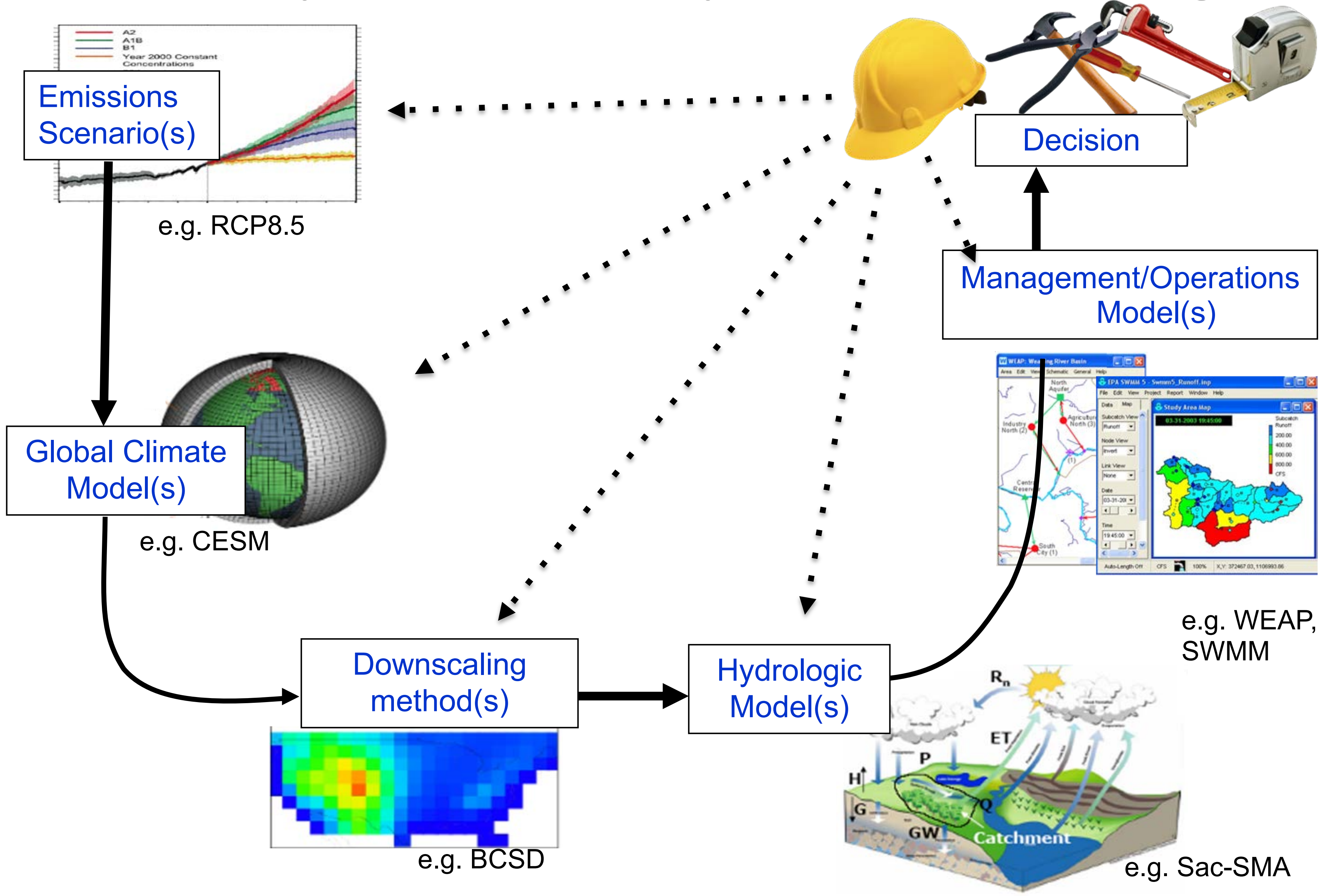
Do not expect perfect results,

- Not prediction, but a tool to test how system responds (what if scenarios)

BUT we can make better choices…

- Seek simple yet defensible (do not need a Cadillac)
- Be aware of models' shortcomings
- Use a range, not a single model outcome

Revised "Top-down" Impacts Modeling Chain



Questions to determine an appropriate models

Different impacts often require different approaches

Where is the area of interest?

How large of an area?

What is the impact of interest?

When in the future?

Does event sequencing matter?

What type of climate uncertainty is important?

What is available?

Figure source: Courtney Mendar (http://www.courtney-mendard.com)

Available Data and Resources

Hydrology on Green Data Oasis (GDO) portal

- BCSD (12km), LOCA (6km)
- VIC streamflow

Dynamical

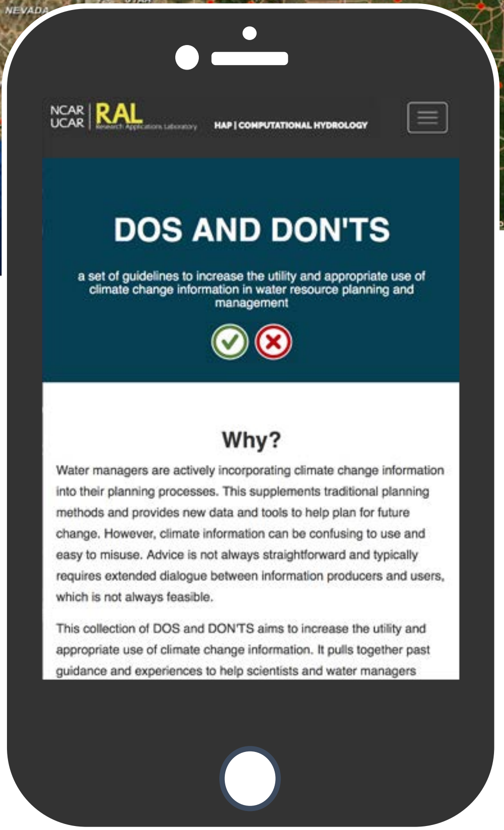
- NARCCAP (50km),
- CORDEX (limited 25km)
- Others over regional domains or limited time periods

USGS GeoDataPortal

- Collection of different archives

Many others (NASA NEX, ARRM)

Multiple assessments provide future projections based on these datasets (e.g., California's Climate Change Assessment; Reclamation's SECURE report; The National Climate Assessment use GDO datasets)

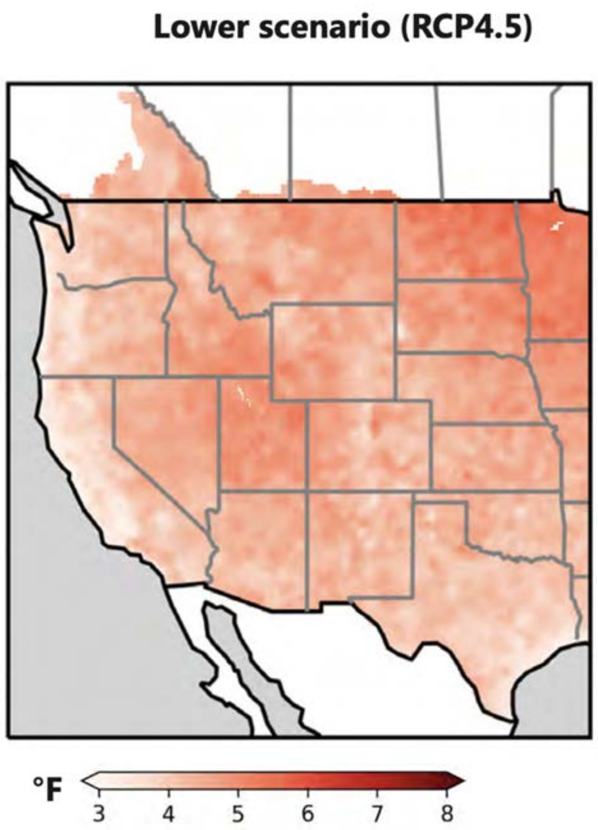


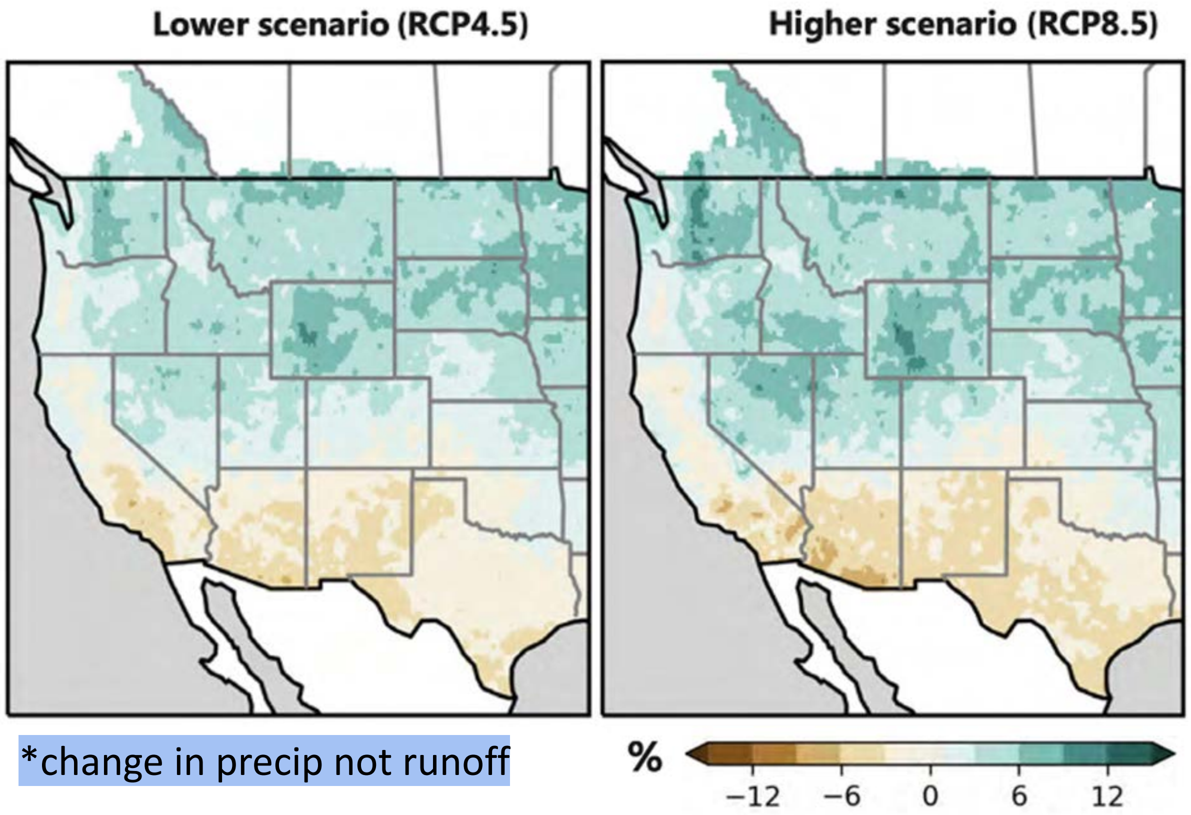
Resources also available to help navigate the appropriateness of these datasets for particular questions, e.g., https://ncar.github.io/dos_and_donts

Regional Hydrologic Changes

Temperature Projections

Precipitation Projections*





*change in precip not runoff

Maps show average change in temperature and precipitation across a two emissions scenarios for the period 2040 - 2069 relative to 1970 - 1999 using the **LO**calized **C**onstructed **A**nalogs (LOCA) downscaling approach.

These maps convey an average across 32 global climate models.

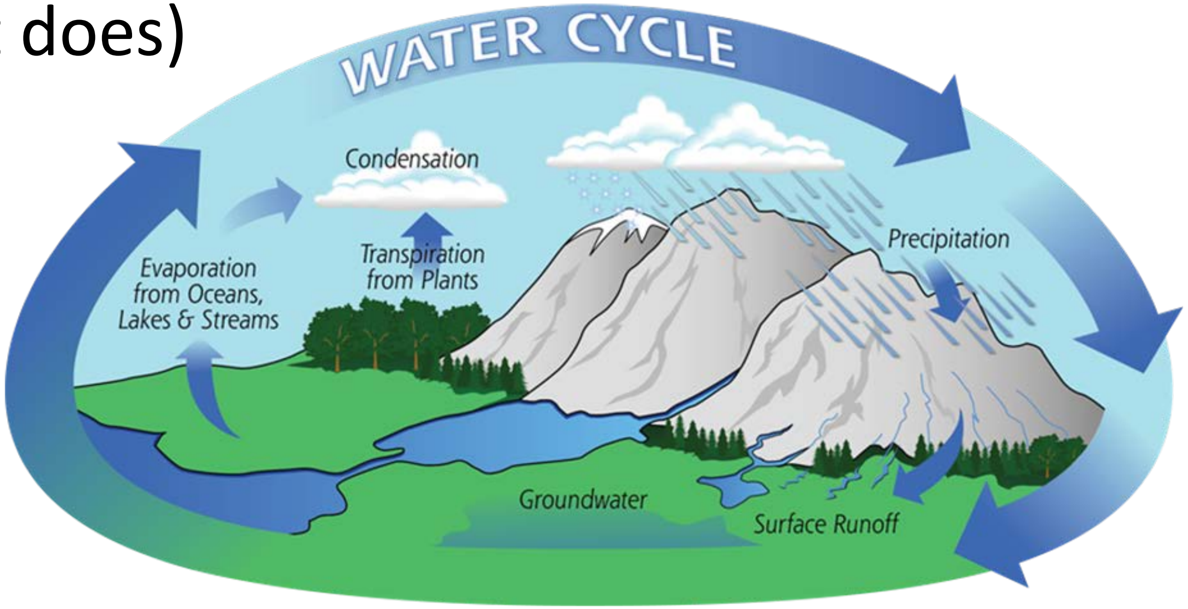
Source: Reclamation's 2021 SECURE Water Act

Part III:
Regional Hydrologic Changes

Brad Udall

Climate Change is Water Change

- Earth's Climate and its Water Cycle are intimately connected
- Heat-Driven Water Cycle will change in profound ways
  - More Evaporation + More Precipitation
  - More Intense Precipitation (when it does)
  - More Floods + More Droughts
  - Earlier Runoff
  - Water Quality Declines



California Winter 2014-2015 Drought

- Winter Temperatures
  - Sierra Winter Above 32°F,
  - (1st time >32°F in 120 years)
- Sierra Precipitation
  - Rain, not Snow
  - Not the driest!
  - (40% to 90% of normal)
- Snowpack
  - Lowest Ever - 5% on April 1
  - (1977 at 25%)
  - 500-Year (?) Return Period
- Drought Worst in 1200 Years(?)
- Record Low CVP Deliveries

Historical and Expected Climate Impacts in California

TABLE 3: A QUALITATIVE DESCRIPTION OF CURRENT UNDERSTANDING OF HISTORICAL AND EXPECTED CLIMATE IMPACTS IN CALIFORNIA

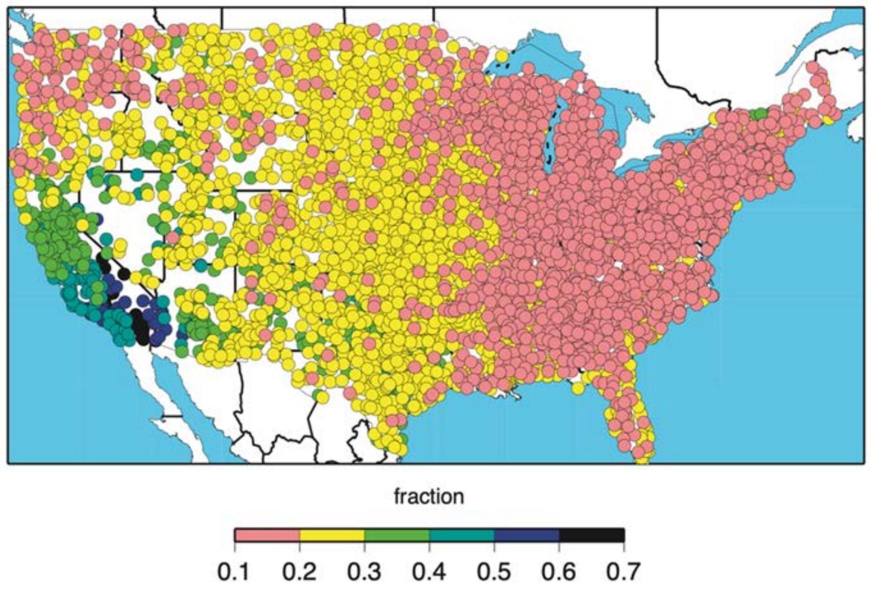
CLIMATE IMPACT	HISTORICAL TRENDS	FUTURE DIRECTION OF CHANGE	CONFIDENCE FOR FUTURE CHANGE
Temperature	Warming (last 100+ years)	Warming	Very High
Sea Levels	Rising (last 100+ years)	Rising	Very High
Snowpack	Declining (last 60+ years)	Declining	Very High
Annual Precipitation	No significant trends (last 100+ years)	Unknown	Low
Intensity of heavy precipitation events	No significant trends (last 100 years)	Increasing	Medium-High
Frequency of Drought	No significant trends (last 100+ years)	Increasing	Medium-High
Frequency and intensity of Santa Ana Winds	No significant trends (last 60+ years)	Unknown	Low
Marine Layer Clouds	Some downward trends; mostly not significant (last 60+ years)	Unknown	Low
Acres Burned by Wildfire	Increasing (last 30+ years)	Increasing	Medium-High

California Specific Issues

- Climate Issues
  - Mediterranean Climate
  - Droughts to Floods
  - Atmospheric Rivers
  - Loss of Snow ("Warm Snow Drought")

- Policy / Management Issues
  - Flood Control vs Conservation Storage
  - Bay Delta
  - State Water Project / CVP

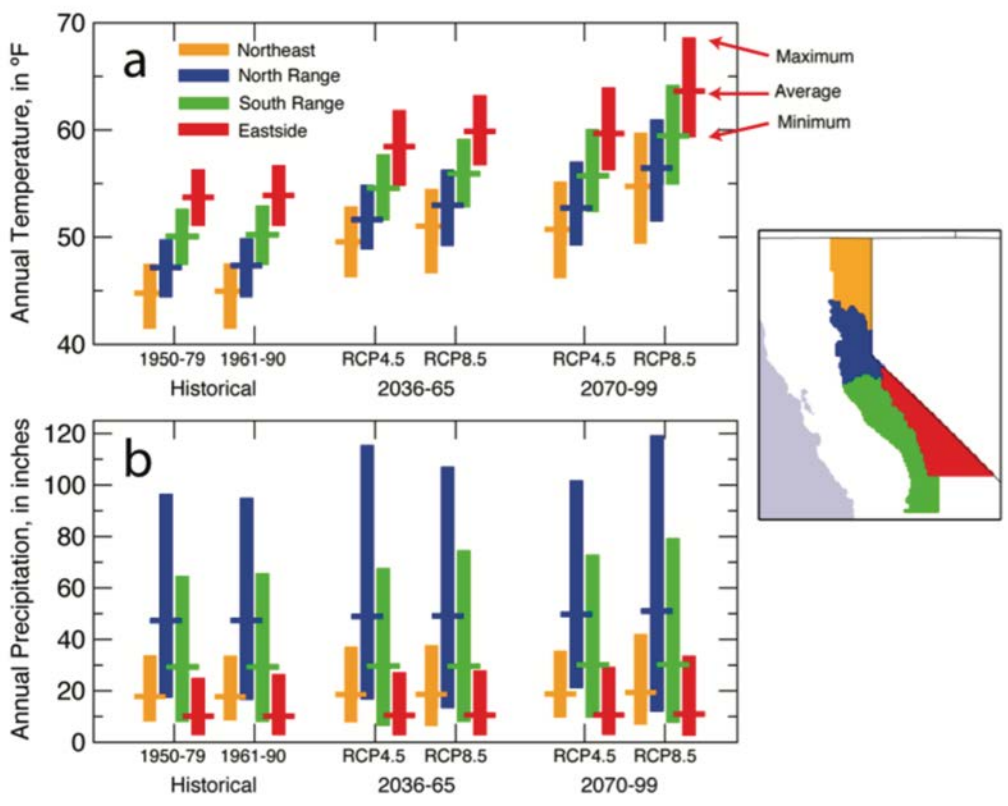
FIGURE 4 | VARIATION IN ANNUAL PRECIPITATION



Nationally, California has the most variable precipitation. Years range from ~50% to 200% of normal.
Elsewhere ~80% to 120% of normal.

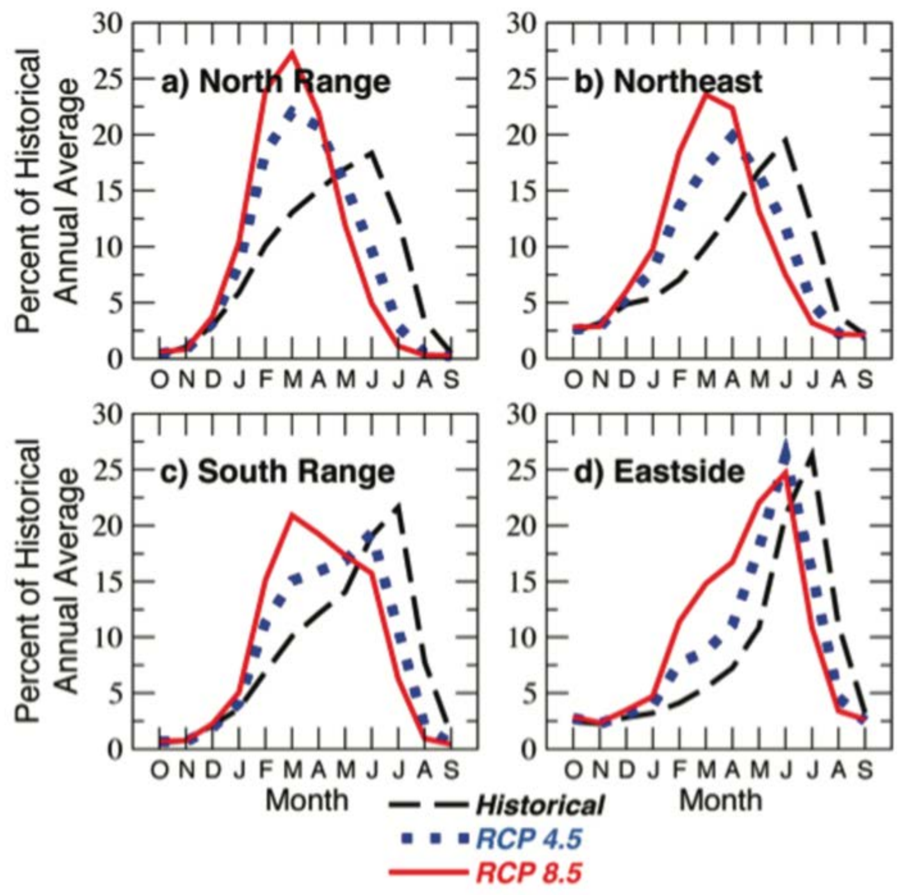
California Future Temp, Precip, Flows

FIGURE 2.3



Changes Temperature and Precipitation for Sierra Regions

FIGURE 2.8



Changes in Annual Hydrographs for Sierra Regions

CVP + SWP Hydrologic Changes

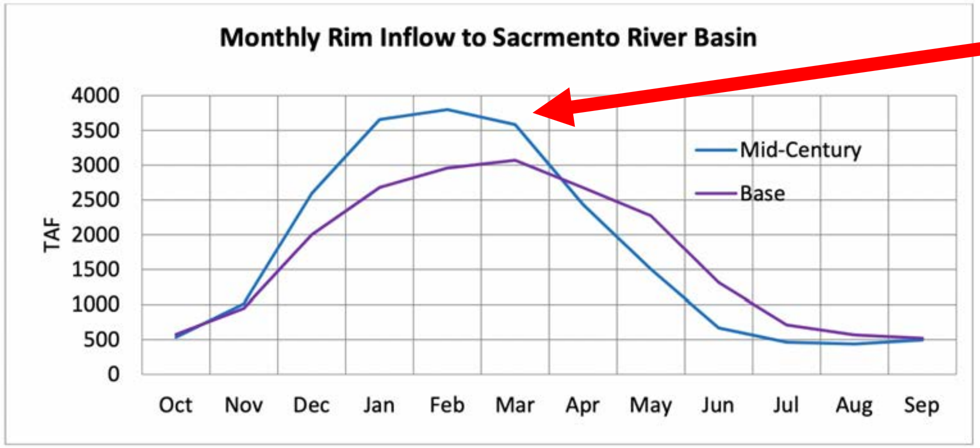
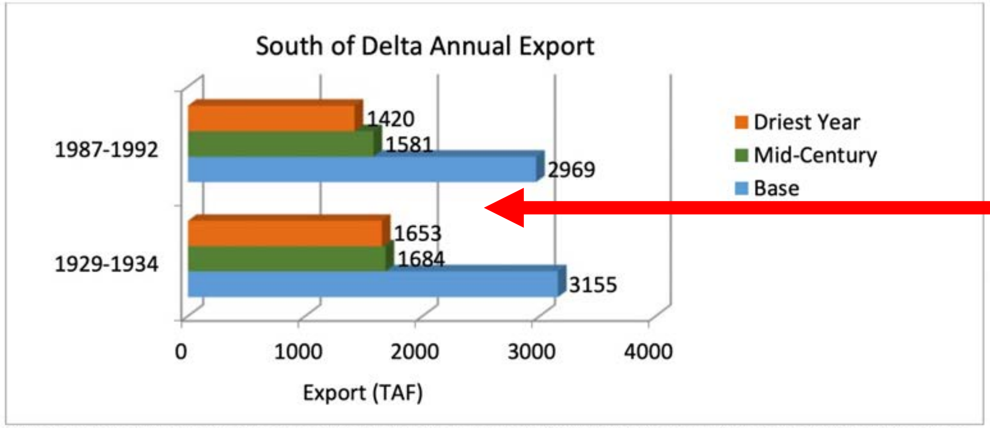


Figure 5: Average Monthly Rim Inflows to Sacramento River Basin for Base and Mid-Century Scenarios



Note: The blue bars represent average annual exports during each historical drought. The green bars represent the anticipated exports if the same drought conditions occur in the middle of this century. The orange bars represent the anticipated exports during the driest years if the same drought conditions occur in the middle of this century.

Figure 13: South of Delta Annual Export During Two Droughts

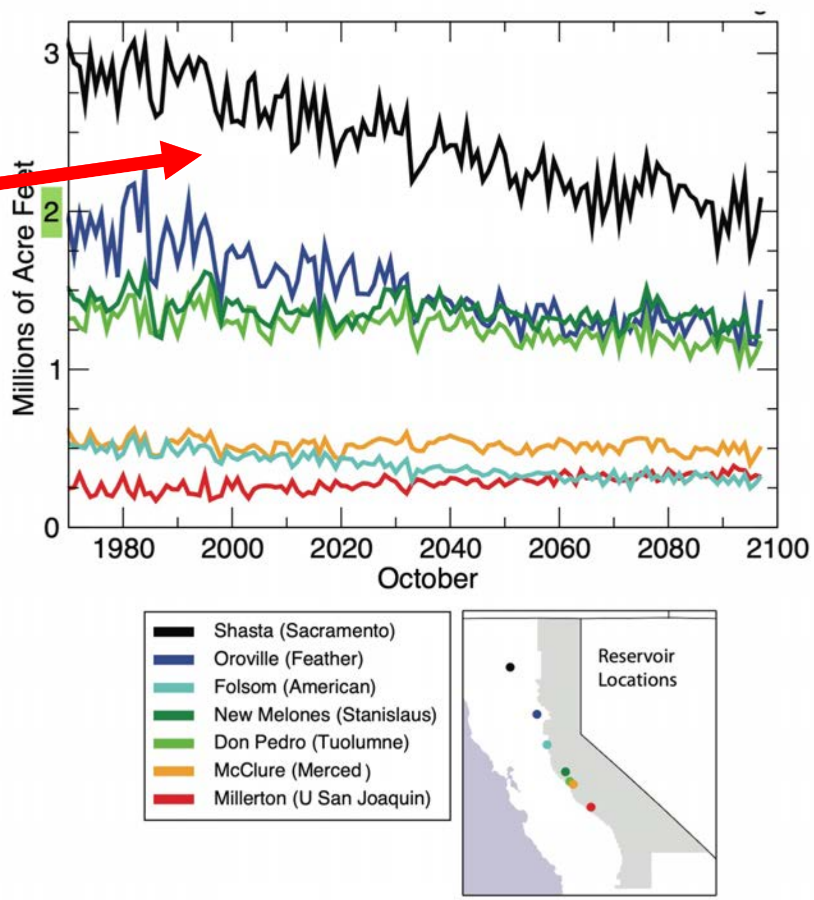
Seasonal Flow Changes drives by 2060…

25% Decrease N. Delta Storage…and

500kaf/yr average less S. Delta Exports…and

50% less Delta Exports compared to historic droughts

FIGURE 17 | POTENTIAL CHANGES IN OCTOBER RESERVOIR STORAGE



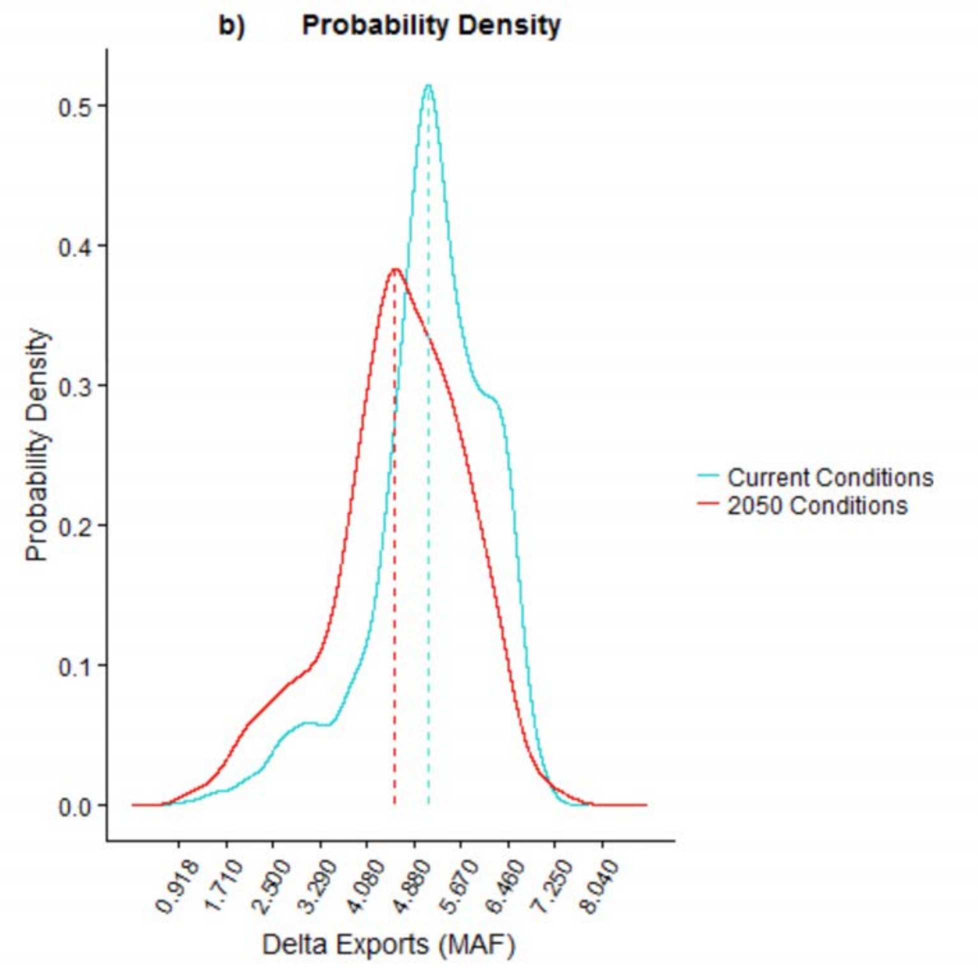
Potential changes of October reservoir storage for major water reservoirs in California. Source: Sierra Nevada Regional Report, 2018.

Why? Can’t capture snowmelt like we used to.

California Groundwater

- Higher Temperatures and Extreme Droughts by end of 21st Century will alter recharge of groundwater due to…
  - Decreased inflow from runoff
  - Increase evaporative losses
  - Warmer and shorter winter seasons
- Imported CVP + SWP for recharge will be…
  - Less reliable and more expensive

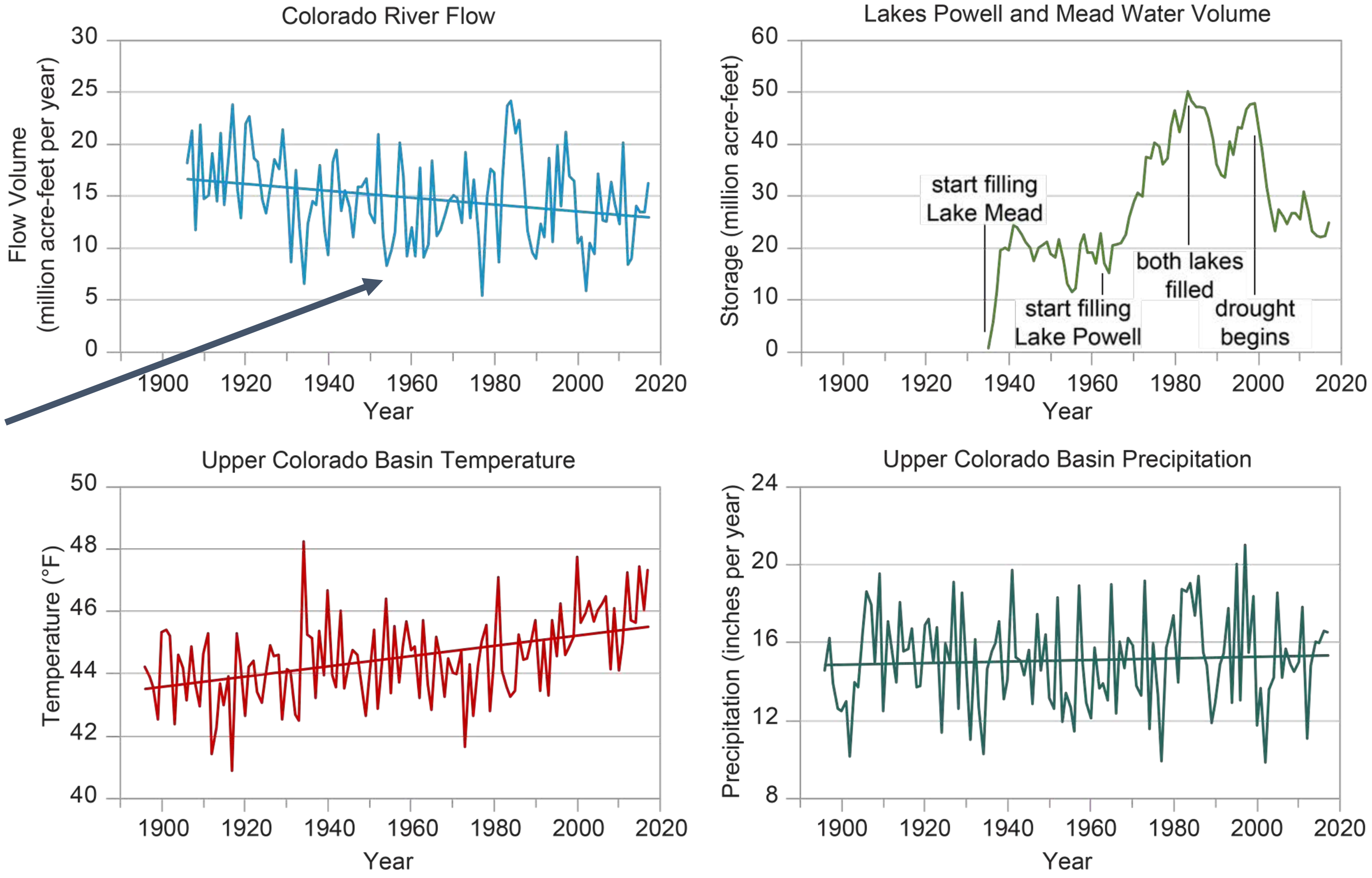
Shift in Delta Exports Current vs 2050



	Mode
Current Conditions	5.11
2050 Conditions	4.56

Colorado River 1900 - 2020

Since 2000, drought that was intensified by long-term trends of higher temperatures due to climate change has reduced the flow in the Colorado River

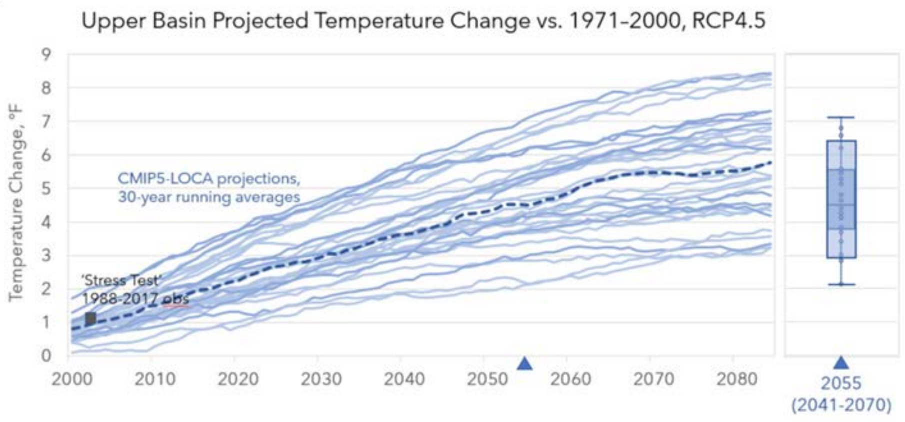


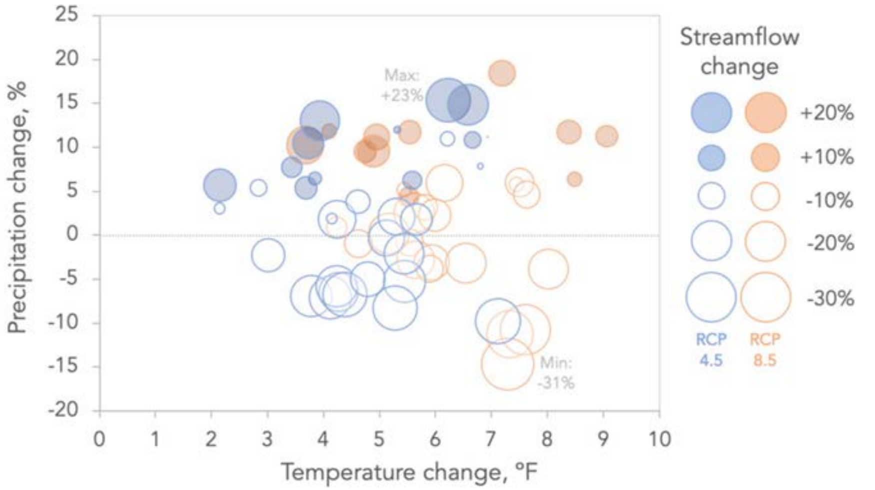
Source: 4th National Climate Assessment Southwest Chapter, 2018

Colorado River Specific Issues

- Climate Issues
  - Temperature-induced Flow Declines
  - Ongoing 20-year Drought (-20% flow)
  - Projected North - South Precipitation Gradient
  - Uncertain Future Precipitation
  - Megadrought Potential

- Policy / Management Issues
  - Colorado River Compact Interpretations
  - 2026 Interim Guidelines Negotiations
  - Salton Sea

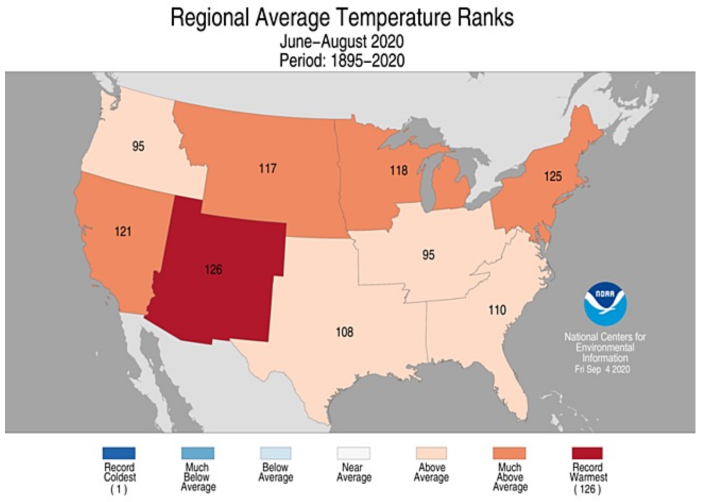


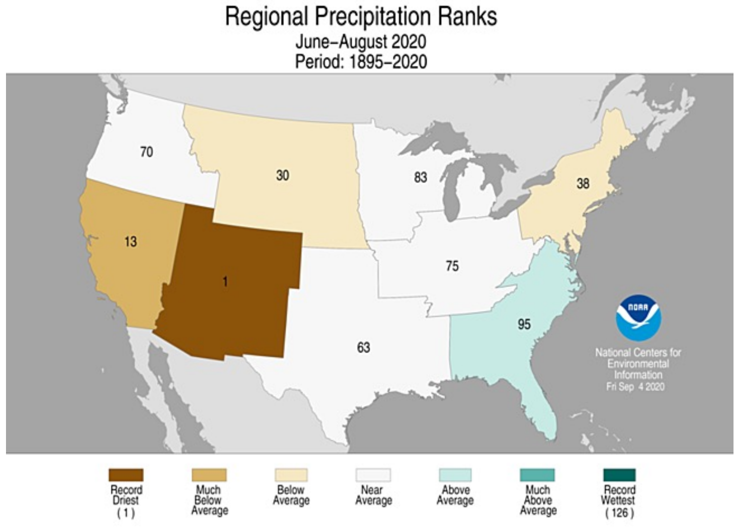


Future Colorado River Streamflow Change at mid-century. Two-thirds

CRB Science Findings since 2016

- Runoff Efficiency down since 1988
- Precipitation declines only half of 20% flow loss
  - Remaining half due to humans
- For every 1°C Temp Increase, Flows decline by 9%
- Recent precip declines may have human cause
- 2050 Flow Reductions range from..
  - -15% to -25% w/ no precip change
  - +5% to -40% w/ full range precip
- Southwest US is in a Megadrought





Important Lessons
1. Underlying flow loss mechanism is increased evaporation in all forms
2. Low soil moisture tied to runoff declines

Dust on Snow

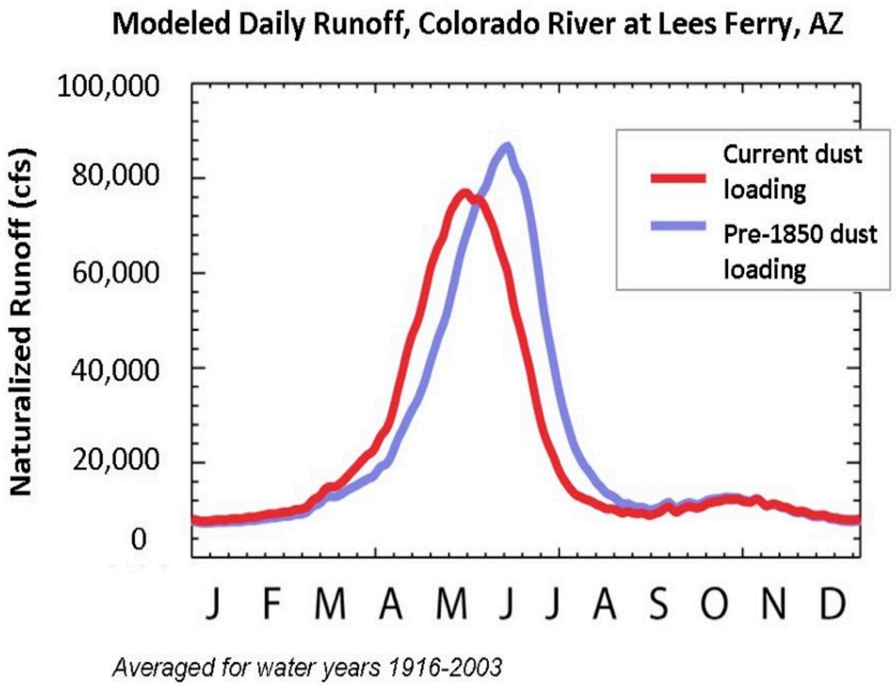
Dust on top of snow is causing earlier snowmelt and runoff in Colorado River

Loss of Flow = 5%

Earlier Runoff by 3 weeks

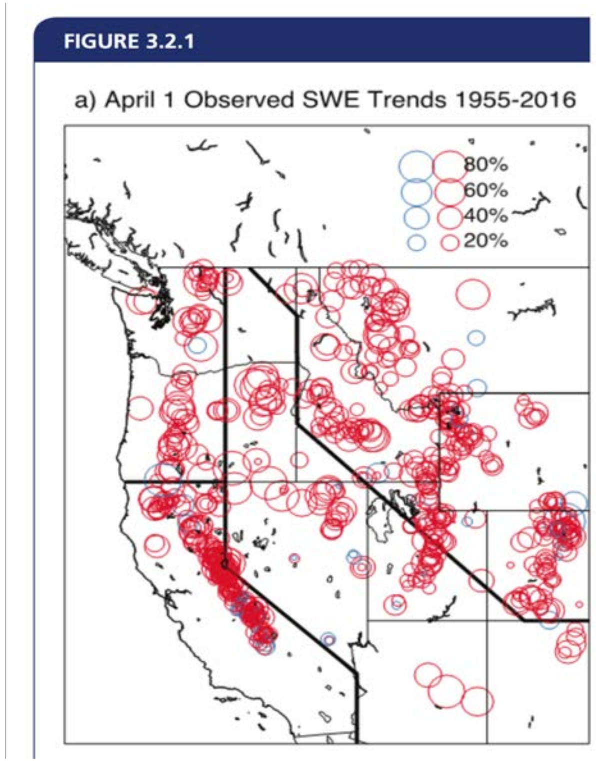
Why: dark surface absorbs more energy, snow melts earlier, allows more evaporation by plants, soil throughout entire year

Dust Source: NE Arizona, S. Utah



Common CA+CRB Hydrologic Changes

- Earlier Runoff
- More Rain, Less Snow
- Declining April 1 Snow Water Content
- Lower Late Season Flow
- Declining Water Quality
- More Year-to-Year Variability
- Wide Range of Future Annual Flow Volumes

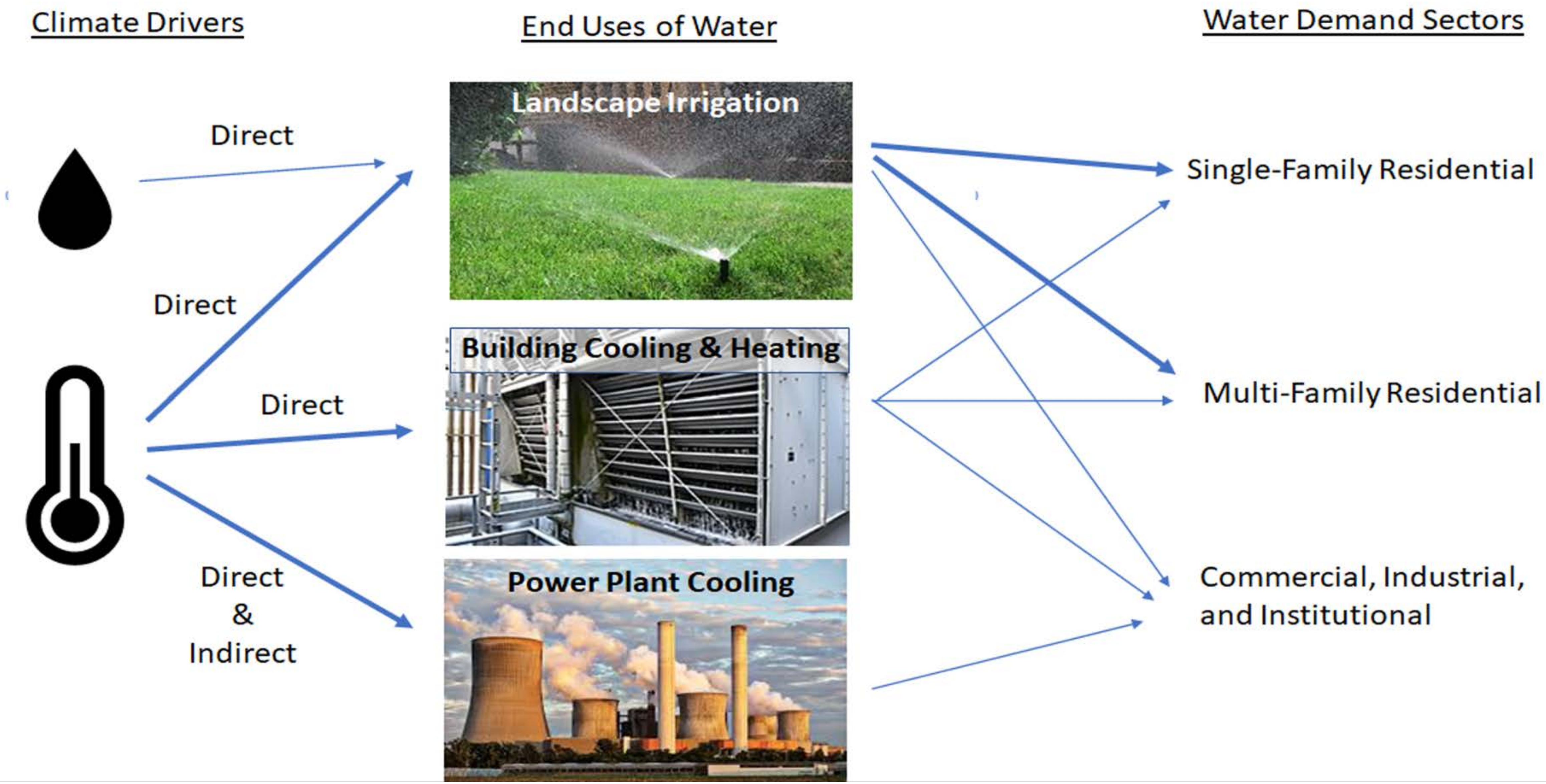


Part IV:

Climate Change and Water Demand

Heather Cooley

Climate Change and Water Demand



Landscape Irrigation

Estimated water use = (ET_0 x Plant Factor x Landscape Area x 0.62) / Irrigation Efficiency

Plant Factors

0 to 0.1 = very low water use plants
0.1 to 0.3 = low water use plants
0.4 to 0.6 = moderate water use plants
0.7 to 1.0 = high water use plants

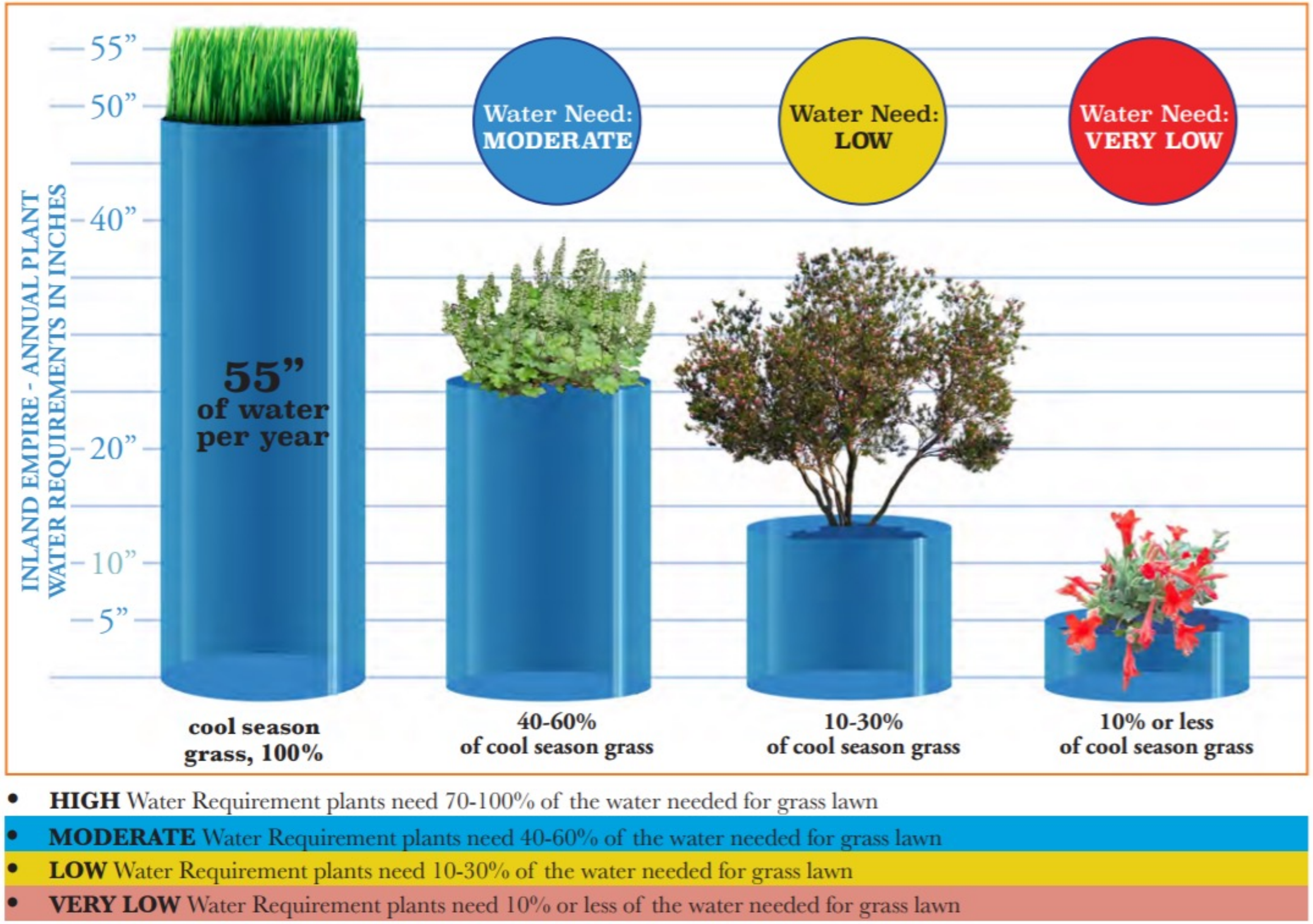


Image from the Inland Empire Landscape Guide

Part V: What Do We Plan For?

Brad Udall

Prudent Planning and "Reasonable Worst Case Future"

What should we be modeling for?

- Ultimately a political / policy decision, informed by science
- Our idea: "Reasonable Worst Case Future"
- Definition: Future that is both politically possible to plan for, and climatologically possible without being on the extreme tail

What science should inform that decision?

Known Science

- Past 21 years of flows, precipitation, and temperature
- Temperature impacts on flow
- Future temperature projections
- All point to declining flows

Unknow Science – mostly precipitation

- Low confidence in models that suggest increases
- Might save the day, but is it prudent to count on this?
- Could also go down – see Hoerling et al, 2019

Ultimately a Policy Decision of What is Prudent and Possible to Plan For

Balancing of Politically Possible and Climatologically Problematic

- Some futures too hard to plan for politically and too uncertain climatologically
- Prudence dictates modeling using flows less than last 21 years but how much less?

BREAK

Questions

Questions submitted prior to the workshop pertaining to charge questions

Submitted Questions

1. In *Systems management, proactive choices* are discussed with regards to system management and design. Is it also possible that existing infrastructure systems will become candidates for, or the focus of, improvements to proactively address future climate impacts? In particular, storage related infrastructure.

Submitted Questions Continued

2. Is there any paleoclimatic evidence of abrupt non-linear climatic changes that might be caused by crossing a critical system threshold or where discrete changes accumulate and find novel inter-relations or expression?

3. Are there scientific analyses that try to assess the mechanisms or probability of potential abrupt climatic shifts?

Submitted Questions Continued

4. Because the “average” is based on a range of possible outcomes, is it possible/plausible to experience in the next 25-40 years “high” events (say temperature) AND “low” events (say precipitation) equivalent to events forecasted for the latter half of this century?

Submitted Questions Continued

5. Are you saying the emphasis on a methodology that offers a range of possible outcomes reinforces the concept of scenario planning being used for the IRP Update?

6. Do the climate change experts believe there is value in exploring a "worst case" climate change scenario that is unlikely happen through one or more of the four IRP scenarios?

Submitted Questions Continued

7. Should MWD consider dust-on-snow effect for the Sierra Nevada watershed too?

Submitted Questions Continued

8. If precipitation has a smaller influence on demand than temperature. What could be said of warmer but wetter climate change scenarios where some of these impacts have a chance to offset each other?

Submitted Questions Continued

9. Should there be consideration to how climate change may impact demands differently based on geographic location within MWD’s service area (rather than sector)?

Submitted Questions Continued

10. How would you be able to quantify impacts with regards to this “Reasonable Worst-Case Future” scenario?

Submitted Questions Continued

11. Does the panel agree that a proper sequence is to first develop the climatologically possible, or plausible, scenarios, in detail, and then develop a process/method to establish the politically possible range of scenarios? This would acknowledge a “bandwidth” of politically possible scenarios, contained within the larger range of climatologically possible scenarios.

12. Can consensus be reached, and options developed, to understand the consequences of developing a politically narrow bandwidth of possible scenarios, when actual, hydrologically plausible scenarios occur outside the politically possible ones?

Submitted Questions Continued

13. Does the expert panel anticipate that climate change will affect other drivers of water supply or demand such as viability of endangered species regulation, critical habitat impacts, economic or social?

BREAK

Other Questions

Submit questions through chat (preferred) or raised hand function

Submitted Questions Continued

14. How much energy and resources should we employ to remediate the effects of global climate change vs the cause of climate change?

Submitted Questions Continued

15. To what extent do the climate models predict water supply impacts, for both local and imported supplies, associated with anticipated water quality changes?

    a) If they do not, is it the assumption that water quality impacts will be addressed with increasingly advanced levels of treatment, thereby increasing the costs and reducing the affordability if water and recycled water supplies?

    b) If so, are these increased costs captured in price elasticity for consumer demands?

Submitted Questions Continued

16. Could climate change have impacts that reduce demands by slowing population growth or causing population decline and/or changing housing locations and types (multi-family vs. single family)?

Submitted Questions Continued

17. How can factors out of MWD’s control, such as the level global emissions (and the global effort to reduce emissions), be incorporated in MWD’s adaptive management strategy?

Conclusion

Facilitator summary

Staff Wrap up and next steps

THE METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA

1928