Climate Change 101
Presentation for USBR Managers

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Outline

- Changing Climate
- Impact on Western US Watersheds

Weather vs. Climate

- **Weather** is local and short-term. It can change day to day, hour to hour, and even minute to minute.
- **Climate** is what the weather is normally like year to year and decade to decade. Climate is usually measured over periods of about 30 years.

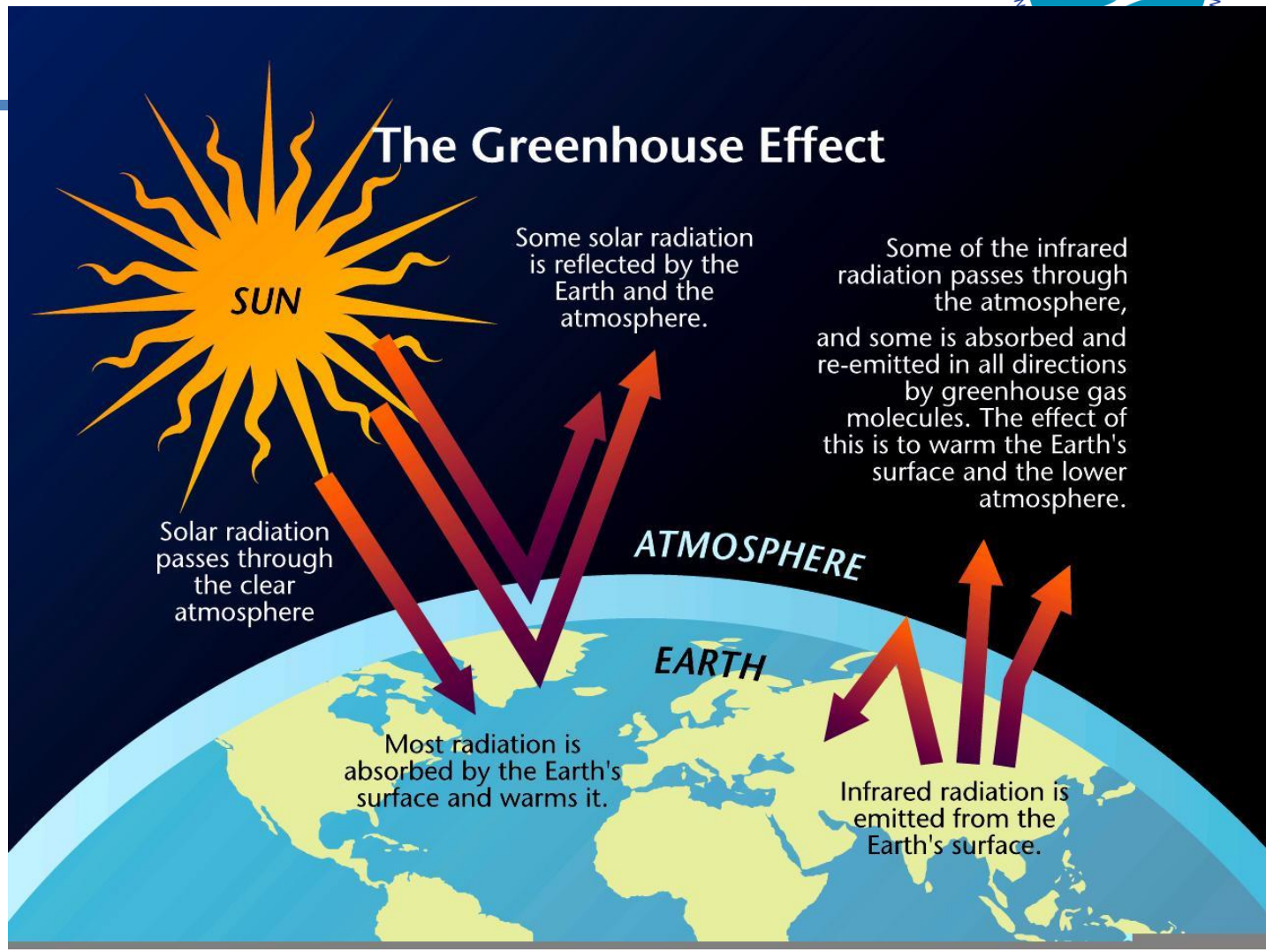
Climate *tells you what clothes to buy and have in your wardrobe.*
Weather *tells you what to wear each day.*

ING Miami Marathon and Half Marathon
January 2008 Florida

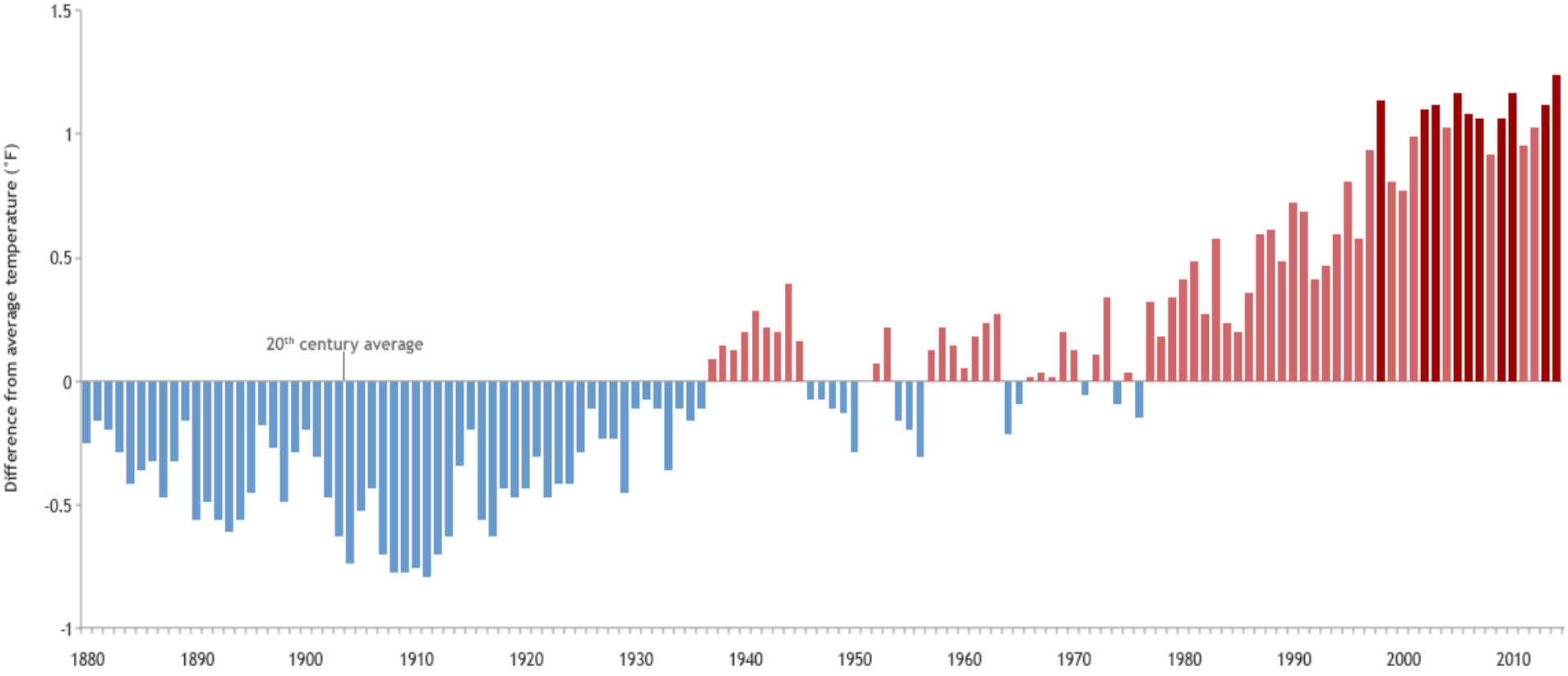
Kahtoola Bigfoot Snowshoe Festival 50K and Marathon
January 2010 Utah

Earth's Atmosphere

Without a natural greenhouse effect Earth's average temperature would be close to 0°F rather than it's current 58°F average.



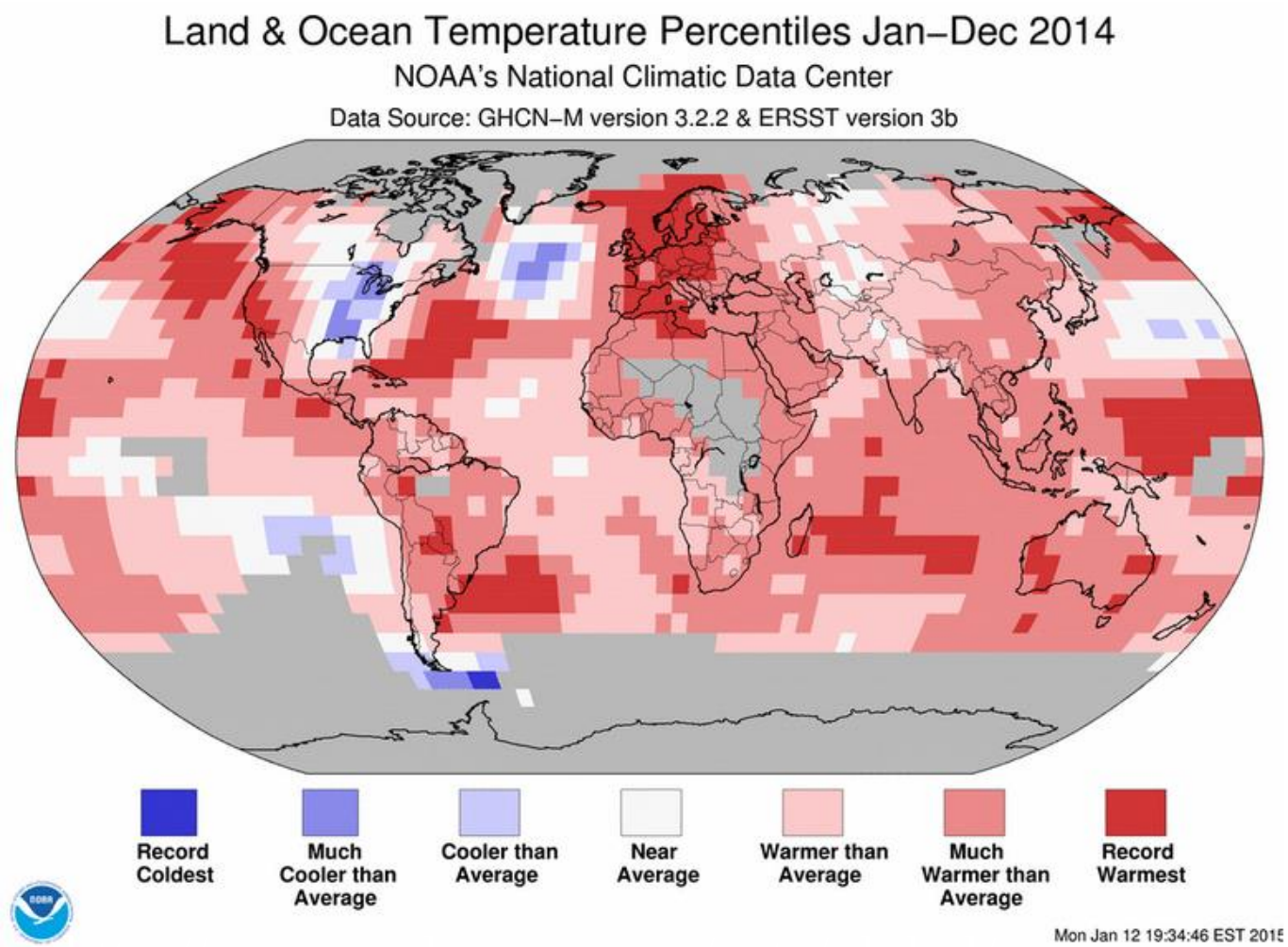
2014 Warmest Year on Record



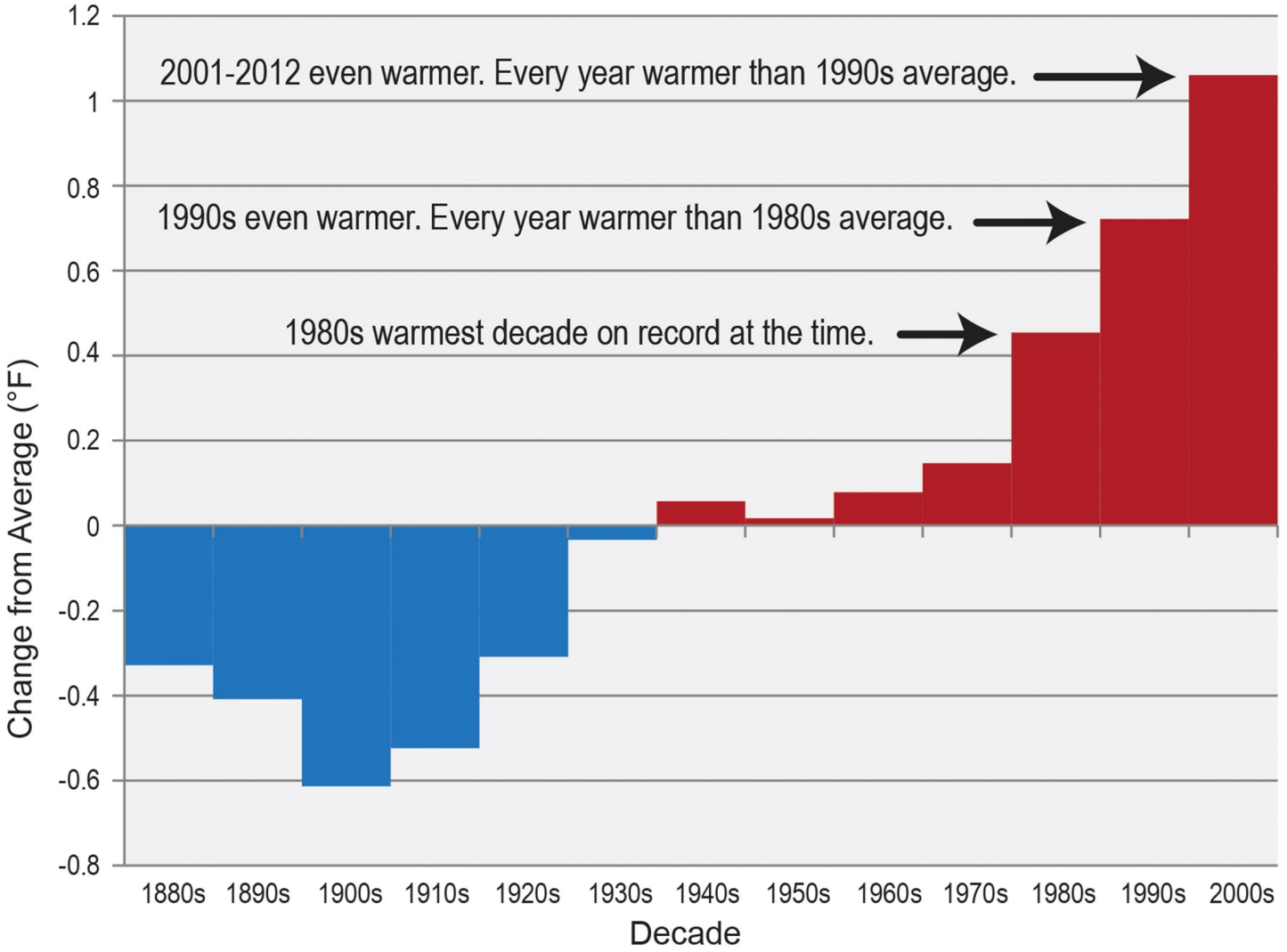
Global Temperatures

RANK 1 = WARMEST PERIOD OF RECORD: 1880–2014	YEAR	ANOMALY °C	ANOMALY °F
1	2014	0.69	1.24
2 (tie)	2010	0.65	1.17
2 (tie)	2005	0.65	1.17
4	1998	0.63	1.13
5 (tie)	2013	0.62	1.12
5 (tie)	2003	0.62	1.12
7	2002	0.61	1.10
8	2006	0.60	1.08
9 (tie)	2009	0.59	1.06
9 (tie)	2007	0.59	1.06

2014 Global Temperature



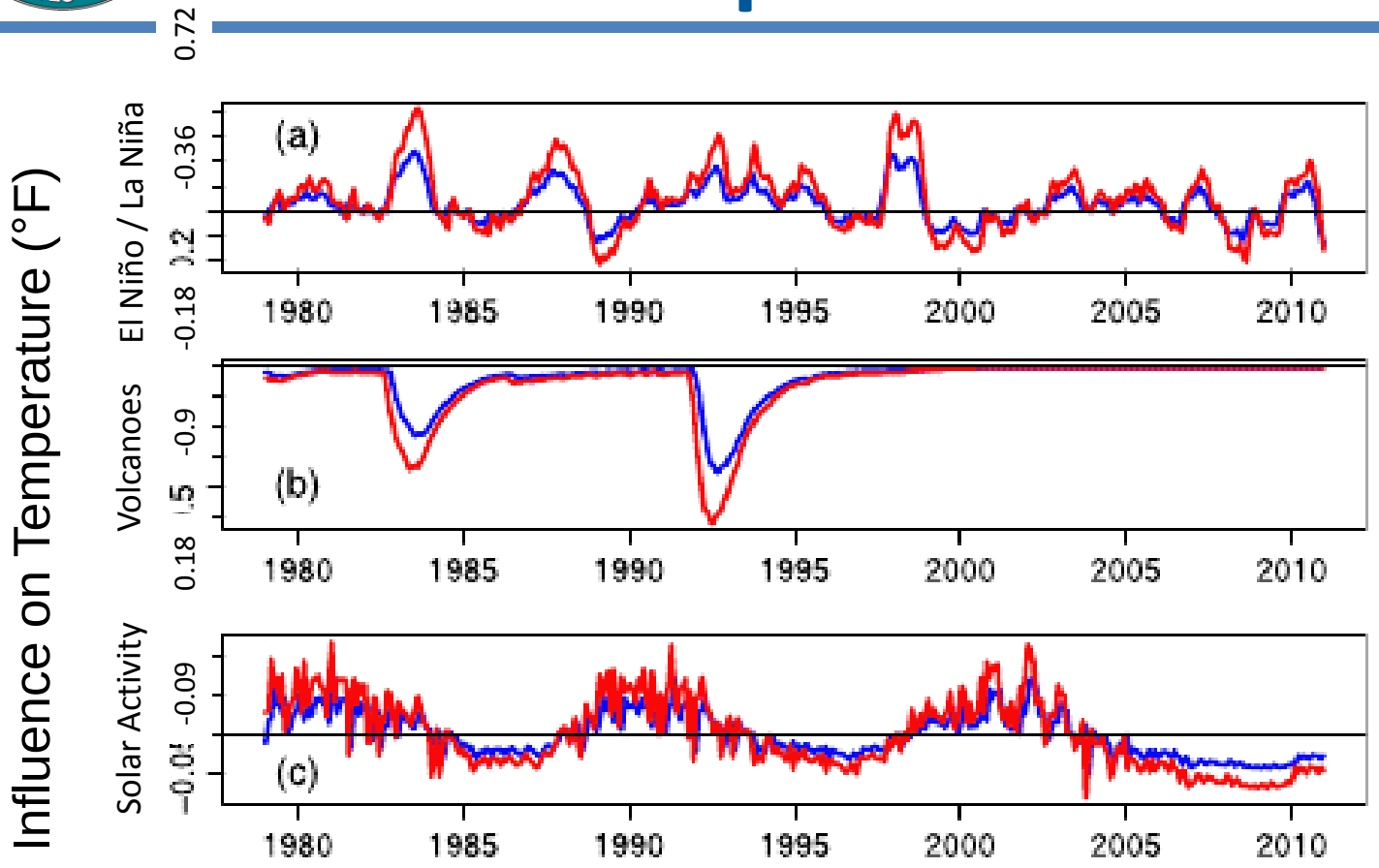
Temperature Change by Decade



Why is it warming?

- Possible reasons
  - ➢ The sun
  - ➢ Heat release from earth itself into atmosphere (e.g. volcanos)
  - ➢ Part of longer term variability
  - ➢ Stuff in the atmosphere

Three Influences on Global Temperature



El Niño / La Niña
~ -0.4°F to +0.7°F

Volcanoes
up to ~-1.0°F

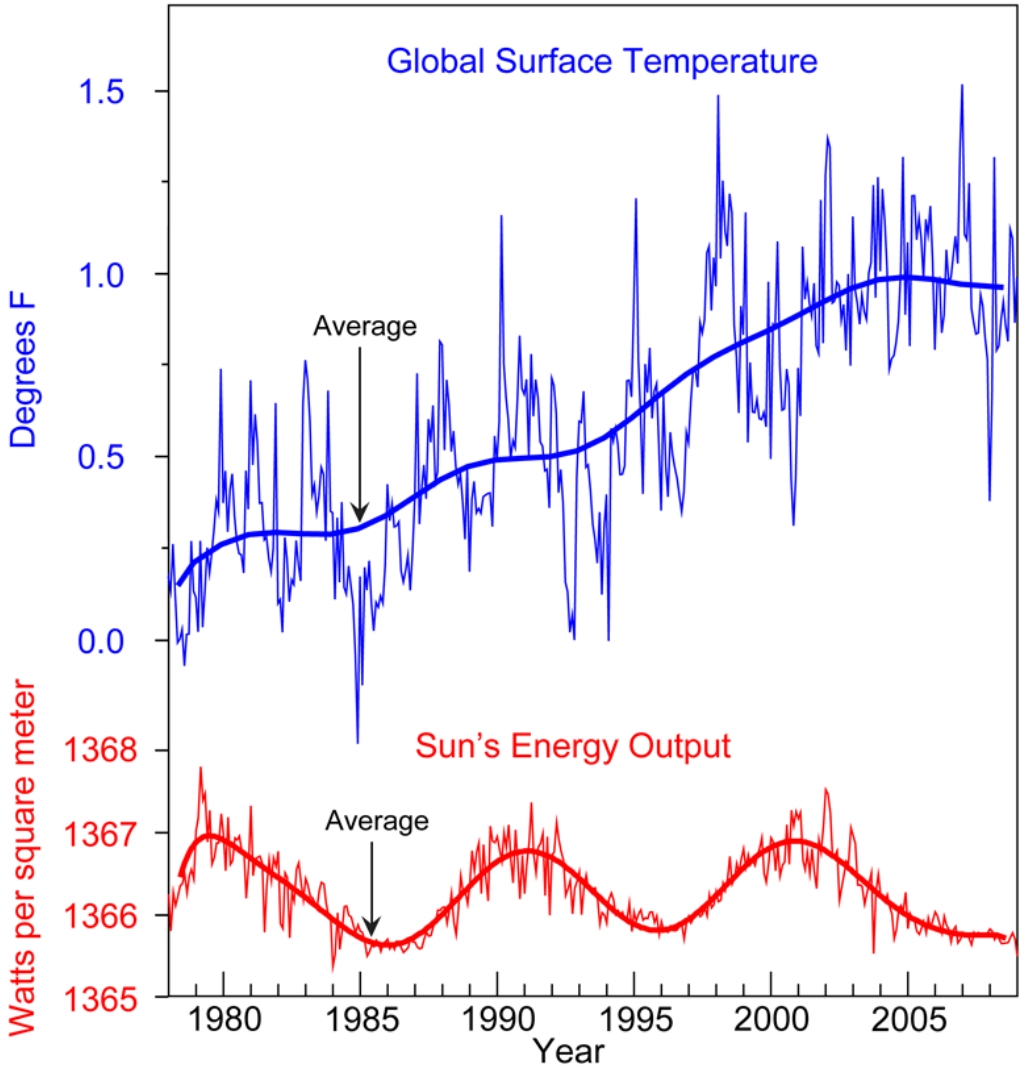
Solar Activity
~ -0.1°F to +0.2°F

Source: Foster and Rahmstorf (2011)

Red line = NASA surface temperatures

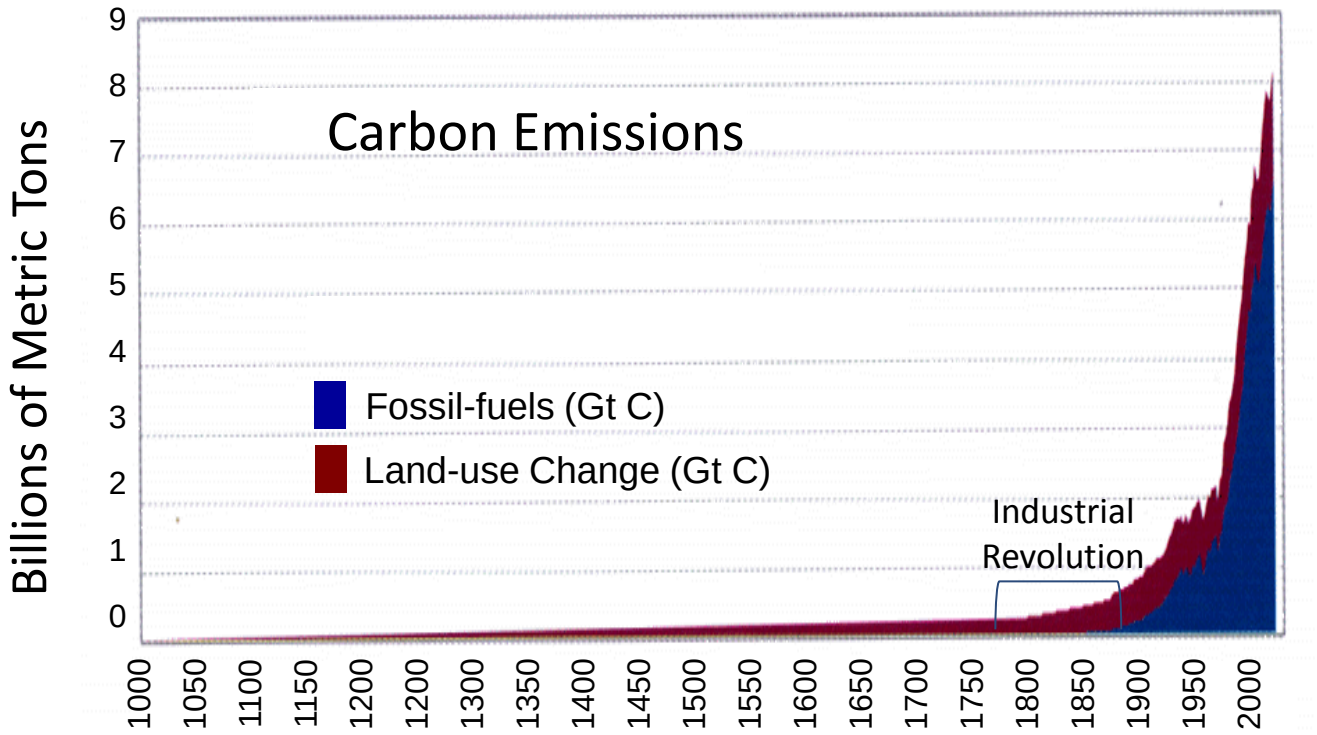
Blue line = RSS lower troposphere temperatures

Temperature vs Sun's Energy Output



Increasing Carbon Dioxide (CO_2) Emissions

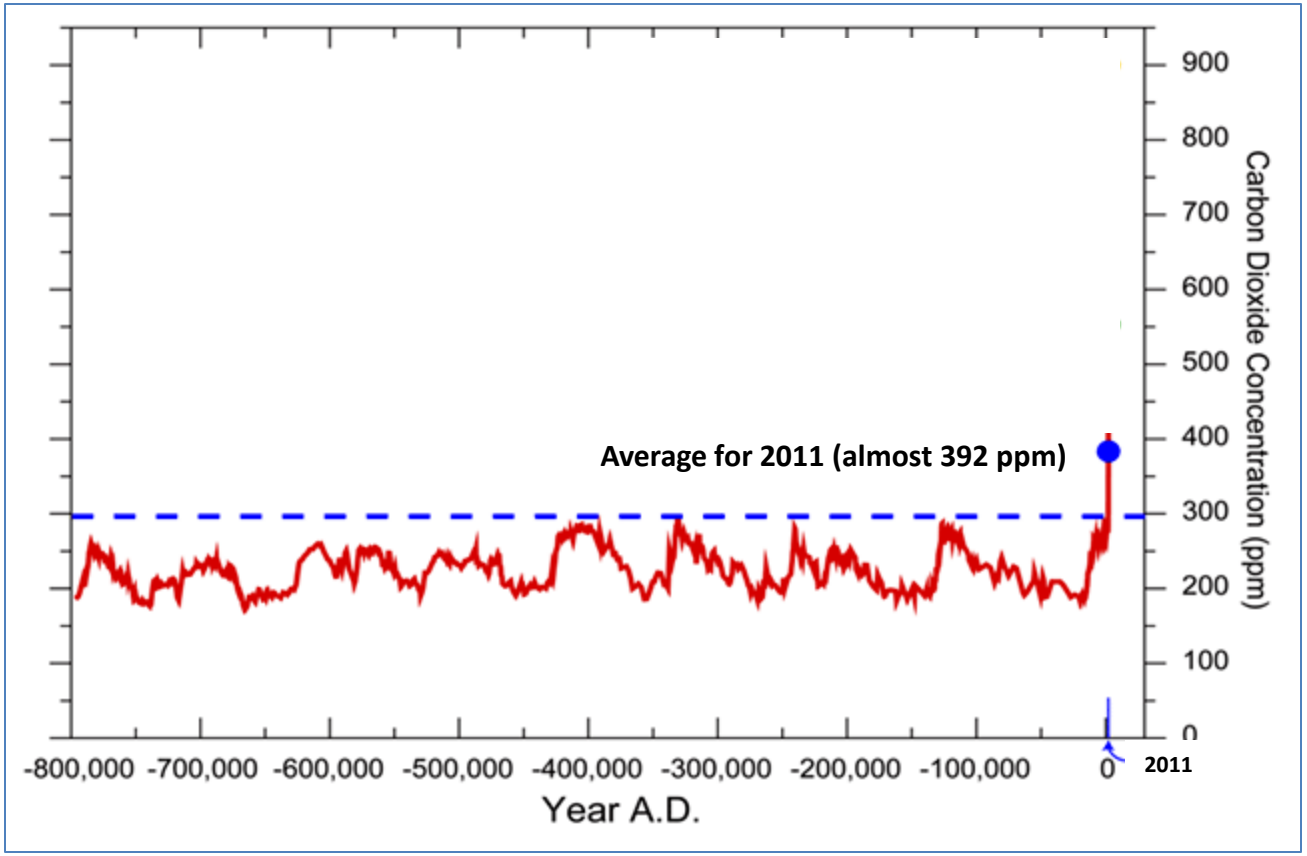
Trends in the Northern Hemisphere



Source: Climate Change Impacts on the US, NAST, 2001

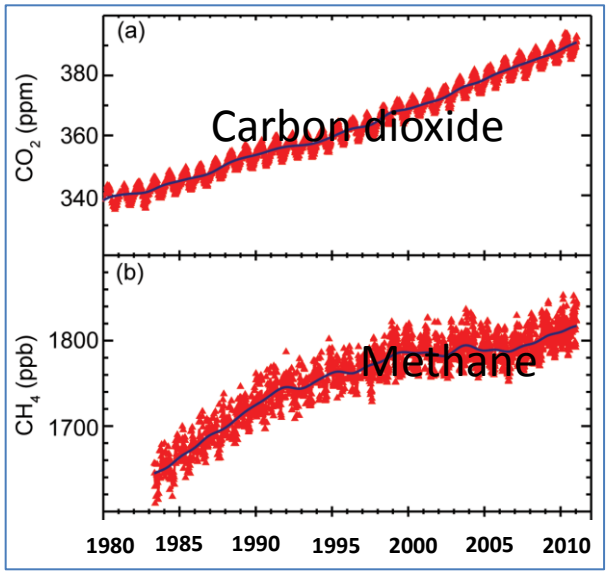
800,000 Year Record of Carbon Dioxide Concentration

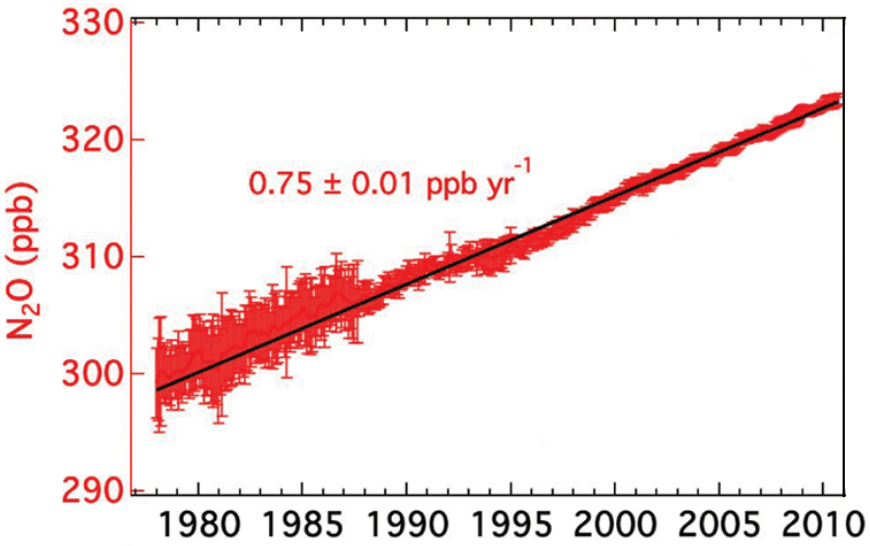
Moving Outside the Range of Historical Variation



Updated from Karl et al 2009

Recent Greenhouse Gas Trends



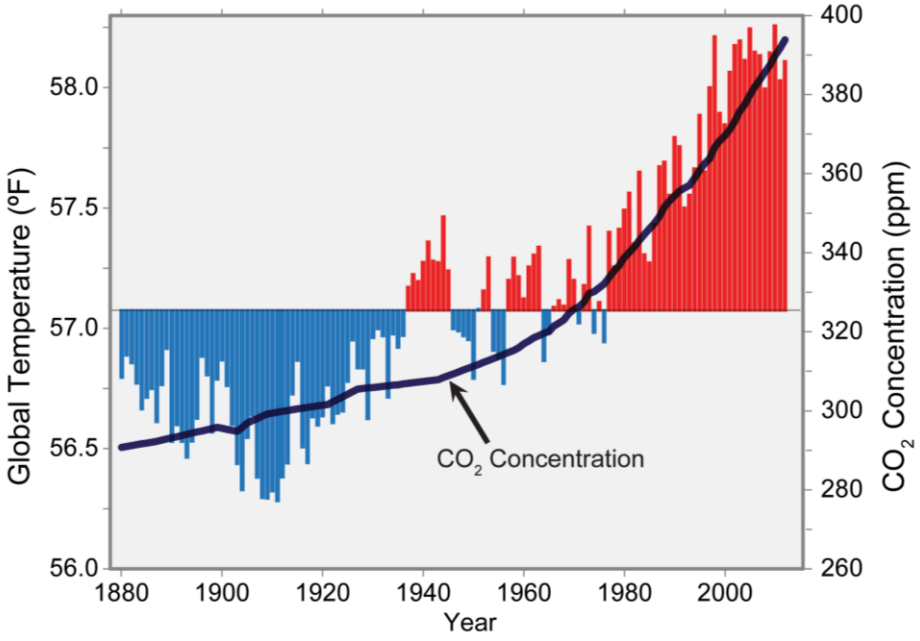


Most major greenhouse gases are

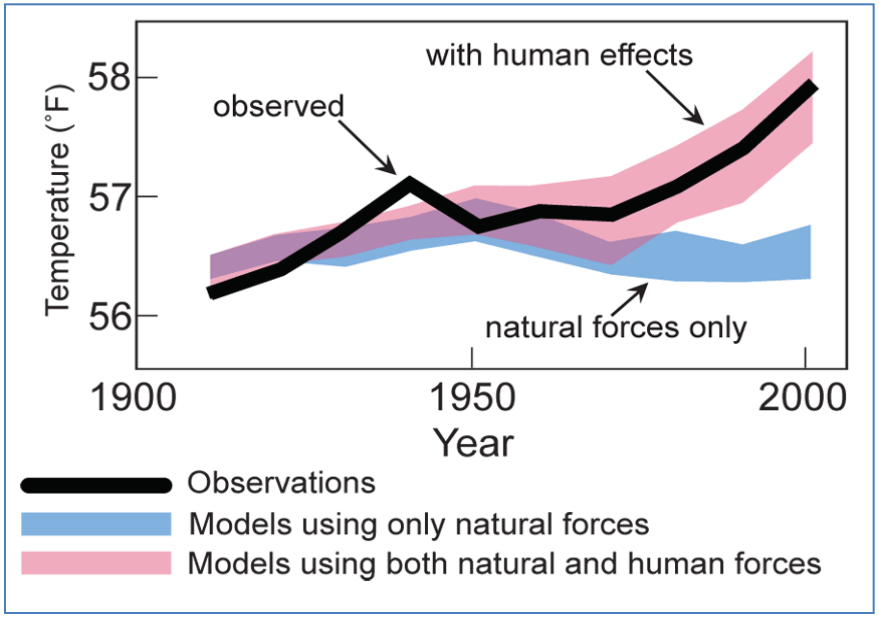
- Carbon dioxide (CO_2)
- Methane (CH_4)
- Nitrous Oxide (N_2O)

Increasing Temperatures Correlate with Human Influences

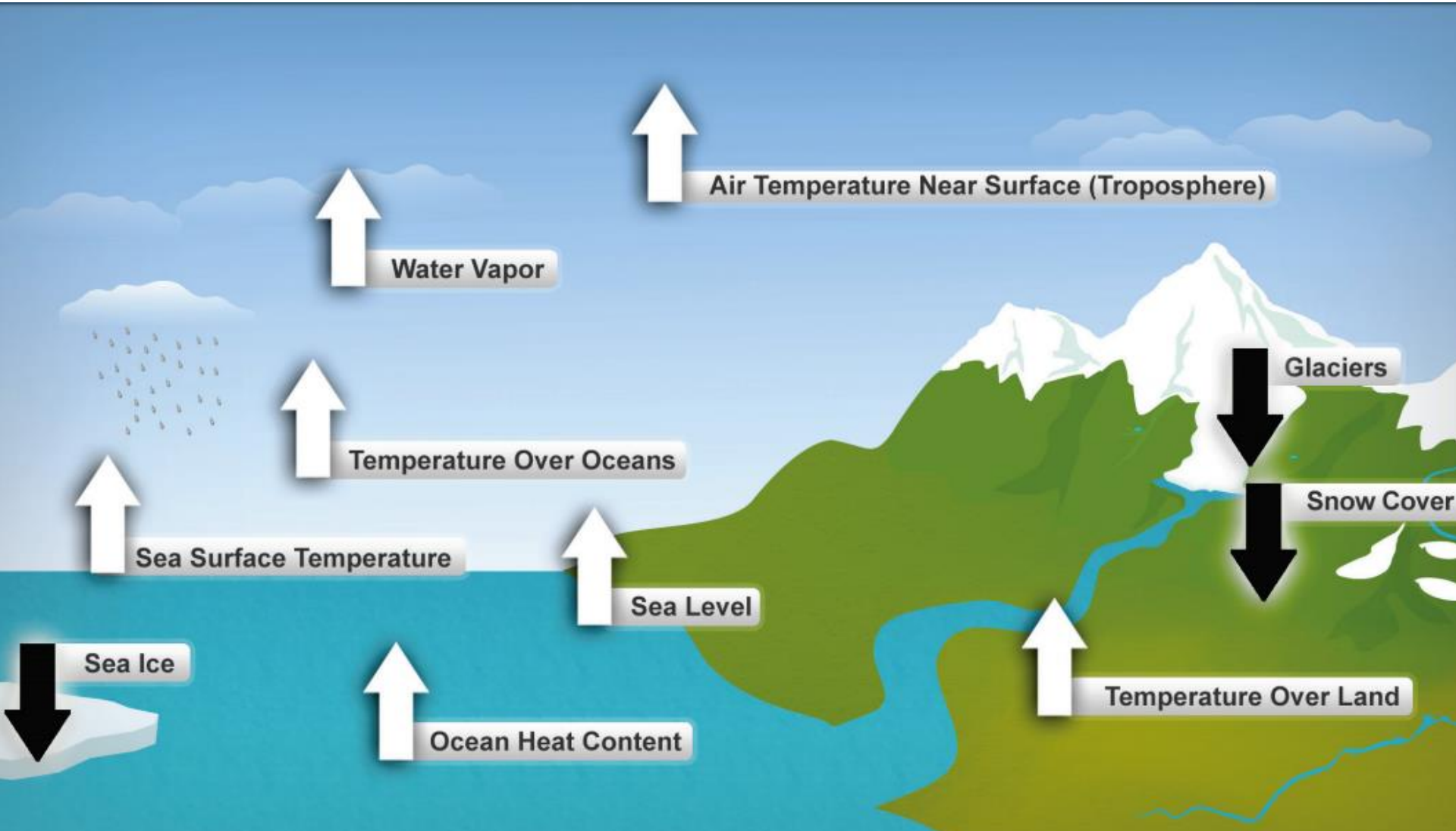
Global Temperature and CO_2



Separating Human and Natural Influences on Climate



All indicators expected to increase in a warming world are increasing and those expected to decrease are decreasing



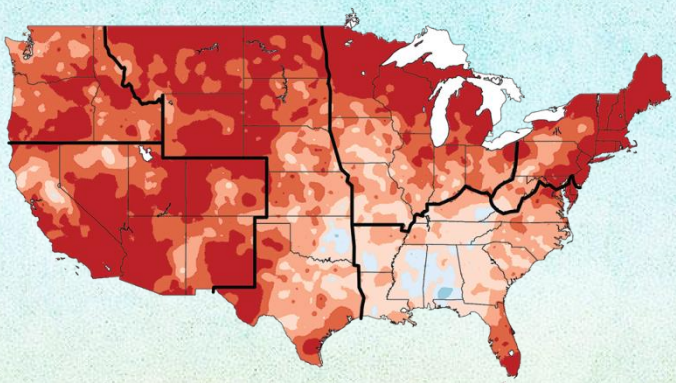
Changes in Muir Glacier, Alaska:
From 1941 to 2004

Image Credit: *National Snow and Ice Data Center*

From 1941 to 2004, the glacier retreated more than seven miles and thinned by more than 875 yards and ocean water filled the valley.

Third National Climate Assessment

Climate Change Impacts in the United States



Main Messages

- Largest & most comprehensive **for the U.S.**
- Climate change is happening **now**
- America is **feeling the effects**
- Important **opportunities** to manage & prepare

GlobalChange.gov
U.S. Global Change Research Program

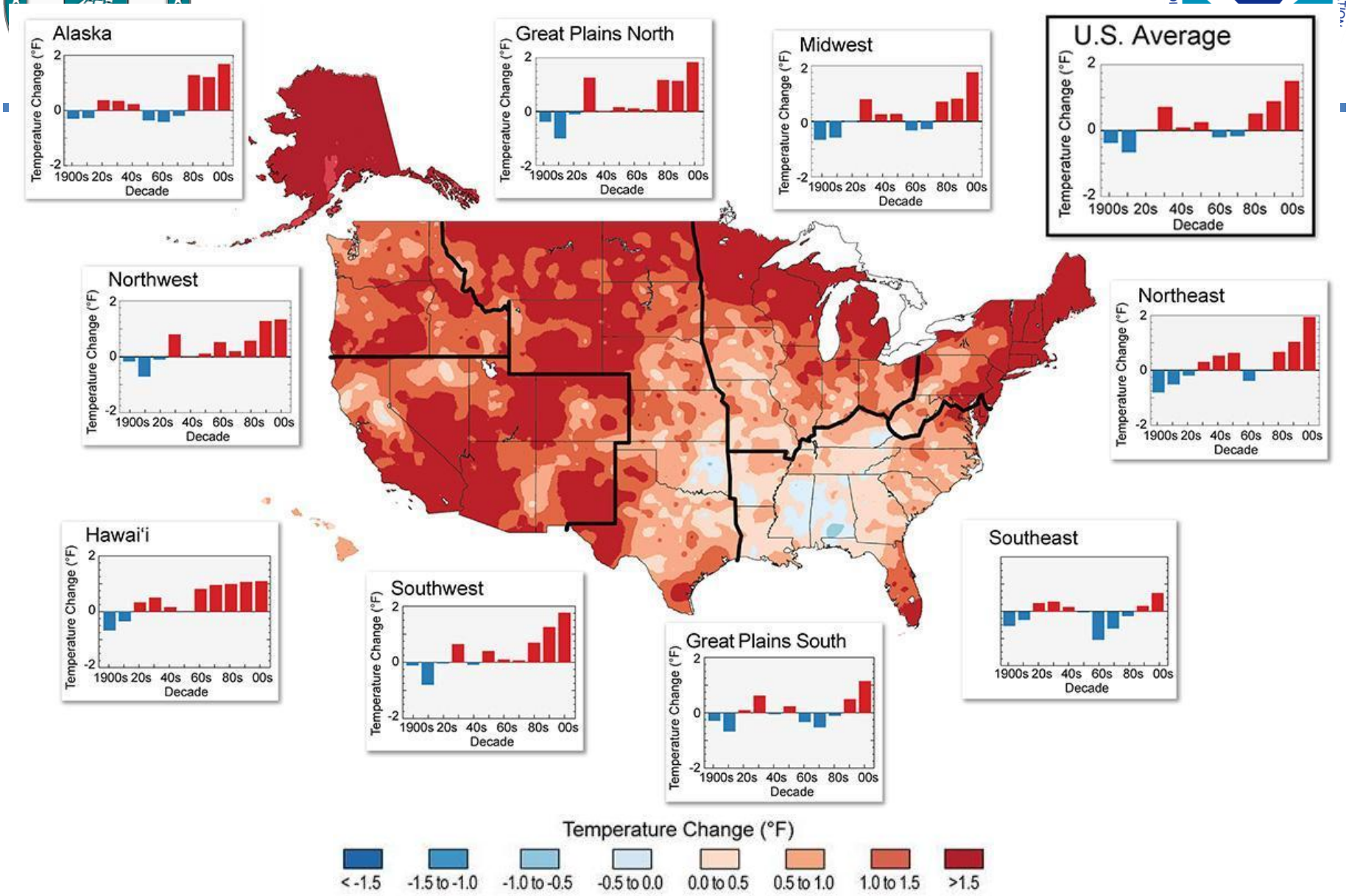
U.S. Global Change Research Program
National Climate Assessment

Report Finding 1

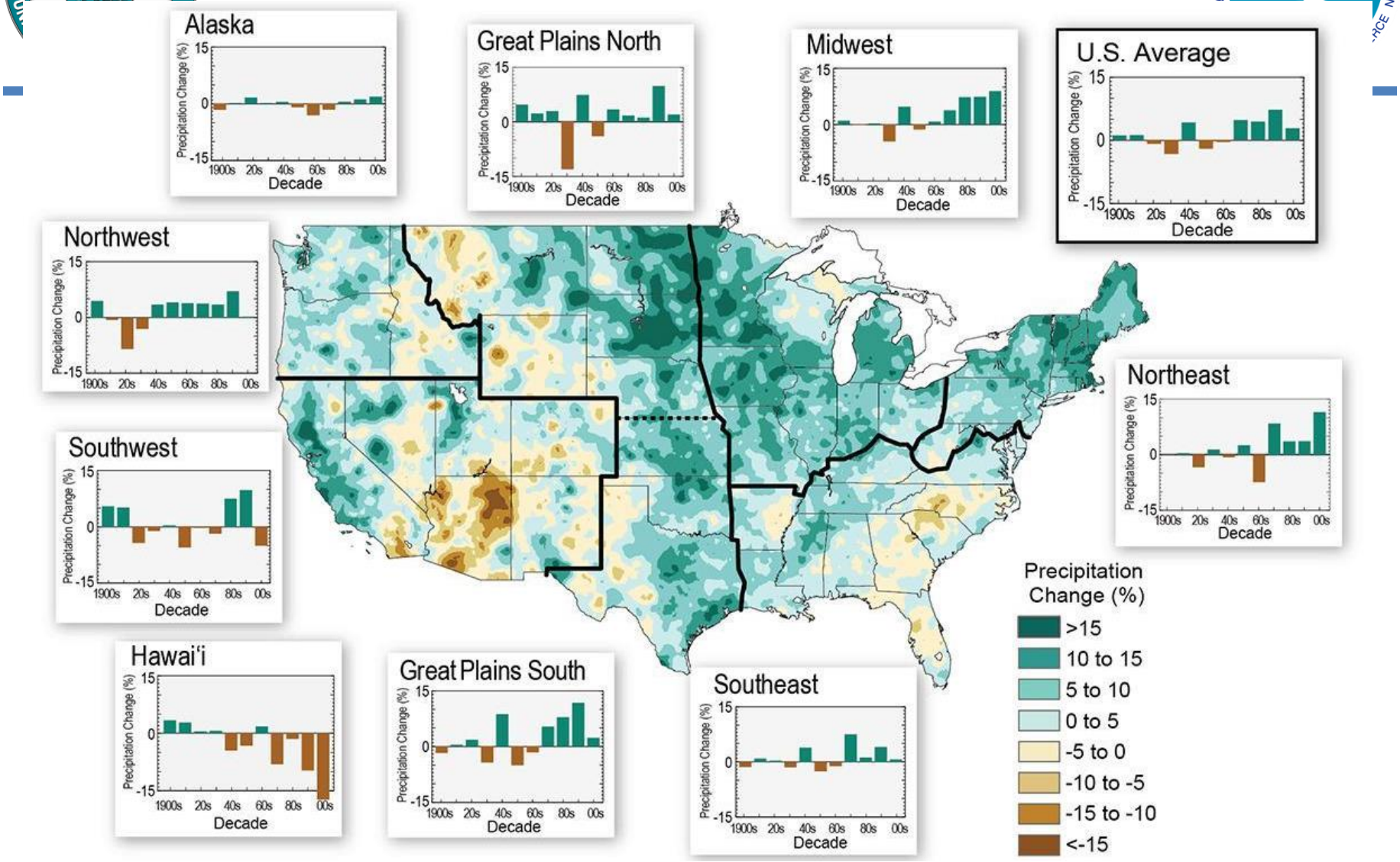
Global climate is changing and this is apparent across the US in a wide range of observations.

The global warming of the past 50 years is primarily due to human activities, predominantly the burning of fossil fuels.

Observed US Temperature Change



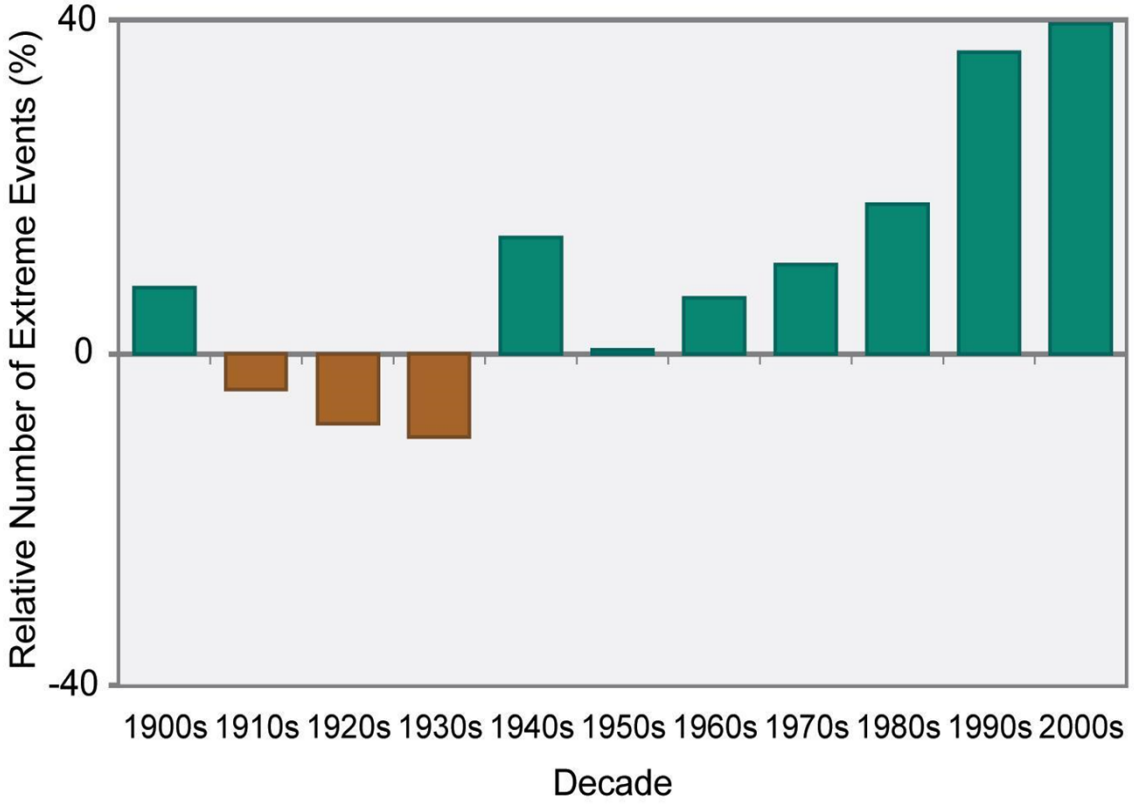
Observed US Precipitation Change



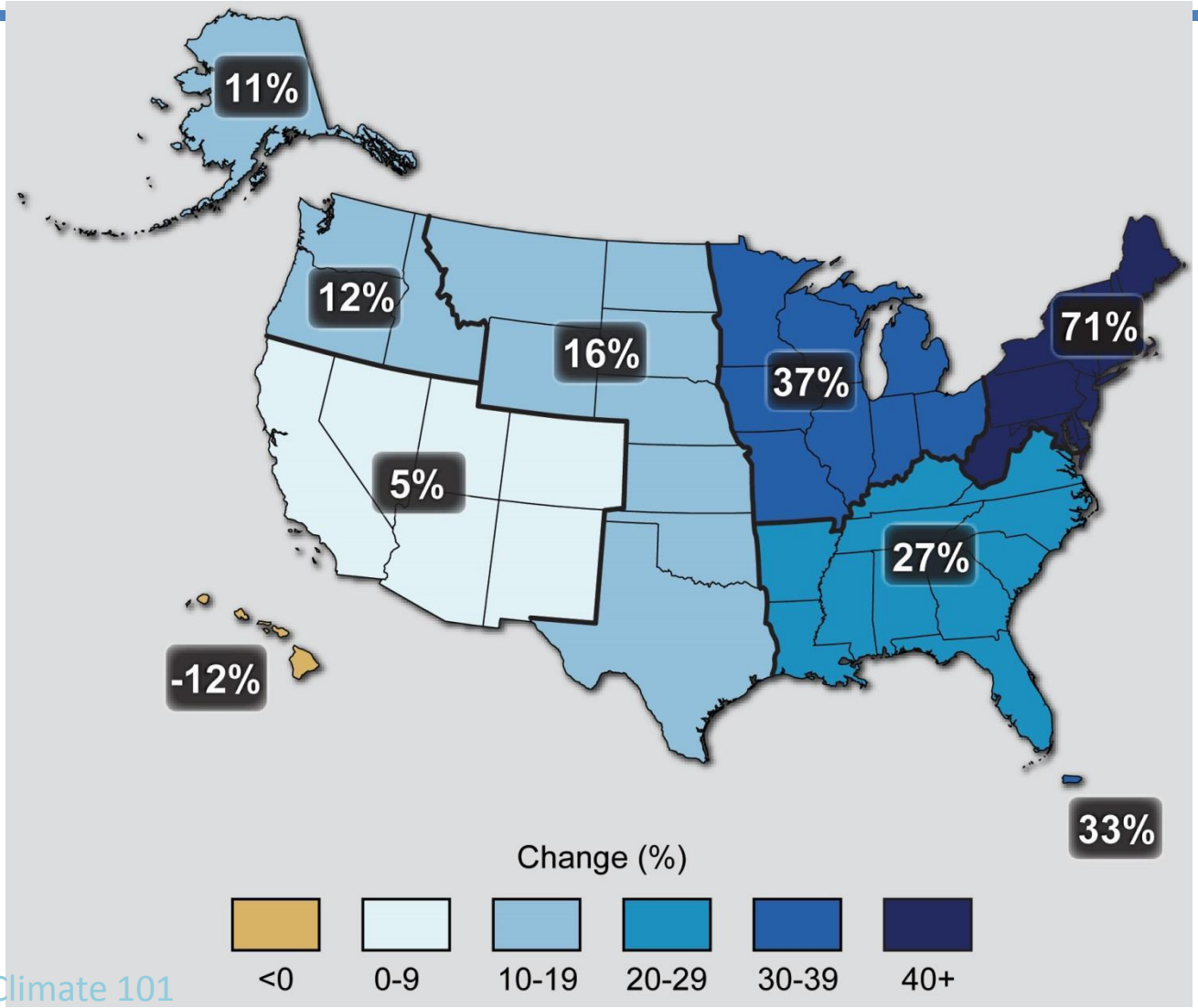
2: EXTREME WEATHER

Observed Trends in Heavy Precipitation Events in the U.S.

Some extreme weather and climate events have increased in recent decades, and new and stronger evidence confirms that some of these increases are related to human activities.



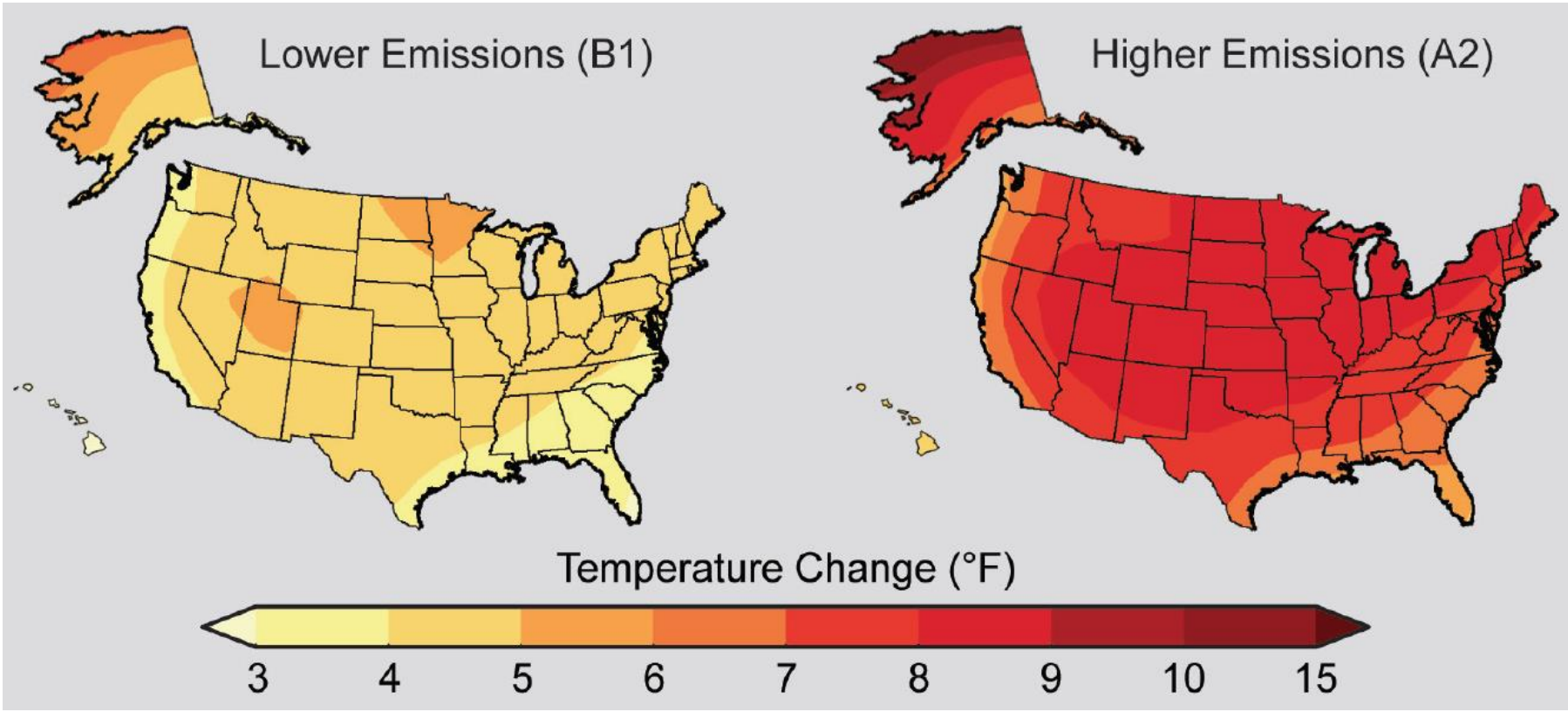
Observed Change in Very Heavy Precipitation



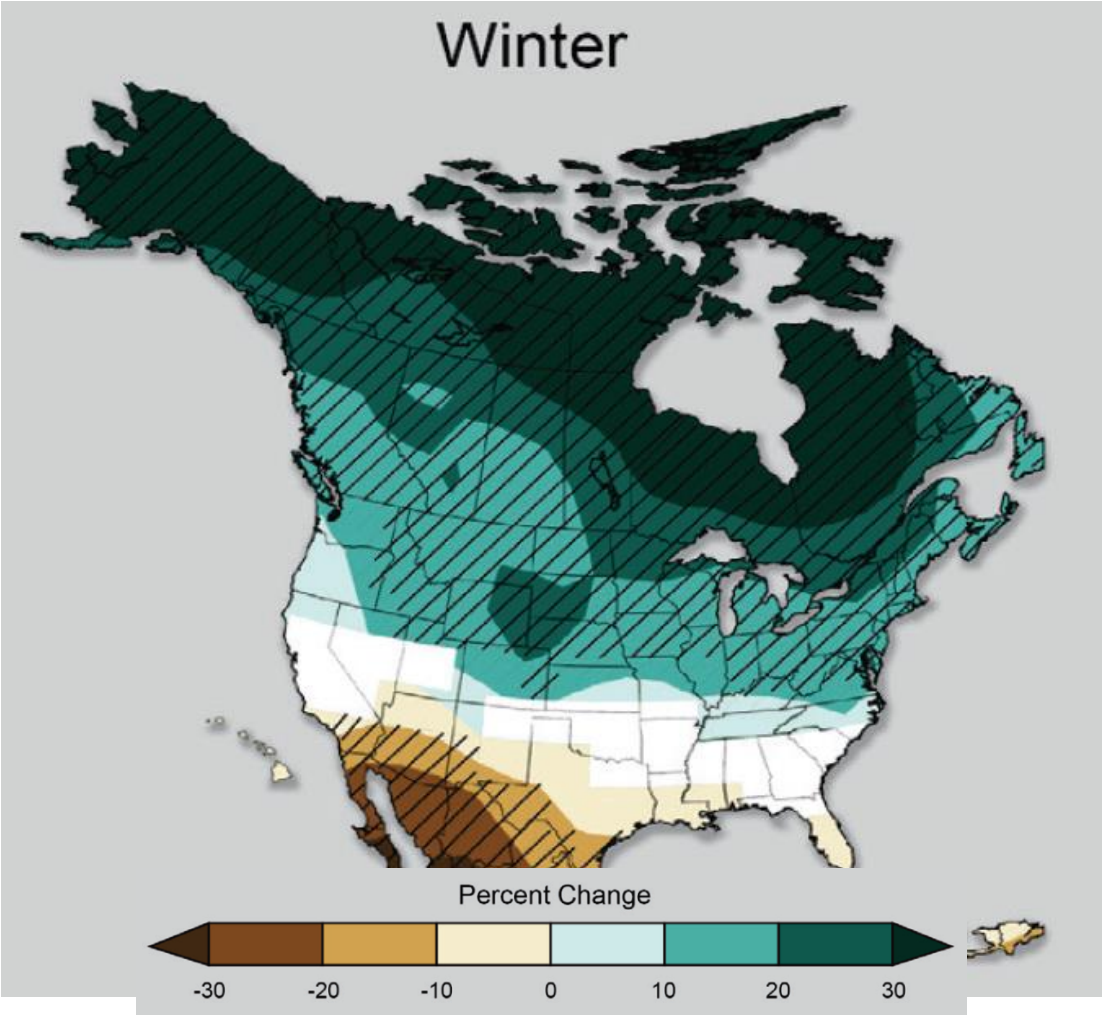
3: FUTURE CLIMATE

Human-induced climate change is projected to continue, and it will accelerate significantly if emissions of heat-trapping gases continue to increase.

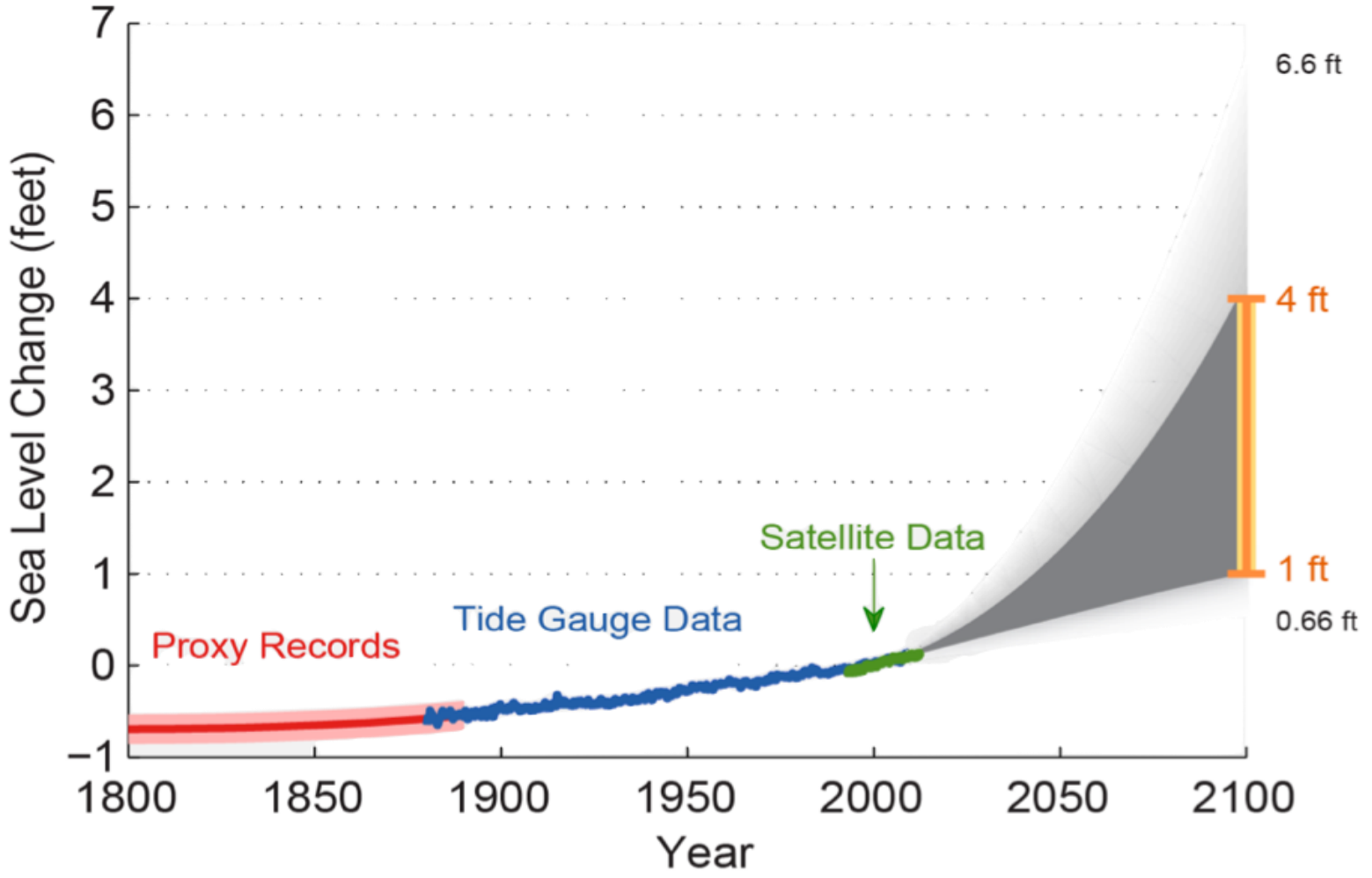
Projected Temperature Change



Projected Precipitation Change
Higher Emissions (A2)



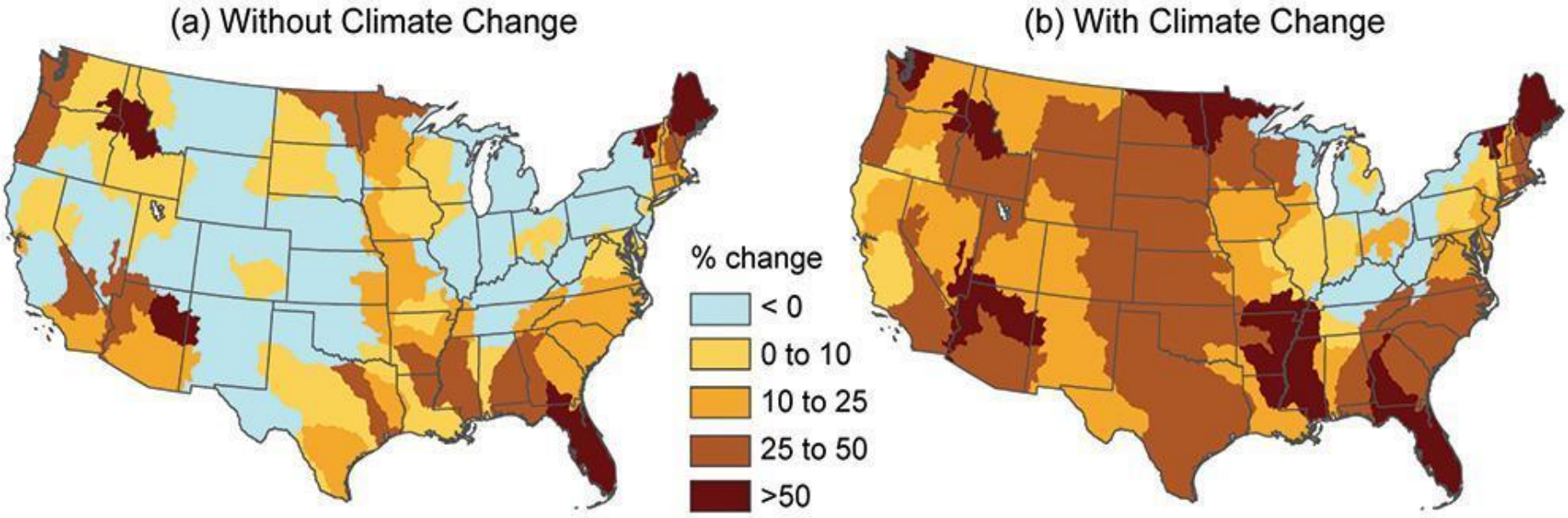
Projected Changes Global Sea Level



7: WATER

Water quality and water supply are jeopardized by climate change in a variety of ways that affect ecosystems and livelihoods.

Projected Changes in Water Withdrawal

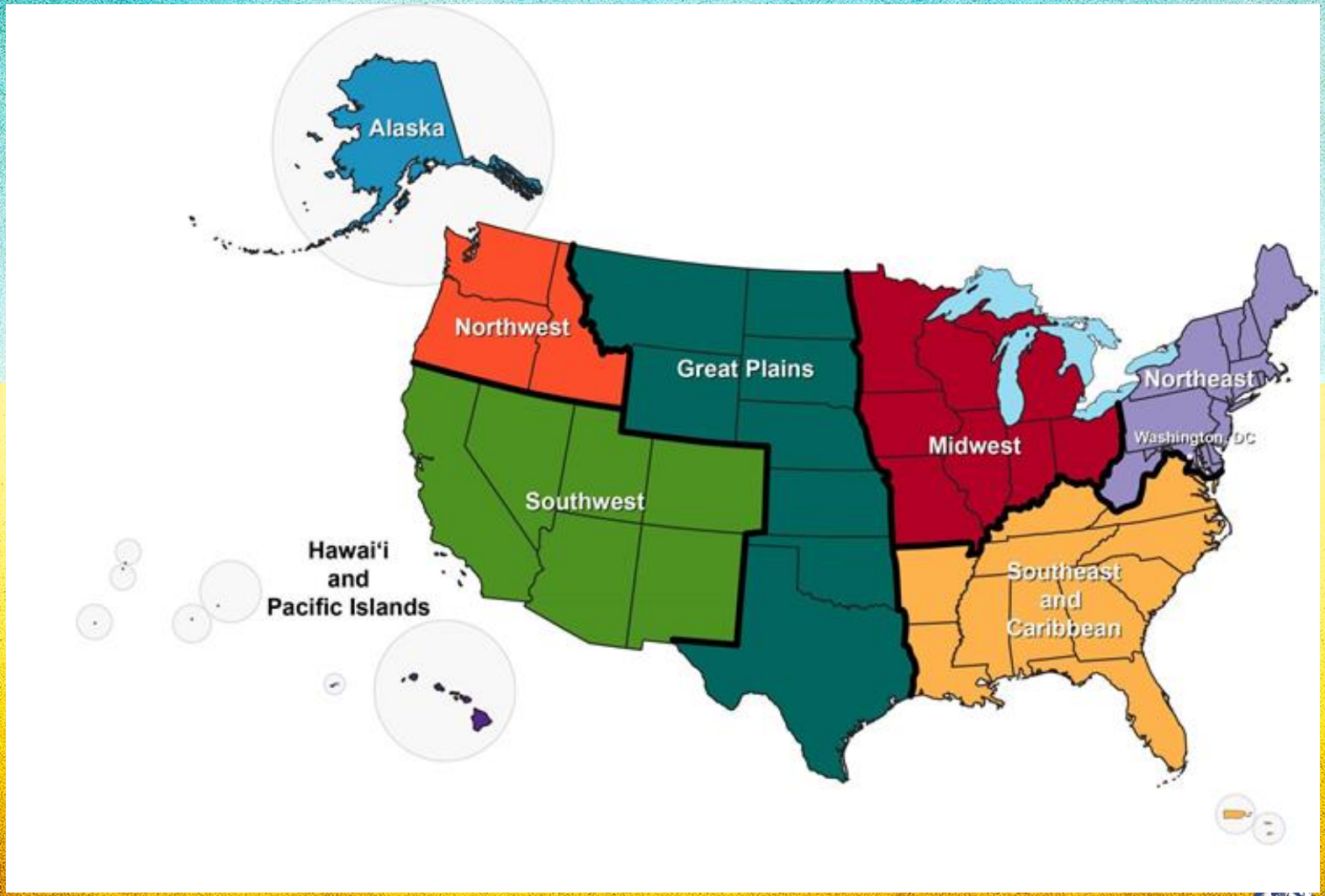


Shift in Plant Hardiness Zones

Average Annual Extreme Minimum Temperature by Climate-Related Planting Zone

No Change in Zone	Zone 5 (-19 to -10 °F)	Zone 7 (1 to 10 °F)	Zone 9 (21 to 30 °F)
Zone 4 (-29 to -20 °F)	Zone 6 (-9 to 0 °F)	Zone 8 (11 to 20 °F)	Zone 10 (31 to 40 °F)

Third National Climate Assessment



Key Messages for the West

Northwest:

1. Water Related Challenges
2. Coastal Vulnerabilities
3. Impacts on Forests
4. Adapting Agriculture

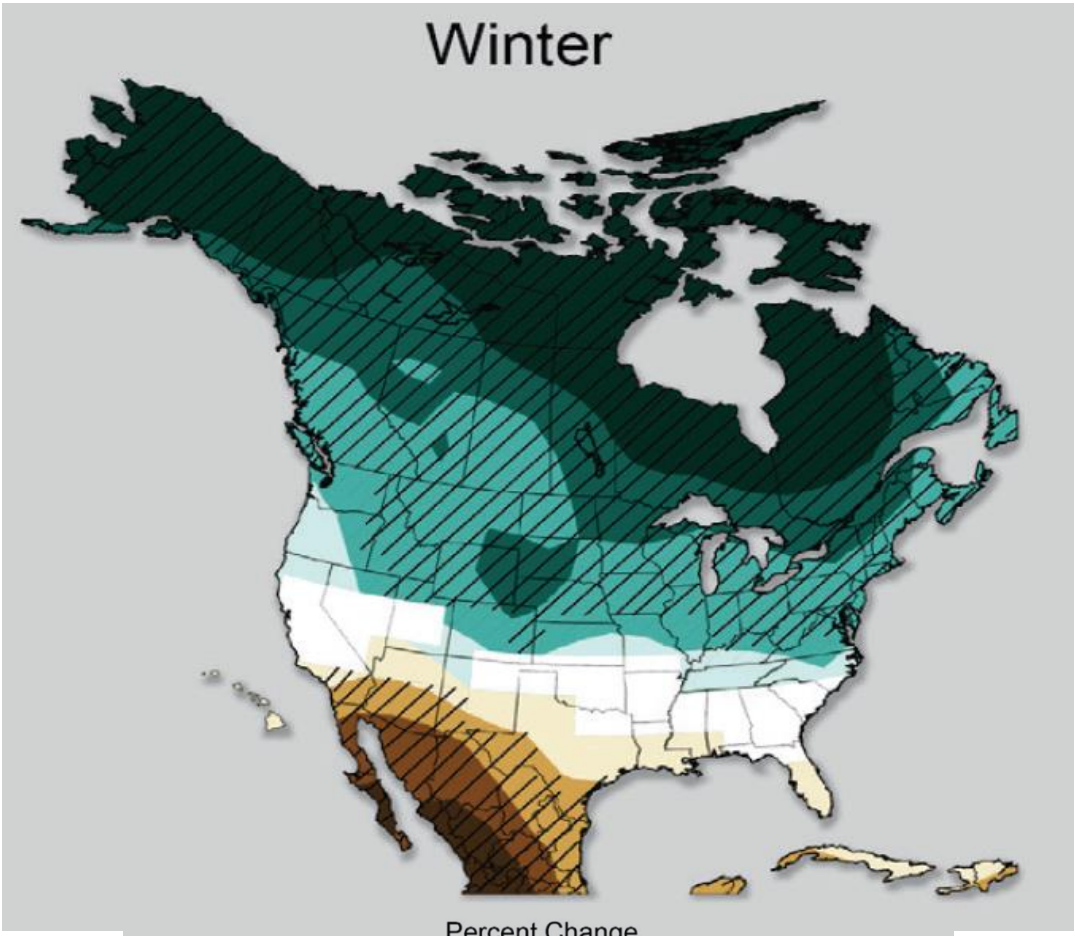
Great Plains:

1. Energy, Water, and Land Use
2. Sustaining Agriculture
3. Conservation and Adaptation
4. Vulnerable Communities
5. Opportunities to Build Resilience

Southwest:

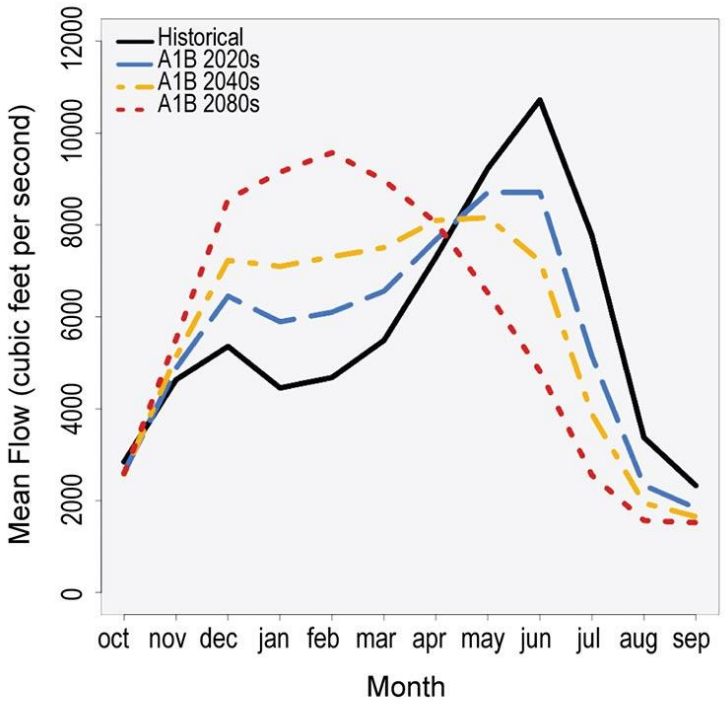
1. Reduced Snowpack and Streamflows
2. Threats to Agriculture
3. Increased Wildfire
4. Sea Level Rise and Coastal Damage
5. Heat Threats to Health

Projected Precipitation Change Higher Emissions (A2)

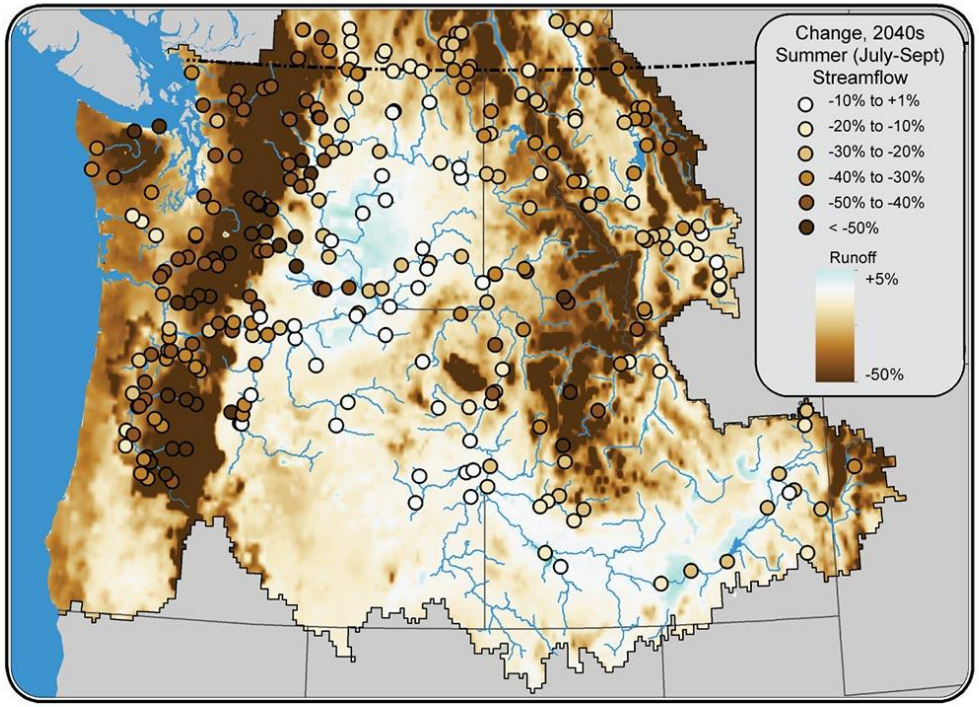


Water-related Challenges

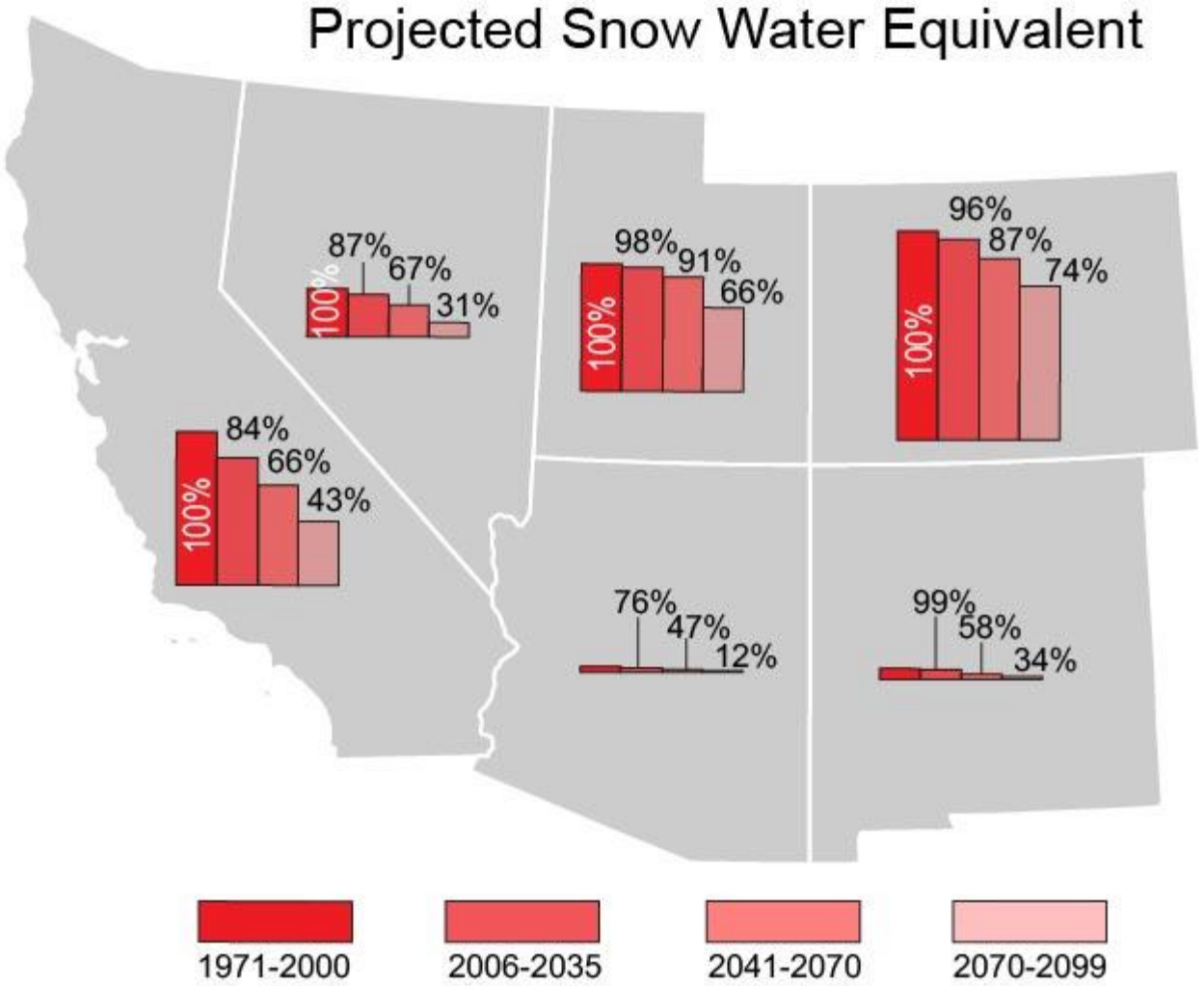
Future Shift in Timing of Stream Flows



Reduced Summer Flows



Water-related Challenges



Big Cottonwood Creek climate sensitivity

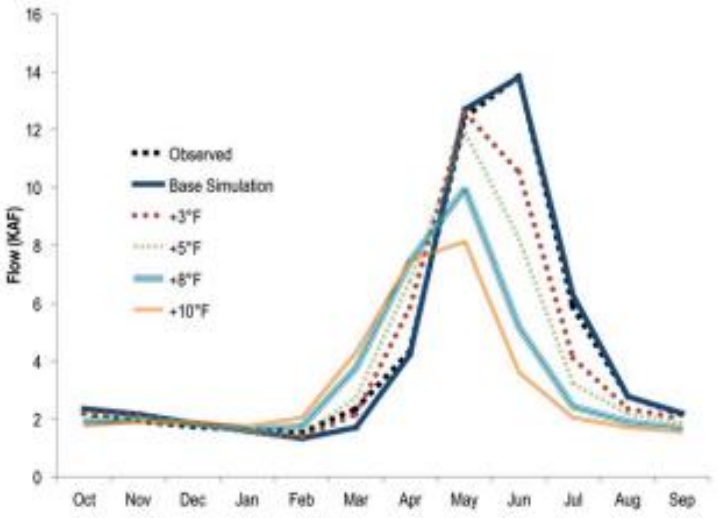
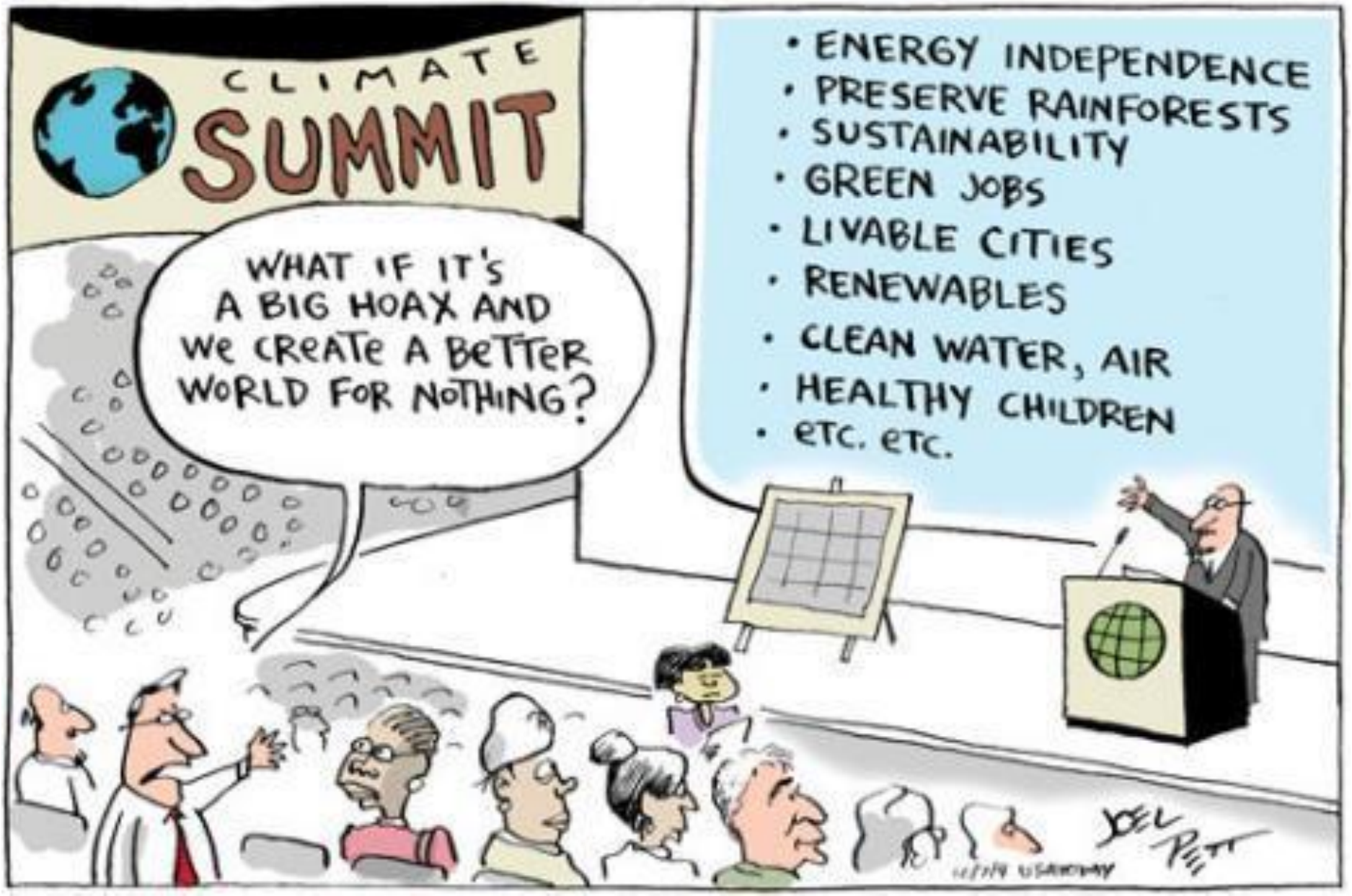


Figure 6. Big Cottonwood Creek runoff sensitivity to temperature as indicated by 30-yr mean (water years 1981–2010) monthly runoff volumes forced by various temperature changes. Temperature changes (°F) are indicated in the legend, where "base" signifies base climate historical simulation with no temperature adjustment. Also shown is the observed mean monthly streamflow.

Credit: Bardsley et al, 2013

Concluding Thoughts

- As the impacts of climate change continue to be realized, resource managers will need to be proactive, innovative, and open to meeting the challenges of a changing future
- Communication and collaboration are essential to being successful and developing future productive and lasting partnerships
- We have exactly enough time to address the impacts of climate change, starting NOW


CLIMATE
SUMMIT
WHAT IF IT'S A BIG HOAX AND WE CREATE A BETTER WORLD FOR NOTHING?
• ENERGY INDEPENDENCE
• PRESERVE RAINFORESTS
• SUSTAINABILITY
• GREEN JOBS
• LIVABLE CITIES
• RENEWABLES
• CLEAN WATER, AIR
• HEALTHY CHILDREN
• ETC. ETC.
JOEL PETT

Regional Reports

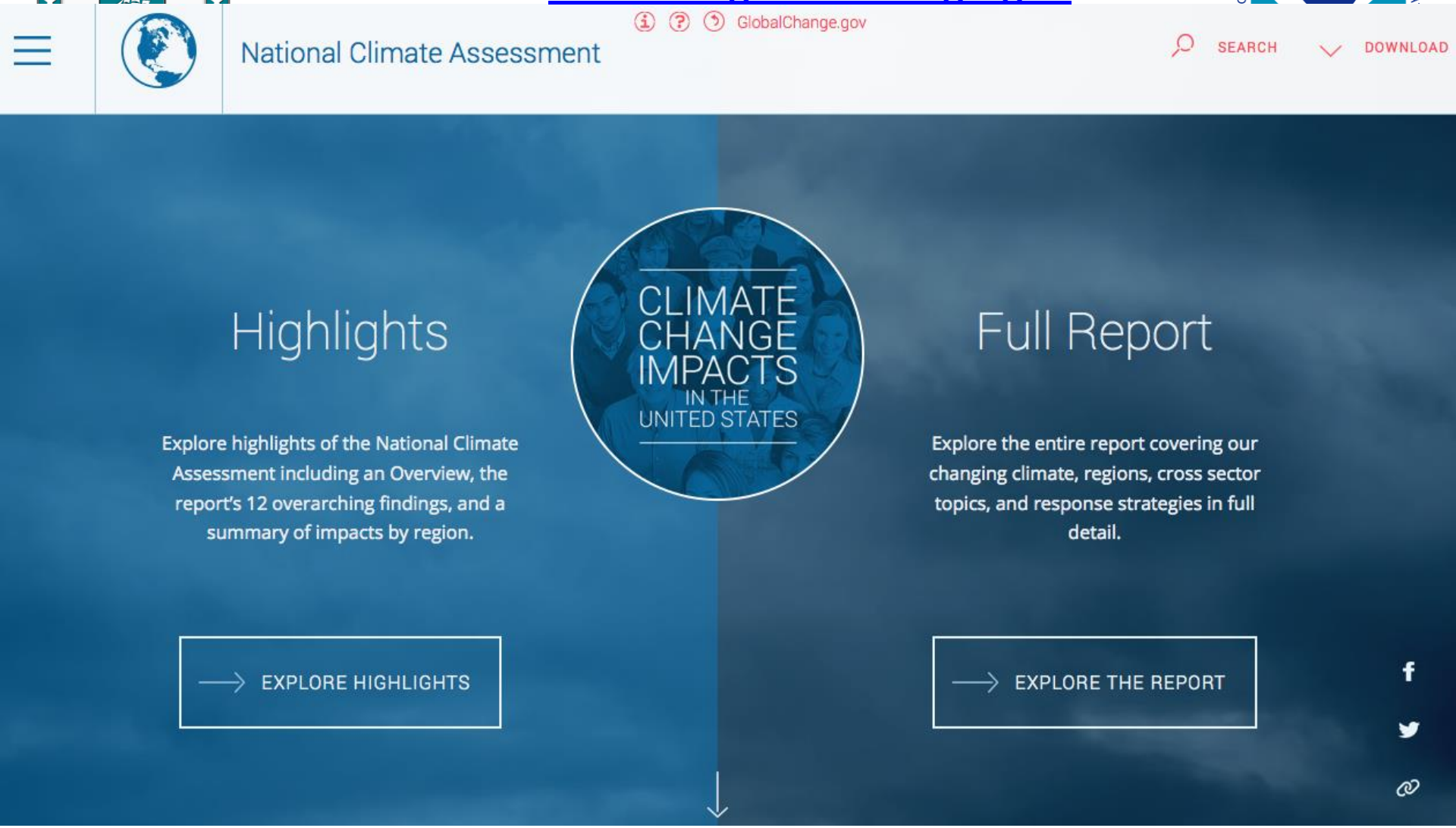
Southwest:
nca2014.globalchange.gov/report/regions/southwest

Northwest:
nca2014.globalchange.gov/report/regions/northwest

Regional Resources

- NOAA
  - Regional Climate Service Director (me!)
  - NOAA River Forecast Centers: Colorado Basin River Forecast Center
  - NOAA Regional Integrated Climate Assessments: Western Water Assessment
  - Regional Climate Centers: Western Regional Climate Center
  - State Climatologists: Utah State Climate Office, USU
- DOI
  - Landscape Conservation Cooperatives
  - DOI Climate Science Centers
- USDA Agriculture Hubs
- And more

nca2014.globalchange.gov



U.S. Climate Resilience Toolkit

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Meet the Challenges of a Changing Climate

The Climate Resilience Toolkit provides resources and a framework for understanding and addressing the climate issues that impact people and their communities.

1. Identify the Problem
2. Determine Vulnerabilities
3. Investigate Options
4. Evaluate Risks & Costs
5. Take Action

Find Out How People Are Building Resilience

Forests to Faucets
Watch video ›

Building a Bridge to Reduce Risk
Watch video ›

Dune Migration and Shoreline Protection
Watch video ›

Louisiana's Front Line Defense from Storm and Surge
Watch video ›

http://toolkit.climate.gov/

Questions?

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