

CLIMATE CHANGE IN THE HEADWATERS WATER AND SNOW IMPACTS

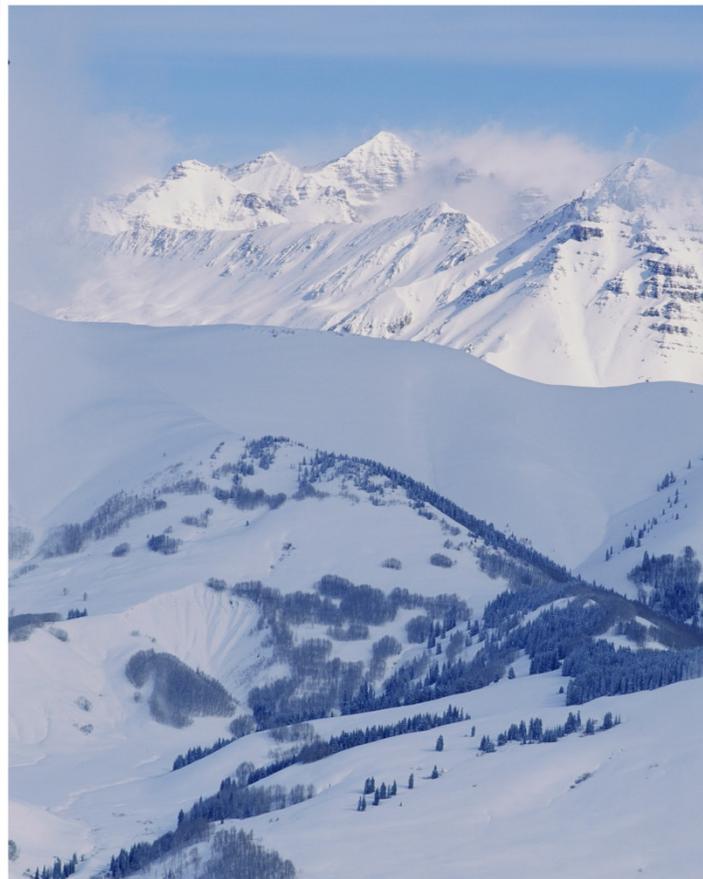
**Presentation to the
Northwest Colorado Council of Governments
Water Quality/Quantity Committee**

**Stephen Saunders
President, the Rocky Mountain Climate Organization**

**Tom Easley
Director of Programs, RMCO**

February 8, 2018

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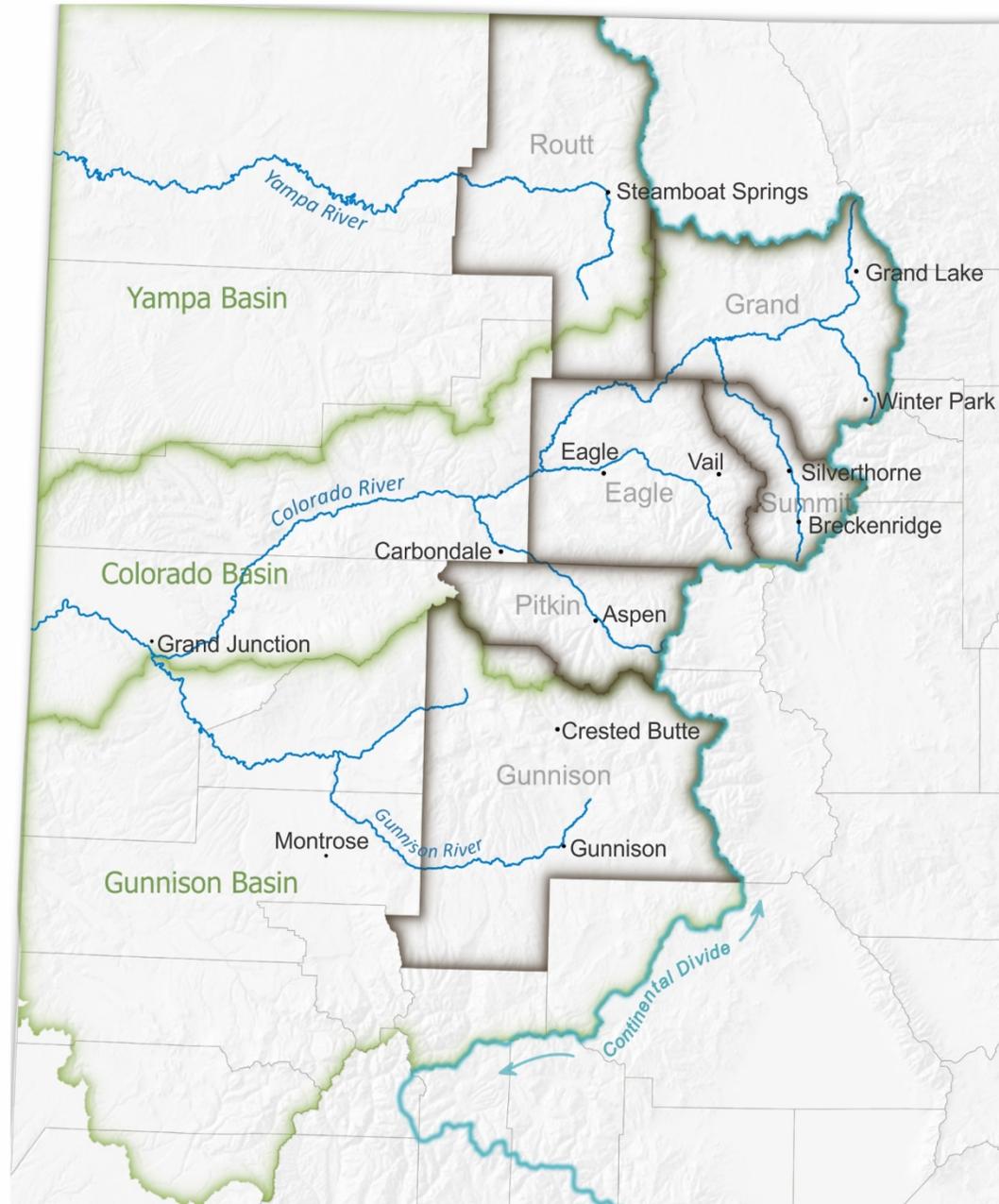


A report to the Northwest Colorado Council of Governments

the
**ROCKY
MOUNTAIN
CLIMATE**
Organization

Stephen Saunders
Tom Easley
2018

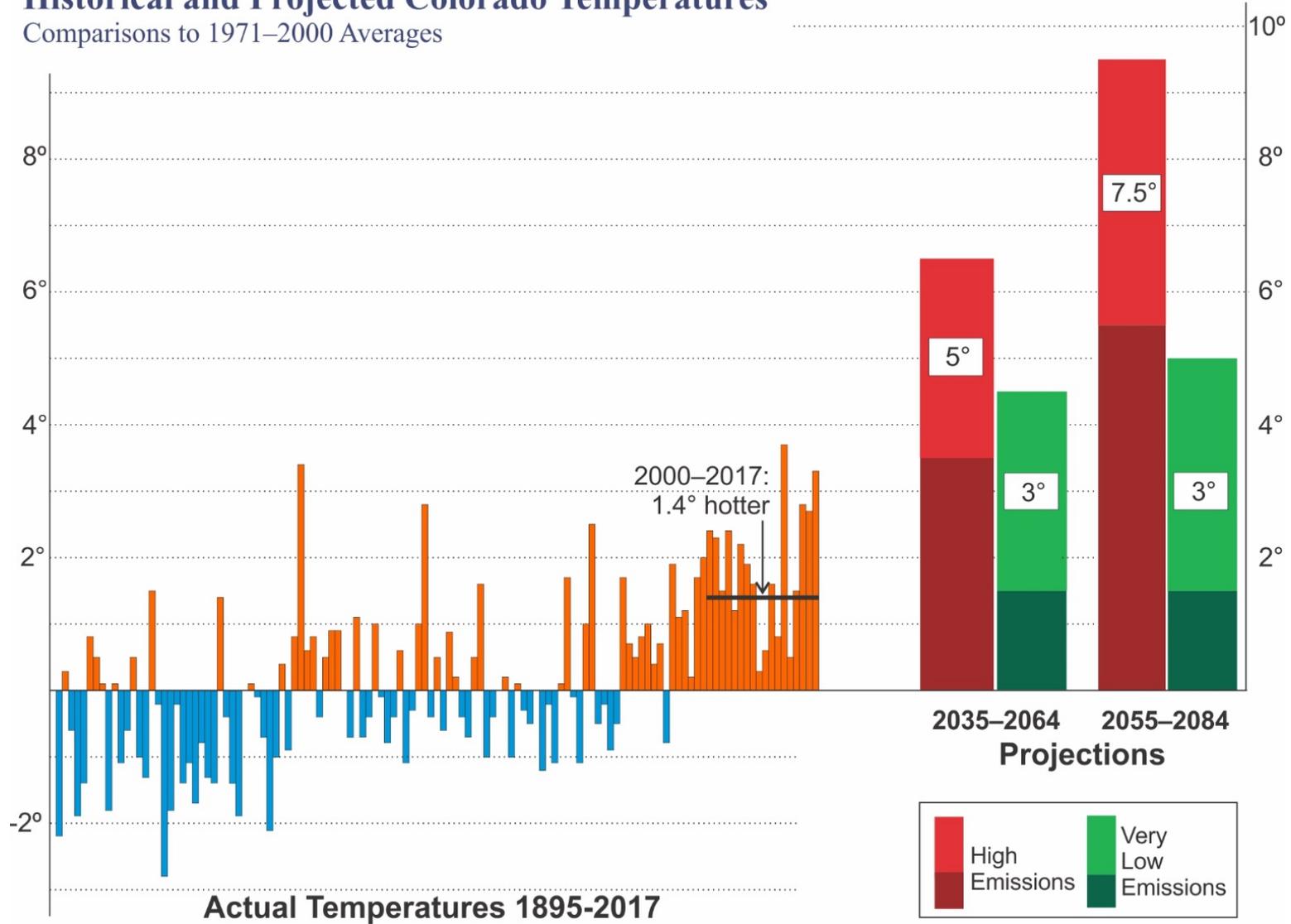
The Headwaters Counties



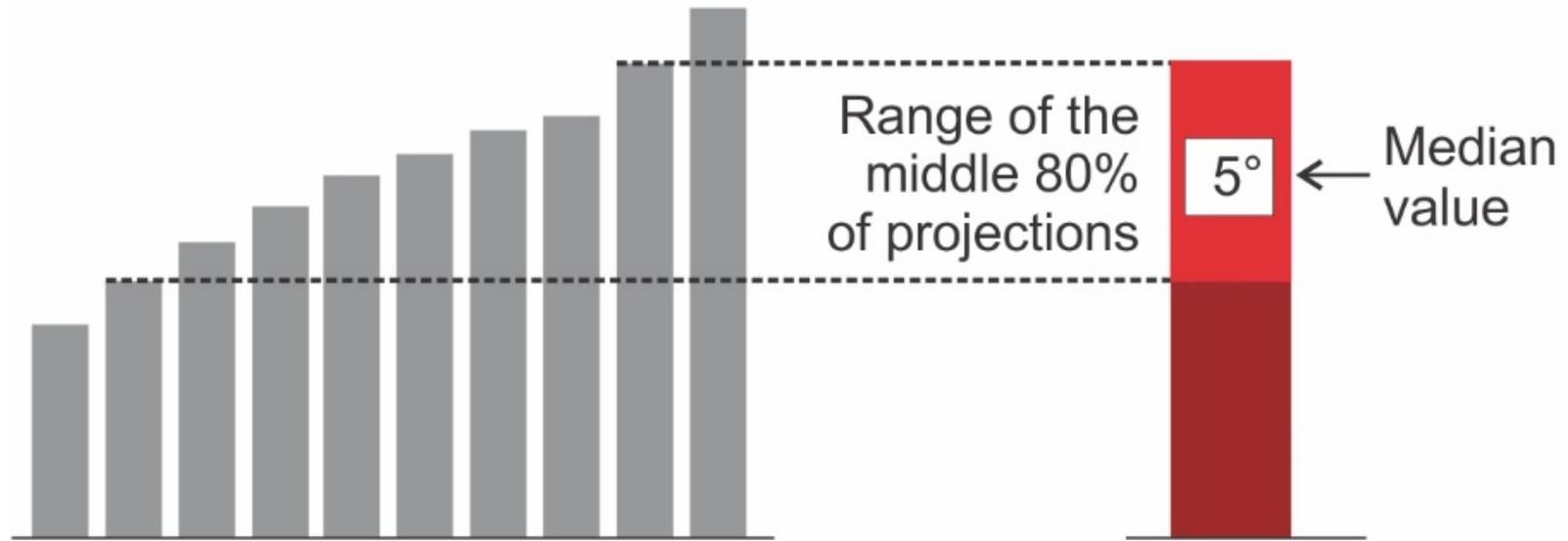
Temperature

Historical and Projected Colorado Temperatures

Comparisons to 1971–2000 Averages

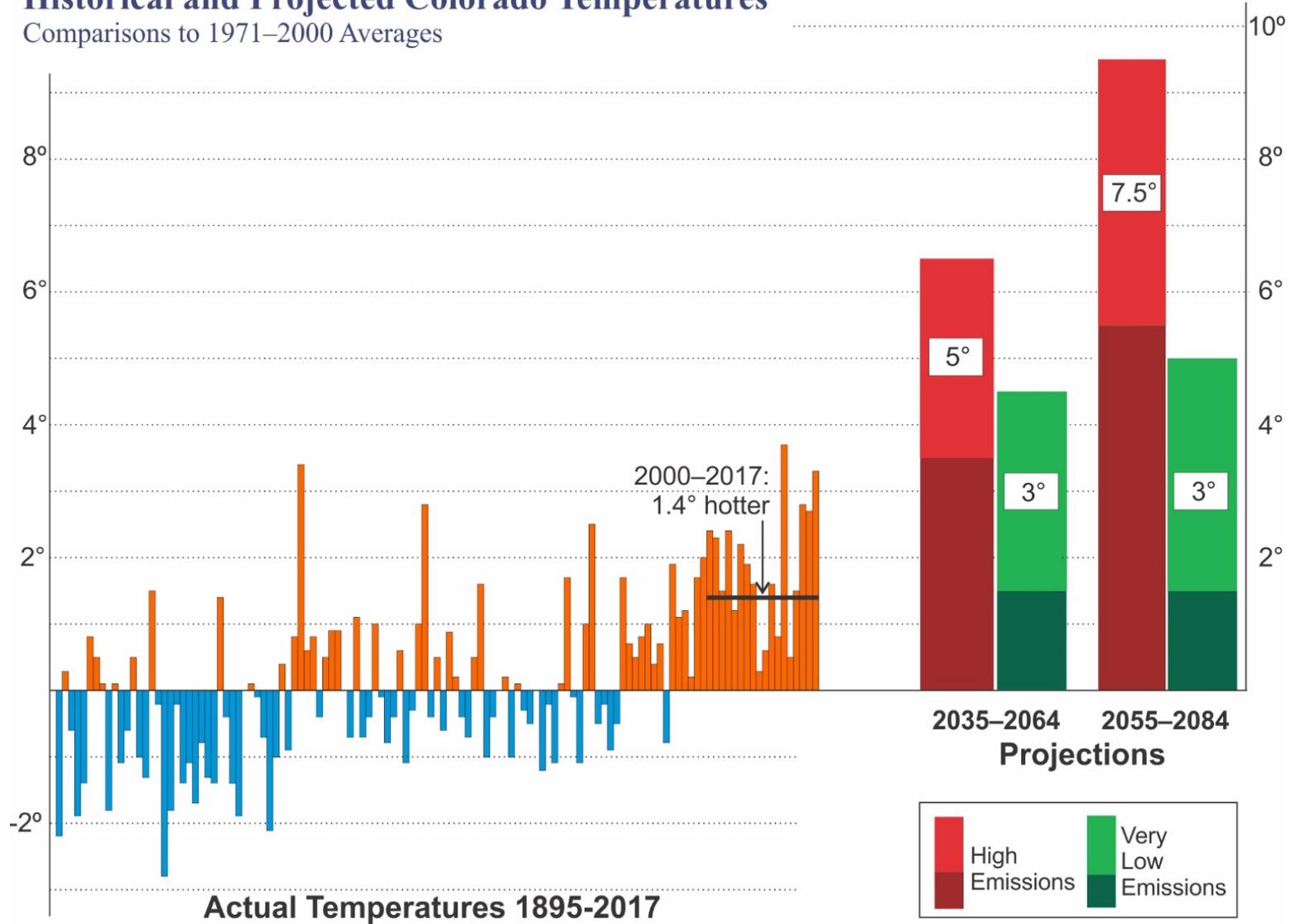


How Multiple Projections Are Represented Above

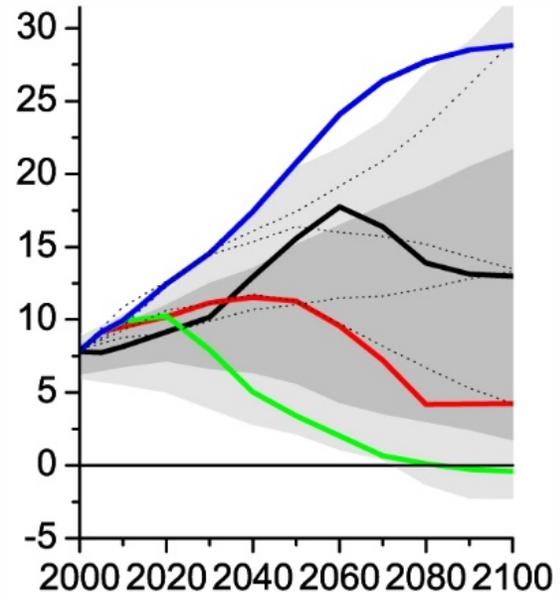


Historical and Projected Colorado Temperatures

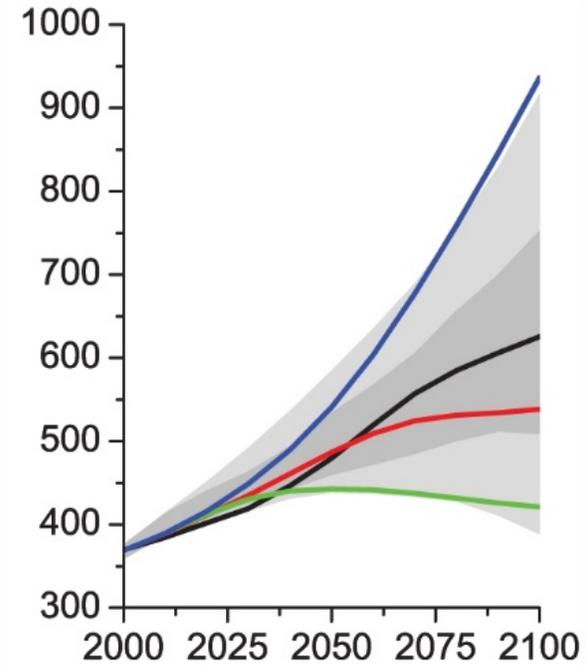
Comparisons to 1971–2000 Averages



Emission Scenarios



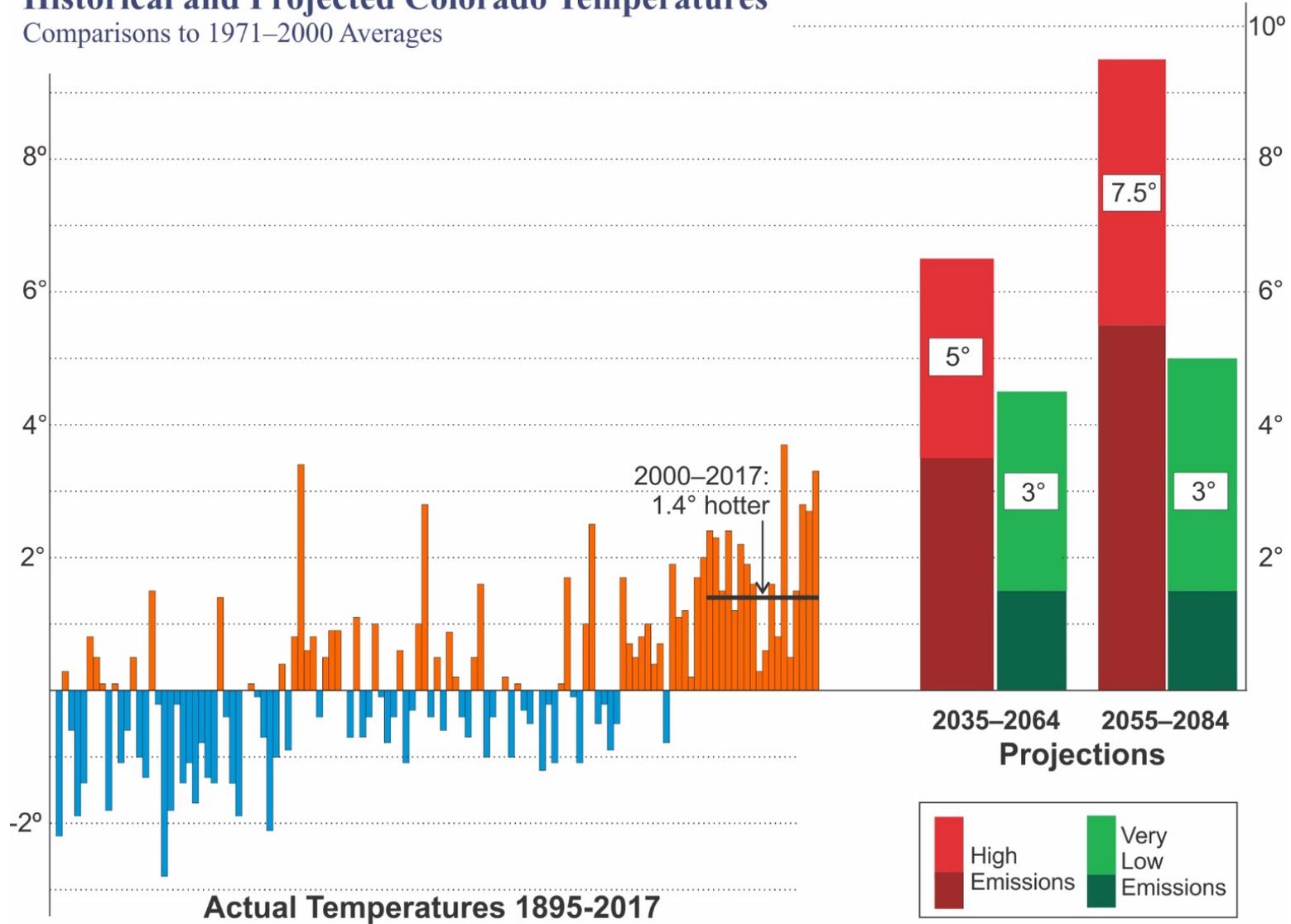
A. Annual Emissions of Carbon Dioxide



B. Atmospheric Concentrations of Carbon Dioxide

Historical and Projected Colorado Temperatures

Comparisons to 1971–2000 Averages



Projected Changes in Statewide Average Temperature

Comparisons to 1971–2000

<u>Time Period</u>	<u>High Emissions</u>	<u>Medium #1 Emissions</u>	<u>Medium #2 Emissions</u>	<u>Very Low Emissions</u>
2035–2064	+5° (+3.5° to +6.5°)	+3.5° (+2.5° to +4.5°)	+3° (+2.5° to +5°)	+3° (+1.5° to +4.5°)
2055–2084	+7.5° (+5.5° to +9.5°)	+5° (+3.5° to +7°)	+4.5° (+2.5° to +6.5°)	+3° (+1.5° to +5°)

Projected Changes in Local Average Temperatures

Results from five representative projections, comparisons to 1950–2005

<u>Time period</u>	<u>Grand Lake</u>	<u>Gunnison</u>	<u>Hayden</u>	<u>Yampa</u>
2025–2054	+3.4° (+1.6° to +5.0°)	+3.6° (+1.7° to +5.2°)	+3.5° (+1.7° to +5.1°)	+3.5° (+1.7° to +5.1°)
2055–2084	+6.1° (+3.9° to +7.5°)	+6.4° (+4.1° to +8.0°)	+6.2° (+4.1° to +8.0°)	+6.3° (+4.0° to +8.0°)

Precipitation

Projected Changes in Statewide Precipitation

Comparisons to 1971–2000 Averages

<u>Time Period</u>	<u>High Emissions</u>	<u>Medium #1 Emissions</u>	<u>Medium #2 Emissions</u>	<u>Very Low Emissions</u>
2035–2064	+2% (-3% to +8%)	+1% (-3% to +6%)	+1% (-6% to +6%)	+3% (-3% to +9%)
2055–2084	+1% (-7% to +9%)	+2% (-5% to +8%)	+3% (-4% to +8%)	+3% (-3% to +9%)

Water and Snow

What Has Happened

Snowfall vs rainfall

- West-wide: decreasing snowfall percentage at $\frac{3}{4}$ of sites

Snowpacks

- West-wide: decreasing
- Colorado: no trend

Snowmelt timing

- Colorado: peak flows 1-4 weeks earlier

Steamflow & water supplies

- Colorado River: higher temperatures now reduce flows

Water demand

- Colorado River: agriculture up 4%
- Colorado River: municipal & industrial up 57%
- Colorado River: evaporation up 35%

What Could Happen

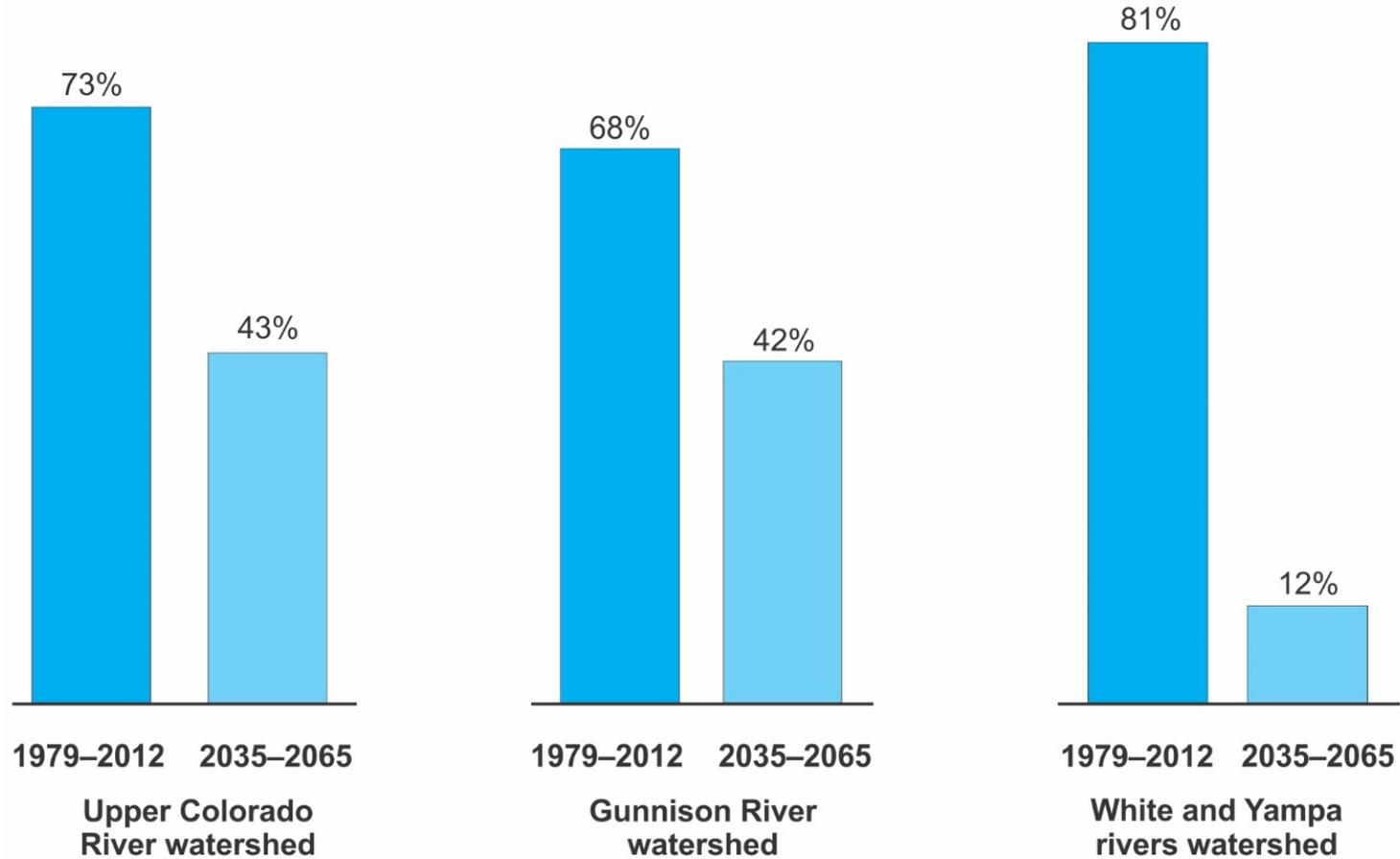
Water demand

CWCB study of Western Slope agriculture:

- For 2025–2054, an average of a 19% increase (8% to 29%)
- For 2055–2084, an average of a 32% increase (31% to 43%)

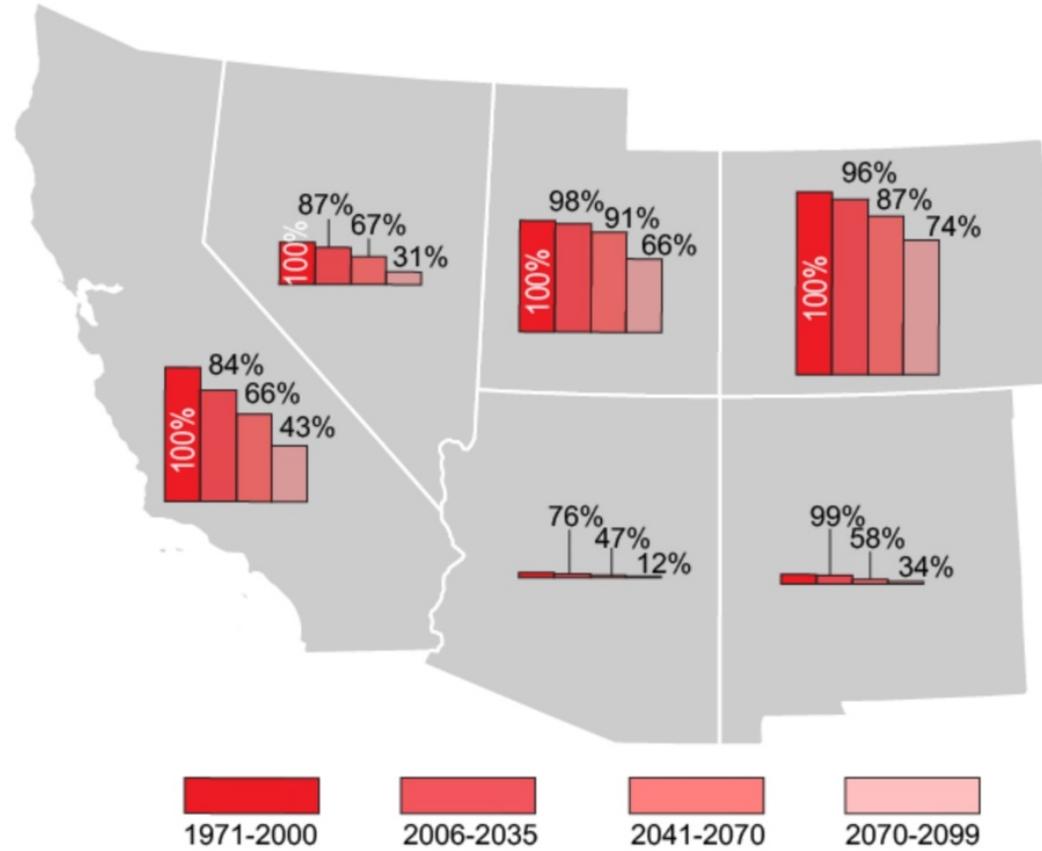
Snowfall as Share of Winter Precipitation

Projections with high emissions



Projected Snowpacks

Projections with medium-high future emissions, comparisons to 1971–2000



Water Shortages

What Could Happen

Colorado River

CWCB study of Western Slope agriculture:

- For 2025–2054, an average of a 19% increase (8% to 29%)
- For 2055–2084, an average of a 32% increase (31% to 43%)

What Could Happen

Colorado River

By 1999, water uses, losses, and deliveries reached 16 million acre-feet per year . . .

vs. 15 million acre-feet of average flow.

Projected Colorado River Flows, Upper Basin to Lower Basin

Projections for 3 alternative emission levels, comparisons to 1950–1999

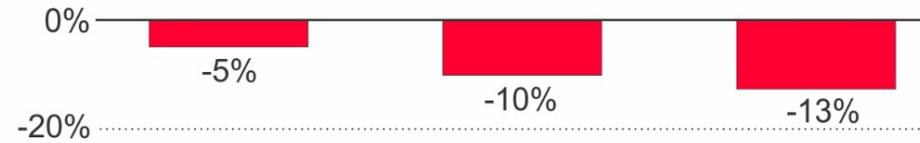
Emissions

2011-2040

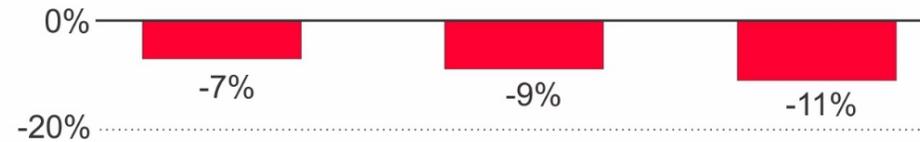
2041-2070

2066-2095

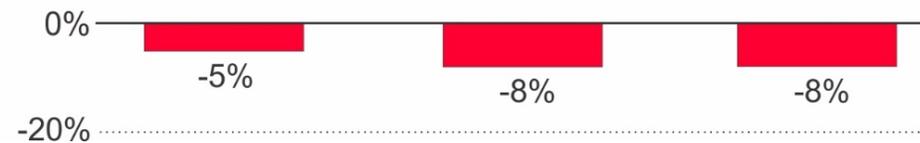
Medium-High



Medium



Medium-Low



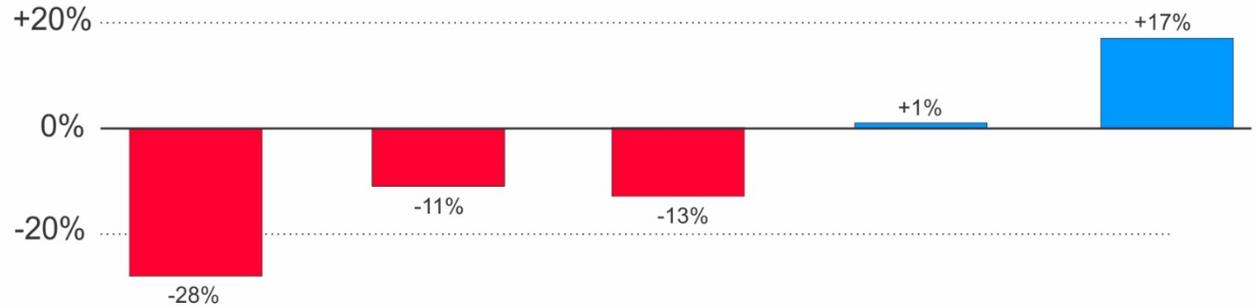
Projected Colorado River Flows, Colorado to Utah

Projections for 5 representative possible futures, comparisons to 1950-2005

<u>Time Period</u>	<u>Projection #1</u>	<u>Projection #2</u>	<u>Projection #3</u>	<u>Projection #4</u>	<u>Projection #5</u>
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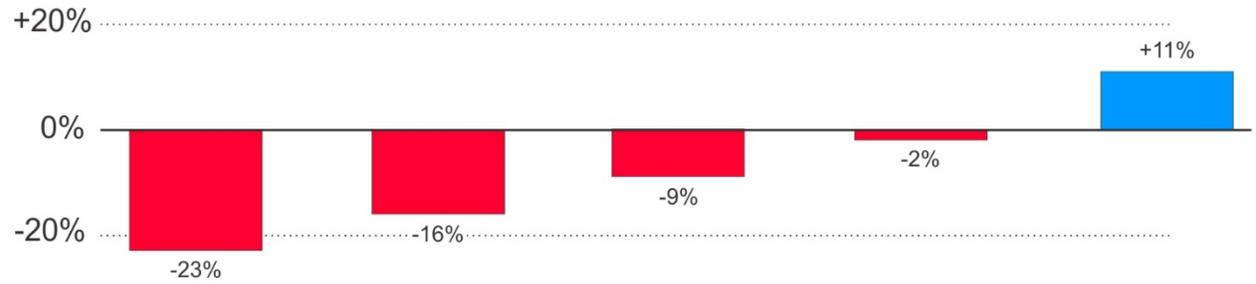
2025-2054

Average projection: -4%



2055-2084

Average projection: -8%



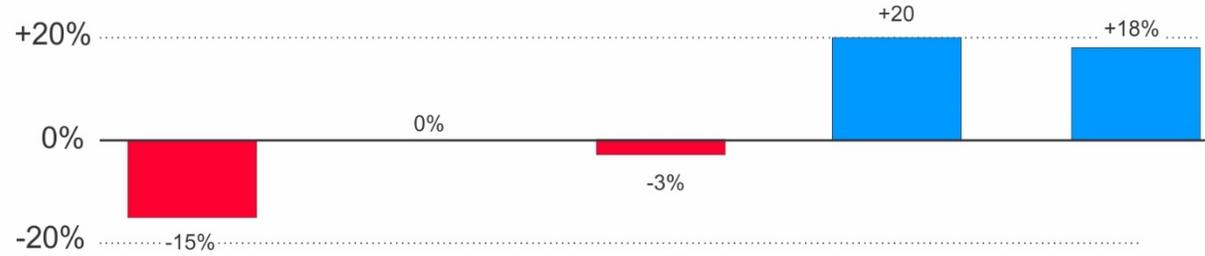
Projected Yampa River Flows, Colorado to Utah

Projections for 5 representative possible futures, comparisons to 1950-2005

<u>Time Period</u>	<u>Projection #1</u>	<u>Projection #2</u>	<u>Projection #3</u>	<u>Projection #4</u>	<u>Projection #5</u>
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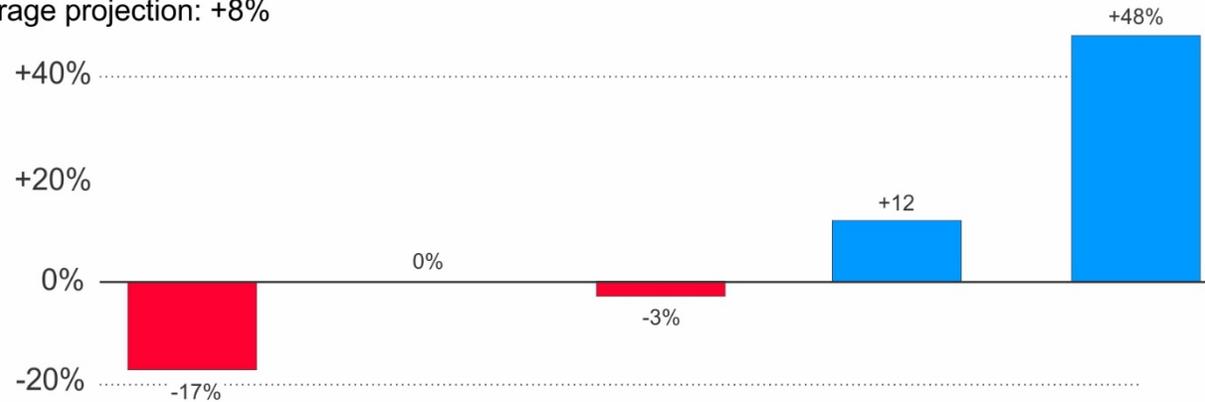
2025-2054

Average projection: +4%



2055-2084

Average projection: +8%



Winter Recreation & Tourism

What Could Happen

Aspen assessment

Medium emissions:

By 2030, snow accumulation at top of Aspen Mountain delayed two weeks, at base by one week.

By 2100, snow accumulation at the top delayed four weeks.
Opening, delayed to mid-December.

High emissions:

By 2100 “skiing in Aspen could be a thing of the past.”

What Is At Stake

Greatest concentration of skiing in the nation. The headwaters counties have 7 of 10 most visited ski resorts in nation.

Statewide, \$4.8 billion in economic activity.

Declining real estate values:

National, 44% to 55%

Colorado, 14%

Warm-Season Recreation & Tourism

What Could Happen

Declines in:

- Fishing
- Rafting
- Boating

What Is At Stake

Statewide, outdoor recreation supports:

- \$28.0 billion in consumer spending
- 229,000 direct jobs

Water Quality

What Could Happen

Projected wildfire increases in Colorado:

- End of century, 5x more frequent wildfires. High emissions, 15x more frequent.
- By 2070, 3-6x increase in area burned.
- 1.8° increase in temperature leads to 7x increase in area burned.
- Mid-century, 3x increase in area burned.
- Late century, 2x increase in area burned.

Result:

- Increased flooding and sedimentation

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