Assessment of Impacts of Climate on New Mexico Water Resources over the Next 50 Years

A Foundation for the New Mexico 50 Year Water Plan

A collaboration between two state-funded agencies

New Mexico Bureau of Geology and Mineral Resources
New Mexico Tech
Earth Science for the 21st Century

Office of the State Engineer
nm
Interstate Stream Commission

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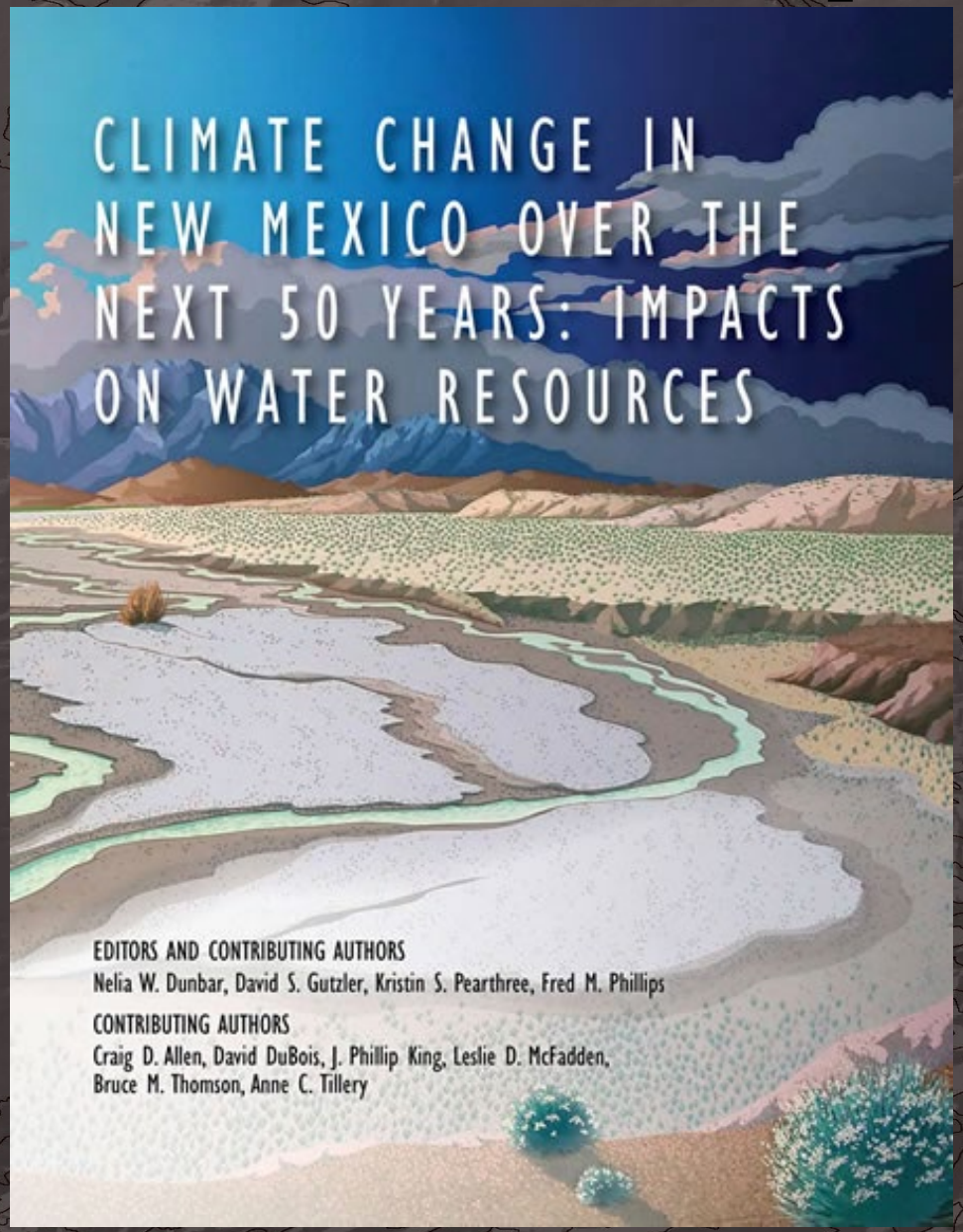
The report is available!



Free PDF download
https://geoinfo.nmt.edu/ClimatePanel/report/

Or…

Search for: Bureau of Geology climate report

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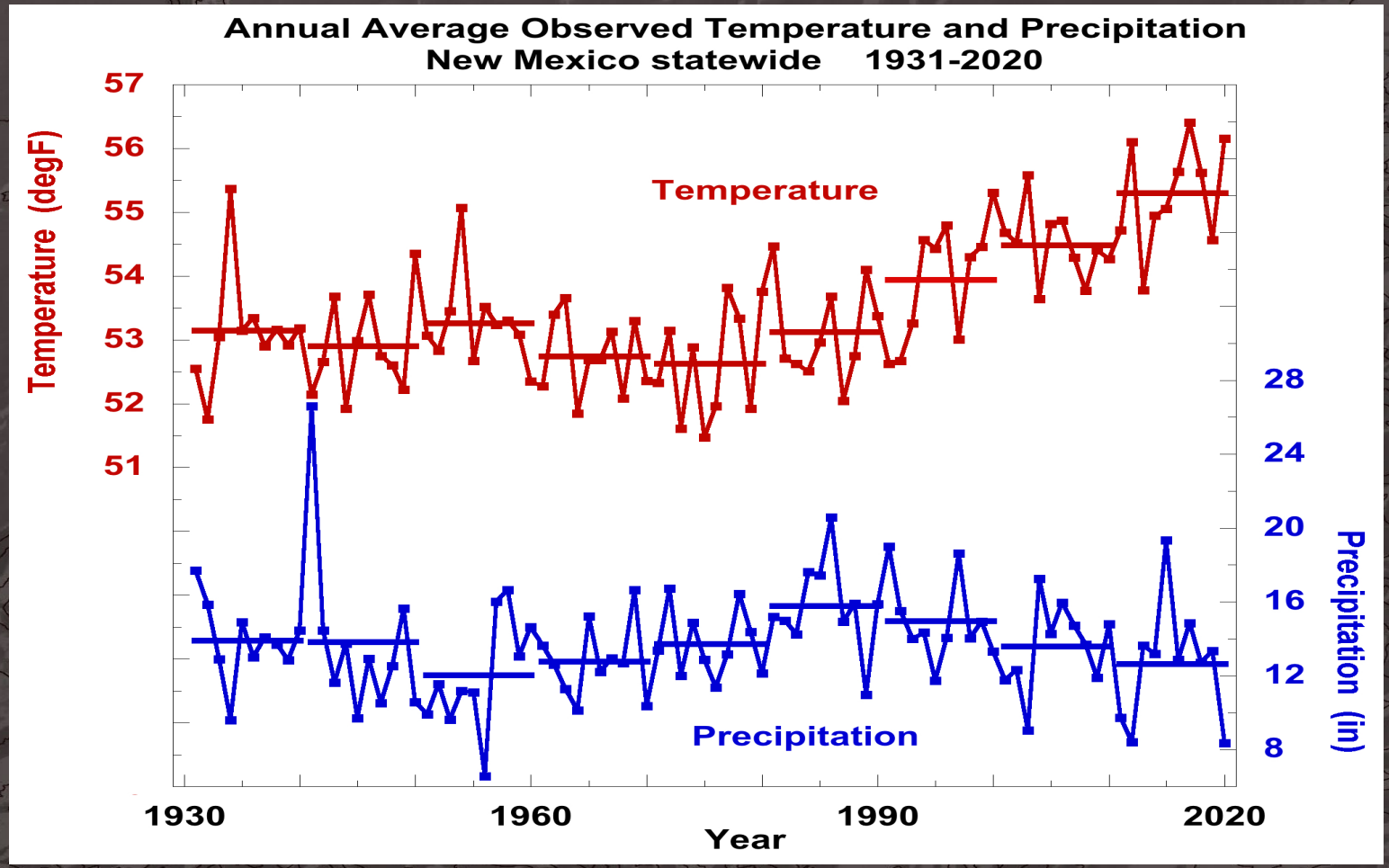
Why do we need this?

New Mexico's climate is warming

A new 50-year water plan for the state must account for ongoing and future changes to our climate and water resource reliability



Decade-average temperatures have been climbing steadily for the past 50 years

Precipitation has no clear trend but is hugely variable, annually and decadally
4 of the 5 driest years since 1930 have occurred in the past two decades

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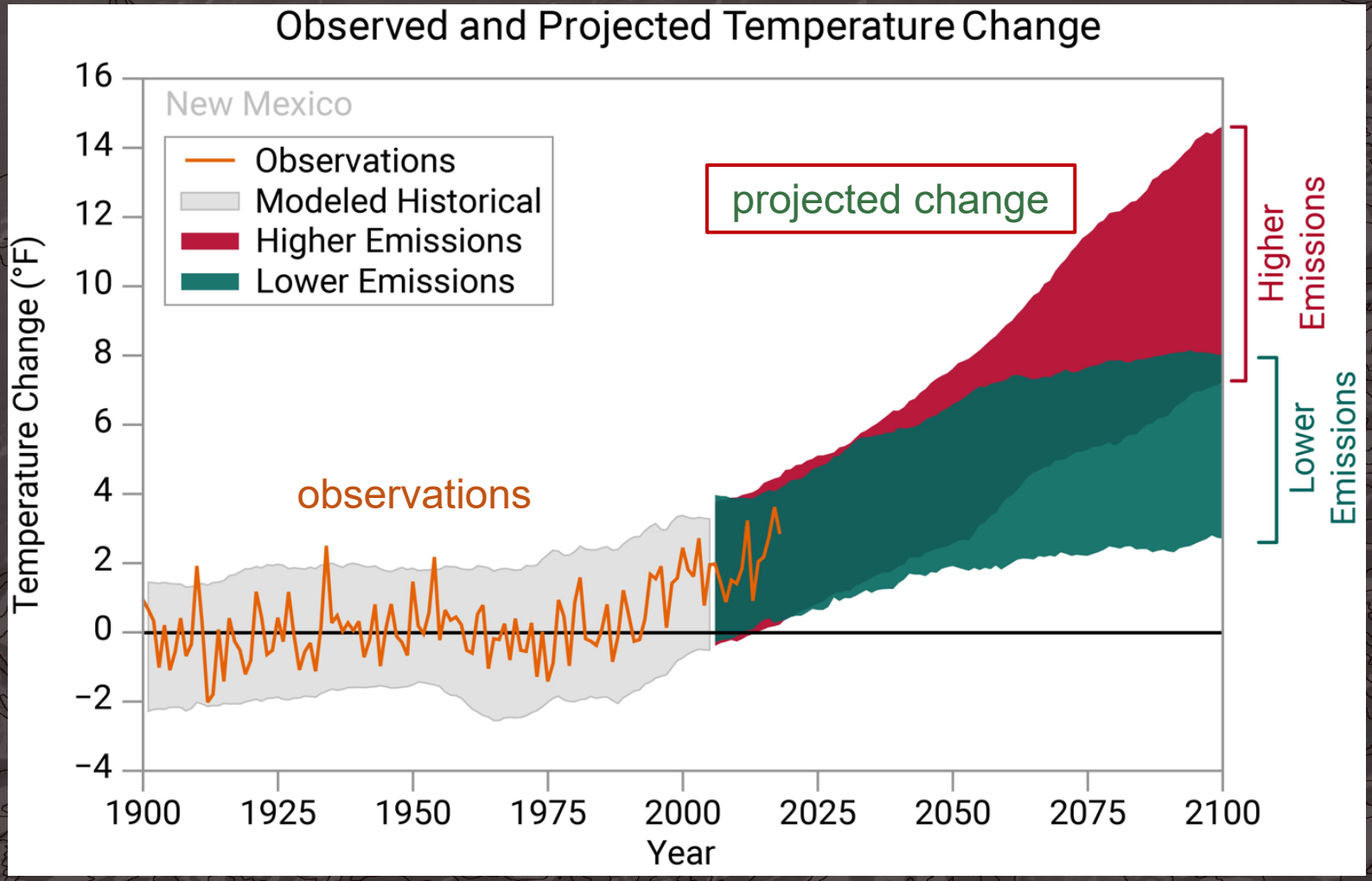
New Mexico's climate will continue to warm in response to increasing concentrations of atmospheric greenhouse gases



Red and **green** bands represent future temperature increases in NM projected by an ensemble of climate models, in response to **higher** or **lower** rates of future greenhouse gas emissions

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Climate change is impacting New Mexico's water resources in multiple ways

- Lower streamflow and recharge because of increased aridity
- Greater interannual variability in precipitation
- Hotter, more severe droughts
- Decreasing snowpack → earlier and diminishing snowmelt runoff
- Greater demands on groundwater
- Vegetation stress
- Increasing catastrophic forest fires
- Increasing flooding/sediment transport
- Irreversible damage to soils through loss of vegetation and erosion
- Degraded quality of surface waters

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An experienced team of New Mexico research experts was assembled to work together, to assess the state of knowledge and develop a review report

- Dave Gutzler (climatologist)
- Fred Phillips (hydrologist)
- Craig Allen (ecologist)
- Dave DuBois (climatologist)
- Phil King (civil engineer)
- Les McFadden (soil scientist)
- Bruce Thomson (environmental scientist/engineer)
- Anne Tillery (surface systems specialist)

Ground rules of the study

→ Assess and synthesize recent scientific literature on climate, hydrology, and impacts of these changes

- Future climate projections
- Changes to the surface water budget
- Ecological dynamics
- Landscape change/fires/erosion
- Extreme precipitation and flooding
- Soils
- Water supply
- Water quality

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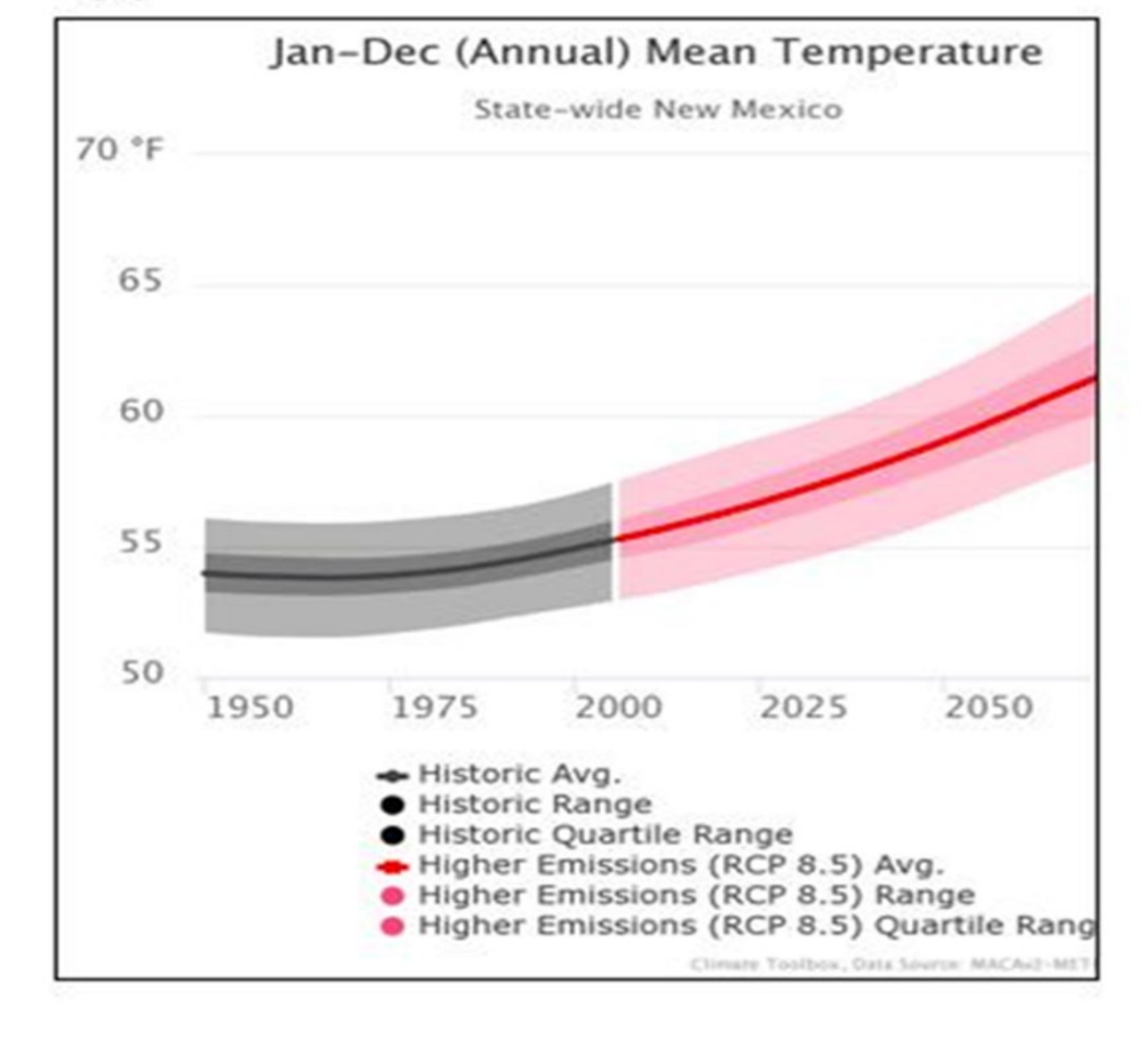
Future Climate Projections- Higher Emission Scenario



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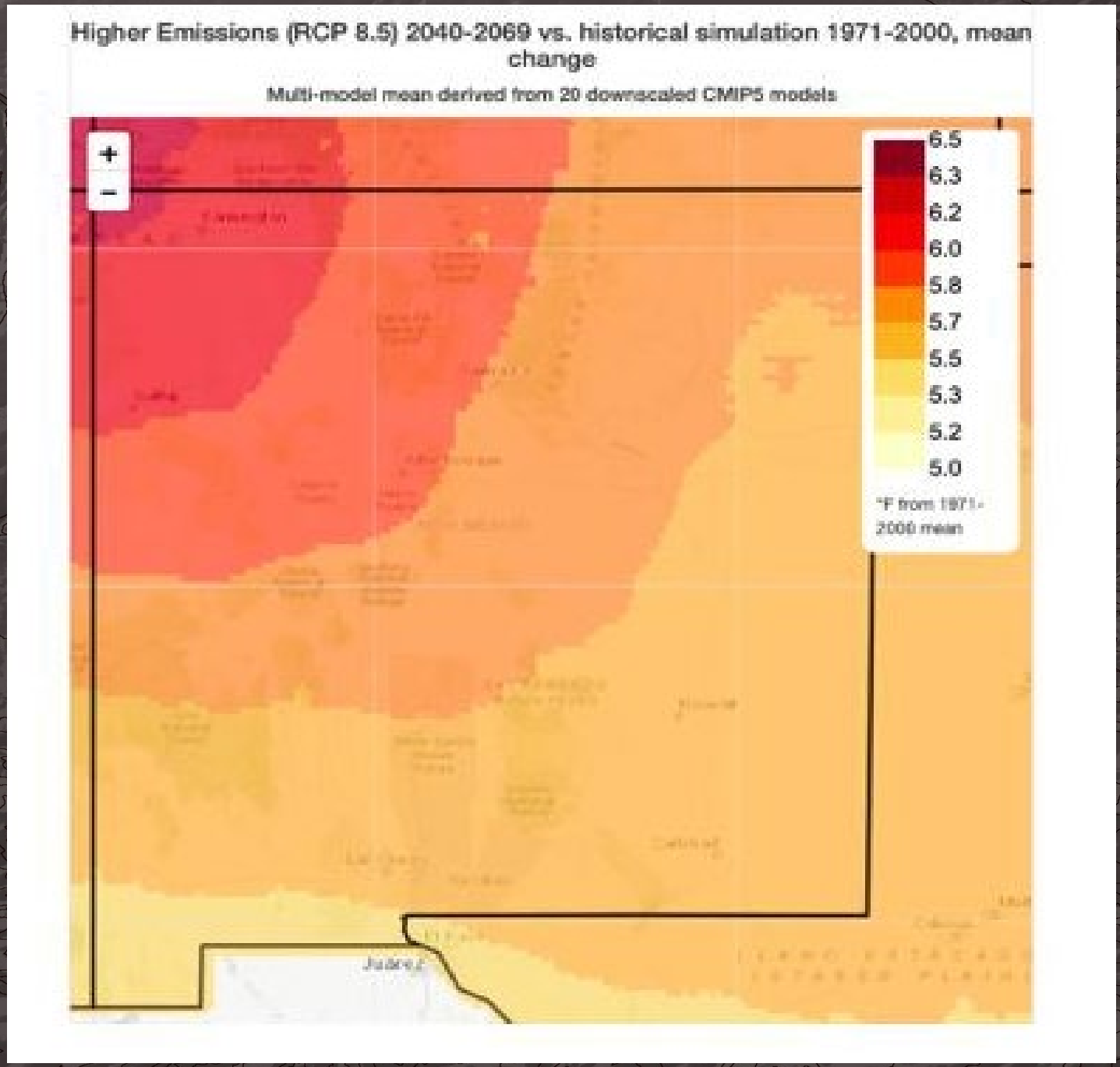
Warming everywhere. Temperature rise non-uniform across the state of New Mexico

Bootheel is around a decade behind the NW corner



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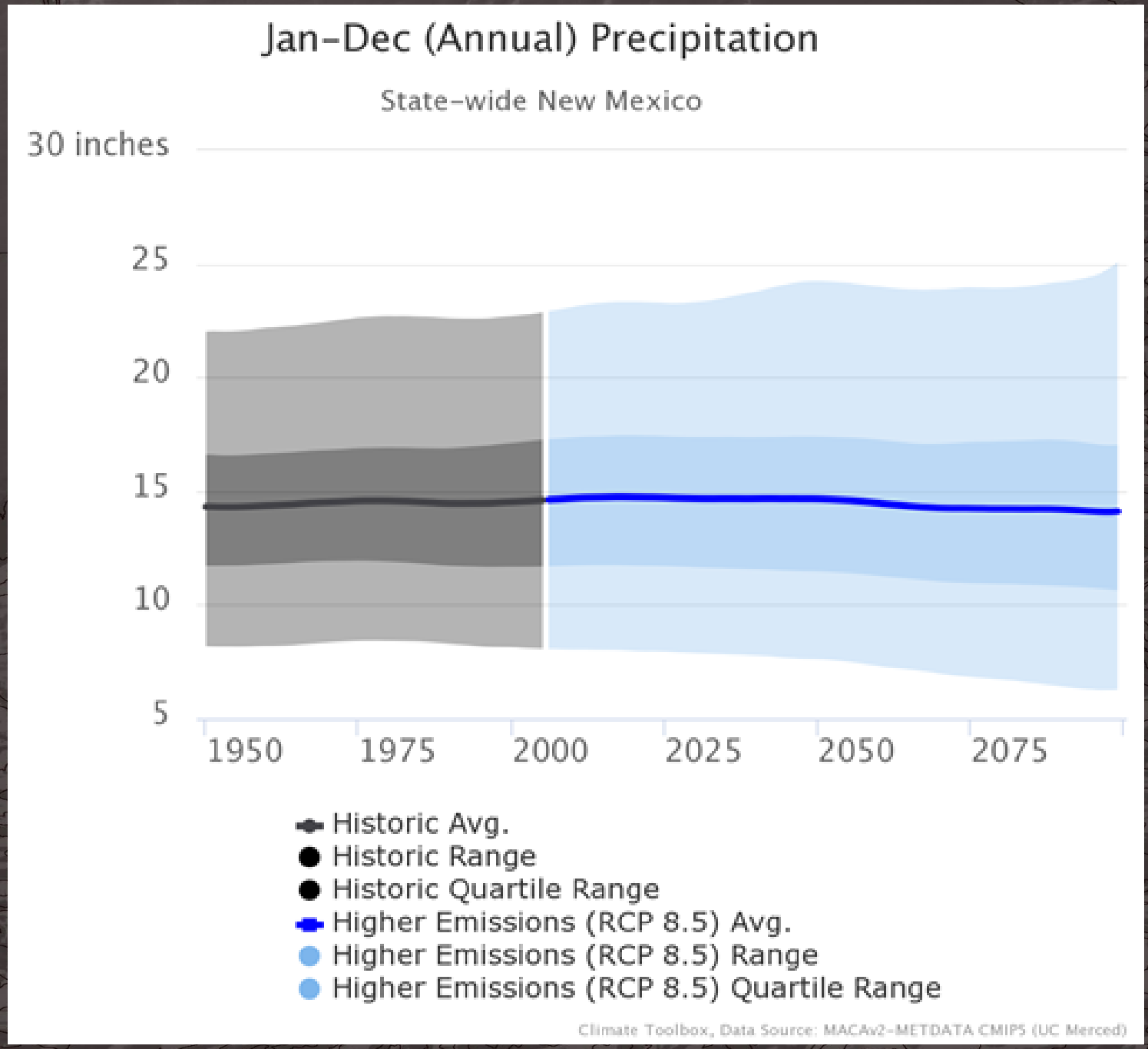
Average Precipitation



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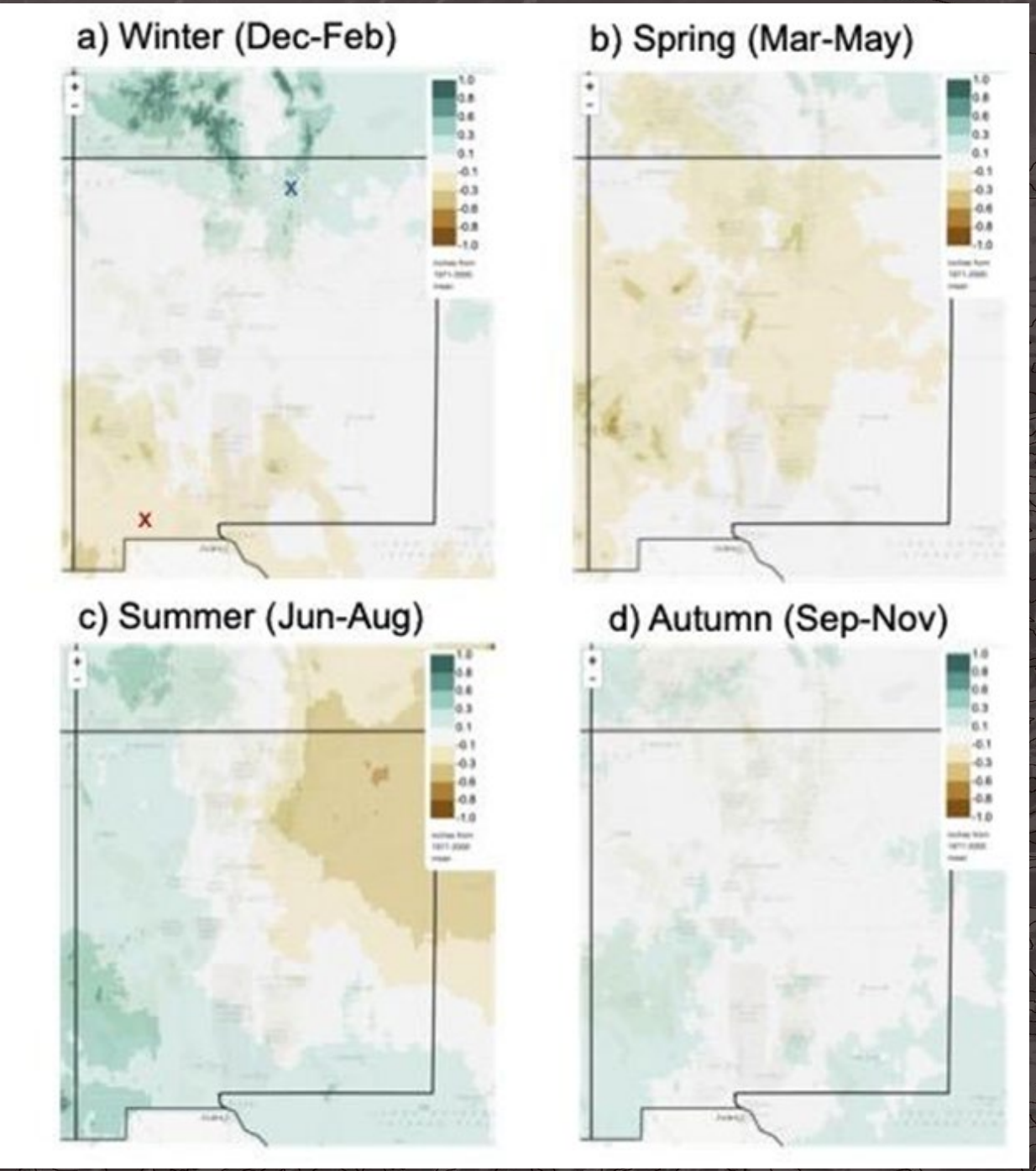
Season/Geographical Distribution of Precipitation

Green=More
Brown=Less



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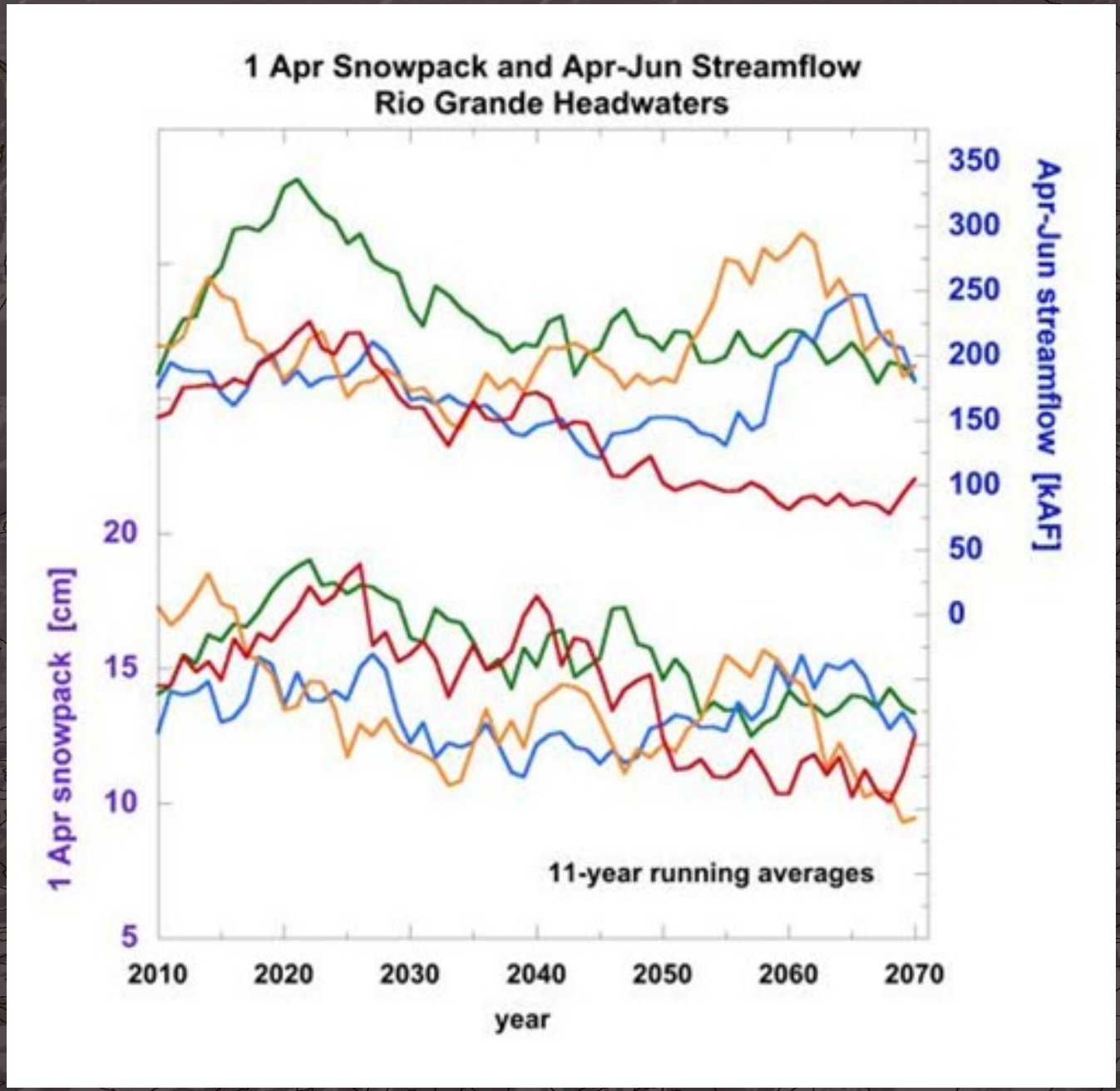
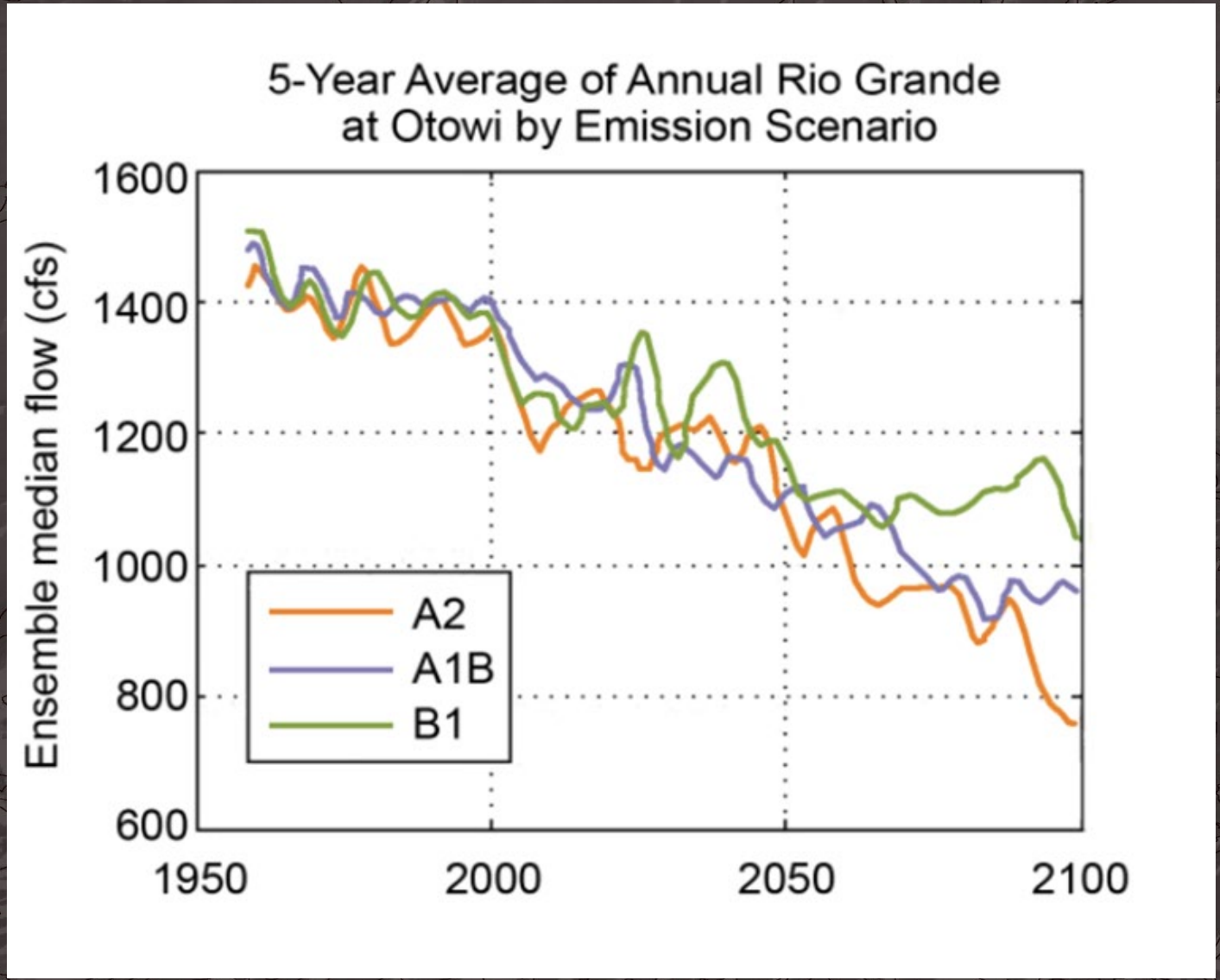
Snowpack and spring streamflow will decline

Different colored lines represent 4 individual simulations that show range of future projections



Runoff

- Rio Grande flow has decreased 4% per decade (at Otowi) since 1997



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Extreme Precipitation

- Based on increased atmospheric moisture and temperature, more extreme precipitation events would be expected.
- Record over past 20 years is notably variable, so difficult to use past data to predict future behavior

Photo by Dana Ulmer-Scholle

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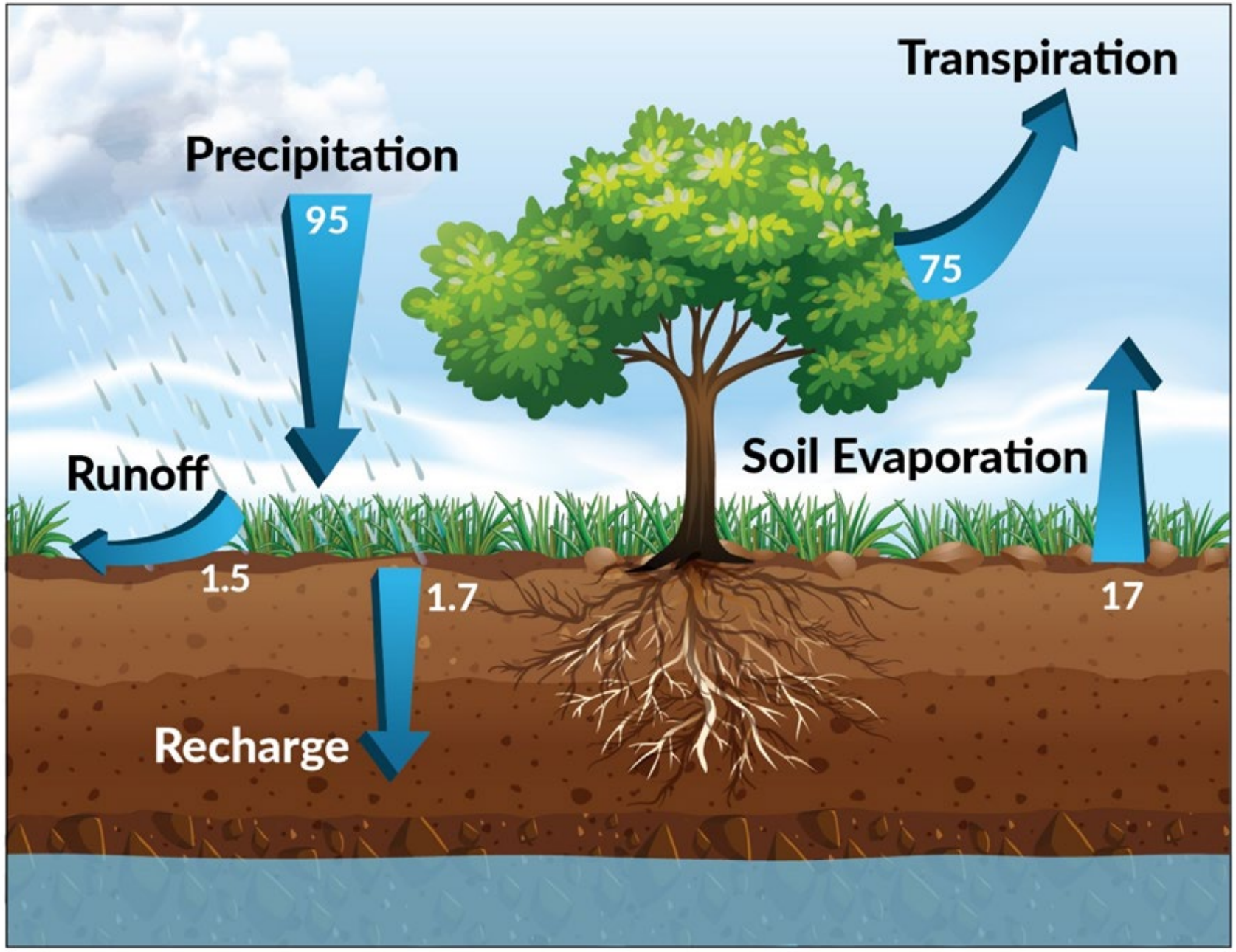
Land-surface water budget in New Mexico's arid climate

Numbers represent millions of acre-feet per year



Even with no trend in precipitation, New Mexico will become more arid because of increasing air temperature

- The amount of water that air can "hold" goes up as the air temperature rises (a ~2°F increase in temperature allows air to hold 7% more water vapor).
- Liquid water will be lost more rapidly from leaves and soil.
- Dry soil "sucks in" precipitation faster than wet soil, causing less runoff and recharge.

Aridity Increases → More Severe Droughts

Recharge

- Difficult to model in our arid environment
- Models estimate declines, but high degrees of uncertainty
- Declines observed in water level in many New Mexico aquifers, but difficult to separate declining recharge from pumping effects
- Despite uncertainties in future projections of both recharge and runoff, indications are towards less of both, largely due to increased evapotranspiration due to warmer air temperature.

Ecological Dynamics

- Hotter, drier conditions stress vegetation
- Additional tree mortality, moved forward by disease and insects

Increased incidence of catastrophic wildfires, may lead to landscape change, which can make plant recolonization challenging

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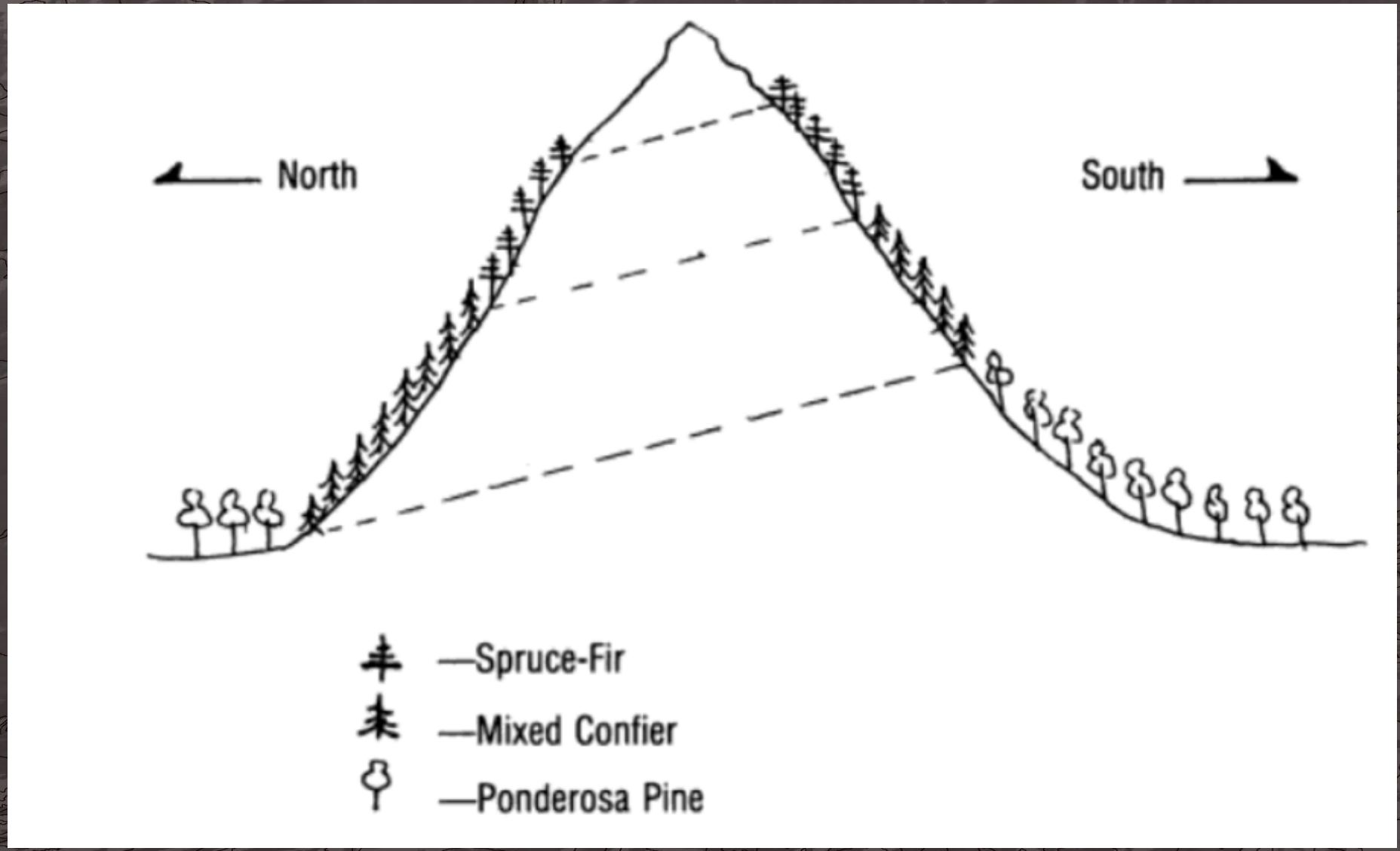
Vegetation gradually migrates upward or northward



Landscape Changes

- Changes in climate result in landscape changes, accelerated by wildfire effects

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Landscape changes that can result from climate change or be accelerated by wildfire

- Increased overland runoff and flooding
- Increased upland erosion/downstream sedimentation
- Mountainous areas will be most impacted
- Arroyo formation in low relief parts of the state
- All of these impacts disrupt normal drainage systems and damage infrastructure.

Soils

- Soils form slowly, but can be destroyed quickly by climate change or wildfire.
- Healthy soils promote infiltration of water into aquifers as well as reducing dustiness in some parts of the state

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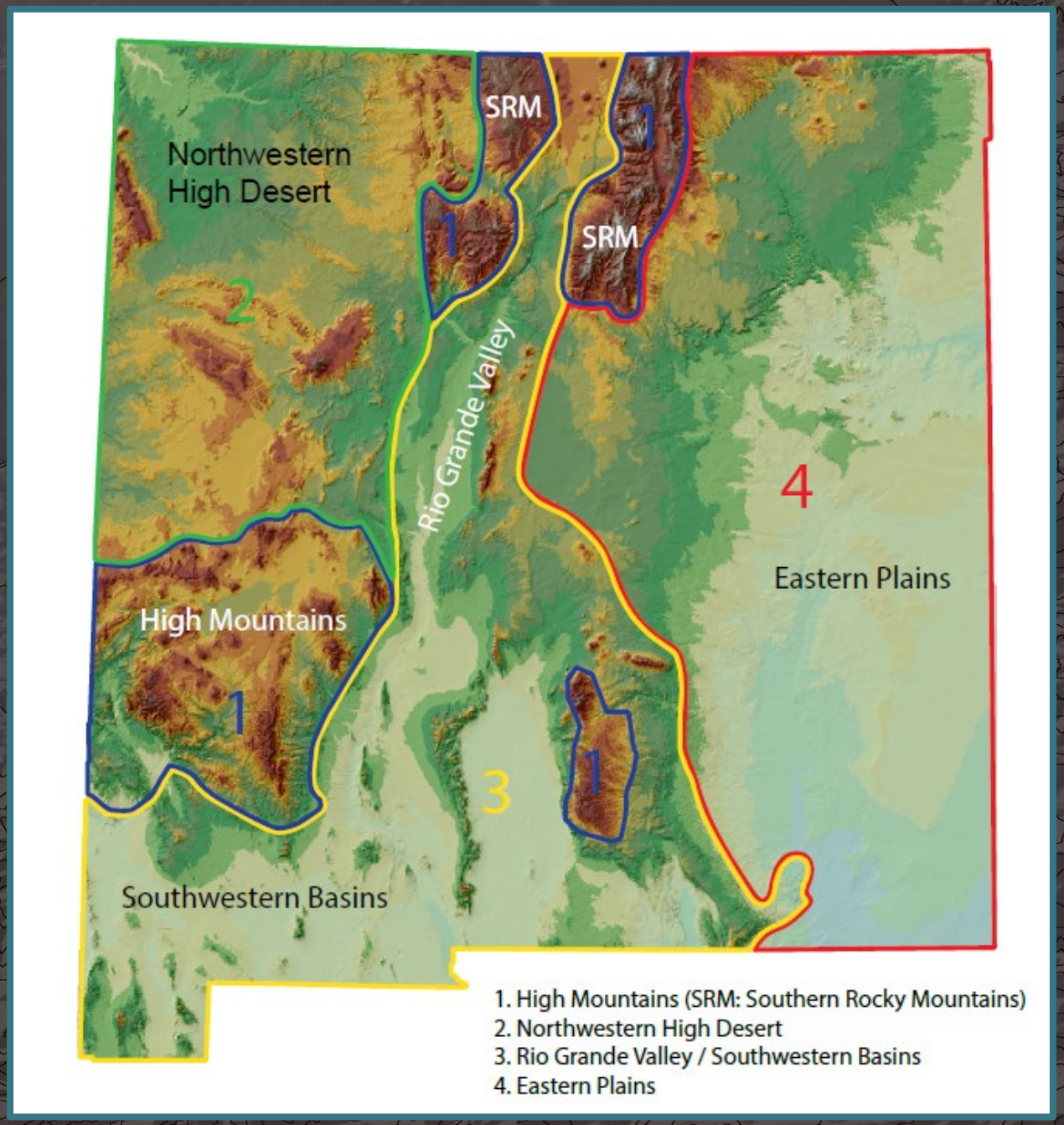
Chapter X. Summary of State-Wide and Regional Impacts of Climate Change on Water Resources

Image from outlookmaps.com

The panelists identified sections of the state where impacts are likely to be similar.

Within these broad regions, there may also be elevation- and topographically related variations.

- High Mountains
- Northwestern High Desert
- Rio Grande Valley/Southwestern Basins
- Eastern Plains



Dominant Impacts by Region

- High Mountains
  - Will be most impacted by climate change, and impacts will be felt throughout the state. Less snowmelt and higher evapotranspiration
  - Changes to plant communities and increased wildfire will be felt not only in the mountains, but also in “downstream” areas
- Northwestern High Desert
  - Loss of soil
  - Increased dustiness
  - Increased arroyo incision
  - Possible transition from grasses to shrubs

Dominant Impacts by Region

- Rio Grande Valley/Basin and Range
  - Lower river flows (25% lower flow in Rio Grande in 50 years), changes in timing of runoff, trending earlier
  - Greater loss of water from reservoirs (with a 5 degree temperature increase, Elephant Butte will lose 2 additional feet of water per year
- Eastern Plains
  - Extreme precipitation events
  - Loss of soil, increased desertification
  - Increased dustiness

Chapter XI. Data Gaps and Research Directions

PRECIPITATION

- Further assessment of extreme precipitation and seasonality of precipitation
- Better understanding of snowmelt runoff

MODELS

- Fine-tuning local climate models, allowing determination of the most probable climate outcomes, as well as better understanding of clouds in GCMs
- Calibrated hydrological model for recharge and runoff specifically for NM
- Simpler vegetation dynamics models that incorporate disturbance processes

OBSERVATIONAL DATA GAPS

- Quantitative and geographically distributed measurements of NM aquifer water levels and public accessibility of such data
- Soil moisture
- Impact of climate change of water quality
- Hydrological response to watershed vegetation changes
- Timing of landscape readjustment to climate disturbance
- Studies of soil, plant communities, and landscape characteristics in high elevation mountain ranges where recharge and runoff occur
- Long-term ecological monitoring and research to understand response of NM ecosystems to climate change, and associated ecohydrological reponses

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Questions?

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https://geoinfo.nmt.edu/ClimatePanel/home.html

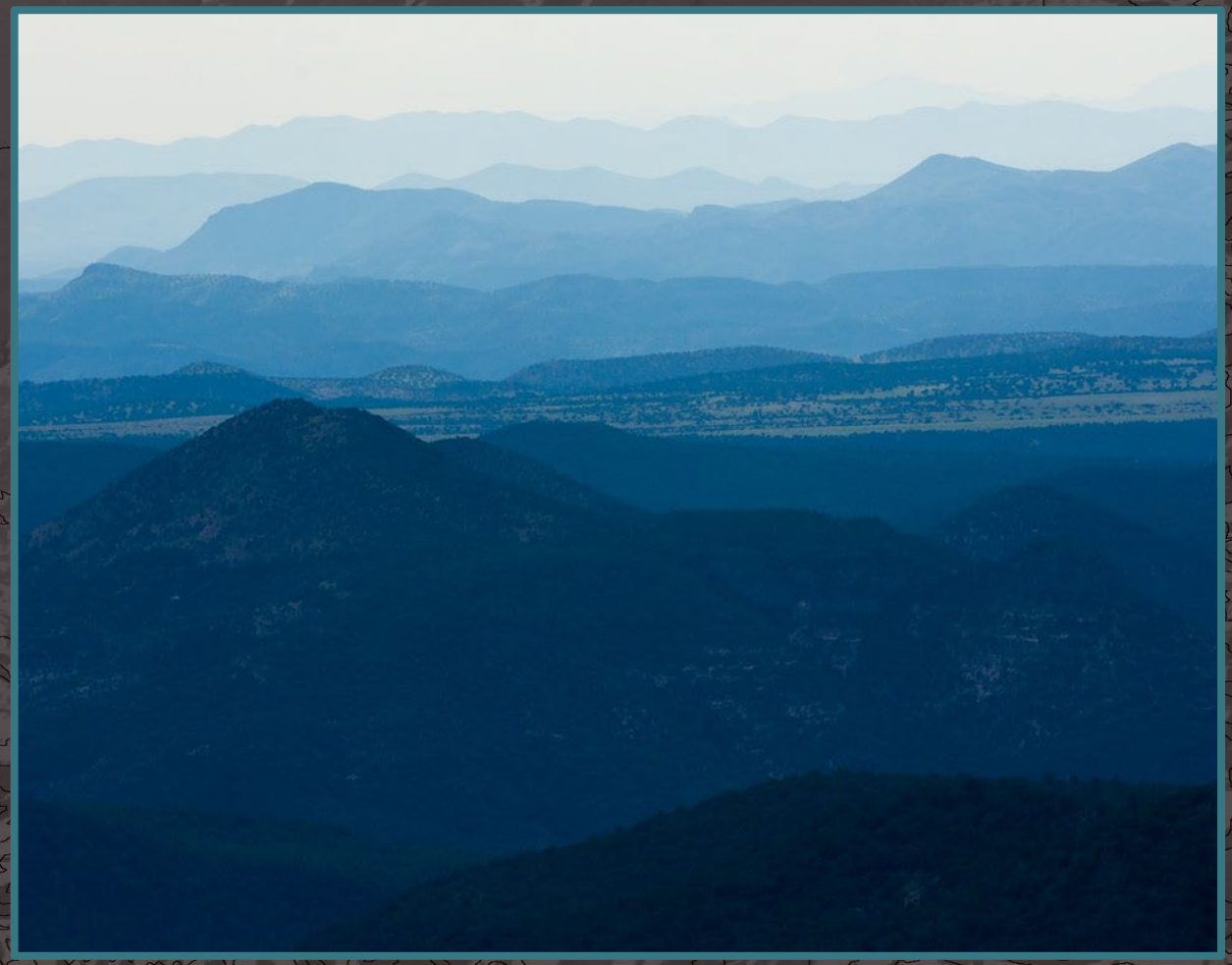

Photo by Matthew Zimmerer