COLORADO

Climate Adaptation

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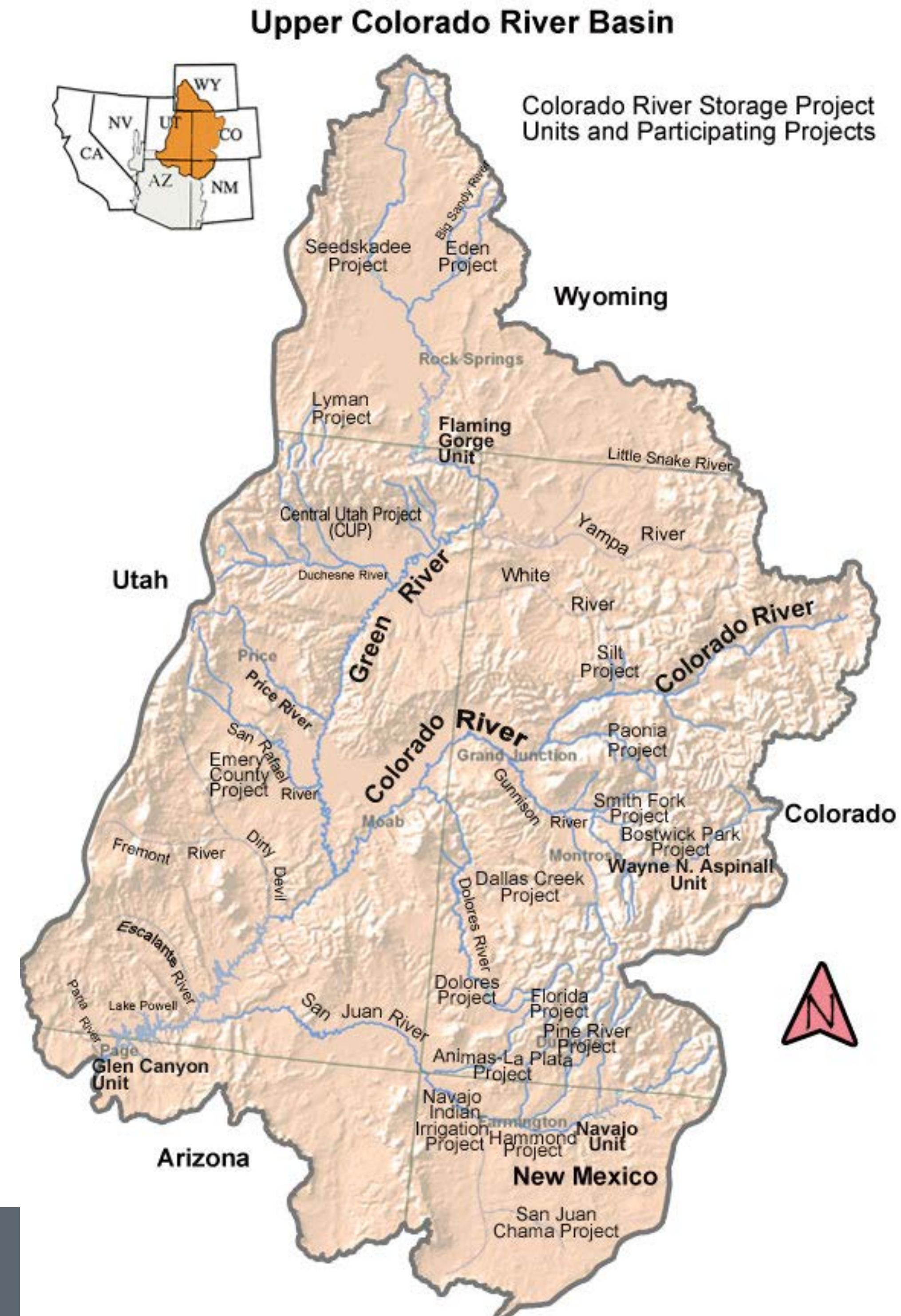
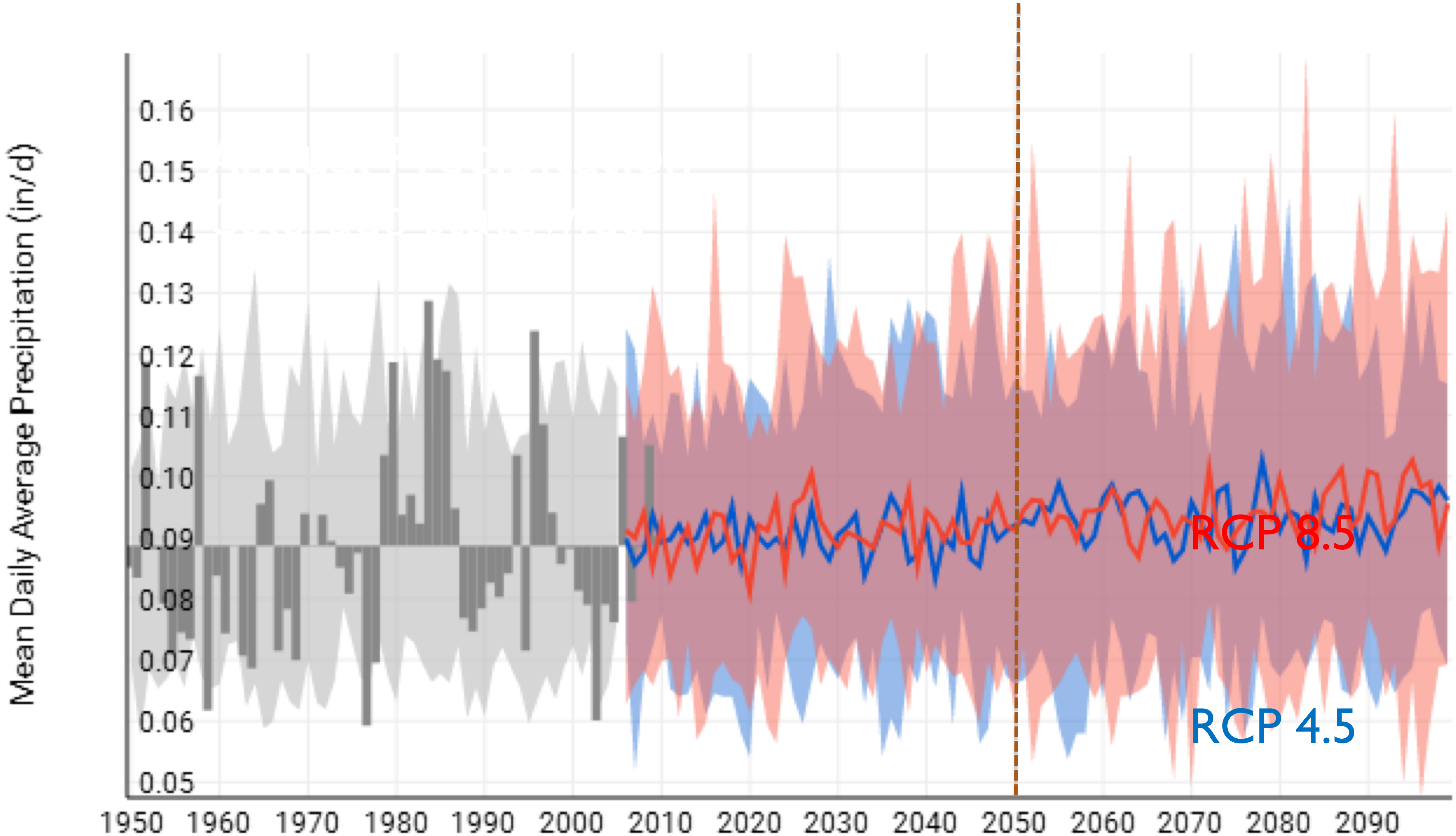
The Upper Basin

- Snowmelt driven
- Peak runoff in May or June
- Cooler avg. annual temperatures
- Better beer ☺

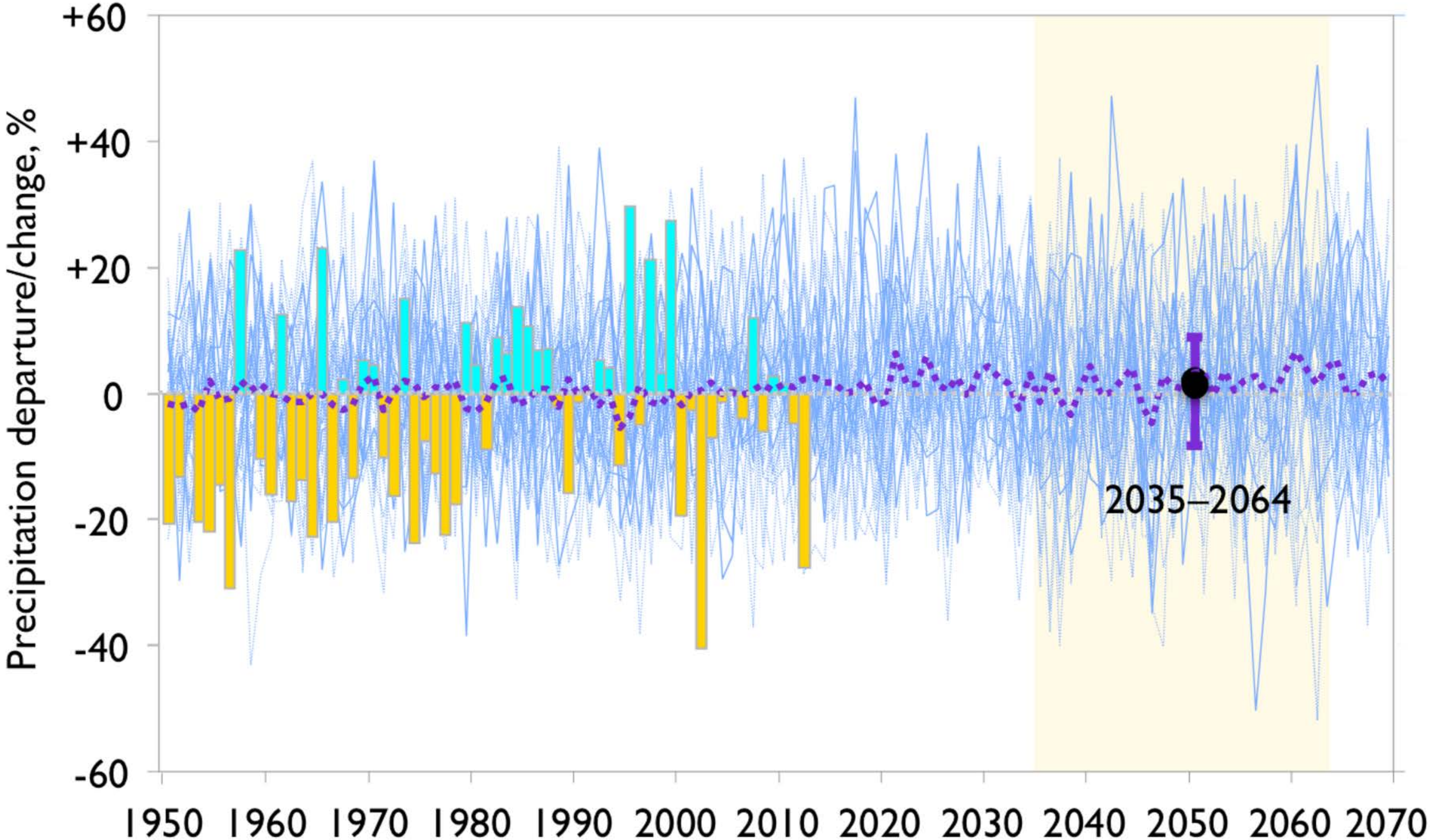


Models don't agree whether Colorado's *annual* **precipitation** will go up or down…though most models suggest more in winter, less in summer



Source: NOAA Climate Explorer

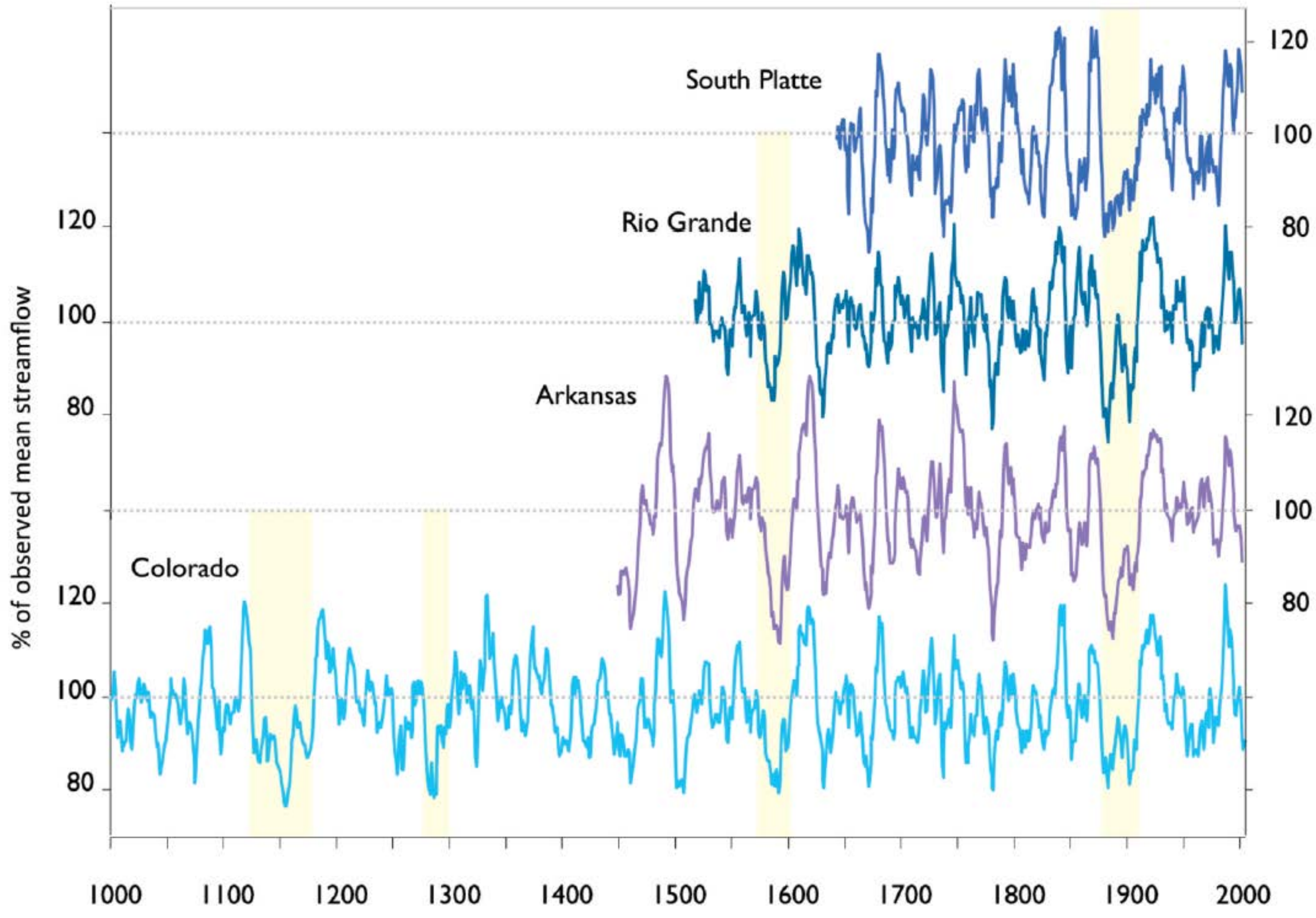
Any future change in annual precipitation will be difficult to detect as such against the high variability



Projected

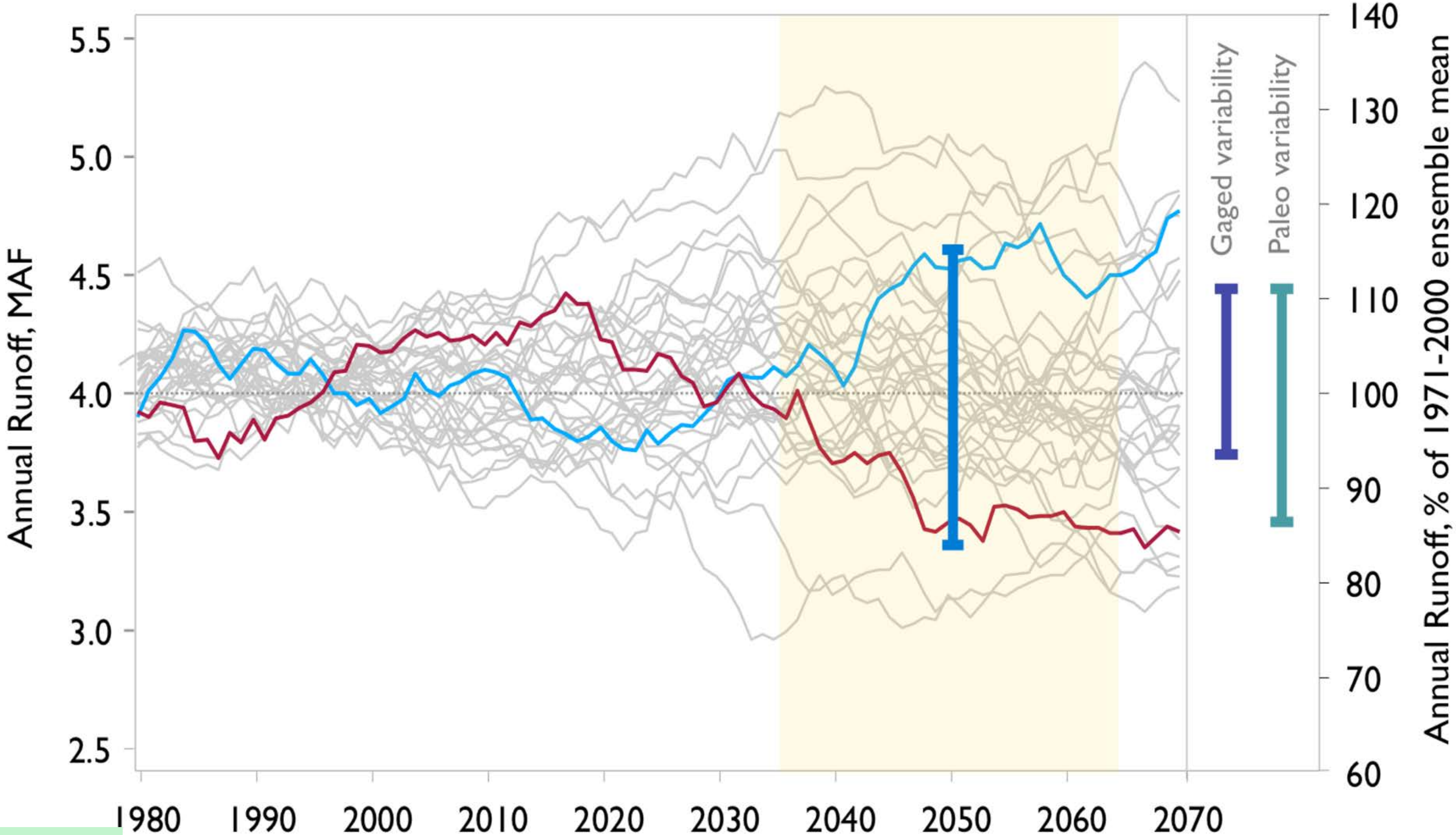
Figure 5-4

Tree-ring reconstructed streamflows for four major Colorado river basins



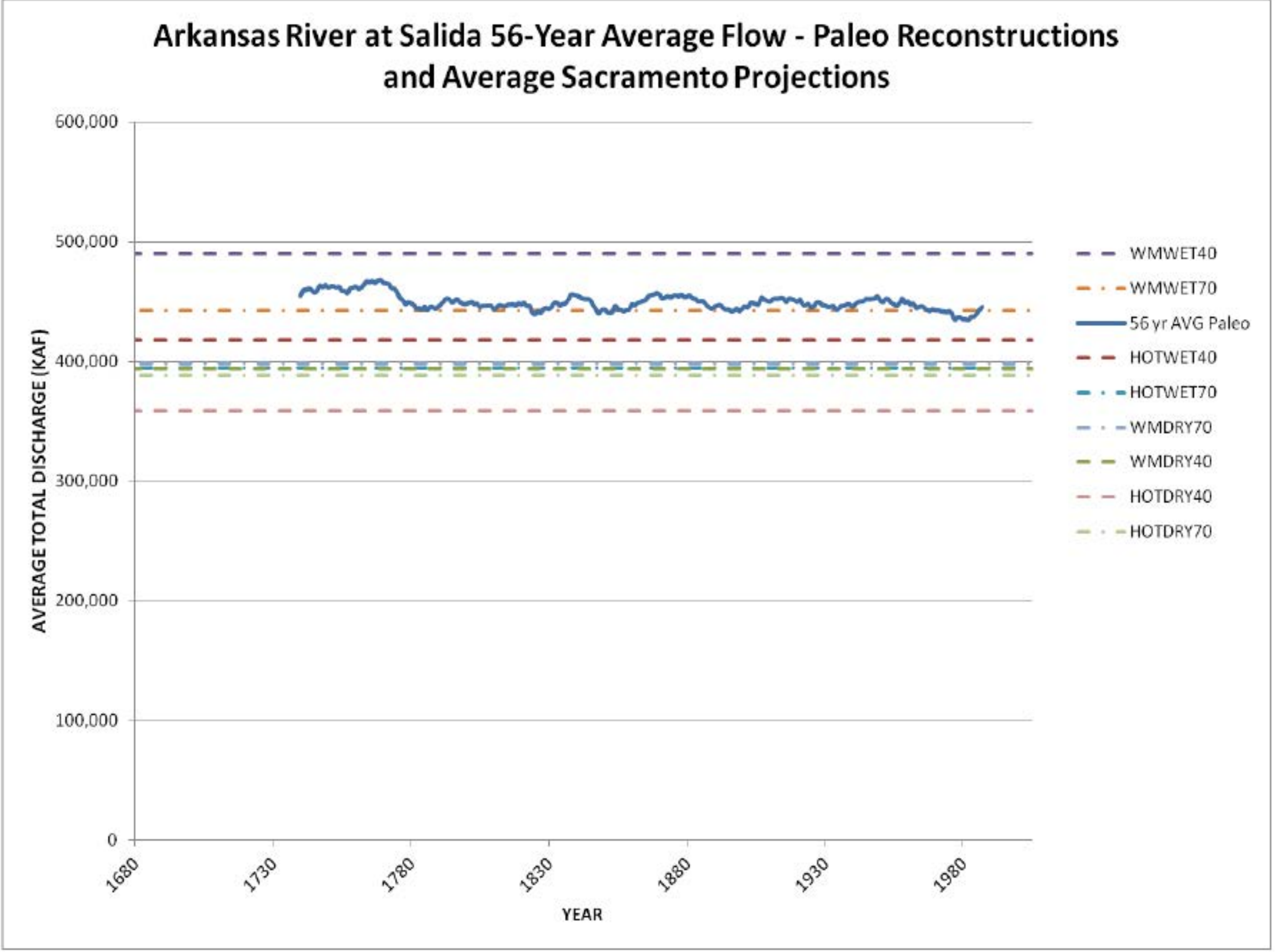
Source: Lukas, Climate Change in Colorado, 2014; Data: TreeFlow web resource; http://treeflow.info

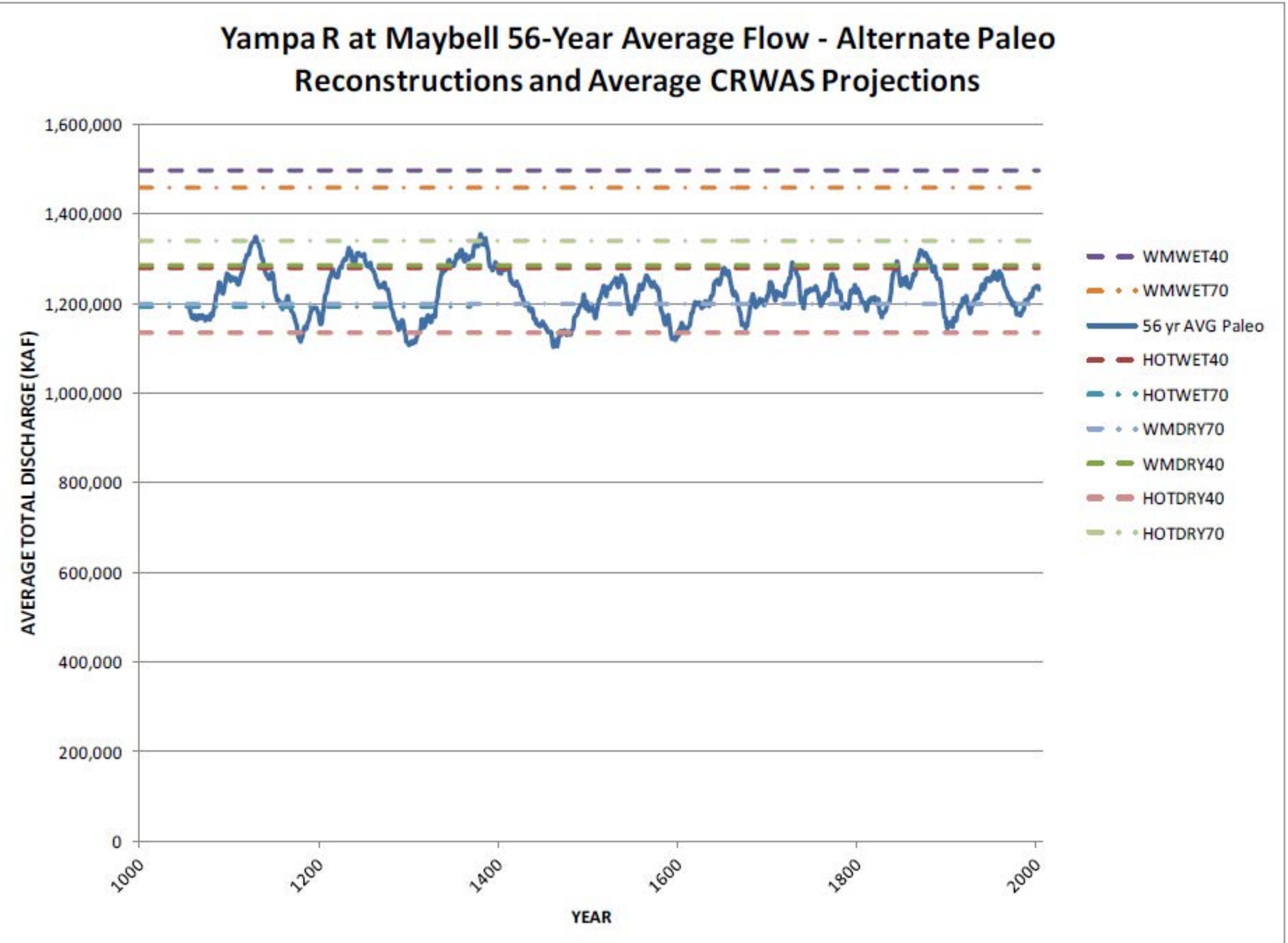
Projected streamflows for Colorado near Cameo (30-year running averages): Broader range of possible futures vs. historical



Projected

Figure 5-15


Arkansas River at Salida 56-Year Average Flow - Paleo Reconstructions and Average Sacramento Projections
AVERAGE TOTAL DISCHARGE (KAF)
600,000
500,000
400,000
300,000
200,000
100,000
0
1680
1730
1780
1830
1880
1930
1980
YEAR
WMWET40
WMWET70
56 yr AVG Paleo
HOTWET40
HOTWET70
WMDRY70
WMDRY40
HOTDRY40
HOTDRY70



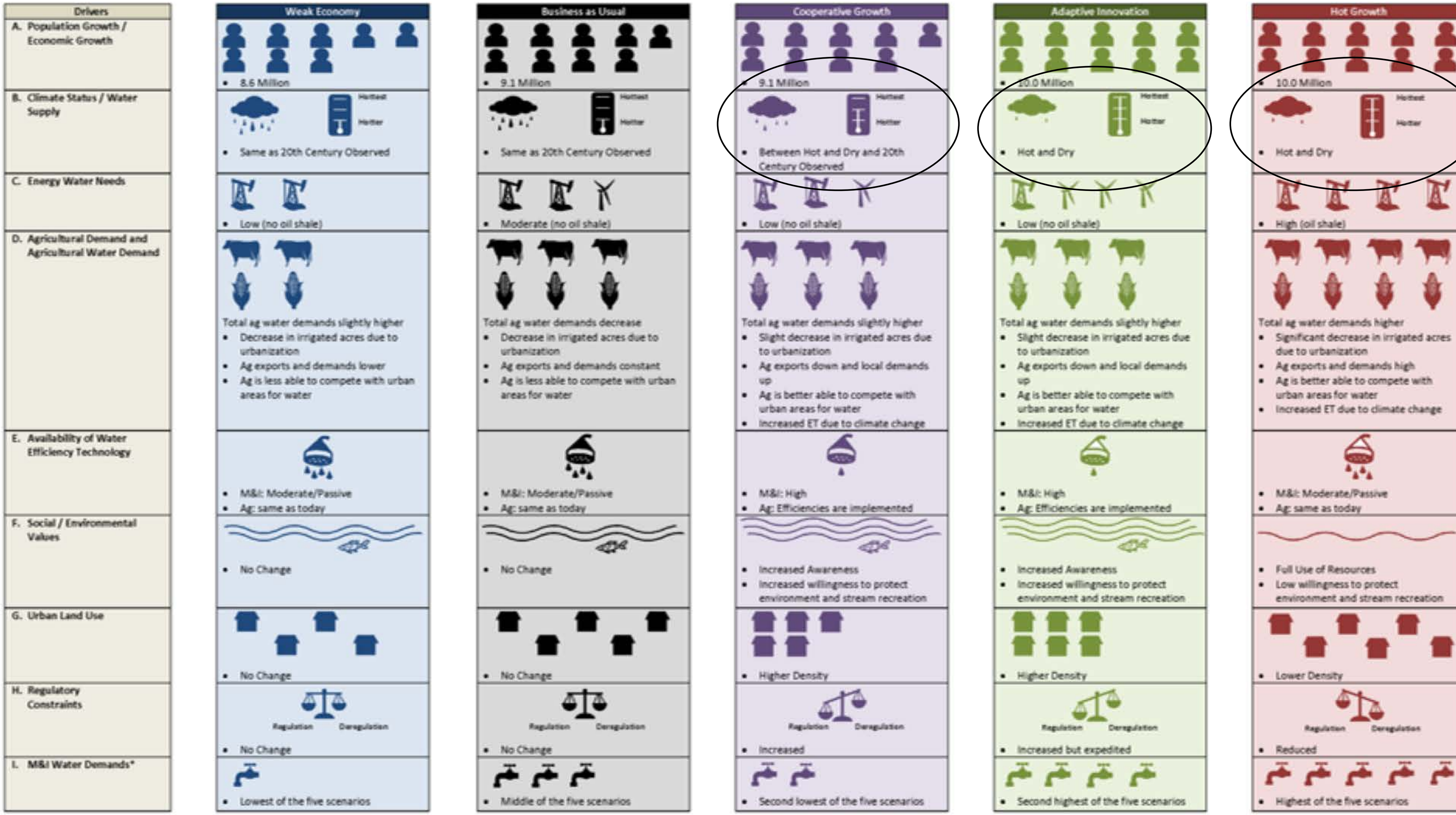
Yampa R at Maybell 56-Year Average Flow - Alternate Paleo Reconstructions and Average CRWAS Projections
1,600,000
1,400,000
1,200,000
1,000,000
800,000
600,000
400,000
200,000
0
AVERAGE TOTAL DISCH ARGE (KAF)
1000
1200
1400
1600
1800
2000
YEAR
WMWET40
WMWET70
56 yr AVG Paleo
HOTWET40
HOTWET70
WMDRY70
WMDRY40
HOTDRY40
HOTDRY70

Projected water cycle impacts for Colorado

- **More rain, less snow in fall and spring**
- Reduced spring snowpacks
- **Earlier snowmelt and peak runoff, reduced late-summer flows**
- Reduced annual flows
- **Reduced summer soil moisture**
- **More severe drought impacts for given a precipitation deficit**
- Increase in heavy precipitation events

Source: Western Water Assessment, Lukas et al 2014

Role of Climate Variability in Long Term Water Planning



Drivers	Weak Economy	Business as Usual	Cooperative Growth	Adaptive Innovation	Hot Growth
A. Population Growth / Economic Growth	• 8.6 Million	• 9.1 Million	• 9.1 Million	• 10.0 Million	• 10.0 Million
B. Climate Status / Water Supply	• Same as 20th Century Observed	• Same as 20th Century Observed	• Between Hot and Dry and 20th Century Observed	• Hot and Dry	• Hot and Dry
C. Energy Water Needs	• Low (no oil shale)	• Moderate (no oil shale)	• Low (no oil shale)	• Low (no oil shale)	• High (oil shale)
D. Agricultural Demand and Agricultural Water Demand	Total ag water demands slightly higher • Decrease in irrigated acres due to urbanization • Ag exports and demands lower • Ag is less able to compete with urban areas for water	Total ag water demands decrease • Decrease in irrigated acres due to urbanization • Ag exports and demands constant • Ag is less able to compete with urban areas for water	Total ag water demands slightly higher • Slight decrease in irrigated acres due to urbanization • Ag exports down and local demands up • Ag is better able to compete with urban areas for water • Increased ET due to climate change	Total ag water demands slightly higher • Slight decrease in irrigated acres due to urbanization • Ag exports down and local demands up • Ag is better able to compete with urban areas for water • Increased ET due to climate change	Total ag water demands higher • Significant decrease in irrigated acres due to urbanization • Ag exports and demands high • Ag is better able to compete with urban areas for water • Increased ET due to climate change
E. Availability of Water Efficiency Technology	• M&I: Moderate/Passive • Ag: same as today	• M&I: Moderate/Passive • Ag: same as today	• M&I: High • Ag: Efficiencies are implemented	• M&I: High • Ag: Efficiencies are implemented	• M&I: Moderate/Passive • Ag: same as today
F. Social / Environmental Values	• No Change	• No Change	• Increased Awareness • Increased willingness to protect environment and stream recreation	• Increased Awareness • Increased willingness to protect environment and stream recreation	• Full Use of Resources • Low willingness to protect environment and stream recreation
G. Urban Land Use	• No Change	• No Change	• Higher Density	• Higher Density	• Lower Density
H. Regulatory Constraints	• No Change	• No Change	• Increased	• Increased but expedited	• Reduced
I. M&I Water Demands*	• Lowest of the five scenarios	• Middle of the five scenarios	• Second lowest of the five scenarios	• Second highest of the five scenarios	• Highest of the five scenarios

Figure 1. State of Colorado Future Water Supply Scenarios

How do we incorporate what we know into planning?

- Water providers are now feeling the need to consider climate impact projections in planning. And people want them to.

- The single biggest challenge is planning under a great deal of uncertainty.

- New “adaptive management” approaches are being developed.

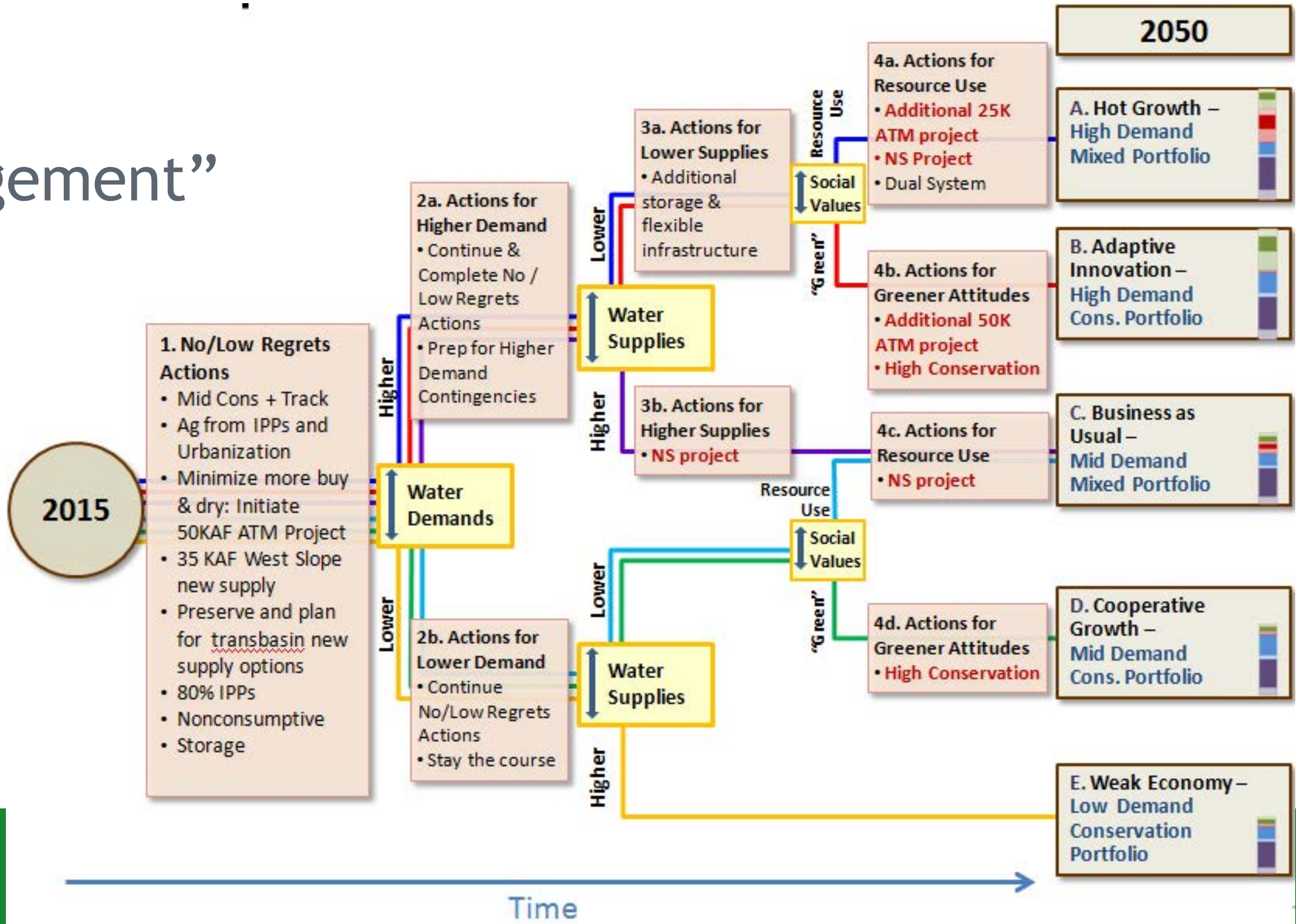
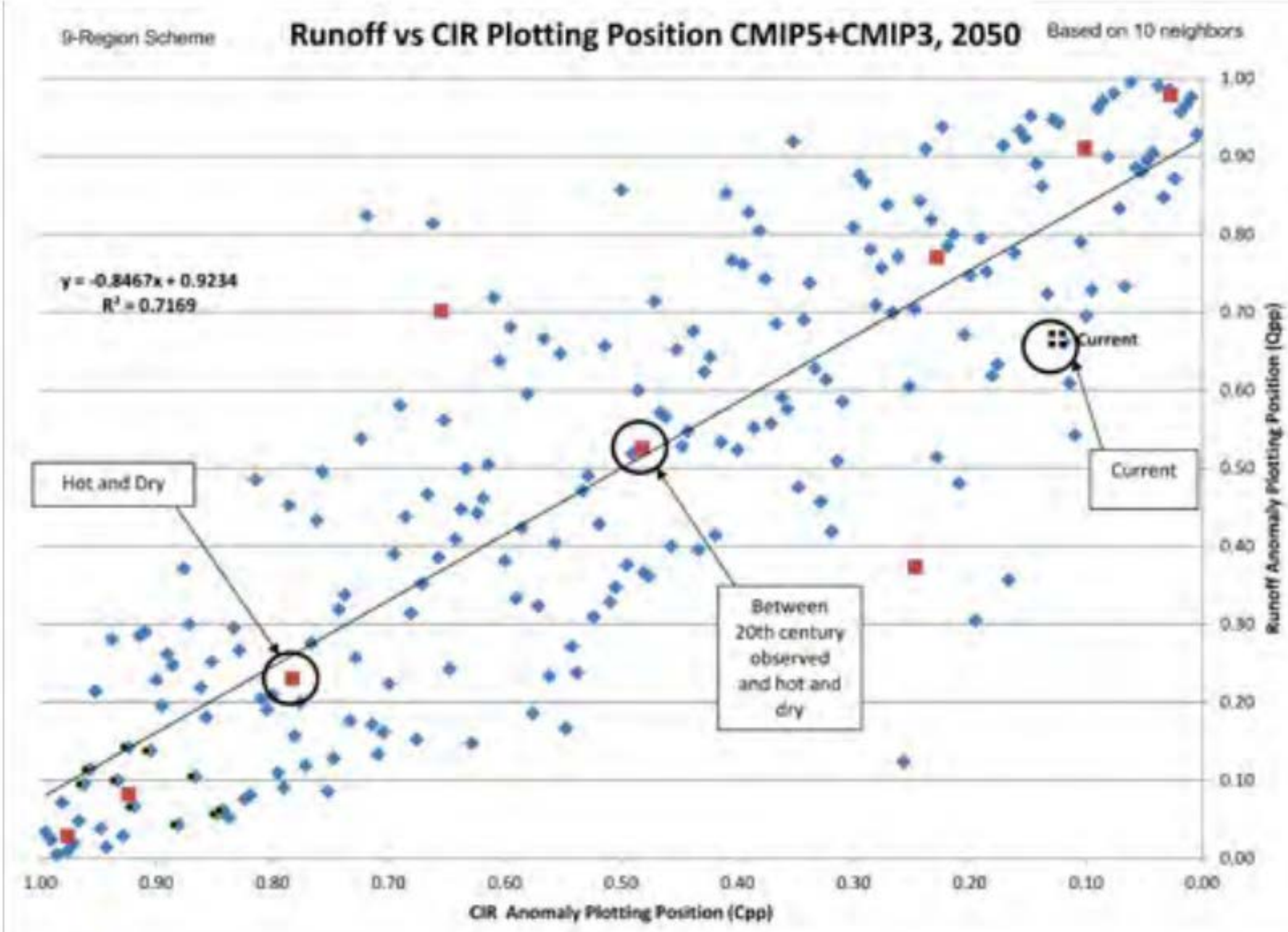
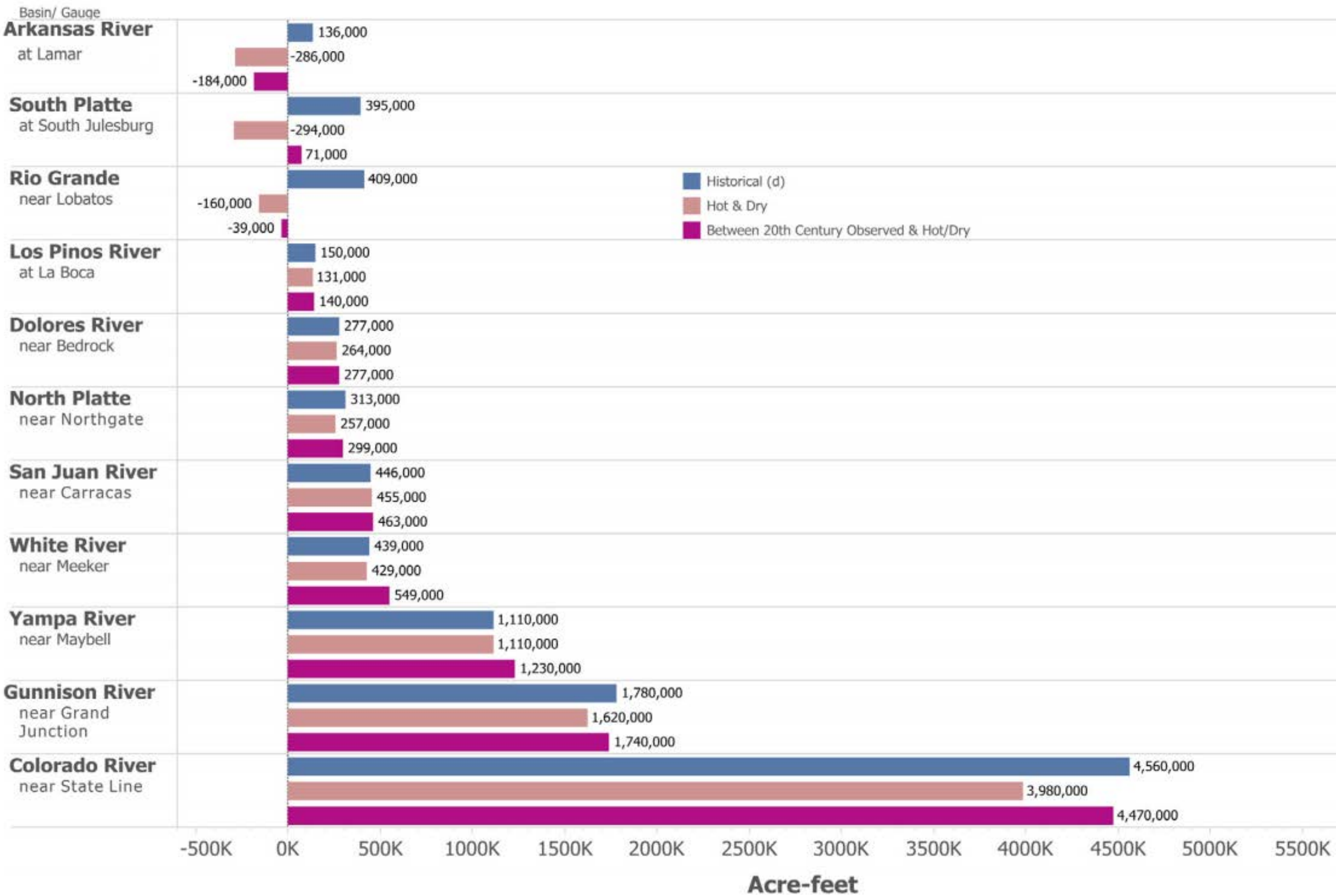


FIGURE 4-9 PLOT OF RUNOFF CROP IRRIGATION REQUIREMENTS USING THE BUREAU OF RECLAMATION ARCHIVE



"Hot and dry" is defined as the 75th percentile of climate projections for crop irrigation requirements (water use), and the 25th percentile for natural flows. In other words, only 25 percent of projections have lower natural flows and 25 percent of projections have higher crop irrigation requirements. "Between 20th century-observed and hot and dry" is defined as the 50th percentile for both natural flows and crop irrigation requirements. This scenario represents the middle of the range in terms of severity. Historical or current conditions, which represents no change in runoff or in crop irrigation requirements, fall at roughly the 9th and 67th percentiles; this means that 91 percent of runs show increases in crop irrigation requirements and about two-thirds show reductions in runoff.

FIGURE 4-10 PROJECTED DEPLETED FLOWS FOR 2050 (ACRE-FEET PER YEAR)



Projected depleted flows for 2050 in acre-feet per year at 11 different sites around the state using the three classifications of historical, hot and dry, and between 20th century-observed and hot and dry.

Putting this to Use

Basin Planning

- Better understanding of a range of plausible climate impacts
- The magnitude to which various parts of the state may experience decreased flows.
- Provide information that can be incorporated into long term planning to increase resilience.

Utility Planning

- Better understanding of which basins may be most heavily impacted by changes in climate, and thus how individual utility's water rights may be affected.
- Maximizing existing resources through efficiency

State Planning

- Incorporation of plausible futures into long term statewide planning processes

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Questions?

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