EFFECT OF CLIMATE CHANGE ON MUNICIPAL WATER DEMANDS IN COLORADO

Governor's Conference on
Managing Drought & Climate Risk

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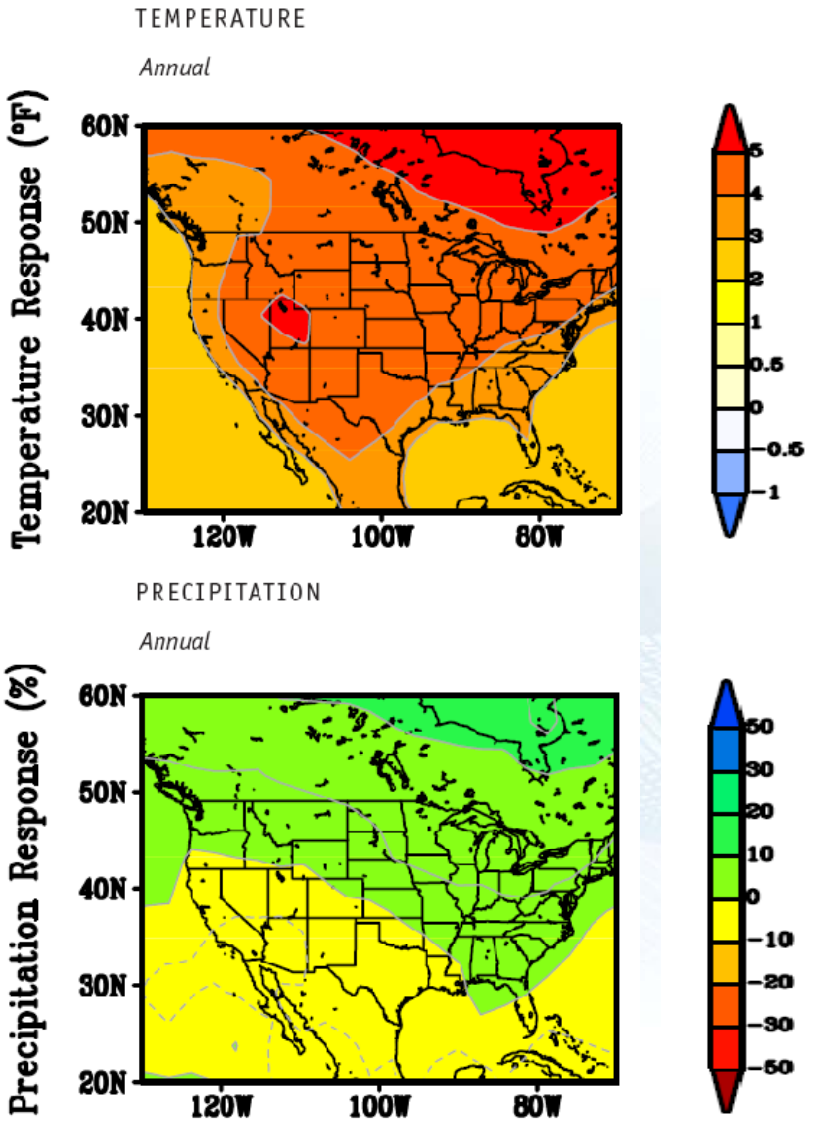
October 8-10, 2008

Outline

- Climate Change Background
- Approach to Climate Change Analyses
- Results
- Summary and Conclusions

Climate Change Background

- Significant advances in the modeling and analysis of climate change and its effects in recent years
- Colorado temperatures are predicted to increase by 2.5 – 5.5 degrees F by 2050 with relatively warmer summers
- Predictions of annual precipitation in Colorado are mixed, with possible increases in winter and decreases in spring



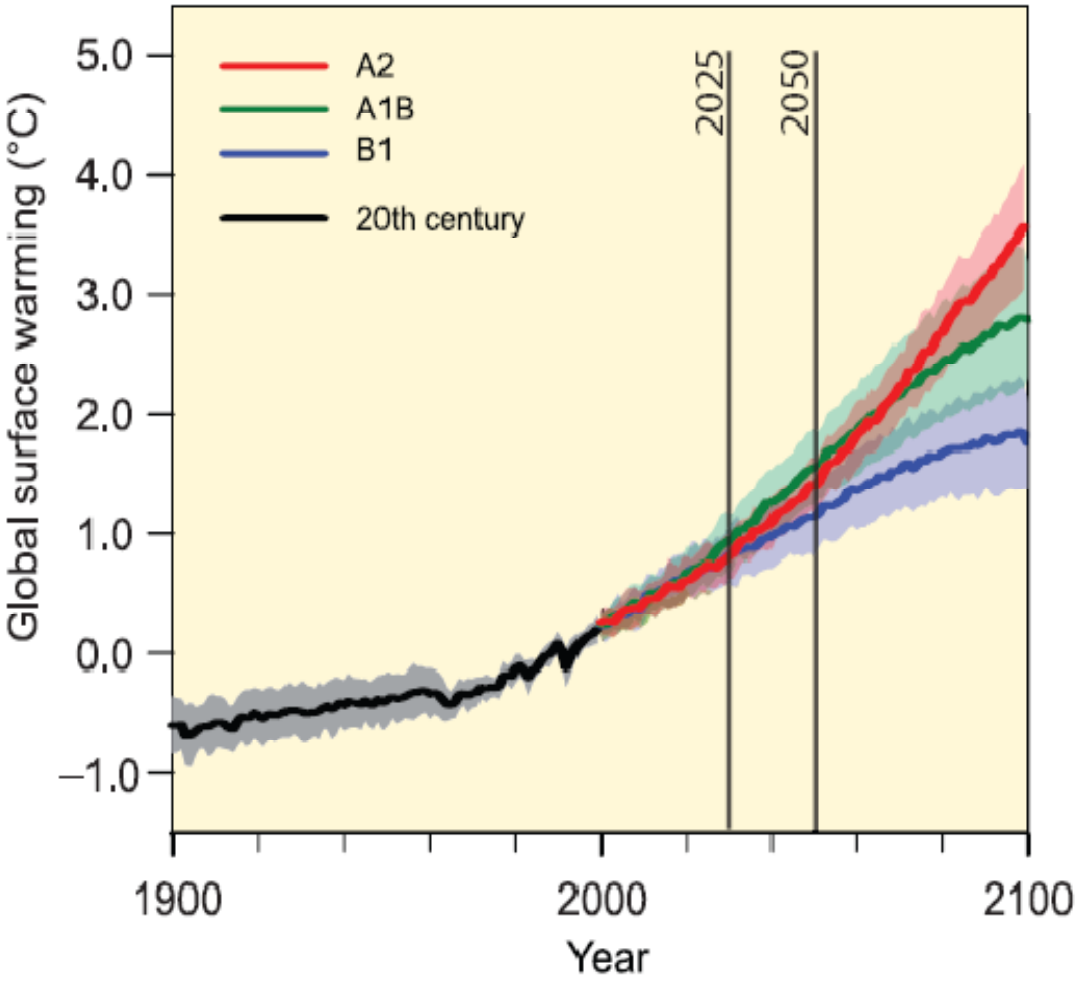
Approach

- Obtained monthly GCM results for representative cities through 2050:
  1. *Used statistically downscaled results at 1/8 x 1/8 degree scale*

Approach - 2

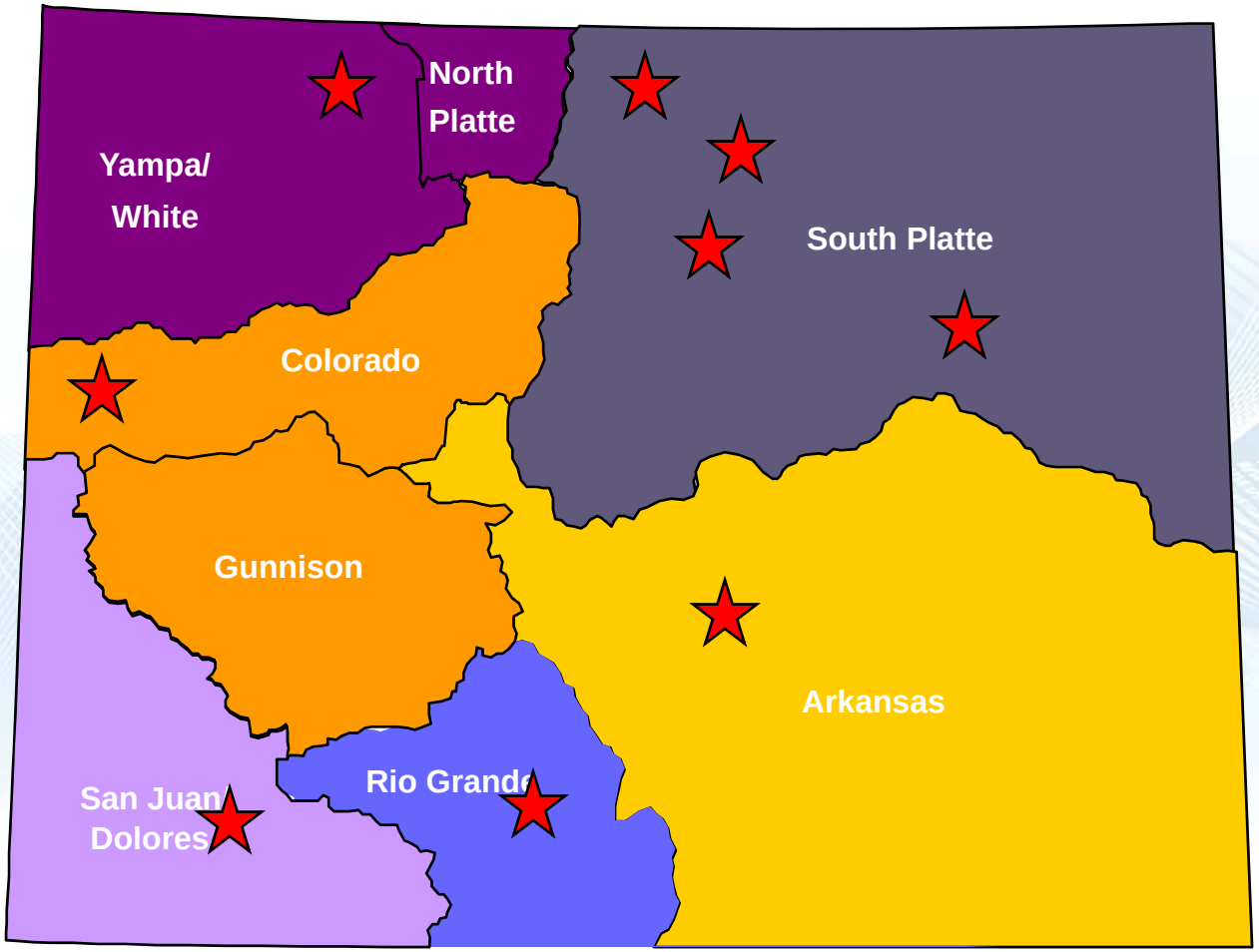
2. *Took mean of 39 models using the 'A1B' (mid-range) emissions scenario*

3. *Selected 11-year periods centered on 2000, 2030 and 2050 to represent those years*



Approach - 3

4. Correlated city results to six watersheds for Statewide evaluations

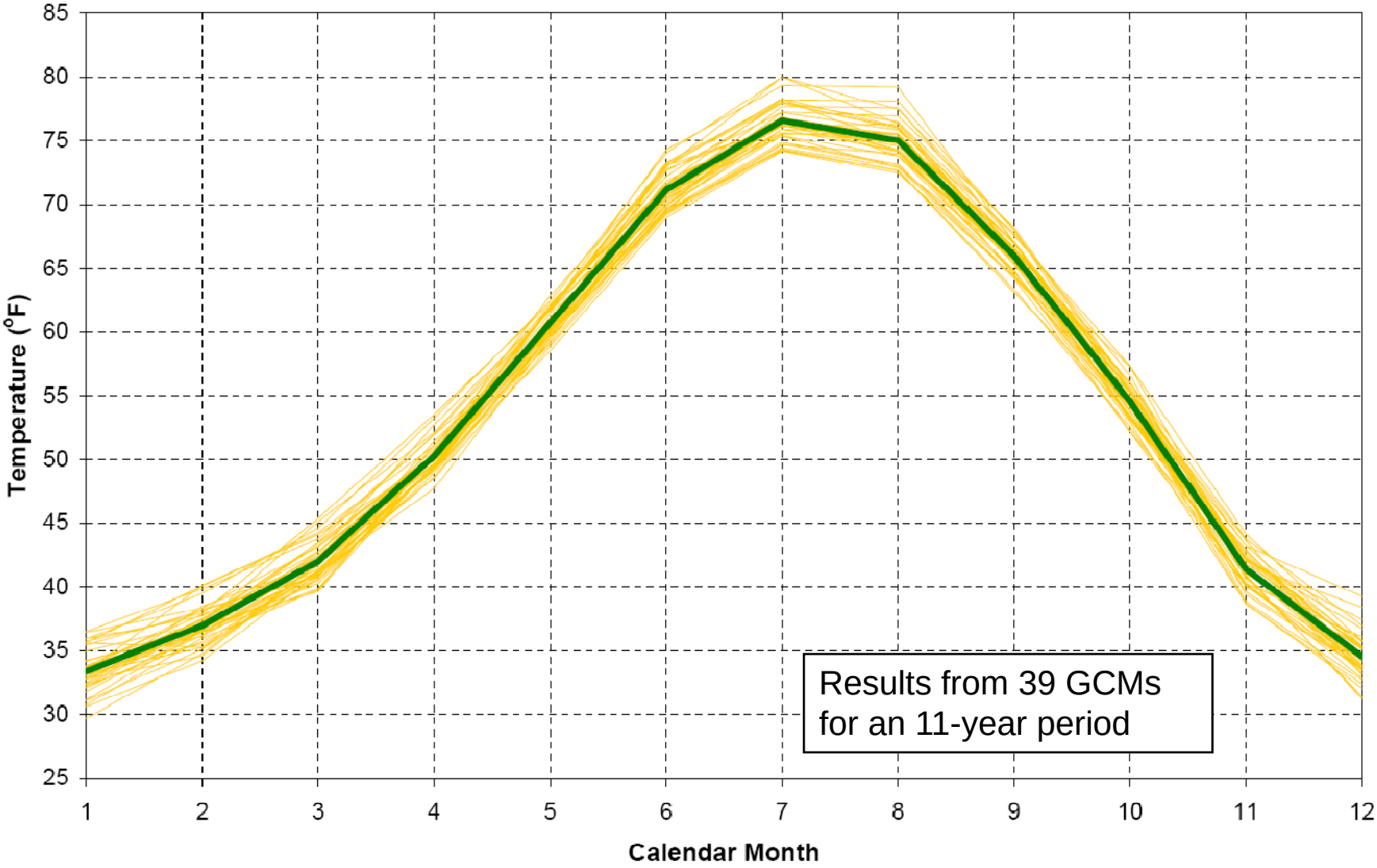


Key Assumptions for Initial Evaluation of Municipal Water Demands

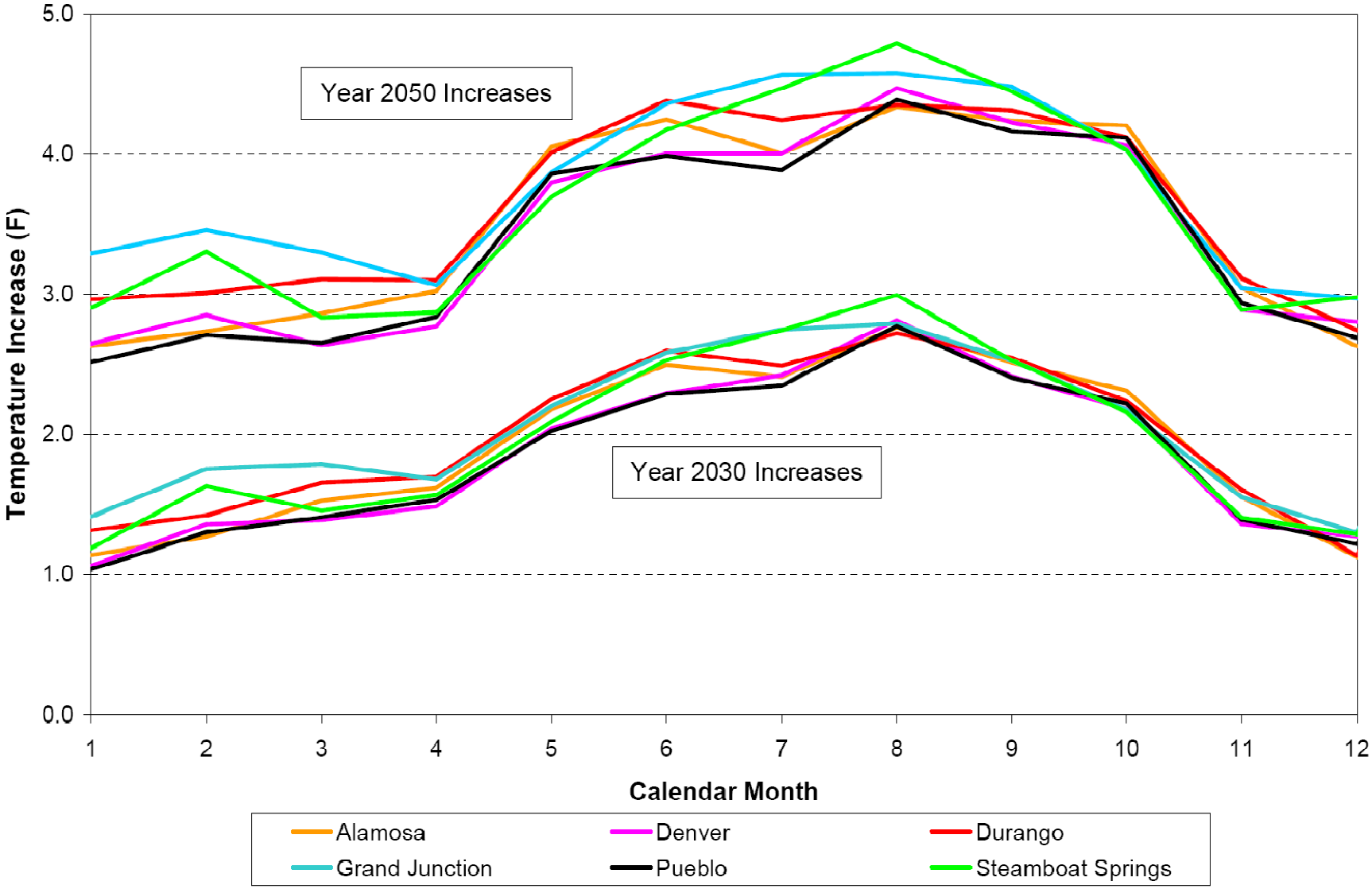
- There are no changes to per capita municipal demand
- Outdoor water demand has major influence
- Temperature is driver for outdoor water demand
- Bluegrass is representative of outdoor municipal landscaping
- Modified Blaney-Criddle Equation used to compute ET

$$ET = K_c * K_t * (t * p/100)$$

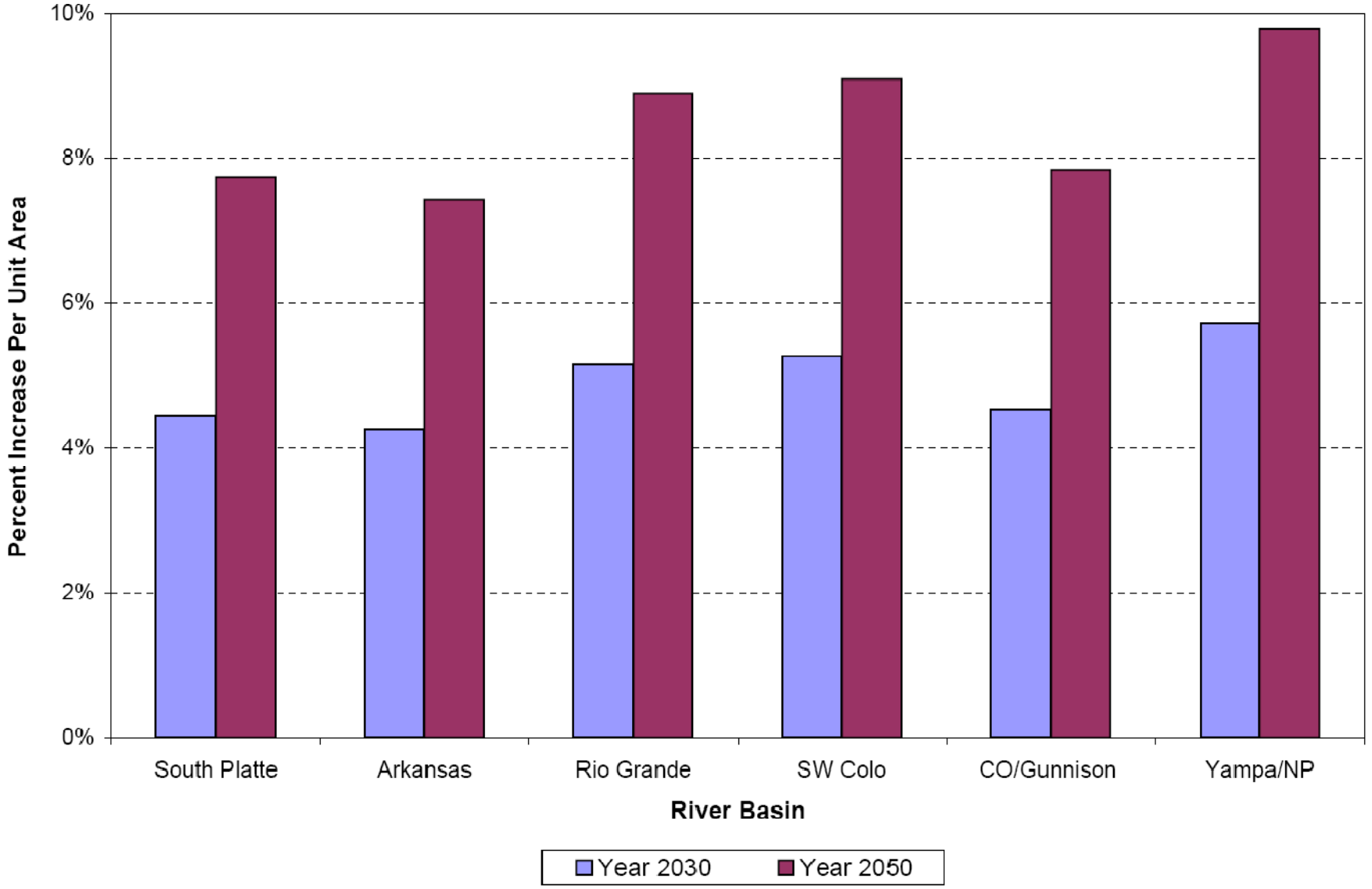
Results – GCM Ensemble for Temperature Year 2030, Denver



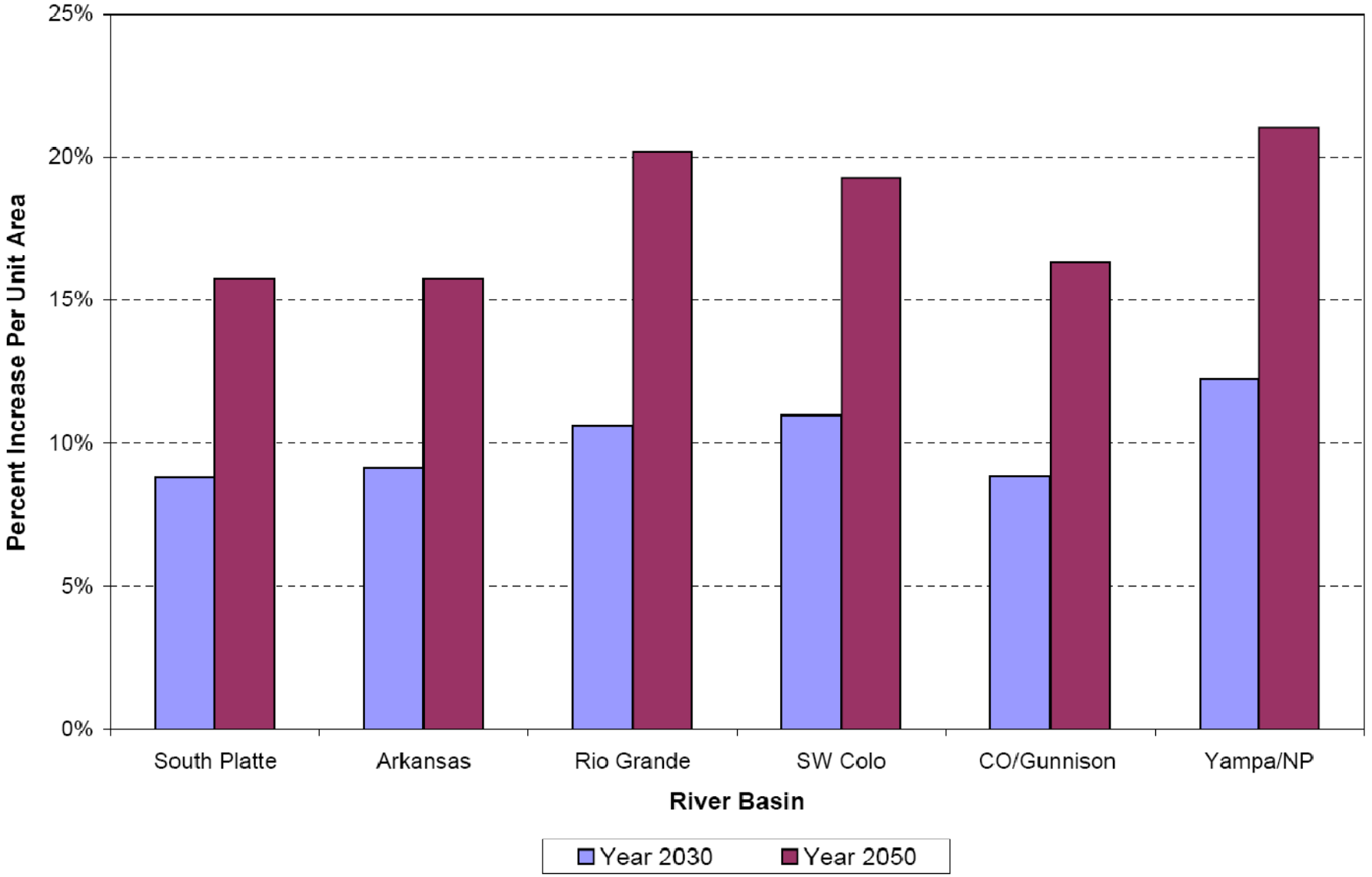
Results – Increase in Temperature Relative to Year 2000



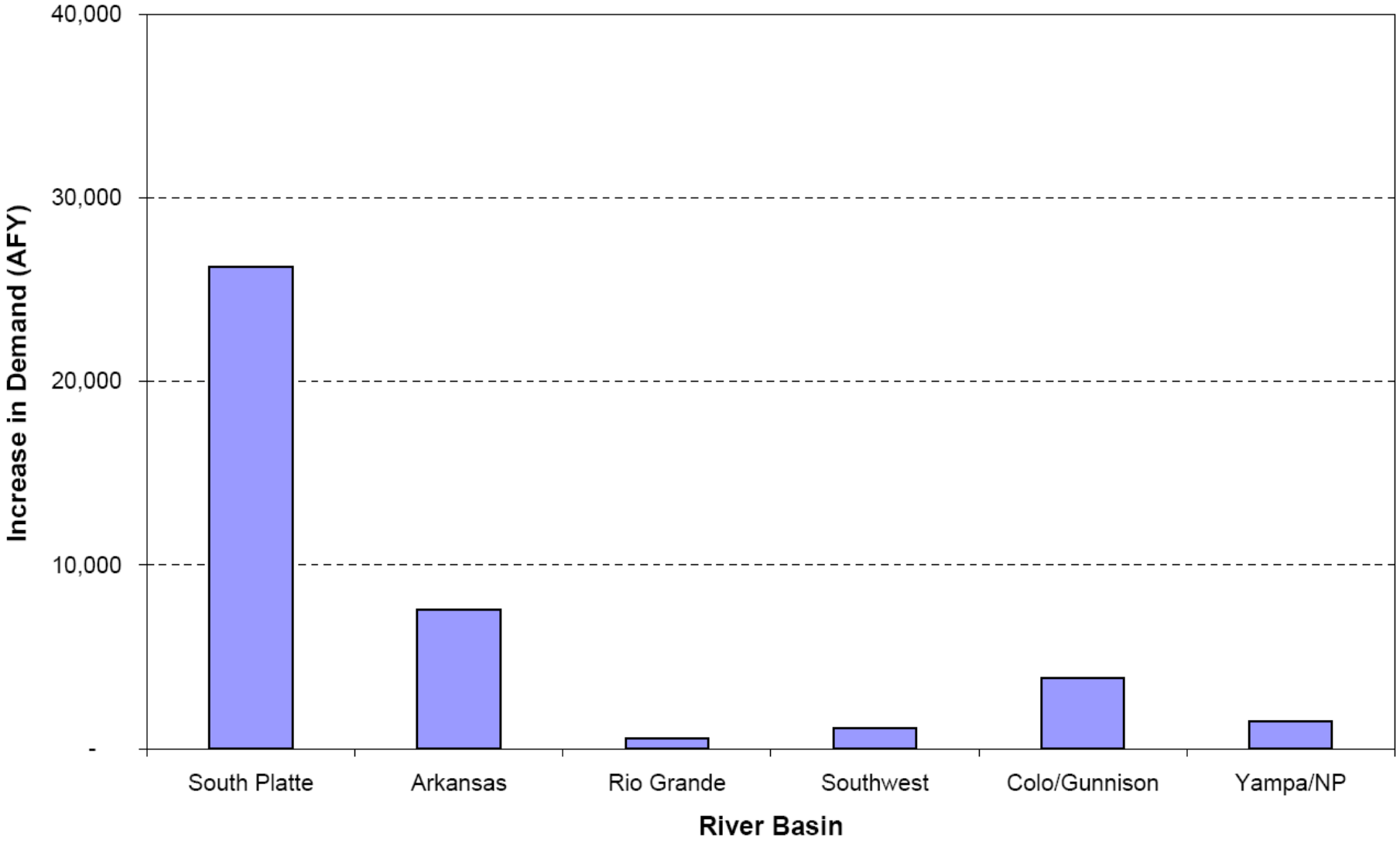
Results – Increase in Bluegrass ET Relative to Year 2000



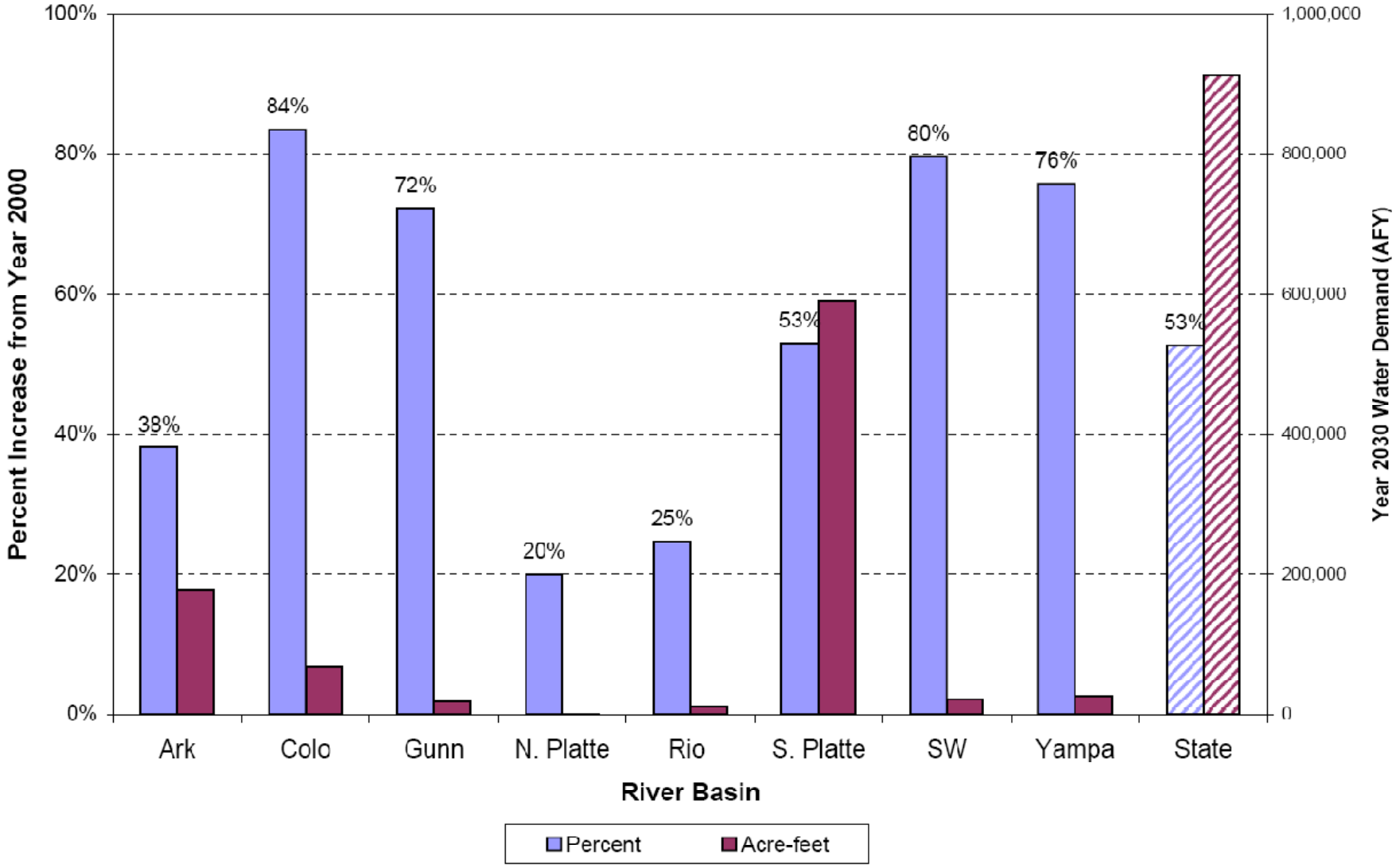
Results – Increase in Alfalfa ET Relative to Year 2000



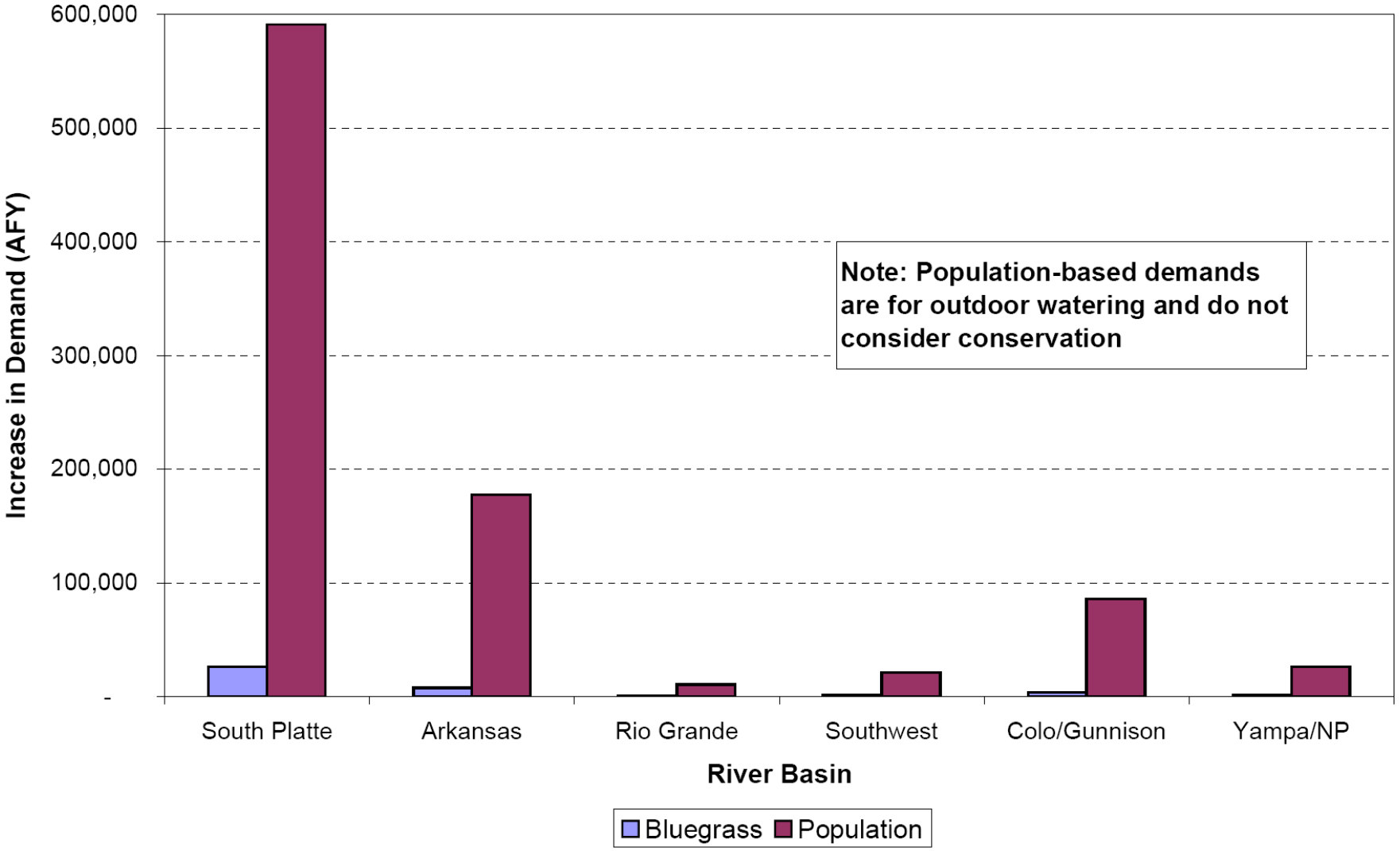
Estimated Bluegrass Water Demands in Year 2030



Change in Outdoor Water Demands in Year 2030 due to Population Growth



Comparison of Factors Increasing Municipal Water Demands in 2030



Summary and Conclusions

- Climate change models provide insight into evaluating future water demands even with their present uncertainties
- When evaluating municipal water demands in Colorado, change in temperature is a reasonable predictor
- Bluegrass water demand is projected to increase by approximately 5 percent in 2030 (~ 40,000 AFY) and 8 to 9 percent in 2050
- Projected growth in municipal demands by 2030 are dominated by increased population, so conservation and water supply planning will be key to meeting needs
- Climate change appears to have a larger effect on municipal water supply than on municipal water demands

Questions?

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The Effect of Climate Change on Municipal Water Demands in Colorado

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As part of its ongoing assessment of statewide water supply needs, the CWCB, Basin Roundtables and IBCC have asked for technical assistance in identifying water demands through the year 2050. This evaluation includes an assessment of the potential effects that climate change could have on municipal water demands. An evaluation was performed on changes in municipal demands through 2030 and is summarized in this presentation.

There have been significant advances in recent years in both modeling and analyses of climate change impacts. A report recently prepared for the CWCB summarizes key findings for the state including historic climate data, climate change modeling, and projections of climate change impacts. In Colorado, temperatures are projected to increase by 2.5 to 5.5 degrees F by 2050 relative to the 1950-1990 average, with relatively more warming in summer. Model predictions show less agreement regarding the change in precipitation in Colorado. While there is predicted to be little change in annual precipitation there is a suggestion of a season shift with more of the precipitation occurring in winter. Due to warmer temperatures more of the winter precipitation will fall as rain instead of snow; so there will be more runoff in the winter and less snowpack. Runoff from snowmelt is likely to occur earlier in the spring leading to lower streamflow in the summer.

The projected increase in temperature will lead to increased municipal demands due to higher consumptive use demands from residential landscaping. Due to the uncertainty in model predictions of the amount and timing of future precipitation, the current analysis assumes that any changes in precipitation that may occur due to climate change will not be significant enough to affect municipal demand. This assumption will be revisited when climate change impacts through 2050 are evaluated.

The approach to estimating changes in municipal water demands involved obtaining data on predicted temperatures for representative municipal locations in Colorado, using the temperature data to calculate increases in consumptive use water demand at each location, and then estimating changes in municipal demand based on year 2030 population and per capita water use projections. Predicted monthly temperature data was obtained from 16 global climate models for the mid-range greenhouse gas emissions scenario agreed to by the international climate change research community. The climate model results had been downscaled to a 1/8 x 1/8 degree grid scale covering the United States and were available through the Bureau of Reclamation. The downscaling involved statistical techniques to reduce bias in the model results and to perform spatial disaggregation from the more coarsely scaled climate models. To further reduce model bias, the current analysis used the change in monthly mean temperature from simulated years 1995-2005 and 2025-2035 to represent the predicted

change in monthly temperatures between the years 2000 and 2030, the years for which municipal demand information exist. Downscaled results were obtained for cities across the state and included Denver, Pueblo, Alamosa, Durango, Grand Junction, and Steamboat Springs. Additional cities will be used when estimating 2050 demands.

The following assumptions were used to translate the temperature predictions into changes in municipal demands. Information presented at a basin scale in the Statewide Water Supply Initiative study, on population and municipal per capita demands for the years 2000 and estimated for the year 2030 were relied on. For the purposes of this analysis it was assumed that there would be no change in per capita municipal demands over time. The change in municipal demands due to climate change will be due to changes in outdoor water demand and approximately half of municipal demand is associated with outdoor water use. Bluegrass consumptive use was used to represent outdoor water demand and was estimated using the modified Blaney-Criddle equation. Results computed for the individual cities are representative of changes in municipal demands for their basin or adjacent basins.

Results of the analysis indicate that bluegrass consumptive use is projected to increase by approximately 5 percent in year 2030 relative to year 2000, increasing to about 8.5 percent by 2050. The higher elevation watersheds (Rio Grande, SW Colorado and Yampa) showed the largest increases. Combining the consumptive use increase with municipal demand projections indicates that there will be an increase in municipal water demand of approximately 41,000 acre-feet per year (afy) due to increases in temperature associated with climate change by the year 2030. Most of the increase will be in the South Platte River basin (approximately 26,000 afy) followed by the Arkansas River basin (approximately 8,000 afy). These increases are relatively minor compared to the projected increase in municipal demand due to population growth (approximately 315,000 afy) but are additional demands on top of those due to population alone. In addition, the climate change models show more rapid increases in temperature by 2050 and beyond so the impact of climate change on municipal demands is likely to be relatively larger in the latter half of the 21st century compared to the year 2030. Including reductions in summer precipitation, as suggested by the climate models, will further increase consumptive demands in the municipal sector.

The results of this evaluation suggest that minor increases in municipal demands can be expected in Colorado due to climate change impacts in the next few decades, but those effects will be larger by 2050 and beyond. Consumptive use from agricultural crops is also likely to increase which will have a significant effect on statewide water demand due to the large amount of water used for agriculture. Combined with predicted changes in the timing of snowmelt runoff and availability in water supply, climate change could have a dramatic effect on the allocation and use of Colorado's water supply in the future.

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Dr. McCurry is a hydrologist with over 25 years of experience with water resource evaluations. He is a senior scientist and project manager with Camp Dresser & McKee in Denver. His areas of emphasis are aquifer evaluations, climate change effects on water resources, and stream-aquifer interactions. Dr. McCurry has been involved in recent years in regional water planning studies through the Colorado Water Conservation Board including the South Platte Decision Support System, the Statewide Water Supply Initiative study, and various Basin Roundtable studies. He has been involved in projects examining climate change impacts on water demands and supply availability since the mid-1990's. Dr. McCurry earned his Ph.D from the University of Colorado.