

Climate Change Trends for the State of the Park Report at Black Canyon of the Gunnison National Park

Prepared by Nicholas Fisichelli, NPS Climate Change Response Program

July 24, 2013

Climate change and National Parks

Climate change, in conjunction with other stressors, is impacting all aspects of park management from natural and cultural resources to park operations and visitor experience. Effective planning and management must be grounded in our comprehension of past dynamics as well as the realization that future conditions may shift beyond the range of variability observed in historical data. Climate change will manifest itself not only as shifts in mean conditions (e.g., increasing mean annual temperature) but also as changes in climate variability (e.g., more intense storms and droughts). Put another way, land managers are dealing with both rapid directional change and tremendous uncertainty. Understanding climate change projections and associated levels of uncertainty will facilitate planning actions that are robust regardless of the precise magnitude of change experienced in the coming decades.

Historical climate trends (1896-2012)

Historical climate trends for Black Canyon of the Gunnison National Park are based on historic climate data from a nearby long-term weather station (Montrose, CO, station 055722, roughly 12 miles west of the park) acquired from the United States Historical Climatology Network (cdiac.ornl.gov). Over the 117 year instrumental record (1896-2012) mean annual temperature showed a significant warming trend (+0.23 °F (+0.13 °C) per decade, $p < 0.0001$) (Figure 1). Annual precipitation was highly variable with no significant linear trend ($p = 0.86$).

Future climate projections

Future climate projections for the area including Black Canyon are from multi-model averaged data (Kunkel et al. 2012). Mean annual temperature, compared with the 1971-1999 average, is projected to increase 4-5 °F by mid-century and 5-8 °F by the end of the century, depending on the greenhouse gas emissions scenario (Figure 1). This is roughly twice the rate of warming experienced during the 20th century. Current greenhouse gas emissions are on a trajectory similar to the higher emissions scenarios (IPCC 2007, Friedlingstein et al. 2010). Warming by mid-century is projected for all seasons, with the greatest increase likely in summer (Figure 2). There is wide agreement among individual climate models in the direction and magnitude of warming over the coming decades. Precipitation models indicate minor changes in annual totals over the coming century (Figure 1), though increases in winter and decreases in summer total precipitation are projected (Figure 3). Precipitation variability is likely to remain large over the coming decades, and there is greater uncertainty in precipitation than temperature projections (Kunkel et al. 2012).

In addition to warmer mean temperatures and changes in total precipitation, climate change will manifest itself in many other ways. This includes more frequent heat waves, droughts, floods, and an extended frost-free season. The number of days with maximum temperatures > 95 °F is projected to increase by 5-10 days per year while the annual number of days with minimum temperatures below freezing is projected to decrease by 30+ days (high (A2) emissions scenario 2041-2070 compared with 1980-2000; Kunkel et al. 2012). Small changes in total annual precipitation may mask large shifts in the precipitation regime and associated

impacts to ecosystems. The annual maximum number of consecutive days with rainfall less than 0.1 inches may increase by 5-10 days while the annual number of days with heavy rainfall (> 1 inch) is projected to increase by 20-40% (high (A2) emissions scenario, 2041-2070 compared with 1980-2000; Kunkel et al. 2012). Significantly warmer temperatures and a more variable precipitation regime, including heavier rain events and an increased number of days between rain events, may lead to both more frequent droughts and more severe flooding and erosion. See the draft National Climate Assessment for more in-depth information (NCADAC 2013; <http://ncadac.globalchange.gov/>)

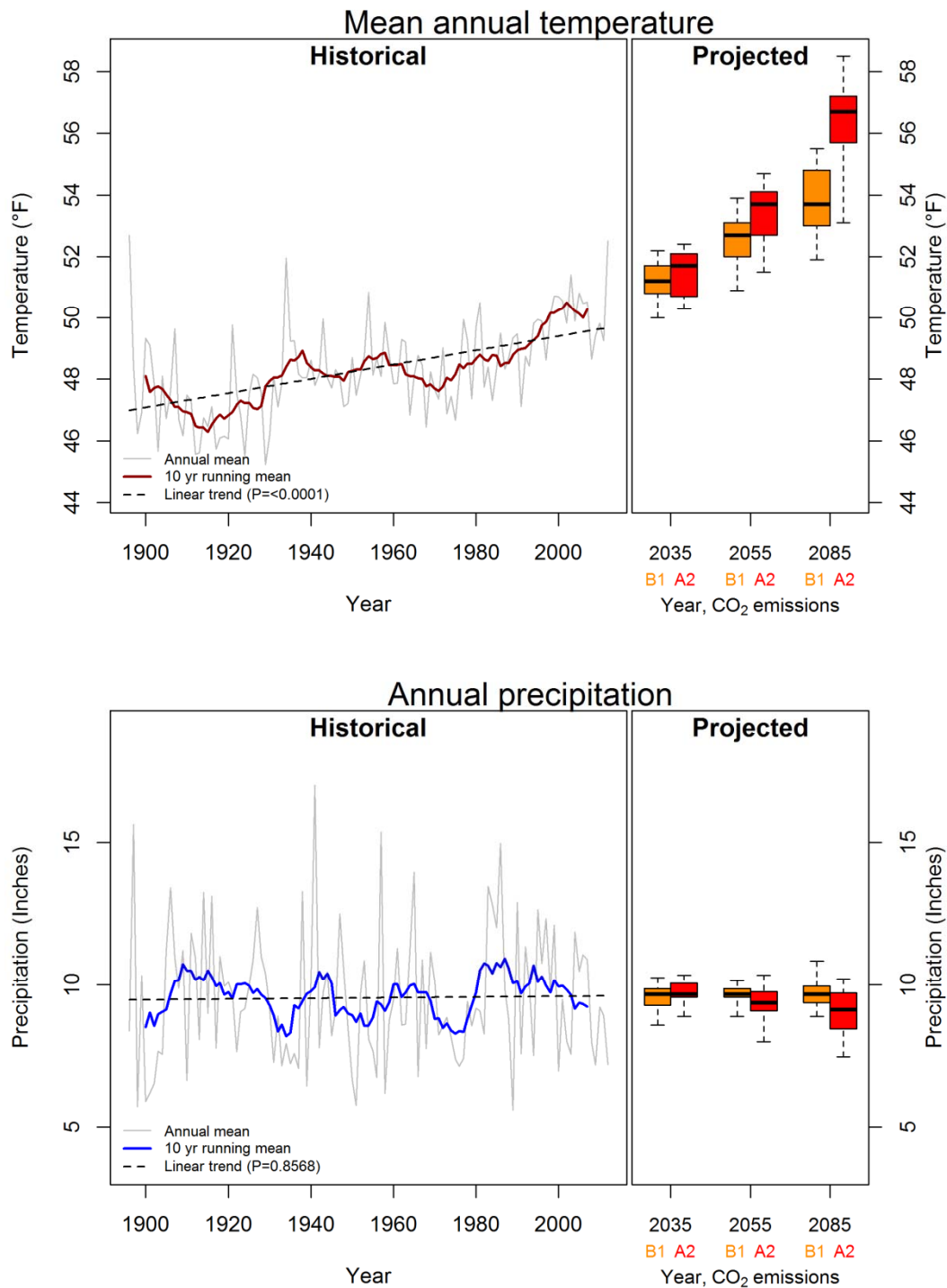


Figure 1. Historical and projected mean annual temperature and annual precipitation for Black Canyon of the Gunnison National Park. Historical data (1896-2012) are from the Montrose, CO long-term weather station (cdiac.ornl.gov). Projected climate change (30 year means) for the region including the park (data from Kunkel et al. 2012, see Tables 4, 6 and Figures 14, 25) are for three future time periods centered on 2035 (2021-2050), 2055 (2041-2070), and 2085 (2070-2099). Two greenhouse gas emissions scenarios are presented, the low (B1) and high (A2) scenarios (IPCC 2007). Projected climate boxplots indicate the variability in future projections among 14-15 CMIP3 climate models. Values for the area including the park are based on projected changes from individual climate models averaged across the southwest region: the bold horizontal black line represents the mean among all models, the upper and lower bounds of the boxes indicate the 75th and 25th percentile model output values and the whiskers show the minimum and maximum change averaged across the region.

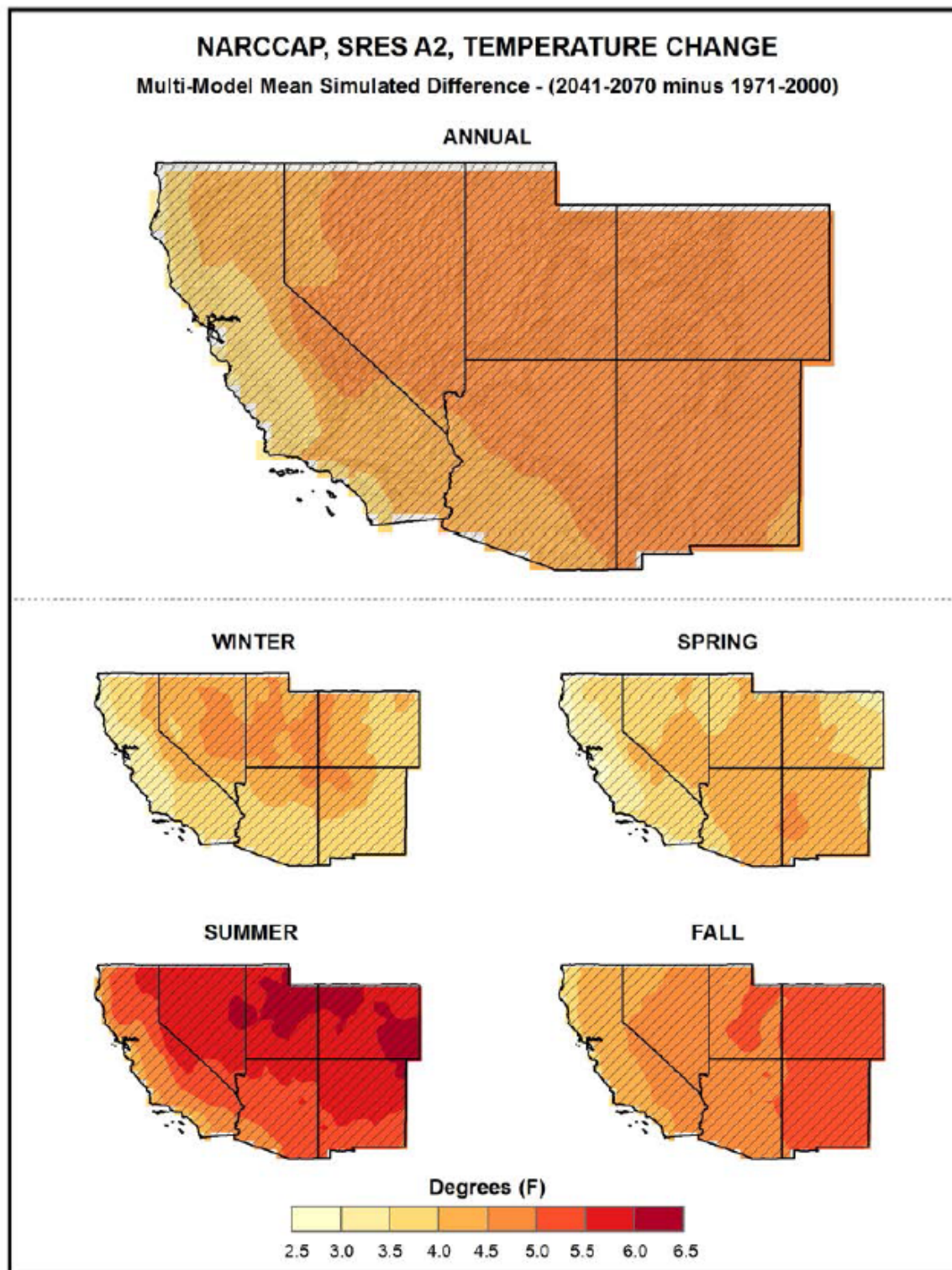


Figure 2. Projected annual and seasonal temperature change. Maps show projected change in average surface air temperature in mid-century (2040-2070) relative to the later part of the last century (1971-1999). Projected changes are averages from 11 NARCCAP regional climate simulations for the high (A2) emissions scenario. Color with hatching indicates that more than 50% of the models show a statistically significant change in temperature, and more than 67% agree on the sign of the change. Figure from Kunkel et al. (2012).

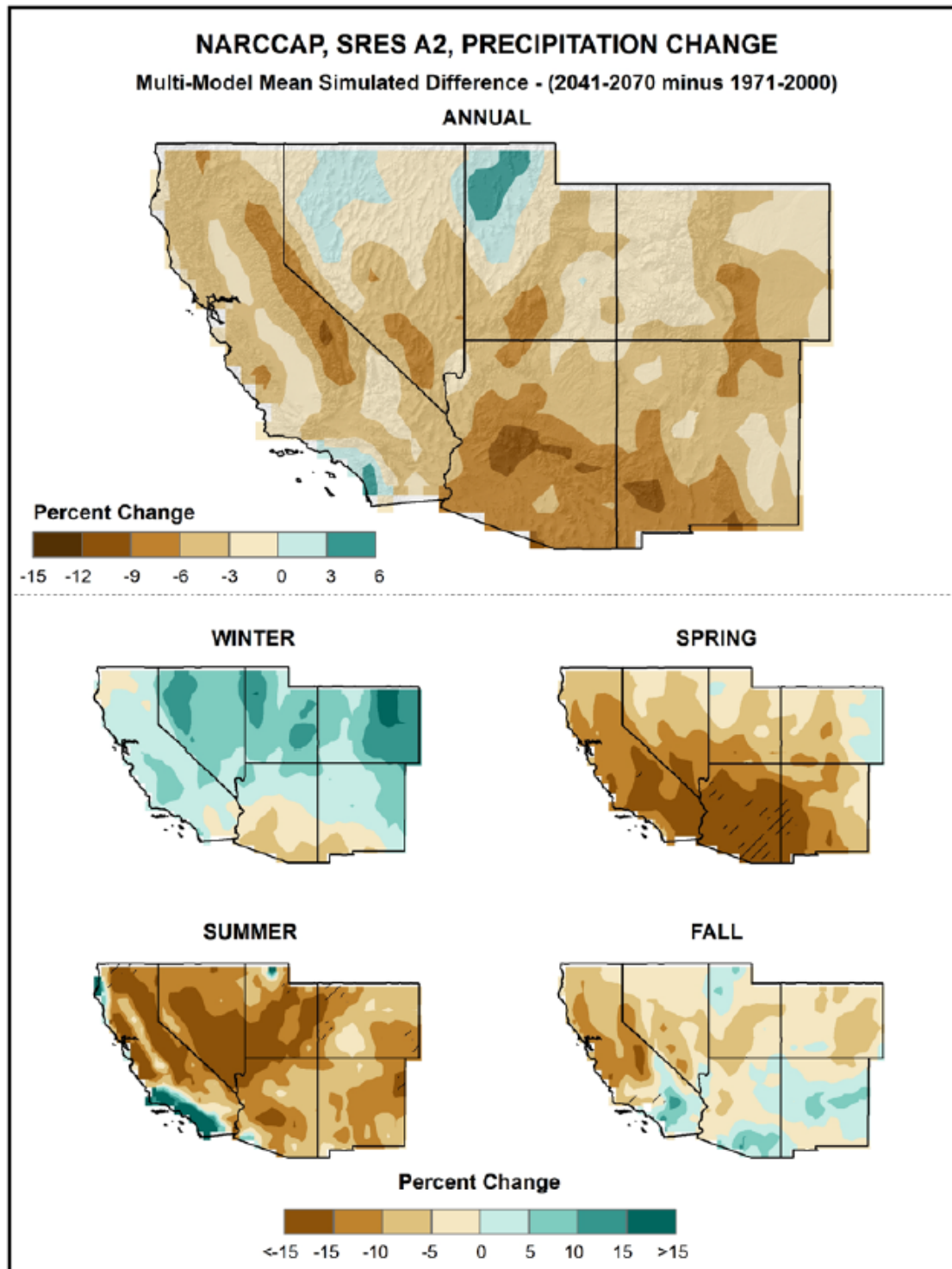


Figure 3. Projected annual and seasonal precipitation change. Maps show projected change in precipitation for mid-century (2040-2070) relative to the later part of the last century (1971-2000). Projected changes are averages from 11 NARCCAP regional climate simulations for the high (A2) emissions scenario. Color only indicates that less than 50% of the models show a statistically significant change in precipitation. Color with hatching indicates that more that 50% of the models show a statistically significant change in temperature, and more than 67% agree on the sign of the change. Figure from Kunkel et al. (2012).

References

Friedlingstein P., R. Houghton, G. Marland, J. Hackler, T. A. Boden, T. Conway, J. Canadell, M. Raupach, P. Ciais, and C. Le Quéré. 2010. Update on CO₂ emissions. *Nature Geoscience* 3:811-812.

Intergovernmental Panel on Climate Change (IPCC). 2007. Climate Change 2007: The Physical Science Basis. Cambridge University Press, Cambridge, UK.

Kunkel, K.E., L.E. Stevens, S.E. Stevens, L. Sun, E. Janssen, D. Wuebbles, and J.G. Dobson, 2012: Regional Climate Trends and Scenarios for the U.S. National Climate Assessment: Part 5. Climate of the Southwest U.S. National Oceanic and Atmospheric Administration Technical Report NESDIS 142-5, Washington, DC.

National Climate Assessment and Development Advisory Committee (NCADAC). 2013. U.S. National Climate Assessment v. 11 Jan 2013 DRAFT. <http://ncadac.globalchange.gov/>