



Climate Summary—Grand Teton National Park

January 2024



Climate change has the potential to alter the timing and amount of snow that covers the Teton Range.
NPS / C. J. ADAMS

Climate summary—Grand Teton National Park: January 2024

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Abstract

Climate change has the potential to profoundly alter national parks, affecting vegetation, wildlife, and cultural resources. In times of rapid change, proactive management is more effective than reactive measures, which simply respond to crises as they occur. Proactive management relies on understanding both past changes and expected future conditions. This resource brief examines historical climate patterns at Grand Teton National Park and compares them to projected conditions for the late 21st century. This type of information is the foundation for understanding potential impacts to nature and other resources in parks and can be used to help develop management strategies to mitigate unwanted change.

Acknowledgments

This project was funded by the [Inflation Reduction Act](#) (IRA), which provides the National Park Service with a historic opportunity to address critical ecosystem resilience, restoration, and environmental planning needs. The [IRA Restoration and Resilience projects](#) in national parks for this year represent broad-scale and impactful resource investments across every corner of our nation—from Alaska to Florida to Maine.

Introduction

Climate change has the potential to profoundly alter national parks, with probable impacts to vegetation, wildlife, and cultural resources (Monahan and Fisichelli 2014, Tercek et al. 2021). During this time of unusually rapid change (Intergovernmental Panel on Climate Change [IPCC] 2022), proactive management—planning that anticipates future conditions—is more likely to be successful than reactive management, which merely responds to crises as they arise. Proactive management depends on a clear understanding of both the changes that have already occurred and those expected in the future. This resource brief discusses historical climate patterns at Grand Teton National Park and compares them to the range of conditions projected for the late 21st century to provide insights for climate-change planning efforts.

Looking to the Future

Our discussion of the future is based on climate *projections*. Unlike weather *forecasts*, which typically extend only a few days to a few months into the future, climate projections, which are based on complex computer models of the earth's atmosphere and geological systems, extend decades into the future. Climate projections are not meant to predict the temperature or rainfall on a particular day or month in the future, but they capture long-term (decades to centuries) trends in average annual and seasonal patterns.

There are over 40 climate projections available from a variety of universities and agencies around the world. These projections include the effects of greenhouse gasses, ocean currents, clouds, and many other processes on future climates—and all indicate some amount of future warming in Grand Teton National Park. Because each projection models these processes differently, they vary in whether precipitation will increase or decrease and to what extent. The amount of water available in the ecosystem is not solely determined by precipitation. It also depends on temperature because warmer temperatures draw more water out of the soil at a faster rate. For this reason, hot projections with more precipitation could actually be drier than cooler projections with less precipitation.

In this resource brief, we chose two projections (Table 1) that span the range of wettest (Warmer projection) to driest soil moisture (Hotter projection) in the late 21st century (2070–2099). In these two projections, the changes in precipitation are expected to be minor.

Table 1. Alternative future projections considered for Grand Teton National Park. Average annual temperature and total annual precipitation increases are calculated for 2070–2099 relative to 1981–2010. Historical data are taken from GRIDMET gridded data, and future data are produced using the MACA downscaling method (Abatzoglou and Brown 2012, Abatzoglou 2013).

Prediction Model	Temperature Increase	Precipitation Change
Warmer (MRI-CGCM3 RCP 8.5)	6°F	–1.5 inches (5%)
Hotter (MIROC-ESM-CHEM RCP 8.5)	14°F	+0.6 inches (2%)

Temperature and Water Availability Patterns

Historical (1911–2022) daytime highs measured at Moran Junction, WY, did not have a strong trend (Figure 1, top), but nighttime lows had a roughly 3–4°F warming trend (Figure 1, bottom). Similar patterns were seen at other weather stations in the area, but Moran Junction had the longest record available. The Warmer projection called for about 6°F of warming in annual average temperature by late century (Figure 2). This would cause the length of the season with below-freezing temperatures to decrease by about 7 weeks (Figure 3). The Hotter projection calls for about 14°F warming in annual temperatures (Figure 2) and a 14-week decrease in the freezing season (Figure 3) by late century. The projected late-century medians for number of days above 85°F (41 days for the Warmer projection, 76 days for the Hotter) is 2–3 times more than the longest historical count (20 days in 2003, Figure 3).

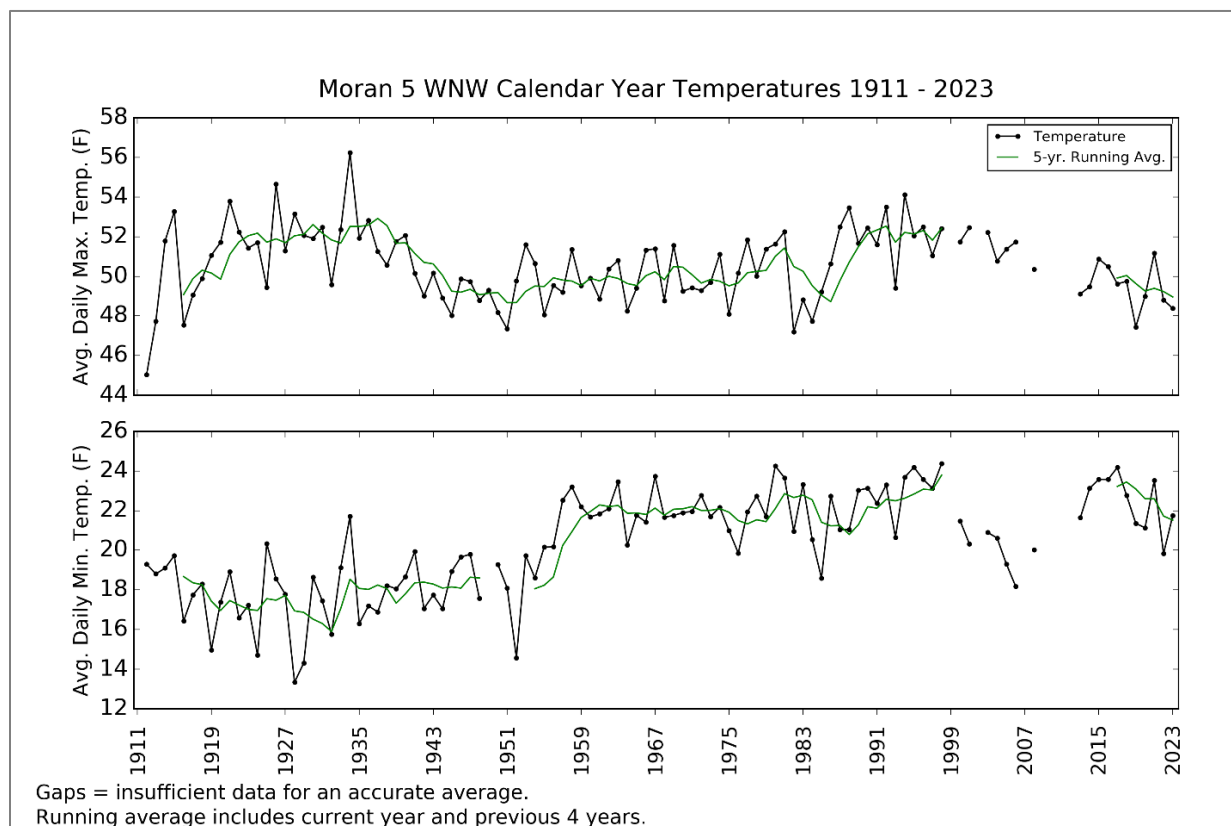


Figure 1. Temperature trends at the Moran Junction, WY, weather station 1911–2022. Blanks are years with data insufficient for calculating an average. Top: Annual averages of daily high temperatures. Bottom: Annual averages of nighttime low temperatures. ([Climate Analyzer.org](https://climateanalyzer.org))

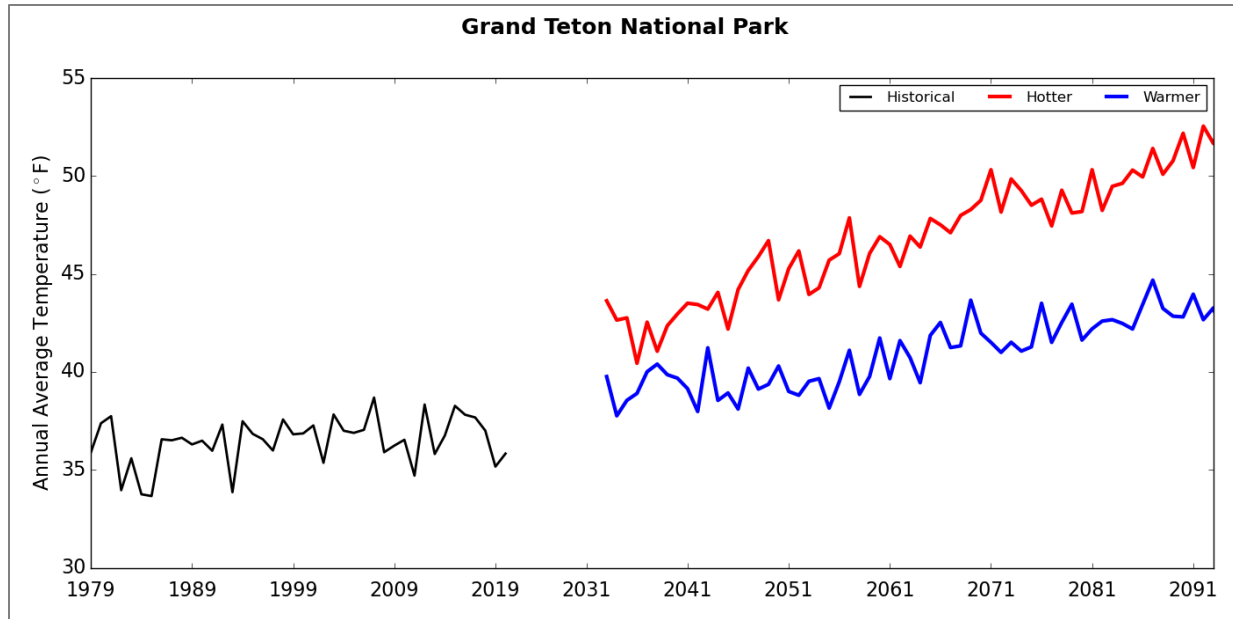


Figure 2. Historical annual average temperatures (black) and two future projections (red and blue) that bracket the range of Hotter vs. Warmer futures at Grand Teton National Park. Data for this graph and those that follow are for the park centroid (43.82, -110.71), which is near Leigh Lake (Abatzoglou and Brown 2012, Abatzoglou 2013).

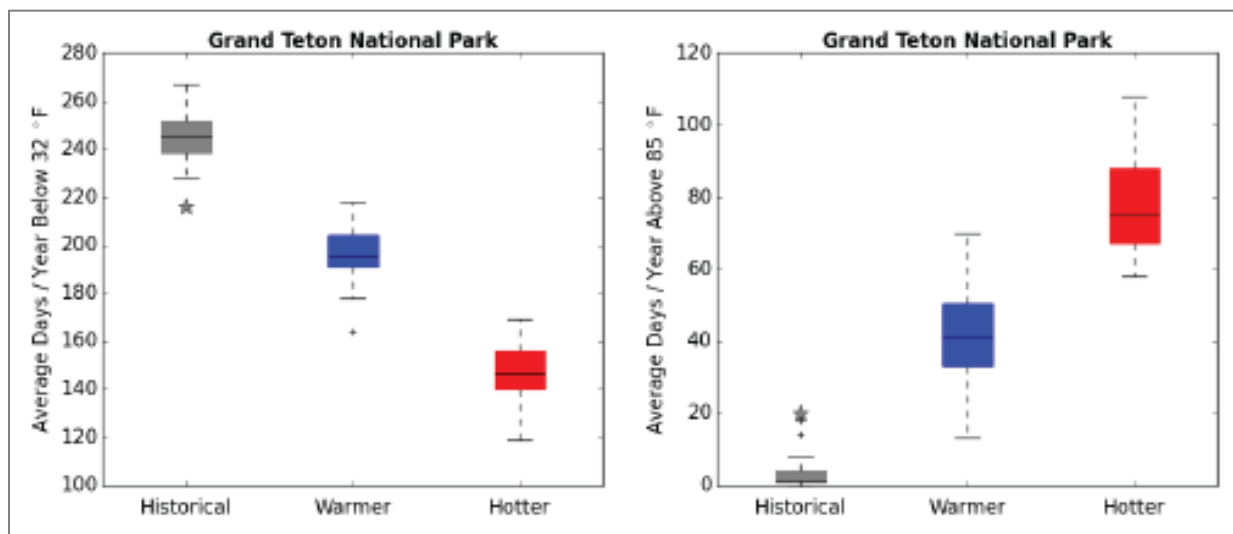


Figure 3. Historical average number of days with temperatures below 32°F and above 85°F compared to Warmer and Hotter future projections for the late 21st century (2070–2099). The left gray star marks the smallest count of below-freezing days during 1979–2022 (216 days in 2015). The right gray star marks the greatest count of days above 85°F during 1979–2022 (20 days in 2003). (Abatzoglou and Brown 2012, Abatzoglou 2013).

There were no clear historical trends in precipitation during 1911–2022 (Figure 4), but future summers in Grand Teton National Park will likely be drier than historical summers. In the future, July and August will likely continue to be the months with the lowest precipitation (Figures 5, 6), but

all of the alternative projections, even those with annual precipitation increases, show lower than historical soil moisture during at least some of the warmest months (April–October; Figure 6) because warming summer temperatures will increase evaporation and transpiration above historical levels (actual evapotranspiration; Figure 6).

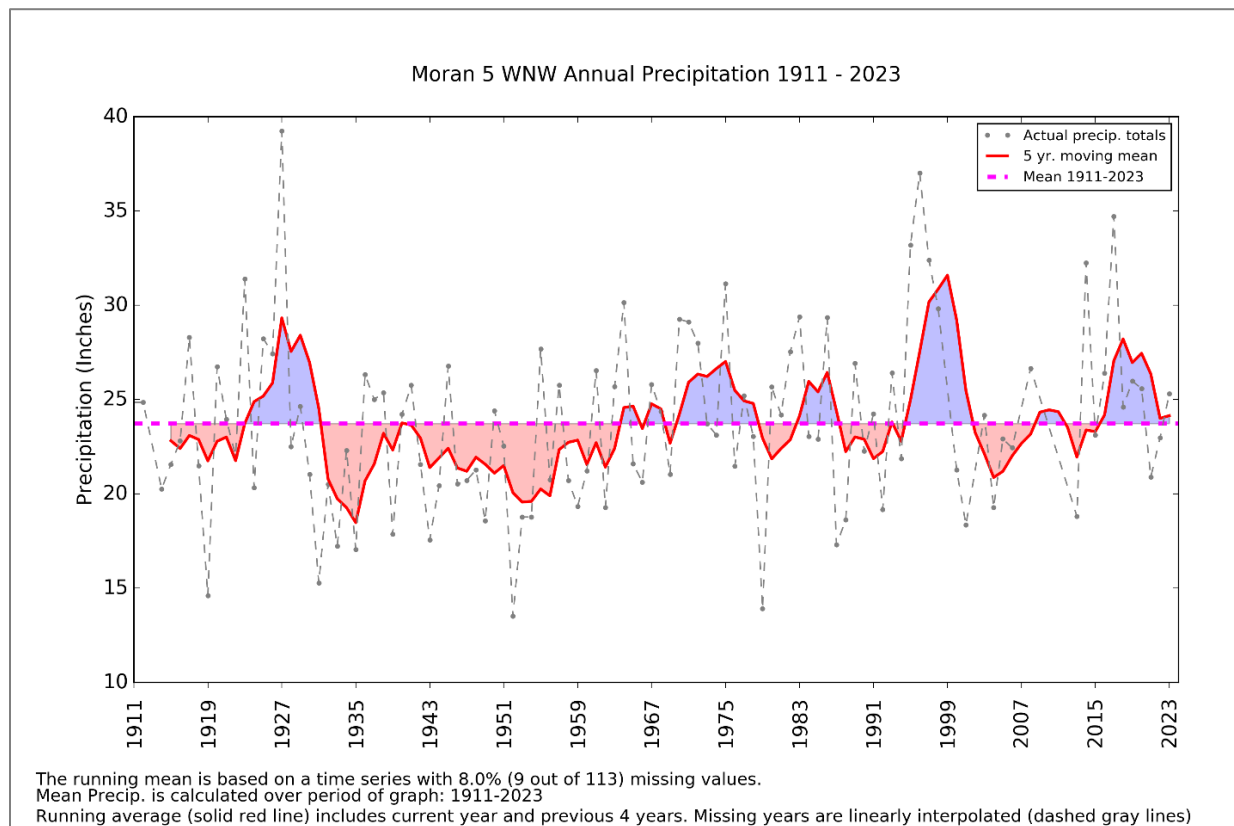


Figure 4. Annual precipitation 1943–2022 at the Moran Junction, WY, weather station. The dashed magenta line represents the period average (23.7 inches) (Tercek et al. 2021, in press).

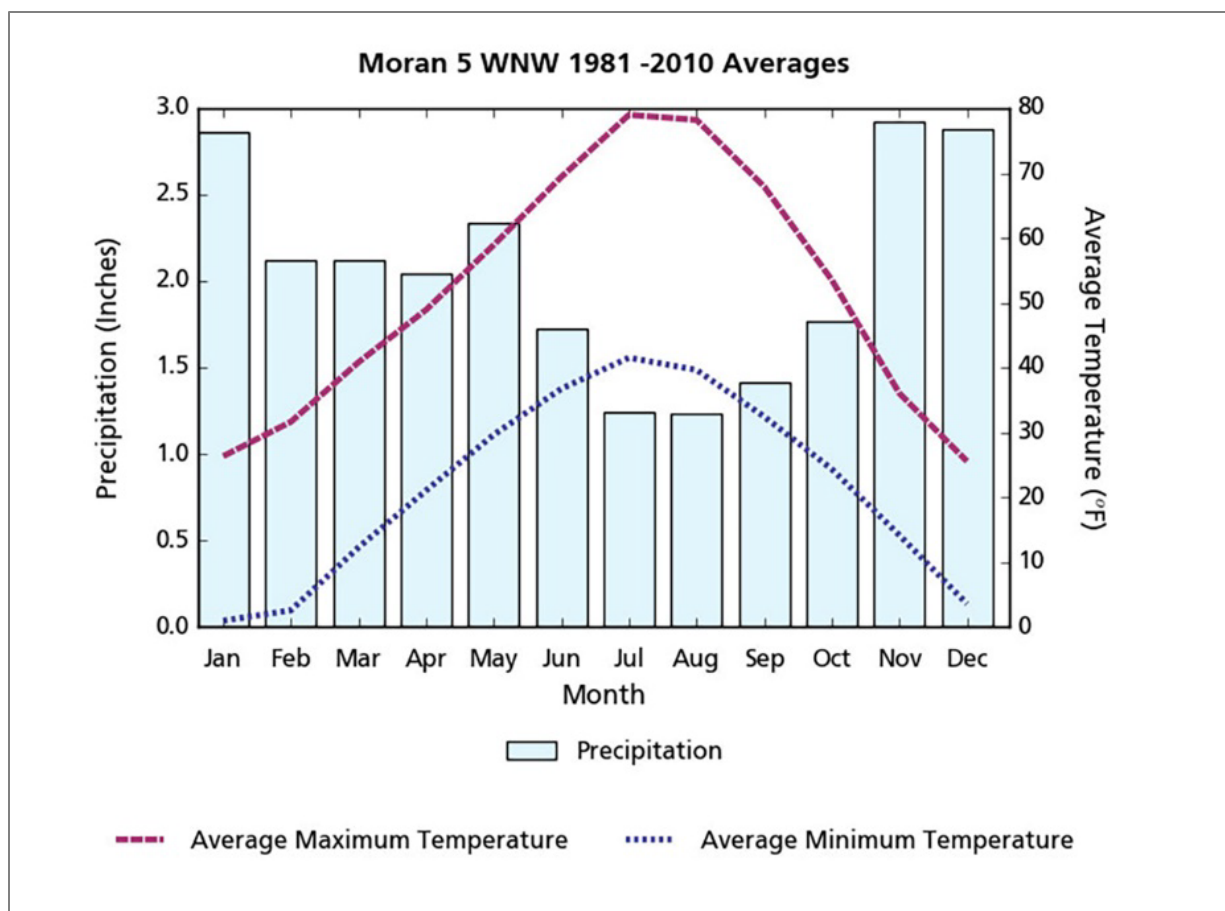


Figure 5. Seasonal patterns in temperature and precipitation 1981–2010 at Moran Junction, WY. July and August had the least precipitation. This graph shows National Weather Service 30-year averages (Tercek et al. 2021, in press).

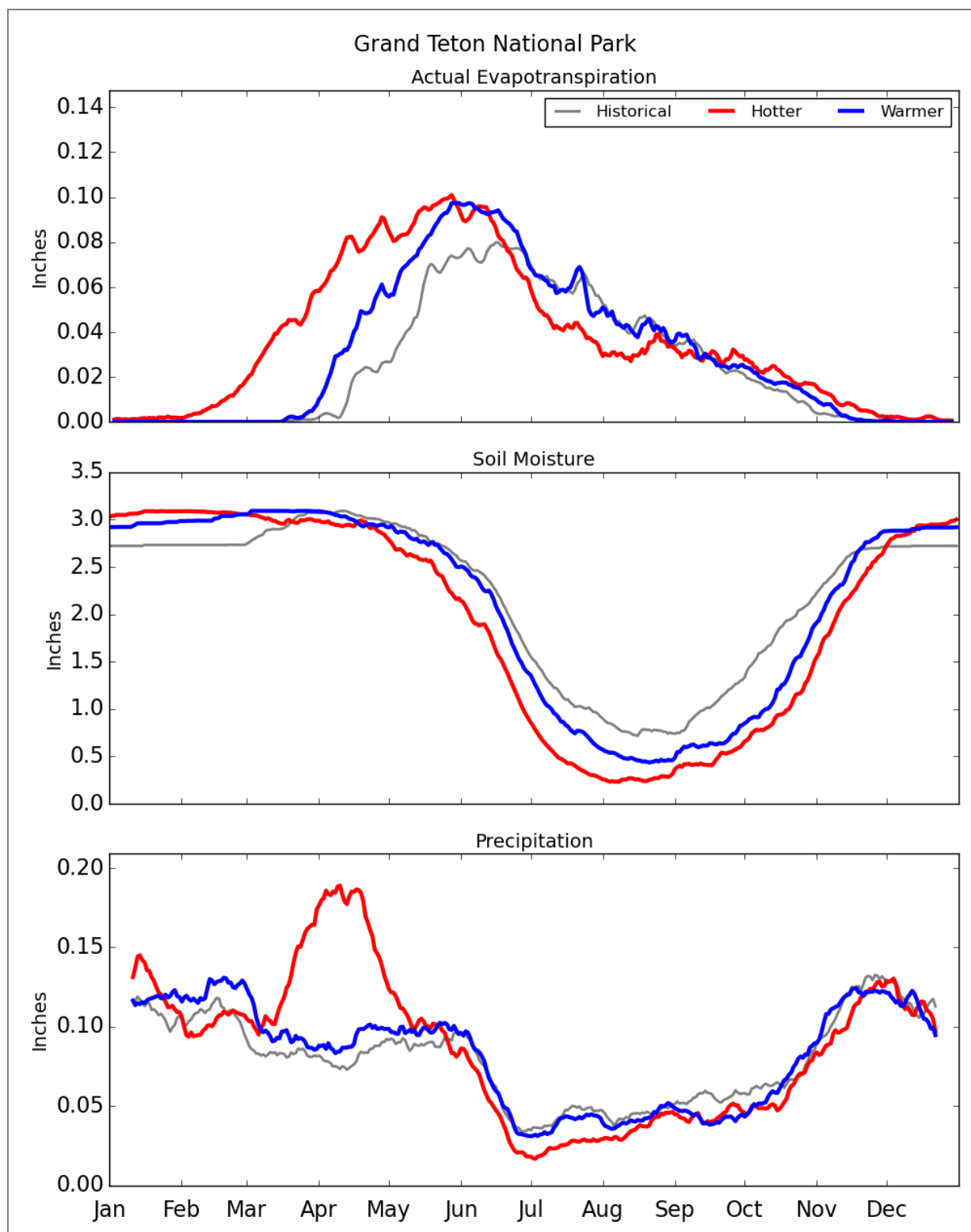


Figure 6. Grand Teton National Park historical (1981–2010) seasonal patterns (gray lines) for hydrologic variables compared to late 21st century (2070–2099) projected Warmer (blue lines) and Hotter (red lines) seasonal patterns. Variables shown are actual evapotranspiration (combined evaporation and plant water use), soil moisture, and precipitation (Tercek et al. 2021, in press).



Projected changes in growing season timing, temperature, and precipitation have the potential to alter vegetative communities and habitats, especially those that are already sensitive like alpine and wetland areas. These changes will also likely have cascading effects on the birds, insects, and mammals that live there (NPS / T. CHAVIS).

Extension of the Growing Season

The length of the growing season can be estimated by actual evapotranspiration (AET), which is the amount of water that can be either evaporated or transpired (used by plants) each day (Tercek et al. 2023). AET is calculated from temperature and precipitation in combination with other information such as soil type, and it is greater than zero only during times when it is relatively warm (generally above 40°F) and water is available in the soil—the same conditions needed for plants to grow. By looking at changes in the seasonal patterns of when AET is greater than zero, scientists can track changes in the growing season length.

By the late 21st century (2070–2099), the Warmer projection, indicates an earlier growing season start (time when $AET > 0$) of about one month (blue line, Figure 6, top panel). In contrast, the projected growing season will begin as much as 2 months earlier in the Hotter projection—March rather than May (red line, Figure 6, top panel). Interestingly, the Hotter projection (red line, Figure 6, top panel) calls for a slight depression in plant growth later in the season as soil moisture becomes depleted (Figure 6, middle panel).

Changes in Snowpack

Climate change is likely to greatly reduce the length of the snow cover season but have less of an effect on peak snowpack depth (Figures 7, 8). Under the Warmer projection, the winter might be only one-third the length of current winters, but the amount of snow that accumulates during this brief window might be comparable to historical levels. On the other hand, the Hotter projection calls for peak snow levels to decrease by 50% or more, at least in the lower elevations (right side of maps shown) with winters that are roughly one-sixth the length of the historical season.

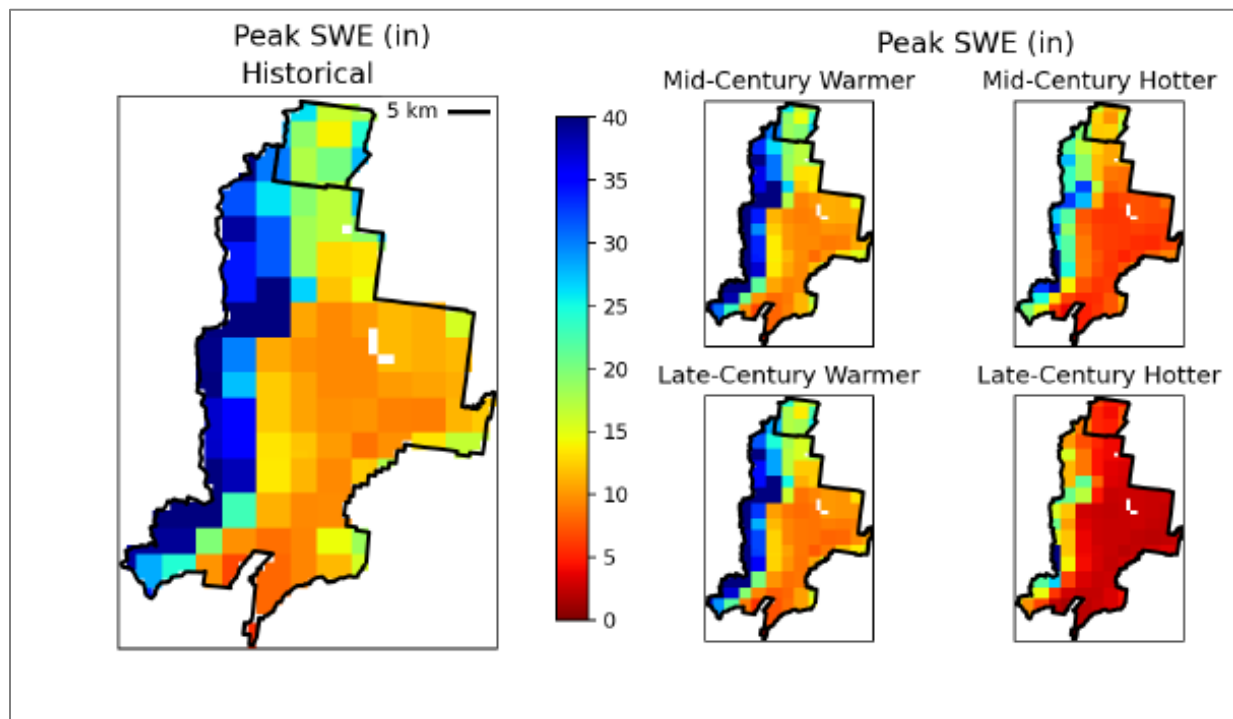


Figure 7. Map of the historical (1981–2010) average peak snow water equivalent (SWE) compared to mid-century (2040–2069) and late-century (2070–2099) SWE projections under the RCP 8.5 climate-change scenario for Grand Teton National Park. The Warmer projection has about 6°F warming by late century and the Hotter has 14°F. White areas within the park boundary are missing data. The Teton Range runs top to bottom along the left side of each map with lower elevations on the right. (Tercek et al. 2021, in press).

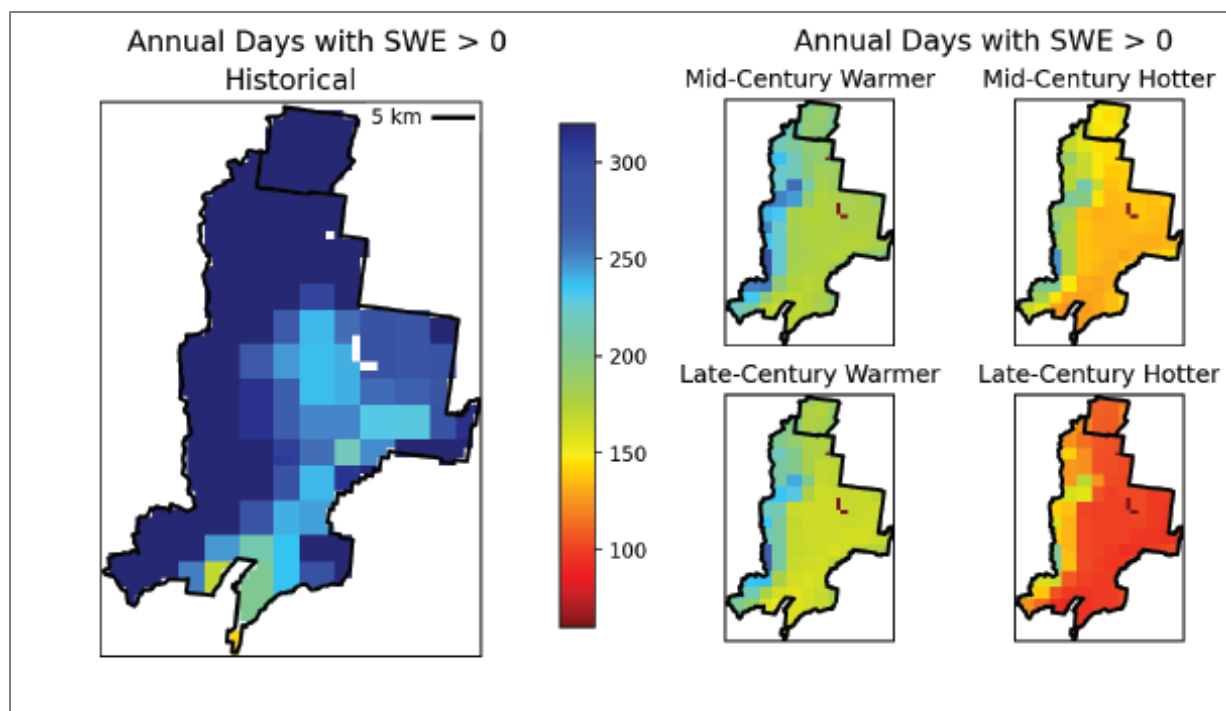


Figure 8. Map of historical (1981–2010) average annual days with snow cover (SWE > 0) compared to mid-century (2040–2069) and late-century (2070–2099) annual days with SWE projections under the RCP 8.5 climate-change scenario for Grand Teton National Park (Tercek et al. 2021, in press).

Conclusions and Implications

As in much of the western US, increasing temperature is a certainty in Grand Teton National Park. Despite any potential increases in precipitation, it will likely be drier during some of the warmest months of the year (April–October). The months that are drier within this period vary among projections, but the dry season will be drier in the Hotter scenario. The period of snow cover will be shorter, and the growing season will be longer in both projections, driven by warmer spring temperatures. This is not necessarily good news for all plants. Cold-adapted species could be pushed out by competitors from lower elevations that are able to use the additional months of growth to monopolize space. Some of these new species will probably be nonnatives or weeds like cheatgrass (*Bromus tectorum*). Drier summertime soils would also put shallower-rooted plants at a disadvantage against deeper-rooted shrubs and trees. It is difficult to predict all the cascading biological effects of these climate changes, but it is likely that plant and animal communities will be dramatically different by the end of the century.

Future vulnerability assessments will examine how these projections may impact park plant and animal species like those found in the sagebrush communities of Grand Teton National Park.

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