



Southern Colorado Plateau

INVENTORY & MONITORING NETWORK

Climate Resource Brief - Mesa Verde National Park

2025

KEY FINDINGS

- Overall, temperatures have warmed at MEVE over time.
- Future projections indicate:
 - a. There will likely be warming of 6-11 (°F) by the end of the century.
 - b. There will be a sharp decrease in the number of days per year below freezing and an increase in the number of days above 90 (°F).
 - c. Lower than historic average soil moisture during some of the warmer (April-October) month
 - d. Total annual precipitation projections are mixed, depending on time of the year.
- These projections will continue the trend of increasing temperature in the park which has been correlated with the occurrence of fire (i.e., >50% of MEVE has burned since 1996).

Background: The [Southern Colorado Plateau Network](#) (SCPN) has been monitoring climate at [Mesa Verde National Park](#) (MEVE) and other parks and monuments, using an existing network of [weather stations](#) around the region. Partners like author Mike Tercek, have also utilized this same data to model much needed future projections and outlooks.

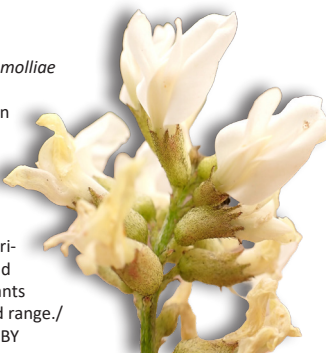


Storm clouds behind the Far View Sites near Chapin Mesa at Mesa Verde National Park/NPS

Introduction: Climate change has the potential to profoundly alter National Parks, with potential impacts to vegetation, wildlife, and cultural resources (Monahan and Fisichelli 2014, Tercek et al. 2021). During this time of unusually rapid change (IPCC 2022), proactive management is more likely to be successful than reactive management, which merely responds to crises as they arise. Proactive management plans depend on a clear understanding of both the changes that have occurred so far and what we might expect in the future. This resource brief discusses historical climate patterns at Mesa Verde National Park and compares them to the range of conditions that we expect for the late 21st Century.

Our discussion of the future is based on climate “projections.” Unlike weather “forecasts,” which typically extend only a few days to a few months in the future, climate projections, which are based on complex computer models of the earth’s atmosphere, land, oceans, and sea ice, 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 are skilled at capturing long-term (decades to centuries) trends in average annual and seasonal patterns. There are over 40 climate projections available. They all call for some amount of future warming in Mesa Verde, but there is disagreement on whether precipitation will increase or decrease. As future warming interacts with changes in precipitation, it will change the amount of water that is available for plants and animals.

Astragalus schmolliiae
(Chapin Mesa
Milkvetch) is an
endemic plant
that grows
in Mesa
Verde
National Park.
Warmer and drier
futures could
impact this plants
already limited range./
Matt Lavin CC-BY



Written by: Mike Tercek - Ecologist - Walking Shadow Ecology

A large amount of warming would greatly increase evaporation and transpiration (plant water use), but less warming would require a smaller increase in precipitation to maintain historically normal moisture levels. In this resource brief we have chosen two projections that capture the range of wettest (most biologically available water) vs. driest (least available water) conditions that are projected for the late 21st century (2070 - 2099).

Temperature Patterns: Temperatures at the Mesa Verde weather station had warming trends during the period of record 1922 – 2024 (Figure 1). Daytime highs generally declined from the 1950s-1970s and have warmed since then. Similar patterns were seen at other weather stations in the area. Similar patterns were seen at other weather stations in the area.

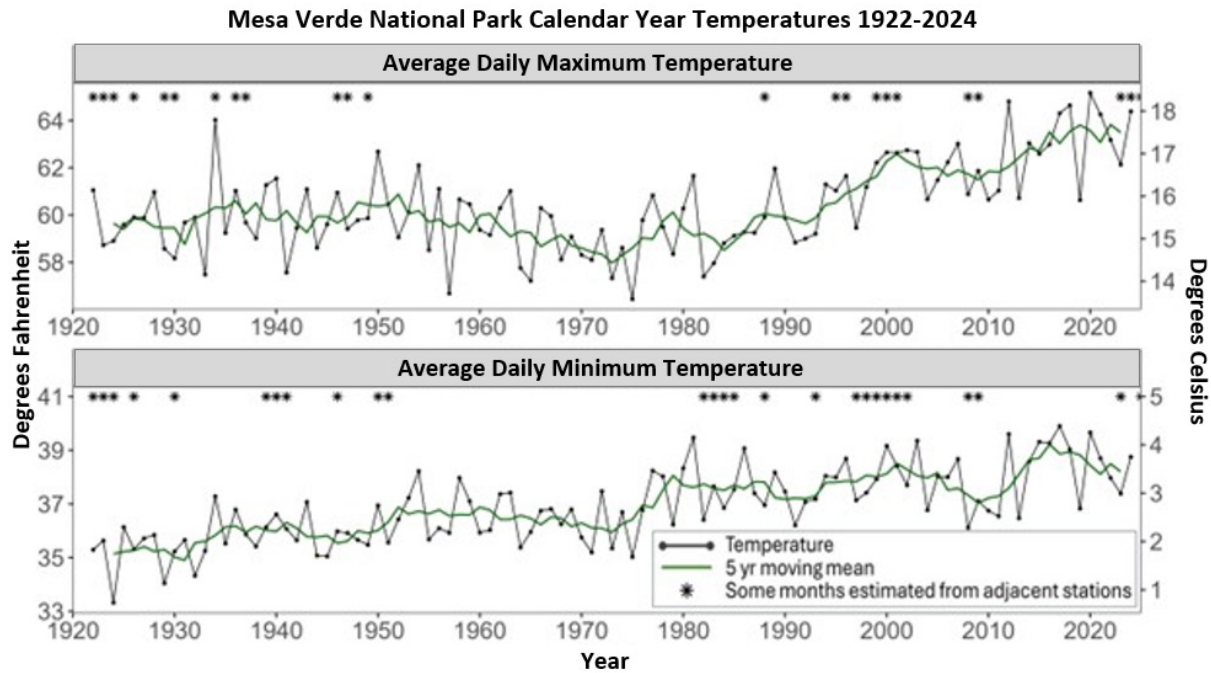


Figure 1. Temperature trends at the Mesa Verde National Park weather station (COOP ID 55531; 37.199, -108.489) 1922 - 2024. Top: Annual averages of daily high temperatures. Bottom: Annual averages of night-time low temperatures. Values were adjusted for changes in station location and methods/equipment changes by using data from multiple adjacent stations. Values with one or more contributing monthly values estimated from adjacent stations are noted with *. Data source citation: Menne et al. (2017).

The two future projections call for roughly 6 - 11 (°F) of warming in annual average temperature by late century compared to the historical average (Figure 2).

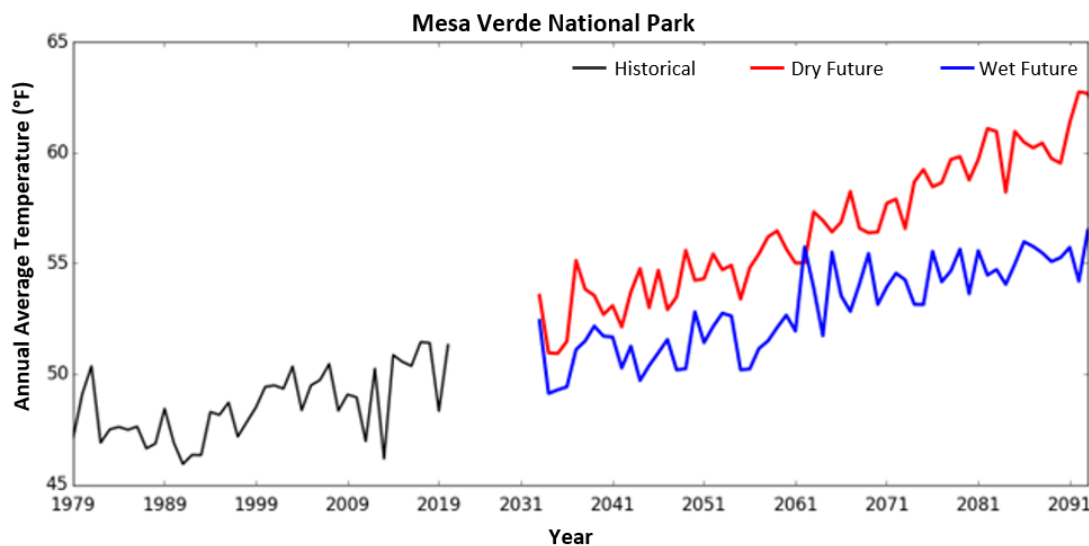


Figure 2. Historical annual average temperatures (annual average of daily average temperatures) and two future projections that bracket the range of driest vs wettest futures at Mesa Verde National Park. Historical data = GRIDMET, Wet Future = MACA downscaled MRI-CGCM3 RCP 8.5. Dry Future = IPSL-CM5A-LR RCP 8.5. Data source citations: Abatzoglou (2012, 2013). [What is MACA?](#)



Mesa Verde is no stranger to wildfires, like the North Face Fire that burned in July 2024. Increased temperatures could lead to more fires in the future. /NPS

This warming would cause sharp decreases in the number of days per year below freezing and increases in the number of days above 90 °F (Figure 3). Under both of the futures, the late century median number of days below freezing (105 days, 85 days for the wet, dry futures) is similar to the lowest historical count of freezing days (100 days in 2017, Figure 3). The late century median number of days above 90 °F (46, 90 days for the wet, dry futures) is 3 - 5 times more than the largest historical count (16 days in 2003, Figure 3).

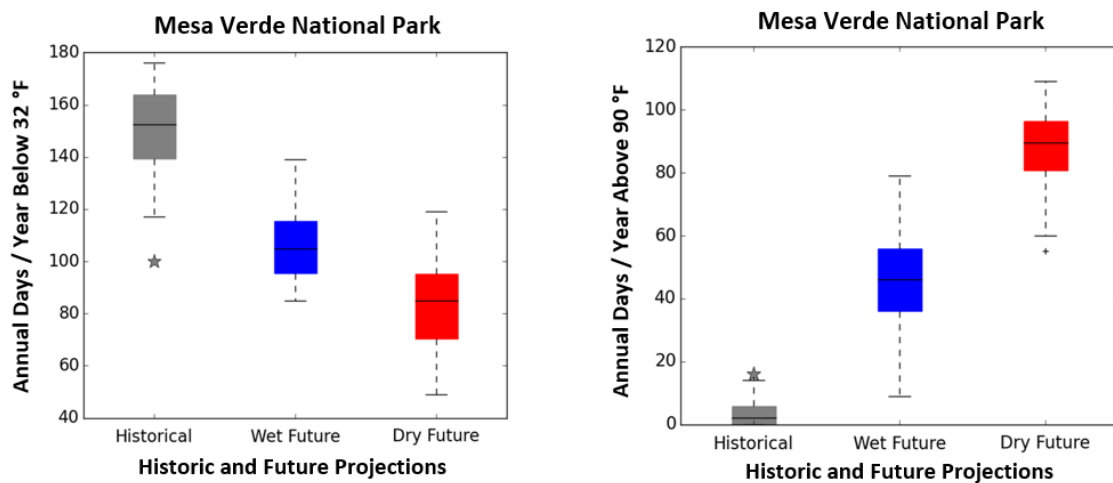


Figure 3. Left: Annual number of days per year below freezing. The gray star marks the smallest count during 1979 – 2024 (100 days in 2017). Right: Annual number of days above 100 F. The gray star marks the greatest count during 1979 – 2024 (16 days in 2003). Data source citations: Abatzoglou (2012, 2013).

Water Availability:

Future trends in total annual precipitation are uncertain, but it is likely that seasonal patterns of water availability will change in clearly-understood ways.

Historic Water

Availability Patterns: At park headquarters, total annual precipitation had no clear increasing or decreasing trend during 1922 – 2022 (Figure 4). Historically, June had the least precipitation. May and April were second and third driest (Figure 5).

Mesa Verde National Park Calendar Year Precipitation 1922-2024

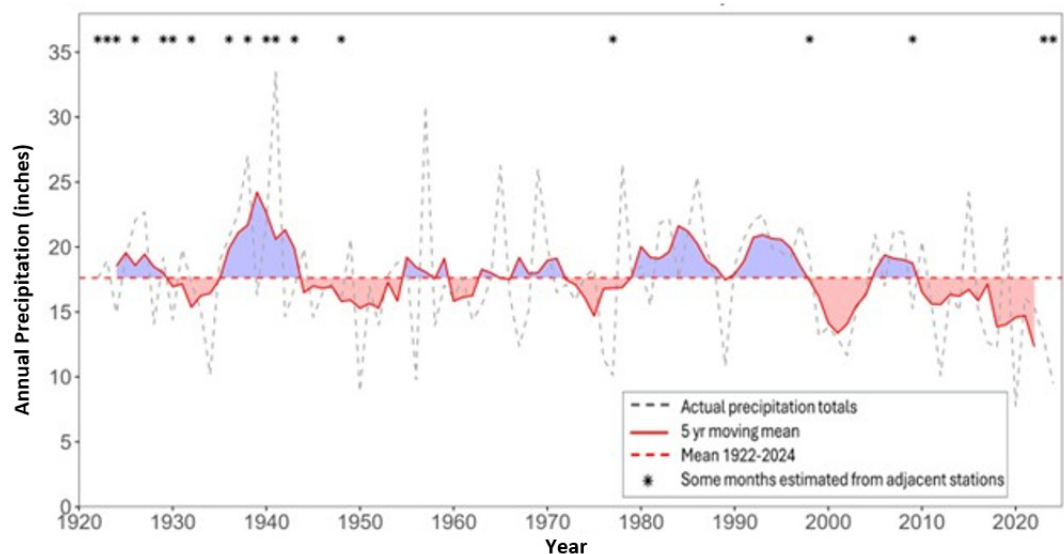


Figure 4. Annual precipitation 1922 – 2024 at the weather station in Mesa Verde National Park COOP ID 55531; latitude 37.199, longitude-108.489). The dashed red line is the period average (17.6 inches). Values with one or more contributing monthly values estimated from adjacent stations are noted with *. Data source citation: Menne et al. (2017).

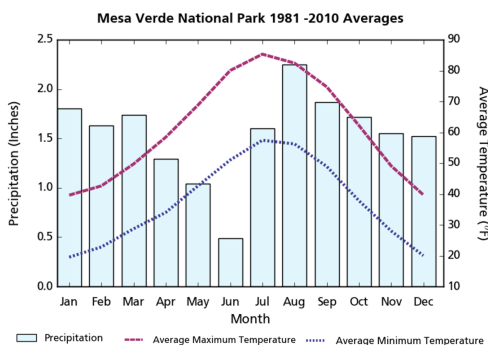


Figure 5. 1981 – 2010 seasonal patterns in temperature and precipitation at the park headquarters weather station in Mesa Verde National Park. April – June had the least precipitation.

Since warmer temperatures cause more evaporation and transpiration, soil water availability was historically at its lowest point in July - August, despite the higher rainfall during those months.



A snowy day view from Spruce Canyon
/John Cahill-NPS

Future Water Availability Patterns: Future projections for total annual precipitation are mixed, ranging from significant increases to significant decreases, but all of the alternative futures, even those with annual precipitation increases, show lower than historical soil moisture during at least some of the warm (April – October) months because warming temperatures remove water from the soil more quickly (Figure 6). Similarly, even though the wet future calls for increased cool season precipitation, it shows earlier snow melt in the spring and approximately 1/3 - 1/5 as much standing snow in January and February (Figure 6). As in the past, June will likely continue to have the least precipitation, but some of the projections (e.g. Figure 6, blue line) show increased precipitation in the fall or spring (Figure 6). These future changes in moisture availability will change the season in which plants are best able to grow, as measured by Actual Evapotranspiration, which is a combined index of evaporation and plant water use. In some of the alternative projections, spring and fall become more favorable for plant growth than mid-summer. For example, the driest projection (red line in top panel, Figure 6) has spring/fall peaks and a dip in summer. In the wettest projection (blue line, Figure 6), plant growth (AET) is similar to historical levels during the hottest months, and the season with these favorable growth conditions becomes longer, extending from April – September.

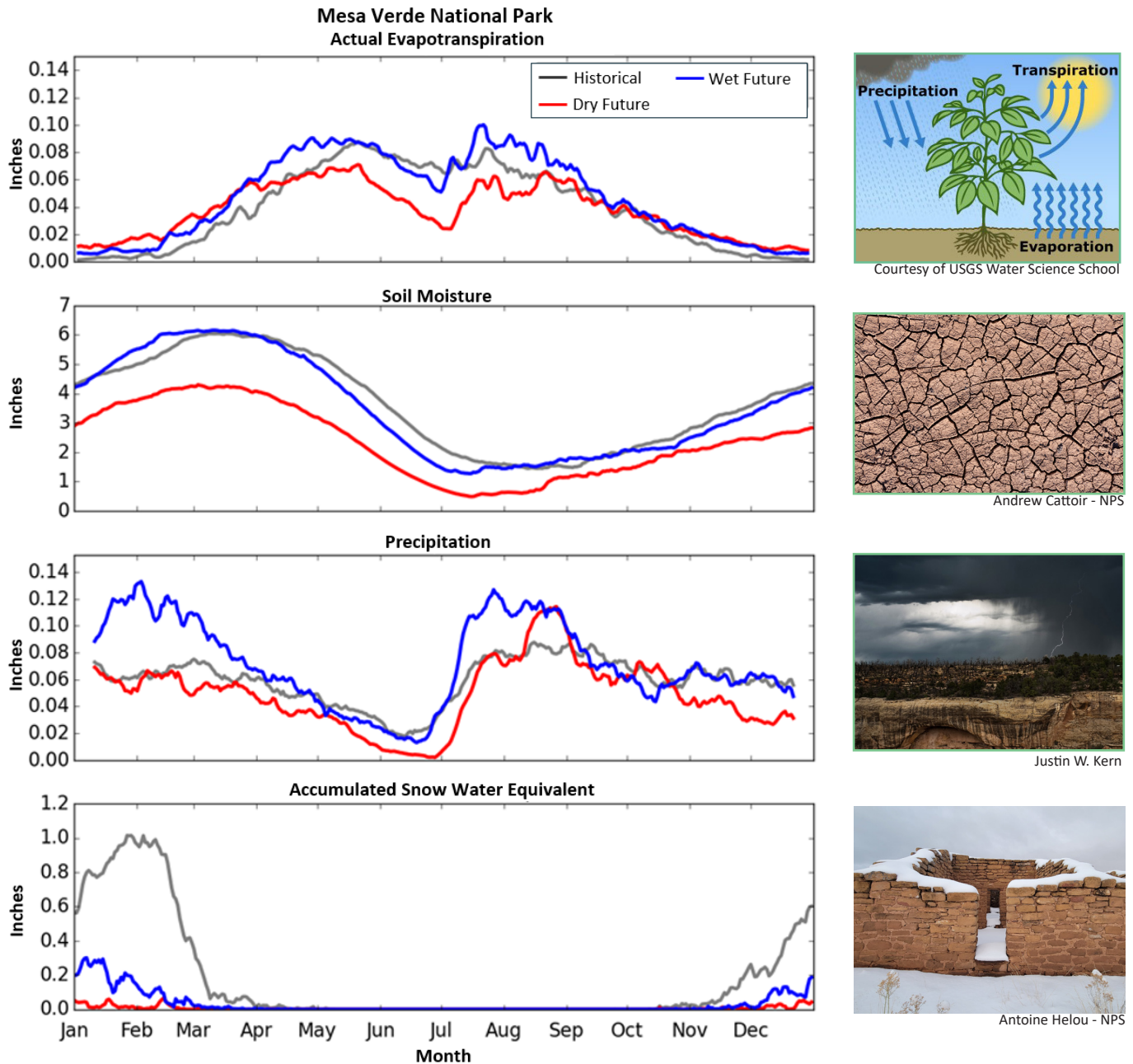
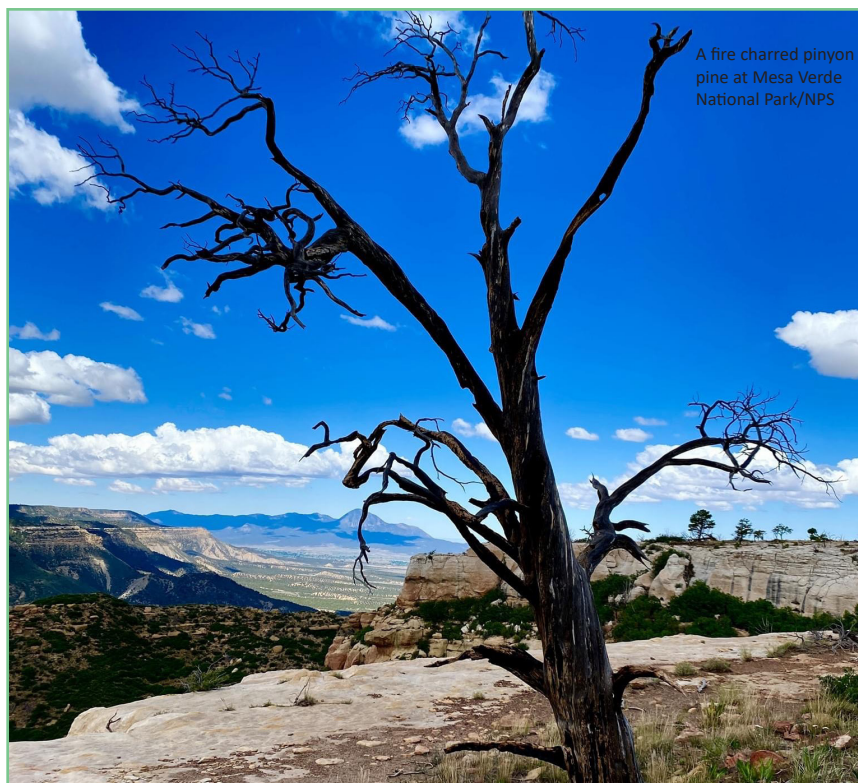


Figure 6. Historical (1981 - 2010) seasonal patterns in Actual Evapotranspiration (combined evaporation and plant water use), soil moisture, precipitation, and Accumulated Snow Water Equivalent compared to Late 21st Century (2070 - 2099) seasonal patterns. Snow Water Equivalent (SWE) is the amount of water contained in snow. Depending on snow density, SWE can be 10% - 50% of snow depth. This graph shows 30-averages of total SWE accumulated (standing). In contrast, the precipitation lines (third panel) show 30-averages of daily rain / snow fall totals. Data source citations: Tercek et al. (2021, 2023), Tercek et al (2023). [Information on calculation methods.](#)

Conclusions: The future in Mesa Verde National Park will likely be warmer. Despite any potential increases in precipitation, it will likely be drier during at least some of the warmest months of the year (April – October), but the exact months that are projected to be drier varies among alternative projections. Some of the projections call for increased precipitation and plant growth in the fall and/or spring. The cold season, with days below freezing, will be only 1/2 – 2/3 the historical length; there will be less than 1/3 as much standing snow; and unusually hot days above 90 (°F) will be 5 – 8 times more frequent than anything seen historically. These changes continue a trend of increasing temperatures seen in the park since the 1970s. As temperatures increased, so too did fires. Since 1996 to the present, more than 50% of the park has burned, leading to widespread loss of old growth pinyon and juniper stands (NPS 2018).



A fire charred pinyon pine at Mesa Verde National Park/NPS

After a storm, a rainbow appears over Cliff Palace /Stephen M. Daniels



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