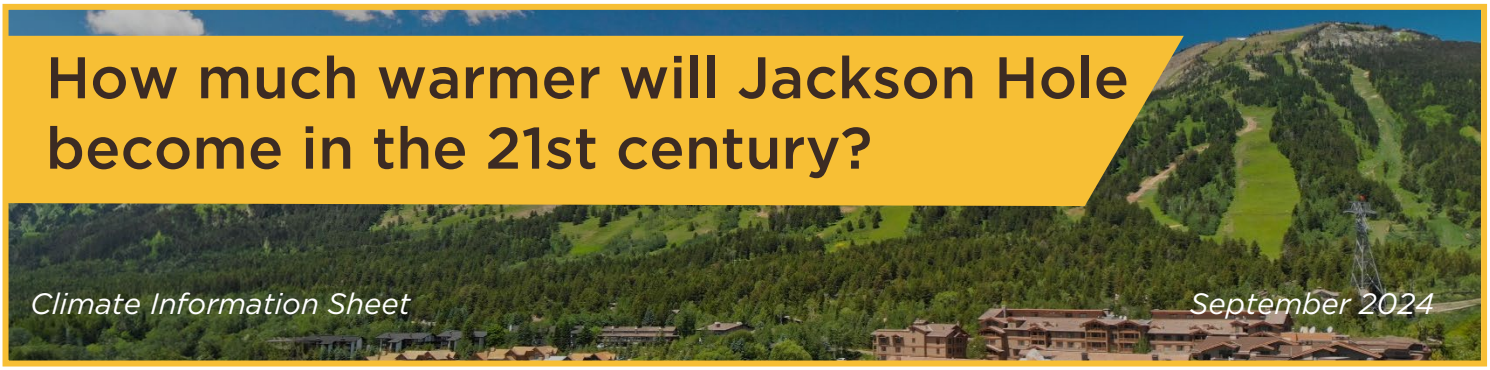
How much warmer will Jackson Hole become in the 21st century?



Climate Information Sheet *September 2024*

- **TEMPERATURES IN JACKSON RISE FASTER THAN THE GLOBAL AVERAGE**
- **JACKSON COULD BECOME A CLIMATE REFUGE**

The climate in Jackson Hole, and in the surrounding Greater Yellowstone Area (GYA), is anticipated to change more rapidly in the 21st century, compared to the last few decades. Here, we provide some quantitative information about anticipated changes in surface air temperature for the 21st century.

The CMIP6 member climate models, built by climate research centers across the world, represent the physical processes underlying interactions between the biosphere, atmosphere, and oceans in slightly different ways, and the representation of these complex processes has inherent uncertainty.

In addition, the climate system carries significant internal variability. Therefore, models disagree about the rate of warming, but they agree on the general future trend.

The "consensus" ensemble mean temperature trend in the GYA, and the variability between models, is shown in Fig. 1. Historically, the models agree rather well with the observed annual-mean temperature and its slight upward trend. More rapid warming is anticipated in future decades. The trend picks up with time to about 1°F per decade, with the most rapid change towards the end of the 21st century. The data in figure 1 are averages over the GYA domain based on hourly data. The daily minimum and the daily maximum, as well as all four seasons, are anticipated to warm at about the same pace (not shown).

The rate of warming, shown in figure 1, is about 1.5 times the global mean warming rate. The global trend assumes a middle-of-the-road carbon emission pathway. The actual warming rate depends on the choices mankind will make, i.e. the rate at which we can decarbonize the economy.

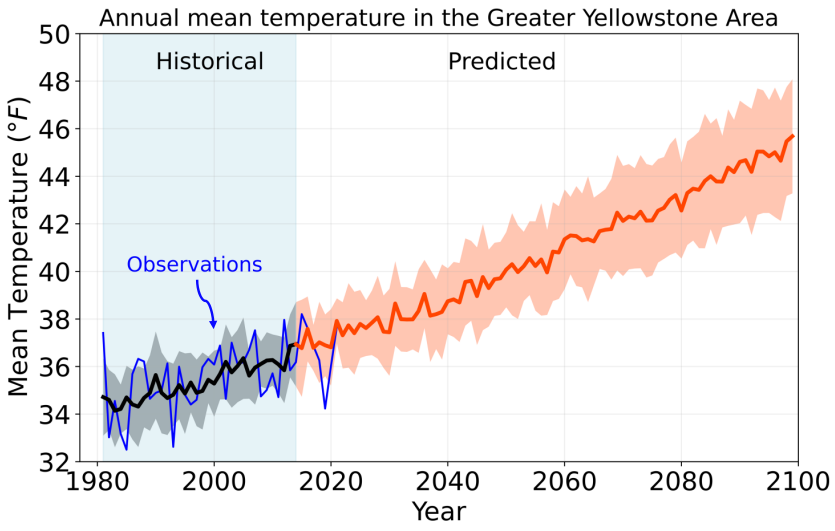


Figure 1. Annual mean temperature in the GYA through 2100.

Solid lines are an ensemble mean, and the shaded region represents the model uncertainty (±1 standard deviation of 15 different climate models, see details on reverse). The observed temperature is based on PRISM.

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EPILOGUE: JACKSON HOLE AS A CLIMATE REFUGE

The warming trend results in a loss in mountain snowpack, shown in another Information Sheet (see box below). This change is expected to occur earlier in other parts of the western United States, especially in more coastal areas and in the Southwest, according to the same dataset (WUSD3) and other sources.

This implies that Jackson Hole, and the GYA in general, will increasingly become a climate refuge. The influx of people seeking refuge from the summer heat or seeking reliable snow in winter represents an opportunity for the hospitality industry. It also implies an increasing pressure on the available housing and demand adequate preparations.

SCIENCE DETAILS

The estimates presented here are based on Intergovernmental Panel for Climate Change (IPCC) 6th Coupled Model Intercomparison Project (CMIP6) under the default Shared Socio-economic Pathway (SSP) 3-7.0. Under this pathway, the atmospheric carbon dioxide concentration will more than double to 870 ppm by 2100, compared to 420 ppm in 2023.

Figure 1 is based on the WUSD3 dataset (Rahimi et al. 2024)[1], which bias-corrects and then dynamically downscales 15 CMIP6 simulations down to a grid resolution of 9 km (5.6 miles). This is sufficient to capture the essential details of the terrain (Fig. 2), although a finer resolution clearly would be better.

This WUSD3 dataset has been validated against historical data (1980-2014), and it does quite well over mountains (Adhikari et al. 2024)[2]. This assessment is an update from the 2021 GYA Climate Assessment, which used the CMIP5 RCP4.5 and RCP8.5 scenarios, and statistical downscaling.

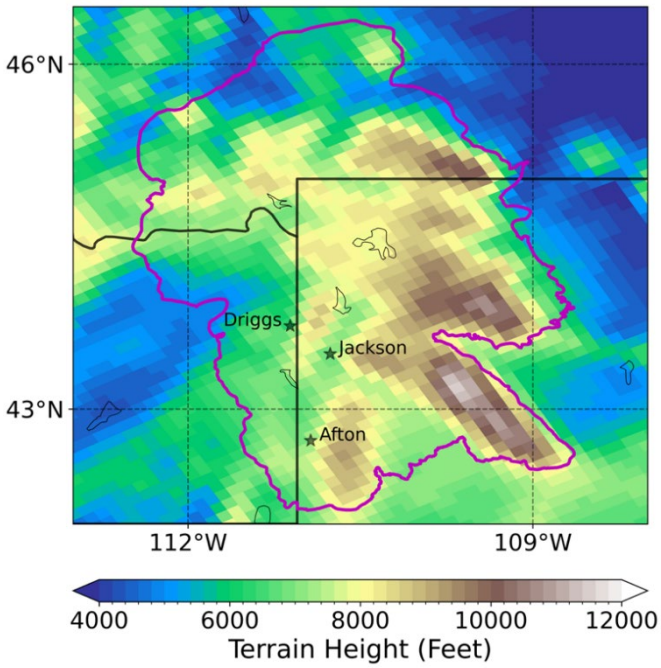

Figure 2: Greater Yellowstone Area boundary (magenta contour), and 9 km resolution terrain

MORE CLIMATE INFORMATION SHEETS

Scan QR code for more information sheets in this series.

What questions do **you** have? Using the QR code, post your questions to help shape future info sheets.

[1] Rahimi, S., and co-authors, 2024: An Overview of the Western United States Dynamically Downscaled Dataset (WUS-D3). Geoscientific Model Development 17, no. 6 (March 20, 2024): 2265–86. https://doi.org/10.5194/gmd-17-2265-2024 The WUS-D3 daily post-processed dataset (Tier 3) can be downloaded from an open-data bucket on Amazon S3: s3://wrf-cmip6-noversioning/ at https://registry.opendata.aws/wrf-cmip6/

[2] Adhikari, P., B. Geerts, S. Rahimi, K. Smith, B. Shuman, and T.L. Schneider, 2024: Evaluation of the mountain hydroclimate across the western United States in dynamically downscaled climate models. J. Hydrometeorology, in review.

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