Climate Scenarios (1976–2099): Temperature

These EnviroAtlas maps show projected changes in minimum and maximum temperature for each season (fall, winter, spring, and summer) and annual period following four Shared Socioeconomic Pathways (SSPs, see inset at right) for states and territories outside of the contiguous U.S. (OCONUS): Alaska, Hawaii, Puerto Rico, U.S. Virgin Islands, American Samoa, Guam, and the Commonwealth of the Northern Mariana Islands. Changes in minimum and maximum temperature are displayed in °F.

Why is it important to explore temperature projections?

The potential impacts of climate change, and subsequent changing average temperatures are widespread. Some of the expected impacts include longer heatwaves, exacerbation of socioeconomic inequities, shifting habitat distributions, and reduced water supply. Increases in the frequency and intensity of heat extremes may lead to heat-related illnesses and deaths, especially among vulnerable populations, while also increasing air conditioning costs and water demand.[1,2] Projected increases in frequency, intensity, and length of high temperature days increases the likelihood of periods of aridity. Even US regions projected to experience higher precipitation are expected to experience more intense and frequent arid conditions.[3] Exploring how the natural environment and human societies potentially will be affected by changing temperatures and how to mitigate and adapt to such changes is important for both the U.S. and the global population. Furthermore, understanding how climate change may affect ecosystems will help ensure their continued protection and ability to provide services to society.

How can I use this information?

This series of maps can help quantify the potential risks of exceeding identifiable thresholds in both physical change and impacts on biological and human systems. Identifying the potential threats of a changing climate and contributing factors may help communities to develop climate adaptation and resiliency strategies. These projections can be used with additional datasets in EnviroAtlas. Future temperature scenarios may be overlaid with Residential Density, Dasymetric Population, or Impervious area per capita maps, if available. Future temperature projections may help in identifying areas where ecosystems that protect threatened

Shared Socioeconomic Pathways

The Intergovernmental Panel on Climate Change (IPCC) develops climate change scenarios to explore the future global environment. These scenarios were a pillar for a major international climate modeling study, called the sixth phase of the Coupled Model Intercomparison Project (CMIP6).[4] The IPCC and CMIP6 are recognized as the authoritative foundations for exploring global climate change.

CMIP6 scenarios are called Shared Socioeconomic Pathways (SSPs), with names coded to reflect global trends in human activities and changes in radiative forcing that result from changes in atmospheric greenhouse gases (GHGs) and aerosol concentrations. In the SSP labels (like SSP1-2.6), the first number refers to a defined socioeconomic pathway (reflecting trends in population, policy, and economic growth), and the second refers to an increase in radiative forcing ($W\ m^{-2}$) relative to preindustrial conditions. For reference, in comparison to *preindustrial* (1850–1900) *average* (PIA), the 2023 observed global mean near-surface temperature increased by 2.61±0.22°F (1.45±0.12°C).[5]

There are four primary "Tier 1" SSPs.

SSP1-2.6: SSP1 ("Sustainability") assumes widespread global climate change mitigation policies, clean energy technologies, and natural environment conservancy. This scenario assumes very low GHG concentration levels and reflects the international climate policy goal of limiting global warming below 3.6°F (2.0°C) at 2100 compared to PIA.

SSP2-4.5: SSP2 ("Middle of the Road") assumes moderate global climate mitigation and adaptation and a slow progress in climate protection measures. This scenario is a medium GHG concentrations pathway. Global temperatures increase by 4.9±1.3°F (2.7±0.7°C) at 2100 compared to PIA.

SSP3-7.0: SSP3 ("Regional Rivalry") assumes high challenges to mitigation and adaptation. Here, nationalism drives policy, and regional and local take precedence over global issues. Global temperatures increase by 6.5±1.6°F (3.6±0.9°C) at 2100 compared to PIA.

SSP5-8.5: SSP5 ("Fossil-fueled Development") reflects high challenges to mitigation and low challenges to adaptation. It is characterized by steadily increasing GHG concentrations. It represents the upper boundary of the range of scenarios. Global temperatures increase by 7.9±2.2°F (4.4±1.2°C) at 2100 compared to PIA.

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and endangered species may experience strain from changing seasonal temperatures.

How were the data for this map created?

These maps were created using bias-corrected data from NASA Earth Exchange Global Daily Downscaled Projections (NEX-GDDP-CMIP6),[6] which is the first downscaled dataset to include localized projections for the United States and all its territorial lands. The NEX-GDDP-CMIP6 temperature datasets (0.25° × 0.25°) were obtained in a gridded format for the 35 members of the CMIP6 global climate model ensemble. NEX-GDDP-CMIP6 data are shown in EnviroAtlas as projected changes between periods reflecting recent history (1976–2005), near-term future (2025–2054), mid-century (2045–2074), and end-of-century (2070–2099). Each value is the ensemble median, and the ensemble minima and maxima provide ranges for each HUC12 and SSPs for each season (fall, winter, spring, and summer) and annual period.

What are the limitations of these data?

All national geospatial data within EnviroAtlas are estimates, particularly with regard to projecting climate variables into the future. The aggregated datasets reflect plausible trajectories based on the state of the science. Even though this dataset is the first known downscaled dataset available throughout the OCONUS locations, it originates from one modeling source based on a specific methodology.[7] Datasets for these regions from other comparable data sources may show different ranges of variability. EnviroAtlas provides the ensemble median, maximum, and minimum to illustrate variability so plausible regional trends can be evaluated and analyzed. Furthermore, climate change metrics were computed using 30-year periods to remove artifacts from single-year events. Due to the lack of validation data over oceans, NEX-GDDP-CMIP6 values over smaller island areas may have lower confidence.[6,7]

How can I access these data?

EnviroAtlas data, including seasonal and annual climate projections, can be viewed in the interactive maps, accessed through web services, or downloaded. The NEX-GDDP-CMIP6 data can be acquired from the NASA Center for Climate Simulation.

Where can I get more information?

Additional information on climate change can be found at the EPA website. For information on how the data were created, see the metadata. For specific questions about the NEX-GDDP-CMIP6 data, please see the NASA Center for Climate Simulation technical note.[7] For additional information about the SSP scenarios, please visit the IPCC website. Specific questions about these maps should be directed to the EnviroAtlas Team.

Acknowledgments

EnviroAtlas is a collaborative effort by EPA, its contractors, and project partners. Dr. Anna M. Jalowska (EPA) and Eamon Horrigan (ORISE Research Fellow) developed these maps for EnviroAtlas and wrote this fact sheet.

Selected Publications

1. Faurie, C., et al. 2022. Association between high temperature and heatwaves with heat-related illnesses: A systematic review and meta-analysis. *Science of The Total Environment*, 852;158332.

2. U.S. Global Change Research Program. 2023. Fifth National Climate Assessment. Accessed May 2025.

3. Overpeck, J.T., and B. Udall. 2020. Climate change and the aridification of North America. *Proceedings of the National Academy of Sciences of the United States of America*, **117**, 11856–11858.

4. Lee, J.-Y., et al. 2021. Future global climate: Scenario-based projections and near-term information. Pages 553–672 *in* Masson-Delmotte, V., et al. (eds.), Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge, U.K., and New York, NY, USA.

5. World Meteorological Organization (WMO). 2024. State of the Global Climate 2023. World Meteorological Organization, Geneva, Switzerland, 53 pp.

6. Thrasher, B., et al. 2022.NASA Global Daily Downscaled Projections, CMIP6. *Scientific Data* 9**:** 262.

7. Thrasher, B., et al. 2012. Technical Note: Bias correcting climate model simulated daily temperature extremes with quantile mapping. *Hydrology and Earth System Sciences* 16:3309–3314.

NEX-GDDP-CMIP6 Disclaimer: "This data is considered provisional and subject to change. This data is provided as is without any warranty of any kind, either express or implied, arising by law or otherwise, including but not limited to warranties of completeness, non-infringement, accuracy, merchantability, or fitness for a particular purpose. The user assumes all risk associated with the use of, or inability to use, this data."