



Update to the Montana Climate Analysis

The Montana Climate Office is developing an update to the climate chapter of the Montana Climate Assessment. The update to the assessment provides a summary of historical climate conditions across the state, as well as an overview of projected changes in Montana's climate given different climate change scenarios. To assess historical climate conditions, we are using gridMET climate data instead of NOAA's station-based climate normals used in the original version. We choose to use gridMET because it is spatially continuous across Montana and we have found it to have high accuracy relative to Montana Mesonet weather stations. Using gridMET allows us to provide an accurate and high-resolution assessment of Montana's historical climate conditions.

To summarize future climate projections, we use data from the sixth version of the Coupled Model Intercomparison Project (CMIP6), whereas the original assessment used CMIP5 projections. Specifically, we use an ensemble of eight models that have been spatially downscaled by the NASA NEX-GDDP project. The ensemble of eight models has been shown to best represent North America's future climate downscaled project ensemble of 8 models that perform well over North America (<https://eartharxiv.org/repository/view/2510/>). While CMIP6 projections are similar to the CMIP5 projections used in the original climate assessment, there are two notable differences:

1. **Different Downscaling Methods.** Both the original climate assessment and the update presented here use downscaled CMIP projections. The standard outputs CMIP models are very coarse in spatial resolution, making it difficult to analyze their output at the county or even state scale. To overcome this issue, statistical methods can be applied to the coarse data to spatially downscale the models to a finer spatial resolution. The original climate assessment used projections using the Multivariate Adaptive Constructed Analogs (MACA) method, whereas this update uses projections downscaled using the Bias-Correction Spatial Disaggregation (BCSD) method. While the results in both the original climate assessment and our update are similar, it is important to note that these two different downscaling methods were used.
2. **Different Climate Scenarios.** In CMIP5 climate projections, future climate scenarios were provided as Representative Concentration Pathways (RCPs). In short, RCPs simulated the amount of warming that would occur given different increases in global CO₂ concentrations. The CMIP6 projections use a similar grouping of scenarios called Shared Socioeconomic Pathways (SSPs). SSPs take a more holistic approach to future emissions scenarios and incorporate information on how changes in the global economy, politics, and population are likely to affect CO₂ emissions. In this analysis, we use the SSP245 and SSP585 scenarios to summarize Montana's future climate projections. These are the closest analogs to the RCP4.5 and RCP8.5 scenarios used in the original climate assessment.

To assess how climate will change under different SSPs, we compare mid-century (2040 - 2069) and end-of-century (2070 - 2099) climate projections to relatively current climate conditions (1981 - 2010). These are the same periods of time that the original climate assessment used in its analysis. Like the original climate assessment, this assessment also uses Montana's climate divisions to summarize future climate conditions, with plans to summarize results at the county and watershed scale in the future.