United States Global Change Research Program

Regional Climate Trends and Scenarios: The Midwest U.S.

This document provides a brief overview of the observed changes in the climate of the Midwest[1] United States as well as possible future climate conditions as simulated by climate models, based on two scenarios of future greenhouse gas emissions. It summarizes the detailed findings presented in one of nine regional and national climate descriptions created by the National Oceanic and Atmospheric Administration (NOAA) in support of the National Climate Assessment (NCA). It is also hoped that these findings are of direct benefit to decision makers and communities seeking to develop adaptation plans. The full Regional Climate Trends and Scenarios report is available at http://scenarios.globalchange.gov/regions/midwest, and should be cited as:

Kunkel, K.E, L.E. Stevens, S.E. Stevens, L. Sun, E. Janssen, D. Wuebbles, S.D. Hilberg, M.S. Timlin, L. Stoecker, N.E. Westcott, and J.G. Dobson, 2013: Regional Climate Trends and Scenarios for the U.S. National Climate Assessment. Part 3. Climate of the Midwest U.S., NOAA Technical Report NESDIS 142-3, 95 pp.

Observed Regional Climate Trends

This section summarizes the observed climate trends of the Midwest U.S., focusing mainly on temperature and precipitation, as well as other climate features, including heat waves, extreme precipitation, and lake ice cover. These historical data are primarily from the National Weather Service's Cooperative Observer Network (COOP), which has been in operation since 1895.

Temperature

- Annual temperatures in the Midwest have generally been well above the 1901-1960 average since the late 1990s, with the decade of the 2000s being the warmest on record.
- Seasonal temperature trends denote warmer winters and springs, with no overall trend in summer and fall. Annual temperature increases, as well as those for the spring season, are statistically significant (at the 95% confidence level).

Precipitation

- Trends in 20th century annual and summer precipitation are upward and statistically significant for the Midwest region.

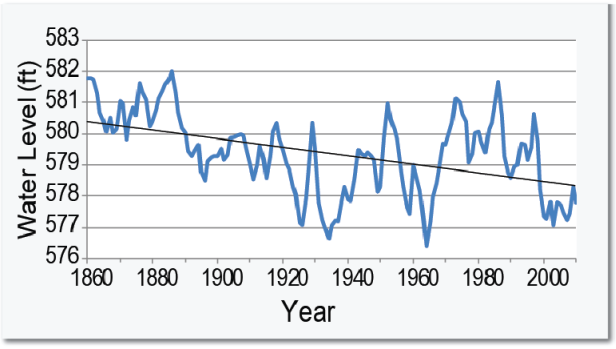
Extremes

- The frequency of cold waves in the Midwest has been very low since the mid-1990s. The frequency of heat waves has not been particularly high in recent decades, with the 1930s "Dust Bowl" remaining as the period with the most intense heat in the historical period of record.
- The frequency and intensity of extreme precipitation in the region has increased, as indicated by multiple metrics.

Additional Climate Features

- Great Lakes water levels have fluctuated over a range of 3 to 6 feet since the late 19th century. Trends on the lakes have been relatively small with the exception of the combined Lake Michigan-Huron system, which has shown a statistically significant downward trend over the past 150 years (see figure).
- Measurements of ice cover on regional lakes indicate a negative trend in both duration of ice cover and percentage of total ice cover.

Mean Annual Water Level
for the Lake Michigan-Huron System



[1] Minnesota, Wisconsin, Michigan, Iowa, Illinois, Indiana, Ohio, and Missouri.

United States Global Change Research Program

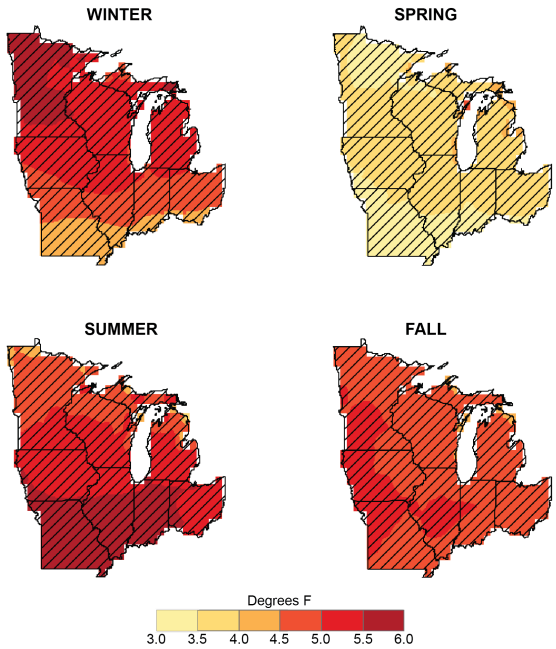
Future Regional Climate Scenarios

This section describes simulated future climate conditions based on climate models using two emissions scenarios generated by the Intergovernmental Panel on Climate Change: the high (A2) scenario, in which emissions of heat-trapping gases continue to rise, and the low (B1) scenario, where emissions peak in the mid-21st century and decline substantially thereafter. These scenarios were chosen because they incorporate much of the range of potential future human impacts on the climate system, and are used in a large body of literature. These simulations use data from the WCRP's Coupled Model Intercomparison Project 3 (CMIP3), as well as from statistically- and dynamically-downscaled data sets, including North American Regional Climate Change Assessment Program (NARCCAP) data (for A2, mid-century only).

Temperature

- CMIP3 models show small spatial variations in simulated annual mean temperature change for both scenarios, though there is a slight tendency for greater warming toward the northwestern part of the region. The models indicate that temperature increases across the Midwest are statistically significant (at the 95% confidence level) for all future time periods and both emissions scenarios.
- Seasonal temperature increases are simulated by the NARCCAP models to be largest in winter and summer, with the two seasons having near-opposite spatial patterns (see figure).
- There is uncertainty within the range of model-simulated temperature changes, but for each model simulation, the warming is unequivocal and large compared to historical temperature variations.
- NARCCAP simulations indicate increases in the number of hot days (maximum temperature of more than 95°F) throughout the region, with the largest increases in southern areas.
- The freeze-free season is simulated by the NARCCAP models to lengthen by 20 to 30 days across the majority of the Midwest region.

Simulated Change in Seasonal Mean Temperature
(A2 Scenario, 2041-2070 minus 1980-2000)



Precipitation

- CMIP3 models simulate the greatest increases in annual mean precipitation for the far north, while indicating a decrease for the southwestern corner of the region. Seasonally, NARCCAP models generally simulate increases in precipitation in winter, spring, and fall, but decreases in summer.
- The range of model-simulated precipitation changes is considerably larger than the multi-model mean change for both the high and low emissions scenarios, meaning that there is great uncertainty associated with precipitation changes in these scenarios.
- NARCCAP simulations indicate increases in the number of wet days (precipitation exceeding 1 inch) for the entire Midwest region, with increases of up to 60%. The largest changes are seen in the states bordering Canada. These increases are statistically significant in northern parts of the region (see figure).
- Statistically significant decreases in the number of consecutive dry days (precipitation of less than 0.1 inches) are also simulated for northern areas. However, simulations indicate an increased number of dry days for southern portions of the region.

Simulated Change in the Annual Mean Number of Days with Precipitation Greater than 1 Inch
(A2 Scenario, 2041-2070 minus 1980-2000)