

DROUGHT VARIABILITY AND TRENDS IN THE MIDWEST UNITED STATES



The Midwest region has endured many droughts that have led to billion dollar losses, with examples over the last 30 years including 1980s, 2005, and 2012. Neither the onset or demise of the 2005 and 2012 droughts over the Midwest were forecast. The goal of this research study led by NOAA's Physical Sciences Laboratory is to build a predictive understanding of drought and to quantify the risks of droughts with certain characteristics in the Midwest region. This summary highlights results focused on overall drought variability and trends in the Midwest.

Drought Variability and its Decrease

The intricacies of regional drought within the Midwest and hydroclimatic differences across the region are shown in Figure 1 by the time series of the Integrated Drought Index (IDI) in the Northern Great Plains, Great Lakes, Central Great Plains, and Ohio Valley regions during 1916-2015. Though droughts are a feature in all four sub-regions, the variability, persistence, and clustering of drought episodes in given decades are largely different. Nonetheless, there are seven epochs in which all four sub-regions experienced low IDI simultaneously: 1917-18, 1925, 1933-34, 1939-40, 1963-64, 1988, and 2012-13.

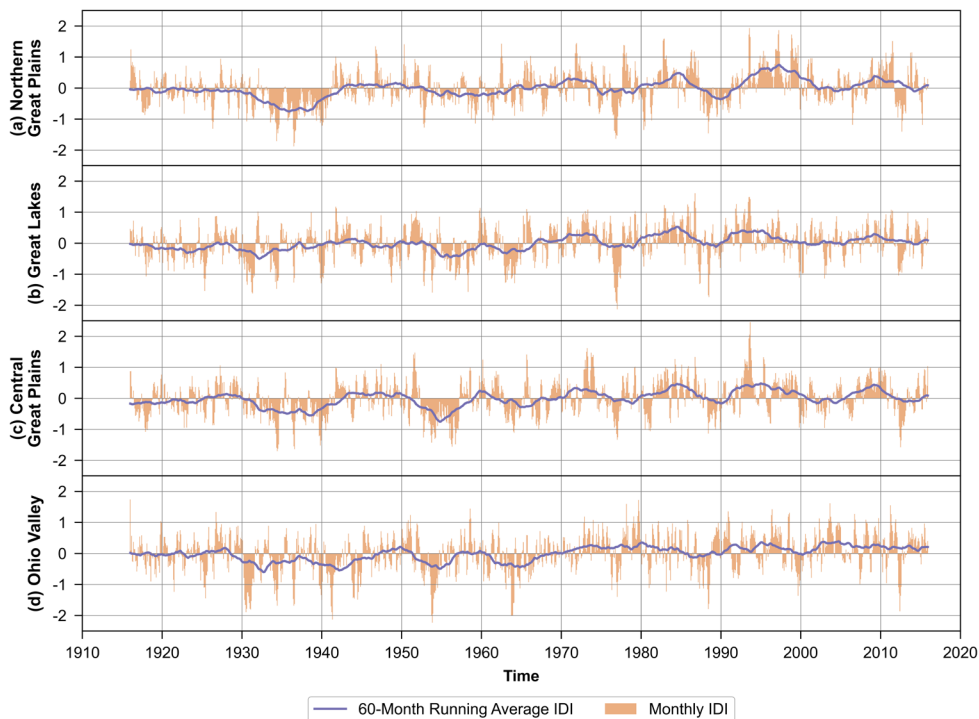


Figure 1. Time series of regional IDI in standardized departures. Shown are the monthly IDI (orange bars) and 60-month running average IDI (purple line).

Key Takeaways:

- Historically, the variability, persistence, and clustering of drought episodes are largely different from one sub-region to the next in the Midwest.
- Region-wide droughts in the Midwest are infrequent, only occurring seven times since 1916.
- Drought prevalence in the Midwest decreased in the 20th and 21st centuries due to an increase in precipitation across the region.

Drought Variability and its Decrease (continued)

Another feature common to all sub-regions is the decrease in drought prevalence from the 20th to the 21st centuries. Droughts were more frequent in the Midwest in the 1930s, 1950s, and 1960s compared to after 1990. All four regions experienced an IDI falling below -0.8 approximately two to four times as often in the 1930s and 1950s compared to the 1990s and 2000s.

Precipitation Increase

The observed decreases in drought prevalence during the 20th and 21st centuries were caused by increases in annual precipitation (Figure 2). More than 80% of the Midwest United States experienced increases in annual precipitation from 1920-1979 to 1980-2009. Increases in annual precipitation of up to 15% occurred over the historically driest areas of the Midwest, notably the Central and Northern Great Plains. Historically wetter areas in the Ohio Valley and Great Lakes regions experienced more modest annual precipitation increases of up to 9% in the recent 30-year period compared to the prior 60 years.

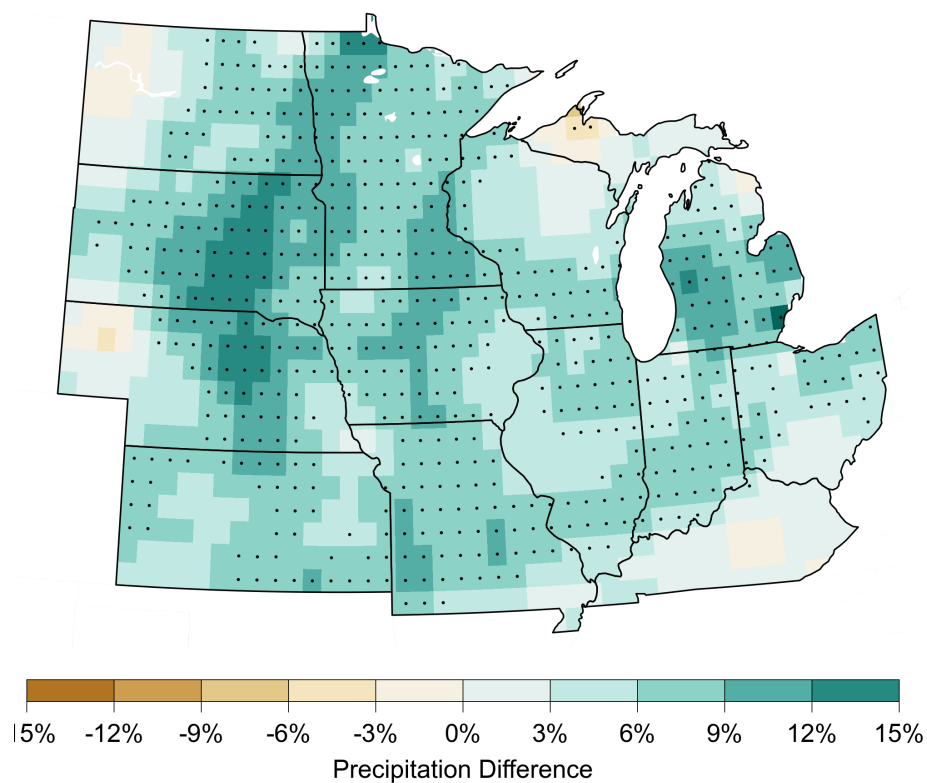
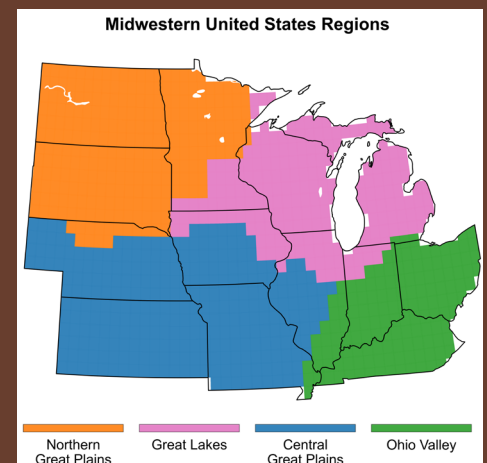


Figure 2. Calendar year precipitation percent difference from 1920-1979 to 1980-2009. Stippling indicates statistically significant differences at the 95% confidence level.

Project Methods: A monthly integrated drought index (IDI) is used to measure drought during 1916-2015. This version of an IDI, adapted from Mo and Lettenmaier (2014, 2018), is defined as the average of three-month standardized runoff and monthly standardized total land surface moisture from four land surface models included in the [UCLA Experimental Surface Water Monitor](#). Total moisture is the sum of column integrated soil moisture and snow water equivalent. Four regions within the Midwestern United States are considered (shown on the right): Ohio Valley, Great Lakes, Central Great Plains, and Northern Great Plains. These regions were identified by applying a hierarchical clustering algorithm based on [Ward \(1963\)](#) to the monthly IDI. The monthly IDI for each region is quantified by calculating the average IDI of all grid points within them.



This report is based on [Characteristics and Predictability of Midwestern United States Drought](#) published in the *Journal of Hydrometeorology*.