# VARIABILITY AND TRANSITIONS IN PRECIPITATION EXTREMES IN THE MIDWEST

The Midwest region regularly experiences precipitation extremes, both flood and drought. However, these extremes and their corresponding impacts are typically studied and communicated independently, without consideration of the compound impacts due to a rapid transition from one extreme to the other. The goal of this research study led by the University of Illinois is to improve our understanding of rapid transitions between precipitation extremes in the Midwest, their causes, and the future risk they pose to the region. The causes and future risk will be highlighted in future summaries.

## Midwest Precipitation Variability

Much of the Midwest has gotten wetter over the past several decades. The annual maximum, average, and minimum 30-day, 90-day, and 180-day precipitation totals have all significantly increased between 1951 and 2019, where precipitation totals are represented in this study by the Standardized Precipitation Index (SPI). It was found that the annual maximum SPI increased more significantly and across a greater area than those for annual minimum, representing an increasing magnitude of wet extremes and continued occurrence of dry extremes. This was particularly the case for areas of Illinois, Missouri and Iowa.

## Transitions in Precipitation Extremes

Transitions between extremely wet and extremely dry conditions, and vice versa, are assessed across the Midwest over the past 70 years. Historically, transition frequency is highest in the southern and eastern Great Lakes region based on short-term (30-day) SPI, while frequency is highest in the Dakotas, Minnesota, and northern Wisconsin based on longer-term (90- and 180-day) SPI (Fig. 1).

### Key Takeaways:

- Wet extremes have increased in magnitude over the past 70 years, while dry extremes have largely remained the same.
- Transitions from wet to dry extremes are happening more quickly and more frequently in the lower Midwest.

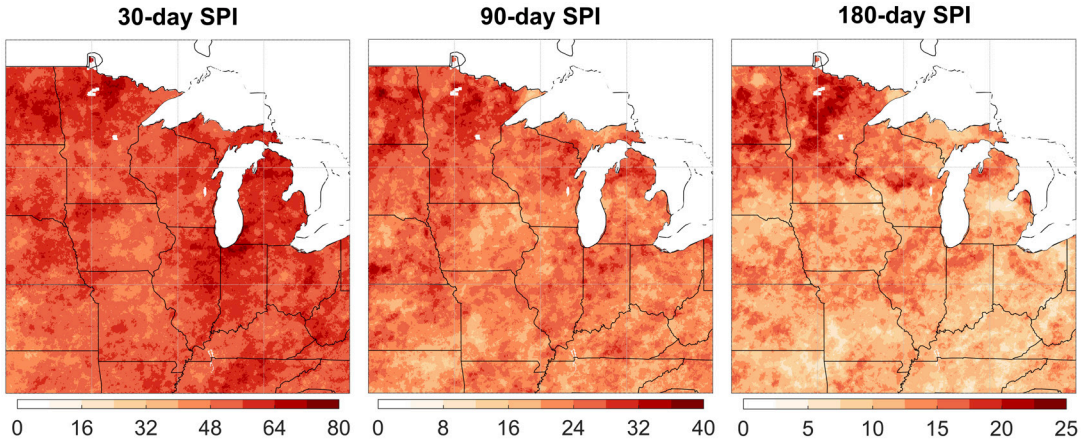


**Figure 1.** Climatological (1951 - 2019) inter-annual transition frequency in (left) 30-day, (middle) 90-day, and (right) 180-day SPI.

## Transitions in Precipitation Extremes (cont.)

Figure 2 shows the trend analysis over time and indicates where transitions have become more or less frequent, and/or slower or quicker. The top panel shows the trend of dry-to-wet transitions, while the bottom shows the trend of wet-to-dry transitions. Areas in yellow (green) depict where there are now more (less) events, but there is no distinct trend on if events are happening more quickly or slower. On the other hand, areas in red, orange, dark blue or teal do have a distinct trend on if rapid transition events are happening more quickly or slower.

Most notably, a large area spanning east-central missouri to southern Ohio has experienced both increased frequency and decreased duration of wet-to-dry-transitions. Meaning, dry extremes in the middle Mississippi to lower Ohio river basins follow wet extremes with significantly decreased transition time, but with higher frequency.

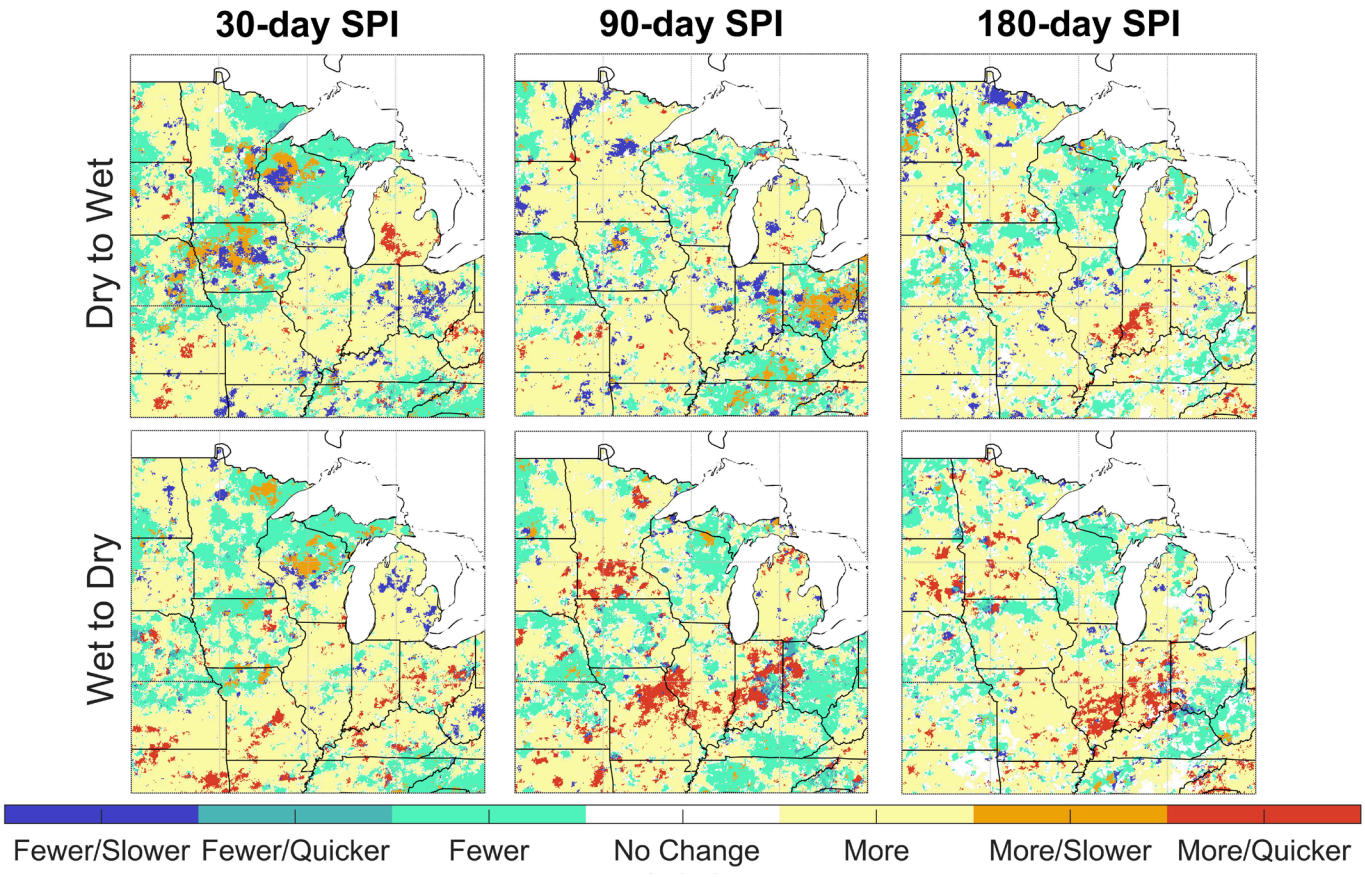


**Figure 2.** Areas are colored depending on the joint change in inter-annual transition duration and frequency. Areas in which transitions are denoted as happening "Quicker" are those with statistically significant, negative duration trends. The top row are dry to wet transitions, and the bottom row are wet to dry transitions.

Project Methods: Standardized Precipitation Index was calculated at 30-, 90-, and 180-day intervals using daily precipitation grids from NOAA's climate division dataset during 1951-2019. Variability is measured by differences and changes in annual maximum and annual minimum SPI at each grid cell in the Midwest. Precipitation extremes transitions are defined by adopting the methods of DeGaetano and Lim (2020). Namely, a transition occurs when the 30-, 90-, or 180-day SPI moves from at or above +1.6 to at or below -1.6, or vice versa. These thresholds approximate the 95th and 5th percentile of historical SPI distributions. Each transition's occurrence is assigned to the date on which the change to the opposite extreme first occurred.