THE CLIMATE OBSERVER

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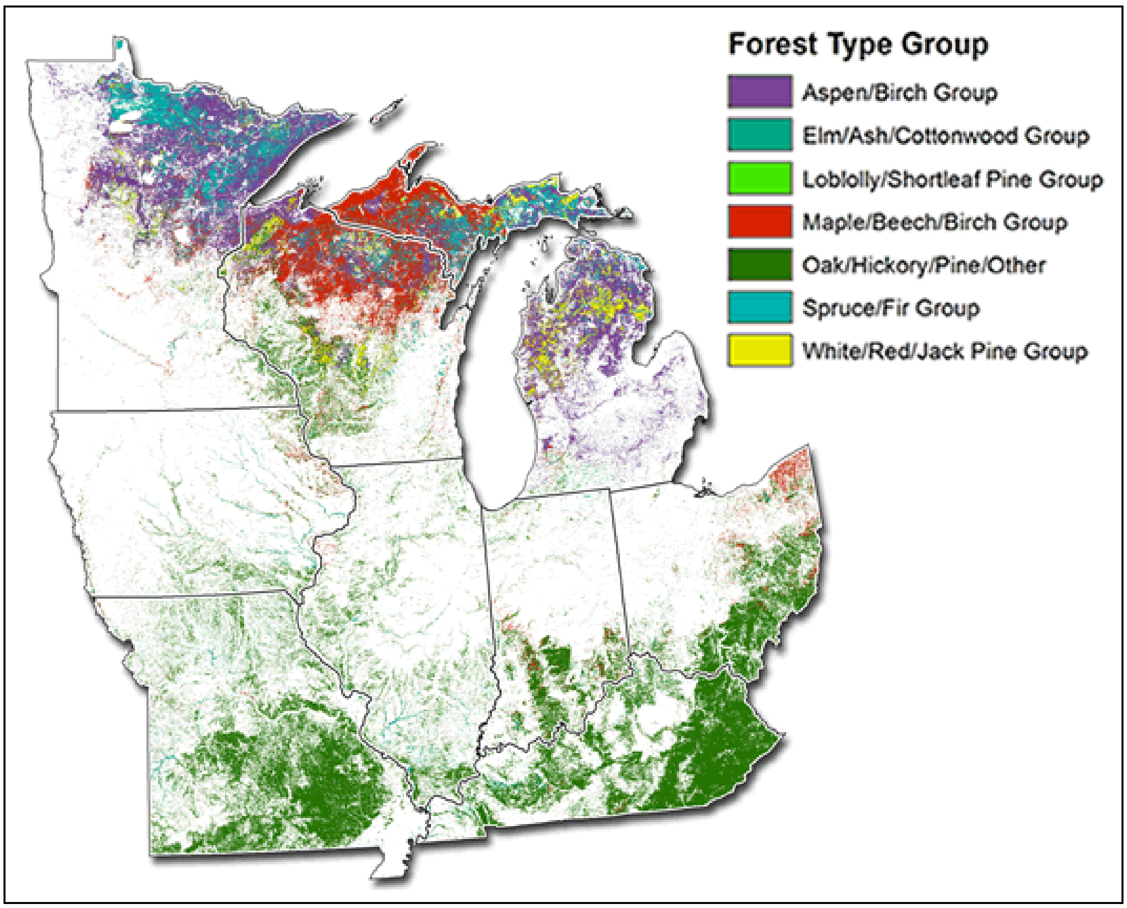
Climate Connections:
Drought and Forest Impacts in the Midwest

Stephen Handler, Northern Inst. of Applied Climate Science and U.S. Forest Service

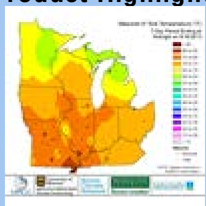
Although many people think the Midwest is an endless expanse of agriculture, our region is actually home to widespread and diverse forests. Across the Midwestern Regional Climate Center footprint, forests account for more than 30% of the total landcover. Boreal conifer forests surround the northern Great Lakes, and oak-hickory forests blanket the Ozarks. Savannahs and woodlands in the central Midwest mark a major transition between forest and grassland regions of the United States. Forests help sustain human communities in the Midwest – ecologically, economically, and culturally.



Climate controls on forests

Midwestern forests result from a variety of interacting factors, including, climate, soils, landform, post-glacial vegetation migration, fire and wind events, and human management.

MRCC Product Highlight:



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Midwestern Regional Climate Center

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On the Road:
NE - High Plains Climate Workshop
IL - National Weather Service Open House, Biennial Governor's Conference on Illinois River System, Illinois GIS Assoc. Fall Conference, Midwest Climate Collaboration
SC - National Weather Assoc. National Meeting
KY - Symposium on Fire and Forest Meteorology
MI - Great Lakes Integrated Science and Assessments Center Symposium
MO - MRCC Road Trip

Climate is the biggest driver that dictates whether a forest can exist in a given area and what species occur, and both temperature and precipitation patterns have an important influence. Forests occur within a range of suitably warm and wet conditions, with conifer forests more common in drier and cooler environments and broadleaf forests more common in warmer and wetter environments. These controls are apparent in the Midwest, with the transition from grassland to broadleaf forest to conifer forest from north to south around the Great Lakes and the transition from grassland to broadleaf forest from west to east across the southern tier of Midwestern states.

Drought impacts on forests

Apart from long-term climate, precipitation patterns over shorter time scales can have a big influence on forest health and productivity. Droughts have been shown to affect forests in a variety of ways. Seasonal droughts can cause trees to prematurely shut down photosynthesis or even drop their leaves early during the growing season. Moisture stress can be particularly damaging for seedlings and young trees, though mature trees can still be affected by multi-year droughts. Droughts can also disrupt the reproduction of tree species with particular moisture and timing requirements for germination.

Drought-stressed trees are also more vulnerable to other forest stressors, such as insects, disease, and fire. For example, oak decline affects red oak, scarlet oak, and black oak throughout the southern half of the Midwest. This condition is correlated with droughts, when stressed trees are prone to attacks by insects and diseases. Similarly, drought stress has been linked to outbreaks of forest tent caterpillar in Minnesota. Drought conditions can also increase wildfire risk, because hot and dry periods of only a few weeks can make forests more susceptible to fire ignition and spread. Drought is often a precursor to large summer wildfires.

Drought trends and projections in the Midwest

Over the 20th century, precipitation has generally increased in the Midwest and severe, widespread droughts have occurred less frequently. Geographically isolated and short-term droughts still occur, but not with the frequency or severity observed between 1930 and 1960. Figure 1 shows the Palmer Drought Severity Index for the Ohio Valley climate region (MO, IL, IN, OH, KY, WV, TN) from April through September for the years 1895 to 2012. The Upper Midwest climate region (MN, WI, MI, IA) experienced an even more pronounced trend toward wetter conditions throughout the 20th century.

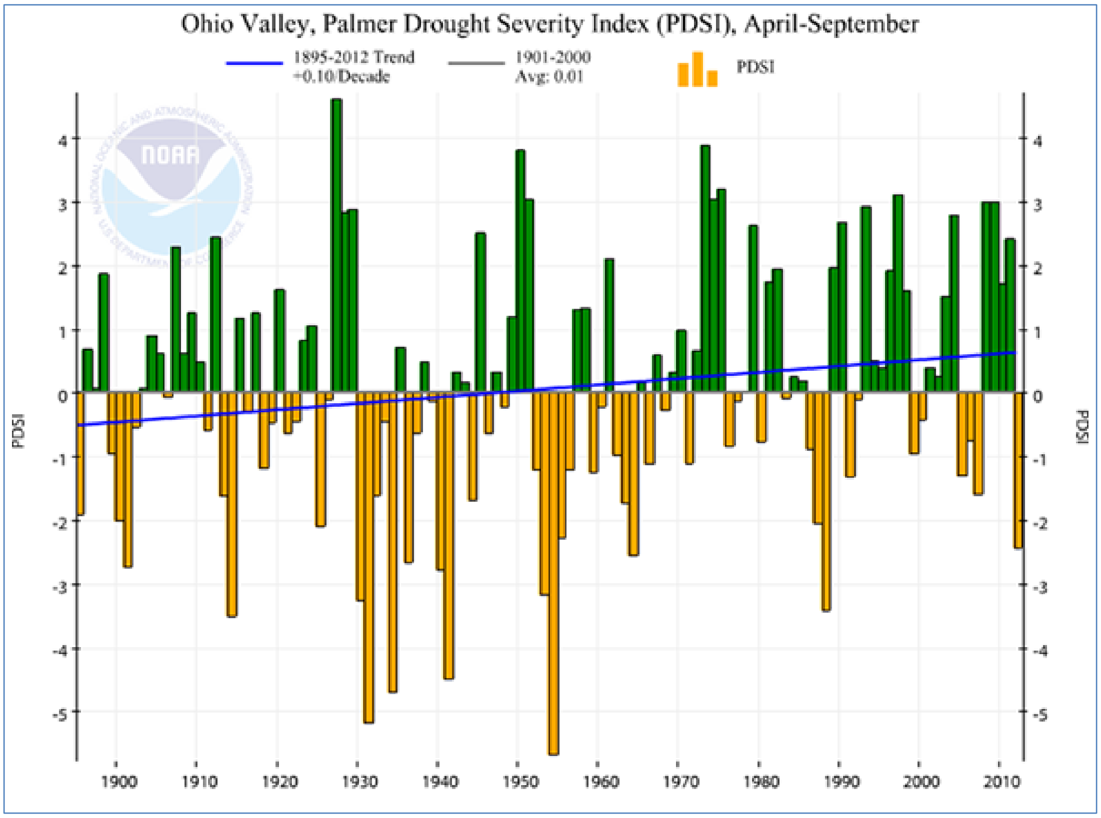
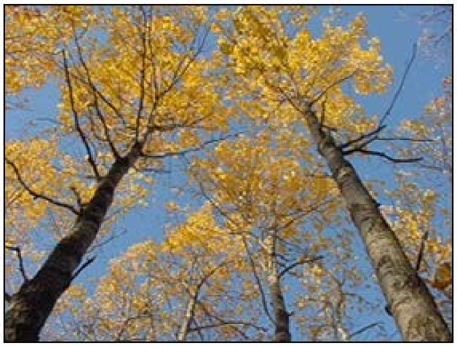


Fig 1: Palmer Drought Severity Index for the Ohio Valley climate region during the months of April through September for the years 1895 to 2012. Higher positive values indicate wetter conditions and lower negative values indicate drier conditions.

This pattern of reduced droughts in the Midwest may not continue. Future climate projections generally agree that temperatures will continue to rise in the Midwest across all seasons, with increases between 5°F and 8°F by 2100. We will experience more days with temperatures above 95°F and longer stretches of consecutive days above 95°F. The growing season may also be about three weeks longer by the end of the century. Climate models tend to show greater variability in precipitation projections, however. Most models project that winter, spring, and fall will be wetter by the end of the century, and the region will receive more total annual precipitation. Summer is generally expected to be a bit drier in the Midwest, with a wide range of potential increases and decreases among individual model projections. A greater proportion of rainfall is projected to fall during large events, a trend that has already been observed in recent decades.

While it might seem counter-intuitive given the increase in overall precipitation, moisture limitations on Midwestern forests are projected to be more common under future climate scenarios. A combination of factors makes this possible: extended growing seasons, increased summer temperatures, and more episodic precipitation patterns. When all these factors act in concert, the potential exists for decreased moisture availability for forests, particularly at the end of the growing season.



What to expect and how to adapt?

How climate change affects specific forests will depend on a variety of factors, including site conditions, forest health, and management. We will not be able to fully anticipate all of the consequences of climate change, particularly the interactions among stressors like drought and forest pests. Forest managers can be proactive in adapting to climate change, however, even in the face of future uncertainty.

In this context, "adapting" means taking action to enhance the ability of forests to thrive in future conditions. There is no single best answer of how to adapt to climate change, because adaptation responses will vary by forest type, site conditions, landowner goals, and other factors. Often, the adaptation process will begin with an assessment of risk or vulnerability across a range of future climates. Foresters are beginning to test adaptation practices in the real world, such as: planting species anticipated to tolerate future conditions, thinning forests to reduce moisture stress and fire risk, and encouraging greater diversity.

The field of climate change adaptation is relatively new, but a growing list of tools and resources is available to help forest landowners assess potential climate impacts and design a custom adaptation plan (see box). More importantly, there is a growing network of forest managers and researchers who are working together to build a community that will support climate adaptation choices within our region. Interested to learn more? Get in touch!

Helpful Climate and Forest Resources

- Climate Change Response Framework– a collaborative climate change adaptation project operating in the Midwest and Northeast: www.forestadaptation.org/
- Climate Change Resource Center – a Forest Service clearinghouse of information on natural resource management and climate change: www.fs.fed.us/ccrc
- *Climate Change Vulnerabilities within the Forestry Sector for the Midwestern United States* – a regional whitepaper contribution to the National Climate Assessment: www.glisa.msu.edu/great_lakes_climate/nca.php
- *Effects of climatic variability and change on forest ecosystems: a comprehensive science synthesis for the U.S* – the national forest sector technical report for the National Climate Assessment: http://www.treesearch.fs.fed.us/pubs/42610

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The 2013 Flash Drought

Dr. Jim Angel, Illinois State Climatologist

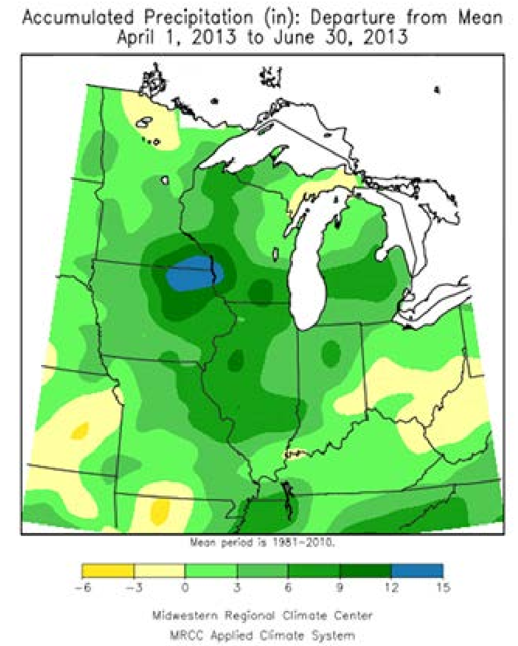

Fig. 1

The first time I heard the phrase "flash drought" was when an Illinois State Water Survey hydrologist used the term to describe the rapid onset of drought in 2000 for Illinois. The term flash drought is a derivative of flash flood, commonly used by the National Weather Service. Of course, the adjective "flash" is relative. Most droughts take months to develop. However, under the right conditions drought can develop in a matter of weeks.

The two ingredients for flash droughts are much below-average precipitation and much above-average temperatures. Precipitation deficits can be on the order of 25% of average or less over the course of several weeks. Flash drought is most likely to occur in the Midwest in July and August when the rates are already highest for evaporation from open water and soils, and for transpiration from plants. The warmer than average temperatures will drive the evapo-transpiration rates even higher. The end result is the rapid depletion of soil moisture that leads to crop damage and stress to yards.

Here is how the 2013 flash drought unfolded. Precipitation across the Midwest was above average for April, May, and June. Most of the Midwest experienced precipitation 3 to 12 inches above average (see figure 1). Based on records extending back to 1895, this was the wettest April-June for the Midwest with a region total of 16.2 inches, 4.9 inches above average. These conditions resulted in two problems for farmers. The first was the significant delay in spring planting, in many places by 2 to 4 weeks. The second problem is that the wet soils discouraged deeper root development early on. Both of these problems made the crops more vulnerable to the conditions they encountered in August and early September.

After a wet start to the growing season, July was cool and dry. While southern Missouri, southern Illinois, and most of Kentucky and Ohio had average to slightly wetter than average conditions, the rest of the region was drier than average. In fact, northern Missouri, most of Iowa, western Wisconsin, and northern Illinois were 2 to 4 inches below average during July. Temperatures were near average in the northern tier states of the Midwest. However, they were 1 to 3°F below average in Iowa, Missouri, Illinois, Indiana, and Kentucky. While the cooler temperatures reduced the stress of the dry weather, it slowed the development of

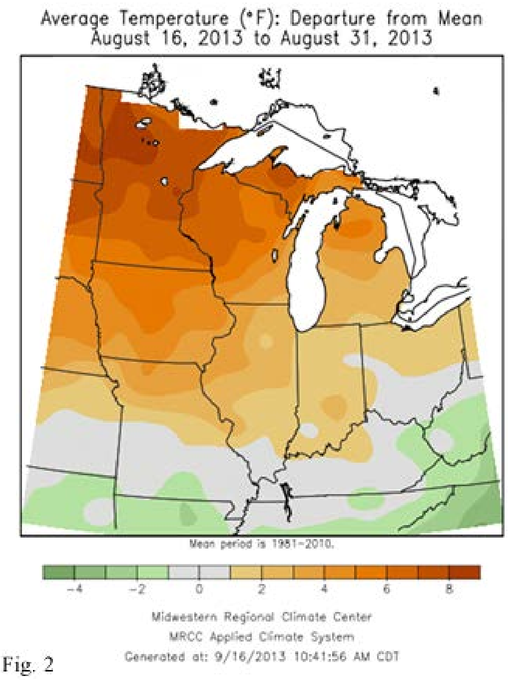

Fig. 2

crops that were already behind schedule due to delayed planting in the spring.

August started out cool and dry before a late season heat-wave arrived in the second half of the month and extended into early September. The precipitation deficits intensified in much of the Midwest. Hardest hit were most of Iowa, northern Missouri, and western Illinois where the deficits were largest and in the neighborhood of 3 to 4 inches. Precipitation was above average in southern Missouri and in Kentucky. Temperatures in the first half of August were 2 to 6°F below average across the region. However, a late-season heat wave arrived in the second half of August with temperature departures ranging from near-average in far southern Missouri, Illinois, and Kentucky to 5-8°F above average in Minnesota, Wisconsin and Iowa (figure 2).

The dry weather in July and August, combined with the hotter temperatures in late August, caused severe stress on crops by Labor Day. Many fields were behind in their development and vulnerable due to poorly developed root systems from the wet spring. The damage could have been much less if spring conditions had been more favorable.

The first half of September continued with below-average precipitation across the Midwest except for Kentucky and north-central Minnesota. Above-average temperatures continued in much of Minnesota, Iowa, Missouri, Wisconsin, Illinois, and Indiana.

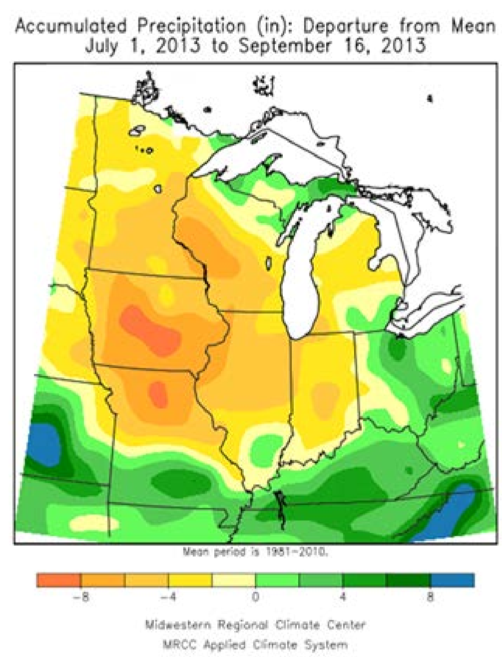

Fig. 3

The precipitation deficits since July 1 are substantial across much of the Midwest. Hardest hit were northern Missouri, much of Iowa, western Illinois, and western Wisconsin where deficits were in the 6 to 8 inch range. Only southern Missouri and Kentucky received above-average precipitation (figure 3).

The 2013 growing season in the Midwest experienced a remarkable change of conditions from the wettest April-June on record to one of the driest July through mid-September, combined with a late-season heat wave. These key ingredients resulted in a flash drought. Field surveys have already identified potential damages. However, the full impact of the flash drought will not be known until the crops are harvested this fall.

For more information on this article or the [Illinois State Climatologist's Office](), please contact Jim Angel via email at [jimangel@illinois.edu]().

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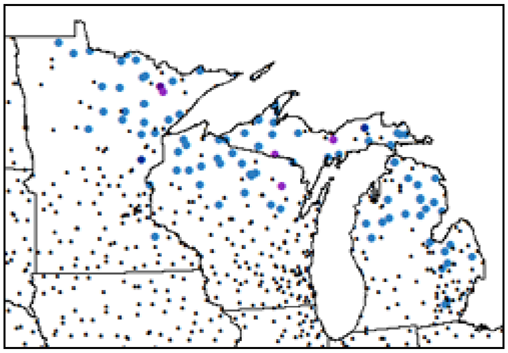
Midwest Climate at a Glance



The second week of September saw a sharp drop in temperatures, with daily minimum temperatures dropping by 20°F or more. Near the end of the week, frosts and freezes were reported across the upper Midwest in Minnesota, Wisconsin, and Michigan. Warm temperatures early in the week balanced out cooler temperatures later in the week, bringing the weekly average very close to normal for the 7-day period.

Rainfall was below normal across most of the region, with the largest area of above normal rainfall in central Minnesota. Waterspouts were observed over Lake Michigan near the Wisconsin-Illinois border on the 12th. Read more...

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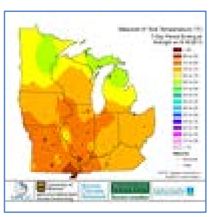
MRCC Product Highlight



Soil temperature maps are being updated daily using data from Midwest mesonets. Temperatures at a 4” depth are from mesonet sites in Illinois, Kentucky, Michigan, and Missouri as well as Climate Reference Network sites throughout the region and in surrounding states. Maps show the soil temperature for a 1-day average and 7-day average ending yesterday. Mesonets provide high resolution data (in both space and time) for a limited domain with the higher resolution allowing users to monitor and research things that they would otherwise be unable to do. The data is typically provided by the mesonet operator in near real-time which also provides great value to users.

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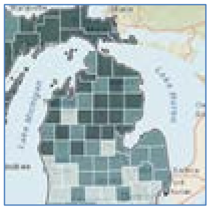
Climate Cool Tool



Socioeconomics and Climate Change in the Great Lakes Region: The interactive online map gives Great Lakes policymakers and decision-makers easy access to targeted data to help them plan for, and adapt to, the regional impacts of climate change. This free online tool provides social, economic and demographic statistics on 225 counties in the Great Lakes region, overlaid with detailed data about municipal spending, land-use change and climate-change characteristics. It was co-developed by the Graham Sustainability Institute (as part of its Great Lakes Adaptation Assessment for Cities project, known as GLAA-C) and Headwaters Economics, an independent, nonprofit research group. The Kresge Foundation funded and facilitated the collaboration.

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MRCC On The Road

Nebraska City, NE (September 18-20) – High Plains Climate Workshop

Allan Curtis will be a participant at the High Plains Climate Workshop. The purpose of the meeting is to meet with regional stakeholders to discuss emerging issues, identify gaps, assess needs, and organize interests into meaningful funding and research opportunities.

Romeoville, IL (September 21) – National Weather Service Open House

Beth Hall will be representing the MRCC at the Chicago/Romeoville National Weather Service Open House. Stop by and say hi if you are in the area!

Peoria, IL (October 2) – 14th Biennial Governor's Conference on the Management of the Illinois River System

Zoe Zaloudek will be part of the Interactive Digital Technologies Open House at the 14th Biennial Governor's Conference on the Management of the Illinois River System. She will be there to highlight the different interactive Geographic Information System (GIS) web maps that the MRCC has made in recent years.

Charleston, SC (October 14-17) – National Weather Association National Meeting

Allan Curtis will be attending the National Weather Association meeting in Charleston, SC to present work related to the MRCC's Vegetation Impact Program, specifically focusing on work done with the Frost/Freeze Guidance project.

Bowling Green, KY (October 15-17) – Tenth Symposium on Fire and Forest Meteorology

Leslie Stoecker and Zoe Zaloudek will be going to the 10th Symposium on Fire and Forest Meteorology, which is sponsored by the American Meteorological Society. They also hope to make stops at the National Weather Service Paducah and Louisville offices, as well as the Kentucky State Climatologist.

Lisle, IL (October 21-22) – Illinois GIS Association Fall Conference

Zoe Zaloudek will be attending the Illinois GIS Association Fall Conference to share ideas with other GIS professionals from across the state.

Champaign, IL (October 29-30) – Midwest Climate Collaboration

The Midwestern Regional Climate Center is hosting the annual Midwest Climate Collaboration workshop. This year, the MRCC is not only inviting state climatologists, but also expanding the invitation to other key climate individuals and organizations in the region.

Ann Arbor, MI (November 4) – Great Lakes Integrated Science and Assessments Center (GLISA) Symposium

Molly Woloszyn will be traveling to Ann Arbor, MI for the 2013 GLISA Symposium. As a recipient of GLISA's grants competition for 2012, she will provide an update on the progress, preliminary findings, and future research goals of the funded project, which is a collaborative effort with Illinois-Indiana Sea Grant.

Missouri (November 11-15) – MRCC Road Trip

Beth Hall and Mike Timlin will be hitting the road for the second of three scheduled regional road trips of 2013. The goals of these trips are to personally meet with our climate partners and network with anyone interested in climate data and products. Kansas City, MO will be one stop on this trip, as well as National Weather Service offices and other climate partners.

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Have something to share as a feature article in an upcoming *The Climate Observer* issue, or interested in being contacted for an article interview? Please let us know!