



# THE CLIMATE OBSERVER

*A publication of the Midwestern Regional Climate Center*

February 2016

## Assessing and Comparing Winter Severity

*Steve Hilberg, Climatologist & Director Emeritus, Midwestern Regional Climate Center*

How severe was last winter? Or, the winter before? The answer to these questions can be somewhat subjective and depend on location. A “normal” winter in Minneapolis would be a record severe winter in, say, Atlanta, GA. The average temperature or total snowfall for a location will paint part of the picture, but it is far from a complete description. The question “How severe was this winter?” does not have a simple answer. At the very least, the severity of a winter is related to the intensity and persistence of cold weather, the frequency and amount of snow, and the amount and persistence of snow on the ground. Winter severity is site-specific, relative to the climatology of the region and the experiences of its population.

Winter seasons have significant societal impacts across all sectors ranging from direct human health and mortality to commerce, transportation, and education. To help put winters in context, researchers Dr. Barbara Mayes Boustead at the National Weather Service in Omaha and Steven Hilberg of the Midwestern Regional Climate Center collaborated to develop the Accumulated Winter Season Severity Index (AWSSI), an objective index that uses commonly available data to quantify and describe the relative severity of the winter season. One motivation for developing such an index was to characterize and compare the winter of 1880-1881 to present-day winters. The winter of 1880-1881 was the brutal winter that was the subject of Laura Ingalls Wilder’s book “The Long Winter” and is the focus of Boustead’s Ph.D. dissertation.

The “Long Winter” of Wilder’s book, set in the Dakota Territory (present-day east central South Dakota), featured a nearly continuous string of blizzards, along with brutal cold air outbreaks, spanning October 1880 through April 1881. Many readers and Wilder fans have wondered if that winter was realistic, if it was the “worst” winter in that area, and if there has been any winter like it since then. Using the AWSSI, combined with available weather data, Boustead was able to determine that the winter of 1880-1881 was among the worst in the region but perhaps not even the worst on record. Depending on the site, the extremity of the Long Winter was rivaled by winters in 1874-1875, 1911-1912, 1950-1951, 1961-1962, 1978-1979, and even as recent as 1996-1997.

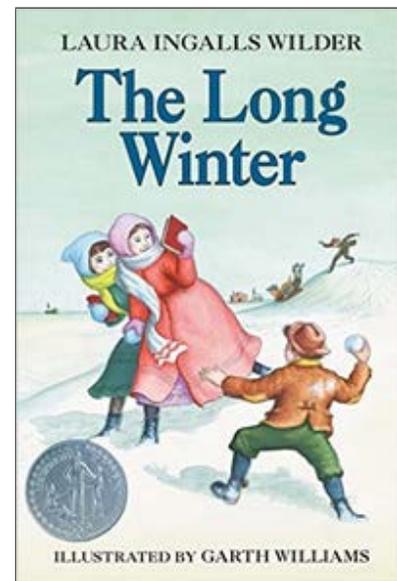
The AWSSI uses daily data – maximum and minimum temperature, snowfall, and snow depth. The season start and end is determined by specific weather events, not by the calendar, so it captures winter weather from its first occurrence to its last during the season. At a minimum for any location winter runs from December through February, assuming that the other triggers do not occur.

The winter season begins when the first of any one of the following instances occurs:

- First measurable snowfall ( $\geq 0.1$  inch)
- Maximum temperature at or below 32°F
- December 1

The winter season ends at the last occurrence of any of the following:

- Last measurable snowfall ( $\geq 0.1$  inch)
- Last day with 1 inch of snow on the ground
- Last day with a maximum temperature of 32°F or lower



### MRCC Product Highlight:



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### Climate Cool Tool:



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[Natl. State of the Climate](#)



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### On the Road:

**Switzerland** - WMO Meeting  
**WI** - Climate Change & Midwest Agriculture  
**SD** - Climate & Agriculture Tools Workshop  
**MO & IL** - MRCC Regional Road Trip  
**IL** - Illinois Assn. for Floodplain and Stormwater Management Annual Conference

- March 1

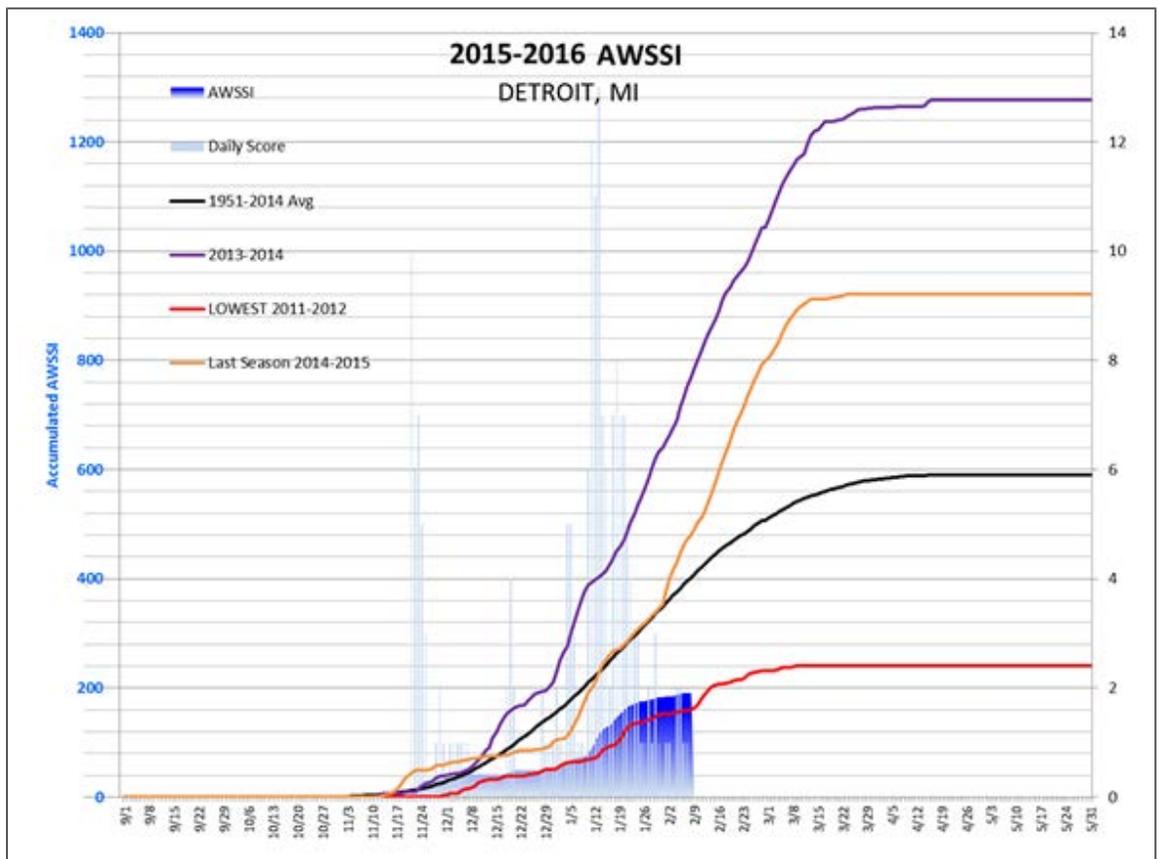
The AWSSI does for winter what other such scales do for hurricanes, tornadoes, and droughts. During the winter season, daily scores are calculated based on scores assigned to temperature, snowfall, and snow depth thresholds. The daily scores are accumulated through the winter season, allowing a running total of winter severity in the midst of a season as well as a final, cumulative value characterizing the full season. Accumulations of the temperature and snow components of the index are computed separately and then added together for the total index. This allows comparison of the relative contribution of each to the total score. The AWSSI can be tracked as the season progresses, and it allows comparisons of winter severity to average and to previous years.

The AWSSI can be calculated for any location that has the requisite temperature and snow data, but to put the AWSSI at a specific location in context requires sufficient historical data. For each location with such data, the AWSSI is calculated for each winter since 1950. The scores are stratified into quintiles, and these were assigned to descriptive categories.

Category	Range of Values
W-1: Mild	Min to 20th percentile
W-2: Moderate	21st to 40th percentile
W-3: Average	41st to 60th percentile
W-4: Severe	61st to 80th percentile
W-5: Extreme	81st percentile to max

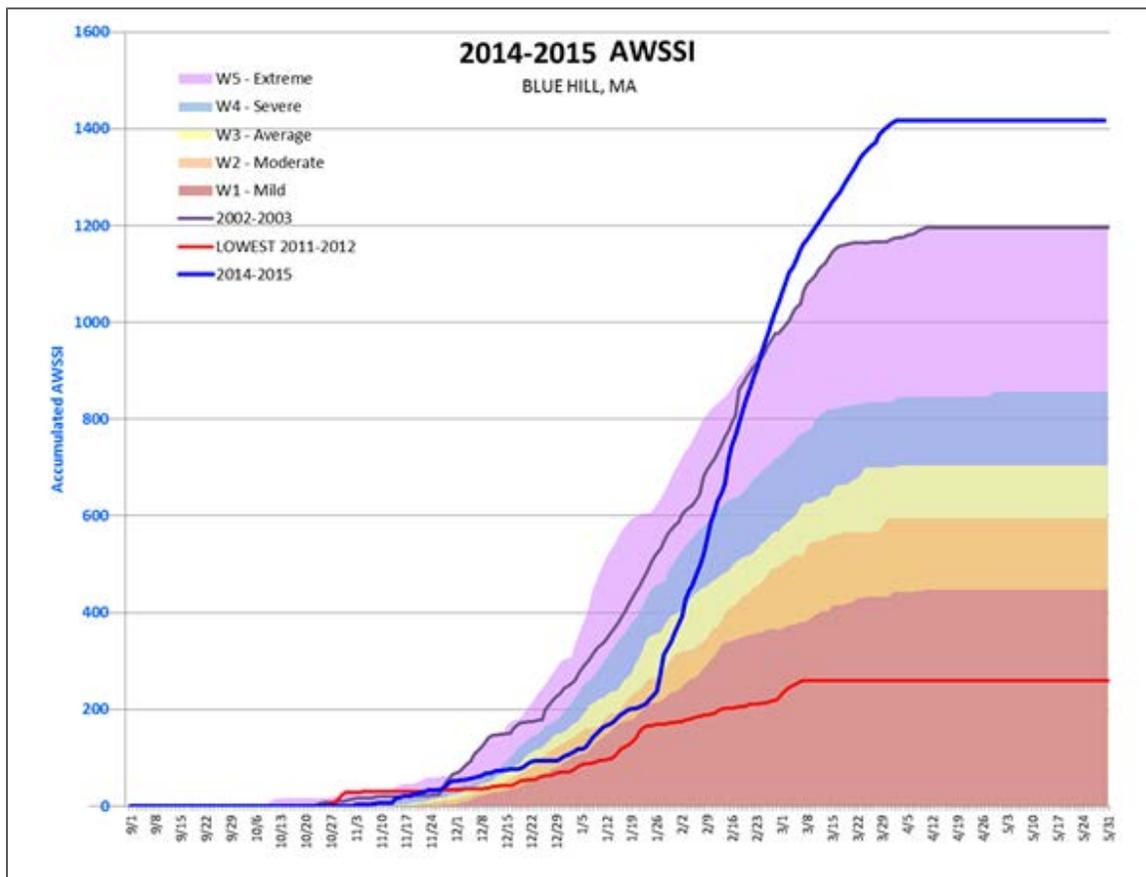
*Category labels, descriptions, percentiles, and color coding the the AWSSI.*

The index values can be compared to other years at the same location to gauge the severity of a given winter. In this example, the AWSSI accumulation is shown for Detroit for the winter of 2013-2014, 2014-2015, and for the current winter. The Detroit AWSSI of 1,274 for the winter of 2013-2014 was a new record (since 1950), eclipsing the old record of 1,048 set during the winter of 1977-1978. The AWSSI reached the Extreme category in early December and stayed there the entire winter. Contrast that to this year, where the AWSSI is in the Mild category, though not likely to end lower than the record Mild year of 2011-2012.



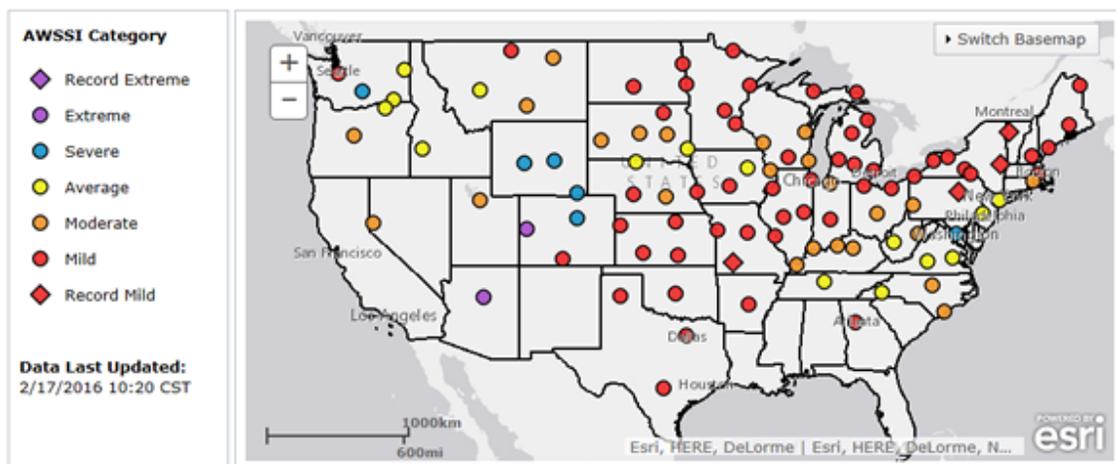
*This chart displays the AWSSI for the current year (blue shaded), along with 2014-2015 (orange), the record AWSSI in 2013-2014 (purple), the lowest (red) in 2011-2012, and the average (black).*

The AWSSI is also helpful in characterizing the progress of a winter (below). During the winter of 2014-2015, the Boston area was experiencing a milder than normal winter. Through mid-January, snowfall totaled only 15.5 inches at Blue Hill, MA, less than half of average through the date. At that point, the AWSSI was in the Moderate category. However, over the next six weeks, winter hit with a vengeance, with persistent bone-chilling cold and another 10 to 12 feet of snow across New England. Blue Hill's AWSSI score went from 229 on January 25 to a record 1,417 on April 3. The average AWSSI for Blue Hill is 674. Blue Hill was chosen to represent the Boston area because daily snow depth is no longer measured at Boston's Logan Airport.



*This chart displays the AWSSI for Blue Hill, MA for 2014-2015 (blue line) compared to the lowest in 2011-2012 (red line) and most severe AWSSI in 2002-2003 (purple line).*

The index values can also be compared at differing locations to compare winter severity among the various cities. The map below shows the status of the AWSSI across the country as of February 17, 2016 and reflects the overall effect of El Niño and the positive phase of the North Atlantic Oscillation on the U.S. Most of the country east of the Rockies is experiencing a mild winter without much snow, while along and west of the Rockies, the winter status is more of a mix, ranging from Extreme to Moderate.



While the AWSSI factors in the major components of temperature and snow, it does not include two elements that can compound a winter's severity. Wind can be a major factor in storms creating impossible travel conditions and dangerous wind chill values. However, wind is typically only measured at airports and can vary greatly during the day and between locations. There is no "daily" wind value that is measured and recorded at most climate locations. Freezing rain is another element that is not factored in. Ice storms can be extremely damaging, and the effects can persist for days or weeks. However, freezing rain is reported as liquid precipitation, and ice thickness is not part of the observation.

The [MRCC AWSSI web page](#) was redesigned this year to include an interactive map. The AWSSI map is updated several times each day. The AWSSI is calculated for about 100 locations across the country, and more locations will continue be added this winter and in future years. The map allows you to select a location and view the updated chart for that location. In addition, for nine of the sites (Blue Hill, MA; Chicago, IL; Denver, CO; Detroit, MI; Minneapolis, MN; New York City, NY; Omaha, NE, Urbana, IL; and Washington, DC), a manually-updated PDF file with the daily scoring and an additional chart can be viewed. Future plans include adding more functionality to the web page, including the ability to compare and plot other years with the current years, the ability to generate the AWSSI on the fly for other locations, and means to download the AWSSI data.

The AWSSI scoring thresholds were determined with impacts in mind. The AWSSI has any number of potential applications and uses, especially sectoral applications. AWSSI and/or its contributing components could be applied to transportation and road maintenance to correlate cost, supplies, or traffic accidents and delays, as well as to health factors such as hospital and emergency room visits or mental health incidents. The index could be correlated to wildlife populations and their markers of abundance, migration, or health. In a predictive sense, awareness among such sectors that AWSSI is approaching a critical threshold of severity may invoke protective or preventative measures to offset potential costs and/or impacts experienced during higher severity. The AWSSI also can be related to climate signals such as the El Niño/Southern Oscillation (ENSO), Arctic Oscillation (AO), North Atlantic Oscillation (NAO), and Pacific Decadal Oscillation (PDO).

#### Further Reading:

The Accumulated Winter Season Severity Index (AWSSI)  
Barbara E. Mayes Boustead, Steven D. Hilberg, Martha D. Shulski, and Kenneth G. Hubbard. Journal of Applied Meteorology and Climatology, Vol. 54, No. 8, August 2015: 1693-1712.

[Abstract](#) | [Full Text](#) | [PDF](#) (2545 KB)

Boustead, Barbara, "The Hard Winter of 1880-1881: Climatological Context and Communication via a Laura Ingalls Wilder Narrative" (2014). Dissertations & Theses in Natural Resources. Paper 98. <http://digitalcommons.unl.edu/natresdiss/98>

For more information on this article or the [AWSSI](#), please contact Steve Hilberg via email at [hberg@illinois.edu](mailto:hberg@illinois.edu)

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## Chicago Nature Museum Opening Weather and Climate Exhibit

**Alvaro Ramos, Vice President and Curator of Museum Experience,**  
**Peggy Notebaert Nature Museum**

At the [Chicago Academy of Sciences / Peggy Notebaert Nature Museum](#), we pride ourselves on producing self-created exhibits on timely issues that will resonate with our family audience. As we celebrate the rich history of our institution during its 160th anniversary, we are busy putting the finishing touches on our most ambitious exhibit yet, one that puts into perspective for families one of the most consequential issues of our time.

On April 2nd, the Nature Museum will open *Weather to Climate: Our Changing World*. The exhibit will



present in an accessible way the fundamentals of weather and climate, the science behind climate change, and what actions people can take to reduce our own impact. The exhibit will run through October 23, 2016 and drive a community-wide conversation about climate change.



*Photos: The Weather To Climate museum exhibit in development*



For the last two years — thanks in large part to a diverse collaboration of subject matter experts

including Molly Woloszyn at the Midwestern Regional Climate Center and Illinois State Climatologist Jim Angel — we have immersed ourselves in this important issue. Throughout this process, we worked hand-in-hand with our education department to make sure the interactive content is presented in a way that is easy to understand. In addition, the exhibit will facilitate ways for visitors to continue discussing climate change after they have left the Nature Museum.

This exhibit also represents our biggest foray into multi-media. The exhibit will feature interactive displays, video games, weather simulations, climate labs and more. From a design standpoint, it has been fascinating to see ideas initially scratched out on paper be transformed into active, dynamic content.

The Nature Museum is dedicated to creating a positive relationship between people and nature through collaborations, education, research and exhibitions such as *Weather to Climate*. As Chicago's urban gateway to nature and science we could not be more proud to bring this global conversation to our own community.



*The Peggy Notebaert Nature Museum is located at 2430 N. Cannon Drive, Chicago, Illinois. For more information on this article or the [Peggy Notebaert Nature Museum](#), please contact Alvaro Ramos via email at [alvaro.ramos@naturemuseum.org](mailto:alvaro.ramos@naturemuseum.org)*

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## Apply now for MRCC's Summer Intern Program!

***Beth Hall, Director, Midwestern Regional Climate Center***

The [Midwestern Regional Climate Center \(MRCC\)](#) has offered paid summer internships to college students for over a decade. Most often, these students have majored in an atmospheric science discipline. Recently, however, the MRCC has recognized the benefits of hiring students seeking interdisciplinary foci (e.g., computer science, social science) who often include an interest in atmospheric science – in particular, climatology. These internships have provided students with an opportunity to work directly with historical atmospheric data and realize the diverse



applications and needs of acquiring, maintaining, and analyzing these data. From serving the public's need for climate information, to participating in applied climate research, to contributing to the development of tools and resources for accessing and interpreting climate data, summer interns gain an appreciation for the field of climate sciences.



*The Urbana, Illinois cooperative weather station (118740) at the Illinois State Water Survey. Photo courtesy Jim Angel, Illinois State Climatologist.*

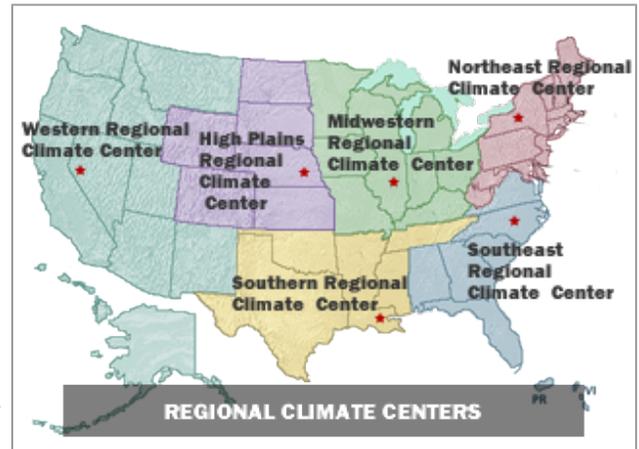
The MRCC is located within the Illinois State Water Survey (ISWS), which is part of the Prairie Research Institute at the University of Illinois at Urbana-Champaign. With a fully equipped, fully functional weather observing site in its backyard, the MRCC and ISWS not only get to experience the reward of contributing to a long history of climate data for a location, but also realize the complexity and challenges that data collection carries in terms of quality control.

The MRCC is one of 6 Regional Climate Centers across the United States that has been supported

through federal funds since the early 1980s. Its mission has four components:

- Provide high-quality climate data, derived information, and data summaries for the Midwest region
- Monitor and assess regional climate conditions and their impacts
- Prepare specialized historical climate data sets
- Coordinate and conduct applied research on climate-related issues and problems

Student interns have the opportunity to help support in the [MRCC Climate Service Office](#) and/or provide support on an applied climate or climate monitoring project. Past projects have covered topics from examining climate teleconnection relationships to widespread drought, using climate data to study and compare heat waves in Chicago, identifying extreme precipitation events that have impacted major metropolitan areas, to improving the metadata records of national climate datasets. Several MRCC interns have even had the opportunity to present their applied climate internship project at professional conferences. Three current MRCC climatologists were former MRCC summer interns, and other past interns have gone on to pursue and succeed in careers within the climatology and atmospheric sciences.



This summer, the MRCC is seeking two summer interns. Both interns will have the opportunity to contribute to applied climate research or monitoring projects. One of the positions will also help support the MRCC Service Office, while the other position will be challenged with product development through the use of programming, design, and/or implementation skills. Position announcements for the 2016 MRCC Summer Internship opportunities can be found at the links below. Please email Beth Hall ([bethhall@illinois.edu](mailto:bethhall@illinois.edu)) for more information.

[MRCC Summer Intern – Climatologist](#)

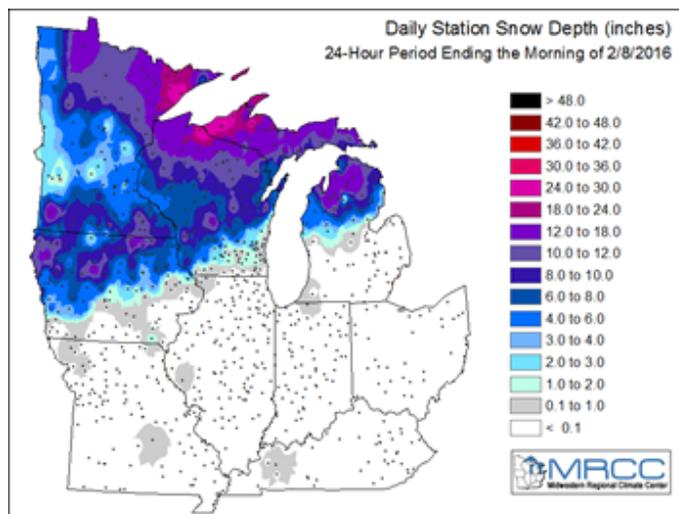
[MRCC Summer Intern – Climatologist / Computer Programmer](#)

*For more information on this article or the MRCC Summer Intern Program, please contact Dr. Beth Hall via email at [bethhall@illinois.edu](mailto:bethhall@illinois.edu)*

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## Midwest Climate at a Glance - Winter 2015-2016

After a warm fall and early winter, winter weather has been more common across the Midwest since Christmas. The rains of December saturated soils for much of the region but conditions have dried out in January and early February. Snowfall totals were well below normal through Christmas but totals since then have picked up with several storms affecting parts of the Midwest, bringing snow and colder winter temperatures. It hasn't been just winter weather in recent weeks, as there have been some warm weeks as well. The last week of January and the first week of February were well above

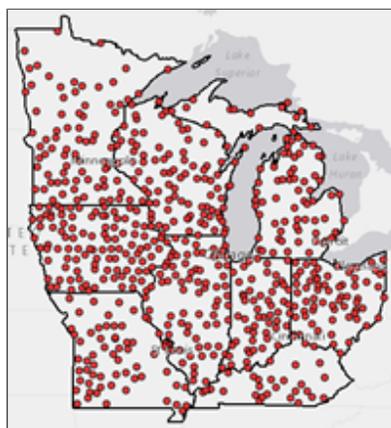


normal for most of the region.

Among the snow storms that have touched the region in recent weeks was a storm that brought blizzard conditions to southern Minnesota and northern Iowa on February 7th and 8th. Despite only picking up an inch or two of snow, gusty winds of 40 to 60 mph whipped up snow previously on the ground to obscure visibility. [Read more...](#)

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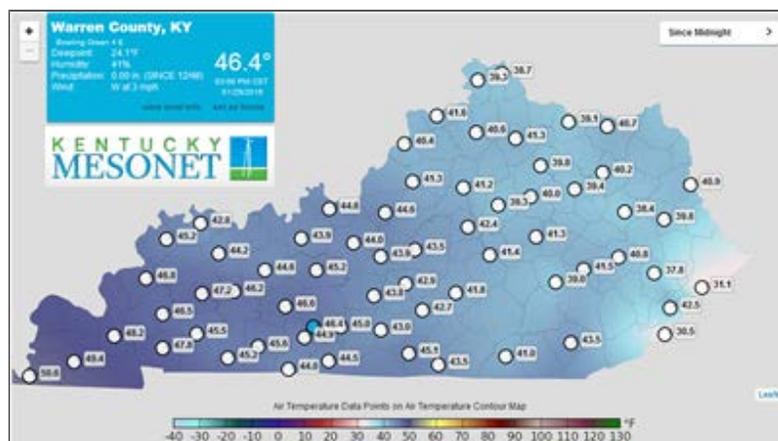
### MRCC Product Highlight



Have you ever wondered how many days on average per year the temperature is 90°F or above for your city? Or how much precipitation fell in the wettest summer on record? Find out these statistics and more using the Midwestern Regional Climate Center's updated [Climate Summaries](#) product! The summaries highlight temperature, precipitation, snowfall, and growing season data, including averages and extremes by month, season, or year. The summaries are available for the MRCC's nine Midwest states (Illinois, Indiana, Iowa, Kentucky, Ohio, Missouri, Michigan, Minnesota, and Wisconsin).

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### Climate Cool Tool



The [Kentucky Mesonet](#) is a network of research-grade automated weather and climate monitoring stations developed by the Kentucky Climate Center at Western Kentucky University to serve diverse needs in communities across the Commonwealth of Kentucky. The interactive website for the Kentucky Mesonet includes real-time data for temperature, dew-point, humidity, precipitation, wind, soil moisture and

temperature (at selected sites), and solar radiation across Kentucky, as well as historical climatological summaries. The website also offers derived products including heat-index values and

event tracking for winds/gusts and precipitation.

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## MRCC On The Road



### **Geneva, Switzerland (Feb. 15-27) – World Meteorological Organization**

Nancy Westcott will be traveling to Switzerland to draft a revision of the Best Practices Guidelines for the Climate Data Rescue project with the World Meteorological Organization.

### **Madison, WI (February 29-March 3) – Climate Change and Midwest Agriculture: Impacts, Challenges, & Opportunities Workshop**

Beth Hall will be attending this workshop that is being sponsored by the USDA Midwest Regional Climate Hub.

### **Brookings, SD (March 2-3) – Climate and Agriculture Tools Workshop**

Mike Timlin will be attending the Climate and Agriculture Tools Workshop in Brookings, SD to present the MRCC tools, many of which are part of the Vegetation Impact Program (VIP) at the MRCC.

### **Missouri and Illinois (March 7-11) – MRCC Regional Road Trip**

Beth Hall and Mike Timlin will be on a regional road trip visiting with stakeholders in Missouri and parts of Illinois. The MRCC does regional road trips throughout the year, each to different parts of our region. If you would like to be on this or a future itinerary, please contact [Beth Hall](#).

### **Tinley Park, IL (March 9-10) – Illinois Association for Floodplain and Stormwater Management Annual Conference**

Molly Woloszyn and Zoe Zaloudek will be attending the IAFSM annual conference, which has the theme of "Partners in Planning". Molly will be presenting about the [Resilient Chicago](#) initiative.

### **Burlington, VT (March 22-24) – Climate Prediction Applications Science Workshop**

Beth Hall and Mike Timlin will be attending the Climate Prediction Applications Science Workshop. Beth Hall will present about MRCC's Vegetation Impact Program and Mike will present on the MRCC's updated hourly database project.

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[Email us](#) your local climate impacts! We are constantly keeping a log of how climate is impacting our region, and our information would not be complete with YOUR help!

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MRCC is based at the Illinois State Water Survey, a division of the Prairie Research Institute at University of Illinois Urbana-Champaign.

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