2018 Shareholders Report

National Weather Service, Louisville

Photo: Don E. Yeoman, Jr.

Contents

Leadership Letter

Welcome to the 14th edition of National Weather Service (NWS) Louisville's Shareholders Report. As I say every year, you are a shareholder in the NWS! This report details our activities and events across southern Indiana and central Kentucky during 2018. From our perspective, 2018 will be remembered as a record wet year in some locations with significant flooding on the Ohio River, for an unusually early season ice storm in November, and for the arrival of 3 new meteorologists at the Louisville weather office.

Early in 2018 we were fortunate to hire enthusiastic meteorologists Cliff Goff, Jessica Bozell, and Samantha Carr. They have already become involved in many outreach opportunities, including the Kentucky Science Teachers Conference, Junior Achievement Inspire, and the Combined Federal Campaign.

In 2019 my top 5 priorities are:

- ✓ Continue to focus on improving all facets of Tornado Warnings
- ✓ Increase our Impact-Based Decision Support Services (IDSS)
- ✓ Begin forecasting for the Barren River in Bowling Green
- ✓ Include structural engineers on storm damage surveys
- ✓ Complete several GIS-based meteorological story maps

I hope you find that our activities demonstrate the sort of stewardship you expect from your public servants. The NWS was appropriated $1.1 billion for Fiscal Year 2018, which was an investment of only $3.35 per American. As the leader of NWS Louisville, I feel it is my duty to report to you how your holdings have fared. I am grateful to Lead Forecaster and Shareholders Report Editor Tom Reaugh for assembling another excellent report, and Science and Operations Officer Ted Funk for his thorough review of the document. I welcome your suggestions as to how the NWS can be an even better investment for you.

Cheers,

John Gordon, *Meteorologist-in-Charge (MIC)*

Impact-Based Decision Support

Joe Sullivan, *Warning Coordination Meteorologist*

Thunder Over Louisville

Working alongside Federal Aviation Administration officials in Thunder Command, Joe Sullivan maintained a constant weather watch during the air show and the practice times beforehand. A Kentucky HAZMAT weather station at the center of the George Rogers Clark Memorial Bridge over the Ohio River provided instantaneous wind information along the air show flightline. The weather station was also used to forecast the trajectory of the fireworks smoke plume that followed the air show for the 600,000+ spectators lined along the Ohio River. Information Technology Officer Toby TenHarmsel provided support to Emergency Management on the Indiana side of the river.

NWS Louisville provided on-site support during the Capitol Plaza Building implosion in Frankfort on March 11. Our office also provided Franklin County Emergency Management with detailed wind forecasts days in advance that allowed them to move the VIP viewing location to a spot that would remain outside the dust cloud.

Oaks, Derby, Breeders

Joe Sullivan, Toby TenHarmsel, and Lead Forecaster Ron Steve shared weather support duties to help protect the public during the Oaks and Derby races that drew more than 250,000 spectators over two days to historic Churchill Downs. TenHarmsel had the task of being in the command center during the wettest Derby Day on record when 1 to 3 inches of rain soaked any spectators not under cover. Sullivan and TenHarmsel then reprised their on-site support in the command center for the 2018 Breeder's Cup held November 2-3.

Occupy ICE

July protests in Louisville

Bourbon Chase

35-hour, 200-mile relay race along the Kentucky Bourbon Trail

Waterfront Wednesdays

Outdoor concerts drawing 10,000 people

Hourly forecasts were created by NWS Louisville to remotely support a number of other events including those shown above.

Seeing by Satellite

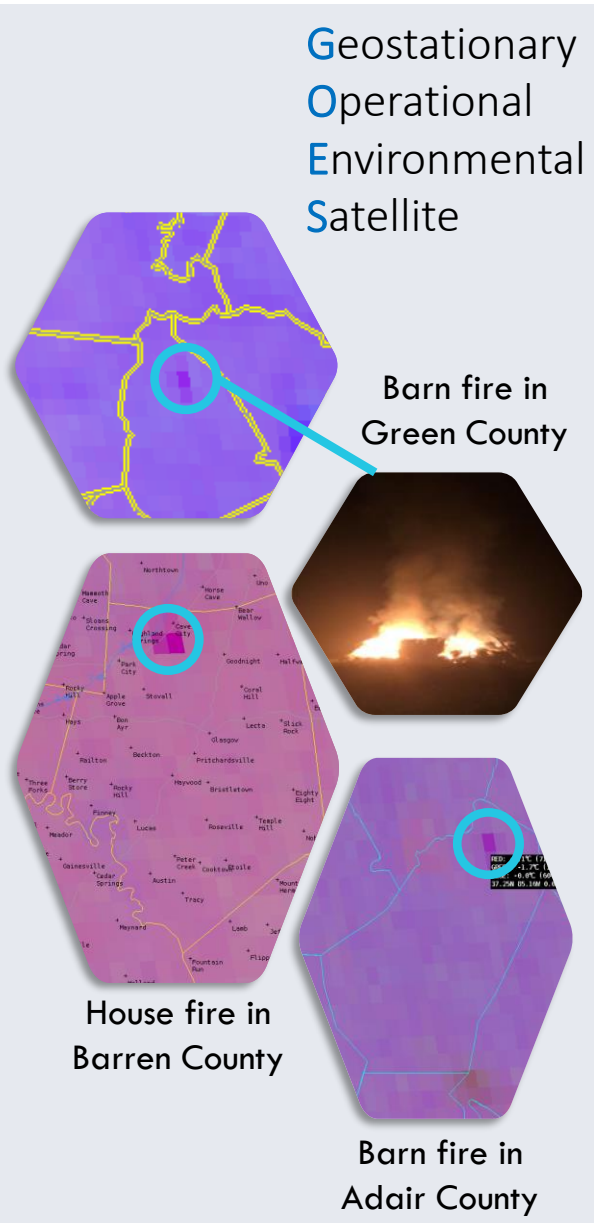
Ryan Sharp, *Lead Forecaster*

Seeing Fires from 22,000 Miles Up

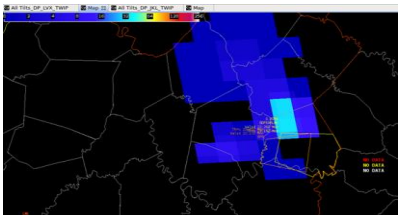
Early on the morning of August 14, a nighttime composite satellite image (top image on right) from GOES-16 indicated a hot spot in northern Green County. After some investigation, meteorologist Corey Houk of WCKQ in Campbellsville learned that a large hay barn had caught fire in the exact location the satellite picked out!

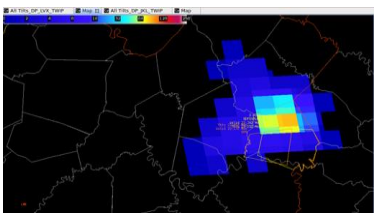
Other structure fires have been detected in recent months as well, as seen in the images to the right. In the case of the barn fire in Adair County, NWS Louisville noticed the hot spot on satellite even before the fire was reported. Lead Forecaster Ryan Sharp called county officials and alerted them to the blaze.

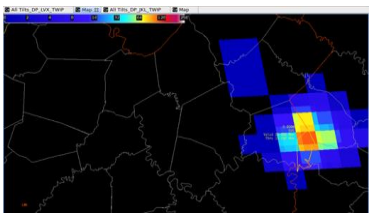
This new satellite has already proven itself "seeing" fires in Kentucky and could have saved Knifley from this isolated barn fire becoming a large wildland fire. Thank you Ryan Sharp and NWS Louisville for keeping eyes on Kentucky!!!
-- Mike Keltner, Adair County Emergency Management



Lightning-Fast Storm Information







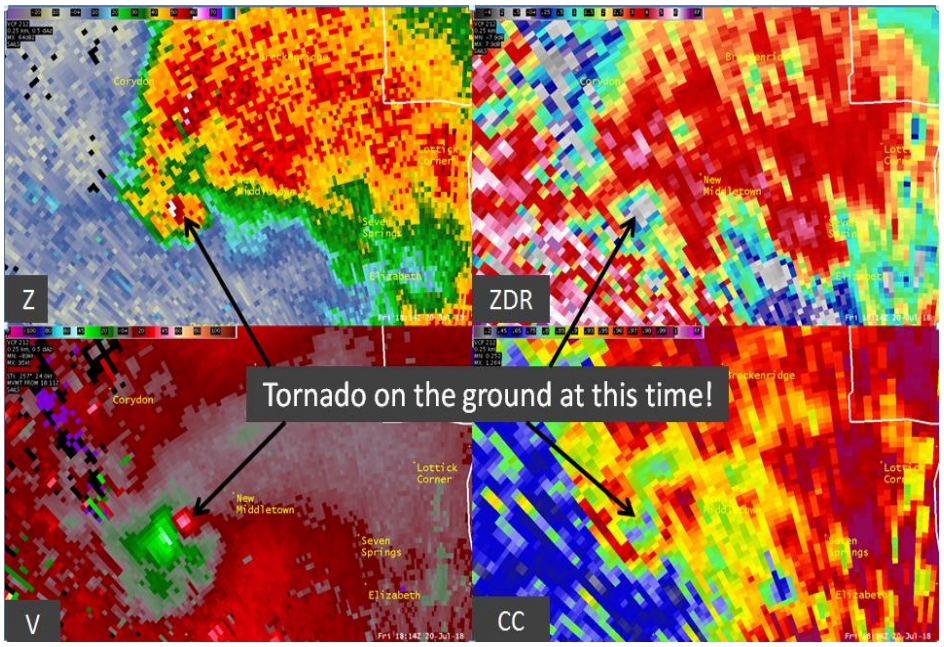
The Global Lightning Mapper gives meteorologists a minute-by-minute look at how lightning is changing inside a thunderstorm. The very day it became available at NWS Louisville, it helped meteorologists decide to issue a Severe Thunderstorm Warning east of Winchester, Kentucky. The sequence of images above shows how the number of lightning flashes increased rapidly as the storm moved from western Clark County into Powell County. The peak value in the third image (far right) shows 114 flashes in a 5-minute period. The storm damaged several trees and unroofed a home along the Clark/Powell County line.

Radar Technology

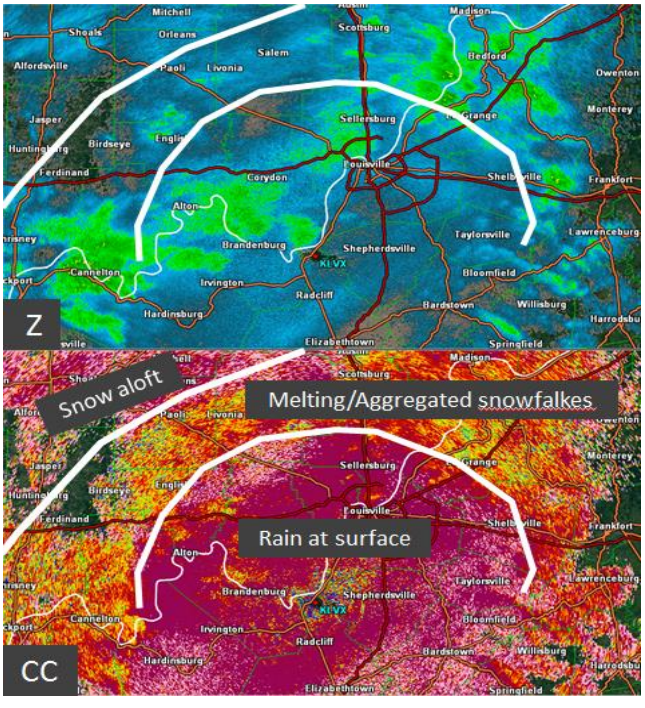
Dan McKemy, *Forecaster*

Dual-polarization Doppler radar data have been available for several years at NWS Louisville and have proven to be extremely helpful in interpreting a variety of weather including severe thunderstorms and dangerous winter weather.

The image at right shows a tornadic thunderstorm in Harrison County, Indiana on July 20. Reflectivity (Z) is top left, differential reflectivity (ZDR) top right, velocity (V) bottom left, and correlation coefficient (CC) bottom right. ZDR and CC indicate debris such as leaves, branches, or parts of buildings being lofted into the air by the tornado. This is a "tornado debris signature" and it gives the warning forecaster confidence that a tornado is occurring even if no reports are received.



Dual-polarization: The radar sends out a horizontal pulse and a vertical pulse of energy
Reflectivity: A measure of power returned to the radar from a target
Differential reflectivity: Gives an idea of the general shape of targets
Velocity: Speed and direction of movement of targets
Correlation coefficient: Degree of similarity among targets



On the left is an example of wintry weather using dual pol data on November 12. Using reflectivity and correlation coefficient together we can see what is falling through the atmosphere. Purple and pink colors of CC indicate uniform particles which, in this case, were raindrops. Higher up we begin to see CC values decrease (yellows) indicating non-uniform particles, which in this case was a mix of rain and snow. Still farther aloft, CC values increase (purples and pinks) indicating the particles are uniform again. All of these targets were snowflakes in colder air higher in the atmosphere. Snow is melting to rain as precipitation falls from the clouds to the ground.

Improving Tornado Warnings

Ryan Sharp, *Lead Forecaster*

One of our top priorities is to improve our tornado warnings. Our False Alarm Ratio (FAR, see right) has been slightly higher than the national average. As an office we have been studying why this might be the case, and how to resolve it.

False Alarm: A warning is issued but severe weather does not occur or is not reported.

Most rotations detected on NWS Doppler radar do not make it to the ground as tornadoes. In the Ohio Valley we have the added difficulty of squall line tornadoes, which are especially difficult to detect compared with classic supercell tornadoes in the Great Plains. We issue warnings based on radar so that the warning is in effect before a tornado touches down, increasing the amount of time people have to reach safety.

In an effort to decrease our FAR, forecasters conduct a self-assessment for any tornado warning they issue, whether there was an actual tornado or not. The typical NWS Louisville radar meteorologist issues an average of only about 2 tornado warnings per year. This number is a very small sample size for what is essentially the most important life-saving product we issue. To counter this lack of opportunities, we now employ warning teams on radar rather than just one or two people attempting to assess a massive amount of radar and environmental data when deciding whether or not to issue a warning. Teams increase awareness, experience, and communication, while mitigating personal bias.

Scientists are making great strides in learning how tornadoes form thanks to research at both the national and local levels. Squall line tornadoes, which can occur any time of year in the Ohio Valley, are especially tough to detect because they are usually quite small, sudden, and short-lived. Science and Operations Officer Ted Funk is serving on a Tornado Warning Improvement Project (TWIP) team to develop expert-level continuing education on the warning decision process. Work by NWS forecasters via TWIP and local research has helped advance ideas that radar forecasters can use to better detect squall line and supercell tornadoes.

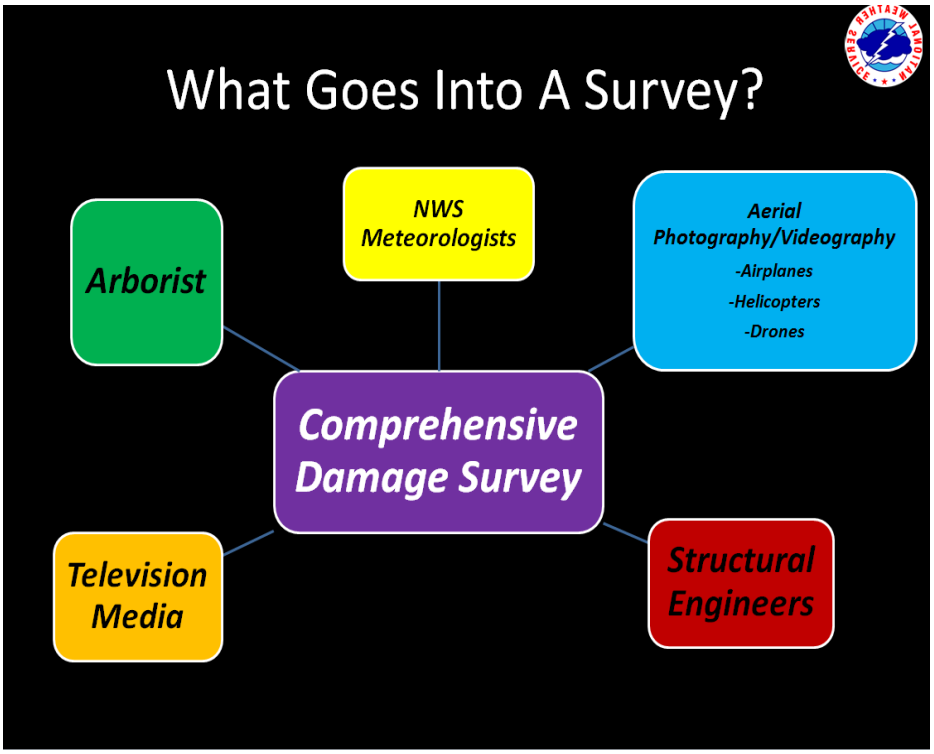
Some tornadoes are extremely small, such as this narrow funnel (upper left) caught on a residential security camera as it spun through Harrison County, Indiana on July 20. Most tornadoes in the Ohio Valley are small and weak, and are therefore difficult to warn. *Image courtesy Patrick Koch.*

Structural Engineers on Storm Surveys

Brian Schoettmer, *Forecaster*

Over the past several years, NWS Louisville has steadily worked toward the goal of having a more comprehensive approach to surveying severe storm damage. We can provide expertise from a meteorological standpoint, such as the type of storm that caused the damage. However, there are more diverse pieces to the damage survey puzzle that require input from other experts. For example, we've used volunteer general aviation pilots and available drone footage to assess damage from an aerial perspective. Also, we've teamed with a University of Kentucky professor with extensive knowledge of how various species of trees respond to wind. The most common type of damage is downed or snapped trees so it is important to have this experience when surveying.

Much like knowledge of tree integrity, understanding structural integrity is critical to assessing the strength of a particular damaging wind. Sometimes the difference between low structural integrity and high structural integrity can mean the difference between indicating a relatively weak tornado (EF-0 or EF-1) versus a strong tornado (EF-2 or EF-3). Meteorologists have some experience in identifying clues to structural integrity; however, the real experts are structural engineers.



In August, NWS Louisville met with a Structural Engineer Emergency Response (SEER) Team from the Structural Engineers Association of Kentucky. The team is extensively trained, following protocols developed by the Federal Emergency Management Agency, in rapidly assessing large areas of buildings to determine if they are safe. During the meeting, meteorologists and engineers discussed ways the two knowledge bases could come together to create more comprehensive damage surveys. The SEER team will assist with damage surveys whenever needed, and will be a great addition to the process. We look forward to working closely with them in the future, and are excited to have this piece of the puzzle in place.

It only took an EF-1 tornado to destroy this structurally unsound bridge in Pennsylvania.

Perfecting the Weather History Books

Tom Reaugh, *Lead Forecaster*

Powerful tornadoes swarmed across much of the eastern United States on April 3, 1974. One of those was an F4 that tore from Elizabethtown to near Taylorsville. The official record was somewhat vague about the path of the storm in Spencer County. Fortunately, an eyewitness, who was 15 at the time of the storm, communicated with us and we were able to more definitively plot the tornado's path. The record is more accurate thanks to assistance from the public. See the back cover of this report for ways to reach us.

On May 18, 1995 powerful thunderstorms roared across Kentucky. In the Nicholasville area considerable damage was deemed, at the time, to be the result of severe straight-line winds. At the end of a Rotary Club talk in Nicholasville in 2018, several members in the audience made an impassioned plea to MIC John Gordon that the storm was actually a tornado. NWS meteorologists opened an investigation by examining radar data, photos, videos, and newspaper articles. Environmental data were analyzed and witnesses were consulted. After extensive and careful review, it was determined that the storm was indeed a tornado of F2 strength. An update was made to the NWS tornado database so that future researchers will have more accurate information.

One of the strongest tornadoes on record in north-central Kentucky was the F4 twister that touched down in Jefferson Memorial Forest and proceeded through Bullitt and Spencer Counties on May 28, 1996. It was discovered that the touchdown point for this tornado had been entered into the historical tornado database incorrectly, and so will be corrected. The integrity of tornado data is of utmost importance and we strive to maintain the database as a world class source of historical severe weather information.

Information about historical tornadoes in southern Indiana and central Kentucky:
https://www.weather.gov/lmk/tornado_climatology

National historical severe weather database:
https://www.spc.noaa.gov/gis/svrgis/

Students Have an Impact

Samantha Carr, *Meteorologist*

Many opportunities exist in the NWS for college students to gain valuable work experience, both as paid scholars and unpaid volunteers. In fact, many current NWS employees began their careers by having participated in such programs. While the unpaid volunteer opportunities generally are targeted at college students majoring in meteorology or atmospheric science, high school students are welcome to visit our office to shadow forecasters. College students learn about NWS forecast and warning services, network with professionals in the field, assist with storm reports, help conduct storm damage surveys, receive operational training, and develop necessary skills to become competitive in the job market.

In 2018, NWS Louisville was fortunate to host three talented volunteers. Kacy Cleveland, a senior at the University of Louisville, helped MIC John Gordon create an in-depth weather history presentation for college students. Carson Meredith, a senior at Western Kentucky University, helped Forecaster Zack Taylor analyze whether or not our Wind Advisory criteria met the needs of our partners. Lastly, Christopher (CJ) Padgett, also a senior at Western Kentucky University, created NWS Louisville's first interactive GIS story map, which recounts the atmospheric setup and devastation experienced from the March 2, 2012 tornado outbreak, including the Henryville EF-4.

Student Coordinator Samantha Carr and volunteer CJ Padgett

Contact NWS Louisville for student volunteer opportunities

w-lmk.webmaster@noaa.gov

Learn more about Ernest F. Hollings Scholarships

https://www.noaa.gov/office-education/hollings-scholarship

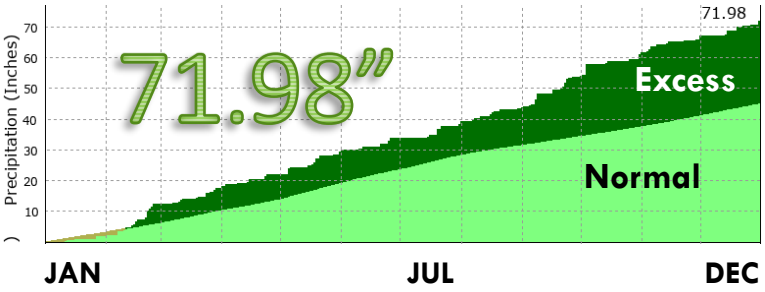
Undergraduates in their sophomore year of college are eligible to apply for the Ernest F. Hollings Scholarship, which includes tuition assistance for two years of full-time study and a 10-week, full-time paid internship at a NOAA facility during the summer between their junior and senior year. Additionally, the scholarship provides funds for each student to attend a professional conference during which they present research findings. After hosting 5 Hollings scholars at NWS Louisville during the summers of 2014-2016, we are looking forward to hosting our 2 new Hollings students, Kristine Chen of the University of Oklahoma and Melissa Piper from Iowa State University, in the summer of 2019.

Wettest Year on Record at Lexington, Louisville, and Frankfort

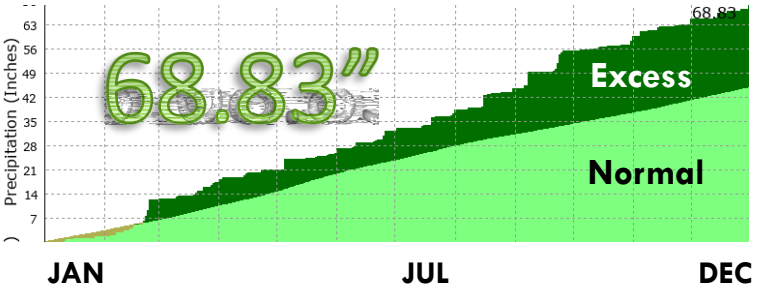
Andrea Schoettmer, *Lead Forecaster*

Repeated rounds of rainfall made 2018 the wettest year ever recorded in Lexington, Louisville, and Frankfort. Not only was it Lexington's wettest calendar year, it was the wettest of any 12-month stretch in the city's recorded history. As a result, periodic episodes of river flooding occurred throughout 2018 with the most notable flooding in February.

2018 Lexington Precipitation

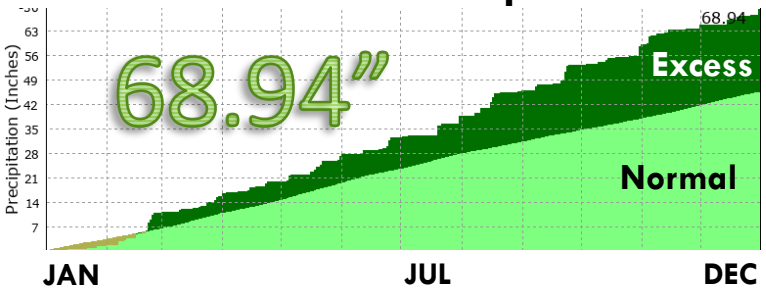


2018 Louisville Precipitation

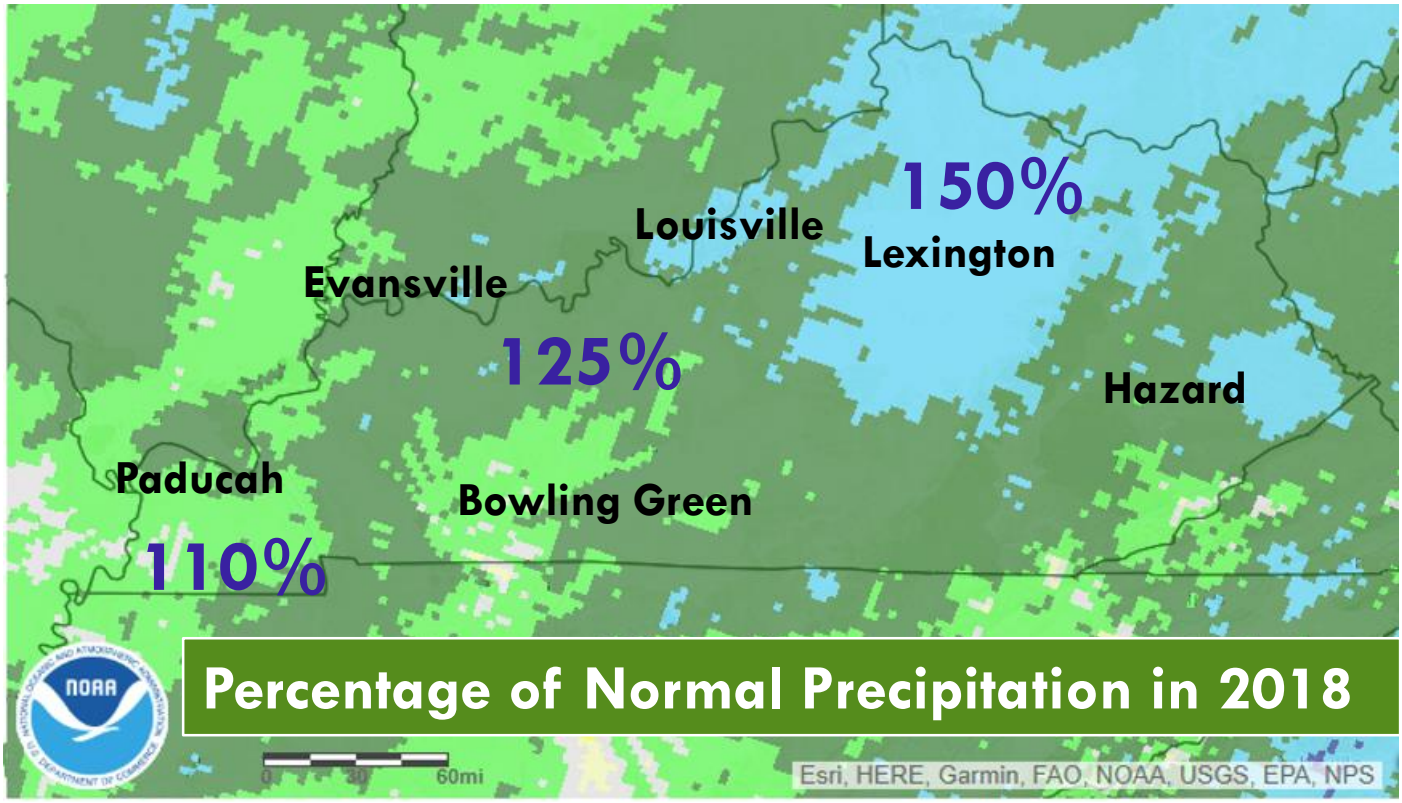


Louisville in February.
Photo: NWS

2018 Frankfort Precipitation



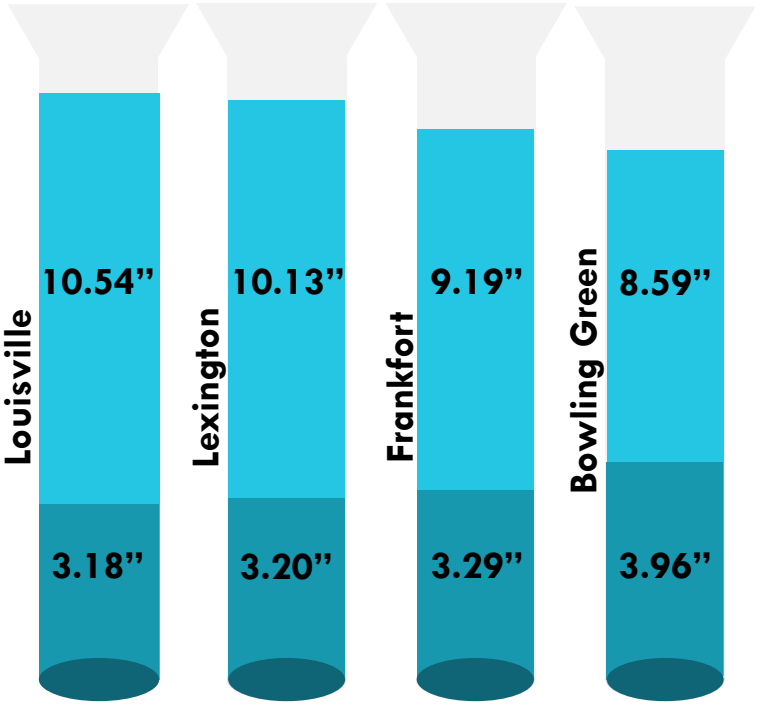
Louisville in February.
Photo: NWS



Spring Flooding

Andrea Schoettmer, *Lead Forecaster*

Repeated rounds of moderate to heavy rainfall across the entire Ohio River basin from February 15 to March 1 resulted in rainfall totals generally 200 to 400% of normal for that period. The large areal extent of the excessive rainfall, as well as the lack of green vegetation that would otherwise help soak up the copious rains, led to significant rises on the Ohio River and other streams across the region. Sites on the Green River, Licking River, Rolling Fork River, and Stoner Creek had multiple crests above flood stage. The Ohio River crested near the end of the month.



The amount of precipitation received in February (top number) compared to normal (bottom number).

Ohio River floodwaters in Louisville

Photos courtesy Molly Miller

Clifty Creek	McAlpine Upper	McAlpine Lower	Cannelton Lock	Tell City
457.3’	35.64’	67.13’	50.68’	49.30’
13th	*10th*	*12th*	*7th*	*7th*

Major flooding developed on the Ohio River at Cannelton, Indiana, with moderate flooding at many other locations. It was the worst Ohio River flood since 1997. The graphics above show local Ohio River crests in February 2018 with their historical rankings, e.g., “7th” indicates the 7th highest stage on record.

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Photo by Chris Allen in Warren County, Kentucky
January 12, 2018