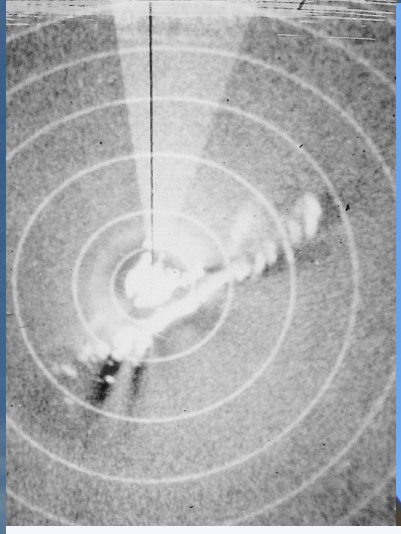

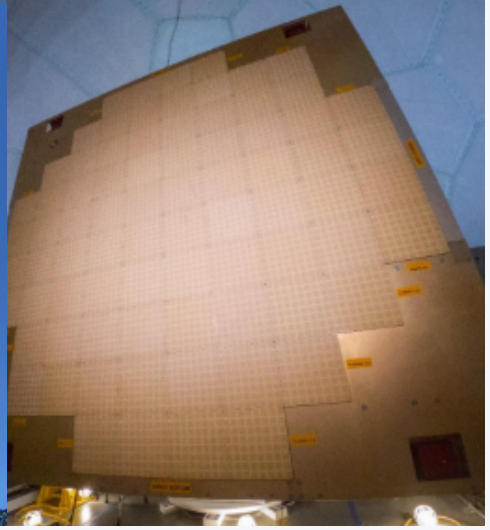

Shareholders Report 2024

National Weather Service
Louisville, Kentucky

Photo: Tom Reaugh

TOPICS

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METEOROLOGIST-IN-CHARGE
John Gordon

EDITOR
Tom Reaugh

VIBRANT PAST, BRIGHT FUTURE

John Gordon, Meteorologist-in-Charge

It's hard to believe that this is our 20th annual National Weather Service (NWS) Louisville (LMK) Shareholders Report! There has been tremendous change, innovation, and hazardous weather since my arrival in January 2005. LMK issued life-saving information and severe weather warnings during numerous catastrophic weather events including the 2021 Quad State major tornado outbreak, the March 2012 tornado outbreak that included an EF4 tornado that struck Henryville, Indiana, the crippling January 2009 ice storm, a Flash Flood Emergency for the city of Louisville August 4, 2009, and many more.

Over the last 20 years, the NWS has experienced substantial positive change in its hazardous weather services. This includes shifting severe weather warnings from county-based to storm-based to be much more specific and accurate, enhancing the Fujita Scale to account for building construction when rating tornado strength, escalating Decision Support Services (DSS) for our partners, introducing innovative Flood Inundation Mapping (FIM), and much more. In addition, LMK is one of the few NWS offices using drones for flood and severe storm damage surveys.

Since 1871 LMK has remained committed to serving the people of southern Indiana and central Kentucky with passion and purpose. Dedicated meteorologists work three shifts per day 24 hours a day, 365 days a year, along with a cadre of great supportive professionals. Extra personnel are called in during significant weather events to support one of the core missions of the NWS: the protection of life and property.

LMK is a leader in the NWS with storm damage surveys, GIS usage, succession planning, drones, Spanish language services, and FIM. LMK's top initiative is tornado warning improvement. We are working with several other NWS offices in the Ohio Valley, along with NOAA/NWS agencies in Oklahoma and Missouri, to improve tornado detection while lowering false alarms (see page 4).

In addition to tornado warnings, we are focused on three other main projects: high-level DSS for our partners, improving operational consistency across all of our services, and completing a tornado history mapping project.

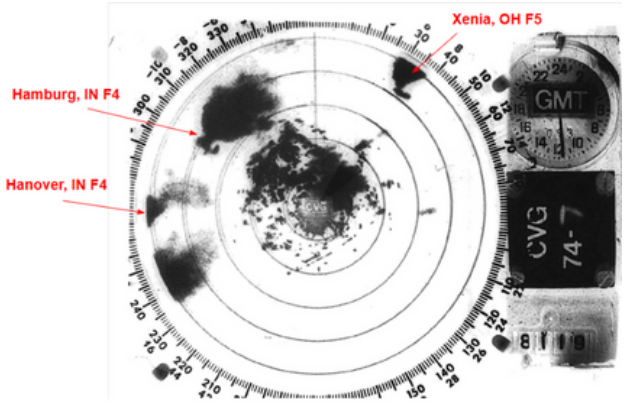
As public servants, our office's core foundation is exceptional customer service. I hope you find that our activities outlined in this report demonstrate that sort of stewardship. The NWS cost each American only $4.05 in 2024. I welcome your suggestions on how we can be an even better investment for you.

I am grateful to Lead Forecaster and Editor Tom Reaugh for assembling this report, and to Science and Operations Officer (SOO) Ryan Sharp for his thorough review of the document.

John D. Gordon

SHARPENING RADAR METEOROLOGISTS' SKILLS IN TORNADO DETECTION

Ryan Sharp, Science and Operations Officer



Covington radar from April 3, 1974, showing three separate supercells producing violent tornadoes.

In 2024 we commemorated the fiftieth anniversary of the Super Outbreak of April 3, 1974. This outbreak produced numerous violent tornadoes across the Ohio Valley, including the only reported F5-level damaging tornado in Kentucky history. Radar technology has come a long way since the hook echo images of that day.

Fast forward to 2024, and we have numerous new technologies and tools to help us diagnose these powerful high-end tornadoes, with recent cases such as the March 2, 2012 EF4 tornado through southern Indiana, and multiple tornadoes causing EF3-level damage across central Kentucky on December 11, 2021. These large tornadoes typically are easier to predict because atmospheric parameters have to come together just right to create them, and the Storm Prediction Center (SPC) in Norman, OK can give the local field offices a good heads up on the potential for violent tornadoes.

What still is not easy to forecast, and very common to the Ohio Valley region, is the small and typically brief EF-0 and EF-1 tornadoes that form within squall lines. These tornadoes can be so short-lived that they may be missed by radar as it scans the atmosphere. Ironically, in early April of 2024, several Super Outbreak commemoration events had to be curtailed because one of these tornado-producing squall lines moved through the region the previous day. Storm damage surveys from those tornadoes kept the office staff very busy on April 3!

The focus from many meteorologists in the Midwest and Ohio Valley over the past several years (Ron Przybylinski, former SOO at NWS St. Louis, MO, and Jason Schaumann, SOO at NWS Springfield, MO, as well as many others) has been to develop strategies to aid the radar warning forecaster in making decisions on when/if tornadoes are possible along these squall lines (also known as Quasi-Linear Convective Systems, or QLCS). Research has shown several precursor signatures that, when identified by the warning operator, can give confidence that a QLCS tornado may drop soon...even if its circulation is never, or only very briefly, scanned by the radar!

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TORNADO DETECTION

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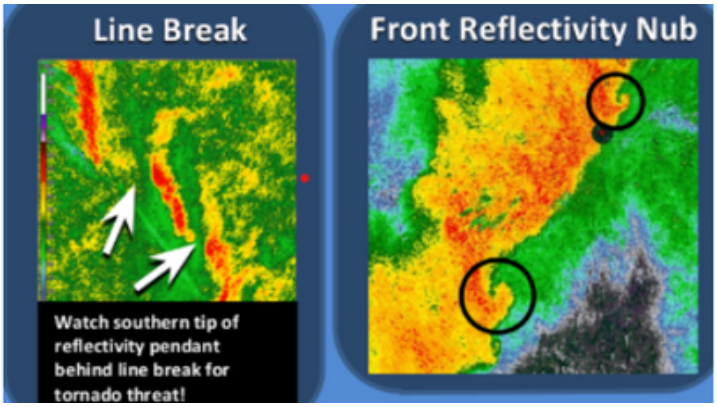
First, the portions of the squall line most likely to produce tornadoes are identified, and then the radar operator looks for certain signatures that act as confidence builders and "nudgers" towards issuing either a Severe Thunderstorm Warning with Tornado Possible (not quite enough confidence a tornado is developing) or a Tornado Warning. These are common signatures in the Ohio Valley. Having just one of the 10 confidence builders typically isn't enough to warrant issuing a Tornado Warning, but seeing several would!

Common confidence building radar signatures for a QLCS tornado. Breaks in the squall line can encourage tornadoes to form on the back side of the line (left image). Nubs along the forward flank of the line (right image) also can indicate areas of potential rotation.



In 2024, training at LMK focused on monthly refreshers on ways tornadoes form as well as strategies to detect them. We started off the year with a simulator training session, testing our ability to identify the confidence builders and nudgers. A forecaster at the Indianapolis NWS office, Randy Bowers, then developed a series of short cases that were useful for our staff to work through. In late February, two forecasters from the SPC visited the office to talk about their work and some tools we could use to relate risk levels to the public on a given severe weather day. In late March, I gave a presentation on how some newer tools could be used on tornadoes from the late winter tornadoes of February and March. In April we had the SOO from NWS Birmingham, AL, speak to the office on what they do for staffing to improve tornado detection while reducing false alarm rate (more on that later). In May, we had Cameron Nixon, a research scientist in Norman, OK, speak to us about tornadogenesis in supercells (large, rotating thunderstorms) and some of the latest research on how they develop.

June and November brought an interesting experiment that the Operations Proving Ground in Kansas City, MO, was testing: the idea of having a subject matter expert provide guidance on issuing tornado warnings during severe storm events. The concept is similar to having an offensive coordinator in the NFL speaking into the earpiece of the quarterback, except it would be an experienced meteorologist offering suggestions to the radar operator about issuing, or not issuing, warnings. A few LMK meteorologists participated in this national testbed, and it benefited both parties as we continued to use simulations to keep our radar skills fresh.

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TORNADO DETECTION

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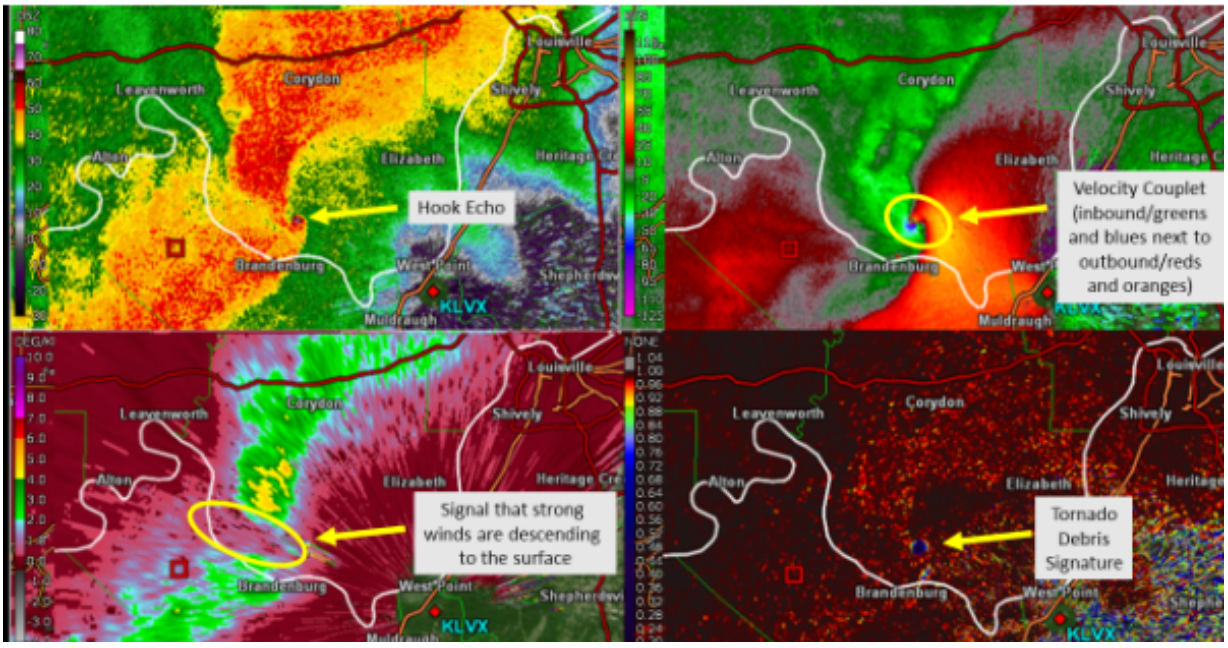
In July LMK hosted a satellite product developer, Jason Apke, for a talk on ways to see severe storms using new satellite tools. August brought a chance for departing meteorologist Dan McKemy to share his radar expertise on why he did NOT issue tornado warnings for several strongly rotating supercells in the Bowling Green area back in March of 2020. No tornadoes were detected during that event, and improving our false alarm rate is a key to better warnings and increased public trust. For September, LMK Meteorologist-in-Charge John Gordon developed a plan to have tornado experts from each of the Midwest and Ohio Valley offices come together in St. Louis in February 2025 to discuss best practices and training initiatives each office is doing to improve their tornado warnings. October was very busy, even though the weather was quiet. At media workshops in Louisville and Lexington, I presented several case studies on recent tornadoes and how we used the above-mentioned tools and techniques. Amanda Wagner, a forecaster at the Ohio River Forecast Center, talked to us about her recent graduate school work concerning social vulnerability and tornado warnings. Lastly, at our office's Winter Operations meeting we ran through a simulation that no one in the office was familiar with since the event had taken place outside our area of responsibility. It was a violent tornado that developed along a squall line in southern South Carolina. Meteorologists were asked to determine what signatures they saw and what they would do at multiple points in the exercise. The image below shows what the storm looked like toward the end of the simulation.



Simulated violent tornado over southern Indiana, used for training the Louisville forecast staff. Data taken from a rare EF4 tornado that formed within a squall line (QLCS) in the Charleston, SC forecast area, and superimposed on a map of the Louisville metro.

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TORNADO DETECTION

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We closed out 2024 testing a new program developed by TJ Turnage, the SOO at NWS Grand Rapids, MI, to assist with running simulations like these but on a wider scale (that is, outside of just one office). I ran this same QLCS tornado simulation as part of the winter training for several Midwest/Ohio Valley NWS offices.

Looking toward the future, the plan for 2025 is to have meteorologists trained with specialized experience on radar for environments more favorable for tornado formation. That is, instead of the whole office receiving a firehose of training, a few will get frequent specialized experience on issuing tornado warnings to become subject matter experts. Some will get more training on identifying environments that are more conducive for tornadoes on small scales (also known as "mesoscale"). Others will work on ways to better communicate, via multiple platforms/partners, which areas need to get ready in the next one to two hours for potential tornadoes. This method of splitting up the training, having experts work in their areas of expertise, has worked well for the Birmingham NWS office.

Looking beyond 2025, the evolution of weather radar technology is poised for a significant leap forward with the advent of RadarNext. This innovative platform aims to replace the current NEXRAD WSR-88D system, which has been a cornerstone of weather monitoring for decades. Unlike the traditional tilt and circular scan method that requires 4-8 minutes to complete a full storm scan, Phased Array Radar offers a revolutionary approach by capturing quick snapshots of entire storms. Testing of this type of system is ongoing in Norman, OK.

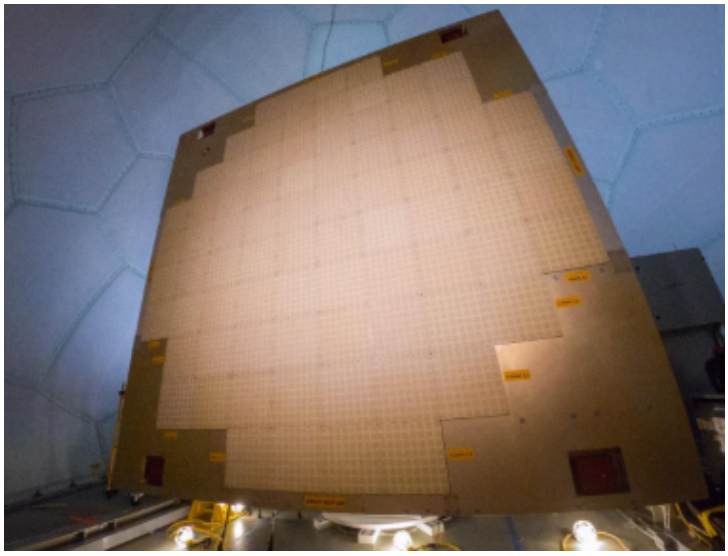
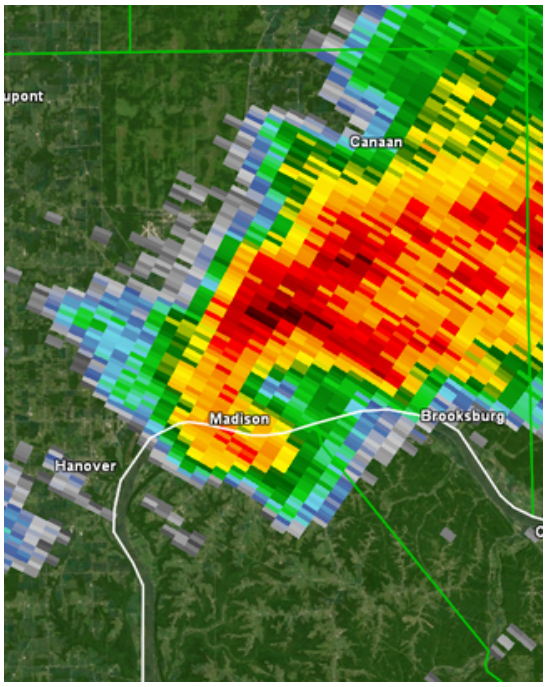


Image of the Advanced Technology Demonstrator, showing multiple radar systems on one flat dish (compared to the single curved radar dish currently in the NEXRAD system). Each radar looks towards a different part of the atmosphere, allowing a snapshot of an entire storm at once. *Photo: NWS*

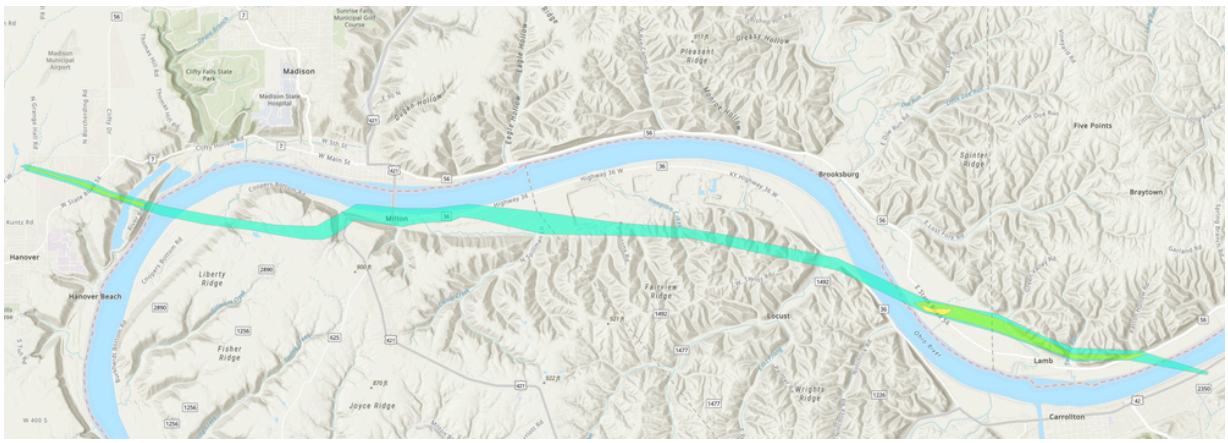
HANOVER-MILTON TORNADO

Tom Reaugh, Senior Meteorologist

A powerful thunderstorm moving through southern Indiana and northern Kentucky on the afternoon of March 14 formed a tornado about a mile north of Hanover, Indiana just before 2pm. The tornado crossed the Ohio River and moved through Milton, Kentucky, with half of the tornado over the river and half of the tornado on shore. Continuing to the east, the twister entered Carroll County, crossed the Ohio River into Jefferson County, Indiana south of Brooksburg, and then crossed the Ohio River a third time re-entering Carroll County east of Carrollton, Kentucky where it dissipated. The tornado reached a peak strength of 115 mph (EF2) east of Milton and south of Brooksburg, and was on the ground for over 18 miles.



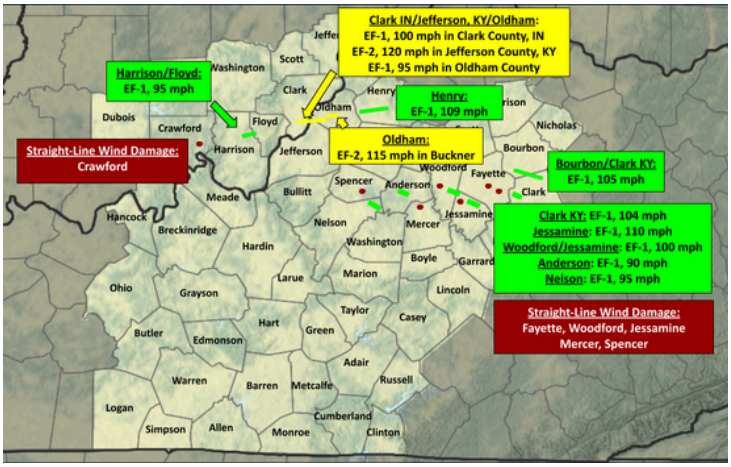
Above top right: The tornadic storm showing a classic “hook echo” shape as it moved along the Ohio River, causing damage in Milton. Above left: EF1 damage to a home in Hanover. Above right: EF2 damage one mile east of Milton. Below: the tornado’s 18-mile long track across three counties, two states, two NWS office areas of responsibility, and three Ohio River crossings. *Photos: NWS*



UTICA-PROSPECT TORNADO RECEIVES NATIONAL MEDIA ATTENTION

CJ Padgett, Meteorologist

Even though we can get severe weather any month of the year in the Ohio Valley, the spring months are prime time for severe storms. A very strong low pressure system was the driving force for a significant tornado outbreak across the Midwestern United States from April 1 to April 3, which resulted in 86 confirmed tornadoes in an area from Oklahoma to Virginia and Illinois to Florida. For central Kentucky and southern Indiana, the peak of the event was on April 2, when ten tornadoes touched down in our area.



Map of tornadoes and straight line wind damage on April 2.

There were two waves of severe weather. The first wave arrived in the morning as a squall line, known in meteorology as a Mesoscale Convective System, dove southeast from the upper Midwest into central Kentucky. Though mid-morning is an unusual time of day for tornadoes, this line of storms produced six tornadoes within a 40-minute period before 9:30 AM EDT. All six tornadoes were EF1 strength. The longest lived tornado produced a damage path 13 miles long in Bourbon and Clark counties east of Lexington.

After the morning tornadoes, there was a lull in storm activity for the rest of the morning and early afternoon hours. This lack of activity allowed for the atmosphere to regenerate energy for thunderstorms to develop again later in the day. By the afternoon, a strong cold front was approaching the region. That was the driving force for the second round of thunderstorms to develop in a favorable environment for tornadoes. Four more tornadoes touched down, two of which were during the evening commute between 5:30 and 6pm just northeast of Louisville.


Tornado damage at Beechland Beach near Prospect, KY. The tornado struck here at 5:37pm. ***Photo: NWS***

The strongest tornado of the day was an EF2 that damaged portions of the northeastern Louisville Metro, from IN 265 near Utica to the Lewis and Clark Bridge, and on into Prospect, KY. This storm went on to produce two more tornadoes in Oldham and Henry Counties.

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UTICA-PROSPECT TORNADO

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The Utica-Prospect tornado was on the ground for over 11.5 miles with 120 mph peak winds causing EF2 damage. Several semi-trucks were flipped over on IN 265 near the start of the tornado's path. A traffic camera on the Lewis and Clark Bridge caught the tornado crossing the Ohio River. Significant damage to homes, as well as traffic cameras showing vehicles getting caught in the twister on the highway, led to national media attention. Thankfully there were no fatalities from this tornado that swept through a highly populated area during the early evening hours, though 22 injuries were reported.

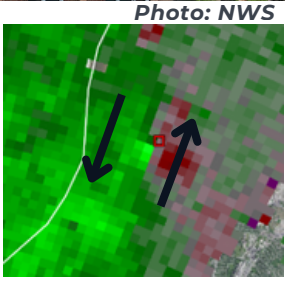
Map showing the tornado track from west of Utica to east of Prospect. Blue colors represent EF0 damage, green is EF1, and yellow shows pockets of EF2 strength.

FOURTH OF JULY LOUISVILLE TORNADO

Tom Reaugh, Senior Meteorologist

Mother Nature gave Louisville a fireworks show of her own on the Fourth of July this year. A line of storms moved from Harrison County, Indiana into the west side of Louisville during the early afternoon hours. Though the storms were not particularly strong, they managed to spin up a small, brief tornado in the Parkland and Park Hill neighborhoods. Most of the damage was along a three block long stretch of Woodland Avenue, mostly consisting of tree damage but there was some minor structural damage as well. The twister only lasted less than two minutes and lifted after a path length of just 2700 feet.

Photo: NWS



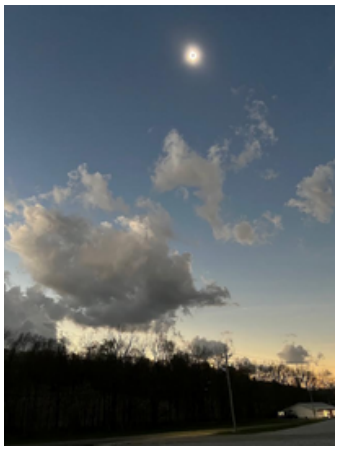
Above: Track of the tornado. The damage path began with a width around 170 yards, then narrowed as the tornado dissipated. Triangles indicate points of damage. Above right: Roof damage to Calvary Baptist Church on Woodland Avenue. Right: About one minute before touchdown, NWS radar briefly indicated adjacent air currents flowing toward (green) and away (red) from the radar about 1400 feet above the ground, suggesting weak circulation.

SUPPORTING OUR PARTNERS

Mike Kochasic, Warning Coordination Meteorologist
Evan Webb, Senior Meteorologist

The Greek philosopher Heraclitus once said "The only constant in life is change." That continues to ring true at NWS Louisville. While one constant over the years has been the NWS Louisville Shareholders Report (20 straight years!), a very different NWS was in place when that first Shareholders Report was written. In the first decade of the new millennium, the NWS was mainly focused on the production of accurate forecasts and timely warnings. In other words, the NWS was primarily concerned with discerning what weather will occur and the atmospheric conditions causing that weather. While these are still a crucial part of the weather forecast and warning process, the NWS of today (and tomorrow) does much more than just tracking the atmosphere; we also consider societal impact through Impact-Based Decision Support Services (IDSS).

In recent years NWS Louisville has focused on IDSS, going above and beyond the forecast so our partners can utilize our information for planning purposes, taking preventive actions to keep people safe. Going beyond the forecast involves risk communication centered around societal impact. In order to meet the demands of the weather enterprise, NWS Louisville staffs large public events and provides IDSS to key decision makers. In 2024, several events took place that required NWS support, including the Kentucky Derby Festival (Thunder Over Louisville, Thurby, Oaks, and Derby), the Madison Regatta, and Louisville's major public concerts for Bourbon & Beyond and Louder Than Life. This year also provided unique opportunities to support non-routine events such as the total solar eclipse in Indiana, the 50th anniversary commemoration of the 1974 tornado Super Outbreak, the PGA championship in Louisville, and the Duke Energy Gallagher Station implosion in Floyd County, Indiana.



Paoli shortly after 3pm during the total eclipse on April 8. ***Photo: Evan Webb***

On April 8 LMK was on-site in Paoli, IN to provide IDSS for the total solar eclipse. NWS Louisville worked directly with Orange County Emergency Management Director Rick Emerick. Along with the first responders in Orange County, Rick was charged with the safety of thousands of people (including many out-of-town visitors) at multiple eclipse viewing events in the Paoli and French Lick areas. Deploying on-site allows NWS meteorologists to provide critical weather updates instantly to decision makers. Thankfully, no severe weather threatened the eclipse viewing gatherings on April 8. However, NWS Louisville did provide Orange County Emergency Management with multiple updates on cloud cover and temperature trends. Partial cloud cover threatened to obscure the magnificent

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SUPPORTING OUR PARTNERS

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view of totality during the eclipse, but luckily clouds moved off in time to provide an awe-inspiring scene.

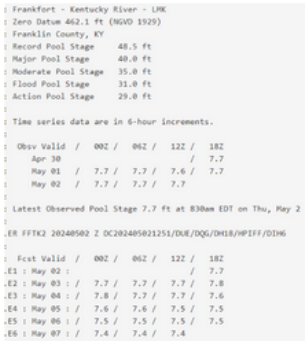
In 2023 NWS Louisville supported 84 remote and onsite events. In 2024, 86 events were supported. The IDSS requests continue to increase as more safety planners recognize their vulnerability to weather impacts. To meet this demand, NWS Louisville continues to train additional forecasters to meet the evolving needs for weather support. At the start of 2024, seven staff members were considered to be deployment ready, having completed specialized training to support safety personnel on site at events. Three additional meteorologists completed the training task book required to become certified as deployment ready, which is an increase of 43% over 2023. Four other staff members are continuing towards the goal of being deployment ready by the end of 2025.

Where will the NWS be in 20 years? It's hard to say exactly with the potential of Artificial Intelligence increasing in the forecast process and other emerging technology being developed. The NWS is making strides to be nimble, mobile, flexible, and able to serve "eye-to-eye" alongside emergency planners. The future NWS certainly will look different than today, just as we've evolved today from the NWS at the turn of the century. The NWS will continue to have a seat at the table providing IDSS where key safety decisions are made revolving around weather impacts. By continuing to train and certify new staff to provide IDSS, NWS Louisville is adapting for any challenge the future may bring.

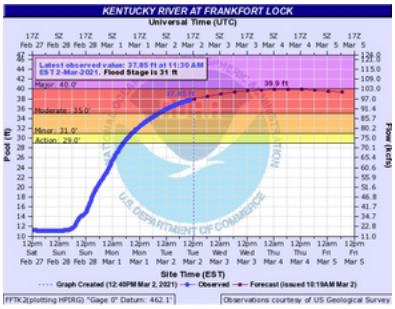
FLOOD INUNDATION MAPPING

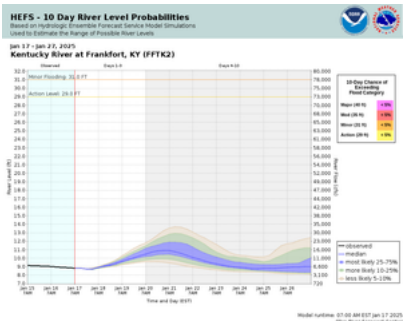
Andrea Schoettmer, Senior Service Hydrologist

River forecasts have come a long way over the past 30 years, from basic text forecasts of river levels to river flood warning polygons and simple flood inundation maps in the late 20th century.



Basic tabular river stage information, as has been provided for decades and is still available today.





Since the turn of the 21st century, river forecasts include a hydrograph of river levels (above left), flood warning polygons, and river model ensembles giving a range of possible river levels (above right).

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FLOOD INUNDATION MAPPING

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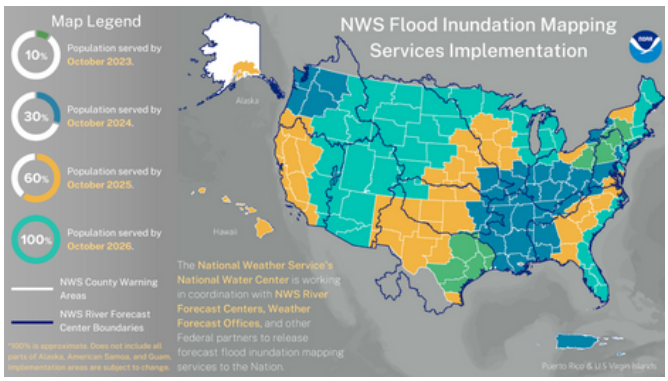
Over the past 2 years, NWS river forecast technology has taken a giant leap forward with the addition of NWS Flood Inundation Mapping (FIM) services. With this new river product, the NWS will not only be able to put numbers to forecast river levels but also show on a map how far flood waters will extend across the landscape away from the river. FIM is believed to be accurate down to the neighborhood level. This will be highly beneficial in communicating flood impacts to our partners and the public since we can now show, on a map, which roads, structures, or portions of a town will flood. Look for NWS Louisville river flood briefings to include important river forecast information in text and hydrograph formats but also the new FIM format.

Approximate neighborhood level inundation expected in Frankfort with a Kentucky River level of 48.1 feet.

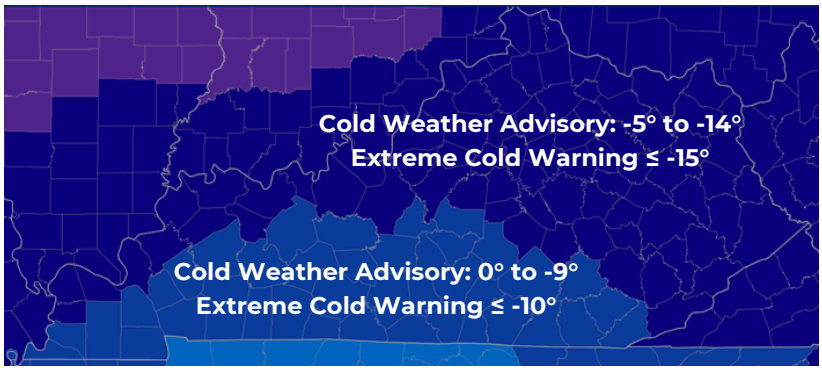


NWS FIM services are being rolled out across the U.S. incrementally over a 4 year period. Much of the Ohio Valley, including NWS Louisville, started FIM in October 2024 with the rest of the U.S. to follow through 2026.

COLD WEATHER HEADLINES

Tom Reaugh, Senior Meteorologist

The NWS is simplifying its suite of cold weather products to improve messaging of these hazards and provide better decision-making services. Data collected during public and partner engagements, surveys, and social science research were used to inform best practices regarding messaging dangerous cold to the public. Toward this end, Wind Chill Watch, Warning, and Advisory have been replaced by the Extreme Cold Watch/Warning and Cold Weather Advisory. These new products will allow the NWS to communicate that all cold is dangerous with or without wind.



Guidance thresholds for new cold weather headline products

NEW AVIATION SERVICE

Brian Schoettmer, Senior Meteorologist

Aviation forecasting is a significant part of the NWS's mission to protect lives and property. In 2024 NWS Louisville added a fifth airport for which we provide detailed aviation weather forecasts called Terminal Aerodrome Forecasts, or TAFs. Central Kentucky Regional Airport (KRGA) near Richmond, KY requested their airport for TAF consideration given the amount of flight operations that they support, which averages out to just over 100 per day. KRGA is the home of Eastern Kentucky University's aviation program, so now student pilots can have detailed forecasts that they use for planning to go along with their flight training.

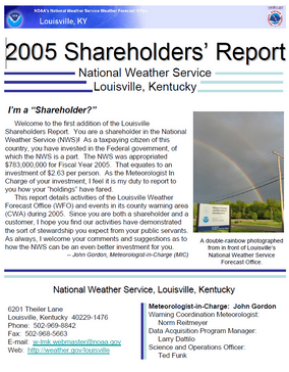
Forecasters study a map of the airport's layout with Airport Operations Manager, Jason Bonham (center). *Photo: NWS*

The forecasts for Central Kentucky Regional Airport went live on March 5, with forecast issuances three times per day. Additional amendments to changing weather conditions and forecasts are issued as needed. Before commencing aviation forecasts for KRGA, forecasters familiarized themselves with the airport layout, nearby terrain, and its climatological tendencies. Several forecasters went for a site visit on January 31 to witness airport operations, meet local pilots, and gain firsthand knowledge of what types of weather impact KRGA the most. NWS Louisville is pleased to provide a local community and state university with valuable weather information to support their programs.

LMK BIDS FAREWELL TO SENIOR METEOROLOGIST DAN MCKEMY

Sam Wilson, Meteorologist

In September NWS Louisville staff celebrated Senior Meteorologist Dan McKemy as he embarked on a new adventure as an Instructor with the Warning Decision Training Division at the National Weather Center in Norman, Oklahoma. Dan arrived at NWS Louisville in January 2017. During his time here, Dan had the opportunity to participate in or lead several programs. Dan's life-saving warnings and lead times during the December 10-11, 2021 tornado outbreak, including the Bowling Green high-end EF3 tornado, led to Dan accepting the Department of Commerce Gold Medal in Washington D.C. on behalf of NWS Louisville. Dan was also awarded the Operational Achievement Award both for his performance during the 2021 tornadoes and for starting a groundbreaking drone program here at NWS Louisville. Dan was a local radar expert, providing radar training to forecasters, giving many presentations on local severe weather events, and providing his fellow meteorologists with great insights into interesting radar phenomena. These accomplishments just scratch the surface of Dan's valuable work while here in Louisville. We thank Dan for his dedication, and wish him well in his future in the NWS.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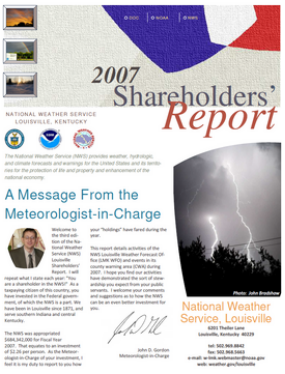
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Shareholders' Report


2009 Shareholders' Report
Your Investment In the National Weather Service
Your Management Team


2010 Shareholders' Report
A Message from the Meteorologist-in-Charge


Shareholders'
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2012
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Report
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2013 Shareholders Report
National Weather Service
Louisville, Kentucky


2014 Shareholders Report


National Weather Service
2015 Shareholders Report
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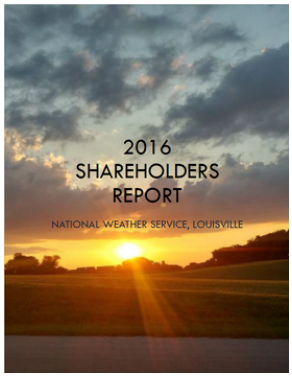
2016
SHAREHOLDERS
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National Weather Service, Louisville
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2018 Shareholders Report
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SHAREHOLDERS REPORT 2019
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2022


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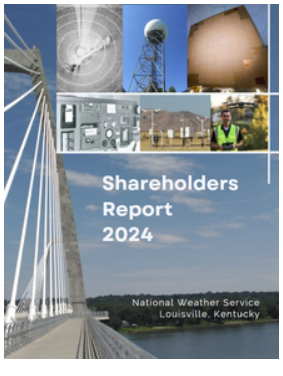
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Photo: CJ Padgett