



2016 SHAREHOLDERS REPORT

NATIONAL WEATHER SERVICE, LOUISVILLE



WELCOME



Welcome to the twelfth 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 the activities of NWS Louisville and events in its county warning area across southern Indiana and central Kentucky during 2016. From our perspective, 2016 will be remembered as a record wet year for some, along with a significant lack of severe weather. There was a major winter storm that affected the Bluegrass region in January resulting in a shutdown of I-75 lasting up to 19 hours.

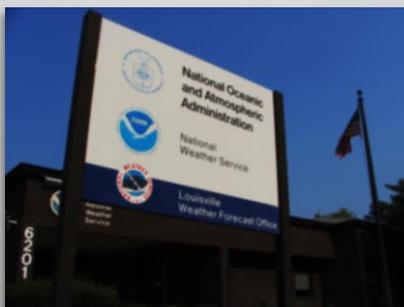
Being short-staffed was a significant challenge that faced NWS Louisville, with Forecaster John Denman having retired in 2015 and Forecaster Kevin Deitsch accepting a promotion to Lead Forecaster in St Louis in August 2016. John served the area for nearly 15 years and was a radar expert and overall great "people person." Kevin was a top notch forecaster who gave 100% on every shift through his extraordinary passion for the weather.

In spite of the challenging staffing, NWS Louisville accomplished many innovative projects via proactive customer service that benefited our shareholders throughout the year. Some our top accomplishments were:

- Providing onsite support during critical hazardous weather during the Kentucky Derby (see page 3)
- Inviting local media to participate in our Partners Operational Weather Simulator (POWS) program (see page 5)
- Expansion of our Weather-Ready Nation Ambassador program (see page 6)
- New river forecast points on the Kentucky River at Camp Nelson and on Elkhorn Creek at Peaks Mill (see page 8)

I hope you find that our activities demonstrate the sort of stewardship you expect from your public servants. The NWS, as a whole, was appropriated \$1.24 billion for Fiscal Year 2016, which was an investment of \$3.84 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.

Sincerely,
John Gordon
Meteorologist-in-Charge



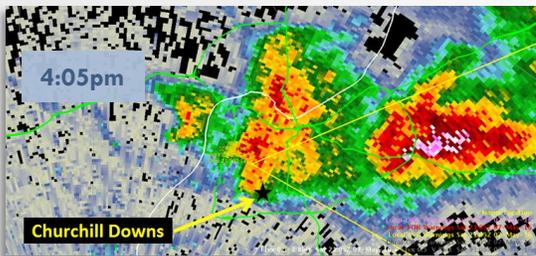
EMBEDDED AT THE DERBY

NWS LOUISVILLE PROVIDES CRUCIAL SUPPORT FOR THE 142ND RUNNING OF THE KENTUCKY DERBY

Brian Schoettmer, Forecaster

Over its 142 year history, the Kentucky Derby has been run during many different types of weather. In 1957 temperatures were in the 40s with winds gusting to 25 mph, then just two years later the mercury soared into the middle 90s on Derby Day. Weather can cause concern for riders due to adverse track conditions and can threaten public comfort and safety. The second largest attendance in the history of the Derby crowded Churchill Downs on May 7, 2016 with severe storms in the forecast. The safety of 167,000 fans plus jockeys, owners, and staff was at stake.

For the ninth consecutive year NWS Louisville provided onsite meteorological support for both the Kentucky Oaks and Derby races. Decision Support Meteorologists joined Louisville's Joint Emergency Services Unit to give critical weather information to law enforcement, military, public safety liaisons, and track officials in and around Churchill Downs. In addition, a second NWS meteorologist was located at the Emergency Operations Center downtown.



The image above shows a thunderstorm about to strike Churchill Downs, while a stronger storm moves off to the east. The thin yellow line is the western edge of a Severe Thunderstorm Warning. The blue colors extending to the west of the storms show the leading edge of gusty winds rushing through the Downs.

Below, weather data are displayed for the meteorologist in the Command Center.



During the late afternoon a storm rapidly developed near New Albany, Indiana and strengthened as it approached Louisville. NWS meteorologists issued a Special Weather Statement about 20 minutes before the storm approached the track. The statement called for brief heavy rain, winds gusting to 40 mph, and the potential for pea sized hail. Shortly thereafter, as the storm continued to intensify, a Severe Thunderstorm Warning was issued for much of the city of Louisville, but did not include Churchill Downs since the storm was expected to be sub-severe at the track. This was an important decision since it is vital to not issue a false alarm, unnecessarily disrupting Louisville's signature event. On the other hand, we needed to raise awareness that a storm was nearby because of the lightning threat to those outdoors.

The storms created a challenging scenario for meteorologists and officials responsible for the public's safety. The race track briefly experienced 30 to 40 mph winds, a quick downpour, and a few distant lightning strikes shortly after 4pm.

After the afternoon storms, focus quickly shifted to the arrival of the second and potentially more impactful round of storms expected that evening. The actual Kentucky Derby still needed to be run, as well as several races following it. Meteorologists briefed officials that the main race would be run without incident, but there was concern about the

post-Derby races. Several briefings and a Severe Thunderstorm Watch later, the final race was run just before additional rounds of strong storms moved through.

See next page for special comments from Churchill Downs Racetrack President Kevin Flanery

NWS AND CHURCHILL DOWNS

PRESIDENT FLANERY EXTOLS VIRTUES OF CLOSE PARTNERSHIP DURING THE KENTUCKY DERBY FESTIVAL

Kevin Flanery, Churchill Downs Racetrack President

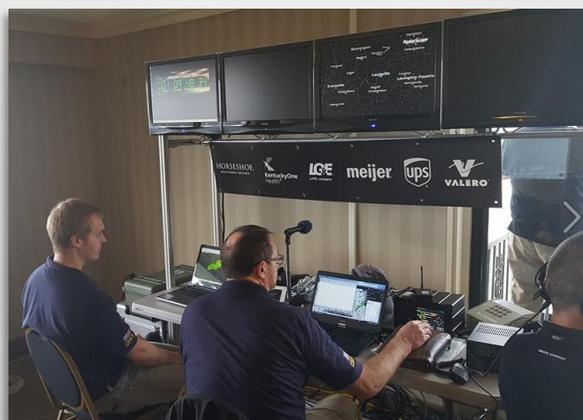


Kevin Flanery

Each year Churchill Downs works closely with more than 40 federal, state, and local law enforcement and public safety agencies in planning the Kentucky Oaks and Derby, working to assure the safety of the nearly 300,000 people that annually attend these events. Each of those partnerships is important, but Churchill Downs's working relationship with NWS Louisville ranks among the most special and critical. Many of our patrons – most notably the more than 60,000 who enjoy the events in our open-air infield – rely on the expertise of NWS meteorologists for an enjoyable and, most importantly, safe experience.

Representatives of key public safety partners join us onsite during those days and their presence – including that of an NWS representative – is vital when decisions that affect the lives and safety of so many people must be made, sometimes quickly. That was especially true in 2012 when a threat of severe weather prompted us to order an unprecedented evacuation of the Kentucky Oaks infield. It happened again during 2016's Derby when we were brushed by a mid-afternoon storm and received key insight and guidance through the rest of the afternoon and early evening on the timing of approaching severe weather that

ultimately arrived shortly after the Derby festivities concluded. As we considered the safety of more than 167,000 patrons and a possible early conclusion to Derby Day because of the weather threat, the guidance of NWS Forecaster Brian Schoettmer was crucial. The Kentucky Derby is America's oldest continuously-held sporting event and one of the largest sports and entertainment events in the world. Countless moving parts must work in unison for the Derby and Oaks to be safe and successful events, key among those being the dedication and passion for public safety displayed annually by NWS Louisville's personnel. Our Churchill Downs team deeply appreciates and values the NWS team's efforts.



Above: Joe Sullivan, NWS Louisville Warning Coordination Meteorologist, and meteorologist August Veron monitor weather conditions at Thunder Over Louisville, kicking off the Kentucky Derby Festival. Other images: Wall cloud and tornado damage at Churchill Downs June 22, 2011. Joe Sullivan assessed the damage and spoke with local media. NWS Louisville has worked with Churchill Downs several times over the years.

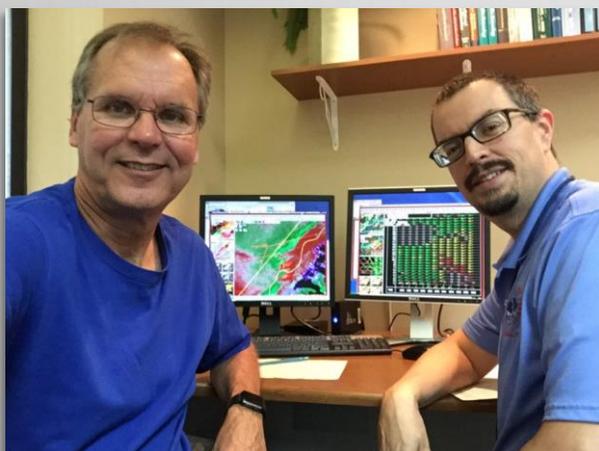
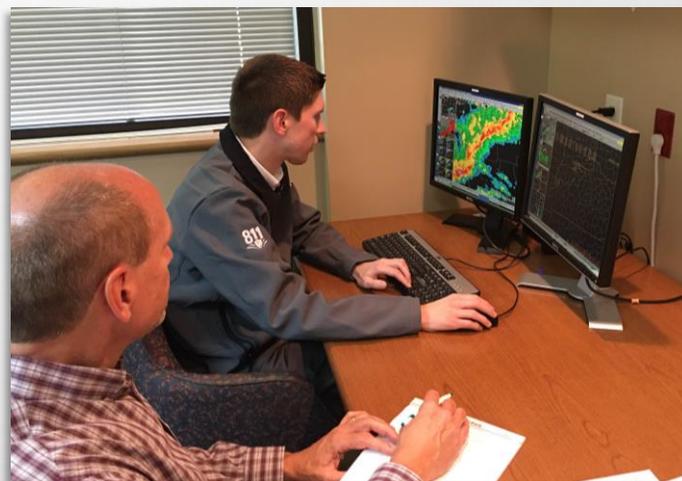
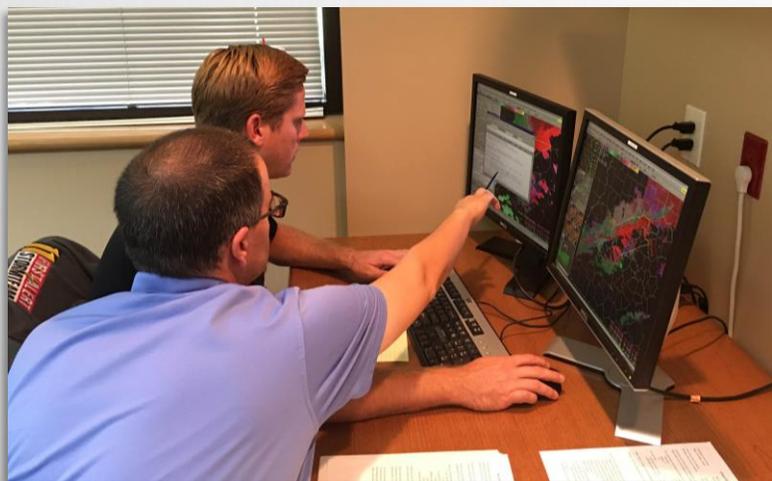
MEDIA IN THE HOT SEAT

TV METEOROLOGISTS EXPERIENCE THE CHALLENGE OF ISSUING NWS SEVERE WEATHER WARNINGS

Ryan Sharp, Lead Forecaster

In an effort to strengthen relationships with our TV media weather partners, we invited broadcasters from all five markets that cover central Kentucky and southern Indiana to take part in a weather event simulation at NWS Louisville. In 2016 eight broadcasters came to our office to participate in the Partners Operational Weather Simulation (POWS) program. A past severe weather event with radar, satellite, and other data was loaded into our Weather Event Simulator (WES). Each participant was given a briefing of the scenario for the event. After being instructed on how to go through the process of composing a warning, they proceeded through the simulation and issued their own warnings as part of the displaced real-time 2-hour exercise. In addition to identifying radar signatures and issuing warnings, the TV meteorologists also received reports from the public. The experience gave broadcasters severe storm structure training and a feel for what we assess to make the decision to issue a Severe Thunderstorm Warning or Tornado Warning. NWS Louisville also benefitted as we learned what the broadcasters are looking for from us during severe weather.

The plan for 2017 is to continue running our media partners through the simulation and to open it up to other meteorologists in the area such as university faculty, private meteorologists, and emergency managers.



Upper left: Ryan Sharp works with WHAS's Ben Pine as Ben issues a severe weather warning.

Upper right: Science and Operations Officer Ted Funk spends some time with Ryan Hoke from WAVE as he monitors an advancing squall line.

Left: WLKY was represented by John Belski, shown with Ryan Sharp. The screen behind John is showing Doppler radar wind data at a certain height above the ground, and the screen behind Ryan is displaying wind information from the surface to many thousands of feet up in the atmosphere.

WEATHER-READY NATION

AMBASSADORS HELP THE NWS INCREASE PUBLIC SAFETY AND AWARENESS DURING SEVERE WEATHER

Joe Sullivan, Warning Coordination Meteorologist



NWS Louisville Hydrologist Mike Callahan (R) with new WRN Ambassador Matt Hammer, Safety Specialist at the U.S. Census Bureau in Jeffersonville, IN.

The Weather-Ready Nation (WRN) Ambassador™ initiative formally recognizes partners who are improving the nation's readiness, responsiveness, and overall resilience against extreme weather, water, and climate events. The number of WRN Ambassadors swelled in 2016, both in the Ohio Valley and across the country.

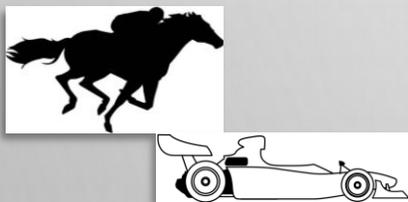


Joe Sullivan (L) welcomes Bullitt County Emergency Management to the WRN Ambassador program with EMA representative Marke Richardson.

With 59 ambassadors at year's end, NWS Louisville was ranked among the top 20 NWS offices for registered ambassadors. While these numbers are encouraging, we feel we've yet to scratch the surface of what we intend for this program, and our ambassadors.



WRN Ambassadors honored in the NWS office. Horses are WRN Ambassadors in Kentucky, race cars in Indiana.



To put it bluntly, we have not yet connected with our ambassadors to the extent we want, and they deserve, as "force multipliers" for our efforts to meet the NWS's mission of enhancing the national economy and protecting lives and property from hazardous weather.

With the arrival of two new forecasters in January 2017, the Louisville office is now fully staffed for the first time in more than two years, allowing us to devote more time and effort to interact with our ambassadors. Planned activities for 2017 include, but are not limited to:

- Office tours for small groups of ambassadors, during which we exchange information, ideas, and concerns
- Seasonal webinars highlighting threats and preparedness suggestions for the season, along with the latest seasonal forecasts
- Seasonal preparedness mailings with information for ambassadors to share with family, friends, co-workers, and the public
- A local WRN Ambassador webpage highlighting all of our ambassadors and their activities assisting their communities

In short, 2017 will be the year that NWS Louisville and its WRN Ambassadors join forces to do what none of us can do alone: make our communities Weather-Ready!

Not yet a WRN Ambassador? You can change that today by visiting weather.gov/com/weatherreadynation and follow the "Become an Ambassador" link to register your agency, business, or organization as an NWS partner.

NEW GIS-BASED DATA MAPS

DAILY TEMPERATURE AND PRECIPITATION MAPS HAVE BEEN REVAMPED USING GIS TECHNOLOGY

Mike Callahan, Hydrologist

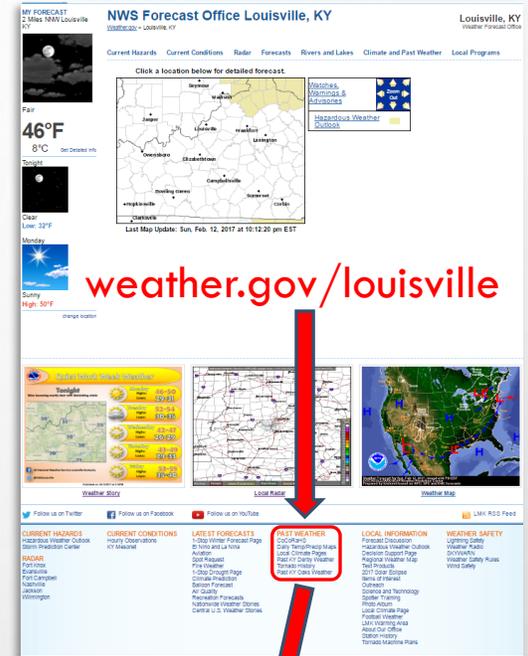
Our new and improved Precipitation and Temperature Archive webpage includes plotted and contoured precipitation amounts from both automated and manual sources. The automated sources are the Kentucky Mesonet, Louisville Metropolitan Sewer District network, airports, Integrated Flood Observing and Warning System, and United States Geological Survey satellites. NWS cooperative observers and CoCoRaHS (Community Collaborative Rain, Hail, and Snow Network) volunteers supply manual observations.

Visitors to the page can compare automated data with manually collected data. Normally, automated data are measured using a midnight-to-midnight time period whereas manual data use 7am-7am timing. This can be a problem when comparing automated and manual amounts since they are taken during different time periods. However, on our new webpage the automated locations are also 7am-7am, so they can be used in conjunction with the manual observations. The resulting contoured maps are for the Louisville Metro, NWS Louisville forecast area, and State of Kentucky.

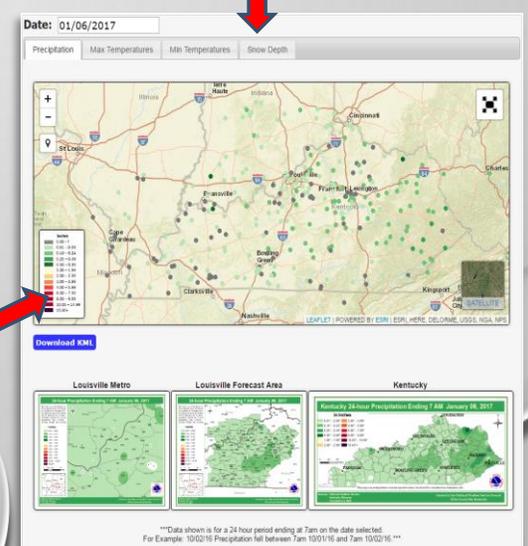
The page also includes maximum temperatures, minimum temperatures, and snow depth. Most maps are archived back to October 2014; contoured Louisville Metro precipitation maps go back to July 2016.

Clicking on a data point displays information for that location. The background map can be changed to allow the colored dots stand out better. One can also zoom and drag the map to isolate locations. For customers who wish to see the data in other programs, all maps can be downloaded as KMLs.

We hope that our customers find this new archive useful. Please feel free to send us comments and suggestions for improvement.



PAST WEATHER
 CoCoRaHS
 Daily Temp/Precip Maps
 Local Climate Pages
 Past KY Nearby Weather
 Tornado History
 Past KY Cocks Weather



**weather.gov/
 louisville**

NEW RIVER FORECAST SITES

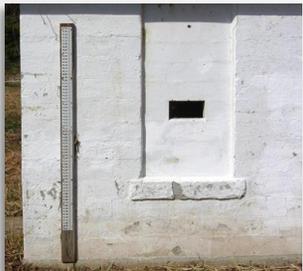
STAGE AND FORECAST CHANGES AT SEVERAL LOCATIONS ON AREA STREAMS

Erin Rau, Forecaster



Wire weight gauge at Peaks Mill

There have been multiple changes to the hydrology program over the last year aimed at enhancing the services we provide. Two new river forecast sites were added in 2016. The first was on Elkhorn Creek at Peaks Mill in Franklin County. Forecasting for this site was requested by Kentucky Emergency Management due to recreation concerns. Flood stage has been set at 10 feet for this gauge, which is the height at which Stillhouse Hollow Road floods.



Staff gauge on gauge house (above) and Flood of '37 high water mark (below) at Camp Nelson

The second new forecast site is on the Kentucky River at Camp Nelson in Jessamine County. Forecasting for this site was requested by the Jessamine County Emergency Manager due to concerns about campground flooding. Flood stage has been set at 30 feet.

In addition to the new forecast sites, flood forecasts are once again being issued on the Green River across from Rochester. A new staff gauge was installed by Ohio County to replace the old one that was washed away in a flood. Forecasts for this site are issued as needed in times of high water. At the flood stage of 17 feet, the Reeds and Rochester ferries can no longer operate.

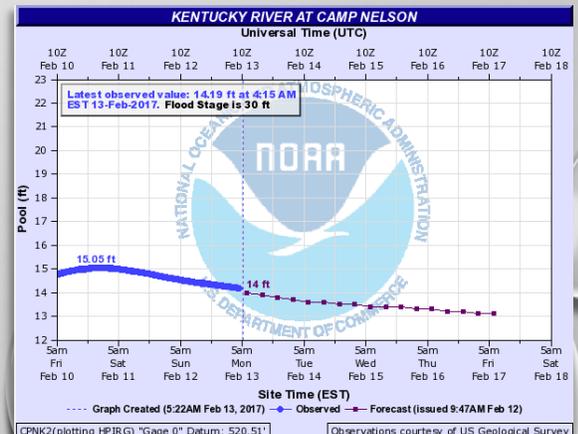
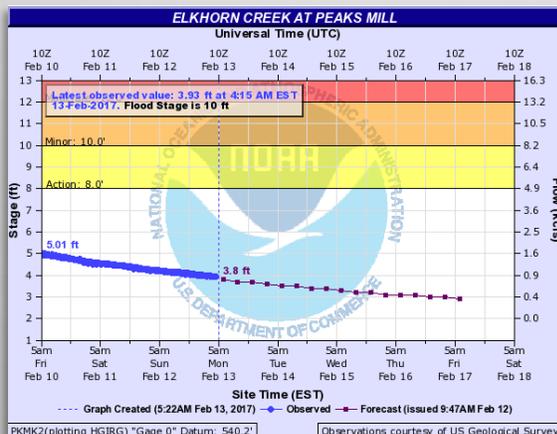


Also on the Green River there has been a gauge change at Woodbury. Previously, the forecast was based on an old gauge below the dam. However, readings from this gauge became unreliable due to issues with retaining observers as well as shifts in the lower lock wall. Therefore, the decision was made to base the forecasts off the USGS gauge above the dam. The stages on the upper gauge are about 7 feet less than the lower gauge. Flood stages and past crests have been adjusted for the new gauge and can be found on our website at water.weather.gov/ahps2/hydrograph.php?wfo=lmk&gage=wdhk2.



New staff gauge at Rochester Ferry

One final gauge change in 2016 was at McAlpine Upper on the Ohio River at Louisville. The previous gauge on the Second Street bridge became too costly to maintain. Therefore, a new gauge was installed on the railroad bridge near the lock. This change did not impact the flood stages.



KENTUCKY MESONET

KENTUCKY'S STATEWIDE SYSTEM OF WEATHER OBSERVING EQUIPMENT CONTINUES TO PROVE ITS WORTH

Dr. Stuart A. Foster, Kentucky State Climatologist

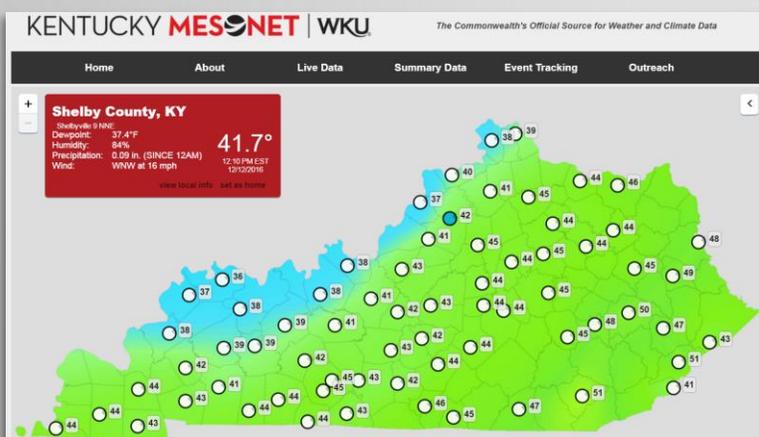
The Kentucky Mesonet at Western Kentucky University (WKU) experienced a transformational year in 2016. A strategic effort to support the mesonet via tiered partnerships at the federal, state, and local levels bore fruit as funding for core operations of the mesonet were approved by the Kentucky Legislature in the 2016-2018 Budget of the Commonwealth. Meanwhile, local initiatives enabled the Mesonet to add three new environmental monitoring stations bringing the total number of stations statewide to 68. New stations came online in Butler (January), Boyle (September), and Shelby (October) counties. These initiatives included commitments for ongoing operational support. Discussions are underway with stakeholders in multiple counties, and these are expected to result in more stations being added to the network in 2017.

Supplemental funding through the NWS National Mesonet Program combined with a grant from the Kentucky Agricultural Development Fund (KADF) are helping to support critical instrumentation upgrades across the network. The KADF grant enabled the mesonet to upgrade its cellular communications system. The upgrade included both new hardware and software, and enables the mesonet to refresh data every 5 minutes (instead of 15 minutes formerly) while significantly lowering communications costs. These funds are also being leveraged to upgrade relative humidity sensors throughout the network and to deploy new precipitation gauges at select sites. In an effort to support Kentucky's agricultural economy, the mesonet also added soil moisture and temperature probes at 12 sites, bringing the total number of sites with soil monitoring to 17.

With a solidified base of support, the Kentucky Mesonet will invest in initiatives to enhance the level of service provided to users through the Commonwealth as 2017 unfolds.

The Kentucky Mesonet represents a partnership between the NWS and the Kentucky Climate Center at WKU. Initial funding was provided by the NWS in 2006, with the first operational mesonet station installed in May 2007 near Bowling Green.

kymesonet.org



(L to R) Rob Rothenberger, former Shelby County Judge Executive; Paul Whitman, Shelby County Emergency Management (EM) Director; Bill Hedges, Magistrate of Shelby County Fiscal Court; Paul and David Case, landowners; Rick Bobo, KY EM Area 4 Manager; and Dr. Stuart Foster, Kentucky State Climatologist gathered at Case Farm in Shelby County for the dedication of a new Kentucky Mesonet station December 12, 2016.

RESEARCH TO OPERATIONS

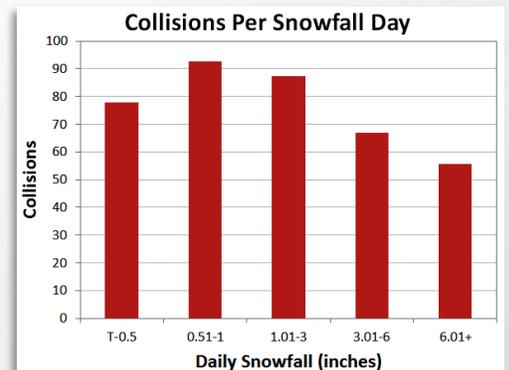
HOLLINGS SCHOLARS SPEARHEAD WINTER WEATHER AND SOCIAL MEDIA PROJECTS

Ted Funk, Science and Operations Officer

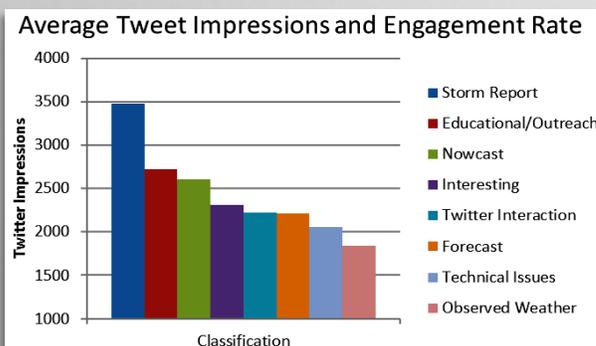
From late May to late July, Earnest Hollings scholarship students Michael Dunn, University of Alabama, and Robert Prestley, Penn State University, spent 9 weeks at NWS Louisville working on research projects that have direct implications to our forecast and warning programs.

Mr. Dunn's research was titled, "*Relationship Between Winter Precipitation Events and Vehicular Collisions in Central Kentucky.*" The goal of the research was to investigate traffic accident rates, injuries, and fatalities in central Kentucky during periods of benign (dry) versus inclement winter weather. Winter seasons from 2005-2015 were investigated in Jefferson and Fayette counties in Kentucky.

Results suggest that light winter precipitation amounts often cause a higher accident frequency than heavy amounts of precipitation. For example, daily snowfall totals of one-half to one inch cause more collisions per snowfall day than any other accumulation category, including over 6 inches (see graphic). This may be due to less public awareness and a false perception that a minor winter weather event requires little or no change in driving habits (e.g., not slowing down), which can cause accidents. In addition, many people stay off the roads during major ice or snowstorms. Results also suggest that while there are more collisions on dry days, this is due to a much higher occurrence of such days. When the data are normalized, ice causes the most accidents per day. In addition, rush hour and local roadways tend to have high accident rates. This information helps our decision making before and during winter weather events to increase public awareness of potential impact.



Mr. Prestley performed the following research, "*An Analysis of Social Media Services at NWS Louisville to Enhance Forecast Operations and High-Impact Weather Event Decision Support.*" This study was designed to gather information and develop best practices to enhance our social media services and reach. It centered on our Twitter (twitter.com/NWSLouisville) and Facebook (facebook.com/NWSLouisville) accounts and included a detailed analytical examination.



Results indicate that NWS Louisville has issued many more tweets and posts since we began a new "decision support services" operational desk in November 2015 focused on increasing outgoing information and interpretive services for our customers. The study also determined that average tweet impressions (total number of times a post is viewed) and engagement rate (total number of interactions with a post including likes, comments, shares, link/picture clicks, etc.) are highest for storm reports and related information, and lowest for more benign observed weather (see graphic). In addition, posts with photos create a higher

engagement rate than links or text only. Finally, the study recommended the issuance of more posts before expected significant weather events to increase customer awareness.

PROBABILITY OF WEATHER TYPE: A NEW FORECAST APPROACH FOR BETTER DECISION MAKING

Zack Taylor, Forecaster

The NWS is committed to being a science and innovation driven agency constantly striving to provide its users, customers, and partners with the most accurate and timely forecast information. Weather can be complicated and rapidly changing. This is especially true in complex winter weather systems. Commonly referred to as a “wintry mix,” snow, sleet, freezing rain, and rain can switch back and forth many times in a very short time frame.

To help NWS meteorologists integrate this into the forecast process, a technique called Probability of Weather Type (PoWT) was developed to diagnose the environment for winter weather. Forecasters use PoWT tools to analyze the temperature and moisture availability at critical levels in the atmosphere including near the surface and in the mid and upper levels to determine what precipitation type will be experienced at the ground.

Gridded probabilities of snow, rain, freezing rain, and sleet are generated from PoWT and then, when combined with hourly temperatures and expected precipitation amounts, hourly weather forecasts are created with specific chances of each weather type occurring. Snow and ice accumulation forecasts are developed from these grids as well. Integrity checks are in place to make sure that all probabilities make meteorological sense and are consistent throughout the forecast period. Neighboring NWS offices use PoWT as well, helping to make a seamless forecast from one NWS office to another.

This new technique is an effort to provide NWS users and partners with a consistent, reliable, and scientifically sound forecast to facilitate better decisions during times of dangerous weather.

NEW SATELLITE SET TO BRING UNPRECEDENTED WEATHER INFORMATION

Ryan Sharp, Lead Forecaster

On November 19, 2016, the first in a new series of powerful observational satellites launched from Kennedy Space Center in Florida. The NOAA satellite, called the Geostationary Operational Environmental Satellite-16 (GOES-16), will bring very high resolution imagery (both spatially and temporally) as well as some new tools for weather forecasters to use to predict hazardous weather. Included in these tools is a new lightning mapper which will provide severe weather warning forecasters a look at how lightning in a storm is evolving. Our current ground-based system primarily looks only at how cloud-to-ground strikes change within a storm, whereas this tool will see not only these strikes, but the more numerous cloud-to-cloud and in-cloud strikes as well. Other tools have been developed to take advantage of the increased resolution of the imagery, including one that determines which clouds have a better chance to develop into storms.



The Western Hemisphere as viewed by GOES-16 on January 15, 2017. Courtesy NOAA

The forecasters at NWS Louisville are in the process of taking several training courses so we can be prepared to use all of the new information as it becomes operational in 2017.

**NATIONAL WEATHER SERVICE
6201 THEILER LANE
LOUISVILLE, KENTUCKY 40229**

Email: w-lmk.webmaster@noaa.gov

Phone: (502) 969-8842

Fax: (502) 968-5663

Louisville Forecast: (502) 968-6025

Lexington Forecast: (502) 966-6670

weather.gov/louisville

twitter.com/NWSLouisville

facebook.com/NWSLouisville