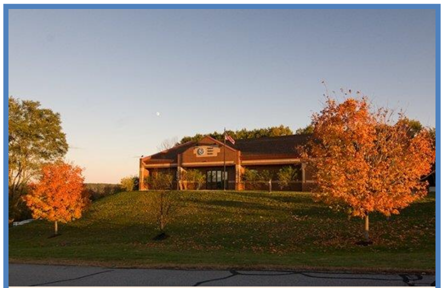
Photo by Mike Cempa

Inside This Issue:

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The Coastal Front

Fall 2016

Volume VII-2

Drought Takes Aim at New England

By Tom Hawley, Senior Hydrologist

Over the last few months the word drought has been used quite a bit. But what is drought? How do we define drought? It is difficult to come up with one definition of drought that would the many ways in which water is used around the globe. For instance 7 days without rain in the Amazon jungle might be considered a drought, but 7 days without rain in Phoenix, Arizona would not. There are also different kinds of drought including meteorological drought, agricultural drought, hydrological drought, socio-economic drought, and even ecological drought. We use a myriad of indices and indicators to try to help define the severity and scope of a drought. Some of the indicators would be precipitation, streamflow, groundwater levels and so on. We also have indices that compute numerical representations of drought. For instance, we may use the Standardized Precipitation Index (SPI) or the Crop Moisture Index (CMI) or many other indices that are available to us.

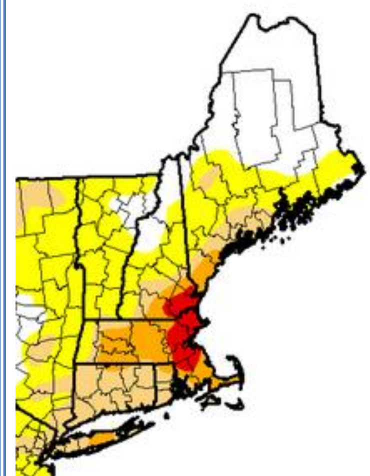
Figure 1: The Drought Monitor from August 30, 2016 shows the extent of drought in New England. Brighter red colors indicate more extreme drought.

The current drought conditions in New England began in April and May with well below normal precipitation. However, drier than normal conditions can be traced back to last year in some places with winter snowfall that was well below normal. This caused below normal river and groundwater levels leading into the growing season. By the end of August, southeast New Hampshire was in an extreme drought and much of the remainder of southeast New Hampshire and southwest Maine was in severe drought. The latest on drought conditions can be found at http://droughtmonitor.unl.edu/

Severe Thunderstorms Bring Damaging Winds to NH

By Margaret Curtis, Meteorologist

On July 23, 2016 a line of severe thunderstorms moved through New Hampshire and Maine. These storms had strong winds which resulted in over thousands of power outages due to trees and poles being knocked down.

All thunderstorms need three things: moisture, instability and a trigger. On July 23 it started off very warm and muggy across the region. Dewpoints in the mid-60s indicated there was plenty of moisture for storms. Instability is a measure of how likely the storms are to grow based on the temperature profile of the atmosphere. Due to the threat of storms an extra weather balloon was launched at 1 PM which found a very unstable atmosphere. The final ingredient needed for thunderstorms is a trigger. On this day a cold front was approaching from Canada which provided the third and final factor.

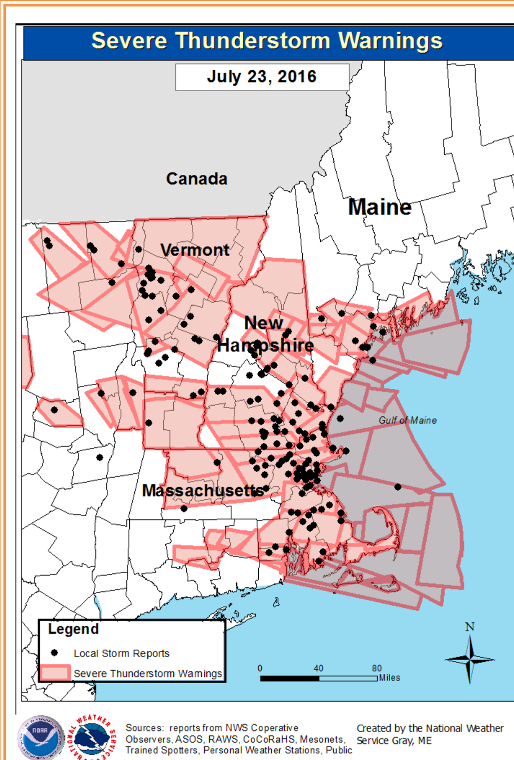

Figure 2: Map of severe thunderstorm warnings (red boxes) and damage reports (black dots) from July 23, 2016.

Storms began across NH and ME around mid-day as the cold front approached. Initially they were just showers without much lightning. As the day heated up the instability increased. NWS Gray collaborated with the Storm Prediction Center in Norman, OK and a decision was made to issue a Severe Thunderstorm Watch for the afternoon. A Severe Thunderstorm Watch should serve as a 'heads up' and gives the alert that Severe thunderstorms are possible.

Location	Peak gust
Manchester Airport	52 mph
Lebanon Airport	51 mph
Portsmouth Airport	49 mph
Rochester Airport	46 mph
Plymouth Airport	40 mph
Concord Airport	37 mph
Laconia Airport	36 mph

Table 1: Measured wind gusts from thunderstorms July 23, 2016

More specific information is provided by Severe Thunderstorm Warnings. Warnings are issued when there is an immediate threat of damaging winds or hail greater than 1" diameter. On July 23 NWS Gray issued 21 warnings covering 6 counties in ME and 9 counties in NH (Figure 2).

As the front moved through the area, the individual storms came together to form a line. This line moved through southern NH causing widespread damage. Measured wind gusts reached over 50 mph (Table 1). Many trees were knocked down resulting in over 50,000 power outages. The line continued into Massachusetts before weakening as it moved over the ocean.

CoCoRaHS Corner: Observer Recruitment

By Stacie Hanes, Lead Meteorologist

The Community Collaborative Rain, Hail and Snow Network, or CoCoRaHS for short, is a network of volunteer backyard weather observers working together to measure and map precipitation in their local communities. CoCoRaHS is a non-profit community-based program which has its origins at Colorado State University in the late 1990s. By using low-cost measurement tools, stressing training and education, and utilizing an interactive website, the aim is to provide high quality data for natural resource, education, and research applications. CoCoRaHS has now been established in all fifty states. The neat thing is that anyone with an enthusiasm for watching the weather can participate. By providing daily observations, participants are contributing an important piece of weather information to many users.

NWS Gray recently gave a training session at the Mount Washington Observatory Weather Discovery Center in North Conway, NH (Figure 3). We encouraged the attendees to join the network, answered questions about common issues they may run into, and demonstrated how their precipitation reports are used in a forecast. Every volunteer counts!

Figure 3: The Mount Washington Weather Discovery Center hosted a training class for CoCoRaHS observers and those interested in becoming observers.

So how does it work? Every time it rains, snows, or hails, volunteers take precipitation measurements and enter them onto the website (http://www.cocorahs.org). Once the observations are entered, they are then displayed on a map. The data are analyzed and used for many situations ranging from water resource analysis, flood warnings, and drought mitigation. Users include, but are not limited to, the National Weather Service, emergency managers, ranchers and farmers, and teachers. NOAA is a major sponsor of CoCoRaHs. We are always looking for more observers, so anyone interested in joining CoCoRaHS should visit the website and click “Join CoCoRaHs”. Although formal training is not a requirement, keep an eye out for upcoming training dates on the CoCoRaHs website.

Harnessing the Power of Multiple Radars

By Chris Legro, Lead Meteorologist

Within the last year, meteorologists at the National Weather Service have gained access to a whole new suite of data to help with forecasting severe weather. This multiple radar/multiple sensor project, or MRMS for short, attempts to take the many sources of data at a forecaster's fingertips and combine them into simple displays, making the data more useful to the forecaster.

The term "multiple radar" refers to the overlapping coverage of National Weather Service radars, Federal Aviation Administration terminal Doppler weather radars (TDWR), and the Canadian radar network that are seamlessly blended together to leverage their individual strengths. The "multiple sensor" is the radar, surface observations, upper air data, lightning, satellite, rain gauges, and numerical weather prediction models.

The heavy lifting of MRMS is done with radar data, from the more than 140 National Weather Service radars, 31 Canadian radars, and 15 TDWRs. The premise is that these radars are scanning 24/7 with varying "views" of weather, including different distances and heights of weather phenomenon. The closer the radar is to the weather, the greater the influence it will have on the MRMS output. That means a forecaster at NWS Gray won't have to have a display up for the radar in Albany, New York to watch the weather near Keene, New Hampshire, and another for the radar in Taunton, Massachusetts for weather near Manchester, New Hampshire, and a third for the radar in Burlington, Vermont to see weather moving into the areas north of the White Mountains. Instead, that same forecaster will be able to monitor one display that shows the best data from all radars of precipitation in the low levels, using a product like Reflectivity At the Lowest Altitude (RALA). An example is provided in Figure 4 below.

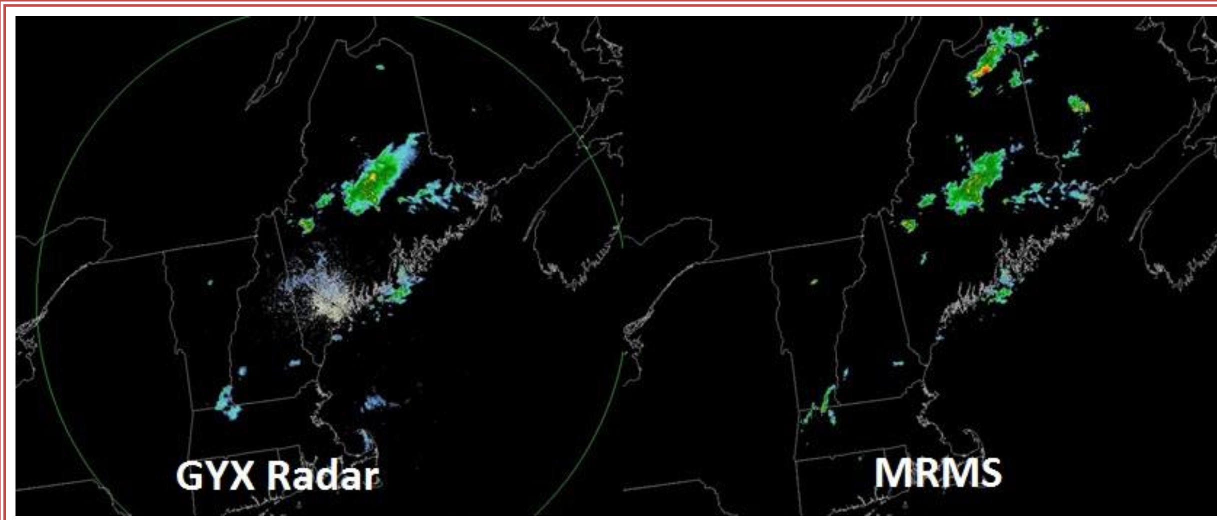

Figure 4: Viewing only one radar (left) gives only one view of the showers across Maine and southwest New Hampshire. Harnessing multiple radars with MRMS (right) can give a more detailed view. Notice the heavier showers in far northern Maine are more defined in MRMS, as are the showers in southern Vermont heading into southwest New Hampshire.

MRMS (continued)

By looking at power returned to the radars at all levels in addition to the lowest altitude, an algorithm can be applied to MRMS data to estimate hail size. Not surprisingly this product is called the maximum estimated hail size, or MESH. Not only can that provide the forecaster with a good first guess for the size of hail to include in a warning product, but it also can help with post-storm verification efforts by showing where a particular storm may have been the strongest.

Incorporating model and weather balloon data about temperature can allow MRMS to estimate frozen water in a column. Changes in this vertically integrated ice (VII) product can show thunderstorm updraft strengthening or weakening, in addition to the onset of lightning activity.

Using velocity data from the radar network MRMS can also point out the strongest areas and tracks of rotation. Severe weather, including tornadoes and damaging straight line winds, is strongly tied to these areas of rotation in thunderstorms. After the storms have passed these rotation tracks can also be helpful to pinpoint areas to look for particularly intense damage, or to assist in directing local storm damage survey teams.

The addition of MRMS to a forecaster's arsenal of tools is important when it comes to severe weather operations. When the workload becomes fast paced, MRMS provides a way to triage storms and prioritize which ones need to be examined more closely first. By saving the forecaster valuable seconds or minutes, that time can be paid forward to people receiving warning information, allowing them to take protective action more quickly. To view MRMS data, head to: http://mrms.ou.edu/

New Voice for NOAA Weather Radio

By Eric Schwibs, Forecaster

NWS Gray has implemented a major upgrade to our NOAA Weather Radio hardware and software late this summer, replacing the previous system (CRS) with a new one (BMH). The new system is integrated with the software we utilize to view weather data and create our forecasts and warnings (called AWIPS-2) and should be more reliable. This new system also comes with an upgraded computerized voice, named Paul. You can test out the new voice at http://neospeech.com/. We'll be tweaking the new BMH system over the next few months to fine tune the system and eliminate any remaining mispronunciations (as it turns out, some local names like Sagadahoc can be hard for a computerized voice to pronounce correctly!). Please forward any questions you may have about our new weather radio system and pronunciation requests to gyx.webmaster@noaa.gov. One of the best ways for us to identify an issue and fix it is for you to let us know! We hope you enjoy the new voice from Paul and the more reliable service.

NWS Staff Profile

By Margaret Curtis, Meteorologist

The staff profile column introduces you to a new NWS staff member every issue. This issue we introduce you to Lead Meteorologist Mike Cempa.

What is your role at the office? I am a lead meteorologist which means I am responsible for all parts of operations during my shift. This includes all the products that go out (forecasts, watches, warnings, etc.), and making sure we have enough staff. Beyond this I have other responsibilities as well. I am the coordinator of our office Skywarn weather spotter program. I schedule and coordinate spotter training sessions, give many of the training sessions, and make sure the database is maintained. I have lots of help with this from other folks in the office. I am also winter weather focal point, and am on several other office teams including tropical weather and social media. I am also the local steward for the National Weather Service Employees Organization, our local union.

How long have you worked for the National Weather Service in Gray? I marked my 10-year anniversary at this office this past July.

Where else have you worked? I have worked in Albany, NY; Binghamton, NY; and Washington, D.C.

Where did you grow up? I grew up in the western part of Long Island, NY, just two miles from the New York City line.

Where did you get your education? University at Albany in NY.

How did you first get interested in weather? Like most meteorologists, as a kid I did have some fascination with thunderstorms and big storms in general. However, I think my interest in the science of weather came initially more out of frustration than fascination. Growing up in the NYC area in the 1970s and 1980s, many winter storms started as snow but eventually changed over to rain. I loved snowstorms, but was disappointed every time a storm started as snow and then changed over to rain (not to mention that school would not be cancelled the next day!). Eventually I became interested in why this always happened and started to investigate the weather with my interest continuing to this day.

What is the most interesting part of your job? It may be cliché, but a part of it is forecasting the big storms, whether it is winter storms or thunderstorm outbreaks. They don't come around often, but when they do we have a chance to experience something impressive. However, as the spotter coordinator, I do enjoy getting out to different parts of the area and meeting new people and sharing weather knowledge. Many of the people who come out to spotter training are also very interested in the weather, and it's great to get to talk to some of them and share weather stories.

NWS Staff Profile (continued)

What is the most challenging aspect of your job? On a personal level, the biggest challenge is rotating shift work. Unfortunately, we can't get away from the fact that weather happens 24/7.

Professionally, the biggest challenge is translating the complexities of the weather to the public. Most meteorologists live and breathe the weather. When we're not at work, we still look at the models and the observations and are forecasting to some degree. We have an intimate knowledge of the atmosphere and how it works. This is because we've spent at least 4 years at college and many years of our lives watching and forecasting the weather. Most people don't share this love and respect for the atmosphere; they just need to know when it's going to rain or snow and how much is going to fall or what the temperature will be. Living in New Hampshire or Maine, you know it's not always that simple. Weather can vary greatly over short distances, and sometimes there's more uncertainty on our part than at other times. It is a challenge to get this part of the message out there and let folks know it's rarely going to be exact (or perfect!).

What is the most memorable weather event that you have worked? I worked two very memorable events here at the Gray office (I know the question only asked for one, but you're getting two for the price of one!), the Patriot's Day Storm of April 2007 and the long-track New Hampshire tornado in July 2008.

Figure 5: Lead Meteorologist Mike Cempa has worked at NWS Gray since 2006. He also heads the local Skywarn spotter program.

The Patriot's Day Storm occurred in April 2007. I worked for several days leading up to it, the day of the storm, and the day after. It had widespread effects and the number of different types of hazardous weather made for some very interesting and challenging days. We had significant flooding: coastal, river and flash flooding. On top of that, there was severe wind damage and heavy snow in the mountains. I almost didn't make it to work during the storm because of many roads closed due to trees down. Then the next day I had the same problem getting to work because so many roads were closed due to flooding.

In July 2008, a long-track tornado tore through New Hampshire. It was an intense day where we watched very persistent strong rotation on the radar and started getting many reports of trees down and wind damage. We didn't get any reports of anyone seeing a tornado because it was wrapped by heavy rain, and to this day we have not seen a picture of this tornado. There has never been a recorded tornado on the ground that long or for that distance in New England, so it was a bit of a challenge to keep that warning going with no visual confirmation of a tornado.

Summer Student Volunteering: A Win-Win

By Justin Arnott, Science and Operations Officer

During the summer of 2016, the National Weather Service (NWS) forecast office in Gray, Maine hosted three student volunteers. The student volunteer program is open to meteorology graduate students or undergraduate students that are entering their Junior or Senior years and are interested in learning more about operations at a NWS forecast office.

One of the primary aspects of the student volunteer position is learning the inner workings of the data acquisition desk. This desk is responsible for ensuring the integrity of data used in the forecast process, including launching a weather balloon twice daily. These data are the backbone of successful forecasts and therefore are natural places for students to learn more about how a NWS forecast comes together.

In addition to learning the inner workings of a NWS forecast office, students have the opportunity to work on science and outreach projects that benefit both their education as well as NWS forecasters, and therefore the public we serve. Finally, students learn about careers in the NWS as well as the job application process.

Two graduate students from Plymouth State University, Joe Cebulko and Rob Megnia, made the nearly two-hour trek 2-3 days per week to take advantage of the student volunteer program this summer. Joe is pursuing a Masters project investigating cool season inverted troughs in the northeastern United States and their connection to high impact weather. Rob's Masters project focuses on teleconnections (large scale atmospheric connections between weather systems) and how these large scale patterns influence the climate across New England.

Ryan Colantonio, a student at The Ohio State University, assisted with a local climate study, created an inventory of historical weather documents at the office, and produced a plethora of outreach materials, including a YouTube video on the heat wave of 1911 that is described elsewhere in this newsletter.

The student volunteer opportunity is a great way to experience NWS operations first hand, which can help a student make the decision of whether a career with the NWS is right for them.

If you are interested in becoming a student volunteer with the NWS, be on the lookout for the announcement for the 2017 program in January. If you have specific questions, you can contact the local program coordinator, Justin Arnott, at justin.arnott@noaa.gov.

The Great Heat Wave of 1911

By Ryan Colantonio, Student Volunteer from The Ohio State University

The July 1911 Heat Wave is possibly the deadliest weather event in New England history, but over the past century it has largely fallen out of the public consciousness. This article will provide a breakdown of the event that led to massive forest fires, deadly lightning, and record temperatures that still stand over 100 years later. Learn more from the YouTube video by following this link: https://www.youtube.com/watch?v=DFfKB7QfP7s&feature=youtu.be

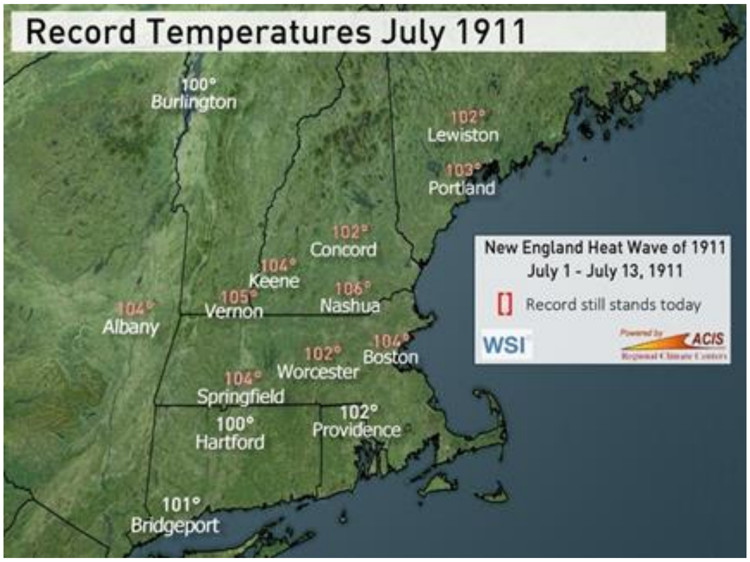

Figure 6: Some record high temperatures set in early July 1911. Values in red are records which still stand today.

The Beginnings

The heat wave began on July 1st when temperatures topped 90 degrees across most of New England for the first time since May of that year. In this pre-air conditioner era, people flocked to the beaches in droves and did whatever they could to escape the heat. When hundred degree temperatures arrived on July 2nd, Revere Beach outside of Boston recorded over 150,000 visitors. Trolleys and ferries found record business as city dwellers rode night and day just to catch a breeze. Even overnight temperatures hovered around the high 80s, and city parks soon became sleeping grounds for thousands across New England.

A Record Setting Fourth of July

July 4, 1911 is one of the hottest days in New England history. The state temperature records for Vermont and Maine at 105, New Hampshire at 106, and the city of Boston at 104 were all set on this hot Fourth of July.

Forest Fires and Crop Damage

With the unrelenting heat came extremely dry conditions and extensive forest fires across Maine and New Hampshire. Fires in Piscataquis and Somerset Counties in Northern Maine spanned thousands of acres and accounted for over one hundred thousand dollars in damages (over $2 million dollars today). The Massachusetts Department of Agriculture had estimated that by July 7th between 5 and 10 million dollars worth of crops had already been scorched by the heat.

July 5th Deadly Thunderstorms

As some parts of New England had been suffering through consecutive hundred degree days, a large low pressure system had been moving across Canada. During the early morning hours of July 5th, the system's cold front finally brought some much needed relief (in some areas the

Heat Wave of 1911 (continued)

temperature dropped more than 25 degrees in one hour as the front moved through). But when the front's cold, dense air wedged under the extremely warm air at the surface, New England was now faced with a new threat: deadly thunderstorms. Lightning decimated towns in Vermont and Western Massachusetts, where property damages exceeded seventy thousand dollars and at least 3 people were struck dead. In Rutland, Vermont, 15 separate buildings were struck, and more fires were sparked across New England. As the cold front moved into Maine on July 6th, another threat had developed: gale force winds. The city of Bangor was hit particularly hard as winds uprooted trees and brought down several buildings.

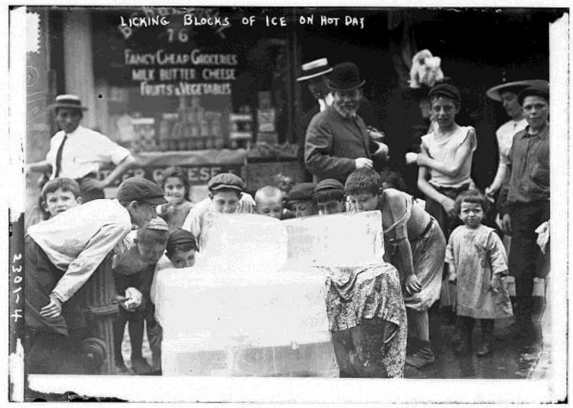

Figure 7: People use ice to cool off during the intense NYC heat (photo from Library of Congress)

July 7-9 Madness

With much of New England now in the cold sector of this low pressure system, July 7th and 8th were the coolest days of the heat wave: if you count the low 80s as cool. But by midday on July 9th, temperatures climbed right back into the 90s. At this point some New Englanders became so fed up with the heat that madness was the next disaster to strike. In Worcester, one man drowned himself, while elsewhere firearms and poison became ways to escape the heat.

July 11 Heroism amidst Tragedy

The worst disaster of the 1911 Heat Wave occurred on the morning of July 11th in Bridgeport, Connecticut. Shortly after 3:00 AM, the Washington to Boston Federal Express careened off the tracks on its way through Bridgeport. With temperatures already racing towards 80 degrees, the train's regular engineer had decided to switch shifts with a less experienced co-worker midway through the trip. While ultimately, the changeover led to 14 lives lost, it also ended up saving countless others. During the changeover, the St. Louis Cardinals baseball team, who were in route to a game against the then Boston Braves, had insisted on being moved from the front of the train to its final two cars to get some sleep. When the Express derailed later that morning, these final two cars were the only ones that remained on the tracks. As first responders, the Cardinals became heroes amidst the tragedy.

July 13 That Cool Refreshing Breeze

Without Upper Air Observations, it's hard to pinpoint exactly what finally broke the heatwave, but it certainly didn't hurt when winds shifted on July 13th and finally allowed the cool New England sea breeze to take hold. In total the Weather Bureau estimated that the heat killed more than 1,000 people across the Atlantic states, with more than 400 of those coming from Boston and New York City alone. Over 100 years later, this heatwave has mostly been lost to history.

New Probabilistic Snowfall Forecasts

By Justin Arnott, Science and Operations Officer

Forecasting snowfall amounts is one of the most difficult challenges facing forecasters at the National Weather Service (NWS) forecast office in Gray. Within in a widespread snow event, there can be particular locations that see significantly more or less snow than others. Traditionally, this uncertainty in the exact snowfall amount at any one location has been handled by expressing expected snowfall in ranges (e.g. 4-8”, 6-12”, etc.). With the recent improvement in computer forecast guidance, as well as an explosion of available computer forecast sources, there is now the ability to express the probability of particular amounts of snowfall at different locations. For example, what is the “worst case scenario” that you might expect from the upcoming storm?

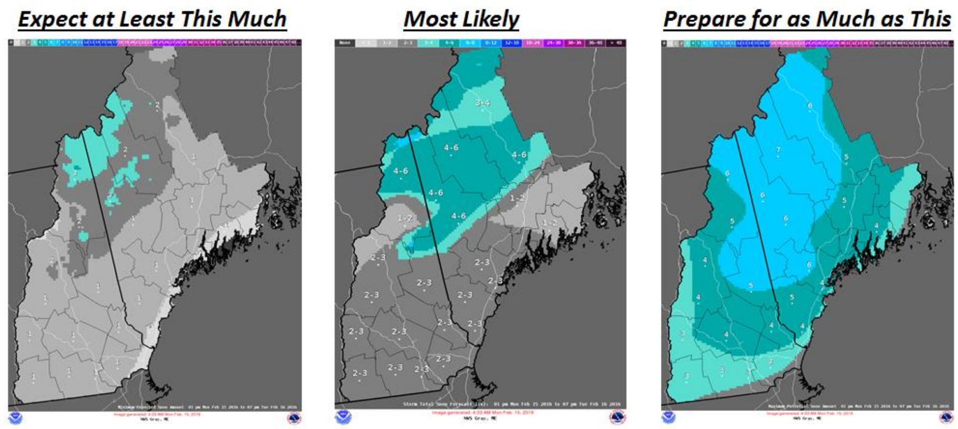

Figure 8: Example for Minimum (left), Most Likely (middle), and Maximum (right) snowfall forecasts.

During the winter of 2015-2016, NWS Gray participated in an experiment designed to explore the potential of making these types of forecasts, called probabilistic snowfall forecasts. During significant snowfall events, NWS Gray forecasters would update a series of graphics and tables containing this new forecast information.

The simplest way to view some of this new information is through the “Minimum”, “Most Likely”, and “Maximum” graphics (Figure 8). The “Minimum” and “Maximum” graphics represent the 10th and 90th percentile forecasts respectively, meaning that 80% of the time, one would expect the actual snowfall to fall between these two amounts. The “Most Likely” graphic represents the official NWS forecast. This is a great way to view what we think the best/worst case scenarios might be together with the official forecast.

Another way users can examine these probabilistic data is to view the likelihood of snowfall falling in particular “range bins”. For a particular snowfall event, this would help explain whether a 2-4” or 4-8” snowfall is more likely at particular locations across the forecast area. Finally, for users that have important decisions based on certain thresholds of snowfall, the interface allows you to view the “Percent Chance that Snow Accumulation will be greater than…” (Figure 9 on next page). This information can help you determine the potential of over one foot of snow during a particular storm, for example.

Probabilistic Snowfall Forecasts (continued)

The experiment will continue for the 2016-2017 winter, with additional offices across the country participating. There will be changes to the graphics created, with the goal of more clearly conveying the probabilistic snowfall forecast information to our users.

To view NWS Gray probabilistic snowfall forecasts, please visit the webpage at www.weather.gov/gray/winter. On this page, we encourage you to provide feedback help improve these probabilistic forecasts in the future.

A

Location	Min	Likely	Max	>=0.1"	>=1"	>=2"	>=4"
Bridgton, ME	1	2	4	97%	86%	43%	7%
Brunswick, ME	1	2	3	96%	84%	38%	3%
Cumberland Center, ME	1	2	3	96%	83%	38%	3%
Gray, ME	1	2	3	98%	84%	38%	3%
Portland, ME	1	2	3	96%	83%	38%	3%

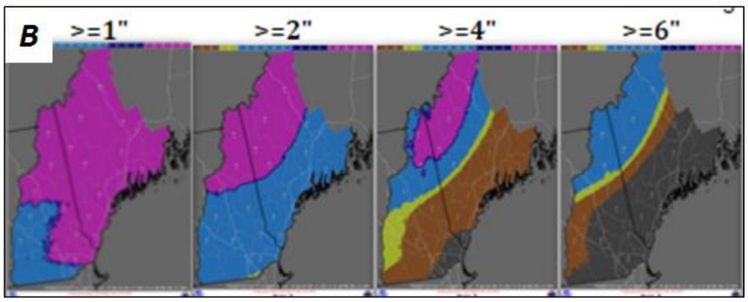

Figure 9: Example table (A) and graphic (B) showing probabilities for particular amounts of snowfall.

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For questions, comments, or suggestions contact us at

GYX-Newsletter@noaa.gov

Photo by Margaret Curtis