Weather Brew

VOLUME 4, ISSUE 2 FALL 2012

INSIDE THIS ISSUE:

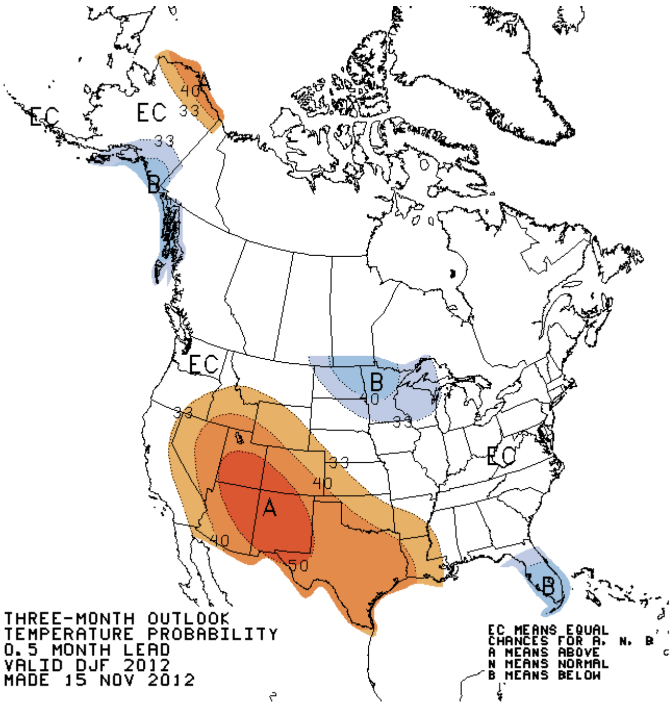
Winter Outlook 2012-2013

By Morgan Brooks

With last winter (December - February) being very docile across southern Wisconsin and the winter season soon upon us, many are wondering if this winter will be a repeat of last year. Could we see a return to a more typical Wisconsin winter, or perhaps, a more harsh winter?

As a reminder, last winter was the 5th warmest on record in Milwaukee, with an average temperature of 31.0 degrees. It was also the 4th warmest winter in Madison, with an average temperature of 28.7 degrees!

Snowfall amounts, while not as impressively anomalous, strayed considerably from the average. Milwaukee's total snowfall last winter was 24.2", 10.9" below normal and Madison's was 22.9", 14.1" below normal.



Winter 2012 - 2013 temperature outlook.

So what does this winter's forecast call for?

The Climate Prediction Center's forecast indicates that all but far southern Wisconsin has an increased chance of below normal temperatures. Far southern Wisconsin has an equal chance of below normal, near normal, or above normal temperatures.

The winter precipitation forecast indicates that all of Wisconsin has an equal chance of below normal, near normal, or above normal precipitation.

One important factor in the winter outlook is the El Niño Southern Oscillation (ENSO). The ENSO phase is coined El Niño when the water of the Pacific Ocean along the equator is warm-

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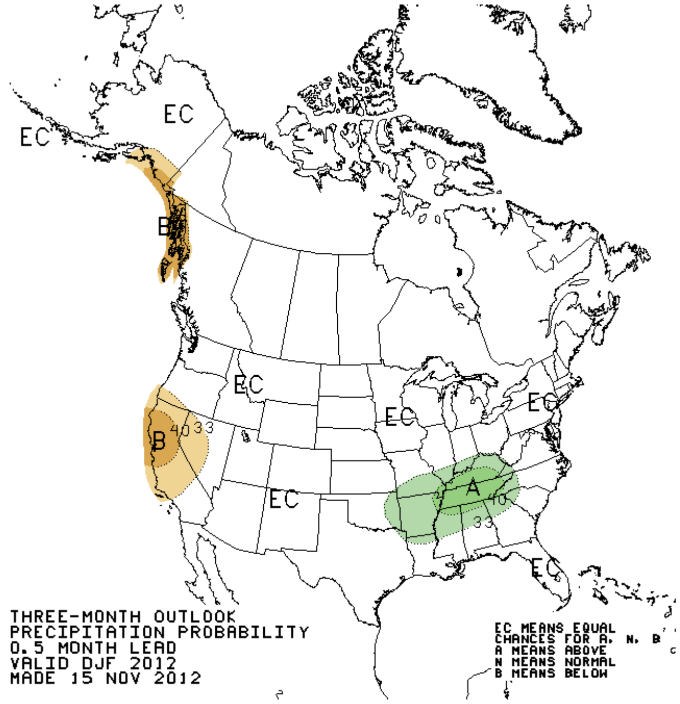
Winter Outlook (Continued)

Winter 2012 - 2013 precipitation outlook.



For those of you looking for a return to a more typical Wisconsin winter this year, the outlook is in *your* favor. Make sure you prepare for the hazards of winter this year before they strike by visiting our "Weather Ready" webpage!

er than normal. Conversely, when the water is cooler than normal, the ENSO phase is La Niña. When the water temperature is near normal, the ENSO phase is neutral.

While the Climate Prediction Center uses multiple other forecast tools such as recent climatology, other oscillations, soil data, statistical forecast tools, and dynamical forecast models, the ENSO phase plays a major role in the forecast.

This year, El Niño did not develop as expected, rather ENSO neutral conditions have developed and are forecast to persist. This pattern creates a bit more uncertainty in the winter forecast.

Jeff Craven, the Science and Operations Officer here at the National Weather Service Milwaukee/Sullivan office, examined the data more closely for southern Wisconsin. He looked at the ENSO phase for every winter since 1950 and compared it to that winter's temperature and precipitation data.

The results showed that, in Milwaukee, El Niño winters have an average snowfall of 44.0", La Niña winters have an average of 53.4", and ENSO neutral winters have an average of 51.7". The normal winter snowfall total is around 50". Approximately 60% of ENSO neutral winters have below normal snowfalls.

El Niño winters have an average temperature of 24.5 degrees, La Niña winters have an average of 24.2 degrees, and ENSO neutral winters have an average of 23.0 degrees. The normal average temperature is 23.9 degrees. Around 40% of ENSO neutral winters have above normal temperatures.

Overall, the results favor slightly below normal snowfall and slightly below normal temperatures. However, there can certainly be exceptions. During the last ENSO neutral winter (2008-2009) 76" of snow fell in Milwaukee. During the two ENSO neutral winter's prior to that (2001-2002 and 2003-2004) less than 40" of snow fell.

Three Consecutive Hot Summers, More to Come?

By Mark Gehring

Madison			Milwaukee		
Rank	Temperature	Seasons	Rank	Temperature	Seasons
1	72.8	2010-2012	1	72.9	2010-2012
2	72.5	1931-1933	2	72.2	1931-1933
2	72.5	1932-1934	3	71.8	1930-1932
4	72.0	1933-1935		71.8	1993-1995

Table 1: Ranking of the combined warmest average temperature for three consecutive summer seasons.

The combined average temperature of the last three summer seasons, from 2010 - 2012, was the hottest among any three consecutive summer periods since records began in the late 19th century (including the Dust Bowl years of the 1930s). Table 1 lists the warmest average summer temperatures for a three season period. Each of the summer seasons of 2010-2012 fell within the top 20 warmest summer seasons for both Madison and Milwaukee, making the average of those three summers the warmest on record.

The average temperature for the three season period from 2010-2012 was 72.8 °F, 3.6 °F above normal. Madison and Milwaukee ranked 1st for the warmest year on record through November 18th (Table 2).

Madison			Milwaukee		
Rank	Temperature	Year	Rank	Temperature	Year
1	54.1	2012	1	54.3	2012
2	53.2	1931	2	53.9	1931
3	53.1	1878	3	53.6	1921
4	52.8	1921	4	53.4	2010
5	52.3	1880	5	52.9	1998

Table 2: Ranking of the warmest years on record through November 18th using average temperature.

Ironically, climate change in Wisconsin has been most represented by mild temperatures in winter and spring, but not as much during the summer. The Wisconsin Initiative on Climate Change Impacts (WICCI), however, is projecting a 3-8 °F increase in average summer temperatures by the middle of the century, as greenhouse gases continue to rise due to fossil fuel combustion caused by man. This would also mean an increase of 22-26 days of maximum temperature greater than or equal to 90 °F across southern Wisconsin. Thus, summers would routinely be very hot and more precipitation would be needed to hold crop yields at satisfactory levels. Other negative effects would be more heat waves and air pollution episodes. Further, various animal species and cold water fish would be threatened by a shift to a much warmer climate. More info on climate change in Wisconsin is available at WICCI: http://www.wicci.wisc.edu/

National Weather Association 2012 Annual Meeting Held In Madison

By Marcia Cronce

The National Weather Association (NWA) is a non-profit, professional organization on the national level whose mission is "Connecting operational meteorologists in pursuit of excellence in weather forecasting, communication and service." Members consist of weather enthusiasts and meteorologists from all sectors, including universities, media, private consulting firms, and federal government organizations such as the National Weather Service. The NWA held its annual meeting at the Monona Terrace in Madison the week of October 7-11, 2012. Given its close proximity to the National Weather Service office in Sullivan, several employees participated on the planning committee, chaired speaker sessions, and gave presentations at the meeting. On Tuesday, October 9th, there was a "Town Hall Meeting" during the NWA Annual Meeting with the subject *"Decision Maker's Perspective – Assessing Weather Impacts."*

The Weather-Ready Nation (WRN) initiative to

The members of the Town Hall panel: (from left to right)
Jerome Popiel
U.S. Coast Guard
Todd Matheson
WI DOT
Lemorris Graham
DHS/FEMA Region V
Edgar Alvarado
DHS/FEMA Region V
Rob Olsen
Xcel Energy
John Blood
MN SEOC
Tim Butcher
Dane County Regional Airport
Karen Munt
Meriter Hospital
David Janda
WI Emergency Management
Gary Cannalte
WISC-TV Madison

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Annual Meeting… (Continue)

The members of the Town Hall panel listening to a question from a member of the audience.

save more lives and livelihoods by getting the country prepared to protect, mitigate, respond to and recover from weather-related disasters involves a team effort from all different entities. The Town Hall Meeting provided an opportunity for the Weather Enterprise to hear first-hand from various users of weather information. People in attendance learned about different requirements and thresholds involved in their strategic planning in support of their organization's mission during active weather.

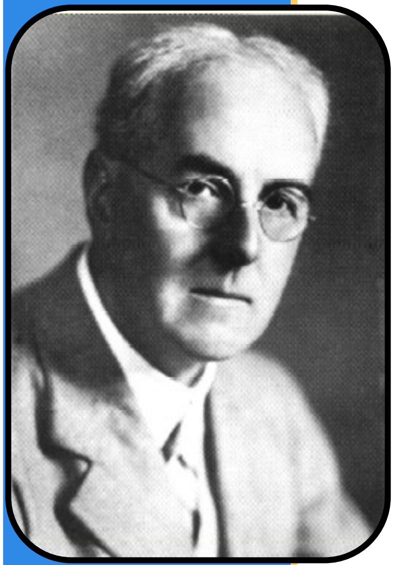
Invitations were sent to various users of weather information who are involved in making decisions for their operations based on weather forecasts. Each participant contributed input about how their organization responds to different weather forecast scenarios. Nine participants were present as panelists at the Town Hall meeting. Introductions to the panelists and the participant pre-meeting responses were presented during the first hour of the Town Hall meeting. The second half of the meeting entailed the panelists answering situational questions specific to their organization. For example, the panelists were given a scenario such as an approaching winter storm (or severe weather) and then asked about ideal lead time, how meteorologists might convey forecast uncertainty, and what amounts/types of precipitation may impact their operations. There was also an opportunity for the audience to ask the panelists questions geared toward the WRN at the end of the meeting.

Improve Your Weather Knowledge

An Introduction to Numerical Models

By Jake Wimberley

In the late 1800s and early 1900s, numerous scientists worked to explain the processes that affect the weather in mathematical terms. These scientists used the laws of physics and thermodynamics to develop equations showing how measurable quantities of the atmosphere (temperature, pressure, humidity, wind, etc.) are related—especially how the changes in one or more of these quantities over time affects the other quantities. Together, these equations form the basis of a *numerical model* of the atmosphere.



Lewis F. Richardson (1881 - 1953).

Lewis F. Richardson, a British mathematician and meteorologist, recognized that accurate prediction of the weather would be possible if, given the conditions observed by weather instruments at the present time, the equations were solved to indicate the changes in those conditions over the following hours or days. Richardson himself used this method, tediously performing the calculations by hand, in an attempt to produce a six-hour weather forecast. He knew that for the technique to be effective for forecasting in real time, the calculations would have to be performed much faster than a single human could. Since electronic computers did not exist at the time Richardson was involved in this research (the 1910s and '20s), so-called *numerical weather prediction* would remain a dream.

In 1950, the world's first computer-generated numerical weather forecast was made by the ENIAC computer (see figure next page). In the years that followed, continued development and research (both in meteorology and computing) led to numerical models being run on a routine schedule, with the model output being made available to meteorologists in various forms. Today, the National Weather Service operates its own supercomputing center, where several models are run multiple times each day. NWS meteorologists use the models' forecasts as guidance in producing their own forecast.

Recall that the input to the equations of the model is a set of observed quantities like temperature and humidity. Before beginning to generate a forecast, the computers running the models must first process thousands and thousands of observations from around the globe. The observations include reports from automated surface stations, weather balloons, wind profilers, satellites, and other platforms. Since the observations are unevenly spaced and taken at different times, the computer must use mathematical methods to determine

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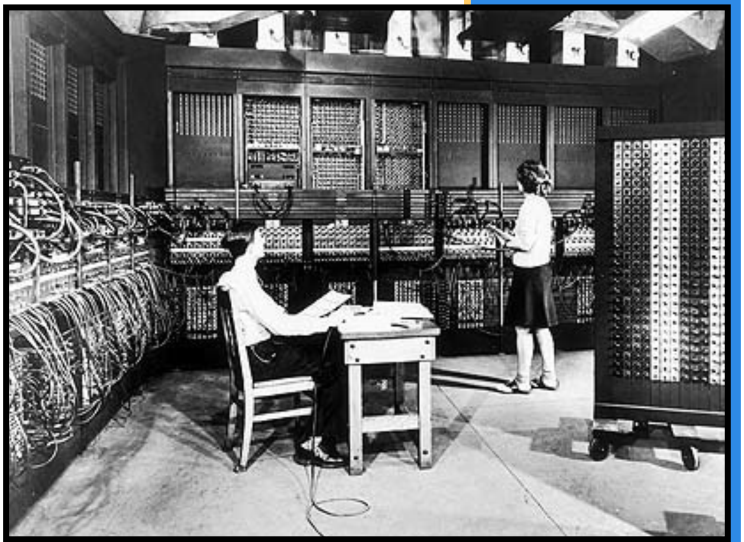
WX Knowledge… (Continue)

what the observed quantities would be at places in **between** the observation sites. Some models can also account for differences in the times at which observations were taken. The result of these very complicated processes (known collectively as *data assimilation*) is a complete set of the quantities needed for input to the equations, with values known for every point on a grid (known as an *analysis*).

The spacing of the grid points in the analysis is very important as it has a direct impact on the accuracy of the model. The closer the points are together, the smaller the features that can be resolved (predicted) by the model. Early weather models could only resolve synoptic-scale storm systems the size of several states; some models today are able to resolve single storm cells only a couple of miles wide! With the analysis complete, the model is ready to begin producing a forecast. The equations must be solved together for essentially **every** grid point. Billions of calculations are required to produce a forecast for a typical grid, and the longer the forecast, the more calculations that are necessary. This means that even for the fastest and most advanced computers, it takes several hours of computations to finish a forecast.

The NWS runs two primary models, the Global Forecast System (GFS) and the North American Mesoscale model (NAM). The GFS models the weather over the entire globe, while the NAM uses a grid that only covers North America. The GFS provides global coverage, but its resolution is coarser than the NAM. This means that the distance between its grid points is larger, and it cannot resolve some smaller weather features that the NAM may be able to. Because of the NAM's increased resolution and therefore increased number of necessary computations over a given area, it only covers North America. The GFS predicts conditions out 16 days from the time of the analysis, but the NAM only goes out 84 hours (3½ days).



The ENIAC (as seen in the above photo) produced the world's first computer-generated numerical weather forecast in 1950.

Output from the GFS, NAM, and other models is used to generate weather charts more or less identical to charts that have been familiar to meteorologists for decades. The charts show weather patterns on surfaces of constant pressure in the atmosphere. The pressure at sea level averages 1013 millibars (mb) and decreases with increasing altitude. The most commonly used levels are 925 mb, 850 mb, 700 mb, 500 mb, 300 mb, 250 mb, and 200 mb. Surface charts are also available, indicating for ex-

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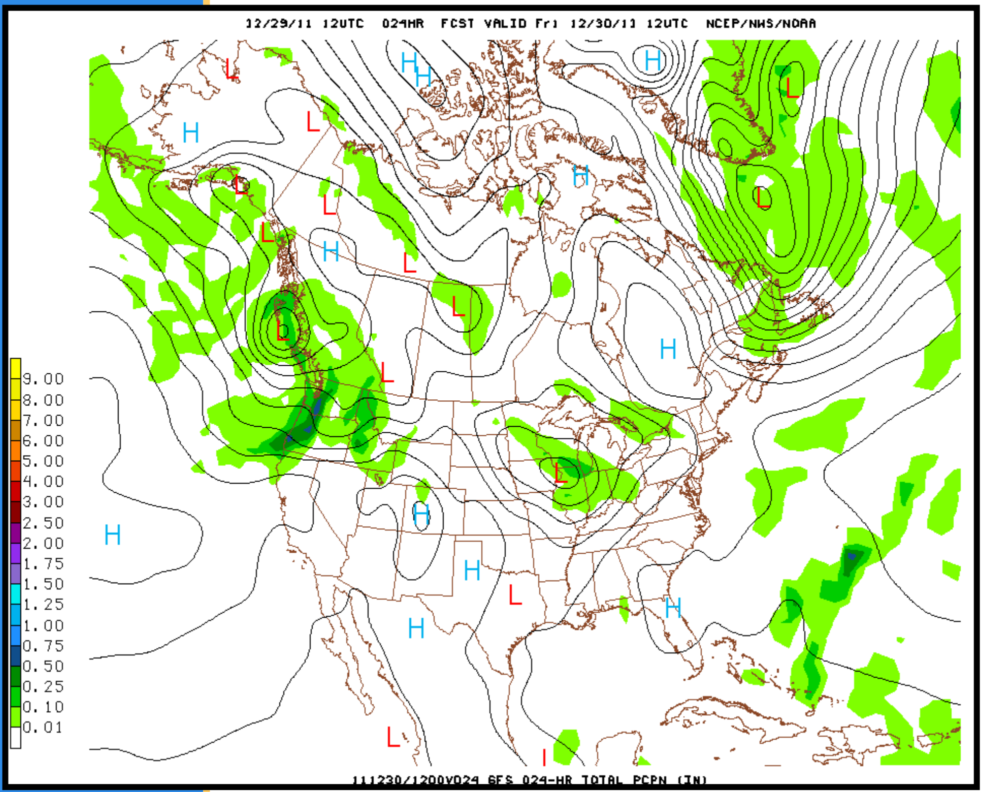
WX Knowledge… (Continue)



GFS model output of a 24 hour forecast displaying 3-hr precipitation accumulation. Valid 12/30/2011 12 UTC (6 am CST) produced from a GFS model run on 12/29/11 12 UTC (6 am CST).

ample, the model's forecasted surface temperatures and precipitation amounts. A meteorologist rarely takes the surface charts at face value—a thorough analysis of the various vertical-level charts is required to understand what causes the model to forecast a certain weather event at the surface. A chart produced by a model usually shows a snapshot of the weather at a particular time. Most models produce output charts in increments of one, three, or six hours. So to compile a 7-day forecast, **a meteorologist will likely examine dozens or even hundreds of charts!** Furthermore, a meteorologist often employs output from several models, since different models use slightly different techniques to process the data and arrive at a forecast solution. Evaluating several models can increase the total number of charts several times over.

It is important to note that while model forecasts continue to improve in accuracy as the science of modeling advances, no one model is accurate enough to be used reliably for forecasting without human intervention. Models may produce forecasts that do not follow a meteorologist's "common sense," like snowstorms over the Plains in July. Similarly, a model may take a weakening tropical depression present in the analysis and turn it into a major hurricane. Models have trouble properly accounting for weather phenomena on very small scales such as the periphery of a thunderstorm. A skilled meteorologist is able to use models in light of these facts, knowing when to trust a model and when to use a different model, or different forecasting techniques altogether. Severe weather events offer one situation where a meteorologist can make a vast improvement on a model forecast.

By convention, meteorologists around the world use *UTC time* to refer to the

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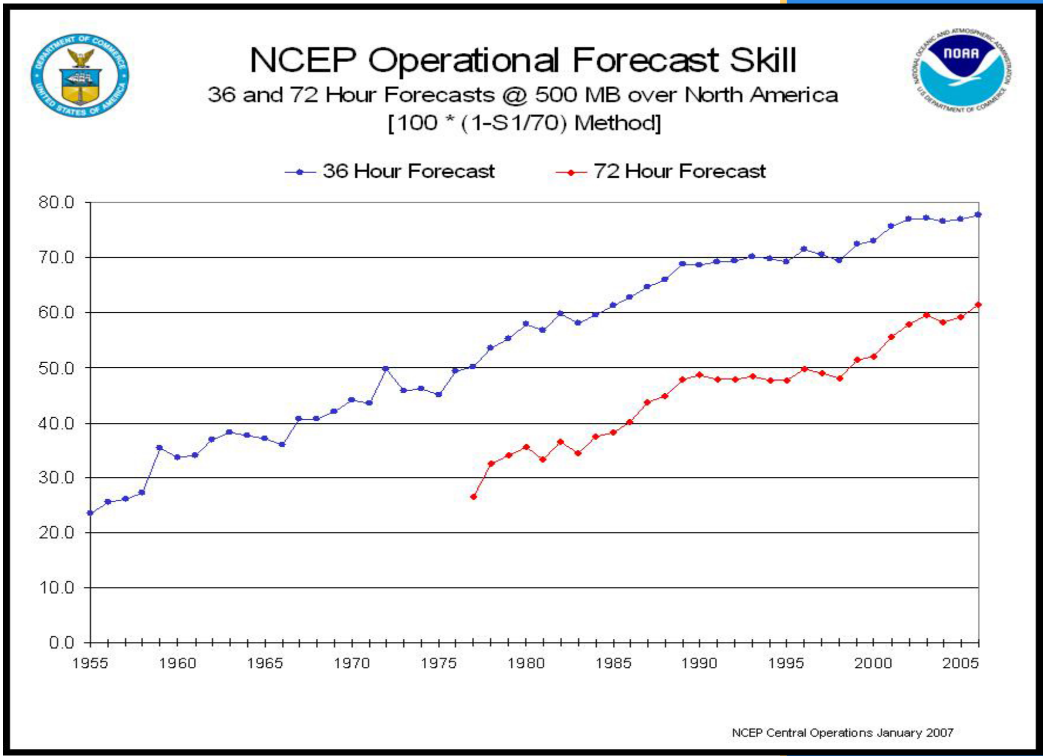
WX Knowledge… (Continue)

time of weather data; furthermore, a 24-hour clock is used, just like military time. These conventions make it easier for forecasters in different time zones to discuss the weather. UTC time is basically Greenwich Mean Time (GMT), and is six hours ahead of local Wisconsin time—except when we are on Daylight Saving Time, when it is only five hours ahead. The GFS and NAM begin a new forecast run every six hours, starting at 0000, 0600, 1200 and 1800 UTC (6:00pm, 12:00am, 6:00am, and 12:00pm CST). Please note: In examining model data, you may see references to "Z-time," which is meteorological jargon for UTC.



Graph showing time (x-axis) versus model accuracy (y-axis) using average S1 Score (a measure of accuracy) of 36- and 72-hr NCEP (National Centers for Environmental Prediction) 500 hPa height forecasts.

Note the improvement with time (i.e., higher the value on the y-axis, the better the forecast).

Each new forecast run takes into account the latest observations available at the time of the analysis (which is concurrent with the beginning of the run). The weather is always changing, so no two analyses are ever exactly the same. The slightest differences in one analysis versus another would cause the model to produce a different forecast from each. For this reason, the same model, initialized at different times, will produce different forecasts for a given later time. As an example, the 00 UTC GFS run from December 15 might predict rain for Milwaukee at 3:00pm December 18, with a temperature of 34°. The following GFS run, from 06 UTC, might predict snow at that same hour, with a temperature of 30°. This type of inconsistency, which is somewhat common, provokes meteorologists to compare the output not only between models, but also between runs of the same model.

Model forecast charts were first distributed within the NWS exclusively by fax, so few people outside the meteorological community had the opportunity to see them. In the 1990s, the explosion of the internet meant that model forecast data, along with all other types of weather data, became available to the general public. Today, the NWS offers model charts freely via the World Wide Web, and anyone may

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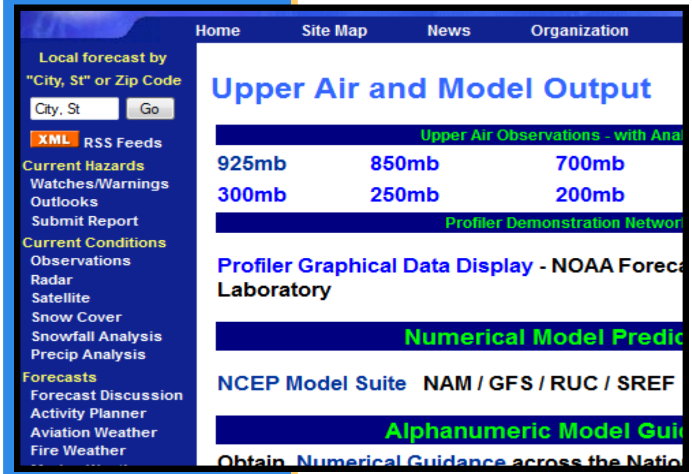


The NWS Milwaukee/Sullivan Numerical Model and Upper Air webpage at: www.crh.noaa.gov/mkx/?n=local-models

take a crack at producing their own forecast using the models.

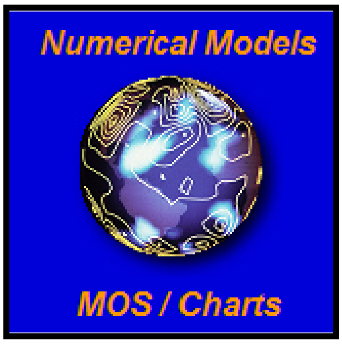
NOTES:

Photo of Lewis F. Richardson and ENIAC computer were from a presentation given June 15, 2004 at a Symposium on the 50th Anniversary of Operational Numerical Weather Prediction.

Photo of National Centers for Environmental Prediction (NCEP) Operational Forecast Skill was from the NOAA 200th Foundations: Weather, Ocean, and Climate Prediction website.

For a sampling, visit the NWS Milwaukee/Sullivan homepage (http://weather.gov/milwaukee)

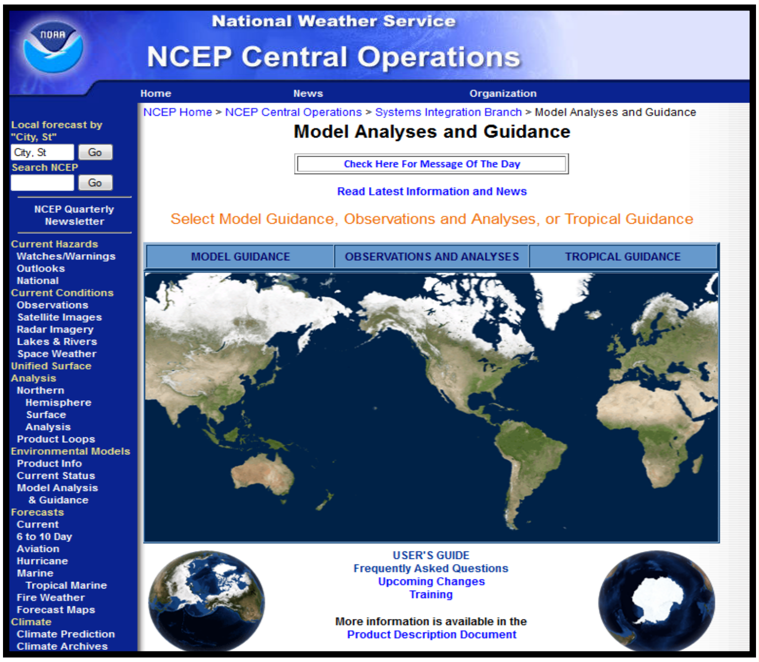
and click the icon below:



If you want more advanced data, the NWS National Centers for Environmental Prediction (NCEP) offers a wide array of model charts at: http://mag.ncep.noaa.gov/.

Goodbye Jake!

Jake recently left the Milwaukee/Sullivan office for a general forecaster Position at the Greenville-Spartanburg, SC Forecast Office. Bonne chance, Jake!

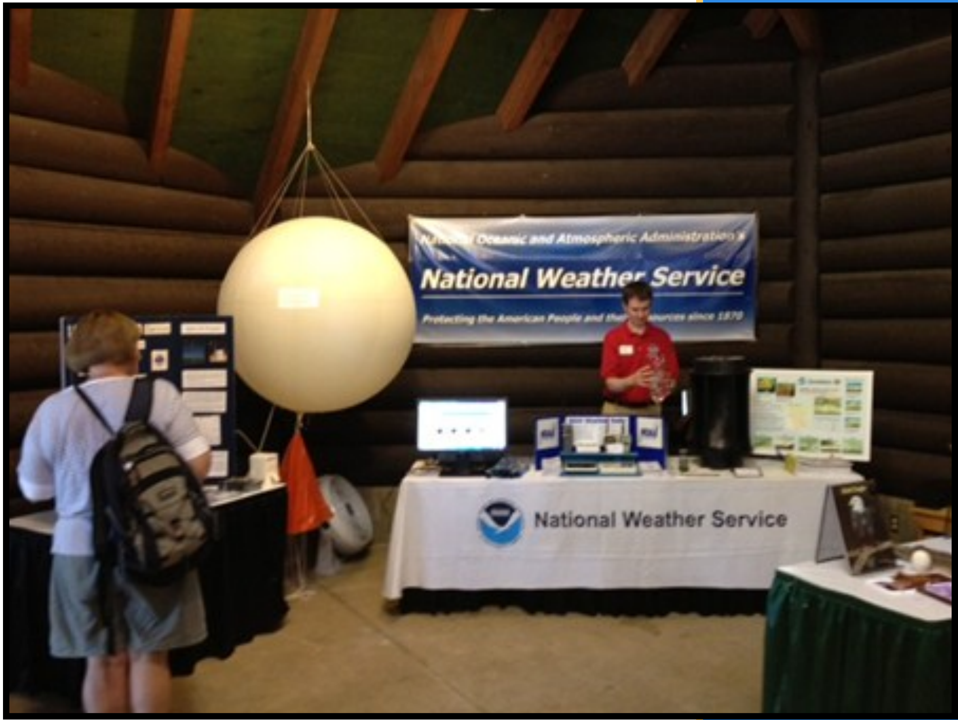


National Centers for Environmental Prediction (NCEP) Model Analyses and Guidance webpage at: mag.ncep.noaa.gov/NCOMAGWEB/appcontroller

2012 Wisconsin State Fair

By Marc Kavinsky

NWS meteorologist J.J. Wood prepares the exhibit for the day.



Thank you to all who visited the National Weather Service (NWS) exhibit at the 2012 Wisconsin State Fair! This continues to be our most successful outreach event of the year. We are estimating over 1**2,000+** visitors stopped by our exhibit during the eleven day run of the fair.

Many visitors wanted to discuss the NOAA All Hazards Weather Radio program, NWS products, and the services and features of our website: (www.weather.gov/mkx) The inflated weather balloon, simulated tornado chamber and children's weather station raffle were also big attractions. Some visitors just stopped by to say hello and tell a weather story.

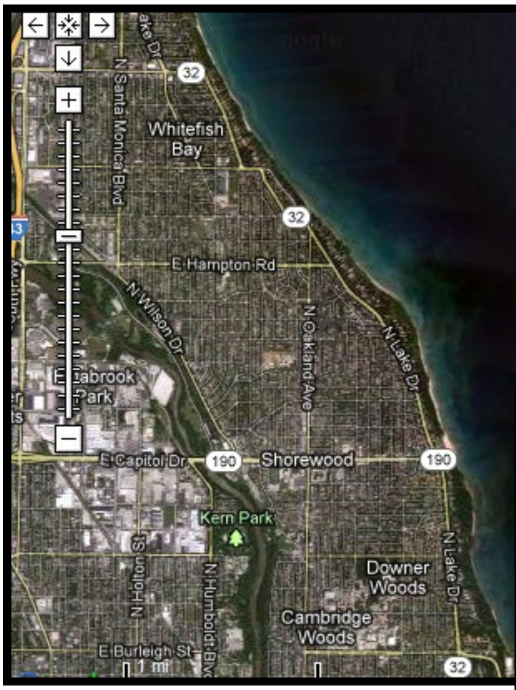
NWS meteorologist Morgan Brooks talks tornadoes with a young fan.

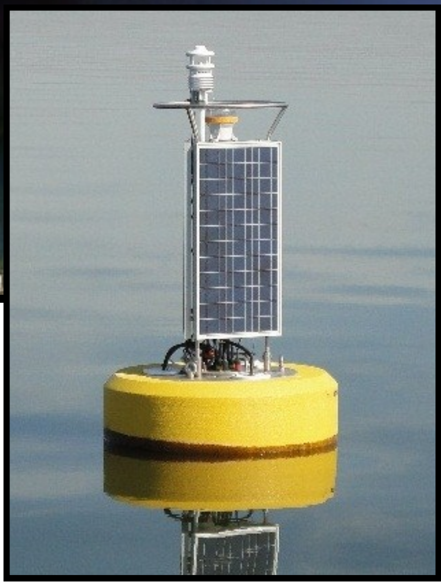
Our exhibit was located in the south pavilion in the Wisconsin DNR Park, just west of the Wisconsin Exposition Center.

We hope to see you next year at the fair!

New Near Shore Buoy

The Great Lakes Water Institute has placed in late July a new buoy in our near shore waters. The buoy, ATW20, is located 1.25 mile (2 km) offshore just northeast of Atwater Beach, which is near the north Milwaukee suburb of Shorewood. The buoy is moored in 20 meters of water. The instrument package is 6.5 feet off the lake surface. Measurement capabilities include: significant wave height; wind speed, direction, and gust; air temperature, air pressure; and RH. This buoy gives NWS Milwaukee another much needed observation in our near shore waters to compare to our forecasts and to assist in decision support services.





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Comments and suggestions are always welcome. Your feedback is important to us.