National Weather Service Quad Cities IA/IL

Weather Home Companion

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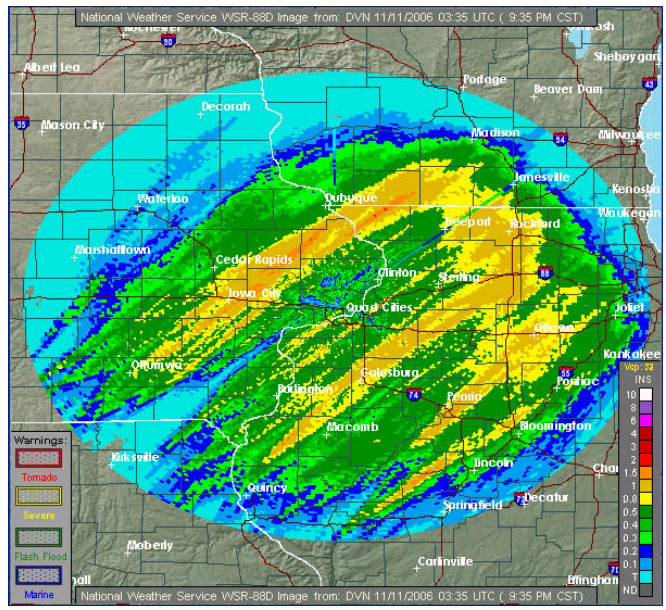
Weather Home Companion is a semiannual publication of the National Weather Service office in the Quad Cities. Contact information can be found on page 8.

How Does Radar Estimate Rainfall?

Jeff Zogg

The National Weather Service (NWS) uses radar to detect the location and intensity of various atmospheric phenomena including thunderstorms, rain and snow. You may have also noticed that radar can also provide rainfall estimates (i.e., amounts). How does radar do that? Continue reading to find out.



Recent example of storm total precipitation from our webpage (www.crh.noaa.gov/dvn).

First, rainfall amounts are directly related to rainfall rates. Specifically, the rainfall amount is given by the average rainfall rate multiplied by duration over which the rate was measured. For example, an average rainfall rate of 0.50 inches over 3 hours would produce a rainfall amount of 1.50 inches. The same concept is used with weather radar.

Rainfall rate and drop size

The rainfall rate (R) is dependent upon three things: (1) the drop diameter, (2) the number of drops in the air and (3) the average drop fall speed. The rainfall rate is most sensitive to changes in the drop diameter. Any change in the drop diameter will increase the rainfall rate by

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Verifying Tornado Warnings

Steve Kuhl

Did you know that the National Weather Service issues tornado warnings on a county basis and keeps verification statistics for these warnings? Whenever a NWS office, including your Quad Cities Weather Forecast Office (WFO), issues a tornado warning, employees work to identify whether or not the tornado actually occurred. If a tornado warning is issued and verified to have occurred, the warning is considered a "hit" and is included in what is called the Probability of Detection (POD) database. If a tornado warning is issued and a tornado does not occur, the warning is considered a "miss" and is included in a False Alarm Rate (FAR) database. A POD of 1 is a perfect score, and a high POD means that most tornado warnings issued were verified to be correct. A FAR of zero is a perfect score, and a low FAR indicates that only a few false alarm warnings were issued.

In addition to POD and FAR, warning lead times are also tracked. The lead time for a

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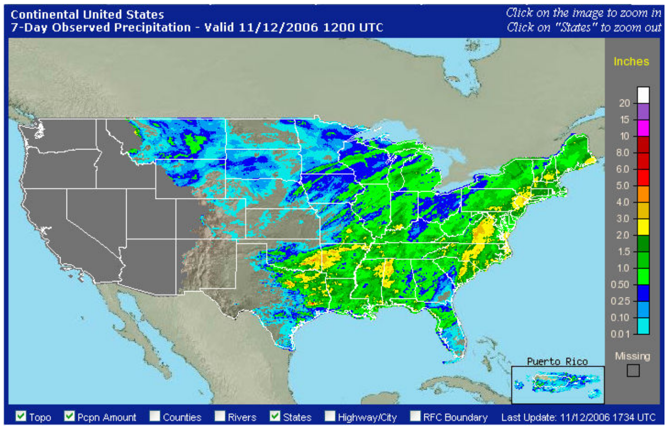
How Does Radar Estimate Rainfall?

(continued from page 1)

...the radar does not directly measure (drop size, distribution or fall speed)...it measures the energy returned from a precipitation target...



Example of a new NWS experimental precipitation analysis product that is based on radar data. It is available on the web at:
www.srh.noaa.gov/rfcshare/precip_analysis_new.php

the third power, or cubed. For example, if the drop diameter doubles, then the rainfall rate will increase by a factor of 8. That is, $2^3 = 8$. Thus, you can see that changes in the drop diameter will lead to much larger changes in the rainfall rate.

Target reflectivity and the radar equation

Unfortunately, the radar does not directly measure any of the above three items. Instead, it measures the energy returned from a precipitation target. A precipitation target can include a rain drop, snowflake or hail stone. The NWS then uses the radar equation which expresses the relationship between the returned energy and reflectivity of a precipitation target. Since all the terms of the radar equation except reflectivity are usually known, the reflectivity can be determined.

Reflectivity (Z) depends on two characteristics of liquid precipitation: (1) the number of drops and (2) the drop diameter. Reflectivity is most sensitive to drop diameter. Any change in drop diameter will increase the reflectivity by the *sixth* power. For example, if the drop size doubles, then the reflectivity will increase by a factor of 64. That is, $2^6 = 64$. Thus, you can see that reflectivity is very sensitive to changes in drop diameter.

Reflectivity-rainfall relationships

Research has provided us with equations that show the relationship between reflectivity (Z) and rainfall rate (R). These equations are called Z-R relationships. Weather radar then uses these equations to estimate R. Various Z-R relationships exist. Different relationships are appropriate for different atmospheric conditions. For example, some Z-R relationships are better for non-tropical showers and thunderstorms while others are better for tropical environments. The radar operator must make sure that the radar is using the appropriate Z-R relationship for the given conditions. If the Z-R relationship is not appropriate then the rainfall estimates may not be accurate. Research is underway to develop accurate Z-R values for other precipitation types such as snow.

Radar rainfall estimates

The NWS Doppler radar estimates the rainfall intensity each time it scans the sky. The radar then uses the rainfall intensity-amount relationship mentioned earlier to estimate the actual amount of rainfall that fell. Although the NWS Doppler radar provides 1- and 3-hour rainfall estimates by default, the radar operator can specify other durations as needed.

Two common sources of error exist in rainfall estimates. One is when hail is present. Hail tends to reflect much higher amounts of energy back to the radar, leading to inflated Z and R values. In addition, wet snow can also lead to inflated Z and R values because it also reflects higher than average amounts of energy back to the radar. The wet snow error is sometimes called the “bright band” error because it appears on the radar screen as relatively higher Z values, when compared to the surrounding lower Z values associated with solely liquid precipitation.

Conclusions

Even though the radar can provide us with rainfall estimates, real-time rainfall and weather observations that cooperative observers and spotters give us are still extremely valuable. We use the rainfall measurements to check the accuracy of the radar rainfall estimates. If we notice that the rainfall estimates are too high or too low then we can make adjustments. Also, we can adjust the radar rainfall estimates in areas where observers report hail. It is important that we receive all of this information as quickly as possible so that we improve our services.

For More information On the Web:

Radar equation and reflectivity (NWS) --
www.wdtb.noaa.gov/courses/dloc/topic3/lesson1/Section2/Section2.html

Radar equation and reflectivity (American Meteorological Society) --
http://amsglossary.allenpress.com/glossary/search?p=1&query=radar+equation

Looking Ahead: El Niño and the Winter Outlook

Barbara Mayes

Despite the cold start to fall, the National Weather Service's Climate Prediction Center is forecasting a better-than-usual chance for a mild winter this year across most of the Plains and upper Mississippi River valley. The winter forecast is based on many factors, but one major contributing factor is the developing El Niño. The El Niño is forecast to persist through the winter and into at least the early spring.

What is El Niño?

The hallmark of El Niño is warmer-than-normal sea surface temperatures in the tropical Pacific Ocean. While that part of the globe might seem far away, the effects of the warmer ocean are far-reaching. Weather patterns across most of the U.S. change during an El Niño, bringing a higher-than-usual chance for the southeastern U.S. to stay cool and the northern and western U.S. to stay warm through the winter.

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...The NWS is forecasting a better-than-usual chance for a mild winter this year…

Verifying Tornado Warnings

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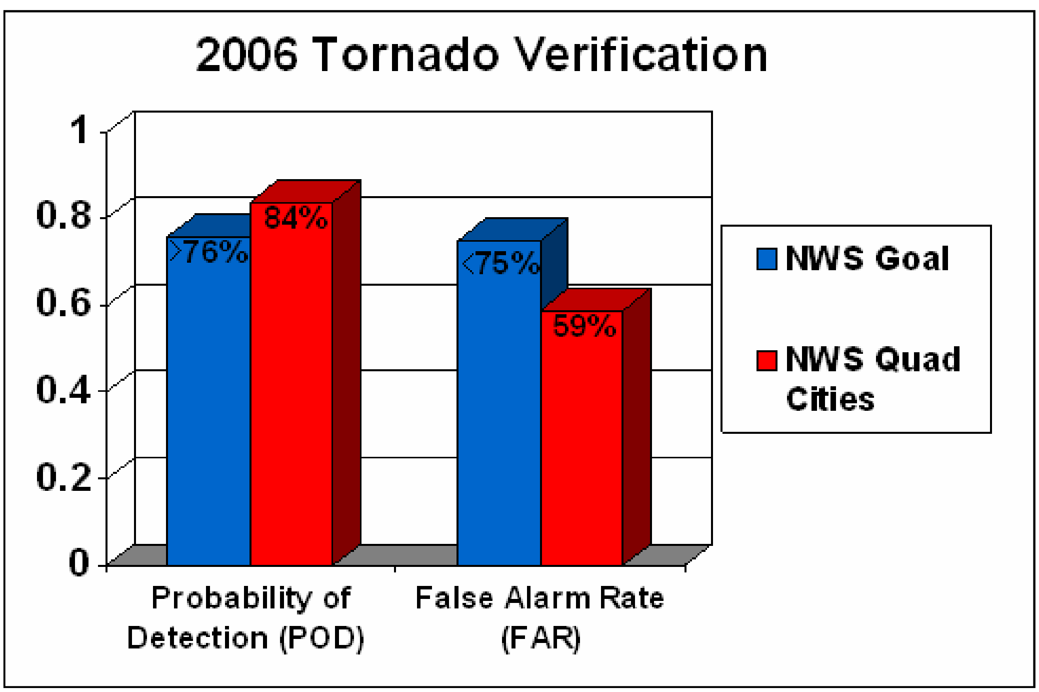
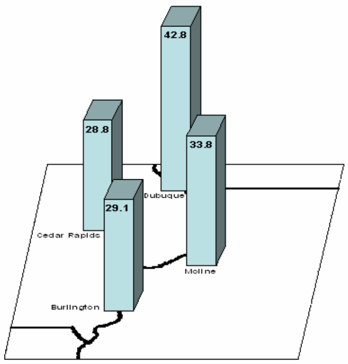
tornado warning is considered to be the time between when the warning is issued and when the tornado actually occurs in the warned location.

The 2006 NWS Probability of Detection goal for tornado warnings across the nation was to be correct 76% of the time, and the False Alarm Rate goal for these warnings was 75%. During the 2006 severe weather season, 31 confirmed tornadoes occurred in the 36 county service area in which WFO Quad Cities has warning responsibility. The actual verification statistics for WFO Quad Cities was a Probability of Detection of 84% and a False Alarm Rate of 59%. Both these scores exceeded the national NWS goals set for the year. Additionally, the 2006 NWS national average tornado warning lead time goal was 13 minutes. WFO Quad Cities tornado warning lead time was 21 minutes, which exceeded the national goal by 8 minutes.

As the Meteorologist in Charge of WFO Quad Cities, I am extremely proud of the warning service our office provided to the citizens of eastern Iowa, western, Illinois, and northeastern Missouri during the 2006 severe weather season. It is my sincere pledge to you that we will remain vigilant and continue to safeguard our public from the threat of severe weather in the years to come.

...Both of these scores (POD and FAR for NWS Quad Cities office) exceeded the national NWS goals set for the year...





Average Annual Snowfall*

Dubuque: 42.8
Cedar Rapids: 28.8
Moline: 33.8
Burlington: 29.1

** Source: NCDC Climate Normals 1971-2000*

Average Winter Season Temperature*

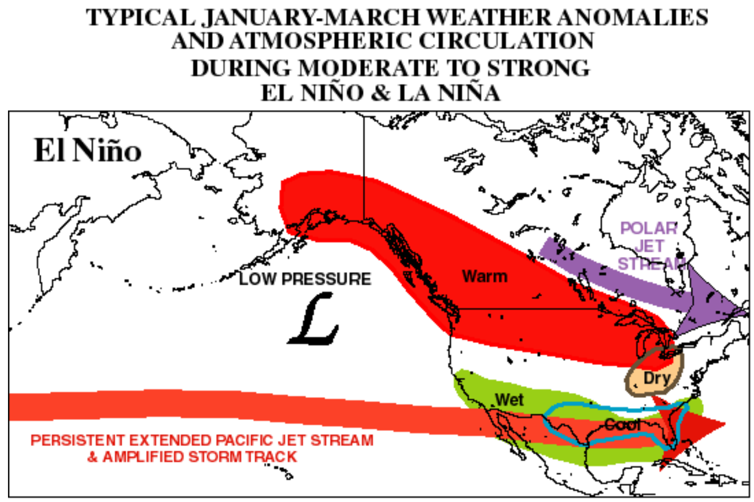
Dubuque: 20.9
Cedar Rapids: 22.2
Moline: 24.8
Burlington: 26.3

*Source: NCDC Climate Normals 1971-2000 for meteorological winter—Dec, Jan and Feb.

Looking Ahead: El Niño and the Winter Outlook

(continued from page 3)

Rainfall patterns also change, mostly in the southern states and along the West Coast. In the Quad Cities forecast area, El Niño winters do tend to be warmer than normal, with no clear trend in the amount of precipitation.



What does the winter forecast mean?

Climate predictions are made in terms of chances of departing from average conditions. Climate forecasts can't tell what the day-to-day weather will be, but they can use information based on ocean temperatures and global flow patterns to determine parts of the U.S. where changes from usual conditions may occur. In this case, the winter outlook calls for a higher-than-average chance that temperatures will be above normal this winter in the Quad Cities forecast area. The precipitation outlook calls for equal chances of being wet, near normal, or dry this winter, since El Niño does not tend to change the climatology of precipitation in the winter in the area. The winter outlook is not able to tell how snowy the winter might be, because snowfall depends not only on temperature and precipitation but also development of storm systems, which cannot be forecast months in advance.

Climate forecasts are available at the national scale (www.cpc.ncep.noaa.gov) and locally (www.weather.gov/climate/calendar_outlook.php?wfo=dvn).

The Local 3-Month Temperature Outlooks are a new way to look at how the climate forecasts can affect temperatures at individual points in the area.

Quad Cities Forecast Office Achieves Top Score for Upper Air

John Hasse

The Quad Cities National Weather Service Forecast Office, is one of nearly 100 offices across the nation that launches weather balloons every day throughout the year. In fact, the balloons are released <u>twice</u> a day, at 6 am and 6 pm CDT or 5 am and 5 pm CST. A radiosonde (instrument package) attached to the balloon, records temperature, relative humidity, pressure, wind direction and wind speed. When winds aloft are also retrieved, the radiosonde is then known as a "rawinsonde". These weather parameters are sent to an office computer through a radio transmitter housed in the radiosonde package. Balloons are usually filled with hydrogen gas (the lightest element), and typically will rise to a height of around 20 miles before bursting. A parachute attached to the radiosonde brings the "train" safely back to earth. Only about 20% of the "sondes" are found and sent back to the National Reconditioning Center in Kansas City, Missouri. There, they are rebuilt and used again. The data received is a "snapshot" of the atmospheric conditions, and used in supercomputers for improving forecasts and warnings. Because this data is so important, your NWS personnel launch balloons in all types of weather (except during lightning, of course).

History

Upper air observations started as early as 1749 in Europe with the

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COOP Observations Needed

Bill Elliott

To our Cooperative Observers around the Davenport Weather Office area:

We need your observations.

Yes, we do get your monthly forms, and we like how they look and that they are on time, but we need to hear from you every day. Our goal is to get every COOP Observer to call us, or in some other way get your observation to us in real time.

There are several reasons we would like to do this, and there are several reasons you might want to help get your observations to us on a real time basis.

The first and most important reason is an increased demand for real time data. Your report would make the daily state summary of observations that goes out to the rest of the world at 815 AM every day of the year. Some of these summaries are read verbatim over the airways of radio, across the state.

Secondly, all of the data, precipitation, snow measurements, and temperatures you record are needed for maps that are sent to the world several times a day. Each of the parameters listed, is accumulated for every reporting site in the U.S. and maps generated from your data are sent to every radio and TV station across the U.S. and around the world. What a great way to get the credit you deserve.

Thirdly, the data you provide are important inputs into computer models and products that are developed by several national agencies on a daily and monthly basis. For example, the National Drought Monitor and the North Central River Forecast Center count on real-time precipitation reports to develop flood guidance for all of the rivers across the Midwest, and to determine the onset and end of droughts, identify precipitation patterns, and evaluate soil moisture. It is of the utmost importance that these agencies receive data real time.

We know you are taking the observations during the early morning hours each day, now we ask that you please call us daily with your vital reports. We answer the phones 24/7 and look forward to hearing from you any time between the hours of 6 AM and 8 AM. If you can't call us during those hours, we still need your report. If you prefer not to call us at our 800 number, we can arrange for you to report by computer or a toll free phone number data collection system. Precipitation calls are needed for both rain and snowfall amounts, from Illinois and Iowa. If you have any questions, please call Mike Zenner, Terry Simmons, or Bill Elliott at 563-386-3976.

We look forward to hearing from you!

...Our goal is to get every COOP Observer to call us, or in some other way get your observation to us in real time...

Reminders for Snow Season

Reports of snow fall and snow depth are in great demand each winter. The prime users of snow measurements are schools, businesses, highway and road departments, insurance agents, actuaries, media, meteorologists, hydrologists, climate researchers and many others. Because demand for snow information is high, it is important for snow measurements to be taken in a consistent manner.

Each season before the first snow, Cooperative observers should review instructions for measuring snow and prepare gages and snowboards.

1. Remove the funnel and inner measuring tube of the eight-inch manual rain gauge. This allows the frozen precipitation to fall into the overflow can for more accurate water equivalent measurements
2. Check the gauge to ensure

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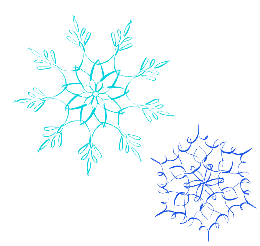
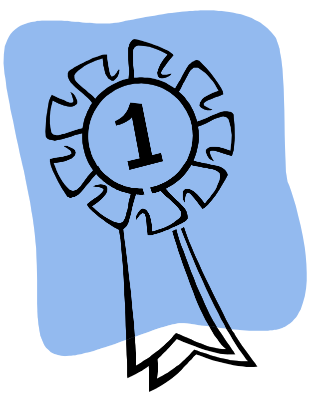


Snow stick measuring record snowfall in Davenport in December 2000.



Ranked #1 in the Nation August 2006

...The upper air program is one of many in the office where we strive for excellence...

Reminders for Snow Season

(Continued from page 5)

there are no leaks. Take appropriate action if leaks are found.

3. Put a snowboard(s) out and mark the location(s) with a flag or some other indicator so boards can be found after a new snowfall. Snowboards should be located in open locations (not under trees, or near other obstructions).

When reporting solid precipitation:

1. Measure and record snowfall (snow, ice pellets) since the previous snowfall observation.
2. Determine the depth of snow on the ground at the normal observation time.
3. Measure and record the water equivalent of snowfall since the previous day's observation.

More complete information and specific instructions on how and where to measure snowfall and winter precipitation, as well as obtaining water equivalent, can be found on the web at the NWS Cooperative Observer website:

www.nws.noaa.gov/om/coop/snowguid.htm.

Quad Cities Forecast Office Achieves Top Score for Upper Air

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use of a kite to carry aloft a thermometer. With the advent of hot air and hydrogen balloons in the 1780's, scientists actually ascended aloft, taking with them weather instruments. As you might imagine, this proved to be very dangerous work. In the meantime, the use of kites in observing the upper atmosphere continued, and by the end of the 1800's, kite observation stations were established in Europe and in the United States. The kites carried aloft meteorological instruments or "meteorographs" that recorded relative humidity, temperature and pressure on a clockwork driven chart recorder. However, a major drawback to using kites was that they could only reach an altitude of a couple of miles.

Inflating weather balloon inside upper air building at NWS Quad Cities.

The advent of airplanes carrying weather instruments from about 1925 to World War II, meant the demise of kite observations. Yet, airplanes could not be flown in bad weather and the data could not be analyzed until the plane landed. The lack of kites and airplanes to achieve high altitudes, operate in any weather conditions, and provide real-time data helped create the need for radio transmission of upper-air data. In the early 1930's, the first radio-meteorographs or radiosondes were flown. And in 1937, the U.S. Weather Bureau established a network of upper air stations, which the National Weather Service continues to this day.

NWS Quad Cities named the best upper air site in the nation in August 2006

To help improve data quality, quantity, and availability, an equation is used to rank upper air station performance at NWS offices across the nation. In August 2006, the NWS Quad Cities had the highest ranking upper air performance in the nation with a score of 299.89 out of 300! The upper air program is one of many in the office where we strive for excellence, helping to bring better forecasts and warnings to the public, using a proven method that started more than 200 years ago.

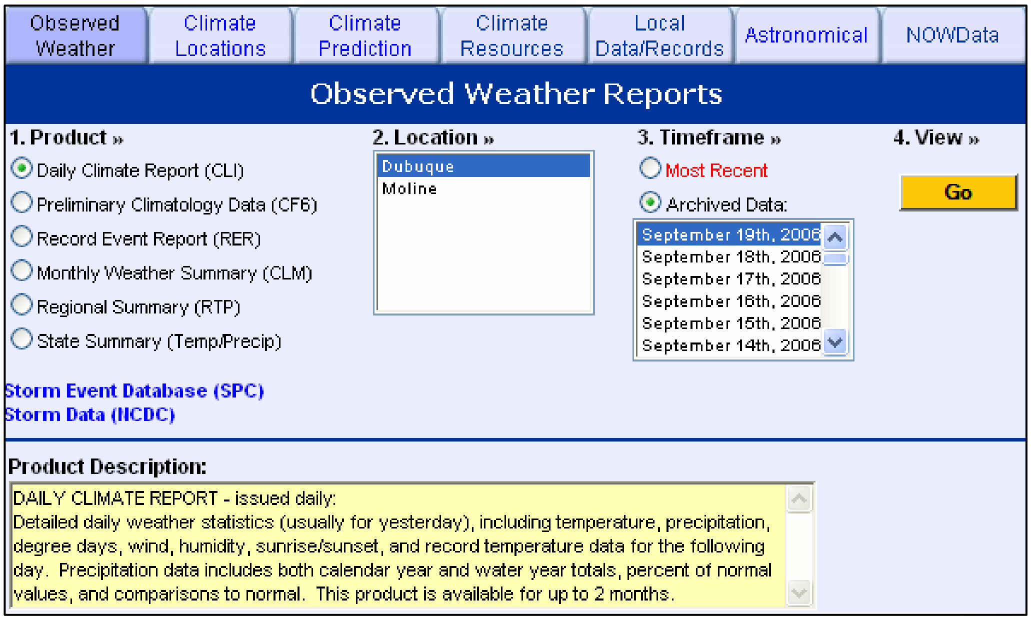
New Climate Web Services from NWS Quad Cities

Ray Wolf

Much has happened in the last two years with the distribution of climate information and Coop data. Most notable is the addition of new climate products on the web:

www.weather.gov/climate/index.php?wfo=dvn

This new web page is the vehicle with which we share virtually all climate-related information. Note the tabs on top of the graphic below, which are used to navigate from topic to topic. Highlights from some of the tabs/topics are described below.



Observed Weather

The ***Observed Weather*** tab provides access to current and archived ASOS-based climate products including the Daily Climate Report, the F6 monthly summary, Record Reports, Monthly Climate Summaries, and the Regional and State Temp/Precip Tables. When a product is selected, the location and timeframe menus update showing what information is available. For example, the F6 database goes back 5 years and the Daily Climate Report goes back three months. Note also links to the SPC and NCDC storm report archives in the bottom left corner. This information is available for several decades prior.

Climate Prediction

The ***Climate Prediction*** tab contains links to the Climate Prediction Center outlooks from week 2 through 1 year, plus El Nino-La Nina information, and the new Local Three-Month Temperature Outlooks (L3MTO). The L3MTO combines CPC long range outlooks and coop climate data and converts the temperature forecast from a large scale down to a single point. This information includes pie charts of the probability distribution of temperatures given the CPC outlook.

Local Data/Records

The ***Local Data/Records*** tab contains a wealth of information including graphs of actual and normal temperature, precipitation and snowfall for the current and past years, local Storm Data reports, area freeze dates and probabilities, snow cover analyses, extreme event web pages, local climate studies conducted by our office, and much more. We have several additional local studies underway which will be posted to this page upon their completion. One project nearing completion is on the changes in local severe weather climatology (tornado and hail days) based on El Nino – La Nina.

NowData

The *NOWData tab* (NOAA's Online Weather Data) is a real-time portal to the Coop observer

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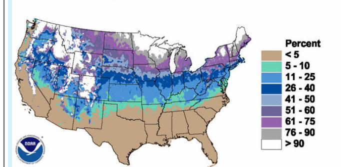
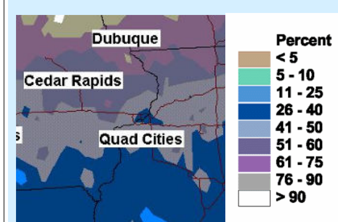
Example of Information Available from Local Data/Records:

Probability of Snowdepth ≥ 1 Inch on Christmas Day

Probability of a White Christmas



This graphic can be found under "local climate studies"



A closer look at a regional graphic, shows the probabilities of a White Christmas in the local area, based on climatology.

Probabilities for individual cities are available. Here are some examples:

- ***Dubuque: 53 %***
- ***Cedar Rapids: 47 %***
- ***Moline: 37 %***
- ***Burlington: 30 %***

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Weather Home Companion

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***Jeff Zogg**, Hydrology Program Manager*

New Climate Web Services from NWS Quad Cities

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and ASOS data for the current year and previous year. You can select from a number of menu options to get normals, daily and monthly records, monthly averages, daily data, and more for all these sites. Since data is available daily, you can see the value of reporting your Coop data each day.

Drought information services have increased beginning in 2005. From the left menu on the main web page (weather.gov/dvn), select *Drought Status* under *Current Conditions*. This links to a page which contains a local drought statement when moderate or greater drought conditions cover a large part of our area and/or significant drought impacts are occurring. You will also find access to the National Drought Monitor on this page.

The Drought Monitor is produced weekly and assigns a rating to drought areas based on a combination of standard objective drought indices plus local input from a broad range of government agencies associated with water resources. We provide the local input for eastern Iowa, northwest Illinois, and extreme northeast Missouri through our interactions with the Corps of Engineers, USGS, State Cooperative Extension Services, and USDA. This is another area where daily Coop observer data is extremely helpful, if not critically important in meeting our mission.

Winter Road Conditions

Illinois: 1-800-452-IDOT (4368)
www.dot.il.gov/operations/inetcond.html

Iowa: 1-800-288-1047 or 511
www.511ia.org

Missouri: 1-800-222-6400
www.modot.org/road_conditions/WinterRoadConditions.htm