SKYWARNEWS

National Weather Service State College, PA - Fall 2006

"Working Together To Save Lives"

What Type of Weather Should We Expect in Central Pennsylvania this Winter ?

By Barry Lambert, Senior Forecaster

The central and eastern equatorial Pacific water temperatures have transitioned from a few degrees below normal (weak La Nina) over the past year to their present 1- 2 deg C warmer than normal (which is a moderate El Nino in intensity) near the International Date Line, and between 80 deg and 110 deg west longitude as of early November.

El Nino, represented by these warm temperature anomalies is expected to persist during the winter of 2006-07 and could even strengthen further.

How do these conditions relate to what we experience here in Pennsylvania

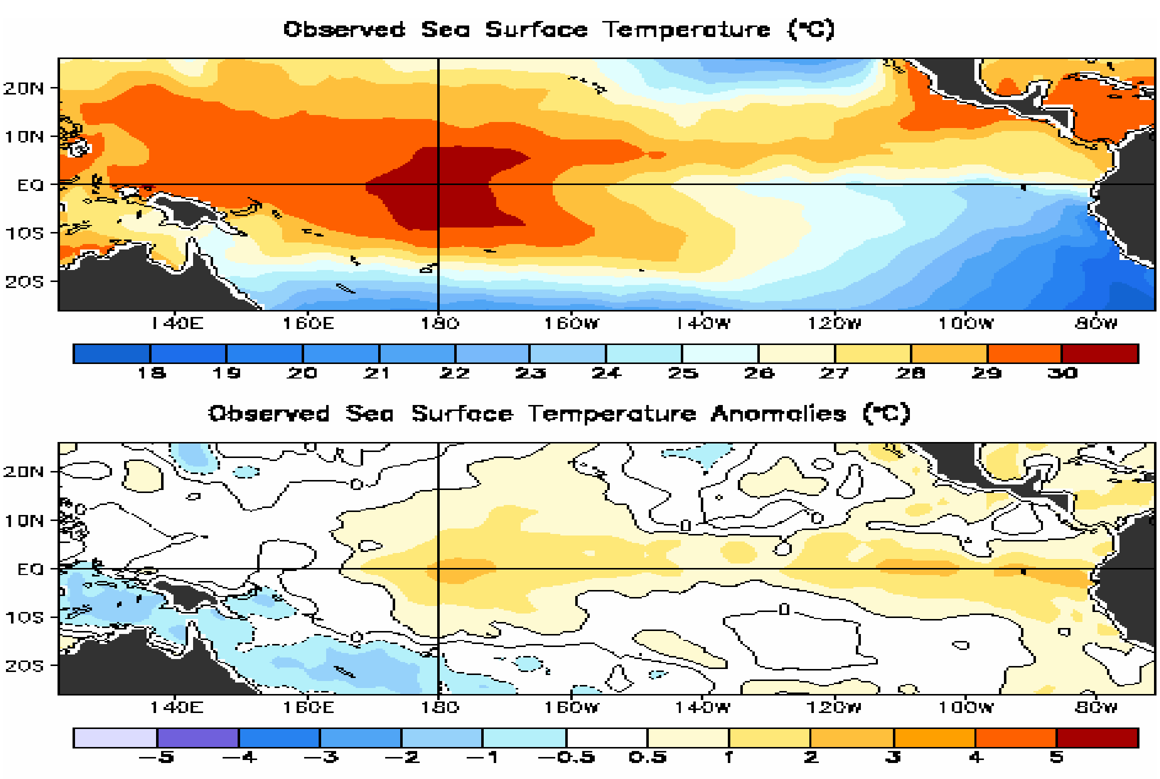


Figure 1. Observed Sea Surface Temperatures (top) and temperature departure from normal (bottom) across the Equatorial Pacific Ocean on 25 October 2006

during the winter? Typically, as illustrated by figure 2, we see near to milder than normal temperatures and near normal precipitation. The milder than normal temperatures often results in storms bringing rain rather than snow.

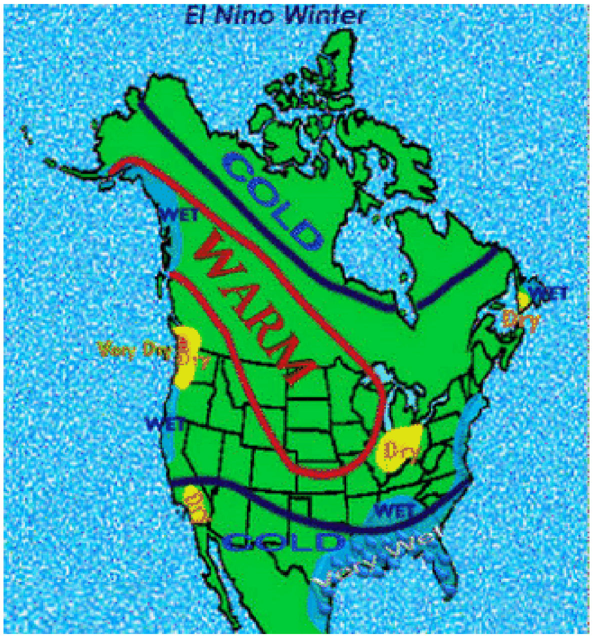


Figure 2. Typical patterns of temperature and precipitation anomalies across North America associated with El Nino

The National Weather Service Climate Prediction Center's 3 month outlook for November 2006 through January 2007 (Figure 3) calls for a near to slightly above normal chances for milder than normal temperatures in Pennsylvania, with essentially equal chances for above or below normal precipitation. As you can see, this shows little connection to definitive effects of El Nino in our region, and that's typically the case with winter-long, "mean" temperatures and precipitation.

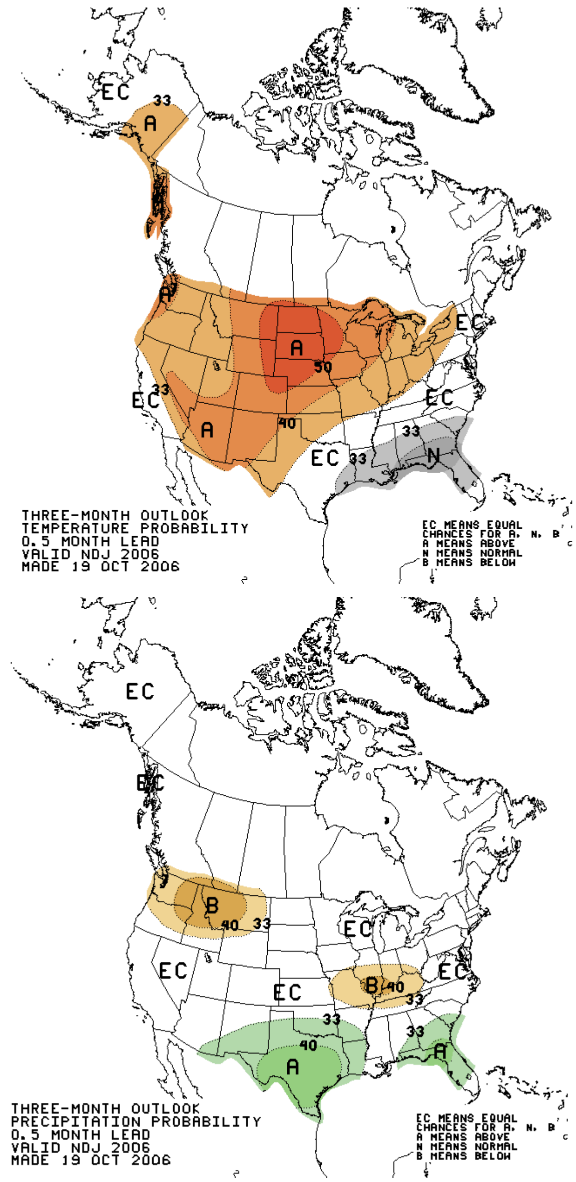


Figure 3. Climate Prediction Center forecast of temperature (top) and precipitation (bottom) anomaly probabilities

El Nino is famous for its strong southern jet stream and higher storm frequency, which brings wetter than normal conditions across much of the southwestern U.S. and Gulf Coast Region. Occasionally strong cold air intrusions heading south from Canada “phase in” with a southern disturbance to form a strong area of low pressure that rides up the east coast and intensifies into a “Nor’easter” dumping heavy rain, and inland snow.

This pattern is reflected by the maps of mean seasonal snowfall during ENSO Neutral years and seasonal snowfall departures during El Nino and La Nina episodes (Figure 4).

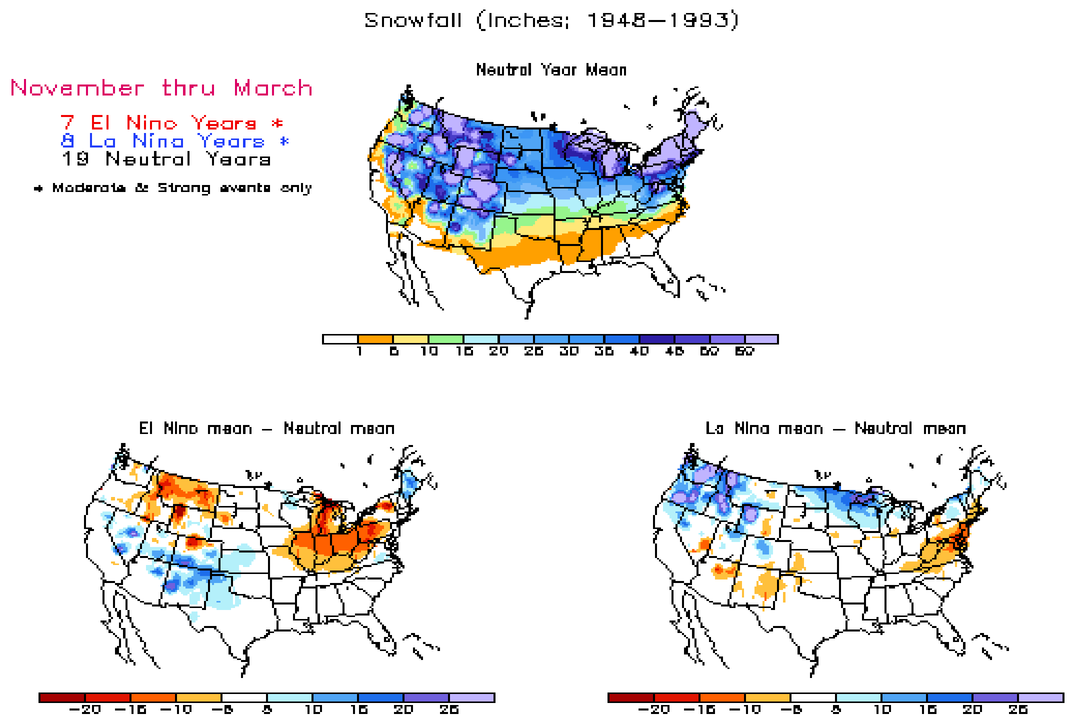


Figure 4 . Maps of seasonal snowfall. ENSO neutral year mean (top), EL Nino mean minus ENSO neutral mean (lower left), and La Nina mean minus ENSO neutral mean (lower right)

These maps, and others displaying the frequency of 2 inch snowfalls (not shown here) combine to indicate less than normal seasonal snowfall in Pennsylvania during both El Nino and La Nina years, stemming from a lower than normal frequency of light to moderate snowfall events (2-4 inches).

It’s interesting to note however, (see Table 1 below) that many (11 out of 24 in Baltimore, MD) of the “largest” snow storms affecting southeastern PA and Northern Maryland have occurred during El Nino episodes, compared to just 2 during La Nina events such as we experienced during the winter of 2005-06. Furthermore, the biggest snowstorm, and 5 of the 10 heaviest single storm snowfalls occurred during El Nino years. Years containing neither an El Nino or La Nina (termed ENSO neutral) accounted for almost half (11 out of 24 of the largest snowstorms in Baltimore).

Figure 5 shows the widespread heavy snowfall of 1 to 2 feet in the Mid Atlantic Region from the Blizzard of 1983. A strong El Nino episode occurred that year.

Rank	Storm Date	Storm Total
1	Feb. 11, 1983	22.8"
2	Jan. 7, 1996	22.5"
3	Feb. 18, 1979	20.0"
4	Feb. 15, 1958	15.5"
5	Jan. 25, 2000	14.9"
6	Dec. 11, 1960	14.1"
7	Mar. 5, 1962	13.0"
8	Jan. 22, 1987	12.3"
9	Jan. 30, 1966	12.1"
10	Mar. 13, 1993	11.9"
11	Mar. 21, 1964	11.5"
12	Feb. 4, 1961	10.7"
13	Feb. 6, 1967	10.6"
14	Mar. 2, 1960	10.5"
15	Feb. 22, 1987	10.1"
16	Jan. 12, 1964	9.9"
17	Jan. 25, 1987	9.6"
18	Feb. 11, 1964	9.1"
19	Feb. 5, 1978	9.1"
20	Dec. 24, 1966	8.5"
21	Jan. 8, 1988	8.4"
22	Nov. 31, 1967	8.4"
23	Feb. 24, 1966	8.4"
24	Mar. 19, 1958	8.2"

Table 1. Listing of the largest Snowstorms in Baltimore, MD. Orange and Red indicate weak and moderate to strong El Nino episodes respectively, while storms during La Nina are highlighted in Blue. Snowstorms during ENSO neutral years are shown in black.

This indicates that although a greater than normal number of storms may bring rain rather than snow, the strength of the southern stream jet stream (and it's ability to tap copious gulf moisture and transport it north via a strengthening "nor'easter"), offers a better chance for a major snowstorm than may occur during a normal winter. Just a few of these major snowstorms could lead to above normal seasonal snowfall in many areas.

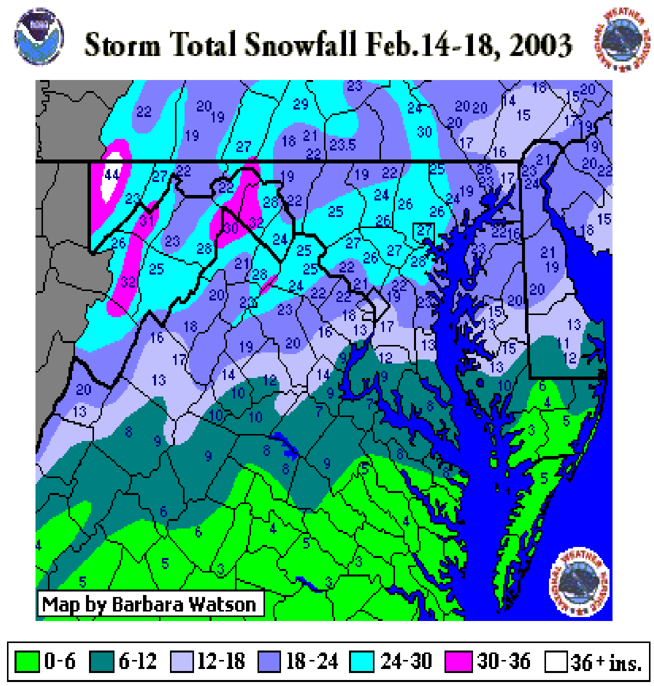


Figure 5. Snowfall Map for Feb 14-18, 1983.

Winter Weather Fun and Exercise

By David Martin, Senior Forecaster

Winter can be a time of great beauty, but also a time where days are short and we long for the sun to rise and beg for a few more minutes before it sets. Shorter days make it harder to get fresh air and natural sunlight. By late winter many of us have cabin fever.

There is overwhelming evidence that proper exercise is important to staying healthy and be more alert. Not only is exercise important in regard to weight control, but more and more research hints it may be important in aiding against other diseases.

While some winter seasons are not severe across Pennsylvania, the last few years have been more like what most of us would associate with a "typical winter" across central Pennsylvania. Whether the cold season starts early or ends late, central Pennsylvania residents can always count on several months of winter like weather.

Now is a good time to plan your winter activities. The following are some suggestions:

- Take frequent short walks.
- Help out with neighborhood activities
- Go on a hike with family and friends.
- Check community calendars for upcoming events.
- Cross country and downhill skiing are other options.

Whatever you do - remember to start slow, practice safety, and have fun.

2006 Summer in Review

By John La Corte, Senior Forecaster

For the second year in a row, Pennsylvania experienced a warm summer. The meteorological summer, which runs from June through August, featured temperatures that were just a bit above normal. Table one shows that temperatures averaged near normal over the western part of the state, and ranged to a little more than one degree above normal over most of the eastern part of the state. While it was a little above average, 2006 was not as toasty as 2005 when temperatures were between 2 to 3 degrees above normal over most of the state.

		Summer Temperatures (deg)			
	Jun	Jul	Aug	Avg	Dep
Pittsburgh	66.2	73.4	72.8	70.8	0.1
Philadelphia	72.8	79.4	78.1	76.8	1.4
Harrisburg	71.7	77.9	76.1	75.2	1.7
Williamsport	68.3	75.6	72.5	72.1	1.7
Erie	65.5	73.5	71.1	70.0	-0.1
Bradford	60.6	67.1	64.8	64.2	0.0
Wilkes Barre	66.5	73.5	70.5	70.2	0.2
Altoona	65.8	72.3	70.6	69.6	-0.2
Allentown	69.4	75.9	72.7	72.7	1.7

Table 1. Monthly Average Temps for Summer 2006

Another measure of the warmth or coolness of a summer is the number of days that experience temperatures that reach or exceed 90 degrees. In a normal summer, western parts of the state usually see just a few of these hot days. The number increases as one moves into eastern parts of the state, with the number of days of 90 or above being averaging about 25 in the Philadelphia area.

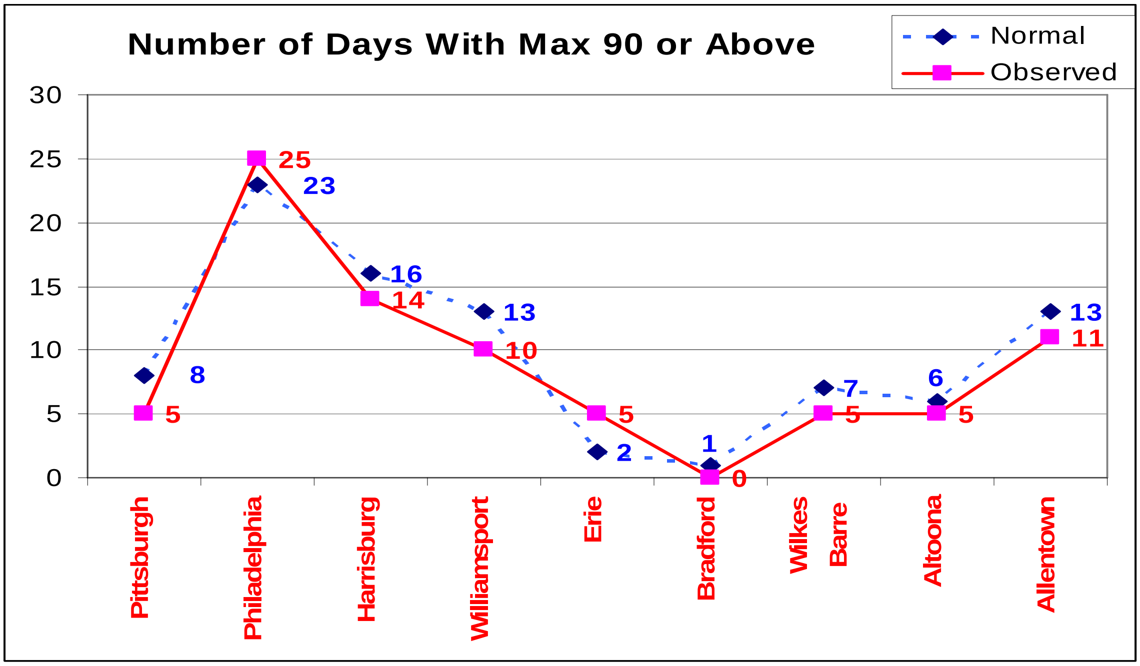


Figure 1. Number of days 90 or Above

This year most locations were pretty close to normal with regard to the number of 90 degree days that were observed. Figure 1 summarizes a number of observing sites across the state. No location was more than a few days above or below their long term averages.

		Summer Precipitation			
	June	July	August	Total	Departure
Pittsburgh	4.37"	3.86"	1.60"	9.83"	-1.63"
Philadelphia	7.95"	4.27"	3.93"	16.15"	4.65"
Harrisburg	8.62"	5.13"	1.41"	15.16"	4.72"
Williamsport	6.42"	3.83"	6.33"	16.58"	4.67"
Erie	2.99"	3.44"	3.30"	9.73"	-2.04"
Bradford	5.43"	6.28"	5.45"	17.16"	3.51"
Wilkes Barre	9.00"	3.02"	4.40"	16.42"	5.61"
Altoona	5.75"	4.56"	1.72"	12.03"	1.64"
Allentown	9.13"	8.17"	2.41"	19.71"	7.10"

Table 2. Monthly Precipitation Summer 2006

While the summer ended up a little warmer than normal, most observing sites were much wetter than normal, especially in the east (Table 2). June started the summer off being quite wet over much of the central and eastern part of the state, while western areas were near normal. July varied in wetness across the region with most western locations near or a little wetter than normal. Eastern locations were much above average. August ended the summer on a mostly dry note. Much of the month was actually quite arid with most of the rain that fell occurring in the last week to ten days.

It might be worth mentioning that while the summer was wet, none of the rain had any direct connection to visiting tropical cyclones. In fact the tropical season so far has been much quieter than was expected with just 9 being named as of mid October. The season had been forecast to be much more active than normal, but the development of an emerging El Nino seems to have put a damper on tropical activity in the Atlantic this season.

Overall the summer will go down as being not very memorable. While flooding rains made their mark early and again late in the season, extended periods of excess heat were all but absent with the hottest weather pretty much confined to late July into early August.

Winter Forecast

So as we do each Fall, we dive into the long range forecast pool and give some prognostications (See our first article "What Type of Weather Should We Expect in Central Pennsylvania this Winter ?") as to what we can expect for the upcoming winter months. The official forecast for our region from the Climate Prediction (CPC) center shows a slightly elevated chance that we will see another warmer than normal winter. This is due to the influence of a weak to moderate El Nino which is expected to continue into early 2007.

The El Nino signal for local precipitation is less clear. The local forecast calls for equal chances of either above, below or near normal precipitation. While it doesn't sound like much of a forecast at all, it attempts to reflect the state of the science which shows that there is no clear trend seen for the upcoming months.

What is Normal?

by Ron Holmes
Information Technology Officer

When it comes to weather extremes, meteorologists like to have something with which to compare the anomaly. What does it mean when they say it will be hot or unseasonably warm? How about a cold snap or rainfall above normal?

Just what is normal anyway?

Normals, or averages, are usually computed for a meteorological variable like temperature or precipitation by looking at that variable over a long time span. The National Climatic Data Center calculates normals based on a 30 year average. It helps for consistency if the station has not moved around a lot during that 30 year period so that it is a representative average for a single location. But is this 30 year average really a true representation? Look at Figure 1 below which shows a 30-year average of daily high temperature for State College, PA. You might expect a 30 year average to be fairly smooth from day to day. However the graph below shows large variability from week to week and often from day to day. Why?

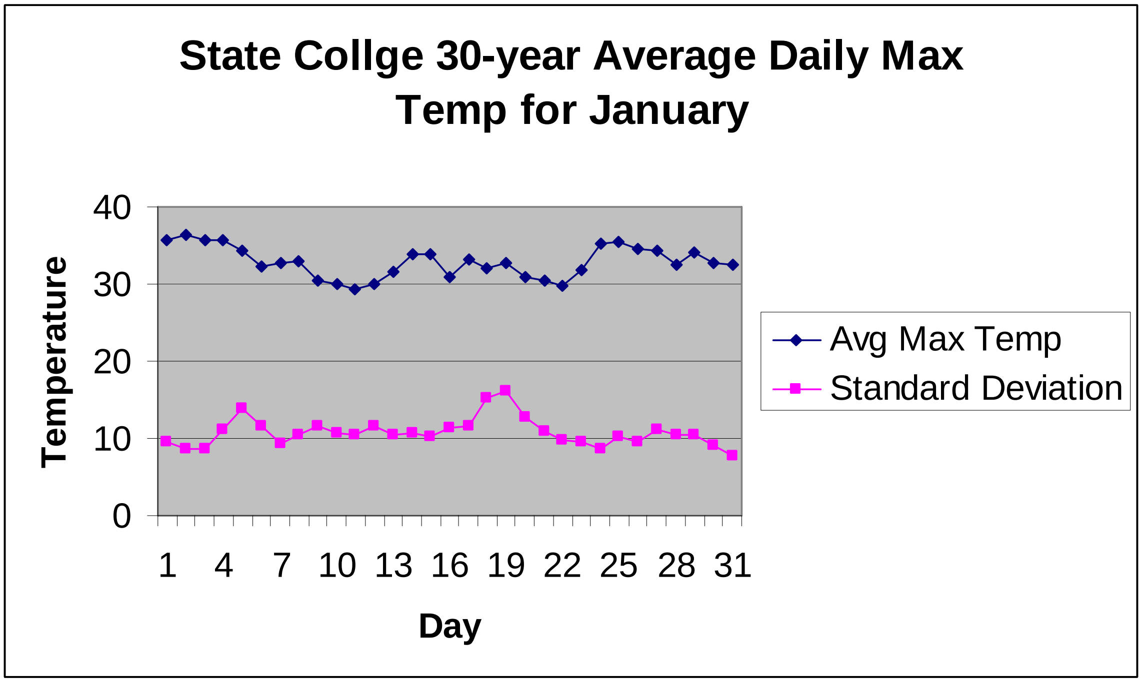


Figure 1. State College 30 Yr Jan Avg Daily Max Temp

Well it just happened that during some of those days throughout the 30 year period there were some extremely hot days or extremely cold days which skewed the 30 year average either upward or downward for that day. We call these rare days outliers or anomalies and they have a dramatic effect on the climatology for a station. We can't simply throw these anomalous days out; they are part of the meteorological record. So how can we reduce this variability to get a more representative normal for a station that doesn't vary from day to day? The answer is to compute a 21-day centered average for each day of the year. That is, for each day of the year from Jan 1 to Dec 31,

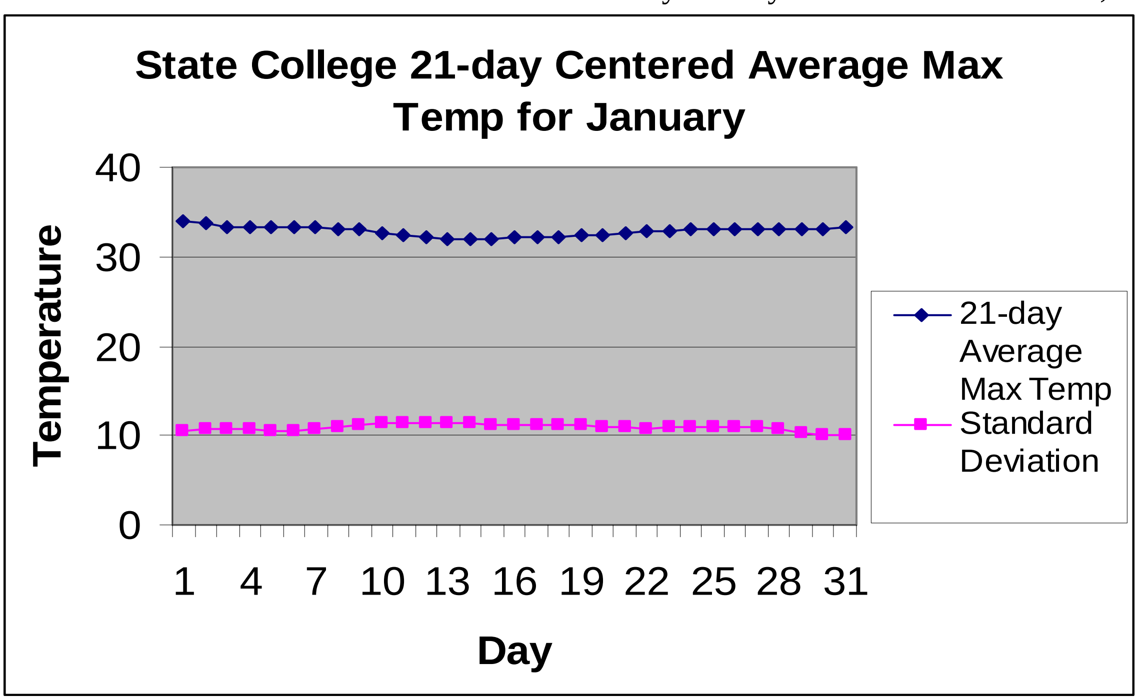


Figure 2. State 21 Day Centered Jan Avg Max

take the average over a time span from 10 days prior to that day to 10 days after that day. The result will be a 21 day average centered on that particular day. This method has the effect of smoothing out those large outliers and results in a much smoother graph as can be seen in Figure 2.

Now we have a true representation of what normal is and can better determine whether a day was truly above or below normal. We can also determine how many standard deviations above or below normal a day is.

What is a "standard deviation"? It is a bit complicated to explain mathematically, but may be thought of as the "mean of the mean". To understand this concept, it may help to understand what statisticians call a "normal distribution of data". A normal distribution of data means that most of the examples in a set of data are close to the average (or mean), while relatively few examples tend to one extreme or the other.

On most days the daily max or min temperature hovers around normal (average) to plus or minus 1 standard deviation. A day that is 2 to 3 standard deviations above or below normal is considered a rare event. For example the graph shown in Figure 3 shows several abnormally hot days during early August, 2006 during one of our heat waves. As you can see high temperatures in early August in State College were around 2 standard deviations above normal. More, real-time graphs and 21-day centered means for other locations around Pennsylvania can be found at:

http://nws.met.psu.edu/coopgraph/temp/tempgraph.htm

So when you hear the forecasters say that it will be near normal or much above or below average, hopefully now you have a better understanding of just what we are talking about.

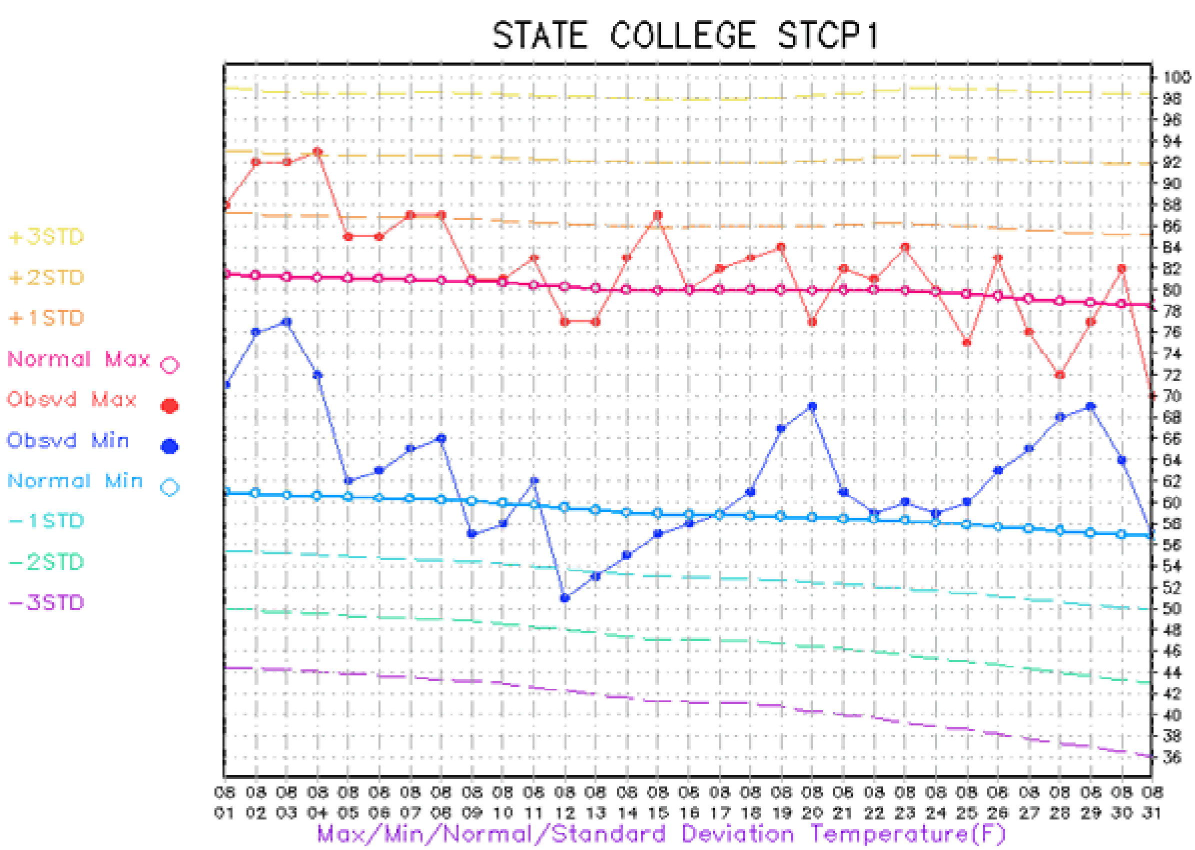


Figure 3. August 2006 State College Temp Plot

New One-Stop Webpage for Snowfall Info

By Michael Dangelo, Senior Forecaster/Webmaster

We have added a few new things to an old page (what was just our Past Event Snow Map Page) to make it a one-stop shop for all the snow information we have available on the web.

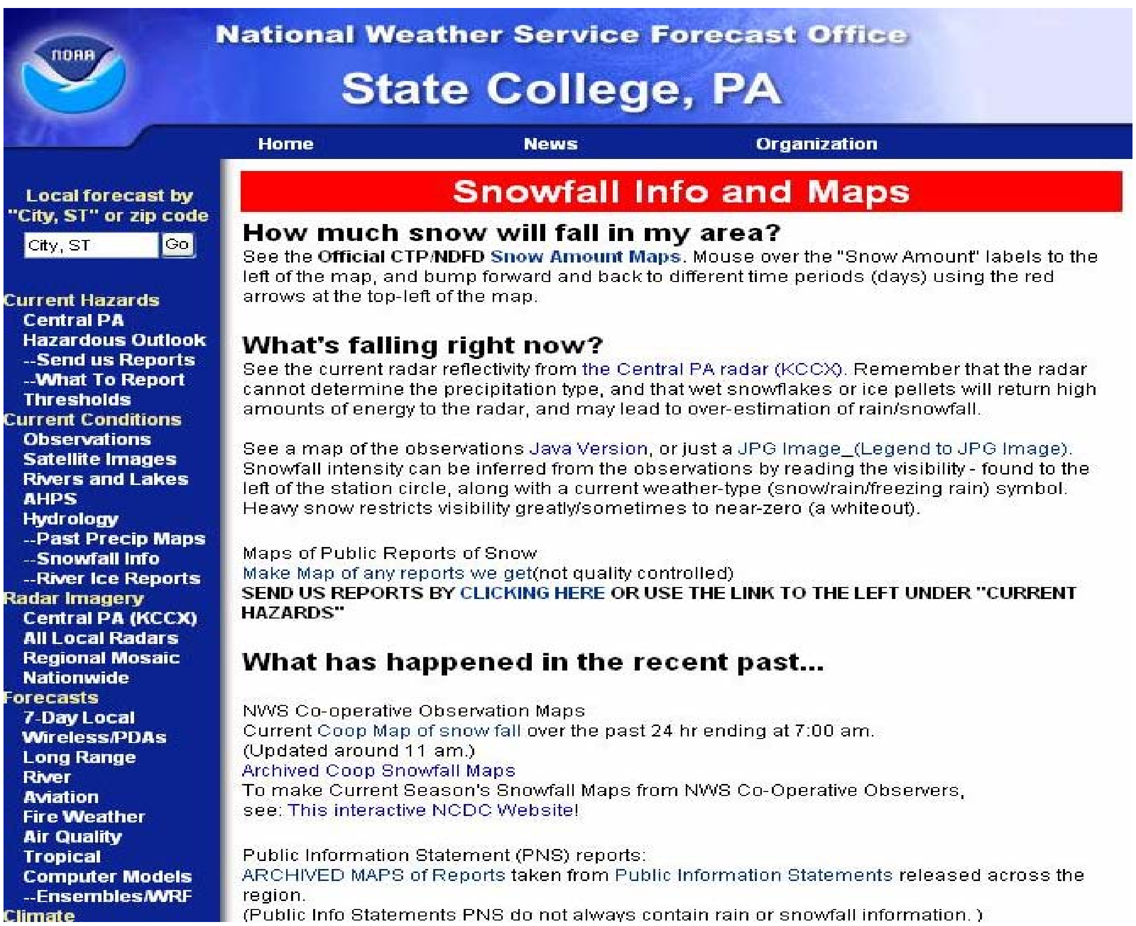
http://www.erh.noaa.gov/ctp/features/snowmaps/

You can check the current radar pictures, see maps of the surface observations, and also use the link available to send in your own snow report to us.

We have kept all the old features available on the Snow Maps page, including:

- see maps of the most recent snow reports that we have received,
- see the maps of previous storms, and previous seasons' snowfalls,
- see a map of the average annual snowfall.

Try out the re-vamped page today!



Relative Humidity or Dewpoint?

By John La Corte, Senior Forecaster

One of the mainstays of the daily weather report besides temperature and wind is something referred to as the Relative Humidity. Most people see or hear it but how many actually understand what it means? Most probably understand that if the humidity is high, the air is moist, but sometimes it can feel downright humid even with the relative humidity being reported as pretty low. What is going on then?

Well let's start by trying to understand what the relative humidity is. Simply put is the ratio of the water vapor in the air compared the maximum amount the air can actually hold (saturation). So what is water vapor? Water vapor is an invisible gas that makes up a part of our atmosphere. Remember, water vapor is not the same as steam or clouds. When we boil water we see the water turn first to steam then disappear altogether. The water isn't gone; it has merely been converted to a gas which we call water vapor.

Dew Point °F	Human Perception
75°+	Extremely uncomfortable, oppressive
70° - 74°	Very Humid, quite uncomfortable
65° - 69°	Uncomfortable for most people
60° - 64°	OK for most, but noticeable
55° - 59°	Comfortable, but some may start to notice
50° - 54°	Very comfortable
49° or lower	Feels like the western US...a bit dry to some

Table 1. Typical Dewpoints and How Most People Feel

We can see the water vapor once again when the air reaches saturation. We all understand saturation, which is what is occurring when we see fog or clouds. It means that the air can hold no more water vapor, and it must start to condense out in the form of visible moisture. If we didn't reach saturation, we would never see rain or snow.

All this is complicated enough, but consider that the air can hold much more water vapor at warm temperatures than it can at cooler temperatures. This may partially explain why it feels so much more humid on a typical day in July than it does in January, even when the relative humidity can be near 100% at either of those times.

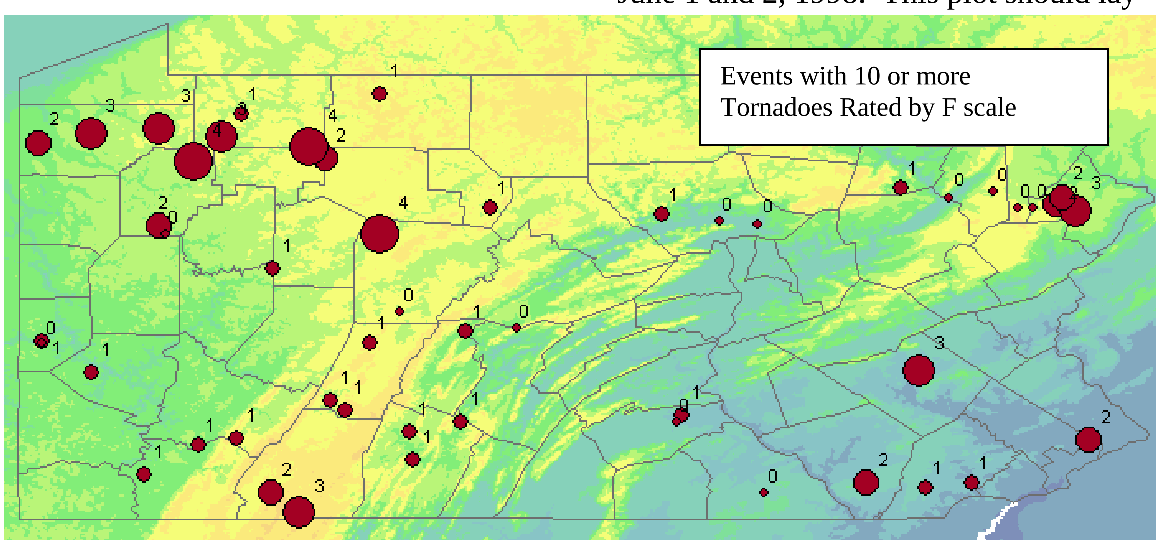
Perhaps a better way to determine just how humid it is would be to examine the dewpoint. The dewpoint is a more accurate representation of the actual moisture in the air and is represented as a temperature. It is the temperature which the air would have to be cooled to in order to condense the moisture out of it. So the dewpoint is really what it sounds like, the point at which dew will form. Let us look at a typical summer day. By mid afternoon the temperature may be about 88 degrees with a typical mid summer dewpoint being about 65 degrees. If you were to see that report on television, the relative humidity would only be 47%, yet rest assured, you would feel uncomfortable. In fact the forecast may sound something like "…Hazy…very warm and humid with highs…" Why is that? It is because the dewpoint is so high. Table 1 summarizes a rough estimation of dewpoints and what most people perceive when they are reached. Ever been to Florida in summer?

Dewpoints are typically in the mid to upper 70s all summer long. So even though temperatures rarely reach 100 in Florida, the humidity is why most people complain that it is so hot. A corresponding day in the desert southwest may reach 100 pretty routinely, but if one manages to stay in the shade it may feel relatively comfortable because dewpoints are generally well below 50.

Using GIS Technology to Analyze Severe Weather Information

by Ron Holmes
Information Technology Officer

Geographic Information Systems (GIS) can be used with meteorological data sets to extract salient features in the data. At NWS State College we use GIS technology to plot various data sets which can be useful for forecasters to



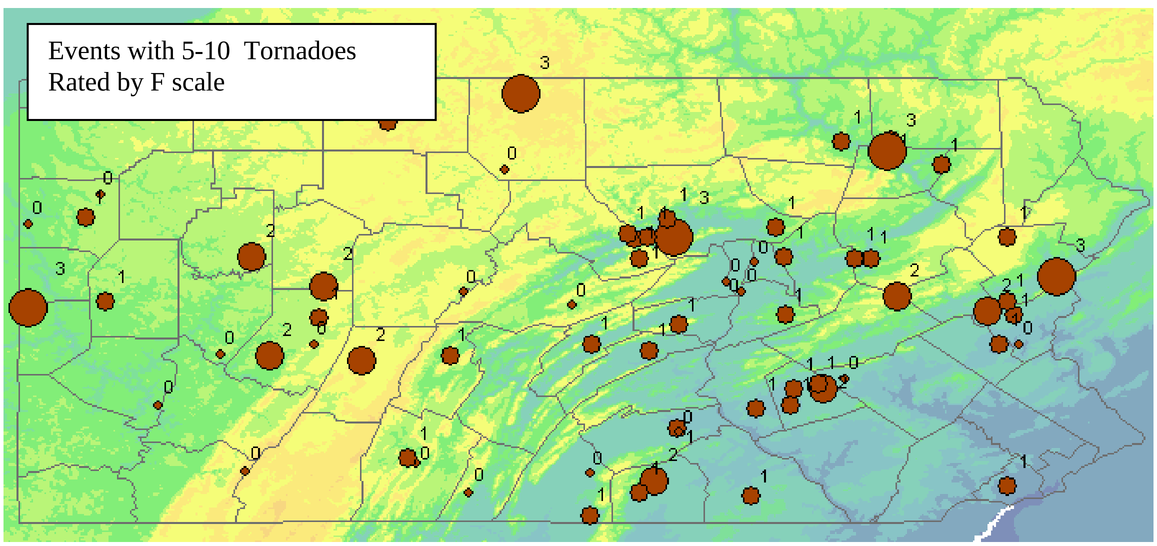
extract trends or signals in the data. One example of this is combining severe weather events with topography to see if there is a relationship between different types and magnitudes of severe weather events and topography.

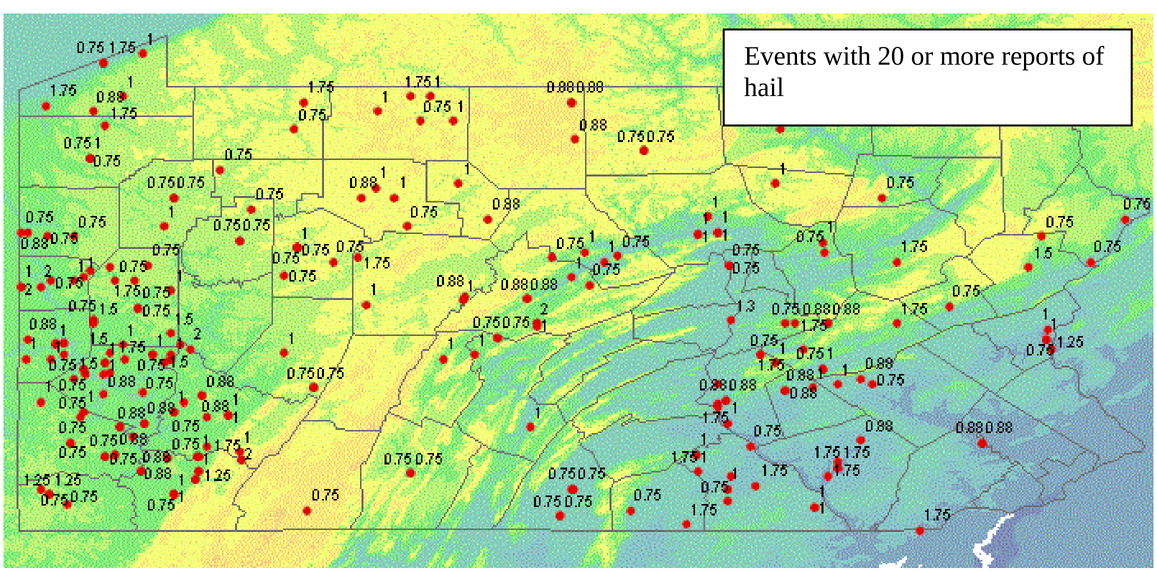
A severe weather data base from the Storm Prediction Center was used to extract tornadic and hail producing events. The data was used with GIS technology to see if there was a signal between big severe weather days (a day that had a large number of events) and less significant days. Tornadic events were comprised of 2 sets: events with tornado reports of 10 or more on any particular day and events with between 5 and 10 reports on a particular day. This data was overlayed on topography to see if there was a geographic distribution to these reports. Below shows a plot of tornadic reports (number plotted is the F scale of the report with stronger tornadoes having larger circles). These reports represent events with 10 or more tornados reported on a particular day. All these events occurred on only 4 days and represent the big severe weather days: May 31, 1985, April 10, 1991, and June 1 and 2, 1998. This plot should lay to rest the misconception that tornados do not form in mountainous terrain. Note however that there are quite a number of the stronger tornados between

F2 and F4. Contrast this plot with the following.

The plot below shows tornadic events that had between 5 and 10 tornados reported on a particular day. There are a lot more of these types of events. While there are some F3 tornados there are no F4 or higher ones. Notice too that they mostly are comprised of the weaker tornados between F0 and F2. A large number of them do "appear" to occur in the valleys however this is most likely because populated areas are usually located in valleys and we get most of our reports from populated areas.

Next we wanted to look at the relationship between topography and hail. Below is a plot of events with 20 or more reports of hail (a big day) on a particular day. The plot for events with between 10 and 20 reports (an average day) looks very similar (not shown). Thus there does not appear to be a clear signal in the hail data that distinguishes between a big severe weather day and an average one. Once again though the data clearly shows the relationship between the higher populated areas in the valleys verses the mountainous areas.





Precipitation Type Forecasting in Central Pennsylvania

By Barry Lambert, Senior Forecaster

Forecasting the type of precipitation is often a difficult endeavor faced by meteorologists. Very small differences in the vertical changes in temperature within several thousand feet of the ground could mean the difference between a storm producing flooding rains, destructive ice accumulation, or a major snowfall across Central Pennsylvania and the Susquehanna Valley.

Computer forecast models are becoming increasingly detailed in their display of the vertical temperature structure and time distribution of precipitation. However, large uncertainty is still intrinsic to these models and forecasts on a county by county scale when large horizontal (north/south, or east/west) or vertical temperature differences exist near and just to the north of a frontal boundary.

As a start in the forecasting process, we know that clouds having "minimum" temperatures above -4C have an 80% chance or greater of containing supercooled water droplets rather than ice particles which are necessary for producing snow flakes. Conversely, with cloud temperatures of -14C or lower, the chance of supercooled water is less than 30%. We first find these dividing lines (if they exist in a particular storm) in our forecast area to define areas of snow or rain. After this initial step, we turn our focus on the vertical temperature structure where mixed frozen, or freezing precipitation (snow and sleet, or freezing rain) will fall. A question we ask ourselves during this part of the forecast process is, "Are there elevated warm layers with temperatures above freezing?" Then, we try to match up these elevated warm layers with places that we think will have surface temperatures stay just below freezing. This last setup is conducive for freezing rain, or possibly sleet if the elevated warm layer of air is thin enough.

Figure 1 shows the relative high frequency of freezing rain across the Susquehanna River Valley and adjacent portions of central Pennsylvania. Most of central Pennsylvania experiences between 40 and 50 hours (nearly 2 full days) of freezing precipitation each winter season.

Figure 2 summarizes the vertical "layering" of warm and cold air at various locations (along line A-B) near a low pressure area and its associated fronts. The bottom half of the figure shows how freezing rain is most likely near and just to the north or east of the surface warm front, where above freezing air streams over a relatively shallow cold air mass. Deeper in the cold air to east of the warm front (near point B), and also behind or to the west the cold front (close to point A), all snow is likely.

Whether freezing rain forms from the cold rain or not depends critically on the characteristics of the surface cold air layer. If the layer is too thick or too cold, it will refreeze the rain into ice pellets (sleet). If the cold layer is too shallow, the rain will continue to the ground as normal rain and will not freeze unless the temperature of the ground or some

other surface it contacts is well below
freezing.

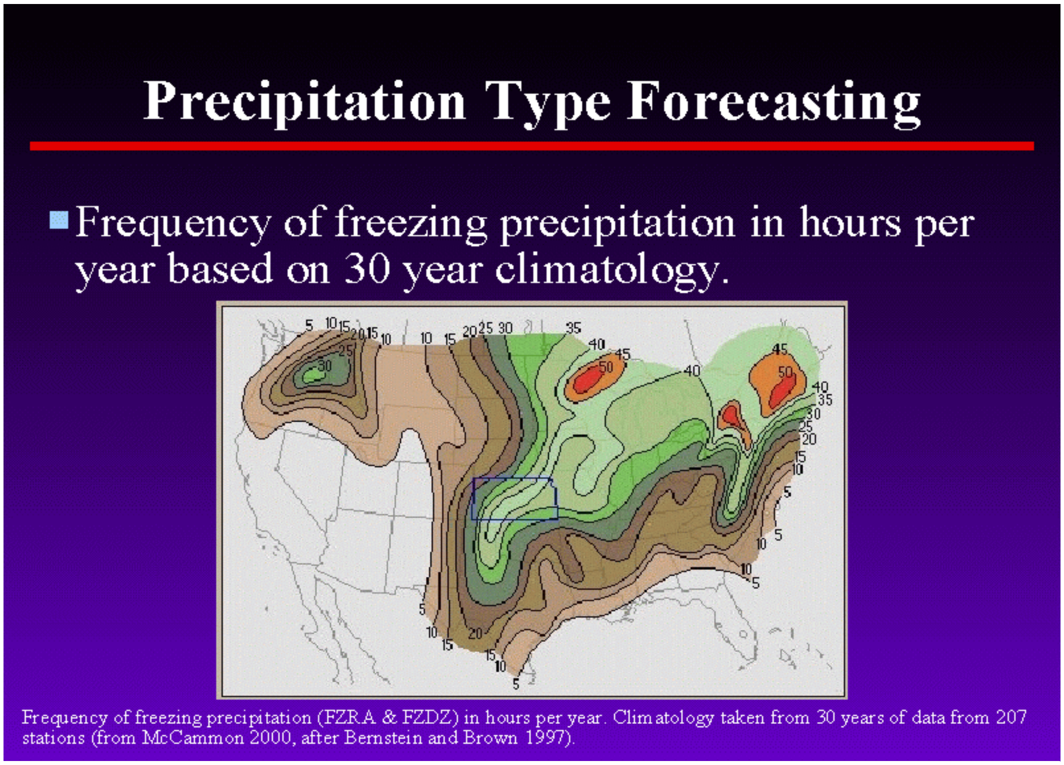


Figure 1. Average number of hours per year with freezing precipitation

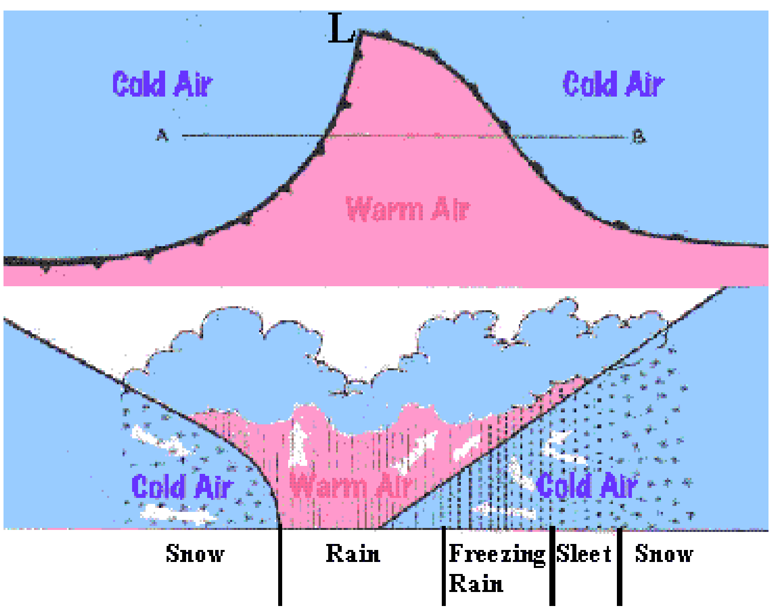


Figure 2. Horizontal and vertical distribution of warm and cold air and associated

In most cases of glaze formation, the temperatures of the air, the rain, and the surface are at or slightly below 0 Deg C (32 Deg F), especially in those events where icing is extensive. Glaze ice usually forms when the air temperature near the surface is in the narrow range of -4Deg C to 0Deg C (25Deg F to 32Deg F). Once the water droplet strikes a surface, the violent impact triggers a rapid transformation of the supercooled liquid water to ice.

For heavy/destructive glaze ice formation, the rain should fall rapidly as large, slightly supercooled drops, and the rate of freezing on the surface must be slower than the rainfall rate. With small drops and rapid freezing, the resulting ice is rime ice having a more crystalline, white/sugar-like texture and lacking the transparency of glaze.

NWS Hosts Open House for Public.

By Dave Ondrejik, Warning Coordination Meteorologist

As many of you know, the National Weather Service Office and the Middle Atlantic River Forecast Center moved from our downtown location in December 2005. I am happy to say that we are fully moved in and ready to show off our new facility to the public.

So, mark you calendars for……….

<u>May 12, 2007 from 10 am to 2 pm.</u> Come meet your favorite NWS employees (me?) and see how we use cutting edge science and computers to forecast daily weather. We will also show you how we use radar data to help us forecast the development of severe thunderstorms, tornadoes, and flooding.

In addition to the tour of the Weather Forecast Office you will also get a tour of the Middle Atlantic River Forecast Center (MARFC). With the repeated flooding events that have occurred in Pennsylvania over the last 5+ years, the MARFC plays a vital role in forecasting the rise and fall of most major rivers in Pennsylvania.

We look forward to seeing you at our open house.

Directions: From Harrisburg, follow US Highway 322 northwest to State College. Follow the highway through town, (do not take business Route 322 - Atherton Street) and exit at Innovation Park (about 1 mile after the exit for Route 26). Make a right turn, then quickly exit to the right using Exit A for Innovation Park. At the stop sign, make a left onto Innovation Boulevard. Follow this to the last building on the left, 328 Innovation Boulevard, Suite 330.

From Interstate 80, use exit 161 to US Highway 220 south. Continue on US Highway 220 south to exit 74 - Innovation Park and Penn State University. Follow the signs (bear right) to Innovation Park, which becomes Innovation Boulevard. Follow this through the Park to the last building on the left, 328 Innovation Boulevard, Suite 330.

From south and west, follow US Highway 220 north, and exit on to US Highway 322. Follow 322 into State College and exit on Park Ave, which is also the exit for the Hospital and the Penn State Stadium. At the bottom of the ramp, make a left and immediately get into the right lane. Exit at the exit for Innovation Park A. At the stop sign, make a left. We are the last building on the left, 328 Innovation Boulevard, Suite 330.

Enter through the front doors. Take the elevator to the 3rd floor where you will be greeted by a staff member.

We look forward to answering your questions and showing off our new work environment.

SKYWARNEWS

National Weather Service
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TO: