National Weather Service Forecast Office Chicago

CHICAGO

Weather Currents

Fall 2010

Volume 8, Issue 3

Inside this issue:

Hot Autumn Weather in Chicago and Rockford 1

Quantifying Weather Risk using National Weather Service Products 3

Skywarn Recognition Day 5

La Niña: What has happened in past winters and what it could mean for our weather this upcoming winter 6

Hot Autumn Weather in Chicago and Rockford

by Jim Allsopp, Warning Coordination Meteorologist

Labor Day weekend is considered by many to be the unofficial end of summer. For meteorologists and climatologists, August 31 is the official end of summer. For astronomers, the equinox on September 22 signals the change of seasons. There is no doubt that September is a transitional month, meteorologically speaking, with the days getting shorter and noticeably cooler. However, sometimes summer hangs on despite the calendar.

Chicago averages 17.8 days a year with temperatures of 90 or greater, but less than 10% of them, 1.7, occur after August 31. 1931 holds the record with nine days of at least 90 degrees in September. By October, 90 degree weather becomes extremely rare. In 129 years of records, only five Octobers have recorded days with a temperature of at least 90 degrees. The latest date of a 90 degree day was October 6, 1963 when the temperature hit 94. 100 degree weather in fall is even more unusual, having occurred only 4 times; 1939, 1960 and twice in 1953.

Septembers with the most days of 90 degrees or warmer
1931...9
1959...8
1971...8
1978...8
1939...7
1953...7
1960...7

Octobers with the most days of 90 or warmer
1971...2
1951...1
1953...1
1954...1
1963...1

Hot Autumn Weather in Chicago and Rockford (cont)

The fall of 1971 was remarkable with ten days of 90 degree weather, eight in September and two in October. Fall (September through November) of 1971 was the third warmest on record. Fall of 1953 is tied for the fourth warmest fall on record. The first three days of September 1953 were 101, 101 and 97. Chicago just missed scoring a third 100 degree day when the mercury hit an astonishing 99 degrees on September 29, the hottest day ever so late in the season. The heat continued in October of 1953 with 90 degrees on the second. Then there was an incredible stretch of Indian summer; eight straight days with temperatures in the 80s from October 15 through 22. The temperature reached at least 80 degrees twenty two times in September and October 1953.

Rockford averages 14.2 days of 90 degree weather a year, with only 1.2 in the fall. The September record for 90 degree days is 11 set in 1939. There have only been four Octobers that have registered a temperature of at least 90. A temperature of 100 degrees or more has occurred eleven times in September. The latest 90 degree day in Rockford was October 6, 1963.

Septembers with the most days of 90 degrees or warmer
1939...11
1927...10
1920… 9
1931… 9
1925… 8
1933… 8
1947… 8
1971… 8

Octobers with the most days of 90 degrees or warmer
1922… 4
1963… 1
1971… 1
1997… 1

The early fall of 1922 was incredibly warm in Rockford. The first eight days of September were above 90 degrees, including three straight days above 100 degrees from the 6th through the 8th. After a brief cool down in the middle of the month, seven of the last ten days of September were in the 80s. October of 1922 had four straight days of 90 degree weather from the 2nd through the 5th. In September of 1939, eleven of the first 16 days were at least 90 degrees, with three of them topping 100.

Quantifying Weather Risk using National Weather Service Products

by Steve Froehlich Student Volunteer

Overview of Weather Derivatives

Weather is a prevalent part of everyday life, however for some individuals and businesses the nature of their work puts them at a greater risk to weather related events. Some examples are energy companies, agriculture, shipping companies, and retail companies. A fast growing product offered by the CME Group (formally Chicago Mercantile Exchange) called weather derivatives, possess a way to hedge against weather risk. A weather derivative is a contract entered in by a company looking to hedge their weather dependent risk and investors seeking profits from absorbing that risk. In the late 1990s the CME Group offered the first weather derivative contract and since then the use of weather derivatives has grown internationally to encompass a multi-billion dollar market, with much of that market trading in Chicago.

What does this mean for Chicago businesses?

The National Weather Service (NWS) can predict the future state of the atmosphere, but not control it. Businesses that read the winter outlook provided by the NWS might find that the predicted weather conditions would have adverse effects on their business. One way to offset the financial effects of weather events is to enter into a weather futures contract or another form of weather derivative. Using a weather derivative the risk associated with our fictitious ominous winter outlook would be transferred to the investor.

What does this mean for Chicago investors?

Investors, companies, and hedge funds are buying into weather derivatives since the underlying asset, weather, has no correlation to other assets in the market. For example during the past recession stocks plummeted, mortgage rates fell, and other assets felt the pressing weight of the recession, however the atmosphere's evolution remained unaffected. Hence investing in weather derivatives is becoming a new robust way for investors to diversify their portfolios.

How can NWS products and weather derivatives help your business or your portfolio?

The products issued by the NWS are of great importance in the traditional sense, however using a simple equation these products can help quantify the risk to your business or aid in your investment decisions. Following from Dutton (2002):

risk = (probability of occurrence)(cost of the consequence of occurrence)

or for short

R=(PROBABILITY)*(COST)

This equation provides a fairly straight forward way to compute risk associated with weather and climate fluctuations. It is not terribly difficult for most investors or businesses to produce an estimate of the cost impacts an unfavorable turn in the weather would have.

Quantifying Weather Risk using National Weather Service Products (cont)

Once the COST variable is determined the PROBABILITY variable must be discerned. There are several ways in which this can be done. The methods listed below are applicable to different types of weather hazards. Each of the first 3 methods is applicable to specific weather hazards, while numbers 4-6 can be used more generically.

1. The Hydrometeorological Prediction Center (HPC) puts out probability forecasts for several winter weather parameters such as snowfall and freezing rain. http://www.hpc.ncep.noaa.gov/wwd/winter_wx.shtml.

2. The Storm Prediction Center (SPC) puts out probability forecasts for severe convective storms and their associated high impact events, such as Tornado, Hail, and High Winds. http://www.spc.noaa.gov/products/outlook/.

3. The Climate Prediction Center (CPC) puts out probabilistic forecasts for temperature and precipitation for a few weeks to several months in advance. http://www.cpc.noaa.gov/.

4. Many NWS forecasters will add forecast certainty to their forecasts or forecast discussions which can be used to calculate PROBABILITY.

5. The NWS Chicago office puts out seasonal outlooks and weekly forecasts which can be used to calculate PROBABILITY.

6. The National Center for Environmental Prediction (NCEP) provides many different probability forecasts based on numerical and statistical models. For example using ensemble model output from NCEP can provide an easy way to discern the probability of a meteorological event. http://www.emc.ncep.noaa.gov/gmb/ens/

All of the above links can also be found on the NWS Chicago website. www.weather.gov/chicago.

Conclusions

The uncertainty inherent in the nonlinearity of the global atmospheric-ocean system provides an unwelcomed sense of helplessness and hesitancy in the face of important weather decisions. The products issued by the National Weather Service and other sources can help ease uncertainty, however the ability to address weather risk is left to individuals and businesses. The use of weather derivatives and analytical tools provides one of many ways to combine weather information with proactive financial solutions. The true depth of dependence of our economy and society on atmospheric fluctuations is rarely unveiled. Quantifying weather risk can help accomplish a better understanding of how sensitive we really are to the weather.

References

Dutton, J. A., 2002: Opportunities and priorities in a new era for weather and climate services. *Bulletin of the American Meteorological Society*., 83, 1303-1311.

CME Group., 2010: Weather Education. *CME Group Official Website.,* www.cmegroup.com/trading/weather/

Skywarn Recognition Day, 2010

by Bill Wilson, Lead Forecaster

Skywarn Recognition Day was developed in 1999 by the National Weather Service and the American Radio Relay League. It celebrates the contributions that volunteer Skywarn spotters and Amateur Radio operators (Hams) make to the National Weather Service for public safety. Spotters, using radio in the Amateur Radio frequencies report severe weather such as flash floods, tornadoes and damaging winds to local county network control radio operators. Then the reports are relayed by radio to the National Weather Service Office in Romeoville. The meteorologists use these reports in preparing warnings for Illinois and Indiana.

The Skywarn Recognition Day is usually the first weekend in December, beginning at 0000 UTC that Saturday. The Chicago office will participate, tentatively, from 6 pm to midnight Friday, December 3, and from 6 am to 6 pm Saturday, December 4. Amateur Radio operators come to the National Weather Service Office in Romeoville to operate radios, and to communicate on most of the amateur radio bands to other National Weather Service offices in the United States and other amateur radio stations in the world. Most of the communication will be in the High Frequency bands (HF) that are allocated to Amateur Radio.

This year the Hams will use the Very High Frequency (VHF) at the 2 meter wavelength and Ultra High Frequency (UHF) at the 70 cm wavelength amateur radio bands to communicate with local Skywarn spotters. Several local repeaters will be used. This will be a chance for local Ham spotters to participate in the Skywarn Recognition Day. A tentative schedule on the times of contacts and repeaters will be posted about a week before Skywarn Recognition Day on the Chicago Forecast Office Web site. (weather.gov/chicago)

If you are an Amateur Radio operator, you may come by the forecast office in Romeoville during Skywarn Recognition Day. Sometime in late October or early November we will announce the date of the Skywarn Recognition Day and how you can sign up for a time to operate on the Chicago Forecast Office Web page. (weather.gov/chicago)

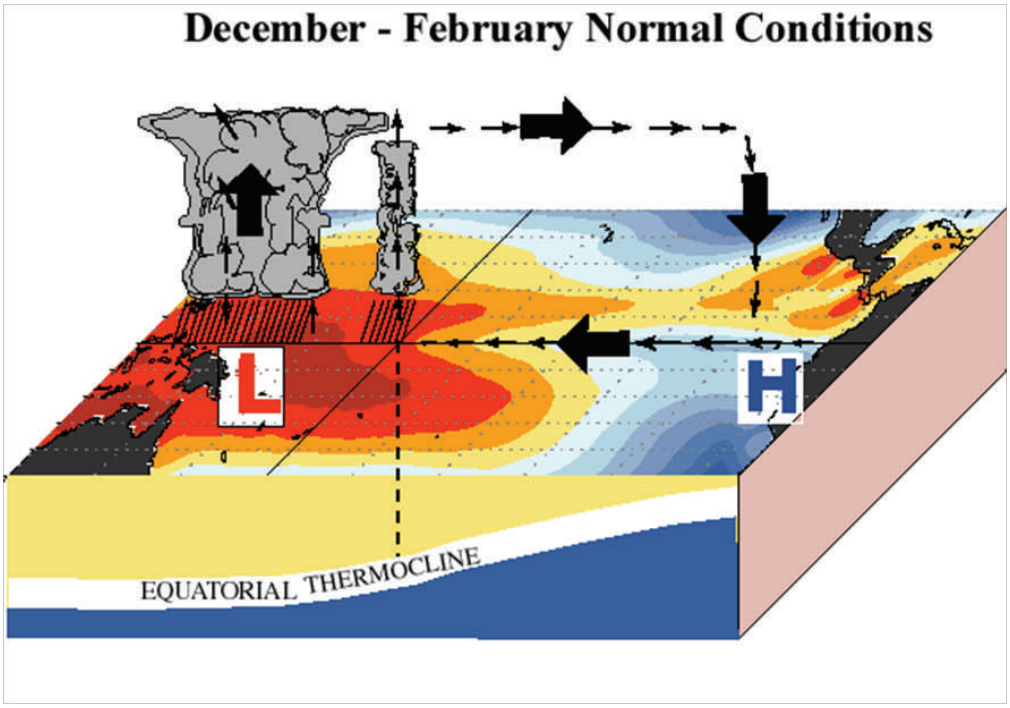
La Niña: What has happened in past winters and what it could mean for our weather this upcoming winter

By Richard Castro, Meteorologist Intern

In its weekly update on September 27th, the National Weather Service Climate Prediction Center (CPC) stated that La Niña conditions exist across the tropical Pacific and they are expected to continue at least through the Northern Hemisphere winter 2010-2011.

What exactly is La Niña?

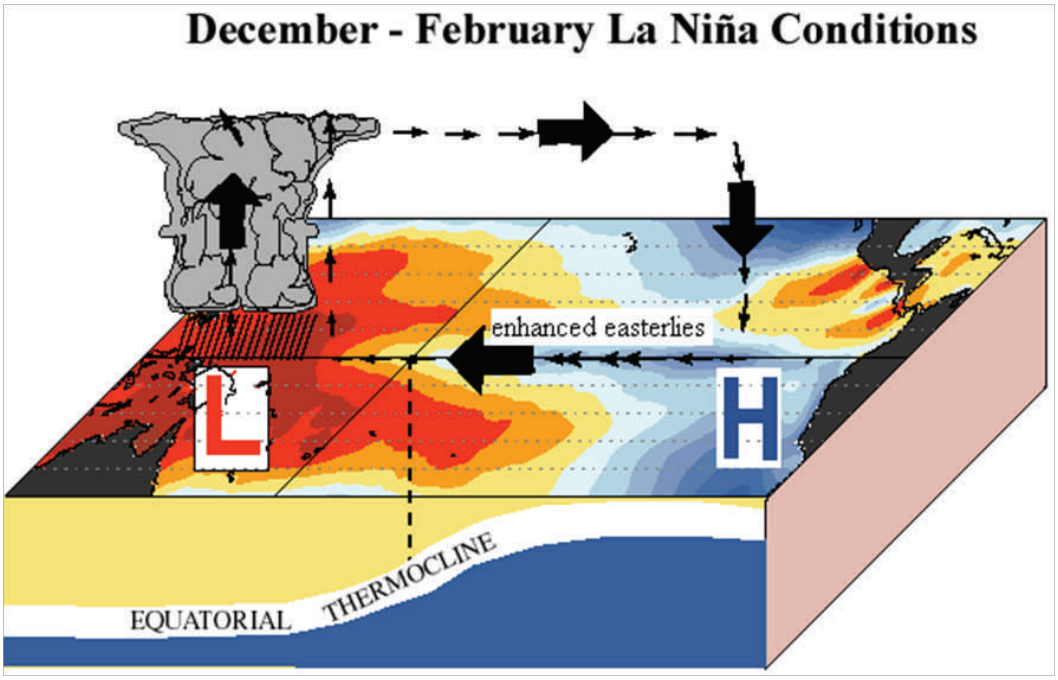
La Niña is the opposite extreme from El Niño in the naturally occurring climate cycle termed El Niño/ Southern Oscillation (ENSO). While El Niño conditions denote above normal, at times much above normal, sea-surface temperatures (SSTs) in the eastern tropical Pacific Ocean, during La Niña events, eastern tropical Pacific SSTs are below normal to well below normal.



Above are the normal atmospheric and oceanic conditions in the tropical Pacific during meteorological winter, December through February. These conditions are reflective of an important large-scale circulation pattern over the Pacific, the equatorial Walker Circulation, as well as the neutral phase of the Southern Oscillation. Low pressure and rising air motion (general storminess) normally covers the western tropical Pacific, with high pressure and sinking air over the eastern tropical Pacific. This pressure pattern causes winds to blow across the pressure gradient from high to low pressure, in the form of low level easterly winds that blow across the Pacific (with corresponding upper level westerly winds). These easterly winds in turn force the warmest surface waters towards the western Pacific into a deep warm layer, causing upwelling of comparatively cooler water over the eastern tropical Pacific, as the equatorial thermocline comes much closer to the surface in that region.

La Niña: (cont)

In La Niña events, the equatorial Walker Circulation is strengthened. Unusually high pressure and subsidence exists over the eastern tropical Pacific and abnormally low pressure and rising air can be found over the western tropical Pacific, a set up that reflects the positive phase of the Southern Oscillation. This enhanced surface pressure gradient enhances the low level easterly flow (and by extension the upper level westerly winds). The enhanced low level easterly flow results in a greater volume of warm surface water being forced toward the western tropical Pacific. Therefore, upwelling of cooler water in the eastern tropical Pacific is also enhanced, cooling the SSTs, with the thermocline coming even closer to the surface. In strong episodes, the cooling extends well out into the central Pacific. These conditions, with SSTs averaging 1°C - 3°C (2°F - 6°F) between the date line and the west coast of South America, usually last an average of 9-12 months, but can sometimes persist for more than 2 years. The SST cooling and atmospheric changes occur in a feedback loop that maintains or intensifies the cooling that occurs. Below is a schematic of atmospheric and oceanic conditions present in the tropical Pacific during La Niña events.

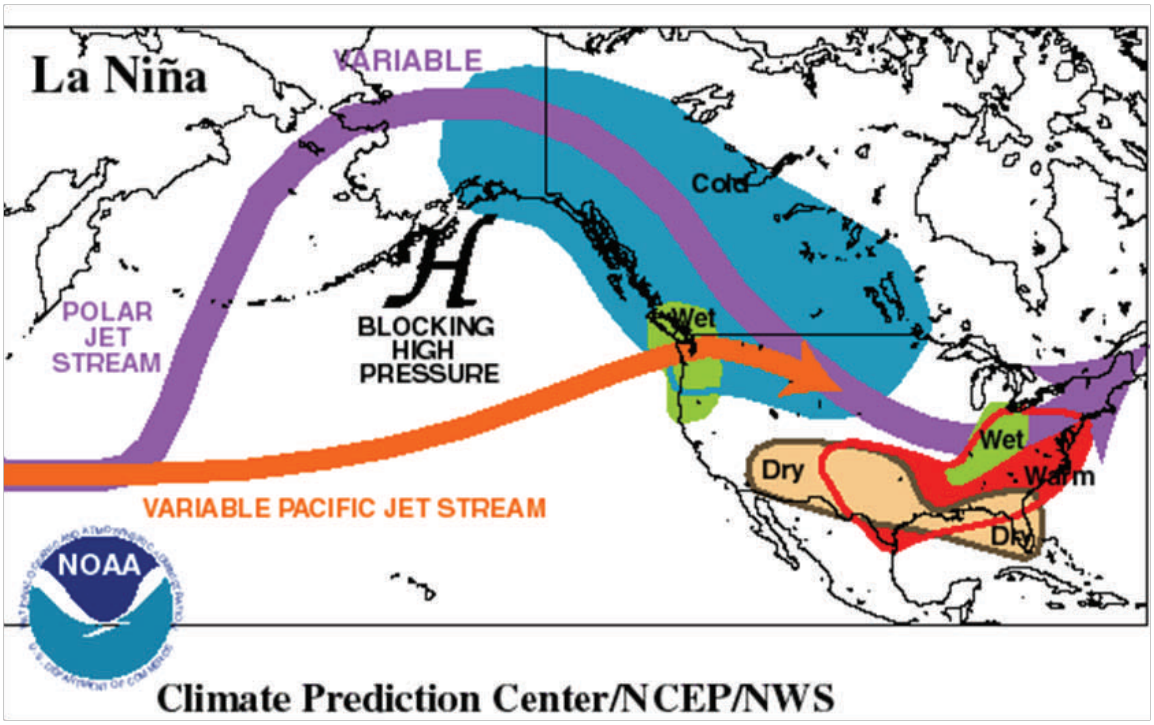


According to CPC, La Niña conditions exist when there is a one month sea surface temperature anomaly less than or equal to 0.5°C below normal in the Niño 3.4 region of the equatorial Pacific (5°N-5°S, 120°-170°W). After these conditions continue for at least 3-months, the Oceanic Niño Index (ONI) threshold is met. The La Niña episode becomes official when the negative SST anomaly ONI threshold is met for 5 consecutive overlapping 3-month seasons. A moderate La Niña is declared when at the peak strength of the event, the 3-month average SST anomaly in the Niño 3.4 region ranges between -1°C and -1.4°C. Strong La Niñas refer to 3-month average SST anomalies of -1.5°C or less in Niño 3.4 during the peak strength of the episode. The peak strength is typically reached in the December to April timeframe.

La Niña: (cont)

Impacts on North American winter weather patterns

La Niña conditions induce important changes in wintertime atmospheric flow patterns across the eastern North Pacific and North America. The varied strength polar jet becomes much more meridional, accompanied by a large ridge of blocking high pressure over the high latitudes of the eastern north Pacific and a prominent trough over the interior of the continent. This allows cold air to build over northern Canada and make regular intrusions southeastward. At the same time, the Pacific jet stream varies widely in strength, entering North America on average in the northwestern US or in southwestern Canada, which leads to increased storminess in those regions. The farther north mean position of the Pacific jet coupled with the meridional flow of the polar jet leads to increased precipitation and a higher frequency of cold outbreaks for large swaths of central North America. In contrast, the southern US experiences warmer and drier than normal conditions. It must be noted that despite the more frequent arctic air intrusions and storminess over central North America, the variable strength of the mean jet streams lends a good deal of volatility to the weather patterns, with often large month to month swings in temperature and precipitation. Following this paragraph is a schematic of the common wintertime atmospheric conditions present during La Niña episodes, as described above.



La Niña: (cont)

A climatology of "La Niña" winters in the Chicago area

Since 1949, there have been thirteen distinct La Niña episodes, as analyzed by CPC. Many of these episodes have spanned multiple years. As a result, there have been twenty separate meteorological winters since 1950 in which La Niña conditions existed. Here are the thirteen events in list format:

Historical La Niña Episodes Based on the ONI

		Lowest ONI Value
ASO 1949	--> FMA 1951	-1.7
MAM 1954	--> DJF 1956/57	-2.1
ASO 1962	--> DJF 1962/63	-0.8
MAM 1964	--> DJF 1964/65	-1.1
NDJ 1967/68	--> MAM 1968	-0.9
JJA 1970	--> DJF 1971/72	-1.3
AMJ 1973	--> MAM 1976	-2.0
SON 1984	--> ASO 1985	-1.0
AMJ 1988	--> AMJ 1989	-1.9
ASO 1995	--> FMA 1996	-0.7
JJA 1998	--> MJJ 2000	-1.6
SON 2000	--> JFM 2001	-0.7
ASO 2007	--> AMJ 2008	-1.4

With knowledge of the general synoptic weather patterns found during La Niña winters, one may surmise that in the WFO Chicago forecast area, this typical pattern has produced winters that on average have enough cold air available due to frequent intrusions of arctic air masses building down from western and central Canada. Furthermore, with the Pacific jet stream usually entering North America in the vicinity of the northwestern US, an active storm track and thus fairly frequent precipitation is likely common to many of these winters. With the combination of enough available cold air and an active storm track, seasonal snowfall totals have likely been relatively high on average as well. Do the statistics for the twenty La Niña winters at Chicago O'Hare support this?

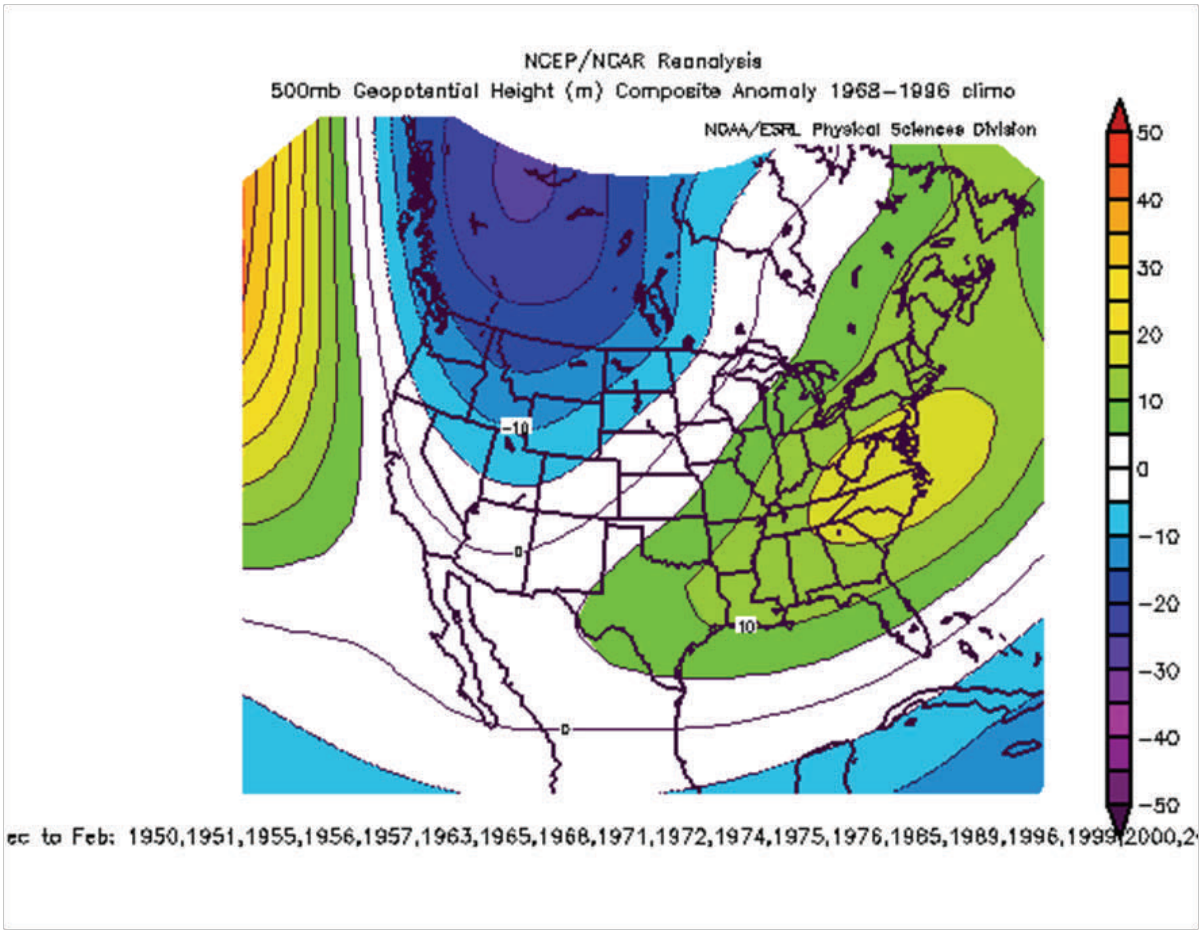
La Niña: (cont)

La Niña Winters at Chicago-O'Hare

Winter	Avg Temp (°F)	Precip (inches)	Snow (inches)	Dec-Feb ONI
1949-1950	29.2	13.79	24.9	-1.7
1950-1951	23.5	7.13	40.1	-1
1954-1955	28.5	5.11	21.2	-1
1955-1956	27.9	3.16	16.5	-1.3
1956-1957	28.3	5.09	24.3	-0.5
1962-1963	19.2	1.85	36.6	-0.6
1964-1965	26.4	7.72	36.4	-0.8
1967-1968	27.2	6.44	20.3	-0.7
1970-1971	26.3	5.21	22.0	-1.3
1971-1972	28.2	7.96	26.7	-0.7
1973-1974	26.5	9.42	54.2	-1.9
1974-1975	28.7	8.32	32.6	-0.6
1975-1976	29.1	6.05	30.3	-1.6
1984-1985	21.9	7.86	38.8	-0.9
1988-1989	26.6	3.99	20.5	-1.7
1995-1996	25.2	2.88	16.1	-0.7
1998-1999	30.4	7.31	32.5	-1.4
1999-2000	29.8	6.00	28.7	-1.6
2000-2001	22.2	5.80	34.6	-0.6
2007-2008	24.8	8.95	52.1	-1.4
Avg	26.5	6.50	30.5	
Median	26.9	6.25	29.5	
1971-2000 Normal	25.5	5.81	28.3	
% Above Normal	70	60	55	
% Below Normal	30	40	45	
top-10 highest				
top-10 lowest				

La Niña: (cont)

As you can see above, La Niña winters in Chicago averaged slightly above normal in terms of average temperatures, precipitation, and snowfall, meaning that temperatures often were not abnormally cold, but cold enough to produce snow. The temperature signal is interesting because of the prior statement about readily available cold air due to the mean configuration of the polar jet stream. However, one degree Fahrenheit is not far above normal. There are no top ten warm winters amongst this group, but there is one top ten cold winter, 1962-1963. These slightly above normal average temperatures likely give credence to the overall volatility of La Niña winters and their noted large swings in temperature. Once again, precipitation has averaged only slightly above normal, but most interesting in this instance is that three of the twenty winters featured top-ten highest seasonal precipitation totals, with 1949-1950 being the wettest winter on record in Chicago. In stark contrast, 1962-1963 was not only the 5th coldest winter on record in Chicago, but also was the 2nd driest winter. However, since it was so cold, there was an above normal seasonal snowfall total. The overall picture for snowfall is similar to that of precipitation, with snowfall slightly more than 2 inches above the 1971-2000 normal, and two top ten snowiest winters amongst the 20 winters. Percentage and median values were provided to give more context to the data. For a closer look at the synoptic set-up during these winters, included below is a National Center for Environmental Prediction/National Center for Atmospheric Research (NCEP/NCAR) reanalysis plot of composite 500 millibar (mb) height anomalies for all twenty La Niña winters combined, based on the climatologically averaged 500 mb heights for December through February from 1968 to 1996.



La Niña: (cont)

The prominent negative height anomalies over northwestern North America and positive height anomalies over the eastern US suggest that often present during these La Niña winters were a persistent deep mid-level trough in the vicinity of the negative anomalies and ridging coincident with the positive anomalies. Lower heights in troughs indicate colder temperatures aloft, while higher heights in ridges indicate warmer temperatures aloft. Troughs and ridges are breeding grounds for cold and warm surface air masses, respectively. This helps explain the cold conditions often present over western Canada that spill into the interior Northwest US and Northern Plains, along with the warmer than normal conditions usually present over the South and Mid-Atlantic US. As the Chicago area is between these two extremes, so to speak, our area is a battle ground for contrasting air masses, with the potential for outbreaks of cold when the mean trough sends arctic air masses toward the region, interspersed by periods of mild temperatures when the mean ridge lifts to our north. This set-up supports the slightly above normal average temperatures in the statistics.

Outlook for Winter 2010-2011

Here is a statement from CPC's La Niña Advisory issued on September 9th 2010, detailing the fore-casted/expected state of the ongoing La Niña heading into the upcoming winter:

Nearly all models predict La Niña to continue at least through early 2011. However, the models continue to disagree on the eventual strength of La Niña. Based on current observations and model guidance, we expect the SST anomalies in the Niño-3.4 region to either persist near the present strength, or to strengthen into the winter as is consistent with the historical evolution of La Niña. Thus, it is likely that the peak strength of this event will be at least moderate (3-month average between –1°C to –1.4°C in Niño-3.4) to strong (3-month average of –1.5°C or less in Niño-3.4).

With the current event expected to remain at least moderate through the winter of 2010-2011, it is helpful to look at some statistics that further break down the 20 La Niña winters into 11 moderate to strong events.

Moderate-Strong La Niña Winters at Chicago-O'Hare

Winter	Avg Temp (°F)	Precip (inches)	Snow (inches)	Dec-Feb ONI
1949-1950	29.2	13.79	24.9	-1.7
1950-1951	23.5	7.13	40.1	-1
1954-1955	28.5	5.11	21.2	-1
1955-1956	27.9	3.16	16.5	-1.3
1970-1971	26.3	5.21	22.0	-1.3
1973-1974	26.5	9.42	54.2	-1.9
1975-1976	29.1	6.05	30.3	-1.6
1988-1989	26.6	3.99	20.5	-1.7
1998-1999	30.4	7.31	32.5	-1.4
1999-2000	29.8	6.00	28.7	-1.6
2007-2008	24.8	8.95	52.1	-1.4
Avg	27.5	6.92	31.2	
Median	27.9	6.05	28.7	
1971-2000 Normal	25.5	5.81	28.3	
% Above Normal	81.8	72.7	54.5	
% Below Normal	19.2	27.3	45.5	
top-10 highest				
top-10 lowest				

La Niña: (cont)

In terms of percentages, with the smaller sample size, there is a stronger signal for warmer than normal temperatures, as 9 of the 11 events featured above normal average temperatures. The actual total average of 27.5 degrees is also a greater departure above normal than in the sample of all La Niña winters. The same can be said for precipitation, as the percentage breakdown shows close to 73% of moderate-strong episodes thus far having above normal precipitation, along with a slightly higher departure from normal for the overall average. Three of the eleven events included top-ten seasonal precipitation totals. Snowfall continues to be more volatile, with a similar 54.5% 45.5% split, but the overall snowfall average is actually close to one inch higher than for the all-La Niña events sample. Two of the eleven events are top-ten snowfall winters.

If the CPC expectation of moderate to possibly strong La Niña conditions this winter comes to fruition, utilizing the above percentages, we have a much higher probability of seeing an above normal average temperature for this winter season than the probability of experiencing a colder than normal winter. The situation is similar for precipitation, albeit with a slightly lower, but still higher probability of experiencing above normal precipitation versus below normal precipitation. Snowfall, once again, is more volatile, but we likely have a slightly higher chance of seeing above average snowfall than below average snowfall as well. As we all know, however, nothing with weather and climate is this simple. The actual weather we experience this winter will ultimately be determined by the complex interaction between the ongoing La Niña conditions and other important atmospheric teleconnection patterns. One thing that we can look for in regards to how cold we may get this winter is the build-up of cold air over western Canada. If this source-region develops unusually cold air, this may allow for more frequent visits by arctic air masses to the Midwest and potentially a colder than normal winter. Of course, the opposite situation could also occur. The latest run of NCEP's Coupled Forecast System (CFS) model, which is used as a guidance tool for seasonal and monthly climate forecasts, is predicting slightly cooler than normal and wetter than normal conditions for December 2010 through February 2011 in the Chicago area.

Here are the links for these products:
http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/lanina/images3/usT2mSeaNorm.gif

http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/lanina/images3/usPrecSeaNorm.gif

La Niña: (cont)

Wildcard: Winter-time Severe Weather/Tornadoes

We have established that in La Niña winters the Pacific jet stream is on average aimed further north than in a neutral ENSO winter. Winter-time severe weather is rare for our area, but does occur. With the jet stream further north, cold season severe weather outbreaks are more likely. The location of the forecast area on the northern fringe of the mean ridge over the eastern CONUS also means that warm, humid air masses occasionally make their way into the region during the winter. When countered by cold air originating from the mean trough over the west, a significant temperature contrast can result, providing some of the ingredients for severe weather. There have been eight winter tornadoes in the WFO Chicago County Warning Area (CWA) since 1950. Significantly, half of these tornadoes occurred during La Niña winters. This is a small sample size, but certainly an interesting statistic. Here is a list of these eight tornadoes, along with their dates and Fujita scale rankings (La Niña winters are highlighted in red):

Kankakee County, IL 1/25/1950: F2
Cook County, IL 12/06/1951: F1
Bureau to LaSalle to Lee County, IL 12/6/1951: F3
La Salle County, IL 12/03/1955: F2
Jasper County, IN 12/8/1966: F2
Iroquois County, IL 12/04/1973: F1
Iroquois County, IL 02/16/2006: F1
Boone to McHenry County, IL 1/07/2008: EF3
(note: use of Enhanced Fujita, EF scale, began on 2/01/2007)

For more information on La Niña and the ENSO Cycle, refer to this link from CPC:
http://www.cpc.noaa.gov/products/precip/CWlink/MJO/enso.shtml