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Date: October 19, 2017

RaysWeather.Com 2018-2019 Winter Fearless Forecast

Background

Unseasonably warm weather continues this fall—no frost yet in the region. The second or third weekend in October is historically the peak of leaf season, and we are still green. Even though winter is currently a distant thought, it is inevitable.

RaysWeather.Com has produced a winter forecast in October for 16 years. Generally scoring last year's forecast, it was great for the mountains but an under-forecast for the Foothills. The highlights included:

1. Being within 3" of the exact seasonal snow total for Boone, Banner Elk, Galax, and Jefferson (see Table 1 for details),
2. An excellent temperature forecast for the whole region. We forecast "temperatures about 1 degree above long-term averages (with big swings warm to cold)". Overall last winger, temperatures were about 2 degrees above average.
3. The forecast for "big temperature swings" worked out well.

Table 1: Last Year's RWC Fearless Winter Snowfall Forecast

Location	Forecast	Actual	Actual - Forecast
Asheville, NC	12"	16"	+4"
Banner Elk, NC	40"	42"	+2"
Beech Mtn, NC	85"	65"	-20"
Boone, NC	34"	37"	+3"
Galax, VA	18"	21"	-3"
Hendersonville	7"	12"	+5"
Hickory	5"	10"	+5"
Independence, VA	19"	22"	+3"
Jefferson & W Jefferson	21"	24"	+3"
Lenoir	5"	15"	+10"
Morganton	5"	14"	+9"
Mt Airy	9"	15"	+6"
Old Fort	6"	14"	+8"
Sparta	20"	25"	+5"
Spruce Pine	18"	21"	+3"
Sugar Mountain	85"	78"	-7"
Waynesville	14"	13"	--1"
Wilkesboro & N Wilkesboro	7"	11"	+4"
Wytheville, VA	20"	28"	+8"

Summary of the Fearless Forecast for Winter 2018-2019

You may want to read the rationale that follows, but we'll give you the "answer" first.

- Snow totals 15% above the 10-year averages with greater than average icing potential.
- Temperatures 1-2 degrees colder than average.
- Cold and snow relative to average will be most extreme during the heart of winter (January and February).

Below are forecast totals for many locations in the Southern Appalachians. (Note: The forecast snowfall total includes snow/ice falling between October 2017 and May 2018.)

Table 2: Specific 2018-19 Snowfall Forecasts for Selected Locations

Location	Expected Total Snow/Ice for Winter 2018-2019
Asheville, NC	16"
Banner Elk, NC	50"
Beech Mountain, NC	100"
Boone, NC	42"
Galax, VA	24"
Hendersonville, NC	11"
Hickory, NC	6"
Independence, VA	23"
Jefferson and West Jefferson	24"
Lenoir, NC	7"
Morganton, NC	7"
Mt. Airy, NC	12"
Old Fort, NC	8"
Sparta, NC	23"
Spruce Pine, NC	24"
Sugar Mountain, NC	100"
Waynesville, NC	17"
Wilkesboro and N. Wilkesboro	9"
Wytheville, VA	25"

Happy Skiing and Snowboarding! We'll keep you informed with the most reliable day-to-day forecasts for the Southern Appalachians and Foothills all winter.

This forecast does not come out of thin air. It comes from serious analysis; continue reading for the rationale.

Fearless Forecast Rationale

ENSO Analysis

As always, the first data considered in a Winter forecast are the current state and forecast for the El Niño/Southern Oscillation (ENSO). ENSO is a measure of large-scale weather conditions in the Equatorial Pacific. It fluctuates between El Niño (associated with warmer than average sea surface temperatures in

the Equatorial Pacific) and La Niña (associated with colder than average sea surface temperatures in the Equatorial Pacific).

Currently, the ENSO is officially classified as Neutral; however, the October 11, 2018, Sea Surface Temperature Anomaly Map shows warmer than average ocean temperature dominating the Equatorial Pacific. We are close to El Niño conditions. As a matter of curiosity, note cooler water in the Eastern Caribbean, mid-Atlantic and southwest of Baja where Michael, Florence, and Sergio respectively churned up the ocean and pulled cooler weather to the surface.
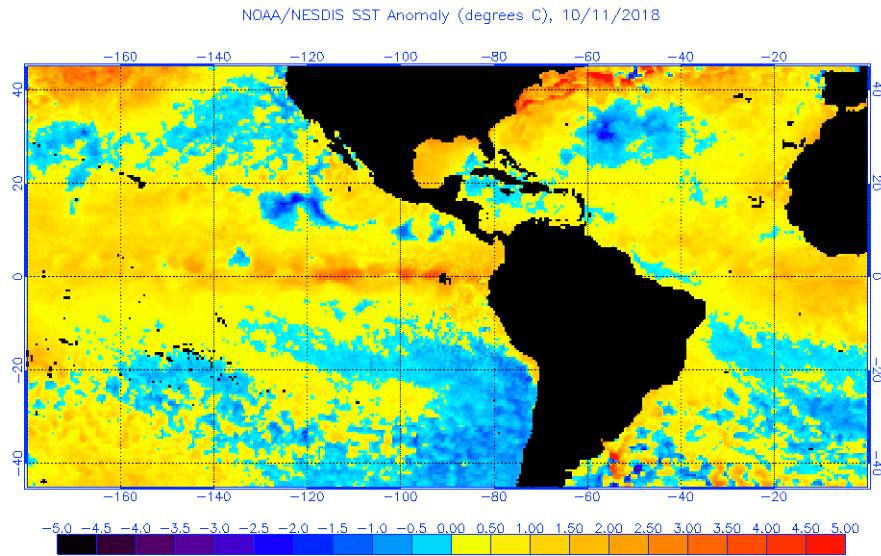
**Figure 1: Sea Surface Temperature Anomaly 10/11/2018
(www.ospo.noaa.gov/Products/ocean/sst/anomaly/)**

Last October, we were in the opposite situation— officially Neutral conditions but close to La Niña and headed toward a moderate La Niña.

ENSO computer models almost unanimously predict El Niño conditions to develop this winter. Figure 2 shows current ENSO model predictions. To be classified as an El Niño, the SST index needs to be above 0.5 for 3 consecutive months. Most models forecast predict a moderate El Niño event (between 0.5 to 1 degree above average for equatorial SSTs); however, as you can see in the graphic, some models forecast a somewhat stronger El Niño winter.
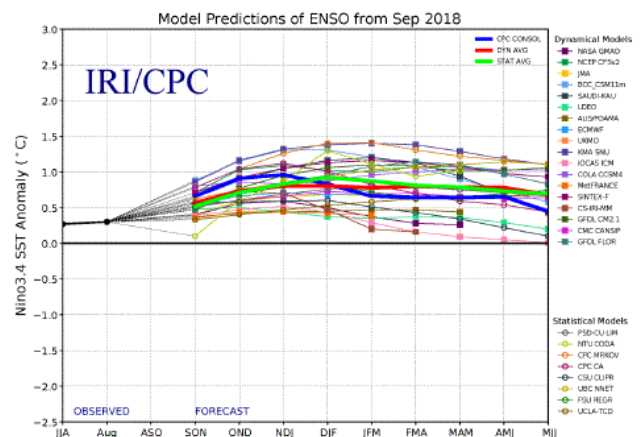
**Figure 2: Forecast for ENSO (from
www.cpc.ncep.noaa.gov/products/analysis_monitoring/
enso_advisory/ensodisc.shtml)**

Figure 3 (next page) shows snow data from Boone, NC. You see seasonal snow data for 59 -years classified by ENSO type (Strong El Niño through Strong La Niña). The graph also shows the long-term average and a 10-year moving average. Note that weak to moderate El Nino winters tend to have more than average snowfall.
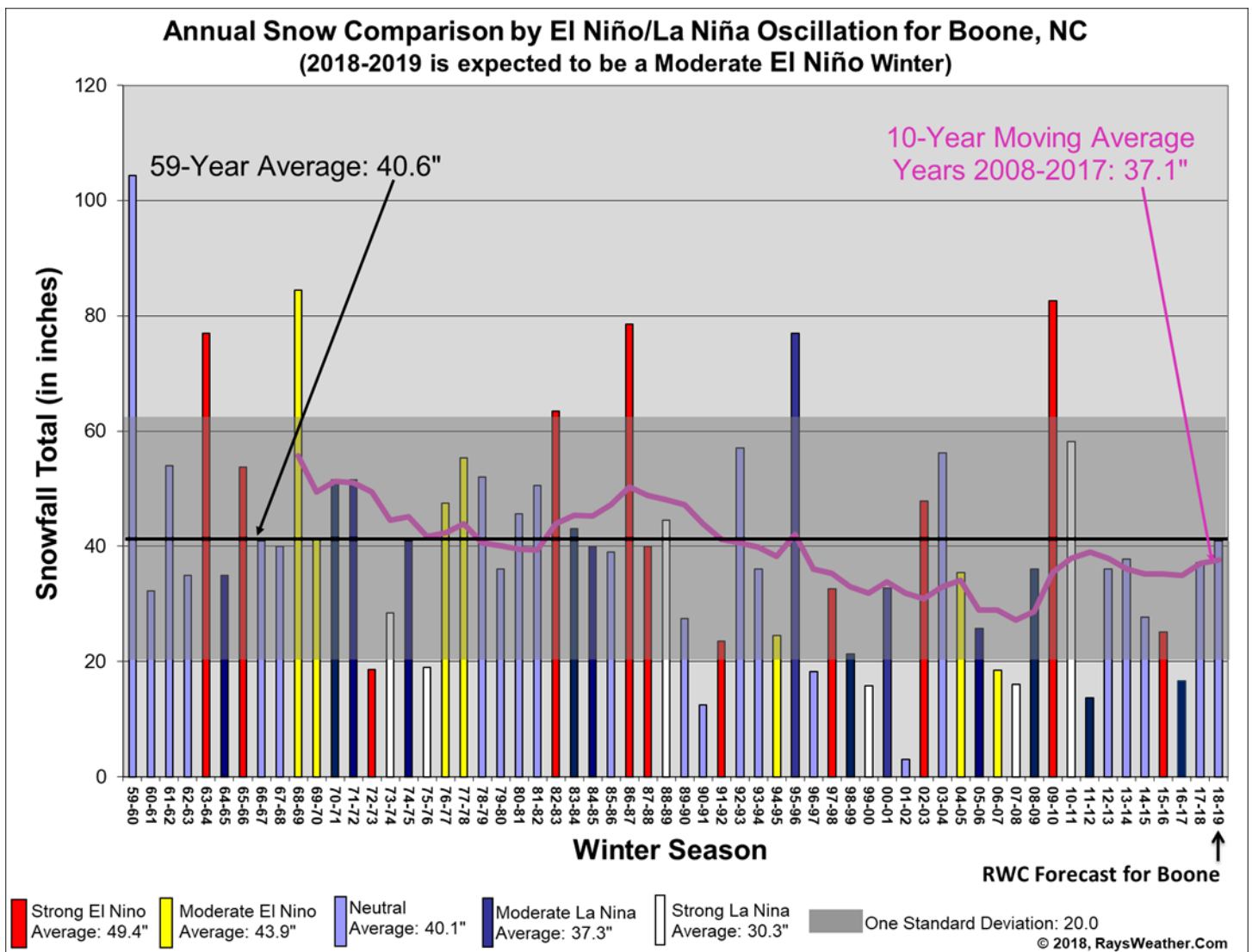
Figure 3: Total Winter Snowfall in Boone, NC, Classified by ENSO (ENSO classifications derived from www.cpc.ncep.noaa.gov/products/analysis_monitoring/ensostuff/ensoyears.shtml)

Not all El Niño's are created equally... The type of El nino we are going into this year is called a El Niño Modoki. See jamstec.go.jp/frcgc/research/d1/iod/enmodoki_home_s.html.en. The El Niño Modoki is characterized by the greatest equatorial warmth in the central Pacific with cooling in the eastern and western Pacific. In contrast, a more classic El Niño has greatest warming in the eastern Pacific and cooling in the central and western.

The area of greatest warmth will ultimately help determine position of troughs and ridges downstream over the U. S. Classic El Niño tends to allow for a strong southern jet into the southern U. S. which brings increased precipitation and cloud cover but can limit cold air intrusions into the East

The El Niño Modoki still has the increased presence of the southern jet over the southern U. S. but the position of the long waves are shifted a bit west and this allows for more cold air intrusions into the eastern U. S. from the north and east (backdoor fronts, wedges, etc.) due to a negative NAO (see NAO discussion below).

Based on predicted ENSO conditions, we chose 10 Best Fit Winters. We chose moderate El Niño winters with Sea Surface Temperature Anomolies generally between +0.7 and +1.3 that includes some winters where the SSTs when slightly above the "moderate" range. The Best Fit Winters are: 2014-05, 2008-09, 2006-07, 2004-05, 1994-95, 1986-87, 1977-78, 1976-77, 1969-70, and 1968-69

Average total snowfall in the Best Fit Winters in Boone, NC, is 43.9", 8% more than the long-term average (40.6") and 18% above the 10-year average. An analysis of the Best Fit Winters comparing each to the 10-year moving average shows that six of these winters have above average snow (four with below average). Figure 4 shows snowfall in Best Fit Winters relative to their 10-year moving average.
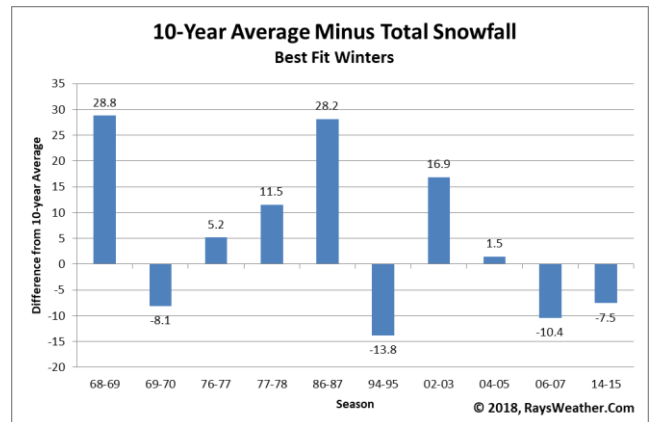

Figure 4: Best Fit Winters Total Snowfall Compared to 10-year Average.

Figure 5 compares Best Fit Winter Snowfall with all Moderate El Niño Winters and all other winters. El Niño Winters tend to concentrate snow in the heart of winter (January and February), a slow start, and more snow than average in April.
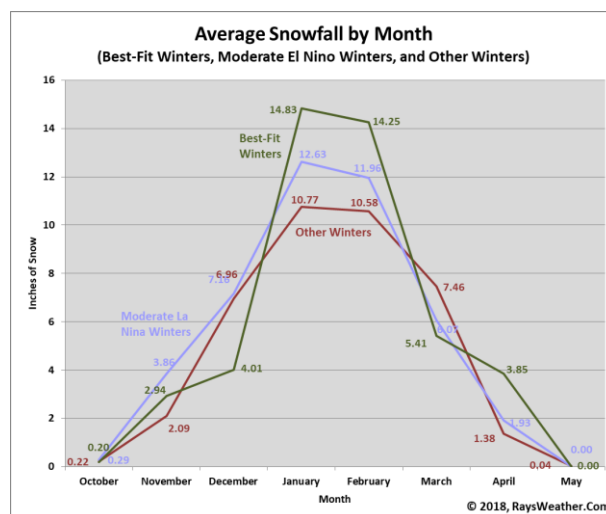

Figure 5: Snow totals from our Best-Fit Winters (2014-05, 2008-09, 2006-07, 2004-05, 1994-95, 1986-87, 1977-78, 1976-77, 1969-70, and 1968-69) compared with all Moderate El Niño Winters and all other winters. Snow totals shown are from Boone, NC.

 El Niño Winters tend to be wetter and stormier than average in the Southeast U. S. because of a persistent southern jet stream bringing energy from the Equatorial Pacific to the Gulf Coast region. Areas of low pressure tend to move east into Southern California and then into the Western Gulf, across the Southeast, and up the East Coast. See Figure 6 for a depiction of the typical El Niño pattern in winter. El Niño Winters tend to be tough for
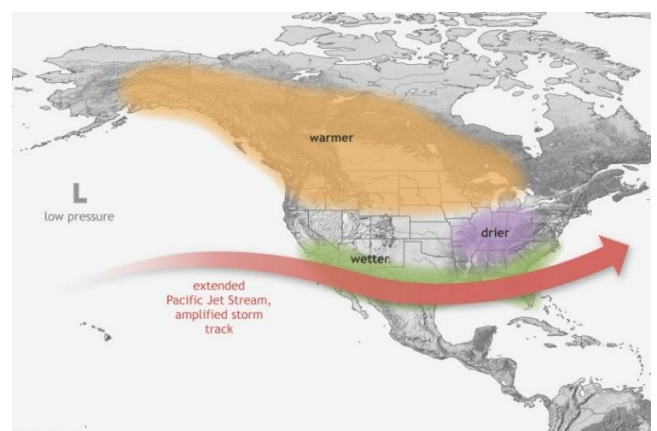

Figure 6: El Nino Winter Climate Pattern
(from www.climate.gov/enso)

the Rocky Mountain Ski industry (warmer and drier than average), colder in the Ohio

Valley and Southeast, and wet along the Gulf Coast. Details on the track and timing of each low determine the type of precipitation with icing and wintry mix event more likely than in other types of winters. A recent NOAA Climate Prediction Center seasonal model forecast; see Figure 7 below.
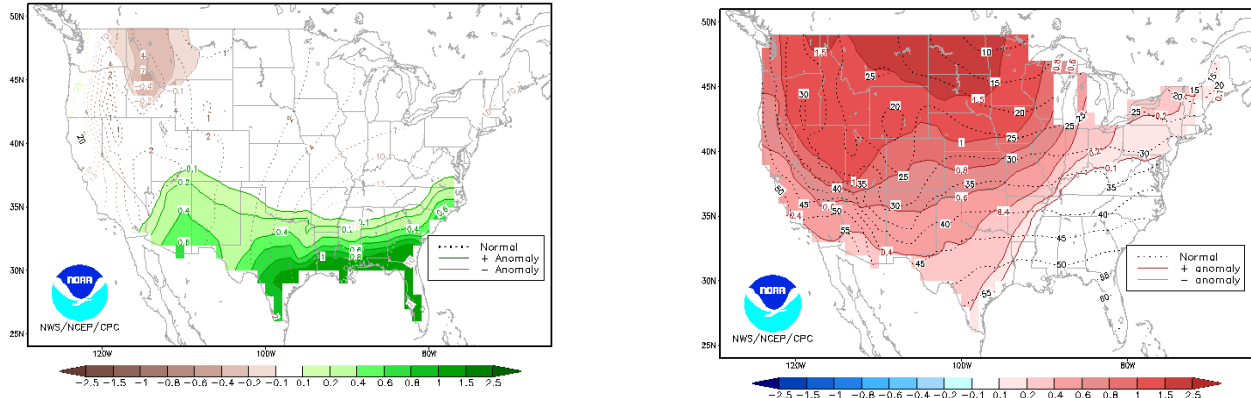
Figure 7 Recent NOAA CPC Seasonal Model Summary for Dec 2018 – Feb 2019
(from www.cpc.noaa.gov/products/predictions/90day/)

Figure 8 compares average temperatures in our Best Fit Winters with all Moderate El Niño Winters and all other winters. El Niño winter temperatures tend to be similar to other years except for January and February. Consistent with the snowfall data, the heart of winter in El Niño years tends to be much colder than other years. Overall, our comparison years were 1.4 degrees colder than average.
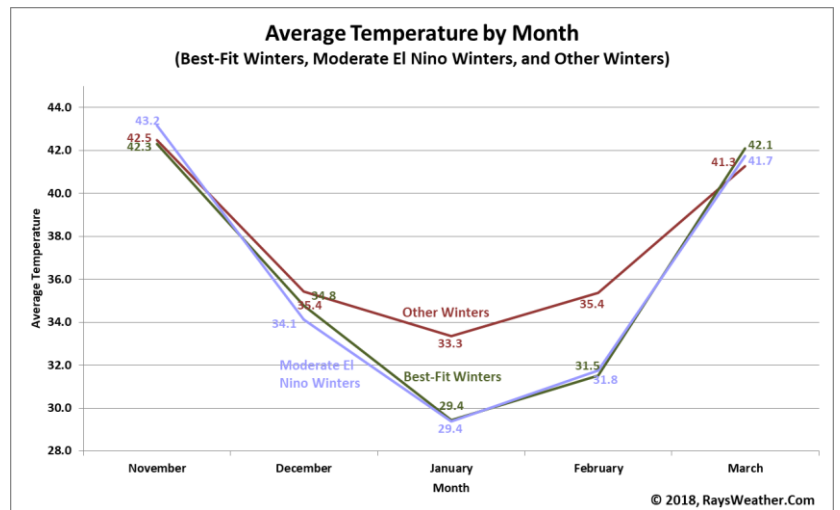

Figure 8: Average temperatures from our Best-Fit Winters compared with Moderate El Nino Winters and all other winters. Temperature data is from Boone, NC.

The main takeaways from the analysis of ENSO forecast for the coming winter are:
1. Below average temperatures in January and February.
2. Seasonal snow totals slightly above average and focused on January/February.

Climate Change

First, climate change is real. If you are interested in a good source of scientific data and analysis on the subject, see http://climate.nasa.gov/evidence/. Second, Figures 9 and 10 show broad measures of climate change effects: Diminishing Arctic Ice and Average Temperatures in North America. The areal extent of Arctic Sea Ice remains near all-time records for least Arctic ice. And the last three years have been the warmest in North America's recorded history.
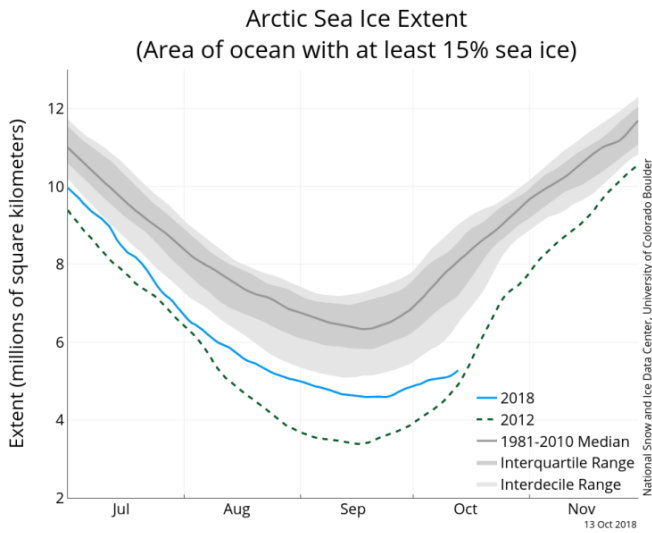
Figure 9: Extent of Arctic Ice (from nsidc.org/arcticseaicenews/)
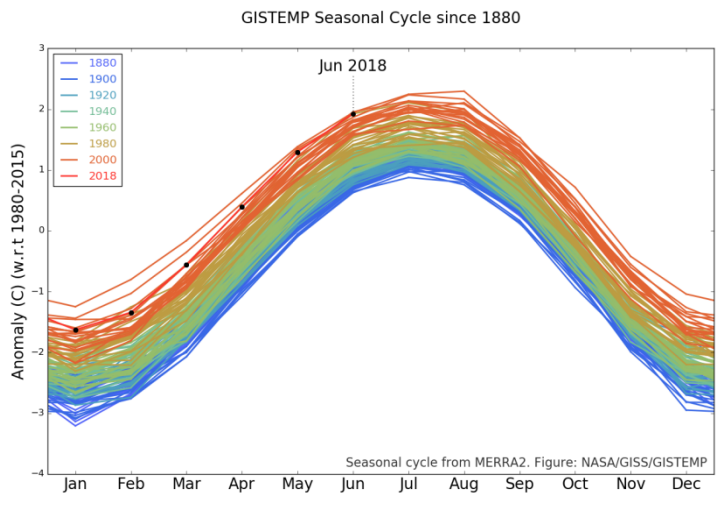
Figure 10: Average Temperature in North America (from data.giss.nasa.gov/gistemp/news/20180716/)

However, the effects of climate change are not linear or uniform in either time or from region to region. Warming, that has been experienced across most of the world, has not evidenced itself as strongly in the Southeast U. S. Figure 11 shows average annual temperature in Boone, NC through 2017. (The "Dust Bowl Years are clearly evident in the 1930s and 1940s.)
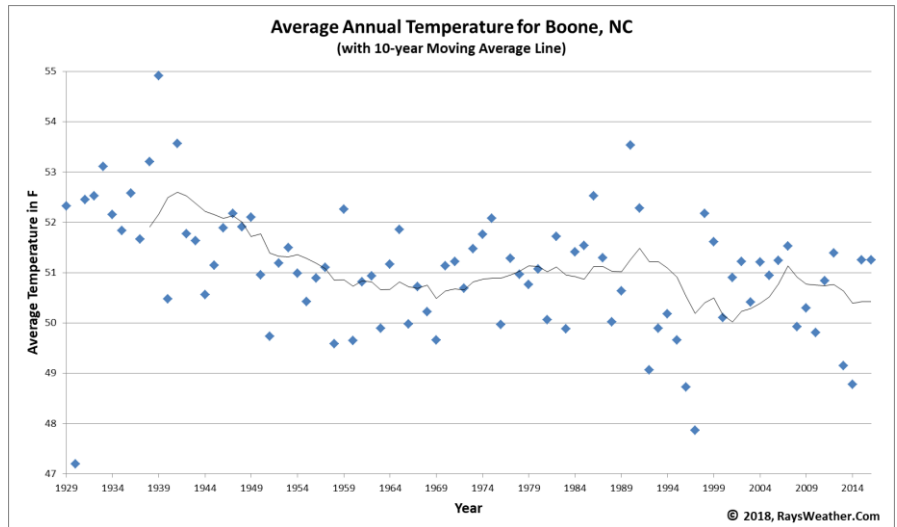
Figure 11: Average Annual Temperature for Boone, NC

Even though temperatures in Boone do not show warming since the 1980s, the amount of snow overall has decreased as shown in the Figure 12.

Regarding the winter forecast as it relates to climate change data, our takeaway is to favor snow totals using the 10-year average instead of the 59-year average.
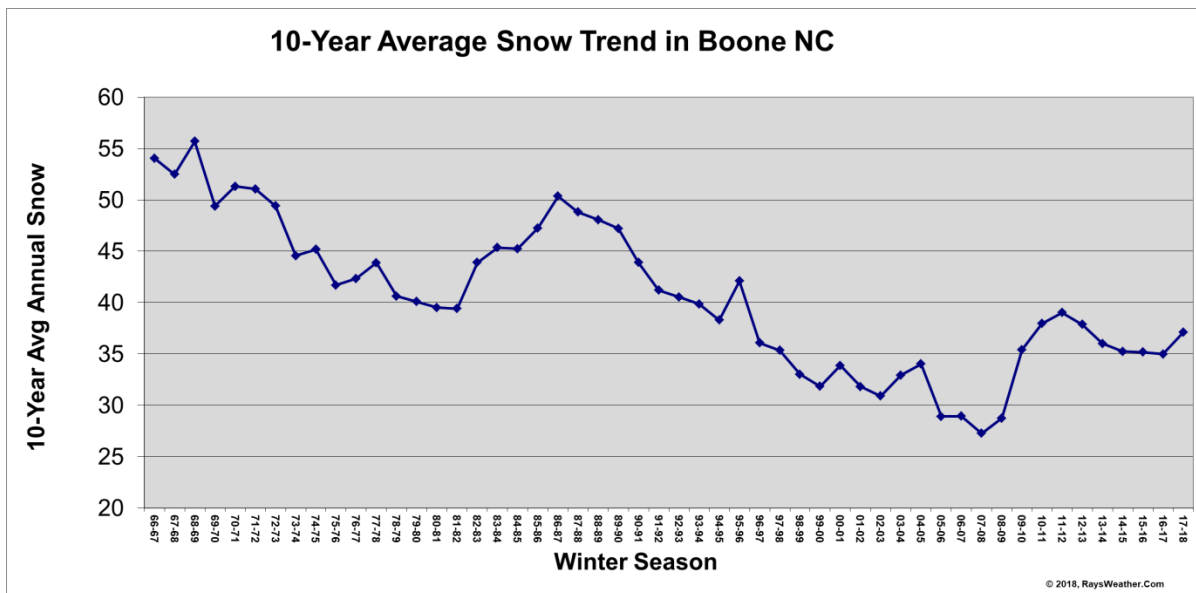
Figure 12: Average Seasonal Snow in Boone, NC

The North Atlantic Oscillation and Arctic Oscillation Wildcards

Every year, the North Atlantic Oscillation (NAO) and the Arctic Oscillation are the biggest wildcards for long-range winter forecasts in the Eastern U. S. The NAO index is based on the pressure difference between the Icelandic low and Azores high. The Arctic Oscillation describes the state of atmospheric circulation over the Arctic. (See climate.ncsu.edu/climate/patterns/nao for details.) These indicators tend to move together and have an enormous impact on winter weather in the Eastern U. S. As described above, El Niño Modoki may signal persistant negative NAO and AO indices. Additionally, some evidence exists that warming at the poles has actually increased the likelihood for a negative NAO and negative AO during the winter, both correlating to cold and snow in the Eastern U. S. If all these factors come together, an even colder/snowier winter than forecast here would occur. Having said all that, long-term NAO and AO forecasting is a low-confidence venture.

Summary

Every year, I caution readers NOT put too much stock in this or any other long-range forecast; pure luck and the NAO will have their say before winter ends. Furthermore, always discard any long-range forecast that lacks a scientific rationale. With all the prudent disclaimers… here's what we think:

- Snow totals 15% above the 10-year averages with greater than average icing potential.
- Temperatures 1-2 degrees colder than average.
- Cold and snow relative to average will be most extreme during the heart of winter (January and February).

Yes, there will be skiing in the Western North Carolina. And yes, schools will have snow days. ☺