December 2011-February 2012 Outlook For the Denver Area and the Rest of Colorado

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November 27, 2011

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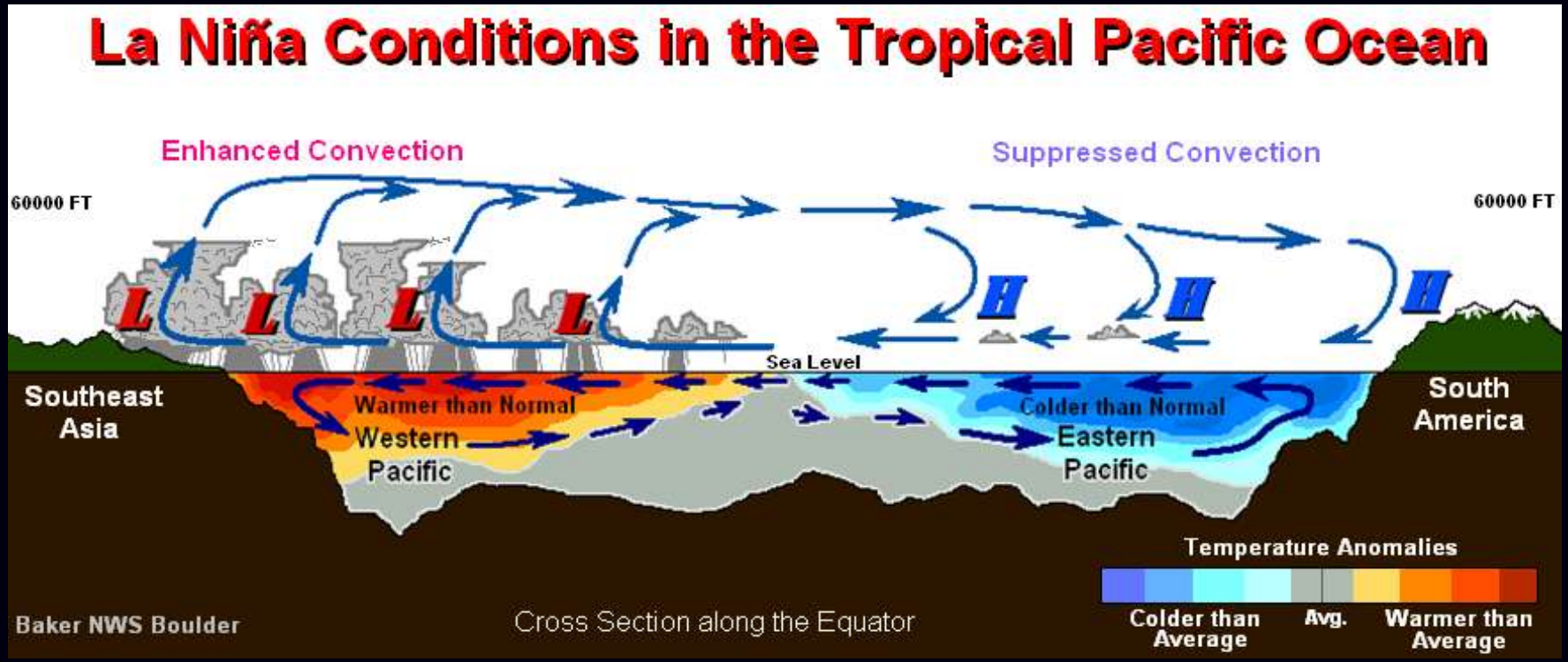
Colder than Average Ocean
Warmer than Average Ocean
La Niña Continues
Baker - NWS Boulder

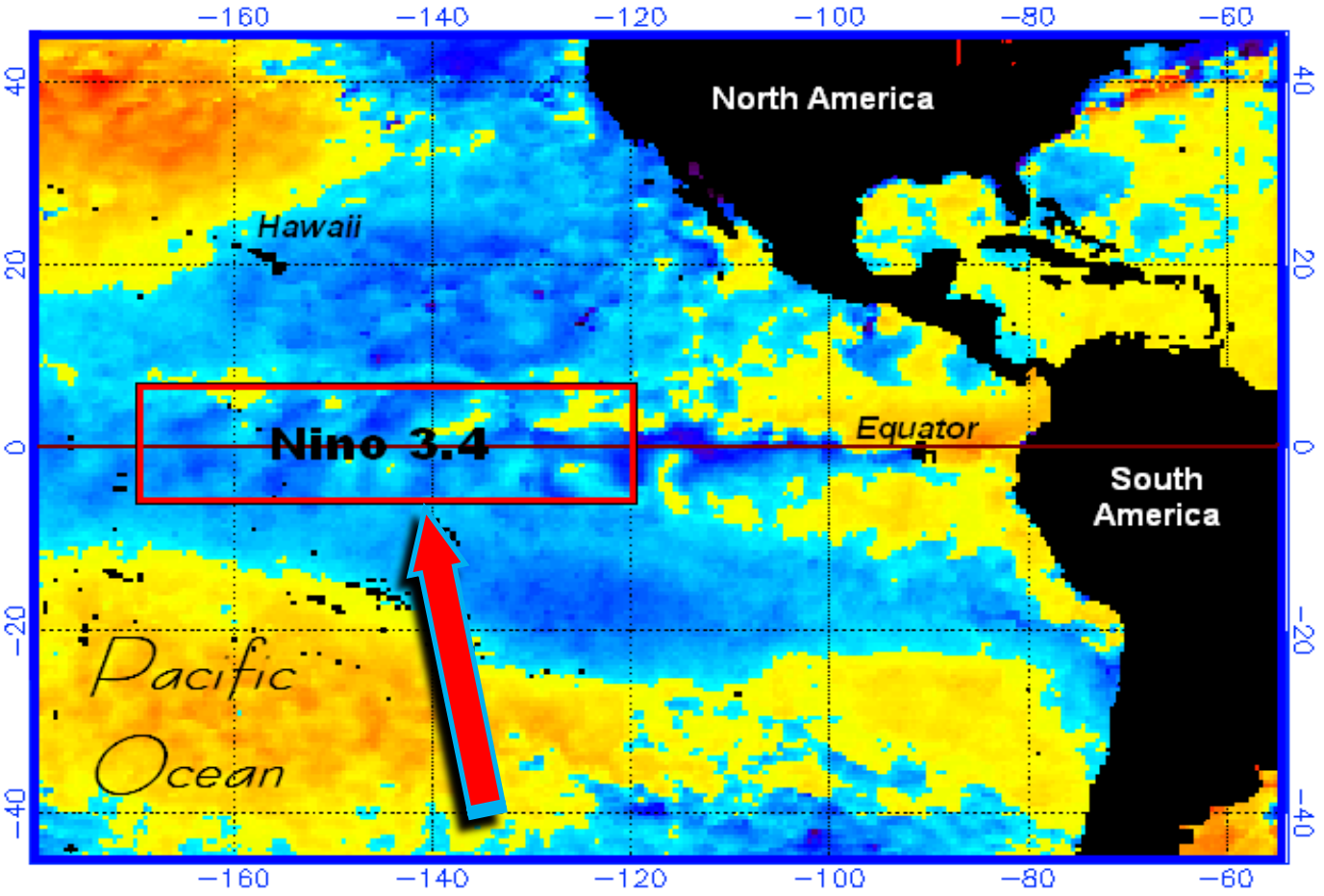


La Niña Advisory Continues

The La Niña in the tropical Pacific Ocean is expected to strengthen some during the month of December and persist through at least the January-March climate season of 2012.

Atmospheric and oceanic circulations present in the equatorial Pacific Ocean during October and November were indicative of a La Niña of at least weak intensity. These conditions include low-level easterly and upper level westerly wind anomalies and abnormally strong easterly subsurface ocean currents which enhance upwelling (cooling) in the eastern Pacific and downwelling (warming) in the western Pacific. The cumulative effect of the current La Niña, however, is not expected to be as pronounced nor as extensive as that produced by the moderate to strong La Niña last winter.

NOAA/NESDIS SST Anomaly (deg C) as of 24 Nov 2011



Nino 3.4 - The principal region in the eastern tropical Pacific Ocean used by the Climate Prediction Center (CPC) for monitoring, assessing and predicting El Nino/Southern Oscillation (ENSO).

This is a map prepared by NOAA's National Environmental Satellite, Data, and Information Service (NESDIS) of sea surface temperature anomalies (SSTA) for the western hemisphere as of 24 November, 2011.

Note the below average SSTs (darker blue shading) along the Equator within the eastern Pacific Ocean region Niño 3.4.

Oceanic Niño Index - ONI

Year	DJF	JFM	FMA	MAM	AMJ	MJJ	JJA	JAS	ASO	SON	OND	NDJ
2000	-1.6	-1.4	-1.0	-0.8	-0.6	-0.5	-0.4	-0.4	-0.4	-0.5	-0.6	-0.7
2001	-0.6	-0.5	-0.4	-0.2	-0.1	0.1	0.2	0.2	0.1	0	-0.1	-0.1
2002	-0.1	0.1	0.2	0.4	0.7	0.8	0.9	1.0	1.1	1.3	1.5	1.4
2003	1.2	0.9	0.5	0.1	-0.1	0.1	0.4	0.5	0.6	0.5	0.6	0.4
2004	0.4	0.3	0.2	0.2	0.3	0.5	0.7	0.8	0.9	0.8	0.8	0.8
2005	0.7	0.5	0.4	0.4	0.4	0.4	0.4	0.3	0.2	-0.1	-0.4	-0.7
2006	-0.7	-0.6	-0.4	-0.1	0.1	0.2	0.3	0.5	0.6	0.9	1.1	1.1
2007	0.8	0.4	0.1	-0.1	-0.1	-0.1	-0.1	-0.4	-0.7	-1.0	-1.1	-1.3
2008	-1.4	-1.4	-1.1	-0.8	-0.6	-0.4	-0.1	0	0	0	-0.3	-0.6
2009	-0.8	-0.7	-0.5	-0.1	0.2	0.6	0.7	0.8	0.9	1.2	1.5	1.8
2010	1.7	1.5	1.2	0.8	0.3	-0.2	-0.6	-1.0	-1.3	-1.4	-1.4	-1.4
2011	-1.3	-1.2	-0.9	-0.6	-0.2	0	0	-0.2	-0.4			

Latest ONI

El Niños (warm phase events): ONI of +0.5 and higher (red numbers)

La Niñas (cold phase events): ONI of -0.5 and lower (blue numbers)

ENSO-Neutral (near average conditions): ONI below 0.5 and above -0.5 (black numbers)

The ONI of -0.4 for the climate season AUG-OCT 2011 is an indication that ENSO-neutral conditions existed in the Pacific Ocean for that 3-month period.

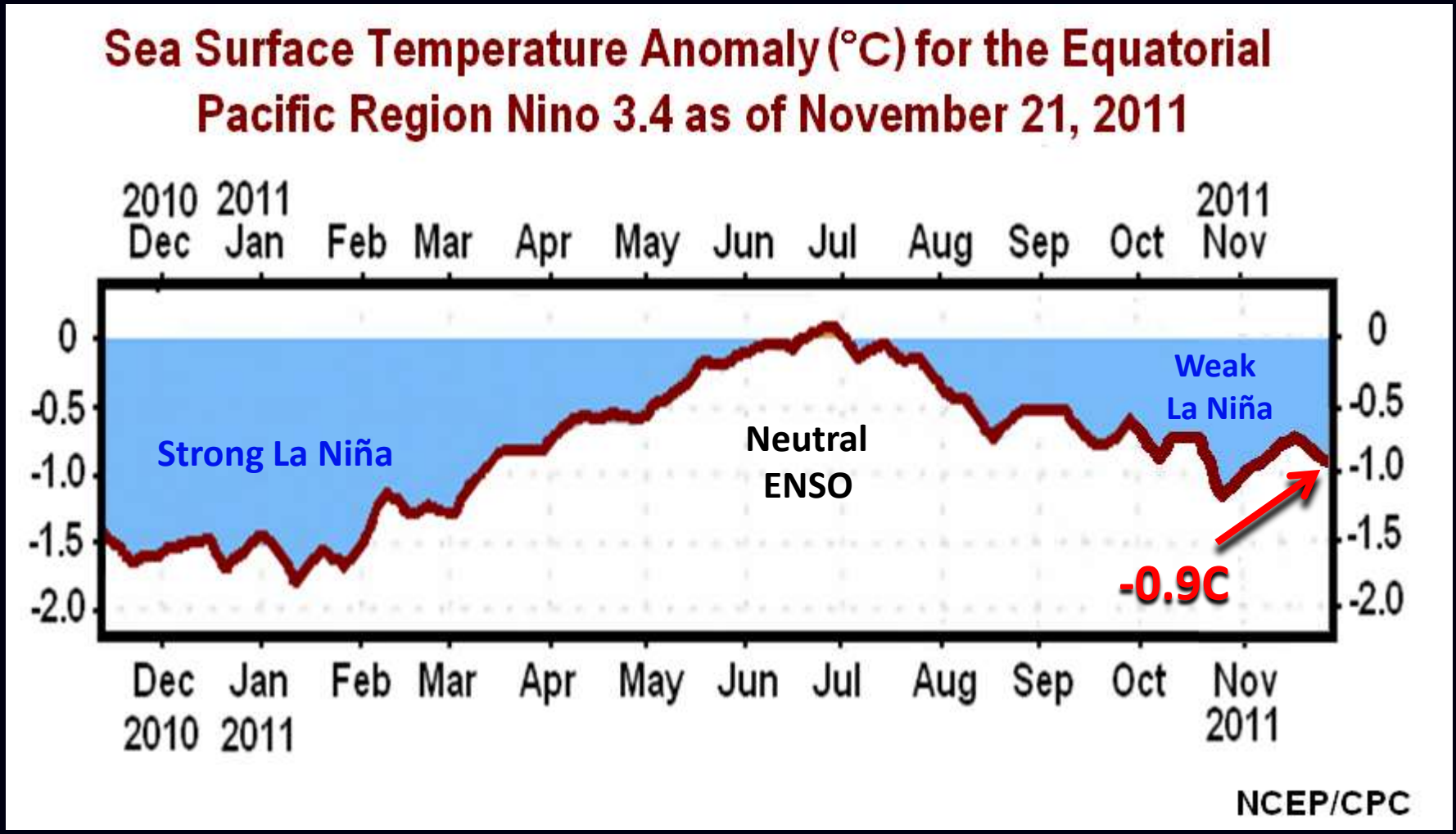
NOAA/CPC Nov 17 2011

The ONI is based on sea surface temperature (SST) departures from average in the Niño 3.4 region of the eastern tropical Pacific and is a principal measure for monitoring, assessing and predicting ENSO.

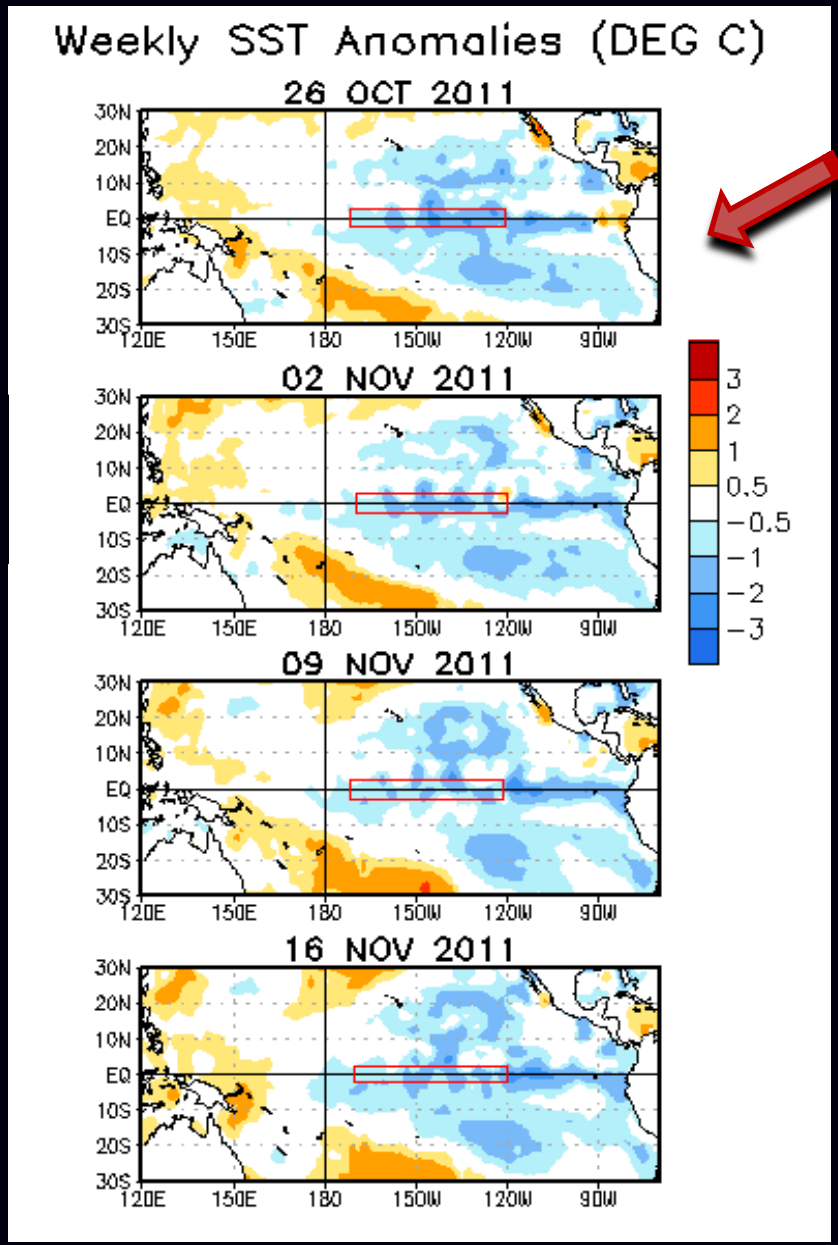
ONI is defined as the three-month running-mean SST departures in the Niño 3.4 region.

ONI is used to place current ENSO and non-ENSO events into a historical perspective.

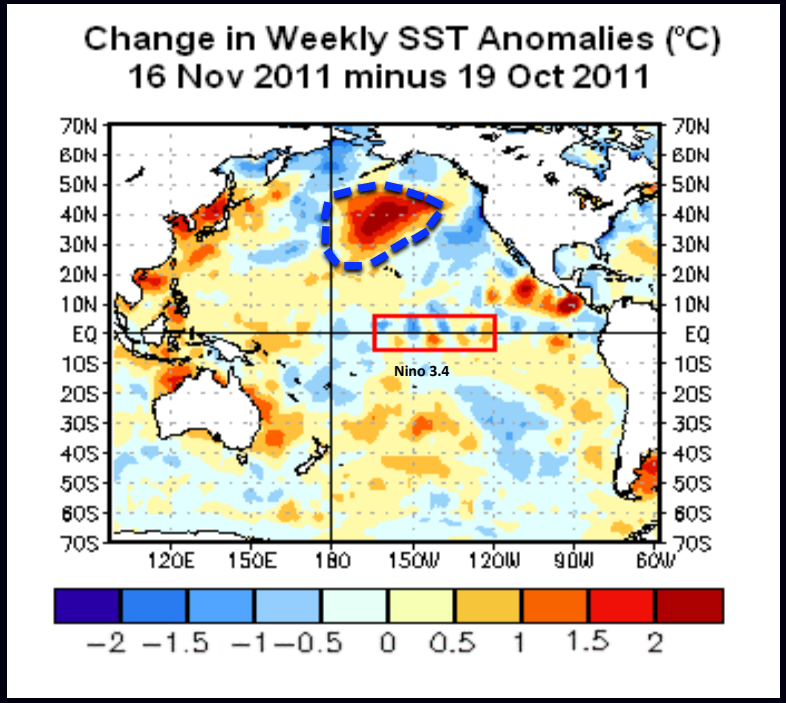
NOAA's operational definitions of El Niño and La Niña are keyed to the ONI index.



As of 21 Nov, 2011 the weekly SST anomaly for Niño 3.4 is -0.9C. This is down -0.1C from 30 days ago.

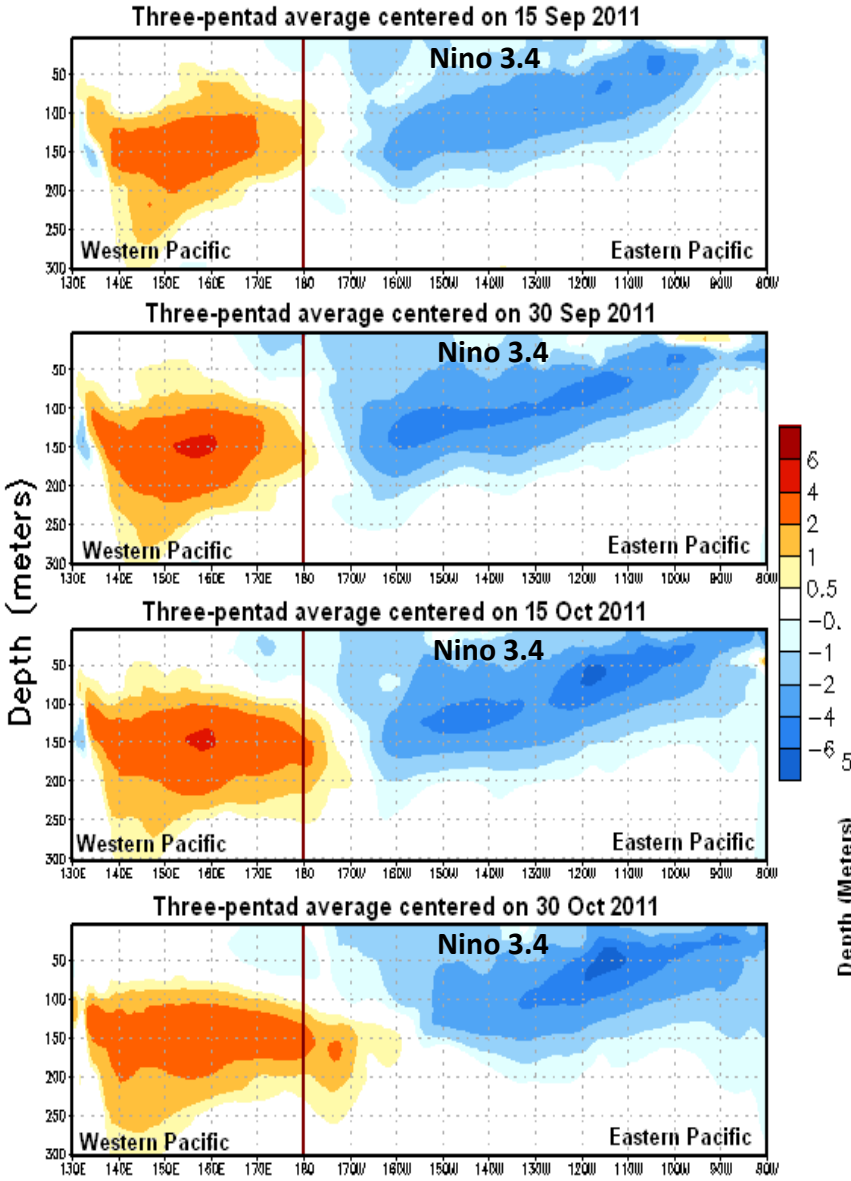


During the last four weeks (26 Oct to 16 Nov, 2011), equatorial sea surface temperatures remained below average across the eastern two-thirds of the Pacific Ocean.



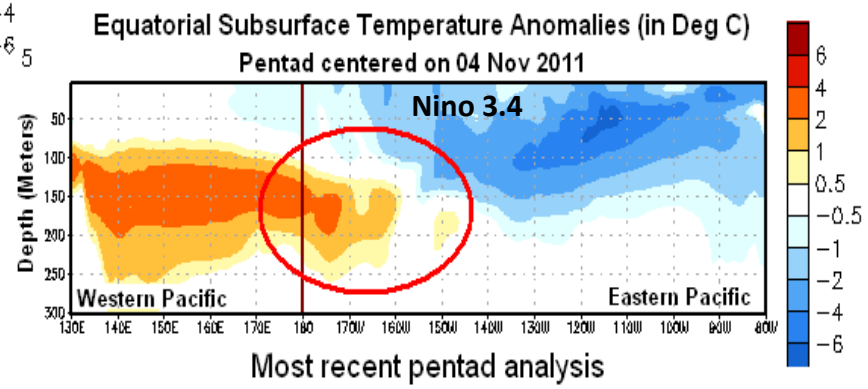
Significant warming (at least 2.0 deg C) also occurred in the northeast Pacific Ocean around 40 degs N latitude (blue dashed area).

Equatorial Subsurface Temperature Anomalies (in deg C)

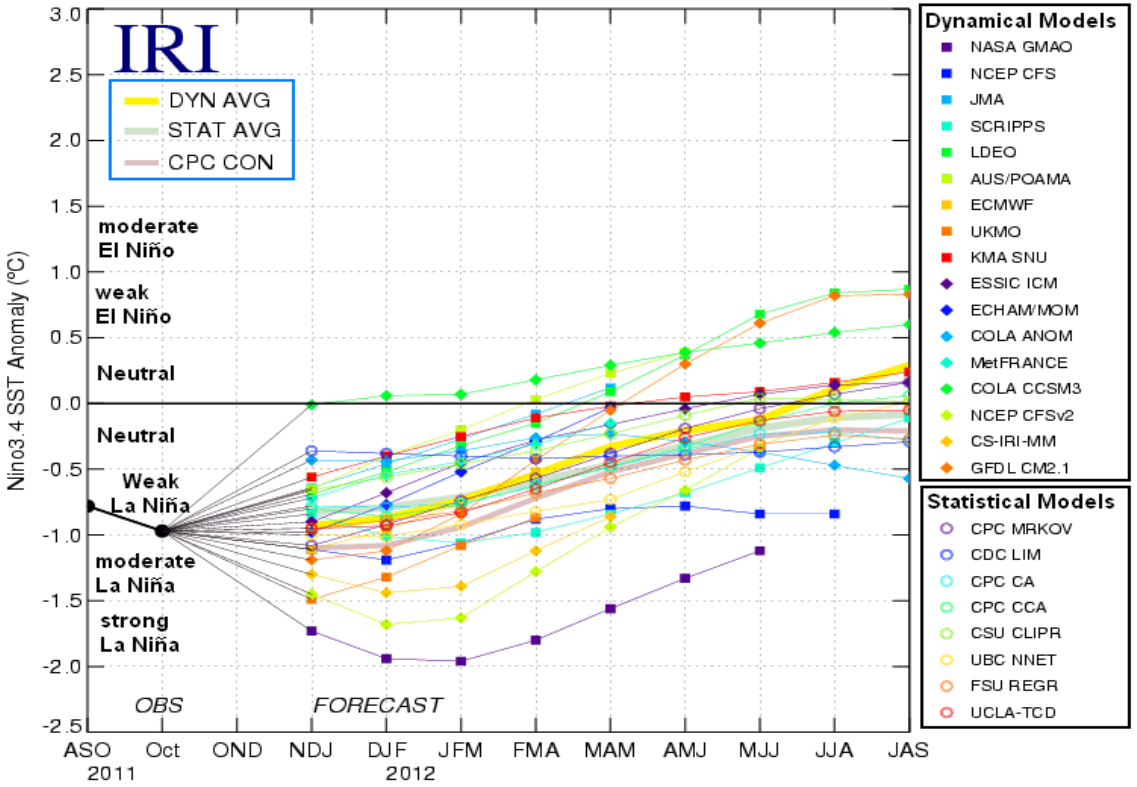


* Since early September 2011, positive subsurface temperature anomalies (100-300m) have been observed in the western Pacific Ocean, while negative anomalies have been present in the central and eastern tropical Pacific.

* In the recent period, the positive anomalies have expanded slightly eastward into the eastern half of the Pacific Ocean, while the negative anomalies persisted in the eastern Pacific.



Most recent pentad analysis



Forecast SST Anomalies (deg C) in the Nino 3.4 Region

	NDJ	DJF	JFM	FMA	MAM	AMJ	MJJ	JJA	JAS
Average, dynamic models	- 0.9	- 0.9	- 0.7	- 0.5	- 0.3	- 0.2	- 0.1		
Average, statistical models	- 0.9	- 0.8	- 0.7	- 0.6	- 0.5	- 0.3	- 0.2	0	0.1
Average, for all models	- 0.9	- 0.8	- 0.7	- 0.6	- 0.4	- 0.3	- 0.2	0	0.1

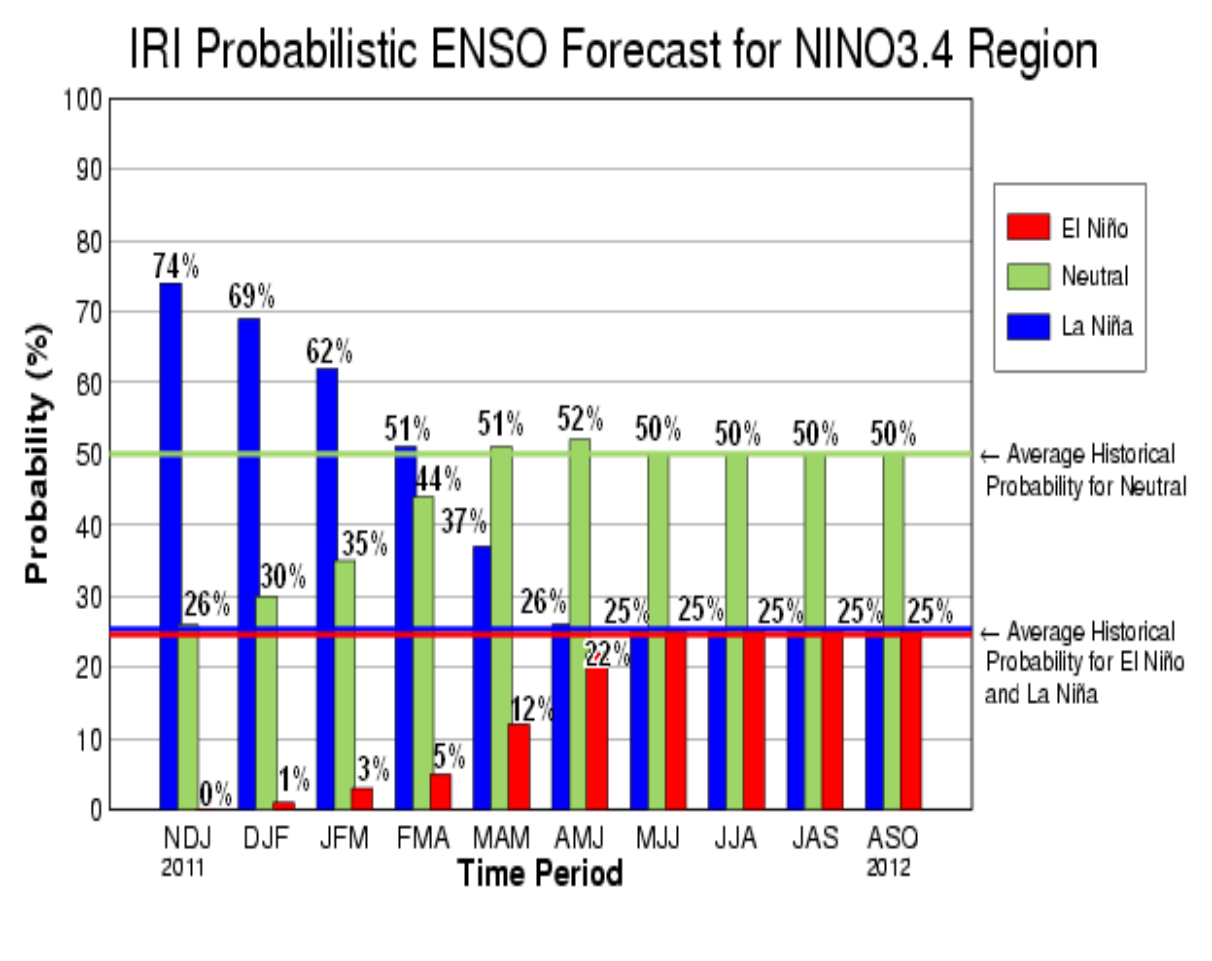
Source: International Research Institute for Climate and Society (IRI) – as of Nov 17 2011

Since September of this year, weak La Niña conditions have existed in the equatorial Pacific Ocean.

Based on a majority of the dynamical and statistical ENSO models, weak La Niña conditions are likely to continue in the Pacific through the winter of 2011-12, then transition to ENSO-neutral conditions during the spring of 2012.

A number of these models including NCEP's Coupled System Forecast Model (CFS), continue to predict a La Niña of moderate strength during the December 2010-March 2012 time period.

No longer do any models predict El Niño conditions this winter.



Based on the latest atmospheric and oceanic observations and model output, there is a 69% and 62% chance that La Niña conditions will exist during the December-February and January-March climate periods, respectively, with corresponding probabilities for ENSO-neutral conditions of 30% and 35%.

There is only a 1% probability that El Niño conditions will exist during the December 2011-February 2012 climate period.

Source: International Research Institute for Climate and Society (IRI) – as of Nov 17 2011

What Weather Patterns Might We See Across Colorado This Winter With A Weak La Niña?

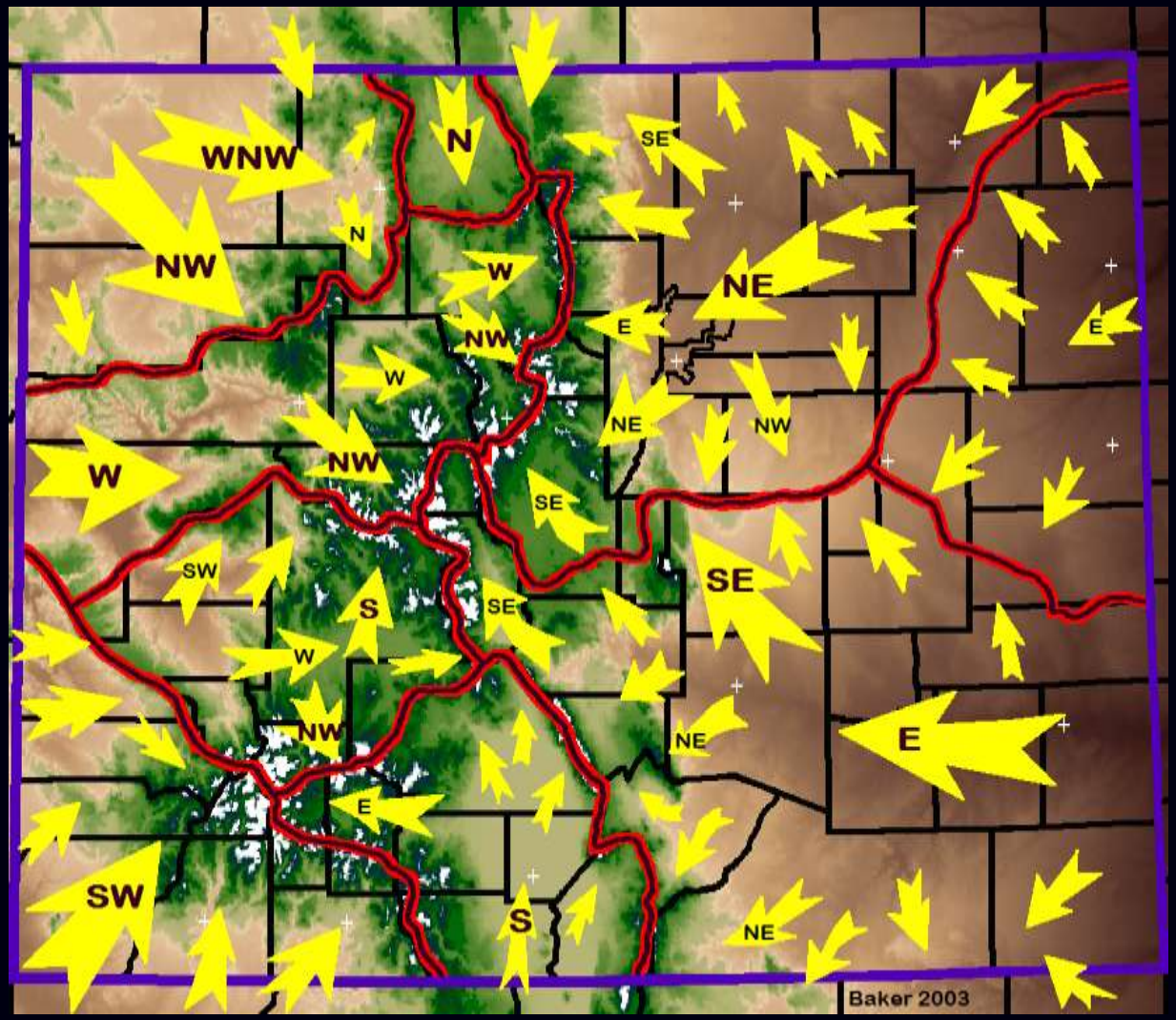
Baker - National Weather Service Boulder, Colorado

The Influence of Terrain on Colorado Weather

Looking Southwest from the High Plains of Northeast Colorado

Colorado's complex topography (its towering mountain ranges, large plateaus, narrow valleys, wide open plains, etc.) significantly affects wind, temperature and precipitation patterns across the state, and even the track of storms.

Wind Components Favoring Orographic (Upslope) Precipitation In Colorado



In northwest Colorado, the optimum upslope wind component is a northwesterly direction;

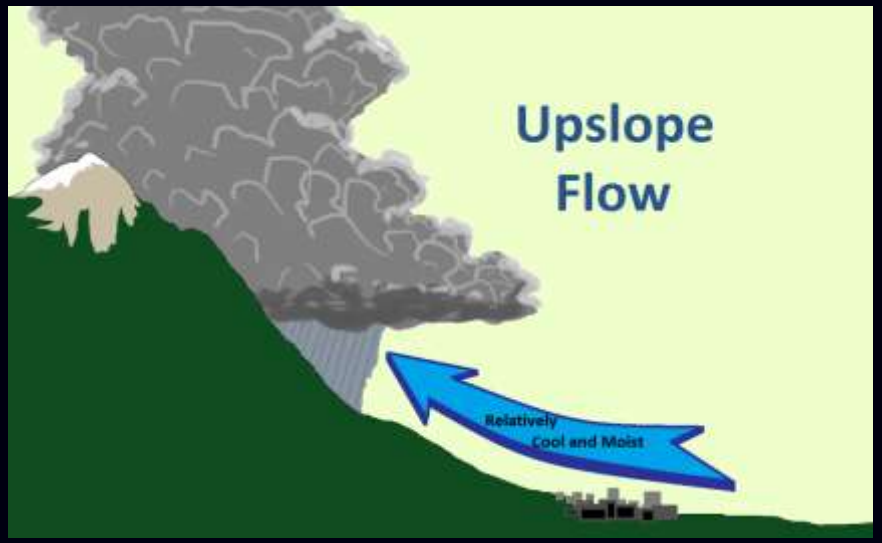
in west-central Colorado, it is generally a westerly component;

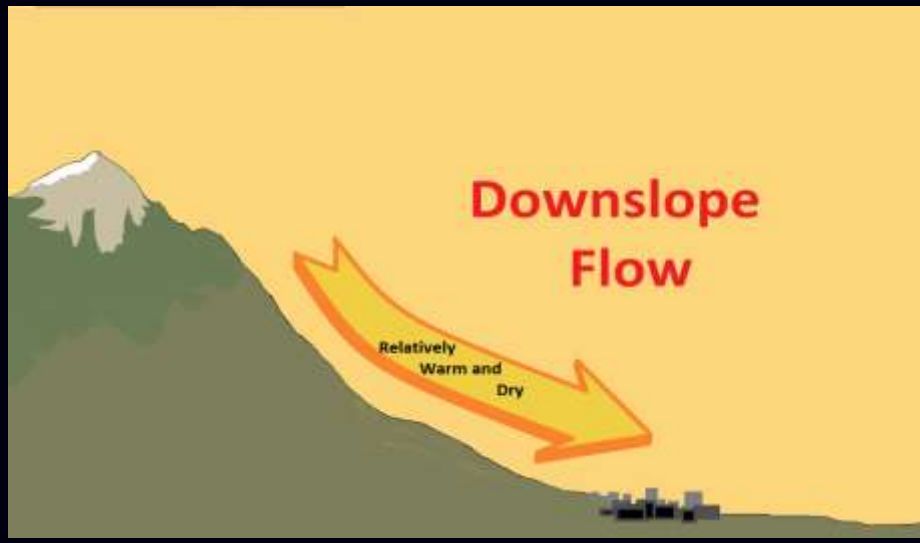
in southwest Colorado, it is a southwesterly direction;

in northeast Colorado, it is an east-northeasterly direction; and

in southeast Colorado, the optimum upslope wind component is an east-southeasterly direction.

The Influence of Upslope and Downslope Winds

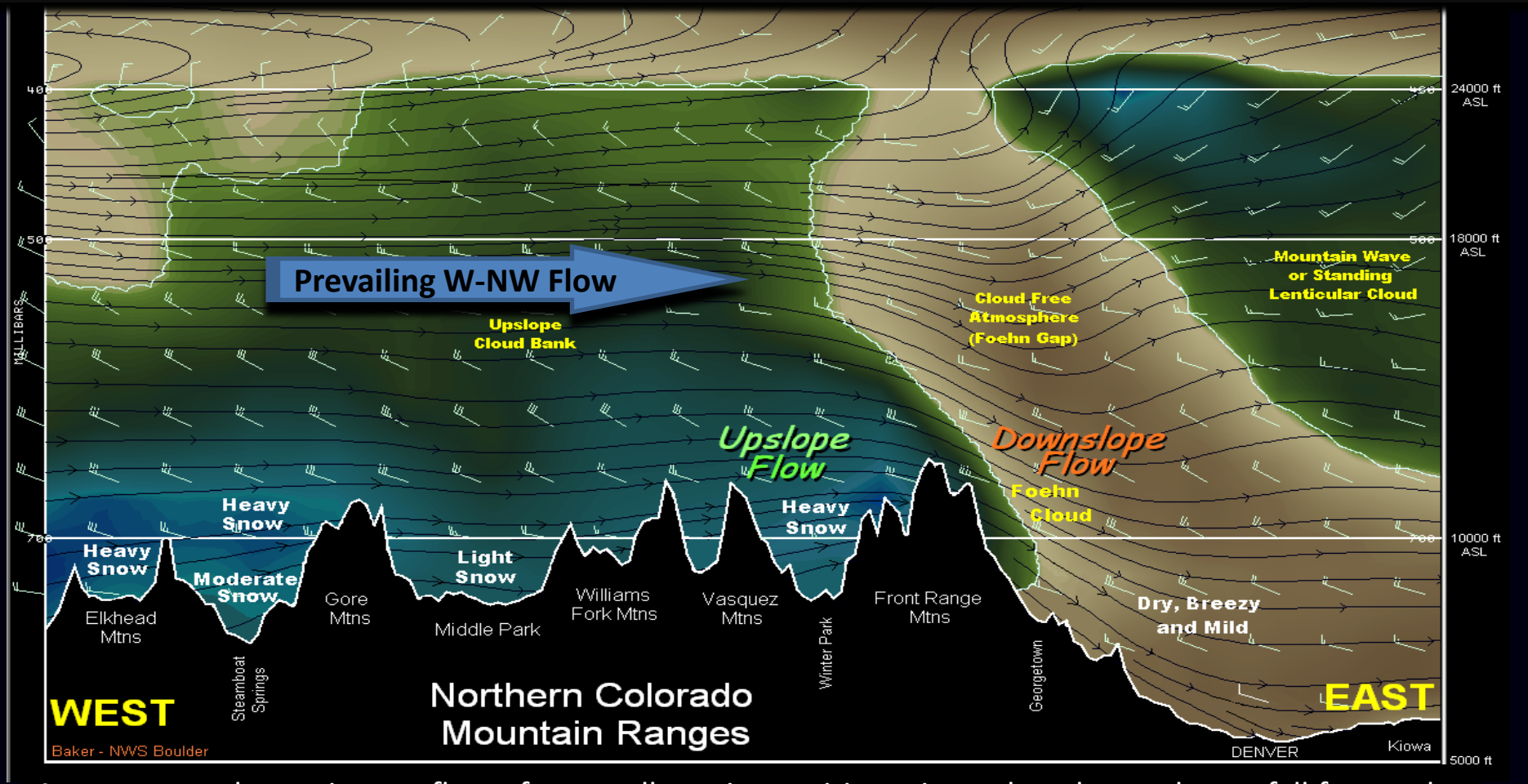




Upslope flow favors cloud formation, the production of precipitation, and higher humidities.

Downslope flow inhibits cloud formation and precipitation, and it normally warms temperatures and lowers humidities.

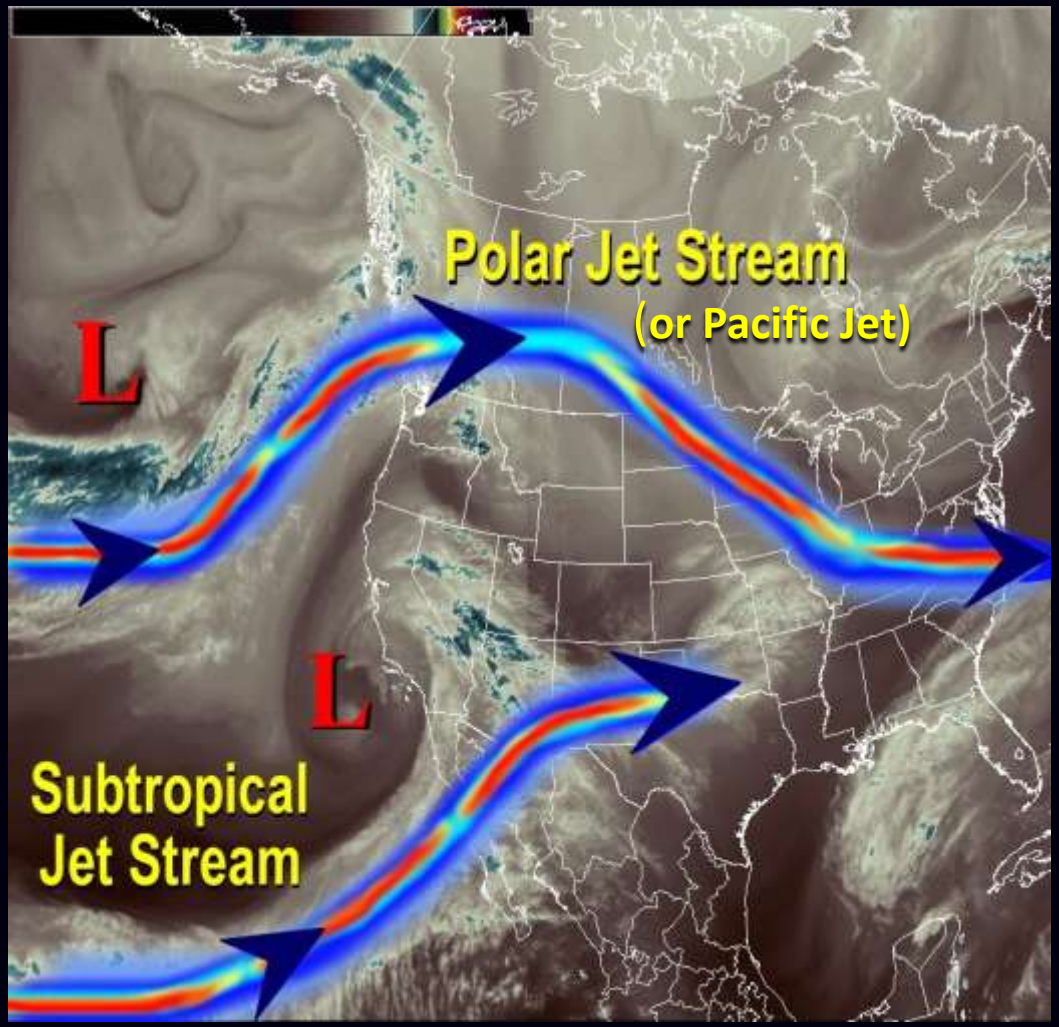
A Composite Vertical Wind Profile Across Northern Colorado For Last Winter and Spring During a Moderate to Strong La Niña



A strong, nearly continuous flow of unusually moist maritime air produced record snowfall for much of northwest and west central Colorado last winter and spring. Simultaneously, this same west-northwest wind profile resulted in abnormally dry, warm and windy conditions in southern and eastern portions of Colorado, particularly along the Front Range foothills in northeast Colorado, and in the Arkansas River and San Luis Valleys in southeast and south central Colorado, respectively.

The Jet Stream

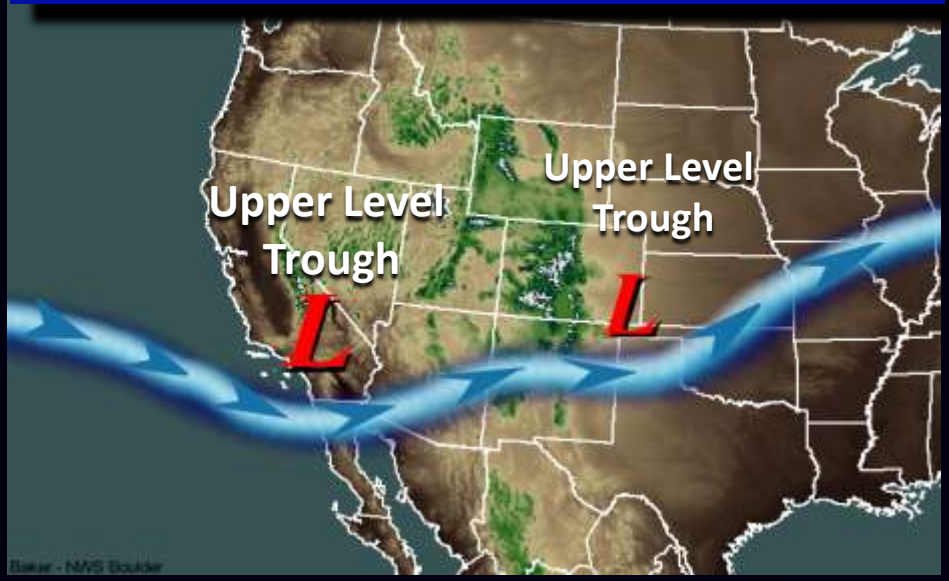
- A channel of strong winds within the Westerly Wind Belt (30-60˚ N latitude)
- Produced by large pressure and temperatures gradients between the poles and the Equator
- May be thousands of miles long, hundreds of miles wide, and thousands of feet deep
- Typically found between 20,000 and 35,000 feet ASL, and occasionally lower in altitude during the winter months.
- Wind speeds may exceed 180 mph
- Its location can vary widely from week to week and even day to day.
- Much of the variability we see in precipitation, temperature, wind and cloud cover, particularly during the winter and spring, can be attributed to the jet stream.



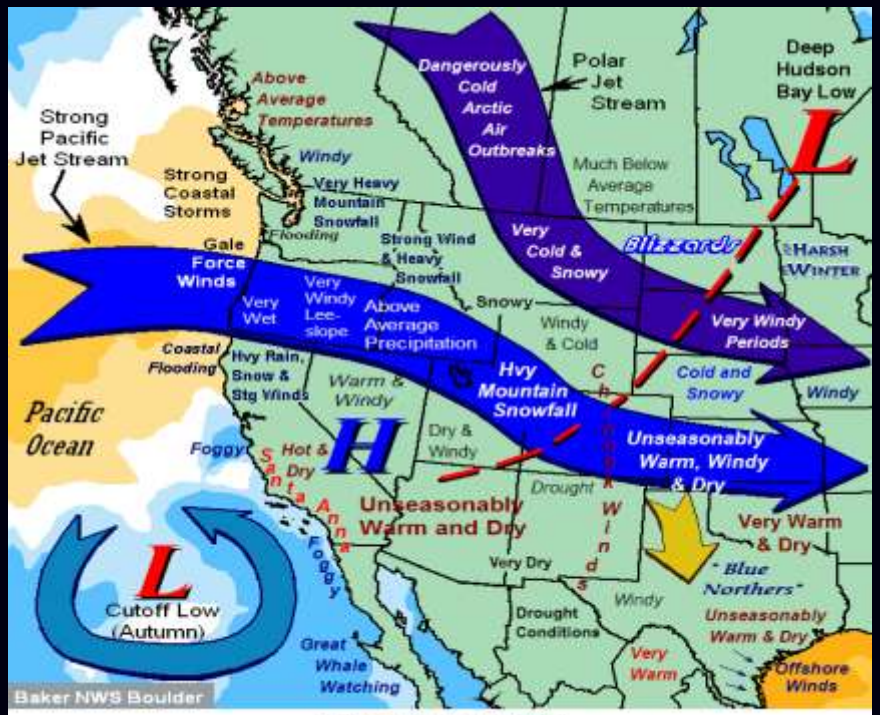
Typical Jet Stream Pattern During La Niñas

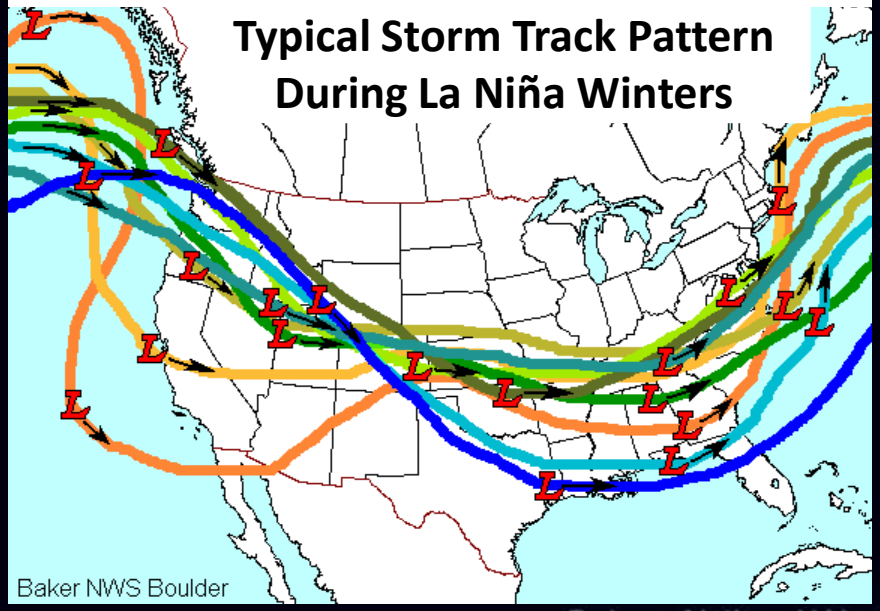
During La Niñas, particularly those of moderate to strong intensity, the Polar or Pacific jet stream will frequently deflect around the top of a large upper level high pressure ridge sitting along the west coast of the continental U.S. for days if not weeks at a time. The jet will then often dive southeast towards the heart of the country passing over Colorado along the way.

Typical Jet Stream Pattern During El Niños



During El Niños, particularly those of moderate to strong intensity, the Pacific jet stream will often curve around the bottom of a broad upper level low pressure trough over the western U.S. Normally the jet would remain over southern California, Arizona and New Mexico, but with occasional diversions up over southern Utah and southern Colorado.



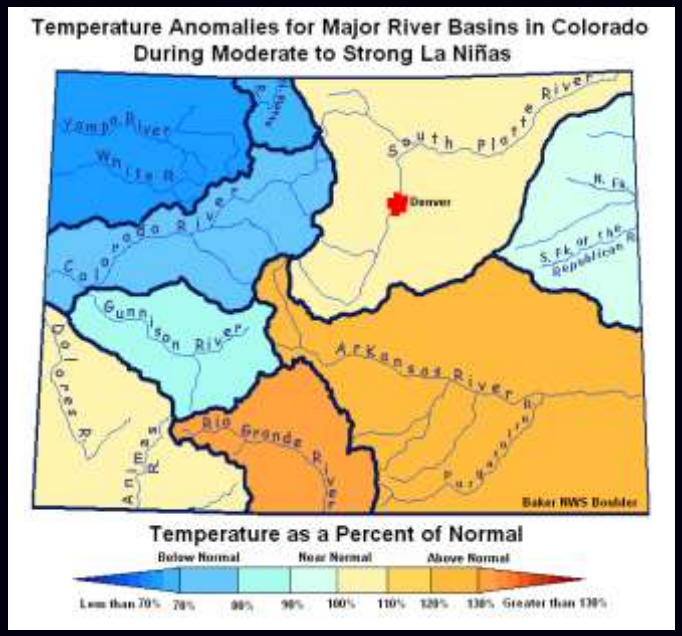


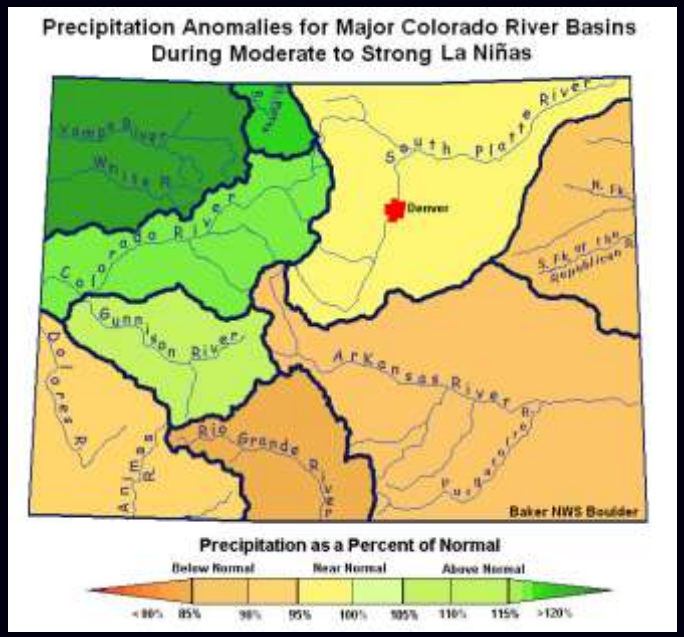
Typical Weather and Storm Track Patterns During the Winter and Spring of Moderate to Strong La Niñas

A majority of the storm systems impacting the western continental United States (CONUS) during the winter and spring of moderate to strong La Niñas originate in the Pacific Northwest region (Washington, Oregon, northern California).

These maritime storm systems capable of copious amounts of precipitation and fierce onshore winds along the coast, race southeast with the Pacific Jet Stream across the northern Great Basin and the central Rocky Mountain region in as little time as a couple of days.

Should the west coast high pressure ridge become positioned farther out over the Pacific Ocean or shift northward over the Gulf of Alaska, the storm track (i.e., the Pacific Jet Stream) will usually shift southward down the west coast, consequently providing the Pacific Northwest a respite from the stormy weather that pattern normally produces.





During Moderate to Strong La Niñas

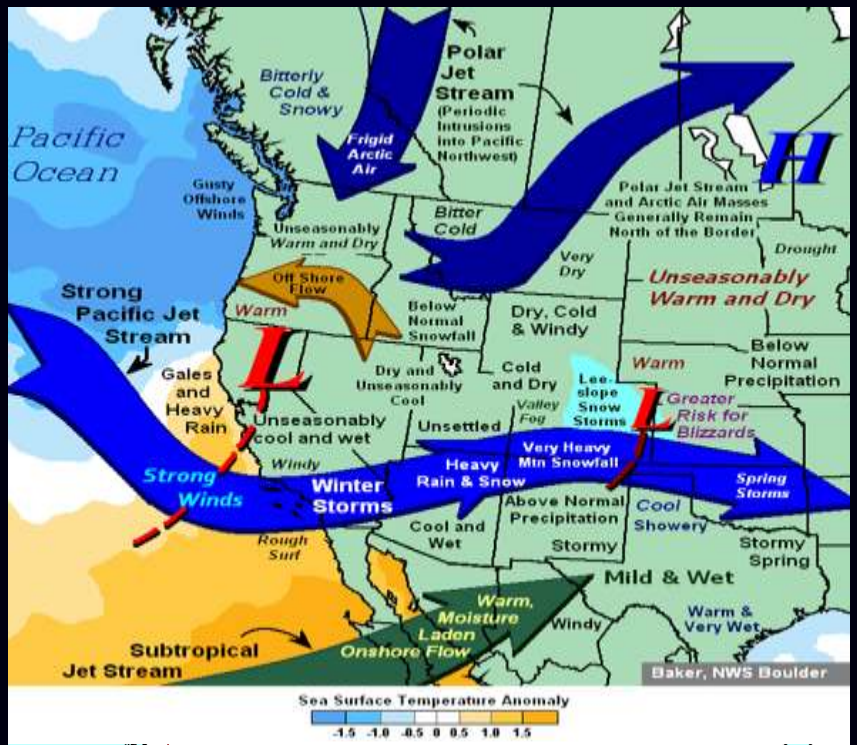
Temperature

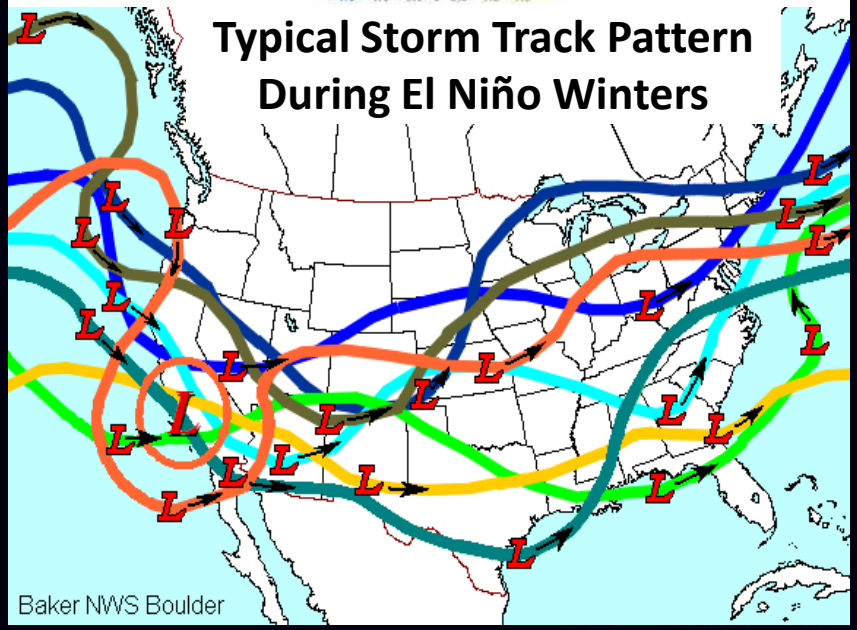
Temperatures typically run colder than average across northwest and west central Colorado and warmer than average across southern and eastern Colorado during moderate to strong La Niñas. During weak La Niñas, this signal is not as strong, but this temperature distribution could still appear for extended periods of time.

Precipitation

During moderate to strong La Niñas, winter season precipitation/snowfall historically has been greater than average across northwest and west central Colorado and less than average for the remainder of the state.

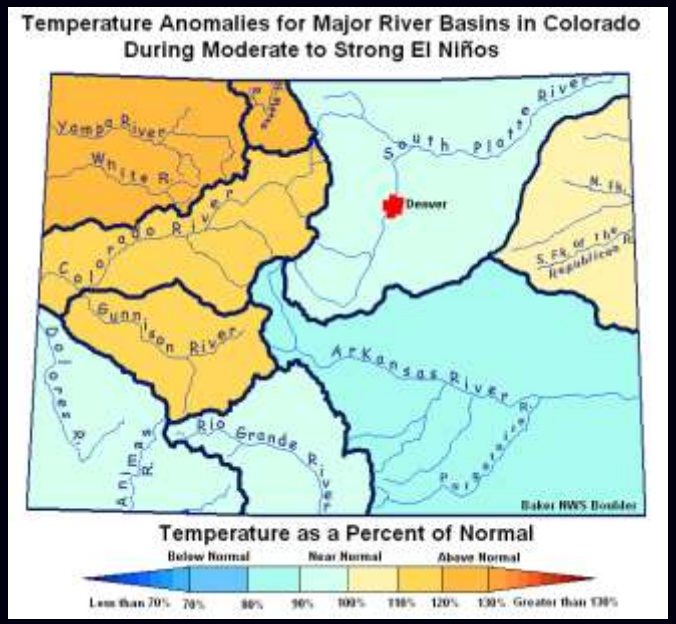
Typical Weather and Storm Track Patterns During the Winter and Spring of Moderate to Strong El Niños





During moderate to strong El Niños, Pacific storms will typically move onshore farther south across central and/or southern California, before tracking east across either the lower Great Basin or the Desert Southwest. Most of the storms will then continue to travel east across the southern Rocky Mountain region. These storm systems possess nearly the same powerful punch as those that pound the Pacific Northwest during moderate to strong La Ninas. However these storm events are typically shorter in duration and occur with less regularity.

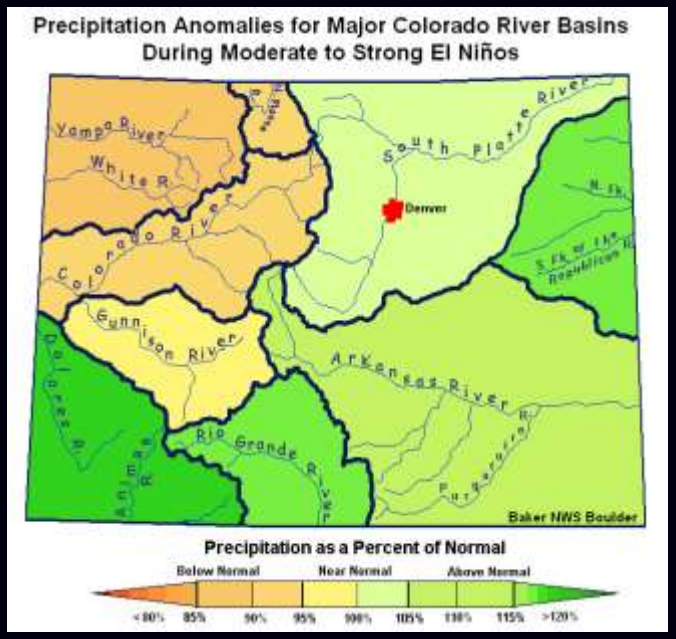
Southern California, the Desert Southwest and the higher terrain of Arizona, southern Utah, southern Colorado and New Mexico normally record above to much above average precipitation and snowfall during the winter and spring with this persistent jet stream and storm track pattern.



During Moderate to Strong El Niños

Temperature

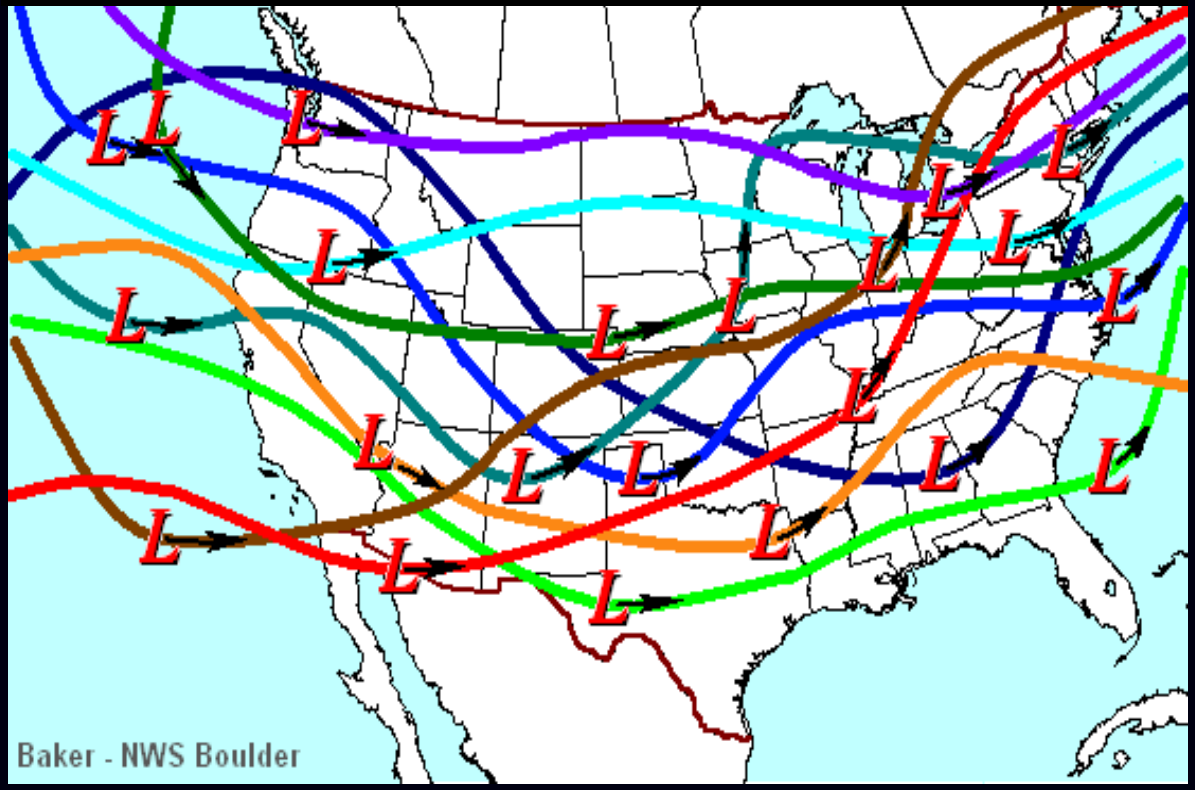
Wintertime temperatures run warmer than average across northwest and west central Colorado and generally colder than average across southern and eastern portions of Colorado during moderate to strong El Niños.



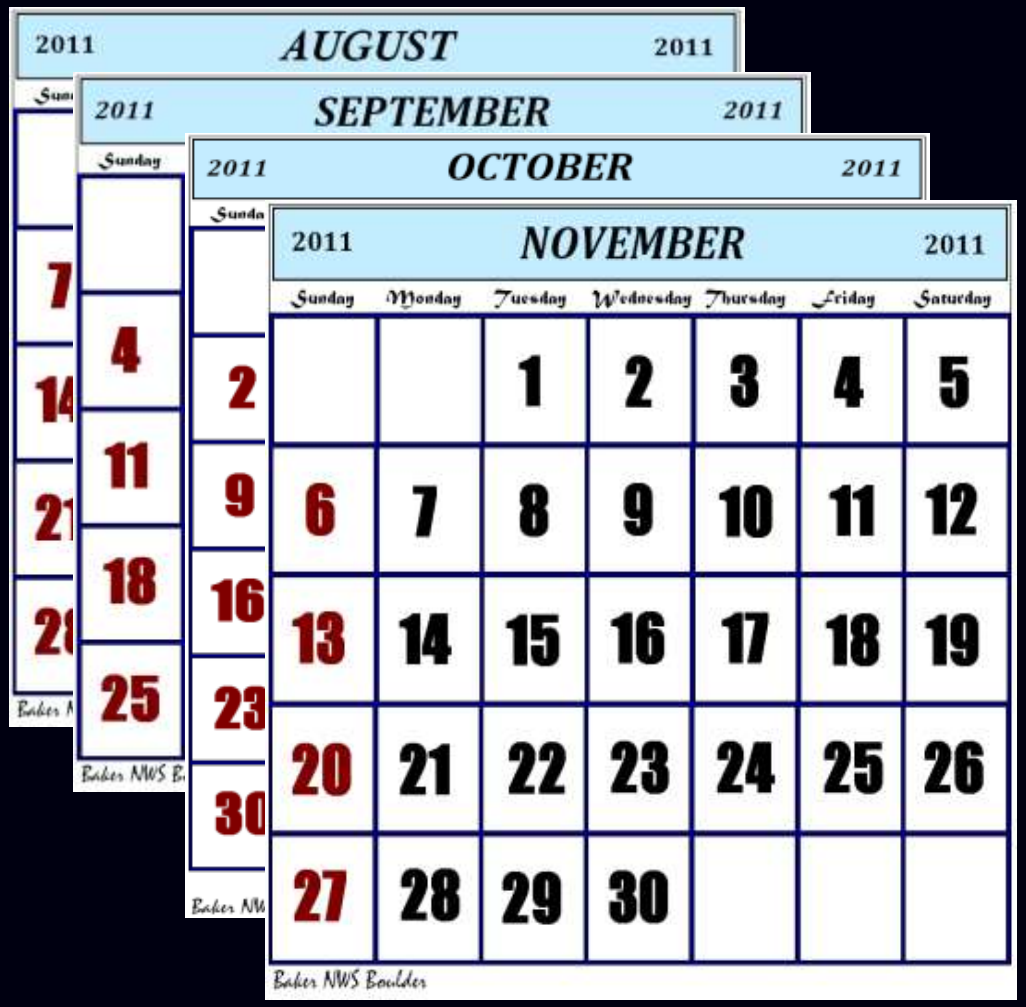
Precipitation

Negative precipitation/snowfall anomalies are common across northwest and west central Colorado during the winter season of moderate to strong El Niños. For the remainder of the state, precipitation was generally above average, with much above average precipitation/snowfall across the southwest corner of the state.

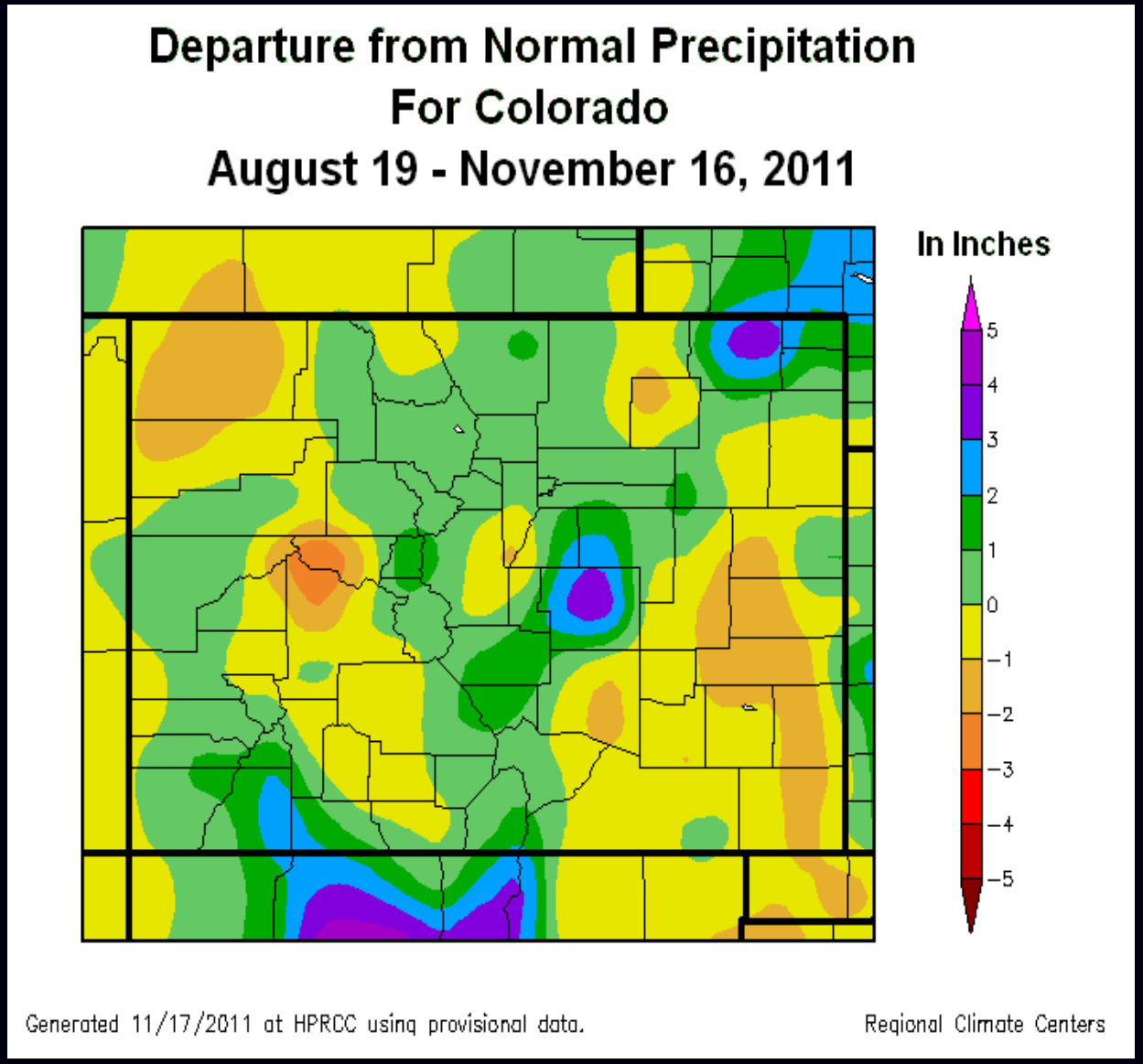
Typical Storm Track Pattern During Weak La Niñas, Weak El Niños and ENSO-Neutral Conditions



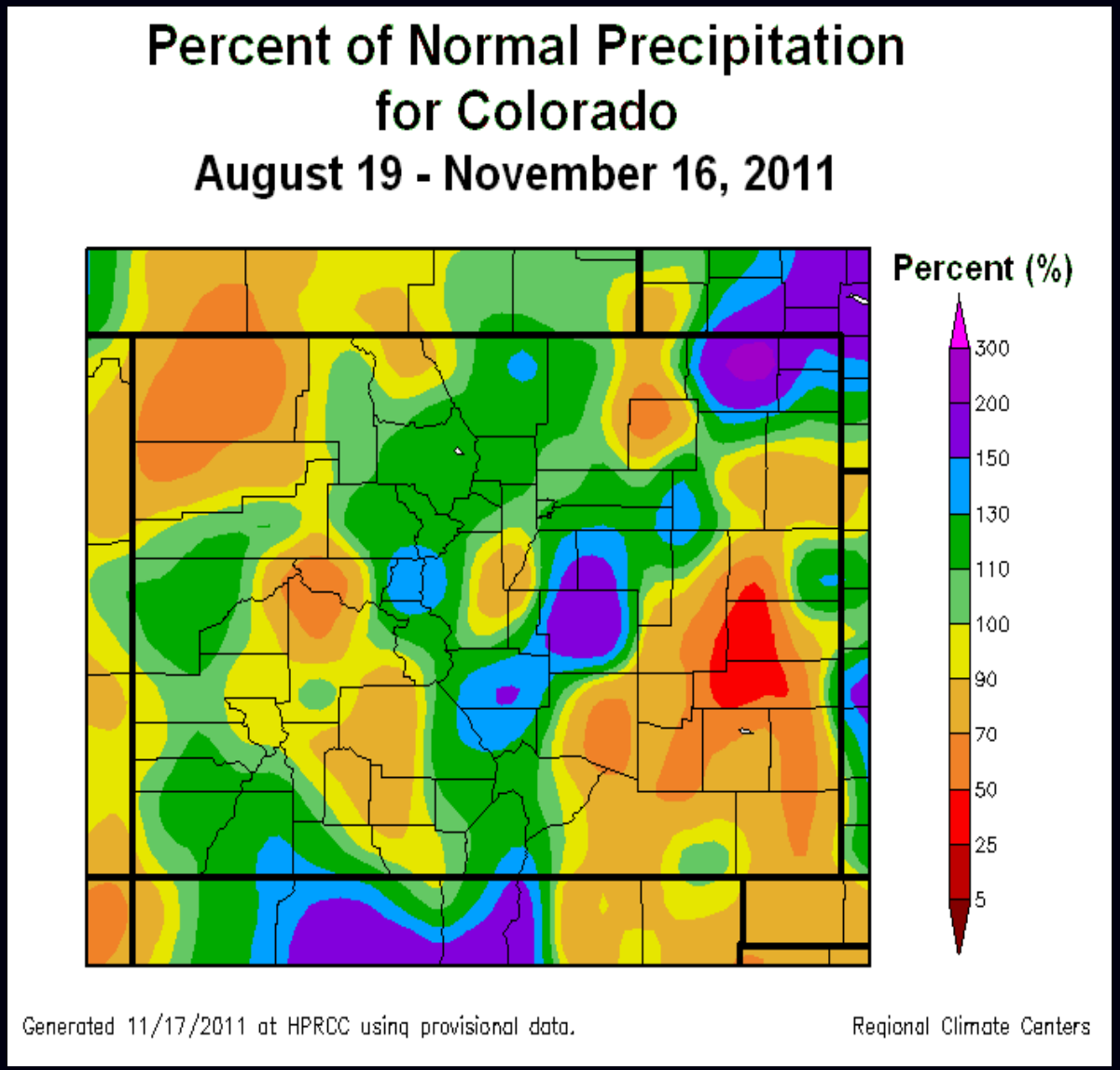
The winter storm track pattern across the continental U.S. tends to be more random in coverage during weak ENSO events and ENSO-neutral conditions. Storms still follow paths similar to those taken by storms during La Niña and El Niño events of moderate to strong intensity, but with far less regularity. This is due in large part to frequent latitudinal oscillations in the Polar/Pacific jet stream. This increased fluctuation in the storm track pattern normally results in fewer temperature extremes and a more uniform distribution of precipitation across Colorado.



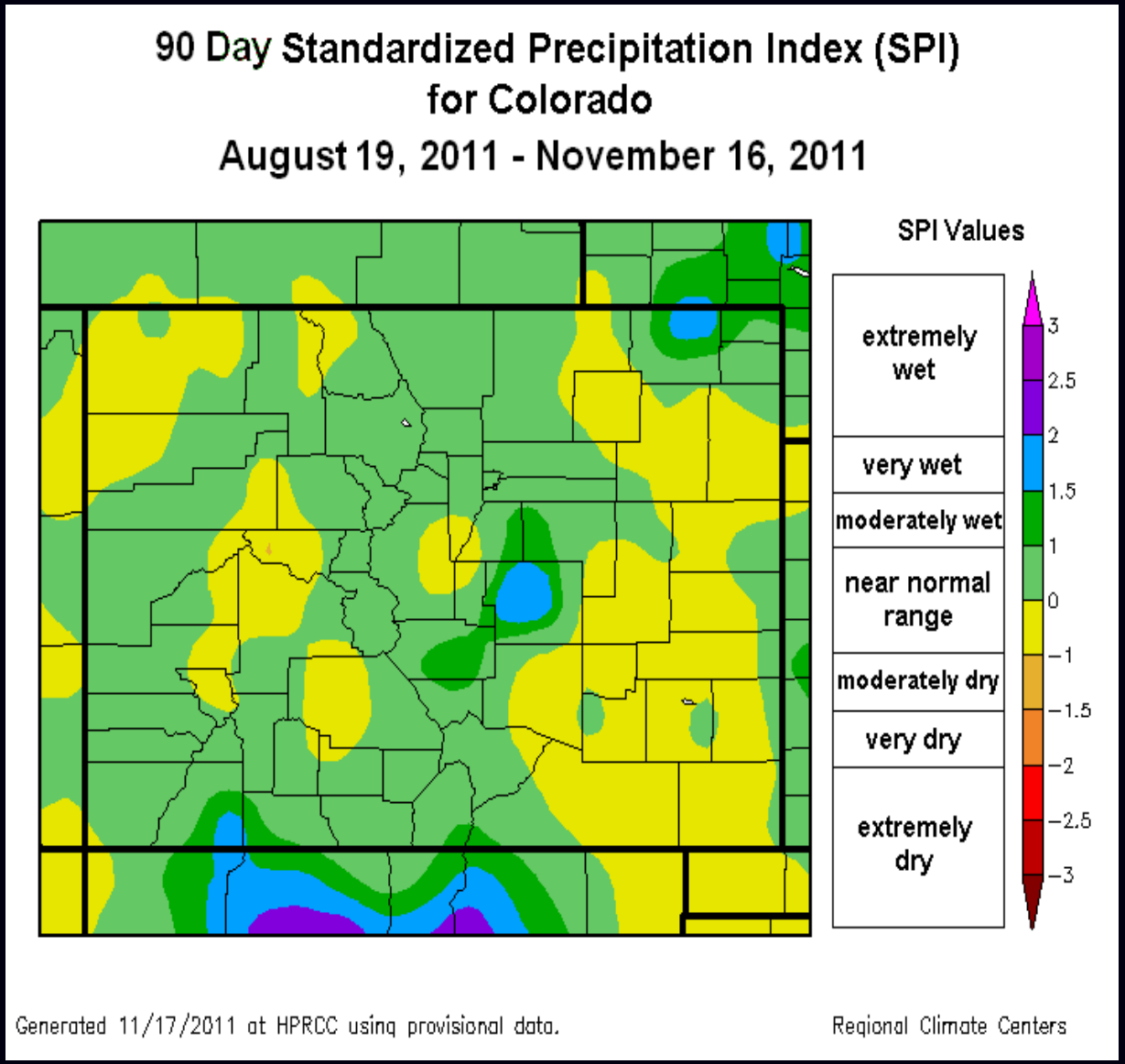
Temperature, Precipitation, and Drought Conditions Across Colorado During the 90-Day Period August 19 to November 16, 2011



During the 90-day period ending November 16, 2011, precipitation across Colorado varied widely, ranging from near 4 inches above normal in central Colorado around Colorado Springs and in Logan County near the Nebraska border, to as much as 3 inches below normal in west central Colorado around the Grand Mesa and Aspen. Negative departures of 1 to 3 inches were also recorded in the Yampa and White River Basins in northwest Colorado and the lower Arkansas River valley in southeast Colorado.



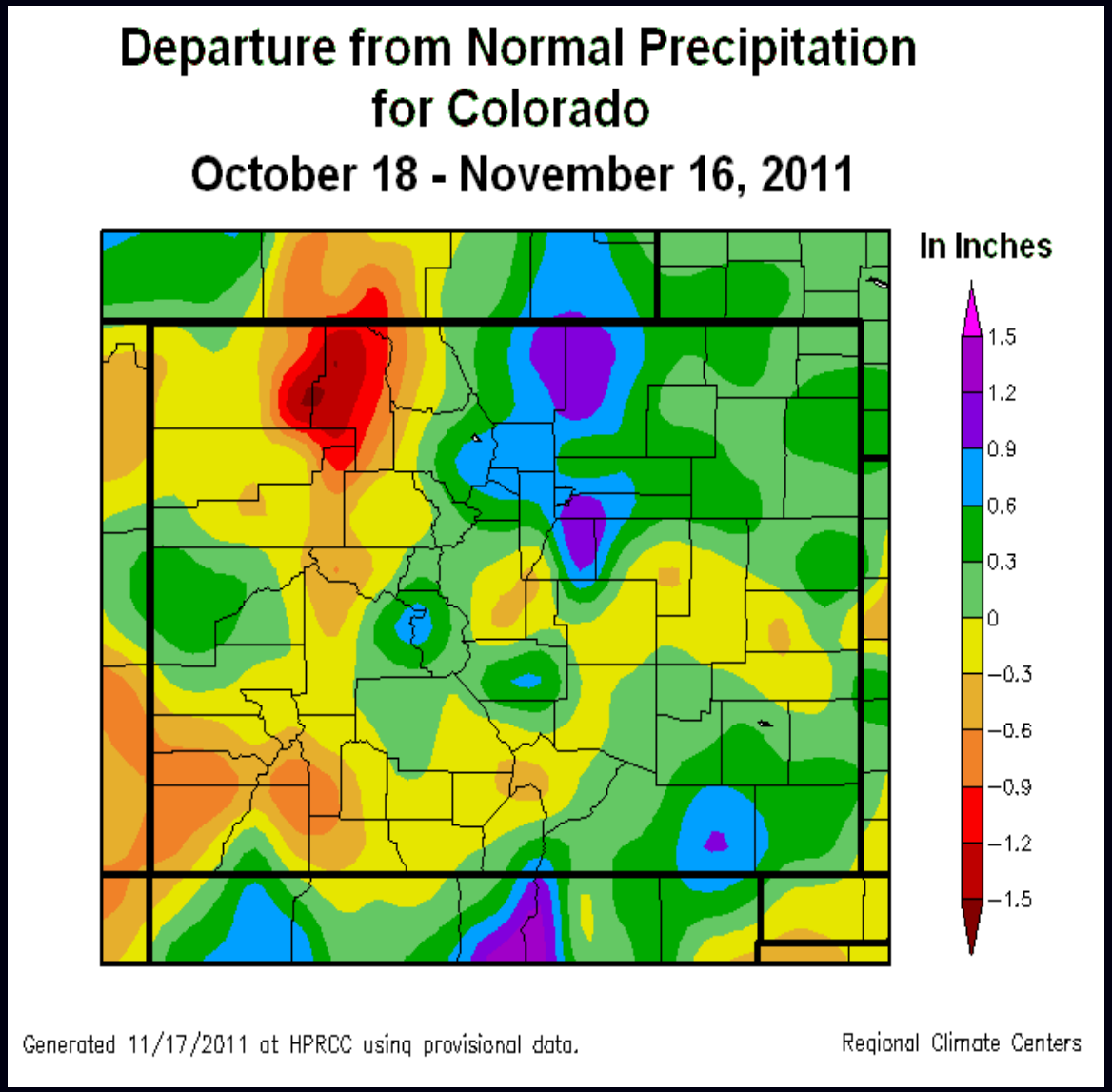
During this same 90-day period, precipitation amounts ranged from around 200 percent above normal in portions of central and northeast Colorado, to as little as 50 percent of normal in portions of southeast Colorado. Most mountain areas and the Palmer Divide area in eastern central Colorado saw amounts ranging from 110 to 150 percent of normal, while the northwest part of the state continued to dry out with precipitation ranging from 50 to 70 percent of normal .



The Standardized Precipitation Index (SPI) for this 90-day period generally indicated near normal moisture conditions across Colorado, with the exception of a couple pockets of very wet conditions in central and northeast Colorado, and along the southwest facing slopes of the San Juan Mountains in southwest Colorado.

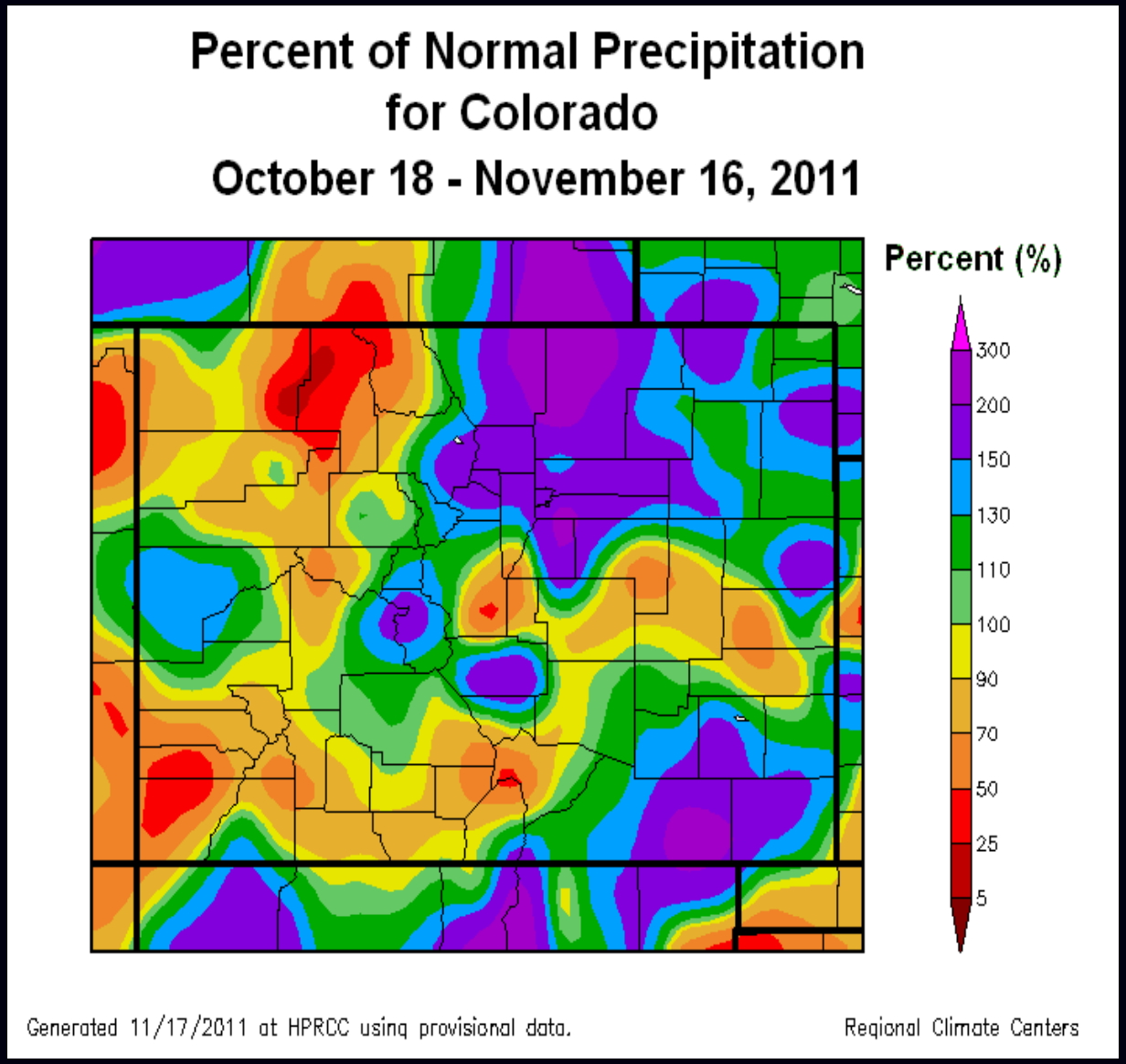
The SPI was developed to monitor potential short term agricultural and long-term hydrological drought conditions. The SPI is a probability index that considers only precipitation.

Temperature, Precipitation, and Drought Conditions Across Colorado During the 30-Day Period August 19 to November 16, 2011



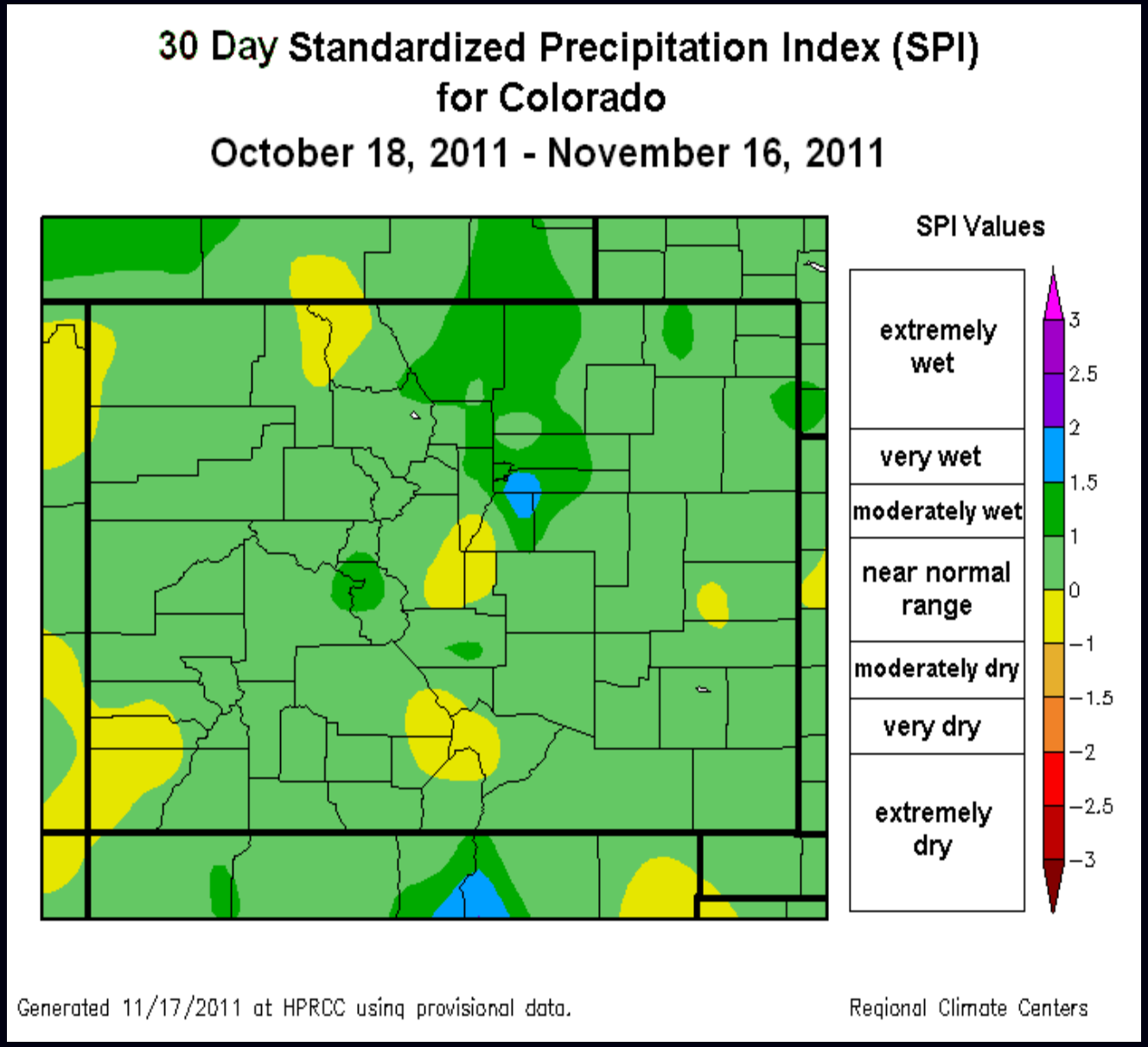
During the 30-day period ending November 16, 2011, precipitation departures varied from just over an inch of water equivalent along the Front Range in north central Colorado and in the vicinity of Colorado Springs in central Colorado, to close to two inches below normal in the upper portions of the Yampa River Valley in northwest Colorado.

Precipitation for the remainder of Colorado varied from a quarter to half inch above normal for much of eastern Colorado and lower portions of the Grand Valley in west central Colorado, to around an inch below normal for much of western Colorado.



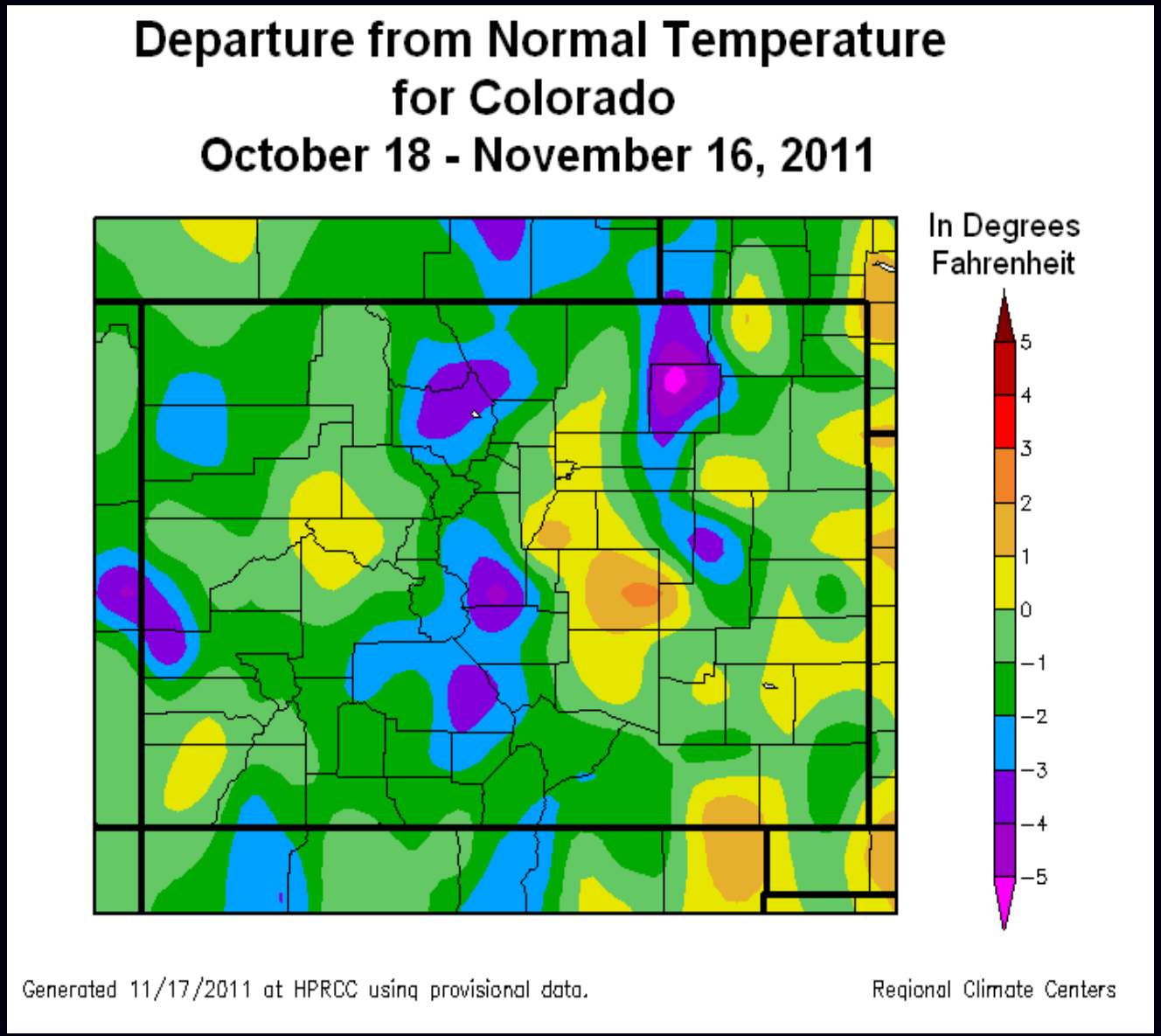
During this same 30-day period, the precipitation along the Front Range in north central Colorado was well above normal, as much as 200 to 300 percent of normal. Portions of southeast Colorado and the Palmer Divide south and southeast of Denver saw similar high percentages.

In contrast, parts of east central Colorado and most of western Colorado, particularly the Yampa Valley River and the Park and Gore Mountain ranges in northwest Colorado, and western portions of the San Juan Mountains in southwest Colorado, saw precipitation totals as low as 25 to 50 percent of normal.



Moisture levels across Colorado, as indicated by the SPI, were generally near normal during the 30-day period ending 16 Nov 2011.

Exceptions to this include the area right along the Front Range in north central Colorado, the Palmer Divide in east central Colorado, the upper Arkansas River Valley near Buena Vista and the far northeast plains where moderately wet to very wet conditions existed.

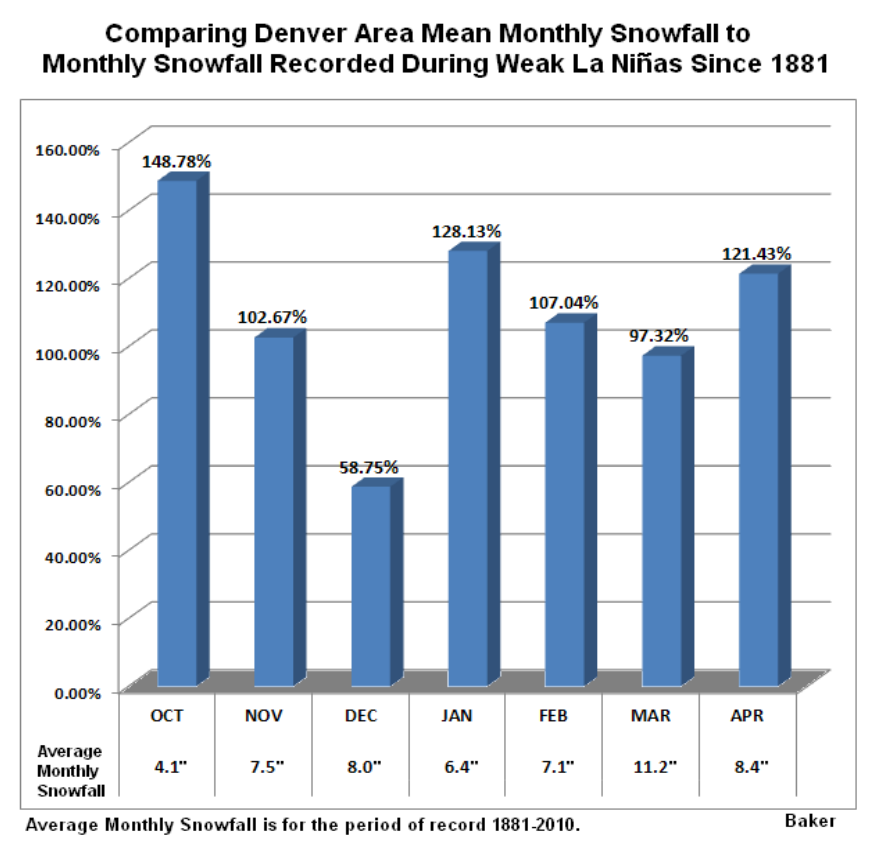


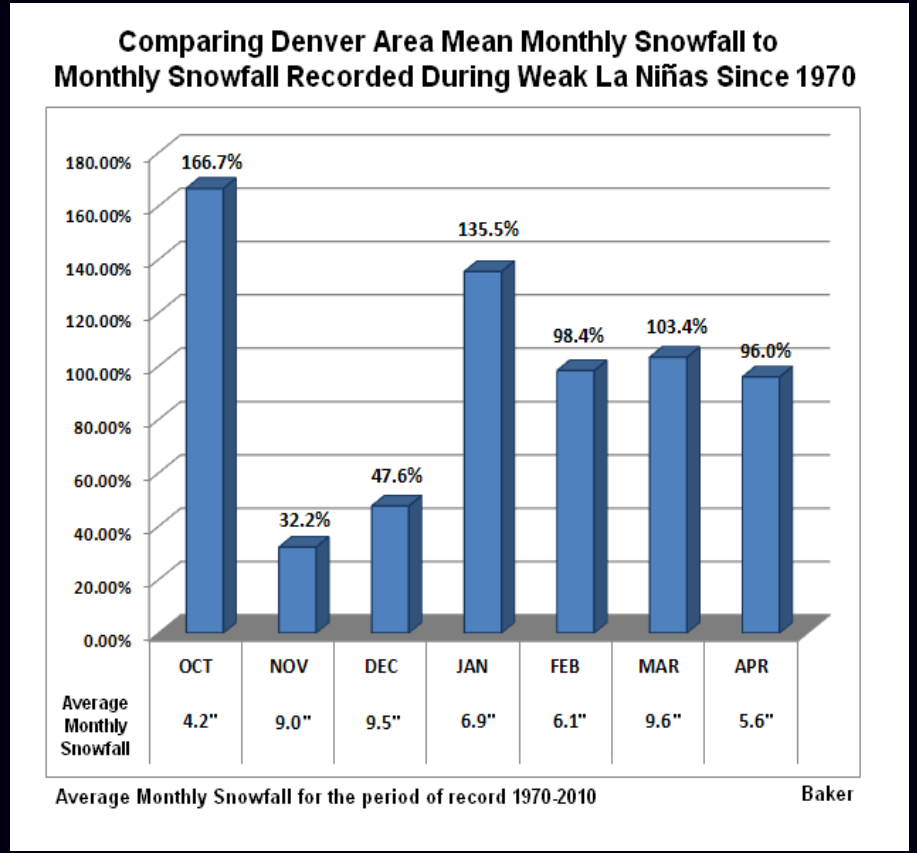
Average monthly temperatures across Colorado during the 30-day period ending Nov 16, 2011, varied widely across the state. Temperatures ranged from close to 5 degs (□F) below normal in parts of the northeast, to around 3 degs (□F) above normal in east central Colorado near Colorado Springs.

Negative temperature anomalies were noted at many mountain locations, as well as along the Utah border.

Historical Temperature and Precipitation Trends for the Denver Area During Weak La Niñas

Snowfall in the Denver Area During Weak La Niñas

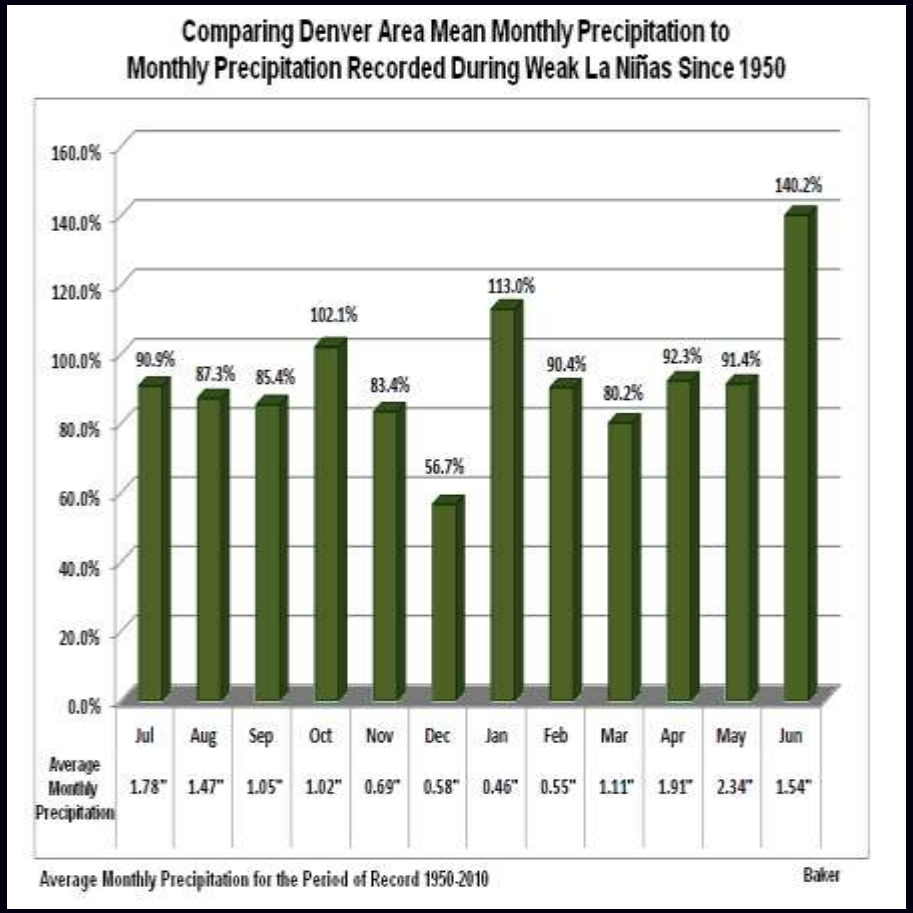


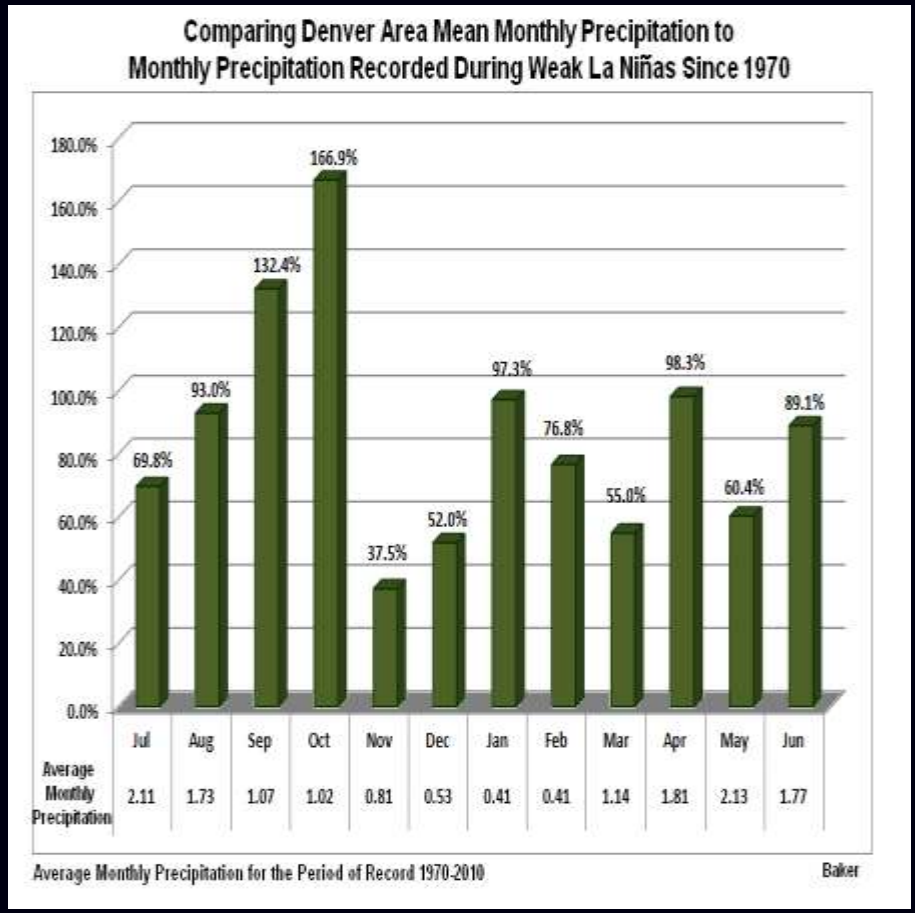


Above Average
(109.0% of Normal)

Average
(99.6% of Normal)

Precipitation in the Denver Area During Weak La Niñas

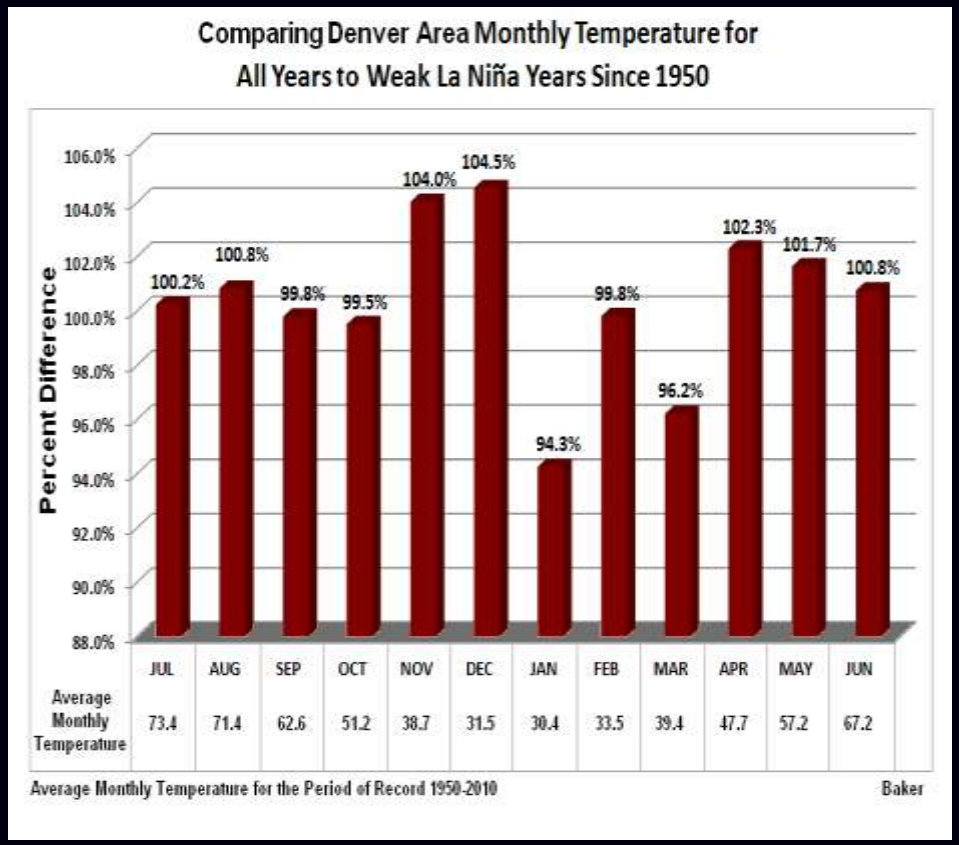


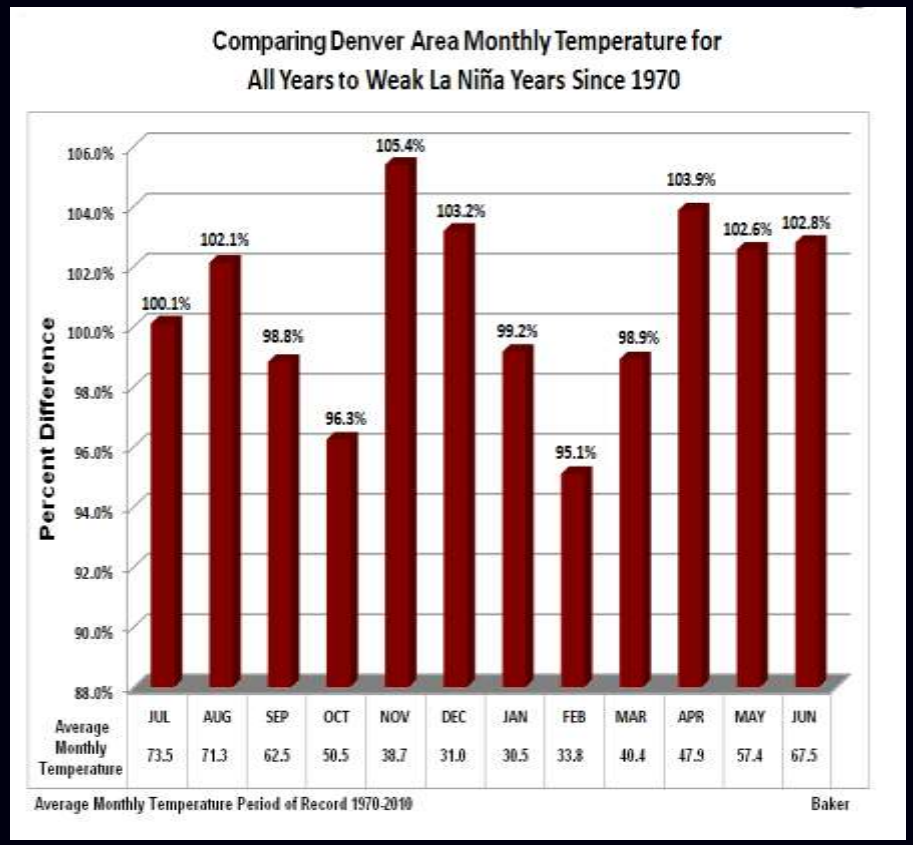


Slightly Below Average
(96.5% of Normal)

Below Average
(85.4% of Normal)

Temperature in the Denver Area During Weak La Niñas





Slightly Below Average
(98.0% of Normal)

Average
(100.7% of Normal)

Historical
Temperature and Precipitation
Trends
for Colorado
During El Niños, La Niñas
and ENSO-Neutral
Conditions

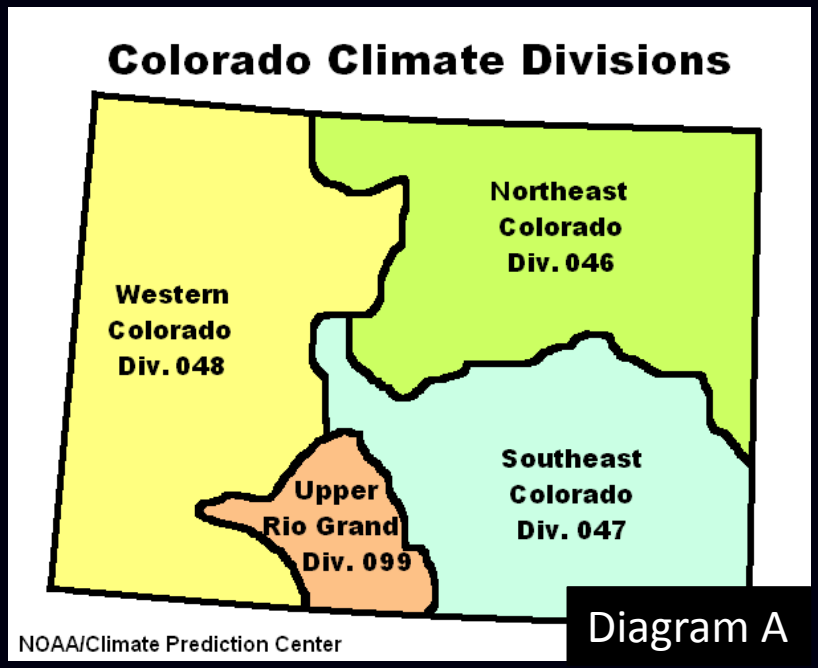


Diagram A

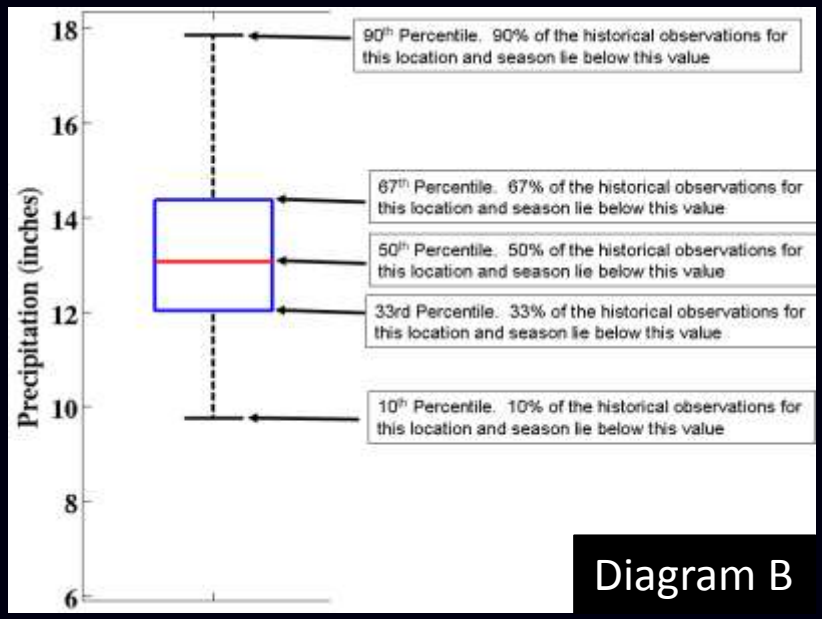


Diagram B

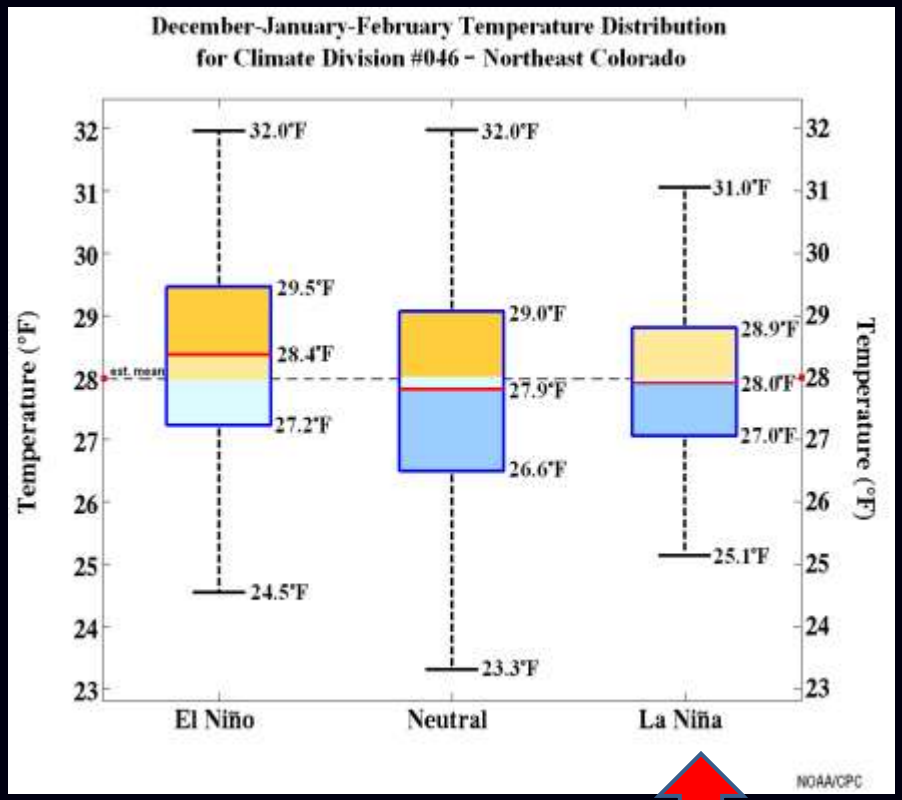
Diagram A depicts the four CPC climate mega-divisions in Colorado. Climate divisions 046, 047 and 099 are located on the east side of the Continental Divide, while division 048 is situated on the state's western slope.

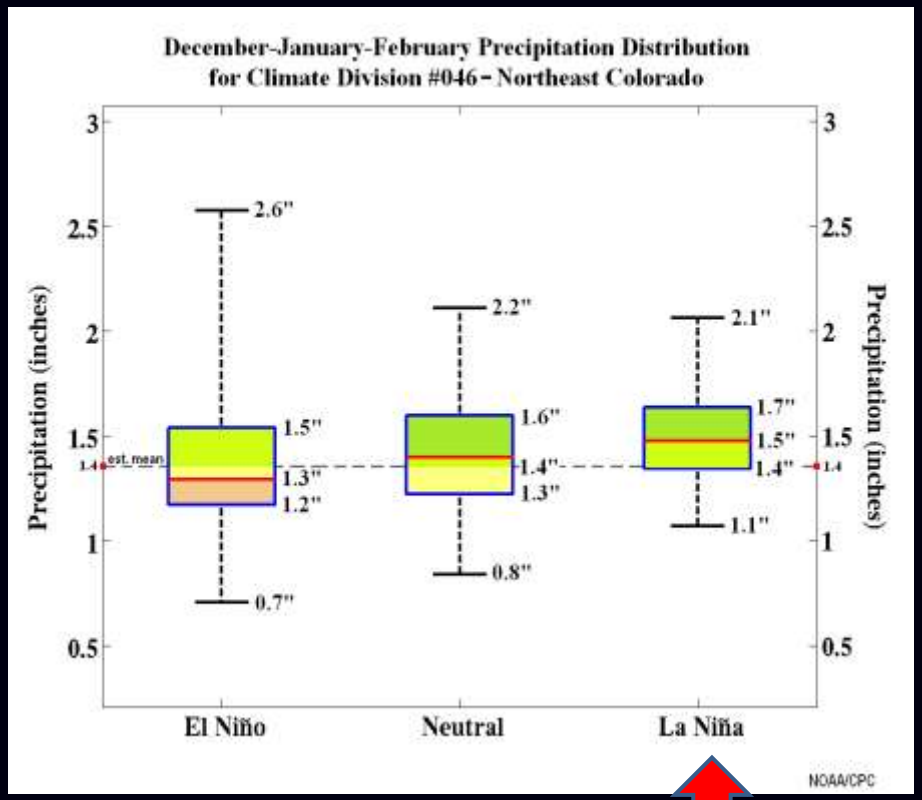
CPC has produced historical 3-month temperature and precipitation distributions associated with three different ENSO categories –El Niño, La Niña and neutral (non-ENSO) conditions – for each climate division in the United States.

Diagram B depicts and describes the ENSO box and whisker analysis plots used by CPC to present these historical temperature and precipitation distributions.

The red line inside the ENSO box represents the mean or 50th percentile of the data (temperature or precipitation) distribution for each climate division. Approximately 34% of the total observations exist within the ENSO box, and the remaining observations (about 66%) lie outside of the box along the whiskers extending above and below the box.

ENSO Box and Whisker Analysis Plots for the Northeast Colorado Climate Division #046 for the 3-Month Season December-February

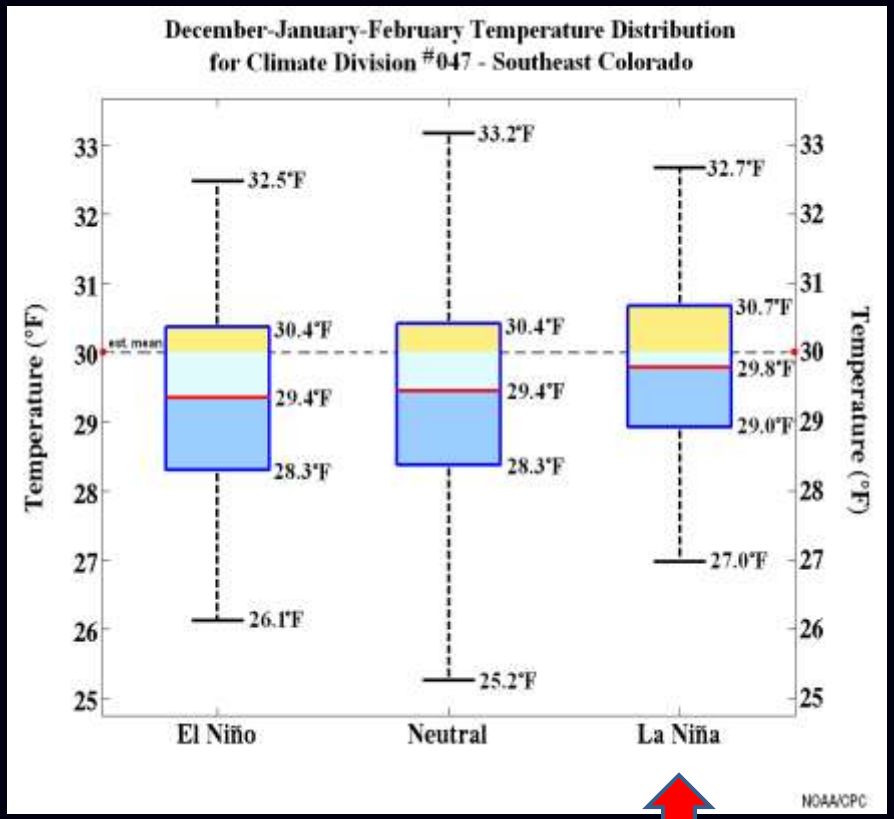


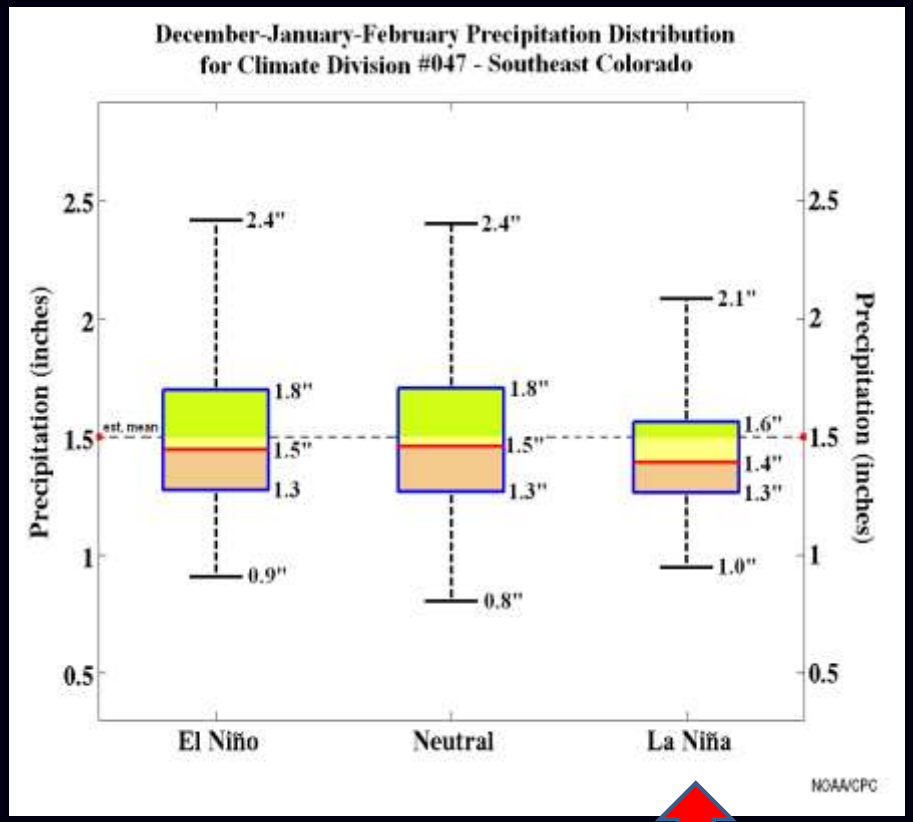


Historically, temperatures for northeast Colorado during the three month climate season December-February were slightly above average for El Niños, and near average for ENSO-neutral conditions and La Niñas.

Precipitation for northeast Colorado during this same three month period was slightly below average during El Niños, near average for ENSO-neutral conditions, and slightly above average during La Niñas.

ENSO Box and Whisker Analysis Plots for the Southeast Colorado Climate Division #047 for the 3-Month Season of December-February

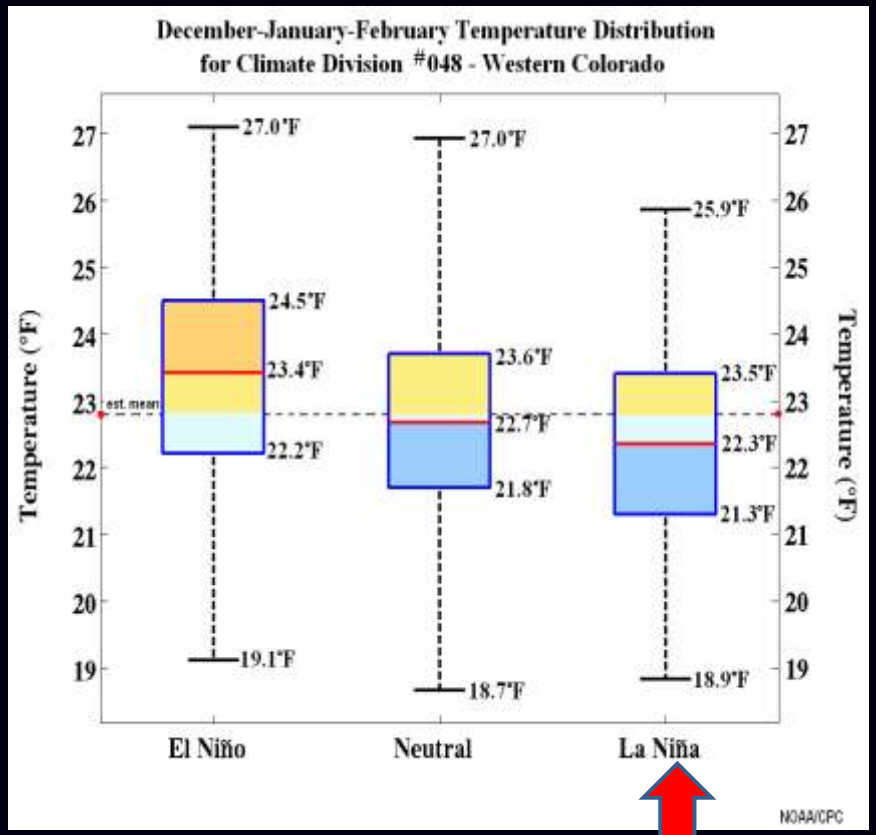




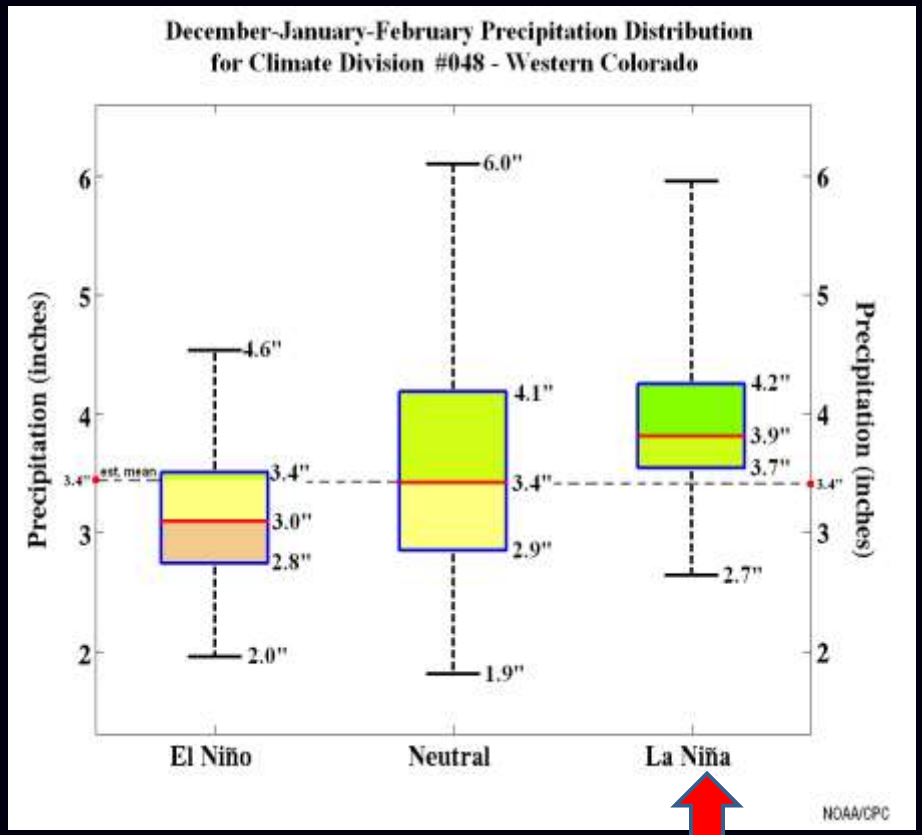
Temperatures in southeast Colorado during the three month climate season December-February have been below average during El Niños and ENSO-neutral conditions and slightly below average during La Niñas.

Precipitation in southeast Colorado for the same three month period was near average during El Niños and ENSO-neutral conditions and slightly below average under La Niñas.

ENSO Box and Whisker Analysis Plots for the Western Colorado Climate Division #048 for the 3-Month Season of December-February



Temperatures for western Colorado during December-January-February historically was above average during El Niños, near average for ENSO-neutral conditions, and below average during La Niñas.



Precipitation for western Colorado during the same three month period was below average during El Niños, near average for ENSO-neutral conditions, and above average during La Niñas.

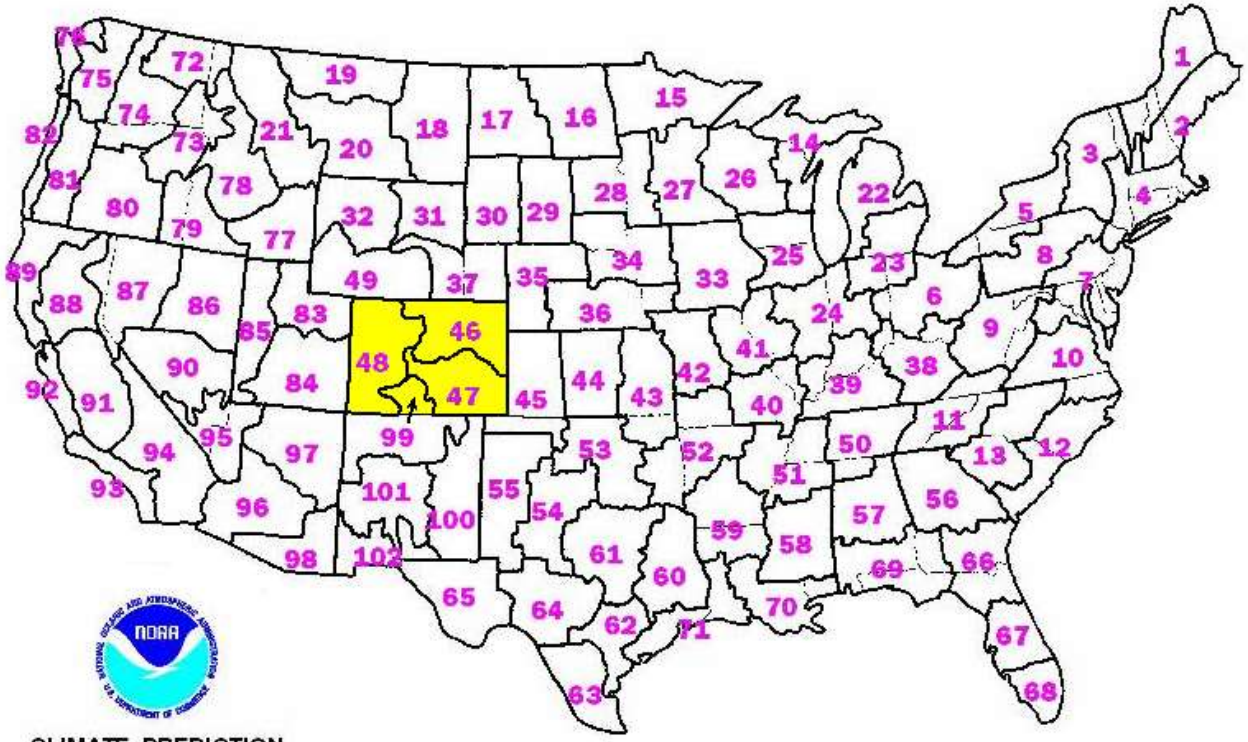
December 2011- February 2012 Temperature and Precipitation Outlook for Colorado Issued by NOAA's Climate Prediction Center

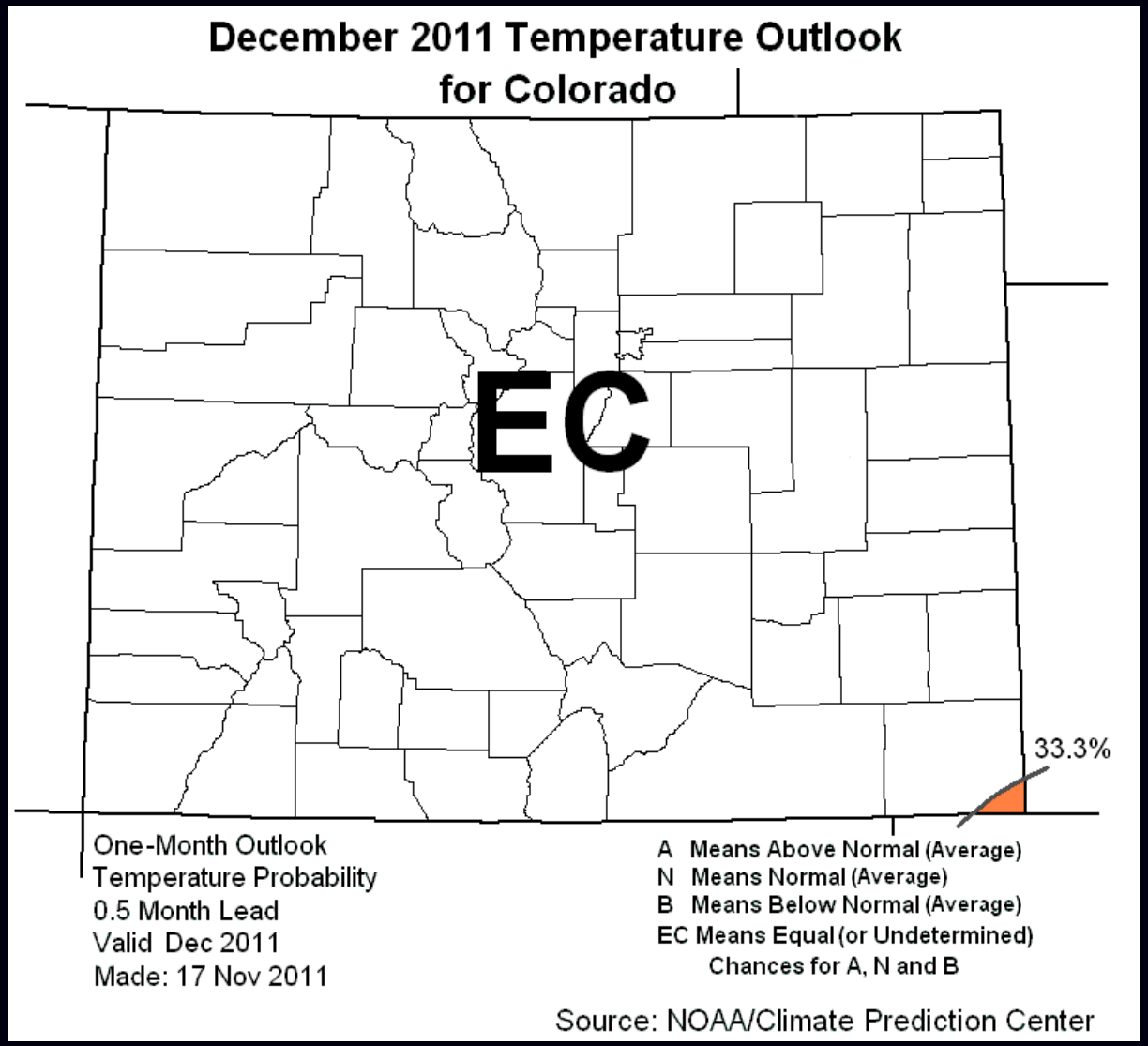
Climate Prediction Center Seasonal Outlooks

The National Weather Service Seasonal Climate Outlooks predict the probability of conditions being among the warmest/coldest or wettest/driest terciles of years compared to the period of record 1981-2010.

The outlooks indicate probability of being in three specific categories in reference to the 30-year climatology from 1981-2010. They are above, below and average.

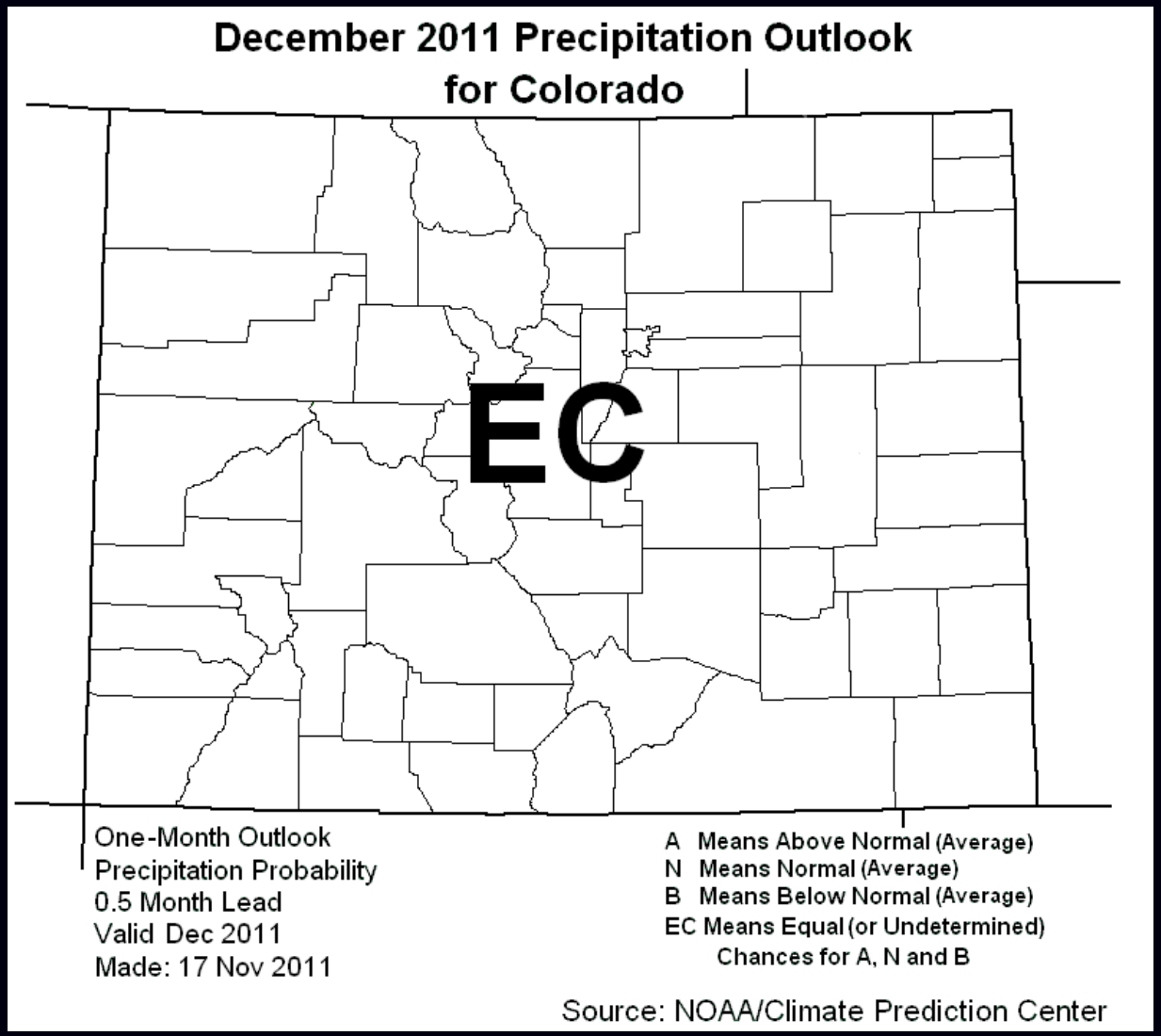
Remember, Climate Predicition Center (CPC) outlooks are made at the scale of the climate megadividions (see the map below).





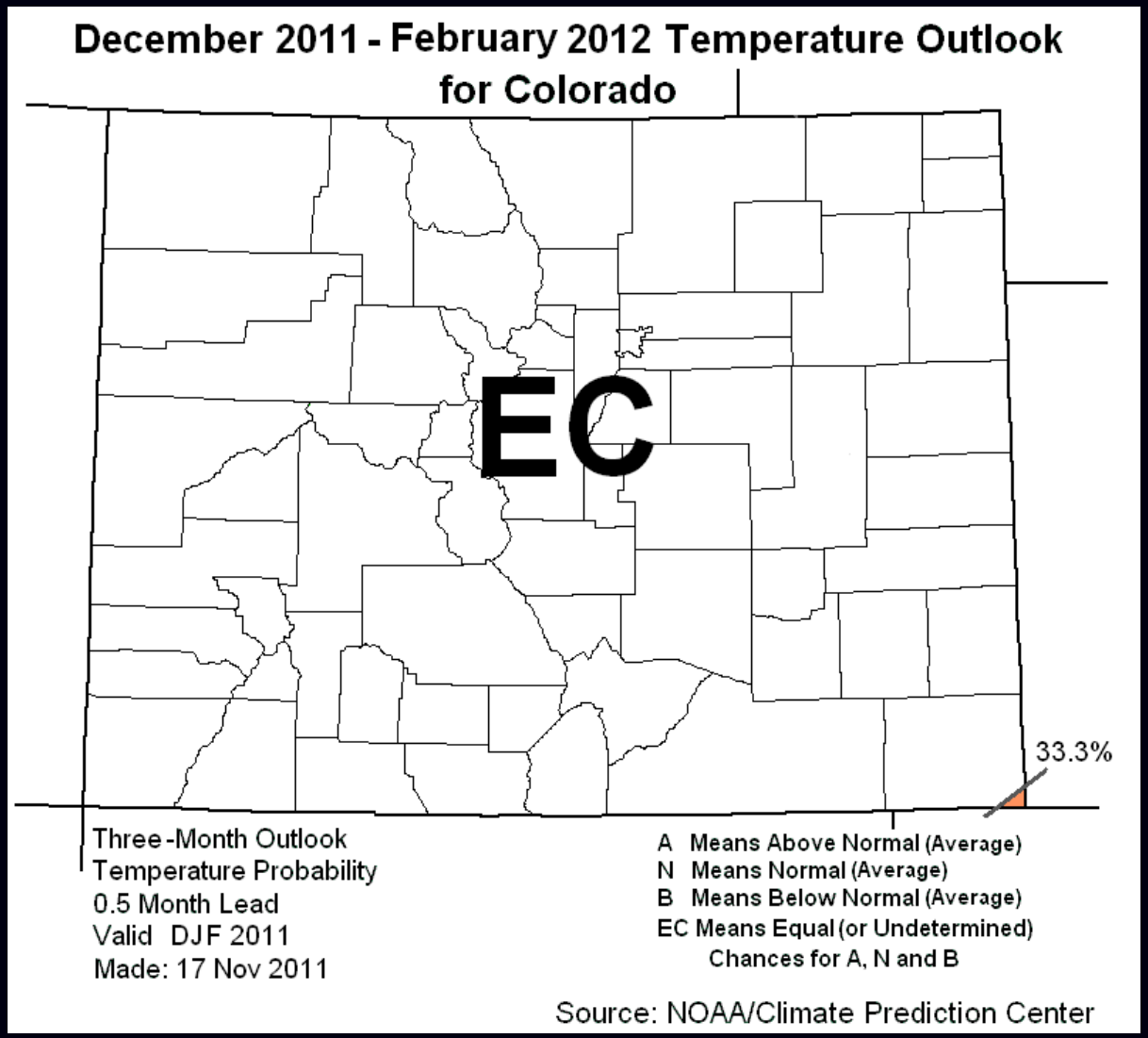
December 2011 Temperature Outlook for Colorado

The latest one-month outlook from NOAA's Climate Prediction Center calls for an equal (or undeterminable) chance of above, below and near average temperatures across Colorado during the month of December.



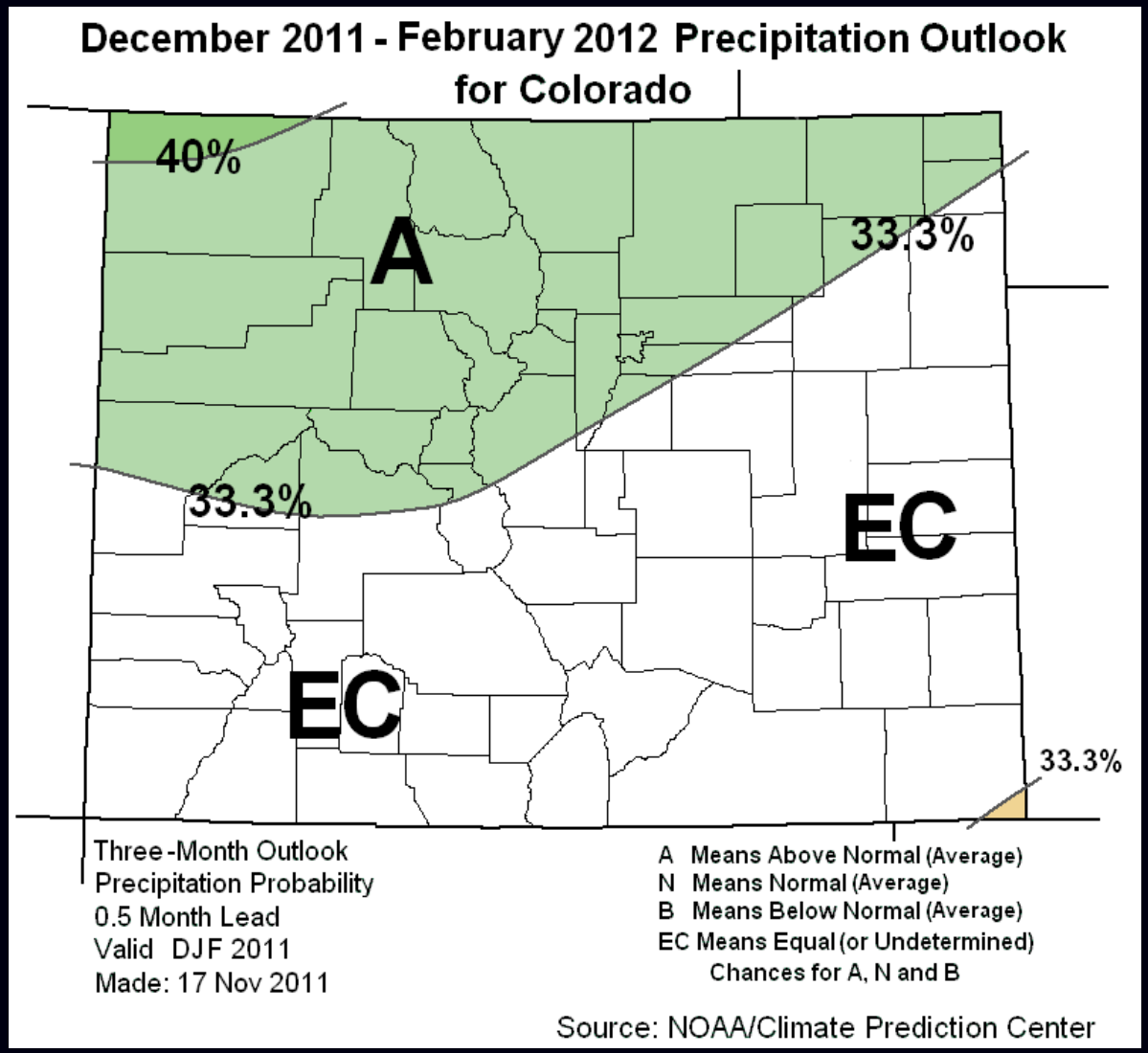
December 2011 Precipitation Outlook for Colorado

CPC is also calling for an equal (or undeterminable) chance of above, below and near average precipitation across Colorado during December.



December 2011-February 2012 Temperature Outlook for Colorado

The latest three-month temperature outlook from CPC calls for an equal (or undeterminable) chance of above, below and near average temperatures across Colorado during the period December 2011 to February 2012.



December 2011-February 2012 Precipitation Outlook for Colorado

Finally, CPC is calling for above average precipitation (a 33.3 to 40% chance) across northwest and north central Colorado during the period December 2011 to February 2012.

For the remainder of the state, CPC is calling for an equal (or undeterminable) chance of above, below and near average precipitation during this three month period—as indicated by the EC symbol.

Summing It Up…

- La Niña has returned for another winter season.
- Climate models predict a La Niña of weak to possibly moderate strength during the December 2011-February 2012 climate season, followed by a gradual transition to ENSO-neutral conditions by the spring of 2012.
- Weak La Niñas historical have had modest impact on winter weather patterns in Colorado, compared to that associated with moderate to strong La Niñas and El Niños.
- During weak La Niñas as is the forecast for the upcoming winter season, temperatures have typically been below average and precipitation above average across northwest and north central Colorado, with slightly above temperatures and slightly below average precipitation for the remainder of the state.
- The latest outlook from NOAA's Climate Prediction Center calls for an equal (or undeterminable) chance for above, below and near normal temperatures and precipitation across nearly all Colorado during the climate season December 2011-February 2012. An exception to this pertains to the northwest and north central parts of the state where the outlook calls for a heighten chance for above normal precipitation.