

# What's Happening to La Niña And A Look Ahead to The Rest of this Winter

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January 21, 2011



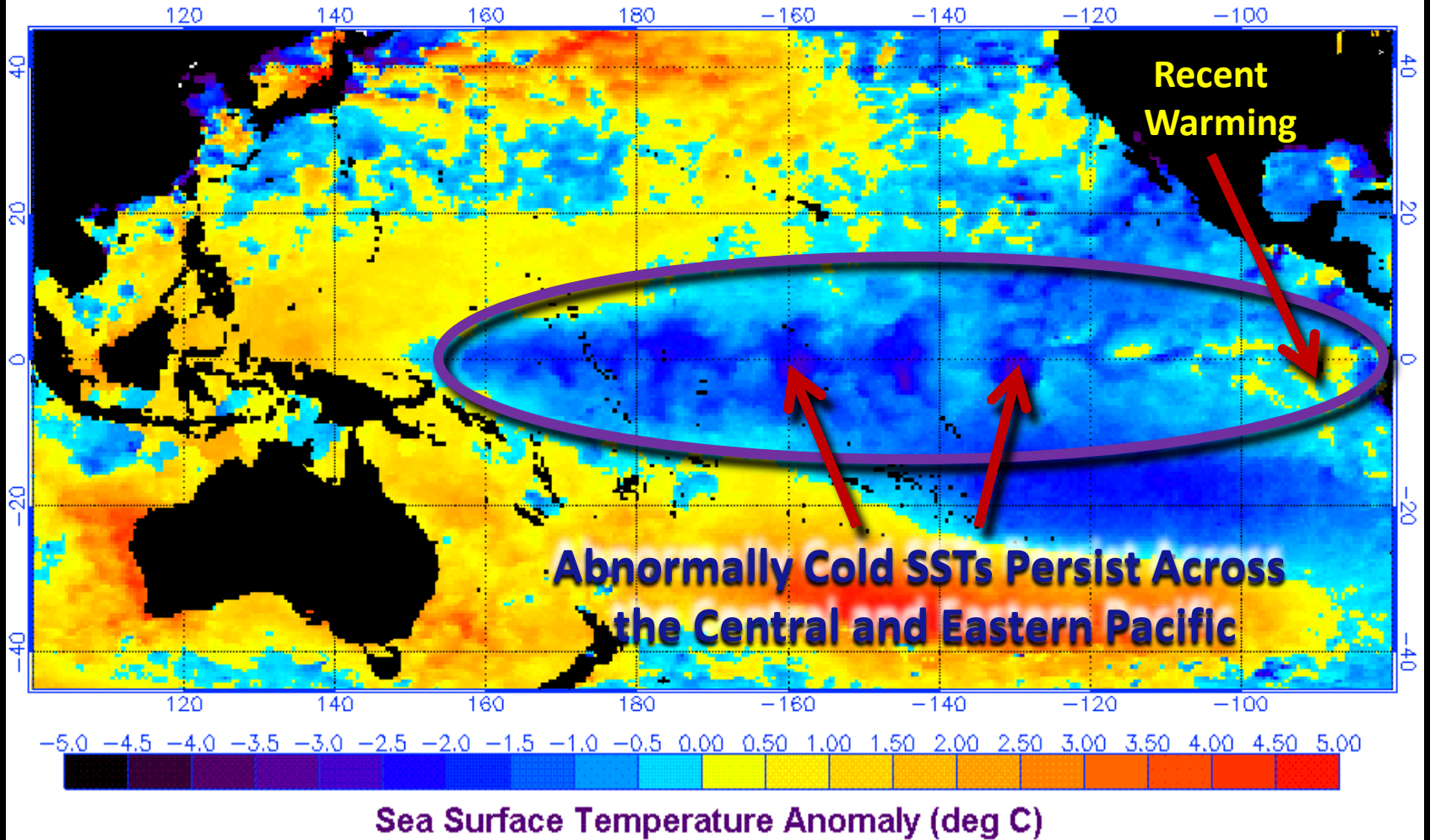
# Overview

- **La Niña conditions persist across the tropical Pacific Ocean.**
- **These conditions are forecast to continue through at least this spring.**
- **Beyond this spring the outlook for this La Niña is considerably more uncertain. A number of the ENSO-climate models indicate ENSO-neutral conditions by this summer. Others indicate a continuation of weak La Niña conditions, while the remaining models suggest the start of a weak El Niño.**
- **Even as the current La Niña weakens, it should continue to play a role in Colorado's weather for the remainder of this winter and perhaps into this spring.**
- **The latest three month outlook prepared by NOAA's Climate Prediction Center indicates a 33-50 percent probability of above normal temperatures and below normal precipitation for all but the extreme northwest corner of Colorado. This maybe suggesting a return to abnormally warm and dry weather statewide by this spring as was observed last fall.**



**La Niña Continues  
But For How  
Much Longer?**

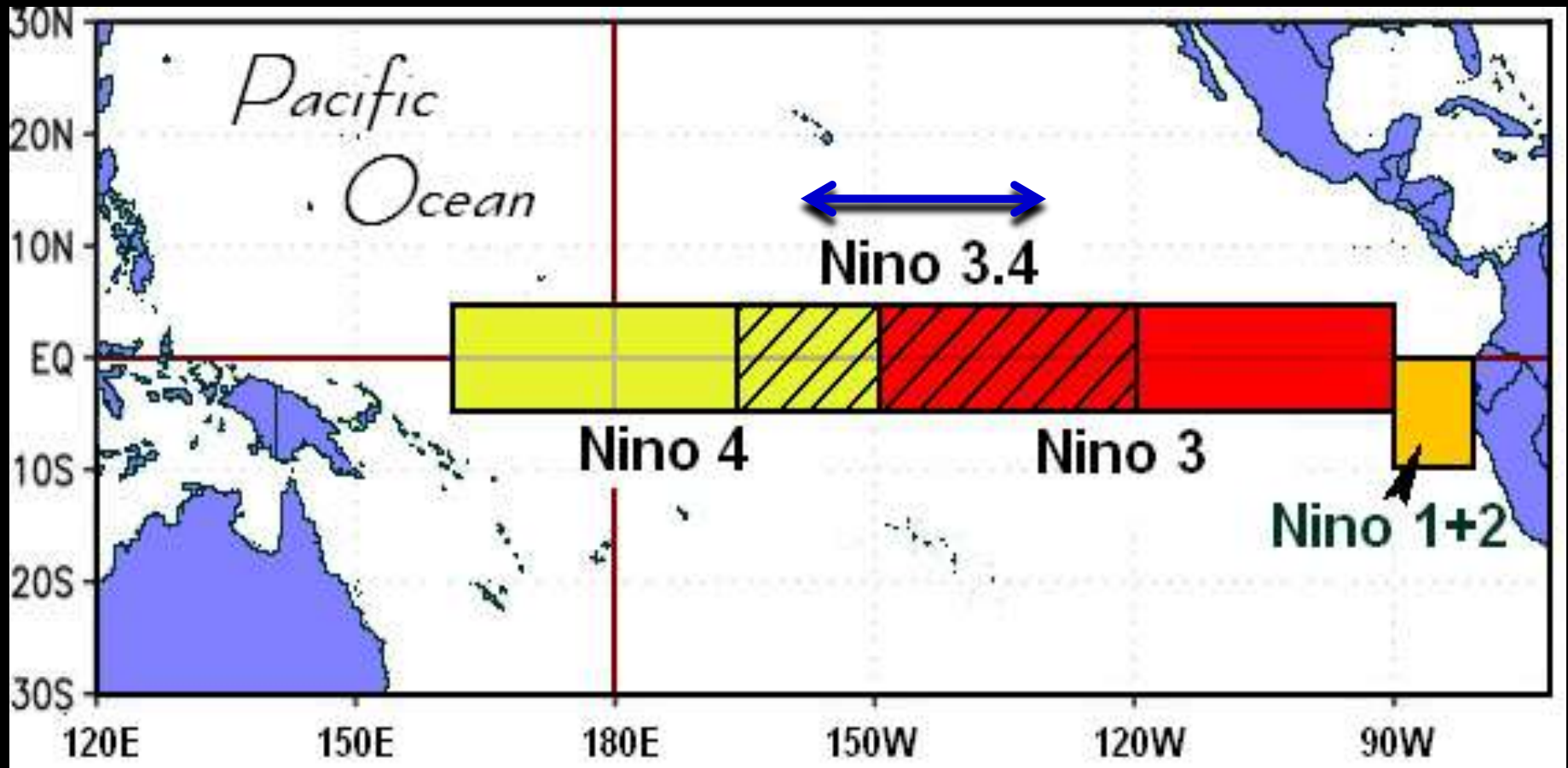
# NOAA/NESDIS SST Anomaly for the Pacific (degrees C) for Jan. 20, 2011



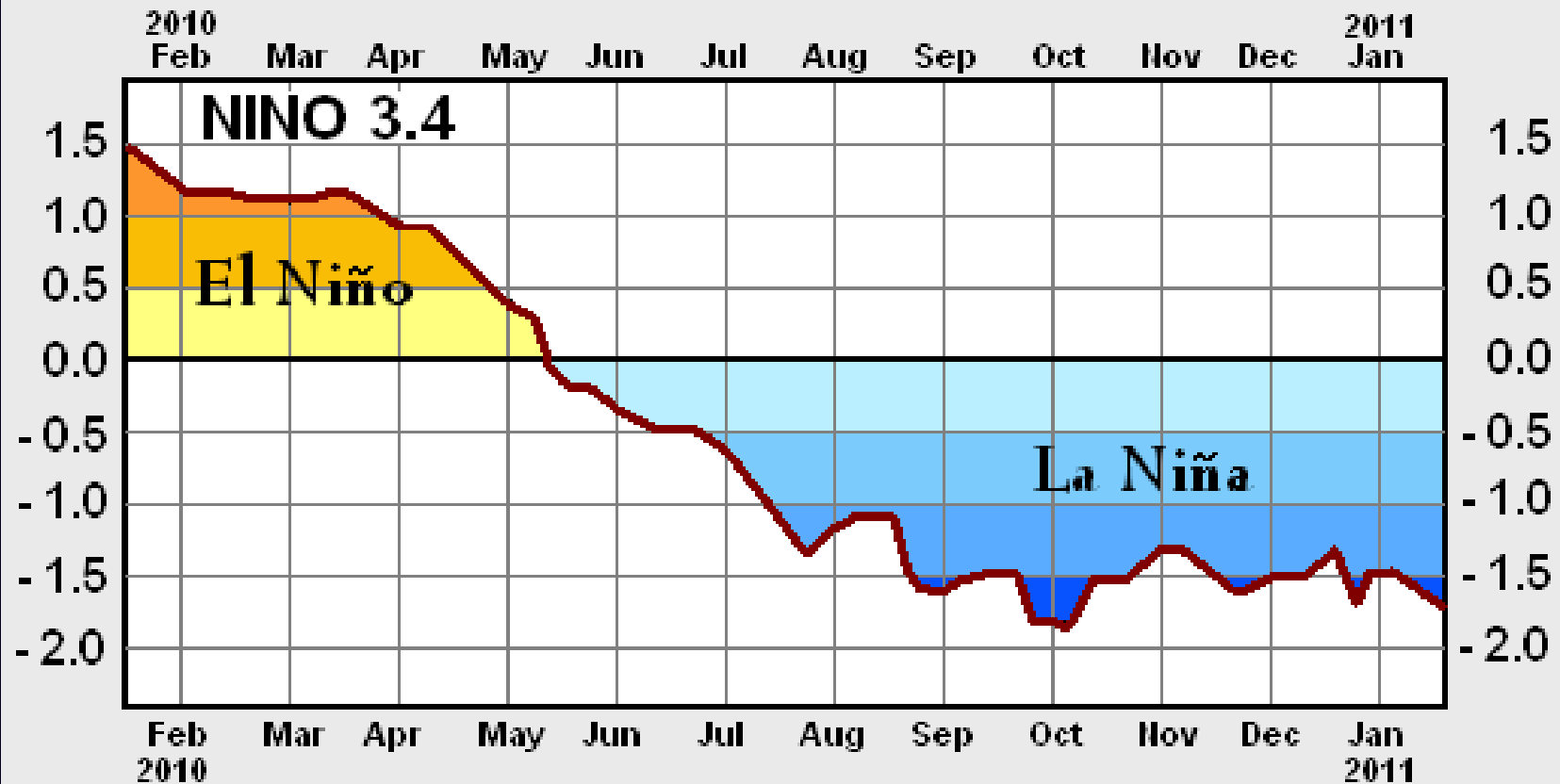
Sea surface temperatures (SSTs) across the central and eastern tropical Pacific remain anomalously cold in January. Although in the past couple of weeks SSTs have begun to warm off the coast of South America, consequently reducing the negative SST anomaly in this region of the tropical Pacific.



# Niño Regions in the Tropical Pacific Ocean



**Niño 3.4 – The principal region in the tropical eastern Pacific used by the Climate Prediction Center (CPC) for monitoring, assessing and predicting ENSO.**



NOAA/Climate Prediction Center (CPC) Jan 17 2011

Below average sea surface temperatures (SSTs) indicative of a moderate to strong La Niña persist across NINO 3.4 region of the tropical eastern Pacific. **The SST departure for the week of Jan 10, 2011 for Niño 3.4 was -1.8°C.** After a small upward spike in December, the mean SST anomaly temperature cooled slightly during the first half of January of 2011.

# Oceanic Niño Index (ONI)

- The **ONI** is based on SST departures from average in the Niño 3.4 region, and is a principal measure for monitoring, assessing, and predicting ENSO.
- Defined as the three-month running-mean SST departures in the Niño 3.4 region.
- Used to place current events into a historical perspective
- **NOAA's operational definitions of El Niño and La Niña are keyed to the ONI index.**

# NOAA Operational Definitions for El Niño and La Niña

El Niño: characterized by a *positive* ONI greater than or equal to +0.5 C.

La Niña: characterized by a *negative* ONI less than or equal to -0.5 C.

By historical standards, to be classified as a full-fledged El Niño or La Niña episode, these thresholds must be exceeded for a period of at least 5 consecutive overlapping 3-month seasons.

*CPC considers El Niño or La Niña conditions to occur when the monthly Niño3.4 OISST departures meet or exceed +/- 0.5°C along with consistent atmospheric features. These anomalies must also be forecasted to persist for 3 consecutive months.*



# Oceanic Niño Index - ONI

| Year | DJF  | JFM  | FMA  | MAM  | AMJ  | MJJ  | JJA  | JAS  | ASO  | SON  | OND  | NDJ  |
|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 2000 | -1.6 | -1.4 | -1   | -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    | 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   | -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 |      |

Warm Episodes - El Niños (in RED): ONI 0.5 and above

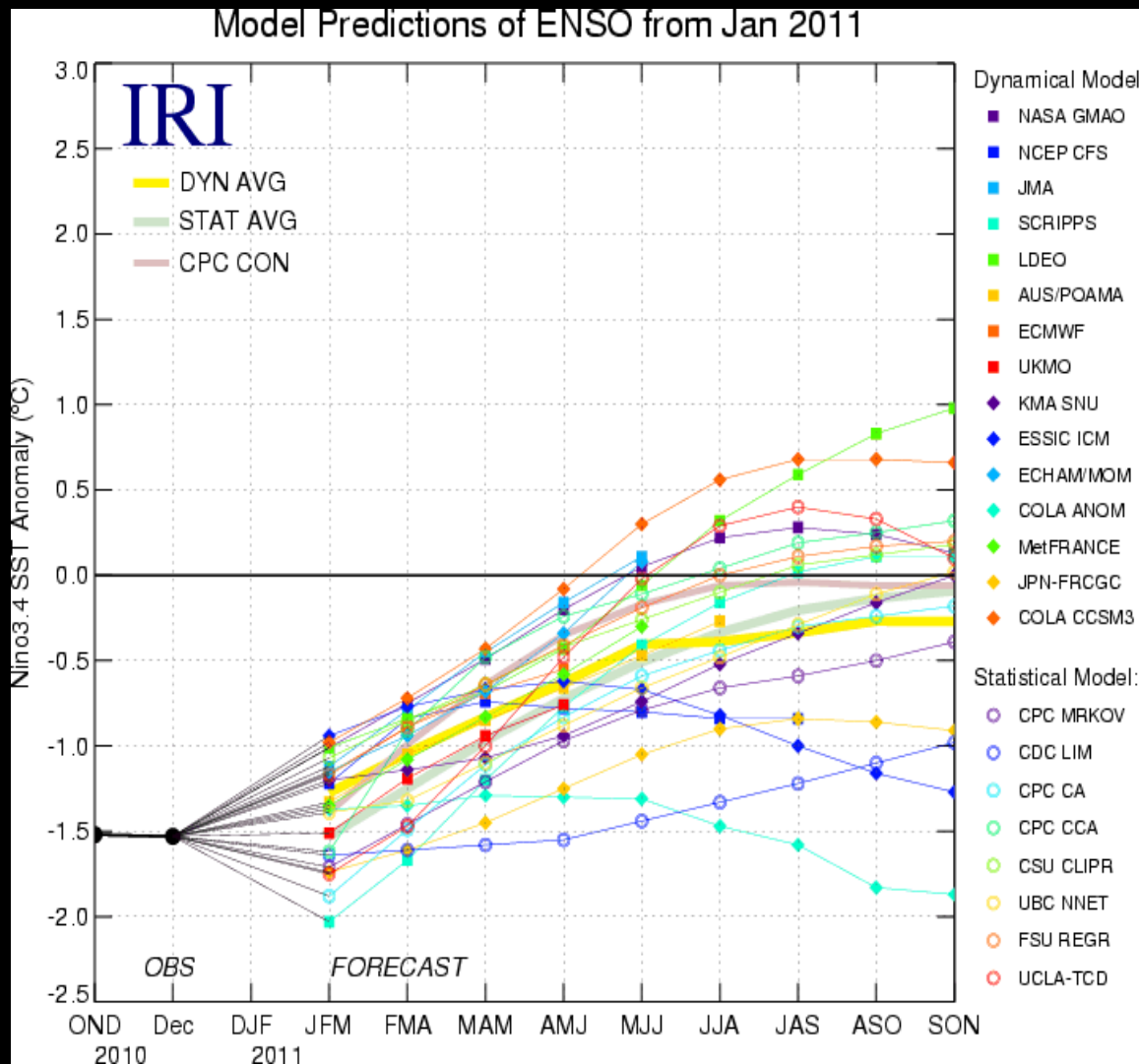
Cold Episodes - La Niñas (In Blue): ONI of -0.5 and below

Neutral Episodes -non-ENSO (In White): ONI above -0.5 and below 0.5

**The latest calculated ONI for the 3-month climate season Oct-Nov-Dec, 2010 is -1.4.**

NOAA/CPC Jan 18 2011

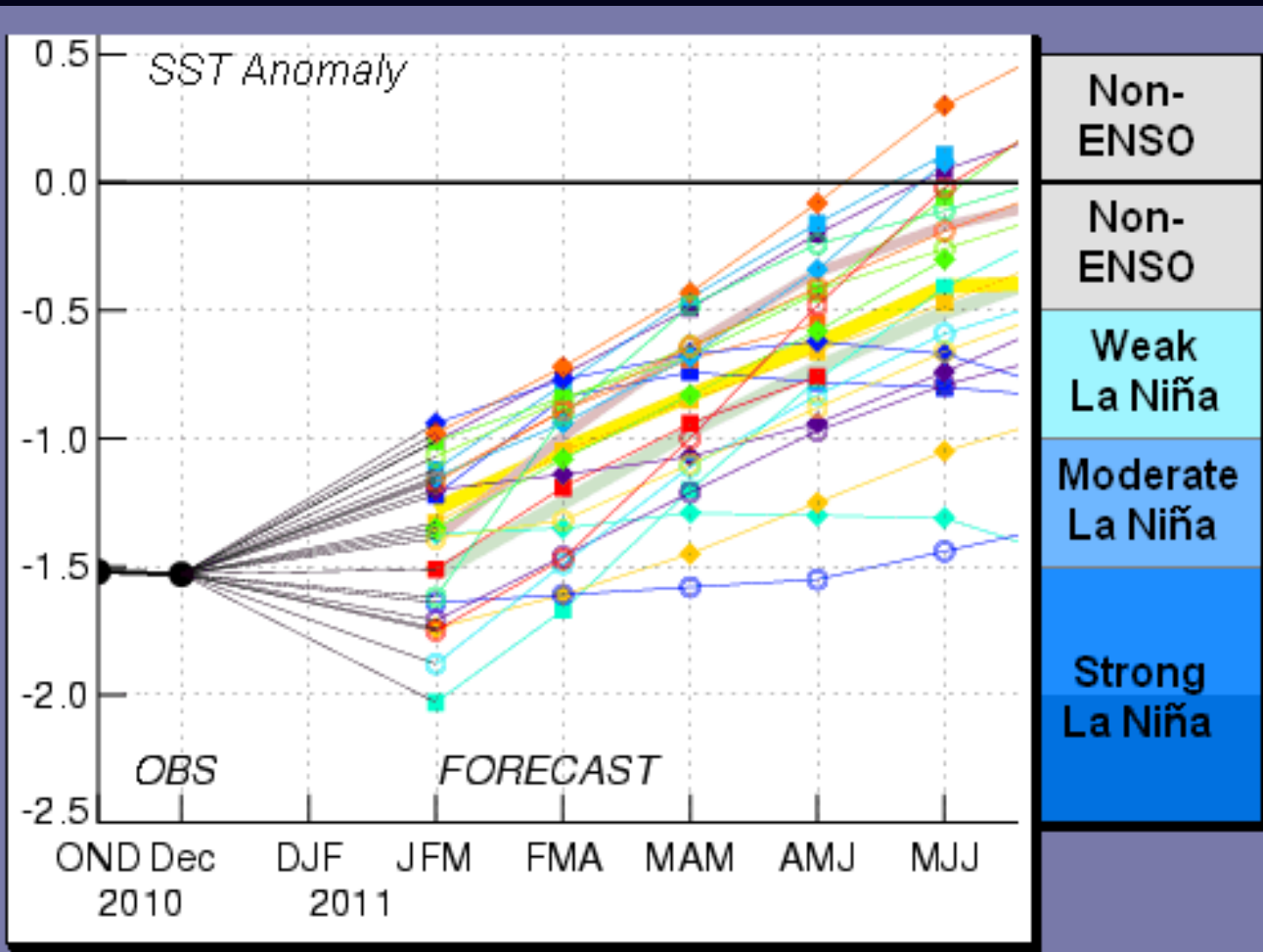
# Pacific Niño 3.4 ENSO Outlook



- All 23 dynamical and statistical ENSO-climate model forecasts indicate a gradual reduction in the negative SST anomalies in the tropical eastern Pacific region identified as Niño 3.4 over the next several months. A majority of the models indicate a weak La Niña (SSTa of  $-0.5^{\circ}\text{C}$  to  $-1.0^{\circ}\text{C}$ ) by this spring.

Beyond this spring, there remains considerable uncertainty in the models as to whether La Niña will persist through the summer, and perhaps even into next year.

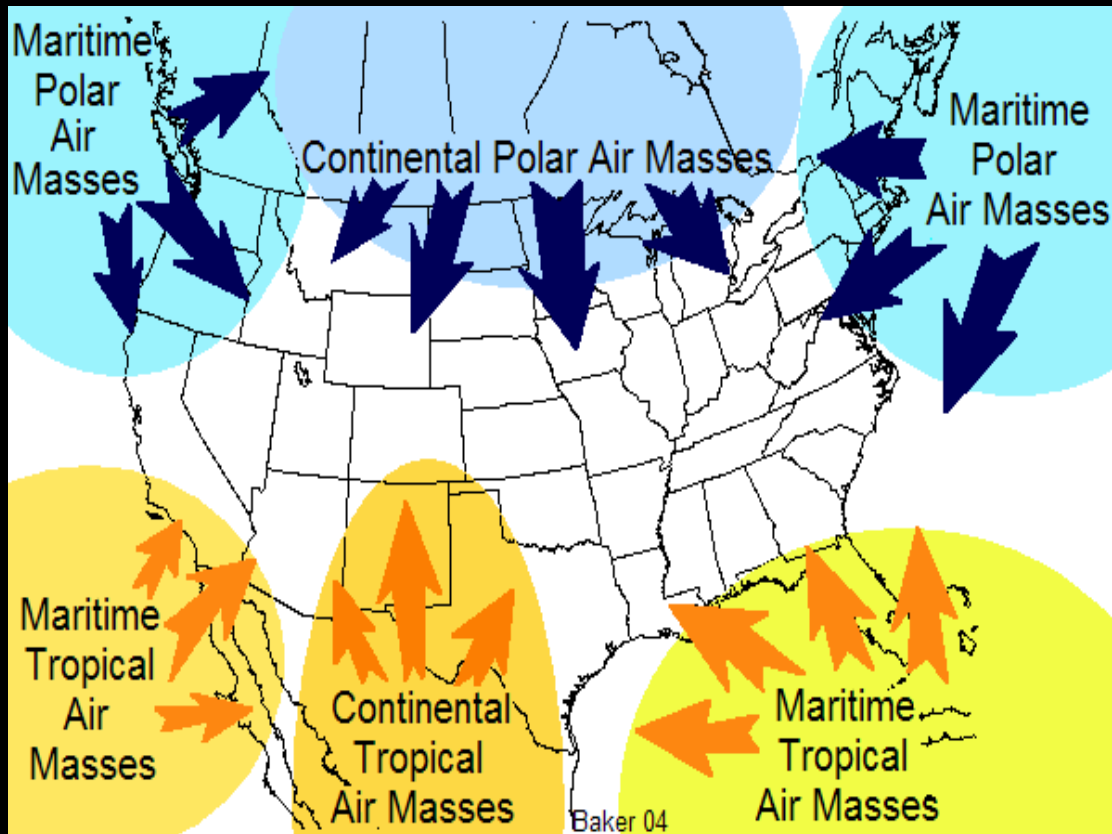
**The Pacific Jet Stream and its  
Influence on Winter and Spring  
Weather Patterns Across Colorado  
In the Presence of a La Niña**



Can the Weakening La Niña Continue to Affect Our Weather for the Rest of this Winter and Perhaps this Spring?

We can reasonably assume it will. The dominating influence of this latest La Niña episode on global weather patterns will likely continue for at least another few months. This “lag” or extended imprint of La Niña affects both the atmosphere and oceans, particularly with respect to their temperature.

# First, We Begin with Air Masses



An air mass represents a large volume of atmosphere near the ground, spanning an area of a thousand miles or more, and possessing temperature and moisture properties uniquely characteristic of its region of origin (its source region).

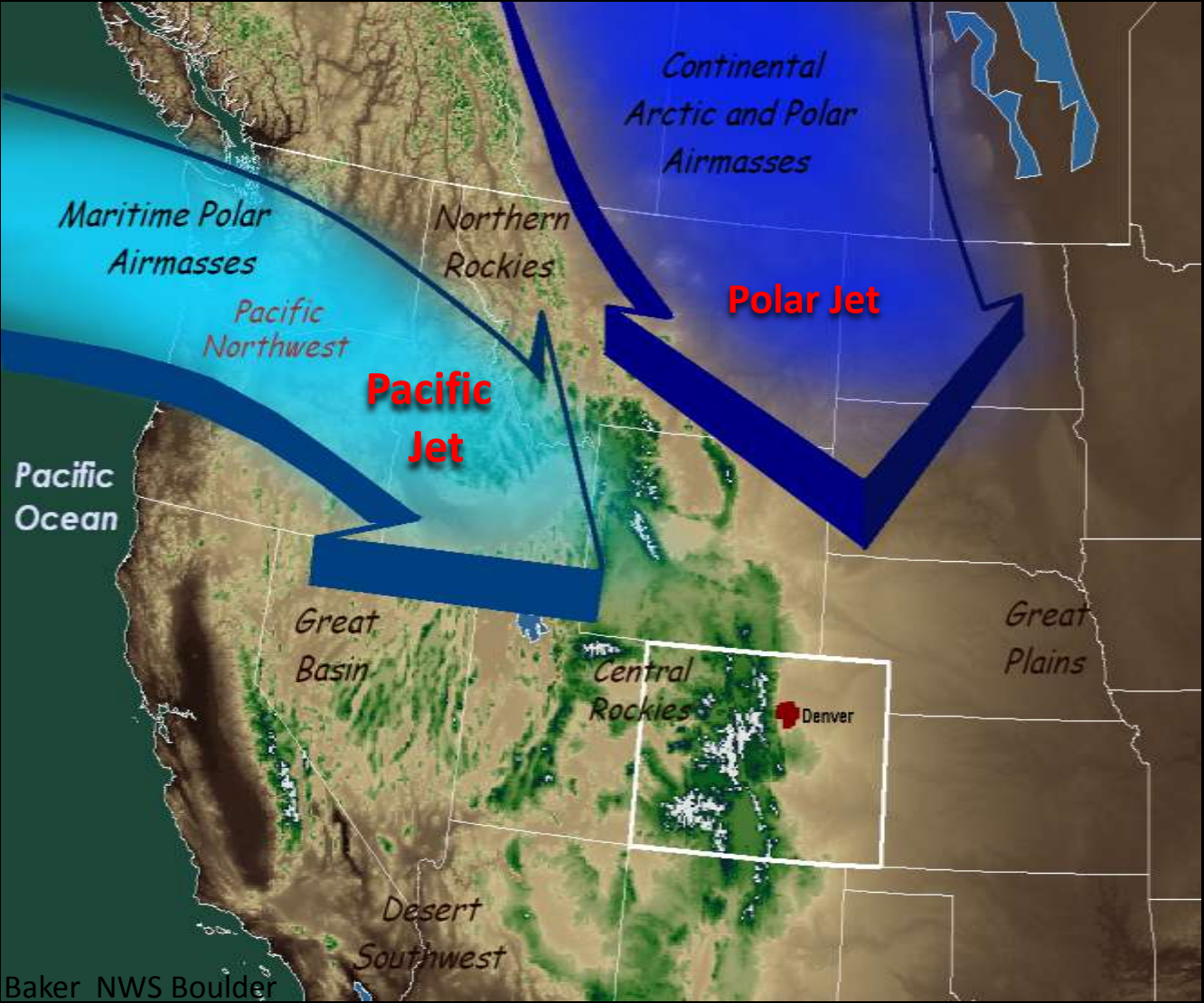
Maritime polar air masses possess more moisture (humidity) and are generally warmer than their counterpart, continental polar (arctic) air masses.

Maritime tropical air masses also possess more moisture (humidity) and are usually not as warm as their counterpart, continental tropical air masses.

Colorado is frequented each year by these distinct air masses. Maritime tropical and maritime polar air masses bring much needed moisture to this semi-arid region of the country. Maritime air masses originating over the eastern Pacific are more likely to enhance precipitation in areas generally west of the Continental Divide in Colorado, while maritime air masses originating over the Gulf of Mexico and even the Caribbean provide much of the moisture necessary for clouds and precipitation for areas generally east of the Continental Divide.

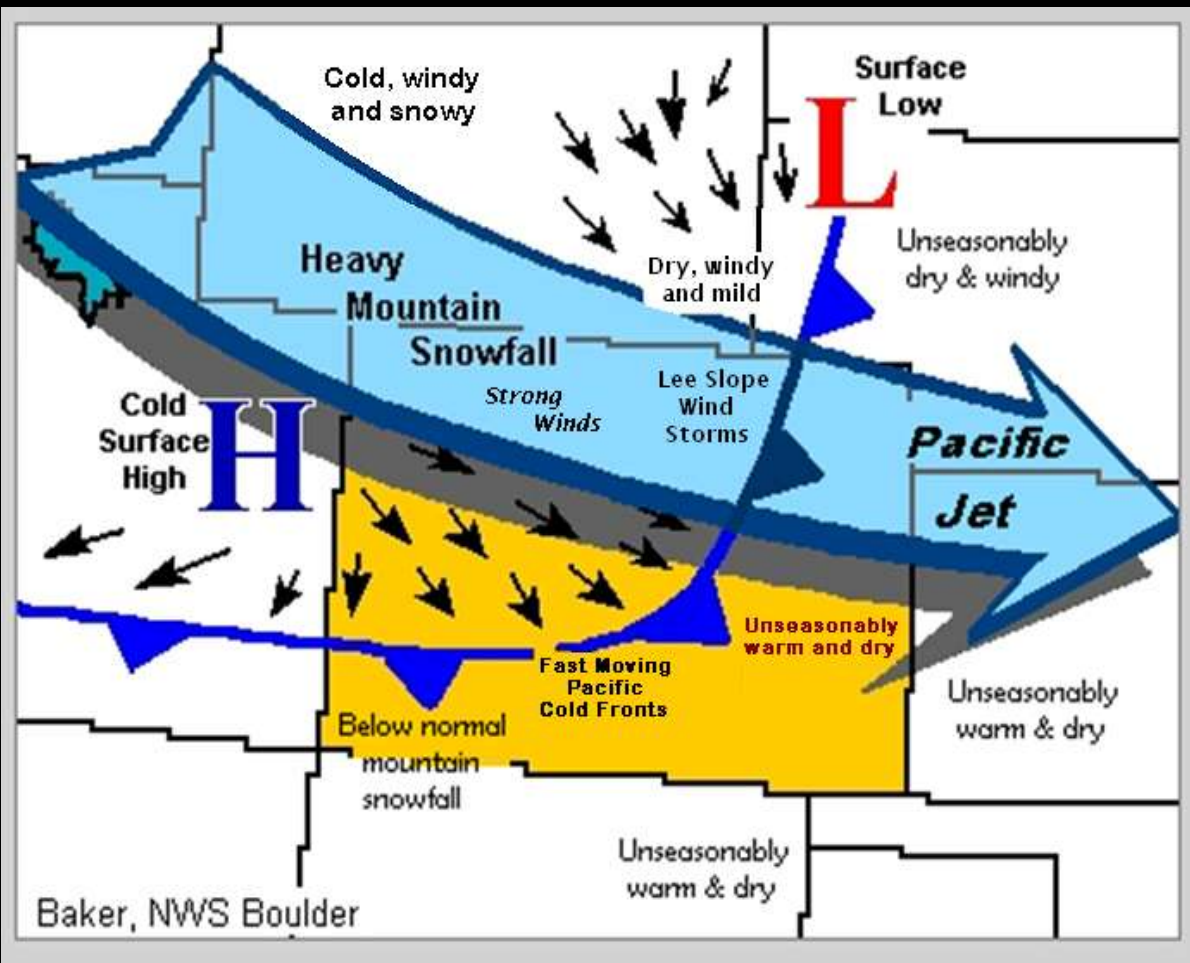


# Air Masses Having the Greatest Impact on Colorado Weather



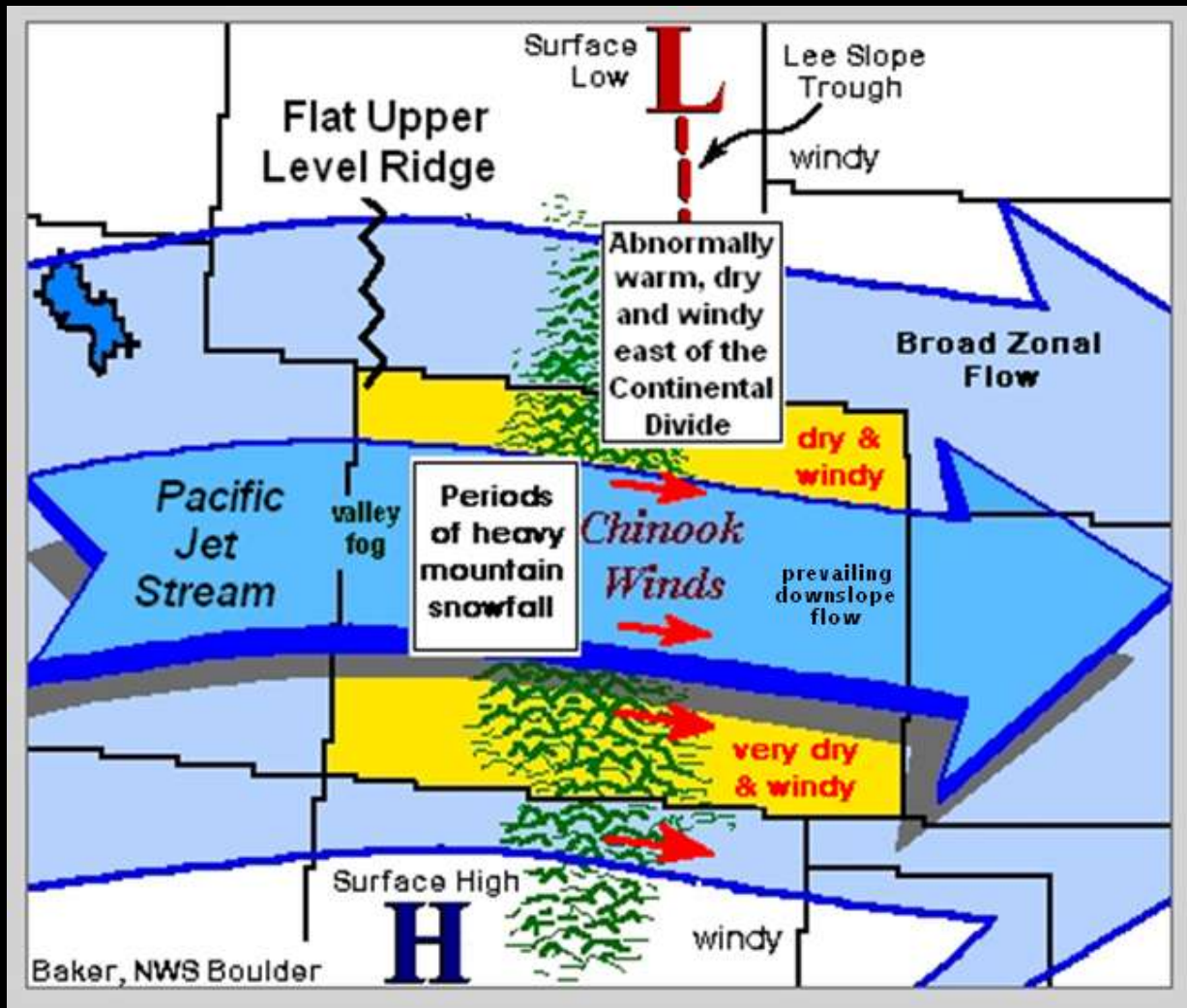
During moderate to strong La Niñas, weather patterns across Colorado during the autumn, winter and spring are more likely to be influenced by maritime polar air masses rather than the much colder and drier continental polar (arctic) air masses originating deep within Canada.





Waves of Pacific moisture are transported inland across the Pacific Northwest by a strong Pacific jet stream. As these waves or storm fronts pass over Colorado they produce strong and very gusty winds, and heavy precipitation (rain and snow) in the mountains and high valleys especially across the northwest and west central portions of the state.

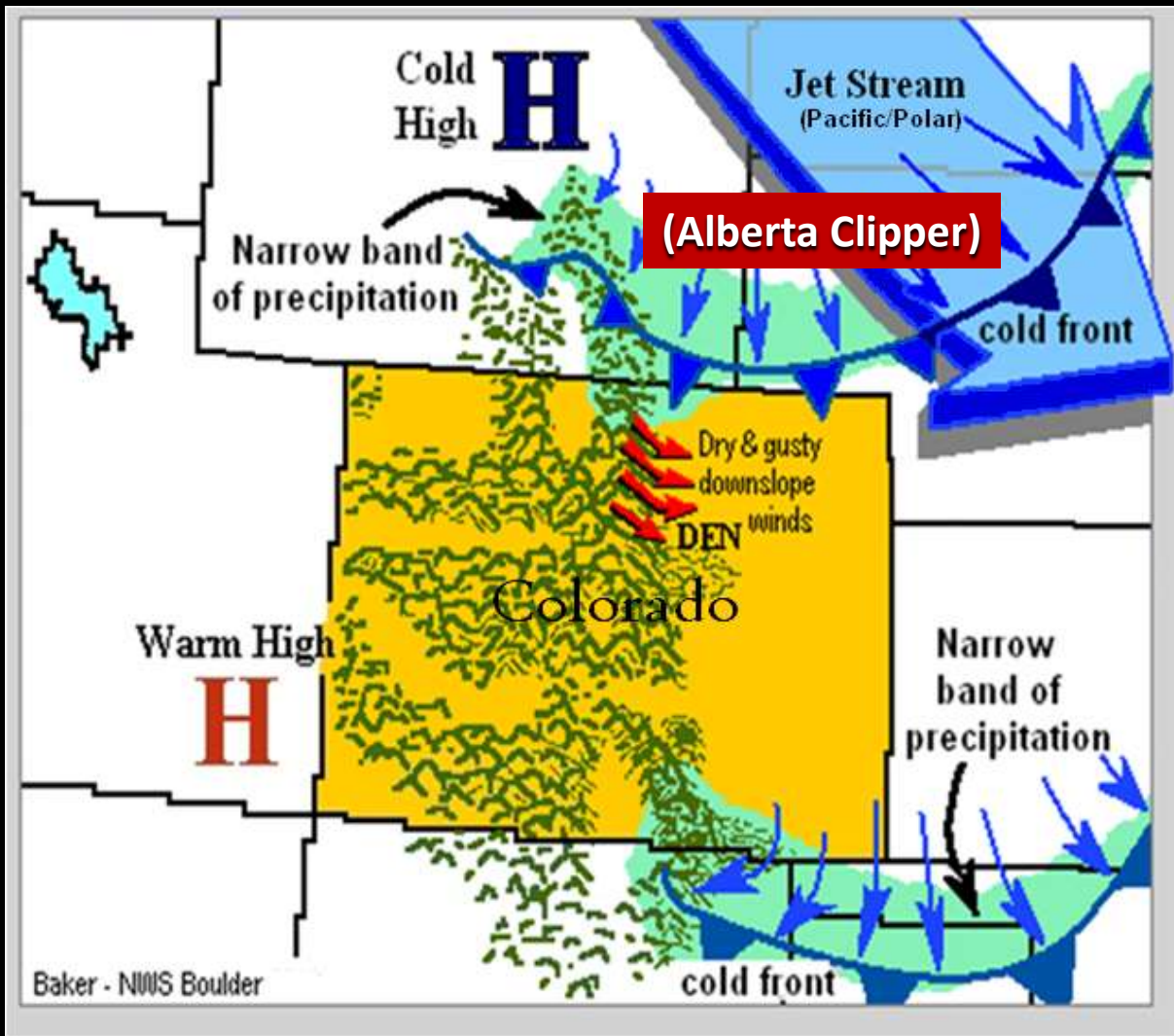
This same storm track or jet stream orientation will also produce unusually warm, dry and windy conditions east of the mountains and across southern portions of Colorado. Fast moving cold fronts driven by this powerful jet stream will race across the mountains and down the east slope of Front Range producing gusty downslope winds, and sometimes damaging Chinook (warm) and Bora (cold) wind storms.



Less common, though equally important is a strong zonal or westerly flow pattern associated with a strong Pacific jet stream passing over Colorado as in this diagram. This set up also has the potential for producing periods of heavy precipitation and strong gusty winds in areas along and west of the Continental Divide.

Valleys on the west slope may also see fog, sometimes quite thick, for days at a time with an influx of moisture laden Pacific air.

This same zonal jet stream pattern can produce abnormally warm, dry and windy conditions in areas east of the Continental Divide, and sometimes damaging downslope wind storms along the Colorado Front Range. When these windy and arid conditions develop, the wildland fire danger will normally increase, sometimes significantly .



Much less often observed in Colorado during the autumn, winter and spring of moderate to strong La Niñas is the presence of continental polar (arctic) air masses. Driven south out of western Canada by winds produced from the merging together of the Pacific and Polar jet streams, these land based air masses are preceded by fast moving cold fronts, sometimes referred to as “Alberta Clippers”.

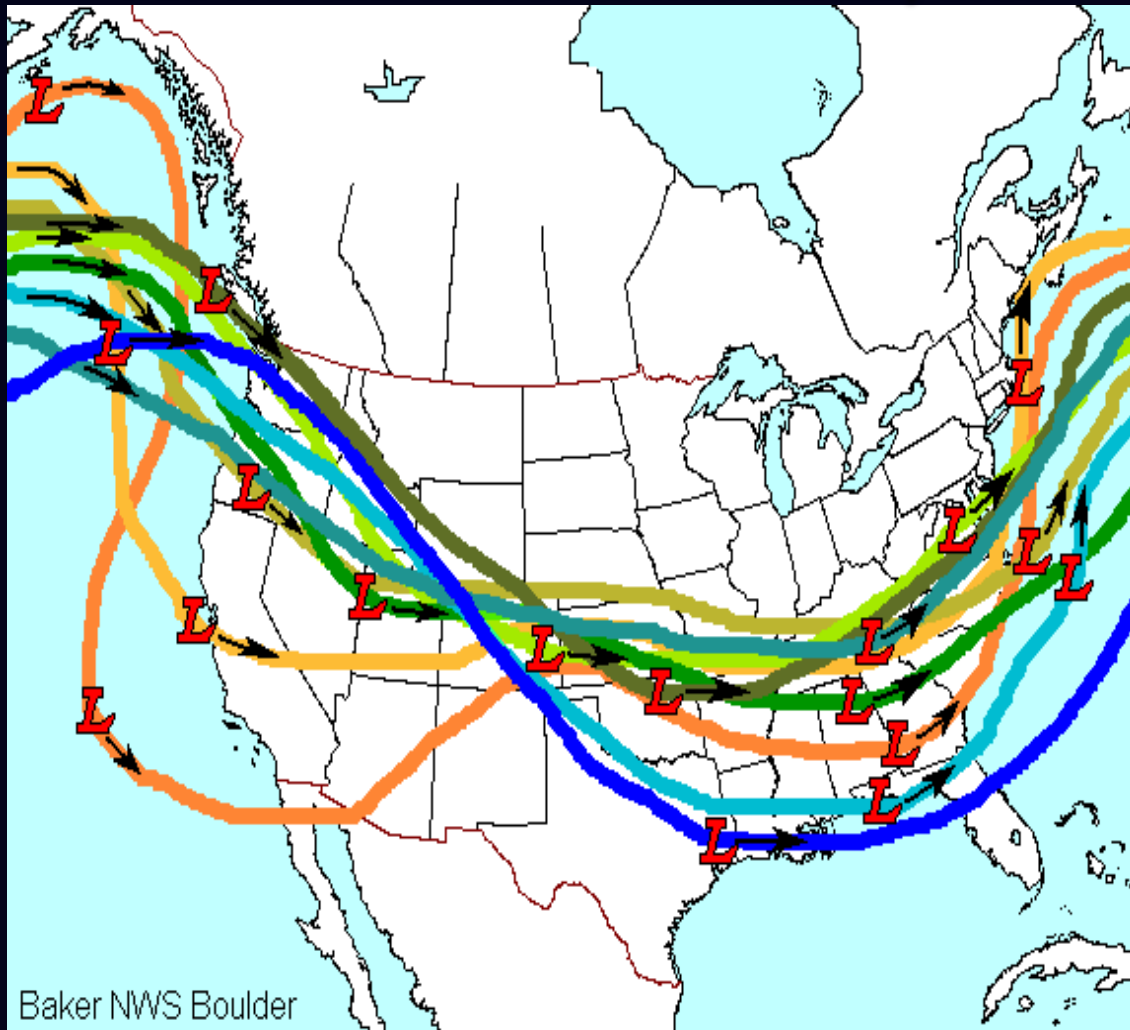
Precipitation produced by these glancing frontal systems is usually of short duration but at times quite intense.

Usually shallow in depth, these cold air masses typically linger for no more than a few days on the plains of eastern Colorado and are rarely felt west of the Continental Divide.

Warm and gusty down slope winds, called Chinook winds, will often develop along the Colorado Front Range hours in advance of these arctic cold fronts.



## Mean Weekly Trajectory of the Pacific Jet Mid-November 2010 to Mid-January 2011

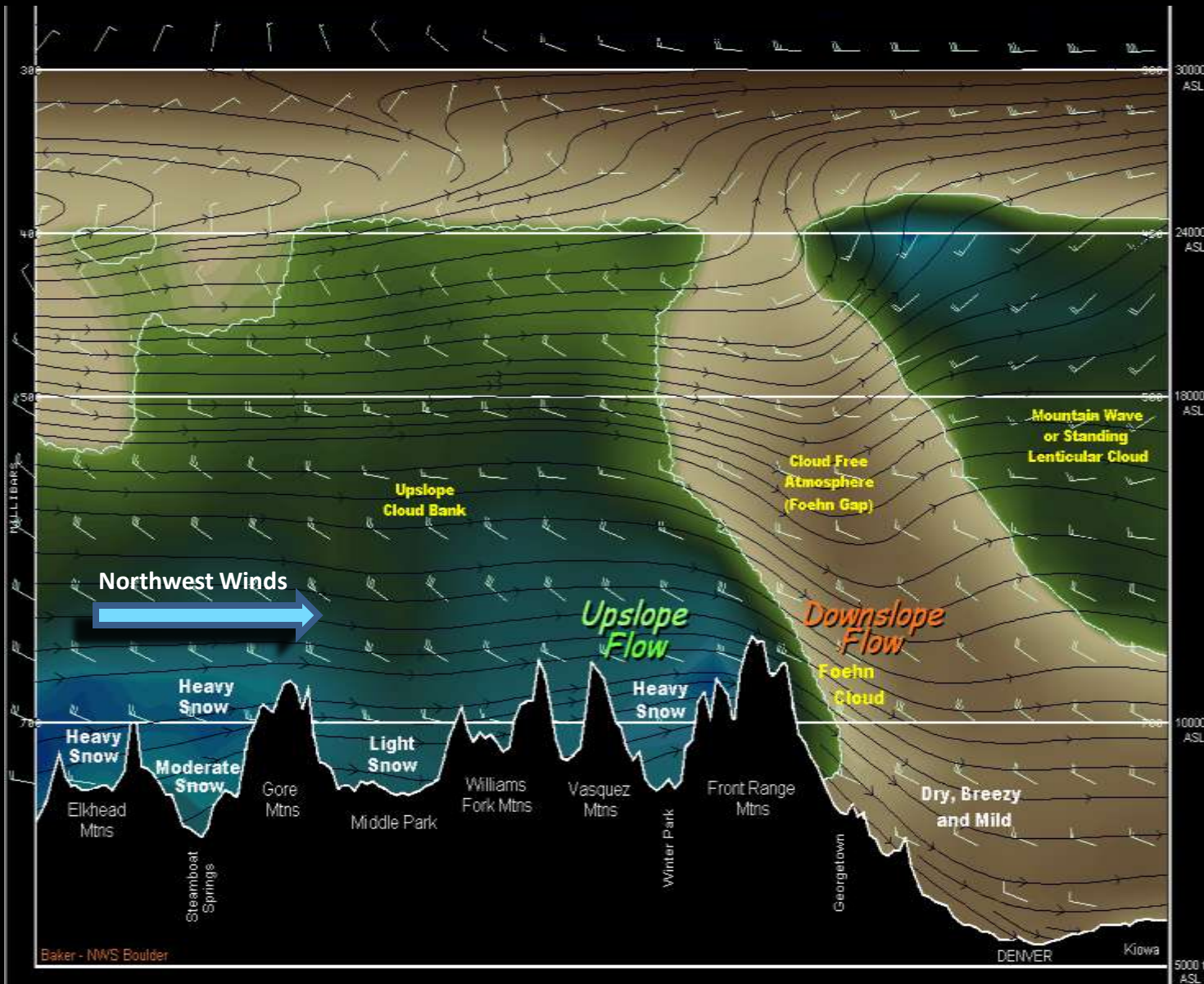


In the past couple of months the general path of the Pacific jet stream across the continental United States resembled a simple sine wave, with a ridge in the west and a trough in the east. This wave configuration in the Pacific jet stream is commonly observed during La Niña episodes.

However this past December, a large kink in the jet formed over the Gulf of Alaska, causing it to turn sharply southward along the west coast. Such a track is more often observed during the winters of El Niño events.

This southward shift in the jet, hence the storm track, resulted in extraordinary precipitation (rain and snow) amounts across southern California, the Desert Southwest and Four Corners regions, including southwest Colorado.

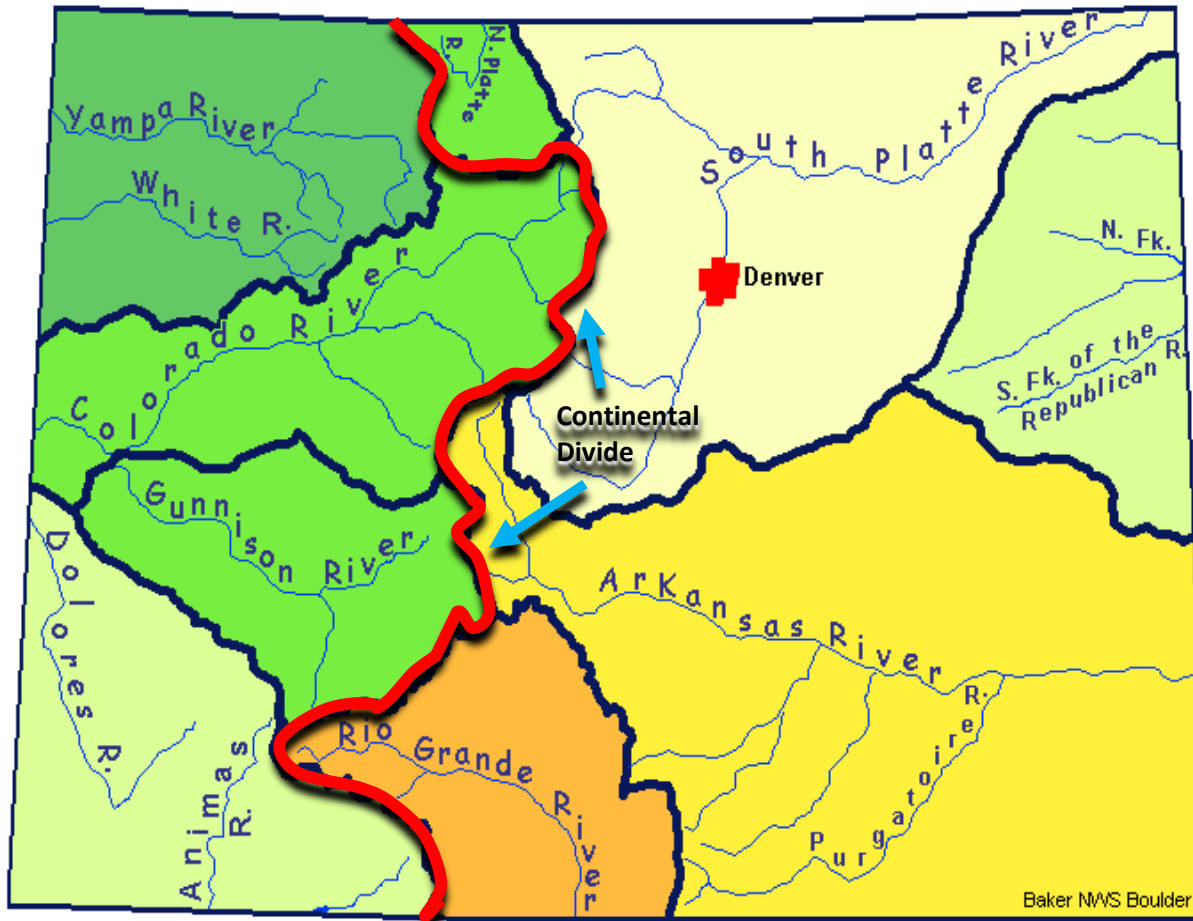
# Understanding the Importance of Upslope and Downslope Flow



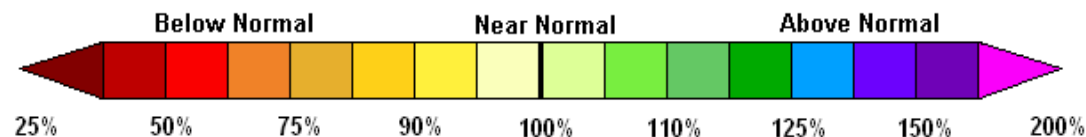
**Moisture laden Pacific air flowing up against and over the mountains of north central Colorado (as depicted in this northwest-southeast cross section) rises and cools. Along the way, much of this moisture condenses out into clouds and orographic (upslope) precipitation.**

**After passing over the crest of the Front Range, this easterly moving air (wind) will begin to flow down slope under the right atmospheric conditions. As this air sinks, it compresses causing it to warm, which lowers its relative humidity.**

## Precipitation Anomalies Observed Across Colorado During Moderate to Strong La Niñas



Basin Precipitation as a Percent of Normal



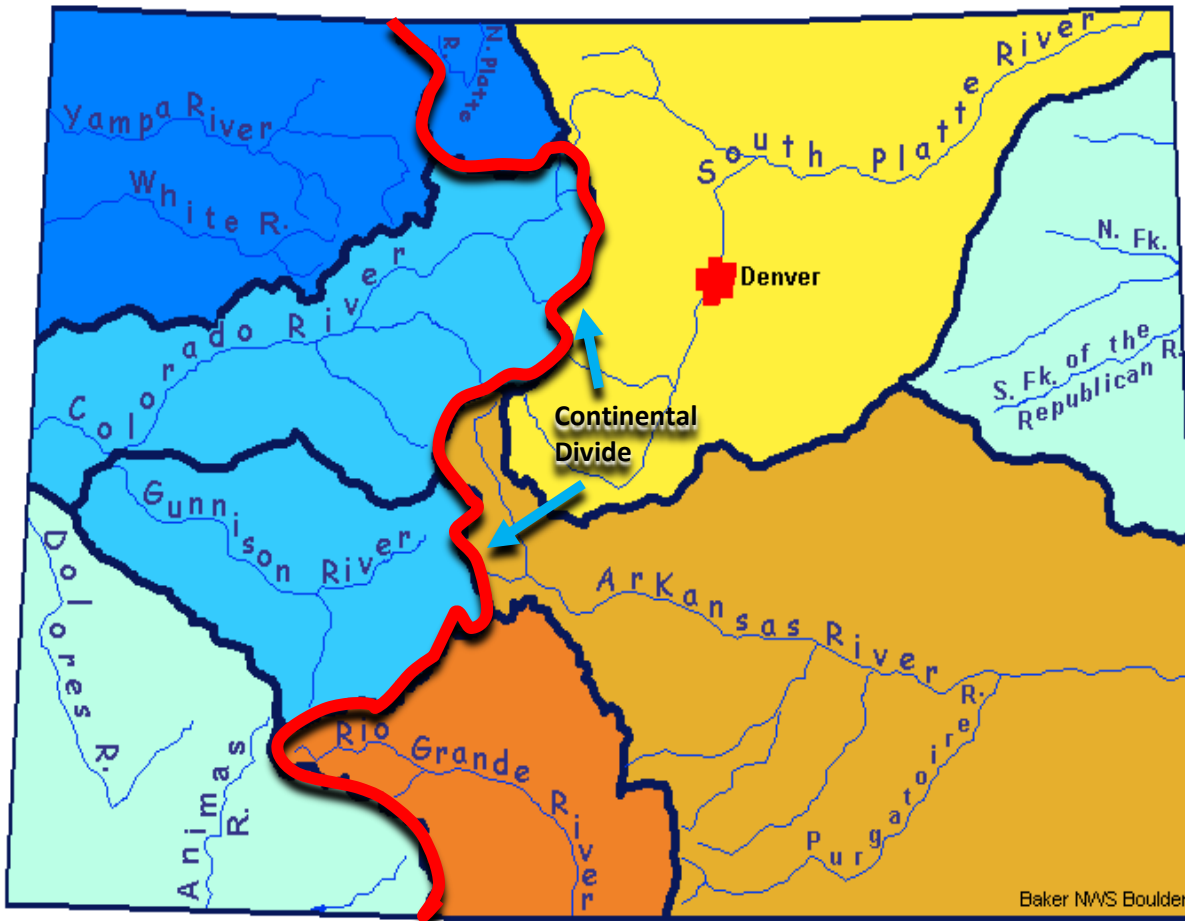
## In General...

**ABOVE NORMAL** precipitation (rain and snow) is observed across northwest and west central Colorado during the winter and spring of moderate to strong La Niñas.

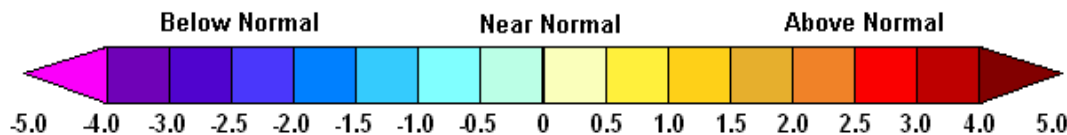
**BELOW to MUCH BELOW NORMAL** precipitation (rain and snow) is observed during the same period and ENSO conditions across southern and eastern Colorado.



## Temperature Anomalies Observed Across Colorado During Moderate to Strong La Niñas



Basin Temperature Departures from Normal in Degr F



## In General...

BELOW to **MUCH BELOW NORMAL** temperatures are observed across northwest and west central Colorado during the winter and spring of moderate to strong La Niñas.

**NEAR to ABOVE AVERAGE** temperatures are observed across the remainder of the state, with the greatest positive departure from normal in the upper Rio Grande River Basin.

# Potential Impacts of a Moderate to Strong La Niña on the Colorado Front Range



Abnormally Warm Temperatures



Abnormally Dry Conditions  
Potentially Resulting  
in Drought



Significantly Reduced Runoff  
Into Lakes and Reservoirs



Increased Risk of  
Large Wildland Fires



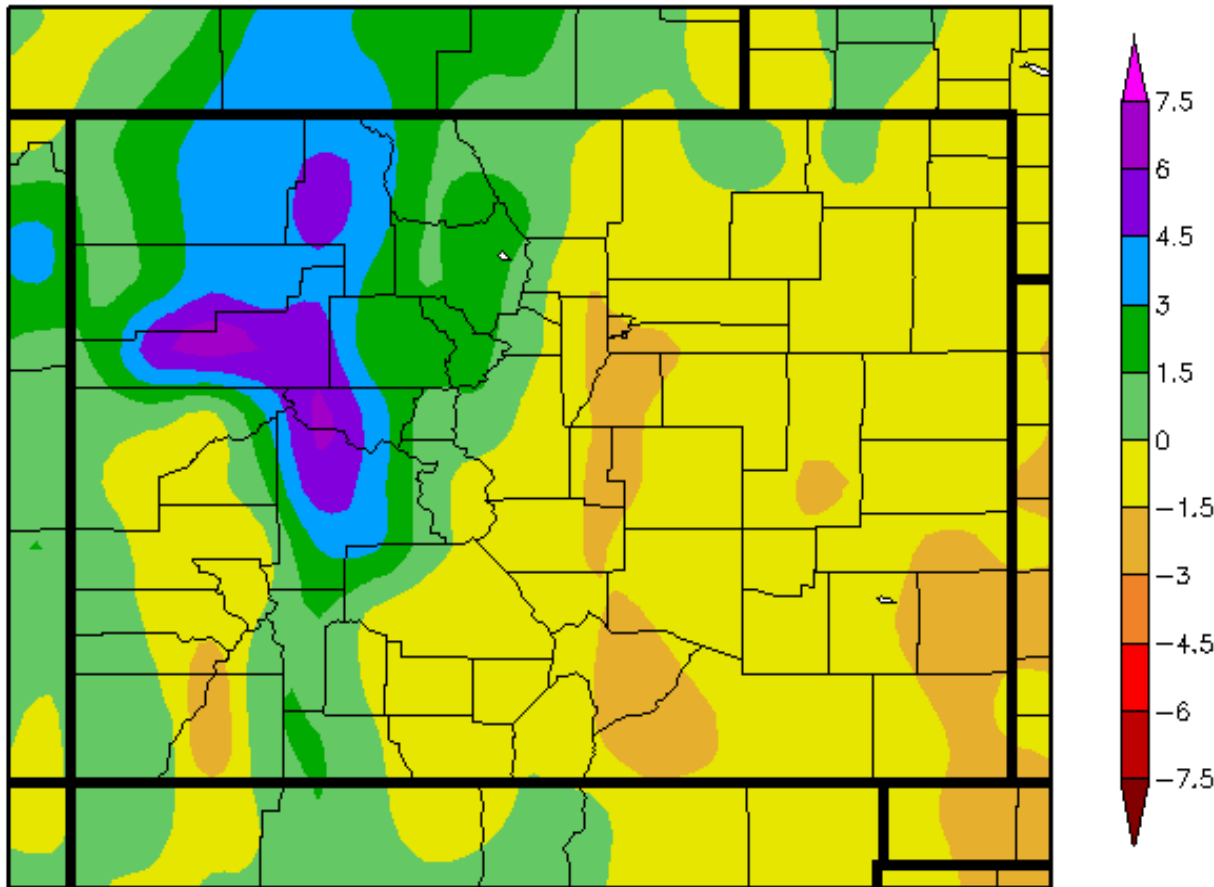
Damaging Downslope  
Wind Storms

|           |           |           |           |           |           |           |                 |          |           |          |  |          |  |      |        |  |  |          |  |  |
|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------------|----------|-----------|----------|--|----------|--|------|--------|--|--|----------|--|--|
| 2010      |           |           |           |           |           |           | <b>OCTOBER</b>  |          |           |          |  |          |  | 2010 |        |  |  |          |  |  |
| 2010      |           |           |           |           |           |           | <b>NOVEMBER</b> |          |           |          |  |          |  | 2010 |        |  |  |          |  |  |
| 2010      |           |           |           |           |           |           | <b>DECEMBER</b> |          |           |          |  |          |  | 2010 |        |  |  |          |  |  |
| Sunday    |           |           | Monday    |           |           | Tuesday   |                 |          | Wednesday |          |  | Thursday |  |      | Friday |  |  | Saturday |  |  |
|           |           |           |           |           |           |           | <b>1</b>        | <b>2</b> | <b>3</b>  | <b>4</b> |  |          |  |      |        |  |  |          |  |  |
| <b>5</b>  | <b>6</b>  | <b>7</b>  | <b>8</b>  | <b>9</b>  | <b>10</b> | <b>11</b> |                 |          |           |          |  |          |  |      |        |  |  |          |  |  |
| <b>12</b> | <b>13</b> | <b>14</b> | <b>15</b> | <b>16</b> | <b>17</b> | <b>18</b> |                 |          |           |          |  |          |  |      |        |  |  |          |  |  |
| <b>19</b> | <b>20</b> | <b>21</b> | <b>22</b> | <b>23</b> | <b>24</b> | <b>25</b> |                 |          |           |          |  |          |  |      |        |  |  |          |  |  |
| <b>26</b> | <b>27</b> | <b>28</b> | <b>29</b> | <b>30</b> | <b>31</b> |           |                 |          |           |          |  |          |  |      |        |  |  |          |  |  |

Baker NWS Boulder

Review of  
Statewide  
Temperature and  
Precipitation,  
Including  
Snow Pack and  
Snow-Water  
Equivalency, for  
October,  
November and  
December of  
2010

## Departure from Normal Precipitation (inches) for Colorado Oct. 1, 2010 - Dec. 31, 2010

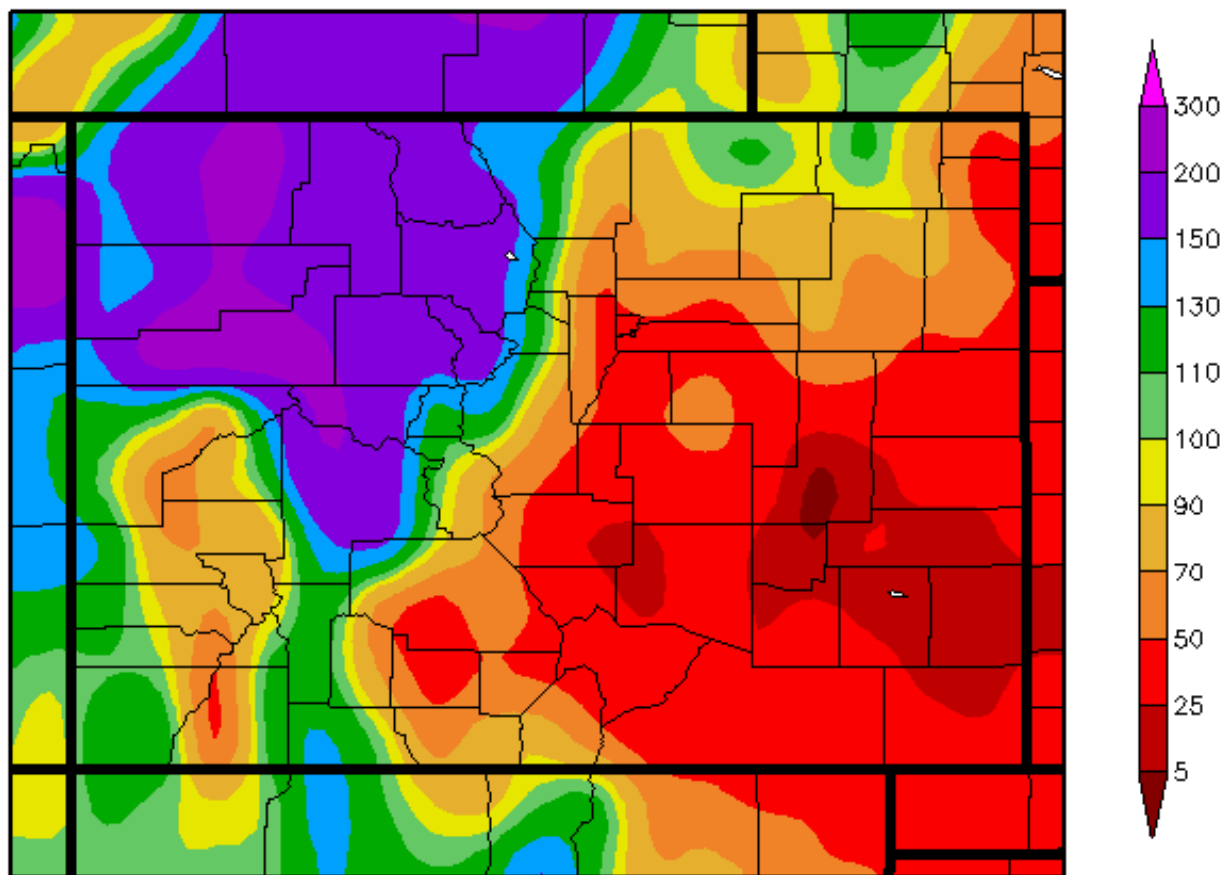


**Above normal precipitation was recorded across most of western Colorado during this three month period, with the greatest totals in the Elk, West Elk and Park ranges, including the Maroon Bell-Snowmass Wilderness Areas, the Flat Tops, and the Upper Yampa River Valley around Steamboat Springs.**

**Below normal precipitation was reported at a few locations on the west slope, but for the most part areas east of the Continental Divide including the upper Rio Grande Valley experienced the driest conditions within Colorado last fall and early winter.**

# Percent of Normal Precipitation (%) for Colorado

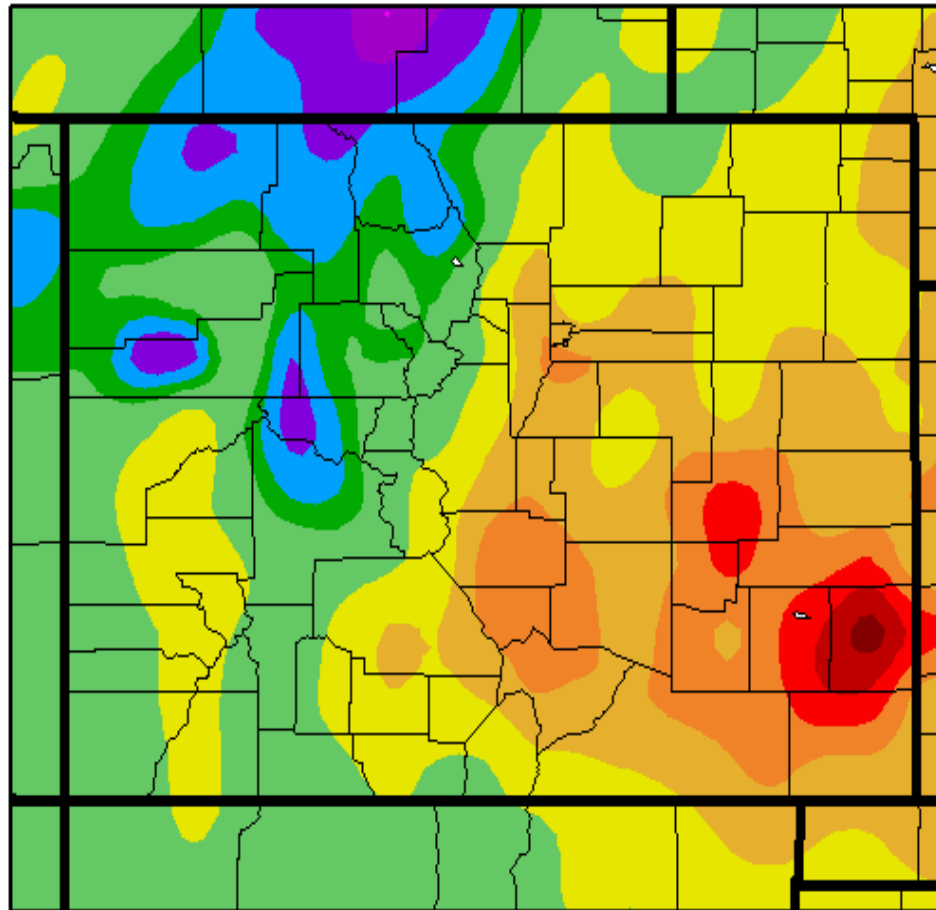
Oct. 1 - Dec. 31, 2010



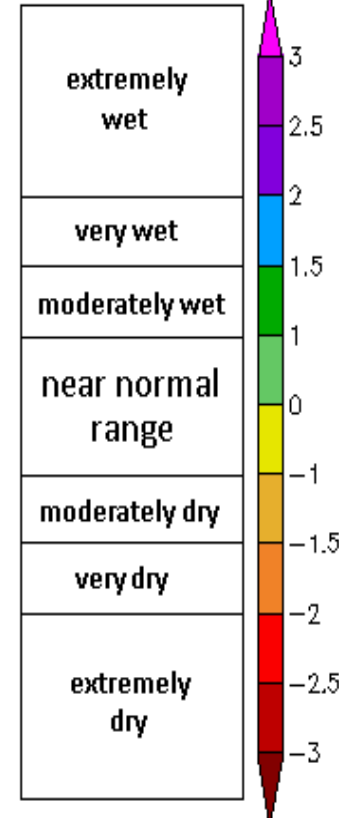
The wettest and driest areas of the state during this three month period clearly stand out on this percent of normal precipitation map.

Notice the northwest-to-southeast alignment of the wettest and driest regions, which happens to align with the prevailing jet stream pattern over the state during the period.

# 3-Month Standardized Precipitation Index (SPI) for Colorado Oct. 1 -Dec. 31, 2010



## SPI Values



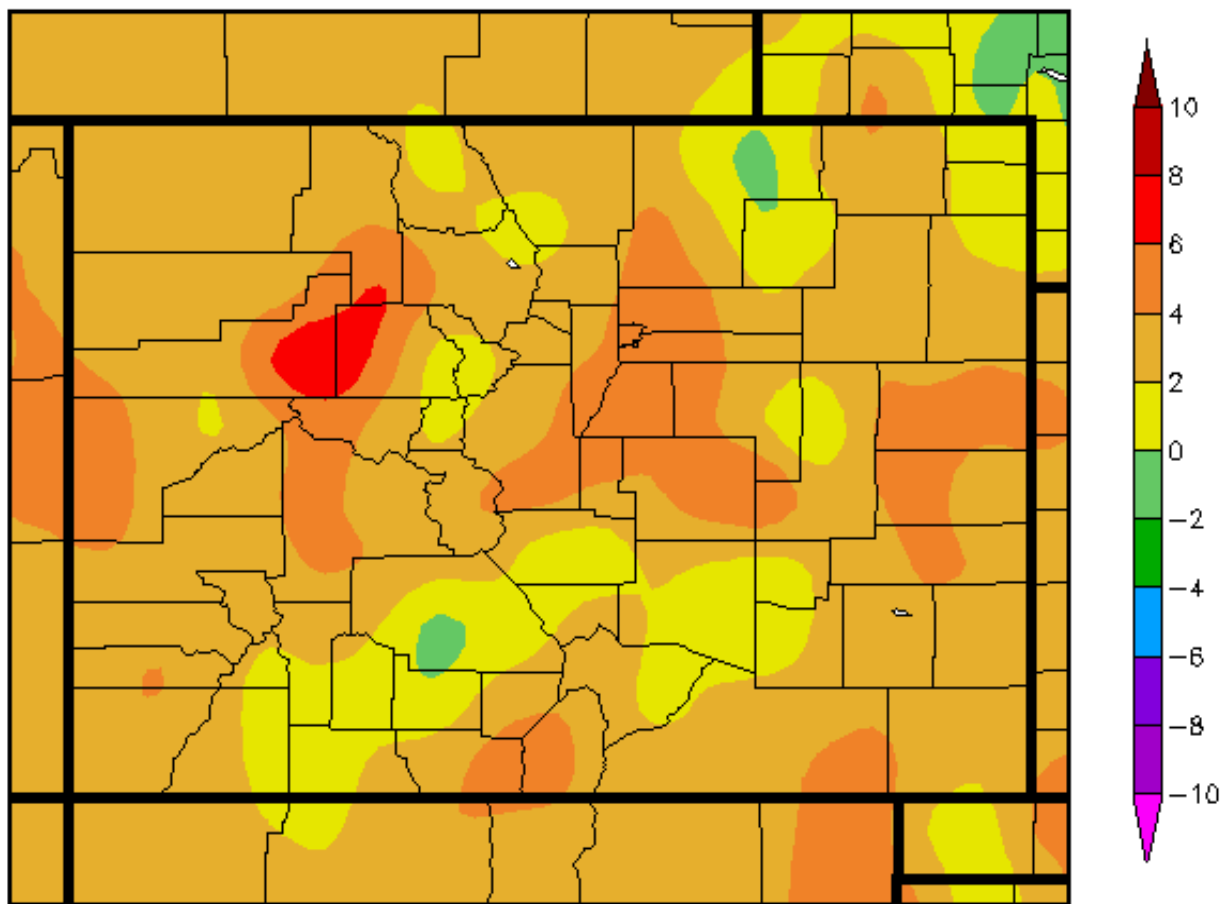
The **Standardized Precipitation Index (SPI)** was developed to monitor potential short term agricultural and long-term hydrological drought conditions. The SPI is a probability index that considers only precipitation.

During the 90 day period ending December 31, 2010, the SPI also indicated wetter than normal conditions across northwest and west central Colorado, and drier than normal conditions in eastern and south-central Colorado. The lowest SPI values are found within the Arkansas River Valley in southeast Colorado.



# Departure from Normal Temperature (°F) for Colorado

Oct. 1 - Dec. 31, 2010



Temperatures during the 90 day period ending December 31, 2010, generally were above normal across the entire state, with a few exceptions on the northeast plains and the San Luis Valley in southern Colorado.

Warmest temperatures were observed along the lee slope of the Front Range in northeast Colorado, central portions of the Colorado River Valley, and on the plains near the Kansas and New Mexico borders.

Autumn 2010 was abnormally warm and dry statewide, but in December snow and temperatures began falling especially across northwest Colorado.

2010      **DECEMBER**      2010

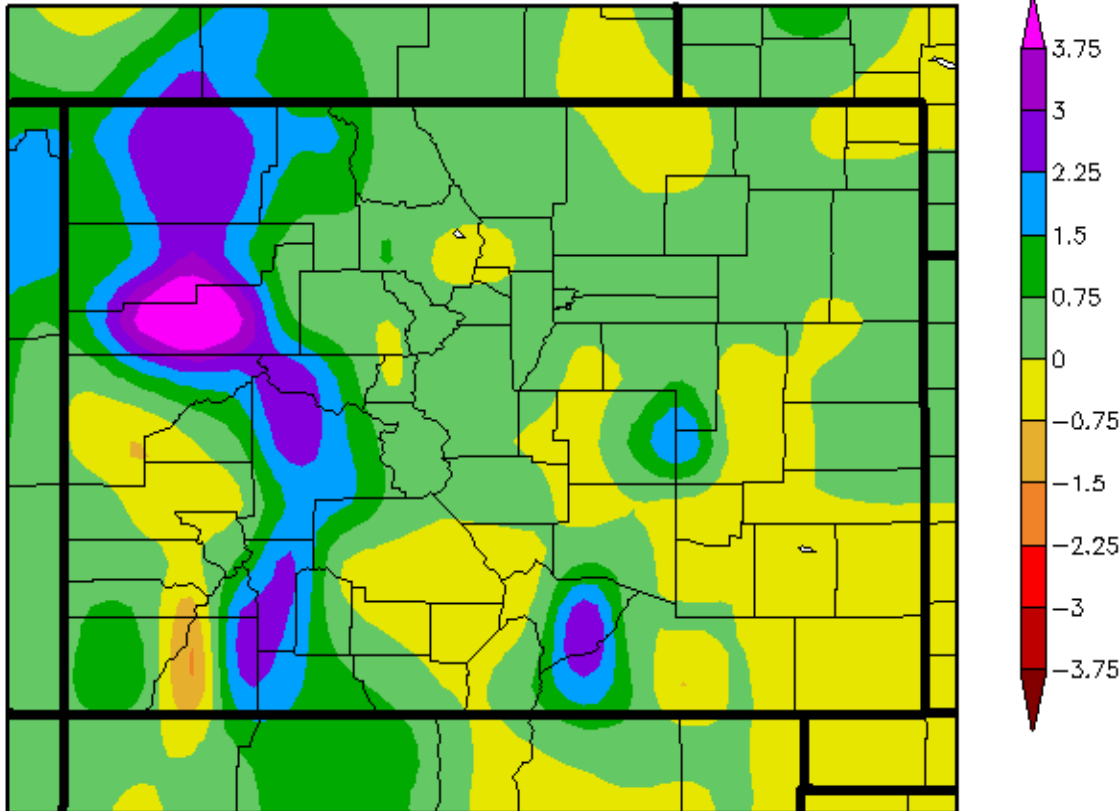
2011      **JANUARY**      2011

| Sunday    | Monday    | Tuesday   | Wednesday | Thursday  | Friday    | Saturday  |
|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
|           |           |           |           |           |           | <b>1</b>  |
| <b>2</b>  | <b>3</b>  | <b>4</b>  | <b>5</b>  | <b>6</b>  | <b>7</b>  | <b>8</b>  |
| <b>9</b>  | <b>10</b> | <b>11</b> | <b>12</b> | <b>13</b> | <b>14</b> | <b>15</b> |
| <b>16</b> | <b>17</b> | <b>18</b> | <b>19</b> | <b>20</b> | <b>21</b> | <b>22</b> |
| <b>23</b> | <b>24</b> | <b>25</b> | <b>26</b> | <b>27</b> | <b>28</b> | <b>29</b> |
| <b>30</b> | <b>31</b> |           |           |           |           |           |

Review of  
Statewide  
Temperature and  
Precipitation,  
Including  
Snow Pack and  
Snow-Water  
Equivalency, for  
the 30-day period  
December 20,  
2010 to January  
18, 2011

# Departure from Normal Precipitation in Inches for Colorado

Dec. 20, 2010 - Jan. 18, 2011



Generated 1/19/2011 at HPRCC using provisional data.

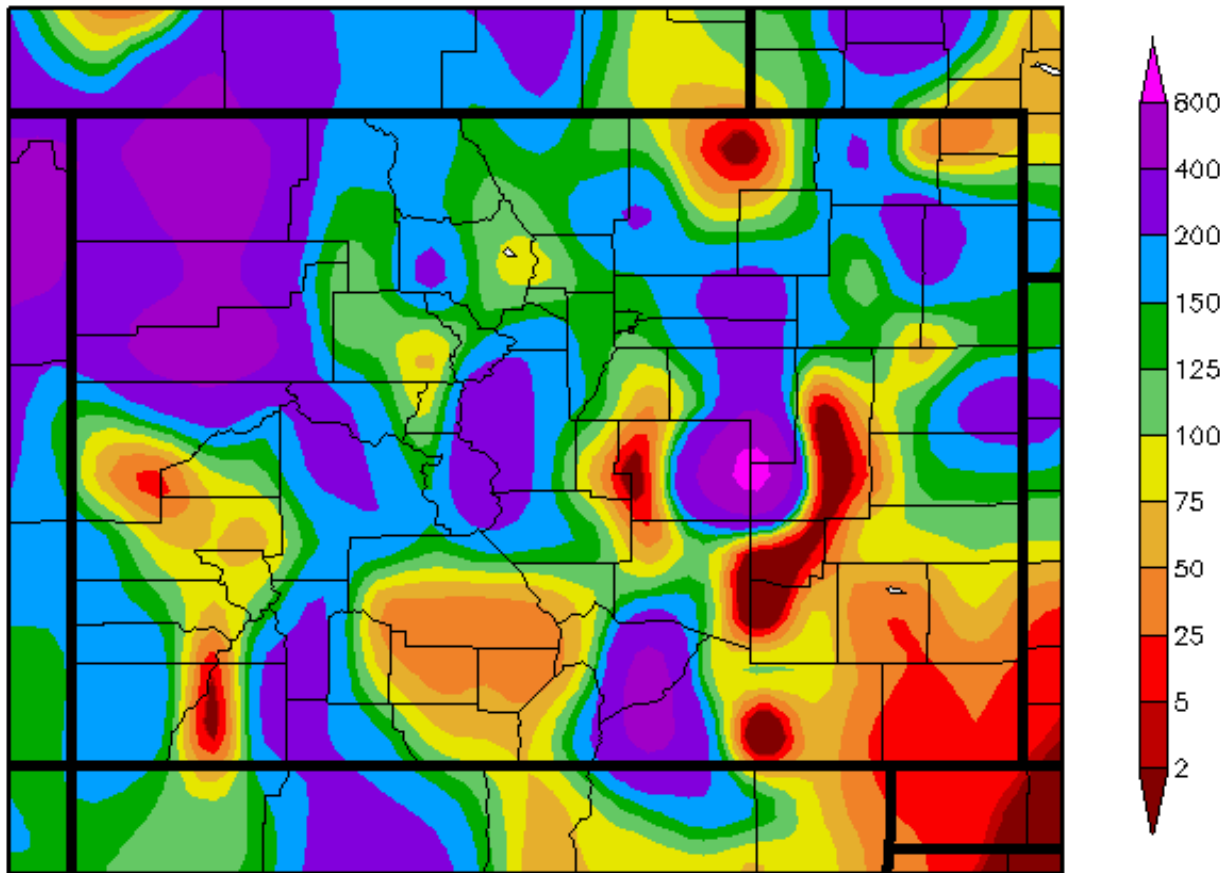
Regional Climate Centers

**Above normal precipitation continued to be observed across much of northwest and west-central Colorado, including the Elk, West Elk and Park Ranges, the Flat Tops, and the Upper Yampa River Valley around Steamboat Springs. However, wetter than normal conditions were now observed on and near the Front Range, the plains of northeast Colorado, along the east slope of the Sangre de Cristo Mountains in southern Colorado, and in and near the San Juan Mountains in southwest Colorado.**

**The large spike in precipitation in the southwest was attributed to a series of extremely wet and windy Pacific storms that pounded the area in December.**

# Percent of Normal Precipitation (%) for Colorado

Dec. 20, 2010 -Jan. 18, 2011

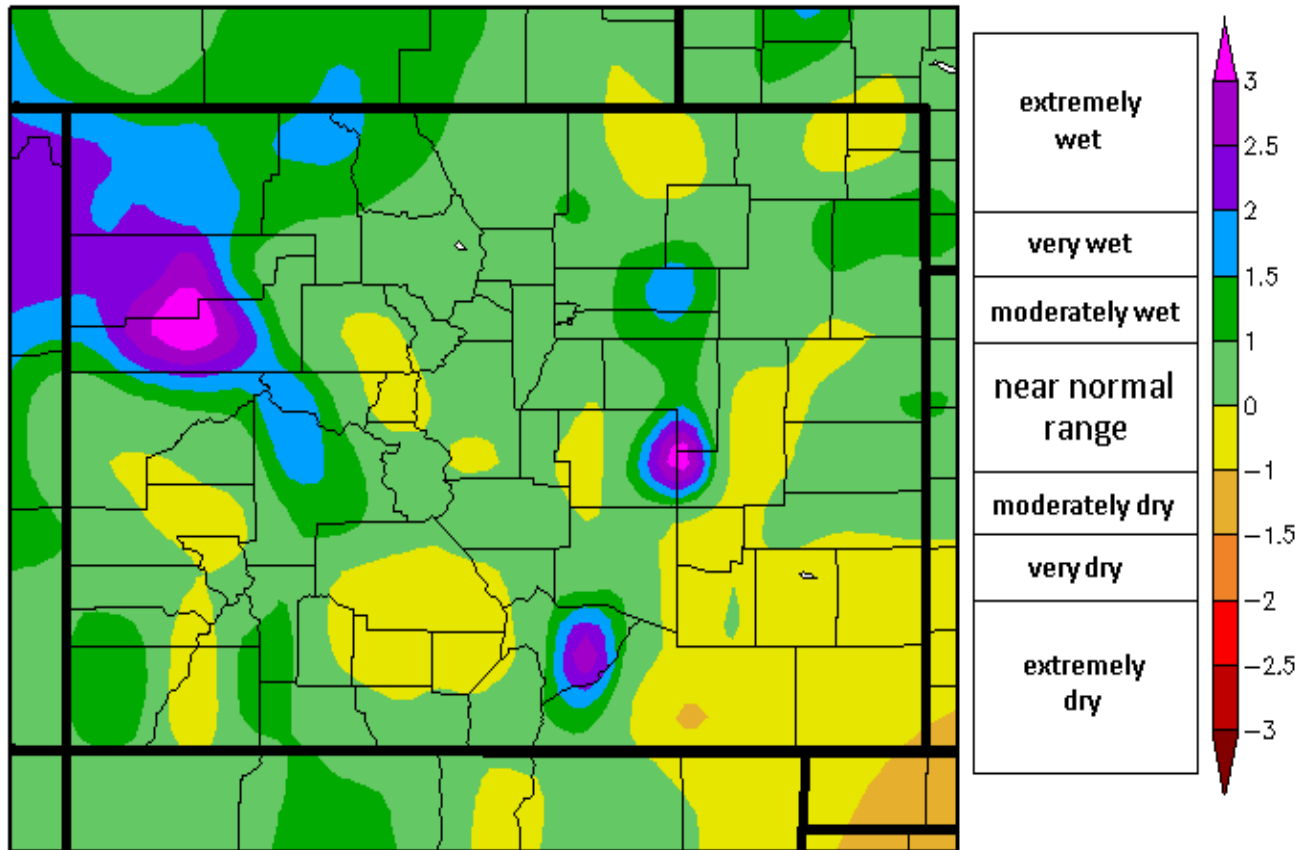


**The very wet (snowy) and very dry areas continue to stand out on this percent of normal precipitation map.**

**The only part of the state to consistently hold onto the trend established last autumn, was northwest and west central Colorado, where precipitation remained above to much above average.**

# 30 Day Standardized Precipitation Index (SPI) for Colorado

Dec. 20, 2010 - Jan. 18, 2011

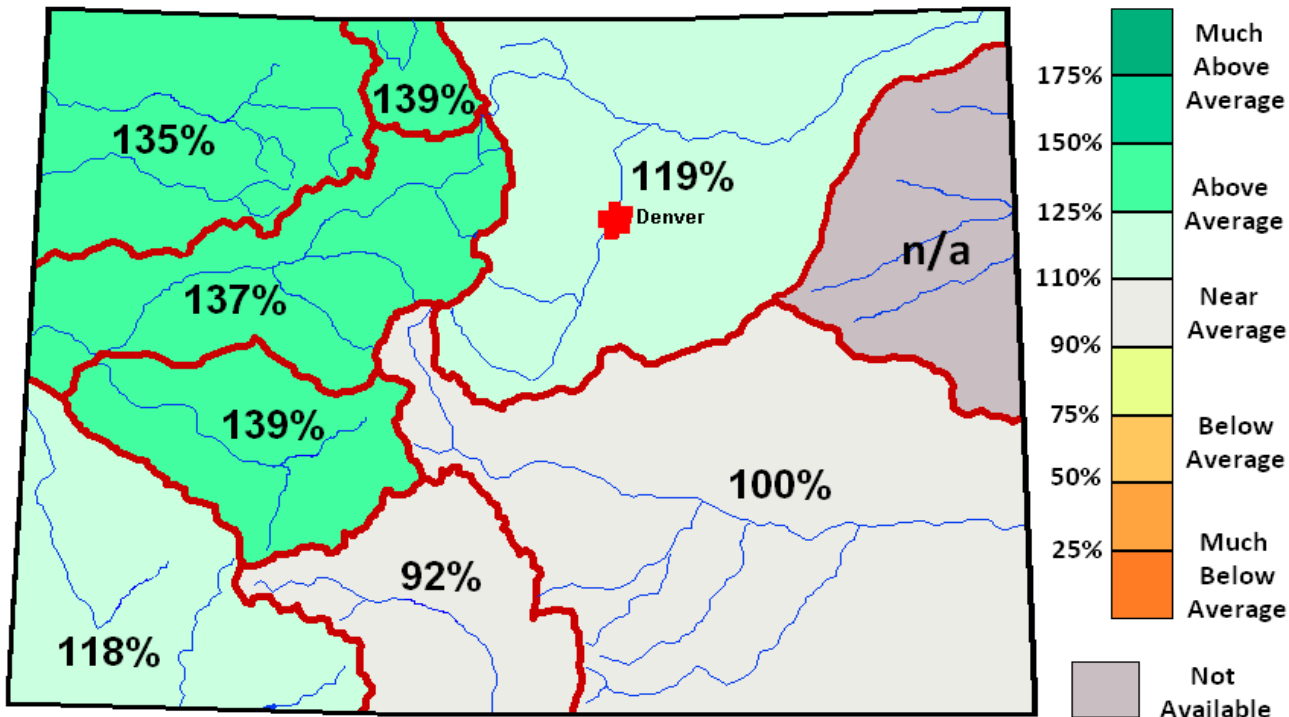


During the 30 day period ending January 18, 2011, the SPI continued to indicate wetter than normal conditions across northwest Colorado, as well as at a few spots in the eastern part of the state.

The southeast continued to have the driest conditions in the state, but only mildly dry compared to that observed in October and November of last year.

## Snow Water Equivalent as a Percent of Average (%)

By Colorado River Basin as of Wednesday, January 20, 2011



Basin Wide Percent of Average (%)

| WEST SLOPE  | EAST SLOPE                        |
|---|-----------------------------------|
| Yampa and White River Basins.....135%                           | South Platte River Basin.....119% |
| Upper Colorado River Basin.....137%                             | Arkansas River Basin.....100%     |
| Gunnison River Basin.....139%                                   |                                   |
| San Miguel, Dolores, Animas &<br>San Juan River Basins.....118% |                                   |
| Upper Rio Grande Basin.....92%                                  |                                   |

Source: USDA Natural Resources Conservation Service--Water and Climate, Portland, Oregon  
provisional data, subject to revision

## Snow Water Equivalents

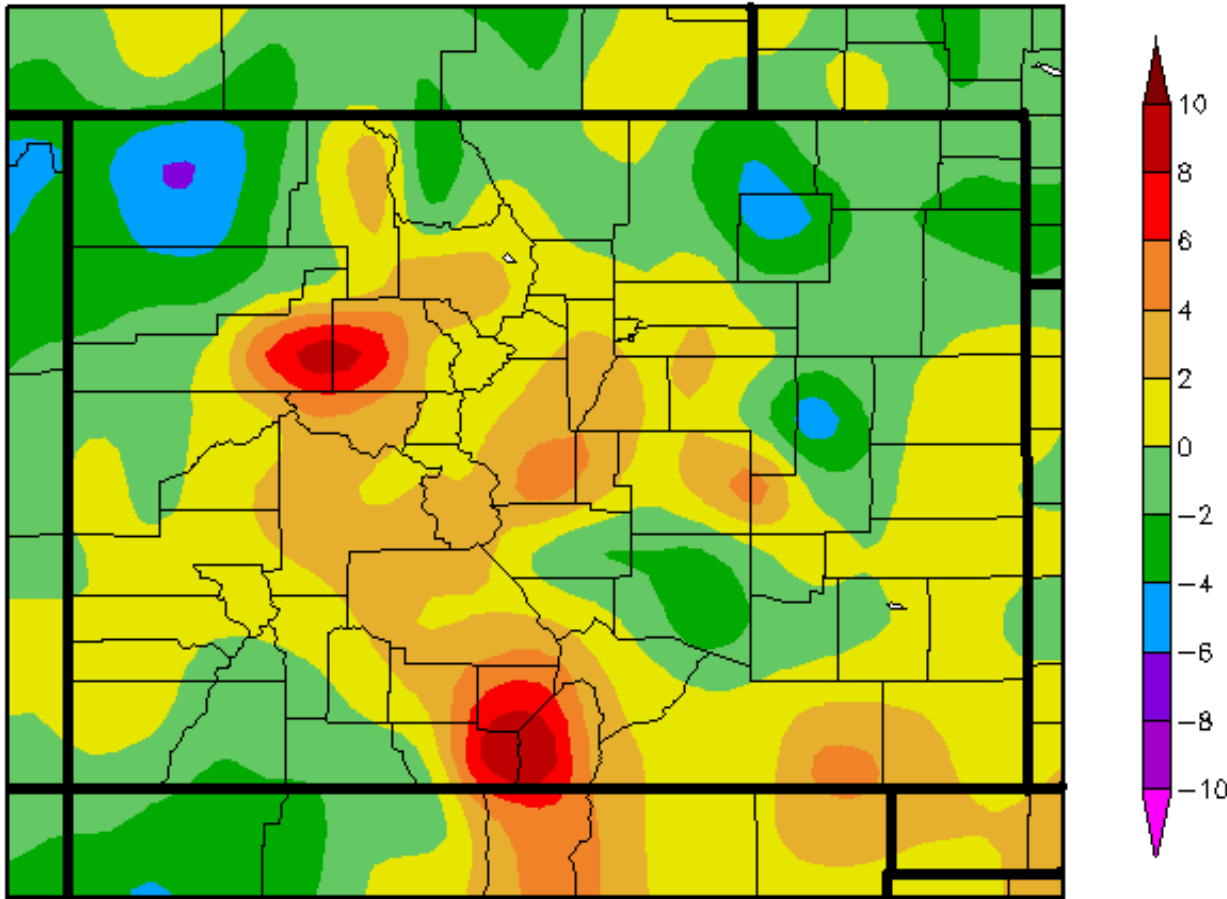
have remained above average in river basins across northwest and west central Colorado; analogous to conditions observed during previous La Niña episodes, particularly those of moderate to strong intensity.

River basins in south central and eastern Colorado showed a slight improvement due to recent precipitation.



# Departure for Normal Temperature (deg F) for Colorado

Dec. 20, 2010 - Jan. 18, 2011



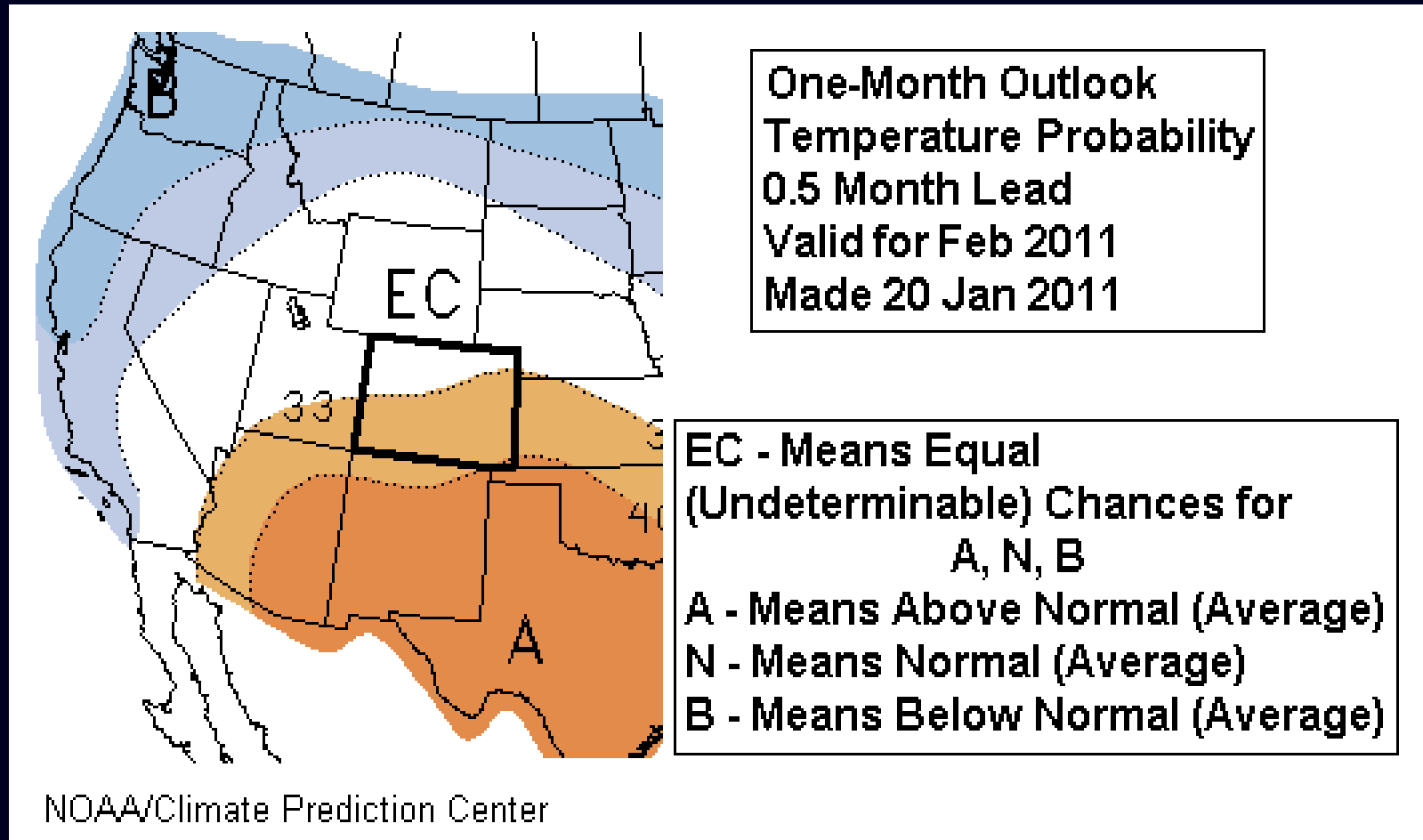
Temperatures during the 30 day period ending January 18, 2011, remained above normal across central and southeastern Colorado, but cooled to below normal in the Four Corners area and the northeast plains. The northwest corner of the state remained below normal, as much as 8°F below normal in the central Yampa River Valley.

Warmest temperatures were recorded in the central Colorado River Valley, in the central mountains, the southeast plains of Colorado, and the San Luis Valley.

Temperature and Precipitation Outlooks  
For February-March-April 2011  
Issued by NOAA's  
Climate Prediction Center

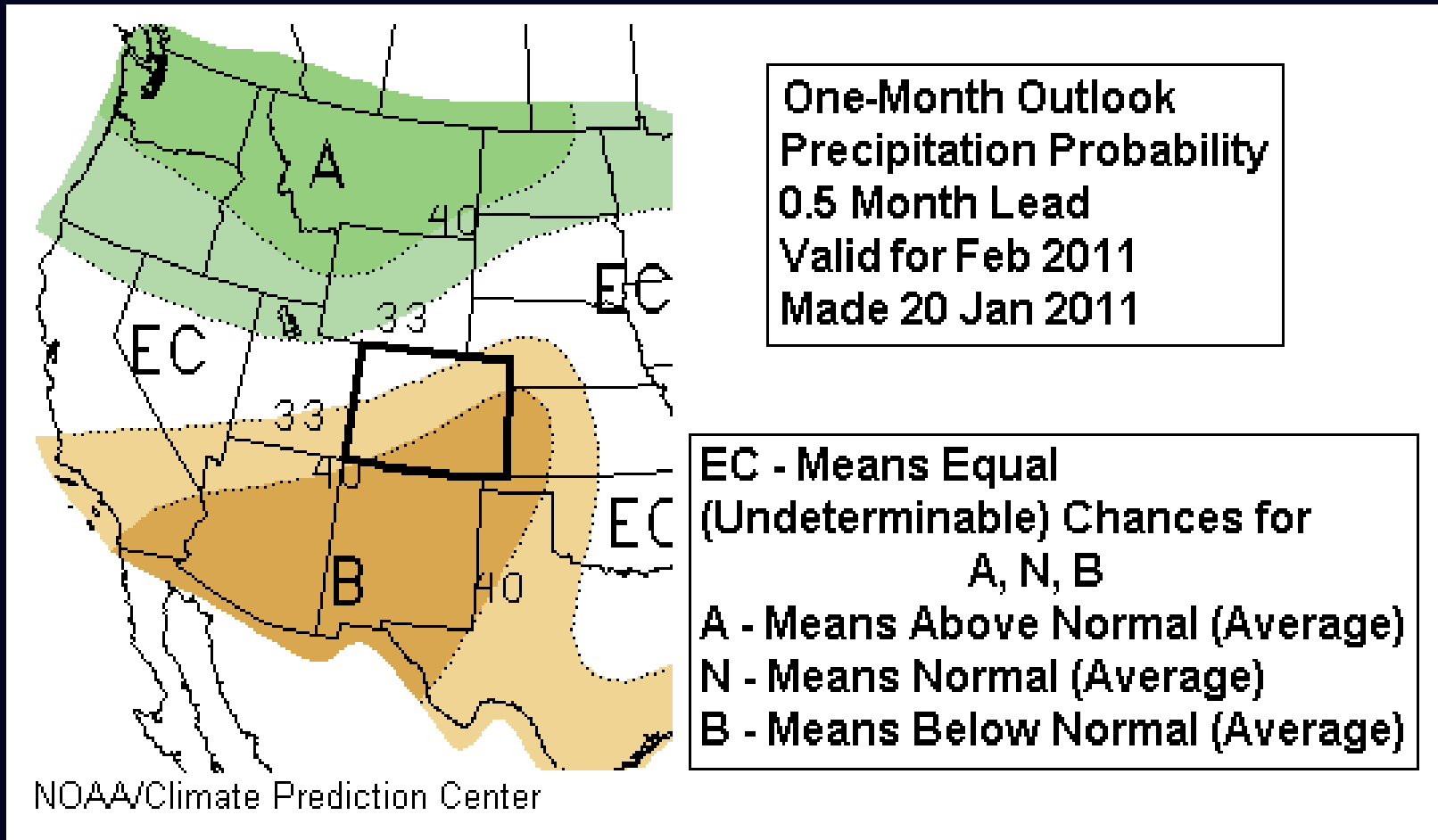


# February 2011 Temperature Outlook



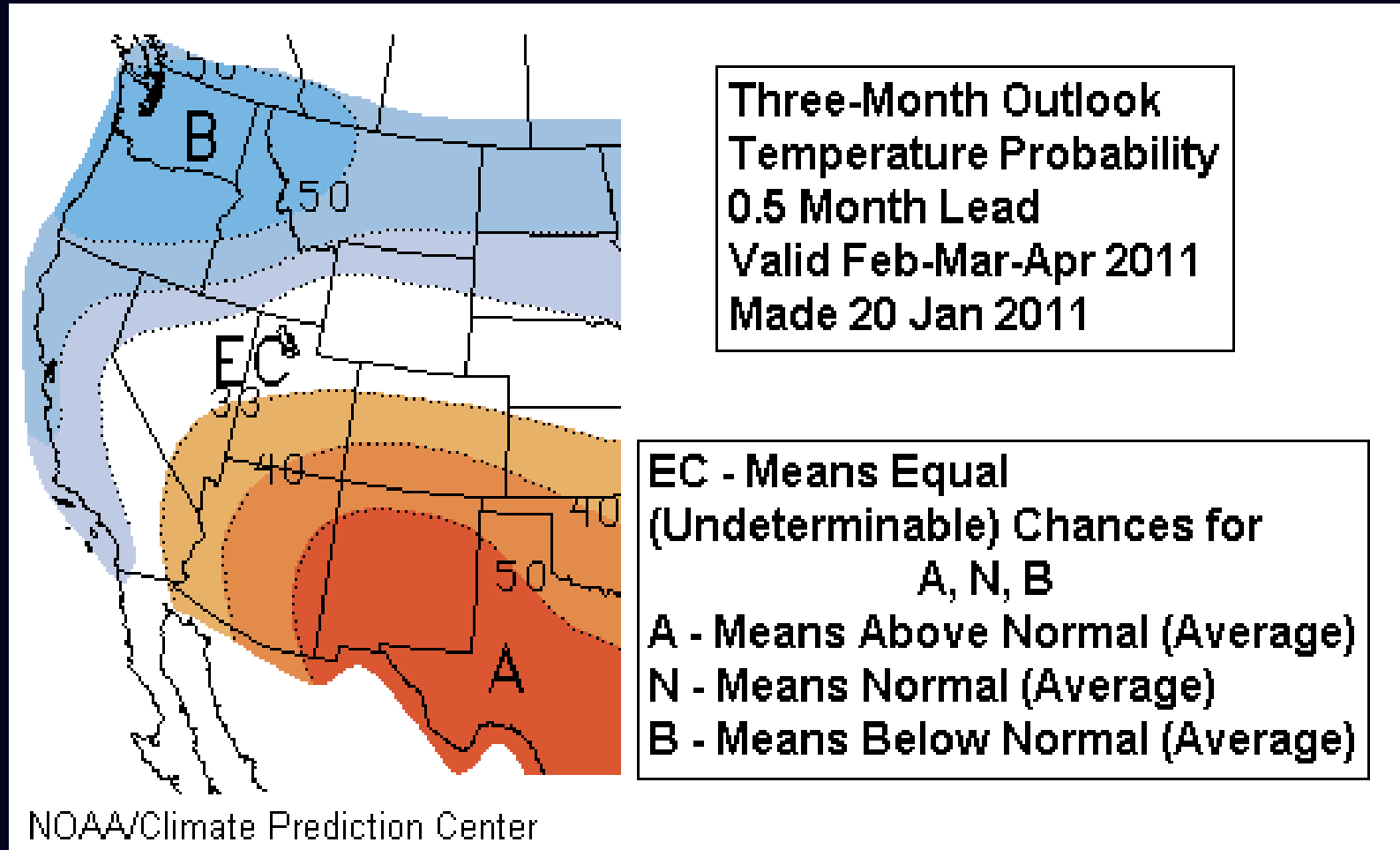
The temperature outlook for Colorado for the month of February 2011 calls for a 33-40% probability of above average temperature across southeastern two-thirds of the state, and equal (or undeterminable ) chances for above, below or near average temperatures across the northwestern one-third of Colorado.

## February 2011 Precipitation Outlook



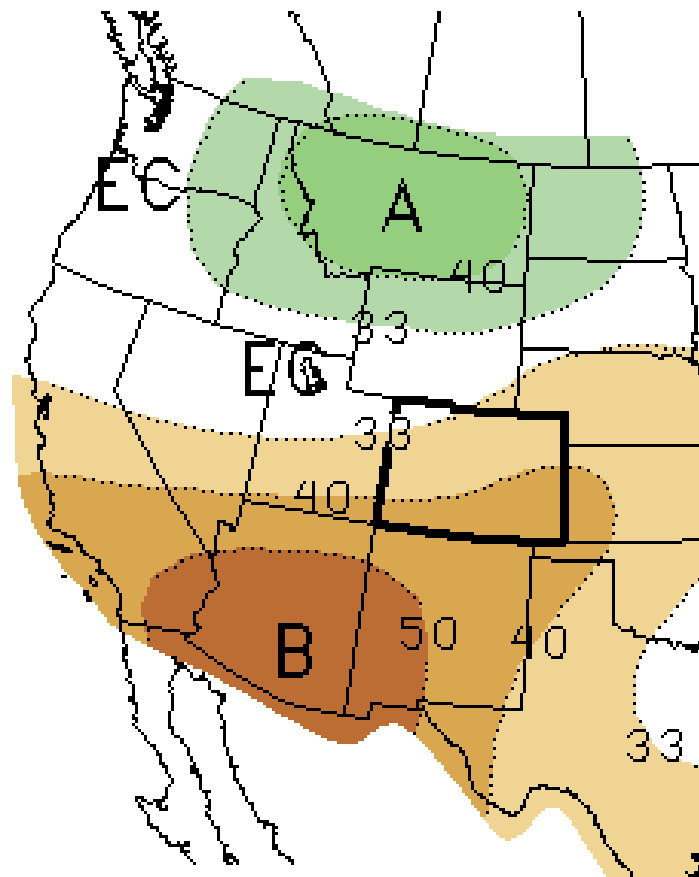
The precipitation outlook for Colorado for the month of February, 2011 calls for a 40-50% probability for below average precipitation across the southeast half of Colorado, a 33-40% chance for below average precipitation from southwest to northeast Colorado, and equal (or undeterminable) chances for above, below or near average precipitation across the northwest corner of the state.

# Feb-Mar-Apr 2011 Temperature Outlook



The temperature outlook for Colorado for the 3-month climate season of February through March of 2011 calls for a 40-50% probability for above average temperature across the southern one-third of Colorado, a 33-40% chance for above average temperatures across central portions of the state, and equal (or undeterminable) chances for above, below or near average temperatures across the northern one-fourth of the state.

## Feb-Mar-Apr 2011 Precipitation Outlook



NOAA/Climate Prediction Center

Three-Month Outlook  
Precipitation Probability  
0.5 Month Lead  
Valid Feb-Mar-Apr 2011  
Made 20 Jan 2011

EC - Means Equal  
(Undeterminable) Chances for  
A, N, B  
A - Means Above Normal (Average)  
N - Means Normal (Average)  
B - Means Below Normal (Average)

The precipitation outlook for Colorado for the 3-month climate season of February through March of 2011 calls for a 40-50% probability for below normal precipitation across the southeast one-third of the state, a 33-40% chance for below average precipitation across the central and northeast portions of the state, and equal (or undeterminable) chances for above, below or near average precipitation across the northwest corner of the state.



# Review

- **La Niña conditions persist across the tropical Pacific Ocean.**
- **These conditions are forecast to continue through at least this spring.**
- **Beyond this spring the outlook for this La Niña is considerably more uncertain. A number of the ENSO-climate models indicate ENSO-neutral conditions by this summer. Others indicate a continuation of weak La Niña conditions, while the remaining models suggest the start of a weak El Niño.**
- **Even as the current La Niña weakens, it should continue to play a role in Colorado's weather for the remainder of this winter and perhaps into this spring.**
- **The latest three month outlook prepared by NOAA's Climate Prediction Center indicates a 33-50 percent probability of above normal temperatures and below normal precipitation for all but the extreme northwest corner of Colorado. This maybe suggesting a return to abnormally warm and dry weather statewide by this spring as was observed last fall.**