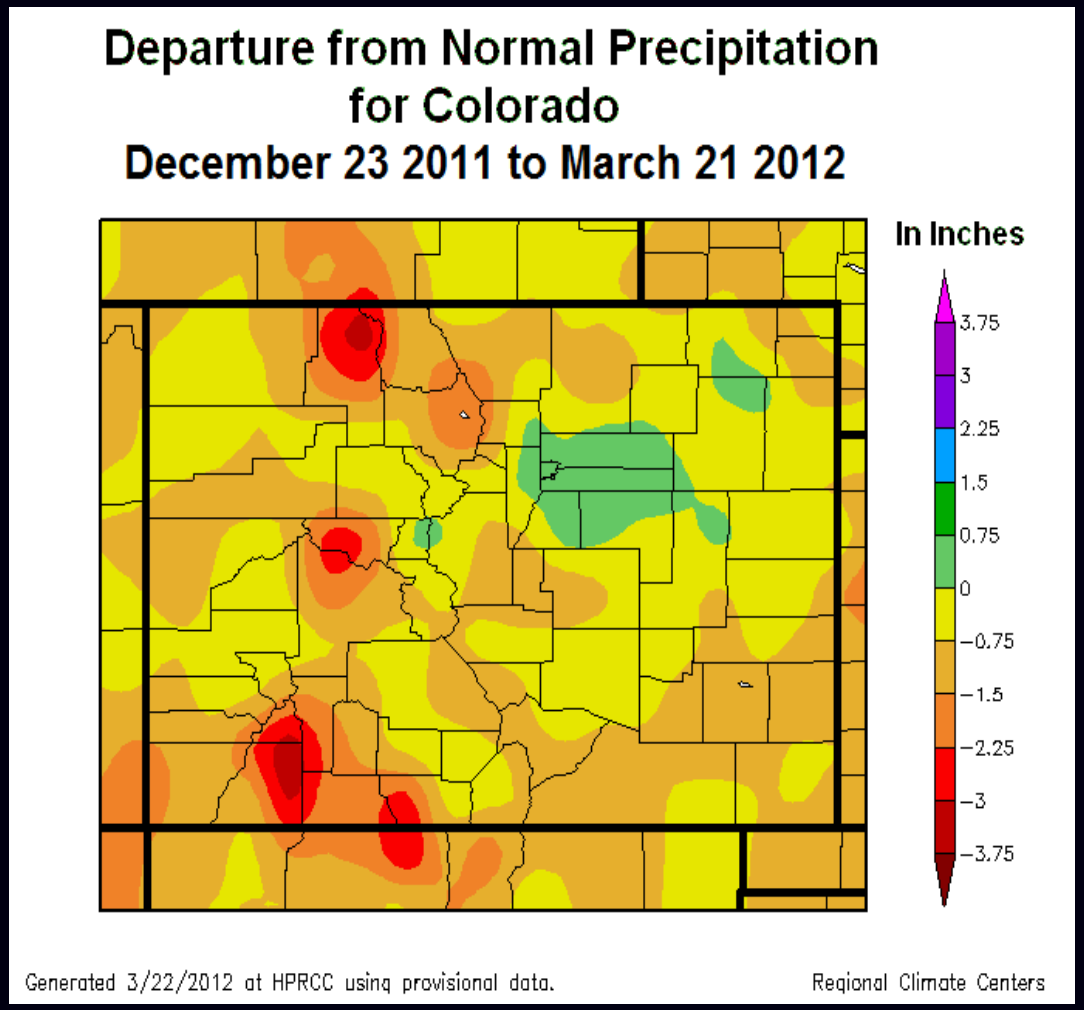
La Niña's Ending—What Next?
Another MJO Perhaps?
Prospects for an Active Wildfire Season
and the
April-May-June 2012
Outlook
For Colorado

Mike Baker
National Weather Service
Boulder, Colorado
March 25, 2012

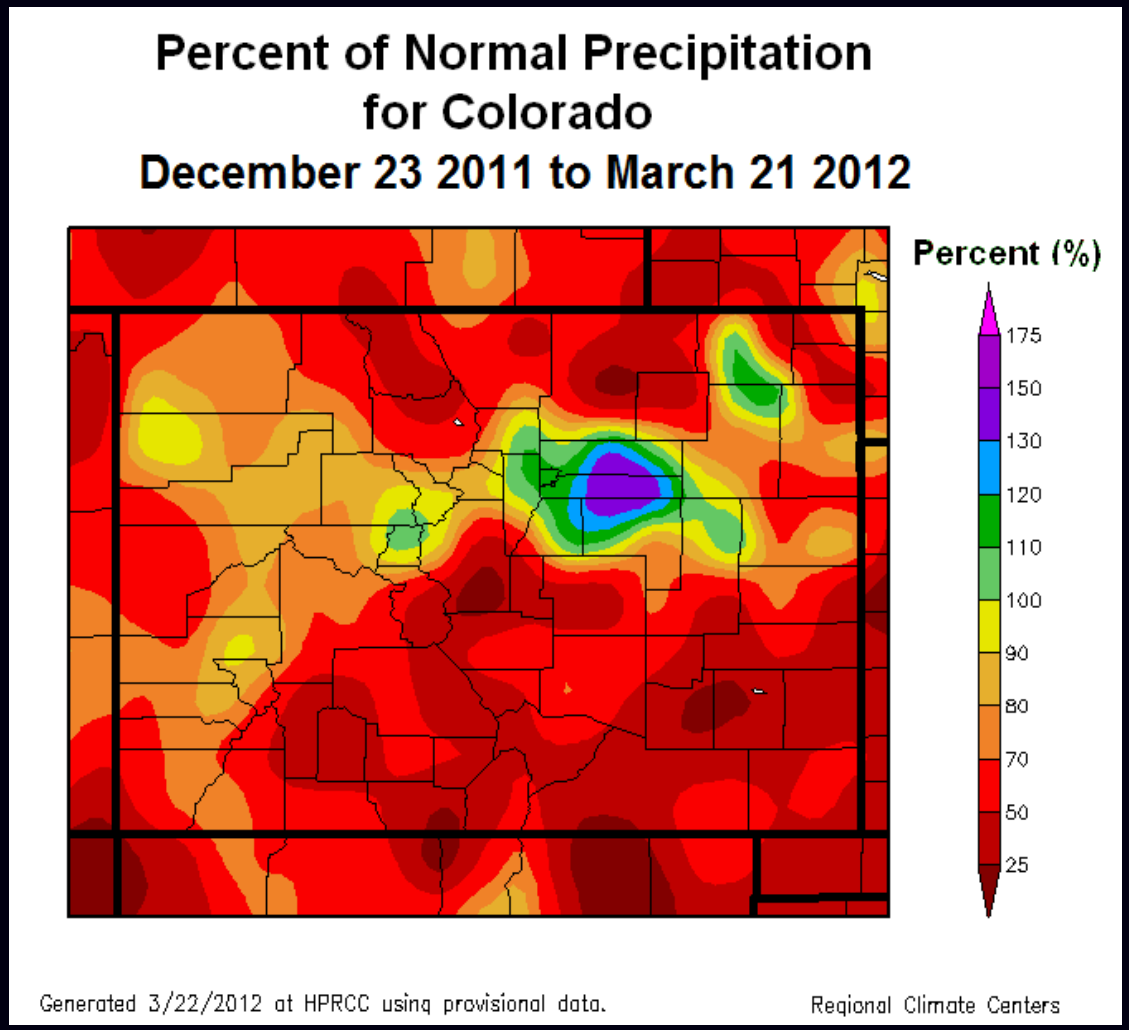
Next Issuance May 25, 2012

First…
A Review of
Weather and Drought Conditions
Across Colorado
During the
90-Day Period
Ending March 21, 2012



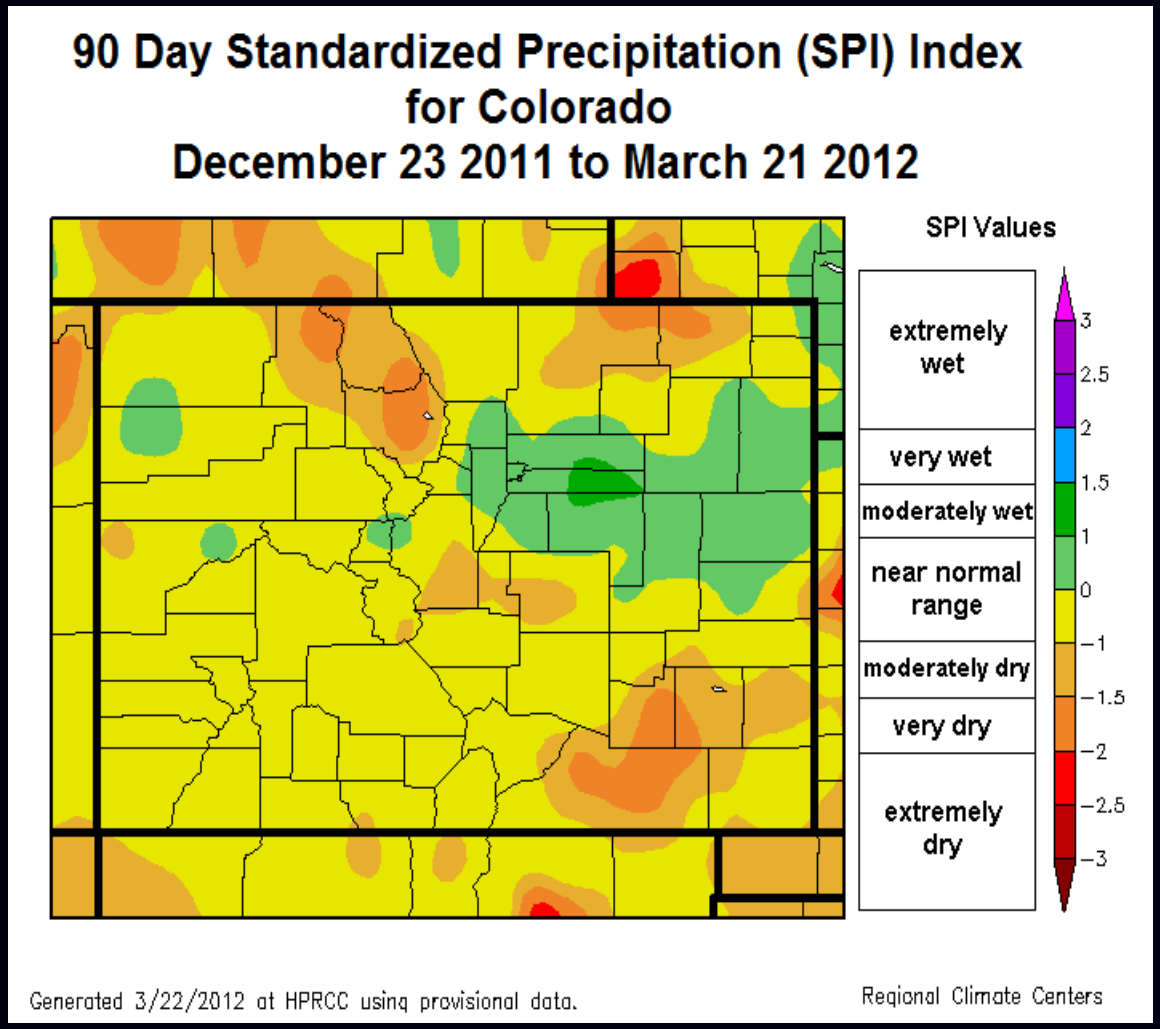
Precipitation across Colorado was for the most part below average during this 90-day period, with deficit amounts ranging from near 4 inches in the Upper Yampa River Basin, around Aspen in west central Colorado and portions of the San Juan Mountains in southwest Colorado. Precipitation departures up around 2 inches are indicated in the head water region of the Colorado River in north central Colorado and in the extreme southwest corner of the state.

Precipitation surpluses are indicated in northeast Colorado specially along the north facing aspect of the Monument Ridge/Palmer Divide in Douglas, Elbert and Lincoln Counties, as well as the greater Denver Metro Area including the nearby Front Range foothills.



From a percentage perspective, precipitation was below to much below average across most of Colorado during this 90-day period, with percentages as low as 25 percent of normal in areas along the Wyoming, Nebraska and New Mexico borders, and on the south side of Middle Park in Park County.

Notable exceptions to this blanket of dryness include the area from the western suburbs of Denver to the city of Limon in northern Lincoln county, along the South Platte River in northeast Colorado, and around Leadville in the Lake County where precipitation amounts ranged from 110 to 150 percent of normal.

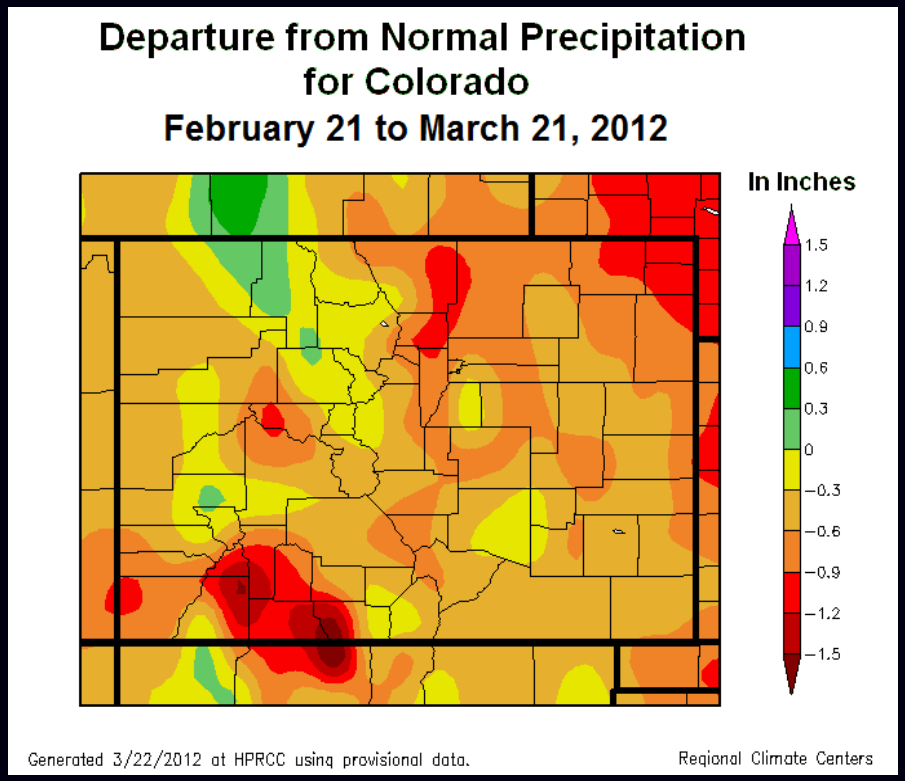


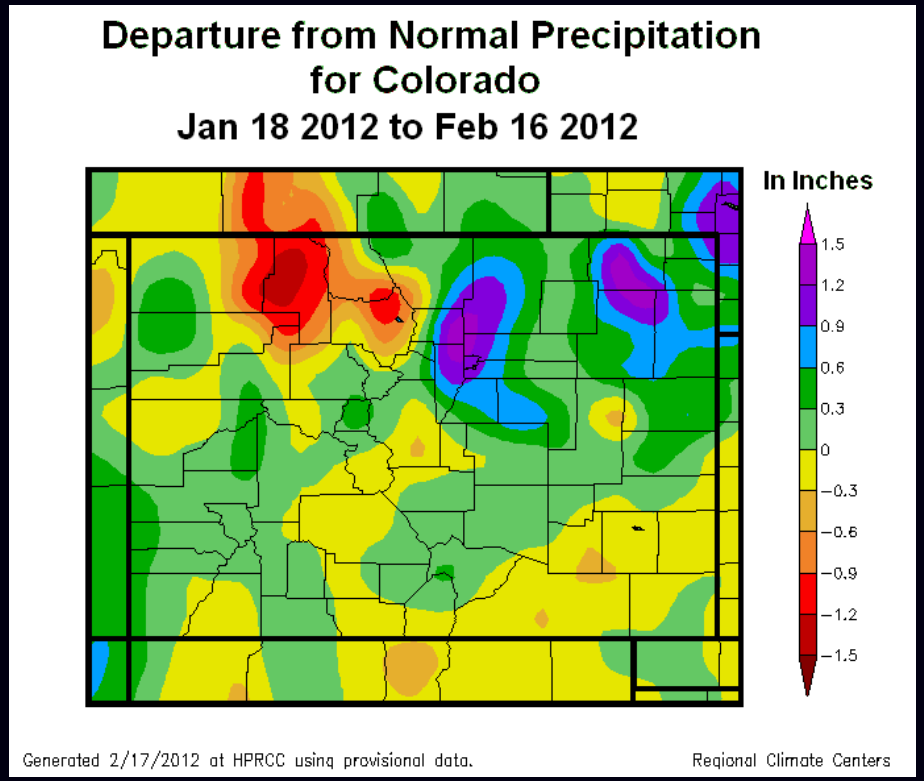
The SPI was developed to monitor potential short term agricultural and long-term hydrological drought conditions. The SPI is a probability index that considers only precipitation.

The Standardized Precipitation Index (SPI) for the 90-day period ending March 21, 2012, indicated dry to very dry soil conditions for nearly all of Colorado. Furthermore, an area of very dry to extremely dry soils has recently appeared in northeast Colorado up along the Nebraska border.

Wet to moderately wet soils are scattered around the state including part of the Upper Yampa River Basin in northwest Colorado, the head water region of the Arkansas River around Leadville, and a wide swath of northeast Colorado from the Front Range to the Kansas border.

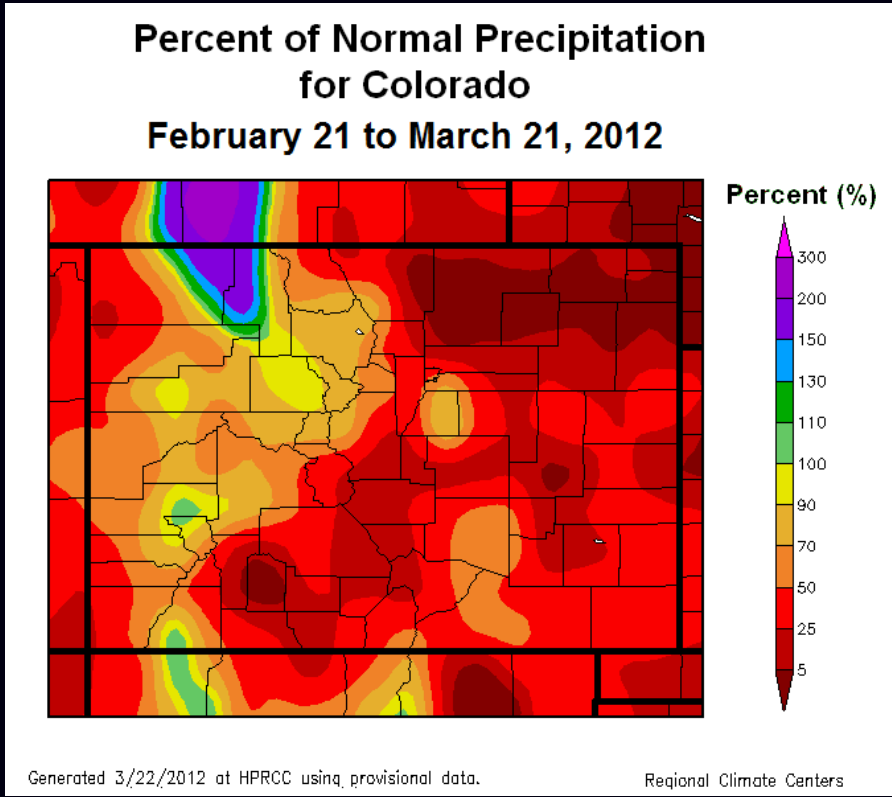
Comparing Weather and Drought Conditions Across Colorado for the 30-Day Periods of January 18-February 16 and February 21 to March 21, 2012

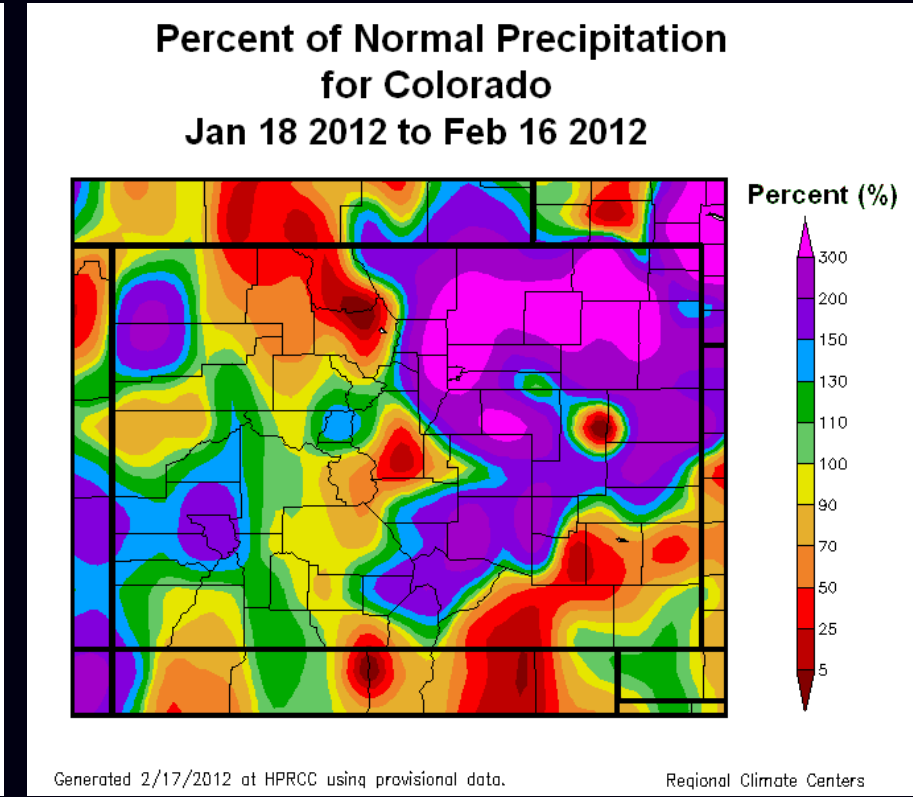




30-day precipitation totals ending March 21, 2012 (map in upper left) were below to much below average for most of Colorado, with 1 to 2 inch deficits in the San Juan Mountains in southwest Colorado, the Aspen area in west central Colorado, along the eastern slope of the Front Range in north central Colorado, and the far northeast corner of the state.

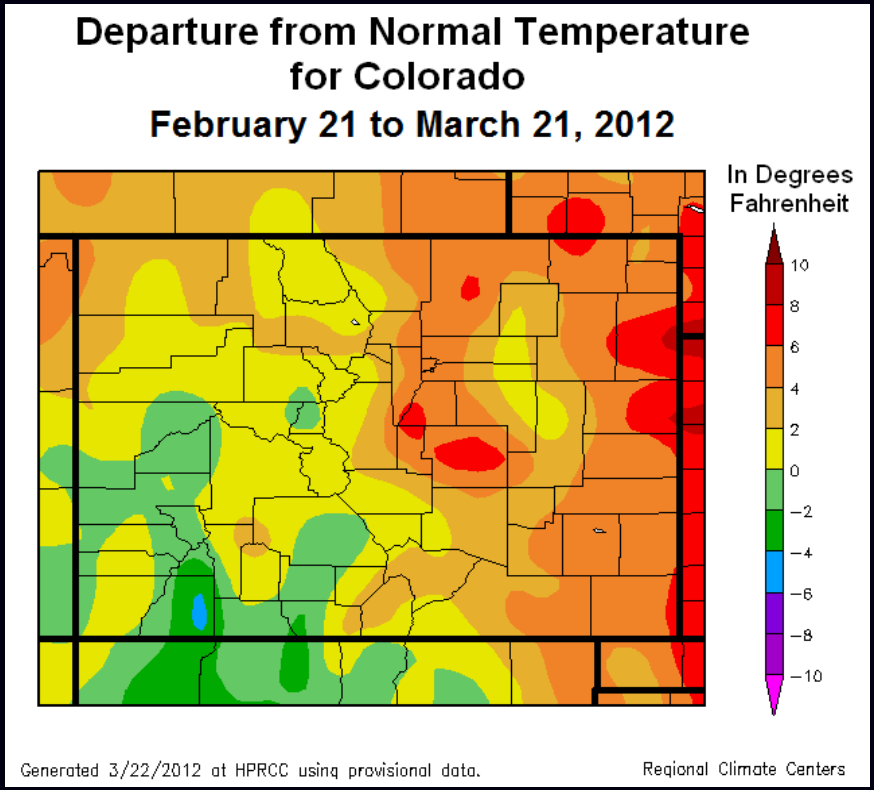
Precipitation totals ending March 21st are in sharp contrast to those observed 30 days earlier when the Steamboat Springs area in northwest Colorado was severely lacking precipitation, and the Front Range urban corridor around Denver and parts of the northeast plains were particularly wet (snowy). A dramatic shift in precipitation also occurred during this period in southwest Colorado.

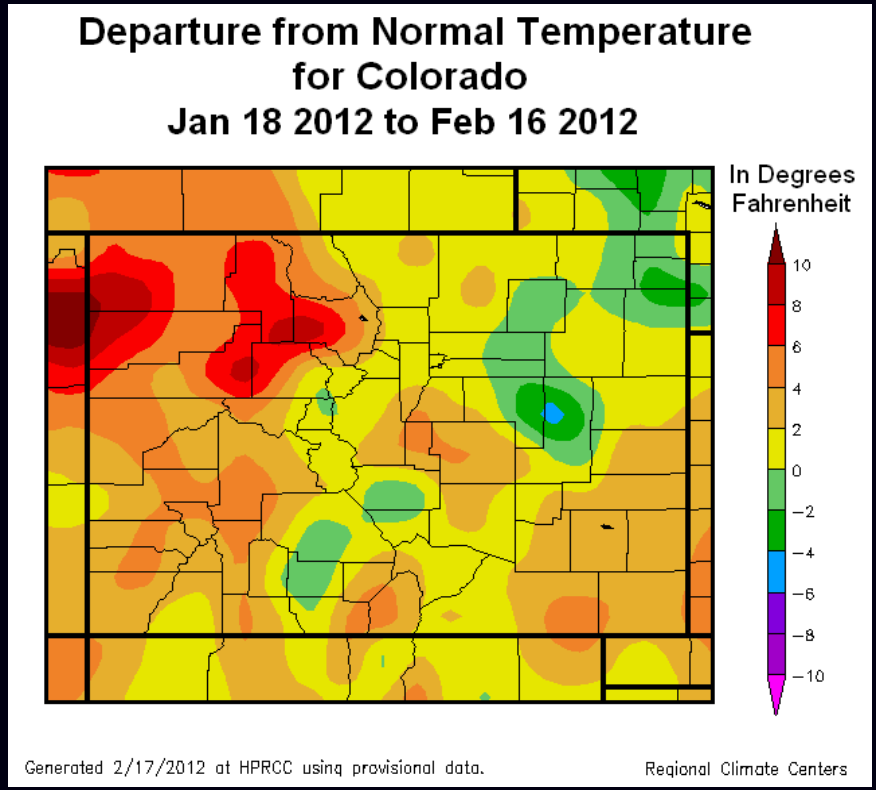




The dramatic month-to-month reversal in precipitation referred on the previous slide is quite evident on these percentage of normal precipitation maps (the most recent period at the upper left.)

The greatest change in precipitation during this two month period occurred in northeast and east central Colorado where several days of precipitation (snowfall) in February of this year resulted in 30-day precipitation totals from 150 percent to over 300 percent of normal.

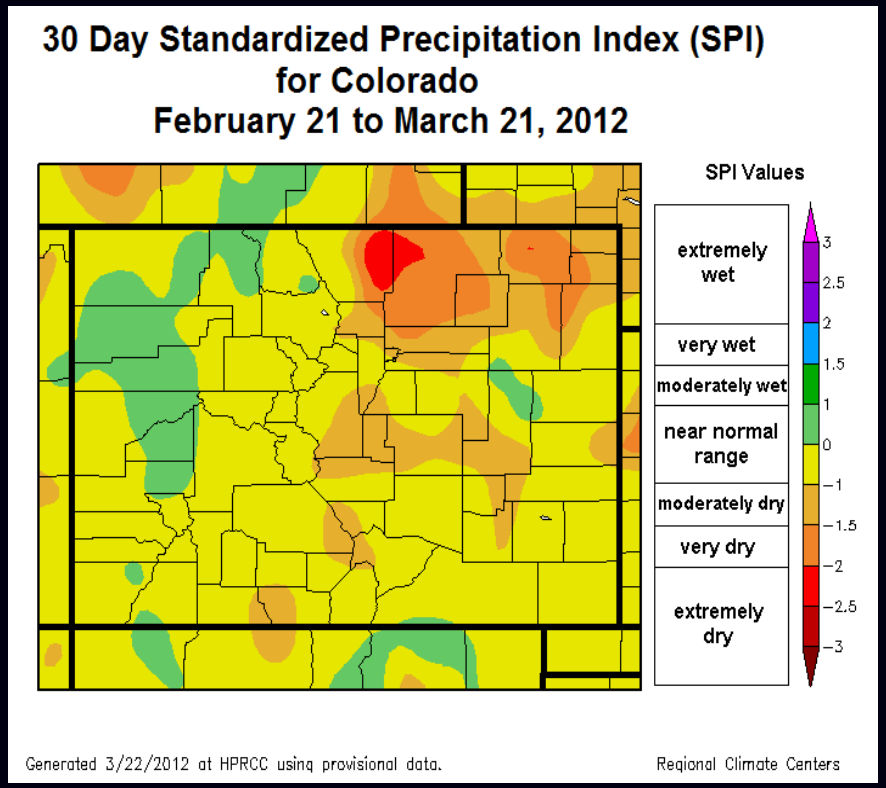


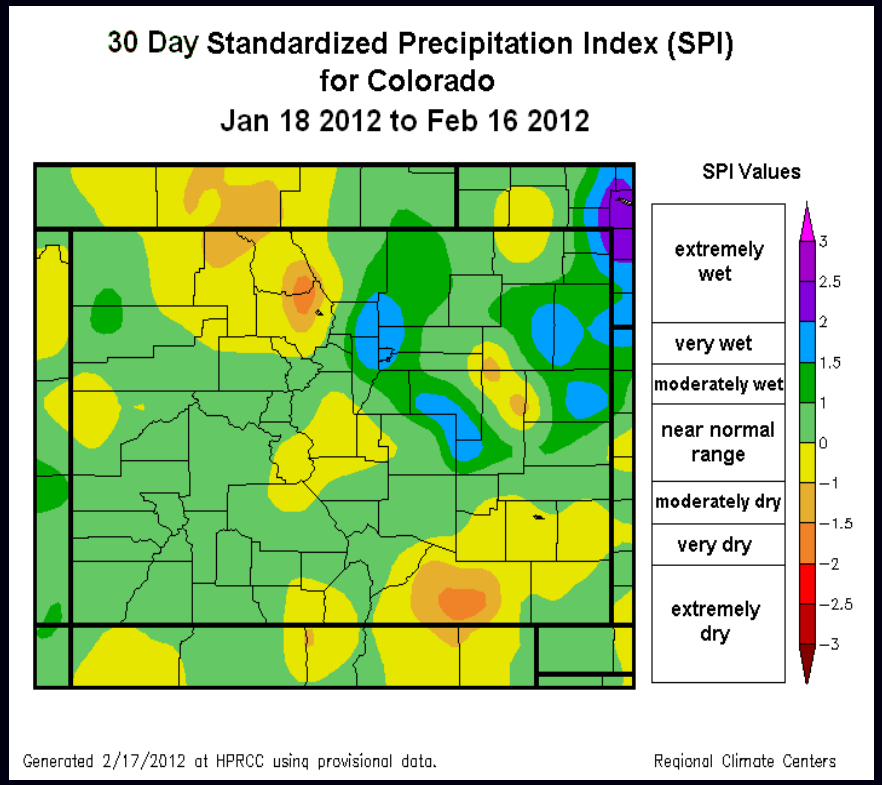


Temperatures across Colorado also underwent a big change during this two month period with the eastern half of the state going from 2 to 10 degrees F above average during the 30-day period ending March 21st (map in upper left) to as low as 6 degrees below average during the 30-day period ending February 16th (map in upper right).

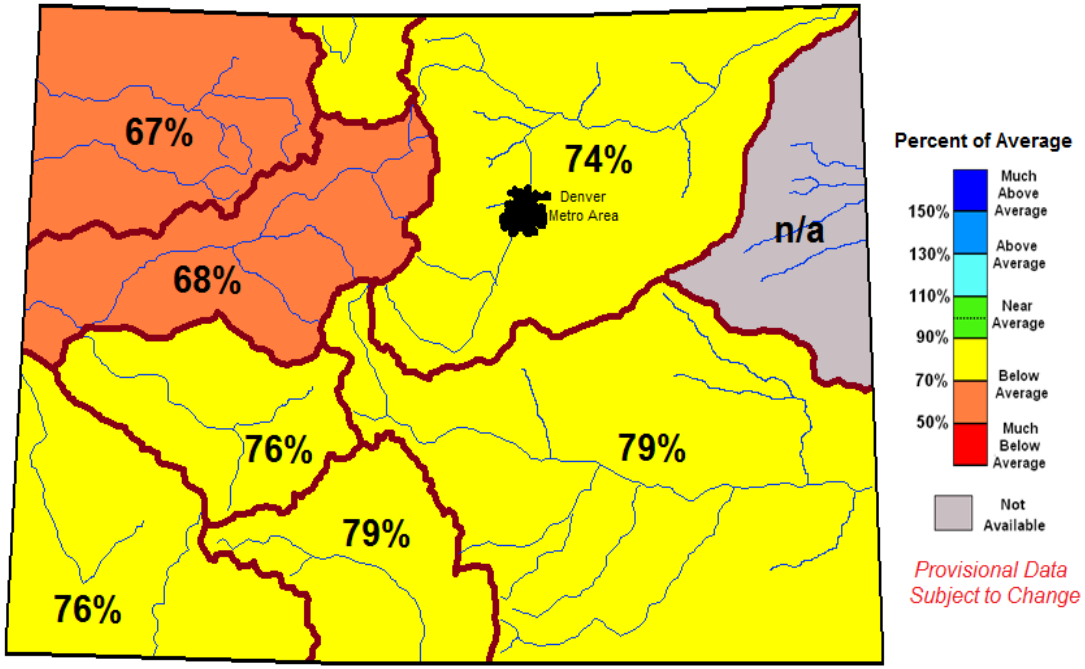
A similar reversal in temperature occurred across western Colorado. Temperatures were generally below average during the 30-day period ending March 21st (map in upper left), and as much as 4 to 10 degrees F above average during the previous 30-day period ending February 16th of this year.

These month-to-month shifts in temperature are attributed to a significant shift in the precipitation distribution during the period.





The Standardized Precipitation Index (SPI) indicates moderate to very dry conditions for nearly all of Colorado for the 30-day period ending March 21, 2012 (map in the upper left), with the driest soil conditions in northeast Colorado along the northern Front Range. Compare that to the significantly wetter conditions observed during the 30-day period ending February 16th of this year (map in the upper right) when the northeast plains of Colorado varied from very wet to extremely wet.



Snow Water Equivalent as a Percent of Average (%) for Colorado by River Basin as of Thursday Mar 22, 2012

Basin Wide Percent of Average (%)

West Slope		East Slope	
Yampa & White River Basins	67%	Laramie & North Platte Basin	71%
Upper Colorado River Basin	68%	South Platte River Basin	74%
Gunnison River Basin	76%	Arkansas River Basin	79%
San Miguel, Dolores Animas & San Juan River Basins	76%		
Upper Rio Grande Basin	79%		

Statewide Avg... 72%

Source: USDA Natural Resources Conversation Service-Water and Climate, Portland, Oregon

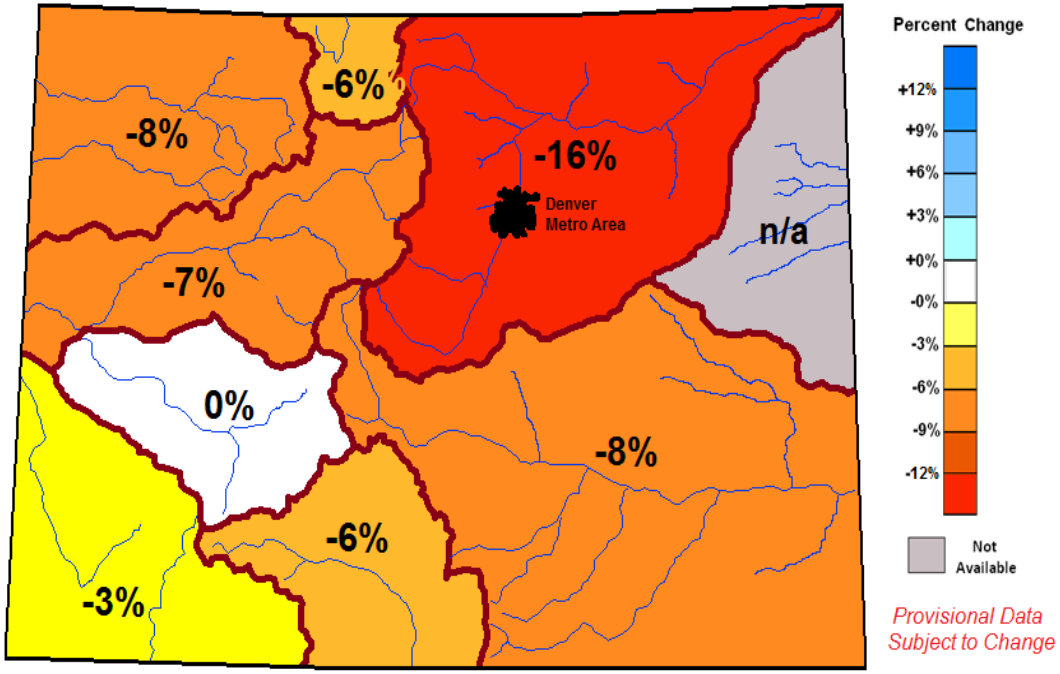
As of March 22, 2012, snowpack (snow water equivalent) for Colorado dropped to 72 percent of average. In comparison, the statewide snowpack last year at this time during the final stages of a strong La Niña was 113 percent of average.

Northwest Colorado continued to report the state's lowest average snowpack at around 67 percent. This is far below the near record snowpack of around 130 percent of average observed one year ago.

SNOTEL sites across the rest of Colorado also continued to report below average snowpack, although percentages were slightly greater over higher elevations in the Arkansas River and Upper Rio Grande basins.

The South Platte River basin snowpack was 45 percent lower than that one year ago.

Colorado SNOTEL Snow Water Equivalent Change Map



Percent Change in Snow Water Equivalent By Colorado River from Feb 24 to Mar 22, 2012

West Slope		East Slope	
Yampa & White River Basins	-8%	Laramie & North Platte Basin	-6%
Upper Colorado River Basin	-7%	South Platte River Basin	-16%
Gunnison River Basin	0%	Arkansas River Basin	-8%
San Migual, Dolores Animas & San Juan River Basins	-3%		
Upper Rio Grande Basin	-6%		

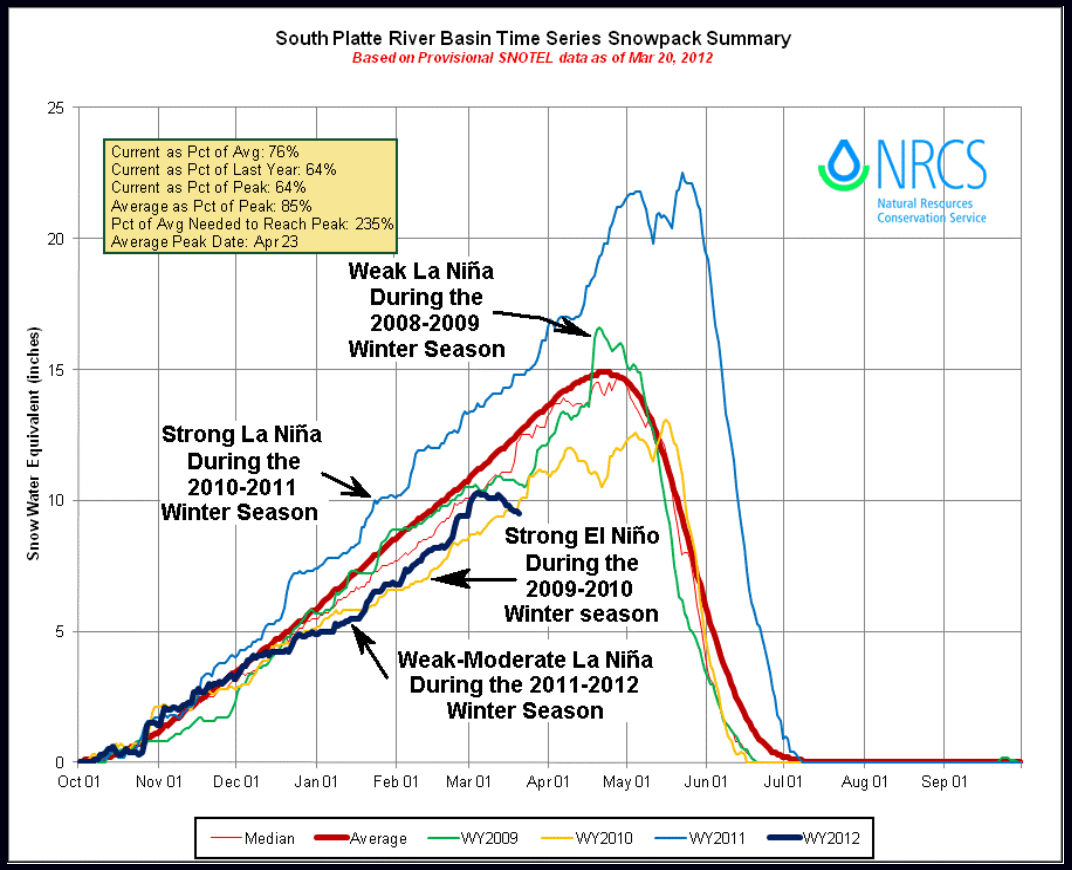
Statewide Avg... -7% Change

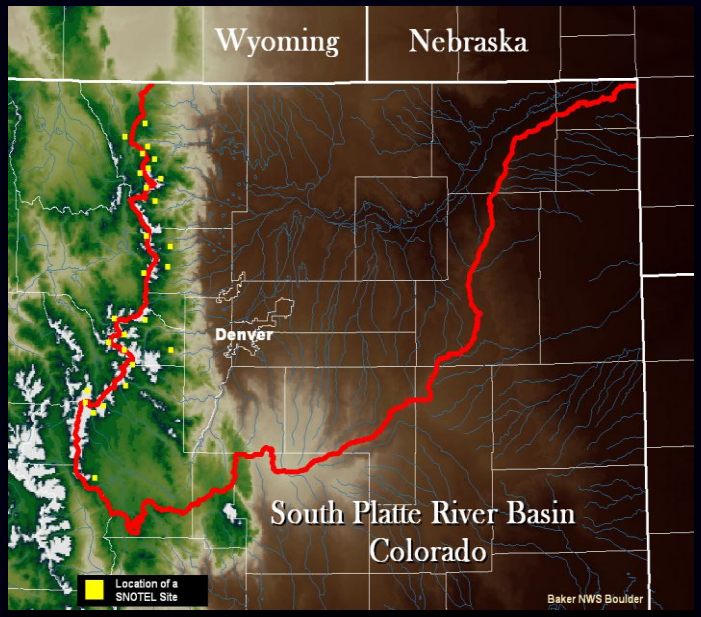
Source: USDA Natural Resources Conversation Service-Water and Climate, Portland, Oregon

From February 24 to March 24 of this year, the snow water equivalent of the state's snowpack decreased by an average of 7 percent.

The South Platte River basin saw the greatest basin-wide decrease (16 percent) in snowpack during this 30 day period. Reasons for this significant reduction due to melting, sublimation and evaporation, include the lack of snowfall, greater insolation, unseasonably warm temperatures and low relative humidities, and frequent periods of strong winds.

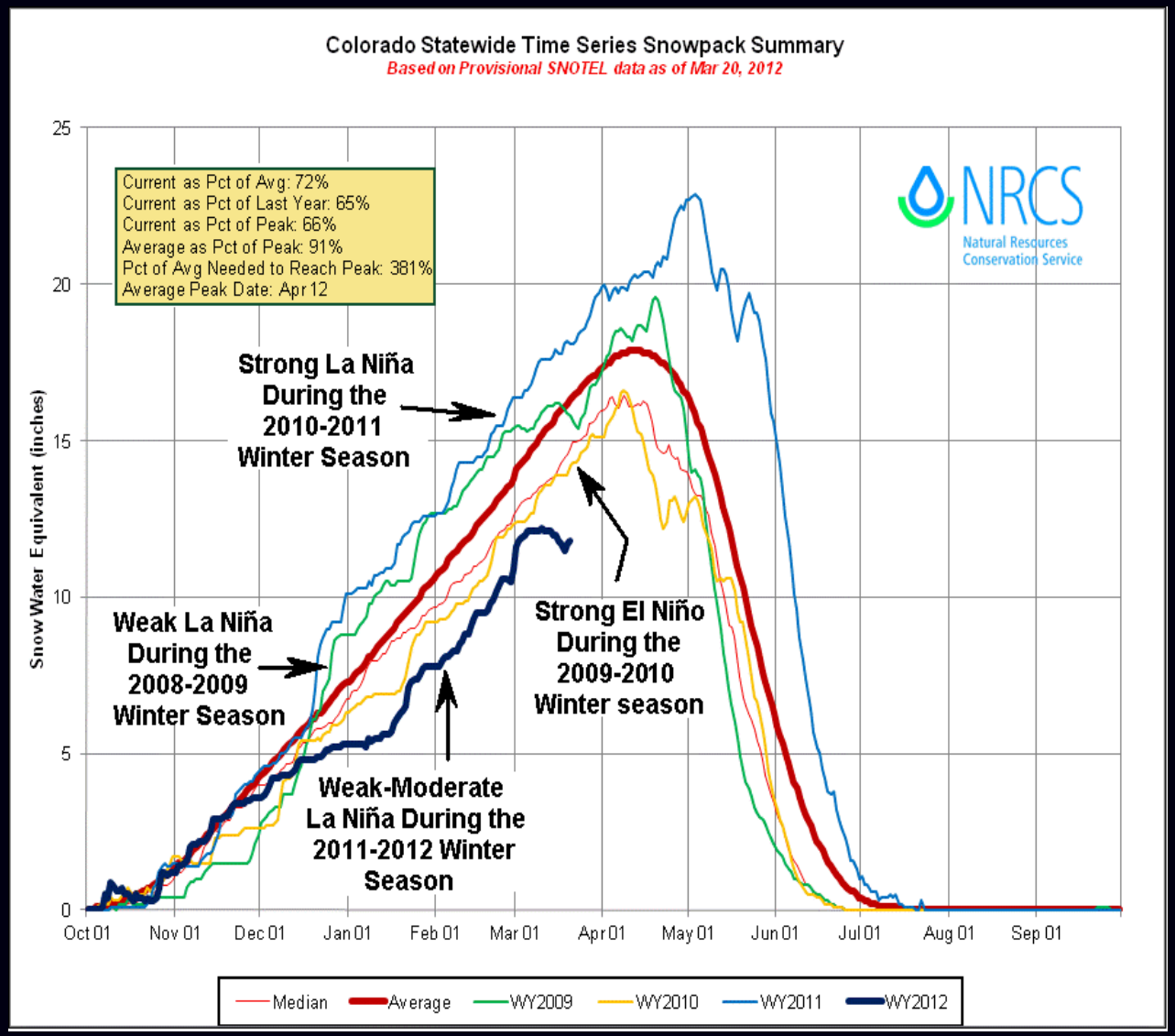
Except for the Gunnison River basin where the snowpack remained about the same, snow water equivalents for the rest of the state decreased by an average of 7 percent, generally for the same reasons mentioned above.





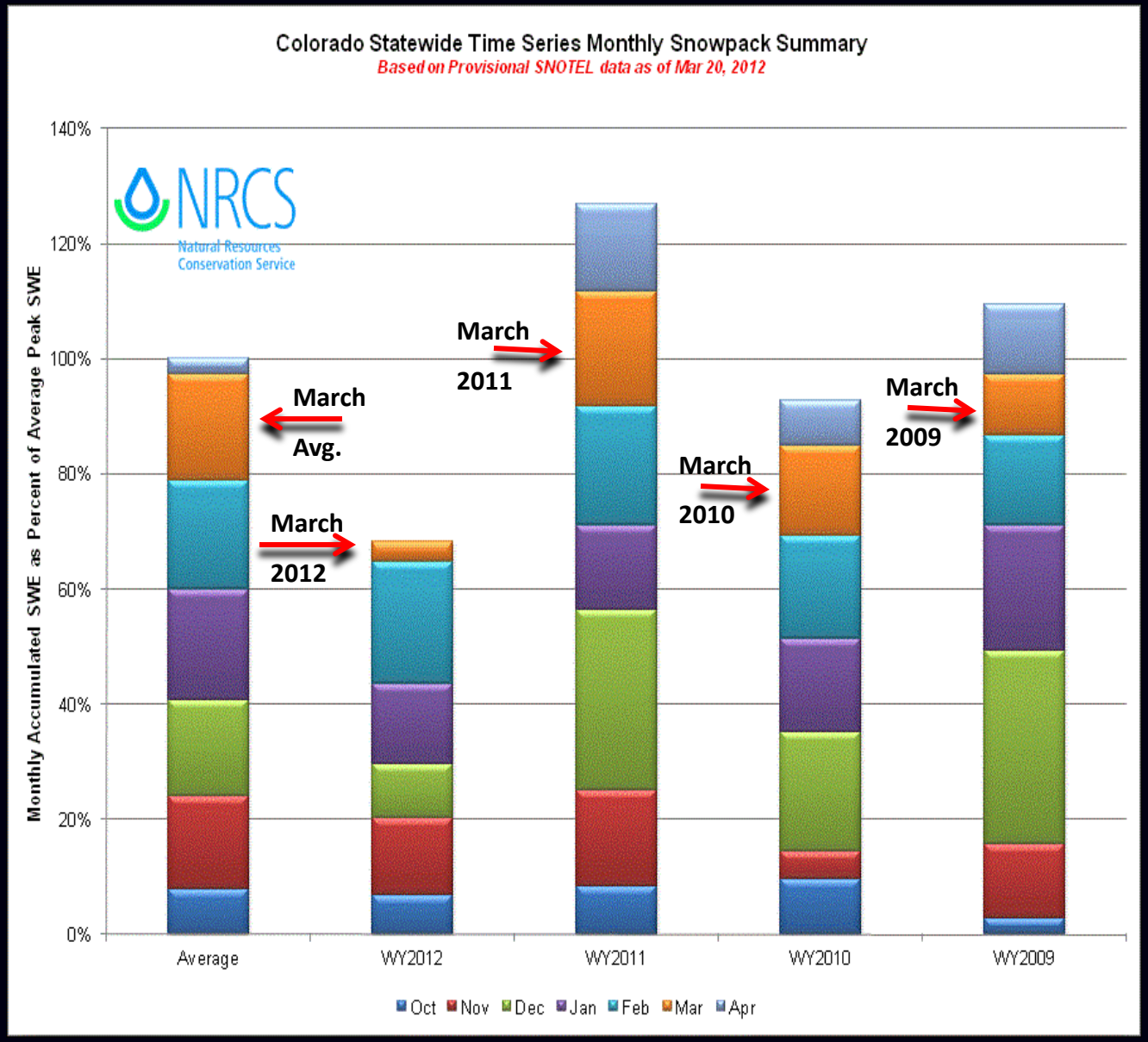
Yellow dots – reporting SNOTEL sites

The snow water equivalents are presented for the South Platte River Basin in northeast Colorado for the water years of 2009, 2010, 2011 and 2012. Each time series represents an average value based on observations taken at 27 SNOTEL sites (all mountain locations) within the basin (see map in upper right). As of March 20, 2012, near the conclusion of a weak to moderate La Niña, the basin average snow water equivalent (thick dark blue line) was approximately 3.5 inches below the 1971-2000 climatological average (thick red line). This was the lowest average value recorded for mid-March in the past four water years. However, the current average is only slightly less than the equivalent observed in March 2010 (yellow line) during a strong El Niño. The greatest basin wide average recorded on this date during these four water years was observed during the 2011 water year-a strong La Niña (blue line), followed by the 2009 water year-a weak La Niña (green line.)



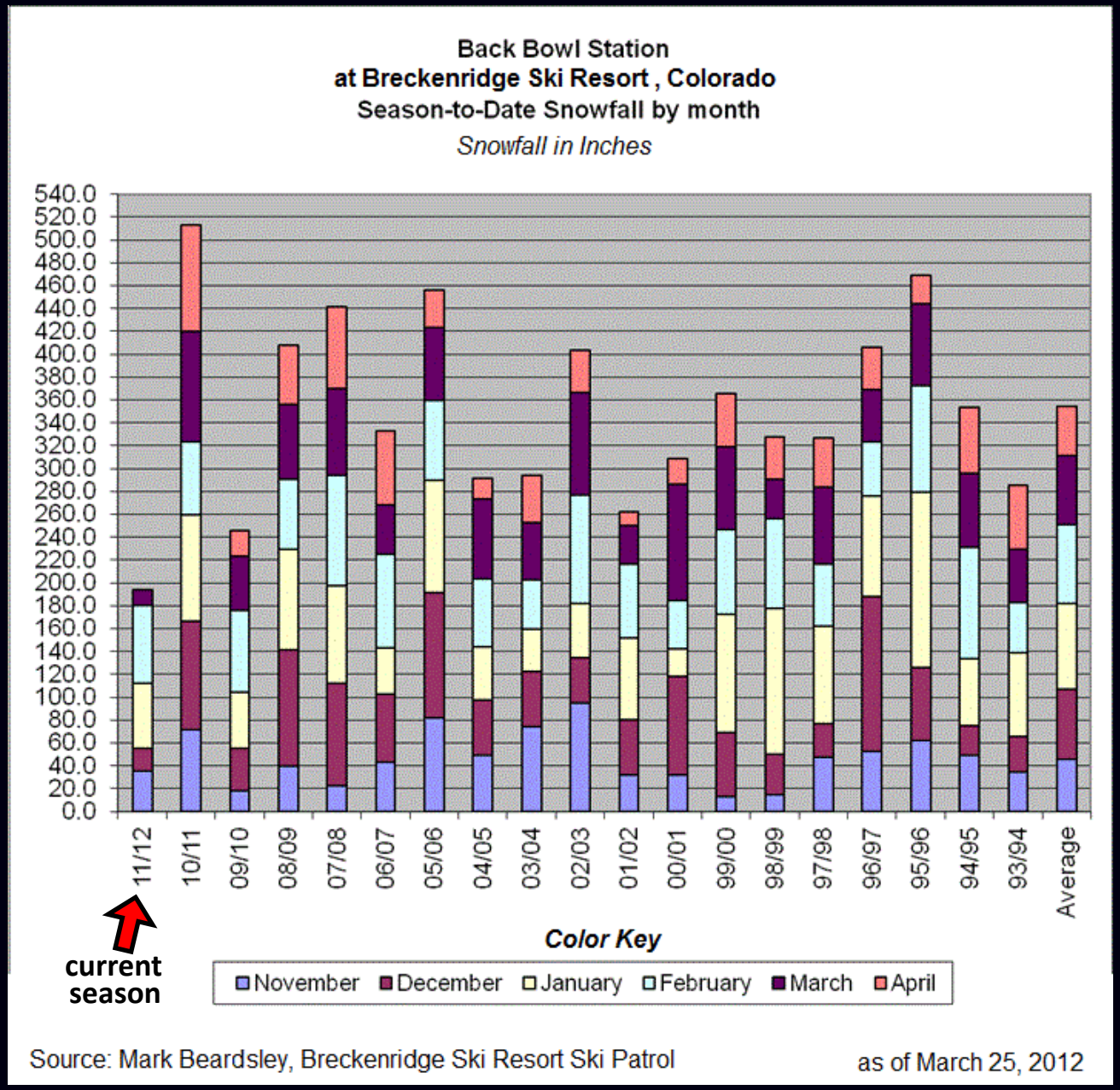
Average snowpack in Colorado as of March 20, 2012 continues to lag behind the pace observed in mid-March during the 2009, 2010 and 2011 water years.

Statewide snowpack (snow water equivalent) as of mid-March was greatest during the 2011 water year (a strong La Niña), followed by the 2009 water year (a weak La Niña), and the 2010 water year (a strong El Niño.)



March 2012 stands out as the least snowiest March in Colorado since to the winter season of 2008-2009.

Without the above average snowfall across southern and eastern Colorado in February, the winter season of 2011-2012 would be in line for the least snowiest water year on record for the state.



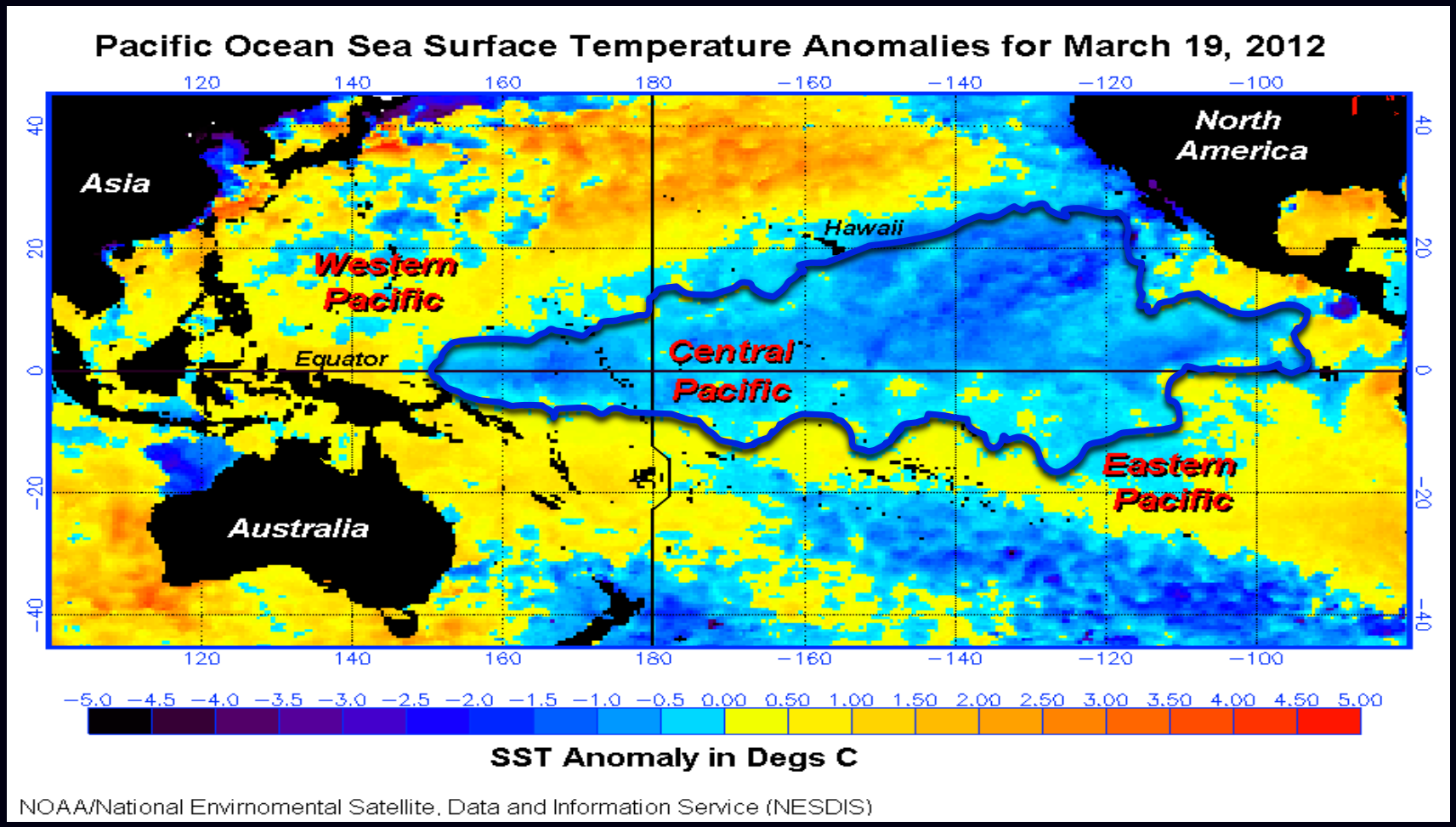
From Most to Least Snowiest in Just Two Seasons

This winter season's snow drought in much of Colorado's high country is quite evident in this season-to-date snowfall time series dating back to the 1993-1994 winter season for the Breckenridge Ski Area in the mountains west of Denver.

Of particular noteworthy, is the significant lack of snowfall during March of this year. And, it was just last winter that the area saw its greatest snowfall in the past 20 years.

La Niña Nearing An End

Baker - National Weather Service Boulder, Colorado



In February, above average sea surface temperatures (SSTs) appeared in the eastern tropical Pacific Ocean with the passage of a strong Madden-Julian Oscillation (MJO). During the first half of March SSTs returned to average or below average with the greatest negative anomalies observed in the central Pacific and off the west coast of Mexico. In the western tropical Pacific Ocean SSTs remained essentially unchanged. However a large pool of abnormally cold waters formed off the northwest coast of Australia, presumably in response to extensive convection associated with the MJO in the region. This Pacific basin-wide SST anomaly pattern is indicative of a weakening La Niña.

The Latest Oceanic Niño Index - ONI

Year	DJF	JFM	FMA	MAM	AMJ	MJJ	JJA	JAS	ASO	SON	OND	NDJ
2000	-1.7	-1.5	-1.1	-0.9	-0.8	-0.7	-0.6	-0.5	-0.5	-0.6	-0.8	-0.8
2001	-0.7	-0.6	-0.5	-0.3	-0.2	-0.1	0.0	0.0	-0.1	-0.2	-0.2	-0.3
2002	-0.2	0.0	0.1	0.3	0.5	0.7	0.8	0.8	0.9	1.2	1.3	1.3
2003	1.1	0.8	0.4	0.0	-0.2	-0.1	0.2	0.4	0.4	0.4	0.4	0.3
2004	0.3	0.2	0.1	0.1	0.1	0.3	0.5	0.7	0.7	0.7	0.7	0.7
2005	0.6	0.4	0.3	0.3	0.3	0.3	0.2	0.1	0.0	-0.2	-0.5	-0.8
2006	-0.9	-0.7	-0.5	-0.3	0.0	0.1	0.2	0.3	0.5	0.8	1.0	1.0
2007	0.7	0.3	-0.1	-0.2	-0.3	-0.3	-0.3	-0.6	-0.9	-1.1	-1.2	-1.4
2008	-1.5	-1.5	-1.2	-0.9	-0.7	-0.5	-0.3	-0.2	-0.1	-0.2	-0.4	-0.7
2009	-0.9	-0.8	-0.6	-0.2	0.1	0.4	0.5	0.6	0.7	1.0	1.4	1.6
2010	1.6	1.4	1.1	0.7	0.2	-0.3	-0.8	-1.2	-1.4	-1.5	-1.5	-1.5
2011	-1.4	-1.3	-1.0	-0.7	-0.4	-0.2	-0.2	-0.3	-0.6	-0.8	-1.0	-1.0
2012	-0.9											

NOAA/CPC Updated 03-05-12

An ONI of -0.9 during the 3-month climate season of DEC-JAN-FEB 2011-2012 is an indication of a weak to moderate La Niña.

El Niño : ONI of +0.5 and higher
Neutral ENSO : ONI lower than +0.5 and higher than -0.5
La Niña: ONI of -0.5 and lower

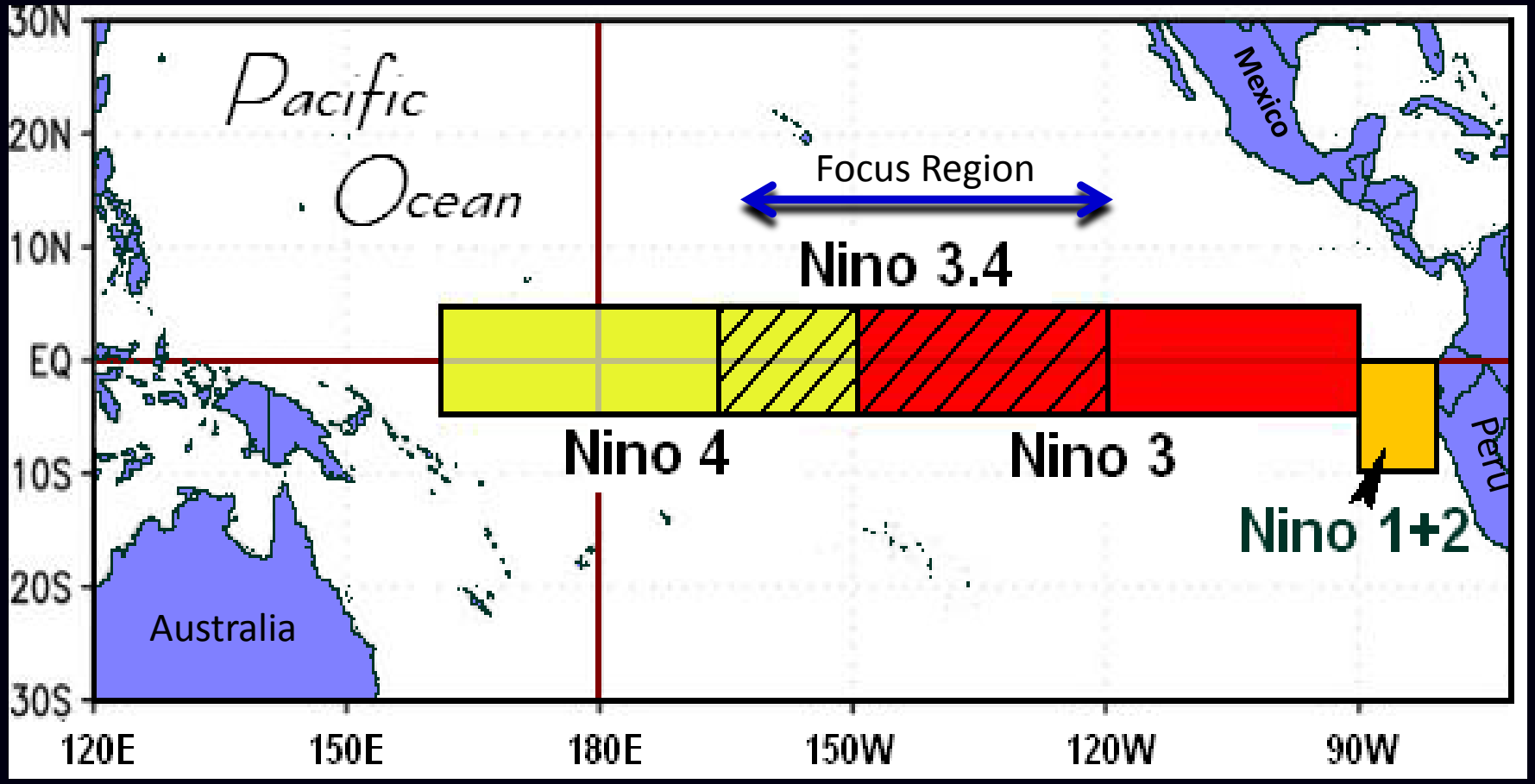
The ONI is based on sea surface temperature (SST) departures from average in the Niño 3.4 region of the eastern tropical Pacific Ocean. It is the principal measure used by NOAA's Climate Prediction Center (CPC) for monitoring, assessing and predicting El Niño/Southern Oscillation (ENSO.)

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

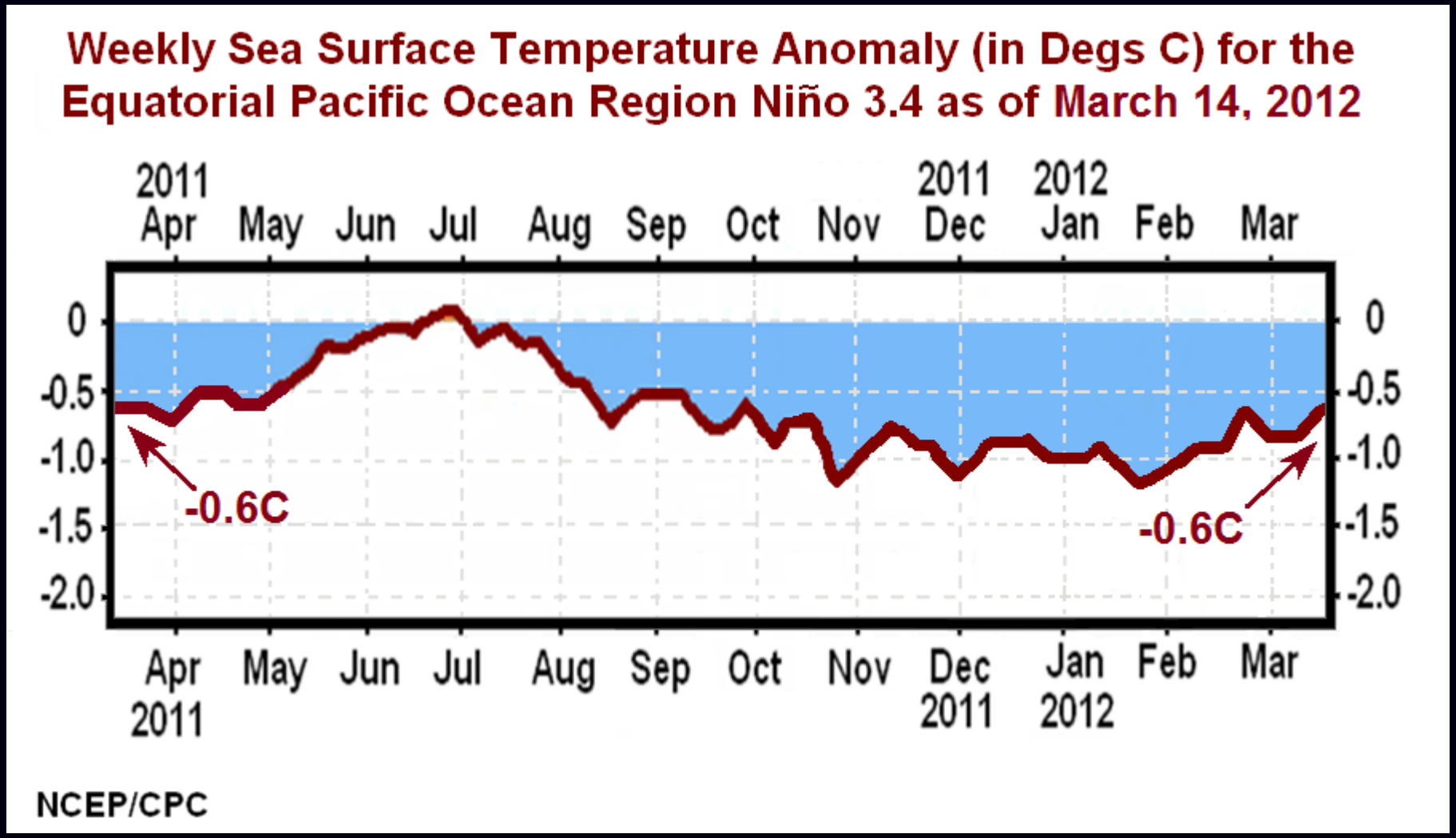
ONI is used to place current ENSO and non-ENSO events into a historical perspective.

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

Niño Regions in the Equatorial Pacific Ocean

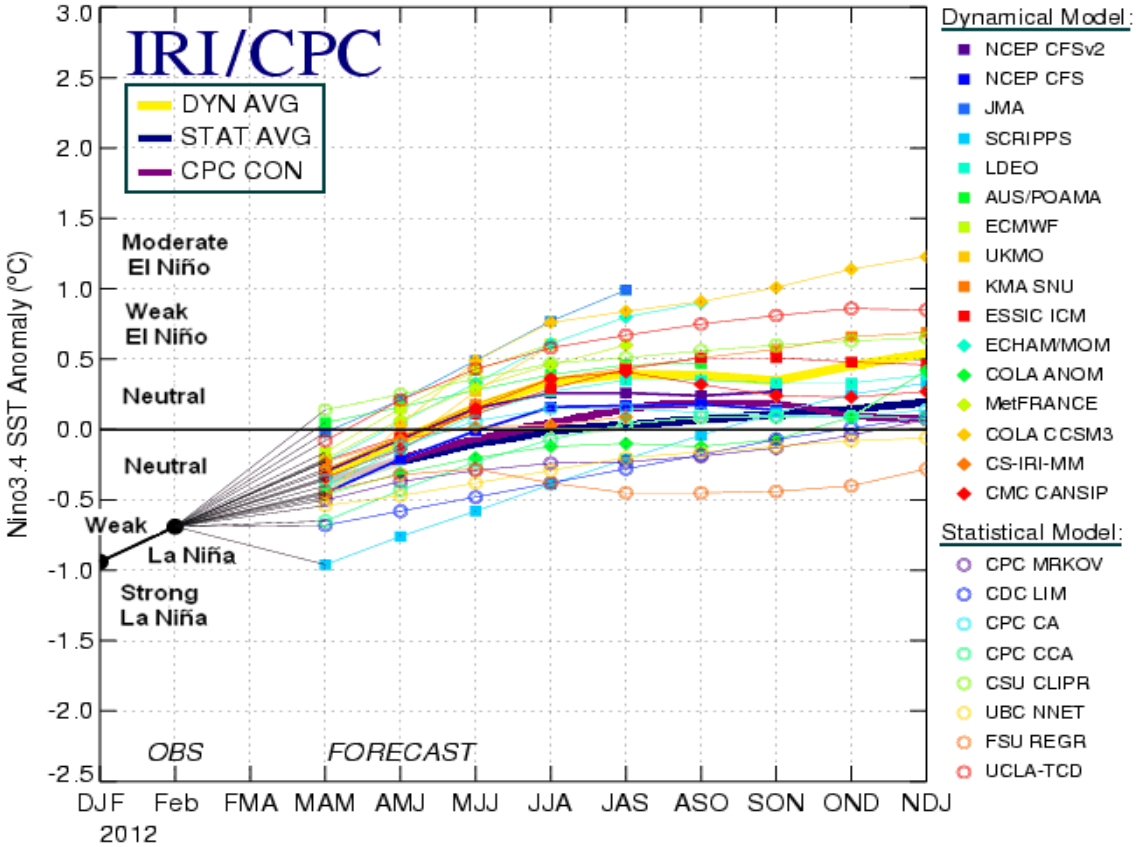


Niño 3.4 – The principal region in the eastern Equatorial Pacific Ocean used by the Climate Prediction Center (CPC) for monitoring, assessing and predicting ENSO (hatched region on the above map) .



As of March 14, 2012 the weekly SST anomaly for Niño 3.4 was -0.6C. One year ago, the SST anomaly was also -0.6C. Weekly SST anomalies in Niño 3.4 have steadily increased in the positive direction during the past four weeks. A SST anomaly of -0.45˚C or lower in the eastern Pacific Ocean is an indicator of La Niña.

Outlook for ENSO



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

	MAM	AMJ	MJJ	JJA	JAS	ASO	SON	OND	NDJ
Average, dynamic models	-0.3	-0.1	0.2	0.3	0.4	0.4	0.3		
Average, statistical models	-0.4	-0.2	-0.1	0	0	0.1	0.1	0.1	0.2
Average, for all models	-0.3	-0.1	0.1	0.2	0.3	0.3	0.2	0.3	

The International Research Institute for Climate and Society / Climate Prediction Center

updated 15 Mar 2012

More than half of the dynamical and statistical ENSO (El Niño-Southern Oscillation) models predict below average sea surface temperatures (SSTs) in the east central tropical Pacific Ocean during the April-May-Jun climate season, but warm enough to be classified as ENSO neutral conditions.

A majority of the models indicate ENSO-neutral conditions at least through the summer of 2012. However, a handful of models predict the development of a weak El Niño during the Jun-Jul-Aug and Jul-Aug-Sep seasons.

Currently, for the second half of 2012, ENSO neutral conditions appear most likely, with the development of El Niño more likely than a return of La Niña.

During the Final Days of La Niña - What May We Expect Along the Colorado Front Range?

Above Average Temperature?

Below Average Precipitation Possibly Resulting in Water Shortages and Drought?

Reduced Runoff from Below Average Mountain Snowpack?

Greater Risk of Wildland Fires?

Potentially Damaging Wind and Dust Storms?

**Yes,
they are
all possible
along the
Front Range
this spring.**

Freeze / Frost Occurrence Data
For Northeast Colorado

All probabilities in whole percent. See notes for probability level description.
- Indicates the probability of occurrence of threshold temperature is less than indicated probability.

State And Station Name	Threshold (F)	Spring (Date)			Fall (Date)			Freeze Free Period (Days)			Probability Level (4)
		Probability Level (1)			Probability Level (2)			Probability Level (3)			
Northeast Colorado		90	50	10	10	50	90	10	50	90	
AKRON 4 E	36	May01	May20	Jun07	Sep09	Sep21	Oct02	144	123	102	54
(Washington County)	32	Apr29	May11	May23	Sep15	Sep27	Oct08	157	138	120	47
	28	Apr19	May01	May13	Sep23	Oct08	Oct24	182	160	138	38
BAILEY	36	Jun22	Jul06	Jul21	Aug01	Aug21	Sep09	69	45	20	75
(Park County)	32	Jun05	Jun24	Jul13	Aug20	Sep06	Sep23	99	73	47	66
	28	May15	May31	Jun16	Aug30	Sep15	Sep30	127	106	84	57
BOULDER	36	May02	May16	May31	Sep14	Sep26	Oct08	151	132	113	47
(Boulder County)	32	Apr24	May04	May14	Sep18	Oct02	Oct16	170	151	131	39
	28	Apr08	Apr22	May07	Sep23	Oct11	Oct30	193	171	149	30
BRIGGSDALE	36	May08	Jun02	Jun28	Sep02	Sep17	Oct01	137	105	74	58
(Weld County)	32	Apr28	May19	Jun09	Sep13	Sep23	Oct03	147	126	105	51
	28	Apr17	May08	May30	Sep20	Oct03	Oct16	172	147	121	43
BYERS 5 ENE	36	May11	May27	Jun13	Sep10	Sep21	Oct01	135	115	96	56
(Arapahoe County)	32	Apr28	May10	May23	Sep14	Sep27	Oct09	159	139	118	49
	28	Apr22	May02	May12	Sep19	Oct03	Oct16	171	153	135	41
CASTLE ROCK	36	May13	May30	Jun16	Sep05	Sep18	Sep30	132	110	88	58
(Douglas County)	32	May03	May22	Jun11	Sep12	Sep24	Oct07	151	124	98	51
	28	Apr22	May06	May19	Sep19	Oct02	Oct14	170	148	126	41
CHERRY CREEK DAM	36	May10	May26	Jun11	Sep11	Sep22	Oct03	139	118	96	55
(Denver County)	32	Apr30	May17	Jun02	Sep15	Sep27	Oct09	156	132	109	47
	28	Apr23	May04	May15	Sep20	Oct05	Oct21	175	154	132	38
DENVER STAPELTON	36	Apr27	May12	May27	Sep15	Sep27	Oct09	158	137	115	50
(Denver County)	32	Apr16	Apr30	May13	Sep18	Oct04	Oct21	182	157	132	42
	28	Apr03	Apr20	May07	Sep28	Oct15	Nov01	200	177	154	32
EVERGREEN	36	Jun02	Jun21	Jul10	Aug20	Sep05	Sep20	98	75	52	68
(Jefferson County)	32	May18	Jun03	Jun18	Sep04	Sep16	Sep28	123	105	86	61
	28	May02	May18	Jun02	Sep12	Sep27	Oct11	154	131	108	52
FLAGLER 1 S	36	May04	May24	Jun13	Sep10	Sep22	Oct04	143	120	97	55
(Kit Carson County)	32	Apr28	May11	May24	Sep15	Sep28	Oct11	160	139	118	48
	28	Apr21	May03	May15	Sep21	Oct07	Oct23	179	156	134	40
FORT COLLINS	36	Apr29	May13	May27	Sep15	Sep24	Oct04	150	134	118	51
(Larimer County)	32	Apr23	May04	May15	Sep18	Oct02	Oct17	171	151	130	43
	28	Apr05	Apr18	May02	Sep24	Oct10	Oct26	195	174	154	35

Source: NOAA/National Climatic Data Center (NCDC), Asheville, North Carolina

State And Station Name	Threshold (F)	Spring (Date)			Fall (Date)			Freeze Free Period (Days)			Probability Level (4)
		Probability Level (1)			Probability Level (2)			Probability Level (3)			
Northeast Colorado		90	50	10	10	50	90	10	50	90	
FORT MORGAN	36	Apr30	May10	May20	Sep15	Sep26	Oct08	152	139	126	52
(Morgan County)	32	Apr22	May02	May12	Sep21	Oct05	Oct18	172	155	138	46
	28	Apr04	Apr18	May03	Sep30	Oct15	Oct29	198	178	159	38
GREELEY UNC	36	Apr28	May12	May26	Sep15	Sep25	Oct04	153	135	117	51
(Weld County)	32	Apr21	May02	May13	Sep17	Oct01	Oct14	169	151	133	44
	28	Apr04	Apr18	May03	Sep25	Oct10	Oct25	195	174	153	35
HOLYOKE	36	Apr30	May13	May26	Sep11	Sep23	Oct04	149	132	114	52
(Phillips County)	32	Apr26	May05	May14	Sep19	Oct03	Oct16	168	150	131	45
	28	Apr13	Apr24	May06	Sep28	Oct13	Oct27	185	170	156	36
JULESBURG	36	Apr30	May14	May28	Sep11	Sep23	Oct04	148	131	114	53
(Sedgwick County)	32	Apr25	May07	May19	Sep15	Sep29	Oct13	164	144	125	46
	28	Apr10	Apr24	May09	Sep24	Oct10	Oct26	190	168	146	38
LAKEWOOD	36	May05	May20	Jun04	Sep13	Sep25	Oct06	148	127	105	51
(Jefferson County)	32	Apr24	May09	May24	Sep18	Oct01	Oct14	168	144	121	43
	28	Apr11	Apr29	May17	Sep24	Oct09	Oct24	187	163	139	33
LONGMONT 2 ESE	36	May02	May17	May31	Sep10	Sep21	Oct02	145	127	108	55
(Boulder County)	32	Apr22	May05	May18	Sep15	Sep28	Oct10	165	145	125	49
	28	Apr10	Apr24	May08	Sep22	Oct08	Oct24	189	166	144	41
NEW RAYMER	36	May07	May24	Jun10	Sep08	Sep18	Sep28	137	117	97	56
(Weld County)	32	Apr29	May14	May28	Sep14	Sep25	Oct07	153	134	114	50
	28	Apr23	May03	May13	Sep19	Oct03	Oct17	170	152	134	42
SEDGWICK 5 S	36	Apr30	May13	May26	Sep13	Sep25	Oct06	151	134	117	50
(Sedgwick County)	32	Apr24	May04	May15	Sep17	Oct03	Oct19	172	151	130	43
	28	Apr10	Apr22	May05	Sep25	Oct12	Oct29	193	172	151	35
STERLING	36	May02	May14	May25	Sep12	Sep20	Sep29	142	129	116	53
(Logan County)	32	Apr23	May06	May19	Sep18	Oct01	Oct14	166	147	129	47
	28	Apr08	Apr21	May05	Sep25	Oct09	Oct22	188	169	151	39

Based on the 1981-2010 Climatological Data Base

Notes:

(1) Probability of later date in spring (thru Jul 31) than indicated.

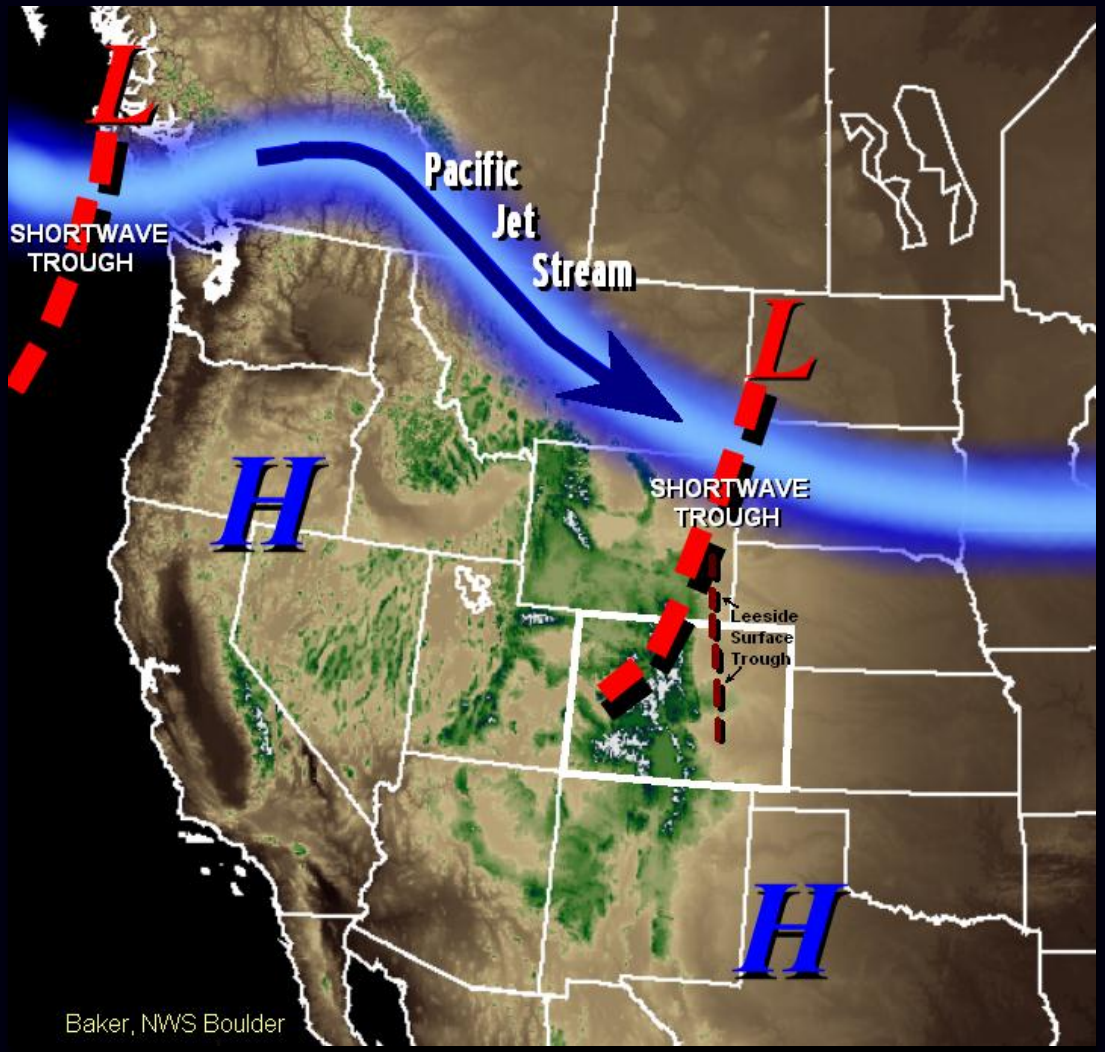
(2) Probability of earlier date in fall (beginning Aug 1) than indicated.

(3) Probability of longer than indicated freeze free period.

(4) Probability of Freeze/Frost in the yearly period (percent of days with temperatures at or below the threshold temperature).

Even with the unusually warm and dry weather lately, snowfall and freezing temperatures remain a possibility well into late spring for many parts of northeast Colorado. Before planting your outdoor garden, refer to the average latest freeze dates in the above table for your area. Dates with a 90 and 50 percent probability of occurrence appear reasonably safe for planning purposes this spring based on the seasonal outlook from the Climate Prediction Center presented later in this slide show.

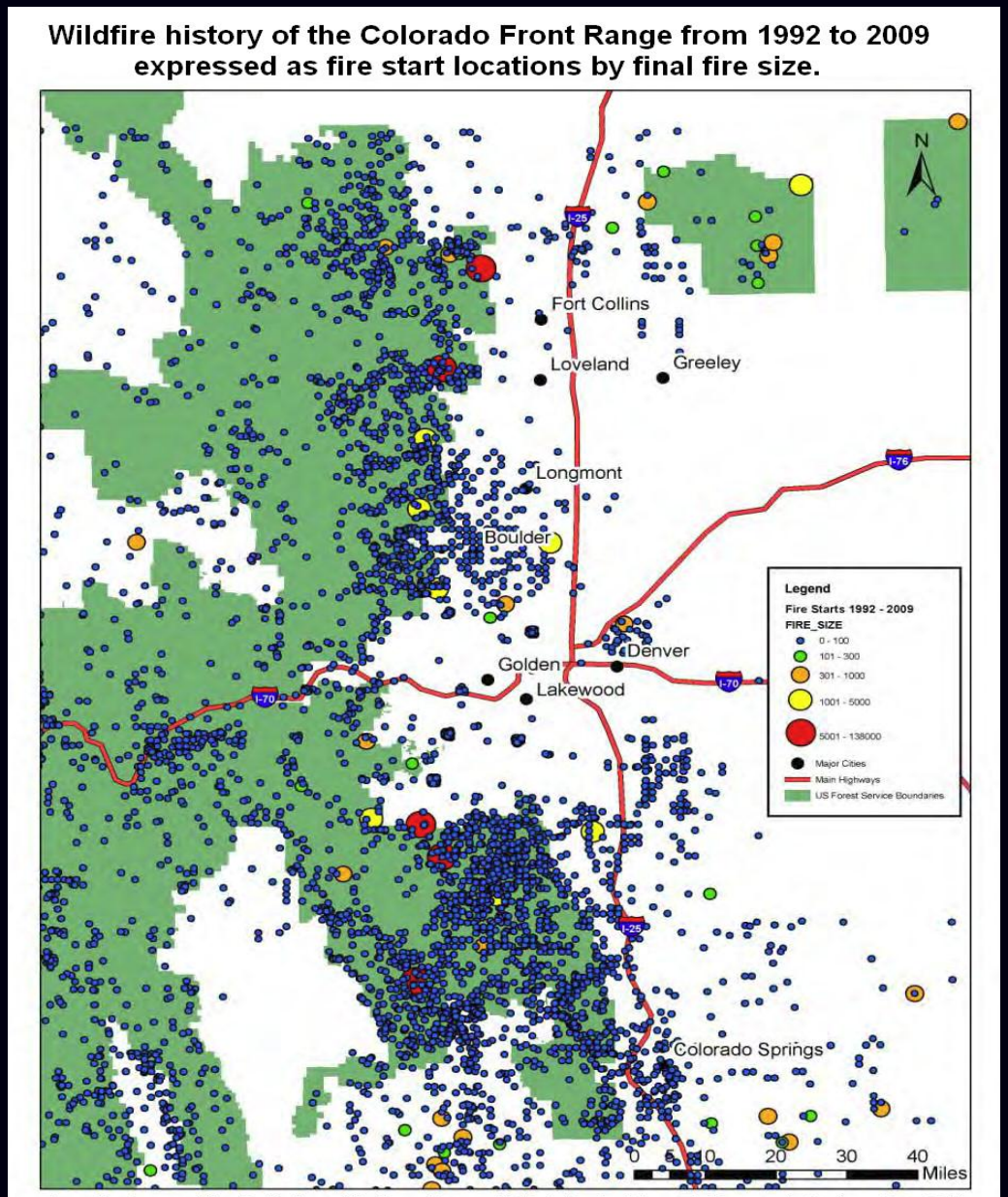
The Seasonal Shift in the Jet Stream



As La Niña weakens, so too will the Pacific Jet Stream as it slowly migrates northward to higher latitudes.

Strong heating of the desert southwest and Great Basin beneath an expanding ridge of high pressure aloft will shift the mean position of the Pacific Jet Stream northward over southern Canada in the next several weeks.

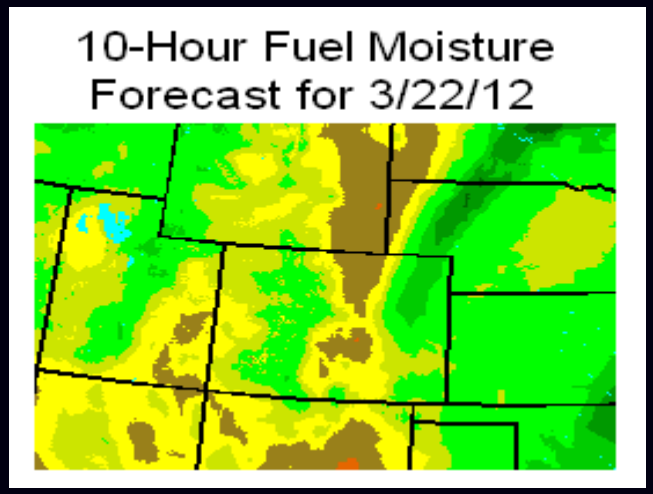
Consequently, weather disturbances or shortwave troughs of low pressure whisked along by the jet stream will play a diminishing role in the creation of precipitation in Colorado during the coming weeks. However, for the Front Range and points east, the passage of these mostly dry weather systems may still result in periods of strong and gusty downslope winds capable of damage, blowing dust and rapid fire spread.

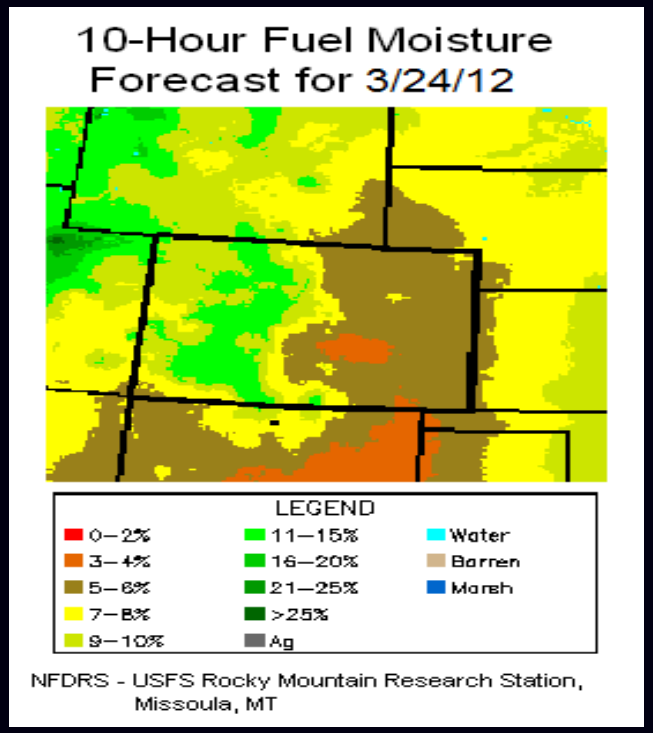


Fourmile Canyon Fire Preliminary Findings Report, USDA, Rocky Mountain Research Station, Oct. 2011

The Colorado Front Range is No Stranger to Wildland Fire

Under the right conditions, wildfires can form any time of the year along the Colorado Front Range. However, the threat for wildland fire is at its greatest in late winter, during spring prior to full green-up, and in late summer and autumn when the leaves are turning and the grasses have cured.





The "fuel hour" corresponds to the diameter of the fuel and the amount of time it takes for an idealized cylinder of vegetation of that size to reach equilibrium moisture content (EMC).

Changing Fuel Moistures In Colorado

One-hour and 10-hour fuels (vegetation up to 1 inch in diameter such as short and long grasses, twigs, stems and small shrubs) respond readily to changes in the weather.

These fine and light fuels can quickly transition from wet (having a moisture level greater than 15 percent) to very dry (a level below 8 percent) within a day's time under hot, dry and windy conditions.

Notice the dramatic change in 10-hour fuel moistures in eastern Colorado in just two days based on guidance from the U.S. Forest Service National Fire Danger Rating System (NFDRS) fuel models. 10-hour fuel moistures in northeast Colorado went from a very moist 16 to 20 percent on the 22nd (upper map) due to recent precipitation, to a very dry 5 to 6 percent moisture content on the 24th (lower map).

Fuel moistures in the mountains and on the western slope have been slower to change due to cooler temperatures and a persistent snow cover. However, these areas are likely to see similar reduction in fuel moistures during the coming months.

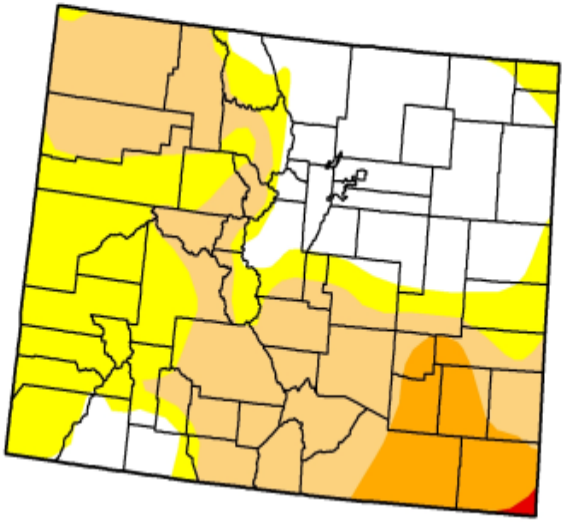
U.S. Drought Monitor

March 20, 2012
Valid 7 a.m. EST

Colorado

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	28.97	71.03	42.60	8.37	0.21	0.00
Last Week (03/13/2012 map)	28.97	71.03	42.60	8.30	0.21	0.00
3 Months Ago (12/20/2011 map)	67.79	32.21	24.98	14.94	0.04	0.00
Start of Calendar Year (12/27/2011 map)	67.79	32.21	24.98	14.94	0.04	0.00
Start of Water Year (09/27/2011 map)	60.62	39.38	27.69	19.99	7.88	0.56
One Year Ago (03/15/2011 map)	41.65	58.35	51.50	35.33	0.00	0.00



Intensity:

- D0 Abnormally Dry
- D1 Drought - Moderate
- D2 Drought - Severe
- D3 Drought - Extreme
- D4 Drought - Exceptional

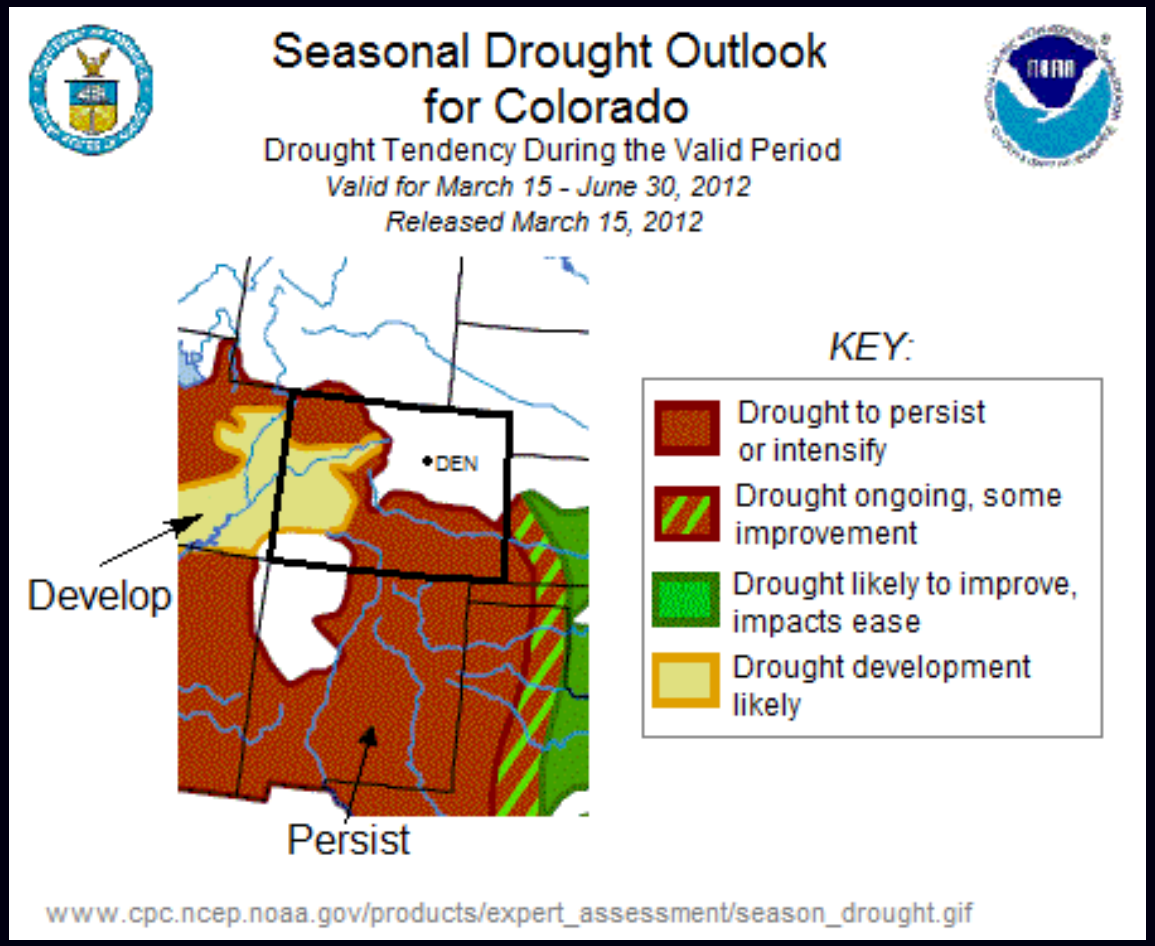
The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

http://droughtmonitor.unl.edu

Released Thursday, March 22, 2012
Eric Luebehusen, USDA

According to the Drought Monitor, drought conditions for Colorado as of March 20, 2012 varied from severe (D2) and extreme drought (D3) across the southeast corner of the state, to moderate (D1) from southeast Colorado and the San Luis Valley northward along the west side of the Continental Divide to the Yampa and White River basins in northwest Colorado. Abnormally dry conditions existed across west central and southwest Colorado and in small areas of the eastern plains. .

Drought was not indicated for the Front Range and the plains of northeast Colorado, as well as the San Juan River basin in southwest Colorado as of the 20th of March.

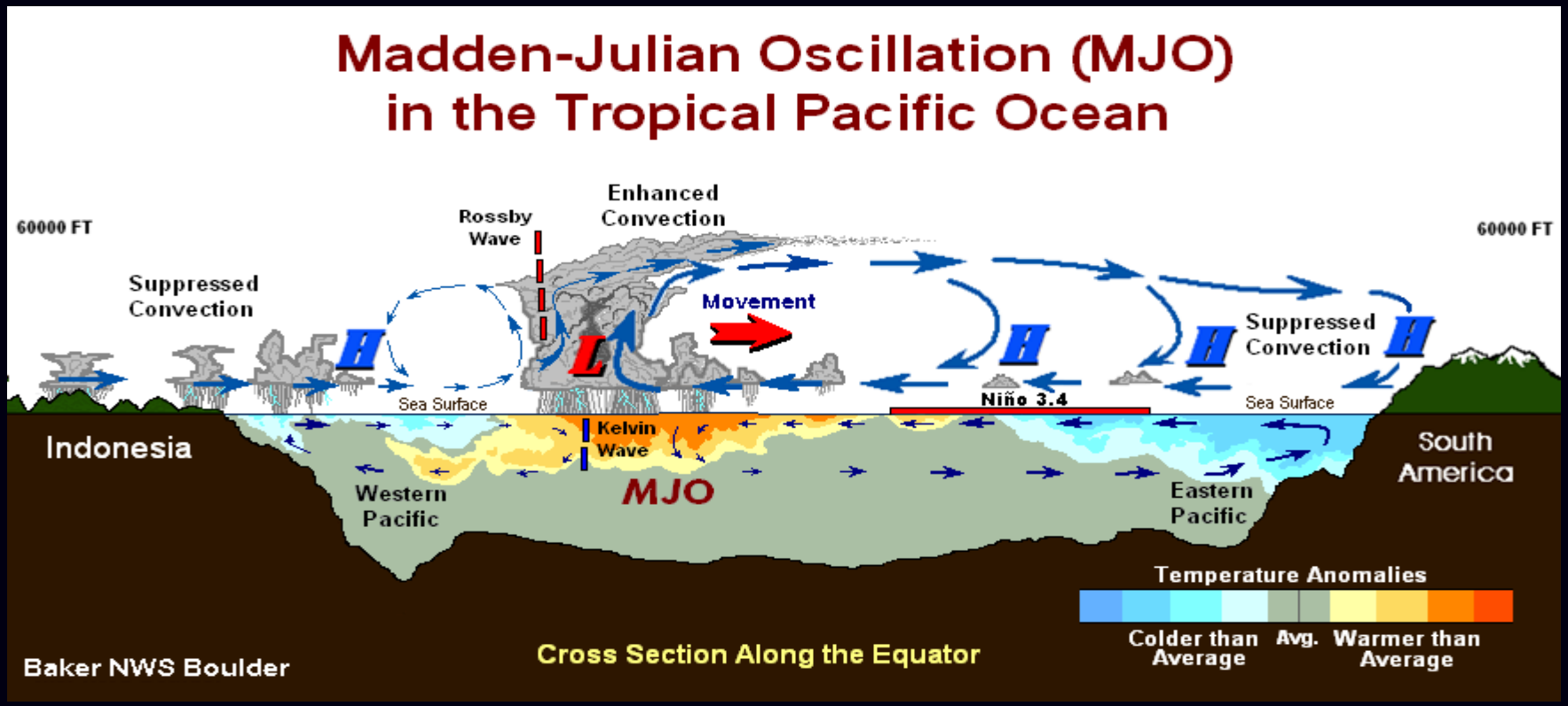


The latest seasonal drought outlook for the 90-day period March 15 to June 15, 2012 calls for further development of drought conditions across northwest and southeast Colorado, and for drought to likely develop in west central and southwest Colorado. Due to recent wetting precipitation, the development of drought conditions along the south face the San Juan Mountains in southwest Colorado is not anticipated at this time.

Drought is also not expected to develop in the northern mountains, the Front Range foothills and high plains of northeast Colorado during this period.

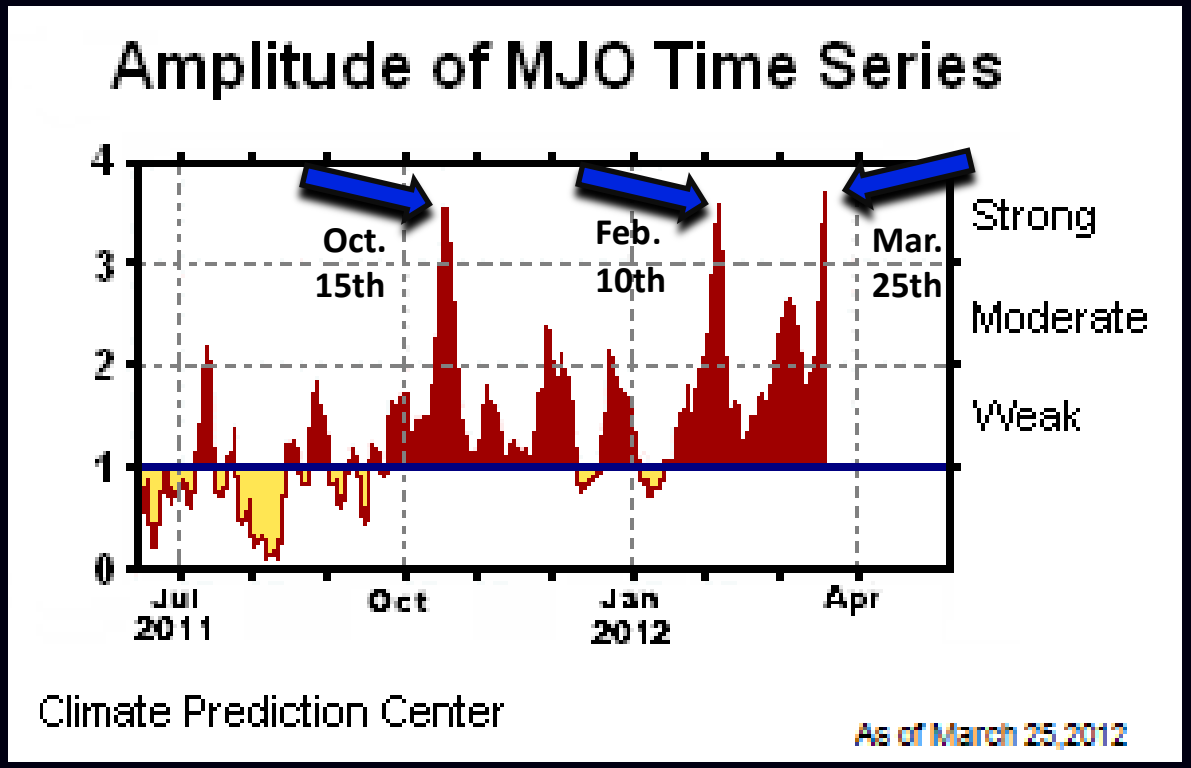
Could we see a reversal in this unusually warm and dry weather pattern?

Could the Madden-Julian Oscillation (MJO) currently in the Pacific Ocean produce another round of wet and snowy weather for parts of Colorado in the near future?



The MJO (or the 30-60 Day Tropical Wave) is a large scale circulation produced by the coupling of an atmospheric Rossby wave and oceanic Kelvin wave, and is characterized by an eastward propagating complex of enhanced and suppressed tropical convective rainfall mainly observed over the Indian and Pacific Oceans (see diagram). An MJO of at least moderate amplitude (strength) can circle the globe ordinarily within a span of 30 to 60 days. An MJO crossing the central and eastern tropical Pacific Ocean can significantly influence circulation and precipitation patterns as far north as Hawaii and the continental United States. Wind and precipitation patterns produced by the MJO often resemble those associated with a moderate to strong El Niño, and can linger from a few days to a couple of weeks over a given region. MJOs form most often during weak La Niñas and ENSO-neutral conditions and are weakest or absent during El Niño events.

Recent Cycle of MJOs



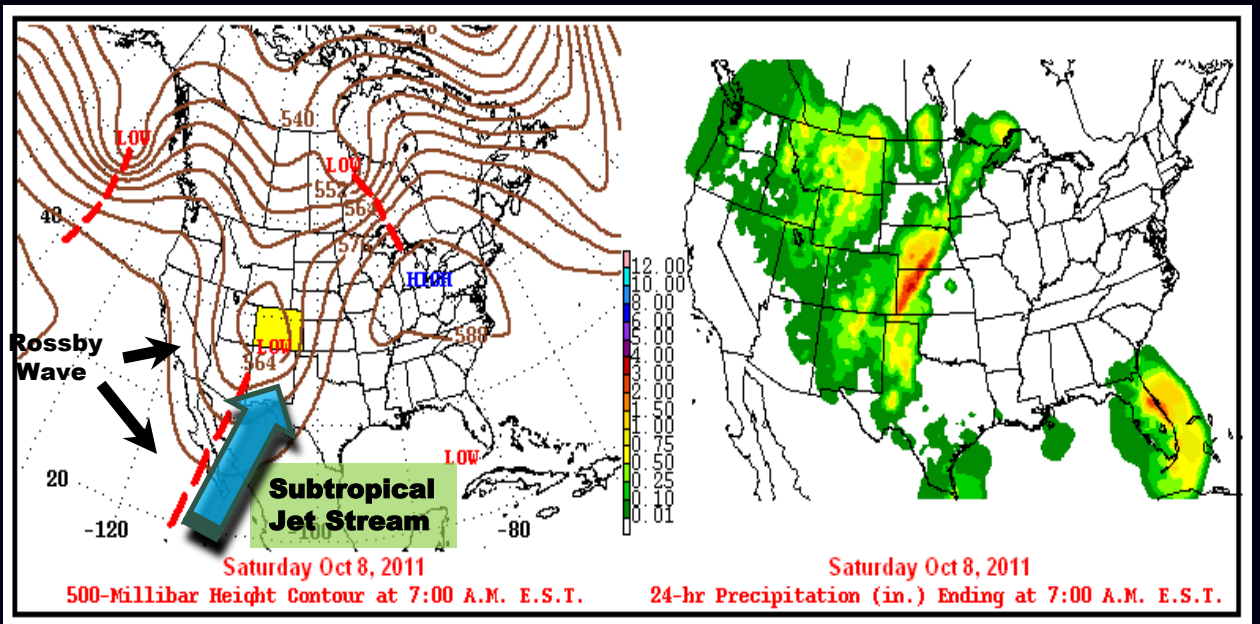
A time series of daily Madden-Julian Oscillation (MJO) amplitude (square root of $RMM1^2$-$RMM2^2$) from 17 June 2011 to 17 March 2012.

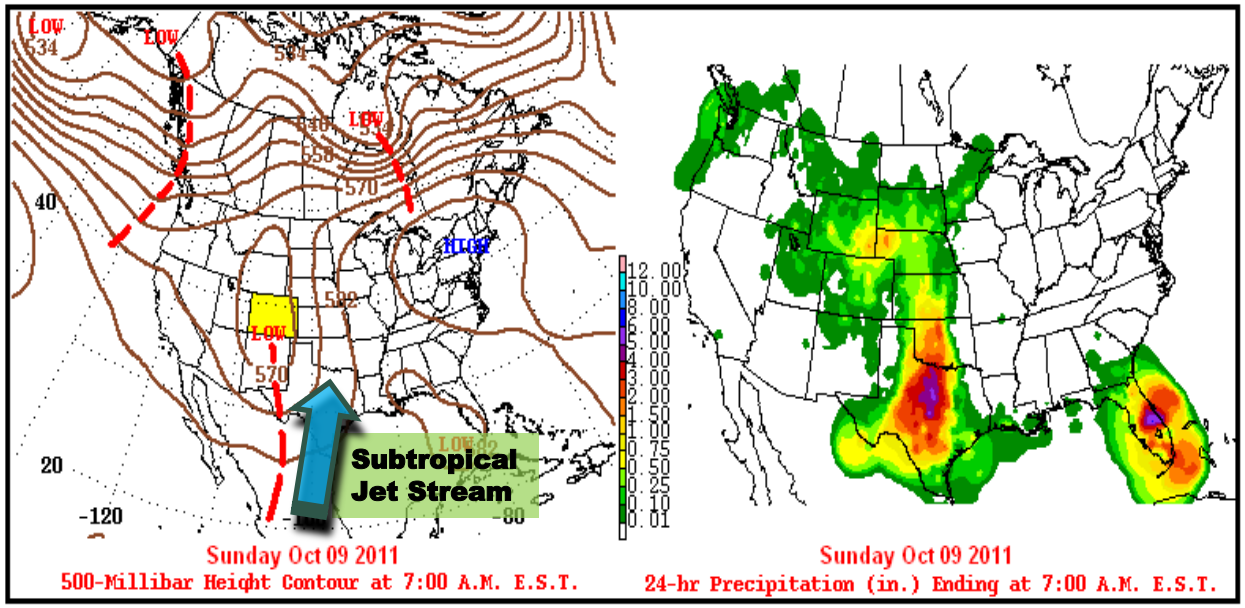
MJO (indicated by red shaded areas) has remained active since the fall of 2011.

The current MJO is equally as strong as those in October 2011 and February 2012 (blue arrows).

So, what sort of influence did the first two MJOs have on Colorado weather?

MJO's Impact on Precipitation Across The Western U.S. in October 2011

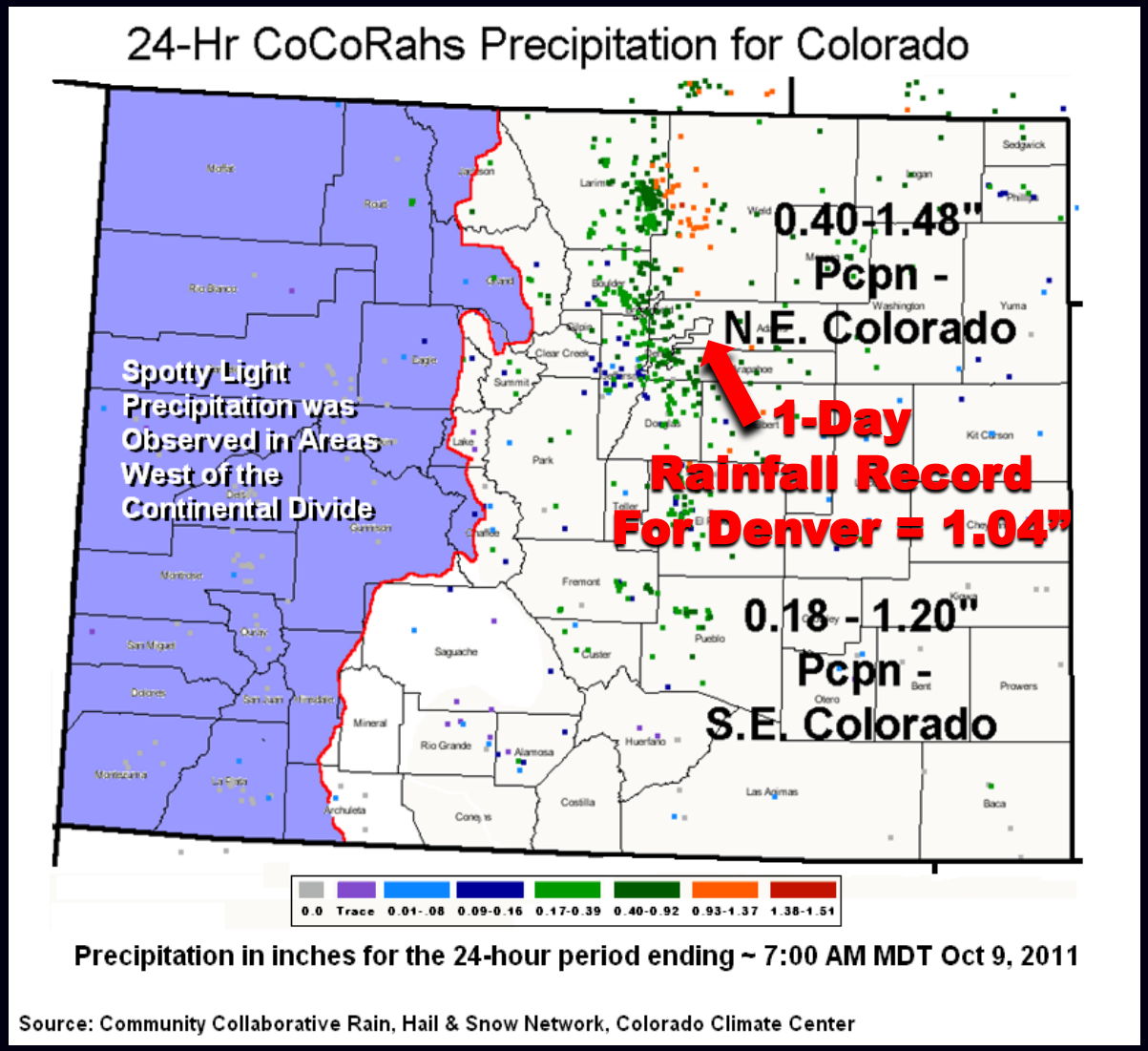




In October of 2011, portions of the desert southwest and Great Plains recorded the first measurable precipitation in several months. For several days around the 10th of the month, moist and unstable air streamed northward over the western U.S., originating from a complex of deep convection associated with a strong MJO crossing the eastern equatorial Pacific Ocean.

On October 9th and 10th, 2011 heavy rainfall produced severe flooding in portions of Texas and Oklahoma. Up to a foot of rain fell on parts of central and southern Texas which helped to relieve the extreme drought conditions gripping the region for over a year.

MJO's Impact on Precipitation in Eastern Colorado in October 2011

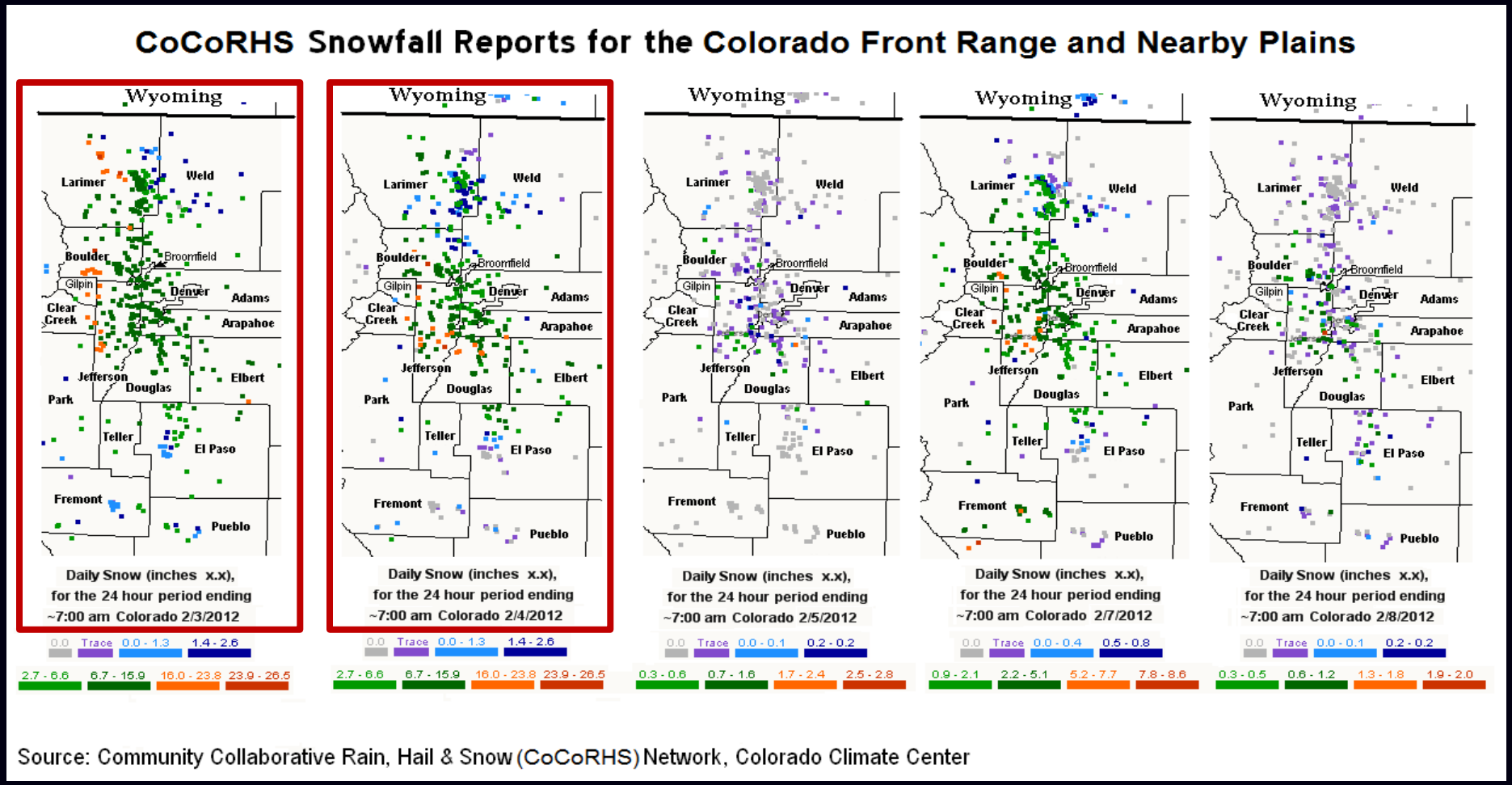


During the first half of October 2011, portions of Colorado saw the first measurable precipitation in many months. Rain heavy at times fell on the plains of eastern Colorado while heavy wet snow blanketed the east face of the Front Range mountains. Moist subtropical air streamed into eastern sections of the state around a deep low pressure system that had formed in northeast New Mexico.

This moist upslope flow produced precipitation along the Colorado Front Range for nearly 48 hours. The greatest rainfall accumulation occurred on the 8th of October with 24-hour totals as of 7 am MDT on the 9th ranging from 0.10 inch on the plains to around 1.5 inches against the Front Range foothills in northeast Colorado. Two day precipitation totals for many locations rivaled amounts normally observed for the entire month of October.

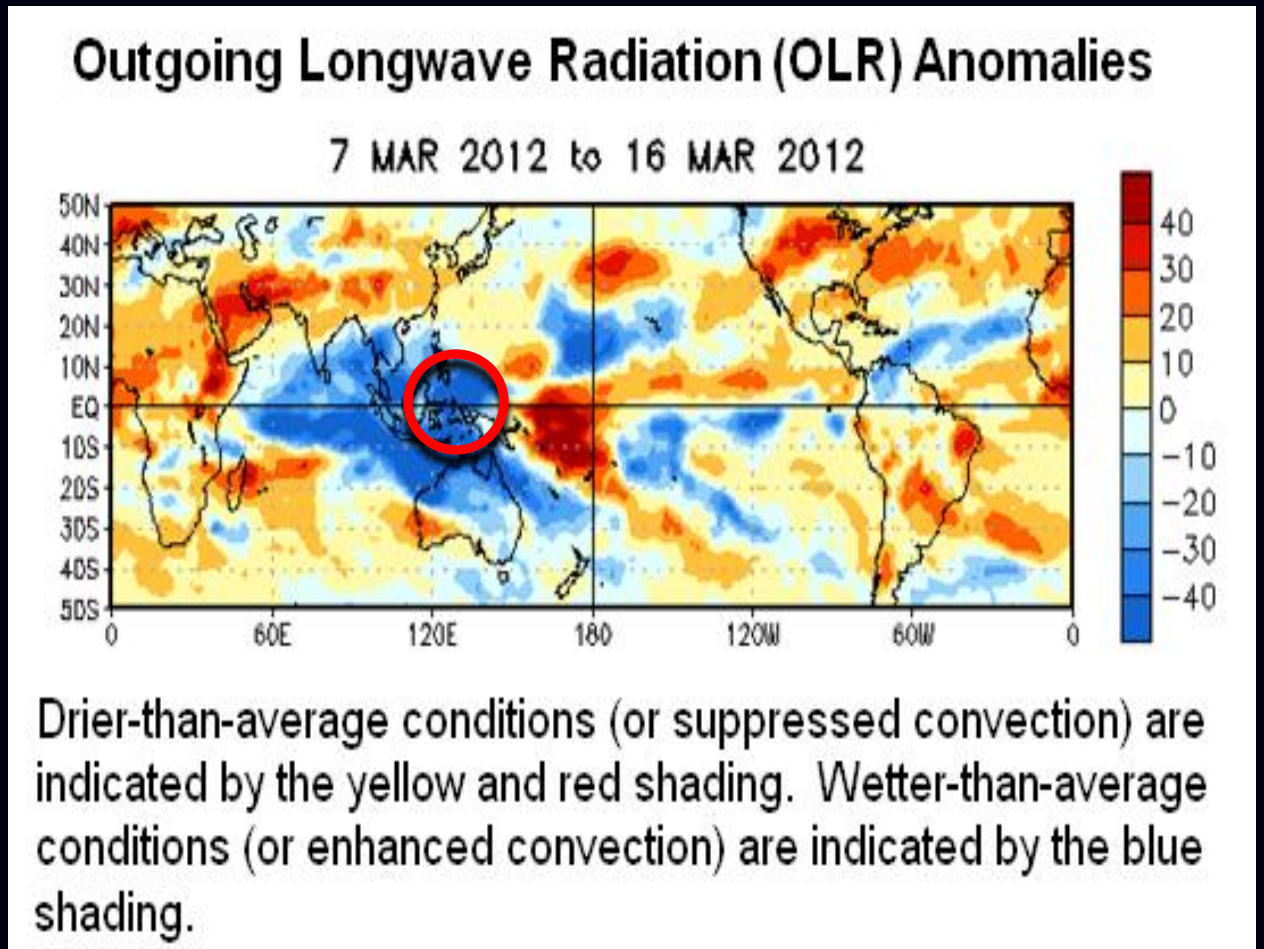
Denver International Airport set a new 1-day rainfall record of 1.04 inches.

MJO's Impact on Precipitation in Eastern Colorado in February 2012



During the first half of February 2012, a second MJO of strong amplitude crossed the eastern tropical Pacific Ocean. It was during this period that the Colorado Front Range and adjacent high plains observed 10 days of measurable snowfall. The greatest snowfall occurred on the 3rd and 4th when over 3 feet of snow buried portions of the Front Range foothills, and up to two feet of wet snow piled up at the foot of the Front Range from Castle Rock south of Denver north to Fort Collins. For many Front Range communities, February 2012 turned out to be the second snowiest February on record.

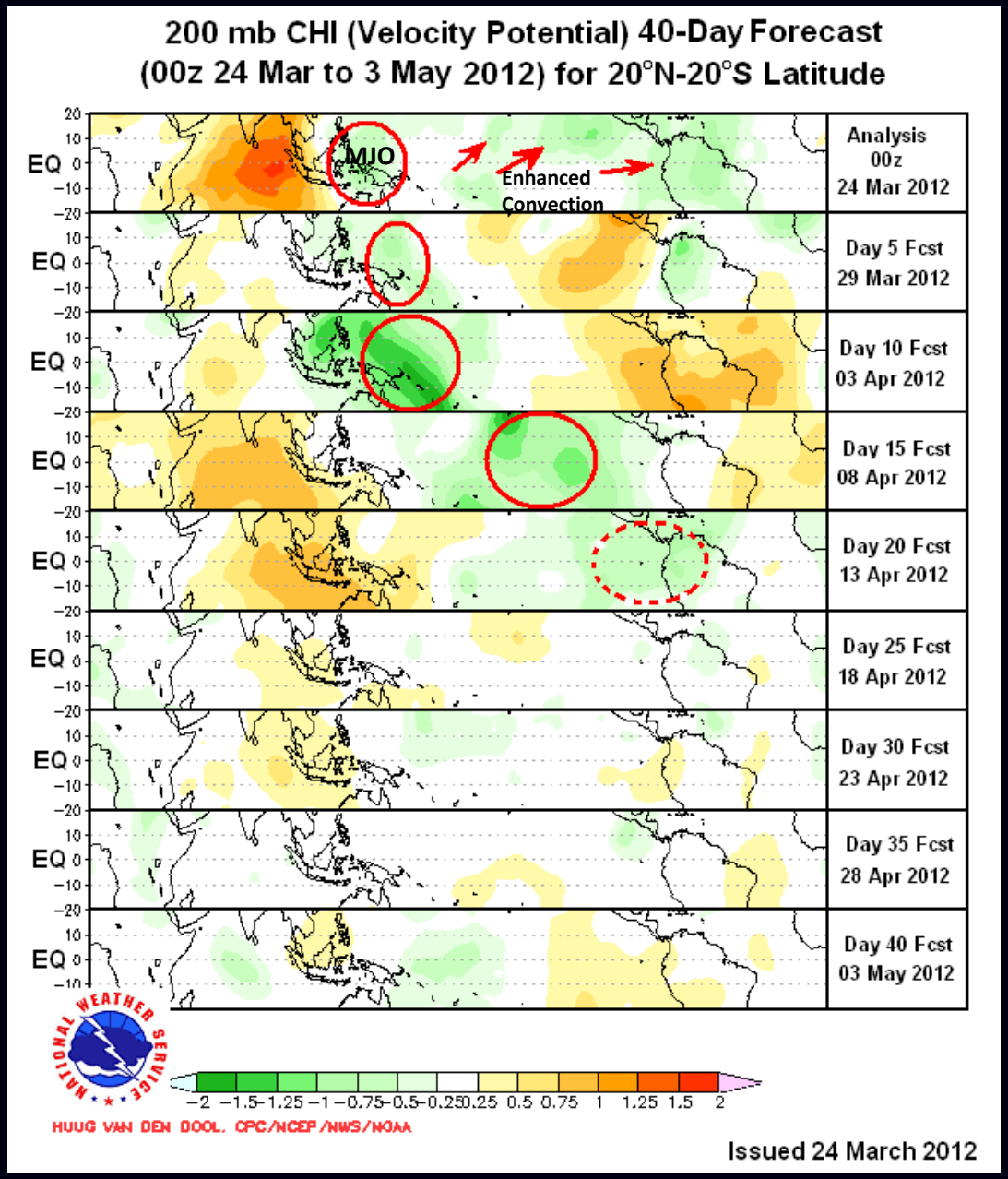
What is the Outlook for MJO and What Impact May It Have on Colorado Weather?



Drier-than-average conditions (or suppressed convection) are indicated by the yellow and red shading. Wetter-than-average conditions (or enhanced convection) are indicated by the blue shading.

Around the first of March 2012, another MJO formed in the Indian Ocean. During the first half of March MJO activity (i.e., convective rainfall) continued to increase with the center of this activity near Papua-New Guinea north of Australia (dark blue shaded area inside the red circle) as of mid-March.

Its growing presence ***enhanced*** convective rainfall (indicated by negative OLR anomalies) across the Indian Ocean and Maritime Continental region of the eastern Pacific Ocean, and ***suppressed*** convective rainfall (indicated by positive OLR anomalies) across the central and eastern Pacific Ocean, the Americas and Africa.



Strong upper level wind divergence (indicated by the darker green shading inside the red circle) on this 200mb CHI (velocity potential) forecast time series corresponds to *enhanced* convective rainfall associated with the MJO crossing the Maritime Continent (Indonesia and Papua-New Guinea.)

The MJO is forecast to remain active as it slowly migrates eastward along the equator in the Pacific over the next few weeks. Circulations associated with the MJO will contribute to enhanced convection (red arrows) over the central and east Pacific that will potentially increase the odds for significant precipitation for the southwest and central United States including southern and eastern portions of Colorado.

Beyond the second week of April, the forecast is for MJO to weaken as it moves east into the tropical Atlantic Ocean, with a return to weak La Niña conditions across Colorado.

So….

Could we see a reverse in this unusually warm and dry weather pattern we have been in for sometime now?

Could the strong Madden-Julian Oscillation (MJO) moving across the Pacific Ocean play a role in producing another round of wet and snowy weather for parts of Colorado in the near future?

ANSWER:

Yes, it is possible during the early half of April.

Looking Forward to the Next Three Months For Colorado

Historical Trends in Temperature and Precipitation and the Latest One and Three-Month Outlooks From NOAA's Climate Prediction Center

Historical Distribution of Temperature and Precipitation In Colorado As They Pertain to El Niño, La Niña and ENSO-Neutral Conditions

Interpreting ENSO Box and Whisker Plots

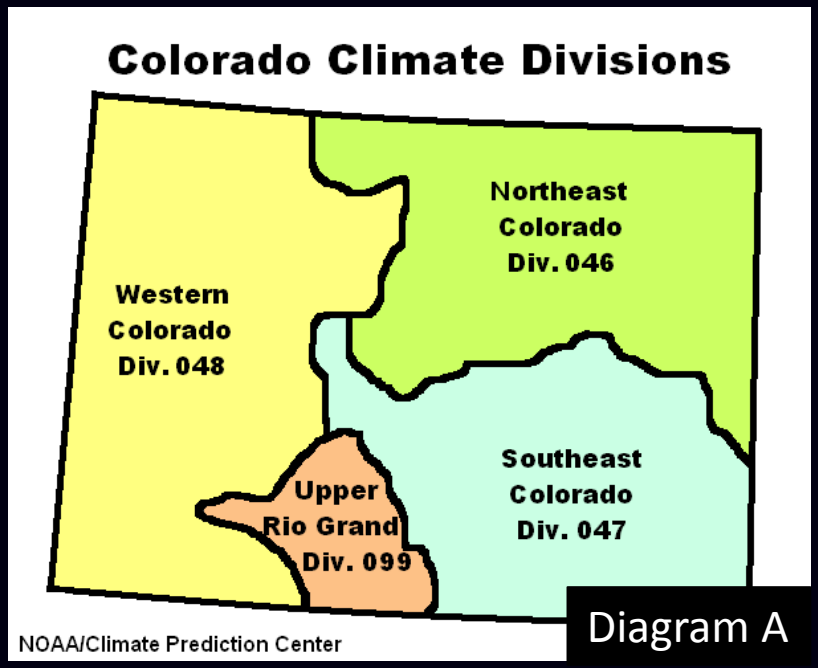


Diagram A

Diagram A is a map of the four climate mega-divisions in Colorado used by the Climate Prediction Center (CPC)—Divisions 046, 047,048 and 099.

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

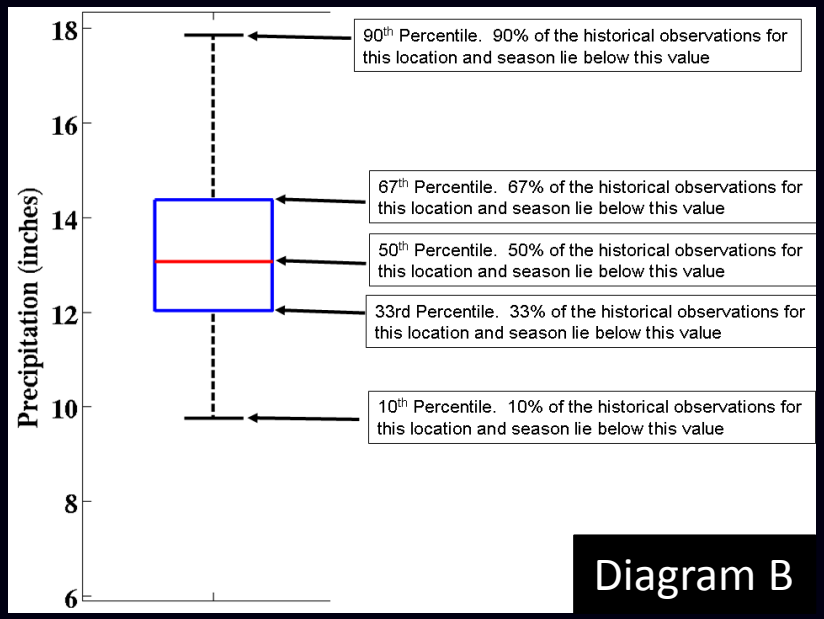
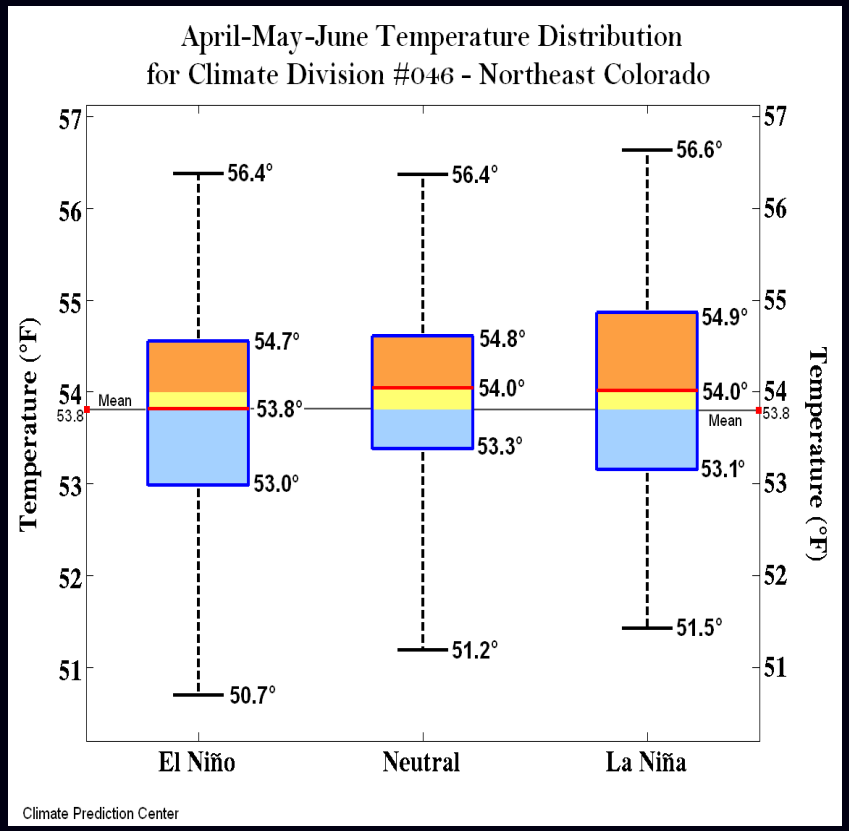


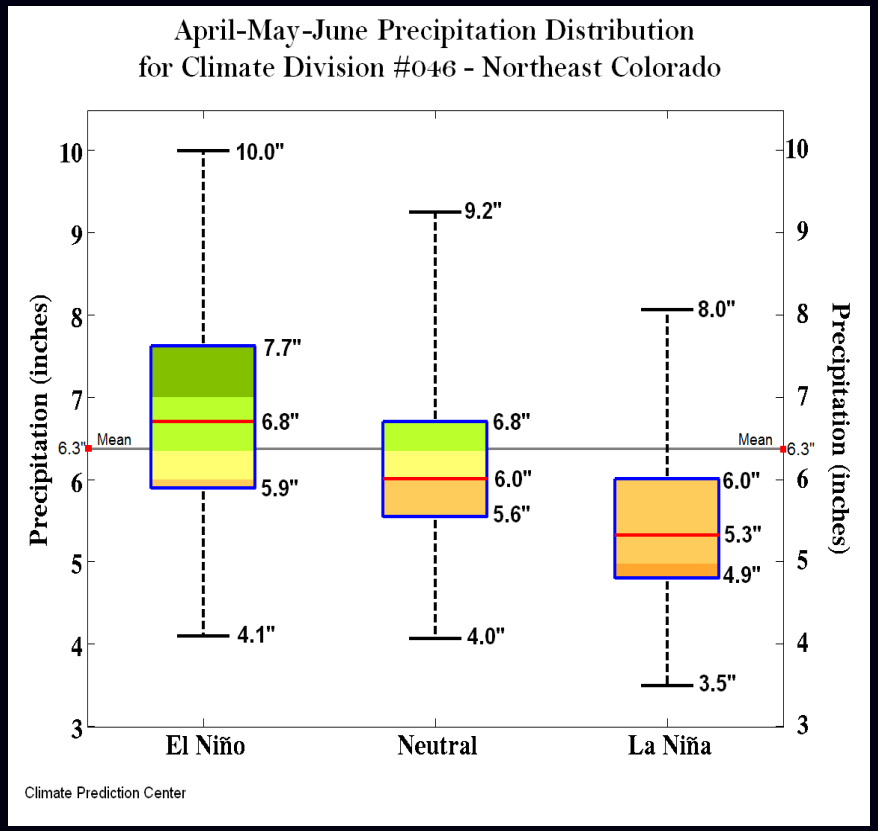
Diagram B

Diagram B is a description of the ENSO box and whisker analysis plot used by CPC to represent historical temperature and precipitation distributions for each ENSO category pertaining to each climate division.

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 April-May-June

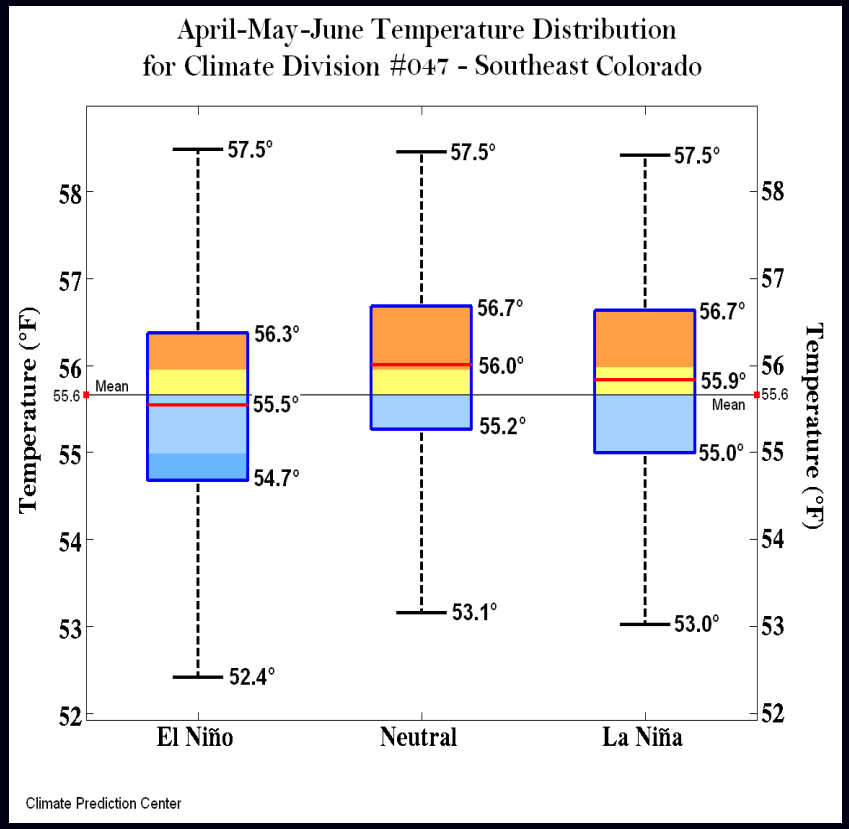


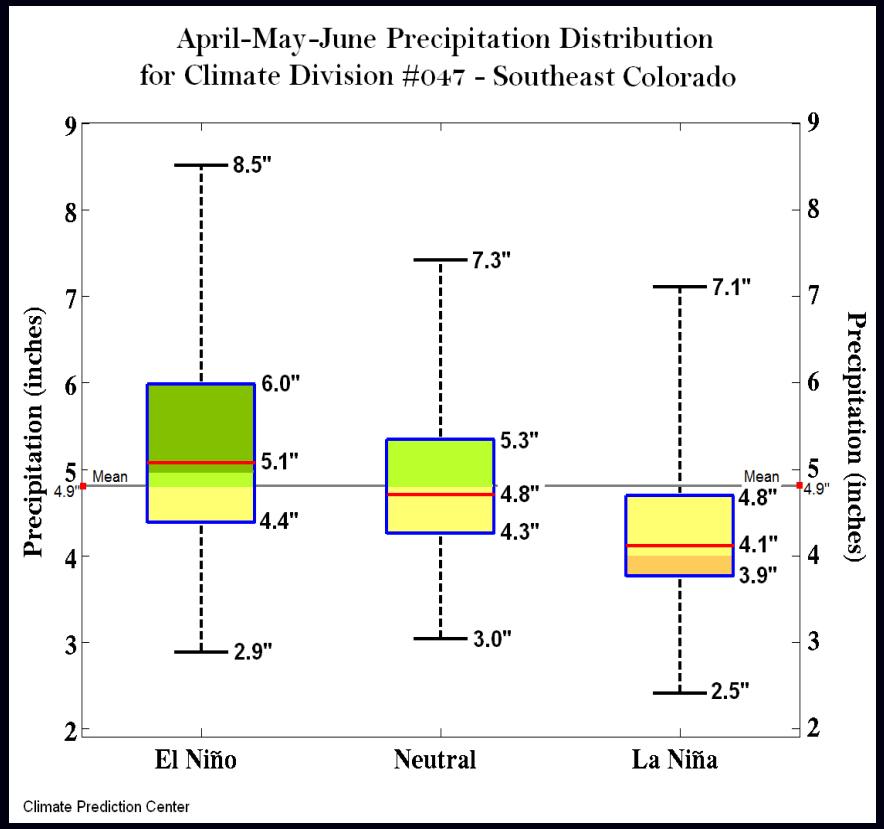


For the climate season April, May and June, temperatures in northeast Colorado historically have been near average during El Niño events, and slightly above average during ENSO-neutral and La Niña conditions.

For the same climate season, precipitation was slightly above average during El Niños, slightly below average during ENSO-neutral conditions, and below average during La Niña events.

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

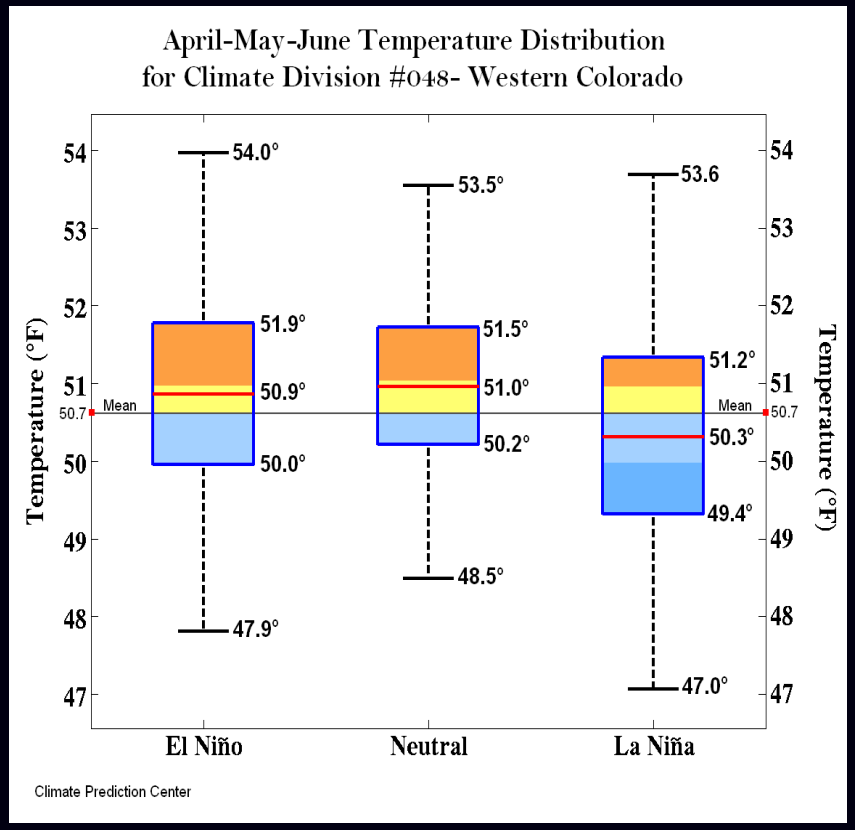


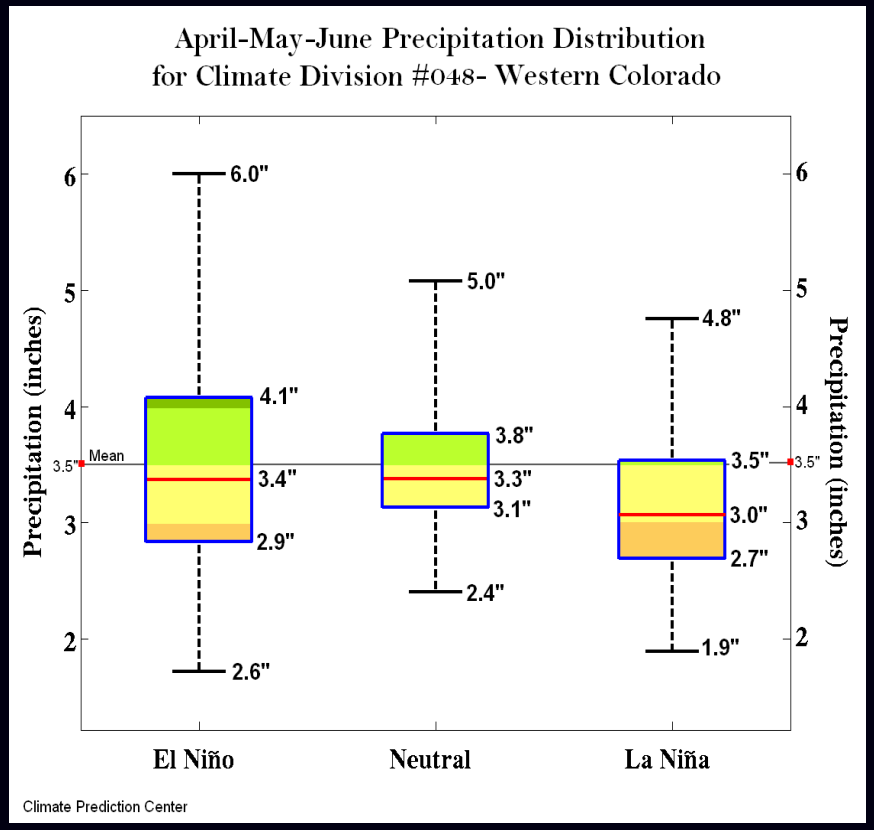


For the climate season April, May and June, temperatures in southeast Colorado historically have been near average during El Niño events, and slightly above average during ENSO-neutral and La Niña conditions.

For the same three month climate season, precipitation was slightly above average during El Niños, near average during ENSO-neutral conditions, and slightly below average during La Niñas.

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





Temperatures in western Colorado during the April-May-June climate season historically have been slightly above average during El Niños and ENSO-neutral conditions, and slightly below average during La Niña events.

Finally, precipitation during this same period historically has been near average during El Niños and ENSO-neutral conditions, and below average during La Niñas. Note, these climate distributions do not take into consideration the strength of the ENSO event (El Niño/La Niña).

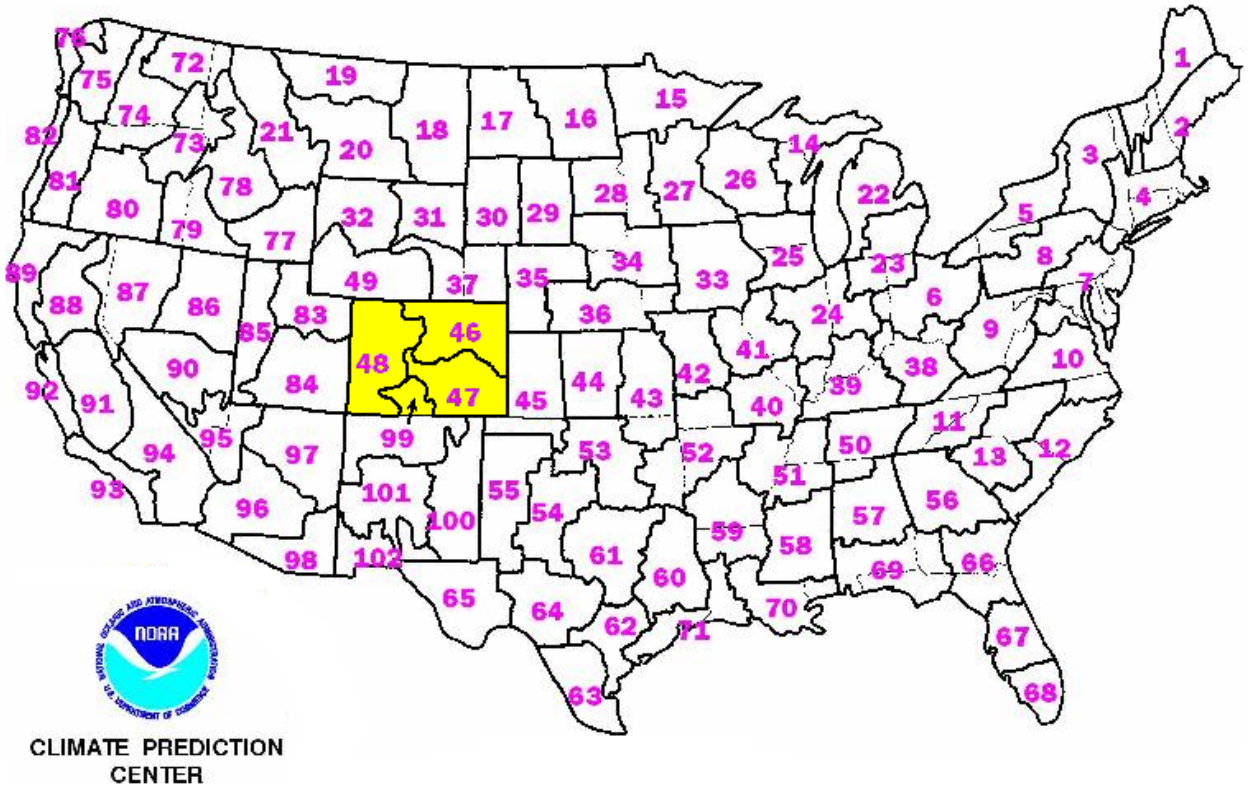
April-May-June 2012 Temperature and Precipitation Outlook for Colorado Issued by NOAA's Climate Prediction Center

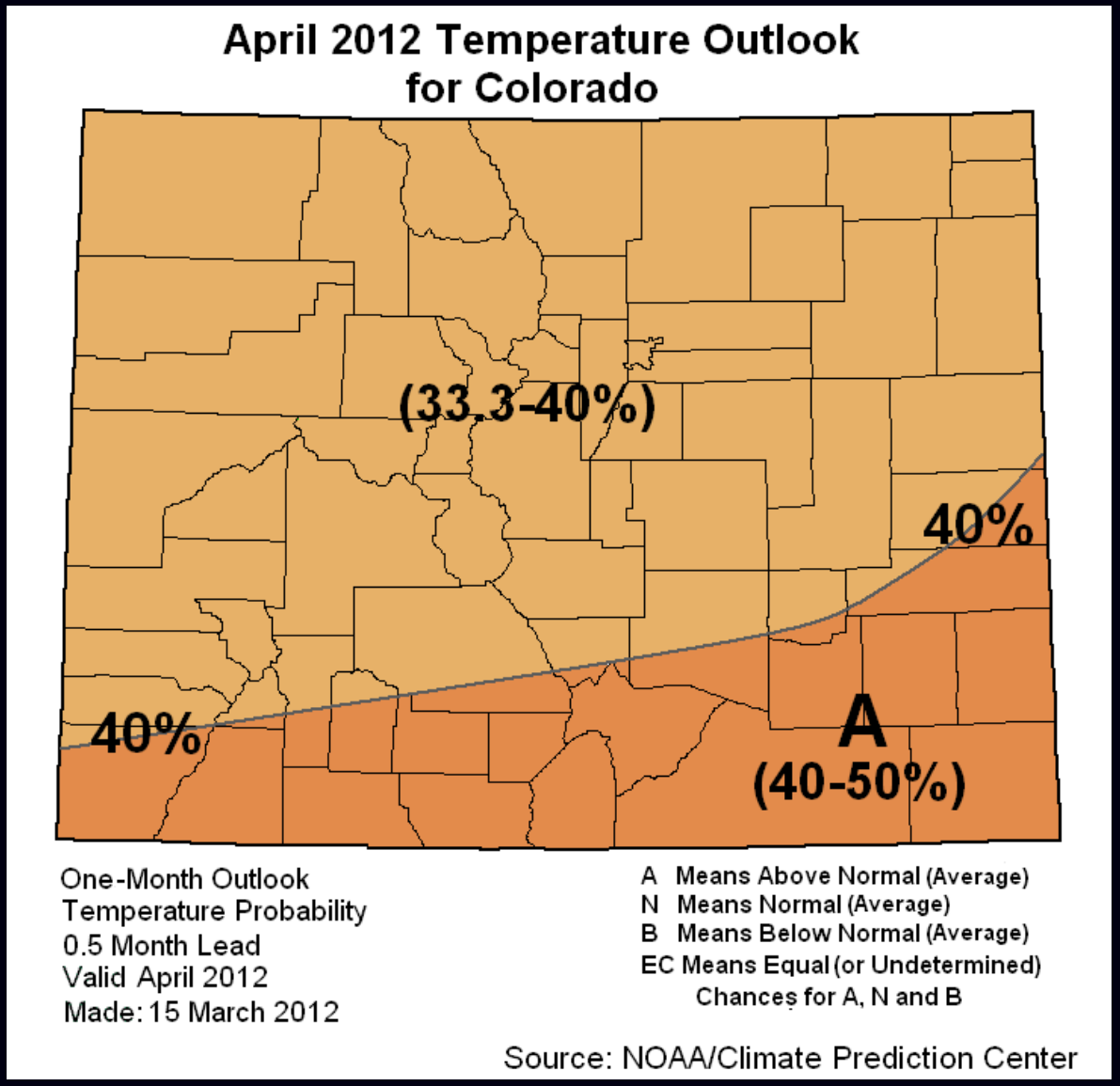
Climate Prediction Center Seasonal Outlooks

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.

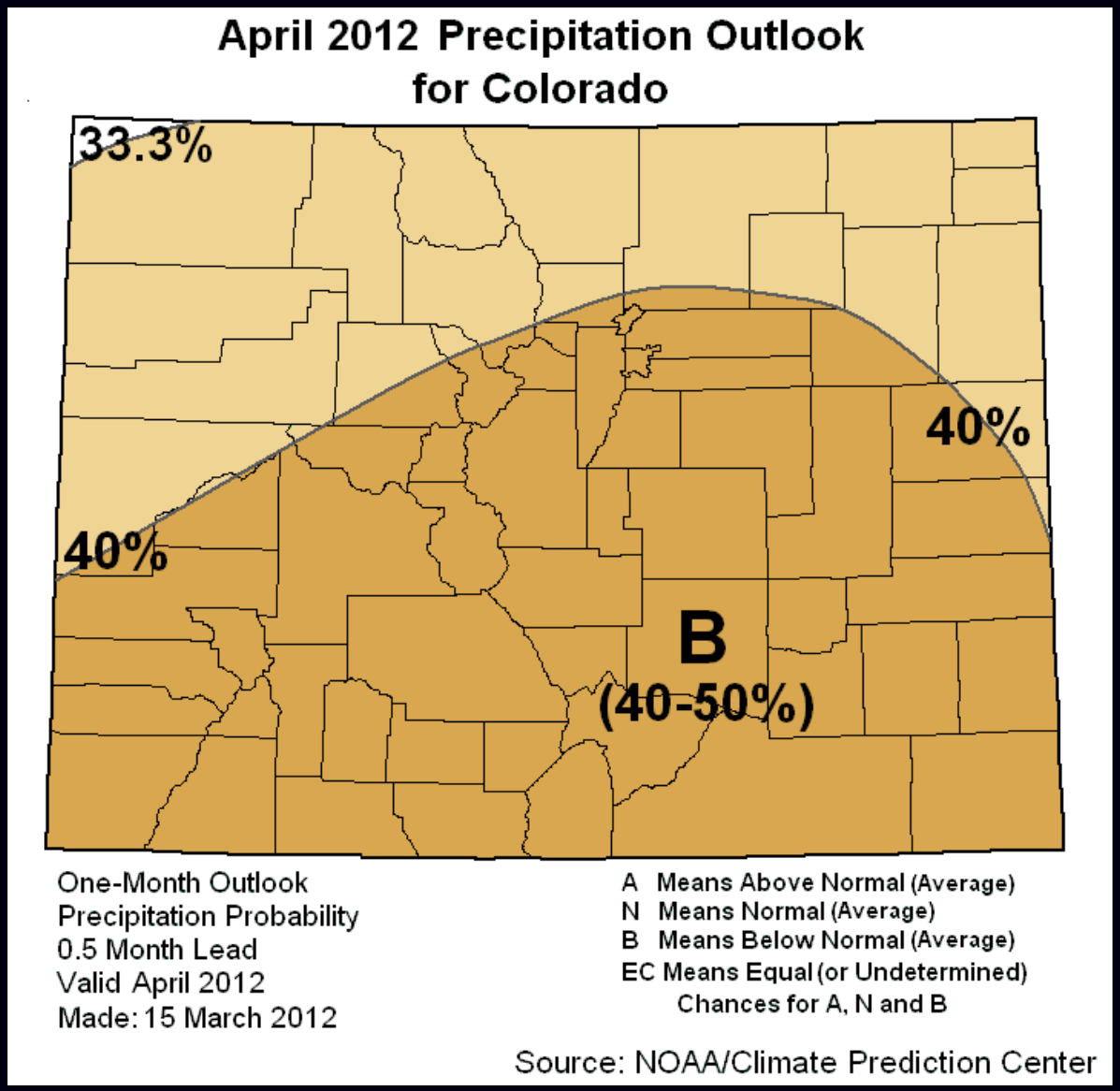
Remember, Climate Predicition Center (CPC) outlooks are made at the scale of the climate megadividions (see the map below).





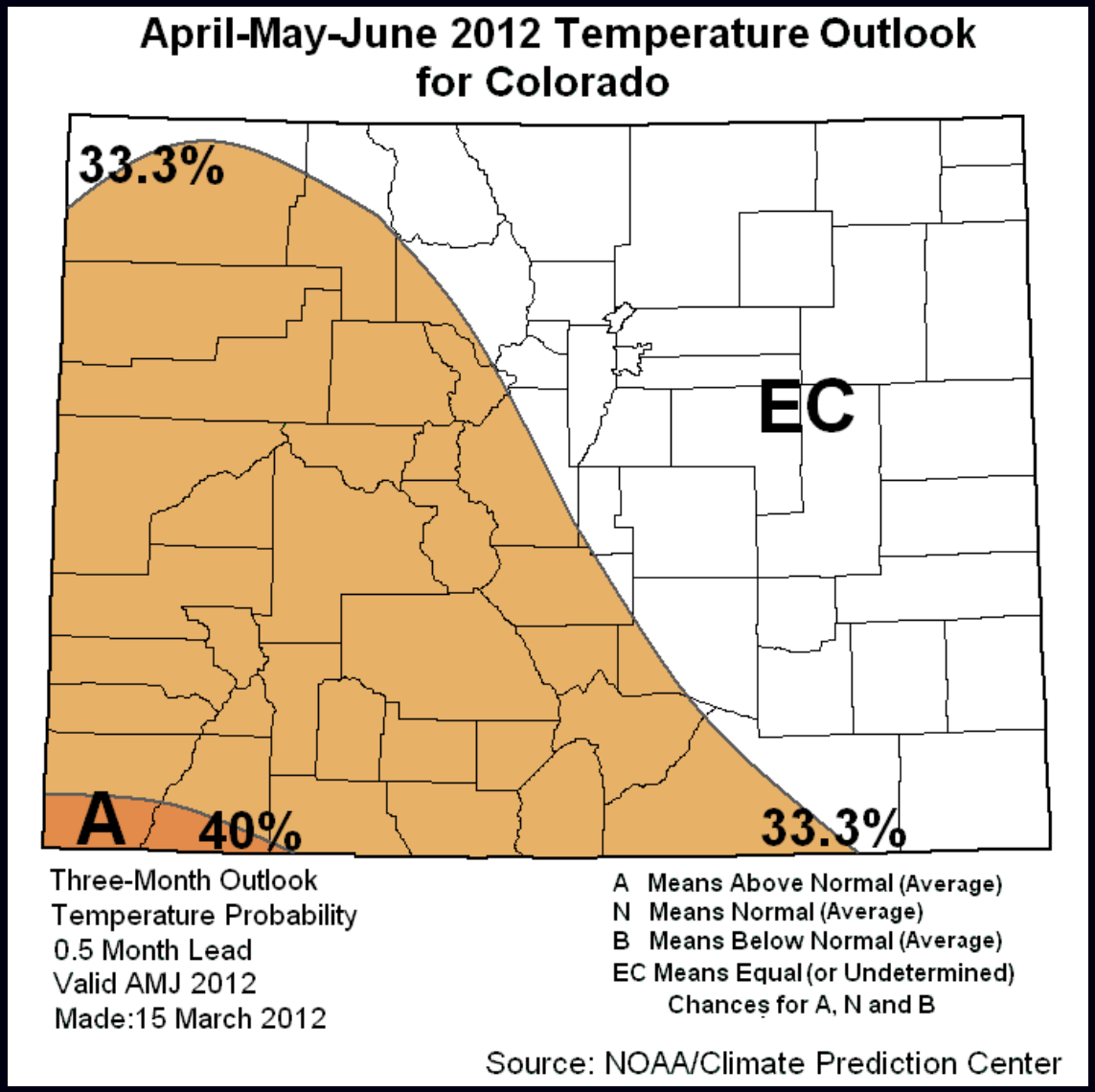
April 2012 Temperature Outlook for Colorado

The March temperature outlook for Colorado from the Climate Prediction Center calls for a 33.3 to 40 percent chance for above average temperatures roughly west of the Continental Divide, a 40 to 50 percent chance for warmer than average temperatures for areas generally east of the Divide, with the highest odds (50-60 percent chance) for above average temperatures along the state's eastern border.



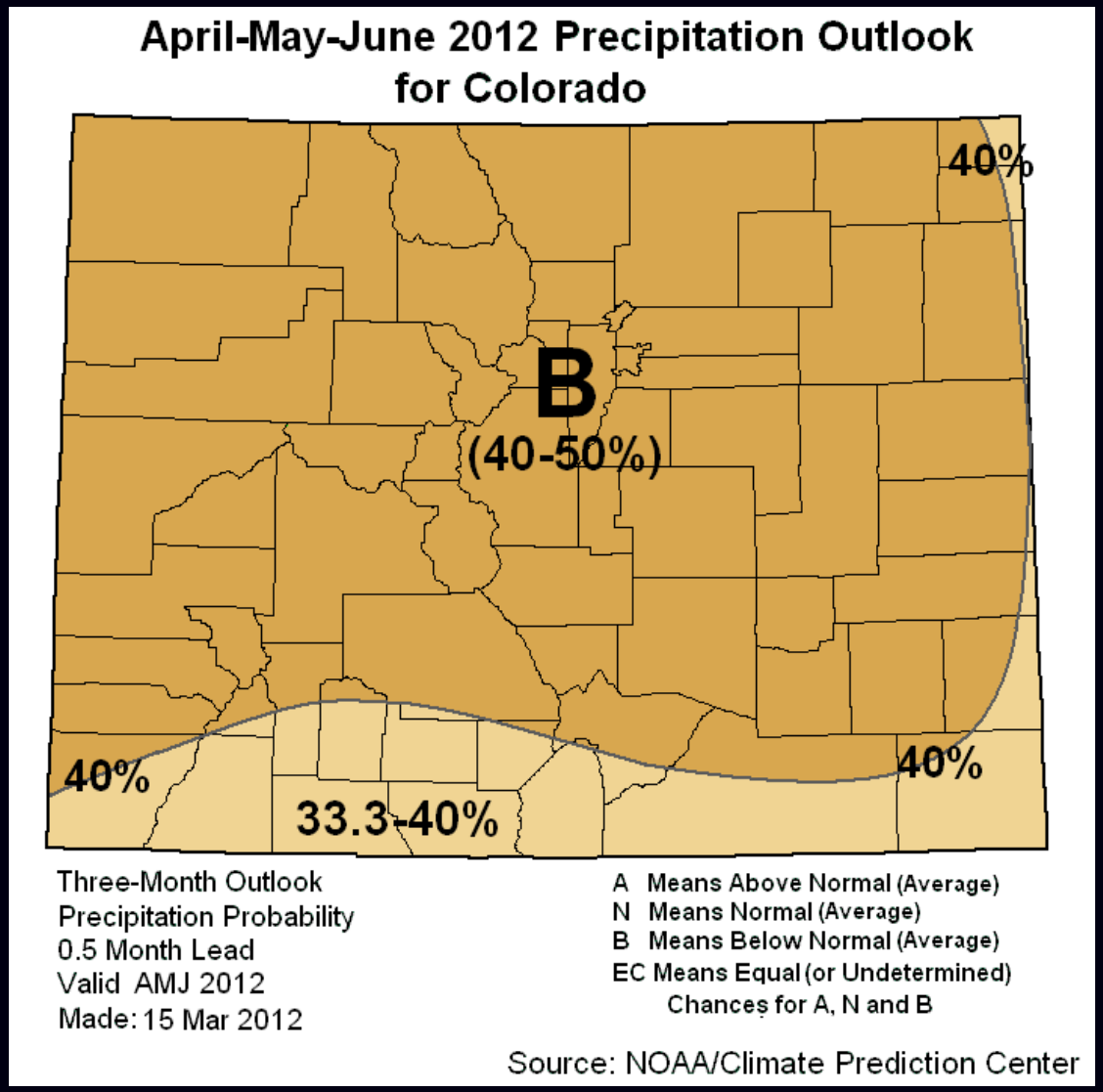
April 2012 Precipitation Outlook for Colorado

The March outlook for Colorado calls for a 33.3 to 40 percent chance of below average precipitation for the entire state, except for the southwest and south central sections where the outlook is calling for a 40 to 50 percent chance of below average precipitation.



March-May 2012 Temperature Outlook for Colorado

The temperature outlook for the three-month period March-May calls for a equal (or undeterminable) chance for above, below and near average temperatures (labeled EC) across the northern third of Colorado. The outlook also calls for a 33.3 to 40 percent chance for above average temperatures for the remainder of Colorado, except for the extreme southwest tip of the state where there is a 40 to 50 percent chance of above average temperatures.



April-May-June 2012 Precipitation Outlook for Colorado

Finally, CPC's outlook for Colorado calls for a 33.3 to 40 percent chance of below average precipitation for the northern third of the state and a 40-50 percent chance of below average precipitation for the lower two-thirds of Colorado.

Note: CPC outlooks do not imply any degree of warmness or coldness, or any amount of precipitation; *only* their probability of occurrence.

Summing It Up

- Since the middle of February this year, the weather has turned unseasonably warm and very dry across Colorado, especially in areas east of the mountains. New high temperature records have been set almost daily somewhere in Colorado since the first of March. For many locations, March 2012 will go down as the driest March on record. The lack of precipitation in March was in sharp contrast to the wet and very snow conditions observed in the mountains and at lower elevations in eastern Colorado during February.
- La Niña is forecast to continue to weaken as sea surface temperatures in Pacific Ocean continue to warm. Even with its decline, La Nina will probably continue to influence weather patterns across the western U.S. and Colorado until the end of spring.
- The strong Madden-Julian Oscillation (MJO) now in the western Pacific Ocean is forecast to cross the tropical Pacific Ocean in the next few weeks, however with some deduction in strength along the way. The enhanced convection associated with the MJO will potentially increase the odds for the first significant precipitation across southern and eastern portions of Colorado since early in February of this year.
- Much above average temperatures, low relative humidity, the lack of precipitation and very low fuel moistures have significantly increased the potential for wildland fire in many parts of Colorado. However, the threat of wildfire would decrease should significant precipitation occur in the next few weeks.
- The outlook for the next three months according the Climate Prediction Center calls for a heighten chance for above average temperatures across southern and western Colorado and a greater than a 1-in-3 chance for below average precipitation for the entire state. The temperature outlook for northeast Colorado is less certain.
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