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Colorado Water Conservation Board
Department of Natural Resources

Seasonal Outlook for Colorado

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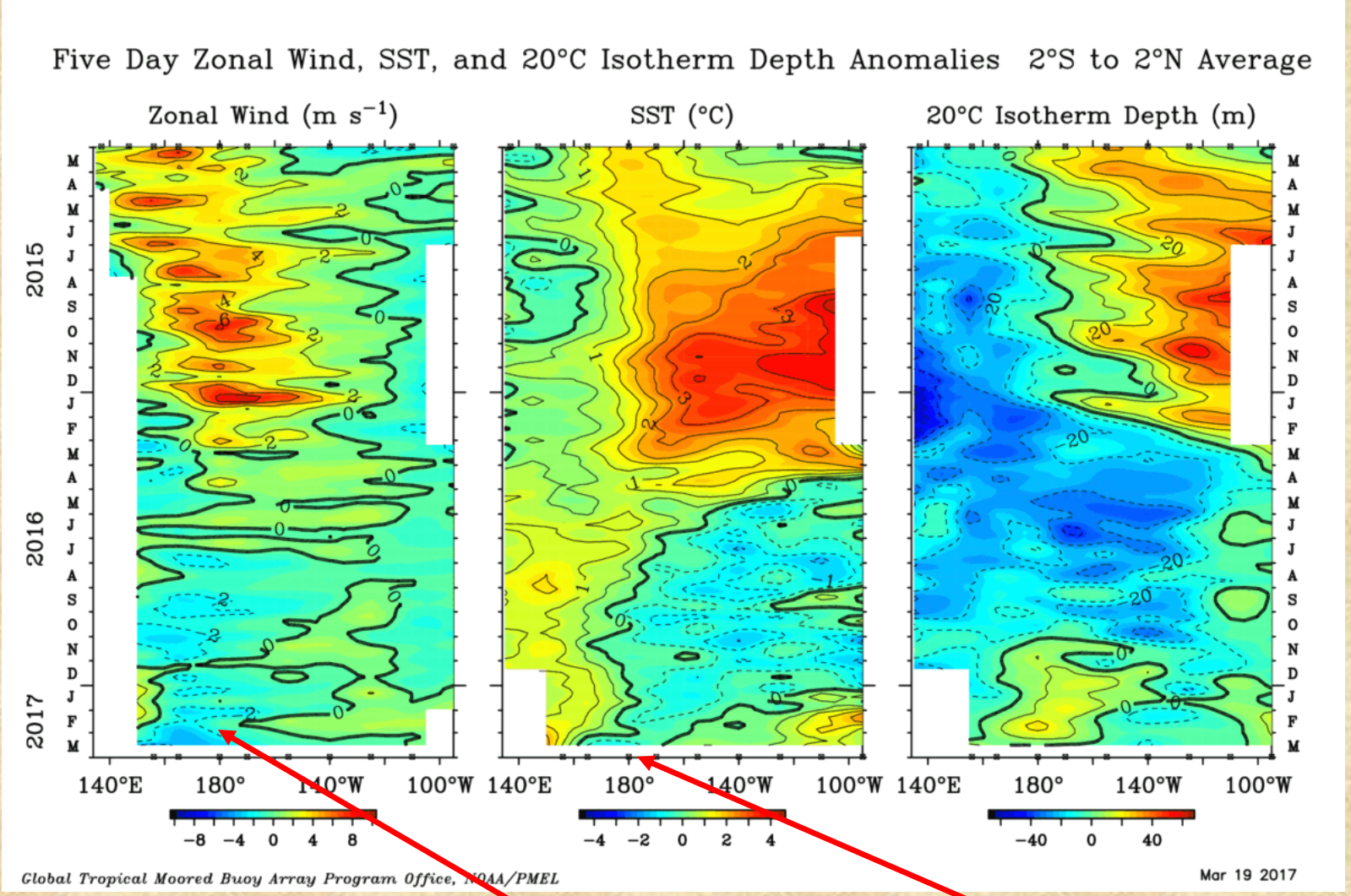
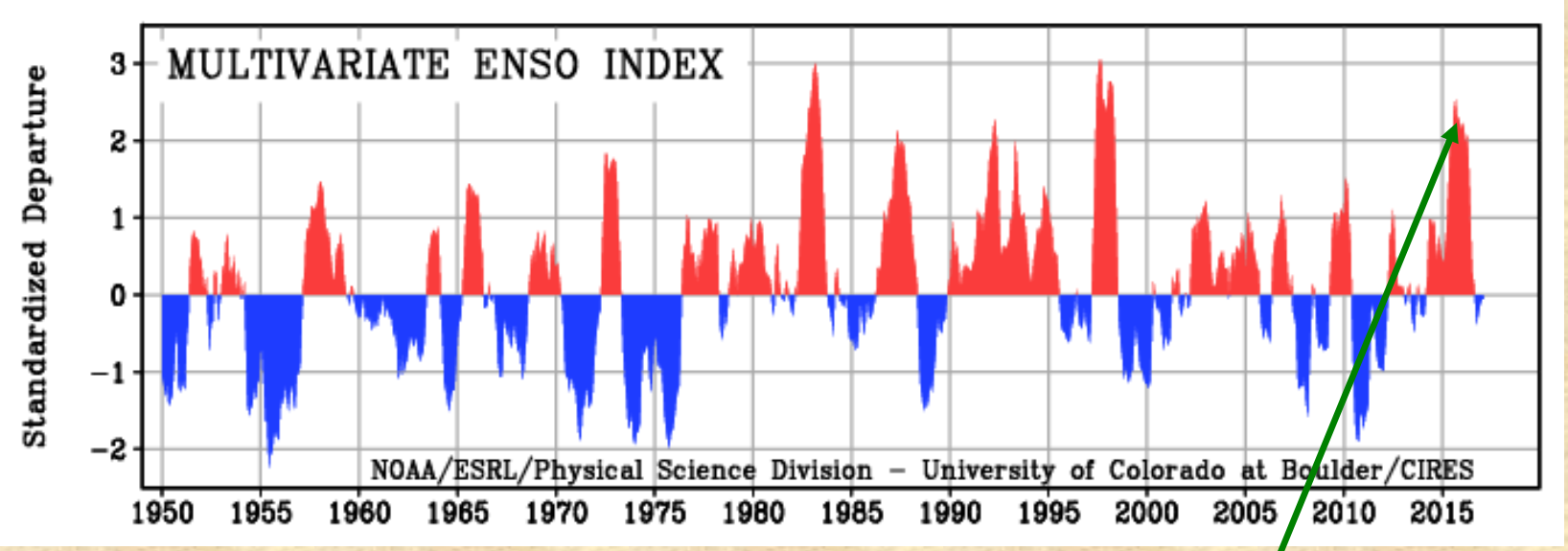
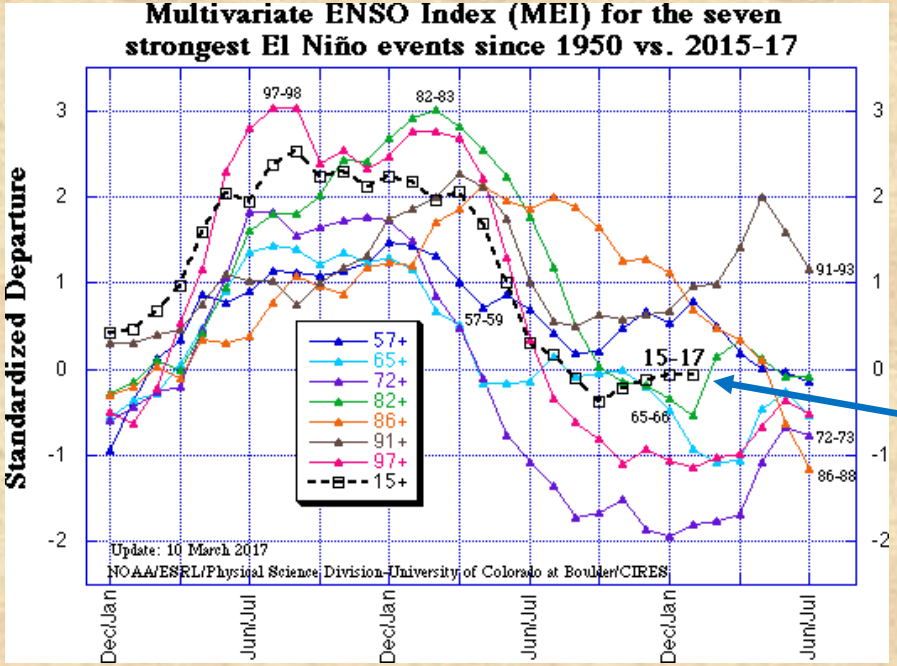
- ***La Niña is over (Niño 3.4 index SST last one to go)***
- ***Postmortem JFM, also 1aprSWE***
- ***CPC forecasts from April-June into July-September***
- ***Experimental forecast guidance & 'analogues'***
- ***Next two weeks***
- ***Executive Summary***



Persistent easterly (negative) wind anomalies (left) near the dateline are the last remnant of the 2016-17 "La Niña", while SST anomalies have dwindled to one last pocket of negative values near the dateline (middle; too far west), and negative upper ocean heat content anomalies came and went by the end of 2016 (right). All in all, I would call this ENSO-neutral, despite the warmth in far eastern Pacific (and associated flooding in Peru).

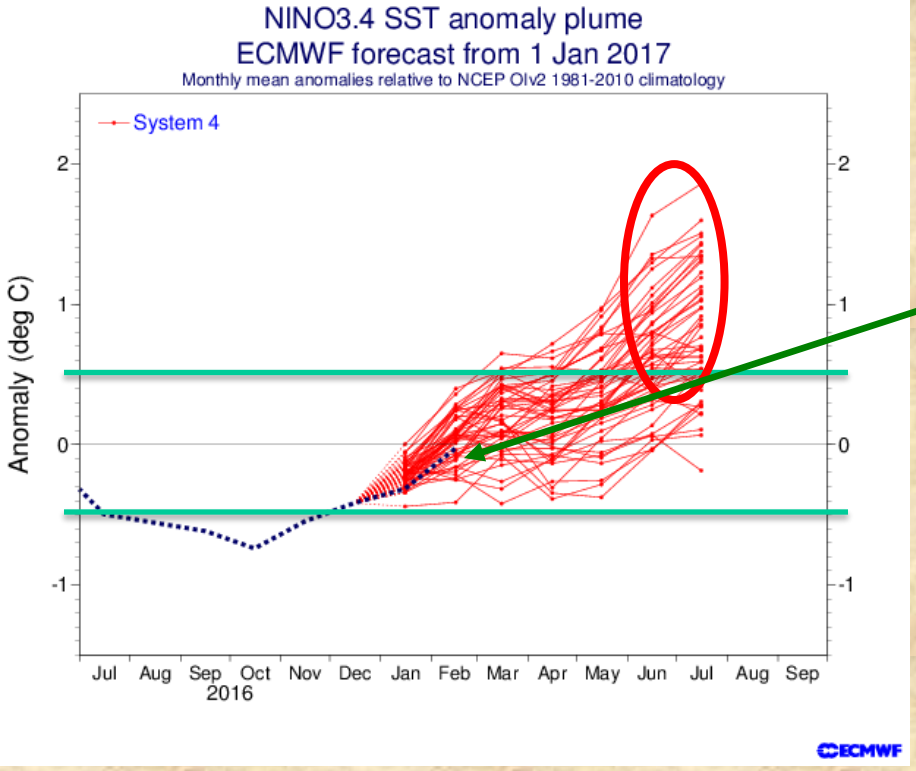
http://www.pmel.noaa.gov/tao/jsdisplay/index.html





The **MEI** monitors ENSO based on all observed fields over the tropical Pacific (pressure, wind, temperatures, cloudiness). **The latest El Niño peaked in Aug/Sep 2015 at +2.53, the largest MEI value since 1998**. Since June-July 2016, I would classify it as ENSO-neutral, with the last three values stagnating near 0 (→ *analogues*).

http://www.esrl.noaa.gov/psd/enso/mei

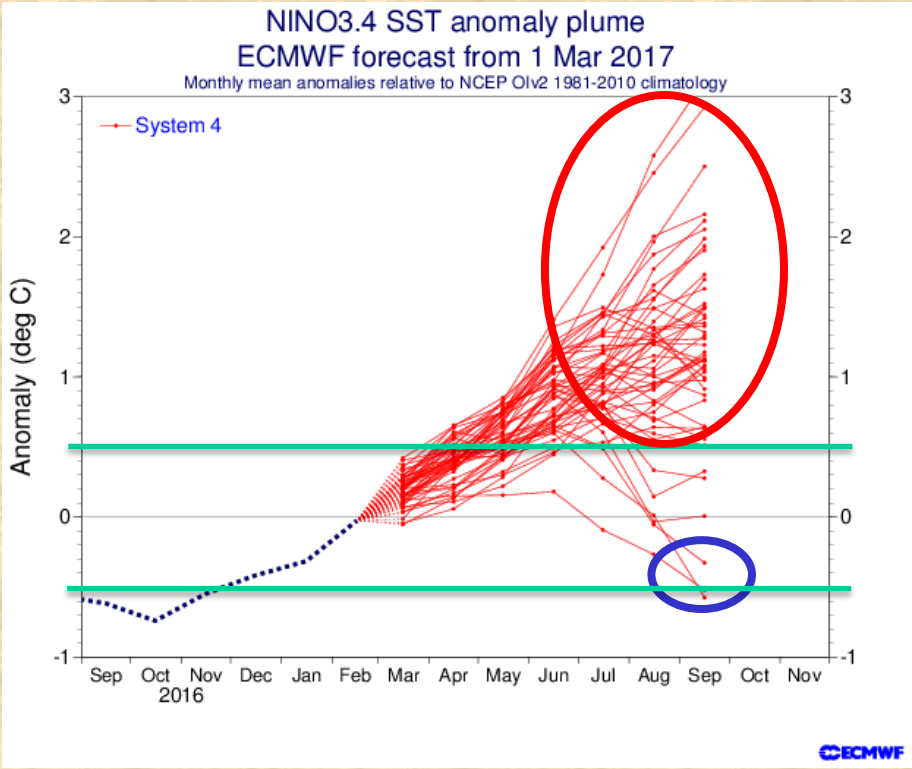


The ECMWF January 2017 forecast (left) was correct in anticipating a warming trend in early 2017. The observed (blue) Niño 3.4 SST ended up in the middle of the plume in February. While it also anticipated a pause in March-April, it put the majority of ensemble members above +0.5C by June/July.

http://www.ecmwf.int/products/forecasts/d/charts/seasonal/forecast/seasonal_range_forecast/

The updated ECMWF forecast (right) shows an huge range of possible outcomes, reminiscent of 2012 (the short-lived El Niño summer which was anchored by that big MJO event – not this time). By September, the average rises above +1.0C, along with a few dissident members that advertise an early demise of the event.

In IRI plume (not shown), the spread among models is similar, with most dynamical models being more gung-ho about El Niño than statistical models.



Postmortem for Jan-March 2017 so far

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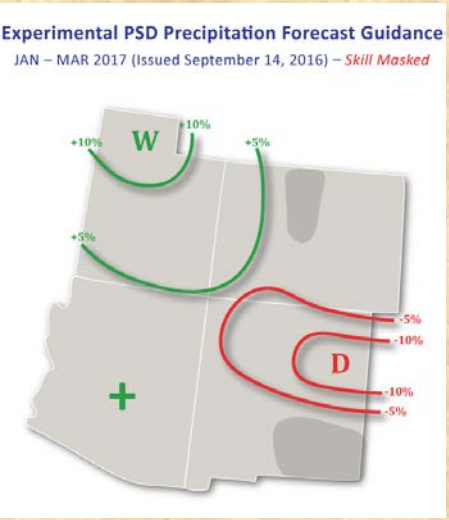
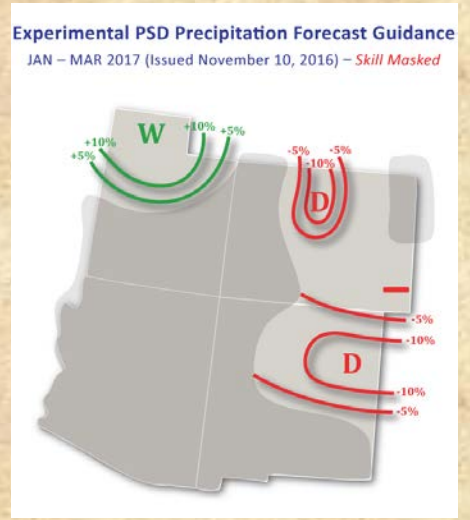
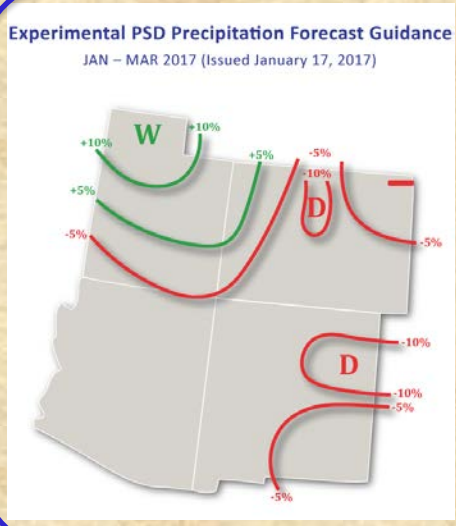
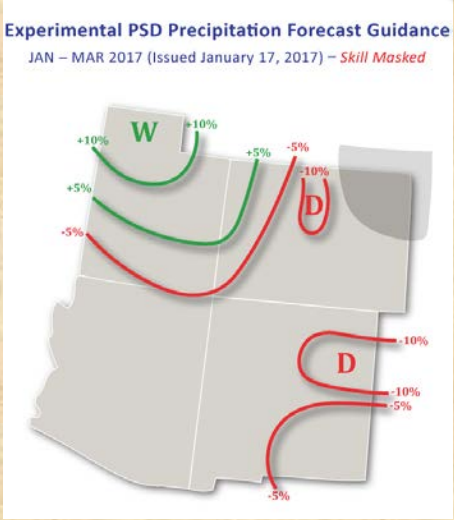


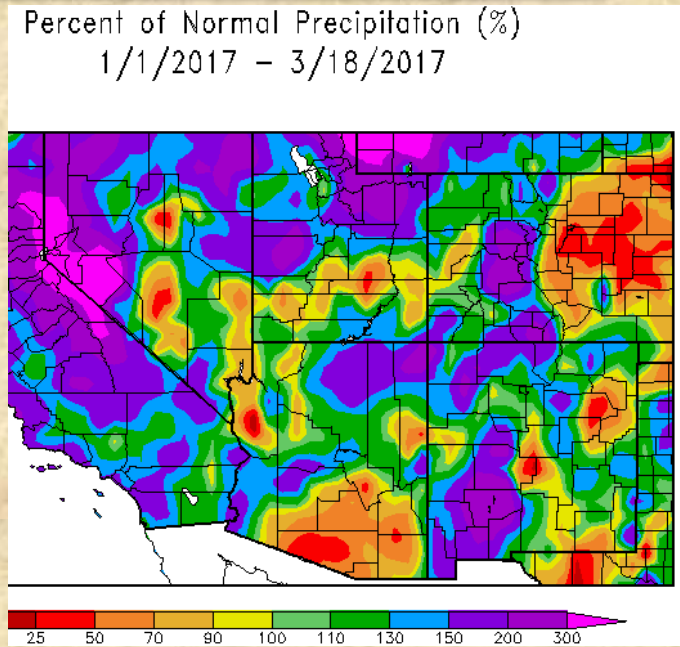




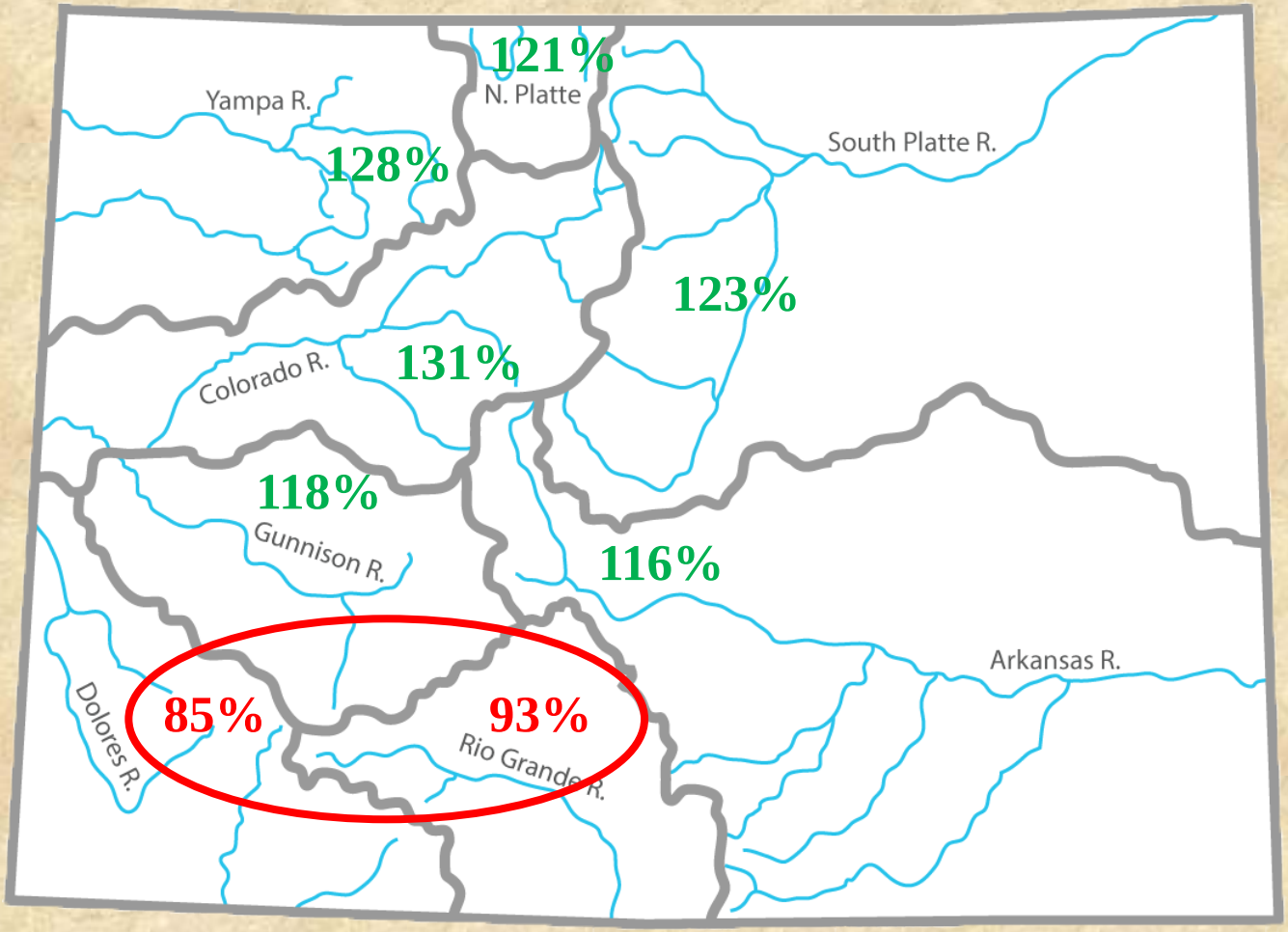


My late winter forecasts were dry for most of Colorado since November, with lingering wetness towards Utah. Overall pattern of wetness to the west and dryness over eastern Colorado was established early in the year, and has been exacerbated by our recent dry spell.

< note forecast for next two weeks!>

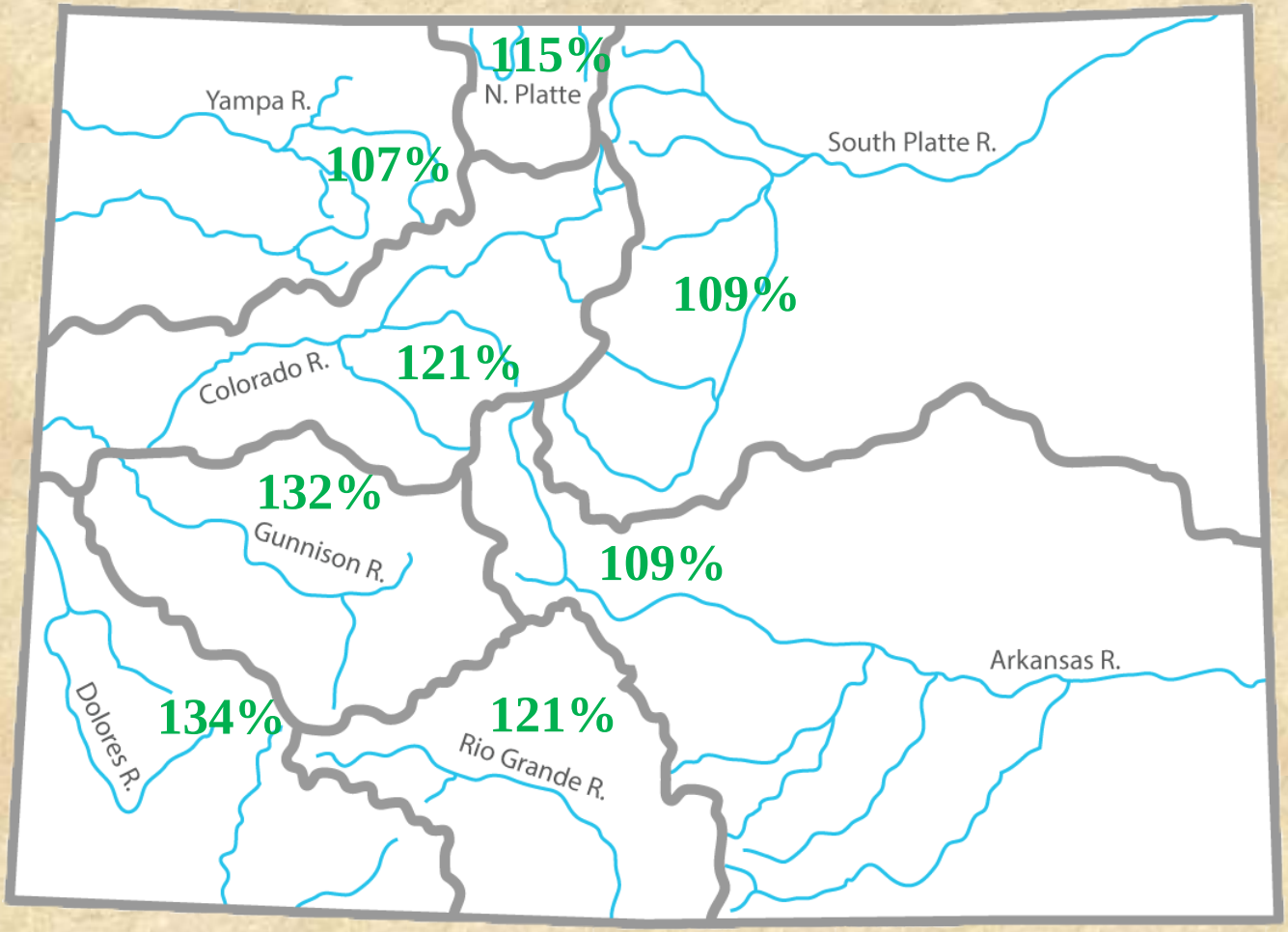


Based on Fall El Niño composites for 1apr SWE



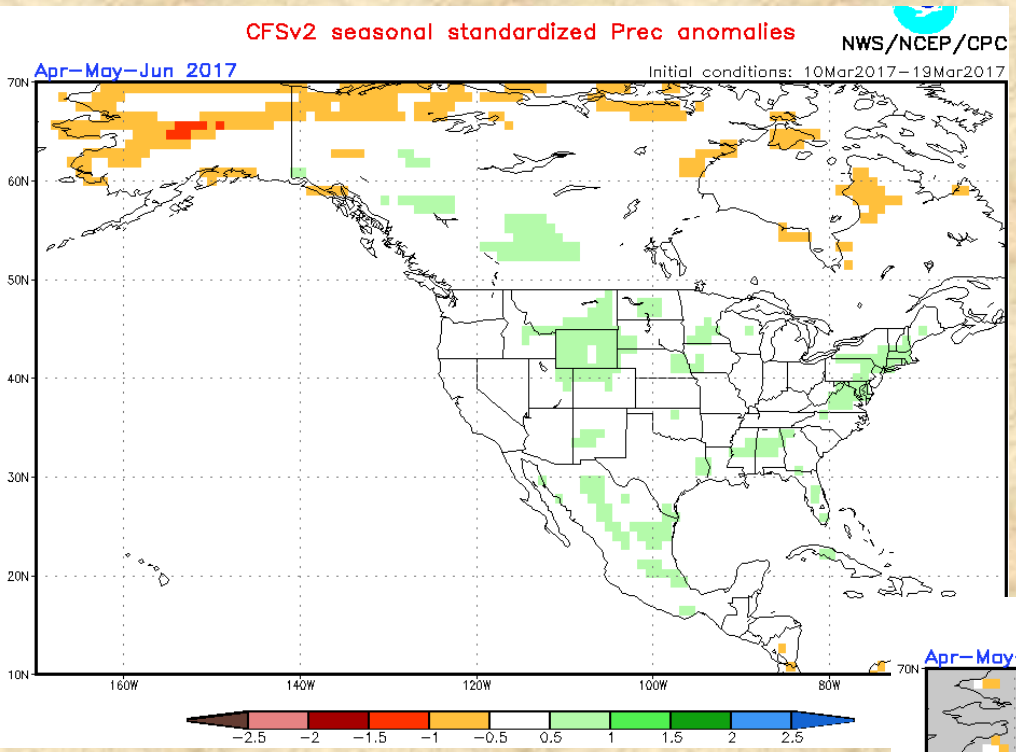
Median outcome for Colorado snowpack based on a subset of six analogue cases since 1950: favorable in the northern, central, and Front Range mountains. Poor in San Juans (cases: 1960, 65, 67, 84, 96, 2006). Statewide average: 114%+

Observed 19mar SWE



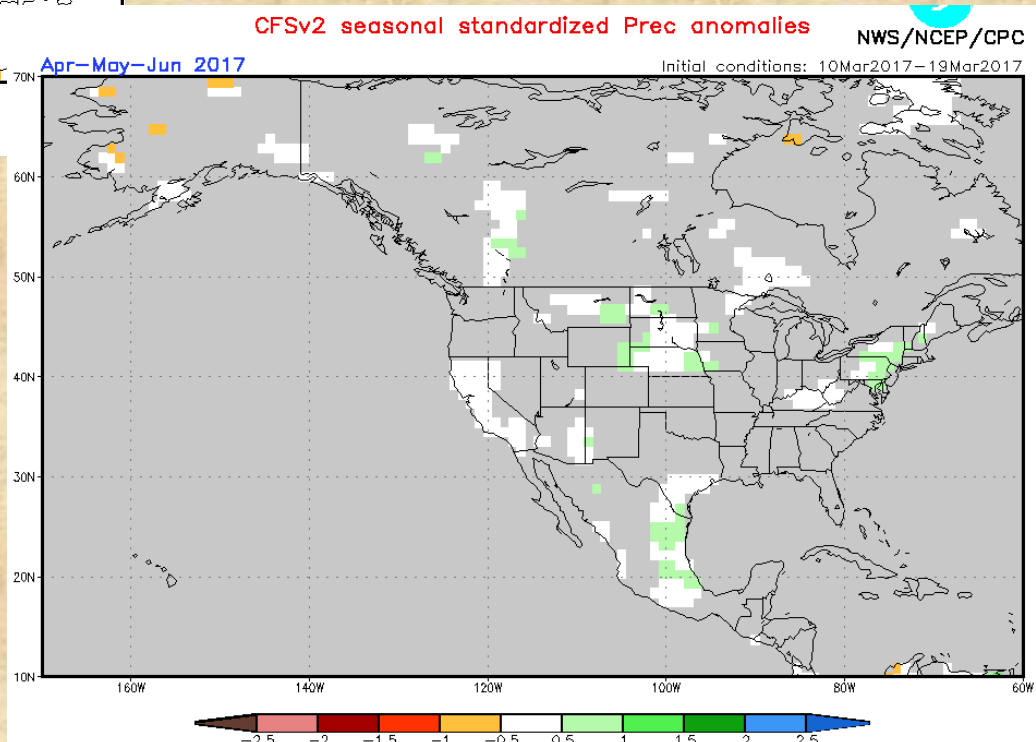
Observed SWE percentages just before expected shot in the arm over next 10 days. Statewide average: 118+%, or 4% more than anticipated. Biggest Δ: Dolores is 49% higher than 'expected', while Yampa is 21% lower. IOW, wetness focused on southern mountains where it was least expected.

CFSv2 forecasts for April-June 2017

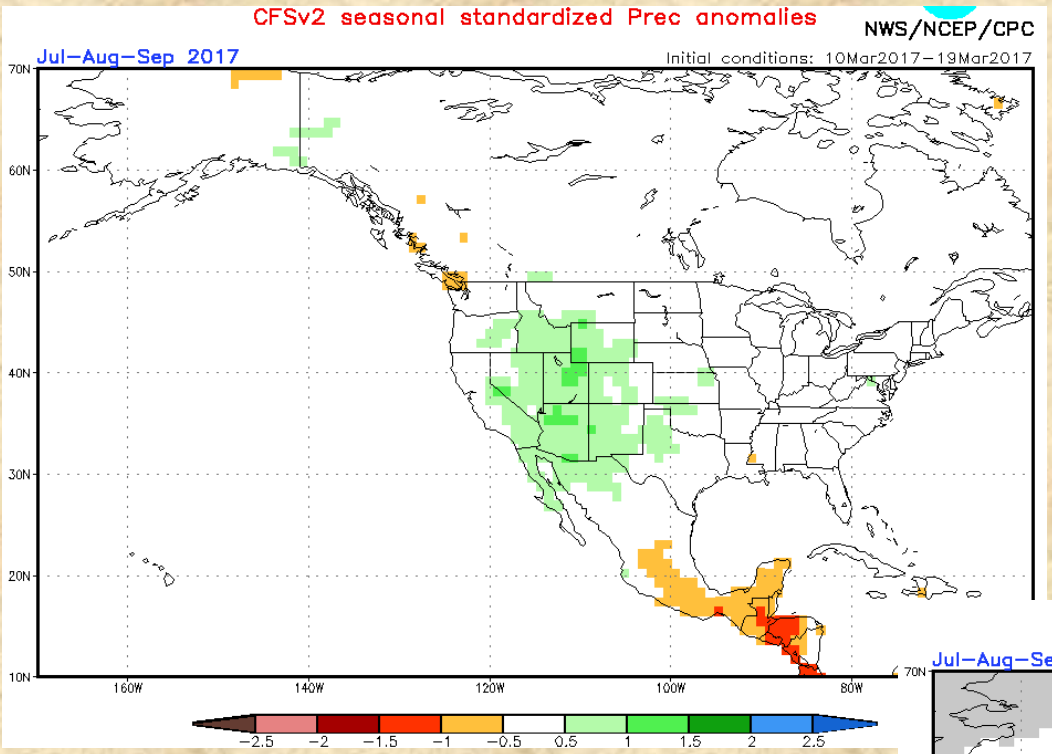


http://www.cpc.ncep.noaa.gov/products/predictions/90day/tools/briefing/

Late spring (top) shows modest chances for a wet outcome in the CFSv2. Unfortunately, this is not supported by noteworthy skill (right).

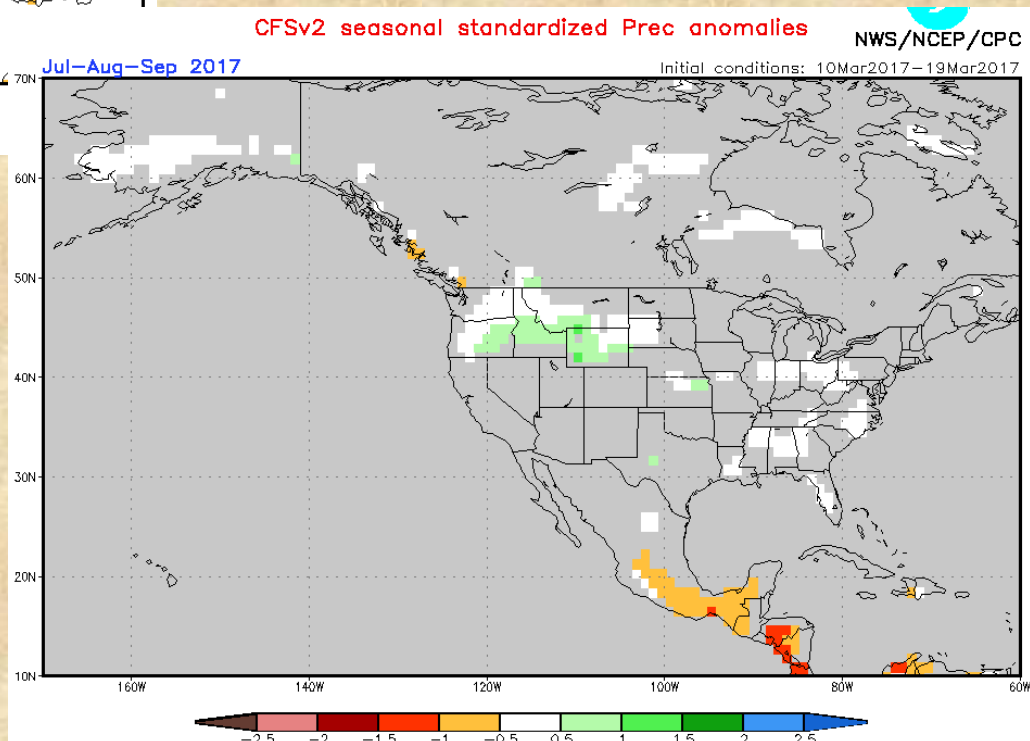


CFSv2 forecasts for July-September 2017

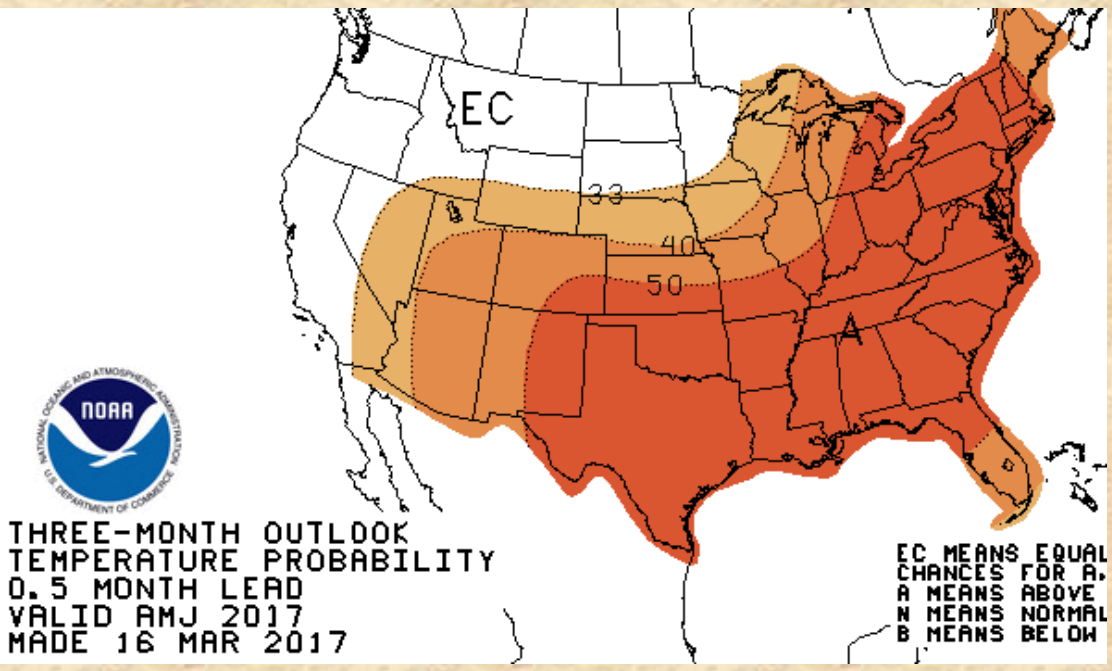


http://www.cpc.ncep.noaa.gov/products/predictions/90day/tools/briefing/

Late summer (top) shows good chances for a wet outcome in the CFSv2. Unfortunately, this is also skill-masked (right).

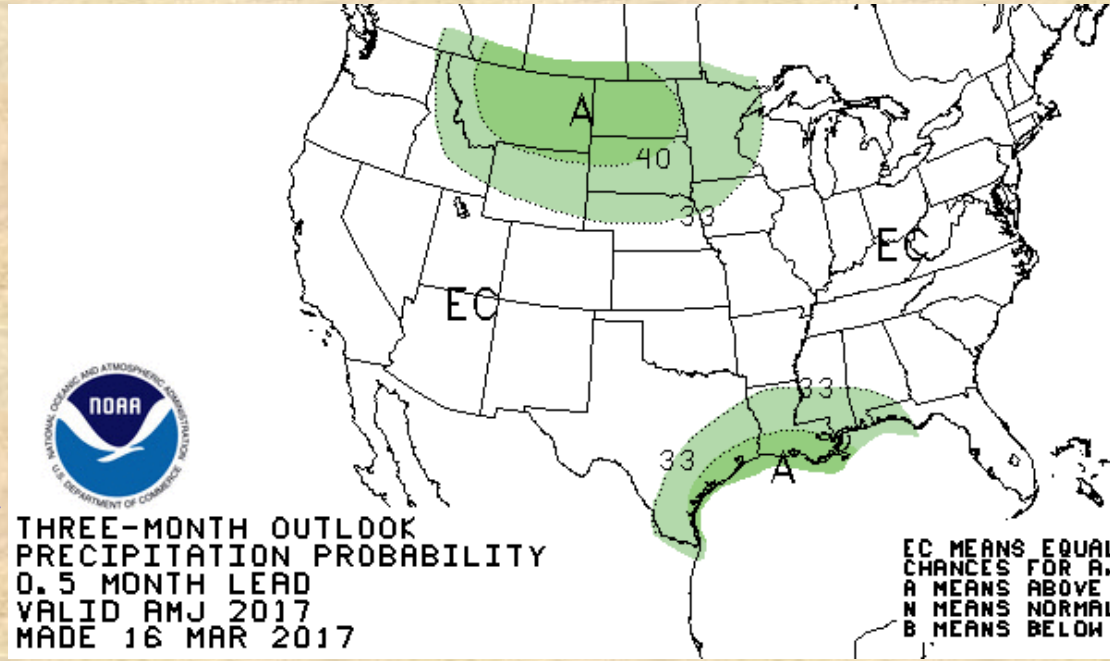


Climate Prediction Center Forecasts (AMJ)

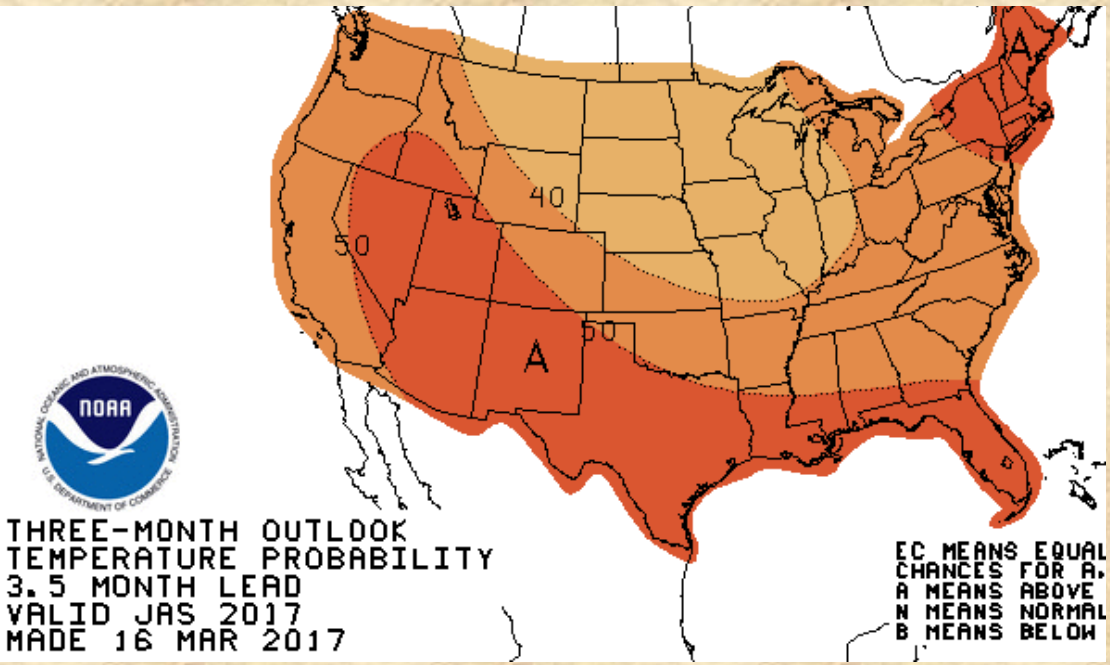


The CPC late spring temperature forecast (top left) is warm for CO, especially in the Arkansas Valley, while the precipitation forecast keeps the best odds for moisture to the north (right) – *could be worse, could be better…*

http://www.cpc.ncep.noaa.gov/products/predictions/

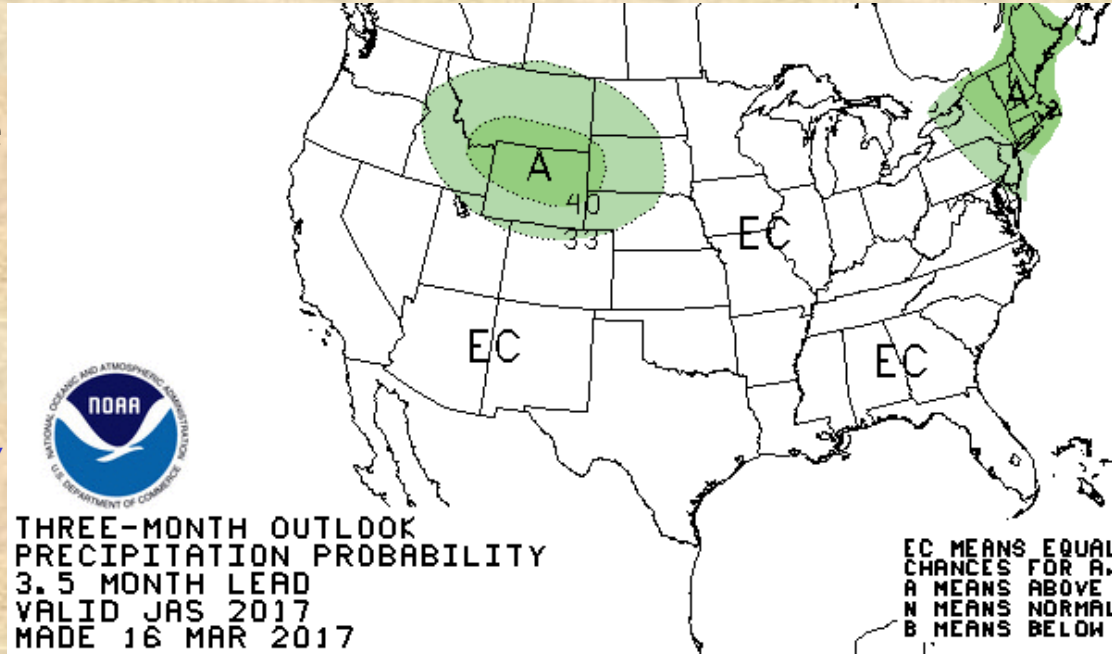


Climate Prediction Center Forecasts (JAS)

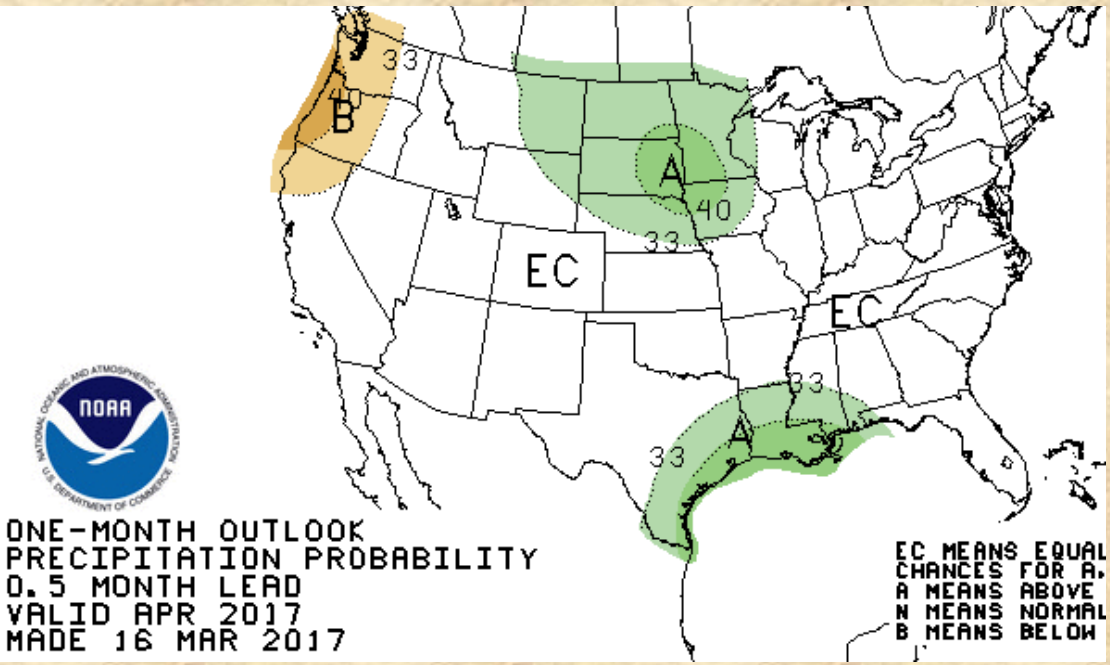


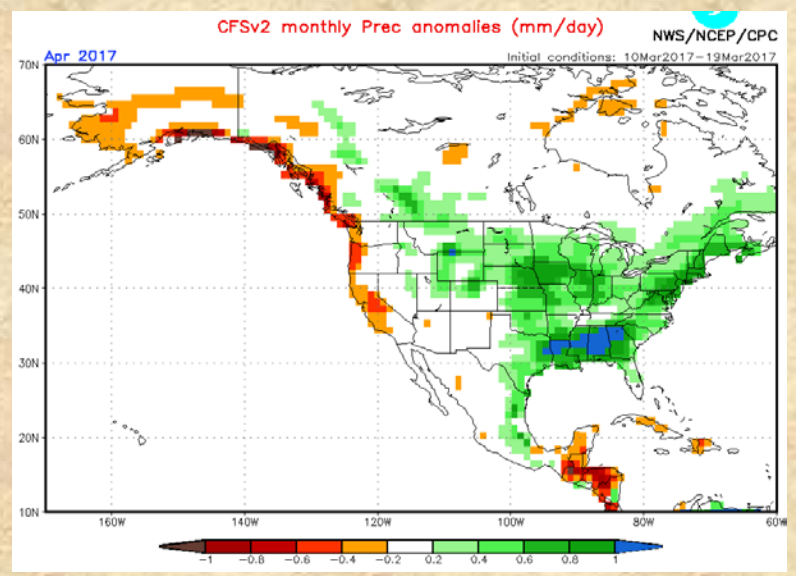
The CPC late summer temperature forecast (top left) is warm for all of the US, especially south and west of here, while the precipitation forecast keeps the best odds for moisture close to the north (right) – *teasing us?!*

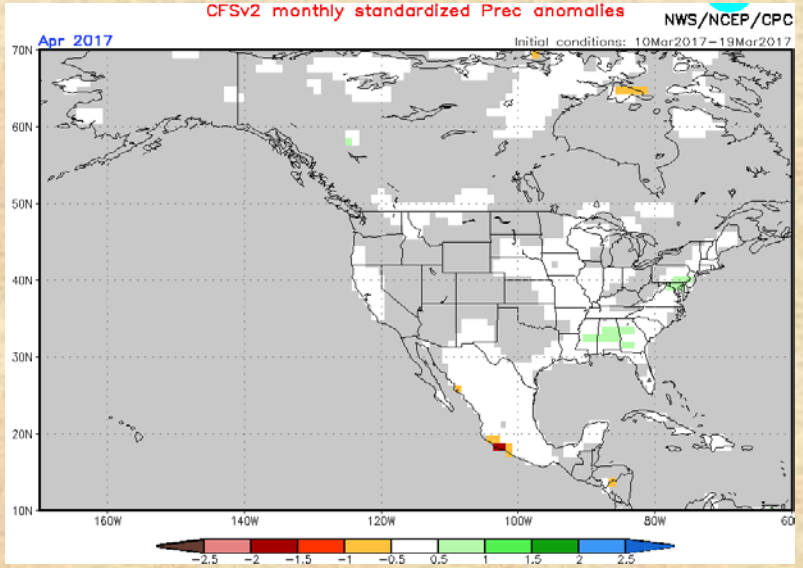
http://www.cpc.ncep.noaa.gov/products/predictions/



Climate Prediction Center Forecasts (April)





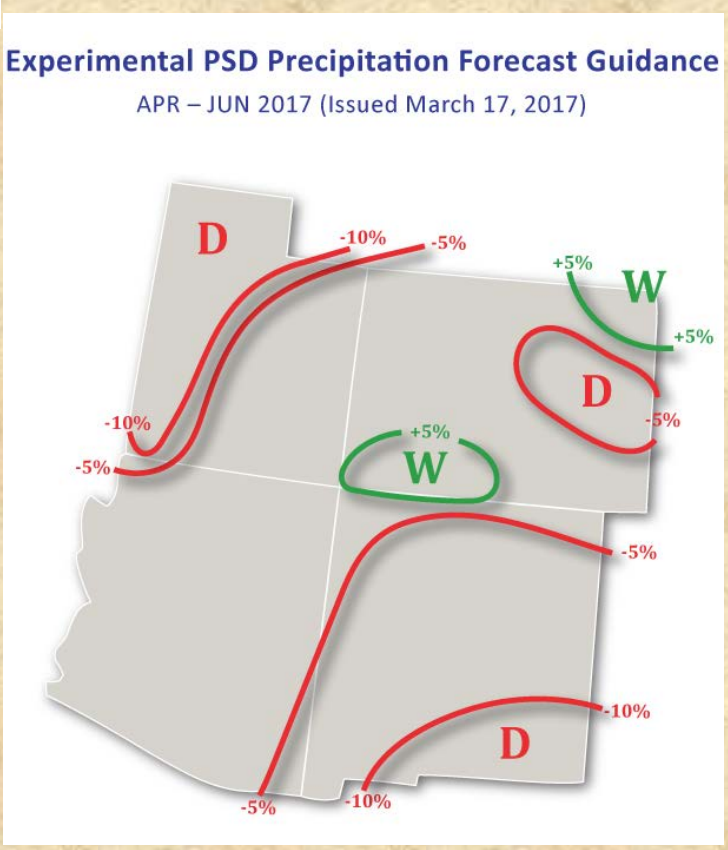


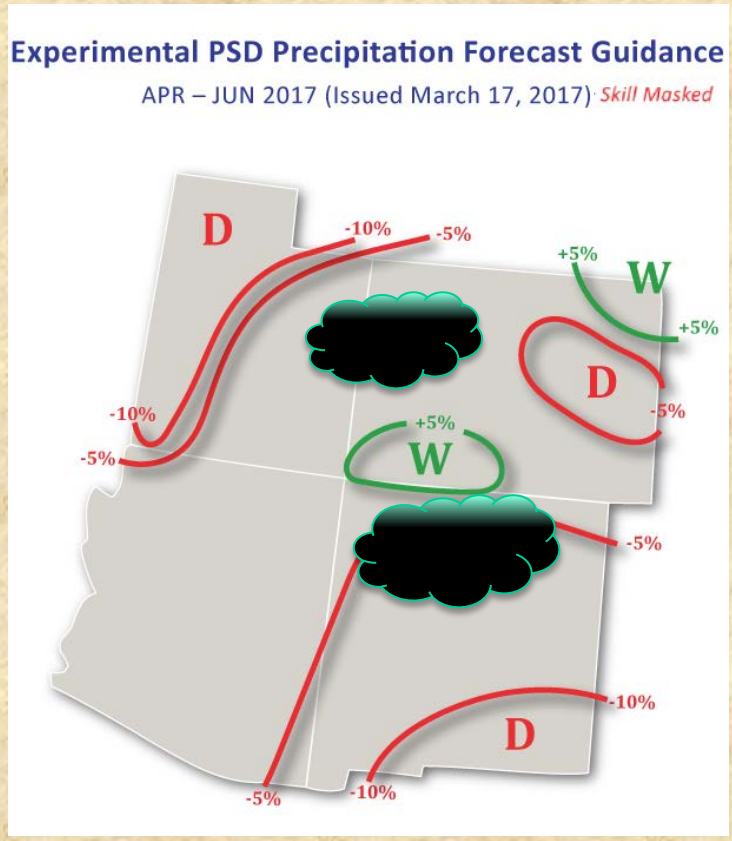
The CPC April precipitation forecast (top left) is EC for CO, while the CFSv2 forecast has an intriguing little bull's eye right over the northern Front Range (top right) – *again, not backed up by skill (bottom right).*

See also weather forecasts below!

http://www.cpc.ncep.noaa.gov/products/predictions/

Forecasts for April-June 2016

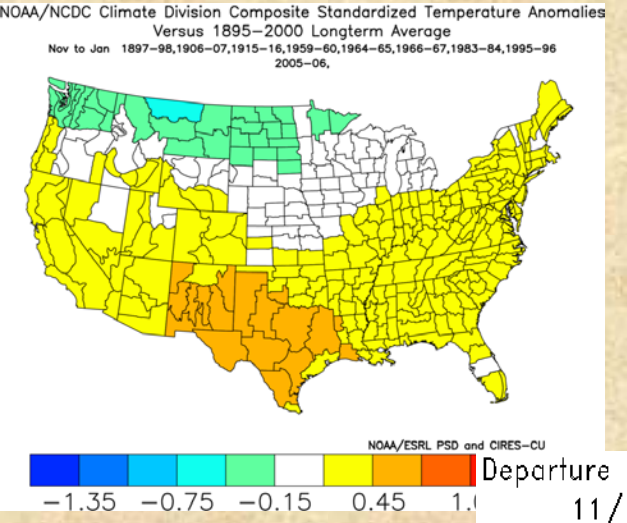


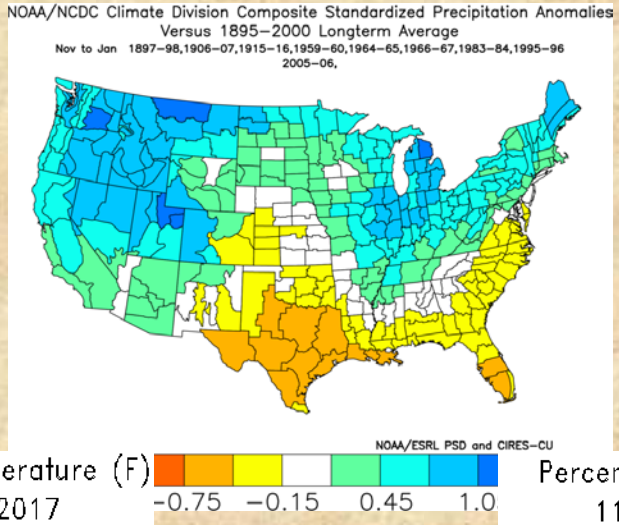


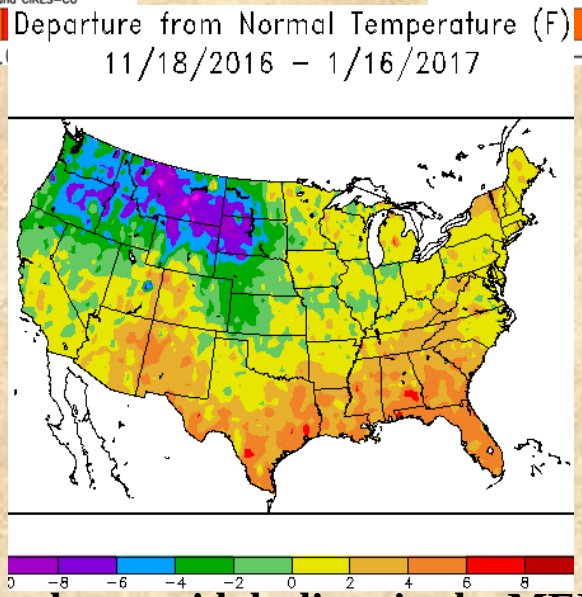
My late spring precipitation forecast is mixed for CO, most encouraging over San Juans and northeastern plains, but dry in between. ***None of our forecast tilts exceed +/-10%.***

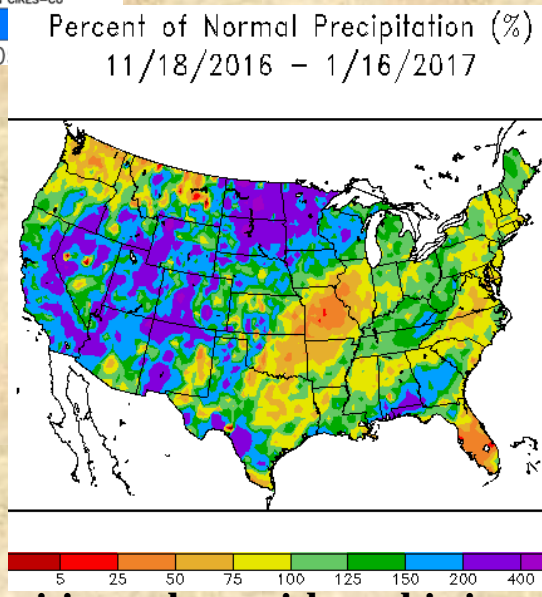

What about those analogues?

November-January Climate Analogue Guidance (@late Oct'16)





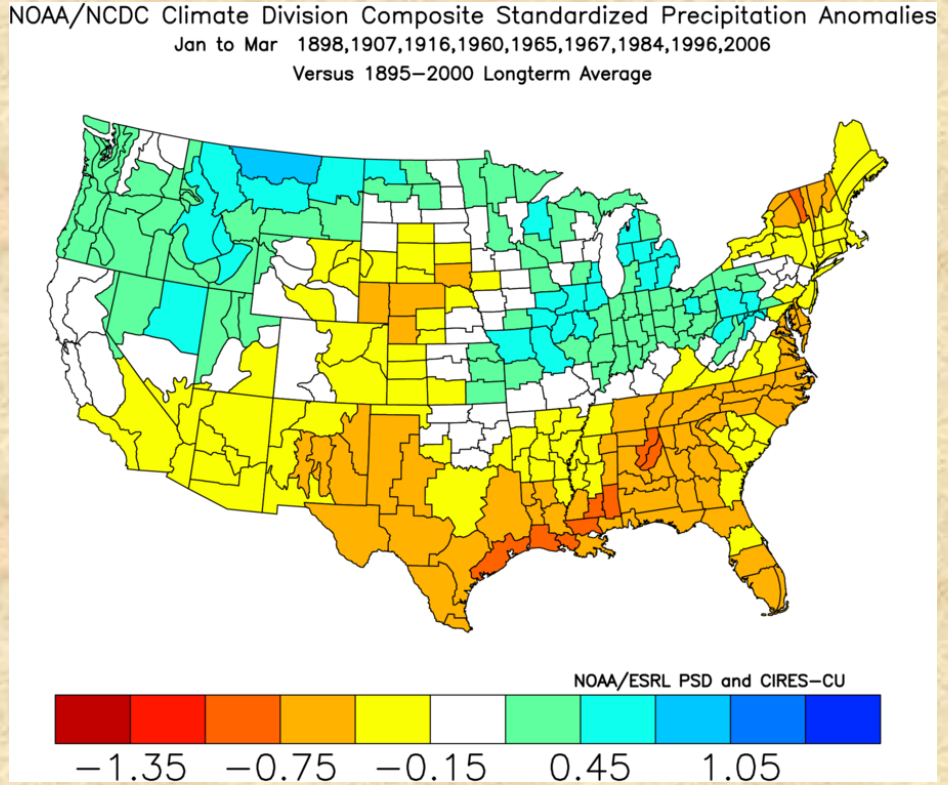


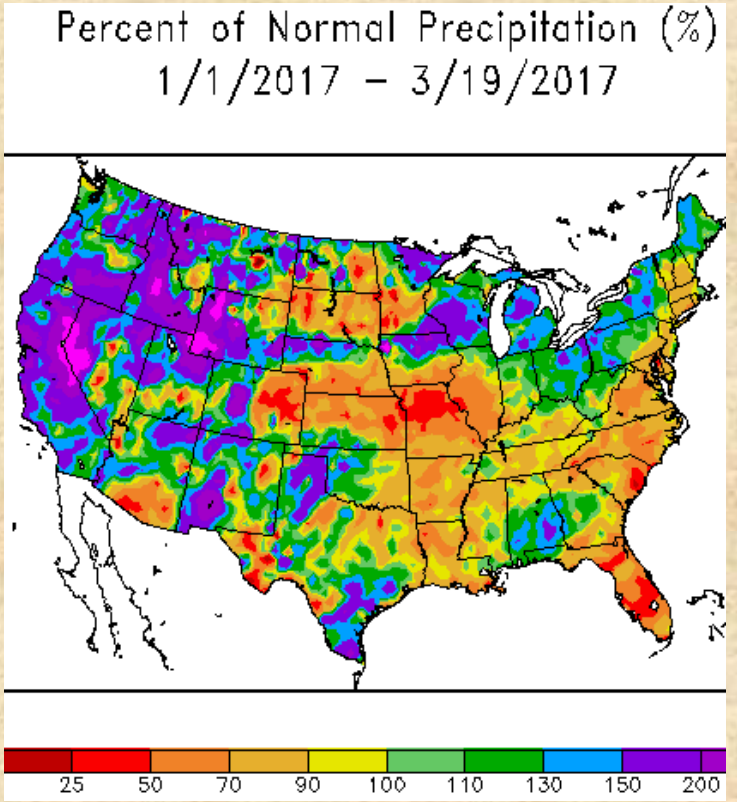


These analogues were based on <u>rapid declines in the MEI and PDO from positive values without hitting major negative values in the following winter</u> during last century(+) for temperatures (left) and precipitation (right). With a sample size of nine, the 2nd color shade (beyond +/-0.45 standard deviations) is considered 'significant'. ***The temperature map correctly anticipated a warm winter over the southwestern US compared to cold conditions from North Dakota westward, while a wet signal for much of the western US was confirmed (and then some)...***

http://www.esrl.noaa.gov/psd/data/usclimdivs/

January-March Climate Analogue Guidance (@late Oct'16)

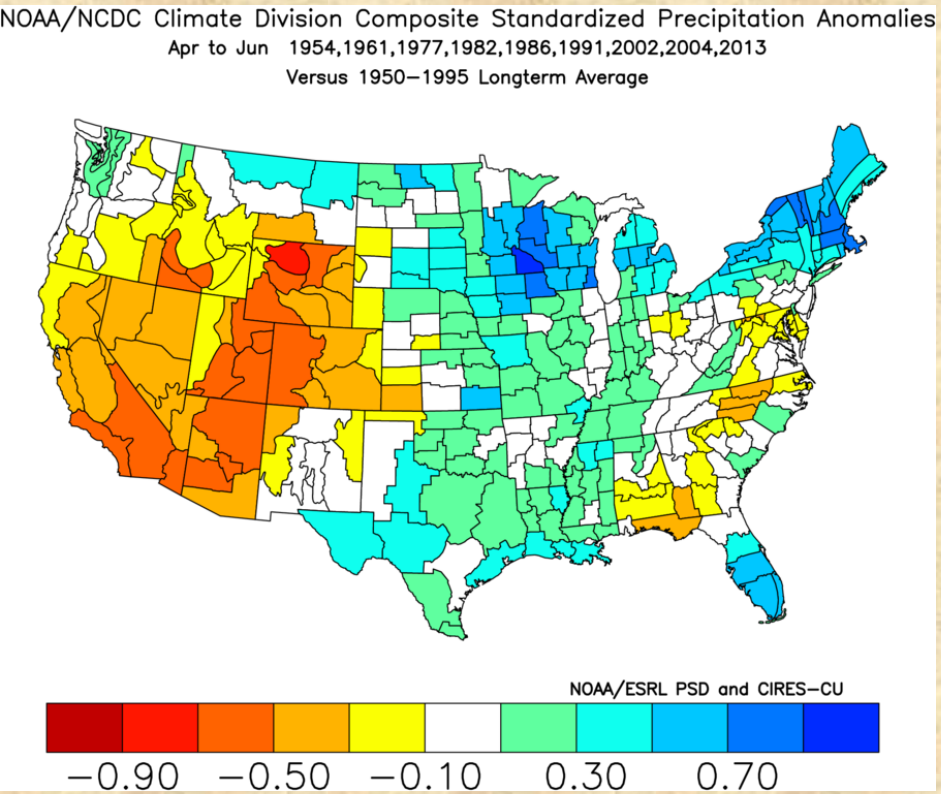


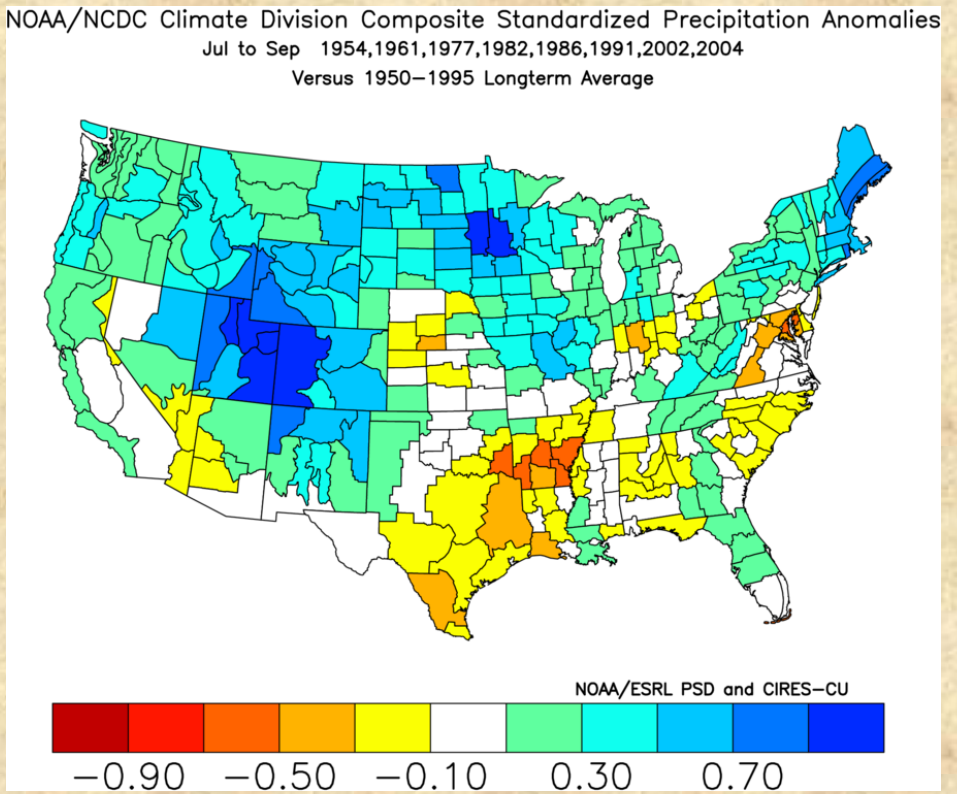


Same set of analogues for precipitation (left) during January-March. ***Not as gung-ho about moisture in western US as before, so the observed anomalies are on the high end of expectations!***

http://www.esrl.noaa.gov/psd/data/usclimdivs/

A new set of analogues based on neutral MEI and little change in last three months





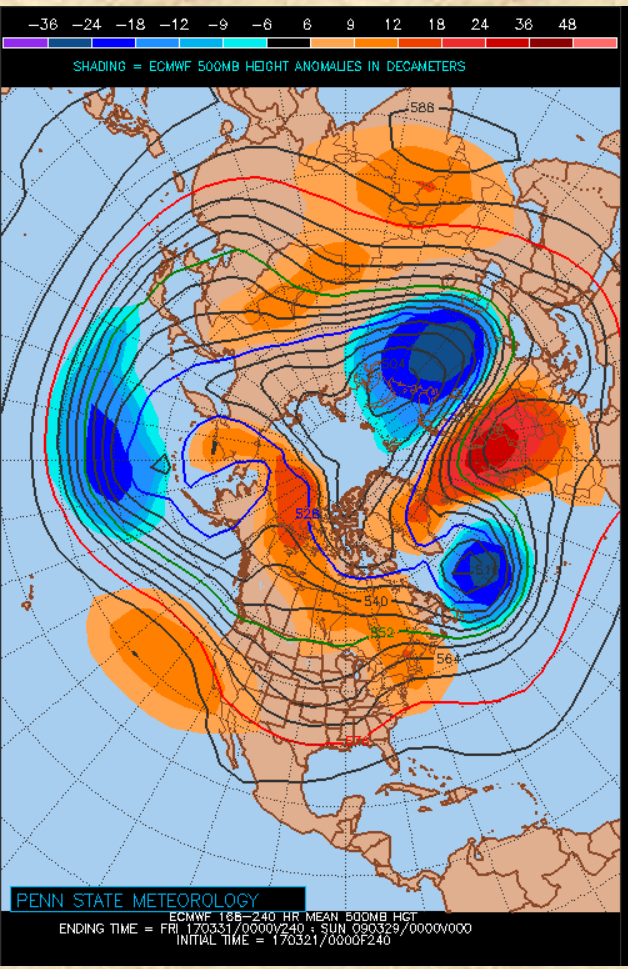
Six of these nine analogues morphed into El Niño before the end of the year ('77, '82, 86, '91, '02, '04), so this is consistent with model forecasts.

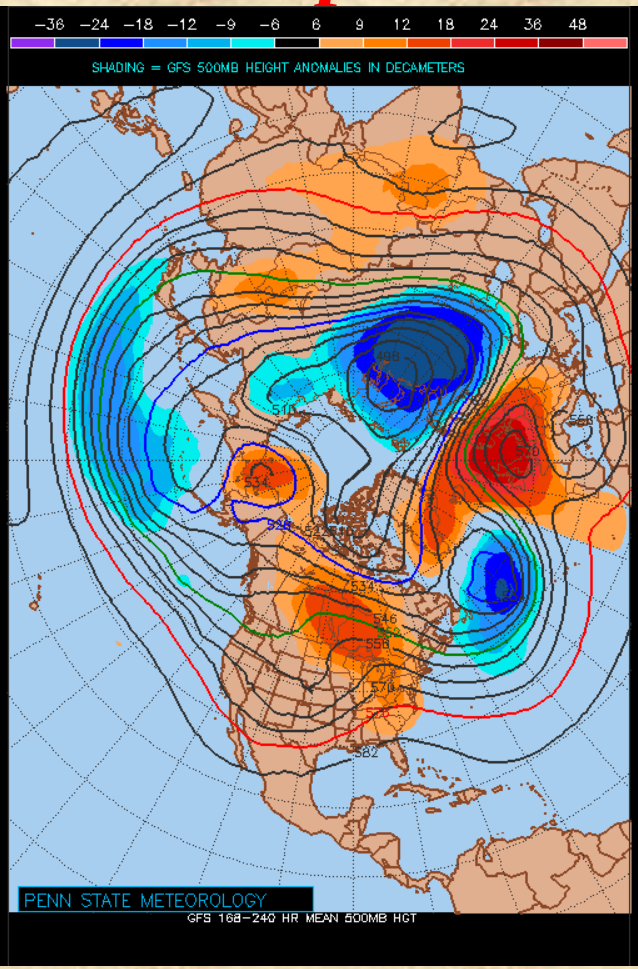
April-June (left) looks dry, especially over western CO (2002 perhaps the worst-case scenario) in contrast to:

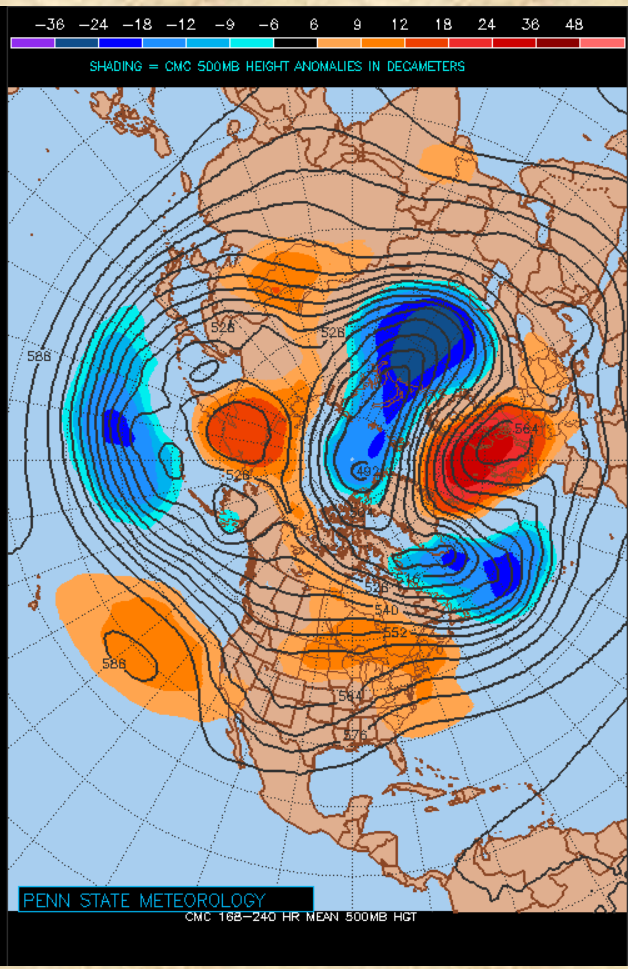
July-September (right) looks wet, especially over western CO, even with 2013 taken out!

http://www.esrl.noaa.gov/psd/data/usclimdivs/

What can we expect next week?

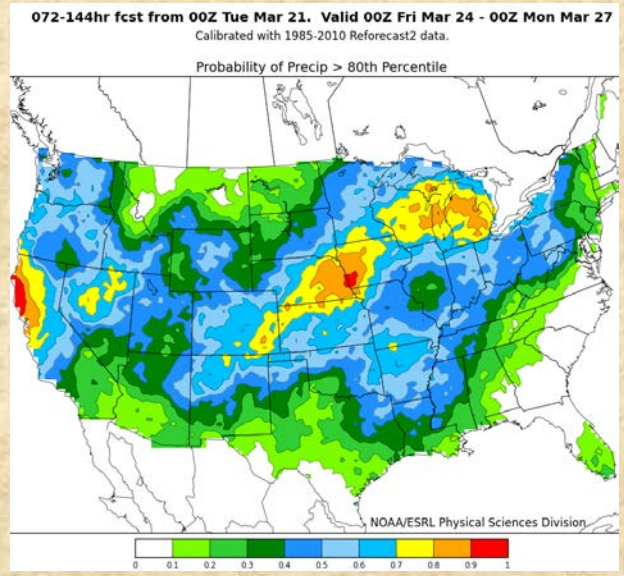


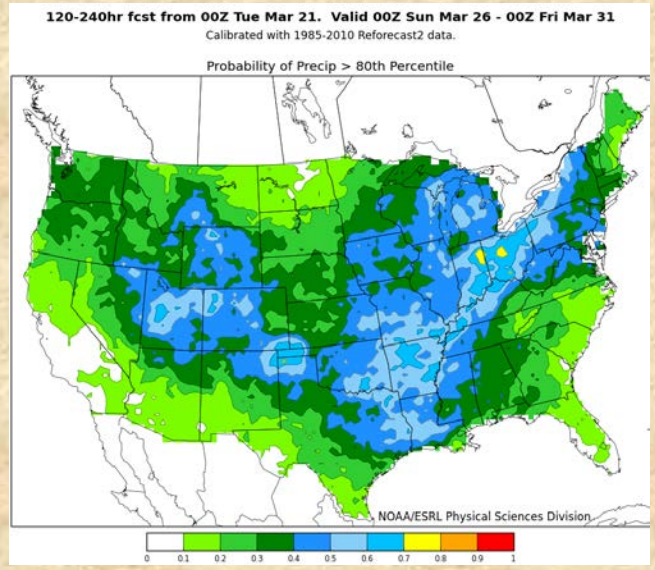




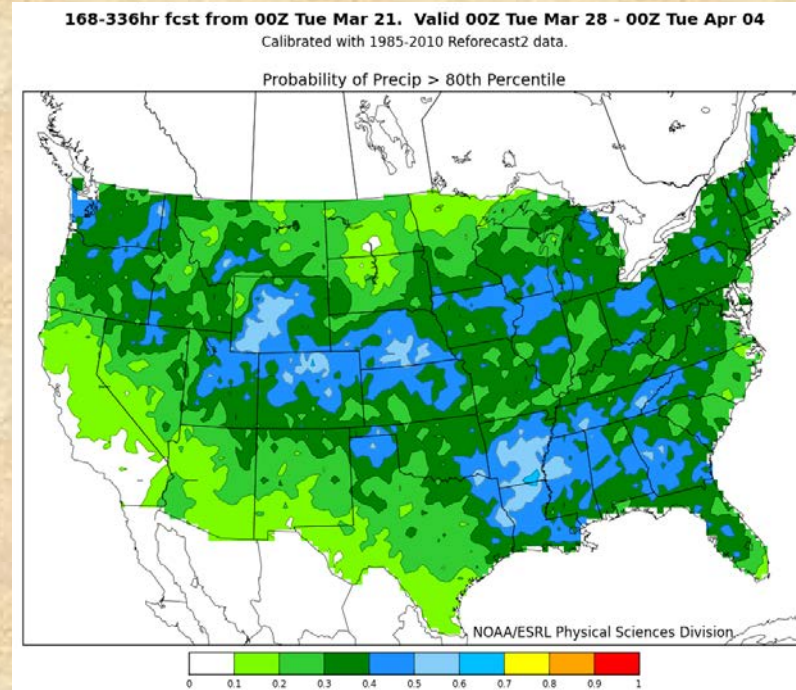
ECMWF (left), GFS (middle,) and CMC (right) show near-normal heights over our state, with higher pressure to the north. Seasonal weather means better chances for precipitation, certainly better than the previous three weeks…

What can we expect based on reforecast tool?





Reforecast for Days 3-6, 6-10, and 8-14 is optimistic for us during all three periods, due to string of storms lining up to hit the western U.S. (note that this is for the 80%ile!)



Executive Summary (21 March 2017)

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- **La Niña snuck in, was weak, and is indeed gone again. Precipitation impacts in Colorado have been consistent with a switch to La Niña during the fall and early winter months (greatly benefitting our snowpack).**

- **Tilts in the odds of the experimental forecast guidance were not impressive for winter, although the east-west gradient from wet in the west to dry over eastern Colorado was anticipated correctly. *Analogues based on recent behavior of the PDO & MEI correctly favored a wet early winter (Nov-Jan) for our mountains, while showing a correct drying trend into March. Going forward, the April-June forecast looks dry for the season, with the promise of an enhanced monsoon based on current analogues.***

- **Forecasts from CPC are 'EC' for the next six months. CFSv2 is more optimistic for the summer in particular, but not supported by skill.**

- **The next two weeks look much more active than recent weeks. In fact, I have just issued my first PSA in 2.5 months for Thursday into Friday, mainly for the higher foothills and west of here. There are storms lined up to hit our state through the next two weeks.**

- **BOTTOMLINE: While the next two weeks look wet, the rest of the spring looks near-normal at best. Let's hope we continue to outperform expectations similar to early winter. If we see El Niño establish itself this summer, the rest of the growing season looks more favorable.**