Earth System Research Laboratory
Physical Sciences Division

CIRES
Cooperative Institute for Research in Environmental Sciences

NIDIS
NATIONAL INTEGRATED DROUGHT INFORMATION SYSTEM

Colorado WATF,
17 November 2015
Denver

Seasonal Outlook for Colorado

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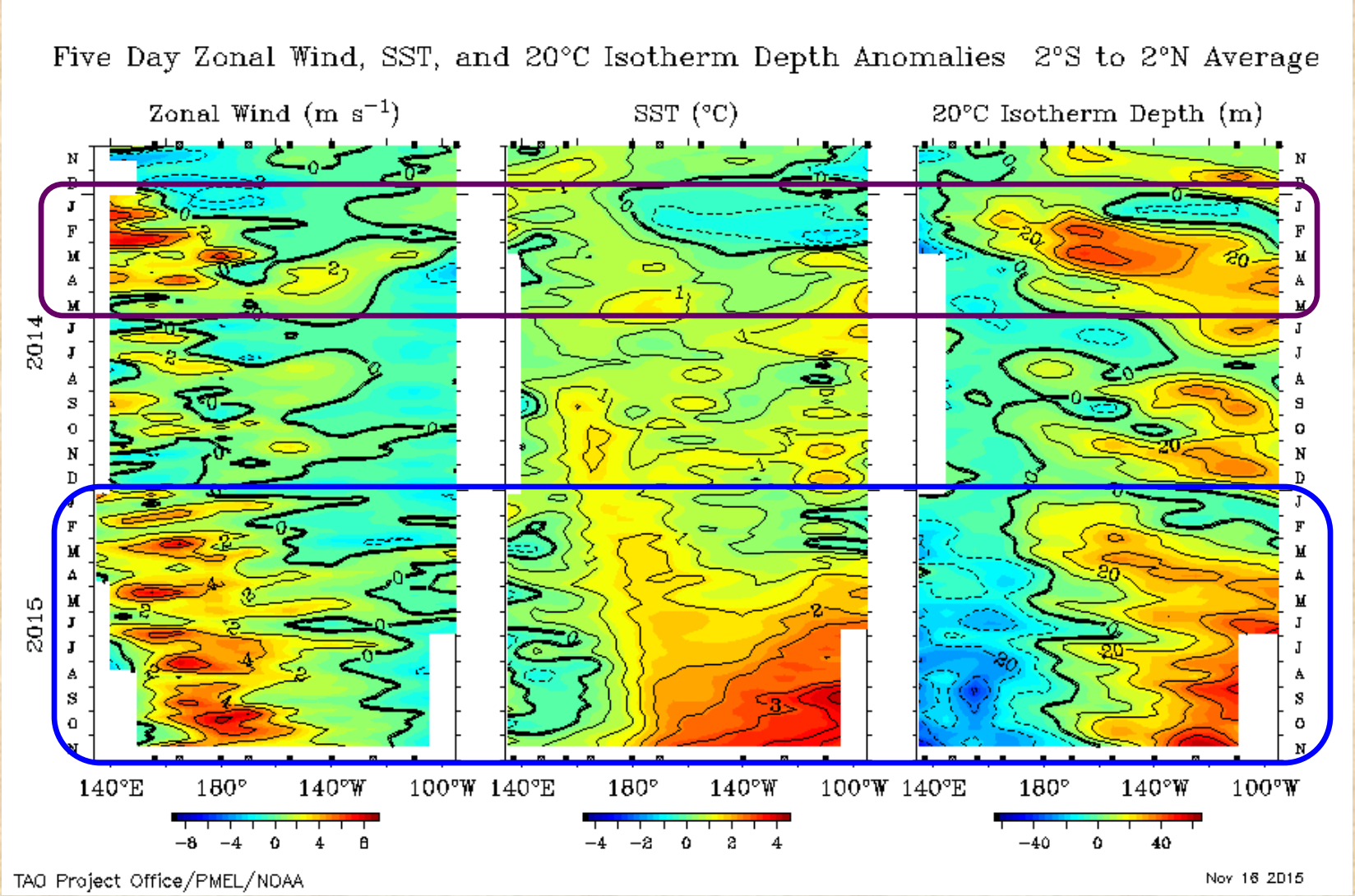
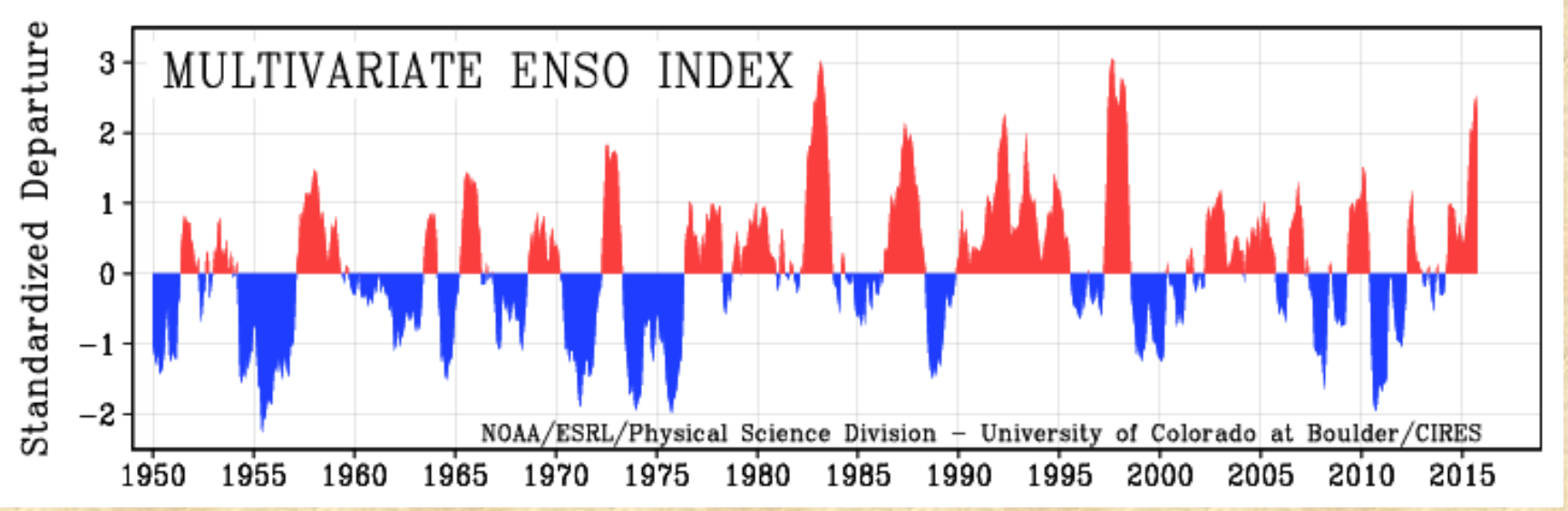
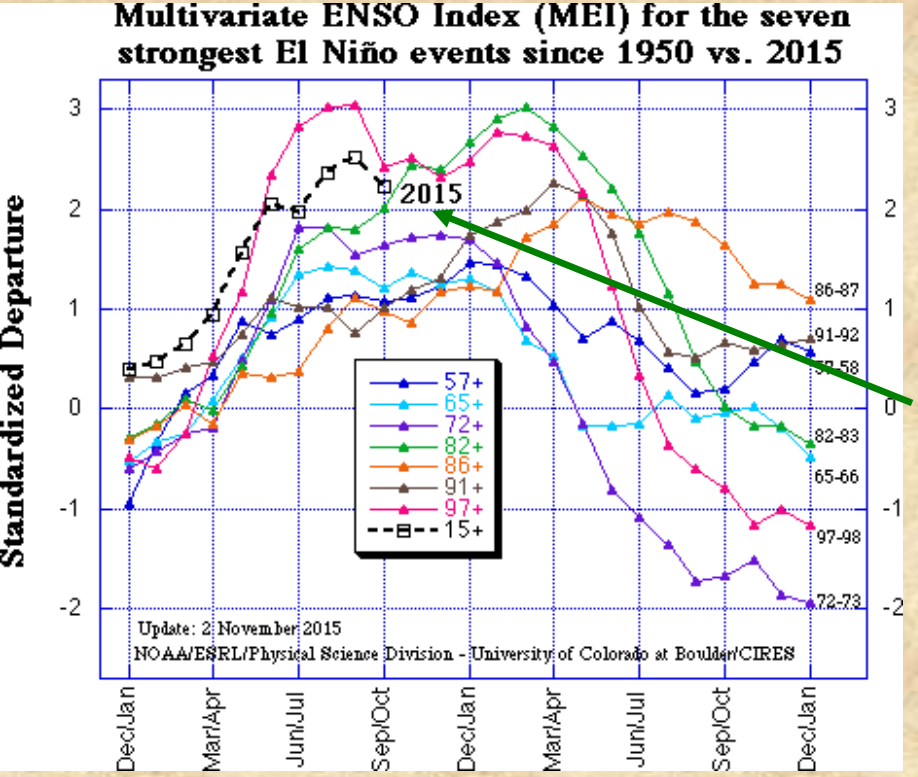
- ***How is our 'Big Boy' doing?***
- **Analogues for this year**
- **CPC forecasts into early 2016**
- **Experimental forecast guidance for precipitation**
- **Executive Summary**



After some pronounced westerly wind bursts in early 2014 (left), and a lull thru the rest of 2014, all of 2015 has seen a more persistent drumbeat of westerly anomalies to give us our current 'Big Boy' El Niño status, exemplified by widespread SST anomalies above +2C (middle), and positive Upper Ocean heat content anomalies east of the dateline (right).

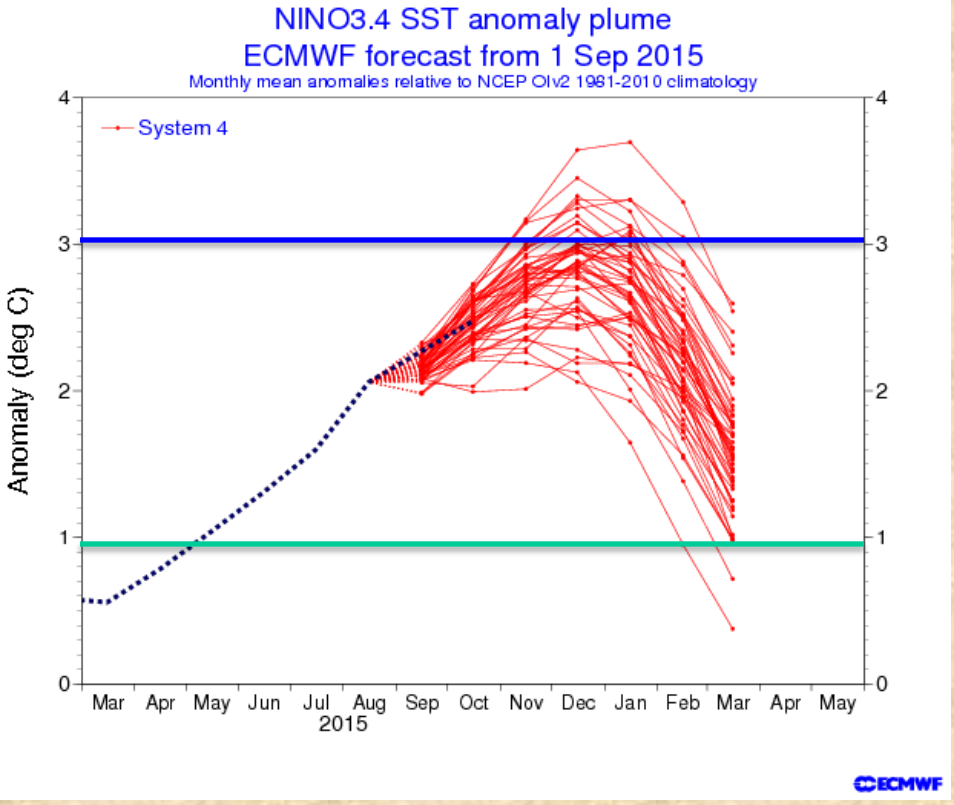
http://www.pmel.noaa.gov/tao/jsdisplay/index.html





The **MEI** monitors ENSO based on all observed fields over the tropical Pacific (pressure, wind, temperatures, cloudiness). It is the 1st combined Principal Component, normalized with respect to the season. **The current El Niño peaked in Aug/Sep at +2.53, the largest MEI value since 1998**. The October update dropped by 0.3, perhaps mimicking 1997, but remains 2nd strongest since 1950 for this time of year.

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

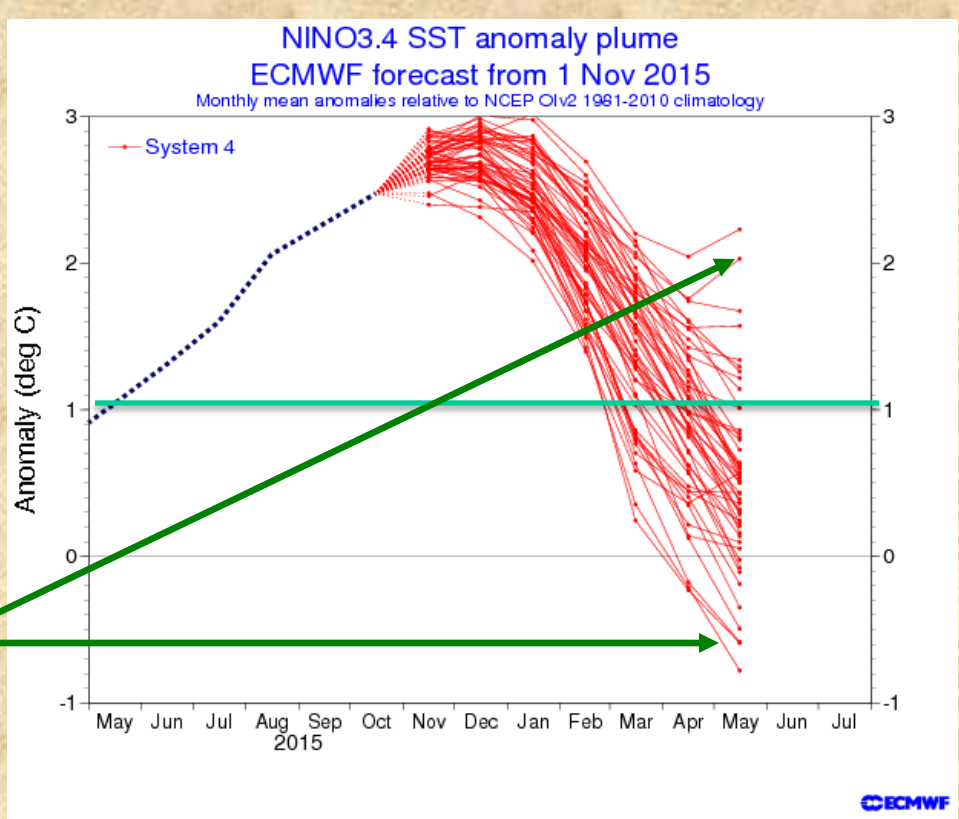


The ECMWF September 2015 forecast (left) was fairly bullish (peak below +3° C) with a wide range. The observed (blue) Niño 3.4 SST has tracked on the high-middle end of the plume. Compared to July and August, fewer ensemble members crested in record-territory above +3° C.

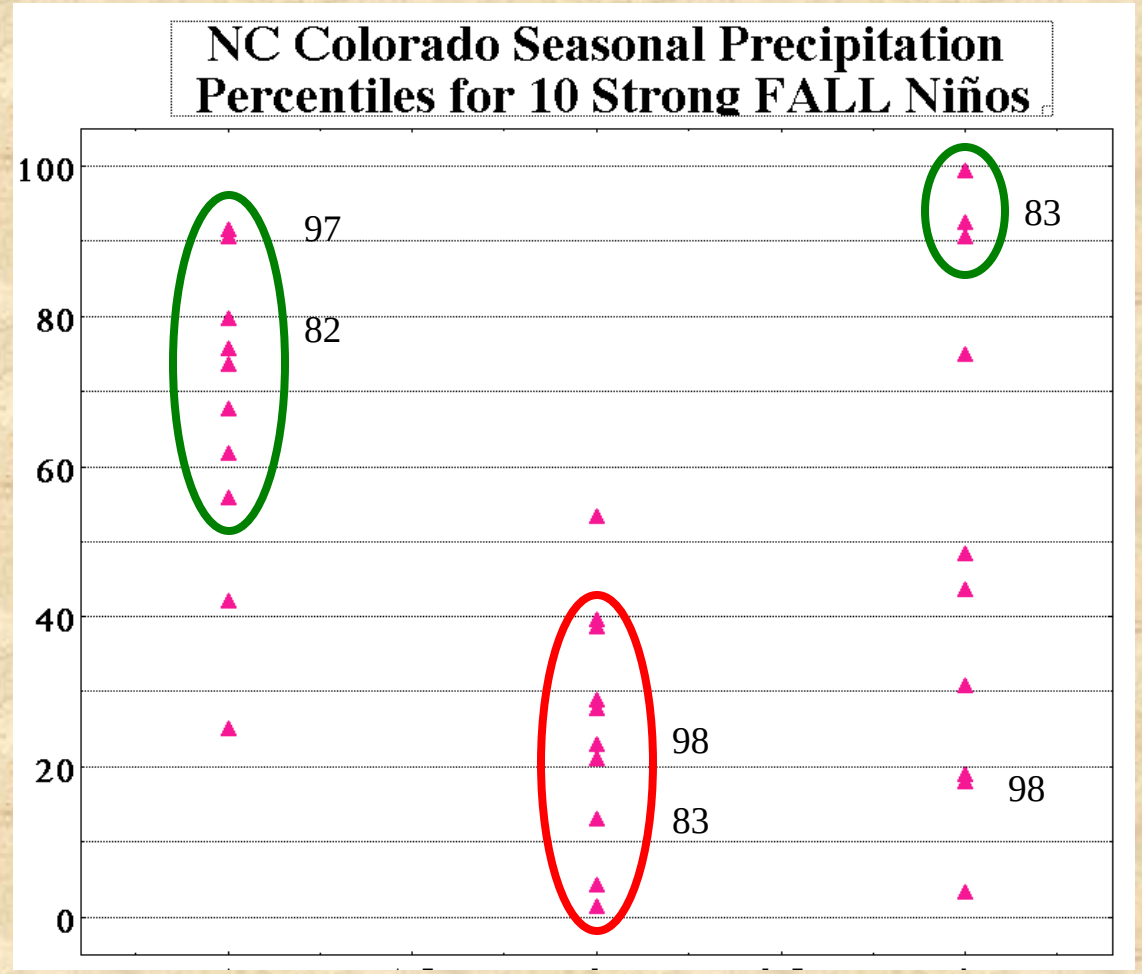
http://www.ecmwf.int/products/forecasts/d/charts/seasonal/forecast/seasonal_range_forecast/

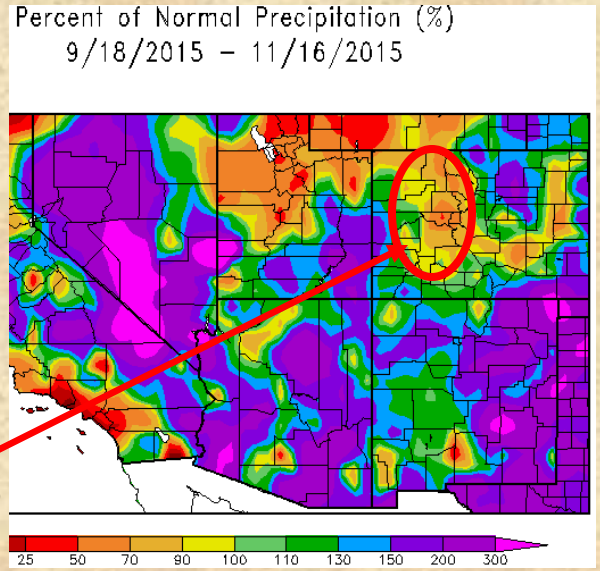
The updated ECMWF forecast (right) shows a more compact plume, with a peak either in November or December around +2.8° C. This seems reasonable. Now the question is whether it will transition into La Niña quickly or not – the range of possible outcomes is huge for May: -0.8C to +2.2C!

New IRI plume similar, not shown here.



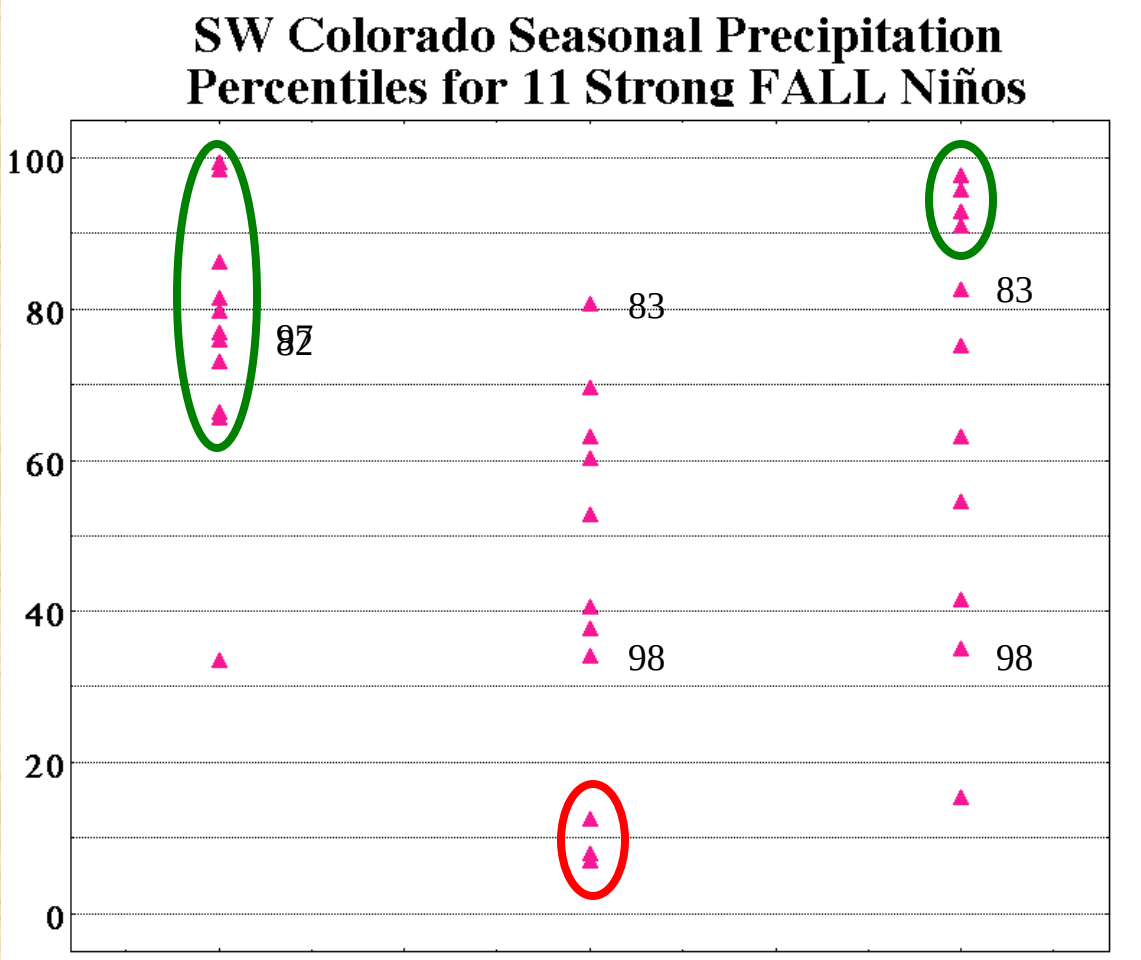
A closer look at the Upper CO Basin

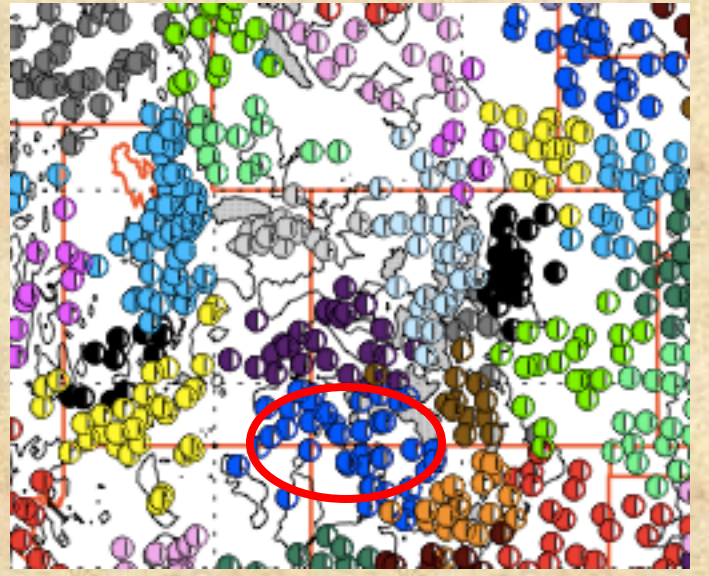


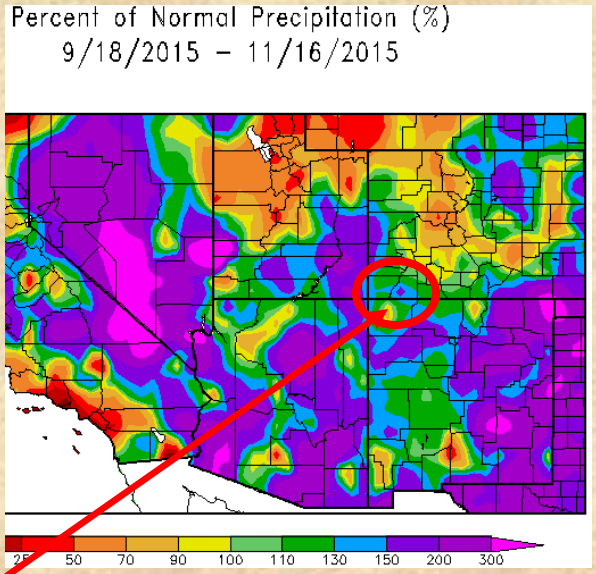


NC CO is favored during the Fall (8 of 10 > median – not this year so far), strongly handicapped during Winter (9 of 10 under 40%ile), and all over the place during spring, including three of the wettest ones. *Still needs work!*

A closer look at the Upper CO Basin







SW CO is also favored during Fall under strong El Niño (10 of 11 > 60%ile), Winter is much more benign than to the north, but three times near 10%ile, modestly wet during Spring (4* in top 10%ile). ***Much better than a month ago!***

Seven analogues for 2015-16

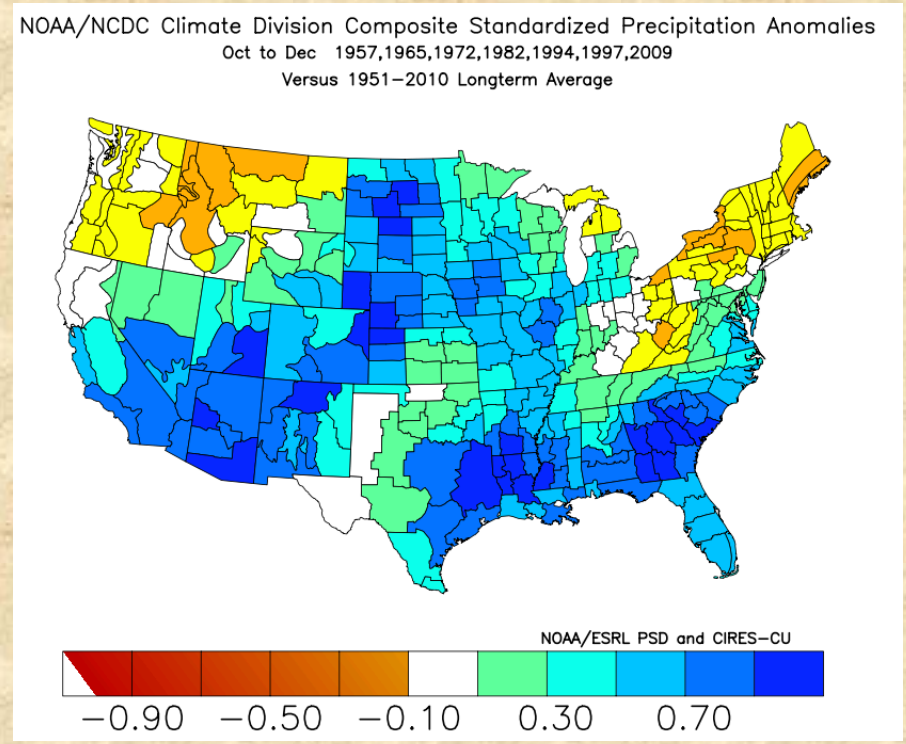
MEI ranks since 1950 (http://www.esrl.noaa.gov/psd/enso/mei/rank.html):

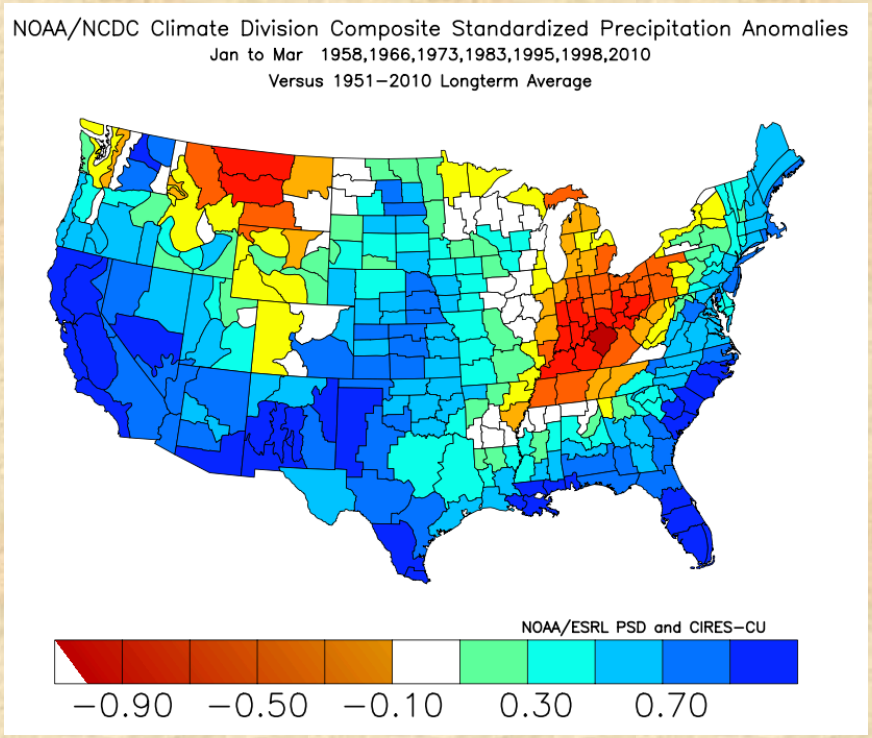
46+ = El Niño (30%ile definition); bold September/October rank if between 57 and 66, and increasing compared to earlier in the year (excluding 1987 and 1993).

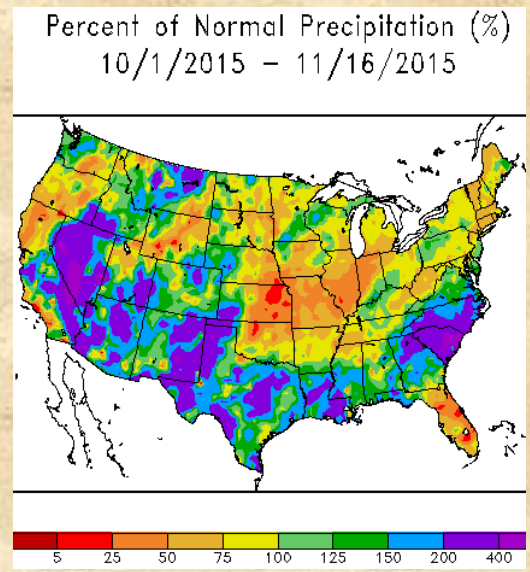
Year	dj	jf	fm	ma	am	mj	jj	ja	as	so	on	nd
1957	14	27	41	44	57	47	53	59	60	**59**	57	59
…												
1965	24	28	24	34	44	53	60	61	61	**60**	62	61
…												
1972	19	26	25	23	43	58	63	63	62	**63**	63	63
…												
1982	32	36	39	29	42	56	61	62	63	**64**	64	65
…												
1994	43	39	42	48	47	48	52	51	56	**61**	60	58
…												
1997	25	22	26	51	60	66	66	66	66	**66**	65	64
…												
2009	16	15	16	24.5	40	52	55	56	53	57	56	54
…												
2015	46	47	51	60	61	64	65	65	65	**65**		

Here is my 'flavor' of El Niño that I picked for 2015-16: Seven fairly strong Niño events (all hit the top 10%iles (rank 60 or higher) at least twice during their life cycles) that were already strong in Sep-Oct, and not in decline yet. What is unique about 2015 is that it already started out as a weak Niño, with 1994 and 1997 being the closest on its heels, starting in March-April.

OND and JFM



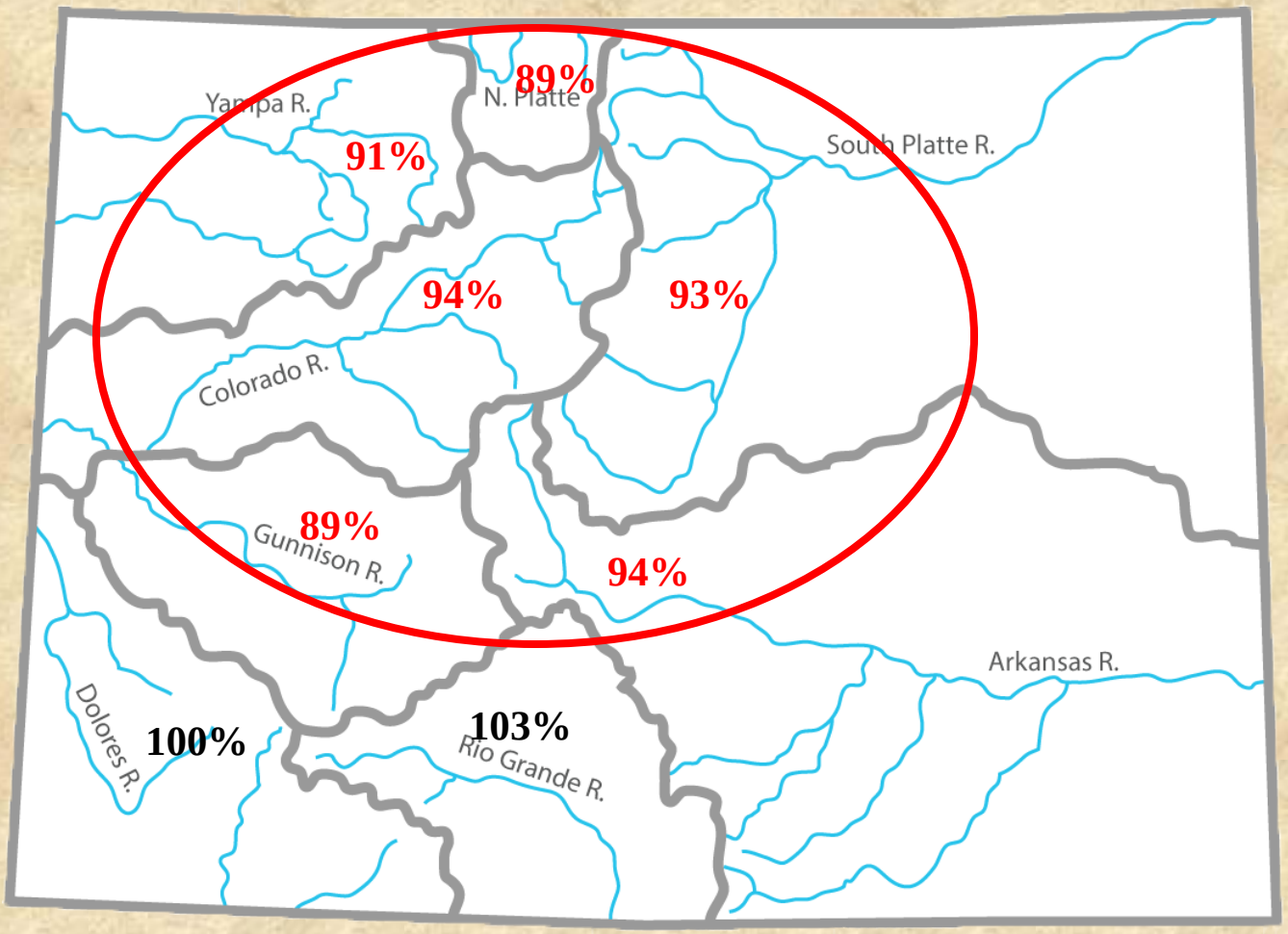




With about half of OND under our belt, I believe the late fall season has a good chance of being fairly consistent with the composite (including CO).

Late winter (JFM) also looks encouraging for eastern CO.

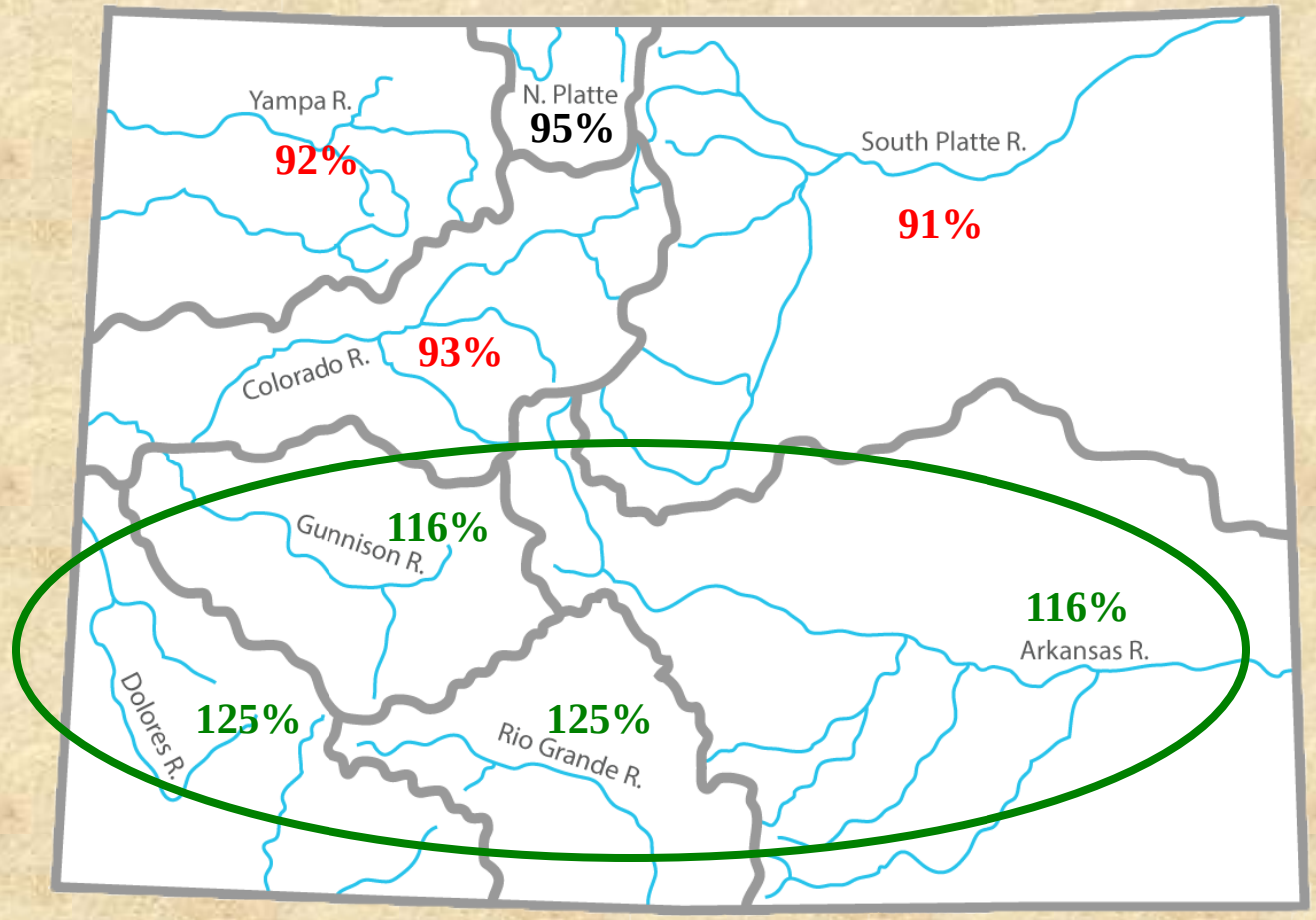
Based on Fall El Niño composites for 1marSWE



Median outcome for strong Los Niños since 1968
(after fall seasons: ‘72, ’82, ’87, ’94, ’97)

http://www.nrcs.usda.gov/wps/portal/nrcs/detail/co/snow/?cid=nrcs144p2_063324

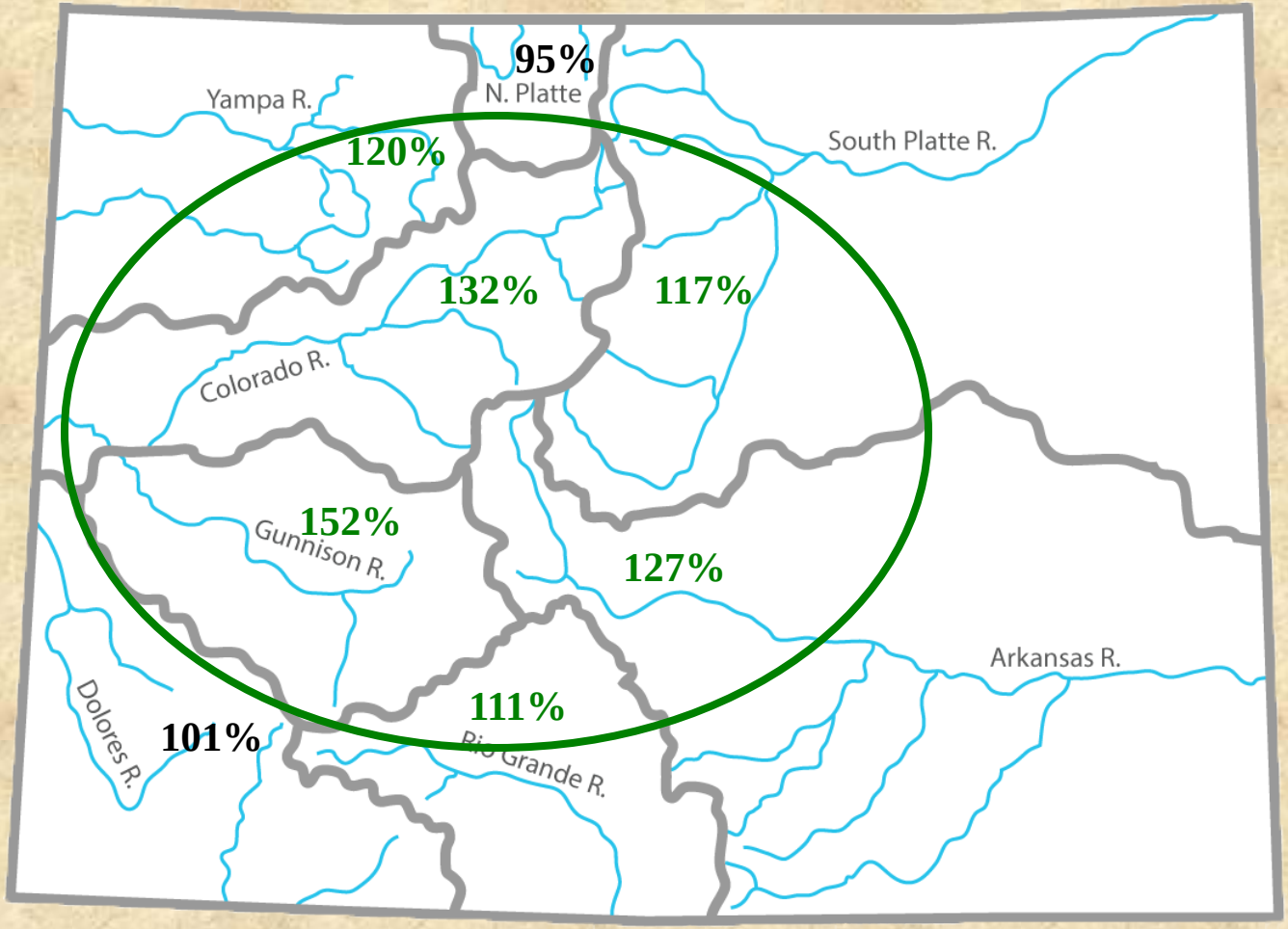
Strong Fall El Niño composites for 1apr SWE



Median outcome for strong Los Niños since 1968
(after fall seasons: ‘72, ’82, ’87, ’94, ’97)

10%+ improvements over 1mar across the southern basins:
Gunnison +27%; San Juans +25%; Rio Grande +22%; Arkansas +22%

Based on Fall El Niño composites for 1may SWE



Median outcome for strong Los Niños since 1968
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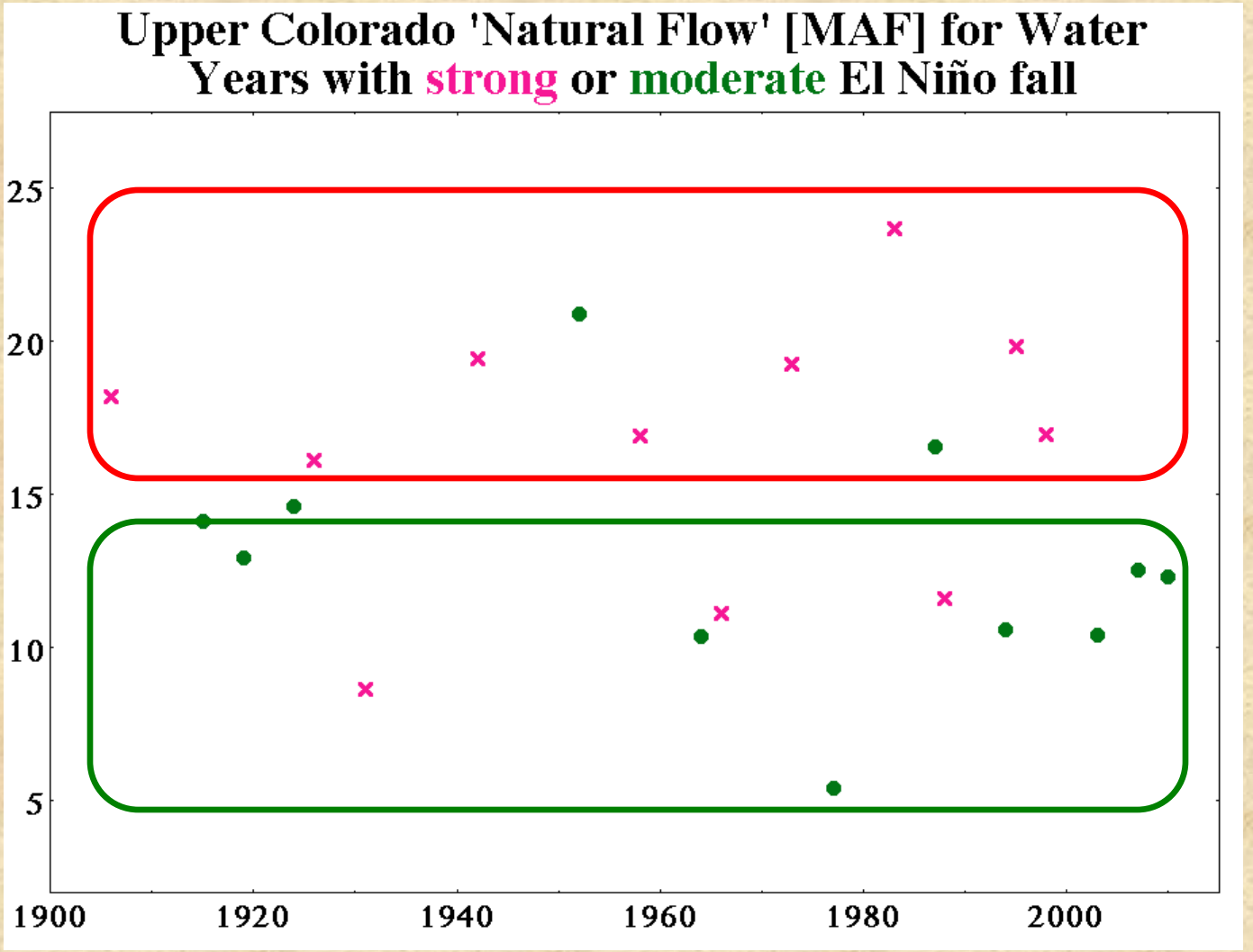
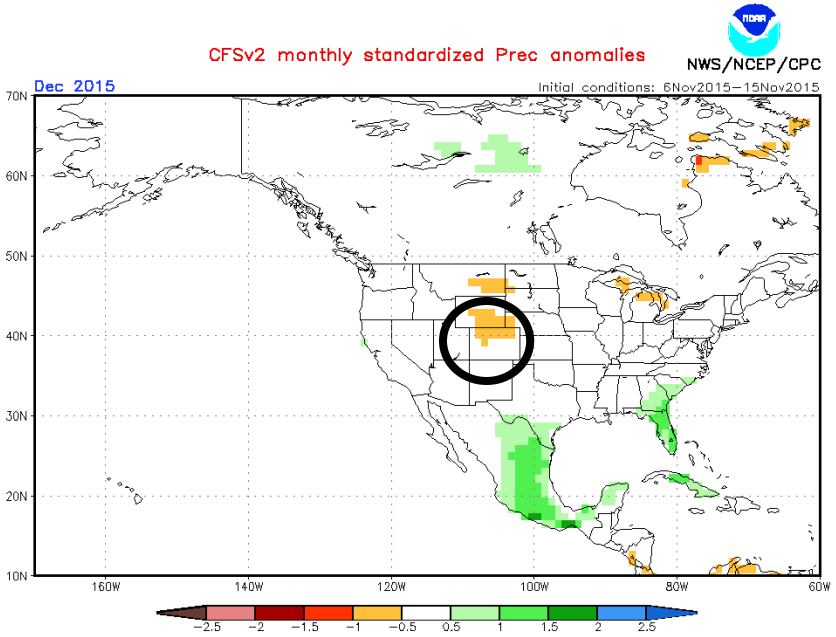


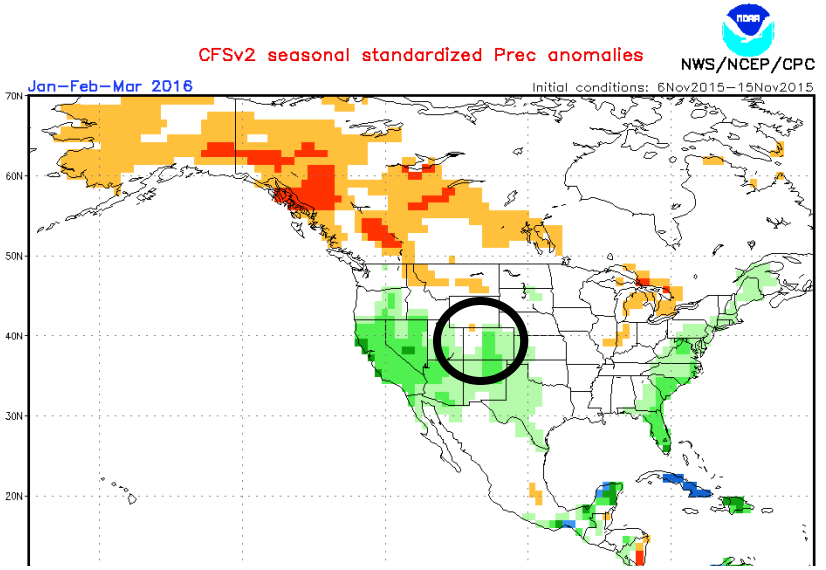
11 cases each between 1906 and 2015 – above the long-term median (14.5MAF):

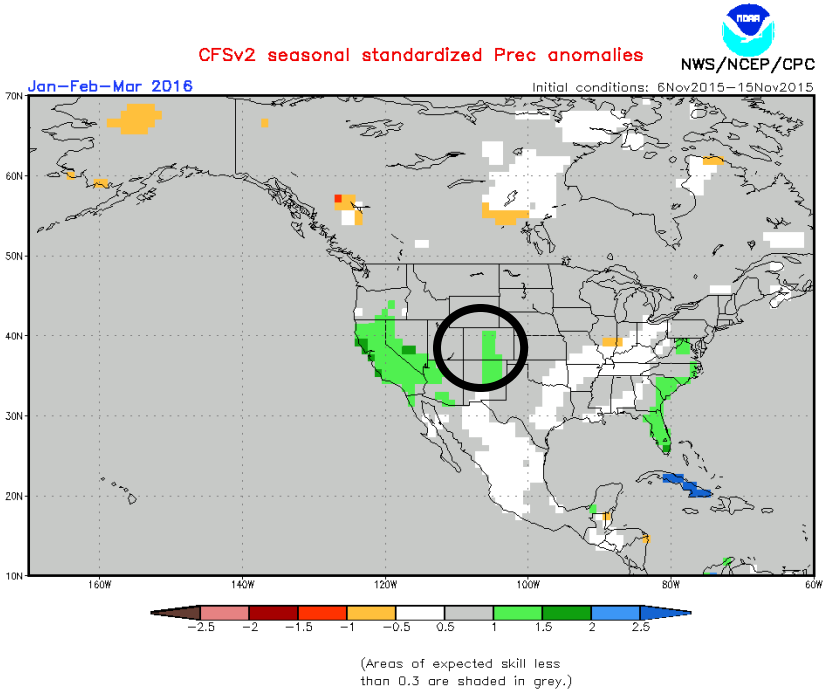
Strong: 8; Moderate: 3

Thank goodness, a strong El Niño is 'in the bag' this fall!

CPC Coupled Forecast System Version 2



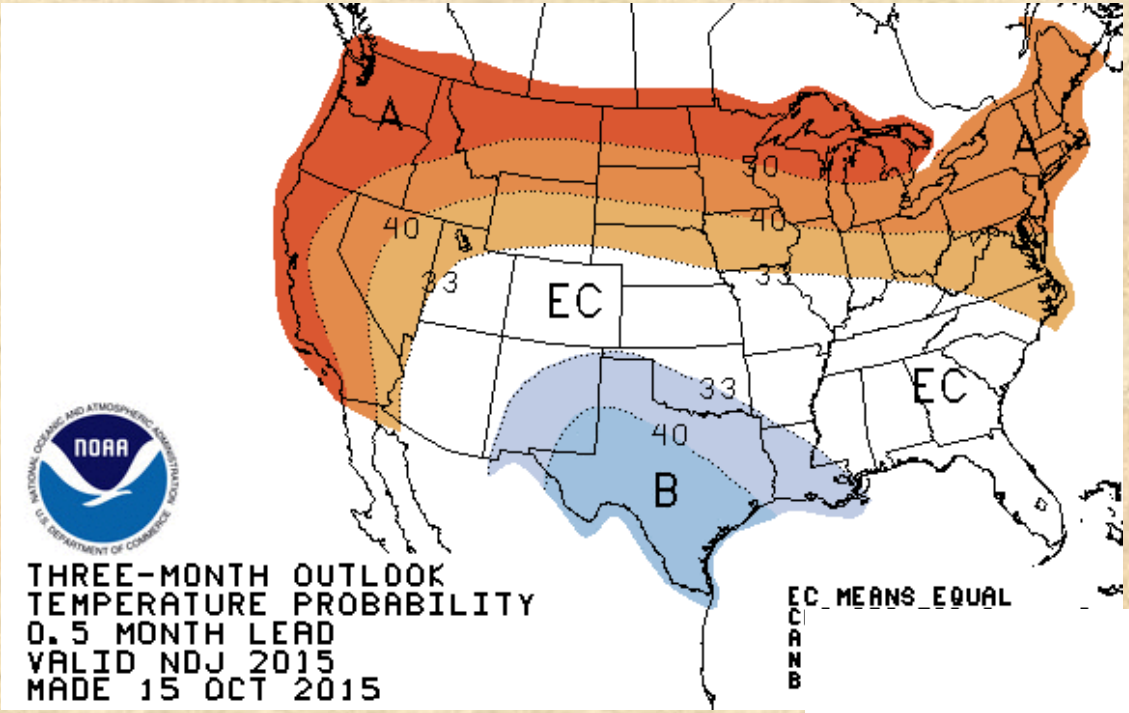


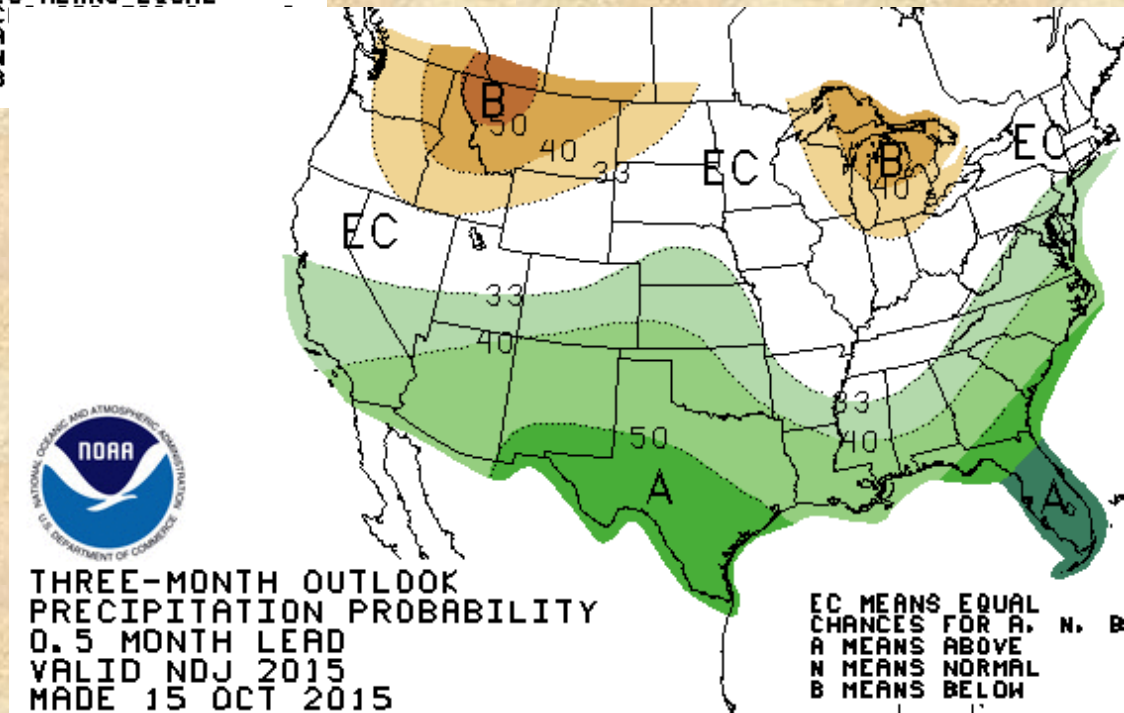


CFS forecasts for Dec (left) and JFM (right – top = normalized anomalies, bottom = with skill mask), hint at dry December in northern CO that shrinks towards NW CO for the skill-masked case (not shown), and a wet late winter for eastern CO that manages to survive the all-cases skill mask.

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

Climate Prediction Center Forecasts

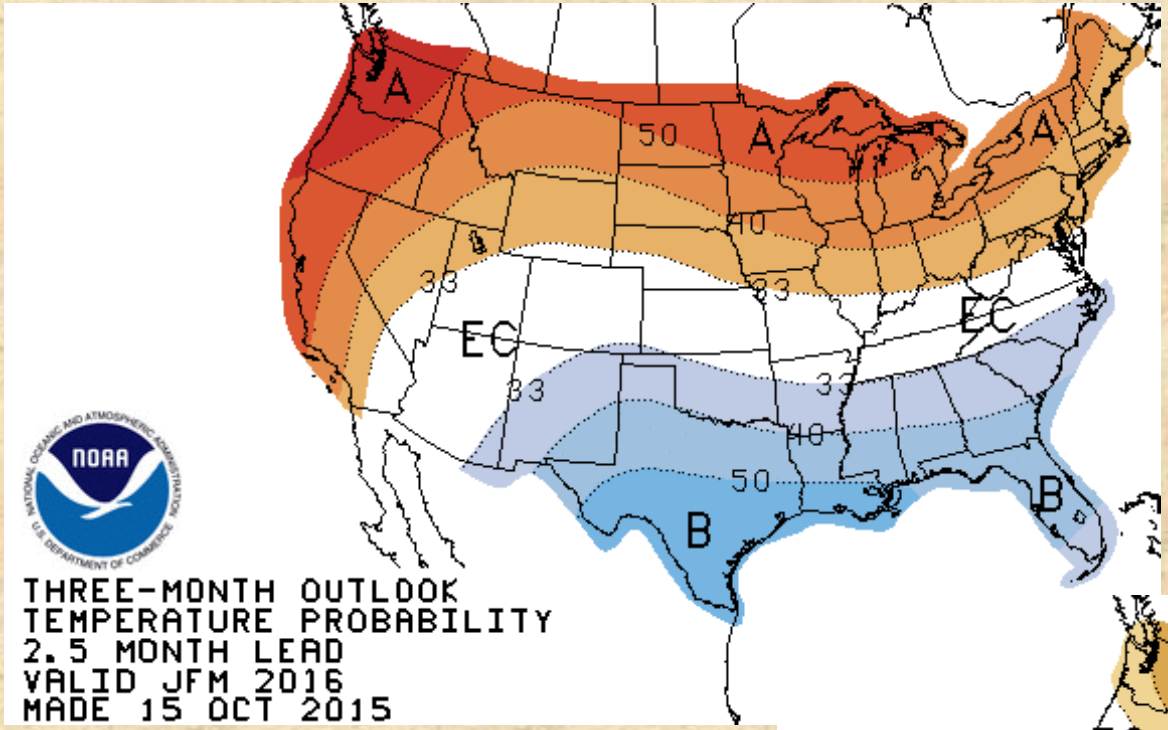




The early winter precipitation (right) and temperature (left) forecasts by CPC appear wet for us, while keeping the coldest air to our south.

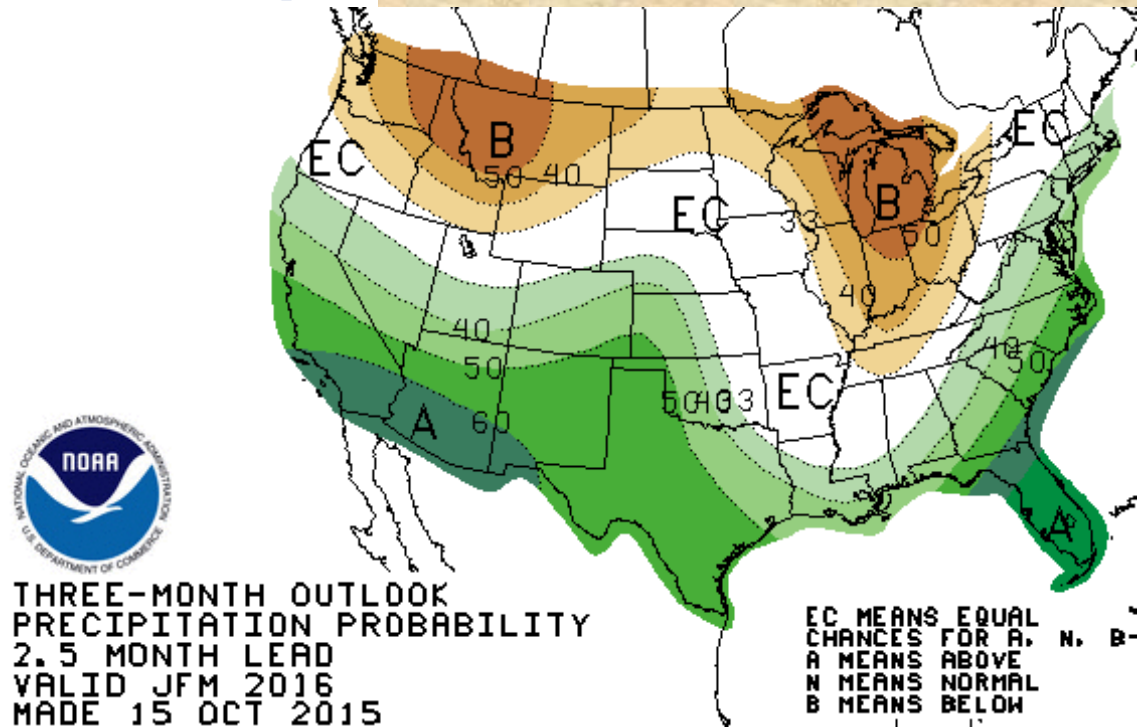
http://www.cpc.ncep.noaa.gov/products/predictions/

Climate Prediction Center Forecasts

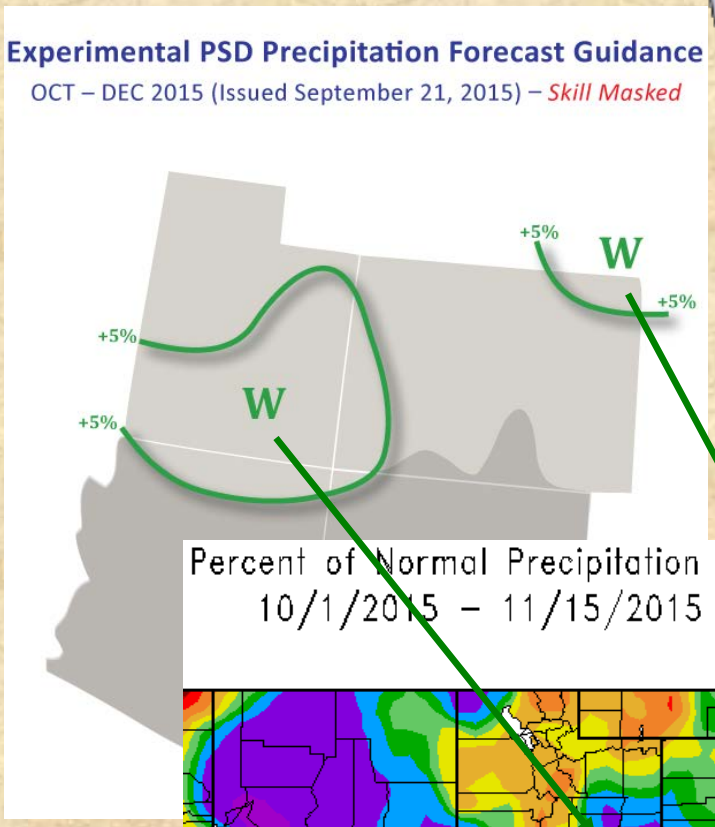


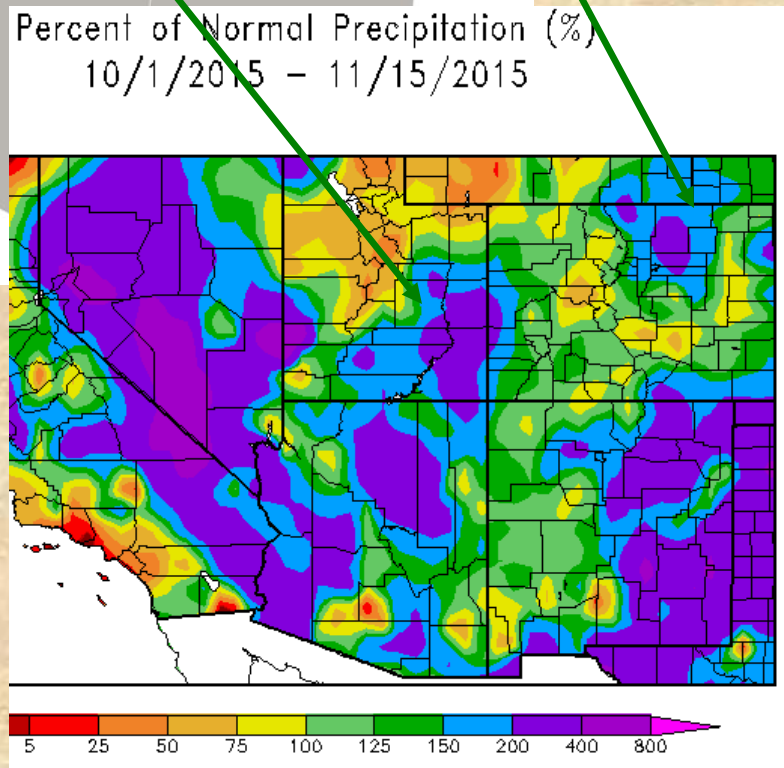
The late winter precipitation (right) and temperature (left) forecasts by CPC puts all but northwestern CO into surplus moisture and southern CO slightly likely to be cold than warm.

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



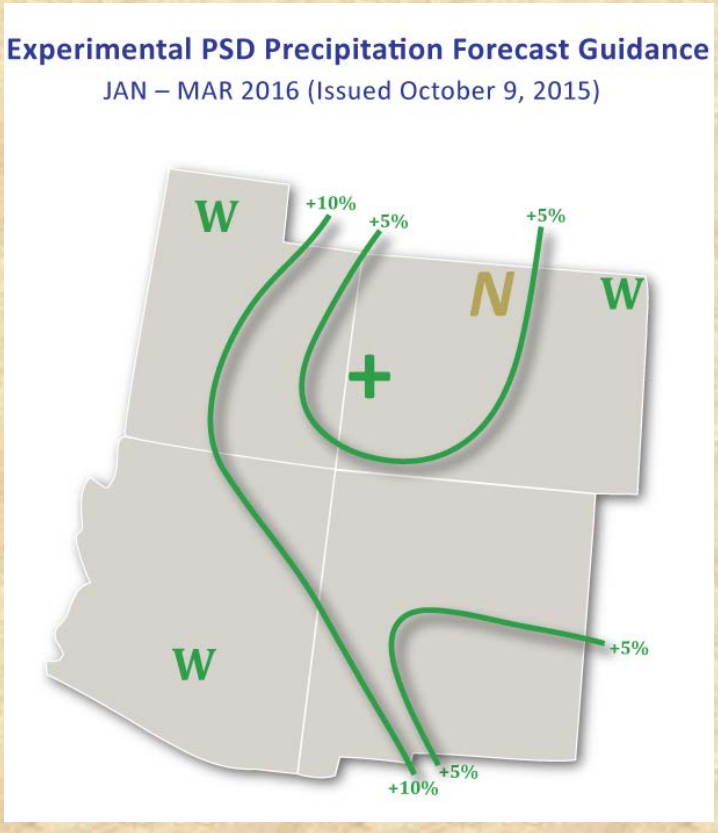
Statistical Forecast for Oct-Dec 2015

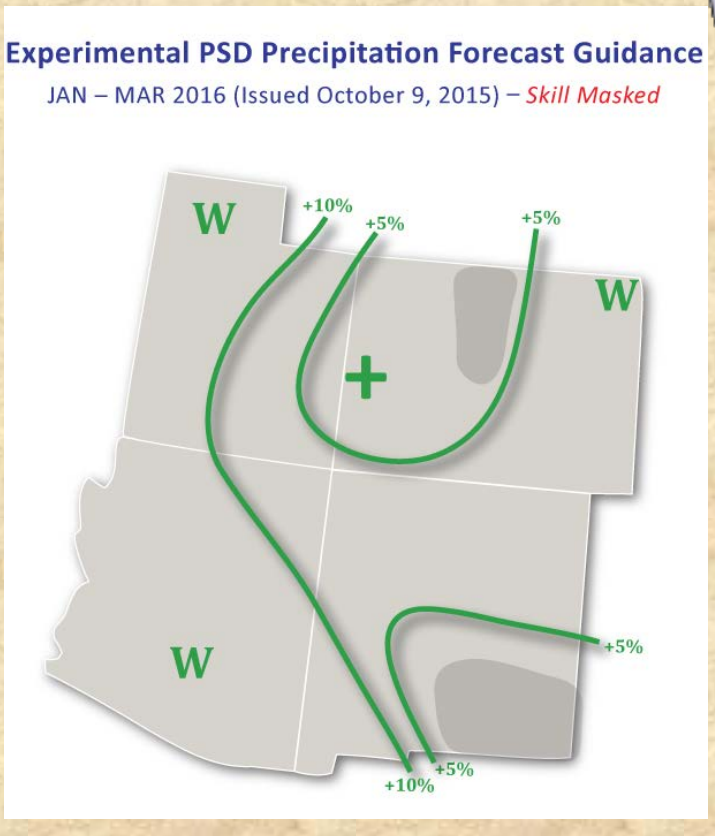




Fall forecast (left) was either neutral (mountains) or on the wet side for Colorado (SW and NE corner). The skill-masked forecast (top right) shows that the wet forecasts for CO are supported by operational skill (since 1999), while forecasts for AZ&NM are not. ***Meanwhile, all the wet forecasts would verify, if the season ended now…***

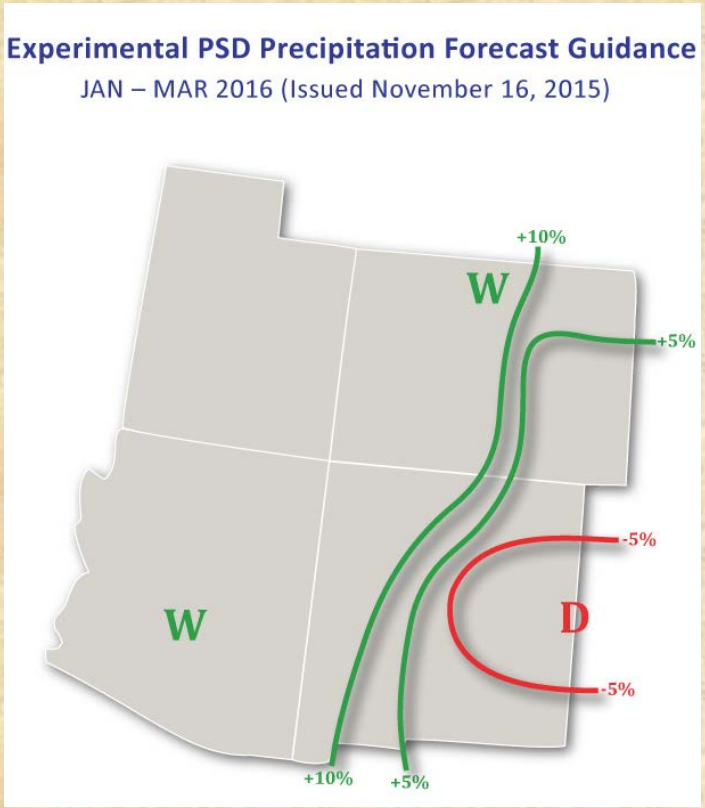
Statistical Forecast for Jan-Mar 2016

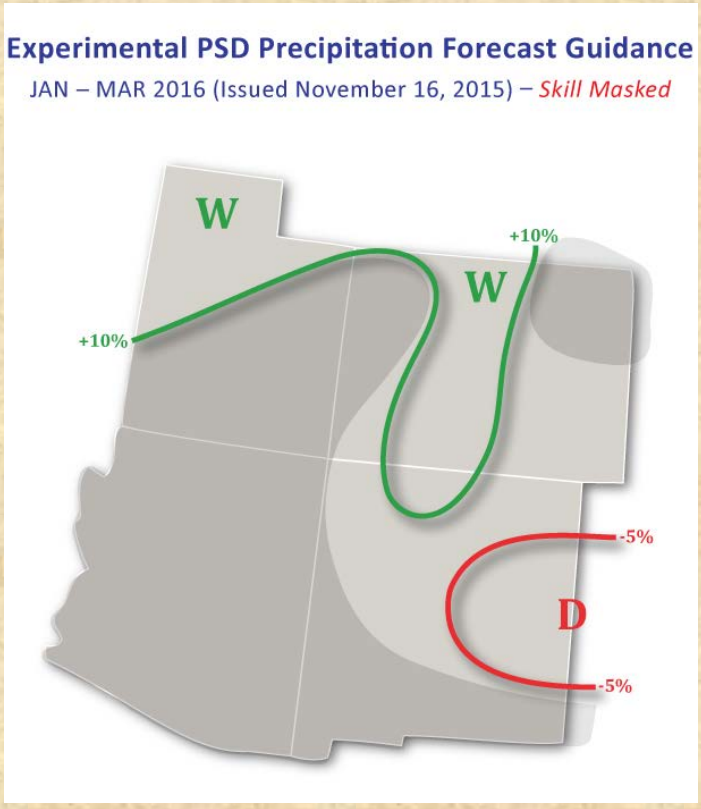




The first winter forecast (left) was either neutral (mountains) or on the wet side (actually everywhere but the mountains). The skill-masked forecast (right) shows that the wet forecasts are supported by operational skill (since 1999). ***This forecast has the most wet coverage for this season and lead-time I have ever seen. Crossing fingers!***

Statistical Forecast for Jan-Mar 2016





Updated winter forecast (left) wet everywhere but from SE Colorado into eastern NM. The skill-masked forecast (right) shows much less area coverage supported by operational skill than in the previous forecast (*getting closer to the forecast season does not always help*). *Given what is known about typical El Niño impacts, the wet outcome is most likely due to a wet March (February may help, too, for instance in 1995 or 2003).*

Water-year (Oct–Sep) runoff following the 10 strongest fall El Niño conditions since 1915

Stream Gage	Colorado - Lees Ferry	South Platte - S. Platte	Arkansas - Salida	Rio Grande - Del Norte
Above-normal runoff	**7/10 El Niño events**	**8/10 events**	**7/10 events**	**6/10 events**

Top 10 Snowstorms along Front Range since 1950

City	Fort Collins	Boulder	Denver	Colorado Springs
El Niño event?	7 of 10	8/10	8/10	5/10
Size	20–32”	23–30”	16–32”	16–29”
Peak	Mar, Apr	**Oct**, Mar, Apr	Nov, Mar	Apr

Executive Summary (17nov2015)

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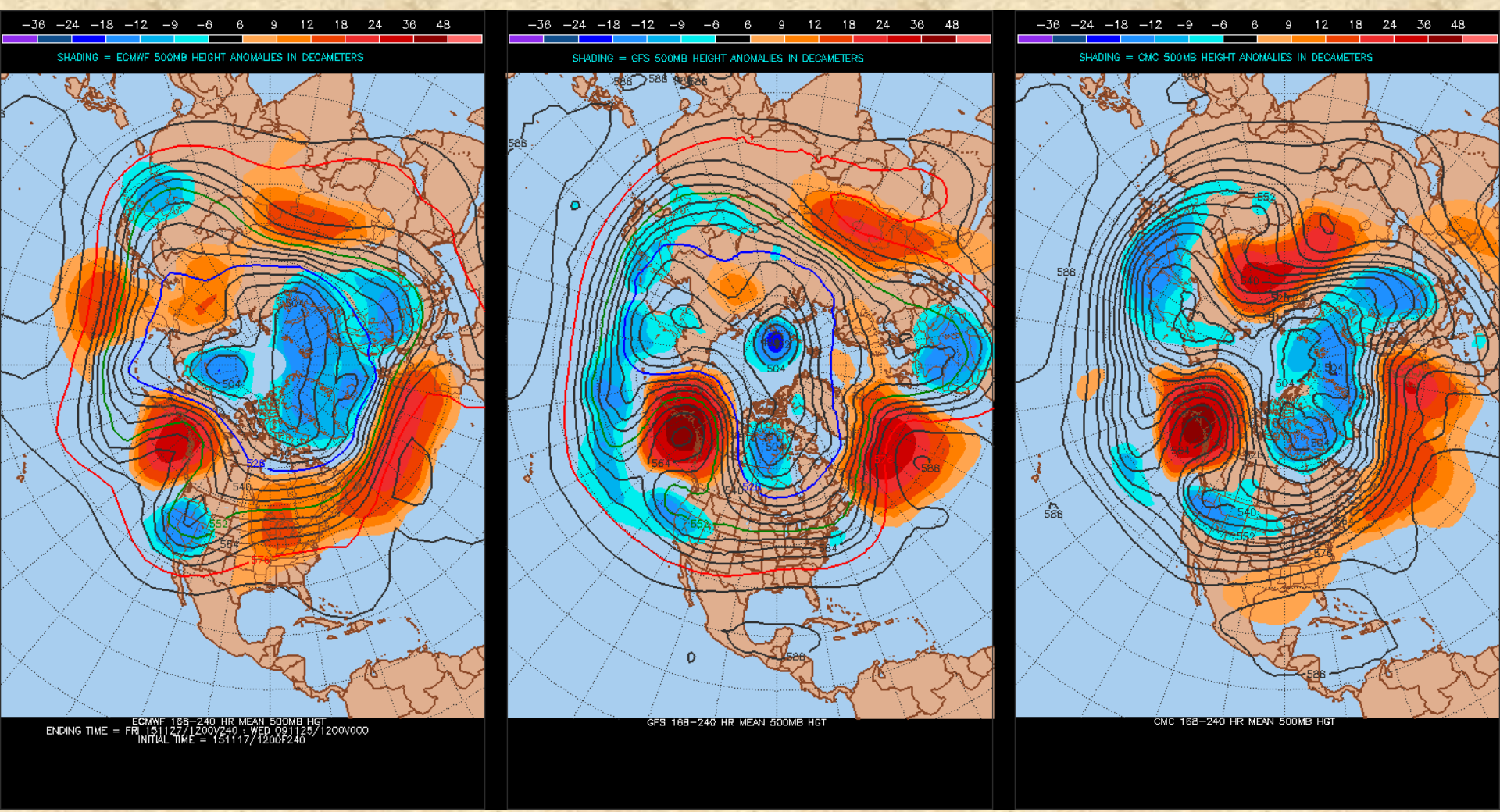
- **El Niño is here, it is strong (I call it 'Big Boy' now), and it should continue into at least early spring. While SST anomalies have continued to grow, most of the forcing is in maintenance mode, thus the peak is near, may have passed already for the MEI.**

- **Our state was supposed to have a good chance for above-normal moisture this fall. October and November have been playing catch-up after a dry September. If the event stays strong, we will face much less favorable odds during winter for the central and northern mountains. Historically strong Los Niños during fall have shown decent odds for increased runoff on pretty much all major rivers in our state, most significantly on the South Platte. We also have much better odds than normal for a Top-10 snow storm along the Front Range, especially during spring.**

- **CPC's forecasts favor CO during late winter, mainly due to an expected wet late winter. This is actually similar to my experimental guidance which is even more bullish for the west slope.**

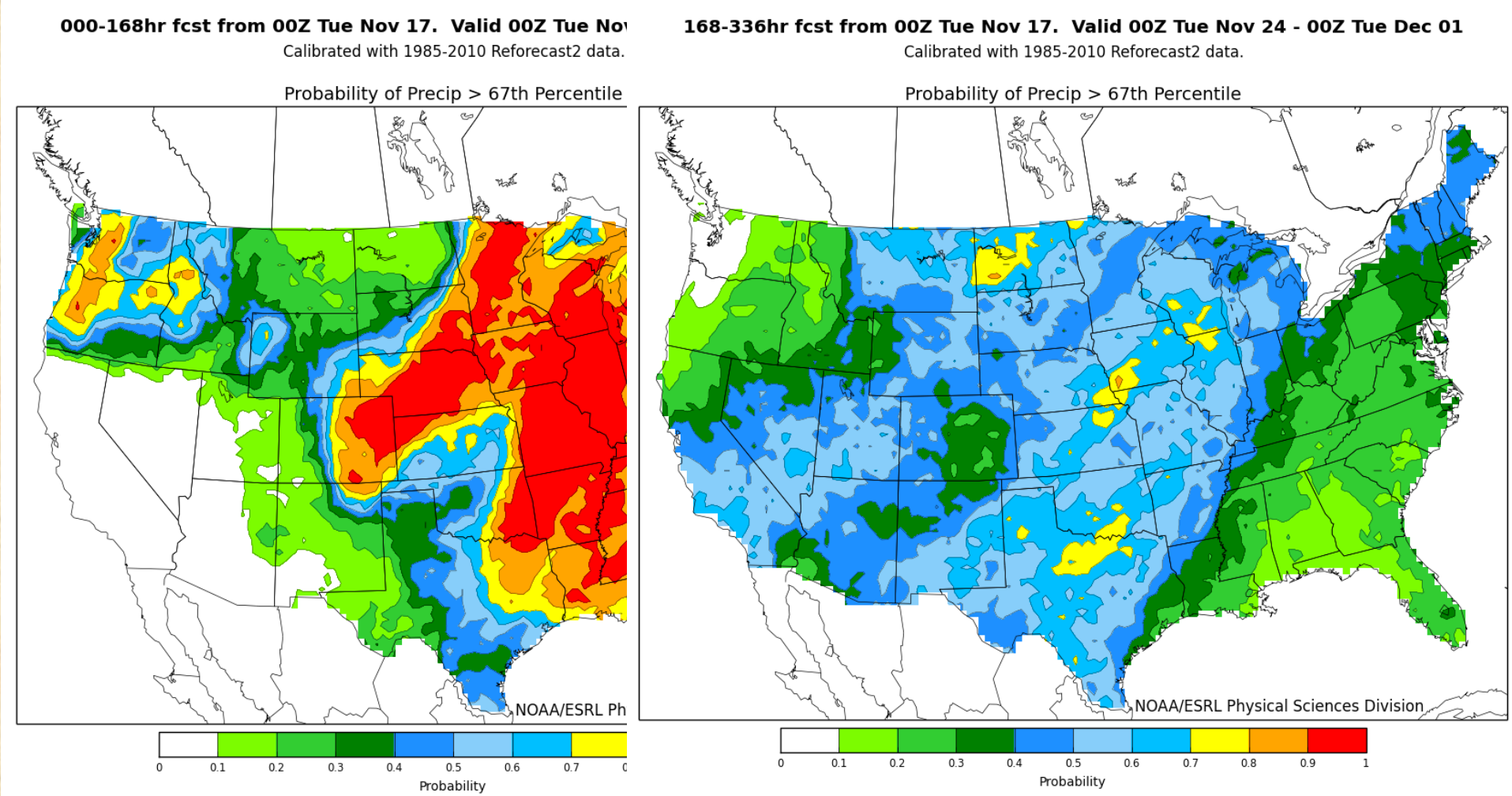
- ***While a strong El Niño in the fall season is more favorable for us than a weaker one, the best combination would be it for it to weaken over the winter, and then come back in spring – we should be so lucky!***

What can we expect towards the end of next week?



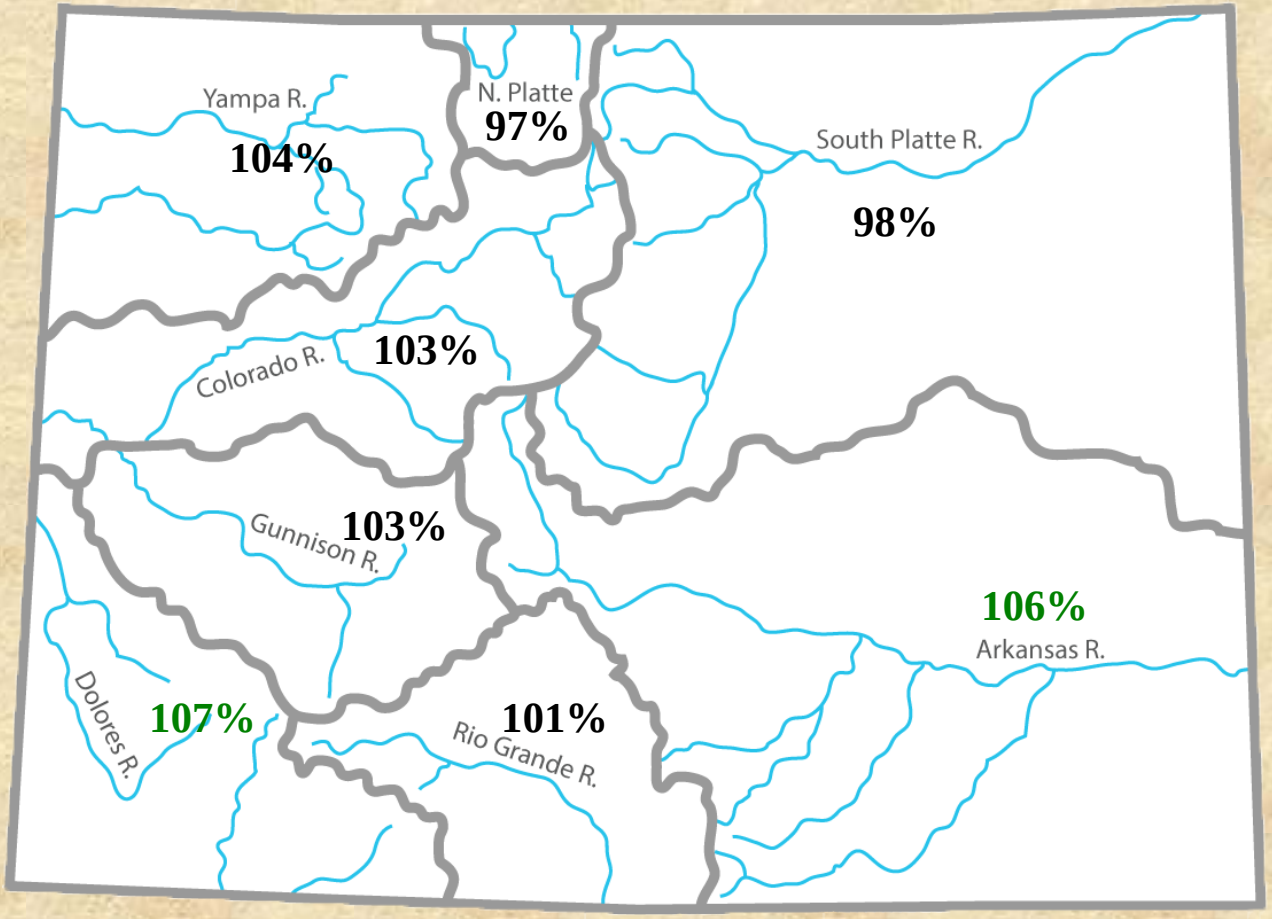
ECMWF (left), GFS (middle,) and CMC (right) *show large-scale troughing over western U.S., perhaps least favorable in GFS. Looks like a cold Thxgvg!*

What can we expect for next two weeks?



Most of the increased moisture odds in Week 1 (left) are leftover from last night's storm, while Week 2 (right) has a hint of that occasional El Niño storm track from southern CA into western CO.

Strong Fall El Niño composites for 1apr SWE



Median outcome for same set of strong Los Niños since 1980 (during fall season: ’82, ’87, ‘91, ’94, ’97)

Main improvements over 1jan: Yampa +16%, Colorado River +13%, and North Platte +12%; main decline for Dolores: -13%, and Rio Grande: -16%