Earth System Research Laboratory
Physical Sciences Division

CIRES
Cooperative Institute for Research in Environmental Sciences

Colorado WATF,
18jan18, Denver

COLORADO
Colorado Water Conservation Board
Department of Natural Resources

Seasonal Outlook for Colorado

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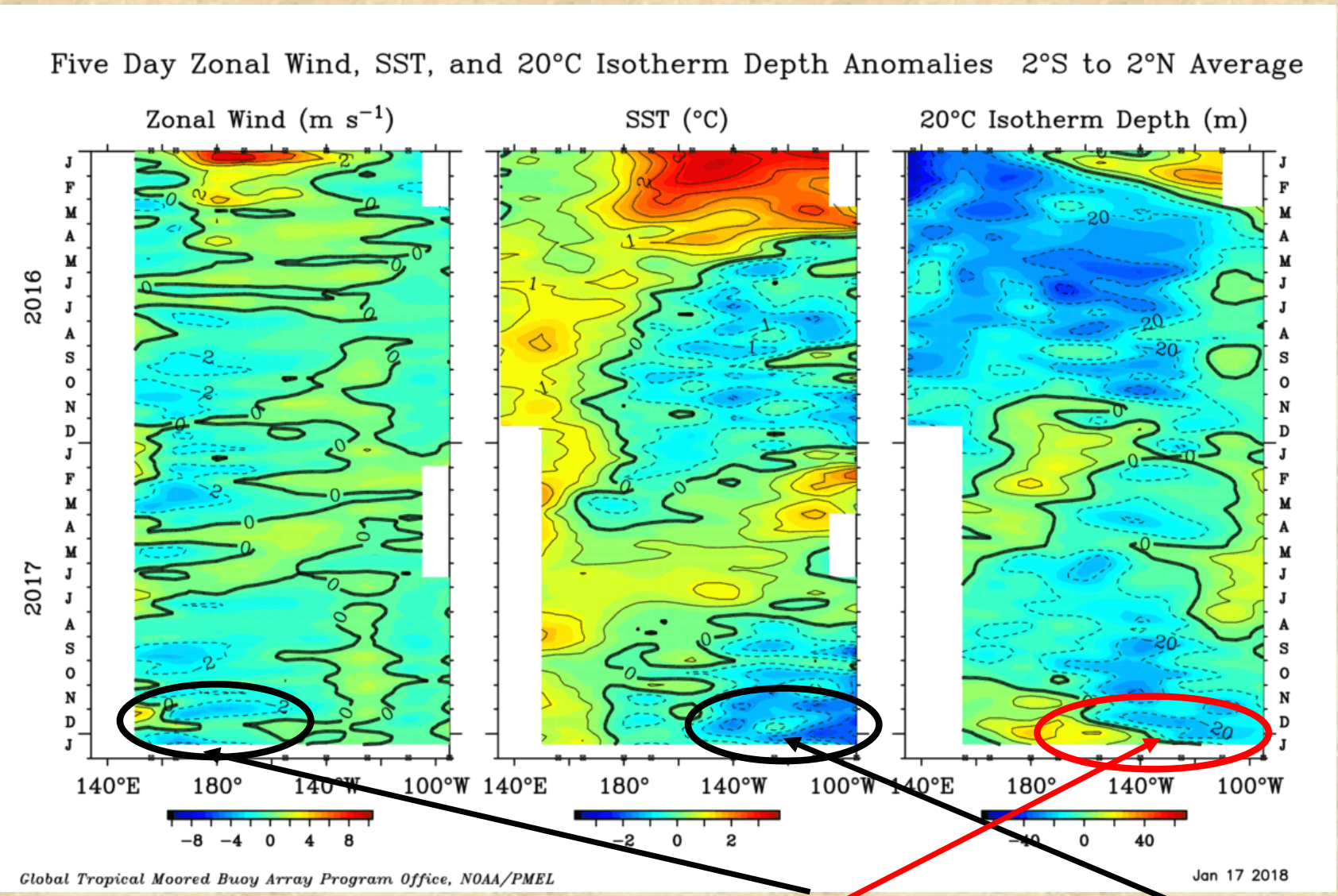
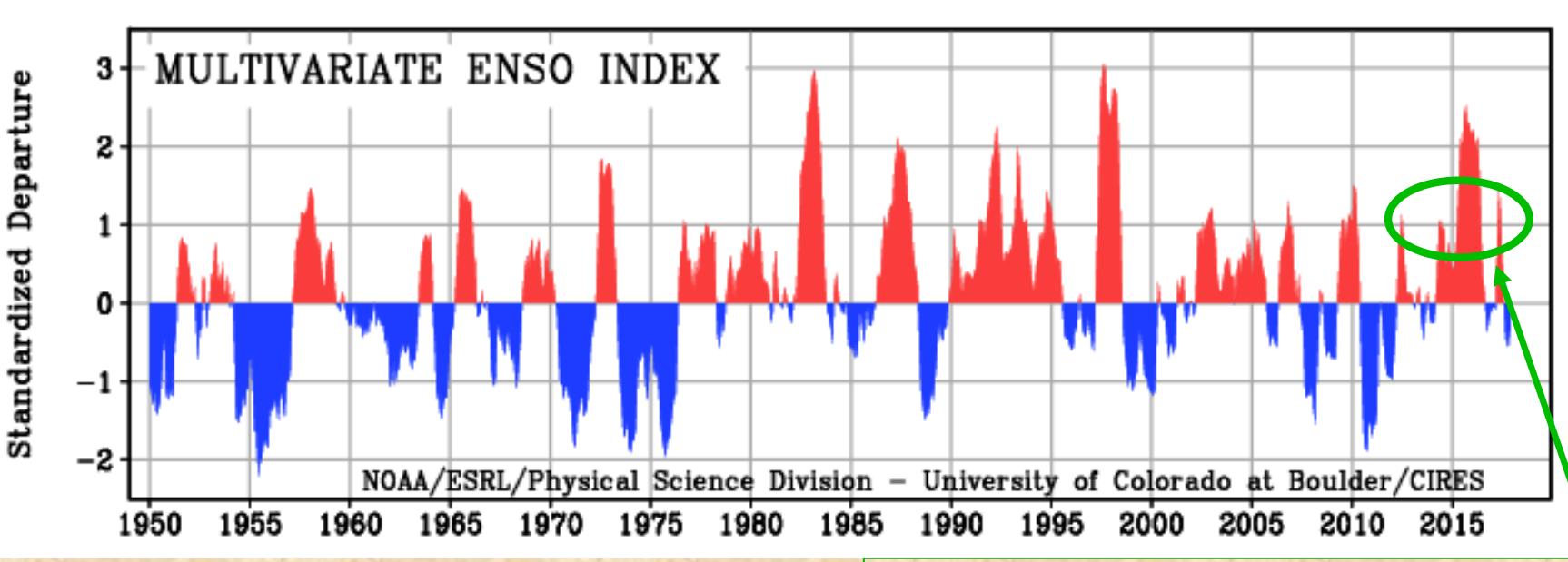
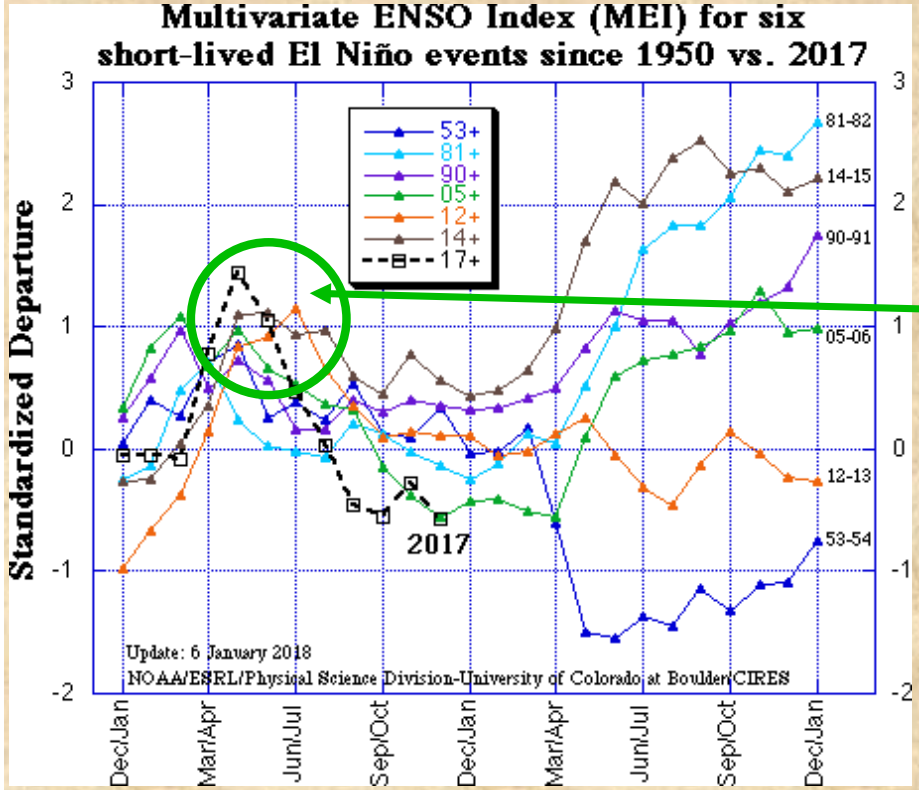
- *Status and outlook for 'Double-Dip' La Niña of 2017-18*
- *CPC/CFSv2 Forecasts thru June 2018*
- *Experimental Forecast Discussion*
- *What Year-2 La Niña 'Analogue' means for our state*
- *What the low 1jan Snowpack means for the Colorado River*
- *Weather Forecasts until 'Groundhog Day'*
- *Executive Summary*



Wind anomalies (left) near the dateline have gone easterly (blue) again, cold SST anomalies (middle) have been more persistent than last year, and negative upper ocean heat content anomalies (right) appear to be on their way out (the 'battery is draining'). All in all, a weak La Niña has been operating for a few months now, back in sync with the MEI (next slide).

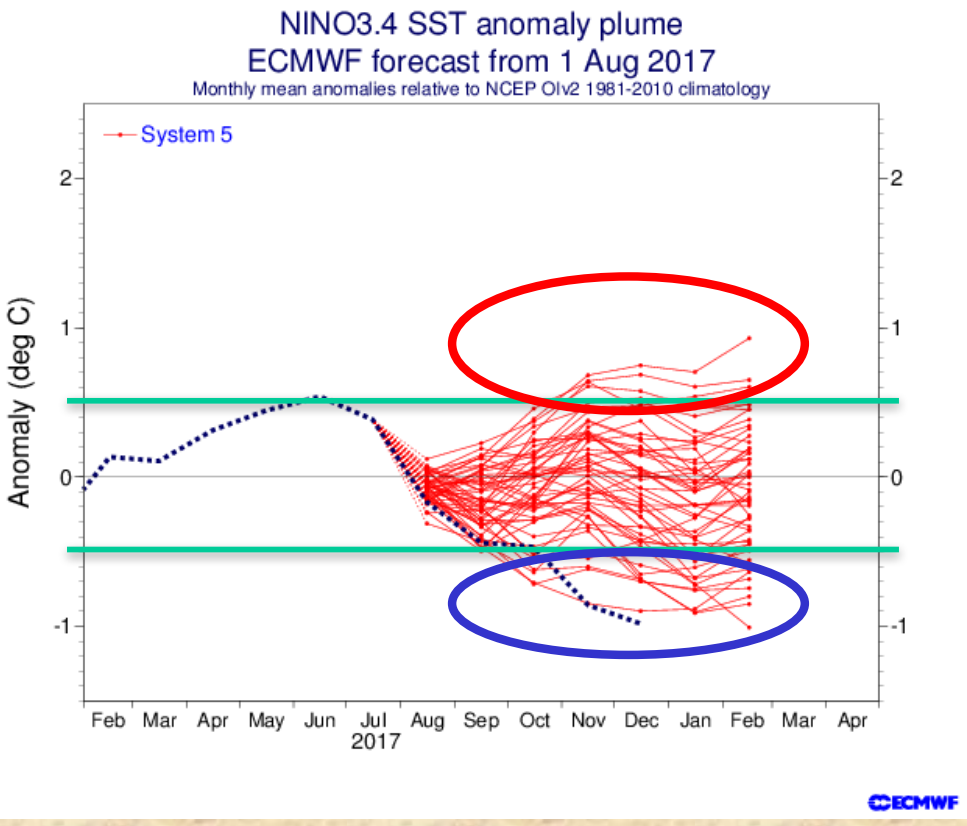
http://www.pmel.noaa.gov/tao/jsdisplay/index.html





The MEI monitors ENSO based on six observed variables over the tropical Pacific (SLP, surface wind components, air- and sea surface temperatures, cloudiness). In 2017, we witnessed a 3rd aborted El Niño in six years (others in 2012 and 2014). Transitioning this quickly from weak La Niña in Fall '16 to El Niño in spring '17, and back to La Niña this fall is very unusual, and has been hard to predict for all forecast models.

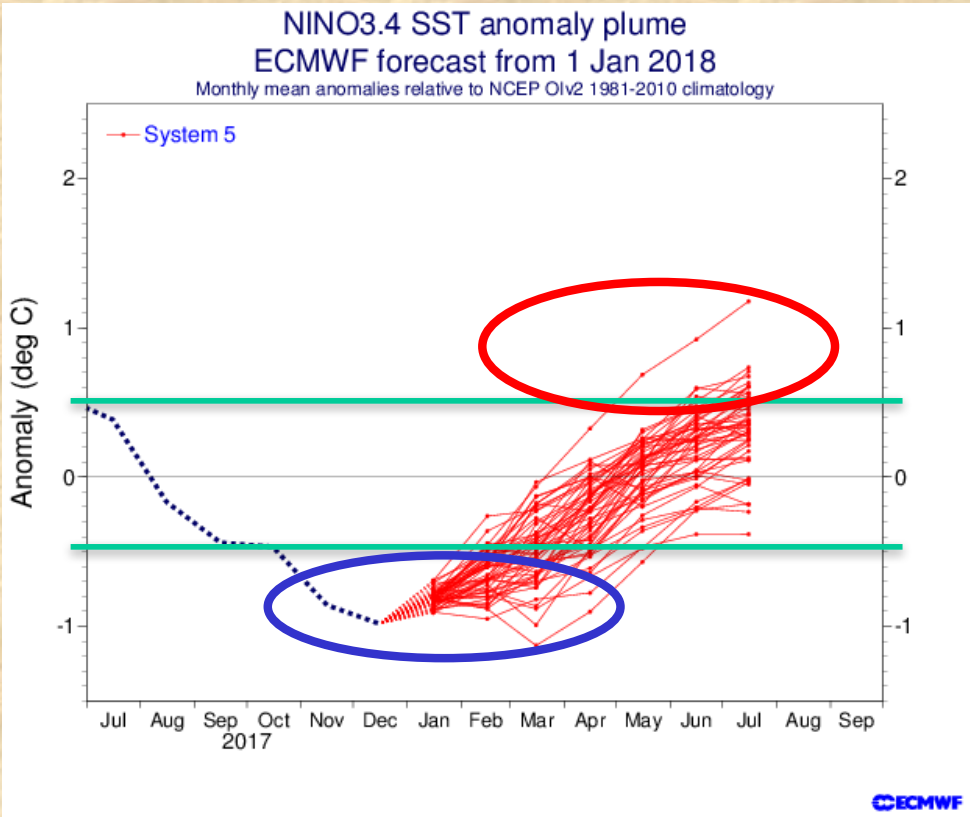
http://www.esrl.noaa.gov/psd/enso/mei



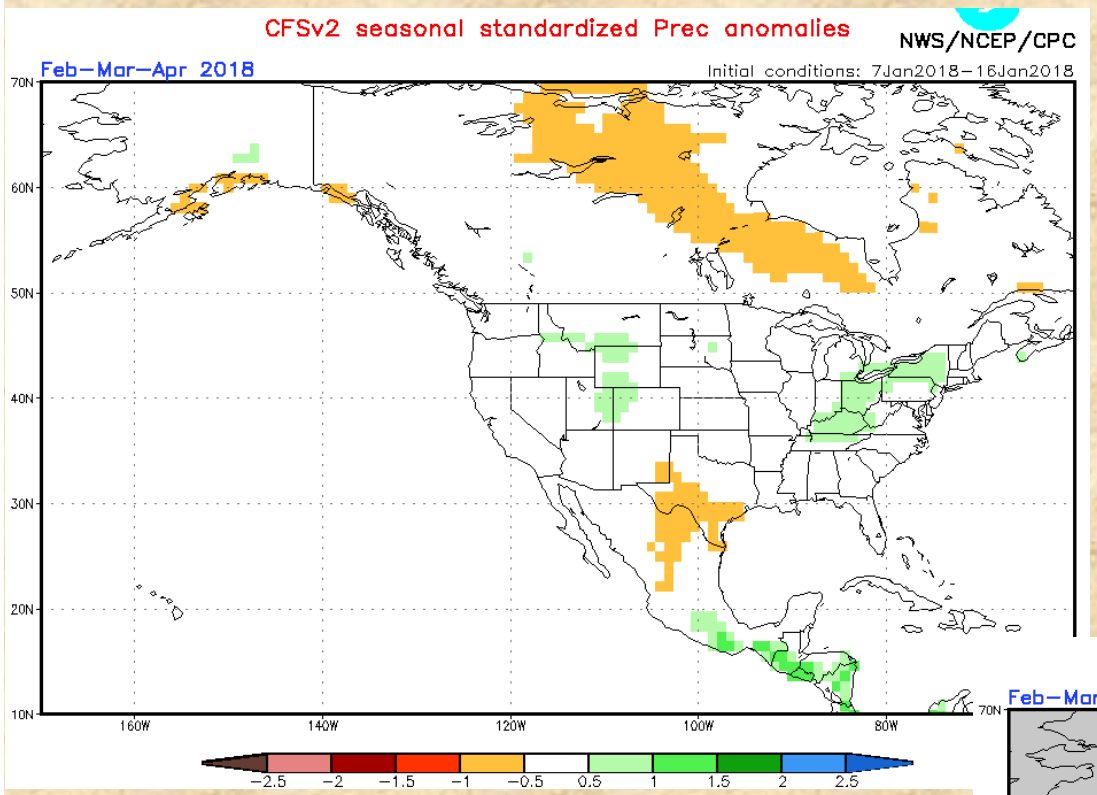
The ECMWF August 2017 forecast (left) showed a large range of possible outcomes, for the 1st time this year with more members advertising La Niña than El Niño. Otherwise, this was the last forecast to show mostly ENSO-neutral outcomes. The actual trajectory (stippled blue) documents a colder outcome than anticipated.

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

The January 2018 ECMWF forecast (right) promises a fairly rapid end to the current La Niña, with the majority of members climbing above 0C by June. While most forecast models share this outlook, a few of them (like the American CFSv2) continue La Niña conditions through 2018. That would be the worst-case scenario (*a 'triple-delight' – NOT!*).

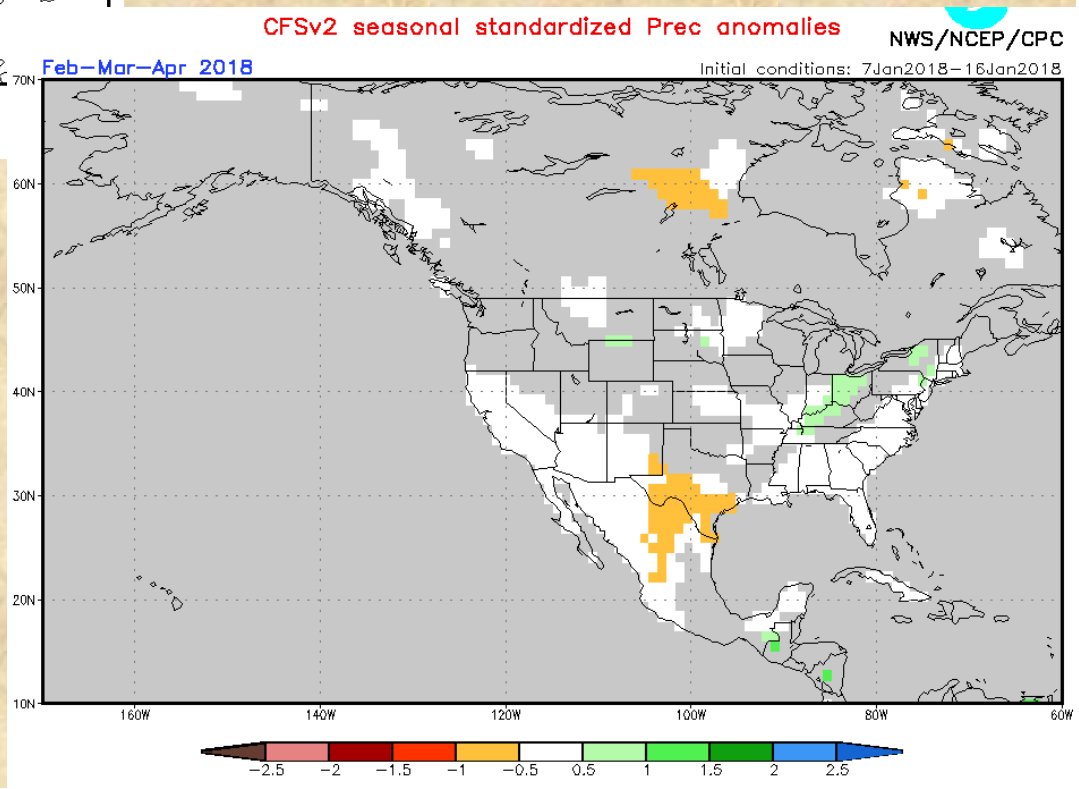


CFSv2 forecasts for February-April 2018

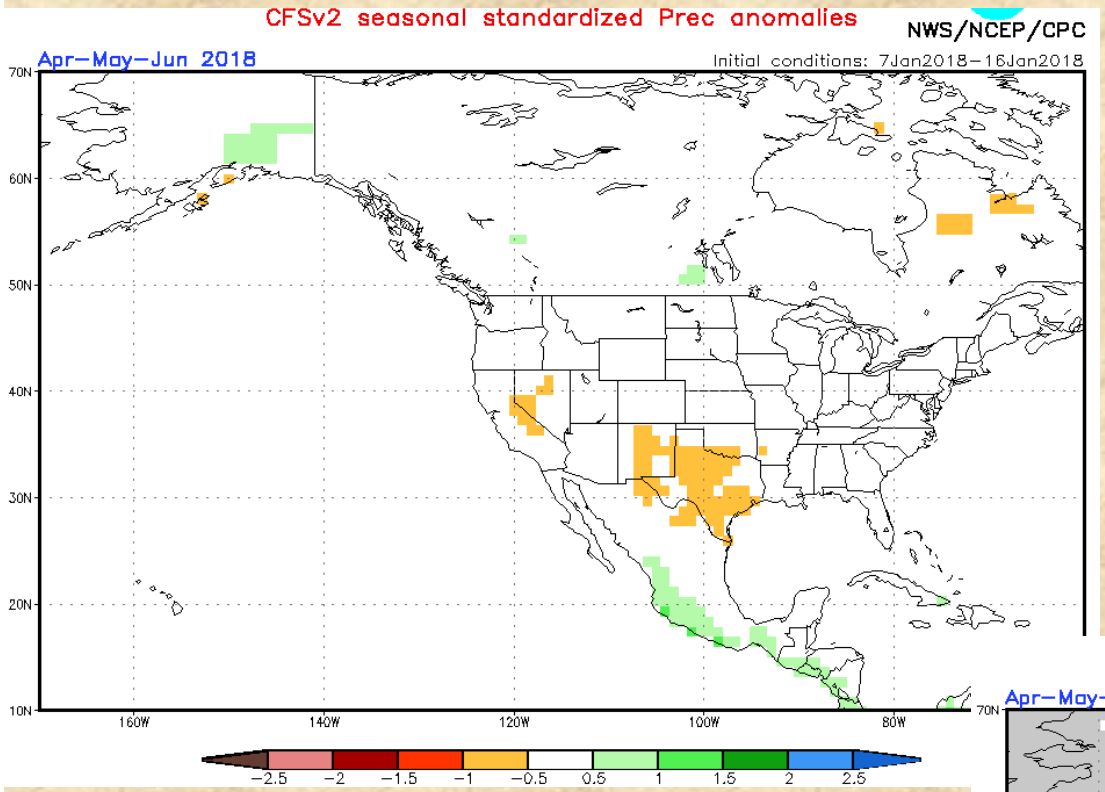


http://www.cpc.ncep.noaa.gov/products/predictions/90day/tools/briefing/

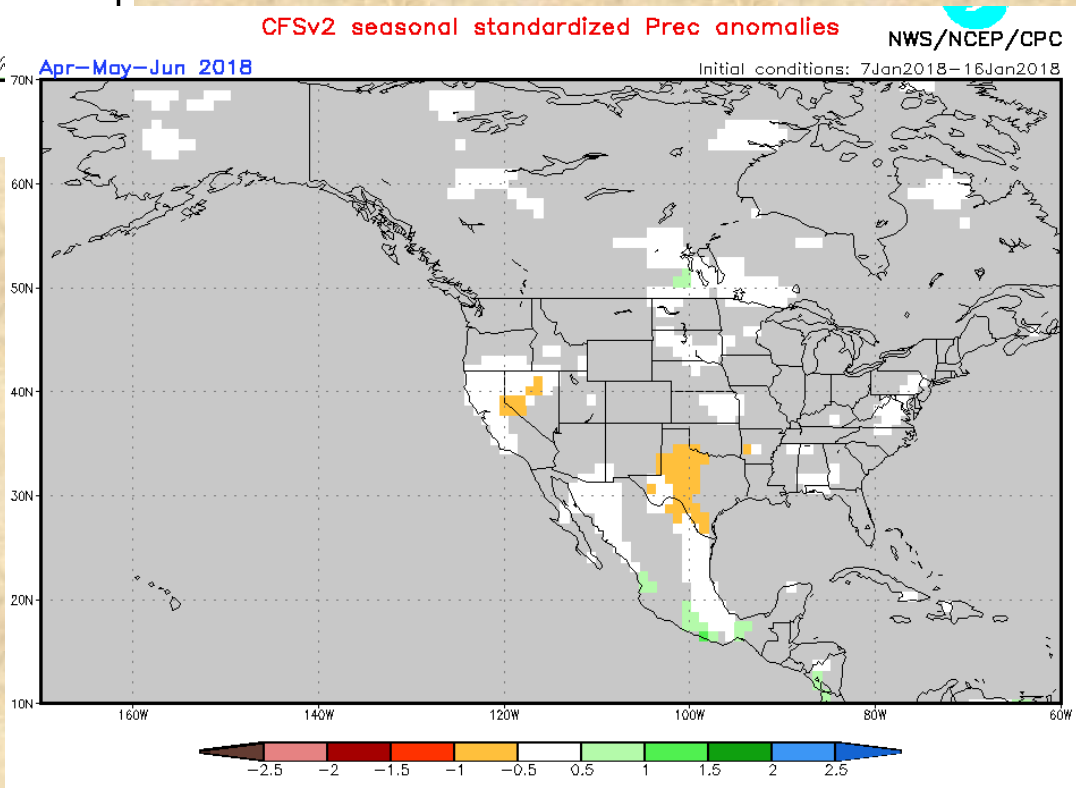
FMA 2018 (top) shows a modest tilt towards a wet outcome over the upper Colorado River basin. None of this survives the skill mask application (right). ***Meanwhile, note worsening drought conditions in TX!***



CFSv2 forecasts for April-June 2018

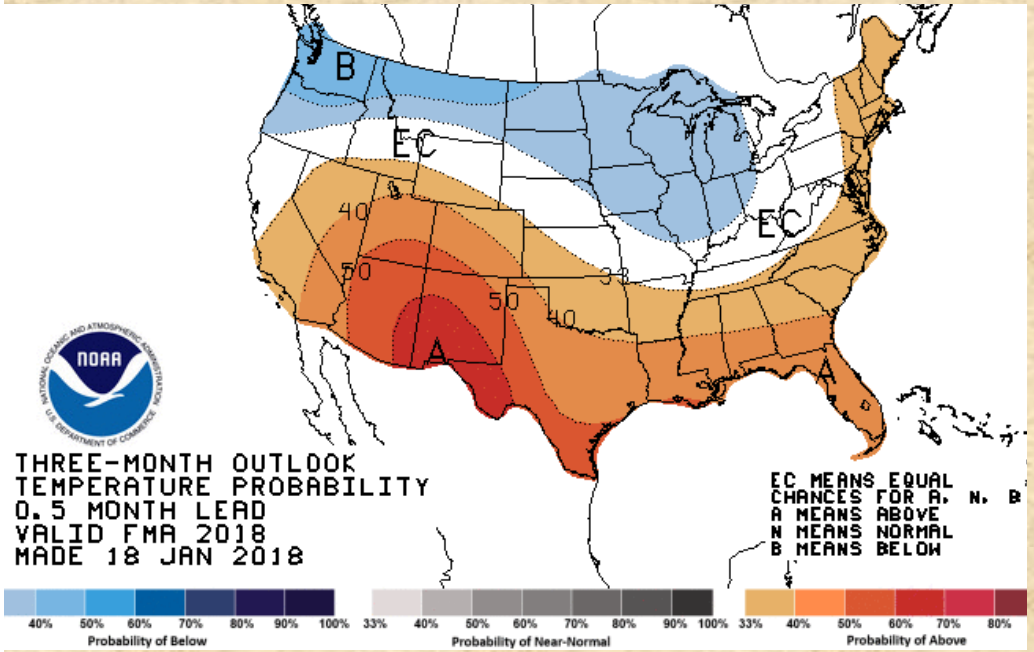


http://www.cpc.ncep.noaa.gov/products/predictions/90day/tools/briefing/



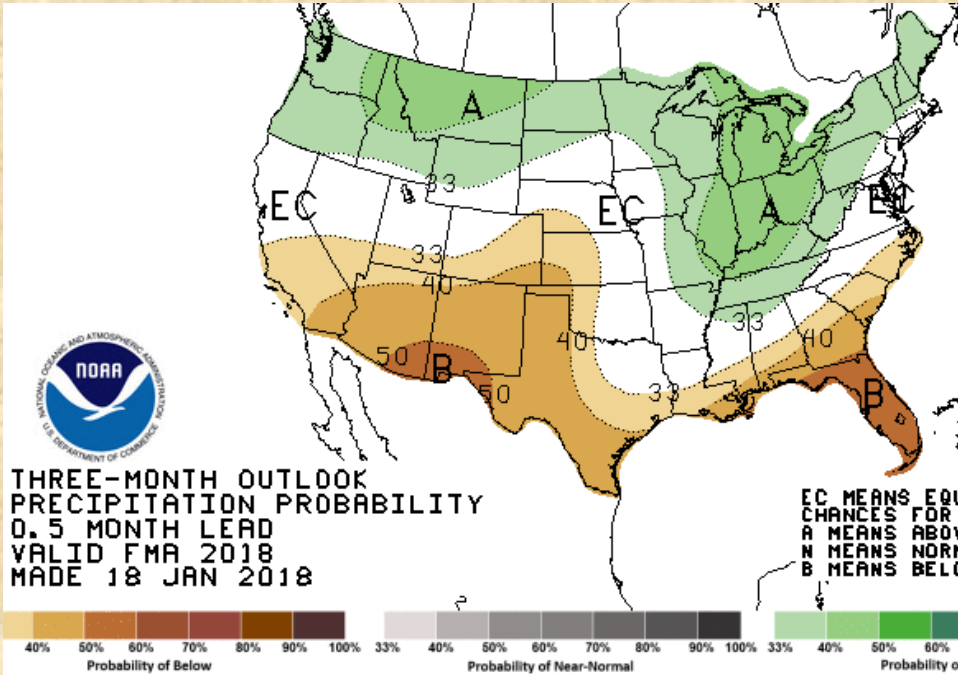
AMJ 2018 (top) shows no tilts to speak of over CO. Not that any of that would have survived the skill mask application (right). Meanwhile, there is confidence (again) in worsening drought conditions to our south and west.

Climate Prediction Center Forecasts (FMA'18)

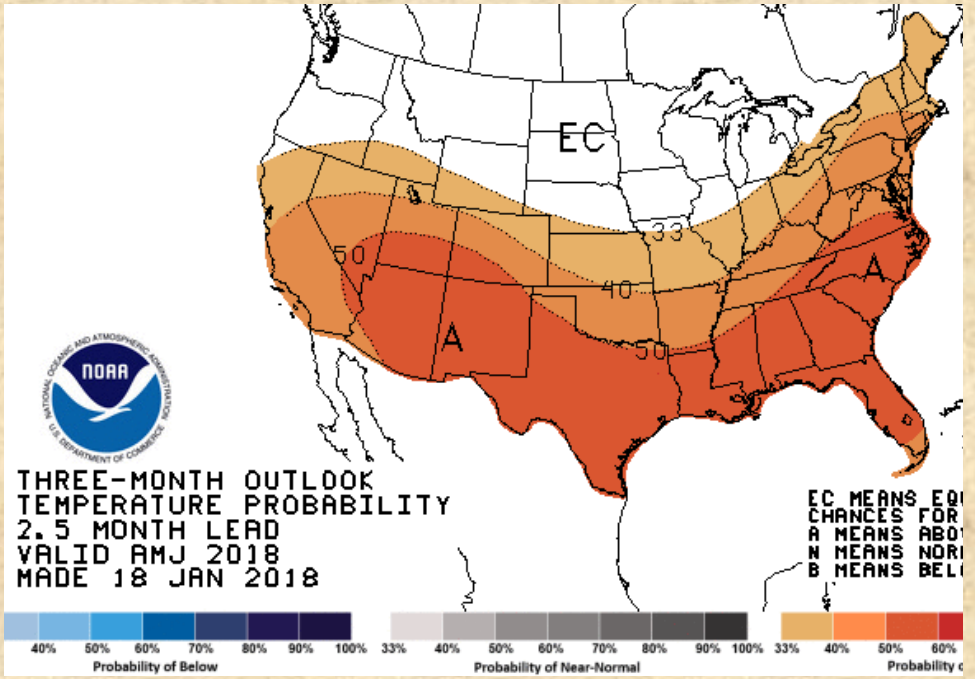


http://www.cpc.ncep.noaa.gov/products/predictions/

The latest CPC early spring temperature forecast (top left) is warm for our region, while the precipitation forecast is 'EC' at best, or mostly dry (right). This is consistent with lingering La Niña effects.



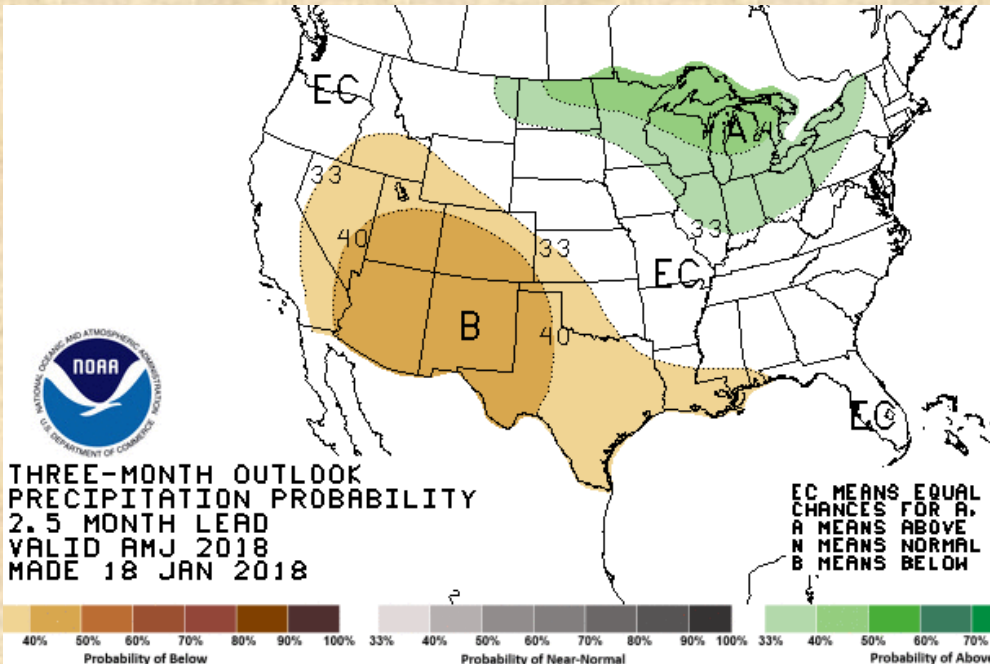
Climate Prediction Center Forecasts (AMJ'18)



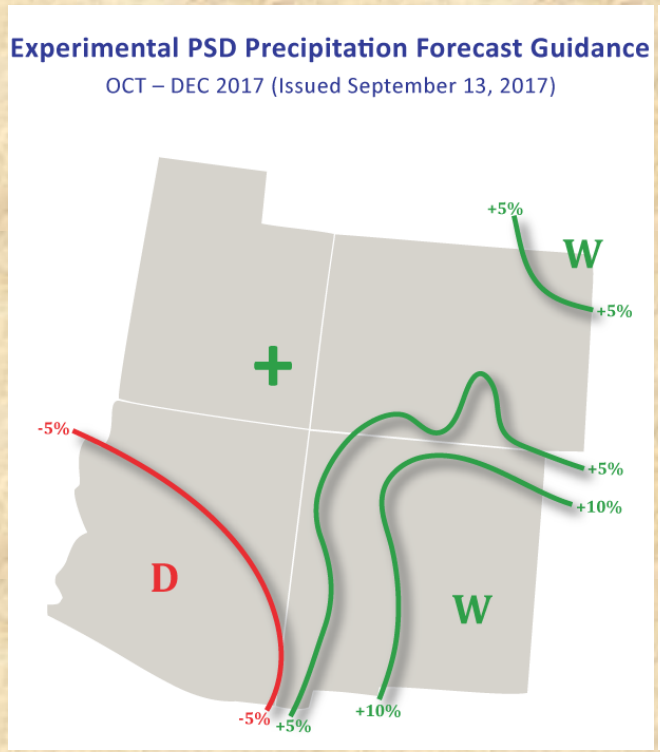
http://www.cpc.ncep.noaa.gov/products/predictions/

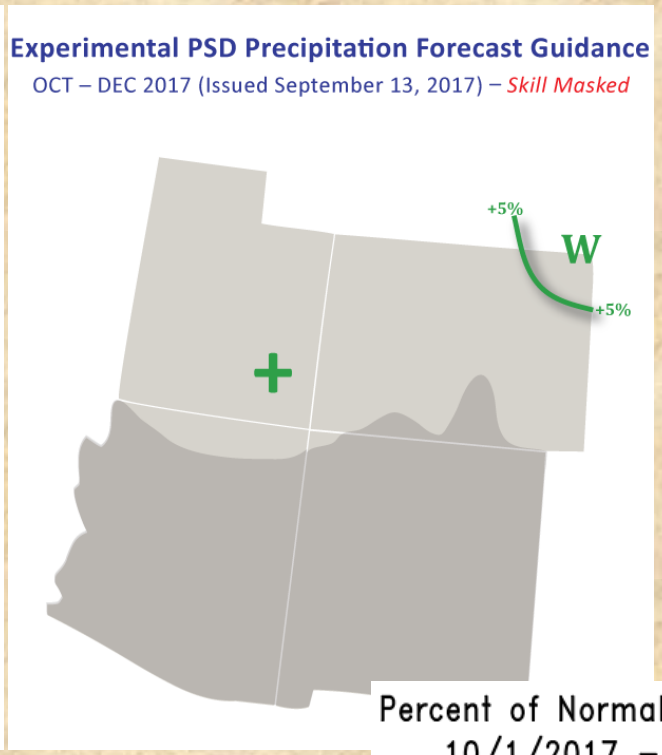
The latest CPC late spring temperature forecast (top left) shows continued warmth for us, while the precipitation forecast (right) is about as dry as it gets for our region and at this lead-time. While La Niña itself is expected to be over by then, lingering effects are typical for this time of year.

Disclosure: These maps had input from me.

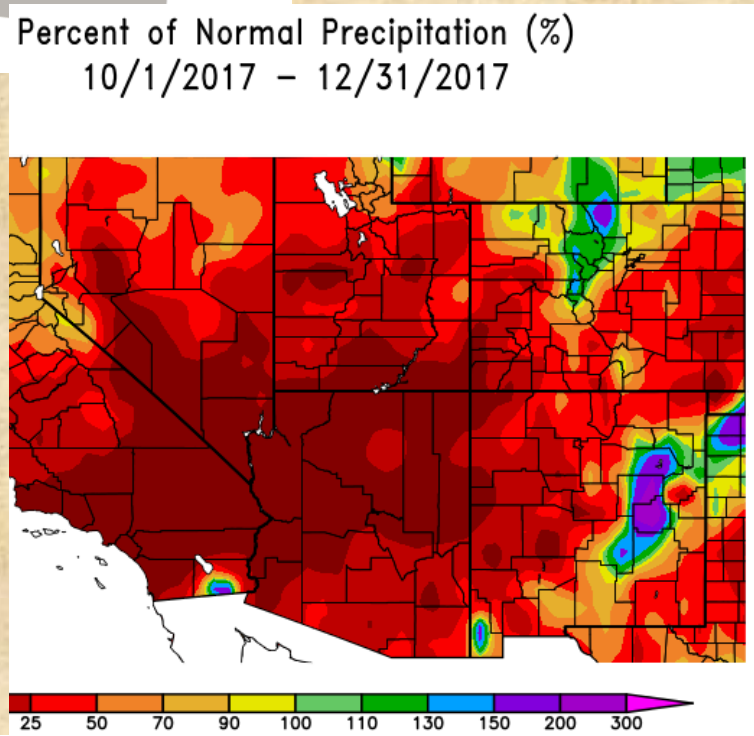


Postmortem October-December 2017

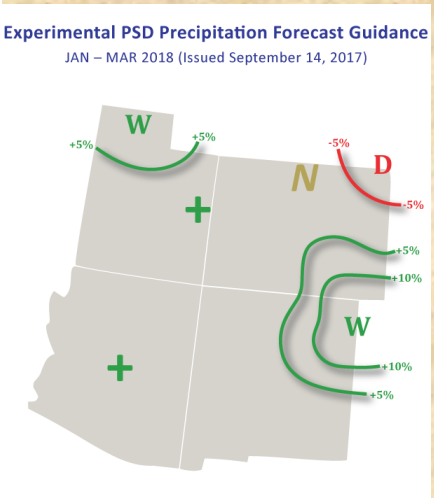


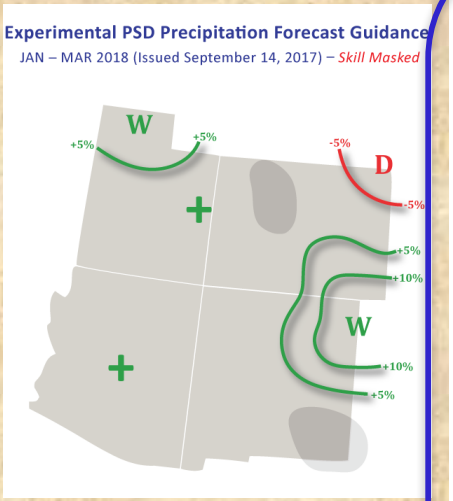


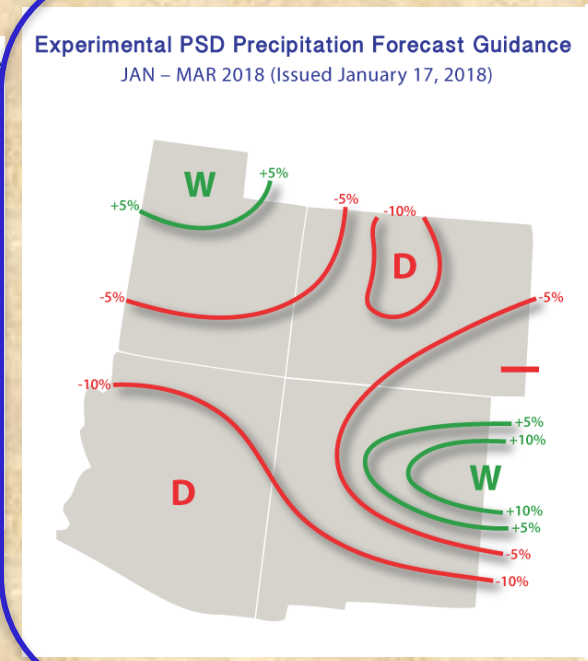
Back in September, my experimental outlook for CO in late fall was too optimistic, plain and simple – most of our state ended up drier than expected, with only a sliver of wetness extending from Larimer down to Lake County. ***Note that this statistical tool did not consider the ill effects of a 2nd year La Niña…***

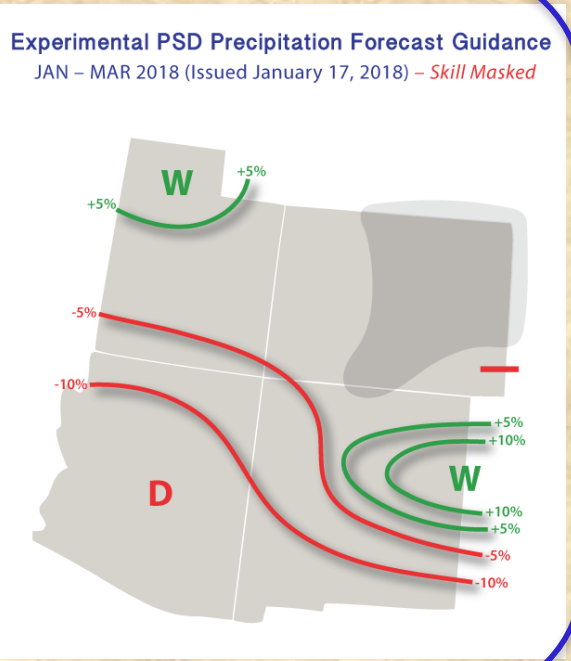


Statistical Outlook January-March 2018





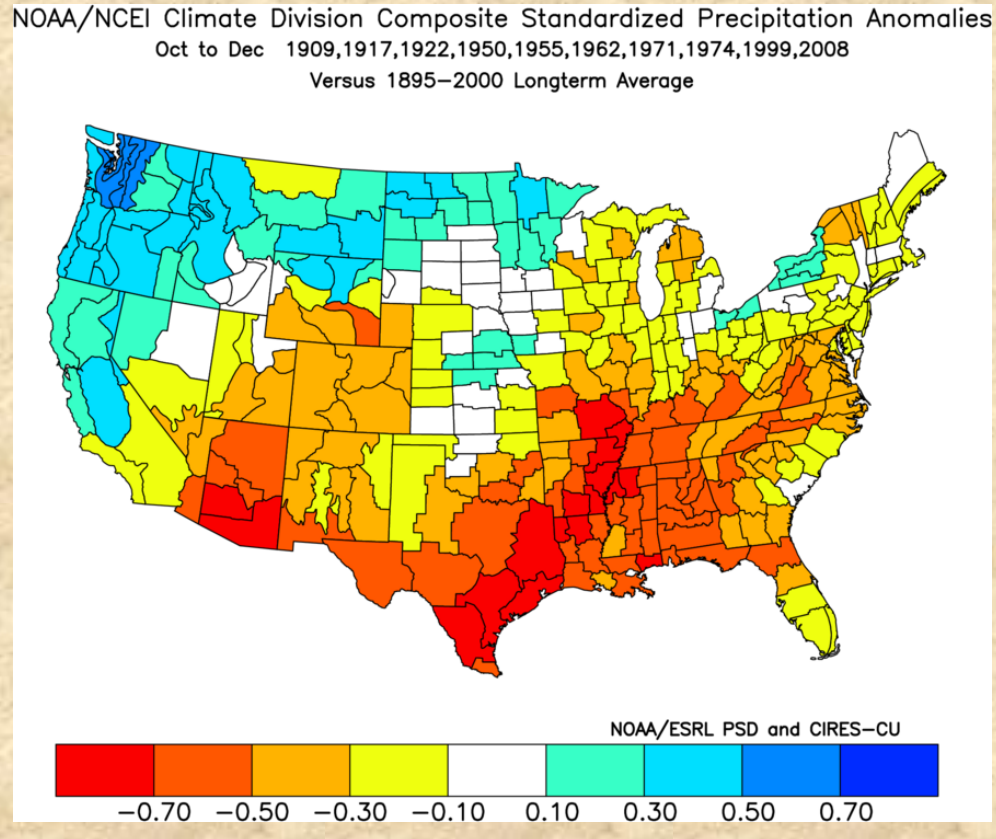


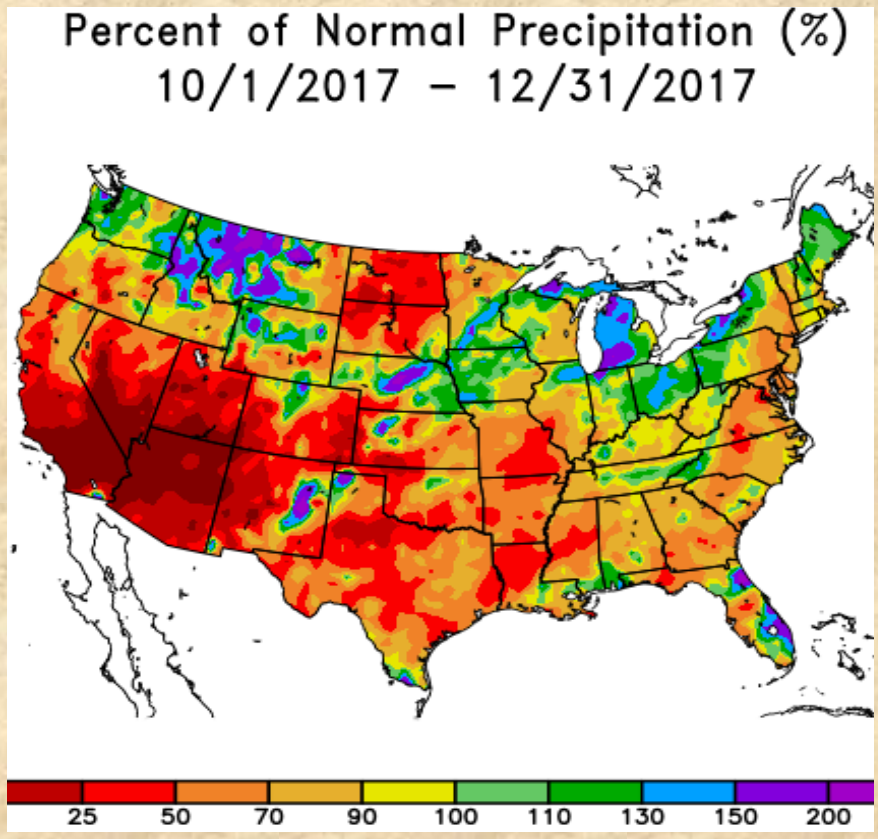


The early winter outlook (far left) was near-normal over northern mountains, otherwise either wet (especially in SE), or dry (towards Nebraska). Applying the skill mask (left middle) removed the northern mountains from the forecast map, otherwise no change.

The latest updated forecast (right middle) is dry across Colorado. Given the poor forecast performance last winter, the skill-masked version (far right) now covers much of our state under a 'cloak of silence'.

Analogue (as used in 2011-12)

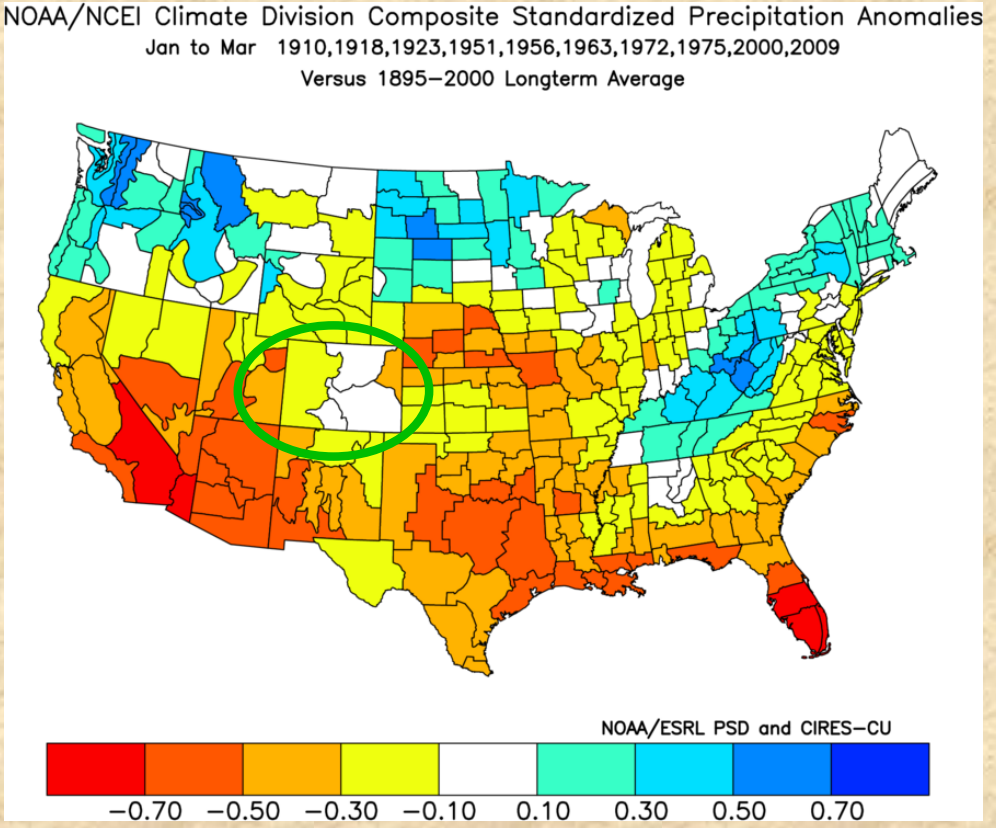


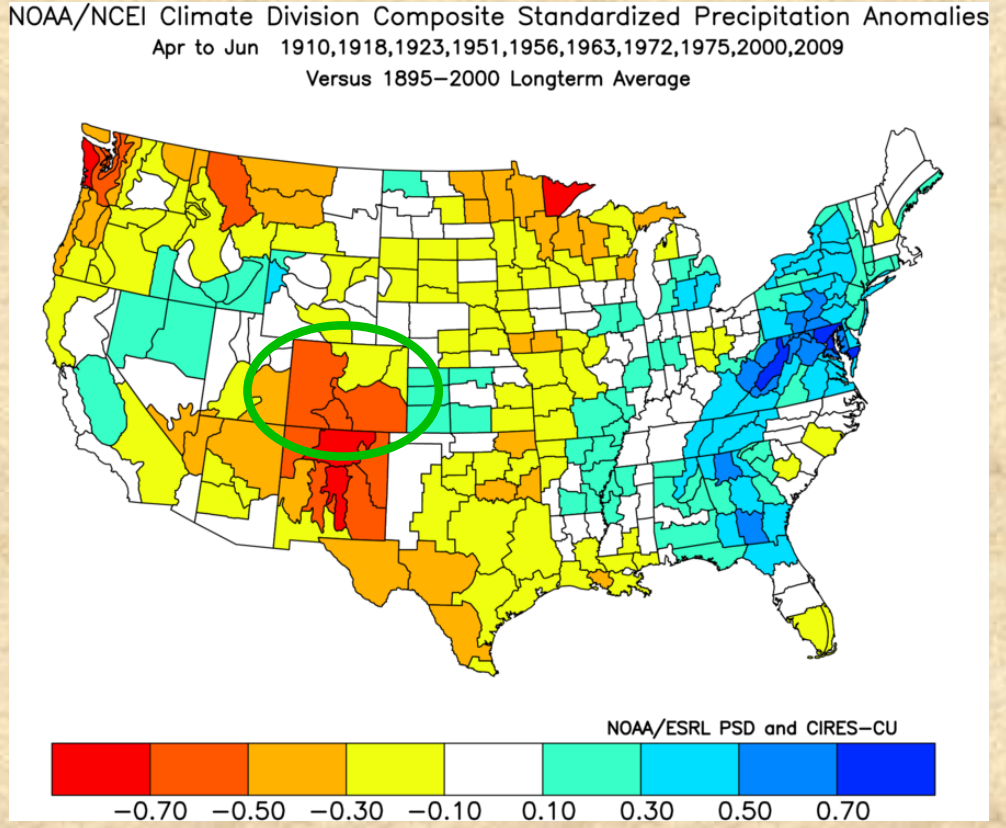


Year-2 La Niña October-December composite (left) was grim enough – reality (right) was even drier for much of Colorado and the rest of the country!

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

Analogue (as used in 2011-12)





Year-2 La Niña composites for January-March (left) and April-June (right) show marginal dryness in the winter over our state, but worsening drought by spring. For Colorado, all three seasonal composites are drier than during Year-1 La Niña seasons.

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

Focus on 2018 Colorado River runoff

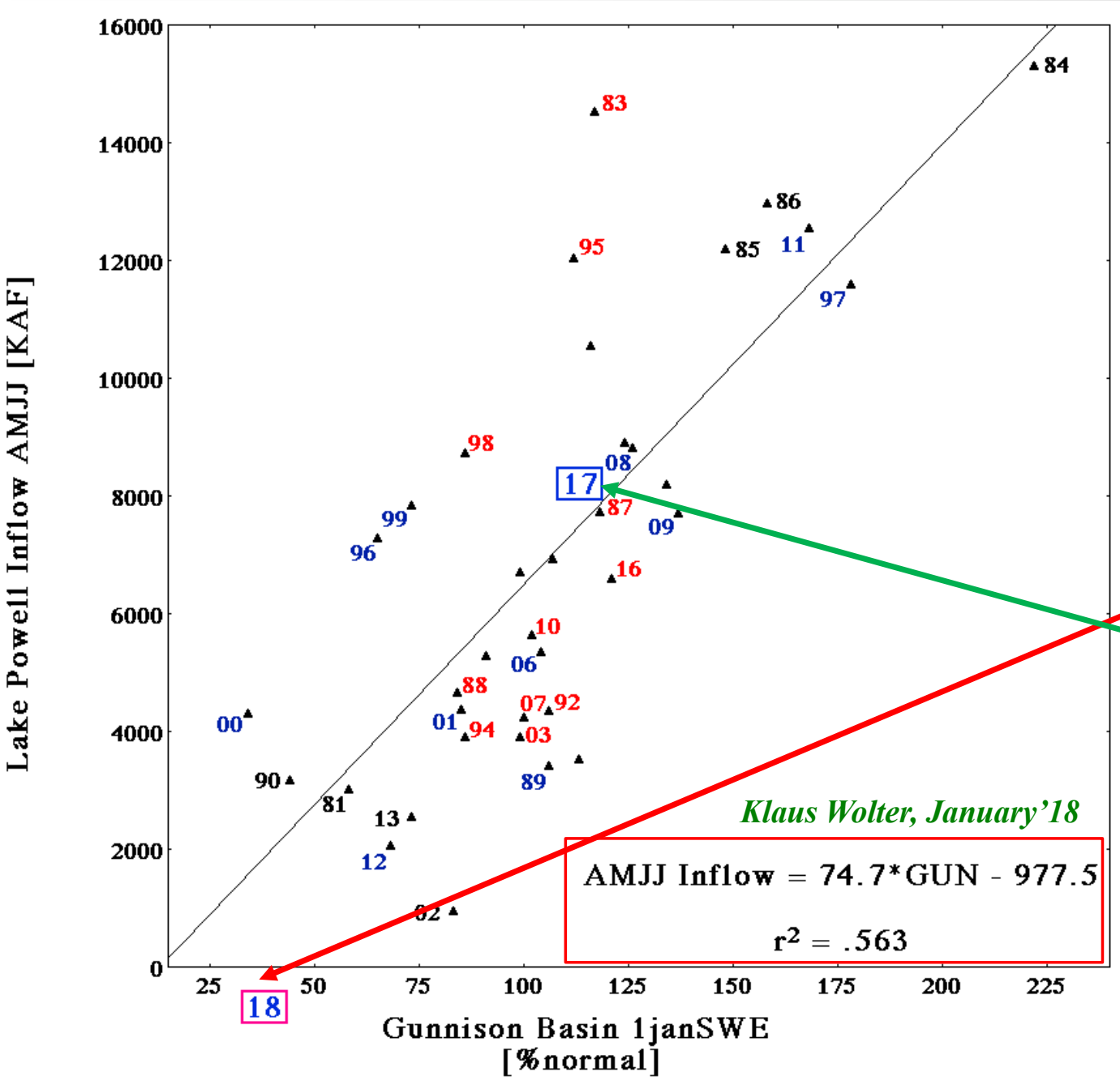
- ***CO 1janSWE is low this year (2nd lowest since 1981 in Gunnison basin).***

- ***While only weak, we are in a 2nd year La Niña, activating a scenario that I discussed in late 2011 as being NOT favorable for Colorado River runoff.***

- ***If you correlate 1jan SWE in Colorado's basins with Colorado River runoff, the Gunnison basin is the best predictor. Furthermore, if you stratify by ENSO phase during fall, you find that correlations are best for ENSO-neutral cases (r-squared of 79%), very good for La Niña (56%), and weak for El Niño (24%), allowing for 'spring surprises'.***

- ***Results are new for (1) April-July runoff (Source: CBRFC) in relation to Gunnison basin 1janSWE (NRCS), and revisited for (2) Year-2 La Niña Water Year 'Natural' flow (Jim Prairie, B. Rec.). For 1981-2016, these two time series correlate above 0.98, so results are virtually interchangeable.***

Gunnison 1janSWE versus AMJJ Lake Powell Inflow



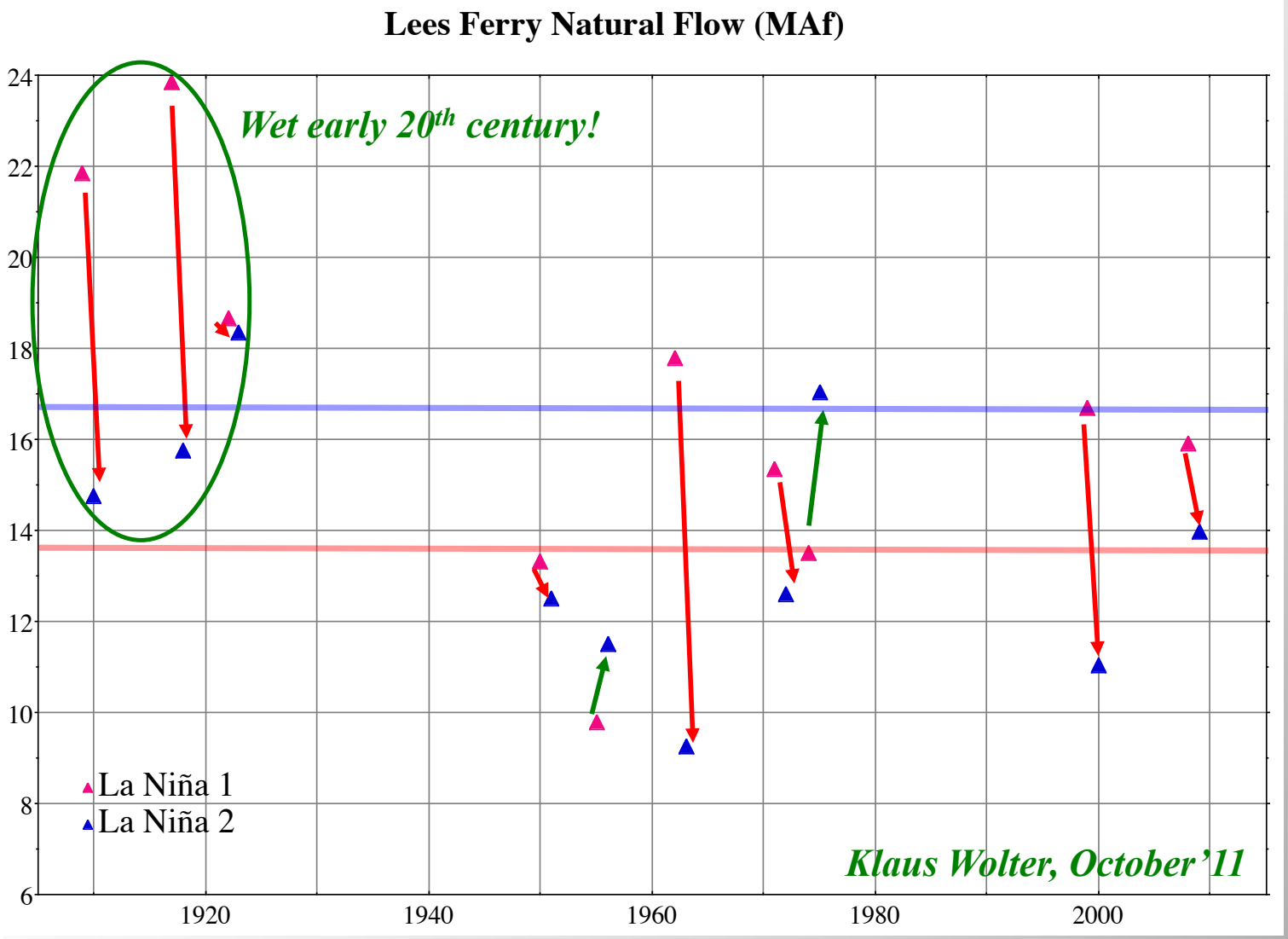
11 fall El Niño cases are highlighted in red, La Niña in blue, while ENSO-neutral high and low runoff years remain black.

SWE is displayed as % of median (81-10), Lake Powell inflow in 1000's of acre-feet.

The regression equation is for all cases. ***The 2018 SWE of 39% is displayed below the horizontal axis. The 2017 case is inserted at the right coordinates (slightly above normal for both).***

The calculated runoff for 2018 is 1936 KAF. ***Based on La Niña cases only, the regressed value is 3208 KAF, or about 50% of normal.***

Ten 'Double-Dip' Las Niñas from 1906-2009



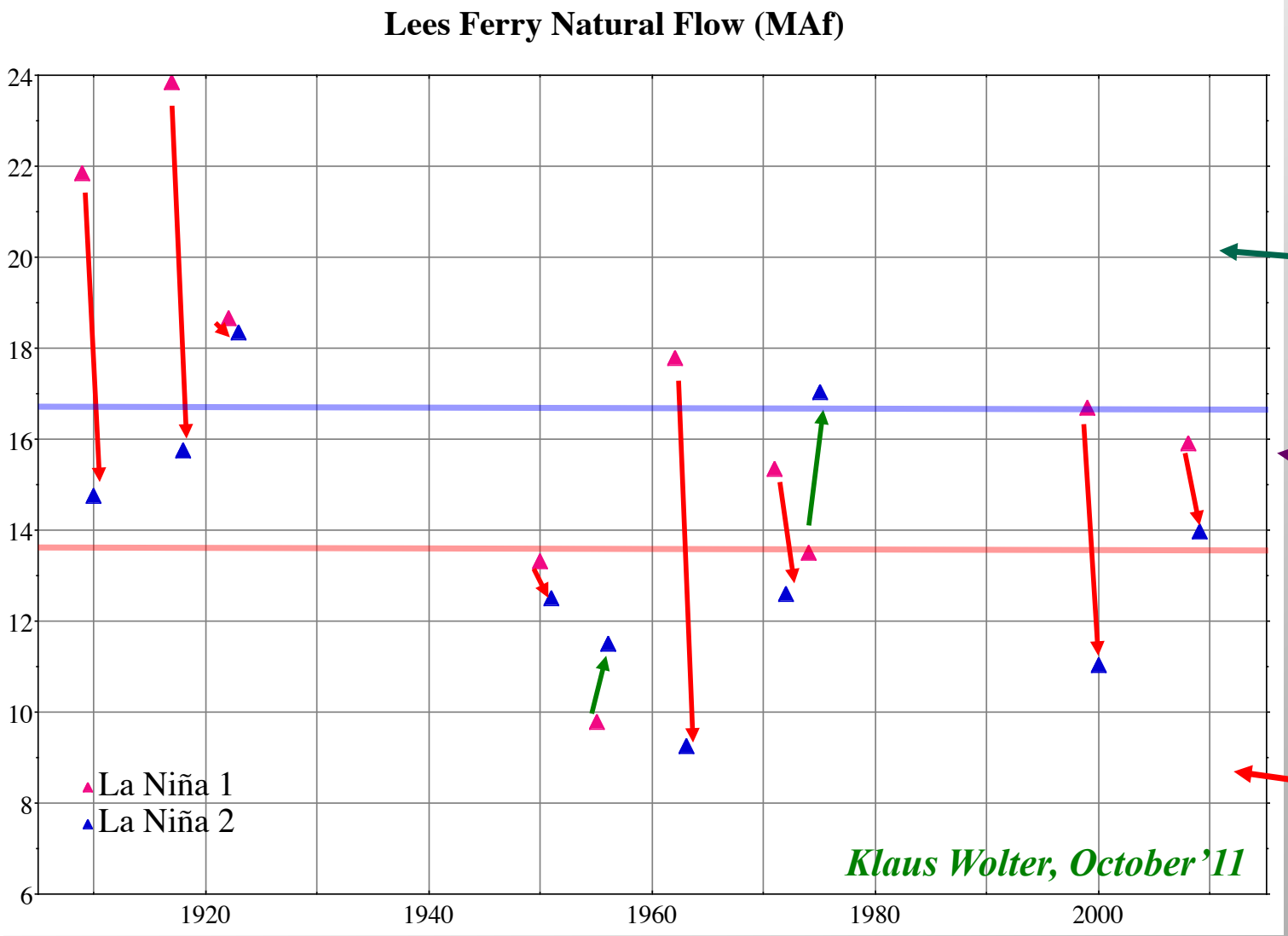
Mean flow for Year 1:
16.75 MAF

Mean flow for Year 2:
13.64 MAF

Difference Yr-1 vs Yr-2 is statistically significant (>0.7 standard deviations).

A drier outcome has been typical (8 of 10 cases) for 2nd year runoff *for the Colorado River. 7 of the Yr-1 runoff totals were above 15MAF, while 7 of the Yr-2 runoff totals were below that.*

First test case was 2011-12; 2017-18 is next in line!



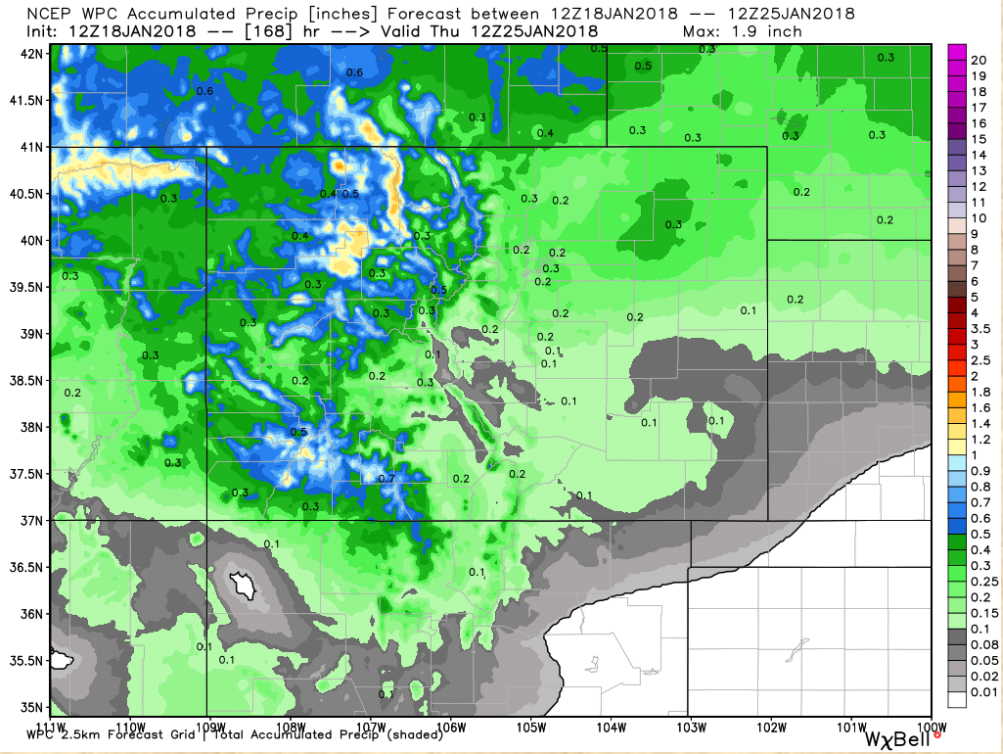
2011: 20.2MAF

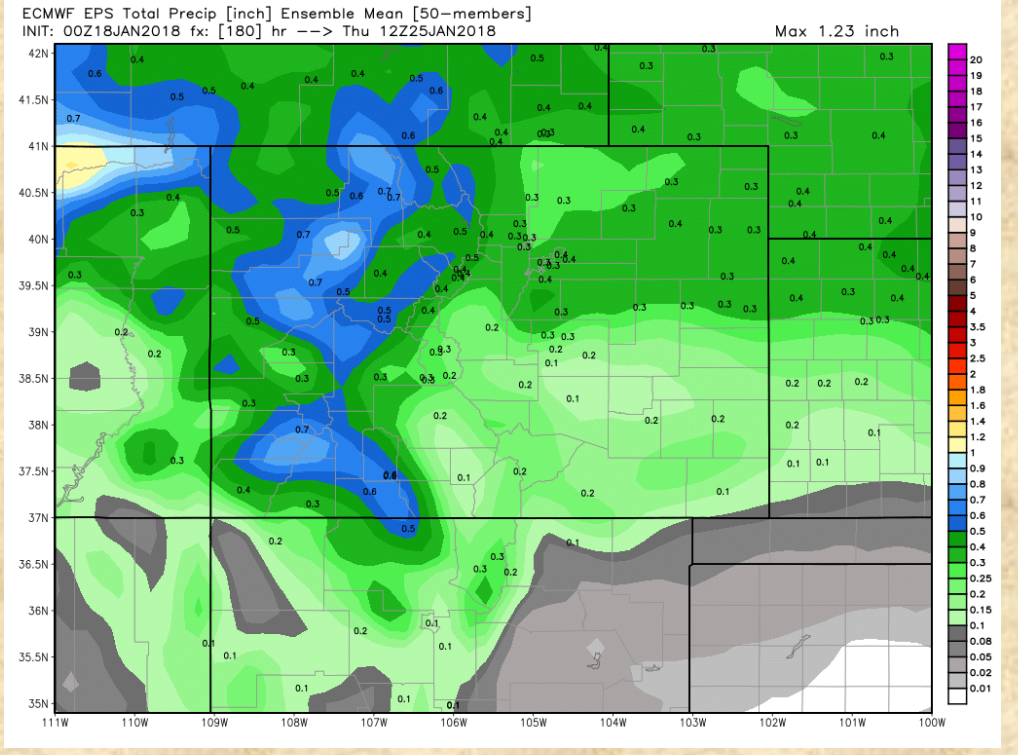
2017: 15.6MAF

2012: 8.4MAF

*2012 confirmed expectations (or fears), realizing the **biggest drop in this collection of cases**! 2017 came in at 15.6MAf, close to the long-term mean for Year-1 La Niña cases – let's hope that the drop compared to last year does not mimic 2012…*

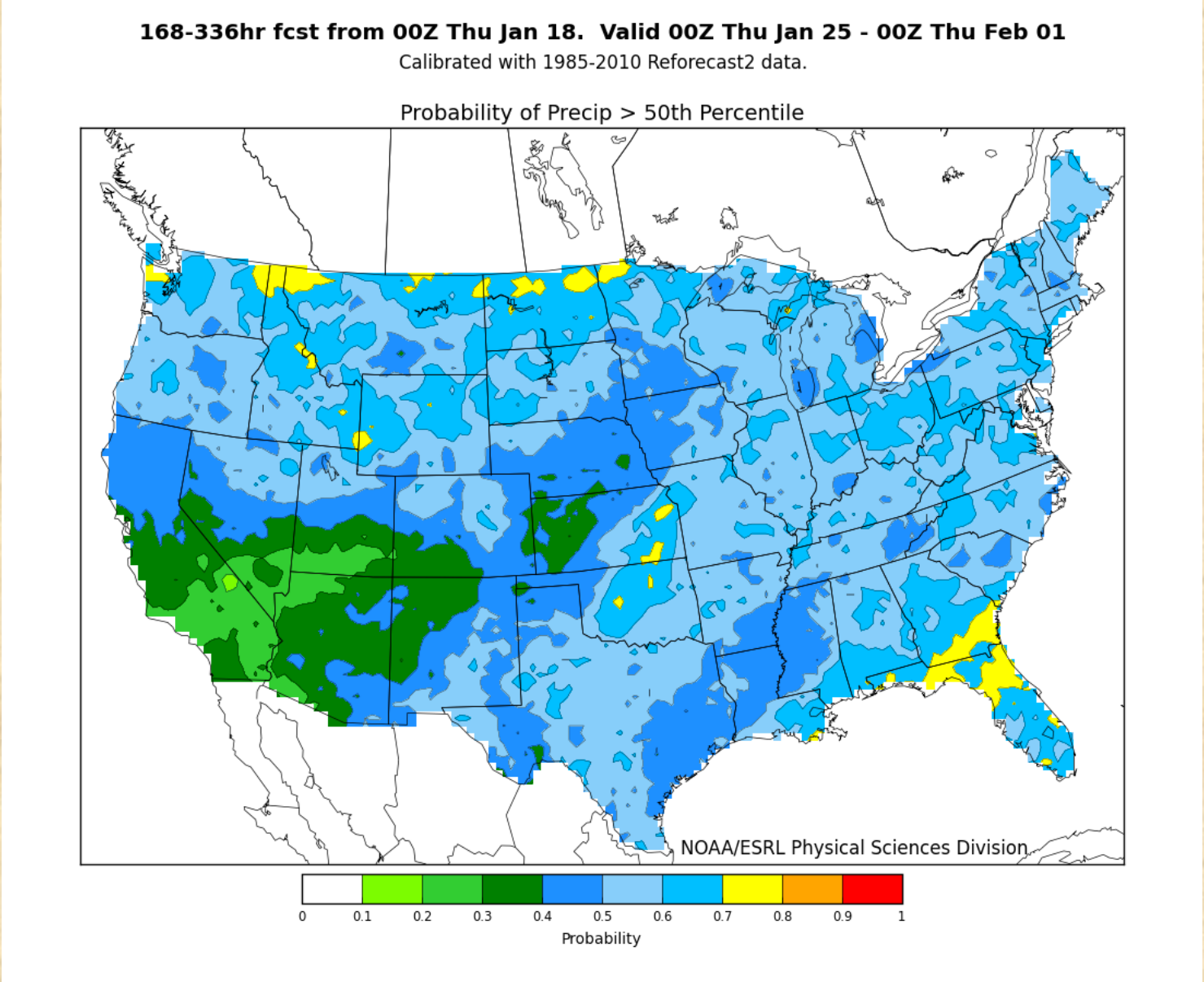
What can we expect in next seven days?





While the next seven days look reasonably stormy (starting this weekend), precipitation totals around 0.5-1" in the mountains are only close to normal, not above-normal. In contrast to last winter, "wet" periods during the last two months have been quite anemic, also compared to forecast-based expectations.

What can we expect during Week 2?



Blue means 50/50 odds are near-normal: about the best we seem to get this winter!

Executive Summary (18 January 2018)

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- **La Niña re-established itself this fall and is leaving a drought footprint consistent with historic Year-2 La Niña analogues. While it might come to a quick end later this spring, a low runoff season appears virtually guaranteed. *There is potential for El Niño conditions later this year, but let's not get fooled again (too soon).***
- **Experimental forecast guidance for late fall verified poorly (it was drier than expected). New forecasts for the remainder of winter are much drier than back in September. On the other hand, a dry fall, winter, and spring is consistent with Year-2 La Niña analogues that appear reasonable despite the weakness of the 2016-17 La Niña. The low snowpack by January 1st cannot be ignored either, since it foreshadows a low runoff year for the Colorado River *(~50% of normal?!)*.**
- **Forecasts from CPC change from 'EC' to dry as we go into spring. Coupled model forecasts show a similar evolution, albeit not strongly.**
- **The next two weeks re-establish a more favorable storm track through our state. Moisture is not abundant, but we should see more snow than during much of the last two months.**
- **BOTTOMLINE: While I 'misunderestimated' the relevance of the Year-2 La Niña scenario last time, it is playing out in typical fashion, leaving little hope for a recovery to near-normal snowpack or runoff in 2018. Given poor forecast skill over the last year, I should not speculate beyond spring…**