California Moisture Forecasts for 2009-10

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- **Background (How did I get into this – *Thanks, Jeanine!*)**
- **What were the forecasts in 2009-10, and Why?**
- **What happened, and How did it match up (so far)?**
- **Parting shots & What more could one do?**

Assessment of current 'state of the art' of climate forecasting / teleconnection research

'Workhorse' forecast tools are mostly statistical, but 'get no respect'

Coupled climate models have come a long way, but are not ready to replace statistical tools just yet

My own statistical efforts are essentially a race against time to see how much more signal can be extracted from historical data before climate stationarity assumption goes out the 'Greenhouse' window…

Dominance of ENSO in teleconnection research has dwarfed other efforts to unravel the workings of the planetary 'Climate Puzzle'

Just because we don't fully understand how and why certain teleconnections work does not mean that they don't work, or that we can't use them

Coupled models need to be trained to reproduce all major teleconnection patterns (better), not just ENSO (with a nod to Bob Livezey)

Focus: California

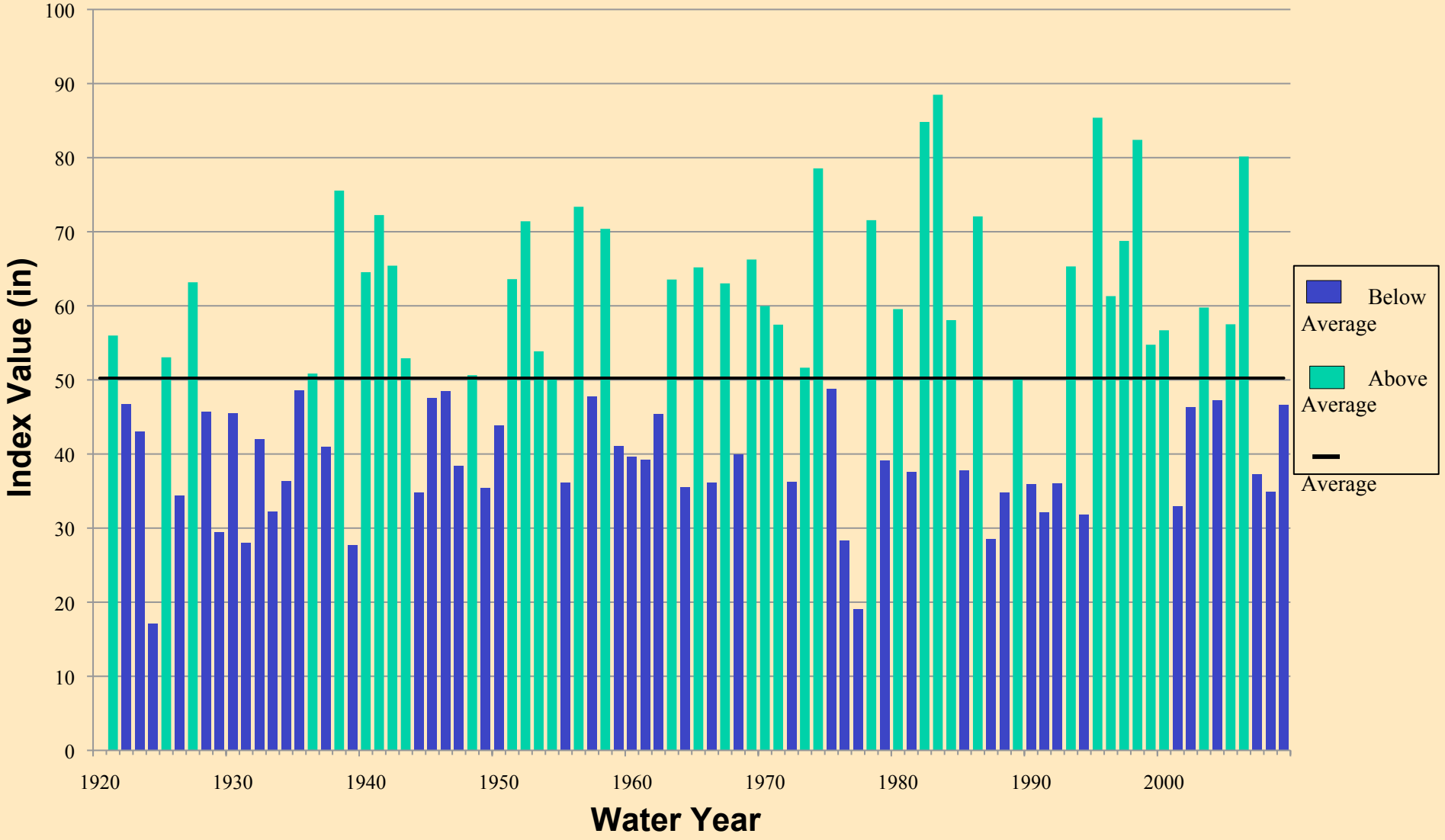
- **Different river basins are well correlated with each other (snowpack as well as runoff); examined eight basin indices from Bend down to Merced**

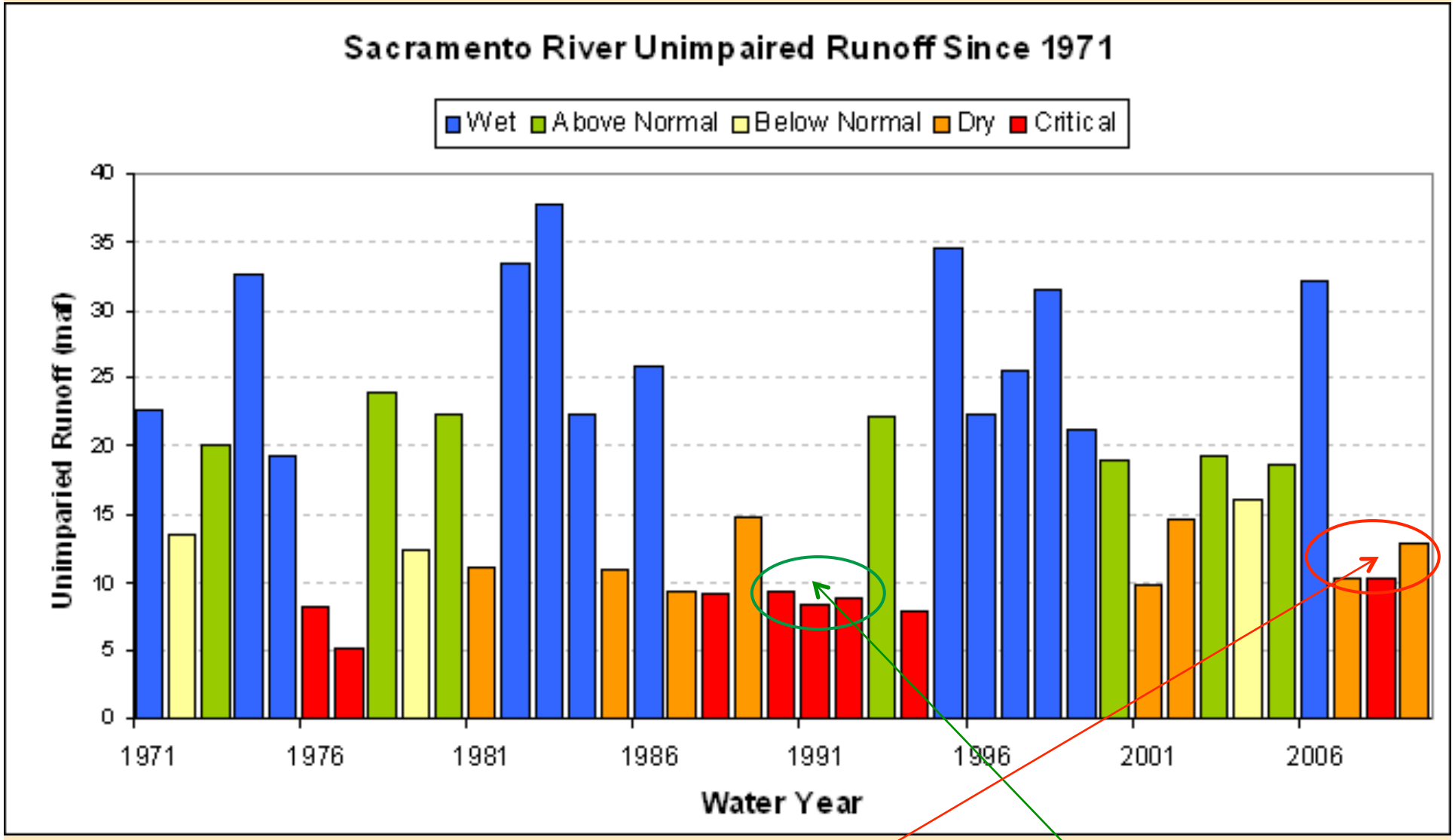
- **Multi-year droughts are not clearly linked to either ENSO or PDO phase**

- **Southern CA precipitation has more straightforward association with ENSO than northern CA (*see below*), but 2006-07 El Niño ended up with the opposite of the expected outcome (driest on record in LA)**

- **Good fraction of annual precipitation comes in 'atmospheric river' events which are still poorly understood, including their link to 'Madden-Julian Oscillations' and ENSO**

Northern Sierra 8 Station Precipitation Index

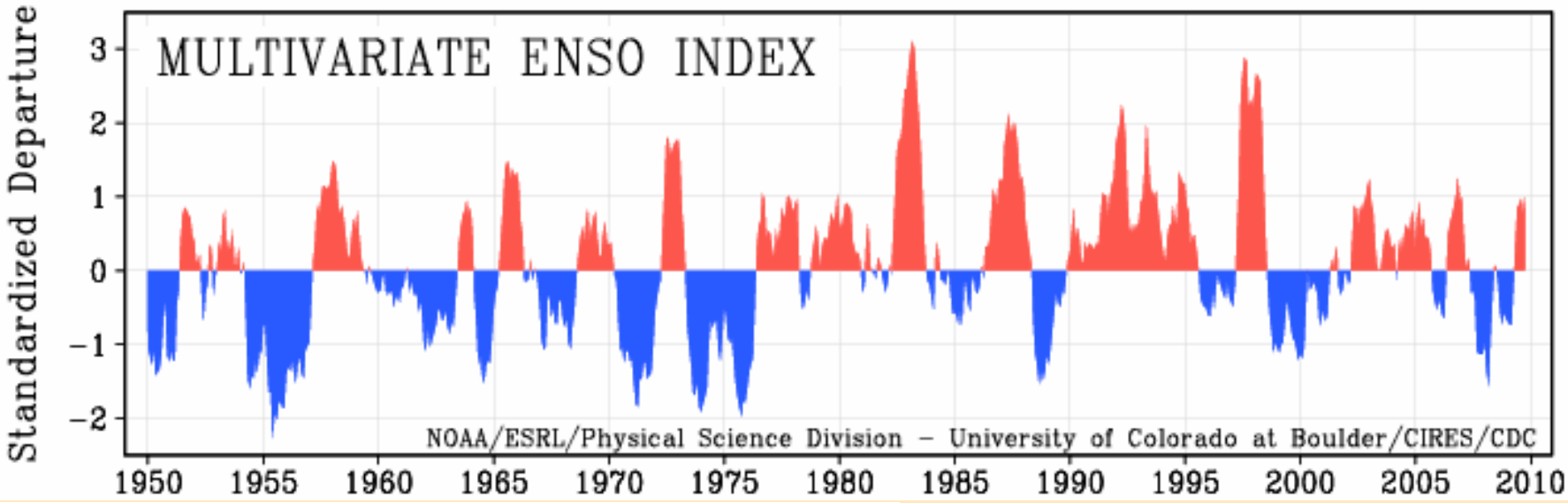


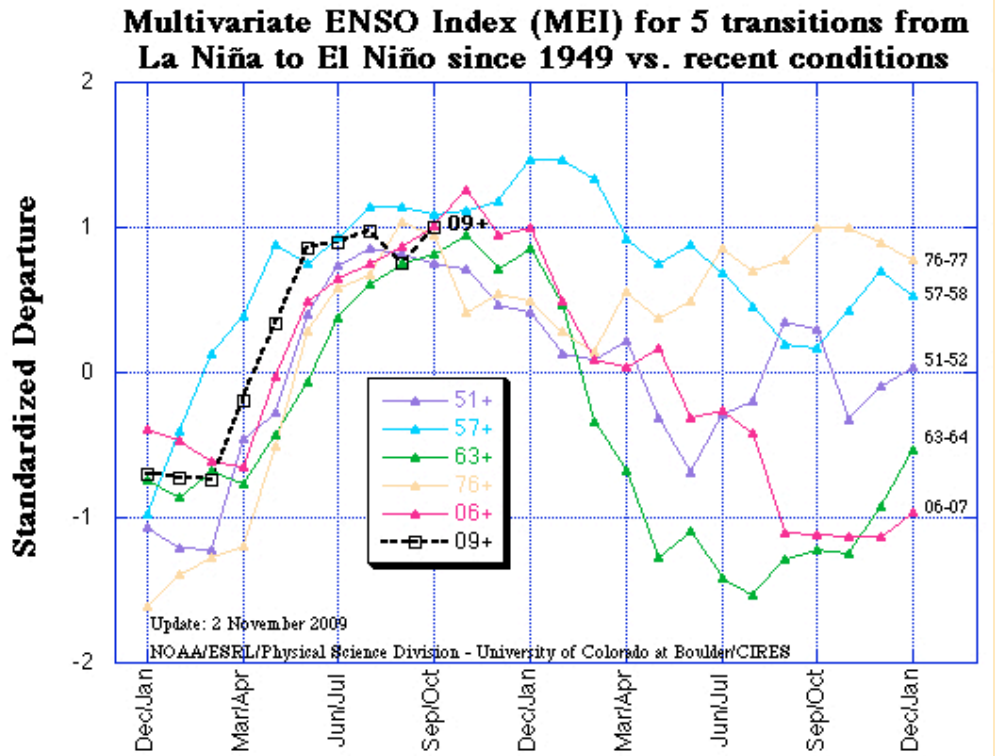


2007-09 average runoff: 11.2 Maf = worst 3year run since early 90s

2009 Runoff Worse Than Precipitation

What was going on with ENSO in late 2009?

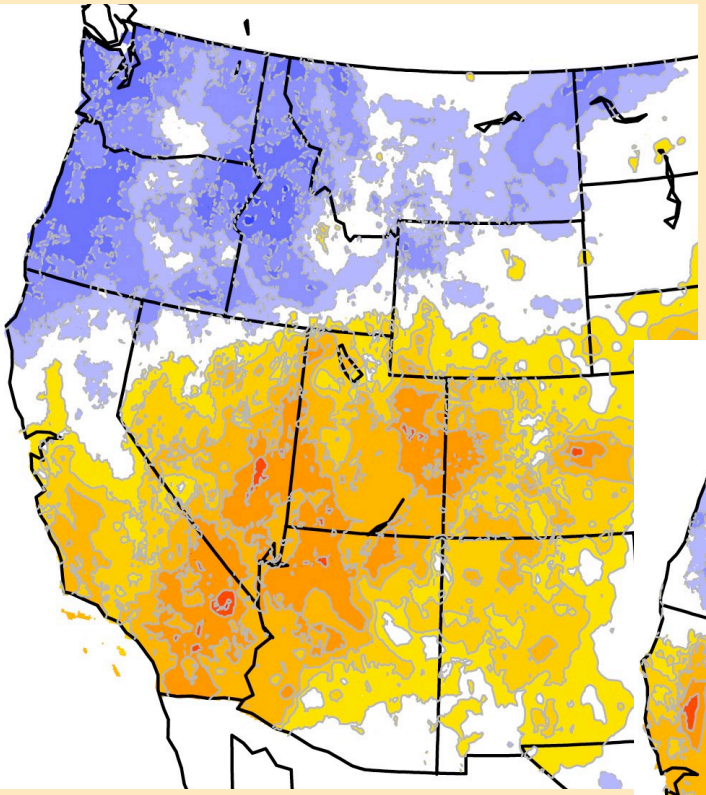




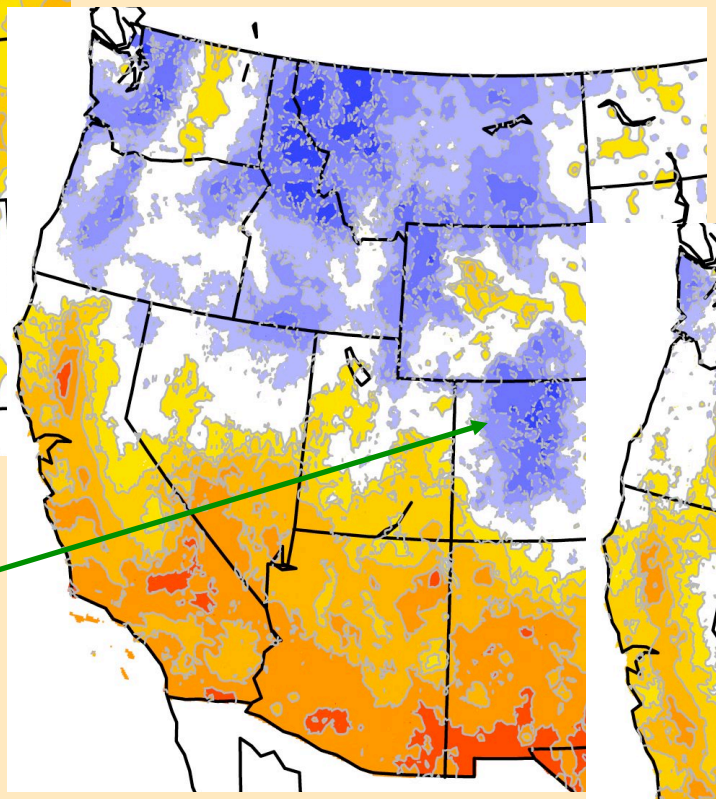
Recap of Fall 2009: El Niño got 'boost in the arm' with increased SST anomalies in October, SOI showing a record-fast drop, and MEI reaching over +1 sigma. Compared to one year earlier, there was much less disagreement on assessing ENSO conditions (and outlook for the winter). The question remained: was this event going to achieve 'strong' status?

What are typical ENSO impacts in Western U.S.?

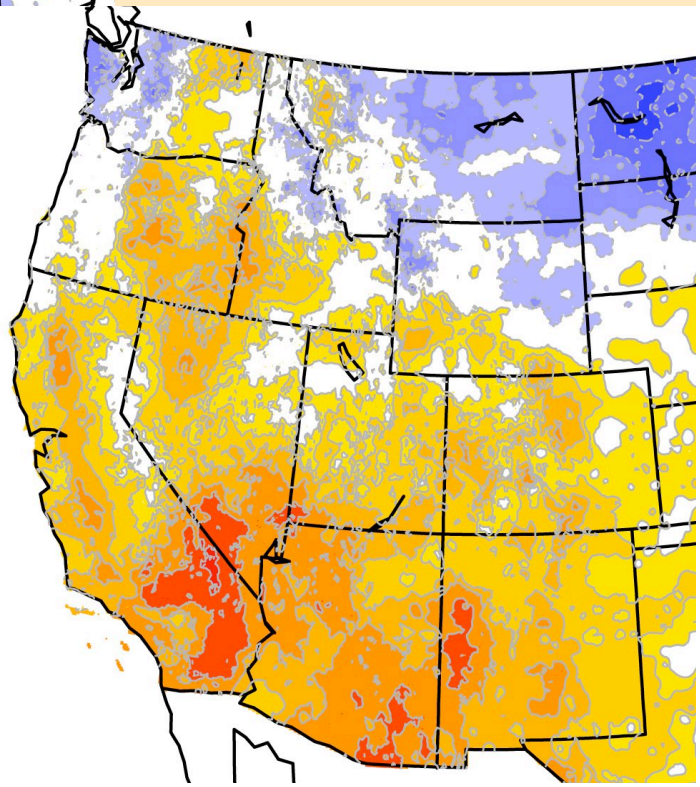
MEI vs. seasonal precipitation: fall is the only season that typically brings more rain to northern CA with La Niña - other seasons and regions tend to be ***wetter with El Niño***, especially in lower elevations, **southern California**, and **spring**!



SEP-NOV

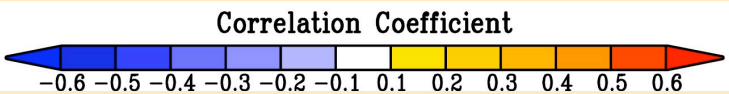


DEC-FEB

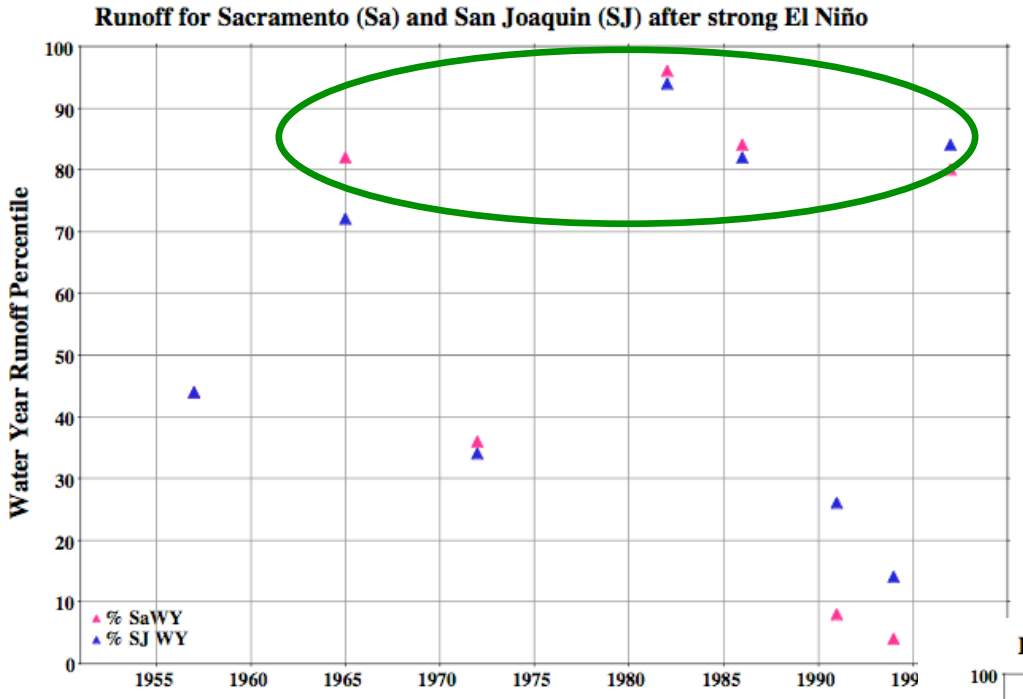


MAR-MAY

Upper Colorado basin prefers La Niña during winter!

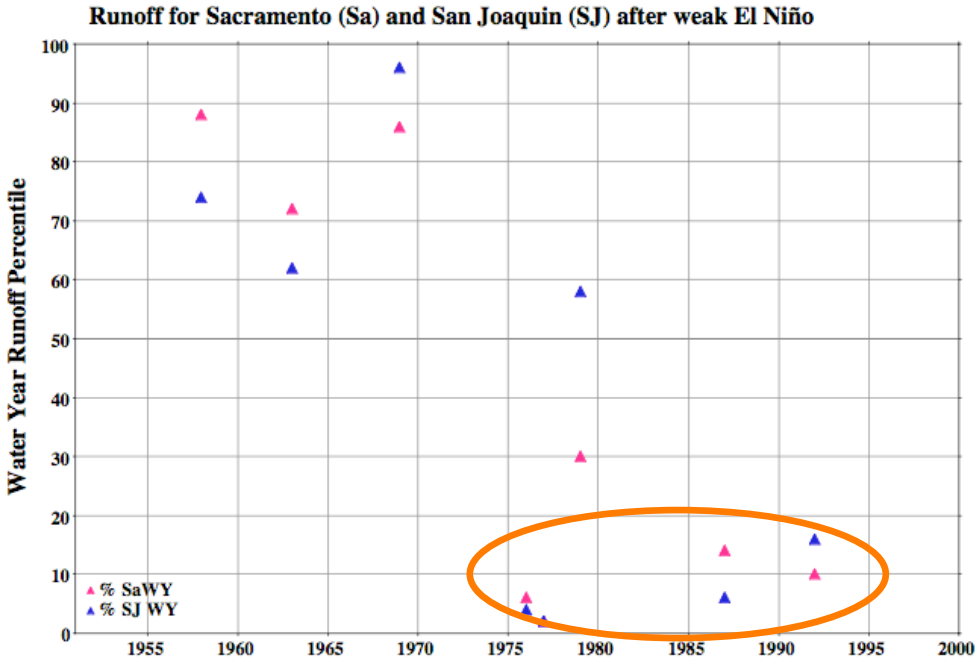


What are typical El Niño impacts in California?

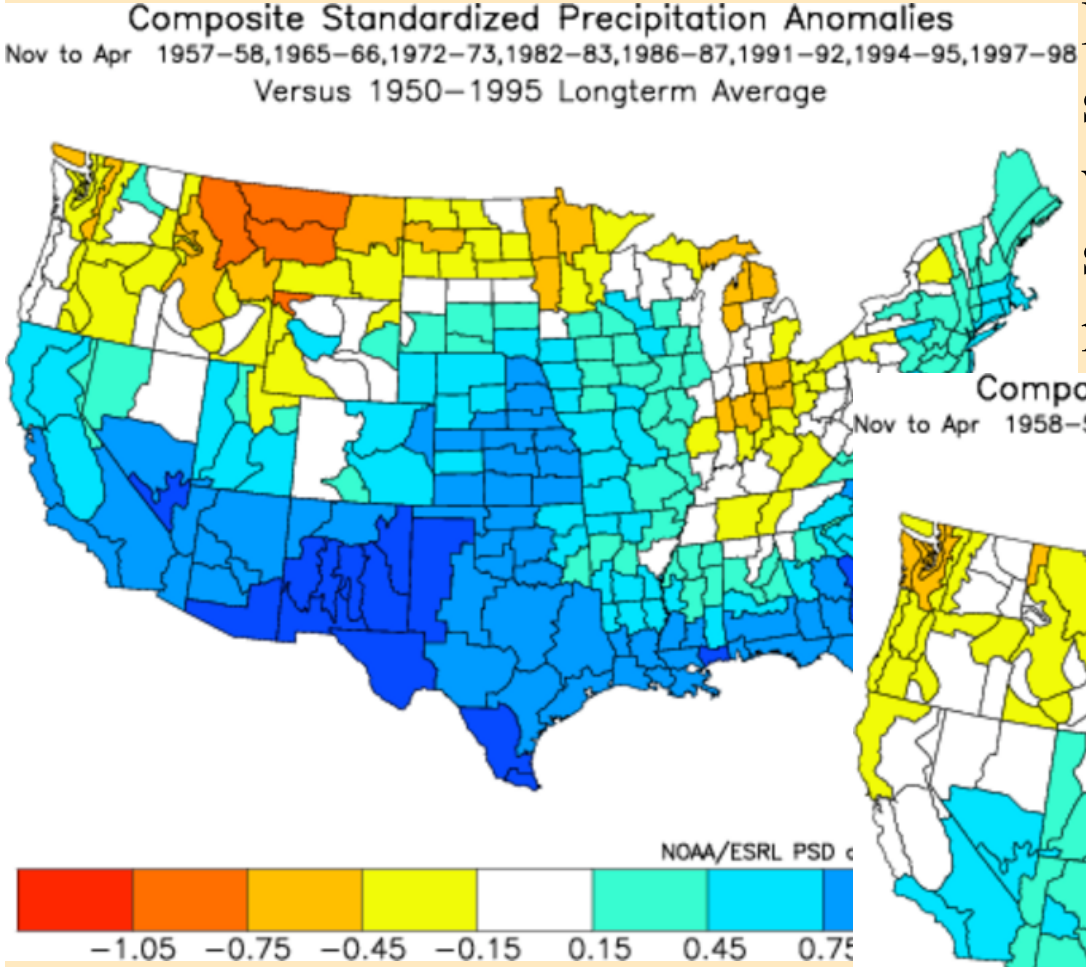


8 **strongest** El Niño winters in 1950-1999 (left) show slight preference in Sacramento & San Joaquin basins for near-normal to high runoff (4 out of 8 in **highest quintile** for Sacramento basin, but 2 in lowest quintile).

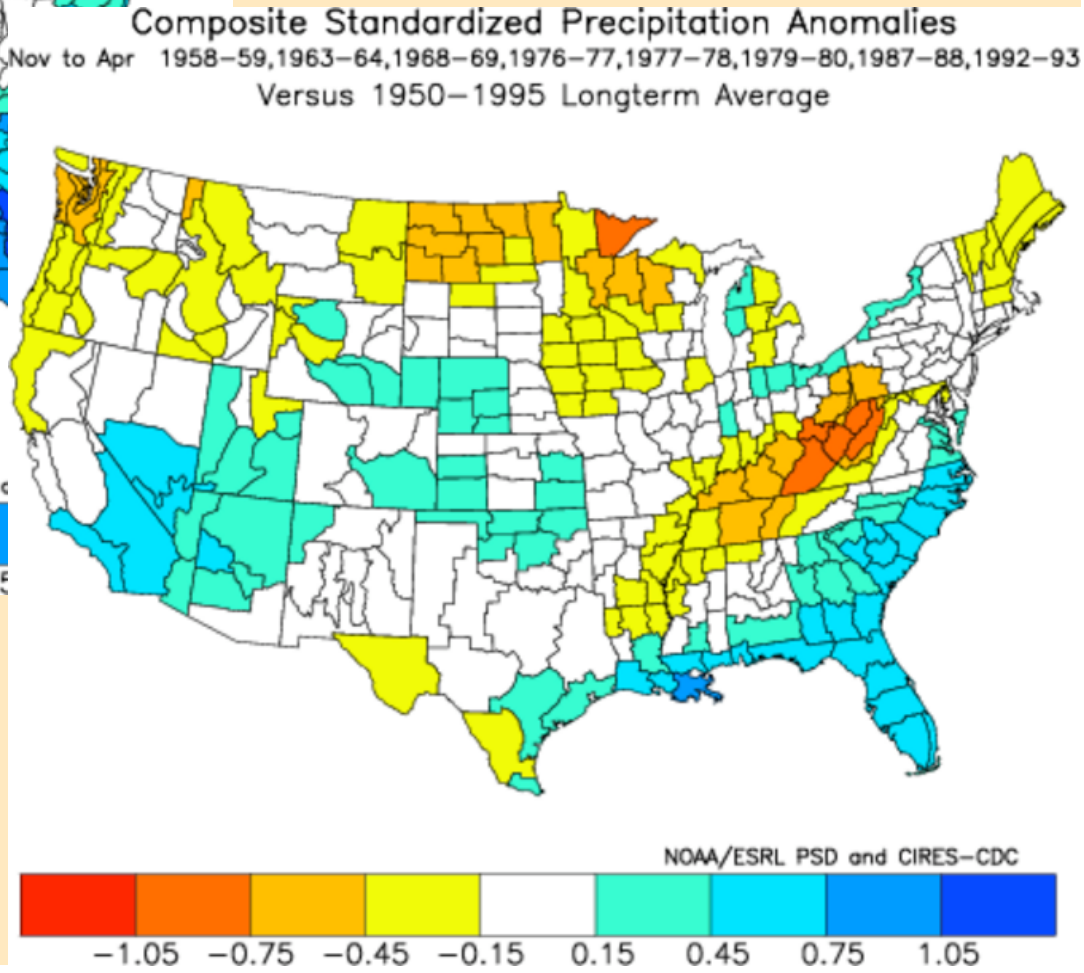
8 **weak-moderate** El Niño winters in 1950-99 (right) show slight preference for near-normal to low runoff, especially from late ‘70s to ‘90s (3 of 8 in **lowest quintile**).



What are typical El Niño impacts on precipitation?

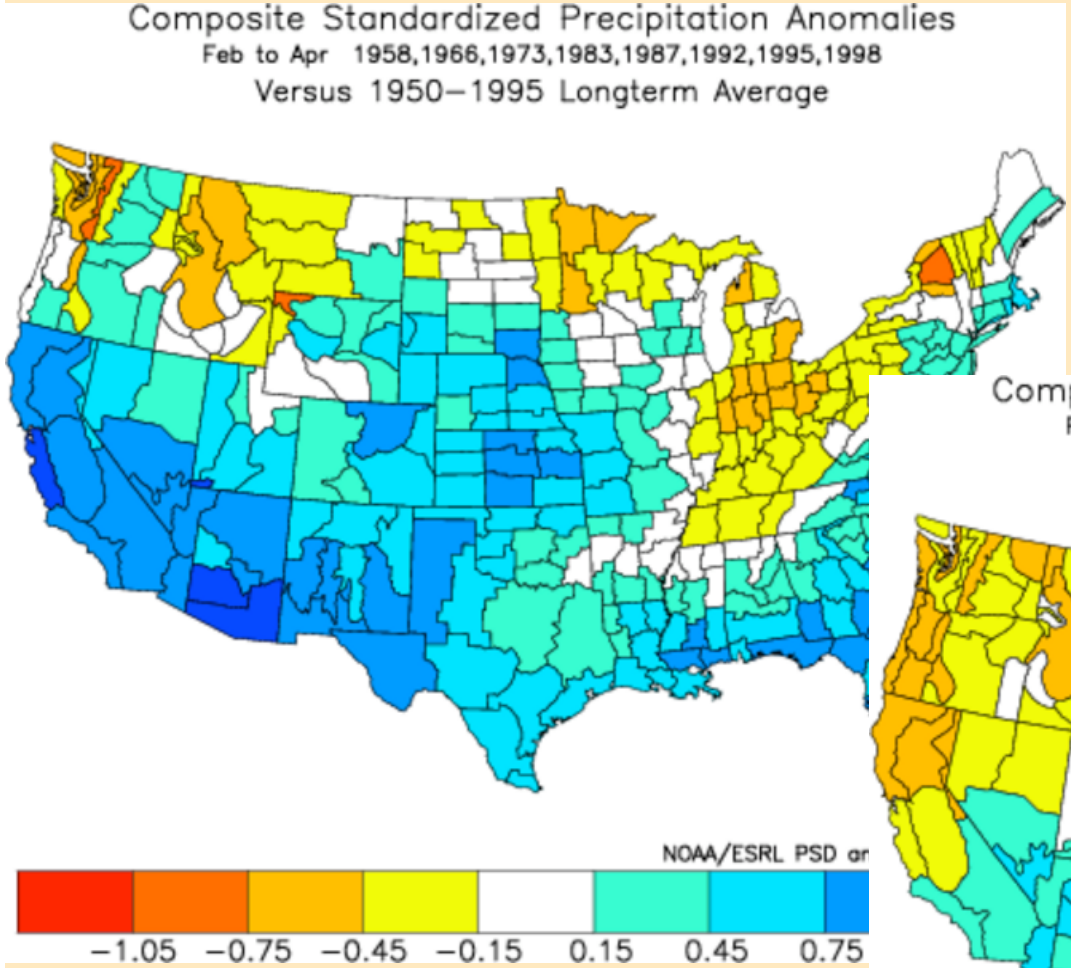


Nov-Apr Precipitation: Eight strong El Niño (**left**) vs. eight weaker El Niño cases (**bottom**) show overall better odds for moisture in southern CA.

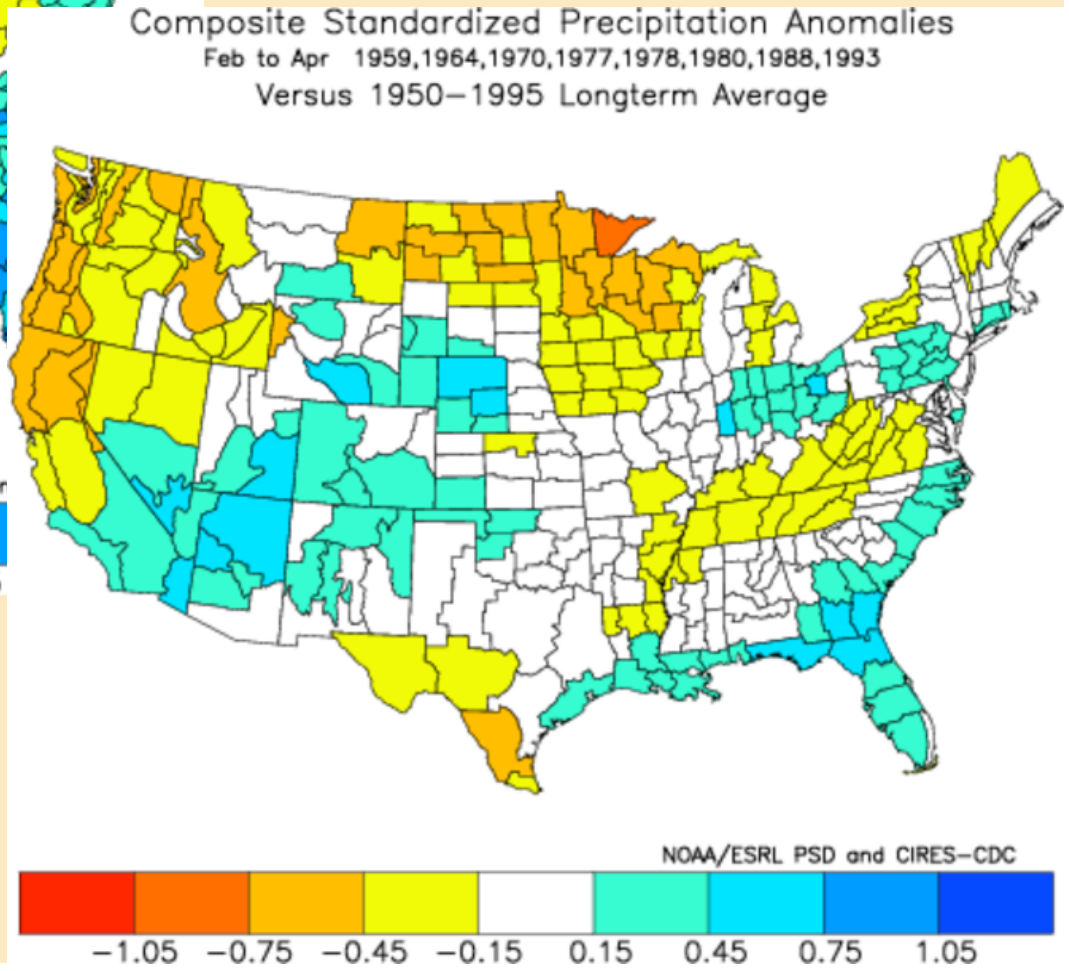


Stronger Los Niños have more reliable wet signal in southern tier of states than weaker Los Niños!

What are typical impacts in Western U.S.?

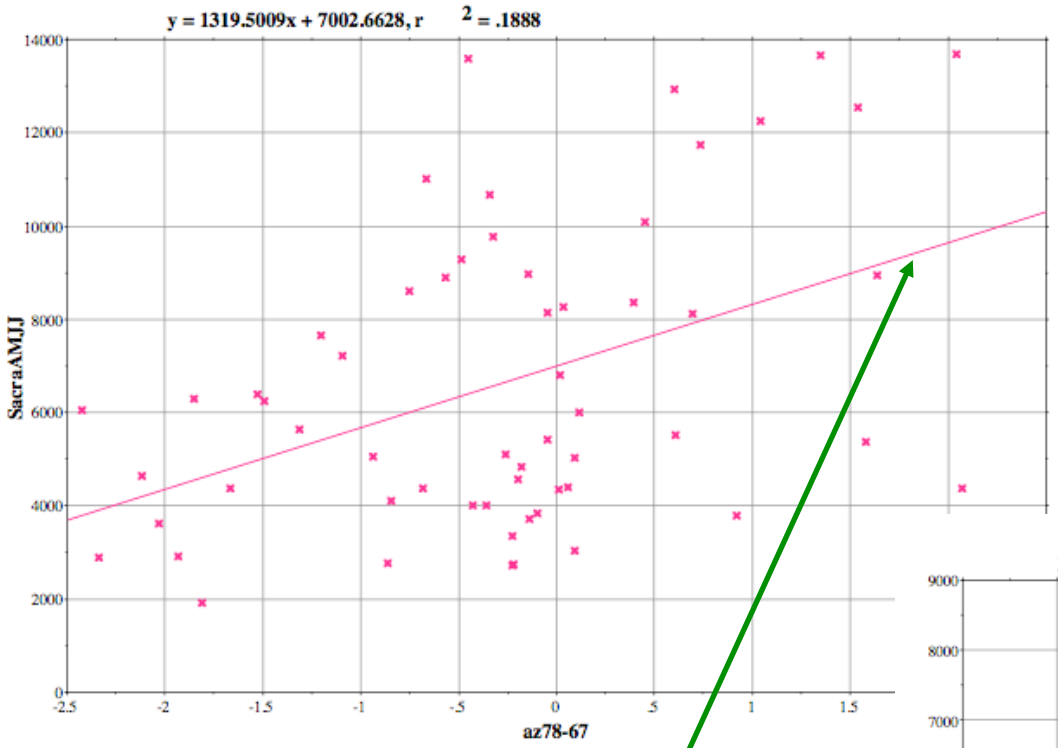


Feb-Apr Precipitation: Eight strong El Niño (**left**) vs. eight weaker El Niño cases (**bottom**) show better odds for moisture in late winter to spring.



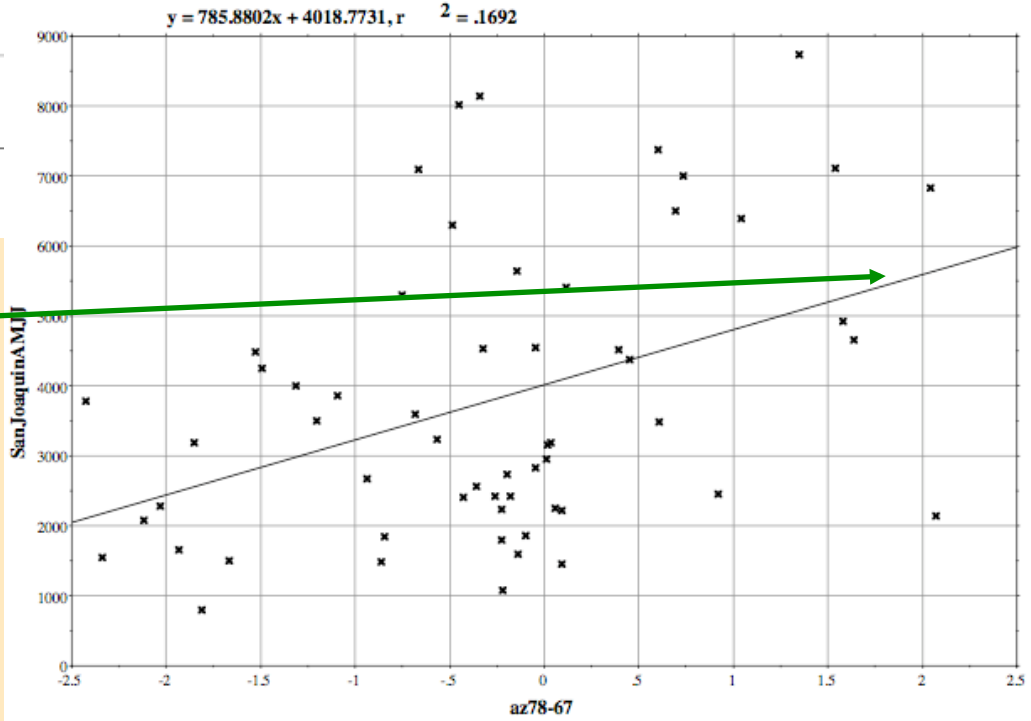
Late season signal is stronger for much of California than full season signal!

Among the many other teleconnections that were considered:



Summer trend in SLP near Azores: Rising pressure in subtropical North Atlantic is often followed by good runoff in Sacramento and San Joaquin basins! ***2009 had good tilt towards wet conditions.***

2009



Indian Ocean Dipole *data was compromised in its western portion ('the pirates stole the data');* ***October cold*** *in central U.S. does not show systematic relation with CA precipitation*

Forecast statement (3 November 2009)

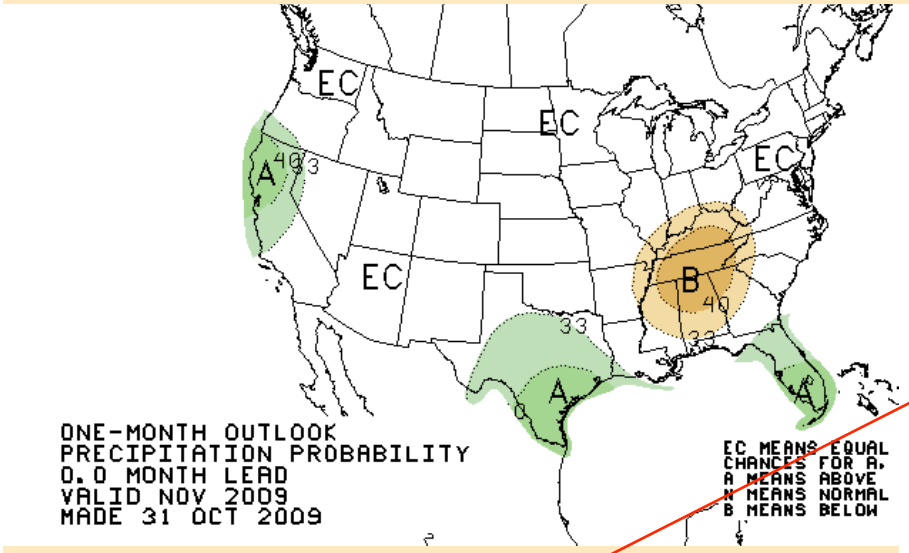
- *Next two weeks don't look as wet as last month; best chance for moisture later this week, mainly in northern California.* √

- **Current classification of growing El Niño / neutral PDO gives southern CA best chances for a wet season, while the odds for moisture improve in all of CA if this El Niño maintains current strength or were to get stronger. If the PDO slips back into the negative phase this winter, El Niño associations could be disrupted again.** ***PDO wavered, but is now positive***

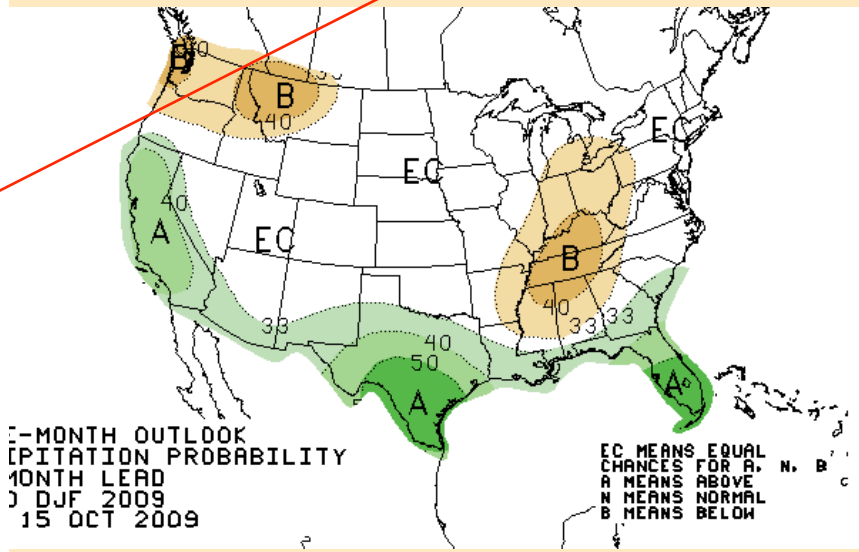
- **Most other influences (Indian Ocean, Azores high) leave us with similar scenarios, while recent cold in high plains (warmth in Alaska) doesn't show much influence one way or the other.**

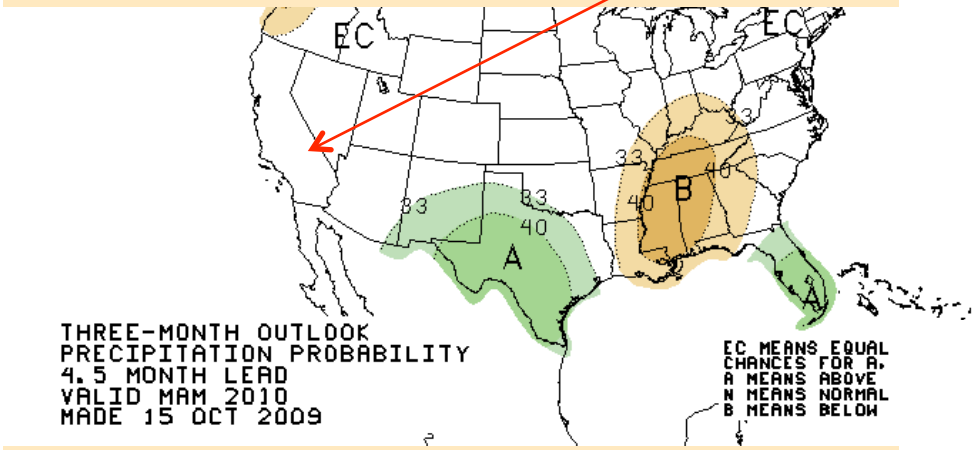
- *Upper Colorado River basin tends to be somewhat dry in the winter with Los Niños, but wet in the spring; if snowpack remains close to normal into the winter, the odds are good for improvement during the spring.* ***Snowpack is a bit low, but should improve***

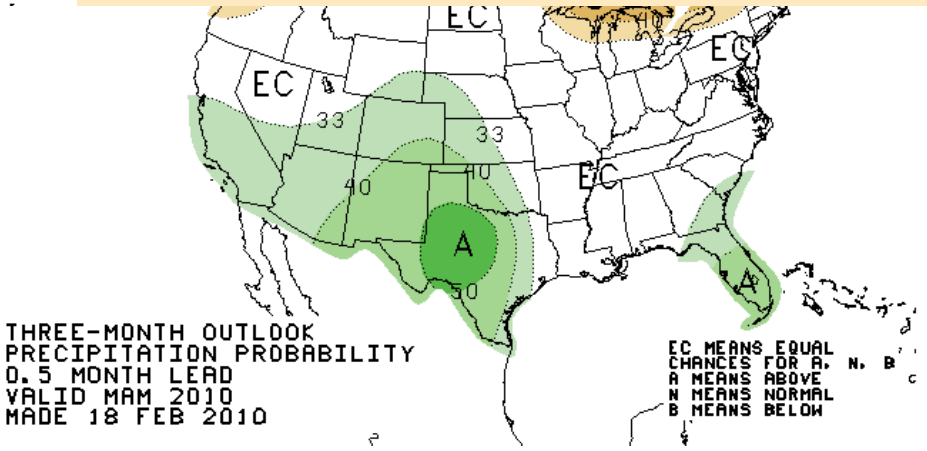
What was the 'official' word from the Climate Prediction Center?



Surprisingly bullish for CA in NDJF, but not MAM!

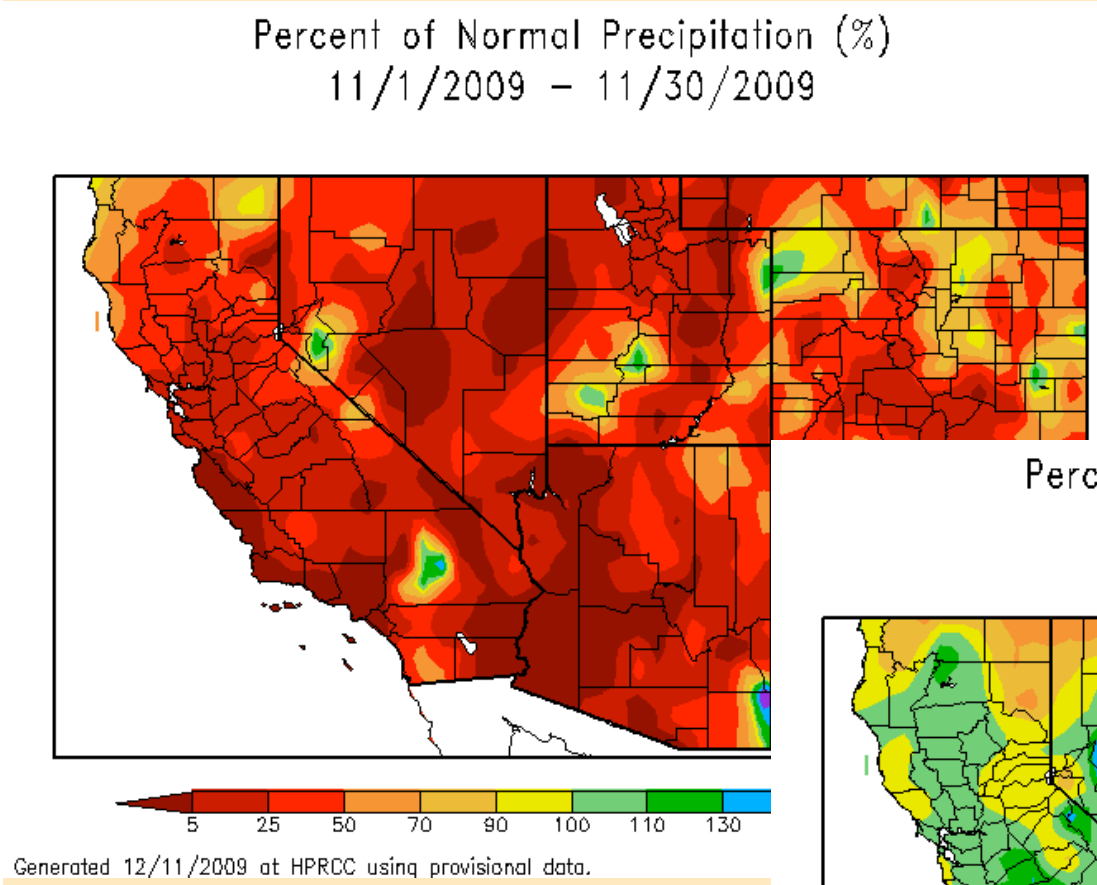




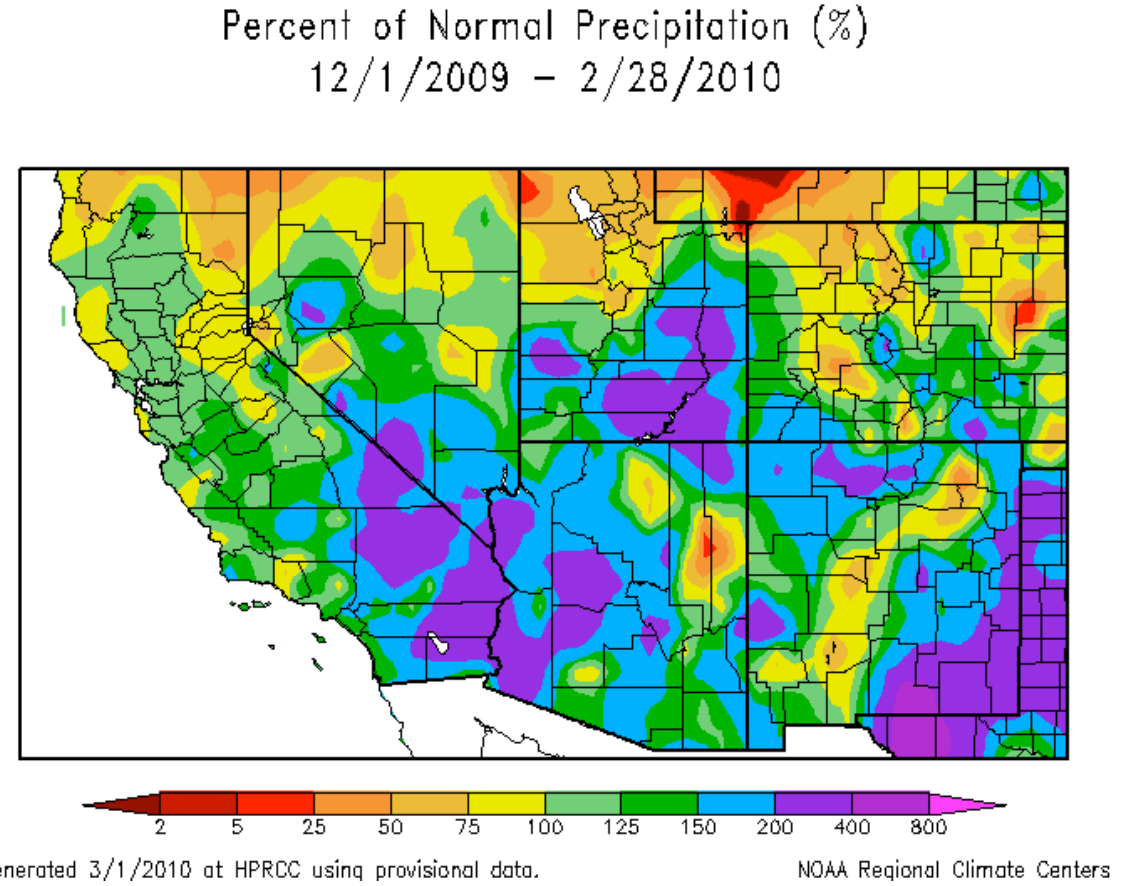


Updated MAM forecast (right) more optimistic

What happened (so far)?



November ended up dry

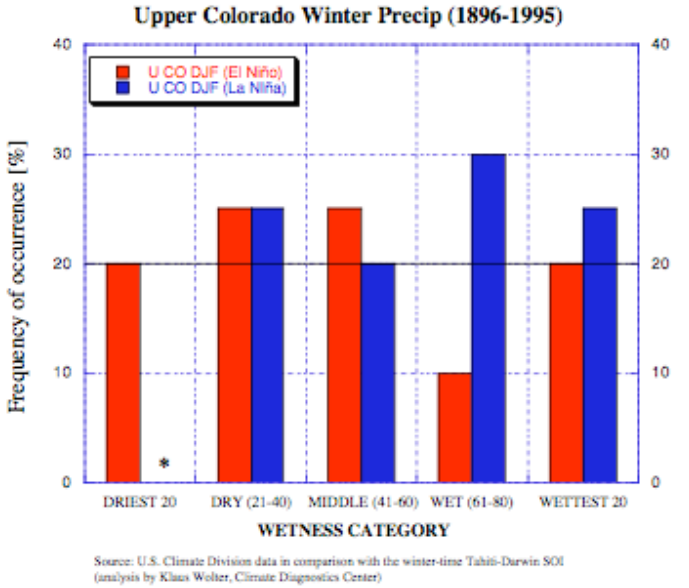


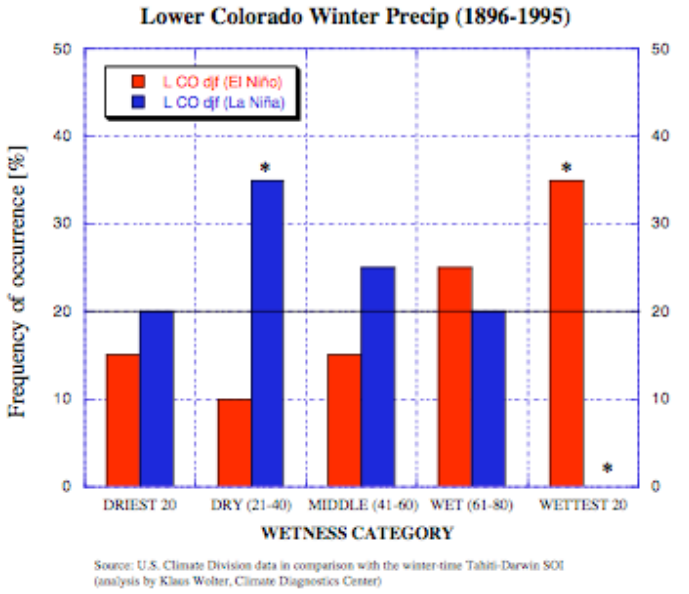
Winter was wet in southern California & near-normal in north thru February; temperatures ended up close to normal (no excessive melting).

Possible improvements to CA climate forecasts

- **Increase effort to similar scale as for interior southwestern U.S. (customize teleconnection predictors for this region)**
- **Look at demand side in addition to supply side (combined temperature&precipitation forecasts?)**
- **Expand temporal scope to two+year forecasts/risk assessments**
- **Get better handle on 'atmospheric rivers' and intraseasonal events (MJOs) and their impacts on seasonal forecasts**
- **Improve coupled models to address above items**

Colorado River El Niño Basin winters&springs





Winter (left)

vs.

Spring (right)