Lessons Learned from 7 years of Water Year Outlooks in California

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- **Background**
- **Focus on Northern CA (8 and 5 Station Indices)**
- **ENSO footprints**
- **CPC skill**
- **Analogues & Experimental Forecasts since 2009/13**
- **Summary**

Background

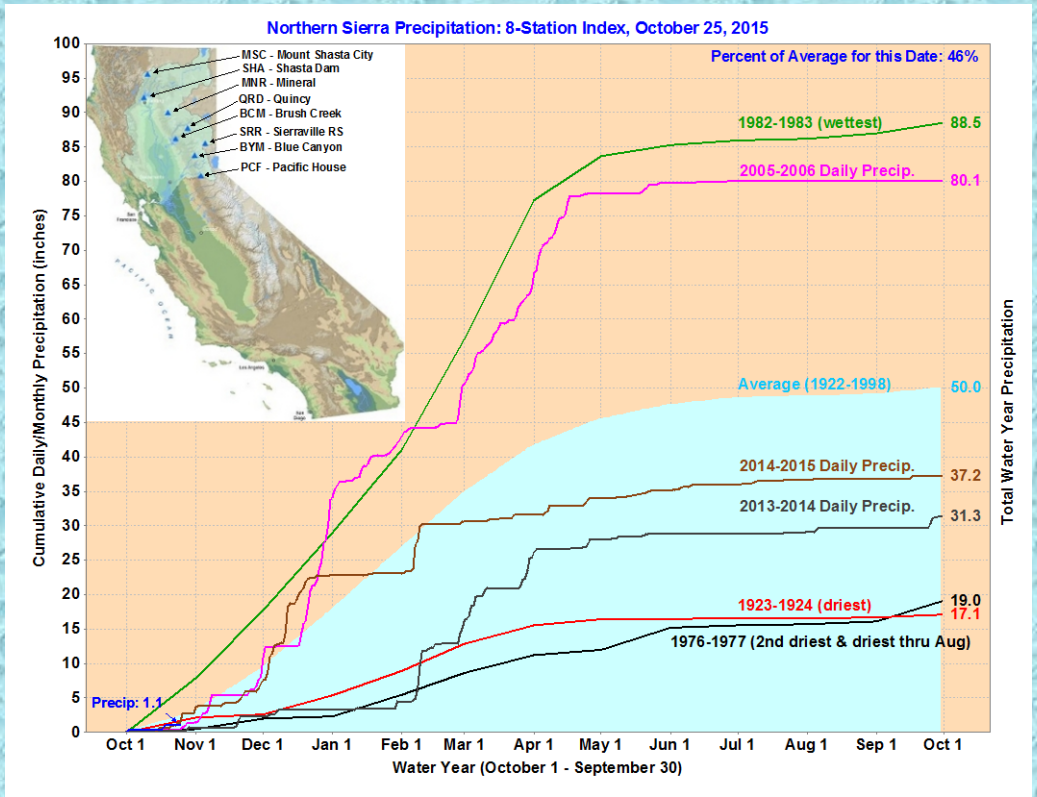
- Outlook presentations at **Colorado Water Availability Task Force** since 1999 first supported through **Western Water Assessment,** now **Colorado Water Conservation Board** and **NIDIS**

- Monthly conference calls with **CPC** to help improve seasonal forecasts on a national scale, e.g. through climate risk tool, just updated to use extended MEI for last 120 years: ***http://www.esrl.noaa.gov/psd/enso/climaterisks/***

- Engagement with **NIDIS** through regional drought early warning briefings across the southern tier of states (*after this El Niño there may be more interest to the north as well*)

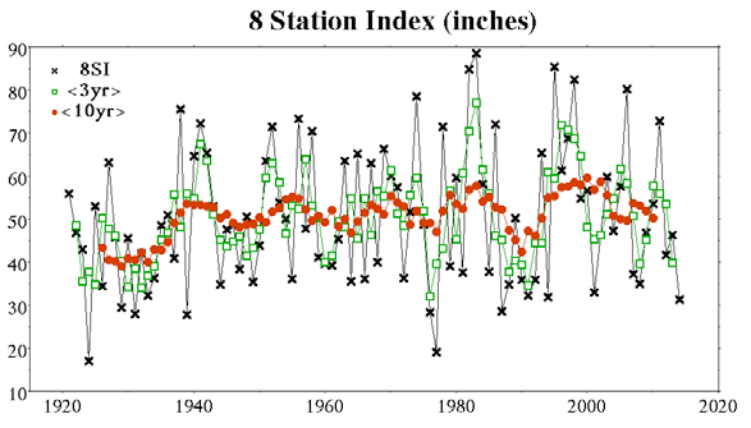
- Annual fall briefings since 2008 about the upcoming Water Year to increase awareness about water supply situation (funded by **California Department of Water Resources**)

Northern CA '8 Station Index' (8SI)



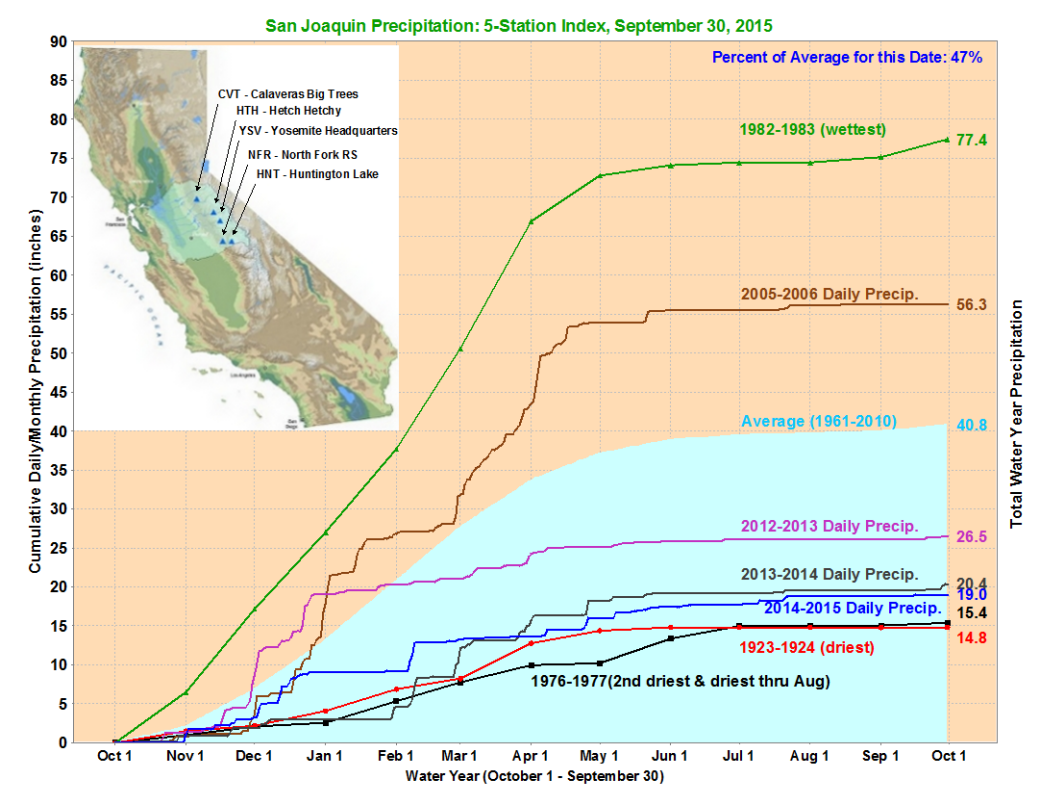
Sacramento Basin is well represented by 8 Station Index (8SI), which just finished a 4th consecutive drought year

http://cdec.water.ca.gov/cgi-progs/products/PLOT_ESI.pdf



8SI shows multi-year droughts since 1921, but little long-term trend (if anything, there is a slight upward trend)

Central CA '5 Station Index' (5SI)

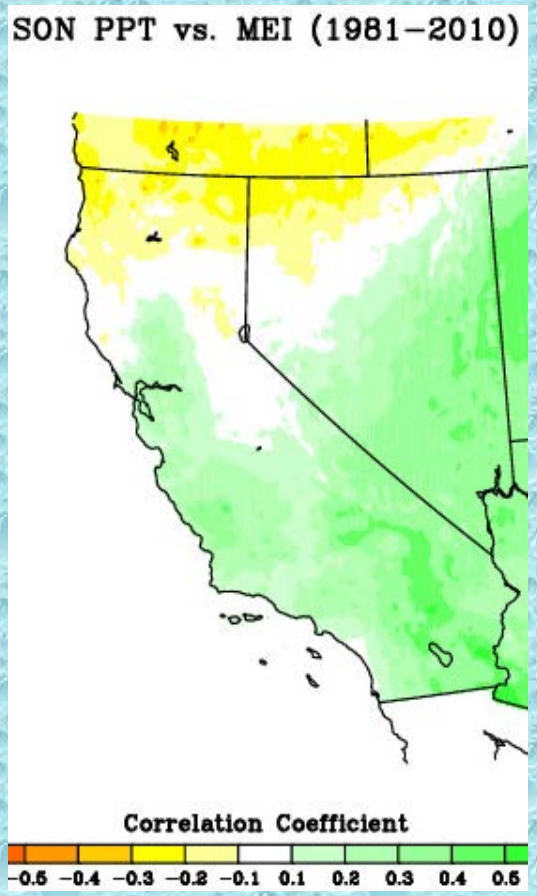


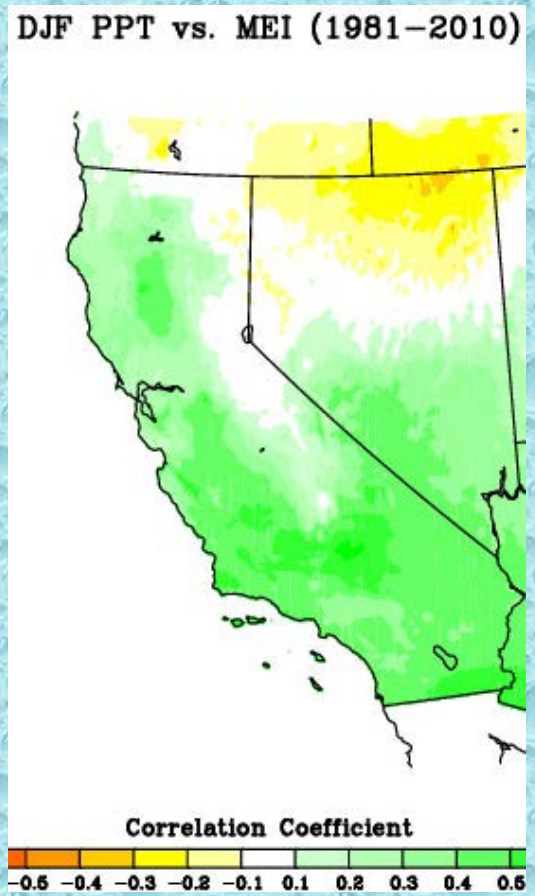
San Joaquin Basin is represented by 5 Station Index (5SI), which just finished off its driest three-year spell on record

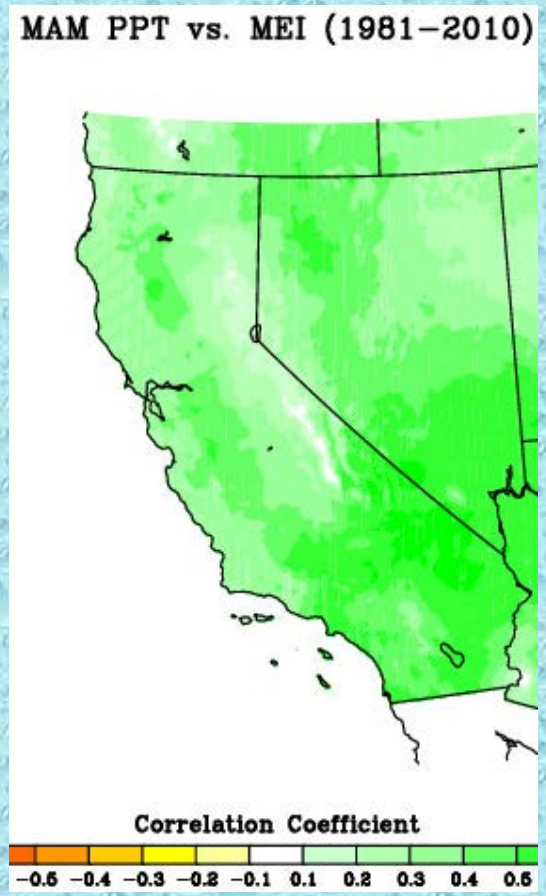
http://cdec.water.ca.gov/cgi-progs/products/PLOT_FSI.pdf

8SI and 5SI correlate at +0.91 for the 95 years in common since WY 1921, with a slightly higher COV for the 5SI (34) than the 8SI (32).

ENSO footprint in California







Most of 'wet El Niño' signal is at lower elevations, while Sierra Nevada remains 'on the fence' all the way into spring, which is the most favorable season overall. ***Dec-Feb contributes 50% of total moisture***

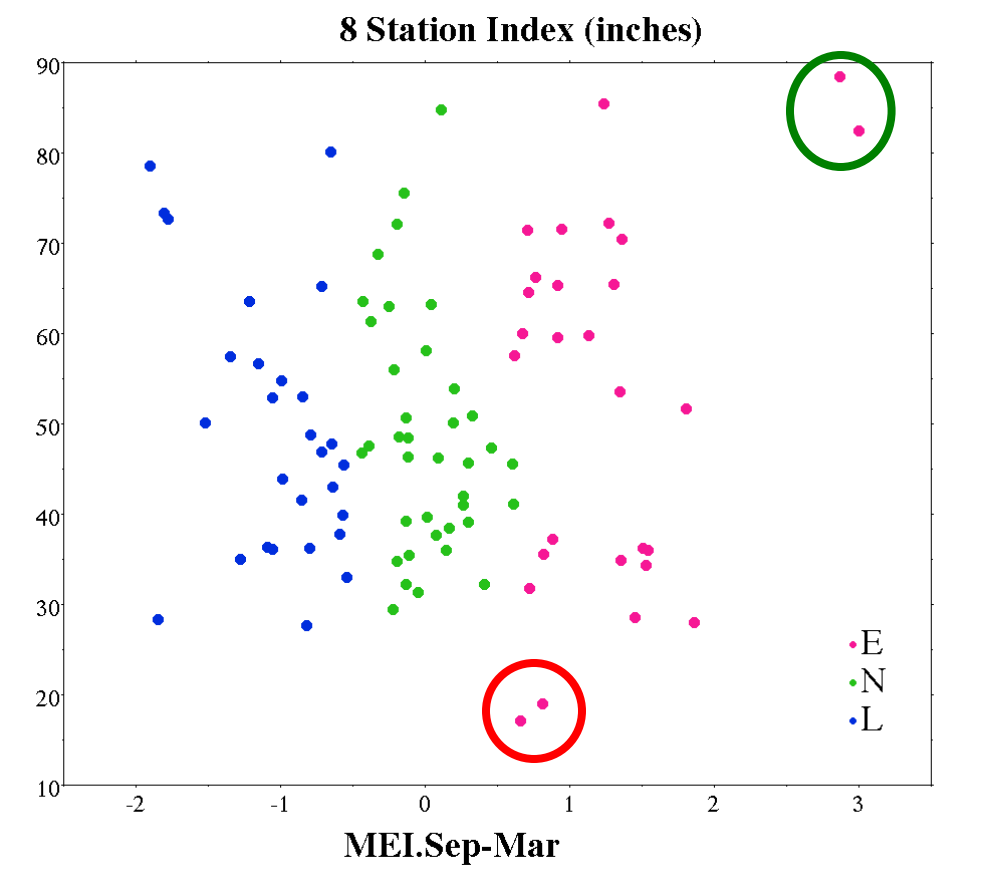
http://www.esrl.noaa.gov/psd/enso/mei/

ENSO and '8 Station Index'

Using an extended version of the MEI*, the last 95 years of the 8SI show little sensitivity to ENSO (linear correlation under 0.1).

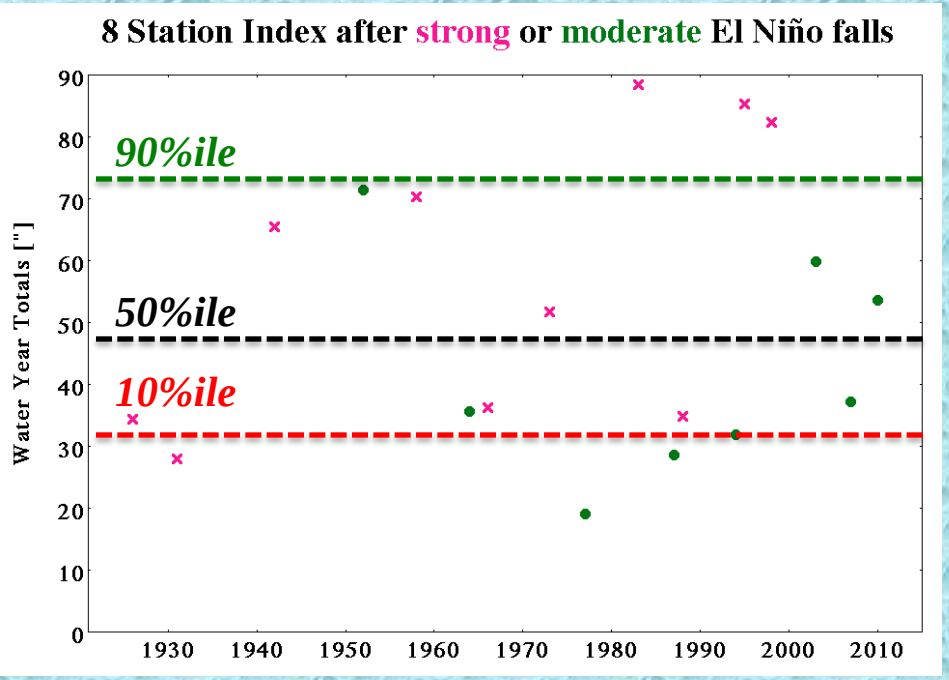
In fact, El Niño events encompass the two driest ('24, '77) and two of the wettest ('83, '98) Water Years.

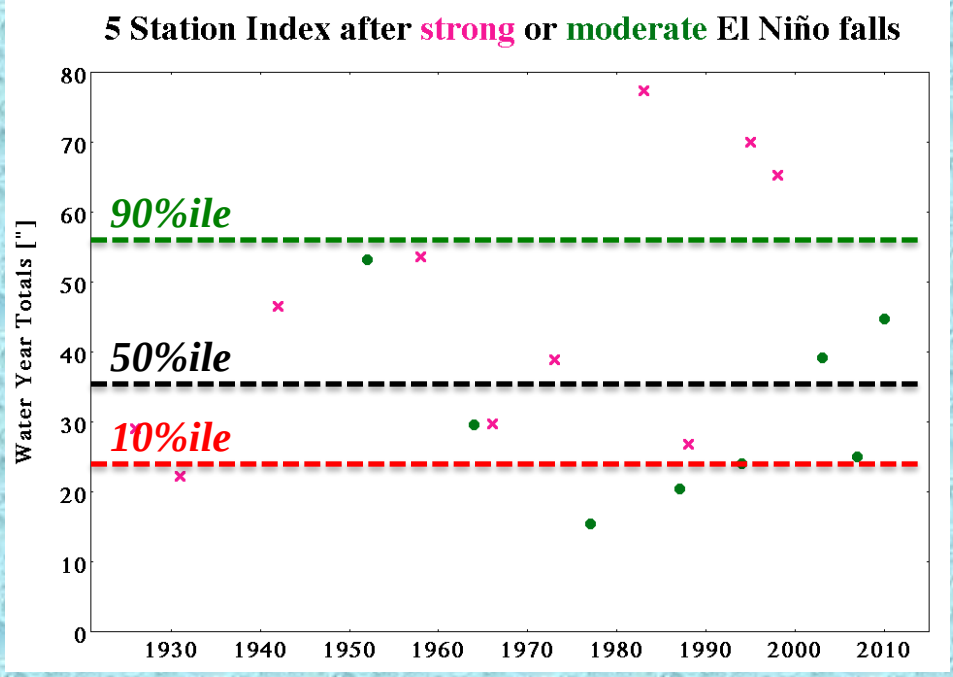
Very similar results for 5SI



Wolter and Timlin, 2011, *Int. J. Climatology**

What about the difference between strong and moderate Niños?





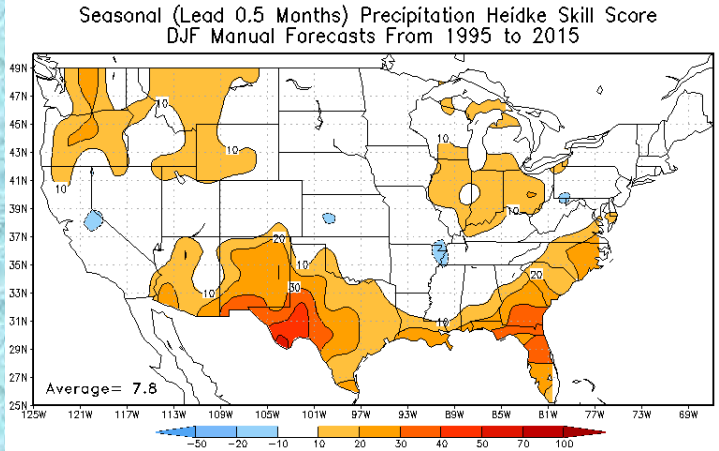
Both the Sacramento and San Joaquin basins get **more precipitation** if a **strong El Niño** is in place during fall (especially if it is a 'Super-El Niño), not too different from modeling results presented later at this workshop (Hoell et al., 2015). **It triples the *a priori* odds for reaching the highest decile of the distribution (*above green lines*) for *strong* El Niño cases, while a *moderate* El Niño situation triples the inverse odds of dropping below the lowest decile threshold (*below red lines*).**

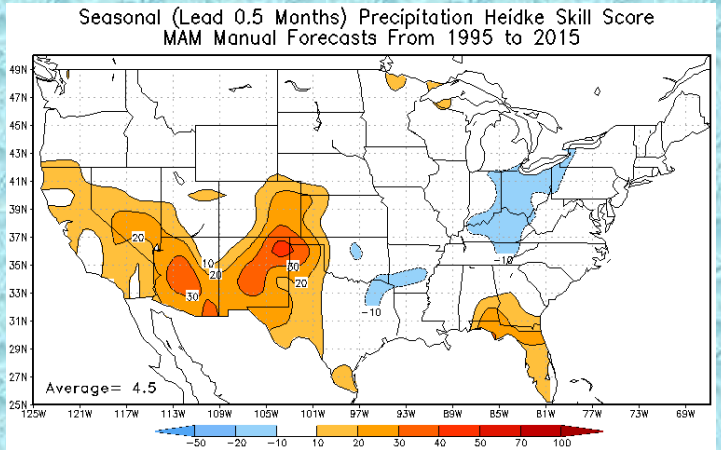
CPC seasonal forecast skill

- **During winter (when it counts the most), CPC forecasts have had a hard time with CA precipitation forecasts**

- **The forecast skill has been better during spring (related to ENSO)**

- ***CPC uses 'Heidke Skill Score' which counts number of tercile hits (1 out of 3 hits is like flipping a coin, or a score of 0, 3 out of 3 = +100, 0 out of 3 = -50)***

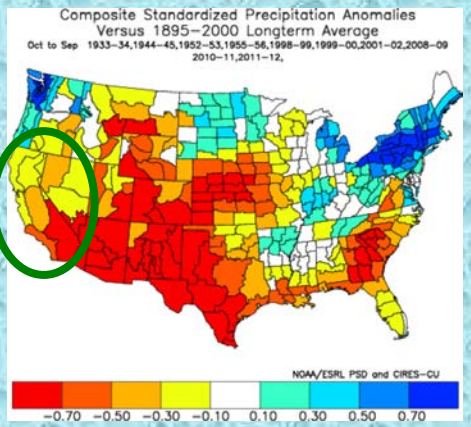


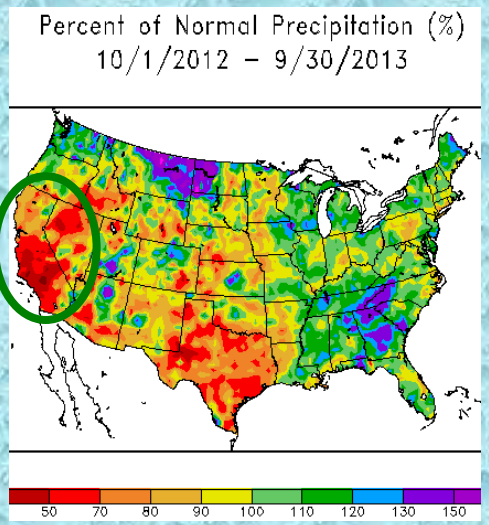


http://www.cpc.ncep.noaa.gov/products/verification/summary/index.php?page=map

Forecasts of Opportunity – 'Analogues'

- Summer of 2012: most extreme combination of negative PDO and positive AMO on record*
- While this spelled drought conditions for CA, it anchored a successful forecast (skill score of +29 for 2012-13)
- In addition to the state of **ENSO** (including 2nd year considerations for La Niña), I key in on the **PDO**, **AMO**, as well as the **NAO**, to pick analogues from the last 100+ years of data





Schubert et al., 2009, J. Climate*

Forecasts of Opportunity – 'Analogues'

Water Year skill levels for CA climate divisions based on analogues (in case of two sets of analogues, it is the average), as well as forecast performance for 8SI &5SI

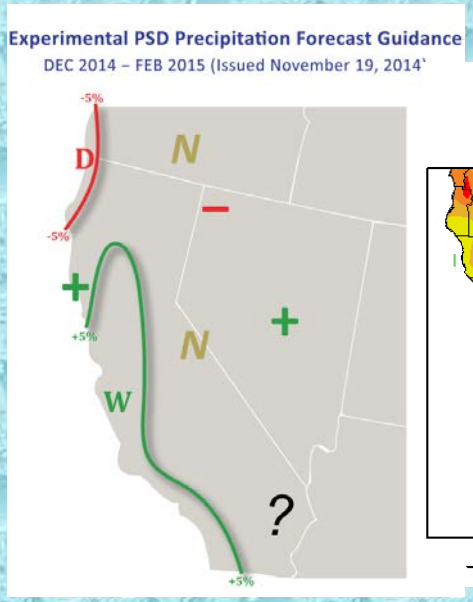
Water Year	Heidke Skill Score 7 CA CD's	8SI (obs/pred)	5SI (obs/pred)	Terciles for 8SI/5SI (obs/pred)
2009	+14	46.9/51.1"	38.9/40.7"	N/N & N/N
2010	+14	53.6/55.6	44.7/45.9	N/N & W/W
2011	-7	72.7/52.9	65.4/46.5	W/N & W/W
2012	+29	41.6/52.7	24.9/42.8	N/N & D/N
2013	+29	44.3/50.7	26.5/37.8	N/N & D/N
2014	+14	31.3/46.6	20.4/33.8	D/N & D/N
2015	-7	37.2/57.5	19.0/40.0	D/W & D/N
<7yr>	+12	46.8/52.4	34.3/41.1	HSS: +36 / +36

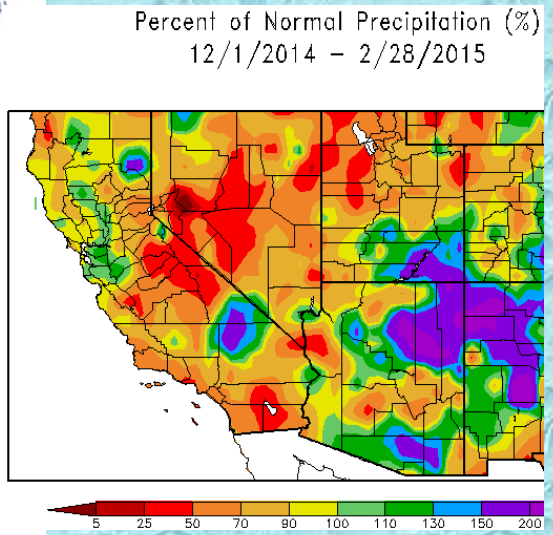
Experimental Forecast Guidance

- Teleconnection indices and regional SST anomalies are utilized for CA precipitation outlooks via cross-validated stepwise multiple linear regression models

- The last winter forecast correctly anticipated more abundant moisture near the coast (“W”) than further inland and further north (“D” or “N”) – *that’s about the most charitable thing that can be said about that forecast season*

- Forecasts have been made for three winter and spring seasons so far, *with mixed success*





Summary and Future Work

- **CA is sensitive to ENSO, but least where it counts the most (unless you get a Super-El Niño) – *Predicting ENSO is not the (only) answer to figuring out CA's water supply!***

- **Analogue forecasts based on 'flavors of ENSO' and other influences have shown moderate skill (*such as the correct tercile for the 8 and 5 Station Indices in 4 out of 7 years*) - a more sophisticated statistical forecast model has had too short a run to be evaluated yet**

- **CA gets much of its moisture from 'Atmospheric River' (AR) events – if there is any seasonal predictability for those, that would be of great benefit**

- **Multi-year droughts are currently not addressed by any forecast system, denoting a clear gap in our capabilities not just for CA**