# Drought in California – Anomaly or Regular Episode

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Experimental Real-Time TRMM Merged Precip Analysis (TMPA-RT); Dec 1-21, 2014

Brief overture:

Relief in December



#### Experimental GEOS5 forecast, Dec 1-21, 2014







Accumulated amounts.

Average over California December 1-21

• On average, about a third of the deficit has been recouped.

However:

- Most of it went to Northern California.
- In addition to the deficit, we need to collect the normal amounts, for the 2014-2015 season.



## INTRODUCTION

- California is at the top amongst agricultural states, with \$42.6 billion agricultural output, leaving Texas ranked only forth by cash receipts [CDFA, 2012].
- California produces 80% of the world's almonds, and at \$4.347 billion value in 2012, it is the third top agricultural commodity of the state.
- The demand for almonds in the past 4-5 years has increased the price 2 to 3 times, while it takes about a gallon of water to grow a single almond.
- How does the recent drought measures with respect to recent history? Have such an episode been experienced at the current population and commercial infrastructure levels?



- Data/Methods:
  - 1. MERRA\*: MATMNXFLX (Turbulent flux diagnostics), "PRECTOT" MAIMCPASM (Assimilated state), "SLP", "U", "V"
  - 2. TRMM\*\*: 3B43 (Monthly merged TRMM and other sources)
- Data over California extracted using shape files in IDL.
- Confidence test of anomalies and correlations: Student's t-test.

- \* Modern-era Retrospective Analysis for Research and Applications
- \*\* Tropical Rainfall Measuring Mission





California mask, using available in IDL shape files.



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Precipitation climatology over California from TRMM and MERRA data.

 Wet season starts August-September. If by March-April California does not receive its regular amounts, it most likely will not recover until the next season.





Average monthly precipitation over California for the time period of TRMM

- The reanalysis and observations are remarkably consistent.
- Both imply the peak of the water season highly variable.





- Monthly Precipitation anomalies over California, at 95% confidence, in the first four months of 2014
- Precipitation in Feb and March is so variable we can't say with 95% confidence if there is an anomaly in 2014.



TRMM and MERRA monthly anomalies regressed to Multivariate ENSO Index. Correlation coefficients at 95% confidence only are shown.





- Consecutive dry years have not been something unusual in the past 35 years in California.
- The strength of the drought of the past two years is clearly distinct, though.





Accumulated precipitation: Climatology, past two water years, and accumulation during significant El Niño episodes.

- Accumulated deficit in precipitation in the past two years = 320 kg/m<sup>2</sup>
- Strong El Nino would <u>very likely</u> help



# Multivariate ENSO Index



Current El Niño is riding a rollercoaster.





Yearly anomalies of sea-level pressure

 The contrast between 2014 and 2013 is promising: the Pacific depression in 2014 is conducive for atmospheric rivers to make landfall in California



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2013



Anomalies of winds at 850 hPa (vectors), and precipitation (shades), in 2013.



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### SUMMARY

- The past two years in California significantly deviate from the recent 35-year climate variability.
- While most deficits in the recent past were immediately followed by excess of precipitation, the current episode has been anomalously persistent for 2+ years.
- The reanalysis and observational precipitation data manifest with significant confidence that strong El Niño (the warm phase of ENSO), would very likely help to recoup the deficit in precipitation.
- The current ENSO is unstable, and there is low confidence (65%, NCEP) it will develop into full-fledged El Niño.
- However, the patterns in atmospheric pressure are favorable to atmospheric rivers reaching California. Three major events in December delivered ~1/5 of yearly amounts.

