Western U.S. Extreme Precipitation Events and Their Relation to ENSO in CCSM4

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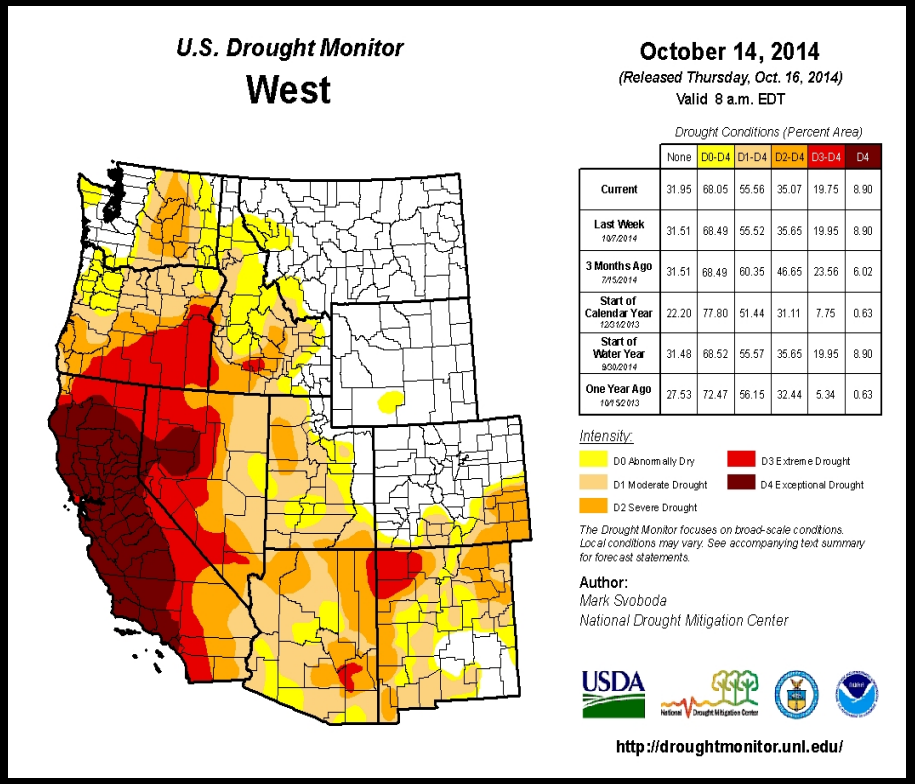
Photo credit: M. DeFlorio

Why study teleconnections and extremes?

- Over $2.2 billion damage and 17,000 agricultural job losses
- 3rd driest water year (Oct '13 – Sept '14) in state history
- Statistically, drought is likely to continue through 2015 regardless of ENSO phase

2013-2014 CALIFORNIA DROUGHT



	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	31.95	68.05	55.56	35.07	19.75	8.90
Last Week 10/7/2014	31.51	68.49	55.52	35.65	19.95	8.90
3 Months Ago 7/15/2014	31.51	68.49	60.35	46.65	23.56	6.02
Start of Calendar Year 12/31/2013	22.20	77.80	51.44	31.11	7.75	0.63
Start of Water Year 9/30/2014	31.48	68.52	55.57	35.65	19.95	8.90
One Year Ago 10/15/2013	27.53	72.47	56.15	32.44	5.34	0.63

Figure credit: U.S. Drought Monitor

Source: Howitt et al. 2014, UC Davis report

July 2011: Folsom Dam

Photo credit: Justin Sullivan

August 2014: Folsom Dam

Photo credit: Justin Sullivan

July 2011: Lake Oroville

Photo credit: Justin Sullivan

August 2014: Lake Oroville

Photo credit: Justin Sullivan

January 18, 2013: California

Image credit: NASA

January 18, 2014: California

Image credit: NASA

Extreme precipitation: not an elixir during prolonged drought

- Extreme precipitation during drought can provide relief to depleted water reservoirs and mountain snowpack
  - But, dangerous flooding and rock/mudslides are common due to extremely dry soil which cannot adequately absorb the heavy bursts of precipitation

Los Angeles flood, Feb-Mar 2014

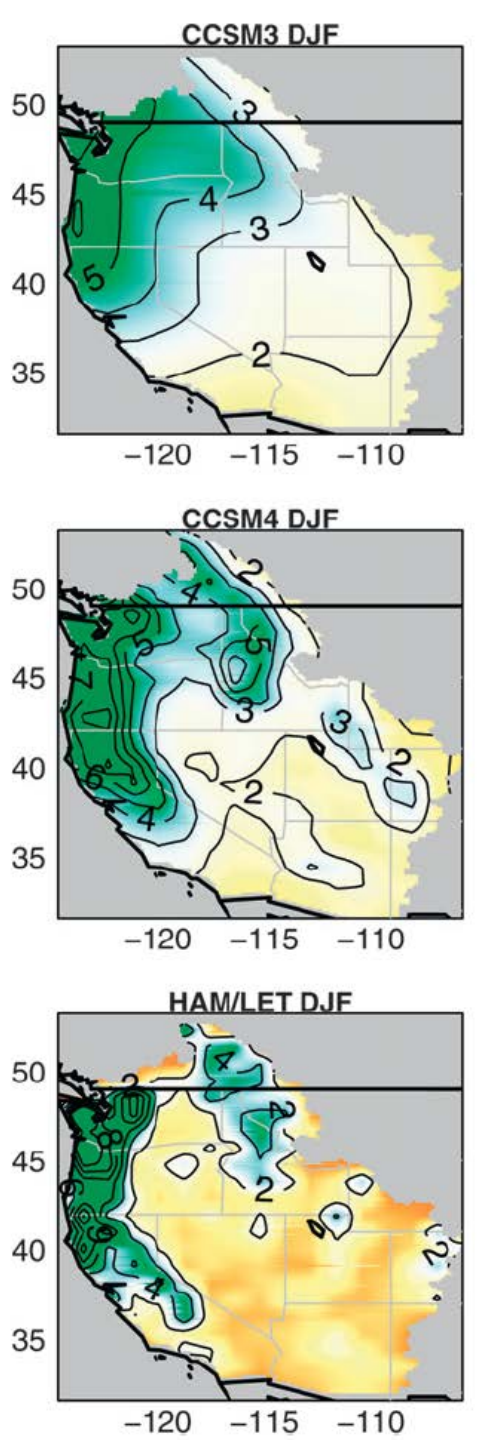
Photo credit: Casey Wian

Photo credit: Johnny Kelly

Evaluating and characterizing western U.S. extreme precipitation events in CCSM4

- CCSM3
  - 500 year monthly P.I. control run, 50 year daily P.I. control run
  - T85 (1.4° lon x 1.4° lat) resolution
- CCSM4
  - 1300 year monthly P.I. control run, 150 year daily P.I. control run
  - 1.25° lon x 0.9° lat resolution
- OBS
  - 53 year daily gridded dataset *(Hamlet and Lettenmaier 2005)*
    - Preferable to station data for model validation *(Chen and Knutsen 2008)*
  - 0.125° lon x 0.125° lat resolution, regridded to model resoluton
  - only used data after 1950 due to large spatial density increase after WWII

DJF precipitation climatology

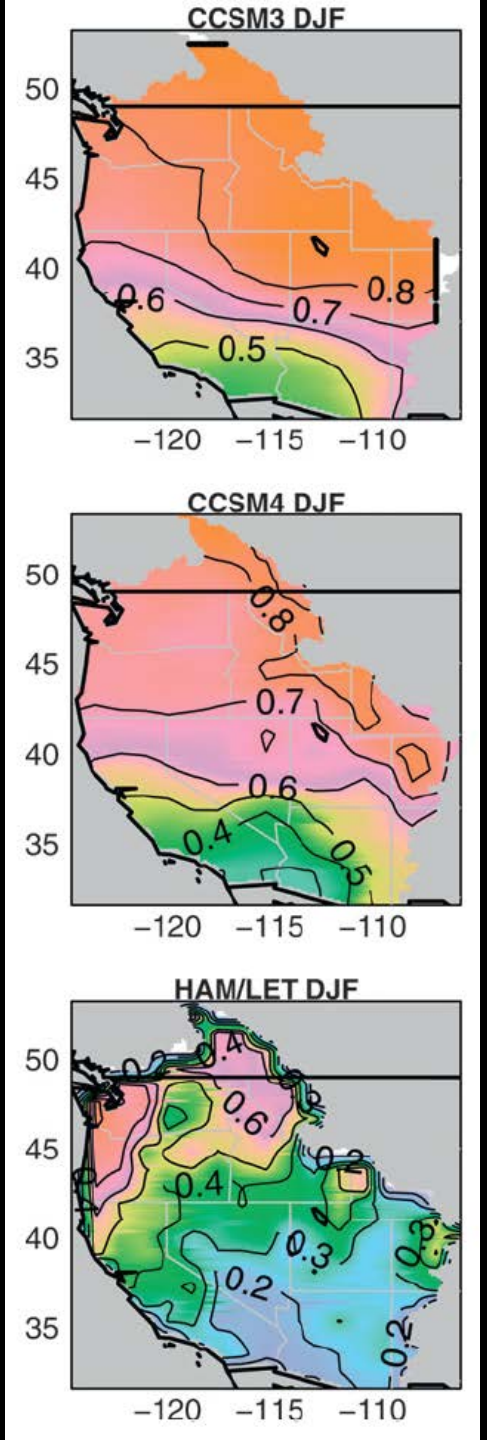


CCSM3

CCSM4

OBS

Fraction of DJF precipitating days (> 0.1mm/day)

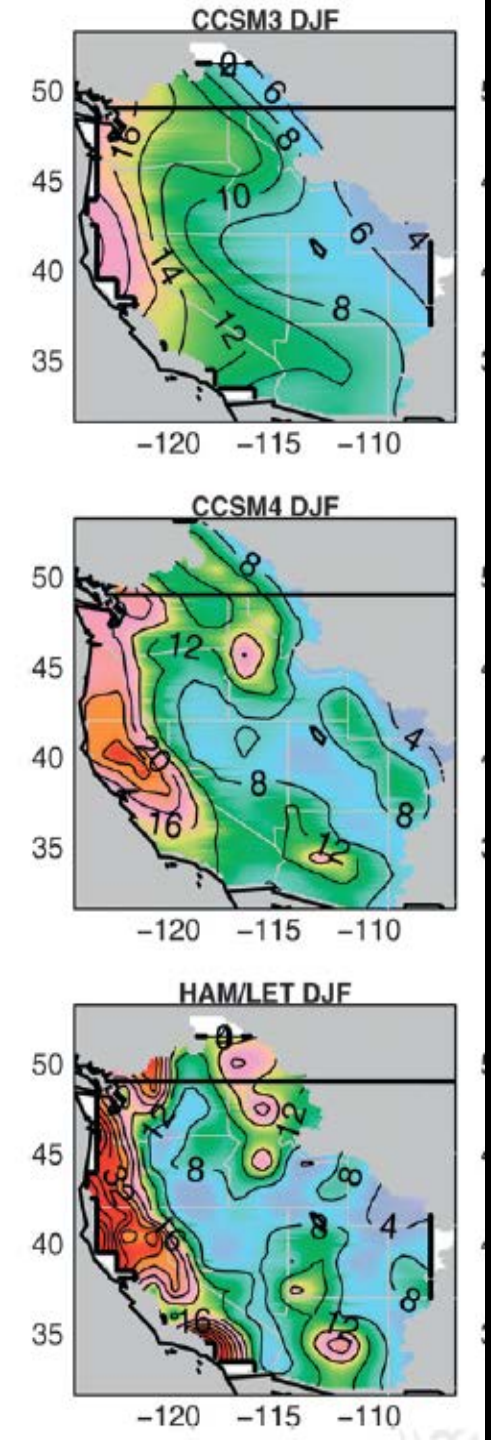


CCSM3

CCSM4

OBS

90th percentile DJF precip intensity (mm/day)



CCSM3

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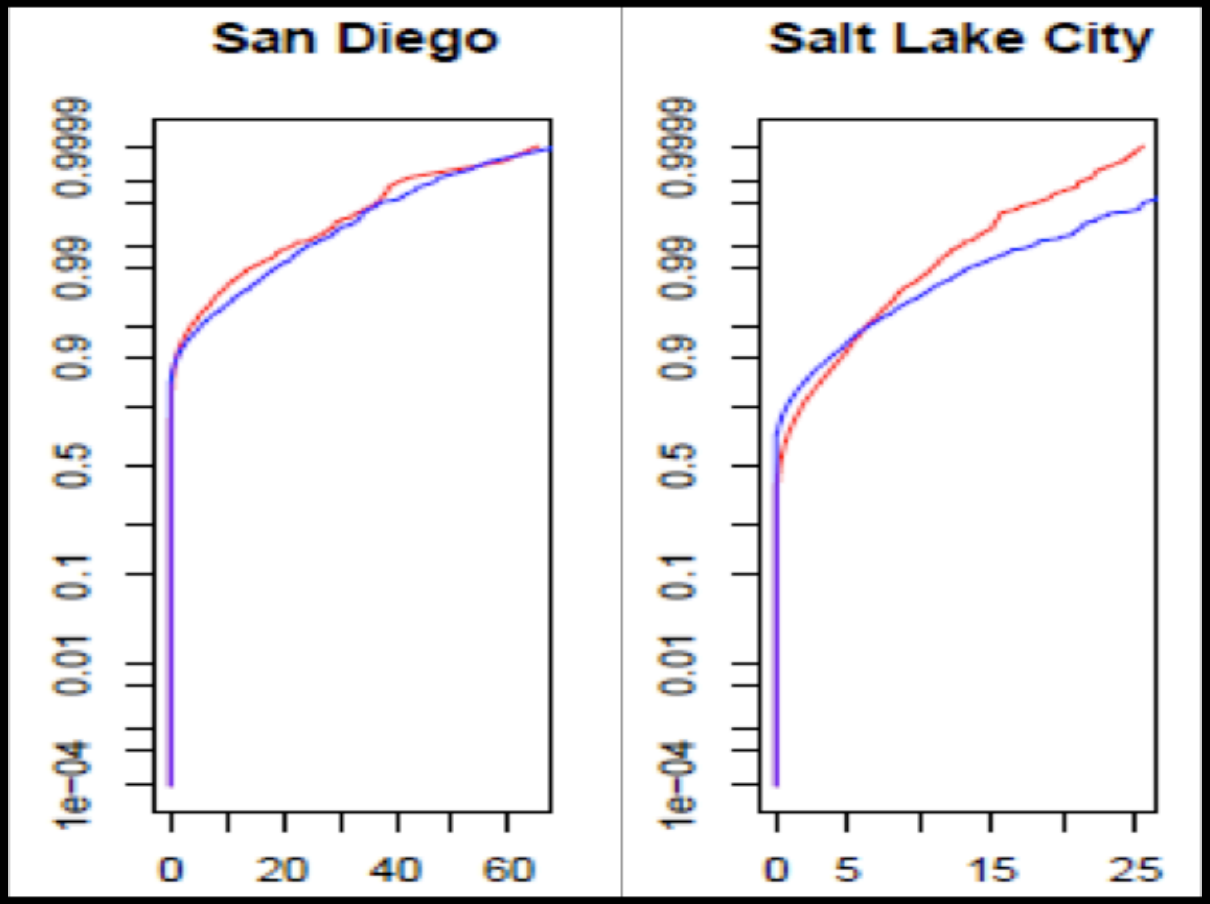
Model vs. obs: CDFs

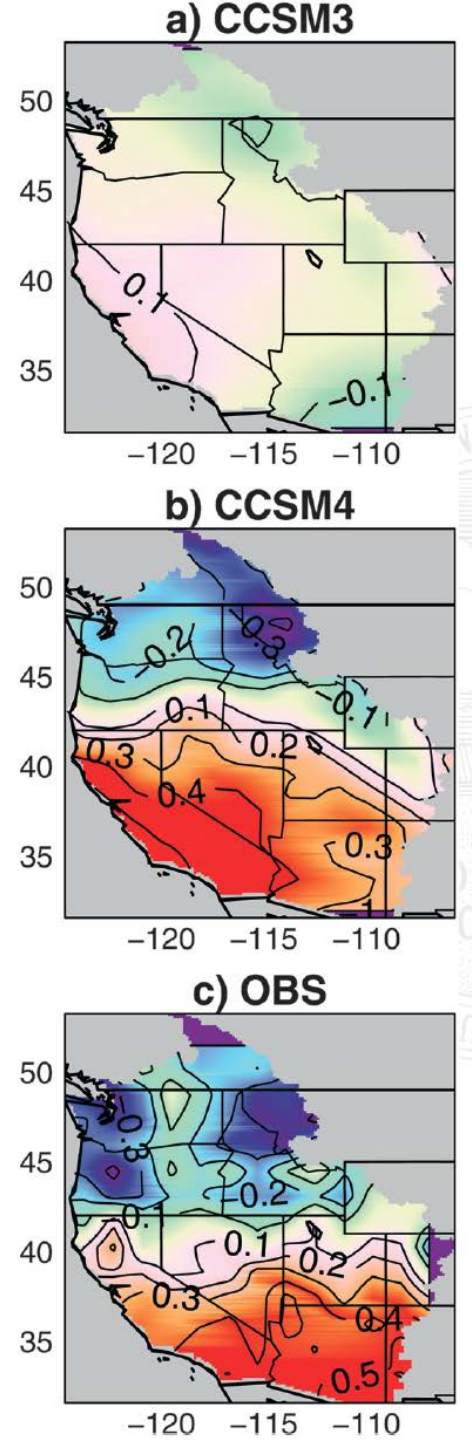
Cumulative Probability



Precipitation (mm/day)

CCSM4 **OBS**

Correlation: Leading ENSO PCs w/ NDJFM precip anomalies



CCSM3

CCSM4

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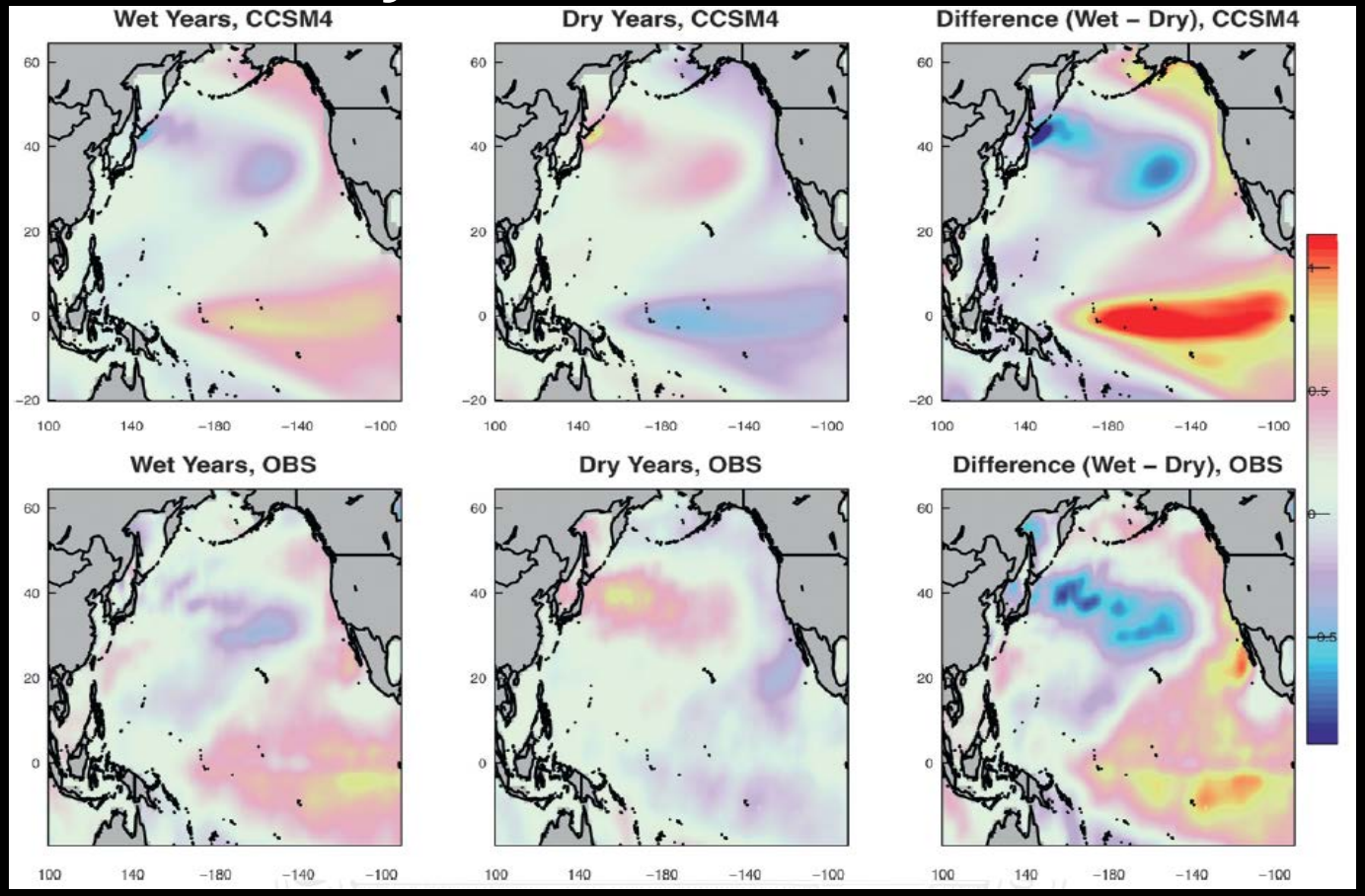
Annually averaged surface temperature anomalies on extreme southwestern U.S. wet/dry years

CCSM4

OBS



Strong tropical Pacific SST anomaly signal associated with southwestern U.S. extreme precipitation regimes in CCSM4; response similar to observations, but more symmetric

Conclusions

- Mean climatology and extreme statistics more realistic in CCSM4, but drizzle problem still present
- Improved representation of Pacific SST – western U.S. precipitation teleconnection in CCSM4
  - Strong tropical SST anomaly signal during extreme precipitation regimes over western U.S.
- Wet tails of precipitation distribution generally more realistic in CCSM4 compared to CCSM3, but sense of error inconsistent for wet/dry locations (no consistency in tail fatness)

Future consequences

- CMIP models are often used to project climate for the next 100 years
  - These projections are dependent on ability of models to represent a vast number of processes in a physically realistic way
- For example, CMIP5 models disagree on sign of annual precipitation change by 2060 in California (Pierce et al. 2013)
- Model evaluation of this kind is necessary to reasonably characterize uncertainty in these projections

Thank you!

- Email: **mdeflori@ucsd.edu**

- For more, see:

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Photo credit: M. DeFlorio, Scripps Pier