



# Hydroclimatic Characteristics of the 2012-2015 California Drought in a Historical Context

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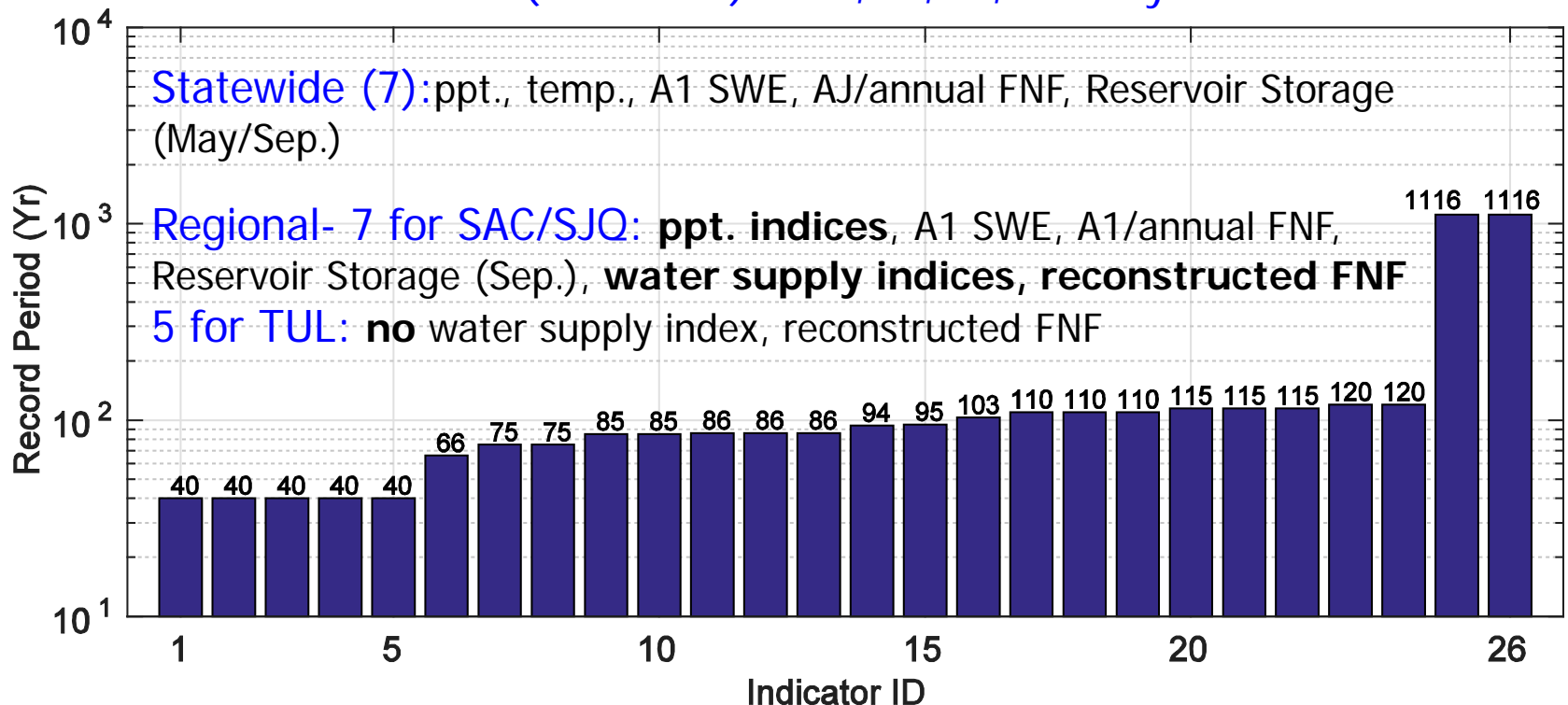
## ❖ What will this presentation cover?

1/3. Development of the drought in a hydrologic framework

Precipitation, April 1<sup>st</sup> snowpack (A1 SWE), April-July full natural flow (AJ FNF), reservoir storage (Sep.): statewide/Sacramento (SAC)/San Joaquin (SJQ)/Tulare(TUL)

2/3. Temporal characteristics of the drought

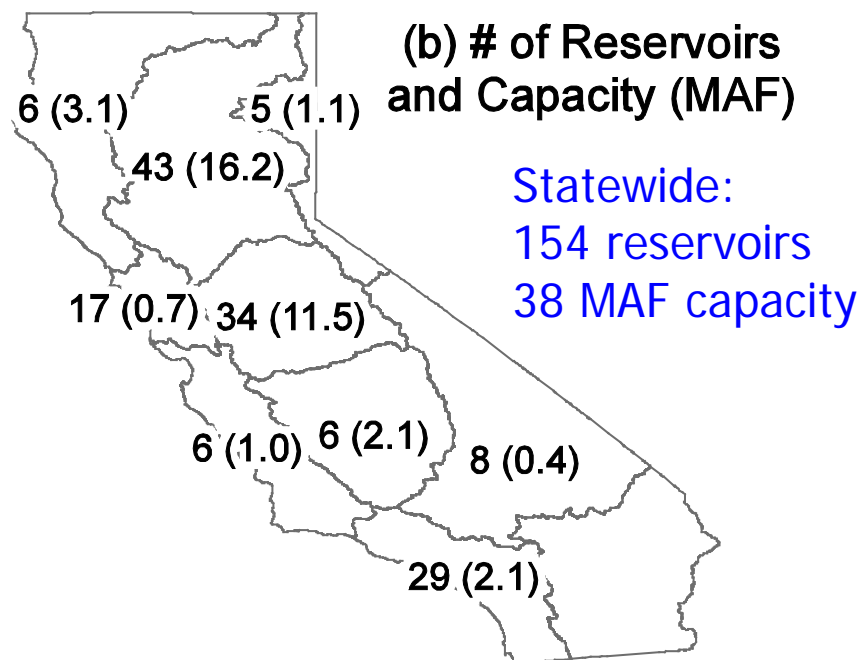
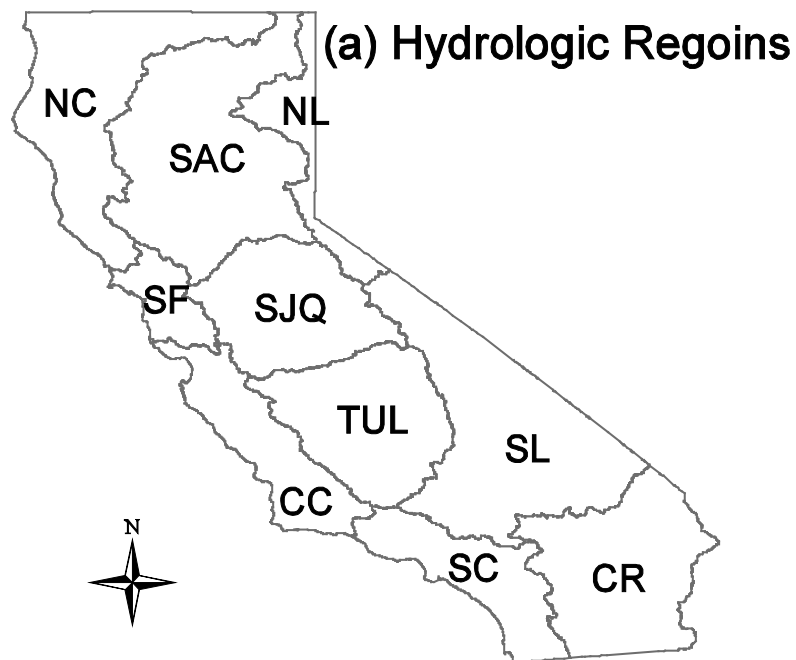
26 variables (indicators) at 1-, 2-, 3-, and 4-year levels



## ❖ What will this presentation cover?

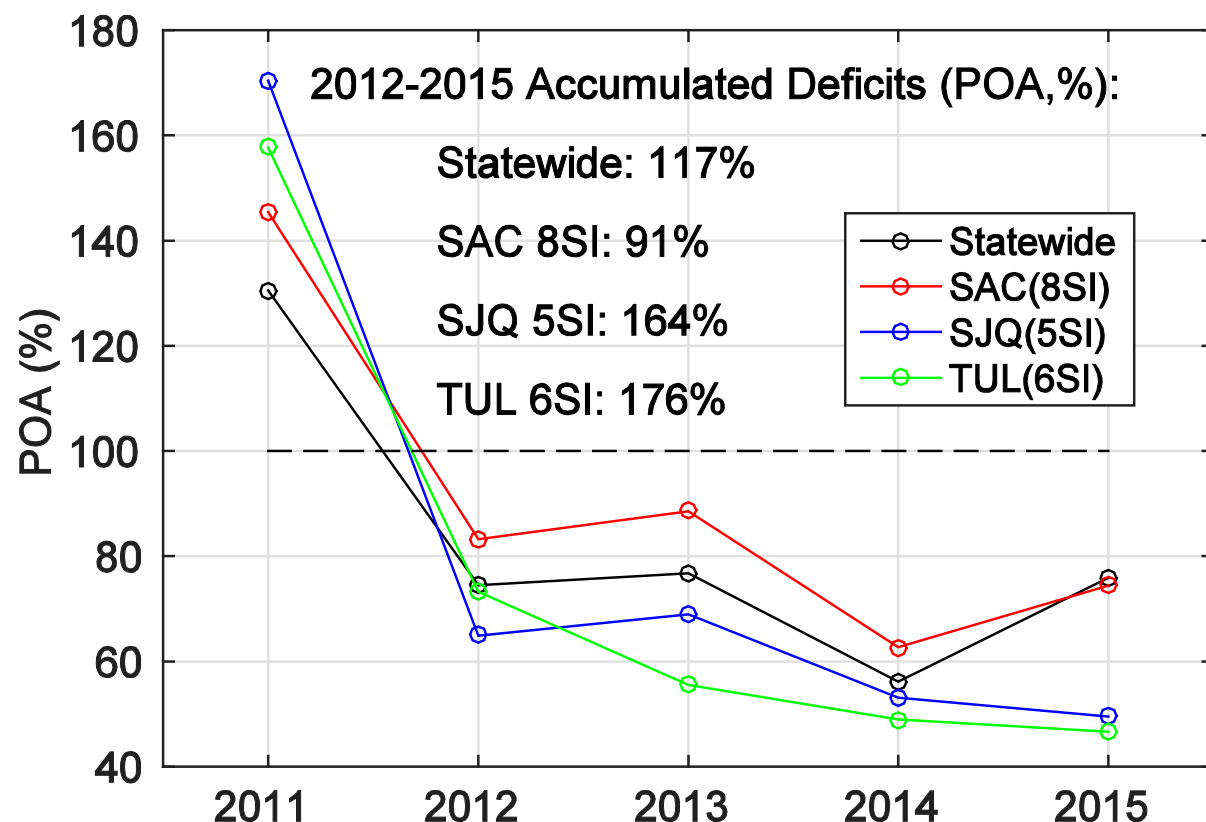
### 3/3. Spatial characteristics

Precipitation, Temperature, April-July full natural flow (AJ FNF), reservoir storage (Sep.): 10 hydrologic regions



## ❖ 2 Metrics applied: percent of average (%) and rank

## ❖ Precipitation



❑ 2011 above normal;  
2012-15 below normal

❑ 8SI relatively higher  
from 2012-15; 6SI  
consistently lower  
2013-15

❑ 4-yr deficits:  
Statewide: 26 in  
8SI: 46 in  
5SI: 62 in  
6SI: 51 in

Long-term average:

Statewide: 22 in (120 yr)

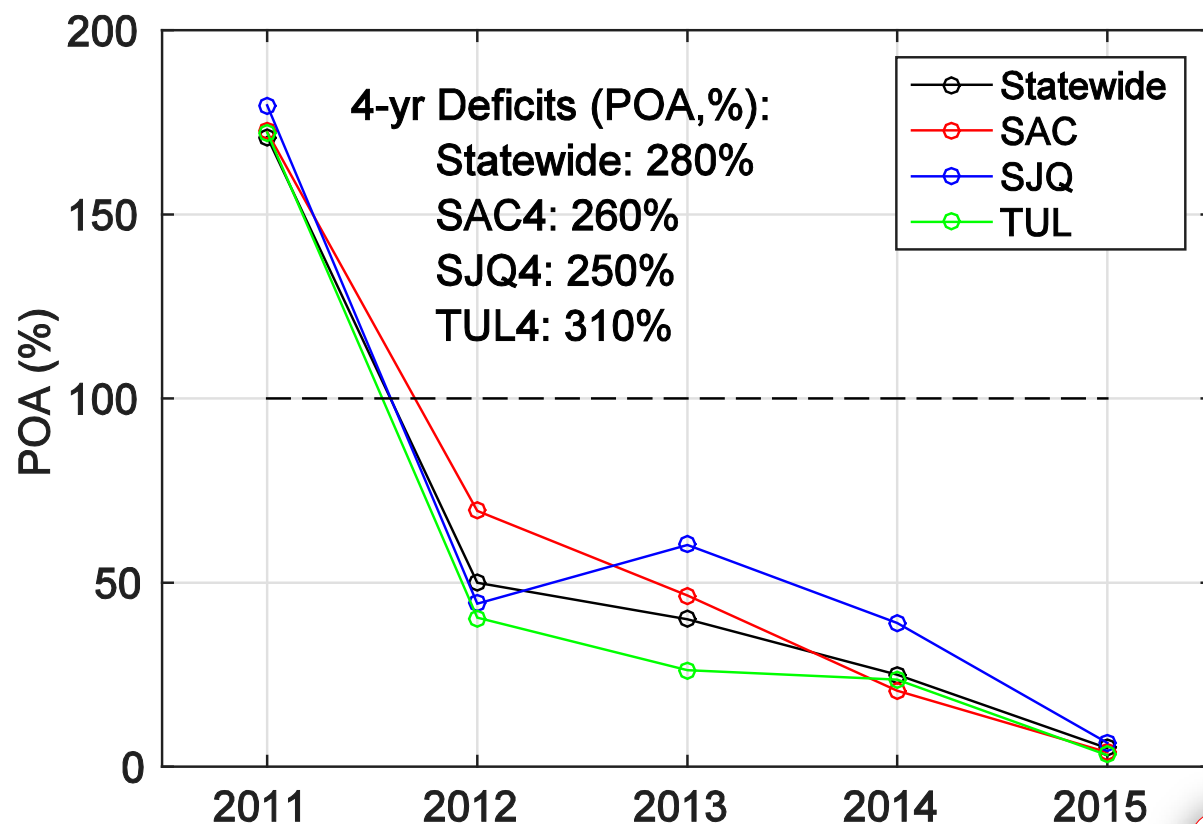
SJQ 5SI : 38 in (103 yr)

SAC 8SI : 50 in (95 yr)

TUL 6SI : 29 in (94 yr)

Data Source: CDEC/NCDC

## ❖ A1 SWE



❑ 2011 above normal;  
2012-15 below normal

❑ Record low in 2015  
(statewide:5%; SAC4:  
4%; SJQ4: 6%; TUL4:  
3%)

❑ 4-yr deficits:  
Statewide: 79 in  
SAC4: 68 in  
SJQ4: 78 in  
TUL4: 61 in

Long-term average:

Statewide: 28.1 in (66 yr)

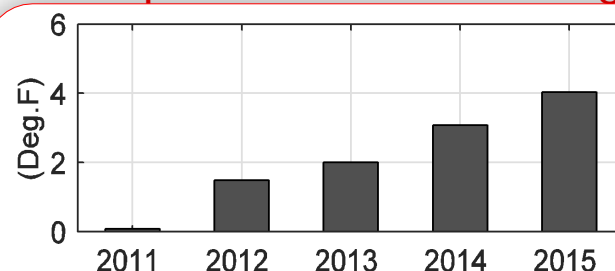
SJQ4 : 31.1 in (86 yr)

SAC4 : 26.1 in (86 yr)

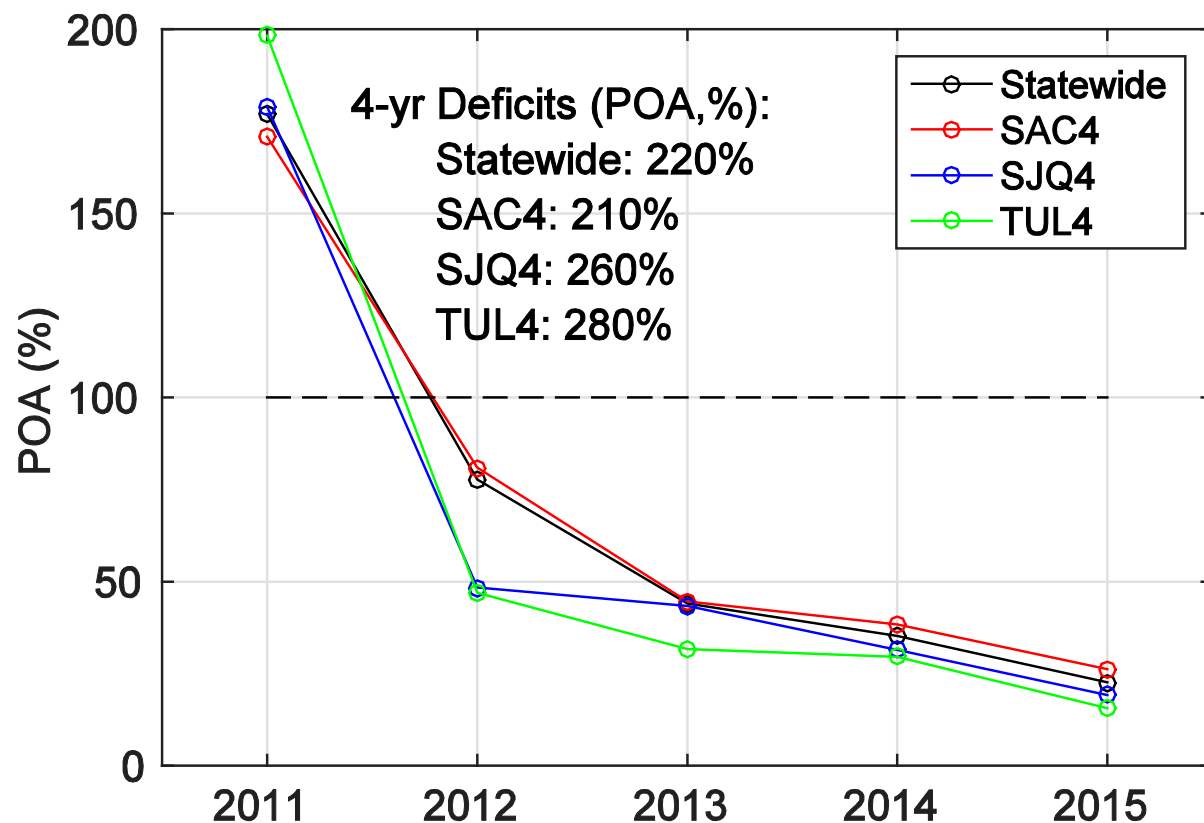
TUL4 : 19.8 in (86 yr)

Data Source: CDEC/NCDC

Temperature above Average



## ❖ AJ FNF



❑ 2011 above normal;  
2012-15 below normal

❑ SAC4 slightly higher &  
TUL4 generally lower  
from 2012-2015

❑ **4-yr deficits:**  
 Statewide: 37.4 MAF  
 SAC4: 14.2 MAF  
 SJQ4: 10.0 MAF  
 TUL4: 5.5 MAF

Long-term average:

Statewide: 17.0 MAF (75 yr)

SJQ4 : 3.85 MAF (115 yr)

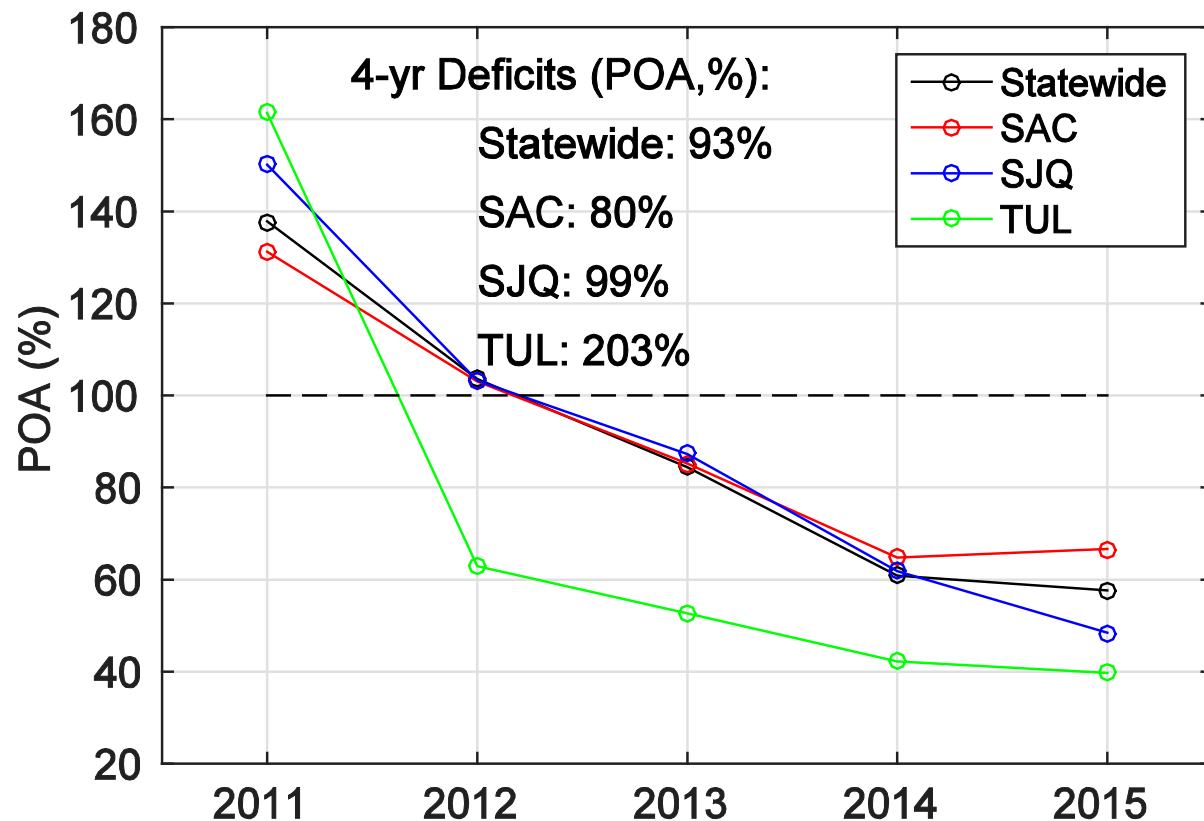
SAC4 : 6.75 MAF (110 yr)

TUL4 : 1.97 MAF (85 yr)

Data Source: CDEC

Data Source: CDEC

## ❖ Reservoir Storage (end of September)



- ❑ 2011-12 above normal; 2013-15 below normal
- ❑ General declining trend since 2011; SAC res. storage increases in 2015
- ❑ **4-yr deficits:**  
 Statewide: 20.6 MAF  
 SAC: 7.9 MAF  
 SJQ: 6.3 MAF  
 TUL: 1.4 MAF

Long-term average:

Statewide: 22.1 MAF (40 yr; 154 res., 38 MAF cap.)

SJQ : 6.4 MAF (40 yr; 34 res., 11.5 MAF cap.)

SAC : 9.9 MAF (40 yr; 43 res., 16.2 MAF cap.)

TUL : 0.7 MAF (40 yr; 6 res., 2.1 MAF cap.)

## ❖ Periods with the lowest precipitation

### Statewide:

2012-14: driest 3-yr

2012-15: driest 4-yr

### SAC 8SI: none

### SJQ 5SI:

2014-15 driest 2-yr

2012-14: driest 3-yr

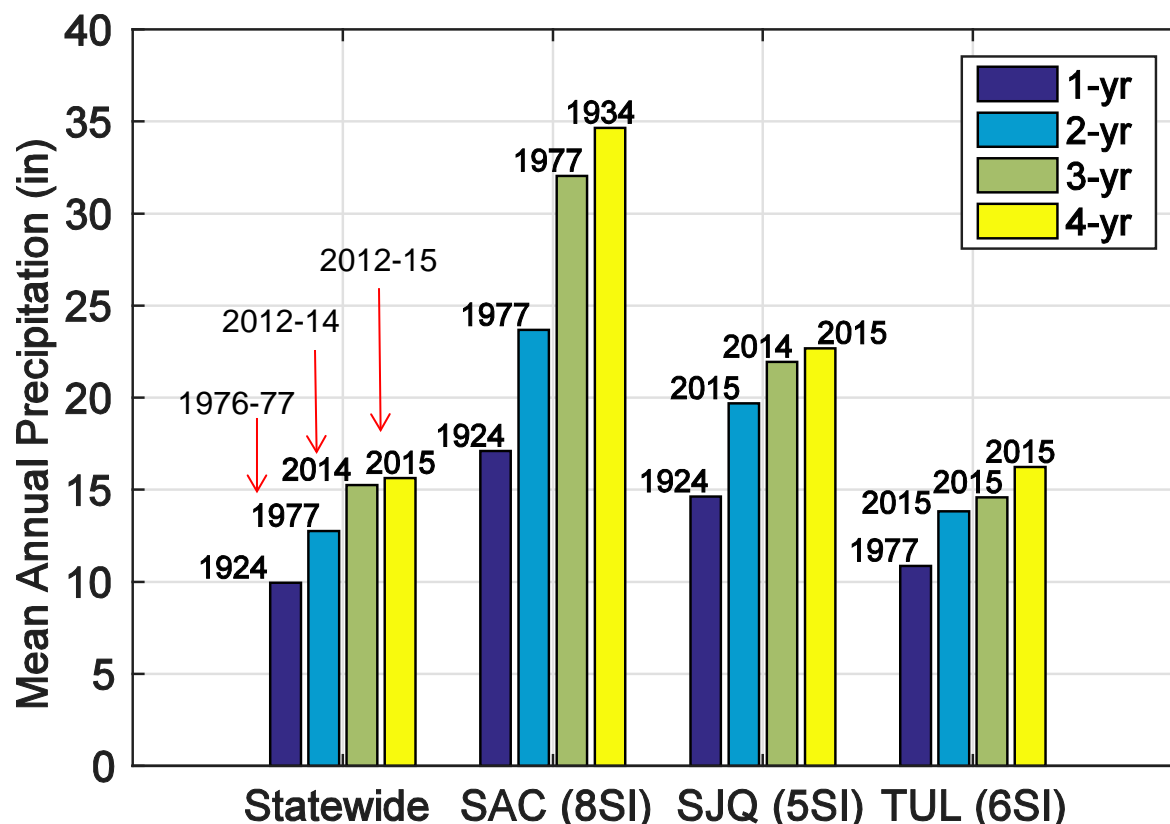
2012-15: driest 4-yr

### TUL 6SI:

2014-15 driest 2-yr

2013-15: driest 3-yr

2012-15: driest 4-yr



Data Source: CDEC/NCDC



## ❖ Periods with the lowest A1 SWE

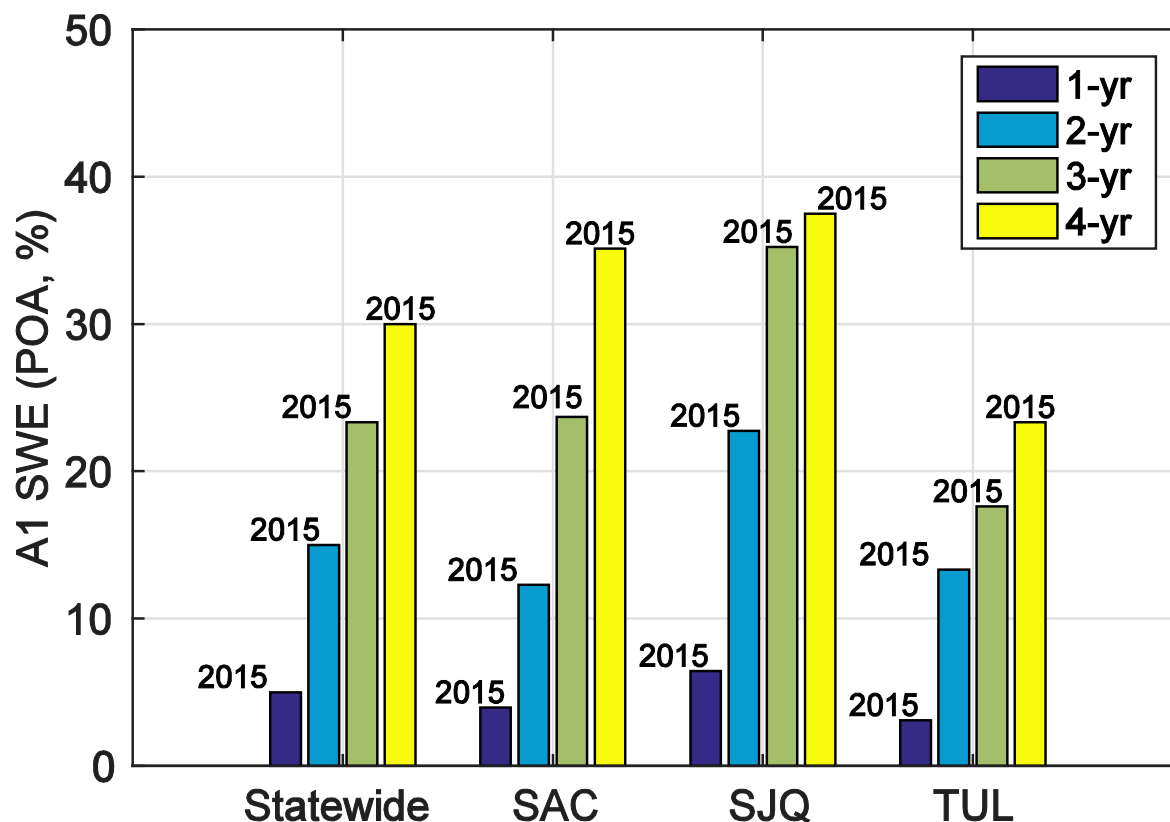
□ April 1<sup>st</sup> SWE

2015: lowest 1-yr

2014-15: lowest 2-yr

2013-15: lowest 3-yr

2012-15: lowest 4-yr



Sample size:

Statewide: 66

SJQ : 86

SAC : 86

TUL : 86

Data Source: CDEC

## Periods with the highest temperature

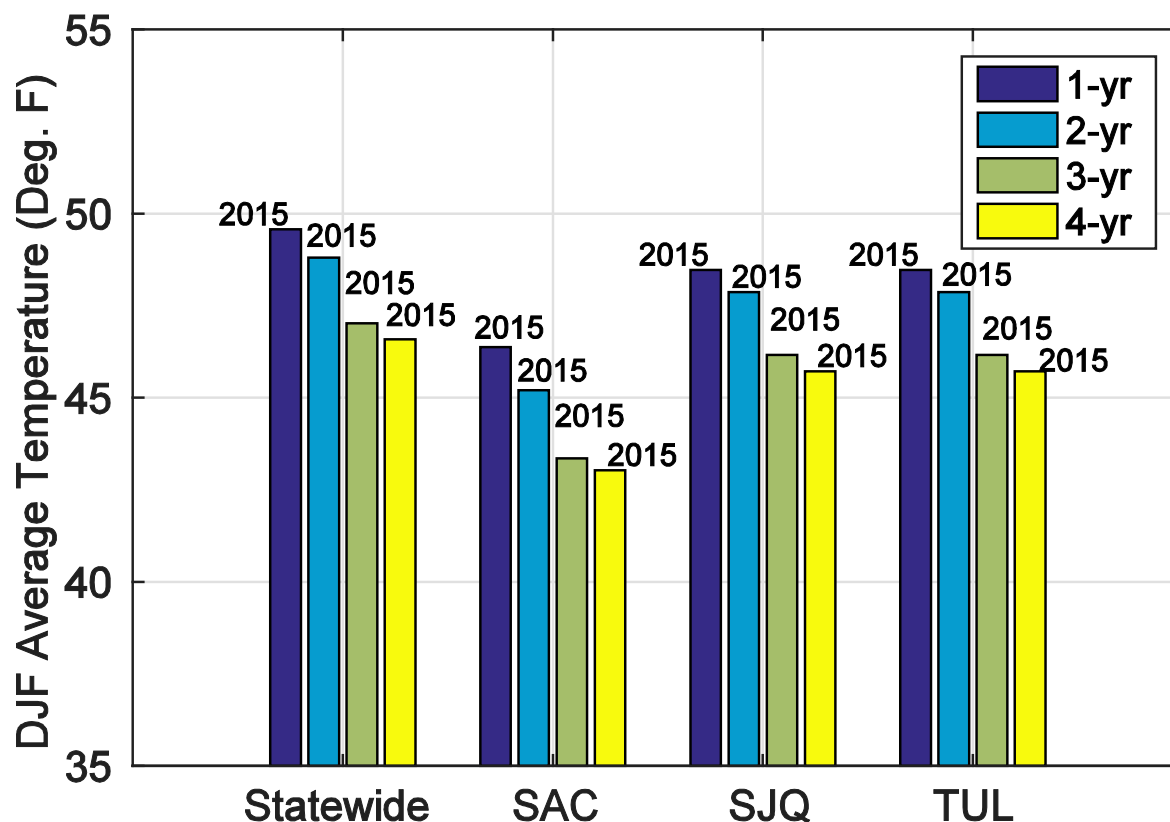
□ Winter (DJF) avg. temperature

2015: hottest 1-yr

2014-15: hottest 2-yr

2013-15: hottest 3-yr

2012-15: hottest 4-yr



Sample size:

Statewide: 120

SAC : 120

SJQ : 120

TUL : 120

Data Source: NCDC

## ❖ Periods with the lowest AJ FNF

□ April-July FNF

Statewide, SAC, TUL:

2015: lowest 1-yr

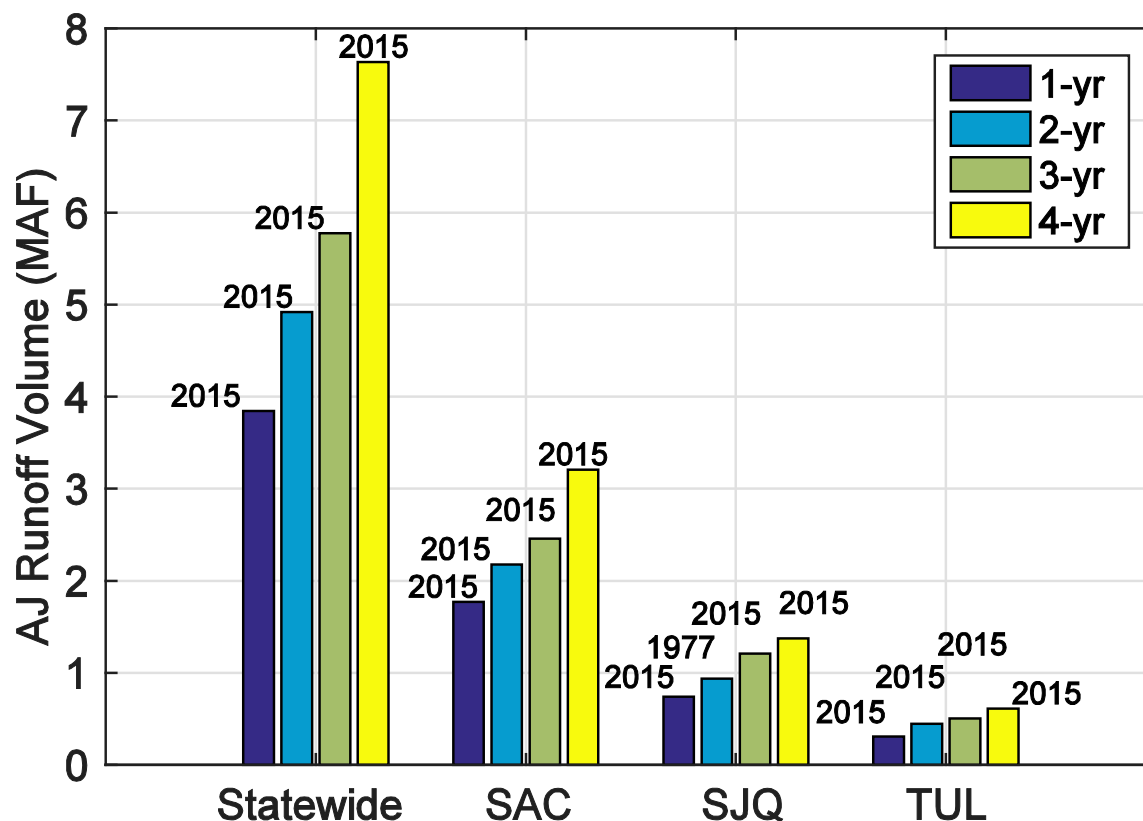
2014-15: lowest 2-yr

2013-15: lowest 3-yr

2012-15: lowest 4-yr

SJQ:

1976-77: lowest 2-yr



Sample size:

Statewide: 75

SJQ : 115

SAC : 110

TUL : 85

Data Source: CDEC

## ❖ Periods with the lowest Res. Storage

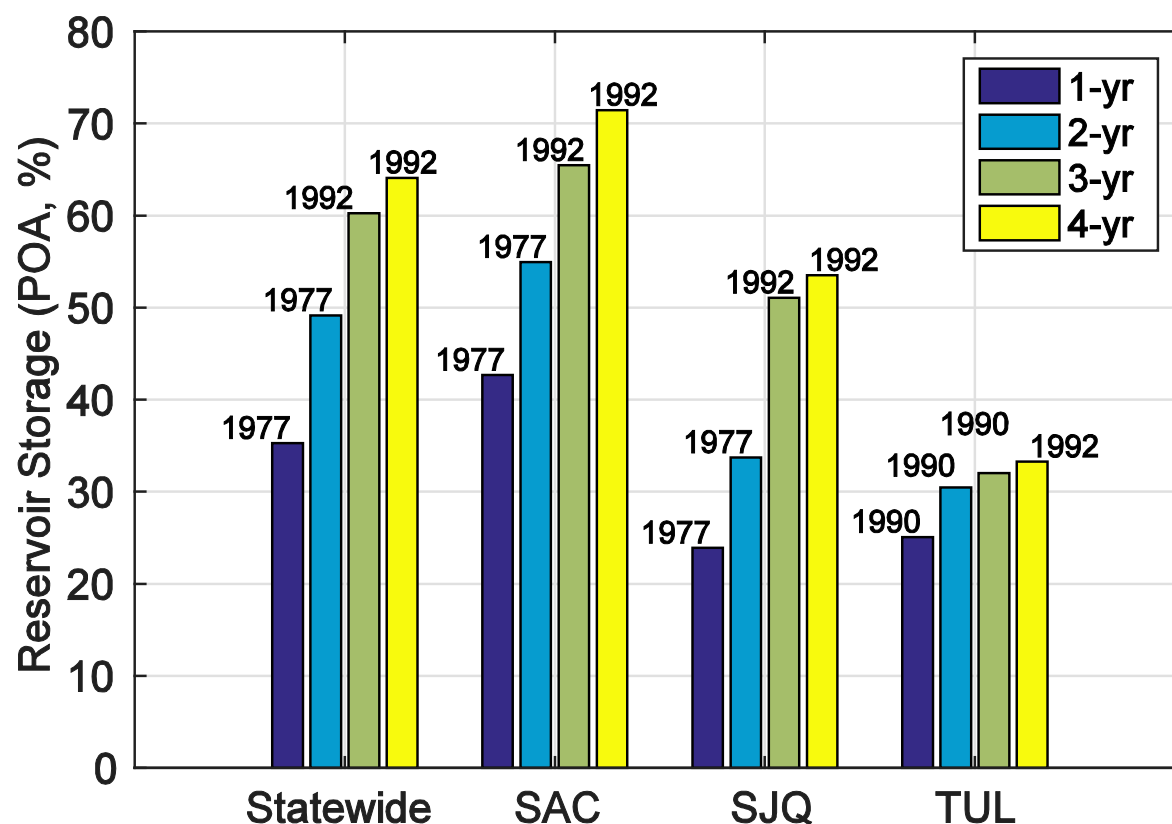
❑ 2012-15 not on the chart

❑ 1-yr level:  
Statewide, SAC, SJQ:  
1977; TUL: 1990

❑ 2-yr level:  
Statewide, SAC, SJQ:  
1976-77;  
TUL: 1989-90

❑ 3-yr level:  
Statewide, SAC, SJQ:  
1990-92  
TUL: 1988-90

❑ 4-yr level: 1989-1992



Sample size:

Statewide: 40

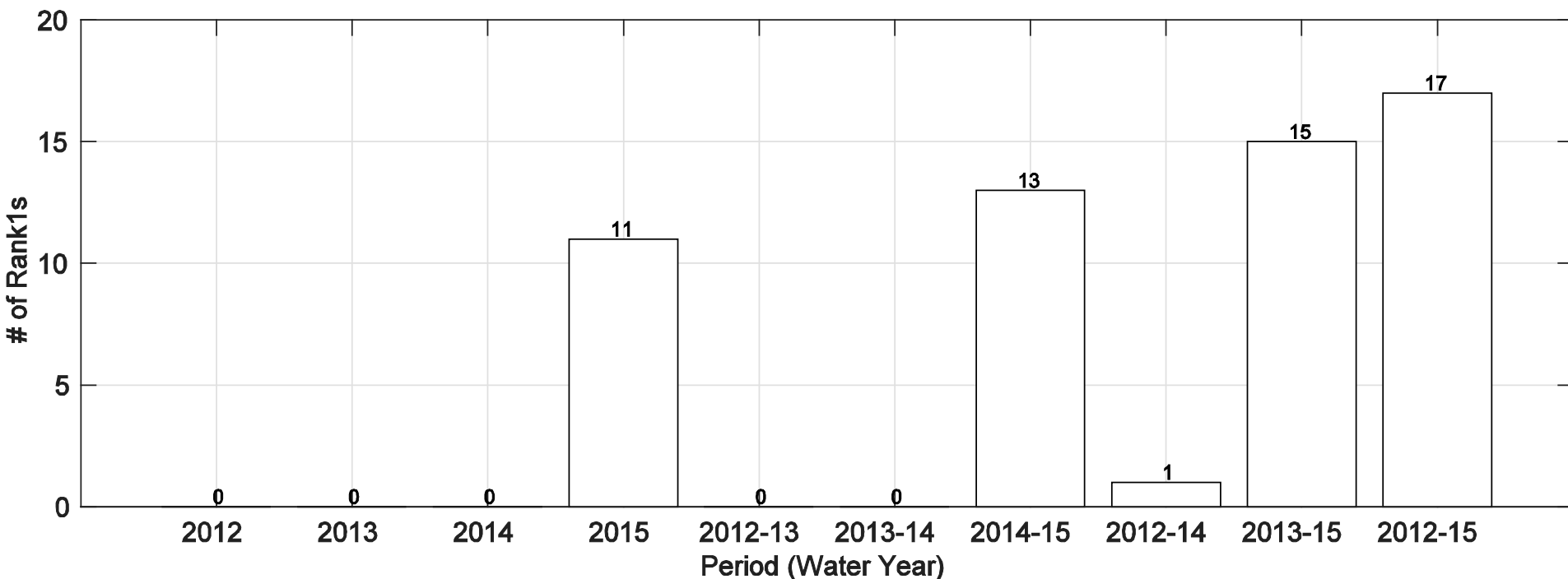
SJQ : 40

SAC : 40

TUL : 40

Data Source: CDEC

- ❖ Number of Rank1s (out of 26 variables/indicators) of different (1-, 2-, 3-, 4-yr) periods

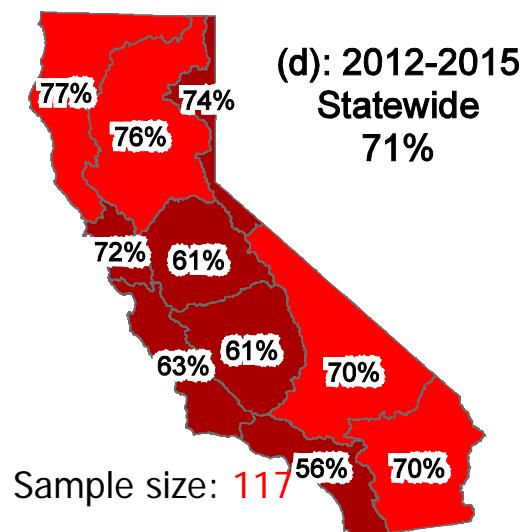
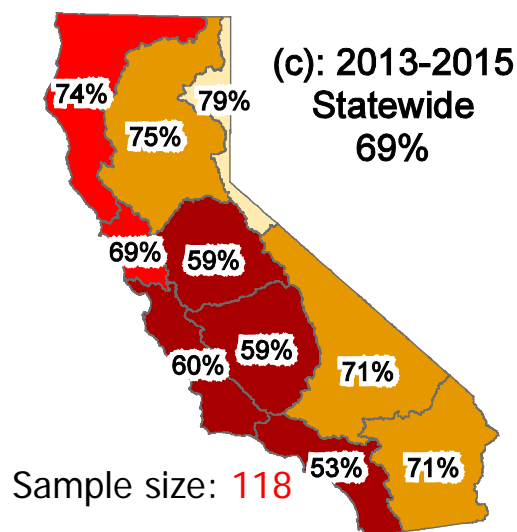
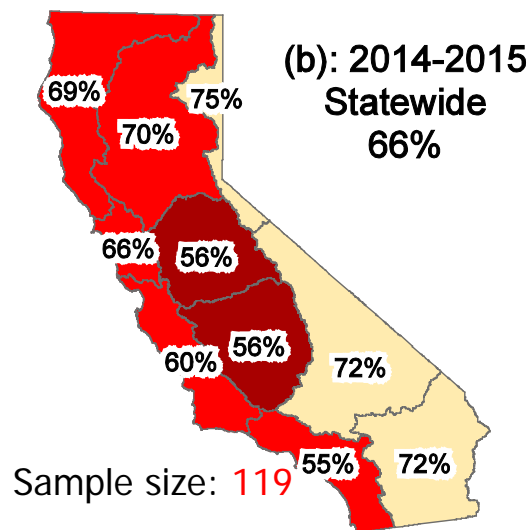
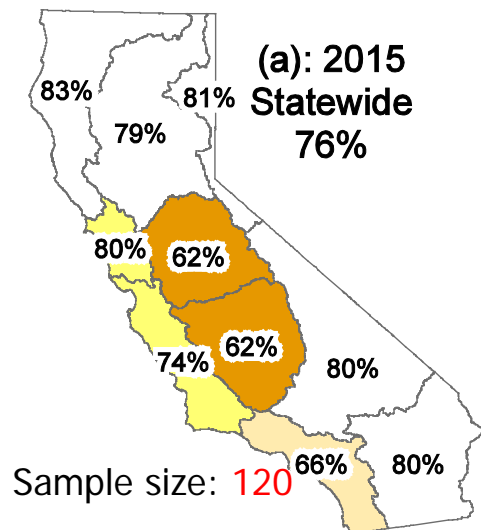


- ❑ 2015: 11(/26) rank #1s (driest year in 2012-2015)
- ❑ 2014-15: 13(/26) rank #1s (driest 2-yr in 2012-2015)
- ❑ 2013-15: 15(/26) rank #1s (driest 3-yr in 2012-15)
- ❑ 2012-15: 17(/26) rank #1s

# Spatial Characteristics

2012-2015 California Drought

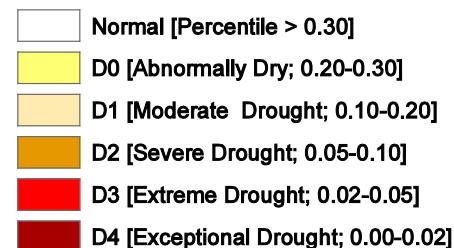
## ❖ Precipitation by Hydrologic Region



Rank	1	2	3	4
2015	SJQ/ TUL	-	SC	CC
2014 -15	SC	SJQ/ TUL	-	CC
2013 -15	SC	SJQ/ TUL	-	CC
2012 -15	SC	SJQ/ TUL	-	CC

\* Rank 1 means lowest precipitation POA

### Legend

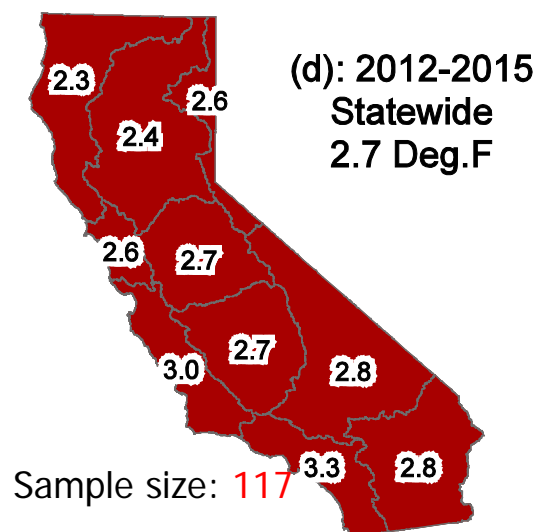
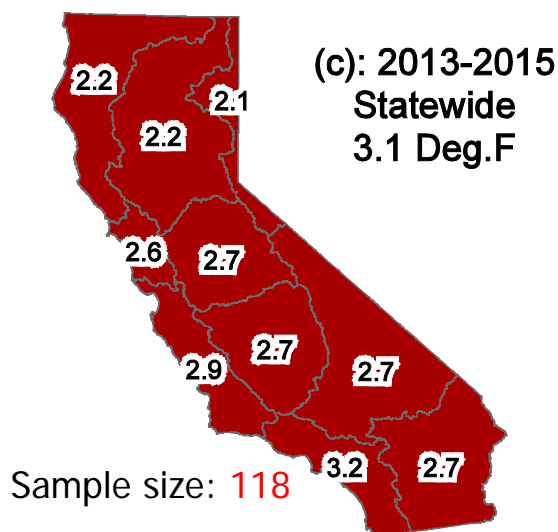
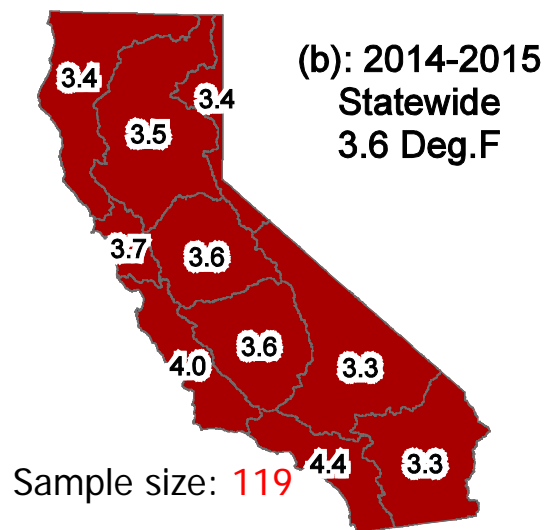
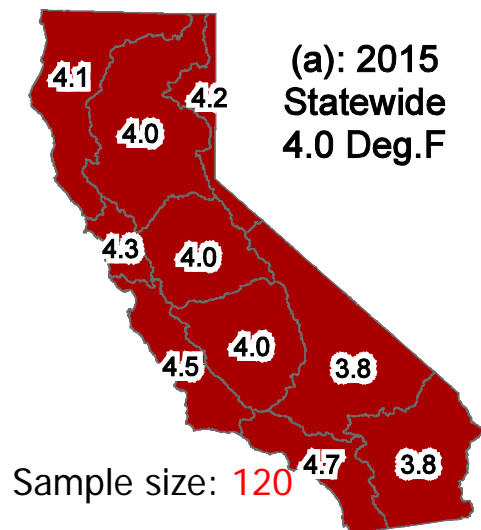


Data Source: NCDC

# Spatial Characteristics

2012-2015 California Drought

## ❖ Temperature by Hydrologic Region



Rank	1	2	3	4
2015	SC	CC	SF	NL
2014-15	SC	CC	SF	SJQ/TUL
2013-15	SC	CC	SJQ/TUL	-
2012-15	SC	CC	SL/CR	-

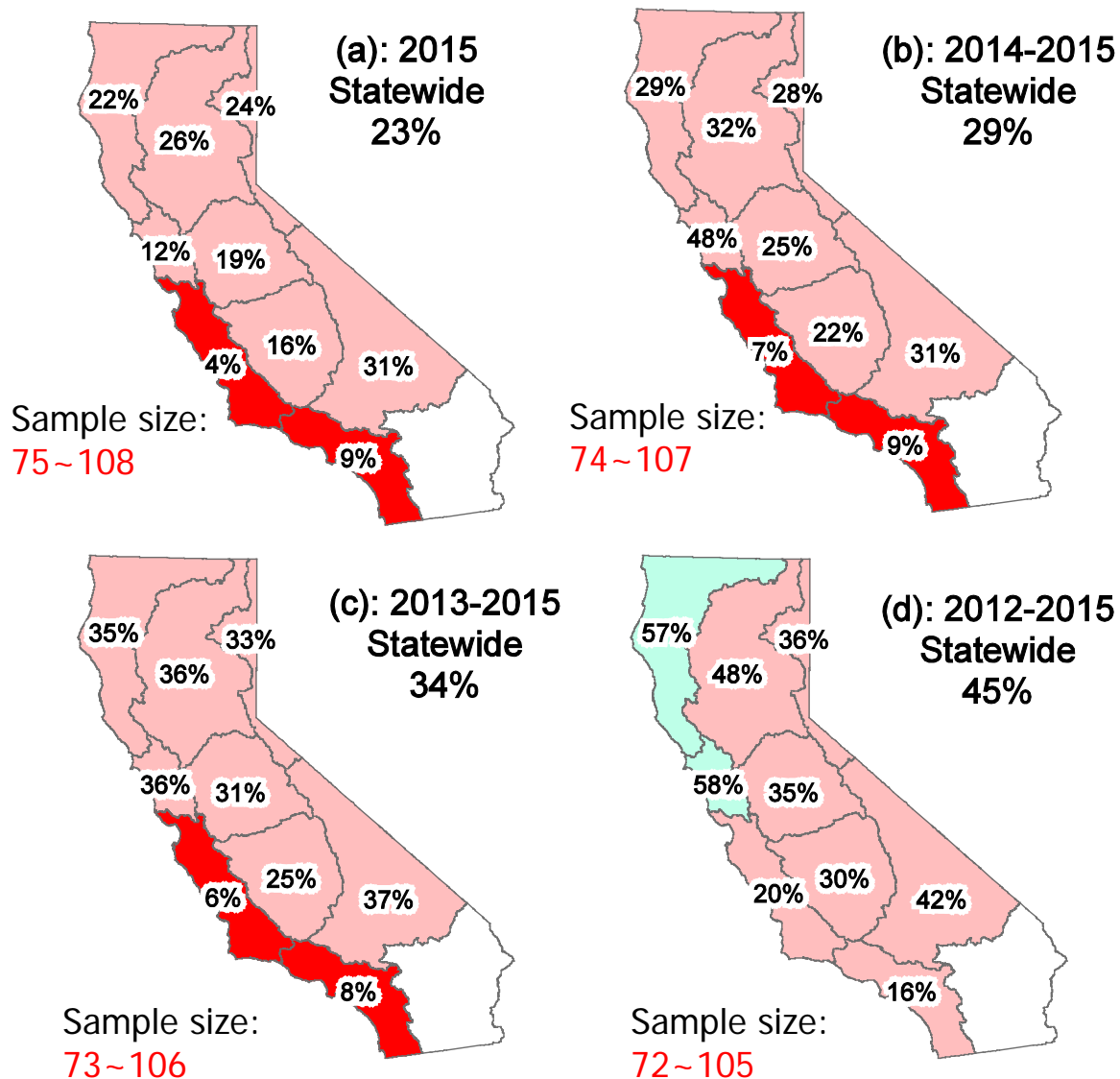
\* Rank 1 means highest temperature increase

Data Source: NCDC

# Spatial Characteristics

2012-2015 California Drought

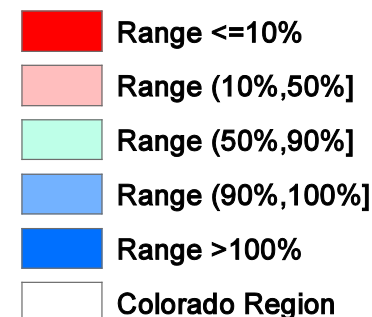
## ❖ AJ FNF by Hydrologic Region



Rank	1	2	3	4
2015	CC	SC	SF	TUL
2014-15	CC	SC	TUL	SJQ
2013-15	CC	SC	TUL	SJQ
2012-15	SC	CC	TUL	SJQ

\* Rank 1 means lowest AJ FNF POA

### Legend

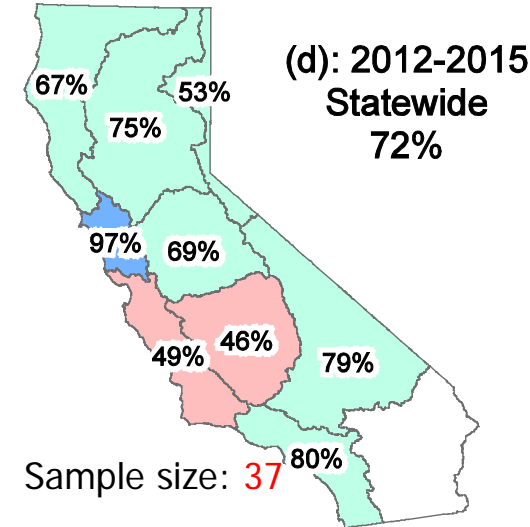
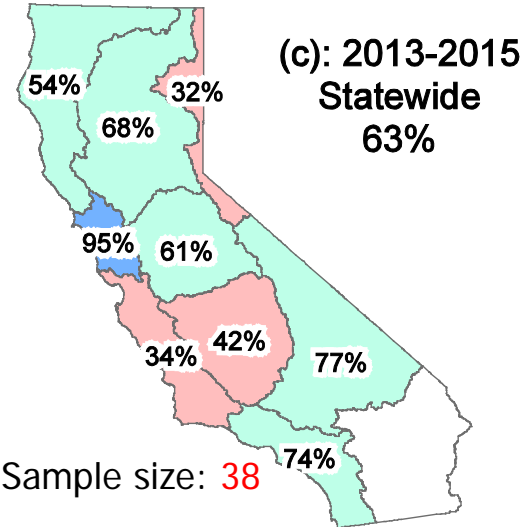
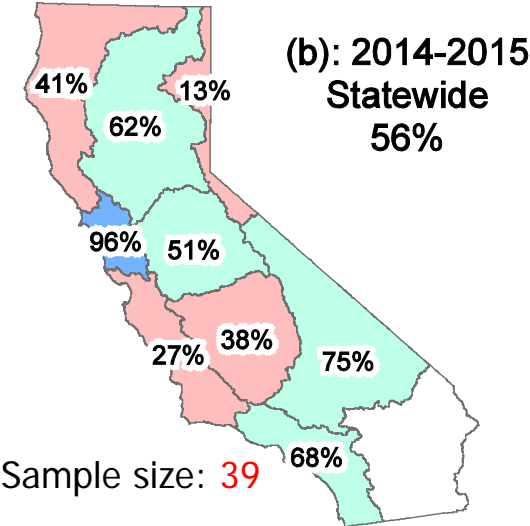
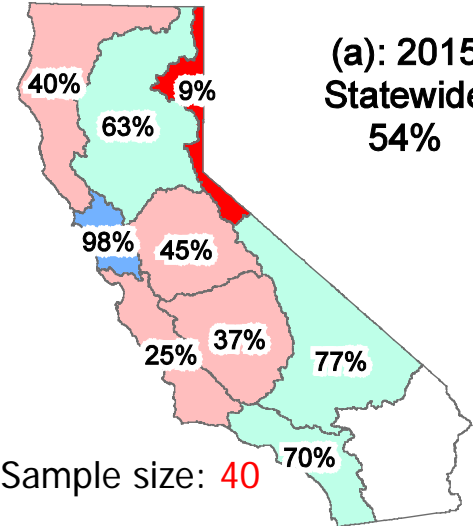


Data Source: CDEC



# Spatial Characteristics

## ❖ Reservoir Storage (September) by Hydrologic Region



Rank	1	2	3	4
2015	NL	CC	TUL	NC
2014-15	NL	CC	TUL	NC
2013-15	NL	CC	TUL	NC
2012-15	TUL	CC	NL	NC

\* Rank 1 means lowest storage POA

### Legend

- Range <=10%
- Range (10%,50%]
- Range (50%,90%]
- Range (90%,100%]
- Range >100%
- Colorado Region

Data Source: CDEC

- ❖ **2012-15 Drought caused** by well below-average precipitation (4-yr statewide deficit: 117%) and record high temperature
- ❖ **Characterized** by record low A1 SWE (statewide 280% deficit), exceptionally low AJ FNF (statewide 220% deficit), and below-average reservoir storage (statewide 93% deficit)

- ❖ **At temporal scale**

**2015:** 11(/26) variables driest; **2013-15:** 15/26; **2014-2015:** 13/26;  
**2012-15:** driest 4-yr period for 17/26 variables;

- ❖ **At spatial (hydrologic region) scale**

- ☐ Precipitation / temperature / AJ FNF:

San Joaquin, Tulare, Central Coast, and South Coast most severe

- ☐ Reservoir storage:

North Lahontan, Central Coast, Tulare, and North Coast most severe

## Questions?

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## Acknowledgements

Stephen Nemeth, Maury Roos, John King, David Parker, Matt Winston, Boone Lek