tmospheric rivers, floods and the ater resources of California

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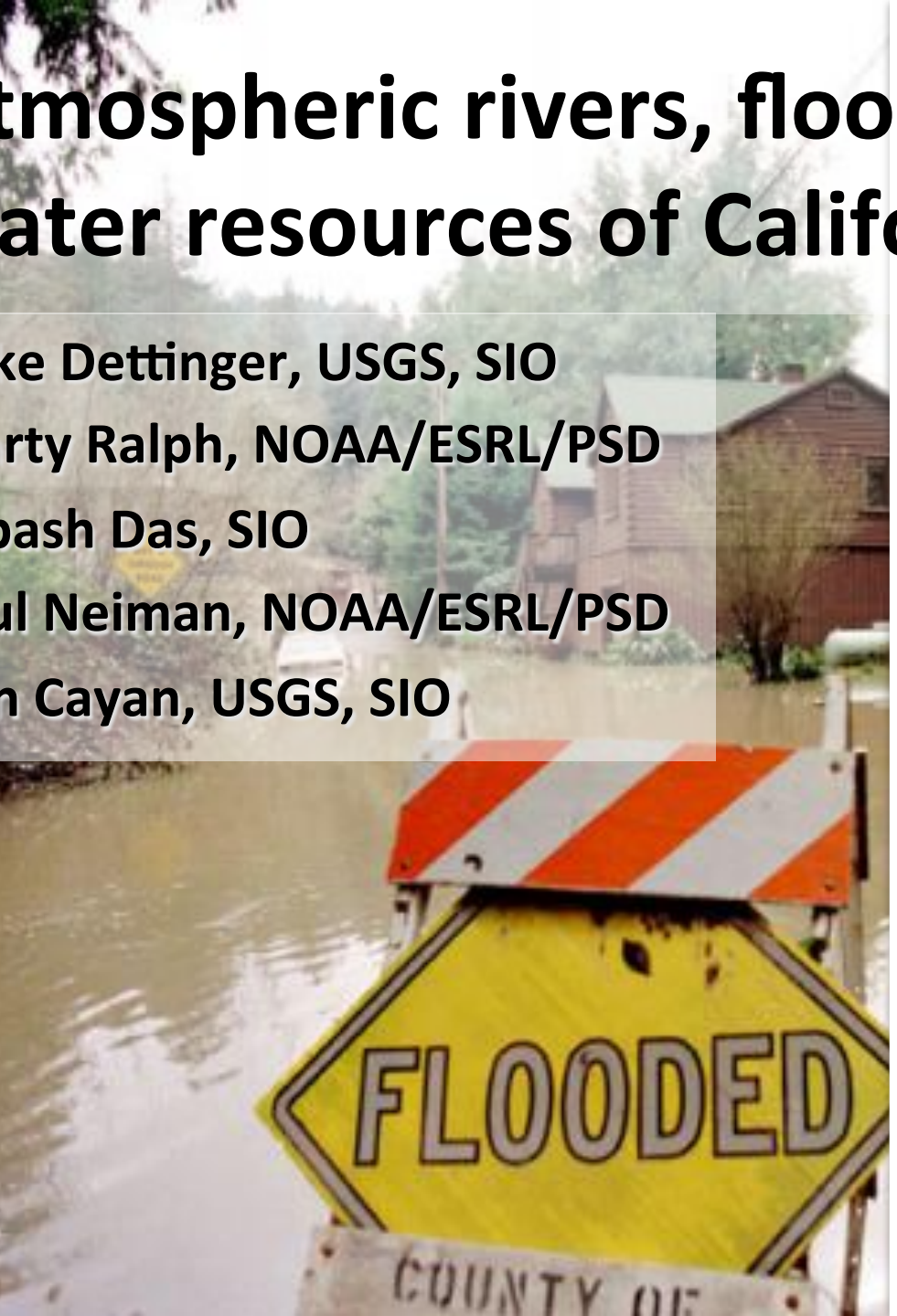


Motivations

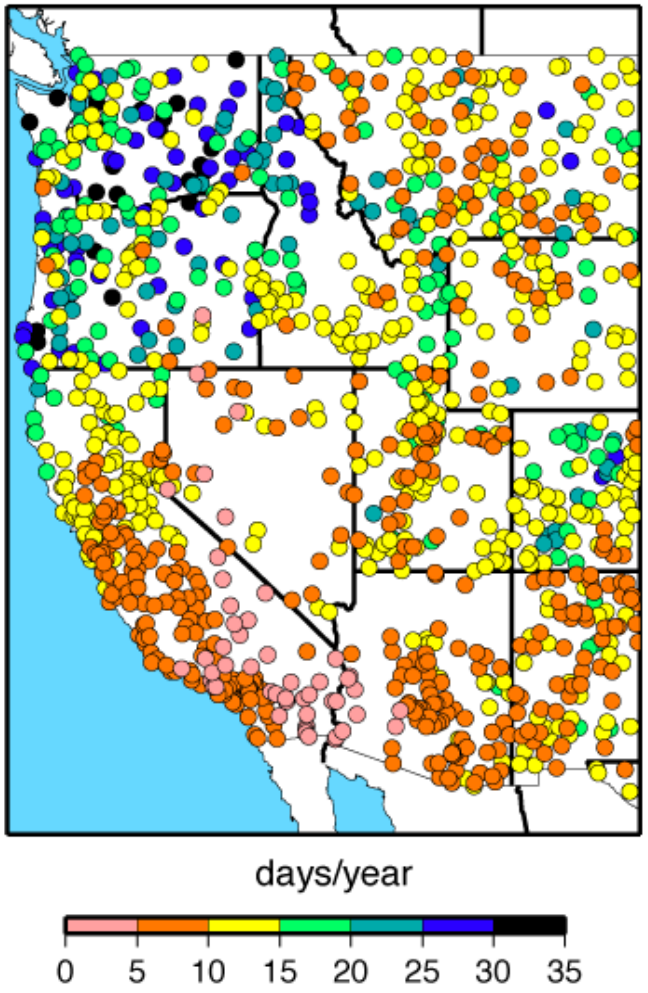
- ***Exploring the nexus between floods and water supplies in California***

  "New to this (2009) Water Plan is an integration of water resource management and flood management throughout the State. This approach aims to increase resiliency in our systems while yielding multiple benefits like increased public safety, habitat protection, *and* water supply reliability." — *Lester Snow, past Director of DWR, Secretary for Natural Resources*

  "Strategy 4: Practice and promote integrated flood management" – *Water management chapter in 2009 California Climate Adaptations Strategy*

- ***Role of Atmospheric Rivers in California water supplies***

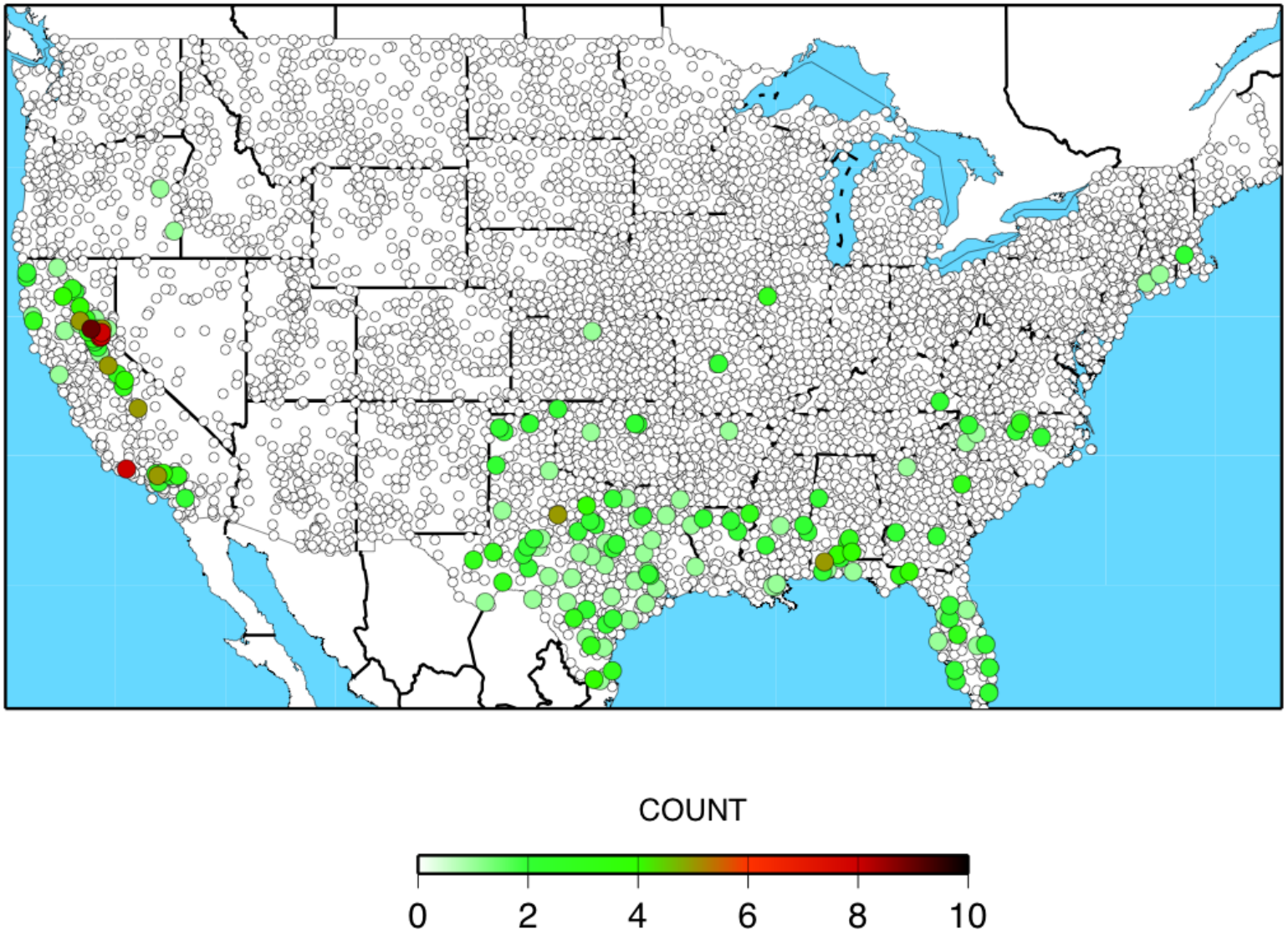
c) AVERAGE NUMBER OF DAYS/YR TO OBTAIN HALF OF TOTAL PRECIPITATION, WY 1951-2008



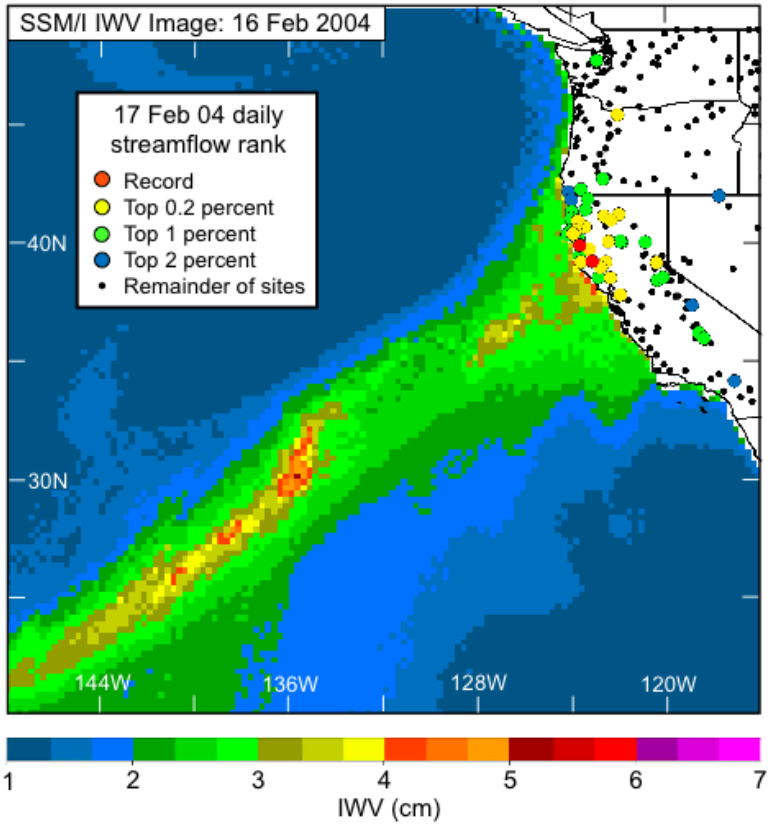
JUST A FEW STORMS EACH YEAR ARE THE CORE OF CALIFORNIA'S WATER SUPPLIES

Three-day episodes with > 40 cm precipitation since 1950

From among 5877 NWS Coop stations

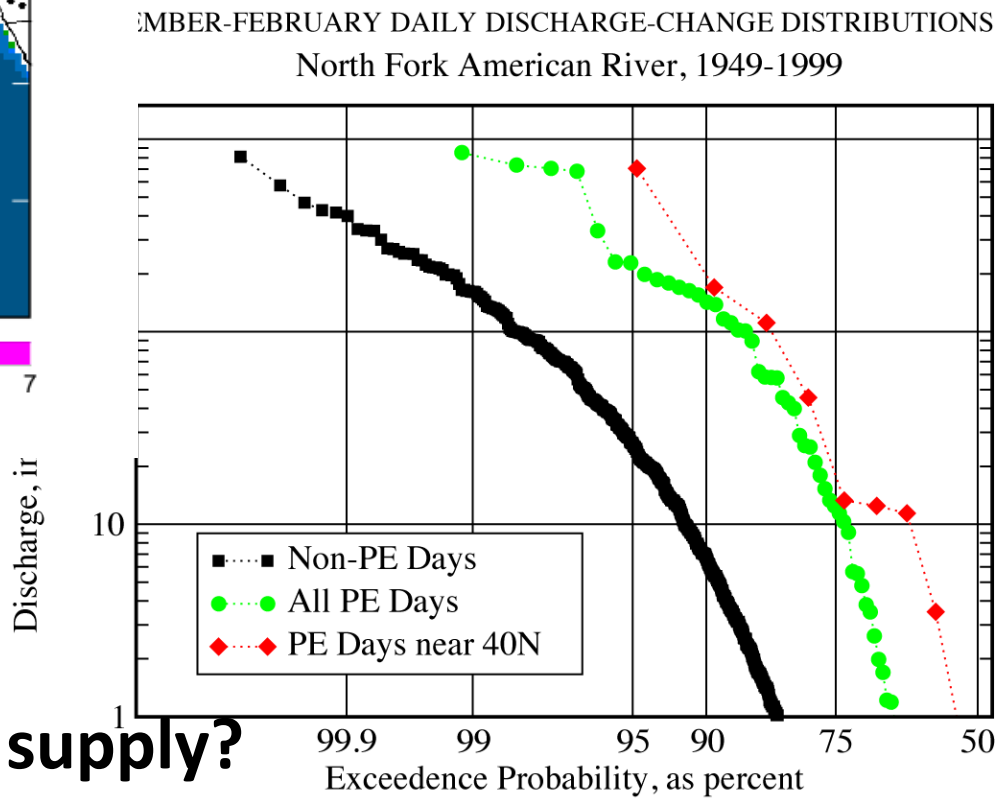


ARs bring floods to California



- All 7 major floods of Russian River since 1997 have been caused by atmospheric rivers

- The 9 largest winter floods of Carson River since 1950 have been atmospheric rivers (I.e., pineapple expresses)



Ralph et al, GRL, 2006; Neiman et al, 2008; Dettinger 2004; Dettinger et al,. in prep

…but what about water supply?

Two "AR" Chronologies

- **AR chronology, 1998-2008,** *based on SSM/I imagery* (Neiman et al, 2008)

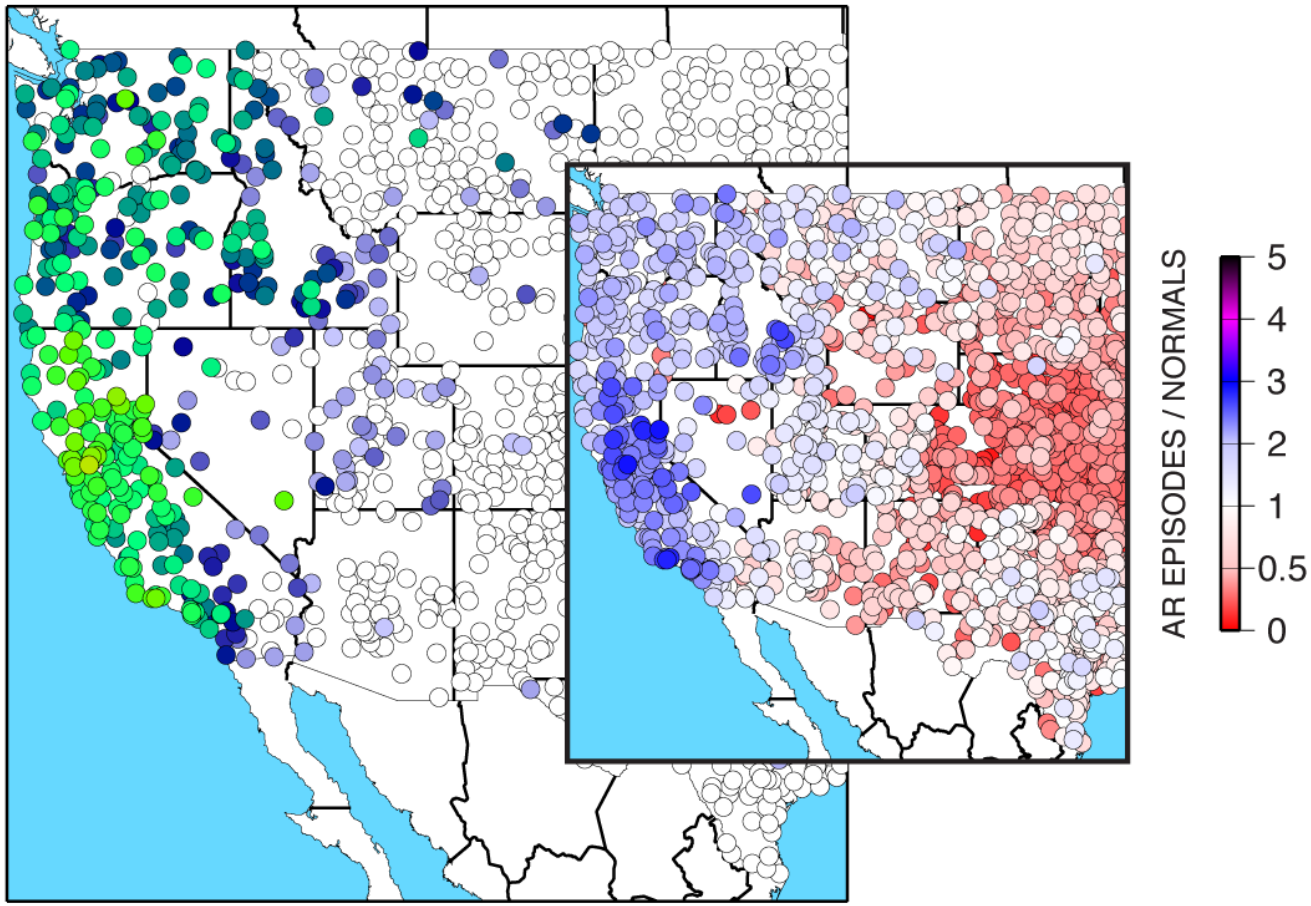
  [11 years; 16 events per Nov-Apr; 176 total]

- **Pineapple-Express chronology, 1948-2008,** *based on Reanalysis IWVs* (Dettinger 2004)

  [61 years; 6.4 events per Nov-Apr; 390 total]

In period of overlap, 71 of 73 PE events are also in the AR chronology

CONTRIBUTIONS OF ALL AR EPISODES (days 0 to +1)
TO TOTAL PRECIPITATION, WY 1998-2008

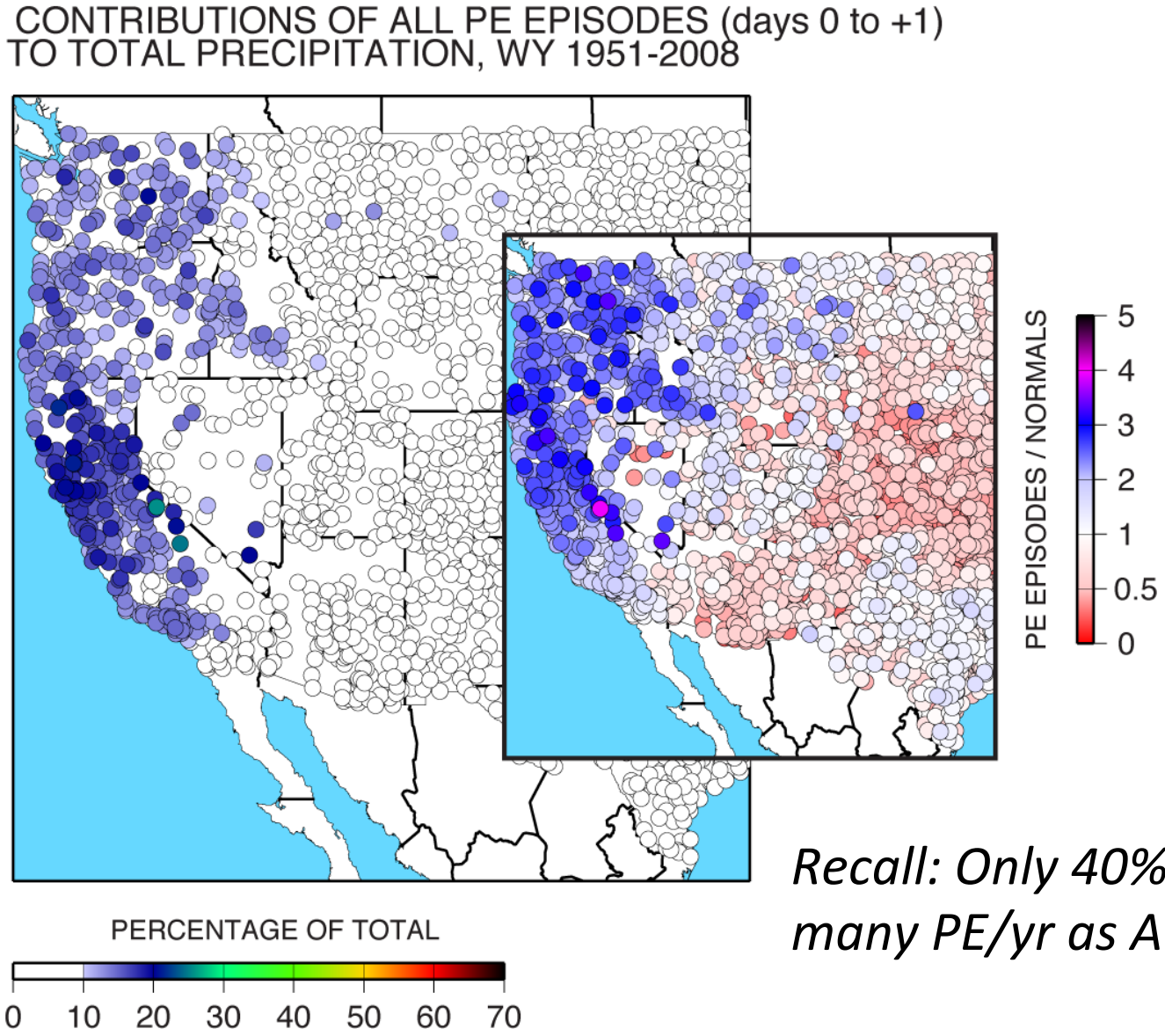


PERCENTAGE OF TOTAL

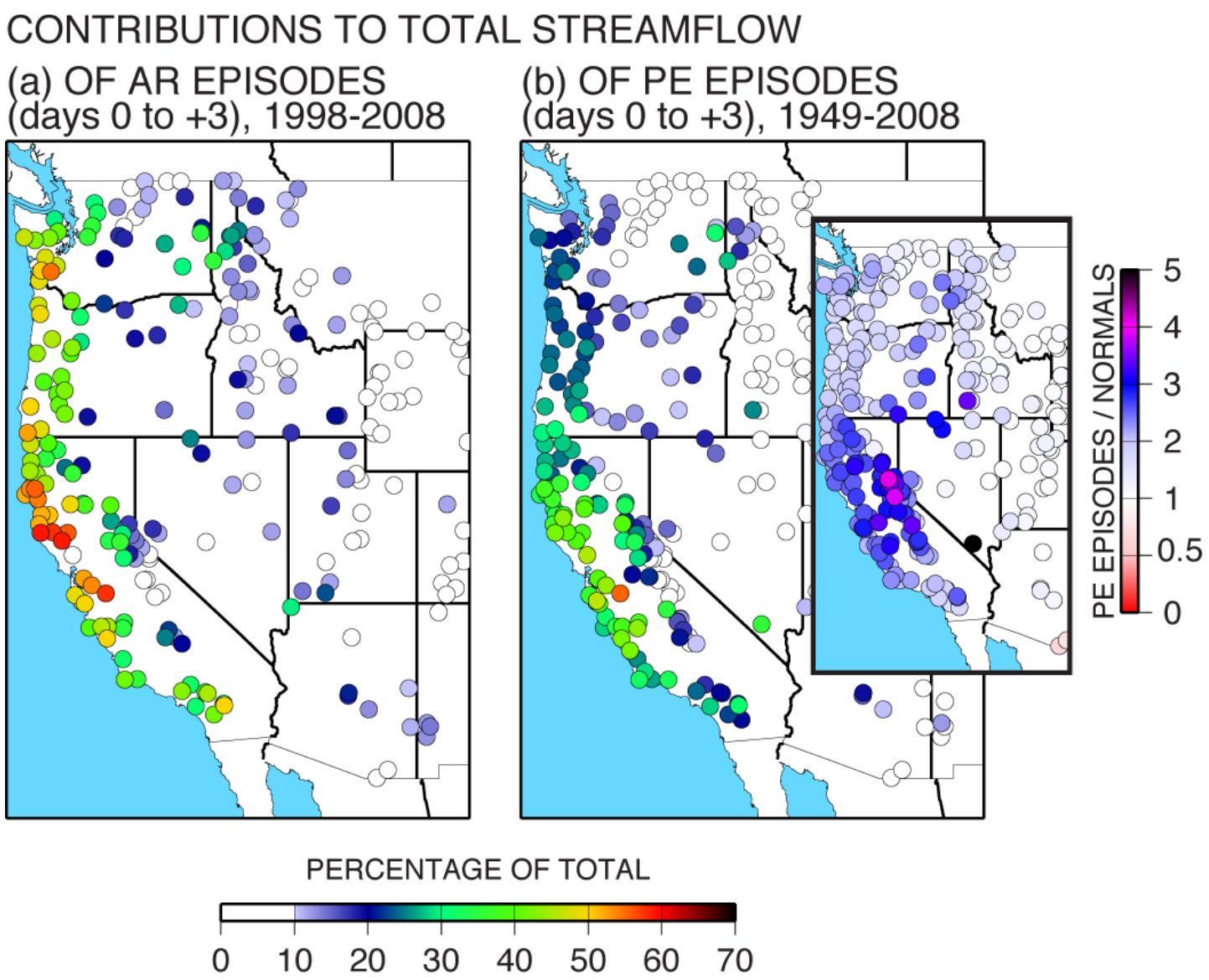
0 10 20 30 40 50 60 70

AR EPISODES / NORMALS

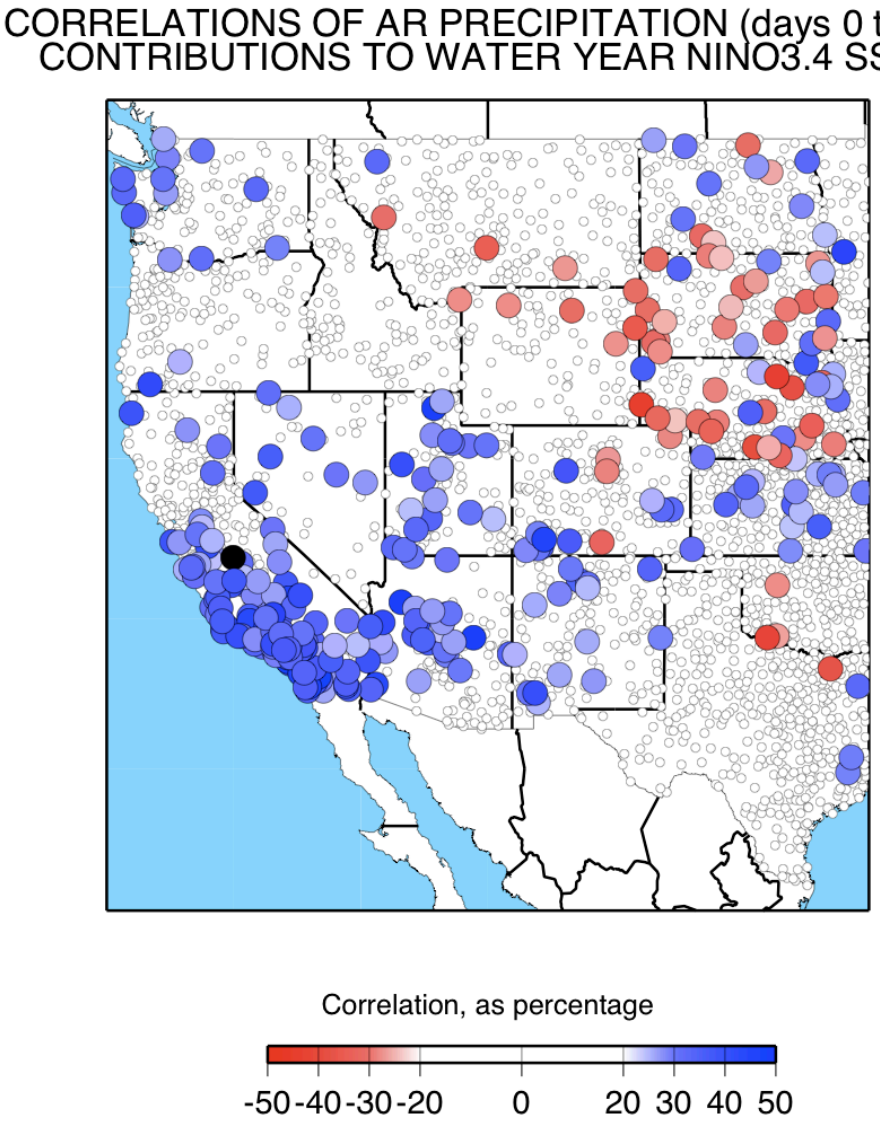
5
4
3
2
1
0.5
0



Recall: Only 40% as many PE/yr as ARs


CONTRIBUTIONS TO TOTAL STREAMFLOW
(a) OF AR EPISODES
(days 0 to +3), 1998-2008
(b) OF PE EPISODES
(days 0 to +3), 1949-2008
PE EPISODES / NORMALS
5
4
3
2
1
0.5
0
PERCENTAGE OF TOTAL
0
10
20
30
40
50
60
70

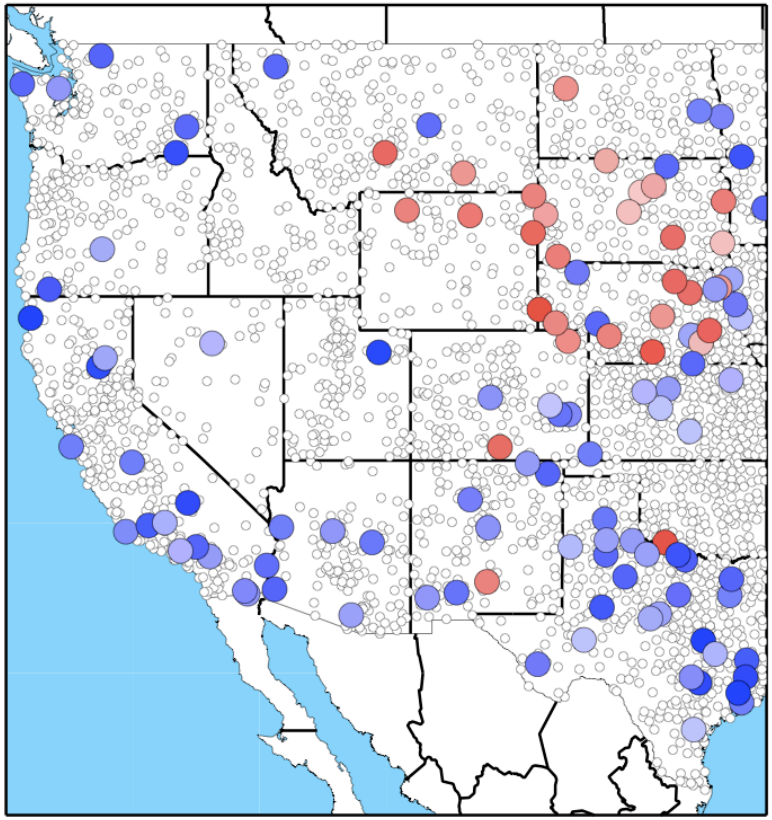
HOW DO PE-day CONTRIBUTIONS TO OVERALL PRECIPITATION CORRELATE WITH ENSO STATUS?



WATER YEARS 1951-2008

ANY *EASY* PREDICTABILITY FROM THIS RELATION?

CORRELATIONS OF AR PRECIPITATION (days 0 to +1)
CONTRIBUTIONS TO PREVIOUS AUG-OCT NINO3.4 SSTs



Correlation, as percentage

-50 -40 -30 -20 0 20 30 40 50

WATER YEARS
1951-2008

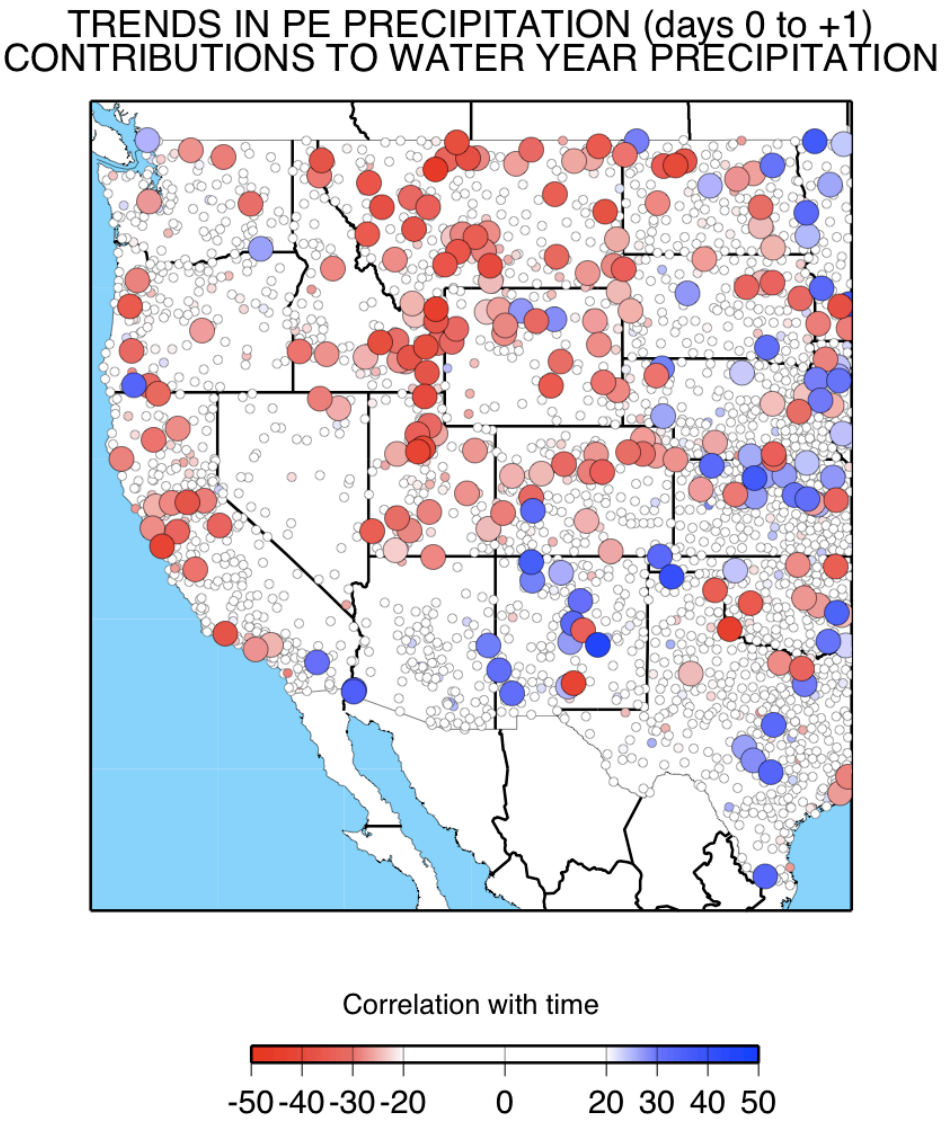
Conclusions

- PEs are a subset of the broader category called ARs
- ARs contribute about 26 – 46% of all precipitation and 19 – 50% of all streamflow in central and northern California, 1998-2008.
- PEs (a subset of ARs) contribute about 11 – 26% of all precipitation and 9 – 35% of all streamflow, 1951-2008.

Thus ARs are critical to BOTH the flood and water supply conditions in California.

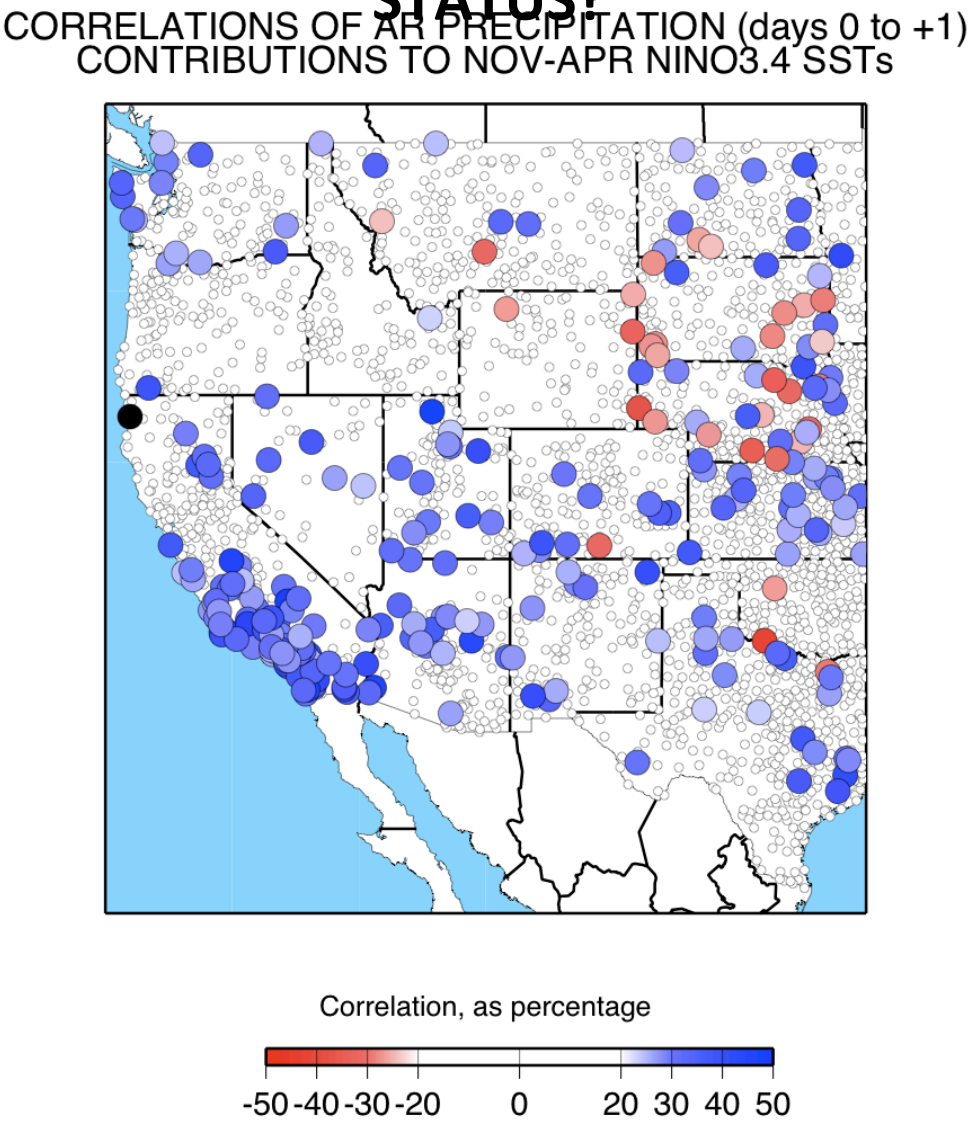
- ENSO status modulates these contributions in southern and central California, somehow.

HAVE PE-day CONTRIBUTIONS TO OVERALL PRECIPITATION TRENDED IN RECENT DECADES?



WATER YEARS 1951-2008

HOW DO PE-day CONTRIBUTIONS TO OVERALL PRECIPITATION CORRELATE WITH NOV-APR ENSO STATUS?



WATER YEARS 1951-2008