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Forecast Informed Reservoir Operations on Water Supply Planning and Flood Control at Don Pedro Reservoir

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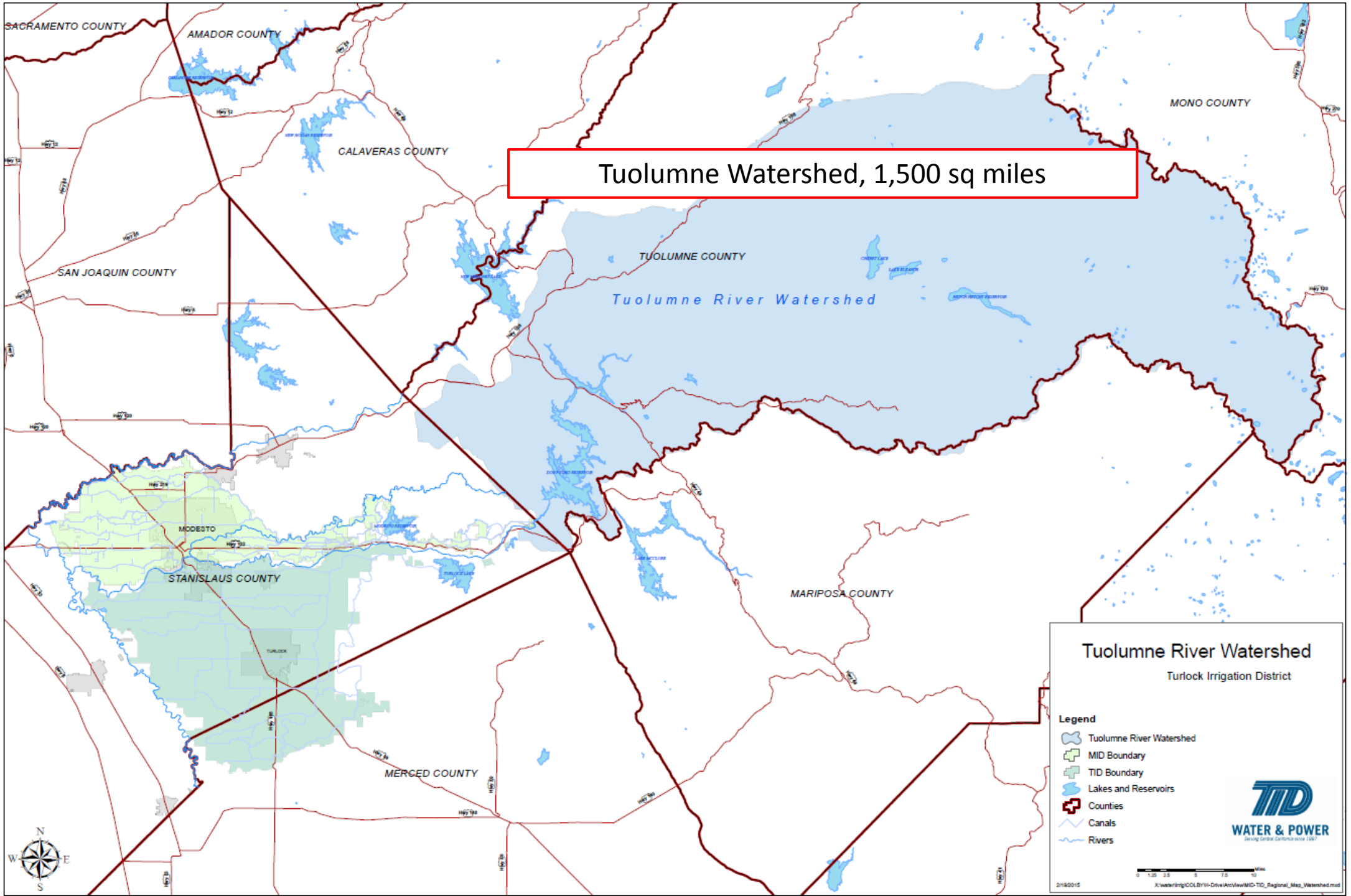

SACRAMENTO COUNTY
AMADOR COUNTY
CALAVERAS COUNTY
MONO COUNTY
Tuolumne Watershed, 1,500 sq miles
TUOLUMNE COUNTY
Tuolumne River Watershed
SAN JOAQUIN COUNTY
MODESTO
STANISLAUS COUNTY
MARIPOSA COUNTY
MERCED COUNTY
Tuolumne River Watershed
Turlock Irrigation District
Legend
Tuolumne River Watershed
MID Boundary
TID Boundary
Lakes and Reservoirs
Counties
Canals
Rivers
WATER & POWER

Don Pedro

- 4th largest dam in California and 9th largest dam in the Nation
- 2,030,000 AF reservoir
- 340,000 af of flood control space
- 9,000 cfs or 55ft at 9th street downstream flood control requirement
  - River releases arrive 23 hours later
  - Dry Creek flows in right before 9th street

Historical Context

"… since snowmelt flood volumes can be forecast well in advance, additional space can be used for conservation purposes during snowmelt season when forecasts indicate that a lesser amount of flood control space is required. Rain floods, however, cannot yet be adequately forecasted far enough in advance for operational purposes and rain flood space requirements cannot be decreased on the basis of a forecast" (USACE Don Pedro Flood Control Manual, 1971).

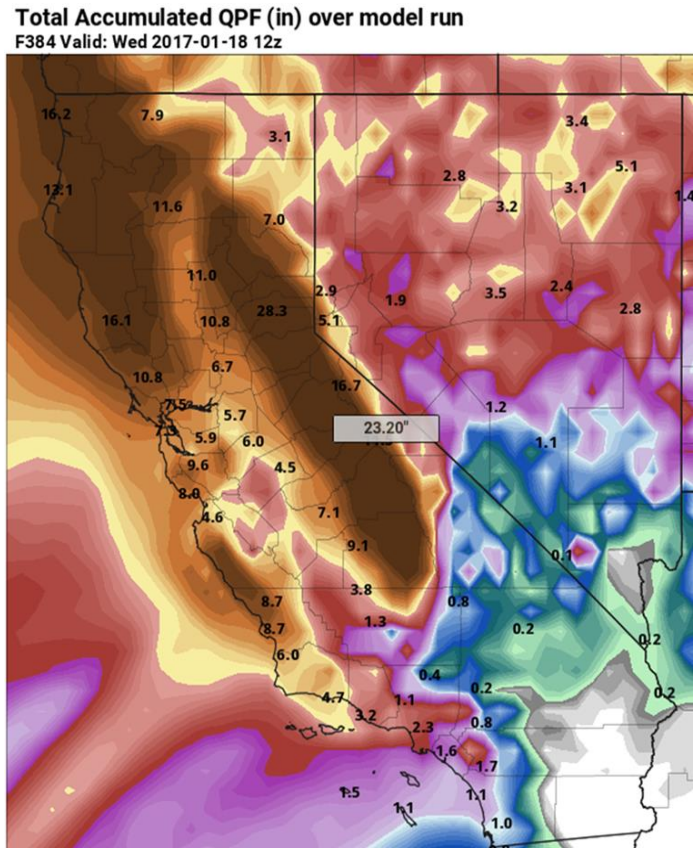
Wet Conditions

- 2017 Wet Example
  - Started looking at making flood releases at Elevation 786, 15.9 Feet below the start of Flood Control Space.
  - 2012-2015 Driest 4 years in 1,100 years and drier by 20% that the previous driest 4 year drought ending 1992. 2016 was below average runoff. Reservoirs in a refill mode.

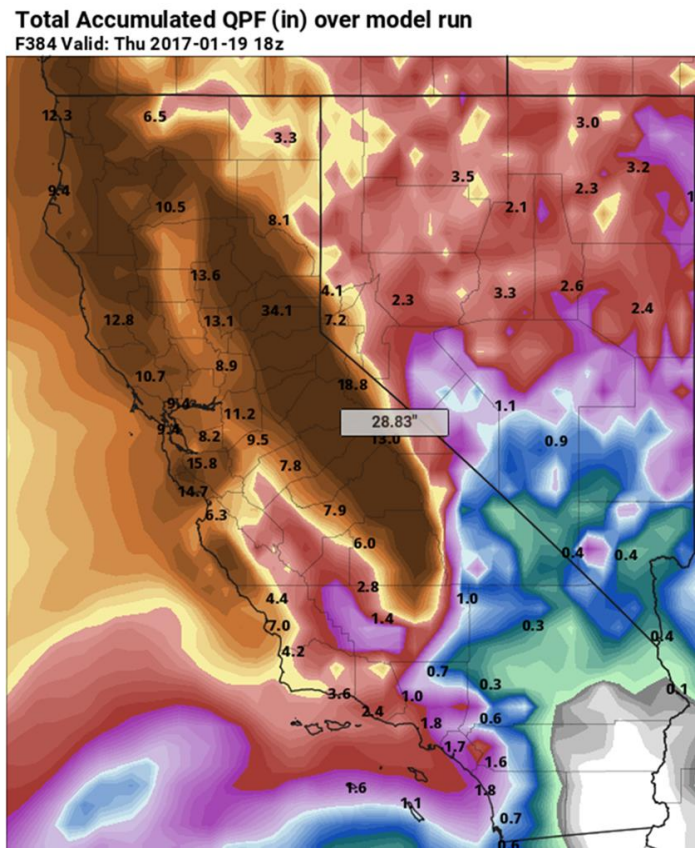
- Watershed Status
  - Oct-September
    - Average =36.05”
  - Oct-December
    - Average = 12.15”
    - 2016 = 16.56”

Set Up to 2017 Events

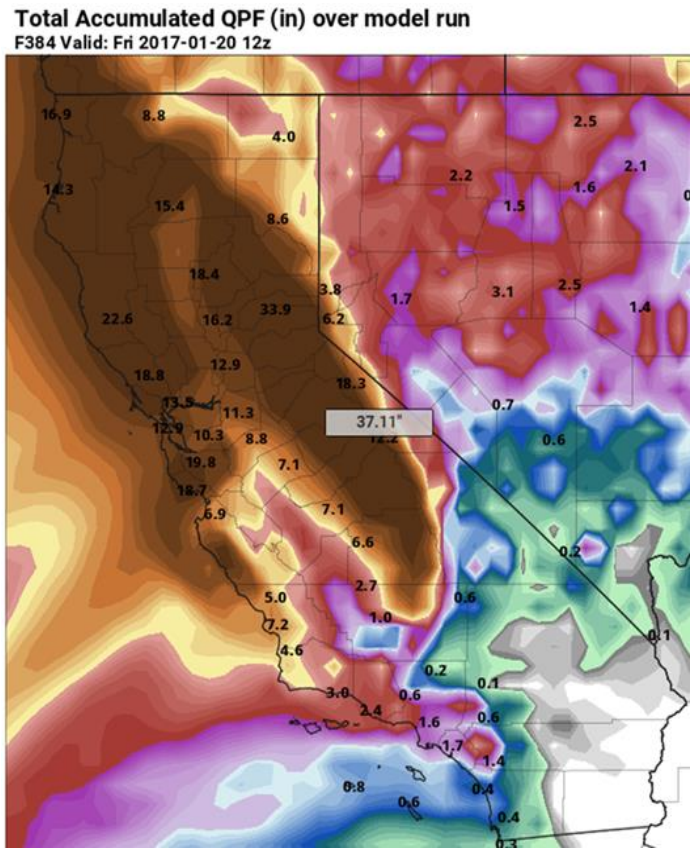
2017/01/02
23.20”



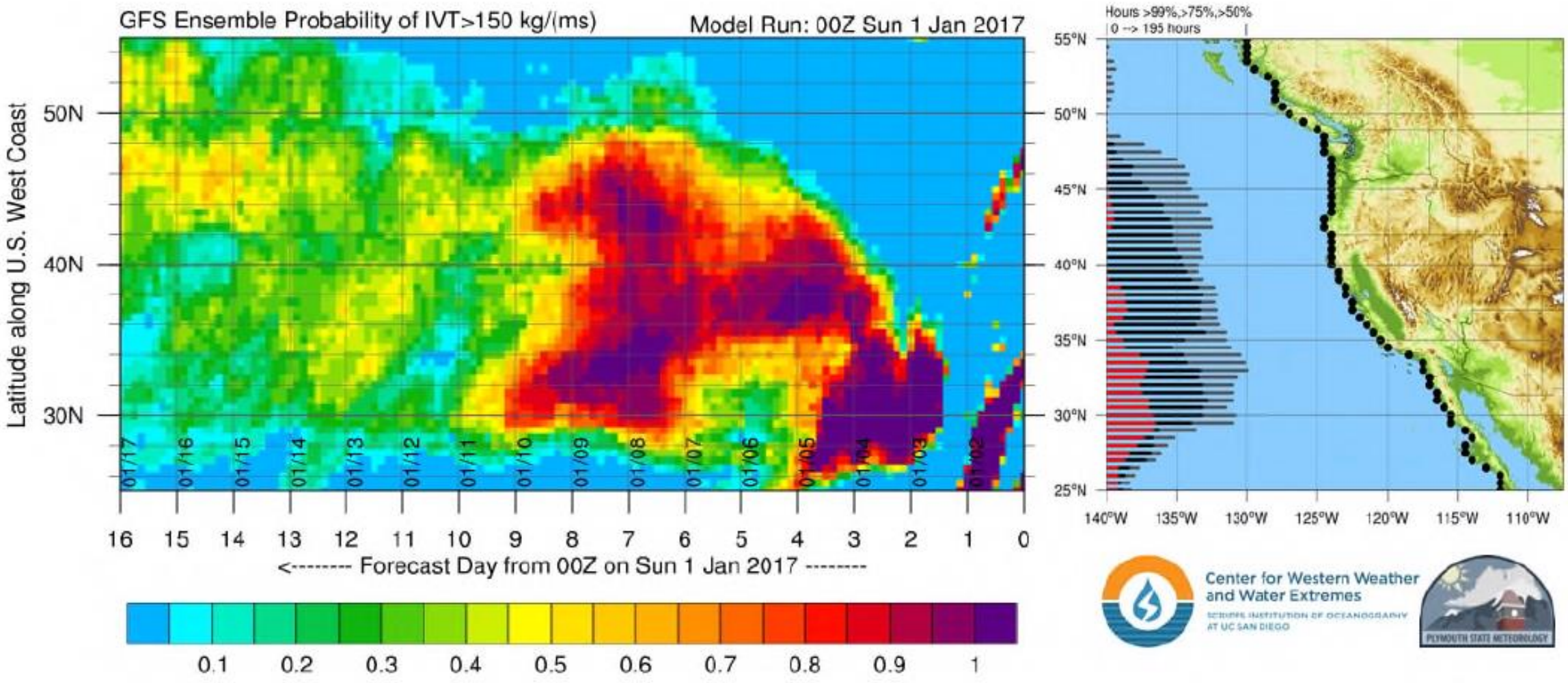
2017/01/03
28.83”



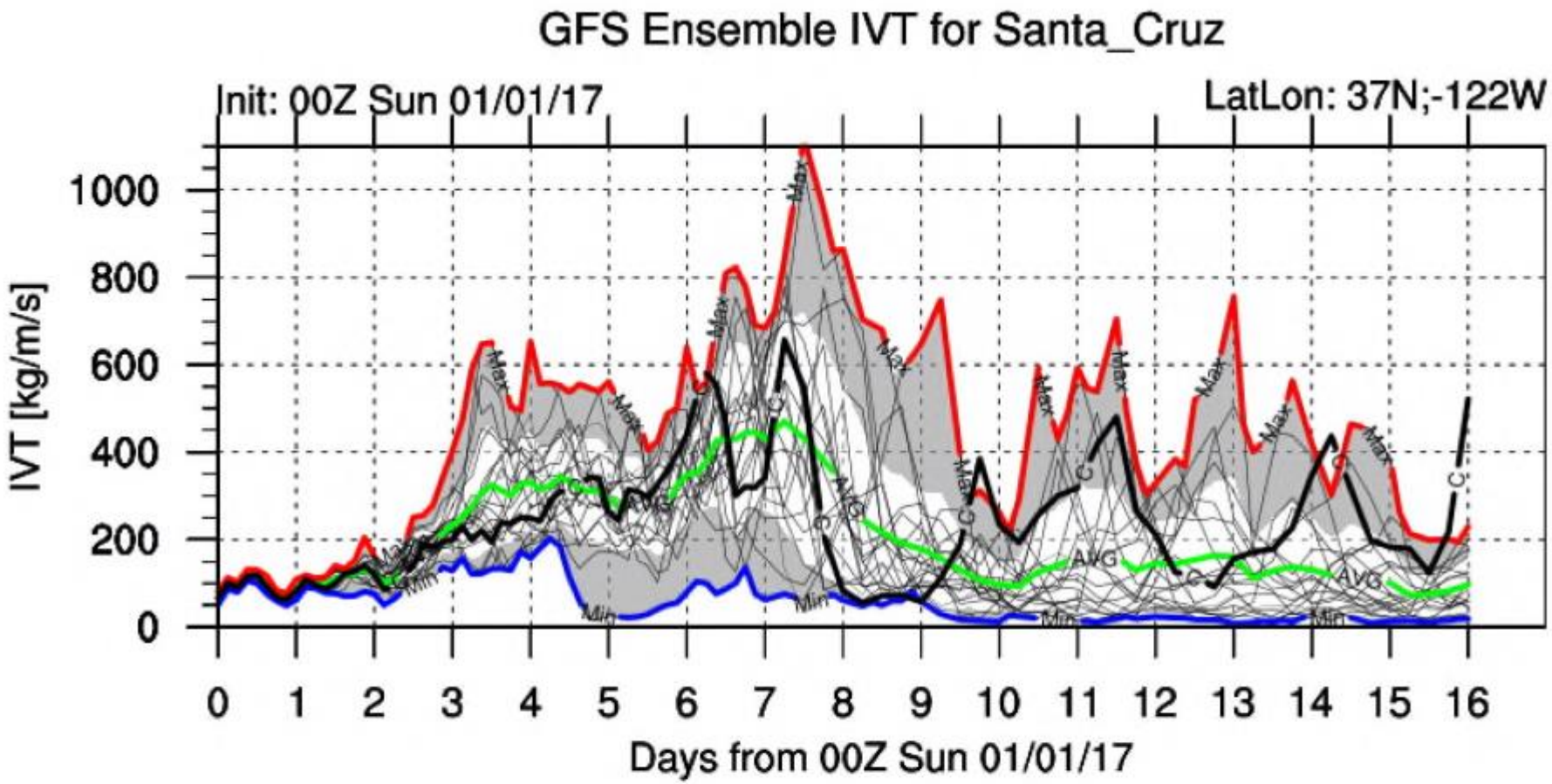
2017/01/04
37.11”



Forecasts to Start Flood Releases

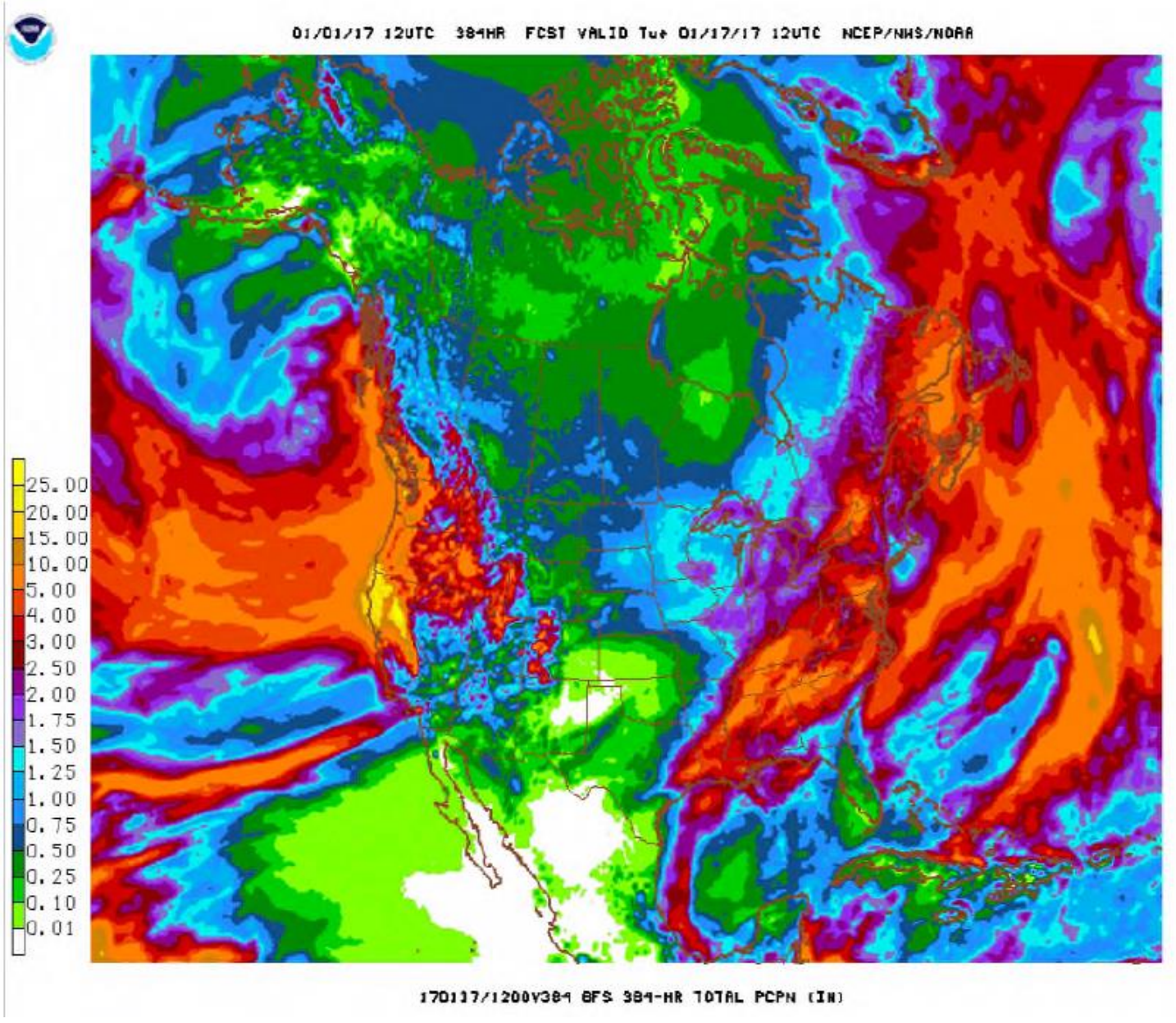


Forecasts to Start Flood Releases

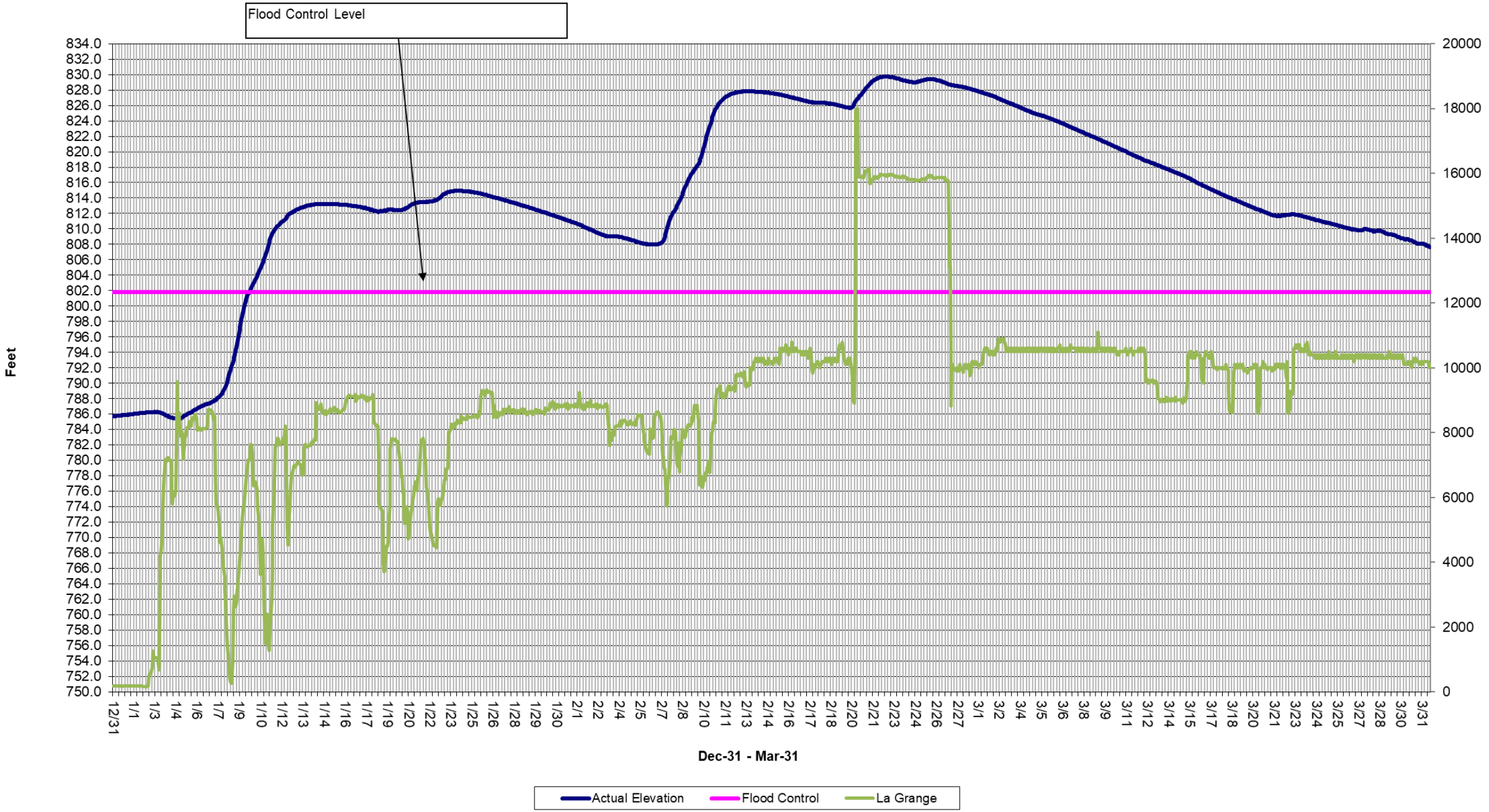


The plume diagram above represents the integrated water vapor transport (IVT) forecast for each of the 20 perturbed GFS ensemble models (thin gray lines), the unperturbed GFS control forecast (black line), the 20-member ensemble mean (green line), and the maximum ensemble value at that forecast hour (red line) and minimum ensemble value at that forecast hour (blue line). The white shading represents the +/- 1 standard deviation forecast from the ensemble mean.

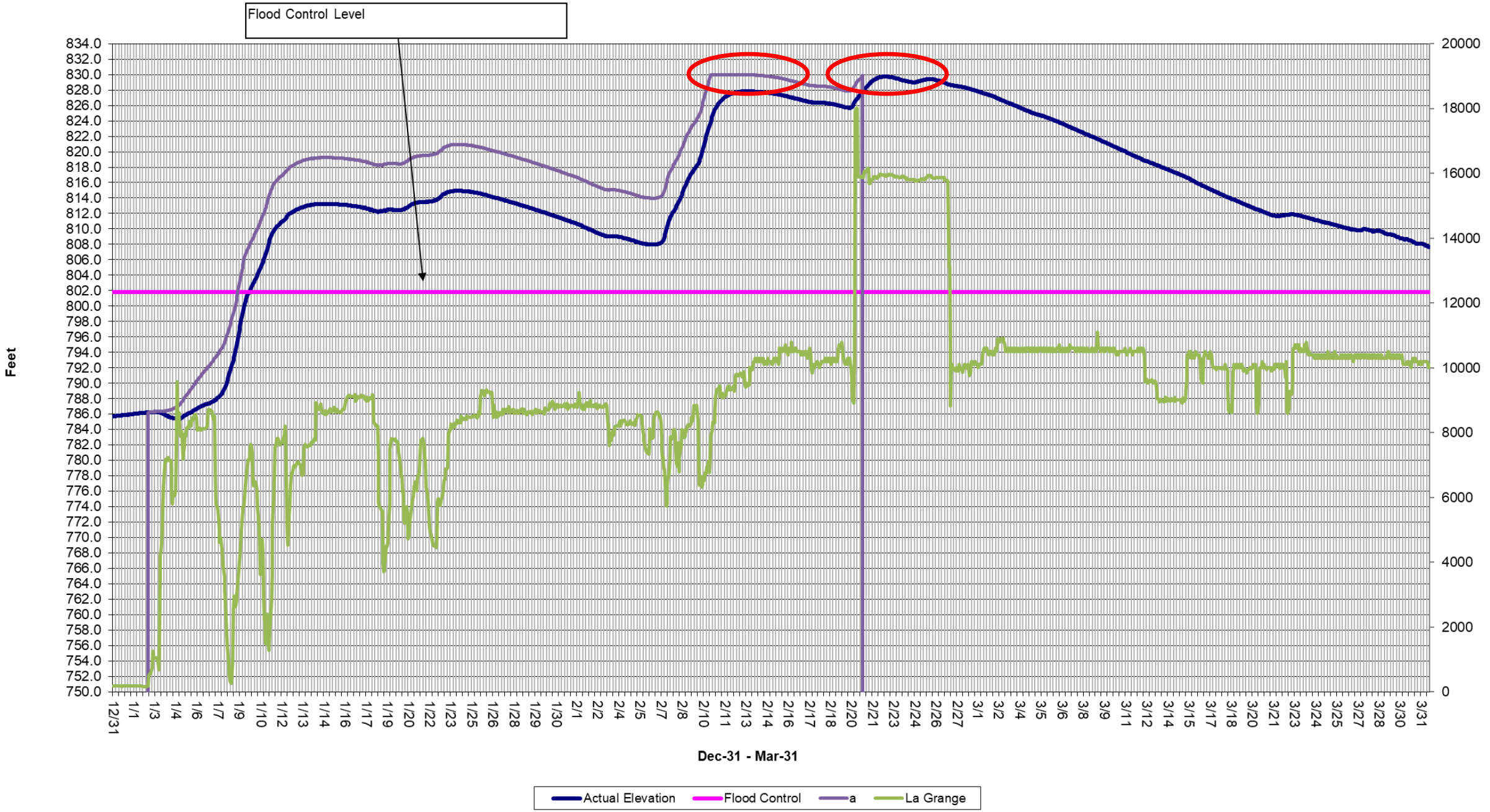
Forecasts to Start Flood Releases



Don Pedro Elevation



Don Pedro Elevation



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February 2017

February 2017

830.00; top of Spill Way Crest
829.74 Max Storage

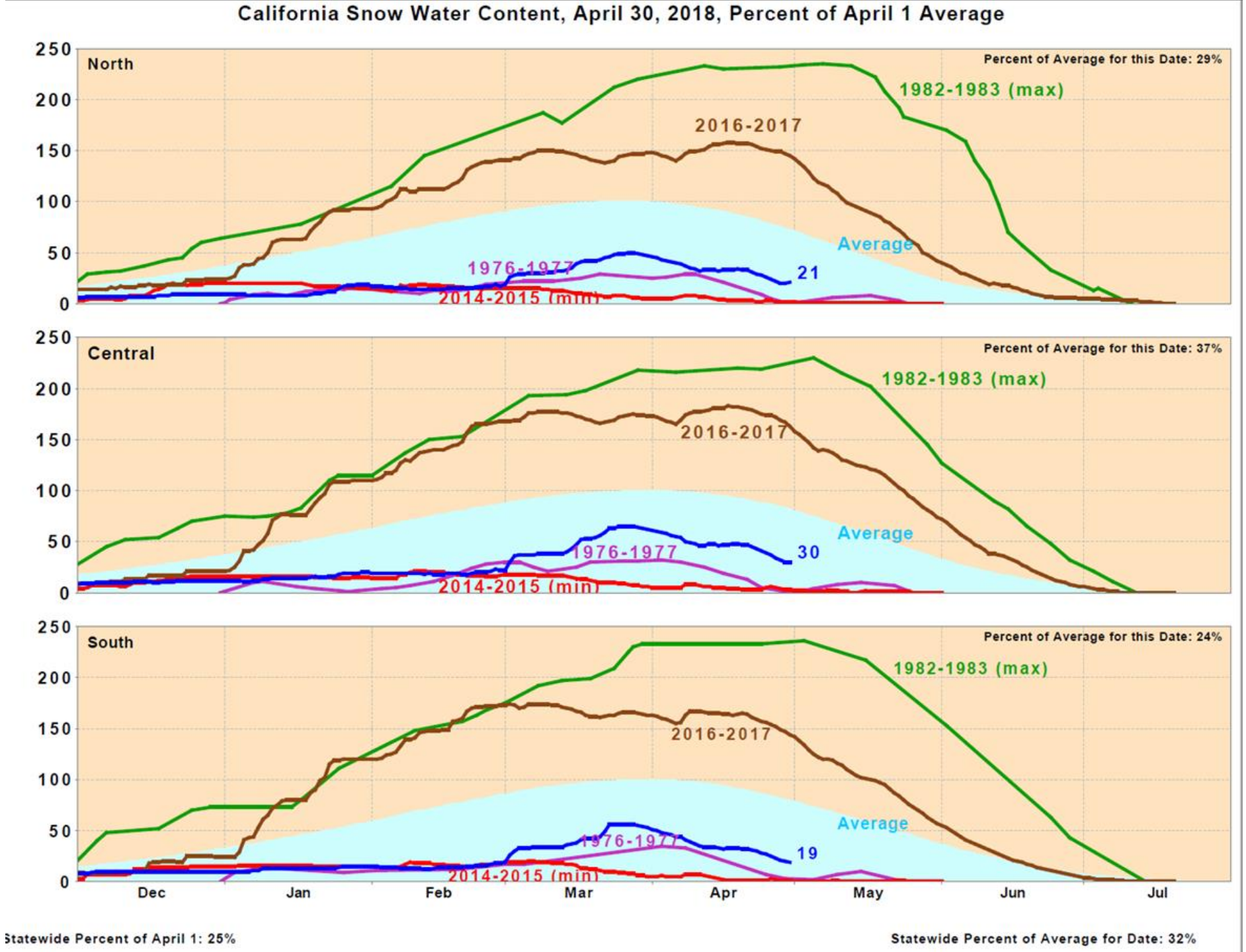
Dry Conditions

2018 Dry Example

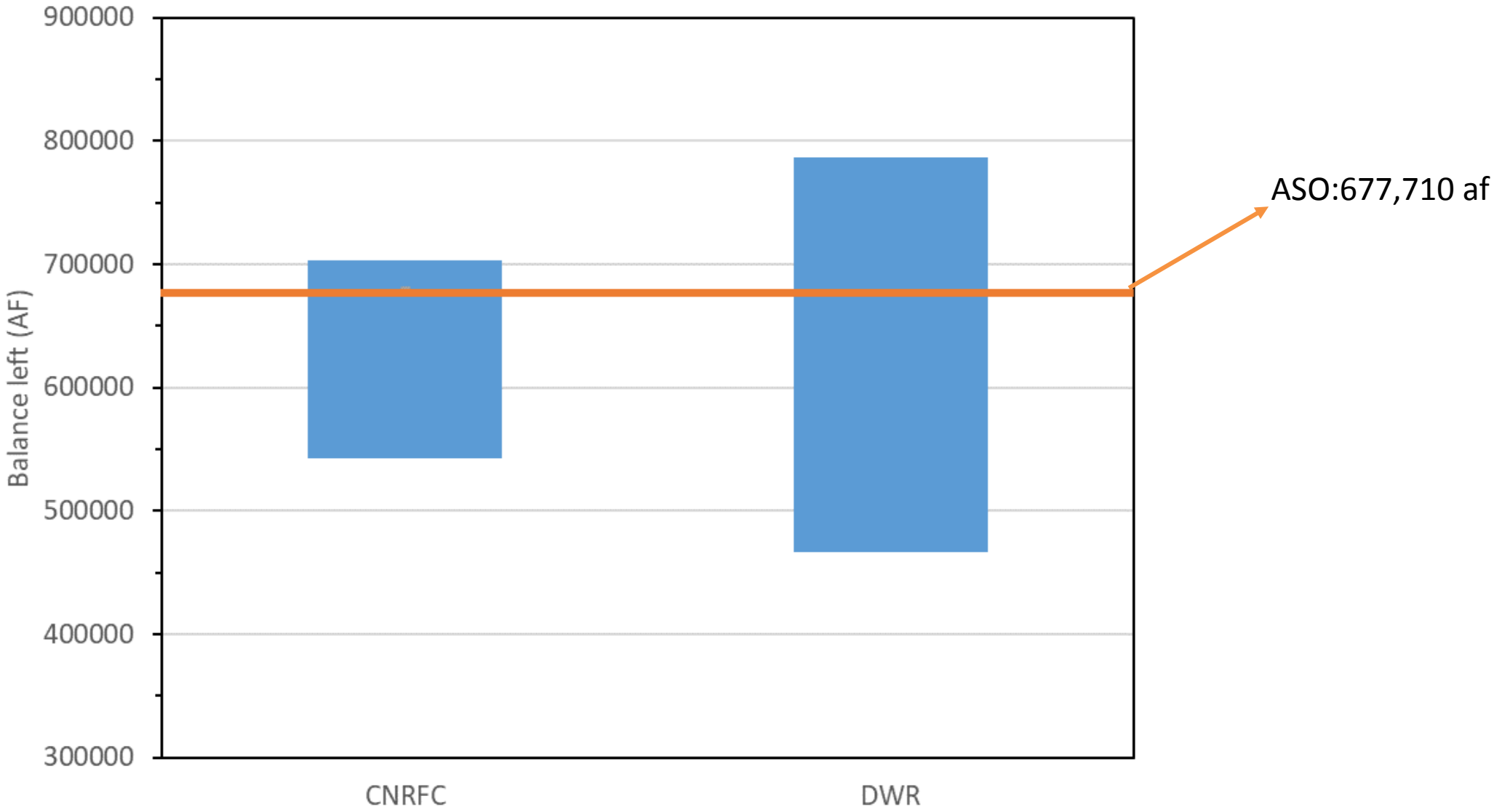
- 4 year drought still in memory

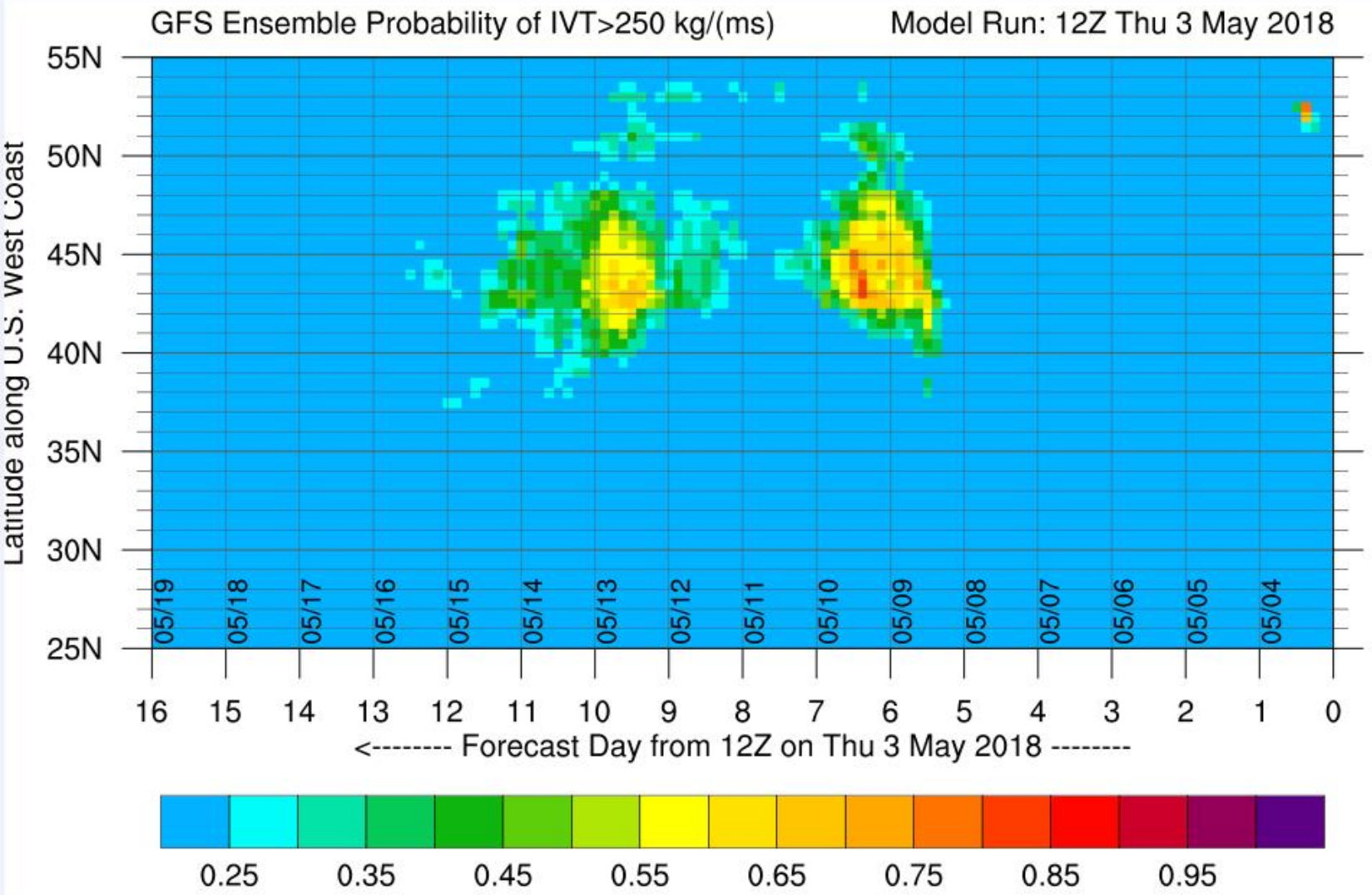
- Major Discussions on Substitute Environmental Document ("DWR SED")
  - 40% to 60% of full natural flow requirement

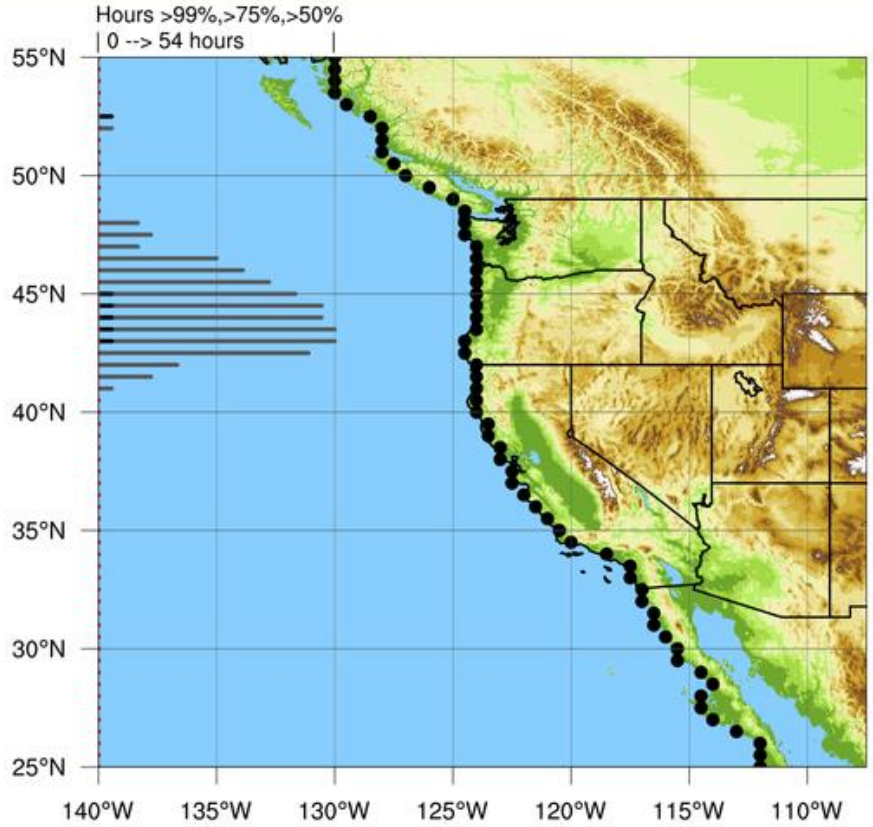
- Going into May Don Pedro was over 50 % encroached


California Snow Water Content, April 30, 2018, Percent of April 1 Average
North
Percent of Average for this Date: 29%
1982-1983 (max)
2016-2017
Average
1976-1977
21
2014-2015 (min)
Central
Percent of Average for this Date: 37%
1982-1983 (max)
2016-2017
Average
1976-1977
30
2014-2015 (min)
South
Percent of Average for this Date: 24%
1982-1983 (max)
2016-2017
Average
1976-1977
19
2014-2015 (min)
250
200
150
100
50
0
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Statewide Percent of April 1: 25%
Statewide Percent of Average for Date: 32%

Comparing Forecast Values (05/01/18)



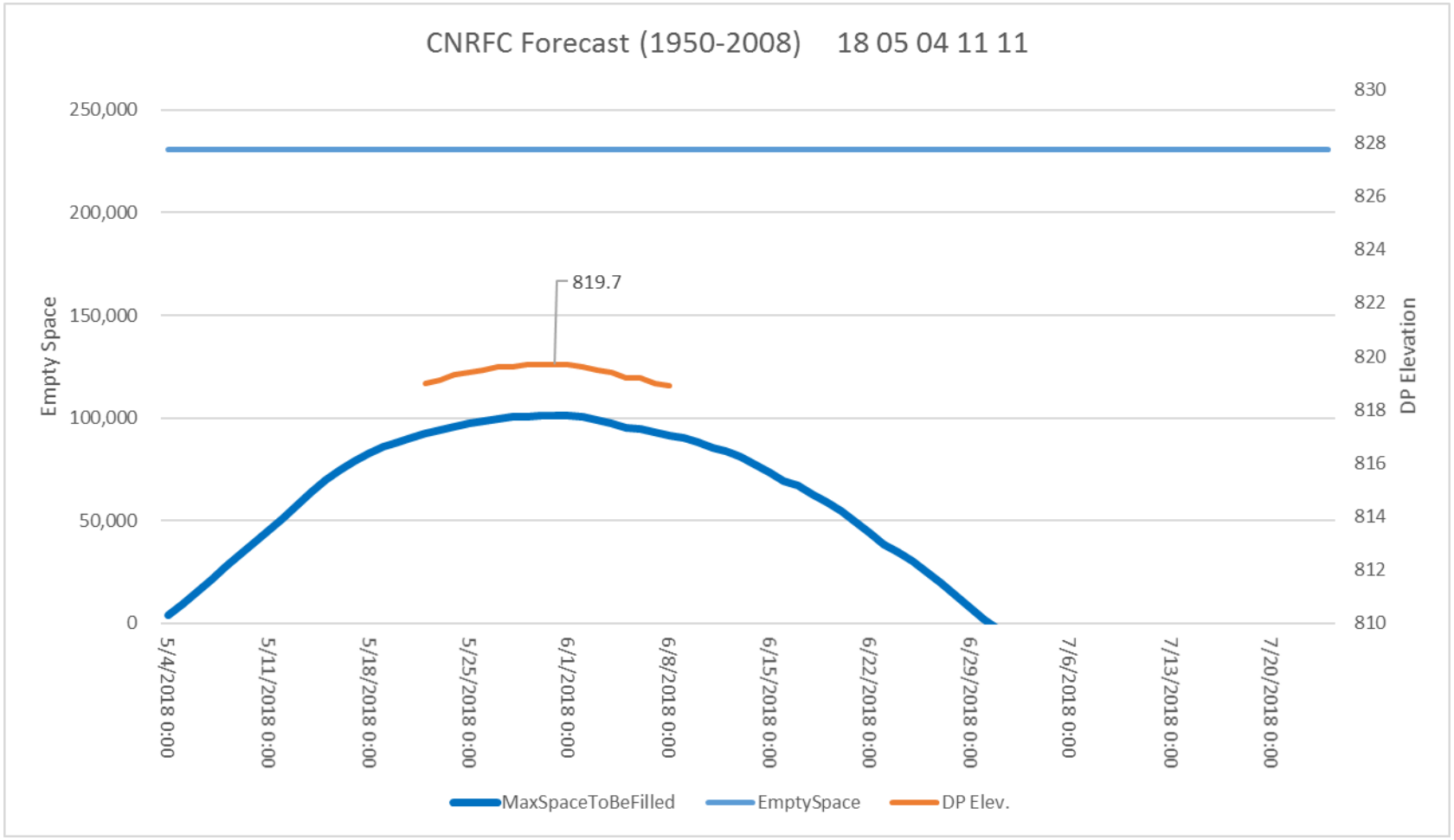




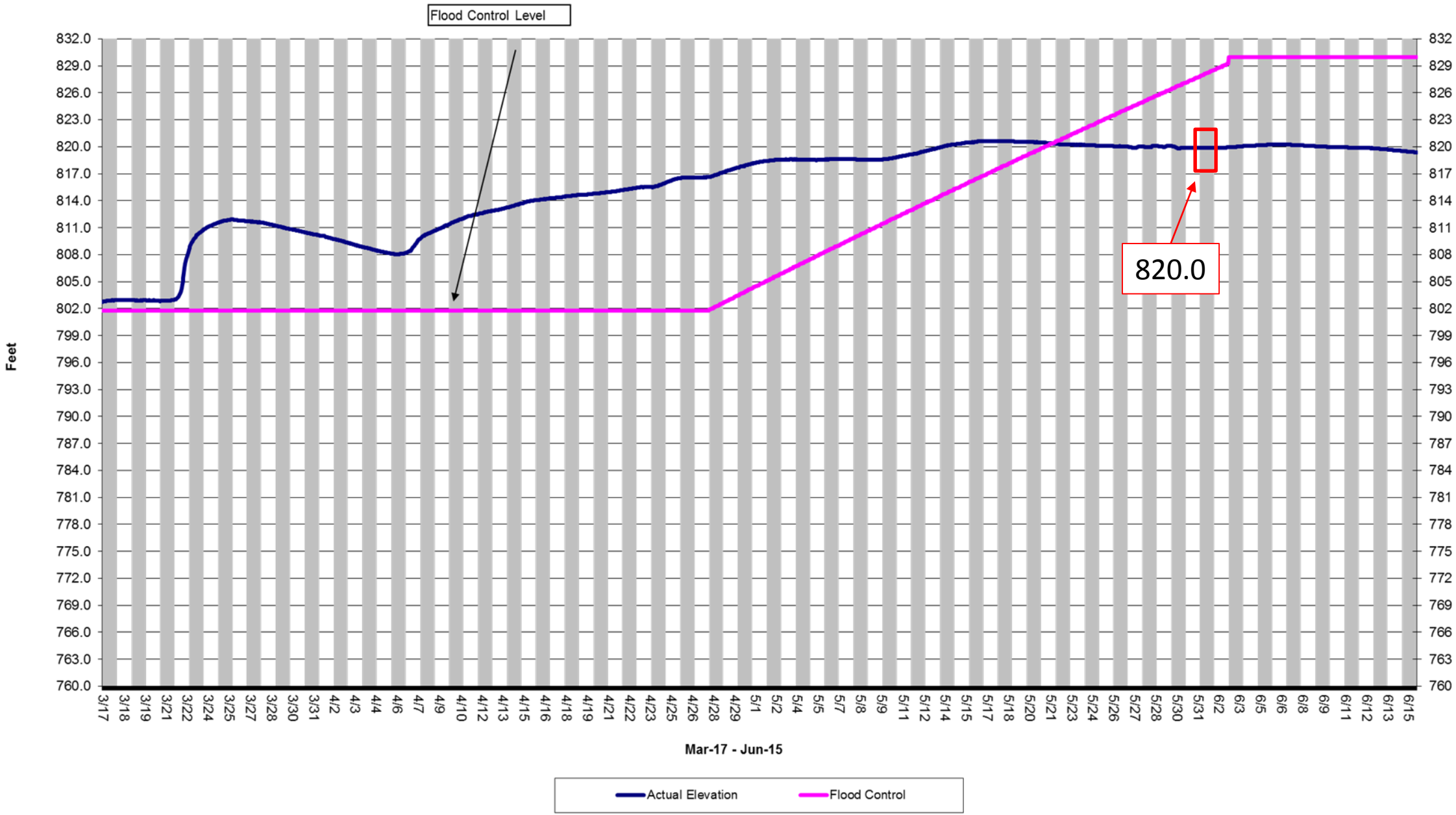
Center for Western Weather and Water Extremes
SCRIPPS INSTITUTION OF OCEANOGRAPHY AT UC SAN DIEGO

PLYMOUTH STATE METEOROLOGY

Don Pedro Releases (1,500 CFS to River)

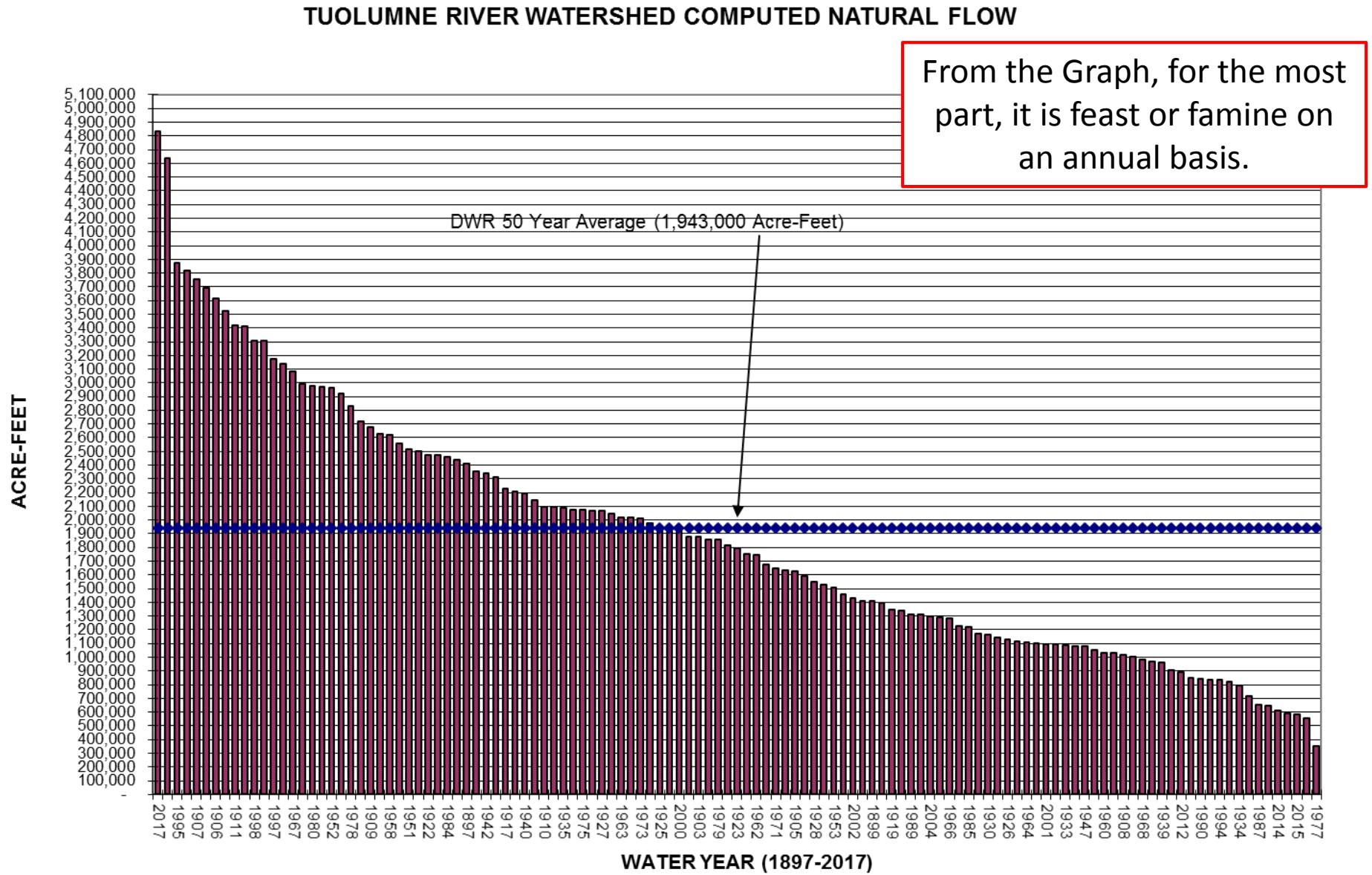


Don Pedro Elevation

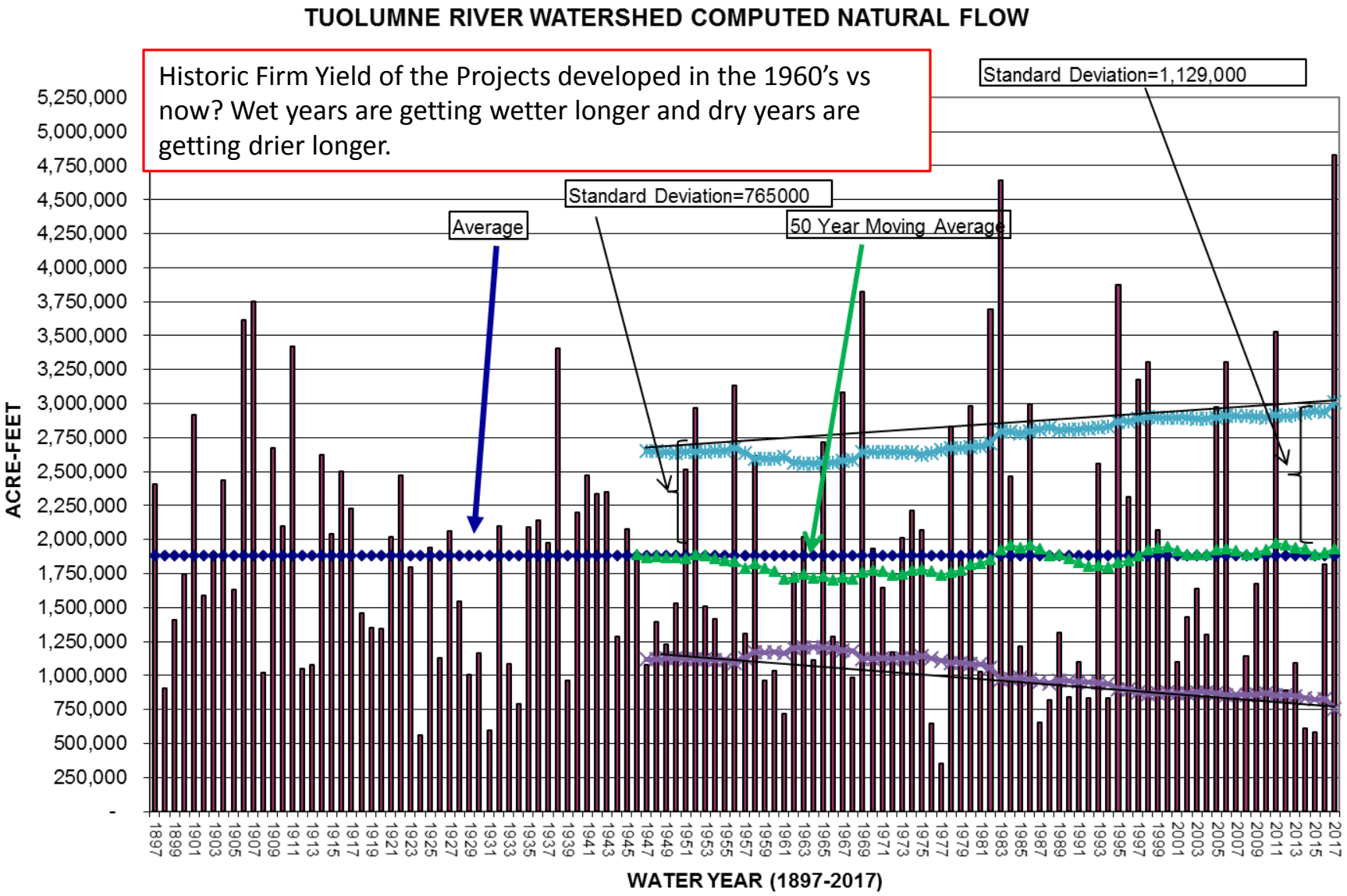


Long Term Implications

(1897-2017)


TUOLUMNE RIVER WATERSHED COMPUTED NATURAL FLOW
From the Graph, for the most part, it is feast or famine on an annual basis.
DWR 50 Year Average (1,943,000 Acre-Feet)
ACRE-FEET
5,100,000
5,000,000
4,900,000
4,800,000
4,700,000
4,600,000
4,500,000
4,400,000
4,300,000
4,200,000
4,100,000
4,000,000
3,900,000
3,800,000
3,700,000
3,600,000
3,500,000
3,400,000
3,300,000
3,200,000
3,100,000
3,000,000
2,900,000
2,800,000
2,700,000
2,600,000
2,500,000
2,400,000
2,300,000
2,200,000
2,100,000
2,000,000
1,900,000
1,800,000
1,700,000
1,600,000
1,500,000
1,400,000
1,300,000
1,200,000
1,100,000
1,000,000
900,000
800,000
700,000
600,000
500,000
400,000
300,000
200,000
100,000
-
2017 1995 1907 1906 1911 1998 1997 1967 1980 1952 1978 1909 1958 1951 1922 1984 1897 1942 1917 1940 1910 1935 1975 1927 1963 1973 1925 2000 1903 1979 1923 1962 1971 1905 1928 1953 2002 1899 1919 1989 2004 1966 1985 1930 1926 1964 2001 1933 1947 1960 1908 1968 1939 2012 1990 1994 1934 1987 2014 2015 1977
WATER YEAR (1897-2017)

The low to high relationship is getting more volatile
Both in magnitude and duration



Future of FIRO

- Increase forecast lead time and accuracy
- Integration of high resolution products like ASO and AR forecasts into hydrologic models
- Improve observation network to help set the initial state of the watershed for modeling purposes
- Create forecast products to be used as public information tools for emergency services

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THANK YOU

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