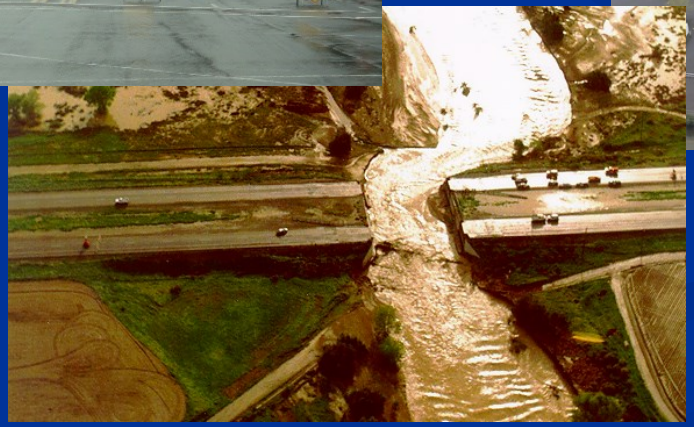
NOAA's National Weather Service
California-Nevada River Forecast Center

# Water Resources Forecasting and the Need for Skillful Climate Forecasts

Rob Hartman
Hydrologist in Charge

# Mission of NWS Hydrologic Services Program

- Provide river and flood forecasts and warnings for the protection of lives and property



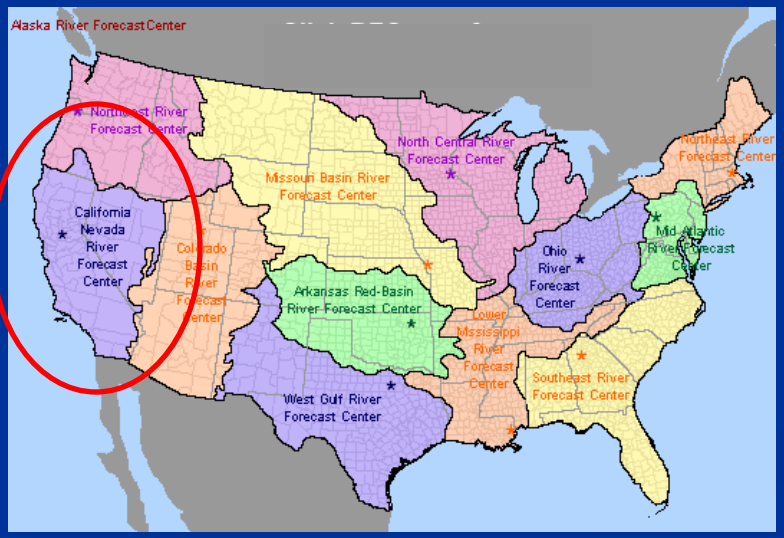
# Mission of NWS Hydrologic Services Program

- Provide basic hydrologic forecast information for the nation's environmental and economic well being

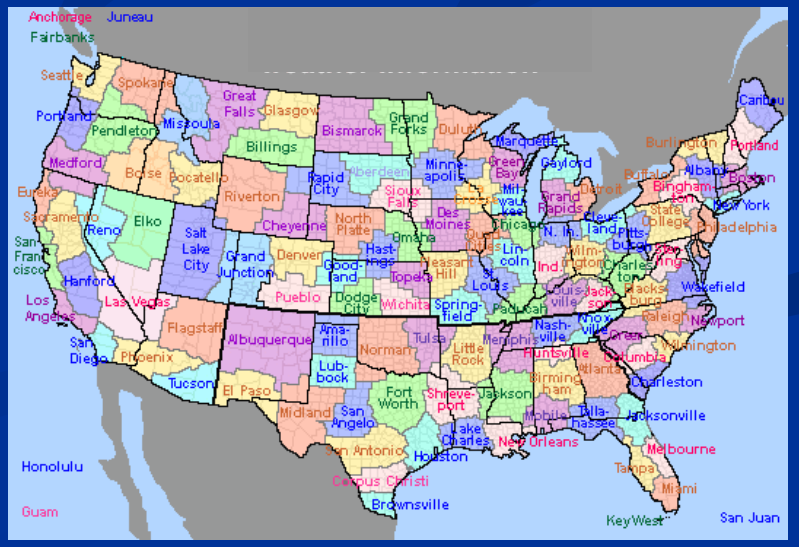
# US NWS Field Offices

9 National Centers
for Environmental Prediction (NCEP)

13 RFCs
River Forecast Centers

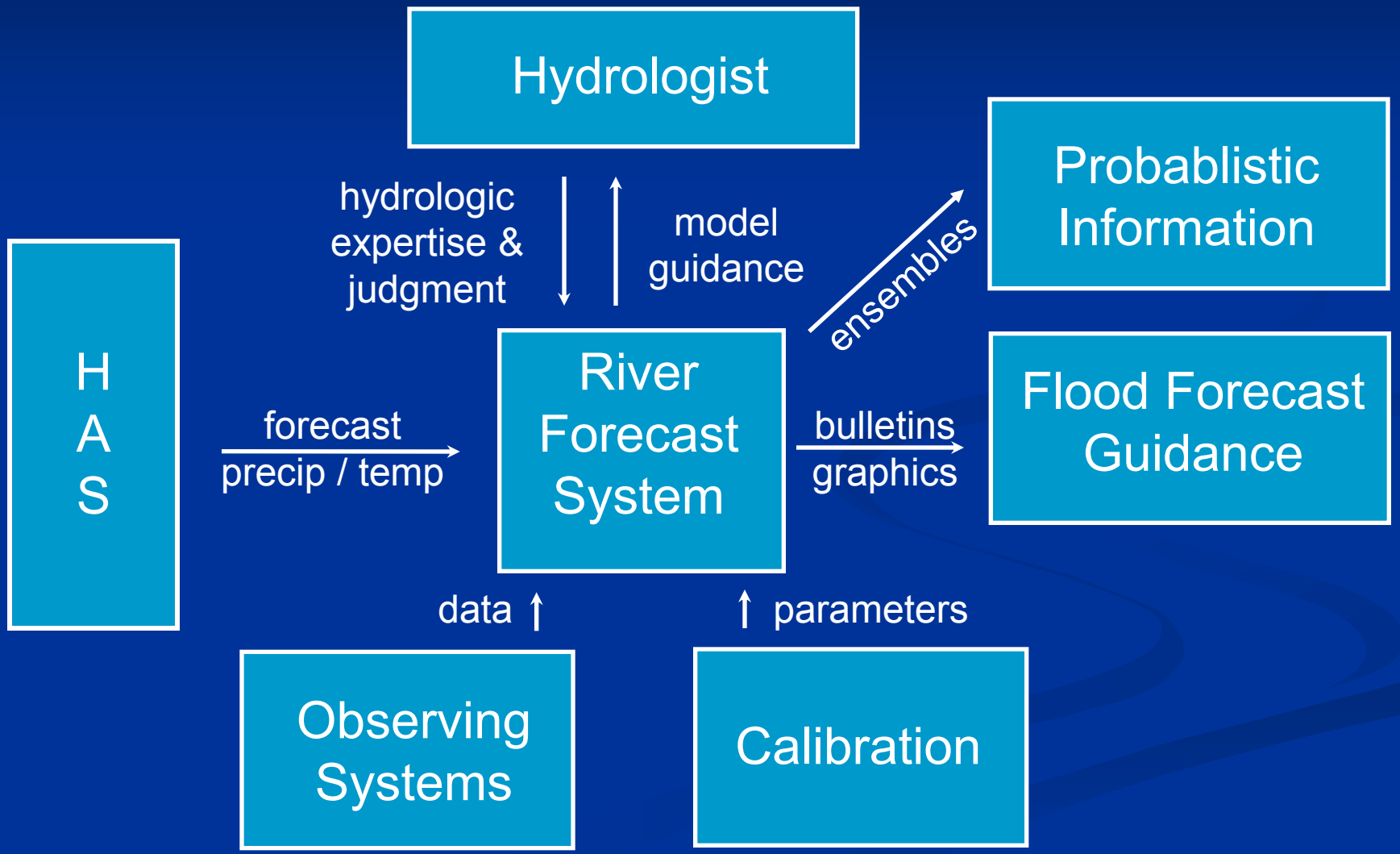



122 WFOs
Weather Forecast Offices

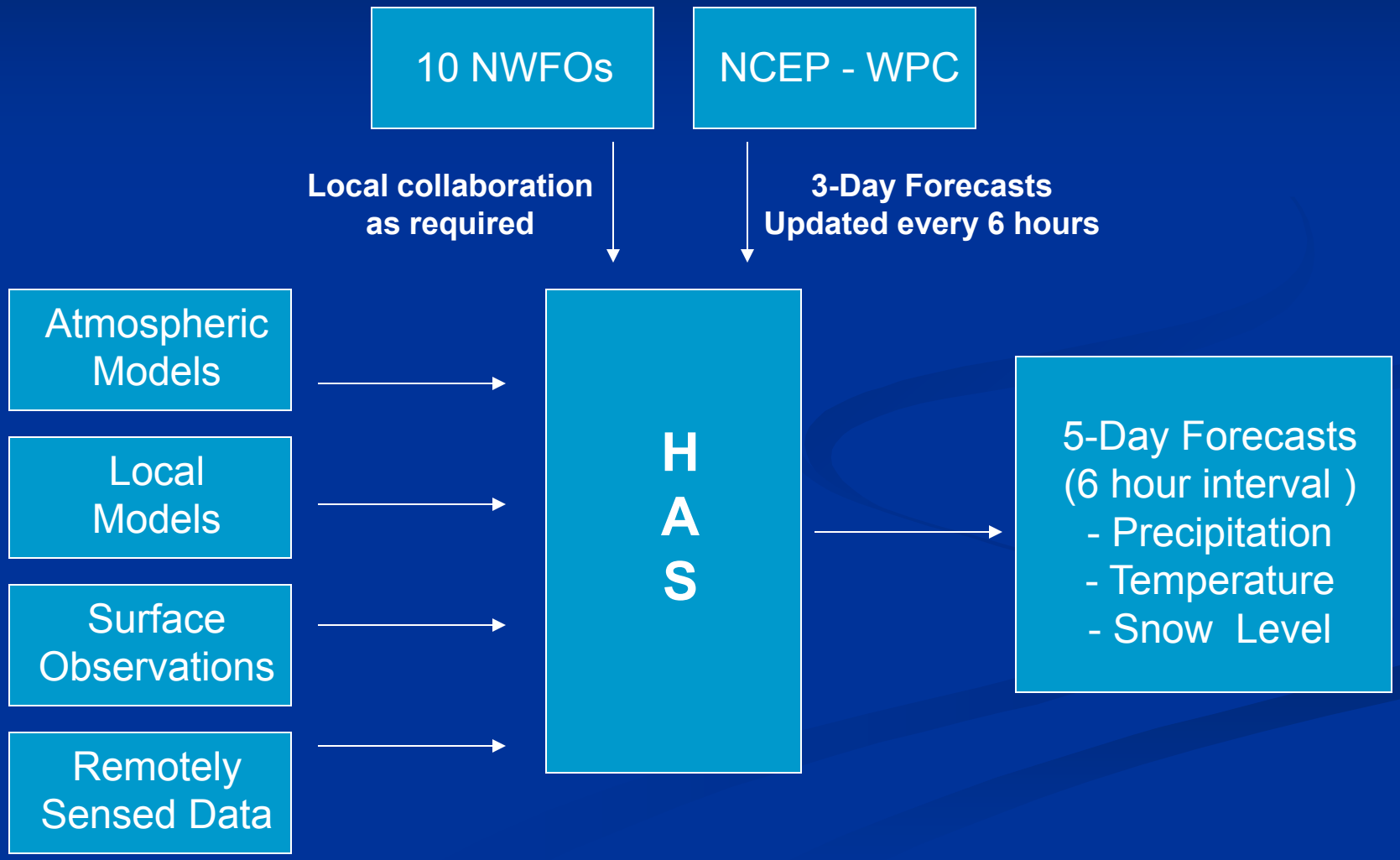


# Operational River Forecasting

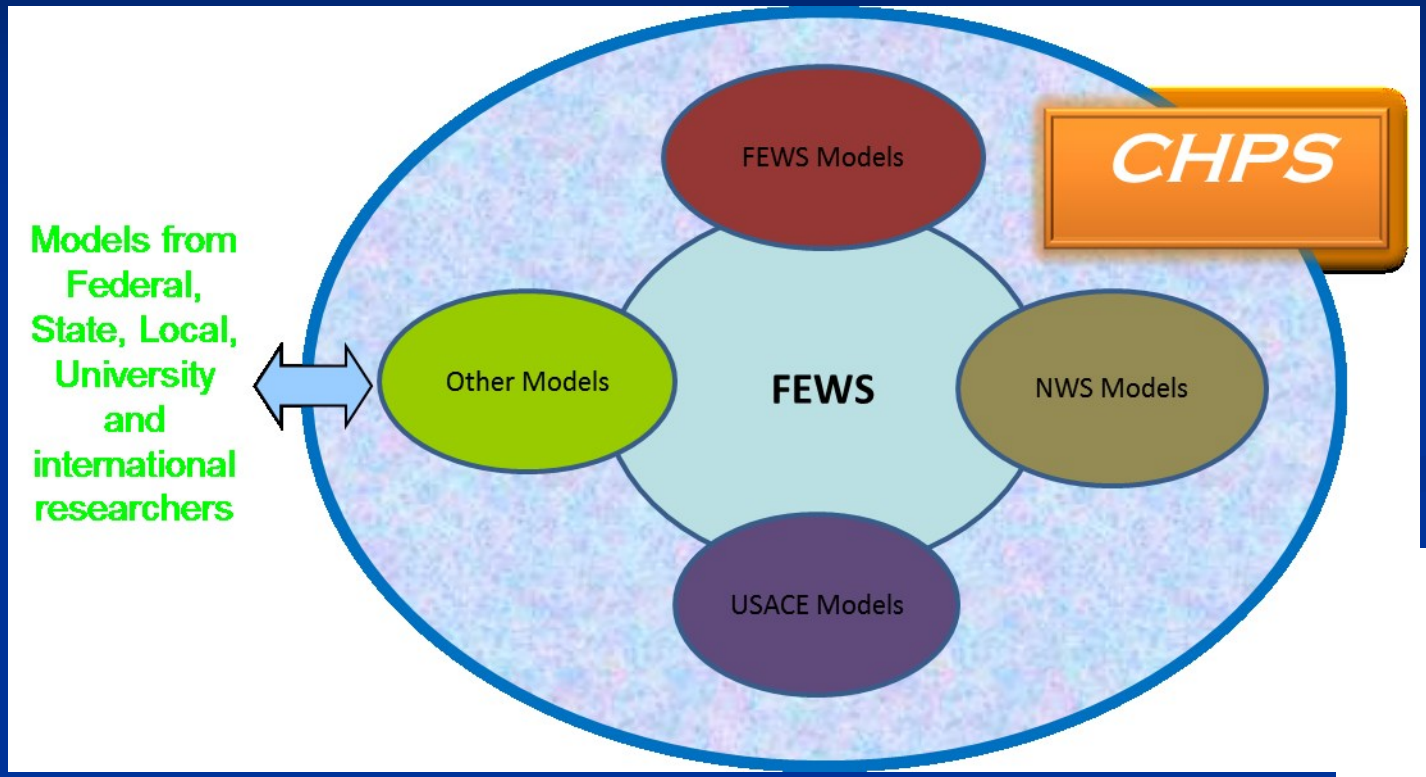
## (Hydrology)

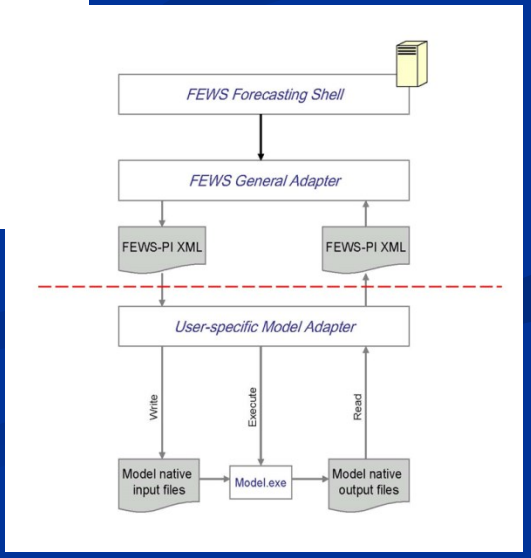


# Operational HAS Function
## (Meteorology)



# Community Hydrologic Prediction System

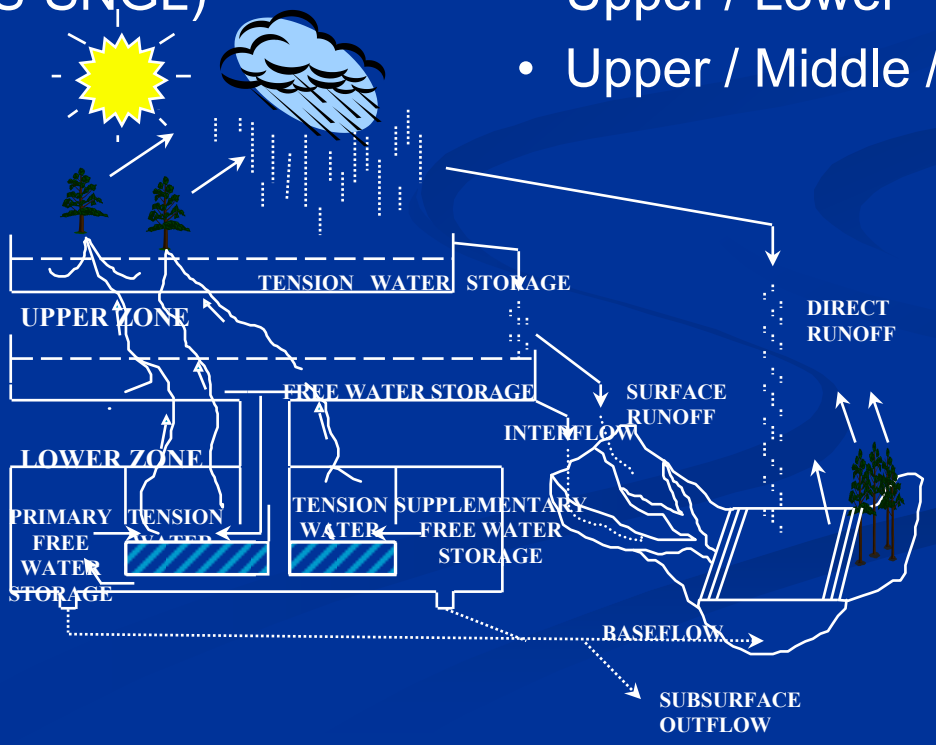


# Community Hydrologic Prediction System (CHPS) Hydrologic Models

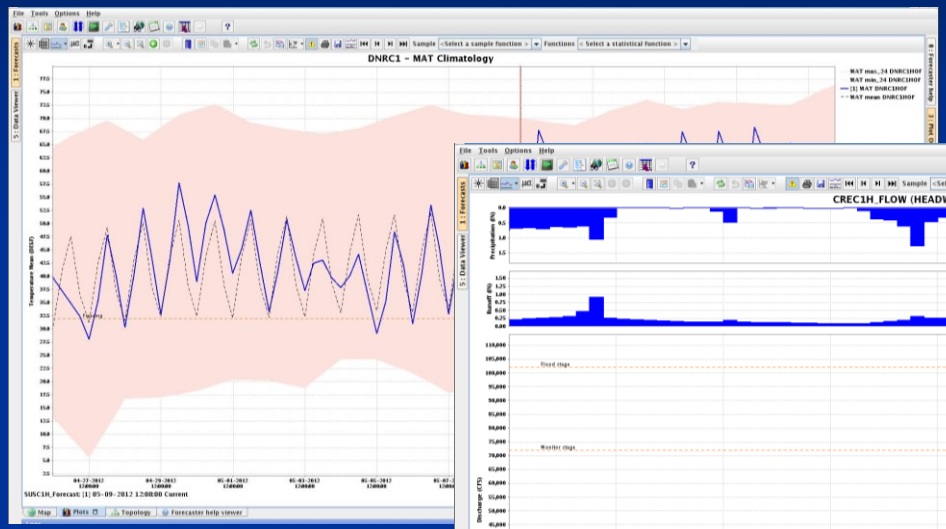
- Rain-Snow Elevation
- Snow-17
- Soil Model (SAC-SMA)
- Unit Hydrograph
- Reservoir Models (RES-SNGL)
- River Routing Models
- Arithmetic Transforms

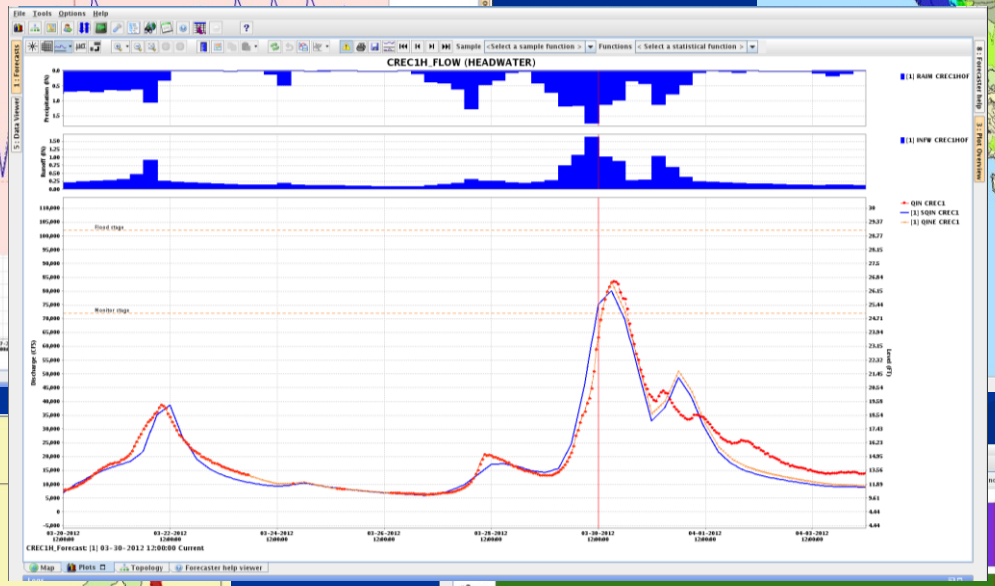
- 6-hr Time Steps
- Lumped (not distributed)
- Mountainous basins
  - Subdivided into
    - Upper / Lower
    - Upper / Middle / Lower

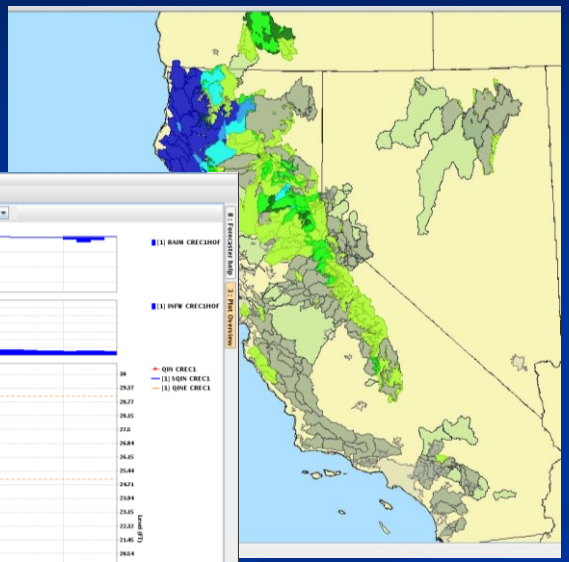


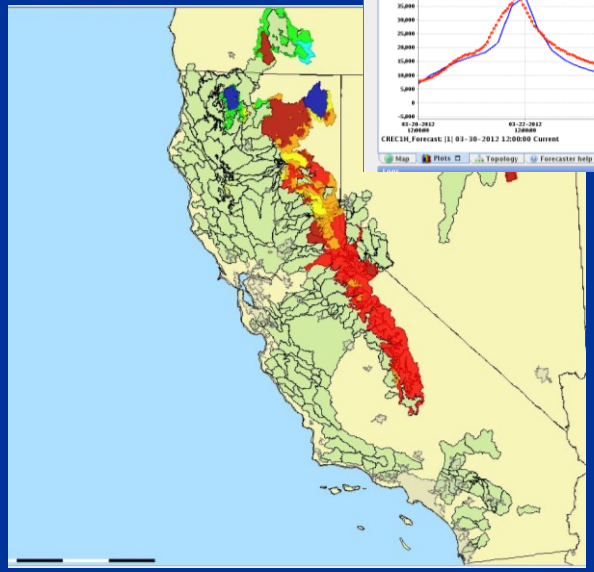
# River Forecast System

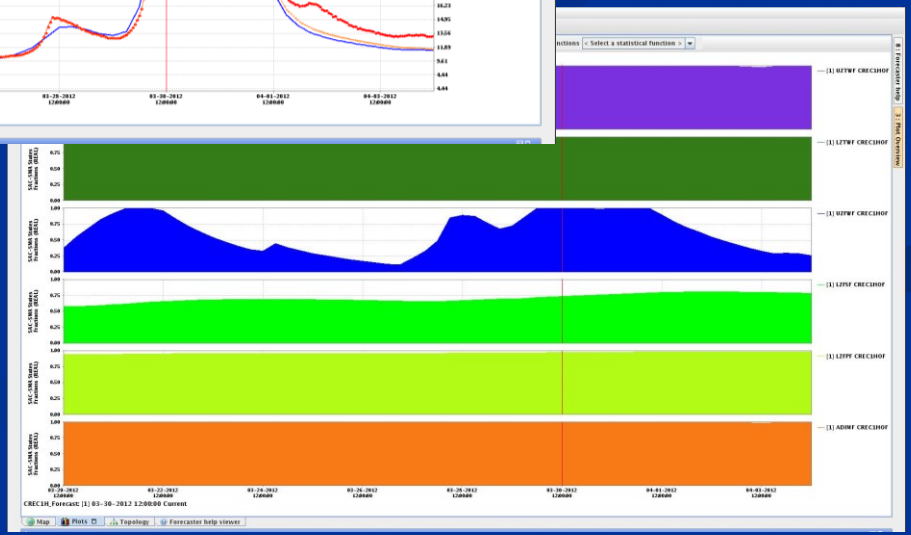
## Community Hydrologic Prediction System (CHPS)







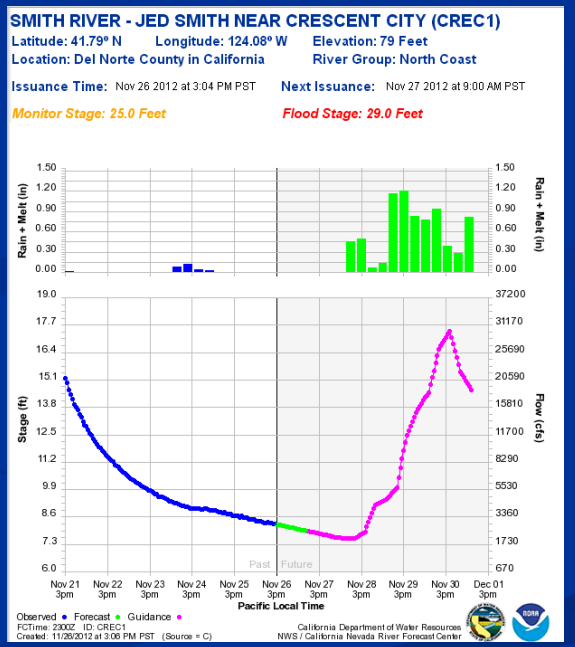
# Deterministic Streamflow Prediction

**Daily RFC Operations**
- Data Ingest
- Data QC
- Model Updating

**HAS Unit Forecasts** → **Mean Areal Time Series**

**Precipitation**
**Temperature** → **CHPS Hydrologic Models** →

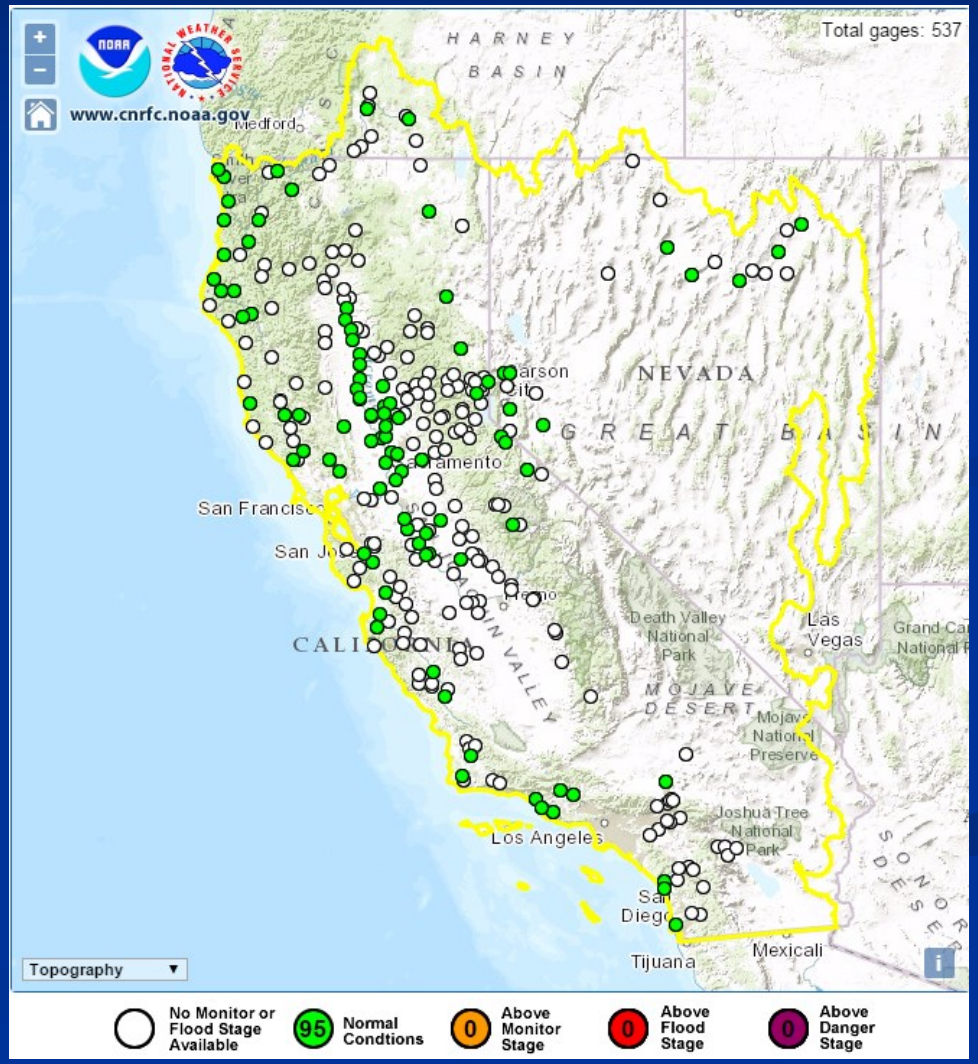
**Current Conditions**
- Soil
- Snow water
- Reservoir Levels
- Streamflow



# River Guidance

- ~275 flood, non-flood, and reservoir locations
- Updated w/each model run
  - 2x / day winter weekdays
  - 1x / day summer weekdays and weekends
  - 4x / day during flood events

(www.cnrfc.noaa.gov)

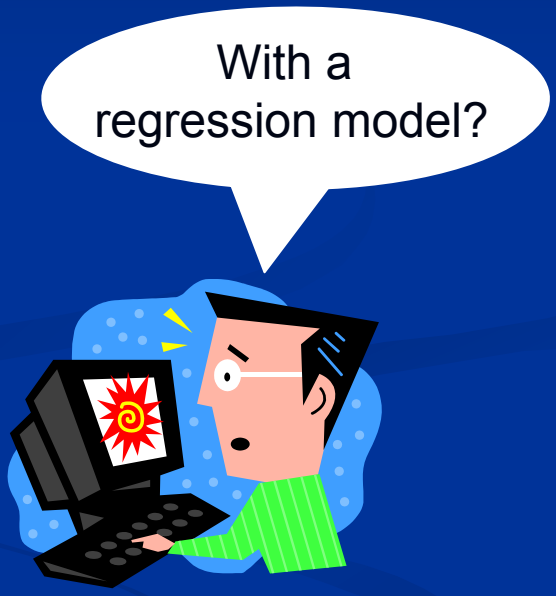


# Water Resources Forecasts
## Traditional Customer Signals

- Issue forecasts as early as possible in the month
- Update forecast at mid-month or when there is a significant change
- Include *reliable* climate signals

# Water Resources Forecasts
## Evolving Customer Signals

- Provide temporal “break-down”
  - Monthly within the full season
  - Weekly/daily near to the spring peak
- Low flow during summer periods
  - Fisheries requirements
  - Riparian management
- Non-traditional locations
  - Not snow melt dominated
- Include weather and climate forecast information



# Ensemble Streamflow Prediction

**Daily RFC Operations**
- Data Ingest
- Data QC
- Model Updating

**Current Conditions**
- Soil Moisture
- Snowpack
- Reservoir Levels
- Streamflow

**HAS Unit Forecasts**

**Historical Time Series**

**All Years of Record**

**Numerical Weather Model Forecasts**

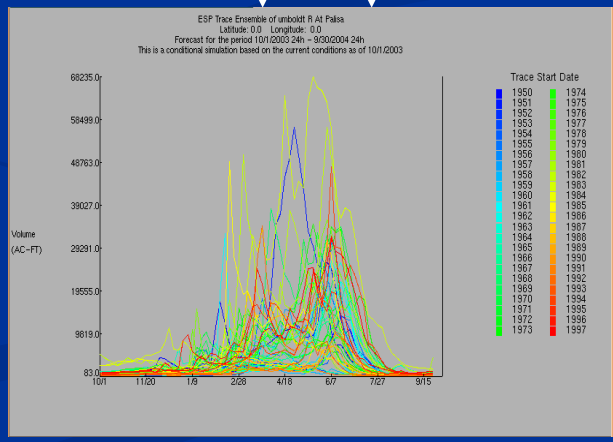
**Met Ensemble Preprocessor**

**Mean Areal Time Series**

**Precipitation Temperature**

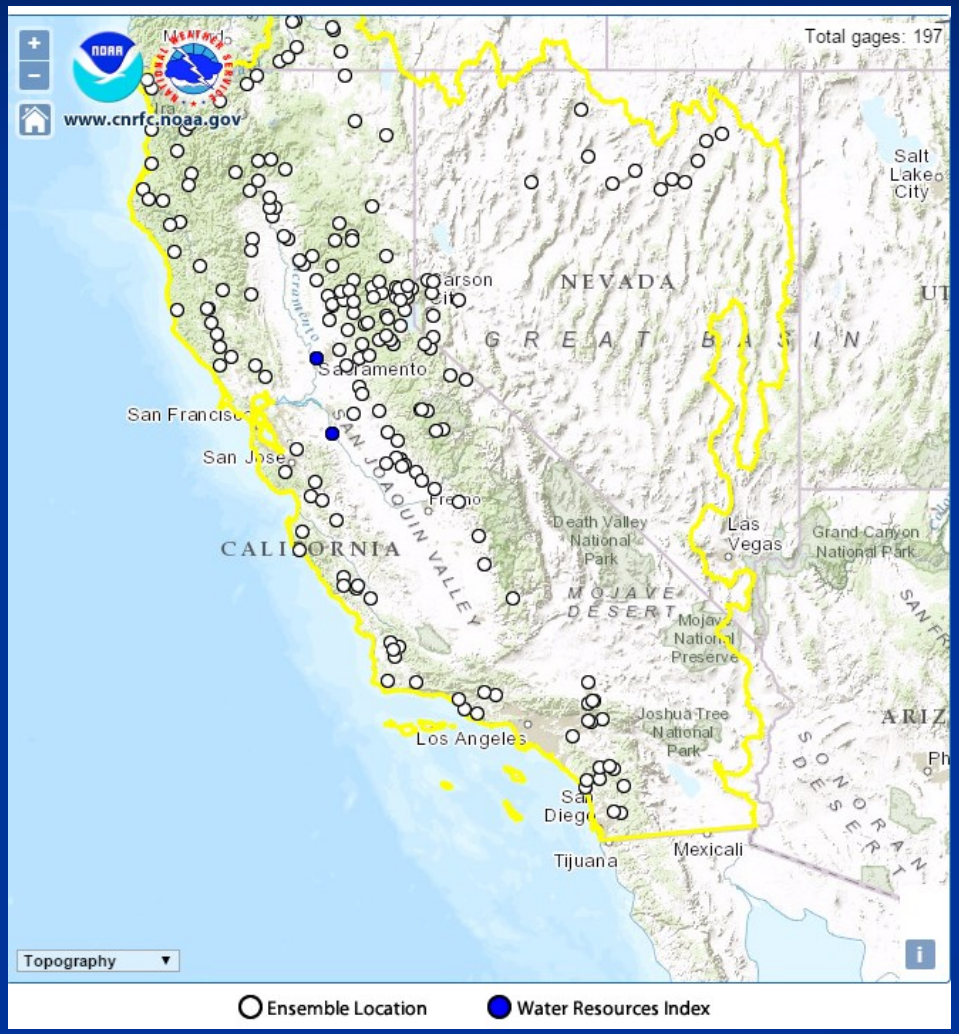
**CHPS Hydrologic Models**

**Flexible Period of Interest**




**Time** →

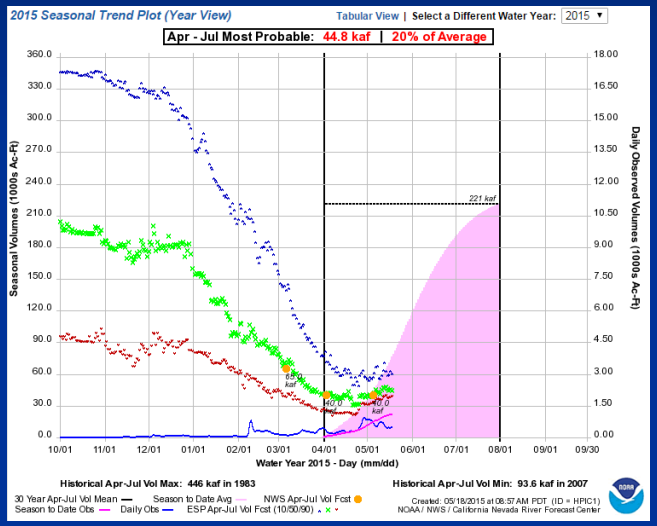
# CNRFC Ensemble Forecasts

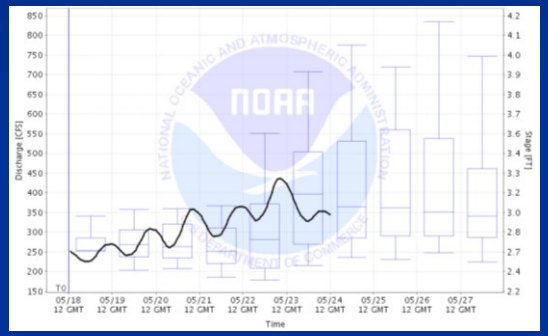


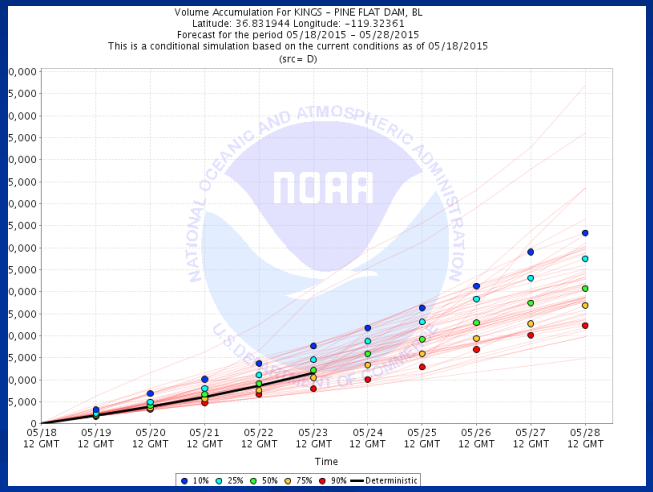

- Updated daily
- ~200 locations
- 365 day duration
- 10 standard graphics
- Build your own interface

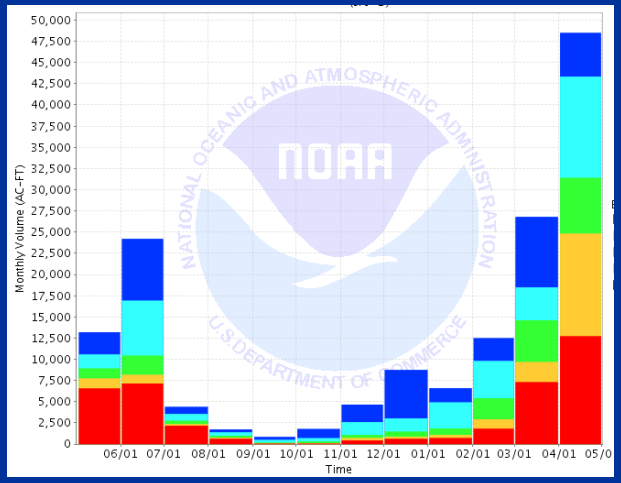
- Includes 14 days of weather forecasts

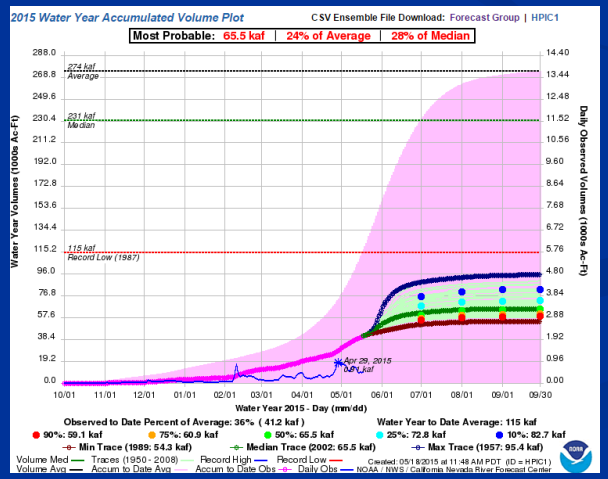
# Sample Ensemble Information

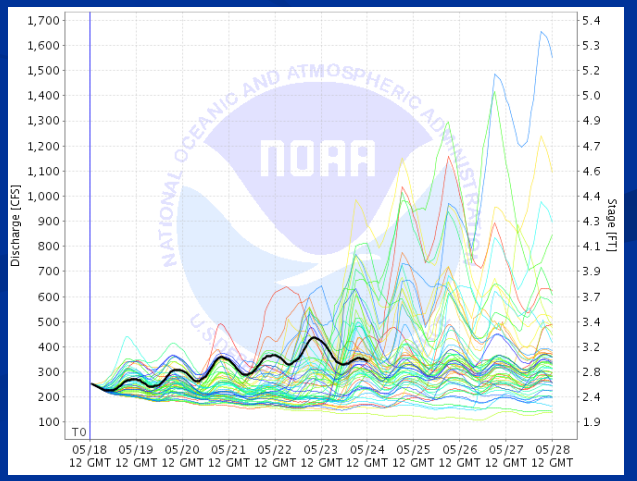


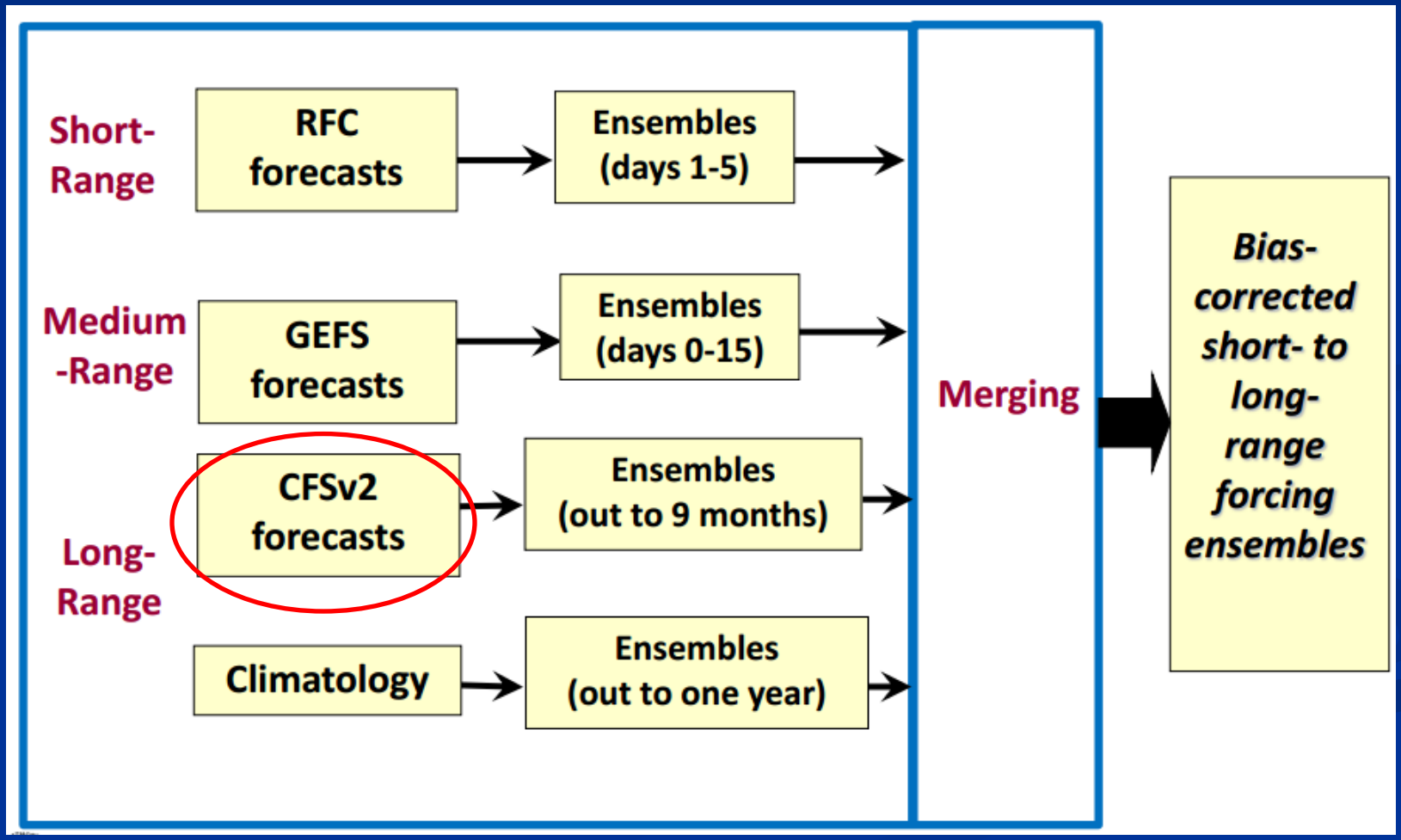



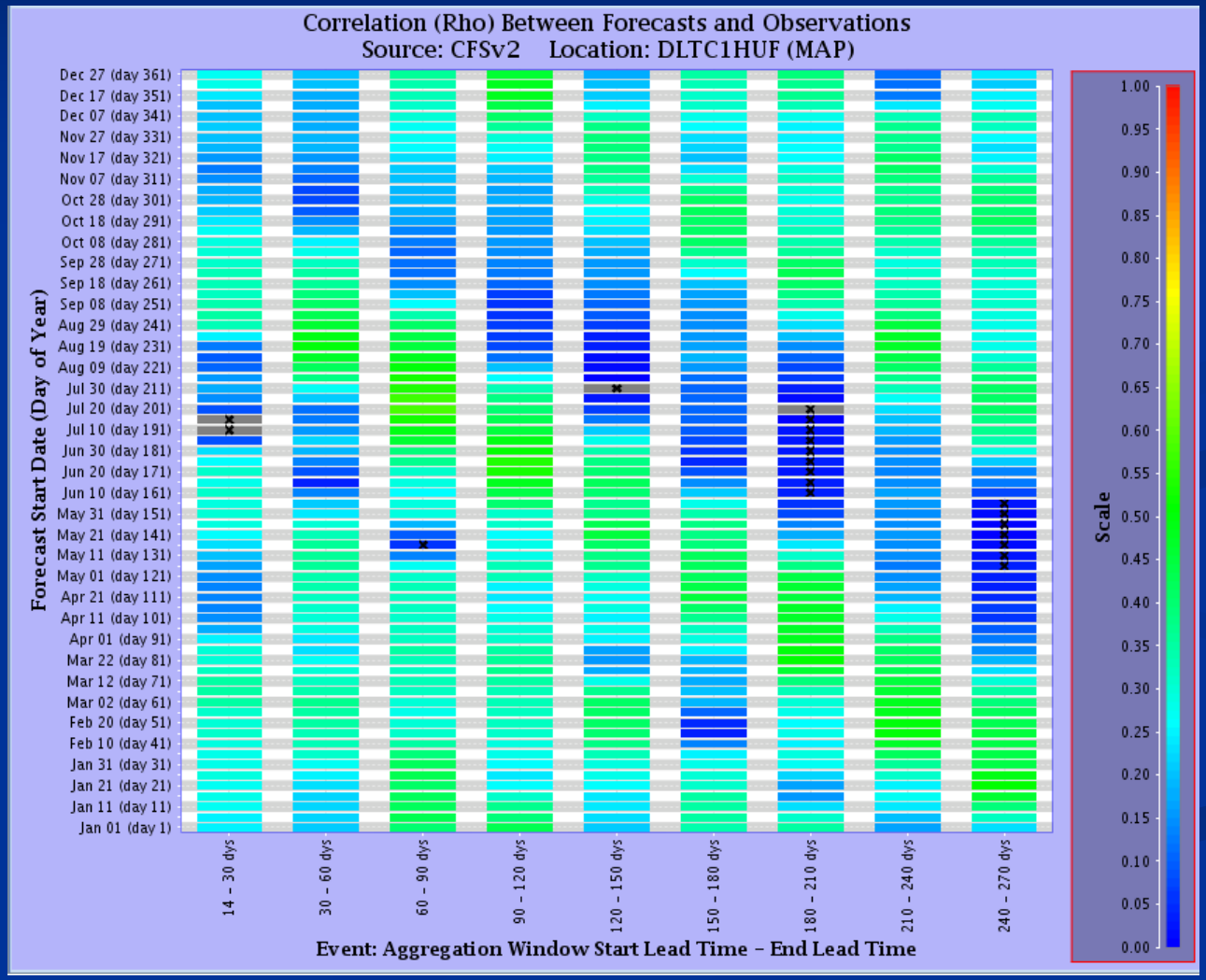



# Meteorological Ensemble Forecast Preprocessor (MEFP)



# CFSv2 Correlations by Date and Period

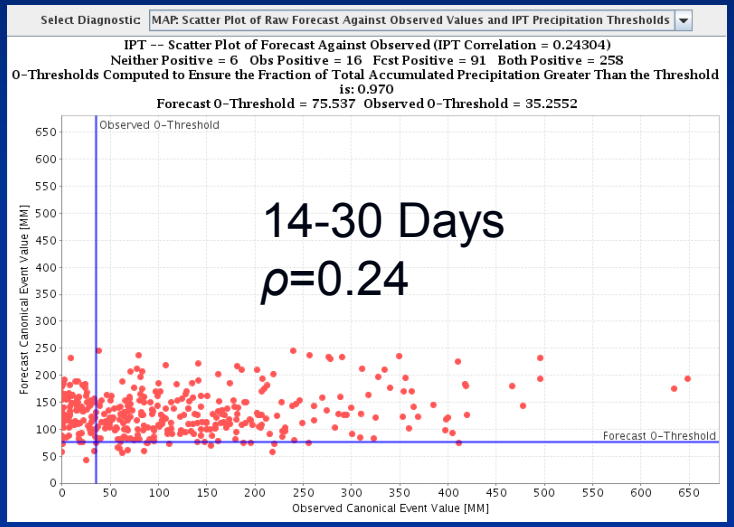
## Sacramento – Delta, CA (above Shasta Lake)

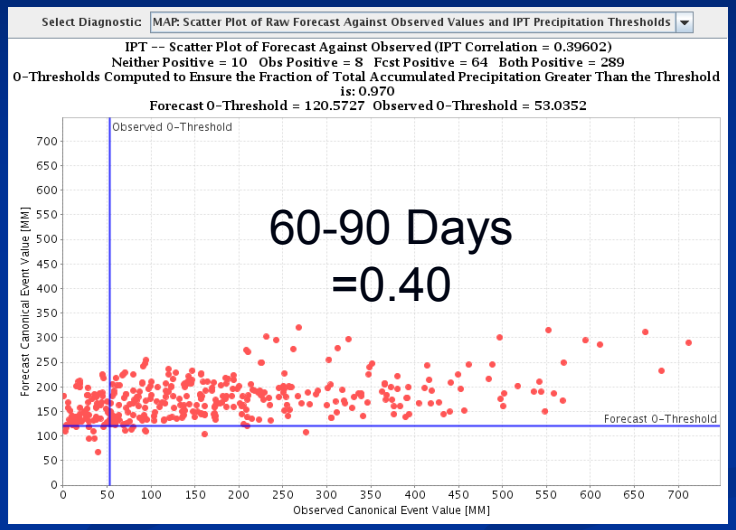


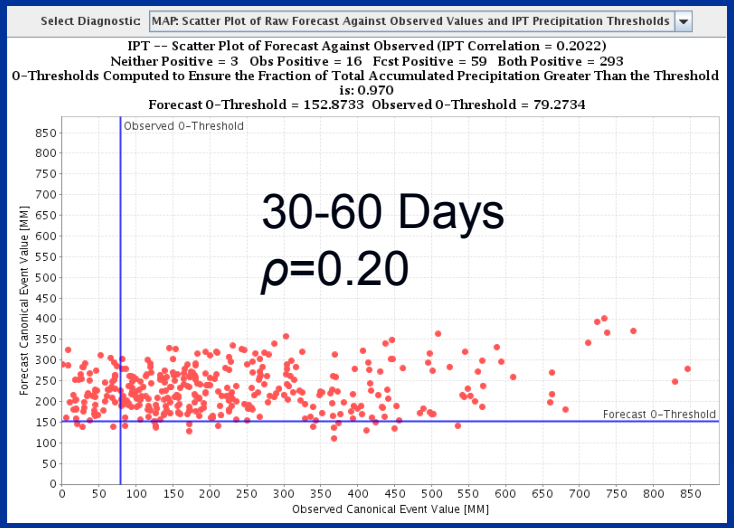
# CFSv2 Correlations for January 1

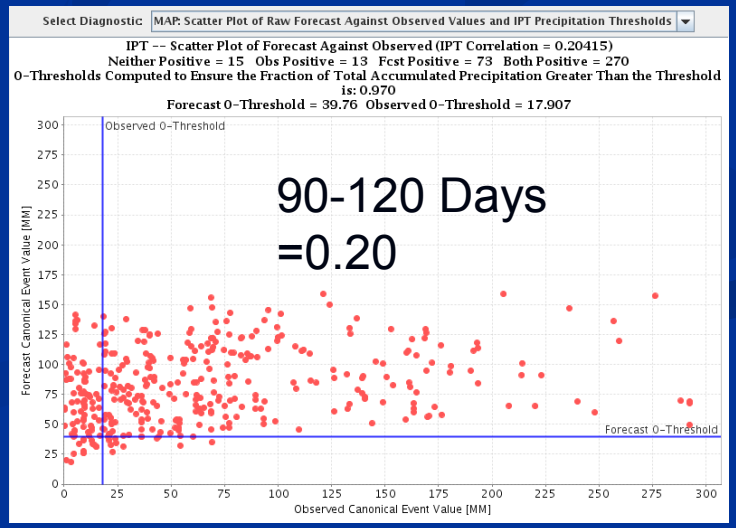
## Sacramento – Delta, CA (above Shasta Lake)

ρ



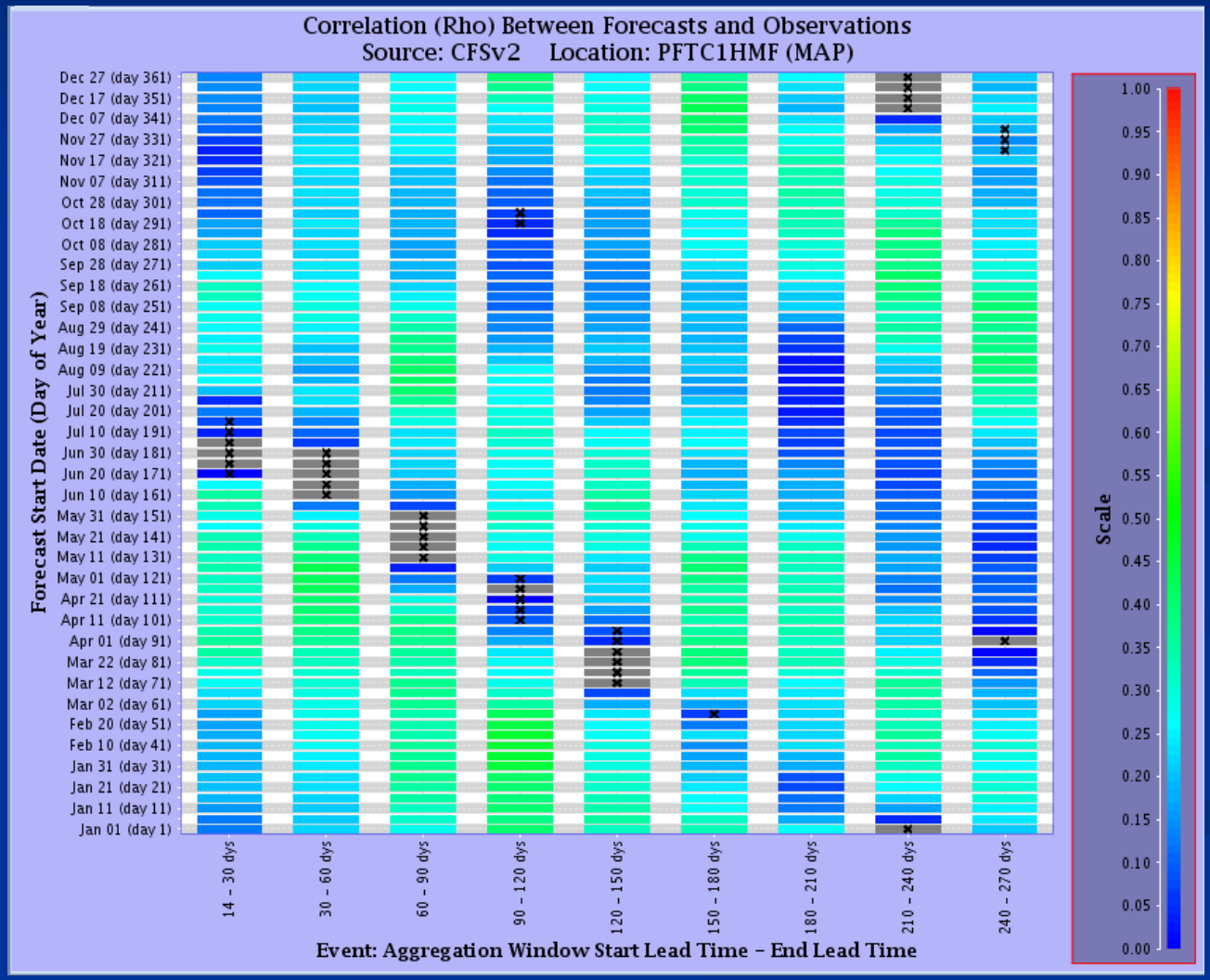



# CFSv2 Correlations by Date and Period

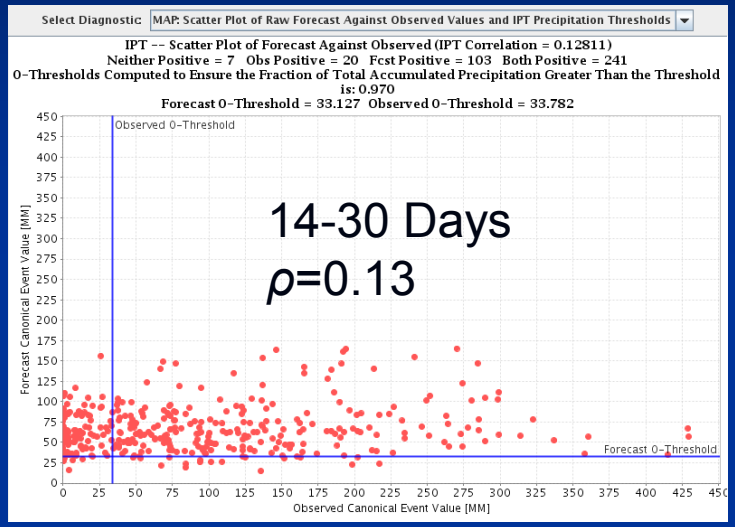
## Kings River inflow to Pine Flat Reservoir

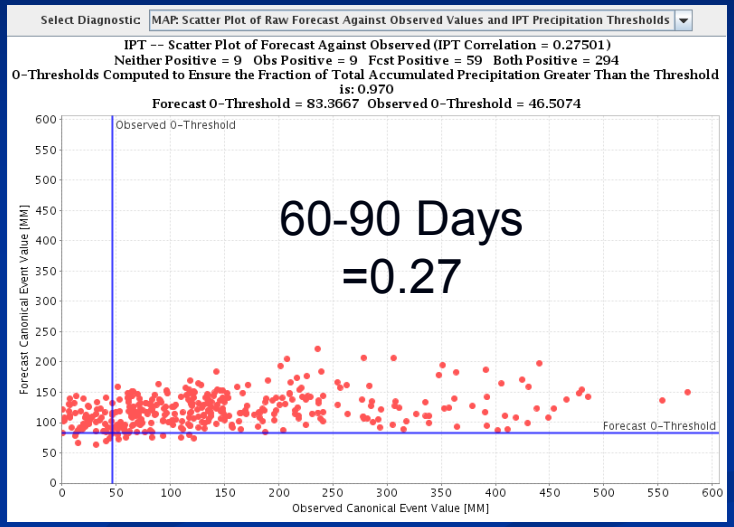


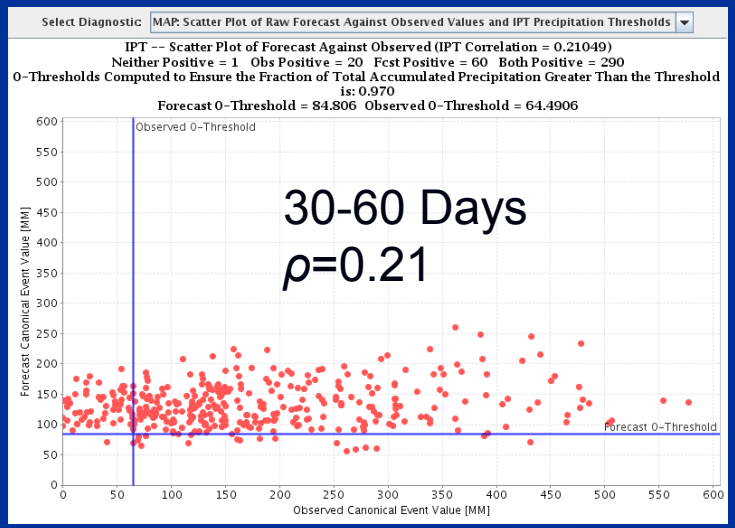
# CFSv2 Correlations for January 1

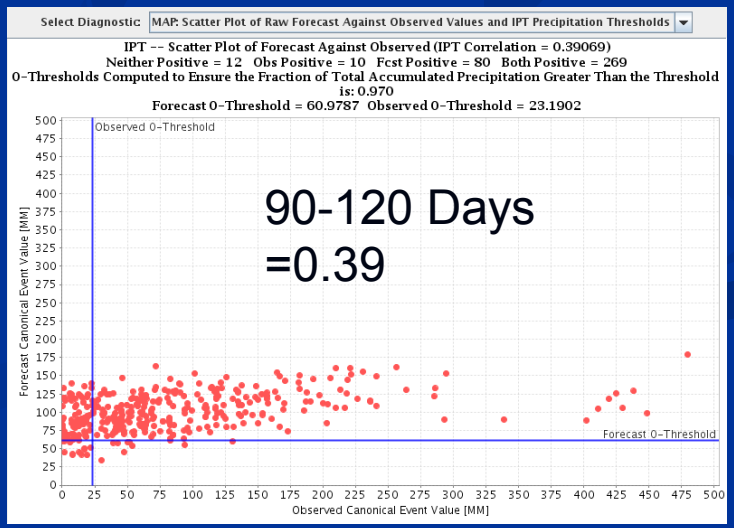
## Kings River inflow to Pine Flat Reservoir

ρ



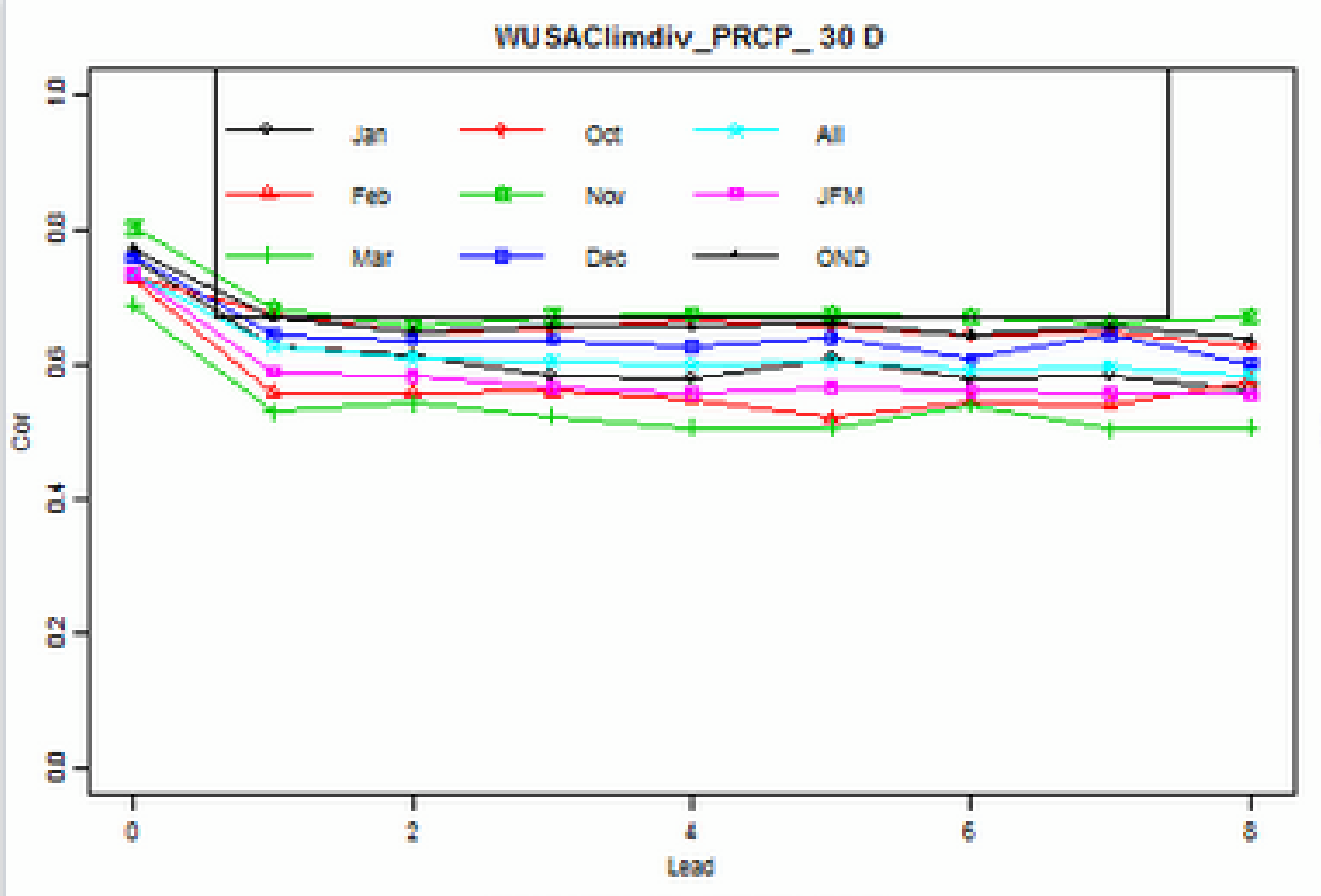



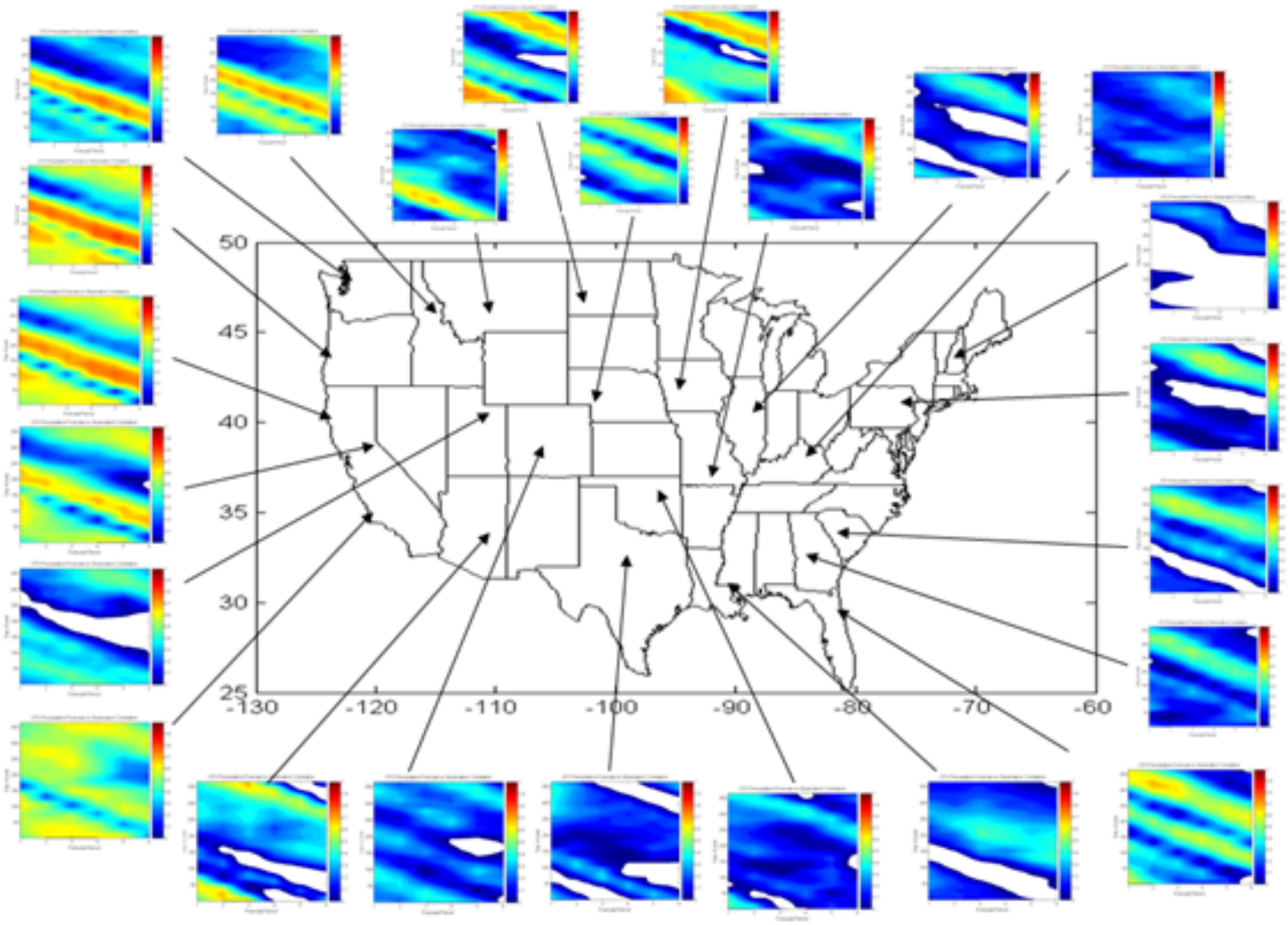



# CFSv2 Verification for Western US

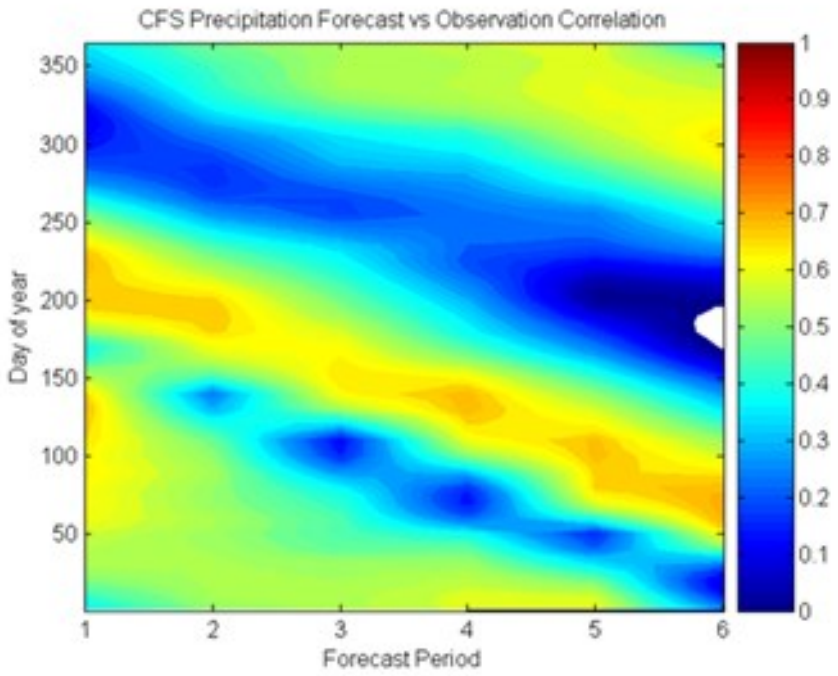
(ref: Satish Regonda)



# CFS Seasonal Forecast Skill - Precipitation



# Example Correlation Plot for North Fork American River, CA



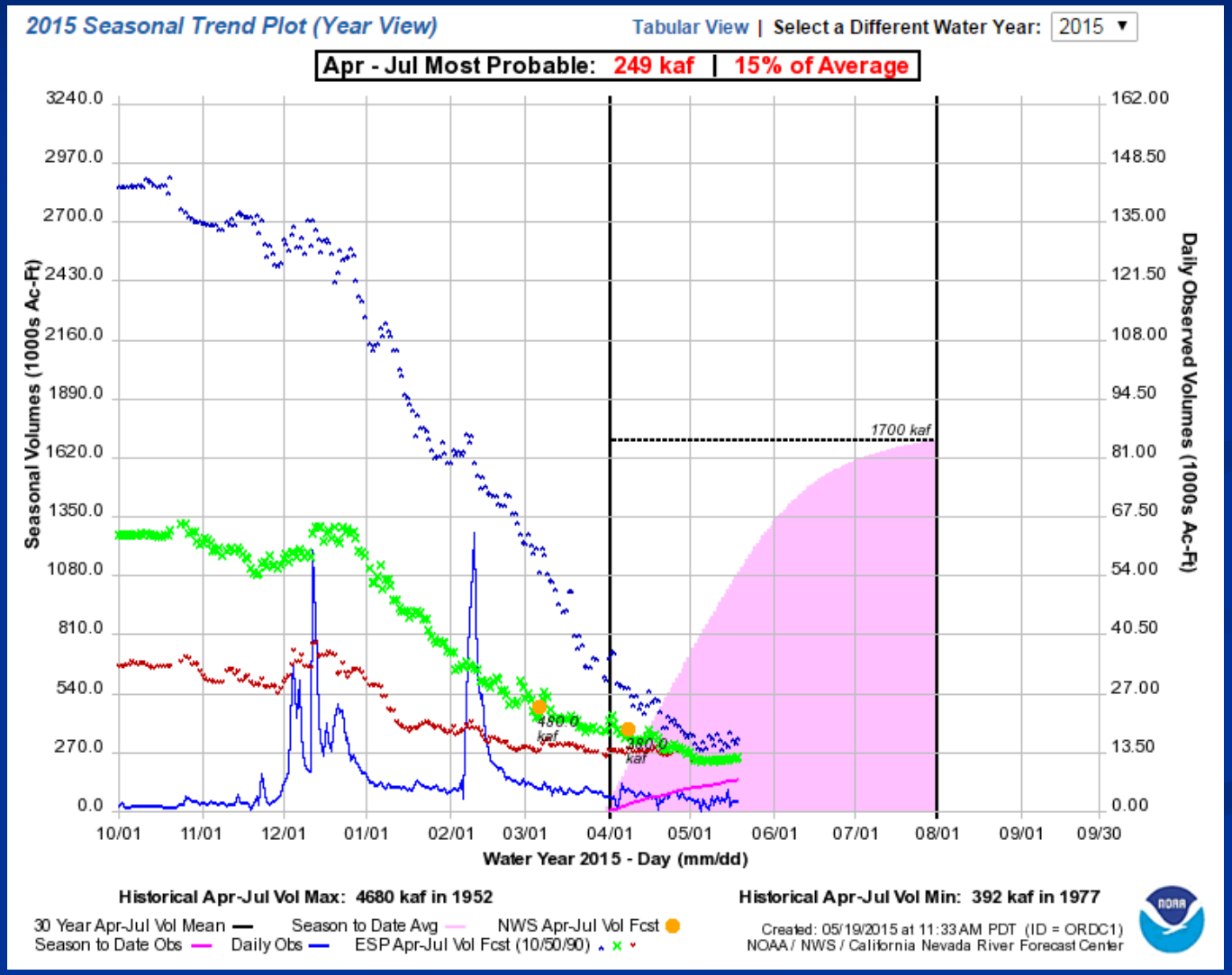

Forecast Period Definition

| Period | Months |
|---|---|
| 1 | 1-3 |
| 2 | 2-4 |
| 3 | 3-5 |
| 4 | 4-6 |
| 5 | 5-7 |
| 6 | 6-8 |

This plot shows how the coefficient of correlation between CFS forecast precipitation and observed precipitation varies during the year, depending on the event being forecast. This plot was constructed for each of the 24 selected MOPEX basins. Separate correlation plots were made for precipitation, tmin and tmax.

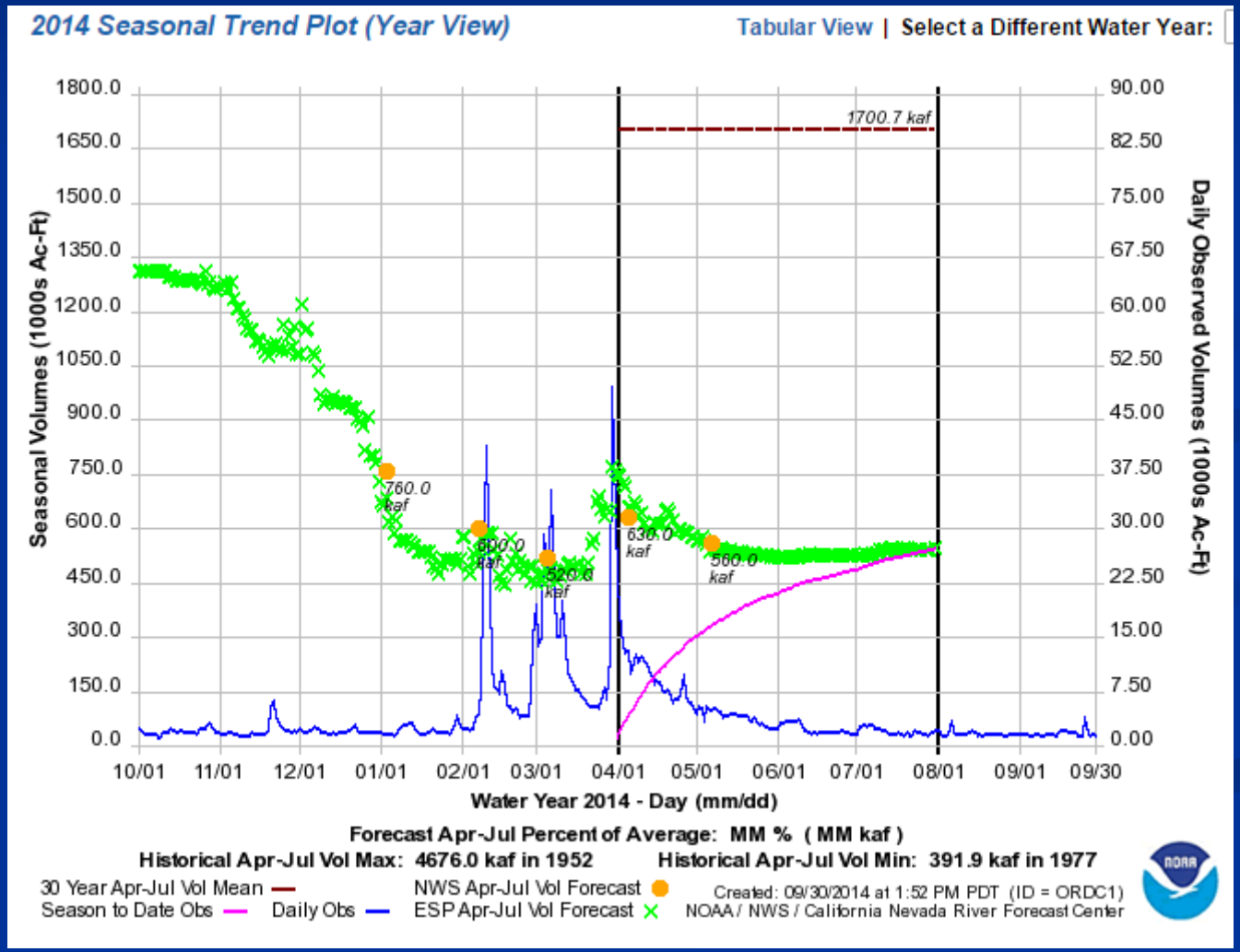
# 2015 Seasonal (April-July) Forecast

## Feather River inflow to Oroville Reservoir



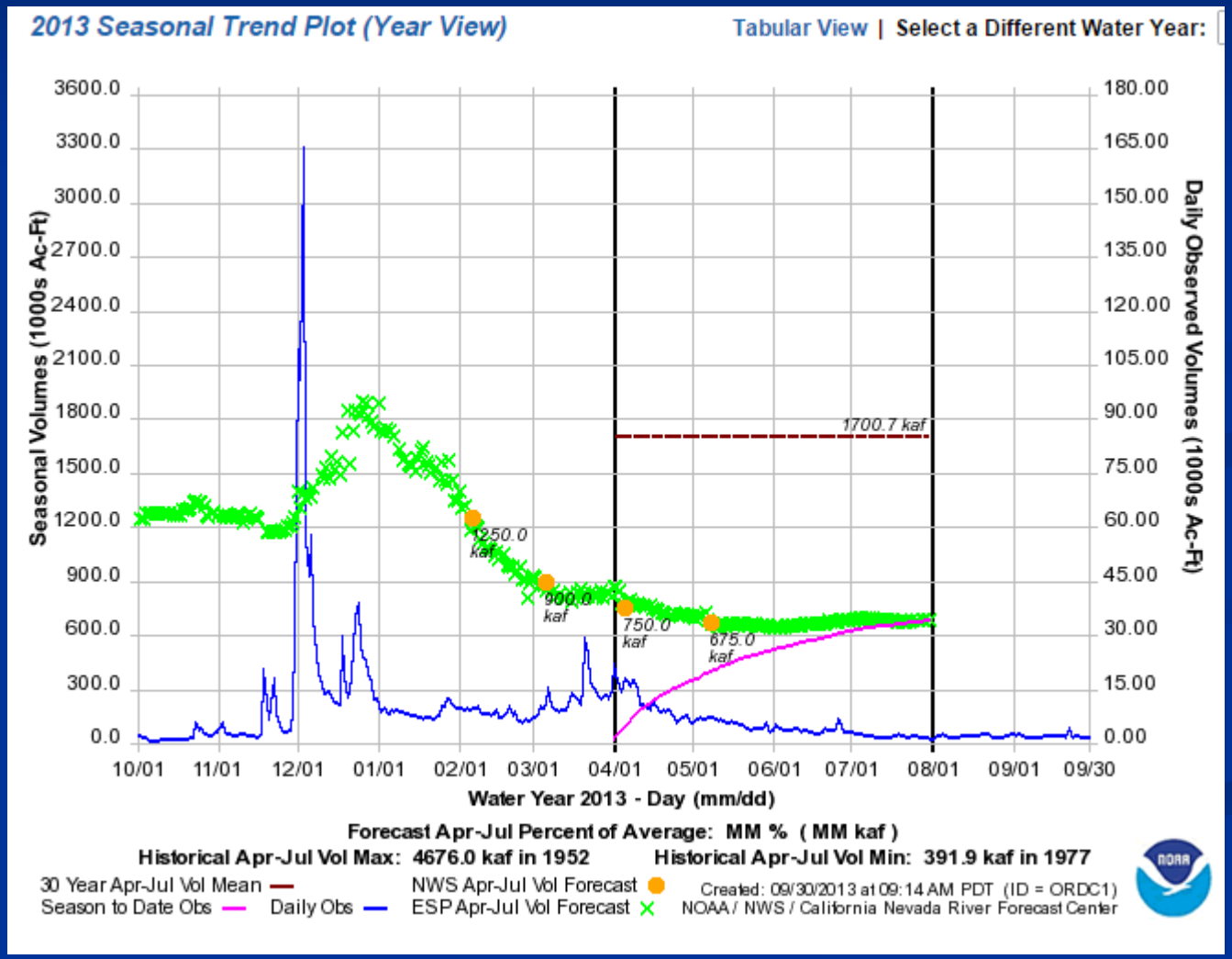
# 2014 Seasonal (April-July) Forecast

## Feather River inflow to Oroville Reservoir



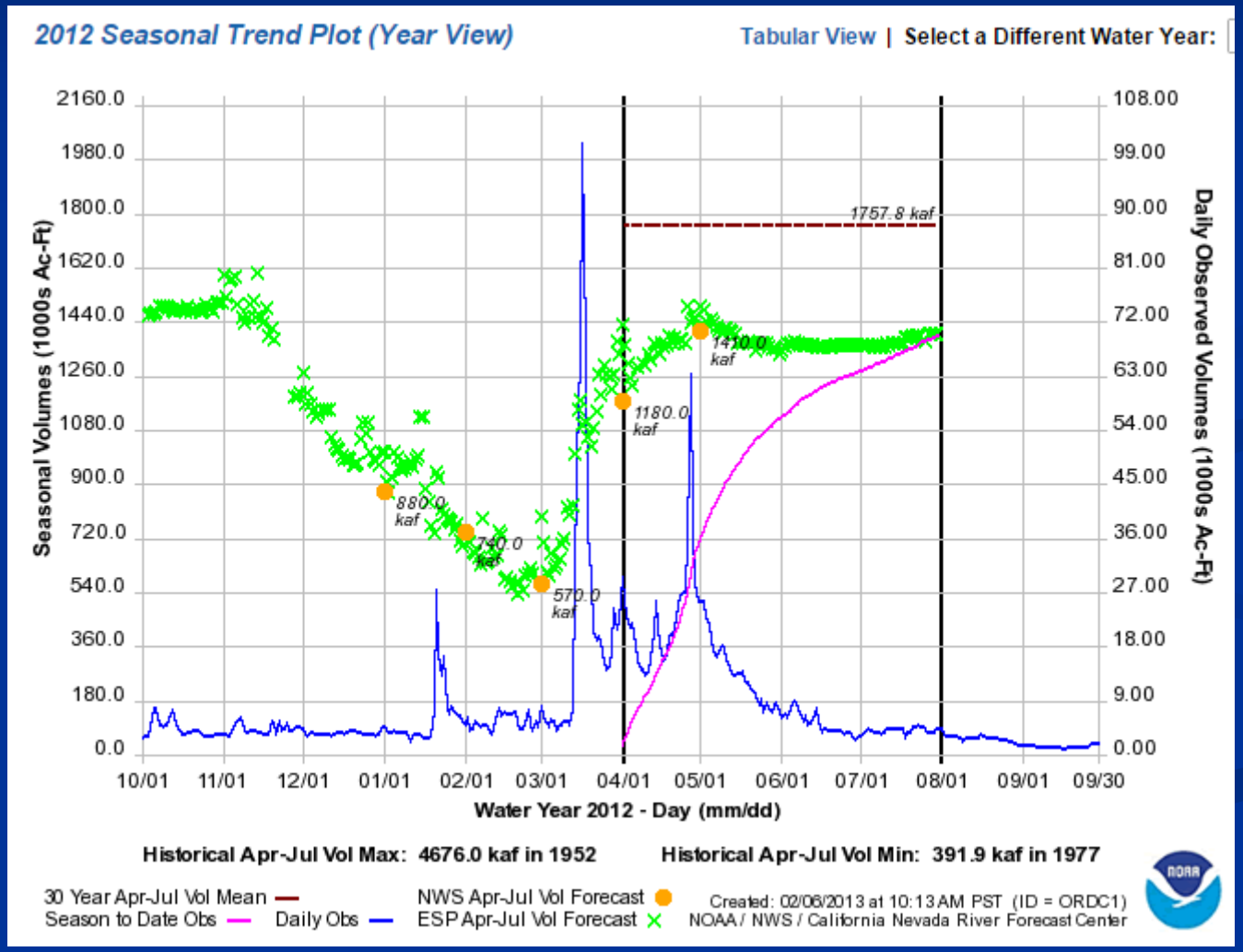
# 2013 Seasonal (April-July) Forecast

## Feather River inflow to Oroville Reservoir



# 2012 Seasonal (April-July) Forecast

## Feather River inflow to Oroville Reservoir



# Summary

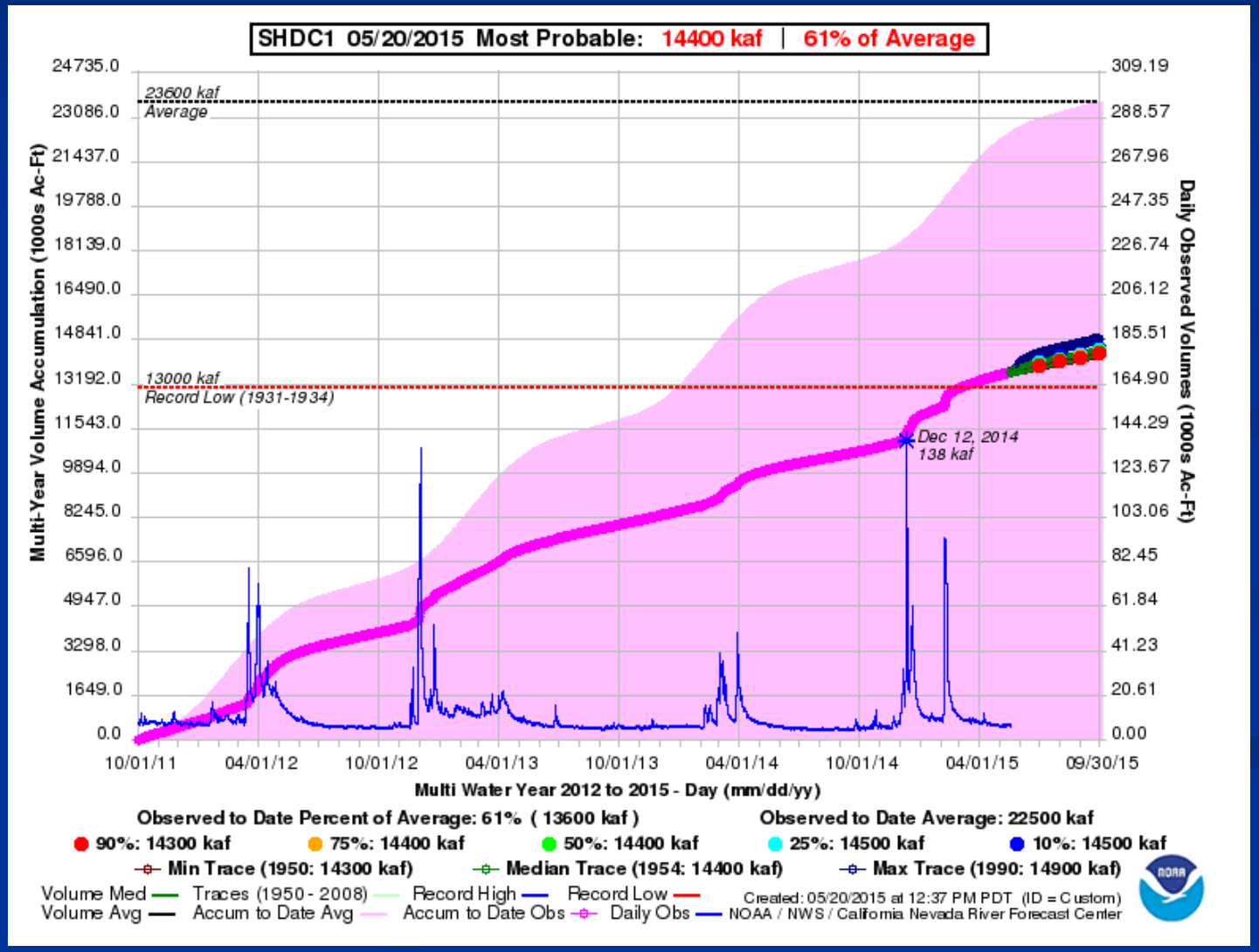
- Water resources are under tremendous pressure given expanding demand and increasing variability of supplies
- Customers of water supply forecasts in the Western U.S. need all the insight we can muster
- NWS has a technique for integrating CFSv2 information, but the skill appears to be quite limited

California-Nevada
River Forecast Center

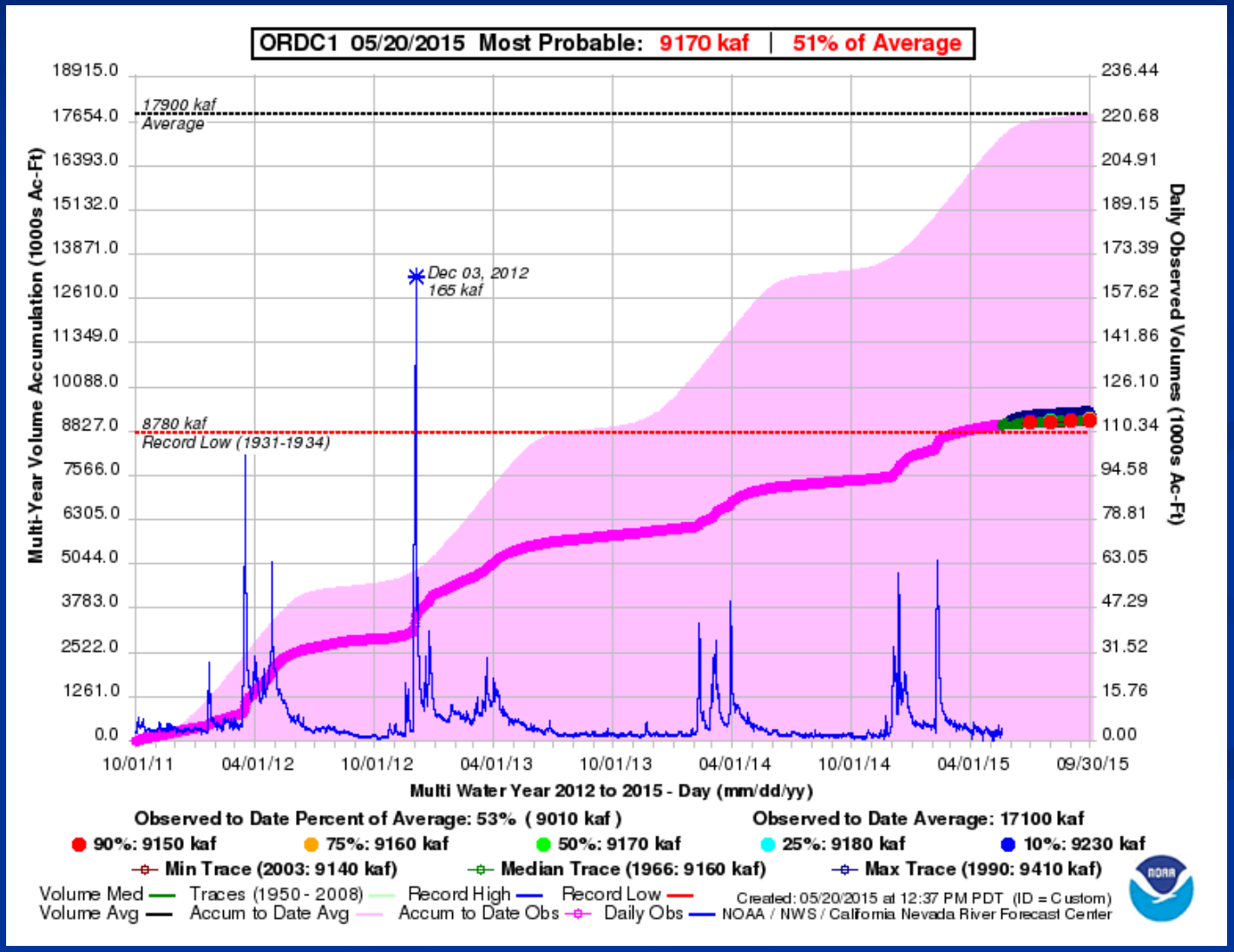
# Thank You

# Additional Slides

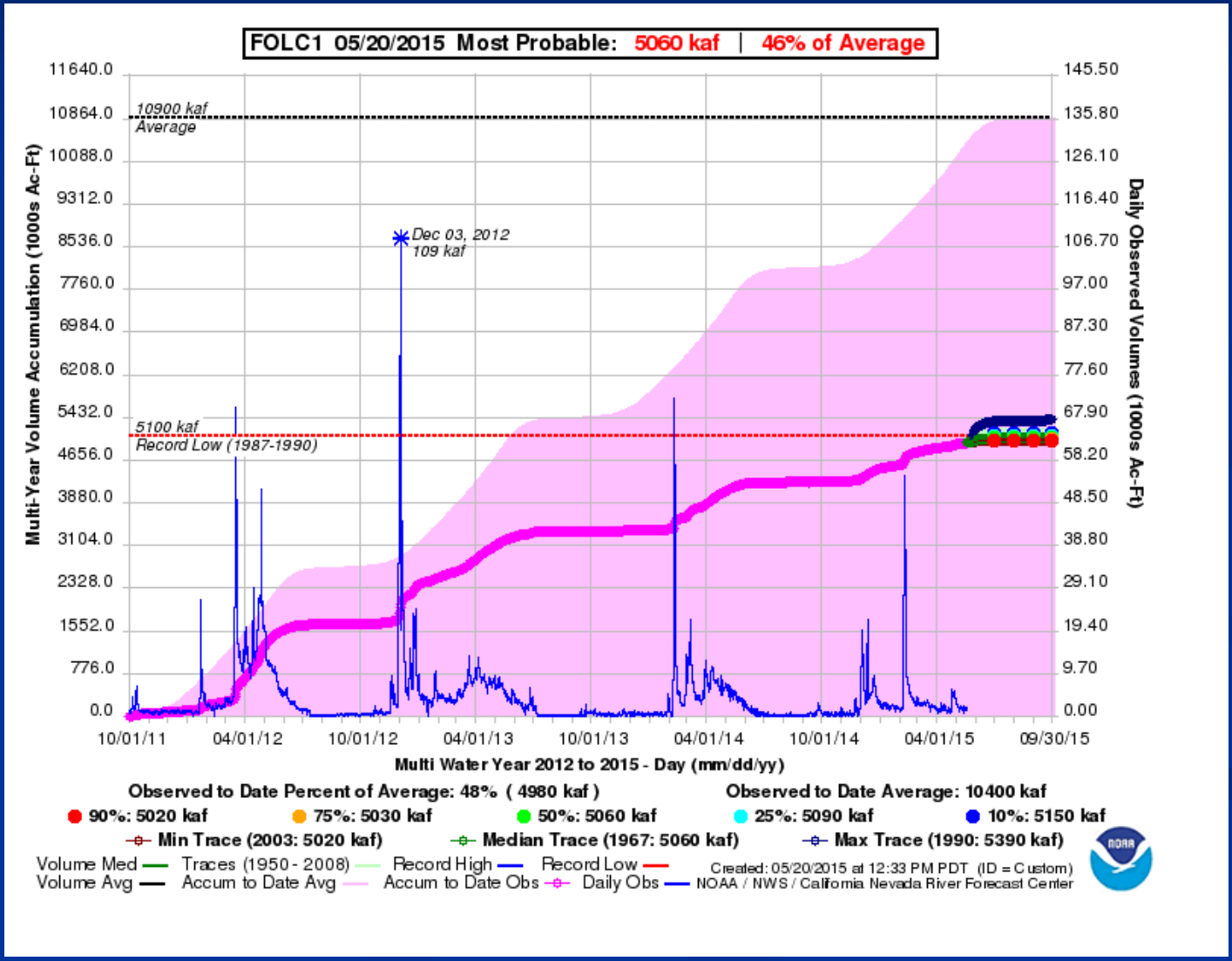
# 4-Year Accumulated Inflow 2012-2015 Shasta Reservoir



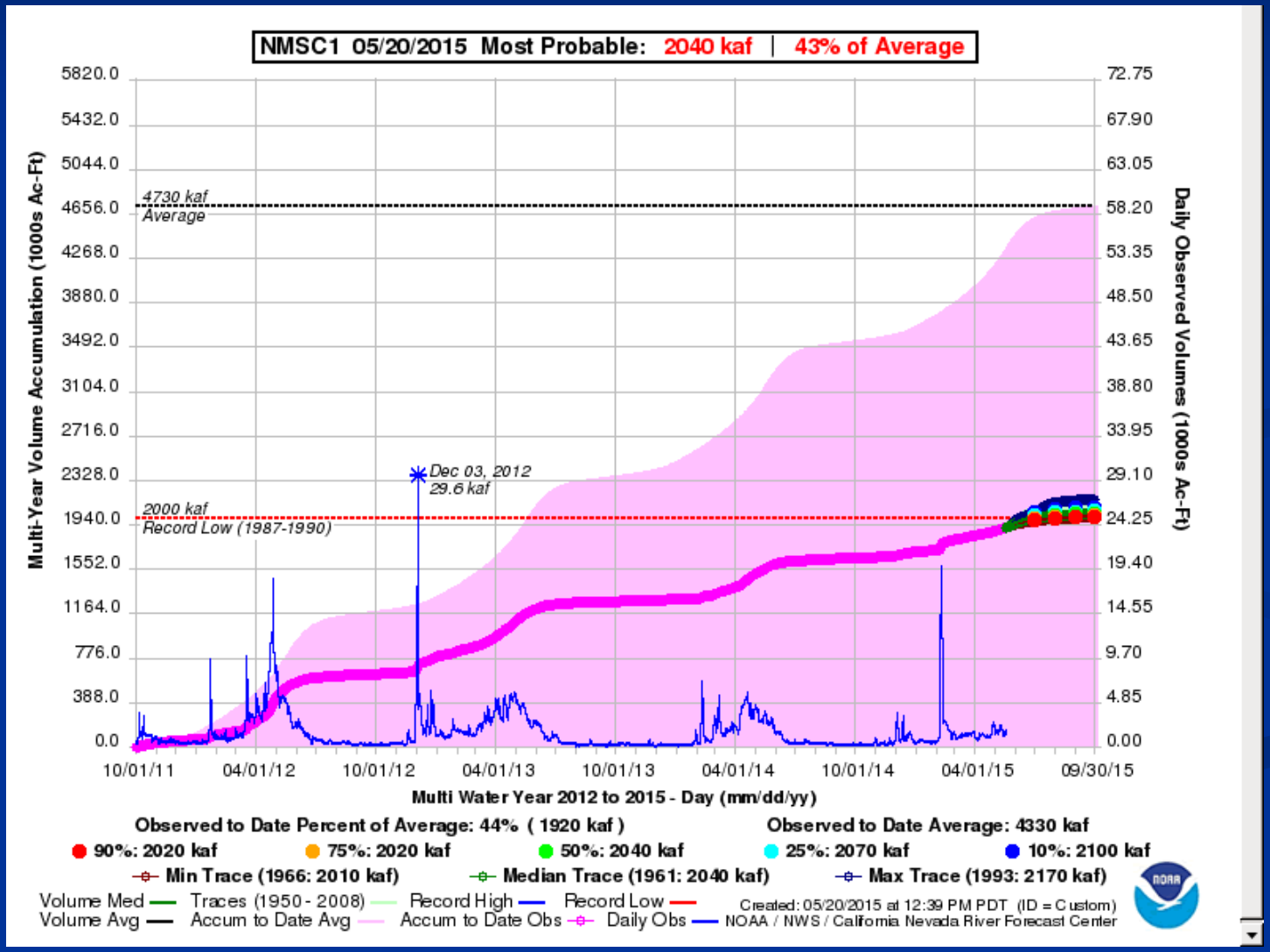
# 4-Year Accumulated Inflow 2012-2015 Oroville Reservoir



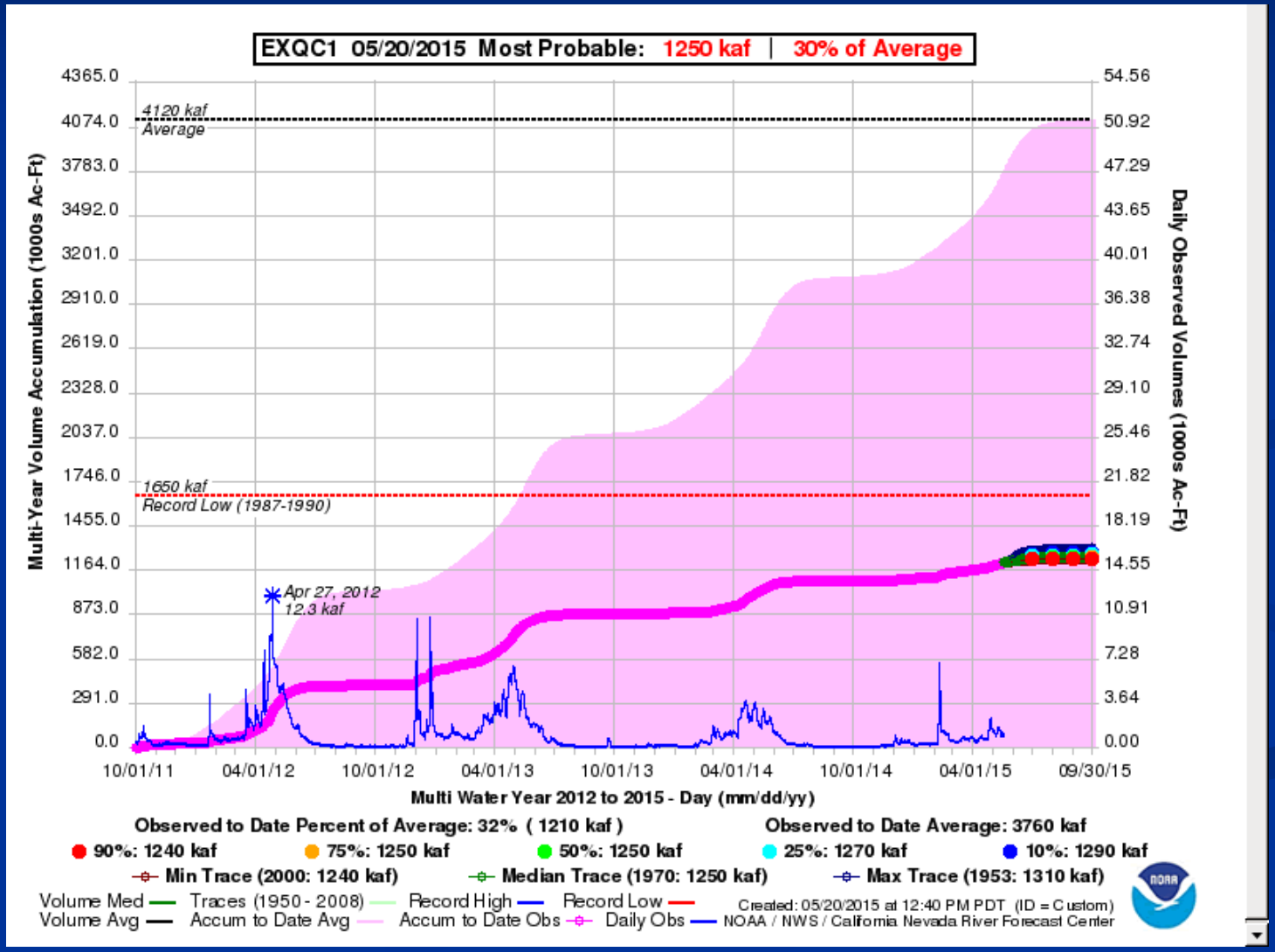
# 4-Year Accumulated Inflow 2012-2015 Folsom Reservoir



# 4-Year Accumulated Inflow 2012-2015 New Melones Reservoir



# 4-Year Accumulated Inflow 2012-2015 Exchequer Reservoir



# 4-Year Accumulated Inflow 2012-2015 Pine Flat Reservoir