



S2S Forecasting of ARs for Water Management – Where We Want to Go

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Sub-Seasonal to Seasonal (S2S) Precipitation Forecasting

- Operational weather models – typically 2 weeks out (higher skill in first week)
- Sub-seasonal – 2 weeks to about 60 days
- Seasonal – up to 12 months

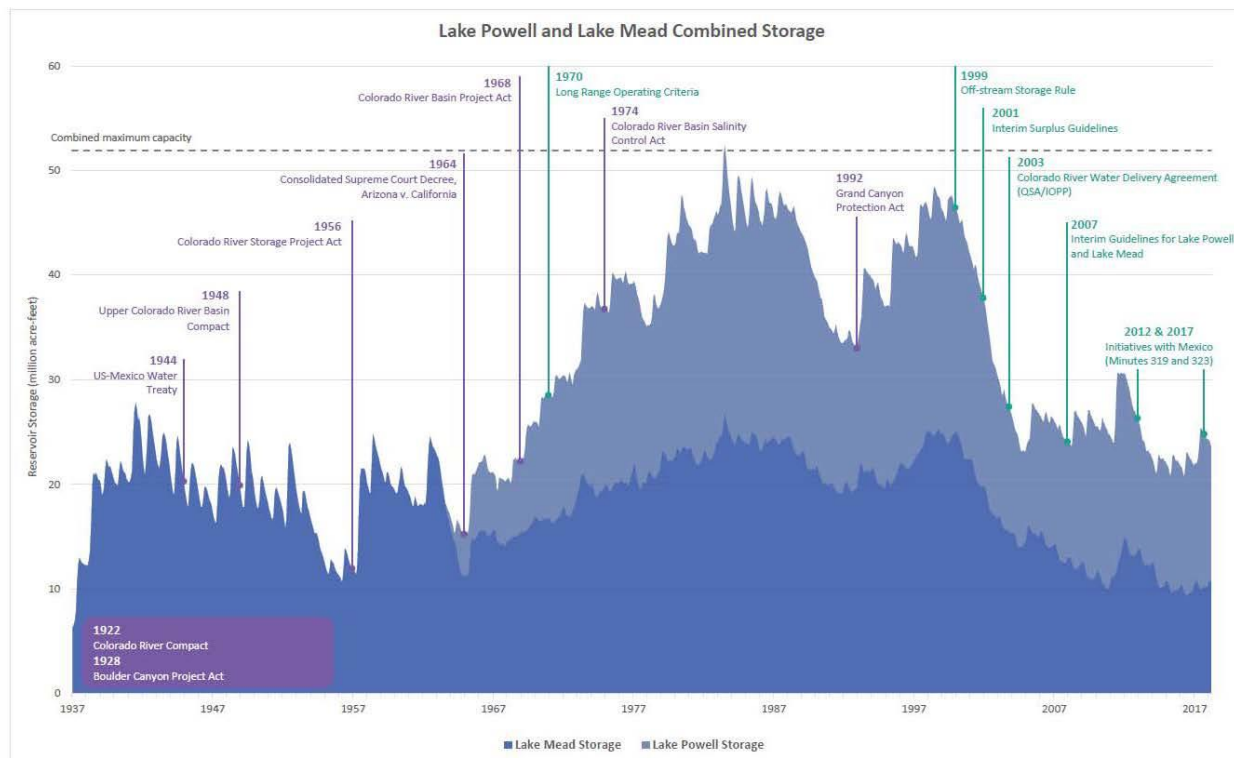


Where Do We Want to Go for California?

- It's mid-November, what will this winter be like?
- It's mid-January, what will the rest of the winter be like?

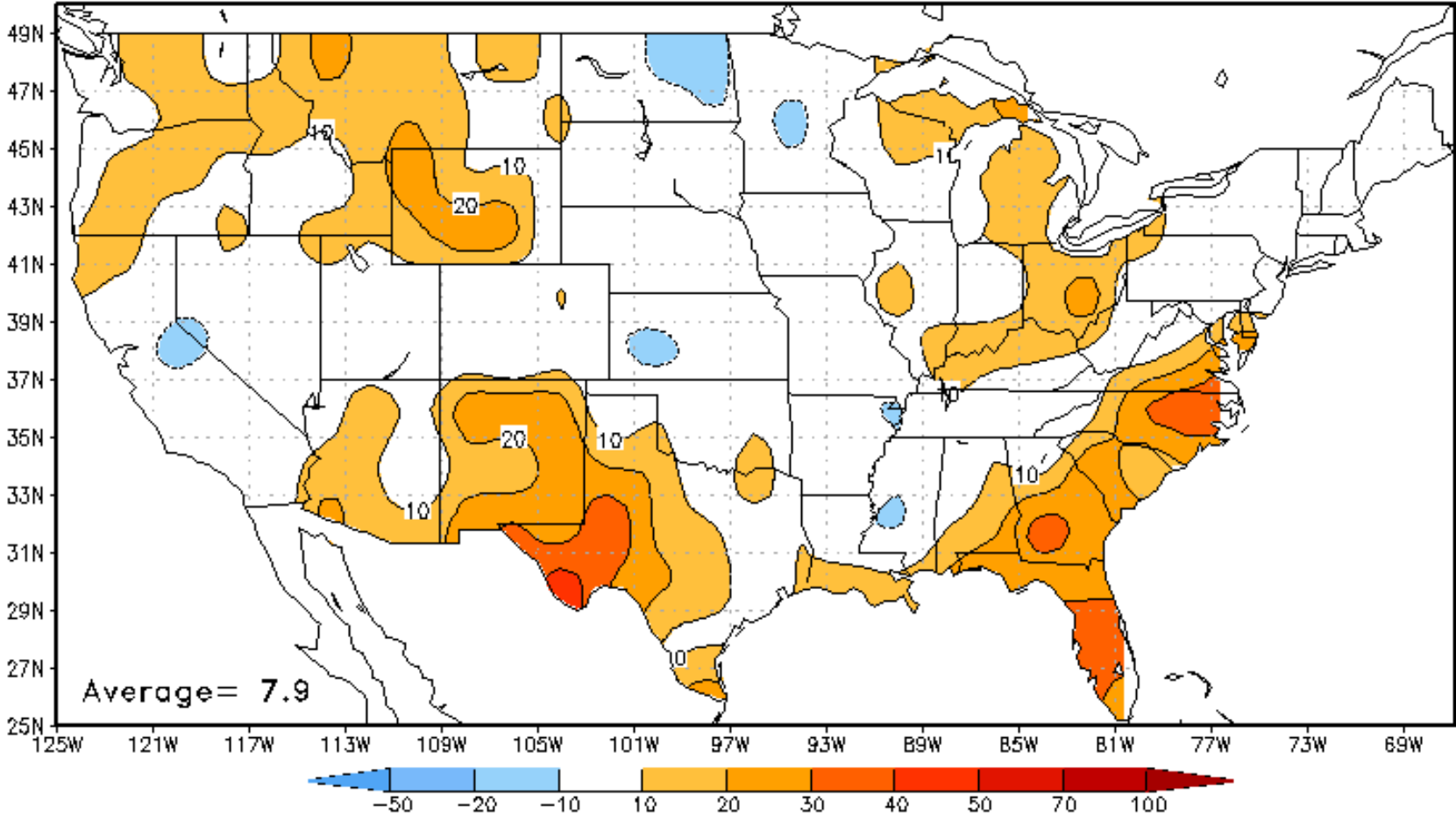


Including California's Water Supplies from the Colorado River Basin....



NOAA NWS Climate Prediction Center Skill Scores

Seasonal (Lead 0.5 Months) Precipitation Heidke Skill Score
DJF Manual Forecasts From 1995 to 2018



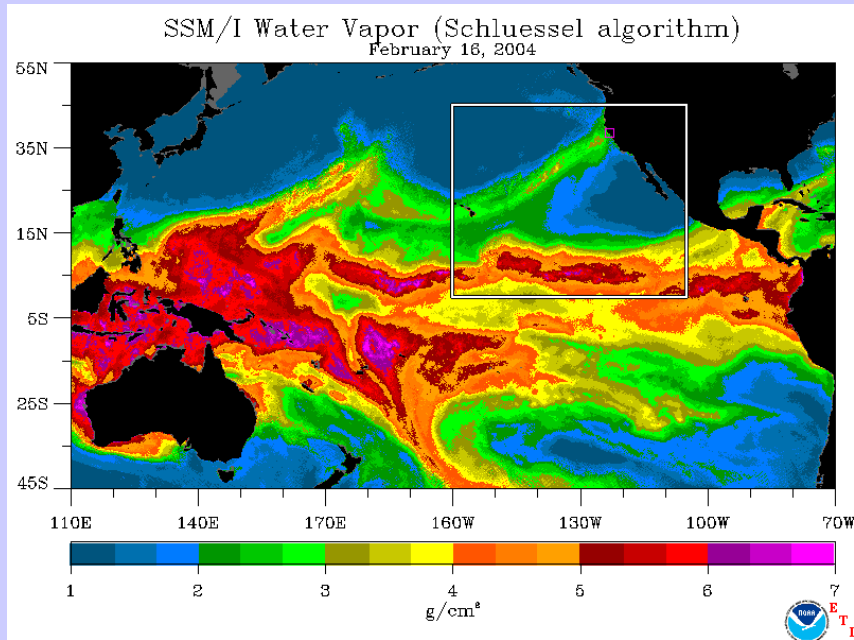
Lead Time Very Important for Water Management

- Public health & safety decisions
- Balancing risk/cost trade-offs
- Increasing water management efficiency
- Operating within legal & regulatory frameworks
- Reducing impacts of extreme events
- Responding to increased competition for resources
- Operating reservoirs and other infrastructure

Can ARs Provide Useful Skill for S2S Forecasting?

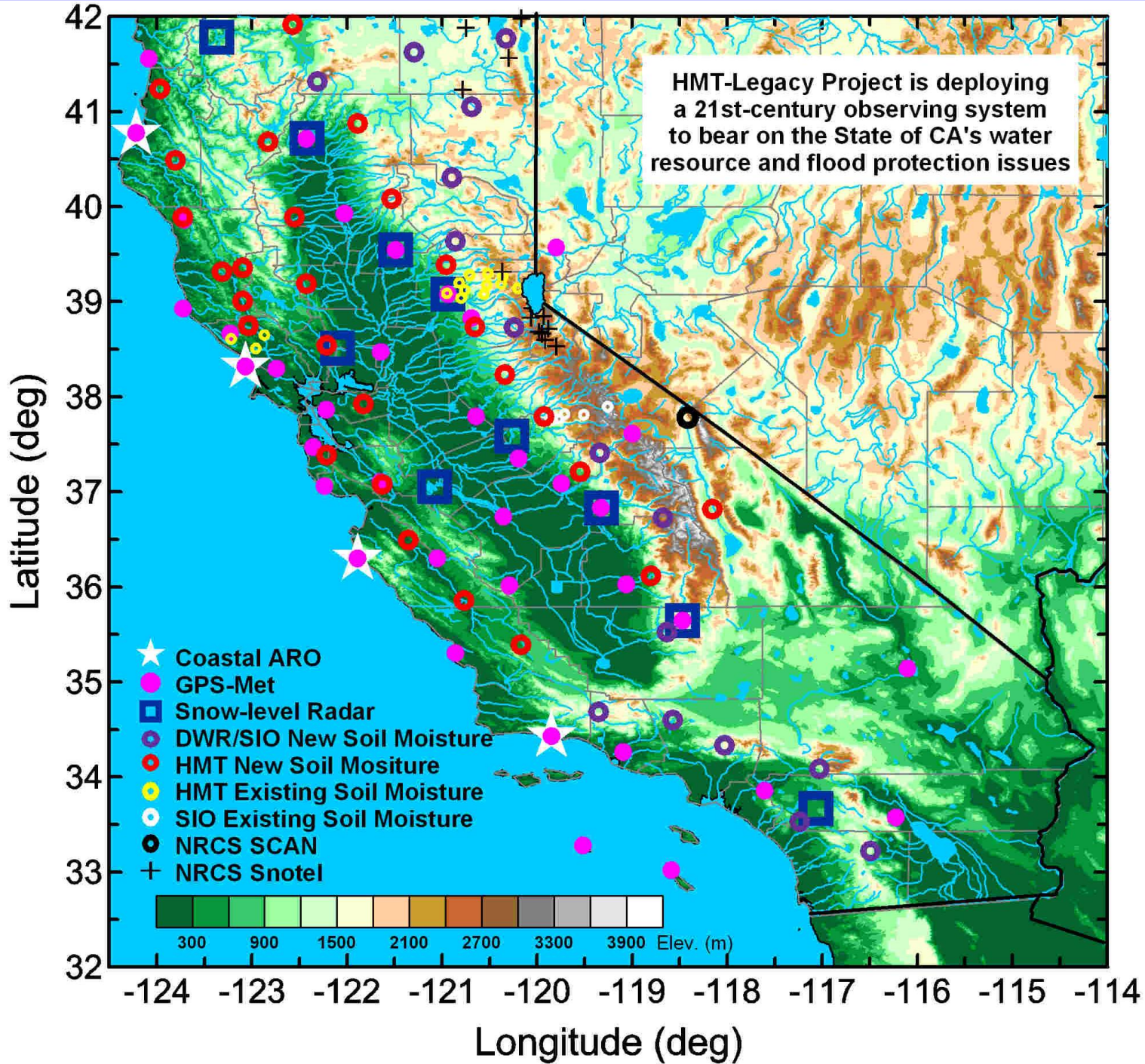
- Forecasts of AR conditions at S2S timescales?
- Forecasts of no AR conditions at S2S timescales? (i.e., ridging/blocking)
- Forecasts of wet/dry regime shifts?

It's All About Results....



State of California Investments in Observing & Understanding Atmospheric River Storms

- NOAA Hydrometeorology Testbed (state share) -- \$15M
- Advanced precipitation monitoring & forecasting grant to Bay Area water agencies -- \$19M
- Calwater I & II field observing campaigns -- \$5M
- Other research with University of California system -- \$3.5M



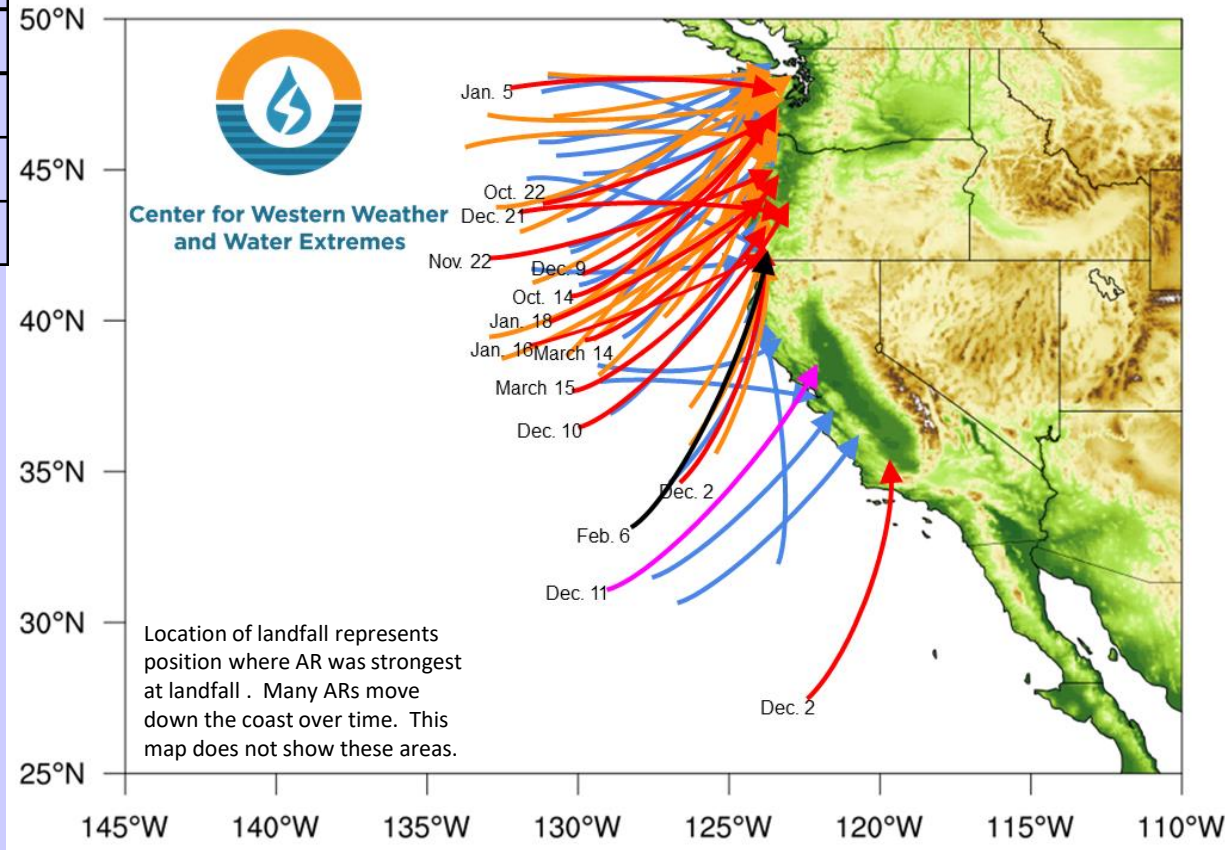
Distribution of Landfalling Atmospheric Rivers on the U.S. West Coast During Water Year 2015

AR Strength	AR Count
Weak	22
Moderate	20
Strong	13
Extreme	1
Exceptional	1

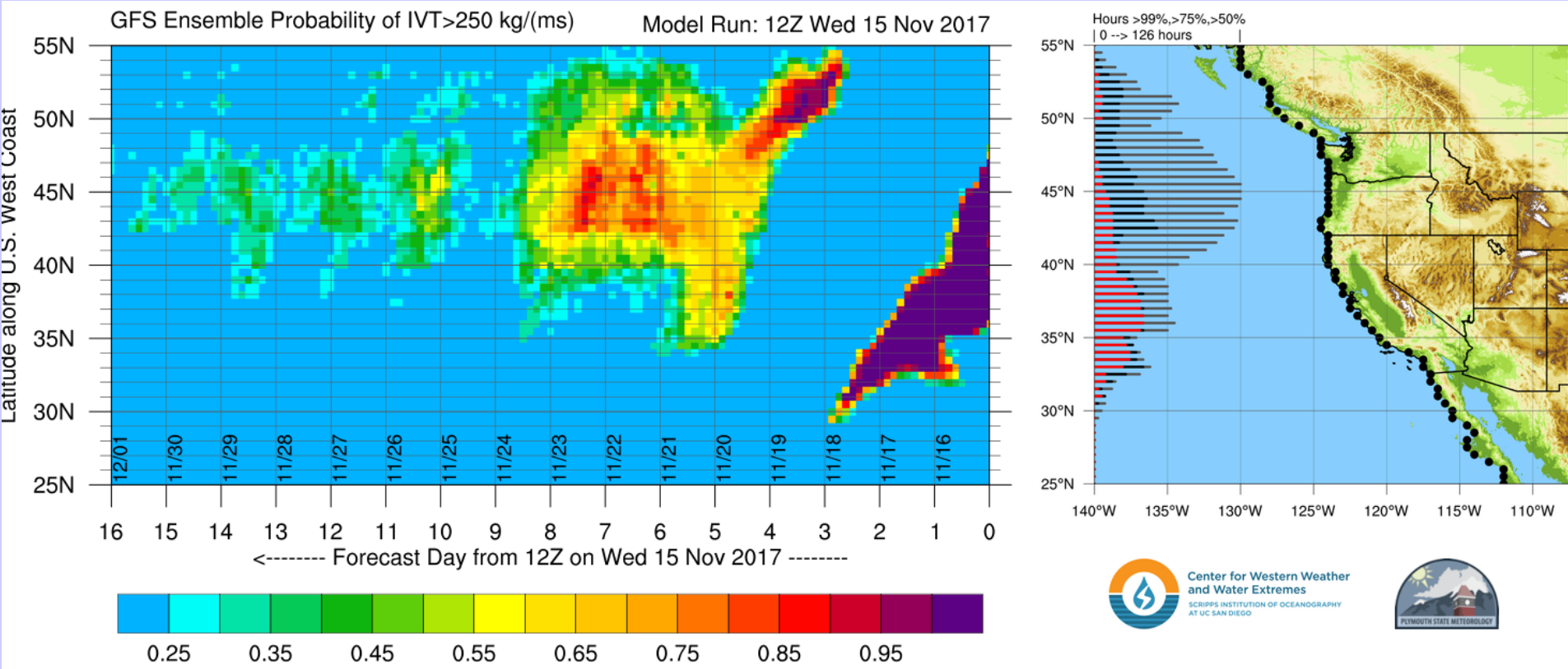
- 57 Atmospheric Rivers made landfall on the USWC during the 2015 water year

Ralph/CW3E AR Strength Scale

■	Weak: $IVT=250-500 \text{ kg m}^{-1} \text{ s}^{-1}$
■	Moderate: $IVT=500-750 \text{ kg m}^{-1} \text{ s}^{-1}$
■	Strong: $IVT=750-1000 \text{ kg m}^{-1} \text{ s}^{-1}$
■	Extreme: $IVT=1000-1250 \text{ kg m}^{-1} \text{ s}^{-1}$
■	Exceptional: $IVT>1250 \text{ kg m}^{-1} \text{ s}^{-1}$



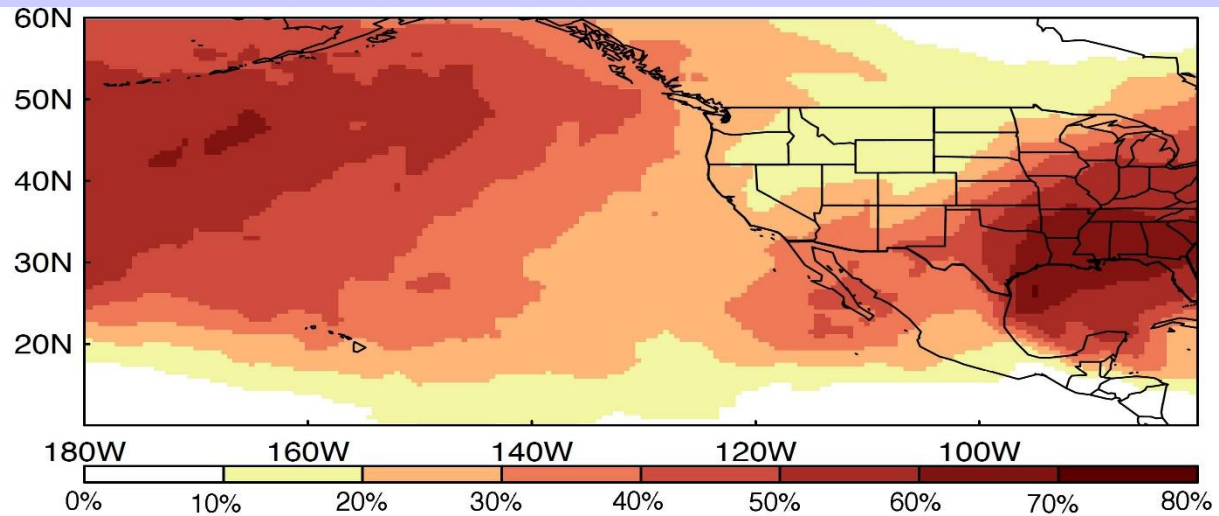
From Observing to Experimental Research Weather Forecasts.....



Initial Preliminary Experimental Research AR S2S Probability Forecasts

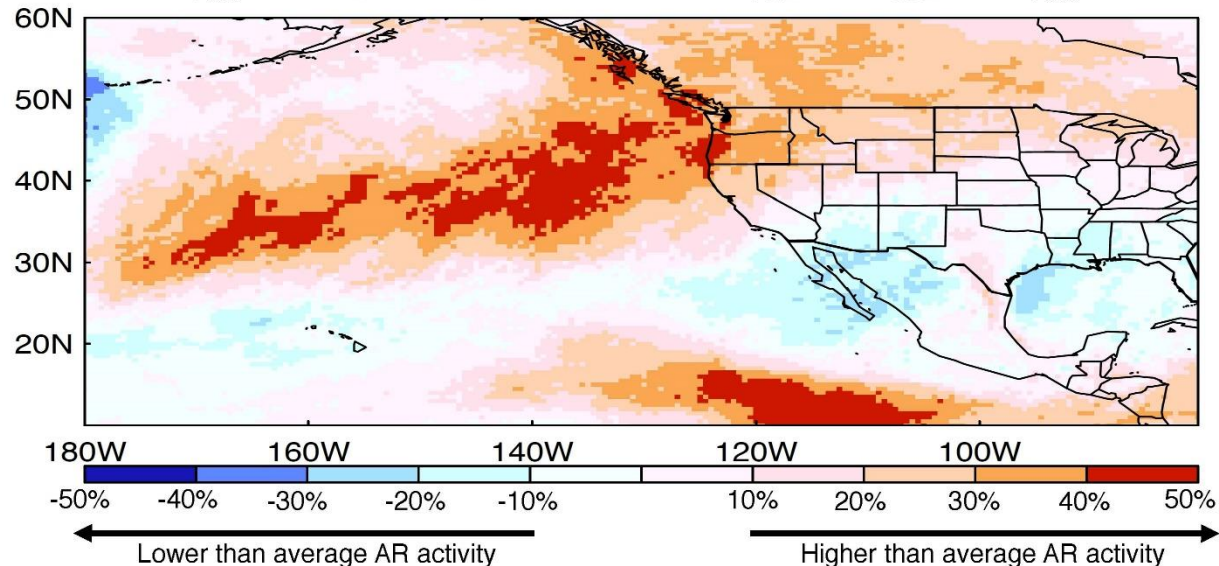
AR Occurrence Climatology

- Chance of an AR occurring sometime during a week-long period in mid-January
- Climatology based on all week-3 ECMWF forecasts from 1996-2015 for mid-January



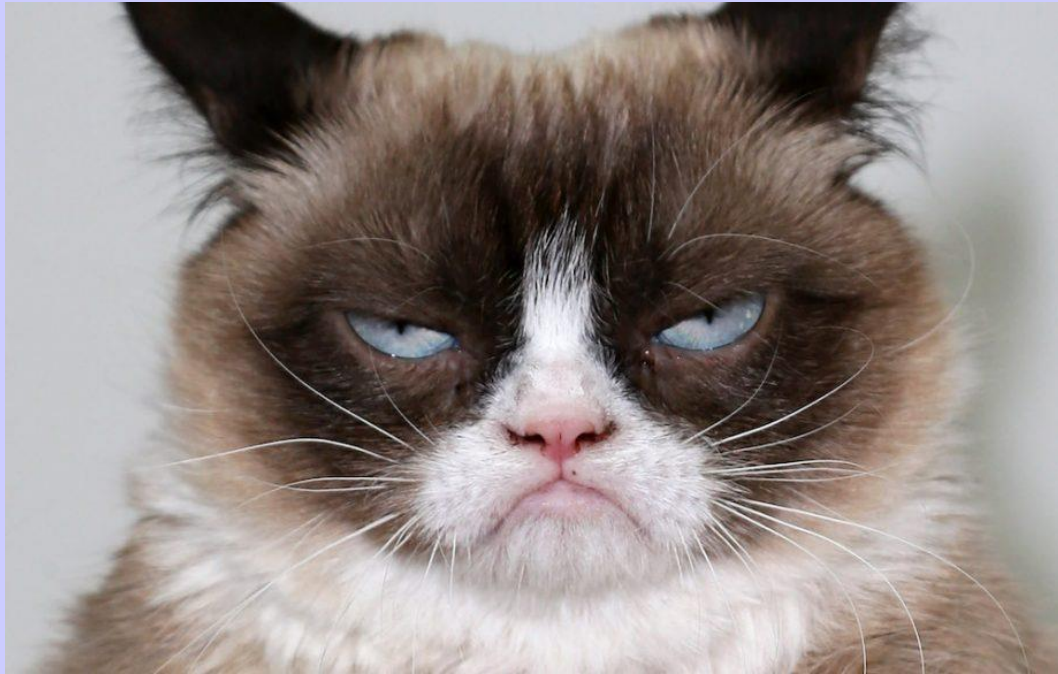
AR Occurrence Forecast Relative to Climatology

- Week 3 ECMWF forecast valid for Jan 16-22, 2018
- Values shown are forecast minus climatology (top)
- ECMWF ensemble forecast includes 51 members



Courtesy of D. Waliser et al.

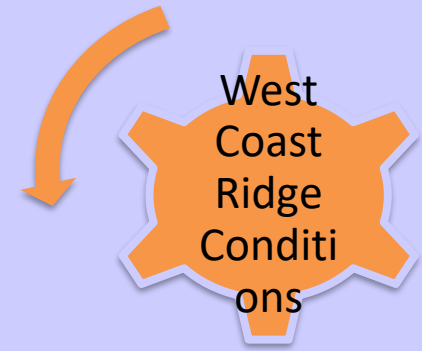
It's not raining



**I love blocking high-
pressure ridges**

Now Amending NASA Contract for Experimental Forecasts of West Coast Ridging

(slide courtesy of D. Waliser et al.)



Project Objectives

- Develop a **US West Coast Drought Ridging Index (WC-DRI)** that is closely tied to U.S. west coast drought
- Quantify subseasonal to seasonal (S2S) **prediction skill** of atmospheric ridging conditions relevant to western U.S. water resources in hindcasts of current generation weather/climate models.
- Identify sources of S2S **predictability** of ridging conditions relevant to U.S. west coast water resources and quantify their predictability characteristics.
- Develop and implement real-time **operational S2S monitoring and prediction** products related to ridging relevant to U.S. west coast water resources.

Regime Shifts/Transitions?

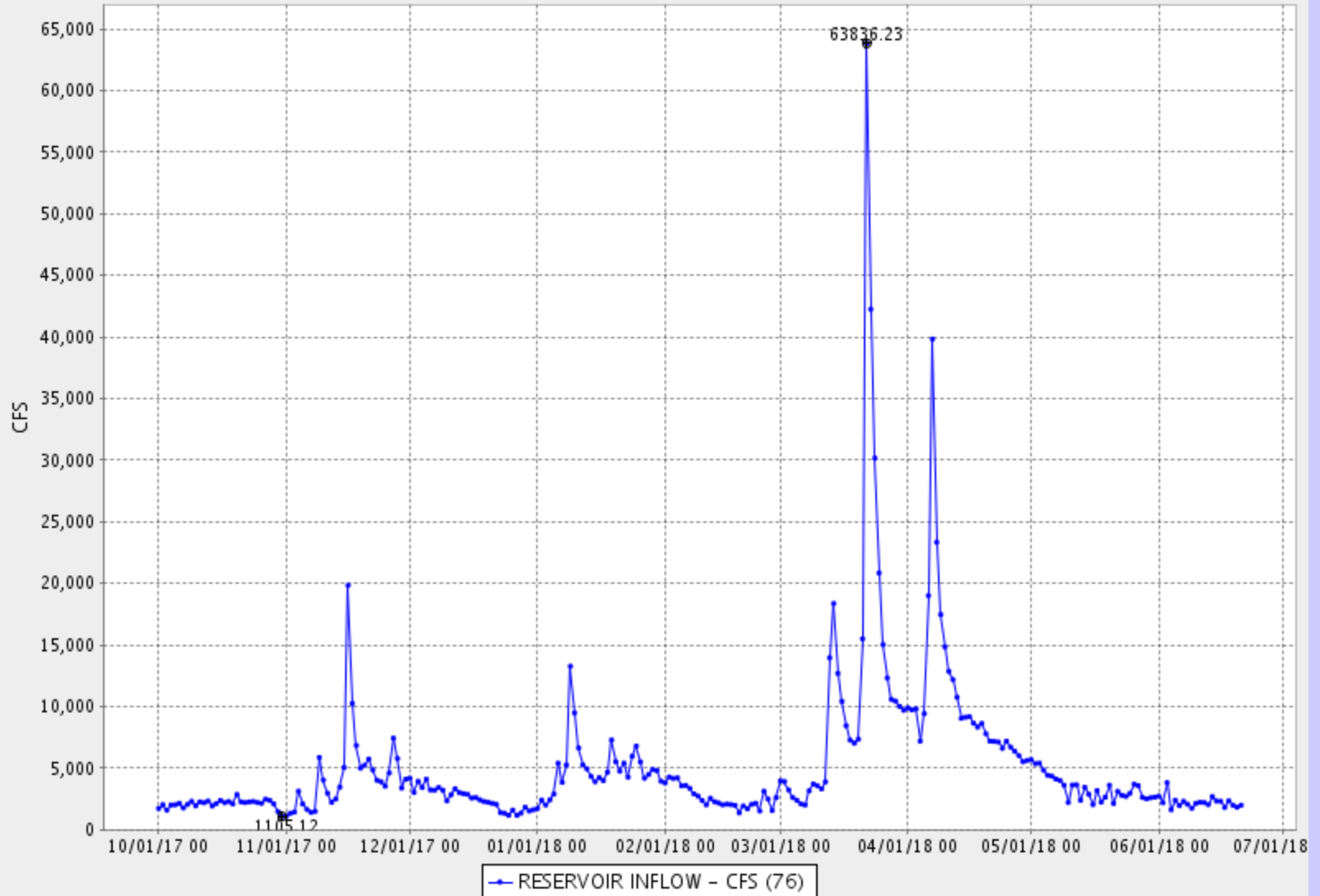


WY 2018 Lake Oroville Inflow

OROVILLE DAM (ORO)

Date from 10/01/2017 through 06/22/2018 09:45 Duration : 0 days

Max of period : (03/22/2018 00:00, 63836.23) Min of period: (10/31/2017 00:00, 1105.12)

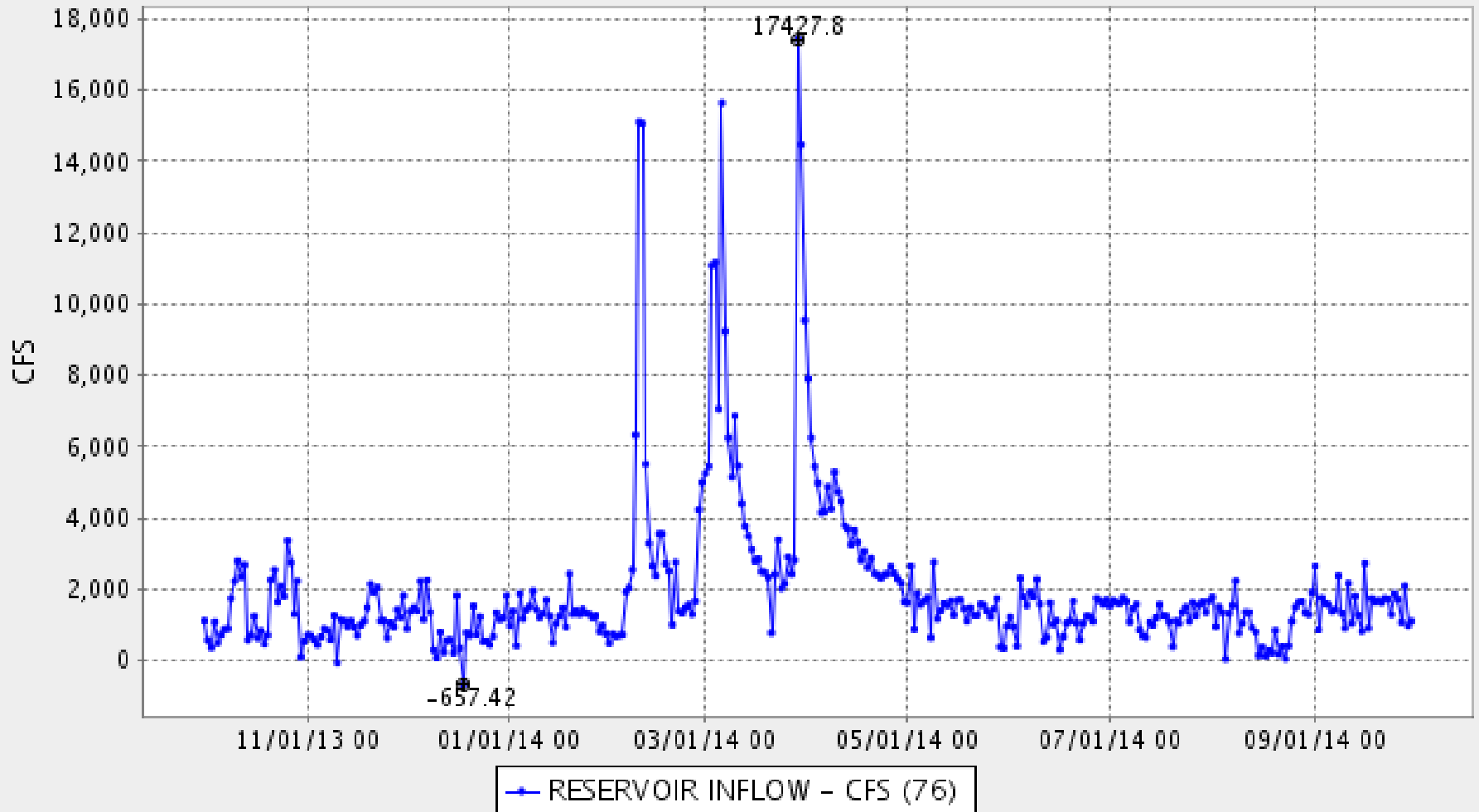


WY 2014 Lake Oroville Inflow

OROVILLE DAM (ORO)

Date from 10/01/2013 through 09/30/2014 Duration : 0 days

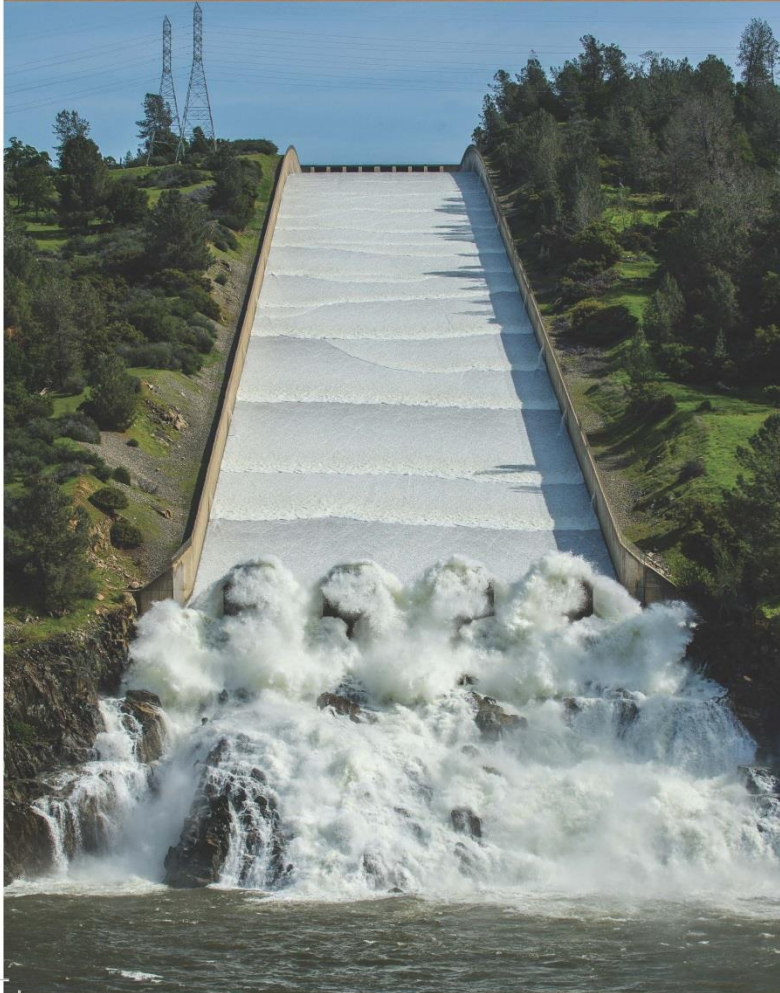
Max of period : (03/29/2014 00:00, 17427.8) Min of period: (12/18/2013 00:00, -657.42)



Next Winter – Wet or Dry??



Improving
Sub-Seasonal to Seasonal
Precipitation Forecasting for
Water Management



WESTERN
STATES
WATER
COUNCIL