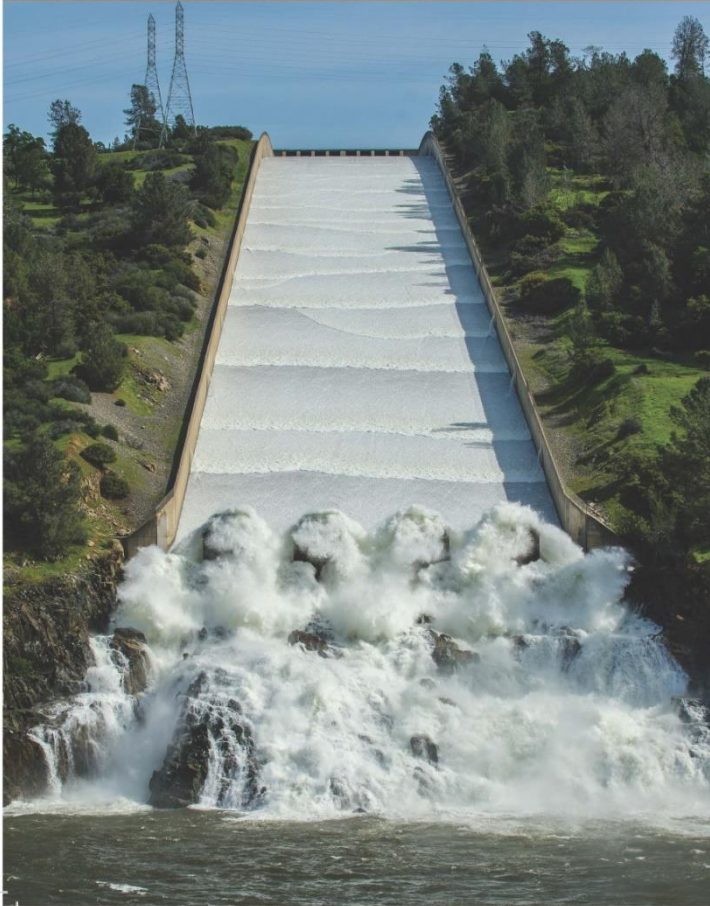


Improving
Sub-Seasonal to Seasonal
Precipitation Forecasting for
Water Management



WESTERN
STATES
WATER
COUNCIL

Jeanine Jones, Western States Water Council

Why This Effort?

Western States Water Council Perspective

- Importance of skillful sub-seasonal to seasonal precipitation forecasting for Western water management
- Lack of resources being directed to improving S2S precipitation forecasting
- Lack of resources being directed to Western precipitation forecasting needs
- Spatial & temporal variability of Western precipitation
- Time is ripe for action

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

Will the Rest of This Winter be Wet or Dry?

Example Sub-Seasonal Decisions

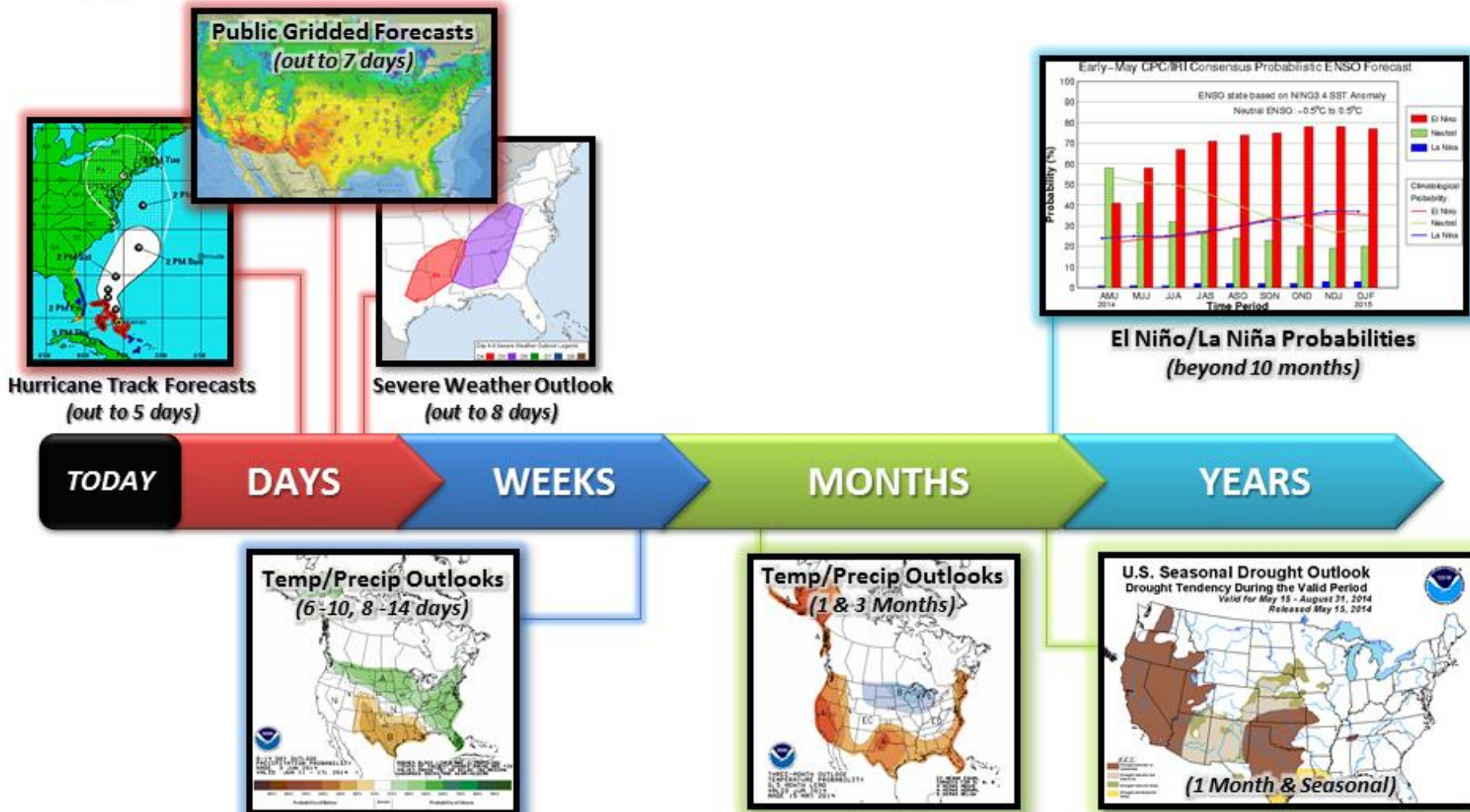
- How much water will we be able to provide to our water users? When can we make the announcement?
- Will we hit hydrologic shortage triggers that require extraordinary conservation measures, or the need to negotiate contracts or adopt regulations?
- Is an elevated flood risk likely this spring? Should we pre-position resources?
- If the rest of this winter looks dry, can we use reservoir flood control space to store water for allocation to users (e.g., forecast-informed reservoir operations)?
- Will we have to curtail diversions on intensively used rivers? How early in the season?

Will This Winter be Wet or Dry?

Example Seasonal Decisions

- Should we begin negotiating contracts for one-time sale of surplus wet-weather water? Can we set up a temporary groundwater banking program to take advantage of wet conditions?
- Do we need to seek additional drought response funding or raise water rates? Do we need to budget for enhanced water conservation activities?
- Should we make plans and adopt regulations for adopting a drought water bank?
- Should we intensify flood preparedness activities in vulnerable areas?

NOAA's Operational Products



NOAA Progress Toward Improving Sub-Seasonal to Seasonal Predictions

Completed

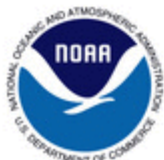
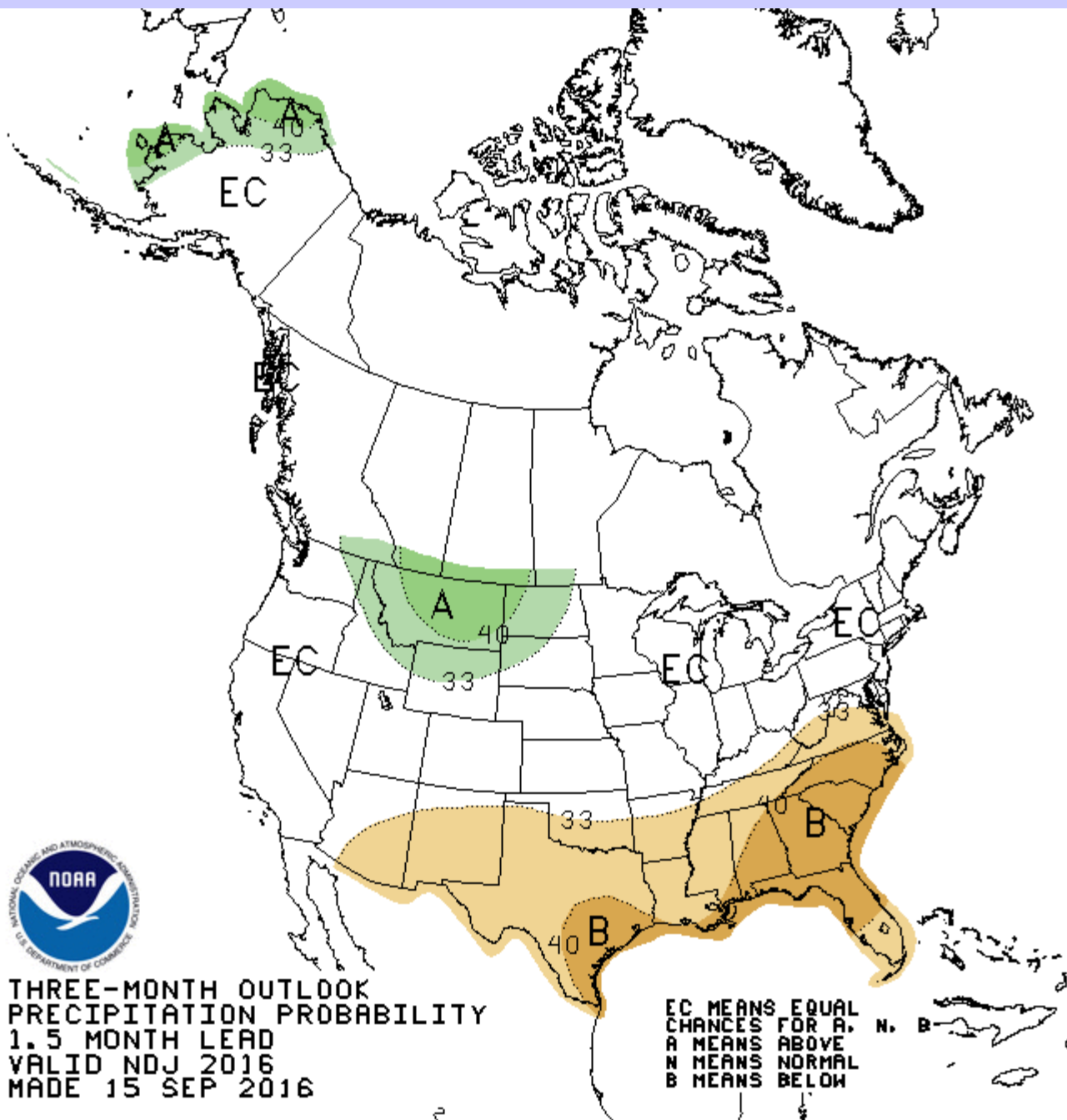
- Operationalized the experimental National Multi-Model Ensemble (NMME), calibrated for predicting extreme events 1-2 months in advance

Initiated in FY16

- Extend current ensemble weather forecast system from a 16 day forecast to a 30 day forecast

In Progress

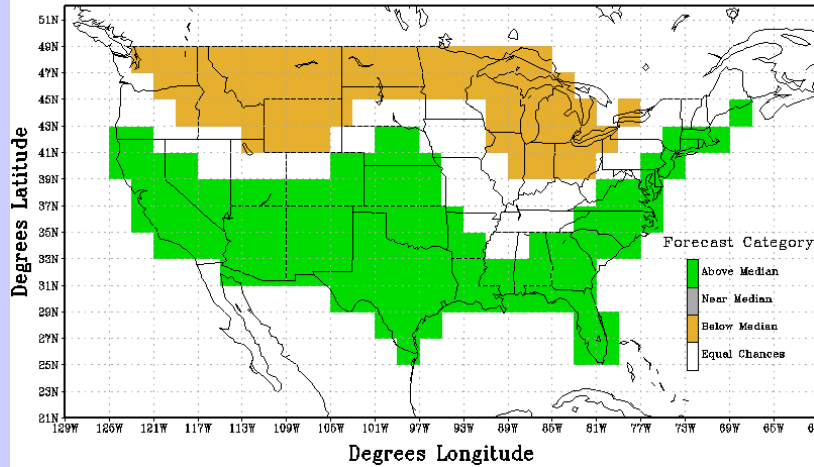
- Improve atmosphere, ocean, land, cryosphere coupling for earth system models
- Linking ensemble based probabilistic forecasts to stakeholder decisions



**THREE-MONTH OUTLOOK
 PRECIPITATION PROBABILITY
 1.5 MONTH LEAD
 VALID NDJ 2016
 MADE 15 SEP 2016**

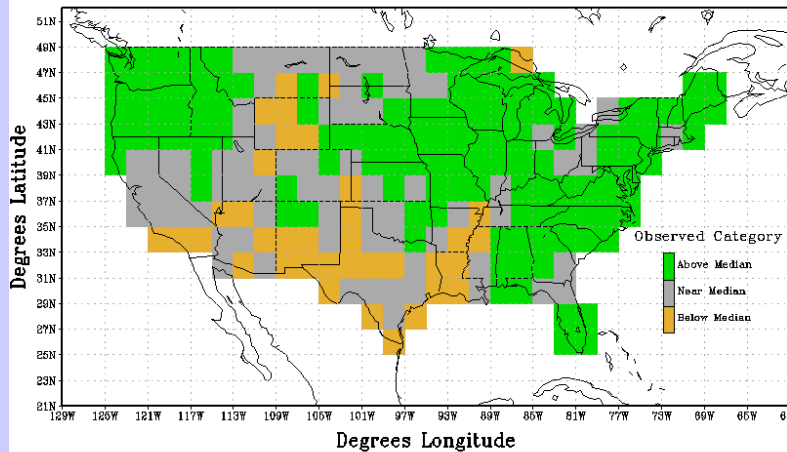
Present Forecasting Skill Not Usable for Water Management

Categorical Precipitation Official Forecast
Issued: Nov 2015 Valid: Dec-Jan-Feb 2015-16



Precipitation Forecast Heidke Skill Scores :
Non-Equal Chance(non EC) forecasts: -7.87
All forecasts: -6.03
% coverage not Equal Chance forecasts : 76.72

Categorical Precipitation Observations
Valid: Dec-Jan-Feb 2015-16



Efforts to Improve S2S Forecasting Skill

From Water User Community

- DWR Winter Outlook Workshops, seeking input from science community over the long-term
- Recent efforts by Western States Water Council
- Pilot application of forecast-informed reservoir operations (FIRO)

From Research Community

- National Research Council science reports in 2010 & 2015
- Call to action in NOAA CA drought service assessment for 2014
- Emerging prospects in research on atmospheric rivers (ARs)

WSWC/NOAA/CDWR Workshop Series on S2S Precipitation Forecasting

- San Diego, May 2015
- Salt Lake City at NWS Western Region HQ, October 2015
- Las Vegas at Colorado River Water Users Association, December 2015
- College Park, April 2016
- San Diego, 2016

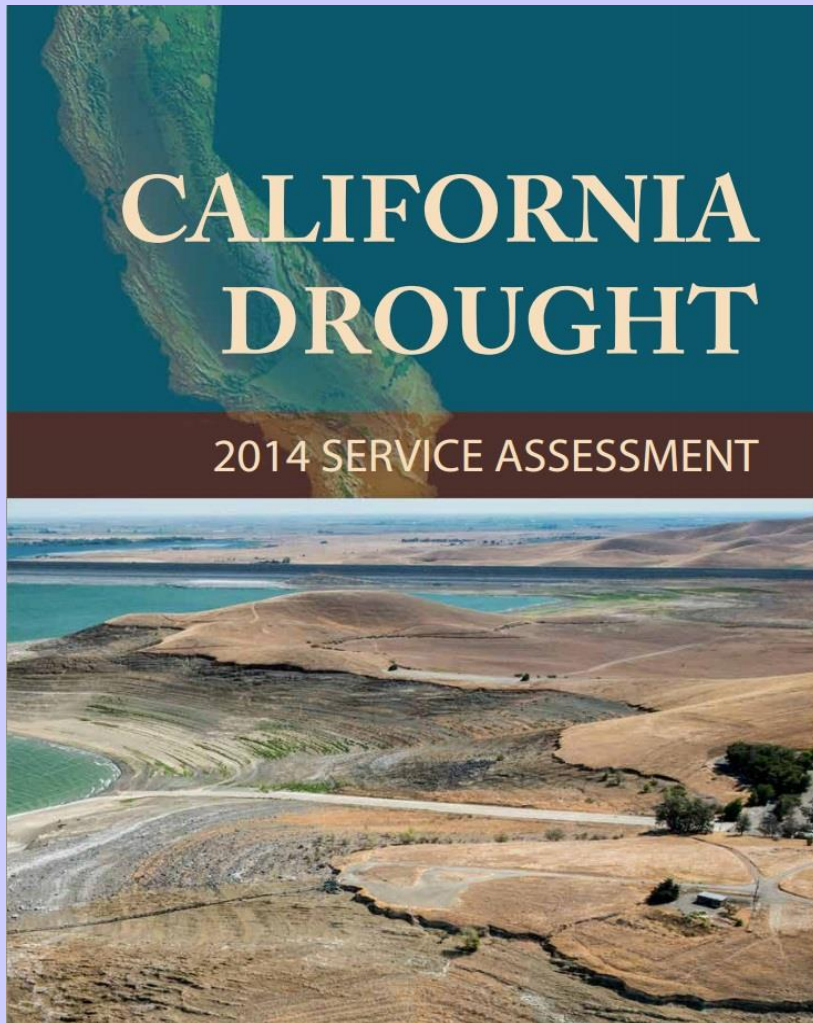
Recent National Academy of Sciences Reports

- Assessment of Intraseasonal to Interannual Climate Prediction & Predictability, 2010
- Next Generation Earth System Prediction, Strategies for Sub-seasonal to Seasonal Forecasts, 2016

Science Challenges Identified

- Understanding processes controlling organization of tropical convection
- Improving understanding & prediction of tropical-extratropical interactions
- Increase understanding & exploit sources of predictability
- Improve the building blocks – data assimilation, improve models, enhance observing networks

NOAA's California Drought Service Assessment



- **Goals:**
 - Understand drought impacted decisions
 - Assess NOAA's effectiveness in supporting those decisions
- **Methodology:**
 - 3 focus sectors (water resources, agriculture, fisheries)
 - 100+ interviews
 - 40+ reviewers
 - 400+ comments
- **Major Recommendations:**
 - Improve seasonal prediction for water resources
 - Develop full natural flow modeling and forecasting
 - Improve NOAA internal coordination

What Would a 10-Year Forecasting Improvement Effort Entail?

- Grant program for mission-driven research on understanding sources of predictability
- Support to modeling centers for model improvements
- Grants program on tailoring products for end users
- Support for testing new tools & transitioning to operations
- High-performance computing augmentation
- Pilot projects, e.g., experimental AR forecasts

For Example, State of California Investments in Observing & Researching AR Storms

- NOAA HMT (state share) -- \$15M
- Advanced precip monitoring & forecasting grant to Bay Area local agencies -- \$19M
- Calwater I & II field observing campaigns -- \$5M
- Research with UCSD/Scripps -- \$3.5M

Next Steps from Water User Perspective

- Increase visibility/awareness of need for improved forecast skill
- Emphasize priority for sustained effort in NOAA budget, for National Weather Service and Office of Atmospheric Research
- Support forecast improvement pilot projects

Member states:



WESTERN STATES
WATER COUNCIL