Skill and reliability of experimental GEFS ensemble forecast guidance designed to inform decision-making in reservoir management in California

+ Information Needs and Potential Entry Points

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Forecast informed deviations in reservoir flood-control and water-supply operational rules to keep or release a little more water provide an opportunity to reduce both flood and water supply risk through a more efficient use of existing infrastructure.
Lake Mendocino Water Management Motivation

Lake Mendocino Water Years 2012 - 2014

- Storage
- Storage Curve
- Cumulative Rainfall

Flood Control Rule Curve

Can we save some of this water?

Reservoir Storage

Cumulative Precipitation

10/11 11/11 12/11 01/12 02/12 03/12 04/12 05/12 06/12 07/12 08/12 09/12 10/12 11/12 12/12 01/13 02/13 03/13 04/13 05/13 06/13 07/13 08/13 09/13 10/13 11/13 12/13 01/14

Storage (Acre-feet)

Cumulative Rainfall (Inches)
Can we also save this water?
Actionable Forecast Information Desired

Plan A

Reliable and skillful subseasonal to seasonal outlooks at 15 to 90 days of the risk for extreme precipitation events in the watershed before the end of the winter/spring rain season

Able to hold additional water in flood pool space until seasonal rule curve changes, adaptive actions can be taken to schedule supply deliveries and enact water conservation practices

Worthy ultimate goal but a prediction challenge at the scale of a specific watershed at these lead times
Plan B

Reliable and skillful outlooks at 6 to 10 days of the low risk for extreme precipitation events in the vicinity of the watershed

Able to hold additional water in flood pool for another day rather than immediately evacuate water from flood

Potentially achievable goal given the reliable predictability of synoptic scale systems/circulation at these lead times
Experimental Actionable Forecast Information (Plan B)

Experimental GEFS ensemble 6 to 10 days forecast guidance for the risk of extreme precipitation events for California using the parametric approach based on censored, shifted gamma distributions (CSGDs) described by Scheuerer and Hamill (2015).

Application

Forecasts verified against the Climatology-Calibrated Precipitation Analysis (CCPA) analysis product which is at a 1/8 degree resolution (~140 km² per grid cell or ~12x~12 km). The reliability and discrimination plots are based on all 1663 grid points within California north of 36 degree latitude.

- Reliability analyses for 14 cool seasons (October - April) 6 to 10 days forecasts starting in the part way through the 2002 cool season to 2015 (2900 days)
- Experimental 6 to 10 days forecasts run for 2016 Water Year
Reliability Diagram for 6 to 10 days forecasts of precipitation >50 mm

Forecast Probability

Observed Frequencies
Reliability Diagram for 6 to 10 days forecasts of precipitation >100 mm
Reliability Diagram for 6 to 10 days forecasts of precipitation >150 mm
2016 Water Year Experimental 6 to 10 Day Forecasts for Lake Mendocino

Analyzed 5–day precipitation accumulations at Lake Mendocino

Corresponding day 6–10 probability forecasts

- P(>50mm)
- P(>100mm)
- P(>150mm)
Real time Experimental California Medium-Range Precipitation Forecasts, Based on NCEP GEFS Reforecasts and CCPA

6 to 10 day forecast made December 3 for December 8 to 13

www.esrl.noaa.gov/psd/forecasts/reforecast2/calif-csgd/index.html
Real time Experimental California Medium-Range Precipitation Forecasts, Based on NCEP GEFS Reforecasts and CCPA

6 to 10 day forecast made December 4 for December 9 to 14

[Image of a map showing precipitation probability]
Real time Experimental California Medium-Range Precipitation Forecasts, Based on NCEP GEFS Reforecasts and CCPA

6 to 10 day forecast made December 5 for December 10 to 15

[Map of California showing precipitation probability]

www.esrl.noaa.gov/psd/forecasts/reforecast2/calif-csgd/index.html
Real time Experimental California Medium-Range Precipitation Forecasts, Based on NCEP GEFS Reforecasts and CCPA

6 to 10 day forecast made December 6 for December 11 to 16

[Link to website](www.esrl.noaa.gov/psd/forecasts/reforecast2/calif-csgd/index.html)
Real time Experimental California Medium-Range Precipitation Forecasts, Based on NCEP GEFS Reforecasts and CCPA

6 to 10 day forecast made December 7 for December 12 to 17

www.esrl.noaa.gov/psd/forecasts/reforecast2/calif-csgd/index.html
Summary

☑ Experimental 6 to 10 days outlooks of extreme precipitation in the proximity of river basins in northern California shows promise in providing skillful information on the risk of 50 mm events that is reliable for probabilities of 40% or less.

Ongoing Effort

➢ Produce experimental forecasts as guidance to inform deviations in reservoir flood-control and water-supply operational rules

➢ Partner with NCEP/WPC, MDL and RFCs to transform experimental forecast information into easy-to-understand and useable products for reservoir flood-control/water-supply operators (e.g., National Blend)
## Decision Calendar - Information Needs and Potential Entry Points

<table>
<thead>
<tr>
<th>Time Frame/Purpose</th>
<th>Nowcast (0 - 6 hours)</th>
<th>Near Real Time (6 - 24 hours)</th>
<th>Short Term (1 day - 1 Week)</th>
<th>Near Term (1 Week - 3 Months)</th>
<th>Mid Term (6 to 24 months)</th>
<th>Long Term (5 years and longer)</th>
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</thead>
<tbody>
<tr>
<td><strong>Flood Mitigation</strong></td>
<td>Flood status assessment</td>
<td>Flood forecast Warning, deploy, System operations</td>
<td>Flood warning, Response, deploy, FIRO</td>
<td>Flood warning, Response, deploy, FIRO</td>
<td>Over-year storage allocation</td>
<td>Flood risk; Capacity development; Climate Resilience;</td>
</tr>
<tr>
<td><strong>Water Supply</strong></td>
<td>Status Assessment; intake and release operations</td>
<td>Forecast Informed Reservoir Operations (FIRO)</td>
<td>FIRO; Emergency conservation</td>
<td>Delivery scheduling; FIRO; Conservation</td>
<td>Over-year Drought Impact Mitigation; Conservation</td>
<td>Capacity Development Demand management; Climate Resilience;</td>
</tr>
<tr>
<td><strong>Ecosystem Enhancement</strong></td>
<td>Status Assessment</td>
<td>Threat assessment; FIRO and River management</td>
<td>Threat assessment; FIRO and River management</td>
<td>Threat assessment; FIRO and River management</td>
<td>Threat assessment; Capacity Development; Drought Impact Mitigation</td>
<td>Ecosystem Services and Capacity Development; Climate Resilience;</td>
</tr>
<tr>
<td><strong>Water Quality</strong></td>
<td>Status Assessment; Real-time control</td>
<td>Waste water capture and treatment</td>
<td>Threat assessment; System Optimization</td>
<td>Threat assessment; Capacity Development; System Optimization</td>
<td>Threat assessment; Capacity Development; System Optimization</td>
<td>Capacity Development; Climate Resilience;</td>
</tr>
<tr>
<td><strong>Recreation</strong></td>
<td>Weather status; Warning</td>
<td>Event Scheduling and Closures</td>
<td>FIRO</td>
<td>FIRO</td>
<td>Capacity Development;</td>
<td>Capacity Development;</td>
</tr>
<tr>
<td><strong>Transportation</strong></td>
<td>Weather status; Warning</td>
<td>Threat assessment; Traffic Scheduling</td>
<td>Threat assessment; Traffic Scheduling; Response and deployment</td>
<td>Threat assessment; Traffic Scheduling; Capacity Development;</td>
<td>Capacity Development;</td>
<td>Capacity Development; Climate Resilience;</td>
</tr>
<tr>
<td><strong>Fisheries Management</strong></td>
<td>Status Assessment; Real-time fish management control</td>
<td>Threat assessment; water quality/ temperature and flow velocities</td>
<td>Threat assessment; hatchery release guidance</td>
<td>Threat assessment; river/estuary habitat status; ocean upwelling/nutrient</td>
<td>Capacity Development; Habitat restoration; Co-management of native fisheries</td>
<td>Capacity Development; Climate Resilience; Habitat restoration; Fishery recovery</td>
</tr>
<tr>
<td><strong>Agriculture</strong></td>
<td>Status Assessment; Real-time frost control</td>
<td>Threat assessment; Frost Risk</td>
<td>Threat assessment; Frost, pests/mold, drought/flood risk</td>
<td>Threat assessment; Frost, pests/mold, drought/flood risk</td>
<td>Capacity Development; irrigation ponds; fans</td>
<td>Capacity Development; Climate Resilience; crop choice, irrigation ponds; fans</td>
</tr>
</tbody>
</table>
Backup Slides
NCEP WPC (Excessive Rainfall Outlook)

Threat score of two inch rainfall events forecast 3 days in advance (3 FY running average)

3-year running average goal = 0.14
Sustaining a 0.14 Threat Score gives confidence to provide ‘high risk’ excessive rainfall outlook category on Day 3

FY19 performance data will be available at the end of the fiscal year. The NWS is currently on track to meet the three-year running average goal of 0.14.
What does a 0.14 Threat Score Mean?

**Threat Score of 0** = NO overlap between forecast & observed location.

**Threat Score of 1** = COMPLETE overlap between forecast & observed location.

**Threat Score of 0.14** = Index score which represents 25% overlap between forecast and observed location

Note: Predictions with some variation are still highly useful to planning for and responding to extreme weather.