Advancing Water Supply Forecasts in the Colorado River Basin for Improved Decision Making

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Partners/Collaborators:
Problem Statement / Goals

How to ensure a sustainable water supply as future water demands increase and threats such as pollution, land use change, and climate change alter the hydrologic landscape?

- Provide improved water supply forecasts
- Show value to decision makers
- Research-to-operations

How do we improve water supply forecasts in the Upper Colorado River Basin?
Solving the problem

River Forecast Center Water Supply Forecast Process

How to we add incremental improvements/addition skill?
Research Distributed Hydrologic Model

- RDHM
- CBRFC

Average Abs. Monthly Vol Error [mm]

CBRFC Mean Error

RDHM Mean Error

NWS HW Basin
Utah Energy Balance Snowmelt Model

- Physically-based single layer model
- Gridded

**Why use an energy balance model?**
- Physics could improve snowmelt modeling
- Better suited for snow data assimilation of observed data (i.e. station based, satellite, etc.)

<table>
<thead>
<tr>
<th>Dolores</th>
<th>NSE</th>
<th>RMSE (cms)</th>
<th>Bias (cms)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SNOW-17</td>
<td>0.91</td>
<td>5.5</td>
<td>0.16</td>
</tr>
<tr>
<td>UEB</td>
<td>0.95</td>
<td>3.9</td>
<td>-0.01</td>
</tr>
</tbody>
</table>

Snow Data Assimilation

Local Ensemble Transform Kalman Filter (LETKF)

Initial Model State  Update w/ SNOTEL  Update w/ MODSCAG  Updated SWE State

Forecast (Propagation)

Analysis:
Update ensemble members

Observation

Initial States

$\mathbf{t}_{k-1}$  $\mathbf{t}_{k}$  $\mathbf{t}_{k+1}$
Regionally Calibrated Satellite Precipitation Data

- Data from Global Precipitation Measurement (GPM) mission
- Regionally bias-correct all passive microwave sensors over Colorado River Basin (CRB) area
- Final product is merged with gage data
- Additional gage data and a CRB specific regional retrieval give CRB-GPROF an advantage over IMERG, compared to PRISM.
**Forecast Verification Results: Incremental Improvements**

- **ENSEMBLE** of current states

- **Traces of historical precip./temp.** (i.e. 5 years of historical data = 5 ESP traces)

**Ensemble Streamflow Prediction**

- Produce probabilistic outlook of streamflow volumes

- ESP reforecasts are made on the 1st of the month from Jan-Apr, WY 1990-2010

- Verification measures are used to evaluate the accuracy and skill of the forecast
**Impacts: Decision Support System**

**Tools for stakeholders**

1. **Deterministic model**
   - Evaluate each trace individually
   - *dynamic programming*

2. **Stochastic model**
   - Evaluate full forecast
   - *sampling stochastic dynamic programming*

**Benefit comparisons**

- CBRFC, RDHM, DA, UEB, etc.

**Post-Processed Work with stakeholders to define benefits (i.e., reduced spill, fewer shortages, etc.)**
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