Evaluation of a Hydrologic Model Applied to a Headwater Basin in the Rio Grande (USA) Using Observed and Modeled Land Surface Fluxes and States

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SAHRA Partners

California
- University of California, Riverside
- University of California, San Diego
- Scripps Institution of Oceanography

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- Desert Research Institute

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- University of Arizona, Tucson

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- New Mexico Tech
- Los Alamos National Laboratory
- Sandia National Laboratories

Utah
- University of Utah

Mexico
- IMADES

Colorado
- USGS
- The Nature Conservancy

Other
- US Army Corps of Engineers
Del Norte Watershed

Rio Grande watershed

- Area ~83,400 km²

Del Norte watershed

- Area ~3,500 km²
- Elevation 2,400m to 4,250m
- Major source of streamflow
- No diversions or storage
- Snow dominated
- Forest and alpine tundra
- “Index” watershed
- Six subwatersheds
- Three NRCS SNOTEL Sites
River-channel evaporation
Irrigated-crop & Riparian evapotranspiration
Irrigation diversions
Canal and drain flow
Canal seepage

River routing
Tributary inflow
Diversions
Irrigation & Wastewater returns
Primary Goals of this Study

(1) Gain a better understanding of the hydrologic model’s ability to accurately simulate streamflow at locations internal to the calibration location – are we getting the right answer for the wrong reason?

(2) Investigate the use of a long term data set as a surrogate for observations in areas with little or no observed hydrologic information.

- Surface forcings (e.g., precipitation and temperature) gridded at a 1/8 degree resolution from observations.
- Simulated hydrologic variables (e.g., streamflow and snow water equivalent) from the VIC model.
- Developed primarily to serve as diagnostic data set in studies where ground based observations are sparse.
Experimental Setup

- Apply MMS hydrologic model to Del Norte watershed at 1/8 degree resolution.
- Calibrate MMS model via comparisons with streamflow at outlet of watershed.
- Compare MMS model streamflow estimates with observations and LTDS at outlet and internal locations.
- Compare MMS SWE estimates with point observations and LTDS estimates.
LTDS is significantly greater than OBS for most years.
• LTDS Del Norte streamflow estimates are positively biased.
• LTDS 30 Mile Bridge estimates positively biased in dry year.
• MMS 30 Mile Bridge estimates are negatively biased.
## Distribution of Runoff

<table>
<thead>
<tr>
<th>Basin</th>
<th>Contributing Area (km²)</th>
<th>OBS</th>
<th>MMS</th>
<th>LTDS</th>
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<tbody>
<tr>
<td>1</td>
<td>719</td>
<td>1.8</td>
<td>20.6</td>
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<td>2</td>
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<td>3.6</td>
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<tr>
<td>6</td>
<td>510</td>
<td>24.2</td>
<td>14.6</td>
<td>26.2</td>
</tr>
</tbody>
</table>

High elevation = MMS<<OBS

Low elevation = MMS>>OBS
Summary and Future Work

- MMS estimates of streamflow at internal nodes indicate that we may be getting the right answer for the wrong reason. (Precipitation distribution?)
- Large positive bias in LTDS streamflow estimates limit their value as a surrogate for observations in areas with little or no observed hydrologic information.
- The distribution of total runoff generated in the LTDS is similar to the observed and may be useful in ungauged watersheds.
- Other LTDS hydrologic fluxes (ET, infiltration, groundwater, etc.) could also be used to evaluate hydrologic model performance.
- A “complete” evaluation requires a multi-objective approach.
Evaluation of Hydrologic Information

POES-AVHRR

SNOTEL Ground Data

SNOTEL Ground Data

Field Measurements

SWE Estimates

Water Resources Applications

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