Evaluation of Downscaled GCM Output

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(FORT, Information Science)

Jeff Falgout
(Core Science Analytics and Synthesis)
BACKGROUND

National Hydrologic Model (NHM)

- Water availability
- Changes in timing and source of flow
- Uncertainty
- Assessment of climate and land use change
- Local, regional, and national scale
Components of the NHM

1. Models

2. Catchment-derived modeling units (Geospatial Fabric) linked to a stream network

3. Climate Data for model forcing from GeoData Portal:
   - National extent
   - Freely available
   - Model ready (processing and formatting)

4. Calibration and parameter transfer for ungaged areas
PRMS Conceptualization of Basin Components

Modular, deterministic, distributed-parameter, physical-process, daily time-step watershed model that simulates watershed response to various combinations of climate and land use.

Coupled ground-water and surface-water flow model based on the integration of PRMS and MODFLOW (Modular Ground-Water Flow Model).

The coupling of PRMS and MWBM with SNTemp allows scientists and watershed managers to evaluate the effects of historical climate and projected climate change, landscape evolution, and resource management scenarios on watershed hydrology and in-stream water temperature.
Models

PRMS
Precipitation Runoff Modeling System

GSFLOW
Coupled ground-water and surface-water flow model based on the integration of PRMS and MODFLOW (Modular Ground-Water Flow Model)

MWBM
Monthly Water Balance Model

SNTEMP
Stream Network TEMPerature model
Components of the NHM

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Geospatial Fabric Methodology

Aggregate NHDPlus catchments based on Points of Interest (POIs) to make Hydrologic Response Units (HRUs)

Making HRUs:
NHDPlus Aggregation to Geospatial Fabric

Flowlines -- 34
Catchments -- 31

HRUs -- 2
Segments -- 1
Flowlines: 3,773,276
Segments: 4,285,366
BACKGROUND

Geospatial Fabric
Components of the NHM

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Community involved

- USGS National Research Program (NRP)
- USGS Water Science Centers (WSC)
- WaterSMART
- DOI Climate Science Centers (CSC)
- DOI Landscape Conservation Cooperatives (LCC)
- Environmental Protection Agency (EPA), Office of Water
- Community for Data Integration (CDI)
- John Wesley Powell Center for Analysis and Synthesis
- Integrated Water Resources Science and Services (IWRSS)
MWBM, PRMS, and STATS (GCPO LCC, SE CSC)

“Assessment of Water Availability and Streamflow Characteristics in the Gulf Coastal Plains and Ozarks Landscape Conservation Cooperative for Current and Future Climatic and Landscape Conditions”

Project Lead: LaFontaine\(^1,2\)
Co-Investigators: Hay\(^2\), Markstrom\(^2\), Regan\(^2\), Viger\(^2\), Archfield\(^6\), Bock\(^3\), Hart\(^4\), Hunt\(^5\), Kern\(^7\) and Montgomery\(^7\)

1 – USGS GA Water Science Center
2 – USGS National Research Program, CO
3 – USGS CO Water Science Center
4 – USGS AR Water Science Center
5 – USGS NC Water Science Center
6 – USGS National Research Program, Reston
7 – USGS Fort Collins Science Center, CO
Current Applications

John Wesley Powell Center for Analysis and Synthesis/ National Water Census

“Water availability for ungaged rivers: an integrative multi-model approach to estimate water availability at ungaged rivers across the US”

Julie Kiang (USGS) (co-PI)
Stacey Archfield (USGS) (co-PI)
Lauren Hay (USGS)
Andy Bock (USGS)
Rodney Knight (USGS)
Will Farmer (USGS)
Thomas Over (USGS)
Kirsti Hakala (USGS)
Martyn Clark (NCAR)
Vazken Areassian (France)
Thorsten Wagener (UK)
Andras Bardossy (Germany)
Alberto Viglione (Austria)
Jan Seibert (Switzerland)
Hillary McMillan (NZ)
Berit Arheimer (Sweden)
Sabina Attinger (Germany)
Current Applications

MWBM (EPA, SC CSC, CDI, GCPO LCC, SE CSC)

“Assessment of Water Availability and Associated Drivers for Current and Future Conditions”

Models → Models Database

Users/Stakeholders → Portal
MWBM (EPA, SC CSC, CDI, GCPO LCC, SE CSC)

"Assessment of Water Availability and Associated Drivers for Current and Future Conditions"

MWBM

MWBM Database

Portal running R scripts

Users/Stakeholders
7 outputs (local and accumulated):
1. average temperature
2. precipitation
3. potential evapotranspiration
4. actual evapotranspiration
5. soil moisture
6. snowpack water equivalent
7. runoff/streamflow

(McCabe and Markstrom, 2007)
MWBM (EPA, SC CSC, CDI, GCPO LCC, SE CSC)  
“Assessment of Water Availability and Associated Drivers for Current and Future Conditions”

Users/Stakeholders

MWBM

MWBM Database

Portal running R scripts

Current Applications
THREDDS server – web browser example

- Terrabytes of output accessible

NHD Region, Parameter Set, Downscaling Type, Model Type, GCM, Emission Scenario, Variable, HRU Index, Time Step Slice, Time Slice

```
Dataset {
    Float64 RO[hru_id = 1][time = 365];
} nwb%2fR11_DEFAULT_SDS_MB_MIROC_a1b_byHRU;
```

Community for Data Integration meeting, September 10, 2014
MWBM (EPA, SC CSC, CDI, GCPO LCC, SE CSC)

“Assessment of Water Availability and Associated Drivers for Current and Future Conditions”

Current Applications

Users/Stakeholders

MWBM

MWBM Database

Portal running R scripts
By Project
Choose location from map:
- Local → give you the HRU
- Contributing area → delineate basin
Choose location from map:
- Local \(\rightarrow\) give you the HRU
- Contributing area \(\rightarrow\) delineate basin
Choose location from map:
- Local → gives you the HRU
- Accumulated → gives you basin
### Station Based: (SB)

**GSD** – gridded station data (Maurer).
- ~12x12 km
- Baseline data set for the BCSD.

**Daymet** – 1x1 km

**PRISM** – Parameter-elevation
- Regressions on Independent SLOPES Model
- 4x4 km

### Statistically Downscaled GCMs from

**CMIP3 or CMIP5 using BCSD:**

CMIP3/CMIP5 -- Coupled Model Intercomparison Project
- phase 3/5

BCSD -- Bias-Correction Spatial Disaggregation method

<table>
<thead>
<tr>
<th>Statistically Downscaled GCMs (SDS)</th>
<th>BCSD</th>
<th>CMIP3</th>
<th>Emission scenario a1b</th>
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<tbody>
<tr>
<td>GSD</td>
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Runoff
Based on Water Years 1982 to 2000

Station Based:
DAYMET – 1x1km
GSD – gridded station data (Maurer).
    ~12x12km
    Baseline data set for the BCSD.
PRISM – Parameter-elevation
    Regressions on Independent
    Slopes Model
    4x4km

Statistically Downscaled GCMs from
CMIP3 or CMIP5 using BCSD:
CMIP3/CMIP5 -- Coupled Model
    Intercomparison Project
    phase 3/5
BCSD -- Bias-Correction Spatial
    Disaggregation method
MWBM

Current and future on a monthly time step for CONUS: potential evapotranspiration, actual evapotranspiration, snow water equivalent, soil moisture storage, streamflow, average temperature, and precipitation

PRMS

Default for CONUS.

Working on:
- Parameterization, evaluation, calibration datasets
- Performance metrics
- Parameter sensitivity analysis
- Stream connectivity
- Snow depletion curves

Automated calibration
- Parameter transfer functions
- Depression storage
- Routing
- Incorporate water use – SWUDS

Evolving parameters – landcover, fire, ...
- Fine resolution nesting
- Canada and Mexico
- Lakes/swamps
- Glacier dynamics

SNTEMP

Stream temperature for current and future on a monthly/daily time step

GSFLOW

multi mode

“The right model at the right location”
OWI will host model output

- All output is in netCDF format
- netCDFs are CF1.6 compliant (transparent for other tools to read)
- Metadata is up to standards
- netCDFs loaded on THREDD servers
- What now???