New Daily and Monthly Downscaled CMIP5 Climate Projections

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Summary

Context: Two statistical downscaling techniques – monthly bias-correction and spatial disaggregation (BCSD) and daily bias-correction and constructed analogs (BCCA) – have been applied to a large ensemble of new climate projections released through the World Climate Research Programme (WCRP) Coupled Model Intercomparison Project phase 5 (CMIP5). The downscaled projections are developed over the contiguous U.S. and represent the latest content addition to the "Bias Corrected and Downscaled WCRP CMIP3/5 Climate and Hydrology Projections" web archive, available at: **http://gdo-dcp.ucllnl.org/downscaled_cmip_projections/**. A subset of the BCSD climate projections have been translated into hydrologic projections over the contiguous U.S.

Archive efforts stem from recognition that water managers need to assess what future climate change could mean for the management of their systems, and to assess when vulnerabilities and impacts would appear to cross thresholds triggering need for adaptive intervention. In order to assess such needs, managers must be able to quickly and easily access global climate projection information that has been bias-corrected to account for systematic climate model errors and downscaled to reflect local controls on climate.

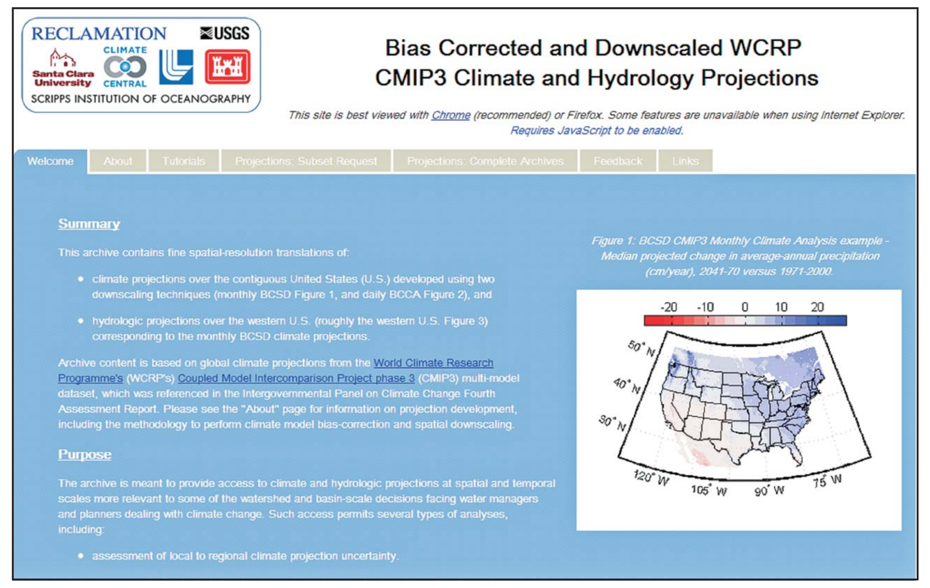
This effort builds on collaborative climate projections downscaling and hydrologic modeling activities that have been ongoing since 2007. Results from these efforts have been made publically available at the archive below. To-date, more than 11,000 data requests have been served through this website in association with planning, research and education activities.

About the Archive

Website
http://gdo-dcp.ucllnl.org/downscaled_cmip3_projections/

Purpose
Provide public access to large collection of contemporary downscaled climate and hydrology projections.
Support planning, research and education activities.

Collaborators
(2007) Reclamation, Santa Clara University, Lawrence Livermore National Laboratory
(2009) U.S. Army Corps of Engineers, Scripps Institution of Oceanography, U.S. Geological Survey, Climate Central, Climate Analytics Group



Content (New!)

Source	Type	Method	Time		Space		Variables	Projection Members
			Step	Period	Resolution	Domain		
CMIP3	Climate (added 2007 and 2010)	BCSD (Wood et al. 2002)	monthly	1950-2099	1/8°	Contiguous U.S. plus portions of Canada and Mexico	precipitation, temperature	112 (16 climate models, 3 emissions (SRES B1, A1b and A2), 1+ runs per combination)
		BCCA (Maurer et al. 2010)	daily	1961-2000, 2046-2065, 2081-2100			precipitation, minimum temperature, and maximum temperature	57 (9 climate models, 3 emissions, 1+ runs per combination)
	Hydrology (added 2011)	Reclamation 2011a (following Wood et al. 2004, Maurer 2007)	monthly, daily	1950-2099	1/8°	western U.S.	monthly (precipitation, mean daily minimum and maximum temperatures, mean wind speed, runoff, evapotranspiration, 1st of month snow water equivalent and soil moisture, and four potential evapotranspiration values); daily (four weather forcing variables and runoff components)	112 (16 climate models, 3 emissions, 1+ runs per combination)
CMIP5	Climate (added 2013)	see CMIP3	monthly	1950-2099	1/8°	Contiguous U.S. plus portions of Canada and Mexico	see CMIP3	234 (37 climate models, 4 emissions (RCPs 2.6, 4.5, 6.0, and 8.5), 1+ runs per combination)
		see CMIP3	daily				see CMIP3	134 (21 climate models, 4 emissions, 1+ runs per combination)
	Hydrology (added 2013)	see CMIP3	monthly, daily				see CMIP3	100 (32 of the 37 BCSD climate models, up to 4 emissions per model, 1 run per combination)

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____, 2012b. Colorado River Basin Water Supply and Demand Study Technical Report G – System Reliability Analysis and Evaluation of Options and Strategies, prepared by the U.S. Department of the Interior, Bureau of Reclamation, 121pp.

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How do precipitation changes from CMIP5 compare to those from CMIP3?

Analysis:

(1) Use monthly BCSD climate sources (CMIP3 and CMIP5) and compute period-change in mean-annual condition for each projection and grid cell.

(2) Pool changes by model at every grid cell and compute the average change (i.e. model-specific change pattern).

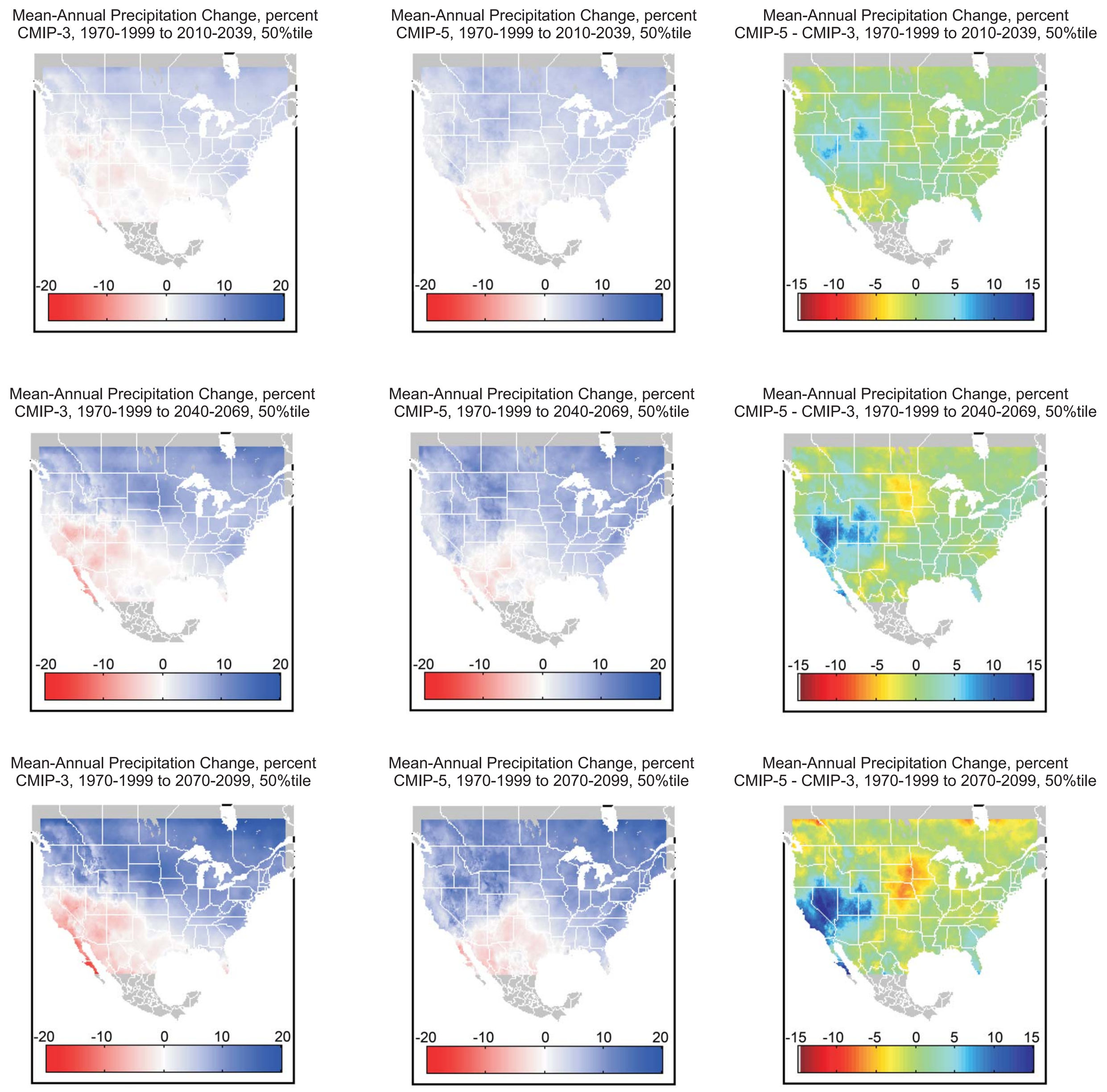
(3) Pool model-specific change patterns and compute the ensemble-median (50th percentile) change (i.e. from 16 model-specific patterns in CMIP3 and from 37 model-specific patterns in CMIP5). (Note - subsetting by emissions scenario can also be done.)

(4) Map the ensemble-median change by future period (rows) and source (first and second columns). Map difference by source (third column).

Impressions:

At the larger scale, CMIP5 and CMIP3 median changes are similar.

At the local scale, significant differences are evident (e.g., by late 20th century, CMIP5 median changes differ from CMIP3 by >10% over much of the U.S. Southwest, and by <-5% over the northern Great Plains.)



How do temperature changes from CMIP5 compare to those from CMIP3?

Analysis:

See above.

Impressions:

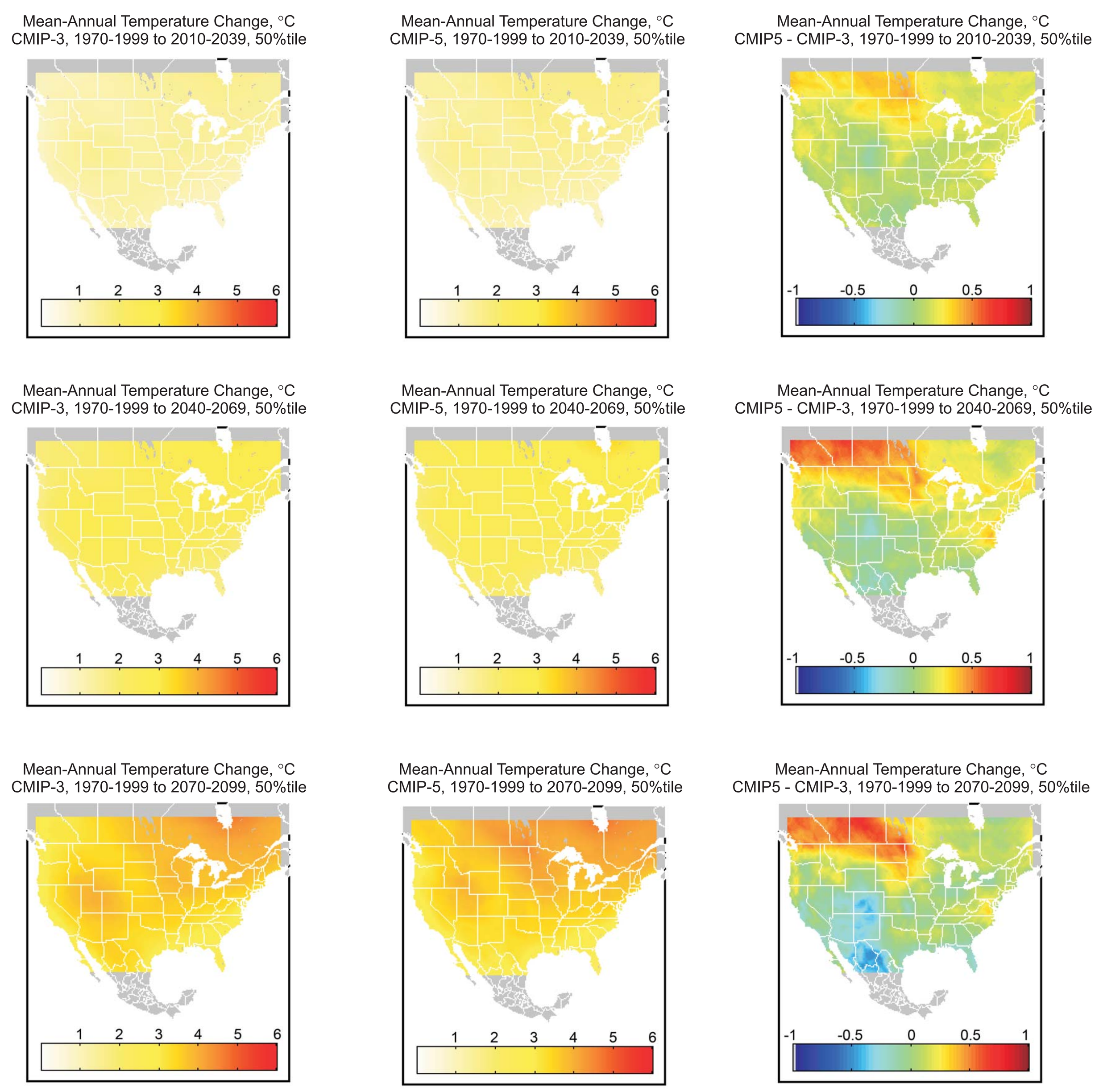
At the larger scale, CMIP5 and CMIP3 median changes are similar.

At the local scale, there are minor differences, but generally less than 0.5 °C.

Summary:

These results show that the CMIP5 and CMIP3 "ensembles of opportunity" express generally similar changes over large areas, but sometimes significantly different changes for more local regions.

The next level of inquiry is to understand why this is the case. Two potential factors are that CMIP5 projections are developed using a different collection of models - representing recent climate science advancements – and are forced by a collection of new climate forcing scenarios (Representative Concentration Pathways). Attributing the differences between CMIP5 and CMIP3 to these two factors remains a matter of research.



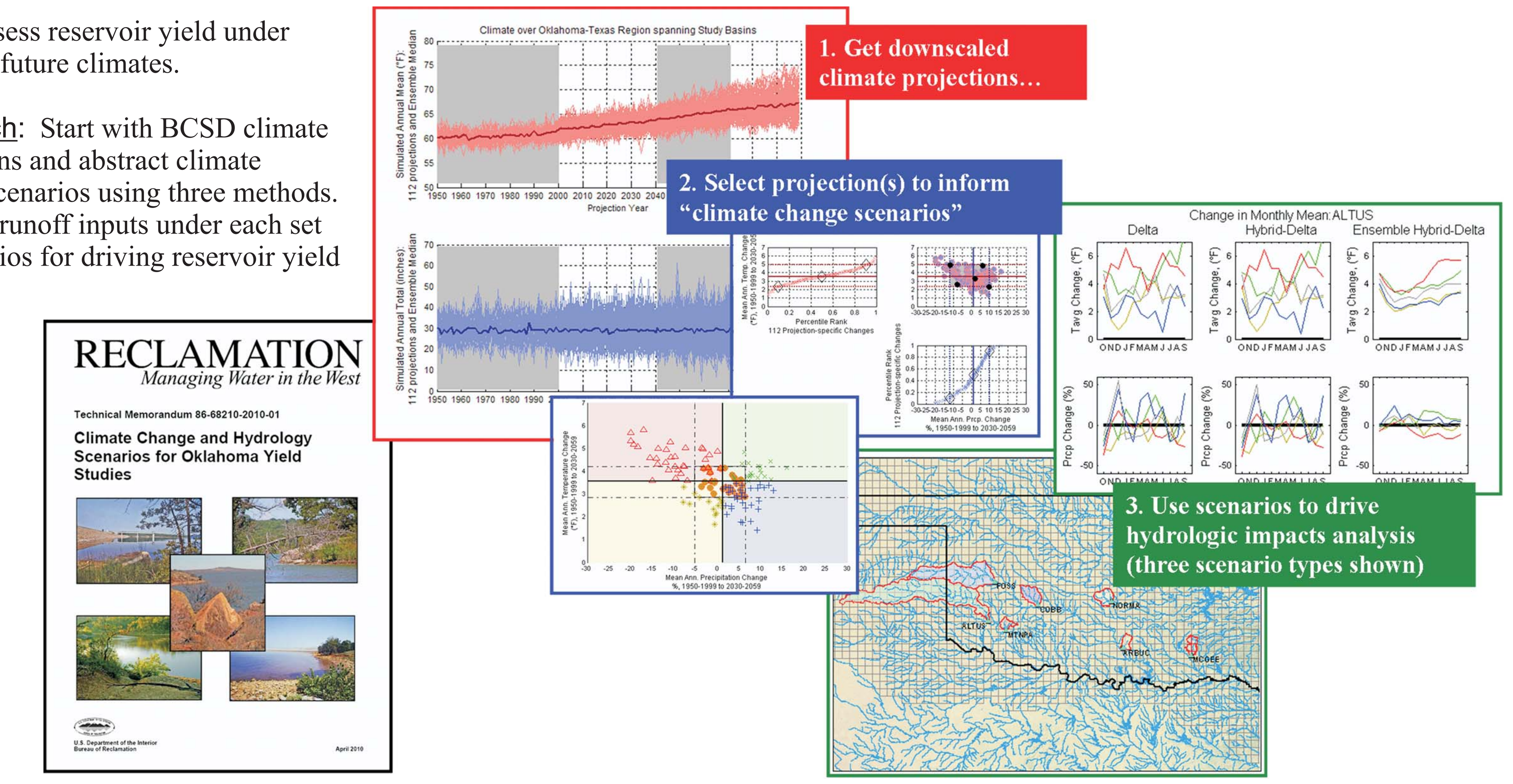
Applications (example studies informed by CMIP3)

Period-Change Analysis: Climate Change →Hydrology and Yield Response

(Reclamation 2010)

Goal: assess reservoir yield under different future climates.

Approach: Start with BCSD climate projections and abstract climate change scenarios using three methods. Develop runoff inputs under each set of scenarios for driving reservoir yield analyses.

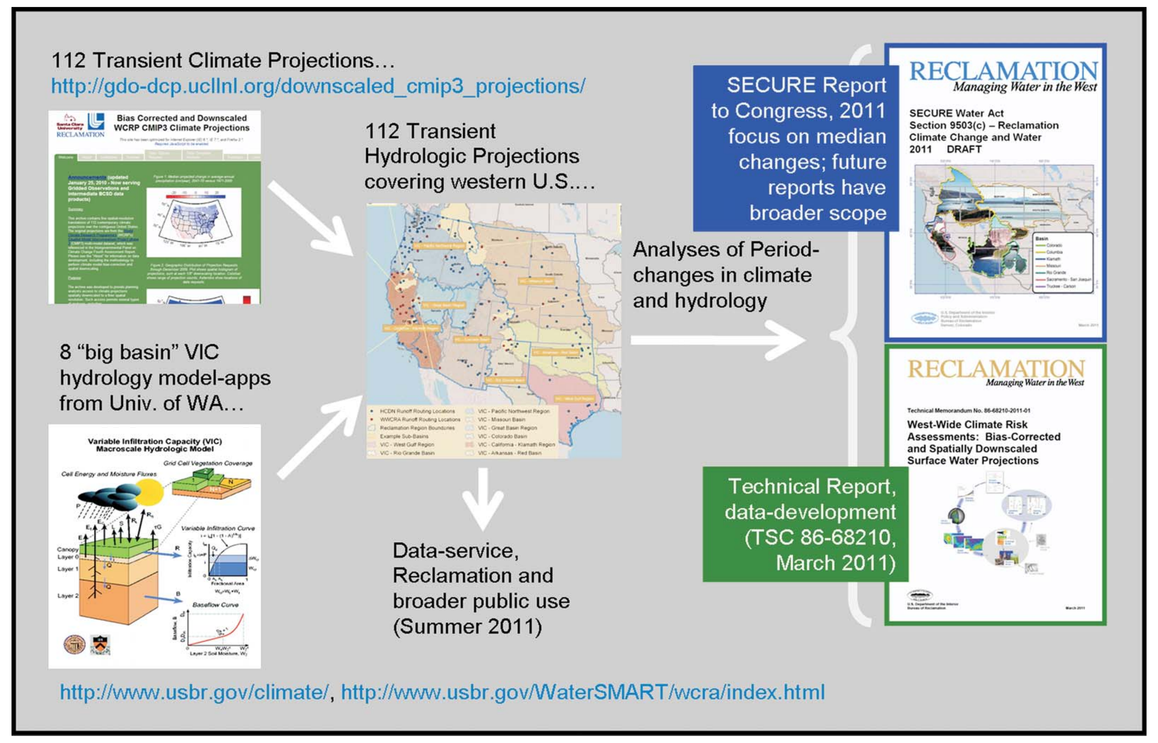


Transient Analysis: Climate, Hydrology, and Operations Projections

(Reclamation 2011b):

Goal: consistently evaluate hydrology and water supply impacts under projected climate conditions for western U.S. river basins.

Approach: Start with BCSD climate projections and apply VIC hydrology models provided by University of Washington to translate BCSD climate projections into hydrology projections (Reclamation 2011a). Use results to support SECURE reporting (Reclamation 2011b). Make results publically available to support planning, research and educational activities (see Content).



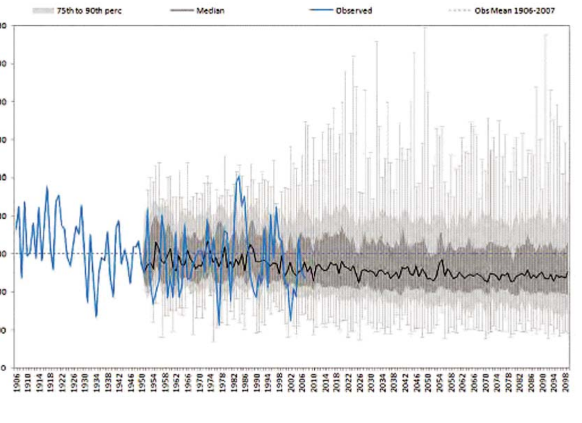
(Reclamation 2012a,b):

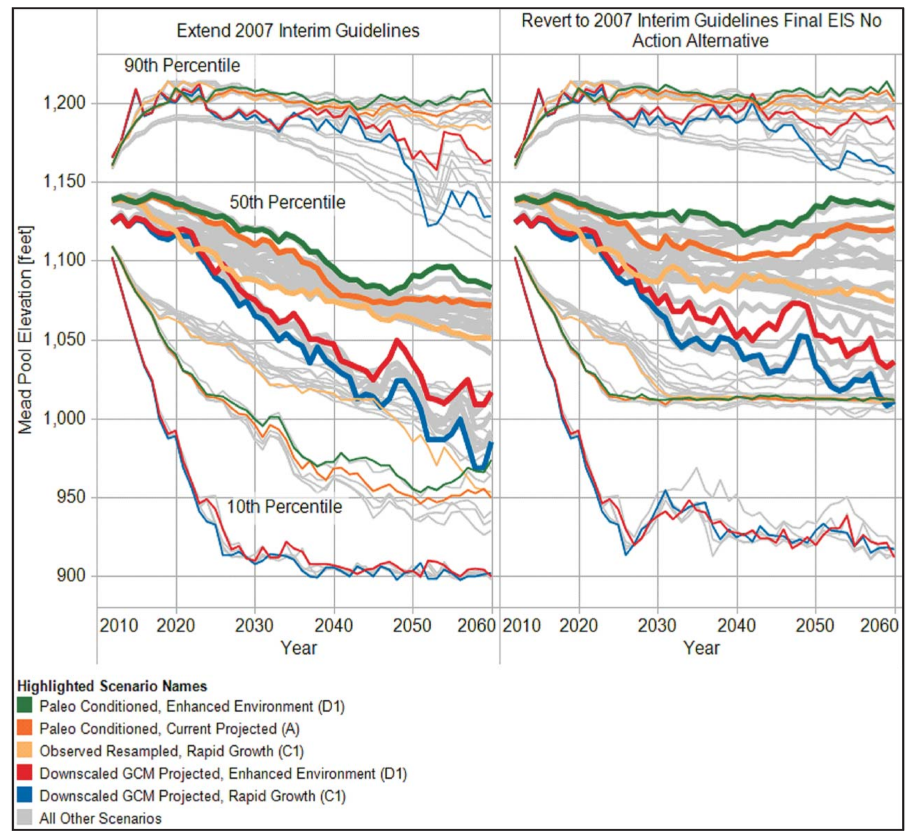
Goal: Characterize current and future water supply and demand imbalances in the Colorado River Basin resources, considering multiple drivers including climate change.

Approach: Use hydrologic projections from Reclamation (2011a) in poly-climate context for characterizing future water supplies (i.e. considering paleoclimate, instrumental records and projected climate information (Reclamation 2012a). Carry information forward, translating hydrologic projections and demand scenarios into operations projections and assessement of system reliability (Reclamation 2012b).

http://www.usbr.gov/lc/region/programs/crbstudy.html

*(**Reclamation 2012b**): (Figure B-46), Colorado River at Lees Ferry, Arizona Natural Flow Statistics for the "Downscaled GCM Projected Scenario" as Compared to Observed Flow (Median (line), 25th–75th percentile band (dark shading), 10th–90th percentile band (light shading), max/min (whiskers), and 1906–2007 observed (blue line).*





*(**Reclamation 2012b**): (Figure G-6) 10th, 50th, 90th Percentiles for Lake Mead End-of-December Pool Elevation under different hydroclimate and demand conditions. Hydrologic projections inform results labeled "Downscaled GCM Projected, …".*