RECLAMATION
Managing Water in the West

U.S. Department of the Interior
Bureau of Reclamation

Western Water and Power Solution Bulletin

Bulletin No. 16
August 2008

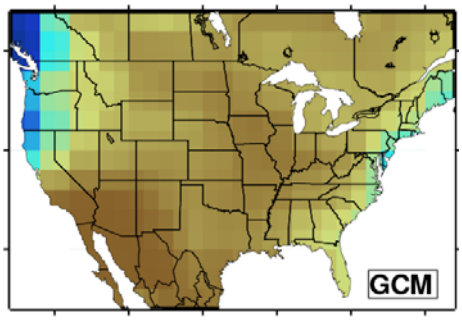
Research and Development Office — Denver, Colorado

Downscaling of Global Climate Model Projections

Projecting Temperature and Precipitation Conditions at a Fine Scale for Planning and Other Analyses

What Is The Problem?

Global climate models (GCM) are used to simulate future temperature and precipitation conditions based on scenarios of increasing greenhouse gas emissions. Such global "projections" have low spatial density and are inadequate for evaluations of local and regional impacts. In fact, GCM's typically simulate temperature, precipitation, and other climate conditions at a spatial resolution of at least 2^o latitude/longitude (approximately 125x125 miles), meaning that each predicted value represents an area of approximately 15,625 square miles. Past observations show that conditions can vary significantly within such an area. Another issue limiting the application of GCM climate projections is that GCMs have tendencies to be too warm or cool, and/or too wet or dry, when simulating the past (i.e. they have model "bias") which implies future projections bias.

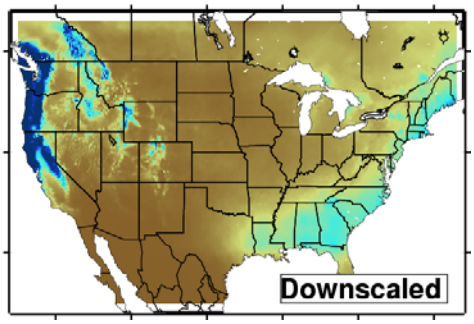


What Is The Solution?

Through collaboration with U.S. Department of Energy's National Energy Technology Laboratory (DOE NETL), Santa Clara University, Lawrence Livermore National Laboratory (LLNL), and University of California's Institute for Research on Climate Change and Its Societal Impacts (IRCCSI), Reclamation has applied proven techniques to bias-correct and spatially "downscale" a large collection of contemporary GCM projections into finer-scale translations. The resultant dataset features bias-corrected and spatially "downscaled" monthly temperature and precipitation projections during a 1950-2099 period, and on a $1/8^o$, or about 7.5-mile, grid covering the continental U.S. With the resolution increased by 256 times, each value represents an area of approximately 56-square miles

A total of 112 unique climate projections from 16 different GCMs were bias-corrected and downscaled. The bias correction involves comparing a specific model's simulation of temperature and precipitation during a historic period to those observed. GCM tendencies are computed and used to correct, or shift, projection values. The bias corrected projections are then downscaled.

The downscaling process uses interpolation to translate the GCM projected "changes" in temperature and precipitation (historical to future) computed on a common low-density grid (2^o) to the higher-density counterpart ($1/8^o$) maintaining the same historical pattern. Hence the resulting downscaled future projections are based on the assumption that past high-density patterns are partially preserved in the future.



The downscaled climate model projections are available at http://gdo-dcp.ucllnl.org/downscaled_cmip3_projections/. The web-service supports custom data-selections by GCM, emissions scenarios, time periods, initial conditions and geographical areas Methods are discussed and references on the method origins are provided. While Reclamation and its collaborators believe the information to be reliable, human or mechanical error are possibilities. Specific limitations are discussed at the website.

Who Can Benefit?

Researchers and decision-makers can use the downscaled projections to evaluate potential future climates, assess societal impacts, and explore adaptation options.

Future Development Plans

Future GCM projections and/or projected variables will be incorporated as they become available. Also, a proposal to expand archive content (e.g., computed drought indices based on projected temperature and precipitation and projected monthly average-day temperature min and max) is under consideration.

More Information

Relevant global climate model related websites include:
http://www-pcmdi.llnl.gov/projects/cmip/index.php
http://www.clivar.org/organization/wgcm/wgcm.php

Contact Information

Levi Brekke, PhD, P.E. Reclamation Technical Service Center
303-445-2494 lbrekke@do.usbr.gov

Collaborators

Reclamation Science and Technology Program, DOE NETL, Santa Clara University, LLNL Green Data Oasis, and University of California IRCCSI