Climate Change Projection for the Department of Energy's Savannah River Site

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As per recent Department of Energy (DOE) requirements for long-term operational sustainability, the Savannah River National Laboratory (SRNL) is developing a climate projection for the DOE's Savannah River Site (SRS) in Aiken, SC. This will comprise data from both a statistical and a dynamic downscaling process, each interpolated to the site.

For the statistical downscaling, we use global climate model (GCM) data from the Climate Model Intercomparison Project, version 5 (CMIP-5), which was used in the IPCC Fifth Assessment Report (AR5). GCM data from five research groups was selected, and two climate change scenarios – RCP 4.5 and RCP 8.5 – are used with observed data from site instruments and other databases to produce the downscaled projections.

We apply a quantile matching downscaling method, which involves the use of the observed cumulative distribution function to correct that of the GCM. This produces a downscaled projection with an interannual variability closer to that of the observed data and allows for more extreme values in the projections, which are often absent in GCM data.

The methods used suggest that a major concern at SRS is the projection of more hot and humid days, which could impede outdoor work on site. The models were generally in agreement that temperatures will rise, and specific humidity will naturally rise along with it. There is less agreement with regards to changes in precipitation, with the overall trend towards greater rainfall at SRS.

Figure 1 Location of the Savannah River Site.

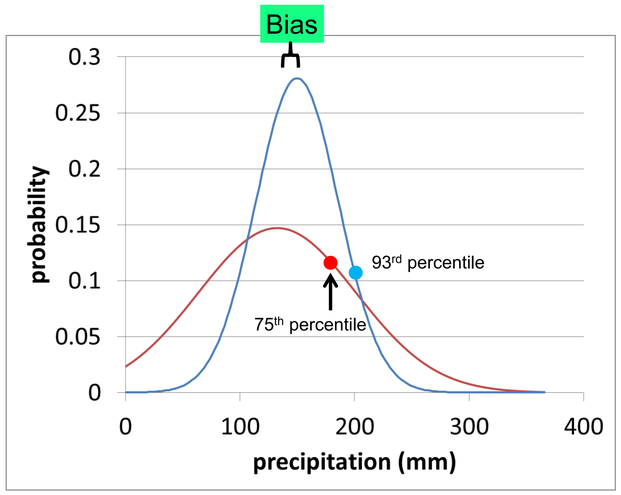


Figure 2 Probabilistic distribution function of July monthly precipitation (mm) for the CESM GCM values (blue) and the observations (red), both at SRS. The circles represent the mean + 50mm. Not only are the GCM values too high, but the distribution is too narrow, making the 50mm deviations less likely in the GCM than is observed.

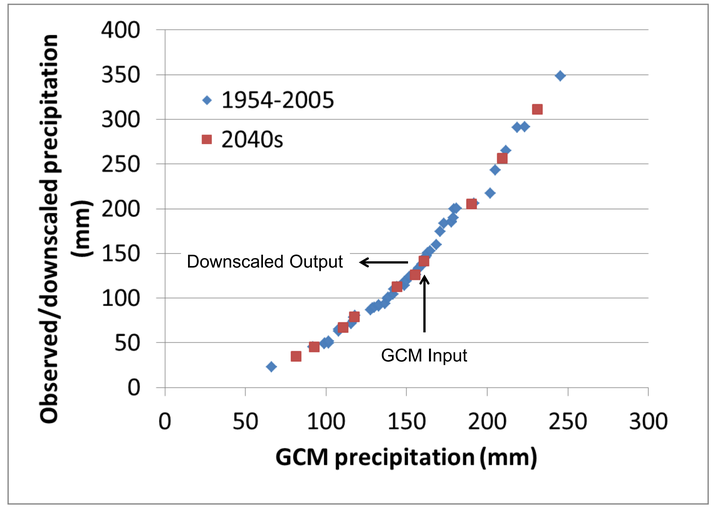


Figure 3 Scatterplot of the observed vs. GCM precipitation ranked July monthly precipitation values, along with the 2040-2049 values interpolated to the curve.

Model	Organization	Number of Realizations
CCSM4	NCAR	3
Can-ESM2	Environment Canada	4
GISS-E2-H	Goddard Inst. Space Studies	4
MPI-ESM-LR	Max Planck Inst.	3
CESM	NOAA/DOE	3

Table 1 Global climate models (GCMs) from which data at SRS was extracted. Note that we have a total of 17 simulations of each forcing scenario.

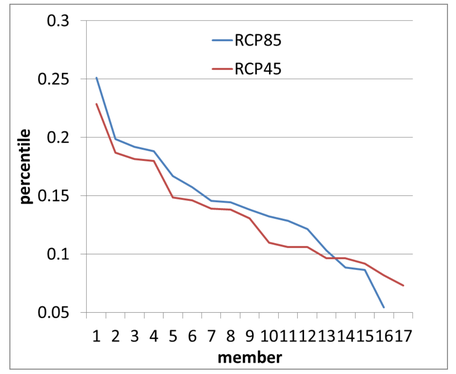
Two Future Scenarios

Representative Concentration Pathways (RCPs)

Greenhouse gas concentration trajectories adopted by the IPCC for its fifth Assessment Report (AR5).

RCP4.5 = +4.5 W/m^2 in 2100

RCP8.5 = +8.5 W/m^2 in 2100



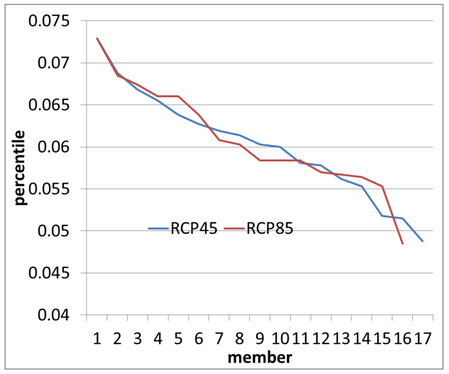


Fig. 4 Left) Fraction of days at SRS from 2040-2049 with daily maximum temperature above the 95th percentile for the downscaled GCM data for all 17 simulations. Right) Fraction of days at SRS from 2040-2049 with precipitation above the 95th percentile for the downscaled GCM data for all 17 simulations.

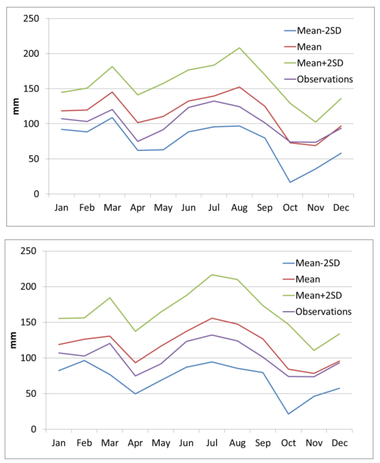


Figure 5 Precipitation annual cycle at SRS averaged over 2040-2049 for the downscaled GCM data for all 17 simulations for (top) the RCP4.5 scenario, and (bottom) the RCP8.5 scenario.

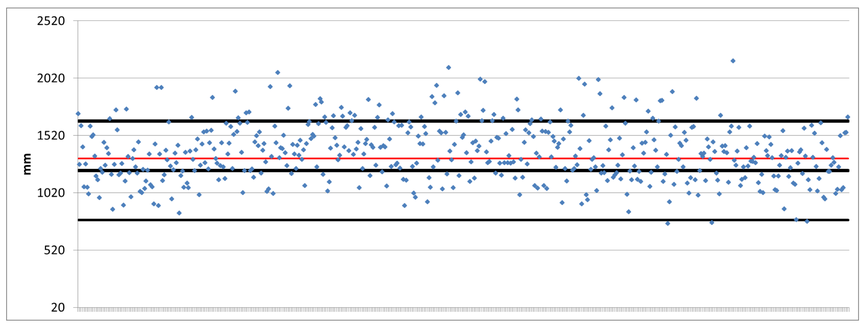


Figure 6 Annual total precipitation for all 510 downscaled-GCM years (17 simulations x 30 years each), for RCP4.5, along with the mean (red line) and the observed mean+/-2 standard deviations (black lines).

Summary

1) Global climate model data was 'downscaled' to provide a climate projection for the Savannah River Site.
2) The trend into the 21st century is towards warmer and wetter conditions.
3) The possibility and consequences of flooding onsite is currently under investigation.

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