Freeman, F. W. 1993. Down-scaling coarse-resolution GCM output to the local-scale for surface runoff, temperature, and precipitation. Ph.D. dissertation. University of California. Los Angeles, California. 408 pp.

The relationships between local-scale hydrologic data and large-scale hydrologic and climatic data are explored using a multiple linear regression model. The predictands are local-scale runoff, temperature, and precipitation measured at individual gauging stations. The predictors are large-scale area averages of runoff, temperature, precipitation, height to the 500-mbar pressure surface, and the zonal and meridional gradients across this surface. A separate regression equation was calibrated for each local-scale predictand, for each gauging station, and for each calendar month. Once the model was calibrated and verified, the large-scale predictors were replaced with GCM simulated values for a CO_2 doubled climate. Solving these equations provided down-scaled values of the predictands for the climate scenario employed by the GCM. Down-scaled values were plotted and contoured to reveal local-scale features. Model performance statistics were retained for each regression and were also plotted to reveal the spatial variability of the model's performance. Model performance was improved for the runoff regressions by screening, transforming, and temporally lagging the observed predictor variables.
The domain space investigated was the southwestern United States, with detailed attention given to the Sacramento and the Upper Colorado River Basins. The data set contains 41 years of monthly values (1948 through 1988) and includes 152 streamflow stations (which provide the runoff data) and 268 combined temperature and precipitation stations. The series length was kept intact by verifying the model with the subsample replacement method of predicted residual sum of squares, or PRESS.
The explained variance of the regression model displayed spatial and temporal differences. For the Sacramento River Basin the explained variance ranged from 60 to 87% for runoff, 72 to 90% for temperature, and 46 to 78% for precipitation. Results for the Upper Colorado River Basin were slightly lower. Overall, the highest explained variance occurred during the winter and spring months. The predictor accounting for most of the explained variance was typically the same variable used as the predictand. Down-scaled values from the regression model also displayed temporal and spatial differences. Spatial variation increased for areas with varied topography.