OAK RIDGE NATIONAL LABORATORY
MANAGED BY UT-BATTELLE FOR THE DEPARTMENT OF ENERGY
FACT SHEET

Geographic Information Science and Technology

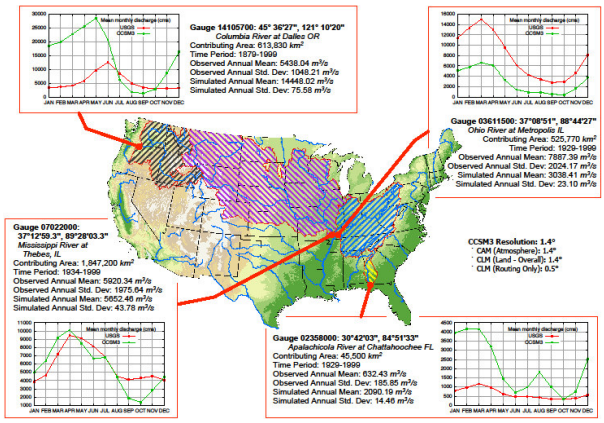
Climate Change Impacts on Water Resources and Hydraulic Infrastructures

From Climate Science to Impacts on the Water Sector

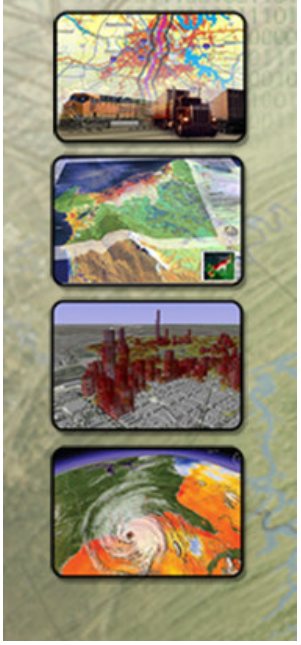
The IPCC suite of global climate models used for their Fourth Assessment Report (AR4) were designed for climate change projections and attributions at continental to global scales in space and over multi-decadal to century scale time horizons. However, as mentioned in a 2010 article in the journal Nature, two of the four remaining *real holes in climate science* are regional prediction and precipitation. Unfortunately, our ability to produce credible assessments for water resources and hydraulic infrastructure managers intersects both the holes. However, while the science of climate is rapidly improving to address this critical requirement, long-standing challenges like cloud microphysics and boundary layer effects which influence precipitation processes may remain. Thus, precipitation changes at regional scales and convective activity remains hard to predict. On the other hand, precipitation extremes show significant skills at aggregate scales, because there is a relatively simple relation that governs the water holding capacity of an atmospheric column to the temperature, which in turn is better predicted than precipitation. Precipitation mean and extreme processes exhibit different predictive skills depending on seasonality, regions of interest, precipitation generating mechanism and other criteria. While precipitation is the primary forcing to models of hydrology and their uncertainties propagate to hydrologic variables like streamflow and soil moisture, additional uncertainties in our understanding of hydrology and in our ability to estimate hydrologic parameters further complicates the problem. A translation of hydrologic prediction to risk indices of relevance to water resources and hydraulic infrastructure managers poses additional challenges.

Technical Approach

We have developed approaches to translate global climate change and natural climate variability to regional scale assessments on water resources and hydraulic infrastructures together with their uncertainties. Changes in mean precipitation processes are corrected for bias and characterized in terms of their variability by comparing among multiple climate model ensembles in the future as well as between model hindcasts and observations or reanalysis data sets in the past. The attributes of precipitation extremes, for example, intensity-duration-frequency (IDF) curves, are computed based on extreme value theory or other methods, with bias and uncertainties characterized in a similar fashion. The corresponding variables from hydrologic models are characterized for bias and uncertainty. For infrastructure managers, the computed IDF values are translated to risks based on a geospatial-temporal index that measures the degree of surprise and provides the likelihood or hazard component, together with potential consequences on population. For water resources managers, population projections are explored in conjunction with changes in land wetness (e.g., streamflow or precipitation minus evaporation). The most likely projections and confidence bounds can inform what-if scenarios for decision support.



Streamflow from a global climate model (CCSM3)



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