EGU21-517
https://doi.org/10.5194/egusphere-egu21-517
EGU General Assembly 2021

Stochastic watershed models using a logarithmic transformation of ratio residuals

William Farmer[1], Ghazal Shabestanipour[2], Jonathan Lamontagne[2], and Richard Vogel[2]
[1]U.S. Geological Survey, APB, Denver, Colorado, United States of America (wfarmer@usgs.gov)
[2]Tufts University, Medford, Massachusetts, United States of America

There is an increasing need to develop stochastic watershed models using post-processing methods to generate stochastic streamflow ensembles from deterministic watershed models (DWMs). Stochastic streamflow ensembles are needed for a wide variety of water resource planning applications relating to both short-term forecasting and long-range simulation. Current methods often involve post-processing of ordinary, differenced residuals defined as the difference between the simulations (S) and observations (O). However, ordinary, differenced residuals from daily and sub-daily DWMs exhibit a high degree of non-normality, heteroscedasticity, and stochastic persistence leading to the need for extremely complex post-processing methods. Using deterministic simulations of daily streamflow at over 1,400 sites across the United States, we document that logarithmically transformed ratio residuals – defined as the natural log of the quotient of S divided by O – are approximately homoscedastic, are approximately normally distributed, and can be well-represented as an autoregressive process. These characteristics make them preferable to ordinary, differenced residuals for post-processing DWMs. Though issues with seasonal fluctuation and long-term persistence are not fully resolved, this simple transformation addresses much of the stochastic complexity of the residuals from a deterministic watershed model and produces streamflow ensemble simulations that more accurately replicate essential elements of the statistical distributions of streamflow (including design events, higher-order moments and extreme values). The use of this transformation and autoregressive models demonstrates that more accurate stochastic modeling of natural resources phenomena can be achieved with relatively elegant solutions to support natural resource management in the past, present and future.