Geophysical Research Abstracts
Vol. 13, EGU2011-9897, 2011
EGU General Assembly 2011

Model calibration in the spectral domain: opportunities for model development and confusion

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Although spectral methods remain relative uncommon in catchment hydrology, there are several application areas, in particular, karst hydrology, where model performance is assessed in the spectral domain. Here, instead of tuning the model parameters to reproduce the observed system behaviour directly in the time- and/or space- domains, the model output and the reference samples are first transformed to the spectral domain, followed by optimization of some performance metric based on the transformed data. The switch from the original (time or space) domain to a spectral domain is usually accomplished by applying a Fourier Transform and some normalization to the modeled and observed series. While the application of this transform is numerically straightforward (through the use of Fast Fourier Transform algorithms), the interpretation of calibration results obtained in the spectral domain can be counter-intuitive, and requires some digging into a mathematical field where engineers and mathematicians speak different languages, creating room for confusion on both sides.

In this contribution, we review several key assumptions and technical aspects underlying spectral analysis methods, before discussing the opportunities it offers for the development and calibration of catchment models. These include the definition of new types of modeling errors, the detection of model structural errors, or model calibration in the absence of concomitant input-output time series.