IAHS2017-291
IAHS Scientific Assembly 2017

Do small-scale hysteretic processes affect the larger-scale behavior of watersheds?

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Hysteresis is a widely observed phenomenon in hydrology and beyond, at a range of spatio-temporal scales. Despite significant research efforts, hysteretic behaviors and their implications for hydrologic modelling and prediction have remained poorly defined and understood. The current state of the art is that almost all practical models in use do not include any hysteretic components or relationships that directly represent such behaviors. Using existing strategies for hysteresis modeling from other disciples, we evaluate to what extent the addition of hysteretic components to a hydrological model (such as soil moisture and soil suction head – soil hydraulic conductivity) would change the model performance and associated uncertainties. Our analyses also show that a properly designed model structures can largely compensate for the lack of hysteretic components in models and allow mimicking the observed hysteretic behaviors.