Geophysical Research Abstracts
Vol. 17, EGU2015-4267, 2015
EGU General Assembly 2015

Using tracer data to develop parsimonious process-based rainfall-runoff models

Christian Birkel (1,2), Chris Soulsby (2), and Doerthe Tetzlaff (2)

(1) University of Costa Rica, Department of Geography, San Jose, Costa Rica, (2) University of Aberdeen, School of Geosciences, Northern Rivers Institute, Aberdeen, United Kingdom (c.birkel@abdn.ac.uk)

The development of parsimonious hydrological models is challenging, but key to learning about the dominant processes of catchment function. How simple or complex a model should be and how much belief can we have in our models needs critical assessment. In this paper, we present insights from experimental work in an upland catchment in northern Scotland that was used in the step-wise conceptualization of process-based, low parameter hydrological models. Different model structures of varying complexity were tested and conditioned based on geomorphic landscape units such as hillslope and riparian saturation areas that also coincide with the main soil types (podzols on the hillslopes and histosols in the saturation area). The observed non-linear runoff generation from saturation overland flow was linked to the dynamic expansion and contraction of the saturation areas connected to the stream network. Empirical maps of the spatial extent of saturation areas during different catchment wetness conditions were used to conceptualize such hydrological connectivity. This connectivity concept was directly implemented into a dynamic model structure. Additionally, stream samples were collected and analysed for the source tracer alkalinity, which showed a characteristic relationship with discharge. This flow-concentration curve was directly used in the model to constrain simulations towards matching low alkalinity values mainly originating from near-surface runoff generation processes during high flow conditions and high alkalinity values from increasing groundwater contributions during drier periods. The model therefore performed an internal hydrograph separation to match the dominating observed water sources. The resulting process-based, five parameter model is based on the dominant process concept reflecting the major landscape units which are dynamically connected. This model showed promising simulation results, which could additionally be constrained against hydrochemical data and groundwater level measurements. The model further evolved through the incorporation of isotope tracer dynamics that enabled catchment storage estimates. We conclude that the step-wise development of simple, low-parameter models that can be constrained against empirical data advance learning about catchment functioning and get us closer to develop models that work for the “right reasons” additionally to reproducing the stream hydrograph.