Geophysical Research Abstracts
Vol. 20, EGU2018-7267-2, 2018
EGU General Assembly 2018

Estimating the value of hydrodynamic and hydrochemical signatures to identify subsurface storm flow

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At many catchments, subsurface storm flow is an important component of the stream flow. Especially during wet periods, it determines the shape and peak value of the rainfall-runoff reaction. Although there has been considerable research to explore and conceptualize subsurface storm flow processes at the hillslope scale, a lack of adequate monitoring and analysis schemes still hampers understanding its dynamics at the catchment scale.
This study explores the value of hydrodynamic and hydrochemical signatures to identify subsurface storm flow. Hydrological signatures transform observations into metrics that describe different aspects of the dynamics of a hydrological system. For instance, different parts of the flow duration curve would describe the high flow, medium flow or low flow dynamics. The hydrological data for our study originates from a small forested catchment which is located in the mountainous north of South Korea and subject to a monsoon season between June and August. Observations in this catchment have indicated a strong subsurface storm flow component.
We hypothesize that signatures can also be used to describe the subsurface storm flow dynamics of our study site. To identify the information content of different hydrological signatures, we use a modeling approach. We select a range of typical hydrodynamic signatures expanded by a set of hydrochemical signatures that reflect dilution and enrichment processes due to the different sources of runoff. Using a newly developed water chemistry-enabled version of the process-based HBV model and a Monte Carlo-based sensitivity analysis scheme, we show that hydrodynamic signatures alone do not provide unique information about the simulated subsurface storm flow processes. But when the hydrochemical signatures are included, the modelled subsurface storm processes are much better identifiable.
With our study, we show how hydrochemical signatures can be used to improve the simulation of subsurface storm flow at the catchment scale. Furthermore, the mutual use of hydrochemical signatures and modeling provides a promising direction to finally explore the dynamics of subsurface storm flow at the catchment scale.