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Linking hydrological signatures to hydrological processes and catchment attributes: a flexible approach applied to baseflow signatures

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Hydrological signatures aim at extracting information about certain aspects of hydrological behaviour. They can be used to quantify hydrological similarity, to explore catchment functioning and to evaluate hydrological models. Relating hydrological signatures to hydrological processes is, however, still a challenge and many signatures remain poorly understood.

We propose a flexible approach for linking hydrological signatures to hydrological processes, which might help to improve our understanding and hence the usefulness of certain hydrological signatures. As a first step, we should build a perceptual model describing the hydrological process of interest. We should then try to find or create relevant – and ideally widely available – catchment attributes that target the process of interest, and hence have the potential to explain the signature in a process-based way. We should control for climate by either incorporating it into our perceptual model or by analysing sub-climates individually, to disentangle the influences of forcing and catchment form. Lastly, simple conceptual models might be a useful tool to systematically explore the controlling factors (parameters, forcing) of a signature. Focusing on hydrological processes and explaining hydrological signatures in a process-based way will make hydrological signatures more meaningful, useful and robust.

The proposed approach is tested on signatures related to baseflow and groundwater processes, such as the baseflow index. Baseflow generation has been studied extensively, and while many regional studies could identify landscape controls on baseflow generation (e.g. soils and geology), continental or global studies have resulted in a less clear picture, partially because of the masking influence of climate at these scales. Furthermore, the relationship between controls, such as climate and catchment form, and baseflow response has often been only described statistically (e.g. by means of regression-type approaches). A mechanistic theory based on widely available catchment attributes (e.g. soils, geology, topography) would thus be a major step towards improved understanding and transferability.