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Analysis of spatial flow patterns across the Indian subcontinent via multi-basin hydrological modelling

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Abstract
In here, we use examples from the recent HYPE hydrological model set-up across 6010 subbasins for the Indian subcontinent, named India-HYPE v1.0 (Pechlivanidis and Arheimer, 2015), and demonstrate the potential of multi-basin modelling for process understanding and comparative hydrology. We analyse the flow characteristics in all modelled 6010 subbasins and group them based on similarities in 12 flow signatures to gain insights in spatial patterns of flow generating processes. We applied a k-means clustering approach within the 12-dimensional space (consisting of the 12 calculated flow signatures) to categorise the subbasins based on their combined similarity in flow signatures. To highlight the hydrological insights gained during model identification, we conducted the clustering analysis on two different steps of the model calibration and explored the sensitivity of calibration on the spatial patterns of flow signatures. Analysis resulted into six different classes of varying size with different distribution in signatures. Although the classes are geographically distinct, their flow response is dependent on the physiographic and climatic characteristics at the regional scale. Factors including for instance the dominance of snow/ice processes, volume in precipitation and evaporation rates affect the catchment functioning and hence drive the clustering. Catchments in the Himalayan region and the Western Ghats respond similarly and are characterised by high mean annual specific runoff values and variable flow regime. Response of the catchments in the tropical zone is characterised by high peaks, while catchments in the dry regions show very strong flow variability and respond quickly to rainfall. Finally, model parameterisation can affect the spatial pattern of clusters in terms of catchment functioning. In particular, clusters after calibration seem to have a consistent spatial structure; this also justifies the validity of parameter regionalisation approaches based a spatial proximity between catchments.

Keywords
Multi-basin modelling, large-scale hydrology, HYPE, flow signatures, spatial patterns, India

References
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