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Exploring elevation zone similarity in large case studies for the semi-distributed regionalisation of the HBV model parameters

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The study aims to propose and test the performance of a group of techniques for transposing rainfall-runoff model parameters to ungauged catchments, especially adapted to the semi-distributed structure (the catchment is split into different altitude zones) of the HBV-based TUWien model.

The methods are tested for two large, but deeply different, datasets: the first is a very densely gauged set of more than 200 catchments across Austria, while the second refers to more than 500 US watersheds (part of the CAMELS dataset) covering most of the country, including wider variety of hydrological conditions and catchment characteristics.

The potential of the semi-distributed structure is fully exploited: first in the model calibration, where, differently from the typical application of the model, the parameters controlling the runoff generation are allowed to vary over the different elevation zones.

Secondly, in the regionalisation procedure, the parameters of each specific altitude zone in any ungauged catchment are estimated based on the parameters obtained for the same altitude zones of the donors. The rationale is to implement a procedure that operates at sub-basin level, in order to have a better simulation of the different hydrological processes taking place at different altitudes.

The set of regionalisation approaches includes both i) “parameters averaging”, where each parameter is obtained as a weighted (according to donors’ similarity) average of the parameters of the donor catchments (independently from each other) and ii) “output averaging”, where the model is run over the ungauged basin using the entire set of parameters of each donor basin and the simulated outputs are then averaged to estimate the target simulated streamflow.

The measure of similarity needed for implementing the regionalisation procedure is of course applied at sub-basin scale, testing geo-morphological and climatic catchment descriptors characterising the elevation bands. One of the main focus is the study of such similarity in order to assess which attributes are more influential at different altitudes.

The performance of the proposed approaches and similarity measures is assessed by jack-knife cross-validation against the observed daily runoff for all the study catchments.

Finally, the resulted regionalisation efficiencies are compared to those obtained by applying the same methods with the typical lumped calibration-regionalisation procedure, thus assessing the potential of the semi-distributed regionalised parameterisation.