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Geostatistical enhancement of macro-scale runoff simulations

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This study presents the results of the research experiment Geostatistical Enhancement of European Hydrological Prediction (GEEHP). GEEHP is developed within the EU funded SWITCH-ON project, which proposes to conduct collaborative experiments in a virtual laboratory in order to share water-related information and to tackle changes in the hydrosphere for operational needs (http://www.water-switch-on.eu). The main objective of GEEHP is to develop a simple and easy-to-apply technique for locally enhancing the performance of macro-scale rainfall-runoff models on the basis of observed streamflow data available at nearby streamgauges, without re-running computationally intensive rainfall-runoff simulations. The experiment relies upon the prediction of regional period-of-record flow-duration curves (FDCs) by means of a geostatistical procedure based on Top-kriging, which has been recently shown to be particularly reliable for the regionalization of FDCs. The procedure developed employs two different types of daily streamflow data collected in a limited portion of territories centred in Tyrol (Austria and Italy): large-scale rainfall-runoff model simulation series (EHYPE, http://hypeweb.smhi.se/europehype) and observed series from 46 gauged catchments. The first phase of the experiment required the implementation and cross-validation of the geostatistically-based regional model over the study area, capable of predicting FDCs in ungauged sites. Cross-validation results showed good overall performances of the regional model, with an average Nash-Sutcliffe efficiency on log-flows (LNSE) equal to 0.898 over the entire river network in Tyrol. In a second phase, we selected 11 target catchments within the study area, for which both EHYPE simulations and observed data were available over the period 1980-2010. Then, we computed residuals between Top-kriged FDCs and FDCs constructed from simulated streamflow series, and, finally, we used these residuals for enhancing simulated time-series at target sites. The application of the enhancement procedure reveals a significant improvement of simulated daily streamflow time-series, with an LNSE value that varies from -0.462 (original EHYPE simulation) to 0.401 (geostatistically-enhanced simulation) for the worst case among the 11 target catchments.