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Performance benchmarking of large-scale models with observations from unregulated streamflow records across Europe

Kerstin Stahl (1,2), Lena M. Tallaksen (1), and Lukas Gudmundsson (1)

(1) Dept. of Geosciences, University of Oslo, Norway (kerstin.stahl@geo.uio.no), (2) Inst. of Hydrology, University of Freiburg, Germany

High-resolution regional climate models and coupled or off-line land surface models routinely provide the basis to study regional patterns of future changes in large-scale hydrology. Hence there is a great need for the validation of simulated characteristics of spatial and temporal runoff dynamics with independent observations. Employing a pan-European data set of over 400 records of unregulated streamflow assembled from the updated European Water Archive and various national agencies provides an opportunity for such an analysis and allows testing the limits of interpretability of spatial and temporal runoff dynamics from large-scale models. The observed records were compared to a high-resolution European re-analysis as well as other land surface model experiments performed for the EU-WATCH project for the time period 1964-2002. For this purpose we first transformed all daily records into their daily percentile series to obtain series of non-parametric anomalies. The agreement between modelled and observed anomalies was investigated by means of correlation analysis as well as by analyzing spatio-temporal patterns of the error field by means of principal component analysis. The general patterns at the European scale were found to agree well. However, the results also allow a more detailed analysis of differences that are particularly pronounced during drought periods. Identifying regions as well as time periods where and when these differences are significant will assist evaluating the reliability of predictions of hydrological change at different scales and suggest specific modifications in model concepts.