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Comparison of regional approaches to modelling probabilities of heavy precipitation

Jan Kysely (1), Ladislav Gaal (1,2), and Jan Picek (3)

(1) Institute of Atmospheric Physics, Prague, Czech Republic (kysely@ufa.cas.cz), (2) Slovak University of Technology, Bratislava, Slovakia, (3) Technical University, Liberec, Czech Republic

Several approaches to estimating distributions of precipitation extremes are compared by means of simulation experiments, and their applications into observed data in the Czech Republic are evaluated. Regional frequency models, which take into account data in fixed or flexible 'regions' when fitting a distribution at any site, lead to estimates with much smaller errors compared to a single-site analysis, and efficiently reduce random and climatologically irrelevant variations in the estimates of the model parameters and high quantiles. The region-of-influence methodology with a built-in regional homogeneity test is recognized as the superior approach that outperforms the Hosking-Wallis regional frequency analysis. Comparison of estimates of the return period of a heavy precipitation event on June 24, 2009, which triggered a disastrous local flash flood, illustrates that the at-site analysis leads to unrealistic and extremely uncertain estimates that strongly depend on whether or not a single outlying observation is involved in the sample, while all regional methods yield return periods in the same order of several hundreds of years, notwithstanding whether the 2009 data is included in the sample or not. The region-of-influence method may be found useful for modelling probabilities of other meteorological variables, extremes of which are strongly influenced by sampling variability, and may also represent an efficient tool for 'smoothing' random variations in the estimates of model parameters and high quantiles of precipitation in high-resolution regional climate model simulations.