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Large-scale derived flood frequency analysis based on continuous simulation

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There is an increasing need for spatially consistent flood risk assessments at the regional scale (several 100.000 km2), in particular in the insurance industry and for national risk reduction strategies. However, most large-scale flood risk assessments are composed of smaller-scale assessments and show spatial inconsistencies. To overcome this deficit, a large-scale flood model composed of a weather generator and catchments models was developed reflecting the spatially inherent heterogeneity. The weather generator is a multisite and multivariate stochastic model capable of generating synthetic meteorological fields (precipitation, temperature, etc.) at daily resolution for the regional scale. These fields respect the observed autocorrelation, spatial correlation and co-variance between the variables. They are used as input into catchment models. A long-term simulation of this combined system enables to derive very long discharge series at many catchment locations serving as a basic for spatially consistent flood risk estimates at the regional scale. This combined model was set up and validated for major river catchments in Germany. The weather generator was trained by 53-year observation data at 528 stations covering not only the complete Germany but also parts of France, Switzerland, Czech Republic and Australia with the aggregated spatial scale of 443,931 km2. 10.000 years of daily meteorological fields for the study area were generated. Likewise, rainfall-runoff simulations with SWIM were performed for the entire Elbe, Rhine, Weser, Donau and Ems catchments. The validation results illustrate a good performance of the combined system, as the simulated flood magnitudes and frequencies agree well with the observed flood data. Based on continuous simulation this model chain is then used to estimate flood quantiles for the whole Germany including upstream headwater catchments in neighbouring countries. This continuous large scale approach overcomes the several drawbacks reported in traditional approaches for the derived flood frequency analysis and therefore is recommended for large scale flood risk case studies.