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21st Century Projections of High Streamflow Events in the UK and Germany

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Radiative effects of anthropogenic changes in atmospheric composition are expected to enhance the hydrological cycle leading to more frequent and intense floods. To explore if there will be an increased risk of river flooding in the future, 21st century projections under global warming scenarios of High Streamflow Events (HSEs) for UK and German rivers are carried out, using a model that statistically relates large-scale atmospheric predictors - 850 hPa Geopotential Height (GPH850) and Integrated Water Vapor Transport (IVT) - to the occurrence of HSEs in one or simultaneously in several streamflow gauges. Here, HSE is defined as the streamflow exceeding the 99th percentile of daily flowrate time series measured at streamflow gauges.

For the common period 1960-2012, historical data from 57 streamflow gauges in UK and 61 streamflow gauges in Germany, as well as, reanalysis data of GPH850 and IVT fields, bounded from 90W to 70E and from 20N to 80N are used.

The link between GPH850 configurations and HSEs, and more precisely, identification of the GPH850 states potentially able to generate HSEs, is performed by a combined Kohonen Networks (Self Organized Map, SOM) and Event Synchronization approach. Complex network and modularity methods are used to cluster streamflow gauges that share common GPH850 configurations. Then a model based on a conditional Poisson distribution, in which the parameter of the Poisson distribution is assumed to be a nonlinear function of GPH850 and IVT, allows for the identification of GPH850 state and threshold of IVT beyond which there is the HSE highest probability.

Using that model, projections of 21st century changes in frequency of HSEs occurrence in UK and Germany are estimated using the simulated fields of GPH850 and IVT from selected GCMs belonging to the Coupled Model Inter-comparison Project Phase 5 (CMIP5). Among the different GCMs, those are selected whose retrospective predictor fields have consistent statistics with the corresponding reanalysis data.