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Investigating the role of changes in the distributions of hydrometeorological drivers in observed changes in extreme river flow

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A change in extreme river flow can be caused by a range of factors, such as changes in landuse, river training, flood detention and retention measures, as well as changes in the meteorological forcing. While identifying the extent to which each of the factors has contributed to a detected change in extreme flow is difficult, a number of attempts have been made to investigate whether one of the factors is behind the change. Extreme river flow is generally caused by a complex temporal evolution of a spatially variable hydrometeorological forcing, such as precipitation and therefore, it is natural to investigate whether changes in such forcing are behind a detected change in extreme river flow. Generation of extreme flow depends on both the spatial distribution and the temporal evolution of the flood triggering meteorological event. An event, which may not be regarded as extreme at a catchment scale may cause an extreme flow depending on its spatial and temporal characteristics. Therefore, analyzing the change in the catchment scale extreme meteorological forcing and comparing the outcome with that of the extreme flow does not necessarily reveal the relationship between the two.

We present a model based approach that makes use of a chain of multi-site multi-variable weather generator and a continuous hydrological model as a basis to attribute changes in extreme river flows to meteorological forcing in a number of meso-scale catchments across Germany. The hydrological model is parameterized and calibrated in such a way that it simulates daily flow under stationary non-climate catchment characteristics. The weather generator produces ensembles of non-stationary daily meteorological variables by sampling the variables from distributions that vary on a yearly basis. Analysis of the changes in the extreme flows simulated by driving the hydrological model using the meteorological variables thus generated reveals whether changes in meteorological forcing have contributed to the changes in the flow extremes. Furthermore, the relative importance of the different components of the meteorological forcing in contributing to the change in extreme flow is investigated by setting one of the variables non-stationary while keeping the others stationary in the weather generator setup.