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Assessing the impacts of climate change and natural variability on hydrological extreme events over Eastern North America and Europe

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The recent accumulation of extreme hydrological events over Eastern North America and Central Europe has stimulated scientific and also societal interest. In addition to the challenges of an improved prediction of such situations and the implications for the associated risk management, there is as yet no confirmed knowledge whether and how climate change contributes to the magnitude and frequency of hydrological extreme events and how regional water management could adapt to the corresponding risks.

The ClimEx project focuses on the effects of climate change on hydro-meteorological extreme events and their implications for water management in Bavaria and Québec. Therefore, a hydro-meteorological model chain is applied. It employs HPC capacity of LRZ's SuperMUC to dynamically downscale 50 members of the Global Circulation Model CanESM2 over European and Eastern North American domains using the Canadian Regional Climate Model (RCM) CRCM5 (0.11° resolution - 1951-2100 - 15.000 model years - 7.500 years in each domain). The unique single model ensemble is conjointly analyzed and compared with the latest information provided through the CORDEX-initiative, to better assess the influence of natural climate variability and climatic change on the dynamics of extreme events.

Hydrological assessment is performed using the process-based and spatially explicit hydrological model WaSiM in high temporal (3h) and spatial (500m) resolution. The simulations form the basis for in depth analysis of hydrological extreme events based on the inputs from the large climate model dataset. The specific data situation enables to establish a new method for 'virtual perfect prediction', which assesses climate change impacts on flood risk and water resources management by identifying patterns in the data which reveal preferential triggers of hydrological extreme events.

The presentation highlights results from the analysis of the large scale ClimEx model ensemble over Eastern North America and Europe, showing the current and future ratio of natural variability and climate change impacts on meteorological extreme events. Hydrological application of this data set is exemplified for catchments in Bavaria, Germany, where hydrological modeling illustrates the capacity to better determine the recurrence periods of hydrological extreme events (e.g. HF100) under conditions of climate change (based on 1.500 model years for the reference period 50x 1981-2010 and 50x three scenario periods 2011-2040, 2041-2070 and 2071-2100, respectively). The regionally specific and non-linear impact of natural climate variability and climate change on extreme stream flows for the Bavarian catchments is discussed.