Geophysical Research Abstracts
Vol. 21, EGU2019-6914-1, 2019
EGU General Assembly 2019

Assessing the development of flood extremes in a changing climate

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Hydro-meteorological extremes, such as droughts and floods are among the grand challenges of our future and pose great interest and concern for water management and public safety. These events are likely to increase in frequency and magnitude with the projected changes in climate. Hence, the ClimEx project (www.climex-project.org) disaggregates the response of the climate system into changing anthropogenic forcing and natural variability by analysing a novel large-ensemble (LE) of climate simulations, operated using High Performance Computing. The comprehensive new dataset (CRCM5-LE) generated 50 transient, independent and evenly likely realizations of the past and the future climate (1950-2099) over two large domains (Europe, Eastern North America) in high spatial (12km) and temporal (1h-1d) resolution. A subset of the resulting 7.500 model years of climate data are then applied to drive the process based, fully distributed, and deterministic hydrological model WaSiM – operating on high spatio-temporal resolution (500m, 3h) for major Bavarian catchments ($\sim$100.000km^2) – to further assess the impacts of a changing climate on floods.

This contribution will give a comprehensive overview of the final results from the ClimEx project, providing a profound basis for the robust assessment of changes in the intensity and frequency of floods in Bavaria. The large number of model years allows for a thorough comparison of statistical methods (parametric and non-parametric) for the estimation of return values, the separation of a climate change signal from natural variability (signal to noise ratio) and the analysis of the interconnectivity of climate and hydrological extremes. Furthermore, changing patterns of flood conditions will be highlighted with the intensification of Vb weather patterns as an example. Results indicate the importance of compound events as a trigger of extremely rare flooding events (larger than the 1000 year return period). In order to support flood risk management, a novel approach for a 'virtual perfect prediction' is introduced, testing the efficiency of flood prevention and mitigation measures based on an analysis of the extensive hydro-meteorological model data set. ClimEx results are summarized in a hydro-meteorological atlas for Bavaria, containing comprehensive maps of climate change impacts on the Bavarian climate and hydrology to inform the public and to support the decision-making of regional authorities with regard to water resources management.