Project: 983
Title: Decadal variability of flood triggering extreme precipitation events
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To quantify the flood risk for European river catchments (namely Danube, Elbe, Oder, Rhine, and Vistula), we develop a centennial dataset of daily 2 m temperature means and precipitation sums, to be used as input for a hydrological rainfall-runoff model developed by the University of East Anglia. We used a regional climate model (RCM) ensemble with a spatial resolution of ~25 km provided by the MiKlip project (Marotzke et al. 2016). The RCM ensemble consists of over 10.000 simulated years with varying sample size through time. For the hydrological application, it is necessary to do a bias correction. After comparing several bias correction methods (for an overview see Fang et al. 2015), we decided to use a quantile mapping with fixed distribution, as this method shows the best results for discharges simulated with the hydrological model. In the case of precipitation, a dry day correction is also needed to reduce well-known modelling artefacts (Feldmann et al. 2018). We used daily E-OBS gridded data (0.25° horizontal resolution, version 17, Haylock et al., 2008) as reference for the dry-day and for the bias correction.
In 2019, we have done the dry-day and the bias correction for the whole RCM ensemble. At the moment, we are working at two papers presenting findings from the project. The first paper (Ehmele et al., 2019) deals with centennial trends and variability of extreme precipitation and has been submitted to Earth System Dynamics. We found a significant increasing trend of heavy precipitation for northern parts of Central Europe and a decreasing trend in the Alpine region. The second paper (Kautz et al., 2019) introduces the applied dry-day and bias correction methods as well as a short overview of the hydrological simulations and will be submitted by the end of 2019. For 2020, we plan two studies. One about the investigation of possible mechanisms behind decadal oscillations. And a second one about seasonal and spatially more detailed trend analyses.

Example of application: Long-Term Trends of Heavy Precipitation across Central Europe

The Figure shows the temporal evolution of the 99% percentile during the 20th and the beginning of the 21st century for the complete RCM sample. The lower boundary changes are small, while these is a visible positive trend of the RCM mean and the upper boundary of the RCM spread. Note that the larger spread from the 1960s onwards might be artificial due to the decisively larger number of members for that time period. Some differences emerge for the Alpine region. There is a distinct decrease of the ensemble mean between 1960 and 1970 which might reveal from the rising number of members.
These trends were also found in the time series of the mean yearly number of days above the 99% percentile compared to the climatology (1961-1990). In addition, we found similar results with the help of ETCCDI climate change indices. R95pTOT (annual total precipitation sum of all values above the climatological 95% percentile of wet days) shows a positive trend for Mid-Europe with a relative change of about 17% and a strong negative trend of approximately -15% for the Alpine region. R99pTOT (same as R95pTOT but for the 99% percentile) shows a positive change for Mid-Europe and slightly negative trend for the Alpine region.

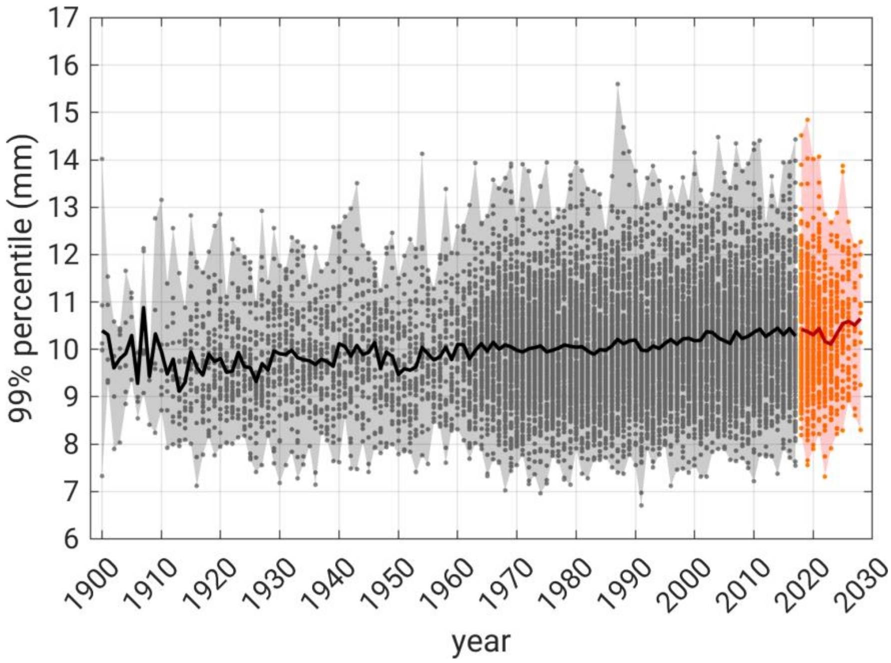

Figure: *Time series of the annual 99% percentile of spatial mean precipitation for Mid-Europe of the RCM ensemble mean (solid line), and the ensemble spread (dots and shaded area) during a time period from 1900 to 2017 (back/gray) and from 2018 to 2028 (reddish). Source: Ehmele et al. 2019.*

Publications made possible through DKRZ-resources in project bb0983:

(1) Ehmele F, Kautz LA, Feldmann H, Pinto JG (2019): Long-Term Variances of Heavy Precipitation across Central Europe using a Large Ensemble of Regional Climate Model Simulations. Earth Syst. Dynam. Discuss. doi: 10.5194/esd-2019-47, *in review*

(2) Kautz LA, Ehmele F, Ludwig P, Lentink HS, Kadlec M, Buldmann B, Feldmann H, Kelemen FD, Pinto JG (2019): Towards the Development of a Pan-European Stochastic Precipitation Dataset. *In preparation*.

Other references

Fang G, Yang J, Chen Y, Zammit C (2015): Comparing bias correction methods in downscaling meteorological variables for a hydrological impact study in an arid area in China, *Hydrology and Erath System Sciences*, **19**, 2547-2559, doi: 10.5194/hess-19-2547-2015

Feldmann H., Frueh B., Schaedler G., Panitz HJ, Keuler K., Jacob D, & Lorenz P (2008): Evaluation of the precipitation for South-western Germany from high resolution simulations with regional climate models. *Meteorologische Zeitschrift*, **17**, 455-465. doi: 10.1127/0941-2948/2008/0295

Haylock MR, Hofstra N, Klein Tank AMG, Klok EJ, Jones PD, New M (2008) A European daily high-resolution gridded dataset of surface temperature and precipitation. *J. Geophys. Res - Atmospheres*, **113**, D20119, doi: 10.1029/2008JD010201.

Marotzke J, Müller WA, Vamborg FS, Becker P, Cubasch U, Feldmann H, ... & Prömmel K (2016): MiKlip: a national research project on decadal climate prediction. *Bulletin of the american meteorological society*, **97**, 2379-2394, doi: 10.1175/BAMS-D-15-00184.1