Geophysical Research Abstracts
Vol. 20, EGU2018-5185, 2018
EGU General Assembly 2018

Disentangling time scales of drivers of long-term flood variability: a case study in Upper Austria

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Clear evidences of flood regime changes over Europe, concerning magnitude, frequency and timing of floods, have been presented in recent studies. The objective of this work is to understand the reasons why these detected flood changes occurred (i.e. flood change attribution). The following drivers of change in flood regimes are considered: atmospheric (e.g. trends in precipitation), catchment (e.g. land-cover changes) and river system processes (e.g. the construction of a dam in the upstream catchment). A data-based approach is used, to quantitatively attribute the detected flood trends to one, or more, of the three drivers, and it's then applied to a case study. Upper Austria is chosen as study area, because of the availability of reliable time series, for different hydrological variables (discharge and precipitation series at different time frequency), and because of consistent evidences, from previous studies, of positive trends in flood peak series. For each of the three potential drivers of change, time series of covariates are selected: precipitation at different time scales representing the atmospheric driver, land-cover for the catchment driver and a dimensionless reservoir index for the river system driver. In particular, the maximum annual daily, weekly and monthly values and the total annual value of precipitation are considered, aggregated at the annual and decadal scale, to identify the relevant atmospheric process and distinguish between its year-to-year variability and the decadal variability of climate. The Generalized Extreme Value Distribution is fitted to annual maximum discharge series, for 97 catchments in the region, allowing the parameters of the distribution to vary with the covariates. Both maximum likelihood (MLE) and Bayesian Monte Carlo Markov Chain (MCMC) are used for parameter estimation, and nested models, differing in the considered covariate, are compared with the Akaike information criterion (AIC) and the Deviance information criterion (DIC). The selection of the best covariate by these criteria is used as an indication of the attribution of the non-stationarity of the flood peak series to one driver at the catchment level. At the regional level, the relative role of the three drivers is quantified and its dependency on catchment scales and time scales is assessed.