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Forced response, warming pauses and surge events in temperature and heavy precipitation extremes

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Stakeholders express a strong need for reliable information on changes in climate extremes in the recent past and coming decades as a basis for adaptation strategies. However, extremes are very rare by definition and occur irregularly due to internal climate variability. In order to maximize the sampling period design of critical infrastructure is often based on return period estimates across the entire observational record. Based on a set of different large initial condition ensemble I demonstrate that thereby the risk of climate extremes may be seriously underestimated particularly if return periods are estimated based on stationary extreme value analysis. In many cases the probability of extremes in the climate of today and of the near future is substantially higher than averaged across the observational period.

Due to internal variability, local to regional trends in extremes may deviate strongly from the forced response in individual simulations and in the real world. This can lead to multi-decadal warming pauses or stagnation periods in extremes, similar to the hiatus or warming holes of hot extremes. I will show that such stagnation periods, during which the forced response is hidden by large variability, may lead to a serious underestimation of the changes in the probability of extremes even if non-stationary extreme value analysis is applied. This is particularly problematic as stagnation periods are often followed by a surge event during which extremes break previous records by a large margin. Large initial condition ensembles provide important guidance on how to robustly assess the risk of extremes in the present-day and near-future climate taking into account the forced climate change signal.