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An ensemble based approach for the effect of climate change on the dynamics of extremes

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In view of the growing importance of climate ensemble simulations, we propose an ensemble approach for following the dynamics of extremes in the presence of climate change. A strict analog of extreme events, a concept based on single time series and local observations, cannot be found. To study nevertheless typical properties over an ensemble, in particular if global variables are of interest, a novel, statistical approach is used, based on a ”zooming in” into the ensemble. To this end, additional sub-ensembles with initially very close members are generated around trajectories of the original ensemble. Plume diagrams initiated on the same day of a year are generated from these sub-ensembles. The trajectories within a plume diagram strongly deviate on the time scale of a few weeks. By defining the extreme deviation as the difference between the maximum and minimum values in a plume diagram, a growth rate for the extreme deviation can be extracted. An average of these taken over the original ensemble (i.e. over all sub-ensembles) characterizes the typical, exponential growth rate of extremes, and the reciprocal of this can be considered the characteristic time of the emergence of extremes. Using a climate model of intermediate complexity, these are found to be on the order of a few days, with some difference between the global mean surface temperature and pressure. Measuring the reciprocal of the growth rate in several years along the last century, results for the temperature turn out to be roughly constant, while a pronounced decaying trend is found in the last decades for the pressure.