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Models are likely to underestimate increase in heavy rainfall in regions with high rainfall intensity

Aleksandra Borodina, Erich M Fischer, and Reto Knutti
ETH Zurich, IAC, D-USYS, Zurich, Switzerland (aleksandra.borodina@env.ethz.ch)

Model projections of heavy rainfall are uncertain. On timescales of few decades, internal variability plays an important role and therefore poses a challenge to detect robust model responses. We show that spatial aggregation across regions with intense heavy rainfall events, - defined as grid cells with high annual precipitation maxima (Rx1day), - allows to reduce the role of internal variability and thus to detect a robust signal during the historical period. This enables us to evaluate models with observational datasets and to constrain long-term projections of the intensification of heavy rainfall, i.e. to recalibrate full model ensemble consistent with observations resulting in narrower range of projections. In the regions of intense heavy rainfall, we found two present-day metrics that are related to a model's projection. The first metric is the observed relationship between the area-weighted mean of the annual precipitation maxima (Rx1day) and the global land temperatures. The second is the fraction of land exhibiting statistically significant relationships between local annual precipitation maxima (Rx1day) and global land temperatures over the historical period. The models that simulate high values in both metrics are those that are in better agreement with observations and show strong future intensification of heavy rainfall. This implies that changes in heavy rainfall are likely to be more intense than anticipated from the multi-model mean.