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Observed heavy precipitation increase in Europe broadly consistent with global and regional climate models

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Environmental phenomena are often first observed, and then explained or simulated quantitatively. The complexity and diversity of processes, the range of scales involved, and the lack of first principles to describe many processes make it challenging to predict conditions beyond the ones observed. Here we use the intensification of heavy precipitation as a counterexample, where seemingly complex and potentially computationally intractable processes to first order manifest themselves in simple ways: the intensification of heavy precipitation is now emerging in the observed record across many regions of the world, confirming both theory and a variety of model predictions made decades ago, before robust evidence arose from observations.

We here compare heavy precipitation changes over Europe and the contiguous United States across station series and gridded observations, theoretical considerations and multi-model ensembles of GCMs and RCMs. We demonstrate that the observed heavy precipitation intensification aggregated over large areas agrees remarkably well with Clausius-Clapeyron scaling. The observed changes in heavy precipitation are consistent yet somewhat larger than predicted by very coarse resolution GCMs in the 1980s and simulated by the newest generation of GCMs and RCMs. For instance the number of days with very heavy precipitation over Europe has increased by about 45% in observations (years 1981-2013 compared to 1951-1980) and by about 25% in the model average in both GCMs and RCMs, although with substantial spread across models and locations.

As the anthropogenic climate signal strengthens, there will be more opportunities to test climate predictions for other variables against observations and across a hierarchy of different models and theoretical concepts.