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Where and when will the next precipitation record be broken?

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Not only will climate change lead to more intense extreme precipitation, it will also lead to more frequent record-breaking daily rainfall. Given the tendency of society to design critical infrastructure and emergency plans based on (statistics derived from) historical observations, an increasing occurrence of record-breaking events – events that are more intense than ever recorded – poses a high risk for loss and damage.

A major challenge in the projection of very extreme events is their inherent rarity. This problem is even more prominent for record events: by definition these events are not present in sample data because they have not yet occurred. An additional difficulty, which is particularly challenging for precipitation, is the high internal variability in and local character of very rare extremes. This implies that, by chance, an observed data sample of finite size might contain few extremes, whereas the true probability and intensity of extremes given by the (unknown) underlying distribution is much higher. In practice, this can lead to "surprise extremes".

With the help of extreme value theory, we approach this problem from two angles, using multi-model CMIP6 data and two different ground-station based observational datasets. Firstly we assess, for all observed land grid cells, where the last observed precipitation record is "extraordinarily long ago" given the theoretical record breaking rate prescribed by historical and future climate according to the CMIP6 models. Secondly, we assess where the last observed record value is "extraordinarily low in intensity" given the historical and future modelled distribution of extreme precipitation. Combining these two approaches, we highlight regions on earth where the probability of record precipitation events in the near future is high.

We find that grid points where the last observed precipitation record is extraordinarily long ago are ubiquitous and scattered globally. When combining this with the observed record intensity, the number of grid points that stand out for their high near-term record probability decreases drastically. We find a somewhat higher density of high-probability grid points in Australia and southern South America, but the pattern is not very clear. Nonetheless, every world region contains a number of grid points where the current observed record is both extraordinarily long ago and low in intensity, and where the near-term probability of a new precipitation record is thus high.