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On the internal variability of simulated precipitation

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Adequate knowledge of expected changes in precipitation is needed for planning as well as for mitigating and adapting to climate change. Potential changes in precipitation can be assessed by using climate model simulations under different scenarios. Yet the climate change signal can be obfuscated by natural variability. Here, we propose an approach that can be used in the attribution of the identified changes. By using long pre-industrial control simulations (in this exercise, a 330-year run of the CMCC Global Circulation Model) we can determine the shortest record length such that randomly chosen time periods of the same length cannot be statistically distinguished from each other. In the context of climate change assessment, this implies that any change simulated over a period of this length could be attributed to a change in forcing and not to natural variability.
For each land grid point, the empirical distribution over a given time period is compared with that of 99 (randomly chosen) periods of the same length. Should the Cramer-von Mises two sample test be unable to reject the hypothesis that the samples stem from the same distribution, then the periods are deemed statistically indistinguishable. Multiple testing is accounted for with the Walker test at the 5 % level. To also test for regional significance, we calculate the Benjamini- Hochberg false-discovery-rate for the 26 IPCC SREX regions. To avoid extra variability due to the seasonal cycle, we analyze July-August (JJA) and December-February (DJF) precipitation separately. We show that this minimum duration length depends on the season, the location and the extent of the region under investigation. For instance, in case of northern hemispheric DJF precipitation, at least 36 seasons are necessary; whereas for southern hemispheric JJA precipitation, the minimum duration length is equal to 12 seasons. For many land grid points 30 seasons (DJF or JJA) suffice. However, there exists regions (especially those close to the oceans) where not even 158 seasons contain enough information.