



Assessment of the stationarity of annual rainfall over global land surface

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Long term planning for water resources, agriculture and irrigation, and for associated infrastructure, is currently based on the ability to adequately characterize variations in hydrologic observables. The starting point is to gather the longest reliable instrumental time series to characterize the hydrologic statistics. To use that historical knowledge requires a further assumption relating to the stationarity of the relevant time series. That assumption has been recently challenged because the hydrologic system may not be stationary with global anthropogenic climate change. Interestingly, in a classic statistical text by Sir Maurice Kendall the annual precipitation time series in London (1813-1912) was used as a typical example of a stationary time series. Despite the importance, the stationarity of rainfall has yet to be formally assessed.

To do that, we use one of the longest instrumental records of annual precipitation - the 244 year (1767-2010) record from the Radcliffe Observatory site at Oxford, UK and a global land-based gridded precipitation database (1940-2009). Applying the formal definition of stationarity, we estimate the auto-correlation function of annual precipitation in all the time series. We find that the auto-correlation for most (76.3%) grid-boxes at the 90% confidence interval was indistinguishable from that for a random time series. We estimate the observed changes in precipitation over the two most recent decades and compare those results with baseline estimates of possible change expected from a purely random time series. We find that the changes at most (84.4%) grid-boxes are within the plausible bounds of no significant change at the 90% confidence interval. The results emphasize that a change in the mean precipitation from one period to the next is a necessary, but not sufficient, condition for non-stationary behaviour and therefore it is important for hydrologists to rigorously incorporate the variance in annual precipitation in assessments of changes in precipitation.