An empirical model of Sahel climate

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Since 1968, the semi-arid region of sub-Saharan Africa, known as the Sahel, has seen a series of devastating droughts, which have been the subject of many studies. The majority of these have approached the problem by investigating the interannual variability of rainfall. Few have attempted to study the variability at shorter time scales. In this study, an empirical model is developed to analyse the daily variability of Sahel rainfall.

The model is developed in three parts. Initially, a 1° gridded daily data set of Sahel rainfall is formed for 1958 - 1997 from station data, using smoothing thin plate splines. A suite of atmospheric predictors is created by extracting the main modes of atmospheric variability in the NCEP reanalysis using a three-dimensional Principal Component Analysis. The domain of the PCA covers four atmospheric levels over sub-Saharan North Africa.

The atmospheric predictors are linked to daily rainfall in six regions of the Sahel, via a series of gamma-distributed Generalised Linear Models, with separate models developed for the two halves of the wet season. The predictors used in the model are picked with a forward stepwise selection procedure. Of the fields examined, specific humidity and zonal and meridional wind speed are seen to have the largest influence on rainfall.

June and July rainfall is most associated with the presence of easterly waves, and with the monsoon, providing southerly flow transports it over the Guinea Coast region. August and September are dominated by the strength of the monsoon flow in the Gulf of Guinea, but are also influenced by several factors describing variability in East Africa, which require further study.