Volatility modeling of rainfall time series

Abstract

Abstract Networks of rain gauges can provide a better insight into the spatial and temporal variability of rainfall, but they tend to be too widely spaced for accurate estimates. A way to estimate the spatial variability of rainfall between gauge points is to interpolate between them. This paper evaluates the spatial autocorrelation of rainfall data in some locations in Peninsular Malaysia using geostatistical technique. The results give an insight on the spatial variability of rainfall in the area, as such, two rain gauges were selected for an in-depth study of the temporal dependence of the rainfall data-generating process. It could be shown that rainfall data are affected by nonlinear characteristics of the variance often referred to as variance clustering or volatility, where large changes tend to follow large changes and small changes tend to follow small changes. The autocorrelation structure of the residuals and the squared residuals derived from autoregressive integrated moving average (ARIMA) models were inspected, the residuals are uncorrelated but the squared residuals show autocorrelation, and the Ljung– Box test confirmed the results. A test based on the Lagrange multiplier principle was applied to the squared residuals from the ARIMA models. The results of this auxiliary test show a clear evidence to reject the null hypothesis of no autoregressive conditional heteroskedasticity (ARCH) effect. Hence, it indicates that generalized ARCH (GARCH) modeling is necessary. An ARIMA error model is proposed to capture the mean behavior and a GARCH model for modeling heteroskedasticity (variance behavior) of the residuals from the ARIMA model. Therefore, the composite ARIMA–GARCH model captures the dynamics of daily rainfall in the study area. On the other hand, seasonal ARIMA model became a suitable model for the monthly average rainfall series of the same locations treated.