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Test for stationarity and subsequent neurocomputing based prediction of the total ozone time series over Kolkata, India in univariate framework

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Climate change persuades the evolution of the ozone layer. The lower stratospheric region contains a relatively higher concentration of ozone. This layer is influenced by climate through variability in transport, temperature and chemical composition. Radiative processes that are having close association with solar UV radiation influence the ozone layer to a considerable extent [1]. Increase in the tropospheric ozone is caused by anthropogenic practices. However, the stratospheric ozone is decreased due to anthropogenic practices. The temperature of the lower atmosphere increases with increase in the tropospheric ozone. On the other hand, the decrease in stratospheric ozone results in a decrease in the temperature. The tropospheric and stratospheric ozone has the capacity to absorb the infrared radiation that is emitted by the surface of the earth. Thus, the heat from the earth's surface is trapped by ozone in troposphere and stratosphere. An additional potential of the stratospheric ozone is to absorb solar radiation. The total column ozone (TCO) signifies over some given region, the sum of tropospheric and stratospheric ozone. A plethora of works have been reported on ozone over India (e.g. [2]).

Complexity of the processes involved in the climate–ozone interaction is well documented in literature. The study reported here aims to develop an autoregressive neural net (ARNN) model to forecast the monthly total ozone concentration over Kolkata that belongs to the Gangetic West Bengal. The primary endeavour is to develop a predictive model in univariate framework by depending upon the time series of total ozone that implies the totality of tropospheric and stratospheric ozone. In order to develop the univariate prediction model, we first test its stationarity through periodogram analysis and as the time series comes out to be stationary, autoregressive moving average (ARMA) [3, 4] is implemented to predict this time series. First, the seasonal indices are calculated for each month and then the data are deseasonalized. The deseasonalized data are now detrended. Then the data are applied to ARMA(p,q) model.

In the second phase of the study, the ARMA model for total ozone is compared to the neurocomputing approach in the univariate settings [5]. The ARMA (10,1) comes out to be the best fit. Keeping in mind the autoregressive structure, ARNN models up to order 10 were generated to examine whether they can produce better results. The ARNN models were applied to deseasonalized and detrended data. While developing the neurocomputing based prediction, the data are normalized to $[0,1]$ in order to avoid the asymptotic effect. The type of nonlinearity chosen is the sigmoid nonlinearity. The single hidden layer ARNN is produced in two ways. In the first approach, the best training set is selected through genetic algorithm and in the second case the input matrix is created by taking 70% of the data and the remaining 30% are the test cases. The ARNN of order 10 with variable selection produced is found to produce the best prediction.

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