TIME SERIES FORECASTING MODEL FOR MONTHLY MEAN TEMPERATURE IN COLOMBO

E. D. T. Somarathne
Faculty of Agriculture, Rajarata University of Sri Lanka, Puliyankulama, Anuradhapura, Sri Lanka.

Introduction

It is important to evaluate how climate or weather has varied and changed in the past. Also, forecasting the climate or weather for a period ahead by analyzing the past is more important. Accordingly, the monthly mean historical climate data can be mapped to demonstrate the baseline climate and seasonality by month in a specific area for specific years. In this study, monthly mean weather components such as temperature, average wind and humidity related to Colombo area are considered. Colombo is an industrial city in Western Province of Sri Lanka, which has a high population density. According to the Koppen climate classification, Colombo has a tropical rainforest climate and the city consists of a geography based on a mix of land and water. Also, the climate of Colombo city is fairly temperate all throughout the year and consists of seasonal and cyclic temperature patterns.The main objective of this research is to develop a time based regression model to forecast monthly mean temperature in Colombo with the most related weather component as the independent variable. Also, it is objective to find the weather patterns exist in monthly mean temperature in Colombo area. Although multiple regression is obviously applied for non correlated data, for some time now it is used for stationary time series data. In this study, monthly mean temperature anomalies (Celsius) of Colombo city for the period of 1986 to 2008 were analyzed and furthermore monthly mean temperatures for the year 2009 were forecast using the estimated model.

Methodology

Secondary data of the department of meteorology related to the weather station in Colombo were used for the study. Monthly mean weather data, temperature (Celsius), average wind (Km/h), rainfall (mm) and average humidity (oktas) from 1986 to 2008 were analyzed to find the weather patterns of each component such as seasonal, cyclic patterns and trend. All the series were checked for stationary and the non stationary series were differenced ata lower order to stationary to apply multiple regression method. Correlations between each component were evaluated using correlation matrix. Several models were identified using multiple regression method to model the monthly mean temperature with the most related component/s as the independent variable/s. Dummy variables were used to remove the seasonality. The best model with

minimized errors was evaluated using stepwise regression. F test and p values were used to test the significance of coefficients while the significance of coefficients was individually checked using t test. Multicollinearity of each predictor Variable was checked using variance inflation factors (VIF) and determinant of X'X matrix. Normality/ Gaussianityof the residuals wasexamined graphically and technically. Residuals were checked for constant variance and correlation using Durbin Watson test. According to the correlation Box Jenkins methodology or Auto Regressive Integrated Moving Average model (ARIMA) was applied to model the residuals. Finally, estimated regression model and the ARIMA model were combined and built up a new equation for the final model. The monthly mean temperatures for 2009 were forecasted using the final estimated model.

Experimental Results and Discussion

All the series were stationary excluding average wind. Therefore the series of average wind was differenced at first order. A within year seasonal pattern was observed in monthly mean temperature as temperature increases from January to May then decreases up to July stepwise. Again temperature increases in August and September but decreases up to December. The highest temperature records in May in Colombo while the months November, December and January consist of the lowest temperature. . The model of monthly mean temperature with the first order differenced average wind and 11 numbers of dummy variables at seasonal lags was the most accurate model. The residuals of the fitted regression model were constant variance and positively correlated. Among the identified ARIMA models in residuals the lowest AIC (Akaike Information Criterion) value was indicated by the ARIMA (2,0,0) or AR(2) model and it was the best fitted model for the residuals. The estimated model of the residuals was AR (2) with the equation

$$Y_t' = 0.3596Y_{t-1}' + 0.1726Y_{t-2}' + \eta_t .$$

The final estimated model for forecasting monthly mean temperature was,

$$T_t = 27.1 + 0.0893W_t + 0.388Z_1 + 1.04Z_2 + 1.33Z_3 + 1.47Z_4 + 1.08Z_5 + 0.838Z_6 + 0.874Z_7 + 0.812Z_8 + 0.374Z_9 + Y'_t.$$

Figure 1: Plot of Actual Monthly Mean Temperatures Vs Estimated Monthly Mean Temperatures

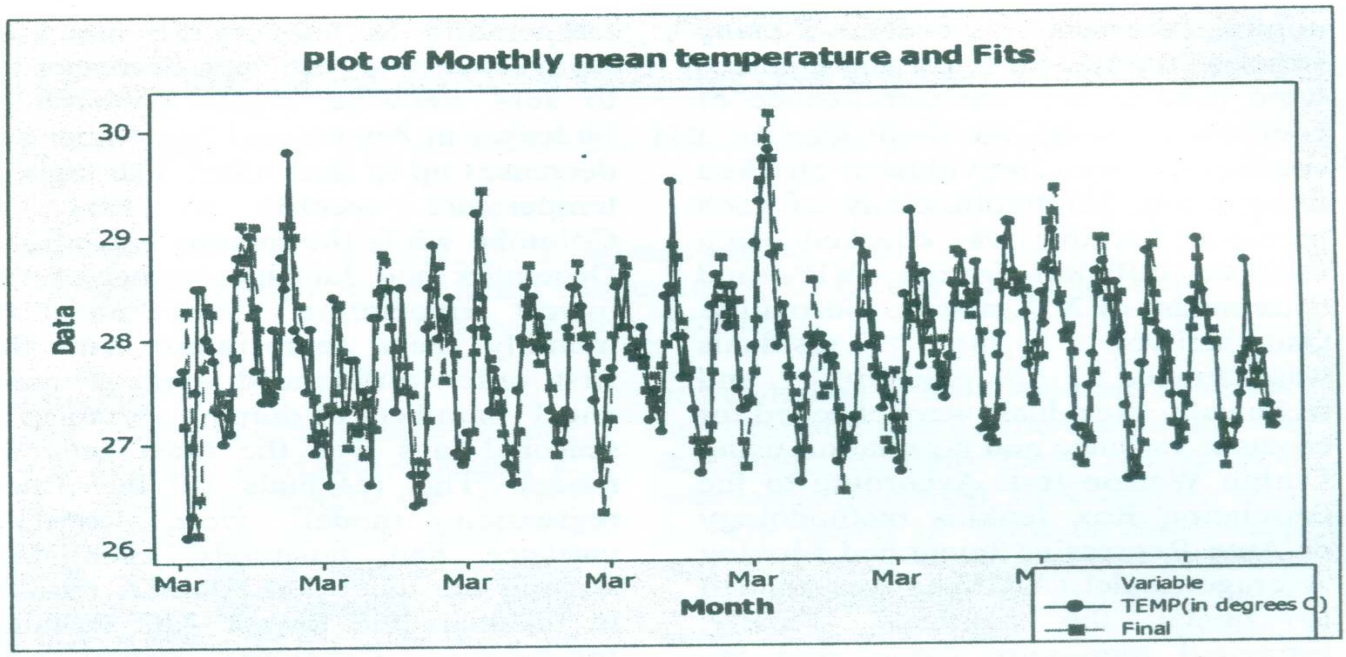
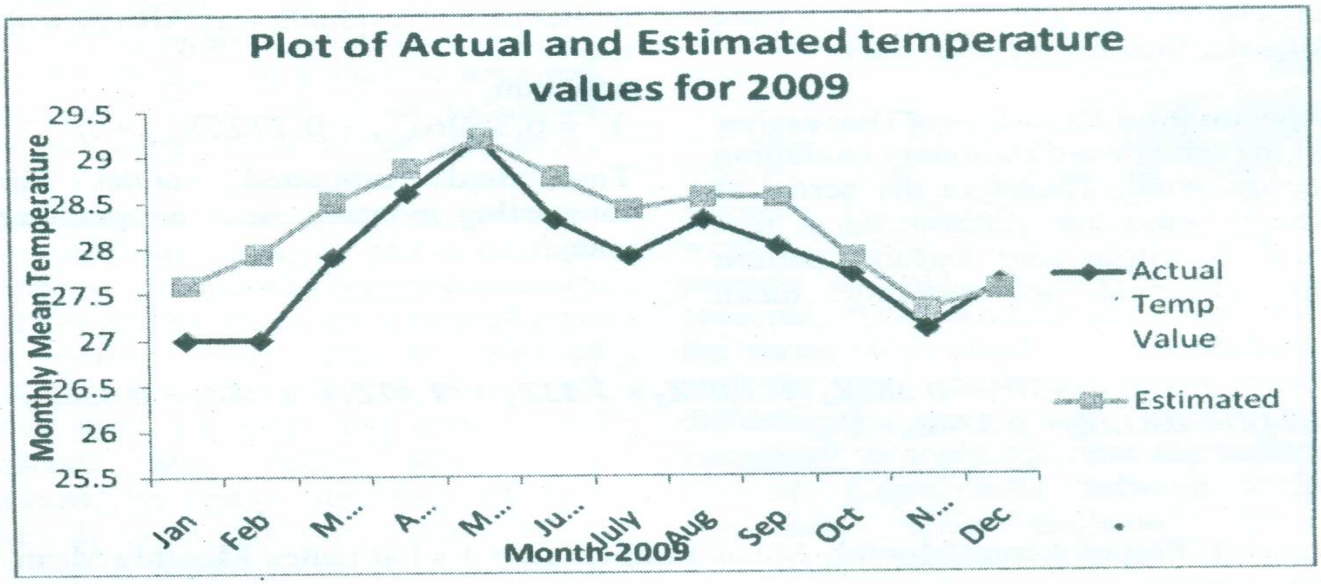


Figure 2: Plot of Actual Monthly Mean TemperaturesVs Estimated Monthly Mean Temperatures in 2009



Conclusion

Among the forecasts I obtained from January to December 2009, forecasts for May, August, November and December are very close to the actual values. Also, the estimated model clearly demonstrates the seasonal patterns exist within year. Since the estimated values are very close to the true values it can be concluded that the

estimated model is appropriate to forecast the monthly mean temperature in Colombo.

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