Applications of Multiple Regression Analysis to estimate Aerosol Optical Depth over the Arabian Gulf

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A statistical model is built to predict the value of aerosol optical depth at 500 nm (AOT 500) from most effective climate parameters. Seasonal data of the Arabian Gulf is used in this study.

The season division is set accordingly to a comprehensive study for weather parameters from May 2009 till May 2010 in conjunction with Aerosol data. These data sets are obtained from ground based measurements of three gulf AERONET sites, Kuwait University, Kuwait, (29.32N, 47.97^{o}E at elevation of 42 meters), Solar Village, Riyadh, (24.91^{o}N, 46.41^{o}E at elevation of 764 meters) and Dhadnah, AlFujairah (25.51^{o}N, 56.327^{o}E at elevation of 81 meters).

New criteria are set for selecting hourly aerosol measurements from the sun photometers according to weather conditions. All hourly readings are with sky clearance $\leq$ 6, humidity (RH) < 83%. If the registered humidity at time of measurements is > 60% and accompanied with rain or rain droplets, then the hourly readings are omitted. The condition for selecting data is summarized as follows:

RH $\geq$ 60 + W2, where (W2 $\geq$ 80)

W2 is a scale measure for weather stability and indication for drizzles and rain.

A correlation value of 0.8 is found between regression standardized predicted values of AOT 500 with the observed values. The prediction of the statistical model shows accuracy near 82% of the observed data , This may be related to the climate nature of Arabian Peninsula, in which most the days during the year are clear from clouds.

The approach to test for errors in model created by step-wise regression is to assess the model against a set of data that was not used to create the model (Mark and Goldberg, 2001).

The AERONET Synergy tool and the Hybrid Single-Particle Lagrangian Integrated Trajectory (HYSPLIT, Draxler and Hess, 1998) together demonstrate the origin and the intensity of desert dust storms. Their results support the prediction model.

The regression equation for spring season in Kuwait yields:

τ_{500}= -1.205α - 0.ΔT – 7.7*10^{-5} visibility + 0.22 WVC + 0.024 *air pressure + 0.053* wind speed.

Where τ_{500} is aerosol optical depth at 500nm, α is the Angstrom exponent obtained from 500nm and 870nm wave lengths , ΔT is the absolute difference between maximum and minimum temperature per day in C^{0} and WVC is the water vapour content.

Residuals for the difference between the predicted value of AOT & the actual mean value = 0. Also most values fall between -2 to 2. The regression standardized residual histogram (Figure 1) is symmetric which means no outliers are found except in small range (less than 1% of data).A plot of expected cumulative probability versus observed cumulative probability (P-P plot) shows normal residuals distribution around line fit graph (Figure 2).

The same standards are applied on all seasons for Kuwait, Solar Village & Dhadnah.

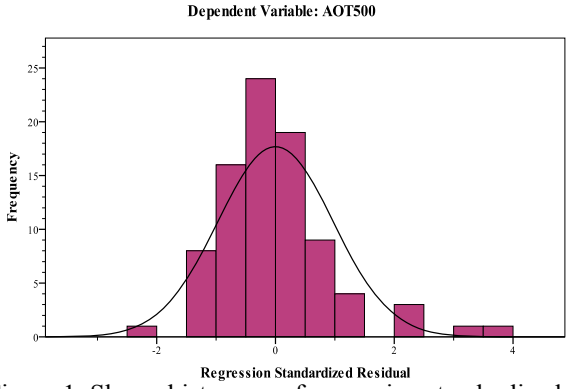

Figure 1: Shows histogram of regression standardized residual.

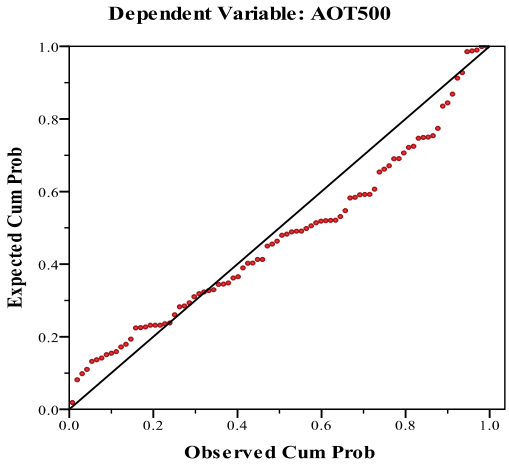

Figure 2: Shows normal P-P plot of regression standardized residual.

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