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Original Article

Rise of Global Emergency of Ozone Layer Depletion and Pakistan's Tomorrow

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Abstract: Events such as the unprecedented huge industrial emissions of chlorofluorocarbon (CFCs) provide a most visible example of man-made atmospheric pollution and global disbalance of the natural ecology. Among other scientific and socio-economic fallouts from this, the phenomenon of ozone layer depletion (OLD) is particularly disturbing. It has already attracted wide attention throughout the globe by way of 1987 Montreal protocol. This paper looks into how to effectively model and forecast the menacing influence of OLD As such, with reference to the data for stratospheric region of Pakistan this communication presents the confidence interval for the population mean of ozone layer depletion (OLD) two significant levels of probability. Then it considers the development of an estimated autoregression model of order one for forecasting time series the data from 1970 to 1997 on monthly basis by identifying a set of related predictors. The issue of validation of the model also has been consider considered by interpreting graphically the predicted and observed data, by residual analysis, and by autocorrelation.

Keywords: Global emergency, stratospheric pollution, ozone layer depletion, maximum likelihood estimator (MLE), autoregressive model

1. INTRODUCTION

The human race has produced hundreds of thousands of "natural" chemicals. Some are regarded as potential threats to mankind and its living environment. Many of these xenobiotics or anthropogenic substances have found their way into the biosphere and have been classified as toxic or potentially harmful chemicals such CFCs, sulphate compounds, and halons.

A radically new conception is that human activities may themselves be responsible for contaminating earth's stratosphere and thus disturbing the balance of its ozone content. But this ozone acts as a shield against the penetration of UV radiation to the earth's surface. In the past few years, a great deal of attention has been focused on the potential environmental hazards like ozone layer depletion (OLD) [1-5].

An agreement, called the Montreal Protocol on substances which deplete the ozone layer, was signed subject to ratification, by 24 countries on 16th September, 1987. A special session of the UN General assembly took place in June 1997 to discuss the results achieved during the 5-year period after the Agenda 21 and Framework Convention for Climate Change. Under such circumstances, it is very important to assess the global ecological situation and potential perspectives of future development as a result of interaction between community and environment. The low level of carbon emissions in the former USSR countries is a result of declining economics. In China and India the emissions are low but in

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view of the necessity of further industrial development in such countries, it is obvious that the total emissions will increase in future.

The threat of global ecological catastrophe has become visible by demonstrating simple assessments where biodiversity plays a decisive role. In this context a decisive role belongs to modeling, simulation, and adequate observing systems should be implemented. Undoubtedly, more efforts are necessary to develop clean and efficient technologies, minimizing the use of energy and raw materials [6-11].

Pakistan is situated in the west and north-west of south Asia. It .lies from 23.45^o to 36.75^o in the northern latitudes, and from 61^o to 75.5^o eastern longitudes. Due to this critical geographical position and the large positive correlation between the potential vorticity deviations and the ozone mixing ratios in the stratosphere, the ozone is transported along with the seasonal variations to Pakistan's atmospheric regions. The effects of ozone layer depletion are being observed as reported previously [5]. The quantification UV flux reaching the Arabian sea through the ozone filter can also be calculated and presented in the next communication by the authors. This ozone filter has been transported to Pakistan via vertical lifting and horizontal mixing of ozone contents.

In the present study stochastic model is employed to describe the contemporary variability of ozone contents An investigative assessment of the ozone layer depletion for Pakistan's atmospheric region is carried out for the first time. The model used in this investigation illustrate physical processes more accurately than the least square model in the atmosphere. We attempt here in to look into the stochastic aspect of the phenomenon for Pakistan's atmosphere using the relevant time series modeling [12-18].developed via various observational programmes on the global ozone network supervised by UNO.

2. STRATOSPHERIC POLLUTION AND O_3 PHOTOCHEMISTRY

Ozone (O_3) is an allotropic form of oxygen which occurs both in the stratospheric ozone layer (stratospheric region is found approximately 15 km to 65 km above sea level) where it is generated by the direct action of ultraviolet (UV) light from the sun on oxygen, and in the troposphere due to intrusion from the stratosphere and photochemical reactions between nitrogen oxides (NO_x)and hydrocarbons. Nitric oxide is found in the stratosphere. This compound results from the oxidation of nitrous oxide, is converted to nitrogen dioxide by reaction with ozone

$$NO + O_3 \rightarrow NO_2 + O_2 \quad (1)$$

$$NO + HO_2 \rightarrow NO_2 + OH \quad (2)$$

$$NO + CH_3O_2 \rightarrow NO_2 + CH_3O. \quad (3)$$

Stratospheric ozone plays an important role in absorption of potentially harmful solar UV radiation before it can penetrate to sea (ground) level.

The first cause of concern in stratospheric pollution was the supersonic transport aircraft which fly in the lower stratosphere. The engines emit nitrogen oxide that participate in ozone formation processes as follows:

$$O_2 + h\nu \rightarrow 2O \quad \lambda < 242\ nm \quad (4)$$

$$O + O_2 + M \rightarrow O_3 + M \quad (5)$$

$$NO + O_3 \rightarrow NO_2 + O_2 \quad (6)$$

$$NO_2 + O \rightarrow NO + O_2 \quad (7)$$

The sum of the two reactions involving nitrogen oxides

$$O + O_3 \rightarrow 2O_2 \quad (8)$$

M is an un-reactive third molecule, usually N_2 or O_2 , required to absorb excess energy from the reaction. There are other reactions which complete the cycle:

$$NO_2 + h\nu \rightarrow NO + O \quad (9)$$

$$O + O_2 + M \rightarrow O_2 + M \quad (10)$$

$$O_3 + NO \rightarrow NO_2 + O_2 \quad (11)$$

A photo-stationary state effectively governs the NO_2 / NO ratio in air. At equilibrium, NO_2 is formed in the reaction as rapidly as it is photolysed in the reaction represented by the chemical equations (10), (11). The NO_2 / NO ratio is monitored by the ozone concentration and the magnitude approaches to zero (night time conditions), in the presence of excess ozone, NO_2 / NO becomes very large, whilst the lowest ratios are associated with bright sunshine.

A disturbing scenario has been theorized that the inert CFCs gradually migrate upward into the stratosphere. At altitude above 30 km, intense UV radiation breaks down the CFCs, causing them to release chlorine, a gas which readily reacts with and destroys ozone as shown in the following chemical reactions:

$$CCl_2F_2 + h\nu \text{ (UV radiation) } \rightarrow Cl + CClF_2 \quad (13)$$

$$Cl + O_3 \rightarrow ClO + O_2 \quad (14)$$

$$ClO + O \rightarrow Cl + O_2 \quad (15)$$

By a chain reaction, each chlorine atom destroys tens of thousands of ozone molecules [3,5]. Thus, ozone layer reduction is manifested on global as well as regional scales.

3. TECHNIQUES OF DETECTING ATMOSPHERIC O_3

Basic methods currently used for O_3 depth or concentration involve optical techniques [5,10]. The ground-based methods make use of radiance measurements from an external light source like the sun or the moon — after the radiation has suffered extinction as a result of atmospheric absorption, molecular scattering and large particle (aerosol) scattering, all of which are wavelength dependent.

Notice the ODDS (Ozone Depth Detecting Spectrophotometer) is the designed standard for the measurement of the depth of O_3 layer in the global network. The data for O_3 layer, employed in this paper, have been collected using ground-based ODDS model No. 100-IN Beck London, UK also No. 43. IN Beck London. [5]

4. TEST OF NORMALITY FOR THE DATA SET AVAILABLE FOR PRESENT STUDY

The problem of fitting a probability law to data that is to be fit are modeled as a collection of realized values of random variables generated by the probability law under consideration. In particular, we have modeled our data comprising 296 observations as realization of the random variables which are independent and have the same probability distribution. This number has been referred as independent and identically distributed (i.i.d) or as a random sample from the probability law.

The Kolmogorove-Smirnov good-ness-of-fit test is shown in Fig. 1.is a popular method for comparing a data set to a theoretical distribution. It has an advantage over the Chi-square test that it is more powerful test and it can be used with small sample sizes also.

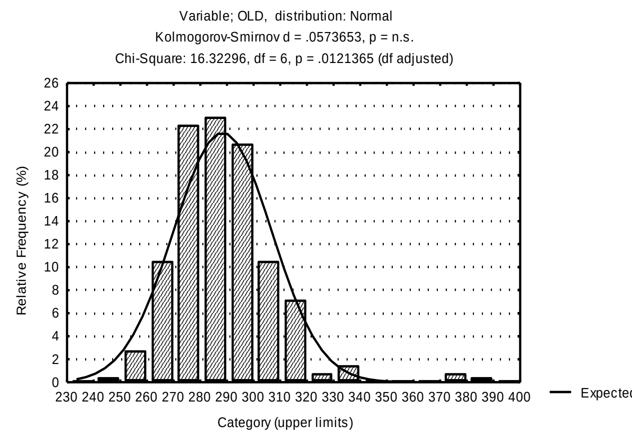

Fig. 1. Kolmogorove-Smirnov good-ness-of-fit for OLD to assess. how well the data set appears to come from a normal distribution (n = 296).

We took 296 observations which appeared to have come from a normal theoretical distribution. As shown in the table # 1, each observed cumulative relative frequency F_o indiates the cumulative values of F_o (the same observed frequencies used in the Chi-square test) expressed as a proportion of the total. In other words, each F_o is calculated by dividing the cumulative observations in each class n by the total number of observations N in the sample, that is n / N.

The null hypothesis in the Kolomogorove-Smirnov test is that the observed distribution does not differ significantly from the theoretical distribution. To perform the Kolomogorove-Smirnov test, we must calculate a cumulated expected frequency $\mathbf{F_e}$ for each class that has been created. The Kolomogorove-Smirnov test uses the maximum absolute difference D between the F_o's and F_e's .

$$D = \text{maximum } |F_o - F_e| \quad (16)$$

Table1 illustrates the maximum absolute difference which is about 0.0574. It can argued that is this difference significantly large so that we reject the null hypothesis and the contention that the ozone layer is from a normal distibution? By obtaining the required concept of Kolmogorov-Smirnov table that is provided. The level of significance is $\alpha = 0.05$, the sample size is 296 in this communication. The value of α = is 0.05 is appropriate. Beacuse the N is more than 35, the D value from the table must be calculated and is 1.36 / $\sqrt{296}$ that is equal to 0.08. Since the value from the table is greater than the maximum D found from calculating equation (16).

Continue to accept H_o and assume that ozone layer depletion can be simulated by sampling from a normal distribution with a mean 288.36 DU (1 DU = 10^{-3} cm at STP) and standard deviation of 18.39 DU.

Table 1. Kolomogorove-Smirnov test # observations = 296, # catagories = 17, Maximum difference D = 0.0574, Chi-square= 16. 323, degrees of freedom = 6 , p = 0.012.

Ozone Depth DU	Cumu % observed	Cumu % expected
240	0.0000	0.4279
250	. 3.378	1.8509
269	3.0405	6.1548
270	13.5135	15.9081
280	35.8109	32.4707
290	58.7838	53.5495
300**	79.3919	73.6554
310	89.8649	88.0287
320	96.9595	95.7292
330	96.9595	98.8205
340	98.9865	99.9597
350	98.9865	99.9951
360	98.9865	99. 9995
370	98.9865	100.000
380	99.6622	100.000
390	100.0000	100.0000
Infinity	100.0000	100.0000

****** Indicates depth of Ozone = 300 DU that occurs at the maximum difference of 0.0574.

5. METHODS OF ESTIMATING DISTRIBUTION PARAMETERS

Estimation is a procedure for inferring the value(s) of one or more population parameters. An estimator, a rule that tells us how to calculate a particular estimate of a parameter based on the information contained in a sample.

A point estimator uses the sample data to calculate a single number that serves as an estimate of a population parameter.

An interval estimator uses the sample data to calculate two numbers that define an interval that is intended to enclose the estimated parameter with some predetermined probability. In this communication this technique has been used to estimate the parameters

$$\tilde{\sigma}^2 = \frac{\Sigma\,(x_i - \bar{X})^2}{n} \qquad (17)$$

Since $\bar{X}$ is an estimator of μ.

5.1. Results of Distribution Parameter Estimation

Assumed distribution:	Normal
Estimated parameter (s):	Mean = 288.36 DU Standard Deviation =18.39 DU Coefficient of variation (CV) = 0.064
Estimation method:	
Ozone depth data points	
Sample size:	296
Confidence interval for:	
normal approximation	
Confidence interval type:	Two-sided
Confidence level:	95 %
Confidence interval:	(i) Lower Confidence level (LCL) = 86.26 (ii) Upper Confidence level (UCL) = 290.46

6. CONSTRUCTION OF CONFIDENCE INTERVALS (CIS) FOR THE POPULATION MEAN OF OZONE CONTENT IN THE STRATOSPHERE OF PAKISTAN, DATA BASED ON 296 OBSERVATIONS (1970-1997)

In this communication we have taken 296 observations (1970-1997) as the sample space from a infinite population (say) of ozone contents. We can find the confidence interval for the population mean using two specified probability (1−α)100% levels.

We know that the population of the ozone has the mean as μ and standard deviation σ. Population mean μ can be computed the exact value of μ unless studied the entire population, so taking a random sample of size n = 296, and calculate the sample mean $\bar{X}$ using Maximum likelihood estimator (MLE). Then it is an estimate for μ, but this is of little use unless accurate the estimate is likely to be. If considering all random samples of size n, the sample means $\bar{X}$ are approximately normally distributed, with mean μ and standard deviation σ.

$$\bar{y} \pm z_{\frac{\alpha}{2}}\sigma_{\bar{y}} = \bar{y} \pm z_{\frac{\alpha}{2}}\left(\frac{\sigma}{\sqrt{n}}\right) \approx \bar{y} \pm z_{\frac{\alpha}{2}}\left(\frac{s}{\sqrt{n}}\right) \quad (18)$$

where $z_{\alpha/2}$ is the z value that locates an area of α / 2 to its right, σ is the standard deviation of the distribution of population from which the sample is selected, n is the sample size, and $\bar{y}$ is the value of the sample mean. [note: when the value of σ is unknown, the sample standard deviation 's' may be used to approximate σ in the formula for the confidence interval (CI). The approximation is generally quite satisfactory when n ≥ 50 or 296].

(i) If the confidence level is 95%, the value of α = 0.05, and the α / 2 = 0.025, then for the standard normal variable z there is a probability 0.95. $\bar{X}$ is an estimate of μ, the *n* = 296 is the size of the sample from the unknown population and standard deviation = σ / $\sqrt{n}$ for a standard normal variable z , there is a probability of 0.0.95 or 95 % that z lies between – a and a.. when we have an inverse normal distribution whose value can be seen from the respective table. When ϕ(a) = 0.975, a = 1.96. that is z lies between – 1.96 and 1.96. 95 % of the sample of size n is written as follows:

$$\mu - 1.96\frac{\sigma}{\sqrt{n}} < \bar{X} < \mu, + 1.96\frac{\sigma}{\sqrt{n}}, \quad (19)$$

$$\bar{X} - 1.96\frac{\sigma}{\sqrt{n}} < \mu, < \bar{X} + 1.96\frac{\sigma}{\sqrt{n}}, \quad (20)$$

This 95 % CI is for μ,.

$\bar{X} \pm 1.96\frac{\sigma}{\sqrt{n}}$ are 95 % confidence limits for μ, $\bar{X} \pm 1.96 \times 18.39 \ / \sqrt{296}$

so the confidence limits $\bar{X} \pm 2.1$ differ for each sample. We have one sample for which $\bar{X}$ = 288.36 and the confidence limits are 290.46 , 286.26. We do not know whether this particular sample is one of the 95 % for which μ lies between the confidence limits or whether it is one of the 5% for which μ does not lie between the limits. The interval 286.26 < μ, < 290.46.

7. COMPUTATION OF COEFFICIENT OF VARIATION (CV)

This is one of the measures of scatter or the spread of the distribution relative to the size of the mean. It is usually used to characterize the positive, right-skewed distributions such as the lognormal distribution. First, calculate both mean and standard deviation. Second, divide the standard deviation by the mean value. Thirdly, multiply the quotient by 100. The CV measure allows comparisons to be made between data sets whose scatter is measured in different units or, like the regional data sets, have different orders of magnitude.

Coefficient of Variation (CV) =

$$\frac{\text{Standard deviation}}{\text{Mean}} = 0.064 \quad (21)$$

Note that the coefficient of variation certifies the degree of normality of the data points. Minimum CV shows high degree of normalcy. The above numerical value indicates that 6.4 % of the data is non-normal.

8. CONSTRUCTION OF TIME SERIES MODEL TO PREDICT OLD FOR PAKISTAN'S ATMOSPHERIC REGION

It has been known that an important aspect of scientific study is crystallized by the idea of a model. A model can define the real situation of a system. We are having the data which consists of continuous variables.

An observed time series can be thought of as particular realization of Stochastic process. Time series is defined by a record of the values of any fluctuating quantity measured at different points of time. We may, for example, have a record of the depths of O_3 layer over a period of 28 years (1970-1997) which is being used in this study.

8.1. Criteria for Model Selection of OLD in Pakistan's Atmospheric Region

The common feature of all the records which fall within the domain of time series analysis' is that they are influenced, at least in part, by the random variations, as the O_3 layer depth is affected by certain atmospheric events. Thus, if we intend to explain particular pattern of the fluctuations in the O_3 depths in the stratospheric region of Pakistan, then we need to construct a mathematical description of the OLD data obtained from a WMO installation of Dobson Spectrophotometer at Geophysical Center, Quetta. Pakistan. Such a model will explain both the deterministic and random features of the OLD.

The construction of the model is one of the basic objectives of OLD analysis, if we can obtain an adequate model for our series, it may provide valuable insight into the physical mechanism generating the data, and it can be used to forecast, for example the future values of the series.

To understand the concept we can illustrate the case of autoregressive model which is frequently used time series model. Autoregressive model is the special case of multiple regression model in which some or all the explanatory variables are lagged values of X_t.

The autoregressive model takes the form

$$X_t = \alpha_o + \phi_1 X_{t-1} + \phi_2 X_{t-2} + \cdots + \phi_S X_{t-S} + e_t \qquad (22)$$

The value X_{t-s} is called the lagged value of Y at time (t – s). The order of autoregrtessive model is s.

where X_t is expressed as a linear combination of its two immediately preceding values. The value of variables X_{t-1} and X_{t-2} are constructed easily by moving the values down the available data.. Auto-correlation between X_t and X_{t-1} and between X_t and X_{t-2} can be computed.

$$X_t = \phi X_{t-1} + \alpha_o \qquad (23)$$

Fig. 2. is a monthly original time plot of ozone depth data.

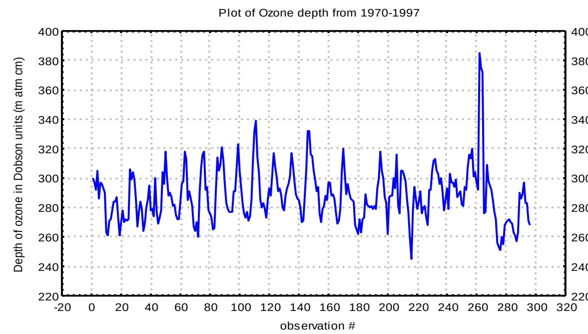

Fig.2. Monthly original time plot of OLD.

and the Fig.3 is a scatter plot of the ozone depth data. From this graph it appears that knowing the value of ozone content in the period (t-1) is useful in predicting the value of the total value of ozone concentration inperiod t. It seems that X_t can be explained as function of X_{t-1}. Now estimate the regression coefficient of order one [16-18].

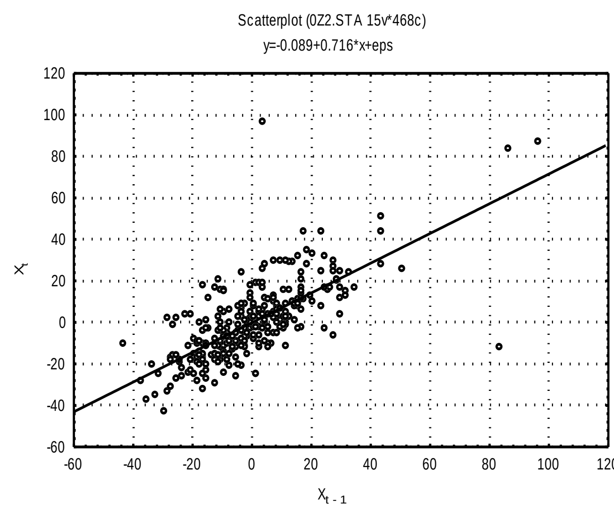

Fig. 3. Ozone depth data: X_{t-1} versus X_t.

$$x_t = \phi_1 X_{t-1} + \alpha_o \qquad (24)$$

$$\hat{x}_t = 81.772 + 0.716\, x_{t-1}$$

t statistics: (6.93) (17.46) R^2 = 51 percent

where α_o = 81.772, ϕ_1= 0.716, and it shows that $\phi_1 < 1$.

The t statistics for ϕ_1 is 17.46 and the value of p = 0.0000 for ϕ_1. The t statistics in an autoregressive model does not exactly follow the t distribution because one of the basic assumptions of the classical linear regression model has been violated.

From the analysis of variance (ANOVA), the coefficient of determination (R^2) can be calculated as

$$R^2 = \frac{SS}{\text{Total SS}} = \frac{50825}{99649} = 0.51. \quad (25)$$

This indicates that 51 % of the variation is explained by the regression model. The remaining 49 % of the variation is itself unexplained. It shows that a good forecast of the value of X is possible when the previous `value of X is known. Using equation (24) to forecast the ozone depth for 297th month by substituting x_{296} = 268 DU. From the equation , we obtain

$\hat{x}_{297} = 81.772 + 0.716\, x_{296}$

x_{296} = 268 DU, and obtain

$\hat{x}_{297} = 81.772 + 0.716\,(268) = 273.66$ DU

Seeing reference (1), recalling that the original data in Dobson unit (1 DU = 10^{-3} cm of O_3 at STP of the atmosphere). Thus the forecast for the 297th of the period specified for this communication.

The periodogram illustrated in Fig. 4, is used to identify randomness in the data series. Also, it helps in identifying seasonality in the given time series, and in recognising the predominance of positive or negative autocorrelation (for positive autocorrelation low-frequency amplitudes should dominate, and for negative autocorrelation, high frequencies should dominate).

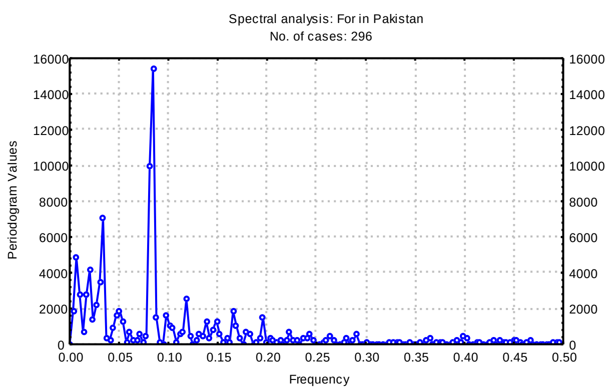

Fig. 4. Periodogram is shown,to identify randomness in the OLD data **.**

(i) Autoregressive processes may be revealed that the patterns of autocorrelations (ACFs), partial autocorrelations (PACs) and within the line spectrum will exhibit a possible model.

(ii) The graph of the data set is a visual assistance to identify the behaviour of the pattern. The autocorrelations and the line spectrum are the summary of the pattern existing in the data. They can reveal a great deal about the data and their characteristics.

The model can be used in the present case to express the dependence between X_t and X_{t-1} in the pair (X_t , X_{t-1}), and to thus relate X_t with X_{t-1} , X_{t-1} with X_{t-2} and so on.. The plot of X_t and X_{t-1} for t = 2, 3, …, 296 is depicted in Fig. 4. It can be examined that the points are scattered around a stratight line. This straight line trend also depicts that X_t does depend on X_{t-1} (X_{t-1} on X_{t-2} , and X_{t-2} on X_{t-3}, and so on). We can write the model relating X_t and X_{t-1} as

$$X_t = \phi X_{t-1} + a_t \quad (26)$$

The above model expresses the dependence of the variable on itself at different times. For model under consideration a_t's at different t are independent, that a_t is independent of a_{t-1}, a_{t-2}, etc. So that just like ε_t the distribution of a_t is assumed to be normal,

$$a_t \sim \text{NID}\,(0, \sigma^2_a) \quad (27)$$

It has been noted that estimated model is completely specified only when σ^2_a is given in addition to ϕ_1. a_t is assumed that it does not depend on the X_{t-2} and X_{t-3} etc.

The value of X_t may increase or decrease without bound because a_t's have fixed finite variance and can not continually increase in magnitude to keep X_t within bound as depicted from the Fig. 5 that explains the residual analysis specified for this model and also confirms that this model is adequate.

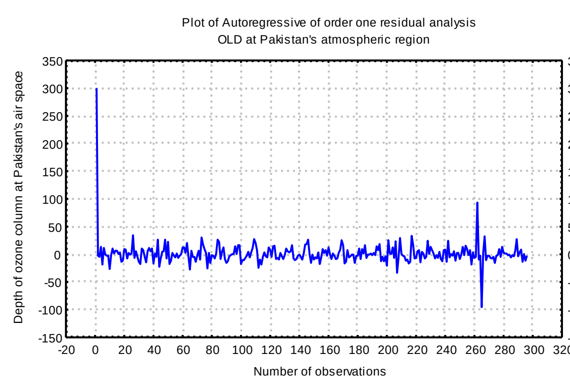

Fig. 5. Plot of Analysis the Residuals for Autoregressive model of order one after fitting to the OLD data for atmospheric region of Pakistan.

Such a situation tells that if ϕ_1 >1 or ϕ_1 < -1, then the series will be nonstationary or unstable time series. For a stationary stable time series, X_t remains bounded in the sense it has finite variance then it is needed that ϕ_1 <1. The Fig. 6, and Fig. 7 illustrate the estimated auto-correlation function and the auto-correlation function for the residual from lags 1 to 15 respectively. The autocorrelation plot represents an important characteristic of the linear stochastic model. The Fig. 6 depicts the estimated correlation between the i^{th} observation and the $(i + m)^{th}$ observation on the y-axis vs the lag number on the x-axis. Similarly, Fig.7 shows autocorrelation plot for the residuals of the ozone layer depths.

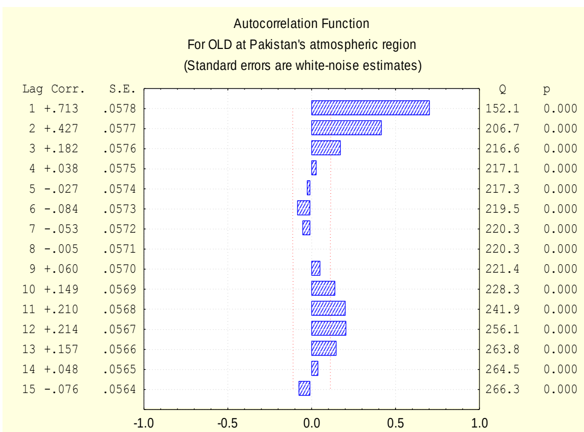

Fig. 6. Plot of Autocorrelation function for OLD

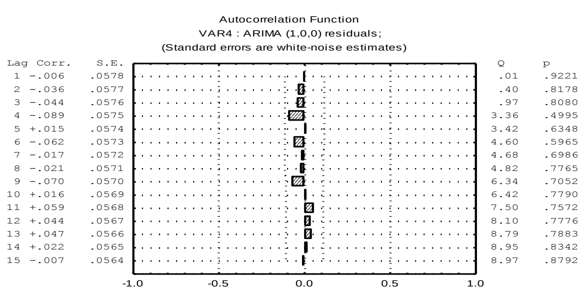

Fig. 7. Autocorrelations for the residuals of OLD, n = 296

The dashed lines in the above mentioned Figures display an approximate 95 % confidence interval for an individual estimated autocorrelation. Thus, for independent observations, a particular confidence limits about 95 % of the time. In these cases, the autocorrelation plots strongly recommend the presence of serial correlation in the ozone data.

8.3. Inspection of Model Adequacy

The constructed model can be inspected by dividing the entire data set into two parts. First section which is regarded as the major part of the data set is operated to estimate or to compute the parameters. The values of the parameters estimated known as the predicted values. These values are compared with the minor portion of the data set which are regarded as the observed values as depicted in the table # 2. Observed values are plotted against predicted values as depicted in the (vide Fig. 8). These illustrations are verifying the results of estimates obtained from the estimating technique.

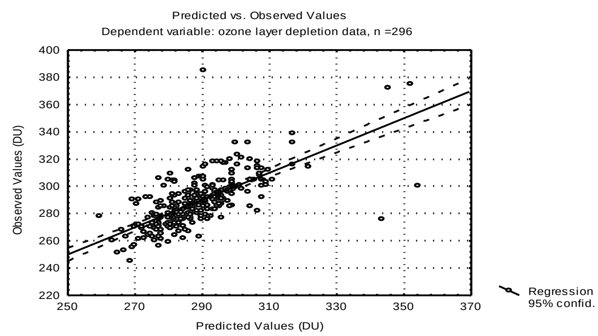

Fig. 8. Plot of observed and predicted values verifying as a results of estimates obtained from the estimating techniques.

Table 2. Comparison of observed and predicted OLD values.

Serial #	Observed	Predicted
297	284.000	267.5927
298	268.000	267.1861
299	265.000	266.000
300	265.000	266.7801
301	262.000	265.9700
302	272.000	265.1600
303	272.000	264.7600
304	273.000	264.3600
305	289.000	263.9500
306	282.000	263.8756

9. CONCLUSIONS

The OLD dilemma will be a very significant research and impact problem in the years ahead, and many investigators in the area will need to provide guidance to decision-makers, if as it is predicted, a significant OLD does occur. It has been found the result which indicates that it is confirmed that the ozone layer is depleting at Pakistan. The principal issue or point is that we need to gauge the impact of the phenomenon of OLD on the present day society apart from the possible impacts which occurred in the past and could occur in future.

The most immediate global environmental threats have been described that we are facing due to high incidences of ultraviolet (UV) radiation at the sea level. Also a disturbing scenario has been demonstrated that the inert CFCs gradually migrate upward into the stratosphere where intense solar UV radiation breaks down the CFCs, causing them to release chlorine, a gas which readily reacts with and destroys ozone which has been depicted in the photochemical reactions. Atmospheric O_3 measurement techniques by various ground-based and satellite-borne instruments have been studied in this communication.

For the available data set ranging from 1970-1997 the normalcy, using Kolmogorove-Smirnov goodness-of-fit test (vide Fig. 1) and (cf. Table 1) has been checked in order to prepare the data for estimating distribution parameters. Here examinations of maximum likelihood estimation procedure may be used to provide acceptable estimator of population parameter. It is simply the value which maximises the information in the sample. The maximum likelihood estimator is identical for that of the moments method examines the construction of confidence intervals (CIs) for the population mean for ozone contents in the stratosphere of Pakistan data based on 296 observations (1970-1997) using two probability levels (+ 95 % and − 95 %). Also the coefficient of variation (CV) has been utilized to check the consistency of the data series. This is one of the measures of scatter or the spread of the distribution relative to the size of the mean estimated in this communication. The coefficient of variation certifies the degree of normality of the data points. Minimum CV shows high degree of normalcy. The numerical value calculated for this indicates that 6.4 % of the data is non-normal.

Finally, It has been established that in order to explain particular pattern of the fluctuations in the O_3 depths in the stratospheric region of Pakistan it is needed to construct a mathematical description of the OLD data obtained from a WMO installation of Dobson Spectrophotometer situated at Quetta Pakistan. This section illustrates the case of autoregressive model that is frequently used time series model and gives fairly accurate results. Predictions regarding OLD made in this paper seems to have been strengthened by the present investigations. Again a decrease in the total ozone content as compared with the global reference content for the Pakistan’s stratosphere From this model forecast value of the 297th month = 273.66 DU obtained starting from 1970 to 1997 that provides reader an insight into the physical mechanism generating the data. It can also be used to forecast, for example the future values of the times series.

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