Available online @ https://jjem.jnnce.ac.in
https: www.doi.org/10.37314/JJEM.SP0205
Indexed in International Scientific Indiexing (ISI)
Impact factor: 1.395 for 2021-22
Published on: 08 December 2024

Climate Change Projection Using Time Series

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Abstract

The challenging issue that the world is facing is Global climate change. Environmental protection, agricultural productivity, and social development are the accurate prediction of climate change. To estimate the global climate change the study investigates the use of the Autoregressive Integrated Moving Average (ARIMA) and Seasonal Autoregressive Integrated Moving Average (SARIMA). The technique which is used to detect the seasonal pattern and non- linear properties accurately in climate data is called the SARIMA model. The line of action such as data cleansing, missing value management converts the data into an analysis ready format which is considered as a data pretreatment process. Taking into the consideration of seasonality and autocorrelation of the climate data the SARIMA model is created. To predict the future global climate, change the SARIMA model is tested by historical climate dataset. The prediction performance is inspected through the SARIMA models. As the SARIMA model predict the global climate change by representing the pattern dynamically. The system results in usefulness and accuracy in predicting the global climate change. The SARIMA model speculates the exact prediction of global climate change and helps in decreasing the mortality from cold waves.

Keywords: *ARIMA, SARIMA, Autocorrelation*

1. Introduction

The current major issue facing in world -wide is global climate change. Environmental conservation, food security as well as social progress depends a lot on accurate predictions about global climate change. Recently on the basis of NOAAs 2023, the combined land, ocean and temperature reports with the average rate of 0.11° Fahrenheit (0.06° Celsius) per decade. The effective method used in machine learning techniques is Autoregressive Integrated Moving Average (ARIMA) and Seasonal Autoregressive Integrated Moving Average (SARIMA) in predicting global climate change. The accurate prediction in identifying the seasonality and nonlinearity within the Weather data is called SARIMA. In addition to satisfactory analysis the data cleaning and missing values are converted to the particular form, which falls under data pre-processing respectively considering the periodicity and autocorrelation nature of weather information. Climate data from past times is utilized to train both the models and in turn anticipate forthcoming general global climatic changes. The performance of the models' prediction will be analyzed to test both the models Relatedness to real-time monitoring of the earth's weather patterns. Experimental results indicate that which model is an excellent representation for the climate data's underlying patters and dynamics. Important that exact predictions made by the SARIMA model should be taken into consideration while trying to forecast and understand our world's future climate conditions.

2. Literature Survey

In the authors Aarati Gangshetty et. al (2021) [1], describes the Seasonal Autoregressive desegregated model which is moving average to predict the Temperature in Pune. The projected values were compared to real values using the ARIMA and SARIMA models. Forecast accuracy measures such as MAE, MSE, a RMSE were calculated. Imrus Salehim. et.al (2020) [5] study uses an LSTM and RNN model to forecast monthly and annual rainfall amounts. They use wind direction, temperature, wind speed, and pressure data to accurately anticipate annual or monthly rainfall amounts. The main goal of this paper is to identify ways farmers might benefit from rainfall predictions. Navaneetha Krishnan M et.al (2022) [8] explores the use of statistical approaches, specifically the ARIMA and SARIMA models, to forecast global mean temperature changes over short time horizons, focusing on 5 to 10 years. To refine the future projection the complex algorithm and wider atmospheric factors are studied. The paper by Peng Chen et.al (2018) [9] focuses on time series forecasting, namely the ARIMA and SARIMA models, to predict monthly mean temperatures in Nanjing using historical data from 1951–2017.The accuracy can be predicted using the mean square method by training and testing the dataset. These MSE values of 0.84,0.89 and 0.94 in sequential years indicates consistent and accurate predictions. The survey study by Janhavi Patil et. al (2022) [4] investigates numerous time series forecasting approaches such as ARIMA, Prophet, and LSTM, focusing on their applications in a variety of fields such as weather prediction, finance, and healthcare analytics, such as COVID-19 data analysis. Shubham Puri et.al(2020) [12] study looks at the forecast of future temperature values and table of historical data from the year 1880 to 2017 in order to make a prognosis on global warming. The SARIMA and SARIMAX models are developed from the basic ARIMA model that is used in the analysis and forecasting of time type data. Mohammed Abdus Samee et. al (2021) [7] developed a prediction model which will estimate future temperature in a certain area using temperature history and regression analysis. Satrio et.al (2021) [11] employes the timeseries Weather prediction techniques like ARIMA, Prophet, LSTM used to forecast the weather system by data-driven. M Bahari, N Z A Hamid (2016) [6] focused on applying a chaotic approach in the analysis and prediction of temperature time series in the town of Jerantut, Pahang, Malaysia. The goal of the study is to demonstrate chaotic dynamics in the temperature series by means of phase space reconstruction and then forecast future temperatures based on a method which employs local mean approximation. Devango Sodha and Geetali Saha (2016) [2] emphasizes on weather prediction in Indian farming, upon which a significant proportion of society and GDP depend. It points out the role played by global warming in reduced farm output and the importance of correct weather forecasts in neutralizing its effects.

3. Methodology

The proposed system takes itself into next step to show that the global climate change prediction helps in awaring the heat wave is on its way to plan energy procurement to prevent power outages the models are created through grid points which then predict the variables of temperature, Co2 emission, NH4, deforestation, afforestation, sea level fossil and industries, and Agriculture burning through grid values, this is done through the following methods.

3.1 Data collection: In this section the data is collected from the power where it contains the dataset from 1990-2020. this dataset includes Co2emission, NH4, temperature dataset includes from1900-2020, addition to that Co2emission, NH4, temperature dataset includes from1900-2020, addition to that afforestation, deforestation fossil and industrial, agricultural and land burning.

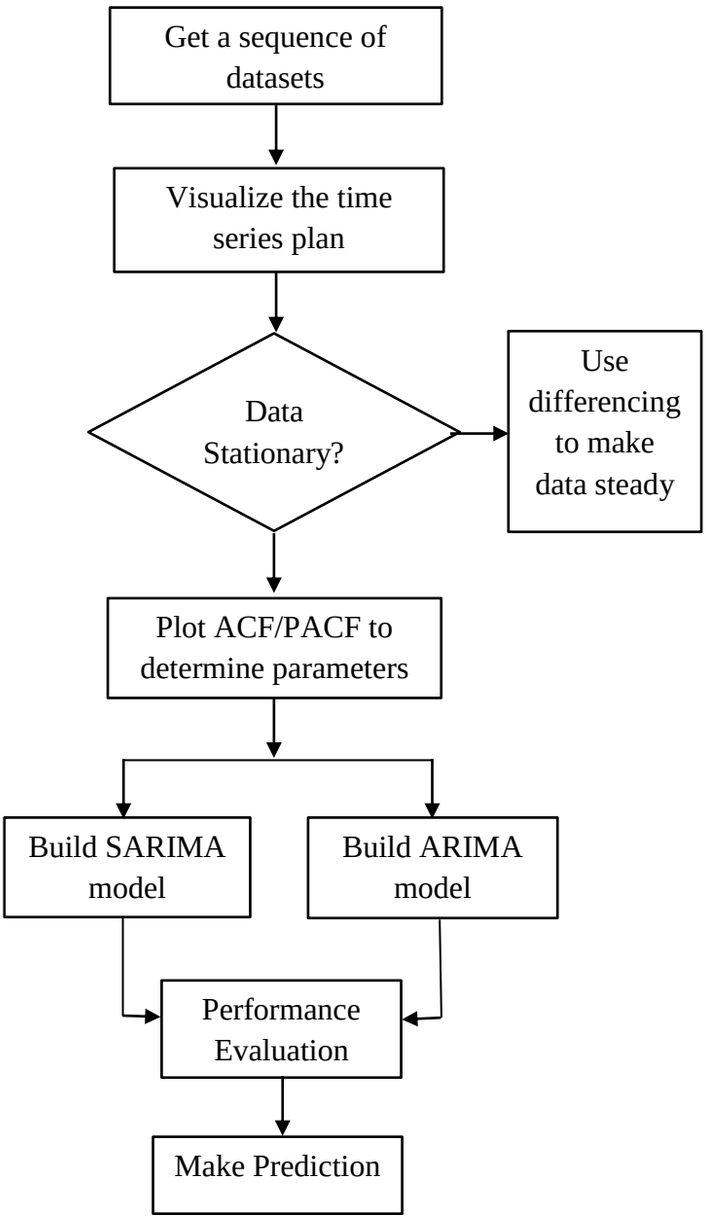

Fig 1: Flow chart of climate change prediction using time series

3.2 Visualize the time series plan: This is used in the understanding based on decision making in proactive climate changes and enhances the change in the climate. After the data collection, clean the time series data in order to process it. This can be done by taking care of missing values, handling outliers or ensuring it is stationary. This helps in monitoring the long-term trends in various climate datasets which identifies the anomalies of changes in the climate.

3.3 Data stationary: Inspect stationarity. In case time series is non-stationary, it should be differenced to make it stationary. We have worked on our data set stationarity through augmented Dickey-Fuller test where it has been found not to have stationarity. First differencing should be done. Progressively difference is 0.05 only when p value is less than or equal to Dickey-Fuller test. The order of differencing (d) will be the one which gives minimum standard deviation". The differenced series that was stationary, now may contain some auto-correlated errors that can be removed by incorporating $p > 1$ AR words while retaining the MA terms for prediction equivalency $q \geq 1$.

This stage illustrates the ACF and PACF of the facts. Autocorrelations and partial autocorrelations are used in model identification. Consequently, there's a gradually decreasing in ACF plot stint in PACF it slit soon after lag. It would be appropriate for the model to have AR (1) according to the graph thus indicating that this model would be appropriate. On the other side as far as individual lags are concerned, PACF first shift is low which signifies significant seasonality present in this differenced series. If the ACF seem to be relatively quiet, the series is 'over differenced' to some extent, and as such an MA phrase is put in to the model and the model is now complete. After that, an optimal model is selected based on a performance criterion such as AIC (Akaike Information Criteria). The below fig 2 and 3 represents the Autocorrelation function and Partial Autocorrelation function.

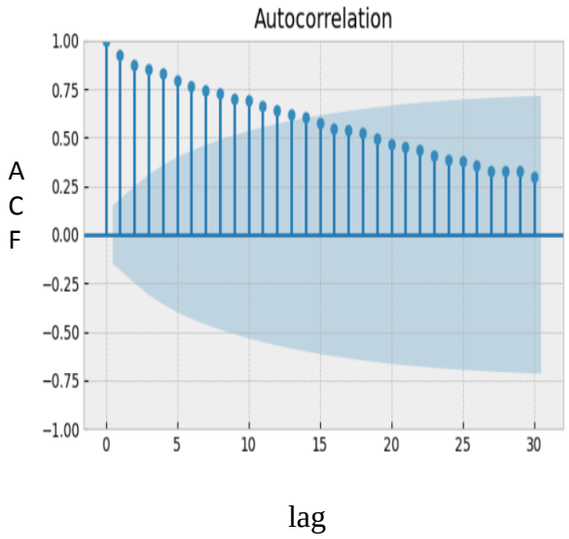

Fig 2 Autocorrelation Function

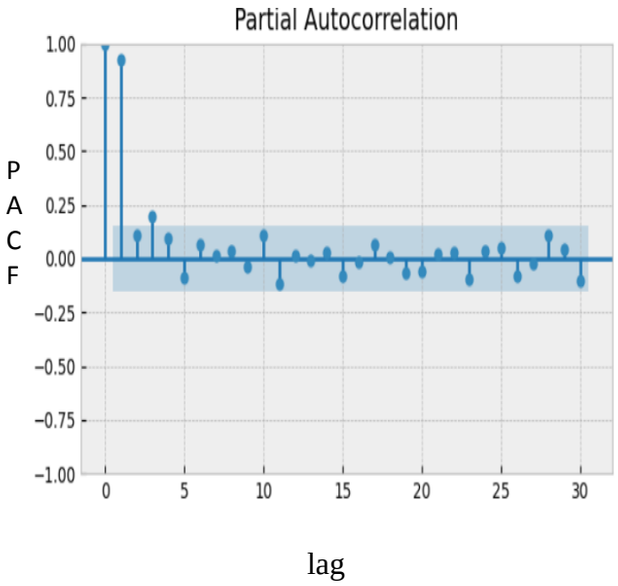

Fig 3 Partial Autocorrelation Function

3.4 ARIMA and SARIMA Model:

The project utilized different techniques of regression to predict climate change.
There are:

- Auto-Regressive Integrated Moving Average (ARIMA)
- Seasonal Auto-Regressive Integrated Moving Average (SARIMA)

3.4.1 ARIMA Model

Auto Regressive Integrated Moving Average Model While ARIMA series is concerned about two processes, that is to say, autoregressive (AR) and moving average (MA). These can amount to

• p: interval orders in the model, dubbed interval observations

• d: series stationary can only be achieved through differencing

• q: window size for moving average also order of moving average

Generally, the ARIMA model is denoted as ARIMA (p, d, q) in accordance with Box Jenkins methodology [10]. Specifically, we can say that the equation that defines the AR (p) model is represented below.

$$Yt = c + \emptyset 1 Y_{t-1} + \emptyset 2 Y_{t-2} + \cdots + \emptyset n Y_{t-n} + et \quad .. (1)$$

Where,

- Yt is response variable at time t,
- $Yt-1, Yt-2 \ldots \ldots Yt-p$ is response variable at time $t-1, t-2,$ and $t-n$ respectively.
- c is constant term
- $\phi 1, \phi 2$ *and* ϕn are coefficients to be estimated
- et is error term at time t
- The MA(q) model is defined by the equation:

$$Yt = c + \theta 1 W_{t-1} + \theta 2 W_{t-2} + \cdots + \theta n W_{t-n} + et \quad \ldots (2)$$

Where,

- Yt is response variable at time t
- c is constant term
- $Wt-1, Wt-2, \ldots Wt-q$ predict error at time series value t-1, t-2 and t-q
- $\theta 1, \theta 2$ and θq are values to be roughly calculated.
- et are blunder at t

By merging equation (1) and (2) Autoregressive integrated moving average model ARIMA (p, d, q) put down mathematically as

$$Y_t = c + \emptyset 1 Y_{t-1} + \emptyset 2 Y_{t-2} + \cdots + \emptyset n Y_{t-n} + \theta 1 W_{t-1} + \theta 2 W_{t-2} + \cdots + \theta n W_{t-q} + wt \quad ..(3)$$

3.4.2 SARIMA model

Seasonal behavior describes the instance where a certain essential pattern that is repeated at certain times stays the same. With the addition of seasonal terms, Seasonal ARIMA model (SARIMA) is a raised based on seasonal ARIMA models that are mentioned in the foregoing.

SARIMA models are written as,

$$ARIMA\ (p, d, q)\ (P, D, Q)\ m \qquad \ldots\ldots.(4)$$

In machinery learning, this term often refers to as (p, d, q) (P, D, Q) m where (p, d, q) stands for the model's non-seasonal and seasonal components. The d constraint simply defines how many orders of differencing would require to make series stationary. Just like the former, the latter specifies m as representing the number of periods per season. The 12-period setting gives the constraint m value.

3.5 Performance Evolution:

We used MSE, RMSE and MAE for deciding how well a system performs. MSE is found by squaring errors because it measures variance among filed data points.

$$MSE = \frac{1}{N \sum_1 e_t^2} \qquad \ldots\ldots\ldots\ldots.(5)$$

The RMSE refers to the Root Mean Squared Error which means that it has the same units as the data. It can be computed as:

$$RMSE = \sqrt{\sum_1 e_t^2} \qquad \ldots\ldots\ldots\ldots..(6)$$

Mean absolute error is simply the mean of the absolute deviation

$$MAE = mea(|e_t|) \qquad \ldots\ldots\ldots..(7)$$

4. Experimental Results

AIC Stands for Akaike's Information Criterion (AIC) is regularly used model selection criterion. AIC simply introduces the issue about model exactness. AIC calculated as:

AIC = -2ln+2k (maximum likehood)

where, k represents the number of independent constraints estimated. Thus, the selected model is the one having a smallest AIC value. (2, 1, 0) (2,1,0) [12] The best AIC value is the smallest one which is -154.198. Considering this one, all the other AIC values are higher. It is therefore the best prediction model.

ARIMA (p, d, q) (P, D, Q) s	**AIC Values**
ARIMA (1,1,1) (0,1,1) [12]	AIC: inf
ARIMA (0,1,0) (0,1,0) [12]	AIC: -11.930
ARIMA (1,1,0) (1,1,0) [12]	AIC: -67.372
ARIMA (1,1,0) (0,1,0) [12]	AIC: -34.688
ARIMA (1,1,0) (2,1,0) [12]	AIC: -85.109
ARIMA (0,1,0) (2,1,0) [12]	AIC: -49.069
ARIMA (2,1,0) (2,1,0) [12]	AIC: -154.198
ARIMA (2,1,0) (1,1,0) [12]	AIC: -139.847
ARIMA (3,1,0) (1,1,0) [12]	AIC: inf
……	…….
ARIMA (3,1,0) (2,1,0) [12]	AIC: -152.198
……..	……..

Table 1: AIC values for ARIMA model

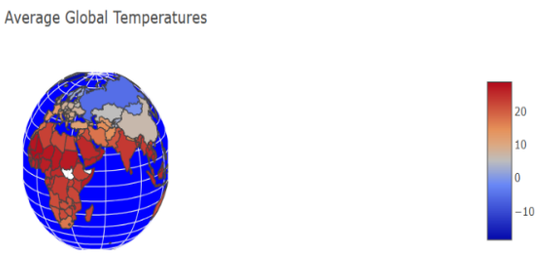

Fig 4: Average global temperature

In the above fig 4 is represented through the historical data which was extracted from NASA power the figure represents the red spots in the glob that defines the high global temperature change region followed by blue defines with minimum temperature rate.

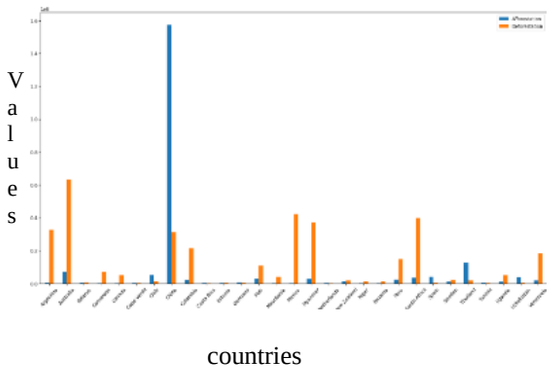

Fig 5 Global Afforestation and Deforestation

In proposed system of global climate change prediction, the application of machine learning techniques is used with the methods name SARIMA and ARIMA which results in the above prediction fig 5.

Conclusion

This paper emphasizes the methods which is used to build this system which results in the best AIC value with lowest rate in addition to this the system represents a global temperature climate change indicating low and high temperature region. This work also results in the best global afforestation and deforestation and other prediction like NH4, Co2, Sea level, Fossil and industrial, and Agricultural burning. Both ARIMA and SARIMA model will give best accuracy result. And the forecasting calculates the accuracy of MAE, MSE and RMSE.

References

1. Aarati Gangshetty, Gurpreet kaure anf Uttam Sitaram Malunje “Time Series Prediction of Temperature in Pune using Seasonal ARIMA Model” Internatinal Journal of Enginnering Research & Technology (IJERT) ISSN: 2278-081 vol. 10 Issue 11, November-2012
2. Devangi Sodha and Geetali Saha “Crop Management of Agricultural Products using Time Series Analysis” IEEE International Conference on Recent Trends in Electronics Information Communication Technology, May 2016.
3. Guo, T., Dong, J., Li, H., & Gao, Y. Simple “convolutional neural network on image classification”. Paper presented at the 2017 IEEE 2nd International Conference on Big Data Analysis (ICBDA), 2017.
4. Janhavi Patil, Prof Nirmala Shinde “Time Series Weather Forecasting Techniques” International Research Journal of Engineering and Technology (IRJET), Vol. 09, Iss. 06, June 2022
5. Imrus Salehim. Iftakhar Mohammad Talha and et.al “An Artificial Intelligence Based Rainfall Prediction Using LSTM and Neural Network” IEEE International Women in Engineering (WIE) conference on Electrical and Computer Engineering (WIECON-ECE) 2020
6. M Bahari, and N Z A Hamid “Analysis and Prediction of Temperature Time Series Using Chaotic Approach” IOP Conf. Sci. 286 012027 doi:10.1088/1755-1315/286/1/012027, 2019

7. Mohammed Abdus Samee, M.S Harsha Vardhan Reddy and Karthik Suresh "Climate Change Prediction" International Research Journal of Engineering and Technology (IRJET), Vol. 08, Iss. 01, Jan 2021

8. Navaneetha Krishnan M, Ranjith R and Lavanya B "Climate change Prediction Using ARIMA Module" International Journal for Research Applied Science & Engineering Technology (IJRASET), ISSN: 2321-9653, IC Value: 45.98; Vol. 10, Issu. VI, June 2022

9. Peng Chen, Aichen Niu and et.al "Time Series Forecasting Temperature using SARIMA" ACMME 2018, IOP Publishing, IOP conf. 2018

10, Prof. Saranjeet Singh and et. al "An effective weather forecasting using neural networks.", International Journal of Emerging Engineering Research and Technology, Vol. 2, Iss. 2, May 2014

11. Satrio, Christophorus Beneditto Aditya, et al."Time series analysis and forecasting of coronavirus disease in Indonesia using ARIMA model and PROPHET." Procedia Computer Science 179 (2021): 524-532.

12. Shubham Puri, Prajwal Selokar and et.al "Forecating of Temperature by Using Time Series Analysis" IJRAR, Vol7, Iss 1, 2020

13. S.Santhosh Baboo and I.Kadar Shereef, "An efficient weather forecasting system using artificial neural network. International journal of Environment science and Development", No.4, October- 2010, ISSN: 2010- 0264

14. Y.Radhika and M.Shashi, "Atmospheric Temperature prediction using Support Vector Machine", International Journal of Computer Theory & Engineering, Vol.1.No.1.April 2009