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An Investigation in Temperature Data Analysis of Middle Atmospheric Variation from SABER Satellite

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ABSTRACT

This paper focuses on significant data analysis for middle atmospheric variations of height of 0 km 100 km. This data was downloaded from the SABER satellite NASA and analyzed with the help of MATLAB. The analysis includes the determination of propagation of wavelengths and oscillations for the semi-annual oscillation (SAO), Annual oscillations (AO), quasi-annual oscillations (QBO), EINIO southern oscillation (ENSO) from the period of Jan 2002 to Dec 2022 past twenty years data. The monthly mean Temperatures, monthly ozone deviations, and overall mean temperatures with standard deviations are estimated for the following altitude regions concerning troposphere (0-20km), stratospheric (21-50 km), mesospheric (51-90 km), and thermospheric regions (91-105 km). However, the results proved that the maximum temperature variations would affect the ozone depletion for the areas concerning the altitude height of 15-40 km region between troposphere and stratospheric in the temperature range of 260K, and average deviations are found in the order of 0.000010 μm for the troposphere region. The presence of harmful gases such as CO, CO_2, NOx, H, and CH_4 released from the automobile and powerplant industry may deplete the ozone layer and cause adverse effects.

INTRODUCTION

The region is subdivided into three categories: 0-10 N, 10-20 N, and 20-30 N. It is necessary to predict the ozone layer variations that occur due to the evolution of various gases and high temperature-based air from different sources like automobiles and power plant-based industries, resulting in higher temperature variations that affect the ozone layer and form global warming (Hansen et al. 2016). The major constituents present in the exhaust gases, such as NO_X, CO, CO_2, H, and S, will affect the atmosphere and may cause serious adverse effects on humans and other living organisms (Samad & Shah 2017). The movement of gases from lower attitudes to higher attitudes by the impact of higher densities in the form of turbulent motion causes the change in atmospheric variation levels. It is noted that at lower altitudes, the transfer of heat is significantly less due to lower temperature regions, and air velocities were very low compared to higher attitudes (Huang et al. 2017). Various research proves that the density of the gases or air increased at higher altitudes in the range of above 40 km will affect the atmospheric change in variations like an increase in temperatures and an increase in air velocities (Kumar et al. 2016a). Various researchers proved the second important factor that affects the change in atmospheric variations. From the various literature, it was observed that the temperature variations depend upon the turbulence effects, atmospheric effects, and wind velocities (Williams 2017). According to Zareie et al. (2016), an increase in the earth's surface temperatures causes a change in climatic conditions and a change in regions. Although various researchers have scientifically proven that 70% of the change in atmospheric variations occurred during the summer seasons due to the availability of a gradual increase in surface temperatures of the earth (Prats et al. 2018). According to Srimanickam and Kumar (2021), the maximum surface temperature of the earth due to this turbulence effect was raised from 27°C to 56°C. The work comprises low latitudes ranging from 0-10N, 10-20N, and 20-30 N at attitude heights of 25 km to 100 km for specifically finding the change in middle atmospheric variations to find the oscillations such as SAO, AO, QBO, and ENSO. This analysis is used to forecast the central atmospheric dynamics that allow various researchers to minimize the constituents present in the air

that prevent ozone layer depletion and global warming. The objective of this research is to determine the thermal performance over the international atmosphere for different altitudes: troposphere (0-20 km), stratospheric (21-50 km), mesospheric (51-90 km), and thermospheric regions (91-105 km). This analysis will be helpful to the young researchers for the maximum temperatures emitted from various automobiles and powerplants and the importance of emissions that will affect the atmospheric regions. Hence, each young researcher must focus on exhaust gas emission reduction by implementing multiple alternative sources of energy that emit fewer pollutants in the replacement of diesel engines and the replacement of fuels in power stations. The various technologies replacing automobiles and emissions sources must be controlled with adaptive sensor technology for building less harmful effects and more conventional time.

MATERIALS AND METHODS

Fig. 1. indicates the methodology process involved in this analysis. The data from Jan 2002 to Dec 2022 was downloaded from the website link of NASA source as Saber satellite and analyzed in Matlab to measure the thermal behavior of gases and air in the ozone layer. This range selection was considered from Lattitude 0-30 N and Longitude 74-84 E. The temperature data is a source for measuring the mean deviations. Wavelet and amplitude analyses were carried out. The properties, such as standard deviation, were analyzed monthly, and this analysis was based on daytime layer O_3-96. The measurement of gases and airflow rate by FFT per amplitude for oscillations was also carried out to determine the wavelength range with respect to temperatures (Karthickeyan et al. 2017)

Experimental Procedure

Fig. 2. represents the experimental procedure involved in this analysis. The central theme of this analysis is to analyze the temperatures from the low latitudes in the range of 0-30 N and longitudes 60-90 E. The periodic time for this analysis is taken as JAN 2002 to DEC 2022. Twenty years of data are recorded in a data logger (Arun et al. 2017, Rupesh et al. 2022). The satellite receives the data and stores it in the data logger. The recorded data was downloaded, and the amplitude variations and wavelet variations in the ozone layer were analyzed to predict the temperature trends that will affect the ozone layer (Li et al.2019, Bishnoi 2023). The analysis is conducted in the altitude range of 25 km to 100 km to determine the mean deviations and oscillations and estimate the trends between the ozone layer. This analysis gives a brief idea about the ozone layer depletion caused due to severe temperatures due to greenhouse gases. The majority of the gas, such as nitrogen dioxide, is released from

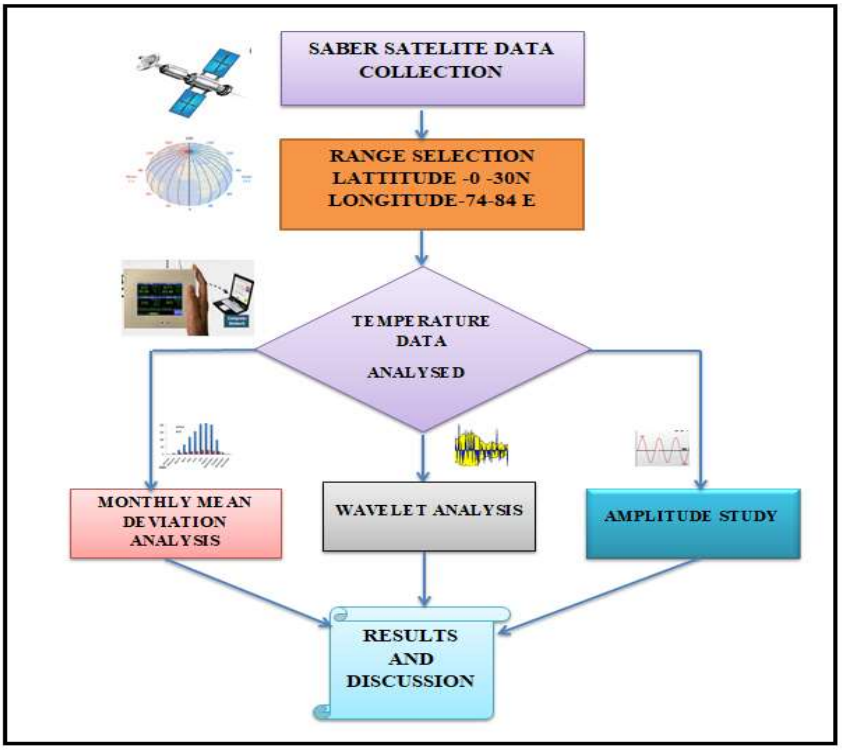

Fig. 1: Methodology.

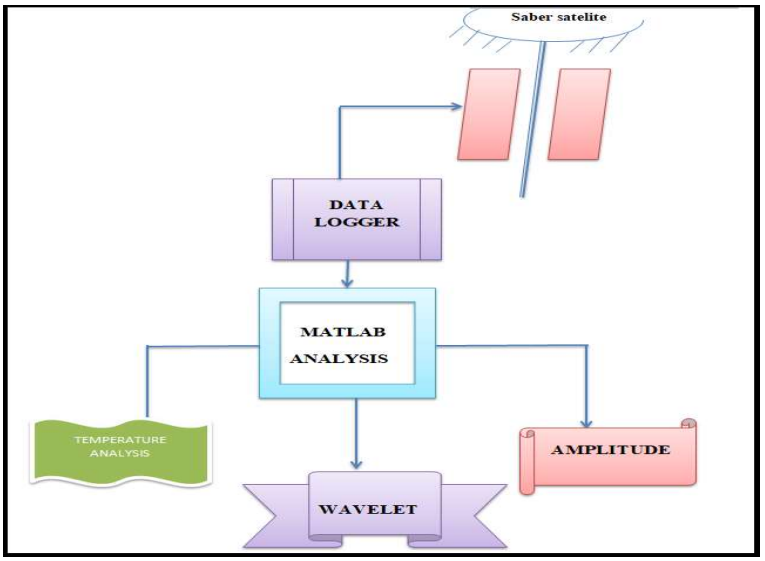

Fig. 2: Experimental procedure.

Table 1: Average temperature data for the period of Jan 2002 to Dec 2022.

S. No.	Altitude in km	Temperature in K	Temp-Standard deviation in K	Ozone-O_3 in mol mol^{-1}	O_3-Standard deviation in mol mol^{-1}
1.	20-25	221.9426	2.34645	$6.75909E^{-06}$	$1.0918E-^{06}$
2.	25-30	230.7924	2.528651	$9.97117E^{-06}$	$6.35033E^{-07}$
3.	30-35	239.9935	2.849822	$9.3162E^{-06}$	$4.57383E^{-07}$
4.	35-40	251.7469	3.082096	$7.07007E^{-06}$	$4.33035E^{-07}$
5.	40-45	260.1246	2.75563	$4.68518E^{-06}$	$3.1743E^{-07}$
6.	45-50	259.084	3.214266	$2.98101E^{-06}$	$2.02864E^{-07}$
7.	50-55	250.1491	3.720108	$1.9012E^{-06}$	$1.44102E^{-07}$
8.	55-60	236.2632	3.951742	$1.17573E^{-06}$	$1.1067E^{-07}$
9.	60-65	221.2786	4.232187	$6.82337E^{-07}$	$1.00247E^{-07}$
10.	65-70	211.351	4.863111	$4.1822E^{-07}$	$7.88635E^{-08}$
11.	70-75	199.2492	5.657504	$2.08599E^{-07}$	$6.08634E^{-08}$
12.	75-80	193.6458	6.358009	$2.82699E^{-07}$	$1.28711E^{-07}$
13.	80-85	193.1838	6.582142	$6.55015E-^{07}$	$2.36238E^{-07}$
14.	85-90	188.3699	5.625287	$1.26276E^{-06}$	$4.18805E^{-07}$
15.	90-95	178.9586	5.649485	$1.21886E^{-06}$	$4.809E^{-07}$
16.	95-100	176.7688	7.651902	$7.22041E^{-07}$	$4.06443E^{-07}$

the power industry and the automobile sector, causing the harsh effect of ozone layer depletion (Gholami et al. 2020). Table 1 represents the average temperature data for the period of January 2002 to 2022.

RESULTS AND DISCUSSION

Monthly Mean Temperatures

It is essential to monitor the temperature distribution in the layers concerning various altitudes for the troposphere (0-20 km), stratospheric (21-50 km), mesospheric (51-90 km), and thermospheric regions (91-105 km). This graphical data gives a brief idea of harmful effects in various areas and causes at multiple altitudes (Ma et al. 2020a). From Fig. 3, it is keenly observed that for maximum temperatures of 260 K, there is a formation of ozone depletion. Beyond this temperature, it is essentially noted that there are no variations formed, and while exceeding and reaching this

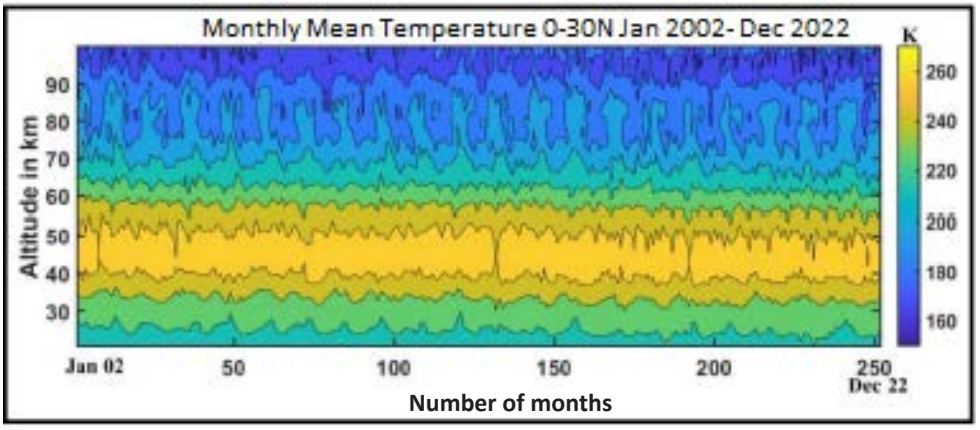

Fig. 3: Monthly Mean temperature variations.

temperature, it causes ozone depletion (Hilton & West 2020). The main constituents such as CO, CO_2, NOx, H, and CH_4 in the summer season released from various automobiles and power plants may cause the highest deviations for the troposphere and stratospheric region (Kumar et al. 2017, Tamura et al. 2020). The highest temperature difference of 260 K is attained in the summer seasons due to an increase in marginal temperatures caused by green gases. This will affect the performance of the ozone layer to deplete the layer.

Monthly Ozone Deviations

Fig. 4. represents the ozone deviations subjected to different attitudes in the range of 25-100 km attitudes. The measurement of ozone depletion is necessary to predict the difference in ozone layer depletion due to temperature differences caused by various green gases (Ma et al. 2020b). The greenhouse gases such as CO, CO_2, NO_x, H, and CH_4 huge green gas have enormous releases that will affect the ozone layer depletions in the altitude range of 10-100 km. It is observed from Fig. 4 that High ozone depletion occurs in the range of 15 km to 35 km. This is due to the concern of high-temperature dissipation of nitrogen gases released from automobiles in the range of 43.5% and sulfur gases in the range of 22% from various power plants (Sunil Kumar et al. 2022). Another reason behind the increase in high ozone variability in the attitudes of 15- 35 km is the dissipation of heat is very low, always in the troposphere region due to the rise in surface temperatures. 70% of heat can be dissipated, and 30% causes the stratosphere to form ozone layer depletion. It is also observed from Fig. 3 that medium ozone variability occurs in the range of 40 to 60 km attitude. Heat dissipation is very low compared to 15 km to 35 km (Tyson & Kennedy 2020). This is due to the lower convective phenomenon occurring in this region due to lower

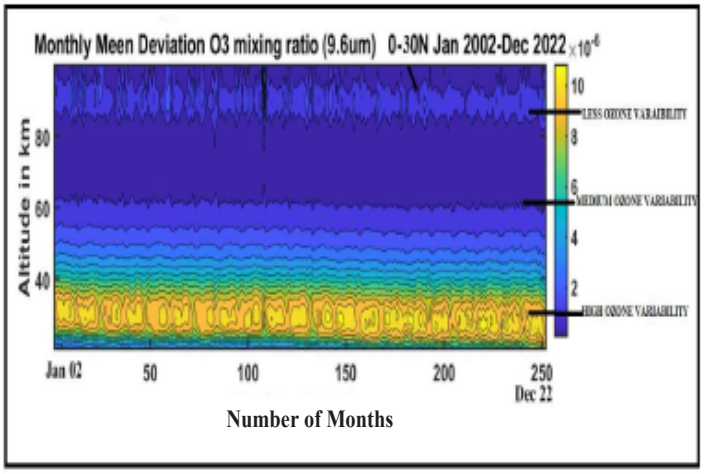

Fig. 4: Ozone deviations.

thermal heat dissipation caused in these regions. Almost 80% of heat dissipation is completed in the area of 15 km to 35 km altitude (Yu et al. 2021). The minimal percentage of 2% heat dissipation doesn't affect the ozone, and there are fewer amplitude variations compared to the troposphere. Very few thermal deviations occurred in the mesosphere region in the range of 60 km to 80 km (mesosphere) and 80 km to 100 km (thermosphere). This is due to the decrease in substantial temperature dissipation concerning the significantly less heat transfer and significantly less convective phenomenal medium of green gases (Mlynczak et al. 2022). An important marginal difference of 2% is happening for the mesosphere region and 1.3% for the thermosphere region compared to the troposphere.

Estimation of Overall Mean Temperatures

It is essential to monitor and measure the overall mean temperatures to estimate the overall thermal performance and heat dissipations for each layer, starting from the troposphere, stratosphere, mesosphere, and thermospheric conditions (Davis et al. 2020). The mean temperature data significantly represents the temperature difference caused at each layer due to the thermodynamic behavior of the green gases evolved in various regions (Meng et al. 2017). Fig.5 depicts the overall thermal temperatures with average standard deviations. From Fig. 5., It is keenly observed that the mean temperature is high at the altitude height of 0 - 45 km in the range of 260 K. This is due to the reason that increases in marginal growth of high-temperature gases were released in this layer 0-20 km (tropospherical region) and 21-45 km (stratospherical part). The heat dissipation occurs by the phenomenon of centrifugal and turbulence effects caused by forced convection phenomenon for the layer 0-20 km (tropospheric area), inductive convection medium occurred at the area 21- 45 km (stratospheric area). The combination of convective and inductive at various wind velocities in the range of 20m/s to 50m/s in the temperature zone of 260 K causes ozone layer depletion (Richardson et al. 2018). Hence, it is required to minimize the usage of greenhouse gases by alternative fuels in the automobile and power industry. For the regions mesosphere and thermosphere at the altitudes height of 50-80 km and 80 -110 km, the overall mean temperature difference is meager in the fields of 180 K and 140 K. A substantial decrease in

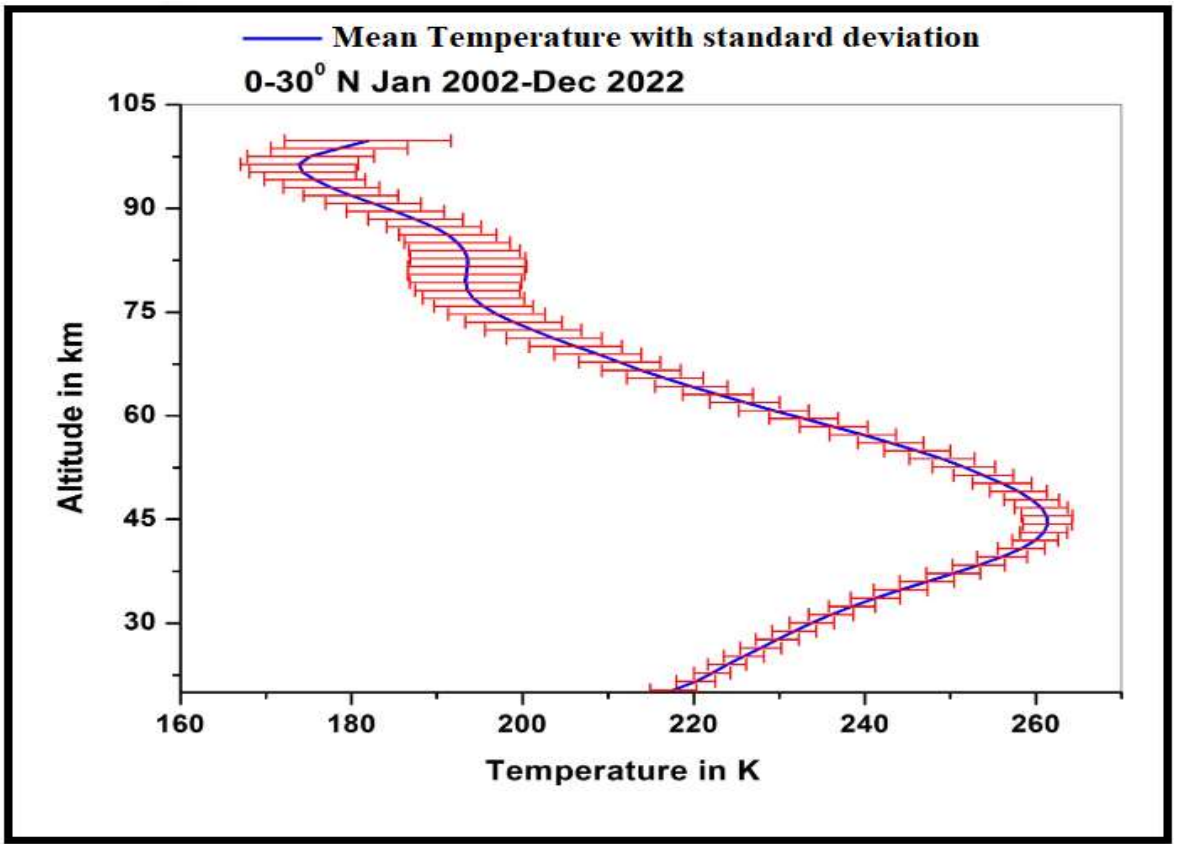

Fig. 5: Overall mean temperatures with standard deviations.

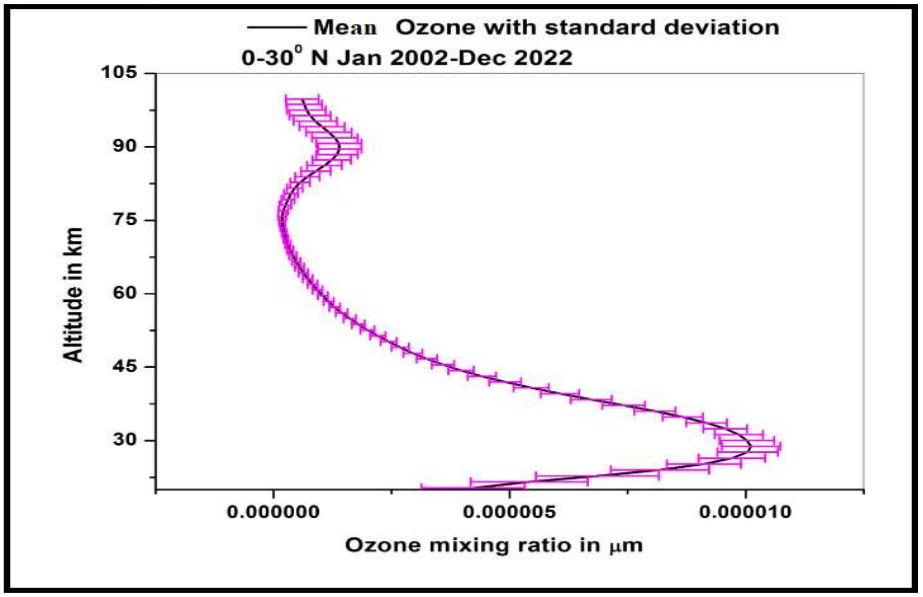

Fig. 6: Overall deviations in ozone.

temperatures is found in the range of 35% for the mesosphere compared to the stratospheric region and a 42% decrease in mean temperatures for the region troposphere compared to the stratospheric region (Vivekananthan et al. 2023). This is due to the absence of convective and inductive forces in this region, which might reduce the turbulence effects and the temperatures compared to the troposphere and stratosphere (Kumar et al. 2016b, Cai et al. 2022).

Estimation of Overall Deviations in Ozone

It is essential to measure the performance by assessing ozone deviations concerning the gases. The ozone mixing depends upon the intensity of the gases released from various sources such as automobiles and power plants. The combined effects of convective and radiative medium with centrifugal and turbulence effects rapidly deplete the ozone layer (Ansmann et al. 2022). Fig. 6. depicts the mixing ratio of ozone due to highly harmful gases released from various sources. From Fig. 6, it is observed that at the tropospheric region, the average deviation is found in the order of 0.000010 μm for the altitude (0-40 km). This is the maximum average standard deviation recorded for the entire period from Jan 2002 to Dec 2022. The rapid extrusion due to the combination of all turbulence effects may propagate the maximum deviations compared to other regions (Muniamuthu et al. 2022). For the regions mesosphere and thermosphere at the altitudes height of 50 -80 km and 80 -110 km, the overall average ozone deviations are very low in the range of 0.00015 μm and 0.0005 μm. This is due to the phenomenon of less corrugated forces and less intensity of radiations in this region due to the formation of fewer temperature distributions at night time compared to the troposphere and stratosphere (Zidan et al. 2022, Kumar et al. 2023).

CONCLUSION

The temperature data from Jan 2002 to Dec 2022 has been downloaded from Saber satellite using the latest data logger. The analysis, such as temperature concerning monthly data and overall year data, is analyzed with the help of Matlab software. The total variations for the entire period are explored, ranging from 0 to 100 km, concerning all the regions troposphere (0-20 km), stratospheric (21-50 km), mesospheric (51-90 km) and thermospheric regions (91-105 km). The effect of ozone layer depletion for the above periods is discussed, and the following results were observed from the analyses. The temperature data is a source for measuring the mean deviations, and wavelet and amplitude analyses were carried out. The main constituents such as CO, CO_2, NOx, H, and CH_4 in the summer season released from various automobiles and power plants may cause the highest deviations for the troposphere and stratospheric regions. High ozone depletion occurs in the range of 15 km to 35 km. This is due to the concern of high-temperature dissipation of nitrogen gases released from automobiles in the field of 43.5% and sulfur gases in the range of 22% from various power plants. The combination of convective and inductive at multiple wind velocities in the field of 20m/s to 50m/s in the temperature zone of 260K causes ozone layer depletion and greenhouse effects. Very few thermal deviations occurred in the mesosphere region in the range of 60 km to 80 km

(mesosphere) and 80 km to 100 km (thermosphere). This is due to the decrease in substantial temperature dissipation concerning the less heat transfer and significantly less convective phenomenal medium of green gases. Hence, this study will give a brief idea to young researchers working in the field of NASA to evolute and minimize the harmful gases released to the atmosphere with the help of other conventional energy sources.

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