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ANALYSIS OF SEASIONAL VARIATION AND MEASURMENT OF TOTAL OZONE OVER BIRGUNJ

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Abstract

The objective of this study was to analyze the seasonal variation and measurement of total ozone concentration (TOC) over Birgunj during one year period from February 2017 to March 2018. The measurement of TOC was made on day time period only. The daily, monthly and seasonal variations of TOC were analyzed during whole study period, the highest value of TOC is found to be 305DU in June 2017 and lowest value of TOC is 215DU in January 2018. The trend of TOC shows the seasonal pattern with maximum in summer and minimum in winter season. Specifically, high value of TOC was found in June and July and low value in December and January. The result illustrates the significant diurnal variation of total ozone with maximum at noon time and minimum at morning time and evening time. The daytime value was subjected to rather larger fluctuation due to increase solar radiation and temperature, lightning during cloudy and rainy days exhaust gases from automobile and industries.

Key words

Ozone depletion; ozone hole; stratosphere; total ozone concentration (TOC); Dobson unit.

Introduction

In 1974, S.C. Kendeigh has defined the environment as a sum of Physical and biological factors that directly influence the survival, growth, development and reproduction of organism. The life activities or growth of organism are centered on the thin surface zone of earth. This life supporting component is known as Biosphere which is closely interrelated with Lithosphere (land), hydrosphere (water) and atmosphere (air). The gaseous envalop of the earth is called atmosphere. It interacts with the environment and affects their ability to support life. It is multi-layered such as exosphere, heterosphere, mesosphere, stratosphere and troposphere. About 90% of the total ozone in the atmosphere concentrates in the stratosphere which lies about 16Km-50Km from earth's surface. In this region the ozone concentration may reach 20ppm. It has the temperature between 45°-75°F. In stratosphere, oxygen is found in ionised form called ozone (O_3). Sothat, this ozone is also called the ozonosphere or ozone layer (Lal, 1957).

Ozone is one of the important gases among the gases found in the earth's atmosphere. The volume of ozone gas present in the atmosphere is about 0.00006 percent of total gas. It plays a significant role in regional and global climate change, human health and environment conditions. The proportion of ozone in the atmosphere is very low so it filters certain wavelengths of incoming harmful solar ultraviolet (uv) radiations and protect the living organism on earth [Molina and Rowland, 1974]. Ozone is formed by the chemical reaction between three atoms of oxygen (O_3). It is a very toxic gas and highly reactive molecule having light pale blue or green colour. It is thin in equatorial sky but thick in 70 degree longitude in two hemispheres. It forms a very thin life saving layer like blanket covering the whole earth called Rachha Kawach i.e; natural protecting umbrella (Madronich, 1992). In the stratosphere, ozone is formed by the photochemical reaction in the presence of sunlight (i.e; UV-radiation) as given below

$O_2+h\nu$ (Sunlight) $O+O$

$O+O_2$ O_3+M

Where, wavelength range of solar radiation is 280 to 320nm and M is another species which absorbs the excess energy given off by the reaction and enables the ozone molecules to stay together. Naturally, creation and destruction of ozone takes place continuously in the balanced way (Federick et al, 1993).

In 1974, several scientists observed that due to human activity the ozone layer is going to deplete i.e; anthropogenic chemical pollutants destroy the ozone layer. The main cause of depletion of ozone is chlorofluorocarbon (CFC) and other chlorine containing volatile gases. Because of chlorine atoms are highly reactive and quickly turn into ozone eaters. Each chlorine atom can destroy thousands molecules of ozone i.e.; single atom of chlorine converts thousands of ozone molecule into ordinary oxygen molecules. This reduces the ozone concentration about 40 percent (Rowland and Molina, 1975). The destruction of ozone layer has been clearly mapped out and has been observed in the Polar Regions i.e; first of all the ozone hole or absence of ozone layer was mapped out over the sky of Antartica in southern polar region. Further, in several studies it has been shown that ozone depletion occurred not only in the Polar Regions but also observed in other latitudes which indicate that it has become a global problem (Bojkov at al., 1990).

Due to the depletion of stratospheric ozone layer, more UV radiations and infrared light reaches the earth surface and the temperature of atmosphere is increased and result of this we can suffered from the several disease such as skin cancer, headache, cough, and eye cataracts (Caldwell et al; 1998). The increasment of UV-radiations on the surface of earth not only effect on human beings but also affect the normal genetic activity of the crops which decreases the growth and production. It can easily affect the oxygen cycles and weather patterns i.e; it takes greater change in climate. It takes green house effect in the atmosphere and spreads dangerous disease (Hoffmann, 2012). Thus the UV-radiation can damage to biological system, there is widespread concern that ozone depletion might be accompanied by numerous adverse impacts to both ecology and human health as a result, atmospheric ozone variations inevitably affect regional as well as global climate change (Houghton, 1996). Sothat the measurement of the temporal and seasonal variation of total ozone become very important.

The ozone layer was first of all discovered by French Physicist Charles Fabry and Henri Buisson. Its properties where explored in detail by the British Metrologist G.M.B. Dobson, who developed a simple spectrophotometer (or Dobson Meter) that could be used to measure atmospheric ozone from the ground i.e.; the presence of ozone in the atmosphere, is measured in Dobson unit (DU). Dobson unit refers to a layer of gas that could be 10µm thick under standard temperature and pressure (Herman et al; 1991). Sometimes it referred as a milli-atom-centimeter. As for example: 400DU of ozone bring to the surface of the earth at 0°c would occupy a layer 4mm thick. Again one dobson unit (1DU) means 2.69×1016 ozone molecule per square centimeter or 2.69×1020 per square meter (Fioletov et al; 2002).

Birgunj lies at the boarder of Nepal-India with most populated metropolitan city in Prades-2 in Nepal. In Nepal some studies have been carried out during the past few years and reported the variation of total ozone in the atmosphere over Kathmandu measured by a Brewer spectrophotometer installed at T.U., Kirtipur, Kathmandu; Nepal and compared with total ozone mapping spectrometer satellite data. The results reported that the total atmospheric ozone over Kathmandu existed low in winter and larger in summer and spring seasons (Chapagain, 2002; Chapagain, 2015). Similarly, the data recorded using satellite measurements over Kathmandu were analyzed in previous studies (Bhattari 2006, Parajuli 2015). Furthermore, total ozone data measured by Brewer spectrophotometer and satellite data analyzed by Hamal (2011) and explained the seasonal variation of ozone layer over Kathmandu. However, the detail analysis of seasonal variation of ozone over Birgunj has not been reported. Thus the main objective of this work is to quantify and present the diurinal variations in the total ozone column in day-to-day and seasonal-wise over Birgunj.

Data Measurement

Data used in this study were obtained from the ozone measuring instrument for the measurement of ozone concentration near the ground; ozone partial pressure was recorded in terms of Dobson unit (DU). In this study, we use data for one-year period during March 2017 to February 2018. To, study the day to day diurnal variations of total ozone, the data presented in this paper are only for a representative days selected from several observations, while for the seasonal study of diurnal variation of total ozone, we have used all data set from one-year-period to estimate the average value of ozone for the corresponding times on each season.

Discussion and Result

Here, the surface level of ozone concentration measurements, over Birgunj on March-15, 2017 are given in the table below .

Table 1

Concentration of ozone level March-15, 2017

Time (NST) Nepali standard time	Value of total ozone (DU)
• 8.00	• 282
• 10.00	• 290
• 12.00	• 295
• 14.00	• 292
• 16.00	• 284
• 18.00	• 280

Table 1 concluded that the amount of ozone over Birgunj increases from early morning time as day progresses and become maximum up to 295DU around noon time and the total ozone value decrease gradually with time in afternoon period i.e; fall to minimum value around 280DU in evening time.

Now the value of the concentration of ozone level over Birgunj with respect to Nepali standard time for the typical days from March 2017 to February 2018 are measured and diurnal variation of total ozone over Birgunj on selected days from different months are given in the different tables. Here ozone level is measured in Dobson unit (DU) while the time is taken in Nepali standard Time (NST).

Table 2

Concentration of ozone level for April -15, 2017

Time (Nepali standard time)	Value of total ozone (DU)
• 8.00	• 290
• 10.00	• 296
• 12.00	• 300
• 14.00	• 298
• 16.00	• 293
• 18.00	• 285

Table 3

Concentration of ozone level for May- 20, 2017

Time (Nepali standard time)	Value of total ozone (DU)
• 8.00	• 291
• 10.00	• 298
• 12.00	• 303
• 14.00	• 298
• 16.00	• 292
• 18.00	• 290

Table 4

Concentration of ozone level for June -15, 2017

Time Nepali standard time	Value of total ozone (DU)
• 8.00	• 288
• 10.00	• 298
• 12.00	• 305
• 14.00	• 300
• 16.00	• 294
• 18.00	• 290

Table 5

Concentration of ozone level for July -10, 2017

Time Nepali standard time	Value of total ozone (DU)
• 8.00	• 295
• 10.00	• 298
• 12.00	• 300
• 14.00	• 299
• 16.00	• 295
• 18.00	• 290

Table 6

Concentration of ozone level for August- 20, 2017

Time Nepali standard time	Value of total ozone (DU)
• 8.00	• 290
• 10.00	• 295
• 12.00	• 300
• 14.00	• 295
• 16.00	• 285
• 18.00	• 292

Table 7

Concentration of ozone level for September- 20, 2017

Time Nepali standard time	Value of total ozone (DU)
• 8.00	• 285
• 10.00	• 290
• 12.00	• 298
• 14.00	• 296
• 16.00	• 294
• 18.00	• 280

Table 8

Concentration of ozone level for October -18, 2017

Time Nepali standard time	Value of total ozone (DU)
• 8.00	• 270
• 10.00	• 275
• 12.00	• 290
• 14.00	• 288
• 16.00	• 280
• 18.00	• 260

Table 9

Concentration of ozone level for November- 15, 2017

Time Nepali standard time	Value of total ozone (DU)
• 8.00	• 245
• 10.00	• 248
• 12.00	• 260
• 14.00	• 255
• 16.00	• 252
• 18.00	• 246

Table 10

Concentration of ozone level for December -15, 2017

Time Nepali standard time	Value of total ozone (DU)
• 8.00	• 235
• 10.00	• 240
• 12.00	• 250
• 14.00	• 245
• 16.00	• 240
• 18.00	• 236

Table 11

Concentration of ozone level for December -15, 2017

Time Nepali standard time	Value of total ozone (DU)
• 8.00	• 220
• 10.00	• 225
• 12.00	• 230
• 14.00	• 227
• 16.00	• 221
• 18.00	• 215

Table 12

Concentration of ozone level for February -22, 2018

Time Nepali standard time	Value of total ozone (DU)
• 8.00	• 255
• 10.00	• 260
• 12.00	• 265
• 14.00	• 261
• 16.00	• 250
• 18.00	• 248

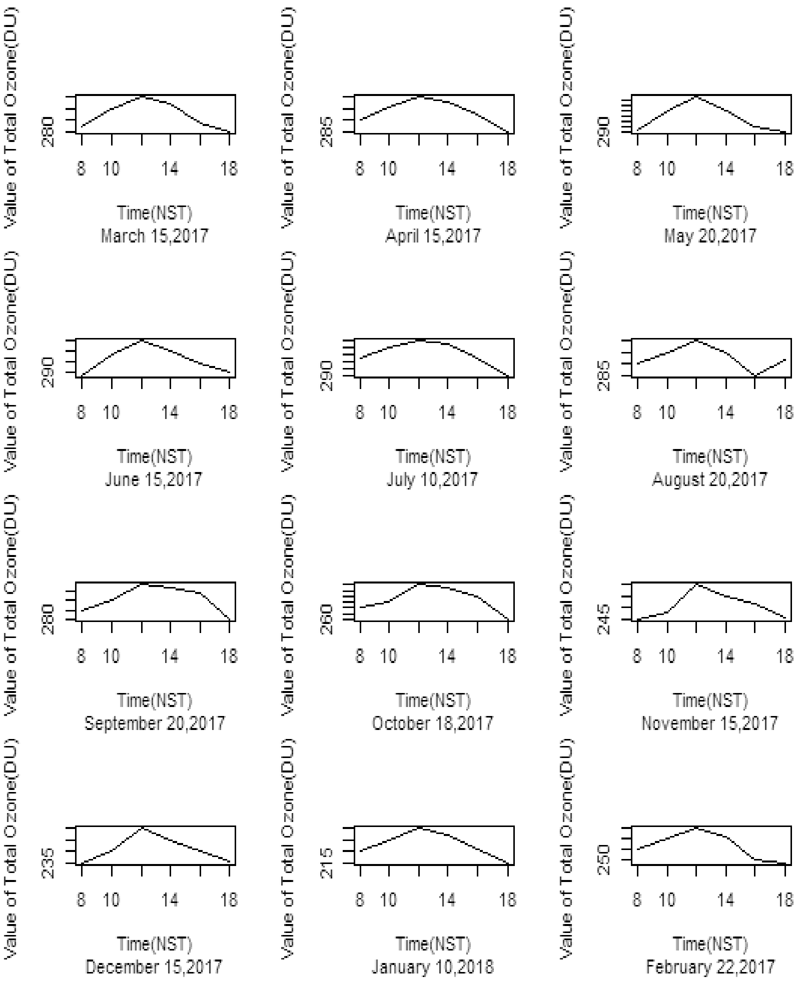

Figure 1: Diurnal variation of total ozone over Birgunj on selected days from different months. Ozone data are measured in Dobson unit (DU) while the time is plotted in Nepali Standard Time (NST).

On the basis of above figure 1, it can be concluded that on April 15, 2017, the ozone values vary from above 285DU to 300DU, while on May-20-2017, range of ozone variation exhibits from 290 to 303DU. Similarly, in june-15-2017, illustrates that the minimum value of total ozone is 288DU at morning time and at evening time, while the maximum value of total ozone is 305DU near noon time. The results for other days from the other tables show the maximum value of total ozone at noon and minimum in morning time. The maximum variations are large on April-15, may-20 and june-15 while the values exist small on march-10, Agust-20, September-15, October-18, November-15, December-15, Januwary-10 and february-22, 2018. This study showed that the diurnal variation is significantly large in spring and summer day with higher values while the value of total ozone is low with small fluctuations in winter days. The results obtained from this study covers only for the day time and not during the night time. The concentration of ozone increases in noon time due to higher photochemical reaction increase in solar intensity. As a result the ozone production rates are relatively higher than the ozone destruction rates near noon time. On the other hand, in morning and evening time, the intensity of solar radiation is weak. So that the slow photochemical reaction takes place and slow ozone production and the concentration of ozone becomes minimum.

During the whole study period for the detail analysis of the diurnal variation for total ozone on different seasons, it has been found that the variation of total ozone in string season [i.e; March, April and May] is 280 to 303DU. Similarly, the variation of total ozone in summer season [i.e.; June, July, and August] is 285 to 305DU, in Autumn season [i.e.; September, October, and November] is 245 to 298 DU and in winter season [i.e.; December, January, February] is 215 to 265DU. The result shows that the variation of total ozone is small in winter season and large in summer season. In this way it can be concluded that the pattern of variation of total ozone is symmetric with increasing the total ozone at every half of a year and decreasing alternatively in the next half of the year.

Conclusion

During the whole study period, the highest value of total ozone concentration (TOC) was found to be 305DU in June 15, 2017 and lowest value of TOC was 215DU in January-10, 2018. In this study, the data were obtained from the ozone measuring instrument over Birgunj during daytime from March 2017 to February 2018 and the results show that the TOC increases around noon time and decrease in morning and evening time. The day to day during variation of TOC gives seasonal variations over Birgunj with maximum values in summer season and minimum values in winter season due to the stronger intensity of solar radiation in summer compared to that in winter season. For the further research work, the satellite-based ozone measurement data can also be compared with the ground based ozone data over Birgunj and other cities in Nepal is recommended.

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