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RESEARCH ARTICLE

EFFECT OF EARTHQUAKE ON OZONE CONCENTRATION AT SOME INDIAN STATIONS - A REVIEW.

N.V.Krishna Prasad¹, M.S.S.R.K.N.Sarma¹, K.S.R.Murthy², K.S.L.D.K.Prasad³

1. Department of Physics, G.S.T, GITAM University, Bengaluru, India.
2. Department of Physics, G.I.T, GITAM University, Visakhapatnam, India.
3. Department of Physics, VITS College(Eng), Visakhapatnam, India.

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*Corresponding Author

N.V.Krishna Prasad.

Abstract

Atmospheric ozone concentration and its change when earthquakes with magnitude greater than 5.0 on the Richter scale that occurred in some parts of India between August 2009 to January 2016 have been studied with the help of satellite data obtained from Total Ozone Mapping Spectrometer (TOMS), and Ozone Monitoring Instrument. The ozone concentration was found to be low on the day of occurrence of earthquake, then increased gradually after the earthquake and reached a maximum value and thereafter reduced to its normal value. The enhancement in ozone concentration depends on the earthquakes magnitude, its depth, direction of wind and also the location of the epicenter.

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Introduction:-

Monitoring and analyzation of the variation in profiles of atmospheric trace gases was very significant for weather forecasting, climate modeling and environmental monitoring in regular life. We know that stratospheric ozone plays a vital role in the chemistry of the earth's atmosphere which is naturally formed by chemical reactions involving ultraviolet sunlight and oxygen molecules. In the last thirty years, it has been discovered that stratospheric ozone is depleting as a result of anthropogenic pollutants. There are a number of chemical reactions that can deplete stratospheric ozone. However, some of the most significant of these involves the catalytic destruction of ozone by halogen radicals such as chlorine and bromine. In addition to these reactions natural disasters like earth quakes also have impact of variability in ozone concentration. Hence it is very important to study the variability of ozone concentration if any due to earth quake which may alter the incoming UV radiation and also changes in the dynamics of the climate.

Earth's crust is made up of tectonic plates that fit together to form the outer shell of the earth. The force due to release of energy by the movement of these plates give rise to earthquake of different magnitudes. During this time heat is produced which in turn heats the atmosphere in contact with it. This heat may be transferred to the upper surface because of gravity waves produced due to change in temperature. This phenomenon causes low atmospheric pressure region at the earthquake site(Pal,2002). (Singh et al. 2007) reported that high electric fields will be developed in the earthquake active regions few days prior to strong earthquake and may penetrate into the ionosphere that create specific irregularities of electron concentrations over the active regions. These consequences may lead to a large amount of particle precipitation at stratospheric altitudes (Tertyshnikov 1996). All these facts may give rise to some changes in the ozone concentration.

Data:-

Total ozone data has been obtained from the website

<http://www.esrl.noaa.gov/gmd/grad/neubrew/SatO3DataTimeSeries.jsp> . The data was collected by satellites Nimbus-7 Total Ozone Mapping Spectrometer (TOMS), Earth probe TOMS and Ozone Monitoring Instrument (OMI). TOMS and OMI provide high resolution daily global information about the total ozone content of the atmosphere by measuring ultraviolet sunlight backscattered from the ground.

Results and discussion:-

Changes in atmospheric ozone concentration for 9 Indian stations where earthquake with a magnitude greater than 5.0 on the Richter scale that occurred during the period August 2009 to January 2016 has been studied. The table below represents the stations at which earth quake occurred and their magnitude.

Table 1:- List of stations where earth quake occurred along with their magnitudes.

S.No	Date	Time(IST)	Location	Latitude	Longitude	Magnitude
1	10-08-2009	01:21	Andaman Islands	14.1 ⁰ N	92.8 ⁰ E	7.7
2	18-09-2011	18:10	Sikkim,Gangtok	27.72 ⁰ N	88.06 ⁰ E	6.9
3	05-03-2012	13:10	New Delhi	28.6 ⁰ N	77.4 ⁰ E	5.2
4	25-04-2012	08:45	Andamann Islands	9.9 ⁰ N	94.0 ⁰ E	6.2
5	21-03-2014	18:41	Andamann Islands	7.6 ⁰ N	94.4 ⁰ E	6.7
6	25-04-2015	11:41	North East	28.14 ⁰ N	84.70 ⁰ E	7.8
7	28-06-2015	06:35	Dibrugarh,Assam	26.5 ⁰ N	90.1 ⁰ E	5.6
8	26-10-2015	09:09	North India	36.14 ⁰ N	71.01 ⁰ E	7.7
9	03-01-2016	23:05	North East	24.8 ⁰ N	93.6 ⁰ E	6.7

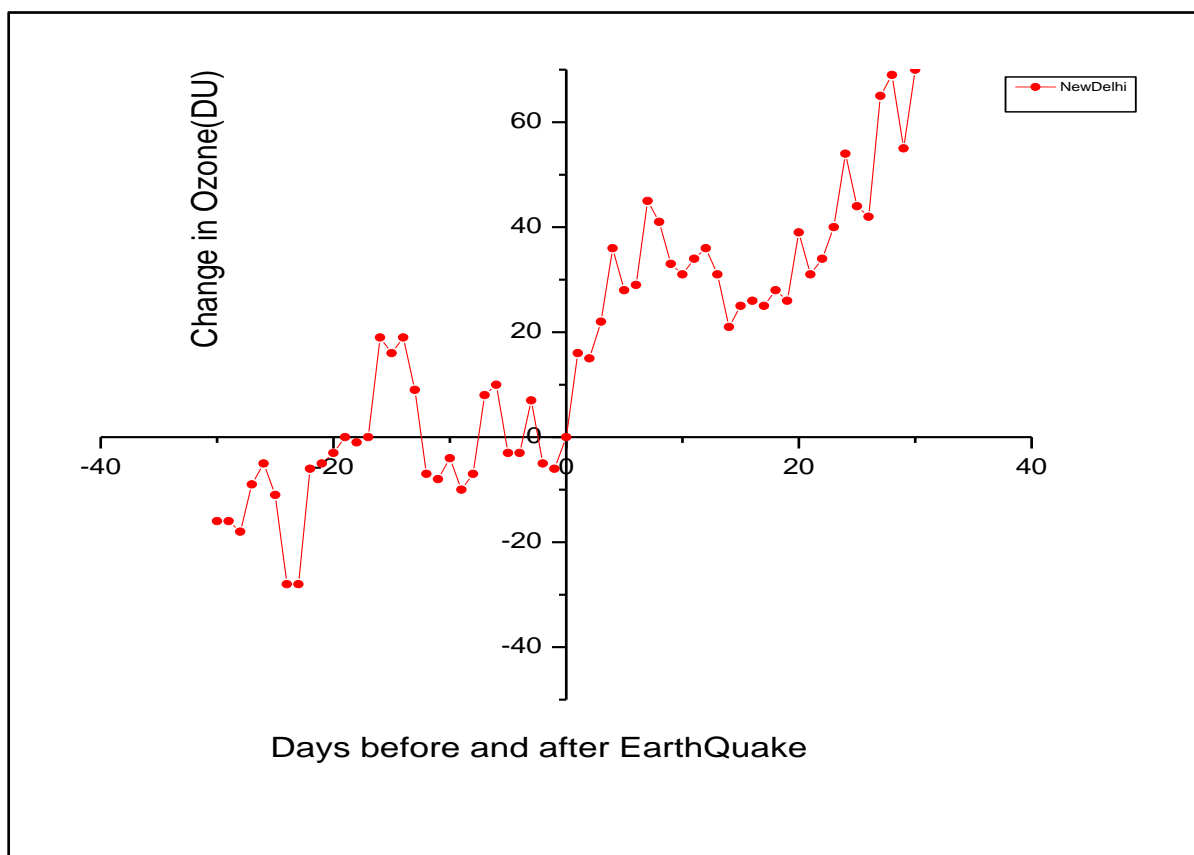


Figure 1:- Comparison of change in total ozone (Dobson Units) with respect to the ozone concentration on the earthquake day for Delhi.

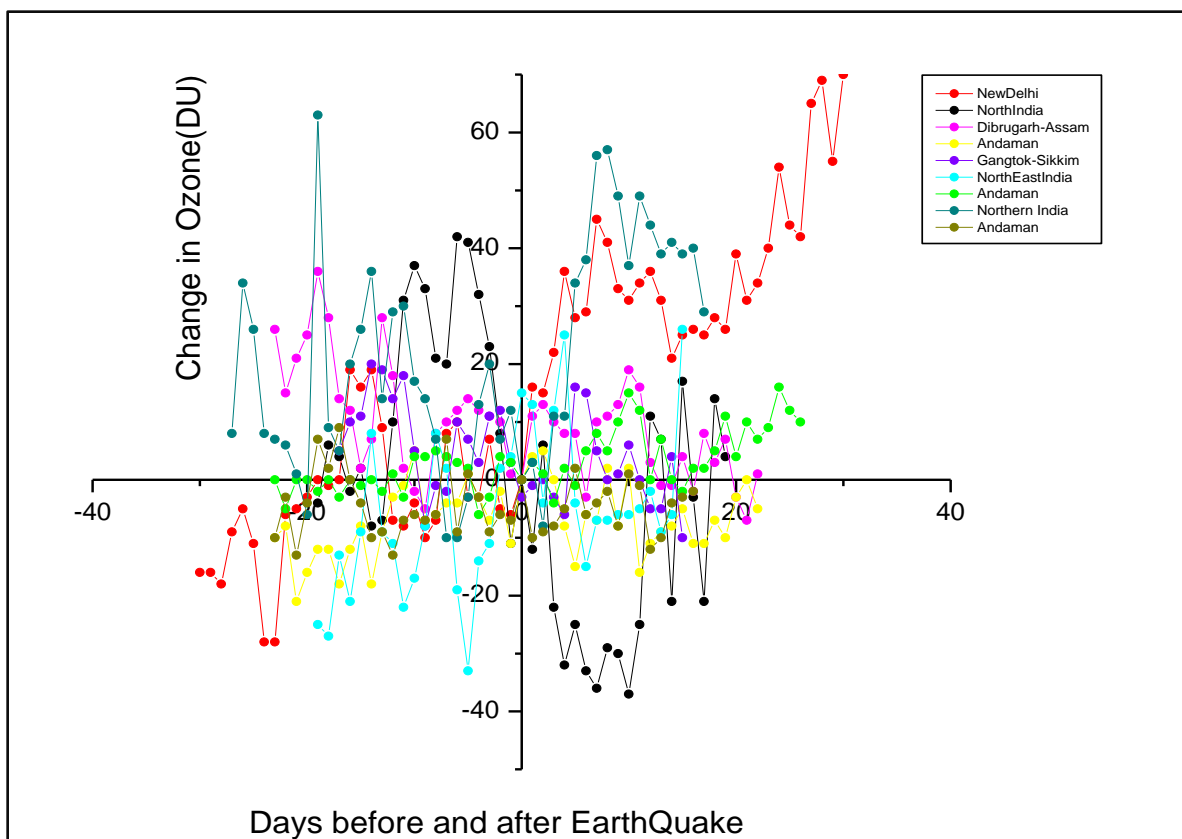


Figure 2:- Comparison of change in total ozone (Dobson Units) with respect to the ozone concentration on the earthquake day for 9 stations.

The trend of variation in total ozone concentration after earth quake for Indian capital New Delhi was shown in Figure 1. Here it is observed that ozone concentration was low on the day of the earthquake and the ozone concentration increased gradually. (Tronin,2002 and Singh et al.,2007 reported the same trend). The ozone concentration reached a maximum value within 10 days and further decreased to its normal value. The ozone concentration on the day of earthquake which is 269 DU varied up to a range of 287 DU-311 DU ie nearly 18 DU to 45 DU.

The trend of variation in total ozone concentration after earth quake for 8 other Indian stations along with New Delhi was shown in Figure 2. Here the trends are same with slight change in ozone variation after earth quake. The change in ozone concentrations for these stations on day of earthquake and their maximum values after earthquake are listed below

Table 2:- List of Indian stations with ozone concentration on the day of earthquake and its maximum value after subsequent days of earthquake.

S.No	Date	Location	Ozone(DU) Earthquake	Maximum Ozone(DU)
1	10-08-2009	Andaman Islands	222	252
2	18-09-2011	Sikkim,Gangtok	260	289
3	05-03-2012	New Delhi	269	311
4	25-04-2012	Andamann Islands	270	272
5	21-03-2014	Andamann Islands	252	267
6	25-04-2015	North East	270	272
7	28-06-2015	Dibrugarh,Assam	290	300
8	26-10-2015	North India	299	330
9	03-01-2016	North East	71	289

As shown in the table above ozone concentration increases after earth quake and this change may be due to change in the dynamics of the upper troposphere. The main drawback during the day of earthquake is the anthropogenic modifications that affect upper ozone concentration cannot be measured.. This may lead to incomplete analysis of the change in ozone concentration during earthquakes. A comparison of total ozone for different monitoring stations lying at lower and higher latitudes compared to the earthquake site, for the 8 October 2005, Kashmir earthquake was reported and found that the ozone concentration at the earthquake site was low on the day of the earthquake 8 October 2005 and reached a maximum on 19 October 2005 (N. D. Ganguly,2009).

Conclusions:-

Ozone data obtained from satellite instruments have been used to investigate the variations in atmospheric ozone concentration for some Indian stations which encountered strong earthquakes. The ozone concentration was found to be low on the day of the earthquake and increased thereafter. Dynamical disturbances, wind direction and transport processes may have a greater influence on the observed increase in ozone concentration compared to photochemical production of tropospheric ozone from some of the gases emitted from the earth's interior during earthquakes. However, since ground based trace gas monitoring measurements are not available at the time and place of occurrence of the earthquakes, it is difficult to conclude strongly on the mechanism leading to the observed increase in ozone concentration.

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