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Diurnal Monitoring Of Surface Ozone And $PM_{2.5}$ Concentration And Its Correlation With Temperature

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ABSTRACT: The ground level O_3 and SPM ($PM_{2.5}$) are the two essential sources which change the quality of ambient air in the atmosphere due to which air pollution caused. The diurnal average of O_3 and $PM_{2.5}$ in 2013 and 2014 reflects the annual variations in their concentrations. The correlation of O_3 and $PM_{2.5}$ with temperature shows negative correlation (r=--0.6015 and -0.3392, r= -0.757 and -0.819) in 2013 and 2014.

Index Terms: Diurnal average, Gaseous pollutants, Particulate pollution, Positive correlation, Suspended Particulate Matter

INTRODUCTION

Ozone is an allotrope which consisting of three oxygen atoms that are bound together (triatomic oxygen) and forms the chemical formula 'O_3'. As such, the gaseous pollutant O_3 (Ozone) is a major constituent which acts as a secondary pollutant in the lower atmosphere. Chemically, when primary pollutants NO_X and VOCs chemically react with the external substance like dust, smog, smoke and suspended particulate matters in the presence of sunlight the resultant is O_3. Today, developing countries in their efforts to match the economy of the developed nations are adopting technological methodologies which are not optimal and scientifically up to date due to the lack of technological and scientific progress. That's the reason, in atmosphere O_3 shows a tremendous fluctuation with other pollutants. One of them is suspended particulate matter which plays a vital role for the formation surface O_3 in ground level. Suspended particulate matters (SPM) are the one of the major pollutants in the developing countries which is mainly occurring from the vehicular emissions and industrial chimneys. The SPM are mainly divided into two parts: $PM_{2.5}$ and PM_{10}. SPM which is less than or up to 2.5 $\mu g/m^3$ in size comes under $PM_{2.5}$. This $PM_{2.5}$ has an adverse impact on human respiratory system. The diurnal fluctuation of O_3 and $PM_{2.5}$ concentrations is monitoring 24 hours of the day. Basically, it is a continuous process which whose average predicted the variation trend throughout the year. Moreover, these gaseous pollutants rapidly fluctuated due to the presence of meteorological parameters. Out of which, temperature is one of the major parameter which is essential to predict the ratio of concentration by using correlation technique. Many studies have already proven that, without the intrusion of any meteorological parameters the correlation cannot be accurate. The impact of temperature on tropospheric ozone concentration shows linear correlation and temporal variation in with temperature. *(Stathopoulou et. al. 2008)* During the study at Jabalpur, various gaseous pollutants (O_3, CO, CH_4 and NO_2) are fluctuating there concentration throughout the years. A result found that, when O_3 concentration was higher (in 2014) concentration of CO and CH_4 was gradually increases whereas, NO_2 concentration was decreased *(Sarkar, S., 2015). Jayamurugan et. al. (2013)*[3] studied the influence of temperature, relative humidity and seasonal variability on ambient air quality. Resultant shows, RSPM and SPM had positive correlation with temperature in all the seasons except post-monsoon.Spatial and temporal variations of PM_1, $PM_{2.5}$, PM_{10} and particle number concentration during the AUPHEP—project" was done by Gomisceka *et. al.* (2004)[4]. (AUPHEP—Austrian Project on Health Effects of Particulates). For this project, they selected four sites in Austria 3 urban sites and 1 in rural for the monitoring data of PM mass fractions - PM_1, $PM_{2.5}$, PM_{10} and TSP as well as the particle number concentrations over a 1 year period. The ratios between the different fractions were based on its daily and seasonal behavior. Annual concentrations for $PM_{2.5}$ and PM_{10} were higher in urban sites whereas, a bit lower at the rural site. At the city Kannur, surface ozone has continuously monitored throughout the study which shown its diurnal variation and correlation with various meteorological parameters *(Nishanth, T. and Satheesh Kumar, M.K., 2011)*[5]. During winter season, mixing ratios of surface ozone has maximum at the rural areas (44.01±3.1ppbv) and urban areas (36.3±5.4ppbv). It has also noticed that during winter, production of ozone was much higher in the afternoon *(Selvaraj et. al., 2013).*At Bhubaneswar the study of surface ozone variation and its correlation with various parameters has performed. It found that, seasonal variation of O_3 concentration was maximum in January (~85ppbv), gradually it has increases in the month of June (~38 ppbv) and minimum in August (~20ppbv). Affected by topography and climatic conditions in contrary, ozone raised during pre-monsoon and monsoon *(Mahapatra et. al., 2012).* Bahauddin and Uddin (2010) studied status of particulate matter and its impact on roadside population of Dhaka city, Bangladesh[8]. This paper investigated the level of particulate matter and to determine adverse impact of this on health of roadside population of Dhaka city. It was a desk research which has involved the collection of previous research reports, newspapers and journal content and also collection and synthesis of existing project reports regarding to air pollution of Bangladesh. In the year 2002-07, the maximum concentration of PM2.5 and PM10 in Dhaka city and average of particulate matter levels were 2 times higher than the Bangladeshi standard and the residential areas. *Zhao et. al. (2013)* investigated "characteristics of visibility and particulate matter (PM) in an urban area of Northeast

China"[9]. They studied visibility data from 2010 to 2012 obtained at Shenyang in Northeast China and the relations between visibility, PM mass concentration and meteorological variables were statistically analyzed. These results demonstrate that the monthly–averaged visibility over Shenyang was higher in March and September with low visibility over Shenyang occurred in January. A study by *David et. al. (2011)*[10] found the distribution of ozone and its precursors over Bay of Bengal*)* shows 61±7 ppb and 53±6 ppb ozone mixing ratio at the head and southeast of BoB. Diurnally ozone mixing ratio was decreased down during noon/afternoon which has increase in nighttime and high in morning.

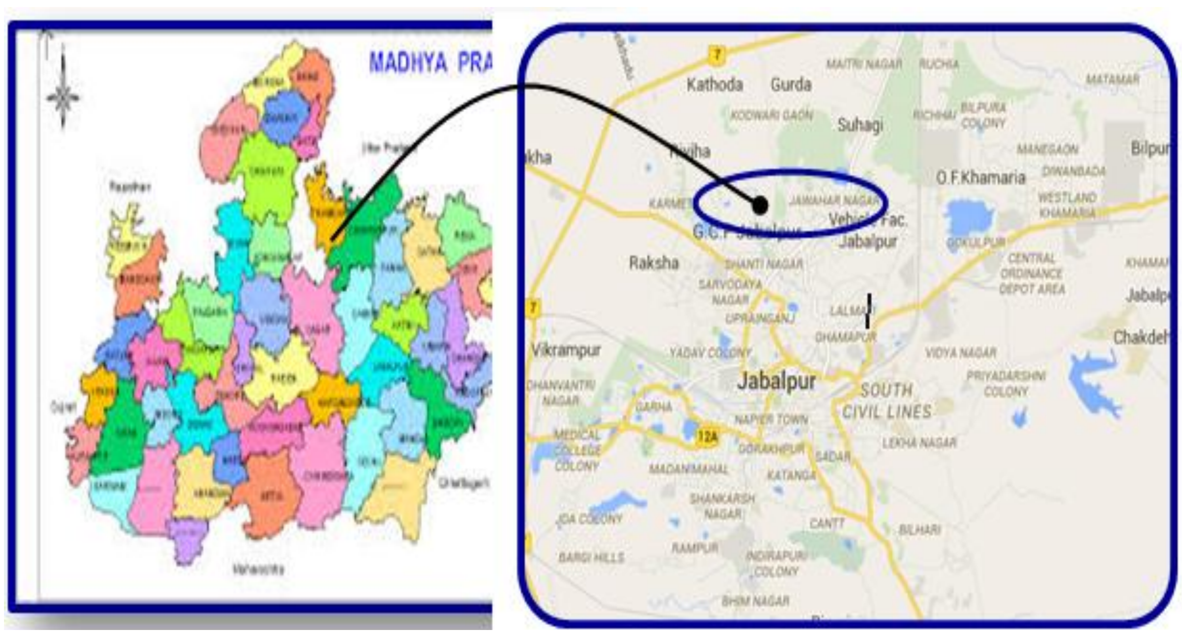
SIGNIFICANCE OF THE STUDY

The study is significant to gain information about the ambient air quality of the city Jabalpur. The observation has continuously monitored by AAQMS (Ambient Air Quality Monitoring System). In the upcoming years, AAQMS is going to enforce in each city to aware the population about its importance and necessity.

MATERIAL AND METHOD

The Study Area:

Madhya Pradesh is generally known as the heart of India. The site Jabalpur is one of the major centers of Madhya Pradesh in India and is famous for its green belt**.** Geographically, it is located at "23.17°N 79.95°E". It has an average elevation of 411 meters (1348 ft). Topographically Jabalpur is rich with forests, hills and mountains which contain lots of minerals in it. On the other hand, quality of air is getting deteriorated slowly by increasing industrialization and due to tremendous increase in number of vehicles plying on the roads.



Sampling and Investigative method:

The instrument ***Ambient Air Quality Monitoring System (AAQMS)*** was manufactured by ***Ecotech*** Australia. It is systematic, assessment of long term pollutants in the surroundings. ***Ecotech*** established the instrument for environmental monitoring that is WinAQMS (Air Quality Monitoring Station). This WinAQMS has two parts: the client as client and the server. The monitoring system consists of the assembly of many transducers and analyzers employing various instrumentation techniques. The instrument has provided all the yearly observation of the O_3 concentration by EC9810 Ozone Analyzer (O_3). In addition to this, BAM1020 provides all the observation of $PM_{2.5}$. The BAM1020 is determined the concentration in units 18 of milligrams or micrograms of particulate per cubic 19 meter of air. A small 14C (carbon 14) element emits a 20 constant source of high-energy electrons known as beta 21 particlesA statistical analysis Pearson correlation coefficient has done to estimate the correlation of O_3 and $PM_{2.5}$ concentration with temperature.

Observation Table:

The study was monitored by two years: 2013 and 2014 in the area of Jabapur which is quite residential but very near to green belt. While on monitoring the ambient air by AAQMS (Ambient Air Quality Monitoring System) of the city, some gaseous pollutants are like ozone (O_3) and $PM_{2.5}$ has obtained. The observation of gaseous pollutants and SPM has been observed from 2013 to 2014. Here, the graphical representation which is showing the annual average comparison of O_3 and $PM_{2.5}$ in different year:

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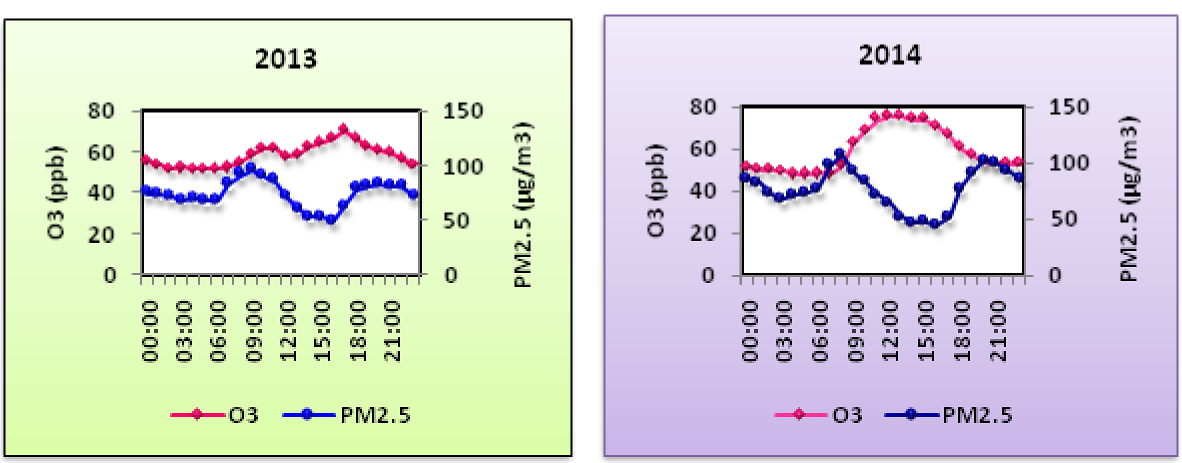
Fig. 2: *Annual comparison of O_3 and $PM_{2.5}$ concentration*

As it seen in fig. 2, the comparing trend of O_3 was almost similar with $PM_{2.5}$ concentration in the initial month (Jan-Feb). According to the observations, O_3 concentration slightly decreases towards the month of August and later on increases. But, in 2014 O_3 decreased down completely throughout the year whereas in 2013 it was quite higher. The diurnal average throughout the year of O_3 and $PM_{2.5}$ shows the fluctuation in between 24 hours time interval of each day in each month:

Fig. 3: *Diurnal average of O_3 and $PM_{2.5}$ concentration*

JANUARY



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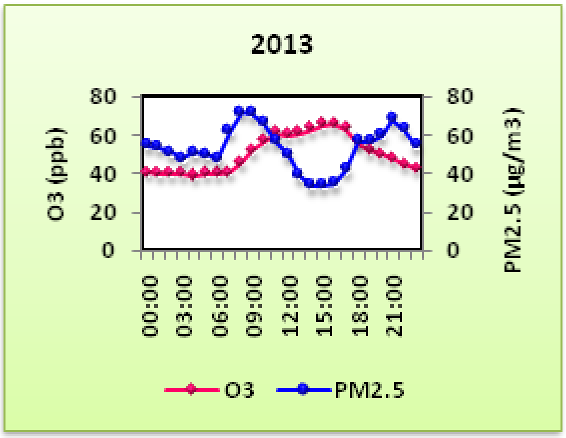

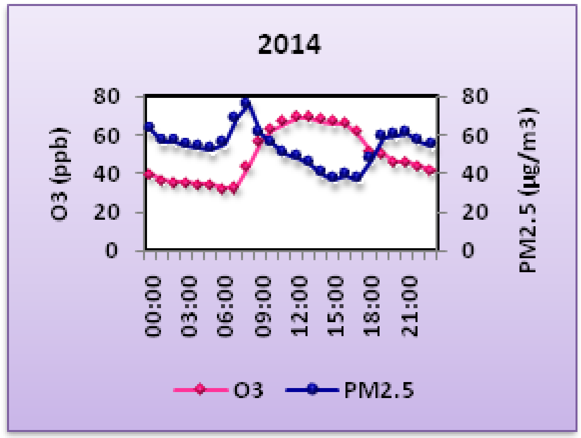

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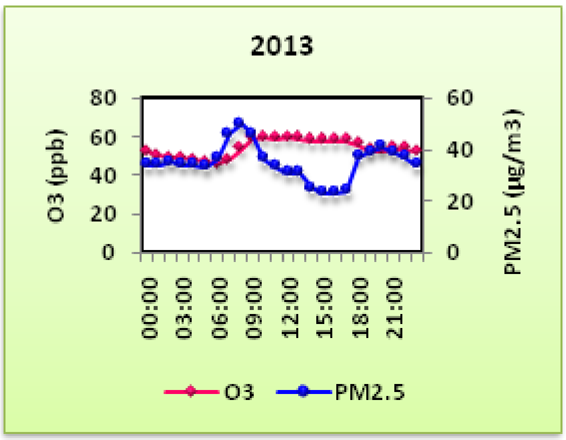

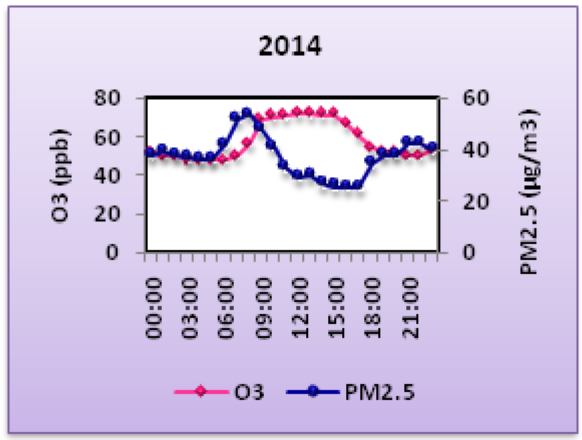

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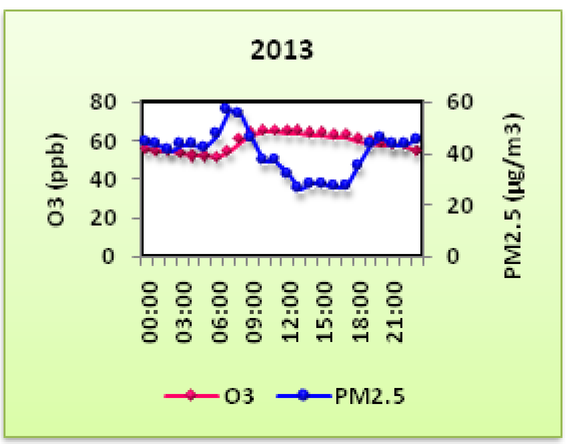

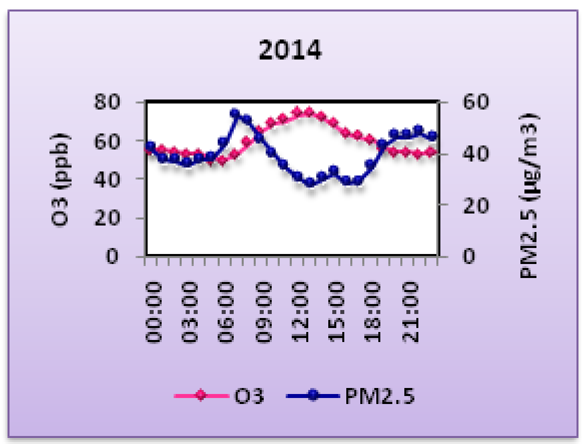

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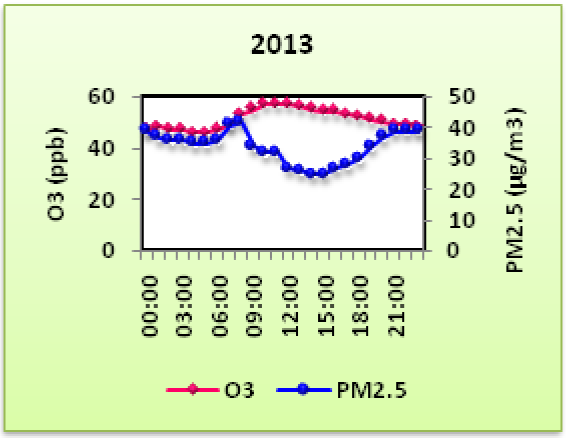

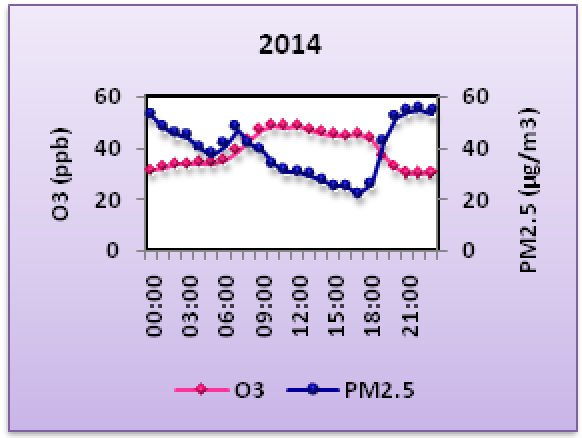

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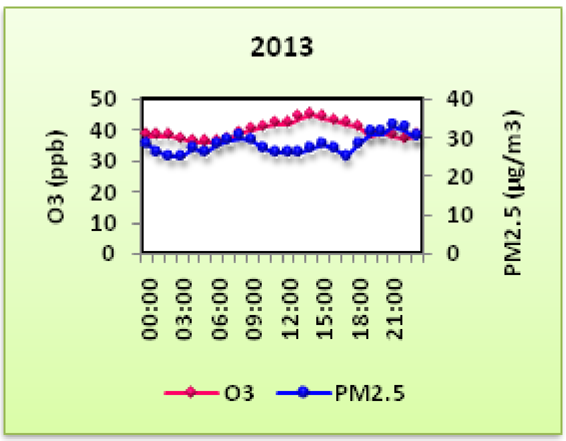

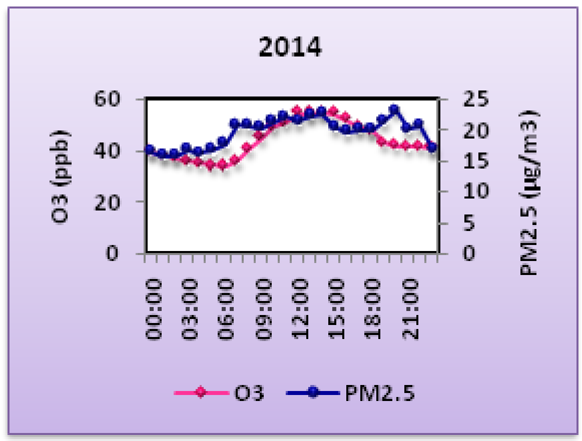

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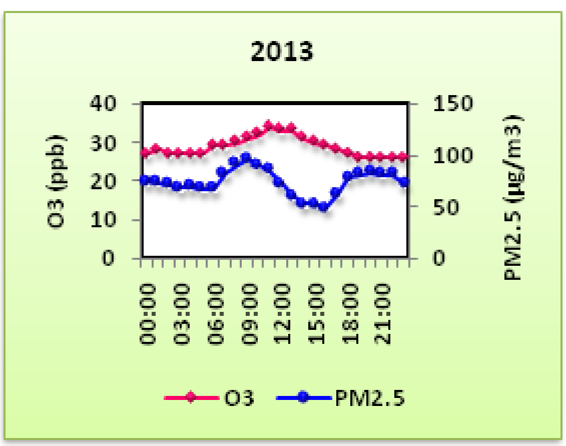

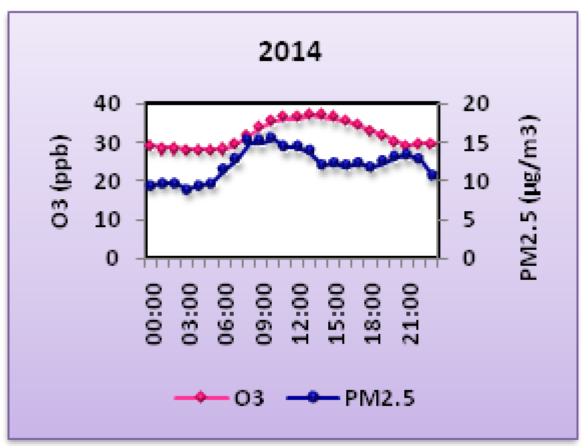

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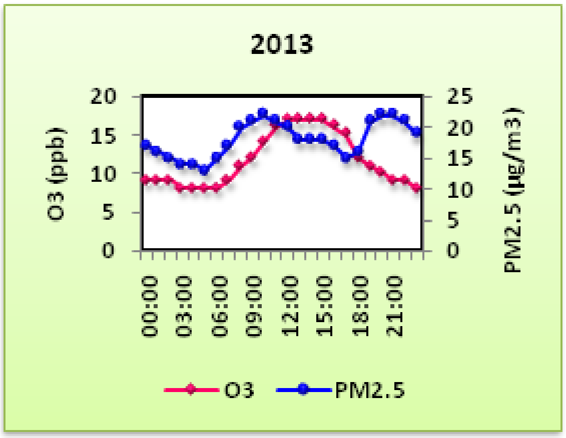
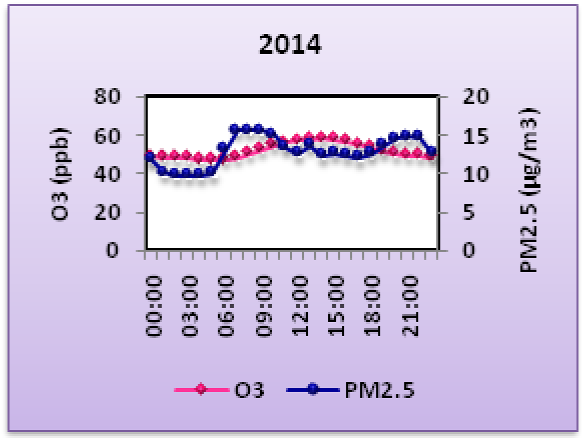
AUGUST





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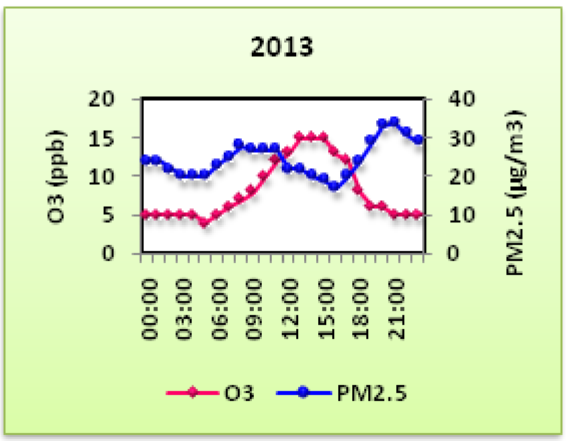

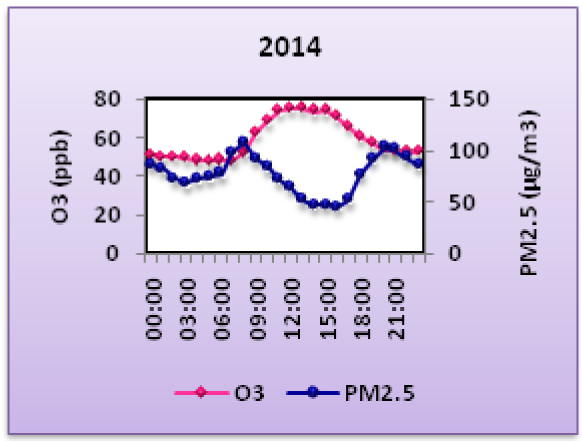

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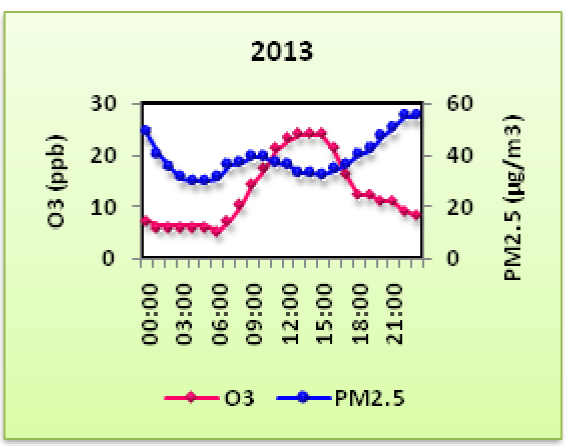

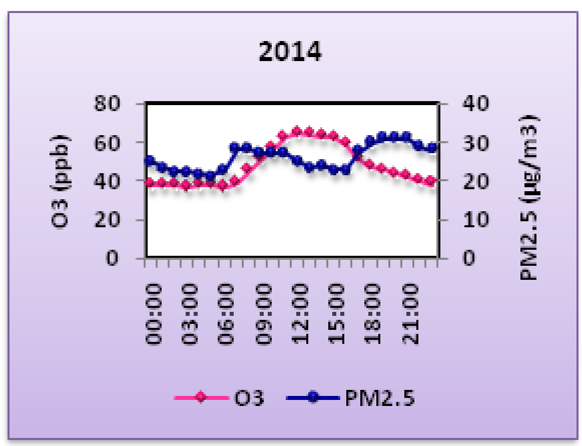

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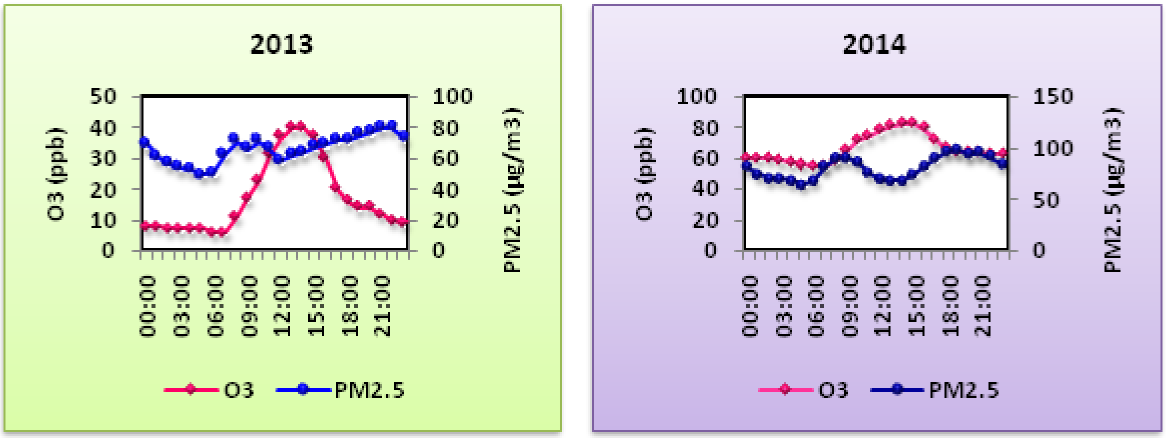

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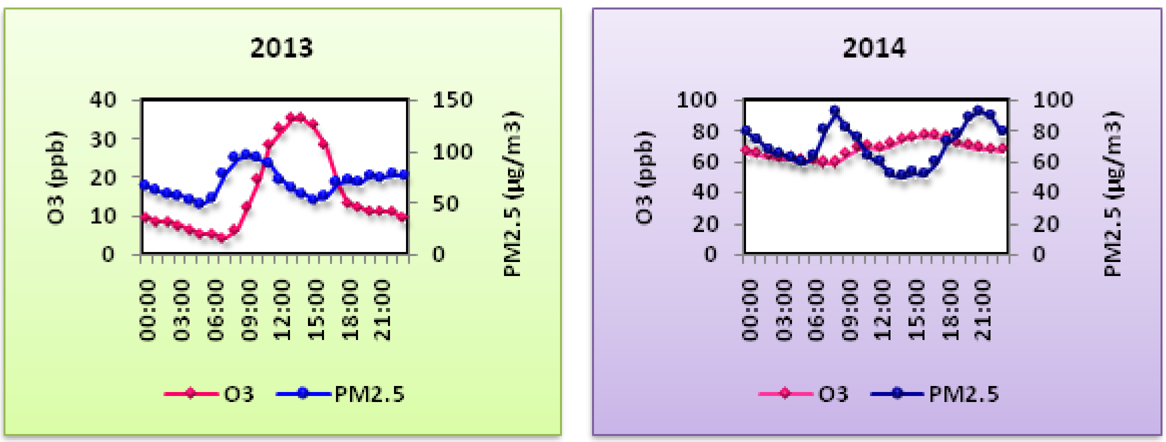


From fig. 3, the comparative study of the diurnal variation of O_3 and $PM_{2.5}$ in 2013 and 2014 shows the major fluctuations simultaneously with each other. In addition to this, the correlation of the two gaseous pollutants with a meteorological parameter (temperature) has been shown the accuracy towards its percept. Moreover, the correlation was based on the annual average concentration of O_3 and $PM_{2.5}$ with annual average temperature.

Fig. 4(a): *Annual correlation of O_3 and $PM_{2.5}$ with Temperature (2013)*

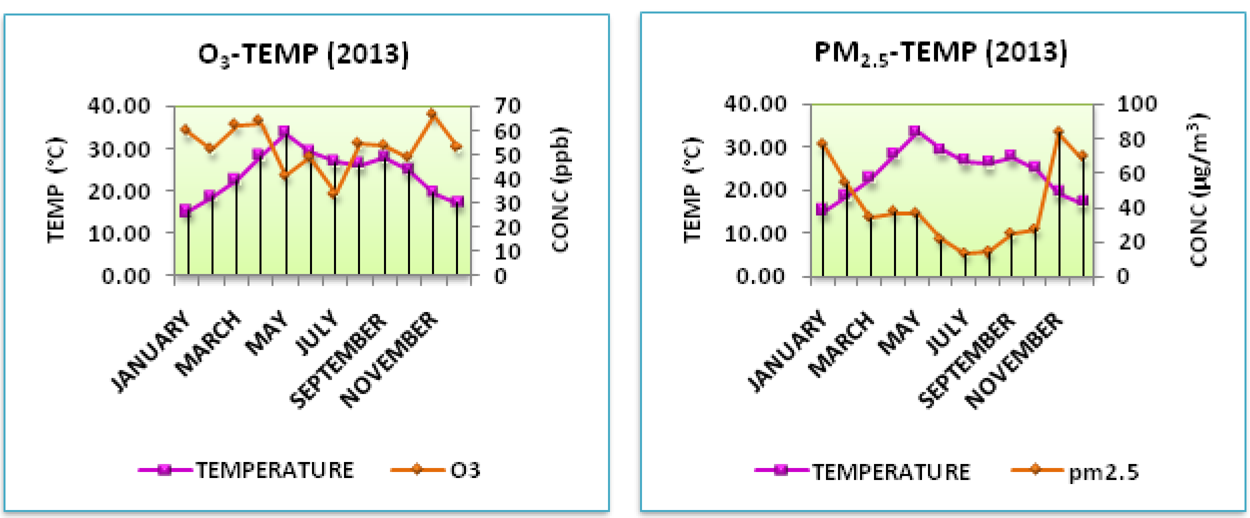
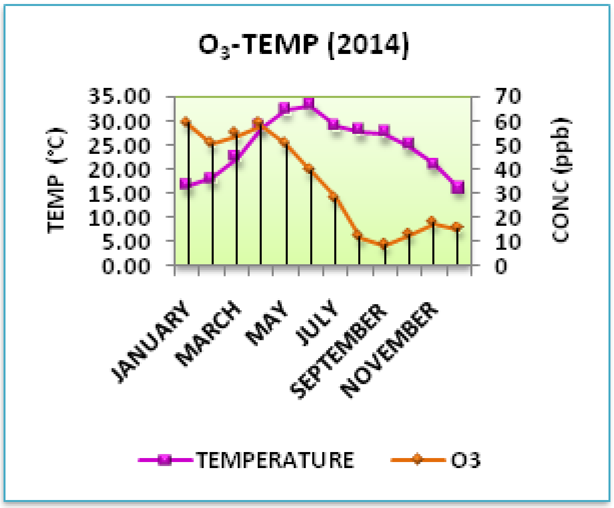
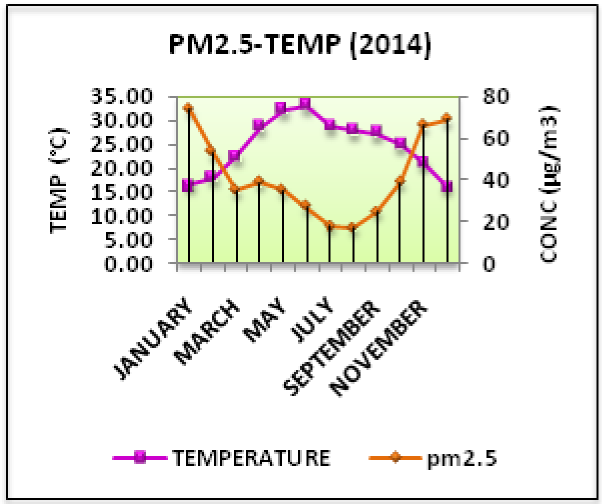


Fig. 4(b): *Annual correlation of O_3 and $PM_{2.5}$ with Temperature (2014)*





The variation in between January-December of 2013 and 2014 performs the correlation with respect to temperature (major meteorological parameter).

RESULT AND DISSCUSSION

The ambient air quality of Jabalpur, shown the diurnal average (24hrs) O_3 and $PM_{2.5}$ in 2013 and 2014. It found that, O_3 and $PM_{2.5}$ has shown major fluctuation in the month of November and December. From fig. 2, in November O_3 and $PM_{2.5}$ (66ppb and 83µg/m^3 respectively) concentrations shows peak value in 2013. In the other hand, in 2014 O_3 was more in January (58ppb) and $PM_{2.5}$ concentration was higher in December (69 µg/m^3). This variation was happened due to the effect of climate and the meteorological parameters which affects the concentration. Somehow, it can easy to understand the correlation in between O_3 and $PM_{2.5}$ with temperature. Thus, the diurnal correlation of O_3 and $PM_{2.5}$ shows negative correlation (Table 1) with temperature.

Resultant shows, high fluctuating trend in the month of December ($O_{3=}$ 15 ppb and $PM_{2.5}$= 58µg/m^3). Other than this, all the month shows nearly similar concentration and very minute fluctuation (Fig.3). In both years: 2013 and 2014 strong negative correlation has been observed throughout the study.

***Table 1:** Result of diurnal comparison of O_3 and $PM_{2.5}$ concentration with Temperature*

DIRUNAL CORRELATION				
2013		**r**	**r^2**	**CORRELATION**
TEMPERATURE	**O_3**	**-0.6015**	**0.362**	**Negative**
	$PM_{2.5}$	**-0.757**	**0.573**	**Negative**
2014		**r**	**r^2**	**CORRELATION**
TEMPERATURE	**O_3**	**-0.3392**	**0.115**	**Negative**
	$PM_{2.5}$	**-0.819**	**0.671**	**Negative**

Where, r= coefficient of correlation
r^2= coefficient of determination

CONCLUSION

A developing city like Jabalpur needs very small initiation to tackle the big need to fight, with the slowly increasing pollution. For this, the best way to secure the atmosphere is, to make people aware the exact condition for the pollution level of the city.

ACKNOWLEDGMENT

The author expresses our regards to Indian Institute of Tropical Meteorology (IITM), Pune to install the Ambient Air Quality Monitoring System (AAQMS) in Environmental Research Laboratory of Government Model Science College. (Autonomous) Jabalpur. Special thanks towards Dr. R. K. Srivastava for his guidance and encouragement. Words are shorts to express my thanks to college colleagues and senior researchers.

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