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OZONEVARIATIONATJABALPURANDINTERRELATIONSHIPSTUDYWITHVARIOUSMETEOROLOGICALPARAMETERS

*Strictly as per the compliance and regulations of :*

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## I. Introduction

The troposphere ozone affects our climate, which has been undergoing a continuous change into what we experience today. Atmospheric chemistry is highly dependent on temperature, humidity and solar radiation and the observed warming will inherently affect the atmosphere. The presence of ozone in the troposphere is understood to arise from two basic processes: (i) tropospheric / stratospheric exchange that causes the transport of stratospheric air, rich in ozone, into the Troposphere and (ii) production of ozone from photochemical reactions occurring within the troposphere. The production of ozone in the troposphere is accomplished through a complex series of reactions referred to as the 'photochemical smog mechanism'. Urban air pollution in many cities is currently an issue of great concern to the general public maintaining a high profile on the political agenda. The reality of numerous situations in which the near-surface ozone concentration exceeds the adopted threshold values, has attracted considerable public attention due to the well-known harmful impact on biosphere, human health, animal populations, agriculture productivity and forestry. Surface ozone ($O_3$) with its precursors namely, carbon monoxide (CO) and oxides of nitrogen (NOx) have been taken on diurnal scale from a tropical semi-urban site, Pune (18.54N, 73.81E) in India. (Beig et al.2007). Ground level ozone is of great concern because of its effects on human health and ecosystem because it is not emitted directly into the atmosphere. It has important impact on the radioactive balance of the atmosphere (Selvaraj et al. 2011),Near surface, ozone is a pollutant of important concern due to its adverse effects on agricultural productivity and human health and is now a major environmental concern in many regions of the world. Surface ozone is mainly produced through photochemical reactions involving volatile organic compounds and NOx in the presence of sunlight, and also acts as a precursor for the highly reactive hydroxyl radical (Roy et al. 2003). Atmospheric $O_3$ (90%) layer is located in Stratosphere. Tropospheric $O_3$ contribute only (10%) to the total $O_3$ column, but its concentration have been steadily rising during last 100 years. Tropospheric $O_3$ production is the result of photochemical reaction of carbon monoxide (CO), methane ($CH_4$), and other hydrocarbons in the presence of NOx ($NO + NO_2$). $O_3$ destruction is also the result of photochemical reactions involving NO,OH. (Bhatia et al. 2012).The higher surface $O_3$ concentration observed in the mid-day and lower concentrations during night time was in tune with the solar UV flux. A significant seasonal variation for $O_3$ and NOx mixing ratios at this site was observed. The average $O_3$ mixing ratios were maximum during winter and minimum during the monsoon period. (Nishant et al. 2012). Diurnal variation of ozone and variation of ozone along with rainfall, cloud cover, temperature, wind speed and relative humidity in different months have been studied. Therefore, changes in these parameters due to climate change will necessarily impact surface ozone concentration. To assess the relation with

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meteorological parameters, the correlation coefficients between the surface ozone concentration and meteorological variables were calculated. The diurnal pattern of surface ozone explains that ozone production depends on the photochemical production process. (Selvaraj. R Samuel et al. 2013).Ozone is a naturally occurring gas found in the troposphere and other parts of the atmosphere. Ozone occurs naturally at ground-level in low concentrations. The two major sources of natural ground-level ozone are hydrocarbons, which are released by plants and soil, and small amounts of stratospheric ozone, which occasionally migrate down to the earth surface. Neither of these sources contributes enough ozone to be considered a threat to the health of humans or the environment. But the ozone that is a by product of certain human activities does become a problem at ground level and this is what we think of as 'bad' ozone Zhang, et al (2007). With increasing populations, more automobiles, and more industry, there's more ozone in the lower atmosphere.

*Source: - Geographical map on satellite*


## II. Objective of The Study

In this study an attempt has been made to address briefly some of the important issues, relevant to the changing ozone, with special emphasis on various meteorological parameters in surface ozone over a Jabalpur site. Study related with the inter relation of ozone and available meteorological parameters (Temperature, Sun Shine, Rainfall, Relative humidity, Wind speed and Pressure) is also carried out and discussed.

## III. Significance of the Study

This monitoring network study is generating huge amount of data, which need to be properly collected, collated, evaluated, interpreted and compiled in the form of reports. The data will provide information on the success of the abatement measures, air quality trend, and impact of policies etc. Good public information system is needed for air pollution in severely polluted countries.

## IV. Monitoring Site and Measurements

The monitoring site is in Jabalpur city at Govt. Model Science College (Autonomous) Jabalpur, PG Deptt. of Environmental Science. Jabalpur (23.1667° N, 79.9333° E.) sub capital of Madhya Pradesh is located in Centre in M.P and has an area of about 367 sq km. It is a densely populated, cosmopolitan city and has one of the highest living standards in M.P. The surface ozone recording system, EC 9810 $O_3$ UV photometric ozone analyzer was used to determine tropospheric ozone levels. The concentrations were correlated to meteorological parameters. The daily and hourly ozone concentrations ranged between 10.00 am to 05.00 pm respectively are taken into account for Jabalpur (M.P). The measured hourly ozone concentration was below as compared to the one hour ozone standard. Ozone behavior shows daily diurnal peaking between 12:00 and 16:00 hours and a low from evening to early morning was observed thus, suggesting anthropogenic activities as a possible source of tropospheric ozone in Jabalpur.

## V. Materials and Methods

### a) *Ambient Air Quality Station*

Ambient Air Quality Monitoring Systems (AQMS) monitored the level of pollutants –NOx, CO, $CH_4$, Particulate Matter ($PM_{10}$& $PM_{2.5}$),Ozone, etc. in the ambient atmosphere. From a single analyzer to complete systems provides a wide range of solutions to meet much of the Ambient Air Quality Monitoring demands.

*Ecotech* established an instrument for environmental monitoring that is Win AQMS (Air Quality Monitoring Station). Win AQMS has been designed as a client/server program. This means that Win AQMS has two parts: the client and the server. The server handles all the communication between the logger and the analysers, recording of data and starting/stopping of calibrations. The client is concerned with giving the users access to settings and data. On its own the server has no user interface and there is no way you can interact with it using the mouse or keyboard. The client is the visual interface of Win AQMS and communicates with the server by requesting information or receiving information that it has asked for at a prior time. This arrangement means that the Win AQMS server must always be turned on before the Win AQMS client program can connect to it.

### b) *Ozone ($O_3$) analyser*

The EC 9810 ozone ($O_3$) analyser is a non dispersive ultraviolet (UV) photometer which alternately switches a selective ozone scrubber in and out of the measuring stream and computes the ratio of transmitted light giving an accurate and reliable measure of ozone concentration in the presence of common atmospheric compounds. A mercury vapor lamp is used as the light source. Its 254 nm line is close to the center of the ozone absorption band. The selective scrubber uses manganese dioxide ($MnO_2$) to selectively destroy ozone and pass other common absorbers such as $SO_2$ and aromatics. Since absorbances add, the resulting difference in beam intensity between the scrubbed and non-scrubbed cycle is a function of ozone concentration. The system is under the control of the EC9800 series microprocessor module. Software algorithms handle all internal adjustments, continuously perform diagnostics, indicate errors, display status and make calculations of ozone concentration. The only operator functions are to perform routine maintenance on the pneumatics and periodically verify calibration of the unit. The microprocessor continuously monitors the source and many other parameters, making adjustment as necessary to ensure stable and accurate operation. In addition to temperature and pressure compensation, the EC9810 analyser can readjust its span ratio based on a known concentration of gas used to span the analyser. Thus feature is not automatically implemented and must be selected by the operator. Data collection and recording is available for either a data acquisition system (such as data logger) or a strip chart recorder. A DB50 connector is also included for digital input control and digital output status. The EC9810 also features internal data storage capabilities. The instrument includes an over-range feature that, when enabled, automatically switches the analog output to a preselected higher range if the reading exceeds 90% of the nominal range. When the reading returns to 80% of the nominal range, the analyser automatically returns to that range.

*c) Ambient Air Quality Station*

*(AAQMS)*

*($O_3$) Analyser*

*d) AWS (Automatic Weather Station*

This instrument provides metrological data e.g. wind speed, pressure, humidity, temperature, wind direction and rain fall with the help of intercept-software. It gives every 10 minutes data.


AWS *(Automatic weather station)*

*Observation Tables*

e) *Annual avg. value of $O_3$ with various meteorological parameters. [2014]*

| Month | Temp. (°C) max. Min. | $O_3$ (ppb) |
|---|---|---|
| *JANUARY* | 17 | 35 |
| *FEBRUARY* | 18 | 38 |
| *MARCH* | 22 | 41 |
| *APRIL* | 29 | 50 |
| *MAY* | 32 | 56 |
| *JUNE* | 33 | 56 |
| *JULY* | 29 | 32 |
| *AUGUST* | 28 | 33 |
| *SEPTEMBER* | 27 | 30 |
| *OCTOBER* | 25 | 29 |
| *NOVEMBER* | 21 | 29 |
| *DECEMBER* | 16 | 24 |

*Fig.1.*

| Month | Sun Shine (°C) | $O_3$ (ppb) |
|---|---|---|
| *JANUARY* | 6 | 35 |
| *FEBRUARY* | 8 | 38 |
| *MARCH* | 8 | 41 |
| *APRIL* | 9 | 50 |
| *MAY* | 10 | 56 |
| *JUNE* | 7 | 56 |
| *JULY* | 4 | 32 |
| *AUGUST* | 4 | 33 |
| *SEPTEMBER* | 6 | 30 |
| *OCTOBER* | 8 | 29 |
| *NOVEMBER* | 8 | 29 |
| *DECEMBER* | 7 | 24 |

*Fig.2.*

| Month | Rain Fall (mm) | $O_3$ (ppb) |
|---|---|---|
| JANUARY | 24.8 | 35 |
| FEBRUARY | 76.0 | 38 |
| MARCH | 4.4 | 41 |
| APRIL | 0.0 | 50 |
| MAY | 10.6 | 56 |
| JUNE | 159.4 | 56 |
| JULY | 316.5 | 32 |
| AUGUST | 241.7 | 33 |
| SEPTEMBER | 199.0 | 30 |
| OCTOBER | 41.6 | 29 |
| NOVEMBER | 0.0 | 29 |
| DECEMBER | 4.8 | 24 |

*Fig.3.*

| Month | R.H (%) | $O_3$ (ppb)) |
|---|---|---|
| JANUARY | 75 | 35 |
| FEBRUARY | 68 | 38 |
| MARCH | 57 | 41 |
| APRIL | 37 | 50 |
| MAY | 46 | 56 |
| JUNE | 46 | 56 |
| JULY | 73 | 32 |
| AUGUST | 76 | 33 |
| SEPTEMBER | 75 | 30 |
| OCTOBER | 67 | 29 |
| NOVEMBER | 55 | 29 |
| DECEMBER | 61 | 24 |

*Fig.4.*

| Month | W.S (m/s) | $O_3$ (ppb) |
|---|---|---|
| JANUARY | 3 | 35 |
| FEBRUARY | 3 | 38 |
| MARCH | 3 | 41 |
| APRIL | 4 | 50 |
| MAY | 6 | 56 |
| JUNE | 7 | 56 |
| JULY | 6 | 32 |
| AUGUST | 6 | 33 |
| SEPTEMBER | 4 | 30 |
| OCTOBER | 3 | 29 |
| NOVEMBER | 2 | 29 |
| DECEMBER | 2 | 24 |

*Fig.5.*

| Month | Pressure (m/s) | $O_3$ (ppb) |
|---|---|---|
| JANUARY | 11 | 35 |
| FEBRUARY | 10 | 38 |
| MARCH | 13 | 41 |
| APRIL | 10 | 50 |
| MAY | 12 | 56 |
| JUNE | 17 | 56 |
| JULY | 21 | 32 |
| AUGUST | 22 | 33 |
| SEPTEMBER | 21 | 30 |
| OCTOBER | 16 | 29 |
| NOVEMBER | 9 | 29 |
| DECEMBER | 8 | 24 |

*Fig.6.*

*Graphs:-*

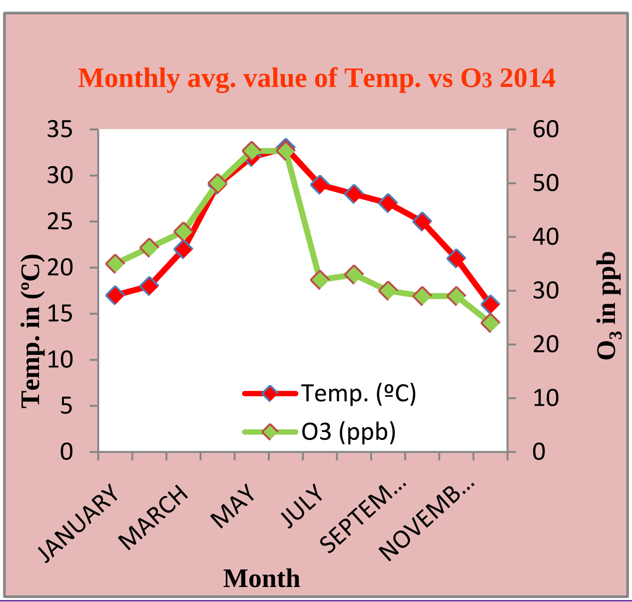


*Fig. 1*

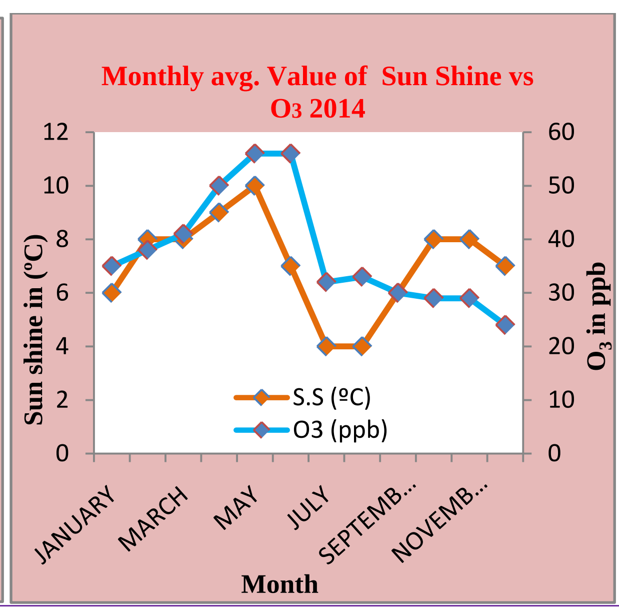


*Fig. 2*

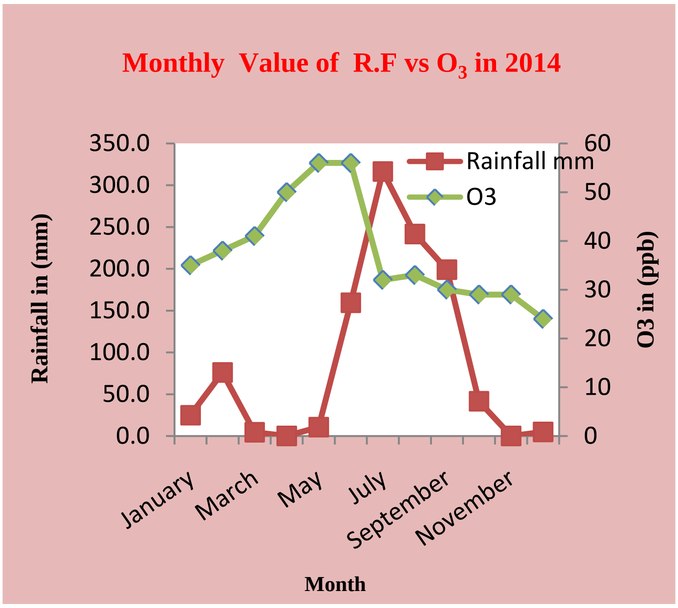


Fig. 3

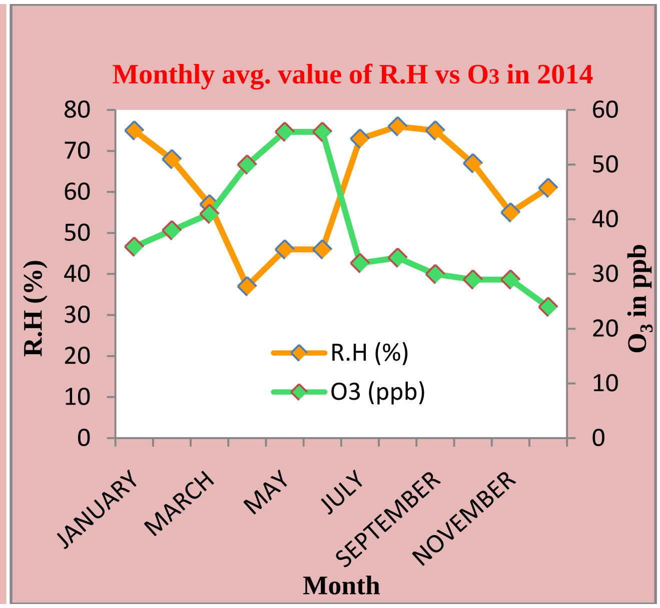


Fig. 4

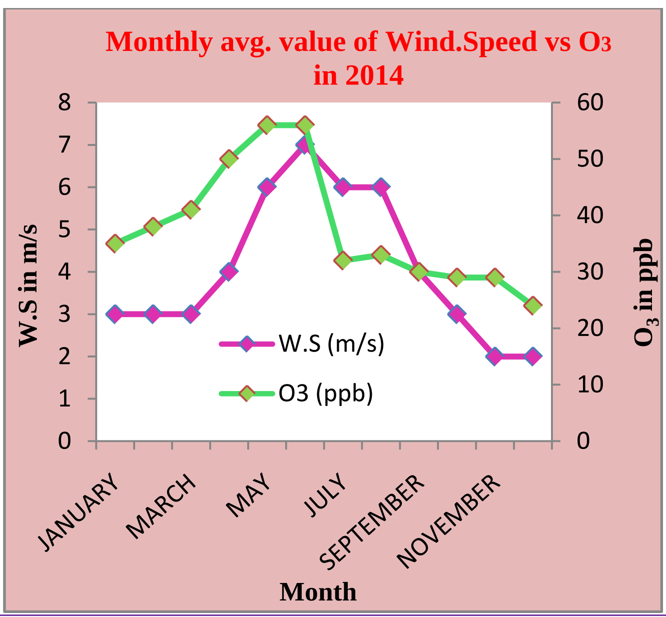


Fig.5

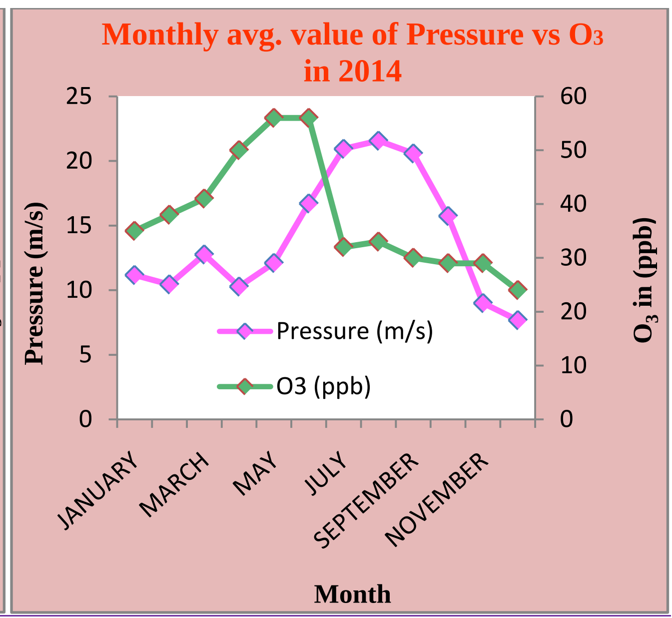


Fig.6

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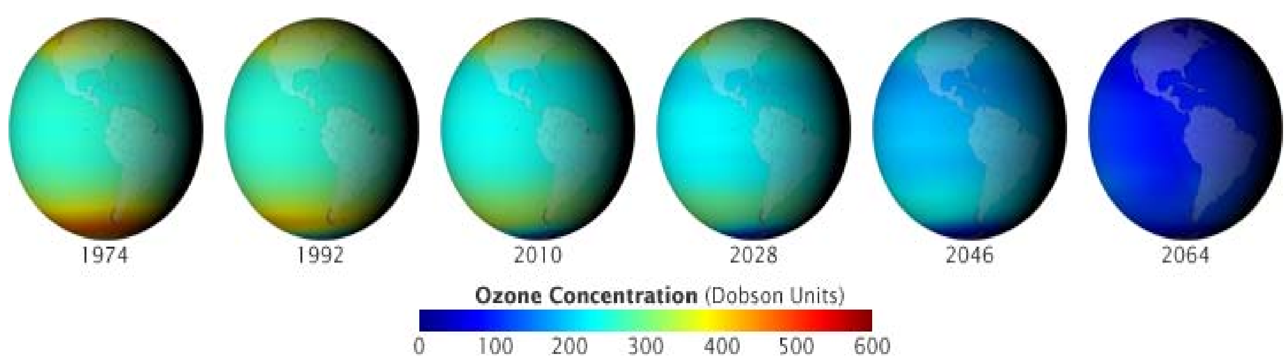
*Source: - MOES [Ministry of Earth Science, New Delhi]*

*Air Quality Index for Ozone (based on 8-hr.avg. concentration)*

| Index Values (Conc. Range) | Air Quality Descriptors | Cautionary Statements for Ozone |
|---|---|---|
| 0 – 50 (0-59 ppb) | Good | **No health impacts are expected when air quality is in this range.** |
| 51 – 100 (60-75 ppb) | Moderate | **Unusually sensitive people should consider limiting prolonged outdoor exertion** |
| 101 – 150 (76-95 ppb) | Unhealthy for Sensitive Groups | **Active children and adults, and people with respiratory disease, such as asthma, should limit prolonged outdoor exertion** |
| 151 – 200 (96-115 ppb) | Unhealthy | **Active children and adults, and people with respiratory disease, such as asthma, should avoid prolonged outdoor exertion; everyone else, especially children should limit prolonged outdoor exertion.** |
| 201 – 300 (116-374 ppb) | Very Unhealthy | **Active children and adults, and people with respiratory disease, such as asthma, should avoid all outdoor exertion; everyone else, especially children, should limit outdoor exertion.** |

*Source –NASA*



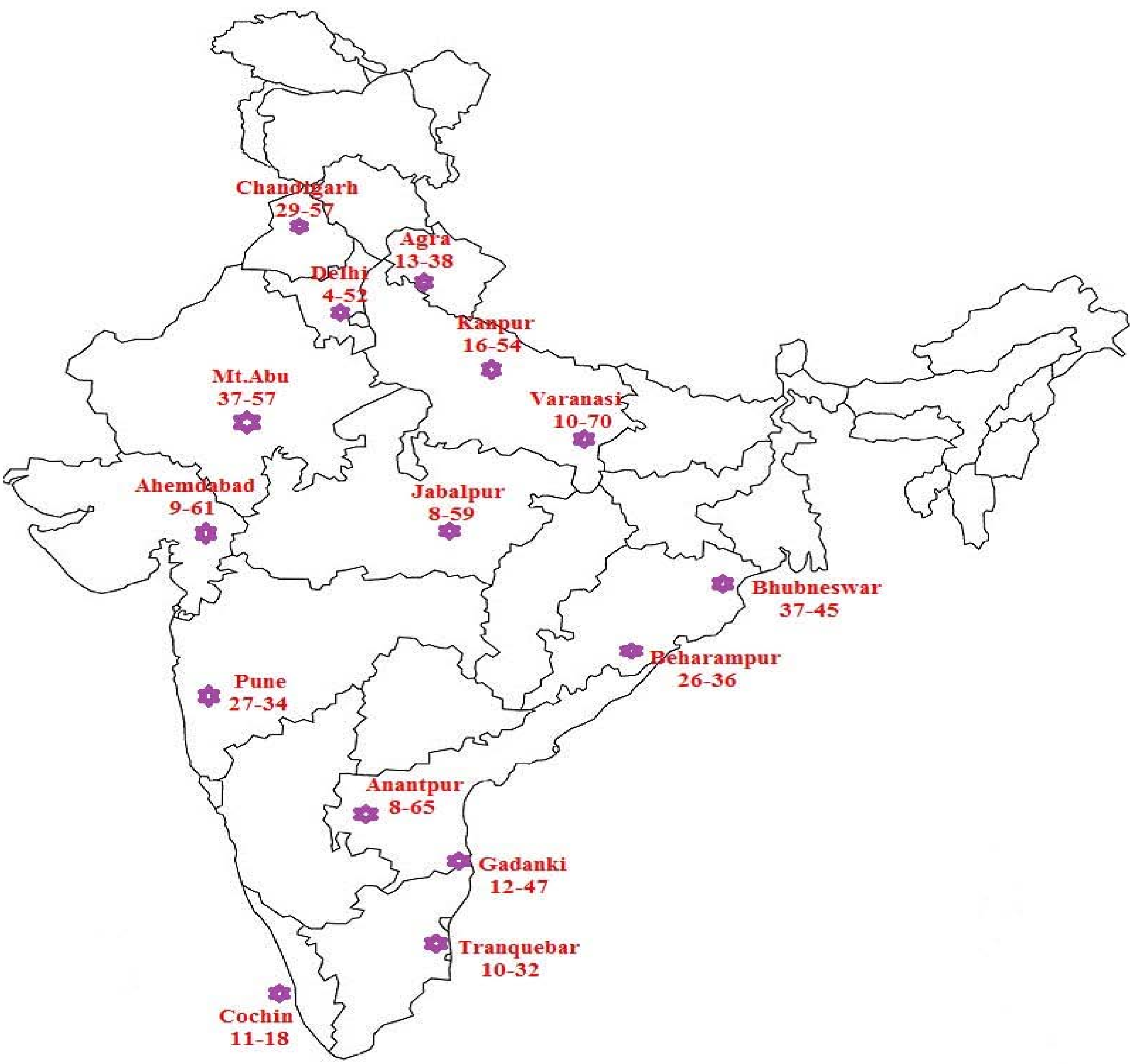



*Fig.1 :* Surface Ozone concentration(ppb) in different sites in india

## VI. Result & Discussion

Annual variation of daytime ozone and its correlation with various meteorological parameters such as *Temperature, Sun Shine, Rainfall, Relative Humidity, Wind Speed and Pressure* we observed during the period from January 2014 to December 2014.The analyzer average data for every 10 minutes interval and stores in the memory which were retrieved regularly for use in the study. The 10 minute data were averaged for each day to find the day time ozone ratio, and then average for a month were again averaged to determine the day time monthly average ozone ratio [*Fig*. 1, 2, 3, 4, 5, 6] . The monthly average of day time ozone ratio from January 2014 to December 2014. Ozone is primarily increasing due to rising NOx emissions, augmented by intercontinental transport. It can be observed that [*Fig.1]* in month of May temperature increase then the ozone concentration also increases to *55ppb* and another one when sunshine increased in month of April and May the ozone concentration increases to *58ppb*. [*Fig. 2*]. So this time is perfect situation to form of ozone mixing ratio. It has been observed that [*Fig. 3*] Jabalpur usually receives the first monsoon showers during the 2nd week of June. Hence the month of June, July, August are included under the monsoon season and a lower day time ozone ratio is expected during this period. In the

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month of July 2014, the average ozone ratio was observed to be lower as *30ppb.* The lowest ozone ratio was recorded in the month of September *28ppb*. [*Fig.4*] The daily average humidity was high in August compared to November and December. All these factors might have played an important role in lowering the ozone.*[Fig.5]* The daily average wind speed was found to be high in May and ozone is also high *58ppb* in the same month because the air helps to flow $O_3$ molecules in the atmosphere. And the last one [*Fig. 6*] observed that atmospheric pressure was low in the month of May, so ozone is highest in this month *60ppb* and compared to pressure which was high in the month of July and August then $O_3$ decreases to *28ppb* in this month.

## VII. Conclusion

An extensive study of day time ozone and relevant meteorological parameters at Jabalpur is presented. The ozone value was found to increase with sunrise and was highest between May due to high temperature. Ozone levels are low at late night and lowest during early morning hours.

However, it can be clearly observed that there was a significant difference in the average ozone values for various seasons. Summer season showed peak ozone ratio values followed by pre monsoon and almost similar values during monsoon and post monsoon periods. Such behavior could be expected due to its direct relationship to the availability of precursors gases and favorable for meteorological conditions.

## VIII. Acknowledgement

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