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Seasonal variation of Ozone in Industrial area of Singrauli, India

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Abstract: The seasonal variation in average ozone concentrations ranges from 15.45 ± 0.57 µg/m^3 during April to June (summer) to a high value of 28.19 ± 1.38 µg/m^3 during October to January (winter) at sampling location Khairi where as concentrations ranges from 23.82 ± 1.06 µg/m^3 during April to June (summer) to a high value of 39.83 ± 1.67 µg/m^3 during October to January (winter) at sampling location Singrauli. Ozone concentrations are observed to be highest during winter month (52.44 ± 0.90 in January at Singrauli sampling location) due to higher amounts of precursor gases, in spite of lower solar radiation at all sampling locations. Higher levels of precursors during winter are due to large scale transportation from the continents and lower boundary layer heights. In the body, ozone reacts with lung tissue and can inflame, harmful changes in breathing passages, decrease the lungs' working ability and cause coughing and chest pains.

Key words: Ozone · Seasonal variation · Health effect

INTRODUCTION

Singrauli area mostly covers the Singrauli district of Madhya and some part in Uttar Pradesh. The district is covered by catchment area of important dam Rihand. Many of the coal based thermal power plants have moved to that area. The area is rich with coal, minerals and other natural resources and has attracted several industries. In addition, carbons and chemicals industries are also functioning in the area.

Ground-level ozone is the major component in what we know as smog. It is not emitted directly into the air but is produced in the atmosphere when gases called hydrocarbons combine with nitrogen oxide compounds in the presence of sunlight. The ozone concentration in any given area results from a combination of formation, transport, destruction and deposition [1]. Elevation also affects surface ozone concentrations, with higher concentrations typically seen at sites located in the free troposphere. Given the many complex natural and anthropogenically induced factors that influence current surface ozone levels and the variability resulting from these factors, it is difficult to assign a single background ozone concentration [2]. It is also unlikely that any area of the Earth is completely free from anthropogenic influences. However, measurements taken at sites least affected by these influences can give an indication of background surface ozone levels.

Ozone is a major secondary air pollutant, produced by a complex series of photochemical reactions from primary pollutants of nitrogen oxides (NOx) and other hydrocarbons and pollutants. High concentrations of ozone are associated with hot sunny weather and occur over wide areas [3].

Background ozone is generally defined as the fraction of ozone present in a given area that is not attributed to anthropogenic sources of local origin. As such, background ozone has several sources, both natural and anthropogenic. These include: (1) downward transport of stratospheric ozone through the free troposphere to near ground level, (2) in situ ozone production from methane emitted from swamps and wetlands reacting with natural NOx (from soils, lightning strikes and downward transport of NO from the stratosphere), (3) in situ production of ozone from reactions of biogenic VOCs with natural NOx and (4) long-range transport of ozone from distant pollutant sources [4]. It is difficult to assign a single background ozone

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concentration. It is also unlikely that any area of the Earth is completely free from anthropogenic influences. The objective of the present study is the effect of seasonal characteristics of background ozone in Sonebhadra district and trends and possible reasons for these observed trends [5].

MATERIALS AND METHODS

Reagents Preparation: All reagents of analytical grade were used in the study. Absorbing Solution (1% potassium iodide-KI in 0.1 m Phosphate Buffer) was prepared by dissolving 13.6 g of potassium dihydrogen phosphate (KH_2PO_4), 14.2 g of disodium hydrogen phosphate (Na_2HPO_4) and 10.0 g of KI in sequence and diluted the mixture to 1 L with water. The solution was kept in a glass stoppered brown bottle at room temperature (27 °C) for at least 1 day before use. It should not be exposed to direct sunlight.

Stock Solution 0.025 M I_2 (0.05 N)- 16 g of KI and 3.173 g of re-sublimed iodine was successively dissolved and diluted the mixture to 500 mL with water. The stock solution was standardized against 0.025 M $Na_2S_2O_3$. The $Na_2S_2O_3$ is standardized against primary standard potassium dichromate ($K_2Cr_2O_7$).

1 M I_2 Solution- From stock solution 4.00 mL 0.025 M solution was pipetted exactly into a 100 mL volumetric flask and diluted to the mark with absorbing solution. All the reagents were prepared in dark places to protect from strong light [6].

Sampling: O_3 was measured by absorbing it in the absorbing solution of 1% KI in 0.1 m Phosphate Buffer. The 10 mL of absorbing solution was taken in a midget impinger. The rate of air sampling was kept at 1 Litre per minute. Do not expose the absorbing reagent to direct sunlight. After sampling measure the volume of sample transferred to sample storage bottle [6].

Analysis: If, appreciable evaporation of the absorbing solution occurs during sampling, water to be added to bring the solution volume to 10 mL. Within 30 to 60 minutes after sample collected, the absorbance in a cuvette at 352 nm against a reference cuvette containing distilled water were analyzed spectroscopically by Dynamica UV-Vis single beam spectrophotometer (Model: Halo SB-10).

The concentration of Ozone was calculated as follows:

$$\text{Ozone}\left(O_3\,\frac{\mu g}{m^3}\right) = \frac{(A_s - A_b \times CF \times 1.962)}{V_a}$$

Where:

A_s is the absorbance of sample,
A_b is the absorbance of reagent blank,
CF is the calibration factor,
V_a is the volume of air sampled in m^3 and
1.962 is the conversion factor, µL to µg.

RESULTS AND DISCUSSION

Khairi location, the concentration of ozone ranged from 23.60 to 29.45 µg/m^3 with an average of 27.62 ± 2.08 µg/m^3 followed by 22.60 to 30.05 µg/m^3 with an average of 26.81 ± 2.18 µg/m^3 and 14.33 to 16.73 µg/m^3 with an average of 15.45 ± 0.69 µg/m^3 in winter season, post winter season and summer season respectively (Fig. 1). The maximum concentration of ozone was observed 38.43 + 2.89 in the month of January (Fig. 2).

At Dorahar location, the concentration of ozone ranged from 32.08 to 36.62 µg/m^3 with an average of 34.03 ± 1.48 µg/m^3 followed by 25.90 to 36.00 µg/m^3 with an average of 32.16 ± 0.63 µg/m^3 and 17.73 to 20.40 µg/m^3 with an average of 19.32 ± 0.92 µg/m^3 in winter season, post winter season and summer season respectively (Fig. 3). The maximum concentration of ozone was observed 46.40 + 2.89 in the month of January (Fig. 4).

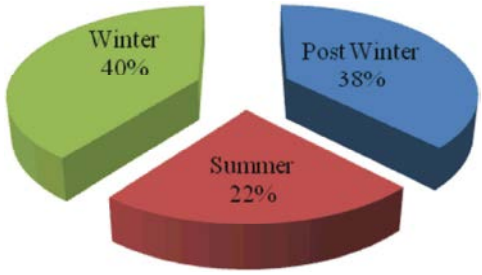

Fig. 1: Seasonal variation of ozone at Khairi sampling location

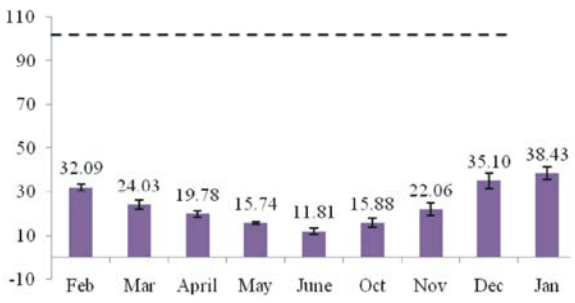

Fig. 2: Monthly variation of O_3 concentration at Khairi sampling location

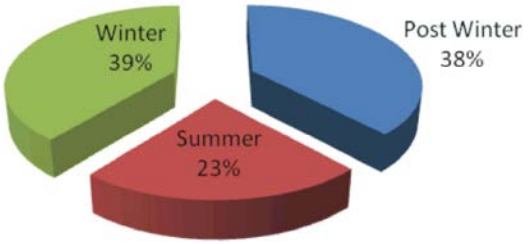

Fig. 3: Seasonal variation of ozone at Dorahar sampling location

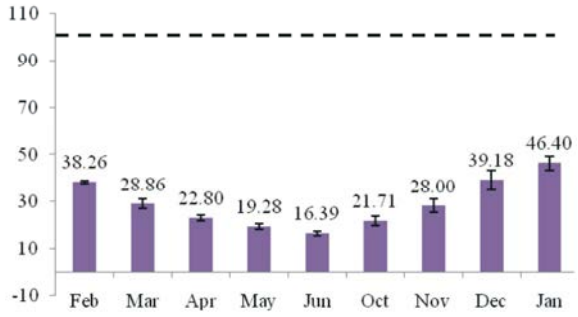

Fig. 4: Monthly variation of O_3 concentration at Dorahar sampling location

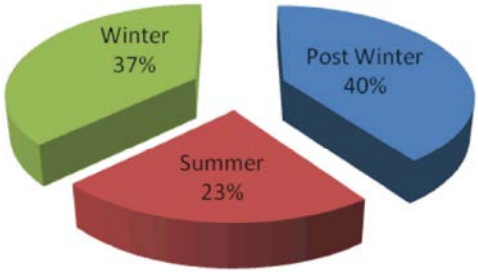

Fig. 5: Seasonal variation of ozone at Singrauli sampling location

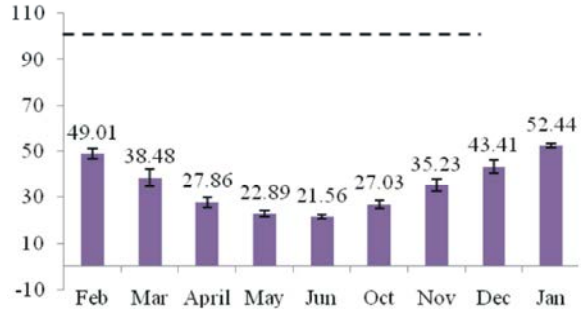

Fig. 6: Monthly variation of O_3 concentration at Singrauli sampling location

At Singrauli location, the concentration of ozone ranged from 33.10 to 45.90 µg/m^3 with an average of 42.07 ± 4.51 µg/m^3 followed by 37.22 to 42.13 µg/m^3 with an average of 39.83 ± 1.67 µg/m^3 and 22.60 to 25.40 µg/m^3

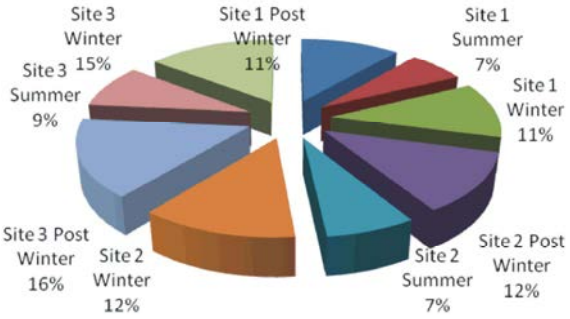

Fig. 7: Seasonal variation of ozone at all sampling locations

with an average of 23.83 ± 1.06 µg/m^3 in post winter season, winter season and summer season respectively (Fig. 5). The maximum concentration of ozone was observed 52.44 + 0.90 in the month of January (Fig. 6).

From the above Fig. 7, it is cleared the overall concentration of ozone in Singrauli location was maximum. In winter season, the January month has highest concentration of ozone observed. Ozone gas has some adverse effect on human. In the body, ozone reacts with lung tissue. It can inflame and cause harmful changes in breathing passages, decrease the lungs' working ability and cause coughing and chest pains. Even healthy people are found to be sensitive to ozone exposure. The adverse effects of ozone on plants were first identified in the 1950s and it is now recognized as the most important rural air pollutant, affecting human health and materials, as well as vegetation. The first of these is acute visible injury [5, 7]. Ozone can reduce agricultural yields by a variety of mechanisms.

CONCLUSIONS

Investigations indicated that the concentration of ozone in the Earth's atmosphere is changing with respect to seasonally. The seasonal variation in average ozone concentrations ranges from 15.45 ± 0.57 µg/m^3 during April to June (summer) to a high value of 28.19 ± 1.38 µg/m^3 during October to January (winter) at sampling location Khairi where as concentrations ranges from 23.82 ± 1.06 µg/m^3 during April to June (summer) to a high value of 39.83 ± 1.67 µg/m^3 during October to January (winter) at sampling location Singrauli. Ozone concentrations are observed to be highest during winter month (52.44 ± 0.90 µg/m^3 in January at Singrauli sampling location) and lowest ranged from 10.2 to 14.2 µg/m^3 with an average of 11.81 ± 1.45 µg/m^3 at Khairi location in the month of June. In the body, ozone reacts with lung tissue and can

inflame, harmful changes in breathing passages, decrease the lungs' working ability and cause coughing and chest pains.

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REFERENCES

1. Mudway, I.S. and F.J. Kelly, 1989. "Ozone and the lung: a sensitive issue", Mol. Aspects Med., 21: 1-48.
2. Hazucha, M.J., D.V. Bates and P.A. Bromberg, 1989. "Mechanism of action of ozone on the human lung", J. Appl. Phys., 67: 1535-1541.
3. Avol, E.L., W.C. Navidi and S.D. Colome, 1998. "Modeling ozone levels in and around Southern California homes", Env.l Sci. Tech., 32: 463-468.
4. EPA (Environmental Protection Agency), 1993. "Air quality criteria for ozone and related photochemical oxidants", Environmental Protection Agency, 3–6, (EPA-600/ P-93-004aF-cF).
5. Vingarzan, R., 2004. "A review of surface ozone background levels and trends", Atm. Env., 38: 3431-3442.
6. Guidelines for sampling and analysis protocol for ozone in ambient air, 2011. NAAQS Monitoring and Analysis Guidelines Volume-I, CPCB, pp: 31-34.
7. Monks, P.S., 2000. "A review of the observations and origins of the spring ozone maximum", Atm. Env. 34: 3545-3561.