

Tvocs Concentration Status and its Correlation with Ozone Concentration in different seasons at GGU campus, Bilaspur (C.G.) India

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Abstract

It is well documented that Volatile organic compounds (VOCs) are determined to be a risk factor in different environments, with the largest source of its emission being the vehicles. This study represents the temporal variability of Total Volatile Organic Compounds Concentration (TVOC) and Ozone at the different locations of the Guru Ghasidas University, Bilaspur (C.G.) India. Eight locations having different vehicular load in the university campus were selected to generate a database of TVOCs and Ozone concentration in different seasons respectively. The TVOC and Ozone concentration were measured by Phoccheck Tiger and Multi Gas Monitor. The obtained data shows that the concentration of TVOC and ozone were found maximum in the summer season and lowest in the winter season at all sites. The site with higher vehicular load (Site-1) record a high concentration of TVOC and Ozone in all the seasons. In contrast, tree cover and vegetation directly reduces the TVOC concentration by lowering the atmospheric temperature and consequently lowers the ozone concentration. The overall data depicts a strong positive significant correlation between TVOC and Ozone. More attention needs to be paid to the places I urban areas where the vehicular load is high, for general welfare of the people, and these sensitive places should be brought under green cover to reduce risk factor caused by TVOCs

Keywords: Total volatile organic compounds concentration (TVOC); Ozone; Vehicular pollution; G.G.U campus

Introduction

Volatile Organic Compounds (VOCs) have come into interest when Haagen-Smit recognized its role in the initiating the photochemical processes and production of tropospheric ozone and other secondary pollutants in the presence nitrogen oxides (NO_x) [1-2]. A number of volatile organic compounds are reported as cancer risk factors in the urban areas [3]. Main anthropogenic source of VOC include transport sector in urban areas. The half of the VOCs got emitted from unburned fuel [4]. Traffic and traffic-related sources are known to be a major source of non-methane hydrocarbons (NMHCs i.e., alkanes, alkenes, alkynes and aromatic HCs) in urban areas [4,5] but in residential or industrial areas other sources may also be important. Non-methane volatile organic compounds influence climate change mainly through the production of organic aerosol and their involvement in the production of Ozone [6]. Surface level ozone are formed by the photochemical oxidation of carbon monoxide (CO), methane (CH₄) or non-methane volatile organic compounds in the presence of nitrogen oxides [7,8].

Many materials used in the construction of buildings like-paints; varnishes, waxes, cleaning supplies and adhesives emit VOCs. Concentrations of VOCs in indoor air are generally 5 to 10 times higher than outdoor [9]. It is identified that these VOCs is probable cause of acute health effect and discomfort among occupants [10]. VOCs are very injurious to human health as benzene causes cancer in humans and main symptoms linked to VOCs exposure are conjunctival irritation, nose and throat discomfort, headache, allergic skin reaction, nausea and dizziness etc [11,12].

Tropospheric ozone considered as strong pollutant because of its strong adverse potential on the human health and agricultural productivity [13]. Over 90% of vegetation damaged may be result of tropospheric ozone alone [14]. High level of Ozone concentration effects visible and physiological process. Physiological effects of ozone exposure include reduced photosynthesis rate. Reich [15] showed that an ozone dose of 20 ppm results in a photosynthesis reduction of 7%

for conifers, 36% for hardwoods and 73% for crops. Ozone also causes respiratory inflammation; reduce respiratory capacity and asthma in humans.

The measurement of TVOCs at varying vehicular load sites can be a good platform to deal with its consequences. However a little monitoring studies on concentration of VOCs and its temporal behavior in the tropical urban/rural sites exist in the literature. Therefore the present work has been taken to measure TVOCs and ozone at different sites in the university campus, which is situated in urban area. The main aim of the present work is to analyze the temporal variation of TVOCs and ozone at different location of the university campus, and the contribution of TVOC in ozone formation. The study can be useful in developing an urban architecture with least TVOC and ozone stress, thus the impact on the health of the population living near the sources or in the downwind regions can be reduced.

Material and Methods

Experimental site

Guru Ghasidas University, (GGU) is situated at the latitude- 22.0796 and longitude- 82.1391 in Bilaspur district of Chhattisgarh state. The university campus is spread over an area of 650 acres and represents a varying vehicular load at different sites of the University.

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The measurements of TVOC and ozone level have been made at different sites in the campus. The measurements were made during the morning time between 9:00 am to 11:00 am and twenty five samples have been measured for TVOC and Ozone concentration at a site and time.

TVOC analysis

The analysis of total VOCs in the air can be expressed as TVOC (Total Volatile Organic Compounds). The concentration of TVOC was measured by the instrument VOC Analyzer (Phocheck Tiger), Ion Science U.K. This instrument is working on the principal of the PID detection and measures 450 different types of VOCs and gives a final concentration of TVOC in ppb for a particular place.

Ozone analysis

The concentration of ozone was measured by the instrument Multi Gas Monitor, Make- GfG, USA. This instrument analyzes the concentrations of ozone by electrochemical method. The concentration of ozone in any area is determined instantly by this instrument in the ppm range.

The sampling locations were as following for present study (Table 1)

Result and Discussion

The monthly mean data from September 2015 to May 2016 for TVOC and ozone have been recorded and presented in Figures 1 and 2. A significant temporal variation in TVOC and ozone at all locations of experimental site were obtained. The results reveal that

the TVOC and Ozone concentration were maximum in the summer and lowest in pre-winter season. The high temperature during the summer season increase the rate of emission of VOCs, thus more concentration of TVOCs have been recorded in summer. Our results are inconsistent with those reported by the Mauzerall et al. [16], Singh et al. [17], Van Langenhove [18], Huang, et al. [19], Barletta, et al. [20]. The concentration of TVOC was recorded high (168.9 ppb) at Site-4 (Indoor pollution area) during the pre winter season (Figure 1), when the painting work was in progress and after completion of the work the level of TVOC was reduced in the winter and, summer season as 19.3 and 13.0 ppb respectively. The same trend was also found at Site- 5 (Indoor pollution area). Different types of VOCs are emitted from the latex paints [21].

At Site- 3 (Parking area) the concentration of TVOCs were found high in all the seasons. This value was 21.7 ppb (pre winter), 25.8 ppb (winter) and 57.83 ppb (summer) respectively (Figure 1). The concentration of Ozone were also found high in winter and summer as 0.089, 0.1025 ppm (Figures 1 and 2) respectively due to parking area. Earlier it has also been shown that parking area is source of TVOC [22] and due to presence of TVOC the ozone concentration was also high. Site- 6,7 and 8 (6 and 7-Tree Cover, 8-Residential Area) have light vehicular pollution load and also have dense forest due to which TVOCs level were found comparatively less [23]. The lowest value for TVOCs was recorded at the Site-8 (3.365 ppb) in winter season. The same trend was followed by the ozone concentration. The site which has high TVOCs level also has high ozone concentrations. The maximum ozone concentrations 0.157 ppm was observed at the Site-1 and lowest

Site Name	Description	Type
SITE-1	Main gate of the Campus connecting the main road having high load of vehicular pollution.	Vehicular pollution
SITE-2	Auditorium building is surrounded by <i>Peltophorum</i> plantation.	Tree cover
SITE-3	Large parking area near IT building.	Parking area
SITE-4	Different types of paints and varnishes are used in the new building for finishing purpose.	Indoor Pollution
SITE-5	Two new hostels buildings area having painting and finishing work.	Indoor Pollution
SITE-6	University guest house area have low pollution load and covered with the vegetation and trees.	Tree cover
SITE-7	The site has two big perennial ponds with mixed cover plantation near residential area.	Tree cover with water bodies
SITE-8	Purely residential area in the campus having controlled vehicular movements, surrounded by natural forest cover.	Residential area

Table 1: The sampling locations were as following for present study.

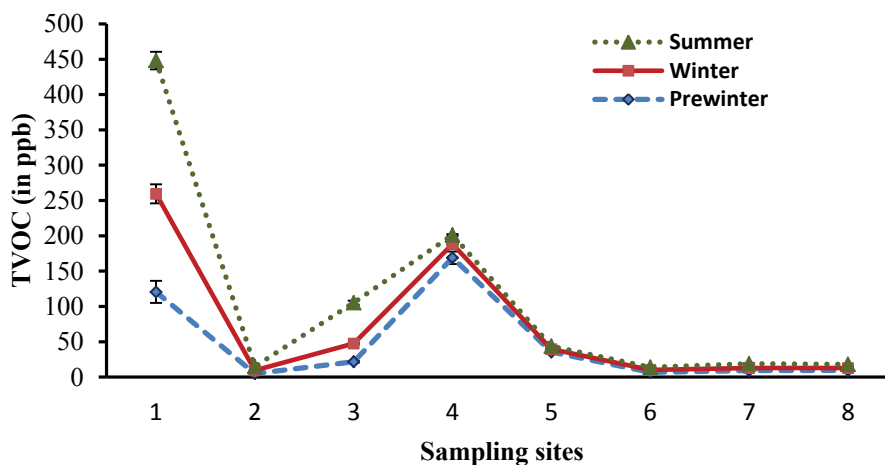


Figure 1: Average TVOC concentration (in ppb) of ambient air at different sites of GGU campus during pre-winter, winter and summer. The error bars represents SD value.

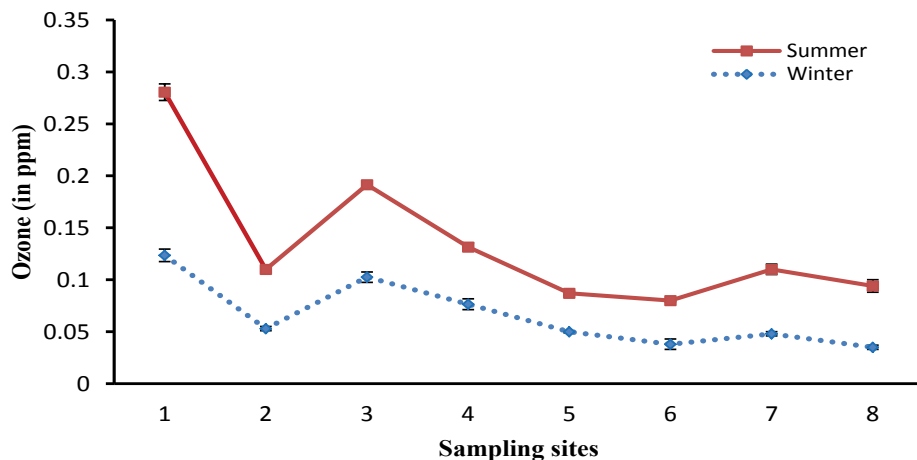


Figure 2: Temporal variation in average ozone concentration (in ppm) of ambient air at different sites of GGU campus during winter and summer. The error bars represents SD value.

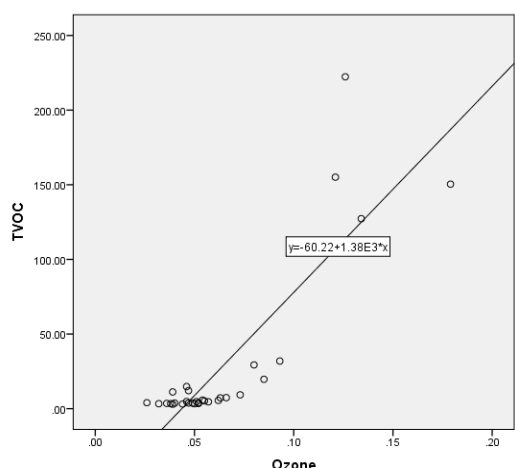


Figure 3: Correlation curve of Ozone and TVOCs concentration.

Correlation is significant at the 0.01 level of probability (two tailed). This value shows that there is a strong positive correlation between the TVOC and ozone concentration during different seasons in the campus [25]. Ozone reduces growth and affects the amount of carbon in the vegetation. Once VOCs are emitted into the atmosphere, it cause not only pollution problem on at local scale but also play important role and induce photochemical ozone formation initialized by the reaction with OH radicals in the troposphere in the presence of nitrogen oxides and sunlight [26]. VOCs and Ozone concentration varies seasonally as the temperature play important role in Ozone formation through VOCs.

Conclusion

The concentration of TVOCs of any area determines its respective impact on the environmental chemistry through its photochemical oxidation. Exposure to ozone and other VOC generated toxic gases causes both visible and physiological damage to the living organisms, thus a need exist to monitor the emission of TVOCs at different urban background. The overall data of the present study depicts a significant temporal variation in the TVOC and ozone concentration at different locations in GGU campus, also a significant diurnal variation in these parameters was recorded. The results insights that TVOC is a key part of ozone production, thus deposition of ozone at surface level can be a key consideration towards understanding the consequences of ozone level. On the other side the tree cover plays an important role in the lowering the concentration of TVOCs and ozone by their influence on temperature, and controlling of microclimate. Thus rich plantation and vegetation cover can minimise the concentration and effect of TVOCs and ozone in the area and can reduce native health effects.

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Correlations			
		TVOC	Ozone
TVOC	Pearson Correlation	1	.860**
	Sig. (2-tailed)		0
	N	31	31
Ozone	Pearson Correlation	.860**	1
	Sig. (2-tailed)	0	
	N	31	31

**Correlation is significant at the 0.01 level (2-tailed).

Table 2: Correlation matrix showing correlation between the Ozone and TVOC.

(0.035 ppm) at Site-8. Strong correlations between the concentration of TVOC and Ozone at all the sites have been observed [24].

Correlation coefficient and Regression coefficient were determined to find out relationship between TVOCs and Ozone concentration at selected site. The Correlation coefficient value for both the parameters are strongly positively correlated (R=0.860) and for regression coefficient the value was R²=0.740 (Figure 3) (Table 2).

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