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Measurement of surface Ozone in the year 2011 at different sites over Tamil Nadu, India

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Abstract

The Ozone concentration is influenced by the intensity of solar radiation and chemical reaction between oxides of nitrogen (NOx) and volatile organic compounds (VOC) in the presence of sunlight. This study aspires to asses distribution of the surface zone concentration, characteristics of hourly and daily mean surface Ozone with different climatic parameters, such as temperature, relative humidity, and wind speed over Tamil Nadu. Measurement was carried out at 11-stations (except this study no data is made available) having different weather conditions during the period from 8th June to 7th July of the year 2011. We were the first researchers visited most of the district of Tamil Nadu state and measured surface Ozone. We have made an effort to identify areas where there is elevated surface Ozone concentration. Results of this study reveals that hourly and daily mean values of ground level Ozone concentrartion in Tamil nadu was 0.0109ppm and 0.0108ppm respectively. The highest ground level Ozone concentration was in Kanniya kumari district (0.0179 ppm). The lowest was in Cuddalore district (0.0038ppm). During the study period, the concentration of ground level Ozone over Tamil Nadu had never exceeded the prescribed value (0.075ppm). The results of this study show that ground level Ozone concentration has a positive correlation with the temperature and negative correlation with the relative humidity and wind speed.

Keywords: Surface Ozone, Diurnal cycle, meteorological parameters,anthropogenic sources,VOCs, NOx.

Introduction

Ground level Ozone is of great concern because of its effects on human health and ecosystem (Dovile Laurinavicine, 2009). Ground level Ozone is not emitted directly into the atmosphere. It has important impact on the radiative balance of the atmosphere (Londhe *et al.,* 2008). Ozone does not have direct natural sources, It results from the photochemical reactions between oxides of nitrogen (NOx) and volatile organic compounds (VOC_s) in the presence of sunlight (Dovile Laurinavicine, 2009). Emission of NOx occurs primarily in motor vehicle engines, power plants, industrial boilers and burning of fossil fuels. Main sources of VOC_s are motor vehicle emissions, gasoline vapours, chemical solvents (Pollution prevention Hand book, 1998). High concentration of ground level Ozone becomes an increasing problem every year because it constitutes the main part of photochemical smog. Photochemical ground level Ozone formation depends on a number of anthropogenic factors. Typical summer weather conditions are responsible for an increase in ground level Ozone production (Debaje *et al.,* 2003). The most efficient Ozone formation reactions are driven by solar radiation and precursors. Meterological parameters (temperature, wind speed and direction, solar radiation, humidity) influence the formation and dispersion of pollutants, the concentration varying widely from region to region, with the time of year, and the time of day (Duenas *et al.,* 2002).

Many studies around the globe have reported that surface Ozone in rural locations near the industrial areas has increased significantly. (Londhe *et al.,* 2008). Examination of surface wind patterns and other meterological parameters suggest that elevated Ozone concentrations occur during the days with intense solar radiation, light winds, and in the presence of unique wind circulation (Wang *et al.,* 2001).

This study intends to assess the ground level Ozone concentration over Tamil Nadu. To determine the ground

Fig.1. Geographical location of study stations of Tamil Nadu State

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Table. 1. Details of study area

S. No	Measurement places	Description of measurement places	Latitude, Longitude
1	Kanniya kumari	Coastal area, More Brick kiln industry.	8^o 04' N 77^o 33' E
2	Myladuthurai	Continental area - Town, Villages	11^o 06' N 79^o 42' E
3	Thirunelveli	a Stretch of Western Ghats and lowland plains, scenic waterfalls, sandy soil and fertile alluvium, Beach Minerals Factory, Vehicles	8^o 44 ' N 77^o 44' E ^{o}
4	Madurai	Continental area - Big Town rubber producing centers, Numerous textile and chemical industries, Granite industries, Brick kiln industry in villages	9^o 58' N 78^o 10'E
5	Tuticorin	Medium seaport (Artificial), Industrial coal, copper concentrate, fertilizer, timber logs, iron ore, pearl fishery	8^o 48' N 78^o 11' E
6	Vellore	Continental area with more industrialization surrounded by plains ,low rocky hills ,tropical wet and dry climate	12^o 55' N 79^o 11'E
7	Kanchipuram	Thriving hand loom industry, Continental area - Surrounded Village	12^o 50' N 79^o 45'E
8	Chennai	Eastern Coastal plains, a tropical wet and dry city, automobile industry, leather exports, more polluted city.	13^o 04' N 80^o 17' E
9	Coimbatore	a Stretch of Western Ghats ,textile and manufacturing hub	11^o 00' N 77^o00' E
10	Trichy	Alluvial soil ,a belt of cretaceous rock, Layers of archaean rocks, granite and gneiss ,thin bed of conglomeratic laterite, Cauvery delta	10^o 50' N 78^o 46' E
11	Cuddalore	Coastal area with less industrialization	11^o 43' N 79^o 49' E

level Ozone concentration, a portable Aeroqual series 200 Ozone monitor has been used. This has been of great assistance in estimating the concentration of ground level Ozone in places where there are no permanent measurements, close to streets, also in residential places, suburbs and villages.

Table 2. National Ambient Air Quality Standards (NAAQS)

	Primary Standards		Secondary Standards	
Pollutant	Level	Averaging Time	Level	Averaging Time
Ozone	0.075 ppm (2008 std)	8-hour	Same as Primary	
	0.08 ppm (1997 std)	8-hour	Same as Primary	
	0.12 ppm	1-hour	Same as Primary	

Method and material

Ground level Ozone concentration measurements were carried out at various locations over the state of Tamil Nadu. A portable Aeroqual series 200 Ozone monitor was used, measurement units being either ppm or mg/m^3. It was supplied by the Unipro Instruments India Pvt Ltd., Mumbai. Digital Anemometer Ms.6250Ms was used for wind speed measurement.

Measurement was carried out at 11-stations which spread throughout Tamil Nadu. Table 1 gives the geographical parameters of the selected stations. In each place, the measurement was done every hour from 08:00 am to 5:00 pm. Fig. 1 gives an idea about how the study locations are spread throughout the state. To assess the relation between ground level Ozone and the meteorological parameters such as temperature, Relative humidity and wind speed, these quantities were also measured using portable instruments. Then, the correlation coefficient between the ground level Ozone and these meteorological parameters were calculated.

Results

The result indicated no major difference between the Hourly and daily average of the O_3 concentrations. And also it does not exceed the National Ambient air quality standard (0.075ppm).

Ambient standards and guidelines for ground-level Ozone are aimed at protecting human health, sensitivity ecosystems, and agricultural plants from the harmful effects of ground-level Ozone. Final rules signed June 2010. National Ambient Air quality standard had attained by using three year average of the daily maximum one hour average value and each value must not exceed 75 ppb (0.075ppm). Table 2 gives the prescribed values of ground level Ozone as per National Ambient Air Quality Standards.

Variation of ground level Ozone concentration in different places

Study results show that hourly and daily mean ground level Ozone concentration in Tamil Nadu state was 0.0109 ppm and 0.0108 ppm. The highest ground level Ozone concentration was observed at Kanniyakumari which is the south most district of Tamil Nadu and its value is 0.0179 ppm. The next higher concentration of 0.0168ppm was observed at Myladuthurai. The lowest ground level Ozone concentration was noticed at Cuddallore (0.0038ppm) (Fig.2 & 3).

Fig. 4 gives the distribution of Ozone and Temperature over the entire day. It reveals that ground level Ozone increases with temperature. This is due to the fact that Ozone formation is enhanced by the temperature. From Fig. 5, we can understand Ozone & Relative Humidity are correlated negatively. Relative humidity decreases with

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Fig.2. Average value of Surface Ozone in different places of Tamil Nadu

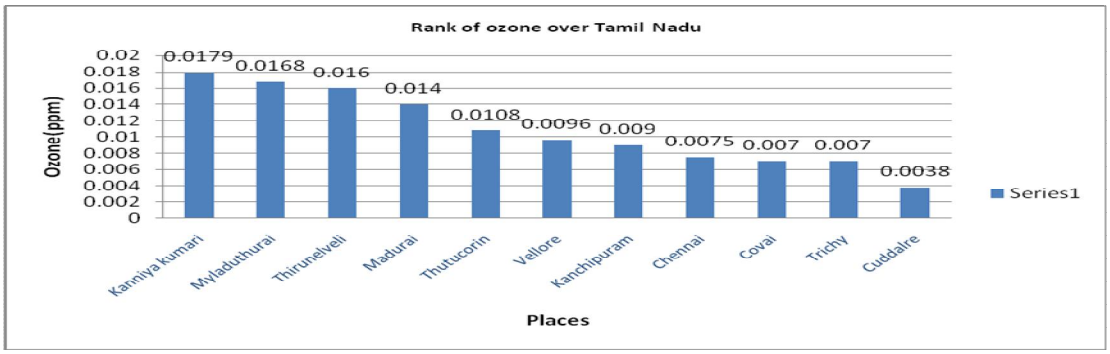


Fig. 3. Variation of surface Ozone in different places of Tamil Nadu.

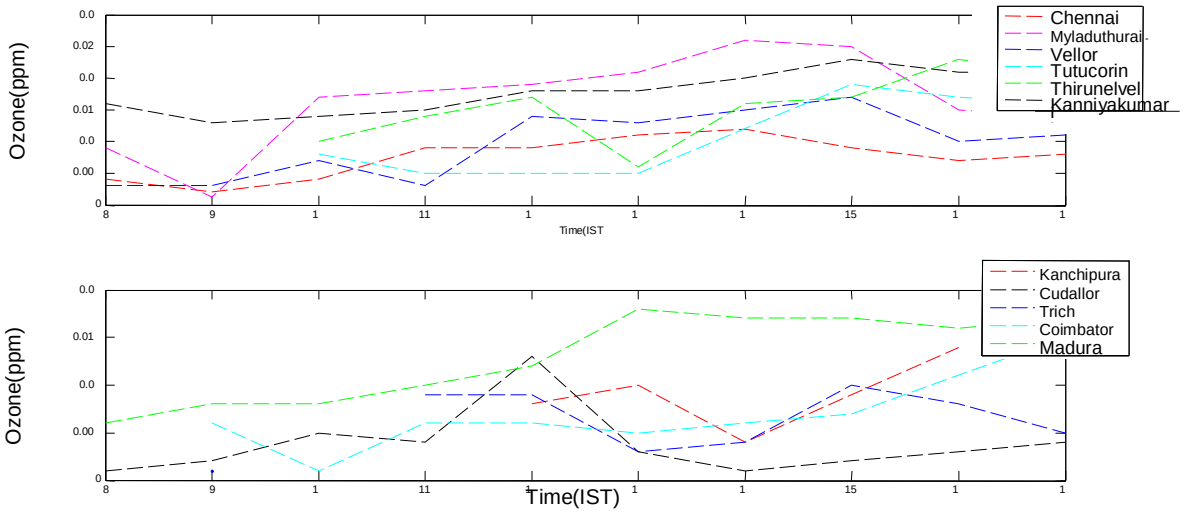


Fig.4. Hourly average of Ozone and Temperature over Tamil Nadu

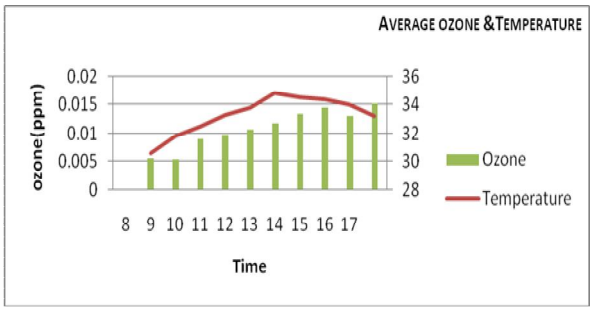


Fig 5. Hourly average of RH and Ozone over Tamil Nadu

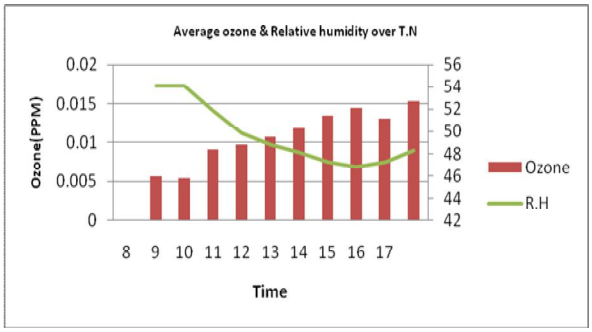


Fig.6. Hourly average of Ozone & wind Speed over Tamil Nadu

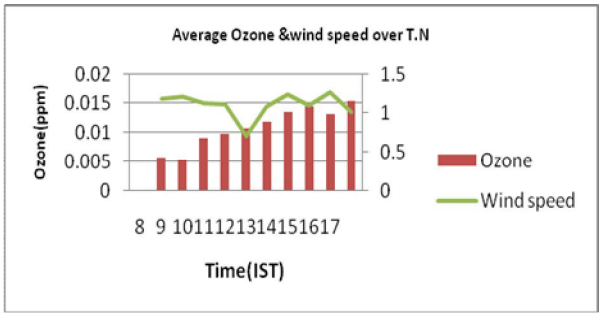
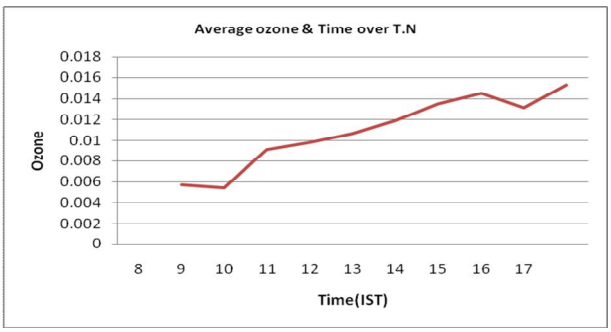


Fig.7. Diurnal variation in the ground level Ozone concentration



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increasing Temperature. From Fig. 6, it is clear that the ground level Ozone is correlated with wind speed negatively to a certain extent.

The minimal ground level Ozone concentration was at 9 hours (0.0054ppm) and maxima at 17.00 hour (0.0153ppm). Fig. 7 shows the two peaks of ground level Ozone. The first peak was observed at 15hours (0.0145ppm), the second at 17 hours

Though Kanniyakumari is not highly industrialized, high concentration of ground level Ozone has been observed in these place. This may be due to the local meteorological factors and the activities involved in brick kilns played a great impact on the observed pattern (Elampari *et al.,* 2010). We have measured Ozone at the place Akkur (between Myladuthurai and Tranquebar) area and previous researcher studied that Ozone concentration at Tranquebar was high (Debage *et al.,* 2003). This increase in Ozone here is attributed to the increase in NOx and other O_3 precursor emissions by different sources in the proximity of the site (Debaje *et al.,* 2003). The ground level Ozone concentration has shown a clear diurnal cycle, with highest value at around 15 hours in the day time. Also, it has been observed that Ozone concentration gradually increased at day time and decreased at night time. Thus, Ozone level is positively correlated with temperature.

The dependence of ground level Ozone concentration on meteorological parameters such as temperature, wind speed and Relative Humidity has been established, have demonstrated that Ozone concentration correlate reasonably well with the temperature (Dovile Laurinavicine, 2009). The others have reported an inverse correlation between the wind speed and Ozone concentration. We also have got similar results. Results of this study have revealed that the ground-level Ozone concentration is significantly correlated with temperature (r = 0.8105) and Relative Humidity (r = -0.9417) and moderately correlated with the Wind speed (r= -0.1348). Also, the ground level Ozone is positively correlated with temperature and inversely correlated with Relative Humidity and Wind speed. It is found that using a portable instrument like the Aeroqual (series, 200) may be the easiest way to measure ground level Ozone in different places.

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