CHARACTERIZATION OF TRACE GASES AND GREEN HOUSE GAS IN MEGACITY NEW DELHI

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ABSTRACT

Air pollution and climate change is serious environmental concern due to its visible negative impact on human health. Around 14 Indian cities are placed among top 20 most polluted cities of the world. Trace gas like O_3, NO_x, CO and CO_2 are important pollutants which is associated with human health, climate change and adverse effect on growth and yield of crops. Stratospheric O_3 absorbs ultraviolet light and prevents it from reaching to the ground. Greenhouse effect of O_3 and CO_2 is prominent, O_3 in upper troposphere and ranked 3rd for its radiative potential after the carbon dioxide and methane. The amount of O_3 generated by photochemical reaction of air pollutants is much larger than the inflow from the stratosphere. This is indicating that trace gases and GHG are generated by anthropogenic activities. It is significantly high in urban area like megacity Delhi as compared to rural area due to excessive anthropogenic activity.

The ground level measurements of surface trace gas like O_3, NO_x, CO and CO_2 were conducted in Delhi-Mathura road near traffic intersection for year 2017, January to December. The daily mean concentration of O_3, NO_x, CO and CO_2 were 23.11±17.26ppb (range 58.38 to 6.42ppb), 26.41±4.24ppb (ranges 48.14 to 24.09ppb), 1.56±4.24ppm (ranges 6.6 to 0.69ppm) and 342.54±33.49 (ranges 508.23 to 323.33ppm), respectively. The mixing ratios of O_3 were highest of 32ppbv and lowest 17ppbv during the pre-monsoon and monsoon seasons, respectively. While the mixing ratios of both CO and NO_x showed highest and lowest values during the winter and monsoon seasons, respectively.

The analysis concluded seasonality of O_3, CO and NO_x were also governed by the long-range transport, mainly with the summer and winter monsoon circulations over the Indian subcontinent. The mixing ratios of CO and NO_x show strong correlations during winter and pre-monsoon seasons, while poor correlation in the monsoon season. The mixing ratios of CO and NO_x decreased with the increase in wind speed, while O_3 tended to increase with the wind speed.

Keywords: Trace gases, GHG, seasonal variability, mixing rate, vehicular pollution

1. METHODOLOGY

Major vehicles for transportation are buses, cars, two- and three-wheelers (motorbikes, scooter and auto-rickshaws). Due to rapidly increasing number of vehicles (about 10–15 % per year), the transport related activities are the major contributors of various pollutants [1-3]. The real time automatic data of ambient pollutant concentration and meteorological data were collected from Automatic Weather Station (AWS) and Automatic Rain Gauge (ARG) for the Year 2017, installed by India Meteorological Department (IMD, India) at Delhi-Mathura Road/National Highway 2 (NH2) passing through Delhi to Agra city. The site is geographically located at 28°37'39.99N 77°14'29.04E at 216 meters above mean sea level (MSL). The ground measured concentration of trace gases O_3 CO, NO_x and CO_2 will be considered for the analysis. The site has very high inflow and outflow of vehicles, about 170,000 vehicles per day but there are other major sources of pollution located in the vicinity of the site, such as sewage treatment plant, gasoline stations and automobile workshops. The major sources of gaseous pollutants in the surrounding areas of the site are vehicular exhaust and biofuel burning. The vehicle composition consists of mainly two-wheelers, three-wheelers, cars, buses and light commercial vehicles (LCVs) during day time and heavy-duty trucks during the night hours [4-6].

2. RESULTS

2.1 Diurnal variation of trace gases

The basic dataset in the present study were recorded for 30 min interval and averaging has been done to derive hourly data. The amplitude of diurnal distribution varied from month to month. The diurnal distributions of O_3 in the pre-monsoon, post-monsoon and winters seasons show strong variability (Figure 1). However, the distribution of O_3 in the monsoon season shows weaker diurnal dependency. The maximum O_3 and minimum NO_x concentration were found during 14-17 hour and min CO, CO_2 concentration during 13-16 hr and maximum concentration were found during morning and evening traffic peak hour (7-11am and 17-20pm, Figure 1).

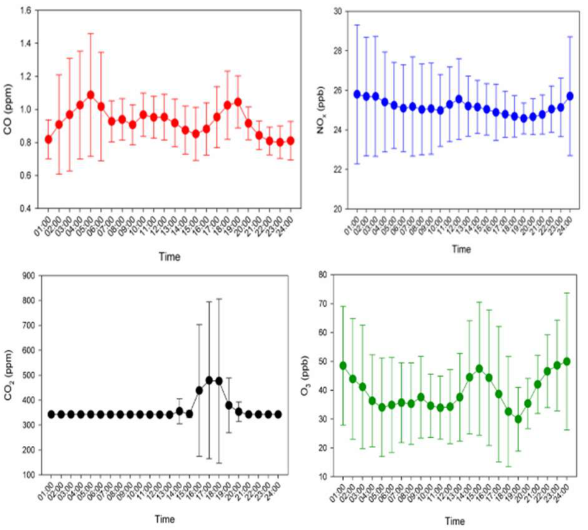

Figure 1: Diurnal variation of air pollutants.

The degree of diurnal variability in both CO and NO_x varied from month to month with strong variability in the pre monsoon, post-monsoon and winters seasons, while weaker diurnal dependency in the monsoon season. The mixing ratios of both CO and NO_x show a sharp peak in the morning hours between 07 hr and 10 hr. Due to elevated planetary boundary layer mixing ratios were observed in the afternoon hours (13–16 hr). The observations from night till early morning hours show high values mainly due to shallow nocturnal boundary layer depth, resisting the mixing of local emissions with the free tropospheric air. In other hand, during after noontime the higher PBL depth provides a larger mixing region and hence the pollutants get diluted. The morning and evening peaks are almost absent during monsoon months and lower concentrations of both NO_x and CO were observed with no significant differences between day and night.

2.2 Seasonal variation of trace gases and GHG gas

The higher O_3concentrationwas found in the pre-monsoon and winter seasons and it associated with the elevated levels of NO_x. The lower concentration of O_3 in the monsoon and post-monsoon seasons were associated with the lower concentration of NO_x. It is also evident that the highest O_3 mixing ratio was observed in the pre-monsoon season, while the maxima in precursor species were observed in the winter seasons (Figure 2).

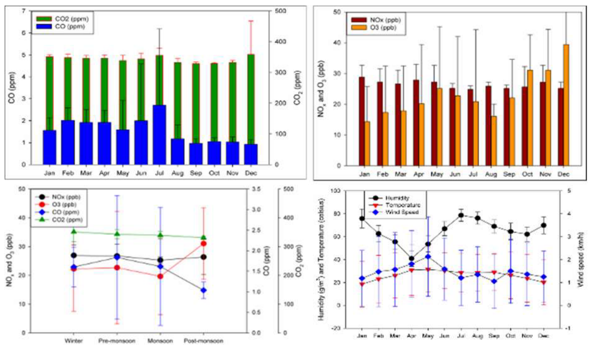

Figure 2: Monthly variation (top), seasonal variation (bottom) of pollutants.

However, CO and CO_2 concentration were found more or less similar trend throughout the year. It is indicating similar source and dominant through-out the year like roadway transportation. The seasonal changes in the long-range transport, emission, boundary layer height and photochemistry (via OH oxidation) play important roles in the observed seasonal variation of O_3 and NO_x concentration.

However, to stimulate the contributions of these processes require detailed model simulation dealing with these processes on local scale. During winter season, Indo-Gangetic Plain influenced the site leading to highest levels of NO_x.

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