C-O-6

MEASUREMENT OF SPM AND SO_2 AT SUGAR FACTORY, RURAL BACKGROUND SITE AND SEMI-URBAN SITE

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Abstract

In this report, we present near surface aerosol (PM1, PM2.5 and PM10) and SO_2 measurements carried out in a campaign mode at Sugar Factory, background rural site (near Dam) and semi-urban site (Pune). Highest concentration of SPM is observed near Sugar Factory compared to Pune and lowest at rural background (Dam) site. When compared to rural background site (Dam), PM1, PM2.5, PM10 and SO_2 concentration found clearly 5.5, 3.7, 3.4 and 2.1 times higher at Sugar Factory respectively.

1. Introduction

Size distribution of near surface aerosols is highly dependent on their sources and sinks, meteorological conditions and the boundary layer circulations (Moorty et al., 1993). Typically, significant fraction of suspended particulate matter (SPM) and SO_2 emitted from sugar industries (Garg et al., 2002). The bagasse fired boilers used in sugar industries emits the SPM and is a cause of concern, as it is felt that cost effective Air Pollution Control (APC) equipments are yet to be identified. On the other hand, significant fraction of SO_2 and SPM in the urban and semi-urban cities are emitted by road transport, industries and domestic sources and degrade the air quality. Though India ranks first in sugar production; per capita availability of sugar is very low as compared to other sugar producing countries and therefore likely to grow in future. In the context of rapid urbanization, industrial development and vehicular growth in the cities are likely to further degrade air quality. Therefore, determination of ambient distribution of SPM and SO_2 is thus necessary and importance measure for characterizing air quality.

2. Method

Measurements of PM1, PM2.5 and PM10 mass concentration (µg/m3) were made continuously using a GRIMM (Model 1.108) portable particle size analyzer/dust monitor. Whereas, SO_2 measurements were made using IR based SO_2 gas analyzer (Environment SA, AF22M). The experiment was conducted from 1-4 Feb 2007 at semi-urban site Pune, 5-11 Feb 2007 at Kasarsarai Sugar Factory (Factory premises) and 12-15 Feb 2007 at background site (Dam). Both the sites are located on western side 35 km away from the Pune city and separated by approximately 4 km away from each other. Observed wind speed and wind direction during 5-15 Feb 2007 is shown in Figure 1. Location of the Dam site and Pune city (Red square) with respect to Sugar Factory (center) is also given in Figure 1. The location of rural back-ground site is such that most of the time winds travel toward Sugar Factory; hence possibility of transport from the Sugar Factory toward Dam site is negligible during observation period.

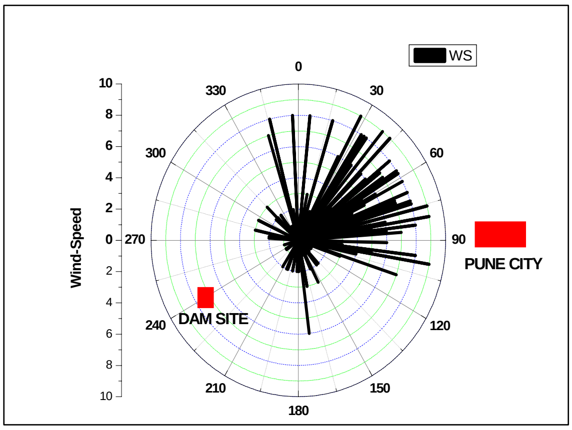

Figure 1. Observed wind speed and wind direction during 5-15 Feb 2007.

3. Results and Discussion

Table 1 shows the general distribution of mean concentration of PM1, PM2.5, PM10, SO_2 and CO at Sugar Factory, Dam site and Pune during the respective observational period. As expected, highest aerosol concentration is observed at Sugar Factory and lowest at Dam site. When compared to rural background site (Dam), PM1, PM2.5, PM10 and SO_2 concentration found clearly 5.5, 3.7, 3.4 and 2.1 times higher at Sugar Factory respectively. Whereas, at Pune PM1, PM2.5, PM10 and SO_2 concentration found 2, 1.5, 1.5 and 1.9 times higher than the Dam site respectively. The sources of emission are quite dispersed in the semi-urban city Pune and therefore concentration observed at measurement site is mainly cumulative concentration transported from all the emission sources at the site. Whereas, the observed concentration is mainly dominated by the emission from point source, as the sugar factor is only the major source.

Table 1. Mean concentration of PM1, PM2.5, PM10, SO_2 and CO during the campaigning period.

Sites	**PM 1.0** (µg/m3)	**PM 2.5** (µg/m3)	**PM 10** (µg/m3)	**SO_2** (ppb)	**CO** (ppb)
Sugar Factory (SF)	86.5 (±9.9)	105.1 (±12.5)	183.2 (±28.5)	5.8 (±1.9)	2.3 (±0.1)
Dam Site (DS)	15.6 (±1.0)	28.1 (±5.4)	53.7 (±14.3)	2 .0(±0.5)	2.1(±0.02)
Pune (IITM)	34.4 (±6.1)	41.4(±7.4)	83.2 (±13.8)	3.9 (±0.8)	--
SF/DS	5.5	3.7	3.4	2.9	1.1
Pune/DM	2.0	1.5	1.5	1.9	--

3.1 Diurnal variation

Figure 1 shows the mean hourly distribution of PM1, PM2.5 and PM10 mass concentration (µg/m3) at surface level observed at Sugar Factory, rural background site(Dam) and semi-urban site, Pune. Similarly, figure 2 shows the mean hourly distribution of SO_2 and CO at same locations. PM1, PM2.5 and PM10 mass concentration shows a strong diurnal variation at Sugar Factory and Pune however shows a weak diurnal cycle at Dam site. Interestingly, diurnal variation observed shows some distinct pattern when compared to each other, which clearly indicates the impact of anthropogenic emission combined with the local meteorology on the diurnal variation. Mass concentration of aerosols (PM1, PM2.5 and PM10) shows afternoon minimum at around 15:00, increase gradually after sunset and attends maximum concentration in the morning. Diurnal variation observed at Dam site follows the same pattern but the amplitude is far week compared to Sugar Factory. Similar diurnal variation is also observed at Pune; expect a minimum concentration in the early morning and afternoon. Besides, there also occurs a strong prominent short-lived peak shortly after sunrise, and less prominent after sunset. Similar type of diurnal variation is also observed in SO_2 and CO concentration at Sugar Factory and Pune. It is also remarkable to note that the PM1 and PM2.5 mass concentrations at Sugar Factory, Pune and Dam site during afternoon is found to be almost similar in magnitude, however PM10 mass concentration found to differ during noontime at Sugar Factory and Pune.

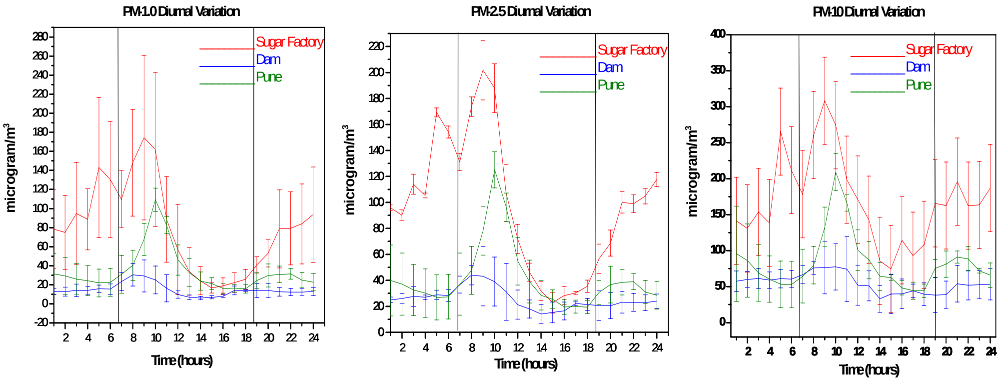

Figure 2. Mean hourly distribution of PM1, PM2.5 and PM10 mass concentration (µg/m3) at surface level observed at Sugar Factory, rural background site (Dam) and semi-urban site, Pune (The local sunrise and sunset is marked with the vertical lines).

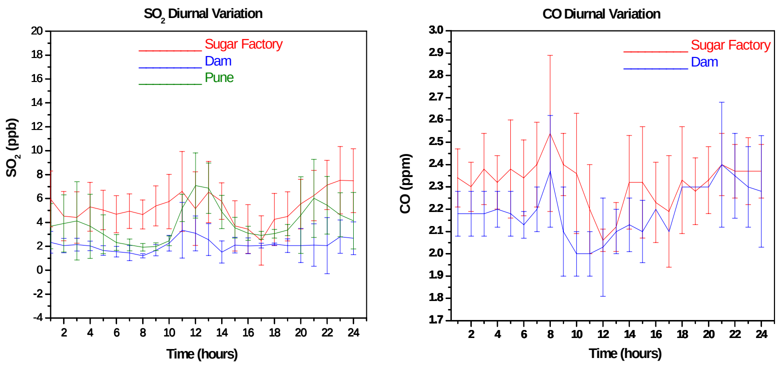

Figure 3. Mean hourly distribution of SO_2 and CO at same locations given in Figure 2.

Diurnal variation of aerosol mass concentration, SO_2 and CO at all the three sites can be attributed mainly due to the dynamics of the atmospheric Boundary Layer (BL). The deepening BL during daytime and associated convective turbulence extensively mix and redistribute the aerosols and other pollutants to a greater vertical extent, which were confined in the shallow nocturnal BL of the previous night. This results in a dilution of their concentrations near surface and dilution increase as BL height increases. After the sunset mixed layer deforms and in the advancing night the BL becomes increasingly stratified finally forming a nocturnal inversion layer and a shallow stable boundary layer near the surface and residual layer aloft. With the night proceeding, the nocturnal inversion gain height and inhibit vertical transport of aerosols and gases (Coyal et al., 2002). The resulting confinement leads to an increase in the species concentration near the surface as observed at Sugar Factory. Though the description above for BL offers an explanation to observed diurnal pattern of aerosol concentration at Sugar Factory, the increase in PM1, PM2.5 and PM10, and SO_2 after sunset cannot be attributed completely to the collapse of the BL and the formation of nocturnal BL. Significant emissions from the local traffic, which increases during the period 1800 to 2200 hr, would be contributing to the rise in concentration after sunset. The vehicular emissions become insignificant after 2100-2200 and aerosol concentration starts reducing again till early morning. After sunrise the BL evolves eventually break the nighttime inversion causing the aerosols in the residual layer to mix with those near the surface leading to a sharp increase in the near-surface concentration, the effect is known as fumigation (Fochesatto et al., 2001).

4. Conclusion

It can be concluded from the study that the bagasse fired boilers used in sugar industries emits the large amount of SPM and exceed the ambient air quality standard (RPM10µm>150 µg/m3) which could be the cause of concern for the health in the local area. This suggests that Pollution Control equipments is needed to improve the degrading air quality due to possible growth in sugar industries in future.

References:

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