# Variation of Carbonaceous Aerosols in Foggy Days in and around Special Episodic Event

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## ABSTRACT

The present study deals with the impact of special episodic event like firework activities on the variation of carbonaceous aerosols in Foggy days during in and around Diwali period vs. background period at three different sites, segregated on the basis of landuse pattern viz. JNU (dense vegetative), VN (residential) and AN (industrial) in Delhi, India. The average Organic Carbon, OC (99.24 µg/m$^3$) and Elemental Carbon, EC (24.31 µg/m$^3$) concentrations were found to be highest at VN, depicts high influence of firework activities during Diwali and other significant sources like vehicular and commercial activities. The MOZART model simulated vertical profile of EC and OC over Delhi also suggest that EC and OC concentrations are increase drastically in lower atmosphere during Diwali and then gradual decline is reported during post-Diwali period. During Post Diwali, OC and EC concentrations showed drastic decline at day as compared to night due to scavenging by fog of aged particles resided after emission from fireworks only in morning hours. This study is first of its kind to identify the nature of carbonaceous aerosols during foggy days which can be studied with respect to in and around firework activity. In addition to detail illustration about the impact of firework activities, this study also helps to comprehend the role of fog in scavenging of aged particles.

Keywords: OC, EC, Fireworks, Foggy days and Delhi..

## INTRODUCTION

Fireworks generate a large amount of pollution in the form of smoke, dust and huge quantities of pollutants over a small period of time. They result in high levels of gaseous pollutants such as NOx, SOx, O3, PAN, etc. (Feng et al. 2012; Moreno et al. 2007), particulate matters (Perrino et al. 2011), organic and inorganic compounds (Yang et al. 2014, Nishanth et al. 2012, Attri et al. 2001). There are a number of festivals globally such as Las Fallas in Spain, Independence Day in US, The Lantern Festival and Spring Festival in China, New Year Eve celebrations in various countries and Diwali festival in India which are always celebrated with burning of firecrackers. In Indo-Gangetic Plain (IGP) and other coastal areas, carbonaceous aerosols were found to be very high and contribute in the formation of secondary aerosols in and around Asia (Ram and Sarin, 2011; Srivastava et al. 2014; Pipal et al. 2014; Singh et al. 2015; Saxena and Kulshrestha, 2016). Nevertheless, none study has been reported yet on identifying the nature of carbonaceous aerosols during foggy days which can be studied with respect to in and around firework activity. This study present and discusses following two important aspects: (i) to assess the concentration of carbonaceous aerosols in foggy days during in and around Diwali festival (ii) to quantify the relative contribution of OC/EC ratios in SOA formation in foggy days considering the Diwali period.

## RATIONALE OF STUDY

Firework activities not only affect air quality but also the meteorological parameters such as visibility (Barman et al. 2008). Besides this, extensive use of crackers during festival are responsible for producing high concentration of air pollutants which affect one of the most important and challenging problem in almost all the countries, called as 'Fog'. Nevertheless, none study has been reported yet on identifying the nature of carbonaceous aerosols during foggy days which can be studied with respect to in and around firework activity. The chemistry of carbonaceous aerosols is very important to study in the regions which are having high population density and also having interesting phenomena called as fog. For this purpose, New Delhi, capital city of India has been chosen which is one of the most polluted city in the world and also famous for severe fog episodes during local winter season.

## METHODOLOGY

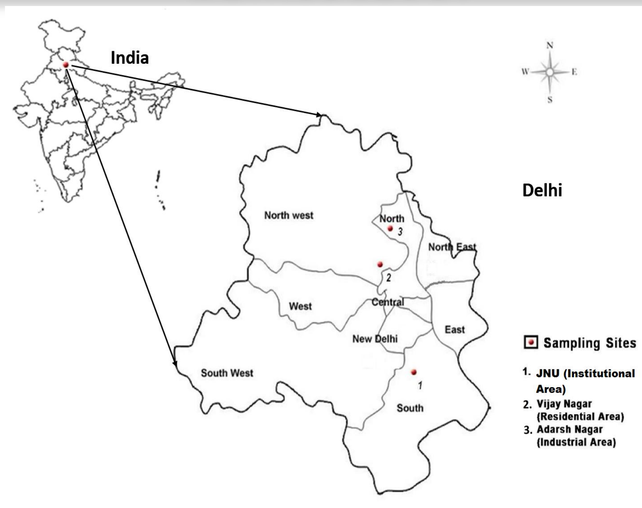


Figure 1: Map of Delhi Showing Sampling Sites in Delhi

In year 2015, Diwali was celebrated on 11$^{th}$ November which is designated as 'Diwali day', 1$^{st}$ - 2$^{nd}$ November is considered as 'Background', 9$^{th}$ - 10$^{th}$ November is 'Pre-Diwali' and 12$^{th}$ – 14$^{th}$ Nov is 'Post Diwali' period. Sampling was conducted in early morning hours i.e. 04:00 – 07:00 hrs and late night hours i.e. 21:00 – 00:00 hrs. Aerosol samples were collected on quartz micro-fiber filters i.e. Whatman, QMA, 47mm using a vacuum pump (flow rate = 30 LPM) during selected days at above mentioned sampling time on all the sites simultaneously and analyzed by OC-EC analyzer. (Saxena and Kulshrestha (2016)). A total of 12 samples were collected from all the sites during respective periods.

## RESULTS & DISCUSSION

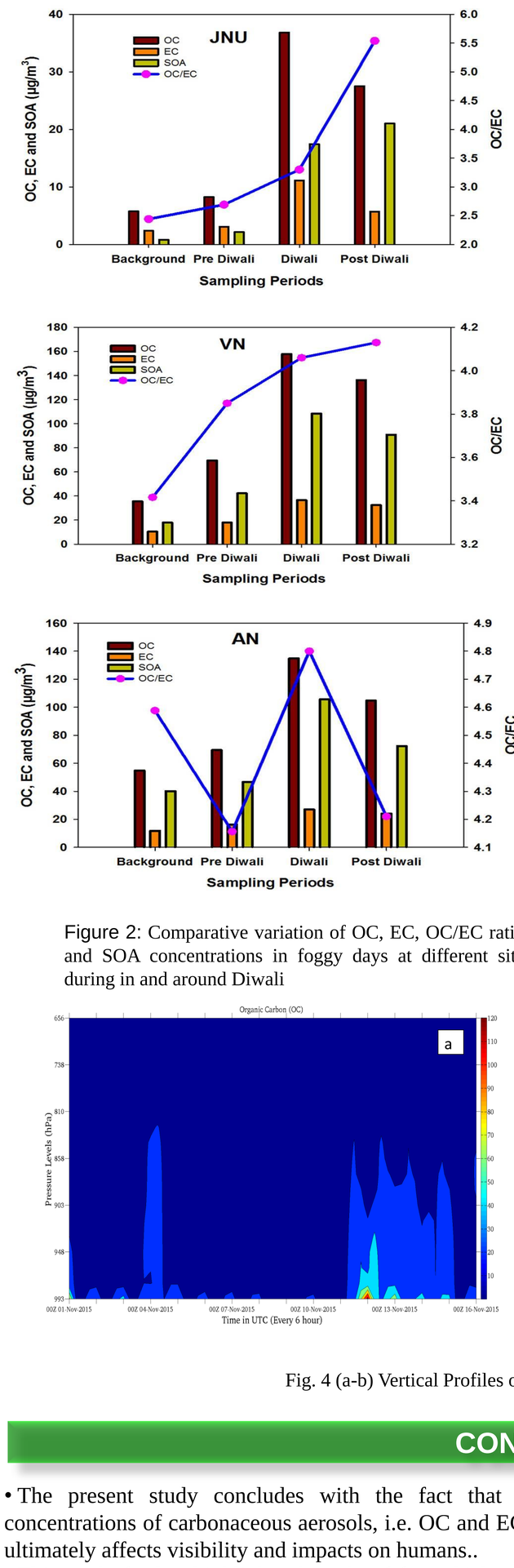


Figure 2: Comparative variation of OC, EC, OC/EC ratios and SOA concentrations in foggy days at different sites during in and around Diwali

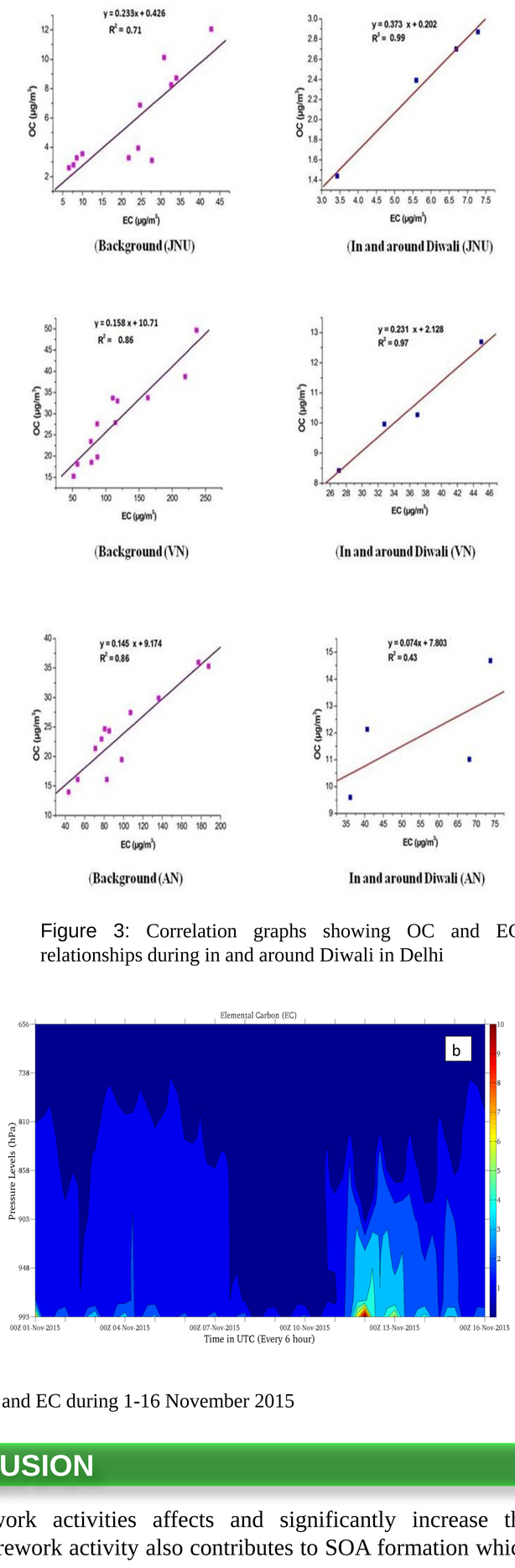


Figure 3: Correlation graphs showing OC and EC relationships during in and around Diwali in Delhi

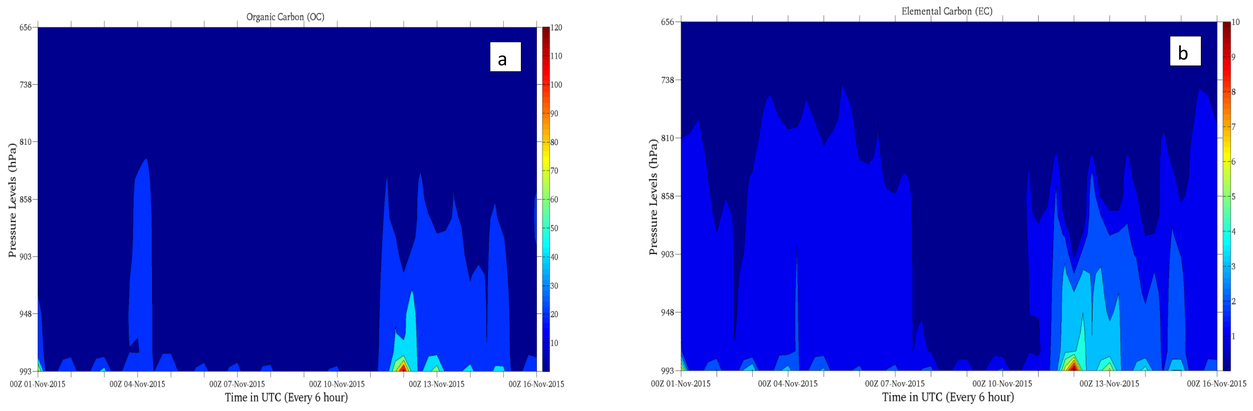


Fig. 4 (a-b) Vertical Profiles of OC and EC during 1-16 November 2015

## CONCLUSION

- The present study concludes with the fact that firework activities affects and significantly increase the concentrations of carbonaceous aerosols, i.e. OC and EC. Firework activity also contributes to SOA formation which ultimately affects visibility and impacts on humans..
- This study further highlights the role of fog which acts as scavenger to reduce the concentrations of OC and EC when it becomes aged particles but not on freshly emitted particles. The general trend that was found in this study is the highest concentration of OC and EC during Diwali then Post Diwali and then Pre-Diwali. During Post Diwali, the role of fog as scavenger has clearly been noticed at all sites where OC and EC concentrations reduced drastically.
- MOZART Model study also supports the fact that OC and EC values are less before Diwali day and well mixed in the atmosphere while high values of OC and EC are reported on Diwali day which reduced gradually in post Diwali period.
- The present study not only illustrates about the impact of firework activities during different selected periods vs. background at three different land use pattern sites but also helps to understand the role of fog in scavenging of aged particles during the selected periods.

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