Urban Climate 12 (2015) 11–20

Contents lists available at ScienceDirect

Urban Climate

journal homepage: www.elsevier.com/locate/uclim

Aerosols and trace gases characterization over Indo-Gangetic plain in semiarid region

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ARTICLE INFO

Article history:
Received 10 June 2013
Revised 13 August 2014
Accepted 1 December 2014

Keywords:
Particulate matter
Aerosol
Trace gas
Chemistry

ABSTRACT

This paper deals with measurements of aerosols, their chemical properties and precursor trace gases at Agra in the Indo-Gangetic plain. The average TSPM level is 441.2 μg m^{-3} and ranges between 60.8 μg m^{-3} and 1004.6 μg m^{-3} which are higher than National Ambient Air Quality Standard Values of India. High wind speed from North West direction influences the aerosol load. TSPM load is higher during prefoggy/foggy days and lower during post foggy days. NH_4^+ concentration is highest followed by NO_3^-, SO_4^{2-}, Cl^-, K^+, Ca^{2+}, Na^+, Mg^{2+} and F^-. The high concentration of NH_4^+ may be probably due to nearby cattle yard, use of fertilizers and biogenic emissions. The concentration of trace gases SO_2, NO_2, HNO_3 and NH_3 are 20.8 μg m^{-3}, 26.3 μg m^{-3}, 1.6 μg m^{-3}, 18.6 μg m^{-3}, respectively. The transportation of urban plumes may be responsible for high concentration of SO_2 and NO_2. HNO_3/NO_3^- ratio is less than unity. There was no correlation between SO_2 and SO_4^{2-}. The ratio of $SO_4^{2-} + NO_3^- + Cl^-/NH_4^+$ are 1.8 and 2.3, respectively indicate that acidifying components are not neutralized only by NH_4^+ ion.

1. Introduction

Atmospheric particulates play an important role in radiative forcing and climate change. In addition, they are responsible for visibility impairment and have significant implications for human health. The particulates are also associated with acid deposition and hence, affect terrestrial and

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http://dx.doi.org/10.1016/j.uclim.2014.12.001
2212-0955/

aquatic ecosystems. The airborne particulates may be produced by a variety of sources, e.g. natural sea spray or wind-blown dust, anthropogenic activities such as stationary fuel combustion, industrial processes, transportation and solid waste disposal (Momin et al., 1999). Chemical composition of these emissions varies widely. In order to trace down the pollution sources and determine the extent of the anthropogenic contribution, a fundamental study of the chemical composition and mass size distribution of atmospheric particulate is required.

Climate change has become a crucial issue receiving tremendous attention worldwide (IPCC, 2001; Li et al., 2008). The Asian region (mainly China, India, and East Asia) is the fastest developing region with increasing levels of pollution from industries and other man-made sources (Akimoto and Narita, 1994; Wang et al., 2001; Hu et al., 2008; Das and Jayraman, 2012). The general wind pattern from north-east direction takes the continental air down to the Indian Ocean during the northern hemisphere (NH) winter period from December to March. Indo-Gangetic plain is considered as sensitive region to global climate change as it has unique landforms patterns, ecosystem, monsoon circulation and hosts 40% of Indian population. Indo-Gangetic plain is experiencing change in seasonal patterns; in the winter temperature goes down to 2 °C, in the summer temperature rises to 48 °C and rain has reduced to about 400–450 mm in the monsoon with increase of aerosol loading and increase of different epidemic diseases viz., malaria, typhoid, pneumonia, chickengunia, monkeygunia, respiratory and cardiovascular diseases, etc. in the last few decades (Kumar et al., 2007). The winds blowing from European countries find Indo-Gangetic plain as void and travel down to Bay of Bengal. Due to this reason Indo-Gangetic plain has attracted attention of scientific community and a few measurements of aerosol have been carried out (Kulshrestha et al., 1998; Parmar et al., 2001; Kumar et al., 2007). Aerosols' physical and chemical properties depend on type of particles (e.g. sea salt, mineral dust, fly ash and biogenic particles). The sulfate aerosols are considered to result in a negative radiative forcing that leads to a cooling of the earth surface. By contrast, soot, or black carbon is an effective absorber of solar radiation and therefore has a warming effect. The chemical constituents of aerosol play important role in radiative effects of aerosol and impacts on public health. However, levels of precursor gases (viz, SO_2, NO_2, HNO_3 and NH_3) also play a significant role in composition of aerosol (Calvo et al., 2013). With this in view, aerosols and trace gas measurements were carried out in water season at Agra over Indo-Gangetic plain. This paper describes atmospheric load of aerosol, chemical properties, and role of precursor gases.

2. Methods and materials

2.1. Site characteristics

Aerosol and trace gas sampling and measurements are carried out in the winter season in Agra over Indo-Gangetic plain. Agra is located in north central India, 200 km south east of Delhi, falls in the Indo-Gangetic plain (Fig. 1). Two thirds of its peripheral boundaries are bounded by the Thar Desert of Rajasthan. The major industrial activities in Agra are ferrous and non-ferrous metal casting, rubber processing, lime oxidation and pulverization, engineering works and chemicals. Apart from the local sources, Mathura refinery and Firozabad glass industries are both situated at a distance of 40 km from west and east of Agra, respectively. Sampling site was the roof of Science Faculty building (about 8 m above the ground level) in the campus of Dayalbagh Educational Institute which is a suburb of Agra. Soil around the sampling site is a mixture of sandy loam containing excess of salts.

2.2. Sampling

Measurement of TSPM and gaseous SO_2, NO_2, HNO_3 and NH_3 were carried out simultaneously in the winter season. Meteorological parameters viz., temperature, relative humidity, wind speed, wind direction and solar radiation were also being monitored at Dayalbagh simultaneously during the sampling period.

Aerosol samples were collected by mounting predesiccated and pre-weighed Whatman 41 filter paper on the High Volume Sampler (Envirotech) system and which was run for 08 h at the average