Dense Haze, Fog and Smog during Early November 2016: Associated with the Crop Residue Burning and Diwali Festival

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ATMOSPHERIC POLLUTION IN THE IGP ASSOCIATED WITH CROP RESIDUE BURNING

In the western parts of India, crop residue burning during Oct. – Nov. greatly influence the air quality ($PM_{2.5}$ and PM_{10}), weather conditions (dense haze, fog and smog) in the Indo-Gangetic plains (IGP) and has serious health impact. The westerly winds and meteorological parameters (RH and temperature) play an important role in the transport of the plumes from the burning fields. Even in 2016 winter season, local Government did experiment to implement odd even number vehicles on the road to see improvement, but not much improvement was observed [1]. This is due to geographical location of Delhi, towering Himalaya in the north, and the westerly winds bring air mass from the western parts and spread over Delhi and its surroundings, often plume reaches in the far east of IGP depending upon the meteorological conditions [2, 3].

Diwali festival (known as festival of lights), was celebrated on 30 October in 2016, depending on the Hindu calendar. From few days prior to the Diwali festival, people light their houses with candle and Diya (oil lamps) and play with fire crackers from evening to mid night, as a result, the atmosphere is loaded with aerosols of different particles sizes such as carbon particles, nickel, lead and arsenic and trace gases (NO_2 and SO_2). Smoke plumes from the crop residue burning source region degrade air quality. Diwali festival is celebrated in every parts of the country and air quality gets affected for two-three days [5].

Atmospheric Pollution in the northern parts associated with crop residue burning and black carbon emissions associated with Diwali festival celebrations in 2016 strongly mixed complicating the tropospheric chemistry over the IGP. We have used satellite data to study the transport of pollutants from the crop residue burning regions of Punjab and western parts of India.

We have considered four boxes: Box 1: W - 74.50, S - 30.30, E - 75.50, N - 31.30, Box 2: W - 76.00, S - 28.80, E - 77.00, N - 29.80, Box 3: W - 77.50, S - 27.30, E - 78.50, N - 28.30 and Box 4: W - 79.50, S - 26.30, E - 80.50, N - 27.30. Our detailed analysis shows pronounced changes in air quality, meteorological conditions (relative humidity, water vapor and wind speed) and aerosol optical parameters, affecting the weather conditions and serious health threat to the 900 million people living in the IGP [6-7].

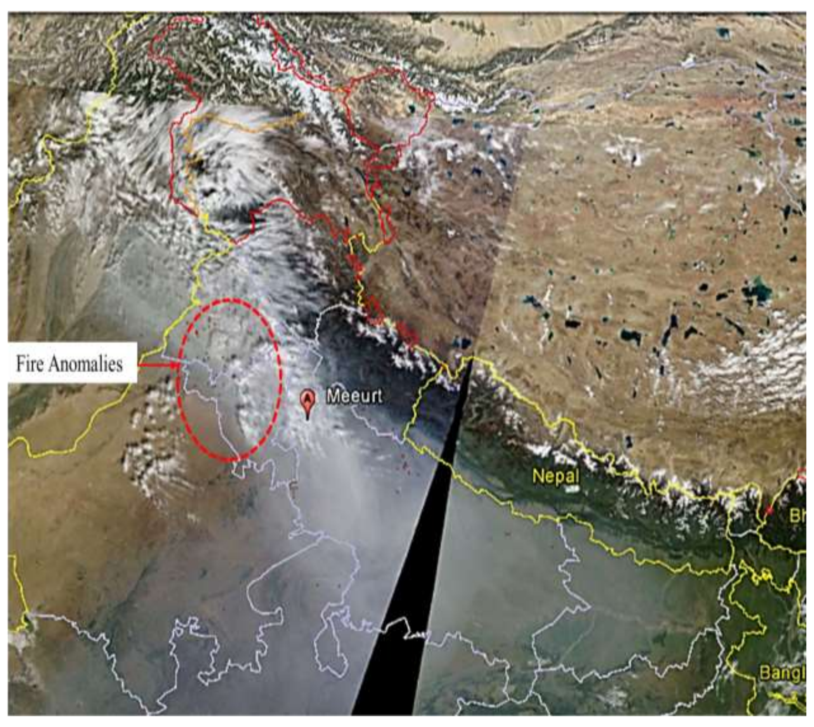

Figure 1: MODIS image showing heavy smog on 30 October 2016

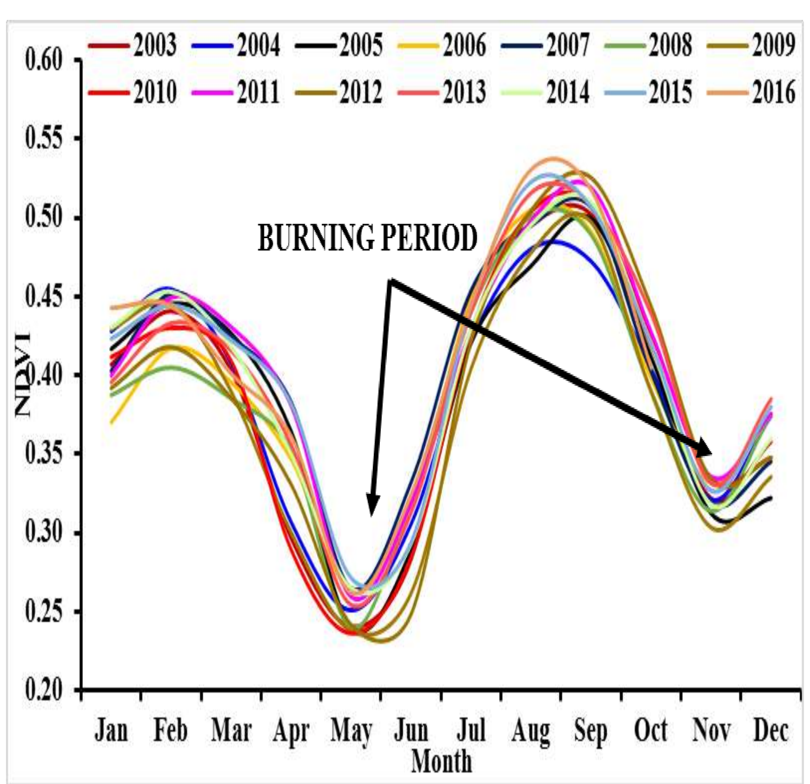

Figure 2: Monthly average NDVI variations for the crop residue burning periods 2003-2010 during April-May and Oct.-Nov. after the harvest period

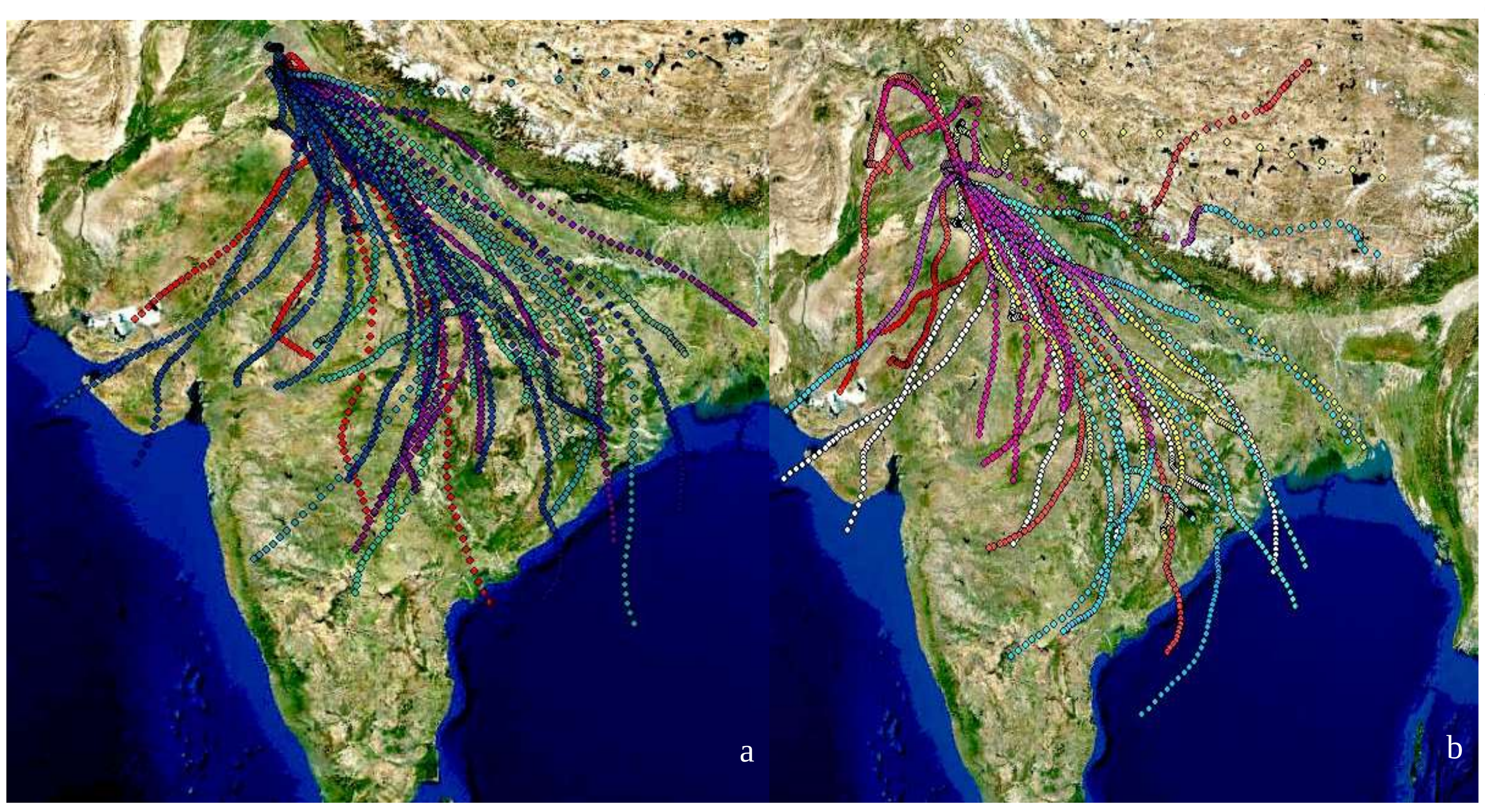

Figure 3(a) and (b): HYSPILT Forward trajectories, showing air mass reaching towards East, South and West parts of India during Oct.-Nov. 2016.

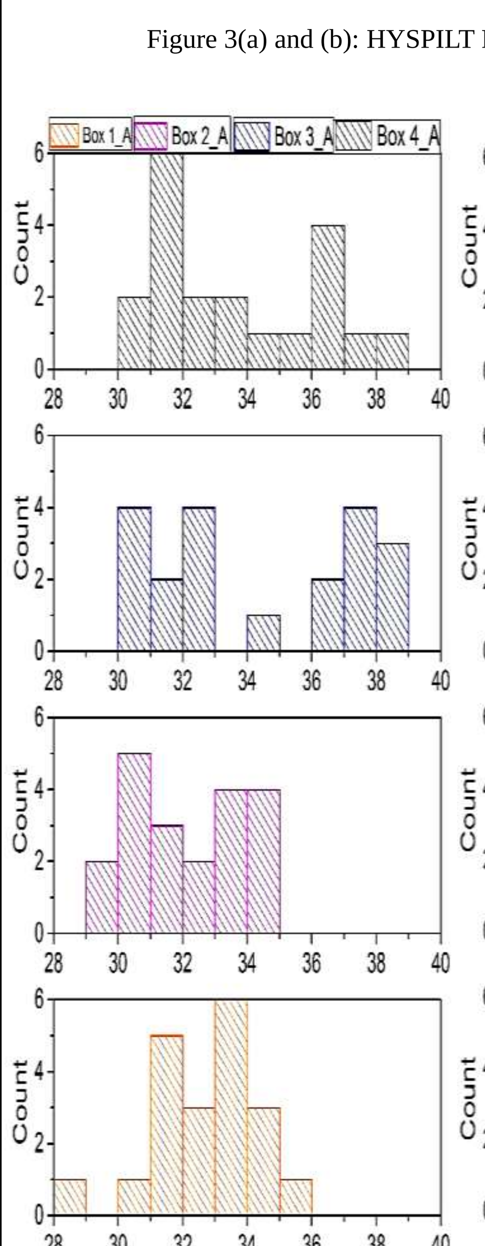

Figure 4(a): Surface temperature (°C) during 2006 to 2016 (Day Time)

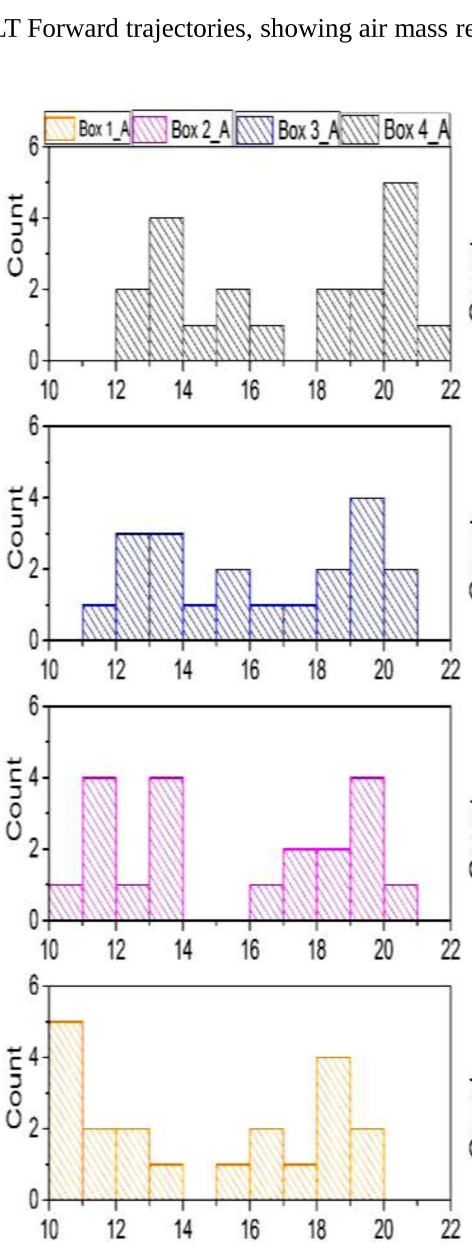

Figure 4(a): Surface temperature (°C) during 2006 to 2016 (Night Time)

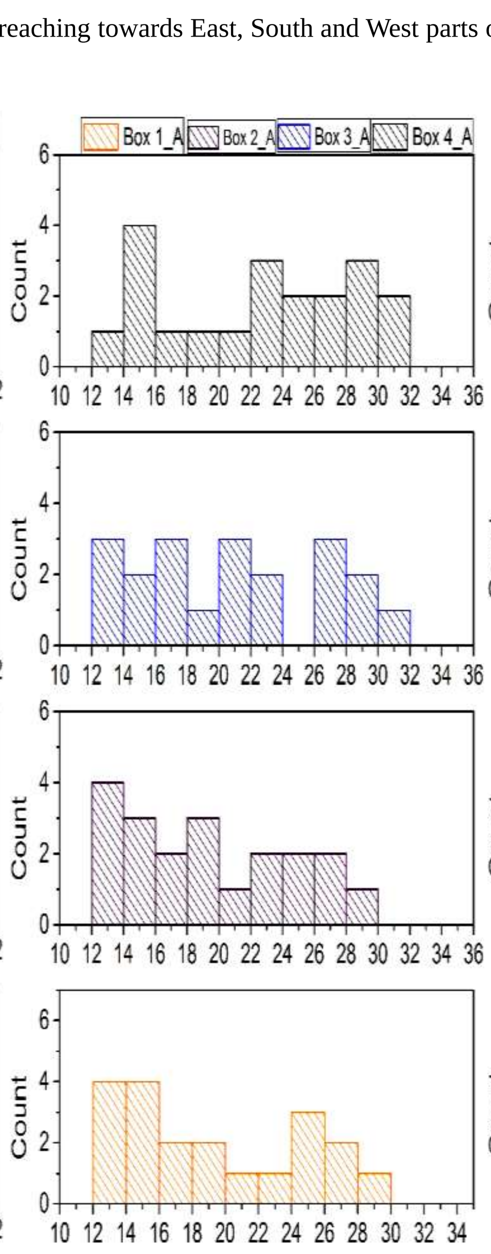

Figure 5(a): Total Column Water during 2006 to 2016 (Day Time)

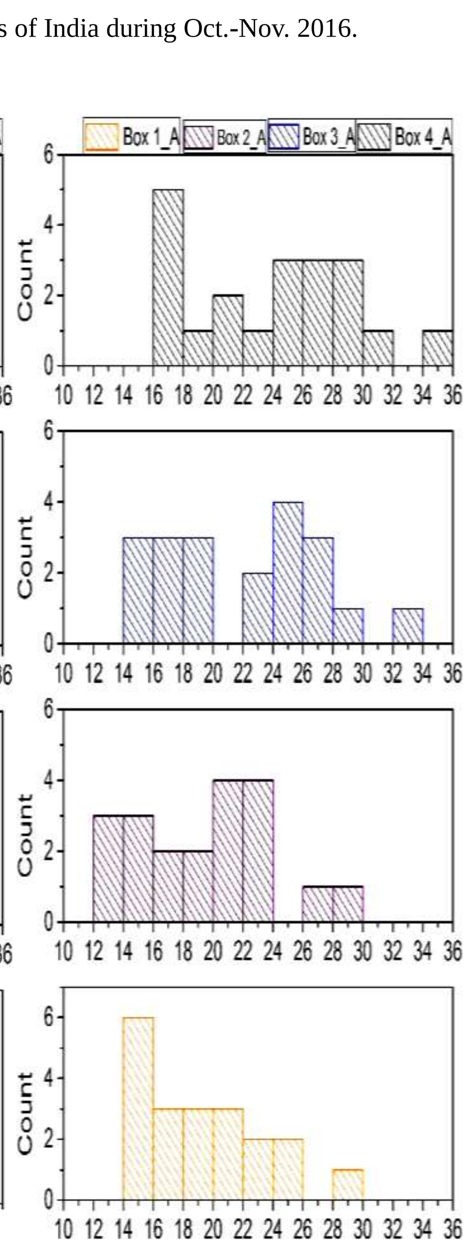

Figure 5(B): Total Column Water during 2006 to 2016 (Night Time)

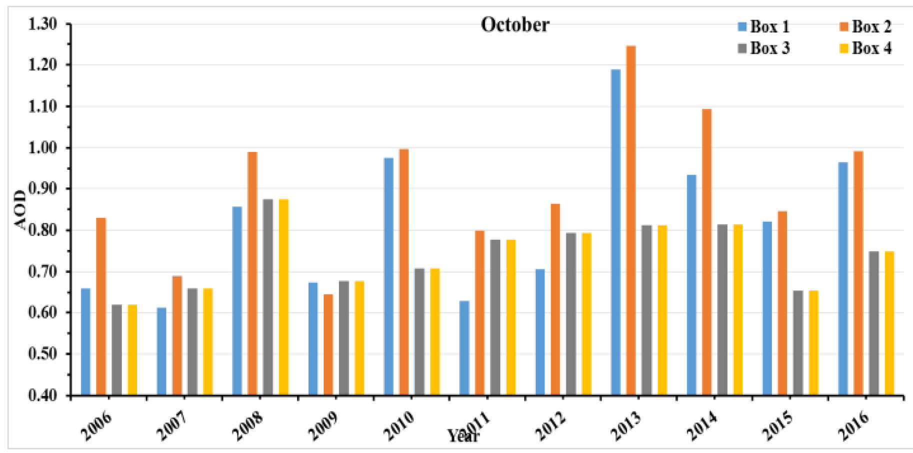

Figure 6(a) Monthly mean AOD (Terra MODIS) for Oct. during 2006-2016

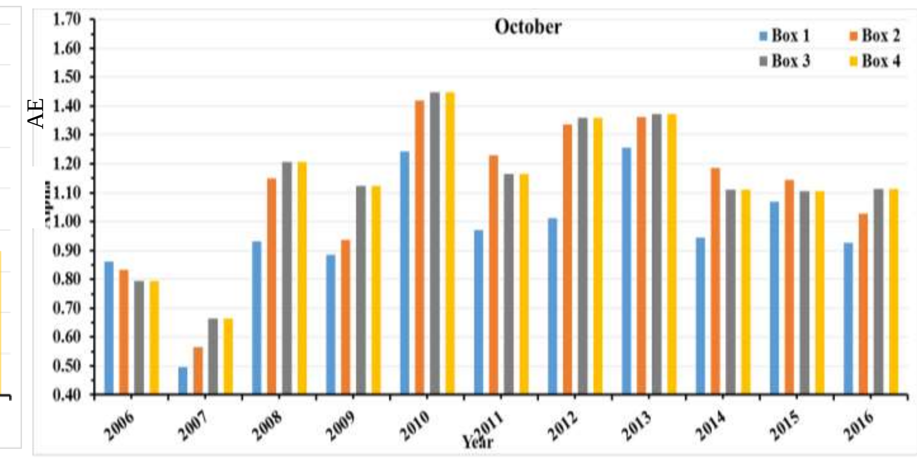

Figure 6(c) Monthly mean AE (Terra MODIS) for Oct. during 2006-2016

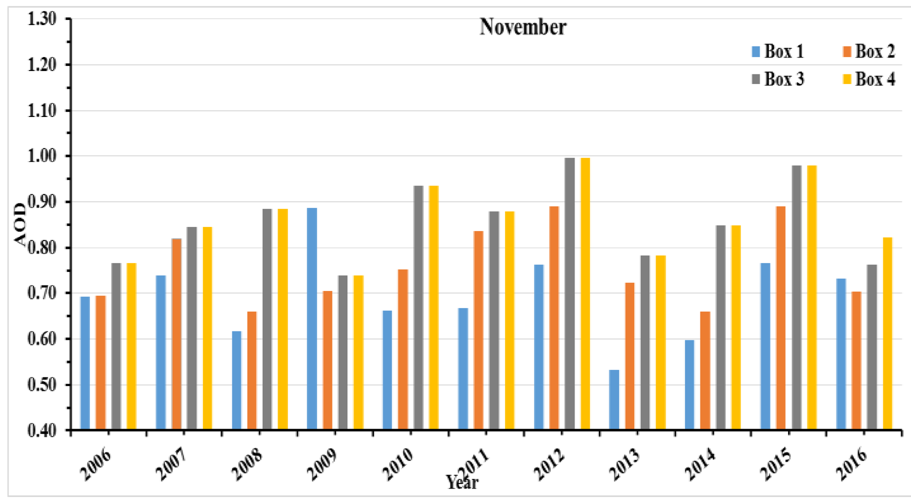

Figure 6(b) Monthly mean AOD (Terra MODIS) for Nov. during 2006-2016

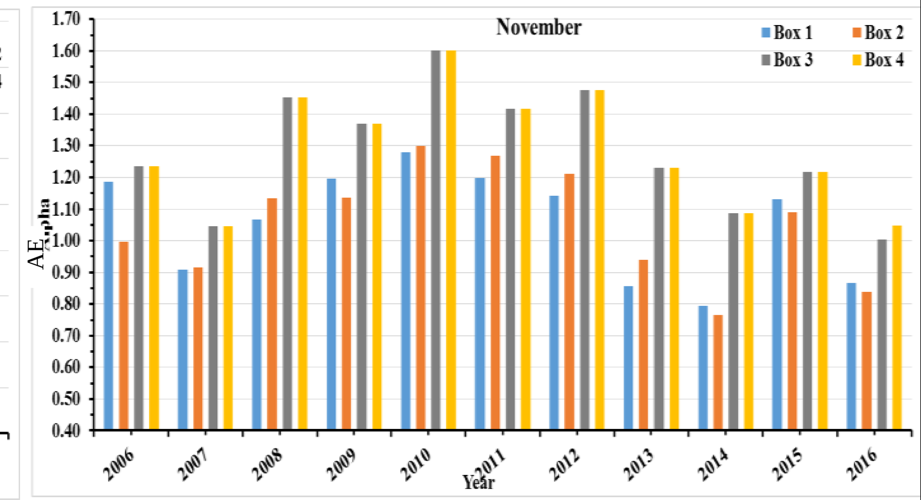

Figure 6(d) Monthly mean AE (Terra MODIS) for Nov. during 2006-2016

AERONET RETRIEVED AEROSOL PARAMETERS

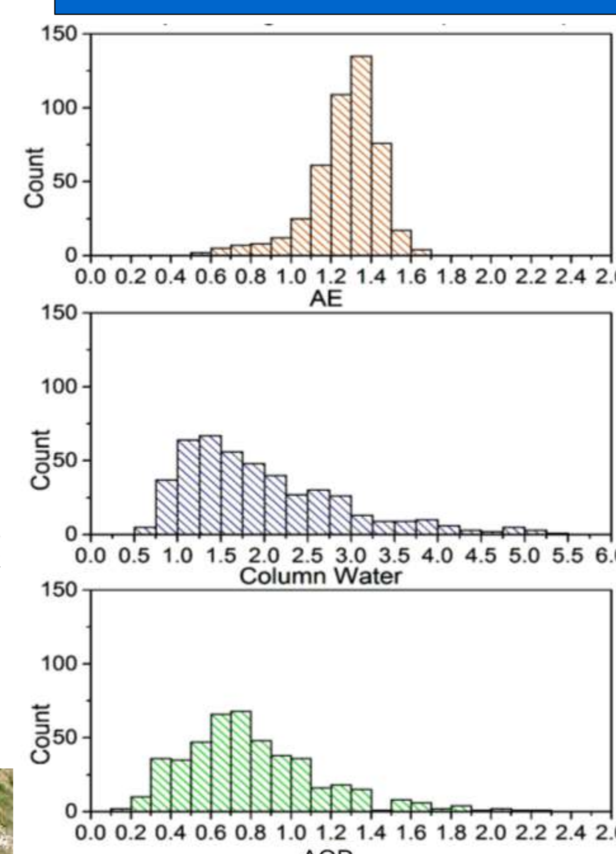

Figure 7 (a) Distribution of AOD, Column Water and AE at Kanpur AERONET for Oct.-Nov. during 2006 to 2016 (Level 1.5 Data).

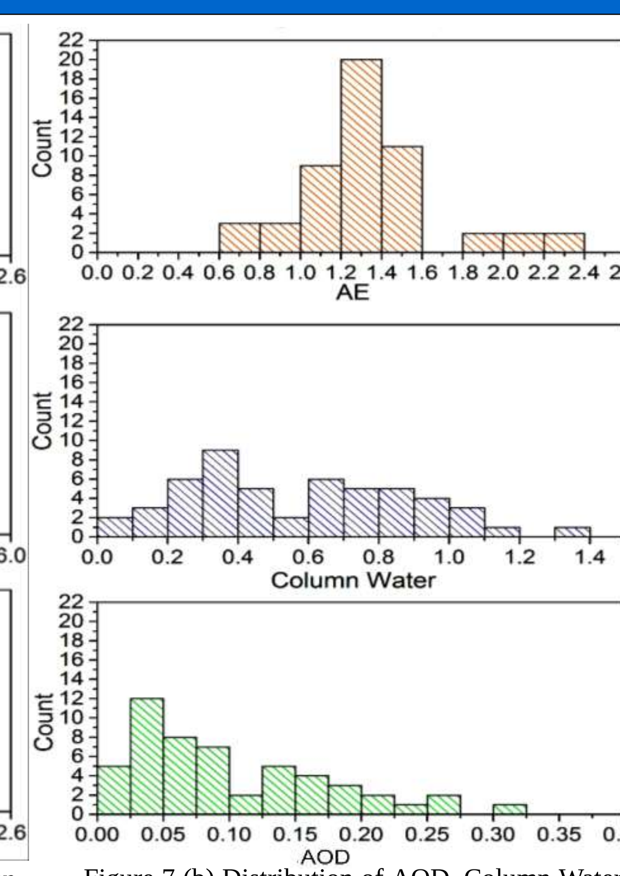

Figure 7 (b) Distribution of AOD, Column Water and AE at Nainital AERONET for Oct.-Nov. during 2008-2010 (Level 1.5 Data).

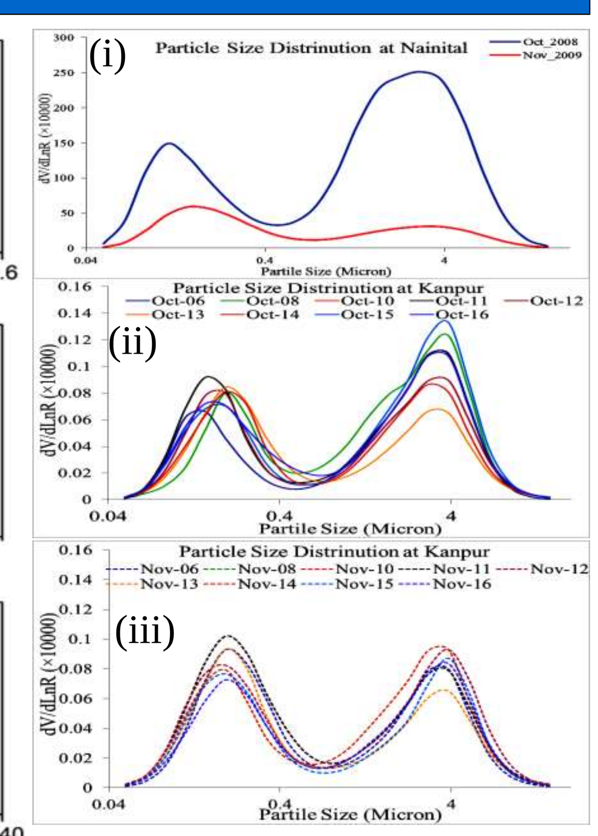

Figure 7 (c) (i) Particle size distribution at Nainital, (ii) and (iii) Kanpur AERONET during for Oct. – Nov. (Level 1.5 data).

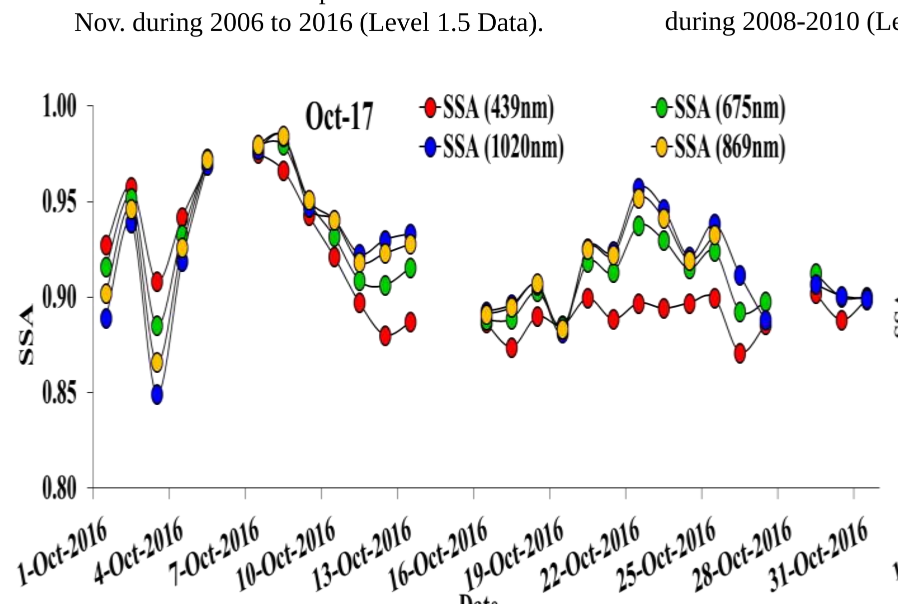

Figure 8(a) Daily mean SSA at Kanpur AERONET during October 2016 (Level 1.5 Data)

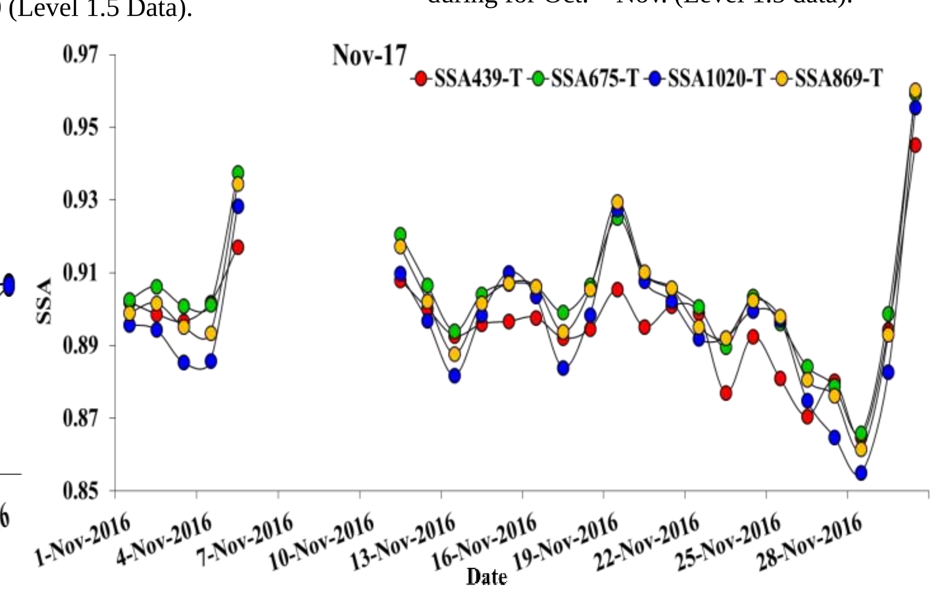

Figure 8(b) Daily mean SSA at Kanpur AERONET during Nov. 2016 (Level 1.5 Data)

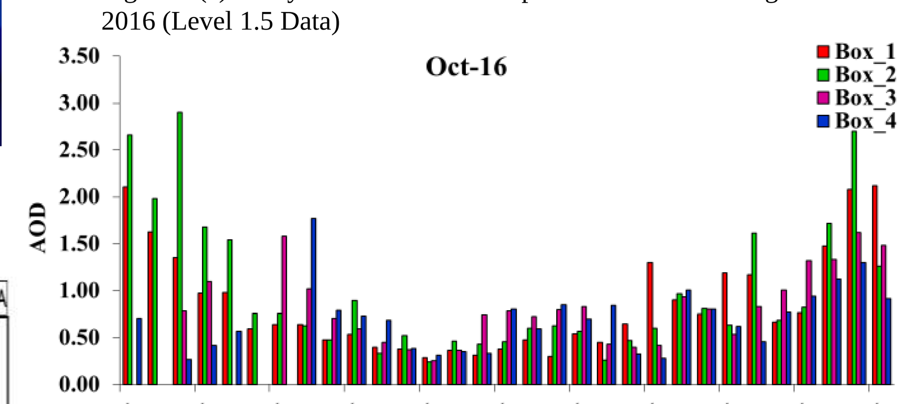

Figure 9(a): Daily mean AOD at Kanpur AERONET during Oct. 2016

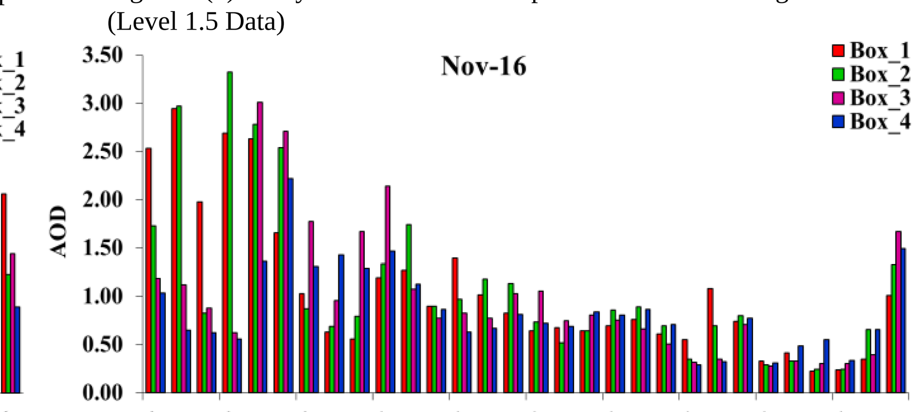

Figure 9(a): Daily mean AOD at Kanpur AERONET during Nov., 2016

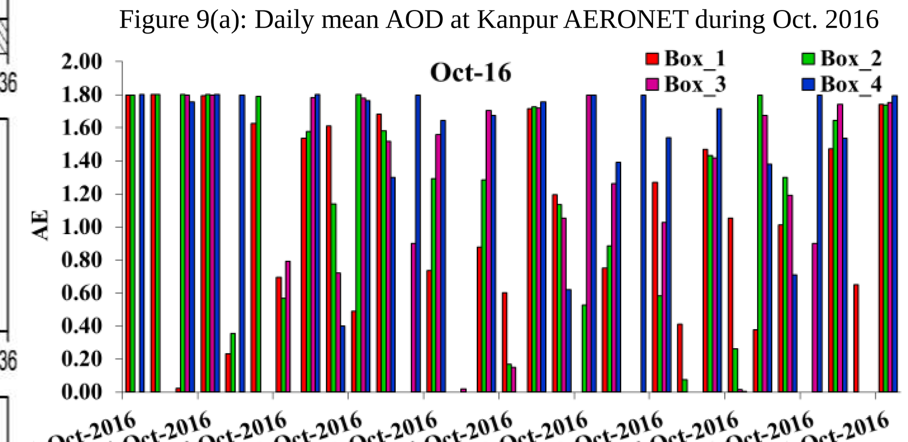

Figure 9(c): Daily mean AE at Kanpur AERONET during Oct. 2016

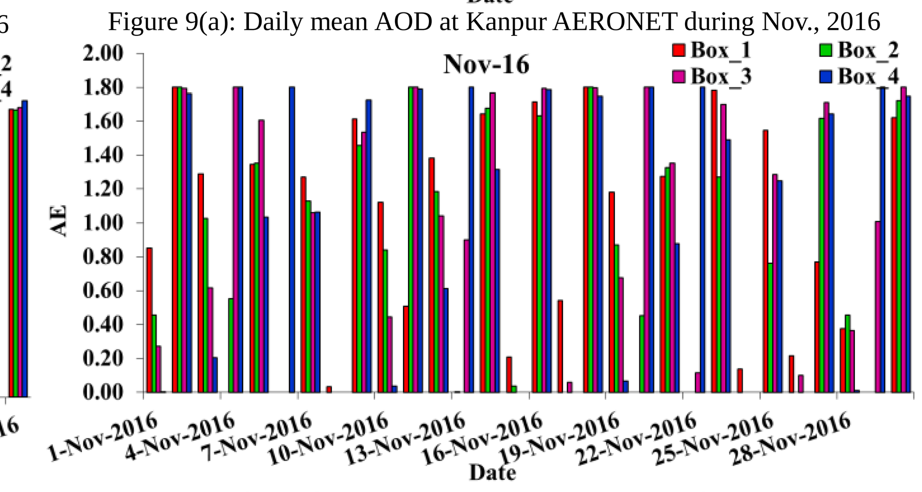

Figure 9(d): Daily mean AE at Kanpur AERONET during Nov. 2016

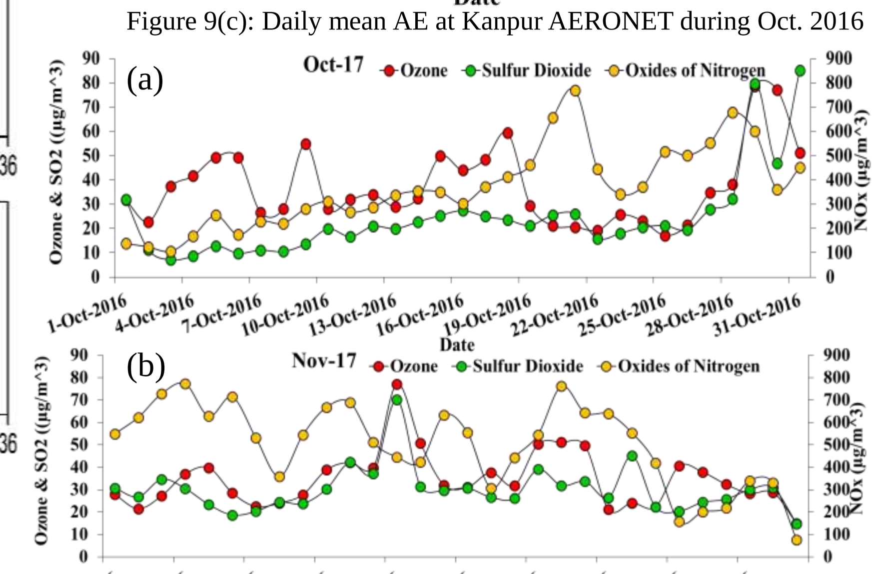

Figure 10 (a) and (b) Daily mean Ozone, SO_2 and NO_x at CPCB Delhi during Oct and Nov 2016

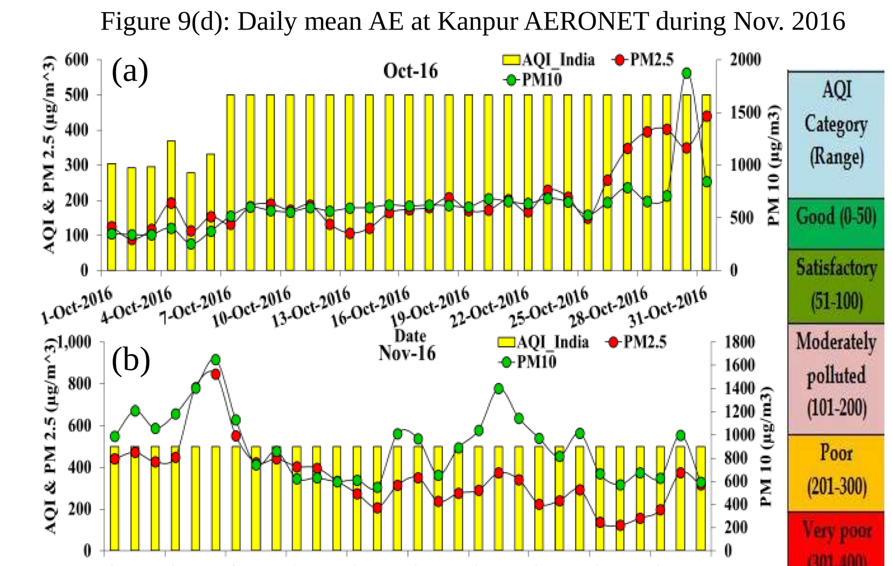

Figure 11 (a) and (b) Daily mean $PM_{2.5}$, PM_{10} and AQI at CPCB Delhi during Oct and Nov 2016

HIGHLIGHTS

The ground and satellite data clearly show intense atmospheric pollution and poor air quality associated with crop residue burning. In 2016 crop burning season and Diwali festival coincided, black carbon emitted from the fire crackers and candle burning show strong aerosol mixing which is reflected from the low values of SSA. The aerosol mixing complicate the atmospheric chemistry as a result intense fog, haze and smog were observed for longer period over Delhi and its surroundings during late Oct and early Nov. 2016. The satellite data show increase in atmospheric pollution and increase in tropospheric ozone measured by CPCB associated with the crop burning which severely impact health of people living in the IGP.

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