SAFAR- System of Air Quality & Weather Forecasting And Research

DELHI'S AIR POLLUTION EMERGENCY-2017

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ABSTRACT

Megacity Delhi plunged into a pollution emergency with thick and light-blocking haze for a prolonged period of a week starting 7th November 2017 during which levels of PM2.5 (peak ~650µg/m^3, 24h average), surpassed Indian national standards by gruesome 11 times, an all time record. The crisis was a result of multiple linkages connecting air quality with large-scale dust storm (which originated at 3000km away from Gulf), monsoon dynamics and local emissions.

OBJECTIVE

To understand the scientific basis of air pollution emergency-2017 and to quantify the relative contribution of different factors using interactive high resolution online multi-domain chemistry transport model.

MODEL SIMULATIONS

The WRF-Chem model with multi-domain and interactive mode configuration is used in this study to perform air quality simulation in Delhi.

Following 3 model sensitivity runs were performed:

(a) RUN-1: Normal model run.
(b) RUN-2: Delhi's local emissions were switched off to understand total external contribution.
(c) RUN-3: GOCART dust module was muted along with local emissions to quantify the contribution of other external sources, mainly stubble burning.
(d) The difference between RUN-1 and RUN-2 provided the contribution of only local emissions.

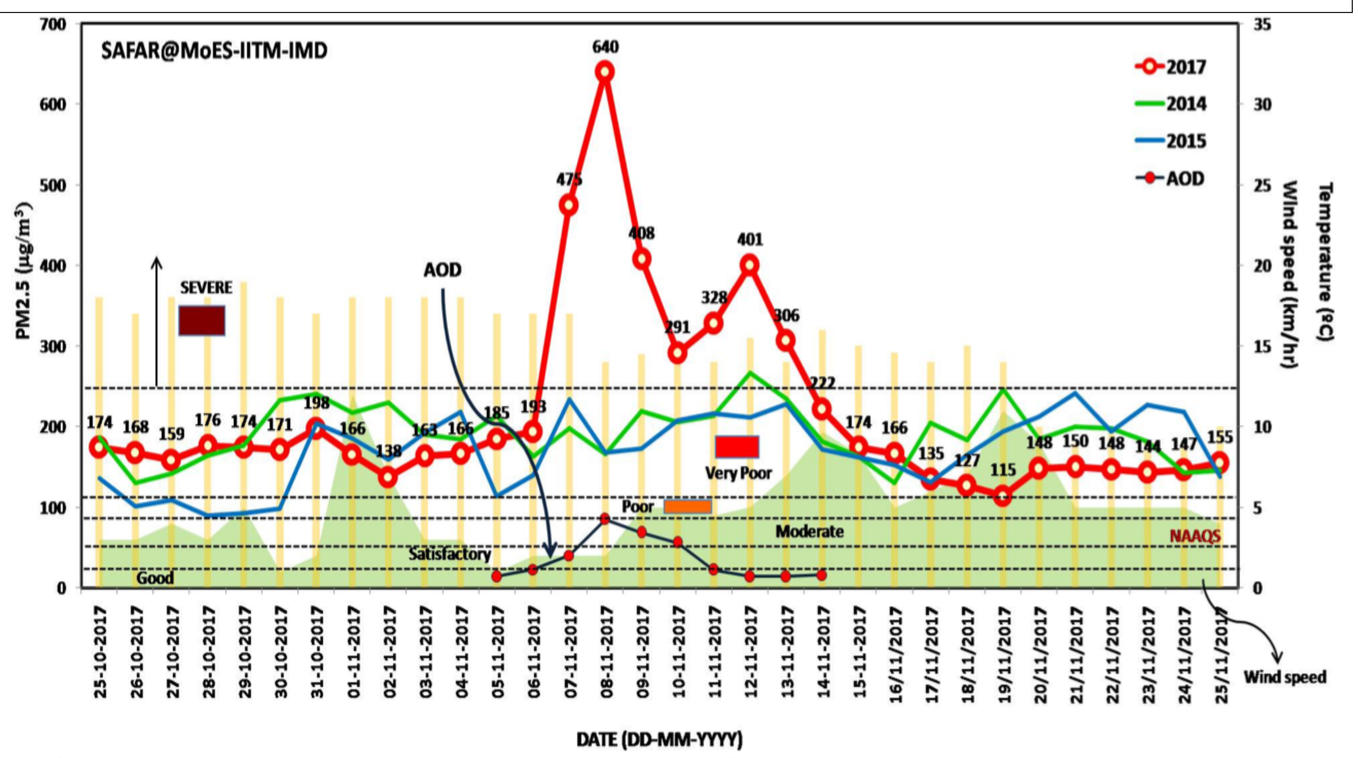

Figure: The SAFAR observed PM2.5 concentration (red line) before during and after the crisis period in 2017 along with data of 2014-2015 for the same duration. The wind speed, aerosol optical depth (AOD) and minimum temperature are also shown with legend at right side. The dotted horizontal line is Indian AQI limit for severe category.

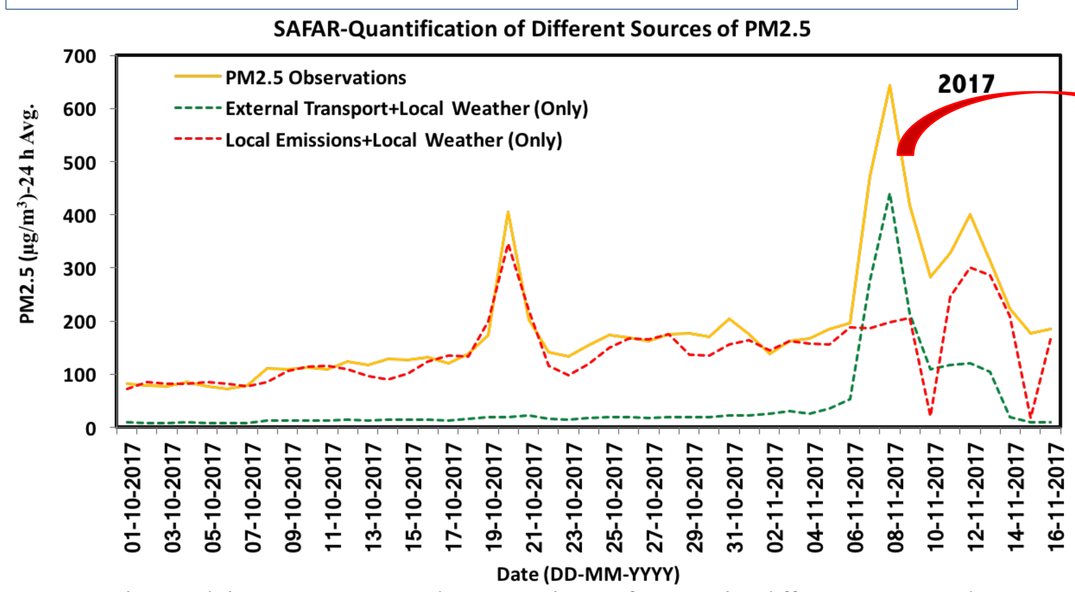

Figure: The model sensitivity runs depicting share of PM2.5 by different sources during 1 Oct to 16 Nov 2017. The yellow line shows the observed data, the contribution of external transport and local emissions are shown as green and red lines respectively.

Relative share of different sources in PM2.5 during peak day of AQE-2017	
Dust Storm	40%
Stubble Burning	25%
Local Sources	35%

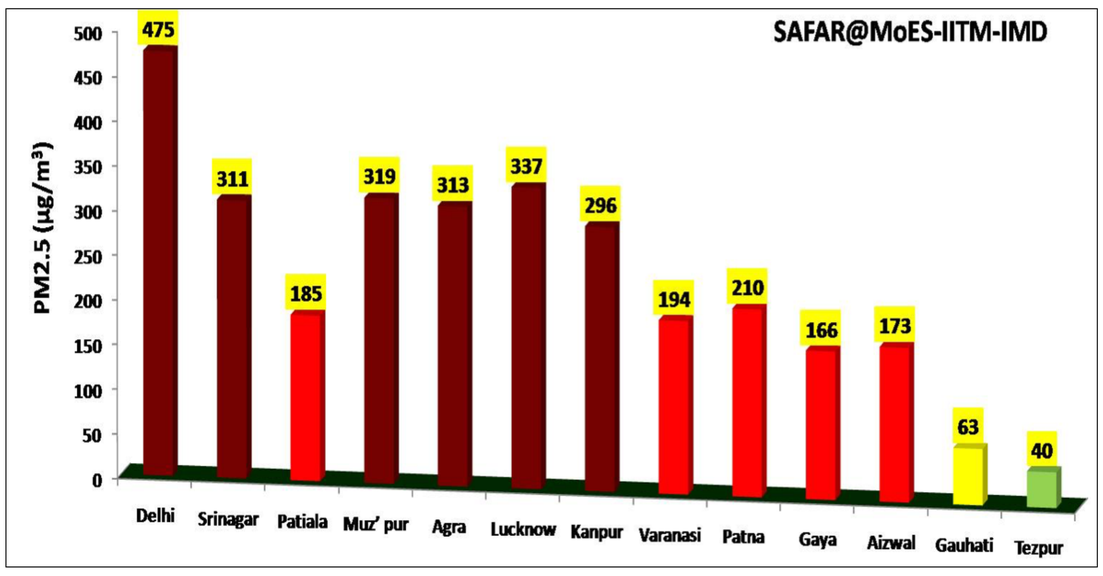

Figure: Elevated levels of PM2.5 concentration in the entire path of haze layer in north India and Indo-Gangetic-Belt confirming that the crisis at Delhi was a large-scale event and not confined to only Delhi. Indication of wide spread large-scale system polluting entire region. The PM2.5 levels before 5Nov 2017 was found to be ranging between 100-140µg/m^3 and shot up during the crisis period as and when dust affected and dissented during 7-10 Nov 2017.

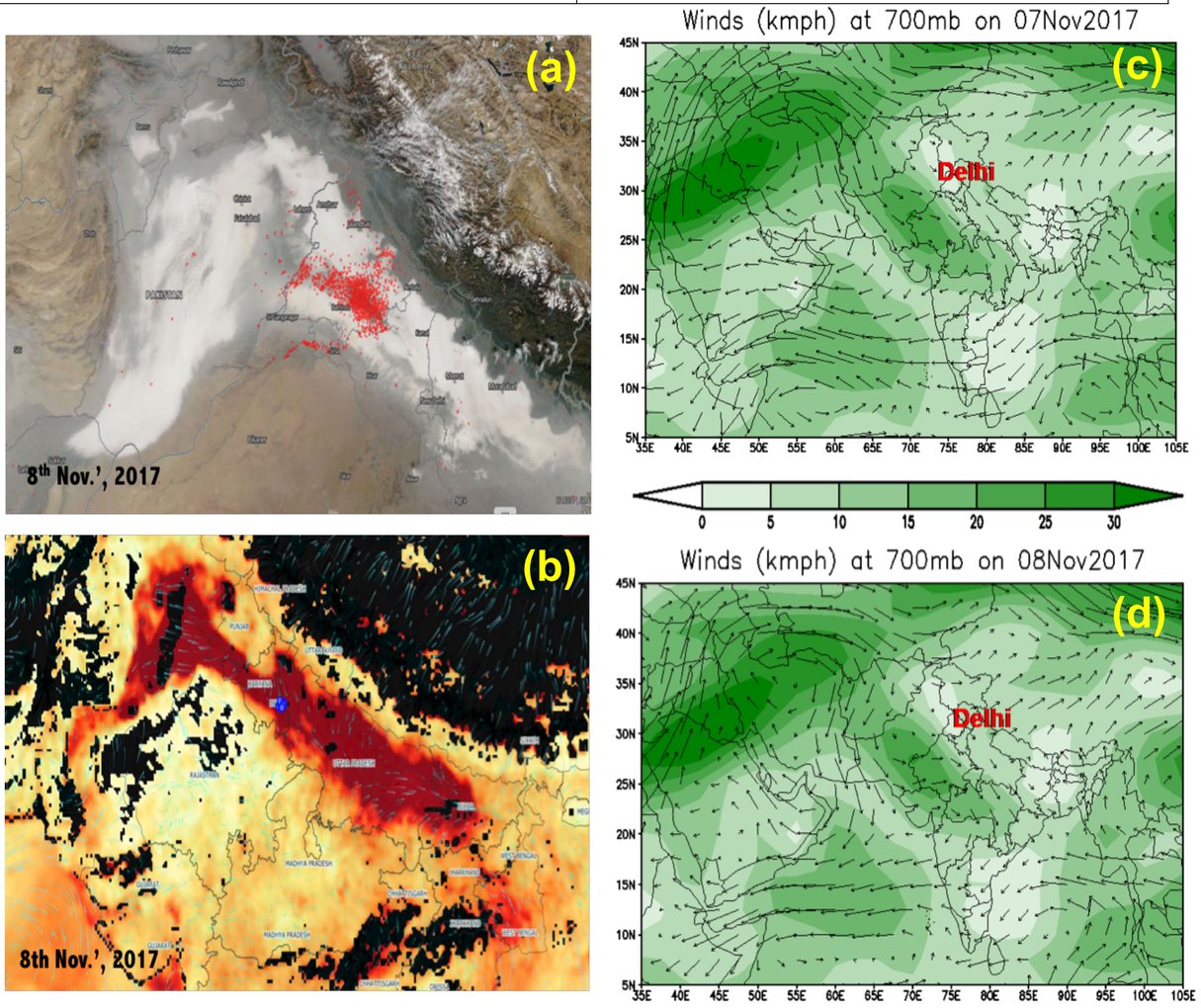

Figure: Satellite images of peak pollution day (8Nov 2017) showing the (a) haze covering the entire north India and neighboring region including part of Pakistan and Afghanistan region as obtained from Terra and Aqua onboard MODIS satellite (b) accumulation of aerosol mass by INSAT-3D; also shown are upper air high wind speed and direction at 700hPa blowing from Gulf region towards eastward including Delhi (marked) on 7Nov, when injection started (c) and (d) peak day (8Nov) injecting huge air mass.

Conclusions

This study provides the scientific interpretation to the worst air quality crisis in Delhi, one of the top ranked megacities in the world. We have highlighted the unique relationship between air pollution and different processes dominated mainly by external sources controlled by large-scale transport processes led by unusual dust storm combined with upper air meteorology from Gulf and anti-cyclonic circulation. Model results show that the relative share of dust storm, stubble burning, and local sources are 40%, 25%, and 35% respectively. The $PM_{2.5}$ levels not only rose to an unprecedented high level but also stretched to a prolonged period, triggering emergency conditions in Delhi.