Drivers of the 2016 particulate matter pollution episode over northern India

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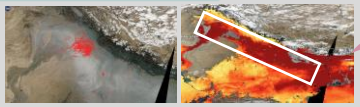
1. Context



Emissions

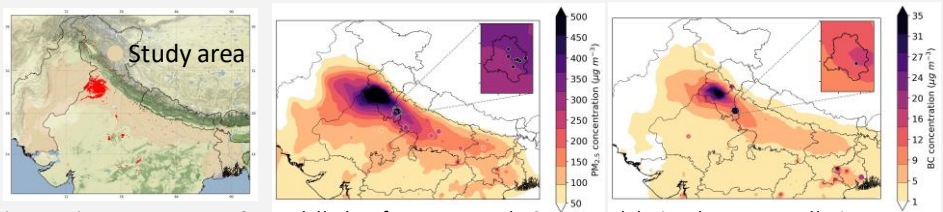
Impact

Climate and health

- Every year the Indo-Gangetic plains (IGP) in northern India is overwhelmed by extreme seasonal spikes in $PM_{2.5}$ during Oct-Nov (post-monsoon).
- Black Carbon (BC) component of $PM_{2.5}$ potentially modifies the local boundary layer dynamics.
- Recurring episodic events have detrimental impact on air quality, visibility and public health.
- Severe episodic events pose a major challenge for stringent policy controls.

2. Chemistry Transport Modelling Set-up

- WRF-Chem v4.2 @12km x 12km horizontal resolution with MOZART-MOSAIC 4-bin aerosol scheme
- Emissions : Latest Anthropogenic (EDGARv5.0) and Fire (FINNv2.5) data
- Sensitivity runs – Base, No Anthropogenic (NoA), No Fire (NoB) emissions



Figures: Fire counts across IGP, modelled surface $PM_{2.5}$ and BC averaged during the severe pollution event

3. Relative contributions of emission sources to $PM_{2.5}$ composition and BC

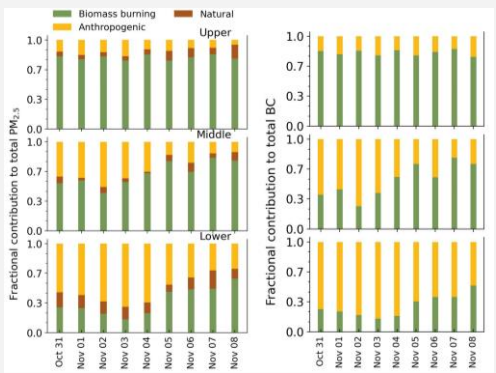


Figure: Fractional contributions of BB, natural and anthropogenic to $PM_{2.5}$ and BC across different regions in IGP

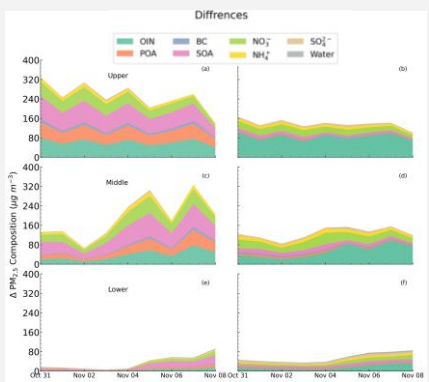


Figure: Absolute contributions to $PM_{2.5}$ from BB and anthropogenic sources across different regions in IGP

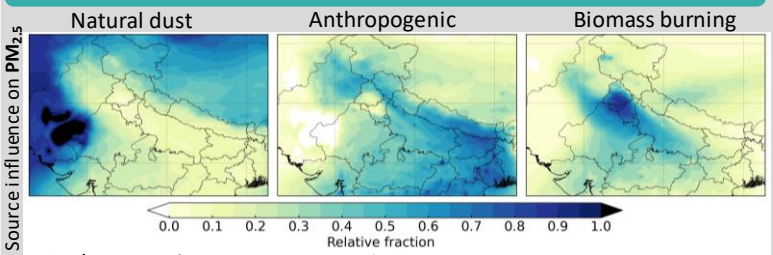
Regional source attribution

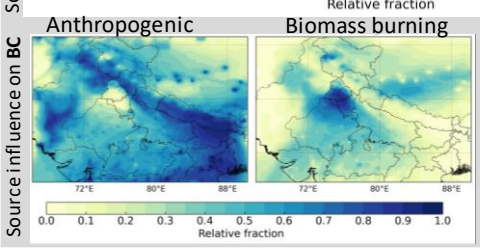
- Nearly 80 % $PM_{2.5}$ pollution came from biomass burning (BB) emissions over northwestern India and Delhi region during intense pollution days.
- BC from BB was 25 – 80 % over Delhi downwind from source region.
- Minor contribution from Natural dust to $PM_{2.5}$ during the episode.
- BB contributed to primary and secondary organic aerosols, nitrate but negligibly to sulfate.
- Anthropogenic share towards $PM_{2.5}$ composition was nearly one-third.

Takeaways

- Newly released FINN2.5 emissions show that earlier estimates underestimate contribution of BB to $PM_{2.5}$ and BC.
- BB emissions contributed comparably to anthropogenic emissions to $PM_{2.5}$ and BC over Delhi.
- The timescale and evolution of the episode across the Delhi was facilitated by prolonged atmospheric stratification and stagnation trapping particulate pollution within and above PBLH.
- **The severity of episodic haze pollution episodes can be reduced by targeting emissions control of BC in dense urban areas.**

4. Spatial variation of source contributions

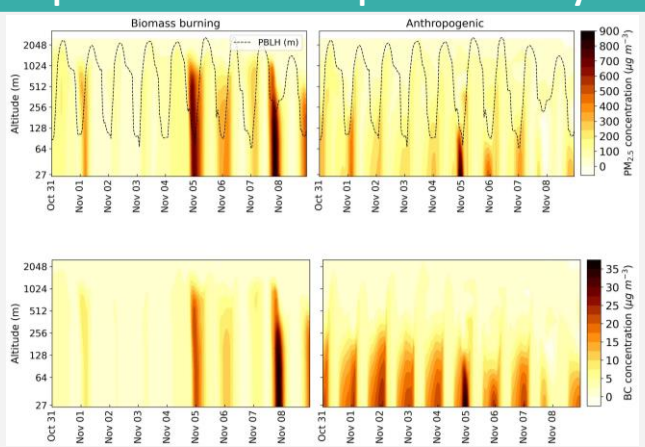




BB share to $PM_{2.5}$ and BC is up to 400 μg m^{-3} and 30 μg m^{-3} across NW and Delhi.

BC is mainly controlled by anthropogenic source across rest of India.

5. Implications for atmospheric stability



BB originated modelled BC and $PM_{2.5}$ over Delhi show peaks as high as 900 μg m^{-3} and 35 μg m^{-3} up to 1 km in atmosphere vertically and coincide with lowest nocturnal PBL heights.

Keywords: Black Carbon, $PM_{2.5}$, PBLH