

Role of Residential and Industrial Emission Sectors in Ambient Fine Particulate Matter (PM_{2.5}) And It's Component Over Indian Subcontinent in Winter Season

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Introduction

- Exposure to fine particulate air pollution (PM_{2.5}) can lead to significant human health impacts (Dockery et al., 1993)
- In India, generally, PM_{2.5} air pollution level exceeds the annual (40 µg/m³) and daily (60 µg/m³) mean National Ambient Air quality standards (NAAQS) over most part of the country and peaked during the winter season.
- As anthropogenic emissions from different source sectors contribute to PM_{2.5} air pollution significantly, it is imperative to learn the role of different emission sectors in the ambient air pollution levels for the development of mitigation policies.

Materials and Methods

Model Configuration

Version : WRF-Chem 3.9.1 (Grell et al., 2005)

Study Domain: India

Resolution: 20 km x 20 km

Grids: 180 x 200

Simulation duration January, 2016

Chemical Mechanism: CBMZ-MOSAIC

Met IC/BC: (NCEP/FNL) meteorological data at 1°x1° & 6h temporal resolution

Anthropogenic Emission Inventory: EDGAR-HTAPv2.2 (2010) : 0.1°x0.1°

Biomass Burning Emission Inventory: NCAR (FINN) version 1.0 (2011)

Biogenic Emission Inventory: MEGAN (2006)

Simulations

Base Simulation = (Anthropogenic Emission (An) + Biogenic emissions + Biomass Burning emissions)

Perturbed Simulation = (An - Residential / Industrial sector Emissions + Biogenic emissions + Biomass Burning emissions)

Emission Sector Contribution = Base Simulation - Perturbed Simulation

Results and Discussion

Ambient PM_{2.5} Concentration

- Indo Gangetic Plain (IGP) emerges as highly polluted region with PM_{2.5} concentration of ~100 µg/m³ and above.
- In IGP, residential sector and industrial sector contributed ~ 40-80 µg/m³ and ~ 20-40 µg/m³, respectively.
- Over Bihar and West Bengal, PM_{2.5} pollution is in range of ~ 180 – 220 µg/m³.
- Maximum contribution from residential and industrial sectors is in Bihar and West Bengal states.
- Over the Bay of Bengal, ~ 70 µg/m³ PM_{2.5} pollution observed. Of which ~ 25 µg/m³ contributed by residential sector and ~ 15 µg/m³ by industrial sector.
- In overall PM_{2.5} air pollution over India, residential sector contributes ~ 40% and the industrial sector contributes ~20 %.

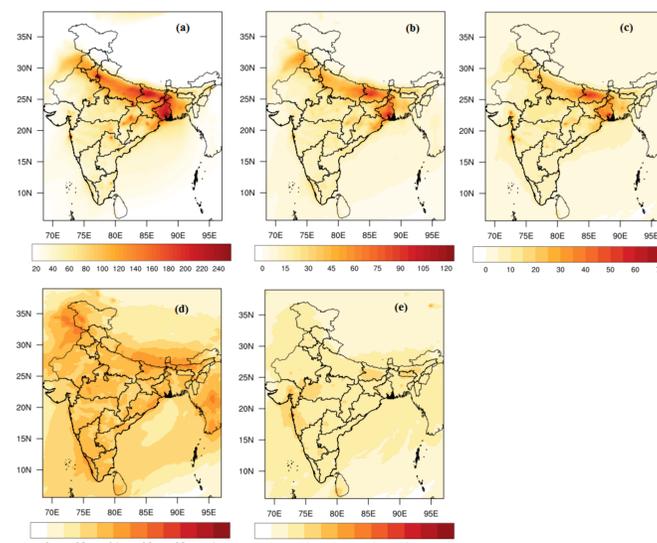


Figure 1: Spatial distribution of (a) total ambient PM_{2.5} (µg/m³) concentration, (b) Residential and (c) Industrial sector contribution and fractional contribution by (d) Residential and (e) Industrial sectors.

Ambient Black Carbon (BC) and Organic Carbon (OC) Concentration.

- For residential sector, OC contribution was observed significantly higher than BC.
- For industrial sector, OC contribution was observed slightly higher than BC.
- In upper and central part of IGP, ~ 5-9 µg/m³ BC and ~ 15-30 µg/m³ OC contributed by residential sector.

- In Bihar and West Bengal States, residential sector BC and OC contribution is ~10-20 µg/m³ and ~ 30-50 µg/m³ respectively.
- Industrial sector contributes higher BC and OC (~ 10-15 µg/m³) over the industrial corridors and city centers.
- Over the rest of domain, Industrial sector contribution of BC and OC is ~ 2-5 µg/m³.

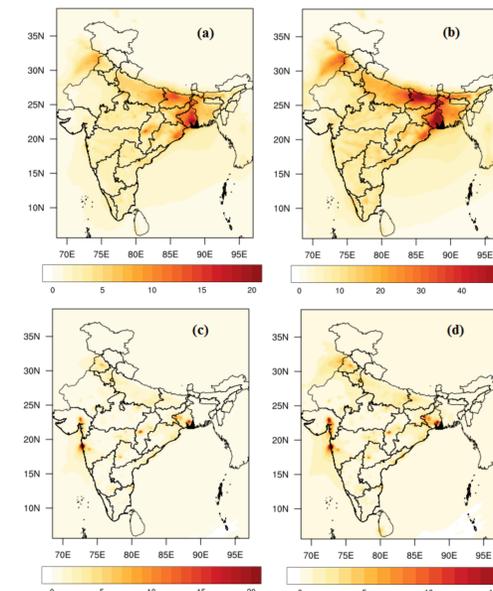


Figure 2: Spatial distribution of Black Carbon (BC) and Organic Carbon (OC) contribution from Residential (a & b) and Industrial Sectors (c & d) in µg/m³.

Ambient NH₄⁺, NO₃⁻, OIN and SO₄²⁻ Concentration

- NH₄⁺, NO₃⁻ and SO₄²⁻ pollution is higher in IGP.
- NH₄⁺ contribution from Residential and Industrial sector are ~ 4-7 µg/m³ and 2-5 µg/m³ respectively in IGP.
- NH₄⁺ contribution over rest of domain is ~ 1-3 µg/m³ by both sectors.
- Residential sector in whole IGP and Industrial sector over Bihar contributes ~ 12-20 µg/m³ to NO₃⁻.
- In Upper and Central IGP Industrial sector contributes ~ 6-9 µg/m³ to NO₃⁻.
- Over rest of domain NO₃⁻ contribution by Residential sector (~4-10 µg/m³) found higher than Industrial sector (~2-6 µg/m³).

- Other Inorganic Ions (OIN) contribution by residential sector was higher (~ 12-15 µg/m³) over central IGP, while OIN contribution by Industrial sector was higher (above 15 µg/m³) over Bihar and West Bengal states.
- SO₄²⁻ contribution by residential sector is very small (up to ~ 1 µg/m³), while Industrial sector contributes ~ 1-3 µg/m³ over most of domain.

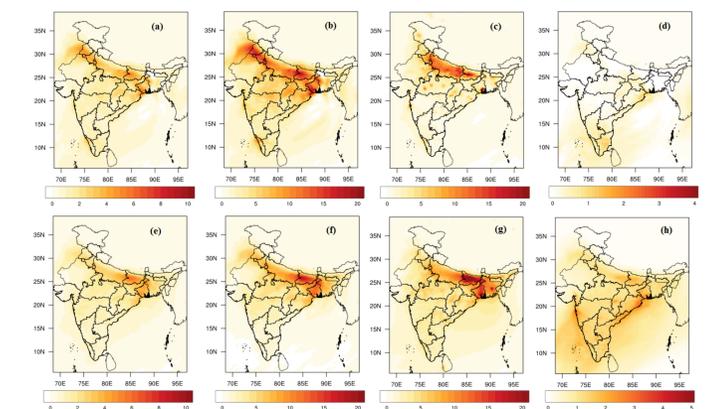


Figure 3: Spatial distribution of NH₄⁺, NO₃⁻, OIN and SO₄²⁻ Concentration contribution by Residential Sector (a,b,c & d) and Industrial Sector (e,f,g & h)

Conclusion

- Indo Gangetic Plain (IGP) emerges as highly polluted region in India.
- Residential Sector dominates over Industrial sector in total ambient PM_{2.5} Pollution in India.
- Bihar and West Bengal observed comparatively higher PM_{2.5} pollution.
- Residential sector contributes significantly to BC, OC, NH₄⁺ and NO₃⁻ concentration, while for OIN and SO₄²⁻, Industrial sector dominates.

References

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- Dockery, D. W., Pope, C. A., Xu, X., et al. (1993). An association between air pollution and mortality in six U.S. cities. *New England Journal of Medicine*, 24, 1753–1759