Modeling Study for the Heavy $PM_{2.5}$ Pollution during the Dry Season in Northwestern India

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Abstract

The remarkable increase in air pollution over the South Asian countries has attracted worldwide attention. Compared to the recommendation for $PM_{2.5}$, e.g. 25 μgm^{-3} 24-hour average, in the World Health Organization's Air Quality Guidelines (AQGs) or that of the Government of India (~60 μgm^{-3}), the $PM_{2.5}$ concentration level in the National Capital Region (NCR) of Delhi, India is significantly higher. Pollution levels over the Delhi NCR and its environs worsen especially during the dry season, from October to February, and are believed to be influenced by seasonally elevated anthropogenic emissions, such as post-harvest open burning of crop residues over the extensive grain-growing region of northwestern India, in addition to stagnation of atmospheric pollutants due to meteorological conditions controlled by continental airmasses. The Aakash project conducted intensive field campaigns with the Compact and Useful $PM_{2.5}$ Instrument with Gas Sensors (CUPI-Gs) in the states of Punjab, Haryana and Delhi from September to November in 2022 and 2023. It is found that $PM_{2.5}$ concentrations in this region rose above 400 μgm^{-3}. The heavily polluted conditions in Delhi were sometimes associated with air mass transport from the Haryana and Punjab region. A regional air quality modeling system using WRF/CMAQ incorporating emission inventories, HTAPv2.1, and GFASv2.1 reasonably simulated $PM_{2.5}$ concentrations in the Delhi-Haryana-Punjab region. During October to November, the classical modeling system greatly underestimate the observed $PM_{2.5}$ concentrations. The modeled sensitivity experiments required very high CRB emissions to explain the observed $PM_{2.5}$ in Punjab. The best model performance was found across all 30 measurement sites when enhanced secondary organic aerosols (SOA) formation mechanisms was enabled in the model system. Based on this modeling study, we discuss about the sources of the enhanced $PM_{2.5}$ concentrations, suggesting up to 60% contribution of anthropogenically produced SOA in total $PM_{2.5}$ in the region during October-November 2022.

Early Career Scientist

NO, I am not an early career scientist.

IGAC Activities

ACAM: Atmospheric Chemistry and the Asian Monsoon, AMIGO: Analysis of eMIssions usinG Observations, GEIA: Global Emissions Initiative, MAP-AQ: Monitoring, Analysis and Prediction of Air Quality, BBURNED: Biomass Burning Uncertainty: ReactioNs, Emissions and Dynamics, Allin-Wayra: Small Sensors for Atmospheric Science

IGAC Regional Working Groups

MANGO: Monsoon Asia and Oceania Networking Group, Japan National Committee