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Regional emission loading of particulate and gaseous air pollutants over India using fine resolution WRF-Chem simulation technique

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Only a few studies have reported sources, characteristics, and strategies for controlling severe air pollution events frequently occurring in several urban areas in India. For a detailed analysis of particulate matter (PM) and gaseous species for their temporal and spatial distribution, a high-resolution simulation through Weather Research and Forecasting with Chemistry (WRF-Chem) model was undertaken for the entire India. Emission Database for Global Atmospheric Research (EDGAR v2.2) was used. WRF-Chem model was used for predicting concentrations of NO_2, O_3, CO, SO_2, and $PM_{2.5}$ along with its components in major cities (Delhi, Lucknow, Patna, Kolkata, Ahmedabad, Mumbai, Hyderabad, Bangalore, Chennai) spread all over India. The model's performance was validated against observations that were available for a few large cities from national ambient air quality monitoring stations. Generally, O_3 predictions did not show an acceptable association with the measurements, but $PM_{2.5}$ predictions did meet the model performance criteria (root mean square error (RMSE), normalized mean bias (NMB), normalized mean error (NME), mean fractional bias (MFB) and mean fractional error (MFE)). Model performance was better for days with higher levels of $PM_{2.5.}$ $PM_{2.5}$ showed the highest concentration levels for India's Northern and Eastern parts and a major portion of the Indo-Gangetic Plain (IGP). Concentrations of $PM_{2.5}$ were observed to be lower during monsoon and higher during the winter seasons. Nitrate levels were found to be 150–240% higher in winter than the yearly average. However, a decrease in solar radiation intensity and temperature during the winter season showed sulfate levels to be much lower than in other seasons. Except for South India, Primary Organic Aerosol (POA) contribution to $PM_{2.5}$ was highest for regional analysis. Analysis of model concentrations indicates the importance of controlling precursor gases for secondary pollutants in India. Conclusively, WRF-Chem predicted particulate and gaseous air pollutant levels can be used to develop control strategies for large regions that are part of the same airshed.