Development of anthropogenic pollutant emission inventory for India and its validation using satellite data

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India is facing serious problems caused by heavy air pollution. Delhi has been ranked as the most polluted city in the world, and other 12 Indian cities have been also ranked within the top 20 polluted cities. It is urgently required to introduce effective strategies to improve air quality over India. Air pollution is caused by primary pollutants which are directly emitted by sources and secondary pollutants which are formed in the atmosphere from various precursors via complex photochemical reactions. Emission inventory which tabulates amount of emissions of primary pollutants and precursors emitted from various sources could be helpful to consider effective strategies.

This study has developed emission inventory of primary pollutants and precursors emitted from anthropogenic sources in India. The target sectors include domestic combustion, transport, industrial combustion, power plants, and non-energy sources. GAINS-Asia model were utilized to estimate CO, NOx, SOx, non-methane volatile organic compounds (NMVOCs) and particulate matter (PM) emissions based on information of emission factors, activities, and abatement technologies. Such information was collected from various reliable government and published data sources.

Estimated amount of CO, NOx, SOx, NMVOC and PM_{10} emissions in whole India is 53.8, 5.41, 7.03, 9.81, and 10.7 Tg for year 2010. The highest contributors to emissions are domestic combustion for CO and NMVOC, transport for NOx, power plants for SOx, and industrial combustion for PM_{10}.

In order to use the emission data in air quality simulations, the emissions were horizontally allocated to 36 x 36 kilometers meshes covering whole India based on district-wise information on registered vehicles and population, and state-wise information on industries. For large industries like cement, refineries, oil and gas explorations, iron and steel, thermal power plants, allocations were made at their exact location. The emissions of some sectors are vertically and temporally allocated based on information including traffic flows, time of cooking, and stack heights.

An air quality simulation using the regional chemical transport model, CMAQ version 5.0.2 were conducted to validate the emission data. The meteorological field was fed from the regional meteorology model, WRF version 3.7.1. In addition to the anthropogenic emissions developed in this study, GFED version 4.1 was used for biomass burning emissions, and MEGAN version 2.0.4 was utilized to estimated biogenic VOC emissions. The target domain consisted of 36 x 36 kilometers meshes includes several surrounding countries as well as whole India. The gridded emission database of ECLIPSE version 5a was used for the anthropogenic emissions from other surrounding countries than India. The gridded concentration fields simulated by the global chemical transport model, MOZART4 were provided as boundary concentrations.

The simulated results were compared with the satellite data. The retrieved values of aerosol optical depth (AOD) over the target domain in the MODIS level 2 dataset, and the simulated values at the corresponding locations and timings were picked up. While the simulation well reproduced features in a horizontal distribution of AOD indicating high aerosol loading over the Indo-Gangetic plains, its absolute level was underestimated. It is much important to improve emission inventory for not only anthropogenic sources but also missing sources including fugitive dust.

Keywords: Emission inventory, Air quality simulation, Satellite data

