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Assessment of AERMOD offline Integration with WRF-ARW Mesoscale Atmospheric model by predicting ground level concentrations of oxides of nitrogen due to area and point sources over an urban area: A case study

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The deterioration of air quality may be attributed to the rapid industrialization, consequent urbanization and increased growth of vehicular traffic. In urban areas, the day to day increase in vehicular traffic has provided the impetus for comprehensive monitoring/modeling of air quality. In the present study, vehicular traffic as area sources and power plant as point source, the two major sources of oxides of nitrogen (NOX), was has considered. Gaussian plume air dispersion model, AERMOD is used for assessment of NOX dispersion over Nagpur city, Maharashtra. The processes within the planetary boundary layer (PBL) play an important role in the dispersion of air pollutants. AERMOD requires surface and upper air meteorological observations and various PBL parameters with good temporal resolution in the stand alone mode and mostly the data on PBL parameters is not available routinely over India. In the present study, an attempt has been made to simulate the necessary boundary layer parameters from WRF-ARW model and then offline coupled with AERMOD dispersion model. High resolution simulations with triple nested domain (horizontal resolution of 27, 9 and 3 km; 27 vertical levels) are carried out with WRF-ARW model. The surface and upper air meteorological data along with the computed PBL parameters of winter and pre-monsoon seasons representing January and April respectively in the year 2009 are considered for dispersion of the NOX over Nagpur. Experiments are conducted with two best PBL parameterization schemes over study region, non-local Yonsei University (YSU) and local Mellor-Yamada-Janjic (MYJ) schemes. AERMOD with 1 km resolution has been used for predicting the concentrations of NOX over Nagpur city. NOX observations from six monitoring stations of Central Pollution Control Board are used for validation of model predicted concentrations. The NOX concentrations are found to have over-predicted in both seasons. Close examination of the computed statistical errors using predicted and observed NOX values reveals the better performance of YSU scheme as mean absolute error, root mean square error, correlation coefficient, normalized mean square error, fractional bias, FAC2 (Factor of 2) and geometric mean variance given by this scheme are close to their respective ideal values. This study shows that the WRF-AERMOD combination predicted the NOX concentrations reasonably well and the YSU parameterization scheme is found to be efficient in air quality modeling over the study region.
[Key words: WRF model, Planetary Boundary layer, AERMOD, Emission, Air quality]