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Ambient Air Quality Assessment Using AERMOD for Line Source

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ABSTRACT. Air pollution in megacities like Ahmedabad, India, is heavily influenced by vehicular emissions. Quantifying this air pollution is challenging due to the complex interaction of vehicle types, emission standards, traffic patterns, and weather conditions. This study employs AERMOD for line source emission estimation in Ahmedabad, addressing a significant research gap in India. It is among the first of its kind in the region, offering valuable insights for urban pollution control. By adapting AERMOD to local conditions, this work not only contributes to the scientific literature but also provides a scalable model for air quality management in other Indian cities. The air dispersion model is used to predict ground-level concentrations of pollutants (PM, NO_2, HC, and CO) emitted by vehicles (line sources) in four identified stretches representing residential, commercial, industrial, and institutional zones of Ahmedabad during the winter season (December 2023 to February 2024). For emission rate estimation, traffic survey data and emission factors from the source apportionment study report by CPCB, India, were used. Other basic model input data, such as GPS coordinates, width, mean sea level, and release height of the stretches, have been gathered, while meteorological data has been acquired from the India Meteorological Department (IMD). The AERMOD results have been compared with government ambient air quality data. The results indicate that the AERMOD-predicted CO concentration is close to the actual measurements, with a slight underprediction. For PM, the model underpredicts the concentration, possibly due to emission sources other than vehicular exhaust, such as road dust, fugitive emissions, construction, and industrial activities. NO_2 concentrations are highly overpredicted, whereas HC concentrations align with vehicular traffic trends. Overall, AERMOD appears to be a useful tool for assessing urban air quality, particularly for mobile emission sources.

Keywords: air quality, air pollution, AERMOD, line source, vehicular emission

Table S1. Details of the identified study area stretches

Stretch No.	Area and Zone	Length of stretch	To - From	Start point	End point
S1	Navrangpura (Institutional + Commercial)	1.1 Km	Vijay Cross road to 2nd Gate of LDCE, University area	23° 2'32.94"N 72°32'56.76"E	23° 1'58.38"N 72°32'57.90"E
S2	Bodakdev (Commercial + Residential)	2.4 Km	Pakwan crossroad to 132 feet ring road (Asopalav)	23° 2'18.84"N 72°30'43.81"E	23° 1'41.74"N 72°31'53.39"E
S3	Chandkheda (Residential)	3.9 Km	ONGC circle to SP ring road	23° 5'54.50"N 72°35'17.84"E	23° 7'49.07"N 72°35'5.78"E
S4	Vatva GIDC (Industrial)	3.6 Km	Vatva GIDC road to Hathijan Circle to	22°57'28.11"N 72°39'22.91"E	22°58'49.74"N 72°38'0.97"E

Table S2. Emission factors of various pollutants

Vehicle type	Types of Fuel	CO (g/Km)	HC (g/Km)	NO_2 (g/Km)	PM (g/km)
Heavy Truck (Trailer)	Diesel	4.13	0.28	8.63	0.42
Buses, truck, agriculture tractor	Diesel	3.92	0.16	6.53	0.30
Light Commercial Vehicle	Diesel	3.66	1.35	2.12	0.48
Car/van	Petrol	0.84	0.12	0.09	0.00
	Diesel	0.06	0.08	0.28	0.02
	CNG	0.06	0.46	0.74	0.01
Auto rickshaw	CNG	1.00	0.26	0.50	0.02
	Diesel	0.41	0.14	0.51	0.09
	Petrol	1.37	2.53	0.20	0.05
Two wheeler	Petrol	0.72	0.52	0.15	0.01

Source: Air Quality monitoring, emission inventory and source apportionment study for Indian cities, February, 2011 by CPCB.

Table S3. Salient features of AERMOD

Model Applied	AERMOD View 12.0.0
Study Area	10 Km radius
Pollutant Being Modeled	PM, NO_2, HC and CO
Averaging Time	24 hr for PM, NO_2, HC and 8 hr for CO
Dispersion Coefficient	Urban
Terrain Type	Flat
Terrain Data	SRTM1/SRTM3 Global (90 m)
Receptor Grid Type	Uniform Cartesian grid
Size of Grid	1000 m x 1000 m
Number of Receptors	441
AERMET- Surface Parameters	Default values of albedo, bowen ratio andsurface roughness for urban land use type(Winter season)
Model Output	24 hr maximum ground level concentration of pollutants for urban land use type

Table S4. Comparison of AERMOD with other existing air quality software

Description	Different Air quality Software			
	Present Study - AERMOD	CAL3QHC (Abdul-Wahab 2004)	CALINE4 (Sudarsan et al. 2020)	WRF-Chem (Garaga et al. 2018)
Parameters	CO, HC, NO_2, PM	CO	CO	NO_2
Study Area	Navrangpura, Bodakdev, Chandkheda, and Vatva GIDC, located in Ahmedabad, Gujarat, India	urban intersection (Star Cinema in Muscat area, Oman)	Chennai, Tamil Nadu, India	Eastern India (Semi – Urban)
Methodology of the study	Traffic Survey, Traffic Volume count, Emission rate estimation, Model run, comparison of model data with government data.	Traffic survey, Emission inventory, Model run, Comparison of CAL3QHC Model and Actual Concentrations	Six locations, Traffic Survey, Monitoring of CO, the measured values were compared with NAAQS standards and the same CO values were predicted using CALINE4 and AERMOD	Review of different Air quality modelling studies span India.
CO	AERMOD performed well in predicting CO concentrations, with underprediction for three locations out of four location.	The result of the evaluation showed that CAL3QHC performed well in predicting CO concentrations, with underprediction for seven out of eight receptor sites.	CO concentration overpredicted at three locations, underpredicted at two locations and given exact prediction at one location.	The model showed under predictions for CO.
HC	HC concentration found higher in industrial area where the movement of heavy vehicles is more.	--	--	--
NO_2	AERMOD over-predict the NO_2 concentration for line source.	--	--	The model showed over predictions for NO_2.

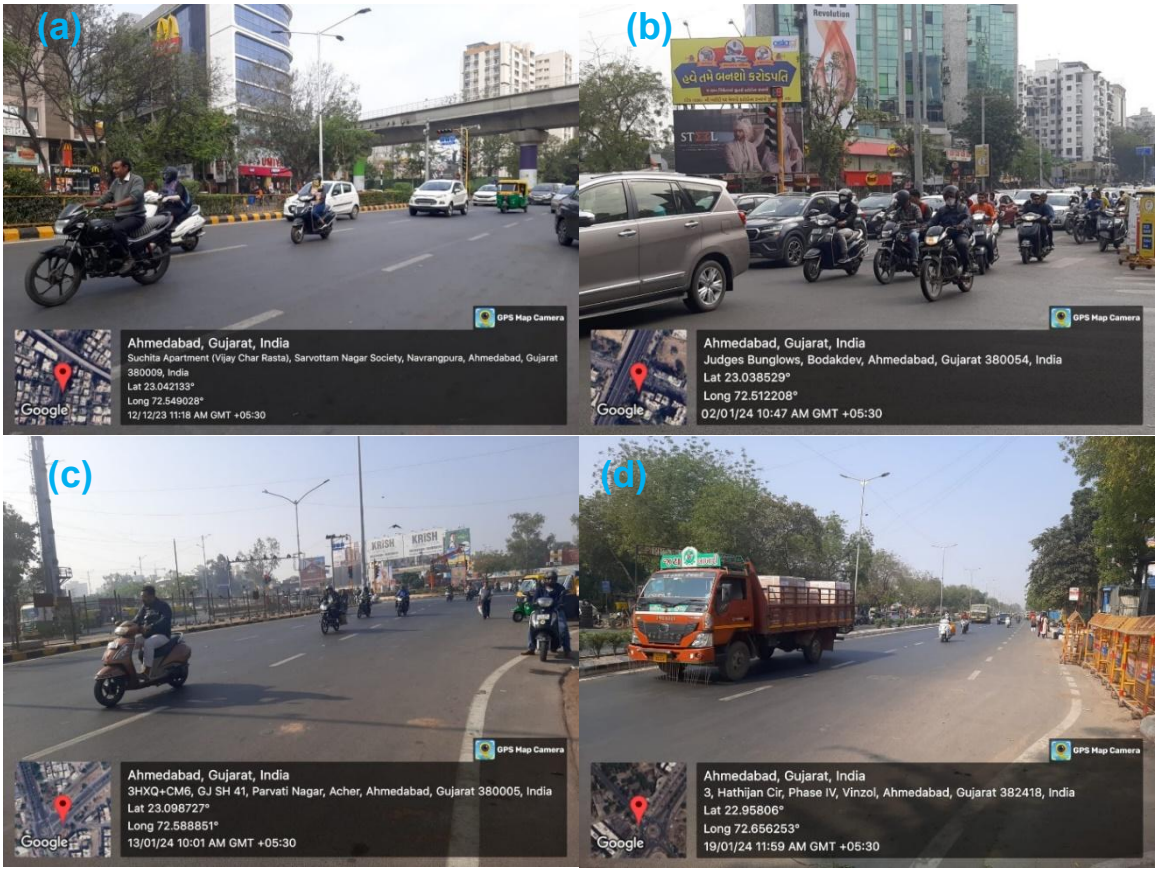

Figure S1. Traffic survey at the identified stretches (a) S1 (b) S2 (c) S3 (d) S4

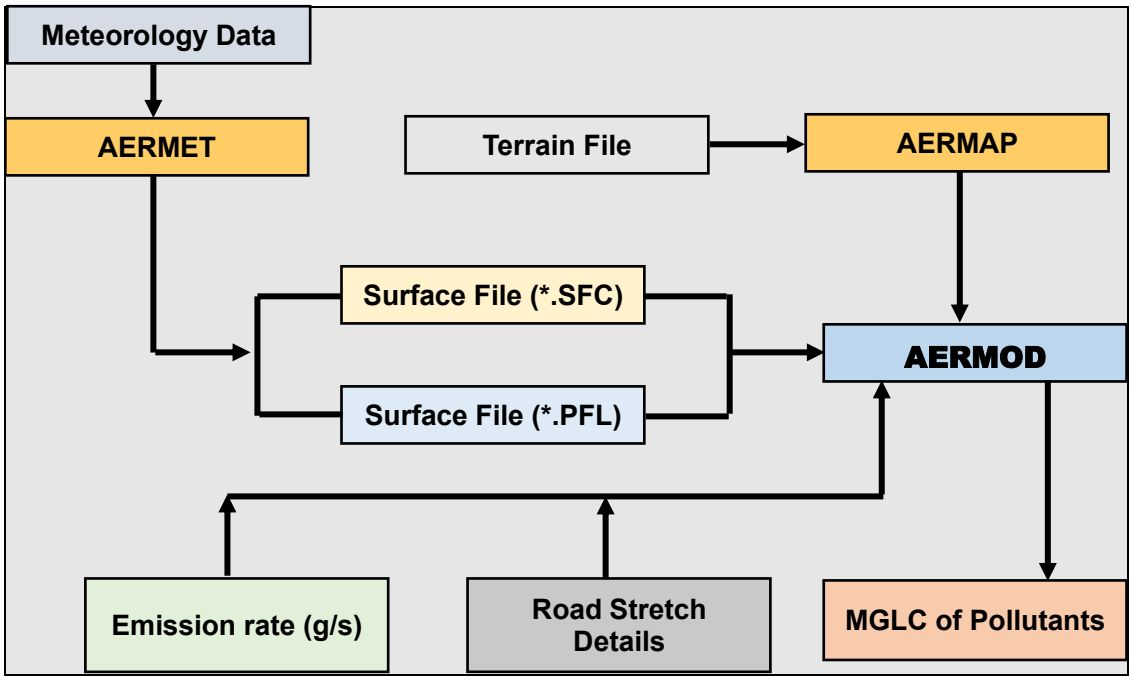

Figure S2. Methodology for AERMOD predication and performance