Supporting Information

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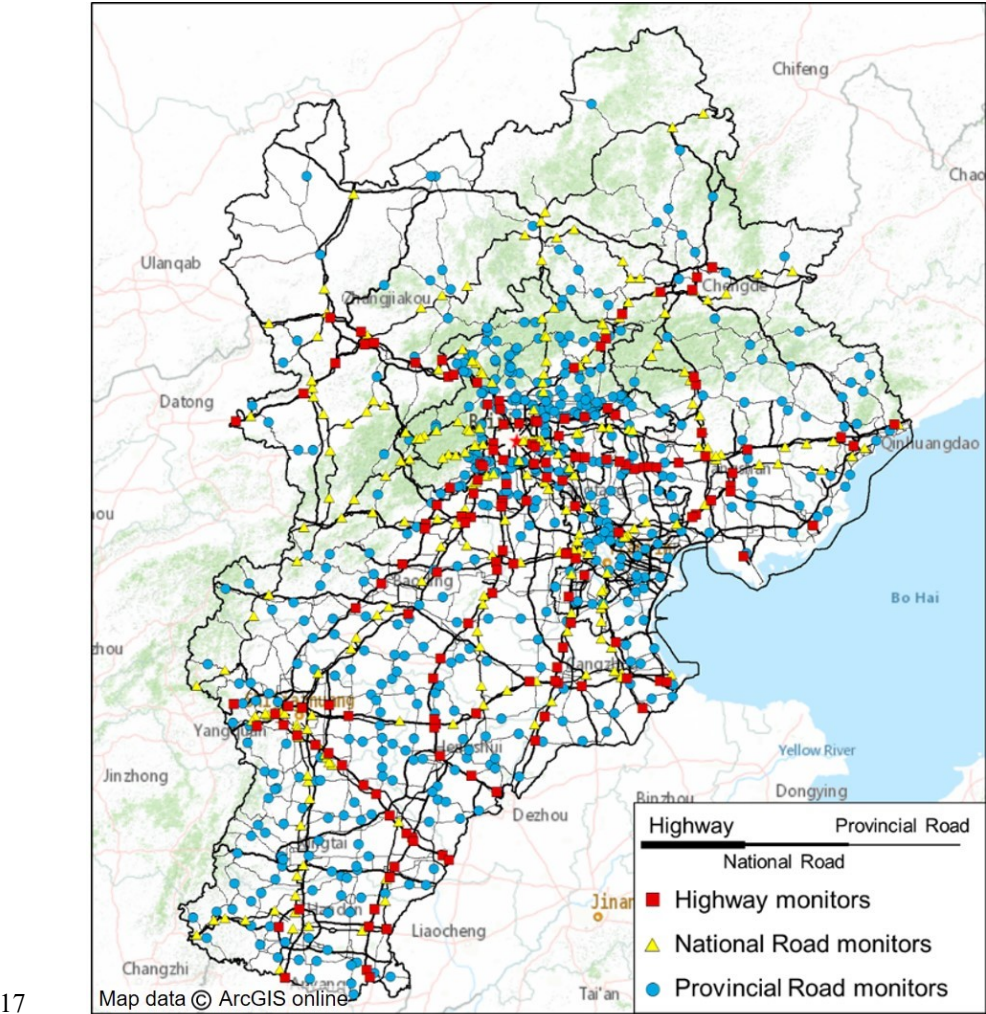
This Supporting Information (SI) document includes 17 pages, 10 supplementary figures (pages S2 to S11) and 6 supplementary tables (pages S12 to S17).

16 **Supplementary Figures**

18 **Figure S1.** Map of traffic monitoring sites with traffic mix data available.

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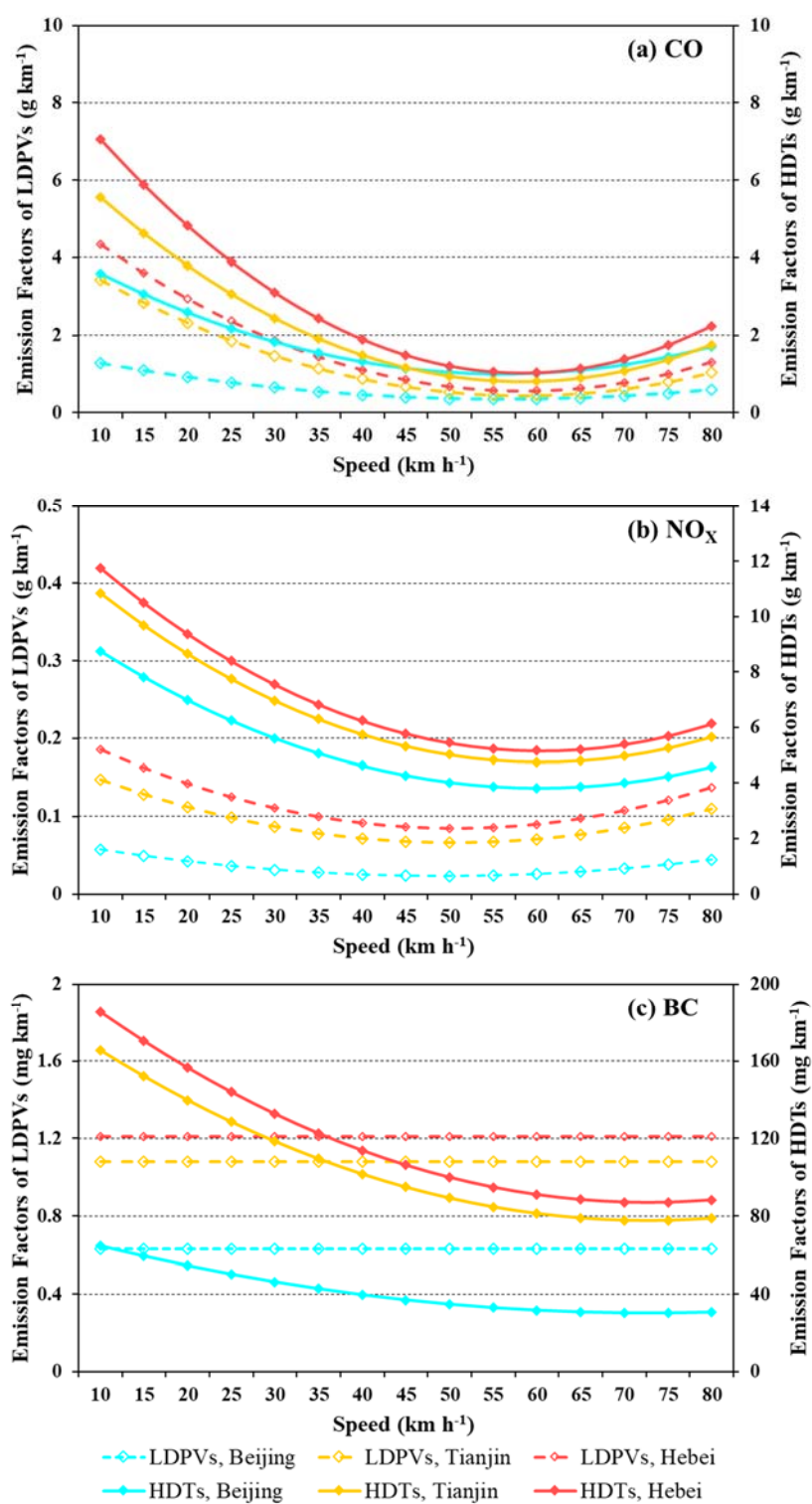
Figure S2. Speed-dependent fleet-average emission factors for LDPVs and HDTs estimated by the EMBEV

model. Speed correction is not applicable to BC emissions from LDPVs due to the lack of testing data.

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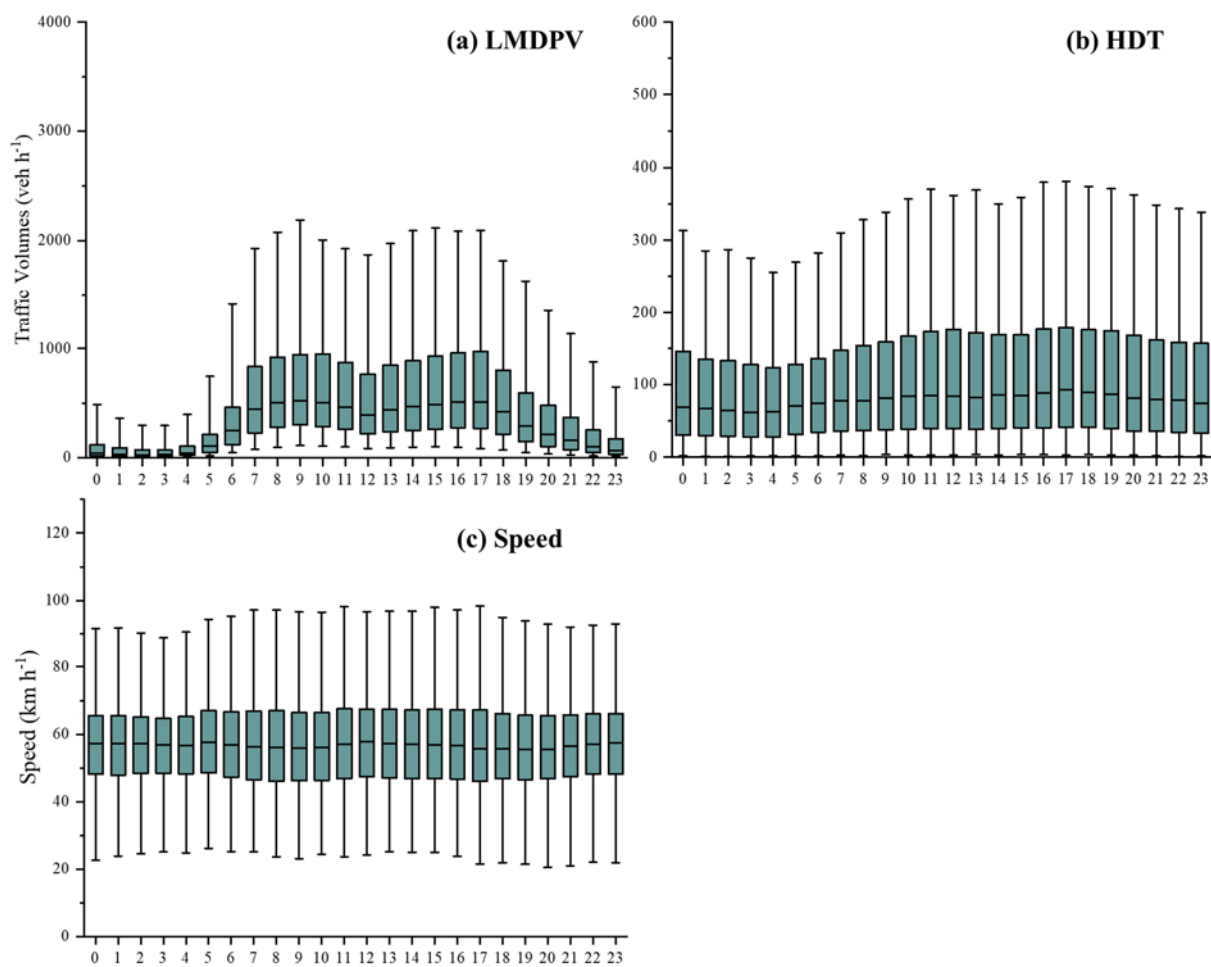
25 **Figure S3.** Box plot of traffic volumes by vehicle category and speed used to train the land use models.

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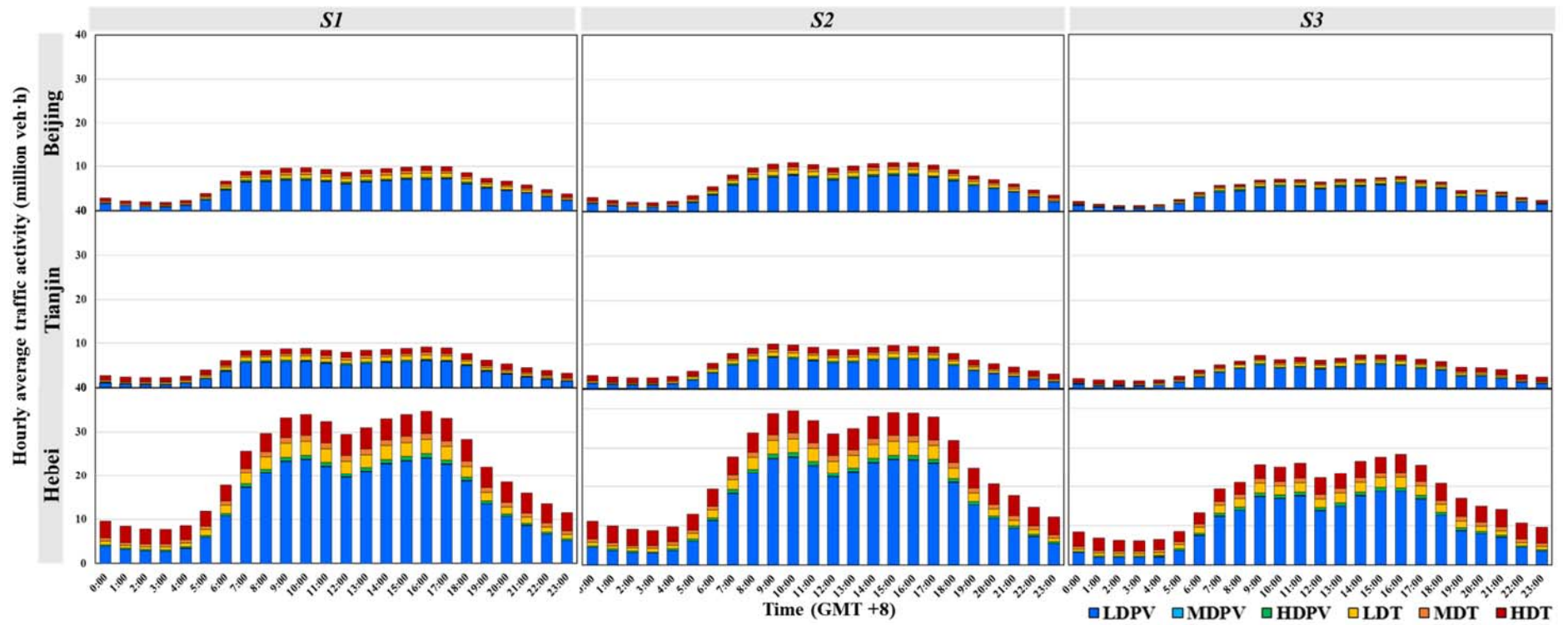
Figure S4. Average diurnal fluctuations in hourly traffic activity by vehicle category of the BTH region during various traffic scenarios *S1* to *S3*

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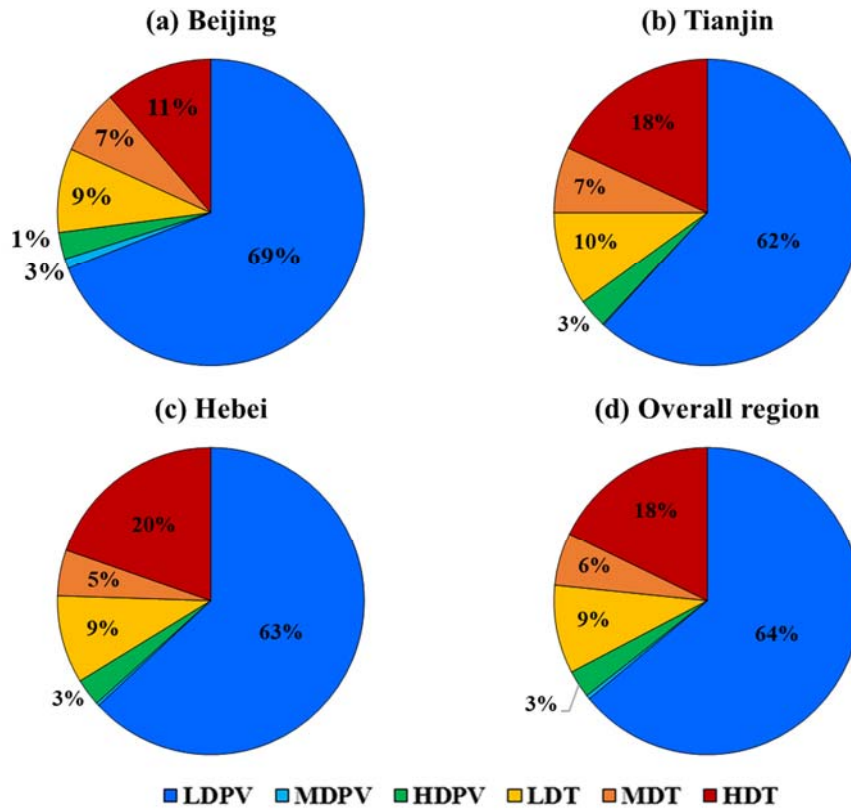
30 **Figure S5.** The proportion of each vehicle category accounting for the total traffic activity of (a) Beijing, (b)

31 Tianjin, (c) Hebei, and (d) the overall region.

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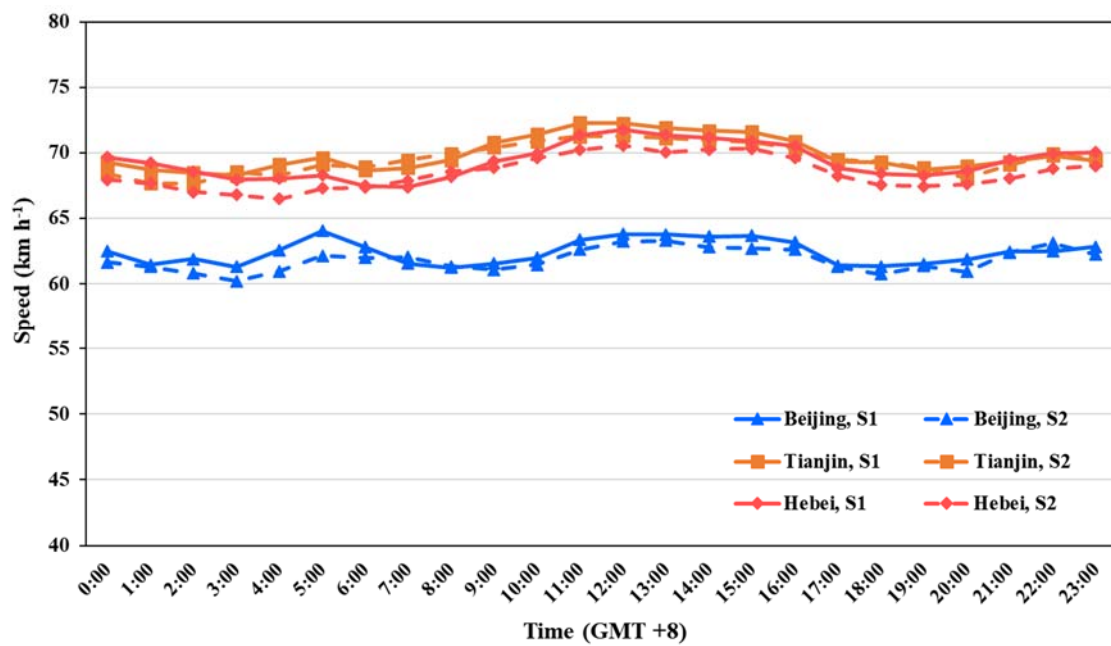
34   **Figure S6.** Average hourly speed by region under various traffic scenarios.

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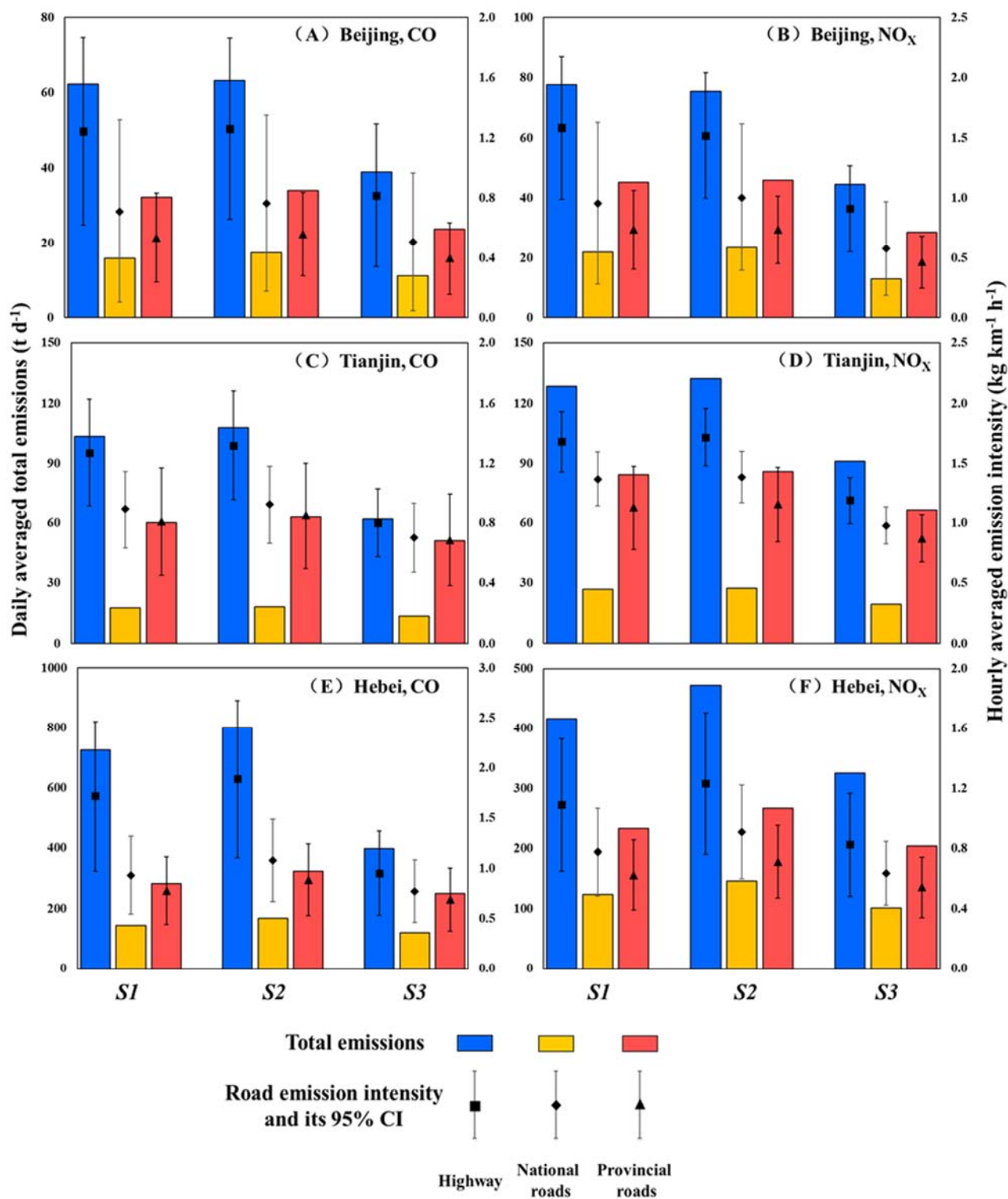
Figure S7. Estimated total emissions and emission intensity of CO and NO$_X$ by region and road type under various traffic

scenarios, S1 to S3.

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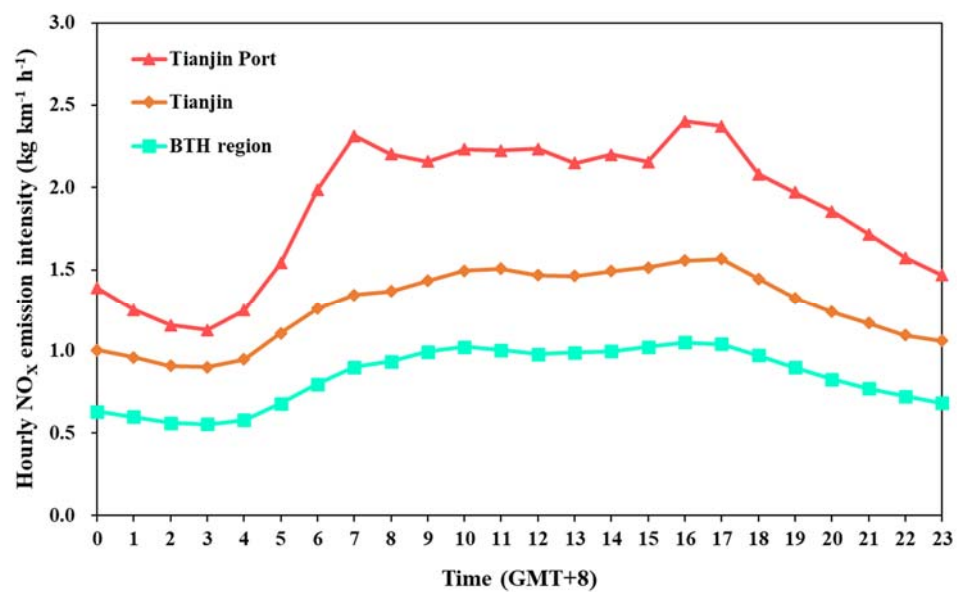
41   **Figure S8.** Hourly emission intensity of NO_X in the region of Tianjin Port, Tianjin and the BTH region.

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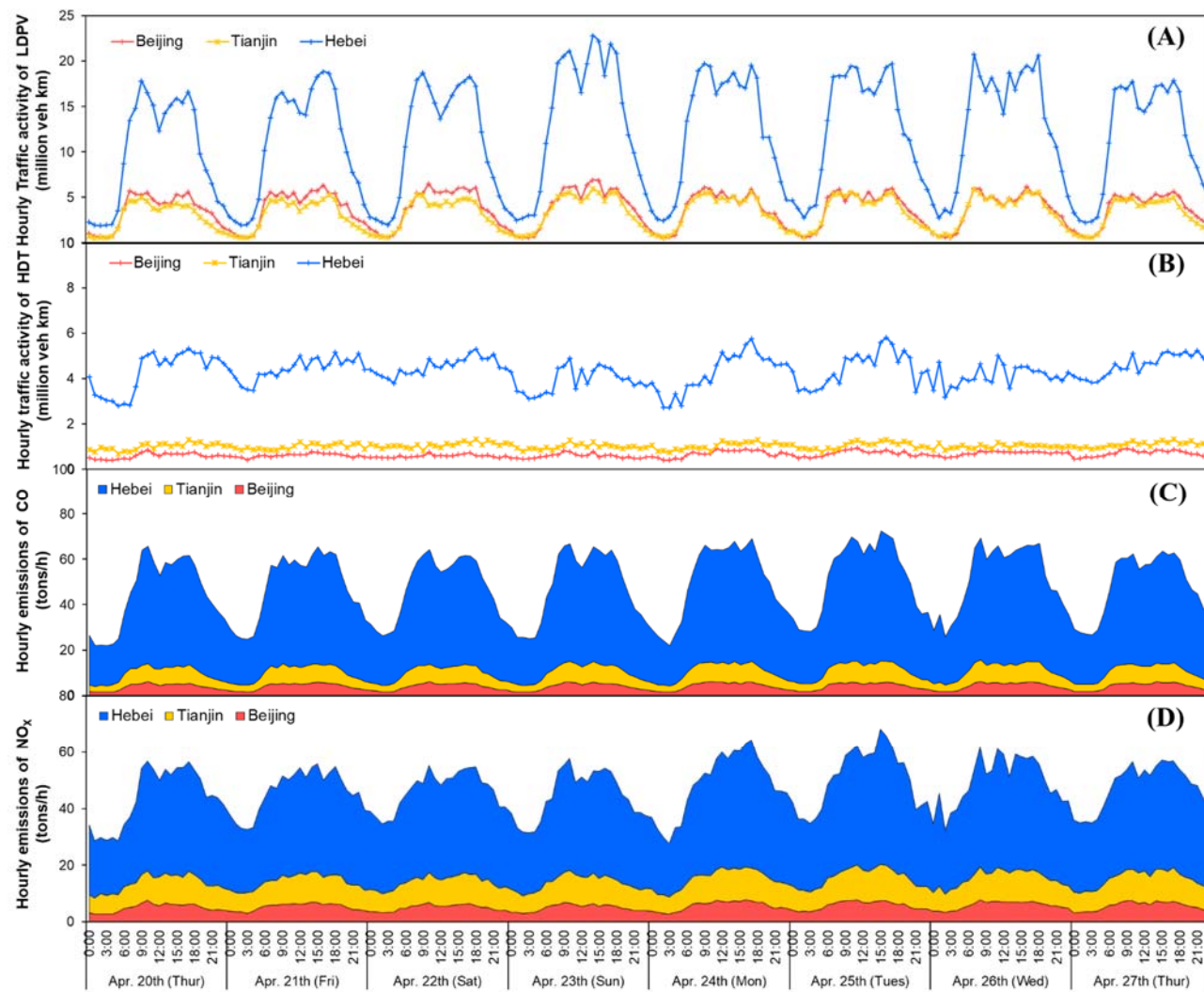
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44 **Figure S9.** Hourly traffic activity of LDPV (A) and HDT (B) and vehicle emissions of CO (C) and BC (D) by region from April 20th to April 27th,2017

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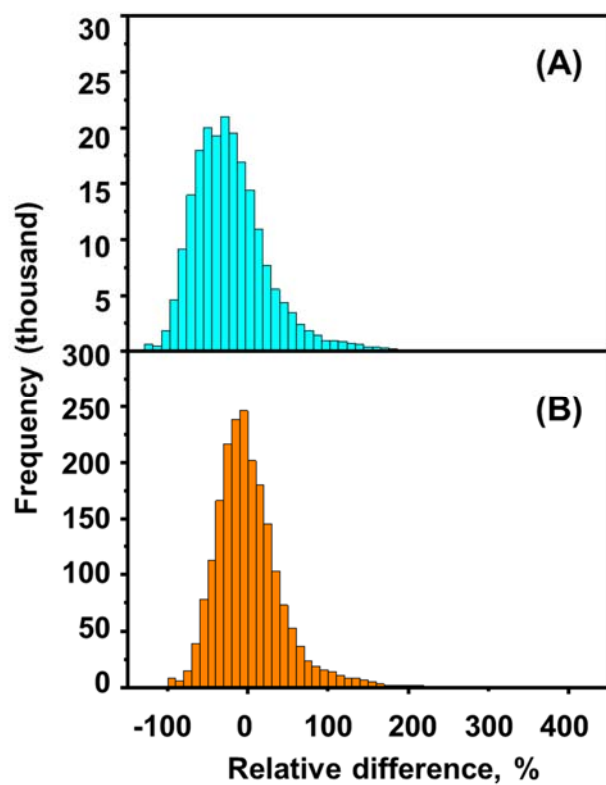
46 **Figure S10.** Distribution of relative differences of CO and NO_X of M2, compared to M1.

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48   **Supplementary Tables**

49   **Table S1.** Definition of road types

Road type	Description	Designed speed
Expressways	Inter-provincial roads, often constructed by the national highway administration	two thirds of the roads above 100 km/h
National highways	Inter-provincial roads, often constructed by the national highway administration	more than half of the roads below 80 km/h
Provincial highways	Inner-provincial roads, often constructed by the provincial highway administration	more than half of the roads below 80 km/h

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52   **Table S2.** Definition and abbreviation of vehicle categories

Vehicle classification	Abbreviation	Description
Light-duty passenger vehicle	LDPV	Length ≤ 3.5 m, PC [a] ≤ 9
Medium-duty passenger vehicle	MDPV	Length < 6 m, 9 < PC ≤ 20
Heavy-duty passenger vehicle	HDPV	Length ≥ 6 m, PC > 20
Light-Duty Truck	LDT	Length < 6 m, GVW [b] ≤4500 kg
Medium-Duty Truck	MDT	Length ≥ 6 m, 4500 < GVW ≤12000 kg
Heavy-Duty Truck [c]	HDT	GVW＞12000 kg [d]

53   Notes: [a] Passenger capacity; [b] Gross vehicle weight; [c] The HDTs are further classified into local HDTs and non-local HDTs
54   according to the registration place; [d] Emission factor for local HDTs are weighted by HDT2 and HDT3 according to their
55   registration number and annual VKT (Zhang et al., 2014).

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57 **Table S3.** Summary of data used to train LURF and GPR

Category	Potential variables	Variable code
Land-use Data		
Land use (total area [km²] / buffer area)	Urban land	urbanland
	Crop land	cropland
	Grass land	grassland
	Bare lands	bareland
Further	Transit	POI_transit
	Restaurant	POI_restaurant
	Office	POI_office
	Mall	POI_mall
	Hotel	POI_hotel
	Education	POI_education
	Bank	POI_bank
	Recreation	POI_recreation
	Touristic	POI_touristic
Distance (Euclidean [m])	Airport	D_airport
	Port	D_port
	Freight	D_freight
	CBD	D_CBD
Population density (total population / buffer area)	Population density	pop
Road Information Data		
Road density (total length [km] / buffer area)	Highways	rd00
	National roads	rd01
	Province roads	rd03
Value extracted at point	Location	Lon/Lat
	Administration	Province/City/County
	Road type	rdtype
	Number of road lane	LaneNum
	Designed road speed	DeSpeed

58 Note: a Buffer radii 50 m, 100 m, 200 m, 300 m, 500 m, 1000 m, 2000 m, 5000 m

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60   **Table S4.** Cross-validated of the LURF and GPR models in predicting hourly-averaged traffic profiles under *S1*.

Traffic profiles	Pearson's R		MAPE		RMSE	
	LURF	GPR	LURF	GPR	LURF	GPR
LMDPV	0.73±0.08	0.51±0.11	1.03±0.30	1.27±0.60	258±133	318±163
HDPV	0.48±0.13	0.38±0.14	1.53±0.19	1.67±0.31	14±4	8±6
LDT	0.54±0.11	0.34±0.11	1.19±0.23	1.42±0.31	54±30	36±22
MDT	0.61±0.03	0.48±0.03	1.37±0.14	1.55±0.18	13±4	27±9
HDT	0.55±0.02	0.45±0.03	1.52±0.14	1.76±0.17	63±13	12±11
Speed	0.71±0.03	0.70±0.03	0.16±0.01	0.17±0.01	1.13±0.80	0.48±0.36

61   Note: The units of RMSE for traffic volumes and speed are in veh h^{-1} and km h^{-1}, respectively.

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63 **Table S5.** Top 10 important variables for the LURF predicting the traffic characteristic

LMDPV	HDPV	LDT	MDT	HDT	Speed
City# (*5.2*)	County# (*2.7*)	pop_5000m* (*5.8*)	County# (*2.6*)	County# (*1*)	rdtype# (*1.0*)
POI_office_5000m* (*6.2*)	City# (*5.5*)	pop_2000m* (*10.7*)	Province# (*2.7*)	rdtype# (*2.0*)	City# (*2.4*)
urbanland_5000m *(*7.5*)	LaneNum# (*9.3*)	Admin# (*12.8*)	City# (*3.7*)	LaneNum# (*3.7*)	County# (*3.5*)
pop_5000m* (*9.8*)	rdtype# (*12*)	pop_1000m* (*14.7*)	POI_office_5000m* (*4.5*)	City# (*5.9*)	rd00_50m# (*3.6*)
rdtype# (*10.9*)	urbanland_5000m* (*20.7*)	LaneNum# (*18.8*)	rdtype# (*8.1*)	Lat# (*7.7*)	rd00_100m# (*4.5*)
County# (*11.5*)	DeSpeed# (*25.6*)	urbanland_5000m* (*24.4*)	urbanland_5000m* (*9.1*)	DeSpeed# (*8.3*)	rd00_200m# (*7.3*)
pop_2000m* (*13*)	Province# (*25.9*)	City# (*26.9*)	urbanland_2000m* (*9.7*)	urbanladn_5000m* (*8.6*)	Province# (*9*)
LaneNum# (*13.7*)	pop_5000m* (*27.3*)	POI_mall_5000m* (*27.9*)	LaneNum# (*14.1*)	rd00_5000m# (*13.5*)	DeSpeed# (*9.5*)
POI_transit_5000m* (*14.8*)	rd00_50m# (*31.9*)	POI_office_5000m* (*28.0*)	pop_5000m* (*15*)	cropland_1000m* (*16.8*)	LaneNum# (*10.3*)
pop_1000m* (*15.9*)	Lat# (*33.4*)	POI_restaurant_5000m* (*28.6*)	POI_transit_5000m* (*15.6*)	rd00_2000m# (*20.1*)	rd00_300m# (*12.9*)

64 Note: The number in the bracket is the average hourly importance ranks of the variables. * variables representing the land-use information; # variables representing the road
65 information.

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67   **Table S6.** The VKT allocation weights by region and road type

		LMDPV	HDPV	LDT	MDT	HDT
Beijing	Expressway	56%	51%	53%	55%	55%
	National-level highways	15%	15%	16%	15%	15%
	Provincial-level highways	29%	34%	31%	30%	30%
Tianjin	Expressway	48%	49%	43%	48%	53%
	National-level highways	11%	12%	11%	12%	12%
	Provincial-level highways	41%	39%	45%	40%	35%
Hebei	Expressway	48%	46%	39%	46%	51%
	National-level highways	17%	18%	19%	18%	18%
	Provincial-level highways	35%	36%	42%	36%	31%

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