

INFRAS/FVT/MKConsulting – Philipp Wuethrich

Handbook Emission Factors for Road Transport 道路交通排放手册 Localizing HBEFA for China 中国本地化

Beijing Landmark Hotel, March 3 2016

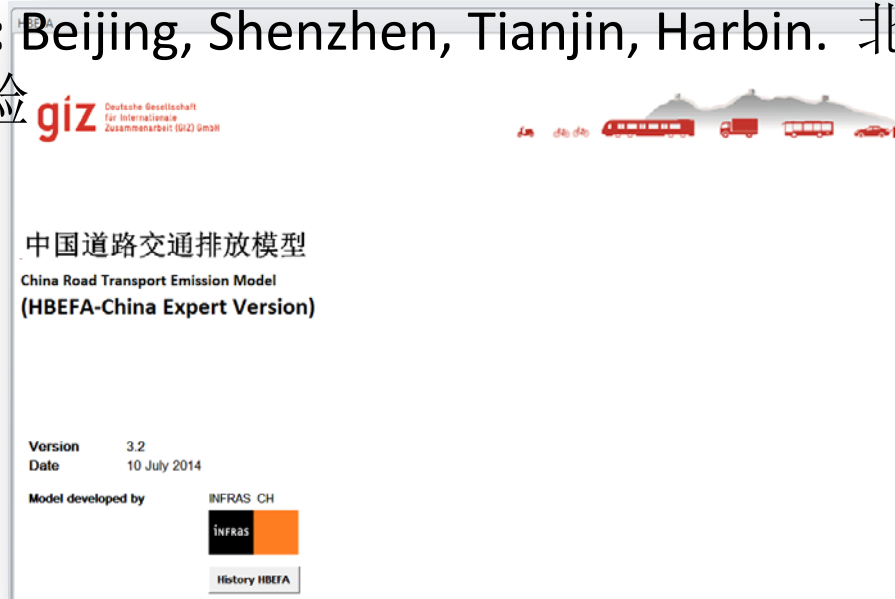


Agenda 目录

1. Key elements for localising HBEFA for China 本地化的关键因素
2. Software tool CRTEM/HBEFA China
3. Conclusions
4. Further steps

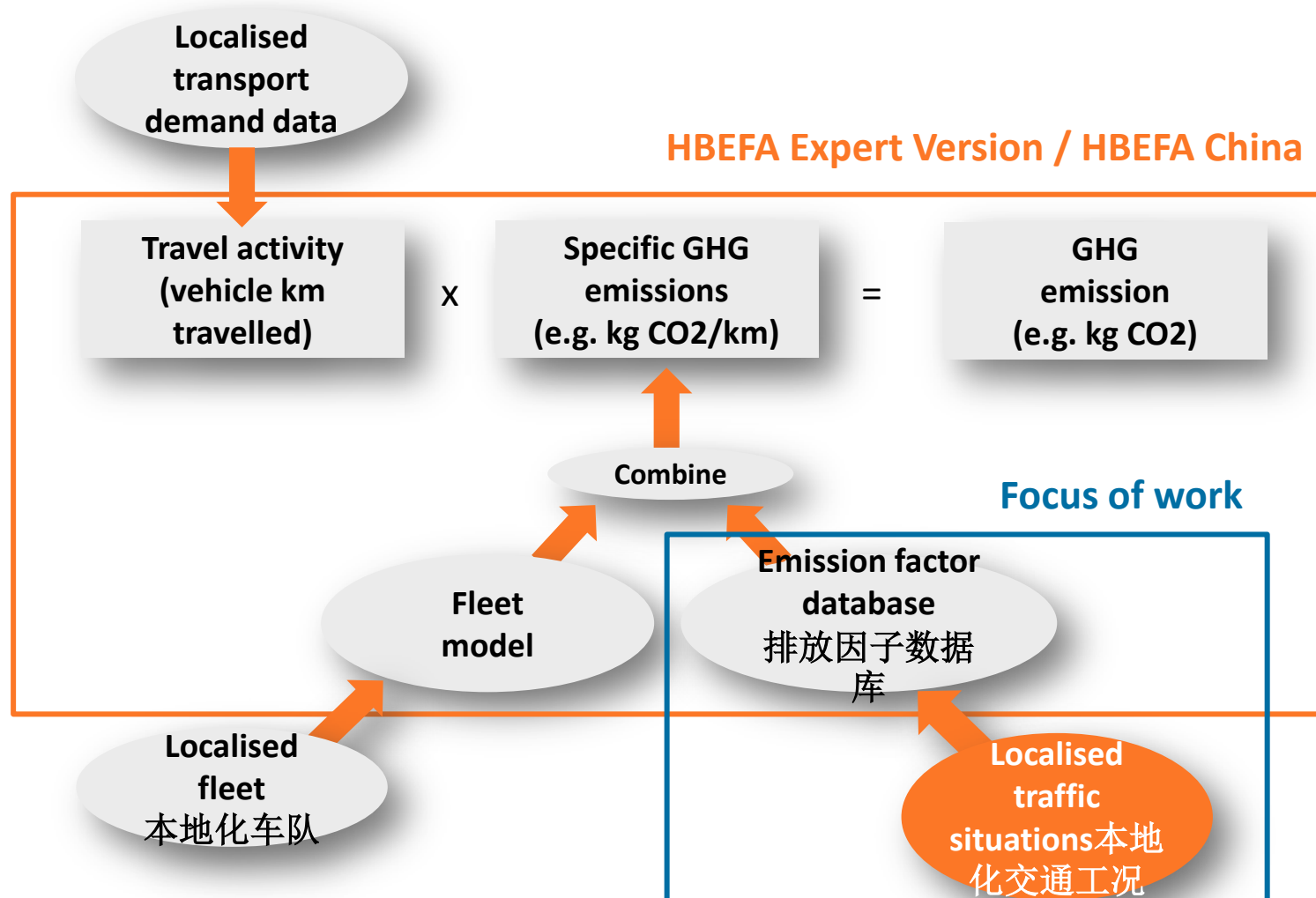
China Road Transport Emission Model (CRTEM) HBEFA China Expert Version 中国道路交通排放 模型(CRTEM)

- Developed on the basis of **HBEFA Europe** (Version 3.2), started in 2012, funded by GIZ. 2012年基于欧洲HBEFA3.2版本开发，GIZ赞助
- Focuses on **greenhouse gas emissions** (but air pollutants included) 关注温室气体排放
- Focuses on **passenger cars** (but other vehicle categories included) 关注轻型客车排放
- **Pilot cities:** Beijing, Shenzhen, Tianjin, Harbin. 北京、深圳、天津、哈尔滨实验



Localizing traffic situations for China

交通工况中国本地化



Are the HBEFA emission factors transferable to Chinese cities? HBEFA的排放因子能适用于其他国家么?

HBEFA emission factors for Europe 欧洲



Emission factors for Chinese cities 中国城市



Vehicle fleet 车队



Comparable (with adaptations) 适用✓

Traffic situations 交通工况



Must be investigated! 需要调研

Adaption of traffic situation scheme: by road types and congestion levels (LOS) 交 通工况分类：根据道路类型和拥堵程度

Separation of traffic situations for Chinese cities by:

- **Road types:** Freeway/Expressway, Major arterial, Minor arterial, Branch 高速/主干道/次干道/之路
- **Level of Service (LOS)服务水平** based on congestion levels: Free flow, Saturated traffic, Heavy traffic, Stop and go, Heavy stop and go (defined by speed bins)基于拥堵等级

Level of service	LOS 1: Free flow	LOS 2: Heavy traffic	LOS 3: Saturated traffic	LOS 4: Stop and go	LOS 5: Heavy stop and go
Congestion level	Unimpeded	Basically Unimpeded	Mild congestion	Moderate congestion	Severe congestion
Unit	km/h	km/h	km/h	km/h	km/h
Highway/Expressway	>55	40-55	30-40	20-30	≤20
Major arterial	>40	30-40	20-30	15-20	≤15
Minor arterial	>35	25-35	15-25	10-15	≤10
Branch	>35	25-35	15-25	10-15	≤10

Development of GHG emissions factors based on typical traffic situations for Chinese cities 中国城市基于典型工况的GHG排放因子发展

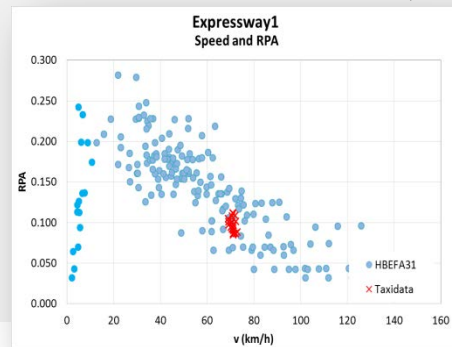
Collection of GPS data 收集GPS数据

- Collection of GPS data to record driving cycles by taxis 出租车GPS数据记录工况
- data collection in Beijing and Shenzhen: around 2,000 hours of GPS data 北京及深圳2000多小时数据

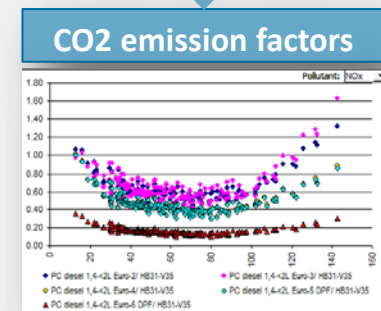
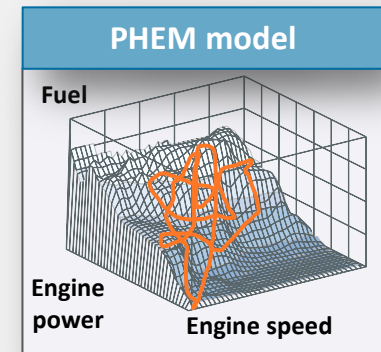


Analyses of GPS data 分析:

- Assignment to road types (map matching) 地图匹配道路类型
- Identification of typical driving cycles ⇨ traffic situations 典型工况识别
- Comparison with traffic situations included in HBEFA 对比

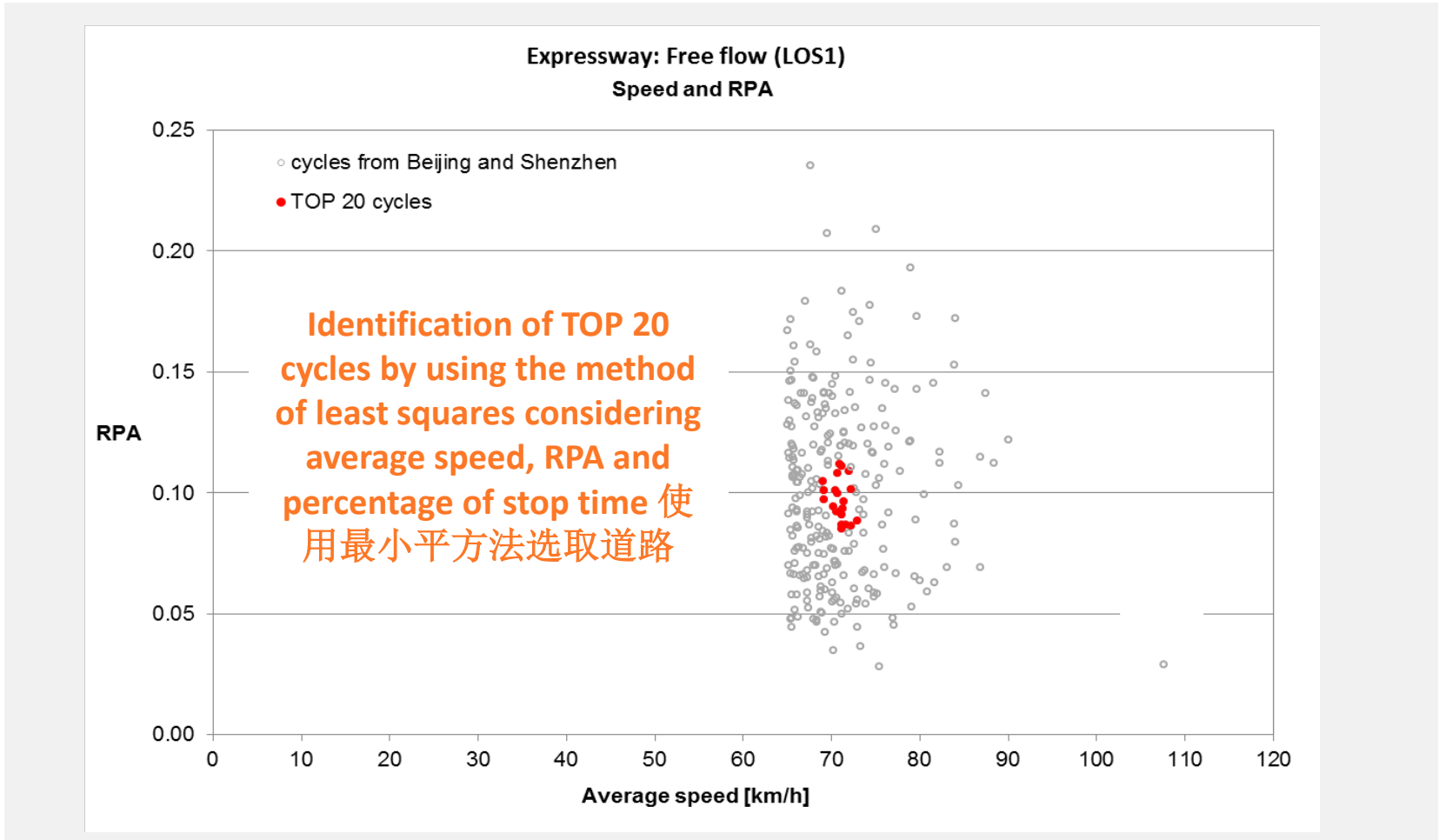


Calculation of new emission factors 计算新的排放因子



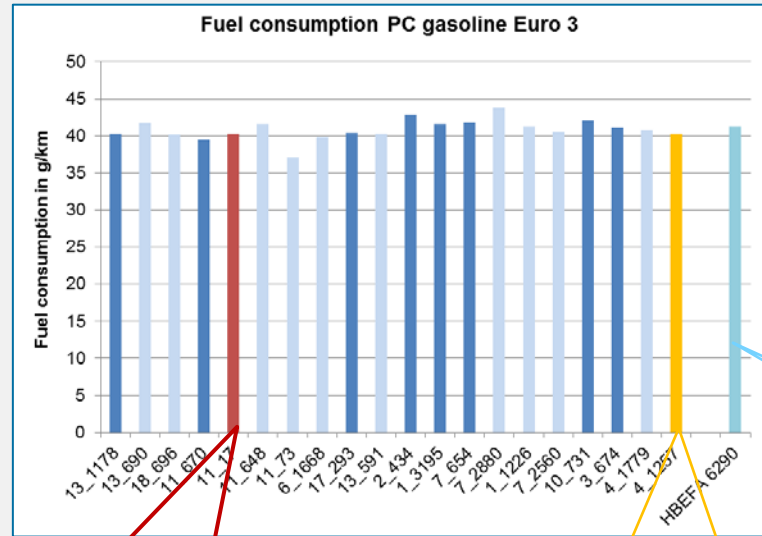
Example: Expressways – Free flow: Selected top 20 cycles based on average speed, RPA and stop share

高速路自由流：基于平均速度、RPA和停车比率的前20条道路



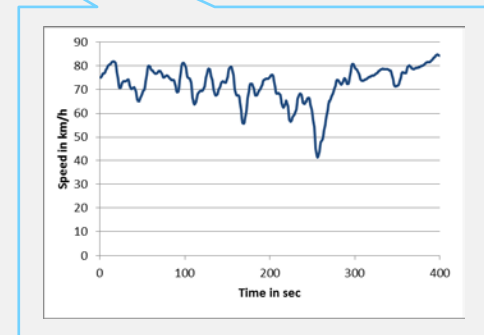
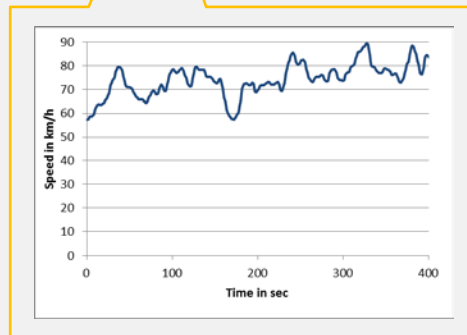
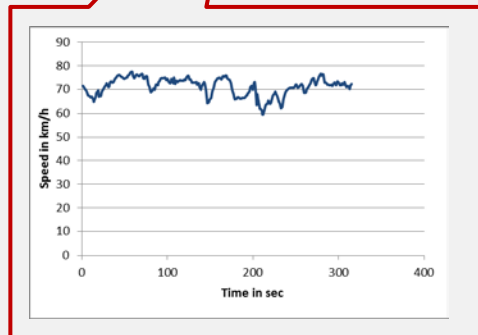
Expressways – Free flow: Identification of typical cycles for Chinese cities

高速路自由流：中国城市典型工况



Legend:

- Untypical driving cycle 非典型工况
- Typical driving cycle (pre-selection) 典型工况
- Selected driving cycle 选定工况
- Second best fitting driving cycle 次优工况
- HBEFA driving cycle HBEFA使用工况



Selection of Chinese specific traffic situations by road type and level of service (1)

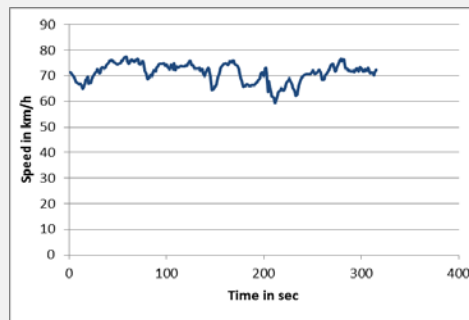
由道路类型和服务水平确定中国典型交通工况

Expressway/Highway 高速路

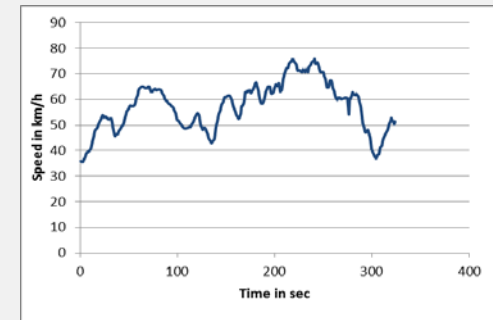
Key parameters 关键参数:

	Average speed	RPA	% stop time
	km/h	m/s3	%
LOS 1	71.2	0.09	0%
LOS 2	57.3	0.11	0%
LOS 3	42.3	0.13	1%
LOS 4	25.8	0.17	7%
LOS 5	12.0	0.17	26%

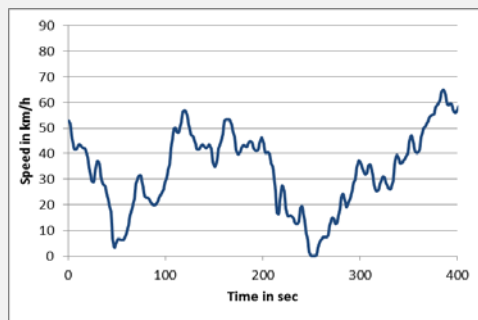
LOS 1: Free flow 自由流



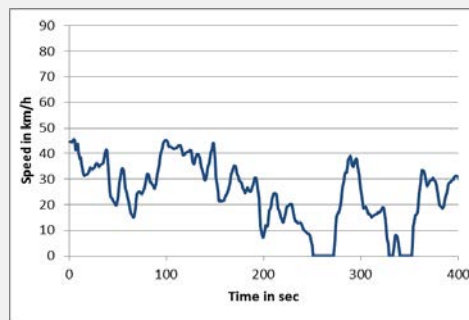
LOS 2: Heavy 较拥堵



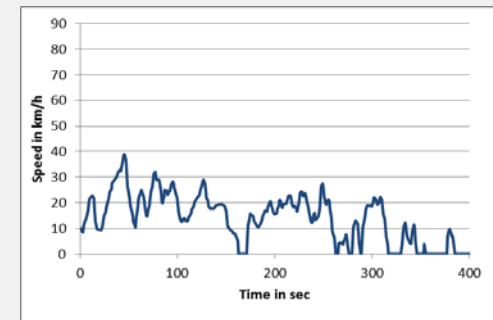
LOS 3: Saturated 饱和



LOS 4: Stop+go 1 堵塞1

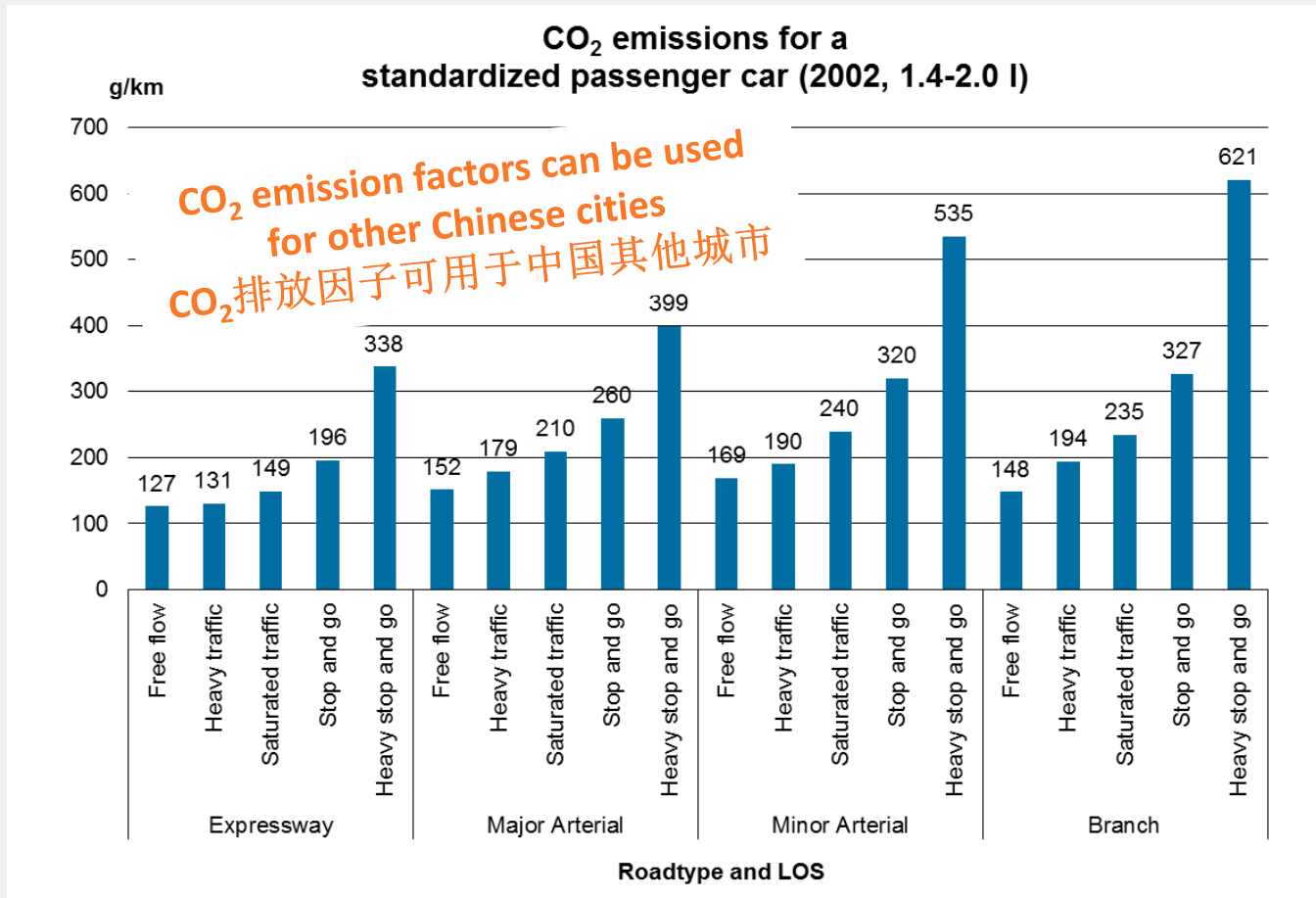


LOS 5: Stop+go 2 堵塞2



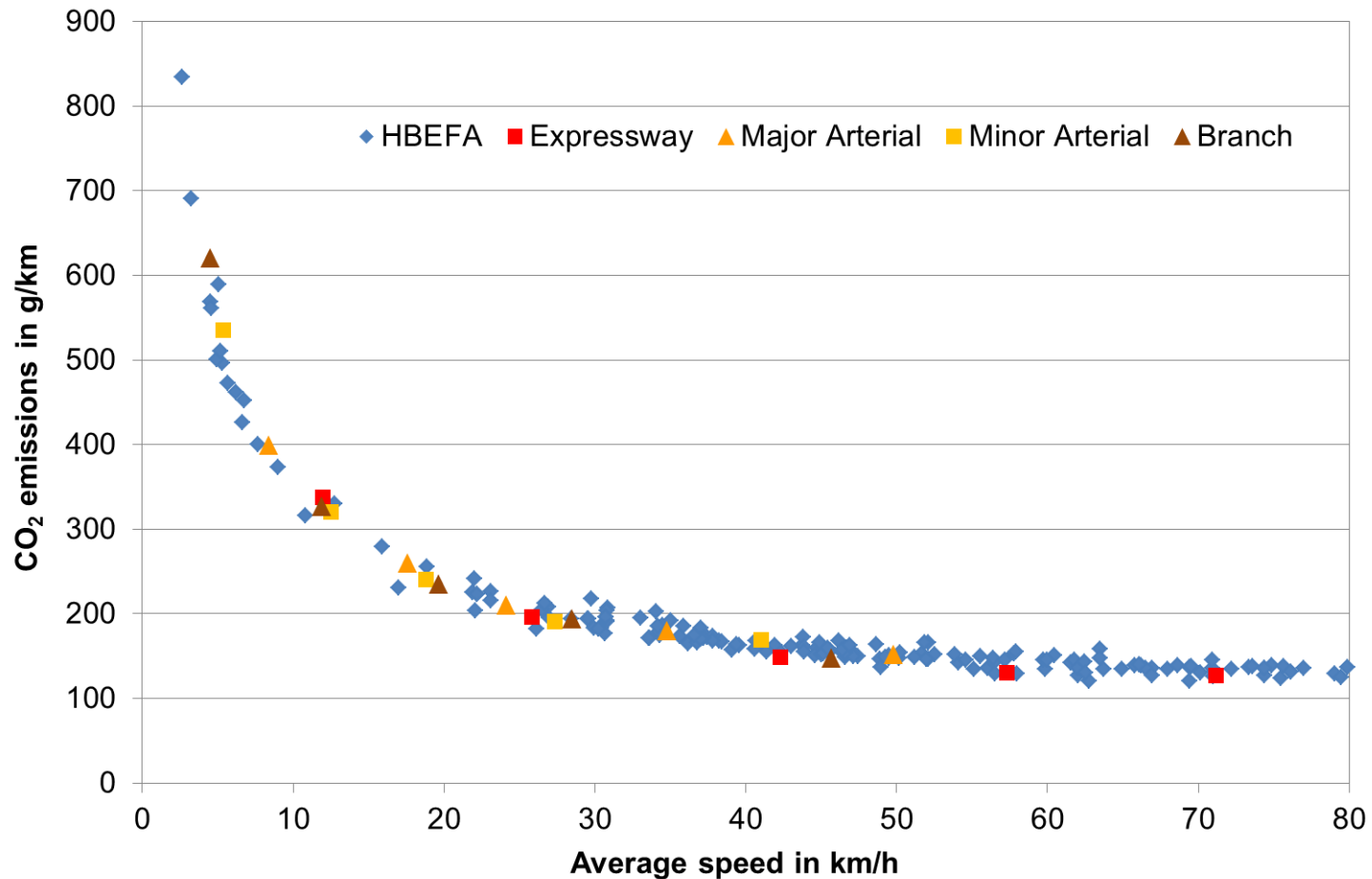
Result: CO₂ emissions of standardized gasoline-fueled passenger car (2002, 1.4-2.0 l) for China

结果：中国小型汽油车(2002,1.4-2.0L) CO₂排放



CO₂ emissions of standardized gasoline fueled cars: Chinese and HBEFA traffic situations

中国和HBEFA的交通工况下CO₂排放因子



Application: CO₂ emission (and air pollutants) calculation tool in Shenzhen 应用 深圳CO₂ (及空气污染物)排放计算工具



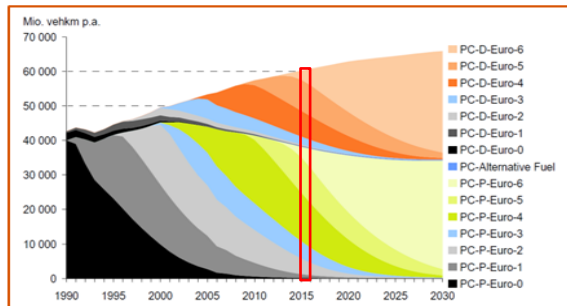
Agenda

1. Key elements for localising HBEFA for China
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CRTEM/HBEFA中国软件工具
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Modules of HBEFA “Expert Version” (EV) “专家版本(EV)”模块

HBEFA «Expert Version» 专家版本

Fleet model

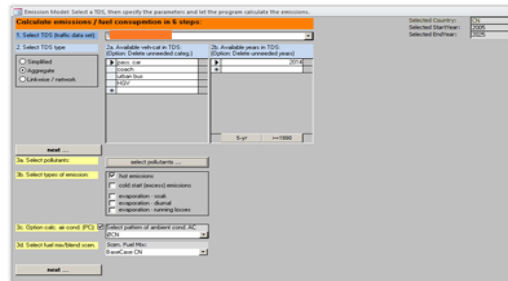


HBEFA «Public Version» 大众版本

Emission factor database

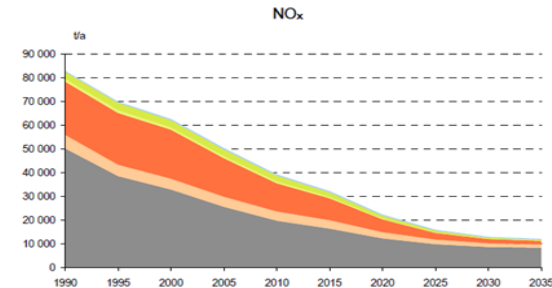
Veh Sub-Segment	Size	Concept	KM Odometer	weight (%)	Speed per SubSegm.			EFA per SubSegm.		
					Avg km/h	Load-0% 100%	km/h	Avg g/km	Load-0% 100%	g/km
PC petrol <1.4L <ECE	<1.4L	PC P China-0	50000	100.0%	71.2			11.480		
PC petrol <1.4L ECE-15'00	<1.4L	PC P China-0	50000	100.0%	71.2			11.480		
PC petrol <1.4L ECE-15'01/02	<1.4L	PC P China-0	50000	100.0%	71.2			11.480		
PC petrol <1.4L ECE-15'03	<1.4L	PC P China-0	50000	100.0%	71.2			11.480		
PC petrol <1.4L ECE-15'04	<1.4L	PC P China-0	50000	100.0%	71.2			8.252		
PC petrol <1.4L AGV82 (CH)	<1.4L	PC P China-0	50000	100.0%	71.2			3.954		
PC petrol <1.4L conv other con	<1.4L	PC P China-0	50000	100.0%	71.2			3.954		
PC petrol <1.4L Ucat	<1.4L	PC P China-0	50000	100.0%	71.2			5.347		
PC petrol <1.4L PreChina 3W/C	<1.4L	PC P China-0	50000	100.0%	71.2			0.646		
PC petrol <1.4L PreChina 3W/C	<1.4L	PC P China-0	50000	100.0%	71.2			0.644		
PC petrol <1.4L China-1	<1.4L	PC P China-1	50000	100.0%	71.2			0.644		
PC petrol <1.4L China-2	<1.4L	PC P China-2	50000	100.0%	71.2			0.283		
PC petrol <1.4L China-3	<1.4L	PC P China-3	50000	100.0%	71.2			0.282		
PC petrol <1.4L China-4	<1.4L	PC P China-4	50000	100.0%	71.2			0.188		
PC petrol <1.4L China-5	<1.4L	PC P China-5	50000	100.0%	71.2			0.201		
PC petrol <1.4L China-6	<1.4L	PC P China-6	50000	100.0%	71.2			0.192		

Emission model



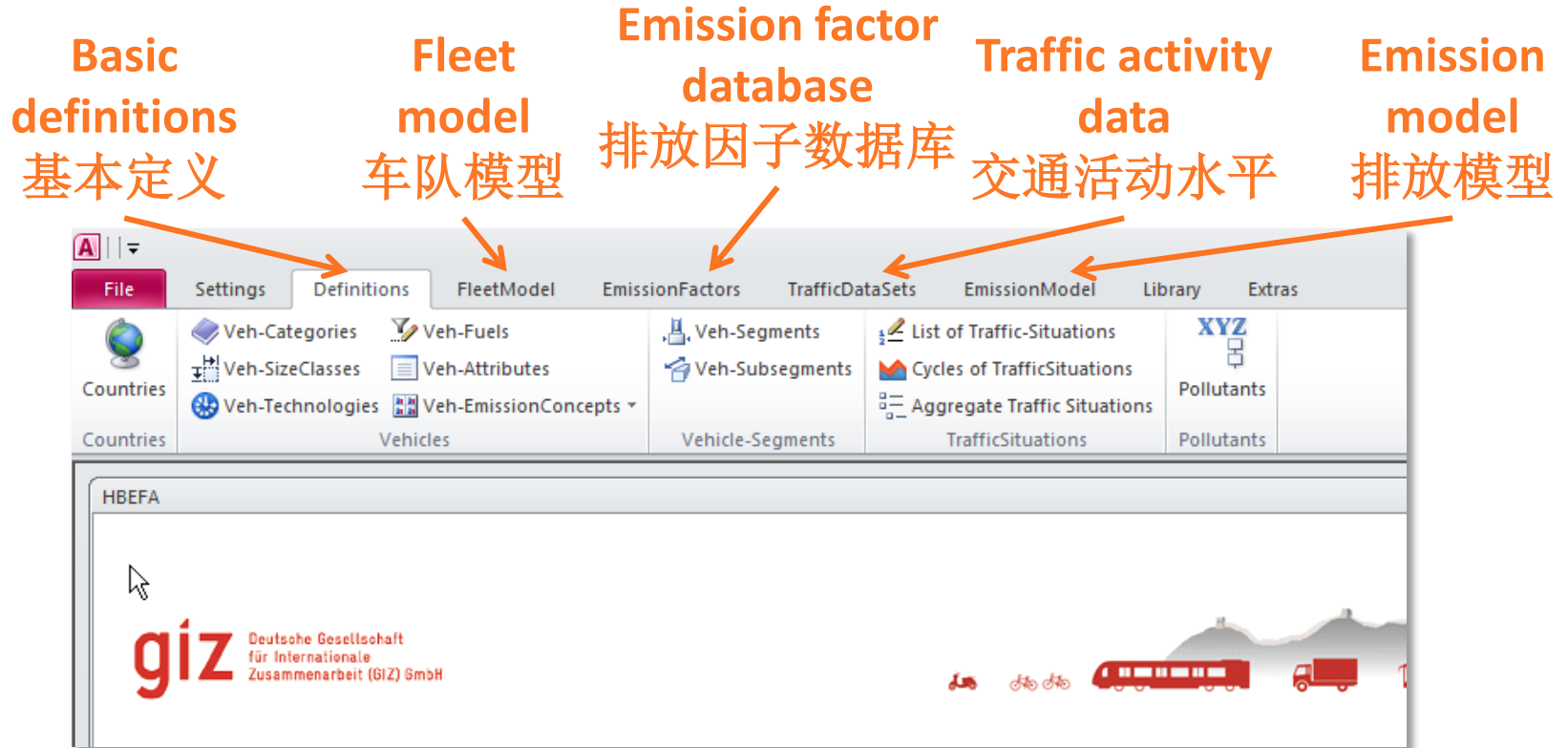
Traffic data

Result: Emissions



Data base tool provides user interface to access the modules of HBEFA China/CRTEM

HBEFA China/CRTEM用户界面



Forms with graphic representation of input data

输入数据表格与图示

Microsoft Access

File Settings Definitions FleetModel EmissionFactors TrafficDataSets EmissionModel Library Extras

Fleet scenarios FuelEfficiency scenarios TrafficActivity scenarios EmissionConcept scenarios

1 Fleet: calculate vehicle turnover
2 Merge Fleet- and TrafficActivity-Scenarios
3 Merge Fleet-, TrafficActivity-, EmConcept-, FuelEff-Scenarios

Analyse Results (Control-queries)
Analyse Results (Figures and Tables)
Define/select/edit traffic scenarios

Define SubScenarios Calculate Traffic Scenario / Fleet Comp. (complex version) Edit Fleet Comp. (simplified version) Analyse TrafficScenarios

User-datapool

Definition of efficiency developments of new registrations

INPUT: reference year and yearly reduction rates (e.g. -1% means 1% efficiency gain compared to the previous year). The program then calculates the cumulative effects compared to the reference year. (PS: the calculation is done automatically for the selected segment only; see options for recalculating the full scenario).

Select FUEL - Reduction Rates-Scenario

RedRate_Scen_Fuel	Com_RedRate_Scen_Fuel	ID	SortCode
default	no annual correction factors	0	0
PC - China	Based on ICCT data, added with preliminary assumptions (Infras)	1	1

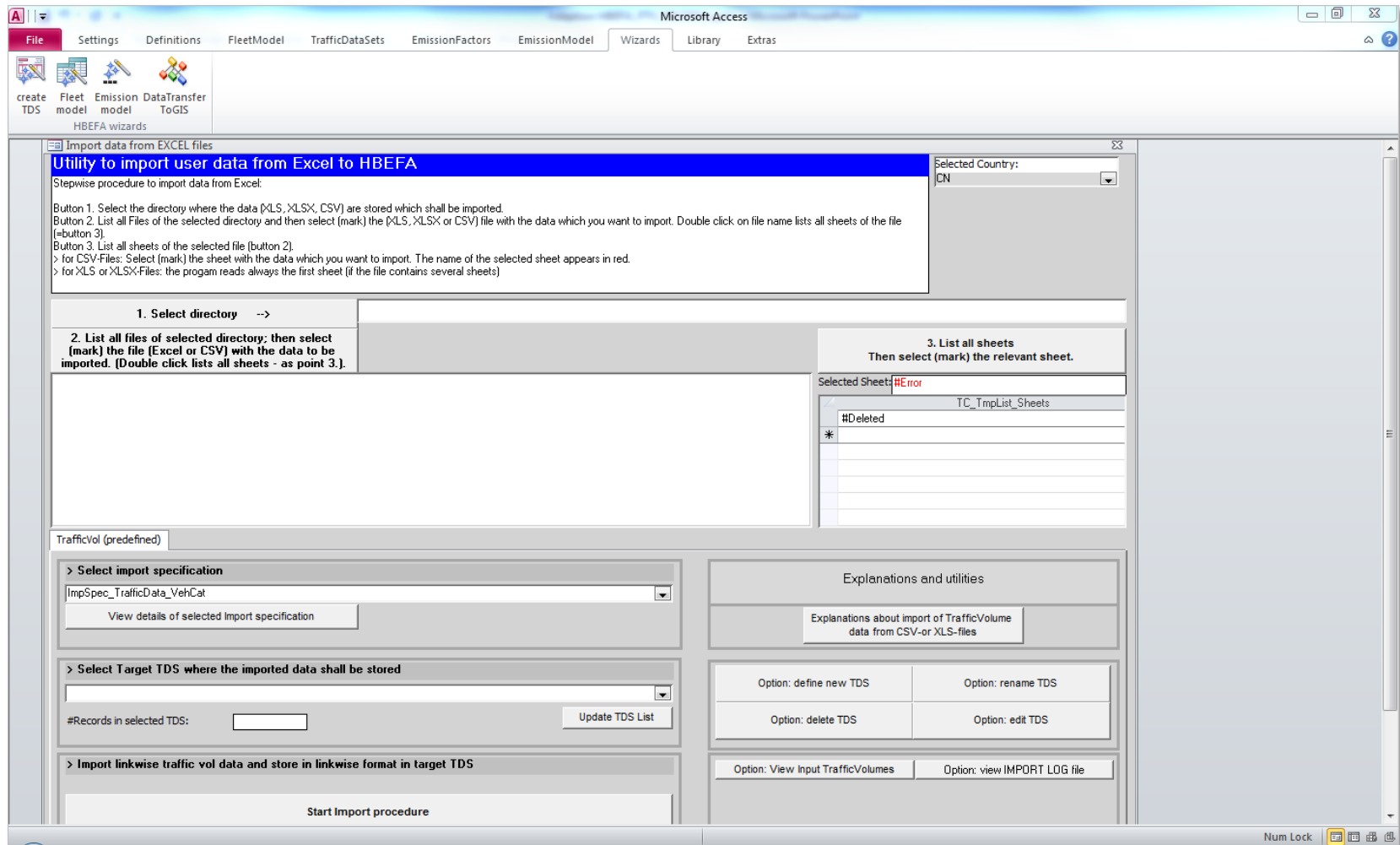
Select Veh-Cat. Select Segment. Select RoadCat. Reference Year (100%): 2010

Option: copy pattern RC unspec to MW/Rura/Urban

Year	Red	Usel	CumulR	C
1980	0.00%	1.00	113.71%	
1981	0.00%	1.00	113.71%	
1982	0.00%	1.00	113.71%	
1983	0.00%	1.00	113.71%	
1984	0.00%	1.00	113.71%	
1985	0.00%	1.00	113.71%	
1986	0.00%	1.00	113.71%	
1987	0.00%	1.00	113.71%	
1988	0.00%	1.00	113.71%	
1989	0.00%	1.00	113.71%	
1990	0.00%	1.00	113.71%	
1991	0.00%	1.00	113.71%	
1992	0.00%	1.00	113.71%	
1993	0.00%	1.00	113.71%	
1994	0.00%	1.00	113.71%	
1995	0.00%	1.00	113.71%	
1996	0.00%	1.00	113.71%	
1997	0.00%	1.00	113.71%	
1998	0.00%	1.00	113.71%	
1999	0.00%	1.00	113.71%	
2000	0.00%	1.00	113.71%	
2001	0.00%	1.00	113.71%	
2002	0.00%	1.00	113.71%	

Interface for automatic import of traffic activity data from TDM

TDM交通活动水平数据自动输入界面



Step-by-step configuration of emission calculation 排放计算的逐步架构

Emission Model: Select a TDS, then specify the parameters and let the program calculate the emissions.

Calculate emissions / fuel consumption in 6 steps:

1. Select TDS (traffic data set): example_aggregated

2. Select TDS type

Simplified
 Aggregate
 Linkwise / network

2a. Available veh-cat in TDS:
(Option: Delete unneeded categ.)

▶ pass. car	
* []	

2b. Available years in TDS:
(Option: Delete unneeded years)

▶ []	2013
* []	

3a. Select pollutants: select pollutants ...

3b. Select types of emission:

hot emissions
 cold start (excess) emissions
 evaporation - soak
 evaporation - diurnal
 evaporation - running losses

3c. Option calc. air cond. (PC): Select pattern of ambient cond. AC
CN

3d. Select fuel mix/blend scen. Scen. Fuel Mix:
BaseCase CN

4. Select fleet (dis)aggregation level in OUTPUT:

vehicle category
 technology (fuel type)
 emission concept
 subsegment (em-conc/size)

Selected Country: CN
Selected StartYear: 2005
Selected EndYear: 2025

next ...

next ...

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Localizing HBEFA for China: Conclusions

- **HBEFA emission factors** are based on the European situation but **are localized to Chinese cities for GHG emission quantification** of road transport. HBEFA排放因子基于欧洲工况，但对中国城市交通GHG排放量进行了本地化
- **The traffic situation approach** used for HBEFA **allows a general use of the emission factors** – in different Chinese cities. HBEFA的交通工况方法使得其排放因子可以被普遍应用
- **Only if additional traffic situations are identified new GHG emission factors have to be calculated** ⇨ this has to be done only once, afterwards the emission factors can be used for all cities 仅当有新的道路工况被定义时，才需要计算新的GHG排放因子
- Emission factors for **air pollutants** are more complex ⇨ since air pollutants depends on fuel quality, vehicle technology and maintenance of the vehicles **European emission factors can only used after a review based on locally measured data (→ see further steps)** 空气污染物的排放因子比较复杂，因此欧洲排放因子需要基于本地化测试数据进行检验后才能使用。

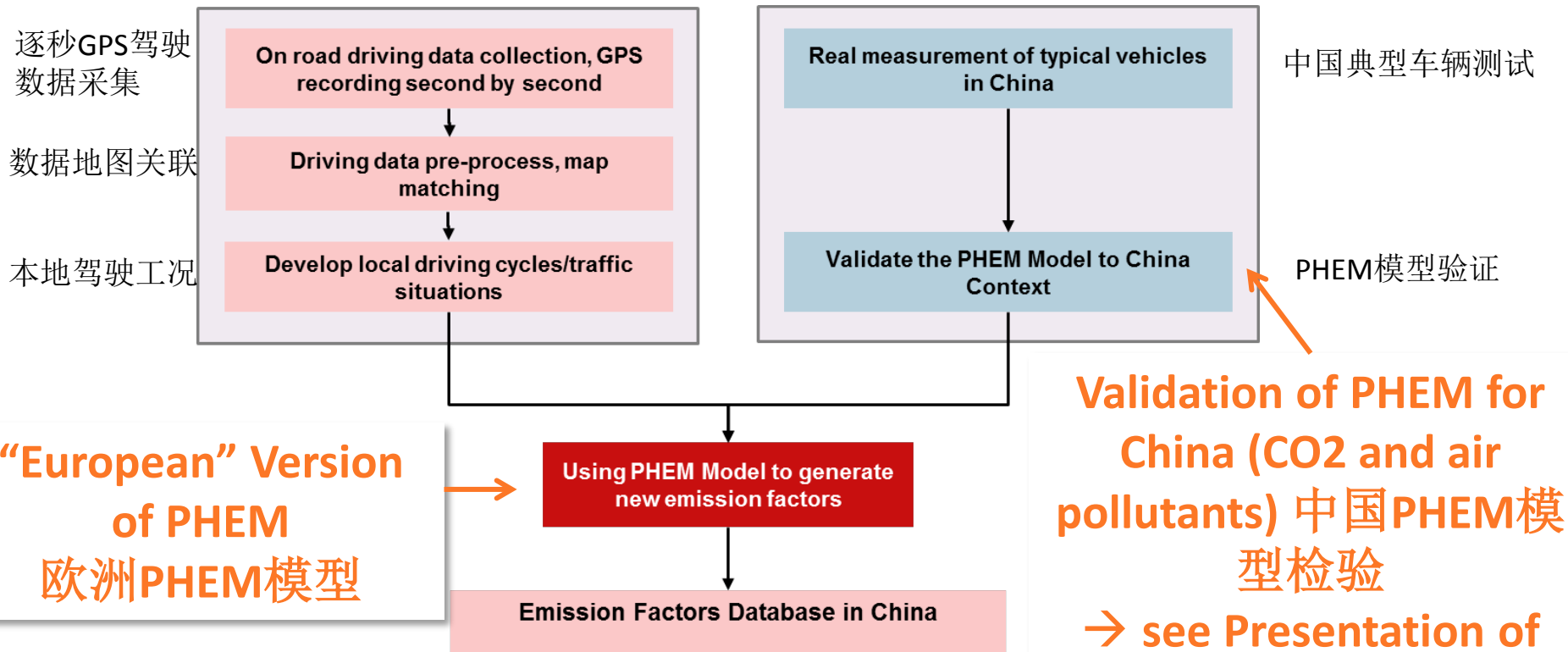
Agenda

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Further steps for localizing HBEFA China (1)

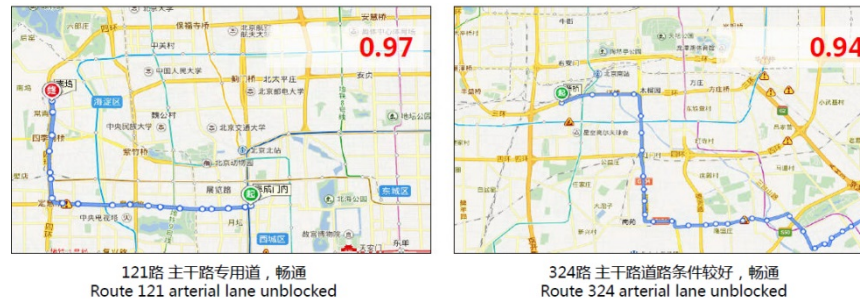
未来计划

Current GIZ-Project (2015-2018) ensures further development of HBEFA China GIZ 2015-2018项目确保了HBEFA China的长远发展



Further steps for localizing HBEFA China (2)

- **Traffic situations for non-PC-vehicle categories 非客车类别的交通工况:** Typical driving cycles for *busses and trucks*. Are included in present version (based on analogies to PC) but need further refinement by evidence from Chinese cities: 公交车和货车的典型工况在本版本是基于小型客车典型工况开发的，需要中国城市实际道路数据修正



Source: College of Metropolitan Transportation Beijing University of Technology

- **Fuel types 燃料类型:** Evaluate existing fuel types (petrol, diesel, CNG, LPG) and add *new types* (LNG, etc.). Update of assumptions for electric vehicles (Plug-in-Hybrids PHEV, battery-electric BEV) 增加新型燃料。更新电动车数据预测
- **Plus 其他:** Training, documentation and communication 培训, 文档编制和交流

Thank you for your attention 感谢

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