WG2 Agenda: Overview

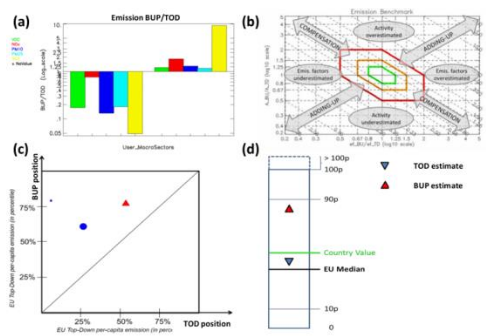
Evaluation of emissions

Benchmarking

Best Practice

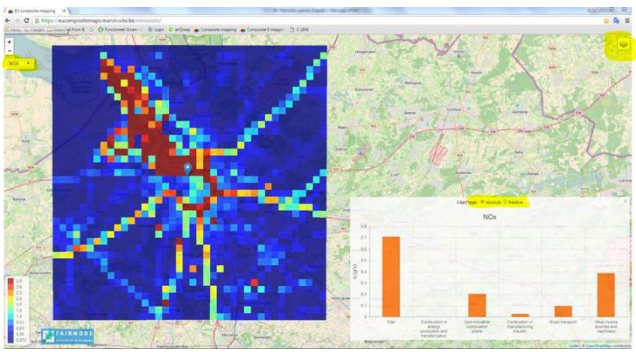
- Mapping (survey)
- Opportunities
- Challenges

∆ Emission tool



- Training
- Benchmarking Conclusions
- Feedback on the Tool

Composite Emission Map



- Benefits
- Requirements
- Outcomes

FAIRMODE
Forum for air quality modelling in Europe

Good practice guidelines on urban traffic emission compilation

FAIRMODE Technical Meeting
27-29 June 2016, Zagreb, Croatia

Marc Guevara[1], Susana López Aparicio[2], Matthias Vogt[2], Leonor Tarrasón[2]

[1] Barcelona Supercomputing Center - Centro Nacional de Supercomputación, Earth Sciences Department, Barcelona, Spain.
[2] NILU - Norwegian Institute for Air Research, Urban Environment and Industry, Kjeller, Norway.

Urban traffic emissions

Road traffic's contribution to air quality in European cities

ETC/ACM Technical Paper 2012/14
November 2012

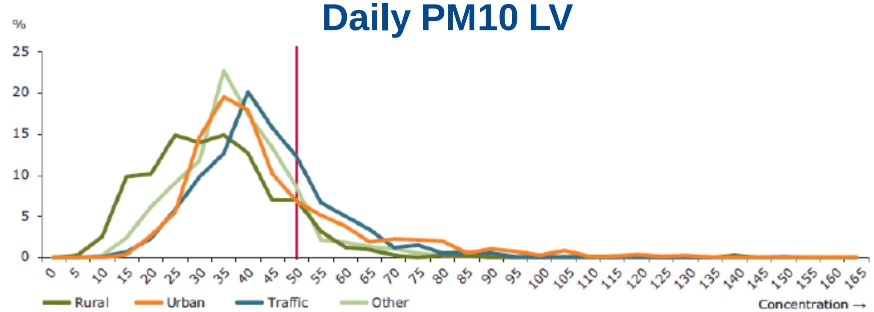
Ingrid Sundvor, Núria Castell Balaguer, Mar Viana, Xavier Querol, Cristina Reche, Fulvio Amato, Giorgos Mellios, Cristina Guerreiro

European Topic Centre on Air Pollution and Climate Change Mitigation

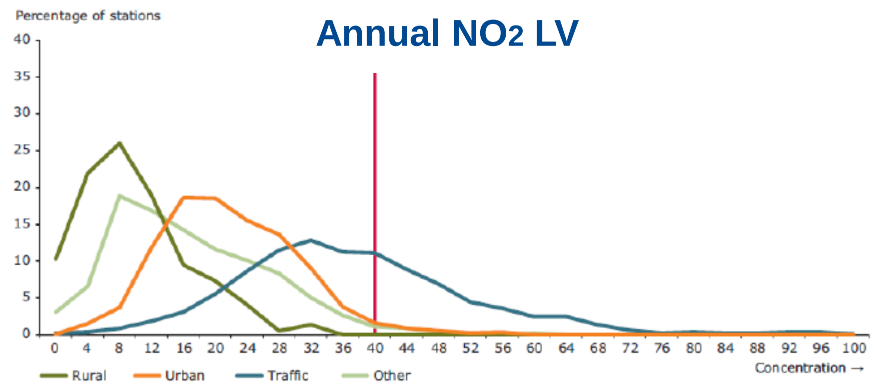
The European Topic Centre on Air Pollution and Climate Change Mitigation (ETC/ACM) is a consortium of European institutes under contract of the European Environment Agency RIVM UBA-V ÖKO AEAT EMISIA CHMI NILU VITO INERIS 4Sfera PBL CSIC

Road traffic is the emission source that contributes most to air pollution in urban areas

Daily PM10 LV



Annual NO_2 LV



Component	Station type	Local traffic % range (average)	Urban traffic % range (average)	Local and Urban % range (average)
PM10	Traffic	6-54 (21)	3-39 (13)	13-61 (34)
NO2	Traffic	10-80 (47)	3-56 (17)	34-91 (64)

Air Quality Planning

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Centro Nacional de Supercomputación
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Air quality observations

Contents lists available at ScienceDirect
Atmospheric Environment
journal homepage: www.elsevier.com/locate/atmosenv

Review

Review of the efficacy of low emission zones to improve urban air quality in European cities

Claire Holman [a,b,*], Roy Harrison [a,1], Xavier Querol [c]

Traffic pollution-reduction measures

effectiveness

Traffic flow

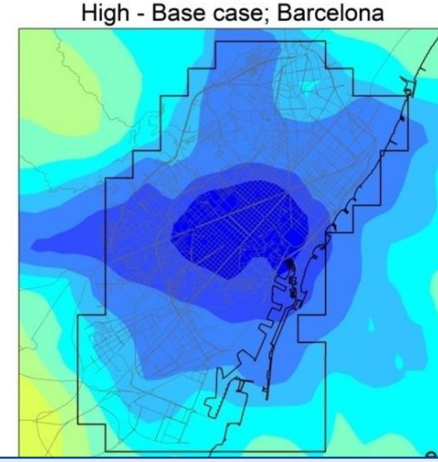
Vehicle fleet composition

EF model

Road Network

Traffic Emissions

NO_2 (ug m-3) Max diff h
High - Base case; Barcelona



Air quality modelling

Current review works

Atmospheric Environment 44 (2010) 2943–2953

Contents lists available at ScienceDirect

Atmospheric Environment

journal homepage: www.elsevier.com/locate/atmosenv

Review

Validation of road vehicle and traffic emission models – A review and meta-analysis

Robin Smit [a,*], Leonidas Ntziachristos [b], Paul Boulter [c]

[a] PAEHolmes, 59 Melbourne Street, South Brisbane QLD 4101, Australia
[b] Laboratory of Applied Thermodynamics, Aristotle University, PO Box 458, GR 54124 Thessaloniki, Greece
[c] TRL Limited, Crowthorne House, Nine Mile Ride, Wokingham RG40 3GA, United Kingdom

A R T I C L E I N F O

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Keywords:
Road traffic
Emission model
Accuracy
Validation
Error
Greenhouse gas

A B S T R A C T

Road transport is often the main source of air pollution in urban areas, and there is an increasing need to estimate its contribution precisely so that pollution-reduction measures (e.g. emission standards, scrapage programs, traffic management, ITS) are designed and implemented appropriately. This paper presents a meta-analysis of 50 studies dealing with the validation of various types of traffic emission model, including 'average speed', 'traffic situation', 'traffic variable', 'cycle variable', and 'modal' models. The validation studies employ measurements in tunnels, ambient concentration measurements, remote sensing, laboratory tests, and mass-balance techniques. One major finding of the analysis is that several models are only partially validated or not validated at all. The mean prediction errors are generally within a factor of 1.3 of the observed values for CO_2, within a factor of 2 for HC and NO_x, and within a factor of 3 for CO and PM, although differences as high as a factor of 5 have been reported. A positive mean prediction error for NO_x (i.e. overestimation) was established for all model types and practically all validation techniques. In the case of HC, model predictions have been moving from underestimation to overestimation since the 1980s. The large prediction error for PM may be associated with different PM definitions between models and observations (e.g. size, measurement principle, exhaust/non-exhaust contribution).

Statistical analyses show that the mean prediction error is generally not significantly different ($p < 0.05$) when the data are categorised according to model type or validation technique. Thus, there is no conclusive evidence that demonstrates that more complex models systematically perform better in terms of prediction error than less complex models. In fact, less complex models appear to perform better for PM. Moreover, the choice of validation technique does not systematically affect the result, with the exception of a CO underprediction when the validation is based on ambient concentration measurements and inverse modelling. The analysis identified two vital elements currently lacking in traffic emissions modelling: 1) guidance on the allowable error margins for different applications/scales, and 2) estimates of prediction errors. It is recommended that current and future emission models incorporate the capability to quantify prediction errors, and that clear guidelines are developed internationally with respect to expected accuracy.

Atmospheric Environment 70 (2013) 84–97

Contents lists available at SciVerse ScienceDirect

Atmospheric Environment

journal homepage: www.elsevier.com/locate/atmosenv

Review

Road vehicle emission factors development: A review

CrossMark

Vicente Franco [a], Marina Kousoulidou [a], Marilena Muntean [a], Leonidas Ntziachristos [b], Stefan Hausberger [c], Panagiota Dilara [a,*]

[a] European Commission Joint Research Centre, Institute for Energy and Transport, Via Enrico Fermi 2749, I-21027 Ispra, VA, Italy
[b] Laboratory of Applied Thermodynamics, Aristotle University, P.O. Box 458, GR-54124 Thessaloniki, Greece
[c] Institute for Internal Combustion Engines and Thermodynamics, Graz University of Technology, Inffeldgasse 21A, A-8010 Graz, Austria

H I G H L I G H T S

- ► The accuracy of road emission models is directly linked to the quality of their emission factors.
- ► Road vehicles have a large natural variability in their emission profiles.
- ► Emission factors may have different resolution according to their intended use.
- ► Emission modellers should combine laboratory data with real-world measurements.

A R T I C L E I N F O

Article history:
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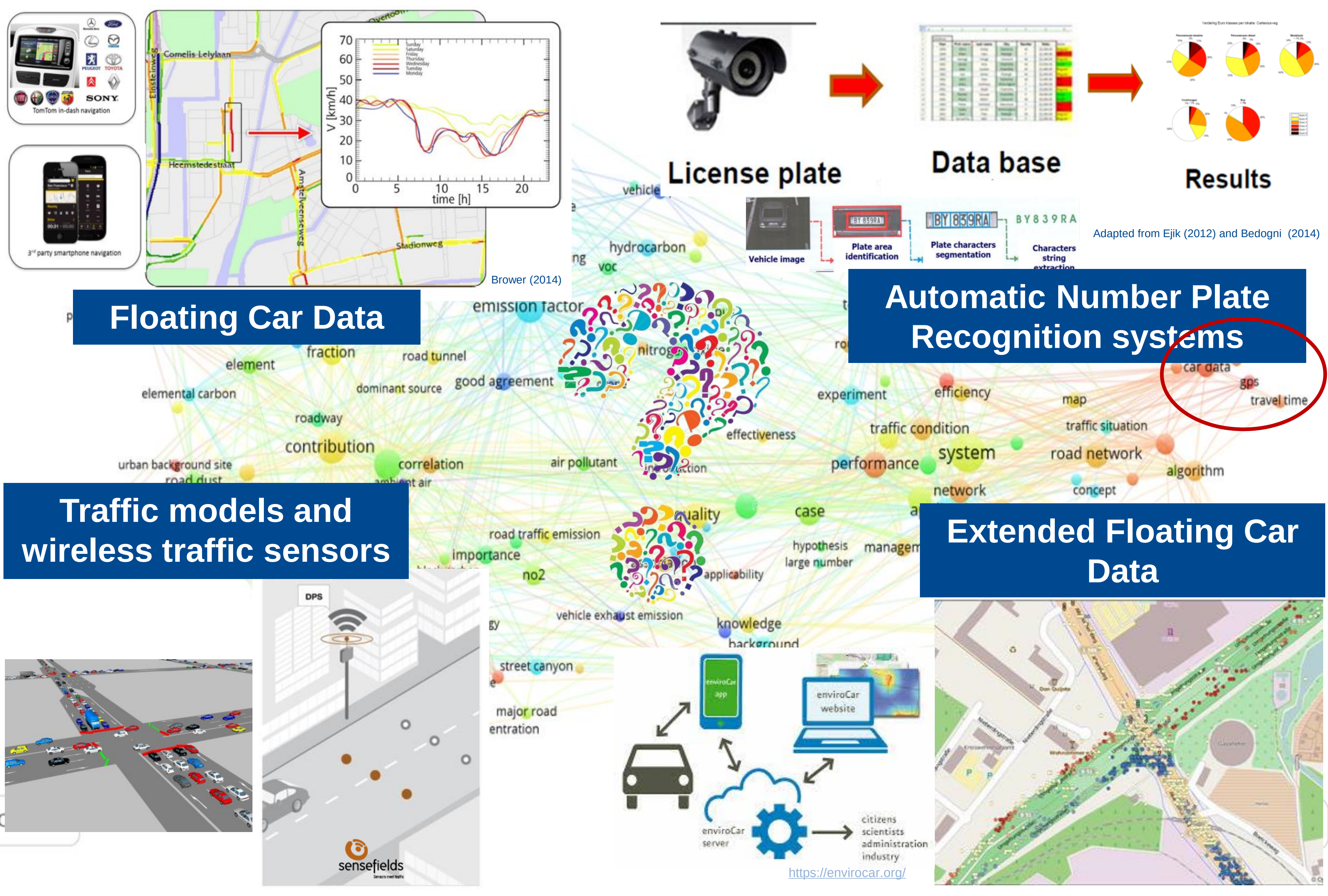
Keywords:
Road transport
Emission inventories
Emission models
Emission factors
Chassis dynamometer
Engine dynamometer
PEMS

A B S T R A C T

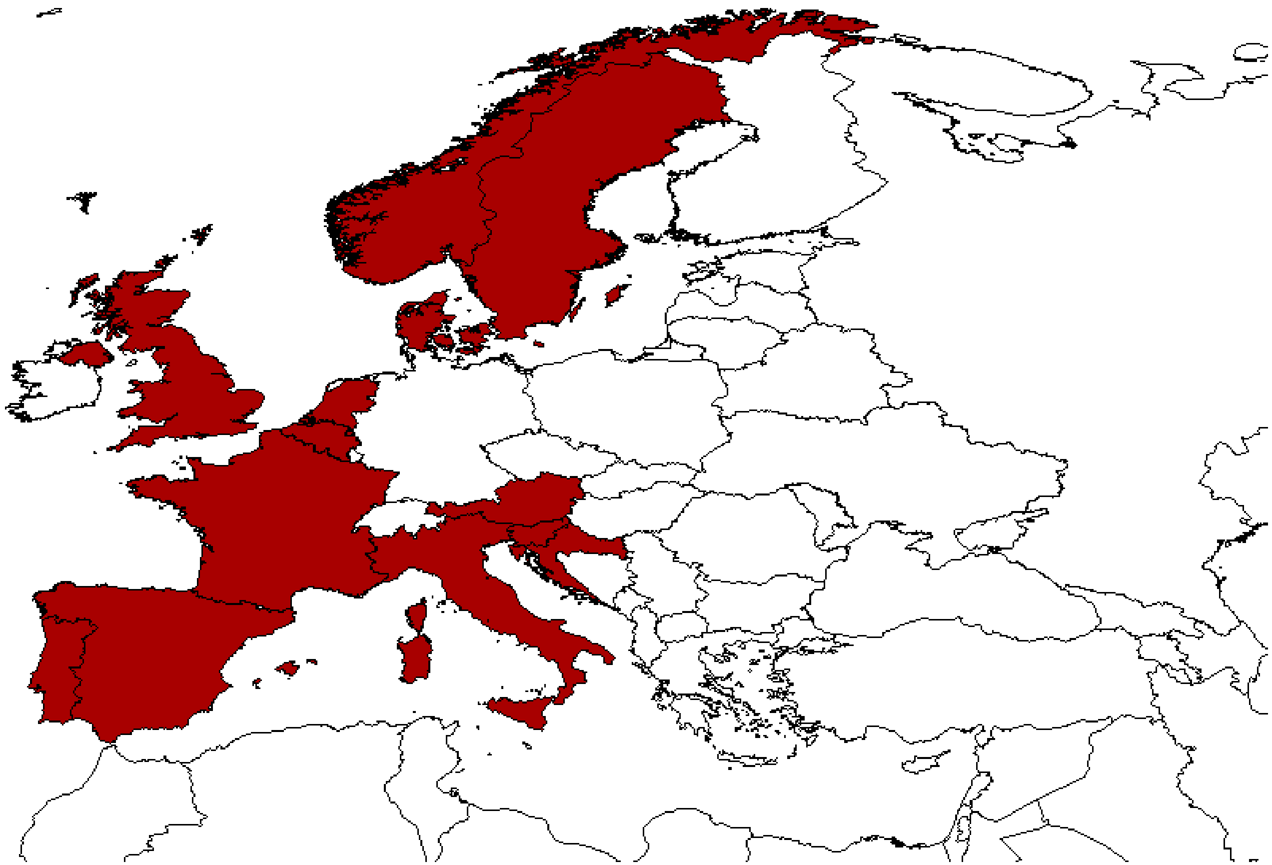
Pollutant emissions need to be accurately estimated to ensure that air quality plans are designed and implemented appropriately. *Emission factors* (EFs) are empirical functional relations between pollutant emissions and the activity that causes them. In this review article, the techniques used to measure road vehicle emissions are examined in relation to the development of EFs found in *emission models* used to produce emission inventories. The emission measurement techniques covered include those most widely used for road vehicle emissions data collection, namely chassis and engine dynamometer measurements, remote sensing, road tunnel studies and portable emission measurements systems (PEMS). The main advantages and disadvantages of each method with regards to emissions modelling are presented. A review of the ways in which EFs may be derived from test data is also performed, with a clear distinction between data obtained under controlled conditions (engine and chassis dynamometer measurements using standard driving cycles) and measurements under real-world operation.

Mapping the best practices for urban traffic emissions



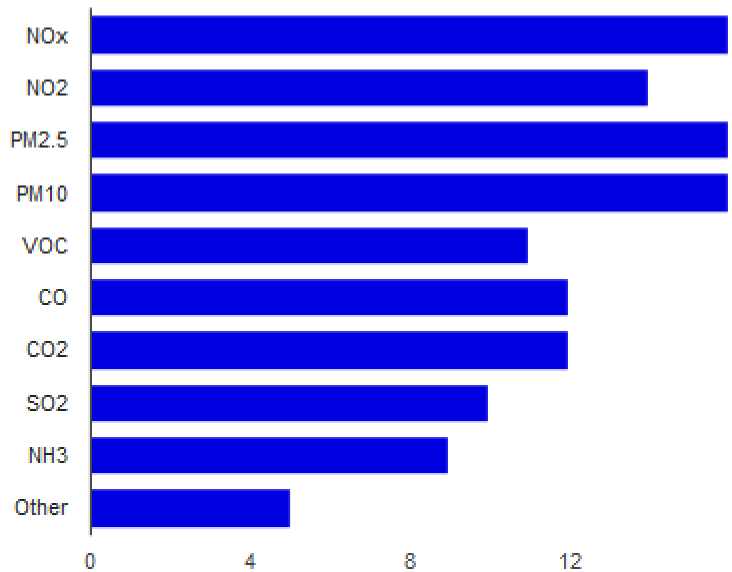
Overview of participation in the survey

- A total of 16 participants
- More than 30 cities from 13 different countries



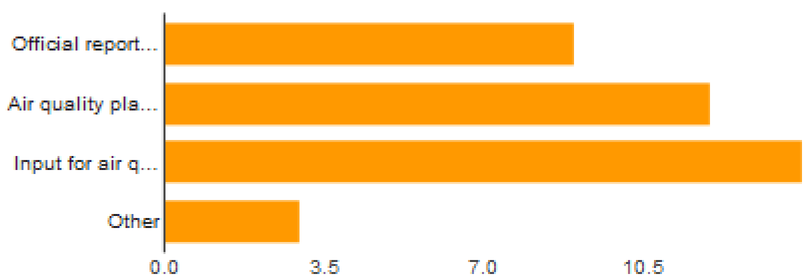
General information on your emission inventory

1. For which components do you estimate urban traffic emissions?



NOx	**16**	100%
NO2	**14**	87.5%
PM2.5	**16**	100%
PM10	**16**	100%
VOC	**11**	68.8%
CO	**12**	75%
CO2	**12**	75%
SO2	**10**	62.5%
NH3	**9**	56.3%
Other	**5**	31.3%

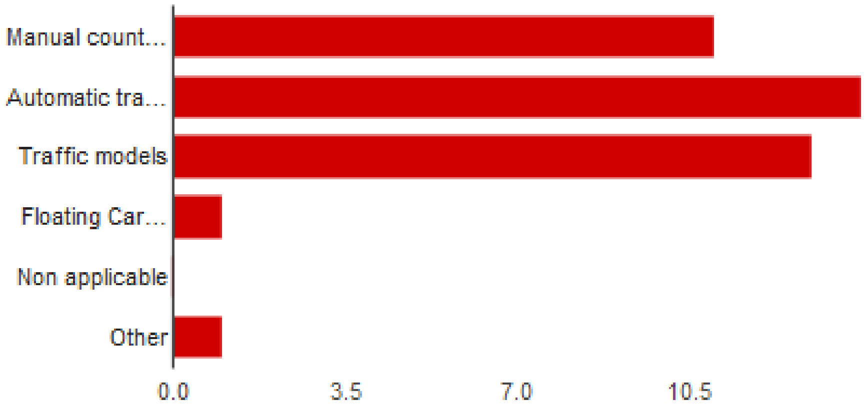
2. For which purpose do you estimate urban traffic emissions?



Official reporting	**9**	56.3%
Air quality planning	**12**	75%
Input for air quality models	**14**	87.5%
Other	**3**	18.8%

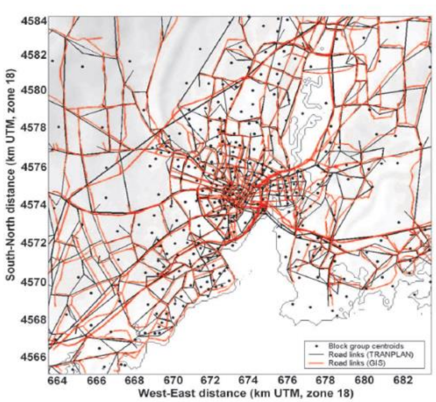
Information on activity data

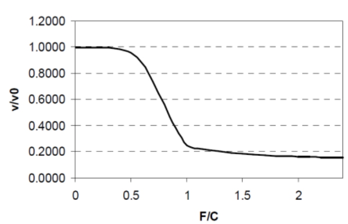
3. What of the following methods do you use to compile traffic volume data?

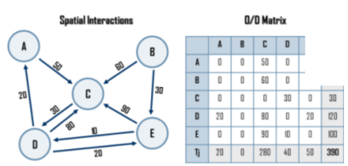


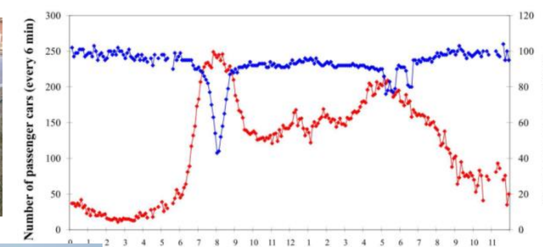
Manual counting or video recording	11	68.8%
Automatic traffic recorders	14	87.5%
Traffic models	13	81.3%
Floating Car Data	1	6.3%
Non applicable	0	0%
Other	1	6.3%

10 answers: Combination of the 3 methods



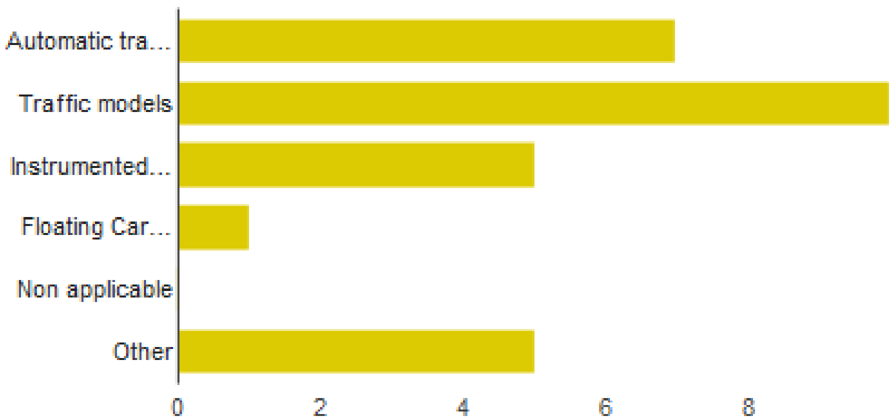






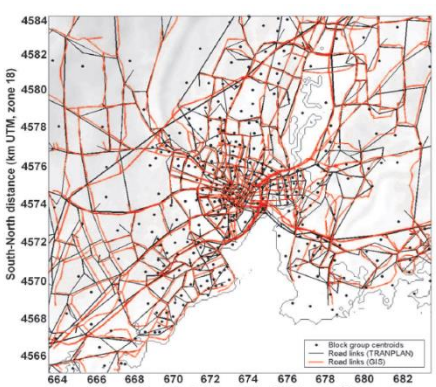
Information on activity data

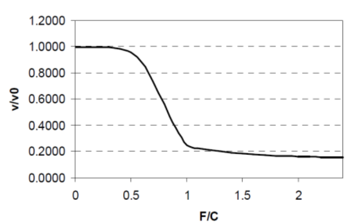
4. What of the following methods do you use to compile speed data?

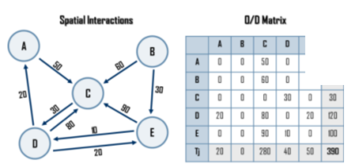


Automatic traffic recorders	7	43.8%
Traffic models	10	62.5%
Instrumented vehicles	5	31.3%
Floating Car Data	1	6.3%
Non applicable	0	0%
Other	5	31.3%

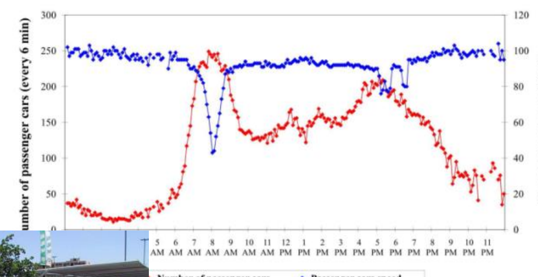
7 answers: Combination of the 3 methods





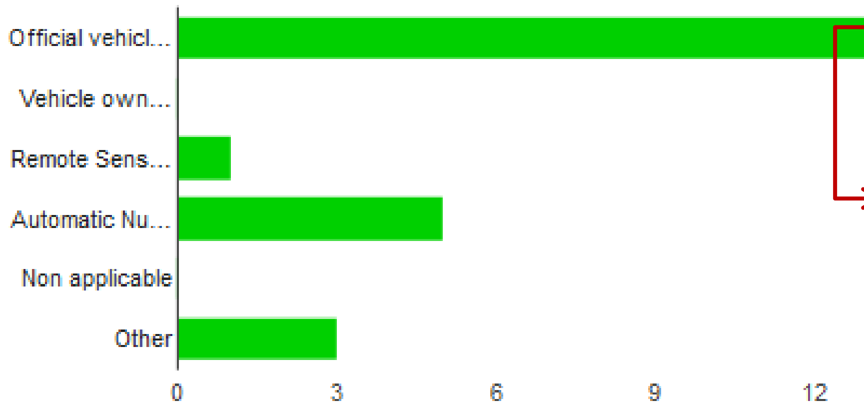


Calibration
Validation



Information on activity data

5. What of the following methods do you use to obtain vehicle fleet composition?



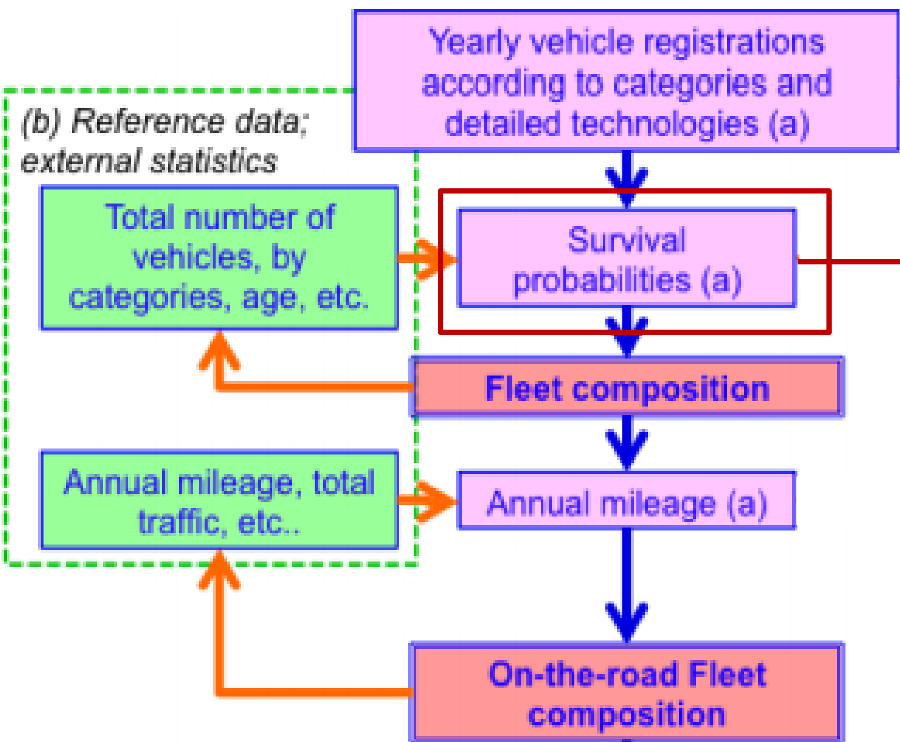
Official vehicle registration data	13	81.3%
Vehicle owner and parking lot surveys	0	0%
Remote Sensing Devices	1	6.3%
Automatic Number Plate Recognition (ANPR) systems	5	31.3%
Non applicable	0	0%
Other	3	18.8%

Cover the diversity of the areas within a city

Source of Uncertainty

Cover the temporal variation of the fleet

2 week-days ~ 600,000 observations



	Current works		
	2012	*2013*	9 sites
Diesel	*73%*	*75%*	**63**
Petrol	*26%*	*25%*	**35**
Hybrid, electric, others	*0,4%*	*0,5%*	**2,3**

André et al. (2014)

Emission factor models

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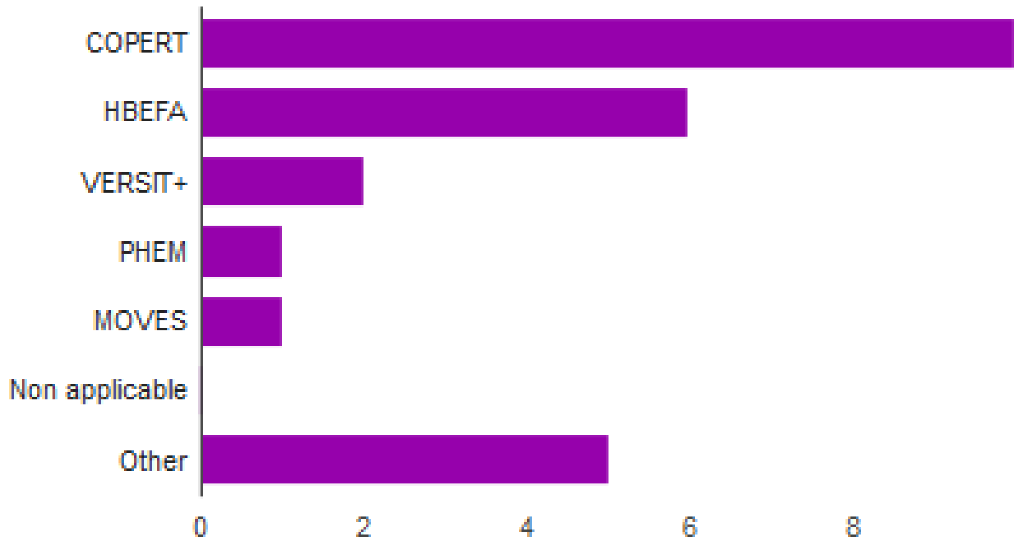
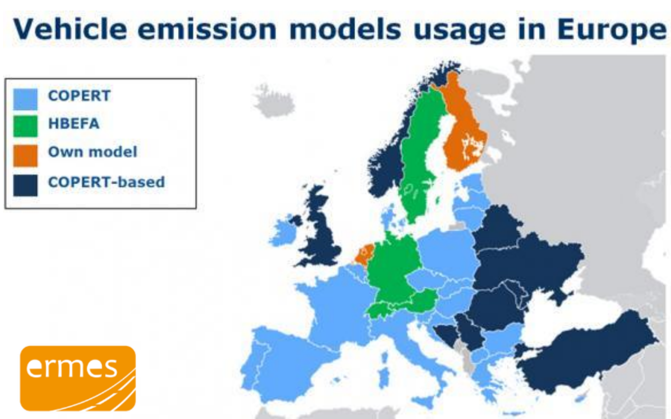
6. What of the following emission factor models do you use?



COPERT	**10**	62.5%
HBEFA	**6**	37.5%
VERSIT+	**2**	12.5%
PHEM	**1**	6.3%
MOVES	**1**	6.3%
Non applicable	**0**	0%
Other	**5**	31.3%

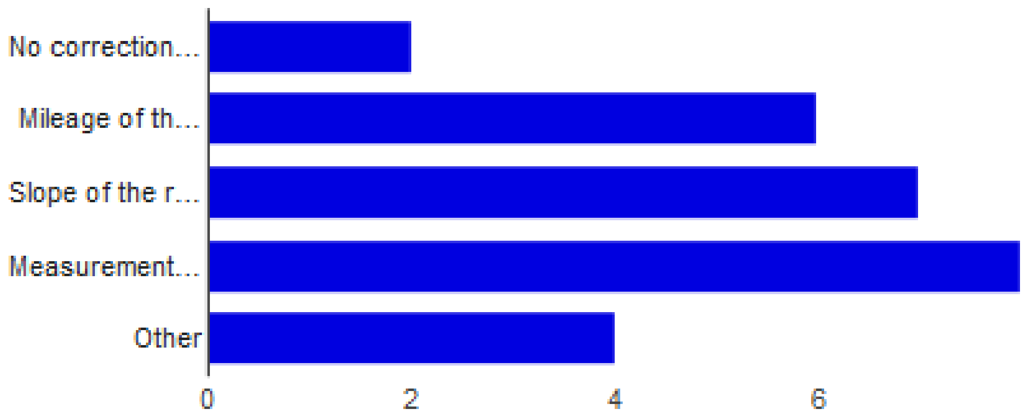
In-house EF datasets (based on real-driving tests)



Even though the approaches behind COPERT and HBEFA are somewhat different, they are largely underpinned by the same experimental data (Franco et al., 2012)

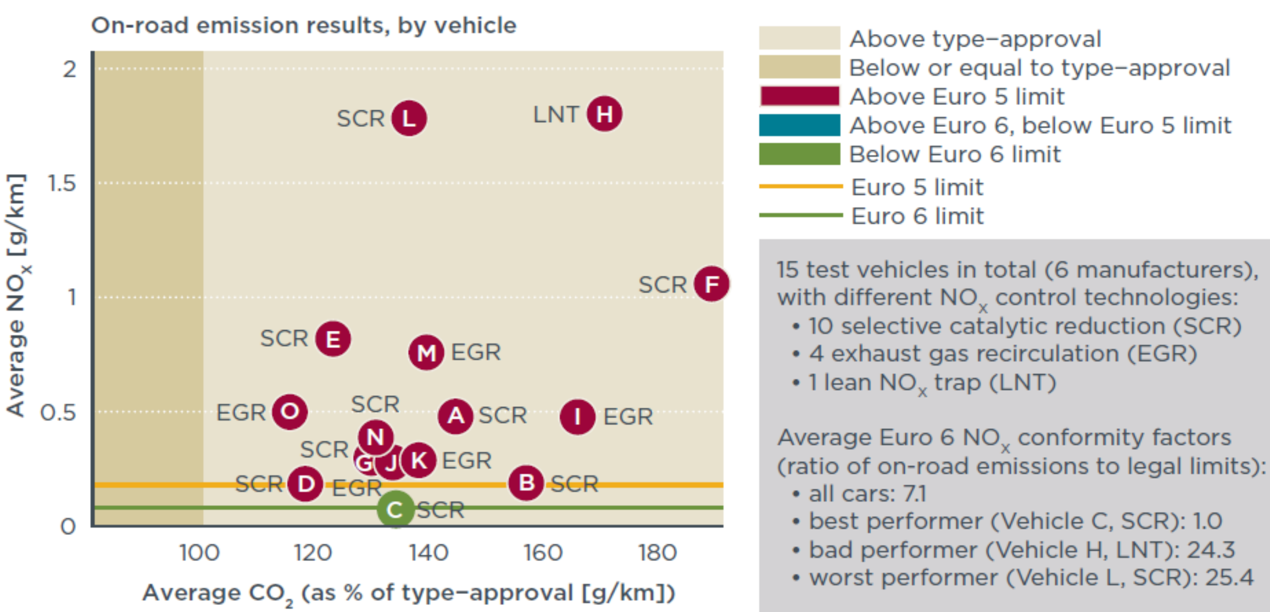
Emission factor models

7. Do you apply corrections to the emission factors?



No corrections are applied	2	13.3%
Mileage of the vehicle	6	40%
Slope of the road	7	46.7%
Measurement based correction	8	53.3%
Other	4	26.7%

PEMS, RSD



Ratio of on-road emissions to legal limits (NOx Euro6):
All cars: 7.1

Franco et al. (2014)

Future work

7. Do you plan to change your method to compile activity data in the future?

- **No (62.5%)**
- Use of **high frequency pollution sensors** to estimate traffic volume in locations **where emission inventories are poor**.
- **Better integration of models/scales** with **regional** traffic demand models / **microsimulation** models
- Use of **FCD** to estimate **hourly speed data**

8. Do you plan to change your emission factor model?

- **No (50%)**
- **Alternative models** for emission computation at **microscale level**.
- **EF based on real world measurements (Diesel Euro V, IV categories)**

9. Which information would you like to receive before planning any changes?

- Quality, accuracy and **uncertainty of emission factors**
- **Comparison between methodologies**

→ **Guidance on and benchmarking of models, Uncertainty, Test cases!**

Conclusions

- **Vehicle activity data:** Traffic models combined with Automatic Traffic Recorders, Manual Counting and Instrumented Vehicles is the most applied approach to obtain traffic volume and speed data
- **FCD**: Its use is limited due to:
  - Privacy concerns (private companies own the data)
  - Big data concerns (large amount of data to process)
  - Limited Volume (need for extrapolation)
- **Vehicle fleet composition:** Automatic Number Plate Recognition data
  - Official registration data is commonly used
  - Automatic Number Plate Recognition Systems is gaining ground
- **Emission Factor Models:**
  - COPERT and HBEFA are the leading EU models.
  - Measurement based corrections (PEMS, RSD) applied to reduce associated uncertainty

www.bsc.es

Masterplan for Masdar City, Abu Dhabi, which keeps cars out of the centre

For further information please contact

marc.guevara@bsc.es

FCD: Challenges and Opportunities

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- **Challenges:**
  - Multiple information sources (not free)
    - Navigation and Car Insurance Companies
    - Specific fleets (e.g. Taxis)
  - Privacy concerns (restricted information)
    - Fuel type, Euro category
  - Big data concerns (large amount of data to process)
    - 3,000 cars (1 week information) → 500MB

- **Opportunities:**
  - Information based on real-world data
  - NRT emission modelling
  - Detection of potential modelling sites (hot spots)

Other Sector to Focus On: Residential Combustion

Use of wood and other biomass in residential sector enhanced by:

- National GHG strategies and targets for renewable energy
- Increase during the economic crisis of other fuel prices (e.g. fuel oil)

Lack of regulation of small combustion appliances at EU level (Eco-design Directive)