*18th International Emission Inventory Conference, Baltimore April 14-17, 2009*

# The Artemis European tools for estimating the transport pollutant emissions

ARTEMIS research project - European Commission, DG TREN

COST346, cooperation action - Heavy duty vehicles emissions

M. André et al.

INRETS

Institut national de recherche sur les transports et leur sécurité

# Summary

1. The ARTEMIS research project
2. The tools - principles
3. Applications
4. European context and perspectives

**Most results on**
http://www.inrets.fr/ur/lte/publi-autresactions/fichesresultats/ficheartemis/artemis.html

INRETS
Institut national de recherche sur les transports et leur sécurité

# 1- The ARTEMIS research project

- Objective : Harmonized European approaches for estimating the transports pollutant emissions
  - At different scales
  - Road and non-road transports

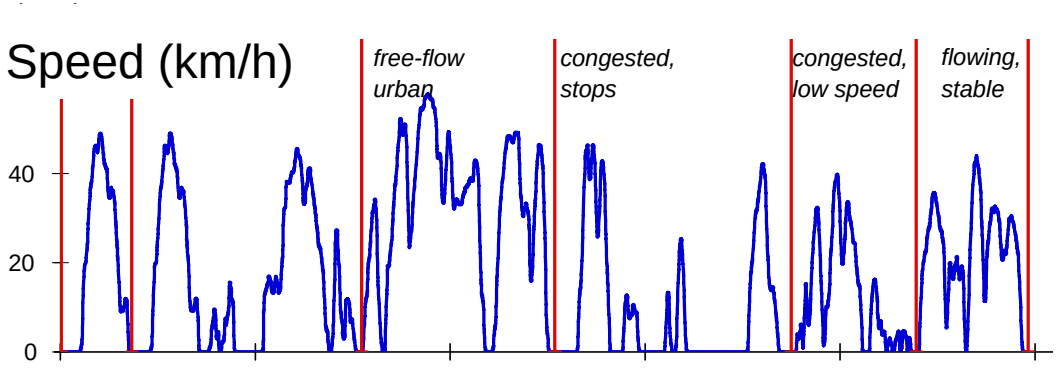
- 37 partners, 15 countries, 5 years, 8.8 M€
- Links with
  - A cooperative action COST346 - emissions / consumption from lorries
  - On-going National research projects
- A significant effort to measure and set-up European emissions factors
- An updated state of the art on transport emissions

INRETS
Institut national de recherche sur les transports et leur sécurité

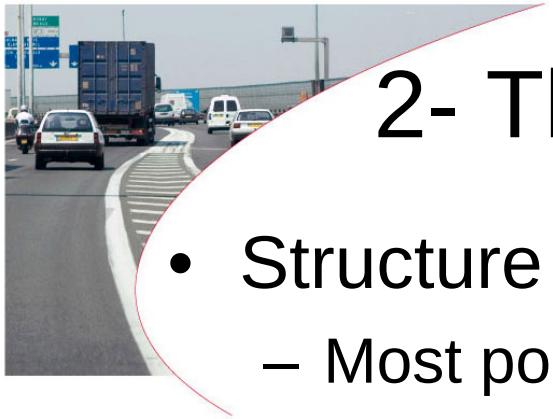
# Main works

- Real-world emission test procedures
  - Driving and test cycles, for PC, HGV, measurement method, uncertainty analysis, recommendation
- Measurements and modelling of the emissions
  - 130 cars tested, database incl. 3,000 light vehicles
  - 120 engine maps (lorries, busses) + transient tests
  - 115 Two-wheelers
  - Cold-start, A/C, evaporative emissions
  - Recent vehicles, non-regulated pollutants and particulates
- Traffic characteristics

  *(fleet, usage, driving conditions)*
- Validation in 3 tunnels




***Artemis urban cycle***



# 2- The road transport Artemis tools

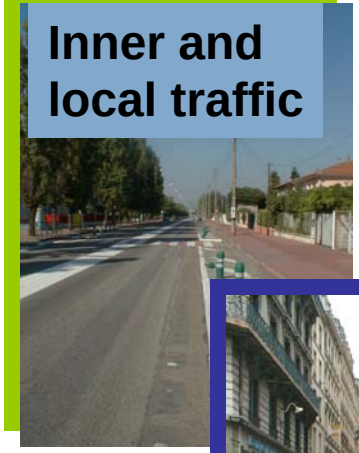
- Structure and content
  - Most pollutants - regulated - non regulated
  - Hot, cold start, evaporative, auxiliaries emissions
  - Light and Heavy duty vehicles, motorcycles / non-road
  - By detailed category, technology, fuel
  - By engine size, HDV weight and configuration
  - Up to the EURO4 regulation and then, reduction rates
- Scales
  - Street, regional, national
  - Aggregation from from Street to upper levels
  - Hourly - Yearly

# A “Traffic situations” approach for local scale

*Road configuration* *x* *Traffic condition*

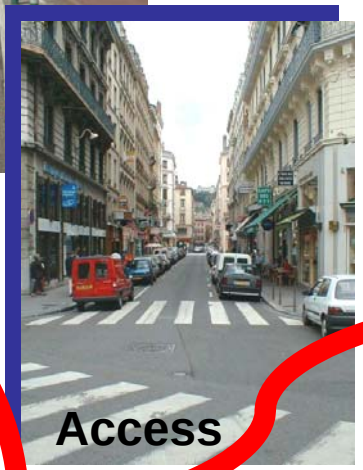
**Urban** | **Rural**

**Strategic network (motorway, major road)**



**Inner and local traffic**

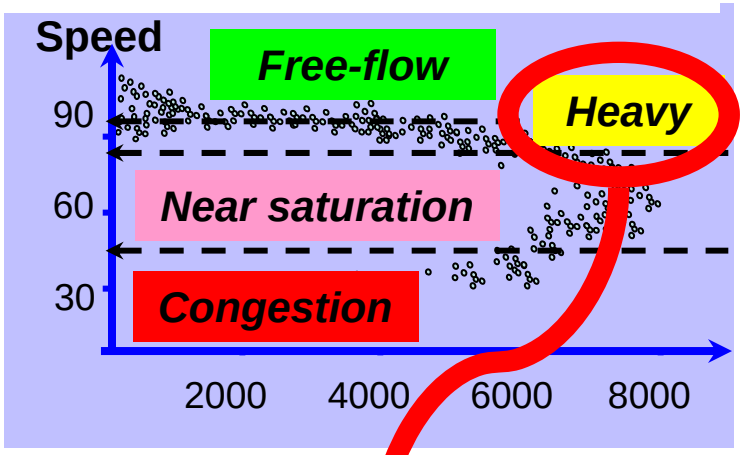
**Urb.Motorway, primary distributor**

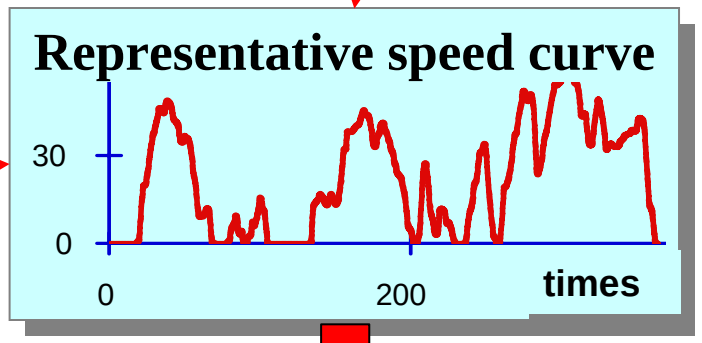


**Access**


**District level**

***+ Speed limit, gradient, sinuosity***




**Emission model**
(per category of vehicle)

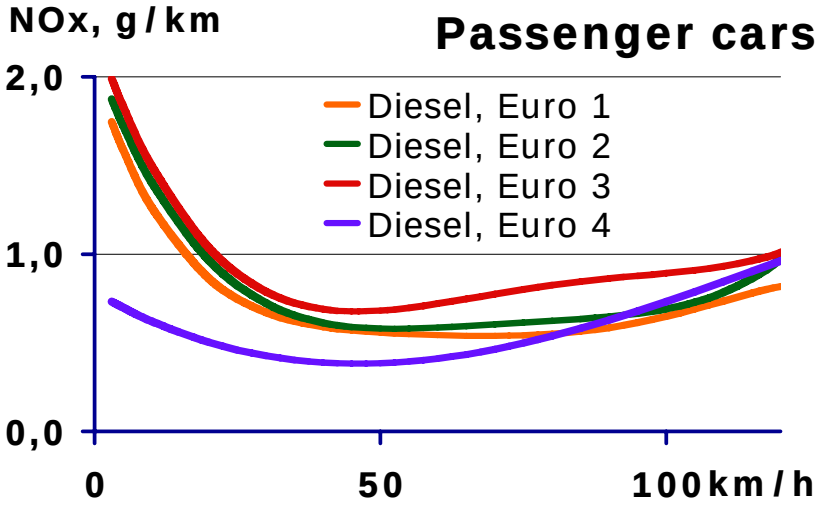
**Emission**

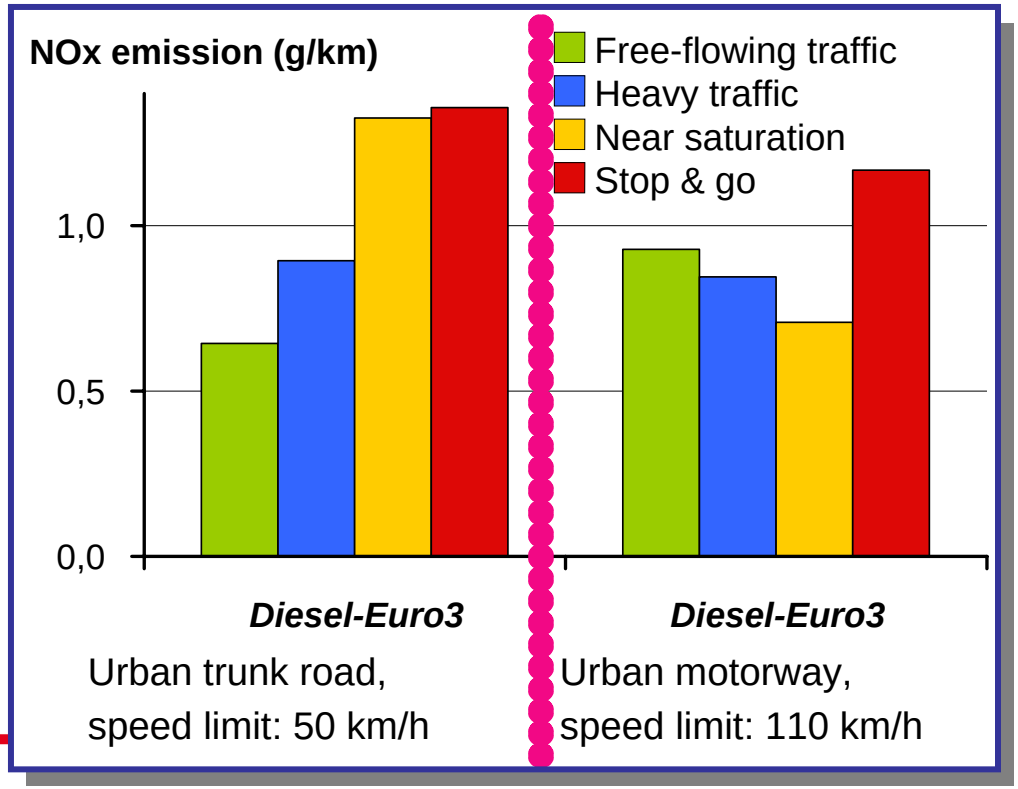
# Different approaches enabled

- Average speed

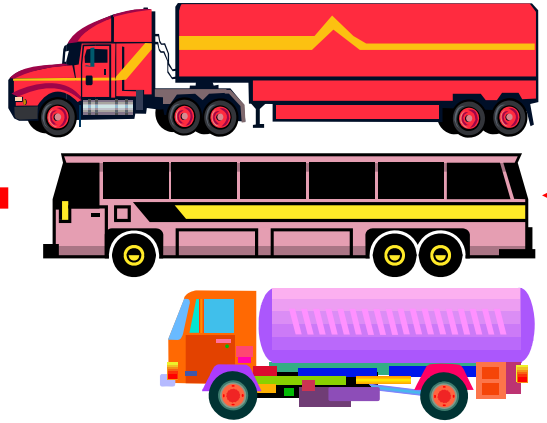
- Detailed traffic situations
  - Better taking into account of the traffic dynamic
  - Better approach of the congestion, etc.

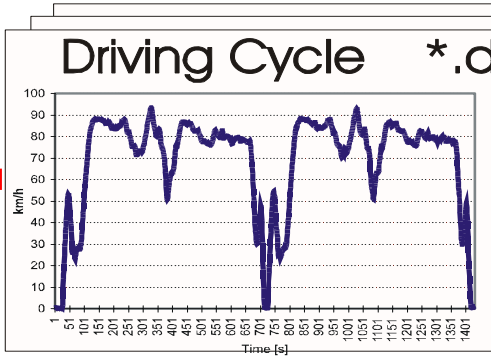
- Composite situations
  - aggregation of Traffic Sit.



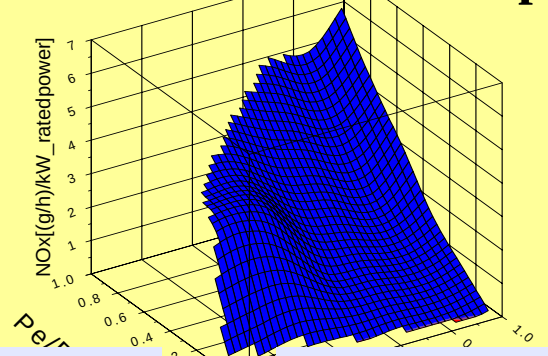
# Emission model principles
## *- Heavy vehicles -*






**Driving resistances & transmission losses**

**Normalized Emission Maps**




**Power** **Engine speed**

**Gear shift model**

**Engine maps**
**from 102 engines**
**EURO 0 to EURO 3**
**Transient tests**
**from 27 engines**

**Fuel Quality**

**Transient Correction**

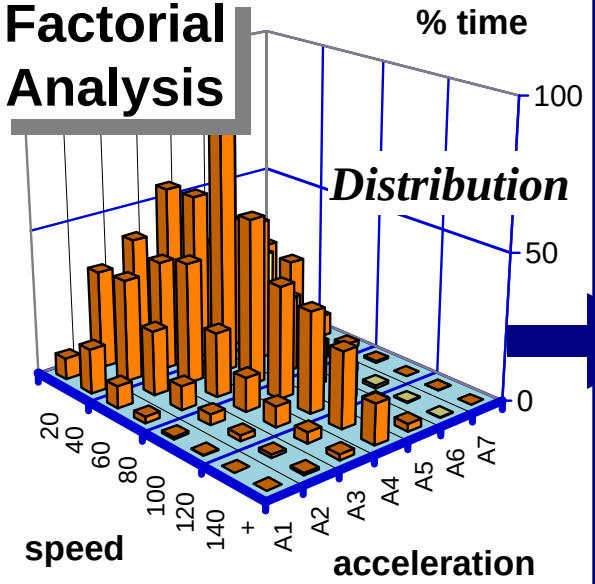
**Engine load, FC, emissions**

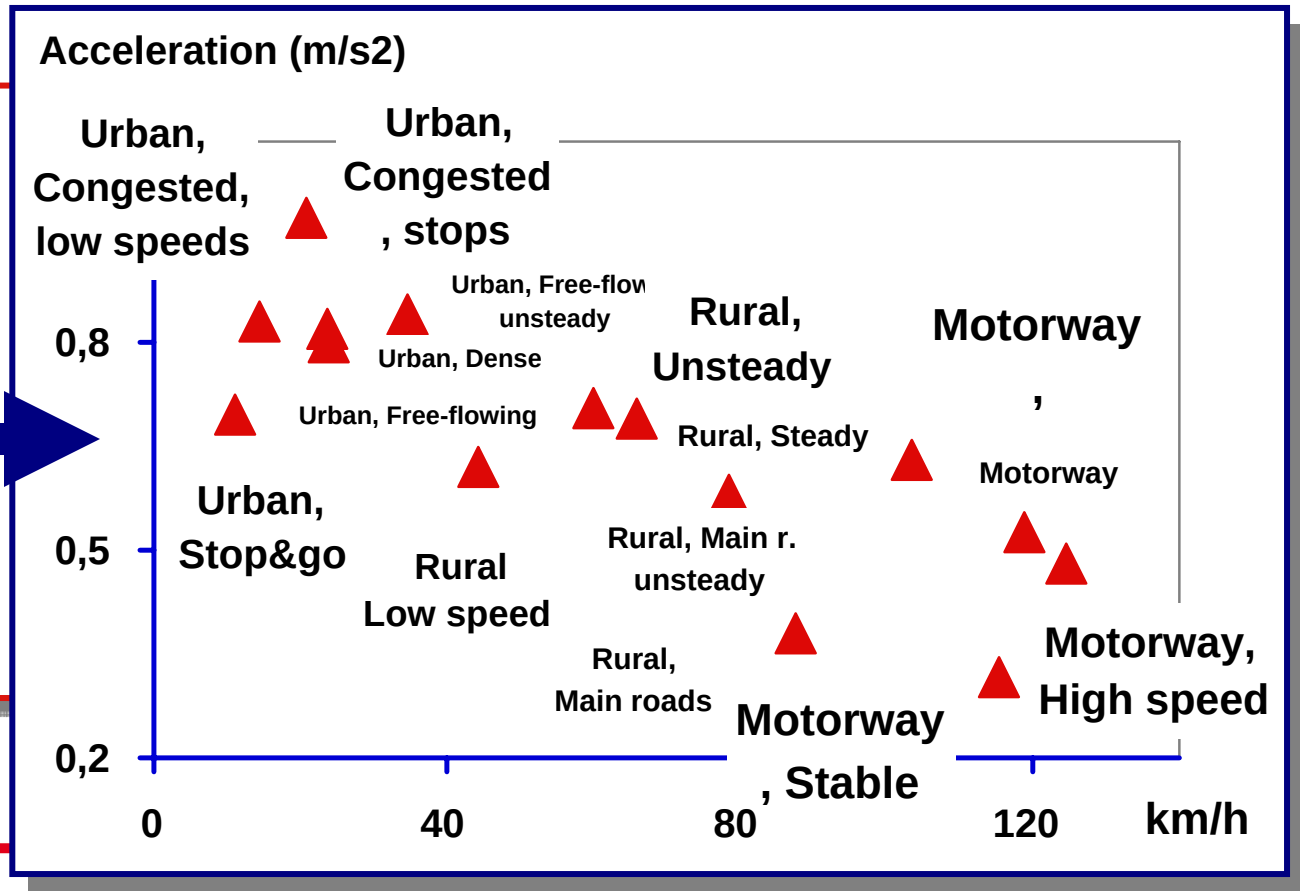
# Emission model principles
## - *Passenger cars* -

**Artemis database**
**2800 cars, 27,000 tests**
**EURO 0 to EURO 4**
**217 driving cycles**

**Reference "Test patterns" and emissions**

**Factorial Analysis**

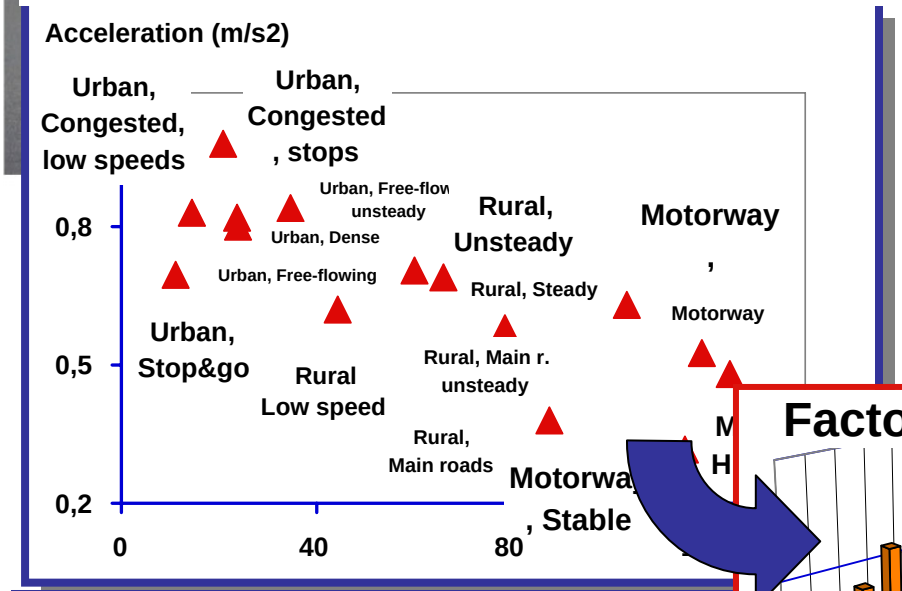


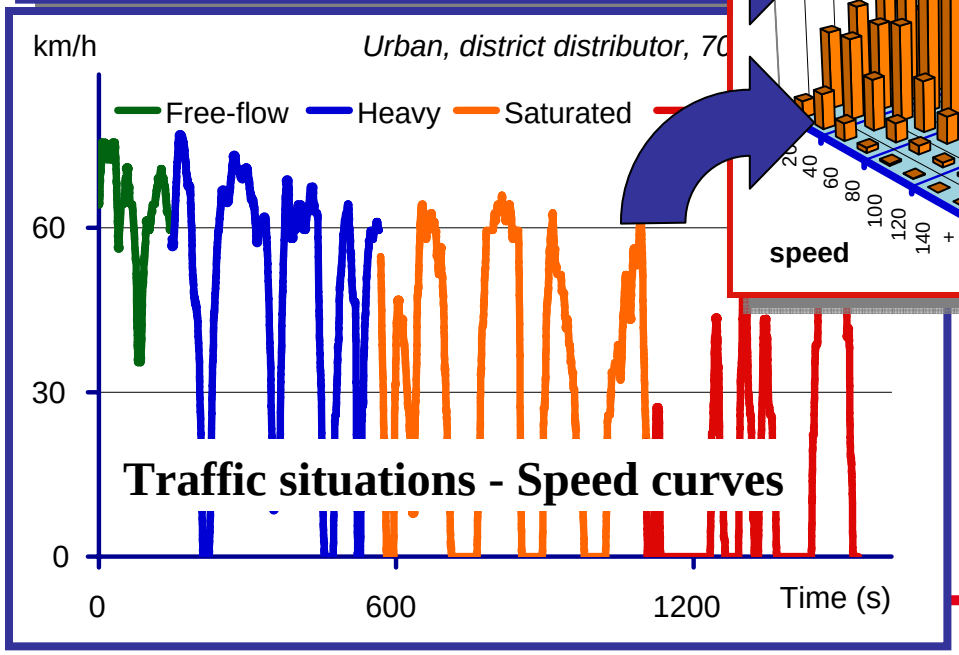



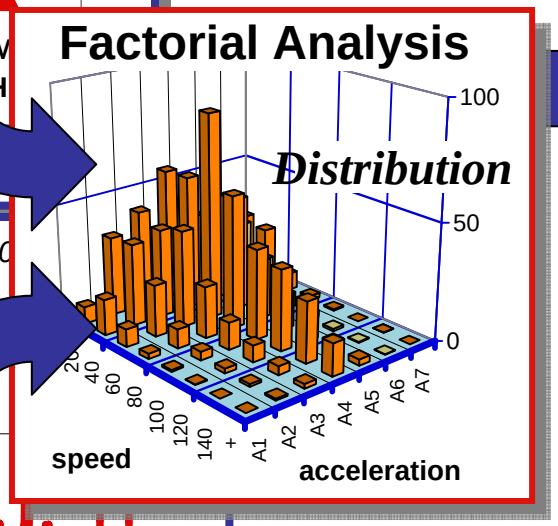

INRETS
Institut national de recherche sur les transports et leur sécurité

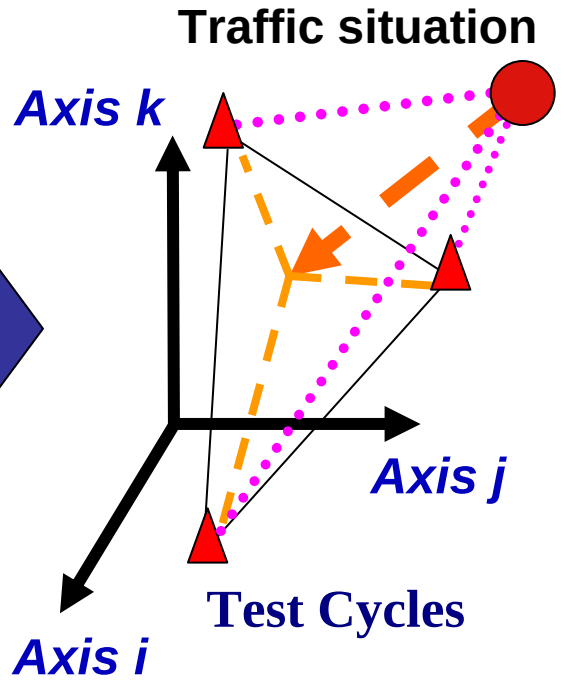
# Emission model principles
## - *Passenger cars* -

**Reference Test patterns and emissions**

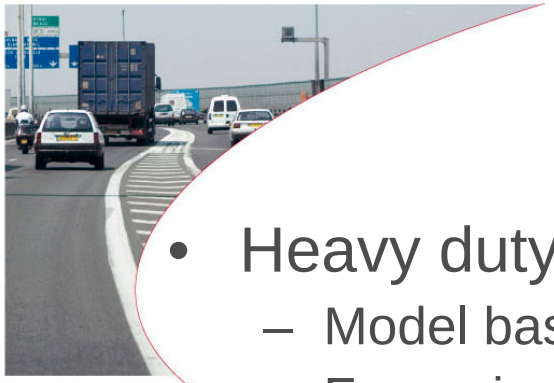



➢*Emission for a large range of traffic situations by interpolation of a representative speed curve amongst the reference test patterns*



# Emissions modelling principles

- Heavy duty vehicles *(and railway Diesel engines)*
  - Model based on Engine emission maps and transient corrections
  - For a given trip / speed curve, simulation of the vehicle operation
  - load and gradient simulation, fuel corrections
- Passenger cars
  - For a given trip / speed curve, Emissions estimated as a linear combination of 15 reference conditions
  - Cold start, air conditioning, fuel evaporation
- 2-Wheelers and Light duty vehicles
  - Emission versus speed curves
  - Load (LDV), cold start / evaporative emission (2W)

- *Maritime: emissions versus speed*
- *Airplanes: emissions by mode (taking-off, cruise, landing)*

# Operational aspects

ARTEMIS / COST 346 - ROAD MODEL

## Fleet model in 3 scenarios

- **Fleet composition**
  - *Vehicle number per detailed categories*
- **Traffic activity**
  - *Vehicle x Km, per segment in urban, rural, motorway*
  - *(Driving conditions Average speed / Aggregated traffic situations)*
  - *Ambient conditions, starts, trips, parking characteristics and temporal variations*
- **Emissions concepts introduction**
  - *Years and shares*

## Emission data set

- Hot, Cold start, Evaporative, regulated / non-regulated emissions data / functions
- Fuel quality
- New concepts reduction rates

## Emission factors processor

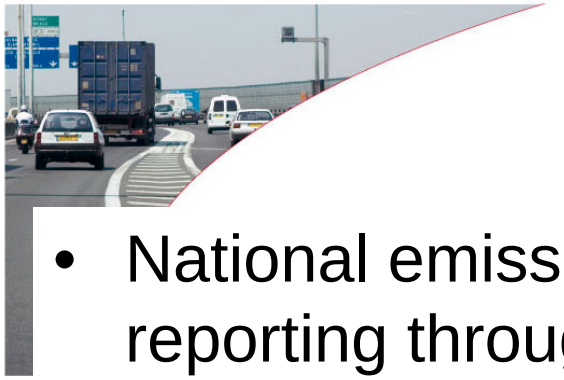
- Aggregated and per vehicle category

## Traffic Data Set - Case study

- *Road / Area configuration and "traffic situations"*
- *Traffic scenarios combining Fleets, activity, usage and ambient patterns*

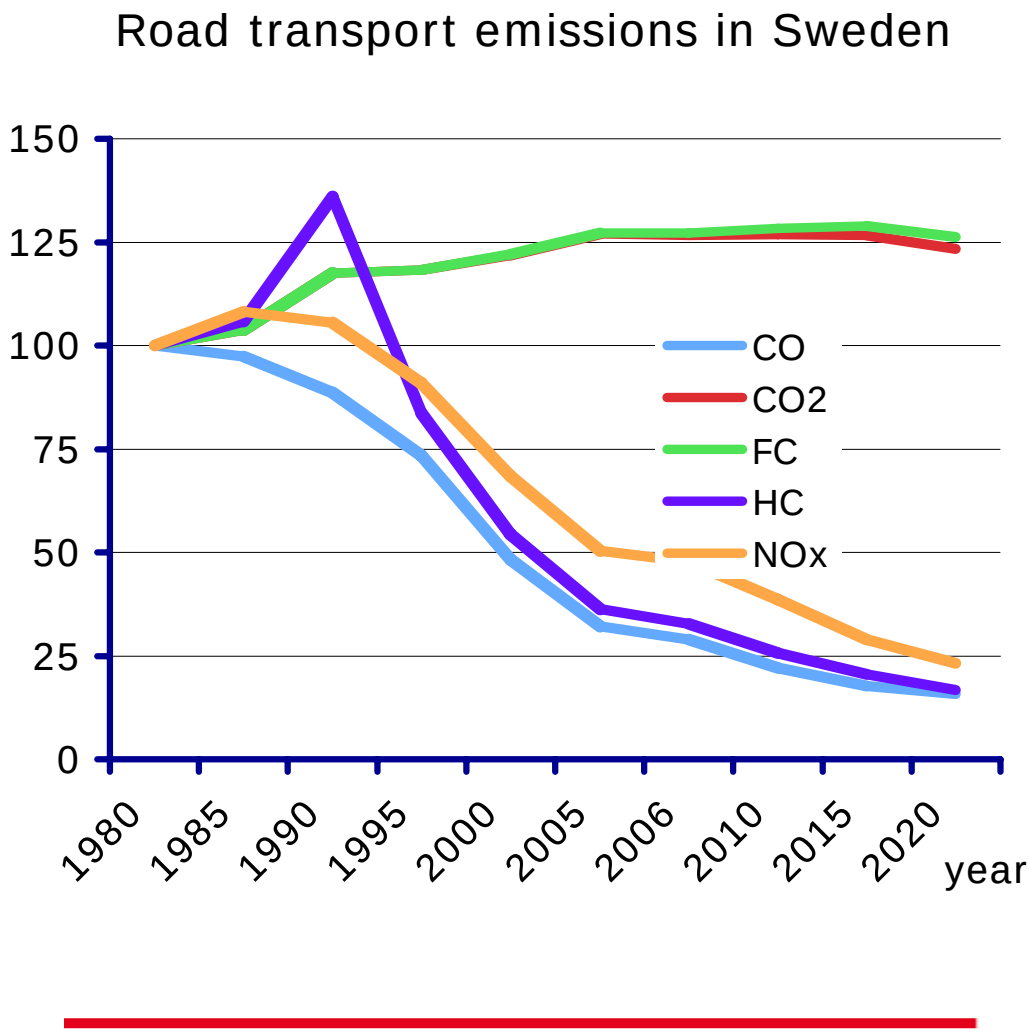
## Emission computation

- Total and per vehicle- and road-categories, traffic conditions, etc.
- Hot, cold, evaporative emissions



# 3- Application - Sweden

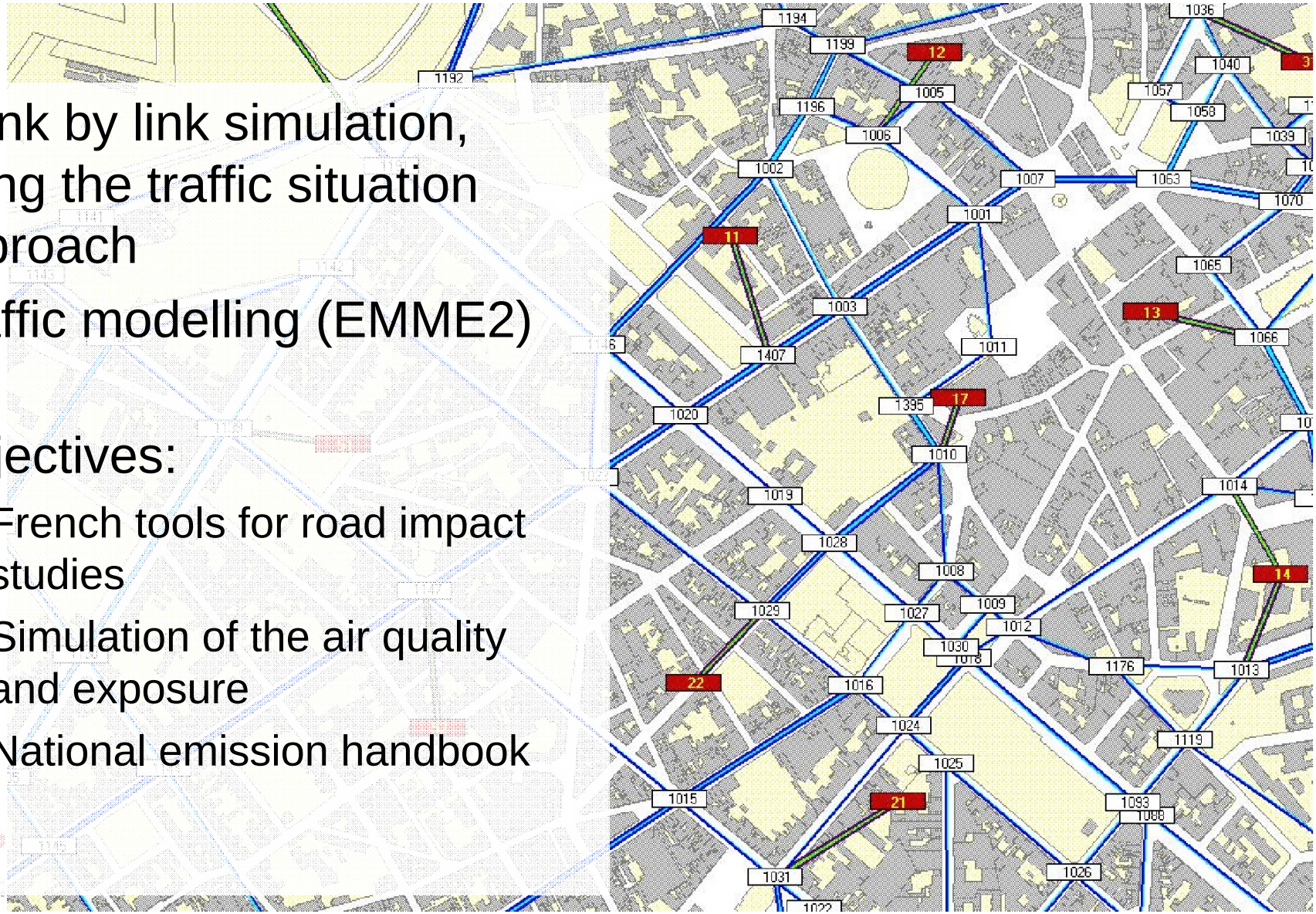
- National emission reporting through a traffic situation approach
- Declination of mileage in:
  - 33 road configurations
  - 85 traffic situations
  - 94% in Free-flow
  - 3% in heavy traffic
  - 2% in saturated traffic,
  - 1% in stop&go
- *Other applications:*
  - *Stockholm urban toll study*
  - *Planning tools*
  - *SIMAIR (Air quality modelling)*

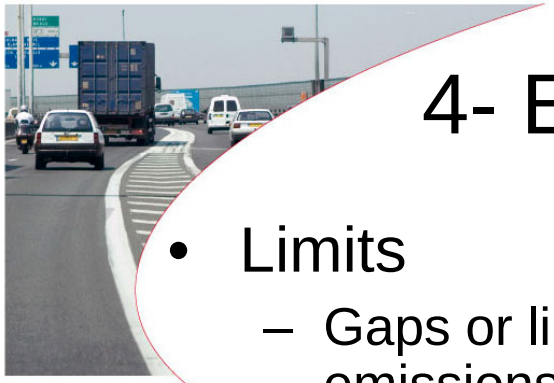


# Applications at a city scale Lille, France

- A link by link simulation, using the traffic situation approach
- Traffic modelling (EMME2)

- Objectives:
  - French tools for road impact studies
  - Simulation of the air quality and exposure
  - National emission handbook





# 4- European context and perspectives

- Limits
  - Gaps or limits for certain pollutants, evaporative and non-exhaust emissions
  - Upgrade needed
  - Complexity of the Artemis tools
  - Several European tools (Artemis, Copert4, Handbook, Versit+, etc.)
- Perspectives
  - A European Working Group of “Developers” and “Users”
  - Coordinated measurement programmes and common basis of emission data
  - National “Handbook” version, easy to use, with integrated traffic data
- Non-road transports
  - implementation and working groups needed

# Conclusions

- ARTEMIS - New European tools for emissions estimation
- A significant research effort and a large number of new measurements
  - Most vehicle categories, regulated and non-regulated pollutants
  - Harmonized approaches at different scales
- A plate-form for assessing  various projects and contexts
  - Local / macroscopic approaches
- Developments through a European working group and emissions measurements coordination

*Thank you for your attention !*

- *Invitation:*

*Transport, Air Pollution and Environment International symposium, Toulouse, 2-4 June 2009*

INRETS
Institut national de recherche sur les transports et leur sécurité

**michel.andre@inrets.fr**