European Network on New Sensing Technologies for Air Pollution Control and Environmental Sustainability - *EuNetAir*

COST Action TD1105

INTERNATIONAL WG1-WG4 MEETING on

New Sensing Technologies and Methods for Air-Pollution Monitoring

European Environment Agency - EEA

Copenhagen, Denmark, 3 - 4 October 2013

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THE BLACK CARBON MAPPER

Bart Elen

WG Member

VITO / Belgium

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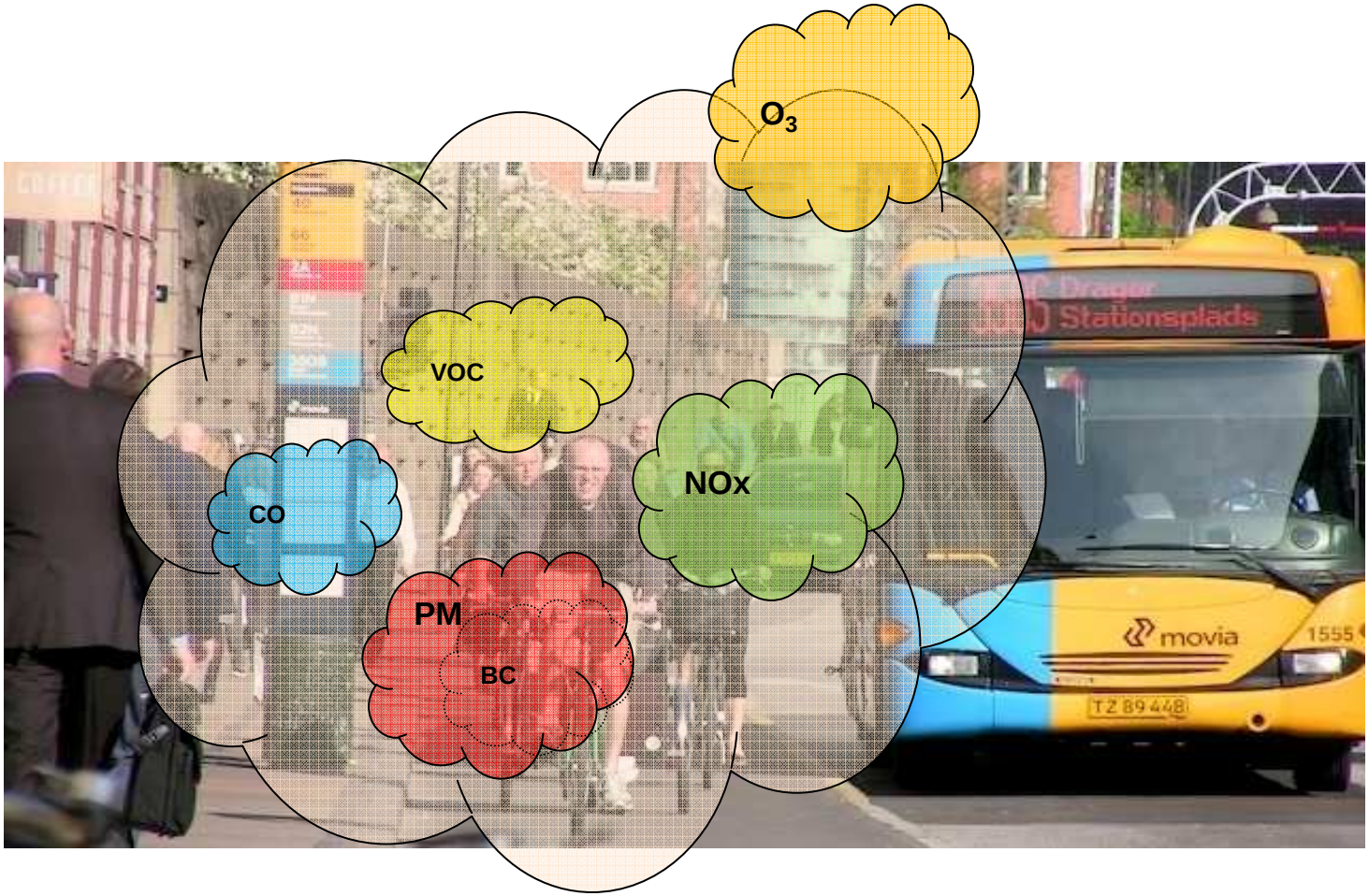
Context – Exposure in urban environments



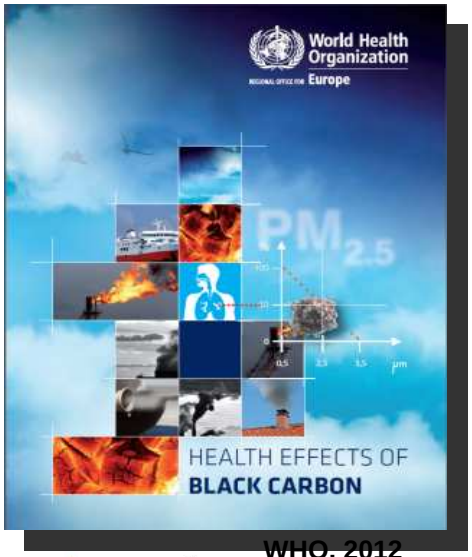
People in urban environments are exposed to a complex mixture of traffic pollutants

Context – Why to measure BC?

Introduction to Black Carbon (BC):

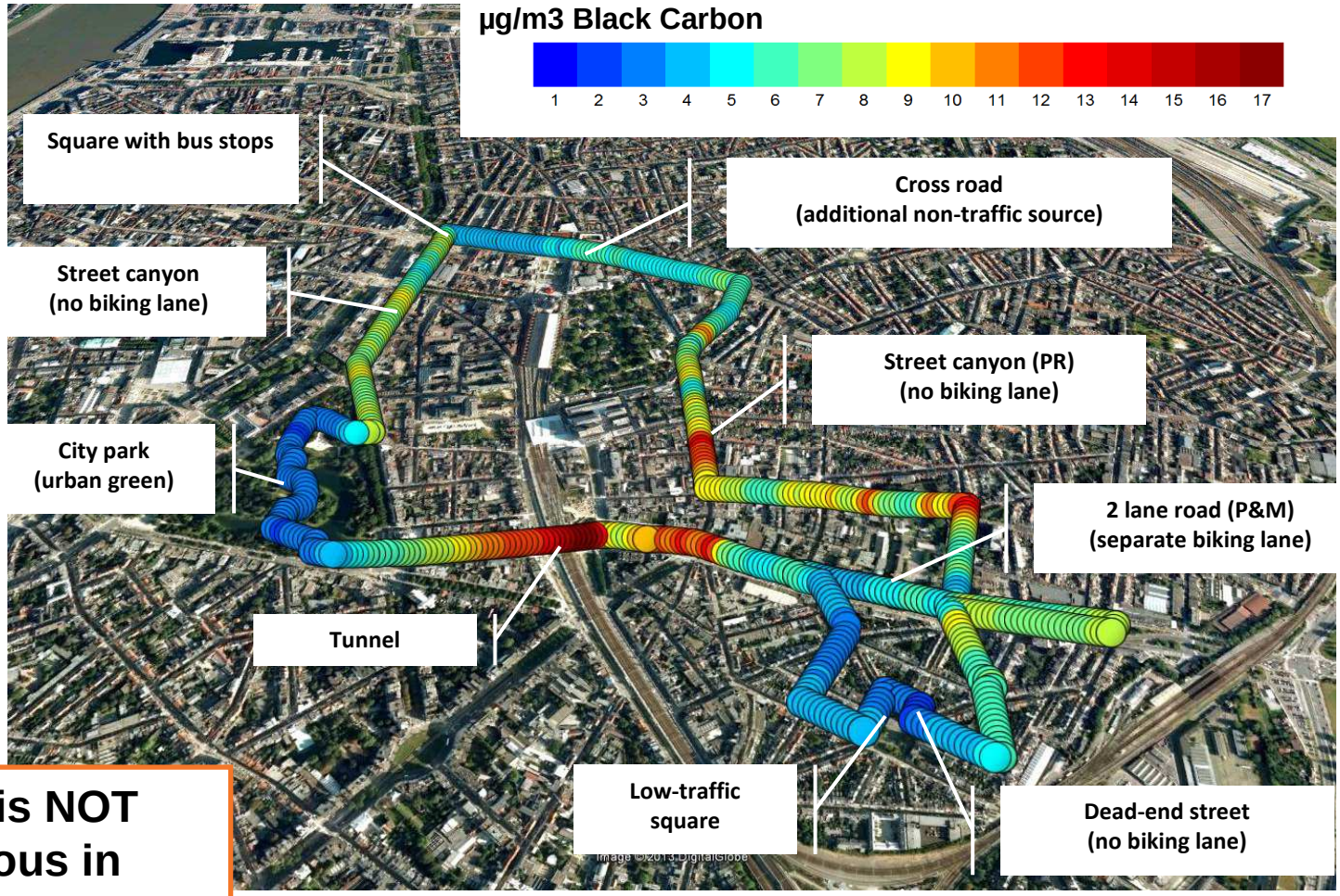
- **BC is an indicator of combustion-related air pollution**
- **BC is part of Particulate Matter (Fine dust)**
- **BC is measured optically**
- **Association with BC exposure and cardiovascular and cardiopulmonary health effects**

World Health Organization claims: "Studies of short-term health effects suggest that BC is a <u>better indicator</u> of harmful particulate substances from combustion sources (especially traffic) than undifferentiated particulate matter (PM) mass."



WHO, 2012

Context – Spatial BC variability



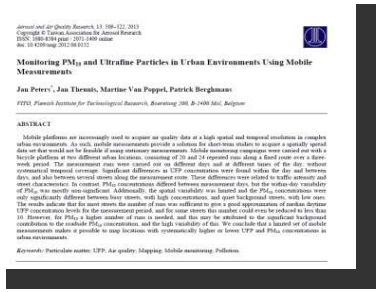
Air quality is NOT homogeneous in urban environments!

Challenge 1 – Repeated measurements needed

Measuring once in a street is not enough

⇩

10 till 20 repeated AQ measurements needed to determine the typical BC exposure in a street



Monitoring PM_{10} and Ultrafine Particles in Urban Environments Using Mobile Measurements

Jan Peters*, Jan Theunis, Martine Van Poppel, Patrick Berghmans

ABSTRACT

Peters, J., Theunis, J., Van Poppel, M., & Berghmans, P. (2013). Monitoring PM10 and ultrafine particles in urban environments using mobile measurements. *Aerosol and Air Quality Research*, *13*, 509–522.) .

To determine the BC exposure in all streets of a city is a huge task

Challenge 2 – Temporal variability

Urban BC exposure has not only spatial variability, also temporal variability

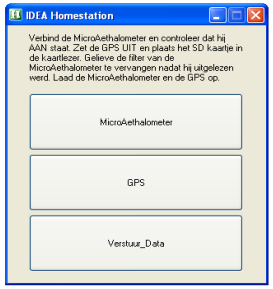
An adequate number of mobile measurements is needed for each time frame of interest

Solution – Black Carbon Mapper

- The VITO Black Carbon Mapper is a tool to collect large amounts of mobile BC measurements and process them into street-level BC exposure maps. It contains two parts:
  - Easy to use measurement devices to allow city personnel and volunteers to collect mobile BC measurements in a ‘cost-effective’ way

The measurement devices: GPS and microAeth

Antwerp city guards



The Home station (left) and its easy-to-use software (right) to read out the measurement devices, transmit the data and to synchronize clocks

- An automated data processing infrastructure to construct and update the BC map

Solution - BCM automated data processing infrastructure

1. Data transmission and storage

Data transmission

BC

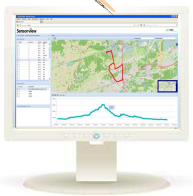
GPS

Raw data in **SensorView** DB

PostGIS

Data is transmitted over the Internet and stored in the SensorView DB

Data queries



2. Quick data visualization

The progress of the measurements is monitored with the SensorView web application

The data is pre-processed

Step 1: Measurement enhancement

Step 2: Data validation

Step 3: Background correction

Step 4: Data aggregation

Data pre-processing

Pre-processed data in GDI DB

PostGIS

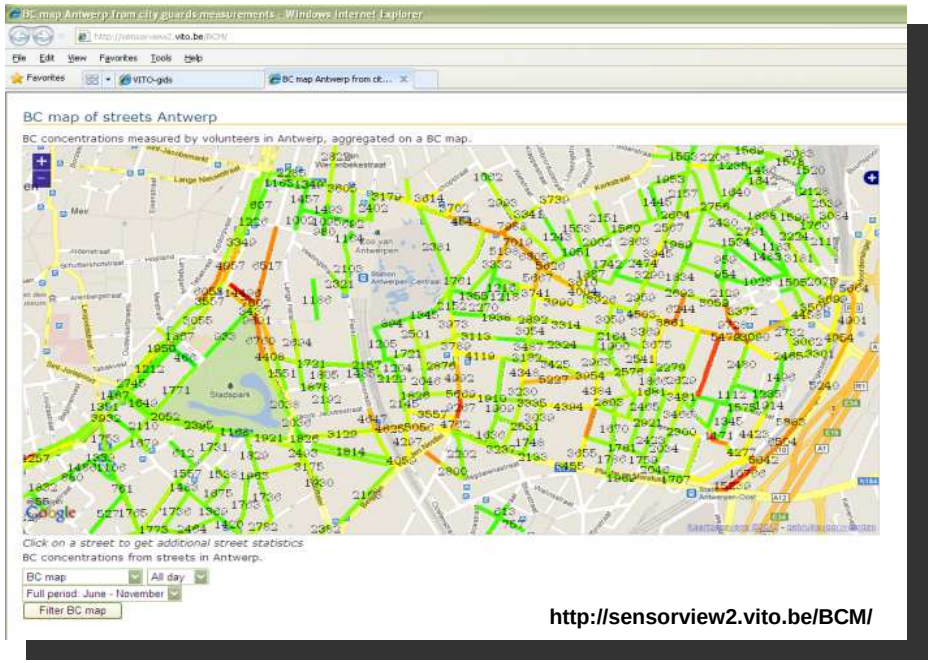
3. Automated data pre-processing chain

Data queries

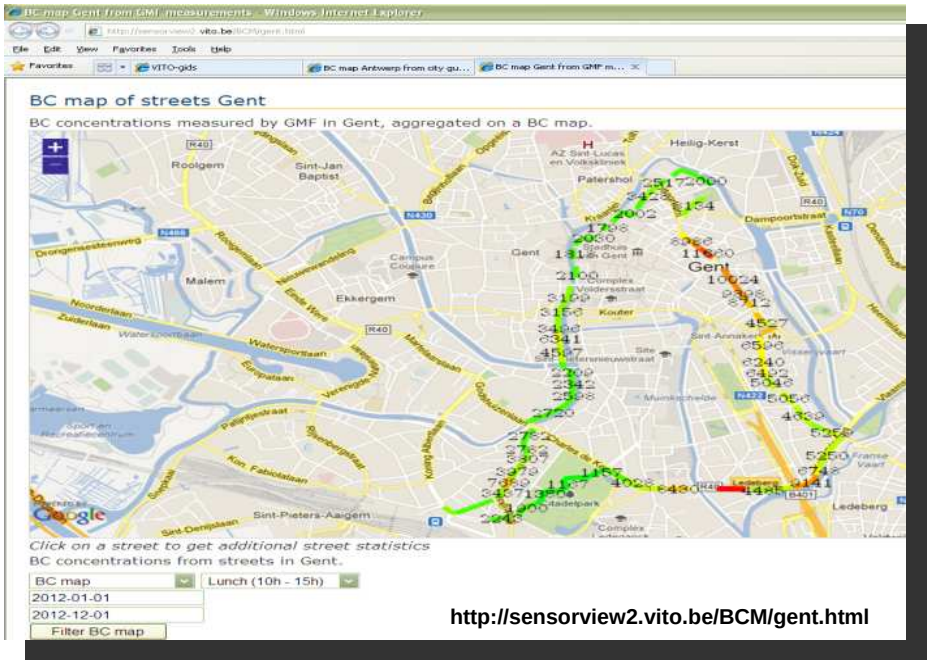
4. Data visualization and analysis

Interactive air quality map as web applications and as WMS service

Results – Test measurement campaigns



http://sensorview2.vito.be/BCM/



http://sensorview2.vito.be/BCM/gent.html

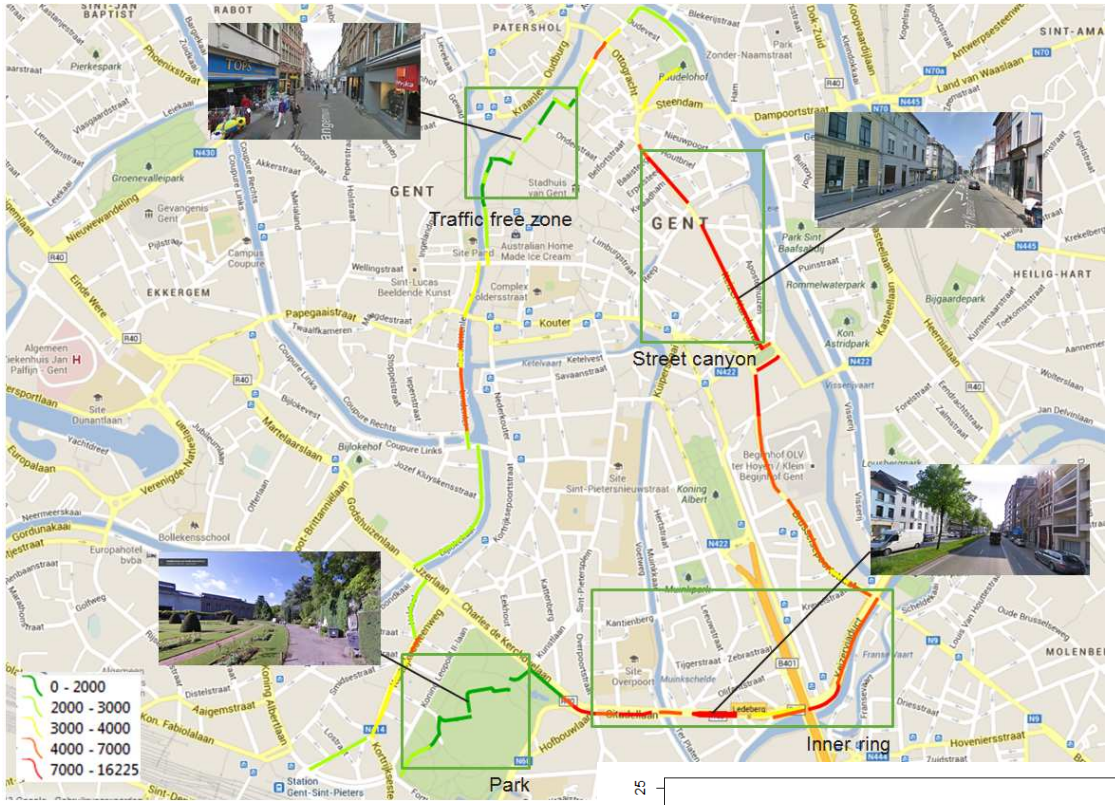
BC map based on 6 months of opportunistic measurements by city guards ("buurttoezichters") of the city of Antwerp

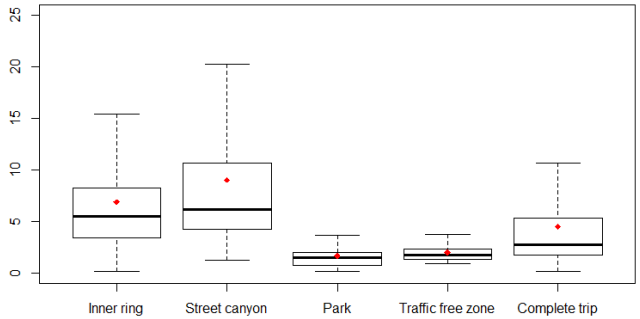
BC map based on a 2 month targeted measurement campaign by the Gents MilieuFront

Results – Test measurement campaigns

Targeted measurements in Gent:
-Measurements collected by volunteers on bike
-13 repetitions over 2 month period
-All measurements are done around lunch time

The BCM allows to compare the mean BC exposure of individual street segments and of city zones:
For street segments : 1.1 µg/m³ - 16.2 µg/m³
For 5 city zones: 1.6 µg/m³ (city park) - 9.0 µg/m³ (street canyon)

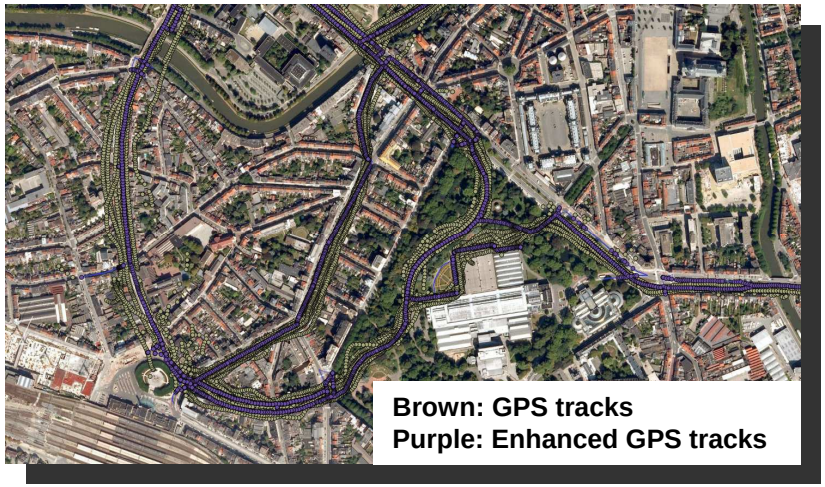




Challenge 3 – GPS quality in city centers

GPS signal is blocked and reflected by buildings

Currently we mitigate this issue by:
-Filtering low quality (and irrelevant) GPS data
-Intelligent map matching: measurement are assigned to closest street segment followed from start till end



We plan to try out new approaches in the future

Challenge 4 – Working with volunteers

Working with volunteers requires:
- **Recruitment**
- **Keeping them motivated**
- **Their privacy needs to be protected**
- **Very good usability of measurement tools**

In our experience, this is often not evident

Future plans

The BCM is under continuous development. Enhancements and extensions are planned for:

GPS track enhancement
- **GPS device comparison**
- **Enhanced post processing**

Background correction
- **With reference station**
- **With local background**

Communicate health in stead of concentrations

Evaluate temporal coverage of opportunistic measurements

Competitors – Fixed AQ-networks

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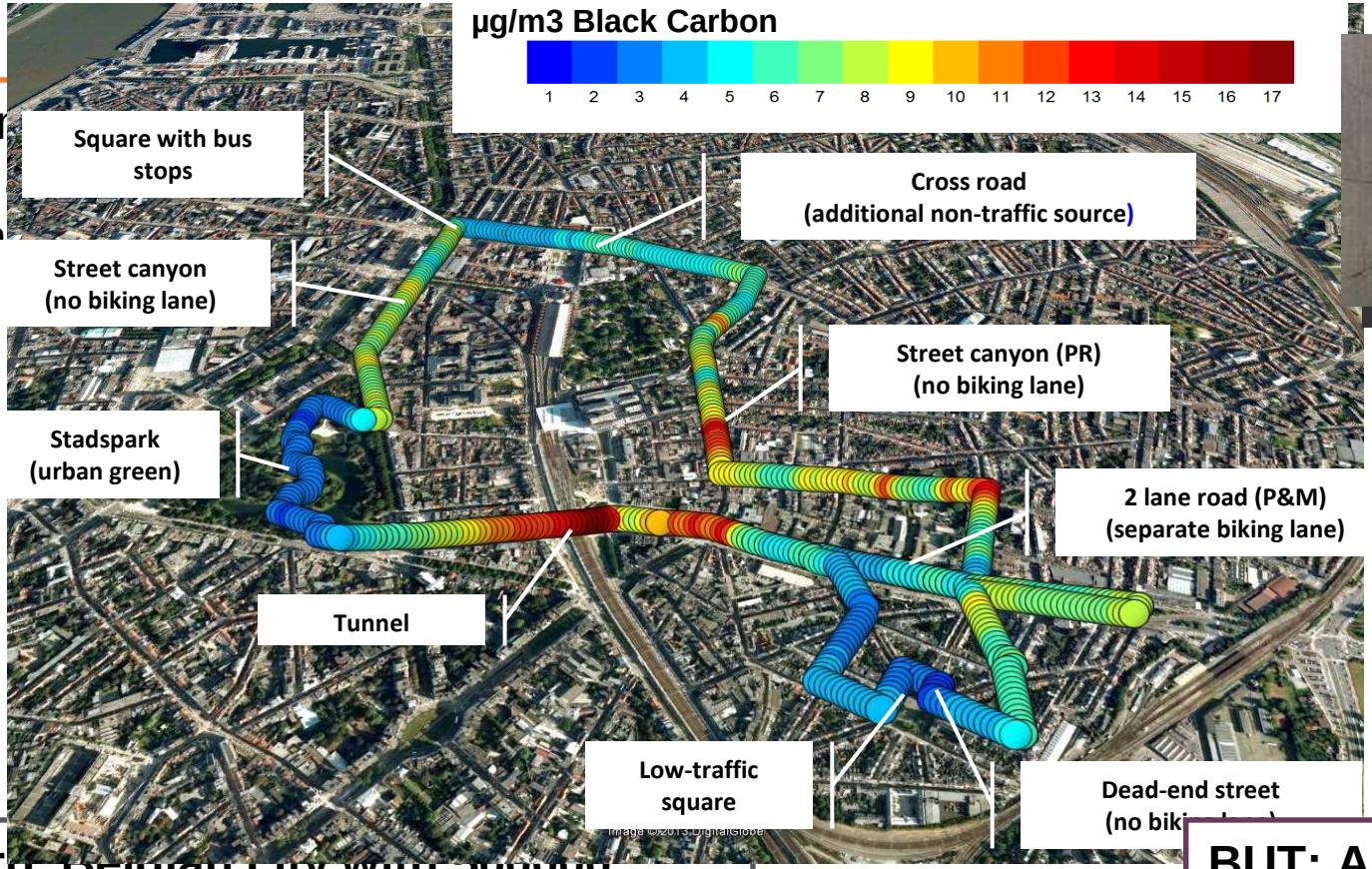
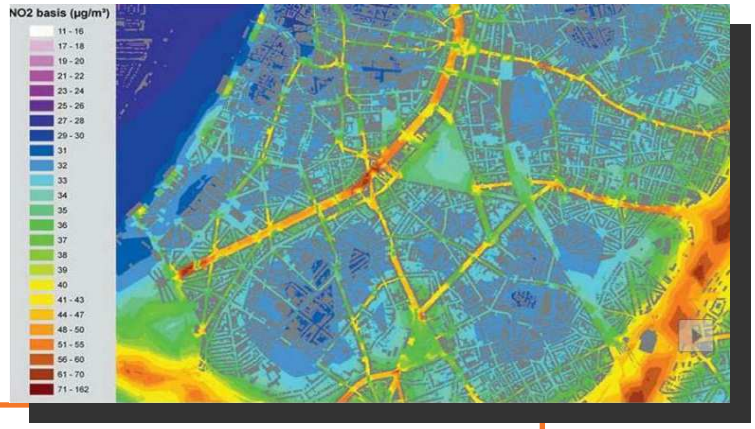


Antwerp, Belgian city with 500000 inhabitants: only 1 urban air quality station to monitor air quality

BUT: Air quality is NOT homogeneous in urban environments!

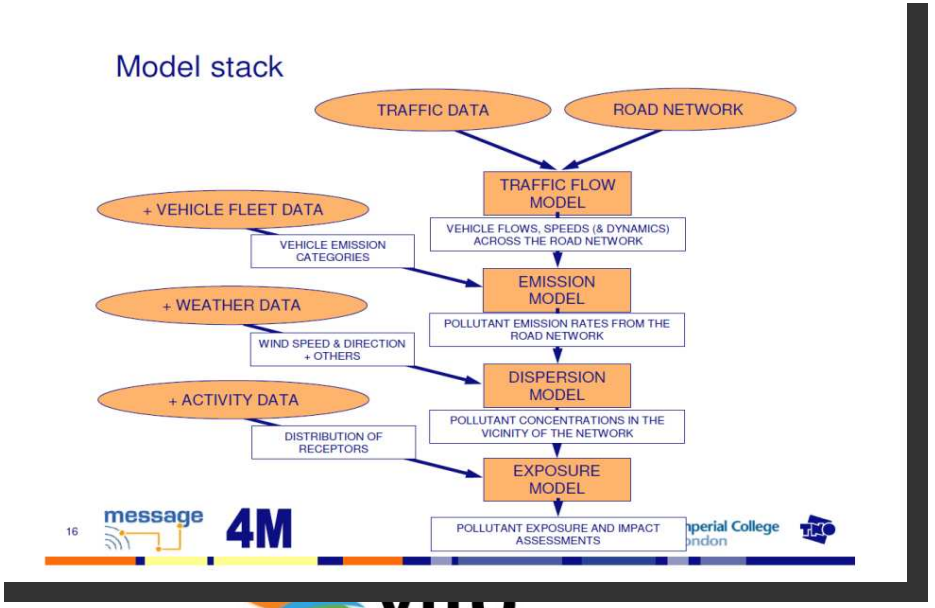
Competitors – Modeled city air quality maps

City wide air quality maps are currently modeled



Building a good street level exposure map is complex and should take into account:

- -Traffic density
- -Traffic composition
- -Traffic flow (speed, acceleration, …)
- -Street composition
- -Orientation of street
- -Weather conditions
- -Location of pedestrian path and bike path
- -Location of car parking's and tree's
- -…



Requires an extended, detailed input data set and is far from evident

Conclusions

The Black Carbon Mapper allows to map the BC exposure of pedestrians and bikers in urban environments on the street level at a feasible cost by cooperating with city personnel and volunteers.

Following the "If you can measure it you can it you can improve it"-principle, the BCM will enable city authorities to reduce the exposure of their inhabitants.

When city authorities see what the impact is in their city of:
- **Traffic intensity**
- **Separate biking lanes**
- **High buildings**
- **Narrow streets**
- **…**

They can take this into account when:
- **Working on new mobility plans (e.g. Send traffic through different streets, advice healthy biking routes, …)**
- **City planning (e.g. Where to build schools, new high buildings, …)**
- **Redesigning streets (e.g. location of biking lanes, trees, …)**
- **…**

Questions?

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