TRAFFIC EMISSION SIMULATION AND VALIDATION WITH MEASURED DATA IN SOUTH KOREA

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INTRODUCTION

• Road traffic → main factor affecting the air quality of big cities around the world

• In urban hot-spot road traffic is the most significant contributor to air pollution

• Tendency to more accurate answers for specific air quality issues in cities

• Information for validation of this microscale approaches is scarce

• Motivation: first approach to the validation of VISSIM-VERSIT+ micro/ENVIVER modelling system with measured data to compute accurate traffic emissions
Modelling domain: POSCO intersection

- 300m x 300m domain covering the intersection of 2 major roads: Teheran and Samseong
- More than 8000 veh·h⁻¹ crossing the signalized intersection at peak hours
- 2 scenarios: 9:00 - 10:00 a.m. (peak) and 15:00 - 16:00 p.m. (off-peak)
Modelling system

**Experimental campaign**
- Traffic Volume (veh/h)
- Vehicle routes
- Fleet composition
  - Vehicle types
- Speed-time profile for each vehicle
- VISSIM
  - Microscopic traffic flow simulation model
- ENVIKER
  - Emission calculation interface
- VERSIT+
  - Emission models
- VERSIT+ micro
  - Microscale emission model
- CFD
  - Microscopic computational fluid dynamics air quality model
- Pollutant concentration
- Mobile laboratory measured data

**Model inputs**
- Network
- Traffic signs
- Bus lines
- VISSIM vehicle types
  - Car
  - SUV
  - Taxi
  - Van
  - Bus
  - HGV
- VERSIT+ classes
  - Urban_2015_Posco_Car
  - Urban_2015_Posco_Bus
  - Urban_2015_Posco_Hgv

**Model results**
- Vehicle specific emissions per distance travelled
- Emissions per vehicle type
- Total emissions per grid cell

**Comparison data**
- Weather conditions
- Traffic signs
- Bus lines
- Fuel and technology
- NOx
- Mobile laboratory measured data
Microscale traffic simulation with PTV VISSIM

Real world

Dynamic traffic data

Traffic volume, routes and composition

Static traffic data

Bus lines and stops

Position of traffic lights and phases

20 links
27 connectors
4 signal heads
9 bus stops
24 bus lines

Scenario simulation
Emission calculation with TNO Versit+micro/Enviver

<table>
<thead>
<tr>
<th>Area</th>
<th>Road type</th>
<th>VISSIM customized classes</th>
<th>VERSIT+ customized vehicle class name</th>
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<td>Posco</td>
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<td></td>
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<td>Bike</td>
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</table>

![Emission calculation diagram](image)

$$ TE_j = \sum_{k,m} \left( E^F \cdot TV \cdot L \right) $$

- **Emissions**
- **Emission factor**
- **Traffic volume**
- **Section length**
- **pollutant**
- **Vehicle class**
- **Speed-time profile**
- **Road section**

![Graph showing speed and acceleration over time](image)
CFD pollutant concentration modelling

- Total emissions per 5m x 5m grid cell
- Meteorological data
  - Wind speed
  - Wind direction
- CFD: microscopic computational fluid dynamics air quality model from KNU
  - k-e turbulence model: For flow field and pollutant dispersion
  - Wall function: For near-wall velocity

Pollutant concentration at 5m x 5m grid resolution

More information: Kwak et al. 2015
KIST Mobile laboratory data recompilation

- NO\textsubscript{x} measurement (calibration before and after)
- GPS location
- Sampling height 2m
- 4 trips for off-peak interval
- 6 trips for peak interval

More information:
- Kim et al., 2014
- Woo et al., 2016
RESULTS AND DISCUSSION

Traffic emissions from the VISSIM-VERSIT+micro/ENVIVER

Concentrations from the CFD model

Concentrations measurements from the Mobile Laboratory

Peak

7780.4 g·h⁻¹ (2.34 g·km⁻¹)

Off-Peak

5074.6 g·h⁻¹ (1.86 g·km⁻¹)
CONCLUSIONS

• First attempt to the validation of the VISSIM-VERSIT+\textsubscript{micro}/ENVIVER modelling system on a real hot-spot using ML data (observations)

• Simulated concentration results are hard to compare to ML measured data:
  • difficult to obtain individual trip data that covers the whole domain for a complete hour
  • comparison is extremely dependant of a correct location of measurements

• Spatial distribution maps present similar concentration patterns:
  • higher concentrations near to the intersection
  • queuing vehicles after traffic lights in main roads
NEXT STEPS

• High concentration levels predicted by the simulation system must be corrected in order to compare the results values directly to the on-road measured data

• Compare simulated emission data using inverse emission estimation from the on-road measured concentrations for emission validation purposes
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Thank you for your attention!

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