UNIMORE UNIVERSITÀ DEGLI STUDI DI MODENA E REGGIO EMILIA Dipartimento di Ingegneria "Enzo Ferrari"

MICROSCALE SIMULATION OF ROAD TRAFFIC EMISSIONS FROM VEHICULAR FLOW AUTOMATIC SURVEYS AND COMPARISON WITH MEASURED CONCENTRATION DATA

Grazia Ghermandi, Sara Fabbi, Alessandro Bigi, Sergio Teggi and Luca Torreggiani*

Department of Engineering "Enzo Ferrari", University of Modena and Reggio Emilia, Modena, Italy, email: grazia.ghermandi@unimore.it
*ARPAE Reggio Emilia, Environmental System Services, Reggio Emilia, Italy

Abstract: In order to assess the impact of road traffic on local air quality, a microscale simulation of pollutant concentration fields due to vehicular traffic emissions have been performed. The investigated area is in downtown Reggio Emilia, a city in central Po valley, Italy, and focused on a crossing within the inner ring road, where an air quality monitoring station is present and where traffic is expected to be the main local source of atmospheric pollutants. A microscale simulation approach is suitable to face dispersion within an urban area, where buildings may lead to local peaks in pollutant concentration. The simulation has been performed by the micro-scale model suite Micro-Swift-Spray (Aria Technologies) a Lagrangian particle dispersion model directly derived from the SPRAY code, able to account for obstacles. Simulated pollutants are NO_x and CO, as main tracers of combustion emissions. Results were compared to local air quality measurements next to the investigated road and within the simulated domain.

MODEL SETUP AND DATA SET

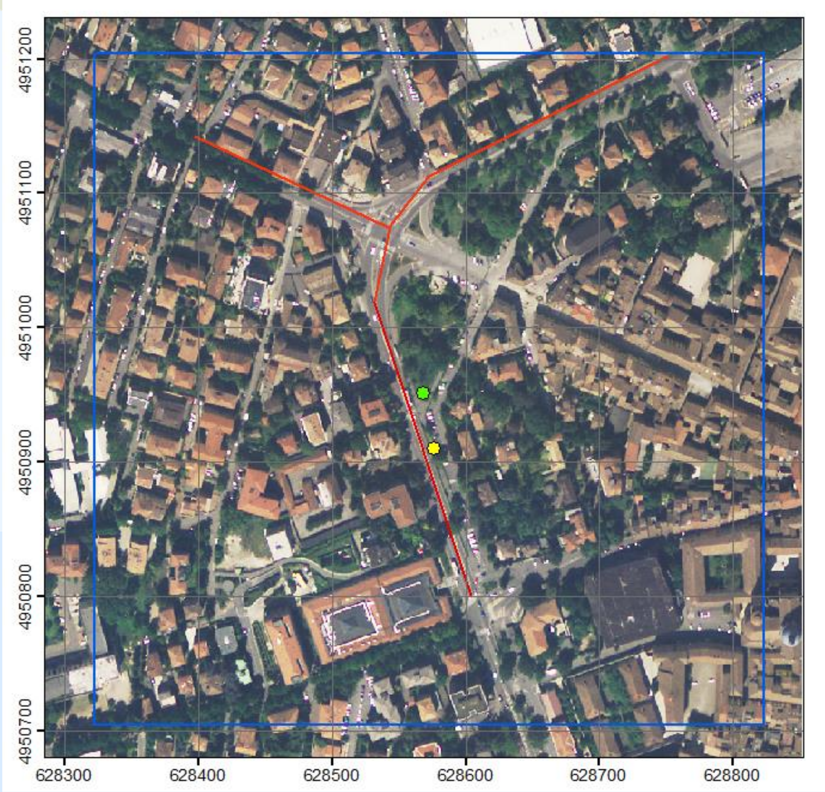
Computation of pollutant concentration field
Extension: 500 m x 500 m
Horizontal resolution: 2 m

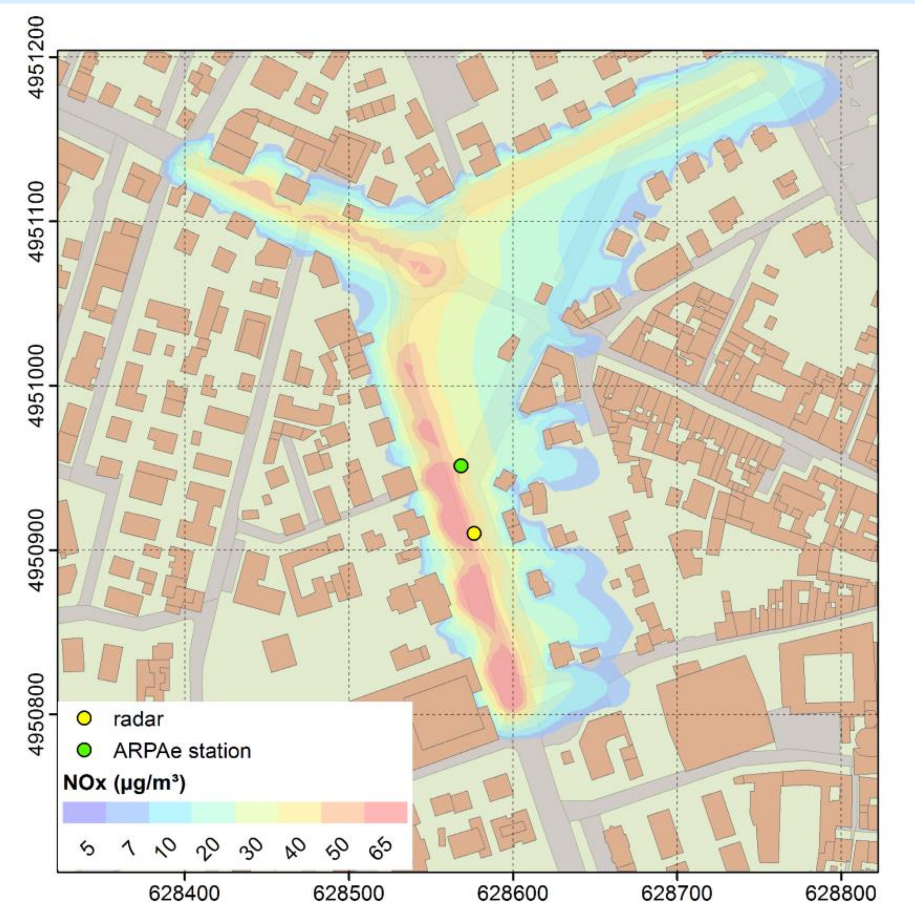
Simulation period
12 days, from 13 to 24 January 2014

Emitting source
Direct measurements of traffic flows with radar traffic counter (yellow point).

Meteorological Dataset
From CALMET model simulations by ARPAE: grid on Po valley with a 5 km x 5 km horizontal spacing.

Building volumes
3D vectorial cartography (UVL_GPG)
from Geoportale Emilia-Romagna (topographic database 2013)





RESULTS

During the simulation period unusual weather conditions for the winter period in the Central Po Valley occurred, with heavy storm rainfall on 18 and 19 January, better suitable for spring time.

This atypical weather condition also affected air quality.

In the figure (on left), as an example, the average daily NO_x concentration map, in the first atmospheric layer, as due to traffic emissions for 17 January 2014, is presented.

The simulated concentration (4 m above ground level) were compared to local air quality measurements. In the figure on right, high, the following time series are shown :

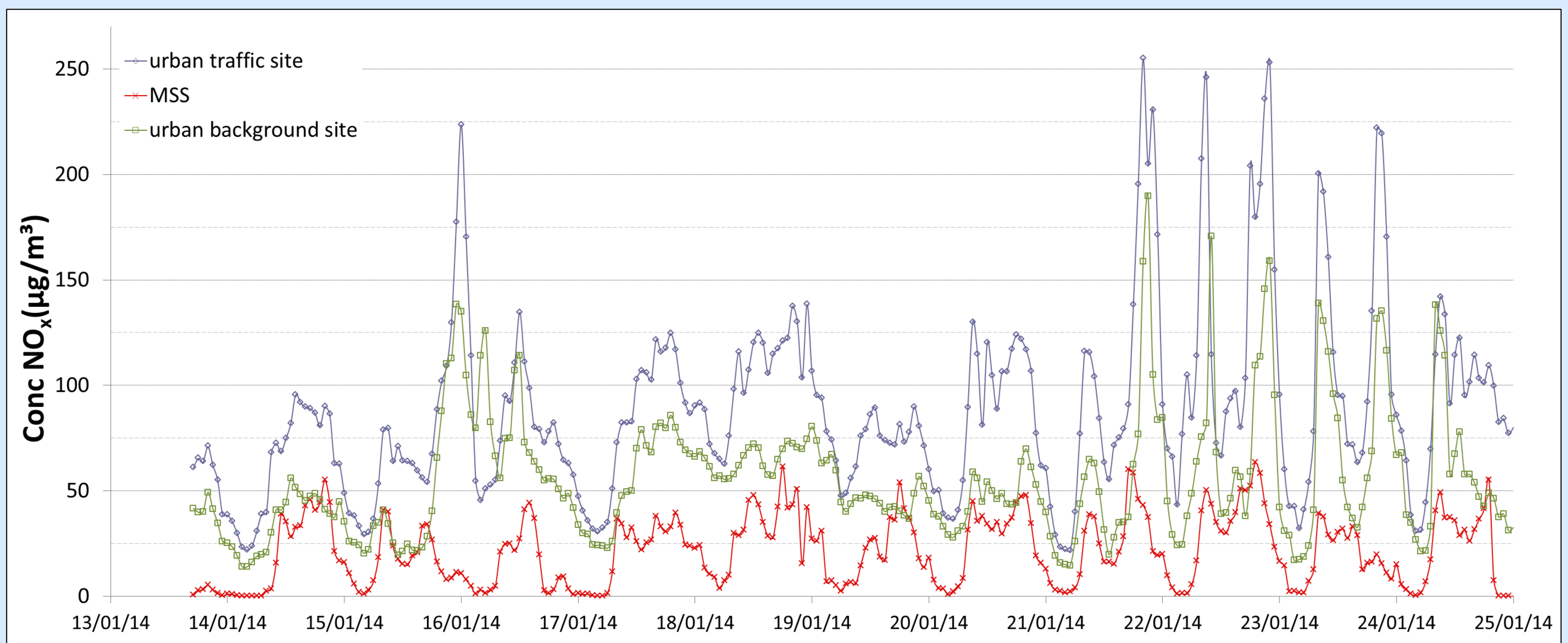
- hourly NO_x concentrations measured at ARPAE urban traffic station (blue)
- hourly NO_x concentrations measured at ARPAE urban background station (green)
- hourly NO_x concentrations simulated by MMS (red)

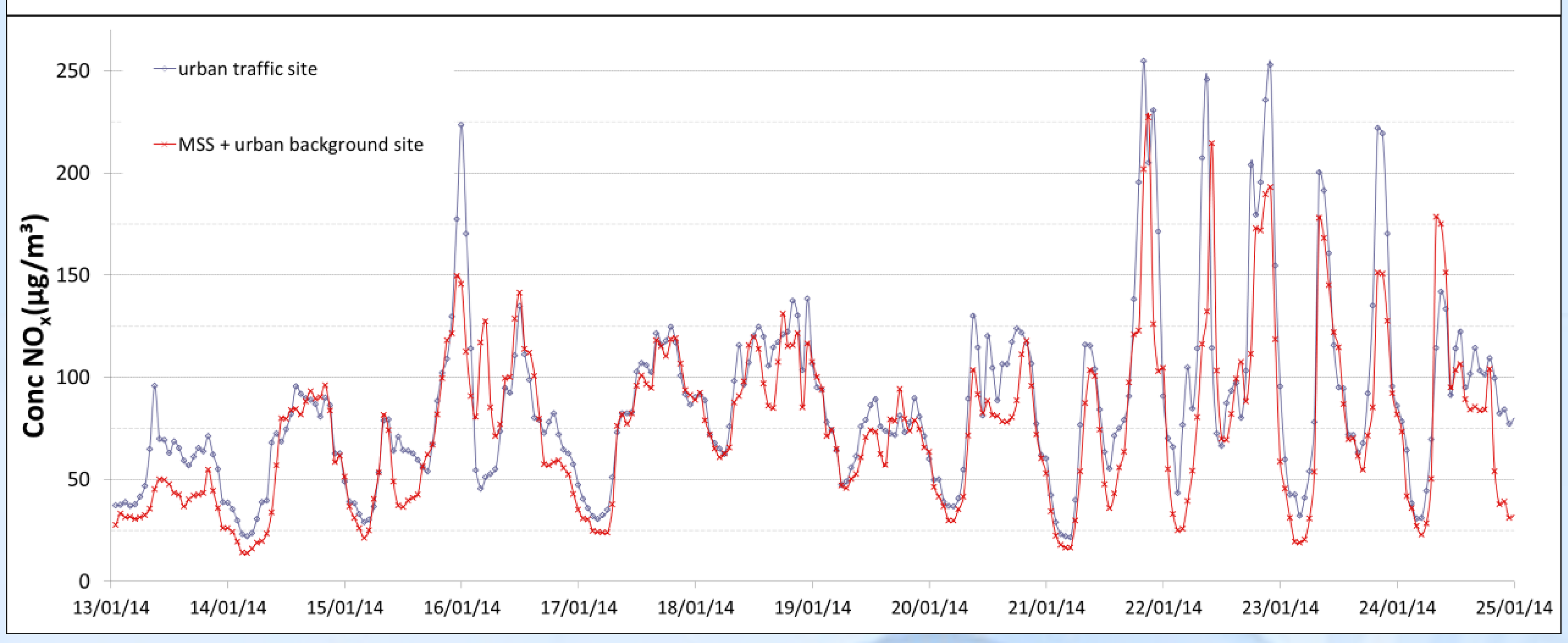
from 13 to 24 January 2014.

The NO_x traffic and urban background measured concentrations show a very similar pattern: the differences can be attributed to the local influence of traffic and this has been here estimated by MSS simulation. The pattern of the three series shows a good agreement, the measured concentration peak on 16/01/2014 (at 01:00) a part.

In the figure on right, down, the hourly NO_x concentrations measured at the ARPAE traffic station are compared with the sum of NO_x hourly simulated concentrations and corresponding urban background measured values. The two time series result highly correlated (Pearson coefficient r = 0.86).

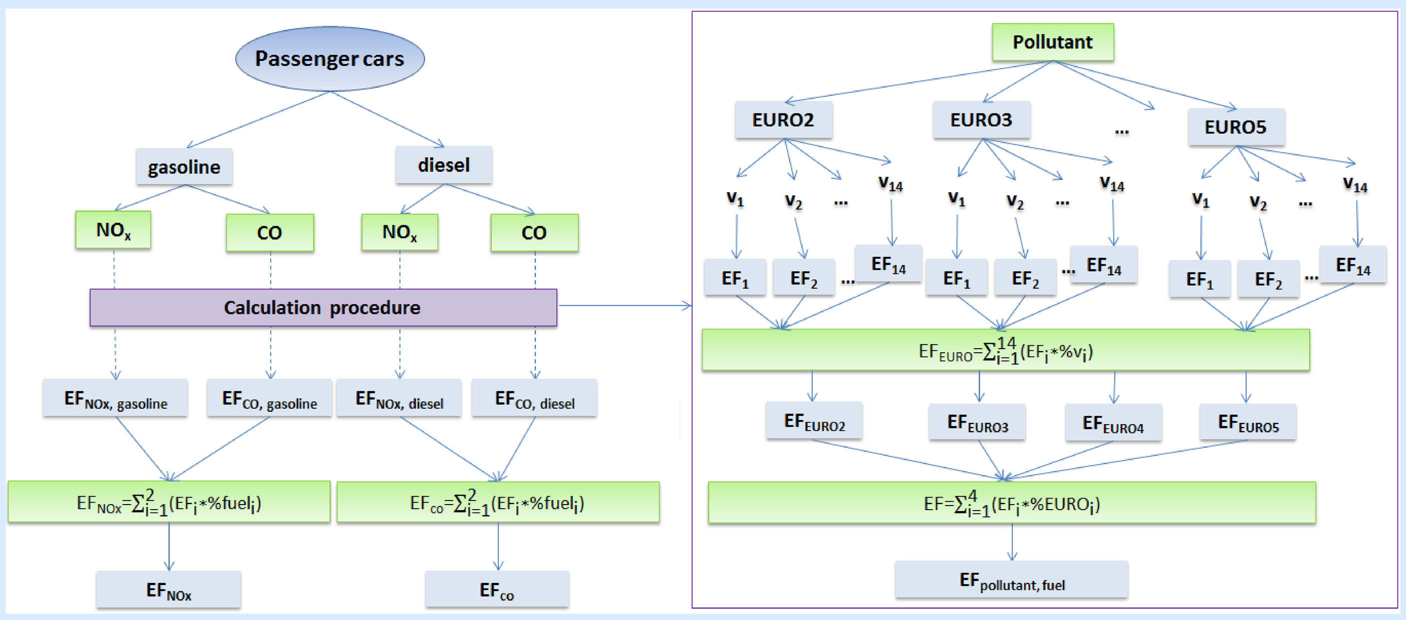
CO monitoring is performed by ARPAE only at traffic site, i.e. urban background data are not available. The correlation between measured and simulated CO is quite large (r = 0.42), due also to low sensitivity of the CO monitoring instrument.





EMISSION FACTORS

The radar traffic counter recorded the time, the length and the speed of each passing vehicle, for all lanes of the adjacent road. Emission factors (EF) were calculated according to the EMEP/EEA guidelines for air pollutant emission inventory.



Specific EFs were used depending on vehicle type, fuel type, speed and EURO category. They were mathematically weighted to obtain a single EF value for each group of vehicles and for each pollutant; the accuracy of the calculation of the weighted EF values depends on the availability of supporting data. The calculation scheme used for the passenger car EF calculation is shown in the figure above .

CONCLUSIONS

The simulated NO_x hourly concentrations highlighted the role of local traffic emissions in occasional exceedances of air quality limit while simulated CO hourly concentrations result always well below limits. Simulated and observed concentrations show a large agreement for NO_x and a fair agreement for CO.

Reference

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CONTACTS:
Prof. Grazia Ghermandi
Dipartimento di Ingegneria "Enzo Ferrari"
University of Modena and Reggio Emilia
via Vivarelli 10, I-41125 Modena
phone: +39-059-2056120
email grazia.ghermandi@unimore.it