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URBAN MICRO-SCALE INVESTIGATION OF NO_X AND CO EMISSIONS FROM VEHICULAR TRAFFIC AND COMPARISON WITH AIR QUALITY DATA

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Abstract. Aim of the study is to test the Micro-Swift-Spray model capability to simulate the dispersion of vehicular traffic emissions: through this test activity some model parameters are optimized, i.e. time modulation pattern of traffic fluxes in Modena, mass flows of emissions according to local vehicle fleet composition and traffic induced turbulence height.

Case study

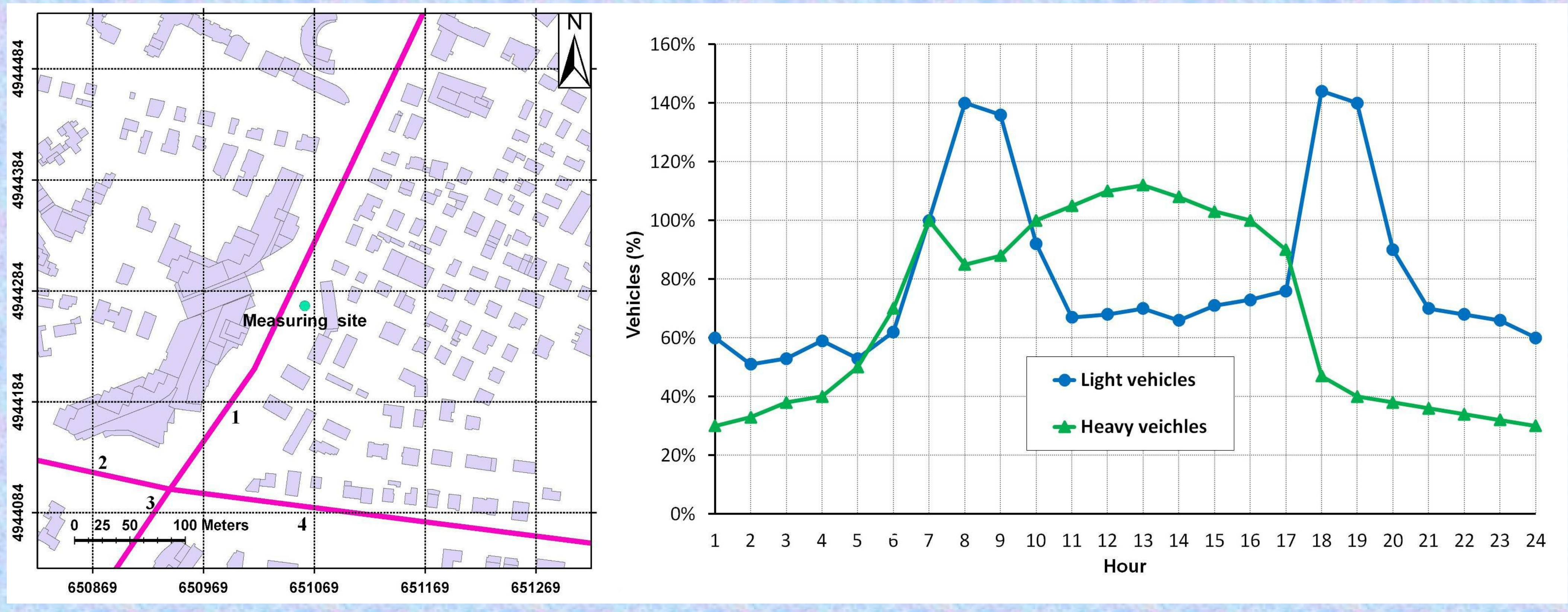

Fig. 1. **Left**: simulation domain map (UTM WGS84): measuring station (E = 654 069 m, N = 4 944 284 m) and road sources (1, 2, 3, 4) for traffic emissions. **Right**: hourly modulation patterns for traffic intensity (light and heavy vehicles) in a typical workday (in percent of the number of vehicles of the same category passing from 7:00 to 8:00). Building arrangement and road geometry were outlined from a high resolution 3D vectorial cartography of the studied domain (E. R., 2011).

Traffic emissions (NO_x and CO) from a urban crossroad;
NO_x: the most critical pollutant for vehicular traffic.
CO: quite a non-reactive chemical specie.

Pollutant mass flows: computed according to Finzi *et al.* (2000) by combining traffic measurements (number of vehicles) with a corresponding emission factor for each vehicle category: cars, buses, light and heavy trucks.

Hourly modulation of pollutant emissions is considered according to the traffic intensity on a typical workday.

Comparison with experimental measurements: air quality data were collected by Local Environmental Protection Agency (ARPA) at measuring site (Fig. 1).

Micro - SWIFT - SPRAY

Microscale model toolkit by Arianet s.r.l.:

Micro-SWIFT: 3D mass-consistent wind-field model.
Micro-SPRAY: Lagrangian Particle Dispersion Model.

Model setup

Horizontal dimensions: 500 x 500 m^2, grid step of 2 m square cells.
1st layer for concentration computing: 2 m above ground level.
Meteorological data: ARPA (Regional Environmental Agency), CALMET model and Osservatorio Geofisico of Modena & Reggio Emilia University.

Results & comparison with air quality data

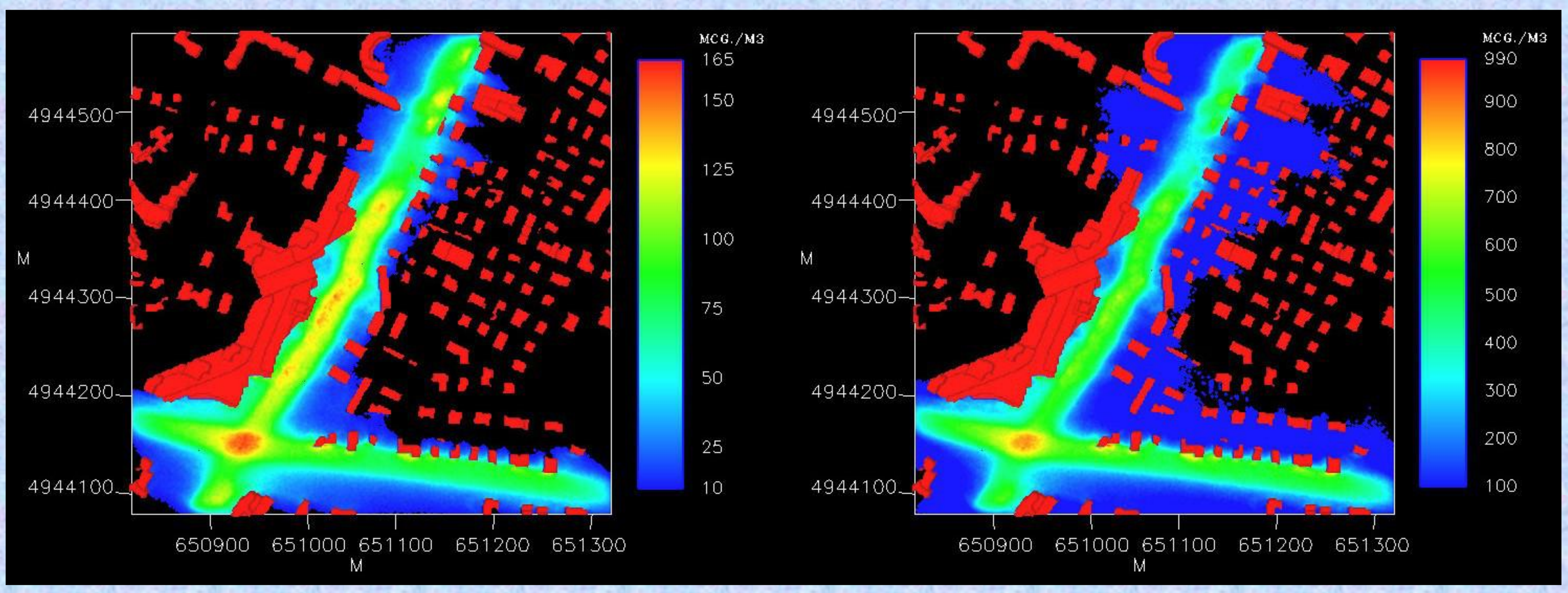

Fig. 2. Average daily concentration maps in the 1st atmospheric layer for NO_x (left) and CO (right).

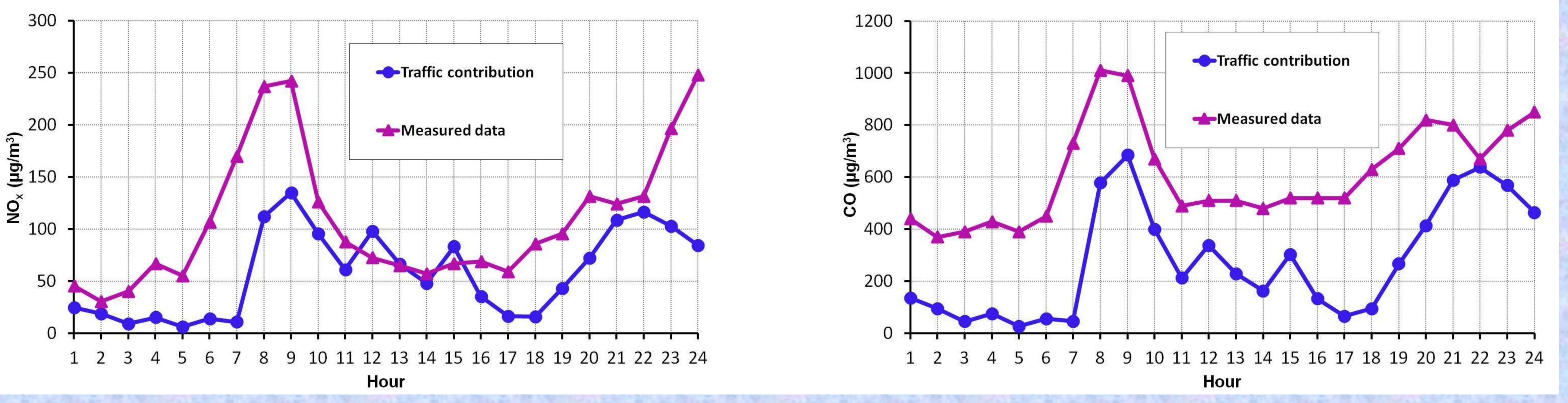

Fig. 3. Daily patterns of hourly average simulated and measured concentrations for NO_x (left) and CO (right) at the measuring site. Data refer to 28th March 2007.

Pollutant concentrations peak along the road lines, but rapidly decrease away from the road.

Urban canopy strictly inhibits pollutant dispersion for ground-level sources like vehicular traffic; pollutant concentration values are mainly controlled by pollutant emission rate, along with possible chemical reactions.

The differences are emphasized between emissions by elevated sources scenario (Ghermandi *et al.*, 2014), i.e. gas plumes from stacks, where both meteorological conditions, gas exit velocity and stack height highly influence ground pollutant concentration.

Comparison with air quality data: analysis of statistical correlation through Pearson's linear coefficient (r).
CO: good correlation (r=0.80), mainly due to the high chemical stability.
NO_x: weaker correlation (r=0.64) since NO_x is photolabile and undergoes several chemical reactions.

Conclusions

A test activity of model parameters needed by Micro-Swift-Spray model to simulate vehicular traffic emissions was carried out with encouraging results. Micro-Swift-Spray model is a reliable tool for the source apportionment of specific emission sources in urban environment, i.e. traffic, power-plants and industrial plants.

References:

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