THE NANTES '99 DATA BASE FOR MODEL VALIDATION OF AIR QUALITY IN STREETS

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THE NANTES '99 EXPERIMENT

The Nantes '99 experiment took place in the centre of the city of Nantes (France) during 5 weeks of June-July 1999. The “rue de Strasbourg” is a street canyon approximately North-South (332° from North). It is a high traffic one-way street, with three lanes, and a good homogeneity in buildings construction (Figure 1). The width of the street is 15 m and the mean height of the buildings is 22 m (H/W = 1.4). The street is 800 m long and the experimental section is located midway between two crossroads which are 60 m apart.

The experimental set up included a densely instrumented street section, a series of traffic counters, and one mobile laboratory belonging to the air quality survey association Air Pays de la Loire. In addition, the permanent network station monitoring "proximity pollution" is located 150 m North from the study section, at 4 m above the ground ; this station measures CO and NO_x. The mobile laboratory was stationed 250 m South from the measurement section (Figure 2) ; it measured CO, NO_x, SO_2, dust and O_3 at 3.5 m above ground, temperature and relative humidity at 5 m, and wind speed and direction at 10 m a.g.

The experiment was conceived in view of validating the numerical models of the participating groups, especially the CHENSI model for flow and pollutant dispersion within streets, and SOLENE for radiation-heat transfers and budgets on building elements. It was focused on the low wind conditions favouring pollution accumulation in the street, especially with high solar radiation which creates high surface temperature differences, generating in turn convective flows. The experiment had three main aims : (1) to document the ventilation wind fields in the street, (2) to document the temperature distribution at the wall surfaces and evaluate its influence on the flow structure in the street and on the pollutant dispersion, (3) to determine the production of turbulent kinetic energy due to vehicles motion, which was expected to influence the pollutant dispersion in very low wind conditions. Carbon monoxide was chosen as a tracer of the traffic pollutant emission, due to its low reaction rates at the scale of the dispersion within the street. CO was measured at 6 out of 8 inlets, at three levels in the street.

The wind field and the turbulence, naturally produced or generated by the vehicle flow, were measured by 6 3-D anemometers, 3 sonic anemometers at the lower levels of the street (1.5 and 4 m a.g., on two small masts located at pedestrian platform edges) and 3 propeller anemometers at the upper levels (4, 12 and 16 m a.g.). In addition, 6 hot wire anemometers measured high frequency turbulence. Air temperature was measured with combs of 7 thermocouples extending from the walls at the levels of the anemometers and across the street at 12m a.g. Surface temperatures were also measured with thermocouples pasted on the walls. Reference wind, CO concentration and temperature were measured at a 7 m high mast over the roof of the western building, along with global, diffuse, and Infra-Red radiations (Figure 3).

The traffic was monitored by vehicle counters and speed sensors at eight different places within the street and within the neighbour streets (Figure 4). In addition to the fixed set-up, a mobile 3D propeller-bivane anemometer was positioned at 3 m a.g. in either one of the lateral streets.

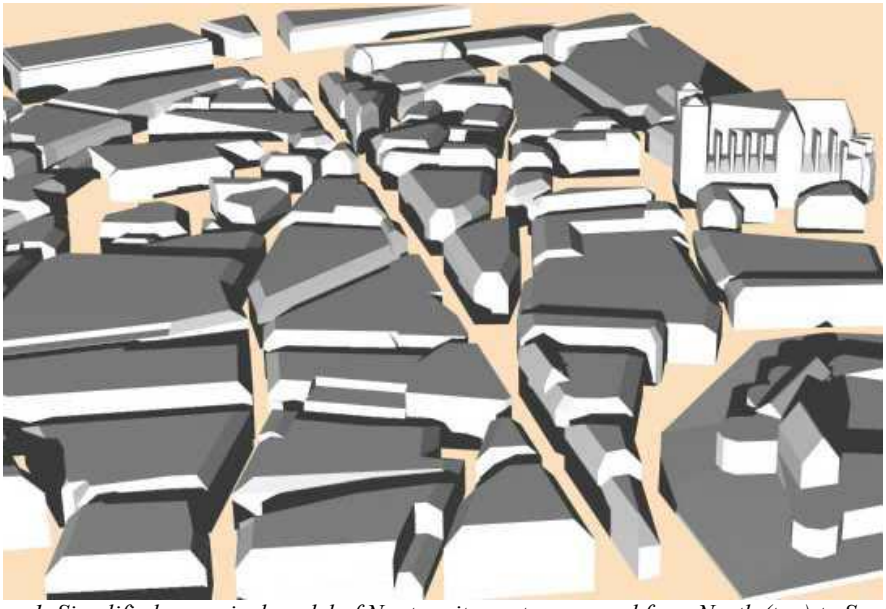

Figure 1. Simplified numerical model of Nantes city centre, crossed from North (top) to South by the Rue de Strasbourg : this simplified $2^1/_2$-D database does not show the yards within the building blocks

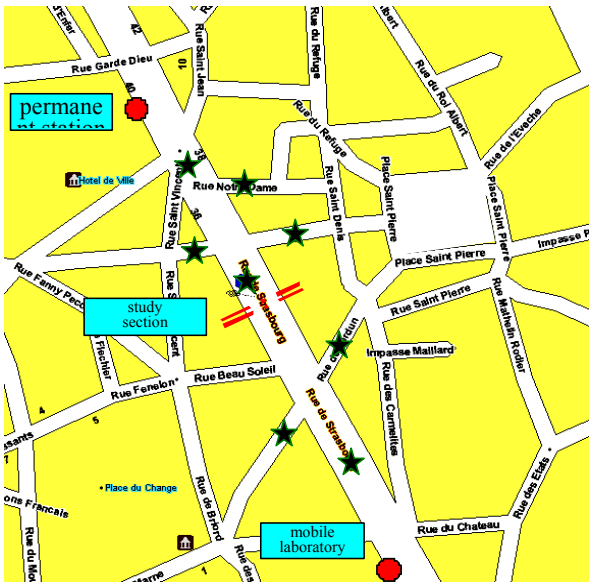

Figure 2. Map of the city centre showing the study section, the permanent monitoring station and mobile laboratory of Air Pays de la Loire, the traffic counters (stars)

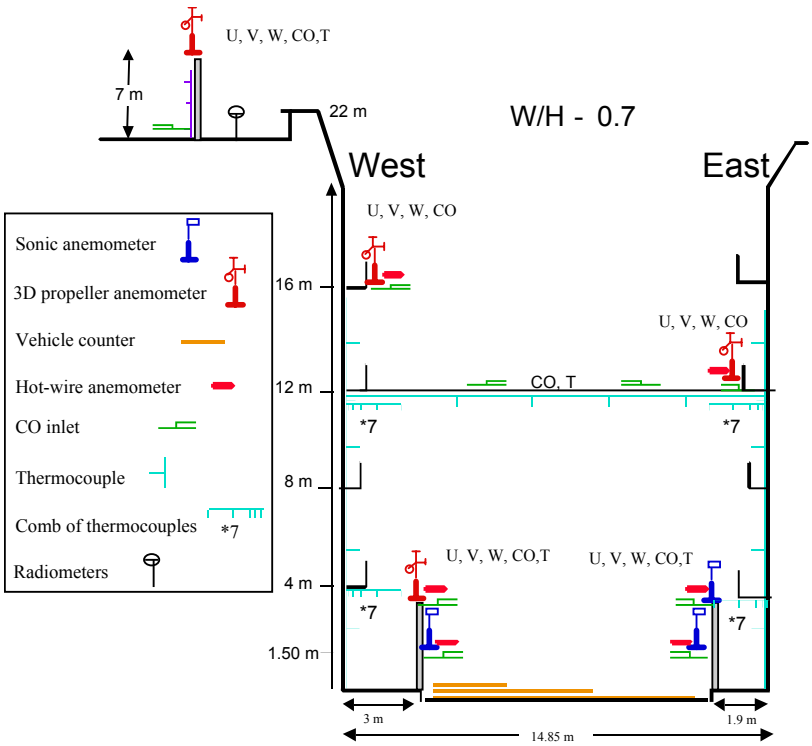

Figure 3. Scheme of the experimental set-up cross-section

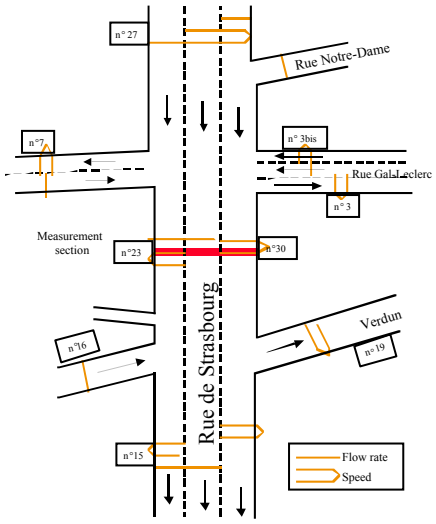

Figure 4. Map of the measurement section and vehicle counters in the neighbour streets.

THE NANTES '99 DATA BASE

A data base comprising the measurements taken during the experiment Nantes'99 has been constructed with Microsoft® Access, for validation purpose. The present version includes only the Intense Observation Periods (IOP) which correspond to days with wind speed less than 3 $m.s^{-1}$ at the reference level (30 m above the ground), large solar radiation, and dense traffic. These atmospheric conditions were chosen in order to obtain high pollution episodes and the most effective thermal situations. During the selected IOPs, all the sensors were operational. The data base is split into three separate data sets : Nantes'99, Trafic'99, and bivane.mdb.

Each table of the "Nantes'99" data set corresponds to one full day of measurements from 0:00 to 24:00 local time, with a time step of 15 minutes. It contains the measurements of wind direction, wind speed, fluctuations of the three wind components, temperature, and CO concentration within the street and at the roof reference mast, the radiation components, the pollutant concentrations at the fixed and mobile stations, the meteorological data obtained at the mobile laboratory.

Each table of "Trafic'99" corresponds to one full day of measurements with a time step of 15 minutes for each traffic sensor. The flux of vehicles per lane, the total flux of vehicles and, according to the type of the counter, the mean velocity of the vehicles or the number of light and heavy-duty vehicles are included in the tables. The data set "bivane.mdb" includes wind measurements within the lateral streets with the bi-vane 3D propeller anemometer (mean wind speed, direction and 3 components).

The data base is openly available on request for model validation, on one CD.

The experiment was described in details by Vachon et al. (2000), while the first scientific analyses were presented by Vachon et al. (2001), Louka et al. (2001), Berkowicz et al. (2001).

ACKNOWLEDGEMENTS

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