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Analysis of urban air quality in 6 European cities by lower cost sensors, Lagrangian urban dispersion modelling and traffic flow modelling: the TRAFAIR project

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Most of worldwide population lives in urban areas, demanding for air quality information with a high spatio-temporal resolution. The most promising approaches for estimating urban air quality within the complex urban topography are small sensor networks and simulation models.

The TRAFAIR project focuses on understanding the role of traffic emissions on urban air quality by the combination of dispersion modelling, space- and time-resolved gas monitoring by lower cost sensors and realistic traffic flow rates by dynamic traffic model based on real time traffic data. Test cities of TRAFAIR are Modena, Florence, Pisa, Livorno, Zaragoza and Santiago de Compostela.

Depending on the size of the urban area, from 6 to 13 sensors units are deployed across each city since August 2019, providing estimates of NO, NO_2, CO and O_3, along with RH and temperature. Metal oxide sensors are deployed in Tuscany (Florence, Pisa, Livorno) and electrochemical cells are used elsewhere. The units are calibrated on a regular basis by co-location at the air quality regulatory stations and subsequently deployed across the town to monitor several representative locations (e.g. Low Emission Zones, hospital surroundings). For each sensor the raw readings (e.g. mV for electrochemical cells) are collected and a regression model (e.g. Random Forest) is applied to derive a calibration function, exploiting the data from the regulatory stations during co-location periods; for instance in Modena, the first short-term calibration provided a model with a Mean Absolute Error between 5 – 6 ppb and 2 – 4 ppb for NO and NO_2 respectively.

The sensors are used for both real-time urban air quality mapping and to test and validate the 24hr forecast service of NOx by the microscale lagrangian dispersion model GRAL. The simulation domains, covering the urban area of each TRAFAIR city, have a horizontal resolution of 4 m and allow to account for the presence of buildings. The dispersion model mainly focuses on NOx by traffic emissions, although domestic heating will be also included in the analysis. Vehicular emissions are based either upon historical traffic data (e.g. induction loops), or upon previously available traffic flow simulation, or upon traffic pattern reconstruction using a traffic flow model followed by a cluster analysis to group streets with similar pattern.

The final goal of the project is the development of a tool to support local policymakers and to inform citizenship about the quality of air and the impact of urban emission sources, particularly traffic. A secondary goal of the project is the development of a valuable QA/QC protocol for small sensor units and the optimization of the modelling chain for the forecast of traffic and domestic heating impact on local air quality at the urban scale.