

# **Development of an integrated air quality management system for urban areas**

A contribution to subproject SATURN

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## **Summary**

This report describes the contribution of GEMAC/University of Aveiro to the SATURN subproject during the last year of work. Principal results in 2000 include the development and testing of an integrated system of two models: (i) the Transport Emission Model for Line Sources (TREM), and (ii) the local air quality model VADIS. This integrated system is planned to be used as a tool to decision support in air quality management at local scale for urban areas.

## **Aim of the research**

The main purpose of the contribution of the University of Aveiro to the SATURN subproject is the development of an air quality management system for urban areas. This research work combines several activities including the development and implementation of an emission model for road transport; the adaptation and improvement of the local scale model VADIS in order to be applied to urban areas; and, the validation and application of the models.

## **Activities during the year**

The local scale VADIS model is based on the Lagrangian approach and is able to calculate instantaneous concentrations of gaseous pollutants. It was improved in order to better describe obstacles (multi-obstacle) and flow fields (any direction) as well as emissions (multi-source, time varying). The model provides a good performance and is particularly valuable under low-wind speed and varying wind conditions.

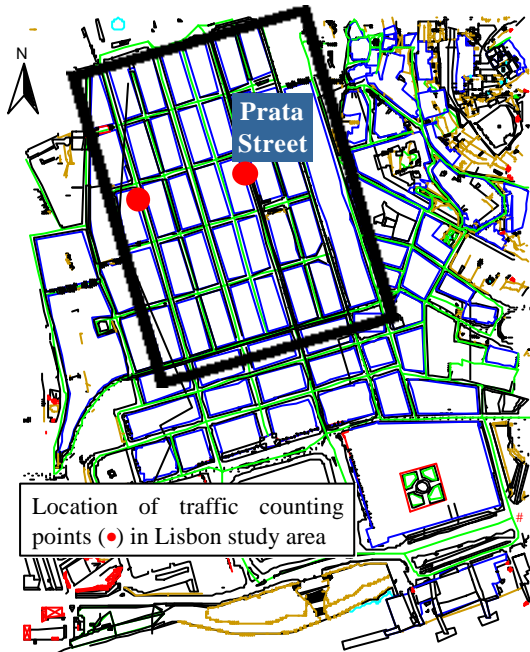
Also, a transport emission model specially adapted for line sources was developed. It is based on MEET/COST methodology and integrated in GIS environment to improve and simplify the spatial data processing. The model distinguishes between different vehicle type, technology, engine capacity, and the average speed approach is used.

The validation with real scale data and with measurements performed at two wind tunnels, at the Department of Environment and Planning of the University of Aveiro, is a task prepared to be sure of the good performance of VADIS.

In addition to the contributions above mentioned, an important work has been done on the project level concerning Quality Assurance/Quality Control. The methodology and general requirements for the QA/QC implementation in SATURN were developed in order to ensure that the appropriate methods and data are used, that error in calculations and measurements are minimised and that documentation is adequate to meet the project objectives.

## Principal results

Aiming to contribute to the Lisbon air quality management, a downtown area was chosen, and the integrated models, TREM and VADIS, were applied for a typical summer week day. Higher values of traffic are observed in the downtown during summer due to its tourist interest.

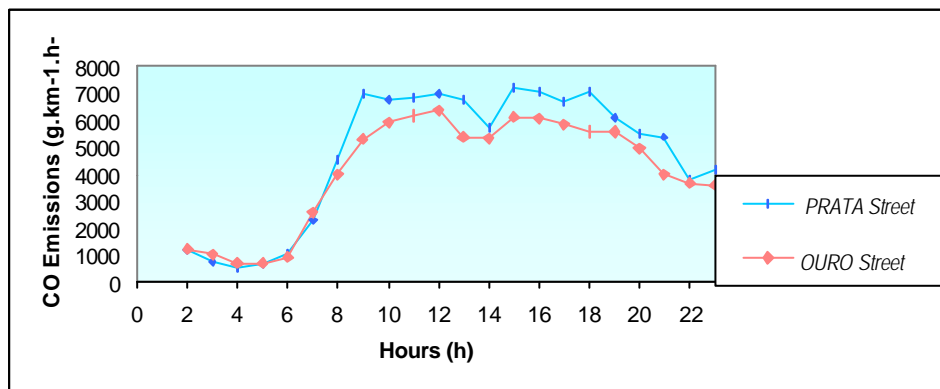


**Figure 1.** Domain simulation for VADIS model.

The study area covers 400 m x 400 m and local hot spot air pollutants levels are expected to occur there.

Hourly traffic emissions were estimated with TREM using local data sets including traffic counting (see figure 2). Emission factors based on average speed were considered as the best approach. Also, different technology (engine type, model year) and engine capacity are distinguished in TREM model to derive emission factors. The following pollutants were covered: CO, NO<sub>x</sub>, SO<sub>2</sub>, VOC, CO<sub>2</sub> and particulates [Borrego et al., 2000]

Figure 2 presents the hourly variation of CO emissions estimated by TREM for Prata and Ouro Streets for August 16<sup>th</sup>.

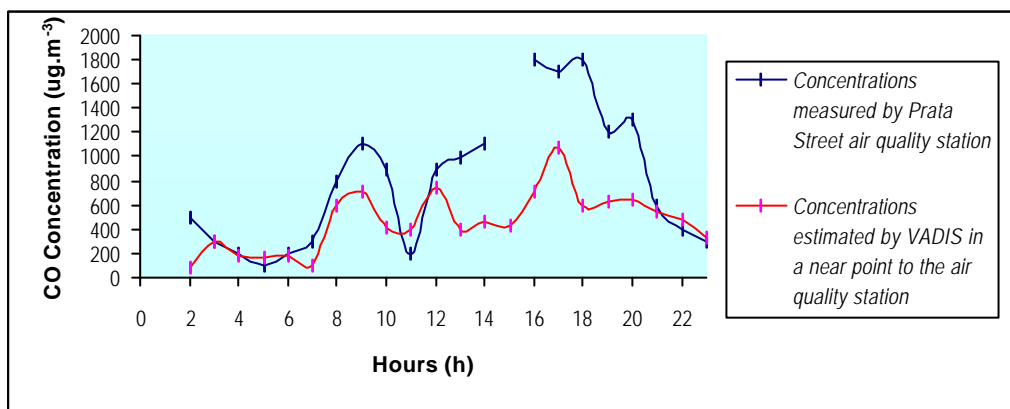


**Figure 2.** Hourly variation of CO emissions for Prata and Ouro Streets for August 16<sup>th</sup> estimated by TREM.

It is possible to notice a similar behaviour of CO emissions in both streets, which is quite related to the traffic flux, with smaller values during night, increasing with the sunrise, until a peak hour, around 9 a.m.

In order to obtain CO concentration levels in this area VADIS was applied. Wind direction during the simulation day was mainly from North and Northeast. Information on the buildings volumetry, CO emissions, and meteorology was given as input data to the model.

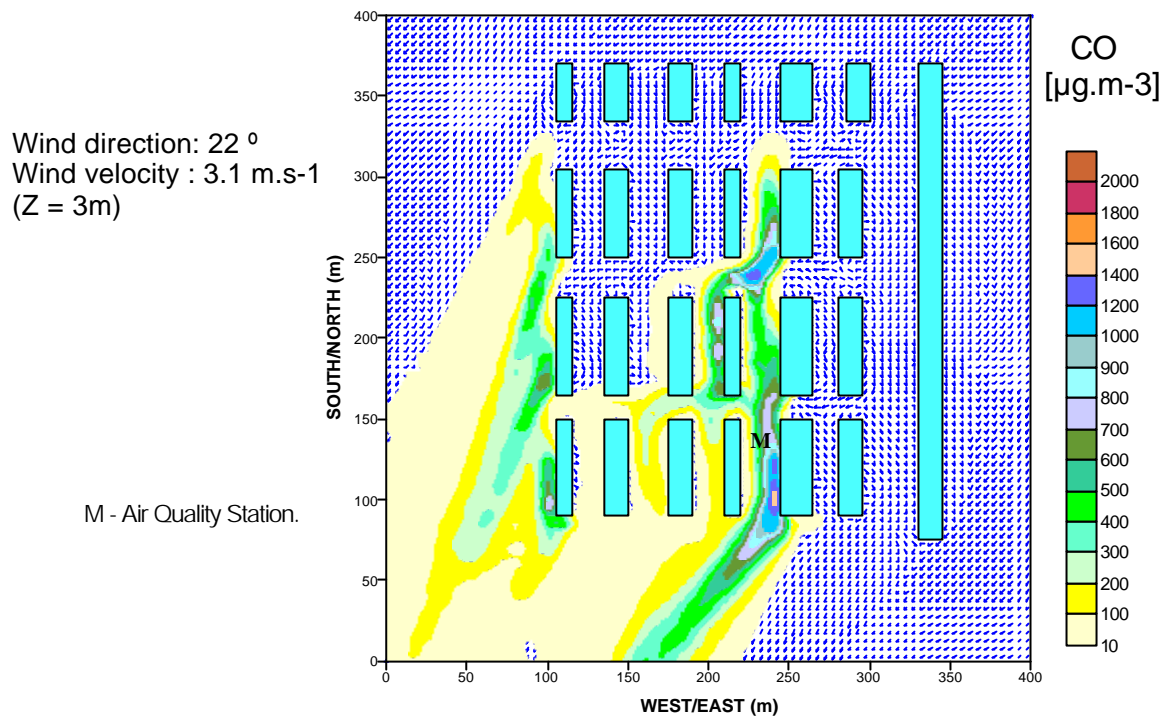
In Figure 3, a comparison between CO measurements from an air quality station located in Prata Street (see figure 4) and VADIS results is presented. CO concentration values, measured and estimated, are not very high, never exceeding the limit hourly value of the Portuguese legislation ( $40\,000\ \mu\text{g}\cdot\text{m}^{-3}$ ) or even the 8-hours average limit value ( $10\,000\ \mu\text{g}\cdot\text{m}^{-3}$ ). During night and the first morning hours, measurements and estimated values are quite similar. However, from midday till 9 p.m. measured values are higher than VADIS results. This behaviour can be related to the transport of CO from other sources (namely, other roads) outside the simulation domain. The model still needs some improvements in order to better integrate boundary and background concentration values.



**Figure 3.** Comparison between CO concentrations measured by the air quality station located at Prata Street and the concentrations calculated by VADIS.

Figure 4 represents the wind and dispersion fields for 12 a.m., when the model has an output similar to the air quality data. It is possible to notice that the higher CO concentration values are located in Prata Street and in the adjacent pedestrian street, since the main winds blow from Northeast. Nevertheless, these values don't exceed the legislation.

VADIS is being applied to other European cities and their results will be carefully analyzed and compared with air quality measurements.



**Figure 4.** CO dispersion simulation for the 12 a.m. of 16<sup>th</sup> August.

## Main conclusions

The developed system TREM / VADIS is a useful and friendly tool (because a graphical interface was developed) for air quality management in urban areas. Several traffic scenarios can be simulated and analysed aiming to support decision in order to improve the urban air quality. This system can also be used to determine local hot-spots values.

The capability of this numerical tool to calculate the flow and dispersion around obstacles under variable wind conditions opens a vast application field in areas like air quality assessment and policy support with regulatory purposes, or in emergency planning. The model results analysis allows obtaining air quality reference values at the simulated area, which can be used in traffic management as a way to improve citizens' life quality.

## Acknowledgements

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## References

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