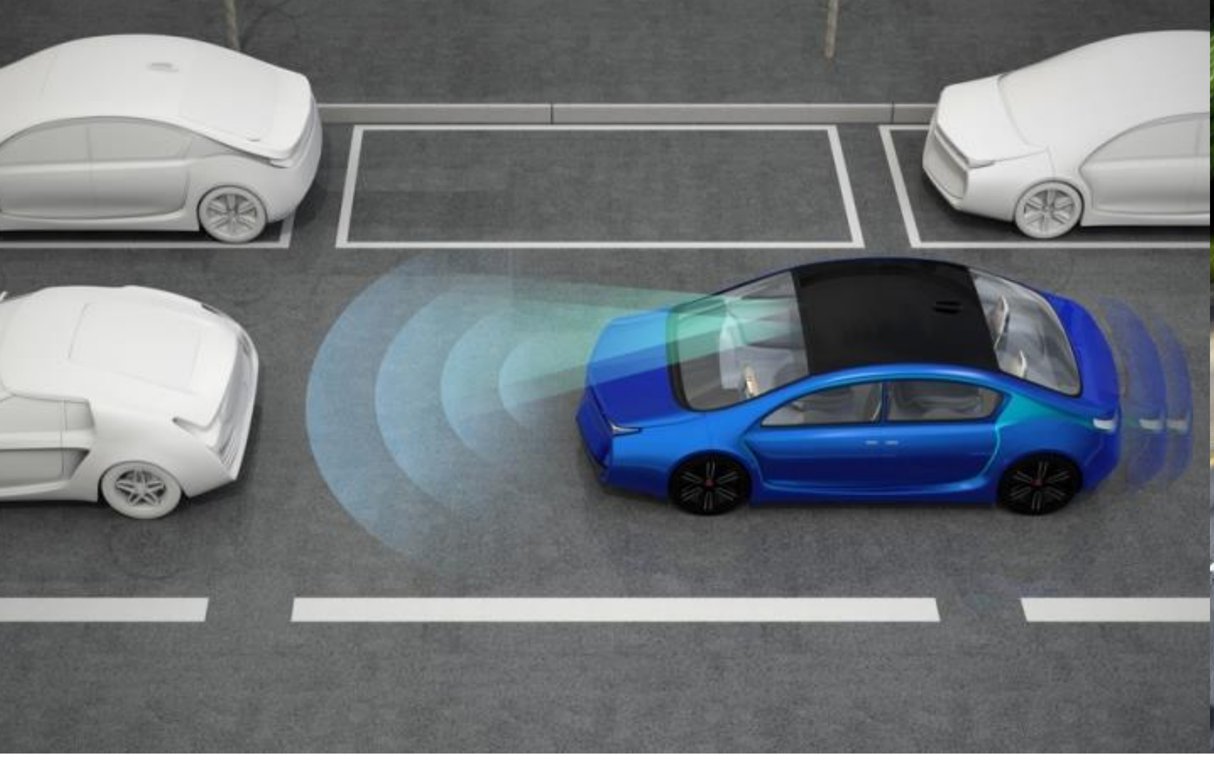
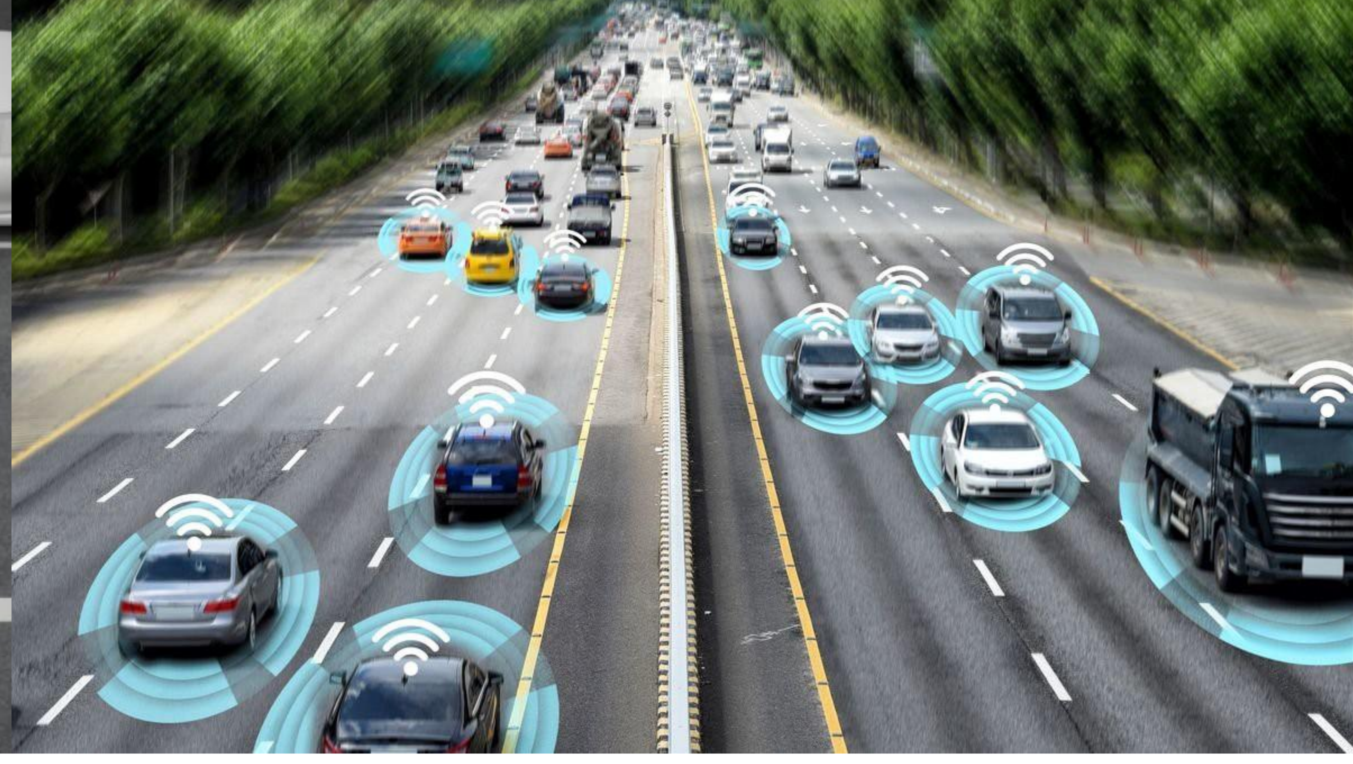
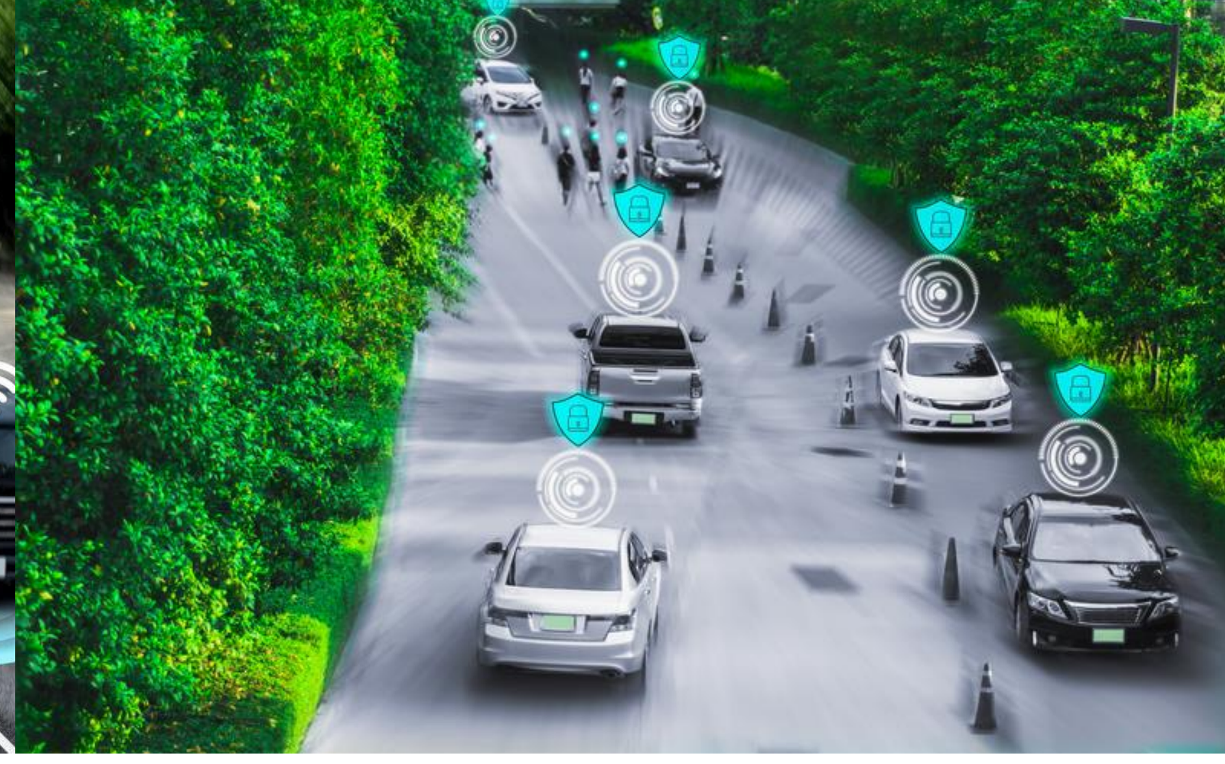

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INFLOWENCE PROJECT: AUTONOMOUS VEHICLES OPPORTUNITIES FOR AIR QUALITY

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Abstract

The European Strategy for Low-Emission Mobility highlights the potential of cooperative, connected and automated vehicles to reduce energy consumption and atmospheric emissions from road transport. The ongoing InFLOWence research project aims to contribute to help policymakers to make wise policy decisions in this rapidly evolving field. InFLOWence will also contribute for improving regulations in order to encourage manufacturers to provide efficiency-optimizing features like automated eco-driving, eco-routing, platooning or on board energy saving algorithms. The main goal of this work is to present the first results of InFLOWence project related to the opportunities of the CAV technology to improve cities air quality.

The problem

Environmental concerns are not usually a priority associated with the task of driving. However, this situation can be changed as vehicles become increasingly connected and autonomous and road infrastructures will progressively incorporate cooperative intelligent transport systems, contributing to the positive-sum game of both efficiency and environmental sustainability. The main vision of InFLOWence is to take advantage of the predictable market penetration of connected and autonomous vehicles (CAVs) in the short-medium term to influence, in a positive way, the performance of the road transport system in terms of congestion, energy consumption and atmospheric pollutant emissions.

The challenge

Understand and quantify the impact (positive or negative) of CAVs on the air quality, focused on NO_2 concentrations, of a medium-sized Portuguese urban area characterized by high road traffic flow.

The approach

The modelling setup composed by the PT VISSIM (to estimate the impact of CAVs on traffic network), VSP - Vehicle Specific Power (to estimate the impact of CAVs on atmospheric emissions) and CFD VADIS (to estimate the CAVs impact on air quality) was applied to:

- Baseline scenario, which considers the current vehicle fleet;
- Six CAVs scenarios, considering different rates of CAVs penetration – 10%, 30%, 50%, 70%, 90% and 100% - and assuming an engine technology in line with the remaining vehicle fleet.

The modelling setup was applied to a main avenue called *Avenida 25 de Abril* of a medium-sized city in the Northwest of Portugal, Aveiro (Fig. 1a). This avenue is located in the city centre, surrounded by residential buildings and two high schools, contributing to high road traffic volume levels at peak hours. All these features make this avenue a perfect worst-case scenario for CAVs, with plenty parameterization to be made. The computational domain used is displayed in Fig. 1b.

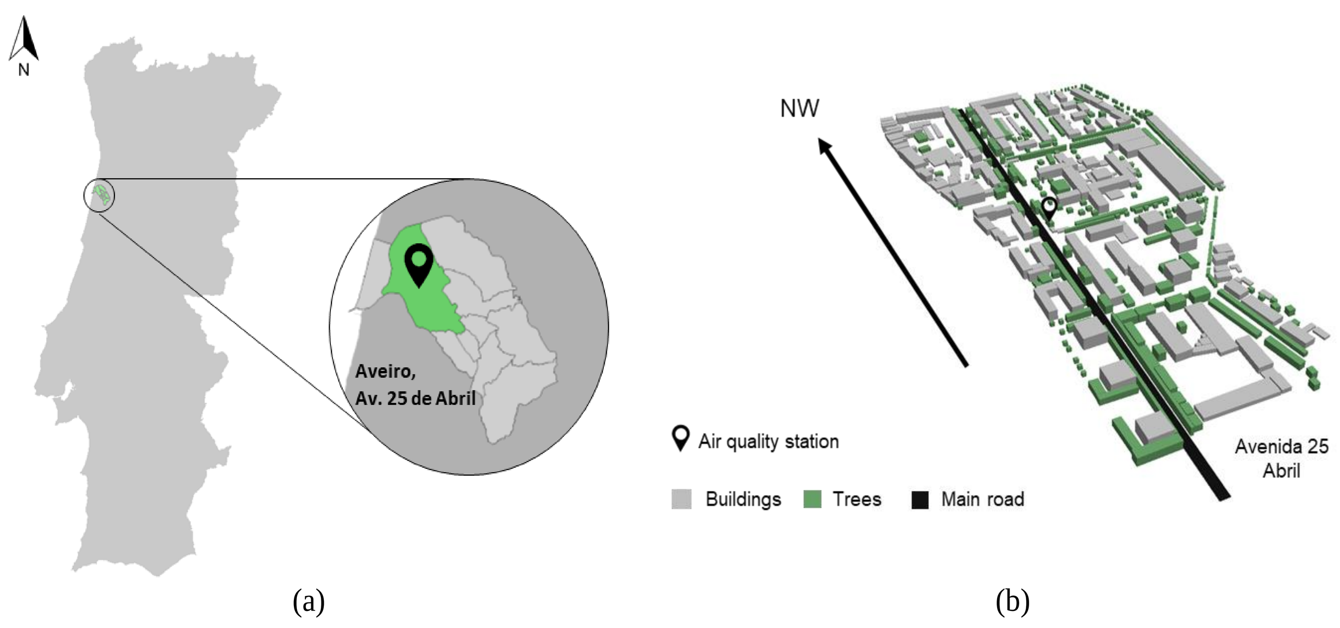

Fig 1 / (a) Geographical location of *Avenida 25 de Abril*. This street is located in the centre region of mainland Portugal, in the municipality of Aveiro. (b) Computational domain considered for the CFD VADIS simulations – *Avenida 25 de Abril* in Aveiro, Portugal.

The assessment was made for a typical weekday, which was characterized in terms of road traffic flow speed, time, distance, vehicle counting in an hourly basis and meteorological conditions during an experimental campaign. A more detailed description of this application can be found on Rafael et al. [1].

Acknowledgements

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References

[1] Rafael S., L.P. Correia, D. Lopes, J. Bandeira, M.C. Coelho, M. Andrade, C. Borrego, A.I. Miranda, 2020: Autonomous vehicles opportunities for cities air quality. Sci Total Environ, 712.

Main outcomes

Main outcomes are shown in Fig. 2, considering, as example, a CAVS penetration rate of 100% (S100). The following were concluded [1]:

- The use of CAVs showed an overall tendency to promote positive benefits (decreases of NO_2 concentrations) on air quality, despite some occasional increases of NO_2 values (negative effects);
- The benefits on air quality increases as higher is the CAVs penetration rate on the vehicle fleet;
- The urban morphology, the road characteristics and the meteorological conditions (wind velocity and wind direction) has a role on the effects of CAVs on air quality (by establishing its behaviour – positive or negative effect – and the magnitude of its impact).

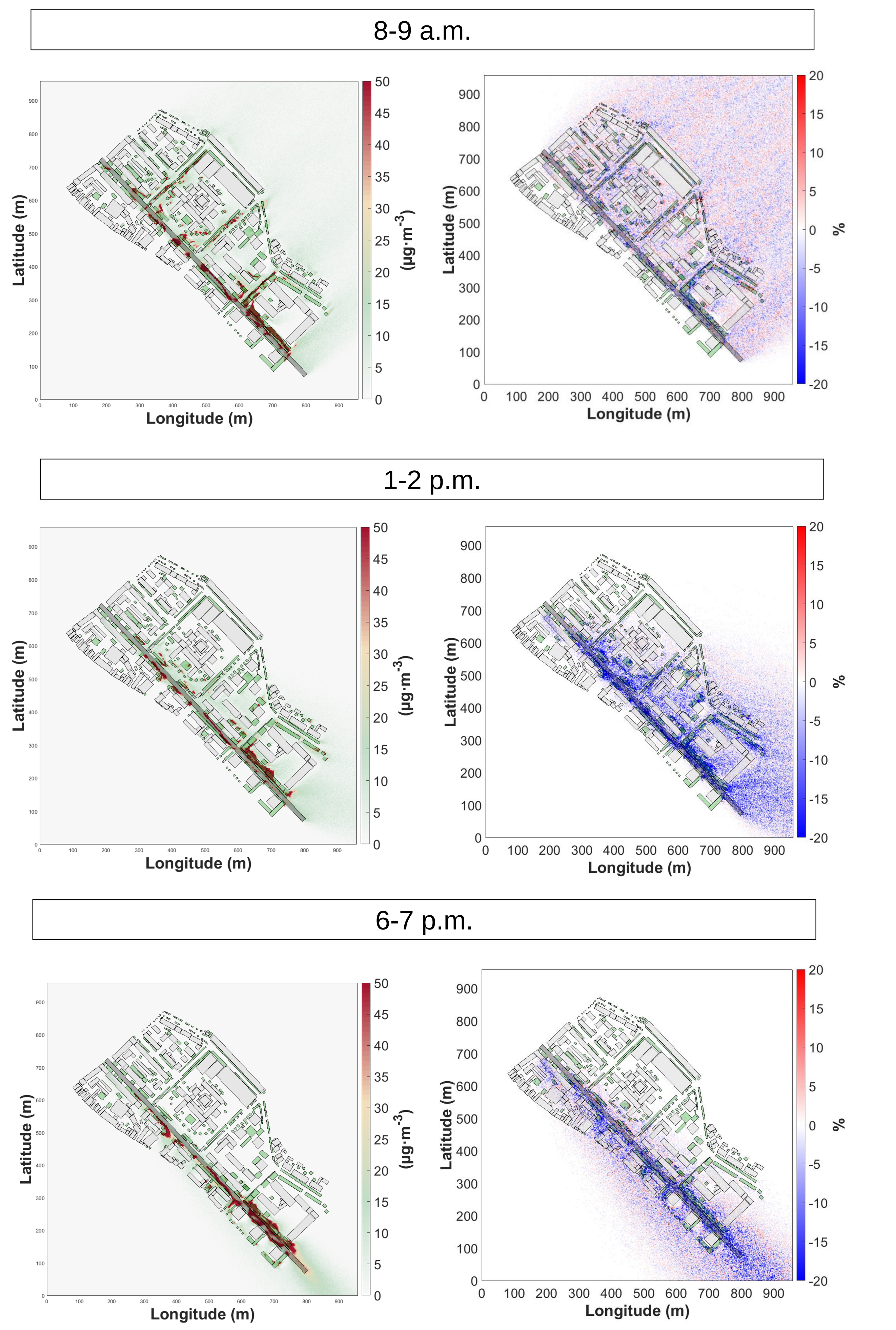

Fig 2 / Spatial distribution of the NO_2 concentrations (on the left) and relative difference (in percentage) between the S100 and baseline scenario (on the right) across the computational domain of Aveiro case study. Contours refer to the period of 8-9 a.m., 1-2 p.m. and 6-7 p.m.

In general, the first results of the InFLOWence project highlights the potential of CAVs technology to improve urban air quality. The CAVs benefits will be maximized if properly planed at operational (driving dynamics) and strategic level (choice of route and propulsion technology). Due to the novelty of this issue, more evidence are needed to improve the evaluation reliability.