Personal exposure to nanoparticles inside Transmilenio Buses on the road corridor Caracas Avenue in Bogotá city - Colombia

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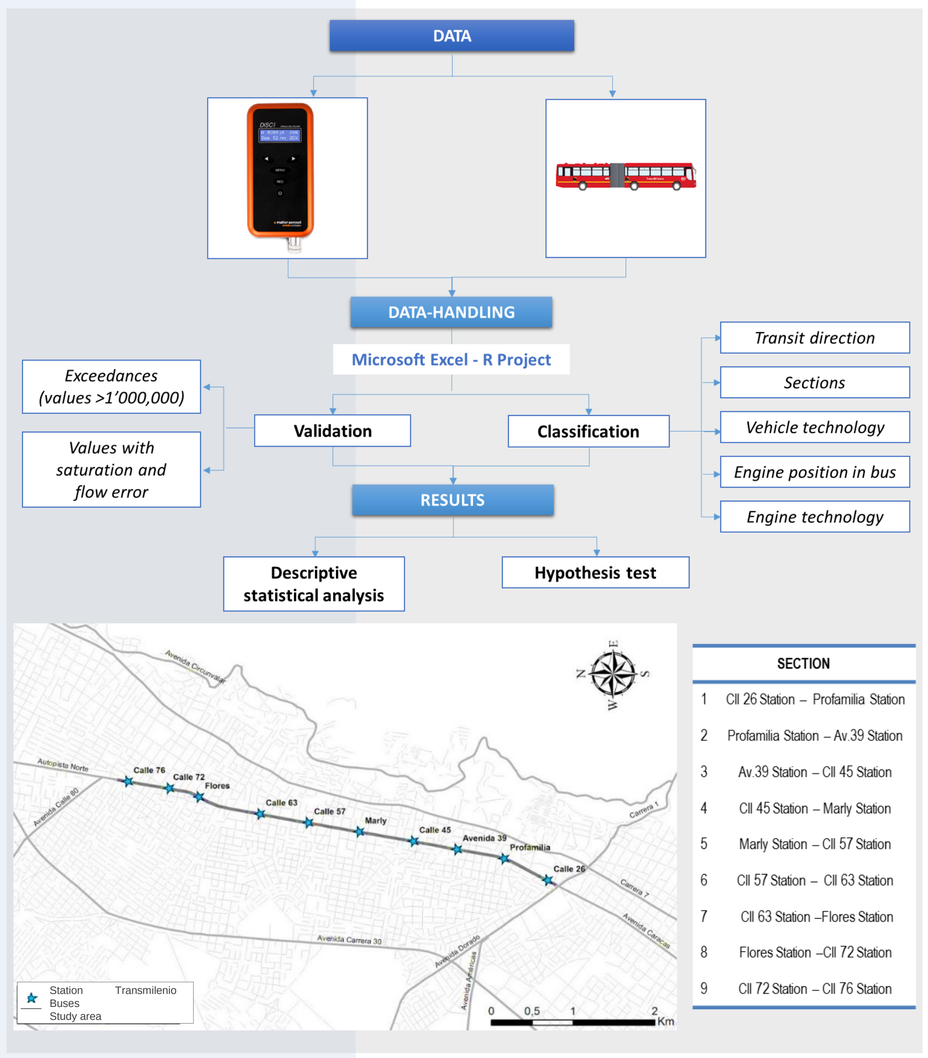
Introduction

The District Secretariat of Environment seeks to reduce emissions of particulate material in mobile sources through the execution of prioritized and complementary actions.

The study seeks to be a baseline to compare the impact of the Diesel Particulate Filter Program in Bogota City at the time of implementation. To this end, the nanoparticles concentration to which Transmilenio passengers are exposed on the road corridor of Caracas Avenue and the correlation with technologies of the sources that move was determined.

The road corridor of Caracas Avenue was chosen due to the fact that it is one of the most predominant way of transport system for the high demand for buses.

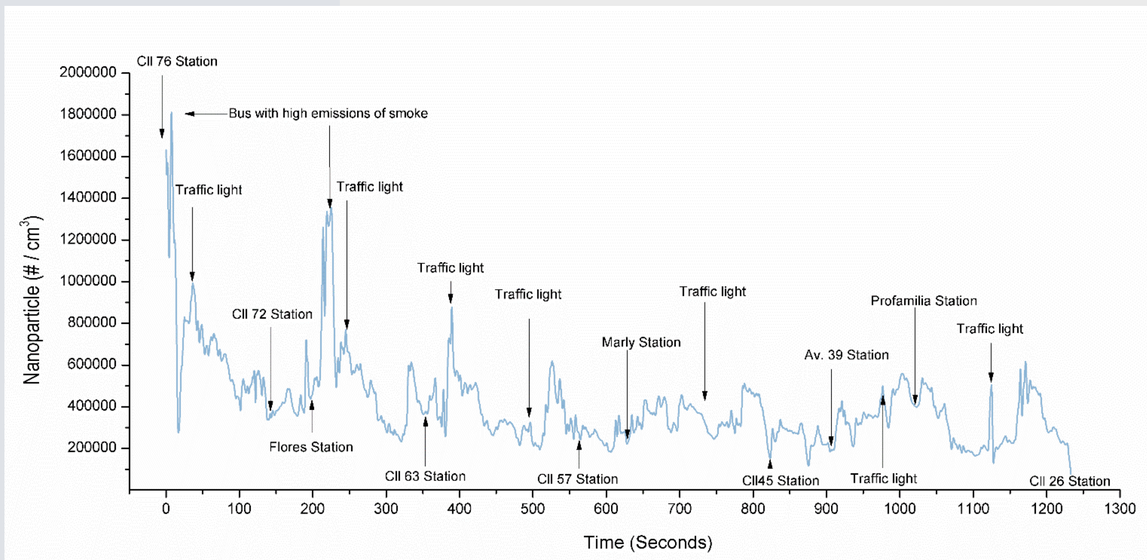
Methodology



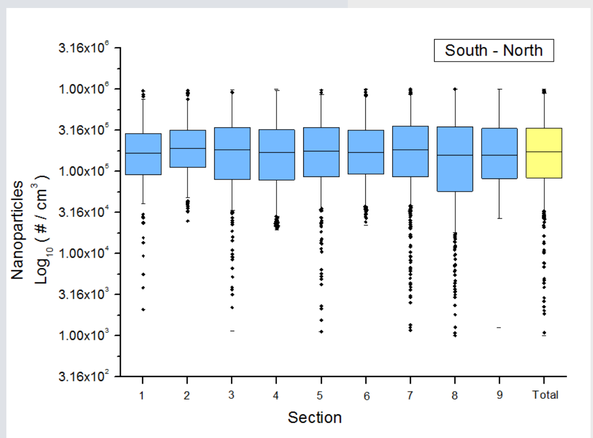
SECTION	
1	Cll 26 Station – Profamilia Station
2	Profamilia Station – Av.39 Station
3	Av.39 Station – Cll 45 Station
4	Cll 45 Station – Marly Station
5	Marly Station – Cll 57 Station
6	Cll 57 Station – Cll 63 Station
7	Cll 63 Station –Flores Station
8	Flores Station –Cll 72 Station
9	Cll 72 Station – Cll 76 Station

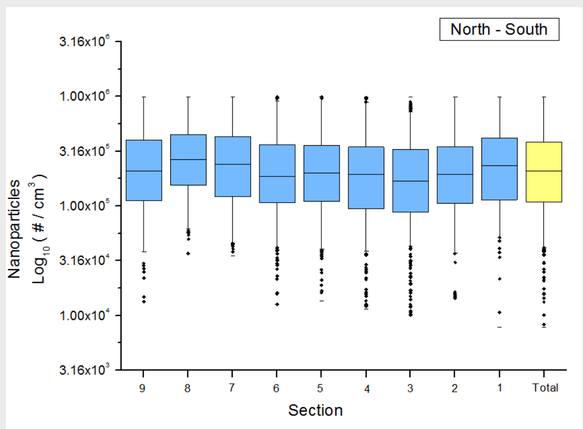
Results

I.-Typical exposure profile to nanoparticles

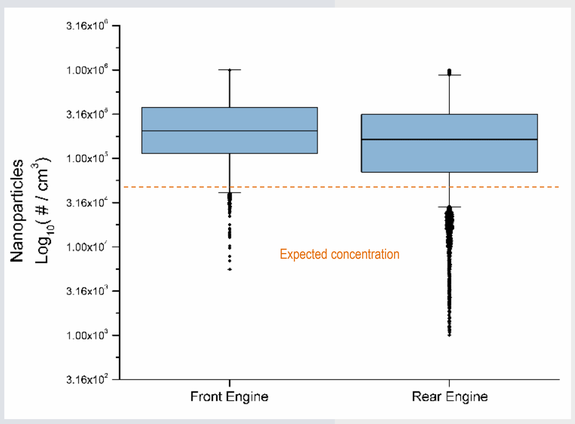


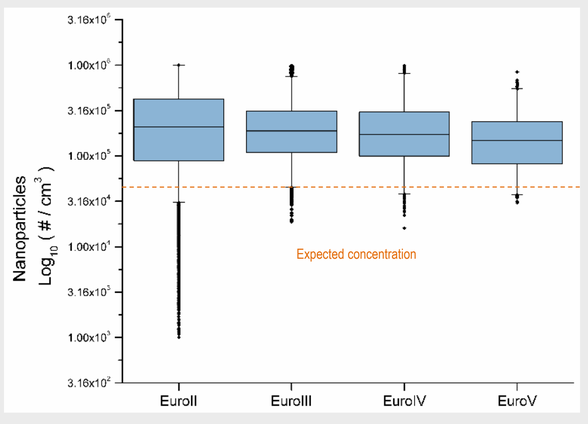
II. Nanoparticles concentration according to direction road





III. Nanoparticles concentration according to emissions standard and engine position





Conclusion

- The nanoparticle concentration within the Transmilenio buses are four times higher compared to international studies in other cities because It presents a median between 233.233 #/cm^3 and 172.647 #/cm^3. Furthermore, they are associated with the external events from the bus such as the passage of other vehicles or stagnation from it in traffic.

- The results show that the average concentration and the dispersion of data decrease as the technology in engine emission increases. Likewise the concentrations when the engine is placed at the front of the bus are higher than when the engine is placed at the rear of the chassis .

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- GICA – Research Group of Air Quality – Universidad Nacional de Colombia.

References

Kumar, P., Morawska, L., Birmili, W., Paasonen, P., Hu, M., Kulmala, M., . . . Britter, R. (2014). Review: Ultrafine particles in cities. Environment International(66), 1-10.

Kumar, P., Robins, A., Vardoulakis, S., & Britter, R. (2010). A review of the characteristics of nanoparticles in the urban atmosphere and the prospects for developing regulatory. Atmospheric Environment, 44(1), 5035-5052.

ALCALDÍA MAYOR DE BOGOTÁ D.C.
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SECRETARÍA DISTRITAL DE AMBIENTE

PERSONAL EXPOSURE TO NANOPARTICLES IN TRANSMILENIO BUSES ON THE ROAD CORRIDOR OF CARACAS AVENUE IN BOGOTA CITY

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The District Secretariat of Environment through the ten-year plan of air decontamination to Bogota City (PDDAB), adopted by 098 District Decree 2011, proposes to reduce emissions of particulate material in fixed and mobile sources, through the execution of an optimal portfolio of prioritized and complementary stockings. Among them, is the implementation of the Particulate Diesel Program for Bogota City – BDPF, established by the 088 and 123 resolutions 2015, wherein it requires the installation of DPF in buses, both the trunk component (Transmilenio), such as the zonal component from de Bogota City Transport Integrated System (SITP).

According to the above, this study seeks to be a comparison point of impact of the Diesel Particulate Filter Program to Bogota City at the time of implementation. To this end, the nano-particles concentration to which Transmilenio passengers are exposed on the road corridor of Caracas Avenue between 26th street and 76th street and the correlation with technologies of the sources that move was determined. This trunk was analyzed due it does not contain the public traditional collective transport traffic (TPC) or zonal urban service routes (SITP); being this, one of the most predominant way of transport system for the high demand for buses.

The measurements were carried out Monday to Friday from 28 September to 6 November 2015, between 11:00 and 13:00, wherein Transmilenio buses routes stopping at all stations were addressed, so that, take tours in both traffic (north-south and south-north); this route had 10 stations which divided into nine sections, comprising the intervals between each of the sections. To determine the nano-particles concentration a diffusion counter portable, DISCmini (Matter Aerosol), which was located at a height approximately 1.4 m above ground level next to sampler in the zanfona of the vehicle was used.

Data obtained the number of particles in the study area were processed using the software DISCmini and subsequently also a descriptive statistical analysis and hypothesis tests for comparing sections, emission standards and the engine position were performed.

The results show that the level of concentration of nanoparticles is different depending on the direction of the road, presenting a median of 233.233 pt/cm^3 to the North-South direction and 172.647 pt/cm^3 to the South-North direction. Also, in the typical exposure profiles of Transmilenio buses variability in nano-particles concentration along the entire path was evidenced; many cases it is observed whenever the bus makes stops, either at traffic lights or at system stations, concentration is

considerably increased, and even can see that concentration also can be affected by external events from the bus such as the passage of other vehicles or stagnation from it in traffic.

Furthermore, the data according emissions standard and engine position from buses addressed were evaluated, there was found that the average concentration and the dispersion of data decrease as the technology in engine emission increases, with results in buses Euro V 30% lower than buses Euro II and an interquartile range 50% lower. Likewise higher concentrations when the engine is placed at the front of the bus, about 20% compared when the engine is placed at the rear of the chassis maintaining a dispersion of similar data were evidenced.

Evaluating data by applying hypothesis tests with a confidence level of 95% for testing sums Wilcoxon range and Kruskal – Wallis test hypotheses alternative are accepted with a value of $p < 0.001$ for all analyzes, setting that statistically medians are different for both directions of the road corridor Caracas Avenue; Also, comparing concentrations according to the standard of emission and engine position of the vehicles tested.

In conclusion, the nanoparticles concentrations within the Transmilenio buses in the road corridor of Caracas Avenue, are 4 times higher compared to international studies which having values of 48.200 ± 30.000 pt/cm^3 in diesel technology buses and 23.700 ± 8.000 particles for diesel technology buses con DPF installed (Knibbs, Cole-Hunter, & Morawska, 2011). For this reason, the authors of the present acknowledge the importance of continuing the process of intervention by the District Secretariat of Environment in the management of nanoparticles from the implementation of strategies such as the Program for Diesel Particulate Filters among others; and that could present great benefits in terms of lowering of air pollution levels by particulate matter in the road corridors where the vehicles with these technologies are driven.

REFERENCE

Knibbs, L. D., Cole-Hunter, T., & Morawska, L. (2011). A review of commuter exposure to ultrafine particles and its health effects. *Atmospheric Environment*, *45*(16), 2611–2622.