



Research Article

The impact on air quality of PM₁₀ emissions from the bus fleet of Buenos Aires City

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Abstract

Automobile transport in megacities poses serious problems in the area of sustainability and environmental security. In the City of Buenos Aires (CABA) it represents 37% of GHG emissions and is an important source of pollutants dangerous to human health. As such, it is an energy consumption sector targeted for the implementation of methods that allow for sustainable urban transport. At the same time, very few previous studies about transport vehicle emissions have utilized the PM₁₀ as an indicator of environmental contamination, considering that the negative impact of this environmental contaminant on human health is widely studied. An emission model linked to an atmospheric dispersion model, statistically validated, were used to study different scenarios of emissions generated by diesel buses. It was observed that in a scenario of zero bus emissions (E0), PM₁₀ immission (air concentrations) concentration in CABA is reduced by half. When studying the energy transition from diesel buses to electric energy, while the rest of the vehicle fleet was maintained at the expense of fossil fuels, the local immission concentration of PM₁₀ in CABA was of the same magnitude of that which was obtained when simulating the (E0) scenario of only private vehicle fleet. This study is relevant in the evaluation of public policy on vehicle emission mitigation that seeks to reduce health risks from poor air quality and to develop a more progressively sustainable city.

Article Highlights

- Transition energy exclusively for buses could reduce PM₁₀ immission values of CABA by 50%.
- Thermal energy needed to the energy transition does not significant impact the PM₁₀ immission values on the local air quality.
- Electric buses could reduce the maximum PM₁₀ immission value by half.

Keywords Mobile sources · PM₁₀ · Pollution plume · Public health · Sustainable public transport · City of Buenos Aires (CABA)

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1 Introduction

Air contamination is a problem in large urban cities, often as a result of policies that are not sustainable in sectors such as transport, energy, waste management, and industry. The majority of contamination sources of outdoor air pollution are beyond people's control and require methods on the part of the government, as well as national and international regulatory bodies that propose responsible consumption and build sustainable communities.

Cities of the world only account for 3% of the earth's surface but represent between 60 and 80% of total energy consumption and 75% of carbon emissions [1]. The generation of energy through the combustion of fossil resources introduces different greenhouse gases (GHGs) and contaminants into the atmosphere that reduce the local air quality and impact human health. In various cities of the world it has been shown that on days when levels of atmosphere contaminant are at their highest, hospitalizations due to cardio-respiratory problems are at their highest too [2–7].

Transport sector emissions are the principal source of air quality degradation in large urban cities. In this sense, it is crucial to know the quantity and distribution of emissions from the transport sector in order to establish public policies that reduce emissions and minimize human exposure to poor air quality, as well as reaching the goals of reducing greenhouse gas carbon emissions and mitigating climate change to build progressively sustainable communities.

In Buenos Aires, the third largest megacity in Latin America, transport is mainly responsible for the reduction in local air quality [8]. Also, it has been reported that the recommended concentration levels for airborne PM10 have been exceeded [9]. On a global scale, the World Health Organization attributes 7 million deaths annually to exposure to fine particles in polluted air [10] and particulate pollution has health effects even at very low concentrations [11]. Therefore, the WHO guidelines recommend the lowest possible concentrations of particles [12].

In the CABA (Buenos Aires City) various estimates and models of anthropogenic emissions have been undertaken, in particular pollutants from vehicle flow, mainly GHG and NO_x (NO and NO₂) emissions [13–19]. In this work, in order to assess the impact of the energy transition of the bus fleet of CABA on local air quality, PM10 emissions from vehicle activity of CABA were estimated and their atmospheric dispersion was studied. PM10 was used as an indicator because diesel is the main fuel that generates particular matter in its combustion and

because of its harmful effects on human health. Focus was placed on diesel buses as the implementation of measures to mitigate emissions from motor transport is more successful in heavy vehicles. The PM10 emissions generated by vehicle activity in CABA were estimated with an air quality model that characterized by vehicle category and fuel; this model is simple and easily transferable to other cities. These types of models are useful for making public policy decisions. In the following section we present the data collection and the air quality model used. Then, we show the results of the work, considering the atmospheric dispersion of PM10 emission from the vehicular flow and the impact on air quality of the energy transition of Diesel buses. Finally, we show the discussion of results and the conclusion of the work.

2 Materials and methods

2.1 Data collection

2.1.1 Study area

The City of Buenos Aires has an area of 203km² and is subdivided into 15 urbanized communes with a population of 3 million. To the east and north-east it borders the Rio de Plata estuary, while to the north, west, and south it is surrounded by 32 municipalities of the Province of Buenos Aires, which are completely or partially urbanized, and share the same atmospheric basin. The city sits on a flat area made up of two geomorphological units: the Pampa and Estuarine plains, with heights ranging from 0 to 27 m above sea level. It has strong winds from different directions throughout the year, most frequently from the north-east. In winter, frontal systems can arrive from the south, while between autumn and spring intense winds from the S-SE sector (south-easterlies) can cause flooding in the coastal zone. The climate is humid temperate with hot summers and cool and irregular winters with heavier rainfall in summer, greatly influenced by the Rio de la Plata and the effects of urbanization. The thermal variation is well differentiated between seasons. Rainfall is usually moderate, considering the period between 1981 and 2010 the annual average temperature was 17.9 degrees Celsius and the annual rainfall was 1236.3 mm. The warmest month is January, with an average temperature of 24.9 °C, while July is the coldest month, with an average temperature of 11.0 degrees Celsius [20].

Buenos Aires city has a vehicle fleet of approximately 1.5 million, representing about 10% of the total vehicle fleet of the country [21]. 1% of the vehicle fleet of CABA is made up of Diesel buses [22].

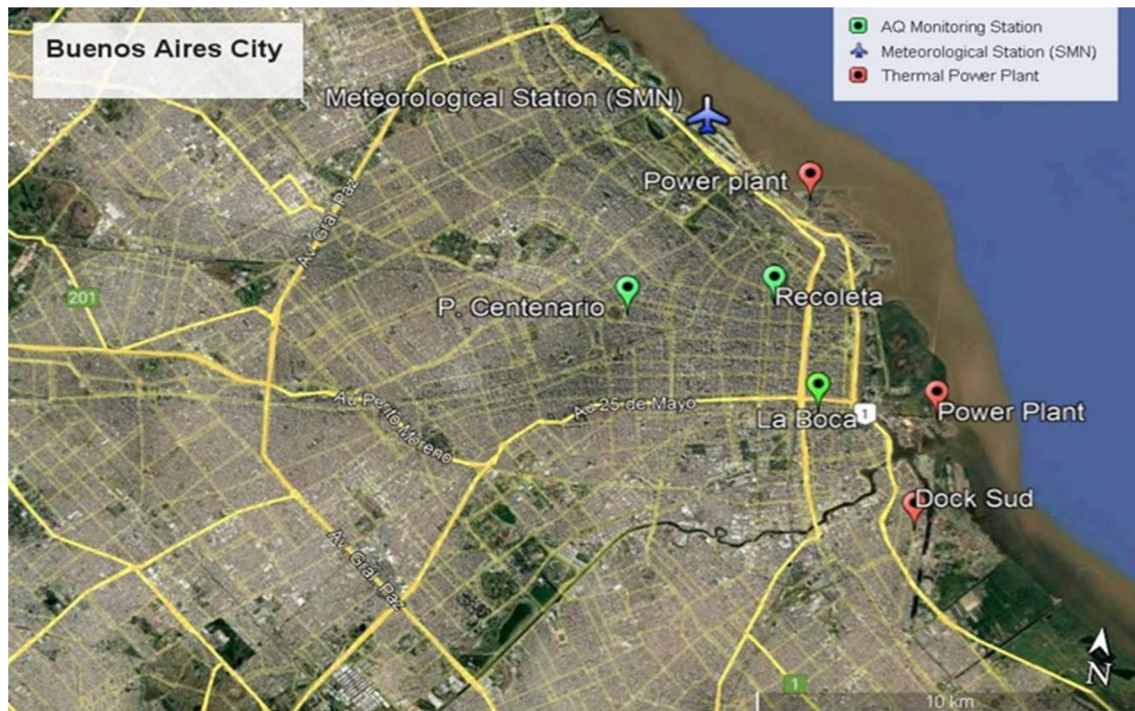


Fig. 1 Map of Buenos Aires City. The location of the three air quality monitoring stations (Parque Centenario, La Boca, Recoleta) are shown; the Aeroparque Jorge Newbury weather station (National

Meteorological Service) and the Costanera and Dock Sud thermo-electrical plants are also shown (source: Google Earth)

2.1.2 Vehicle flow

To quantify emissions from vehicle activity, vehicle flow was broken down into vehicle category and type of fuel consumed, using georeferenced vehicle flow data provided by the Environmental Protection Agency of CABA (APrA). It corresponds to an automatic monitoring in sections of the hierarchical road network where vehicle volumes were measured and were complemented with manual vehicle classification censuses into: light vehicles (< 3.5 tons) and heavy vehicles (> 3.5 tons). The vehicle flow map is shown in Fig. 3A (APrA, 2018).

2.1.3 Sampling of vehicle flow by category

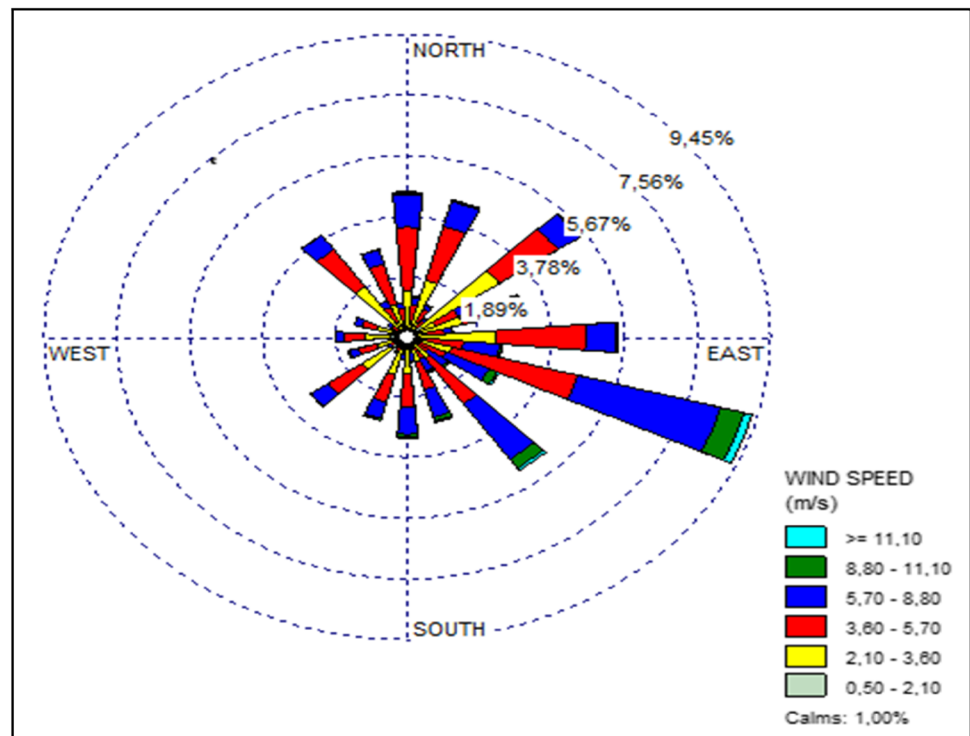
A monitoring was carried out to estimate the proportion of each vehicle category in CABA vehicle flow. It was split into five categories: Motorcycles, Cars, Pick-ups, Buses, and Trucks. Sampling was carried out near to each of the three APrA air quality monitoring stations during the months of June to July 2018.

The hourly variation of vehicular flow was determined using ambient NO_x concentration data recorded at the three APrA air quality monitoring stations. This was used as it is estimated that 80% of NO_x emissions are related to mobile sources [23]. Thus, the hourly vehicular flow

was obtained by vehicle category (supplementary material, Fig. 1A and 1B). Then, the number of weekly vehicles of each vehicle category was calculated from the count made at each sampling point and the daily variation of vehicular flow from the concentration of environmental NO_x as a proxy variable, discriminating between business days and non-business days. Thus, the number of daily vehicles at each sampling point was obtained, broken down by vehicle category. The environmental NO_x data used corresponds to the months of June-July 2018, those being the same months that the vehicle sampling was carried out.

From the results of this sampling, the proportion of each vehicle category at each sampling point was calculated, and since this proportion was similar in each one, the average was used to establish the percentages of each vehicle category. The proportion of light vehicles was: 0.71 cars; 0.18 pickups; 0.11 motorcycles and the proportion of heavy vehicles: 0.19 trucks and 0.81 buses. In this way, the proportion of motorcycles, cars, and pickups was assigned to light traffic data (< 3.5 tons), and the proportion of trucks and buses to heavy traffic data, measured and georeferenced by the Environmental Protection Agency. Thus, the daily average traffic was obtained in each artery of CABA by vehicle category.

Fig. 2 Wind Rose, meteorological data average from the period between 31-12-2013 and 01-01-2019 recorded by National Meteorological Service at the Aeroparque Jorge Newbery meteorological station. [elaboration with software WRPLOT View]



2.1.4 Air quality data: PM₁₀ and NO_x concentration

Hourly environmental concentration data for PM₁₀ and NO_x (constituted by nitrogen oxide and nitrogen dioxide, NO and NO₂ respectively), provided by the Buenos Aires City Environmental Protection Agency (APrA), was used. The environmental concentration data of PM₁₀ was compared with the immission values obtained from the air quality model used in order to validate it statistically. The NO_x data was used as a proxy variable to determine the hourly and daily variation of vehicle traffic. The PM₁₀ data corresponds to the months between July 2017 and July 2018 from three monitoring stations, while the environmental NO_x data used corresponds to between June and July 2018, also from the same monitoring stations. The monitoring stations are located in the neighborhoods of: La Boca, a residential-industrial area with medium/low vehicle flow with fixed sources incidence (located in the incidence area of the Matanza-Riachuelo basin); Recoleta, a residential-commercial area with high vehicle flow and very low incidence of fixed sources (characteristic of the main avenues of the city); and Parque Centenario, a residential-commercial area with medium vehicle flow and a very low incidence of fixed sources (next to an arboreal space located in the geographical center of the city). Figure 1 shows the location of the three CABA air quality monitoring stations.

2.1.5 Meteorology of the study area

For emission modeling, meteorological data from the National Meteorological Service of the Aeroparque Jorge Newbery Meteorological Station (Lat: - 34.559414; Long: - 58.415749), recorded between December 31, 2013 and January 1, 2019 was used. In the average time used for the modeling, winds from the southeast and northwest prevailed, with a very low percentage of calm of 1%, Fig. 2. Figure 1 shows the location of this meteorological station.

3 Air quality model

3.1 Emission model

Emissions are related to vehicle activity through the following formula (EMEP, 2016):

$$E(c) = \sum N(ijs) \times EF(ijc) \times L(s).$$

where E=Emission, is the mass of the pollutant c emitted in the study area per unit of time (kg/d); N=Number of sampled vehicles of category j and fuel i assigned to segment s (n° of vehicles/d); EF=Emission Factor of pollutant c that depends on the category of vehicle j and the fuel i used (kg/km); L=Length of the street segment s (km). The length of the traveled segment was obtained from the automatic vehicle monitoring carried out by the APrA. In

Table 1 Emissions factors (g/km)

Type of vehicle	Fuel/size	Prop (%)	NOX	PM10
Motorcycles	Gasoline 4t Euro III	5	0.06	0.0140
Personal cars	Gasoline Light > 1.4 Euro II	14	2.53	0.0022
Personal cars	Gasoline Light > 1.4 Euro III	15	0.26	0.0011
Personal cars	Gasoline > 2.0 Euro III	16	3.90	0.0022
Personal cars	GNC Euro II	11	0.06	0.0011
Personal cars	Diesel Light > 1,4 Euro II	5	0.55	0.1170
Personal cars	Diesel Light > 1,4 Euro III	12	0.72	0.0780
Personal cars	Diesel > 2.0 Euro III	7	0.87	0.0780
Light Duty	Gasoline < 3.5t Euro II	5	0.56	0.0022
Light Duty	Diesel < 3.5t Euro II	2	1.22	0.1170
HD	Diesel < 32 t Euro III	5	7.52	0.0880
HD	Diesel > 32 t Euro III	2	9.04	0.1510
BUS	Bus diesel Euro III	1	10.00	0.2308

Prop proportion to active fleet

this way, the linear emissions of vehicle flow in each artery of CABA was obtained.

The active vehicular fleet has been considered from national database included in INDEC (2021), DNRP (2021), CNRT (2021). This database includes new registered cars by Provinces, divided in this main categories: motorcycles, personal cars, trucks, and buses. Table S1 (suppl. Mat.) shows the monthly new registered vehicles and active fleet by Province and vehicular type.

EMEP/EEA Emission Factors, 2016/2019 were used [24]. EURO III was considered according to the predominant vehicle models in Argentina. The used emission factors (g/km) are shown in Table 1 for vehicular type and fuel. The table also show the proportion of each vehicle

type according to sample in the study area and studies in [25–27]. According to the national transportation regulation office (CNRT, 2021) there are an average 10,000 urban buses in Argentina with ages raging of 4.38–5.21 years depending on Province and year. Table S3 (Suppl. Mat.) and Table S4 (Suppl. Mat) shows the age structure for personal cars and buses (respectively).

Area type emission sources were plotted on the CABA map. To do this, a grid of cells with a 500 m by 500 m spatial resolution was intersected with the linear emission map obtained from the emission model. In this way, the emissions of all the arteries that make up the same cell were added up and the PM10 emissions map of the vehicle flow was established (Fig. 3B). It is shown that the most critical areas are associated with the main avenues, highways, and traffic congestion centers.

3.2 Atmospheric dispersion model

The “AERMOD” Lakes Software (*American Meteorology Society/EPA Regulatory Model*) [28] was used.

Set parameters: 500 m x 500 m area type emission sources. Flat topography was assumed as CABA is basically flat with heights that do not exceed 27 m above sea level. An emission height of 2.5 m was set as motor vehicles emit from exhausts at a height of between 0.5 m and 1 m depending on vehicle category and there is a mixed layer of a height up to 2.5 m [29]. The “building downwash” was disregarded as the model does not aim to evaluate direct exposure. The model proposed here seeks to visualize the average chronic situation that CABA experiences in terms of its air quality and the focus is on estimating the daily “base” concentrations of airborne particulate matter from bus vehicle flow.

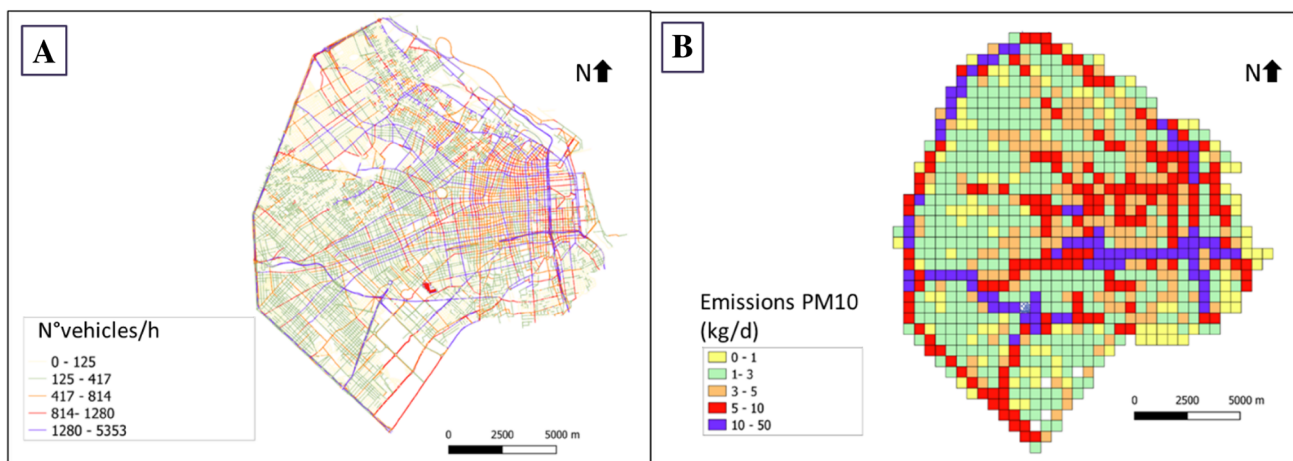


Fig. 3 **A** CABA automotive flow map; **B** Map of daily average PM10 emissions from CABA automotive flow (carried out using GIS software)

Table 2 Statistical indicators of the model's performance (³⁰Chang and Hanna, 2004): FAC2: fraction of estimations within a factor of two observations; FB: fractional bias; MG: geometric mean; NMSE: normalized mean square error; VG: geometric variance. Simulation period one year

	Recoleta	Parque Centenario	La Boca
	Daily average		
FAC2	0.95	0.94	0.93
FB	0.00	-0.02	0.00
MG	0.99	0.98	0.95
NMSE	0.20	0.23	0.25
VG	1.18	1.20	1.22

3.3 Model validation

The PM₁₀ obtained from the model was compared statistically with data from three APrA monitoring stations. Due to the presence of airborne particulate matter from emission sources other than mobile sources, such as the presence of fixed sources, the resuspension of particulate material, and emissions from neighboring cells, a background value was considered for each air quality monitoring station. It was calculated as the mean difference between the data recorded at the monitoring stations and the values obtained by the model and was added to the values produced by the model. The performance of the model was evaluated with the statistical parameters described by Chang and Hanna, 2004 [30] to evaluate air quality models. As is shown in Table 2, the statistical parameters allow for validation of the model, which shows a good performance. In a perfect model FAC2, MG and VG must equal 1; and FB and NMSE must equal 0. An acceptable model must satisfy the following: $FAC2 > 0.5$; $-0.3 < BF < 0.3$ and $NMSE < 1.5$.

A better approximation to the data was obtained in the Recoleta and Parque Centenario zones. In the La Boca zone, a greater discrepancy is observed between what was simulated and what was measured. This may be due to the fact that this monitoring zone has a medium-low vehicle flow and a high incidence of fixed sources. Originally, it was thought that the greatest impact would originate from the point sources from the chimneys of the Costanera and Dock Sud thermoelectric plants. For this reason, the PM₁₀ emissions from these chimneys were modeled and added to the immission from the CABA vehicle flow. However, the result of this modeling showed that these fixed sources did not significantly influence the local PM₁₀ immission of the evaluated area. This is most likely due to the height of these chimneys, together with the meteorology of the study area and they do not exert their greatest impact on the local air quality of CABA. Other possible sources

of PM₁₀ emissions were investigated that could impact the air quality in the area where the La Boca air quality monitoring station is located and it was observed that in Dock Sud, in addition to the thermal-electrical power plant, there are several oil refineries that emit particulate material into the atmosphere and on the banks of the river there are different types of industry, for example concrete mixing plants. In turn, this neighborhood has uncovered land that contributes to the increased particulate matter in the atmosphere. In addition, this area of CABA there is a port with high cargo ship traffic. Taking into account that in the time period studied the wind direction was predominantly from the southeast it is highly likely that this monitoring station was strongly impacted by these other types of emissions different from mobile sources [31].

4 Results

Once the model was validated the dispersion of PM₁₀ emissions from the vehicle flow of CABA, the different scenarios of emissions from the diesel bus fleet, and the transition to electric power of this vehicle category were studied.

5 Contaminant dispersion

Figure 4A plots the spatial dispersion of the pollutant generated by the total vehicle fleet at the expense of fossil fuel. The results show that the average daily concentration exceeds local regulations at some points near the highways in the southern part of the city. For the annual average PM₁₀ concentration, values below local regulations were obtained (Law No.1356/CABA, which establishes a permitted maximum 24-h average of 150 $\mu\text{g}/\text{m}^3$ and a permitted annual average of 50 $\mu\text{g}/\text{m}^3$). Nevertheless, we do not have air quality data in the location where the contamination focus are located. Figure 4B shows the spatial dispersion of the exclusive emissions of diesel buses. The high concentration of PM₁₀ in air pollution by this vehicle category is shown and reaches PM₁₀ immission levels of 100 $\mu\text{g}/\text{m}^3$ in the daily average on contamination focus.

With the objective of visualizing the magnitude of the impact of diesel buses on air pollution in CABA, a scenario where exclusive emissions from the private vehicle fleet (E0) was modeled, taking zero local emissions from buses into consideration. This is shown in Fig. 5A, where it can be seen that the distribution of PM₁₀ immission concentration values, without the contribution of diesel buses, moves considerably towards lower concentration values. In fact, the average obtained without the contribution of emissions from diesel buses is 30 $\mu\text{g}/\text{m}^3$ with a maximum

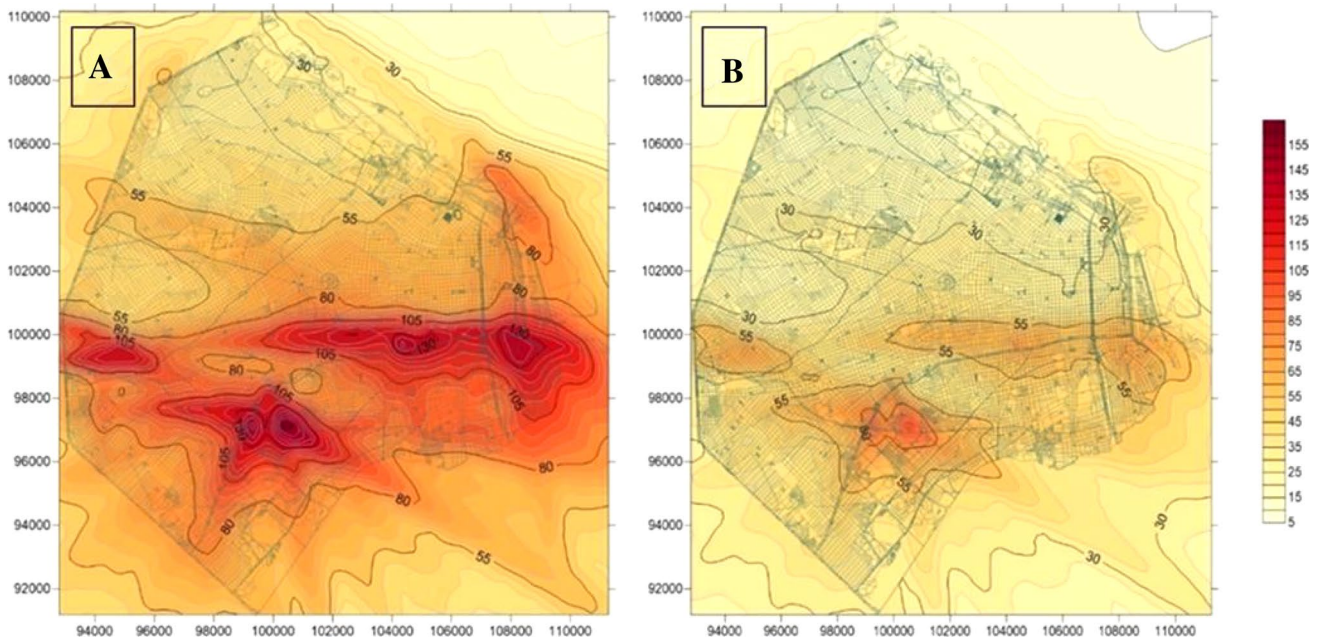


Fig. 4 Pollution plume, PM10 daily average immission ($\mu\text{g}/\text{m}^3$); **A** from total vehicle fleet emissions; **B** from bus fleet emissions [carried out using Surfer software, coordinates UTN (m)]

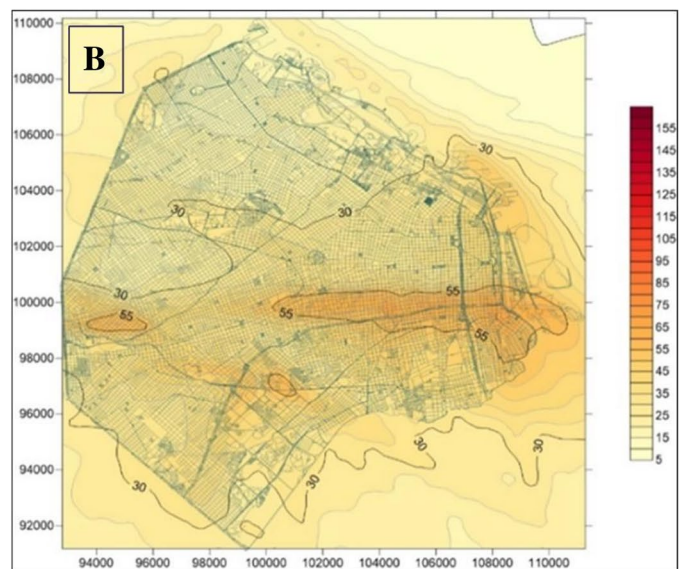
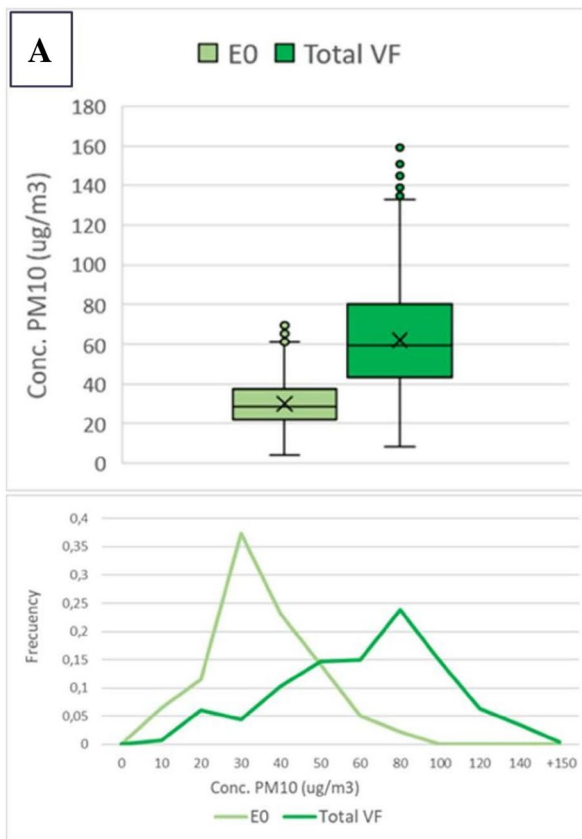
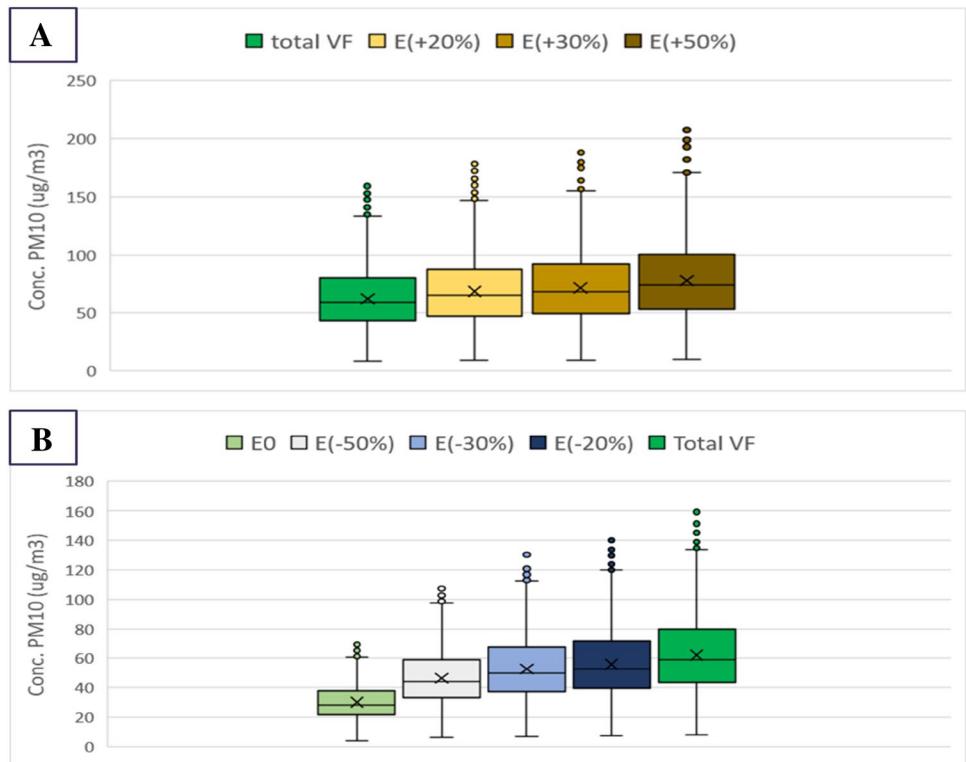


Fig. 5 A Distribution of the daily average PM10 immission concentration in CABA. *VF* = vehicle fleet, *E0* = emissions from the private vehicle fleet, with a scenario of zero local emissions from the bus

fleet [Carried out using Excel]; **B** Pollution plume, daily average PM10 immission ($\mu\text{g}/\text{m}^3$) from private vehicle fleet (*E0*) [carried out using Surfer software, coordinates UTN (m)]

Fig. 6 A y B Distribution of the daily average intake of PM10 ($\mu\text{g}/\text{m}^3$). Total VF = total vehicle fleet, PA = private vehicle fleet (E0), E + 20%, E + 30% and E + 50% = scenario of a 20%, 30%, and 50% increase in diesel bus emissions respectively. E - 20%, E - 30% and E - 50% = a scenario of a reduction of 20%, 30%, and 50% in diesel bus emissions respectively. [Carried out using Excel]



of $69 \mu\text{g}/\text{m}^3$. When the contribution of diesel buses is taken into consideration the average is $62 \mu\text{g}/\text{m}^3$ and the maximum is $159 \mu\text{g}/\text{m}^3$. The difference in the value of P (95) is also important, being $54 \mu\text{g}/\text{m}^3$ and $118 \mu\text{g}/\text{m}^3$, respectively.

Figure 5B represents the spatial dispersion of the pollutant in the scenario E0. Here it is evident that although the contamination focus remains in the same location, because it is the traffic congestion zone, they are of a considerably smaller amplitude than those of the entire vehicle fleet (Fig. 4A), with immission values reduced by half.

Likewise, Fig. 4B, which relates to PM10 emissions exclusively from the diesel bus fleet, its shown that contamination focus are more extensive and pronounced, in that they cover a larger area and have maximum concentration values of approximately one third higher than what is

obtained with the exclusive emission of particular mobile sources (E0), (Fig. 5B). This shows that diesel buses have a considerable impact on air pollution in CABA.

Different emission scenarios from the current CABA diesel bus fleet were evaluated. Figure 6A shows that, in the three scenarios in which diesel bus emissions were increased, the average and median do not differ considerable in respect to the current fleet. However, the maximum values reached do present differences that are more important.

Figure 6B and Table 3 show the analysis of the emission reduction scenarios in the diesel bus fleet. When comparing the current scenario with the scenario where bus emissions were reduced by 20% (E-20), a decrease of 11% was obtained in the median distribution of PM10 immission concentration; if diesel bus emissions are reduced by

50% (E-50%), the decrease is 25% (Table 3). A significant decrease is even obtained in the maximum values reached in each proposed scenario by exclusively reducing diesel bus emissions (Fig. 6B).

5.1 Transition to electric buses

To evaluate the impact of the introduction of electric buses on the air quality of CABA, the alternative where the bus fleet was changed to electric power was studied. In this proposed scenario, the power needed to mobilize this vehicle category was added to the existing thermoelectric plants of the city, so these emissions were modeled and the PM10 immissions generated by these thermoelectric plants (recharged) were added to the PM10 immissions generated by private transport at the expense of fossil fuel. To model this scenario 500 MW of power was added proportionally to the thermal power plants of CABA: 350 MW estimated for the mobilization of the entire current bus fleet, and 150 MW for the energy needed to transport electricity from the thermal power plants, and loss of efficiency in this process. The necessary power calculated here has been overestimated in order to evaluate a "worst case" scenario.

In this proposed scenario, when evaluating the spatial distribution of the pollutant a pollution plume was obtained that was very similar to that obtained by simulating the exclusive emissions of private transport (E0), that is, zero bus emissions (Fig. 4B). The results show that an exclusive bus fleet energy transition would result in a positive impact of great magnitude on the air quality of Buenos Aires city.

6 Discussion

Very few previous studies on transport vehicle emissions have used PM10 as an indicator of environmental pollution. Considering that the negative impact of this environmental pollutant on human health has been widely studied, it's important that we focus our attention on it. In this research, when modeling scenarios in which diesel bus emissions were increased, the maximum PM10 immission values also increased considerably (Fig. 6A). This is relevant when evaluating the frequency of regulation levels being exceeded. Another interesting observation is that the percentage of change in the median shows that the pollutant growth rate is half the growth rate of the emissions of this vehicle category (Table 3). This is something to be taken into account when increasing the number of diesel buses. The analysis of the emission reduction scenarios in the diesel bus fleet demonstrates that emission mitigation measures in this vehicle category could considerably improve

the air quality of CABA, since an important decrease is obtained in the median and maximum values reached in each proposed scenario (Fig. 6B). Furthermore, taking the Percentile (95) into consideration, the magnitude of the positive impact that the reduction of emissions from this vehicle category would produce on the city's air quality is evident (Table 3).

In various cities around the world, in order to mitigate emissions from the transport sector, alternatives have been implemented that include traffic management measures to prevent congestion. These include promoting the use of bicycles and public transport, the redesigning of land use in order to decentralize labor, educational and commercial activities, improvements in technological efficiency, and the use of cleaner energy, etc. A combination of these alternatives appears to be the best option for mitigating atmospheric emissions from mobile sources. The massive change from fossil fuels to renewable energies seems unlikely in the short to medium term.

Argentina, as in most underdeveloped countries, is faced with various problems when approaching the challenges that such a change requires. A policy is required that places this issue on the public agenda and considers it an environmental priority, as well as a long-term plan with continuity in its management and financing for its undertaking. It also requires public acceptance and changes in the habits of citizens. Without this, it is difficult to implement adequate mitigation measures. Although, many cities around the world are introducing electric buses as an effective emission mitigation measure [32–35].

Here we study the transition to electrical energy of the CABA bus fleet from the perspective of the impact on local air quality. The results suggest that an exclusive electric transition of the bus fleet would have a highly positive impact on the local air quality of the City of Buenos Aires, since PM10 emissions from buses represent 50% of the immissions generated by the total vehicle flow. Furthermore, in CABA only 1% of the total motor vehicle flow corresponds to diesel buses. Therefore, this vehicle category is a target for the implementation of methods that would allow for a sustainable public transport system. However, other authors suggest that when evaluating the life cycle assessment, PM10 emissions are higher in electric buses than in diesel ones due to the use of coal in the generation of energy in thermoelectric plants [36]. We show here that, PM10 emissions from thermal power plants from the generation of energy needed to mobilize the bus vehicle fleet do not significantly impact the local air quality of Buenos Aires city. In addition, these kind of emissions can be reduced by the use of alternative fuel or renewable energy sources.

In this context, the Government of the City of Buenos Aires launched a pilot test where 8 electric units were

incorporated into 4 public transport lines. The results of this first test will allow for the evaluation of other important aspects concerning the feasibility of implementing measures of this type. In turn, this type of alternative mitigation will have a positive impact on the reduction of noise pollution in the city, which can be assessed by the noise map developed by the APrA in 2018. Noise pollution reduction will also have a positive impact on public health, which in turn will promote public acceptance of environmental mitigation measures, which also favors progress towards sustainable communities.

7 Conclusion

The hypothesis that PM10 emissions from CABA public transport represent an important contributor to local air pollution, resulted in PM10 emissions from automobile flow at the expense of fossil fuels being quantified and their atmospheric dispersion over the study area evaluated. We observed that with the exclusive reduction of emissions from diesel buses, the air quality in CABA could be considerably improved. By reducing diesel bus emissions by 50%, the concentration of PM10 immissions from vehicle activity is reduced by 25%. When studying the impact on air quality of the transition to electric energy of the bus fleet, a 50% reduction in the concentration of PM10 immissions in the study area was obtained.

The model used here has the advantage of being easy to apply and has a good resolution for the scope desired in this investigation, where the focus was on evaluating the baseline concentrations of PM10 in the city of Buenos Aires and evaluating the relevance of bus emissions as a contributor to these baseline concentrations. However, this model can be improved in its resolution if the background values (from sources other than mobile ones) are added with greater precision and if further variables are taken into account in the emission model, such as vehicle speed, braking frequency, etc. However, the latter would increase the complexity of the model.

This work recommends to carry out the optimization study of the energy transition of the Buenos Aires city bus fleet. This will have a positive impact on the health and quality of life of citizens which, with government promotion, could stimulate environmental awareness in the population as a whole, allowing for the change towards a sustainable city. Likewise, a mitigation measure of this type allows for it to be linked to other mitigation strategies, such as the generation of electrical energy by renewable energy sources, the replanning of land use, or a change of habits in the general public, which is perhaps is more complex to achieve.

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