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IMPACTOS DA GREVE DOS CAMINHONEIROS DE 2018 EM POLUENTES PRIMÁRIOS E SECUNDÁRIOS EM SÃO PAULO

Júlio Barboza Chiquetto[1]; José Roberto Rozante[2]; Vinícius Rozante[3]; Jayant Pendharkar[2]; Débora Souza Alvim[4]
Autor para correspondência: julio22@usp.br

[1]Department of Geography, University of São Paulo, SP; [2]Centre for Weather Forecast and Climatic Studies, - CPTEC/INPE, Cachoeira Paulista, SP; [3]School of Chemical engineering (FEQ), State University of Campinas (UNICAMP),Campinas, SP; [4]Universidade Federal do ABC - CCNH/UFABC, Santo André, SP

RESUMO

A qualidade do ar afeta diretamente a saúde da população, em especial nos grandes centros urbanos. Durante o período de 21 a 31 de maio de 2018, ocorreu uma greve de caminhoneiros no Brasil, que paralisou não apenas a circulação de veículos pesados, mas também grande diminuição na circulação de veículos leves. O objetivo deste trabalho foi de avaliar o comportamento dos poluentes CO, NO e O_3 durante esse período nas estações da CETESB do Terminal Parque d. Pedro II, Pinheiros e Ibirapuera, para compreender o impacto desta mobilização social na qualidade do ar em diferentes microambientes urbanos. Os resultados foram avaliados na forma de ciclos diurnos, comparando uma média dos cinco anos anteriores (2013-2017, sem greve) com 2018 (com a greve) durante o mesmo período. Durante o período da greve, ocorreu redução intensa nos poluentes primários avaliados (CO e NO), diretamente associados à emissão veicular (ex: 50% de redução no CO). Houve aumento de ozônio, possivelmente devido à mudança no regime NOx/COV e à condições atmosféricas favoráveis. A redução dos poluentes primários foi mais acentuada nas estações Parque D. Pedro e Pinheiros do que na estação Ibirapuera, enquanto que o aumento de ozônio foi proporcionalmente igual, com o dobro dos valores observados no período durante a greve em comparação ao mesmo período sem greve dos anos anteriores. Os resultados deste estudo são importantes para apontar a contribuição das fontes de poluentes e estudar o impacto da poluição veicular no ar urbano.

PALAVRAS-CHAVE: São Paulo; poluição veicular; microambientes urbanos

IMPACT OF THE TRUCK DRIVER'S STRIKE OF 2018 ON PRIMARY AND SECONDARY POLLUTANTS IN SÃO PAULO

ABSTRACT

Air quality directly affects population health, particularly in large urban conglomerations. During the period from 21 to 31 of May, 2018, there was a truck driver strike in Brazil which paralyzed heavy-duty vehicles operation and greatly impacted light-duty vehicle circulation as well. The objective of this work was to evaluate the behaviour of the pollutants CO, NO and O_3 during this period in the State Environmental Agency (CETESB) stations Terminal Parque d. Pedro II, Pinheiros and Ibirapuera, in order to understand how this social mobilization impacted air quality in different urban microenvironments. Results were analysed in the form of diurnal cycles, comparing the average of the five previous years (2013-2017, no strike) to 2018 (with strike) during the same period. During the strike, there was an intense decrease in the primary pollutants (CO and NO), directly associated to

vehicular emission. There was a strong increase in ozone, possibly due to changes in the NOx/VOC ratio and to favourable atmospheric conditions. The decrease in primary pollutants was sharper in Parque D. Pedro and Pinheiros stations than Ibirapuera; however, ozone increased proportionally in all stations, essentially doubling during the strike period in comparison with the same period in previous years without strike. Results of this study are important for determining the pollutant source contributions and study the impacts of vehicular pollution in the urban air.

KEY-WORDS: São Paulo; vehicular pollution; urban microenvironments

INTRODUÇÃO / INTRODUCTION

In large urban centres dominated by services and commerce, the transportation sector often corresponds to a large percentage of air pollution sources. In the Metropolitan Area of São Paulo (MASP), light and heavy-duty vehicles emitted 97% of carbon monoxide (CO), 70% of the nitrogen oxides (NOx), 80% of hydrocarbons (HCs) and 40% of the particulate matter (PM) in the region, according to a report by CETESB, the Environmental Agency of the State of São Paulo (CETESB, 2018).

Pollutant concentration levels are dependent upon many factors, such as pollutant emission rates and atmospheric conditions (BRASSEUR; ORLANDO; TYNDALL, 1999). It is then logical to assume that, in large urban areas such as the MASP, changes on vehicle circulation will impact pollutant emission and concentrations as well. During the 21th-31th of May, 2018, a nation-wide truck driver strike took place in Brazil, demanding a decrease in fuel prices and improvements on working conditions for this sector (https://www.bbc.com/portuguese/brasil-44302137). It almost paralyzed entirely the heavy-duty vehicles circulation throughout all Brazil, and deeply impacted light-duty vehicle circulation as well, because of the impact on fuel supply. Large urban centres are comprised of many different urban microenvironments which represent different exposure characteristics across megacities, according to factors such as land use and distance from emission sources (LEVY et al., 2014). Thus, changes in pollutant emission, such as the truck driver's strike, are likely to have different spatial responses accordingly. The study period covers a nationwide truck strike period which created a natural laboratory for an absence of diesel operated trucks and a great decrease in light-duty vehicles that are important source of emissions over the urban environment.

The objectives of this study were to analyse the concentrations of CO, NO and O_3 at three stations from the CETESB network which represent urban downtown and urban background microenvironments during the period of the truck driver's strike. The analysis was performed through diurnal cycles from this the strike period in 2018, comparing to an average of the same period in the previous five years, when there was no strike. Results showed that the strike caused strong decreases in the primary air pollutants analysed (CO and NO) and an increase in ozone.

OBJETIVOS DO TRABALHO / OBJECTIVES

The objectives of this study were to analyse the concentrations of CO, NO and O3 at three stations from the CETESB network which represent urban downtown and urban background microenvironments during the period of the truck driver's strike in 2018.

MATERIAIS E MÉTODOS / MATERIALS AND METHODS

Hourly pollutant data from the CETESB online database were obtained (http://qualar.cetesb.sp.gov.br/qualar/home.do) from the year 2018 and the previous five years (2013-2017) for comparison. Three monitoring sites in the city of São Paulo were selected: Parque D. Pedro II, at 50 m from the emission sources and directly impacted mostly by heavy-duty vehicles, Pinheiros, at 10 m from the pollution sources and directly impacted by mixed vehicle types, and Ibirapuera, at 300 m from the pollution sources and not directly impacted by them.

Daily cycles of pollutants were calculated, which allowed for a more smoothed verification of the impacts of pollutant concentrations during the strike. We calculated an average using the same observed hour of the day for each day of the period 05/16/2018 to 06/04/2018, resulting in an averaged value for that hour of the day for the whole period. This was performed for all 24 hours of the day, resulting in one diurnal cycle which represents all averaged hourly values for each 24 hours of the day. Two diurnal cycles were calculated: 1) during the period from 16/05/2018 to 04/06/2018 (year with strike), and 2) from averaged hourly values for the same period from 2013-2017 (to better characterize an average for a period without strike).

RESULTADOS E DISCUSSÃO / RESULTS AND DISCUSSION

Figure 1 shows the diurnal cycle obtained for each pollutant at each monitoring station, for the periods 2018 (with strike – red line) and averaged previous five years, from 2013 to 2017 (no strike – blue line). CO and NO, directly associated to vehicular emissions, sharply decreased in 2018 in all monitoring stations, showing the impact of the truck driver's strike on primary pollutant emission and concentration. Ibirapuera station shows much lower concentrations than the other stations during non-strike conditions and very close to zero in 2018. This makes sense due to the fact that this station is removed from the emission sources, and so, represents an urban background microenviroment (not directly impacted by vehicular emissions). In stations Parque D. Pedro and Pinheiros, CO concentrations in 2018 decreased to similar concentrations levels to Ibirapuera in the years 2013-2017. Overall, CO at 20 hours (night time rush hour) decreased about 50% in all stations comparing 2018 to the non-strike period.

NO concentrations also showed a sharp decrease in all stations, with concentrations near zero during the afternoon in 2018. This is probably due to the fact that NO is a very reactive gas with a short residence time in the atmosphere (SEINFELD & PANDIS, 2006), undergoing less transport – so, drastic changes in emission (as during the truck driver's strike) are more likely to affect this gas than other less reactive compounds such as CO. Again, concentrations are much lower in Ibirapuera station, which decreased from 13 $\mu g.m^{-3}$ (2013-2017) to 2 $\mu g.m^{-3}$ (2018). In the other stations much more intense absolute decreases were observed: in Parque D. Pedro II station, from 25 to 8 $\mu g.m^{-3}$ and in Pinheiros station, from 60 to 15 $\mu g.m^{-3}$. This makes sense due to the fact that these stations are more directly affected by vehicular emissions.

Another study conducted at a public strike in the city of Hyderabad in India showed significant reduction of BC (48%) and PM (28%) during the first strike period analysed (MAHALAKSHMI et al., 2014). Also, a significant reduction, of about 20%, in CO concentration during strike period (18 to 21 January 2010) was observed as compared to the pre-strike period (14-17 January 2010). These results are comparable to the ones obtained in this study and reveals that the MASP is also under intense influence from vehicular emissions, experimenting impacts similar to Hyderabad.

Ozone, on the other hand, increased in all monitoring stations in the MASP. Being a secondary pollutant, with concentrations dependent on the ratio of its precursors and atmospheric variables (mainly sunlight), ozone concentrations usually behave in non-linear ways in large urban centres (SEINFELD & PANDIS, 2006). Since the MASP is NOx-saturated (ALVIM et al., 2018), it is possible to suggest that the decrease in NOx favoured local increase of ozone in the MASP during the truck driver's strike. The VOCs/ NOx ratio is low in the MASP, with a relative abundance of NOx, and so, ozone formation will depend on the concentration of VOCs. In such areas, the decrease in VOCs leads to a decrease in ozone concentration, and the decrease in NOx, as occurred on days of strike, leads to increased ozone (ORLANDO et al. 2010; CHIQUETTO et al., 2016; ALVIM et al., 2018). Higher ozone concentrations were observed in Ibirapuera station due to its distance from emission sources (and possible biogenic VOCs influence), but there was a proportional increase in all stations, essentially doubling concentration averages observed during the strike (from 40 to 80 $\mu g.m^{-3}$ in Ibirapuera, 35 to 70 $\mu g.m^{-3}$ in Parque D Pedro and 25 to 50 $\mu g.m^{-3}$ in Pinheiros). Also, atmospheric conditions might have also played a role in the increase in ozone in 2018 compared to the average of the five previous years, and so, this remains to be investigated.

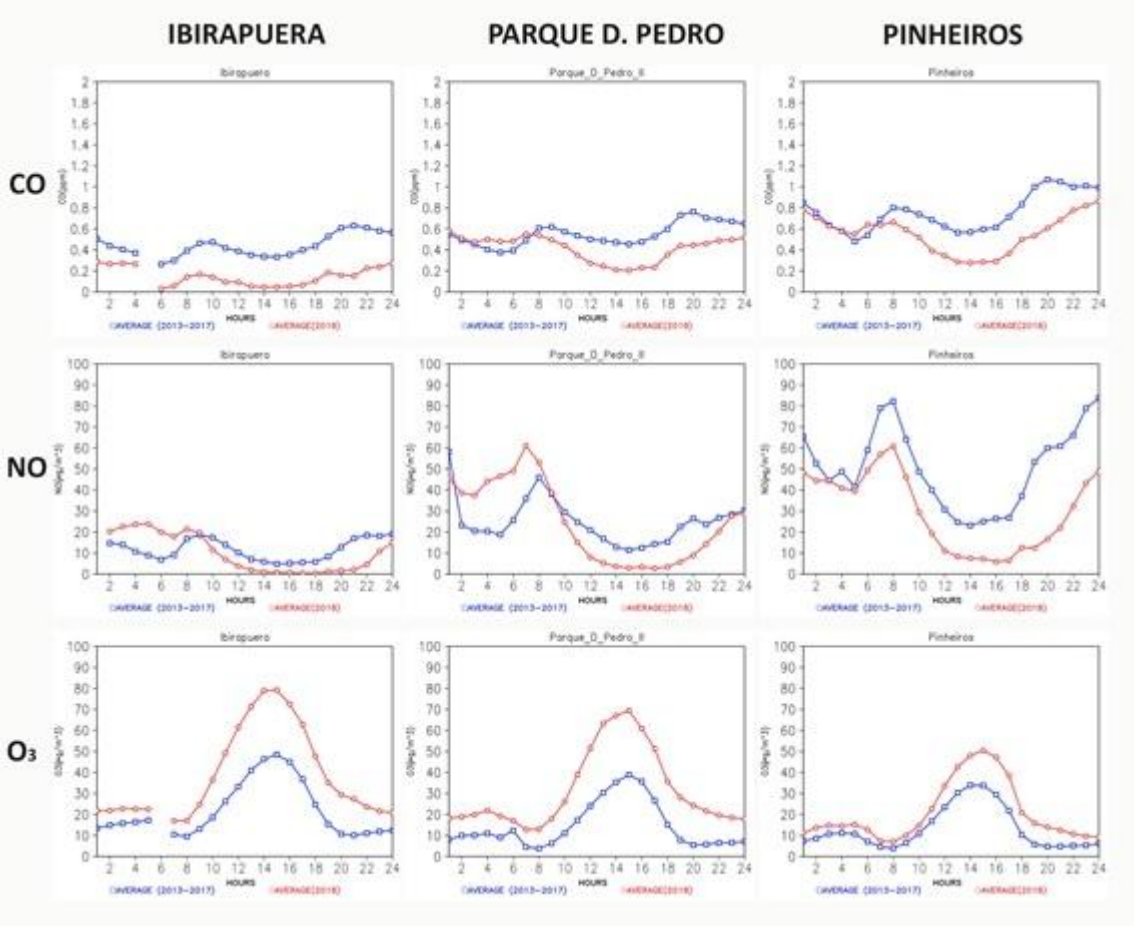

Figure 1: Diurnal cycles of the three pollutants analysed in the three monitoring stations, for the period 16th of May to 04th of June during the strike in 2018 (red line) and in the previous five years, 2013 to 2017(blue line). Rows indicate different pollutants and collumns indicate different stations.

CONCLUSÃO / CONCLUSION

As a result from this analysis, the truck driver's strike impacted air pollution in different ways in the MASP. There was an evident decrease for pollutants directly associated to vehicular emissions (CO and NO). NO concentrations were nearly zero during the afternoon. CO is less reactive and so, its concentrations did not decrease as NO, although experimenting significant decrease during the strike (50% compared to the averaged five years without strike).

There was an overall increase in ozone, of about 100%, in all monitoring stations during the strike period, compared to the non-strike period in the previous five years. Studies for the MASP indicated that this region is NOx-satured, and so, a decrease in such compounds might lead to an increase in ozone, despite the possible decrease in VOCs due to the decreased vehicular activity. Also, meteorological conditions might have played a role due to their importance in the photochemical reactions, which suggests potential ideas for future studies. It is possible to suppose that almost all NO emitted at the time of the strike was oxidized to NO_2, so the removal of O_3 by NO was minimum. This could explain the near-zero NO concentrations and the increase of O_3. Other compounds, such as NO_2 and MP must be studied in more CETESB stations in order to comprehend these phenomena more completely.

Results of the study indicate that São Paulo is under considerable influence of emissions from trucks operating on diesel fuel and that a truck driver's strike affects light-duty vehicles as well, with impacts varying according to the nature of the pollutant and the microenvironment monitored. Effective management of heavy-duty vehicles with fuel-efficient engines holds key for improving air quality in this urban region. In addition to health related effects of urban pollutants, better management of urban environments are required for improved fuel supply conditions.

APOIO / ACKNOWLEDGMENT

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